Backward Hadron Production in Hadron-Nucleus Reactions at 4GeV/c

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Abstract

We have performed a systematic measurement of backward hadron production in hadron-nucleus reactions at 4GeV/c. The experiment was carried out with the 12 GeV proton synchrotron in National Laboratory for High Energy Physics in Japan (KEK). Differential cross sections of emitted particles of π^+, π^- and p from the targets of ^{6}Li, C, Al, Sn, Cu, and Pb for incident particles of π^+, π^- and p were measured over an angular range of $66° < \theta_{lab} < 145°$. The spectrum of proton production does not depend on the type of the incident particles. In the case of pion production such universality is not valid. Mass number (A) dependence of the cross sections for proton production is almost linear in A, while that for pion production is proportional to $A^{2/3}$. A comparison is made with 400GeV proton data. A calculation based on a quark-parton model reproduces the observed data at backward angles but it is not consistent with the data in the angular range of $\theta_{lab} < 90°$.

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Chapter 1

Introduction

In 1971 the backward particle production, where particles are produced with much higher kinetic energies than those expected by reactions with free nucleons at rest, was found in high-energy deuteron-nucleus collisions [1,2]. The cross section was very large. This experiment explored a new field of high energy nuclear physics.

One of the current interest in the intermediate and high energy nuclear physics is to establish a link between nuclear phenomena and the behavior of quarks in nucleus. We should thus investigate the nuclear phenomena which cannot be interpreted on nucleonic level but can only be explained on quark-gluon level. Under the view point of nucleus as a nucleon/quark complex, one of the most stimulating issues in high energy nuclear physics is the possible observation of some exotic states of nuclear matter which reveal the interrelation between two completely different types of constituents in nucleus, i.e., nucleons and quarks. However, the major part of hadron-nucleus reactions at high energy can be understood in a rather simple picture as a superposition of quasi-free hadron-nucleon interactions incorporated with Fermi motion. On the other hand, backward hadron production can provide a probe for investigating possible many-body effects in nucleus.

Since 1971, the backward hadron production has been investigated at accelerator energies from a few GeV up 400GeV and even with cosmic rays above 1TeV with a special interest in both the mechanism of nuclear reactions and the structure of nuclei [3]. As a result, the following properties of inclusive particle spectra in the backward particle production are established.

1. Inclusive cross sections obey approximately an exponential function such as $\alpha_0 e^{-T/T_0}$ where T is the kinetic energy of produced particles and α_0 and T_0 are parameters.

2. Inclusive cross sections are independent of both the type of incident particles and its energy.

3. Inclusive cross sections depend strongly on the mass number A of the target nucleus in such way as A^n where the power n is greater than 2/3 or nearly equal to one.

On the observation of these properties, many theorists challenged to obtain an appropriate interpretation of backward hadron production. Some of the following models have been widely discussed; Fluctuations of nuclear matter in a nucleus (fluctons) [4,5], multi quark bags [6,7,8], a superdense nuclear core (cluster) [9], coherent tubes of nucleons [10], short range correlations [11], multiple scattering and fermi motion tail [12]. However, there was no conclusive description. Each model is able to reproduce only limiting features of the experimental data.

Experimentally, those properties were found clearly at an incident energy 400GeV where a systematic measurement was done [13,14]. In contrast to such high energy, a few GeV region seems to be rather transient on the appearance of such properties. There are a few experimental works in this region, each of which was carried out under a rather limited condition [15,16]. For example, one measured various types of particles at fixed angle using one type of projectile while another measured one type of particle at various angles using various types of projectile. To study this phenomenon in a few GeV region more precisely, we thus made a systematic measurement of various types of particles produced at various angles using various types of projectiles.

The experiments were performed using 12GeV proton synchrotron at National Laboratory for High Energy Physics in Japan (KEK). For incident particles, we used 4GeV/c π^+, π^- and p. For target nuclei, we used 6 types of nucleus, ^{6}Li, C, Al, Sn, Cu, and Pb. In the experiment, we used a large-aperture multiparticle spectrometer FANCY. We measured differential cross sections of emitted particles of π^+, π^- and p at backward angles from 66° to 145° in laboratory system.

This thesis is organized as follows. In Chapter 2, we will describe the experimental instrumentation. In Chapter 3, we will describe the analysis and performance of detectors. In Chapter 4, experimental analysis and the results will be presented. Discussions will be given in Chapter 5. In Chapter 6, conclusions will be given.

Chapter 2

Setup

2.1 Overview

The experiment was performed at $\pi 2$ beam line of 12 GeV proton synchrotron (PS) in National Laboratory for High Energy Physics (KEK). Fig.2.1 shows the overview of the beam line. For the incident beam, 4GeV/c positive pions, negative pions and protons were used. Beam line characteristics is described in Table 2.1. Fig.2.2 shows the overview of the detector system used in this experiment. As shown in the figure, the detector system mainly consists of 3 parts. The One is a beam detector system. The second is a central detector system. And the third is a forward detector system,which was not used for the analysis of this thesis. In the followings, each part is described in details.

2.2 Beam line detectors

2.2.1 Beam counters

Sintillation counters for beam particles

Four plastic scintillation counters (S0, S1, S2, S3) were used as beam counters. Beam particle is identified by the time of flight (TOF) between S0 and S2. Its flight length is about 13m. S0 is located at the intermediate focal plane of beam line. S3 was a defining counter. S1 was used to give a redundancy. S2 is the start counter of all TOF measurement. Table 2.2 shows their characteristics.

Gas Cherenkov counters (GCs)

Two threshold type gas cherenkov counters (GCs) were used for identification of beam particle. A Freon gas was used as a radiator, because its reflective index is suitable. The gas pressure was monitored during the experiment. The size of GCs is listed in Table 2.2.

Photodiode (PD)

In addition to the scintillation counters, we used large-area PIN silicon photodiode (PD) as a beam defining counter. As target was put in the central detector system, there were magnetic field of 3kG around the target. We cannot put a scintillation counter under such condition because photomultiplier does not operate correctly. However we can operate PD normally in the magnetic field and it is small enough to be put in the central detector system. Sensitive area of PD is 10×10mm and wafer thickness is 500μm. In Table 2.3, the characteristics of PD is shown .

2.2.2 Beam tracking detectors

For tracking of beam particle, 2mm wire spacing multi-wire proportional chambers(MWPCs) and 500μm spacing silicon microstripe detectors(SMDs) were used.

Multi-wire proportional chambers(MWPCs)

Two sets of multi-wire proportional chambers (MWPCs) were used for beam tracking. One of them was placed at 1850mm upstream from the target position. Another one was placed at 1410mm upstream from the target position. These chambers defined the X and Y position of the beam particles. They were of anode readout type with 2mm anode wire spacing. Preamplified signal was sent to the CAMAC buffer memory modules and address number of hit wires were recorded. The characteristics of the chambers are listed in Table 2.4.

Si microstripe detectors(SMDs)

In addition to the MWPCs, we used two sets of Si microstripe detectors(SMDs) for beam tracking. One set includes two plates of SMD, one of which detects X or Y position of beam track. They were placed at 530mm and 680mm upstream from the target position. The effective area is 28mm $\times$ 28mm. Although incident beam directly hits the

SMDs, radiation damage gave no problem during the period of experiment. The pitch of stripe is 500μm. Each stripe was connected to a preamplifier and then to a CAMAC buffer memory modules. Address number of hit stripes were recorded. A typical efficiency of SMDs is 95%. Table 2.5 shows the characteristics of SMDs.

2.3 Central detector system (CDS)

To detect the secondary particles emitted in the central region, we set up a central detector system (CDS). The schematic view of the CDS is shown in Fig.2.3. It consists of a solenoid magnet "OHSHO", a cylindrical drift chamber (CDC) and a cylindrical hodoscope (CDH). The sensitive region of CDS covers about 60% of 4π solid angle for the target. Fig.2.4 shows the acceptance of CDS. Kinematical limit line of reaction with single nucleon target is also shown in the figure.

2.3.1 Solenoid magnet "OHSHO"

To supply a magnetic field to the CDC, a solenoid magnet called "OHSHO" was used. Its effective volume is 1420mmϕ × 1600mm. It has an aperture of 780mm at both forward and backward ends. This large opening deteriorated the uniformity of magnetic field at its endcaps. To improve the uniformity, a correction coil was installed. It makes the uniformity within 1% or less in the CDC's effective volume. The maximum field is 3kG. The value was kept during experiment as an operating field. The operating current was monitored and stabilized within 1%. Table 2.6 shows characteristics of "OHSHO". Fig.2.5 shows a view of "OHSHO". Uniformity of magnetic field of "OHSHO" is shown in Fig.2.6.

2.3.2 Cylindrical hodoscope (CDH)

Twenty four plastic scintillation counters were installed in the "OHSHO" as a cylindrical hodoscope (CDH). They were put to surround the CDC. Photomultipliers were connected to both ends of each counter. Each counter's size is 1200mm long, 170mm wide and 20mm thick. The pulse hight and timing of output signal were recorded through the ADC and TDC modules. TDC data were used for a time of flight measurement from the target to the counter and ADC data were used for a position measurement along the counter. They were also used for correction of the time of flight measurement, because leading edge type discriminators were used. In the present target position, the CDH covered a polar angle between 66 and 145 degrees and a full azimuthal angle of 2π. Its overall detection efficiency was limited up to $93 \pm 1\%$ because of the absorption of emitted particles in the supporting poles of CDC. Table 2.7 shows characteristics of CDH.

2.3.3 Cylindrical drift chamber (CDC)

In the solenoid magnet "OHSHO", a cylindrical drift chamber (CDC) is installed. Table 2.8 shows characteristics of CDC. The size of CDC is 1240mm in diameter and 1200mm in length. The frame of CDC was constructed from two disk-shaped endplates of aluminum and twelve supporting poles of stainless steel. The thickness of upstream endplate was 30mm and that of downstream endplate was 20mm. To minimize the amount of material through which forward going particles passed, the inner side (radius < 310cm) of the down stream endplate was thinned down to 10mm. Supporting poles were of 40mm in diameter and imbedded along the circumference of 1220mm in diameter. Fig.2.7 shows framework of the CDC. They blinds about 7% of CDH's aperture. The wire configuration of CDC is a so-called jet-chamber type as used in JADE collaboration of PETRA at DESY and AFS of ISR at CERN for collider experiments, which is characterized by large drift sectors and resistive-wire readout. The CDC is installed as its axis is just along to the beam line. The beam line is assigned to Z axis of which direction is from upstream to downstream. Wires are stretched parallel to the axis of cylinder. Particle trajectory is reconstructed by wire position and drift time in R-ϕ plane and by charge division of forward and backward signals in Z direction. The CDC has 24 sectors and 36 layers. That means it has 864 sense wires, 1872 field wires and 912 potential wires. Only 384 sense wires are used for reducing the number of channels in the readout system. In other words, only 16 layers were actually used.

We used a gas mixture of 50% Ar and 50% ethane in normal pressure, with a flow of 200cc/min. By the ventilation using a silicon oil bubbler, we can avoid quenching of electrons by contamination of oxygen and water vapor from surroundings. The supplied voltages were 0V for sense wires and -1.92 kV for potential wires. The field gradient in drift space was about 1.1 kV/cm so as to reach the saturation of electron's drift velocity. The potential of field wires along the boundary of sector is gradually increased from -4.1 kV to -8.8 kV and that of field wires along the outer boundary and the inner boundary is increased from -1.9 kV to -8.8 kV. The electric field was perpendicular to the central plane. The gas gain was $(2 \sim 4) \times 10^4$. Fig.2.8 shows the wire position of CDC.

Layers are clusterized to inner, middle and outer blocks. This formation had an advantage of better momentum resolution and simpler local track finding. The maximum drift length of ionized electrons is 20mm at the innermost side of sector and 70mm at the outermost side. A staggering of 200μm resolves the left-right ambiguity. The sense wire is a resistive nichrome wire of 25μm in diameter. A tension of 60 g is applied on it. There are 1488 field wires along the boundary planes of sectors, 288 and 96 field wires along the outer and inner boundaries, respectively. The potential wire is a gold plated molybdenum wire of 125μm in diameter. A tension of 200 g is applied on it. The signals of the sense wire were read out from both sides with low impedance current preamplifiers. The signals were transferred to the front end module through 60m coaxial cables. The front end module is a rather complicated module which consists of charge integrators, a time-to-amplitude-converter and analog memories. The wire was soldered to a feed-through pin. Three kinds of information were obtained per one sense wire: integrated charges at both sides of a wire and a drift time of electrons. The track information can be obtained from these values in the following way;

1. R direction : sense wire position,
2. ϕ direction: drift time of ionized electrons,
3. z direction : ratio of charges induced at both sides of sense wire,
4. dE/dx : truncated mean of induced charges.

The last information was used to identify a specie of particle. A typical position resolution was about 160μm in ϕ direction and about 10cm in Z direction.

2.4 Forward spectrometer

To detect forward going particles, a forward spectrometer was set downstream of the central detector system. The forward spectrometer consists of 1mm wire spacing MWPC's, three large drift chambers, a dipole magnet between MWPC's and drift chambers, and a large hodoscope.

2.4.1 Dipole magnet "USHIWAKA"

To bend the trajectory of forward going particles for getting its momentum information, a dipole magnet named "USHIWAKA" was used. Its maximum magnetic field strength is 12kG. Operating field strength was 8kG. The aperture of USHIWAKA is 820mm in width, 400mm in height.

2.4.2 Forward multi-wire proportional chambers (FMWPCs)

Two sets of multi-wire proportional chambers (FMWPCs) of 1mm wire spacing was placed 620mm and 785mm downstream from the target to measure the trajectory of forward going particles. FMWPC's effective area is 96mm × 96mm. The gas mixture used was the same as that for beam MWPC's. A typical efficiency of 93% was observed by on-line monitoring.

2.4.3 Forward drift chambers (FDCs)

Three planar drift chambers were set for tracking forward going particles. The effective area of chamber is 1600mm wide, 1200mm high and 100mm thick. They consist of aluminum end plates and sus poles.

They were placed at intervals of 1000mm. Each chamber has 39 drift cells. The size of cell is 40mm thick and 80mm wide. The gas mixture is the same as CDC's. Both ends of sense wire are connected to preamplifiers. The arrival time and integrated charges of signal were recorded.

2.4.4 Forward hodoscope (FH)

Down stream of FDCs, a forward hodoscope (FH) which consists of nine plastic scintillation counters was set. Each counter is 200mm wide, 1650mm high and 30mm thick. Time of flight with flight length of about 8m from the target to the hodoscope was used for identification of forward going particles.

2.5 Target

We used six types of nuclear target, i.e., ^{6}Li, C, Al, Cu, Sn, Pb. The thickness of the targets was determined based on the in/out ratio of the event trigger and the energy loss of emitted particles in the target. By considering the in/out ratio which was defined by the number of events with a target divided by that without the target in the same-data-taking period, we prefer a thick target. On the contrary, when energy loss is considered, it is desirable that the thickness of the target should be as thin as possible. Target properties are listed in Table 2.9. ^{6}Li was an enriched target from natural Li. The enrichment of ^{6}Li was 93%. The target was covered with a polyester film of 200μm in thickness to keep out oxygen. Each of the target was set at the center of the CDC with a mylar supporting tube of 200μm in thickness. It was placed at the 930mm downstream from the CDC's upstream endplate (the origin in CDC coordinates). The acceptance of the detector system is from 66° to 145° in emission angle θ_{lab}.

2.6 Data acquisition system

2.6.1 VME system

The data acquisition system was renewed for this experiment. That is VME data acquisition system. Schematic view of it is described in Fig 2.9. It is divided into three parts; main VME system, sub VME system and VAX. On the main VME system, versatile data acquisition system(VEDA) which contains a 32-bit MC68020 micro-computer was loaded. On the sub VME system, 11 versatile peripheral controllers(VPCs) were implemented. The VPC contains MC68010 micro-computer. As an operating system, OS9 was used on VEDA and Idris was used on VPC. VEDA plays a role of grand master. In our drift chamber readout system, the data from CDC and FDCs are gathered by 10 slave VPCs(SVPCs) which were regarded as front-end processors. Then master VPC(MVPC) gathers SVPC's data and send to VEDA. VEDA gathers other detector's data through CAMAC and records all data into 8 mm video tape (VDT). In addition, VEDA sends a part of data to VAX. Using VAX, monitoring and analysis of data were done in on-line mode.

2.6.2 Data aquisition of drift chambers

The preamplified signals of CDC and FDCs are fed into the front-end modules (FEMs) at the electronics hat through the coaxial cables of 60m in length. The FEM, which has a capacity of storing up to four multiple hit signals at the same time, holds the analog data, i.e., drift time and pulse heights of CDC and FDC. The analog to digital conversion module (ADCM) collects and digitizes true data in the FEM and rejects spurious ones. This process is controlled by VPC. Then the VPC stores the data on the common memory module. To acquire a large number of data from the CDC and FDCs, ten VPCs are used and achieve these procedures at the same time. One VPC controls one ADCM, which manages about forty FEMs. The schematic diagram of the readout electronics of the CDC and FDCs is shown in Fig.2.10.

2.6.3 CAMAC data aquisition

The CAMAC system acquires the data of other detectors except for CDC and FDCs, i.e., the data of the beam line counters, MWPCs, SMDs, PD, CDH, FWH, and the various scalers and monitors of the excitation current of magnet and high voltage power supplies for the chambers. The data of counters and PD are stored in the CAMAC modules of ADCs and TDCs. The hits of MWPCs and SMDs are encoded into the preassigned wire addresses and only hit wire addresses are stored in a CAMAC buffer memory module. In Fig.2.11, the CAMAC system is shown.

2.6.4 Trigger

Trigger signals of each event used for the data acquisition are generated by signals of the beam counters, PD and CDH. The description of the trigger logic diagram is shown in Fig 2.11. There were 3 types of trigger mode in this experiment, i.e., '*Beam*','*C1*' and '*C2copl*'. The '*Beam*' trigger signal was generated by a coincidence of all signals from the beam counters and PD. The events obtained by this trigger mode is used for beam analysis such as the ratio of beam particles. The '*C1*' trigger signal was generated under the condition when at least one signals of 24 CDH coincided with a '*Beam*'. This is main trigger mode of this experiment. The '*C2copl*' trigger mode required the simultaneous hits in two scintillation counters of CDH faced with each other. This trigger mode was used for the momentum calibration of CDH.

Chapter 3

Detector analysis

This chapter is devoted to explain calibrations of detector systems. We have performed detector analysis on beam system and central detector system. First, we introduce two types of coordinate systems (Cartesian and cylindrical) to our detector system. Each of them is used in case by case. In both systems Z axis is defined along the beam axis. Its direction is the same as beam direction. The origin of the Z coordinates is set at the inner surface of upstream endplate of CDC. For the Cartesian coordinate, X direction is set from right to left and Y direction is set from down to up when looked toward the beam direction, to be a right handed coordinate. The origin of X-Y plane is set at the center of CDC. For the cylindrical coordinate, the zero degree in ϕ corresponds to $+X$ axis in Cartesian coordinate. The origin of R-ϕ plane is set at the center of CDC.

3.1 Calibration of beam line detectors

3.1.1 Beam particle identification

Beam particle identification was performed by TOF measurement between S0 and S2 counter and by the pulse hight of two gas Cherenkov counters after rejection of doubly entering beams. For the rejection, pulse hight correlation of S0 and S2 is checked. The resolution of the TOF measurement was obtained as 300psec in r.m.s. after pulse hight correction. By controlling gas pressure, GC1 was set below kaon and above pion threshold, and GC2 was set below pion and above muon threshold. The identification of particles was based on the logical conditions presented in Boolean algebra as follows;

$\overline{(\mathrm{GC1})} \cap \overline{(\mathrm{GC2})} \cap (\mathrm{TOF}\ p)$: proton,

$\overline{(\mathrm{GC1})} \cap (\mathrm{GC2}) \cap (\mathrm{TOF}\ \pi)$: π,

$\overline{(\mathrm{GC1})} \cap \overline{(\mathrm{GC2})} \cap (\mathrm{TOF}\ d)$: deuteron,

$(\mathrm{GC1}) \cap (\mathrm{GC2}) \cap (\mathrm{TOF}\ \pi)$: e and μ contamination,

$\overline{(\mathrm{GC1})} \cap \overline{(\mathrm{GC2})} \cap (\mathrm{TOF}\ K)$: kaon contamination.

Antiproton's contamination is negligible in this momentum region. The contents of beam particles on an average are listed in Table 3.1.

3.1.2 Beam particle tracking

Beam tracking was performed in the case that all beam line chambers and SMDs were hit. Least square fit was done and the worse χ^2 tracks were rejected. The standard deviations in the distribution of residuals between hit points and tracks are listed in Table 3.2.

3.1.3 Incident beam normalization

The number of incident beam particles was normalized as

$$N_{p\ or\ \pi} = N_{beam} \cdot f \cdot \varepsilon_{bt} \tag{3.1}$$

$N_{p\ or\ \pi}$: normalized number of protons or pions in the beam,

N_{beam} : number of beam particles measured by the four fold coincidence of S0-S3 counters and PD,

f : fraction of protons or pions in the beam obtained by the particle identification in the '*Beam*' trigger run,

ε_{bt} : beam tracking efficiency for the condition that the χ^2 value of the tracking is less than 3.0.

The parameter f is listed in Table 3.1. Typical value of ε_{bt} is 91%, and it varied within 3%.

3.2 Analysis of central detector system

3.2.1 Calibration of CDC

Drift time calibration

In principle, the hit position of CDC in R-ϕ plane can be calculated from the drift time information as follows.

$$
\begin{aligned}
X &= X_0 \mp l_{drift} \cdot \sin\theta_l \cdot \sin\phi_0, &(3.2)\\
Y &= Y_0 \pm l_{drift} \cdot \cos\theta_l \cdot \cos\phi_0, &(3.3)\\
l_{drift} &= (T - T_0) \cdot v_{drift}, &(3.4)\\
T &= g_{TDC} \cdot \mathrm{TDC}, &(3.5)
\end{aligned}
$$

where

X_0, Y_0 : position of the sense wires on the Cartesian coordinate system,
ϕ_0 : azimuthal angle of a sense wire in the polar coordinate system,
v_{drift} : drift velocity of electrons,
l_{drift} : drift length of electrons,
θ_l : Lorentz angle caused by the magnetic field,
T : drift time of electrons,
T_0 : time origin of drift time,
g_{TDC} : conversion gain of TDC,
TDC : drift time read out from TDC.

There are two hit point candidates for one drift time information in the above equation. This is because we observe drift time of electrons for each cell, which cannot directly define from which side the drift electrons come. This left/right ambiguity is resolved in the tracking process using the staggered arrangement of sense wires. Practically we must consider following corrections.

1. Correction for the nonuniformity of the sector structure
   As electric field is not uniform near the sense wires and the field wires, the drift velocity of electrons is not constant. This nonuniformity causes non-linear relation between the drift time and the drift length. For representing the relation, a quadratic

function was used. The parameters varied their value in each layer because of the density difference of field wires.

2. Correction for Lorentz angle
   Drift direction of electron is rotated by same angle in the magnetic field. The angle is called Lorentz angle. It breaks the symmetry in drift directions of electrons. The effect is corrected by adopting the different sets of parameters of the quadratic function for the different drift direction.

3. Time slewing correction
   For the drift time measurement, we used leading-edge type discriminator which causes time shift according to the pulse hight of signal. The correction of this shift gave modification of typically about 200μm in a drift length.

4. Correction for the signal propagation
   The correction of signal propagation in sense wire must be done. Faster one of forward and backward readout signals was used for the stop signal of time measurement. We got the Z position by a charge division method (described in the next subsection) and judged where the stop signal is generated. This correction gave about 100μm in a drift length.

With these corrections the Eqs. of 3.4 and 3.5 are modified as follows.

$$l_{drift} = (v_{i\pm} + \epsilon_{i\pm} \cdot T') \cdot T' \quad (3.6)$$

$$T' = g_{TDC} \times \text{TDC} - \frac{\alpha}{\text{ADC}} - \frac{Z}{V_p} - T_0, \quad (3.7)$$

where

$v_{i\pm}$: first order drift velocity,

$\epsilon_{i\pm}$: second order drift velocity,

g_{TDC} : measured conversion gain of TDC,

α : measured time slewing correction parameter,

V_p : propagation velocity of signal in the wire (20cm/nsec),

T_0 : time origin of the drift time.

Suffix $i,\pm$ means the ith layer and the drift direction of left and right respectively. The parameters of v, ε, T_0 are determined by analyzing the data of a calibration run using

$p+p \rightarrow p+p$ elastic scattering. The calibration parameters are listed in Table 3.3. Finally we have got a tracking resolution of 300μm in R-ϕ plane in standard deviation.

Z coordinate calibration

Charge division method was used to get the position in Z coordinate. In principle, Z position of hit point can be calculated by forward and backward signals as follows.

$$Z_i = \frac{\mathrm{L}}{2} \cdot \frac{(\mathrm{ADC}_f)_i - (\mathrm{ADC}_b)_i}{(\mathrm{ADC}_f)_i + (\mathrm{ADC}_b)_i}, \tag{3.8}$$

where ADC_f and ADC_b are a forward signal and a backward signal, respectively. L is the wire length. To this ideal equation, two types of corrections are made:

1. Gain difference correction between forward and backward electronics.
2. Correction for the effect of the input impedance of pre-amplifier.

As the pre-amplifiers of CDC are coupled directly to the sense wires, the input impedance of it should be taken into account as an effective length of the sense wire. The resistance of the sense wire is 3kΩ. The input impedance of the pre-amplifier is about 50Ω.

Corrected equation of Z position is expressed as follows.

$$Z_i = \frac{\mathrm{L}'}{2} \cdot \frac{(\mathrm{ADC}_f)_i - (g_{rel})_i(\mathrm{ADC}_b)_i}{(\mathrm{ADC}_f)_i + (g_{rel})_i(\mathrm{ADC}_b)_i} + \mathrm{L}_{shift}, \tag{3.9}$$

$$\mathrm{L}' = \mathrm{L} + d\mathrm{L}_f + d\mathrm{L}_b, \tag{3.10}$$

$$\mathrm{L}_{shift} = \frac{d\mathrm{L}_f - d\mathrm{L}_b}{2}, \tag{3.11}$$

where $d\mathrm{L}_f$ and $d\mathrm{L}_b$ are effective length of sense wire in the forward end and the backward end, respectively. $(g_{rel})_i$ is the relative gain of backward-preamplifier signal to forward one defined in each layer.

Each parameter is determined in the track reconstruction process. An iterative adjustment was done so as to minimize the deviation of each hit position from the trajectory of the particle determined by the least-square method. These calibration parameters are listed with their accuracy in Table 3.3. The resolution of Z position from CDC tracking is 14.9mm in the standard deviation.

Track reconstruction

In the track reconstruction, we have to consider three points as follows.

1. Treatment of multi-track in the same sector.
2. Solution of left/right ambiguity of hit points in R-ϕ plane.
3. Reduction of computing time.

The track reconstruction was performed according to the following procedures.

1.) At first the track finding are done in the R-ϕ plane. By considering the sector structure, we classify all hit points into two types of ϕ cluster. One is the simple ϕ cluster where all hit points are coming from the same sector. The other is the sector crossing cluster where hit points from adjacent sectors are involved.

2.a) In the case of the simple ϕ cluster, we have done the further clustering of hit points into the blocks which are inner, middle and outer block in layer, respectively. Then left/right ambiguities are solved by fitting the each clusterized block in R-ϕ plane independently. After rejecting hit points far from others in the R-Z plane, the fitting is done using the block left/right information.

2.b) In the case of the sector crossing cluster, we calculate the curvatures for every inner points in conjunction with the outer most hit point and the origin of CDC. The points with a close value of curvature are gathered as track candidates. The same calculation proceeds with a new outermost hit until getting all track candidates.

3.) Finally we determine the tracks by fitting the selected candidates. The fitting is done with a linear function in R-Z plane and with a quadratic function in R-ϕ plane. We should use circular function in R-ϕ plane, but we use quadratic one for reduction of computing time and simplicity of determining the track. This approximation makes systematic error, but it is small enough to be negligible when we determine the momentum.

Momentum calibration of CDC

The absolute momentum determined by CDC is calibrated by the elastic scattering,

$$p+p \to p+p \quad \text{at } 1.5\text{GeV/c}.$$

For this purpose, we set a polyethylene target at the origin of the coordinate. The trigger mode of the calibration runs was set to '*C2copl*'. This trigger condition required the simultaneous hits in two scintillation counters of CDH faced with each other. Quasi-free elastic scattering events on carbon nucleus may be also gathered. However, since outgoing proton produced in this reaction is recoiled by the nucleon with Fermi-motion in the nucleus, both protons can not be in the same reaction plane. To suppress the contamination of them, we put the condition that the relative azimuthal angle of two outgoing protons is 180° within a tolerance of 3°.

With this target position, the transverse momentum P_T of outgoing protons is almost constant and limited around 600MeV/c by the detector acceptance. According to this advantage, we calibrated the parameters which are introduced in this section, in R-ϕ plane and in R-Z plane. ADC relative gain parameters were checked by θ_3-θ_4 relation. θ_3,θ_4 means the scattered angle of each outgoing protons.

In Fig.3.1, P_T histogram is shown. Fig 3.2 shows P_T versus P_Z scatter plot of the calibration data with the kinematical calculation for the $p+p \to p+p$ elastic scattering. Fig.3.3 shows θ_3 versus θ_4 scatter plot.

dE/dx of CDC

The dE/dx is calculated in the following way;

$$\begin{aligned}
\frac{dE}{dx} &= \sum_i \left(\frac{dE}{dx}\right)_i \\
&= \sum_i \text{ADC}_i \\
&= (g_{abs})_i((\text{ADC}_f)_i + (g_{rel})_i(\text{ADC}_b)_i),
\end{aligned} \tag{3.12}$$

where the symbols in use are as follows;

$(g_{abs})_i$: absolute gain of ADC defined in each layer,

$(\mathrm{ADC}_f)_i$: content of ADC of forward-preamplifier signal,

$(\mathrm{ADC}_b)_i$: content of ADC of backward-preamplifier signal,

$(g_{rel})_i$: relative gain of backward-preamplifier signal to forward one defined in each layer.

The subscript i means the layer number of CDC.

To calculate each layer's energy loss, a correction with an emission angle (θ) is needed. In an ideal case, $(dE/dx)_i$ is expressed as follows.

$$(dE/dx)_i = (\mathrm{ADC})_i \sin\theta. \tag{3.13}$$

When the particle trajectory crosses the sense wire nearly perpendicularly, a saturation of gas gain is occurred. We parametrized this effect and fitted with an empirical expression as follows,

$$\begin{aligned}(dE/dx)_i &= (\mathrm{ADC})_i \sin\theta[k_1 + (k_2 + k_3 \cot\theta)\cot\theta] \\ &\quad +((\mathrm{ADC})_i \sin\theta)^2[k_4 + (k_5 + k_6 \cot\theta)\cot\theta]. \end{aligned}\tag{3.14}$$

These parameters are calibrated by using the data of negative pions($\beta \sim 1$) which are minimum ionizing particles and easy to be selected. The parameters k_{1-6} were optimized so that the parameter θ bears not much relation to the ADCs. The parameters g^i_{abs} are defined so as to have almost similar value to each other. The parameters g^i_{rel} are determined in the Z position calibration.

3.2.2 Calibration of CDH

The TOF value of CDH is expressed by the following equation.

$$\mathrm{TOF} = g_{TDC} \cdot \mathrm{TDC} - \mathrm{T}_0 + \frac{\alpha}{\sqrt{\mathrm{ADC}}} + \frac{Z}{v_{light}} \tag{3.15}$$

where the symbols in use are as follows;

ADC : contents of ADC of photo-multiplier signal,

TDC : flight time read out from TDC,

g_{TDC} : conversion gain of TDC,

T_0 : offset of TOF,

α : correction parameter of time slewing,

v_{light} : light velocity in scintillator medium,

Z : Z coordinate of particle in crossing the CDH.

α is determined by measuring the correlation between ADC and TDC. v_{light} is determined by measuring the correlation between Z and TOF. The resolution of TOF was 300psec in standard deviation.

3.2.3 Particle identification of CDS

The particle identification (PID) of outgoing particles in the CDS is carried out with the TOF value of CDH in conjunction with their momenta from CDC tracking. In Fig 3.4, it is shown the TOF versus momentum scatter plot. Fig 3.5 shows the probability of missing identification versus the momentum. The proton contamination in pion was less than 2%.

3.2.4 Performance of the CDS

Resolution

Momentum resolution was estimated from the position resolution and Coulombic multiple-scattering effect. Its result is as follows [17,18].

$$\Delta P = \sqrt{\left[\frac{\Delta P_T}{\sin\theta}\right]^2 + \left[\frac{P_T \cdot \Delta\theta \cdot \cos\theta}{\sin^2\theta}\right]^2} \tag{3.16}$$

$$\frac{\Delta P_T}{P_T} = \sqrt{\left[\frac{\sigma_{r\phi}\sqrt{A_n}P_T}{0.3BL^2}\right]^2 + \left[\frac{0.047}{\sqrt{3}\beta BL}\sqrt{C_n}\sqrt{\frac{L_t}{L_r}}\right]^2} \tag{3.17}$$

$$\Delta\theta = \sqrt{\left[\frac{\sigma'_z}{\sqrt{\sum(r_i-\bar{r})^2}}\right]^2 + \left[\frac{0.0141}{\sqrt{3}P\beta}\sqrt{\frac{L_t}{L_r}}\right]^2} \tag{3.18}$$

where the symbols in use denote as follows;

P : particle momentum in GeV/c,

P_T : transverse momentum in GeV/c,

θ : polar angle,

B : magnetic field strength in Tesla (0.3 T),

L : effective radius of the CDC in meter (0.35 m),

L_t : $L/\sin\theta$,

A_n : coefficient determined by the number of wires and their configuration (~ 16),

C_n : coefficient determined by the wires' configuration (~ 1.6),

β : velocity of the particle in an unit of light velocity,

L_r : radiation length of the chamber gas Ar/C_2H_6 in meter ($\sim$ 100m),

r_i : radial position of each sense wire,

$\bar{r}$: average of r_i,

$\sigma_{r,\phi}$: position resolution in $R-\phi$ plane,

σ_Z : position resolution in $R-Z$ plane,

σ'_Z : $\sigma_Z \sin\theta$.

The first terms in Eqs.4.16 and 4.17 are coming from position resolution and the second terms from multiple scattering. These evaluations for pions and protons are shown in Fig 3.6. The resolution of the transverse momentum for $\beta \sim 1$ particles were about

$$\Delta P_T = 10\% \times P_T. \tag{3.19}$$

Efficiency

The absolute detection efficiency of CDC was counted by an eye scan of several hundreds displays as follows,

$$\text{Efficiency} = \frac{\text{(Tracks by the tracking program)}}{\text{(Tracks by an eye scan)}}. \tag{3.20}$$

It was 95% in the range of the polar angle between 66° to 145°. The CDC efficiency depends on a momentum of the emitted particle, a polar angle and an azimuthal angle. It was checked with CDH by the following expression,

$$\text{Efficiency}(P,\theta,\phi) = \frac{((\text{Track by CDC}) \cap (\text{Hit of CDH}))}{(\text{hits of CDH})}. \qquad (3.21)$$

The CDH hits were spatially selected by some criteria for the aim of excluding spurious hits obtained by only CDH information. The efficiency dependence on momentum of outgoing particles are shown Fig 3.7. The dependence on the emission angles and the azimuthal angle was less than $\pm 2\%$.

Chapter 4

Reduction of differential cross sections

4.1 Correction for absorption and energy loss

To get invariant cross sections, the absorption and energy loss of emitted particles in the target material should be considered. The absorption is caused by the secondary nuclear interaction while the energy loss is caused by the Coulomb interaction. A method of absorption correction is described bellow.

4.1.1 Energy loss in the target material

The Coulomb interactions with electrons in the target material cause the energy loss of emitted particle. It is given well by the Bethe-Bloch formula.

$$\frac{dE}{dx} = D\frac{Z\rho}{\beta^2 A}z^2(\ln(\frac{2m_e v^2}{I(1-\beta^2)}) - \beta^2) \qquad (\mathrm{MeV/cm}) \tag{4.1}$$

where $D = 4\pi N_A r_e^2 m_e c^2 = 0.3070$ MeV cm^2/g, Z and z are the charge of the target nuclei and the incident particles respectively, ρ and A are the mass density of the target and its atomic mass number, respectively, and I is the ionization potential given by the equation of

$$I \sim 16(Z)^{0.9}\mathrm{eV}. \tag{4.2}$$

Because of uncertainty of the CDH trigger, we remove the pions of which momenta $p \leq$

70MeV/c and the protons of which momenta $p \leq 230$MeV/c. The kinetic energies of hadrons measured in the CDC are less than 1GeV for the most part. Therefore, the shell correction term and higher order electrodynamics term for very slow particles and the density effect term for ultra-relativistic particles are neglected in the present case.

The estimation of energy loss is done as follows. We generate the particles at the center of target in X-Y plane. Z coordinate in the target is given by the uniform random numbers from 0 to thickness divided into 50 pieces. Then we trace the particle along to each emission angle and flight pass in the target. We divide flight pass into 20 pieces and calculate the dE/dx for each piece. Thus we get the average energy loss and its variance. Table 4.1 shows the estimated values. Number of particles which lost all energy in the target is also shown.

4.1.2 Absorption due to nuclear collisions

The probability of the absorption of emitted particle due to nuclear interactions with other target material is given by the expression as follows,

$$P = \exp(-\frac{x}{\lambda}), \tag{4.3}$$

$$\lambda = \frac{A}{N_A \sigma}, \tag{4.4}$$

where

x : flight path in the target,

A : mass number of the target,

N_A : Avogadro number,

σ : total cross section of the nuclear interaction of emitted particle with target nucleus.

The total cross section σ for π is given in Ref.19. This cross section is formulated as

$$\sigma = \sigma_0 \cdot A^n, \tag{4.5}$$

where

σ_0 : cross section of elementary process,

i.e., $\sigma_0 = \sigma(\pi N)$

A : mass number,

n : parameter,

We can obtain σ for pion with kinetic energy T_π from 75MeV to 325MeV.

The cross section σ for proton are tabulated in Ref.20 for the nuclei of C, Al, Cu and Pb. For ^{6}Li target, we get it by extrapolation of C and O data. For Sn target, we get it by interpolation of Ag and Pb data.

Typical values of absorption were calculated for π or p which were emitted in the angle θ_{lab} from 70° to 140° in the intervals of 10° and are given in Table 4.2.

4.1.3 Multiple Coulomb scattering

The elastic Coulomb scattering from the nuclei in the target make some deflection on the motion of emitted particles. The probability for angular deflection is approximated by the Gaussian distribution, the standard deviation of which is given by the following equation,

$$\theta_0 = \frac{14.1(\mathrm{MeV/c})}{p\beta} z\sqrt{\frac{L}{L_R}}\left(1+\frac{1}{9}\log_{10}\left(\frac{L}{L_R}\right)\right) \quad \text{(radians)} \tag{4.6}$$

where

p : momentum (Mev/c),

β : velocity in the unit of light velocity,

z : charge of the particle,

L/L_R : thickness of target material in the radiation length.

The radiation lengths L_R are tabulated in Ref.20. The deflection is evaluated to be at most 8.7° for pions and 7.3° for protons emitted in the direction of $\theta_{lab} = 90°$ with the kinetic energy of 100MeV on Pb target. Those are the maximum values. It is within 3° for the almost all other cases. Table 4.3 shows the estimated values θ_{lab} from 70° to 140°.

4.1.4 Correction method

We have performed the correction for the energy loss due to Coulomb interactions and the absorption due to nuclear collisions. For the deflection of emitted angle caused by multiple Coulomb scattering, we did not make any correction because this correction is negligibly small as shown in Table 4.3.

For the correction caused by the energy loss and absorption, the flight path of emitted particle in the target was estimated. The production point in R-ϕ plane was determined by the beam tracking. Its position resolution is about 1mm. The emission angle θ and the azimuthal angle ϕ of emitted particle were measured by CDC tracking. The position resolution of the CDC in R-ϕ plane is 300μm. The flight path in R-ϕ plane is given by the distance between the production point and the intersection of emitted particles track with the circumference edge of the target. The Z position of the production point measured by the CDC has a poor position resolution of $\sigma_Z \sim 1.2$cm. To take the Z position uncertainty into account, a Monte-Carlo method was used. A randomized uniform distribution of production point over the target thickness was assumed. After all, the flight path in the target was obtained for each track.

The flight path is divided into twenty pieces. The number of division 20 was chosen because as it was the minimum number which gave the same absorption correction as that obtained by finer division. The corrections for the energy loss and the nuclear absorption are carried out on each piece. As for the energy loss, we trace the kinetic energy of emitted particle back to the original kinetic energy through the flight path. As for the nuclear absorption, an absorption factor is calculated at each piece with corrected kinetic energy. The absorption factor for each piece is multiplied with each other into one value and used as a weight for the accumulation of the events in the reduction of differential cross sections.

The randomization in Z direction causes the broadening of kinetic energy of emitted particles. However, as estimated in Table 4.1, the energy distribution is not so spread and we can neglect this broadening effect. In the same sense, we can neglect the effect of randomization on absorption correction because the nuclear absorption cross section does not so strongly depend on emitted particle's energy.

4.2 Reduction of differential cross section

The differential cross section is evaluated in the following ways;

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{p}\frac{d^2\sigma}{dTd\Omega} = \frac{1}{p}\frac{1}{\Delta E_k \Delta\Omega}\frac{N_{trk}}{N_{beam}N_T\varepsilon}, \tag{4.7}$$

$$N_T = \frac{N_A \rho d}{A}, \tag{4.8}$$

where

ΔE_k	: kinetic energy bin in 50MeV,
$\Delta\Omega$	: solid angle bin in $2\ \pi \times 0.2$ steradian,
N_{trk}	: number of particles measured in the 'CI' trigger,
N_{beam}	: number of incident beam particles,
N_A	: Avogadro number,
ρ	: density of the target,
d	: thickness of the target,
A	: mass number of the target.

The overall trigger efficiency ε is given by

$$\begin{aligned} \varepsilon &= \varepsilon_{trig}\varepsilon_{beam}\varepsilon_{CDC}\varepsilon_{corr}, && (4.9) \\ \varepsilon_{trig} &= N_{acpt}/N_{trig}, && (4.10) \\ \varepsilon_{beam} &= N'_{beam}/N_{beam}, && (4.11) \\ \varepsilon_{CDC} &= \varepsilon_{Ctrig}\varepsilon_{Ctrk}\varepsilon_{Ctgt}, && (4.12) \end{aligned}$$

where

N_{acpt}	: number of recorded events,
N_{trig}	: number of events monitored,
N'_{beam}	: number of the beam particle after the cut of the bad tracking events,
ε_{Ctrig}	: efficiency of the 'CI' trigger,
ε_{Ctrk}	: tracking efficiency of the CDC,
ε_{Ctgt}	: vertex-cut efficiency on the target position,
ε_{corr}	: nuclear absorption correction factor.

Typical values of these efficiencies are listed in Table 4.4 with systematic errors.

4.3 Results

The resulting differential cross sections as a function of produced particle's kinetic energy are tabulated in Table 4.5 ~ 4.7, and shown in Fig. 4.1 ~ 4.5. For the data of pion production, fitted lines by an exponential function are also shown.

Chapter 5

Discussion

5.1 General features of results

From the results of our experiment (see Table 4.5 ~ 4.7 and Fig. 4.1 ~ 4.5), some characteristic features are observed.

In the case of proton production(see Fig. 4.1), both the shapes and absolute values of invariant cross sections are independent of the type of projectile particles at every emission angle on every target nucleus.

On the other hand, the invariant cross sections of pion production are not independent of the type of projectile particles.

In the case of pion projection, the invariant cross sections of positive pion production are quite similar to those of negative pion production in shape as shown in Fig. 4.2 and 4.3. The ratio of absolute values are as follows.

$$d\sigma(\pi^+A \to \pi^+X) \ / \ d\sigma(\pi^-A \to \pi^-X) = 1.0 \pm 0.1 \tag{5.1}$$

$$d\sigma(\pi^+A \to \pi^-X) \ / \ d\sigma(\pi^-A \to \pi^+X) = 1.0 \pm 0.1 \tag{5.2}$$

$$d\sigma(\pi^-A \to \pi^-X) \ / \ d\sigma(\pi^+A \to \pi^-X) = 1.6 \pm 0.1 \tag{5.3}$$

In the case of proton projection (see Fig. 4.4 and 4.5), the invariant cross sections of positive pion production are almost the same as those of negative pion production while the invariant cross sections fall off more rapidly at higher energies than those in the case of pion projection. We may consider that this is because the kinetic energy of incident proton is about 0.6GeV smaller than that of incident pion at 4GeV/c.

The dependences of invariant cross sections on the target mass number A are shown in Fig 5.1, where the cross sections are normalized to that of Al target. The solid line shows a function of A^1 and $A^{2/3}$ for proton production and pion production, respectively.

The invariant cross sections for proton production depend almost linearly on the mass number A. However, in low mass region less than Al, the dependence is slightly different. The invariant cross section for light nuclei seems to have a smaller value than that expected by A^1-dependence. This may be explained that "hazy" effect of nuclear surface is more crucial in light nuclei than in heavy nuclei.

The mass number dependence of invariant cross sections for pion production is not linear in A but almost $A^{2/3}$ over the measured region of kinetic energy. The "hazy" effect also seems to be present in this case.

5.2 Kinetic energy dependence of invariant cross section

It has been observed since an early stage of the study of backward particle production [2] that the invariant cross sections obey the following parametrization

$$E\frac{d^3\sigma}{d^3p} = \alpha_0 \exp(-\frac{T}{T_0}), \tag{5.4}$$

where α_0 and T_0 are parameters.

We have performed the fitting of our invariant cross sections with the function expressed above in the region of kinetic energy from 125MeV to 525MeV.

For proton production, T_0 is almost independent of the projectile type and the mass number A but strongly dependent on the cosine of emission angle $cos\theta_{lab}$. T_0 increases as $cos\theta_{lab}$ increases (see Fig. 5.2). T_0 is almost independent of mass number A (see Fig. 5.3) for all $\cos\theta_{lab}$. α_0 is almost independent of $\cos\theta_{lab}$ (see Fig. 5.4). α_0 increases with increase of mass number A, but it seems to be saturated at higher mass (see Fig. 5.5).

For pion production, the fitting with an exponential function(eq. 5.4) does not seem to work so well, especially for heavy nuclear target. Fig. 4.2 $\sim$ 4.5 shows fitted lines in addition to the data. In the case of pion projection, we can see the difference of α_0 between the combinations of charged states for projectile and ejectile(see Fig. 5.6 and 5.7). However, T_0 is almost independent of such a combination(see Fig. 5.10 and 5.11). In the case of proton projection, T_0 is smaller than that in pion projection case as mentioned in previous section.

5.3 Comparison with the 400-GeV proton data

We can compare our data with the 400GeV proton data [13,14].

For proton production, our data are almost the same as those of 400GeV for all targets and angles as shown in Fig. 5.14. Therefore, the energy- and projectile- independence of invariant cross section seems to be kept down to 4GeV/c for proton production. For the more precise comparison, we fit the 400GeV proton data by exponential function in the same way as that for our data. Fig. 5.15 shows the $\cos\theta_{lab}$ dependence of α_0 and T_0. They are almost the same as those of 4GeV/c, but T_0 seems slightly larger than that of our data in the region of $\theta_{lab} \geq 90°$. This means that the high momentum component increases more in the forward region. We may explain this difference by the fact that the secondary process is increase α_0 in comparison with 4GeV/c data with energy because the multiplicity of pion is increased with energy at forward angles. The pseudorapidity distribution of pion multiplicity is shown in Fig. 5.16 [3].

For pion production, our data are different from those of 400GeV(see Fig. 5.17). In comparison with our data, T_0 has a slightly larger value but a similar dependence on $\cos\theta_{lab}$, while α_0 similarly increases as a function of the mass number A with a larger gradient. This phenomena also may be explained by the increase of pion multiplicity. For the pion production, we have a possibility to detect more pions from quasi-free reactions than proton production because of kinematical reason. Therefore, the increase of pion multiplicity with energy affects the pion production case at high mass region unlike proton case, which is almost completely backward production(kinematically forbidden region of particle production in the reaction with single nucleon). In the multiplicity distribution of pion production, its peak position moves to backward as the target mass number increases (see Fig. 5.18) [3]. This may explain the more increase of α_0 at higher mass region than that at lower mass region.

5.4 Calculation based on a quark-parton model

There are many models to be tried to explain nuclear reactions at intermediate and high energies. Among them, quark-parton model (QPM) is thought to be based on the most simplified view with a sophisticated method of calculation. Thus, we have performed QPM calculation and compared it with our data.

Quark-parton model of a nucleus was proposed by G.Berlad and his collaborators in 1980 [21]. This model is applicable to deep inelastic lepton scattering, lepton pair production, W-boson production, particle production at large x small P_T and backward particle production in high-energy hadron-nucleus collisions. Especially, quark-parton model can reproduce the experimental data of backward particle production remarkably well without the use of any free parameters.

Models of particle production from a nucleon at high energies require a knowledge of the momentum distribution of quarks and gluons in the nucleon when it is viewed from a high-momentum frame. To extend these models to the particle production from nucleus, one needs to know the momentum distribution of quarks and gluons in ultrarelativistic nucleus. These distributions can either be extracted from deep inelastic leptoproduction from nuclear targets or be estimated from theoretical models.

The momentum distribution of quarks and gluons in a fast nucleus may be estimated by convoluting the quark and gluon distributions in nucleon that were extracted from deep-inelastic leptoproduction from isolated nucleon with the momentum distribution of the nucleons inside a fast nucleus.

The momentum distribution of nucleons in a nucleus that moves with a relativistic velocity cannot be extracted from its nonrelativistic wave function. Instead, realistic and simple "nuclear counting rules" were assumed to determine these distributions. When a nucleus is viewed from a high-momentum frame in hadron-nucleus reaction, it is Lorentz-contracted. All its nucleons that lie within an "imaginary tube" with a hadron-nucleon cross section σ, which is drawn along the momentum axis, are contracted into a small volume with the same cross section. Owing to the shortening of longitudinal dimensions all the quarks in the contracted tube will now communicate easily via exchange of massless gluons, while their communication in the transverse direction will not be affected. Lorentz contraction will simultaneously increase the longitudinal momentum components of the quarks due to the uncertainty principle and reduce the strength of their interactions due to asymptotic freedom. Thus the quarks in a Lorentz-contracted tube will behave like a free Fermi gas, except for clustering of quarks into weakly interacting nucleons which reduces their total Fermi energy. The total momentum of the tube will therefore be distributed among its constituent nucleons according to phase-space rules. The momentum distribution of quarks in a relativistic nucleus is derived in Appendix A.1.

When the reaction is viewed from the projectile rest frame, the backward hadron production corresponds to the large x and small P_T particle production by a high-energy tube incident on a projectile hadron. The production cross section with large-x and small P_T is given as follows;

$$\sigma_T(p \to M) = C_M^q(\sigma_{pT} - \sigma_{qT})q_p(x), \tag{5.5}$$

The details are described in Appendix A.2. Therefore, we can get the cross section of backward pion production as follows;

$$\sigma_A(a \to b) = \frac{\sigma^A}{\sigma}\sum_{i=1}^{A} P(i, A)\sigma_i(a \to b), \tag{5.6}$$

The details are described in Appendix A.3.

The results of calculation by quark-parton model are shown in Fig. 5.19 $\sim$ 5.27 in comparison with the data. Table 5.1 shows the nuclear inelastic cross sections for ^{6}Li, Al and Pb. For pion production, we used the value of a recombination factor

$$C = 0.4, \tag{5.7}$$

that was derived from pD collision data [22]. For proton production, we have no reference about the recombination factor. Then, we adopted the value

$$C = 2.0, \tag{5.8}$$

to get a good agreement with the data at backward angles. We got the good agreement with data not only in absolute value but also in shape at backward angles, while in the range of $\theta_{lab} \leq 90°$ there are disagreements in both absolute value and shape. The recombination factor stands for the probability of recombination between sea quark and valence quark(s). It should not be over unity. To resolve this artificial controversy, we have to note that we have not taken into account of the spin states of di-quark in its distribution function. When we take it account, we can interpret the recombination factor as

$$C = 0.5 \times (1(\text{spin singlet}) + 3(\text{spin triplet})) = 2. \tag{5.9}$$

To reproduce our data, the tubes of up to three nucleons play an essential role. Fig. 5.28 and Fig. 5.29 show the contribution of each tube to the invariant cross section for pion production and proton production, respectively.

Chapter 6

Conclusions

We have studied the backward hadron production in hadron-nucleus reactions at 4GeV/c incident momentum systematically. This is the first systematic measurement in a few GeV region. Incident particles we used are positive pion and negative pion and proton. We used the targets of ^{6}Li, C, Al, Cu, Sn and Pb. We measured the outgoing particles of positive pion, negative pion and proton. The angular region we measured was $66° \leq \theta_{lab} \leq 145°$.

The experiment was carried out at 12GeV proton synchrotron in National Laboratory for High Energy Physics in Japan (KEK) by using the general purpose multiparticle spectrometer FANCY. This detector system covers a very wide solid angle, i.e., 60% of 4 π.

We give the conclusions of this work as follows.

1. Invariant cross section for proton production is independent of type of incident particles.

2. Mass number dependence of invariant cross section for proton production is almost linear in A.

3. Invariant cross section for pion production is not independent of type of incident particles.

4. Concerned with the charge states of projectile and ejectile, invariant cross sections for pion production with pion projection show differences only in absolute values as follows;

$$d\sigma(\pi^+ A \rightarrow \pi^+ X) \;\; / \;\; d\sigma(\pi^- A \rightarrow \pi^- X) = 1.0 \pm 0.1$$

$$d\sigma(\pi^+ A \rightarrow \pi^- X) \;\; / \;\; d\sigma(\pi^- A \rightarrow \pi^+ X) = 1.0 \pm 0.1$$
$$d\sigma(\pi^- A \rightarrow \pi^- X) \;\; / \;\; d\sigma(\pi^+ A \rightarrow \pi^- X) = 1.6 \pm 0.1$$

5. In the case of pion production with proton projection, invariant cross section falls off more rapidly than that with pion projection.

6. Mass number dependence of invariant cross section for pion production is proportional to $A^{2/3}$.

7. Invariant cross sections are well parametrized by the following formula;

$$E\frac{d^3\sigma}{dp^3} = \alpha_0 e^{-T/T_0}$$

8. α_0 is almost constant in $cos\theta_{lab}$ but strongly varied in mass number.

9. T_0 is almost constant in mass number but strongly varied in $cos\theta_{lab}$.

10. In comparison with 400GeV data, general features of our data are almost the same.

11. Mass number dependence at 4GeV/c is a little bit more suppressed at higher masses than that at 400GeV.

12. Calculation based on a quark-parton model reproduced our data well at backward region. However, it is different from our data at $\theta_{lab} \leq 90°$.

Appendix A

Quark Parton Model Calculation

Here, a method of calculating the differential cross sections of backward hadron production is described on the basis of a Quark Parton Model(QPM);Ref.21.

A.1 Momentum distributions of quarks in relativistic nuclei

At first, momentum distributions of quarks and gluons in relativistic nuclei is needed. This can be estimated by convoluting the quarks and gluons distributions in a nucleon, that were extracted from deep-inelastic leptoproduction from an isolated nucleon, with the momentum distribution of nucleons inside a fast nucleus. However, momentum distributions of nucleons inside a fast nucleus cannot be extracted directly from QCD. In fact, a knowledge of this distribution requires the solution of a complicated relativistic quantum-mechanical many-body problem. To get this distribution, an imaginary tube is naturally taken into consideration because the nucleus is Lorentz contracted when it is viewed from a high momentum frame. It is a tube with a nucleon cross section σ, which is drawn along the momentum axis. Owing to the shortening of longitudinal dimensions, all the quarks in the contracted tube will now communicate easily via exchange of massless gluons, while their communication in the transverse direction will not be affected. Lorentz contraction will simultaneously increase the longitudinal momentum components of the quarks due to the uncertainty principle and reduce the strength of their interactions due to asymptotic freedom. Thus the quarks in a Lorentz-contracted tube will behave like a free Fermi gas, except for clustering of quarks into weakly interacting nucleons which reduces their total

Fermi energy. The total momentum of the tube will therefore be distributed among its constituent nucleons according to phase-space rules.

Momentum distribution of quarks in a tube is given as follows.

$$q_t(x_{qt}) = \int_0^1 \int_0^1 q_N(x_{qN}) N_t(x_{Nt}) \delta(x - x_{qN}x_{Nt}) dx_{qN} dx_{Nt} \qquad (A.1)$$

where

x_{qN} $= P_q/P_N$; momentum fraction of quark in nucleon,

x_{Nt} $= P_N/P_t$; momentum fraction of nucleon in tube,

x_{qt} $= P_q/P_t$; momentum fraction of quark in tube,

$N_t(x_{Nt})$; momentum distribution of nucleons in a tube.

The $q_N(x)$ is extracted from deep-inelastic scattering of leptons on nucleons and it can be expressed in the following way under the assumption of isospin invariance $d_n = u_p$ and $u_n = d_p$:

$$u_p(x) = d_n(x) = \frac{36}{16}\frac{(1-x)^3}{\sqrt{x}}, \qquad (A.2)$$

$$d_p(x) = u_n(x) = \frac{315}{256}\frac{(1-x)^4}{\sqrt{x}}, \qquad (A.3)$$

and $N_t(x)$ is derived from the phase-space density $P(x)$ as follows.

$$N_t(x) = \frac{iP(x)}{\int P(x)dx} \simeq i(2i-1)(2i-2)x(1-x)^{2i-3}, \qquad (A.4)$$

$$P(x)dx = \int_{i-1} \cdots \int_1 \prod_{j=1}^{i} \frac{d^3p_j}{2E_j} \delta\left(E - E_i - \sum_{k=1}^{i-1} E_k\right), \qquad (A.5)$$

where

$$E - E_i \cong E - xE = (1-x)E.$$

From these equations we obtain the structure functions of quarks in a tube of i protons;

$$\tilde{u}_i(x) = \frac{36}{16}\frac{3}{2i+1}\frac{(1-x)^{2i+1}}{\sqrt{x}}F(2.5, 2i-2, 2i+2; 1-x), \tag{A.6}$$

$$\tilde{d}_i(x) = \frac{315}{256}\frac{12}{(2i+1)(2i+2)}\frac{(1-x)^{2i+2}}{\sqrt{x}}F(3.5, 2i-2, 2i+3; 1-x). \tag{A.7}$$

Then the structure function of quarks in a tube which contains $(Z/A)i$ protons and $[(A-Z)/A]i$ neutrons can be expressed as

$$u_i(x) = \frac{Z}{A}\tilde{u}_i(x) + \frac{A-Z}{A}\tilde{d}_i(x), \tag{A.8}$$

$$d_i(x) = \frac{Z}{A}\tilde{d}_i(x) + \frac{A-Z}{A}\tilde{u}_i(x). \tag{A.9}$$

F(a,b,c;z) is the confluent hypergeometric function, represented by the integral

$$F(a,b,c;z) = \frac{1}{B(b,c-b)}\int_0^1 t^{b-1}(1-t)^{c-b-1}(1-tz)^{-a}dt, \tag{A.10}$$

where

$$B(u,v) = \frac{\Gamma(u)\Gamma(v)}{\Gamma(u+v)}. \tag{A.11}$$

A.2 Production of particles with large-x and small P_T on nuclei

Here, we discuss the production of particles with large-x and small P_T on nuclei before discussing backward hadron production. At first we adopt the following quark picture of production of hadrons with large-x and small P_T by high-energy incident hadrons. A fragmentation of an incident hadron occurs when one of its constituents collides with a target nucleon. Its other constituents can either escape inelastic collisions within the target and retain their original fractions x of the incident momentum (spectators) or suffer collisions which change their nature and/or momentum (wounded quarks). The constituents hadronize by fragmentation and recombination with other constituents newly produced or already present in the target or in the projectile. Hadrons with large x are mainly produced through the fragmentation and recombination of the valence quarks of the projectile. Because of large values of x, x distribution of gluons and sea quarks is very small compared with that of valence quarks.

Let us first consider production of particles that have only a single valence quark in common with the projectile, such as $pp \to \pi^{\pm} + X$. The produced particle can then be formed through a direct recombination of the valence quark from the projectile with a sea quark. If this valence quark has not lost momentum via collisions in the target, then the x distribution of the produced hadron is given by the x distribution of the valence quark in the projectile, i.e.,

$$\sigma_T(p \to M) = C_M^q(\sigma_{pT} - \sigma_{qT})q_p(x), \tag{A.12}$$

where $\sigma_T(p \to M)$ stands either for $E(d^3\sigma/dp^3)(pT \to M)$ at a fixed P_T or for its integral over P_T. C_M^q is a constant that depends on the specific recombination process, $q_p(x)$ is the x distribution of valence quark q in p. T and M denote the target particle and a meson, respectively.

A.3 Cross sections of backward hadron production

For backward production on nuclear target, the quark-parton model describes the following picture. When a high-energy projectile collides with a nucleus, it interacts with all the nucleons that lie within a tube of cross section σ drawn along its straight path through the nucleus. Ignoring "friction forces", the rest of the nucleus except those in the tube is inactive during the collision and acts as a spectator. Ignoring also the cascading of reaction products inside the spectator part of the nucleus, we can express a nondiffractive inelastic cross section of a nucleus as a sum of tube cross sections;

$$\sigma_A(a \to b) = \frac{\sigma^A}{\sigma}\sum_{i=1}^{A} P(i, A)\sigma_i(a \to b), \tag{A.13}$$

where

σ^A/σ	: effective number of nuclear tubes,
$P(i, A)$	: probability of finding a tube of i nucleons in a nucleus of mass-number A,
$\sigma_i(a \to b)$	: cross section for $a \to b$ on such a tube.

Particles that are produced in the laboratory with large angles in the rest frame of the projectile a look like large-x and small P_T particles that are produced by a high-energy tube i incident on a. In particular,

$$\sigma_i(a \to b(180^\circ)) = \sigma_a(i \to b(0^\circ)). \tag{A.14}$$

Neglecting the contributions from wounded quarks, we may write from the discussion of the previous section,

$$\sigma_a(i \to \pi^+) = C(\sigma_{ap} - \sigma_{qa})u_i(x) \tag{A.15}$$

and

$$\sigma_a(i \to \pi^-) = C(\sigma_{ap} - \sigma_{qa})d_i(x), \tag{A.16}$$

where x is now the momentum fraction of quark in the tube i (in the projectile-rest frame) that is carried by the π,

$$C \simeq C_\pi^u \simeq C_\pi^d \tag{A.17}$$

is a recombination factor, and u_i, d_i are quark distribution functions. σ_{pp},σ_{qp} are pp,qp absorption cross sections, respectively. The factor $(\sigma_{ap} - \sigma_{qa})$ means the cross section when one quark escapes the collision with a while the remaining diquark suffers the collision. This equation have been written under the assumption that each quark in the tube penetrates through all the nucleons in front of it. If we take into account that a quark from a nucleon in a tube that recombines into the produced hadron must escape collisions with all the nucleons in front of it, including those in the projectile, we must rewrite the equation as

$$\sigma_a(i \to \pi^+) = C\gamma(i)(\sigma_{ap} - \sigma_{qa})u_i(x) \tag{A.18}$$

and

$$\sigma_a(i \to \pi^-) = C\gamma(i)(\sigma_{ap} - \sigma_{qa})d_i(x) \tag{A.19}$$

where

$$\gamma(i) = \frac{9}{14i}[6 - 7(\frac{2}{3})^i + (\frac{2}{9})^i]. \tag{A.20}$$

$\gamma(i)$ has been normalized such that $\gamma(1) = 1$. It is derived under the assumption that the probability of a quark colliding when a proton hits another proton is $\sigma_{qp}/\sigma_{pp} = \frac{1}{3}$. We thus arrive at the result

$$\sigma_A(a \to \pi^+(180°)) = \frac{2}{3}C\sigma_{aA}\sum_{i=1}^{A} P(i, A)\gamma(i)u_i(x) \tag{A.21}$$

$$\sigma_A(a \to \pi^-(180°)) = \frac{2}{3}C\sigma_{aA}\sum_{i=1}^{A} P(i, A)\gamma(i)d_i(x). \tag{A.22}$$

Moreover, if we assume factorization of the x distribution and the P_T distribution of the valence quarks within the nucleon, then since the Fermi momentum of nucleons within nuclei is approximately small and constant over the periodic table, we may also write for small P_T,

$$\sigma_A(a \to \pi^+) = f(P_T)\sigma_A(a \to \pi^+(180°)), \tag{A.23}$$

$$\sigma_A(a \to \pi^-) = f(P_T)\sigma_A(a \to \pi^-(180°)). \tag{A.24}$$

$f(P_T)$ can be obtained as empirical P_T distribution of the produced hadrons from experiments. For *pp* collisions this can be well represented by the function

$$f(P_T) = \frac{[\exp(-10P_T^2) + 0.45\exp(-2.7P_T^2)]}{1.45}, \quad (P_T \text{ in } GeV/c). \tag{A.25}$$

This function is derived in ref. 24.

Finally, the cross sections of backward pion production is expressed

$$\sigma_A(a \to \pi^+) = \frac{2}{3} C f(P_T) \sigma_{aA} \sum_{i=1}^{A} P(i, A) \gamma(i) u_i(x) , \tag{A.26}$$

$$\sigma_A(a \to \pi^-) = \frac{2}{3} C f(P_T) \sigma_{aA} \sum_{i=1}^{A} P(i, A) \gamma(i) d_i(x) , \tag{A.27}$$

where

C : recombination factor,

f : empirically reduced P_T distribution of quark(s) in a nucleon,

σ_{aA} : the total cross section of the reaction aA.

$P(i, A)$: probability of finding a tube of i nucleons in a nucleus of mass number A,

$\gamma(i)$: attenuation factor of a quark in a tube; the quark that recombines into the produced hadron must escape collisions with all the nucleons in front of it,

$u_i(x), d_i(x)$: u and d quark distribution in nuclei viewed from high momentum frame.

The contributions from wounded quarks, i.e., quarks that have suffered collisions within the nucleus, is neglected since they are rather small.

For the case of backward proton production, the cross section can be described as

$$\sigma_A(a \to p) = C f(P_T) \sigma_{aA} \sum_{i=1}^{A} P(i, A) [(1/3) \gamma_D(i) D_i(x) + (2/3) \gamma_D(i) D_i^1(x)] , \tag{A.28}$$

$$\gamma_D(i) = \frac{9}{14i} \left[3 - 7 \left(\frac{1}{3} \right)^i + 4 \left(\frac{2}{9} \right)^i \right] , \tag{A.29}$$

where $D_i(x)(D_i^1(x))$ is a spin-singlet diquark (wounded diquark)$(ud)_0$ distribution function in the i nucleon tube. $\gamma_D(i)$ is an attenuation factor of the diquark in the tube.

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Tables

Momentum range	1.0 - 4.3 GeV/c
Production target	
Target nuclei	Be , W
Target size	1.0 $\phi\times$ 15 mm^3
Central production angle	10°
Solid angle acceptance	0.6 msr
Horizontal acceptance	9 mr
Vertical acceptance	21 mr
Momentum bite	$\pm$ 1.0 %
Intermediate focus	
Dispersion	-1.08 cm/% ($\Delta p/p$)
At target position	
Beam size	2 cm ϕ (4 GeV/c)

Table 2.1: Characterristics of the $\pi 2$ beam line

Beam counter	size
S0	$80\times 80\times 10$ mm^3
S1	$100\times 100\times 10$ mm^3
S2	$50\times 50\times 10$ mm^3
S3	$20\phi\times 1$ mm^3
GC1/GC2	$165\phi\times 930$ mm long

Table 2.2: Characteristics of beam-line counters

Sensitive area	10×10 mm
Spectral response	
Range	$320 \sim 1120$ nm
Peak wave length	980 nm
wafer thickness	$500 \mu m$
Typical dark current	8 nA
Depletion voltage	100 V
Breakdown voltage	150 V
Breakdown current	2 mA

Table 2.3: Characteristics of PD

Anode read out chambers (BC1-BC4)	
effective area	$128 \times 128 \mathrm{mm}^2$
channel #	64 ch
anode wire	2.0 mm spacing; W(Au) 20 $\mu\phi$
cathode wire	1.5 mm spacing; Cu(Be) 125 $\mu\phi$
anode cathode gap	6.0 mm
operation voltage	4.8 kV
typical efficiency	99%
gas	Ar : C_4H_{10} : freon : methylal
	= 52.3 : 34.0 : 0.5 : 13.2 %
BC1/BC4 for Y coordinate, BC2/BC3 for X coordinate	

Table 2.4: Characteristics of BMWPCs

Sensitive area	28 × 28 mm
Stripe pitch	500μm
No. of stripes	56
Stripe length	28000μm
Stripe width	400μm
Stripe gap	100μm
Leakage current	15 (at 50 V) nA
Breakdown Voltage	75 V
Stripe capacitance	17 (at 30 V) pF
Depletion Voltage	30 V
Wafer thickness	200μm

Table 2.5: Characteristics of SMDs

Aperture	inside diameter	1420 mmϕ
	length	2060 mm
Maximum field		3 kG
Coil	maximum current	2450 A
	maximum voltage	192 V
	maximum power	472 kW
	resistance	78.5 mΩ
Weight		20 ton

Table 2.6: Characteristics of OHSHO

Cylindrical hodoscope	
CDH	$1200 \times 200 \times 20\text{mm}^3$: 24 unit
CDH time resolution	300 psec (rms)

Table 2.7: Characteristics of the CDH

Total volume	1240 $\phi\times$ 1260 mm^3
Total weight	550 kg
Effective area	R_{min} = 140 mm ; R_{max} = 490 mm
	Z = 1200 mm
Sense wires	864 wires ; nichrome 25 μm ϕ
	staggering $\pm$ 200 μm
	tension 60 grams
	read out channel 424
Potential wire	936 wires ; Mo(Au) 125μm ϕ
	tension 200 grams
Field shaping wire	1488 wires ; Mo(Au) 125μm ϕ
Total tension	540 kg
Electric field	1.1 kV/cm
No. of sectors	24 (15°$\times$ 24)
Gas	Ar : ethane = 50 : 50 %
Typical resolution	300 μ m for drift distance
	1.2 cm for charge division
	1.5 mm (SD) for vertex resolution in R-ϕ plane.

Table 2.8: Characteristics of the CDC

Target	A	Z	t	ρ	d
			(cm)	(g/cm^3)	(g/cm^2)
^{6}Li	6.00	3	3.6	0.462	1.66
C	12.01	6	0.3	1.74	0.52
			0.6		1.04
			1.1		1.91
Al	26.98	13	0.2	2.70	0.54
			0.4		1.08
Cu	63.54	29	0.05	8.96	0.45
			0.1		0.90
Sn	118.69	50	0.1	7.31	0.73
			0.2		1.46
Pb	207.19	82	0.05	11.25	0.57
			0.1		1.14

radius $3.2cm$

($3.0cm$ for ^{6}Li)

Table 2.9: Characteristics of targets

4 GeV/c plus charged beam	
p	63.4 ± 0.3 %
π^+	26.9 ± 0.2 %
K^+	2.0 ± 0.1 %
e, μ	6.4 ± 0.1 %
4 GeV/c minus charged beam	
π^-	67.9 ± 0.5 %
K^-	6.4 ± 0.1 %
e, μ	24.7 ± 0.2 %

Table 3.1: Average species of the beam particles

		Standard deviation
BC1	X	0.38 mm
BC1	Y	0.39
BC2	X	0.53
BC2	Y	0.53
SMD1	X	0.11
SMD1	Y	0.11
SMD2	X	0.10
SMD2	Y	0.10

Table 3.2: Standard deviation of residual distribution between hit points and tracks

Calibration constants		Accuracy	Calibration method
g_{TDC}	Conversion gain of TDC	$\pm 0.5ns$	Test pulse.
α	Time slewing coefficient	$\pm 70\mu m$	Test pulse .
T_0	The origin of the drift time	$\pm 50\mu m$	Tracks crossing the sense wire plane.
V_p	Propagation velocity on wire	$\pm 10\%$	Straight tracks.
v	Drift velocity	$\pm 0.2\%$	Tracks crossing the field wire plane.
θ_L	Lorentz angle	$\pm 10\%$	Fixed by theory.
ADC^{ped}	Pedestal of ADC	$\pm 1ch$	Test pulse.
g_{rel}	Relative analogue gain	$\pm 2\%$	Track fitting in RZ plane.
g_{abs}	Analogue gain to each layer	$\pm 2\%$	Pulse heights in the same track

Table 3.3: Caliblation constants for the CDC

Particle = π Target = Li $36mm$ $\rho = 0.46g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	99.41	99.41	99.39	99.41	99.41	99.39	99.36	99.31
	0.15	0.11	0.00	0.11	0.15	0.19	0.24	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
125.	124.49	124.49	124.47	124.49	124.49	124.47	124.44	124.40
	0.13	0.10	0.00	0.10	0.13	0.17	0.21	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
150.	149.54	149.55	149.53	149.55	149.54	149.53	149.50	149.47
	0.12	0.09	0.00	0.09	0.12	0.15	0.19	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
175.	174.59	174.59	174.57	174.59	174.59	174.57	174.55	174.51
	0.11	0.08	0.00	0.08	0.11	0.14	0.17	0.22
	0.	0.	0.	0.	0.	0.	0.	0.
200.	199.62	199.62	199.61	199.62	199.62	199.61	199.58	199.55
	0.10	0.07	0.00	0.07	0.10	0.13	0.16	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
225.	224.65	224.65	224.63	224.65	224.65	224.63	224.61	224.58
	0.09	0.07	0.00	0.07	0.09	0.12	0.15	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
250.	249.67	249.67	249.66	249.67	249.67	249.66	249.64	249.61
	0.09	0.06	0.00	0.06	0.09	0.11	0.14	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
275.	274.69	274.69	274.68	274.69	274.69	274.68	274.66	274.63
	0.08	0.06	0.00	0.06	0.08	0.10	0.13	0.17
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.71	299.71	299.70	299.71	299.71	299.70	299.68	299.66
	0.08	0.06	0.00	0.06	0.08	0.10	0.12	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.72	324.72	324.71	324.72	324.72	324.71	324.70	324.67
	0.07	0.05	0.00	0.05	0.07	0.09	0.11	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.74	349.74	349.73	349.74	349.74	349.73	349.71	349.69
	0.07	0.05	0.00	0.05	0.07	0.09	0.11	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.75	374.75	374.74	374.75	374.75	374.74	374.73	374.71
	0.06	0.05	0.00	0.05	0.06	0.08	0.10	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.76	399.76	399.76	399.76	399.76	399.76	399.74	399.72
	0.06	0.05	0.00	0.05	0.06	0.08	0.10	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.78	424.78	424.77	424.78	424.78	424.77	424.76	424.74
	0.06	0.04	0.00	0.04	0.06	0.07	0.09	0.12
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.79	449.79	449.78	449.79	449.79	449.78	449.77	449.75
	0.06	0.04	0.00	0.04	0.06	0.07	0.09	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.80	474.80	474.79	474.80	474.80	474.79	474.78	474.76
	0.05	0.04	0.00	0.04	0.05	0.07	0.08	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.81	499.81	499.80	499.81	499.81	499.80	499.79	499.77
	0.05	0.04	0.00	0.04	0.05	0.06	0.08	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.82	524.82	524.81	524.82	524.82	524.81	524.80	524.78
	0.05	0.04	0.00	0.04	0.05	0.06	0.08	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.83	549.83	549.82	549.83	549.83	549.82	549.81	549.79
	0.05	0.03	0.00	0.03	0.05	0.06	0.07	0.09
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.83	574.83	574.83	574.83	574.83	574.83	574.82	574.80
	0.04	0.03	0.00	0.03	0.04	0.05	0.07	0.09
	0.	0.	0.	0.	0.	0.	0.	0.

Table 4.1: Estimation of energy loss in the target

Particle = π Target = C $3mm$ $\rho = 1.7g/cm^3$

Ek (MeV)	Angle (deg.) → / Ek' (MeV) / deviation (MeV) / stopping event	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
100.	Ek'	99.26	98.55	97.30	98.55	99.26	99.50	99.61	99.67
	deviation	0.43	0.85	0.00	0.85	0.43	0.30	0.23	0.19
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
125.	Ek'	124.36	123.73	122.64	123.73	124.36	124.56	124.66	124.71
	deviation	0.38	0.74	0.00	0.74	0.38	0.26	0.20	0.17
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
150.	Ek'	149.42	148.86	147.88	148.86	149.42	149.60	149.69	149.74
	deviation	0.34	0.67	0.00	0.67	0.34	0.23	0.18	0.15
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
175.	Ek'	174.47	173.95	173.05	173.95	174.47	174.64	174.72	174.76
	deviation	0.31	0.61	0.00	0.61	0.31	0.21	0.17	0.14
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
200.	Ek'	199.51	199.03	198.19	199.03	199.51	199.66	199.74	199.78
	deviation	0.29	0.57	0.00	0.57	0.29	0.20	0.15	0.13
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
225.	Ek'	224.54	224.09	223.31	224.09	224.54	224.68	224.75	224.79
	deviation	0.27	0.53	0.00	0.53	0.27	0.19	0.15	0.12
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
250.	Ek'	249.56	249.14	248.40	249.14	249.56	249.70	249.77	249.81
	deviation	0.26	0.50	0.00	0.50	0.26	0.18	0.14	0.11
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
275.	Ek'	274.59	274.19	273.49	274.19	274.59	274.72	274.78	274.82
	deviation	0.24	0.47	0.00	0.47	0.24	0.17	0.13	0.11
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
300.	Ek'	299.61	299.23	298.56	299.23	299.61	299.73	299.79	299.82
	deviation	0.23	0.45	0.00	0.45	0.23	0.16	0.12	0.10
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
325.	Ek'	324.62	324.26	323.63	324.26	324.62	324.74	324.80	324.83
	deviation	0.22	0.43	0.00	0.43	0.22	0.15	0.12	0.10
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
350.	Ek'	349.64	349.30	348.69	349.30	349.64	349.75	349.81	349.84
	deviation	0.21	0.41	0.00	0.41	0.21	0.14	0.11	0.09
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
375.	Ek'	374.66	374.33	373.75	374.33	374.66	374.77	374.82	374.85
	deviation	0.20	0.39	0.00	0.39	0.20	0.14	0.11	0.09
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
400.	Ek'	399.67	399.35	398.80	399.35	399.67	399.77	399.82	399.85
	deviation	0.19	0.38	0.00	0.38	0.19	0.13	0.10	0.09
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
425.	Ek'	424.68	424.38	423.84	424.38	424.68	424.78	424.83	424.86
	deviation	0.19	0.36	0.00	0.36	0.19	0.13	0.10	0.08
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
450.	Ek'	449.70	449.40	448.89	449.40	449.70	449.79	449.84	449.86
	deviation	0.18	0.35	0.00	0.35	0.18	0.12	0.10	0.08
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
475.	Ek'	474.71	474.43	473.93	474.43	474.71	474.80	474.84	474.87
	deviation	0.17	0.34	0.00	0.34	0.17	0.12	0.09	0.08
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
500.	Ek'	499.72	499.45	498.97	499.45	499.72	499.81	499.85	499.87
	deviation	0.17	0.32	0.00	0.32	0.17	0.11	0.09	0.07
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
525.	Ek'	524.73	524.47	524.01	524.47	524.73	524.81	524.86	524.88
	deviation	0.16	0.31	0.00	0.31	0.16	0.11	0.09	0.07
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
550.	Ek'	549.74	549.49	549.04	549.49	549.74	549.82	549.86	549.88
	deviation	0.15	0.30	0.00	0.30	0.15	0.11	0.08	0.07
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.
575.	Ek'	574.75	574.50	574.08	574.50	574.75	574.83	574.87	574.89
	deviation	0.15	0.29	0.00	0.29	0.15	0.10	0.08	0.07
	stopping event	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = C $6mm$ $\rho = 1.7g/cm^3$

Ek (MeV)	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Angle (deg.) — Ek' (MeV) / deviation (MeV) / stopping event							
100.	98.52	97.92	97.30	97.92	98.52	98.99	99.21	99.34
	0.87	0.89	0.00	0.89	0.87	0.60	0.46	0.39
	0.	0.	0.	0.	0.	0.	0.	0.
125.	123.71	123.18	122.64	123.18	123.71	124.12	124.31	124.42
	0.76	0.78	0.00	0.78	0.76	0.52	0.40	0.34
	0.	0.	0.	0.	0.	0.	0.	0.
150.	148.84	148.36	147.88	148.36	148.84	149.21	149.38	149.48
	0.68	0.70	0.00	0.70	0.68	0.47	0.36	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.94	173.50	173.05	173.50	173.94	174.27	174.43	174.52
	0.63	0.64	0.00	0.64	0.63	0.43	0.33	0.28
	0.	0.	0.	0.	0.	0.	0.	0.
200.	199.01	198.61	198.19	198.61	199.01	199.32	199.47	199.56
	0.58	0.60	0.00	0.60	0.58	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
225.	224.07	223.69	223.31	223.69	224.07	224.37	224.51	224.59
	0.54	0.56	0.00	0.56	0.54	0.37	0.29	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
250.	249.13	248.77	248.40	248.77	249.13	249.40	249.54	249.61
	0.51	0.53	0.00	0.53	0.51	0.35	0.27	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
275.	274.17	273.83	273.49	273.83	274.17	274.43	274.56	274.63
	0.49	0.50	0.00	0.50	0.49	0.33	0.26	0.22
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.21	298.89	298.56	298.89	299.21	299.46	299.58	299.65
	0.46	0.47	0.00	0.47	0.46	0.32	0.25	0.21
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.25	323.94	323.63	323.94	324.25	324.49	324.60	324.66
	0.44	0.45	0.00	0.45	0.44	0.30	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.28	348.99	348.69	348.99	349.28	349.51	349.62	349.68
	0.42	0.43	0.00	0.43	0.42	0.29	0.22	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.31	374.03	373.75	374.03	374.31	374.53	374.63	374.69
	0.40	0.41	0.00	0.41	0.40	0.28	0.22	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.34	399.07	398.80	399.07	399.34	399.55	399.65	399.71
	0.39	0.40	0.00	0.40	0.39	0.27	0.21	0.17
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.37	424.11	423.84	424.11	424.37	424.57	424.66	424.72
	0.37	0.38	0.00	0.38	0.37	0.26	0.20	0.17
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.39	449.14	448.89	449.14	449.39	449.58	449.68	449.73
	0.36	0.37	0.00	0.37	0.36	0.25	0.19	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.41	474.18	473.93	474.18	474.41	474.60	474.69	474.74
	0.34	0.35	0.00	0.35	0.34	0.24	0.18	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.44	499.21	498.97	499.21	499.44	499.61	499.70	499.75
	0.33	0.34	0.00	0.34	0.33	0.23	0.18	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.46	524.23	524.01	524.23	524.46	524.63	524.71	524.76
	0.32	0.33	0.00	0.33	0.32	0.22	0.17	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.48	549.26	549.04	549.26	549.48	549.64	549.72	549.77
	0.31	0.32	0.00	0.32	0.31	0.21	0.16	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.49	574.29	574.08	574.29	574.49	574.65	574.73	574.77
	0.30	0.30	0.00	0.30	0.30	0.20	0.16	0.13
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = C 11mm $\rho = 1.7g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	97.90	97.63	97.30	97.63	97.90	98.20	98.56	98.79
	0.96	0.76	0.00	0.76	0.96	1.02	0.85	0.71
	0.	0.	0.	0.	0.	0.	0.	0.
125.	123.17	122.93	122.64	122.93	123.17	123.42	123.74	123.94
	0.84	0.66	0.00	0.66	0.84	0.89	0.74	0.62
	0.	0.	0.	0.	0.	0.	0.	0.
150.	148.35	148.14	147.88	148.14	148.35	148.58	148.87	149.05
	0.75	0.59	0.00	0.59	0.75	0.80	0.67	0.56
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.49	173.29	173.05	173.29	173.49	173.70	173.96	174.13
	0.69	0.54	0.00	0.54	0.69	0.73	0.61	0.51
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.60	198.41	198.19	198.41	198.60	198.79	199.03	199.19
	0.64	0.50	0.00	0.50	0.64	0.68	0.57	0.48
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.68	223.51	223.31	223.51	223.68	223.87	224.10	224.24
	0.60	0.47	0.00	0.47	0.60	0.64	0.53	0.45
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.76	248.60	248.40	248.60	248.76	248.93	249.15	249.28
	0.56	0.45	0.00	0.45	0.56	0.60	0.50	0.42
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.83	273.67	273.49	273.67	273.83	273.99	274.19	274.32
	0.53	0.42	0.00	0.42	0.53	0.57	0.48	0.40
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.88	298.74	298.56	298.74	298.88	299.04	299.23	299.36
	0.51	0.40	0.00	0.40	0.51	0.54	0.45	0.38
	0.	0.	0.	0.	0.	0.	0.	0.
325.	323.93	323.80	323.63	323.80	323.93	324.08	324.27	324.39
	0.48	0.38	0.00	0.38	0.48	0.52	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.98	348.85	348.69	348.85	348.98	349.13	349.30	349.41
	0.46	0.37	0.00	0.37	0.46	0.49	0.41	0.35
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.02	373.90	373.75	373.90	374.02	374.16	374.33	374.44
	0.44	0.35	0.00	0.35	0.44	0.47	0.39	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.06	398.94	398.80	398.94	399.06	399.20	399.36	399.46
	0.43	0.34	0.00	0.34	0.43	0.45	0.38	0.32
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.10	423.99	423.84	423.99	424.10	424.23	424.38	424.48
	0.41	0.32	0.00	0.32	0.41	0.44	0.36	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.14	449.02	448.89	449.02	449.14	449.26	449.41	449.50
	0.39	0.31	0.00	0.31	0.39	0.42	0.35	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.17	474.06	473.93	474.06	474.17	474.29	474.43	474.52
	0.38	0.30	0.00	0.30	0.38	0.40	0.34	0.28
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.20	499.10	498.97	499.10	499.20	499.31	499.45	499.54
	0.36	0.29	0.00	0.29	0.36	0.39	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.23	524.13	524.01	524.13	524.23	524.34	524.47	524.55
	0.35	0.28	0.00	0.28	0.35	0.37	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.26	549.16	549.04	549.16	549.26	549.36	549.49	549.57
	0.34	0.27	0.00	0.27	0.34	0.36	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.28	574.19	574.08	574.19	574.28	574.38	574.51	574.59
	0.33	0.26	0.00	0.26	0.33	0.35	0.29	0.24
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = Al $2mm$ $\rho = 2.7g/cm^3$

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	99.14	98.30	95.25	98.30	99.14	99.41	99.54	99.62
	0.51	1.00	0.00	1.00	0.51	0.35	0.27	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
125.	124.24	123.51	120.83	123.51	124.24	124.48	124.60	124.66
	0.45	0.88	0.00	0.88	0.45	0.30	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
150.	149.31	148.65	146.23	148.65	149.31	149.53	149.64	149.69
	0.40	0.80	0.00	0.80	0.40	0.28	0.21	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
175.	174.37	173.75	171.52	173.75	174.37	174.57	174.66	174.72
	0.37	0.74	0.00	0.74	0.37	0.25	0.20	0.17
	0.	0.	0.	0.	0.	0.	0.	0.
200.	199.41	198.83	196.75	198.83	199.41	199.60	199.69	199.74
	0.35	0.69	0.00	0.69	0.35	0.24	0.19	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
225.	224.44	223.90	221.94	223.90	224.44	224.62	224.70	224.75
	0.33	0.65	0.00	0.65	0.33	0.22	0.17	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
250.	249.47	248.96	247.10	248.96	249.47	249.64	249.72	249.76
	0.31	0.61	0.00	0.61	0.31	0.21	0.17	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
275.	274.50	274.01	272.23	274.01	274.50	274.65	274.73	274.77
	0.30	0.59	0.00	0.59	0.30	0.20	0.16	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.52	299.05	297.35	299.05	299.52	299.67	299.74	299.78
	0.28	0.56	0.00	0.56	0.28	0.19	0.15	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.54	324.09	322.46	324.09	324.54	324.68	324.75	324.79
	0.27	0.54	0.00	0.54	0.27	0.19	0.15	0.12
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.55	349.12	347.55	349.12	349.55	349.69	349.76	349.80
	0.26	0.52	0.00	0.52	0.26	0.18	0.14	0.12
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.57	374.15	372.64	374.15	374.57	374.71	374.77	374.81
	0.25	0.50	0.00	0.50	0.25	0.17	0.13	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.58	399.18	397.72	399.18	399.58	399.72	399.78	399.81
	0.24	0.48	0.00	0.48	0.24	0.17	0.13	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.60	424.21	422.80	424.21	424.60	424.72	424.79	424.82
	0.24	0.47	0.00	0.47	0.24	0.16	0.13	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.61	449.23	447.86	449.23	449.61	449.73	449.79	449.83
	0.23	0.45	0.00	0.45	0.23	0.16	0.12	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.62	474.26	472.93	474.26	474.62	474.74	474.80	474.83
	0.22	0.44	0.00	0.44	0.22	0.15	0.12	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.63	499.28	497.99	499.28	499.63	499.75	499.80	499.84
	0.22	0.43	0.00	0.43	0.22	0.15	0.11	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.64	524.30	523.05	524.30	524.64	524.76	524.81	524.84
	0.21	0.41	0.00	0.41	0.21	0.14	0.11	0.09
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.65	549.32	548.10	549.32	549.65	549.76	549.82	549.85
	0.20	0.40	0.00	0.40	0.20	0.14	0.11	0.09
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.66	574.34	573.15	574.34	574.66	574.77	574.82	574.85
	0.20	0.39	0.00	0.39	0.20	0.14	0.11	0.09
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = Al $4mm$ $\rho = 2.7g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	98.28	96.90	95.25	96.90	98.28	98.82	99.09	99.23
	1.02	1.63	0.00	1.63	1.02	0.69	0.54	0.45
	0.	0.	0.	0.	0.	0.	0.	0.
125.	123.48	122.28	120.83	122.28	123.48	123.96	124.19	124.32
	0.89	1.43	0.00	1.43	0.89	0.61	0.47	0.40
	0.	0.	0.	0.	0.	0.	0.	0.
150.	148.63	147.54	146.23	147.54	148.63	149.06	149.27	149.39
	0.81	1.29	0.00	1.29	0.81	0.55	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.73	172.73	171.52	172.73	173.73	174.13	174.33	174.44
	0.75	1.19	0.00	1.19	0.75	0.51	0.40	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.82	197.88	196.75	197.88	198.82	199.19	199.37	199.47
	0.70	1.11	0.00	1.11	0.70	0.48	0.37	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.88	223.00	221.94	223.00	223.88	224.24	224.41	224.50
	0.66	1.05	0.00	1.05	0.66	0.45	0.35	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.94	248.10	247.10	248.10	248.94	249.28	249.44	249.53
	0.62	0.99	0.00	0.99	0.62	0.43	0.33	0.28
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.99	273.19	272.23	273.19	273.99	274.31	274.46	274.55
	0.59	0.95	0.00	0.95	0.59	0.41	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.03	298.27	297.35	298.27	299.03	299.34	299.49	299.57
	0.57	0.91	0.00	0.91	0.57	0.39	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.07	323.34	322.46	323.34	324.07	324.37	324.51	324.59
	0.55	0.87	0.00	0.87	0.55	0.37	0.29	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.11	348.40	347.55	348.40	349.11	349.39	349.52	349.60
	0.53	0.84	0.00	0.84	0.53	0.36	0.28	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.14	373.46	372.64	373.46	374.14	374.41	374.54	374.62
	0.51	0.81	0.00	0.81	0.51	0.35	0.27	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.17	398.51	397.72	398.51	399.17	399.43	399.56	399.63
	0.49	0.78	0.00	0.78	0.49	0.34	0.26	0.22
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.19	423.56	422.80	423.56	424.19	424.45	424.57	424.64
	0.47	0.76	0.00	0.76	0.47	0.32	0.25	0.21
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.22	448.60	447.86	448.60	449.22	449.47	449.59	449.65
	0.46	0.73	0.00	0.73	0.46	0.31	0.24	0.21
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.24	473.65	472.93	473.65	474.24	474.48	474.60	474.66
	0.45	0.71	0.00	0.71	0.45	0.30	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.27	498.69	497.99	498.69	499.27	499.50	499.61	499.67
	0.43	0.69	0.00	0.69	0.43	0.30	0.23	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.29	523.72	523.05	523.72	524.29	524.51	524.62	524.68
	0.42	0.67	0.00	0.67	0.42	0.29	0.22	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.31	548.76	548.10	548.76	549.31	549.53	549.63	549.69
	0.41	0.65	0.00	0.65	0.41	0.28	0.22	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.33	573.79	573.15	573.79	574.33	574.54	574.64	574.70
	0.40	0.63	0.00	0.63	0.40	0.27	0.21	0.18
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = Cu 0.5mm $\rho = 8.9g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	99.22	98.47	82.17	98.47	99.22	99.47	99.59	99.65
	0.46	0.90	0.00	0.90	0.46	0.31	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
125.	124.31	123.65	109.51	123.65	124.31	124.53	124.64	124.69
	0.40	0.80	0.00	0.80	0.40	0.28	0.21	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
150.	149.38	148.77	136.02	148.77	149.38	149.57	149.67	149.72
	0.37	0.73	0.00	0.73	0.37	0.25	0.20	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
175.	174.42	173.86	162.10	173.86	174.42	174.60	174.69	174.74
	0.34	0.67	0.00	0.67	0.34	0.23	0.18	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
200.	199.46	198.93	187.93	198.93	199.46	199.63	199.71	199.76
	0.32	0.63	0.00	0.63	0.32	0.22	0.17	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
225.	224.48	223.98	213.59	223.98	224.48	224.65	224.73	224.77
	0.30	0.60	0.00	0.60	0.30	0.21	0.16	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
250.	249.51	249.03	239.14	249.03	249.51	249.66	249.74	249.78
	0.29	0.57	0.00	0.57	0.29	0.20	0.15	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
275.	274.53	274.07	264.61	274.07	274.53	274.68	274.75	274.79
	0.28	0.55	0.00	0.55	0.28	0.19	0.15	0.12
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.55	299.11	290.01	299.11	299.55	299.69	299.76	299.80
	0.27	0.53	0.00	0.53	0.27	0.18	0.14	0.12
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.56	324.14	315.37	324.14	324.56	324.70	324.77	324.80
	0.26	0.51	0.00	0.51	0.26	0.18	0.14	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.58	349.17	340.69	349.17	349.58	349.71	349.78	349.81
	0.25	0.49	0.00	0.49	0.25	0.17	0.13	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.59	374.19	365.98	374.19	374.59	374.72	374.78	374.82
	0.24	0.48	0.00	0.48	0.24	0.17	0.13	0.11
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.60	399.22	391.25	399.22	399.60	399.73	399.79	399.82
	0.23	0.46	0.00	0.46	0.23	0.16	0.12	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.61	424.24	416.50	424.24	424.61	424.74	424.79	424.83
	0.23	0.45	0.00	0.45	0.23	0.16	0.12	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.62	449.26	441.73	449.26	449.62	449.74	449.80	449.83
	0.22	0.44	0.00	0.44	0.22	0.15	0.12	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.63	474.28	466.94	474.28	474.63	474.75	474.80	474.84
	0.22	0.43	0.00	0.43	0.22	0.15	0.11	0.10
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.64	499.29	492.14	499.29	499.64	499.75	499.81	499.84
	0.21	0.42	0.00	0.42	0.21	0.14	0.11	0.09
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.65	524.31	517.33	524.31	524.65	524.76	524.81	524.84
	0.21	0.41	0.00	0.41	0.21	0.14	0.11	0.09
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.66	549.33	542.51	549.33	549.66	549.77	549.82	549.85
	0.20	0.40	0.00	0.40	0.20	0.14	0.11	0.09
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.67	574.34	567.68	574.34	574.67	574.77	574.82	574.85
	0.20	0.39	0.00	0.39	0.20	0.13	0.10	0.09
	0.	0.	0.	0.	0.	0.	0.	0.

	Particle = π Target = Cu $1mm$ $\rho = 8.9g/cm^3$							
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	98.44	96.92	82.17	96.92	98.44	98.94	99.17	99.31
	0.92	1.83	0.00	1.83	0.92	0.63	0.49	0.41
	0.	0.	0.	0.	0.	0.	0.	0.
125.	123.62	122.28	109.51	122.28	123.62	124.06	124.27	124.39
	0.81	1.61	0.00	1.61	0.81	0.55	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
150.	148.75	147.53	136.02	147.53	148.75	149.14	149.33	149.44
	0.74	1.46	0.00	1.46	0.74	0.50	0.39	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.84	172.71	162.10	172.71	173.84	174.21	174.38	174.48
	0.68	1.35	0.00	1.35	0.68	0.47	0.36	0.30
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.91	197.85	187.93	197.85	198.91	199.25	199.42	199.51
	0.64	1.27	0.00	1.27	0.64	0.44	0.34	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.97	222.96	213.59	222.96	223.97	224.29	224.45	224.54
	0.61	1.20	0.00	1.20	0.61	0.42	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
250.	249.02	248.06	239.14	248.06	249.02	249.33	249.48	249.56
	0.58	1.14	0.00	1.14	0.58	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
275.	274.06	273.14	264.61	273.14	274.06	274.36	274.50	274.58
	0.56	1.10	0.00	1.10	0.56	0.38	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.09	298.21	290.01	298.21	299.09	299.38	299.52	299.60
	0.53	1.05	0.00	1.05	0.53	0.37	0.28	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.13	323.28	315.37	323.28	324.13	324.40	324.53	324.61
	0.52	1.02	0.00	1.02	0.52	0.35	0.27	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.15	348.33	340.69	348.33	349.15	349.42	349.55	349.62
	0.50	0.98	0.00	0.98	0.50	0.34	0.27	0.22
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.18	373.38	365.98	373.38	374.18	374.44	374.56	374.63
	0.48	0.95	0.00	0.95	0.48	0.33	0.26	0.22
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.20	398.43	391.25	398.43	399.20	399.46	399.58	399.64
	0.47	0.92	0.00	0.92	0.47	0.32	0.25	0.21
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.23	423.47	416.50	423.47	424.23	424.47	424.59	424.65
	0.46	0.90	0.00	0.90	0.46	0.31	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.25	448.52	441.73	448.52	449.25	449.48	449.60	449.66
	0.44	0.87	0.00	0.87	0.44	0.30	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.27	473.55	466.94	473.55	474.27	474.50	474.61	474.67
	0.43	0.85	0.00	0.85	0.43	0.30	0.23	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.28	498.59	492.14	498.59	499.28	499.51	499.62	499.68
	0.42	0.83	0.00	0.83	0.42	0.29	0.22	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.30	523.62	517.33	523.62	524.30	524.52	524.63	524.69
	0.41	0.81	0.00	0.81	0.41	0.28	0.22	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.32	548.65	542.51	548.65	549.32	549.53	549.64	549.70
	0.40	0.79	0.00	0.79	0.40	0.28	0.21	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.33	573.68	567.68	573.68	574.33	574.54	574.65	574.70
	0.39	0.77	0.00	0.77	0.39	0.27	0.21	0.18
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = Sn $1mm$ $\rho = 7.3g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	98.73	97.48	85.55	97.48	98.73	99.13	99.32	99.43
	0.75	1.49	0.00	1.49	0.75	0.51	0.40	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
125.	123.87	122.77	112.36	122.77	123.87	124.23	124.40	124.50
	0.67	1.32	0.00	1.32	0.67	0.45	0.35	0.30
	0.	0.	0.	0.	0.	0.	0.	0.
150.	148.97	147.97	138.54	147.97	148.97	149.30	149.45	149.54
	0.61	1.20	0.00	1.20	0.61	0.42	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
175.	174.04	173.11	164.39	173.11	174.04	174.34	174.49	174.57
	0.56	1.11	0.00	1.11	0.56	0.39	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
200.	199.10	198.22	190.03	198.22	199.10	199.38	199.52	199.60
	0.53	1.05	0.00	1.05	0.53	0.36	0.28	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
225.	224.14	223.31	215.55	223.31	224.14	224.41	224.54	224.62
	0.50	1.00	0.00	1.00	0.50	0.35	0.27	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
250.	249.18	248.39	240.98	248.39	249.18	249.44	249.56	249.63
	0.48	0.95	0.00	0.95	0.48	0.33	0.26	0.22
	0.	0.	0.	0.	0.	0.	0.	0.
275.	274.21	273.45	266.35	273.45	274.21	274.46	274.58	274.65
	0.46	0.91	0.00	0.91	0.46	0.32	0.25	0.21
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.24	298.51	291.66	298.51	299.24	299.48	299.60	299.66
	0.45	0.88	0.00	0.88	0.45	0.31	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.27	323.55	316.94	323.55	324.27	324.50	324.61	324.67
	0.43	0.85	0.00	0.85	0.43	0.30	0.23	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.29	348.60	342.19	348.60	349.29	349.51	349.62	349.68
	0.42	0.83	0.00	0.83	0.42	0.29	0.22	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.31	373.64	367.41	373.64	374.31	374.53	374.63	374.69
	0.41	0.80	0.00	0.80	0.41	0.28	0.22	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.33	398.68	392.62	398.68	399.33	399.54	399.64	399.70
	0.40	0.78	0.00	0.78	0.40	0.27	0.21	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.35	423.71	417.81	423.71	424.35	424.55	424.65	424.71
	0.39	0.76	0.00	0.76	0.39	0.26	0.21	0.17
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.36	448.74	442.99	448.74	449.36	449.56	449.66	449.71
	0.38	0.74	0.00	0.74	0.38	0.26	0.20	0.17
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.38	473.77	468.15	473.77	474.38	474.57	474.67	474.72
	0.37	0.72	0.00	0.72	0.37	0.25	0.20	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.39	498.80	493.30	498.80	499.39	499.58	499.68	499.73
	0.36	0.71	0.00	0.71	0.36	0.25	0.19	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.40	523.82	518.45	523.82	524.40	524.59	524.68	524.73
	0.35	0.69	0.00	0.69	0.35	0.24	0.19	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.42	548.85	543.59	548.85	549.42	549.60	549.69	549.74
	0.34	0.68	0.00	0.68	0.34	0.24	0.18	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.43	573.87	568.72	573.87	574.43	574.61	574.70	574.74
	0.34	0.66	0.00	0.66	0.34	0.23	0.18	0.15
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = Sn $2mm$ $\rho = 7.3g/cm^3$

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	97.44	94.91	85.54	94.91	97.44	98.25	98.64	98.86
	1.51	3.03	0.00	3.03	1.51	1.03	0.80	0.67
	0.	0.	0.	0.	0.	0.	0.	0.
125.	122.73	120.51	112.35	120.51	122.73	123.45	123.80	123.99
	1.34	2.66	0.00	2.66	1.34	0.91	0.71	0.59
	0.	0.	0.	0.	0.	0.	0.	0.
150.	147.93	145.91	138.53	145.91	147.93	148.59	148.90	149.08
	1.22	2.42	0.00	2.42	1.22	0.83	0.65	0.54
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.08	171.20	164.38	171.20	173.08	173.69	173.98	174.14
	1.13	2.24	0.00	2.24	1.13	0.77	0.60	0.50
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.19	196.43	190.03	196.43	198.19	198.76	199.04	199.19
	1.07	2.11	0.00	2.11	1.07	0.73	0.57	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.28	221.61	215.54	221.61	223.28	223.83	224.09	224.23
	1.01	2.00	0.00	2.00	1.01	0.69	0.54	0.45
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.36	246.76	240.97	246.76	248.36	248.88	249.13	249.27
	0.97	1.91	0.00	1.91	0.97	0.66	0.51	0.43
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.42	271.89	266.34	271.89	273.42	273.92	274.16	274.30
	0.93	1.83	0.00	1.83	0.93	0.63	0.49	0.41
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.48	297.00	291.65	297.00	298.48	298.96	299.19	299.32
	0.89	1.77	0.00	1.77	0.89	0.61	0.48	0.40
	0.	0.	0.	0.	0.	0.	0.	0.
325.	323.53	322.10	316.93	322.10	323.53	324.00	324.22	324.34
	0.87	1.71	0.00	1.71	0.87	0.59	0.46	0.39
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.58	347.19	342.18	347.19	348.58	349.03	349.24	349.36
	0.84	1.65	0.00	1.65	0.84	0.57	0.45	0.37
	0.	0.	0.	0.	0.	0.	0.	0.
375.	373.62	372.27	367.41	372.27	373.62	374.05	374.26	374.38
	0.81	1.61	0.00	1.61	0.81	0.56	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
400.	398.65	397.35	392.62	397.35	398.65	399.08	399.28	399.40
	0.79	1.56	0.00	1.56	0.79	0.54	0.42	0.35
	0.	0.	0.	0.	0.	0.	0.	0.
425.	423.69	422.41	417.80	422.41	423.69	424.10	424.30	424.42
	0.77	1.52	0.00	1.52	0.77	0.53	0.41	0.34
	0.	0.	0.	0.	0.	0.	0.	0.
450.	448.72	447.48	442.98	447.48	448.72	449.12	449.32	449.43
	0.75	1.49	0.00	1.49	0.75	0.52	0.40	0.34
	0.	0.	0.	0.	0.	0.	0.	0.
475.	473.75	472.54	468.14	472.54	473.75	474.15	474.34	474.44
	0.74	1.45	0.00	1.45	0.74	0.50	0.39	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
500.	498.78	497.59	493.30	497.59	498.78	499.16	499.35	499.45
	0.72	1.42	0.00	1.42	0.72	0.49	0.38	0.32
	0.	0.	0.	0.	0.	0.	0.	0.
525.	523.80	522.64	518.44	522.64	523.80	524.18	524.36	524.47
	0.70	1.39	0.00	1.39	0.70	0.48	0.37	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
550.	548.83	547.69	543.58	547.69	548.83	549.20	549.38	549.48
	0.69	1.36	0.00	1.36	0.69	0.47	0.37	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
575.	573.85	572.74	568.71	572.74	573.85	574.22	574.39	574.49
	0.68	1.33	0.00	1.33	0.68	0.46	0.36	0.30
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = Pb 0.5mm ρ = 11.3g/cm^3

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	99.00	98.03	76.78	98.03	99.00	99.32	99.47	99.56
	0.59	1.16	0.00	1.16	0.59	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
125.	124.11	123.25	104.86	123.25	124.11	124.40	124.53	124.61
	0.52	1.03	0.00	1.03	0.52	0.36	0.28	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
150.	149.19	148.40	131.79	148.40	149.19	149.45	149.57	149.64
	0.48	0.94	0.00	0.94	0.48	0.33	0.25	0.21
	0.	0.	0.	0.	0.	0.	0.	0.
175.	174.25	173.51	158.15	173.51	174.25	174.48	174.60	174.66
	0.44	0.88	0.00	0.88	0.44	0.30	0.24	0.20
	0.	0.	0.	0.	0.	0.	0.	0.
200.	199.29	198.60	184.18	198.60	199.29	199.51	199.62	199.68
	0.42	0.83	0.00	0.83	0.42	0.29	0.22	0.19
	0.	0.	0.	0.	0.	0.	0.	0.
225.	224.32	223.67	209.99	223.67	224.32	224.54	224.64	224.70
	0.40	0.79	0.00	0.79	0.40	0.27	0.21	0.18
	0.	0.	0.	0.	0.	0.	0.	0.
250.	249.35	248.72	235.65	248.72	249.35	249.56	249.66	249.71
	0.38	0.75	0.00	0.75	0.38	0.26	0.20	0.17
	0.	0.	0.	0.	0.	0.	0.	0.
275.	274.38	273.77	261.21	273.77	274.38	274.57	274.67	274.72
	0.37	0.72	0.00	0.72	0.37	0.25	0.20	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
300.	299.40	298.81	286.70	298.81	299.40	299.59	299.68	299.73
	0.36	0.70	0.00	0.70	0.36	0.24	0.19	0.16
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.42	323.85	312.12	323.85	324.42	324.60	324.69	324.74
	0.34	0.68	0.00	0.68	0.34	0.24	0.18	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.43	348.88	337.50	348.88	349.43	349.61	349.70	349.75
	0.33	0.66	0.00	0.66	0.33	0.23	0.18	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.45	373.91	362.85	373.91	374.45	374.62	374.71	374.75
	0.33	0.64	0.00	0.64	0.33	0.22	0.17	0.15
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.46	398.94	388.16	398.94	399.46	399.63	399.71	399.76
	0.32	0.62	0.00	0.62	0.32	0.22	0.17	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.47	423.96	413.44	423.96	424.47	424.64	424.72	424.77
	0.31	0.61	0.00	0.61	0.31	0.21	0.16	0.14
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.49	448.99	438.71	448.99	449.49	449.65	449.73	449.77
	0.30	0.60	0.00	0.60	0.30	0.21	0.16	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.50	474.01	463.95	474.01	474.50	474.66	474.73	474.78
	0.30	0.58	0.00	0.58	0.30	0.20	0.16	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.51	499.03	489.18	499.03	499.51	499.66	499.74	499.78
	0.29	0.57	0.00	0.57	0.29	0.20	0.15	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.52	524.05	514.40	524.05	524.52	524.67	524.74	524.78
	0.28	0.56	0.00	0.56	0.28	0.19	0.15	0.13
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.53	549.07	539.60	549.07	549.53	549.68	549.75	549.79
	0.28	0.55	0.00	0.55	0.28	0.19	0.15	0.12
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.54	574.08	564.80	574.08	574.54	574.68	574.75	574.79
	0.27	0.54	0.00	0.54	0.27	0.19	0.15	0.12
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = π Target = Pb $1mm$ $\rho = 11.3g/cm^3$

