ESRF	**Experiment title:** Is the bond stretching dispersion really reflecting dynamic charge inhomogeneity in copper oxide superconductors?	**Experiment number:** HS-3460
Beamline: ID28	**Date of experiment:** from: 05 December 2007 to: 11 December 2007	**Date of report:**
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Report:
Copper-oxygen bond stretching modes in high-temperature superconducting cuprate (HTcS) show an anomalous dispersion, The origin of the anomaly is still an open issue. Along with electron-phonon coupling effects, a mechanism involving the formation of inhomogeneous charge state, also known as *stripes* has been discussed [1, 2].

This interpretation has been partially adopted in a recent paper [3] in which previous data on HTcS, are compared to new ones, in particular for $La_{2-x}Ba_xCuO_{4+\delta}$. In this system, and for x=1/8 (Ref. [3]), stripes are believed to be almost static, suppressing superconductivity, while in superconducting materials they are supposed to be dynamic. The authors of Ref. [3] in describing their high resolution inelastic neutron scattering data observe an additional sharp dip (see Fig. A), which they interpret as a kind of Khon anomaly for stripes. In a recent paper [4] we argue that the effect is in fact only due to short life-time, as the Q-resolution in [3] does not allow to follow the supposed dip.
This is suggested, in the data of Ref. [4], by the fact that the width seems energy-resolution independent, while the Q-resolution is far better (see comparison between inelastic neutron and X-ray scattering resolution in Fig. A). However, lack of data points along (ξ, 0, 0), and the different system ($La_{2-x}Sr_xCuO_{4+\delta}$ do not show stripe pinning) prevented us from reaching a conclusion.
Therefore, we decided to undergo a high ($\mathbf{Q}, \omega$)-resolution measurement in $La_{2-x}Ba_xCuO_{4+\delta}$ using inelastic X-ray scattering (IXS) on ID28.

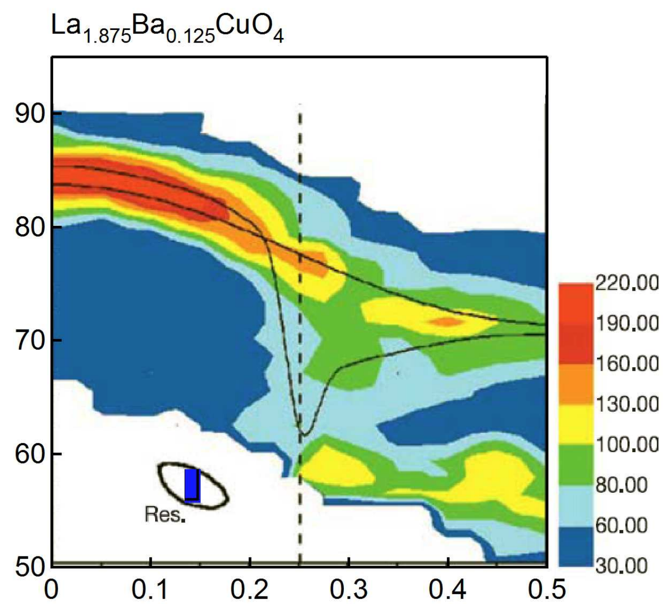

Fig. A.
Measurements of $La_{2-x}Ba_xCuO_{4+\delta}$ *for x=1/8 from Ref.[3]. The 3-axes inelastic neutron scattering instrumental function ellipsoid 2D cut in (E,h) is compared to the inelastic x-ray scattering resolution for the configuration of Ref. [4] (blue rectangle).*

