Supplementary Information

Here we include magnetic susceptibility data as a confirmation of sample quality, and K scans above T_c to address the details of the temperature dependence.

Superconducting volume fraction and transition width

The $La_{2-x}Sr_xCuO_4$ $x = 0.12$ sample studied in this work was a 399 mg cuboid, which was cut and cleaved with its principle axes along the crystal symmetry directions with $a = 1.8$ mm, $b = 1.4$ mm and $c = 1.0$ mm. Figure 1 shows zero field cooled DC susceptibility data measured with an applied field of $H = 1$ mT along the c direction. A demagnetization factor of 0.4391 calculated for a cuboid was applied to the data. These magnetization data are consistent with bulk superconductivity in the sample with a superconducting transition width of ~ 3 K.

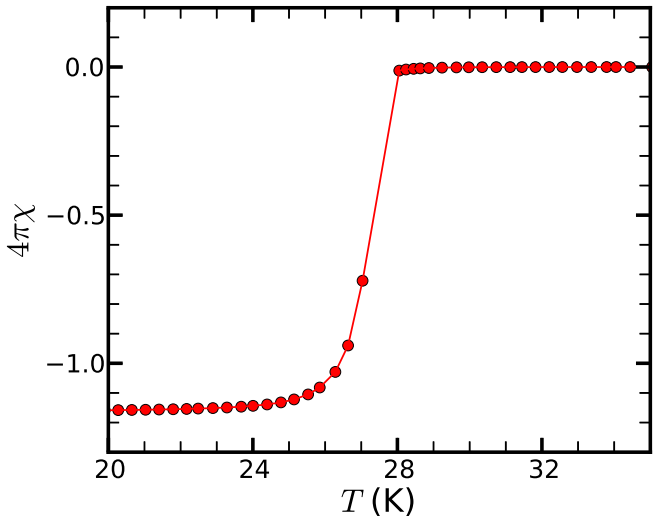

FIG. 1. (Color online) DC susceptibility measurement at $H = 1$ mT showing diamagnetic screening consistent with 100% superconducting volume fraction.

Transverse split above T_c

Figure 2 shows a line cut along the transverse (K) direction at $T = 36.1$ K, above the onset of the superconducting transition at $T_c = 27.5$ K, to emphasize that the split along K is not correlated with T_c. The increase in the peak widths with temperature makes it harder to resolve the two peaks clearly at temperatures above 40 K, but the data is still best described by two peaks separated by a fixed value (within error bars). Further, since one peak is weaker than the other, the charge order peak intensity at higher temperatures is dominated by the stronger peak, leading to the appearance of there being only one peak. We note here that there is no reason *a priori*, for the two peaks to have equal intensity.

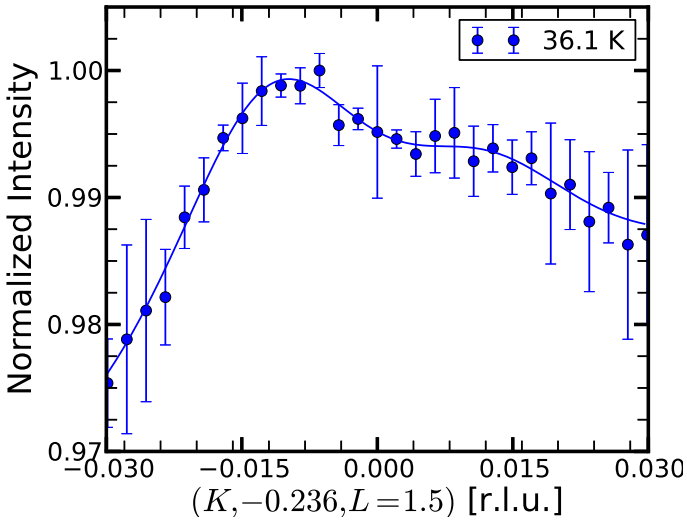

FIG. 2. (Color online) K scan through the CO peaks at $T = 36.1$ K showing the splitting along the transverse direction above $T_c = 27.5$ K. As for the other soft x-ray scattering data reported in the paper, this was also measured at $L = 1.5$ at 931 eV.