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	98.00	96.03	76.78	96.03	98.00	98.64	98.94	99.11
	1.18	2.35	0.00	2.35	1.18	0.81	0.63	0.52
	0.	0.	0.	0.	0.	0.	0.	0.
125.	123.23	121.49	104.86	121.49	123.23	123.79	124.06	124.21
	1.05	2.08	0.00	2.08	1.05	0.71	0.56	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
150.	148.38	146.79	131.79	146.79	148.38	148.89	149.14	149.28
	0.96	1.89	0.00	1.89	0.96	0.65	0.51	0.43
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.49	172.02	158.15	172.02	173.49	173.97	174.20	174.33
	0.89	1.76	0.00	1.76	0.89	0.61	0.47	0.40
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.58	197.19	184.18	197.19	198.58	199.03	199.24	199.36
	0.84	1.66	0.00	1.66	0.84	0.57	0.45	0.37
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.64	222.33	209.99	222.33	223.64	224.07	224.28	224.40
	0.80	1.58	0.00	1.58	0.80	0.55	0.42	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.70	247.44	235.65	247.44	248.70	249.11	249.31	249.42
	0.76	1.51	0.00	1.51	0.76	0.52	0.41	0.34
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.75	272.54	261.21	272.54	273.75	274.15	274.34	274.44
	0.74	1.45	0.00	1.45	0.74	0.50	0.39	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.79	297.62	286.70	297.62	298.79	299.18	299.36	299.46
	0.71	1.40	0.00	1.40	0.71	0.49	0.38	0.32
	0.	0.	0.	0.	0.	0.	0.	0.
325.	323.83	322.70	312.12	322.70	323.83	324.20	324.38	324.48
	0.69	1.36	0.00	1.36	0.69	0.47	0.37	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.86	347.76	337.50	347.76	348.86	349.22	349.40	349.49
	0.67	1.32	0.00	1.32	0.67	0.46	0.36	0.30
	0.	0.	0.	0.	0.	0.	0.	0.
375.	373.90	372.82	362.85	372.82	373.90	374.24	374.41	374.51
	0.65	1.28	0.00	1.28	0.65	0.44	0.35	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
400.	398.92	397.88	388.16	397.88	398.92	399.26	399.43	399.52
	0.63	1.25	0.00	1.25	0.63	0.43	0.34	0.28
	0.	0.	0.	0.	0.	0.	0.	0.
425.	423.95	422.93	413.44	422.93	423.95	424.28	424.44	424.53
	0.62	1.22	0.00	1.22	0.62	0.42	0.33	0.28
	0.	0.	0.	0.	0.	0.	0.	0.
450.	448.97	447.98	438.71	447.98	448.97	449.30	449.45	449.54
	0.61	1.19	0.00	1.19	0.61	0.41	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
475.	473.99	473.02	463.95	473.02	473.99	474.31	474.47	474.55
	0.59	1.17	0.00	1.17	0.59	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.02	498.06	489.18	498.06	499.02	499.33	499.48	499.56
	0.58	1.14	0.00	1.14	0.58	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.03	523.10	514.40	523.10	524.03	524.34	524.49	524.57
	0.57	1.12	0.00	1.12	0.57	0.39	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.05	548.13	539.60	548.13	549.05	549.35	549.50	549.58
	0.56	1.10	0.00	1.10	0.56	0.38	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.07	573.17	564.80	573.17	574.07	574.36	574.51	574.59
	0.55	1.08	0.00	1.08	0.55	0.37	0.29	0.24
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Li $36mm$ $\rho = 0.46g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	97.22	97.23	97.14	97.23	97.22	97.14	96.97	96.73
	0.72	0.54	0.00	0.54	0.72	0.91	1.16	1.50
	0.	0.	0.	0.	0.	0.	0.	0.
125.	122.76	122.77	122.69	122.77	122.76	122.69	122.56	122.37
	0.58	0.43	0.00	0.43	0.58	0.73	0.93	1.20
	0.	0.	0.	0.	0.	0.	0.	0.
150.	148.11	148.12	148.05	148.12	148.11	148.06	147.95	147.78
	0.49	0.36	0.00	0.36	0.49	0.62	0.78	1.01
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.36	173.36	173.31	173.36	173.36	173.31	173.21	173.07
	0.42	0.32	0.00	0.32	0.42	0.54	0.68	0.88
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.54	198.54	198.49	198.54	198.54	198.50	198.41	198.29
	0.38	0.28	0.00	0.28	0.38	0.48	0.61	0.78
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.68	223.68	223.64	223.68	223.68	223.64	223.56	223.45
	0.34	0.25	0.00	0.25	0.34	0.43	0.55	0.71
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.79	248.79	248.75	248.79	248.79	248.75	248.68	248.58
	0.31	0.23	0.00	0.23	0.31	0.40	0.50	0.65
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.88	273.88	273.85	273.88	273.88	273.85	273.78	273.69
	0.29	0.22	0.00	0.22	0.29	0.37	0.46	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.96	298.96	298.92	298.96	298.96	298.92	298.86	298.78
	0.27	0.20	0.00	0.20	0.27	0.34	0.43	0.56
	0.	0.	0.	0.	0.	0.	0.	0.
325.	324.02	324.02	323.99	324.02	324.02	323.99	323.93	323.85
	0.25	0.19	0.00	0.19	0.25	0.32	0.41	0.52
	0.	0.	0.	0.	0.	0.	0.	0.
350.	349.07	349.08	349.04	349.08	349.07	349.05	348.99	348.91
	0.24	0.18	0.00	0.18	0.24	0.30	0.38	0.49
	0.	0.	0.	0.	0.	0.	0.	0.
375.	374.12	374.12	374.09	374.12	374.12	374.09	374.04	373.97
	0.23	0.17	0.00	0.17	0.23	0.29	0.36	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
400.	399.16	399.16	399.13	399.16	399.16	399.14	399.09	399.02
	0.22	0.16	0.00	0.16	0.22	0.27	0.35	0.45
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.20	424.20	424.17	424.20	424.20	424.17	424.13	424.06
	0.21	0.15	0.00	0.15	0.21	0.26	0.33	0.43
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.23	449.23	449.20	449.23	449.23	449.21	449.16	449.10
	0.20	0.15	0.00	0.15	0.20	0.25	0.32	0.41
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.26	474.26	474.23	474.26	474.26	474.24	474.19	474.13
	0.19	0.14	0.00	0.14	0.19	0.24	0.31	0.40
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.28	499.29	499.26	499.29	499.28	499.26	499.22	499.16
	0.18	0.14	0.00	0.14	0.18	0.23	0.30	0.38
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.31	524.31	524.29	524.31	524.31	524.29	524.25	524.19
	0.18	0.13	0.00	0.13	0.18	0.23	0.29	0.37
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.33	549.33	549.31	549.33	549.33	549.31	549.27	549.21
	0.17	0.13	0.00	0.13	0.17	0.22	0.28	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.35	574.35	574.33	574.35	574.35	574.33	574.29	574.24
	0.17	0.13	0.00	0.13	0.17	0.21	0.27	0.35
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = C $3mm$ $\rho = 1.7g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	96.62	93.22	87.16	93.22	96.62	97.70	98.22	98.51
	2.01	4.04	0.00	4.04	2.01	1.36	1.06	0.88
	0.	0.	0.	0.	0.	0.	0.	0.
125.	122.27	119.59	114.82	119.59	122.27	123.14	123.56	123.79
	1.62	3.20	0.00	3.20	1.62	1.10	0.85	0.71
	0.	0.	0.	0.	0.	0.	0.	0.
150.	147.70	145.45	141.47	145.45	147.70	148.43	148.78	148.98
	1.36	2.68	0.00	2.68	1.36	0.93	0.72	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
175.	173.00	171.04	167.60	171.04	173.00	173.63	173.94	174.11
	1.18	2.32	0.00	2.32	1.18	0.81	0.63	0.53
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.21	196.48	193.43	196.48	198.21	198.78	199.05	199.21
	1.05	2.06	0.00	2.06	1.05	0.72	0.56	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.38	221.82	219.06	221.82	223.38	223.90	224.14	224.28
	0.95	1.86	0.00	1.86	0.95	0.65	0.51	0.42
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.52	247.08	244.56	247.08	248.52	248.99	249.21	249.34
	0.87	1.71	0.00	1.71	0.87	0.60	0.46	0.39
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.63	272.30	269.97	272.30	273.63	274.06	274.27	274.39
	0.81	1.58	0.00	1.58	0.81	0.55	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.72	297.48	295.30	297.48	298.72	299.12	299.32	299.43
	0.76	1.48	0.00	1.48	0.76	0.52	0.40	0.34
	0.	0.	0.	0.	0.	0.	0.	0.
325.	323.79	322.63	320.58	322.63	323.79	324.17	324.36	324.46
	0.71	1.39	0.00	1.39	0.71	0.49	0.38	0.32
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.86	347.76	345.82	347.76	348.86	349.22	349.39	349.49
	0.67	1.31	0.00	1.31	0.67	0.46	0.36	0.30
	0.	0.	0.	0.	0.	0.	0.	0.
375.	373.91	372.87	371.03	372.87	373.91	374.26	374.42	374.52
	0.64	1.25	0.00	1.25	0.64	0.44	0.34	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
400.	398.96	397.96	396.21	397.96	398.96	399.29	399.45	399.54
	0.61	1.19	0.00	1.19	0.61	0.42	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
425.	424.01	423.05	421.37	423.05	424.01	424.32	424.47	424.56
	0.59	1.14	0.00	1.14	0.59	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.05	448.13	446.51	448.13	449.05	449.35	449.49	449.57
	0.56	1.10	0.00	1.10	0.56	0.38	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.08	473.19	471.64	473.19	474.08	474.37	474.51	474.59
	0.54	1.06	0.00	1.06	0.54	0.37	0.29	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.11	498.26	496.75	498.26	499.11	499.39	499.53	499.60
	0.52	1.02	0.00	1.02	0.52	0.36	0.28	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.14	523.31	521.86	523.31	524.14	524.41	524.54	524.62
	0.51	0.99	0.00	0.99	0.51	0.35	0.27	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.17	548.36	546.95	548.36	549.17	549.43	549.56	549.63
	0.49	0.96	0.00	0.96	0.49	0.34	0.26	0.22
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.19	573.41	572.04	573.41	574.19	574.45	574.57	574.64
	0.48	0.93	0.00	0.93	0.48	0.33	0.25	0.21
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = C 6mm $\rho = 1.7 g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	93.09	90.15	87.16	90.15	93.09	95.33	96.39	96.98
	4.15	4.29	0.00	4.29	4.15	2.79	2.15	1.79
	0.	0.	0.	0.	0.	0.	0.	0.
125.	119.48	117.17	114.82	117.17	119.48	121.25	122.10	122.57
	3.28	3.39	0.00	3.39	3.28	2.23	1.72	1.44
	0.	0.	0.	0.	0.	0.	0.	0.
150.	145.36	143.43	141.47	143.43	145.36	146.84	147.55	147.95
	2.75	2.83	0.00	2.83	2.75	1.87	1.45	1.21
	0.	0.	0.	0.	0.	0.	0.	0.
175.	170.97	169.30	167.60	169.30	170.97	172.25	172.87	173.21
	2.38	2.45	0.00	2.45	2.38	1.63	1.26	1.06
	0.	0.	0.	0.	0.	0.	0.	0.
200.	196.42	194.94	193.43	194.94	196.42	197.55	198.10	198.41
	2.11	2.18	0.00	2.18	2.11	1.45	1.12	0.94
	0.	0.	0.	0.	0.	0.	0.	0.
225.	221.76	220.42	219.06	220.42	221.76	222.79	223.28	223.56
	1.91	1.97	0.00	1.97	1.91	1.31	1.02	0.85
	0.	0.	0.	0.	0.	0.	0.	0.
250.	247.03	245.81	244.56	245.81	247.03	247.97	248.42	248.68
	1.75	1.80	0.00	1.80	1.75	1.20	0.93	0.78
	0.	0.	0.	0.	0.	0.	0.	0.
275.	272.25	271.12	269.97	271.12	272.25	273.12	273.54	273.77
	1.62	1.67	0.00	1.67	1.62	1.11	0.86	0.72
	0.	0.	0.	0.	0.	0.	0.	0.
300.	297.43	296.38	295.30	296.38	297.43	298.24	298.63	298.85
	1.51	1.55	0.00	1.55	1.51	1.04	0.81	0.68
	0.	0.	0.	0.	0.	0.	0.	0.
325.	322.58	321.59	320.58	321.59	322.58	323.35	323.71	323.92
	1.42	1.46	0.00	1.46	1.42	0.97	0.76	0.64
	0.	0.	0.	0.	0.	0.	0.	0.
350.	347.71	346.78	345.82	346.78	347.71	348.44	348.78	348.98
	1.34	1.38	0.00	1.38	1.34	0.92	0.72	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
375.	372.83	371.94	371.03	371.94	372.83	373.51	373.84	374.03
	1.28	1.31	0.00	1.31	1.28	0.88	0.68	0.57
	0.	0.	0.	0.	0.	0.	0.	0.
400.	397.93	397.08	396.21	397.08	397.93	398.58	398.90	399.07
	1.22	1.25	0.00	1.25	1.22	0.84	0.65	0.55
	0.	0.	0.	0.	0.	0.	0.	0.
425.	423.01	422.20	421.37	422.20	423.01	423.64	423.94	424.11
	1.17	1.20	0.00	1.20	1.17	0.80	0.62	0.52
	0.	0.	0.	0.	0.	0.	0.	0.
450.	448.09	447.31	446.51	447.31	448.09	448.69	448.98	449.15
	1.12	1.15	0.00	1.15	1.12	0.77	0.60	0.50
	0.	0.	0.	0.	0.	0.	0.	0.
475.	473.16	472.41	471.64	472.41	473.16	473.74	474.02	474.18
	1.08	1.11	0.00	1.11	1.08	0.74	0.58	0.48
	0.	0.	0.	0.	0.	0.	0.	0.
500.	498.22	497.50	496.75	497.50	498.22	498.78	499.05	499.21
	1.04	1.07	0.00	1.07	1.04	0.72	0.56	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
525.	523.28	522.57	521.86	522.57	523.28	523.82	524.08	524.23
	1.01	1.04	0.00	1.04	1.01	0.69	0.54	0.45
	0.	0.	0.	0.	0.	0.	0.	0.
550.	548.33	547.65	546.95	547.65	548.33	548.86	549.11	549.25
	0.98	1.01	0.00	1.01	0.98	0.67	0.52	0.44
	0.	0.	0.	0.	0.	0.	0.	0.
575.	573.38	572.71	572.04	572.71	573.38	573.89	574.14	574.28
	0.95	0.98	0.00	0.98	0.95	0.65	0.51	0.43
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = C 11mm ρ = 1.7g/cm^3								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	90.05	88.75	87.16	88.75	90.05	91.48	93.25	94.38
	4.61	3.63	0.00	3.63	4.61	4.93	4.06	3.37
	0.	0.	0.	0.	0.	0.	0.	0.
125.	117.10	116.07	114.82	116.07	117.10	118.23	119.61	120.50
	3.63	2.86	0.00	2.86	3.63	3.88	3.21	2.68
	0.	0.	0.	0.	0.	0.	0.	0.
150.	143.38	142.52	141.47	142.52	143.38	144.32	145.47	146.21
	3.03	2.39	0.00	2.39	3.03	3.24	2.69	2.25
	0.	0.	0.	0.	0.	0.	0.	0.
175.	169.26	168.51	167.60	168.51	169.26	170.07	171.06	171.70
	2.63	2.07	0.00	2.07	2.63	2.80	2.33	1.95
	0.	0.	0.	0.	0.	0.	0.	0.
200.	194.90	194.24	193.43	194.24	194.90	195.62	196.50	197.07
	2.33	1.84	0.00	1.84	2.33	2.49	2.07	1.73
	0.	0.	0.	0.	0.	0.	0.	0.
225.	220.39	219.79	219.06	219.79	220.39	221.04	221.83	222.35
	2.10	1.66	0.00	1.66	2.10	2.25	1.87	1.57
	0.	0.	0.	0.	0.	0.	0.	0.
250.	245.77	245.23	244.56	245.23	245.77	246.37	247.10	247.57
	1.93	1.52	0.00	1.52	1.93	2.06	1.71	1.44
	0.	0.	0.	0.	0.	0.	0.	0.
275.	271.09	270.58	269.97	270.58	271.09	271.64	272.31	272.75
	1.78	1.41	0.00	1.41	1.78	1.90	1.59	1.33
	0.	0.	0.	0.	0.	0.	0.	0.
300.	296.35	295.88	295.30	295.88	296.35	296.86	297.49	297.90
	1.66	1.31	0.00	1.31	1.66	1.78	1.48	1.24
	0.	0.	0.	0.	0.	0.	0.	0.
325.	321.57	321.12	320.58	321.12	321.57	322.05	322.64	323.02
	1.56	1.23	0.00	1.23	1.56	1.67	1.39	1.17
	0.	0.	0.	0.	0.	0.	0.	0.
350.	346.75	346.33	345.82	346.33	346.75	347.21	347.77	348.13
	1.48	1.17	0.00	1.17	1.48	1.58	1.32	1.10
	0.	0.	0.	0.	0.	0.	0.	0.
375.	371.91	371.51	371.03	371.51	371.91	372.35	372.88	373.22
	1.41	1.11	0.00	1.11	1.41	1.50	1.25	1.05
	0.	0.	0.	0.	0.	0.	0.	0.
400.	397.05	396.67	396.21	396.67	397.05	397.47	397.97	398.30
	1.34	1.06	0.00	1.06	1.34	1.43	1.19	1.00
	0.	0.	0.	0.	0.	0.	0.	0.
425.	422.18	421.81	421.37	421.81	422.18	422.57	423.06	423.37
	1.28	1.01	0.00	1.01	1.28	1.37	1.14	0.96
	0.	0.	0.	0.	0.	0.	0.	0.
450.	447.29	446.94	446.51	446.94	447.29	447.67	448.14	448.44
	1.23	0.97	0.00	0.97	1.23	1.32	1.10	0.92
	0.	0.	0.	0.	0.	0.	0.	0.
475.	472.39	472.05	471.64	472.05	472.39	472.75	473.20	473.49
	1.19	0.94	0.00	0.94	1.19	1.27	1.06	0.89
	0.	0.	0.	0.	0.	0.	0.	0.
500.	497.48	497.15	496.75	497.15	497.48	497.83	498.26	498.54
	1.15	0.91	0.00	0.91	1.15	1.23	1.02	0.86
	0.	0.	0.	0.	0.	0.	0.	0.
525.	522.56	522.24	521.86	522.24	522.56	522.90	523.32	523.59
	1.11	0.88	0.00	0.88	1.11	1.19	0.99	0.83
	0.	0.	0.	0.	0.	0.	0.	0.
550.	547.63	547.32	546.95	547.32	547.63	547.96	548.37	548.63
	1.08	0.85	0.00	0.85	1.08	1.15	0.96	0.81
	0.	0.	0.	0.	0.	0.	0.	0.
575.	572.70	572.40	572.04	572.40	572.70	573.02	573.42	573.67
	1.05	0.83	0.00	0.83	1.05	1.12	0.93	0.78
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Al $2mm$ $\rho = 2.7g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	96.16	92.25	77.11	92.25	96.16	97.39	97.98	98.31
	2.29	4.68	0.00	4.68	2.29	1.55	1.20	1.00
	0.	0.	0.	0.	0.	0.	0.	0.
125.	121.90	118.81	107.19	118.81	121.90	122.89	123.36	123.63
	1.84	3.70	0.00	3.70	1.84	1.25	0.97	0.81
	0.	0.	0.	0.	0.	0.	0.	0.
150.	147.38	144.79	135.19	144.79	147.38	148.21	148.61	148.84
	1.55	3.10	0.00	3.10	1.55	1.05	0.82	0.69
	0.	0.	0.	0.	0.	0.	0.	0.
175.	172.72	170.47	162.20	170.47	172.72	173.44	173.79	173.98
	1.35	2.69	0.00	2.69	1.35	0.92	0.71	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
200.	197.96	195.97	188.65	195.97	197.96	198.61	198.92	199.09
	1.20	2.39	0.00	2.39	1.20	0.82	0.64	0.53
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.15	221.35	214.75	221.35	223.15	223.74	224.02	224.18
	1.09	2.16	0.00	2.16	1.09	0.74	0.58	0.48
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.30	246.65	240.61	246.65	248.30	248.84	249.10	249.24
	1.00	1.98	0.00	1.98	1.00	0.68	0.53	0.45
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.43	271.89	266.31	271.89	273.43	273.92	274.16	274.30
	0.93	1.84	0.00	1.84	0.93	0.63	0.49	0.41
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.53	297.09	291.88	297.09	298.53	298.99	299.22	299.34
	0.87	1.72	0.00	1.72	0.87	0.59	0.46	0.39
	0.	0.	0.	0.	0.	0.	0.	0.
325.	323.61	322.26	317.36	322.26	323.61	324.05	324.26	324.38
	0.82	1.61	0.00	1.61	0.82	0.56	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.69	347.41	342.77	347.41	348.69	349.10	349.30	349.41
	0.77	1.53	0.00	1.53	0.77	0.53	0.41	0.35
	0.	0.	0.	0.	0.	0.	0.	0.
375.	373.75	372.53	368.13	372.53	373.75	374.15	374.34	374.44
	0.74	1.45	0.00	1.45	0.74	0.50	0.39	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
400.	398.81	397.64	393.43	397.64	398.81	399.18	399.36	399.47
	0.70	1.39	0.00	1.39	0.70	0.48	0.37	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
425.	423.85	422.74	418.71	422.74	423.85	424.22	424.39	424.49
	0.68	1.33	0.00	1.33	0.68	0.46	0.36	0.30
	0.	0.	0.	0.	0.	0.	0.	0.
450.	448.90	447.83	443.95	447.83	448.90	449.25	449.41	449.51
	0.65	1.28	0.00	1.28	0.65	0.44	0.35	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
475.	473.94	472.90	469.16	472.90	473.94	474.27	474.43	474.53
	0.63	1.24	0.00	1.24	0.63	0.43	0.33	0.28
	0.	0.	0.	0.	0.	0.	0.	0.
500.	498.97	497.97	494.36	497.97	498.97	499.30	499.45	499.54
	0.61	1.20	0.00	1.20	0.61	0.41	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.00	523.03	519.53	523.03	524.00	524.32	524.47	524.56
	0.59	1.16	0.00	1.16	0.59	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.03	548.09	544.69	548.09	549.03	549.34	549.49	549.57
	0.57	1.12	0.00	1.12	0.57	0.39	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.06	573.14	569.84	573.14	574.06	574.36	574.50	574.58
	0.55	1.09	0.00	1.09	0.55	0.38	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Al $4mm$ $\rho = 2.7g/cm^3$

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	92.12	85.31	77.11	85.31	92.12	94.70	95.91	96.58
	4.76	7.99	0.00	7.99	4.76	3.17	2.44	2.03
	0.	0.	0.	0.	0.	0.	0.	0.
125.	118.71	113.47	107.19	113.47	118.71	120.74	121.70	122.24
	3.76	6.17	0.00	6.17	3.76	2.53	1.96	1.64
	0.	0.	0.	0.	0.	0.	0.	0.
150.	144.71	140.38	135.19	140.38	144.71	146.40	147.21	147.66
	3.15	5.11	0.00	5.11	3.15	2.13	1.65	1.38
	0.	0.	0.	0.	0.	0.	0.	0.
175.	170.40	166.67	162.20	166.67	170.40	171.87	172.57	172.96
	2.73	4.41	0.00	4.41	2.73	1.85	1.44	1.20
	0.	0.	0.	0.	0.	0.	0.	0.
200.	195.90	192.60	188.65	192.60	195.90	197.21	197.83	198.18
	2.43	3.90	0.00	3.90	2.43	1.65	1.28	1.07
	0.	0.	0.	0.	0.	0.	0.	0.
225.	221.29	218.31	214.75	218.31	221.29	222.47	223.03	223.35
	2.19	3.52	0.00	3.52	2.19	1.49	1.16	0.97
	0.	0.	0.	0.	0.	0.	0.	0.
250.	246.59	243.87	240.61	243.87	246.59	247.68	248.19	248.49
	2.01	3.22	0.00	3.22	2.01	1.37	1.07	0.89
	0.	0.	0.	0.	0.	0.	0.	0.
275.	271.84	269.32	266.31	269.32	271.84	272.84	273.32	273.59
	1.86	2.98	0.00	2.98	1.86	1.27	0.99	0.83
	0.	0.	0.	0.	0.	0.	0.	0.
300.	297.05	294.70	291.88	294.70	297.05	297.98	298.43	298.69
	1.74	2.79	0.00	2.79	1.74	1.19	0.92	0.77
	0.	0.	0.	0.	0.	0.	0.	0.
325.	322.22	320.01	317.36	320.01	322.22	323.10	323.52	323.76
	1.64	2.62	0.00	2.62	1.64	1.12	0.87	0.73
	0.	0.	0.	0.	0.	0.	0.	0.
350.	347.37	345.28	342.77	345.28	347.37	348.20	348.60	348.83
	1.55	2.48	0.00	2.48	1.55	1.06	0.82	0.69
	0.	0.	0.	0.	0.	0.	0.	0.
375.	372.50	370.51	368.13	370.51	372.50	373.29	373.67	373.88
	1.48	2.36	0.00	2.36	1.48	1.01	0.78	0.66
	0.	0.	0.	0.	0.	0.	0.	0.
400.	397.61	395.71	393.43	395.71	397.61	398.36	398.73	398.93
	1.41	2.25	0.00	2.25	1.41	0.96	0.75	0.63
	0.	0.	0.	0.	0.	0.	0.	0.
425.	422.71	420.88	418.71	420.88	422.71	423.43	423.78	423.98
	1.35	2.16	0.00	2.16	1.35	0.92	0.72	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
450.	447.79	446.04	443.95	446.04	447.79	448.49	448.83	449.02
	1.30	2.08	0.00	2.08	1.30	0.89	0.69	0.58
	0.	0.	0.	0.	0.	0.	0.	0.
475.	472.87	471.18	469.16	471.18	472.87	473.54	473.87	474.05
	1.26	2.00	0.00	2.00	1.26	0.86	0.67	0.56
	0.	0.	0.	0.	0.	0.	0.	0.
500.	497.94	496.31	494.36	496.31	497.94	498.59	498.91	499.08
	1.21	1.94	0.00	1.94	1.21	0.83	0.64	0.54
	0.	0.	0.	0.	0.	0.	0.	0.
525.	523.00	521.42	519.53	521.42	523.00	523.64	523.94	524.11
	1.18	1.88	0.00	1.88	1.18	0.80	0.63	0.52
	0.	0.	0.	0.	0.	0.	0.	0.
550.	548.06	546.53	544.69	546.53	548.06	548.68	548.97	549.14
	1.14	1.82	0.00	1.82	1.14	0.78	0.61	0.51
	0.	0.	0.	0.	0.	0.	0.	0.
575.	573.12	571.62	569.84	571.62	573.12	573.71	574.00	574.16
	1.11	1.77	0.00	1.77	1.11	0.76	0.59	0.50
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Cu 0.5mm $\rho = 8.9g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	96.62	93.20	0.00	93.20	96.62	97.71	98.22	98.51
	2.01	4.09	0.00	4.09	2.01	1.36	1.05	0.88
	0.	0.	51.	0.	0.	0.	0.	0.
125.	122.27	119.55	39.91	119.55	122.27	123.14	123.55	123.79
	1.62	3.25	0.00	3.25	1.62	1.10	0.85	0.72
	0.	0.	0.	0.	0.	0.	0.	0.
150.	147.68	145.40	89.09	145.40	147.68	148.42	148.77	148.97
	1.37	2.73	0.00	2.73	1.37	0.93	0.72	0.61
	0.	0.	0.	0.	0.	0.	0.	0.
175.	172.98	170.99	125.06	170.99	172.98	173.62	173.93	174.10
	1.20	2.38	0.00	2.38	1.20	0.82	0.63	0.53
	0.	0.	0.	0.	0.	0.	0.	0.
200.	198.19	196.42	156.88	196.42	198.19	198.77	199.04	199.20
	1.07	2.12	0.00	2.12	1.07	0.73	0.57	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
225.	223.36	221.76	186.66	221.76	223.36	223.88	224.13	224.27
	0.97	1.92	0.00	1.92	0.97	0.66	0.51	0.43
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.49	247.02	215.23	247.02	248.49	248.97	249.20	249.33
	0.89	1.76	0.00	1.76	0.89	0.61	0.47	0.40
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.60	272.23	243.02	272.23	273.60	274.04	274.25	274.38
	0.83	1.63	0.00	1.63	0.83	0.56	0.44	0.37
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.69	297.41	270.27	297.41	298.69	299.10	299.30	299.41
	0.77	1.53	0.00	1.53	0.77	0.53	0.41	0.34
	0.	0.	0.	0.	0.	0.	0.	0.
325.	323.76	322.56	297.12	322.56	323.76	324.15	324.34	324.45
	0.73	1.44	0.00	1.44	0.73	0.50	0.39	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.83	347.69	323.68	347.69	348.83	349.20	349.38	349.48
	0.69	1.36	0.00	1.36	0.69	0.47	0.37	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
375.	373.88	372.80	350.01	372.80	373.88	374.24	374.41	374.50
	0.66	1.30	0.00	1.30	0.66	0.45	0.35	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
400.	398.93	397.89	376.16	397.89	398.93	399.27	399.43	399.52
	0.63	1.24	0.00	1.24	0.63	0.43	0.33	0.28
	0.	0.	0.	0.	0.	0.	0.	0.
425.	423.97	422.98	402.16	422.98	423.97	424.30	424.45	424.54
	0.60	1.19	0.00	1.19	0.60	0.41	0.32	0.27
	0.	0.	0.	0.	0.	0.	0.	0.
450.	449.01	448.05	428.05	448.05	449.01	449.32	449.47	449.56
	0.58	1.15	0.00	1.15	0.58	0.40	0.31	0.26
	0.	0.	0.	0.	0.	0.	0.	0.
475.	474.05	473.12	453.83	473.12	474.05	474.35	474.49	474.57
	0.56	1.11	0.00	1.11	0.56	0.38	0.30	0.25
	0.	0.	0.	0.	0.	0.	0.	0.
500.	499.08	498.18	479.54	498.18	499.08	499.37	499.51	499.59
	0.54	1.07	0.00	1.07	0.54	0.37	0.29	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
525.	524.10	523.23	505.18	523.23	524.10	524.39	524.52	524.60
	0.53	1.04	0.00	1.04	0.53	0.36	0.28	0.24
	0.	0.	0.	0.	0.	0.	0.	0.
550.	549.13	548.28	530.75	548.28	549.13	549.40	549.54	549.61
	0.51	1.01	0.00	1.01	0.51	0.35	0.27	0.23
	0.	0.	0.	0.	0.	0.	0.	0.
575.	574.15	573.33	556.28	573.33	574.15	574.42	574.55	574.62
	0.50	0.98	0.00	0.98	0.50	0.34	0.27	0.22
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Cu $1mm$ $\rho = 8.9g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV) / deviation (MeV) / stopping event							
100.	93.09	85.70	0.00	85.70	93.09	95.34	96.40	96.99
	4.15	8.84	0.00	8.84	4.15	2.78	2.14	1.79
	0.	0.	51.	0.	0.	0.	0.	0.
125.	119.46	113.78	39.91	113.78	119.46	121.24	122.09	122.56
	3.30	6.79	0.00	6.79	3.30	2.23	1.73	1.44
	0.	0.	0.	0.	0.	0.	0.	0.
150.	145.33	140.62	89.09	140.62	145.33	146.82	147.53	147.93
	2.78	5.62	0.00	5.62	2.78	1.88	1.46	1.22
	0.	0.	0.	0.	0.	0.	0.	0.
175.	170.93	166.87	125.06	166.87	170.93	172.22	172.85	173.19
	2.41	4.85	0.00	4.85	2.41	1.64	1.27	1.07
	0.	0.	0.	0.	0.	0.	0.	0.
200.	196.37	192.77	156.88	192.77	196.37	197.52	198.08	198.39
	2.15	4.30	0.00	4.30	2.15	1.46	1.14	0.95
	0.	0.	0.	0.	0.	0.	0.	0.
225.	221.70	218.46	186.66	218.46	221.70	222.75	223.25	223.53
	1.95	3.88	0.00	3.88	1.95	1.33	1.03	0.86
	0.	0.	0.	0.	0.	0.	0.	0.
250.	246.97	244.00	215.23	244.00	246.97	247.93	248.39	248.65
	1.79	3.55	0.00	3.55	1.79	1.22	0.95	0.79
	0.	0.	0.	0.	0.	0.	0.	0.
275.	272.19	269.44	243.02	269.44	272.19	273.08	273.51	273.75
	1.66	3.29	0.00	3.29	1.66	1.13	0.88	0.74
	0.	0.	0.	0.	0.	0.	0.	0.
300.	297.37	294.80	270.27	294.80	297.37	298.20	298.60	298.83
	1.55	3.08	0.00	3.08	1.55	1.06	0.82	0.69
	0.	0.	0.	0.	0.	0.	0.	0.
325.	322.52	320.10	297.12	320.10	322.52	323.31	323.68	323.90
	1.46	2.90	0.00	2.90	1.46	1.00	0.78	0.65
	0.	0.	0.	0.	0.	0.	0.	0.
350.	347.65	345.36	323.68	345.36	347.65	348.39	348.75	348.95
	1.39	2.74	0.00	2.74	1.39	0.95	0.74	0.62
	0.	0.	0.	0.	0.	0.	0.	0.
375.	372.76	370.58	350.01	370.58	372.76	373.47	373.81	374.00
	1.32	2.61	0.00	2.61	1.32	0.90	0.70	0.59
	0.	0.	0.	0.	0.	0.	0.	0.
400.	397.86	395.77	376.16	395.77	397.86	398.54	398.86	399.05
	1.26	2.49	0.00	2.49	1.26	0.86	0.67	0.56
	0.	0.	0.	0.	0.	0.	0.	0.
425.	422.94	420.94	402.16	420.94	422.94	423.60	423.91	424.08
	1.21	2.39	0.00	2.39	1.21	0.83	0.64	0.54
	0.	0.	0.	0.	0.	0.	0.	0.
450.	448.02	446.10	428.05	446.10	448.02	448.65	448.95	449.12
	1.17	2.30	0.00	2.30	1.17	0.80	0.62	0.52
	0.	0.	0.	0.	0.	0.	0.	0.
475.	473.09	471.23	453.83	471.23	473.09	473.69	473.98	474.15
	1.13	2.22	0.00	2.22	1.13	0.77	0.60	0.50
	0.	0.	0.	0.	0.	0.	0.	0.
500.	498.15	496.35	479.54	496.35	498.15	498.74	499.02	499.18
	1.09	2.15	0.00	2.15	1.09	0.74	0.58	0.49
	0.	0.	0.	0.	0.	0.	0.	0.
525.	523.21	521.46	505.18	521.46	523.21	523.77	524.05	524.20
	1.06	2.09	0.00	2.09	1.06	0.72	0.56	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
550.	548.26	546.56	530.75	546.56	548.26	548.81	549.07	549.22
	1.03	2.03	0.00	2.03	1.03	0.70	0.55	0.46
	0.	0.	0.	0.	0.	0.	0.	0.
575.	573.30	571.65	556.28	571.65	573.30	573.84	574.10	574.24
	1.00	1.97	0.00	1.97	1.00	0.68	0.53	0.45
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Sn $1mm$ $\rho = 7.3g/cm^3$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Ek' (MeV)							
	deviation (MeV)							
	stopping event							
100.	94.46	88.68	0.00	88.68	94.46	96.26	97.10	97.58
	3.31	6.92	0.00	6.92	3.31	2.23	1.72	1.44
	0.	0.	51.	0.	0.	0.	0.	0.
125.	120.54	116.02	64.03	116.02	120.54	121.97	122.65	123.03
	2.65	5.41	0.00	5.41	2.65	1.80	1.39	1.16
	0.	0.	0.	0.	0.	0.	0.	0.
150.	146.23	142.46	103.01	142.46	146.23	147.43	148.01	148.33
	2.24	4.51	0.00	4.51	2.24	1.52	1.18	0.99
	0.	0.	0.	0.	0.	0.	0.	0.
175.	171.70	168.44	135.66	168.44	171.70	172.75	173.25	173.54
	1.95	3.90	0.00	3.90	1.95	1.33	1.03	0.86
	0.	0.	0.	0.	0.	0.	0.	0.
200.	197.06	194.16	165.70	194.16	197.06	197.99	198.44	198.69
	1.74	3.47	0.00	3.47	1.74	1.19	0.92	0.77
	0.	0.	0.	0.	0.	0.	0.	0.
225.	222.33	219.70	194.31	219.70	222.33	223.18	223.58	223.81
	1.58	3.14	0.00	3.14	1.58	1.08	0.84	0.70
	0.	0.	0.	0.	0.	0.	0.	0.
250.	247.54	245.13	222.06	245.13	247.54	248.32	248.70	248.91
	1.45	2.88	0.00	2.88	1.45	0.99	0.77	0.65
	0.	0.	0.	0.	0.	0.	0.	0.
275.	272.72	270.48	249.23	270.48	272.72	273.44	273.79	273.98
	1.35	2.67	0.00	2.67	1.35	0.92	0.71	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
300.	297.86	295.77	275.98	295.77	297.86	298.54	298.86	299.05
	1.26	2.50	0.00	2.50	1.26	0.86	0.67	0.56
	0.	0.	0.	0.	0.	0.	0.	0.
325.	322.98	321.02	302.44	321.02	322.98	323.62	323.93	324.10
	1.19	2.35	0.00	2.35	1.19	0.81	0.63	0.53
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.09	346.22	328.67	346.22	348.09	348.69	348.98	349.15
	1.13	2.23	0.00	2.23	1.13	0.77	0.60	0.50
	0.	0.	0.	0.	0.	0.	0.	0.
375.	373.18	371.40	354.72	371.40	373.18	373.75	374.03	374.19
	1.07	2.12	0.00	2.12	1.07	0.73	0.57	0.48
	0.	0.	0.	0.	0.	0.	0.	0.
400.	398.25	396.56	380.63	396.56	398.25	398.81	399.07	399.22
	1.03	2.03	0.00	2.03	1.03	0.70	0.55	0.46
	0.	0.	0.	0.	0.	0.	0.	0.
425.	423.32	421.69	406.43	421.69	423.32	423.85	424.11	424.25
	0.99	1.95	0.00	1.95	0.99	0.67	0.52	0.44
	0.	0.	0.	0.	0.	0.	0.	0.
450.	448.39	446.82	432.14	446.82	448.39	448.90	449.14	449.28
	0.95	1.88	0.00	1.88	0.95	0.65	0.51	0.42
	0.	0.	0.	0.	0.	0.	0.	0.
475.	473.44	471.92	457.76	471.92	473.44	473.93	474.17	474.30
	0.92	1.81	0.00	1.81	0.92	0.63	0.49	0.41
	0.	0.	0.	0.	0.	0.	0.	0.
500.	498.49	497.02	483.33	497.02	498.49	498.97	499.20	499.33
	0.89	1.76	0.00	1.76	0.89	0.61	0.47	0.40
	0.	0.	0.	0.	0.	0.	0.	0.
525.	523.53	522.11	508.83	522.11	523.53	524.00	524.22	524.35
	0.86	1.70	0.00	1.70	0.86	0.59	0.46	0.39
	0.	0.	0.	0.	0.	0.	0.	0.
550.	548.58	547.19	534.29	547.19	548.58	549.03	549.24	549.36
	0.84	1.66	0.00	1.66	0.84	0.57	0.45	0.37
	0.	0.	0.	0.	0.	0.	0.	0.
575.	573.61	572.27	559.71	572.27	573.61	574.05	574.26	574.38
	0.82	1.61	0.00	1.61	0.82	0.56	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Sn $2mm$ $\rho = 7.3g/cm^3$

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	88.48	74.83	0.00	74.83	88.48	92.32	94.09	95.07
	7.05	16.41	0.00	16.41	7.05	4.63	3.54	2.95
	0.	0.	51.	0.	0.	0.	0.	0.
125.	115.86	106.05	63.96	106.05	115.86	118.84	120.24	121.02
	5.50	11.74	0.00	11.74	5.50	3.68	2.83	2.36
	0.	0.	0.	0.	0.	0.	0.	0.
150.	142.33	134.40	102.97	134.40	142.33	144.80	145.98	146.63
	4.58	9.48	0.00	9.48	4.58	3.09	2.39	2.00
	0.	0.	0.	0.	0.	0.	0.	0.
175.	168.33	161.57	135.63	161.57	168.33	170.47	171.49	172.06
	3.97	8.08	0.00	8.08	3.97	2.69	2.08	1.74
	0.	0.	0.	0.	0.	0.	0.	0.
200.	194.06	188.11	165.66	188.11	194.06	195.96	196.86	197.37
	3.52	7.12	0.00	7.12	3.52	2.39	1.85	1.55
	0.	0.	0.	0.	0.	0.	0.	0.
225.	219.62	214.26	194.29	214.26	219.62	221.33	222.15	222.61
	3.19	6.40	0.00	6.40	3.19	2.17	1.68	1.41
	0.	0.	0.	0.	0.	0.	0.	0.
250.	245.05	240.16	222.04	240.16	245.05	246.63	247.38	247.80
	2.93	5.85	0.00	5.85	2.93	1.99	1.55	1.30
	0.	0.	0.	0.	0.	0.	0.	0.
275.	270.41	265.89	249.20	265.88	270.41	271.87	272.57	272.96
	2.71	5.41	0.00	5.41	2.71	1.85	1.44	1.20
	0.	0.	0.	0.	0.	0.	0.	0.
300.	295.70	291.48	275.96	291.48	295.70	297.07	297.72	298.09
	2.54	5.05	0.00	5.05	2.54	1.73	1.34	1.13
	0.	0.	0.	0.	0.	0.	0.	0.
325.	320.95	316.98	302.42	316.98	320.95	322.23	322.85	323.20
	2.39	4.75	0.00	4.75	2.39	1.63	1.27	1.06
	0.	0.	0.	0.	0.	0.	0.	0.
350.	346.16	342.40	328.65	342.40	346.16	347.38	347.96	348.29
	2.27	4.50	0.00	4.50	2.27	1.55	1.20	1.01
	0.	0.	0.	0.	0.	0.	0.	0.
375.	371.34	367.76	354.71	367.76	371.34	372.50	373.06	373.37
	2.16	4.28	0.00	4.28	2.16	1.47	1.14	0.96
	0.	0.	0.	0.	0.	0.	0.	0.
400.	396.50	393.08	380.62	393.08	396.50	397.61	398.14	398.44
	2.06	4.09	0.00	4.09	2.06	1.41	1.10	0.92
	0.	0.	0.	0.	0.	0.	0.	0.
425.	421.64	418.36	406.42	418.36	421.64	422.70	423.21	423.50
	1.98	3.92	0.00	3.92	1.98	1.35	1.05	0.88
	0.	0.	0.	0.	0.	0.	0.	0.
450.	446.76	443.61	432.12	443.61	446.76	447.79	448.28	448.56
	1.91	3.78	0.00	3.78	1.91	1.30	1.01	0.85
	0.	0.	0.	0.	0.	0.	0.	0.
475.	471.87	468.83	457.75	468.83	471.87	472.86	473.34	473.61
	1.84	3.64	0.00	3.64	1.84	1.26	0.98	0.82
	0.	0.	0.	0.	0.	0.	0.	0.
500.	496.97	494.02	483.31	494.02	496.97	497.93	498.39	498.65
	1.78	3.53	0.00	3.53	1.78	1.22	0.95	0.79
	0.	0.	0.	0.	0.	0.	0.	0.
525.	522.06	519.20	508.82	519.20	522.06	522.99	523.44	523.69
	1.73	3.42	0.00	3.42	1.73	1.18	0.92	0.77
	0.	0.	0.	0.	0.	0.	0.	0.
550.	547.15	544.37	534.28	544.37	547.15	548.05	548.48	548.73
	1.68	3.32	0.00	3.32	1.68	1.15	0.89	0.75
	0.	0.	0.	0.	0.	0.	0.	0.
575.	572.22	569.52	559.70	569.52	572.22	573.10	573.52	573.76
	1.64	3.23	0.00	3.23	1.64	1.12	0.87	0.73
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Pb $0.5mm$ $\rho = 11.3g/cm^3$

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	95.74	91.38	0.00	91.38	95.74	97.11	97.76	98.13
	2.54	5.21	0.00	5.21	2.54	1.71	1.33	1.11
	0.	0.	51.	0.	0.	0.	0.	0.
125.	121.56	118.10	0.00	118.10	121.56	122.66	123.18	123.48
	2.04	4.13	0.00	4.13	2.04	1.39	1.08	0.90
	0.	0.	51.	0.	0.	0.	0.	0.
150.	147.08	144.18	66.72	144.18	147.08	148.01	148.45	148.70
	1.73	3.46	0.00	3.46	1.73	1.18	0.91	0.76
	0.	0.	0.	0.	0.	0.	0.	0.
175.	172.45	169.93	109.25	169.93	172.45	173.26	173.65	173.86
	1.51	3.01	0.00	3.01	1.51	1.03	0.80	0.67
	0.	0.	0.	0.	0.	0.	0.	0.
200.	197.72	195.47	144.02	195.47	197.72	198.44	198.79	198.98
	1.35	2.68	0.00	2.68	1.35	0.92	0.71	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
225.	222.92	220.89	175.56	220.89	222.92	223.58	223.90	224.08
	1.22	2.43	0.00	2.43	1.22	0.84	0.65	0.54
	0.	0.	0.	0.	0.	0.	0.	0.
250.	248.09	246.22	205.34	246.22	248.09	248.69	248.99	249.15
	1.13	2.23	0.00	2.23	1.13	0.77	0.60	0.50
	0.	0.	0.	0.	0.	0.	0.	0.
275.	273.22	271.49	234.01	271.49	273.22	273.79	274.06	274.21
	1.05	2.07	0.00	2.07	1.05	0.72	0.56	0.47
	0.	0.	0.	0.	0.	0.	0.	0.
300.	298.34	296.71	261.94	296.71	298.34	298.86	299.12	299.26
	0.98	1.94	0.00	1.94	0.98	0.67	0.52	0.44
	0.	0.	0.	0.	0.	0.	0.	0.
325.	323.43	321.90	289.34	321.90	323.43	323.93	324.17	324.30
	0.93	1.83	0.00	1.83	0.93	0.63	0.49	0.41
	0.	0.	0.	0.	0.	0.	0.	0.
350.	348.51	347.06	316.34	347.06	348.51	348.98	349.21	349.34
	0.88	1.74	0.00	1.74	0.88	0.60	0.47	0.39
	0.	0.	0.	0.	0.	0.	0.	0.
375.	373.58	372.20	343.05	372.20	373.58	374.03	374.24	374.37
	0.84	1.65	0.00	1.65	0.84	0.57	0.45	0.37
	0.	0.	0.	0.	0.	0.	0.	0.
400.	398.64	397.32	369.51	397.32	398.64	399.07	399.28	399.39
	0.80	1.58	0.00	1.58	0.80	0.55	0.43	0.36
	0.	0.	0.	0.	0.	0.	0.	0.
425.	423.69	422.42	395.79	422.42	423.69	424.11	424.30	424.42
	0.77	1.52	0.00	1.52	0.77	0.53	0.41	0.34
	0.	0.	0.	0.	0.	0.	0.	0.
450.	448.74	447.52	421.92	447.52	448.74	449.14	449.33	449.44
	0.74	1.46	0.00	1.46	0.74	0.51	0.39	0.33
	0.	0.	0.	0.	0.	0.	0.	0.
475.	473.78	472.60	447.91	472.60	473.78	474.17	474.35	474.46
	0.72	1.41	0.00	1.41	0.72	0.49	0.38	0.32
	0.	0.	0.	0.	0.	0.	0.	0.
500.	498.82	497.68	473.80	497.68	498.82	499.19	499.37	499.47
	0.69	1.37	0.00	1.37	0.69	0.47	0.37	0.31
	0.	0.	0.	0.	0.	0.	0.	0.
525.	523.86	522.74	499.61	522.74	523.86	524.22	524.39	524.49
	0.67	1.33	0.00	1.33	0.67	0.46	0.36	0.30
	0.	0.	0.	0.	0.	0.	0.	0.
550.	548.89	547.81	525.33	547.81	548.89	549.24	549.41	549.50
	0.66	1.29	0.00	1.29	0.66	0.45	0.35	0.29
	0.	0.	0.	0.	0.	0.	0.	0.
575.	573.92	572.86	550.99	572.86	573.92	574.26	574.42	574.52
	0.64	1.26	0.00	1.26	0.64	0.44	0.34	0.29
	0.	0.	0.	0.	0.	0.	0.	0.

Particle = p Target = Pb $1mm$ $\rho = 11.3g/cm^3$

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	Ek' (MeV) / deviation (MeV) / stopping event							
100.	91.24	81.54	0.00	81.54	91.24	94.12	95.46	96.21
	5.30	11.62	0.00	11.62	5.30	3.53	2.71	2.26
	0.	0.	51.	0.	0.	0.	0.	0.
125.	117.99	110.68	0.00	110.68	117.99	120.26	121.33	121.93
	4.19	8.74	0.00	8.74	4.19	2.82	2.18	1.82
	0.	0.	51.	0.	0.	0.	0.	0.
150.	144.09	138.08	66.72	138.08	144.09	145.99	146.89	147.39
	3.52	7.18	0.00	7.18	3.52	2.38	1.84	1.54
	0.	0.	0.	0.	0.	0.	0.	0.
175.	169.85	164.68	109.25	164.68	169.85	171.49	172.28	172.72
	3.06	6.17	0.00	6.17	3.06	2.07	1.61	1.35
	0.	0.	0.	0.	0.	0.	0.	0.
200.	195.40	190.83	144.02	190.83	195.40	196.87	197.57	197.96
	2.72	5.46	0.00	5.46	2.72	1.85	1.44	1.20
	0.	0.	0.	0.	0.	0.	0.	0.
225.	220.83	216.70	175.56	216.70	220.83	222.16	222.79	223.15
	2.47	4.93	0.00	4.93	2.47	1.68	1.30	1.09
	0.	0.	0.	0.	0.	0.	0.	0.
250.	246.16	242.39	205.34	242.39	246.16	247.38	247.97	248.29
	2.27	4.52	0.00	4.52	2.27	1.54	1.20	1.01
	0.	0.	0.	0.	0.	0.	0.	0.
275.	271.44	267.94	234.01	267.94	271.44	272.57	273.11	273.41
	2.10	4.18	0.00	4.18	2.10	1.44	1.11	0.93
	0.	0.	0.	0.	0.	0.	0.	0.
300.	296.66	293.39	261.94	293.39	296.66	297.72	298.23	298.51
	1.97	3.91	0.00	3.91	1.97	1.34	1.04	0.88
	0.	0.	0.	0.	0.	0.	0.	0.
325.	321.85	318.77	289.34	318.77	321.85	322.85	323.33	323.60
	1.86	3.68	0.00	3.68	1.86	1.27	0.99	0.83
	0.	0.	0.	0.	0.	0.	0.	0.
350.	347.01	344.09	316.34	344.09	347.01	347.96	348.41	348.67
	1.76	3.49	0.00	3.49	1.76	1.20	0.93	0.78
	0.	0.	0.	0.	0.	0.	0.	0.
375.	372.15	369.37	343.05	369.37	372.15	373.05	373.49	373.73
	1.68	3.32	0.00	3.32	1.68	1.15	0.89	0.75
	0.	0.	0.	0.	0.	0.	0.	0.
400.	397.27	394.62	369.51	394.62	397.27	398.14	398.55	398.79
	1.61	3.18	0.00	3.18	1.61	1.10	0.85	0.72
	0.	0.	0.	0.	0.	0.	0.	0.
425.	422.38	419.83	395.79	419.83	422.38	423.21	423.61	423.83
	1.54	3.05	0.00	3.05	1.54	1.05	0.82	0.69
	0.	0.	0.	0.	0.	0.	0.	0.
450.	447.48	445.02	421.92	445.02	447.48	448.28	448.66	448.88
	1.49	2.94	0.00	2.94	1.49	1.02	0.79	0.66
	0.	0.	0.	0.	0.	0.	0.	0.
475.	472.56	470.19	447.91	470.19	472.56	473.33	473.70	473.91
	1.44	2.84	0.00	2.84	1.44	0.98	0.76	0.64
	0.	0.	0.	0.	0.	0.	0.	0.
500.	497.64	495.34	473.80	495.34	497.64	498.39	498.74	498.95
	1.39	2.75	0.00	2.75	1.39	0.95	0.74	0.62
	0.	0.	0.	0.	0.	0.	0.	0.
525.	522.71	520.48	499.61	520.48	522.71	523.43	523.78	523.98
	1.35	2.67	0.00	2.67	1.35	0.92	0.72	0.60
	0.	0.	0.	0.	0.	0.	0.	0.
550.	547.77	545.60	525.33	545.60	547.77	548.48	548.82	549.01
	1.31	2.59	0.00	2.59	1.31	0.90	0.70	0.59
	0.	0.	0.	0.	0.	0.	0.	0.
575.	572.83	570.72	550.99	570.72	572.83	573.52	573.85	574.03
	1.28	2.52	0.00	2.52	1.28	0.87	0.68	0.57
	0.	0.	0.	0.	0.	0.	0.	0.

Particle : π Target : Li 36 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9957	0.9959	0.9960	0.9959	0.9957	0.9953	0.9947	0.9937
125.	0.9974	0.9975	0.9976	0.9975	0.9974	0.9972	0.9968	0.9962
150.	0.9980	0.9981	0.9982	0.9981	0.9980	0.9979	0.9976	0.9971
175.	0.9983	0.9984	0.9984	0.9984	0.9983	0.9981	0.9979	0.9975
200.	0.9983	0.9984	0.9984	0.9984	0.9983	0.9981	0.9979	0.9975
225.	0.9982	0.9983	0.9983	0.9983	0.9982	0.9981	0.9978	0.9974
250.	0.9980	0.9981	0.9981	0.9981	0.9980	0.9978	0.9975	0.9971
275.	0.9979	0.9980	0.9980	0.9980	0.9979	0.9977	0.9974	0.9969
300.	0.9977	0.9978	0.9978	0.9978	0.9977	0.9975	0.9971	0.9966

Particle : π Target : C 3 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9850	0.9707	0.9497	0.9707	0.9850	0.9897	0.9920	0.9933
125.	0.9761	0.9534	0.9205	0.9534	0.9761	0.9836	0.9872	0.9892
150.	0.9693	0.9404	0.8988	0.9404	0.9693	0.9789	0.9835	0.9862
175.	0.9654	0.9330	0.8866	0.9330	0.9654	0.9762	0.9814	0.9844
200.	0.9657	0.9336	0.8875	0.9336	0.9657	0.9764	0.9816	0.9845
225.	0.9670	0.9360	0.8915	0.9360	0.9670	0.9773	0.9823	0.9851
250.	0.9703	0.9423	0.9019	0.9423	0.9703	0.9796	0.9841	0.9866
275.	0.9711	0.9440	0.9047	0.9440	0.9711	0.9802	0.9845	0.9870
300.	0.9734	0.9482	0.9118	0.9482	0.9734	0.9817	0.9857	0.9880

Particle : π Target : C 6 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9703	0.9489	0.9497	0.9489	0.9703	0.9796	0.9841	0.9866
125.	0.9527	0.9193	0.9205	0.9193	0.9527	0.9674	0.9745	0.9786
150.	0.9395	0.8974	0.8988	0.8974	0.9395	0.9582	0.9674	0.9725
175.	0.9320	0.8849	0.8866	0.8849	0.9320	0.9530	0.9632	0.9691
200.	0.9326	0.8858	0.8875	0.8858	0.9326	0.9534	0.9635	0.9693
225.	0.9351	0.8899	0.8915	0.8899	0.9351	0.9551	0.9649	0.9705
250.	0.9414	0.9004	0.9019	0.9004	0.9414	0.9595	0.9684	0.9734
275.	0.9431	0.9033	0.9047	0.9033	0.9431	0.9607	0.9693	0.9742
300.	0.9474	0.9105	0.9118	0.9105	0.9474	0.9637	0.9717	0.9762

Particle : π Target : C 11 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9465	0.9489	0.9497	0.9489	0.9465	0.9628	0.9710	0.9756
125.	0.9156	0.9193	0.9205	0.9193	0.9156	0.9410	0.9538	0.9611
150.	0.8927	0.8974	0.8988	0.8974	0.8927	0.9248	0.9410	0.9502
175.	0.8798	0.8849	0.8866	0.8849	0.8798	0.9155	0.9336	0.9440
200.	0.8807	0.8858	0.8875	0.8858	0.8807	0.9162	0.9342	0.9445
225.	0.8850	0.8899	0.8915	0.8899	0.8850	0.9192	0.9366	0.9465
250.	0.8959	0.9004	0.9019	0.9004	0.8959	0.9271	0.9428	0.9518
275.	0.8989	0.9033	0.9047	0.9033	0.8989	0.9292	0.9445	0.9532
300.	0.9064	0.9105	0.9118	0.9105	0.9064	0.9345	0.9487	0.9568

Table 4.2: Absorption correction facter of nuclear collision in the target

Particle : π Target : Al 2 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9896	0.9797	0.9480	0.9797	0.9896	0.9929	0.9945	0.9954
125.	0.9840	0.9688	0.9207	0.9688	0.9840	0.9890	0.9915	0.9928
150.	0.9803	0.9615	0.9029	0.9615	0.9803	0.9865	0.9895	0.9911
175.	0.9781	0.9574	0.8927	0.9574	0.9781	0.9850	0.9883	0.9902
200.	0.9785	0.9581	0.8944	0.9581	0.9785	0.9852	0.9885	0.9903
225.	0.9790	0.9591	0.8970	0.9591	0.9790	0.9856	0.9888	0.9906
250.	0.9810	0.9629	0.9062	0.9629	0.9810	0.9870	0.9898	0.9915
275.	0.9811	0.9631	0.9068	0.9631	0.9811	0.9870	0.9899	0.9915
300.	0.9822	0.9653	0.9120	0.9653	0.9822	0.9878	0.9905	0.9920

Particle : π Target : Al 4 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9794	0.9598	0.9480	0.9598	0.9794	0.9859	0.9890	0.9907
125.	0.9683	0.9385	0.9207	0.9385	0.9683	0.9782	0.9830	0.9857
150.	0.9610	0.9246	0.9029	0.9246	0.9610	0.9731	0.9790	0.9824
175.	0.9567	0.9166	0.8927	0.9166	0.9567	0.9702	0.9767	0.9804
200.	0.9574	0.9179	0.8944	0.9179	0.9574	0.9707	0.9771	0.9808
225.	0.9585	0.9199	0.8970	0.9199	0.9585	0.9714	0.9777	0.9813
250.	0.9623	0.9271	0.9062	0.9271	0.9623	0.9741	0.9798	0.9830
275.	0.9626	0.9276	0.9068	0.9276	0.9626	0.9742	0.9799	0.9831
300.	0.9647	0.9317	0.9120	0.9317	0.9647	0.9757	0.9811	0.9841

Particle : π Target : Cu 0.5mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9926	0.9855	0.8585	0.9855	0.9926	0.9949	0.9961	0.9967
125.	0.9890	0.9784	0.7968	0.9784	0.9890	0.9925	0.9941	0.9951
150.	0.9870	0.9745	0.7641	0.9745	0.9870	0.9911	0.9930	0.9942
175.	0.9858	0.9722	0.7455	0.9722	0.9858	0.9903	0.9924	0.9936
200.	0.9861	0.9729	0.7510	0.9729	0.9861	0.9905	0.9926	0.9938
225.	0.9863	0.9733	0.7539	0.9733	0.9863	0.9906	0.9927	0.9939
250.	0.9875	0.9755	0.7724	0.9755	0.9875	0.9914	0.9933	0.9944
275.	0.9873	0.9750	0.7685	0.9750	0.9873	0.9913	0.9932	0.9943
300.	0.9877	0.9760	0.7763	0.9760	0.9877	0.9916	0.9935	0.9945

Particle : π Target : Cu 1 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9852	0.9711	0.8585	0.9711	0.9852	0.9899	0.9921	0.9934
125.	0.9781	0.9573	0.7968	0.9573	0.9781	0.9850	0.9883	0.9902
150.	0.9741	0.9497	0.7641	0.9497	0.9741	0.9822	0.9861	0.9884
175.	0.9718	0.9452	0.7455	0.9452	0.9718	0.9806	0.9849	0.9873
200.	0.9725	0.9465	0.7510	0.9465	0.9725	0.9811	0.9853	0.9876
225.	0.9728	0.9472	0.7539	0.9472	0.9728	0.9813	0.9855	0.9878
250.	0.9751	0.9516	0.7724	0.9516	0.9751	0.9829	0.9867	0.9888
275.	0.9747	0.9507	0.7685	0.9507	0.9747	0.9826	0.9864	0.9886
300.	0.9756	0.9526	0.7763	0.9526	0.9756	0.9833	0.9870	0.9890

Particle : π Target : Sn 1 mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9892	0.9788	0.8944	0.9788	0.9892	0.9926	0.9942	0.9952
125.	0.9844	0.9695	0.8508	0.9695	0.9844	0.9893	0.9917	0.9930
150.	0.9821	0.9650	0.8308	0.9650	0.9821	0.9877	0.9904	0.9920
175.	0.9807	0.9624	0.8188	0.9624	0.9807	0.9868	0.9897	0.9913
200.	0.9813	0.9635	0.8239	0.9635	0.9813	0.9872	0.9900	0.9916
225.	0.9814	0.9637	0.8246	0.9637	0.9814	0.9872	0.9900	0.9916
250.	0.9829	0.9665	0.8374	0.9665	0.9829	0.9882	0.9908	0.9923
275.	0.9822	0.9652	0.8317	0.9652	0.9822	0.9878	0.9905	0.9920
300.	0.9826	0.9660	0.8353	0.9660	0.9826	0.9881	0.9907	0.9922

Particle : π Target : Sn 2 mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9785	0.9581	0.8944	0.9581	0.9785	0.9852	0.9885	0.9903
125.	0.9690	0.9399	0.8508	0.9399	0.9690	0.9787	0.9834	0.9860
150.	0.9645	0.9313	0.8308	0.9313	0.9645	0.9756	0.9810	0.9840
175.	0.9618	0.9261	0.8188	0.9261	0.9618	0.9737	0.9795	0.9828
200.	0.9629	0.9283	0.8239	0.9283	0.9629	0.9745	0.9801	0.9833
225.	0.9631	0.9286	0.8246	0.9286	0.9631	0.9746	0.9802	0.9834
250.	0.9660	0.9341	0.8374	0.9341	0.9660	0.9766	0.9818	0.9847
275.	0.9647	0.9317	0.8317	0.9317	0.9647	0.9757	0.9811	0.9841
300.	0.9655	0.9332	0.8353	0.9332	0.9655	0.9763	0.9815	0.9845

Particle : π Target : Pb 0.5mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9924	0.9850	0.8546	0.9850	0.9924	0.9948	0.9959	0.9966
125.	0.9892	0.9789	0.8010	0.9789	0.9892	0.9926	0.9943	0.9952
150.	0.9880	0.9765	0.7806	0.9765	0.9880	0.9918	0.9936	0.9946
175.	0.9872	0.9750	0.7679	0.9750	0.9872	0.9912	0.9932	0.9943
200.	0.9877	0.9759	0.7753	0.9759	0.9877	0.9916	0.9934	0.9945
225.	0.9876	0.9758	0.7745	0.9758	0.9876	0.9915	0.9934	0.9945
250.	0.9885	0.9776	0.7895	0.9776	0.9885	0.9922	0.9939	0.9949
275.	0.9879	0.9763	0.7790	0.9763	0.9879	0.9917	0.9935	0.9946
300.	0.9880	0.9765	0.7809	0.9765	0.9880	0.9918	0.9936	0.9946

Particle : π Target : Pb 1 mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9848	0.9703	0.8546	0.9703	0.9848	0.9896	0.9919	0.9932
125.	0.9786	0.9583	0.8010	0.9583	0.9786	0.9853	0.9886	0.9904
150.	0.9762	0.9536	0.7806	0.9536	0.9762	0.9836	0.9872	0.9893
175.	0.9746	0.9506	0.7679	0.9506	0.9746	0.9825	0.9864	0.9886
200.	0.9755	0.9523	0.7753	0.9523	0.9755	0.9832	0.9869	0.9890
225.	0.9754	0.9521	0.7745	0.9521	0.9754	0.9831	0.9868	0.9889
250.	0.9772	0.9556	0.7895	0.9556	0.9772	0.9844	0.9878	0.9898
275.	0.9760	0.9532	0.7790	0.9532	0.9760	0.9835	0.9871	0.9892
300.	0.9762	0.9536	0.7809	0.9536	0.9762	0.9837	0.9873	0.9893

Particle : p Target : Li 36 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9960	0.9962	0.9962	0.9962	0.9960	0.9956	0.9951	0.9941
125.	0.9960	0.9961	0.9962	0.9961	0.9960	0.9956	0.9950	0.9941
150.	0.9959	0.9961	0.9962	0.9961	0.9959	0.9956	0.9950	0.9941
175.	0.9957	0.9959	0.9960	0.9959	0.9957	0.9954	0.9948	0.9938
200.	0.9955	0.9957	0.9958	0.9957	0.9955	0.9951	0.9945	0.9935
225.	0.9954	0.9957	0.9957	0.9957	0.9954	0.9951	0.9944	0.9933
250.	0.9954	0.9956	0.9956	0.9956	0.9954	0.9950	0.9943	0.9932
275.	0.9953	0.9955	0.9956	0.9955	0.9953	0.9949	0.9942	0.9931
300.	0.9952	0.9954	0.9955	0.9954	0.9952	0.9948	0.9941	0.9930
325.	0.9952	0.9954	0.9955	0.9954	0.9952	0.9948	0.9941	0.9930
350.	0.9952	0.9954	0.9955	0.9954	0.9952	0.9948	0.9941	0.9930
375.	0.9952	0.9954	0.9955	0.9954	0.9952	0.9948	0.9941	0.9930
400.	0.9952	0.9954	0.9955	0.9954	0.9952	0.9948	0.9941	0.9930
425.	0.9953	0.9955	0.9956	0.9955	0.9953	0.9949	0.9942	0.9931
450.	0.9954	0.9956	0.9957	0.9956	0.9954	0.9950	0.9943	0.9933
475.	0.9955	0.9957	0.9958	0.9957	0.9955	0.9951	0.9945	0.9934
500.	0.9956	0.9958	0.9958	0.9958	0.9956	0.9952	0.9946	0.9935
525.	0.9956	0.9958	0.9959	0.9958	0.9956	0.9953	0.9947	0.9936
550.	0.9957	0.9959	0.9960	0.9959	0.9957	0.9953	0.9947	0.9937
575.	0.9958	0.9960	0.9960	0.9960	0.9958	0.9954	0.9948	0.9938
600.	0.9958	0.9960	0.9961	0.9960	0.9958	0.9955	0.9949	0.9939

Particle : p Target : C 3 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9866	0.9737	0.9548	0.9737	0.9866	0.9908	0.9928	0.9940
125.	0.9878	0.9761	0.9588	0.9761	0.9878	0.9916	0.9935	0.9945
150.	0.9890	0.9784	0.9629	0.9784	0.9890	0.9925	0.9941	0.9951
175.	0.9893	0.9791	0.9640	0.9791	0.9893	0.9927	0.9943	0.9952
200.	0.9897	0.9798	0.9652	0.9798	0.9897	0.9929	0.9945	0.9954
225.	0.9898	0.9801	0.9657	0.9801	0.9898	0.9930	0.9946	0.9954
250.	0.9900	0.9804	0.9662	0.9804	0.9900	0.9931	0.9947	0.9955
275.	0.9901	0.9807	0.9667	0.9807	0.9901	0.9932	0.9947	0.9956
300.	0.9903	0.9809	0.9671	0.9809	0.9903	0.9933	0.9948	0.9956
325.	0.9903	0.9809	0.9671	0.9809	0.9903	0.9933	0.9948	0.9956
350.	0.9902	0.9809	0.9670	0.9809	0.9902	0.9933	0.9948	0.9956
375.	0.9902	0.9808	0.9669	0.9808	0.9902	0.9933	0.9948	0.9956
400.	0.9902	0.9808	0.9668	0.9808	0.9902	0.9933	0.9948	0.9956
425.	0.9900	0.9804	0.9663	0.9804	0.9900	0.9932	0.9947	0.9955
450.	0.9899	0.9801	0.9657	0.9801	0.9899	0.9931	0.9946	0.9955
475.	0.9897	0.9798	0.9652	0.9798	0.9897	0.9929	0.9945	0.9954
500.	0.9895	0.9795	0.9647	0.9795	0.9895	0.9928	0.9944	0.9953
525.	0.9894	0.9793	0.9643	0.9793	0.9894	0.9928	0.9944	0.9953
550.	0.9893	0.9790	0.9639	0.9790	0.9893	0.9927	0.9943	0.9952
575.	0.9892	0.9788	0.9635	0.9788	0.9892	0.9926	0.9942	0.9952
600.	0.9891	0.9786	0.9631	0.9786	0.9891	0.9925	0.9942	0.9951

Particle : p Target : C 6 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9733	0.9541	0.9548	0.9541	0.9733	0.9817	0.9857	0.9880
125.	0.9757	0.9582	0.9588	0.9582	0.9757	0.9833	0.9870	0.9891
150.	0.9781	0.9623	0.9629	0.9623	0.9781	0.9850	0.9883	0.9902
175.	0.9788	0.9635	0.9640	0.9635	0.9788	0.9854	0.9887	0.9905
200.	0.9795	0.9646	0.9652	0.9646	0.9795	0.9859	0.9890	0.9908
225.	0.9798	0.9651	0.9657	0.9651	0.9798	0.9861	0.9892	0.9909
250.	0.9801	0.9656	0.9662	0.9656	0.9801	0.9863	0.9893	0.9911
275.	0.9804	0.9661	0.9667	0.9661	0.9804	0.9865	0.9895	0.9912
300.	0.9807	0.9666	0.9671	0.9666	0.9807	0.9867	0.9897	0.9913
325.	0.9806	0.9666	0.9671	0.9666	0.9806	0.9867	0.9896	0.9913
350.	0.9806	0.9665	0.9670	0.9665	0.9806	0.9867	0.9896	0.9913
375.	0.9805	0.9664	0.9669	0.9664	0.9805	0.9866	0.9896	0.9912
400.	0.9805	0.9663	0.9668	0.9663	0.9805	0.9866	0.9896	0.9912
425.	0.9801	0.9658	0.9663	0.9658	0.9801	0.9864	0.9894	0.9911
450.	0.9798	0.9652	0.9657	0.9652	0.9798	0.9862	0.9892	0.9909
475.	0.9795	0.9647	0.9652	0.9647	0.9795	0.9859	0.9890	0.9908
500.	0.9792	0.9641	0.9647	0.9641	0.9792	0.9857	0.9889	0.9907
525.	0.9790	0.9637	0.9643	0.9637	0.9790	0.9856	0.9887	0.9905
550.	0.9787	0.9633	0.9639	0.9633	0.9787	0.9854	0.9886	0.9904
575.	0.9785	0.9630	0.9635	0.9630	0.9785	0.9852	0.9885	0.9903
600.	0.9783	0.9626	0.9631	0.9626	0.9783	0.9851	0.9884	0.9902

Particle : p Target : C 11 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9519	0.9541	0.9548	0.9541	0.9519	0.9666	0.9739	0.9781
125.	0.9562	0.9582	0.9588	0.9582	0.9562	0.9696	0.9763	0.9801
150.	0.9605	0.9623	0.9629	0.9623	0.9605	0.9726	0.9786	0.9821
175.	0.9618	0.9635	0.9640	0.9635	0.9618	0.9735	0.9793	0.9826
200.	0.9630	0.9646	0.9652	0.9646	0.9630	0.9743	0.9800	0.9832
225.	0.9635	0.9651	0.9657	0.9651	0.9635	0.9747	0.9803	0.9834
250.	0.9640	0.9656	0.9662	0.9656	0.9640	0.9751	0.9806	0.9837
275.	0.9645	0.9661	0.9667	0.9661	0.9645	0.9754	0.9808	0.9839
300.	0.9651	0.9666	0.9671	0.9666	0.9651	0.9758	0.9811	0.9841
325.	0.9650	0.9666	0.9671	0.9666	0.9650	0.9757	0.9811	0.9841
350.	0.9649	0.9665	0.9670	0.9665	0.9649	0.9757	0.9810	0.9841
375.	0.9648	0.9664	0.9669	0.9664	0.9648	0.9756	0.9810	0.9840
400.	0.9647	0.9663	0.9668	0.9663	0.9647	0.9756	0.9809	0.9840
425.	0.9642	0.9658	0.9663	0.9658	0.9642	0.9752	0.9806	0.9837
450.	0.9636	0.9652	0.9657	0.9652	0.9636	0.9748	0.9803	0.9835
475.	0.9630	0.9647	0.9652	0.9647	0.9630	0.9744	0.9800	0.9832
500.	0.9625	0.9641	0.9647	0.9641	0.9625	0.9740	0.9797	0.9829
525.	0.9620	0.9637	0.9643	0.9637	0.9620	0.9737	0.9795	0.9827
550.	0.9616	0.9633	0.9639	0.9633	0.9616	0.9734	0.9792	0.9826
575.	0.9612	0.9630	0.9635	0.9630	0.9612	0.9731	0.9790	0.9824
600.	0.9608	0.9626	0.9631	0.9626	0.9608	0.9728	0.9788	0.9822

Particle : p Target : Al 2 mm

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	correction factor (deg.)							
100.	0.9917	0.9838	0.9583	0.9838	0.9917	0.9943	0.9956	0.9963
125.	0.9922	0.9848	0.9608	0.9848	0.9922	0.9947	0.9959	0.9965
150.	0.9927	0.9857	0.9633	0.9857	0.9927	0.9950	0.9961	0.9967
175.	0.9929	0.9861	0.9643	0.9861	0.9929	0.9952	0.9962	0.9968
200.	0.9931	0.9865	0.9653	0.9865	0.9931	0.9953	0.9963	0.9969
225.	0.9932	0.9867	0.9657	0.9867	0.9932	0.9954	0.9964	0.9970
250.	0.9933	0.9869	0.9662	0.9869	0.9933	0.9954	0.9964	0.9970
275.	0.9934	0.9870	0.9666	0.9870	0.9934	0.9955	0.9965	0.9970
300.	0.9935	0.9872	0.9670	0.9872	0.9935	0.9955	0.9965	0.9971
325.	0.9935	0.9872	0.9669	0.9872	0.9935	0.9955	0.9965	0.9971
350.	0.9935	0.9871	0.9669	0.9871	0.9935	0.9955	0.9965	0.9971
375.	0.9934	0.9871	0.9668	0.9871	0.9934	0.9955	0.9965	0.9971
400.	0.9934	0.9871	0.9667	0.9871	0.9934	0.9955	0.9965	0.9971
425.	0.9933	0.9869	0.9662	0.9869	0.9933	0.9954	0.9964	0.9970
450.	0.9932	0.9867	0.9658	0.9867	0.9932	0.9954	0.9964	0.9970
475.	0.9932	0.9866	0.9654	0.9866	0.9932	0.9953	0.9964	0.9969
500.	0.9931	0.9864	0.9649	0.9864	0.9931	0.9953	0.9963	0.9969
525.	0.9930	0.9863	0.9646	0.9863	0.9930	0.9952	0.9963	0.9969
550.	0.9929	0.9862	0.9643	0.9862	0.9929	0.9952	0.9962	0.9968
575.	0.9929	0.9860	0.9640	0.9860	0.9929	0.9951	0.9962	0.9968
600.	0.9928	0.9859	0.9637	0.9859	0.9928	0.9951	0.9962	0.9968

Particle : p Target : Al 4 mm

Ek (MeV)	Angle (deg.) 70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
	correction factor (deg.)							
100.	0.9835	0.9678	0.9583	0.9678	0.9835	0.9887	0.9912	0.9926
125.	0.9845	0.9697	0.9608	0.9697	0.9845	0.9894	0.9917	0.9931
150.	0.9855	0.9717	0.9633	0.9717	0.9855	0.9901	0.9923	0.9935
175.	0.9859	0.9725	0.9643	0.9725	0.9859	0.9903	0.9925	0.9937
200.	0.9863	0.9732	0.9653	0.9732	0.9863	0.9906	0.9927	0.9939
225.	0.9865	0.9736	0.9657	0.9736	0.9865	0.9907	0.9928	0.9939
250.	0.9867	0.9739	0.9662	0.9739	0.9867	0.9909	0.9929	0.9940
275.	0.9868	0.9742	0.9666	0.9742	0.9868	0.9910	0.9930	0.9941
300.	0.9870	0.9746	0.9670	0.9746	0.9870	0.9911	0.9931	0.9942
325.	0.9870	0.9745	0.9669	0.9745	0.9870	0.9911	0.9931	0.9942
350.	0.9869	0.9745	0.9669	0.9745	0.9869	0.9911	0.9930	0.9942
375.	0.9869	0.9744	0.9668	0.9744	0.9869	0.9910	0.9930	0.9941
400.	0.9869	0.9743	0.9667	0.9743	0.9869	0.9910	0.9930	0.9941
425.	0.9867	0.9740	0.9662	0.9740	0.9867	0.9909	0.9929	0.9940
450.	0.9865	0.9736	0.9658	0.9736	0.9865	0.9908	0.9928	0.9940
475.	0.9864	0.9733	0.9654	0.9733	0.9864	0.9906	0.9927	0.9939
500.	0.9862	0.9730	0.9649	0.9730	0.9862	0.9905	0.9926	0.9938
525.	0.9861	0.9727	0.9646	0.9727	0.9861	0.9904	0.9926	0.9938
550.	0.9859	0.9725	0.9643	0.9725	0.9859	0.9904	0.9925	0.9937
575.	0.9858	0.9723	0.9640	0.9723	0.9858	0.9903	0.9924	0.9936
600.	0.9857	0.9720	0.9637	0.9720	0.9857	0.9902	0.9924	0.9936

Particle : p Target : Cu 0.5mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9947	0.9896	0.8972	0.9896	0.9947	0.9964	0.9972	0.9976
125.	0.9951	0.9903	0.9032	0.9903	0.9951	0.9966	0.9974	0.9978
150.	0.9954	0.9909	0.9093	0.9909	0.9954	0.9968	0.9975	0.9979
175.	0.9955	0.9911	0.9111	0.9911	0.9955	0.9969	0.9976	0.9980
200.	0.9956	0.9913	0.9130	0.9913	0.9956	0.9970	0.9976	0.9980
225.	0.9956	0.9914	0.9139	0.9914	0.9956	0.9970	0.9977	0.9980
250.	0.9957	0.9915	0.9147	0.9915	0.9957	0.9970	0.9977	0.9981
275.	0.9957	0.9916	0.9156	0.9916	0.9957	0.9971	0.9977	0.9981
300.	0.9958	0.9917	0.9165	0.9917	0.9958	0.9971	0.9977	0.9981
325.	0.9958	0.9917	0.9164	0.9917	0.9958	0.9971	0.9977	0.9981
350.	0.9957	0.9916	0.9162	0.9916	0.9957	0.9971	0.9977	0.9981
375.	0.9957	0.9916	0.9160	0.9916	0.9957	0.9971	0.9977	0.9981
400.	0.9957	0.9916	0.9159	0.9916	0.9957	0.9971	0.9977	0.9981
425.	0.9957	0.9915	0.9151	0.9915	0.9957	0.9970	0.9977	0.9981
450.	0.9956	0.9914	0.9142	0.9914	0.9956	0.9970	0.9977	0.9981
475.	0.9956	0.9913	0.9134	0.9913	0.9956	0.9970	0.9977	0.9980
500.	0.9956	0.9913	0.9126	0.9913	0.9956	0.9970	0.9976	0.9980
525.	0.9955	0.9912	0.9120	0.9912	0.9955	0.9969	0.9976	0.9980
550.	0.9955	0.9911	0.9115	0.9911	0.9955	0.9969	0.9976	0.9980
575.	0.9955	0.9911	0.9109	0.9911	0.9955	0.9969	0.9976	0.9980
600.	0.9954	0.9910	0.9104	0.9910	0.9954	0.9969	0.9976	0.9980

Particle : p Target : Cu 1 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9895	0.9794	0.8972	0.9794	0.9895	0.9928	0.9944	0.9953
125.	0.9901	0.9807	0.9032	0.9807	0.9901	0.9932	0.9947	0.9956
150.	0.9908	0.9819	0.9093	0.9819	0.9908	0.9937	0.9951	0.9959
175.	0.9910	0.9823	0.9111	0.9823	0.9910	0.9938	0.9952	0.9960
200.	0.9912	0.9827	0.9130	0.9827	0.9912	0.9939	0.9953	0.9960
225.	0.9913	0.9829	0.9139	0.9829	0.9913	0.9940	0.9953	0.9961
250.	0.9914	0.9830	0.9147	0.9830	0.9914	0.9941	0.9954	0.9961
275.	0.9914	0.9832	0.9156	0.9832	0.9914	0.9941	0.9954	0.9962
300.	0.9915	0.9834	0.9165	0.9834	0.9915	0.9942	0.9955	0.9962
325.	0.9915	0.9834	0.9164	0.9834	0.9915	0.9942	0.9955	0.9962
350.	0.9915	0.9833	0.9162	0.9833	0.9915	0.9942	0.9955	0.9962
375.	0.9915	0.9833	0.9160	0.9833	0.9915	0.9942	0.9955	0.9962
400.	0.9915	0.9833	0.9159	0.9833	0.9915	0.9942	0.9955	0.9962
425.	0.9914	0.9831	0.9151	0.9831	0.9914	0.9941	0.9954	0.9961
450.	0.9913	0.9829	0.9142	0.9829	0.9913	0.9940	0.9954	0.9961
475.	0.9912	0.9828	0.9134	0.9828	0.9912	0.9940	0.9953	0.9961
500.	0.9911	0.9826	0.9126	0.9826	0.9911	0.9939	0.9953	0.9960
525.	0.9911	0.9825	0.9120	0.9825	0.9911	0.9939	0.9952	0.9960
550.	0.9910	0.9824	0.9115	0.9824	0.9910	0.9938	0.9952	0.9960
575.	0.9910	0.9823	0.9109	0.9823	0.9910	0.9938	0.9952	0.9959
600.	0.9909	0.9821	0.9104	0.9821	0.9909	0.9938	0.9951	0.9959

Particle : p Target : Sn 1 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9931	0.9864	0.9310	0.9864	0.9931	0.9952	0.9963	0.9969
125.	0.9935	0.9872	0.9349	0.9872	0.9935	0.9955	0.9965	0.9971
150.	0.9939	0.9879	0.9388	0.9879	0.9939	0.9958	0.9967	0.9973
175.	0.9940	0.9881	0.9398	0.9881	0.9940	0.9959	0.9968	0.9973
200.	0.9941	0.9883	0.9408	0.9883	0.9941	0.9959	0.9968	0.9973
225.	0.9941	0.9884	0.9412	0.9884	0.9941	0.9960	0.9969	0.9974
250.	0.9942	0.9885	0.9417	0.9885	0.9942	0.9960	0.9969	0.9974
275.	0.9942	0.9886	0.9422	0.9886	0.9942	0.9960	0.9969	0.9974
300.	0.9943	0.9887	0.9426	0.9887	0.9943	0.9961	0.9969	0.9974
325.	0.9943	0.9887	0.9426	0.9887	0.9943	0.9961	0.9969	0.9974
350.	0.9942	0.9887	0.9425	0.9887	0.9942	0.9961	0.9969	0.9974
375.	0.9942	0.9887	0.9424	0.9887	0.9942	0.9961	0.9969	0.9974
400.	0.9942	0.9887	0.9424	0.9887	0.9942	0.9961	0.9969	0.9974
425.	0.9942	0.9886	0.9420	0.9886	0.9942	0.9960	0.9969	0.9974
450.	0.9942	0.9885	0.9416	0.9885	0.9942	0.9960	0.9969	0.9974
475.	0.9941	0.9884	0.9412	0.9884	0.9941	0.9960	0.9969	0.9974
500.	0.9941	0.9884	0.9408	0.9884	0.9941	0.9959	0.9968	0.9973
525.	0.9940	0.9883	0.9405	0.9883	0.9940	0.9959	0.9968	0.9973
550.	0.9940	0.9882	0.9402	0.9882	0.9940	0.9959	0.9968	0.9973
575.	0.9940	0.9882	0.9399	0.9882	0.9940	0.9959	0.9968	0.9973
600.	0.9940	0.9881	0.9397	0.9881	0.9940	0.9959	0.9968	0.9973

Particle : p Target : Sn 2 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9862	0.9729	0.9310	0.9729	0.9862	0.9905	0.9926	0.9938
125.	0.9870	0.9745	0.9349	0.9745	0.9870	0.9911	0.9930	0.9942
150.	0.9878	0.9760	0.9388	0.9760	0.9878	0.9916	0.9935	0.9945
175.	0.9880	0.9764	0.9398	0.9764	0.9880	0.9917	0.9936	0.9946
200.	0.9882	0.9768	0.9408	0.9768	0.9882	0.9919	0.9937	0.9947
225.	0.9883	0.9770	0.9412	0.9770	0.9883	0.9920	0.9937	0.9947
250.	0.9884	0.9772	0.9417	0.9772	0.9884	0.9920	0.9938	0.9948
275.	0.9885	0.9774	0.9422	0.9774	0.9885	0.9921	0.9938	0.9948
300.	0.9886	0.9776	0.9426	0.9776	0.9886	0.9922	0.9939	0.9949
325.	0.9885	0.9775	0.9426	0.9775	0.9885	0.9921	0.9939	0.9949
350.	0.9885	0.9775	0.9425	0.9775	0.9885	0.9921	0.9939	0.9949
375.	0.9885	0.9775	0.9424	0.9775	0.9885	0.9921	0.9939	0.9949
400.	0.9885	0.9775	0.9424	0.9775	0.9885	0.9921	0.9939	0.9948
425.	0.9884	0.9773	0.9420	0.9773	0.9884	0.9921	0.9938	0.9948
450.	0.9883	0.9772	0.9416	0.9772	0.9883	0.9920	0.9938	0.9948
475.	0.9883	0.9770	0.9412	0.9770	0.9883	0.9919	0.9937	0.9947
500.	0.9882	0.9768	0.9408	0.9768	0.9882	0.9919	0.9937	0.9947
525.	0.9881	0.9767	0.9405	0.9767	0.9881	0.9919	0.9937	0.9947
550.	0.9881	0.9766	0.9402	0.9766	0.9881	0.9918	0.9936	0.9947
575.	0.9880	0.9765	0.9399	0.9765	0.9880	0.9918	0.9936	0.9946
600.	0.9879	0.9764	0.9397	0.9764	0.9879	0.9917	0.9936	0.9946

Particle : p Target : Pb 0.5mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9959	0.9919	0.9191	0.9919	0.9959	0.9972	0.9978	0.9982
125.	0.9960	0.9920	0.9202	0.9920	0.9960	0.9972	0.9978	0.9982
150.	0.9960	0.9922	0.9213	0.9922	0.9960	0.9973	0.9979	0.9982
175.	0.9961	0.9923	0.9223	0.9923	0.9961	0.9973	0.9979	0.9982
200.	0.9961	0.9924	0.9234	0.9924	0.9961	0.9973	0.9979	0.9983
225.	0.9961	0.9924	0.9239	0.9924	0.9961	0.9974	0.9979	0.9983
250.	0.9962	0.9925	0.9243	0.9925	0.9962	0.9974	0.9980	0.9983
275.	0.9962	0.9925	0.9248	0.9925	0.9962	0.9974	0.9980	0.9983
300.	0.9962	0.9926	0.9253	0.9926	0.9962	0.9974	0.9980	0.9983
325.	0.9962	0.9926	0.9253	0.9926	0.9962	0.9974	0.9980	0.9983
350.	0.9962	0.9926	0.9252	0.9926	0.9962	0.9974	0.9980	0.9983
375.	0.9962	0.9926	0.9252	0.9926	0.9962	0.9974	0.9980	0.9983
400.	0.9962	0.9926	0.9251	0.9926	0.9962	0.9974	0.9980	0.9983
425.	0.9962	0.9925	0.9248	0.9925	0.9962	0.9974	0.9980	0.9983
450.	0.9962	0.9925	0.9244	0.9925	0.9962	0.9974	0.9980	0.9983
475.	0.9962	0.9924	0.9240	0.9924	0.9962	0.9974	0.9980	0.9983
500.	0.9961	0.9924	0.9236	0.9924	0.9961	0.9974	0.9979	0.9983
525.	0.9961	0.9924	0.9233	0.9924	0.9961	0.9973	0.9979	0.9983
550.	0.9961	0.9923	0.9231	0.9923	0.9961	0.9973	0.9979	0.9983
575.	0.9961	0.9923	0.9228	0.9923	0.9961	0.9973	0.9979	0.9983
600.	0.9961	0.9923	0.9225	0.9923	0.9961	0.9973	0.9979	0.9982

Particle : p Target : Pb 1 mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	correction factor (deg.)							
100.	0.9918	0.9839	0.9191	0.9839	0.9918	0.9944	0.9956	0.9963
125.	0.9919	0.9842	0.9202	0.9842	0.9919	0.9945	0.9957	0.9964
150.	0.9920	0.9844	0.9213	0.9844	0.9920	0.9945	0.9958	0.9964
175.	0.9921	0.9846	0.9223	0.9846	0.9921	0.9946	0.9958	0.9965
200.	0.9923	0.9848	0.9234	0.9848	0.9923	0.9947	0.9959	0.9965
225.	0.9923	0.9849	0.9239	0.9849	0.9923	0.9947	0.9959	0.9966
250.	0.9924	0.9850	0.9243	0.9850	0.9924	0.9948	0.9959	0.9966
275.	0.9924	0.9851	0.9248	0.9851	0.9924	0.9948	0.9960	0.9966
300.	0.9925	0.9852	0.9253	0.9852	0.9925	0.9948	0.9960	0.9966
325.	0.9925	0.9852	0.9253	0.9852	0.9925	0.9948	0.9960	0.9966
350.	0.9925	0.9852	0.9252	0.9852	0.9925	0.9948	0.9960	0.9966
375.	0.9925	0.9852	0.9252	0.9852	0.9925	0.9948	0.9960	0.9966
400.	0.9924	0.9852	0.9251	0.9852	0.9924	0.9948	0.9960	0.9966
425.	0.9924	0.9851	0.9248	0.9851	0.9924	0.9948	0.9960	0.9966
450.	0.9924	0.9850	0.9244	0.9850	0.9924	0.9948	0.9959	0.9966
475.	0.9923	0.9849	0.9240	0.9849	0.9923	0.9947	0.9959	0.9966
500.	0.9923	0.9849	0.9236	0.9849	0.9923	0.9947	0.9959	0.9965
525.	0.9923	0.9848	0.9233	0.9848	0.9923	0.9947	0.9959	0.9965
550.	0.9922	0.9847	0.9231	0.9847	0.9922	0.9947	0.9959	0.9965
575.	0.9922	0.9847	0.9228	0.9847	0.9922	0.9947	0.9958	0.9965
600.	0.9922	0.9846	0.9225	0.9846	0.9922	0.9946	0.9958	0.9965

particle = π Target = Li 36mm Radiation Length =1550mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.419	0.408	0.404	0.408	0.419	0.438	0.469	0.501
125.	0.347	0.338	0.335	0.338	0.347	0.363	0.389	0.416
150.	0.298	0.290	0.288	0.290	0.298	0.312	0.334	0.357
175.	0.262	0.255	0.253	0.255	0.262	0.274	0.294	0.314
200.	0.235	0.229	0.227	0.229	0.235	0.246	0.263	0.281
225.	0.213	0.207	0.206	0.207	0.213	0.223	0.239	0.255
250.	0.195	0.190	0.188	0.190	0.195	0.204	0.219	0.234
275.	0.180	0.176	0.174	0.176	0.180	0.189	0.202	0.216
300.	0.168	0.163	0.162	0.163	0.168	0.175	0.188	0.201
325.	0.157	0.153	0.151	0.153	0.157	0.164	0.176	0.188

particle = π Target = C 3mm Radiation Length =188mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.638	0.932	1.312	0.932	0.638	0.516	0.448	0.406
125.	0.529	0.772	1.088	0.772	0.529	0.428	0.372	0.337
150.	0.454	0.663	0.934	0.663	0.454	0.367	0.319	0.289
175.	0.400	0.584	0.822	0.584	0.400	0.323	0.281	0.254
200.	0.358	0.522	0.736	0.522	0.358	0.289	0.251	0.228
225.	0.325	0.474	0.667	0.474	0.325	0.263	0.228	0.207
250.	0.297	0.434	0.612	0.434	0.297	0.241	0.209	0.189
275.	0.275	0.401	0.565	0.401	0.275	0.222	0.193	0.175
300.	0.256	0.373	0.525	0.373	0.256	0.207	0.179	0.163
325.	0.239	0.349	0.491	0.349	0.239	0.193	0.168	0.152

particle = π Target = C 6mm Radiation Length =188mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.940	1.323	1.312	1.323	0.940	0.760	0.661	0.599
125.	0.779	1.097	1.088	1.097	0.779	0.630	0.548	0.497
150.	0.669	0.942	0.934	0.942	0.669	0.541	0.470	0.427
175.	0.589	0.829	0.822	0.829	0.589	0.476	0.414	0.375
200.	0.527	0.742	0.736	0.742	0.527	0.426	0.371	0.336
225.	0.478	0.673	0.667	0.673	0.478	0.387	0.336	0.305
250.	0.438	0.617	0.612	0.617	0.438	0.354	0.308	0.279
275.	0.405	0.570	0.565	0.570	0.405	0.327	0.285	0.258
300.	0.376	0.530	0.525	0.530	0.376	0.304	0.265	0.240
325.	0.352	0.496	0.491	0.496	0.352	0.285	0.247	0.224

particle = π Target = C 11mm Radiation Length =188mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.316	1.323	1.312	1.323	1.316	1.066	0.927	0.840
125.	1.091	1.097	1.088	1.097	1.091	0.883	0.768	0.697
150.	0.937	0.942	0.934	0.942	0.937	0.759	0.660	0.598
175.	0.824	0.829	0.822	0.829	0.824	0.668	0.580	0.526
200.	0.738	0.742	0.736	0.742	0.738	0.598	0.520	0.471
225.	0.669	0.673	0.667	0.673	0.669	0.542	0.471	0.427
250.	0.613	0.617	0.612	0.617	0.613	0.497	0.432	0.392
275.	0.567	0.570	0.565	0.570	0.567	0.459	0.399	0.362
300.	0.527	0.530	0.525	0.530	0.527	0.427	0.371	0.336
325.	0.493	0.496	0.491	0.496	0.493	0.399	0.347	0.315

Table 4.3: Deflection angle of multiple Coulomb scattering

particle = π Target = Al $2mm$ Radiation Length =$89mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.773	1.127	1.985	1.127	0.773	0.625	0.543	0.492
125.	0.640	0.934	1.645	0.934	0.640	0.518	0.450	0.408
150.	0.550	0.802	1.413	0.802	0.550	0.445	0.387	0.350
175.	0.484	0.706	1.244	0.706	0.484	0.392	0.340	0.308
200.	0.433	0.632	1.113	0.632	0.433	0.351	0.305	0.276
225.	0.393	0.573	1.010	0.573	0.393	0.318	0.276	0.250
250.	0.360	0.525	0.925	0.525	0.360	0.291	0.253	0.229
275.	0.333	0.485	0.855	0.485	0.333	0.269	0.234	0.212
300.	0.309	0.451	0.795	0.451	0.309	0.250	0.217	0.197
325.	0.289	0.422	0.743	0.422	0.289	0.234	0.203	0.184

particle = π Target = Al $4mm$ Radiation Length =$89mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.137	1.655	1.985	1.655	1.137	0.920	0.800	0.725
125.	0.942	1.372	1.645	1.372	0.942	0.763	0.663	0.601
150.	0.809	1.178	1.413	1.178	0.809	0.655	0.570	0.516
175.	0.712	1.037	1.244	1.037	0.712	0.576	0.501	0.454
200.	0.637	0.928	1.113	0.928	0.637	0.516	0.449	0.407
225.	0.578	0.842	1.010	0.842	0.578	0.468	0.407	0.369
250.	0.530	0.771	0.925	0.771	0.530	0.429	0.373	0.338
275.	0.489	0.713	0.855	0.713	0.489	0.396	0.344	0.312
300.	0.455	0.663	0.795	0.663	0.455	0.368	0.320	0.290
325.	0.426	0.620	0.743	0.620	0.426	0.345	0.300	0.272

particle = π Target = Cu $0.5mm$ Radiation Length =$14.3mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.989	1.440	5.429	1.440	0.989	0.800	0.695	0.631
125.	0.819	1.194	4.500	1.194	0.819	0.663	0.576	0.523
150.	0.704	1.025	3.865	1.025	0.704	0.570	0.495	0.449
175.	0.619	0.902	3.401	0.902	0.619	0.501	0.436	0.395
200.	0.554	0.808	3.045	0.808	0.554	0.449	0.390	0.354
225.	0.503	0.733	2.761	0.733	0.503	0.407	0.354	0.321
250.	0.461	0.671	2.530	0.671	0.461	0.373	0.324	0.294
275.	0.426	0.620	2.337	0.620	0.426	0.344	0.299	0.271
300.	0.396	0.577	2.174	0.577	0.396	0.320	0.278	0.252
325.	0.370	0.539	2.033	0.539	0.370	0.300	0.260	0.236

particle = π Target = Cu $1mm$ Radiation Length =$14.3mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.453	2.113	5.429	2.113	1.453	1.177	1.023	0.928
125.	1.204	1.752	4.500	1.752	1.204	0.975	0.848	0.769
150.	1.034	1.505	3.865	1.505	1.034	0.838	0.729	0.661
175.	0.910	1.324	3.401	1.324	0.910	0.737	0.641	0.581
200.	0.815	1.185	3.045	1.185	0.815	0.660	0.574	0.520
225.	0.739	1.075	2.761	1.075	0.739	0.598	0.521	0.472
250.	0.677	0.985	2.530	0.985	0.677	0.548	0.477	0.433
275.	0.625	0.910	2.337	0.910	0.625	0.507	0.441	0.400
300.	0.582	0.846	2.174	0.846	0.582	0.471	0.410	0.372
325.	0.544	0.791	2.033	0.791	0.544	0.441	0.383	0.348

particle = π Target = Sn $1mm$ Radiation Length $=12.1mm$

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.593	2.318	5.949	2.318	1.593	1.291	1.123	1.019
125.	1.321	1.921	4.931	1.921	1.321	1.070	0.931	0.844
150.	1.134	1.650	4.235	1.650	1.134	0.919	0.799	0.725
175.	0.998	1.452	3.727	1.452	0.998	0.809	0.703	0.638
200.	0.894	1.300	3.336	1.300	0.894	0.724	0.630	0.571
225.	0.810	1.179	3.026	1.179	0.810	0.657	0.571	0.518
250.	0.743	1.080	2.773	1.080	0.743	0.602	0.523	0.475
275.	0.686	0.998	2.561	0.998	0.686	0.556	0.483	0.439
300.	0.638	0.928	2.382	0.928	0.638	0.517	0.450	0.408
325.	0.597	0.868	2.228	0.868	0.597	0.483	0.420	0.381

particle = π Target = Sn $2mm$ Radiation Length $=12.1mm$

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	2.337	3.395	5.949	3.395	2.337	1.895	1.649	1.497
125.	1.937	2.814	4.931	2.814	1.937	1.571	1.367	1.240
150.	1.664	2.417	4.235	2.417	1.664	1.349	1.174	1.065
175.	1.464	2.127	3.727	2.127	1.464	1.187	1.033	0.937
200.	1.311	1.904	3.336	1.904	1.311	1.063	0.925	0.839
225.	1.189	1.727	3.026	1.727	1.189	0.964	0.839	0.761
250.	1.089	1.582	2.773	1.582	1.089	0.883	0.769	0.697
275.	1.006	1.462	2.561	1.462	1.006	0.816	0.710	0.644
300.	0.936	1.360	2.382	1.360	0.936	0.759	0.660	0.599
325.	0.875	1.271	2.228	1.271	0.875	0.710	0.618	0.560

particle = π Target = Pb $0.5mm$ Radiation Length $=5.6mm$

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.663	2.419	9.066	2.419	1.663	1.348	1.172	1.063
125.	1.378	2.005	7.514	2.005	1.378	1.117	0.972	0.881
150.	1.184	1.722	6.454	1.722	1.184	0.959	0.834	0.757
175.	1.042	1.515	5.679	1.515	1.042	0.844	0.734	0.666
200.	0.933	1.356	5.084	1.356	0.933	0.756	0.657	0.596
225.	0.846	1.230	4.611	1.230	0.846	0.685	0.596	0.541
250.	0.775	1.127	4.225	1.127	0.775	0.628	0.546	0.496
275.	0.716	1.041	3.903	1.041	0.716	0.580	0.505	0.458
300.	0.666	0.968	3.630	0.968	0.666	0.540	0.469	0.426
325.	0.623	0.906	3.395	0.906	0.623	0.505	0.439	0.398

particle = π Target = Pb $1mm$ Radiation Length $=5.6mm$

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	2.439	3.543	9.066	3.543	2.439	1.978	1.721	1.562
125.	2.022	2.936	7.514	2.936	2.022	1.639	1.427	1.295
150.	1.736	2.522	6.454	2.522	1.736	1.408	1.225	1.112
175.	1.528	2.219	5.679	2.219	1.528	1.239	1.078	0.978
200.	1.368	1.987	5.084	1.987	1.368	1.109	0.965	0.876
225.	1.241	1.802	4.611	1.802	1.241	1.006	0.876	0.795
250.	1.137	1.651	4.225	1.651	1.137	0.922	0.802	0.728
275.	1.050	1.525	3.903	1.525	1.050	0.852	0.741	0.673
300.	0.977	1.419	3.630	1.419	0.977	0.792	0.689	0.625
325.	0.913	1.327	3.395	1.327	0.913	0.741	0.645	0.585

particle = p Target = Li 36mm Radiation Length =1550mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.348	0.339	0.336	0.339	0.348	0.364	0.390	0.417
125.	0.282	0.274	0.272	0.274	0.282	0.295	0.316	0.337
150.	0.237	0.231	0.229	0.231	0.237	0.248	0.266	0.284
175.	0.205	0.200	0.198	0.200	0.205	0.215	0.230	0.246
200.	0.182	0.177	0.175	0.177	0.182	0.190	0.204	0.218
225.	0.163	0.159	0.157	0.159	0.163	0.171	0.183	0.195
250.	0.148	0.144	0.143	0.144	0.148	0.155	0.166	0.177
275.	0.136	0.132	0.131	0.132	0.136	0.142	0.152	0.163
300.	0.126	0.122	0.121	0.122	0.126	0.132	0.141	0.151
325.	0.117	0.114	0.113	0.114	0.117	0.122	0.131	0.140

particle = p Target = C 3mm Radiation Length =188mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.531	0.774	1.091	0.774	0.531	0.429	0.373	0.338
125.	0.429	0.627	0.883	0.627	0.429	0.347	0.301	0.273
150.	0.362	0.528	0.743	0.528	0.362	0.292	0.254	0.230
175.	0.313	0.457	0.644	0.457	0.313	0.253	0.220	0.199
200.	0.277	0.404	0.569	0.404	0.277	0.224	0.194	0.176
225.	0.249	0.363	0.511	0.363	0.249	0.201	0.175	0.158
250.	0.226	0.330	0.464	0.330	0.226	0.183	0.159	0.144
275.	0.207	0.302	0.426	0.302	0.207	0.167	0.145	0.132
300.	0.192	0.280	0.394	0.280	0.192	0.155	0.135	0.122
325.	0.178	0.260	0.367	0.260	0.178	0.144	0.125	0.114

particle = p Target = C 6mm Radiation Length =188mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.781	1.100	1.091	1.100	0.781	0.632	0.549	0.498
125.	0.632	0.890	0.883	0.890	0.632	0.511	0.444	0.403
150.	0.532	0.750	0.743	0.750	0.532	0.431	0.374	0.339
175.	0.461	0.649	0.644	0.649	0.461	0.373	0.324	0.294
200.	0.408	0.574	0.569	0.574	0.408	0.330	0.287	0.260
225.	0.366	0.515	0.511	0.515	0.366	0.296	0.257	0.233
250.	0.332	0.468	0.464	0.468	0.332	0.269	0.234	0.212
275.	0.305	0.429	0.426	0.429	0.305	0.247	0.214	0.194
300.	0.282	0.397	0.394	0.397	0.282	0.228	0.198	0.180
325.	0.263	0.370	0.367	0.370	0.263	0.212	0.185	0.167

particle = p Target = C 11mm Radiation Length =188mm								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.094	1.100	1.091	1.100	1.094	0.886	0.770	0.699
125.	0.885	0.890	0.883	0.890	0.885	0.717	0.623	0.565
150.	0.746	0.750	0.743	0.750	0.746	0.604	0.525	0.476
175.	0.646	0.649	0.644	0.649	0.646	0.523	0.455	0.412
200.	0.571	0.574	0.569	0.574	0.571	0.462	0.402	0.365
225.	0.512	0.515	0.511	0.515	0.512	0.415	0.361	0.327
250.	0.465	0.468	0.464	0.468	0.465	0.377	0.328	0.297
275.	0.427	0.429	0.426	0.429	0.427	0.346	0.301	0.273
300.	0.395	0.397	0.394	0.397	0.395	0.320	0.278	0.252
325.	0.368	0.370	0.367	0.370	0.368	0.298	0.259	0.235

particle = p Target = Al $2mm$ Radiation Length $=89mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.642	0.937	1.650	0.937	0.642	0.520	0.452	0.409
125.	0.520	0.758	1.335	0.758	0.520	0.420	0.365	0.331
150.	0.438	0.639	1.125	0.639	0.438	0.354	0.308	0.279
175.	0.379	0.553	0.974	0.553	0.379	0.307	0.267	0.242
200.	0.335	0.489	0.861	0.489	0.335	0.271	0.236	0.214
225.	0.301	0.439	0.773	0.439	0.301	0.243	0.211	0.192
250.	0.273	0.399	0.702	0.399	0.273	0.221	0.192	0.174
275.	0.251	0.366	0.644	0.366	0.251	0.203	0.176	0.160
300.	0.232	0.338	0.596	0.338	0.232	0.188	0.163	0.148
325.	0.216	0.315	0.555	0.315	0.216	0.175	0.152	0.138

particle = p Target = Al $4mm$ Radiation Length $=89mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.945	1.376	1.650	1.376	0.945	0.765	0.665	0.603
125.	0.764	1.113	1.335	1.113	0.764	0.619	0.538	0.488
150.	0.644	0.938	1.125	0.938	0.644	0.521	0.453	0.411
175.	0.558	0.812	0.974	0.812	0.558	0.452	0.393	0.356
200.	0.493	0.718	0.861	0.718	0.493	0.399	0.347	0.315
225.	0.443	0.644	0.773	0.644	0.443	0.358	0.311	0.282
250.	0.402	0.585	0.702	0.585	0.402	0.325	0.283	0.257
275.	0.369	0.537	0.644	0.537	0.369	0.299	0.260	0.235
300.	0.341	0.497	0.596	0.497	0.341	0.276	0.240	0.218
325.	0.318	0.462	0.555	0.462	0.318	0.257	0.224	0.203

particle = p Target = Cu $0.5mm$ Radiation Length $=14.3mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	0.822	1.197	4.513	1.197	0.822	0.665	0.578	0.524
125.	0.665	0.969	3.651	0.969	0.665	0.538	0.468	0.424
150.	0.560	0.816	3.076	0.816	0.560	0.453	0.394	0.357
175.	0.485	0.707	2.664	0.707	0.485	0.393	0.341	0.309
200.	0.429	0.625	2.355	0.625	0.429	0.347	0.302	0.273
225.	0.385	0.561	2.114	0.561	0.385	0.311	0.271	0.245
250.	0.350	0.509	1.920	0.509	0.350	0.283	0.246	0.223
275.	0.321	0.467	1.762	0.467	0.321	0.260	0.226	0.205
300.	0.297	0.432	1.629	0.432	0.297	0.240	0.209	0.189
325.	0.276	0.402	1.517	0.402	0.276	0.224	0.194	0.176

particle = p Target = Cu $1mm$ Radiation Length $=14.3mm$								
	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.208	1.757	4.513	1.757	1.208	0.978	0.851	0.772
125.	0.977	1.421	3.651	1.421	0.977	0.791	0.688	0.624
150.	0.823	1.197	3.076	1.197	0.823	0.667	0.580	0.526
175.	0.713	1.037	2.664	1.037	0.713	0.577	0.502	0.455
200.	0.630	0.917	2.355	0.917	0.630	0.510	0.444	0.403
225.	0.566	0.823	2.114	0.823	0.566	0.458	0.398	0.361
250.	0.514	0.748	1.920	0.748	0.514	0.416	0.362	0.328
275.	0.471	0.686	1.762	0.686	0.471	0.382	0.332	0.301
300.	0.436	0.634	1.629	0.634	0.436	0.353	0.307	0.279
325.	0.406	0.591	1.517	0.591	0.406	0.329	0.286	0.259

particle = p Target = Sn 1mm Radiation Length =12.1mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.325	1.927	4.946	1.927	1.325	1.073	0.933	0.847
125.	1.072	1.559	4.001	1.559	1.072	0.868	0.755	0.685
150.	0.903	1.313	3.371	1.313	0.903	0.731	0.636	0.577
175.	0.782	1.137	2.919	1.137	0.782	0.634	0.551	0.500
200.	0.691	1.005	2.580	1.005	0.691	0.560	0.487	0.442
225.	0.620	0.902	2.316	0.902	0.620	0.503	0.437	0.397
250.	0.564	0.820	2.104	0.820	0.564	0.457	0.397	0.360
275.	0.517	0.752	1.931	0.752	0.517	0.419	0.364	0.331
300.	0.478	0.696	1.785	0.696	0.478	0.387	0.337	0.306
325.	0.445	0.648	1.662	0.648	0.445	0.361	0.314	0.285

particle = p Target = Sn 2mm Radiation Length =12.1mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.943	2.823	4.946	2.823	1.943	1.575	1.371	1.244
125.	1.572	2.284	4.001	2.284	1.572	1.275	1.109	1.007
150.	1.324	1.924	3.371	1.924	1.324	1.074	0.934	0.848
175.	1.147	1.666	2.919	1.666	1.147	0.930	0.809	0.734
200.	1.014	1.473	2.580	1.473	1.014	0.822	0.715	0.649
225.	0.910	1.322	2.316	1.322	0.910	0.738	0.642	0.583
250.	0.827	1.201	2.104	1.201	0.827	0.670	0.583	0.529
275.	0.759	1.102	1.931	1.102	0.759	0.615	0.535	0.486
300.	0.701	1.019	1.785	1.019	0.701	0.569	0.495	0.449
325.	0.653	0.949	1.662	0.949	0.653	0.530	0.461	0.418

particle = p Target = Pb 0.5mm Radiation Length =5.6mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	1.383	2.011	7.537	2.011	1.383	1.120	0.974	0.884
125.	1.119	1.627	6.097	1.627	1.119	0.906	0.788	0.715
150.	0.942	1.370	5.136	1.370	0.942	0.763	0.664	0.602
175.	0.816	1.187	4.449	1.187	0.816	0.661	0.575	0.522
200.	0.721	1.049	3.932	1.049	0.721	0.584	0.508	0.461
225.	0.647	0.942	3.530	0.942	0.647	0.525	0.456	0.414
250.	0.588	0.856	3.207	0.856	0.588	0.477	0.415	0.376
275.	0.540	0.785	2.942	0.785	0.540	0.437	0.380	0.345
300.	0.499	0.726	2.721	0.726	0.499	0.404	0.352	0.319
325.	0.465	0.676	2.533	0.676	0.465	0.377	0.328	0.297

particle = p Target = Pb 1mm Radiation Length =5.6mm

	Angle (deg.)							
	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00
Ek (MeV)	Deflection Angle (deg.)							
100.	2.028	2.945	7.537	2.945	2.028	1.644	1.431	1.299
125.	1.641	2.383	6.097	2.383	1.641	1.330	1.158	1.051
150.	1.382	2.007	5.136	2.007	1.382	1.121	0.975	0.885
175.	1.197	1.739	4.449	1.739	1.197	0.971	0.845	0.767
200.	1.058	1.537	3.932	1.537	1.058	0.858	0.747	0.678
225.	0.950	1.379	3.530	1.379	0.950	0.770	0.670	0.608
250.	0.863	1.253	3.207	1.253	0.863	0.700	0.609	0.553
275.	0.792	1.150	2.942	1.150	0.792	0.642	0.559	0.507
300.	0.732	1.063	2.721	1.063	0.732	0.594	0.517	0.469
325.	0.682	0.990	2.533	0.990	0.682	0.553	0.481	0.436

Parameter		Value
Ratio of the data acquisition	ε_trig	$33 \pm 0.6\%$
Beam tracking efficiency	ε_beam	$91 \pm 3\%$
Efficiency of 'C1' trigger	ε_{Ctrig}	$93 \pm 2\%$
CDC tracking efficiency	ε_{Ctrk}	$96 \pm 9.7\%$
Vertex cut efficiency on target	ε_{Ctgt}	$92 \pm 4\%$
nuclear absorption correction factor	ε_{corr}	$Table$ 4.2

Table 4.4: Typical value of efficiencies

$\pi^+ + Li \to \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$5.4E-2$	$4.E-3$
75.	$3.8E-2$	$2.E-3$
125.	$1.5E-2$	$1.E-3$
175.	$6.2E-3$	$7.E-4$
225.	$2.8E-3$	$4.E-4$
275.	$1.3E-3$	$3.E-4$
325.	$3.E-4$	$1.E-4$
375.	$4.E-4$	$1.E-4$
425.	$8.E-5$	$5.E-5$
475.	$3.E-5$	$3.E-5$
525.	$6.E-5$	$4.E-5$
625.	$3.E-5$	$3.E-5$

$\pi^+ + Li \to \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$5.8E-2$	$4.E-3$
75.	$4.2E-2$	$2.E-3$
125.	$1.7E-2$	$1.E-3$
175.	$7.5E-3$	$7.E-4$
225.	$2.8E-3$	$4.E-4$
275.	$1.6E-3$	$3.E-4$
325.	$1.4E-3$	$3.E-4$
375.	$5.E-4$	$1.E-4$
425.	$1.5E-4$	$8.E-5$
475.	$1.4E-4$	$7.E-5$
525.	$6.E-5$	$4.E-5$
575.	$3.E-5$	$3.E-5$
625.	$3.E-5$	$3.E-5$
725.	$2.E-5$	$2.E-5$

$\pi^+ + Li \to \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.0E-2$	$3.E-3$
75.	$2.3E-2$	$2.E-3$
125.	$7.3E-3$	$8.E-4$
175.	$3.7E-3$	$5.E-4$
225.	$1.4E-3$	$3.E-4$
275.	$8.E-4$	$2.E-4$
325.	$3.E-4$	$1.E-4$
375.	$1.7E-4$	$8.E-5$
425.	$4.E-5$	$4.E-5$

$\pi^+ + Li \to \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.8E-2$	$3.E-3$
75.	$2.6E-2$	$2.E-3$
125.	$1.1E-2$	$1.E-3$
175.	$3.7E-3$	$5.E-4$
225.	$1.7E-3$	$3.E-4$
275.	$1.3E-3$	$3.E-4$
325.	$4.E-4$	$1.E-4$
375.	$1.7E-4$	$8.E-5$
425.	$1.5E-4$	$8.E-5$
475.	$7.E-5$	$5.E-5$

$\pi^+ + Li \to p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.05E-2$	$1.E-3$
75.	$1.06E-2$	$8.E-4$
125.	$3.1E-3$	$4.E-4$
175.	$9.E-4$	$2.E-4$
225.	$6.E-4$	$1.E-4$
275.	$2.4E-4$	$8.E-5$
325.	$7.E-5$	$4.E-5$
425.	$4.E-5$	$3.E-5$
525.	$2.E-5$	$2.E-5$
575.	$2.E-5$	$2.E-5$
725.	$1.E-5$	$1.E-5$
775.	$1.E-5$	$1.E-5$

$\pi^+ + Li \to p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.5E-2$	$1.E-3$
75.	$1.32E-2$	$8.E-4$
125.	$4.6E-3$	$4.E-4$
175.	$1.3E-3$	$2.E-4$
225.	$8.E-4$	$2.E-4$
275.	$2.4E-4$	$8.E-5$
325.	$7.E-5$	$4.E-5$
425.	$2.E-5$	$2.E-5$
475.	$4.E-5$	$3.E-5$
525.	$2.E-5$	$2.E-5$

Table 4.5: Invariant cross sections in the reaction of π^+ incident

$\pi^+ + Li \rightarrow \pi^+ + X$

$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.4E-2$	$4.E-3$
75.	$4.6E-2$	$2.E-3$
125.	$1.8E-2$	$1.E-3$
175.	$9.7E-3$	$8.E-4$
225.	$5.2E-3$	$6.E-4$
275.	$3.3E-3$	$4.E-4$
325.	$1.4E-3$	$3.E-4$
375.	$9.E-4$	$2.E-4$
425.	$5.E-4$	$1.E-4$
475.	$3.E-4$	$1.E-4$
525.	$1.6E-4$	$7.E-5$
575.	$1.2E-4$	$6.E-5$
625.	$1.1E-4$	$5.E-5$
675.	$8.E-5$	$4.E-5$
725.	$2.E-5$	$2.E-5$

$\pi^+ + Li \rightarrow \pi^- + X$

$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$4.4E-2$	$3.E-3$
75.	$2.7E-2$	$2.E-3$
125.	$1.3E-2$	$1.E-3$
175.	$3.7E-3$	$5.E-4$
225.	$2.5E-3$	$4.E-4$
275.	$1.E-3$	$2.E-4$
325.	$5.E-4$	$2.E-4$
375.	$1.7E-4$	$8.E-5$
425.	$2.3E-4$	$9.E-5$
475.	$1.4E-4$	$7.E-5$
575.	$3.E-5$	$3.E-5$
625.	$3.E-5$	$3.E-5$
725.	$2.E-5$	$2.E-5$

$\pi^+ + Li \rightarrow p + X$

$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.8E-2$	$1.E-3$
75.	$1.73E-2$	$1.E-3$
125.	$6.5E-3$	$5.E-4$
175.	$2.8E-3$	$3.E-4$
225.	$1.4E-3$	$2.E-4$
275.	$4.E-4$	$1.E-4$
325.	$2.0E-4$	$7.E-5$
375.	$7.E-5$	$4.E-5$
425.	$8.E-5$	$4.E-5$
525.	$4.E-5$	$3.E-5$
575.	$2.E-5$	$2.E-5$
725.	$1.E-5$	$1.E-5$

$\pi^+ + Li \rightarrow \pi^+ + X$

$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.0E-2$	$4.E-3$
75.	$5.4E-2$	$3.E-3$
125.	$1.9E-2$	$1.E-3$
175.	$8.5E-3$	$8.E-4$
225.	$4.7E-3$	$5.E-4$
275.	$2.6E-3$	$4.E-4$
325.	$2.7E-3$	$4.E-4$
375.	$9.E-4$	$2.E-4$
425.	$9.E-4$	$2.E-4$
475.	$6.E-4$	$1.E-4$
525.	$3.E-4$	$1.E-4$
575.	$9.E-5$	$5.E-5$
625.	$8.E-5$	$5.E-5$
675.	$1.0E-4$	$5.E-5$
725.	$2.E-5$	$2.E-5$
775.	$2.E-5$	$2.E-5$

$\pi^+ + Li \rightarrow \pi^- + X$

$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$5.9E-2$	$4.E-3$
75.	$3.8E-2$	$2.E-3$
125.	$1.3E-2$	$1.E-3$
175.	$6.6E-3$	$7.E-4$
225.	$3.3E-3$	$5.E-4$
275.	$1.5E-3$	$3.E-4$
325.	$8.E-4$	$2.E-4$
375.	$5.E-4$	$2.E-4$
425.	$2.6E-4$	$1.E-4$
475.	$1.0E-4$	$6.E-5$
575.	$6.E-5$	$4.E-5$
775.	$2.E-5$	$2.E-5$

$\pi^+ + Li \rightarrow p + X$

$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.7E-2$	$2.E-3$
75.	$2.3E-2$	$1.E-3$
125.	$9.9E-3$	$6.E-4$
175.	$4.2E-3$	$4.E-4$
225.	$2.3E-3$	$3.E-4$
275.	$1.E-3$	$2.E-4$
325.	$3.4E-4$	$9.E-5$
375.	$2.2E-4$	$7.E-5$
425.	$8.E-5$	$4.E-5$
475.	$6.E-5$	$3.E-5$
525.	$9.E-5$	$4.E-5$
575.	$2.E-5$	$2.E-5$
725.	$5.E-5$	$3.E-5$

$\pi^+ + Li \to \pi^+ + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$7.2E-2$	$4.E-3$
75.	$5.8E-2$	$3.E-3$
125.	$2.7E-2$	$2.E-3$
175.	$1.31E-2$	$1.E-3$
225.	$7.6E-3$	$7.E-4$
275.	$4.4E-3$	$5.E-4$
325.	$2.9E-3$	$4.E-4$
375.	$1.4E-3$	$2.E-4$
425.	$1.5E-3$	$2.E-4$
475.	$9.E-4$	$2.E-4$
525.	$4.E-4$	$1.E-4$
575.	$4.E-4$	$1.E-4$
625.	$2.5E-4$	$8.E-5$
675.	$2.6E-4$	$8.E-5$
725.	$5.E-5$	$3.E-5$
775.	$7.E-5$	$4.E-5$

$\pi^+ + Li \to \pi^- + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$5.7E-2$	$4.E-3$
75.	$4.0E-2$	$2.E-3$
125.	$1.8E-2$	$1.E-3$
175.	$9.3E-3$	$8.E-4$
225.	$4.4E-3$	$5.E-4$
275.	$2.2E-3$	$3.E-4$
325.	$1.5E-3$	$3.E-4$
375.	$7.E-4$	$2.E-4$
425.	$4.E-4$	$1.E-4$
475.	$2.1E-4$	$8.E-5$
525.	$1.6E-4$	$7.E-5$
575.	$3.E-5$	$3.E-5$
625.	$8.E-5$	$5.E-5$
675.	$3.E-5$	$3.E-5$