The results obtained are shown in Fig. B. Surprisingly, we can follow, for the first time, the dip, which was guessed at, although not directly seen, in Ref. [3]. The minimum of the dispersion of the Cu-O bond stretching mode is not located, as expected, at ξ=0.5, in our simple shell-model calculation or in the more sophisticated *ab-initio* calculations [5] but at ξ=0.7 (supposed to be equivalent to ξ=0.3 for this mode). For this sample, the Ba content x is precisely determined, from T_c and micro-probe, to be around 0.16, well above the value of x=0.125 for commensurate, pinned stripes. This lead to a stripe-propagation-vector $q_s \approx 0.3$ in striking agreement with our findings. However, if one inspects the data reported in Ref. [3] (see Fig. A), the real minimum seems also at ξ=0.3 for x=0.125. This aspect would need a further clarification, possibly using IXS, on a sample with x=0.125.
In Ref. [3], it is also argued that the two degenerate Cu-O Bond stretching mode split, as only one of them, travelling perpendicular to the stripes direction, shows an anomaly while the second follows a gentle dispersion. Our data shows, in all case where the mode is clearly visible only one structureless feature, which can not be fitted with two modes unambiguously. The only point where some structure could, eventually, be fitted, is for the q vector corresponding to the dip minimum $q_s \approx 0.3$, as shown in Fig. C. We report in Fig. B the alternative fitted energy position with red hollow circles symbols. The result for the dispersion is changed for the anomaly $q_s \approx 0.3$, with a slightly larger anomaly.

Currently, a run of ARPES measurements, using a LASER source for high energy resolution, on the same sample, is programmed end of June 2008, in order to check if some anomaly in the wave-vector dependence of the kink is visible, in particular close to $q_s \approx 0.3$, as suggested in a recent work [6].

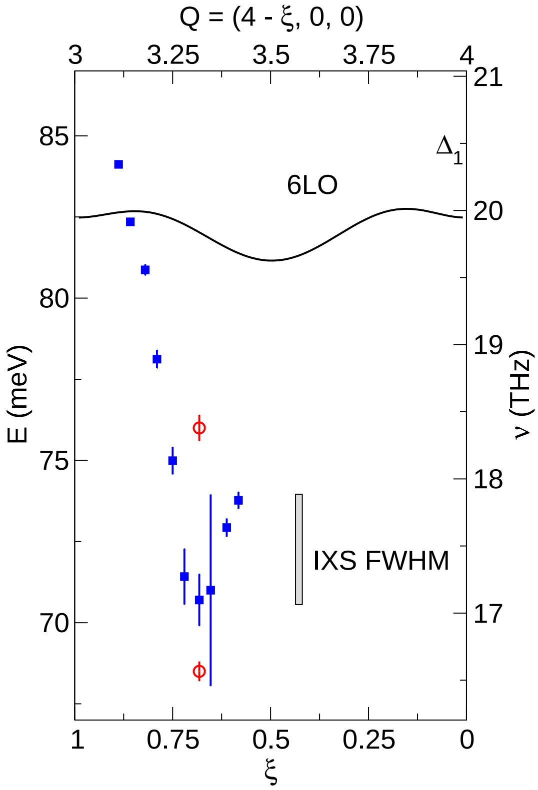

Fig. B.
$La_{2-x}Ba_xCuO_{4+\delta}$ *Cu-O bond stretching (BS) dispersion. Blue square represent frequencies from model fit with one mode, while red hollow circles represents fit with two modes. The line correspond to a shell model lattice dynamics calculation.*

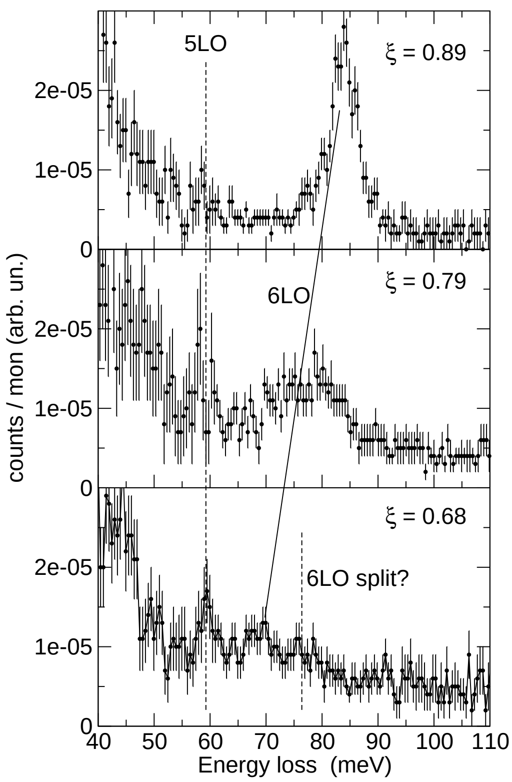

Fig. C.
Example IXS scan on $La_{2-x}Ba_xCuO_{4+\delta}$ *Cu-O Bond stretching*

References

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