Renner *et al.* Reply: In their Comment, Tallon and Williams [1] question our interpretation of the pseudogap measured by tunneling spectroscopy in $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ (BSCCO) in terms of precursor pairing [2]. We do not exclude the fact that one can construct a model, where the pseudogap and the superconducting gap have different origins, while nevertheless reflecting the density of states, we observe experimentally. Such a model, reflecting to some extent the spectroscopy we obtained on underdoped BSCCO, is proposed by Tallon and Williams [1]. However, the tunneling spectroscopy we present in our Letter imposes a number of constraints which go beyond the predictions of that particular model. We find that the amplitude of the pseudogap is similar to that of the superconducting gap at all doping levels we investigated, and that the two gaps scale as a function of oxygen doping. We further find that the superconducting gap decreases monotonically with increasing oxygen doping as shown in Fig. 1 of Ref. [2]. A closer inspection of Figs. 2 and 4 of Ref. [2] leads to the same conclusion. Thus, we are clearly able to distinguish underdoped from overdoped samples. The above characteristics result in a very smooth evolution of one gap structure into the other at the superconducting transition temperature (T_c), both for underdoped and overdoped samples. Although one may reproduce this behavior in models where the two gaps have different origins, it will happen only if their amplitudes are by chance very close to each other at each doping level. One characteristic of the model suggested by Tallon and Williams [1] is a slight shift of the conductance peaks to lower energies as T_c is approached from below. They emphasize that this effect should be readily seen by tunneling spectroscopy, especially in slightly overdoped BSCCO, where they expect the pseudogap to become substantially smaller than the superconducting gap. Our tunneling data show two striking deviations from this picture. First, we find a well developed pseudogap at oxygen overdoping levels, where it has already vanished within the analysis of Tallon and Williams [3]. Second, even in moderately overdoped BSCCO ($T_c = 74.3$ K), we did not observe any shift of the conductance peaks to lower energy near T_c that would be associated with a reduced pseudogap. On the contrary, our tunneling data on overdoped BSCCO show precisely the same behavior as in underdoped samples, except for lower temperature and energy scales.

Our measurements are also quite different with respect to the evolution through T_c . At low temperature, the spectra are essentially symmetric in their peak structure. Above T_c , they become highly asymmetric as the negative bias conductance peak disappears while the positive bias conductance peak shifts to a higher energy and remains finite. Tallon and Williams [1] argue that the shift of the positive bias conductance peak arises essentially from thermal broadening effects. A closer analysis of our data shows that this is not the case. Indeed, for all the spec-

tra measured below T_c , the position of the conductance peaks is well reproduced by thermally smearing the 4.2 K spectrum to the experimental temperature, implying a temperature independent superconducting gap [4,5]. This correspondence breaks down for the spectra measured above T_c , where temperatures much higher than the experimental ones are required to reproduce the actual peak position. Thus, increasing scattering due to temperature is not sufficient to explain the shift of the positive bias peak. It cannot either account for the behavior of the negative bias conductance peak. The latter vanishes abruptly at the inductively measured T_c , allowing us to identify the bulk T_c . This demonstrates the fact that we observe essentially bulk properties and not surface related ones. More recent observations of the pseudogap structure at low temperature inside the vortex cores in BSCCO [6] bring the pseudogap into a new perspective, and further support our arguments given here. They clearly demonstrate that in the pseudogap state, the positive bias conductance peak really shifts to a higher energy, since we observe the same shift in the vortex cores at 4.2 K, thus excluding thermal smearing effects. There is no indication that the pseudogap becomes smaller than the superconducting gap [1]. They further show the existence of a pseudogap in the moderately overdoped samples which scales with the superconducting gap. Finally, they exclude superconducting fluctuations as the origin of the pseudogap, since it is observed at 4.2 K, far below T_c .

In summary, we have shown that the model by Tallon and Williams [1], although reflecting the smooth evolution of the pseudogap into the superconducting gap at T_c in underdoped BSCCO, is not compatible with the spectroscopic features we measure in overdoped samples. Thus, we believe that precursor pairing remains an open and challenging approach to understanding the quasiparticle tunneling spectra we obtained [2,6].

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