$\pi^+ + Li \to p + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$2.8E-2$	$2.E-3$
75.	$3.6E-2$	$1.E-3$
125.	$1.64E-2$	$8.E-4$
175.	$7.6E-3$	$5.E-4$
225.	$3.7E-3$	$3.E-4$
275.	$1.9E-3$	$2.E-4$
325.	$8.E-4$	$1.E-4$
375.	$6.E-4$	$1.E-4$
425.	$5.E-4$	$1.E-4$
475.	$2.0E-4$	$6.E-5$
525.	$7.E-5$	$4.E-5$
575.	$1.2E-4$	$5.E-5$
625.	$3.E-5$	$2.E-5$
675.	$3.E-5$	$2.E-5$
725.	$6.E-5$	$3.E-5$
775.	$3.E-5$	$2.E-5$

$\pi^+ + Li \to \pi^+ + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$9.2E-2$	$5.E-3$
75.	$7.4E-2$	$3.E-3$
125.	$4.0E-2$	$2.E-3$
175.	$2.0E-2$	$1.E-3$
225.	$1.26E-2$	$9.E-4$
275.	$9.2E-3$	$7.E-4$
325.	$4.8E-3$	$5.E-4$
375.	$4.5E-3$	$4.E-4$
425.	$3.2E-3$	$3.E-4$
475.	$1.7E-3$	$2.E-4$
525.	$1.3E-3$	$2.E-4$
575.	$1.1E-3$	$2.E-4$
625.	$7.E-4$	$1.E-4$
675.	$6.E-4$	$1.E-4$
725.	$4.1E-4$	$1.E-4$
775.	$2.7E-4$	$8.E-5$

$\pi^+ + Li \to \pi^- + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$6.8E-2$	$4.E-3$
75.	$5.4E-2$	$3.E-3$
125.	$2.8E-2$	$2.E-3$
175.	$1.6E-2$	$1.E-3$
225.	$9.6E-3$	$8.E-4$
275.	$6.9E-3$	$6.E-4$
325.	$4.1E-3$	$4.E-4$
375.	$2.1E-3$	$3.E-4$
425.	$1.2E-3$	$2.E-4$
475.	$9.E-4$	$2.E-4$
525.	$3.E-4$	$1.E-4$
575.	$5.E-4$	$1.E-4$
625.	$3.0E-4$	$9.E-5$
675.	$2.3E-4$	$8.E-5$
725.	$1.2E-4$	$5.E-5$
775.	$1.1E-4$	$5.E-5$

$\pi^+ + Li \to p + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$4.2E-2$	$2.E-3$
75.	$5.4E-2$	$2.E-3$
125.	$3.1E-2$	$1.E-3$
175.	$1.52E-2$	$7.E-4$
225.	$8.0E-3$	$5.E-4$
275.	$4.4E-3$	$3.E-4$
325.	$2.7E-3$	$3.E-4$
375.	$1.5E-3$	$2.E-4$
425.	$9.E-4$	$1.E-4$
475.	$3.1E-4$	$8.E-5$
525.	$2.8E-4$	$7.E-5$
575.	$1.4E-4$	$5.E-5$
625.	$2.1E-4$	$6.E-5$
675.	$1.7E-4$	$5.E-5$
725.	$1.1E-4$	$4.E-5$
775.	$6.E-5$	$3.E-5$

$\pi^+ + C \to \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$1.81E-1$	$5.E-3$
75.	$4.2E-2$	$2.E-3$
125.	$4.3E-2$	$2.E-3$
175.	$2.0E-2$	$1.E-3$
225.	$1.01E-2$	$7.E-4$
275.	$5.8E-3$	$5.E-4$
325.	$2.7E-3$	$3.E-4$
375.	$1.8E-3$	$2.E-4$
425.	$7.E-4$	$1.E-4$
475.	$6.E-4$	$1.E-4$
525.	$3.1E-4$	$8.E-5$
575.	$2.5E-4$	$7.E-5$
625.	$1.9E-4$	$6.E-5$
675.	$7.E-5$	$4.E-5$
725.	$1.0E-4$	$4.E-5$
775.	$6.E-5$	$3.E-5$

$\pi^+ + C \to \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$7.9E-2$	$4.E-3$
75.	$2.0E-2$	$1.E-3$
125.	$2.6E-2$	$1.E-3$
175.	$1.06E-2$	$7.E-4$
225.	$4.5E-3$	$4.E-4$
275.	$2.7E-3$	$3.E-4$
325.	$1.7E-3$	$2.E-4$
375.	$7.E-4$	$1.E-4$
425.	$3.4E-4$	$1.E-4$
475.	$1.9E-4$	$7.E-5$
525.	$9.E-5$	$4.E-5$
575.	$1.7E-4$	$6.E-5$
625.	$6.E-5$	$3.E-5$
675.	$7.E-5$	$4.E-5$

$\pi^+ + C \to p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.4E-2$	$1.E-3$
75.	$6.2E-2$	$2.E-3$
125.	$2.08E-2$	$8.E-4$
175.	$6.6E-3$	$4.E-4$
225.	$2.3E-3$	$2.E-4$
275.	$9.E-4$	$1.E-4$
325.	$2.4E-4$	$6.E-5$
375.	$1.E-4$	$4.E-5$
425.	$6.E-5$	$3.E-5$
475.	$6.E-5$	$3.E-5$
575.	$2.E-5$	$2.E-5$
625.	$1.E-5$	$1.E-5$
725.	$3.E-5$	$2.E-5$
775.	$3.E-5$	$2.E-5$

$\pi^+ + C \to \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$1.80E-1$	$5.E-3$
75.	$5.2E-2$	$2.E-3$
125.	$5.4E-2$	$2.E-3$
175.	$2.6E-2$	$1.E-3$
225.	$1.22E-2$	$7.E-4$
275.	$7.2E-3$	$5.E-4$
325.	$4.3E-3$	$4.E-4$
375.	$2.3E-3$	$3.E-4$
425.	$9.E-4$	$2.E-4$
475.	$1.2E-3$	$2.E-4$
525.	$6.E-4$	$1.E-4$
575.	$2.5E-4$	$7.E-5$
625.	$2.9E-4$	$7.E-5$
675.	$1.8E-4$	$6.E-5$
725.	$5.E-5$	$3.E-5$
775.	$2.E-5$	$2.E-5$

$\pi^+ + C \to \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$8.9E-2$	$4.E-3$
75.	$2.5E-2$	$1.E-3$
125.	$3.0E-2$	$1.E-3$
175.	$1.49E-2$	$9.E-4$
225.	$6.2E-3$	$5.E-4$
275.	$4.2E-3$	$4.E-4$
325.	$1.8E-3$	$2.E-4$
375.	$1.E-3$	$2.E-4$
425.	$6.E-4$	$1.E-4$
475.	$3.9E-4$	$1.E-4$
525.	$1.8E-4$	$6.E-5$
575.	$6.E-5$	$4.E-5$
625.	$8.E-5$	$4.E-5$
675.	$5.E-5$	$3.E-5$
725.	$2.E-5$	$2.E-5$
775.	$3.E-5$	$2.E-5$

$\pi^+ + C \to p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.2E-2$	$1.E-3$
75.	$7.3E-2$	$2.E-3$
125.	$2.60E-2$	$9.E-4$
175.	$8.9E-3$	$5.E-4$
225.	$2.7E-3$	$2.E-4$
275.	$1.2E-3$	$2.E-4$
325.	$4.3E-4$	$9.E-5$
375.	$1.1E-4$	$4.E-5$
425.	$1.2E-4$	$4.E-5$
475.	$4.E-5$	$2.E-5$
525.	$4.E-5$	$2.E-5$
575.	$2.E-5$	$2.E-5$
675.	$3.E-5$	$2.E-5$
725.	$2.E-5$	$1.E-5$
775.	$5.E-5$	$2.E-5$

$\pi^+ + C \rightarrow \pi^+ + X$ $(-0.4 < \cos\theta < -0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.77E-1$	$5.E-3$
75.	$5.9E-2$	$2.E-3$
125.	$5.5E-2$	$2.E-3$
175.	$2.9E-2$	$1.E-3$
225.	$1.64E-2$	$8.E-4$
275.	$9.5E-3$	$6.E-4$
325.	$5.1E-3$	$4.E-4$
375.	$3.7E-3$	$3.E-4$
425.	$2.0E-3$	$2.E-4$
475.	$1.2E-3$	$2.E-4$
525.	$7.E-4$	$1.E-4$
575.	$5.E-4$	$1.E-4$
625.	$4.2E-4$	$9.E-5$
675.	$1.8E-4$	$6.E-5$
725.	$1.0E-4$	$4.E-5$
775.	$6.E-5$	$3.E-5$

$\pi^+ + C \rightarrow \pi^- + X$ $(-0.4 < \cos\theta < -0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$9.7E-2$	$4.E-3$
75.	$3.1E-2$	$2.E-3$
125.	$3.4E-2$	$1.E-3$
175.	$1.60E-2$	$9.E-4$
225.	$8.8E-3$	$6.E-4$
275.	$5.2E-3$	$4.E-4$
325.	$2.3E-3$	$3.E-4$
375.	$1.4E-3$	$2.E-4$
425.	$9.E-4$	$2.E-4$
475.	$6.E-4$	$1.E-4$
525.	$1.6E-4$	$6.E-5$
575.	$1.7E-4$	$6.E-5$
625.	$4.E-5$	$3.E-5$
775.	$5.E-5$	$3.E-5$

$\pi^+ + C \rightarrow p + X$ $(-0.4 < \cos\theta < -0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.7E-2$	$1.E-3$
75.	$8.6E-2$	$2.E-3$
125.	$3.37E-2$	$1.E-3$
175.	$1.17E-2$	$5.E-4$
225.	$4.1E-3$	$3.E-4$
275.	$1.5E-3$	$2.E-4$
325.	$4.7E-4$	$9.E-5$
375.	$2.7E-4$	$7.E-5$
425.	$1.6E-4$	$5.E-5$
475.	$8.E-5$	$3.E-5$
525.	$3.E-5$	$2.E-5$
575.	$4.E-5$	$2.E-5$
625.	$2.E-5$	$2.E-5$
675.	$3.E-5$	$2.E-5$
725.	$3.E-5$	$2.E-5$
775.	$5.E-5$	$2.E-5$

$\pi^+ + C \rightarrow \pi^+ + X$ $(-0.2 < \cos\theta < 0.0)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.67E-1$	$5.E-3$
75.	$6.5E-2$	$2.E-3$
125.	$5.8E-2$	$2.E-3$
175.	$3.4E-2$	$1.E-3$
225.	$1.82E-2$	$9.E-4$
275.	$1.15E-2$	$7.E-4$
325.	$6.6E-3$	$5.E-4$
375.	$4.6E-3$	$4.E-4$
425.	$2.9E-3$	$3.E-4$
475.	$1.9E-3$	$2.E-4$
525.	$1.2E-3$	$2.E-4$
575.	$8.E-4$	$1.E-4$
625.	$6.E-4$	$1.E-4$
675.	$2.7E-4$	$7.E-5$
725.	$1.2E-4$	$5.E-5$
775.	$1.4E-4$	$5.E-5$

$\pi^+ + C \rightarrow \pi^- + X$ $(-0.2 < \cos\theta < 0.0)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$9.0E-2$	$4.E-3$
75.	$3.6E-2$	$2.E-3$
125.	$3.3E-2$	$1.E-3$
175.	$2.0E-2$	$1.E-3$
225.	$1.15E-2$	$7.E-4$
275.	$6.8E-3$	$5.E-4$
325.	$3.7E-3$	$3.E-4$
375.	$2.0E-3$	$2.E-4$
425.	$1.0E-3$	$2.E-4$
475.	$5.E-4$	$1.E-4$
525.	$4.0E-4$	$9.E-5$
575.	$8.E-5$	$4.E-5$
625.	$1.9E-4$	$6.E-5$
675.	$7.E-5$	$4.E-5$
725.	$7.E-5$	$3.E-5$
775.	$5.E-5$	$3.E-5$

$\pi^+ + C \rightarrow p + X$ $(-0.2 < \cos\theta < 0.0)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.00E-2$	$8.E-4$
75.	$9.1E-2$	$2.E-3$
125.	$4.1E-2$	$1.E-3$
175.	$1.54E-2$	$6.E-4$
225.	$5.6E-3$	$3.E-4$
275.	$2.4E-3$	$2.E-4$
325.	$9.E-4$	$1.E-4$
375.	$4.2E-4$	$8.E-5$
425.	$1.8E-4$	$5.E-5$
475.	$1.8E-4$	$5.E-5$
525.	$1.2E-4$	$4.E-5$
575.	$1.5E-4$	$4.E-5$
625.	$7.E-5$	$3.E-5$
675.	$7.E-5$	$3.E-5$
725.	$4.E-5$	$2.E-5$
775.	$9.E-5$	$3.E-5$

$\pi^+ + C \rightarrow \pi^+ + X$		
$(0.0 < \cos\theta < 0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2/sr$)	
25.	$1.84E-1$	$6.E-3$
75.	$7.3E-2$	$3.E-3$
125.	$7.5E-2$	$2.E-3$
175.	$4.5E-2$	$2.E-3$
225.	$2.6E-2$	$1.E-3$
275.	$1.60E-2$	$8.E-4$
325.	$8.6E-3$	$5.E-4$
375.	$6.8E-3$	$4.E-4$
425.	$4.8E-3$	$4.E-4$
475.	$3.3E-3$	$3.E-4$
525.	$2.0E-3$	$2.E-4$
575.	$1.1E-3$	$2.E-4$
625.	$4.6E-4$	$9.E-5$
675.	$2.7E-4$	$7.E-5$
725.	$1.4E-4$	$5.E-5$
775.	$2.2E-4$	$6.E-5$

$\pi^+ + C \rightarrow \pi^- + X$		
$(0.0 < \cos\theta < 0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2/sr$)	
25.	$1.01E-1$	$4.E-3$
75.	$4.2E-2$	$2.E-3$
125.	$4.6E-2$	$2.E-3$
175.	$3.1E-2$	$1.E-3$
225.	$1.60E-2$	$8.E-4$
275.	$1.01E-2$	$6.E-4$
325.	$5.7E-3$	$4.E-4$
375.	$2.8E-3$	$3.E-4$
425.	$1.7E-3$	$2.E-4$
475.	$9.E-4$	$2.E-4$
525.	$7.E-4$	$1.E-4$
575.	$3.7E-4$	$9.E-5$
625.	$2.9E-4$	$7.E-5$
675.	$1.6E-4$	$5.E-5$
725.	$1.2E-4$	$5.E-5$
775.	$1.E-4$	$4.E-5$

$\pi^+ + C \rightarrow p + X$		
$(0.0 < \cos\theta < 0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2/sr$)	
25.	$1.49E-2$	$1.E-3$
75.	$1.16E-1$	$2.E-3$
125.	$6.5E-2$	$1.E-3$
175.	$2.54E-2$	$8.E-4$
225.	$1.03E-2$	$5.E-4$
275.	$4.6E-3$	$3.E-4$
325.	$2.0E-3$	$2.E-4$
375.	$9.E-4$	$1.E-4$
425.	$8.E-4$	$1.E-4$
475.	$3.9E-4$	$7.E-5$
525.	$3.0E-4$	$6.E-5$
575.	$1.7E-4$	$5.E-5$
625.	$8.E-5$	$3.E-5$
675.	$1.0E-4$	$3.E-5$
725.	$2.0E-4$	$5.E-5$
775.	$1.2E-4$	$4.E-5$

$\pi^+ + C \rightarrow \pi^+ + X$		
$(0.2 < \cos\theta < 0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2/sr$)	
25.	$2.31E-1$	$6.E-3$
75.	$1.02E-1$	$3.E-3$
125.	$9.8E-2$	$3.E-3$
175.	$6.2E-2$	$2.E-3$
225.	$3.8E-2$	$1.E-3$
275.	$2.56E-2$	$1.E-3$
325.	$1.57E-2$	$7.E-4$
375.	$1.24E-2$	$6.E-4$
425.	$7.3E-3$	$4.E-4$
475.	$5.7E-3$	$4.E-4$
525.	$3.3E-3$	$3.E-4$
575.	$1.9E-3$	$2.E-4$
625.	$1.5E-3$	$2.E-4$
675.	$9.E-4$	$1.E-4$
725.	$5.1E-4$	$9.E-5$
775.	$3.4E-4$	$7.E-5$

$\pi^+ + C \rightarrow \pi^- + X$		
$(0.2 < \cos\theta < 0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2/sr$)	
25.	$1.39E-1$	$5.E-3$
75.	$6.1E-2$	$2.E-3$
125.	$5.9E-2$	$2.E-3$
175.	$3.7E-2$	$1.E-3$
225.	$2.5E-2$	$1.E-3$
275.	$1.46E-2$	$7.E-4$
325.	$8.8E-3$	$5.E-4$
375.	$5.5E-3$	$4.E-4$
425.	$3.9E-3$	$3.E-4$
475.	$2.0E-3$	$2.E-4$
525.	$1.2E-3$	$2.E-4$
575.	$9.E-4$	$1.E-4$
625.	$6.E-4$	$1.E-4$
675.	$3.6E-4$	$8.E-5$
725.	$2.2E-4$	$6.E-5$
775.	$1.9E-4$	$6.E-5$

$\pi^+ + C \rightarrow p + X$		
$(0.2 < \cos\theta < 0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2/sr$)	
25.	$3.0E-2$	$1.E-3$
75.	$1.69E-1$	$3.E-3$
125.	$8.8E-2$	$2.E-3$
175.	$3.71E-2$	$9.E-4$
225.	$1.64E-2$	$6.E-4$
275.	$7.9E-3$	$4.E-4$
325.	$4.1E-3$	$3.E-4$
375.	$2.6E-3$	$2.E-4$
425.	$1.8E-3$	$2.E-4$
475.	$1.3E-3$	$1.E-4$
525.	$8.E-4$	$1.E-4$
575.	$5.5E-4$	$8.E-5$
625.	$4.4E-4$	$7.E-5$
675.	$3.6E-4$	$6.E-5$
725.	$4.3E-4$	$7.E-5$
775.	$2.1E-4$	$5.E-5$

$\pi^+ + Al \to \pi^+ + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.7E-1$	$2.E-2$
75.	$2.8E-1$	$2.E-2$
125.	$9.1E-2$	$8.E-3$
175.	$4.0E-2$	$4.E-3$
225.	$2.5E-2$	$3.E-3$
275.	$1.1E-2$	$2.E-3$
325.	$4.E-3$	$1.E-3$
375.	$3.1E-3$	$9.E-4$
425.	$1.5E-3$	$7.E-4$
475.	$5.E-4$	$3.E-4$
525.	$5.E-4$	$3.E-4$
725.	$5.E-4$	$2.E-4$

$\pi^+ + Al \to \pi^- + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.5E-1$	$2.E-2$
75.	$1.6E-1$	$1.E-2$
125.	$5.0E-2$	$6.E-3$
175.	$2.6E-2$	$4.E-3$
225.	$8.E-3$	$2.E-3$
275.	$3.E-3$	$1.E-3$
325.	$4.E-3$	$1.E-3$
375.	$1.4E-3$	$6.E-4$
425.	$7.E-4$	$4.E-4$
475.	$8.E-4$	$5.E-4$
575.	$6.E-4$	$3.E-4$

$\pi^+ + Al \to p + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.0E-1$	$1.E-2$
75.	$3.7E-1$	$1.E-2$
125.	$1.09E-1$	$6.E-3$
175.	$3.8E-2$	$3.E-3$
225.	$1.2E-2$	$2.E-3$
275.	$5.9E-3$	$1.E-3$
325.	$1.E-3$	$4.E-4$
375.	$4.E-4$	$3.E-4$
425.	$5.E-4$	$2.E-4$
575.	$2.E-4$	$1.E-4$
675.	$2.E-4$	$2.E-4$

$\pi^+ + Al \to \pi^+ + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.4E-1$	$3.E-2$
75.	$3.0E-1$	$2.E-2$
125.	$1.09E-1$	$8.E-3$
175.	$4.5E-2$	$5.E-3$
225.	$2.6E-2$	$3.E-3$
275.	$1.5E-2$	$2.E-3$
325.	$6.E-3$	$1.E-3$
375.	$6.E-3$	$1.E-3$
425.	$2.2E-3$	$8.E-4$
475.	$1.5E-3$	$7.E-4$
525.	$9.E-4$	$4.E-4$
575.	$3.E-4$	$2.E-4$
625.	$3.E-4$	$3.E-4$
675.	$4.E-4$	$3.E-4$

$\pi^+ + Al \to \pi^- + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.6E-1$	$2.E-2$
75.	$1.9E-1$	$1.E-2$
125.	$6.6E-2$	$7.E-3$
175.	$3.5E-2$	$4.E-3$
225.	$1.3E-2$	$2.E-3$
275.	$6.E-3$	$2.E-3$
325.	$2.3E-3$	$8.E-4$
375.	$4.E-3$	$1.E-3$
425.	$1.3E-3$	$6.E-4$
525.	$8.E-4$	$4.E-4$
625.	$9.E-4$	$4.E-4$

$\pi^+ + Al \to p + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.5E-1$	$1.E-2$
75.	$4.3E-1$	$1.E-2$
125.	$1.42E-1$	$6.E-3$
175.	$5.2E-2$	$3.E-3$
225.	$2.0E-2$	$2.E-3$
275.	$7.E-3$	$1.E-3$
325.	$2.8E-3$	$7.E-4$
375.	$2.0E-3$	$5.E-4$
425.	$1.0E-3$	$3.E-4$
475.	$2.E-4$	$2.E-4$
525.	$3.E-4$	$2.E-4$
725.	$1.E-4$	$1.E-4$
775.	$2.E-4$	$1.E-4$

$\pi^+ + Al \to \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$4.5E-1$	$3.E-2$
75.	$3.0E-1$	$2.E-2$
125.	$1.33E-1$	$9.E-3$
175.	$6.6E-2$	$6.E-3$
225.	$3.2E-2$	$4.E-3$
275.	$1.1E-2$	$2.E-3$
325.	$1.4E-2$	$2.E-3$
375.	$6.E-3$	$1.E-3$
425.	$5.E-3$	$1.E-3$
475.	$3.7E-3$	$9.E-4$
525.	$1.9E-3$	$7.E-4$
575.	$1.3E-3$	$5.E-4$
625.	$7.E-4$	$4.E-4$
675.	$1.1E-3$	$4.E-4$
725.	$6.E-4$	$3.E-4$

$\pi^+ + Al \to \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.0E-1$	$2.E-2$
75.	$3.0E-1$	$2.E-2$
125.	$1.29E-1$	$9.E-3$
175.	$7.5E-2$	$6.E-3$
225.	$3.4E-2$	$4.E-3$
275.	$2.0E-2$	$3.E-3$
325.	$1.3E-2$	$2.E-3$
375.	$1.1E-2$	$2.E-3$
425.	$8.E-3$	$1.E-3$
475.	$5.E-3$	$1.E-3$
525.	$2.7E-3$	$8.E-4$
575.	$4.E-4$	$3.E-4$
625.	$1.6E-3$	$5.E-4$
675.	$6.E-4$	$3.E-4$
725.	$6.E-4$	$3.E-4$

$\pi^+ + Al \to \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.8E-1$	$2.E-2$
75.	$2.1E-1$	$1.E-2$
125.	$8.9E-2$	$7.E-3$
175.	$3.7E-2$	$4.E-3$
225.	$1.8E-2$	$3.E-3$
275.	$9.E-3$	$2.E-3$
325.	$6.E-3$	$1.E-3$
375.	$3.E-3$	$1.E-3$
425.	$2.4E-3$	$8.E-4$
475.	$1.7E-3$	$7.E-4$
525.	$5.E-4$	$3.E-4$
625.	$7.E-4$	$3.E-4$
725.	$4.E-4$	$2.E-4$

$\pi^+ + Al \to \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.7E-1$	$2.E-2$
75.	$2.3E-1$	$1.E-2$
125.	$8.9E-2$	$7.E-3$
175.	$5.4E-2$	$5.E-3$
225.	$2.8E-2$	$4.E-3$
275.	$1.5E-2$	$2.E-3$
325.	$9.E-3$	$2.E-3$
375.	$3.E-3$	$1.E-3$
425.	$2.8E-3$	$9.E-4$
475.	$2.4E-3$	$7.E-4$
525.	$1.1E-3$	$4.E-4$
725.	$4.E-4$	$2.E-4$

$\pi^+ + Al \to p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.59E-1$	$1.E-2$
75.	$4.6E-1$	$1.E-2$
125.	$1.86E-1$	$7.E-3$
175.	$5.9E-2$	$4.E-3$
225.	$2.5E-2$	$2.E-3$
275.	$1.1E-2$	$1.E-3$
325.	$5.0E-3$	$9.E-4$
375.	$2.4E-3$	$6.E-4$
425.	$1.3E-3$	$4.E-4$
475.	$5.E-4$	$3.E-4$
575.	$5.E-4$	$2.E-4$
625.	$2.E-4$	$2.E-4$
675.	$2.E-4$	$1.E-4$
775.	$2.E-4$	$2.E-4$

$\pi^+ + Al \to p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.5E-2$	$6.E-3$
75.	$3.7E-1$	$1.E-2$
125.	$2.09E-1$	$8.E-3$
175.	$7.7E-2$	$4.E-3$
225.	$2.8E-2$	$2.E-3$
275.	$1.4E-2$	$2.E-3$
325.	$8.E-3$	$1.E-3$
375.	$3.3E-3$	$7.E-4$
425.	$1.7E-3$	$5.E-4$
475.	$1.4E-3$	$4.E-4$
525.	$6.E-4$	$3.E-4$
575.	$4.E-4$	$3.E-4$
625.	$2.E-4$	$2.E-4$
725.	$2.E-4$	$1.E-4$
775.	$2.E-4$	$2.E-4$

$\pi^+ + Al \rightarrow \pi^+ + X$

$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.3E-1$	$2.E-2$
75.	$3.5E-1$	$2.E-2$
125.	$2.1E-1$	$1.E-2$
175.	$9.7E-2$	$7.E-3$
225.	$5.9E-2$	$5.E-3$
275.	$3.5E-2$	$3.E-3$
325.	$2.1E-2$	$3.E-3$
375.	$1.6E-2$	$2.E-3$
425.	$7.E-3$	$1.E-3$
475.	$1.1E-2$	$2.E-3$
525.	$4.E-3$	$1.E-3$
575.	$2.9E-3$	$8.E-4$
625.	$1.5E-3$	$4.E-4$
675.	$1.1E-3$	$5.E-4$
725.	$1.1E-3$	$4.E-4$
775.	$2.E-4$	$2.E-4$

$\pi^+ + Al \rightarrow \pi^- + X$

$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.0E-1$	$2.E-2$
75.	$2.6E-1$	$1.E-2$
125.	$1.34E-1$	$9.E-3$
175.	$6.3E-2$	$6.E-3$
225.	$3.6E-2$	$4.E-3$
275.	$3.0E-2$	$3.E-3$
325.	$1.6E-2$	$2.E-3$
375.	$9.E-3$	$2.E-3$
425.	$5.E-3$	$1.E-3$
475.	$4.4E-3$	$9.E-4$
525.	$3.1E-3$	$8.E-4$
575.	$7.E-4$	$4.E-4$
625.	$4.E-4$	$3.E-4$
675.	$3.E-4$	$2.E-4$

$\pi^+ + Al \rightarrow p + X$

$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$8.4E-2$	$7.E-3$
75.	$5.0E-1$	$1.E-2$
125.	$2.79E-1$	$9.E-3$
175.	$1.22E-1$	$5.E-3$
225.	$5.4E-2$	$3.E-3$
275.	$2.6E-2$	$2.E-3$
325.	$1.7E-2$	$2.E-3$
375.	$1.E-2$	$1.E-3$
425.	$7.2E-3$	$1.E-3$
475.	$1.8E-3$	$5.E-4$
525.	$2.0E-3$	$5.E-4$
575.	$8.E-4$	$4.E-4$
625.	$1.8E-3$	$5.E-4$
675.	$6.E-4$	$3.E-4$
725.	$6.E-4$	$3.E-4$
775.	$7.E-4$	$2.E-4$

$\pi^+ + Al \rightarrow \pi^+ + X$

$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.8E-1$	$3.E-2$
75.	$4.4E-1$	$2.E-2$
125.	$2.3E-1$	$1.E-2$
175.	$1.22E-1$	$8.E-3$
225.	$8.2E-2$	$6.E-3$
275.	$5.9E-2$	$5.E-3$
325.	$3.8E-2$	$3.E-3$
375.	$3.1E-2$	$3.E-3$
425.	$1.8E-2$	$2.E-3$
475.	$1.1E-2$	$2.E-3$
525.	$1.0E-2$	$1.E-3$
575.	$7.E-3$	$1.E-3$
625.	$4.3E-3$	$8.E-4$
675.	$3.8E-3$	$8.E-4$
725.	$2.1E-3$	$6.E-4$
775.	$1.8E-3$	$5.E-4$

$\pi^+ + Al \rightarrow \pi^- + X$

$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.5E-1$	$3.E-2$
75.	$3.7E-1$	$2.E-2$
125.	$1.8E-1$	$1.E-2$
175.	$8.9E-2$	$7.E-3$
225.	$5.3E-2$	$5.E-3$
275.	$3.0E-2$	$3.E-3$
325.	$2.3E-2$	$3.E-3$
375.	$1.5E-2$	$2.E-3$
425.	$9.E-3$	$1.E-3$
475.	$6.E-3$	$1.E-3$
525.	$3.9E-3$	$9.E-4$
575.	$3.0E-3$	$8.E-4$
625.	$2.2E-3$	$6.E-4$
675.	$1.4E-3$	$5.E-4$
725.	$5.E-4$	$3.E-4$
775.	$3.E-4$	$2.E-4$

$\pi^+ + Al \rightarrow p + X$

$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.7E-1$	$1.E-2$
75.	$7.8E-1$	$2.E-2$
125.	$3.6E-1$	$1.E-2$
175.	$1.70E-1$	$6.E-3$
225.	$9.1E-2$	$4.E-3$
275.	$4.7E-2$	$3.E-3$
325.	$2.7E-2$	$2.E-3$
375.	$1.7E-2$	$2.E-3$
425.	$8.E-3$	$1.E-3$
475.	$5.7E-3$	$9.E-4$
525.	$3.5E-3$	$6.E-4$
575.	$3.0E-3$	$6.E-4$
625.	$2.5E-3$	$5.E-4$
675.	$1.7E-3$	$4.E-4$
725.	$1.1E-3$	$3.E-4$
775.	$1.2E-3$	$3.E-4$

$\pi^+ + Cu \to \pi^+ + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.0E-1$	$5.E-2$
75.	$4.5E-1$	$3.E-2$
125.	$1.7E-1$	$2.E-2$
175.	$7.4E-2$	$1.E-2$
225.	$2.7E-2$	$5.E-3$
275.	$2.1E-2$	$5.E-3$
325.	$8.E-3$	$3.E-3$
375.	$1.E-2$	$2.E-3$
425.	$6.E-3$	$2.E-3$
475.	$1.6E-3$	$8.E-4$
525.	$7.E-4$	$5.E-4$

$\pi^+ + Cu \to \pi^+ + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$8.1E-1$	$6.E-2$
75.	$5.0E-1$	$3.E-2$
125.	$2.1E-1$	$2.E-2$
175.	$6.9E-2$	$9.E-3$
225.	$4.2E-2$	$7.E-3$
275.	$2.5E-2$	$5.E-3$
325.	$1.5E-2$	$3.E-3$
375.	$1.E-2$	$3.E-3$
425.	$8.E-3$	$2.E-3$
475.	$3.E-3$	$1.E-3$
525.	$4.E-3$	$2.E-3$
575.	$1.5E-3$	$9.E-4$
675.	$7.E-4$	$6.E-4$

$\pi^+ + Cu \to \pi^- + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.5E-1$	$5.E-2$
75.	$3.4E-1$	$3.E-2$
125.	$9.E-2$	$1.E-2$
175.	$4.0E-2$	$7.E-3$
225.	$1.8E-2$	$5.E-3$
275.	$1.1E-2$	$3.E-3$
325.	$6.E-3$	$3.E-3$
375.	$2.E-3$	$1.E-3$
425.	$2.E-3$	$1.E-3$
475.	$1.E-3$	$1.E-3$

$\pi^+ + Cu \to \pi^- + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.8E-1$	$6.E-2$
75.	$3.5E-1$	$3.E-2$
125.	$1.4E-1$	$1.E-2$
175.	$4.2E-2$	$7.E-3$
225.	$3.1E-2$	$6.E-3$
275.	$1.4E-2$	$4.E-3$
325.	$6.E-3$	$2.E-3$
375.	$7.E-3$	$2.E-3$
425.	$4.E-3$	$2.E-3$
475.	$3.E-3$	$1.E-3$
725.	$9.E-4$	$6.E-4$

$\pi^+ + Cu \to p + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.0E+0$	$4.E-2$
75.	$1.1E+0$	$3.E-2$
125.	$3.3E-1$	$2.E-2$
175.	$1.08E-1$	$8.E-3$
225.	$3.6E-2$	$4.E-3$
275.	$1.7E-2$	$3.E-3$
325.	$6.E-3$	$2.E-3$
375.	$4.E-3$	$1.E-3$
425.	$1.E-3$	$5.E-4$
525.	$9.E-4$	$4.E-4$

$\pi^+ + Cu \to p + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.0E+0$	$4.E-2$
75.	$1.3E+0$	$3.E-2$
125.	$4.3E-1$	$2.E-2$
175.	$1.41E-1$	$9.E-3$
225.	$5.6E-2$	$5.E-3$
275.	$2.4E-2$	$3.E-3$
325.	$1.5E-2$	$3.E-3$
375.	$4.E-3$	$1.E-3$
425.	$1.8E-3$	$8.E-4$
475.	$5.E-4$	$3.E-4$
525.	$1.3E-3$	$5.E-4$
725.	$3.E-4$	$3.E-4$
775.	$5.E-4$	$3.E-4$

$\pi^+ + Cu \to \pi^+ + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$7.6E-1$	$6.E-2$
75.	$5.2E-1$	$3.E-2$
125.	$2.4E-1$	$2.E-2$
175.	$1.1E-1$	$1.E-2$
225.	$4.8E-2$	$7.E-3$
275.	$2.4E-2$	$4.E-3$
325.	$1.8E-2$	$4.E-3$
375.	$1.4E-2$	$3.E-3$
425.	$6.E-3$	$2.E-3$
475.	$6.E-3$	$2.E-3$
525.	$3.E-3$	$1.E-3$
575.	$2.E-3$	$1.E-3$
625.	$8.E-4$	$7.E-4$
675.	$1.5E-3$	$8.E-4$

$\pi^+ + Cu \to \pi^+ + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$4.3E-1$	$4.E-2$
75.	$6.2E-1$	$4.E-2$
125.	$2.4E-1$	$2.E-2$
175.	$9.E-2$	$1.E-2$
225.	$5.9E-2$	$8.E-3$
275.	$3.3E-2$	$6.E-3$
325.	$2.1E-2$	$4.E-3$
375.	$1.5E-2$	$3.E-3$
425.	$8.E-3$	$2.E-3$
475.	$1.1E-2$	$2.E-3$
525.	$4.E-3$	$1.E-3$
575.	$1.5E-3$	$9.E-4$
625.	$8.E-4$	$7.E-4$
675.	$1.1E-3$	$8.E-4$
725.	$1.4E-3$	$7.E-4$

$\pi^+ + Cu \to \pi^- + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$8.2E-1$	$6.E-2$
75.	$4.8E-1$	$3.E-2$
125.	$1.6E-1$	$2.E-2$
175.	$5.7E-2$	$8.E-3$
225.	$4.2E-2$	$7.E-3$
275.	$3.2E-2$	$5.E-3$
325.	$9.E-3$	$3.E-3$
375.	$7.E-3$	$2.E-3$
425.	$1.4E-3$	$9.E-4$
475.	$1.3E-3$	$8.E-4$

$\pi^+ + Cu \to \pi^- + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$5.2E-1$	$5.E-2$
75.	$3.9E-1$	$3.E-2$
125.	$1.9E-1$	$2.E-2$
175.	$1.2E-1$	$1.E-2$
225.	$4.2E-2$	$6.E-3$
275.	$2.2E-2$	$5.E-3$
325.	$1.6E-2$	$4.E-3$
375.	$1.1E-2$	$3.E-3$
425.	$6.E-3$	$2.E-3$
475.	$2.E-3$	$1.E-3$
525.	$3.E-3$	$1.E-3$
575.	$1.8E-3$	$9.E-4$
625.	$1.0E-3$	$7.E-4$
725.	$6.E-4$	$4.E-4$

$\pi^+ + Cu \to p + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$8.0E-1$	$3.E-2$
75.	$1.4E+0$	$4.E-2$
125.	$5.1E-1$	$2.E-2$
175.	$1.9E-1$	$1.E-2$
225.	$6.0E-2$	$5.E-3$
275.	$2.6E-2$	$4.E-3$
325.	$1.4E-2$	$2.E-3$
375.	$9.E-3$	$2.E-3$
425.	$3.E-3$	$1.E-3$
475.	$2.2E-3$	$8.E-4$
525.	$1.7E-3$	$8.E-4$
625.	$4.E-4$	$3.E-4$
725.	$8.E-4$	$4.E-4$

$\pi^+ + Cu \to p + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$2.2E-1$	$2.E-2$
75.	$8.7E-1$	$3.E-2$
125.	$5.0E-1$	$2.E-2$
175.	$2.1E-1$	$1.E-2$
225.	$8.8E-2$	$7.E-3$
275.	$3.3E-2$	$4.E-3$
325.	$1.6E-2$	$3.E-3$
375.	$7.E-3$	$2.E-3$
425.	$6.E-3$	$1.E-3$
475.	$4.E-3$	$1.E-3$
525.	$1.9E-3$	$8.E-4$
575.	$1.2E-3$	$5.E-4$
625.	$6.E-4$	$4.E-4$
675.	$4.E-4$	$4.E-4$
725.	$1.9E-3$	$6.E-4$

$\pi^+ + Cu \to \pi^+ + X$ (0.0 < $\cos\theta$ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$6.0E-1$	$5.E-2$
75.	$6.4E-1$	$4.E-2$
125.	$3.4E-1$	$2.E-2$
175.	$1.8E-1$	$2.E-2$
225.	$9.4E-2$	$1.E-2$
275.	$6.0E-2$	$8.E-3$
325.	$4.5E-2$	$6.E-3$
375.	$3.3E-2$	$5.E-3$
425.	$2.5E-2$	$4.E-3$
475.	$1.9E-2$	$3.E-3$
525.	$5.E-3$	$2.E-3$
575.	$5.E-3$	$2.E-3$
625.	$2.E-3$	$1.E-3$
675.	$4.E-3$	$1.E-3$
725.	$2.E-3$	$1.E-3$

$\pi^+ + Cu \to \pi^- + X$ (0.0 < $\cos\theta$ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.2E-1$	$5.E-2$
75.	$5.2E-1$	$3.E-2$
125.	$2.7E-1$	$2.E-2$
175.	$1.4E-1$	$1.E-2$
225.	$6.4E-2$	$8.E-3$
275.	$5.1E-2$	$7.E-3$
325.	$2.1E-2$	$4.E-3$
375.	$1.6E-2$	$3.E-3$
425.	$1.1E-2$	$3.E-3$
475.	$7.E-3$	$2.E-3$
525.	$3.E-3$	$1.E-3$
575.	$2.E-3$	$1.E-3$
625.	$1.1E-3$	$8.E-4$
775.	$6.E-4$	$6.E-4$

$\pi^+ + Cu \to p + X$ (0.0 < $\cos\theta$ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.5E-1$	$2.E-2$
75.	$1.2E+0$	$3.E-2$
125.	$6.8E-1$	$2.E-2$
175.	$3.0E-1$	$1.E-2$
225.	$1.35E-1$	$8.E-3$
275.	$6.2E-2$	$5.E-3$
325.	$3.8E-2$	$4.E-3$
375.	$2.2E-2$	$3.E-3$
425.	$1.1E-2$	$2.E-3$
475.	$5.E-3$	$1.E-3$
525.	$3.E-3$	$1.E-3$
575.	$2.6E-3$	$9.E-4$
625.	$3.2E-3$	$9.E-4$
675.	$1.4E-3$	$6.E-4$
725.	$7.E-4$	$5.E-4$
775.	$5.E-4$	$4.E-4$

$\pi^+ + Cu \to \pi^+ + X$ (0.2 < $\cos\theta$ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.2E+0$	$7.E-2$
75.	$7.6E-1$	$4.E-2$
125.	$3.6E-1$	$2.E-2$
175.	$2.4E-1$	$2.E-2$
225.	$1.4E-1$	$1.E-2$
275.	$1.2E-1$	$1.E-2$
325.	$6.3E-2$	$7.E-3$
375.	$5.1E-2$	$6.E-3$
425.	$4.0E-2$	$5.E-3$
475.	$1.8E-2$	$3.E-3$
525.	$2.2E-2$	$3.E-3$
575.	$1.E-2$	$2.E-3$
625.	$1.2E-2$	$2.E-3$
675.	$6.E-3$	$2.E-3$
725.	$5.E-3$	$1.E-3$
775.	$2.1E-3$	$1.E-3$

$\pi^+ + Cu \to \pi^- + X$ (0.2 < $\cos\theta$ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.2E+0$	$7.E-2$
75.	$6.5E-1$	$4.E-2$
125.	$2.9E-1$	$2.E-2$
175.	$1.7E-1$	$1.E-2$
225.	$8.7E-2$	$1.E-2$
275.	$7.6E-2$	$8.E-3$
325.	$4.3E-2$	$6.E-3$
375.	$3.0E-2$	$5.E-3$
425.	$1.4E-2$	$3.E-3$
475.	$7.E-3$	$2.E-3$
525.	$6.E-3$	$2.E-3$
575.	$7.E-3$	$2.E-3$
625.	$2.E-3$	$1.E-3$
675.	$3.E-3$	$1.E-3$
725.	$3.E-3$	$1.E-3$
775.	$1.7E-3$	$8.E-4$

$\pi^+ + Cu \to p + X$ (0.2 < $\cos\theta$ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.0E+0$	$4.E-2$
75.	$2.2E+0$	$4.E-2$
125.	$9.7E-1$	$3.E-2$
175.	$4.2E-1$	$2.E-2$
225.	$2.0E-1$	$1.E-2$
275.	$1.10E-1$	$7.E-3$
325.	$6.6E-2$	$5.E-3$
375.	$3.0E-2$	$3.E-3$
425.	$2.0E-2$	$3.E-3$
475.	$1.2E-2$	$2.E-3$
525.	$6.E-3$	$1.E-3$
575.	$6.E-3$	$1.E-3$
625.	$7.E-3$	$1.E-3$
675.	$3.7E-3$	$1.E-3$
725.	$4.E-3$	$1.E-3$
775.	$3.9E-3$	$1.E-3$

$\pi^+ + Sn \to \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$9.6E-1$	$7.E-2$
75.	$7.1E-1$	$4.E-2$
125.	$2.3E-1$	$2.E-2$
175.	$1.E-1$	$1.E-2$
225.	$4.3E-2$	$8.E-3$
275.	$2.5E-2$	$5.E-3$
325.	$2.0E-2$	$5.E-3$
375.	$1.1E-2$	$3.E-3$
425.	$2.E-3$	$1.E-3$
475.	$2.E-3$	$1.E-3$
525.	$2.E-3$	$1.E-3$
575.	$8.E-4$	$7.E-4$
675.	$1.E-3$	$8.E-4$

$\pi^+ + Sn \to \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.0E+0$	$7.E-2$
75.	$5.7E-1$	$4.E-2$
125.	$2.5E-1$	$2.E-2$
175.	$1.1E-1$	$1.E-2$
225.	$5.0E-2$	$8.E-3$
275.	$2.2E-2$	$5.E-3$
325.	$2.1E-2$	$5.E-3$
375.	$1.6E-2$	$4.E-3$
425.	$7.E-3$	$2.E-3$
475.	$3.E-3$	$2.E-3$
525.	$2.E-3$	$1.E-3$
575.	$3.E-3$	$1.E-3$
625.	$1.1E-3$	$9.E-4$

$\pi^+ + Sn \to \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.4E+0$	$9.E-2$
75.	$5.5E-1$	$4.E-2$
125.	$1.3E-1$	$2.E-2$
175.	$4.5E-2$	$9.E-3$
225.	$1.9E-2$	$5.E-3$
275.	$1.3E-2$	$4.E-3$
325.	$9.E-3$	$3.E-3$
375.	$4.E-3$	$2.E-3$
425.	$2.E-3$	$1.E-3$
475.	$1.E-3$	$1.E-3$
525.	$9.E-4$	$7.E-4$

$\pi^+ + Sn \to \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.3E+0$	$8.E-2$
75.	$6.9E-1$	$4.E-2$
125.	$2.0E-1$	$2.E-2$
175.	$7.E-2$	$1.E-2$
225.	$4.0E-2$	$7.E-3$
275.	$2.7E-2$	$6.E-3$
325.	$1.5E-2$	$4.E-3$
375.	$4.E-3$	$2.E-3$
425.	$5.E-3$	$2.E-3$
525.	$1.E-3$	$1.E-3$
575.	$1.1E-3$	$9.E-4$

$\pi^+ + Sn \to p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.7E+0$	$6.E-2$
75.	$2.2E+0$	$5.E-2$
125.	$6.6E-1$	$2.E-2$
175.	$2.0E-1$	$1.E-2$
225.	$6.8E-2$	$7.E-3$
275.	$2.6E-2$	$4.E-3$
325.	$1.0E-2$	$2.E-3$
375.	$5.E-3$	$2.E-3$
425.	$3.E-3$	$1.E-3$
475.	$8.E-4$	$6.E-4$
625.	$5.E-4$	$4.E-4$
725.	$7.E-4$	$5.E-4$

$\pi^+ + Sn \to p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.3E+0$	$5.E-2$
75.	$2.4E+0$	$5.E-2$
125.	$7.2E-1$	$3.E-2$
175.	$2.4E-1$	$1.E-2$
225.	$9.3E-2$	$8.E-3$
275.	$4.7E-2$	$5.E-3$
325.	$1.2E-2$	$2.E-3$
375.	$6.E-3$	$2.E-3$
425.	$4.E-3$	$1.E-3$
625.	$1.1E-3$	$7.E-4$
675.	$9.E-4$	$5.E-4$
725.	$7.E-4$	$5.E-4$
775.	$4.E-4$	$3.E-4$

$\pi^+ + Sn \to \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$9.4E-1$	$7.E-2$
75.	$6.7E-1$	$4.E-2$
125.	$3.3E-1$	$3.E-2$
175.	$1.4E-1$	$2.E-2$
225.	$7.3E-2$	$1.E-2$
275.	$3.8E-2$	$7.E-3$
325.	$2.5E-2$	$5.E-3$
375.	$1.8E-2$	$4.E-3$
425.	$1.4E-2$	$4.E-3$
475.	$6.E-3$	$2.E-3$
525.	$3.E-3$	$1.E-3$
575.	$3.E-3$	$1.E-3$
625.	$2.E-3$	$1.E-3$
675.	$1.2E-3$	$8.E-4$

$\pi^+ + Sn \to \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$5.1E-1$	$5.E-2$
75.	$6.6E-1$	$4.E-2$
125.	$2.9E-1$	$2.E-2$
175.	$1.4E-1$	$2.E-2$
225.	$8.E-2$	$1.E-2$
275.	$4.5E-2$	$7.E-3$
325.	$3.6E-2$	$6.E-3$
375.	$2.3E-2$	$5.E-3$
425.	$1.5E-2$	$4.E-3$
475.	$1.3E-2$	$3.E-3$
525.	$7.E-3$	$2.E-3$
575.	$6.E-3$	$2.E-3$
625.	$5.E-3$	$2.E-3$
725.	$2.E-3$	$1.E-3$

$\pi^+ + Sn \to \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$1.4E+0$	$9.E-2$
75.	$7.6E-1$	$5.E-2$
125.	$2.1E-1$	$2.E-2$
175.	$1.E-1$	$1.E-2$
225.	$5.2E-2$	$8.E-3$
275.	$3.6E-2$	$6.E-3$
325.	$2.0E-2$	$4.E-3$
375.	$9.E-3$	$3.E-3$
425.	$3.E-3$	$2.E-3$
475.	$3.E-3$	$2.E-3$
525.	$2.E-3$	$1.E-3$
575.	$1.4E-3$	$9.E-4$

$\pi^+ + Sn \to \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$8.6E-1$	$7.E-2$
75.	$6.8E-1$	$4.E-2$
125.	$2.7E-1$	$2.E-2$
175.	$1.0E-1$	$1.E-2$
225.	$5.0E-2$	$8.E-3$
275.	$3.5E-2$	$7.E-3$
325.	$2.4E-2$	$5.E-3$
375.	$1.5E-2$	$4.E-3$
425.	$7.E-3$	$3.E-3$
475.	$6.E-3$	$2.E-3$
525.	$3.E-3$	$1.E-3$
575.	$2.E-3$	$1.E-3$

$\pi^+ + Sn \to p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$9.1E-1$	$4.E-2$
75.	$2.6E+0$	$6.E-2$
125.	$8.3E-1$	$3.E-2$
175.	$3.0E-1$	$2.E-2$
225.	$1.19E-1$	$9.E-3$
275.	$5.0E-2$	$5.E-3$
325.	$2.5E-2$	$4.E-3$
375.	$9.E-3$	$2.E-3$
425.	$1.E-2$	$2.E-3$
475.	$1.5E-3$	$9.E-4$
525.	$5.E-4$	$4.E-4$
575.	$1.3E-3$	$7.E-4$
625.	$1.1E-3$	$7.E-4$
675.	$9.E-4$	$5.E-4$
725.	$4.E-4$	$3.E-4$

$\pi^+ + Sn \to p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$2.4E-1$	$2.E-2$
75.	$1.4E+0$	$4.E-2$
125.	$9.1E-1$	$3.E-2$
175.	$3.3E-1$	$2.E-2$
225.	$1.5E-1$	$1.E-2$
275.	$5.8E-2$	$6.E-3$
325.	$3.5E-2$	$4.E-3$
375.	$1.8E-2$	$3.E-3$
425.	$8.E-3$	$2.E-3$
475.	$7.E-3$	$2.E-3$
525.	$5.E-3$	$1.E-3$
575.	$2.4E-3$	$1.E-3$
625.	$1.8E-3$	$9.E-4$
725.	$1.2E-3$	$6.E-4$
775.	$1.7E-3$	$8.E-4$

$\pi^+ + Sn \rightarrow \pi^+ + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	4.9E − 1	5.E − 2
75.	7.6E − 1	5.E − 2
125.	3.8E − 1	3.E − 2
175.	2.5E − 1	2.E − 2
225.	1.4E − 1	1.E − 2
275.	8.1E − 2	1.E − 2
325.	5.8E − 2	8.E − 3
375.	4.4E − 2	6.E − 3
425.	2.0E − 2	4.E − 3
475.	1.9E − 2	4.E − 3
525.	1.0E − 2	3.E − 3
575.	6.E − 3	2.E − 3
625.	2.E − 3	1.E − 3
675.	2.E − 3	1.E − 3
725.	2.E − 3	1.E − 3
775.	7.E − 4	5.E − 4

$\pi^+ + Sn \rightarrow \pi^- + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	9.4E − 1	7.E − 2
75.	8.3E − 1	5.E − 2
125.	3.3E − 1	3.E − 2
175.	1.6E − 1	2.E − 2
225.	9.E − 2	1.E − 2
275.	5.5E − 2	8.E − 3
325.	3.5E − 2	6.E − 3
375.	2.6E − 2	5.E − 3
425.	1.8E − 2	4.E − 3
475.	7.E − 3	2.E − 3
525.	7.E − 3	2.E − 3
625.	1.3E − 3	9.E − 4
725.	1.2E − 3	8.E − 4

$\pi^+ + Sn \rightarrow p + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	3.0E − 1	2.E − 2
75.	1.8E + 0	5.E − 2
125.	1.2E + 0	3.E − 2
175.	4.9E − 1	2.E − 2
225.	2.3E − 1	1.E − 2
275.	1.22E − 1	9.E − 3
325.	6.0E − 2	6.E − 3
375.	3.3E − 2	4.E − 3
425.	1.8E − 2	3.E − 3
475.	1.2E − 2	2.E − 3
525.	5.E − 3	1.E − 3
575.	5.E − 3	1.E − 3
625.	2.9E − 3	1.E − 3
675.	1.4E − 3	7.E − 4
725.	2.7E − 3	1.E − 3
775.	2.3E − 3	8.E − 4

$\pi^+ + Sn \rightarrow \pi^+ + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	1.6E + 0	9.E − 2
75.	1.1E + 0	6.E − 2
125.	5.9E − 1	3.E − 2
175.	3.2E − 1	2.E − 2
225.	1.9E − 1	2.E − 2
275.	1.2E − 1	1.E − 2
325.	7.5E − 2	9.E − 3
375.	6.7E − 2	8.E − 3
425.	3.9E − 2	6.E − 3
475.	4.8E − 2	6.E − 3
525.	3.0E − 2	5.E − 3
575.	2.4E − 2	4.E − 3
625.	1.6E − 2	3.E − 3
675.	4.E − 3	2.E − 3
725.	7.E − 3	2.E − 3
775.	5.E − 3	2.E − 3

$\pi^+ + Sn \rightarrow \pi^- + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	2.E + 0	1.E − 1
75.	8.6E − 1	5.E − 2
125.	4.8E − 1	3.E − 2
175.	2.3E − 1	2.E − 2
225.	1.6E − 1	1.E − 2
275.	1.0E − 1	1.E − 2
325.	5.0E − 2	7.E − 3
375.	4.3E − 2	6.E − 3
425.	3.2E − 2	5.E − 3
475.	2.2E − 2	4.E − 3
525.	1.5E − 2	3.E − 3
575.	4.E − 3	2.E − 3
625.	4.E − 3	2.E − 3
675.	4.E − 3	2.E − 3
725.	1.4E − 3	9.E − 4
775.	2.E − 3	1.E − 3

$\pi^+ + Sn \rightarrow p + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	1.4E + 0	5.E − 2
75.	3.8E + 0	7.E − 2
125.	1.6E + 0	4.E − 2
175.	7.3E − 1	2.E − 2
225.	3.5E − 1	2.E − 2
275.	1.61E − 1	1.E − 2
325.	1.00E − 1	7.E − 3
375.	4.8E − 2	5.E − 3
425.	3.8E − 2	4.E − 3
475.	1.7E − 2	3.E − 3
525.	1.6E − 2	3.E − 3
575.	9.E − 3	2.E − 3
625.	1.E − 2	2.E − 3
675.	7.E − 3	2.E − 3
725.	5.E − 3	1.E − 3
775.	4.E − 3	1.E − 3

$\pi^+ + Pb \rightarrow \pi^+ + X$
$(-0.8 < \cos\theta < -0.6)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.E+0$	$1.E-1$
75.	$8.1E-1$	$7.E-2$
125.	$3.8E-1$	$4.E-2$
175.	$1.3E-1$	$2.E-2$
225.	$4.E-2$	$1.E-2$
275.	$5.E-2$	$1.E-2$
325.	$2.6E-2$	$7.E-3$
375.	$1.7E-2$	$5.E-3$
425.	$9.E-3$	$4.E-3$
475.	$2.E-3$	$2.E-3$
675.	$3.E-3$	$2.E-3$
725.	$2.E-3$	$1.E-3$

$\pi^+ + Pb \rightarrow \pi^+ + X$
$(-0.6 < \cos\theta < -0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.E+0$	$1.E-1$
75.	$9.7E-1$	$7.E-2$
125.	$3.5E-1$	$4.E-2$
175.	$1.1E-1$	$2.E-2$
225.	$6.E-2$	$1.E-2$
275.	$5.E-2$	$1.E-2$
325.	$3.2E-2$	$8.E-3$
375.	$2.5E-2$	$7.E-3$
425.	$1.5E-2$	$5.E-3$
475.	$1.0E-2$	$4.E-3$
525.	$5.E-3$	$3.E-3$
575.	$3.E-3$	$2.E-3$
625.	$4.E-3$	$2.E-3$
675.	$3.E-3$	$2.E-3$
725.	$2.E-3$	$1.E-3$

$\pi^+ + Pb \rightarrow \pi^- + X$
$(-0.8 < \cos\theta < -0.6)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.E+0$	$1.E-1$
75.	$6.3E-1$	$6.E-2$
125.	$1.6E-1$	$3.E-2$
175.	$1.0E-1$	$2.E-2$
225.	$3.2E-2$	$1.E-2$
275.	$1.9E-2$	$7.E-3$
325.	$5.E-3$	$4.E-3$
375.	$6.E-3$	$3.E-3$
475.	$2.E-3$	$2.E-3$
675.	$2.E-3$	$1.E-3$

$\pi^+ + Pb \rightarrow \pi^- + X$
$(-0.6 < \cos\theta < -0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.E+0$	$1.E-1$
75.	$6.3E-1$	$6.E-2$
125.	$3.2E-1$	$4.E-2$
175.	$1.E-1$	$2.E-2$
225.	$7.E-2$	$1.E-2$
275.	$4.E-2$	$1.E-2$
325.	$2.9E-2$	$7.E-3$
375.	$4.E-3$	$3.E-3$
425.	$7.E-3$	$3.E-3$
675.	$2.E-3$	$1.E-3$

$\pi^+ + Pb \rightarrow p + X$
$(-0.8 < \cos\theta < -0.6)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.E+0$	$1.E-1$
75.	$3.5E+0$	$9.E-2$
125.	$1.0E+0$	$4.E-2$
175.	$3.4E-1$	$2.E-2$
225.	$1.3E-1$	$1.E-2$
275.	$3.4E-2$	$7.E-3$
325.	$1.9E-2$	$4.E-3$
375.	$2.E-3$	$1.E-3$
425.	$4.E-3$	$2.E-3$
475.	$2.E-3$	$1.E-3$
625.	$1.0E-3$	$8.E-4$

$\pi^+ + Pb \rightarrow p + X$
$(-0.6 < \cos\theta < -0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.E+0$	$1.E-1$
75.	$3.9E+0$	$1.E-1$
125.	$1.1E+0$	$5.E-2$
175.	$3.5E-1$	$2.E-2$
225.	$1.5E-1$	$1.E-2$
275.	$5.5E-2$	$8.E-3$
325.	$2.5E-2$	$5.E-3$
375.	$1.2E-2$	$4.E-3$
425.	$2.E-3$	$2.E-3$
475.	$2.E-3$	$2.E-3$
525.	$1.E-3$	$1.E-3$

$\pi^+ + Pb \to \pi^+ + X$
$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.E+0$	$1.E-1$
75.	$9.8E-1$	$7.E-2$
125.	$4.6E-1$	$4.E-2$
175.	$1.8E-1$	$2.E-2$
225.	$8.E-2$	$1.E-2$
275.	$7.E-2$	$1.E-2$
325.	$3.4E-2$	$9.E-3$
375.	$2.5E-2$	$7.E-3$
425.	$1.6E-2$	$5.E-3$
475.	$1.E-2$	$4.E-3$
525.	$1.0E-2$	$4.E-3$
575.	$6.E-3$	$3.E-3$
675.	$4.E-3$	$2.E-3$

$\pi^+ + Pb \to \pi^+ + X$
$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$8.6E-1$	$9.E-2$
75.	$7.9E-1$	$7.E-2$
125.	$3.5E-1$	$4.E-2$
175.	$2.1E-1$	$3.E-2$
225.	$1.1E-1$	$2.E-2$
275.	$7.E-2$	$1.E-2$
325.	$6.E-2$	$1.E-2$
375.	$4.5E-2$	$9.E-3$
425.	$1.8E-2$	$5.E-3$
475.	$1.5E-2$	$4.E-3$
525.	$1.8E-2$	$5.E-3$
575.	$4.E-3$	$2.E-3$
625.	$3.E-3$	$2.E-3$
725.	$3.E-3$	$2.E-3$

$\pi^+ + Pb \to \pi^- + X$
$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.E+0$	$1.E-1$
75.	$8.0E-1$	$7.E-2$
125.	$3.3E-1$	$4.E-2$
175.	$1.E-1$	$2.E-2$
225.	$7.E-2$	$1.E-2$
275.	$5.E-2$	$1.E-2$
325.	$3.0E-2$	$8.E-3$
375.	$8.E-3$	$4.E-3$
425.	$4.E-3$	$3.E-3$
475.	$8.E-3$	$4.E-3$

$\pi^+ + Pb \to \pi^- + X$
$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.E+0$	$1.E-1$
75.	$7.1E-1$	$6.E-2$
125.	$3.5E-1$	$4.E-2$
175.	$1.7E-1$	$2.E-2$
225.	$9.E-2$	$1.E-2$
275.	$5.E-2$	$1.E-2$
325.	$3.0E-2$	$8.E-3$
375.	$2.5E-2$	$7.E-3$
425.	$1.1E-2$	$5.E-3$
475.	$7.E-3$	$4.E-3$
525.	$2.E-3$	$1.E-3$
625.	$2.E-3$	$1.E-3$
725.	$2.E-3$	$2.E-3$

$\pi^+ + Pb \to p + X$
$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.E+0$	$1.E-1$
75.	$5.E+0$	$1.E-1$
125.	$1.4E+0$	$5.E-2$
175.	$4.7E-1$	$3.E-2$
225.	$1.8E-1$	$2.E-2$
275.	$5.6E-2$	$8.E-3$
325.	$4.2E-2$	$7.E-3$
375.	$1.1E-2$	$3.E-3$
425.	$1.E-2$	$3.E-3$
475.	$3.E-3$	$2.E-3$
575.	$2.E-3$	$1.E-3$
675.	$1.E-3$	$7.E-4$
725.	$9.E-4$	$7.E-4$
775.	$9.E-4$	$7.E-4$

$\pi^+ + Pb \to p + X$
$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$5.9E-1$	$5.E-2$
75.	$2.6E+0$	$8.E-2$
125.	$1.3E+0$	$5.E-2$
175.	$5.1E-1$	$3.E-2$
225.	$2.1E-1$	$2.E-2$
275.	$1.1E-1$	$1.E-2$
325.	$5.3E-2$	$8.E-3$
375.	$1.9E-2$	$4.E-3$
425.	$2.0E-2$	$4.E-3$
475.	$7.E-3$	$2.E-3$
525.	$6.E-3$	$2.E-3$
575.	$5.E-3$	$2.E-3$
625.	$5.E-3$	$2.E-3$
675.	$4.E-3$	$2.E-3$
775.	$1.5E-3$	$9.E-4$

$\pi^+ + Pb \to \pi^+ + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$8.5E-1$	$9.E-2$
75.	$9.5E-1$	$7.E-2$
125.	$5.6E-1$	$5.E-2$
175.	$3.0E-1$	$3.E-2$
225.	$1.8E-1$	$2.E-2$
275.	$1.0E-1$	$2.E-2$
325.	$7.E-2$	$1.E-2$
375.	$5.3E-2$	$1.E-2$
425.	$4.1E-2$	$8.E-3$
475.	$2.3E-2$	$6.E-3$
525.	$1.3E-2$	$5.E-3$
575.	$8.E-3$	$3.E-3$
625.	$3.E-3$	$2.E-3$
675.	$4.E-3$	$2.E-3$
775.	$1.E-3$	$1.E-3$

$\pi^+ + Pb \to \pi^- + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.E+0$	$1.E-1$
75.	$9.4E-1$	$7.E-2$
125.	$4.9E-1$	$4.E-2$
175.	$2.0E-1$	$3.E-2$
225.	$1.2E-1$	$2.E-2$
275.	$7.E-2$	$1.E-2$
325.	$5.E-2$	$1.E-2$
375.	$3.1E-2$	$8.E-3$
425.	$2.3E-2$	$6.E-3$
475.	$1.1E-2$	$4.E-3$
525.	$5.E-3$	$3.E-3$
575.	$1.E-2$	$4.E-3$

$\pi^+ + Pb \to p + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.2E-1$	$5.E-2$
75.	$3.3E+0$	$9.E-2$
125.	$1.8E+0$	$6.E-2$
175.	$7.8E-1$	$3.E-2$
225.	$3.4E-1$	$2.E-2$
275.	$1.8E-1$	$1.E-2$
325.	$8.7E-2$	$1.E-2$
375.	$5.2E-2$	$7.E-3$
425.	$2.7E-2$	$5.E-3$
475.	$1.3E-2$	$3.E-3$
525.	$8.E-3$	$3.E-3$
575.	$3.E-3$	$2.E-3$
625.	$4.E-3$	$2.E-3$
675.	$1.E-3$	$1.E-3$
725.	$3.E-3$	$1.E-3$
775.	$4.E-3$	$2.E-3$

$\pi^+ + Pb \to \pi^+ + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.E+0$	$1.E-1$
75.	$1.2E+0$	$8.E-2$
125.	$6.5E-1$	$5.E-2$
175.	$4.1E-1$	$4.E-2$
225.	$2.2E-1$	$2.E-2$
275.	$1.3E-1$	$2.E-2$
325.	$1.5E-1$	$2.E-2$
375.	$1.1E-1$	$1.E-2$
425.	$4.2E-2$	$8.E-3$
475.	$4.7E-2$	$9.E-3$
525.	$1.8E-2$	$5.E-3$
575.	$2.3E-2$	$5.E-3$
625.	$1.4E-2$	$4.E-3$
675.	$8.E-3$	$3.E-3$
725.	$2.E-3$	$2.E-3$
775.	$3.E-3$	$2.E-3$

$\pi^+ + Pb \to \pi^- + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.E+0$	$2.E-1$
75.	$1.5E+0$	$9.E-2$
125.	$5.4E-1$	$5.E-2$
175.	$2.8E-1$	$3.E-2$
225.	$1.7E-1$	$2.E-2$
275.	$1.5E-1$	$2.E-2$
325.	$7.E-2$	$1.E-2$
375.	$5.0E-2$	$1.E-2$
425.	$3.7E-2$	$8.E-3$
475.	$2.8E-2$	$7.E-3$
525.	$1.2E-2$	$4.E-3$
575.	$8.E-3$	$3.E-3$
625.	$4.E-3$	$2.E-3$
725.	$3.E-3$	$2.E-3$
775.	$4.E-3$	$2.E-3$

$\pi^+ + Pb \to p + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.E+0$	$1.E-1$
75.	$6.E+0$	$1.E-1$
125.	$2.5E+0$	$7.E-2$
175.	$1.1E+0$	$4.E-2$
225.	$5.3E-1$	$3.E-2$
275.	$2.3E-1$	$2.E-2$
325.	$1.3E-1$	$1.E-2$
375.	$8.9E-2$	$9.E-3$
425.	$4.7E-2$	$7.E-3$
475.	$3.0E-2$	$5.E-3$
525.	$1.6E-2$	$4.E-3$
575.	$1.4E-2$	$3.E-3$
625.	$8.E-3$	$2.E-3$
675.	$5.E-3$	$2.E-3$
725.	$1.0E-2$	$3.E-3$
775.	$1.E-2$	$3.E-3$

$\pi^- + Li \to \pi^+ + X$	($-0.8 < \cos\theta < -0.6$)	
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$5.3E-2$	$5.E-3$
75.	$3.6E-2$	$3.E-3$
125.	$1.4E-2$	$2.E-3$
175.	$5.7E-3$	$9.E-4$
225.	$2.6E-3$	$5.E-4$
275.	$2.0E-3$	$4.E-4$
325.	$8.E-4$	$3.E-4$
375.	$2.E-4$	$1.E-4$
425.	$3.E-4$	$2.E-4$
475.	$3.E-4$	$1.E-4$
525.	$2.E-4$	$1.E-4$

$\pi^- + Li \to \pi^+ + X$	($-0.6 < \cos\theta < -0.4$)	
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$5.6E-2$	$5.E-3$
75.	$4.5E-2$	$3.E-3$
125.	$1.8E-2$	$2.E-3$
175.	$6.3E-3$	$9.E-4$
225.	$3.9E-3$	$7.E-4$
275.	$1.5E-3$	$4.E-4$
325.	$1.4E-3$	$3.E-4$
375.	$8.E-4$	$3.E-4$
425.	$4.E-4$	$2.E-4$
475.	$1.3E-4$	$9.E-5$
525.	$3.E-4$	$1.E-4$
575.	$5.E-5$	$5.E-5$

$\pi^- + Li \to \pi^- + X$	($-0.8 < \cos\theta < -0.6$)	
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.20E-1$	$7.E-3$
75.	$6.8E-2$	$4.E-3$
125.	$2.2E-2$	$2.E-3$
175.	$9.E-3$	$1.E-3$
225.	$3.4E-3$	$6.E-4$
275.	$2.2E-3$	$5.E-4$
325.	$8.E-4$	$3.E-4$
375.	$5.E-4$	$2.E-4$
425.	$1.4E-4$	$1.E-4$
475.	$6.E-5$	$6.E-5$
775.	$4.E-5$	$4.E-5$

$\pi^- + Li \to \pi^- + X$	($-0.6 < \cos\theta < -0.4$)	
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.42E-1$	$8.E-3$
75.	$7.7E-2$	$4.E-3$
125.	$2.7E-2$	$2.E-3$
175.	$8.E-3$	$1.E-3$
225.	$5.4E-3$	$8.E-4$
275.	$2.0E-3$	$4.E-4$
325.	$5.E-4$	$2.E-4$
375.	$5.E-4$	$2.E-4$
425.	$3.E-4$	$1.E-4$
475.	$6.E-5$	$6.E-5$
625.	$5.E-5$	$5.E-5$

$\pi^- + Li \to p + X$	($-0.8 < \cos\theta < -0.6$)	
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.6E-2$	$2.E-3$
75.	$1.1E-2$	$1.E-3$
125.	$4.1E-3$	$6.E-4$
175.	$1.1E-3$	$3.E-4$
225.	$7.E-4$	$2.E-4$
275.	$5.E-5$	$5.E-5$
325.	$1.3E-4$	$8.E-5$
375.	$4.E-5$	$4.E-5$
425.	$4.E-5$	$4.E-5$
625.	$3.E-5$	$3.E-5$

$\pi^- + Li \to p + X$	($-0.6 < \cos\theta < -0.4$)	
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.8E-2$	$2.E-3$
75.	$1.5E-2$	$1.E-3$
125.	$3.5E-3$	$5.E-4$
175.	$1.8E-3$	$3.E-4$
225.	$8.E-4$	$2.E-4$
275.	$3.E-4$	$1.E-4$
325.	$3.E-4$	$1.E-4$
375.	$8.E-5$	$6.E-5$
425.	$4.E-5$	$4.E-5$
475.	$4.E-5$	$4.E-5$
775.	$3.E-5$	$3.E-5$

Table 4.6: Invariant cross sections in the reaction of π^- incident

$\pi^- + Li \to \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$6.9E-2$	$5.E-3$
75.	$3.4E-2$	$3.E-3$
125.	$2.3E-2$	$2.E-3$
175.	$8.E-3$	$1.E-3$
225.	$5.2E-3$	$8.E-4$
275.	$3.4E-3$	$6.E-4$
325.	$2.1E-3$	$4.E-4$
375.	$1.E-3$	$3.E-4$
425.	$5.E-4$	$2.E-4$
475.	$4.E-4$	$2.E-4$
525.	$1.2E-4$	$8.E-5$
575.	$3.E-4$	$1.E-4$
625.	$2.0E-4$	$1.E-4$
675.	$1.9E-4$	$9.E-5$
725.	$4.E-5$	$4.E-5$

$\pi^- + Li \to \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$6.1E-2$	$5.E-3$
75.	$4.5E-2$	$3.E-3$
125.	$2.3E-2$	$2.E-3$
175.	$1.2E-2$	$1.E-3$
225.	$6.0E-3$	$8.E-4$
275.	$3.0E-3$	$5.E-4$
325.	$2.0E-3$	$4.E-4$
375.	$1.4E-3$	$3.E-4$
425.	$8.E-4$	$2.E-4$
475.	$4.E-4$	$2.E-4$
525.	$6.E-5$	$6.E-5$
575.	$1.6E-4$	$9.E-5$
625.	$1.E-4$	$7.E-5$
675.	$1.9E-4$	$9.E-5$
725.	$9.E-5$	$6.E-5$

$\pi^- + Li \to \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$1.28E-1$	$7.E-3$
75.	$8.4E-2$	$4.E-3$
125.	$3.3E-2$	$2.E-3$
175.	$1.2E-2$	$1.E-3$
225.	$6.5E-3$	$9.E-4$
275.	$3.9E-3$	$6.E-4$
325.	$1.4E-3$	$3.E-4$
375.	$8.E-4$	$2.E-4$
425.	$1.4E-4$	$1.E-4$
475.	$3.E-4$	$1.E-4$
525.	$6.E-5$	$6.E-5$
575.	$1.1E-4$	$8.E-5$
625.	$5.E-5$	$5.E-5$
675.	$5.E-5$	$5.E-5$
725.	$4.E-5$	$4.E-5$

$\pi^- + Li \to \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$1.40E-1$	$8.E-3$
75.	$1.01E-1$	$5.E-3$
125.	$4.0E-2$	$3.E-3$
175.	$1.5E-2$	$1.E-3$
225.	$8.7E-3$	$1.E-3$
275.	$4.1E-3$	$6.E-4$
325.	$2.0E-3$	$4.E-4$
375.	$1.5E-3$	$3.E-4$
425.	$5.E-4$	$2.E-4$
475.	$4.E-4$	$2.E-4$
525.	$6.E-5$	$6.E-5$
575.	$5.E-5$	$5.E-5$
625.	$1.E-4$	$7.E-5$
725.	$4.E-5$	$4.E-5$

$\pi^- + Li \to p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$2.5E-2$	$2.E-3$
75.	$2.1E-2$	$1.E-3$
125.	$7.5E-3$	$8.E-4$
175.	$2.6E-3$	$4.E-4$
225.	$1.4E-3$	$3.E-4$
275.	$4.E-4$	$1.E-4$
325.	$3.E-4$	$1.E-4$
375.	$8.E-5$	$6.E-5$
425.	$8.E-5$	$5.E-5$

$\pi^- + Li \to p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2/sr$)	error
25.	$3.0E-2$	$2.E-3$
75.	$3.3E-2$	$2.E-3$
125.	$1.05E-2$	$9.E-4$
175.	$4.5E-3$	$5.E-4$
225.	$2.2E-3$	$3.E-4$
275.	$1.E-3$	$2.E-4$
325.	$8.E-4$	$2.E-4$
375.	$5.E-4$	$1.E-4$
425.	$1.9E-4$	$8.E-5$
475.	$7.E-5$	$5.E-5$
575.	$6.E-5$	$4.E-5$

$\pi^- + Li \rightarrow \pi^+ + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.1E-2$	$6.E-3$
75.	$5.6E-2$	$4.E-3$
125.	$3.1E-2$	$2.E-3$
175.	$1.6E-2$	$1.E-3$
225.	$7.5E-3$	$9.E-4$
275.	$6.4E-3$	$8.E-4$
325.	$3.9E-3$	$6.E-4$
375.	$2.2E-3$	$4.E-4$
425.	$1.9E-3$	$4.E-4$
475.	$1.1E-3$	$3.E-4$
525.	$6.E-4$	$2.E-4$
575.	$6.E-4$	$2.E-4$
625.	$1.5E-4$	$9.E-5$
675.	$1.9E-4$	$9.E-5$
725.	$9.E-5$	$6.E-5$
775.	$2.1E-4$	$9.E-5$

$\pi^- + Li \rightarrow \pi^- + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.35E-1$	$8.E-3$
75.	$9.2E-2$	$5.E-3$
125.	$4.6E-2$	$3.E-3$
175.	$2.1E-2$	$2.E-3$
225.	$1.1E-2$	$1.E-3$
275.	$7.8E-3$	$9.E-4$
325.	$3.8E-3$	$6.E-4$
375.	$2.7E-3$	$5.E-4$
425.	$1.2E-3$	$3.E-4$
475.	$3.E-4$	$1.E-4$
525.	$4.E-4$	$2.E-4$
575.	$2.E-4$	$1.E-4$
625.	$1.5E-4$	$9.E-5$
675.	$1.9E-4$	$9.E-5$
725.	$1.3E-4$	$8.E-5$
775.	$4.E-5$	$4.E-5$

$\pi^- + Li \rightarrow p + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$4.9E-2$	$3.E-3$
75.	$4.4E-2$	$2.E-3$
125.	$2.0E-2$	$1.E-3$
175.	$8.9E-3$	$7.E-4$
225.	$4.0E-3$	$5.E-4$
275.	$2.1E-3$	$3.E-4$
325.	$1.6E-3$	$3.E-4$
375.	$6.E-4$	$2.E-4$
425.	$4.E-4$	$1.E-4$
475.	$2.1E-4$	$9.E-5$
525.	$1.3E-4$	$7.E-5$
575.	$2.5E-4$	$9.E-5$
625.	$9.E-5$	$5.E-5$
675.	$6.E-5$	$4.E-5$
725.	$3.E-5$	$3.E-5$

$\pi^- + Li \rightarrow \pi^+ + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$9.8E-2$	$6.E-3$
75.	$7.9E-2$	$4.E-3$
125.	$4.6E-2$	$3.E-3$
175.	$2.3E-2$	$2.E-3$
225.	$1.5E-2$	$1.E-3$
275.	$1.1E-2$	$1.E-3$
325.	$6.6E-3$	$7.E-4$
375.	$5.4E-3$	$6.E-4$
425.	$3.0E-3$	$5.E-4$
475.	$3.1E-3$	$4.E-4$
525.	$1.8E-3$	$3.E-4$
575.	$7.E-4$	$2.E-4$
625.	$1.3E-3$	$3.E-4$
675.	$5.E-4$	$2.E-4$
725.	$7.E-4$	$2.E-4$
775.	$2.1E-4$	$9.E-5$

$\pi^- + Li \rightarrow \pi^- + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.77E-1$	$9.E-3$
75.	$1.31E-1$	$6.E-3$
125.	$6.9E-2$	$3.E-3$
175.	$3.6E-2$	$2.E-3$
225.	$1.9E-2$	$1.E-3$
275.	$1.4E-2$	$1.E-3$
325.	$7.5E-3$	$8.E-4$
375.	$5.8E-3$	$7.E-4$
425.	$3.0E-3$	$5.E-4$
475.	$2.3E-3$	$4.E-4$
525.	$1.5E-3$	$3.E-4$
575.	$5.E-4$	$2.E-4$
625.	$5.E-4$	$2.E-4$
675.	$3.E-4$	$1.E-4$
725.	$2.2E-4$	$1.E-4$
775.	$4.E-5$	$4.E-5$

$\pi^- + Li \rightarrow p + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$5.2E-2$	$3.E-3$
75.	$7.1E-2$	$3.E-3$
125.	$3.7E-2$	$2.E-3$
175.	$1.8E-2$	$1.E-3$
225.	$1.06E-2$	$8.E-4$
275.	$5.8E-3$	$5.E-4$
325.	$2.4E-3$	$3.E-4$
375.	$1.7E-3$	$3.E-4$
425.	$1.E-3$	$2.E-4$
475.	$8.E-4$	$2.E-4$
525.	$2.7E-4$	$9.E-5$
575.	$1.9E-4$	$8.E-5$
625.	$1.5E-4$	$7.E-5$
675.	$2.0E-4$	$8.E-5$
725.	$2.2E-4$	$8.E-5$
775.	$1.8E-4$	$7.E-5$

$\pi^- + C \to \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$7.3E-2$	$4.E-3$
75.	$5.4E-2$	$2.E-3$
125.	$2.1E-2$	$1.E-3$
175.	$8.5E-3$	$7.E-4$
225.	$4.1E-3$	$4.E-4$
275.	$1.7E-3$	$3.E-4$
325.	$9.E-4$	$2.E-4$
375.	$7.E-4$	$1.E-4$
425.	$3.3E-4$	$1.E-4$
475.	$9.E-5$	$4.E-5$
575.	$6.E-5$	$4.E-5$
625.	$3.E-5$	$2.E-5$

$\pi^- + C \to \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$7.2E-2$	$4.E-3$
75.	$5.7E-2$	$2.E-3$
125.	$2.6E-2$	$1.E-3$
175.	$1.07E-2$	$8.E-4$
225.	$5.9E-3$	$5.E-4$
275.	$3.2E-3$	$4.E-4$
325.	$1.9E-3$	$3.E-4$
375.	$1.2E-3$	$2.E-4$
425.	$6.E-4$	$1.E-4$
475.	$5.E-4$	$1.E-4$
525.	$8.E-5$	$4.E-5$
575.	$1.5E-4$	$6.E-5$
625.	$6.E-5$	$4.E-5$
675.	$7.E-5$	$3.E-5$

$\pi^- + C \to \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$1.39E-1$	$5.E-3$
75.	$1.01E-1$	$3.E-3$
125.	$3.4E-2$	$2.E-3$
175.	$1.23E-2$	$8.E-4$
225.	$6.8E-3$	$6.E-4$
275.	$3.9E-3$	$4.E-4$
325.	$1.7E-3$	$3.E-4$
375.	$6.E-4$	$1.E-4$
425.	$5.E-4$	$1.E-4$
475.	$1.7E-4$	$7.E-5$
525.	$1.3E-4$	$6.E-5$
575.	$5.E-5$	$4.E-5$

$\pi^- + C \to \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$1.72E-1$	$5.E-3$
75.	$1.19E-1$	$3.E-3$
125.	$4.3E-2$	$2.E-3$
175.	$1.9E-2$	$1.E-3$
225.	$9.3E-3$	$7.E-4$
275.	$5.5E-3$	$5.E-4$
325.	$2.6E-3$	$3.E-4$
375.	$1.4E-3$	$2.E-4$
425.	$5.E-4$	$1.E-4$
475.	$4.E-4$	$1.E-4$
525.	$3.0E-4$	$8.E-5$
575.	$5.E-5$	$4.E-5$
625.	$4.E-5$	$3.E-5$
675.	$3.E-5$	$2.E-5$
725.	$2.E-5$	$2.E-5$

$\pi^- + C \to p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$4.0E-2$	$2.E-3$
75.	$5.1E-2$	$1.E-3$
125.	$1.74E-2$	$7.E-4$
175.	$5.8E-3$	$4.E-4$
225.	$2.2E-3$	$2.E-4$
275.	$9.E-4$	$1.E-4$
325.	$2.5E-4$	$7.E-5$
375.	$5.E-5$	$3.E-5$
425.	$4.E-5$	$2.E-5$
525.	$5.E-5$	$3.E-5$
675.	$4.E-5$	$2.E-5$
725.	$1.E-5$	$1.E-5$
775.	$3.E-5$	$2.E-5$

$\pi^- + C \to p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$4.0E-2$	$2.E-3$
75.	$7.0E-2$	$2.E-3$
125.	$2.23E-2$	$8.E-4$
175.	$7.9E-3$	$4.E-4$
225.	$3.8E-3$	$3.E-4$
275.	$1.3E-3$	$2.E-4$
325.	$6.E-4$	$1.E-4$
375.	$3.2E-4$	$7.E-5$
425.	$1.3E-4$	$4.E-5$
475.	$7.E-5$	$3.E-5$
525.	$3.E-5$	$2.E-5$
725.	$3.E-5$	$2.E-5$
775.	$2.E-5$	$2.E-5$

$\pi^- + C \to \pi^+ + X$

$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2$/sr)	error
25.	$8.1E-2$	$4.E-3$
75.	$6.8E-2$	$3.E-3$
125.	$3.1E-2$	$1.E-3$
175.	$1.55E-2$	$9.E-4$
225.	$7.1E-3$	$6.E-4$
275.	$4.1E-3$	$4.E-4$
325.	$2.4E-3$	$3.E-4$
375.	$1.7E-3$	$2.E-4$
425.	$9.E-4$	$2.E-4$
475.	$6.E-4$	$1.E-4$
525.	$3.6E-4$	$9.E-5$
575.	$1.1E-4$	$5.E-5$
625.	$4.E-5$	$3.E-5$
675.	$1.2E-4$	$5.E-5$
725.	$7.E-5$	$3.E-5$

$\pi^- + C \to \pi^- + X$

$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2$/sr)	error
25.	$1.60E-1$	$5.E-3$
75.	$1.28E-1$	$3.E-3$
125.	$5.3E-2$	$2.E-3$
175.	$2.2E-2$	$1.E-3$
225.	$1.18E-2$	$7.E-4$
275.	$7.6E-3$	$5.E-4$
325.	$3.8E-3$	$4.E-4$
375.	$2.2E-3$	$3.E-4$
425.	$1.1E-3$	$2.E-4$
475.	$8.E-4$	$1.E-4$
525.	$3.1E-4$	$9.E-5$
575.	$1.9E-4$	$7.E-5$
625.	$7.E-5$	$4.E-5$
675.	$3.E-5$	$3.E-5$
725.	$7.E-5$	$4.E-5$
775.	$4.E-5$	$2.E-5$

$\pi^- + C \to p + X$

$(-0.4 < \cos\theta < -0.2)$

Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2$/sr)	error
25.	$2.7E-2$	$1.E-3$
75.	$7.8E-2$	$2.E-3$
125.	$3.02E-2$	$1.E-3$
175.	$1.07E-2$	$5.E-4$
225.	$4.6E-3$	$3.E-4$
275.	$2.1E-3$	$2.E-4$
325.	$9.E-4$	$1.E-4$
375.	$2.7E-4$	$7.E-5$
425.	$2.2E-4$	$6.E-5$
475.	$1.2E-4$	$4.E-5$
525.	$4.E-5$	$2.E-5$
575.	$7.E-5$	$3.E-5$
625.	$5.E-5$	$2.E-5$
675.	$2.E-5$	$2.E-5$

$\pi^- + C \to \pi^+ + X$

$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2$/sr)	error
25.	$7.0E-2$	$3.E-3$
75.	$6.8E-2$	$3.E-3$
125.	$3.3E-2$	$1.E-3$
175.	$1.63E-2$	$9.E-4$
225.	$9.9E-3$	$7.E-4$
275.	$5.3E-3$	$5.E-4$
325.	$4.5E-3$	$4.E-4$
375.	$2.5E-3$	$3.E-4$
425.	$1.6E-3$	$2.E-4$
475.	$9.E-4$	$2.E-4$
525.	$7.E-4$	$1.E-4$
575.	$5.E-4$	$1.E-4$
625.	$1.9E-4$	$6.E-5$
675.	$2.4E-4$	$7.E-5$
725.	$6.E-5$	$3.E-5$
775.	$2.E-5$	$2.E-5$

$\pi^- + C \to \pi^- + X$

$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2$/sr)	error
25.	$1.43E-1$	$5.E-3$
75.	$1.26E-1$	$3.E-3$
125.	$5.7E-2$	$2.E-3$
175.	$2.5E-2$	$1.E-3$
225.	$1.48E-2$	$8.E-4$
275.	$8.9E-3$	$6.E-4$
325.	$5.4E-3$	$4.E-4$
375.	$3.3E-3$	$3.E-4$
425.	$1.9E-3$	$2.E-4$
475.	$9.E-4$	$2.E-4$
525.	$7.E-4$	$1.E-4$
575.	$3.5E-4$	$9.E-5$
625.	$1.2E-4$	$5.E-5$
675.	$1.2E-4$	$4.E-5$
725.	$1.1E-4$	$4.E-5$
775.	$6.E-5$	$3.E-5$

$\pi^- + C \to p + X$

$(-0.2 < \cos\theta < 0.0)$

Ek (MeV)	Inv. $d\sigma$ ($mb \cdot c^3/GeV^2$/sr)	error
25.	$1.04E-2$	$9.E-4$
75.	$8.0E-2$	$2.E-3$
125.	$3.9E-2$	$1.E-3$
175.	$1.50E-2$	$6.E-4$
225.	$6.2E-3$	$4.E-4$
275.	$2.7E-3$	$2.E-4$
325.	$1.3E-3$	$2.E-4$
375.	$9.E-4$	$1.E-4$
425.	$4.8E-4$	$9.E-5$
475.	$1.8E-4$	$5.E-5$
525.	$1.3E-4$	$4.E-5$
575.	$1.4E-4$	$4.E-5$
625.	$6.E-5$	$2.E-5$
675.	$4.E-5$	$2.E-5$
725.	$7.E-5$	$3.E-5$
775.	$8.E-5$	$3.E-5$

$\pi^- + C \to \pi^+ + X$ $(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.9E-2$	$4.E-3$
75.	$7.6E-2$	$3.E-3$
125.	$4.8E-2$	$2.E-3$
175.	$2.6E-2$	$1.E-3$
225.	$1.62E-2$	$8.E-4$
275.	$9.4E-3$	$6.E-4$
325.	$6.3E-3$	$5.E-4$
375.	$4.3E-3$	$4.E-4$
425.	$2.4E-3$	$3.E-4$
475.	$1.7E-3$	$2.E-4$
525.	$1.2E-3$	$2.E-4$
575.	$7.E-4$	$1.E-4$
625.	$4.0E-4$	$9.E-5$
675.	$1.8E-4$	$6.E-5$
725.	$1.3E-4$	$5.E-5$
775.	$6.E-5$	$3.E-5$

$\pi^- + C \to \pi^- + X$ $(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.53E-1$	$5.E-3$
75.	$1.56E-1$	$4.E-3$
125.	$8.4E-2$	$2.E-3$
175.	$4.0E-2$	$1.E-3$
225.	$2.4E-2$	$1.E-3$
275.	$1.56E-2$	$8.E-4$
325.	$1.0E-2$	$6.E-4$
375.	$6.2E-3$	$4.E-4$
425.	$3.6E-3$	$3.E-4$
475.	$2.1E-3$	$2.E-4$
525.	$1.2E-3$	$2.E-4$
575.	$8.E-4$	$1.E-4$
625.	$3.4E-4$	$8.E-5$
675.	$3.0E-4$	$7.E-5$
725.	$1.3E-4$	$5.E-5$
775.	$9.E-5$	$4.E-5$

$\pi^- + C \to p + X$ $(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.8E-2$	$1.E-3$
75.	$1.07E-1$	$2.E-3$
125.	$5.6E-2$	$1.E-3$
175.	$2.36E-2$	$8.E-4$
225.	$1.20E-2$	$5.E-4$
275.	$5.9E-3$	$3.E-4$
325.	$2.8E-3$	$2.E-4$
375.	$1.9E-3$	$2.E-4$
425.	$9.E-4$	$1.E-4$
475.	$5.2E-4$	$9.E-5$
525.	$3.7E-4$	$7.E-5$
575.	$2.8E-4$	$6.E-5$
625.	$1.6E-4$	$4.E-5$
675.	$1.3E-4$	$4.E-5$
725.	$1.4E-4$	$4.E-5$
775.	$8.E-5$	$3.E-5$

$\pi^- + C \to \pi^+ + X$ $(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.03E-1$	$4.E-3$
75.	$1.01E-1$	$3.E-3$
125.	$5.8E-2$	$2.E-3$
175.	$3.1E-2$	$1.E-3$
225.	$2.14E-2$	$1.E-3$
275.	$1.28E-2$	$7.E-4$
325.	$9.4E-3$	$6.E-4$
375.	$5.8E-3$	$4.E-4$
425.	$4.8E-3$	$4.E-4$
475.	$3.2E-3$	$3.E-4$
525.	$2.1E-3$	$2.E-4$
575.	$1.2E-3$	$2.E-4$
625.	$9.E-4$	$1.E-4$
675.	$6.E-4$	$1.E-4$
725.	$4.8E-4$	$9.E-5$
775.	$2.6E-4$	$6.E-5$

$\pi^- + C \to \pi^- + X$ $(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.85E-1$	$6.E-3$
75.	$1.70E-1$	$4.E-3$
125.	$9.2E-2$	$3.E-3$
175.	$5.2E-2$	$2.E-3$
225.	$3.4E-2$	$1.E-3$
275.	$1.95E-2$	$9.E-4$
325.	$1.36E-2$	$7.E-4$
375.	$9.2E-3$	$5.E-4$
425.	$6.0E-3$	$4.E-4$
475.	$3.9E-3$	$3.E-4$
525.	$2.9E-3$	$3.E-4$
575.	$2.0E-3$	$2.E-4$
625.	$1.0E-3$	$1.E-4$
675.	$8.E-4$	$1.E-4$
725.	$4.8E-4$	$9.E-5$
775.	$1.9E-4$	$5.E-5$

$\pi^- + C \to p + X$ $(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.3E-2$	$2.E-3$
75.	$1.49E-1$	$2.E-3$
125.	$7.3E-2$	$1.E-3$
175.	$3.60E-2$	$9.E-4$
225.	$1.79E-2$	$6.E-4$
275.	$1.04E-2$	$4.E-4$
325.	$5.7E-3$	$3.E-4$
375.	$2.9E-3$	$2.E-4$
425.	$1.9E-3$	$2.E-4$
475.	$1.2E-3$	$1.E-4$
525.	$7.6E-4$	$1.E-4$
575.	$5.3E-4$	$8.E-5$
625.	$4.1E-4$	$7.E-5$
675.	$4.2E-4$	$7.E-5$
725.	$3.1E-4$	$6.E-5$
775.	$1.9E-4$	$5.E-5$

$\pi^- + Al \to \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.5E-1$	$1.E-2$
75.	$1.79E-1$	$7.E-3$
125.	$6.6E-2$	$4.E-3$
175.	$2.9E-2$	$2.E-3$
225.	$1.6E-2$	$1.E-3$
275.	$8.9E-3$	$1.E-3$
325.	$4.9E-3$	$7.E-4$
375.	$1.6E-3$	$4.E-4$
425.	$8.E-4$	$3.E-4$
475.	$1.E-3$	$3.E-4$
525.	$3.E-4$	$2.E-4$
575.	$2.E-4$	$1.E-4$
725.	$1.6E-4$	$9.E-5$

$\pi^- + Al \to \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.6E-1$	$1.E-2$
75.	$1.79E-1$	$7.E-3$
125.	$7.9E-2$	$4.E-3$
175.	$3.6E-2$	$2.E-3$
225.	$1.7E-2$	$1.E-3$
275.	$8.4E-3$	$9.E-4$
325.	$5.2E-3$	$7.E-4$
375.	$3.4E-3$	$5.E-4$
425.	$2.3E-3$	$4.E-4$
475.	$1.5E-3$	$3.E-4$
525.	$7.E-4$	$2.E-4$
575.	$4.E-4$	$2.E-4$
625.	$2.E-4$	$1.E-4$
725.	$1.1E-4$	$7.E-5$

$\pi^- + Al \to \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$5.3E-1$	$2.E-2$
75.	$3.04E-1$	$9.E-3$
125.	$9.3E-2$	$4.E-3$
175.	$3.6E-2$	$2.E-3$
225.	$1.8E-2$	$2.E-3$
275.	$1.1E-2$	$1.E-3$
325.	$5.0E-3$	$7.E-4$
375.	$2.7E-3$	$5.E-4$
425.	$9.E-4$	$3.E-4$
475.	$7.E-4$	$2.E-4$
525.	$5.E-4$	$2.E-4$

$\pi^- + Al \to \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$5.5E-1$	$2.E-2$
75.	$3.47E-1$	$1.E-2$
125.	$1.15E-1$	$5.E-3$
175.	$4.5E-2$	$3.E-3$
225.	$2.2E-2$	$2.E-3$
275.	$1.3E-2$	$1.E-3$
325.	$8.0E-3$	$9.E-4$
375.	$4.9E-3$	$6.E-4$
425.	$1.9E-3$	$4.E-4$
475.	$8.E-4$	$2.E-4$
525.	$5.E-4$	$2.E-4$
575.	$3.E-4$	$2.E-4$
675.	$8.E-5$	$6.E-5$

$\pi^- + Al \to p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.14E-1$	$6.E-3$
75.	$2.83E-1$	$6.E-3$
125.	$9.3E-2$	$3.E-3$
175.	$2.9E-2$	$1.E-3$
225.	$1.05E-2$	$8.E-4$
275.	$4.7E-3$	$5.E-4$
325.	$1.8E-3$	$3.E-4$
375.	$5.E-4$	$2.E-4$
425.	$1.5E-4$	$9.E-5$
475.	$9.E-5$	$6.E-5$
525.	$7.E-5$	$6.E-5$
575.	$1.4E-4$	$8.E-5$
625.	$5.E-5$	$4.E-5$
675.	$6.E-5$	$5.E-5$
725.	$2.1E-4$	$8.E-5$

$\pi^- + Al \to p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.07E-1$	$6.E-3$
75.	$3.40E-1$	$6.E-3$
125.	$1.16E-1$	$3.E-3$
175.	$3.8E-2$	$2.E-3$
225.	$1.49E-2$	$1.E-3$
275.	$6.4E-3$	$6.E-4$
325.	$2.7E-3$	$4.E-4$
375.	$1.5E-3$	$3.E-4$
425.	$3.E-4$	$1.E-4$
475.	$3.E-4$	$1.E-4$
525.	$1.2E-4$	$7.E-5$
575.	$3.E-4$	$1.E-4$
625.	$8.E-5$	$5.E-5$
725.	$1.2E-4$	$6.E-5$
775.	$1.5E-4$	$6.E-5$

$\pi^- + Al \rightarrow \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($\mathrm{mb}\cdot c^3/GeV^2/\mathrm{sr}$)	error
25.	$2.4E-1$	$1.E-2$
75.	$2.04E-1$	$7.E-3$
125.	$8.7E-2$	$4.E-3$
175.	$3.7E-2$	$2.E-3$
225.	$1.8E-2$	$2.E-3$
275.	$1.3E-2$	$1.E-3$
325.	$6.7E-3$	$8.E-4$
375.	$4.2E-3$	$6.E-4$
425.	$3.5E-3$	$5.E-4$
475.	$1.4E-3$	$3.E-4$
525.	$1.3E-3$	$3.E-4$
575.	$6.E-4$	$2.E-4$
625.	$2.E-4$	$1.E-4$
675.	$1.7E-4$	$1.E-4$
725.	$1.6E-4$	$9.E-5$
775.	$1.5E-4$	$9.E-5$

$\pi^- + Al \rightarrow \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($\mathrm{mb}\cdot c^3/GeV^2/\mathrm{sr}$)	error
25.	$6.2E-1$	$2.E-2$
75.	$3.63E-1$	$1.E-2$
125.	$1.32E-1$	$5.E-3$
175.	$5.4E-2$	$3.E-3$
225.	$3.4E-2$	$2.E-3$
275.	$1.8E-2$	$1.E-3$
325.	$1.1E-2$	$1.E-3$
375.	$6.3E-3$	$7.E-4$
425.	$3.2E-3$	$5.E-4$
475.	$2.0E-3$	$4.E-4$
525.	$1.E-3$	$2.E-4$
575.	$6.E-4$	$2.E-4$
625.	$3.E-4$	$1.E-4$
675.	$1.2E-4$	$8.E-5$
725.	$9.E-5$	$7.E-5$
775.	$7.E-5$	$5.E-5$

$\pi^- + Al \rightarrow p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($\mathrm{mb}\cdot c^3/GeV^2/\mathrm{sr}$)	error
25.	$1.41E-1$	$5.E-3$
75.	$3.75E-1$	$6.E-3$
125.	$1.30E-1$	$3.E-3$
175.	$5.3E-2$	$2.E-3$
225.	$2.0E-2$	$1.E-3$
275.	$9.4E-3$	$7.E-4$
325.	$4.1E-3$	$5.E-4$
375.	$1.8E-3$	$3.E-4$
425.	$1.0E-3$	$2.E-4$
475.	$2.E-4$	$1.E-4$
525.	$1.7E-4$	$8.E-5$
575.	$1.3E-4$	$7.E-5$
625.	$1.4E-4$	$7.E-5$
675.	$1.4E-4$	$8.E-5$
725.	$2.1E-4$	$8.E-5$
775.	$5.E-5$	$4.E-5$

$\pi^- + Al \rightarrow \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($\mathrm{mb}\cdot c^3/GeV^2/\mathrm{sr}$)	error
25.	$2.2E-1$	$1.E-2$
75.	$2.00E-1$	$7.E-3$
125.	$1.01E-1$	$4.E-3$
175.	$4.9E-2$	$3.E-3$
225.	$2.3E-2$	$2.E-3$
275.	$1.5E-2$	$1.E-3$
325.	$1.1E-2$	$1.E-3$
375.	$7.4E-3$	$8.E-4$
425.	$4.4E-3$	$6.E-4$
475.	$3.9E-3$	$5.E-4$
525.	$1.7E-3$	$4.E-4$
575.	$6.E-4$	$2.E-4$
625.	$3.E-4$	$1.E-4$
675.	$4.E-4$	$1.E-4$
725.	$5.E-4$	$1.E-4$

$\pi^- + Al \rightarrow \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($\mathrm{mb}\cdot c^3/GeV^2/\mathrm{sr}$)	error
25.	$4.1E-1$	$1.E-2$
75.	$3.50E-1$	$1.E-2$
125.	$1.59E-1$	$5.E-3$
175.	$7.7E-2$	$3.E-3$
225.	$3.9E-2$	$2.E-3$
275.	$2.5E-2$	$2.E-3$
325.	$1.1E-2$	$1.E-3$
375.	$9.5E-3$	$9.E-4$
425.	$5.2E-3$	$6.E-4$
475.	$2.8E-3$	$4.E-4$
525.	$1.9E-3$	$4.E-4$
575.	$6.E-4$	$2.E-4$
625.	$5.E-4$	$2.E-4$
675.	$2.0E-4$	$1.E-4$
725.	$1.3E-4$	$9.E-5$
775.	$7.E-5$	$5.E-5$

$\pi^- + Al \rightarrow p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ ($\mathrm{mb}\cdot c^3/GeV^2/\mathrm{sr}$)	error
25.	$5.6E-2$	$3.E-3$
75.	$3.13E-1$	$6.E-3$
125.	$1.52E-1$	$4.E-3$
175.	$6.1E-2$	$2.E-3$
225.	$2.7E-2$	$1.E-3$
275.	$1.24E-2$	$8.E-4$
325.	$6.1E-3$	$5.E-4$
375.	$3.4E-3$	$4.E-4$
425.	$1.8E-3$	$3.E-4$
475.	$9.E-4$	$2.E-4$
525.	$7.E-4$	$2.E-4$
575.	$6.E-4$	$1.E-4$
625.	$3.E-4$	$1.E-4$
675.	$1.0E-4$	$6.E-5$
725.	$2.1E-4$	$9.E-5$
775.	$3.2E-4$	$9.E-5$

$\pi^- + Al \rightarrow \pi^+ + X$
$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.2E-1$	$1.E-2$
75.	$2.35E-1$	$8.E-3$
125.	$1.36E-1$	$5.E-3$
175.	$6.5E-2$	$3.E-3$
225.	$4.3E-2$	$2.E-3$
275.	$2.3E-2$	$2.E-3$
325.	$1.9E-2$	$1.E-3$
375.	$1.10E-2$	$1.E-3$
425.	$8.0E-3$	$8.E-4$
475.	$5.8E-3$	$7.E-4$
525.	$3.0E-3$	$4.E-4$
575.	$2.4E-3$	$4.E-4$
625.	$1.2E-3$	$3.E-4$
675.	$9.E-4$	$2.E-4$
725.	$4.E-4$	$1.E-4$
775.	$1.8E-4$	$9.E-5$

$\pi^- + Al \rightarrow \pi^+ + X$
$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.7E-1$	$1.E-2$
75.	$3.10E-1$	$9.E-3$
125.	$1.51E-1$	$5.E-3$
175.	$9.8E-2$	$4.E-3$
225.	$6.2E-2$	$3.E-3$
275.	$3.6E-2$	$2.E-3$
325.	$2.4E-2$	$2.E-3$
375.	$1.9E-2$	$1.E-3$
425.	$1.11E-2$	$9.E-4$
475.	$8.4E-3$	$8.E-4$
525.	$5.5E-3$	$6.E-4$
575.	$4.2E-3$	$5.E-4$
625.	$2.7E-3$	$4.E-4$
675.	$2.7E-3$	$4.E-4$
725.	$1.2E-3$	$2.E-4$
775.	$1.2E-3$	$2.E-4$

$\pi^- + Al \rightarrow \pi^- + X$
$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$4.8E-1$	$2.E-2$
75.	$4.1E-1$	$1.E-2$
125.	$2.09E-1$	$6.E-3$
175.	$1.09E-1$	$4.E-3$
225.	$5.6E-2$	$3.E-3$
275.	$3.8E-2$	$2.E-3$
325.	$2.6E-2$	$2.E-3$
375.	$1.6E-2$	$1.E-3$
425.	$1.02E-2$	$9.E-4$
475.	$6.8E-3$	$7.E-4$
525.	$3.4E-3$	$5.E-4$
575.	$2.1E-3$	$4.E-4$
625.	$6.E-4$	$2.E-4$
675.	$5.E-4$	$2.E-4$
725.	$3.E-4$	$1.E-4$
775.	$2.2E-4$	$1.E-4$

$\pi^- + Al \rightarrow \pi^- + X$
$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.5E-1$	$2.E-2$
75.	$5.0E-1$	$1.E-2$
125.	$2.55E-1$	$7.E-3$
175.	$1.45E-1$	$5.E-3$
225.	$8.4E-2$	$3.E-3$
275.	$5.4E-2$	$2.E-3$
325.	$3.8E-2$	$2.E-3$
375.	$2.7E-2$	$2.E-3$
425.	$1.8E-2$	$1.E-3$
475.	$1.17E-2$	$9.E-4$
525.	$7.0E-3$	$7.E-4$
575.	$4.1E-3$	$5.E-4$
625.	$2.3E-3$	$4.E-4$
675.	$1.9E-3$	$3.E-4$
725.	$1.4E-3$	$3.E-4$
775.	$6.E-4$	$2.E-4$

$\pi^- + Al \rightarrow p + X$
$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.7E-2$	$3.E-3$
75.	$4.05E-1$	$7.E-3$
125.	$2.15E-1$	$4.E-3$
175.	$8.9E-2$	$3.E-3$
225.	$4.4E-2$	$2.E-3$
275.	$2.4E-2$	$1.E-3$
325.	$1.10E-2$	$7.E-4$
375.	$6.2E-3$	$5.E-4$
425.	$4.3E-3$	$4.E-4$
475.	$2.4E-3$	$3.E-4$
525.	$1.1E-3$	$2.E-4$
575.	$6.E-4$	$2.E-4$
625.	$7.E-4$	$2.E-4$
675.	$3.E-4$	$1.E-4$
725.	$4.E-4$	$1.E-4$
775.	$3.1E-4$	$9.E-5$

$\pi^- + Al \rightarrow p + X$
$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.14E-1$	$6.E-3$
75.	$6.33E-1$	$8.E-3$
125.	$2.90E-1$	$5.E-3$
175.	$1.39E-1$	$3.E-3$
225.	$7.3E-2$	$2.E-3$
275.	$3.8E-2$	$1.E-3$
325.	$2.1E-2$	$1.E-3$
375.	$1.20E-2$	$8.E-4$
425.	$6.9E-3$	$6.E-4$
475.	$4.7E-3$	$4.E-4$
525.	$3.0E-3$	$4.E-4$
575.	$1.7E-3$	$2.E-4$
625.	$1.1E-3$	$2.E-4$
675.	$1.2E-3$	$2.E-4$
725.	$1.2E-3$	$2.E-4$
775.	$8.E-4$	$2.E-4$

$\pi^- + Cu \rightarrow \pi^+ + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$	error ($mb \cdot c^3/GeV^2/sr$)
25.	$4.8E-1$	$3.E-2$
75.	$3.3E-1$	$2.E-2$
125.	$1.13E-1$	$8.E-3$
175.	$4.4E-2$	$5.E-3$
225.	$2.6E-2$	$3.E-3$
275.	$2.0E-2$	$3.E-3$
325.	$1.0E-2$	$2.E-3$
375.	$3.4E-3$	$9.E-4$
425.	$1.7E-3$	$7.E-4$
475.	$8.E-4$	$5.E-4$
525.	$7.E-4$	$4.E-4$
575.	$2.E-4$	$2.E-4$
625.	$3.E-4$	$3.E-4$
675.	$4.E-4$	$2.E-4$

$\pi^- + Cu \rightarrow \pi^- + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$	error ($mb \cdot c^3/GeV^2/sr$)
25.	$1.3E+0$	$4.E-2$
75.	$5.3E-1$	$2.E-2$
125.	$1.55E-1$	$9.E-3$
175.	$6.0E-2$	$5.E-3$
225.	$2.6E-2$	$3.E-3$
275.	$1.5E-2$	$2.E-3$
325.	$9.E-3$	$2.E-3$
375.	$2.2E-3$	$8.E-4$
425.	$2.0E-3$	$7.E-4$
475.	$1.2E-3$	$5.E-4$
625.	$3.E-4$	$3.E-4$

$\pi^- + Cu \rightarrow p + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$	error ($mb \cdot c^3/GeV^2/sr$)
25.	$9.6E-1$	$2.E-2$
75.	$9.6E-1$	$2.E-2$
125.	$2.89E-1$	$9.E-3$
175.	$8.8E-2$	$4.E-3$
225.	$3.4E-2$	$2.E-3$
275.	$1.4E-2$	$2.E-3$
325.	$5.2E-3$	$9.E-4$
375.	$2.8E-3$	$6.E-4$
425.	$6.E-4$	$3.E-4$
475.	$4.E-4$	$2.E-4$
575.	$3.E-4$	$2.E-4$
725.	$1.2E-4$	$1.E-4$
775.	$2.E-4$	$1.E-4$

$\pi^- + Cu \rightarrow \pi^+ + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$	error ($mb \cdot c^3/GeV^2/sr$)
25.	$6.0E-1$	$3.E-2$
75.	$3.6E-1$	$2.E-2$
125.	$1.35E-1$	$9.E-3$
175.	$6.5E-2$	$5.E-3$
225.	$2.8E-2$	$3.E-3$
275.	$1.4E-2$	$2.E-3$
325.	$1.0E-2$	$2.E-3$
375.	$6.E-3$	$1.E-3$
425.	$7.E-3$	$1.E-3$
475.	$1.1E-3$	$5.E-4$
525.	$1.2E-3$	$5.E-4$
625.	$4.E-4$	$3.E-4$
675.	$5.E-4$	$3.E-4$
725.	$2.E-4$	$2.E-4$

$\pi^- + Cu \rightarrow \pi^- + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$	error ($mb \cdot c^3/GeV^2/sr$)
25.	$1.2E+0$	$4.E-2$
75.	$6.2E-1$	$2.E-2$
125.	$1.9E-1$	$1.E-2$
175.	$8.3E-2$	$6.E-3$
225.	$4.1E-2$	$4.E-3$
275.	$2.6E-2$	$3.E-3$
325.	$1.4E-2$	$2.E-3$
375.	$8.E-3$	$1.E-3$
425.	$3.3E-3$	$9.E-4$
475.	$2.5E-3$	$7.E-4$
525.	$1.8E-3$	$6.E-4$
575.	$4.E-4$	$3.E-4$
625.	$3.E-4$	$3.E-4$
675.	$3.E-4$	$2.E-4$
775.	$2.E-4$	$2.E-4$

$\pi^- + Cu \rightarrow p + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$	error ($mb \cdot c^3/GeV^2/sr$)
25.	$8.7E-1$	$2.E-2$
75.	$1.1E+0$	$2.E-2$
125.	$3.54E-1$	$1.E-2$
175.	$1.14E-1$	$5.E-3$
225.	$4.0E-2$	$3.E-3$
275.	$1.8E-2$	$2.E-3$
325.	$8.E-3$	$1.E-3$
375.	$4.3E-3$	$8.E-4$
425.	$1.3E-3$	$4.E-4$
475.	$6.E-4$	$3.E-4$
525.	$6.E-4$	$3.E-4$
575.	$4.E-4$	$2.E-4$
725.	$2.E-4$	$1.E-4$
775.	$2.E-4$	$1.E-4$

$\pi^- + Cu \to \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$5.6E-1$	$3.E-2$
75.	$3.6E-1$	$2.E-2$
125.	$1.57E-1$	$1.E-2$
175.	$7.1E-2$	$6.E-3$
225.	$3.5E-2$	$4.E-3$
275.	$2.3E-2$	$3.E-3$
325.	$1.9E-2$	$2.E-3$
375.	$1.4E-2$	$2.E-3$
425.	$6.E-3$	$1.E-3$
475.	$3.7E-3$	$9.E-4$
525.	$1.E-3$	$5.E-4$
575.	$1.2E-3$	$5.E-4$
625.	$8.E-4$	$4.E-4$
675.	$5.E-4$	$3.E-4$

$\pi^- + Cu \to \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.3E+0$	$4.E-2$
75.	$6.5E-1$	$2.E-2$
125.	$2.2E-1$	$1.E-2$
175.	$9.5E-2$	$7.E-3$
225.	$5.1E-2$	$4.E-3$
275.	$3.2E-2$	$3.E-3$
325.	$2.2E-2$	$3.E-3$
375.	$1.2E-2$	$2.E-3$
425.	$5.E-3$	$1.E-3$
475.	$3.3E-3$	$9.E-4$
525.	$1.6E-3$	$6.E-4$
575.	$1.3E-3$	$5.E-4$

$\pi^- + Cu \to p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$6.9E-1$	$2.E-2$
75.	$1.2E+0$	$2.E-2$
125.	$4.1E-1$	$1.E-2$
175.	$1.34E-1$	$5.E-3$
225.	$5.5E-2$	$3.E-3$
275.	$2.6E-2$	$2.E-3$
325.	$1.1E-2$	$1.E-3$
375.	$5.0E-3$	$8.E-4$
425.	$2.2E-3$	$5.E-4$
475.	$1.7E-3$	$5.E-4$
525.	$1.0E-3$	$3.E-4$
575.	$4.E-4$	$2.E-4$
625.	$2.E-4$	$2.E-4$
675.	$4.E-4$	$2.E-4$
725.	$3.E-4$	$2.E-4$
775.	$2.E-4$	$1.E-4$

$\pi^- + Cu \to \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.7E-1$	$2.E-2$
75.	$3.6E-1$	$2.E-2$
125.	$2.0E-1$	$1.E-2$
175.	$8.0E-2$	$6.E-3$
225.	$5.1E-2$	$4.E-3$
275.	$3.2E-2$	$3.E-3$
325.	$1.6E-2$	$2.E-3$
375.	$1.1E-2$	$2.E-3$
425.	$8.E-3$	$1.E-3$
475.	$6.E-3$	$1.E-3$
525.	$2.7E-3$	$7.E-4$
575.	$3.6E-3$	$8.E-4$
625.	$7.E-4$	$4.E-4$
675.	$7.E-4$	$3.E-4$
725.	$3.E-4$	$2.E-4$
775.	$2.E-4$	$2.E-4$

$\pi^- + Cu \to \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$6.7E-1$	$3.E-2$
75.	$5.8E-1$	$2.E-2$
125.	$2.3E-1$	$1.E-2$
175.	$1.28E-1$	$8.E-3$
225.	$6.5E-2$	$5.E-3$
275.	$3.9E-2$	$4.E-3$
325.	$2.5E-2$	$3.E-3$
375.	$1.6E-2$	$2.E-3$
425.	$8.E-3$	$1.E-3$
475.	$4.7E-3$	$1.E-3$
525.	$3.0E-3$	$8.E-4$
575.	$2.2E-3$	$6.E-4$
625.	$1.5E-3$	$5.E-4$
675.	$4.E-4$	$2.E-4$
725.	$5.E-4$	$3.E-4$
775.	$6.E-4$	$3.E-4$

