Wollman *et al.* Reply: In the preceding Comment [1], Klemm raises concerns about the role of the corners in our dc SQUID measurements of the phase anisotropy of YBCO crystals. He argues that there could be singular behavior in the current paths near the corner, contributing to the phase integral around the SQUID or creating a difference in the probability of flux trapping at the corner compared to the edge. In support of this picture, Klemm cites magneto-optical images which show that magnetic flux penetrates preferentially from the edges and is excluded along the diagonals in square crystals cooled in a magnetic field.

We have explicitly calculated the current distribution near the corner of a superconducting sample in a weak magnetic field and found it to be smooth, exhibiting no evidence for singularities even for a perfectly sharp corner. Even if singular behavior were present in this geometry, it would likely be removed by the rounding of the sample corners that occurs in any real sample. It is also not clear how current distortions could give the phase shift of π that we consistently observe in our experiments.

We do agree that flux trapping is a potential problem in our experiments. As discussed in our paper, we have taken great precautions to reduce residual magnetic fields and accounted for flux trapping by measuring distributions of phase shifts in many samples and in multiple cooldowns of the same sample. We do not believe that flux trapping at corners can account for our observations for the following reasons:

(1) We find a phase shift of π in all corner devices and never in edge devices. If flux trapping were responsible for the phase shift, we would expect the results to vary from sample to sample and run to run depending on whether we happen to trap a vortex near the SQUID loop. According to the magneto-optic results, flux trapping should be less likely at the corners and not affect the corner measurements in which we see the phase shift. In contrast, the edge measurements should be more susceptible to trapped flux, but here we see the zero phase shift expected independent of the pairing state.

(2) It is highly unlikely that the trapping of isolated vortices is determined by the sample geometry. The magneto-optic images are taken in large magnetic fields (>100 G) so that $H > H_{c1}$. In this regime, the exclusion of flux along the diagonal is due to the collective effect of the vortices, producing screening supercurrents that flow around the periphery of the crystal. These currents and the resulting flux pattern are then sensitive to the sample geometry. In contrast, our measurements are taken at fields well below H_{c1} (<1 mG) where there is only a low density of isolated vortices trapped during cooling. In this case, vortex trapping is sensitive to the local environment at length scales of the order of the penetration depth (~0.1 μm) and most likely occurs at defects in the sample. In fact, it is probable that most of the flux trapping we observe actually occurs in the Pb films, which are polycrystalline and have very thin edges, rather than in the YBCO single crystals that are thick and extremely homogeneous. Even if flux lines were to trap in the crystal, the corners of the crystals are rounded on the relevant length scale, although they are sharp compared to the width and spacing of our junctions (~100 μm). As a result, we believe it is unlikely that there is any difference in the probability of flux trapping in the edge SQUIDs compared to the corner devices.

(3) To eliminate flux trapping as a possible explanation for the phase shifts, we also reported measurements of the flux modulation of single Josephson junctions on the edges and corners of a crystal. The much smaller flux-coupling area makes these measurements less susceptible to residual fields and flux trapping. It also reduces the effects of SQUID asymmetry, eliminating the need for extrapolation to zero bias current required in the SQUID measurements. The single junction measurements show strong evidence for the phase shift of π between orthogonal directions, in agreement with the SQUID data [2,3]. When flux trapping does occur, it creates a noticeable skewing of the flux modulation patterns (not the simple phase shift that occurs in a SQUID). These measurements provide more direct evidence that flux trapping cannot account for our observations. Recent measurements of the spontaneously induced circulating supercurrents in YBCO rings that have no corners also exhibit a π phase shift, in agreement with our SQUID results [4].

In conclusion, we do not believe that the presence of corners can mimic an intrinsic phase shift of π for the experimental and theoretical reasons outlined above. Although we find this evidence convincing, we do agree with the author that a good test is to repeat the experiment on a conventional material with corners. We are doing this now with $Ba_{1-x}K_xBiO_3$ crystals, which is generally believed to be an isotropic s wave superconductor and has crystals of comparable geometry to the YBCO ones. Rounding the corners as suggested by the authors is not a viable option since the crystals are already significantly rounded on the scale of the penetration depth; further rounding would introduce excessive inductance into the SQUID loops, complicating the interpretation.

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