$\pi^- + Cu \to p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.9E-1$	$1.E-2$
75.	$8.0E-1$	$2.E-2$
125.	$4.4E-1$	$1.E-2$
175.	$1.65E-1$	$6.E-3$
225.	$7.6E-2$	$4.E-3$
275.	$3.2E-2$	$2.E-3$
325.	$1.9E-2$	$2.E-3$
375.	$8.E-3$	$1.E-3$
425.	$5.9E-3$	$9.E-4$
475.	$3.2E-3$	$6.E-4$
525.	$1.1E-3$	$4.E-4$
575.	$1.5E-3$	$4.E-4$
625.	$1.3E-3$	$4.E-4$
675.	$1.E-3$	$3.E-4$
725.	$6.E-4$	$2.E-4$
775.	$2.E-4$	$1.E-4$

| $\pi^- + Cu \to \pi^+ + X$ | | |
$(0.0 < \cos\theta < 0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$4.4E-1$	$3.E-2$
75.	$4.7E-1$	$2.E-2$
125.	$2.1E-1$	$1.E-2$
175.	$1.29E-1$	$8.E-3$
225.	$7.1E-2$	$5.E-3$
275.	$4.8E-2$	$4.E-3$
325.	$2.7E-2$	$3.E-3$
375.	$1.8E-2$	$2.E-3$
425.	$9.E-3$	$2.E-3$
475.	$1.1E-2$	$2.E-3$
525.	$4.8E-3$	$9.E-4$
575.	$5.0E-3$	$1.E-3$
625.	$1.5E-3$	$5.E-4$
675.	$1.5E-3$	$5.E-4$
725.	$1.3E-3$	$4.E-4$
775.	$3.E-4$	$2.E-4$

| $\pi^- + Cu \to \pi^- + X$ | | |
$(0.0 < \cos\theta < 0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$8.9E-1$	$4.E-2$
75.	$7.2E-1$	$2.E-2$
125.	$3.5E-1$	$1.E-2$
175.	$1.67E-1$	$9.E-3$
225.	$9.7E-2$	$6.E-3$
275.	$6.4E-2$	$5.E-3$
325.	$4.8E-2$	$4.E-3$
375.	$2.1E-2$	$2.E-3$
425.	$1.3E-2$	$2.E-3$
475.	$1.3E-2$	$2.E-3$
525.	$5.E-3$	$1.E-3$
575.	$3.5E-3$	$8.E-4$
625.	$1.3E-3$	$5.E-4$
675.	$2.2E-3$	$6.E-4$
725.	$8.E-4$	$4.E-4$
775.	$1.0E-3$	$4.E-4$

| $\pi^- + Cu \to p + X$ | | |
$(0.0 < \cos\theta < 0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.2E-1$	$1.E-2$
75.	$9.8E-1$	$2.E-2$
125.	$5.6E-1$	$1.E-2$
175.	$2.48E-1$	$7.E-3$
225.	$1.16E-1$	$5.E-3$
275.	$5.4E-2$	$3.E-3$
325.	$2.9E-2$	$2.E-3$
375.	$1.6E-2$	$2.E-3$
425.	$9.E-3$	$1.E-3$
475.	$4.9E-3$	$8.E-4$
525.	$3.0E-3$	$6.E-4$
575.	$2.5E-3$	$5.E-4$
625.	$2.5E-3$	$5.E-4$
675.	$1.7E-3$	$4.E-4$
725.	$1.4E-3$	$4.E-4$
775.	$5.E-4$	$2.E-4$

| $\pi^- + Cu \to \pi^+ + X$ | | |
$(0.2 < \cos\theta < 0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$8.1E-1$	$3.E-2$
75.	$6.0E-1$	$2.E-2$
125.	$2.8E-1$	$1.E-2$
175.	$1.70E-1$	$9.E-3$
225.	$9.5E-2$	$6.E-3$
275.	$7.3E-2$	$5.E-3$
325.	$4.5E-2$	$4.E-3$
375.	$3.1E-2$	$3.E-3$
425.	$2.9E-2$	$3.E-3$
475.	$1.5E-2$	$2.E-3$
525.	$1.2E-2$	$2.E-3$
575.	$6.E-3$	$1.E-3$
625.	$5.7E-3$	$1.E-3$
675.	$3.7E-3$	$8.E-4$
725.	$3.1E-3$	$7.E-4$
775.	$9.E-4$	$4.E-4$

| $\pi^- + Cu \to \pi^- + X$ | | |
$(0.2 < \cos\theta < 0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$1.5E+0$	$5.E-2$
75.	$9.0E-1$	$3.E-2$
125.	$4.7E-1$	$2.E-2$
175.	$2.4E-1$	$1.E-2$
225.	$1.47E-1$	$8.E-3$
275.	$9.0E-2$	$5.E-3$
325.	$5.8E-2$	$4.E-3$
375.	$4.1E-2$	$3.E-3$
425.	$2.7E-2$	$3.E-3$
475.	$2.4E-2$	$2.E-3$
525.	$1.3E-2$	$2.E-3$
575.	$1.1E-2$	$1.E-3$
625.	$8.E-3$	$1.E-3$
675.	$3.2E-3$	$7.E-4$
725.	$2.9E-3$	$7.E-4$
775.	$9.E-4$	$4.E-4$

| $\pi^- + Cu \to p + X$ | | |
$(0.2 < \cos\theta < 0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$9.4E-1$	$2.E-2$
75.	$1.8E+0$	$3.E-2$
125.	$7.7E-1$	$1.E-2$
175.	$3.48E-1$	$9.E-3$
225.	$1.71E-1$	$6.E-3$
275.	$8.9E-2$	$4.E-3$
325.	$4.7E-2$	$3.E-3$
375.	$2.8E-2$	$2.E-3$
425.	$1.5E-2$	$1.E-3$
475.	$1.0E-2$	$1.E-3$
525.	$6.4E-3$	$9.E-4$
575.	$5.3E-3$	$8.E-4$
625.	$4.1E-3$	$7.E-4$
675.	$2.4E-3$	$5.E-4$
725.	$3.1E-3$	$5.E-4$
775.	$1.9E-3$	$4.E-4$

$\pi^- + Sn \to \pi^+ + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.0E-1$	$4.E-2$
75.	$4.5E-1$	$2.E-2$
125.	$1.7E-1$	$1.E-2$
175.	$5.9E-2$	$6.E-3$
225.	$3.4E-2$	$4.E-3$
275.	$2.1E-2$	$3.E-3$
325.	$1.E-2$	$2.E-3$
375.	$8.E-3$	$2.E-3$
425.	$5.E-3$	$1.E-3$
475.	$4.0E-3$	$1.E-3$
525.	$1.4E-3$	$6.E-4$
625.	$4.E-4$	$3.E-4$
675.	$3.E-4$	$2.E-4$
725.	$3.E-4$	$2.E-4$

$\pi^- + Sn \to \pi^+ + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.7E-1$	$4.E-2$
75.	$4.9E-1$	$2.E-2$
125.	$2.0E-1$	$1.E-2$
175.	$7.6E-2$	$7.E-3$
225.	$4.2E-2$	$5.E-3$
275.	$2.4E-2$	$3.E-3$
325.	$1.9E-2$	$3.E-3$
375.	$1.3E-2$	$2.E-3$
425.	$7.E-3$	$1.E-3$
475.	$4.E-3$	$1.E-3$
575.	$1.2E-3$	$5.E-4$
625.	$1.E-3$	$5.E-4$
725.	$3.E-4$	$2.E-4$

$\pi^- + Sn \to \pi^- + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.9E+0$	$6.E-2$
75.	$7.8E-1$	$3.E-2$
125.	$2.2E-1$	$1.E-2$
175.	$9.6E-2$	$8.E-3$
225.	$5.6E-2$	$5.E-3$
275.	$2.6E-2$	$3.E-3$
325.	$1.5E-2$	$2.E-3$
375.	$1.E-2$	$2.E-3$
425.	$4.E-3$	$1.E-3$
475.	$1.9E-3$	$8.E-4$
525.	$8.E-4$	$5.E-4$
575.	$4.E-4$	$3.E-4$
675.	$3.E-4$	$2.E-4$

$\pi^- + Sn \to \pi^- + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.0E+0$	$6.E-2$
75.	$8.8E-1$	$3.E-2$
125.	$2.7E-1$	$1.E-2$
175.	$1.19E-1$	$8.E-3$
225.	$6.7E-2$	$6.E-3$
275.	$3.7E-2$	$4.E-3$
325.	$2.1E-2$	$3.E-3$
375.	$9.E-3$	$2.E-3$
425.	$5.E-3$	$1.E-3$
475.	$3.0E-3$	$9.E-4$
525.	$1.3E-3$	$6.E-4$
575.	$7.E-4$	$4.E-4$

$\pi^- + Sn \to p + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.5E+0$	$3.E-2$
75.	$1.9E+0$	$3.E-2$
125.	$5.9E-1$	$1.E-2$
175.	$1.65E-1$	$7.E-3$
225.	$5.5E-2$	$4.E-3$
275.	$2.2E-2$	$2.E-3$
325.	$9.E-3$	$1.E-3$
375.	$3.8E-3$	$8.E-4$
425.	$7.E-4$	$3.E-4$
475.	$1.3E-3$	$4.E-4$
525.	$8.E-4$	$3.E-4$

$\pi^- + Sn \to p + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.3E+0$	$3.E-2$
75.	$2.1E+0$	$3.E-2$
125.	$6.6E-1$	$1.E-2$
175.	$2.14E-1$	$8.E-3$
225.	$9.2E-2$	$5.E-3$
275.	$3.6E-2$	$3.E-3$
325.	$1.3E-2$	$2.E-3$
375.	$7.E-3$	$1.E-3$
425.	$2.7E-3$	$7.E-4$
475.	$1.5E-3$	$5.E-4$
525.	$3.E-4$	$2.E-4$
575.	$7.E-4$	$3.E-4$
625.	$3.E-4$	$2.E-4$
675.	$3.E-4$	$2.E-4$
725.	$5.E-4$	$3.E-4$
775.	$5.E-4$	$2.E-4$

$\pi^- + Sn \rightarrow \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.3E-1$	$4.E-2$
75.	$5.6E-1$	$2.E-2$
125.	$2.3E-1$	$1.E-2$
175.	$9.7E-2$	$8.E-3$
225.	$4.8E-2$	$5.E-3$
275.	$3.2E-2$	$4.E-3$
325.	$2.1E-2$	$3.E-3$
375.	$1.3E-2$	$2.E-3$
425.	$1.E-2$	$2.E-3$
475.	$5.E-3$	$1.E-3$
525.	$2.5E-3$	$8.E-4$
575.	$1.7E-3$	$6.E-4$
625.	$1.E-3$	$5.E-4$
725.	$8.E-4$	$4.E-4$
775.	$3.E-4$	$3.E-4$

$\pi^- + Sn \rightarrow \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.9E+0$	$6.E-2$
75.	$9.6E-1$	$3.E-2$
125.	$3.3E-1$	$2.E-2$
175.	$1.35E-1$	$9.E-3$
225.	$7.7E-2$	$6.E-3$
275.	$5.7E-2$	$5.E-3$
325.	$2.4E-2$	$3.E-3$
375.	$1.3E-2$	$2.E-3$
425.	$9.E-3$	$2.E-3$
475.	$5.E-3$	$1.E-3$
525.	$4.0E-3$	$1.E-3$
575.	$2.8E-3$	$8.E-4$
625.	$7.E-4$	$4.E-4$
675.	$3.E-4$	$2.E-4$

$\pi^- + Sn \rightarrow p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$8.4E-1$	$2.E-2$
75.	$2.3E+0$	$3.E-2$
125.	$7.5E-1$	$2.E-2$
175.	$2.60E-1$	$9.E-3$
225.	$1.03E-1$	$5.E-3$
275.	$4.8E-2$	$3.E-3$
325.	$2.2E-2$	$2.E-3$
375.	$9.E-3$	$1.E-3$
425.	$6.E-3$	$1.E-3$
475.	$2.1E-3$	$6.E-4$
525.	$1.4E-3$	$5.E-4$
575.	$1.5E-3$	$5.E-4$
625.	$8.E-4$	$3.E-4$
675.	$1.1E-3$	$4.E-4$
725.	$1.2E-3$	$4.E-4$
775.	$5.E-4$	$2.E-4$

$\pi^- + Sn \rightarrow \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$4.0E-1$	$3.E-2$
75.	$5.1E-1$	$2.E-2$
125.	$2.2E-1$	$1.E-2$
175.	$1.14E-1$	$8.E-3$
225.	$6.1E-2$	$6.E-3$
275.	$5.0E-2$	$5.E-3$
325.	$3.7E-2$	$4.E-3$
375.	$1.7E-2$	$2.E-3$
425.	$1.3E-2$	$2.E-3$
475.	$9.E-3$	$2.E-3$
525.	$3.2E-3$	$9.E-4$
575.	$3.4E-3$	$9.E-4$
625.	$1.3E-3$	$6.E-4$
675.	$5.E-4$	$4.E-4$
725.	$4.E-4$	$3.E-4$
775.	$6.E-4$	$3.E-4$

$\pi^- + Sn \rightarrow \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.0E+0$	$4.E-2$
75.	$9.2E-1$	$3.E-2$
125.	$3.7E-1$	$2.E-2$
175.	$1.8E-1$	$1.E-2$
225.	$9.5E-2$	$7.E-3$
275.	$5.4E-2$	$5.E-3$
325.	$3.3E-2$	$4.E-3$
375.	$1.9E-2$	$3.E-3$
425.	$1.1E-2$	$2.E-3$
475.	$8.E-3$	$1.E-3$
525.	$3.0E-3$	$9.E-4$
575.	$1.6E-3$	$6.E-4$
625.	$1.6E-3$	$6.E-4$
675.	$7.E-4$	$4.E-4$
725.	$8.E-4$	$4.E-4$

$\pi^- + Sn \rightarrow p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.0E-1$	$1.E-2$
75.	$1.2E+0$	$2.E-2$
125.	$7.9E-1$	$2.E-2$
175.	$2.91E-1$	$9.E-3$
225.	$1.28E-1$	$6.E-3$
275.	$5.7E-2$	$4.E-3$
325.	$2.6E-2$	$2.E-3$
375.	$1.2E-2$	$2.E-3$
425.	$8.E-3$	$1.E-3$
475.	$4.9E-3$	$9.E-4$
525.	$3.8E-3$	$8.E-4$
575.	$1.7E-3$	$5.E-4$
625.	$7.E-4$	$3.E-4$
675.	$1.2E-3$	$4.E-4$
725.	$1.1E-3$	$4.E-4$
775.	$7.E-4$	$3.E-4$

$\pi^- + Sn \to \pi^+ + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.6E-1$	$3.E-2$
75.	$5.9E-1$	$2.E-2$
125.	$3.3E-1$	$2.E-2$
175.	$1.7E-1$	$1.E-2$
225.	$8.7E-2$	$7.E-3$
275.	$6.2E-2$	$5.E-3$
325.	$5.0E-2$	$4.E-3$
375.	$2.7E-2$	$3.E-3$
425.	$2.5E-2$	$3.E-3$
475.	$1.6E-2$	$2.E-3$
525.	$9.E-3$	$2.E-3$
575.	$6.E-3$	$1.E-3$
625.	$3.1E-3$	$9.E-4$
675.	$2.4E-3$	$7.E-4$
725.	$1.1E-3$	$4.E-4$
775.	$8.E-4$	$4.E-4$

$\pi^- + Sn \to \pi^- + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.2E+0$	$5.E-2$
75.	$1.2E+0$	$4.E-2$
125.	$5.2E-1$	$2.E-2$
175.	$2.3E-1$	$1.E-2$
225.	$1.39E-1$	$8.E-3$
275.	$9.3E-2$	$6.E-3$
325.	$5.7E-2$	$5.E-3$
375.	$3.6E-2$	$4.E-3$
425.	$2.4E-2$	$3.E-3$
475.	$1.6E-2$	$2.E-3$
525.	$1.E-2$	$2.E-3$
575.	$6.E-3$	$1.E-3$
625.	$4.1E-3$	$1.E-3$
675.	$2.9E-3$	$8.E-4$
725.	$8.E-4$	$4.E-4$
775.	$3.E-4$	$3.E-4$

$\pi^- + Sn \to p + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.8E-1$	$1.E-2$
75.	$1.6E+0$	$3.E-2$
125.	$1.1E+0$	$2.E-2$
175.	$4.3E-1$	$1.E-2$
225.	$2.01E-1$	$7.E-3$
275.	$1.03E-1$	$5.E-3$
325.	$4.9E-2$	$3.E-3$
375.	$2.9E-2$	$2.E-3$
425.	$1.8E-2$	$2.E-3$
475.	$7.E-3$	$1.E-3$
525.	$5.7E-3$	$9.E-4$
575.	$3.4E-3$	$7.E-4$
625.	$2.4E-3$	$6.E-4$
675.	$1.7E-3$	$5.E-4$
725.	$2.9E-3$	$6.E-4$
775.	$2.4E-3$	$5.E-4$

$\pi^- + Sn \to \pi^+ + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.2E+0$	$5.E-2$
75.	$8.7E-1$	$3.E-2$
125.	$4.3E-1$	$2.E-2$
175.	$2.3E-1$	$1.E-2$
225.	$1.47E-1$	$8.E-3$
275.	$8.1E-2$	$6.E-3$
325.	$6.6E-2$	$5.E-3$
375.	$4.8E-2$	$4.E-3$
425.	$3.9E-2$	$3.E-3$
475.	$2.5E-2$	$3.E-3$
525.	$1.9E-2$	$2.E-3$
575.	$1.5E-2$	$2.E-3$
625.	$7.E-3$	$1.E-3$
675.	$7.E-3$	$1.E-3$
725.	$2.0E-3$	$6.E-4$
775.	$2.0E-3$	$6.E-4$

$\pi^- + Sn \to \pi^- + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.5E+0$	$7.E-2$
75.	$1.4E+0$	$4.E-2$
125.	$6.3E-1$	$2.E-2$
175.	$3.2E-1$	$1.E-2$
225.	$1.83E-1$	$1.E-2$
275.	$1.40E-1$	$8.E-3$
325.	$8.6E-2$	$6.E-3$
375.	$6.7E-2$	$5.E-3$
425.	$4.2E-2$	$4.E-3$
475.	$2.7E-2$	$3.E-3$
525.	$1.6E-2$	$2.E-3$
575.	$1.3E-2$	$2.E-3$
625.	$9.E-3$	$1.E-3$
675.	$4.2E-3$	$9.E-4$
725.	$3.7E-3$	$8.E-4$
775.	$1.8E-3$	$6.E-4$

$\pi^- + Sn \to p + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.1E+0$	$3.E-2$
75.	$3.5E+0$	$4.E-2$
125.	$1.4E+0$	$2.E-2$
175.	$6.1E-1$	$1.E-2$
225.	$3.01E-1$	$9.E-3$
275.	$1.48E-1$	$6.E-3$
325.	$8.1E-2$	$4.E-3$
375.	$4.4E-2$	$3.E-3$
425.	$2.9E-2$	$2.E-3$
475.	$1.8E-2$	$2.E-3$
525.	$1.1E-2$	$1.E-3$
575.	$9.E-3$	$1.E-3$
625.	$5.3E-3$	$8.E-4$
675.	$4.3E-3$	$7.E-4$
725.	$4.3E-3$	$7.E-4$
775.	$4.0E-3$	$7.E-4$

$\pi^- + Pb \to \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$7.5E-1$	$6.E-2$
75.	$5.4E-1$	$4.E-2$
125.	$2.0E-1$	$2.E-2$
175.	$8.E-2$	$1.E-2$
225.	$5.2E-2$	$8.E-3$
275.	$1.9E-2$	$4.E-3$
325.	$1.6E-2$	$4.E-3$
375.	$2.E-3$	$1.E-3$
425.	$4.E-3$	$2.E-3$
475.	$2.E-3$	$1.E-3$
525.	$3.E-3$	$1.E-3$
575.	$1.2E-3$	$9.E-4$
625.	$1.1E-3$	$7.E-4$

$\pi^- + Pb \to \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$9.0E-1$	$6.E-2$
75.	$5.1E-1$	$4.E-2$
125.	$2.2E-1$	$2.E-2$
175.	$1.1E-1$	$1.E-2$
225.	$5.1E-2$	$8.E-3$
275.	$3.5E-2$	$6.E-3$
325.	$1.7E-2$	$4.E-3$
375.	$1.E-2$	$3.E-3$
425.	$5.E-3$	$2.E-3$
475.	$6.E-3$	$2.E-3$
525.	$3.E-3$	$1.E-3$
625.	$1.1E-3$	$9.E-4$
725.	$1.3E-3$	$8.E-4$
775.	$1.E-3$	$6.E-4$

$\pi^- + Pb \to \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$3.E+0$	$1.E-1$
75.	$1.1E+0$	$5.E-2$
125.	$3.0E-1$	$2.E-2$
175.	$1.3E-1$	$1.E-2$
225.	$6.7E-2$	$9.E-3$
275.	$2.9E-2$	$5.E-3$
325.	$2.9E-2$	$5.E-3$
375.	$9.E-3$	$3.E-3$
425.	$5.E-3$	$2.E-3$
475.	$1.4E-3$	$9.E-4$
525.	$2.E-3$	$1.E-3$
575.	$1.2E-3$	$8.E-4$
725.	$7.E-4$	$4.E-4$

$\pi^- + Pb \to \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$3.E+0$	$1.E-1$
75.	$1.2E+0$	$5.E-2$
125.	$3.5E-1$	$2.E-2$
175.	$1.3E-1$	$1.E-2$
225.	$6.1E-2$	$9.E-3$
275.	$3.4E-2$	$6.E-3$
325.	$3.2E-2$	$5.E-3$
375.	$1.2E-2$	$3.E-3$
425.	$8.E-3$	$3.E-3$
475.	$3.E-3$	$1.E-3$
575.	$2.E-3$	$1.E-3$
675.	$2.2E-3$	$8.E-4$

$\pi^- + Pb \to p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$3.3E+0$	$8.E-2$
75.	$3.1E+0$	$6.E-2$
125.	$8.7E-1$	$3.E-2$
175.	$2.6E-1$	$1.E-2$
225.	$9.4E-2$	$7.E-3$
275.	$2.5E-2$	$3.E-3$
325.	$1.0E-2$	$2.E-3$
375.	$2.E-3$	$1.E-3$
425.	$2.0E-3$	$9.E-4$
675.	$7.E-4$	$4.E-4$

$\pi^- + Pb \to p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$3.1E+0$	$7.E-2$
75.	$3.4E+0$	$6.E-2$
125.	$1.0E+0$	$3.E-2$
175.	$3.4E-1$	$1.E-2$
225.	$1.20E-1$	$8.E-3$
275.	$3.7E-2$	$4.E-3$
325.	$1.7E-2$	$3.E-3$
375.	$7.E-3$	$2.E-3$
425.	$6.E-3$	$1.E-3$
475.	$2.2E-3$	$8.E-4$
525.	$1.8E-3$	$7.E-4$
575.	$1.5E-3$	$6.E-4$
675.	$9.E-4$	$4.E-4$
725.	$4.E-4$	$3.E-4$

$\pi^- + Pb \to \pi^+ + X$ $(-0.4 < \cos\theta < -0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.1E+0$	$7.E-2$
75.	$7.2E-1$	$4.E-2$
125.	$2.9E-1$	$2.E-2$
175.	$1.4E-1$	$1.E-2$
225.	$6.2E-2$	$8.E-3$
275.	$3.4E-2$	$6.E-3$
325.	$3.2E-2$	$5.E-3$
375.	$2.0E-2$	$4.E-3$
425.	$8.E-3$	$2.E-3$
475.	$8.E-3$	$2.E-3$
525.	$3.E-3$	$1.E-3$
575.	$3.E-3$	$1.E-3$
625.	$3.E-3$	$1.E-3$
675.	$1.4E-3$	$8.E-4$
725.	$7.E-4$	$6.E-4$

$\pi^- + Pb \to \pi^+ + X$ $(-0.2 < \cos\theta < 0.0)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$6.4E-1$	$5.E-2$
75.	$5.4E-1$	$4.E-2$
125.	$3.3E-1$	$2.E-2$
175.	$1.3E-1$	$1.E-2$
225.	$6.9E-2$	$9.E-3$
275.	$4.1E-2$	$6.E-3$
325.	$2.6E-2$	$5.E-3$
375.	$2.2E-2$	$4.E-3$
425.	$1.8E-2$	$4.E-3$
475.	$9.E-3$	$2.E-3$
525.	$8.E-3$	$2.E-3$
575.	$3.E-3$	$1.E-3$
625.	$3.E-3$	$1.E-3$
675.	$2.E-3$	$1.E-3$
725.	$1.3E-3$	$8.E-4$

$\pi^- + Pb \to \pi^- + X$ $(-0.4 < \cos\theta < -0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.E+0$	$1.E-1$
75.	$1.4E+0$	$6.E-2$
125.	$4.1E-1$	$3.E-2$
175.	$2.0E-1$	$2.E-2$
225.	$9.E-2$	$1.E-2$
275.	$7.5E-2$	$9.E-3$
325.	$4.1E-2$	$6.E-3$
375.	$1.8E-2$	$4.E-3$
425.	$1.8E-2$	$4.E-3$
475.	$5.E-3$	$2.E-3$
525.	$4.E-3$	$1.E-3$
575.	$2.E-3$	$1.E-3$
775.	$1.3E-3$	$6.E-4$

$\pi^- + Pb \to \pi^- + X$ $(-0.2 < \cos\theta < 0.0)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.4E+0$	$8.E-2$
75.	$1.2E+0$	$5.E-2$
125.	$4.2E-1$	$3.E-2$
175.	$2.2E-1$	$2.E-2$
225.	$1.1E-1$	$1.E-2$
275.	$8.4E-2$	$9.E-3$
325.	$4.9E-2$	$6.E-3$
375.	$2.1E-2$	$4.E-3$
425.	$2.1E-2$	$4.E-3$
475.	$7.E-3$	$2.E-3$
525.	$5.E-3$	$2.E-3$
575.	$3.E-3$	$1.E-3$
625.	$7.E-4$	$7.E-4$

$\pi^- + Pb \to p + X$ $(-0.4 < \cos\theta < -0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.4E+0$	$6.E-2$
75.	$3.9E+0$	$6.E-2$
125.	$1.1E+0$	$3.E-2$
175.	$3.6E-1$	$2.E-2$
225.	$1.29E-1$	$9.E-3$
275.	$6.3E-2$	$6.E-3$
325.	$2.3E-2$	$3.E-3$
375.	$1.8E-2$	$3.E-3$
425.	$7.E-3$	$2.E-3$
475.	$2.E-3$	$1.E-3$
525.	$1.0E-3$	$6.E-4$
575.	$5.E-4$	$5.E-4$
625.	$1.2E-3$	$5.E-4$
725.	$1.0E-3$	$6.E-4$
775.	$1.0E-3$	$5.E-4$

$\pi^- + Pb \to p + X$ $(-0.2 < \cos\theta < 0.0)$		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$5.6E-1$	$3.E-2$
75.	$2.2E+0$	$5.E-2$
125.	$1.2E+0$	$3.E-2$
175.	$4.5E-1$	$2.E-2$
225.	$1.7E-1$	$1.E-2$
275.	$8.3E-2$	$7.E-3$
325.	$3.3E-2$	$4.E-3$
375.	$2.2E-2$	$3.E-3$
425.	$1.1E-2$	$2.E-3$
475.	$3.E-3$	$1.E-3$
525.	$2.1E-3$	$8.E-4$
575.	$2.2E-3$	$9.E-4$
625.	$3.E-3$	$1.E-3$
675.	$1.6E-3$	$8.E-4$
725.	$1.1E-3$	$6.E-4$
775.	$2.7E-3$	$8.E-4$

$\pi^- + Pb \to \pi^+ + X$		
$(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.6E-1$	$5.E-2$
75.	$7.2E-1$	$4.E-2$
125.	$3.9E-1$	$3.E-2$
175.	$2.1E-1$	$2.E-2$
225.	$1.2E-1$	$1.E-2$
275.	$8.3E-2$	$9.E-3$
325.	$4.2E-2$	$6.E-3$
375.	$3.3E-2$	$5.E-3$
425.	$2.2E-2$	$4.E-3$
475.	$1.2E-2$	$3.E-3$
525.	$1.4E-2$	$3.E-3$
575.	$6.E-3$	$2.E-3$
625.	$3.E-3$	$1.E-3$
675.	$3.E-3$	$1.E-3$
725.	$1.3E-3$	$9.E-4$
775.	$1.3E-3$	$7.E-4$

$\pi^- + Pb \to \pi^- + X$		
$(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.0E+0$	$9.E-2$
75.	$1.5E+0$	$6.E-2$
125.	$6.1E-1$	$3.E-2$
175.	$3.5E-1$	$2.E-2$
225.	$1.8E-1$	$1.E-2$
275.	$1.3E-1$	$1.E-2$
325.	$8.3E-2$	$9.E-3$
375.	$5.8E-2$	$7.E-3$
425.	$3.6E-2$	$5.E-3$
475.	$2.5E-2$	$4.E-3$
525.	$1.5E-2$	$3.E-3$
575.	$8.E-3$	$2.E-3$
625.	$4.E-3$	$2.E-3$
675.	$1.1E-3$	$7.E-4$
725.	$1.E-3$	$8.E-4$

$\pi^- + Pb \to p + X$		
$(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.8E-1$	$3.E-2$
75.	$2.9E+0$	$5.E-2$
125.	$1.5E+0$	$3.E-2$
175.	$6.0E-1$	$2.E-2$
225.	$2.8E-1$	$1.E-2$
275.	$1.30E-1$	$8.E-3$
325.	$6.4E-2$	$5.E-3$
375.	$3.1E-2$	$4.E-3$
425.	$1.5E-2$	$3.E-3$
475.	$1.4E-2$	$2.E-3$
525.	$1.0E-2$	$2.E-3$
575.	$6.E-3$	$1.E-3$
625.	$3.E-3$	$1.E-3$
675.	$3.6E-3$	$9.E-4$
725.	$2.5E-3$	$9.E-4$
775.	$1.6E-3$	$7.E-4$

$\pi^- + Pb \to \pi^+ + X$		
$(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.5E+0$	$8.E-2$
75.	$1.0E+0$	$5.E-2$
125.	$5.1E-1$	$3.E-2$
175.	$2.9E-1$	$2.E-2$
225.	$1.5E-1$	$1.E-2$
275.	$1.4E-1$	$1.E-2$
325.	$7.7E-2$	$8.E-3$
375.	$7.8E-2$	$8.E-3$
425.	$5.1E-2$	$6.E-3$
475.	$4.1E-2$	$5.E-3$
525.	$2.6E-2$	$4.E-3$
575.	$1.3E-2$	$3.E-3$
625.	$7.E-3$	$2.E-3$
675.	$7.E-3$	$2.E-3$
725.	$3.E-3$	$1.E-3$
775.	$1.2E-3$	$8.E-4$

$\pi^- + Pb \to \pi^- + X$		
$(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.E+0$	$1.E-1$
75.	$1.8E+0$	$7.E-2$
125.	$7.7E-1$	$4.E-2$
175.	$4.3E-1$	$2.E-2$
225.	$2.6E-1$	$2.E-2$
275.	$1.6E-1$	$1.E-2$
325.	$1.01E-1$	$9.E-3$
375.	$6.4E-2$	$7.E-3$
425.	$5.6E-2$	$6.E-3$
475.	$3.5E-2$	$5.E-3$
525.	$1.8E-2$	$3.E-3$
575.	$1.4E-2$	$3.E-3$
625.	$4.E-3$	$2.E-3$
675.	$4.E-3$	$2.E-3$
725.	$8.E-3$	$2.E-3$
775.	$1.3E-3$	$7.E-4$

$\pi^- + Pb \to p + X$		
$(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.2E+0$	$7.E-2$
75.	$5.6E+0$	$8.E-2$
125.	$2.1E+0$	$4.E-2$
175.	$8.4E-1$	$2.E-2$
225.	$4.1E-1$	$2.E-2$
275.	$2.2E-1$	$1.E-2$
325.	$1.13E-1$	$7.E-3$
375.	$6.6E-2$	$5.E-3$
425.	$3.7E-2$	$4.E-3$
475.	$3.0E-2$	$3.E-3$
525.	$1.4E-2$	$2.E-3$
575.	$9.E-3$	$2.E-3$
625.	$7.E-3$	$2.E-3$
675.	$7.E-3$	$1.E-3$
725.	$6.E-3$	$1.E-3$
775.	$7.E-3$	$1.E-3$

$p + Li \rightarrow \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$5.7E-2$	$3.E-3$
75.	$4.6E-2$	$2.E-3$
125.	$1.5E-2$	$1.E-3$
175.	$5.4E-3$	$6.E-4$
225.	$2.3E-3$	$3.E-4$
275.	$9.E-4$	$2.E-4$
325.	$4.E-4$	$1.E-4$
375.	$2.0E-4$	$8.E-5$
425.	$1.2E-4$	$6.E-5$
475.	$5.E-5$	$4.E-5$
525.	$5.E-5$	$4.E-5$

$p + Li \rightarrow \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$6.7E-2$	$4.E-3$
75.	$5.3E-2$	$2.E-3$
125.	$1.9E-2$	$1.E-3$
175.	$5.7E-3$	$6.E-4$
225.	$3.1E-3$	$4.E-4$
275.	$1.3E-3$	$2.E-4$
325.	$5.E-4$	$1.E-4$
375.	$3.E-4$	$1.E-4$
425.	$9.E-5$	$5.E-5$
475.	$3.E-5$	$3.E-5$
525.	$5.E-5$	$4.E-5$
575.	$2.E-5$	$2.E-5$

$p + Li \rightarrow \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$5.1E-2$	$3.E-3$
75.	$3.2E-2$	$2.E-3$
125.	$1.05E-2$	$9.E-4$
175.	$2.4E-3$	$4.E-4$
225.	$9.E-4$	$2.E-4$
275.	$4.E-4$	$1.E-4$
325.	$4.E-5$	$4.E-5$
375.	$3.E-5$	$3.E-5$
425.	$6.E-5$	$4.E-5$
525.	$3.E-5$	$3.E-5$
625.	$2.E-5$	$2.E-5$

$p + Li \rightarrow \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$5.9E-2$	$3.E-3$
75.	$3.9E-2$	$2.E-3$
125.	$1.22E-2$	$9.E-4$
175.	$3.7E-3$	$5.E-4$
225.	$1.4E-3$	$3.E-4$
275.	$3.E-4$	$1.E-4$
325.	$2.6E-4$	$1.E-4$
375.	$1.7E-4$	$7.E-5$
425.	$6.E-5$	$4.E-5$

$p + Li \rightarrow p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$5.9E-3$	$7.E-4$
75.	$1.33E-2$	$8.E-4$
125.	$3.9E-3$	$4.E-4$
175.	$1.4E-3$	$2.E-4$
225.	$6.E-4$	$1.E-4$
275.	$2.1E-4$	$7.E-5$
325.	$2.E-5$	$2.E-5$
375.	$2.E-5$	$2.E-5$
525.	$3.E-5$	$2.E-5$
625.	$3.E-5$	$2.E-5$
675.	$1.E-5$	$1.E-5$

$p + Li \rightarrow p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$1.02E-2$	$9.E-4$
75.	$1.82E-2$	$9.E-4$
125.	$5.9E-3$	$4.E-4$
175.	$2.3E-3$	$3.E-4$
225.	$7.E-4$	$1.E-4$
275.	$4.5E-4$	$1.E-4$
325.	$8.E-5$	$4.E-5$
425.	$2.E-5$	$2.E-5$
675.	$1.E-5$	$1.E-5$
725.	$1.E-5$	$1.E-5$

Table.4.7: Invariant cross sections in the reaction of p incident

$p + Li \to \pi^+ + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$6.6E-2$	$4.E-3$
75.	$5.4E-2$	$2.E-3$
125.	$2.2E-2$	$1.E-3$
175.	$8.3E-3$	$7.E-4$
225.	$3.8E-3$	$4.E-4$
275.	$1.5E-3$	$2.E-4$
325.	$1.2E-3$	$2.E-4$
375.	$3.E-4$	$1.E-4$
425.	$2.7E-4$	$9.E-5$
475.	$1.1E-4$	$5.E-5$
525.	$5.E-5$	$4.E-5$
625.	$2.E-5$	$2.E-5$
675.	$4.E-5$	$3.E-5$

$p + Li \to \pi^+ + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$7.0E-2$	$4.E-3$
75.	$6.2E-2$	$2.E-3$
125.	$2.5E-2$	$1.E-3$
175.	$9.9E-3$	$8.E-4$
225.	$4.8E-3$	$5.E-4$
275.	$3.2E-3$	$4.E-4$
325.	$1.7E-3$	$2.E-4$
375.	$9.E-4$	$2.E-4$
425.	$3.3E-4$	$1.E-4$
475.	$2.7E-4$	$9.E-5$
525.	$1.3E-4$	$6.E-5$
575.	$5.E-5$	$3.E-5$
625.	$2.E-5$	$2.E-5$
725.	$2.E-5$	$2.E-5$

$p + Li \to \pi^- + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$6.6E-2$	$4.E-3$
75.	$4.9E-2$	$2.E-3$
125.	$1.5E-2$	$1.E-3$
175.	$5.3E-3$	$6.E-4$
225.	$2.7E-3$	$4.E-4$
275.	$1.1E-3$	$2.E-4$
325.	$1.9E-4$	$8.E-5$
375.	$2.3E-4$	$9.E-5$
425.	$3.E-5$	$3.E-5$
475.	$8.E-5$	$5.E-5$
575.	$7.E-5$	$4.E-5$
675.	$4.E-5$	$3.E-5$

$p + Li \to \pi^- + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$6.4E-2$	$3.E-3$
75.	$4.9E-2$	$2.E-3$
125.	$1.7E-2$	$1.E-3$
175.	$6.0E-3$	$6.E-4$
225.	$2.8E-3$	$4.E-4$
275.	$1.2E-3$	$2.E-4$
325.	$6.E-4$	$1.E-4$
375.	$5.E-4$	$1.E-4$
425.	$2.1E-4$	$8.E-5$
475.	$8.E-5$	$5.E-5$
575.	$2.E-5$	$2.E-5$
675.	$2.E-5$	$2.E-5$
725.	$2.E-5$	$2.E-5$

$p + Li \to p + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$1.8E-2$	$1.E-3$
75.	$2.8E-2$	$1.E-3$
125.	$9.6E-3$	$6.E-4$
175.	$3.2E-3$	$3.E-4$
225.	$1.8E-3$	$2.E-4$
275.	$7.E-4$	$1.E-4$
325.	$1.9E-4$	$6.E-5$
375.	$9.E-5$	$4.E-5$
425.	$3.E-5$	$2.E-5$
475.	$1.1E-4$	$4.E-5$
525.	$7.E-5$	$3.E-5$
575.	$1.E-5$	$1.E-5$
675.	$1.E-5$	$1.E-5$
725.	$1.E-5$	$1.E-5$
775.	$2.E-5$	$2.E-5$

$p + Li \to p + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb·c^3/GeV^2/sr)	
25.	$2.5E-2$	$1.E-3$
75.	$4.4E-2$	$1.E-3$
125.	$1.54E-2$	$7.E-4$
175.	$6.0E-3$	$4.E-4$
225.	$2.5E-3$	$2.E-4$
275.	$1.2E-3$	$2.E-4$
325.	$6.E-4$	$1.E-4$
375.	$1.8E-4$	$6.E-5$
425.	$1.E-4$	$4.E-5$
475.	$6.E-5$	$3.E-5$
525.	$4.E-5$	$3.E-5$
575.	$1.E-5$	$1.E-5$
675.	$1.E-5$	$1.E-5$
725.	$2.E-5$	$2.E-5$
775.	$2.E-5$	$2.E-5$

$p + Li \rightarrow \pi^+ + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.5E-2$	$4.E-3$
75.	$6.0E-2$	$2.E-3$
125.	$3.1E-2$	$2.E-3$
175.	$1.31E-2$	$9.E-4$
225.	$6.8E-3$	$6.E-4$
275.	$3.8E-3$	$4.E-4$
325.	$2.3E-3$	$3.E-4$
375.	$1.5E-3$	$2.E-4$
425.	$9.E-4$	$2.E-4$
475.	$6.E-4$	$1.E-4$
525.	$5.E-4$	$1.E-4$
575.	$2.6E-4$	$8.E-5$
625.	$1.7E-4$	$6.E-5$
675.	$1.6E-4$	$6.E-5$
725.	$6.E-5$	$3.E-5$
775.	$4.E-5$	$3.E-5$

$p + Li \rightarrow \pi^- + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.6E-2$	$4.E-3$
75.	$5.7E-2$	$2.E-3$
125.	$2.3E-2$	$1.E-3$
175.	$1.11E-2$	$8.E-4$
225.	$4.8E-3$	$5.E-4$
275.	$2.5E-3$	$3.E-4$
325.	$1.3E-3$	$2.E-4$
375.	$1.E-3$	$2.E-4$
425.	$4.E-4$	$1.E-4$
475.	$1.6E-4$	$7.E-5$
525.	$1.0E-4$	$5.E-5$
575.	$5.E-5$	$3.E-5$
625.	$4.E-5$	$3.E-5$
675.	$4.E-5$	$3.E-5$

$p + Li \rightarrow p + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.5E-2$	$2.E-3$
75.	$6.9E-2$	$2.E-3$
125.	$2.75E-2$	$9.E-4$
175.	$1.26E-2$	$6.E-4$
225.	$5.7E-3$	$4.E-4$
275.	$3.0E-3$	$3.E-4$
325.	$1.6E-3$	$2.E-4$
375.	$8.E-4$	$1.E-4$
425.	$3.3E-4$	$7.E-5$
475.	$2.2E-4$	$6.E-5$
525.	$1.2E-4$	$4.E-5$
575.	$1.E-4$	$4.E-5$
625.	$8.E-5$	$3.E-5$
675.	$4.E-5$	$2.E-5$
725.	$2.E-5$	$2.E-5$
775.	$2.E-5$	$2.E-5$

$p + Li \rightarrow \pi^+ + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$9.2E-2$	$4.E-3$
75.	$8.6E-2$	$3.E-3$
125.	$4.7E-2$	$2.E-3$
175.	$2.5E-2$	$1.E-3$
225.	$1.42E-2$	$8.E-4$
275.	$7.6E-3$	$6.E-4$
325.	$5.9E-3$	$5.E-4$
375.	$3.6E-3$	$3.E-4$
425.	$2.8E-3$	$3.E-4$
475.	$1.9E-3$	$2.E-4$
525.	$9.E-4$	$2.E-4$
575.	$9.E-4$	$1.E-4$
625.	$5.E-4$	$1.E-4$
675.	$4.7E-4$	$1.E-4$
725.	$1.9E-4$	$6.E-5$
775.	$2.2E-4$	$6.E-5$

$p + Li \rightarrow \pi^- + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$8.0E-2$	$4.E-3$
75.	$6.9E-2$	$3.E-3$
125.	$3.9E-2$	$2.E-3$
175.	$2.0E-2$	$1.E-3$
225.	$1.10E-2$	$7.E-4$
275.	$6.6E-3$	$5.E-4$
325.	$4.6E-3$	$4.E-4$
375.	$2.4E-3$	$3.E-4$
425.	$1.E-3$	$2.E-4$
475.	$6.E-4$	$1.E-4$
525.	$5.E-4$	$1.E-4$
575.	$2.6E-4$	$8.E-5$
625.	$2.2E-4$	$7.E-5$
675.	$8.E-5$	$4.E-5$
725.	$2.E-5$	$2.E-5$
775.	$4.E-5$	$3.E-5$

$p + Li \rightarrow p + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.5E-2$	$2.E-3$
75.	$1.09E-1$	$2.E-3$
125.	$5.7E-2$	$1.E-3$
175.	$2.83E-2$	$9.E-4$
225.	$1.45E-2$	$6.E-4$
275.	$8.0E-3$	$4.E-4$
325.	$4.1E-3$	$3.E-4$
375.	$2.4E-3$	$2.E-4$
425.	$1.6E-3$	$2.E-4$
475.	$7.E-4$	$1.E-4$
525.	$7.E-4$	$1.E-4$
575.	$4.2E-4$	$8.E-5$
625.	$2.4E-4$	$6.E-5$
675.	$3.0E-4$	$6.E-5$
725.	$3.0E-4$	$6.E-5$
775.	$2.1E-4$	$5.E-5$

$p + Al \to \pi^+ + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ ($mb{\cdot}c^3/GeV^2/sr$)	error
25.	$2.6E-1$	$2.E-2$
75.	$2.2E-1$	$1.E-2$
125.	$7.3E-2$	$5.E-3$
175.	$2.7E-2$	$3.E-3$
225.	$1.E-2$	$1.E-3$
275.	$4.2E-3$	$9.E-4$
325.	$2.9E-3$	$7.E-4$
375.	$1.0E-3$	$4.E-4$
425.	$1.0E-3$	$3.E-4$
525.	$4.E-4$	$2.E-4$
775.	$1.3E-4$	$9.E-5$

$p + Al \to \pi^+ + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb{\cdot}c^3/GeV^2/sr$)	error
25.	$3.3E-1$	$2.E-2$
75.	$2.2E-1$	$1.E-2$
125.	$7.4E-2$	$5.E-3$
175.	$2.4E-2$	$3.E-3$
225.	$1.3E-2$	$2.E-3$
275.	$6.E-3$	$1.E-3$
325.	$2.5E-3$	$7.E-4$
375.	$9.E-4$	$4.E-4$
425.	$9.E-4$	$3.E-4$
475.	$6.E-4$	$3.E-4$
525.	$2.E-4$	$1.E-4$
625.	$2.E-4$	$1.E-4$

$p + Al \to \pi^- + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ ($mb{\cdot}c^3/GeV^2/sr$)	error
25.	$3.1E-1$	$2.E-2$
75.	$1.57E-1$	$9.E-3$
125.	$4.2E-2$	$4.E-3$
175.	$1.7E-2$	$2.E-3$
225.	$6.E-3$	$1.E-3$
275.	$2.4E-3$	$7.E-4$
325.	$1.2E-3$	$5.E-4$
375.	$2.E-4$	$2.E-4$

$p + Al \to \pi^- + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb{\cdot}c^3/GeV^2/sr$)	error
25.	$3.2E-1$	$2.E-2$
75.	$1.74E-1$	$9.E-3$
125.	$5.7E-2$	$4.E-3$
175.	$1.6E-2$	$2.E-3$
225.	$8.E-3$	$1.E-3$
275.	$4.2E-3$	$9.E-4$
325.	$1.7E-3$	$6.E-4$
375.	$1.2E-3$	$4.E-4$
425.	$2.E-4$	$2.E-4$
525.	$3.E-4$	$2.E-4$
575.	$2.E-4$	$2.E-4$

$p + Al \to p + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ ($mb{\cdot}c^3/GeV^2/sr$)	error
25.	$2.45E-1$	$9.E-3$
75.	$2.90E-1$	$8.E-3$
125.	$8.9E-2$	$4.E-3$
175.	$2.9E-2$	$2.E-3$
225.	$8.4E-3$	$1.E-3$
275.	$3.0E-3$	$5.E-4$
325.	$1.2E-3$	$3.E-4$
375.	$4.E-4$	$2.E-4$
475.	$1.1E-4$	$7.E-5$
625.	$1.4E-4$	$9.E-5$
725.	$8.E-5$	$6.E-5$

$p + Al \to p + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb{\cdot}c^3/GeV^2/sr$)	error
25.	$2.33E-1$	$9.E-3$
75.	$3.84E-1$	$9.E-3$
125.	$1.25E-1$	$4.E-3$
175.	$4.3E-2$	$2.E-3$
225.	$1.6E-2$	$1.E-3$
275.	$4.7E-3$	$7.E-4$
325.	$2.3E-3$	$5.E-4$
375.	$5.E-4$	$2.E-4$
425.	$4.E-4$	$2.E-4$
675.	$9.E-5$	$8.E-5$
725.	$1.7E-4$	$1.E-4$

$p + Al \to \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.7E-1$	$2.E-2$
75.	$2.3E-1$	$1.E-2$
125.	$1.03E-1$	$6.E-3$
175.	$3.6E-2$	$3.E-3$
225.	$1.9E-2$	$2.E-3$
275.	$8.E-3$	$1.E-3$
325.	$6.E-3$	$1.E-3$
375.	$4.7E-3$	$8.E-4$
425.	$9.E-4$	$4.E-4$
475.	$1.1E-3$	$3.E-4$
525.	$4.E-4$	$2.E-4$
575.	$4.E-4$	$2.E-4$
725.	$1.3E-4$	$9.E-5$

$p + Al \to \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.4E-1$	$1.E-2$
75.	$2.5E-1$	$1.E-2$
125.	$1.12E-1$	$6.E-3$
175.	$5.0E-2$	$4.E-3$
225.	$2.2E-2$	$2.E-3$
275.	$1.2E-2$	$1.E-3$
325.	$9.E-3$	$1.E-3$
375.	$3.5E-3$	$8.E-4$
425.	$4.3E-3$	$8.E-4$
475.	$1.3E-3$	$4.E-4$
525.	$9.E-4$	$4.E-4$
575.	$2.E-4$	$2.E-4$
625.	$2.E-4$	$1.E-4$
675.	$4.E-4$	$2.E-4$

$p + Al \to \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.2E-1$	$2.E-2$
75.	$1.90E-1$	$1.E-2$
125.	$7.5E-2$	$5.E-3$
175.	$2.3E-2$	$3.E-3$
225.	$1.1E-2$	$2.E-3$
275.	$9.E-3$	$1.E-3$
325.	$2.6E-3$	$7.E-4$
375.	$1.2E-3$	$4.E-4$
425.	$7.E-4$	$3.E-4$
475.	$6.E-4$	$3.E-4$
575.	$5.E-4$	$2.E-4$
625.	$2.E-4$	$1.E-4$

$p + Al \to \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.6E-1$	$2.E-2$
75.	$2.2E-1$	$1.E-2$
125.	$8.3E-2$	$5.E-3$
175.	$3.4E-2$	$3.E-3$
225.	$1.7E-2$	$2.E-3$
275.	$7.E-3$	$1.E-3$
325.	$3.9E-3$	$8.E-4$
375.	$3.1E-3$	$6.E-4$
425.	$1.4E-3$	$5.E-4$
475.	$1.E-3$	$4.E-4$
525.	$3.E-4$	$2.E-4$
575.	$2.E-4$	$1.E-4$
625.	$2.E-4$	$1.E-4$

$p + Al \to p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.74E-1$	$7.E-3$
75.	$4.37E-1$	$9.E-3$
125.	$1.58E-1$	$5.E-3$
175.	$5.9E-2$	$3.E-3$
225.	$2.3E-2$	$2.E-3$
275.	$8.5E-3$	$9.E-4$
325.	$3.2E-3$	$6.E-4$
375.	$1.7E-3$	$4.E-4$
425.	$8.E-4$	$2.E-4$
475.	$3.E-4$	$1.E-4$
525.	$2.E-4$	$1.E-4$
575.	$1.5E-4$	$9.E-5$
725.	$1.E-4$	$1.E-4$

$p + Al \to p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.5E-2$	$5.E-3$
75.	$3.73E-1$	$9.E-3$
125.	$1.95E-1$	$6.E-3$
175.	$7.0E-2$	$3.E-3$
225.	$2.9E-2$	$2.E-3$
275.	$1.6E-2$	$1.E-3$
325.	$6.3E-3$	$8.E-4$
375.	$3.8E-3$	$5.E-4$
425.	$1.8E-3$	$4.E-4$
475.	$1.4E-3$	$3.E-4$
525.	$7.E-4$	$2.E-4$
575.	$5.E-4$	$2.E-4$
625.	$3.E-4$	$2.E-4$
675.	$1.4E-4$	$9.E-5$
725.	$3.E-4$	$1.E-4$
775.	$8.E-5$	$5.E-5$

$p + Al \to \pi^+ + X$
$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.6E-1$	$2.E-2$
75.	$2.6E-1$	$1.E-2$
125.	$1.32E-1$	$7.E-3$
175.	$5.7E-2$	$4.E-3$
225.	$3.6E-2$	$3.E-3$
275.	$2.4E-2$	$2.E-3$
325.	$1.5E-2$	$2.E-3$
375.	$9.E-3$	$1.E-3$
425.	$6.1E-3$	$9.E-4$
475.	$2.8E-3$	$6.E-4$
525.	$2.5E-3$	$6.E-4$
575.	$1.2E-3$	$4.E-4$
625.	$5.E-4$	$3.E-4$
675.	$4.E-4$	$2.E-4$
725.	$3.E-4$	$2.E-4$

$p + Al \to \pi^- + X$
$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.6E-1$	$2.E-2$
75.	$2.4E-1$	$1.E-2$
125.	$1.03E-1$	$6.E-3$
175.	$5.5E-2$	$4.E-3$
225.	$2.5E-2$	$2.E-3$
275.	$1.8E-2$	$2.E-3$
325.	$6.E-3$	$1.E-3$
375.	$4.4E-3$	$8.E-4$
425.	$2.3E-3$	$6.E-4$
475.	$1.1E-3$	$4.E-4$
525.	$9.E-4$	$3.E-4$
575.	$4.E-4$	$2.E-4$
625.	$4.E-4$	$2.E-4$
725.	$1.E-4$	$1.E-4$

$p + Al \to p + X$
$(0.0 < \cos\theta < 0.2)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.9E-2$	$5.E-3$
75.	$5.2E-1$	$1.E-2$
125.	$2.96E-1$	$7.E-3$
175.	$1.28E-1$	$4.E-3$
225.	$5.7E-2$	$3.E-3$
275.	$2.8E-2$	$2.E-3$
325.	$1.6E-2$	$1.E-3$
375.	$8.4E-3$	$8.E-4$
425.	$4.2E-3$	$6.E-4$
475.	$2.2E-3$	$4.E-4$
525.	$1.3E-3$	$3.E-4$
575.	$8.E-4$	$2.E-4$
625.	$8.E-4$	$2.E-4$
675.	$1.1E-3$	$3.E-4$
725.	$5.E-4$	$2.E-4$
775.	$2.E-4$	$1.E-4$

$p + Al \to \pi^+ + X$
$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.7E-1$	$2.E-2$
75.	$3.3E-1$	$1.E-2$
125.	$1.76E-1$	$8.E-3$
175.	$8.7E-2$	$5.E-3$
225.	$4.5E-2$	$3.E-3$
275.	$2.8E-2$	$2.E-3$
325.	$2.1E-2$	$2.E-3$
375.	$1.7E-2$	$2.E-3$
425.	$1.1E-2$	$1.E-3$
475.	$6.8E-3$	$9.E-4$
525.	$5.5E-3$	$8.E-4$
575.	$3.4E-3$	$6.E-4$
625.	$1.9E-3$	$5.E-4$
675.	$2.1E-3$	$4.E-4$
725.	$9.E-4$	$3.E-4$
775.	$4.E-4$	$2.E-4$

$p + Al \to \pi^- + X$
$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$3.8E-1$	$2.E-2$
75.	$2.6E-1$	$1.E-2$
125.	$1.34E-1$	$7.E-3$
175.	$6.8E-2$	$4.E-3$
225.	$3.3E-2$	$3.E-3$
275.	$2.2E-2$	$2.E-3$
325.	$1.5E-2$	$2.E-3$
375.	$8.E-3$	$1.E-3$
425.	$6.7E-3$	$1.E-3$
475.	$3.5E-3$	$7.E-4$
525.	$1.8E-3$	$5.E-4$
575.	$7.E-4$	$3.E-4$
625.	$7.E-4$	$3.E-4$
675.	$1.0E-3$	$3.E-4$
725.	$5.E-4$	$2.E-4$
775.	$1.E-4$	$1.E-4$

$p + Al \to p + X$
$(0.2 < \cos\theta < 0.4)$

Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.74E-1$	$9.E-3$
75.	$8.4E-1$	$1.E-2$
125.	$4.01E-1$	$8.E-3$
175.	$2.02E-1$	$5.E-3$
225.	$1.01E-1$	$3.E-3$
275.	$5.6E-2$	$2.E-3$
325.	$3.1E-2$	$2.E-3$
375.	$1.6E-2$	$1.E-3$
425.	$1.03E-2$	$9.E-4$
475.	$6.2E-3$	$7.E-4$
525.	$3.0E-3$	$5.E-4$
575.	$2.1E-3$	$4.E-4$
625.	$2.0E-3$	$3.E-4$
675.	$1.3E-3$	$3.E-4$
725.	$1.4E-3$	$3.E-4$
775.	$9.E-4$	$2.E-4$

$p + Cu \to \pi^+ + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$5.1E-1$	$3.E-2$
75.	$4.3E-1$	$2.E-2$
125.	$1.2E-1$	$1.E-2$
175.	$4.5E-2$	$6.E-3$
225.	$1.4E-2$	$3.E-3$
275.	$7.E-3$	$2.E-3$
325.	$4.E-3$	$1.E-3$
375.	$9.E-4$	$6.E-4$
425.	$2.1E-3$	$8.E-4$
475.	$2.0E-3$	$8.E-4$
525.	$7.E-4$	$4.E-4$
575.	$6.E-4$	$4.E-4$

$p + Cu \to \pi^+ + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$6.0E-1$	$4.E-2$
75.	$4.2E-1$	$2.E-2$
125.	$1.3E-1$	$1.E-2$
175.	$5.4E-2$	$6.E-3$
225.	$2.5E-2$	$4.E-3$
275.	$8.E-3$	$2.E-3$
325.	$5.E-3$	$1.E-3$
375.	$5.E-3$	$1.E-3$
525.	$7.E-4$	$4.E-4$

$p + Cu \to \pi^- + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.1E-1$	$4.E-2$
75.	$3.2E-1$	$2.E-2$
125.	$7.0E-2$	$8.E-3$
175.	$2.2E-2$	$4.E-3$
225.	$1.0E-2$	$2.E-3$
275.	$3.E-3$	$1.E-3$
325.	$4.E-3$	$1.E-3$
475.	$1.E-3$	$6.E-4$
625.	$4.E-4$	$3.E-4$

$p + Cu \to \pi^- + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.9E-1$	$4.E-2$
75.	$3.4E-1$	$2.E-2$
125.	$1.14E-1$	$1.E-2$
175.	$3.5E-2$	$5.E-3$
225.	$1.6E-2$	$3.E-3$
275.	$9.E-3$	$2.E-3$
325.	$4.E-3$	$1.E-3$
375.	$4.E-3$	$1.E-3$
475.	$1.E-3$	$6.E-4$
525.	$4.E-4$	$3.E-4$

$p + Cu \to p + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$8.7E-1$	$3.E-2$
75.	$9.1E-1$	$2.E-2$
125.	$2.56E-1$	$1.E-2$
175.	$7.7E-2$	$5.E-3$
225.	$2.8E-2$	$3.E-3$
275.	$1.0E-2$	$2.E-3$
325.	$2.9E-3$	$8.E-4$
375.	$1.4E-3$	$5.E-4$
425.	$4.E-4$	$3.E-4$
675.	$4.E-4$	$2.E-4$

$p + Cu \to p + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$9.2E-1$	$3.E-2$
75.	$1.1E+0$	$2.E-2$
125.	$3.1E-1$	$1.E-2$
175.	$1.02E-1$	$6.E-3$
225.	$3.7E-2$	$3.E-3$
275.	$1.4E-2$	$2.E-3$
325.	$5.E-3$	$1.E-3$
375.	$1.7E-3$	$6.E-4$
425.	$1.2E-3$	$5.E-4$
475.	$4.E-4$	$3.E-4$
525.	$2.E-4$	$2.E-4$
575.	$5.E-4$	$3.E-4$
625.	$2.E-4$	$2.E-4$
725.	$2.E-4$	$1.E-4$
775.	$2.E-4$	$2.E-4$

$p + Cu \rightarrow \pi^+ + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$6.1E-1$	$4.E-2$
75.	$4.2E-1$	$2.E-2$
125.	$1.7E-1$	$1.E-2$
175.	$6.5E-2$	$7.E-3$
225.	$2.4E-2$	$4.E-3$
275.	$1.5E-2$	$3.E-3$
325.	$7.E-3$	$2.E-3$
375.	$6.E-3$	$2.E-3$
425.	$4.E-3$	$1.E-3$
475.	$2.5E-3$	$9.E-4$
525.	$1.6E-3$	$7.E-4$
575.	$5.E-4$	$4.E-4$
625.	$6.E-4$	$4.E-4$
675.	$5.E-4$	$4.E-4$
725.	$4.E-4$	$3.E-4$

$p + Cu \rightarrow \pi^- + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.4E-1$	$4.E-2$
75.	$3.9E-1$	$2.E-2$
125.	$1.2E-1$	$1.E-2$
175.	$4.2E-2$	$5.E-3$
225.	$2.2E-2$	$4.E-3$
275.	$1.1E-2$	$2.E-3$
325.	$3.E-3$	$1.E-3$
375.	$2.4E-3$	$1.E-3$
425.	$1.8E-3$	$7.E-4$
475.	$1.4E-3$	$7.E-4$

$p + Cu \rightarrow p + X$ ($-0.4 < \cos\theta < -0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$7.4E-1$	$2.E-2$
75.	$1.3E+0$	$3.E-2$
125.	$4.2E-1$	$1.E-2$
175.	$1.37E-1$	$7.E-3$
225.	$5.7E-2$	$4.E-3$
275.	$2.0E-2$	$2.E-3$
325.	$1.0E-2$	$2.E-3$
375.	$5.E-3$	$1.E-3$
425.	$1.3E-3$	$5.E-4$
475.	$9.E-4$	$4.E-4$
675.	$2.E-4$	$2.E-4$
725.	$5.E-4$	$3.E-4$

$p + Cu \rightarrow \pi^+ + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.1E-1$	$3.E-2$
75.	$3.6E-1$	$2.E-2$
125.	$1.8E-1$	$1.E-2$
175.	$7.7E-2$	$7.E-3$
225.	$4.4E-2$	$5.E-3$
275.	$2.3E-2$	$4.E-3$
325.	$1.1E-2$	$2.E-3$
375.	$1.0E-2$	$2.E-3$
425.	$6.E-3$	$1.E-3$
475.	$3.E-3$	$1.E-3$
525.	$5.E-4$	$4.E-4$
575.	$1.7E-3$	$7.E-4$
625.	$4.E-4$	$4.E-4$
725.	$5.E-4$	$3.E-4$
775.	$3.E-4$	$2.E-4$

$p + Cu \rightarrow \pi^- + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$4.8E-1$	$3.E-2$
75.	$3.7E-1$	$2.E-2$
125.	$1.4E-1$	$1.E-2$
175.	$5.7E-2$	$6.E-3$
225.	$2.8E-2$	$4.E-3$
275.	$2.2E-2$	$3.E-3$
325.	$1.3E-2$	$2.E-3$
375.	$2.2E-3$	$1.E-3$
425.	$2.5E-3$	$1.E-3$
475.	$1.5E-3$	$7.E-4$
525.	$8.E-4$	$4.E-4$
575.	$5.E-4$	$4.E-4$
625.	$4.E-4$	$3.E-4$

$p + Cu \rightarrow p + X$ ($-0.2 < \cos\theta < 0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.1E-1$	$1.E-2$
75.	$8.4E-1$	$2.E-2$
125.	$4.4E-1$	$1.E-2$
175.	$1.70E-1$	$8.E-3$
225.	$6.7E-2$	$4.E-3$
275.	$3.8E-2$	$3.E-3$
325.	$1.5E-2$	$2.E-3$
375.	$5.E-3$	$1.E-3$
425.	$3.8E-3$	$9.E-4$
475.	$2.5E-3$	$7.E-4$
525.	$2.4E-3$	$6.E-4$
575.	$1.1E-3$	$4.E-4$
675.	$3.E-4$	$2.E-4$

$p + Cu \rightarrow \pi^+ + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$4.7E-1$	$3.E-2$
75.	$4.5E-1$	$2.E-2$
125.	$2.2E-1$	$1.E-2$
175.	$9.3E-2$	$8.E-3$
225.	$7.2E-2$	$7.E-3$
275.	$3.0E-2$	$4.E-3$
325.	$2.0E-2$	$3.E-3$
375.	$1.4E-2$	$2.E-3$
425.	$1.1E-2$	$2.E-3$
475.	$5.E-3$	$1.E-3$
525.	$4.E-3$	$1.E-3$
575.	$9.E-4$	$6.E-4$
625.	$1.2E-3$	$6.E-4$
675.	$1.4E-3$	$6.E-4$
725.	$9.E-4$	$5.E-4$

$p + Cu \rightarrow \pi^- + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$5.6E-1$	$3.E-2$
75.	$4.3E-1$	$2.E-2$
125.	$1.7E-1$	$1.E-2$
175.	$9.0E-2$	$8.E-3$
225.	$4.6E-2$	$5.E-3$
275.	$2.6E-2$	$4.E-3$
325.	$1.7E-2$	$3.E-3$
375.	$8.E-3$	$2.E-3$
425.	$5.E-3$	$1.E-3$
475.	$2.3E-3$	$9.E-4$
525.	$2.6E-3$	$9.E-4$
625.	$1.4E-3$	$6.E-4$
725.	$5.E-4$	$3.E-4$

$p + Cu \rightarrow p + X$ (0.0 < cos θ < 0.2)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$2.8E-1$	$2.E-2$
75.	$1.2E+0$	$2.E-2$
125.	$7.1E-1$	$2.E-2$
175.	$3.0E-1$	$1.E-2$
225.	$1.37E-1$	$6.E-3$
275.	$6.1E-2$	$4.E-3$
325.	$3.2E-2$	$3.E-3$
375.	$2.0E-2$	$2.E-3$
425.	$9.E-3$	$1.E-3$
475.	$4.5E-3$	$9.E-4$
525.	$3.6E-3$	$8.E-4$
575.	$1.6E-3$	$5.E-4$
625.	$1.6E-3$	$5.E-4$
675.	$5.E-4$	$3.E-4$
725.	$8.E-4$	$3.E-4$
775.	$1.1E-3$	$4.E-4$

$p + Cu \rightarrow \pi^+ + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$8.6E-1$	$4.E-2$
75.	$5.8E-1$	$3.E-2$
125.	$3.0E-1$	$2.E-2$
175.	$1.5E-1$	$1.E-2$
225.	$9.1E-2$	$7.E-3$
275.	$6.4E-2$	$6.E-3$
325.	$3.5E-2$	$4.E-3$
375.	$2.6E-2$	$3.E-3$
425.	$2.5E-2$	$3.E-3$
475.	$1.E-2$	$2.E-3$
525.	$1.E-2$	$2.E-3$
575.	$5.E-3$	$1.E-3$
625.	$5.E-3$	$1.E-3$
675.	$3.6E-3$	$9.E-4$
725.	$1.8E-3$	$7.E-4$
775.	$1.6E-3$	$5.E-4$

$p + Cu \rightarrow \pi^- + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$9.9E-1$	$5.E-2$
75.	$5.2E-1$	$3.E-2$
125.	$2.4E-1$	$1.E-2$
175.	$1.07E-1$	$9.E-3$
225.	$7.0E-2$	$7.E-3$
275.	$3.4E-2$	$4.E-3$
325.	$2.7E-2$	$3.E-3$
375.	$1.7E-2$	$3.E-3$
425.	$1.1E-2$	$2.E-3$
475.	$6.E-3$	$1.E-3$
525.	$4.E-3$	$1.E-3$
575.	$1.5E-3$	$7.E-4$
625.	$1.9E-3$	$7.E-4$
675.	$1.1E-3$	$5.E-4$
775.	$5.E-4$	$3.E-4$

$p + Cu \rightarrow p + X$ (0.2 < cos θ < 0.4)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.0E+0$	$3.E-2$
75.	$2.2E+0$	$3.E-2$
125.	$9.6E-1$	$2.E-2$
175.	$4.6E-1$	$1.E-2$
225.	$2.31E-1$	$8.E-3$
275.	$1.15E-1$	$5.E-3$
325.	$6.6E-2$	$4.E-3$
375.	$4.1E-2$	$3.E-3$
425.	$2.4E-2$	$2.E-3$
475.	$1.5E-2$	$2.E-3$
525.	$6.E-3$	$1.E-3$
575.	$6.E-3$	$1.E-3$
625.	$3.6E-3$	$8.E-4$
675.	$3.9E-3$	$8.E-4$
725.	$3.5E-3$	$7.E-4$
775.	$2.8E-3$	$6.E-4$

$p + Sn \to \pi^+ + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.9E-1$	$5.E-2$
75.	$5.3E-1$	$3.E-2$
125.	$1.9E-1$	$1.E-2$
175.	$6.1E-2$	$8.E-3$
225.	$1.6E-2$	$4.E-3$
275.	$1.1E-2$	$3.E-3$
325.	$7.E-3$	$2.E-3$
375.	$4.E-3$	$1.E-3$
425.	$2.E-3$	$1.E-3$
475.	$1.3E-3$	$8.E-4$
525.	$7.E-4$	$6.E-4$
675.	$4.E-4$	$3.E-4$

$p + Sn \to \pi^+ + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$8.8E-1$	$5.E-2$
75.	$5.3E-1$	$3.E-2$
125.	$1.8E-1$	$1.E-2$
175.	$6.3E-2$	$8.E-3$
225.	$2.5E-2$	$4.E-3$
275.	$1.4E-2$	$3.E-3$
325.	$1.E-2$	$2.E-3$
375.	$2.E-3$	$1.E-3$
425.	$3.E-3$	$1.E-3$
475.	$2.2E-3$	$1.E-3$
525.	$1.0E-3$	$7.E-4$
575.	$1.E-3$	$7.E-4$
625.	$6.E-4$	$5.E-4$
725.	$7.E-4$	$4.E-4$

$p + Sn \to \pi^- + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.1E+0$	$6.E-2$
75.	$4.4E-1$	$3.E-2$
125.	$1.1E-1$	$1.E-2$
175.	$3.4E-2$	$6.E-3$
225.	$1.4E-2$	$3.E-3$
275.	$7.E-3$	$2.E-3$
325.	$5.E-3$	$2.E-3$
375.	$4.E-3$	$1.E-3$
475.	$9.E-4$	$6.E-4$

$p + Sn \to \pi^- + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.1E+0$	$6.E-2$
75.	$4.7E-1$	$3.E-2$
125.	$1.3E-1$	$1.E-2$
175.	$5.0E-2$	$7.E-3$
225.	$2.1E-2$	$4.E-3$
275.	$1.5E-2$	$3.E-3$
325.	$4.E-3$	$1.E-3$
375.	$1.6E-3$	$9.E-4$
425.	$3.E-3$	$1.E-3$
475.	$6.E-4$	$4.E-4$
525.	$5.E-4$	$4.E-4$
725.	$4.E-4$	$3.E-4$
775.	$4.E-4$	$3.E-4$

$p + Sn \to p + X$ ($-0.8 < \cos\theta < -0.6$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.5E+0$	$4.E-2$
75.	$1.8E+0$	$3.E-2$
125.	$4.9E-1$	$2.E-2$
175.	$1.28E-1$	$7.E-3$
225.	$4.6E-2$	$4.E-3$
275.	$1.2E-2$	$2.E-3$
325.	$3.E-3$	$1.E-3$
375.	$2.2E-3$	$8.E-4$
425.	$1.0E-3$	$5.E-4$
475.	$3.E-4$	$3.E-4$
525.	$3.E-4$	$2.E-4$
625.	$4.E-4$	$3.E-4$

$p + Sn \to p + X$ ($-0.6 < \cos\theta < -0.4$)		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.3E+0$	$4.E-2$
75.	$2.2E+0$	$4.E-2$
125.	$6.2E-1$	$2.E-2$
175.	$1.88E-1$	$9.E-3$
225.	$6.8E-2$	$5.E-3$
275.	$2.3E-2$	$3.E-3$
325.	$1.E-2$	$2.E-3$
375.	$5.E-3$	$1.E-3$
425.	$2.2E-3$	$8.E-4$
725.	$2.E-4$	$2.E-4$

$p + Sn \rightarrow \pi^+ + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$8.4E-1$	$5.E-2$
75.	$5.6E-1$	$3.E-2$
125.	$2.3E-1$	$2.E-2$
175.	$7.6E-2$	$8.E-3$
225.	$3.2E-2$	$5.E-3$
275.	$2.7E-2$	$4.E-3$
325.	$1.4E-2$	$3.E-3$
375.	$6.E-3$	$2.E-3$
425.	$6.E-3$	$2.E-3$
475.	$4.E-3$	$1.E-3$
525.	$4.E-3$	$1.E-3$
625.	$7.E-4$	$5.E-4$

$p + Sn \rightarrow \pi^+ + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$3.5E-1$	$3.E-2$
75.	$5.1E-1$	$3.E-2$
125.	$2.4E-1$	$2.E-2$
175.	$8.1E-2$	$9.E-3$
225.	$4.4E-2$	$6.E-3$
275.	$3.2E-2$	$5.E-3$
325.	$2.4E-2$	$4.E-3$
375.	$7.E-3$	$2.E-3$
425.	$9.E-3$	$2.E-3$
475.	$7.E-3$	$2.E-3$
525.	$2.1E-3$	$8.E-4$
575.	$1.4E-3$	$8.E-4$
625.	$1.8E-3$	$8.E-4$
725.	$4.E-4$	$3.E-4$

$p + Sn \rightarrow \pi^- + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$1.2E+0$	$6.E-2$
75.	$5.8E-1$	$3.E-2$
125.	$1.5E-1$	$1.E-2$
175.	$6.0E-2$	$8.E-3$
225.	$3.2E-2$	$5.E-3$
275.	$1.8E-2$	$3.E-3$
325.	$9.E-3$	$2.E-3$
375.	$4.E-3$	$2.E-3$
425.	$2.E-3$	$1.E-3$
475.	$1.1E-3$	$6.E-4$
525.	$1.4E-3$	$7.E-4$

$p + Sn \rightarrow \pi^- + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$6.1E-1$	$4.E-2$
75.	$4.5E-1$	$3.E-2$
125.	$2.1E-1$	$2.E-2$
175.	$7.6E-2$	$8.E-3$
225.	$3.8E-2$	$5.E-3$
275.	$2.3E-2$	$4.E-3$
325.	$1.0E-2$	$2.E-3$
375.	$9.E-3$	$2.E-3$
425.	$8.E-4$	$7.E-4$
475.	$3.E-3$	$1.E-3$
525.	$9.E-4$	$6.E-4$
725.	$9.E-4$	$5.E-4$

$p + Sn \rightarrow p + X$		
$(-0.4 < \cos\theta < -0.2)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$8.8E-1$	$3.E-2$
75.	$2.3E+0$	$4.E-2$
125.	$7.5E-1$	$2.E-2$
175.	$2.6E-1$	$1.E-2$
225.	$9.8E-2$	$6.E-3$
275.	$3.9E-2$	$4.E-3$
325.	$2.3E-2$	$3.E-3$
375.	$7.E-3$	$1.E-3$
425.	$2.6E-3$	$8.E-4$
475.	$1.4E-3$	$6.E-4$
525.	$1.5E-3$	$5.E-4$
675.	$3.E-4$	$2.E-4$
725.	$5.E-4$	$3.E-4$

$p + Sn \rightarrow p + X$		
$(-0.2 < \cos\theta < 0.0)$		
Ek	Inv. $d\sigma$	error
(MeV)	(mb$\cdot c^3/GeV^2$/sr)	
25.	$2.4E-1$	$2.E-2$
75.	$1.3E+0$	$3.E-2$
125.	$8.5E-1$	$2.E-2$
175.	$3.1E-1$	$1.E-2$
225.	$1.35E-1$	$7.E-3$
275.	$5.9E-2$	$5.E-3$
325.	$2.8E-2$	$3.E-3$
375.	$1.6E-2$	$2.E-3$
425.	$5.E-3$	$1.E-3$
475.	$3.4E-3$	$1.E-3$
525.	$1.1E-3$	$5.E-4$
575.	$1.9E-3$	$7.E-4$
625.	$1.2E-3$	$5.E-4$
675.	$9.E-4$	$4.E-4$
775.	$5.E-4$	$3.E-4$

$p + Sn \to \pi^+ + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb\cdot c^3/GeV^2/sr$)	error
25.	$5.0E-1$	$4.E-2$
75.	$6.0E-1$	$3.E-2$
125.	$2.9E-1$	$2.E-2$
175.	$1.5E-1$	$1.E-2$
225.	$7.0E-2$	$7.E-3$
275.	$4.5E-2$	$5.E-3$
325.	$2.8E-2$	$4.E-3$
375.	$2.4E-2$	$4.E-3$
425.	$1.3E-2$	$2.E-3$
475.	$5.E-3$	$1.E-3$
525.	$5.E-3$	$1.E-3$
575.	$3.E-3$	$1.E-3$
625.	$2.5E-3$	$1.E-3$
675.	$1.E-3$	$6.E-4$

$p + Sn \to \pi^- + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb\cdot c^3/GeV^2/sr$)	error
25.	$6.1E-1$	$4.E-2$
75.	$6.8E-1$	$3.E-2$
125.	$2.5E-1$	$2.E-2$
175.	$1.3E-1$	$1.E-2$
225.	$6.6E-2$	$7.E-3$
275.	$3.4E-2$	$5.E-3$
325.	$1.5E-2$	$3.E-3$
375.	$1.3E-2$	$3.E-3$
425.	$1.0E-2$	$2.E-3$
475.	$4.E-3$	$1.E-3$
525.	$2.E-3$	$1.E-3$
575.	$1.3E-3$	$7.E-4$
625.	$1.2E-3$	$6.E-4$

$p + Sn \to p + X$ ($0.0 < \cos\theta < 0.2$)		
Ek (MeV)	Inv. $d\sigma$ ($mb\cdot c^3/GeV^2/sr$)	error
25.	$2.9E-1$	$2.E-2$
75.	$1.8E+0$	$3.E-2$
125.	$1.2E+0$	$2.E-2$
175.	$5.2E-1$	$2.E-2$
225.	$2.24E-1$	$9.E-3$
275.	$1.11E-1$	$6.E-3$
325.	$6.1E-2$	$4.E-3$
375.	$2.8E-2$	$3.E-3$
425.	$1.5E-2$	$2.E-3$
475.	$1.1E-2$	$2.E-3$
525.	$8.E-3$	$1.E-3$
575.	$2.6E-3$	$8.E-4$
625.	$2.2E-3$	$7.E-4$
675.	$2.6E-3$	$7.E-4$
725.	$1.1E-3$	$5.E-4$
775.	$1.8E-3$	$6.E-4$

$p + Sn \to \pi^+ + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb\cdot c^3/GeV^2/sr$)	error
25.	$9.9E-1$	$5.E-2$
75.	$7.7E-1$	$4.E-2$
125.	$4.0E-1$	$2.E-2$
175.	$2.0E-1$	$1.E-2$
225.	$1.04E-1$	$9.E-3$
275.	$6.6E-2$	$7.E-3$
325.	$5.4E-2$	$6.E-3$
375.	$4.5E-2$	$5.E-3$
425.	$3.0E-2$	$4.E-3$
475.	$1.8E-2$	$3.E-3$
525.	$1.1E-2$	$2.E-3$
575.	$9.E-3$	$2.E-3$
625.	$6.E-3$	$2.E-3$
675.	$4.E-3$	$1.E-3$
725.	$3.E-3$	$1.E-3$
775.	$2.2E-3$	$8.E-4$

$p + Sn \to \pi^- + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb\cdot c^3/GeV^2/sr$)	error
25.	$1.4E+0$	$7.E-2$
75.	$8.0E-1$	$4.E-2$
125.	$3.1E-1$	$2.E-2$
175.	$1.6E-1$	$1.E-2$
225.	$8.3E-2$	$8.E-3$
275.	$5.0E-2$	$6.E-3$
325.	$3.5E-2$	$4.E-3$
375.	$1.7E-2$	$3.E-3$
425.	$1.3E-2$	$3.E-3$
475.	$1.0E-2$	$2.E-3$
525.	$4.E-3$	$1.E-3$
575.	$3.E-3$	$1.E-3$
625.	$2.2E-3$	$9.E-4$
675.	$1.9E-3$	$7.E-4$
725.	$1.6E-3$	$7.E-4$
775.	$6.E-4$	$4.E-4$

$p + Sn \to p + X$ ($0.2 < \cos\theta < 0.4$)		
Ek (MeV)	Inv. $d\sigma$ ($mb\cdot c^3/GeV^2/sr$)	error
25.	$1.3E+0$	$4.E-2$
75.	$4.0E+0$	$5.E-2$
125.	$1.6E+0$	$3.E-2$
175.	$7.2E-1$	$2.E-2$
225.	$3.8E-1$	$1.E-2$
275.	$1.81E-1$	$8.E-3$
325.	$1.03E-1$	$6.E-3$
375.	$5.0E-2$	$4.E-3$
425.	$3.5E-2$	$3.E-3$
475.	$1.7E-2$	$2.E-3$
525.	$1.2E-2$	$2.E-3$
575.	$1.E-2$	$1.E-3$
625.	$9.E-3$	$1.E-3$
675.	$5.E-3$	$1.E-3$
725.	$6.E-3$	$1.E-3$
775.	$5.4E-3$	$1.E-3$

$p + Pb \to \pi^+ + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2$/sr)	
25.	$1.0E+0$	$8.E-2$
75.	$6.9E-1$	$5.E-2$
125.	$2.0E-1$	$2.E-2$
175.	$8.E-2$	$1.E-2$
225.	$4.4E-2$	$8.E-3$
275.	$1.6E-2$	$5.E-3$
325.	$4.E-3$	$2.E-3$
375.	$5.E-3$	$2.E-3$
425.	$2.E-3$	$1.E-3$
525.	$1.E-3$	$1.E-3$

$p + Pb \to \pi^+ + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2$/sr)	
25.	$1.1E+0$	$8.E-2$
75.	$7.3E-1$	$5.E-2$
125.	$2.4E-1$	$2.E-2$
175.	$8.E-2$	$1.E-2$
225.	$1.6E-2$	$5.E-3$
275.	$1.4E-2$	$4.E-3$
325.	$8.E-3$	$3.E-3$
375.	$8.E-3$	$3.E-3$
425.	$3.E-3$	$2.E-3$
475.	$1.E-3$	$1.E-3$
525.	$1.1E-3$	$8.E-4$
675.	$1.5E-3$	$9.E-4$
725.	$1.4E-3$	$9.E-4$

$p + Pb \to \pi^- + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2$/sr)	
25.	$2.E+0$	$1.E-1$
75.	$5.8E-1$	$4.E-2$
125.	$1.3E-1$	$2.E-2$
175.	$6.E-2$	$1.E-2$
225.	$2.4E-2$	$6.E-3$
275.	$6.E-3$	$3.E-3$
325.	$8.E-3$	$3.E-3$
375.	$1.E-3$	$1.E-3$
425.	$2.E-3$	$1.E-3$
475.	$1.2E-3$	$9.E-4$

$p + Pb \to \pi^- + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2$/sr)	
25.	$2.E+0$	$1.E-1$
75.	$6.7E-1$	$5.E-2$
125.	$1.9E-1$	$2.E-2$
175.	$6.E-2$	$1.E-2$
225.	$2.4E-2$	$6.E-3$
275.	$1.8E-2$	$5.E-3$
325.	$1.2E-2$	$4.E-3$
375.	$4.E-3$	$2.E-3$
425.	$2.E-3$	$1.E-3$

$p + Pb \to p + X$		
$(-0.8 < \cos\theta < -0.6)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2$/sr)	
25.	$3.3E+0$	$9.E-2$
75.	$3.0E+0$	$6.E-2$
125.	$7.2E-1$	$3.E-2$
175.	$2.5E-1$	$1.E-2$
225.	$6.3E-2$	$7.E-3$
275.	$2.7E-2$	$4.E-3$
325.	$6.E-3$	$2.E-3$
375.	$3.E-3$	$1.E-3$
425.	$3.E-3$	$1.E-3$
675.	$9.E-4$	$6.E-4$

$p + Pb \to p + X$		
$(-0.6 < \cos\theta < -0.4)$		
Ek	Inv. $d\sigma$	error
(MeV)	($mb \cdot c^3/GeV^2$/sr)	
25.	$3.2E+0$	$8.E-2$
75.	$3.5E+0$	$7.E-2$
125.	$9.6E-1$	$3.E-2$
175.	$3.2E-1$	$2.E-2$
225.	$1.0E-1$	$9.E-3$
275.	$3.6E-2$	$5.E-3$
325.	$1.1E-2$	$3.E-3$
375.	$3.E-3$	$1.E-3$
425.	$3.E-3$	$1.E-3$
475.	$3.E-3$	$1.E-3$
725.	$6.E-4$	$6.E-4$

$p+Pb\rightarrow\pi^{+}+X$ ($-0.4<\cos\theta<-0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$1.1E+0$	$8.E-2$
75.	$7.7E-1$	$5.E-2$
125.	$3.2E-1$	$3.E-2$
175.	$9.E-2$	$1.E-2$
225.	$5.6E-2$	$9.E-3$
275.	$2.8E-2$	$6.E-3$
325.	$1.8E-2$	$4.E-3$
375.	$1.5E-2$	$4.E-3$
425.	$8.E-3$	$3.E-3$
475.	$3.E-3$	$2.E-3$
525.	$2.E-3$	$1.E-3$
575.	$2.E-3$	$1.E-3$
625.	$2.E-3$	$1.E-3$
775.	$8.E-4$	$6.E-4$

$p+Pb\rightarrow\pi^{-}+X$ ($-0.4<\cos\theta<-0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.E+0$	$1.E-1$
75.	$7.8E-1$	$5.E-2$
125.	$2.5E-1$	$2.E-2$
175.	$8.E-2$	$1.E-2$
225.	$3.8E-2$	$7.E-3$
275.	$2.7E-2$	$6.E-3$
325.	$1.1E-2$	$4.E-3$
375.	$7.E-3$	$3.E-3$
475.	$2.E-3$	$1.E-3$
575.	$1.E-3$	$1.E-3$
625.	$1.E-3$	$7.E-4$

$p+Pb\rightarrow p+X$ ($-0.4<\cos\theta<-0.2$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$2.4E+0$	$7.E-2$
75.	$4.0E+0$	$7.E-2$
125.	$1.1E+0$	$3.E-2$
175.	$3.8E-1$	$2.E-2$
225.	$1.4E-1$	$1.E-2$
275.	$6.7E-2$	$7.E-3$
325.	$2.4E-2$	$4.E-3$
375.	$1.0E-2$	$2.E-3$
425.	$9.E-3$	$2.E-3$
475.	$4.E-3$	$1.E-3$
525.	$2.E-3$	$1.E-3$
575.	$8.E-4$	$6.E-4$
625.	$6.E-4$	$4.E-4$
725.	$1.2E-3$	$7.E-4$
775.	$5.E-4$	$4.E-4$

$p+Pb\rightarrow\pi^{+}+X$ ($-0.2<\cos\theta<0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$5.5E-1$	$6.E-2$
75.	$6.6E-1$	$5.E-2$
125.	$3.0E-1$	$3.E-2$
175.	$1.3E-1$	$2.E-2$
225.	$5.2E-2$	$9.E-3$
275.	$5.4E-2$	$8.E-3$
325.	$2.5E-2$	$6.E-3$
375.	$2.0E-2$	$5.E-3$
425.	$1.2E-2$	$3.E-3$
475.	$8.E-3$	$3.E-3$
525.	$4.E-3$	$2.E-3$
575.	$2.E-3$	$1.E-3$
625.	$2.E-3$	$1.E-3$
675.	$2.E-3$	$1.E-3$

$p+Pb\rightarrow\pi^{-}+X$ ($-0.2<\cos\theta<0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$6.8E-1$	$6.E-2$
75.	$6.2E-1$	$4.E-2$
125.	$2.6E-1$	$2.E-2$
175.	$1.1E-1$	$1.E-2$
225.	$8.E-2$	$1.E-2$
275.	$2.3E-2$	$6.E-3$
325.	$2.1E-2$	$5.E-3$
375.	$1.E-2$	$3.E-3$
425.	$5.E-3$	$2.E-3$
475.	$2.E-3$	$1.E-3$
525.	$2.E-3$	$1.E-3$

$p+Pb\rightarrow p+X$ ($-0.2<\cos\theta<0.0$)		
Ek (MeV)	Inv. $d\sigma$ (mb$\cdot c^3/GeV^2$/sr)	error
25.	$6.7E-1$	$4.E-2$
75.	$2.5E+0$	$6.E-2$
125.	$1.3E+0$	$4.E-2$
175.	$4.8E-1$	$2.E-2$
225.	$1.9E-1$	$1.E-2$
275.	$7.4E-2$	$7.E-3$
325.	$3.9E-2$	$5.E-3$
375.	$2.4E-2$	$4.E-3$
425.	$1.1E-2$	$2.E-3$
475.	$5.E-3$	$2.E-3$
525.	$3.E-3$	$1.E-3$
575.	$8.E-4$	$7.E-4$
625.	$3.E-3$	$1.E-3$
675.	$1.7E-3$	$9.E-4$
775.	$5.E-4$	$4.E-4$

$p + Pb \rightarrow \pi^+ + X$ $(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.1E-1$	$6.E-2$
75.	$8.4E-1$	$5.E-2$
125.	$4.3E-1$	$3.E-2$
175.	$1.6E-1$	$2.E-2$
225.	$1.2E-1$	$1.E-2$
275.	$6.7E-2$	$9.E-3$
325.	$4.1E-2$	$7.E-3$
375.	$2.6E-2$	$5.E-3$
425.	$2.0E-2$	$4.E-3$
475.	$1.5E-2$	$4.E-3$
525.	$6.E-3$	$2.E-3$
575.	$2.E-3$	$1.E-3$
625.	$2.E-3$	$1.E-3$
725.	$2.E-3$	$1.E-3$
775.	$8.E-4$	$6.E-4$

$p + Pb \rightarrow \pi^- + X$ $(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.2E+0$	$8.E-2$
75.	$8.6E-1$	$5.E-2$
125.	$3.6E-1$	$3.E-2$
175.	$1.5E-1$	$2.E-2$
225.	$7.E-2$	$1.E-2$
275.	$5.0E-2$	$9.E-3$
325.	$3.6E-2$	$7.E-3$
375.	$1.2E-2$	$4.E-3$
425.	$8.E-3$	$3.E-3$
475.	$1.E-3$	$1.E-3$
525.	$4.E-3$	$2.E-3$
575.	$2.E-3$	$1.E-3$
725.	$8.E-4$	$6.E-4$

$p + Pb \rightarrow p + X$ $(0.0 < \cos\theta < 0.2)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$7.6E-1$	$4.E-2$
75.	$3.3E+0$	$7.E-2$
125.	$1.8E+0$	$4.E-2$
175.	$7.7E-1$	$3.E-2$
225.	$3.1E-1$	$2.E-2$
275.	$1.45E-1$	$1.E-2$
325.	$7.6E-2$	$7.E-3$
375.	$4.1E-2$	$5.E-3$
425.	$2.6E-2$	$4.E-3$
475.	$1.3E-2$	$2.E-3$
525.	$4.E-3$	$1.E-3$
575.	$8.E-3$	$2.E-3$
625.	$5.E-3$	$1.E-3$
675.	$4.E-3$	$1.E-3$
725.	$5.E-3$	$1.E-3$
775.	$4.E-3$	$1.E-3$

$p + Pb \rightarrow \pi^+ + X$ $(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$1.4E+0$	$9.E-2$
75.	$1.0E+0$	$6.E-2$
125.	$4.8E-1$	$3.E-2$
175.	$2.5E-1$	$2.E-2$
225.	$1.5E-1$	$1.E-2$
275.	$9.E-2$	$1.E-2$
325.	$6.4E-2$	$9.E-3$
375.	$5.1E-2$	$7.E-3$
425.	$3.7E-2$	$6.E-3$
475.	$2.9E-2$	$5.E-3$
525.	$2.2E-2$	$4.E-3$
575.	$9.E-3$	$3.E-3$
625.	$1.1E-2$	$3.E-3$
675.	$7.E-3$	$2.E-3$
725.	$4.E-3$	$2.E-3$
775.	$3.E-3$	$1.E-3$

$p + Pb \rightarrow \pi^- + X$ $(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.E+0$	$1.E-1$
75.	$1.1E+0$	$6.E-2$
125.	$4.8E-1$	$3.E-2$
175.	$2.2E-1$	$2.E-2$
225.	$1.1E-1$	$1.E-2$
275.	$6.4E-2$	$9.E-3$
325.	$3.8E-2$	$7.E-3$
375.	$1.9E-2$	$5.E-3$
425.	$2.1E-2$	$5.E-3$
475.	$1.0E-2$	$3.E-3$
525.	$6.E-3$	$2.E-3$
575.	$5.E-3$	$2.E-3$
625.	$2.E-3$	$1.E-3$
725.	$8.E-4$	$6.E-4$

$p + Pb \rightarrow p + X$ $(0.2 < \cos\theta < 0.4)$		
Ek (MeV)	Inv. $d\sigma$ (mb·c^3/GeV^2/sr)	error
25.	$3.1E+0$	$8.E-2$
75.	$6.4E+0$	$9.E-2$
125.	$2.5E+0$	$5.E-2$
175.	$1.1E+0$	$3.E-2$
225.	$5.4E-1$	$2.E-2$
275.	$2.7E-1$	$1.E-2$
325.	$1.35E-1$	$9.E-3$
375.	$8.0E-2$	$7.E-3$
425.	$4.8E-2$	$5.E-3$
475.	$2.7E-2$	$4.E-3$
525.	$1.6E-2$	$3.E-3$
575.	$9.E-3$	$2.E-3$
625.	$1.1E-2$	$2.E-3$
675.	$7.E-3$	$2.E-3$
725.	$7.E-3$	$2.E-3$
775.	$6.E-3$	$1.E-3$

Target	σ_{inel}^{Nucl}
^{6}Li	150 mb
Al	380 mb
Pb	1700 mb

Table 5.1: Nuclear inelastic cross sections

Figure captions

Chapter 2

Figure 2.1 The $\pi 2$ beam line of the 12-GeV proton synchrotron (PS) at KEK. The secondary beam is originated at the internal target (IT) in PS. Between D2 and D3 beams are achromatically focused and then selected by its momentum . The beams are focused again at the target point.

Figure 2.2 The global set-up of this experiment. The spectrometer consists of beam-line detectors , a cylindrical detector system and a forward detector system.

Figure 2.3 The schematic drawing of the Cylindrical Detector System (CDS).

Figure 2.4 Detector acceptance of CDS. Reaction kinematics in the reactions of an incident pion and proton on a single nucleon target is also shown for pion production (top) and proton production (bottom).

Figure 2.5 The schematic drawing of the solenoidal magnet 'OHSHO'.

Figure 2.6 Magnetic-field uniformity of 'OHSHO' with 3 kG field at its center. We achieved a uniformity of the magnetic field within 1% over the effective volume of the CDC.

Figure 2.7 The schematic view of the CDC structure. The frame of CDC is made of Al endplates and SUS poles . The CDH and CDC are mounted by an aluminum dram.

Figure 2.8 The close-up view to adjacent two sectors of the CDC and the CDH. Sixteen anode wires in a sector which are pointed by allows are actually read out . They are clusterized into inner, middle and outer block.

Figure 2.9 The schematic diagram of data taking system. The system is composed of the CDC part which managed the readout electronics of CDC and CAMAC part which managed that of the other detectors.

Figure 2.10 The schematic diagram of readout electronics for the CDC.

Figure 2.11 The schematic diagram of CAMAC system.

Figure 2.12 The schematic diagram of trigger logics.

Chapter 3

Figure 3.1 Transverse momentum distribution in $pp \to pp$ scattering at 1.5 GeV/c. According to the kinematical calculation the peak should be around 600 MeV/c. Using these data we calibrated the CDC tracks in R-ϕ plane.

Figure 3.2 Scatter plot of the transverse momenta versus the longitudinal momentum in $pp \to pp$ scattering at 1.5 GeV/c . The solid line shows the kinematical calculation of the scattering. The data were used in calibration of CDC tracks.

Figure 3.3 Scatter plot of θ_3 and θ_4 which are the scattering angles of outgoing protons in the scattering $pp \to pp$ at 1.5 GeV/c.

Figure 3.4 The scatter plot of the TOF of the CDH vs. the momentum. The solid lines indicate the kind of particles. Negative sign of momentum means negative charged particles.

Figure 3.5 Typical miss-identification probabilities and escaping probabilities for outgoing particles in our particle-identification procedure. a) shows those when TOF by the CDH and dE/dx by the CDC are both available , b) shows those when only the dE/dx is available.[23]

Figure 3.6 Momentum resolution of the CDC for particles emitted in 90 and 120 degrees, which was estimated from the tracking-position resolution and multiple-scattering effects. Solid lines are for protons and dashes for pions.

Figure 3.7 Tracking efficiency of the CDC as a function of momentum of particles. The upper figure is for protons and the lower for pions.

Chapter 4

Figure 4.1 Invariant differential cross section of proton production as a function of kinetic energy for each scattered angles and for each target. Circle symbol shows positive pion projection, square symbol shows negative pion projection and cross symbol shows proton projection.

Figure 4.2 Invariant differential cross section of positive pion production as a function of kinetic energy for each scattered angles, for each target and for incident particle of positive and negative pion. Solid line shows the fitted line with exponential function.

Figure 4.3 Invariant differential cross section of negative pion production as a function of kinetic energy for each scattered angles, for each target and for incident particle of positive and negative pion. Solid line shows the fitted line with exponential function.

Figure 4.4 Invariant differential cross section of positive pion production as a function of kinetic energy for each scattered angles, for each target and for incident particle of proton. Solid line shows the fitted line with exponential function.

Figure 4.5 Invariant differential cross section of negative pion production as a function of kinetic energy for each scattered angles, for each target and for incident particle of proton. Solid line shows the fitted line with exponential function.

Chapter 5

Figure 5.1 Mass number dependence of invariant cross section. Invariant cross section value is normalized at Al. Each symbol shows the difference of scattered angle. Dot dash line shows $A^{2/3}$ for pion production and A^1 for proton production.

Figure 5.2 $\cos\theta_{lab}$ dependence of fitted parameter T_0 for proton production.

Figure 5.3 mass number dependence of fitted parameter T_0 for proton production.

Figure 5.4 $\cos\theta_{lab}$ dependence of fitted parameter α_0 for proton production. The symbols are the same as in Fig. 5.2.

Figure 5.5 mass number dependence of fitted parameter α_0 for proton production. The symbols are the same as in Fig. 5.3.

Figure 5.6 $\cos\theta_{lab}$ dependence of fitted parameter α_0 for pion production with pion incident. The symbols are the same as in Fig. 5.2.

Figure 5.7 mass number dependence of fitted parameter α_0 for pion production with pion incident. The symbols are the same as in Fig. 5.3.

Figure 5.8 $\cos\theta_{lab}$ dependence of fitted parameter T_0 for pion production with pion incident. The symbols are the same as in Fig. 5.2.

Figure 5.9 mass number dependence of fitted parameter T_0 for pion production with pion incident. The symbols are the same as in Fig. 5.3.

Figure 5.10 $\cos\theta_{lab}$ dependence of fitted parameter T_0 for pion production with proton incident. The symbols are the same as in Fig. 5.2.

Figure 5.11 mass number dependence of fitted parameter T_0 for pion production with proton incident. The symbols are the same as in Fig. 5.3.

Figure 5.12 $\cos\theta_{lab}$ dependence of fitted parameter α_0 for pion production with proton incident. The symbols are the same as in Fig. 5.2.

Figure 5.13 mass number dependence of fitted parameter α_0 for pion roduction with proton incident. The symbols are the same as in Fig. 5.3.

Figure 5.14 Comparison of our data (crosses) with 400 GeV proton incident data (circles) [13,14], for positive pion production (A) and for proton production (B) in the case of targets ^{6}Li, Al and Cu.

Figure 5.15 $\cos\theta_{lab}$ dependence and mass number dependence of fitted parameter α_0 and T_0 for 400 GeV data of proton production.[14]

Figure 5.16 The η spectrum of charged particles in 200 GeV/c $\pi^- p$ (solid line), π^-Cu (dot) and π^-Pb (dashes) collisions.[3]

Figure 5.17 $\cos\theta_{lab}$ dependence and mass number dependence of fitted parameter α_0 and T_0 for 400 GeV data of pion production.[13]

Figure 5.18 The η spectrum of shower particles in pEm (emulsion) collisions at 67, 200, 300 and 400 GeV/c.[3]

Figure 5.19 Comparison of a quark-parton model calculation with our data for each scattered angle region in the case of positive pion incident. Target nucleus is ^{6}Li.

Figure 5.20 The similar comparison as in Fig. 5.19 for the case of negative pion incident and ^{6}Li target.

Figure 5.21 The similar comparison as in Fig. 5.19 for the case of proton incident and ^{6}Li target.

Figures

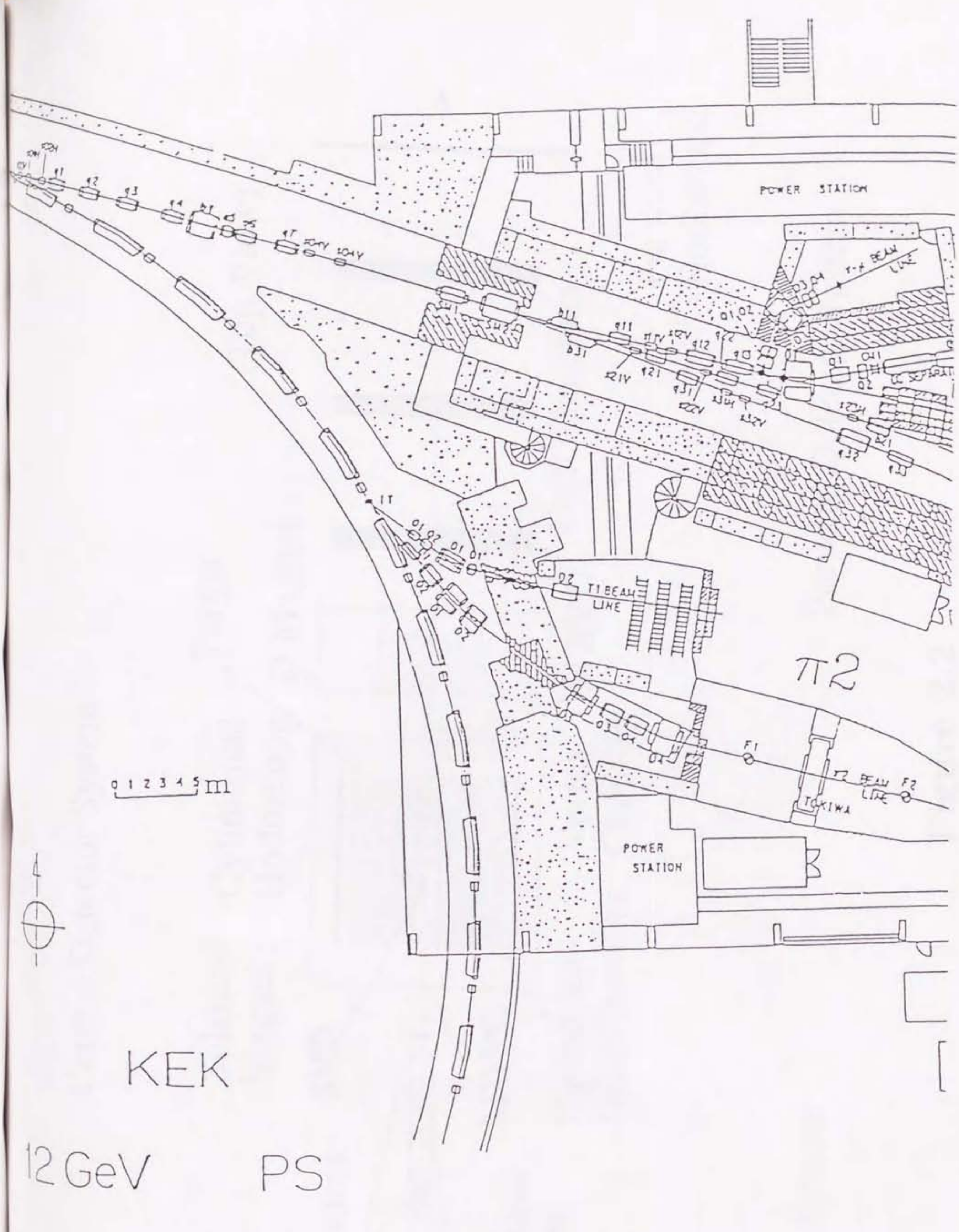

POWER STATION
T1 BEAM LINE
π2
π2 BEAM LINE
F1
F2
TOKIWA
POWER STATION
0 1 2 3 4 5 m
KEK
12 GeV PS

Figure 2.1

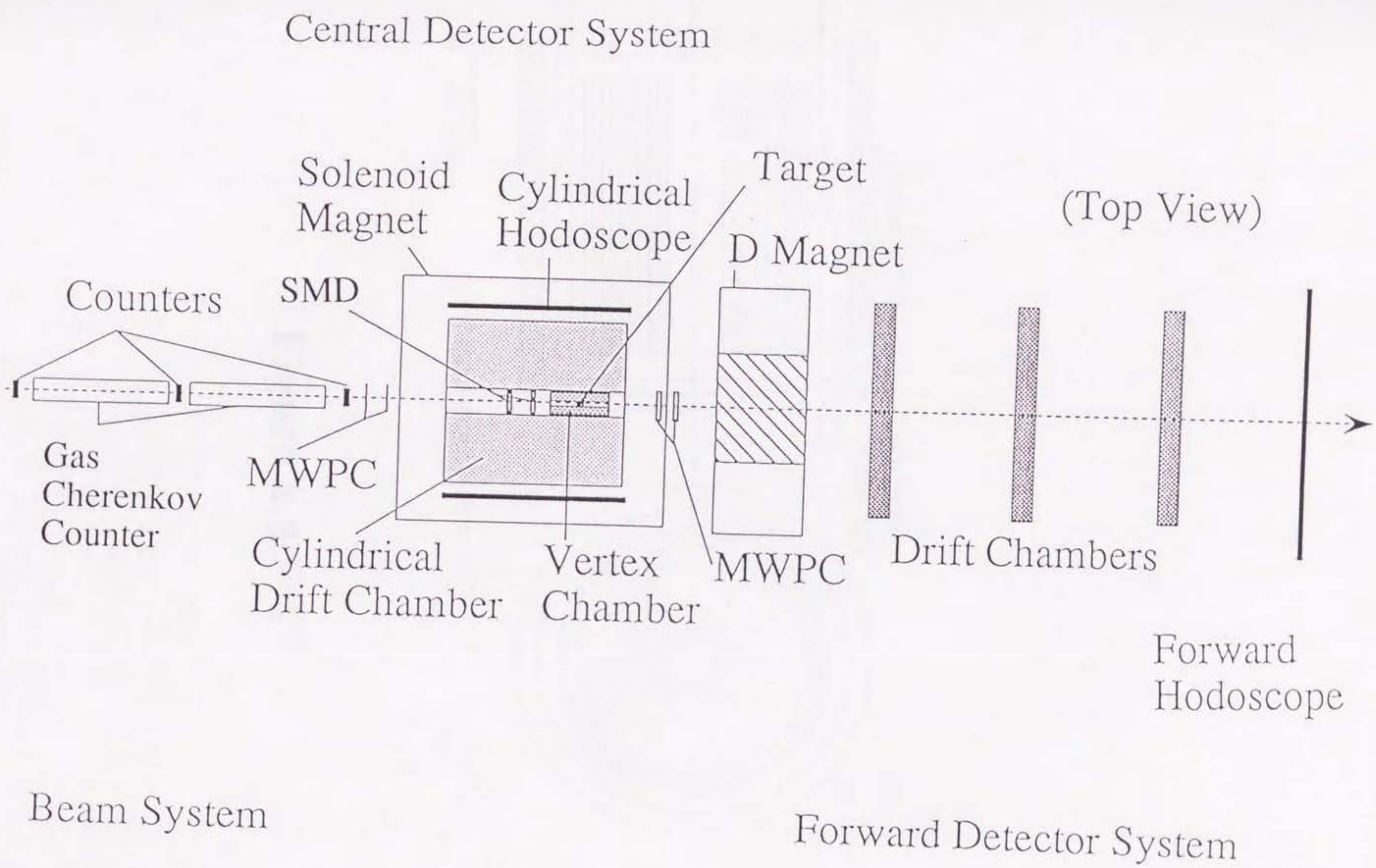
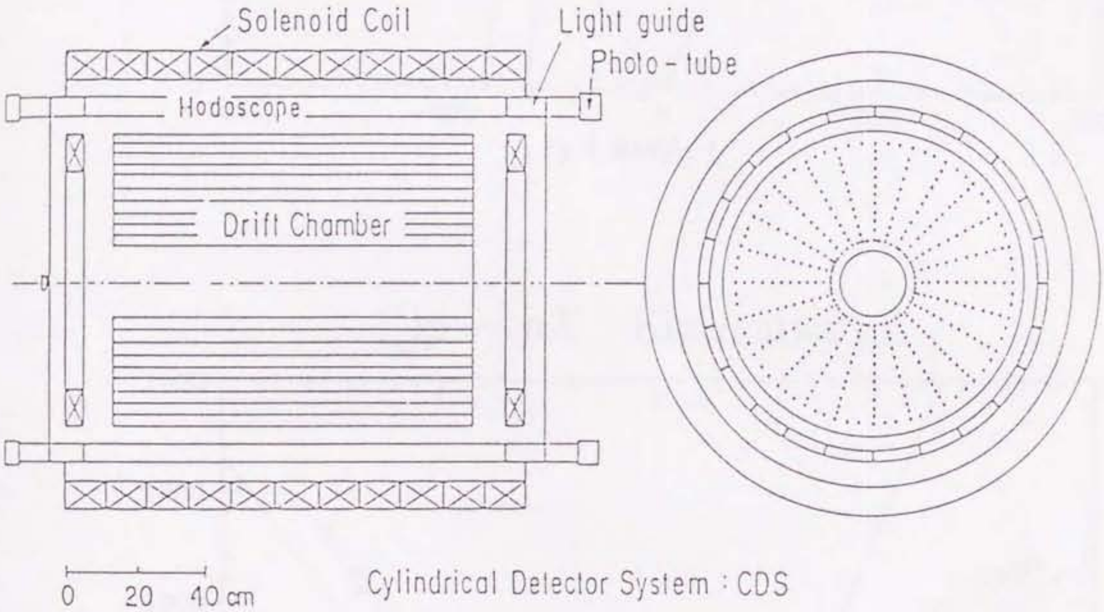

Central Detector System
Solenoid
Magnet
Cylindrical
Hodoscope
Target
(Top View)
D Magnet
Counters
SMD
Gas
Cherenkov
Counter
MWPC
Cylindrical
Drift Chamber
Vertex
Chamber
MWPC
Drift Chambers
Forward
Hodoscope
Beam System
Forward Detector System

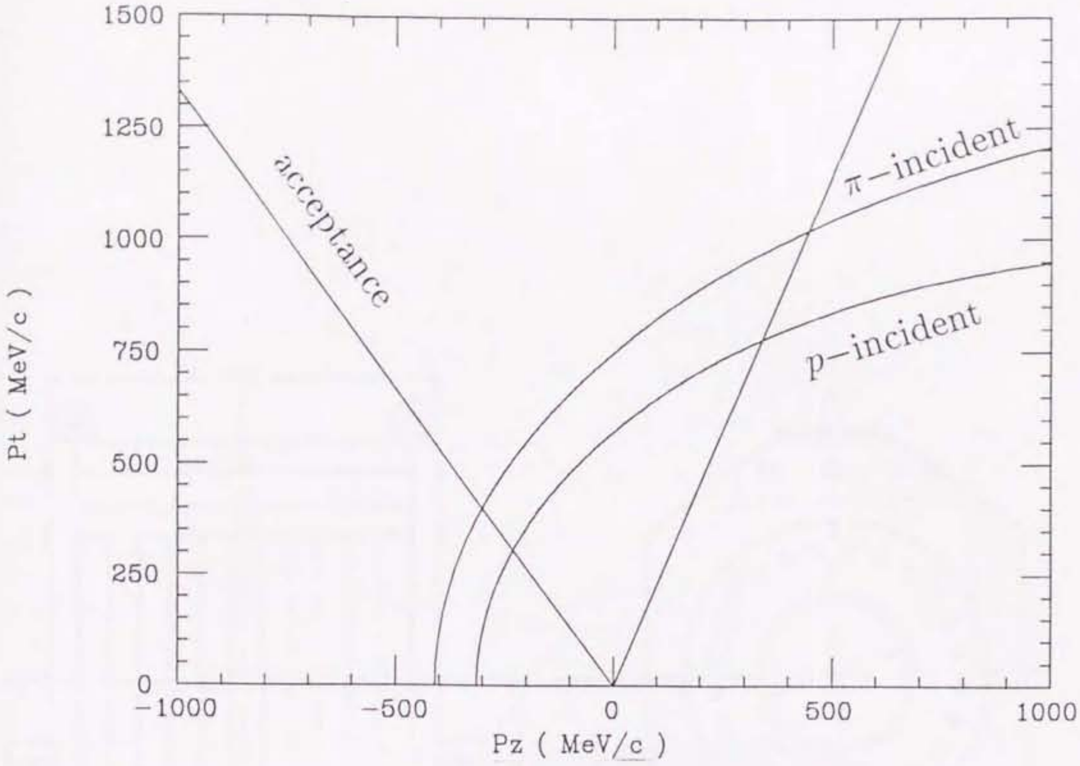
Figure 2.2



Cylindrical Detector System : CDS

Figure 2.3

$\binom{\pi}{p}p \rightarrow \pi X$: Kinematics



$\binom{\pi}{p}p \rightarrow pX$: Kinematics

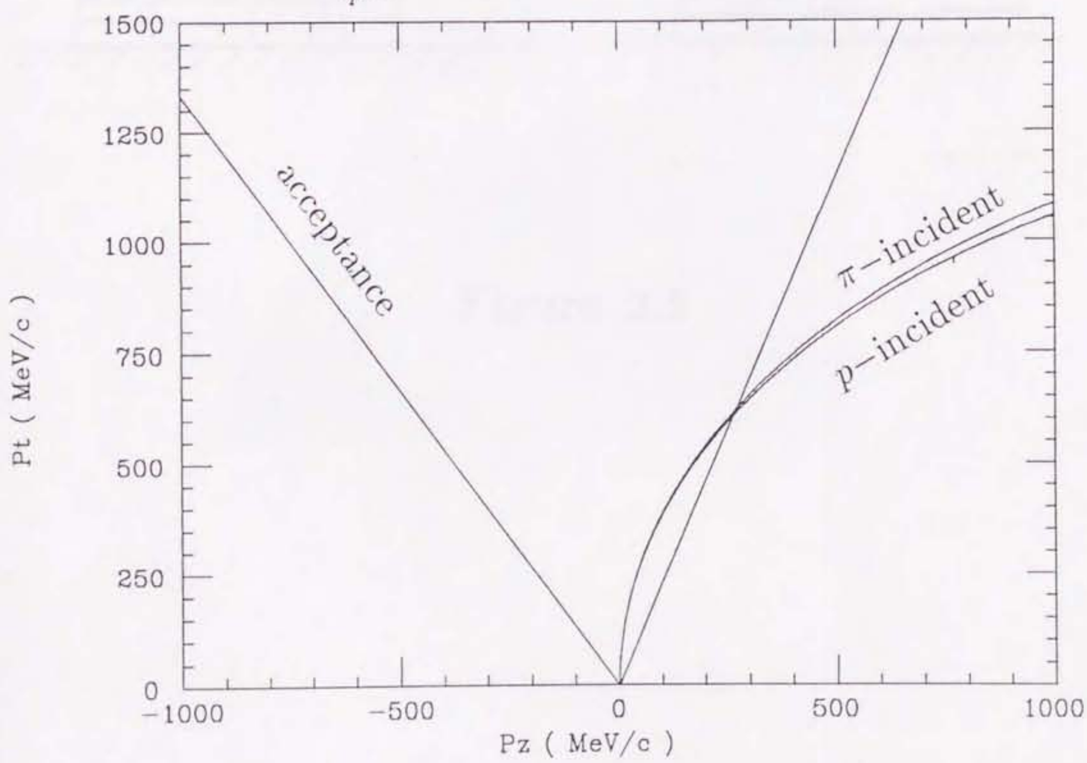


Figure 2.4

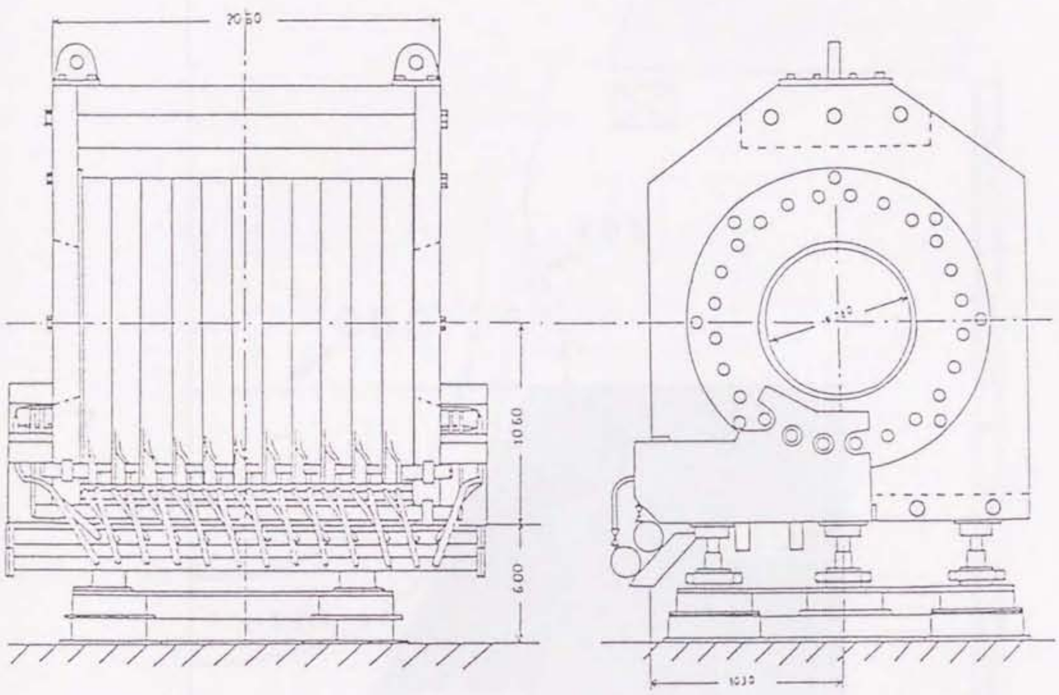


Figure 2.5

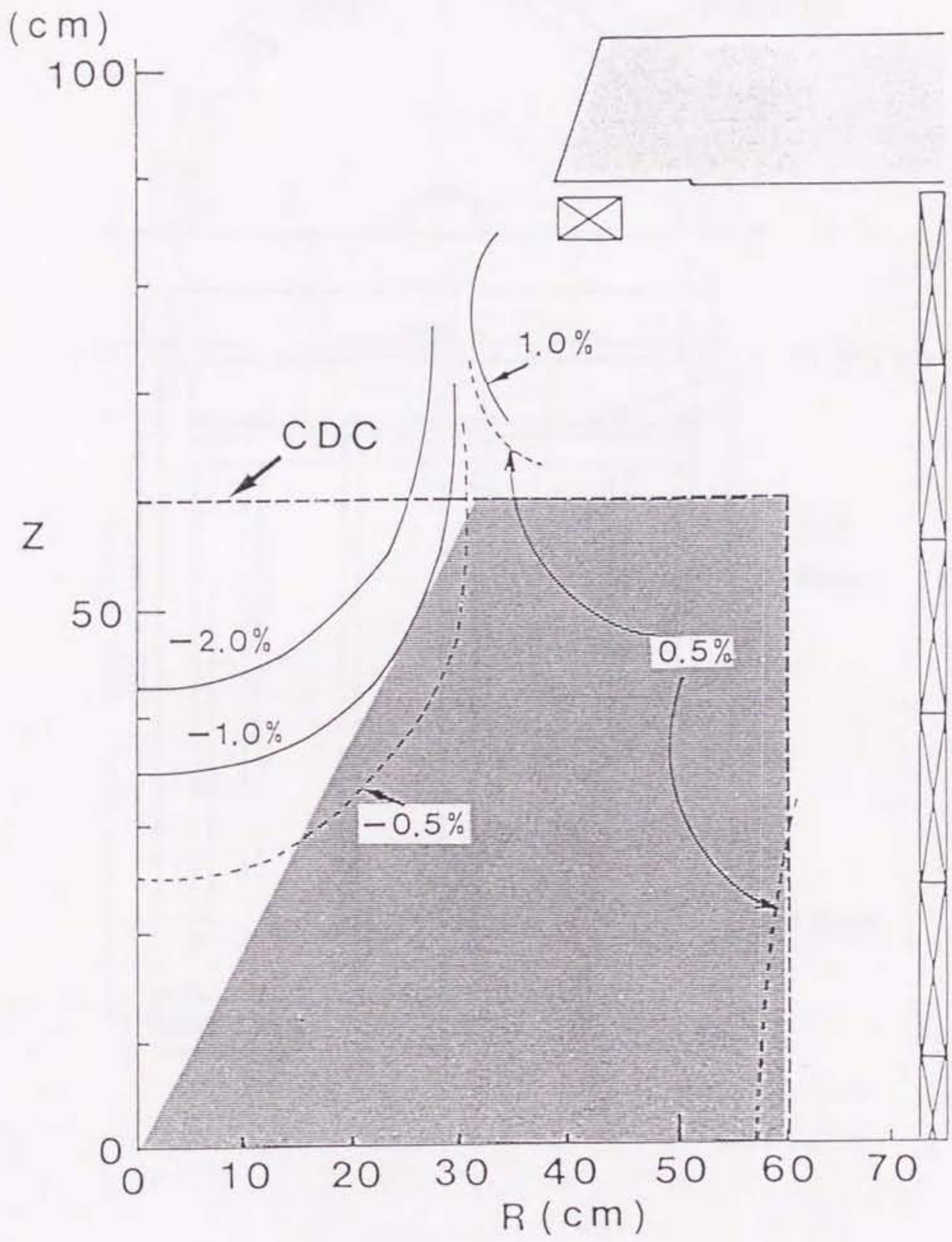
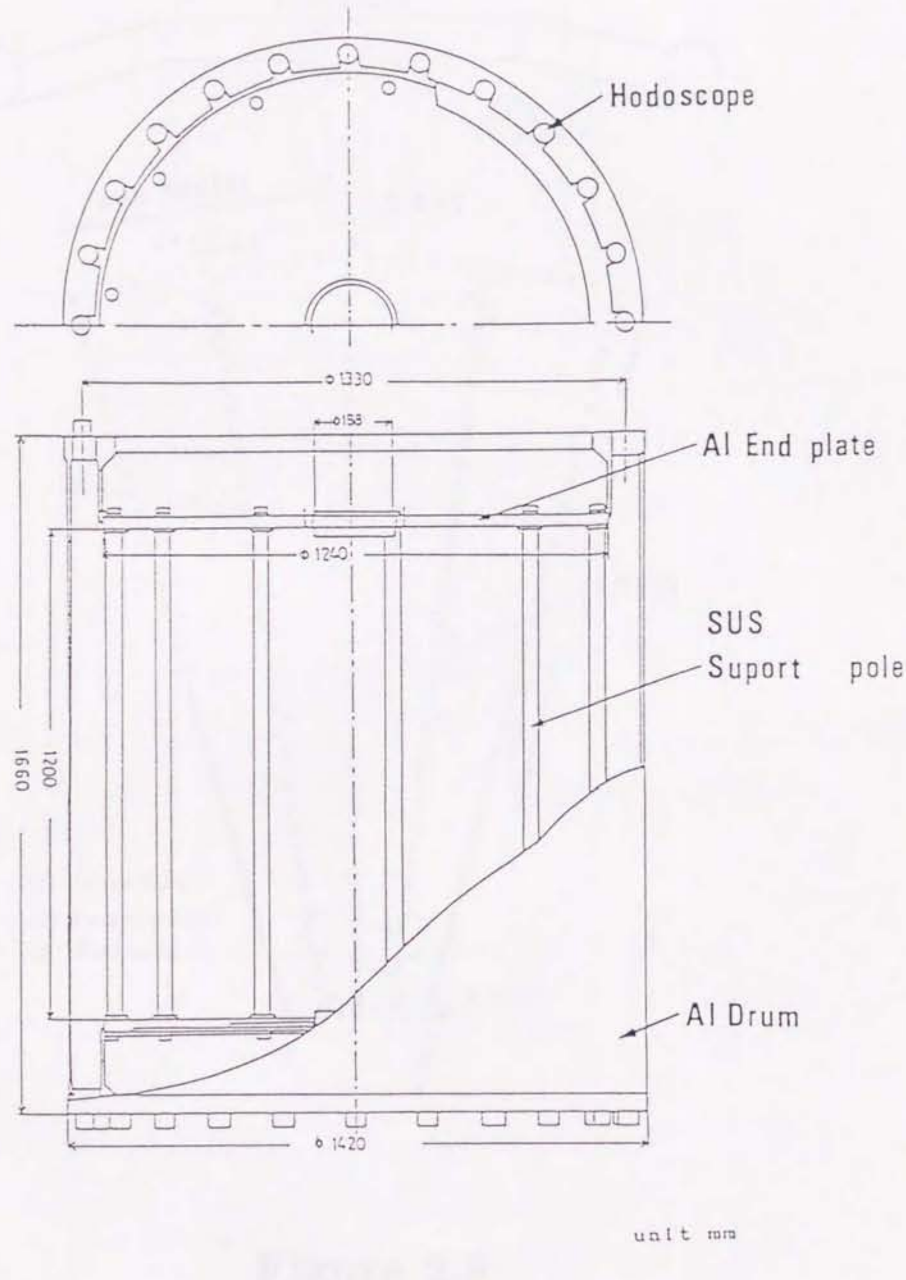


Figure 2.6



Hodoscope
φ 1330
φ 158
Al End plate
φ 1240
SUS
Suport pole
1660
1200
Al Drum
φ 1420
unit mm

Figure 2.7

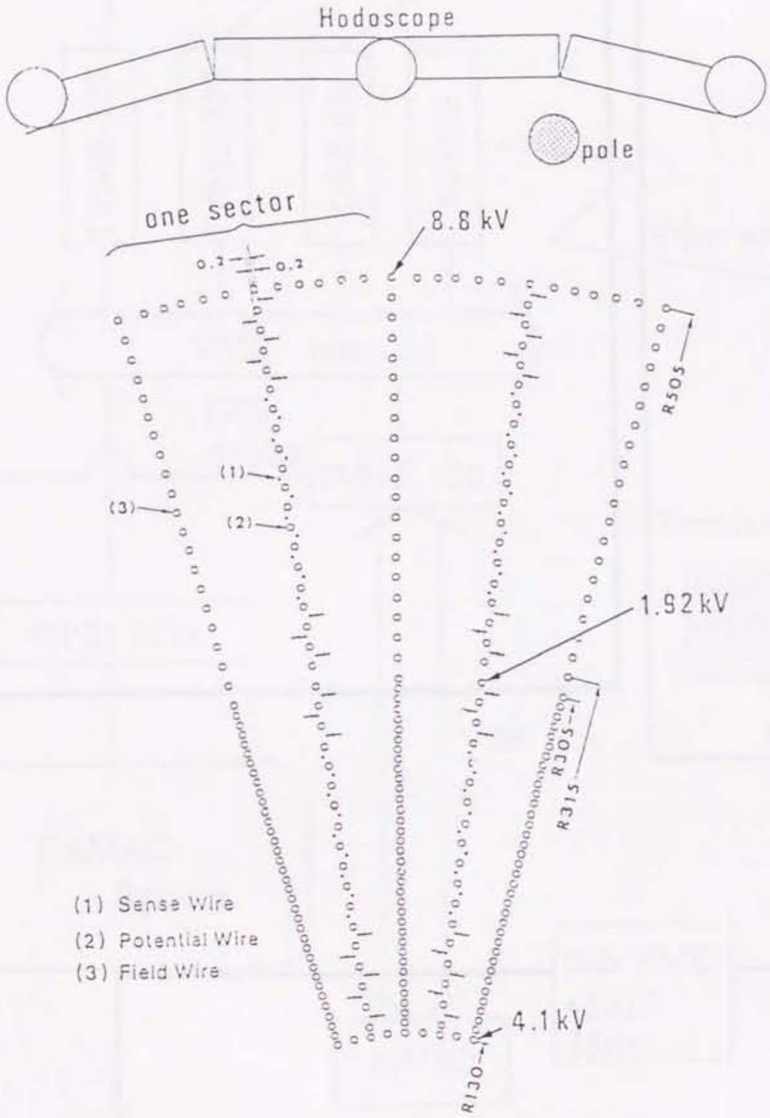
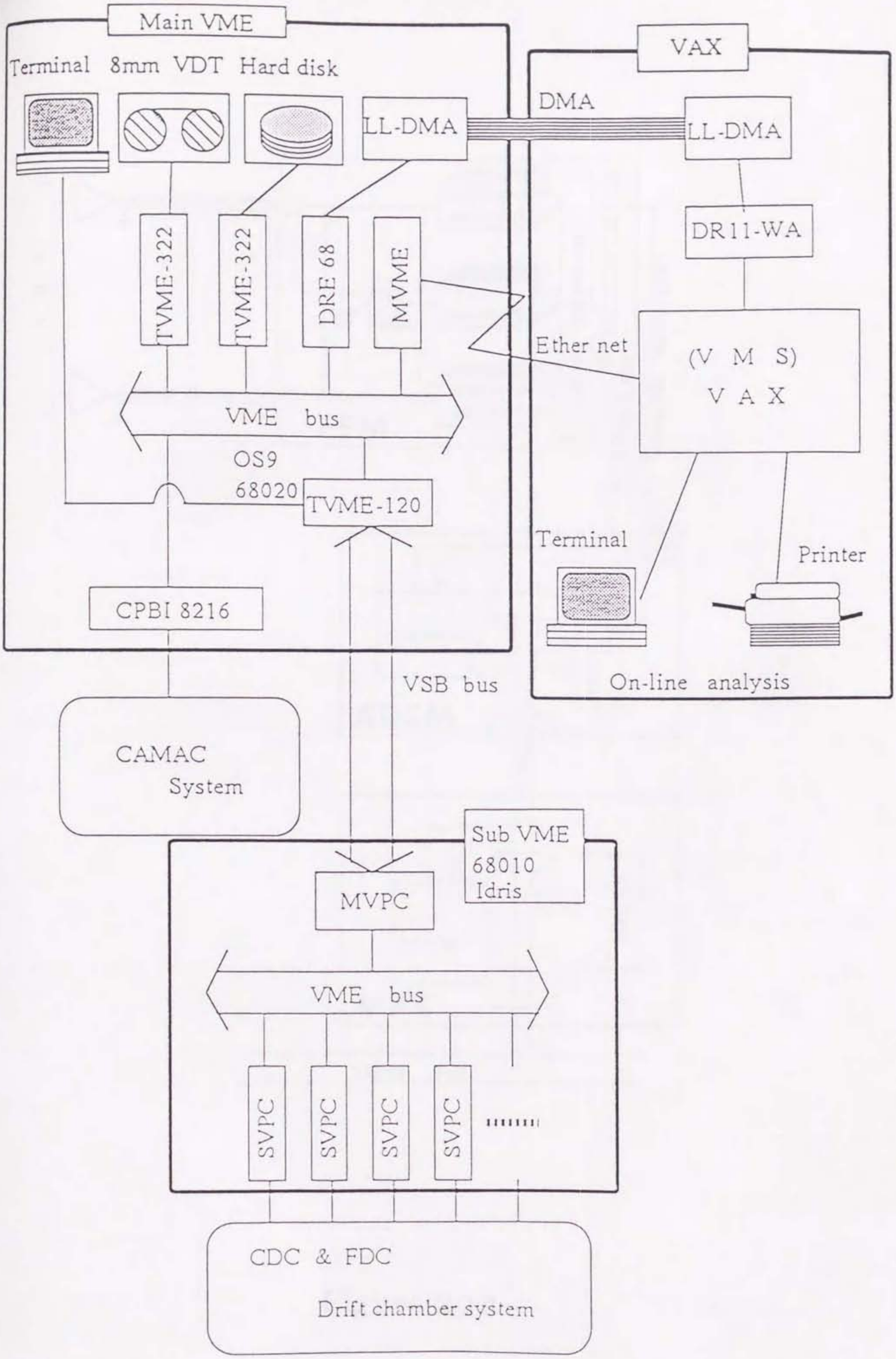

Hodoscope
pole
one sector
8.8 kV
0.2
0.2
R505
(1)
(3)
(2)
1.92 kV
R305
R315
(1) Sense Wire
(2) Potential Wire
(3) Field Wire
4.1 kV
R130

Figure 2.8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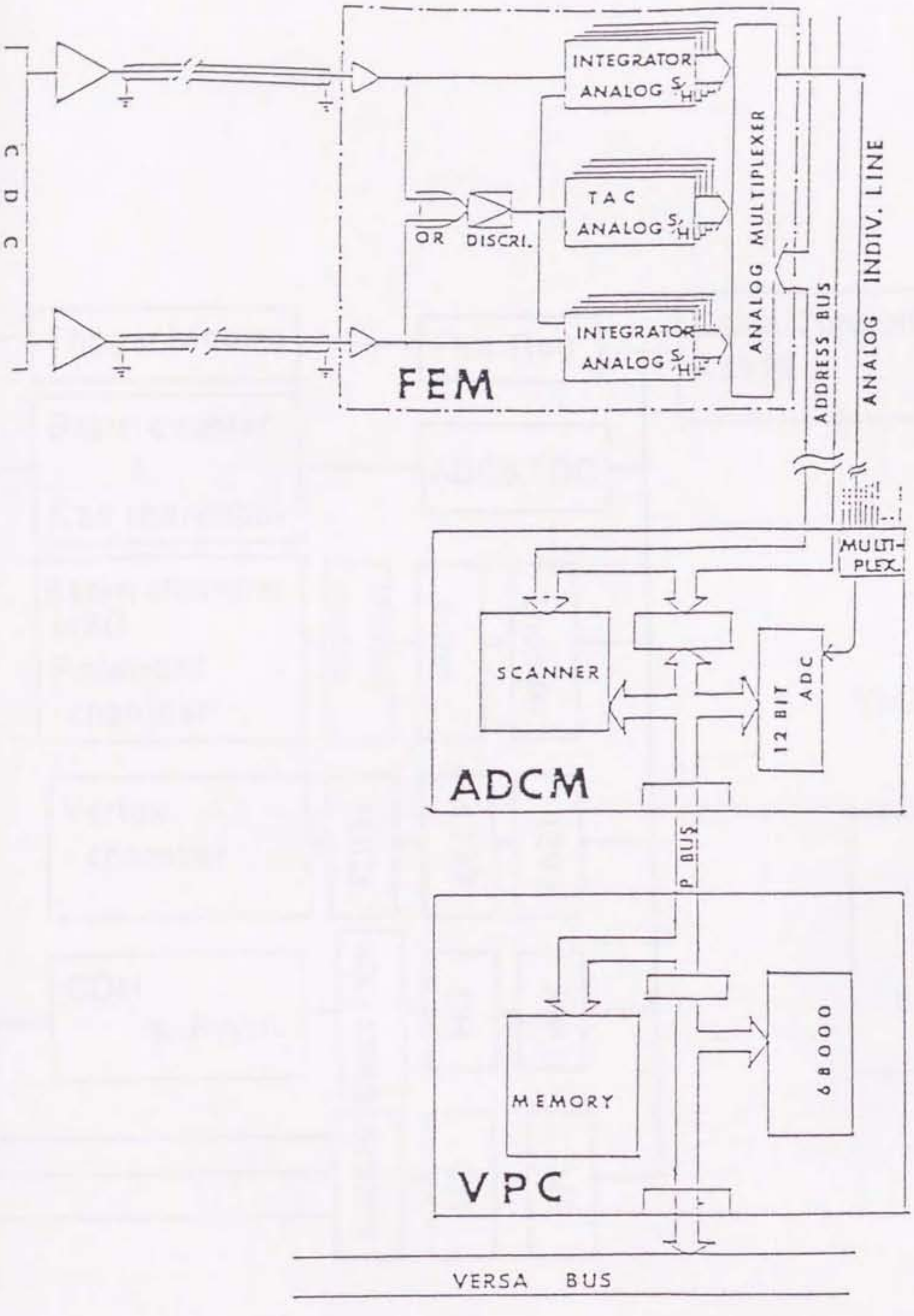
8mm VDT
Hard disk
LL-DMA
TVME-322
TVME-322
DRE 68
MVME
VME bus
OS9
68020
TVME-120
CPBI 8216
VAX
DMA
LL-DMA
DR11-WA
Ether net
(V M S)
V A X
Terminal
Printer
On-line analysis
VSB bus
CAMAC
System
Sub VME
68010
Idris
MVPC
VME bus
SVPC
SVPC
SVPC
SVPC
CDC & FDC
Drift chamber system

Figure 2.9



CDC
INTEGRATOR
ANALOG S/H
TAC
ANALOG S/H
OR
DISCRI.
INTEGRATOR
ANALOG S/H
FEM
ANALOG MULTIPLEXER
ADDRESS BUS
ANALOG INDIV. LINE
MULTI-PLEX.
SCANNER
12 BIT ADC
ADCM
P BUS
MEMORY
68000
VPC
VERSA BUS

Figure 2.10

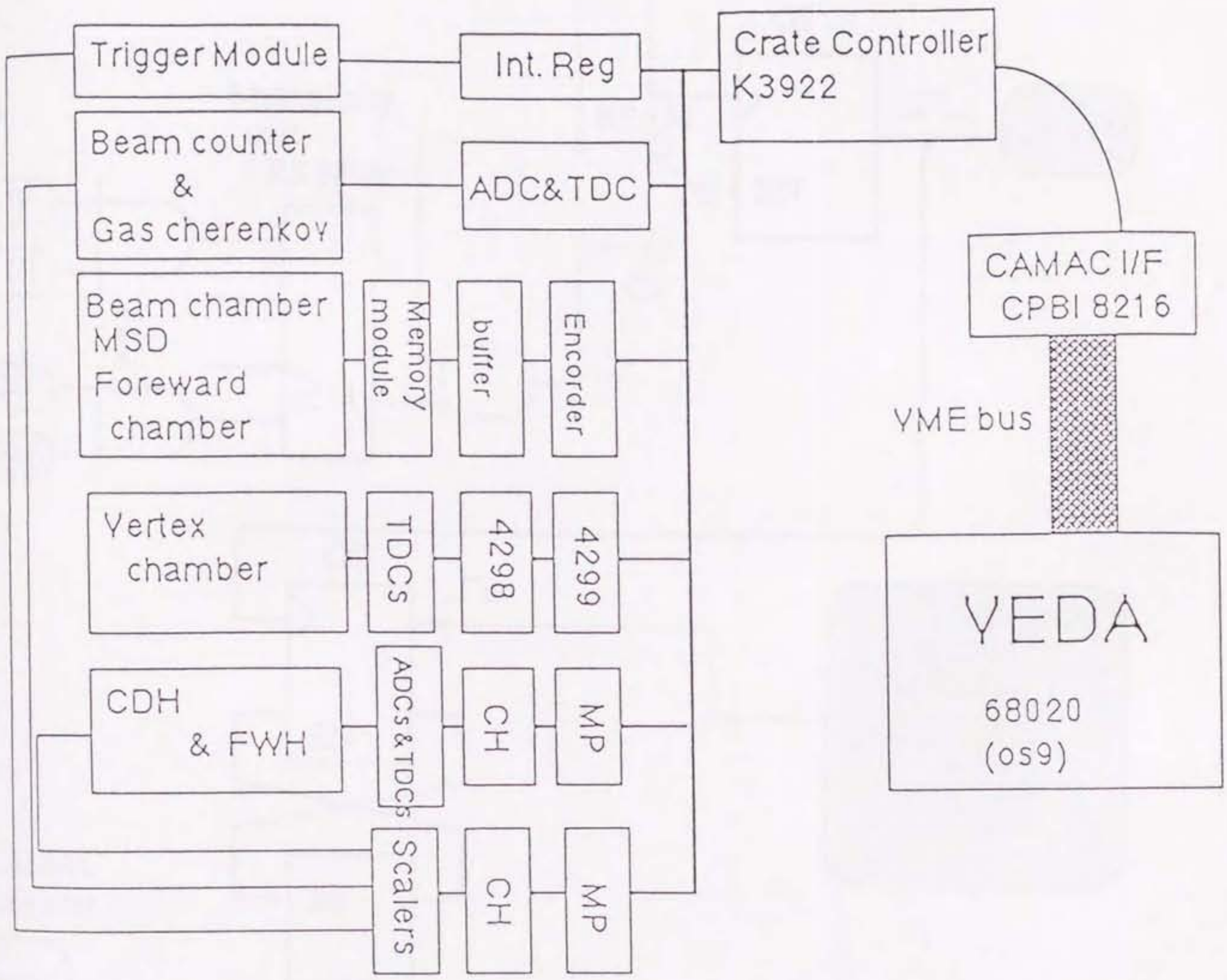
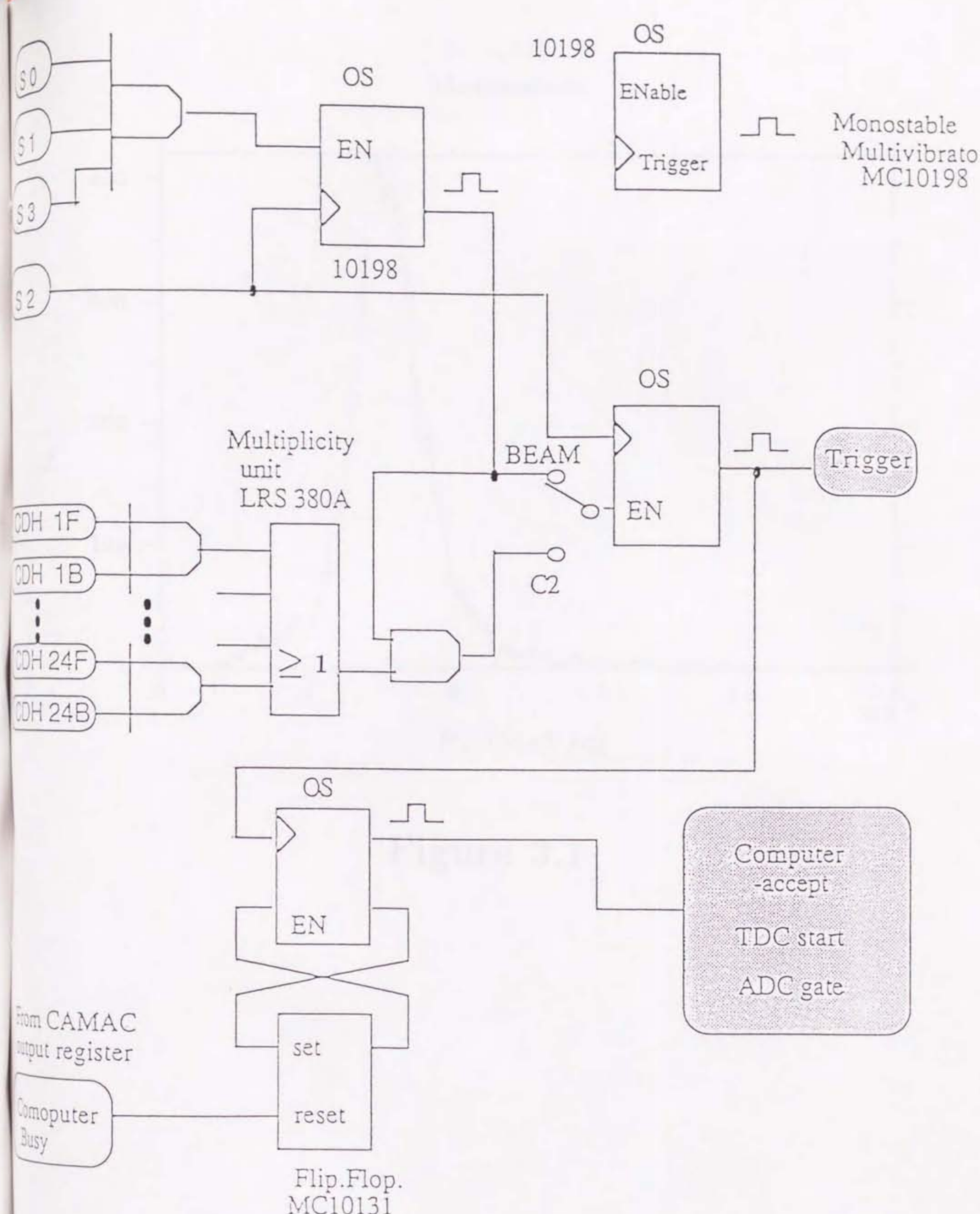

Trigger Module
Int. Reg
Crate Controller
K3922
Beam counter
&
Gas cherenkov
ADC&TDC
CAMAC I/F
CPBI 8216
Beam chamber
MSD
Foreward
chamber
Memory module
buffer
Encorder
VME bus
Vertex
chamber
TDCs
4298
4299
VEDA
68020
(os9)
CDH
& FWH
ADCs & TDCs
CH
MP
Scalers
CH
MP

Figure 2.11



10198
OS
ENable
Trigger
Monostable
Multivibrato
MC10198
S0
S1
S3
S2
OS
EN
10198
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Multiplicity
unit
LRS 380A
BEAM
EN
Trigger
C2
CDH 1F
CDH 1B
CDH 24F
CDH 24B
≥ 1
OS
EN
Computer
-accept
TDC start
ADC gate
From CAMAC
output register
Comoputer
Busy
set
reset
Flip.Flop.
MC10131

Figure 2.12

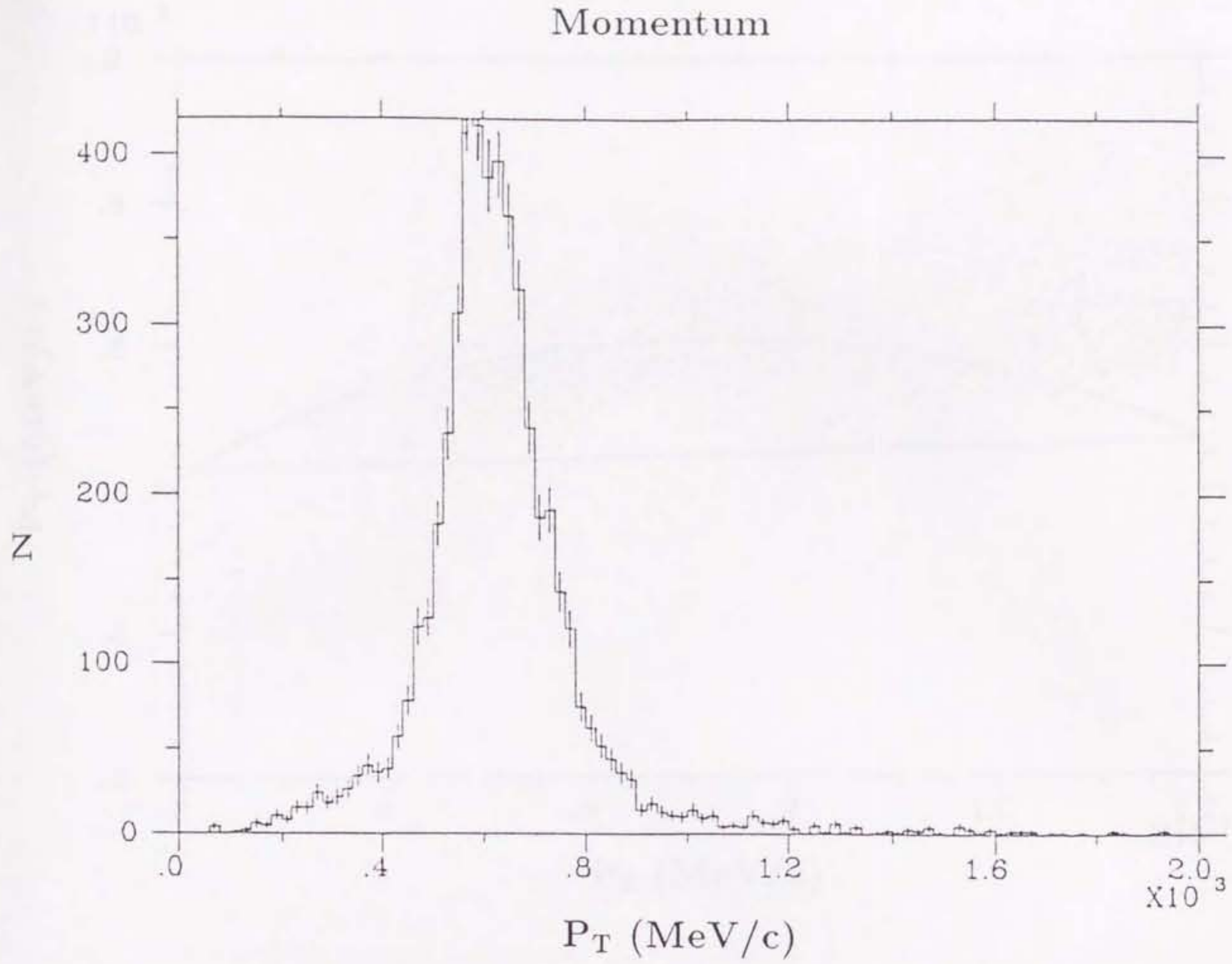


Figure 3.1

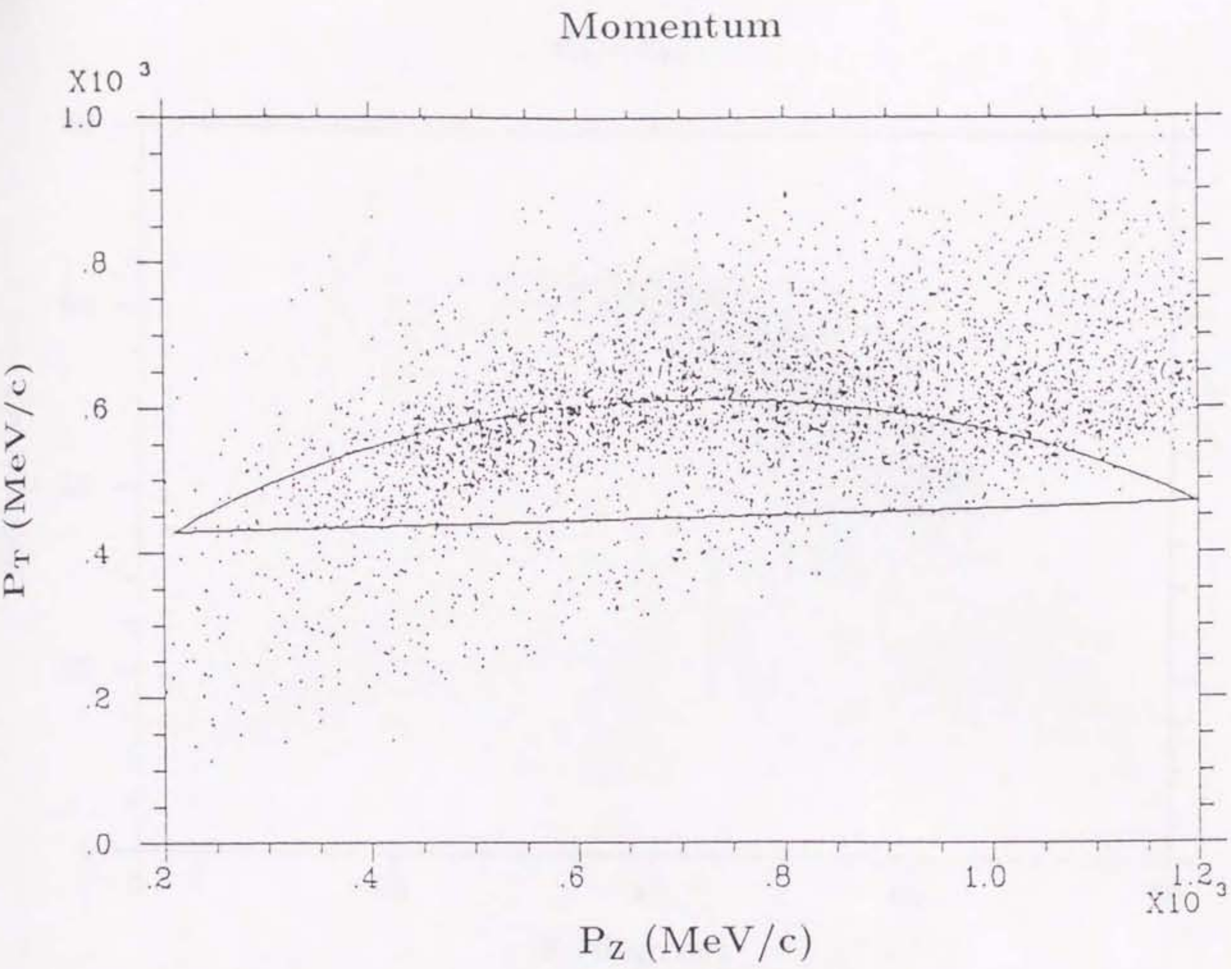
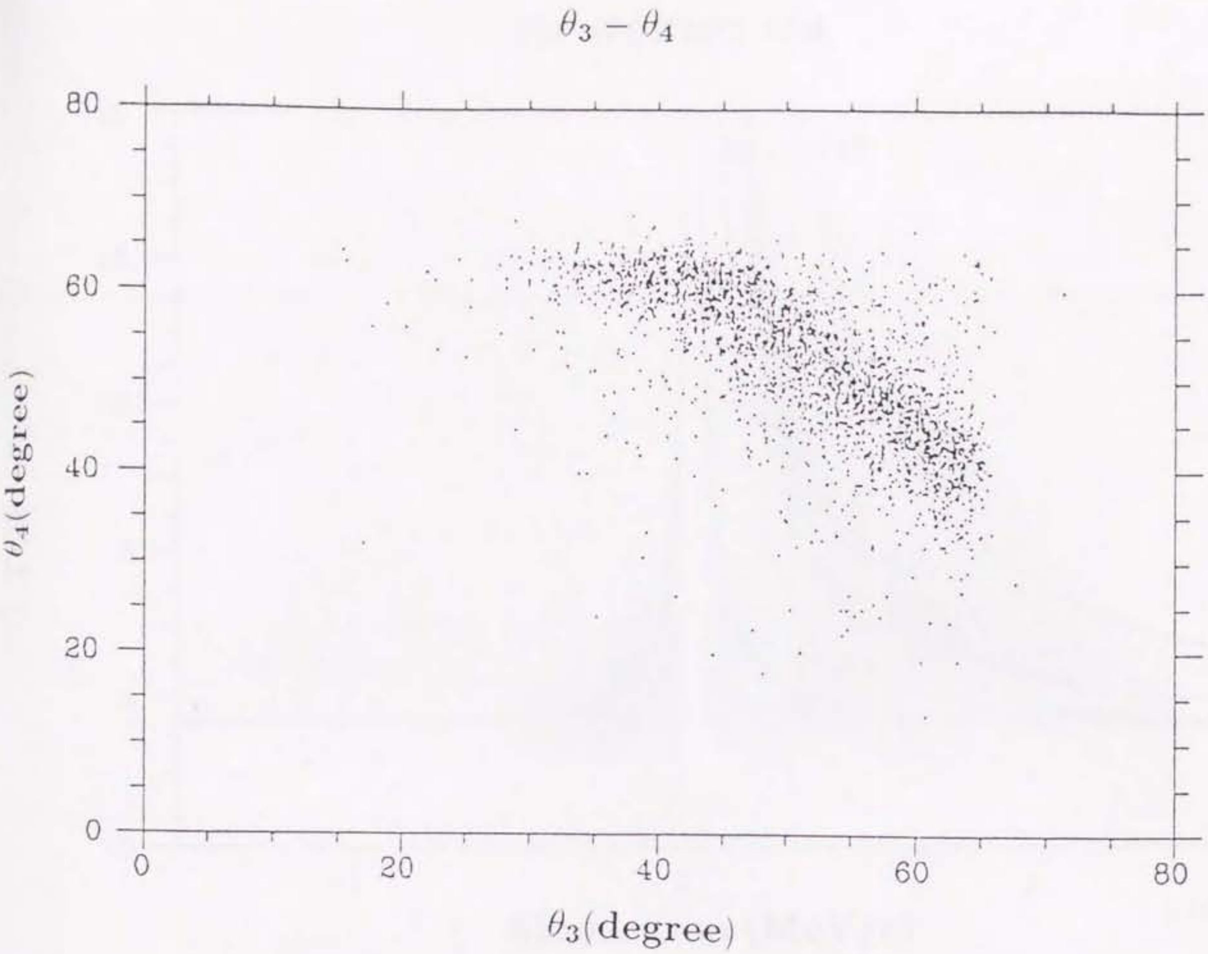


Figure 3.2



$\theta_3 - \theta_4$
80
60
40
20
0
0
20
40
60
80
θ_4(degree)
θ_3(degree)

Figure 3.3

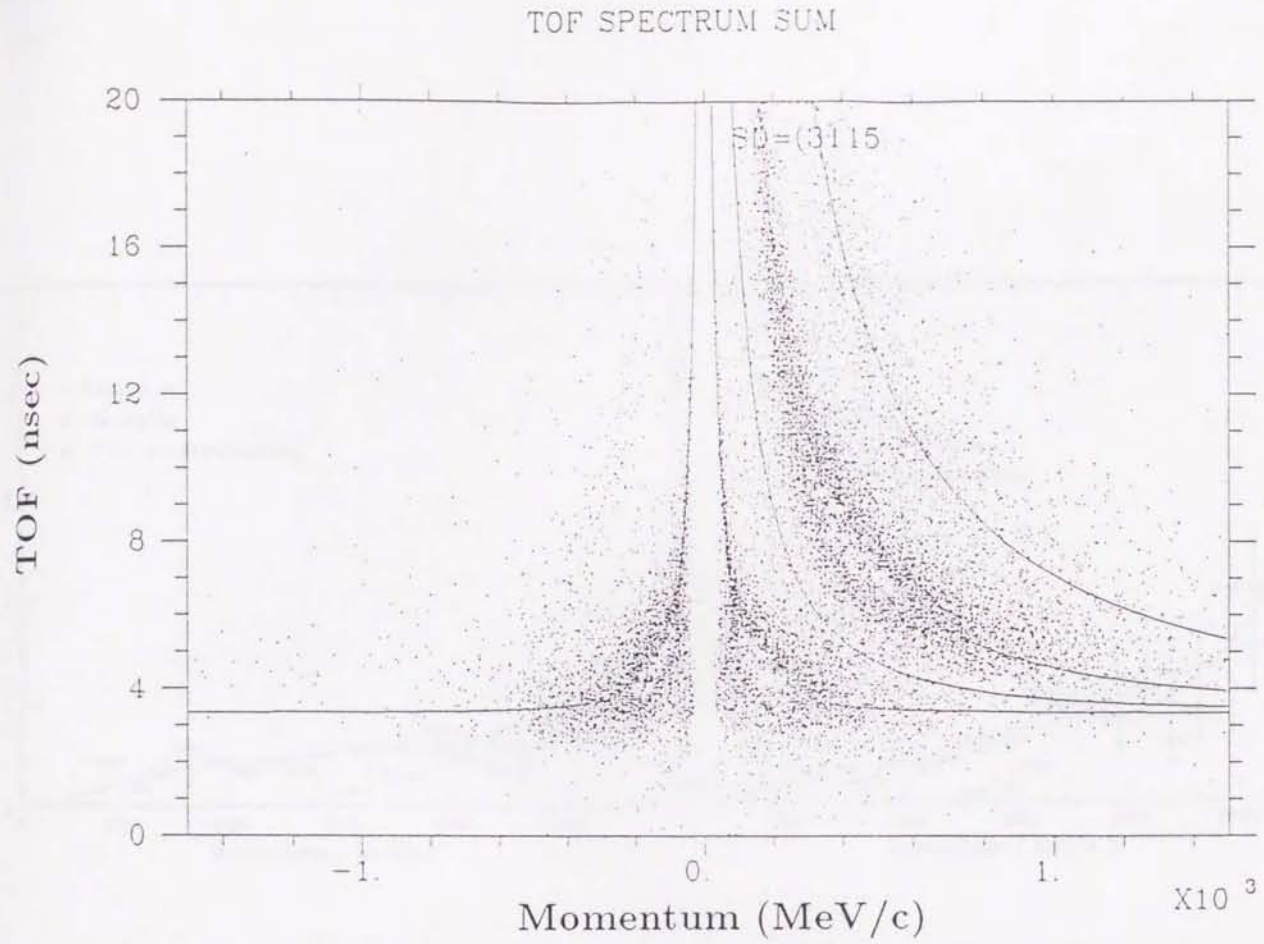
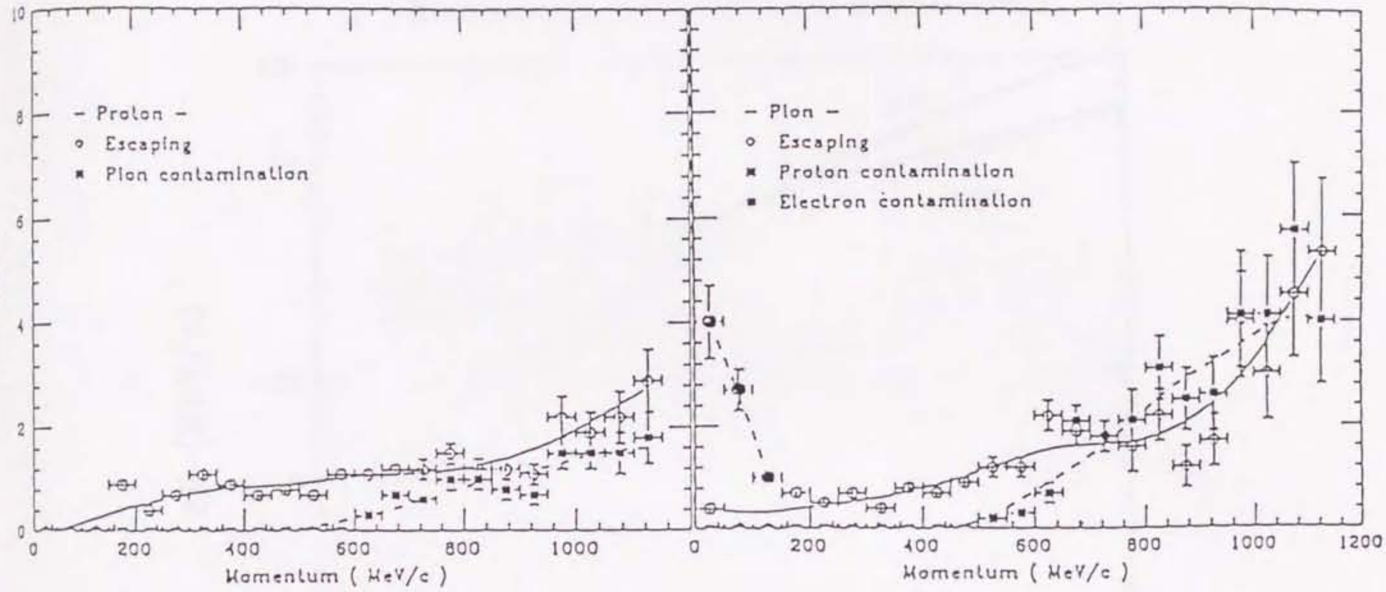

TOF SPECTRUM SUM
SD=(3115
20
16
12
8
4
0
TOF (nsec)
-1.
0.
1.
X10 3
Momentum (MeV/c)

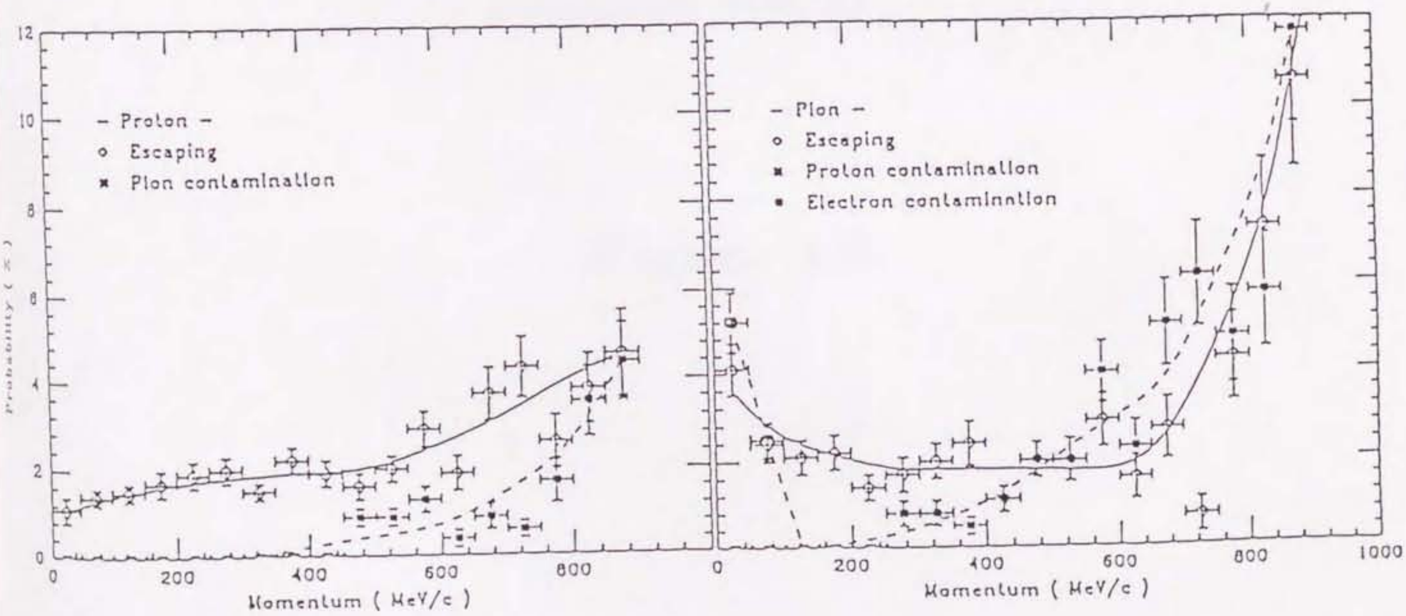
Figure 3.4

a)



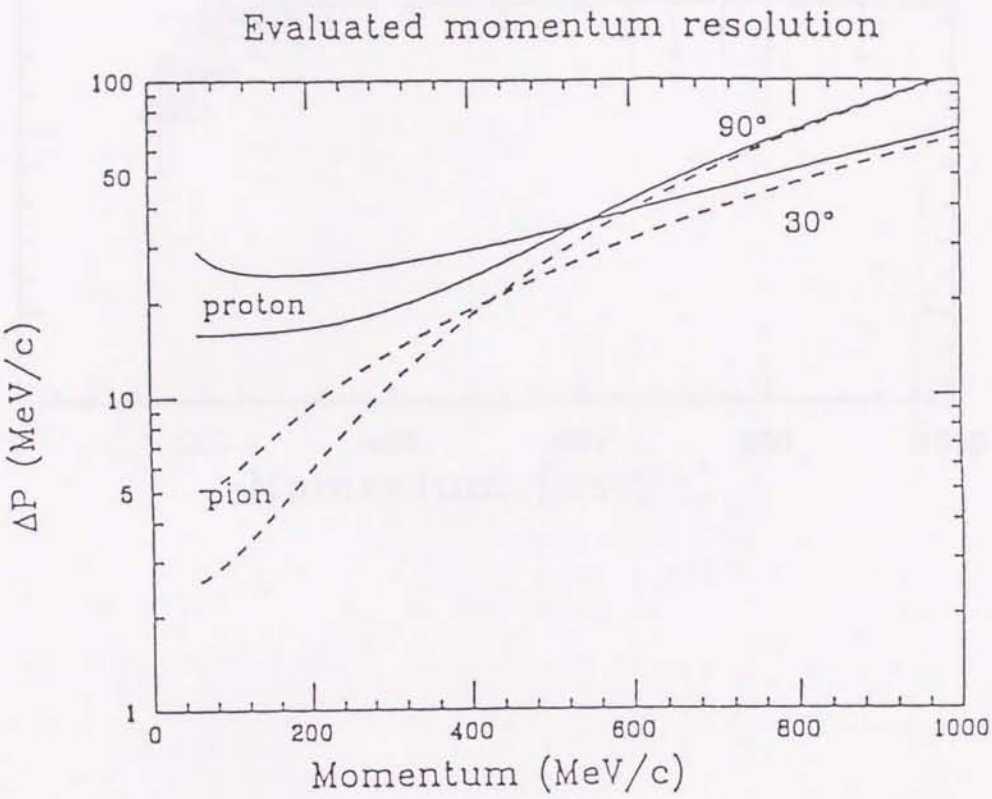
- Proton -
Escaping
Pion contamination
- Pion -
Escaping
Proton contamination
Electron contamination
Momentum (MeV/c)
Momentum (MeV/c)

b)



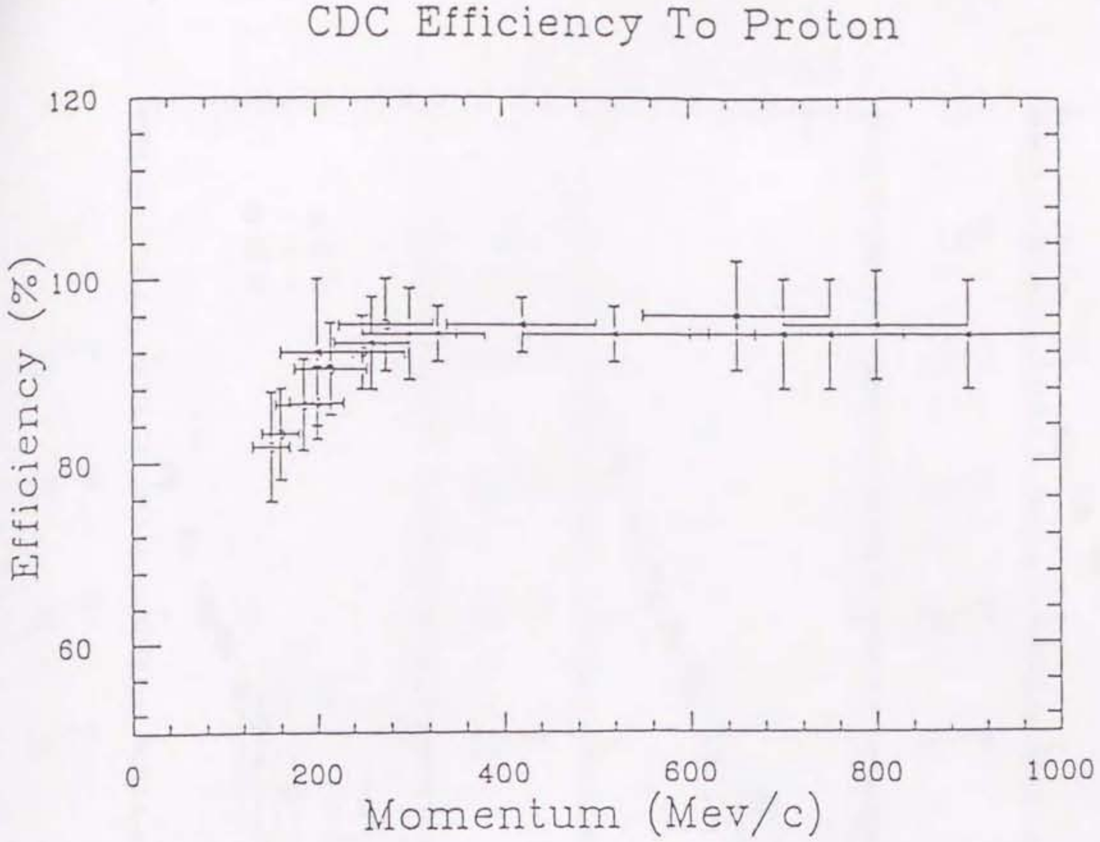
- Proton -
Escaping
Pion contamination
- Pion -
Escaping
Proton contamination
Electron contamination
Momentum (MeV/c)
Momentum (MeV/c)

Figure 3.5



Evaluated momentum resolution
100
50
10
5
1
0
200
400
600
800
1000
90°
30°
proton
pion
ΔP (MeV/c)
Momentum (MeV/c)

Figure 3.6


CDC Efficiency To Proton
120
100
80
60
Efficiency (%)
0
200
400
600
800
1000
Momentum (Mev/c)

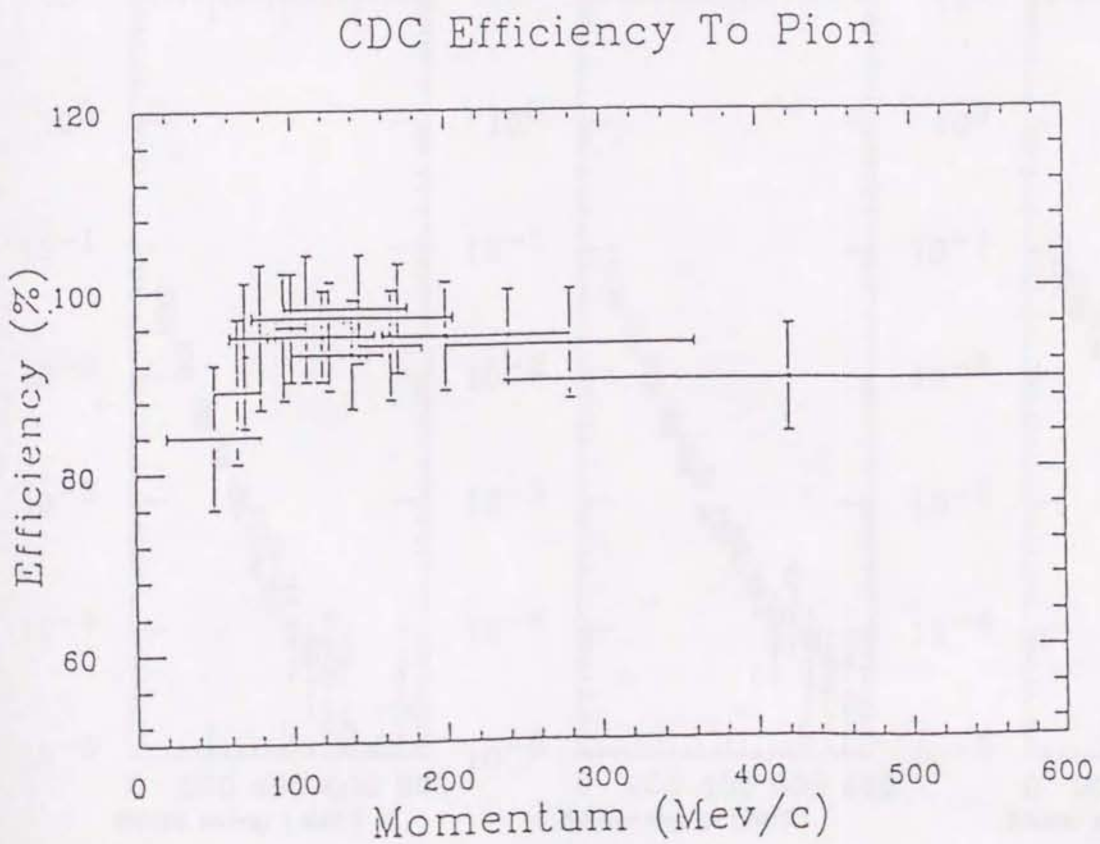
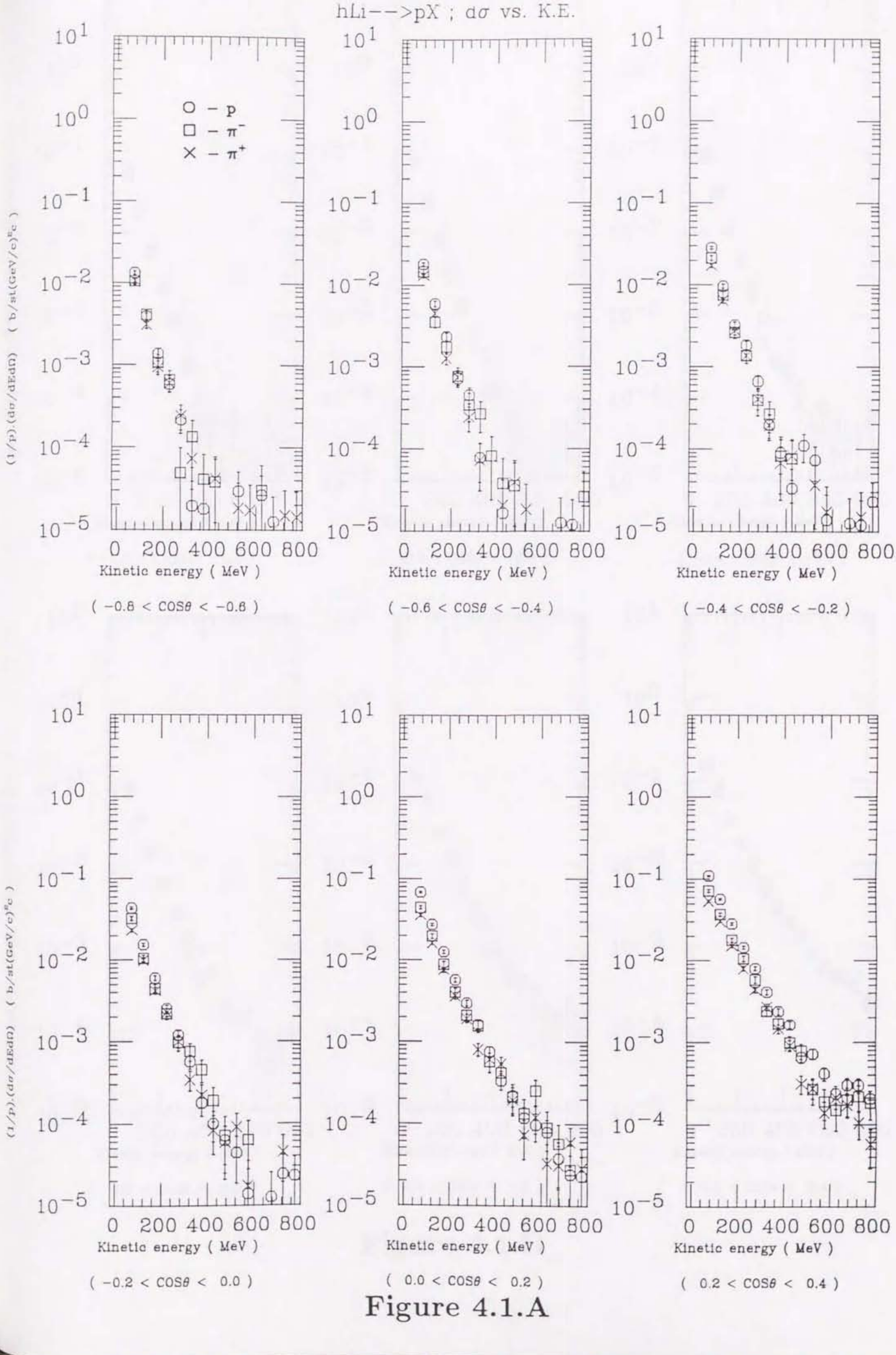

CDC Efficiency To Pion
120
100
80
60
Efficiency (%)
0
100
200
300
400
500
600
Momentum (Mev/c)

Figure 3.7



hLi-->pX ; dσ vs. K.E.
○ - p
□ - π⁻
× - π⁺
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
10¹
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.1.A

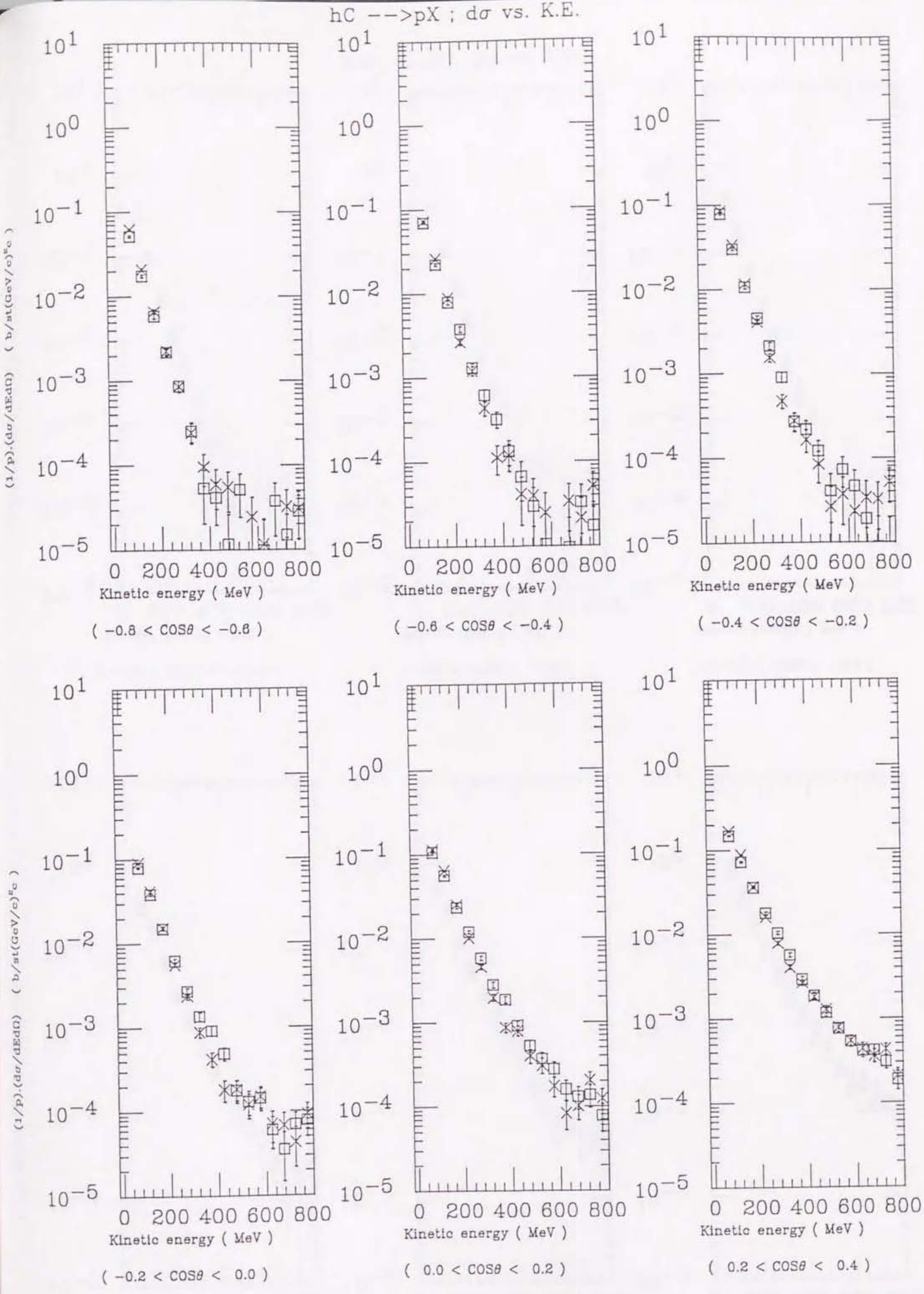

hC -->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.1.B

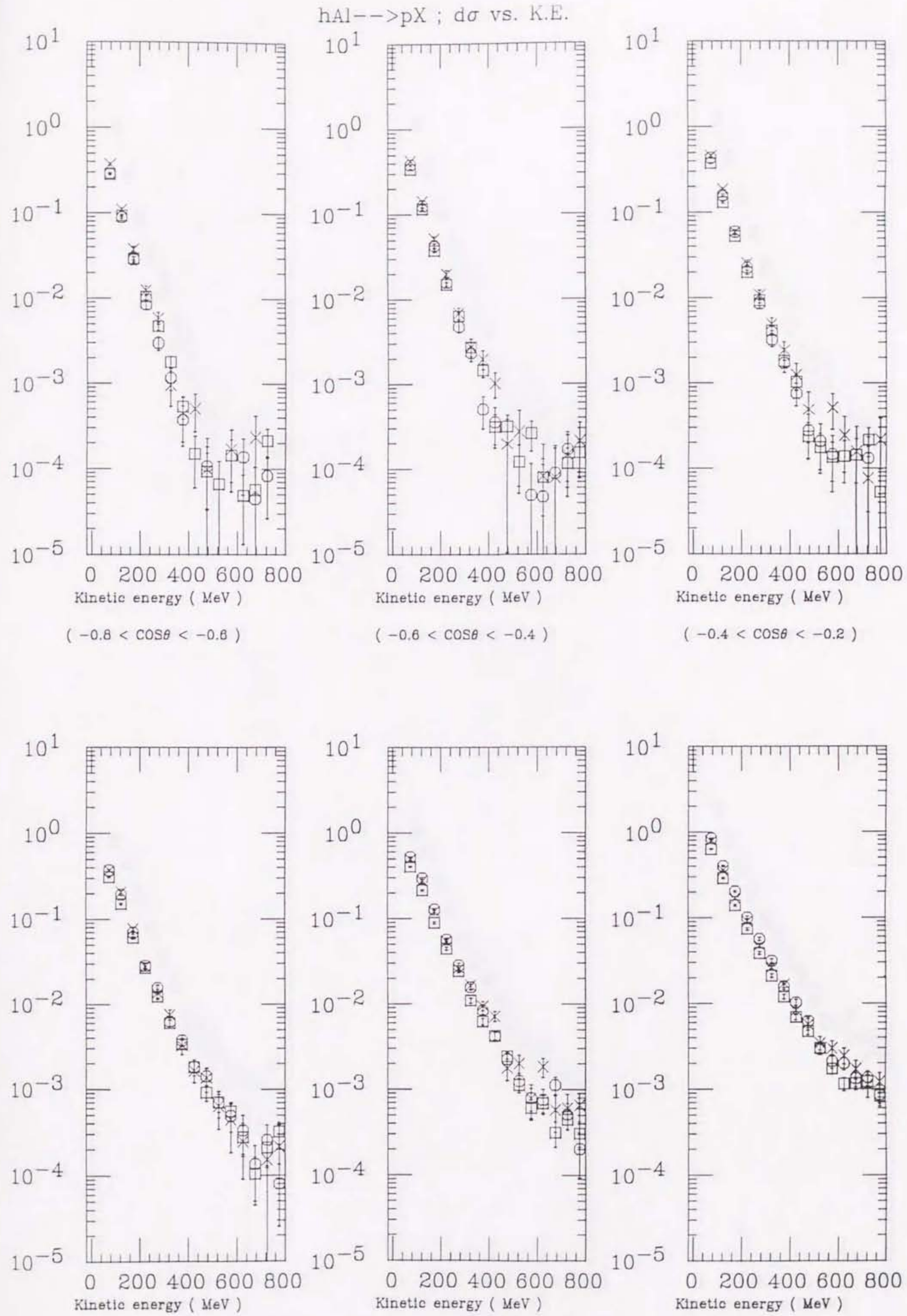

hAl-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^2c)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.1.C

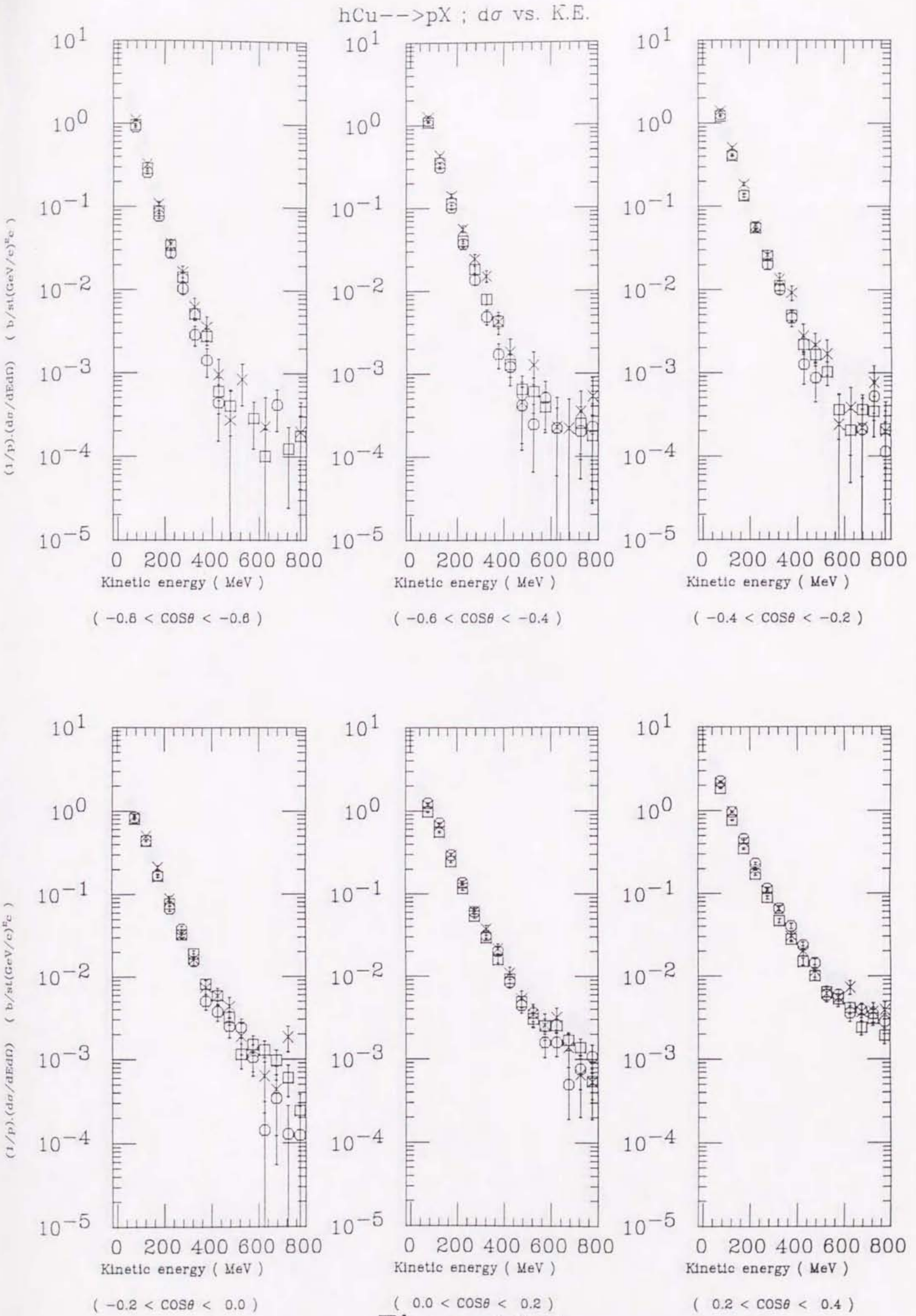

hCu-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/sr(GeV/c)²c)
10¹
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.1.D

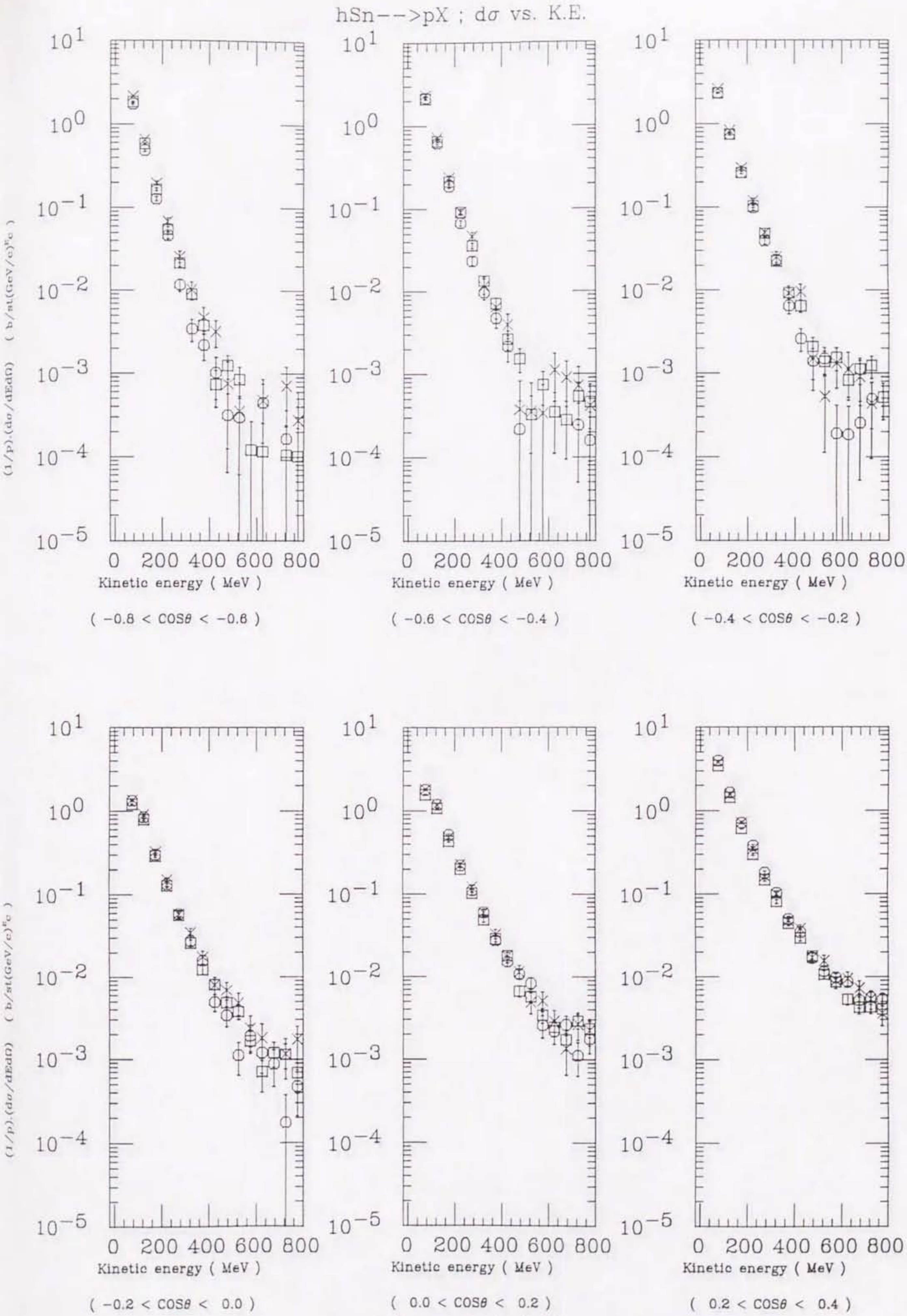

hSn-->pX ; dσ vs. K.E.
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.1.E

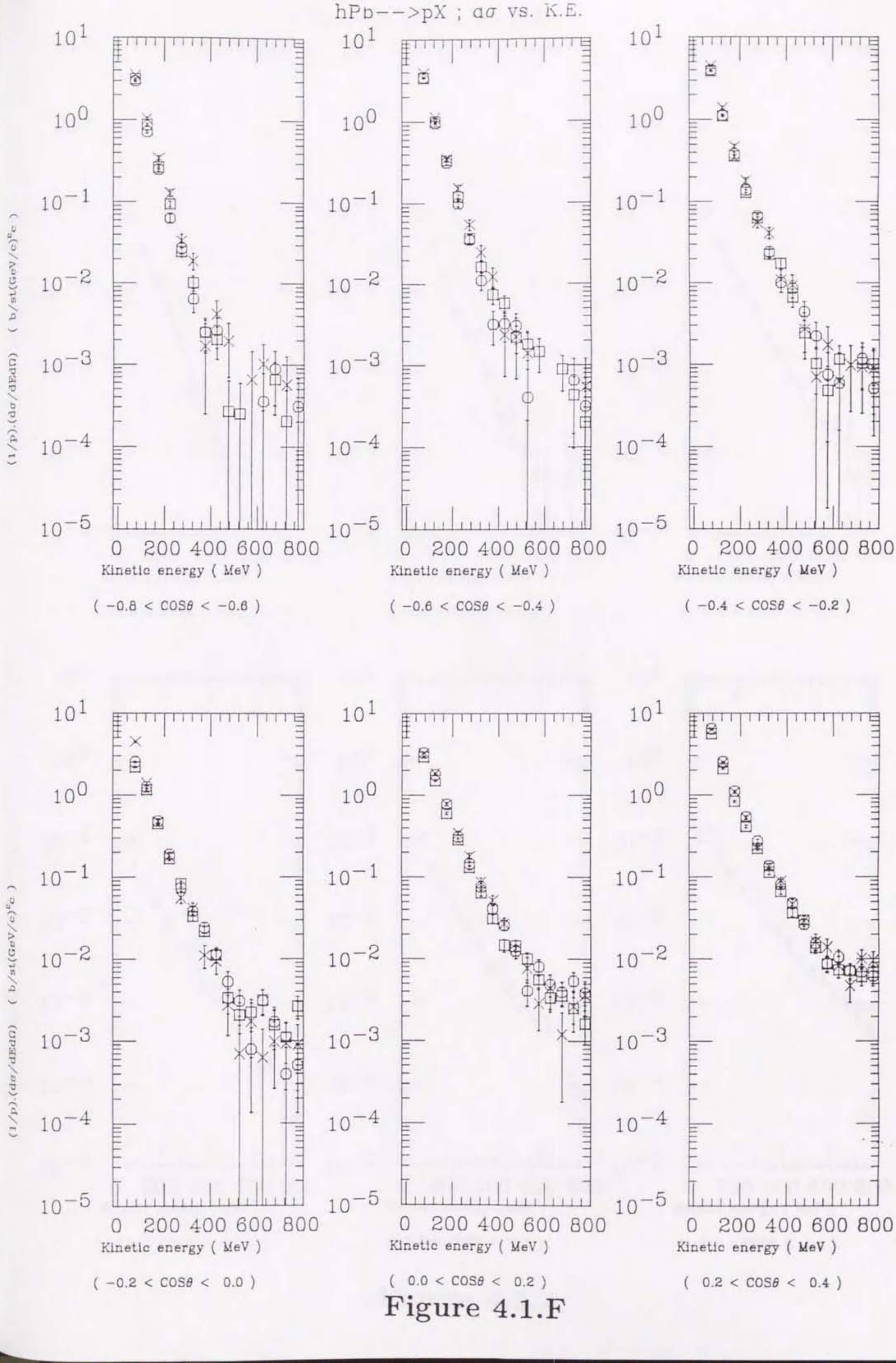

hPb-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^{2}c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.1.F

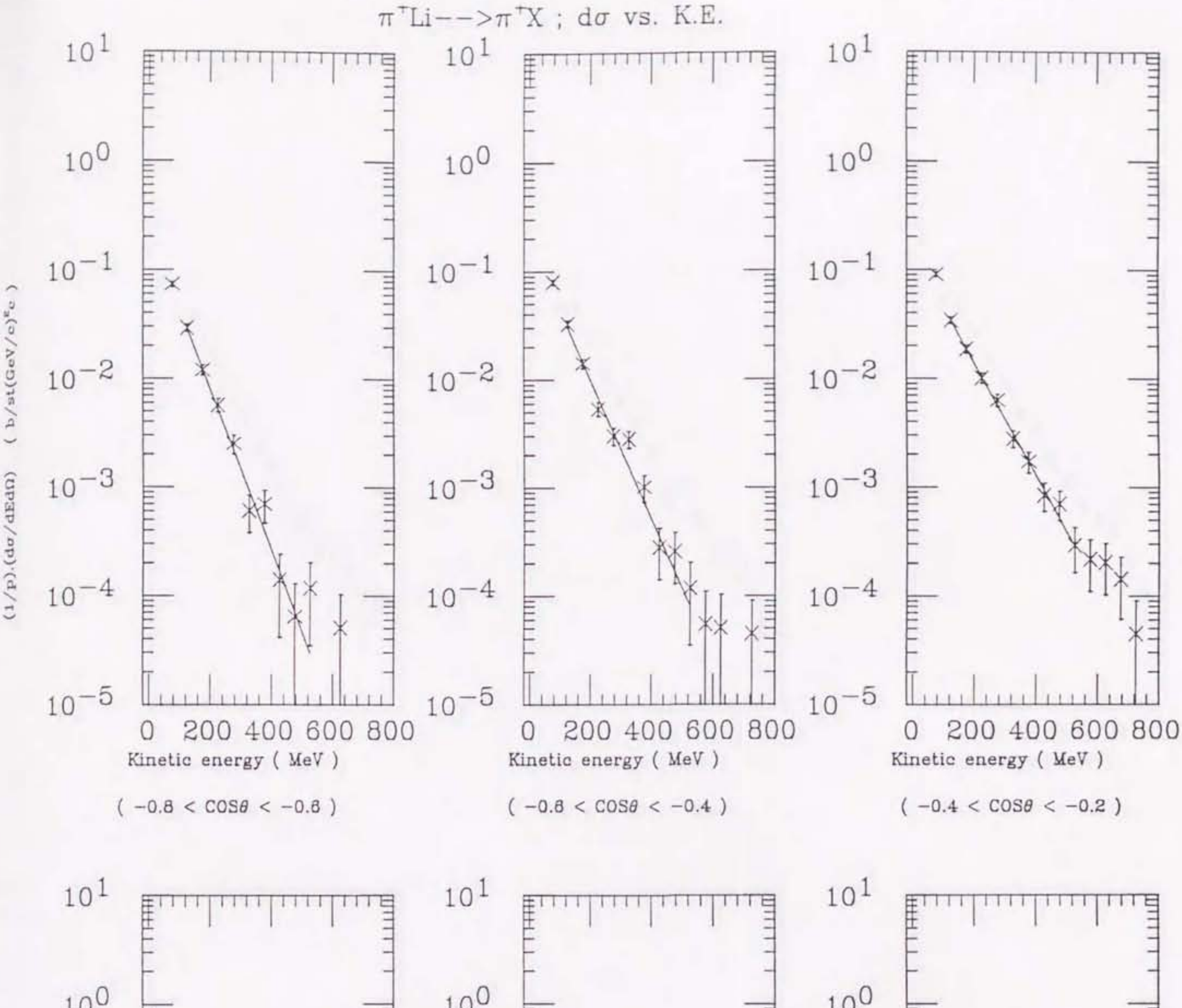
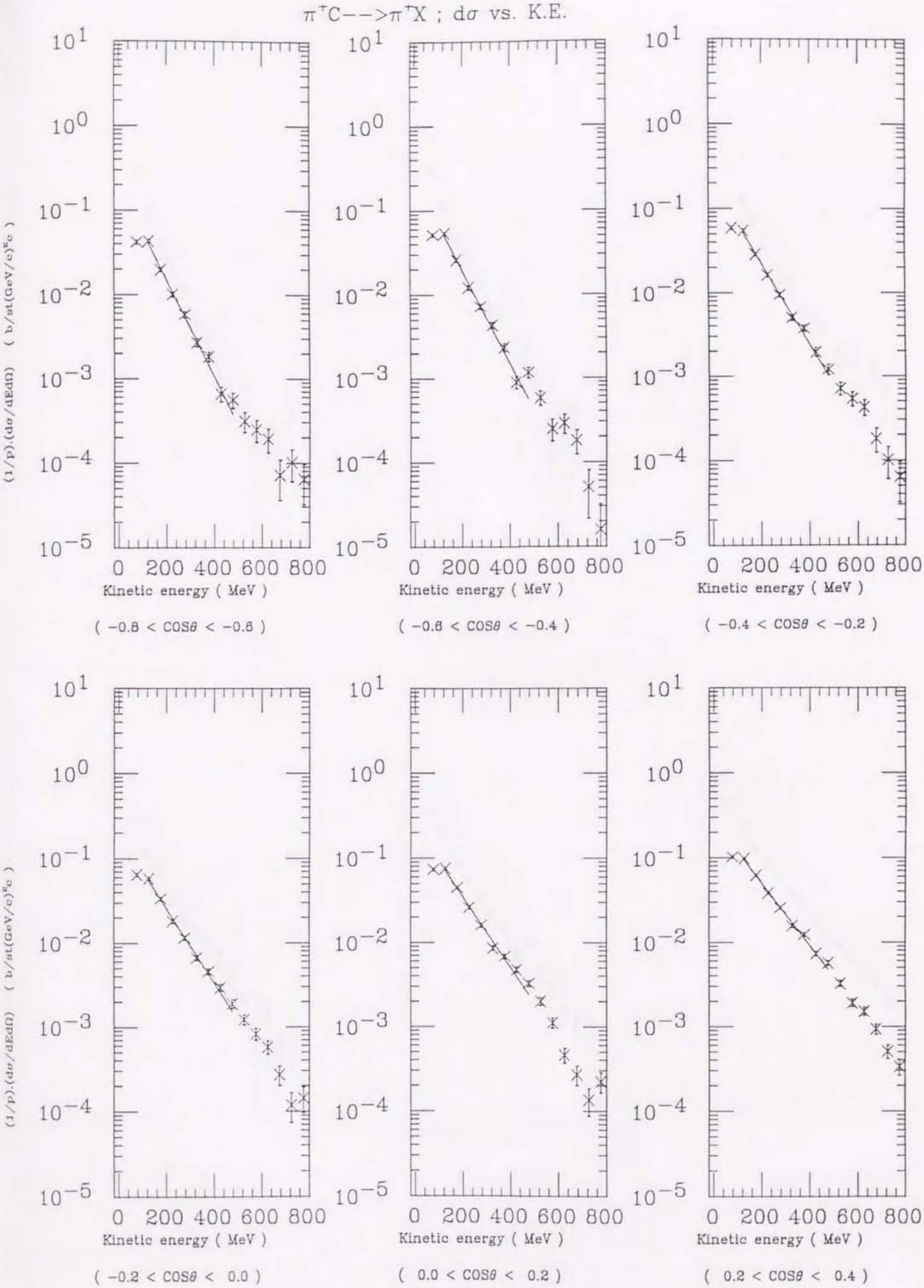
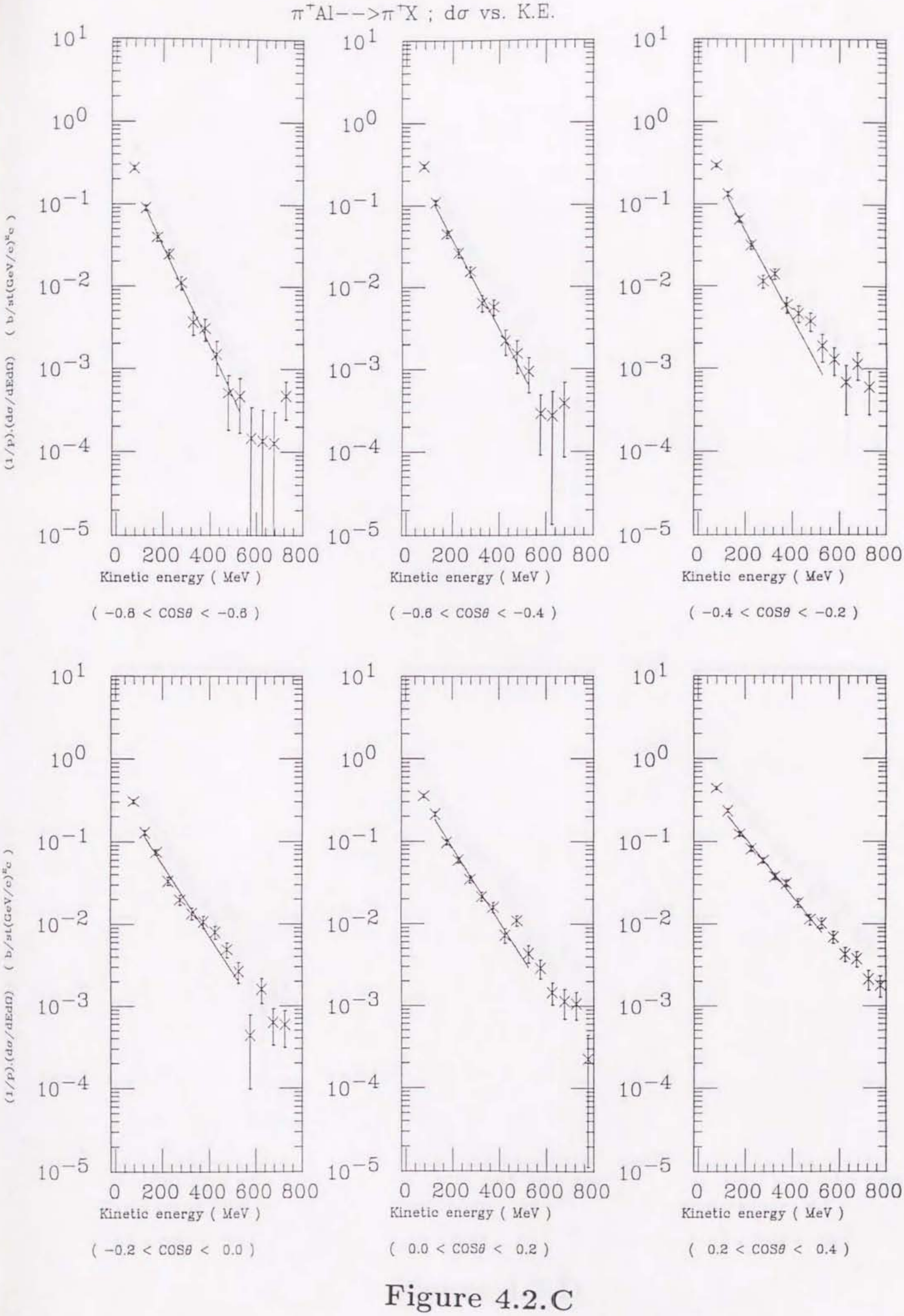

π+Li-->π+X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.A



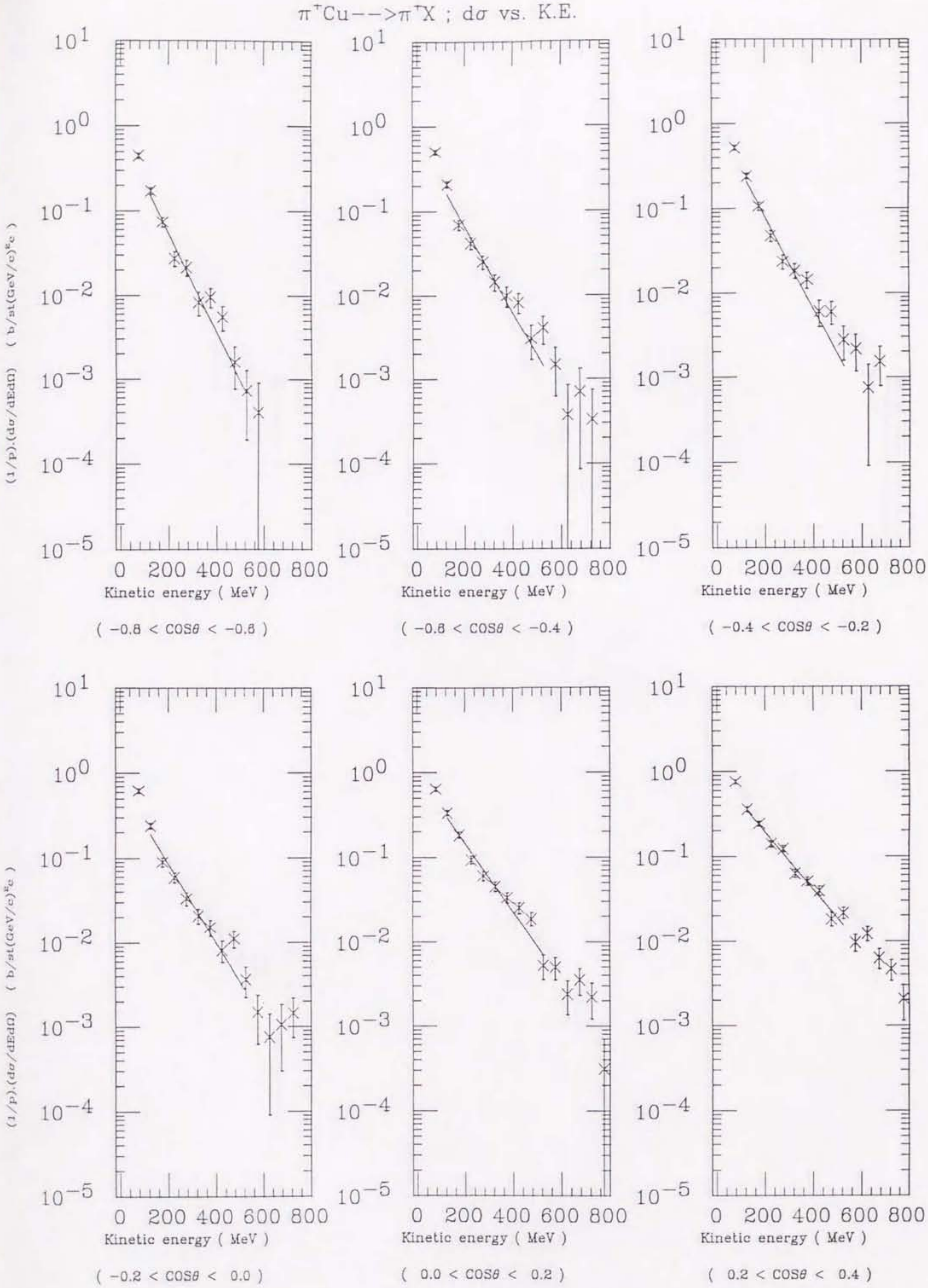
π⁺C-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)³c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.B



π⁺Al-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.C



π⁺Cu-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
10¹
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.D

$\pi^+Sn \to \pi^+X$; $d\sigma$ vs. K.E.

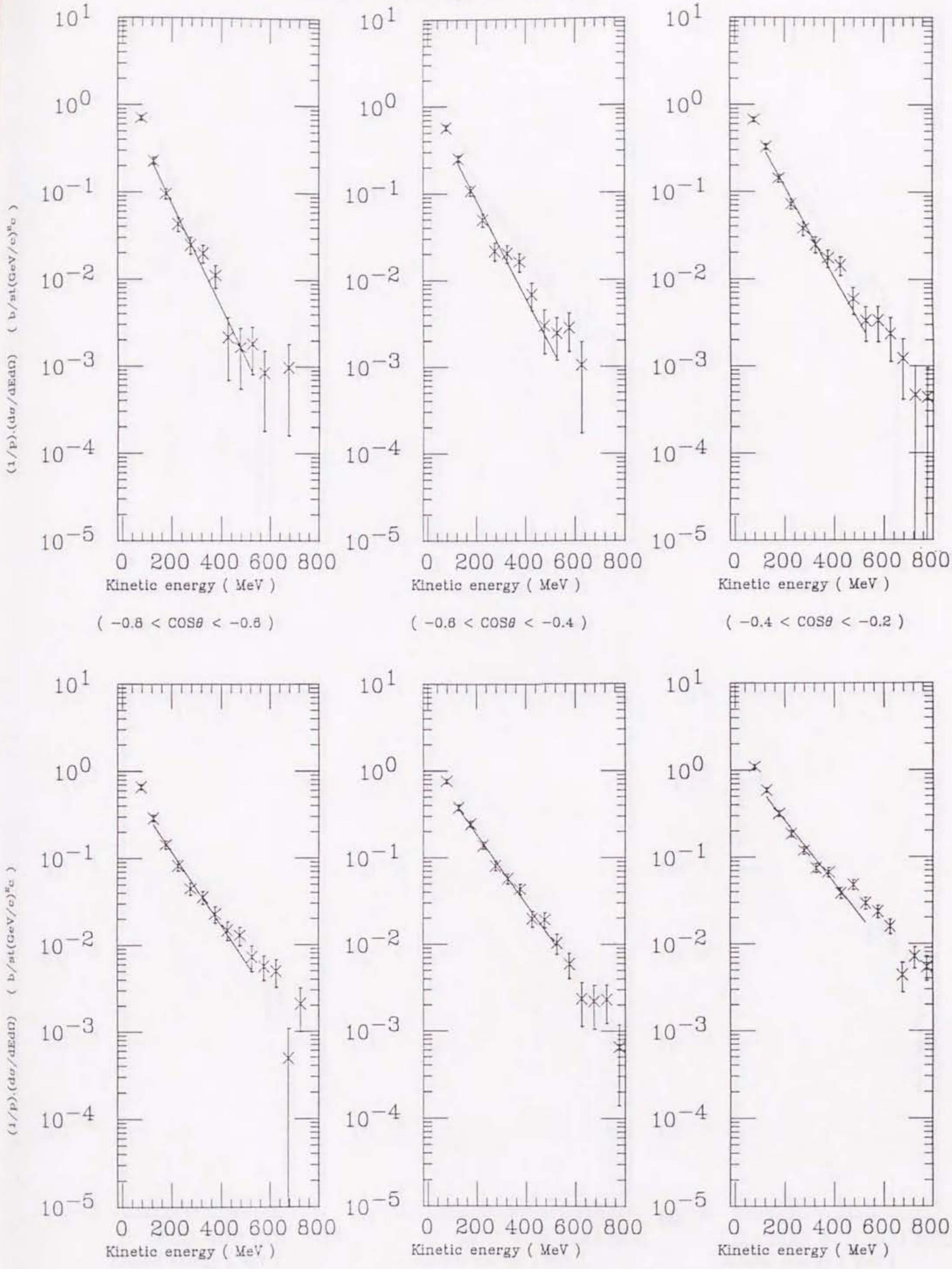


Figure 4.2.E

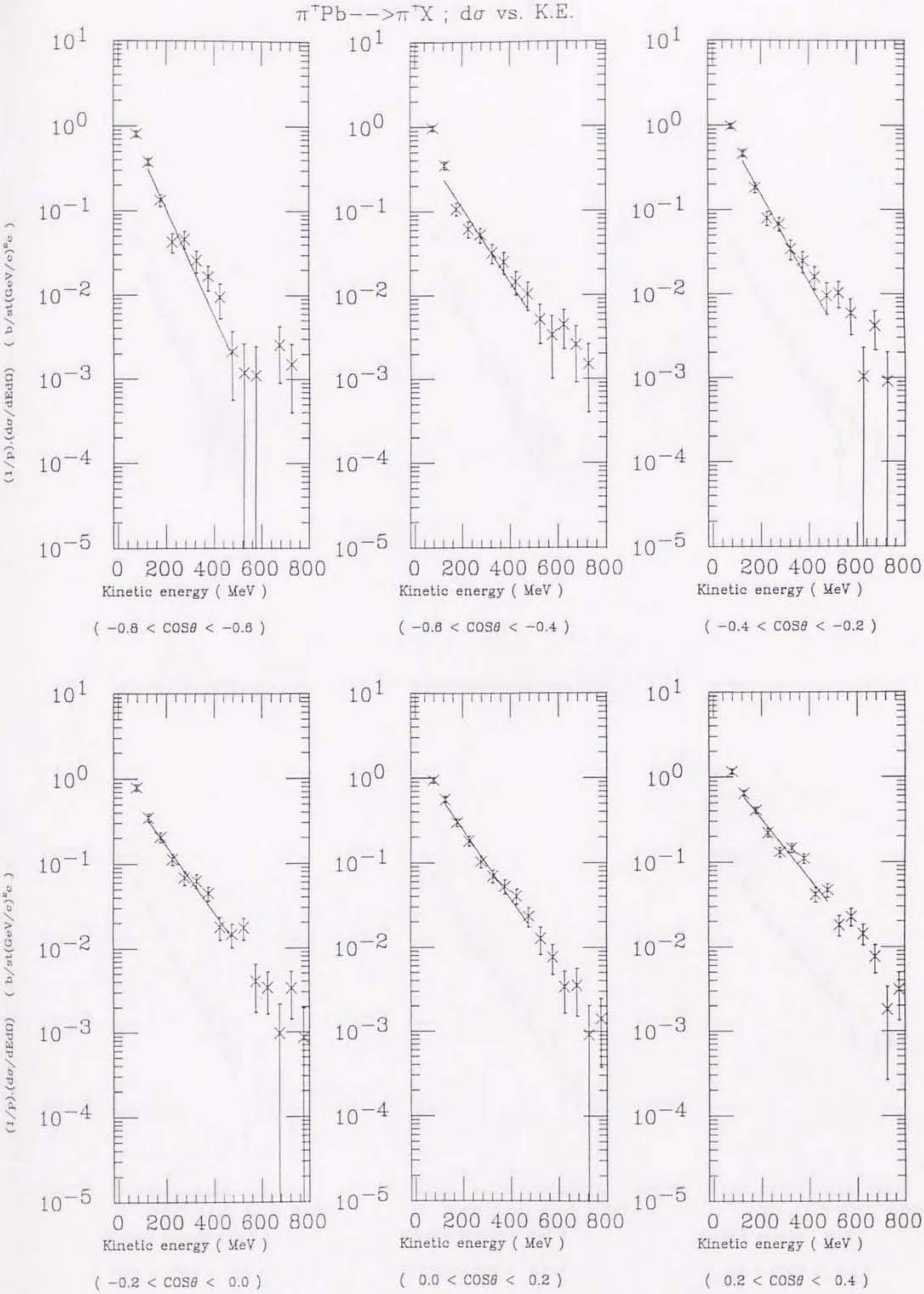

π⁺Pb-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.F

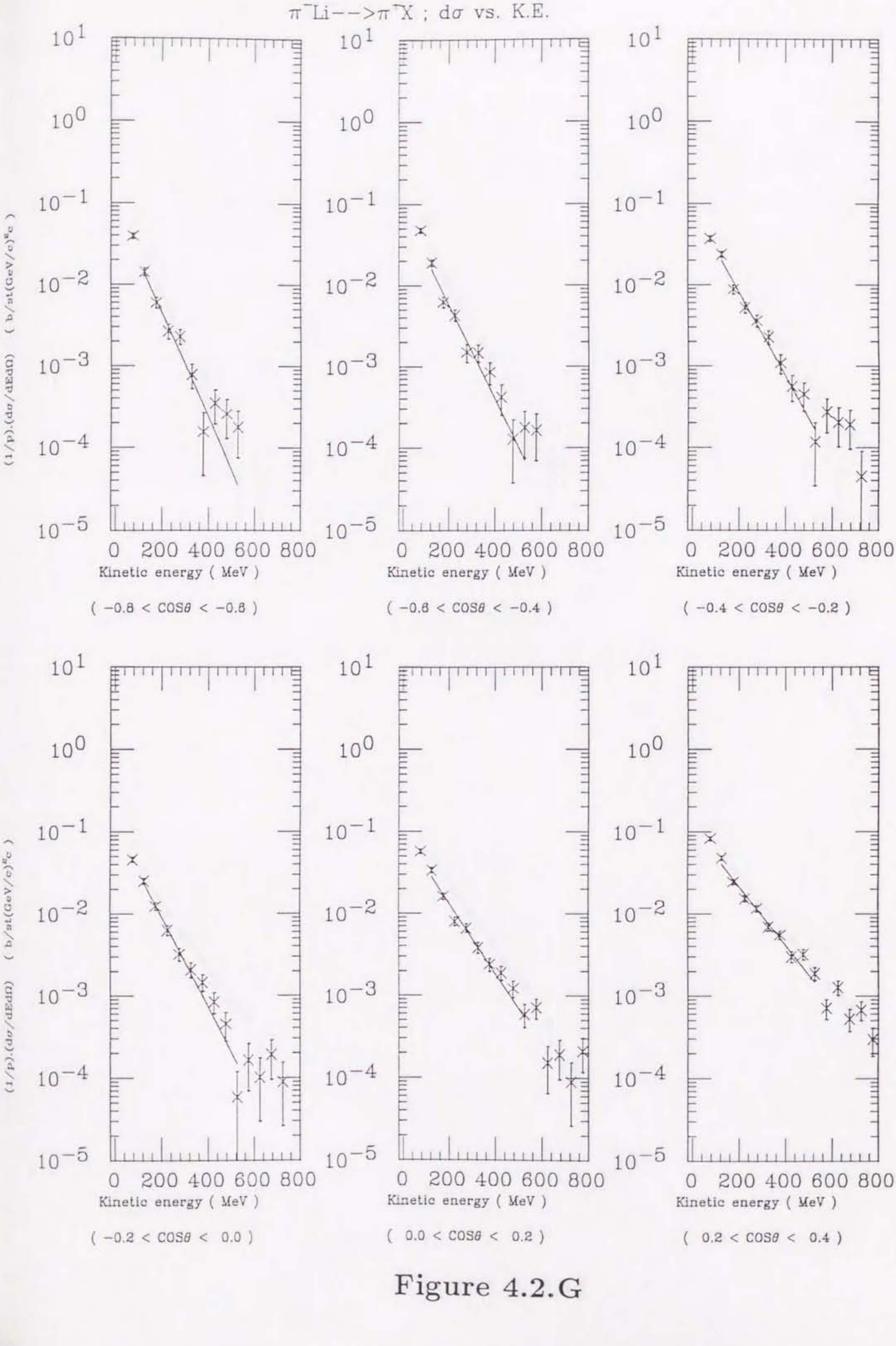

π⁻Li-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.G

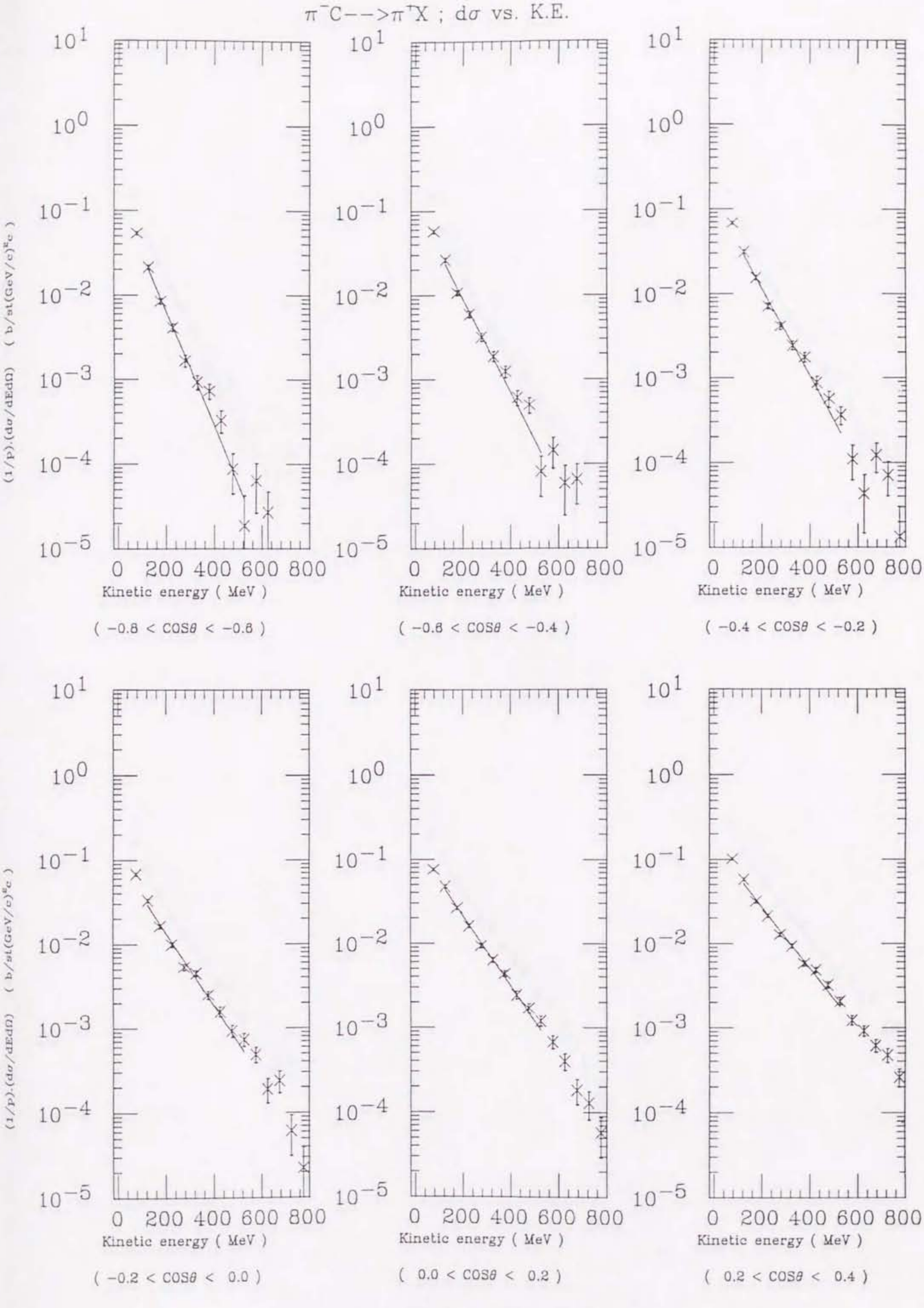

π⁻C-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.H

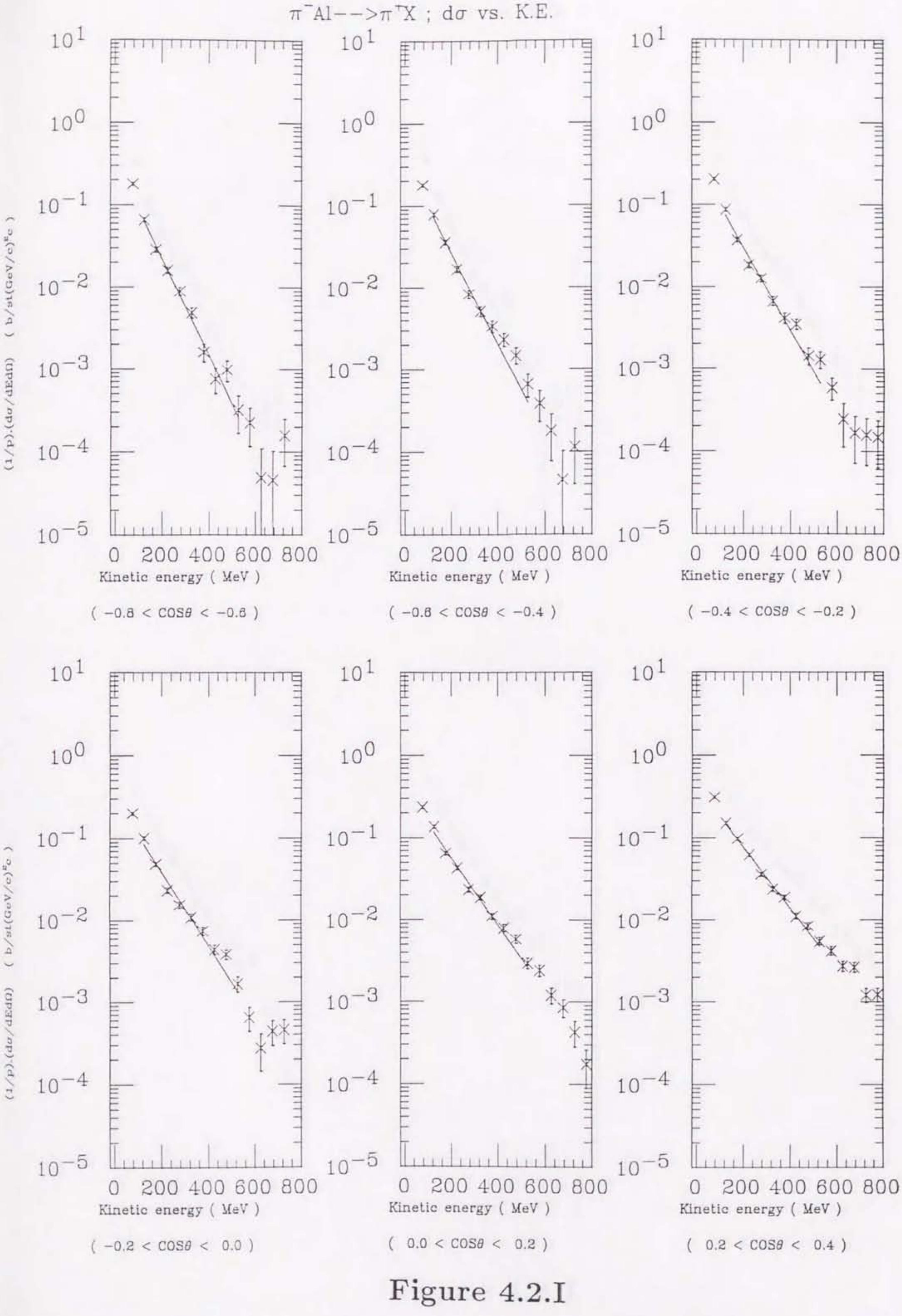

π⁻Al-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
10¹
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.I

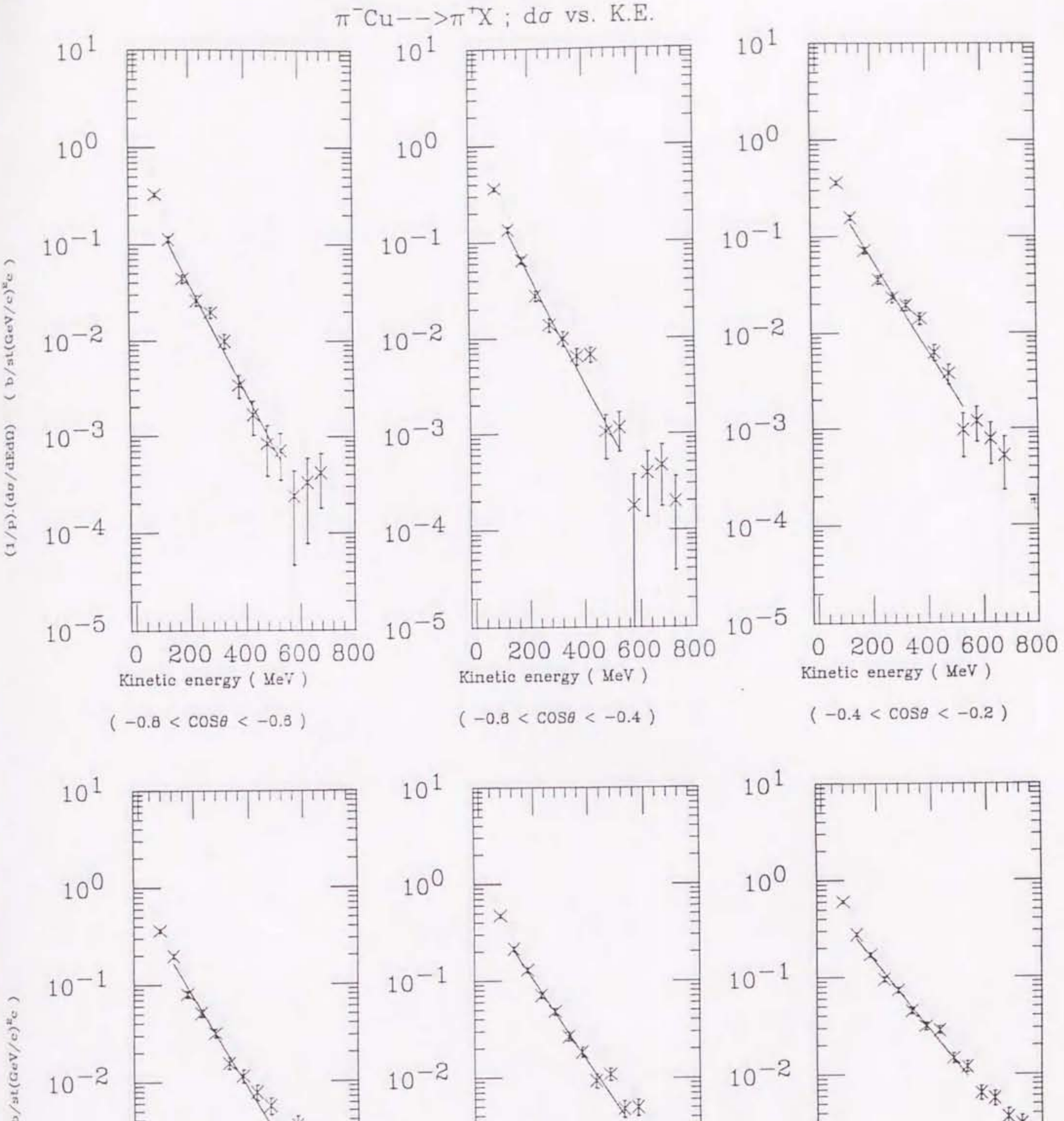

π⁻Cu-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.J

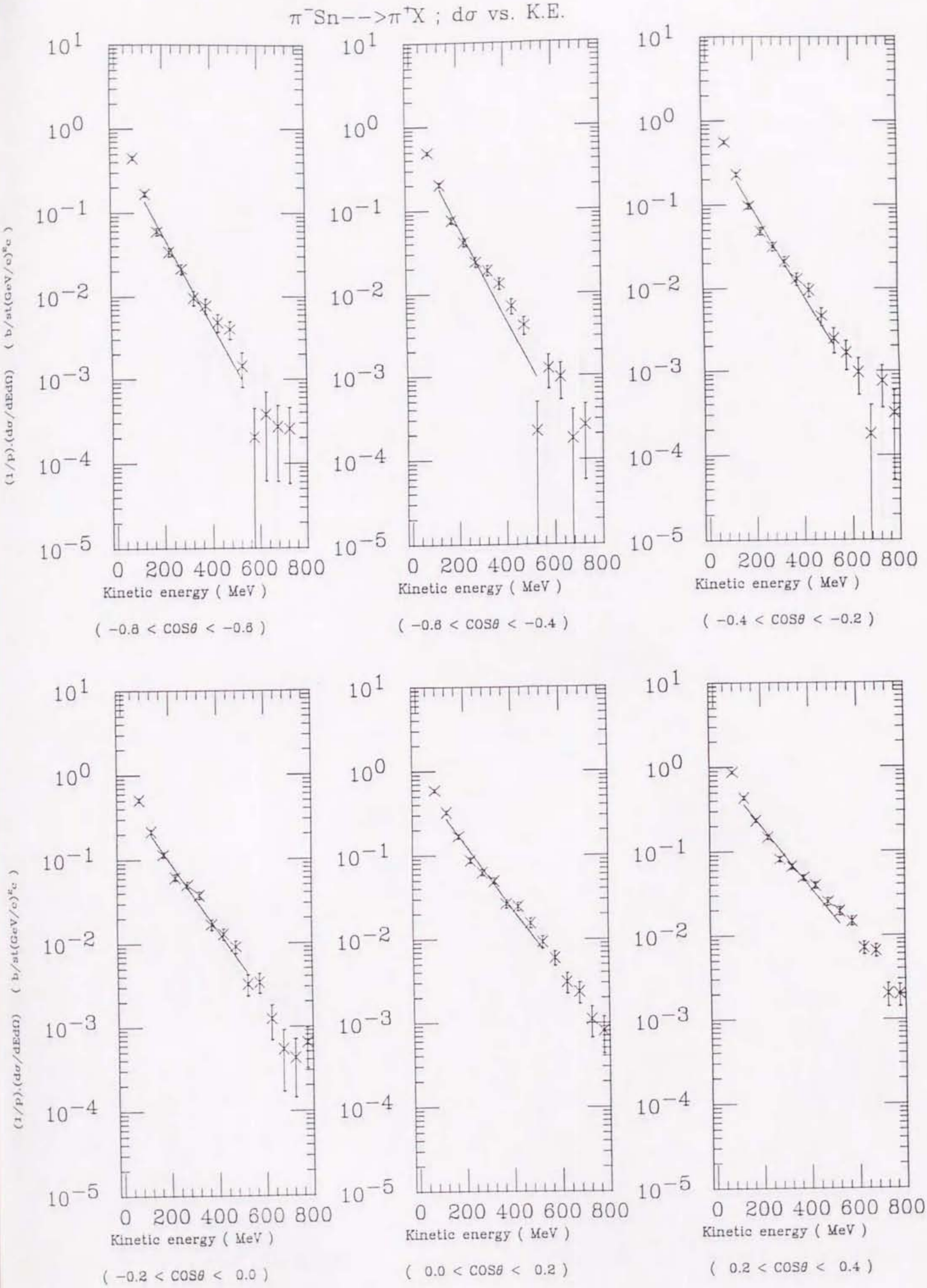

π⁻Sn-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.K

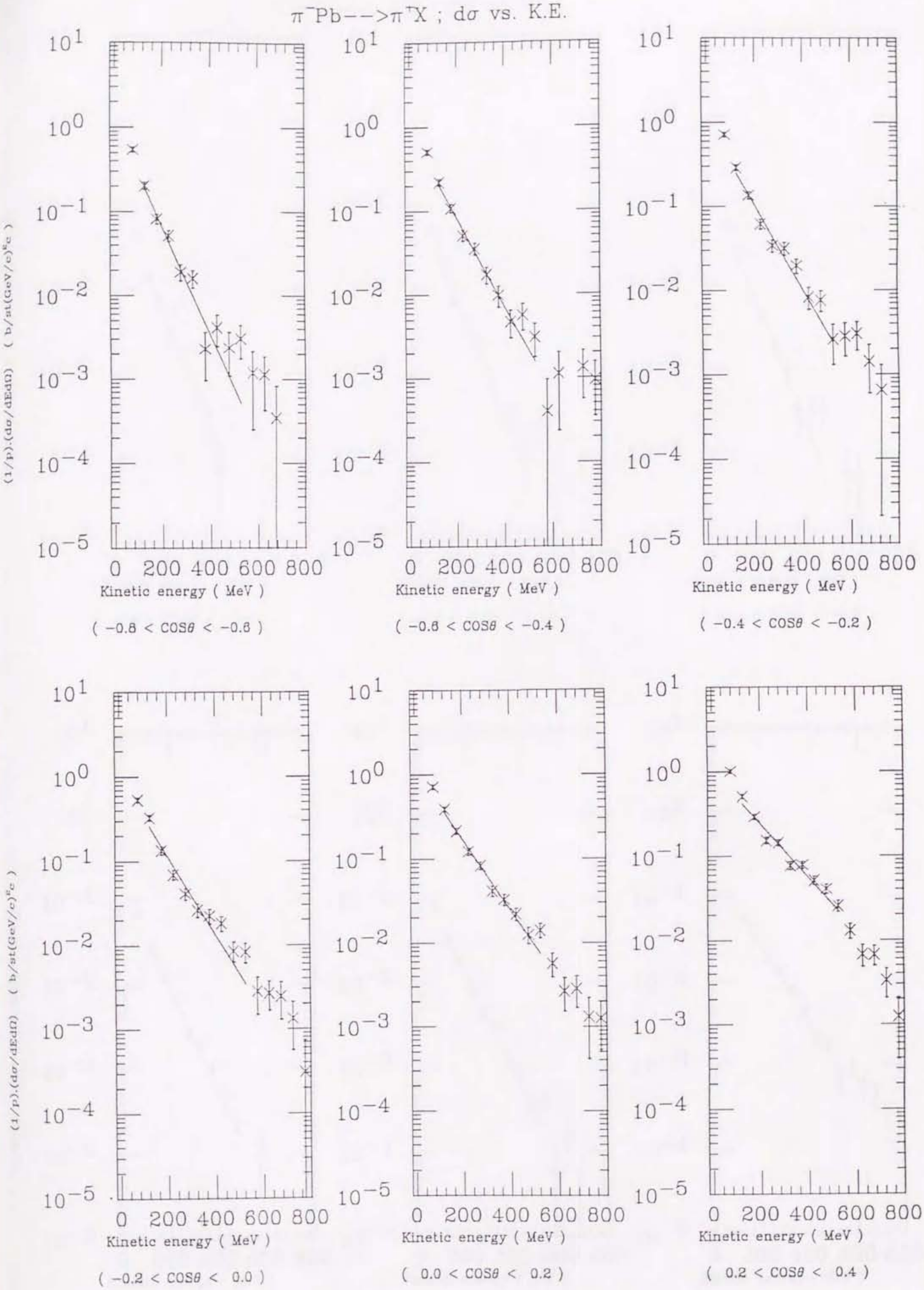

π⁻Pb-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.2.L

$\pi^+ Li \to \pi^- X$; dσ vs. K.E.

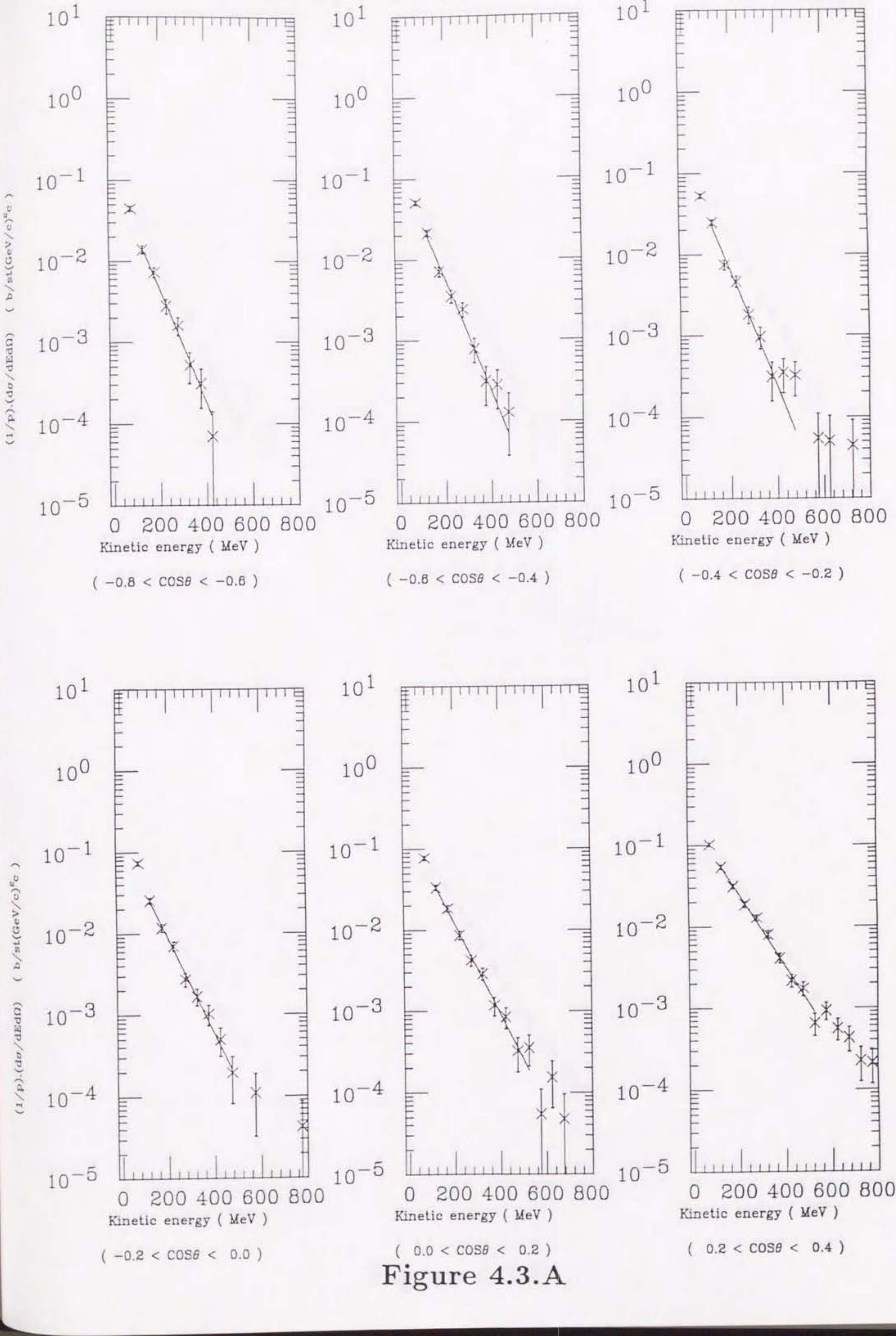
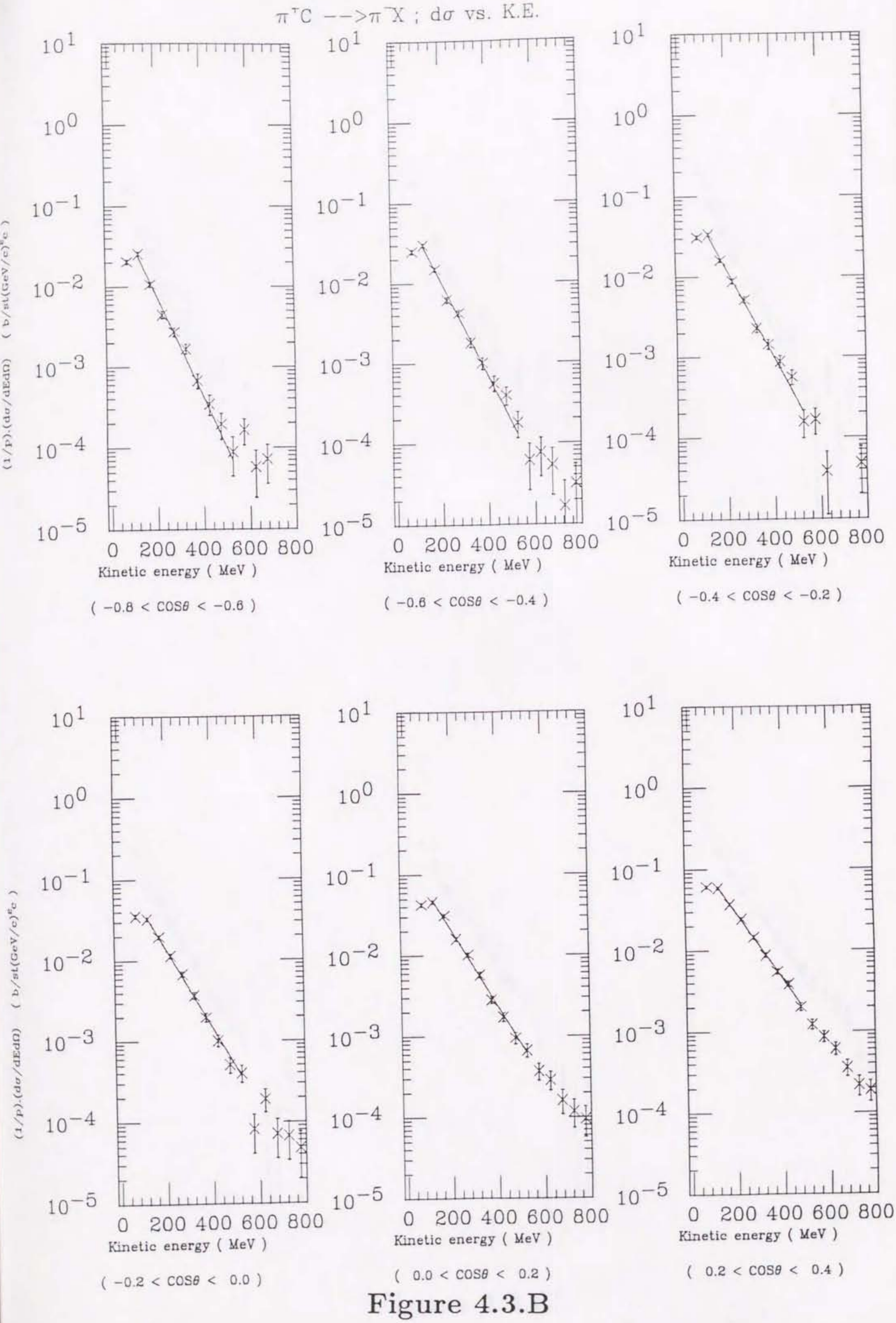
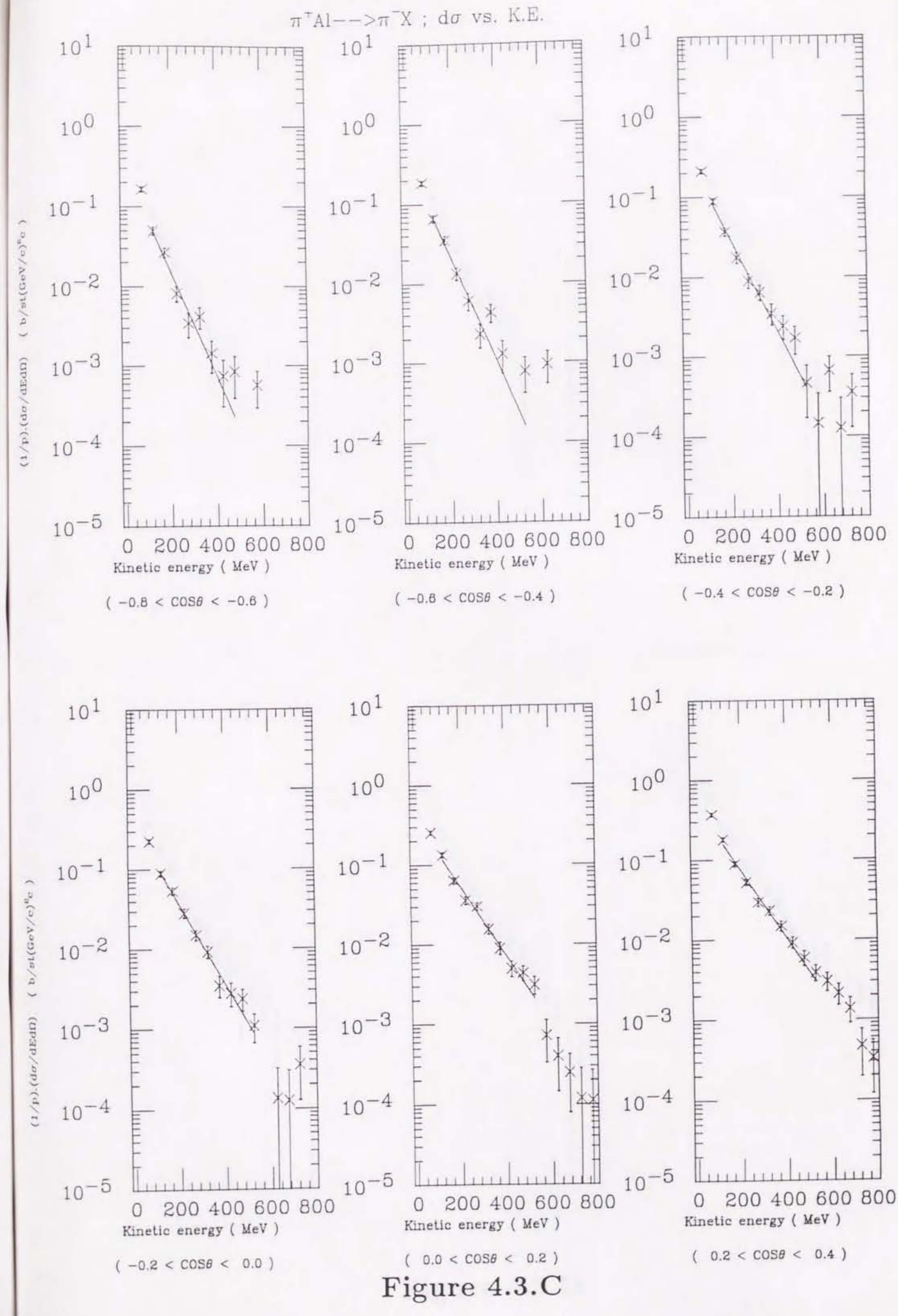


Figure 4.3.A



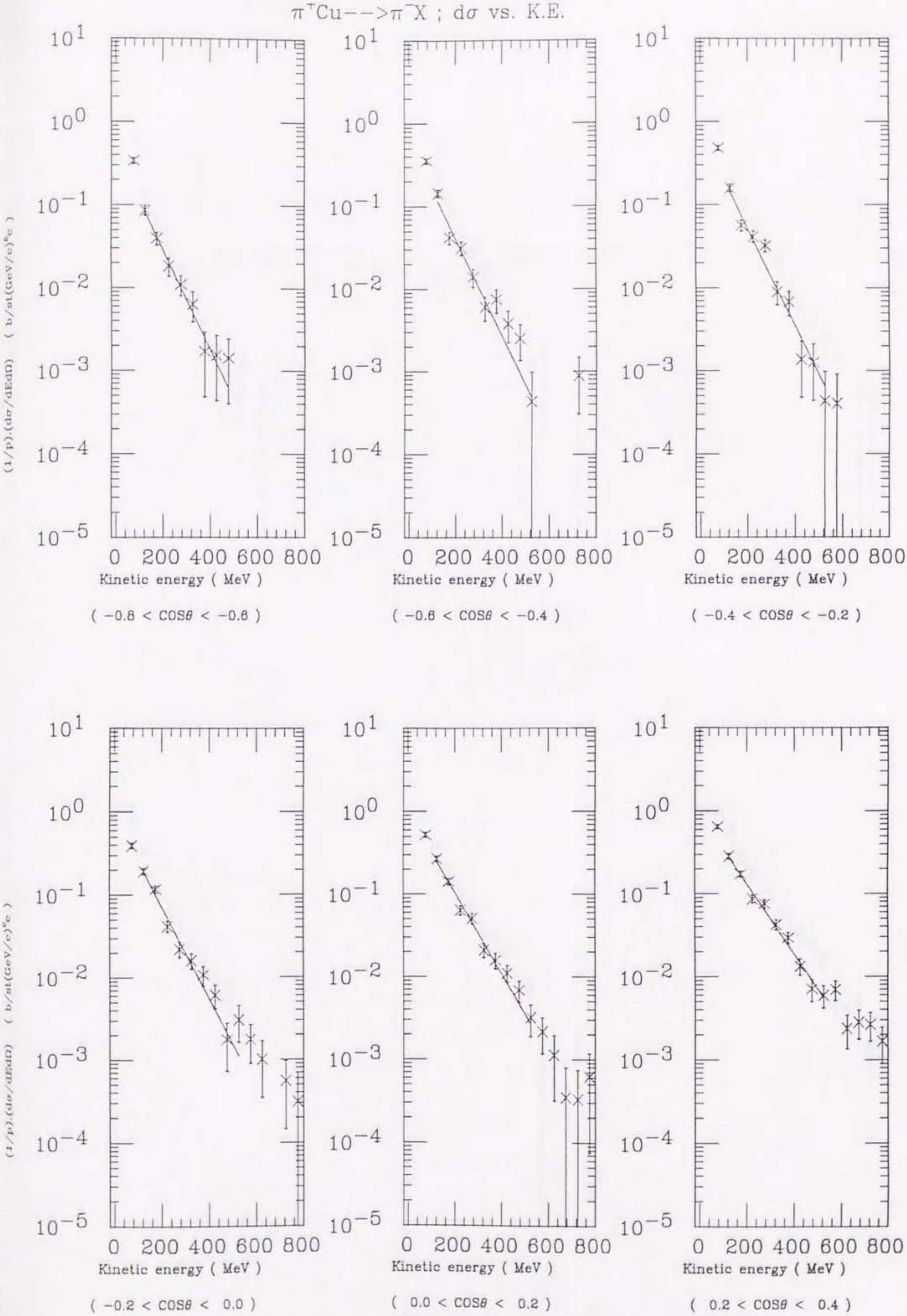
$\pi^+C \dashrightarrow \pi^- X$; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(−0.8 < COSθ < −0.6)
(−0.6 < COSθ < −0.4)
(−0.4 < COSθ < −0.2)
(−0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.B



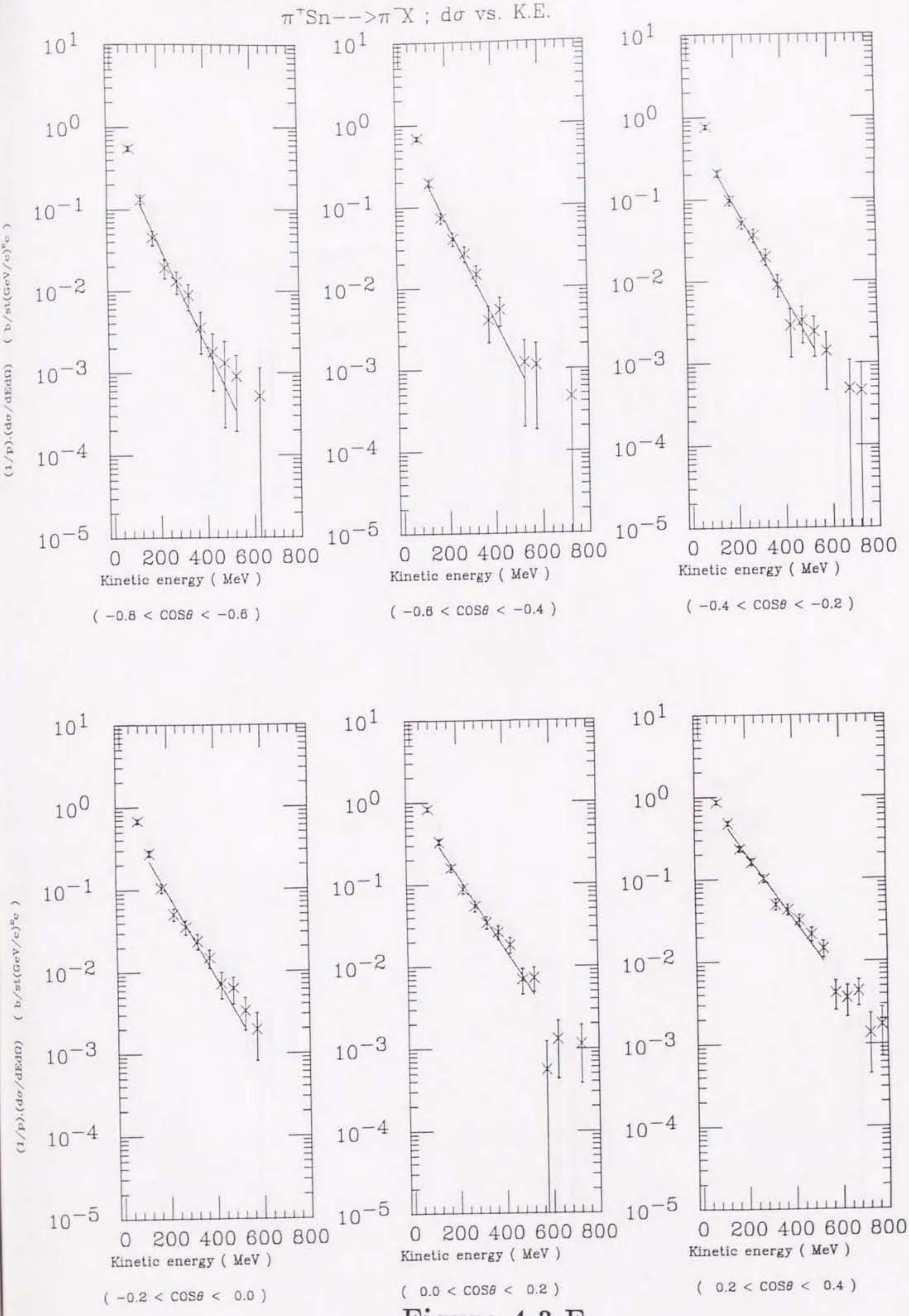
$\pi^+ Al \rightarrow \pi^- X$; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.C



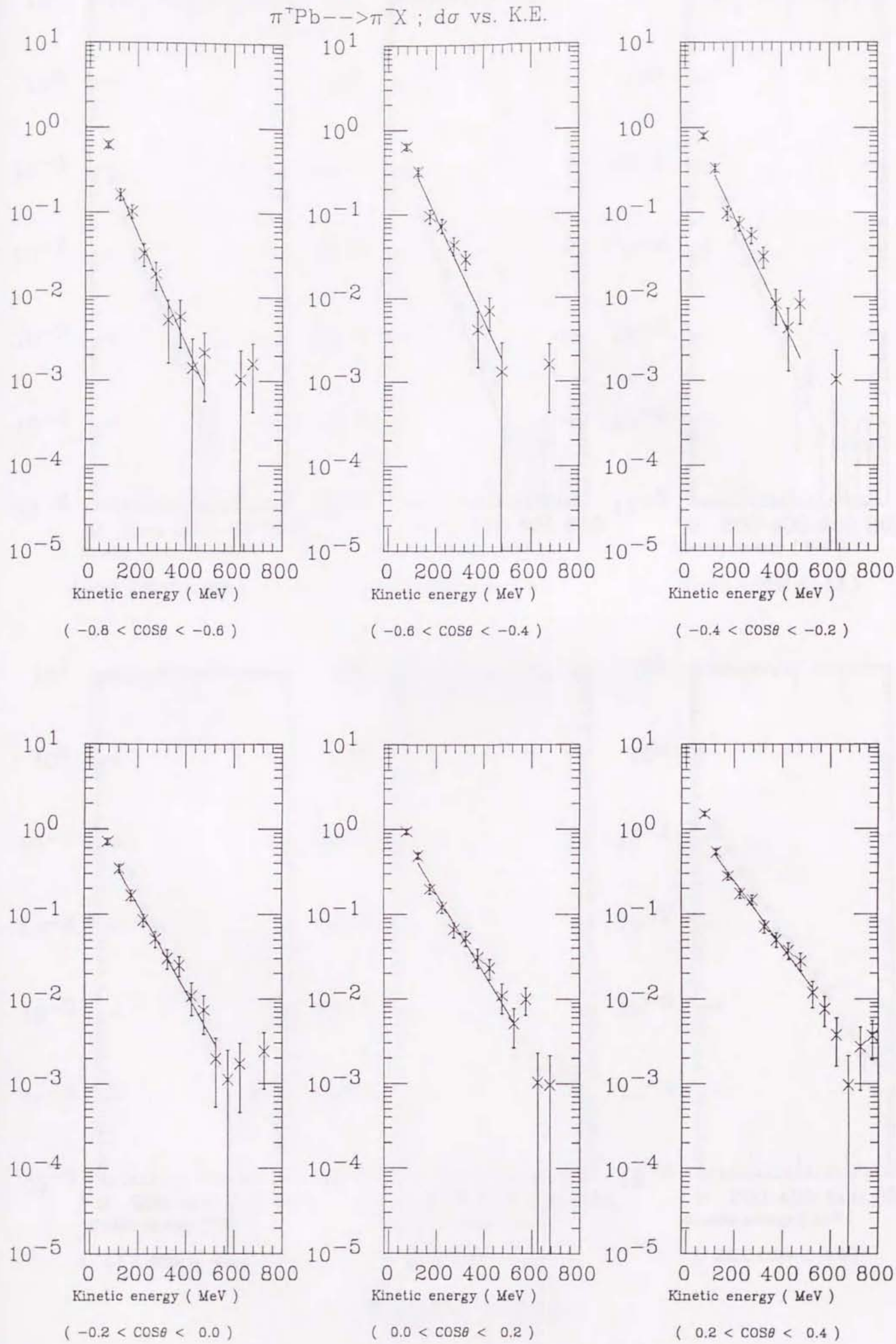
π⁺Cu-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.D



$\pi^+Sn \rightarrow \pi^- X$; dσ vs. K.E.
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^{2}c)
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.E



$\pi^+Pb \rightarrow \pi^- X$; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.F

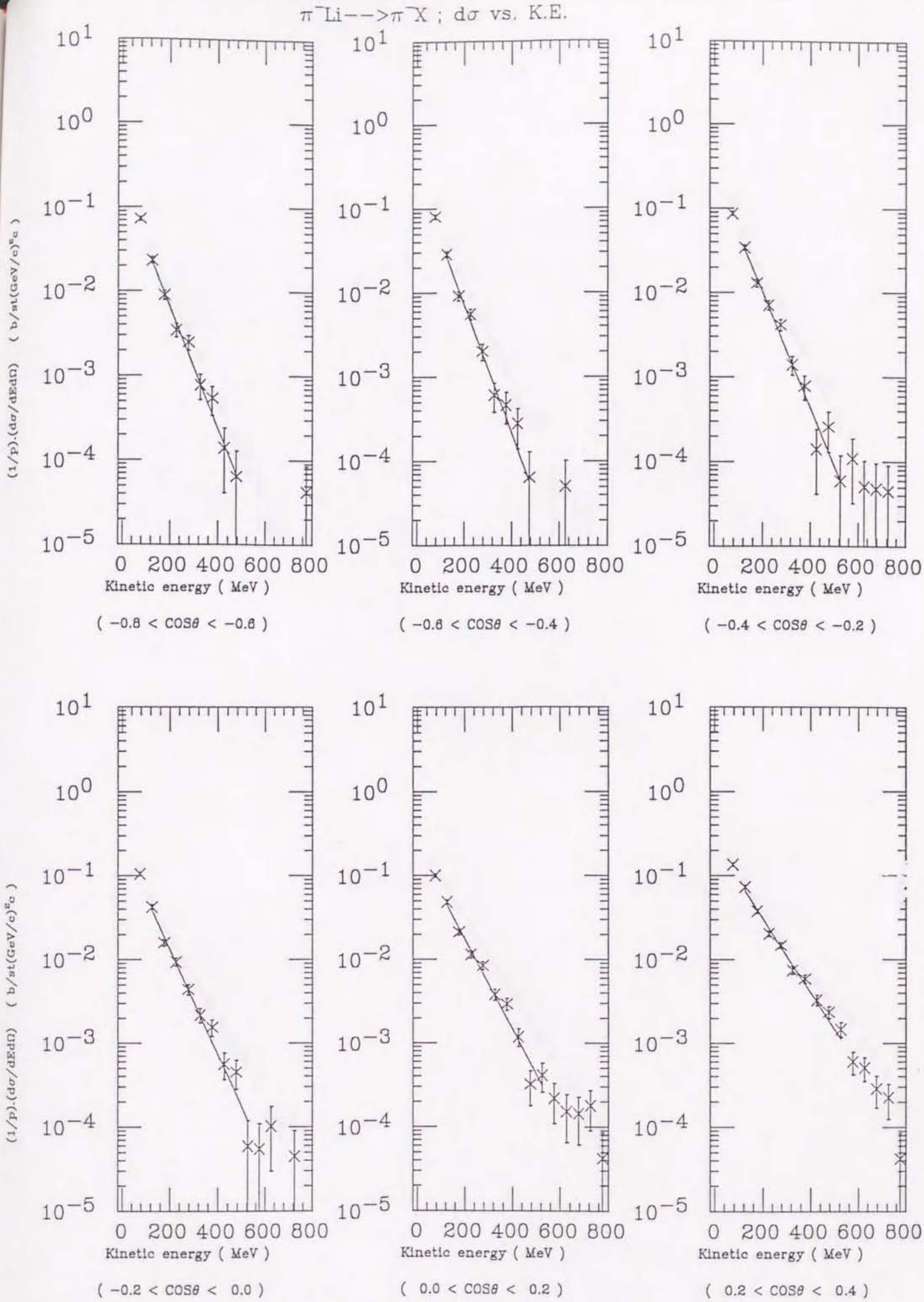

π⁻Li-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.G

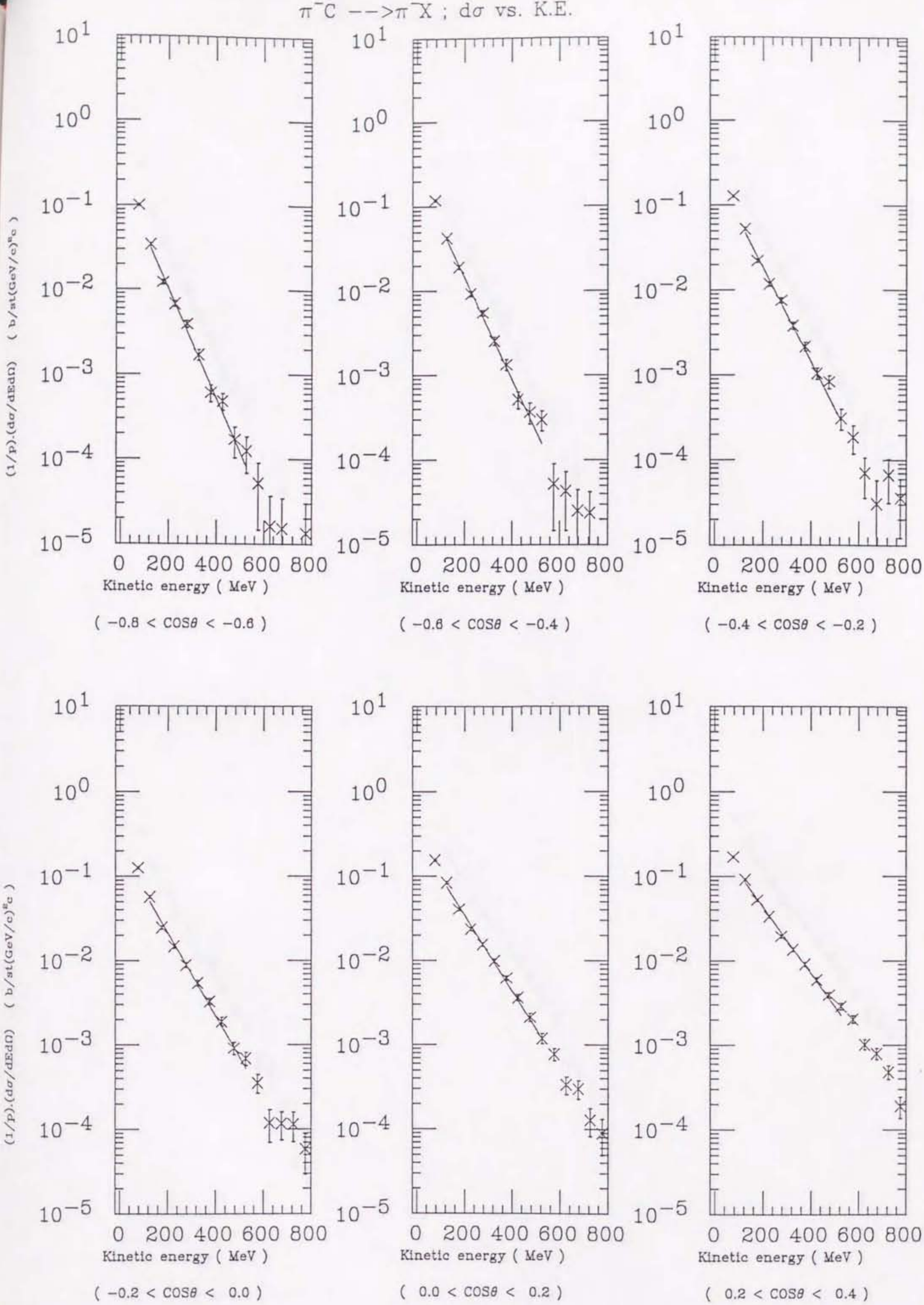

$\pi^-C \to \pi^-X$; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^{2}c)
Kinetic energy (MeV)
(−0.8 < COSθ < −0.6)
(−0.6 < COSθ < −0.4)
(−0.4 < COSθ < −0.2)
(−0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.H

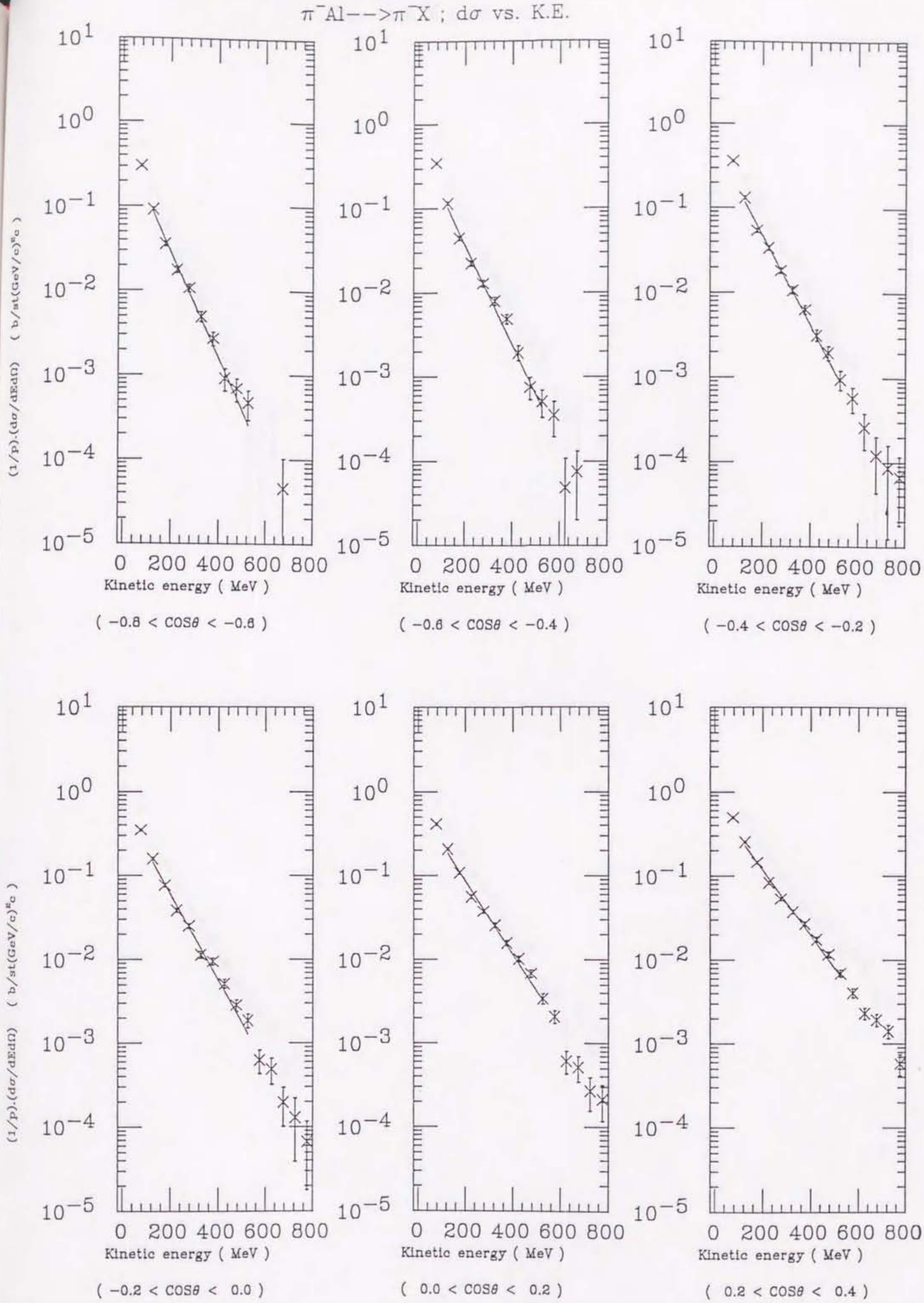
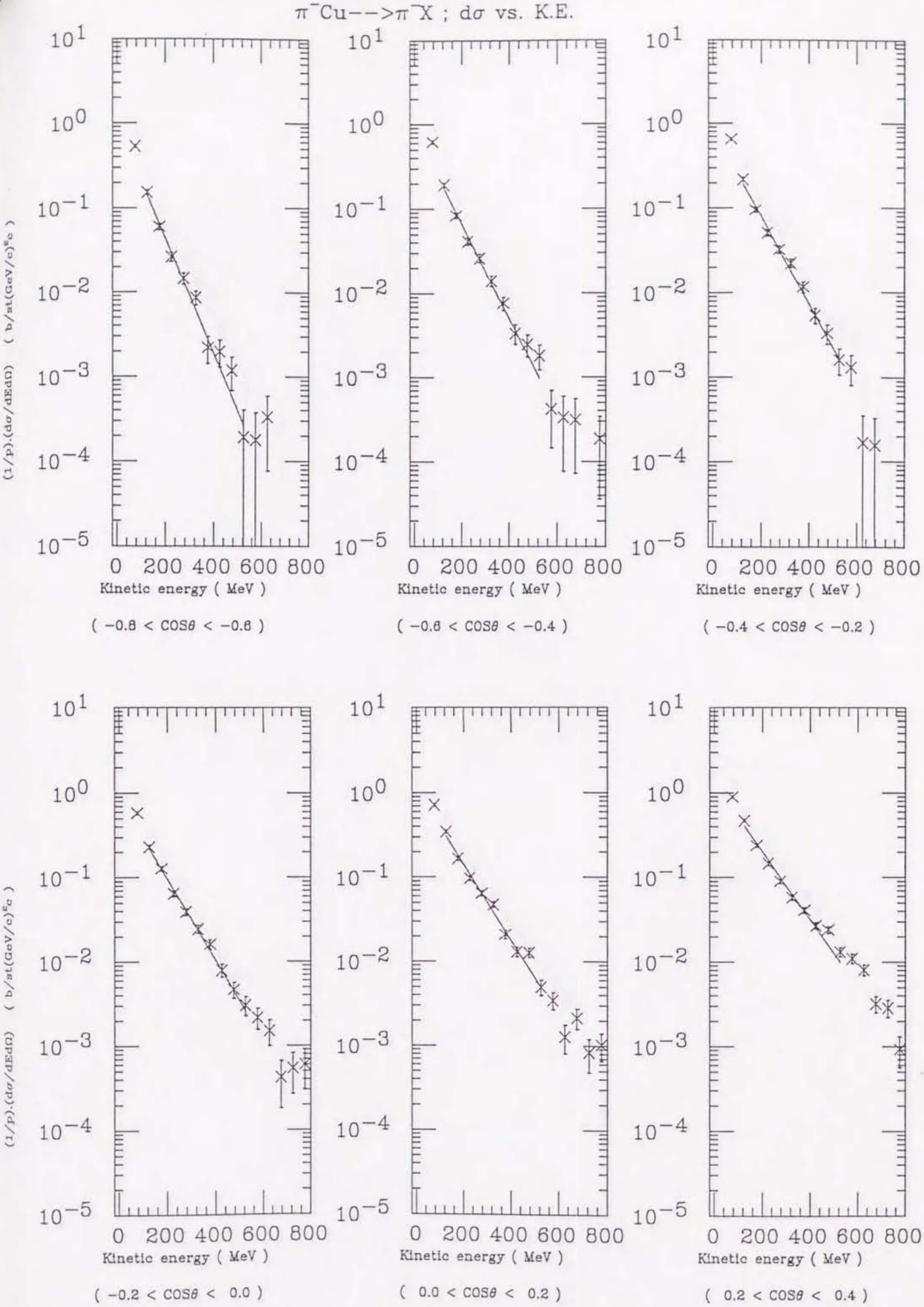

π¯Al-->π¯X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.I



π^-Cu-->π^-X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^{2}c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.J

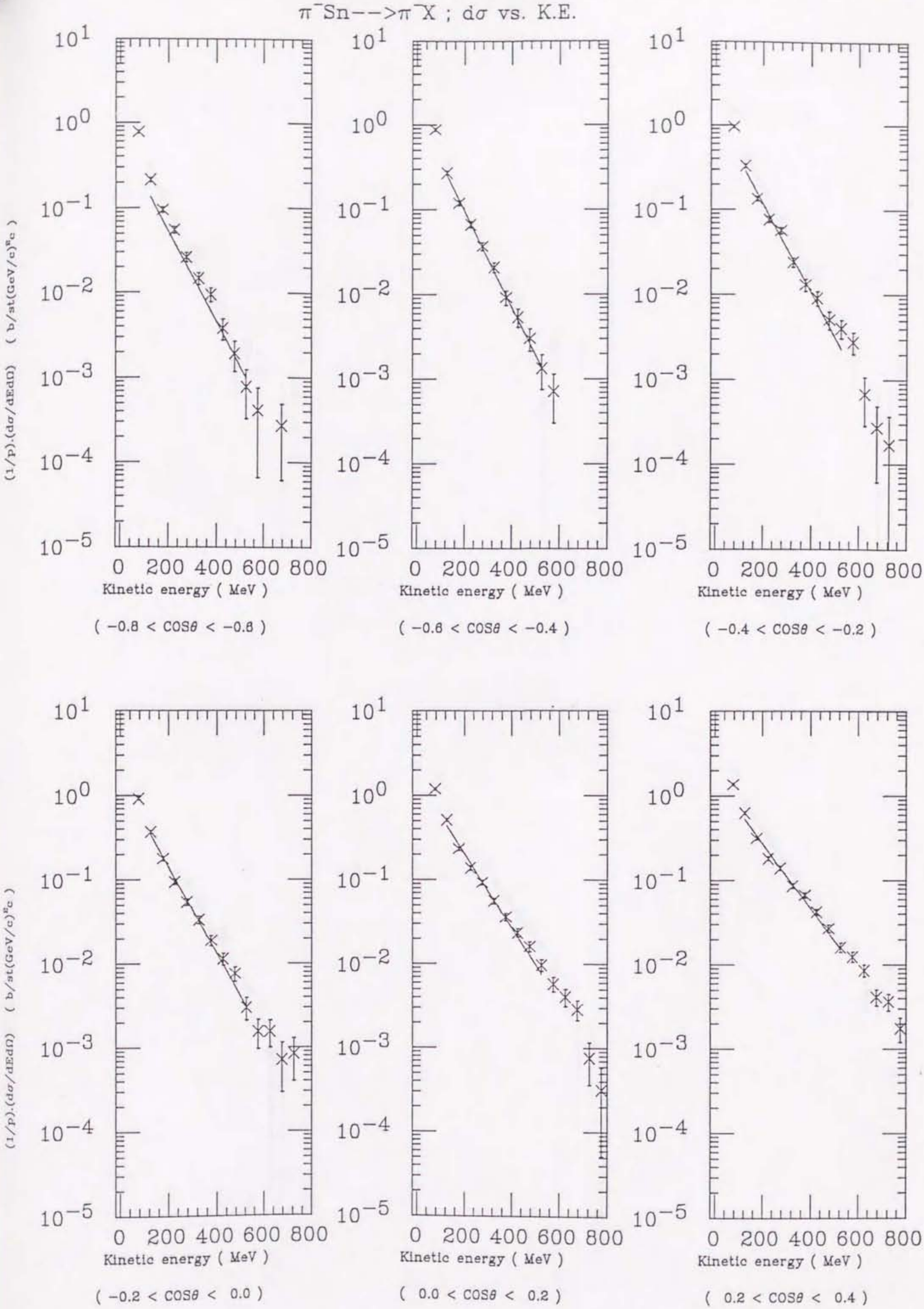

π⁻Sn-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.K

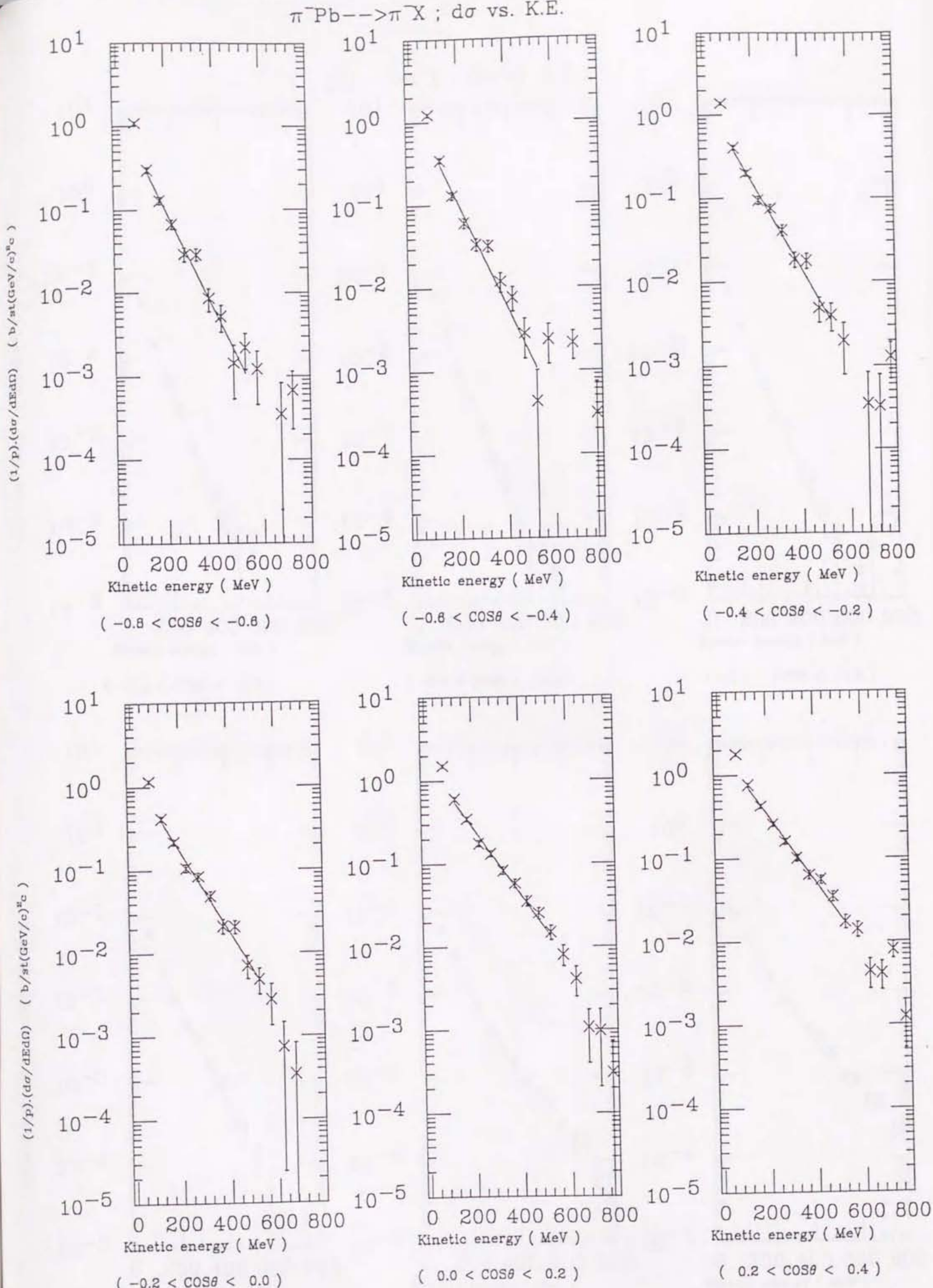
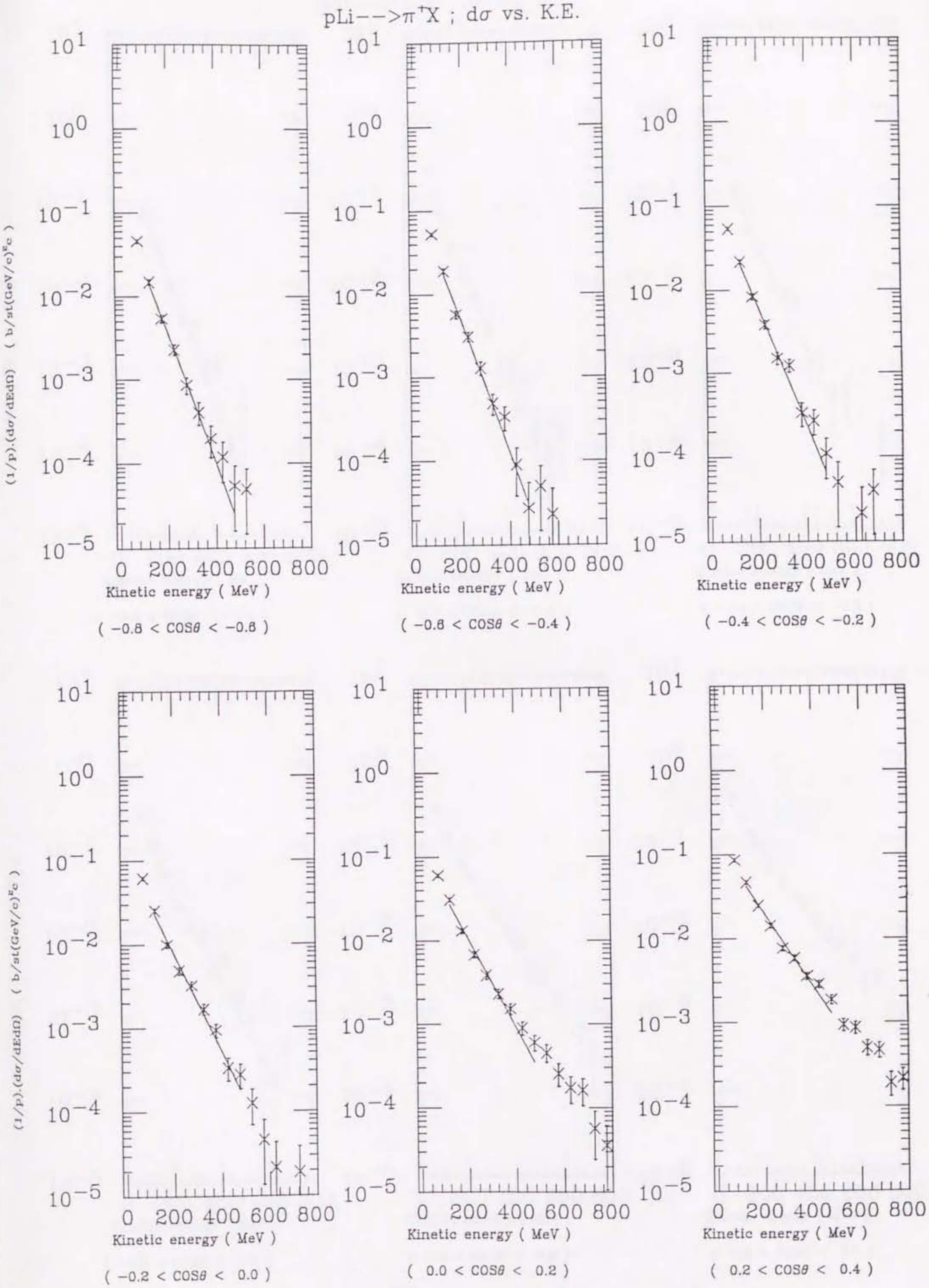

π⁻Pb-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.3.L



pLi-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
10¹
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.4.A

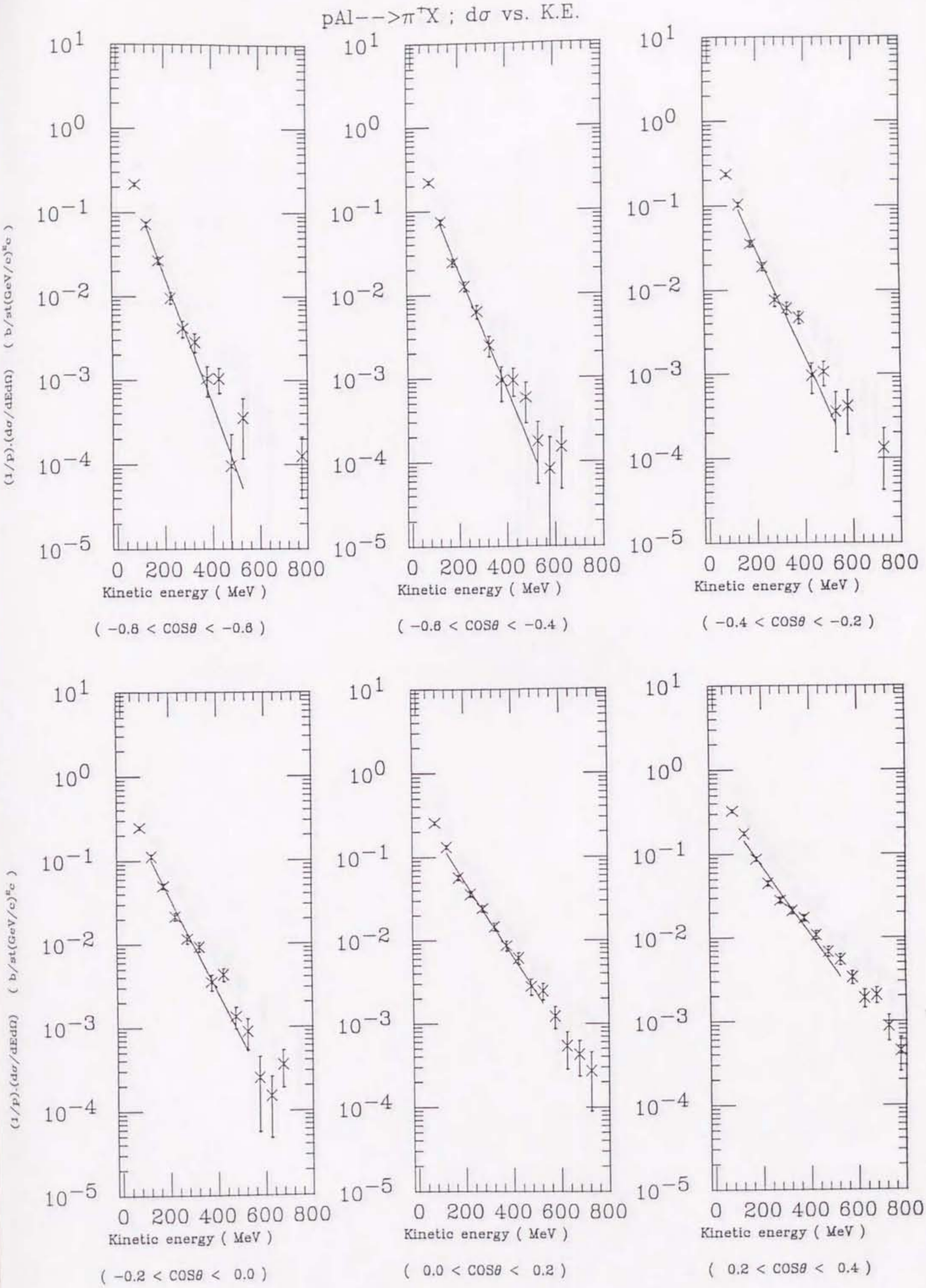

pAl-->π+X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^2c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.4.B

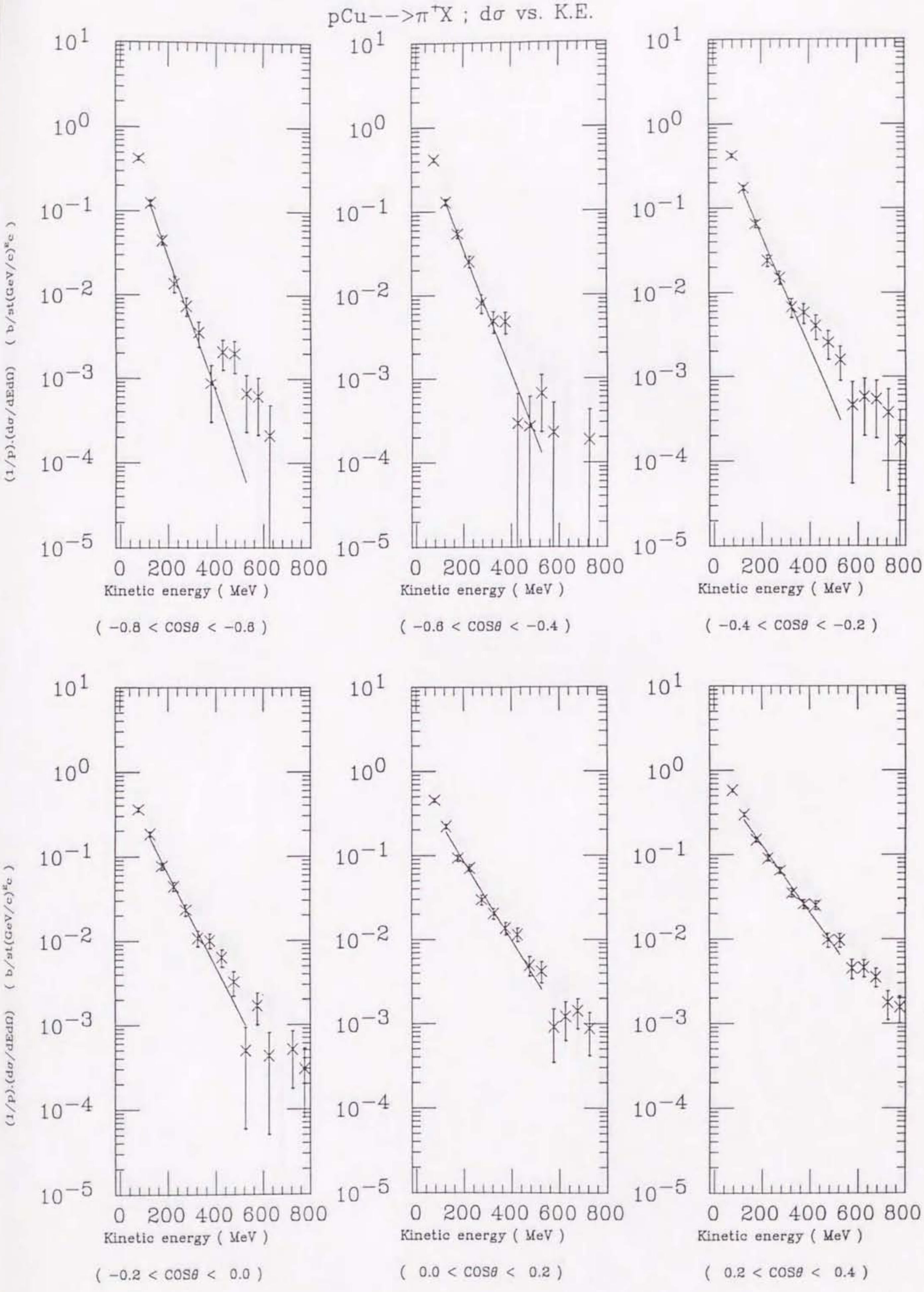

pCu-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.4.C

pSn-->π^+X ; dσ vs. K.E.

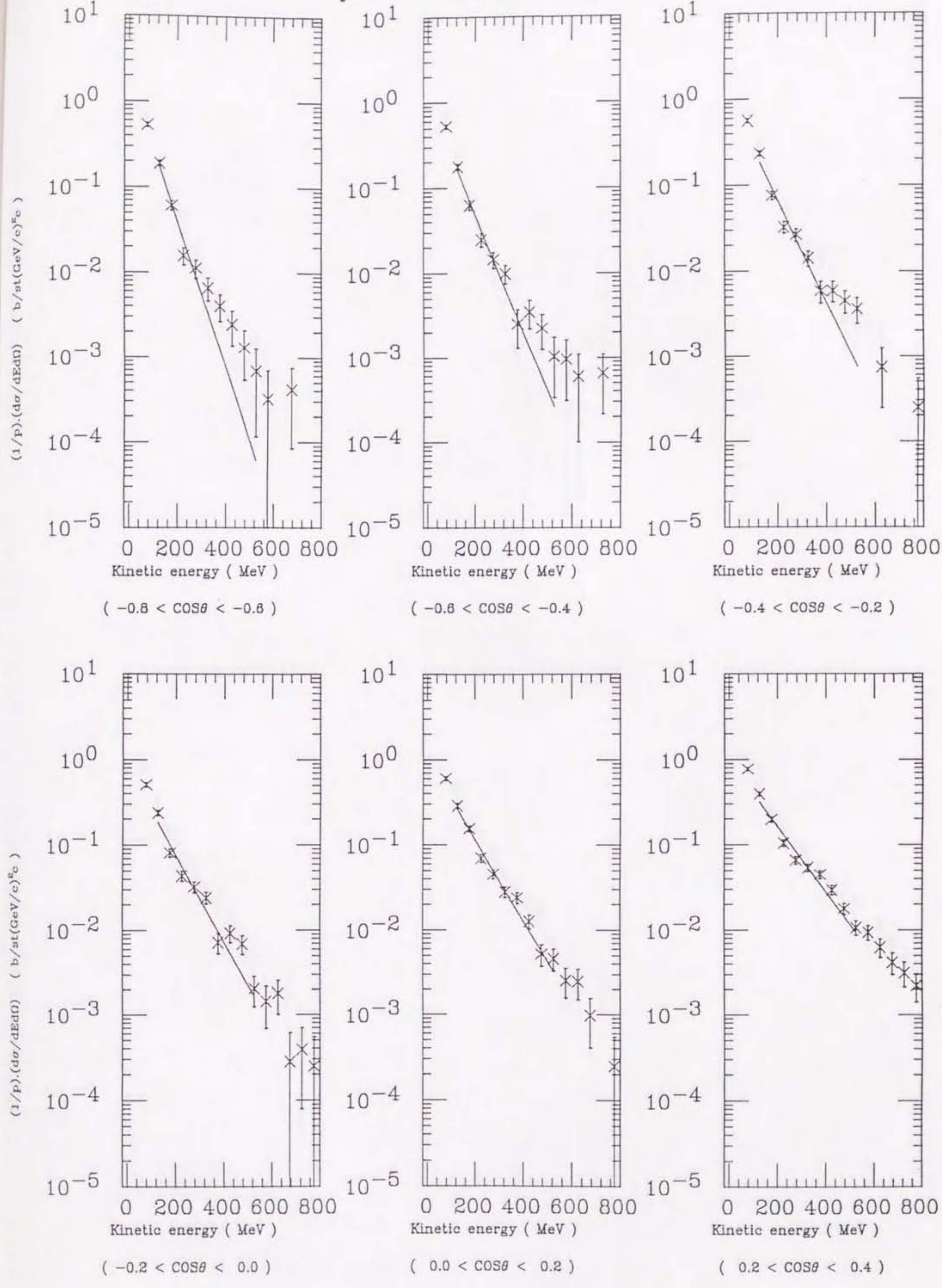


Figure 4.4.D

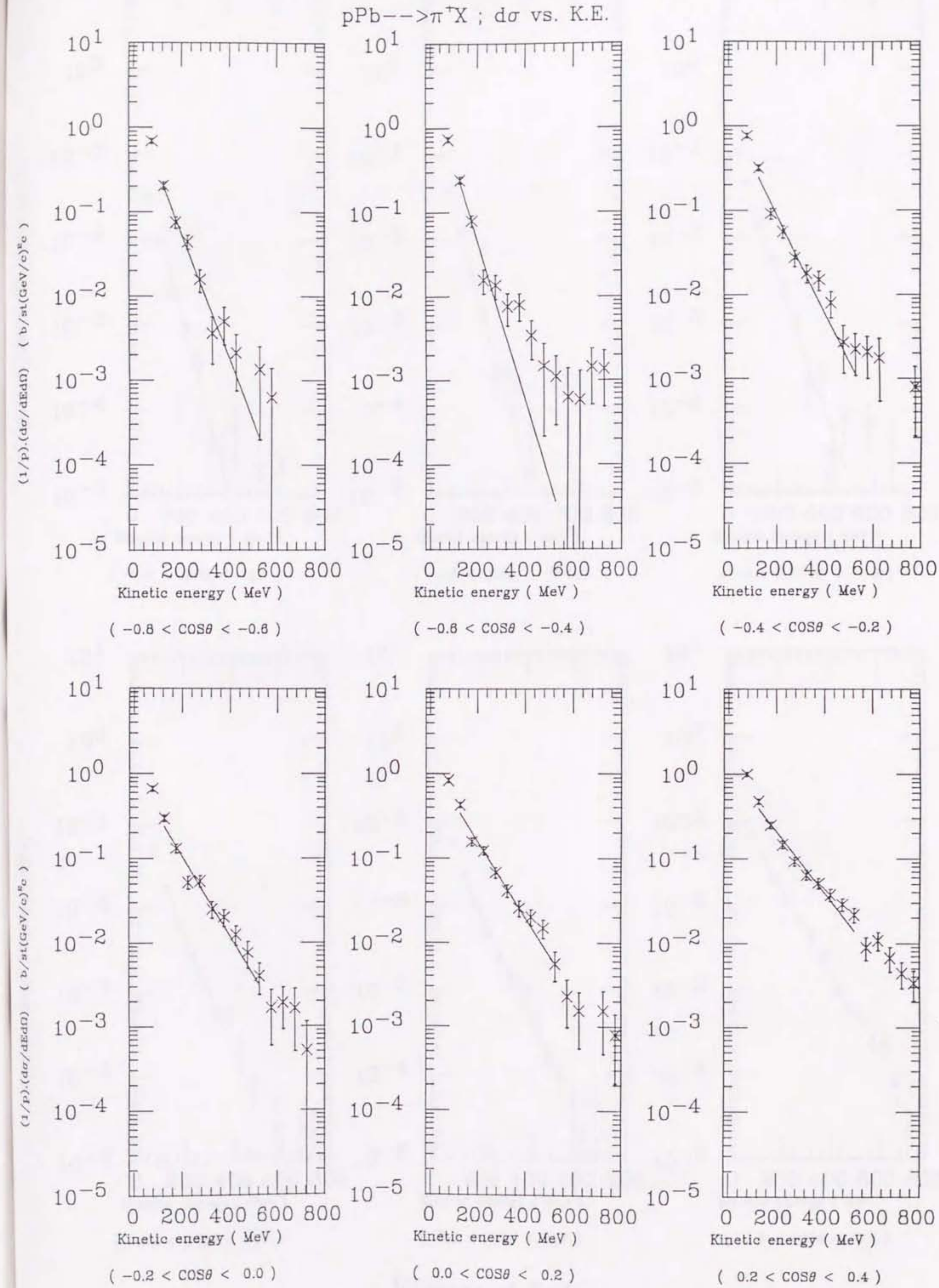

pPb-->π+X ; dσ vs. K.E.
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
0 200 400 600 800
Kinetic energy (MeV)
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^2c)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.4.E

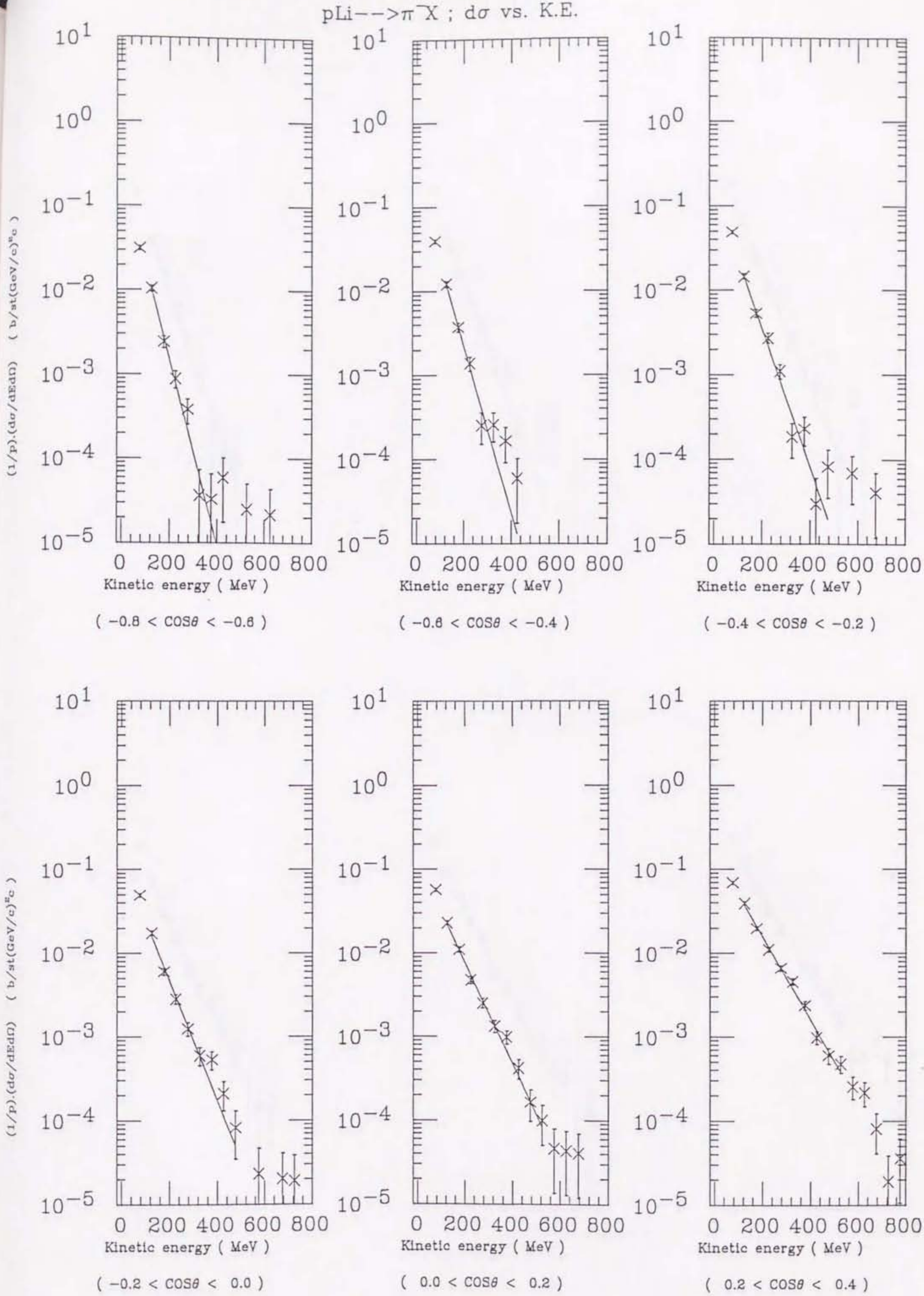

pLi-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)³c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.5.A

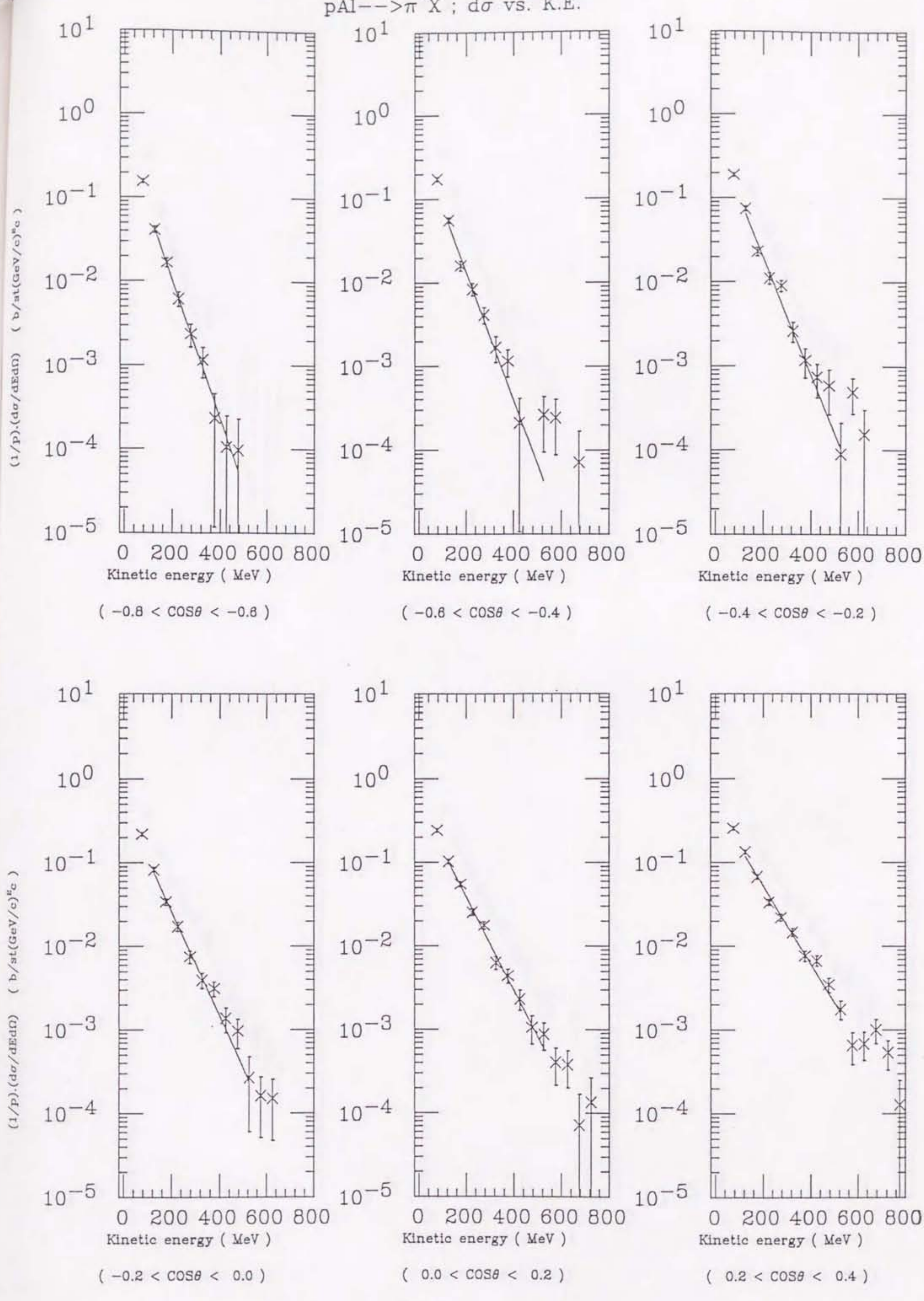

pAl-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.5.B

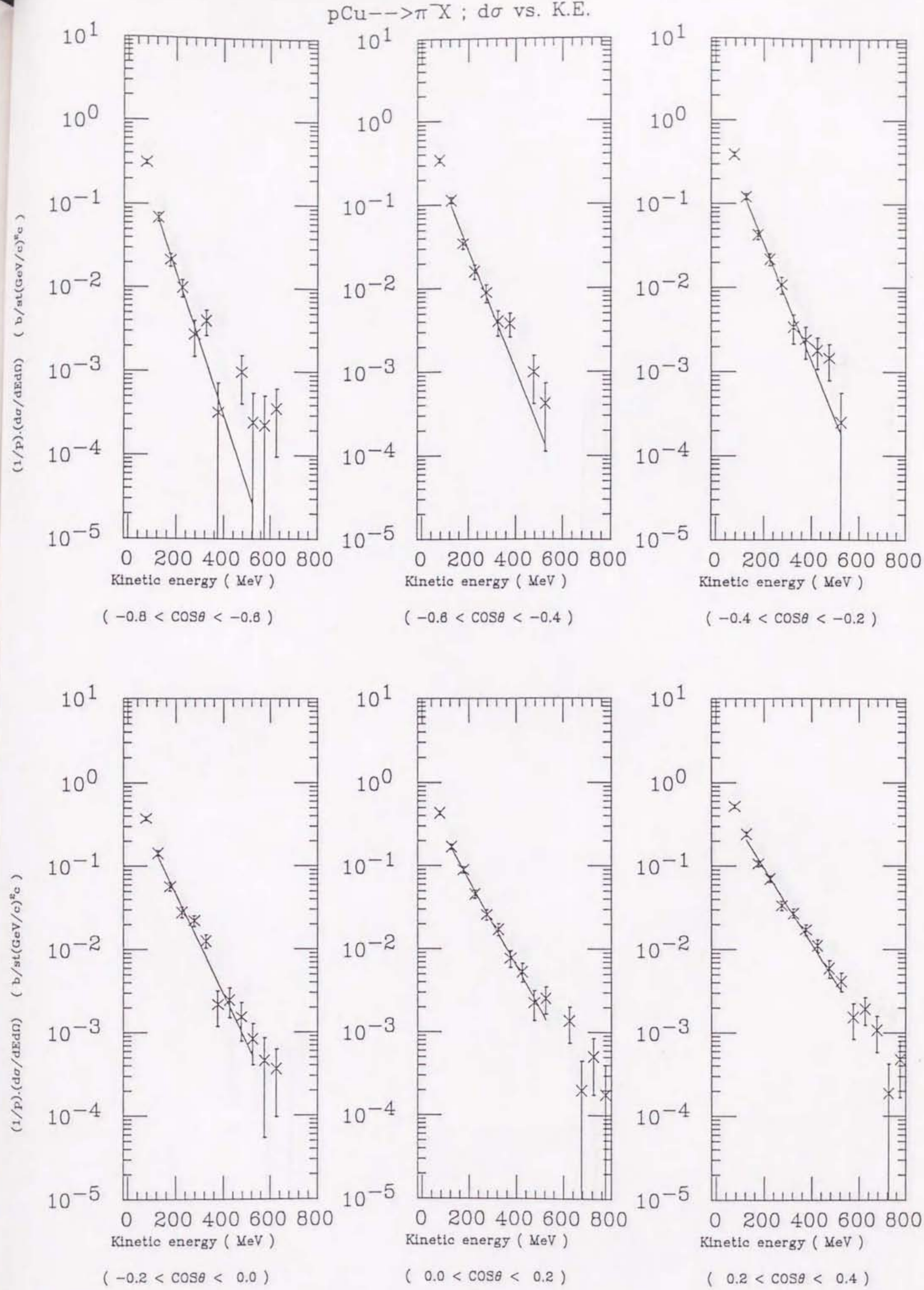

pCu-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.5.C

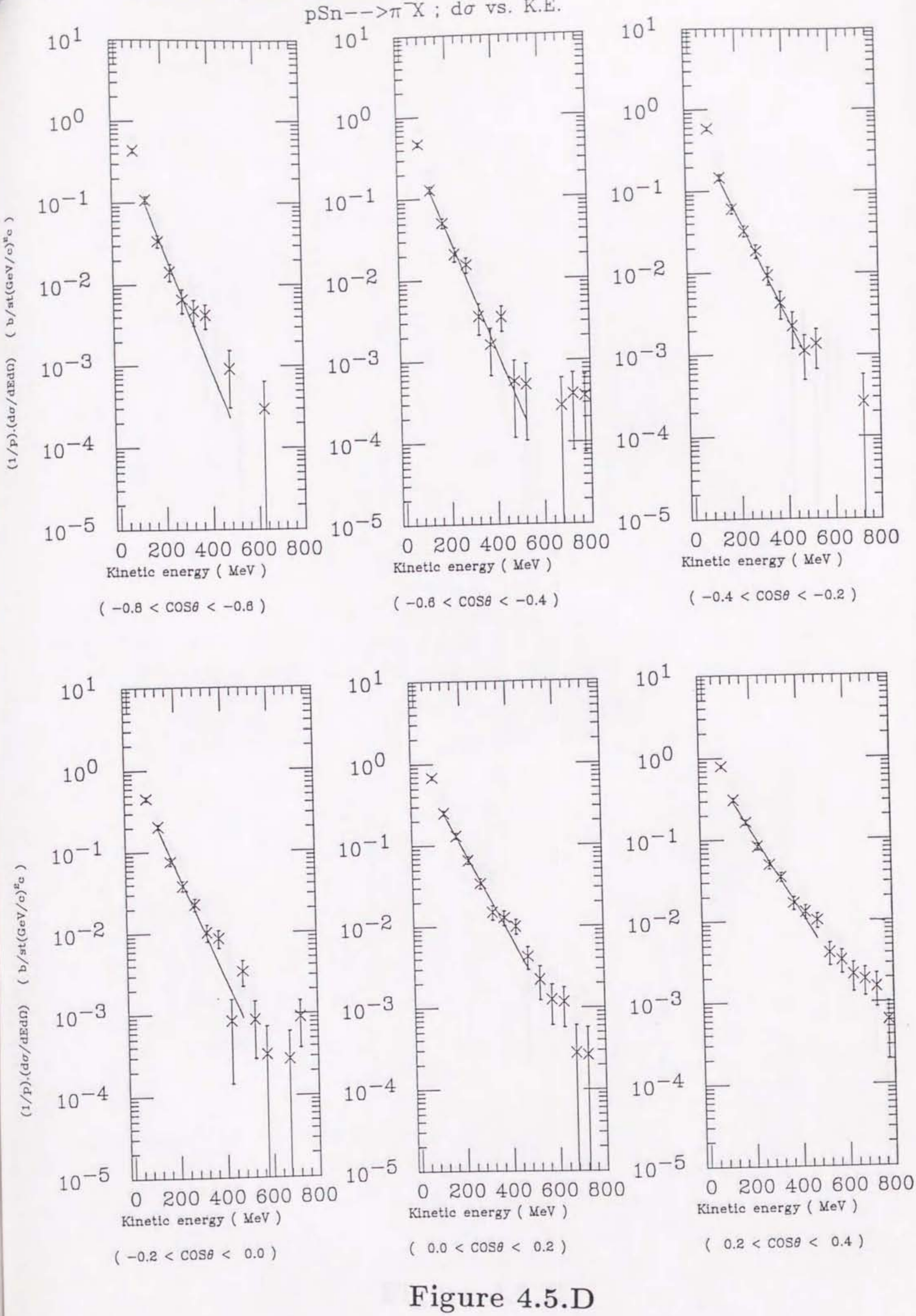

pSn-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.5.D

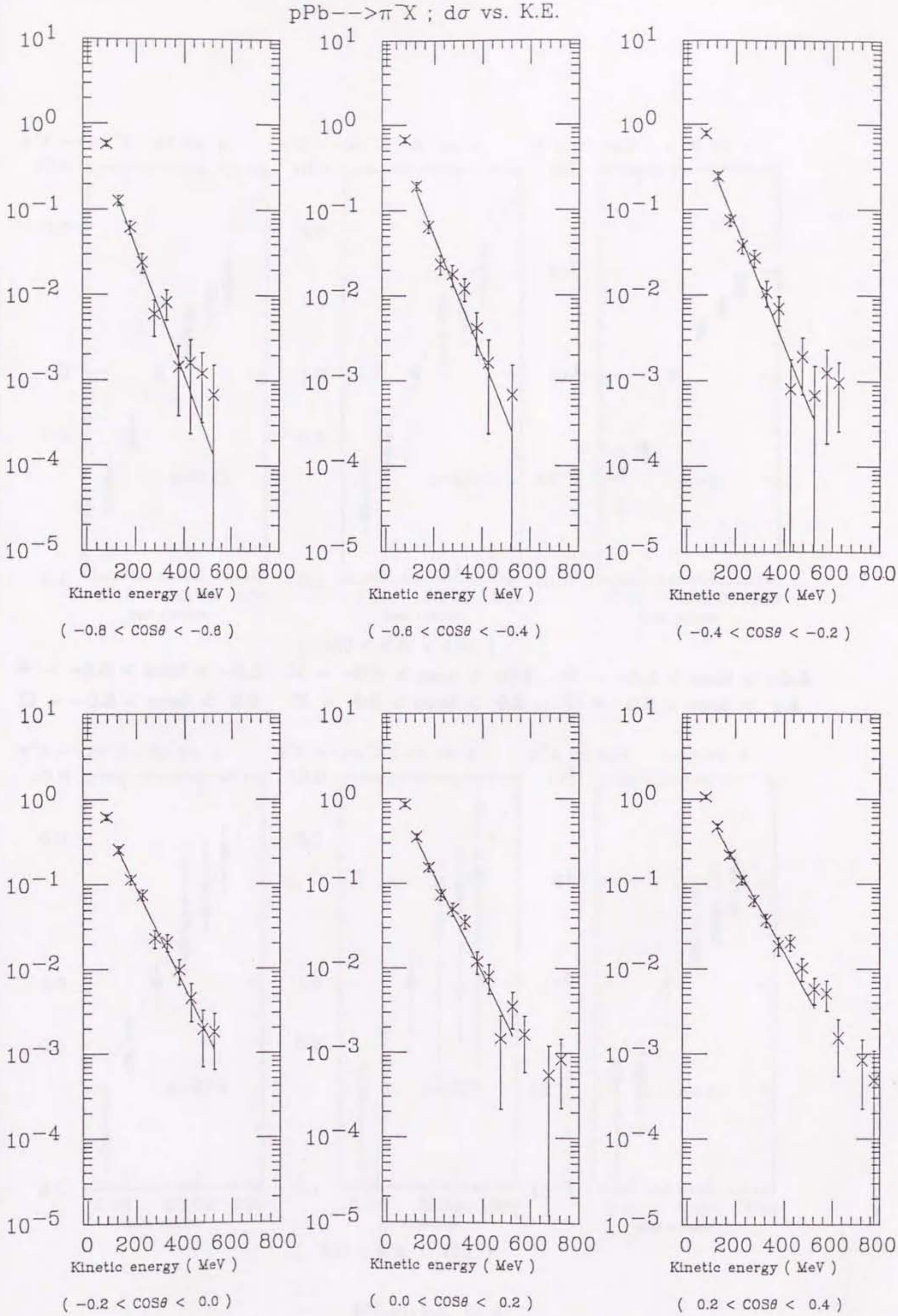
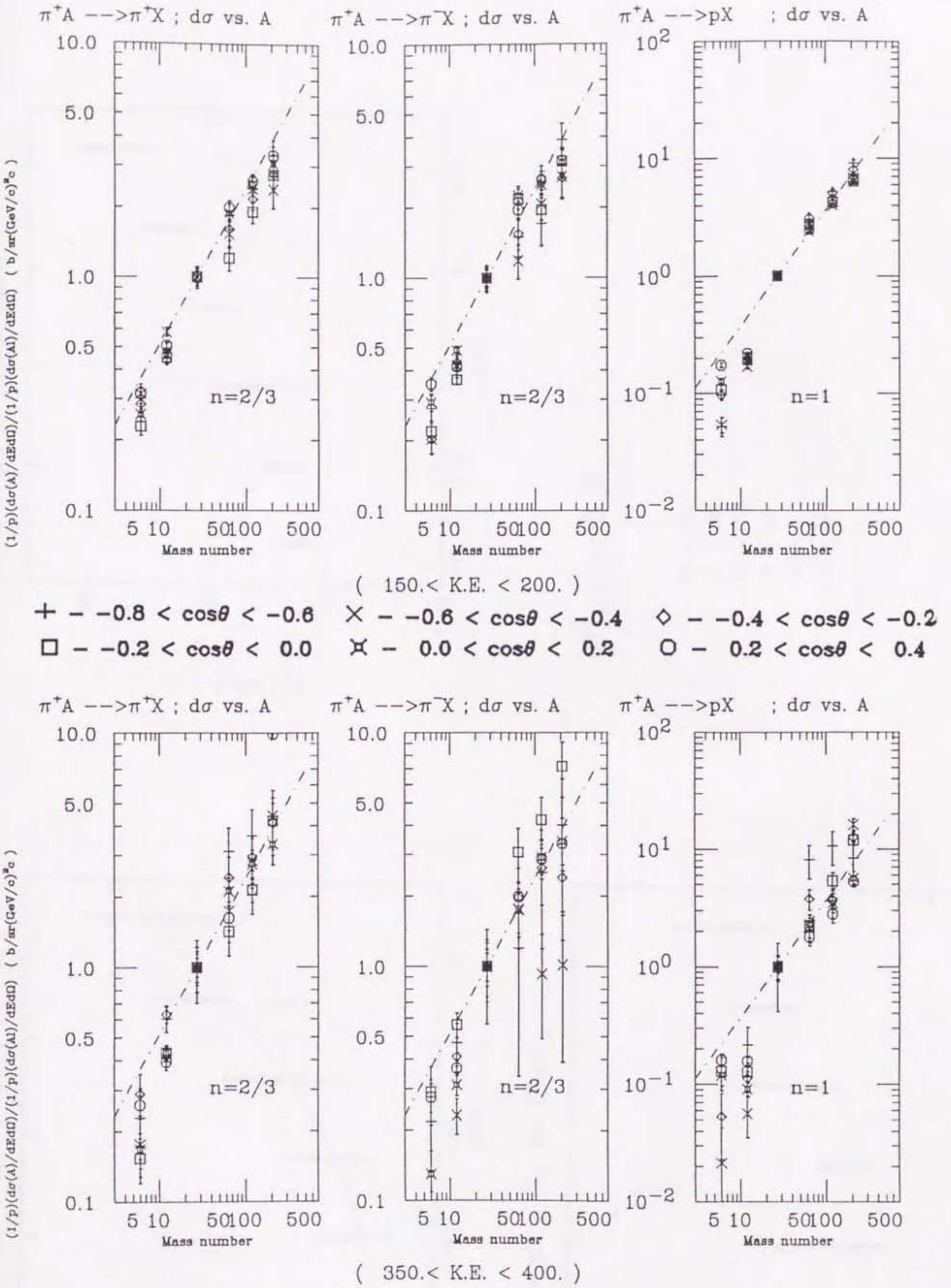
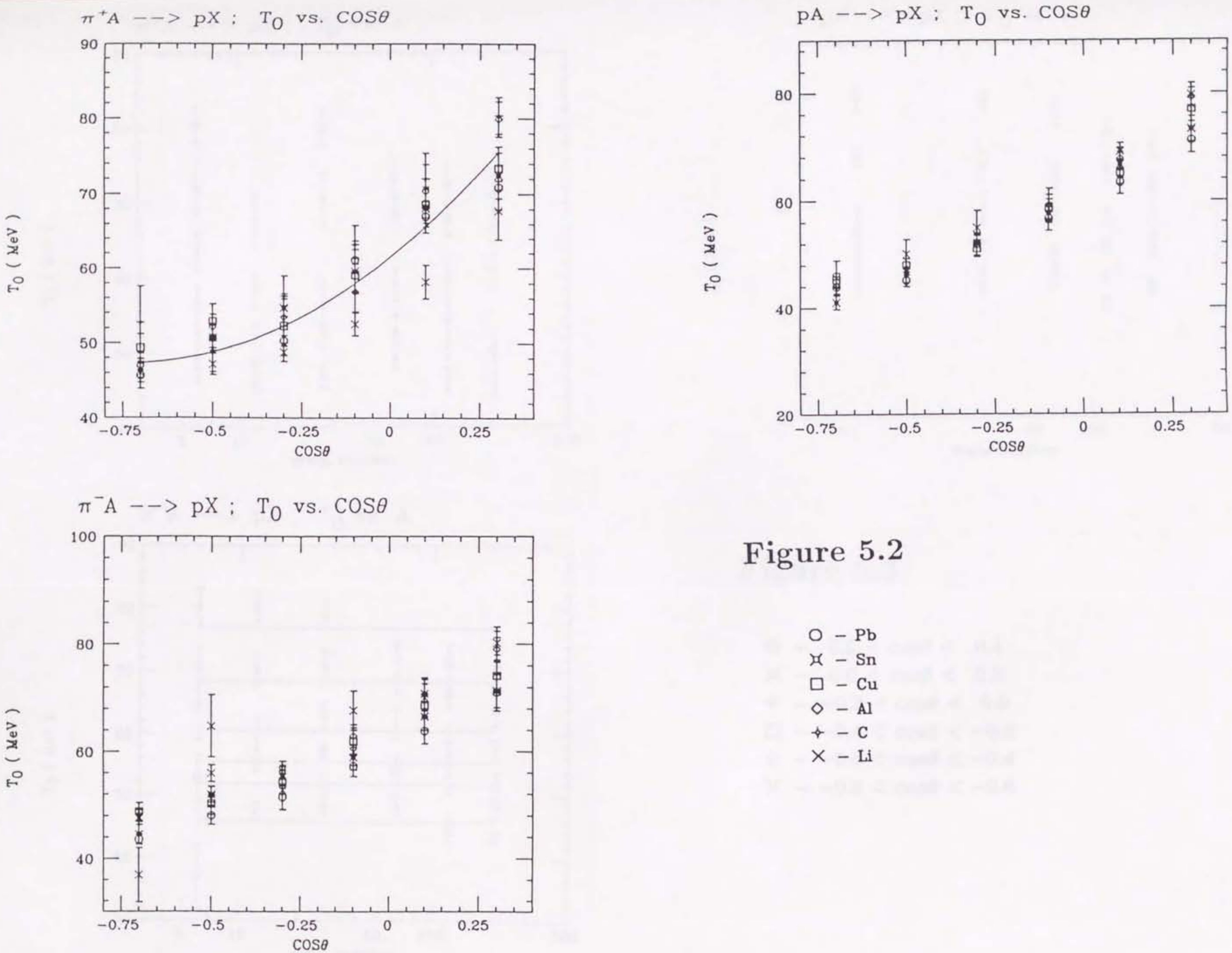

pPb-->π⁻X ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 4.5.E



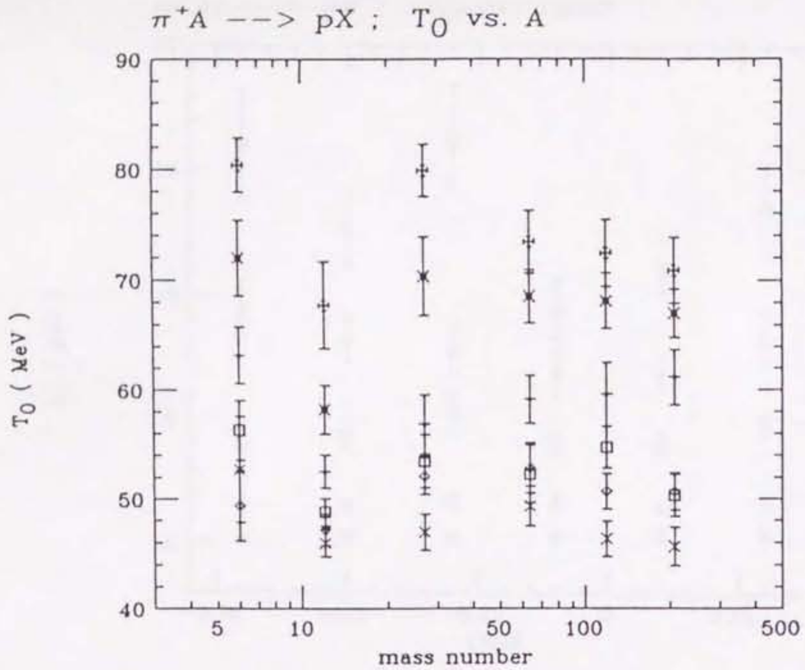
π+A -->π+X ; dσ vs. A
π+A -->π−X ; dσ vs. A
π+A -->pX ; dσ vs. A
(1/p)(dσ(A)/dEdΩ)/(1/p)(dσ(Al)/dEdΩ) (b/sr(GeV/c)²c)
n=2/3
n=2/3
n=1
Mass number
(150.< K.E. < 200.)
+ - -0.8 < cosθ < -0.6
× - -0.6 < cosθ < -0.4
◇ - -0.4 < cosθ < -0.2
□ - -0.2 < cosθ < 0.0
⌘ - 0.0 < cosθ < 0.2
○ - 0.2 < cosθ < 0.4
π+A -->π+X ; dσ vs. A
π+A -->π−X ; dσ vs. A
π+A -->pX ; dσ vs. A
n=2/3
n=2/3
n=1
Mass number
(350.< K.E. < 400.)

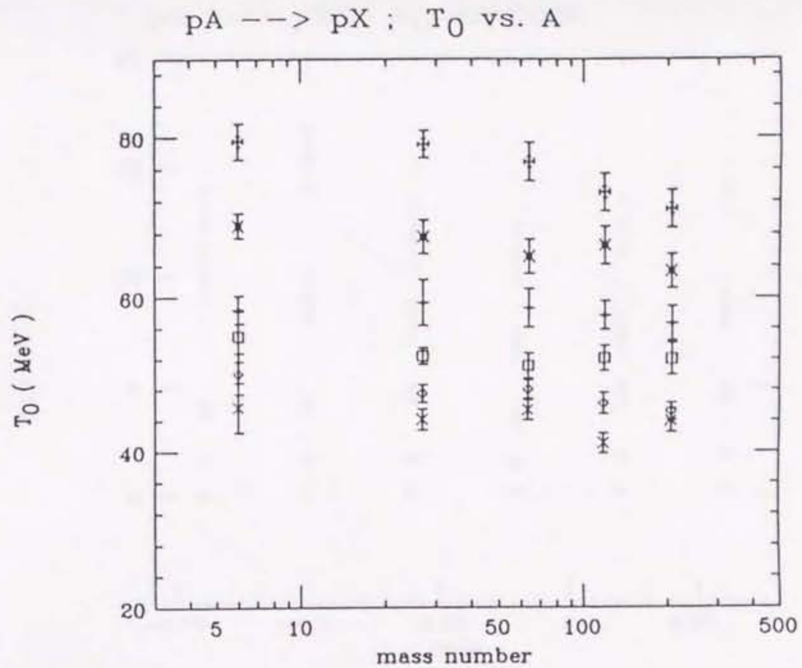
Figure 5.1



π^+A --> pX ; T_0 vs. COSθ
pA --> pX ; T_0 vs. COSθ
π^-A --> pX ; T_0 vs. COSθ
T_0 (MeV)
COSθ
90
80
70
60
50
40
20
100
-0.75
-0.5
-0.25
0
0.25
○ – Pb
⌘ – Sn
□ – Cu
◇ – Al
✦ – C
× – Li

Figure 5.2





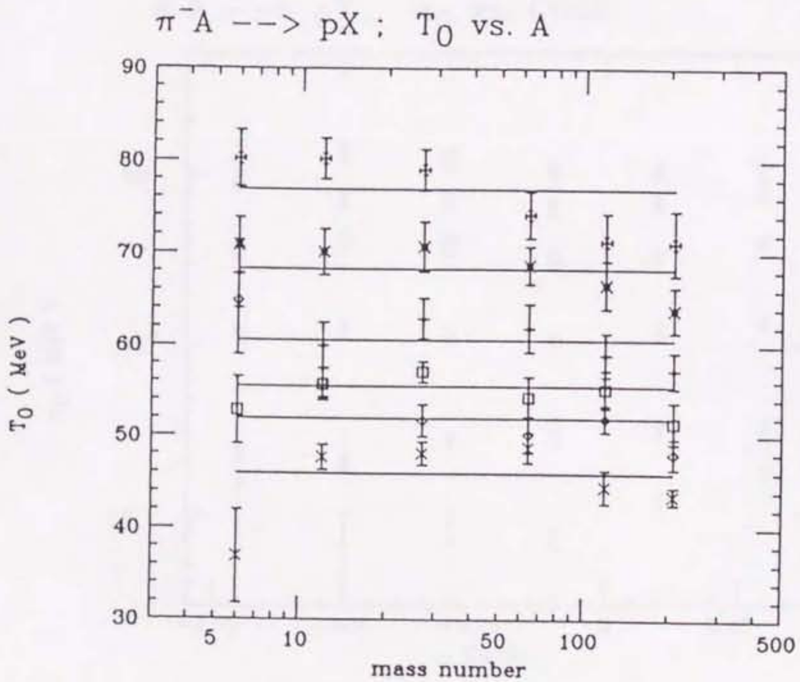
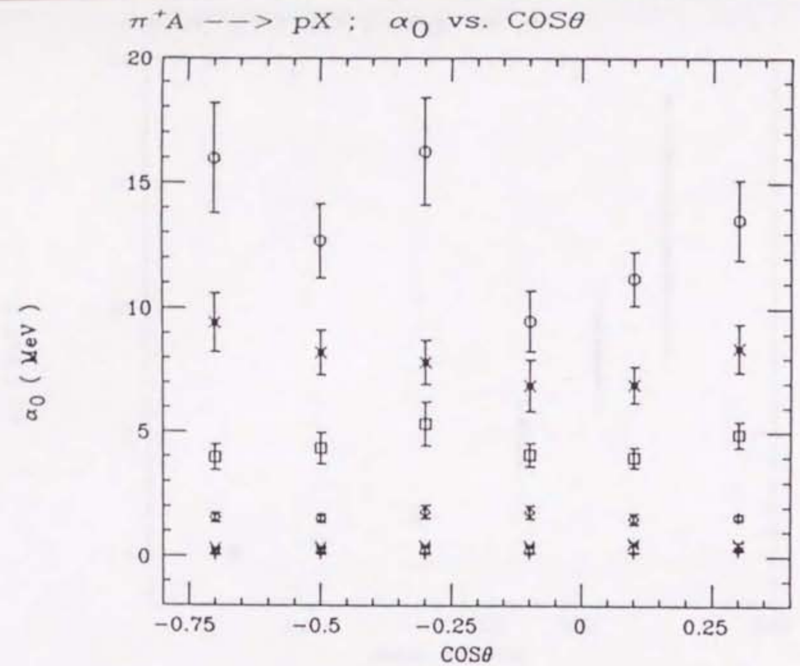
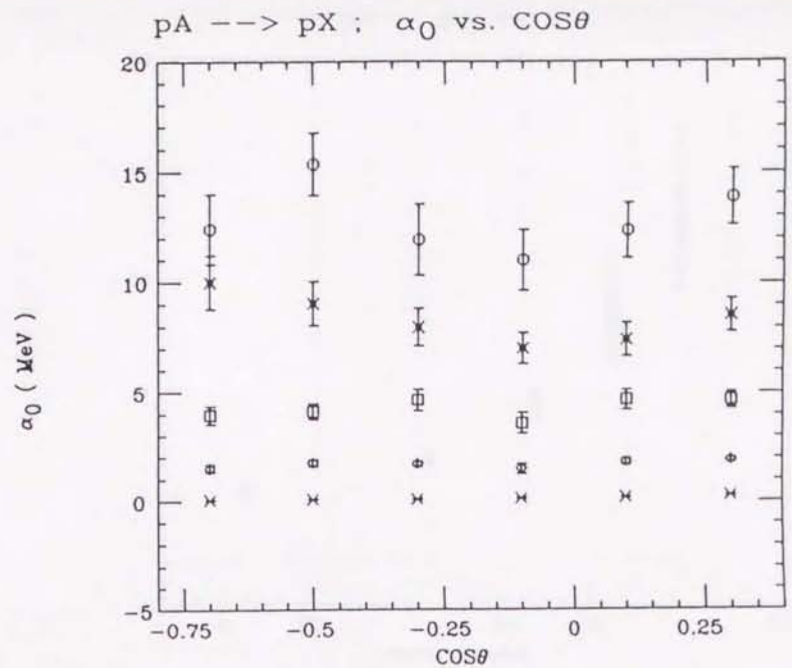


Figure 5.3

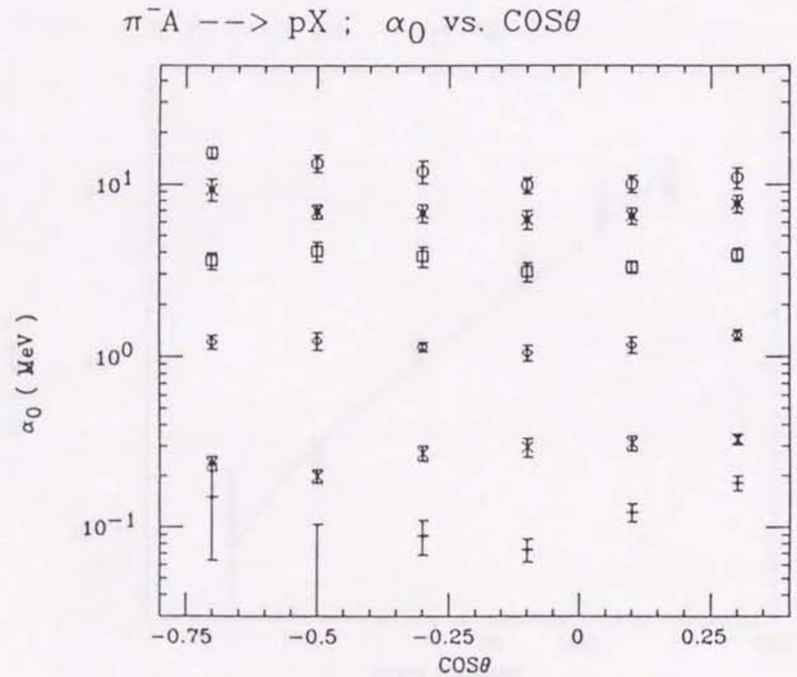
- ✢ – $0.2 < \cos\theta < 0.4$
- ⌘ – $0.0 < \cos\theta < 0.2$
- ✧ – $-0.2 < \cos\theta < 0.0$
- □ – $-0.4 < \cos\theta < -0.2$
- ◇ – $-0.6 < \cos\theta < -0.4$
- × – $-0.8 < \cos\theta < -0.6$



π^+A --> pX ; α_0 vs. COSθ
α_0 (MeV)
COSθ

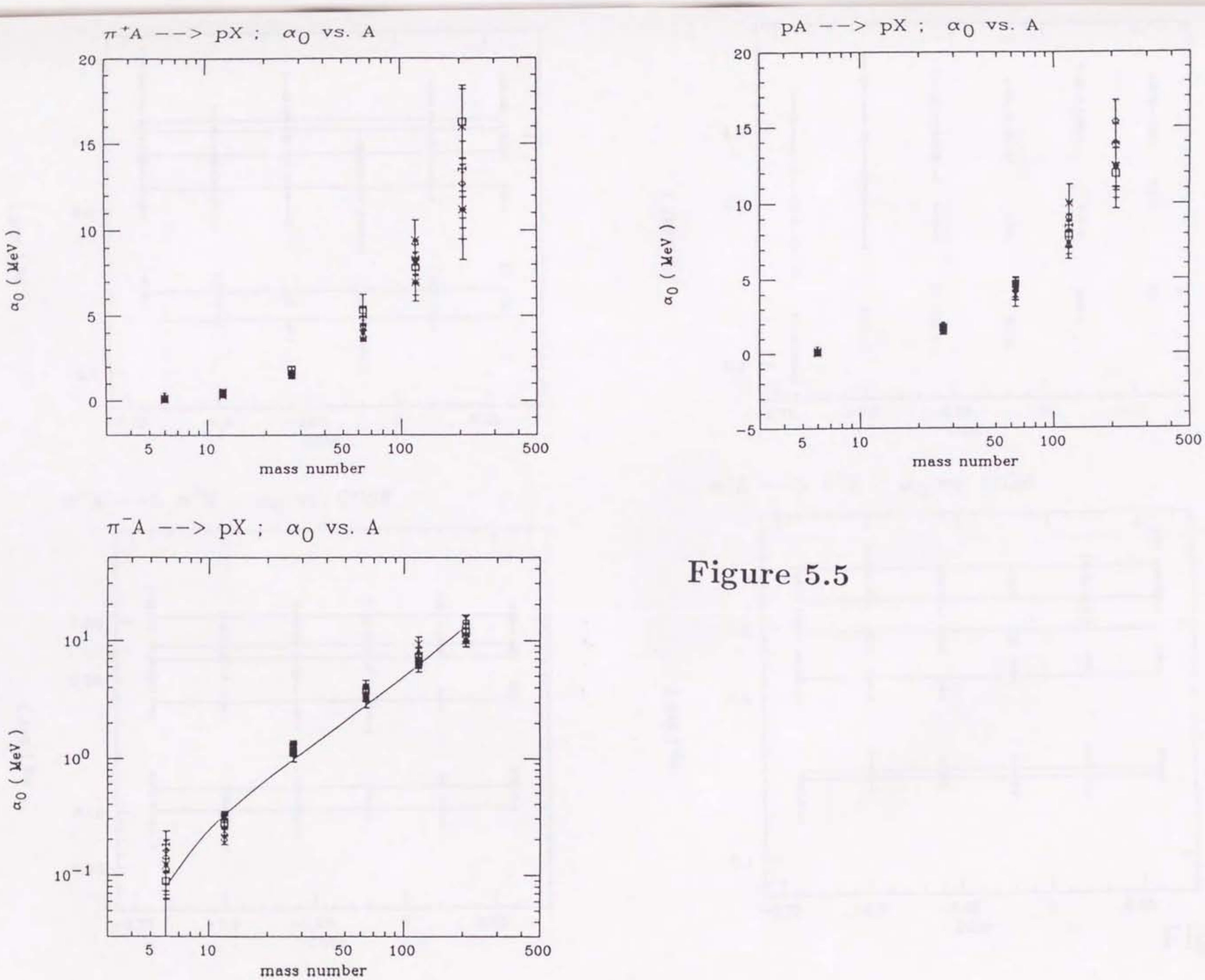


pA --> pX ; α_0 vs. COSθ
α_0 (MeV)
COSθ



π^-A --> pX ; α_0 vs. COSθ
α_0 (MeV)
COSθ

Figure 5.4



π⁺A --> pX ; α0 vs. A
α0 (MeV)
mass number
pA --> pX ; α0 vs. A
α0 (MeV)
mass number
π⁻A --> pX ; α0 vs. A
α0 (MeV)
mass number

Figure 5.5

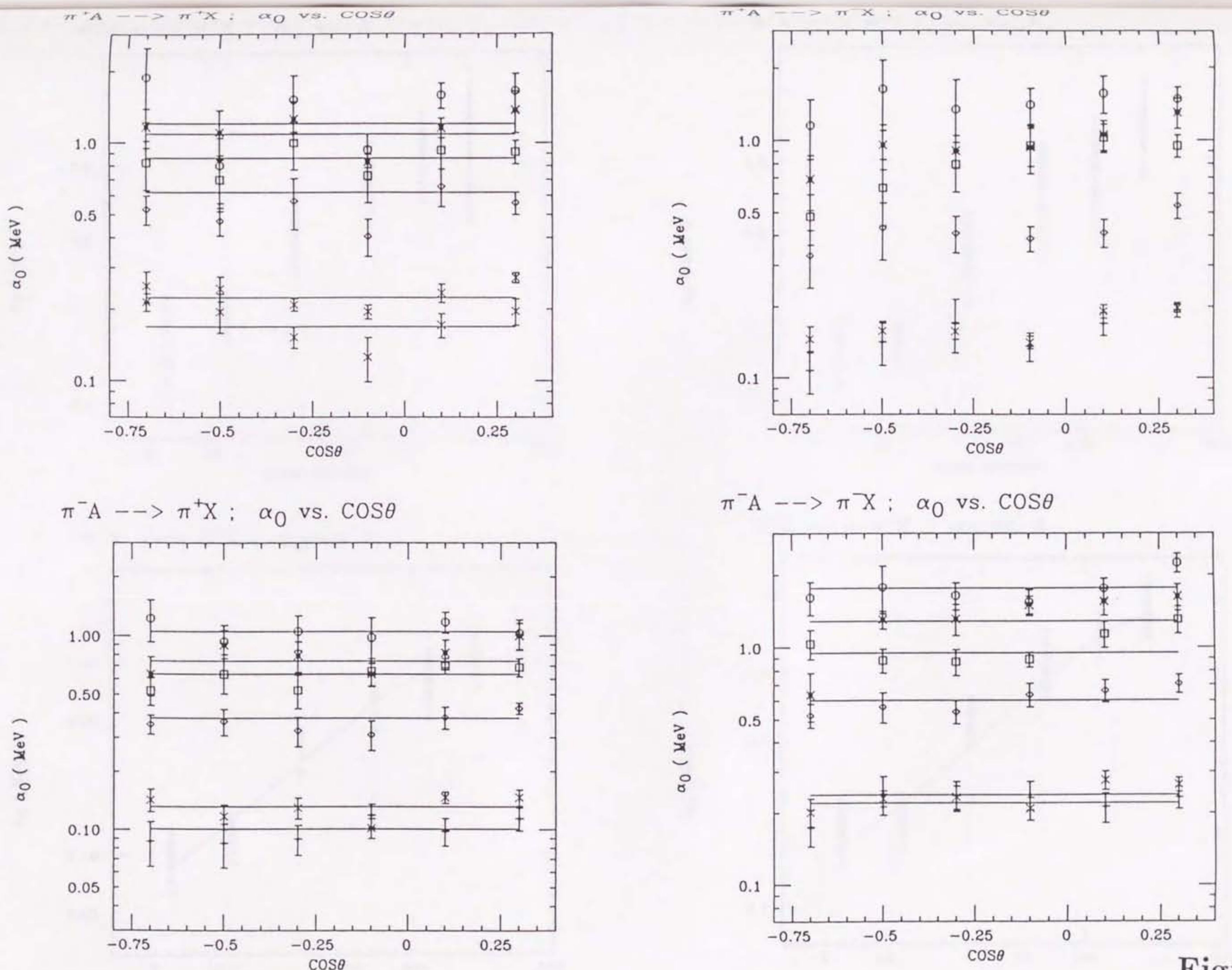
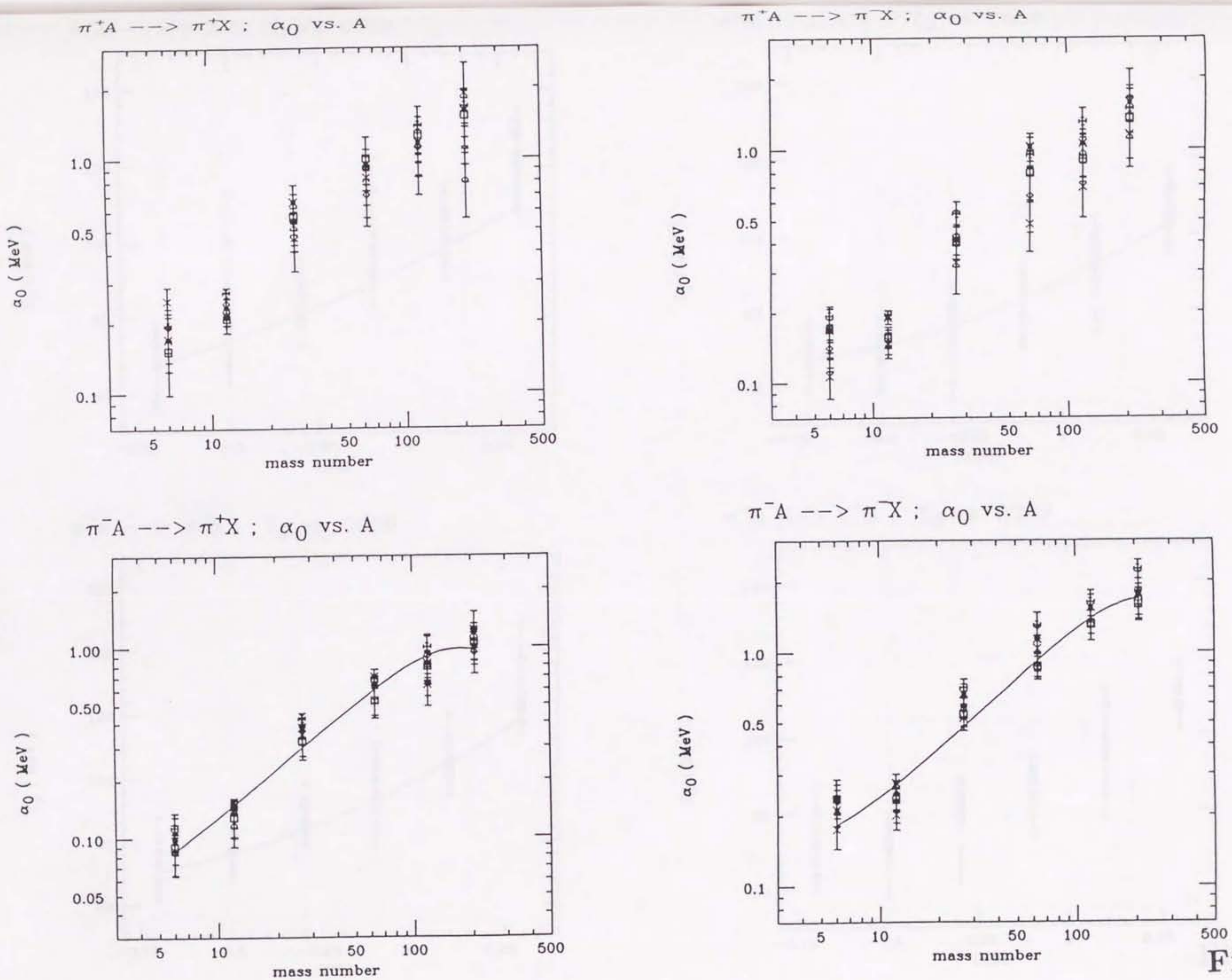
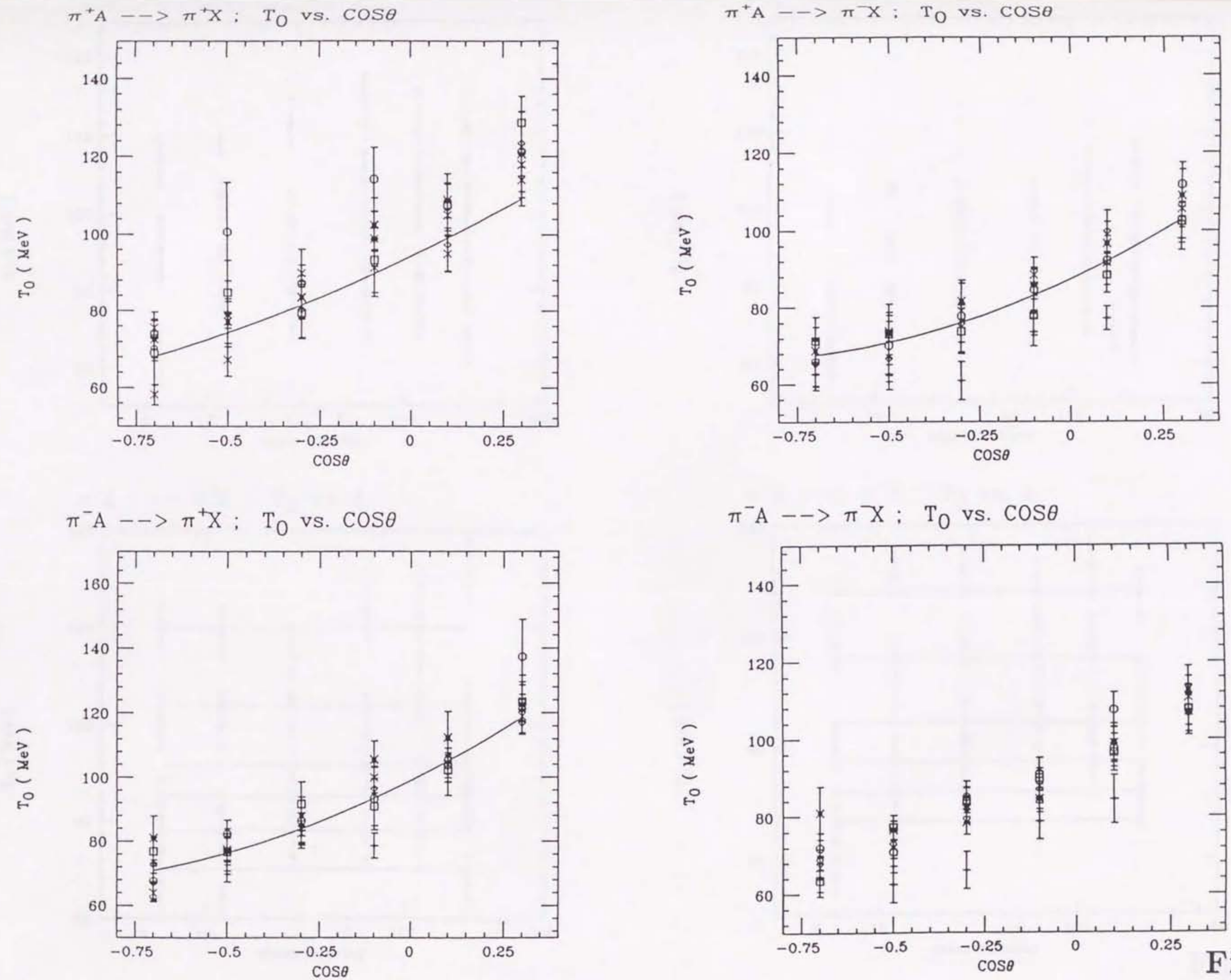

π⁺A --> π⁺X ; α0 vs. COSθ
π⁺A --> π⁻X ; α0 vs. COSθ
π⁻A --> π⁺X ; α0 vs. COSθ
π⁻A --> π⁻X ; α0 vs. COSθ
α0 (MeV)
COSθ
-0.75
-0.5
-0.25
0
0.25
1.0
0.5
0.1
1.00
0.50
0.10
0.05

Figure 5.6



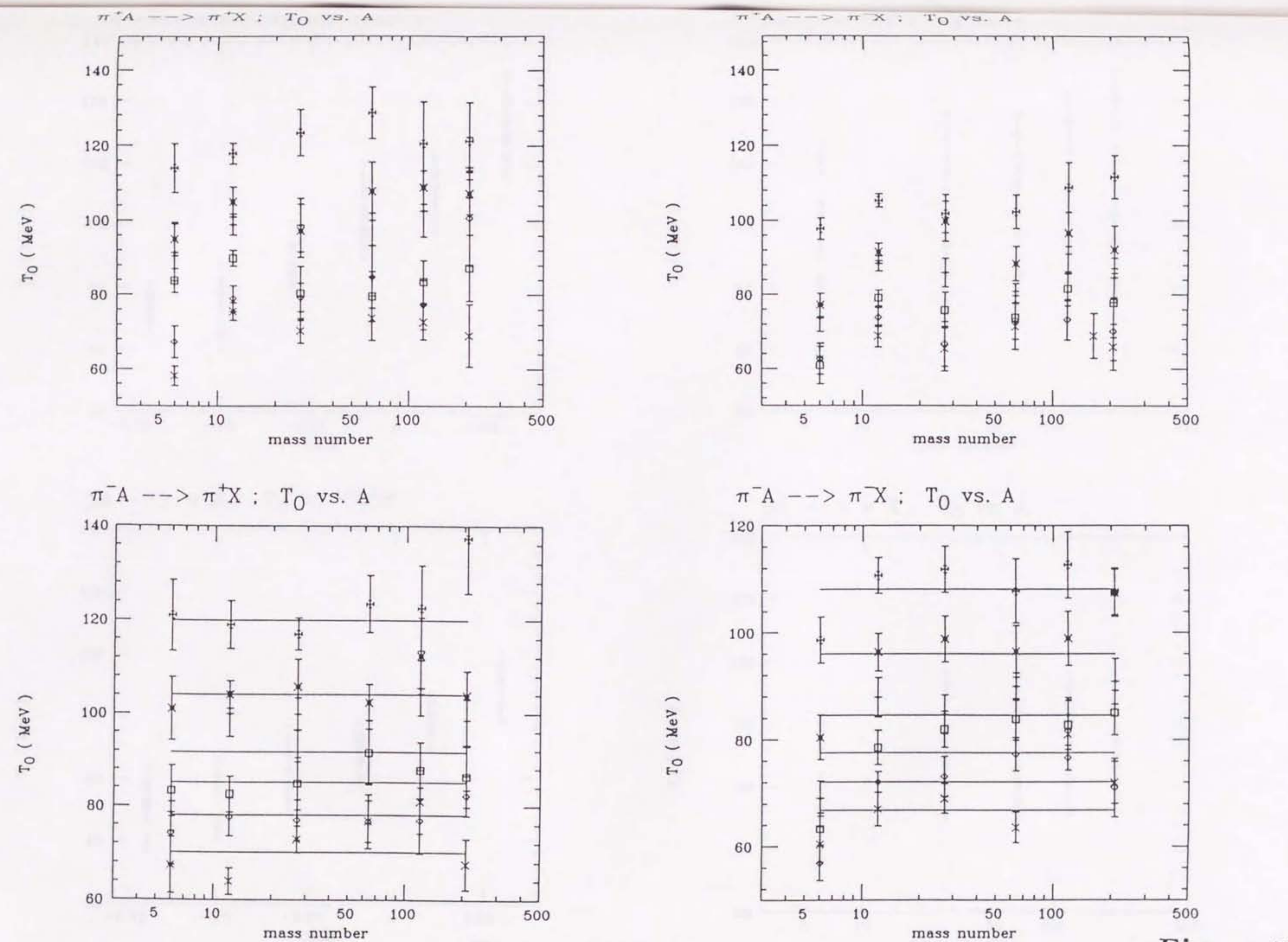
π⁺A --> π⁺X ; α0 vs. A
α0 (MeV)
mass number
π⁺A --> π⁻X ; α0 vs. A
α0 (MeV)
mass number
π⁻A --> π⁺X ; α0 vs. A
α0 (MeV)
mass number
π⁻A --> π⁻X ; α0 vs. A
α0 (MeV)
mass number

Figure 5.7



π^+A --> π^+X ; T_0 vs. COSθ
π^+A --> π^-X ; T_0 vs. COSθ
π^-A --> π^+X ; T_0 vs. COSθ
π^-A --> π^-X ; T_0 vs. COSθ
T_0 (MeV)
COSθ

Figure 5.8



π⁺A --> π⁺X ; T0 vs. A
π⁺A --> π⁻X ; T0 vs. A
π⁻A --> π⁺X ; T0 vs. A
π⁻A --> π⁻X ; T0 vs. A
T0 (MeV)
mass number

Figure 5.9

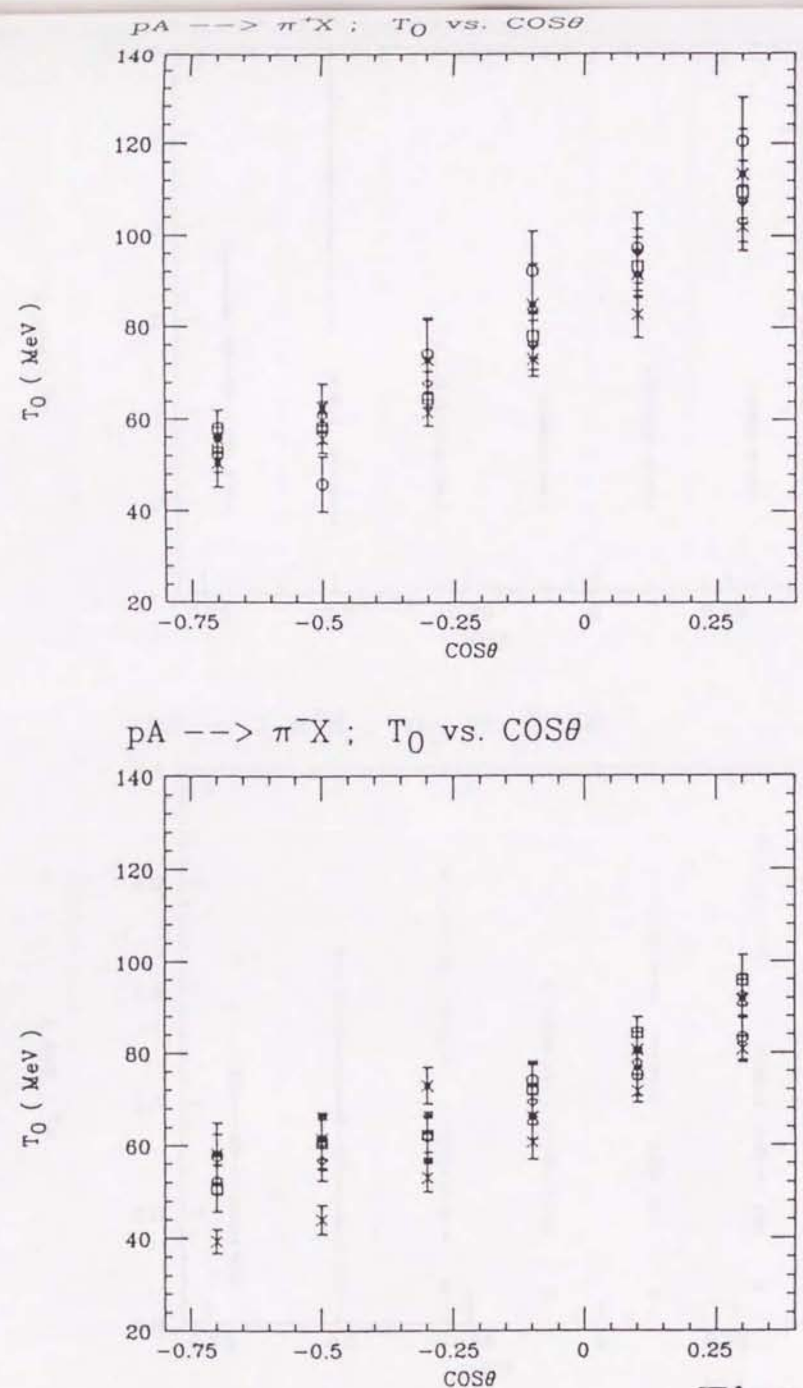


Figure 5.10

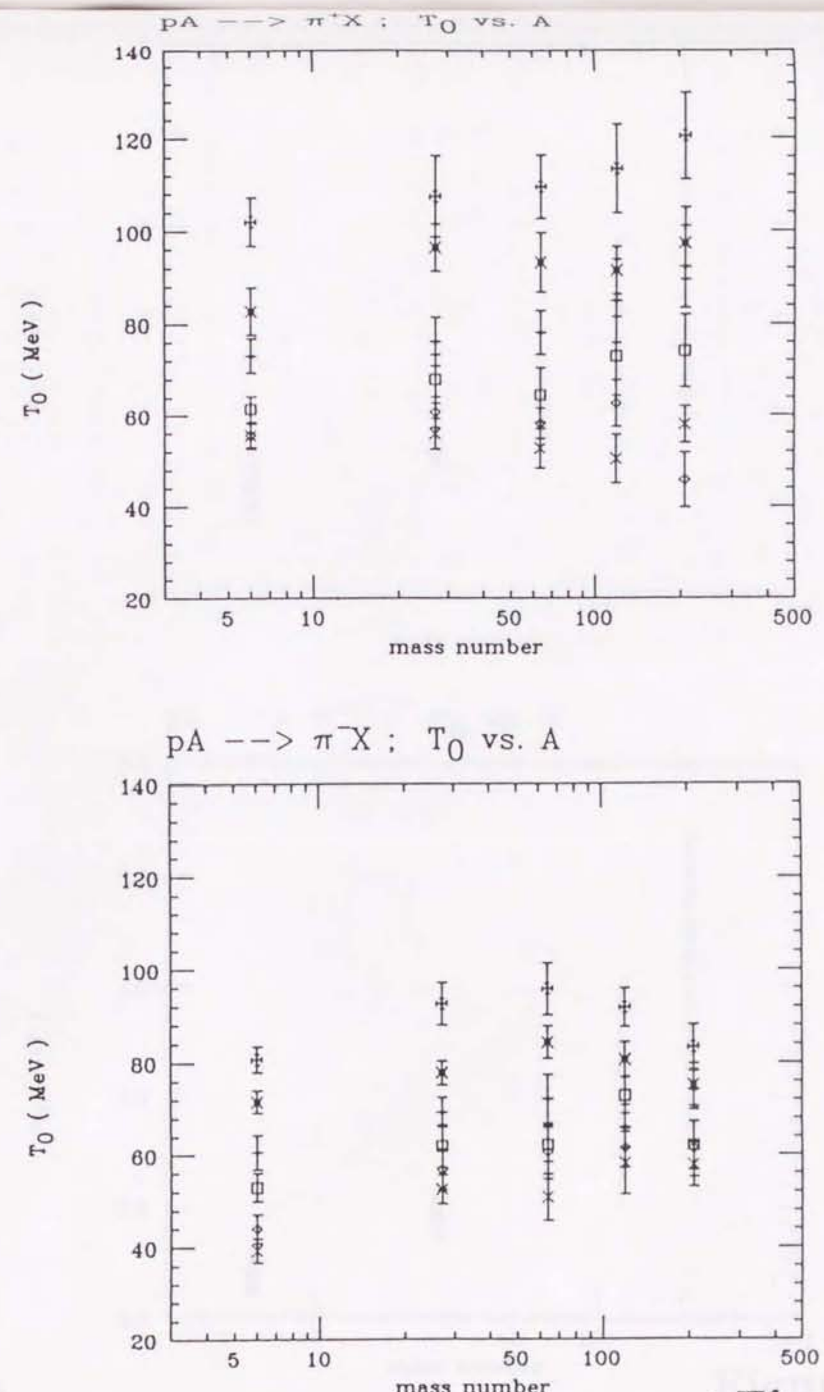


Figure 5.11

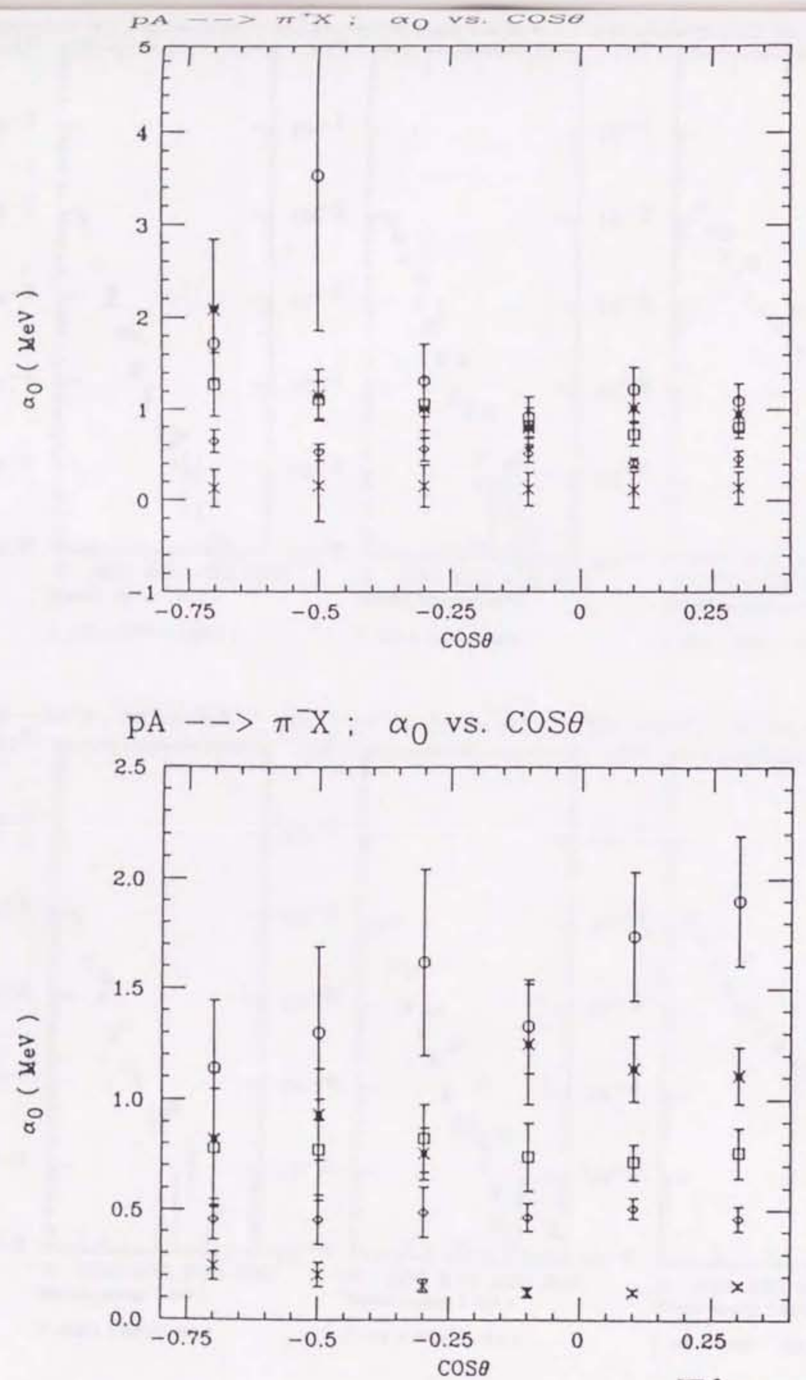


Figure 5.12

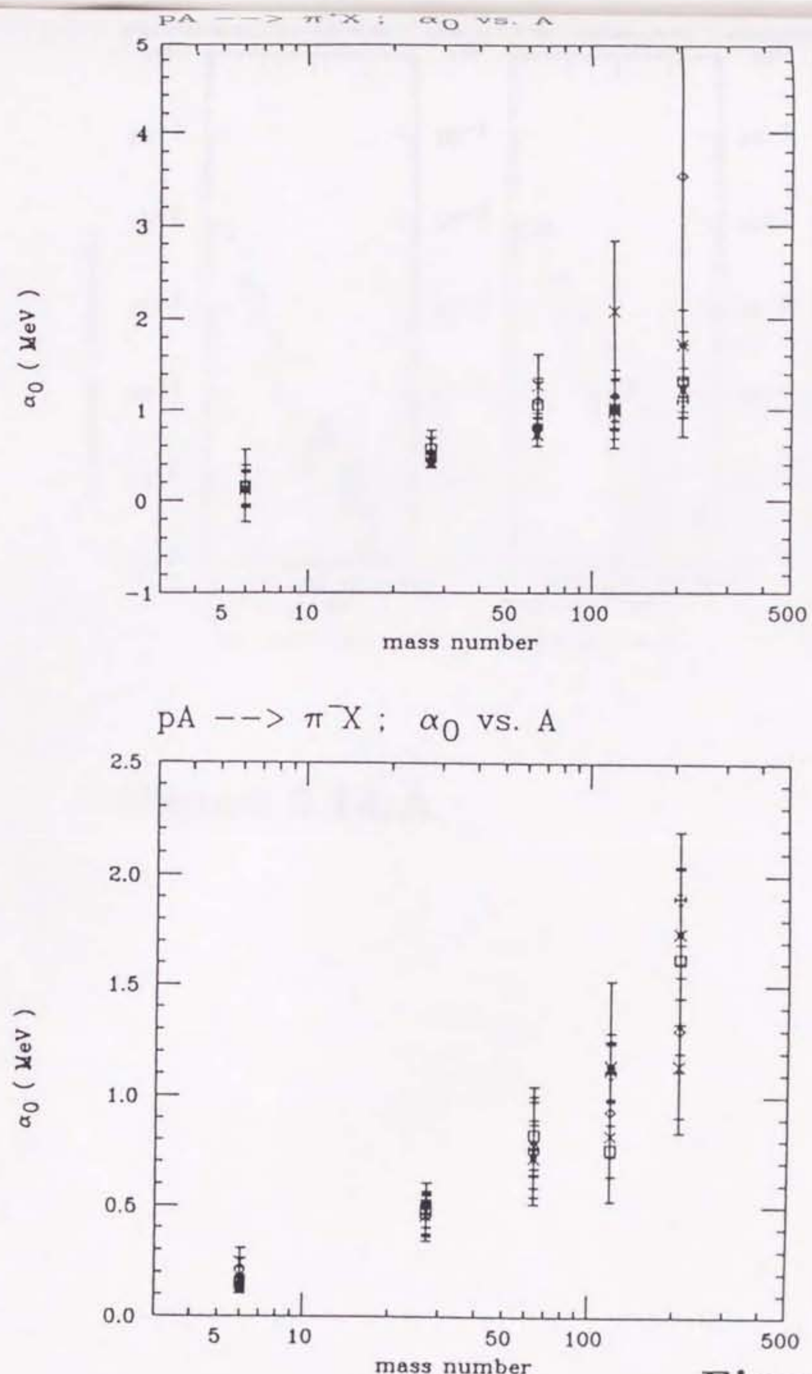
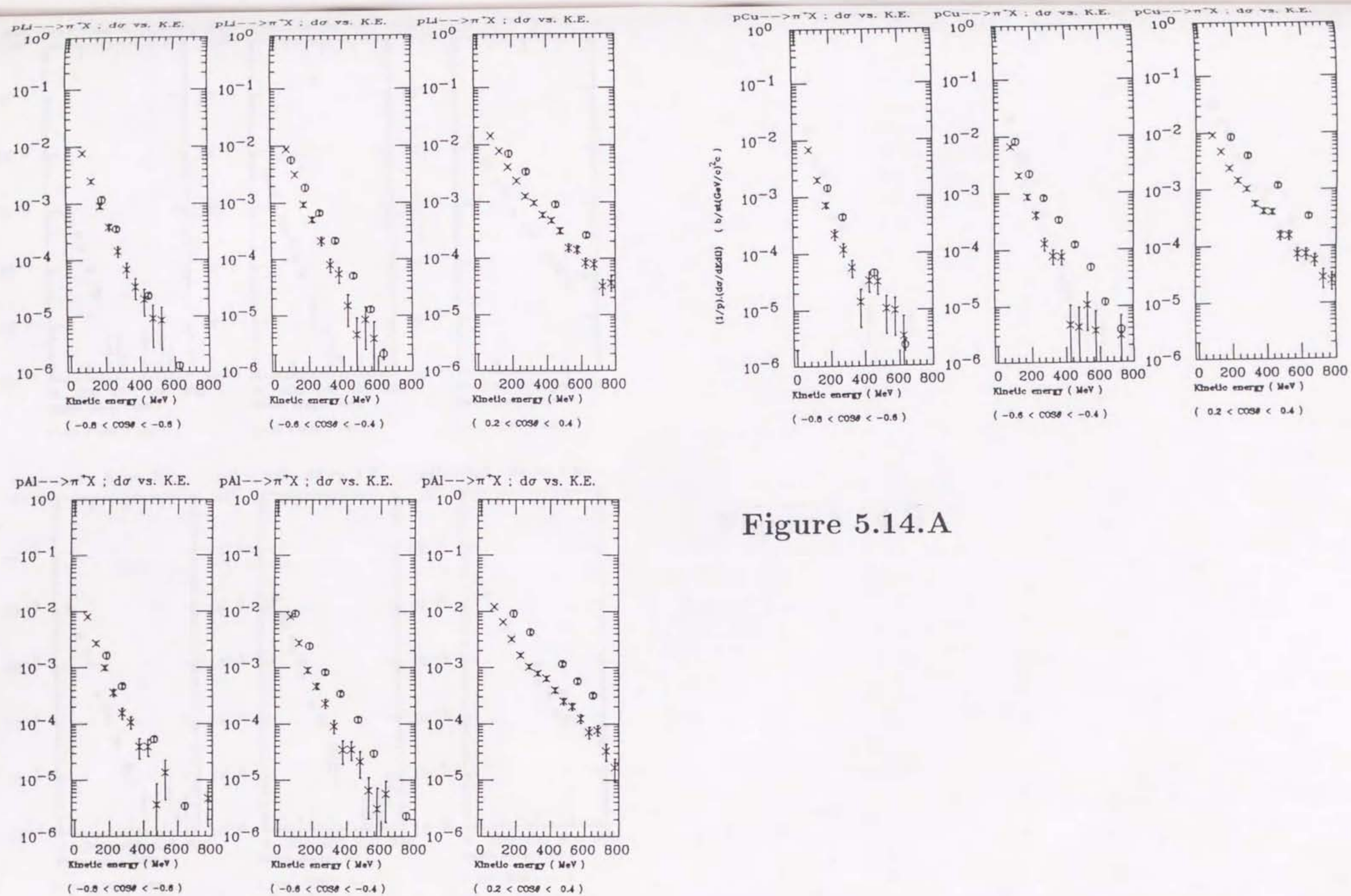
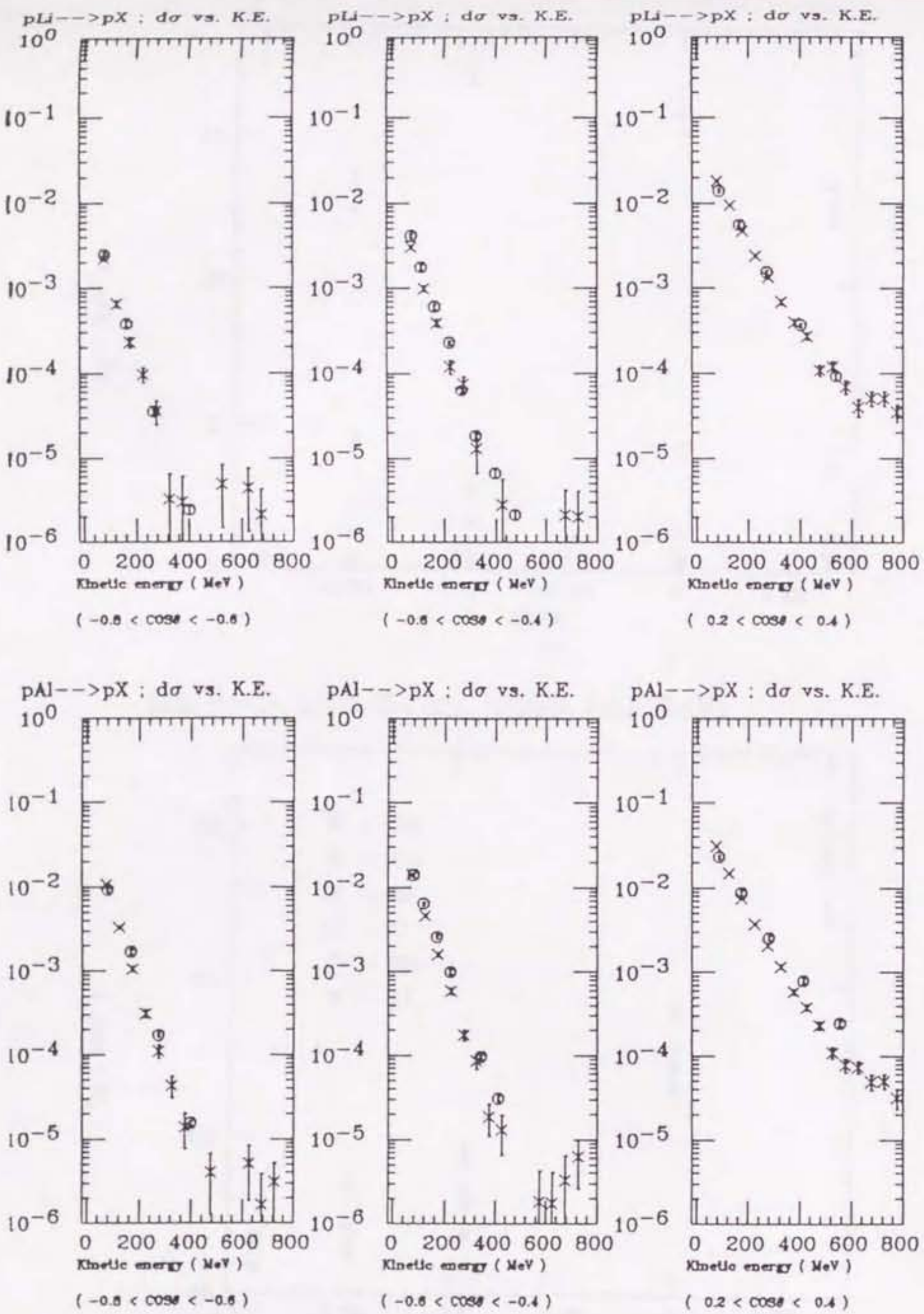


Figure 5.13

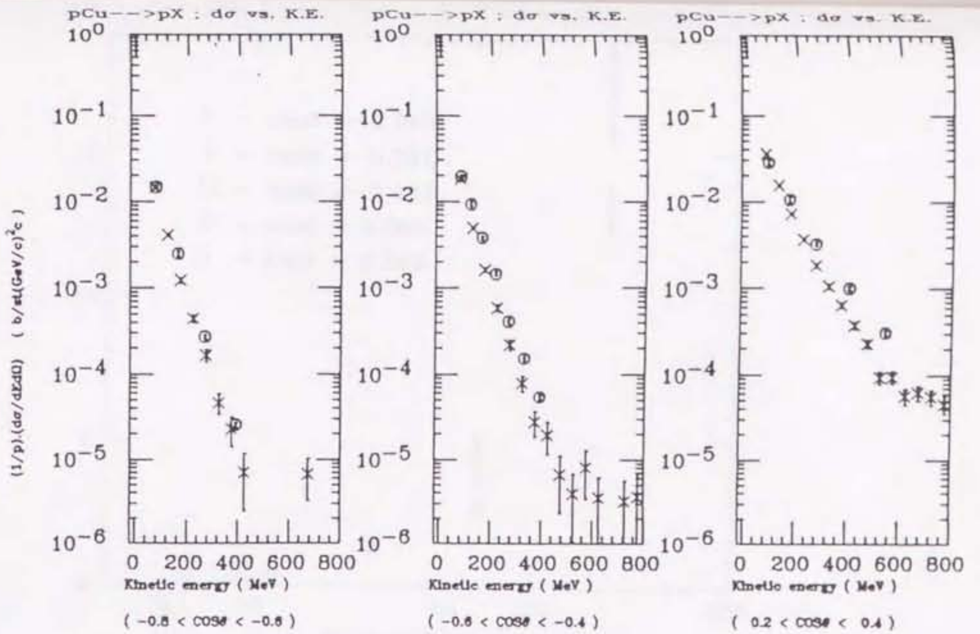


pLi-->π⁺X ; dσ vs. K.E.
pCu-->π⁺X ; dσ vs. K.E.
pAl-->π⁺X ; dσ vs. K.E.
(1/p).(dσ/dΩdE) (b/sr(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(0.2 < COSθ < 0.4)

Figure 5.14.A



pLi-->pX ; dσ vs. K.E.
pAl-->pX ; dσ vs. K.E.
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(0.2 < COSθ < 0.4)



pCu-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(0.2 < COSθ < 0.4)

Figure 5.14.B

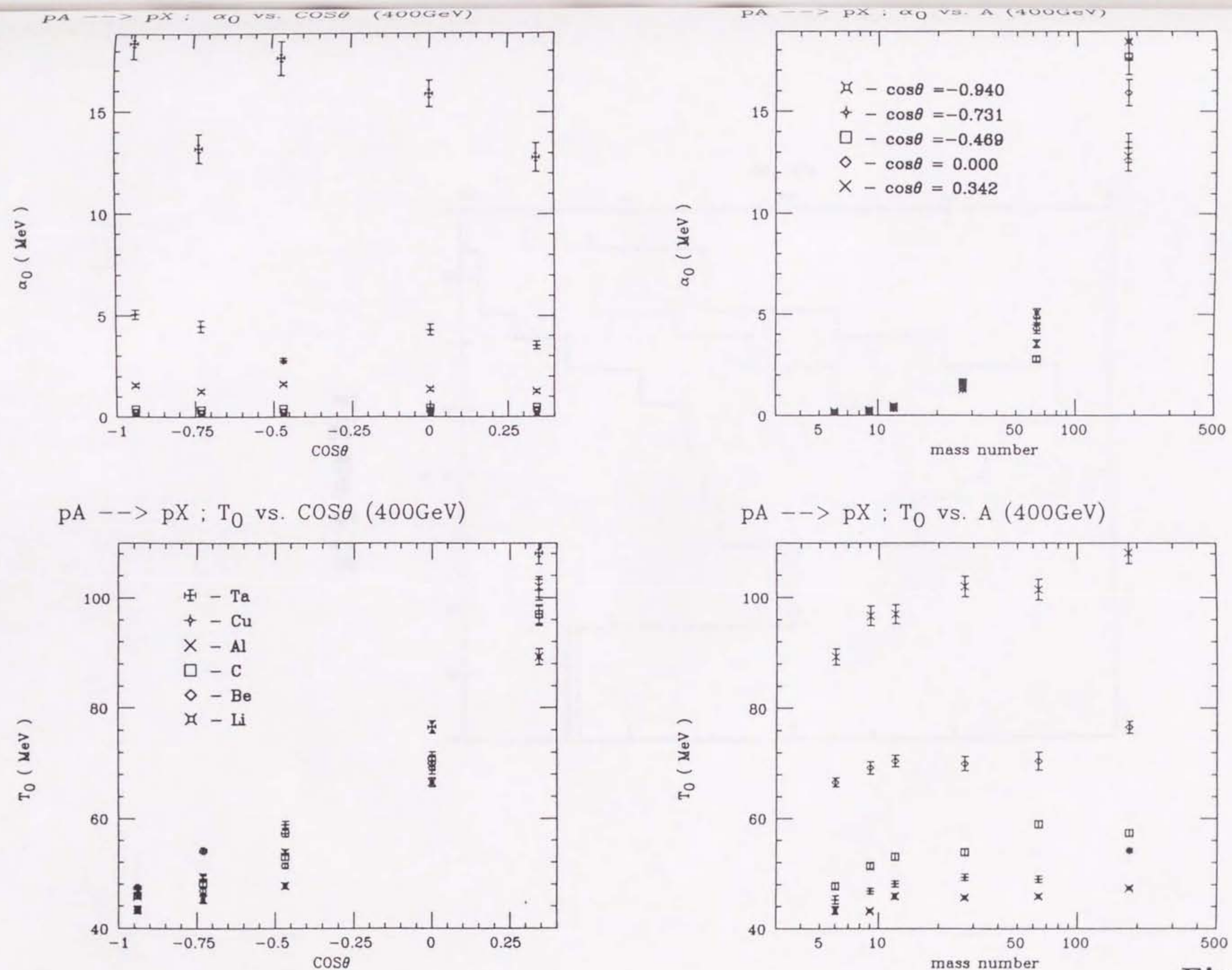

pA --> pX ; α0 vs. COSθ (400GeV)
α0 (MeV)
COSθ
pA --> pX ; α0 vs. A (400GeV)
cosθ =-0.940
cosθ =-0.731
cosθ =-0.469
cosθ = 0.000
cosθ = 0.342
α0 (MeV)
mass number
pA --> pX ; T0 vs. COSθ (400GeV)
Ta
Cu
Al
C
Be
Li
T0 (MeV)
COSθ
pA --> pX ; T0 vs. A (400GeV)
T0 (MeV)
mass number

Figure 5.15

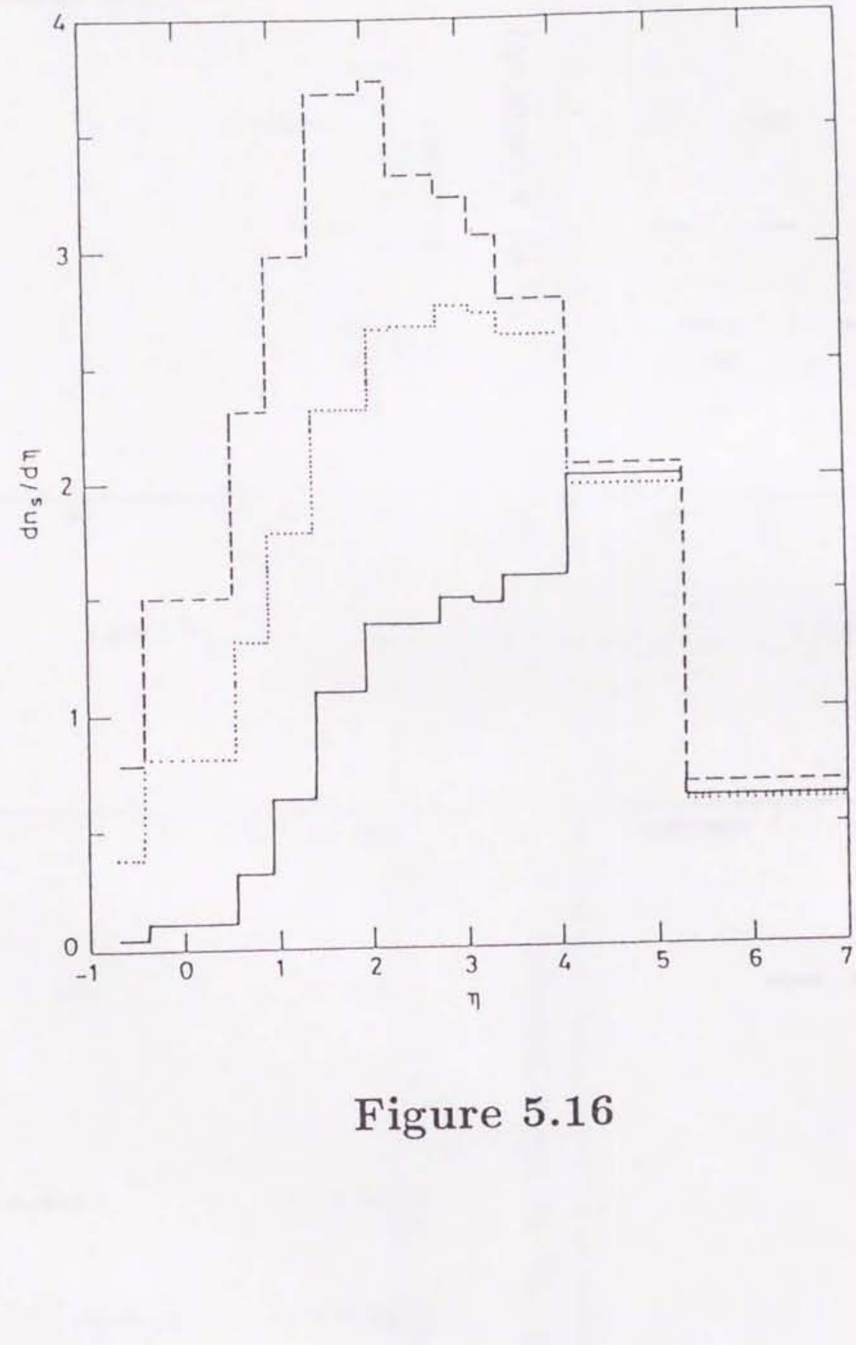


Figure 5.16

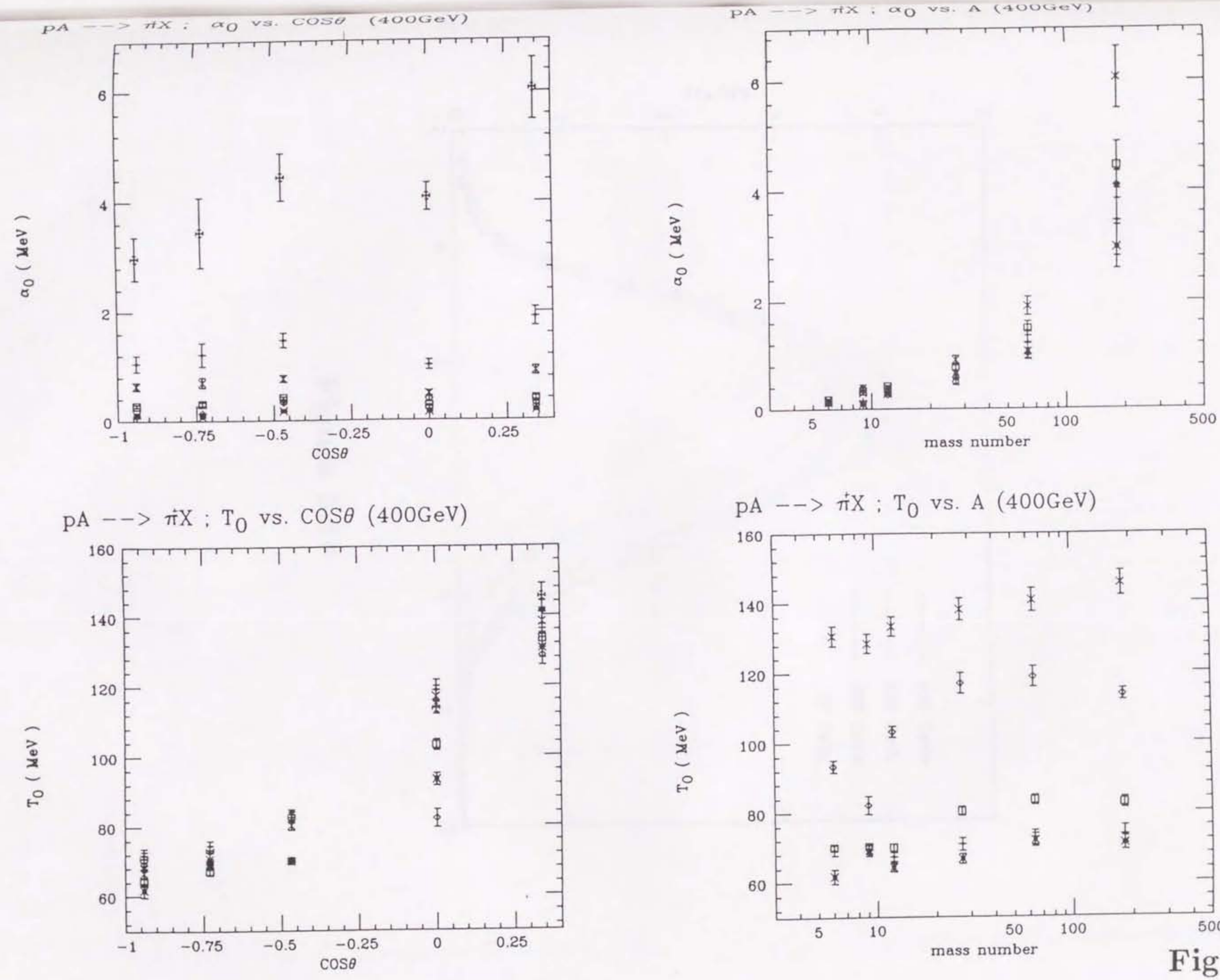

pA --> πX ; α_0 vs. COSθ (400GeV)
α_0 (MeV)
COSθ
pA --> πX ; α_0 vs. A (400GeV)
mass number
pA --> πX ; T_0 vs. COSθ (400GeV)
T_0 (MeV)
pA --> πX ; T_0 vs. A (400GeV)

Figure 5.17

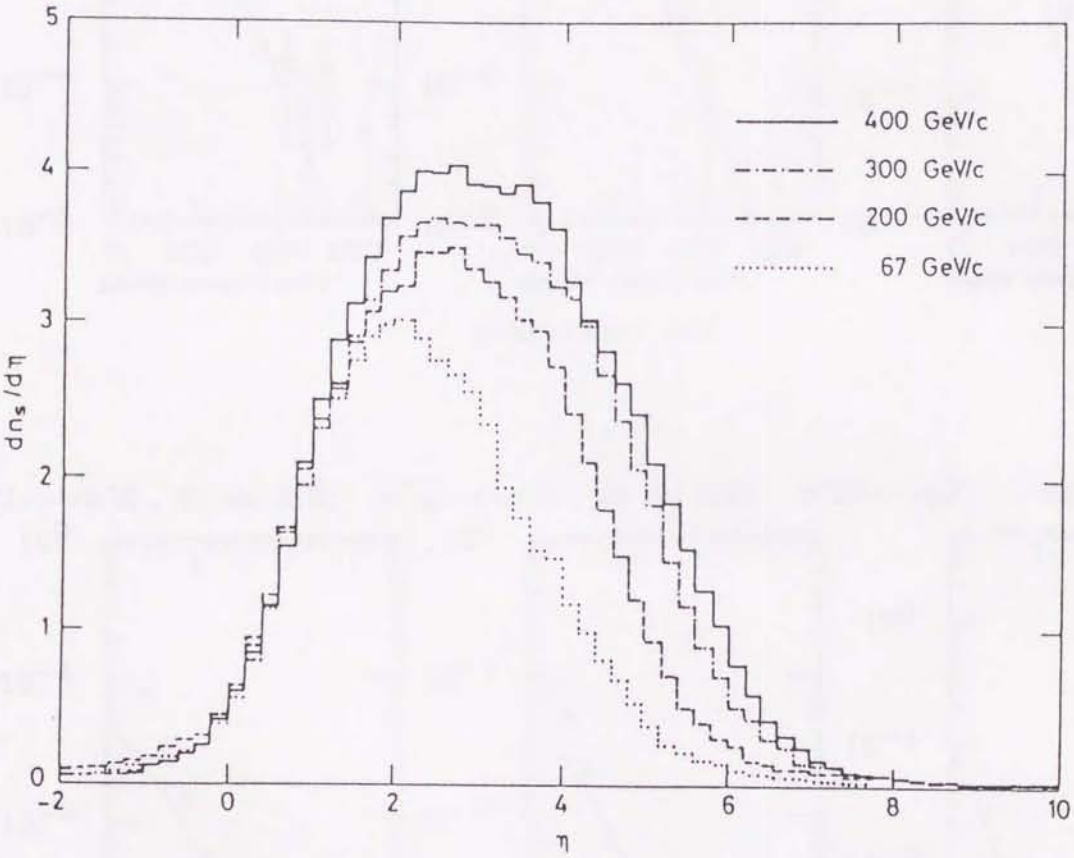
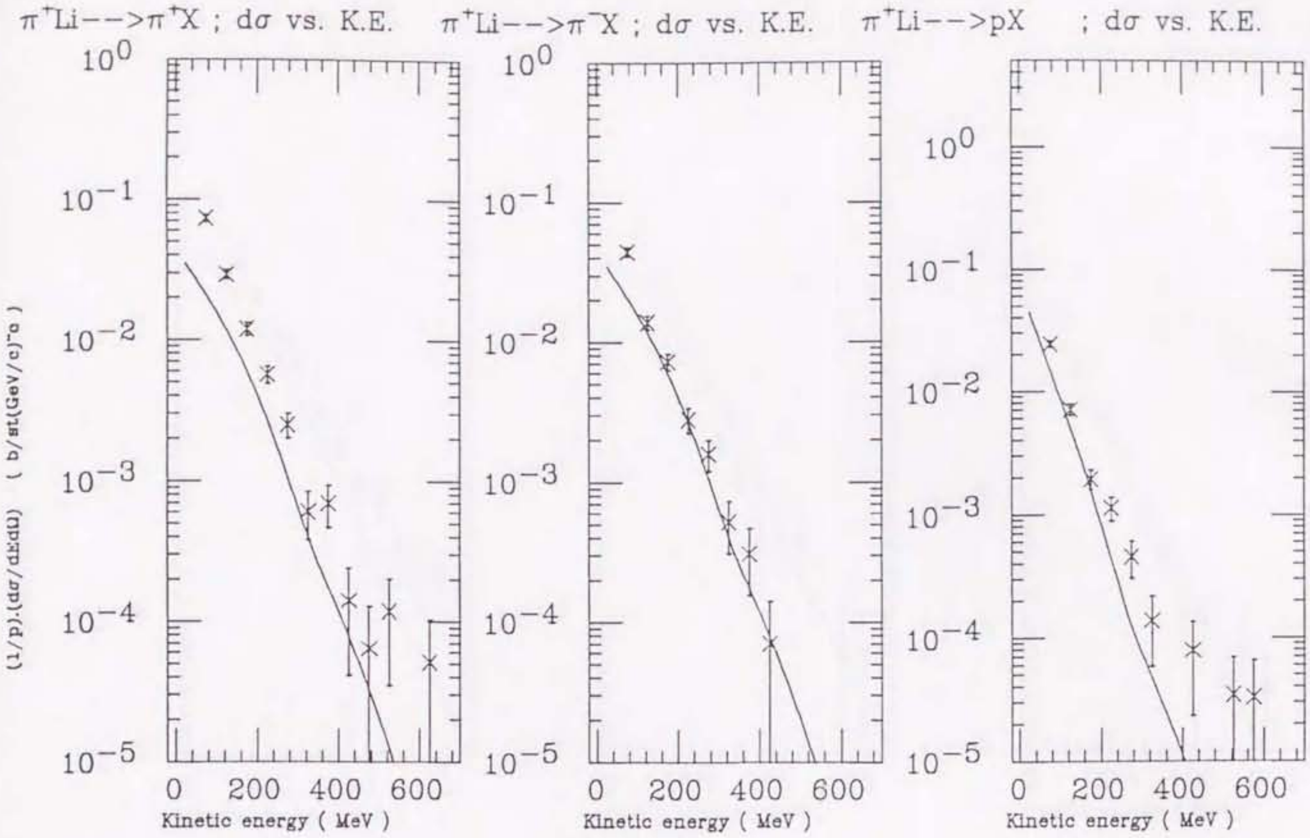
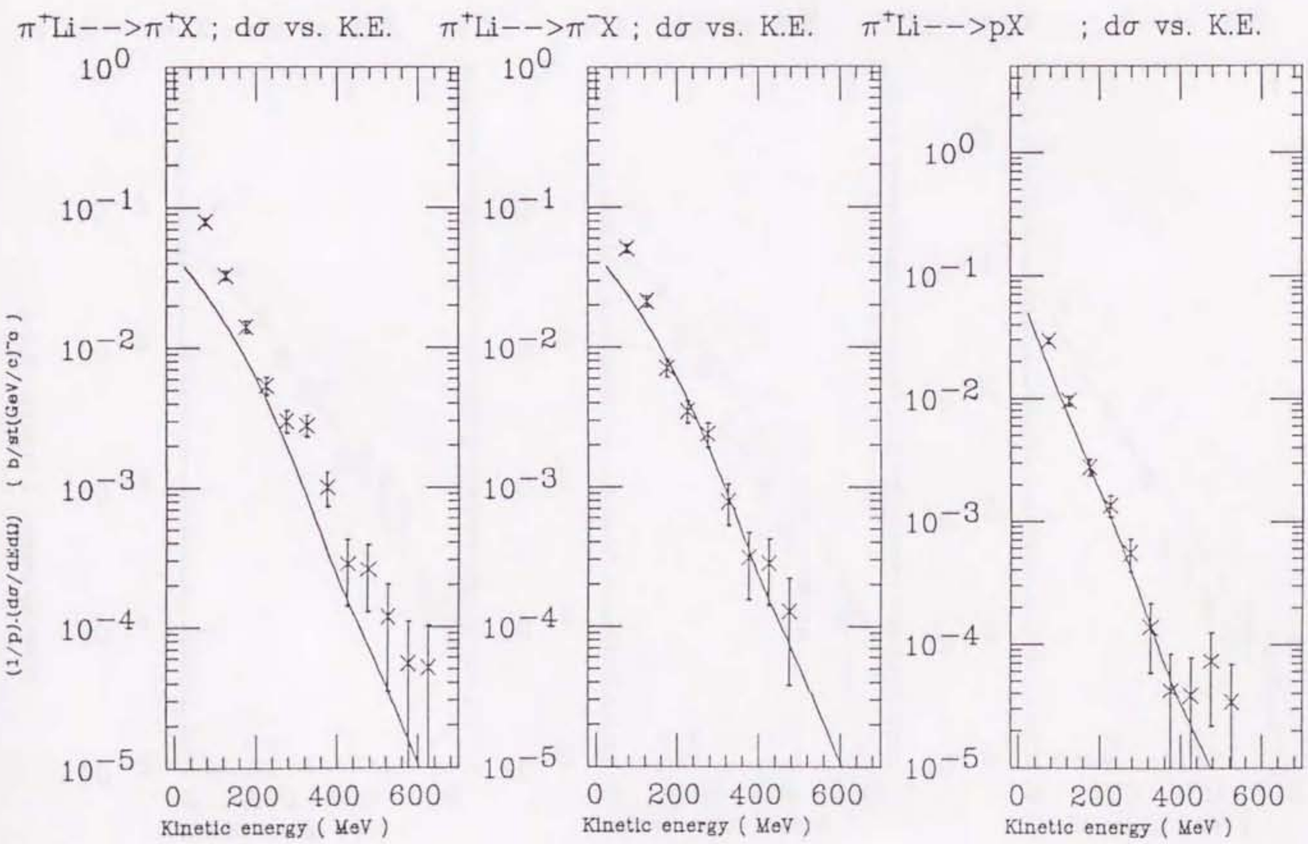


Figure 5.18

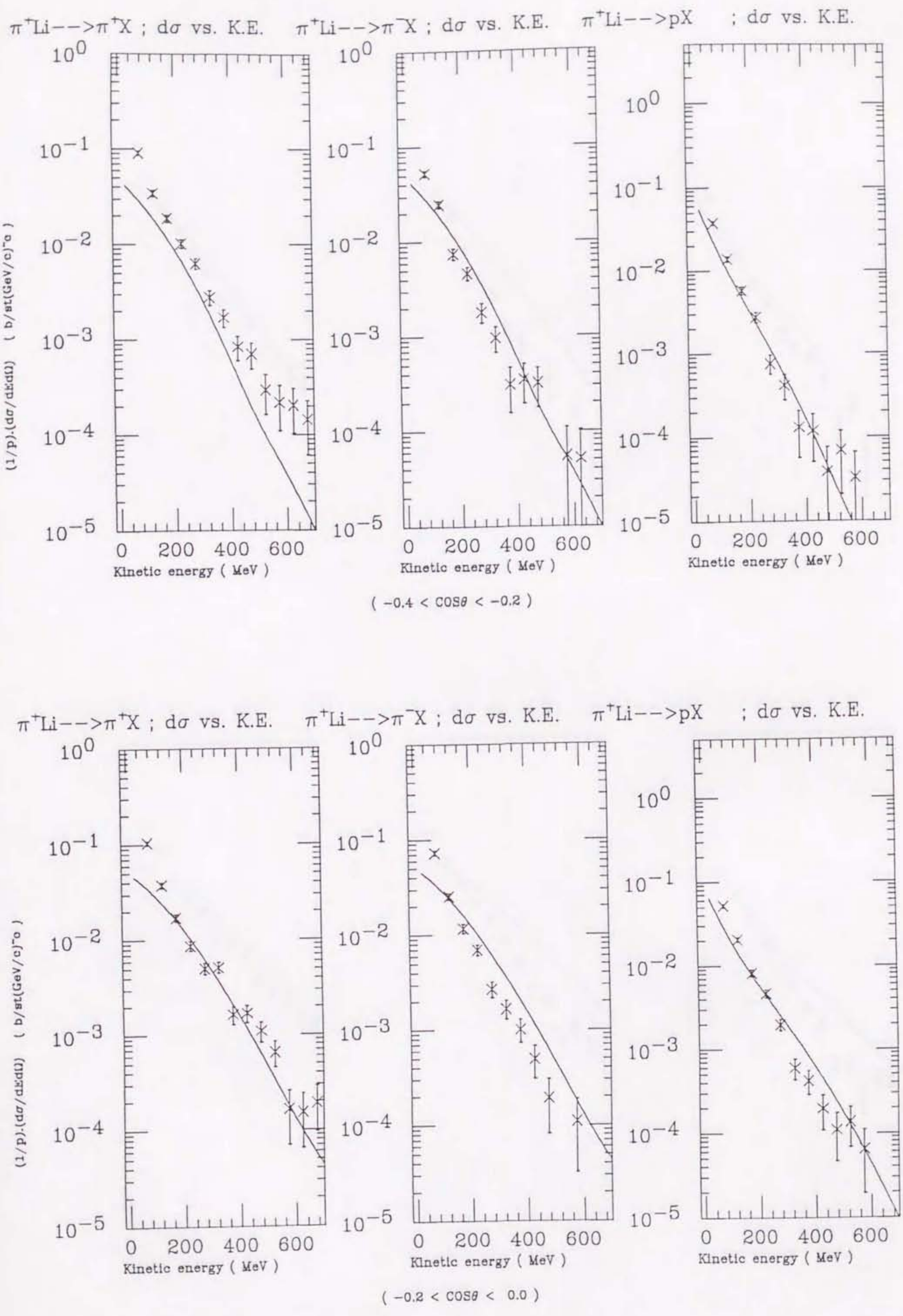


(-0.8 < COSθ < -0.6)



(-0.6 < COSθ < -0.4)

Figure 5.19.A



$\pi^+Li\text{-->}\pi^+X$; $d\sigma$ vs. K.E.
$\pi^+Li\text{-->}\pi^-X$; $d\sigma$ vs. K.E.
$\pi^+Li\text{-->}pX$; $d\sigma$ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^-2)
Kinetic energy (MeV)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)

Figure 5.19.B

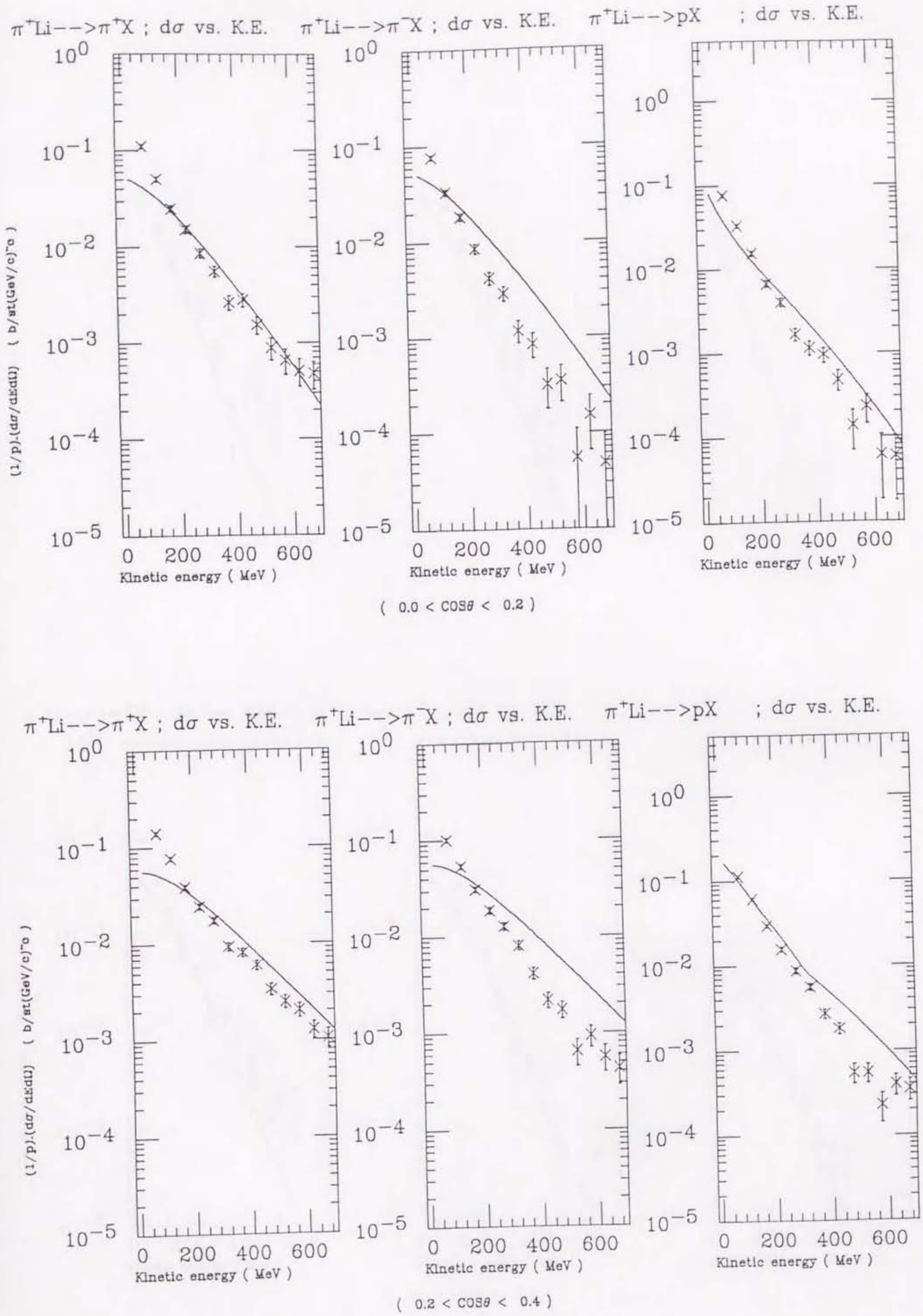
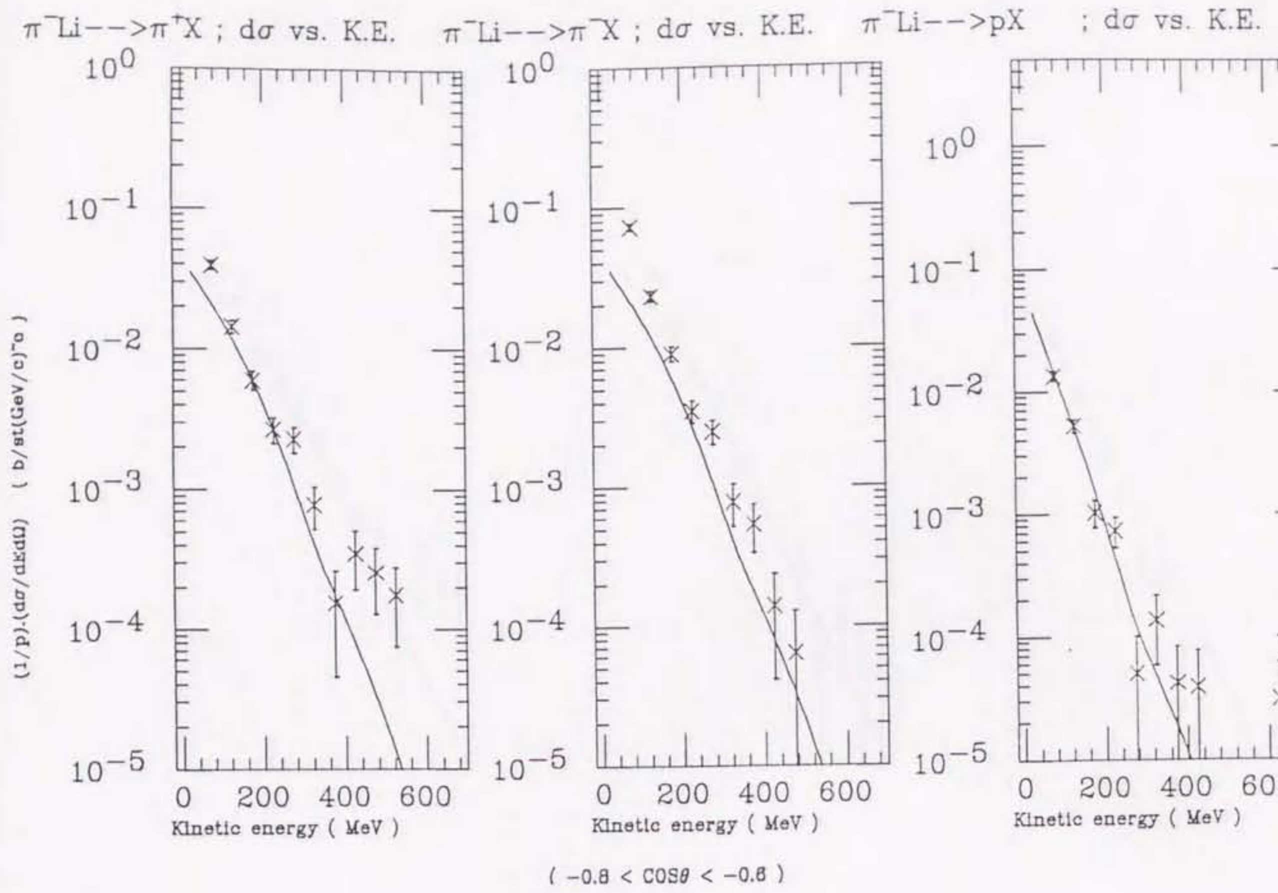
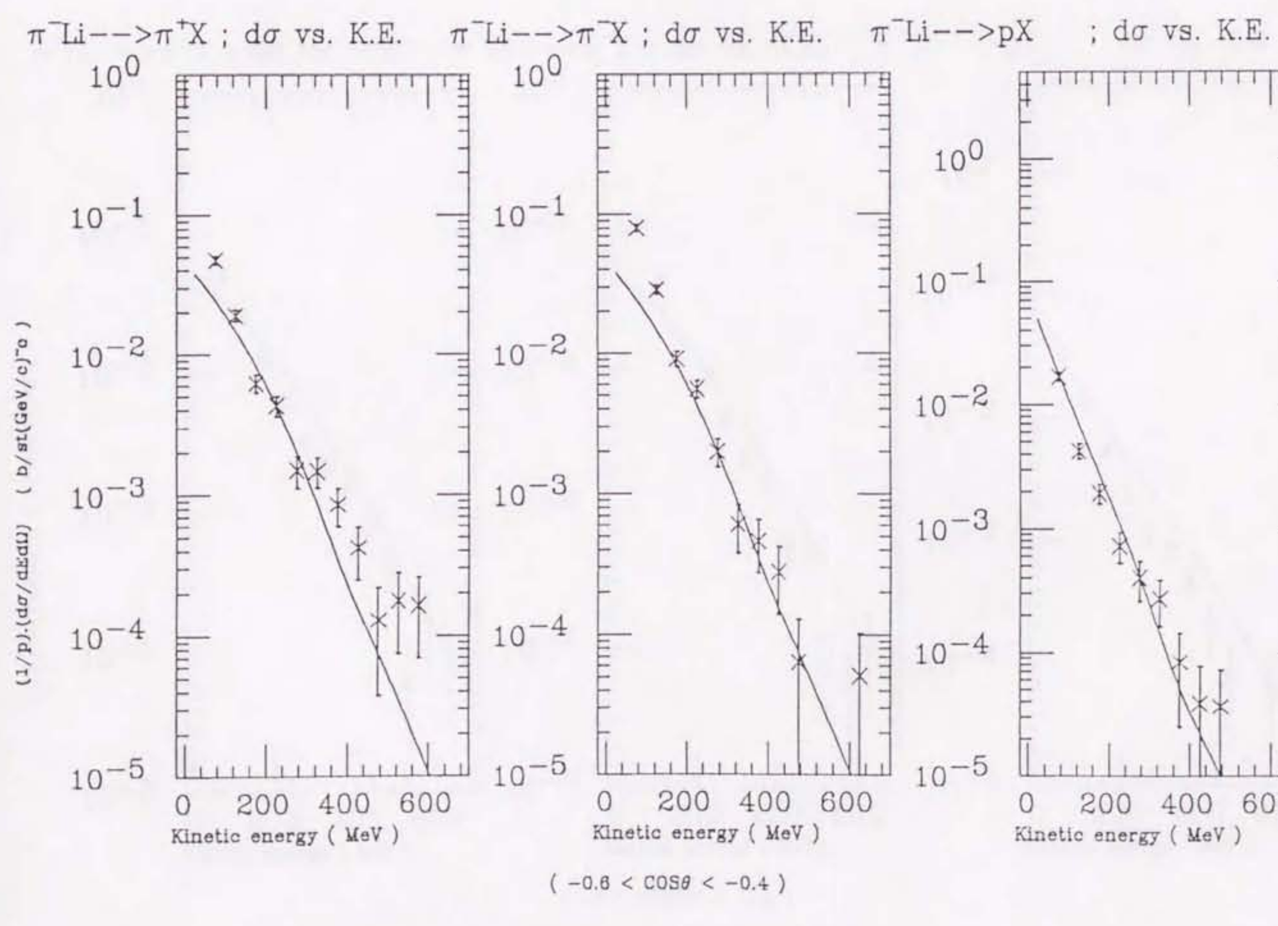

π⁺Li-->π⁺X ; dσ vs. K.E.
π⁺Li-->π⁻X ; dσ vs. K.E.
π⁺Li-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/sr(GeV/c)^2)
Kinetic energy (MeV)
(0.0 < COSθ < 0.2)
π⁺Li-->π⁺X ; dσ vs. K.E.
π⁺Li-->π⁻X ; dσ vs. K.E.
π⁺Li-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/sr(GeV/c)^2)
Kinetic energy (MeV)
(0.2 < COSθ < 0.4)

Figure 5.19.C

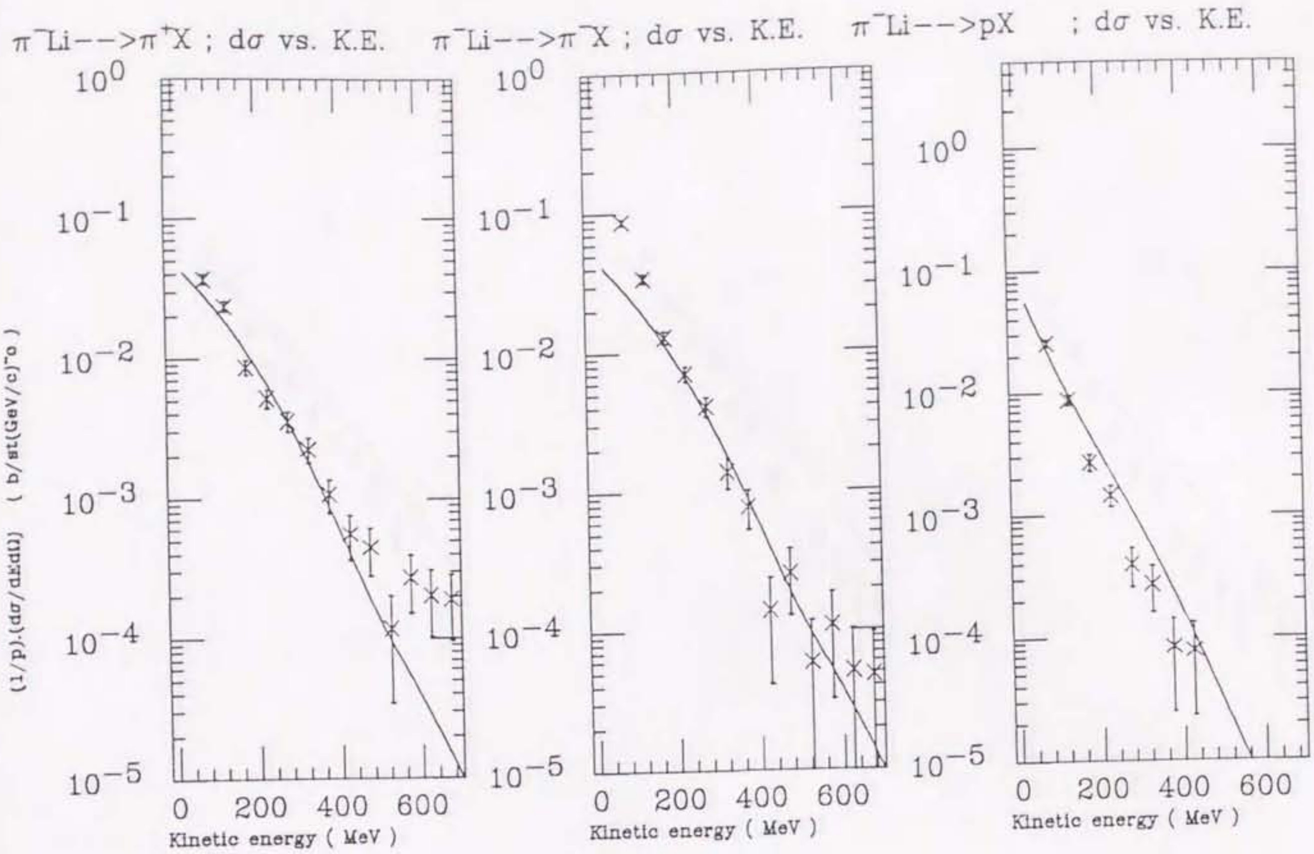


π^-Li-->π^+X ; dσ vs. K.E.
π^-Li-->π^-X ; dσ vs. K.E.
π^-Li-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/sr(GeV/c)$^-$c)
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)

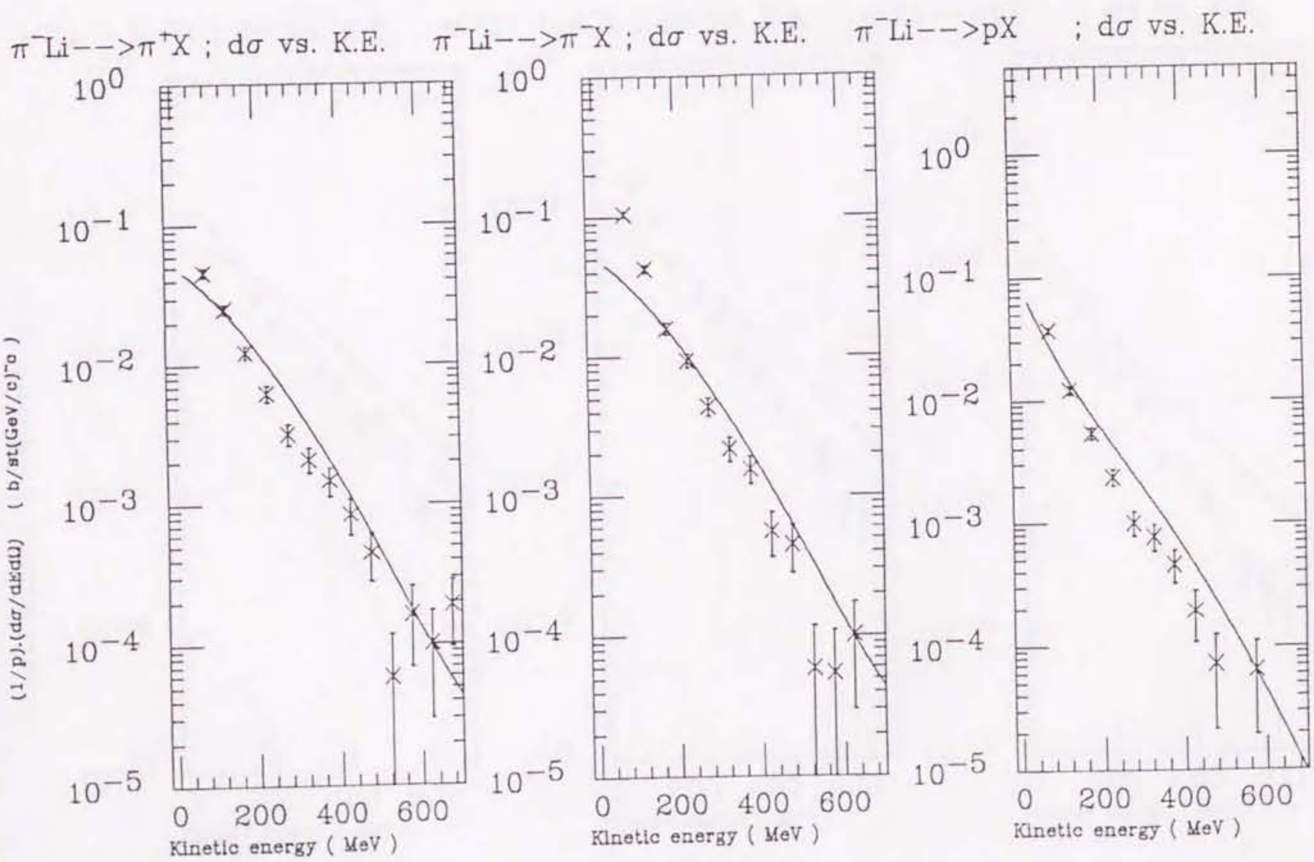


π^-Li-->π^+X ; dσ vs. K.E.
π^-Li-->π^-X ; dσ vs. K.E.
π^-Li-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/sr(GeV/c)$^-$c)
Kinetic energy (MeV)
(-0.6 < COSθ < -0.4)

Figure 5.20.A

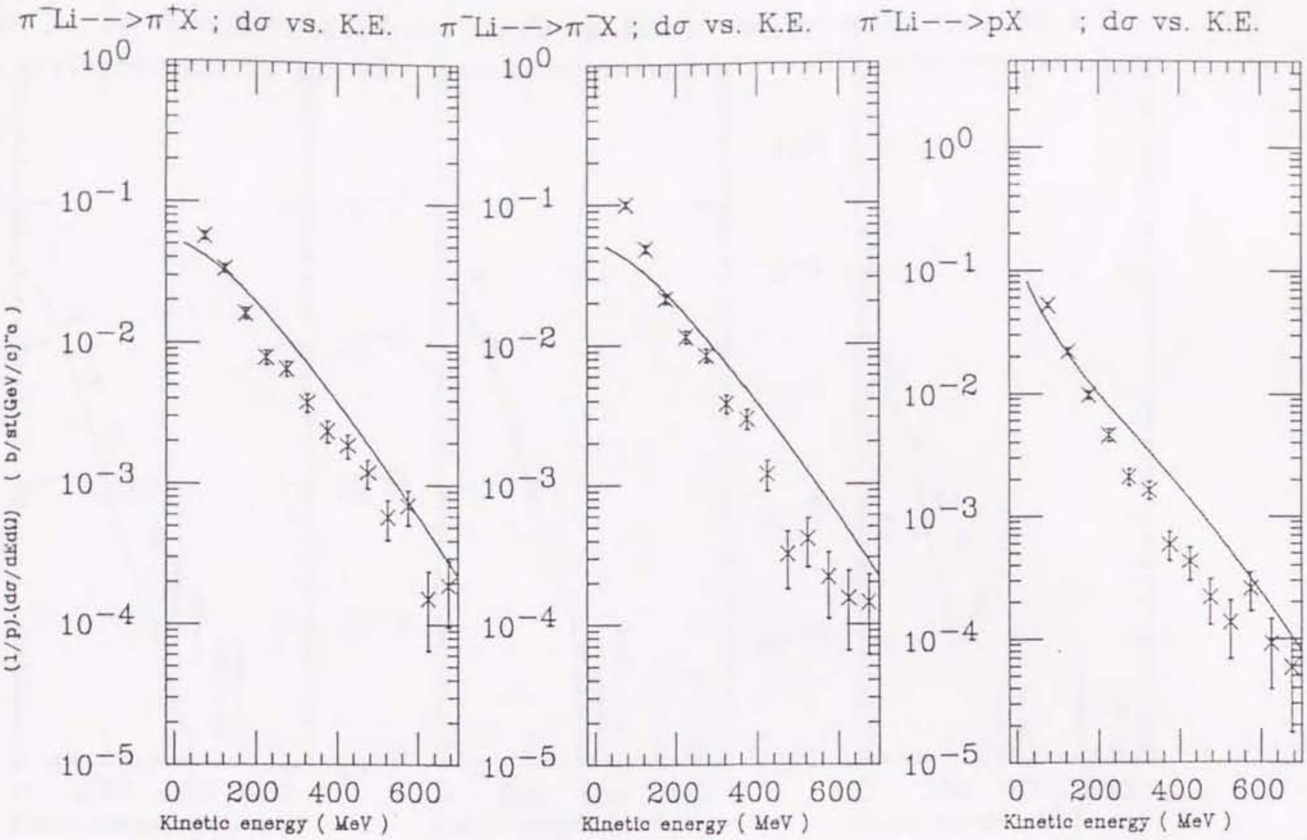


($-0.4 < \cos\theta < -0.2$)

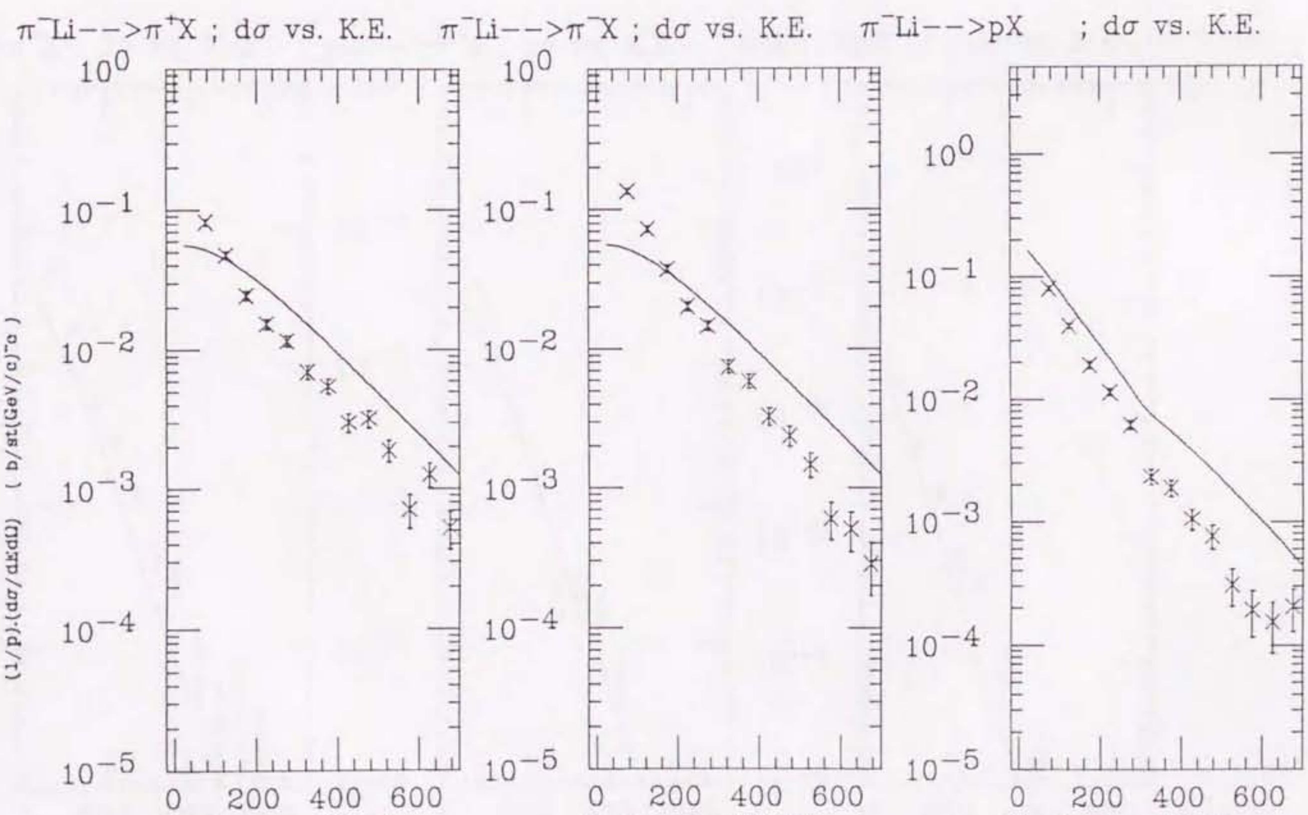


($-0.2 < \cos\theta < 0.0$)

Figure 5.20.B

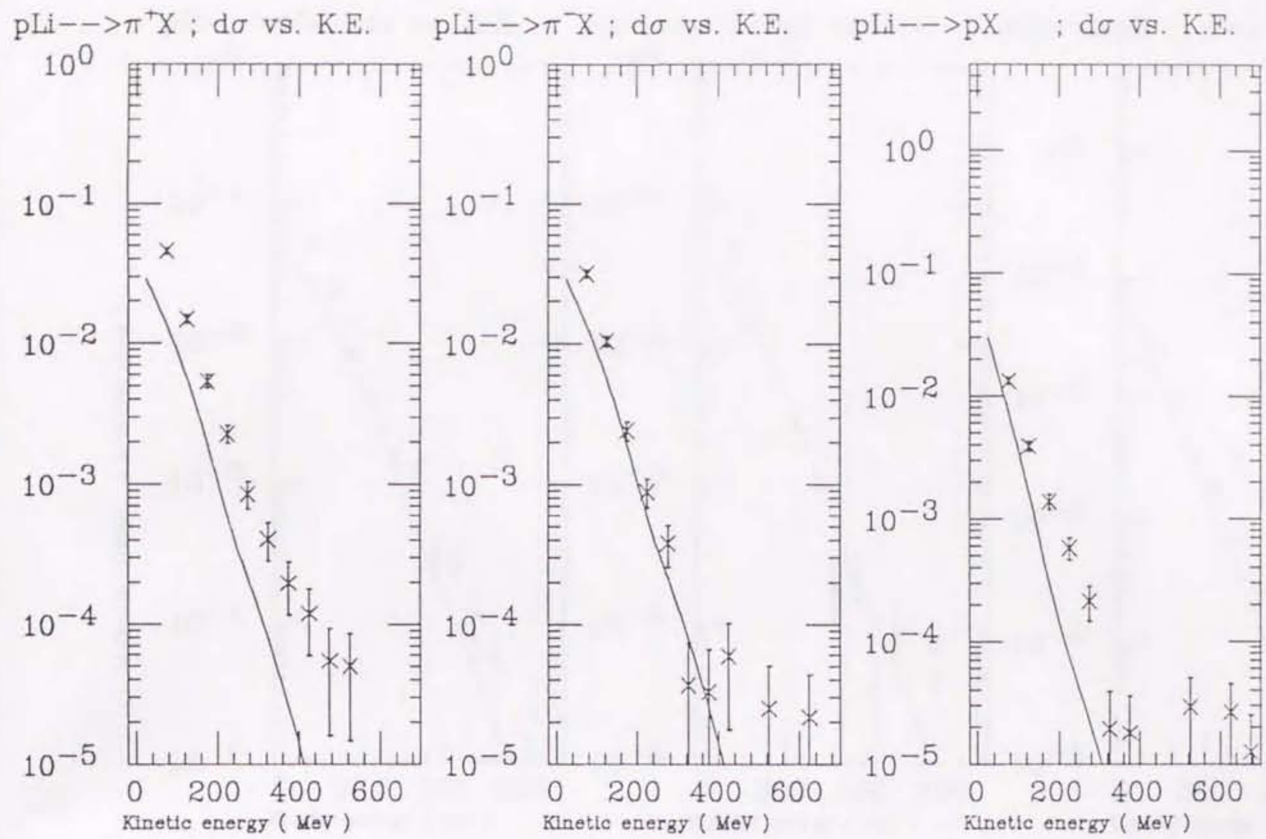


(0.0 < COSθ < 0.2)

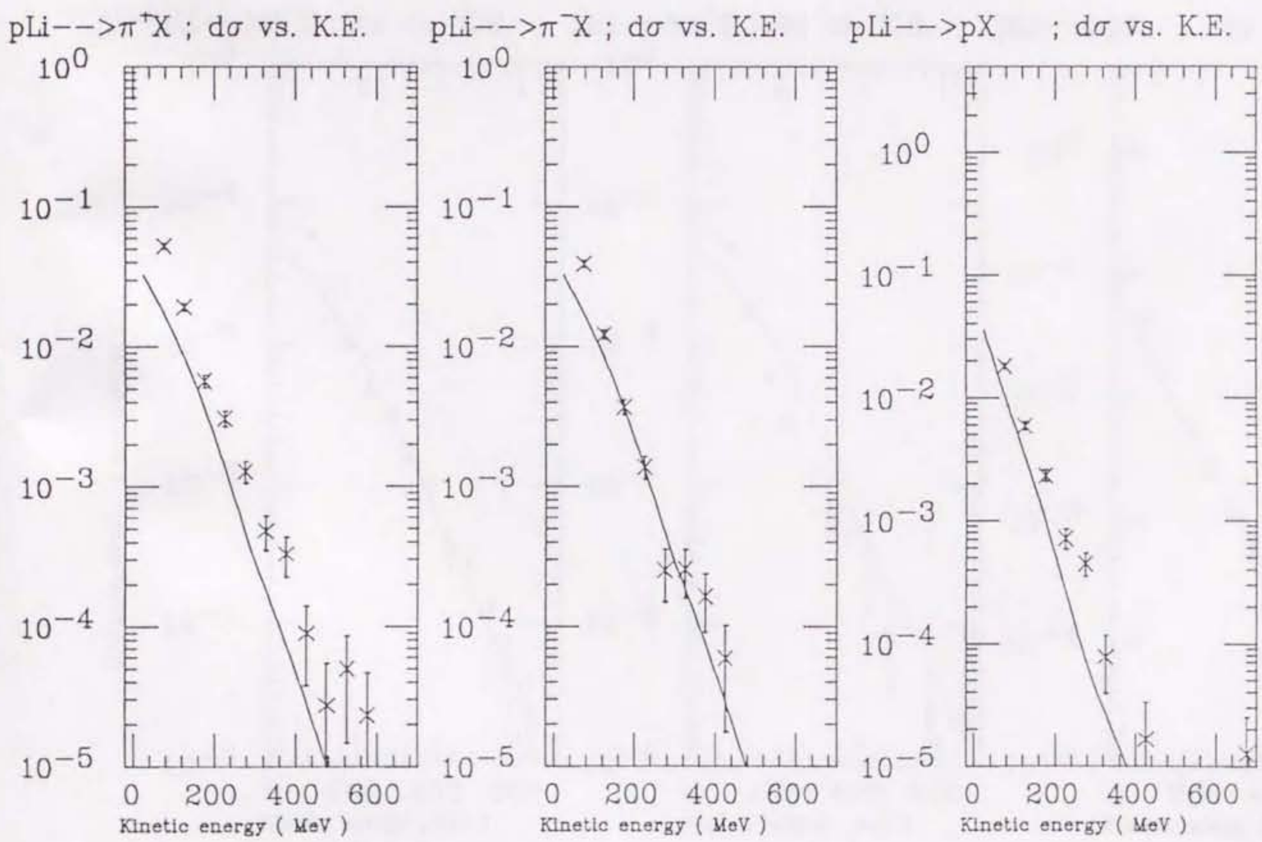


(0.2 < COSθ < 0.4)

Figure 5.20.C



($-0.8 < \cos\theta < -0.6$)



($-0.6 < \cos\theta < -0.4$)

Figure 5.21.A

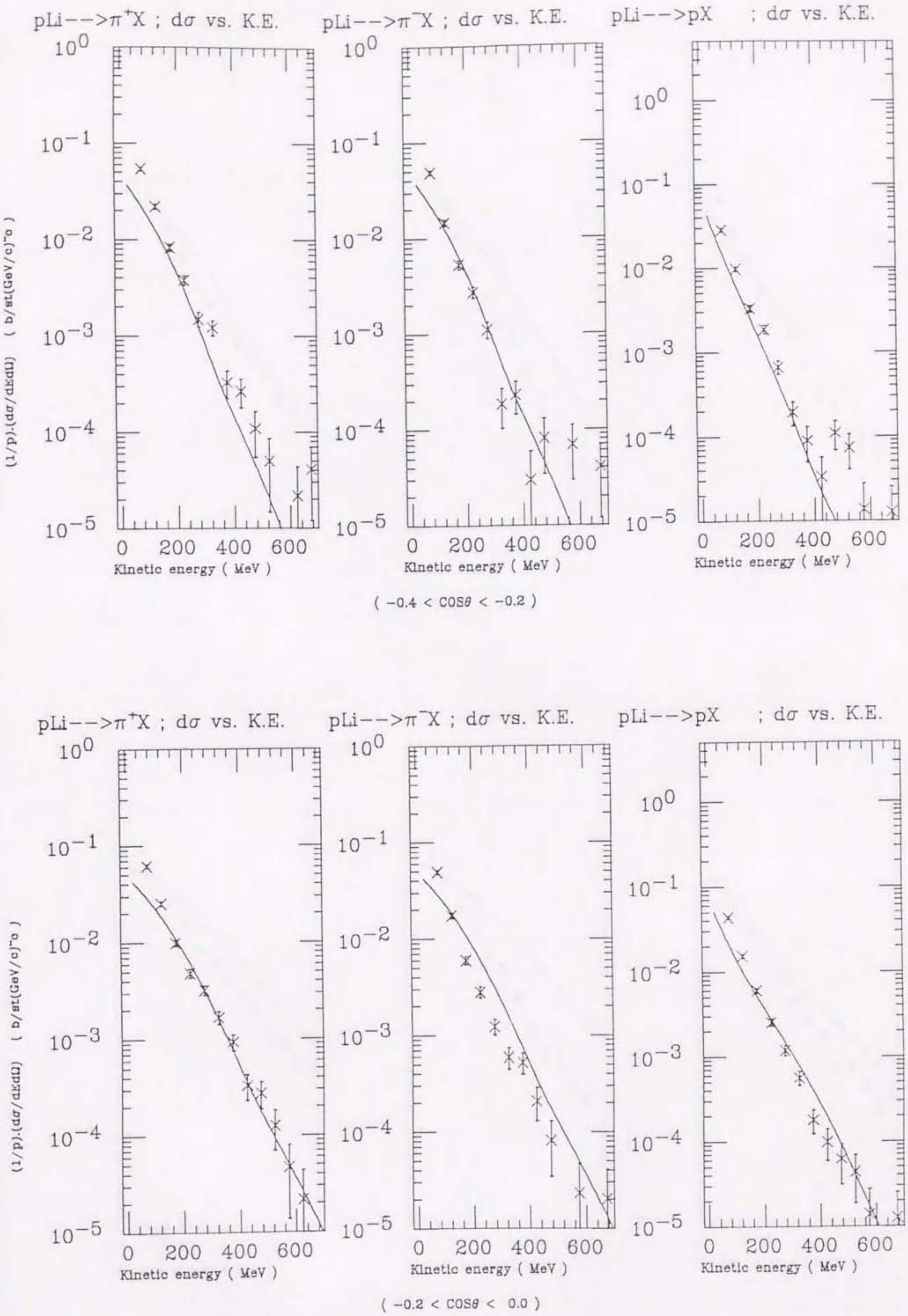
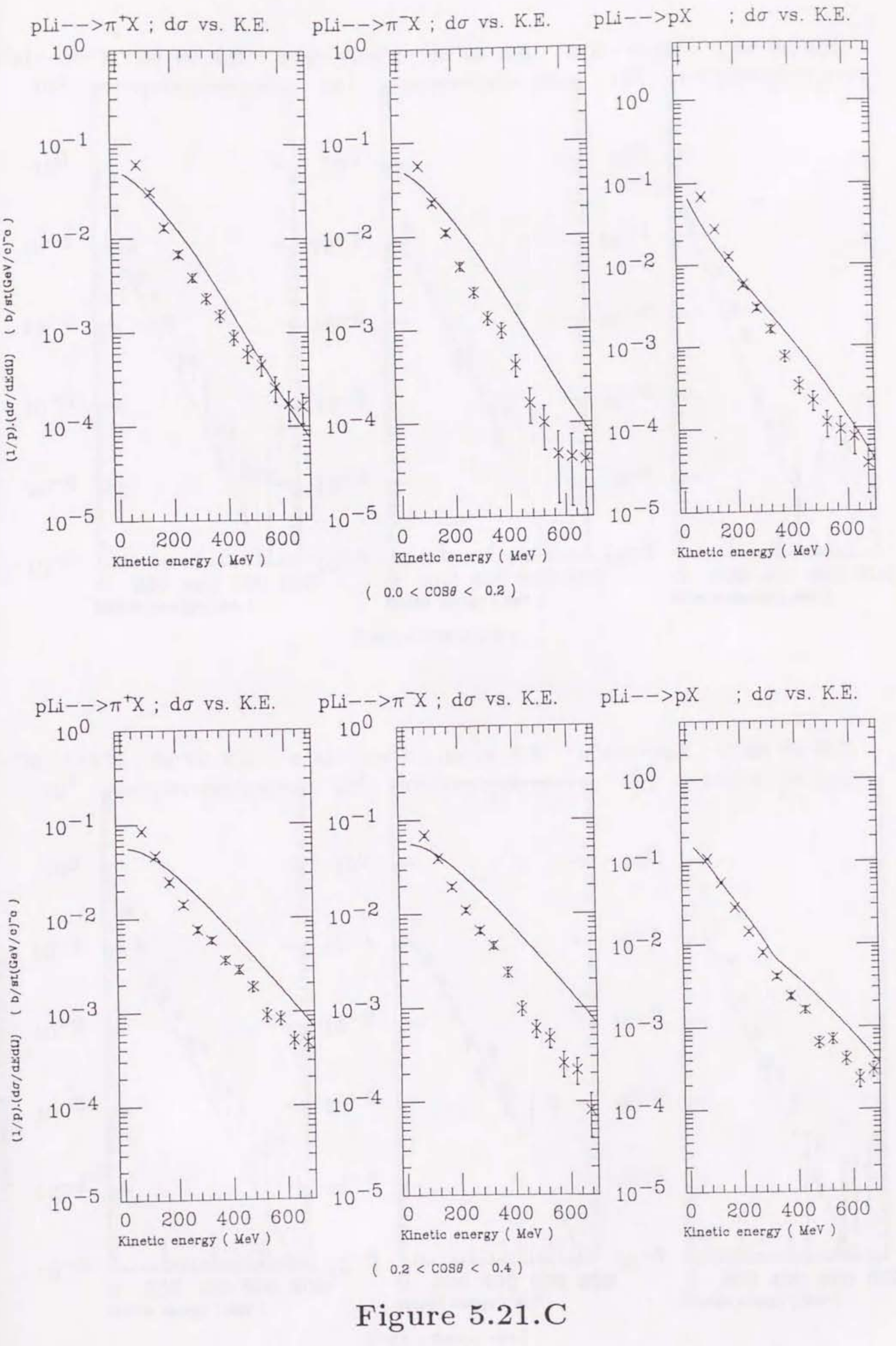
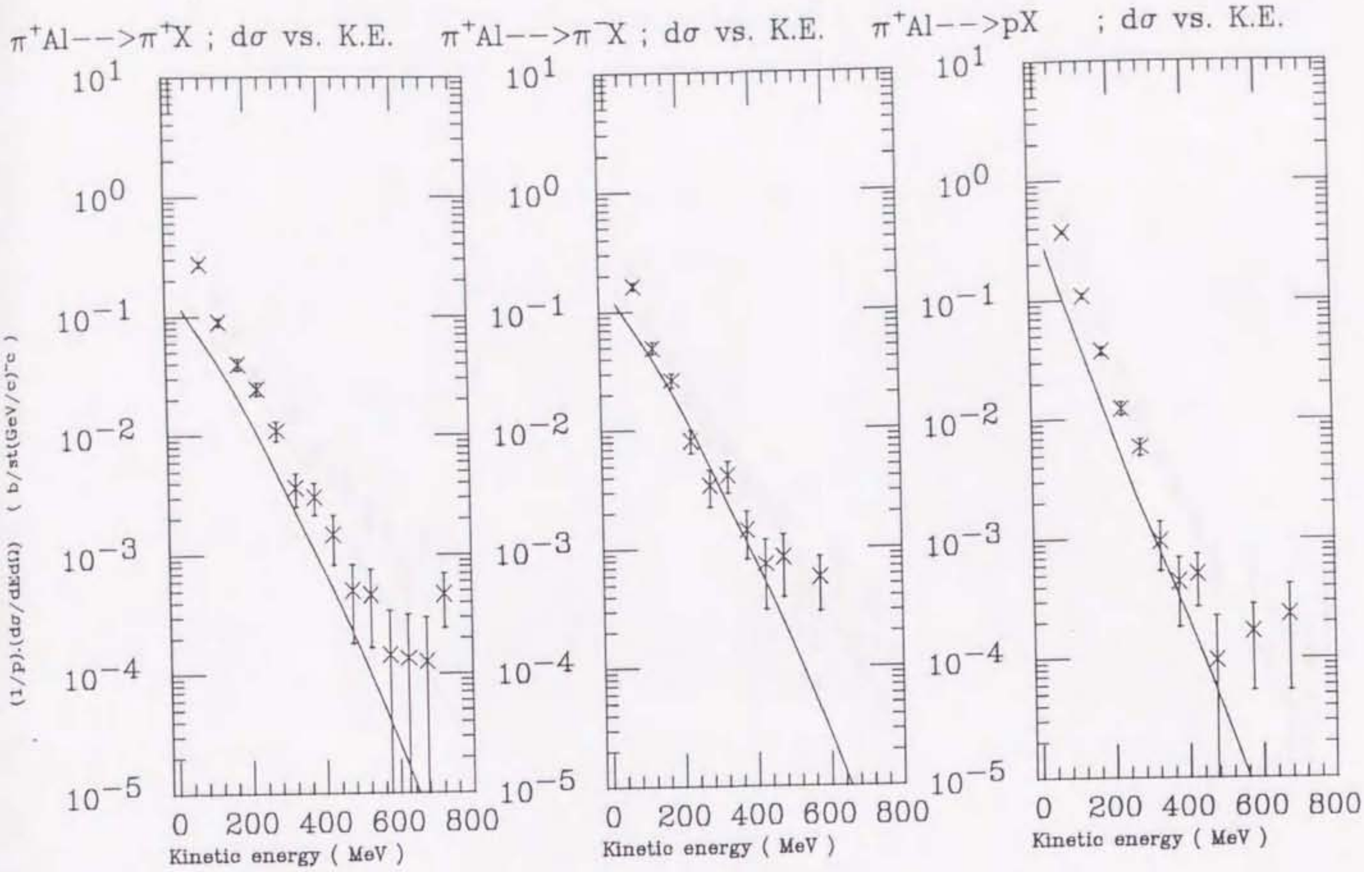

pLi-->π+X ; dσ vs. K.E.
pLi-->π-X ; dσ vs. K.E.
pLi-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/sr(GeV/c)^-2)
Kinetic energy (MeV)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)

Figure 5.21.B

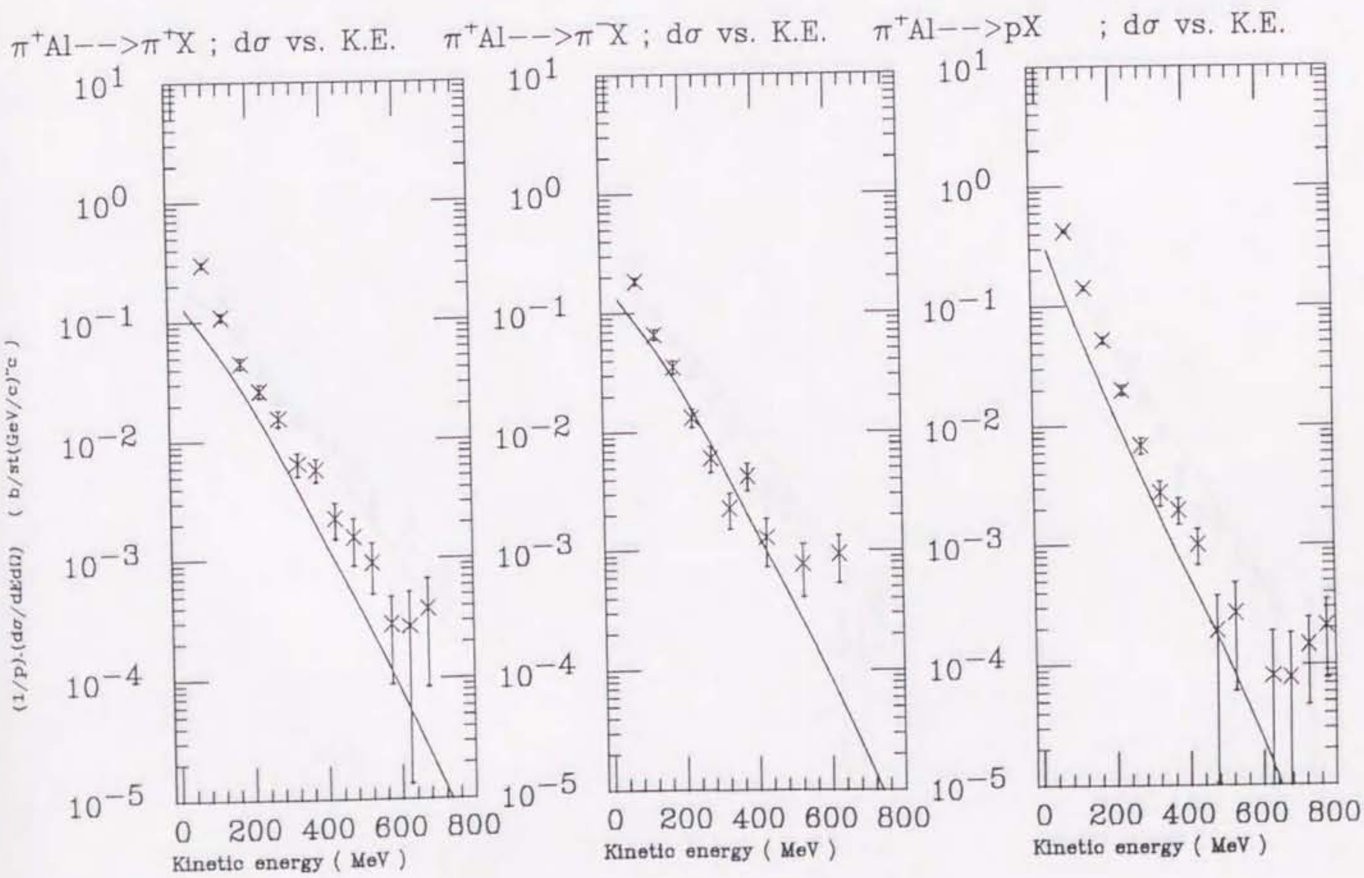


pLi-->π⁺X ; dσ vs. K.E.
pLi-->π⁻X ; dσ vs. K.E.
pLi-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)⁻c)
Kinetic energy (MeV)
(0.0 < COSθ < 0.2)
pLi-->π⁺X ; dσ vs. K.E.
pLi-->π⁻X ; dσ vs. K.E.
pLi-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)⁻c)
Kinetic energy (MeV)
(0.2 < COSθ < 0.4)

Figure 5.21.C

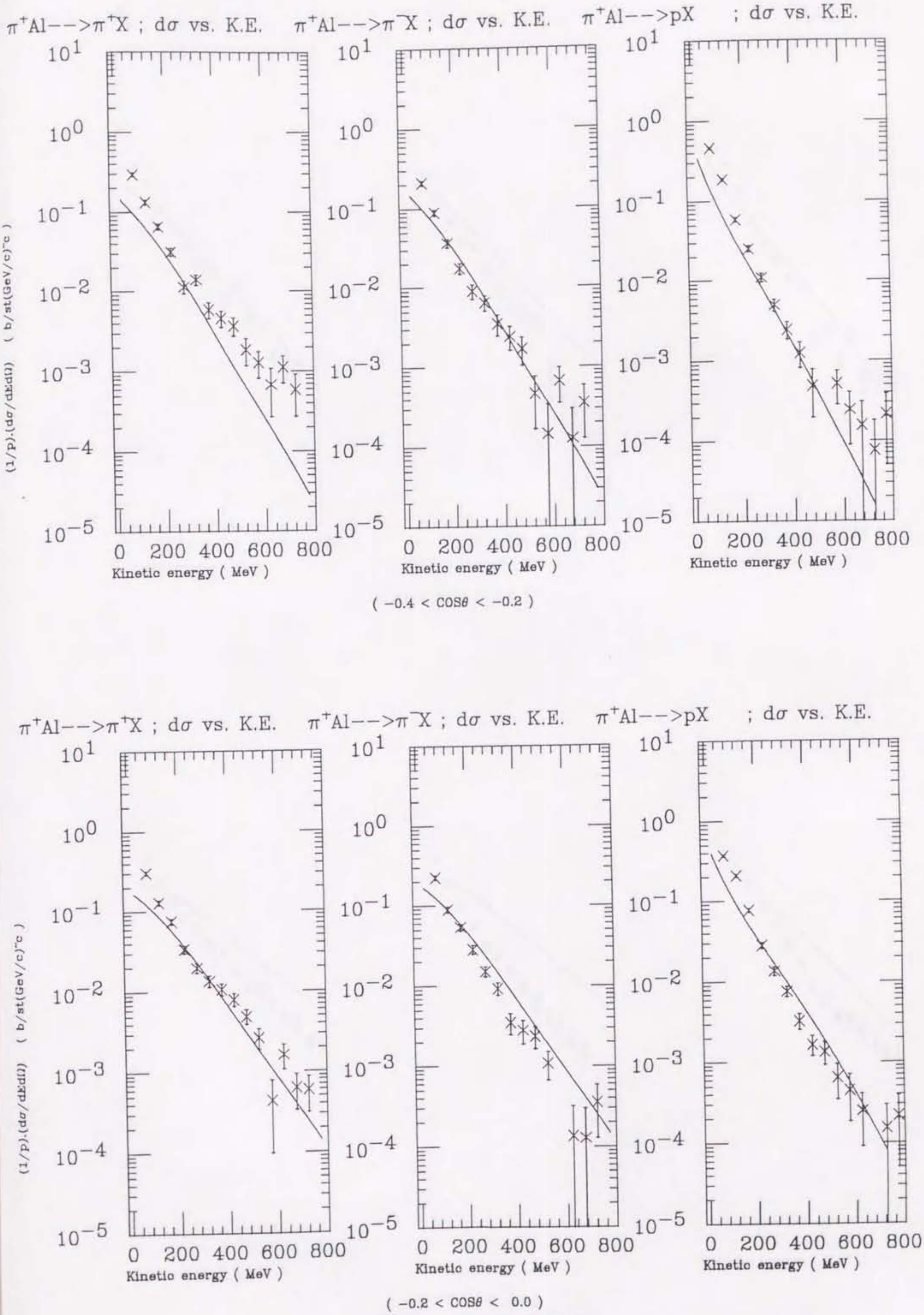


(−0.8 < COSθ < −0.6)



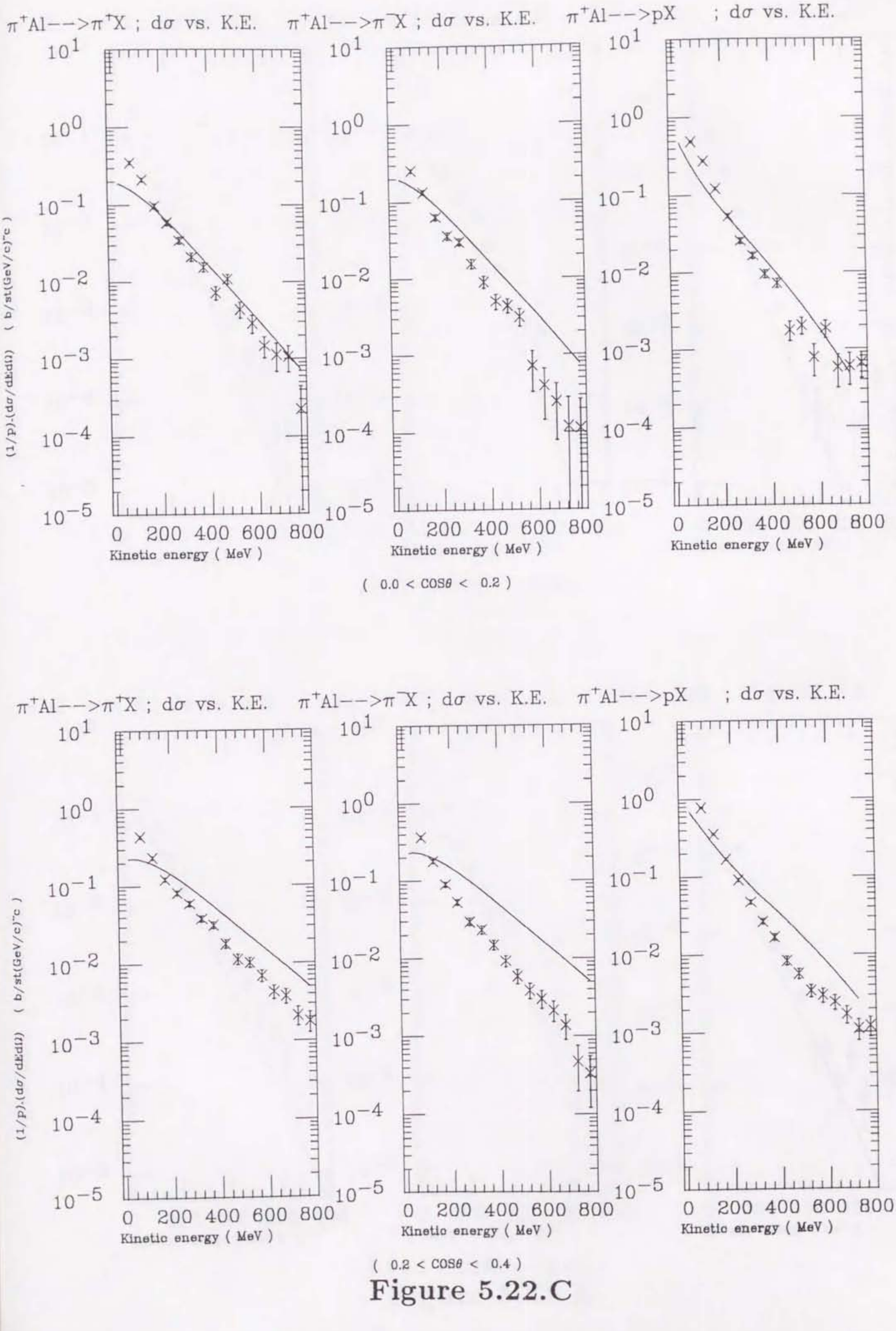
(−0.6 < COSθ < −0.4)

Figure 5.22.A



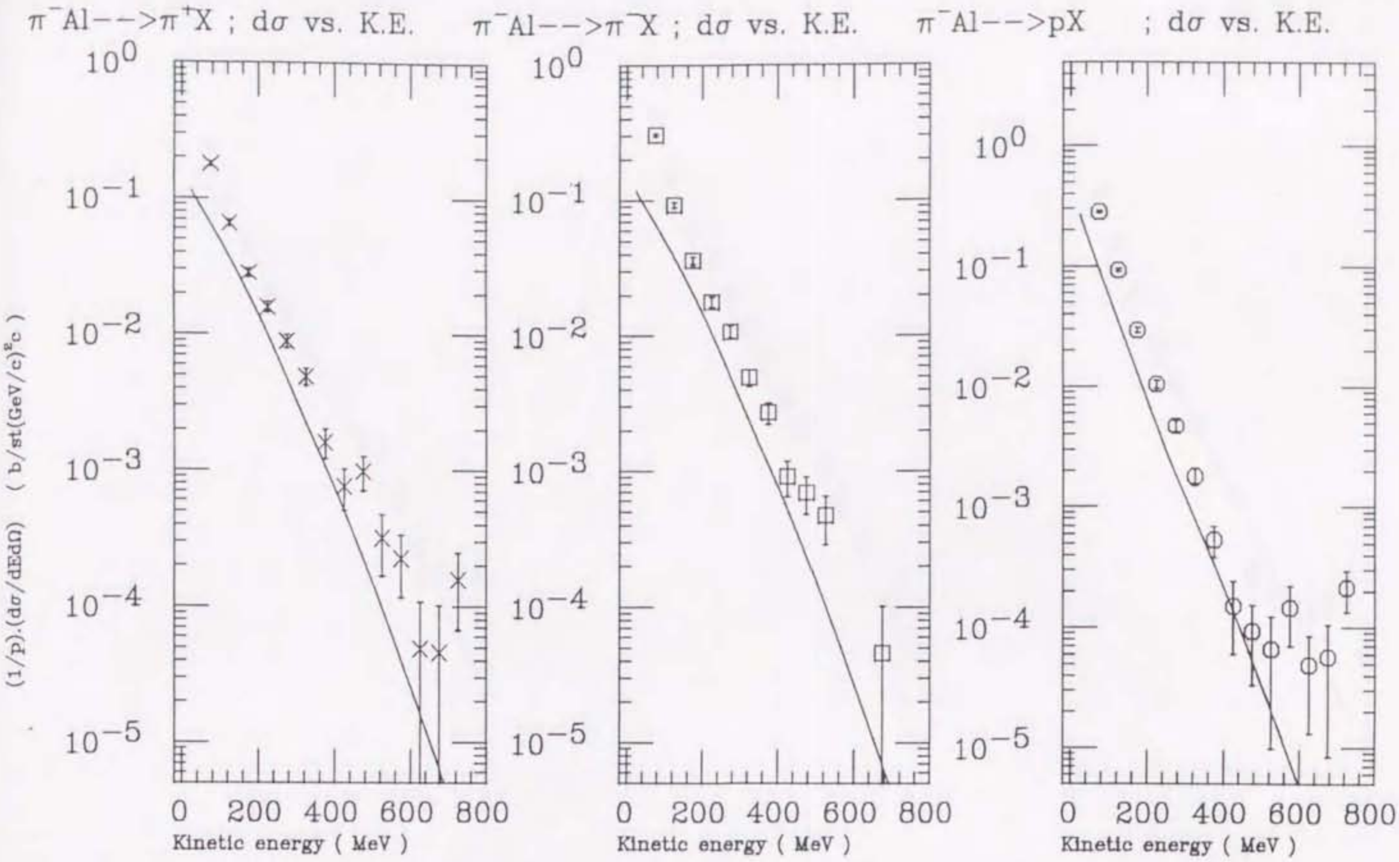
π⁺Al-->π⁺X ; dσ vs. K.E.
π⁺Al-->π⁻X ; dσ vs. K.E.
π⁺Al-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^c)
Kinetic energy (MeV)
0 200 400 600 800
10^1 10^0 10^-1 10^-2 10^-3 10^-4 10^-5
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)

Figure 5.22.B

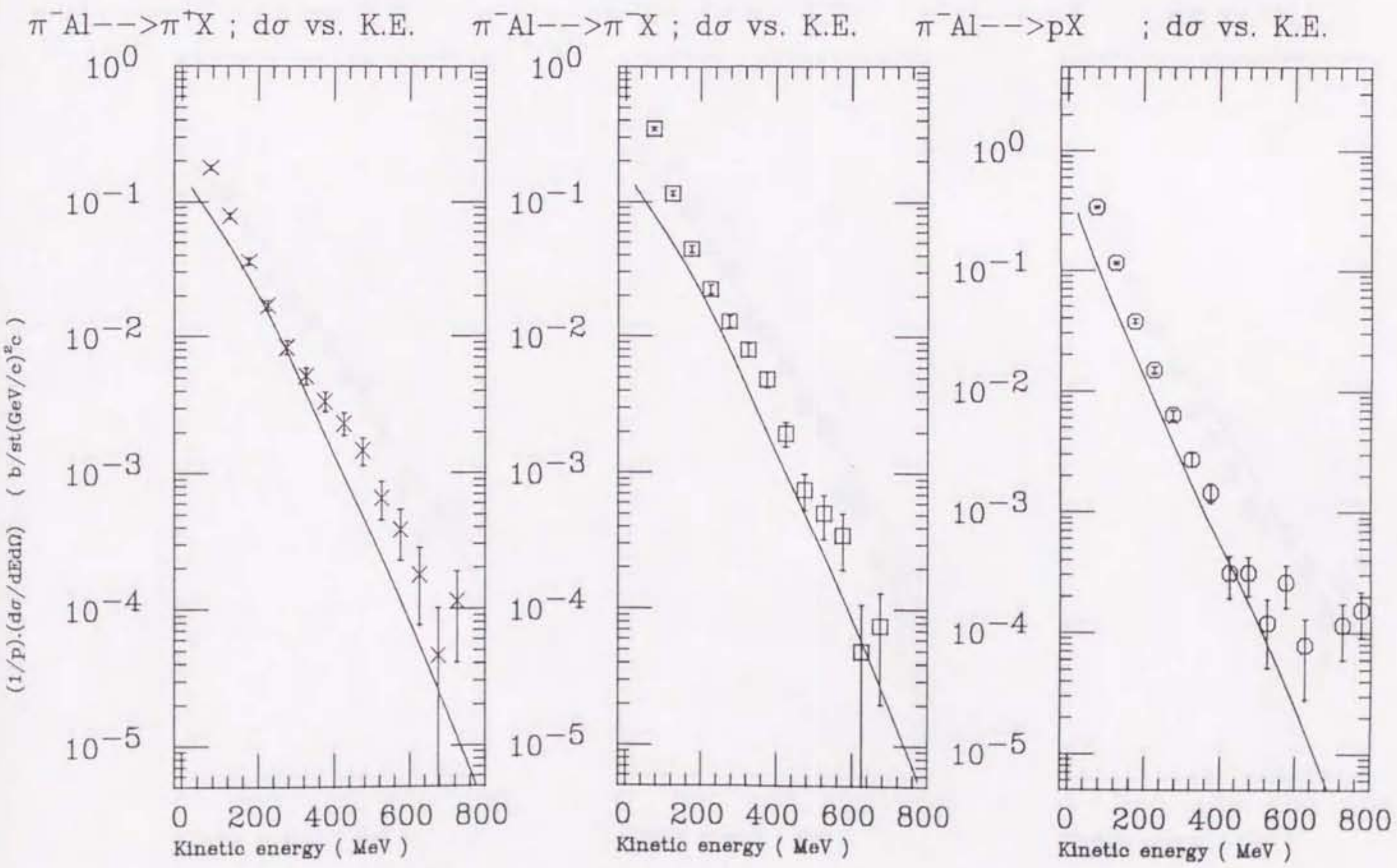


π⁺Al-->π⁺X ; dσ vs. K.E.
π⁺Al-->π⁻X ; dσ vs. K.E.
π⁺Al-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)^c)
Kinetic energy (MeV)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 5.22.C

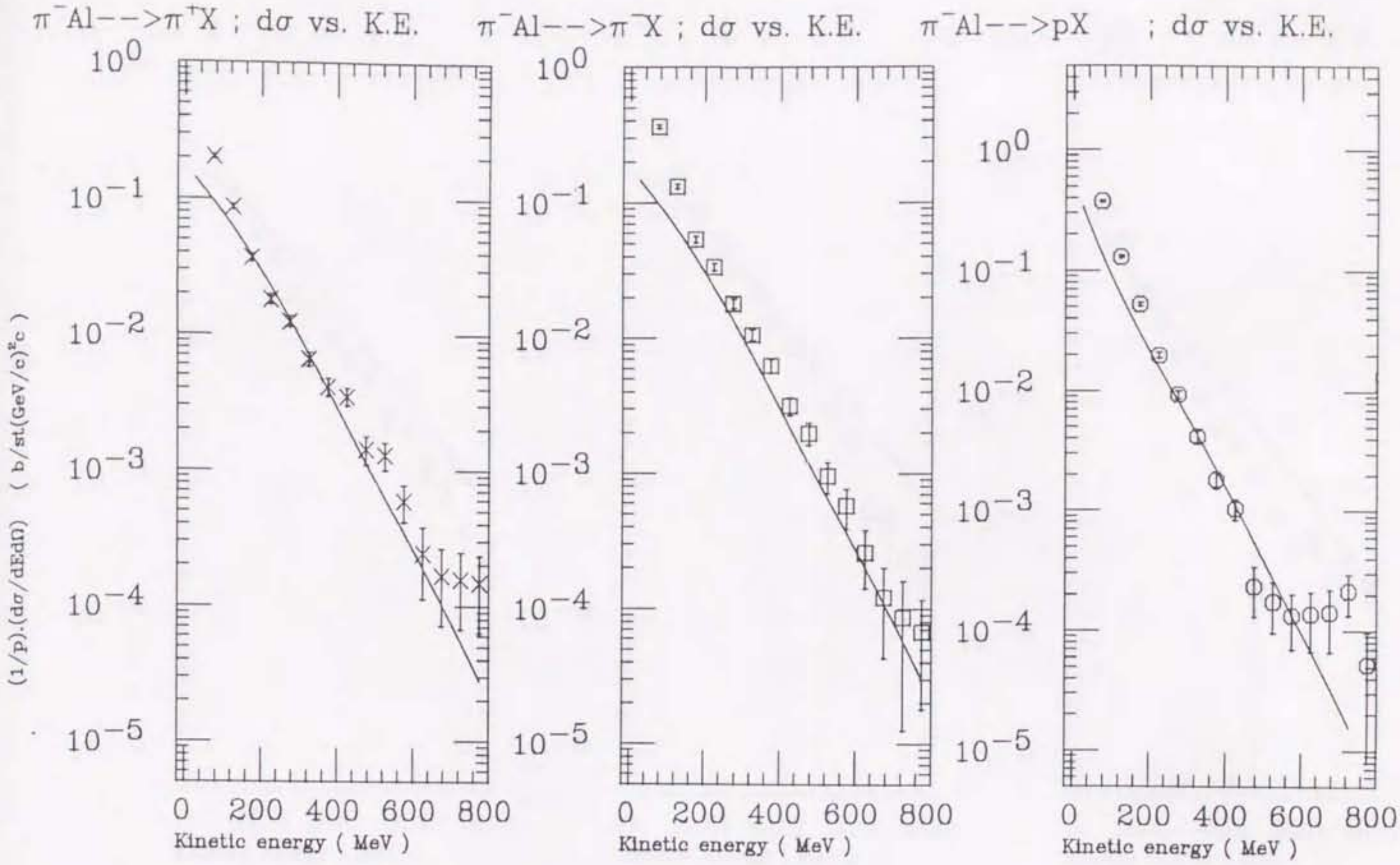


($-0.8 < \cos\theta < -0.6$)

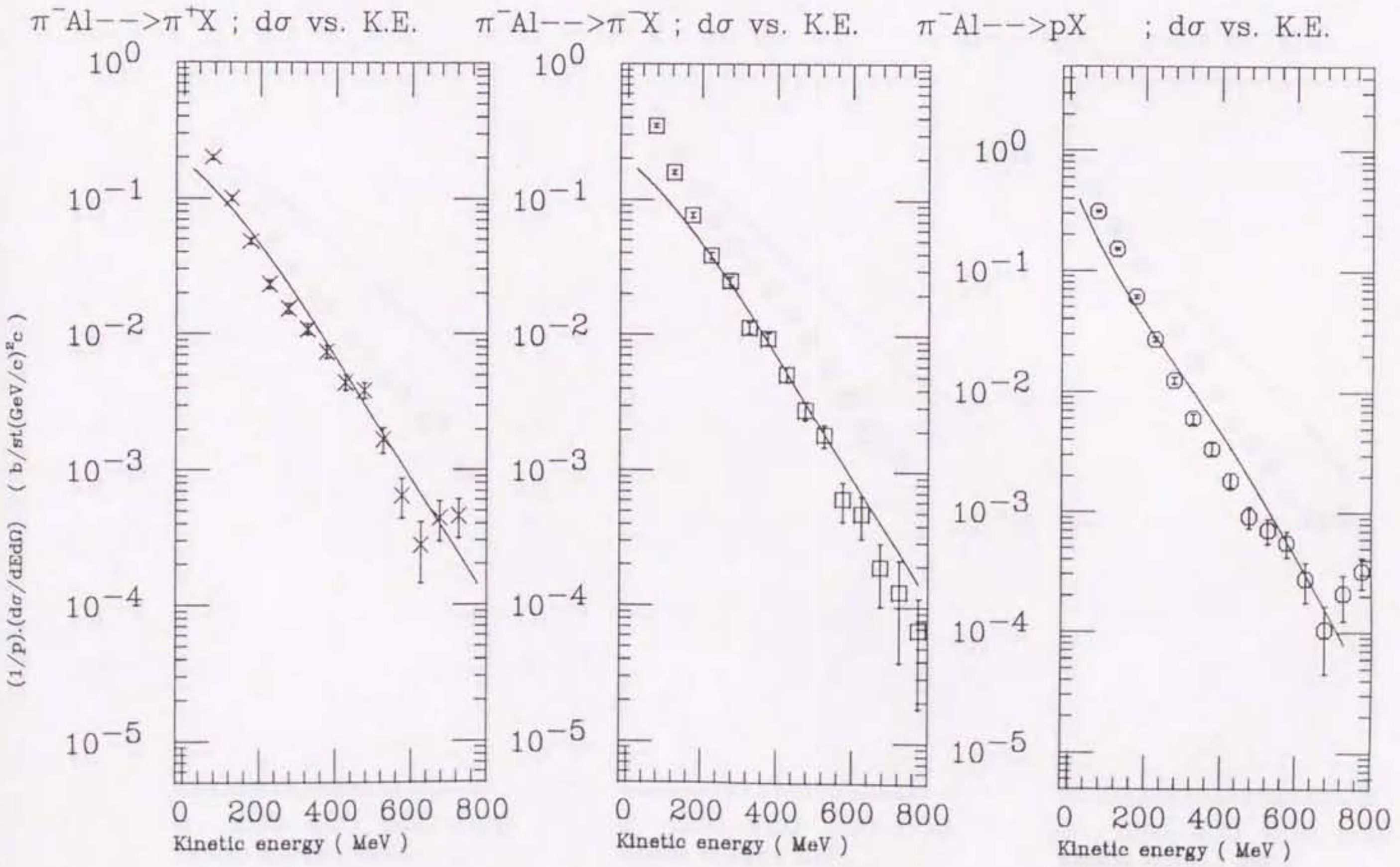


($-0.6 < \cos\theta < -0.4$)

Figure 5.23.A

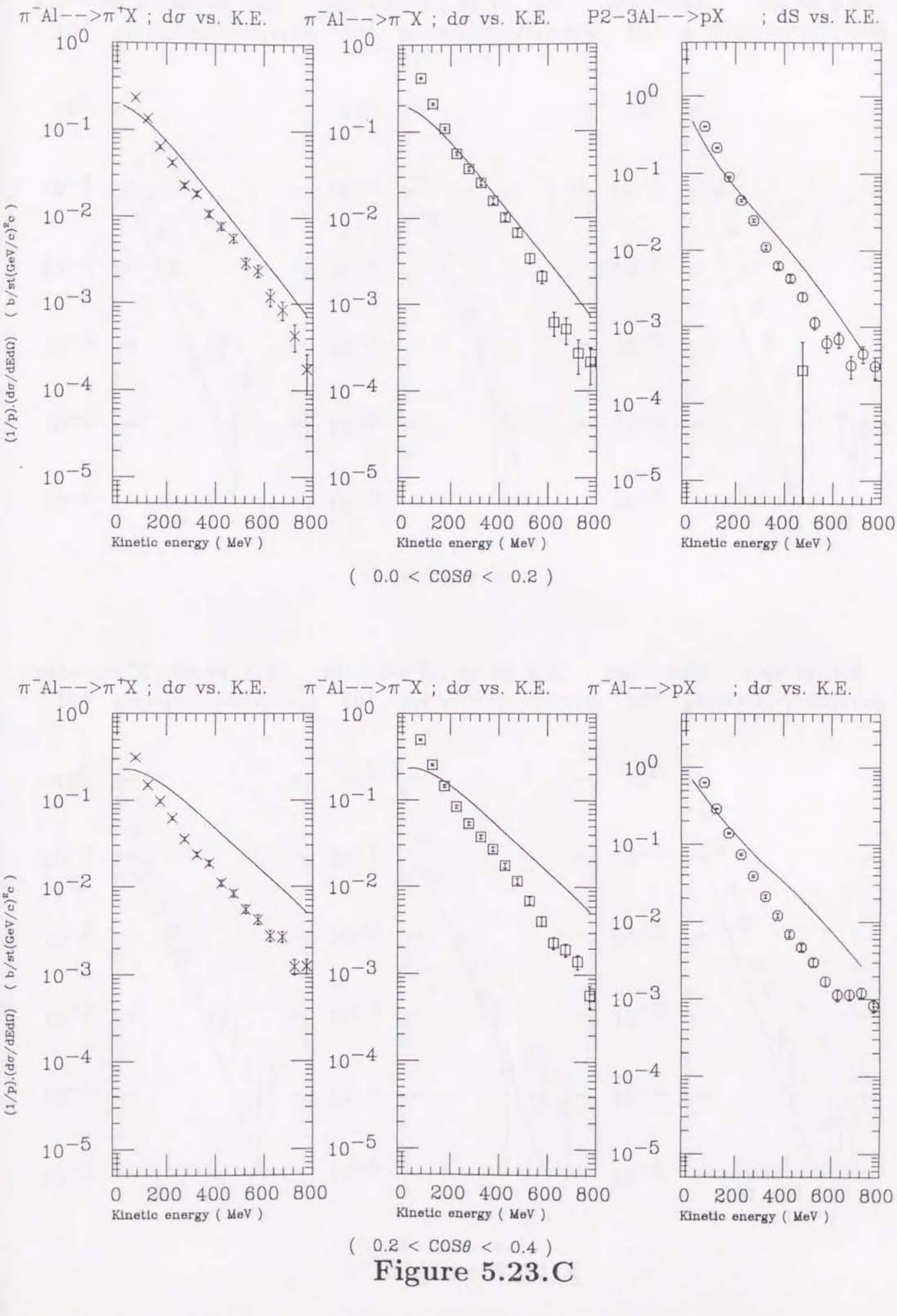


(−0.4 < COSθ < −0.2)



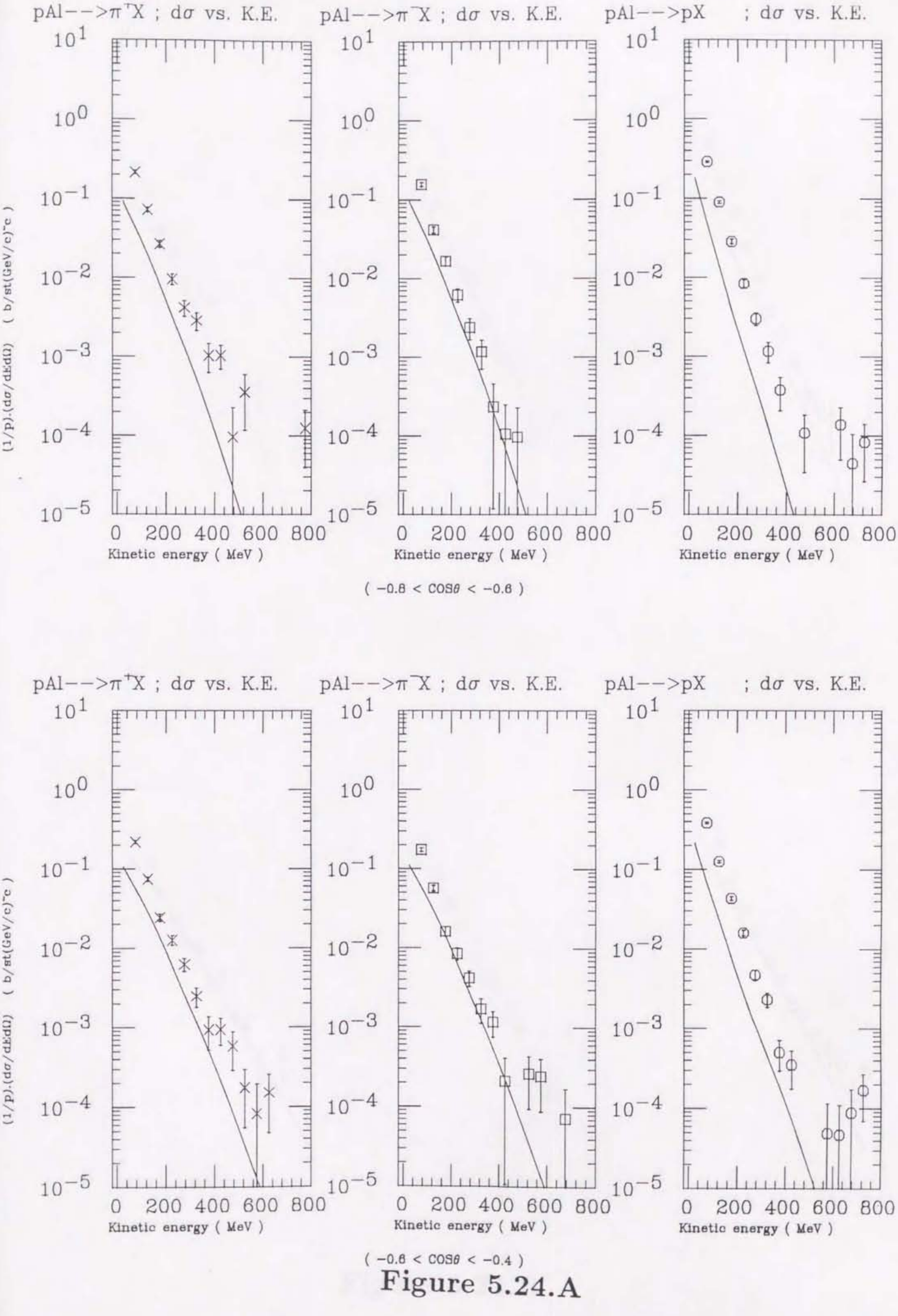
(−0.2 < COSθ < 0.0)

Figure 5.23.B



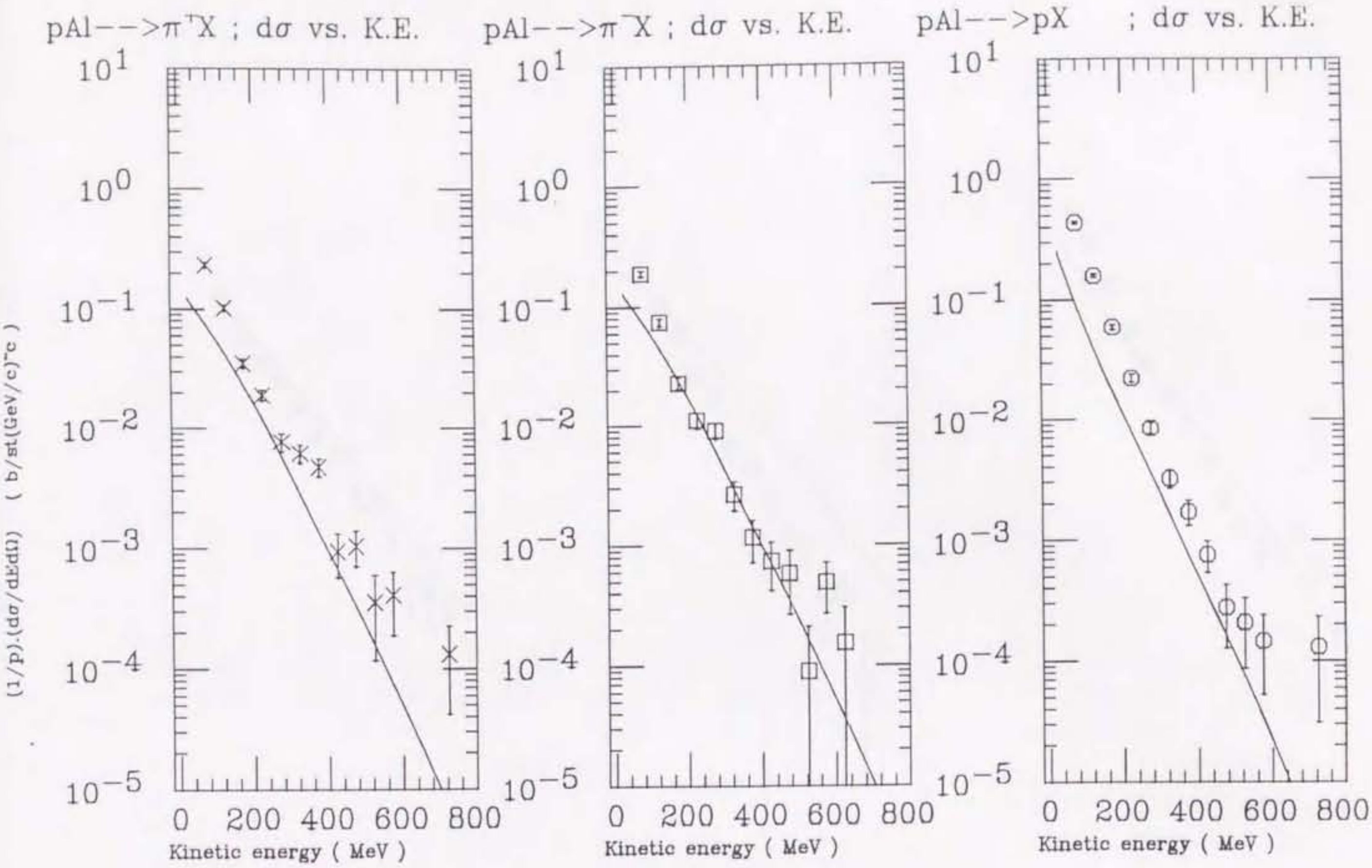
π⁻Al-->π⁺X ; dσ vs. K.E.
π⁻Al-->π⁻X ; dσ vs. K.E.
P2-3Al-->pX ; dS vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(0.0 < COSθ < 0.2)
π⁻Al-->π⁺X ; dσ vs. K.E.
π⁻Al-->π⁻X ; dσ vs. K.E.
π⁻Al-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(0.2 < COSθ < 0.4)

Figure 5.23.C

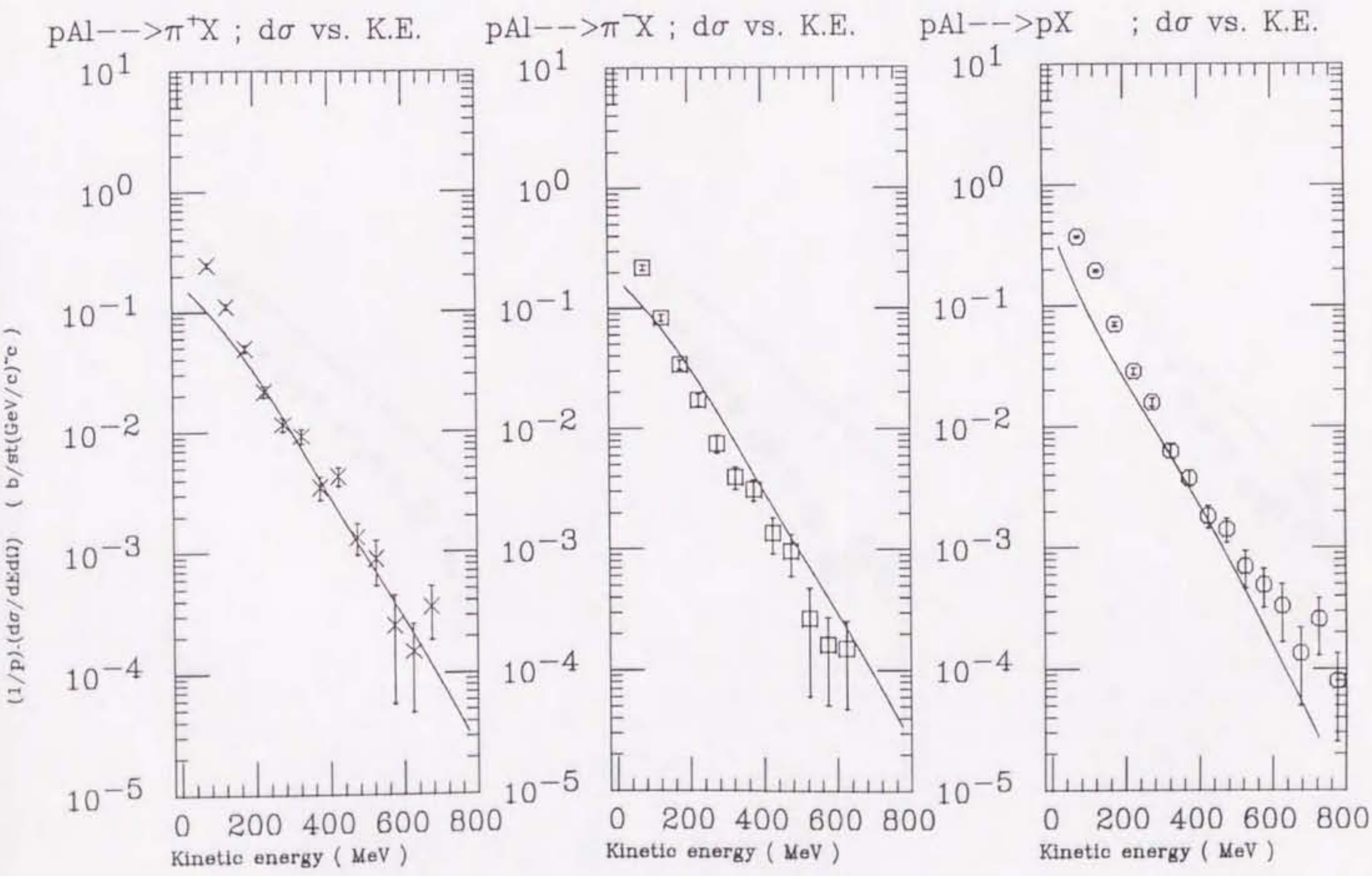


pAl-->π⁺X ; dσ vs. K.E.
pAl-->π⁻X ; dσ vs. K.E.
pAl-->pX ; dσ vs. K.E.
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)

Figure 5.24.A



(−0.4 < COSθ < −0.2)



(−0.2 < COSθ < 0.0)

Figure 5.24.B

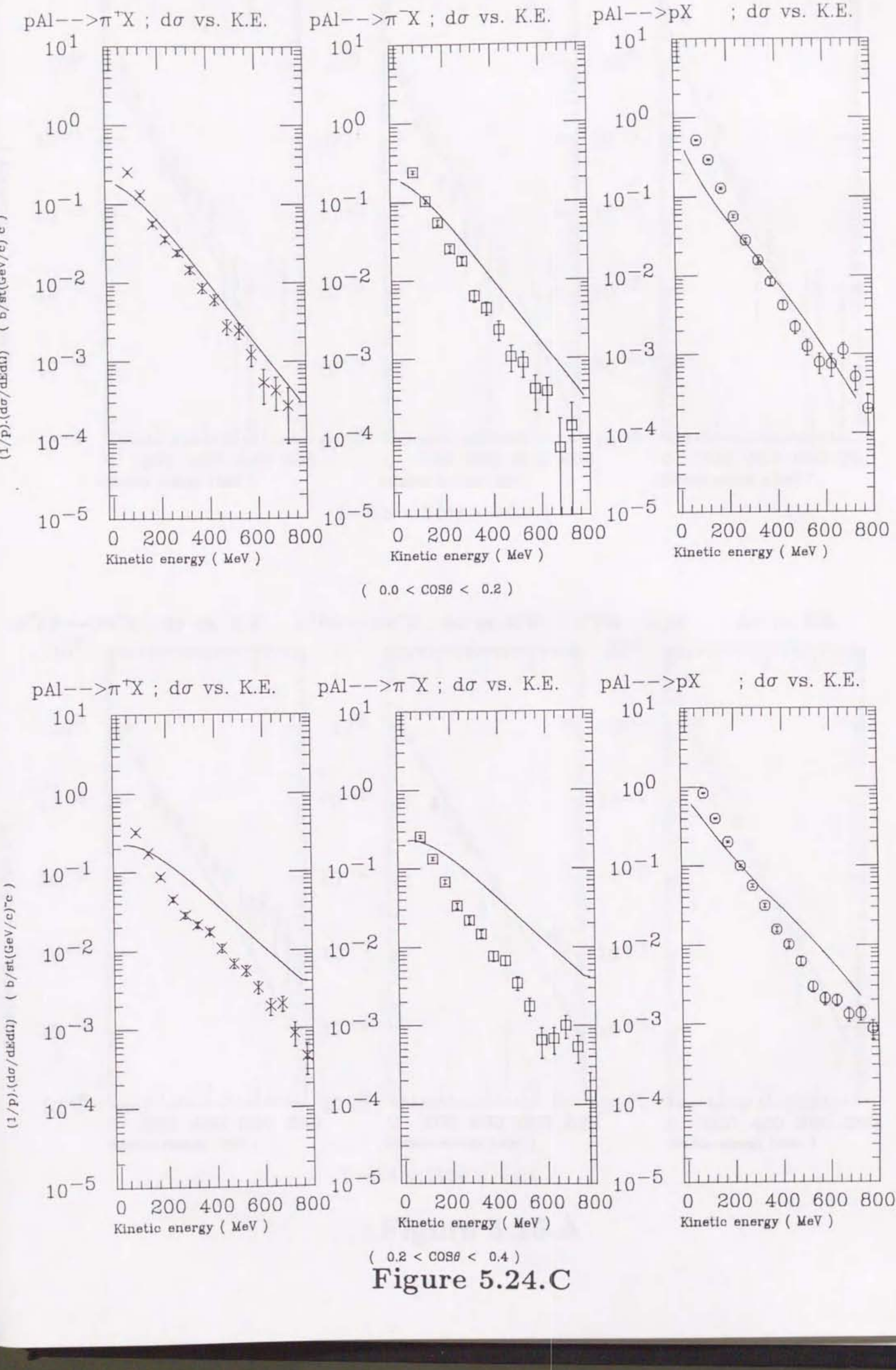
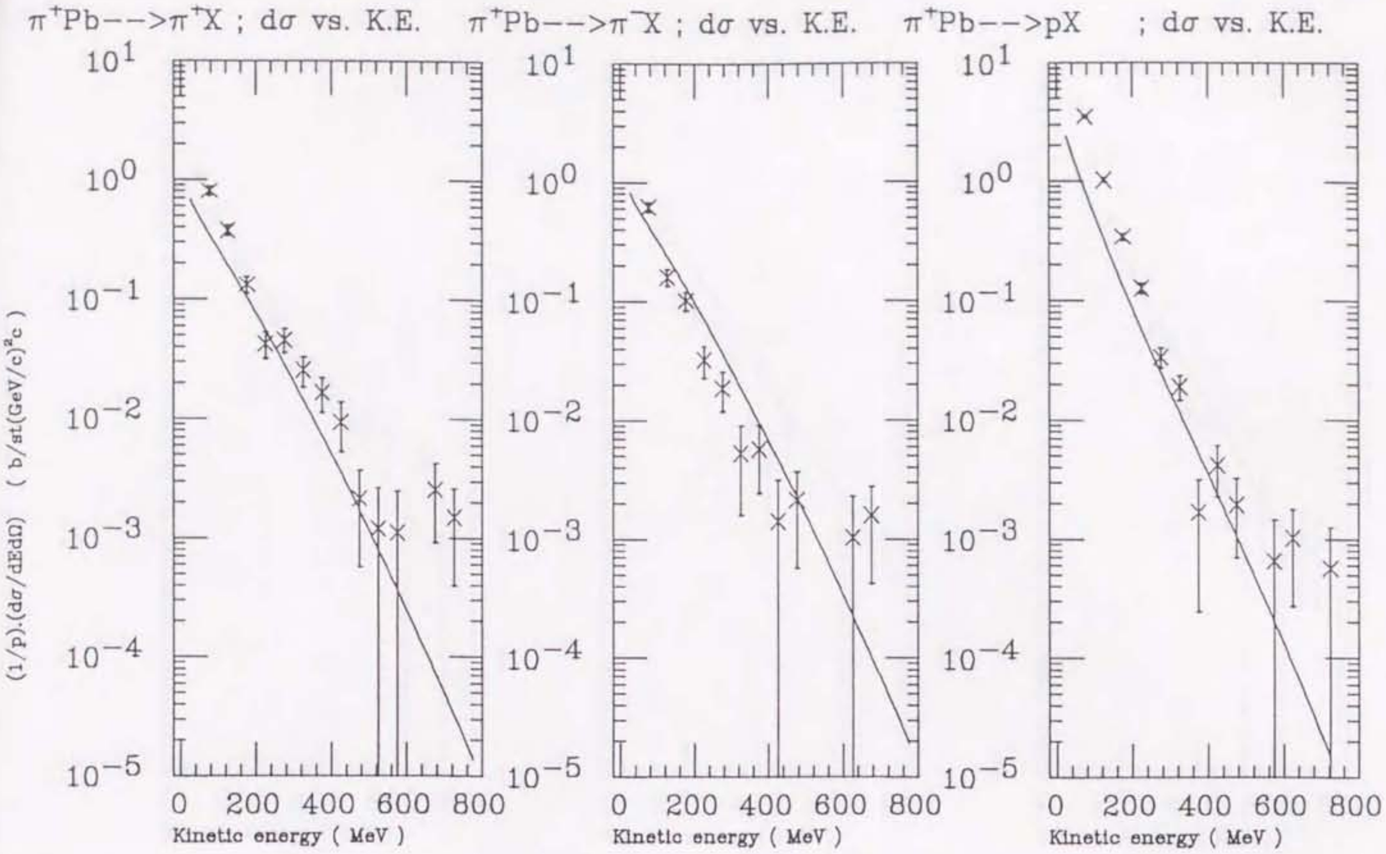
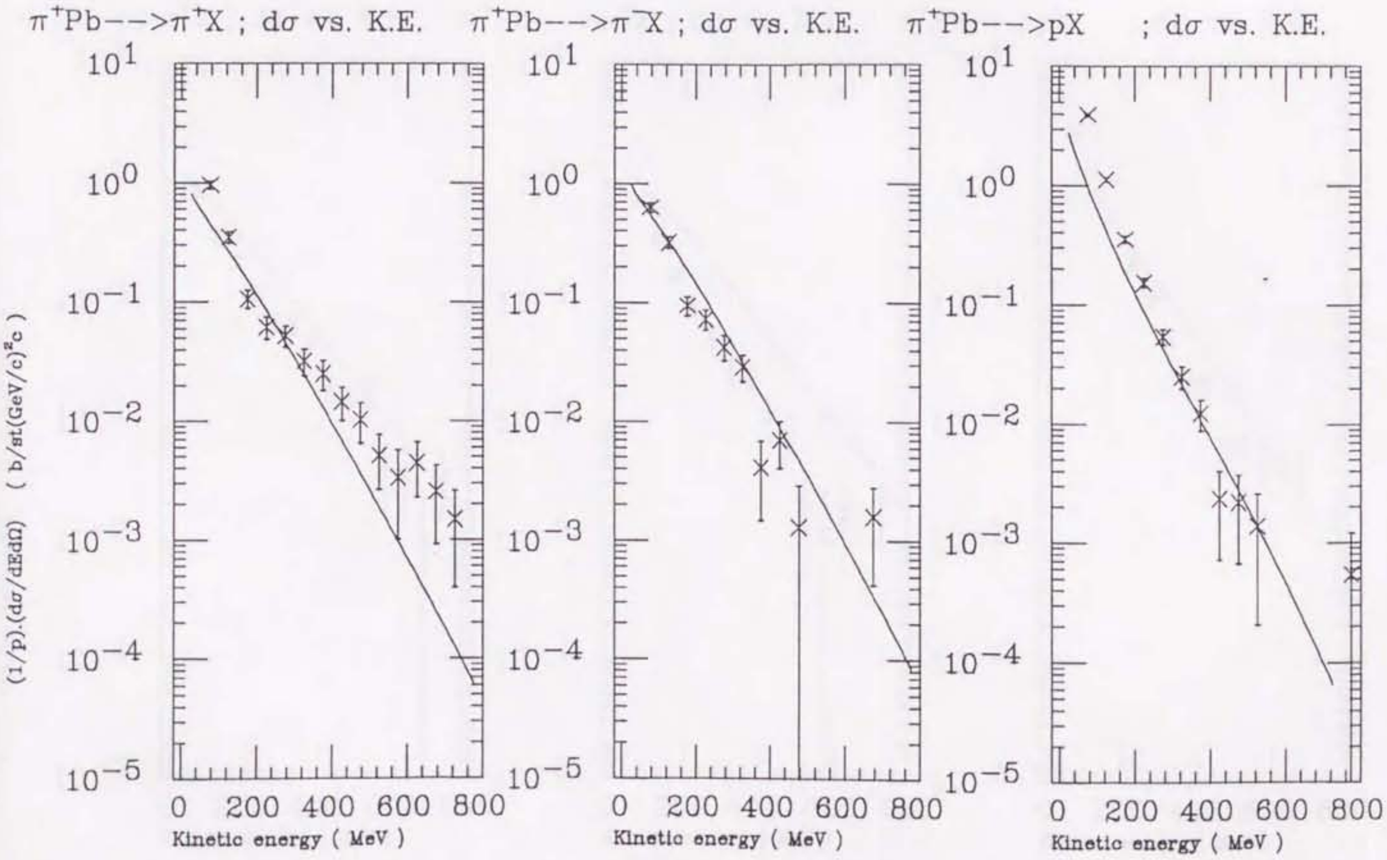

pAl-->π⁺X ; dσ vs. K.E.
pAl-->π⁻X ; dσ vs. K.E.
pAl-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)³c)
Kinetic energy (MeV)
(0.0 < COSθ < 0.2)
pAl-->π⁺X ; dσ vs. K.E.
pAl-->π⁻X ; dσ vs. K.E.
pAl-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)³c)
Kinetic energy (MeV)
(0.2 < COSθ < 0.4)

Figure 5.24.C

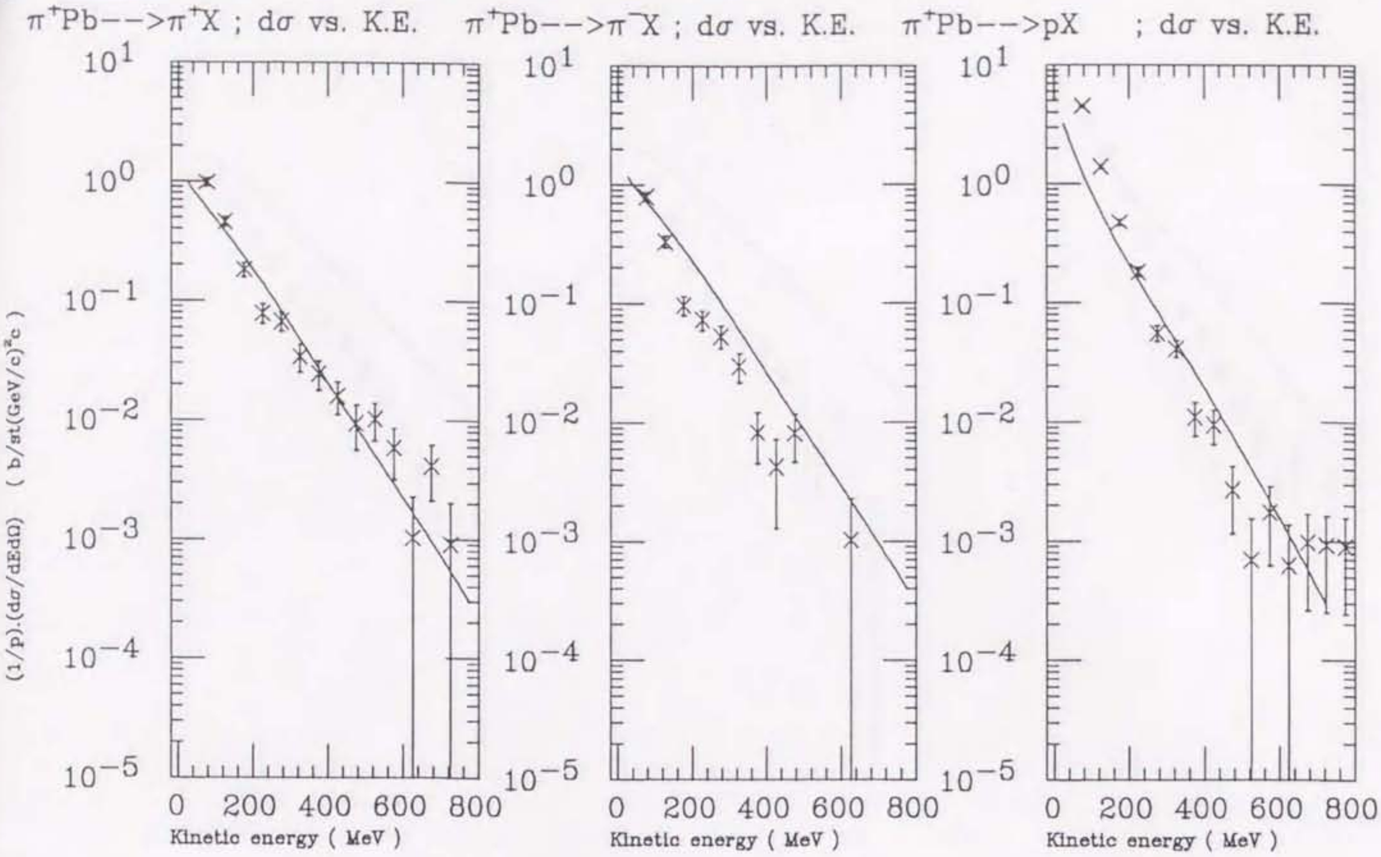


(−0.8 < COSθ < −0.6)

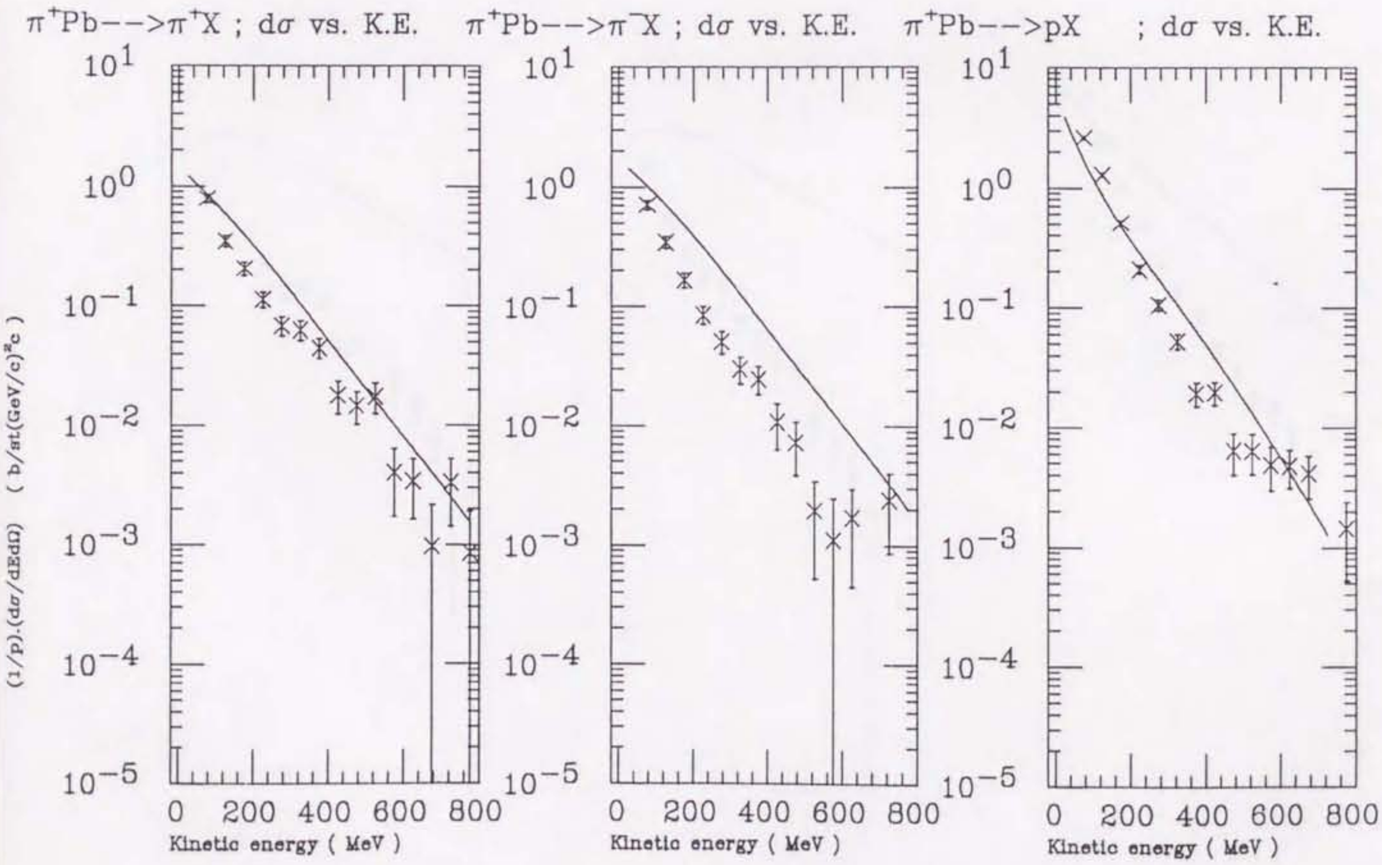


(−0.6 < COSθ < −0.4)

Figure 5.25.A



(−0.4 < COSθ < −0.2)



(−0.2 < COSθ < 0.0)

Figure 5.25.B

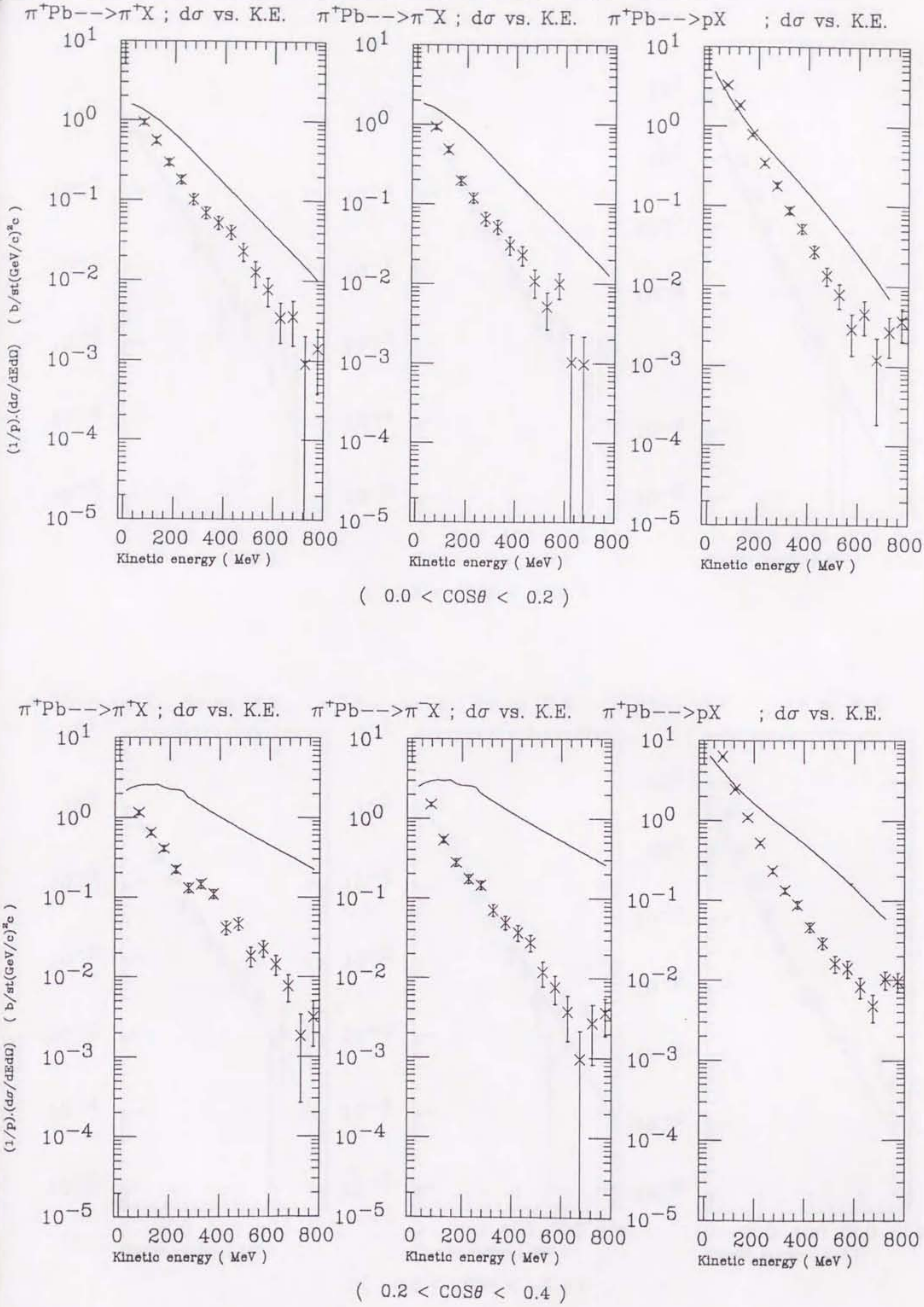
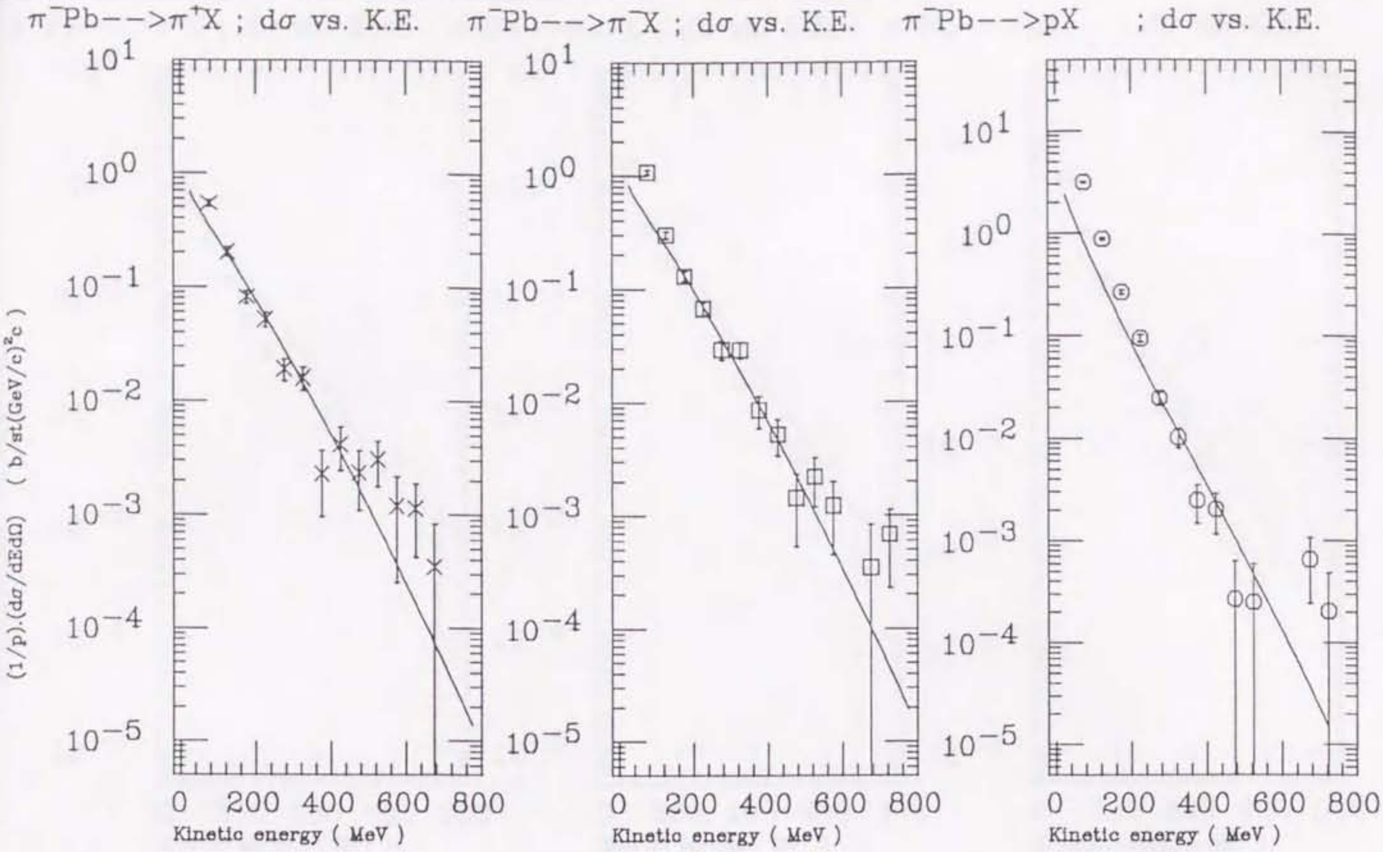
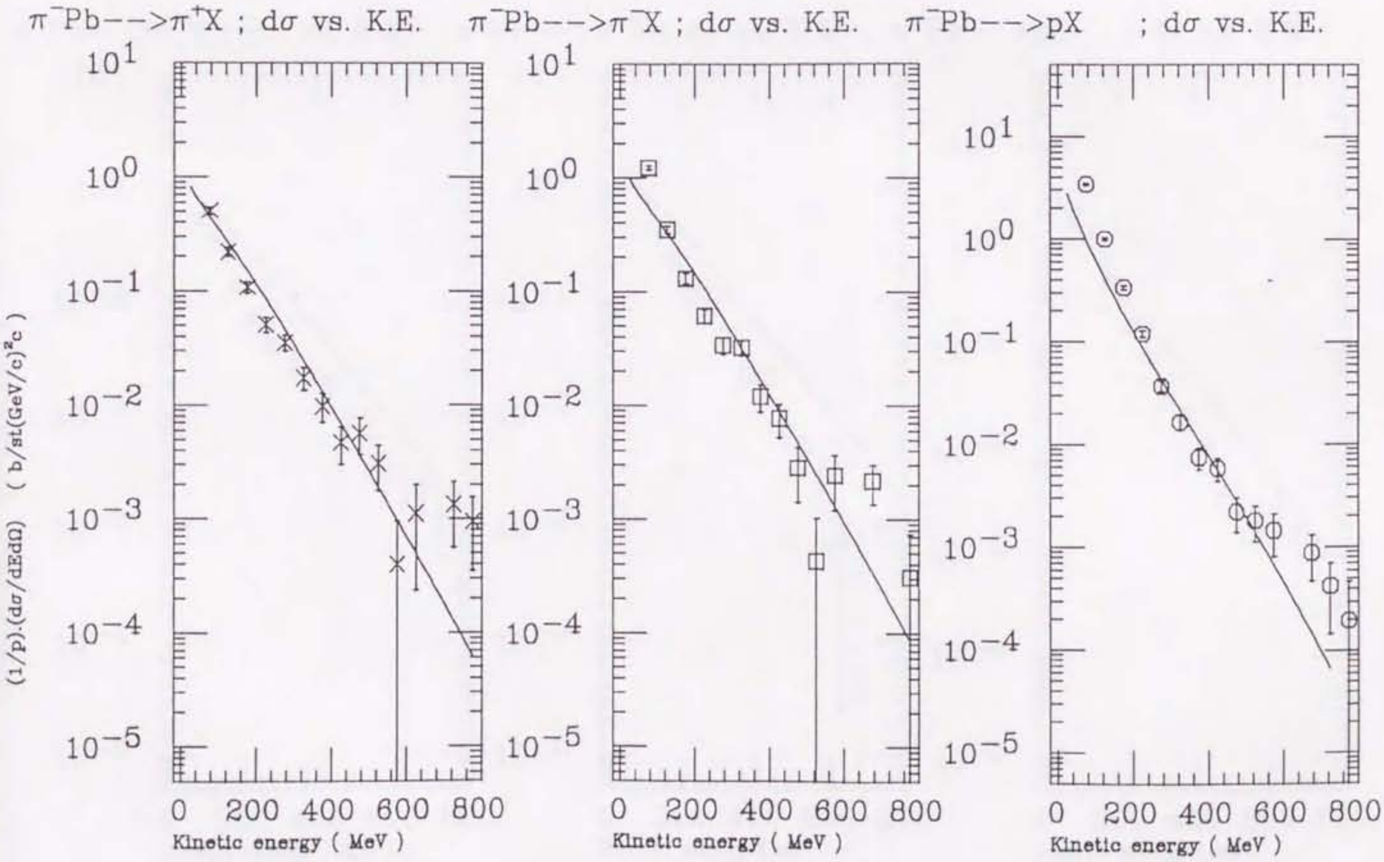

π⁺Pb-->π⁺X ; dσ vs. K.E.
π⁺Pb-->π⁻X ; dσ vs. K.E.
π⁺Pb-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
Kinetic energy (MeV)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 5.25.C

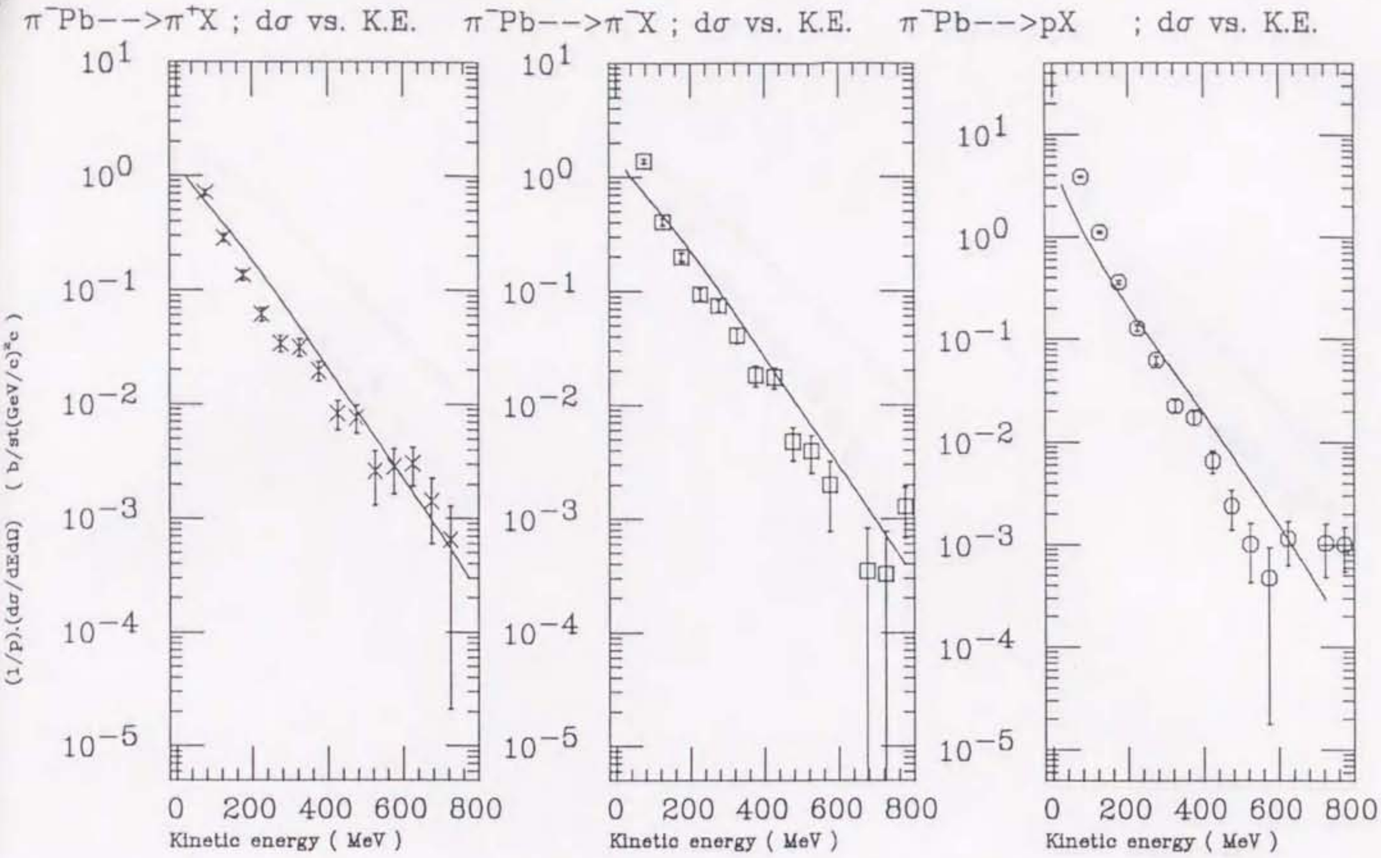


($-0.8 < \cos\theta < -0.6$)

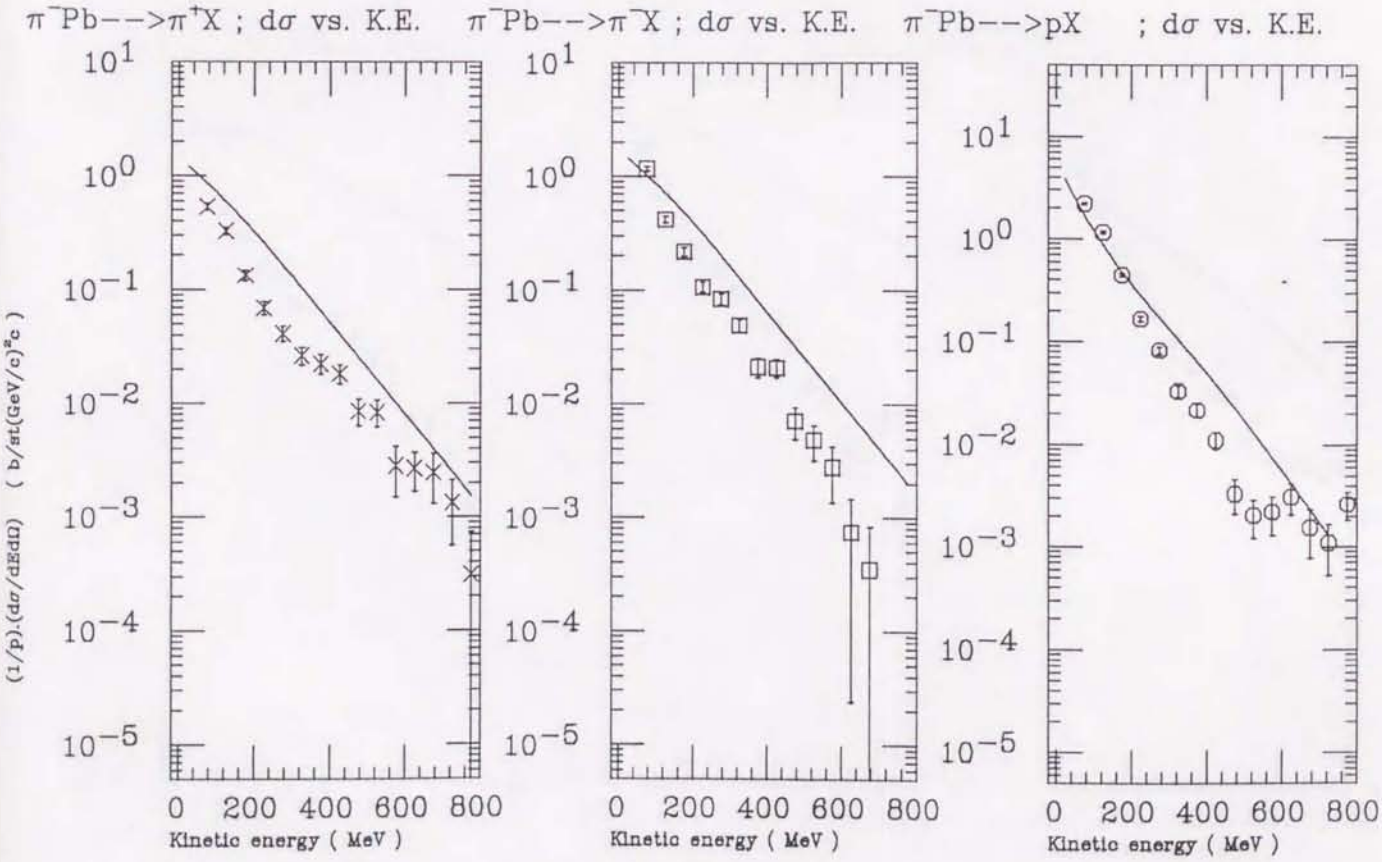


($-0.6 < \cos\theta < -0.4$)

Figure 5.26.A

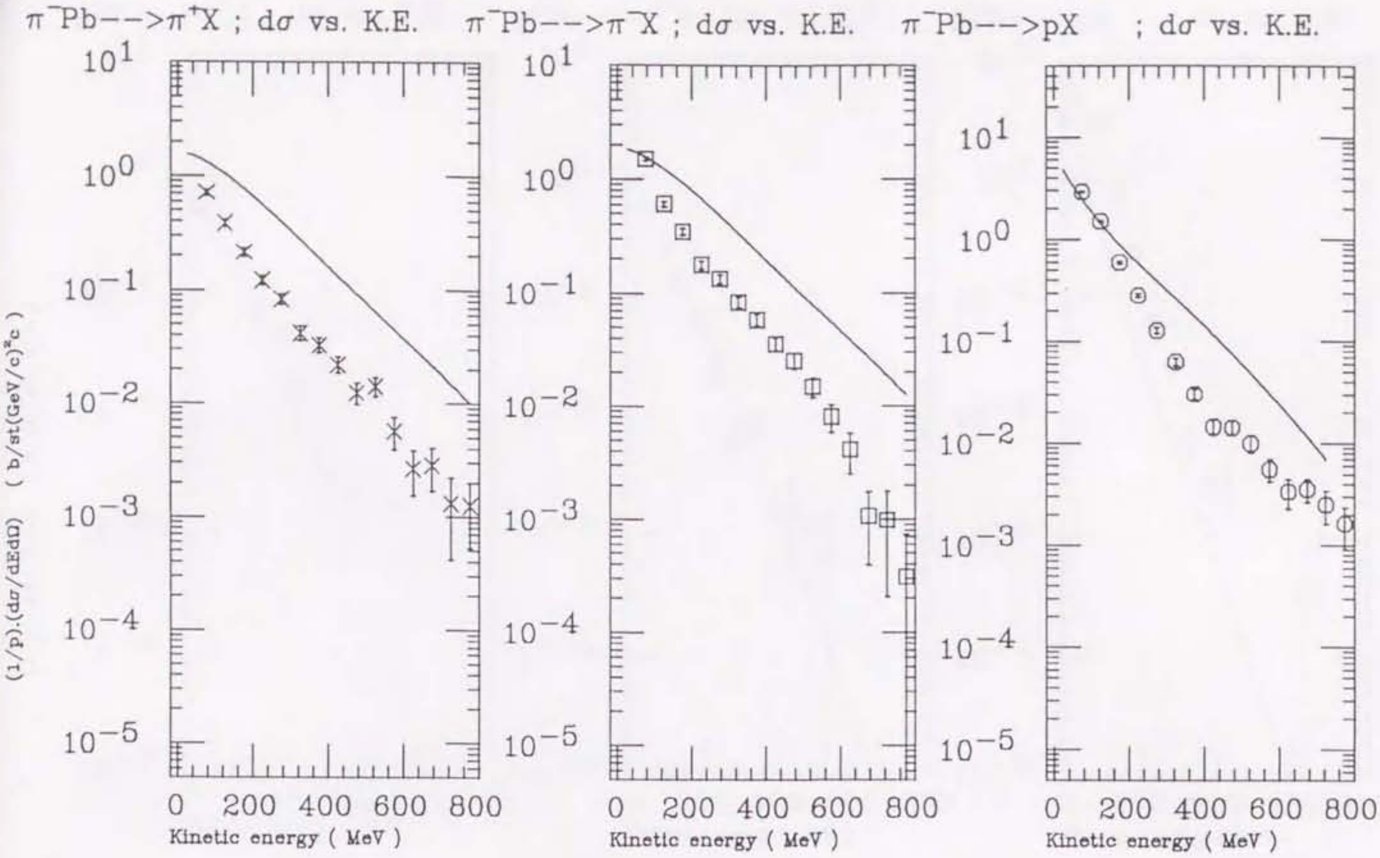


(−0.4 < COSθ < −0.2)

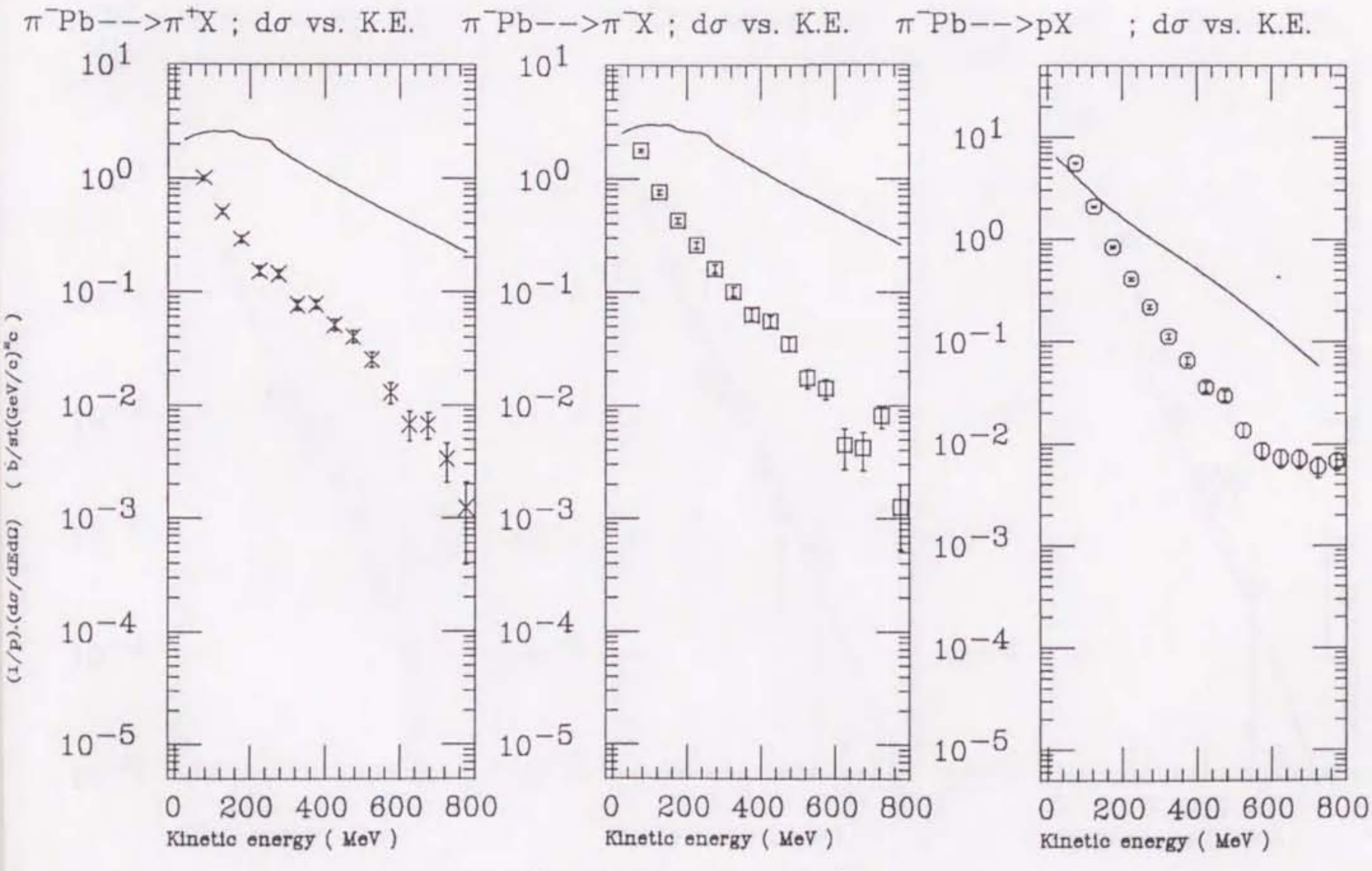


(−0.2 < COSθ < 0.0)

Figure 5.26.B

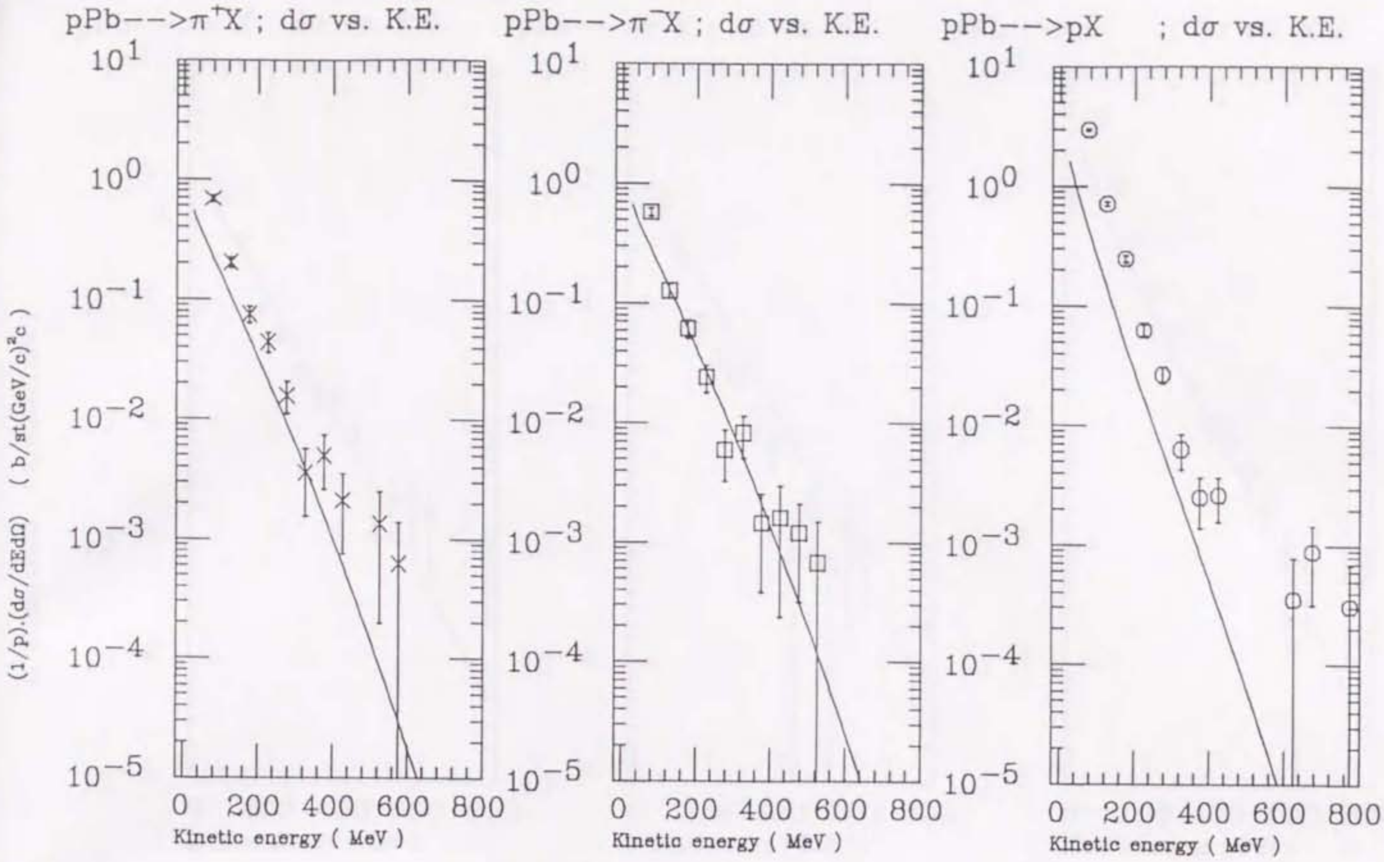


(0.0 < COSθ < 0.2)

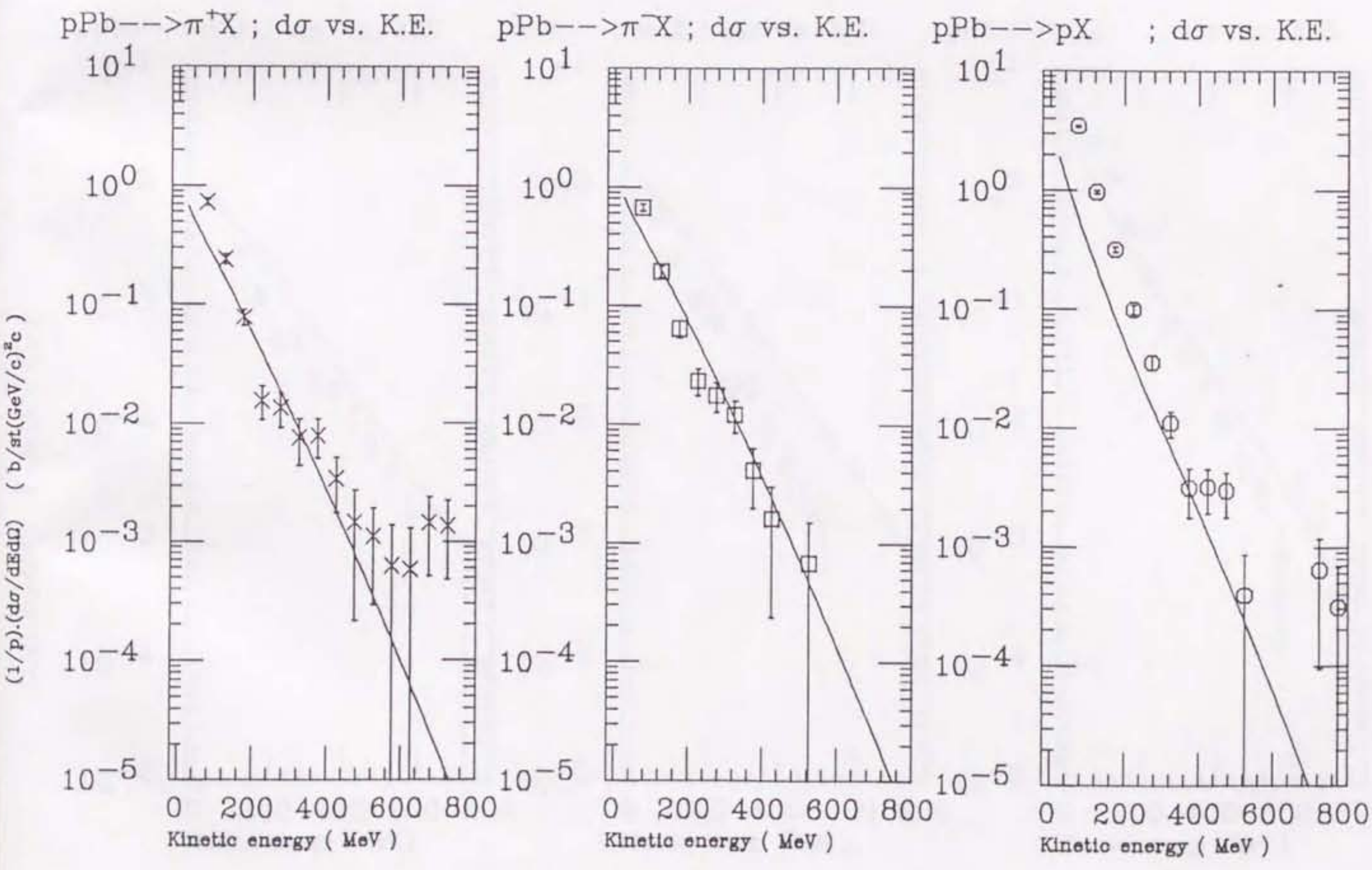


(0.2 < COSθ < 0.4)

Figure 5.26.C

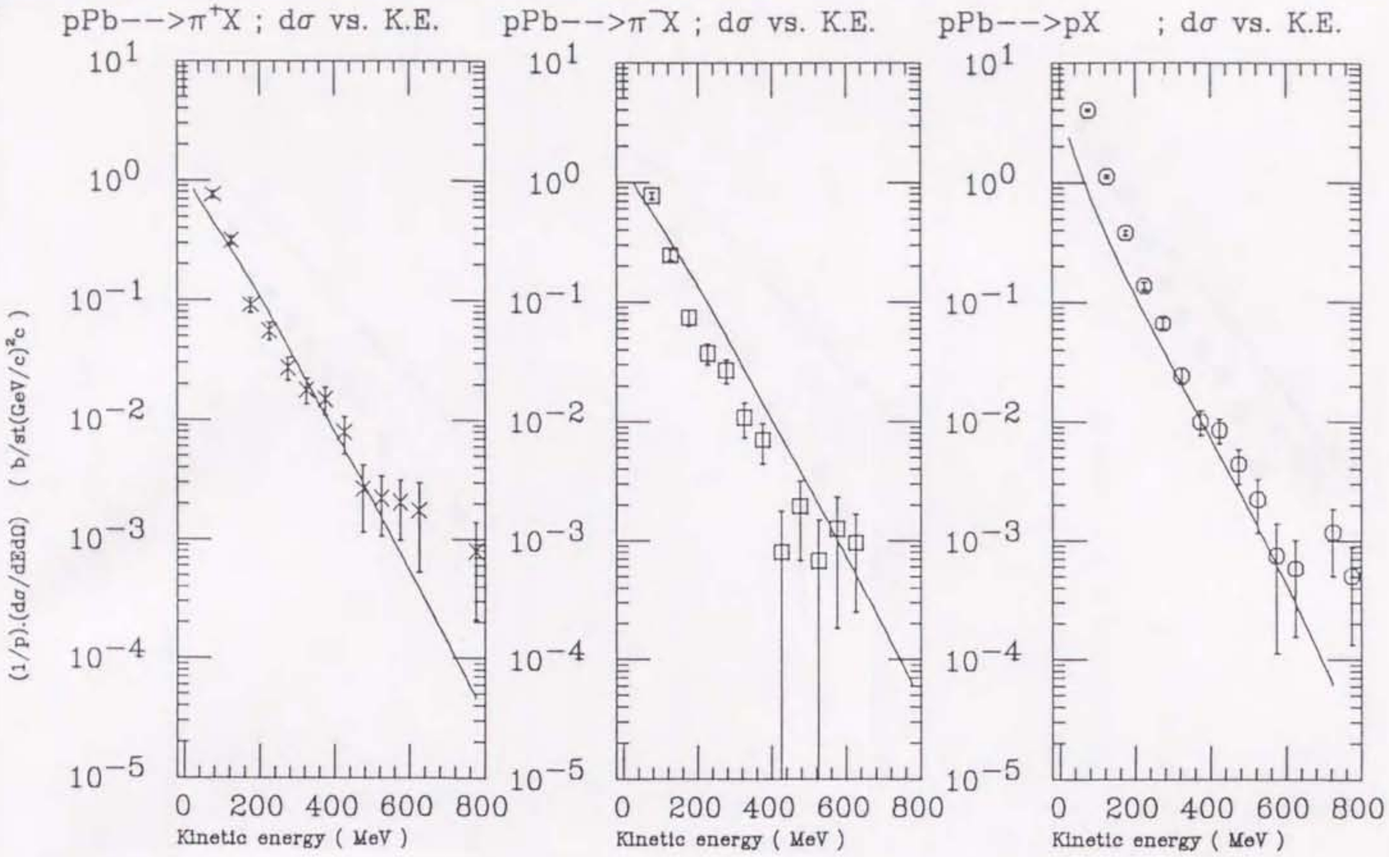


(−0.8 < COSθ < −0.6)

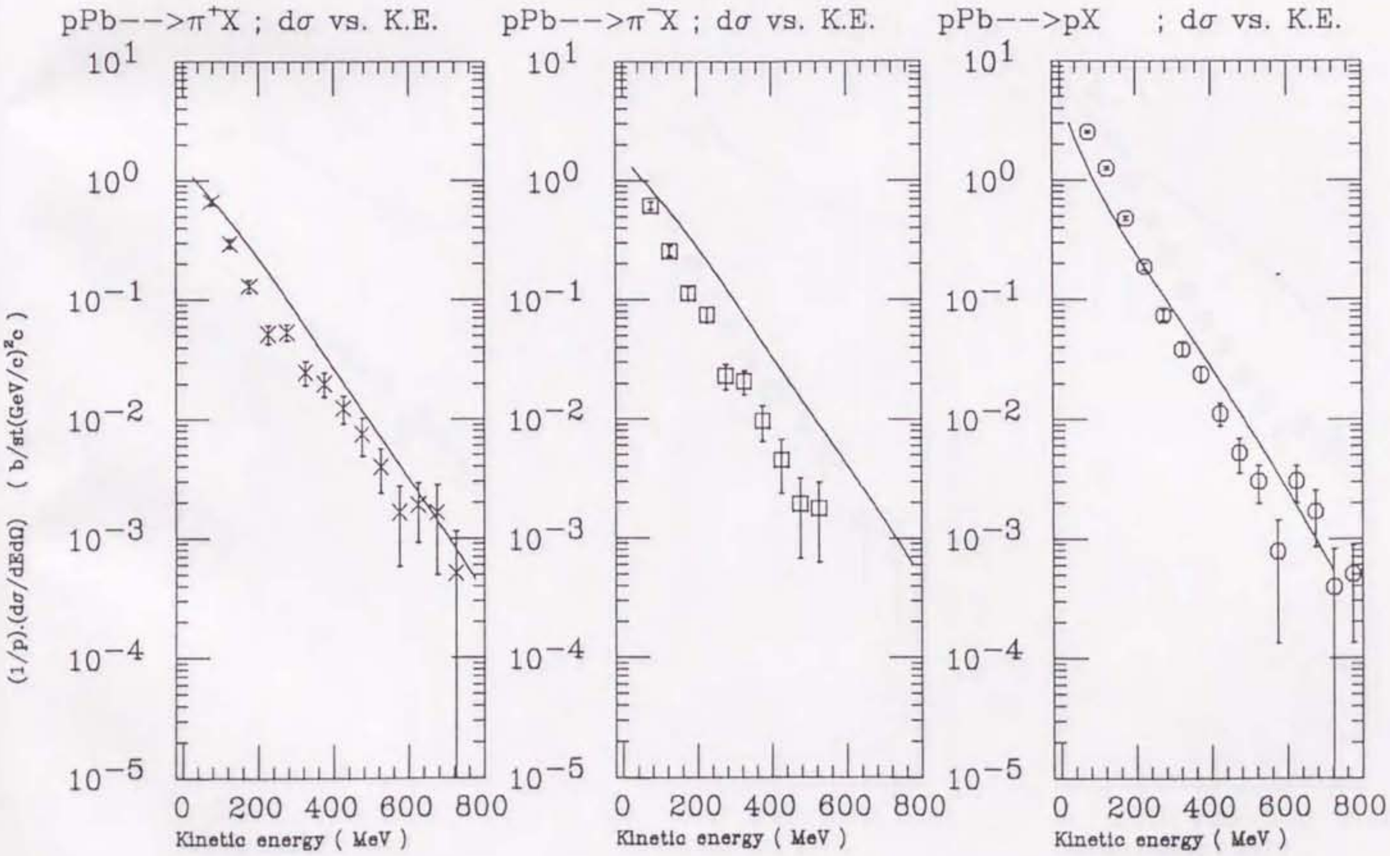


(−0.6 < COSθ < −0.4)

Figure 5.27.A

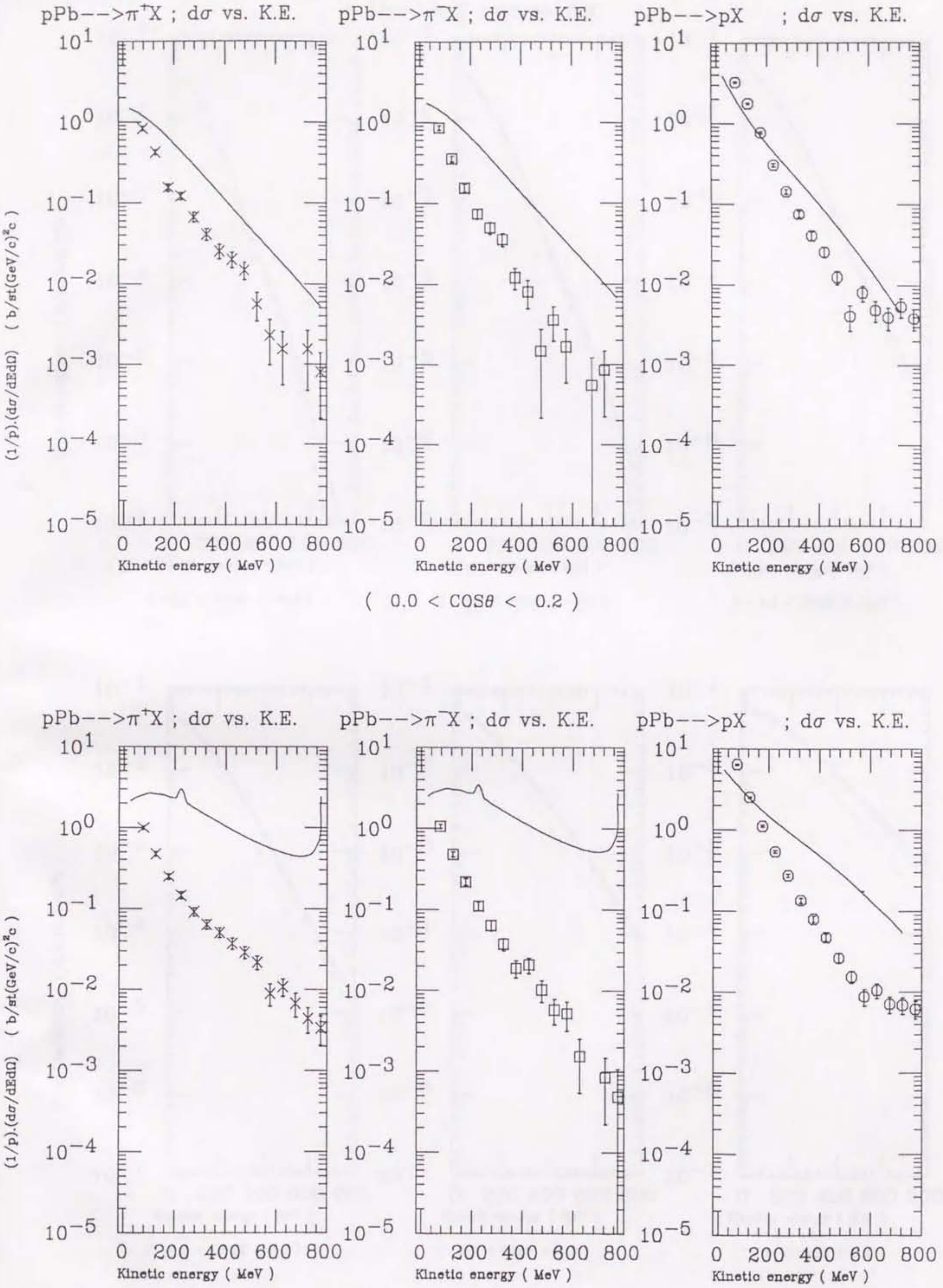


(−0.4 < COSθ < −0.2)



(−0.2 < COSθ < 0.0)

Figure 5.27.B



pPb-->π⁺X ; dσ vs. K.E.
pPb-->π⁻X ; dσ vs. K.E.
pPb-->pX ; dσ vs. K.E.
10¹
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
0 200 400 600 800
Kinetic energy (MeV)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 5.27.C

π Li-->π X ; dσ vs. K.E.

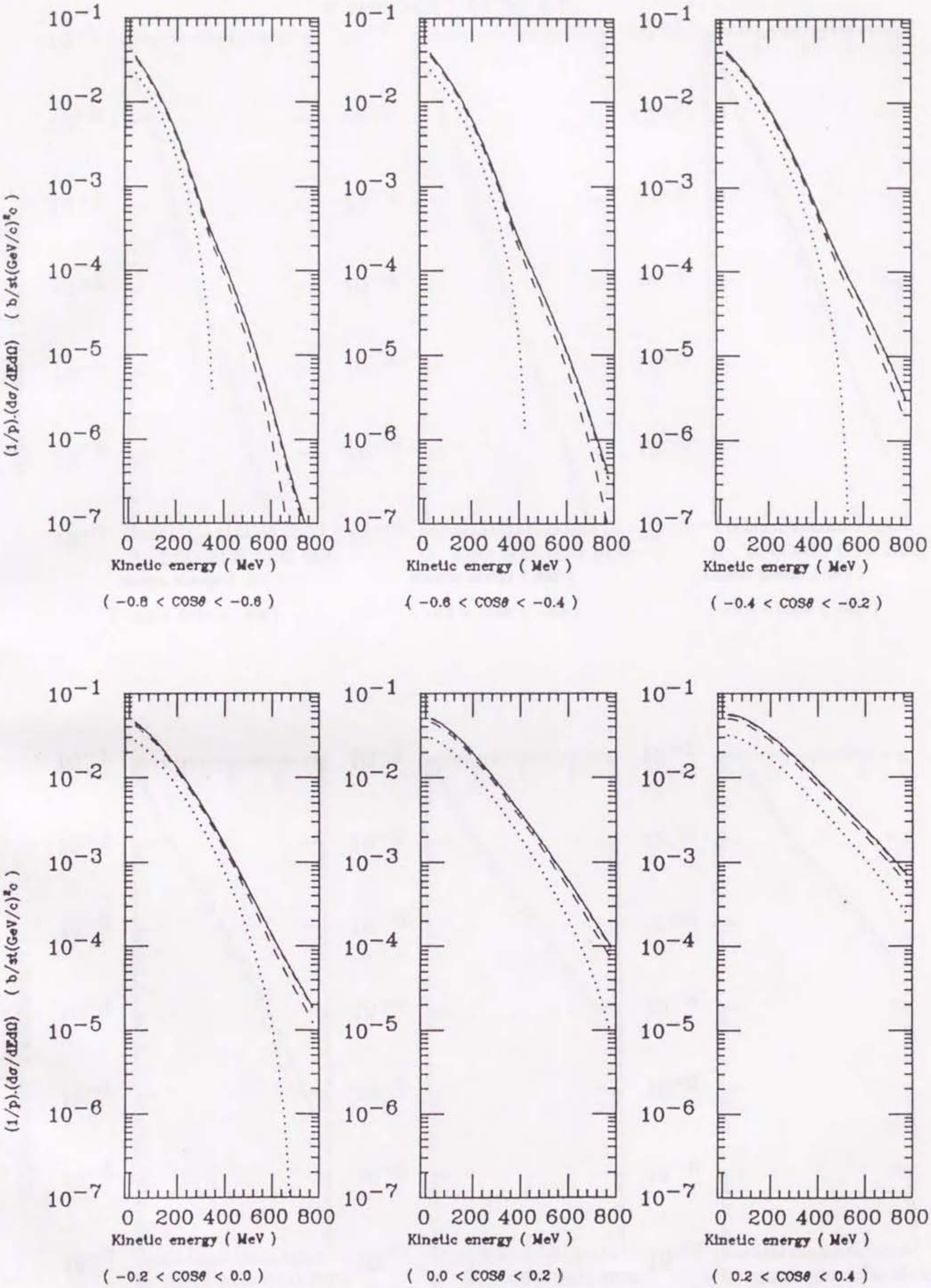


Figure 5.28

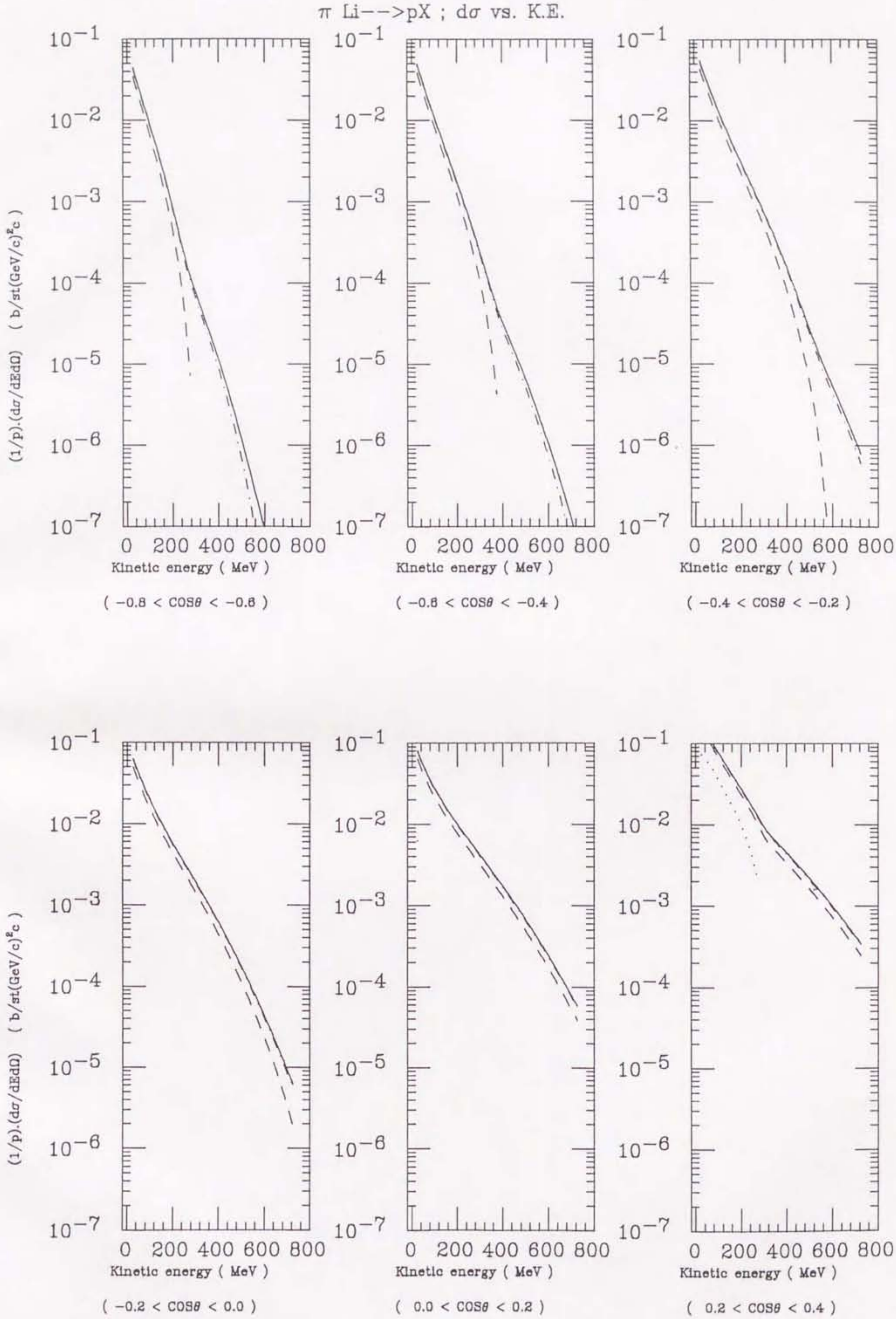
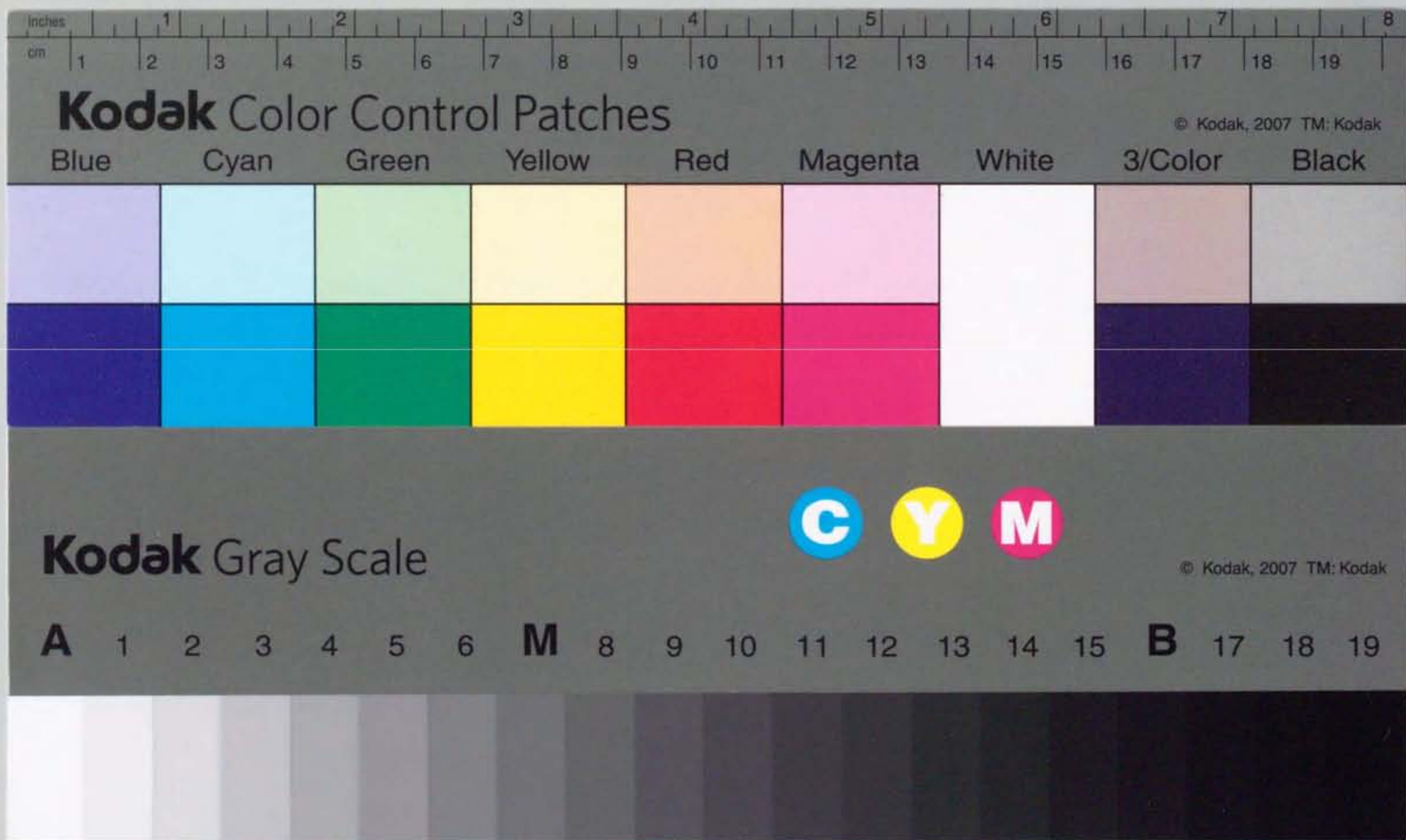

π Li-->pX ; dσ vs. K.E.
(1/p).(dσ/dEdΩ) (b/st(GeV/c)²c)
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
10⁻⁷
0 200 400 600 800
Kinetic energy (MeV)
(-0.8 < COSθ < -0.6)
(-0.6 < COSθ < -0.4)
(-0.4 < COSθ < -0.2)
(-0.2 < COSθ < 0.0)
(0.0 < COSθ < 0.2)
(0.2 < COSθ < 0.4)

Figure 5.29



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Black
C Y M
Kodak Gray Scale
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