ESRF	**Experiment title:** Resonant Inelastic X-ray Scattering study of charge density waves in highly overdoped superconducting $La_{2-x}Ca_xCuO_4$ thin films	**Experiment number**: HC5041
Beamline: ID32	**Date of experiment**: from: 06/10/2022 to: 12/10/2022	**Date of report**: 24/02/2022
Shifts: 18	**Local contact(s)**: Flora Yakhou-Harris (email: yakhou@esrf.fr)	*Received at ESRF:*

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Report:

The main goal of our experiment was to look for charge density wave order in overdoped $La_{2-x}Ca_xCuO_4$ (LCCO) films. We measured RIXS spectra for a wide range of momenta q in LCCO films for several dopings x = 0.1, 0.15, 0.2, 0.25, 0.3 and 0.4. By integrating the quasilastic intensity and plotting it as a function of q for different dopings, we were able to observe clear charge order peaks for the doping levels x = 0.15, 0.2, 0.25, and 0.3 but not for x = 0.1. A weak charge order peak is possibly also present for x = 0.4. However, we ran out of time before we could optimize the sample orientation to confirm and quantify the correct intensity of the charge order signal for the x = 0.4 sample. From the (H,0) scans reported in Fig. 1, we are able to deduce the position of the charge order peak in reciprocal space and also the correlation length in the longitudinal direction. We further characterized the correlation length in the transverse direction [by doing K cross scans at (H_{CDW},0)]. We also measured a preliminary temperature dependent dataset of the charge order peak up to 100 K for selected doping levels (Fig. 2). This shows a pretty monotonic behavior and limited competition with superconductivity, possibly due to the weak superconducting fluid density of these films [1], leaving open the question whether this charge order signal decreases at higher temperature as the charge density waves in other cuprate materials.

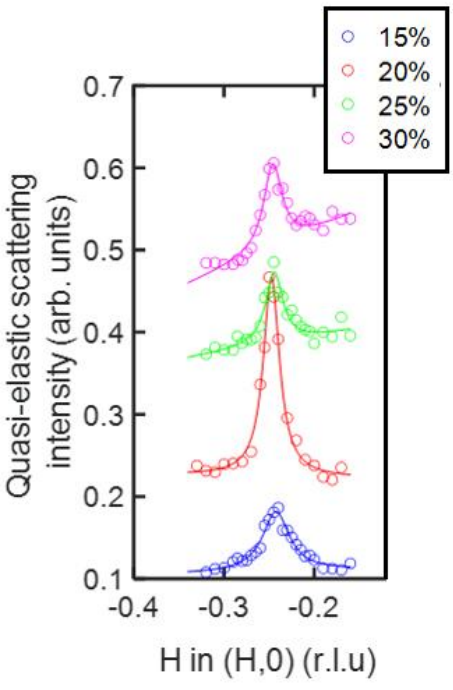

Fig. 1: Integrated quasielasic intensity as a function of H in (H,0) for different dopings.

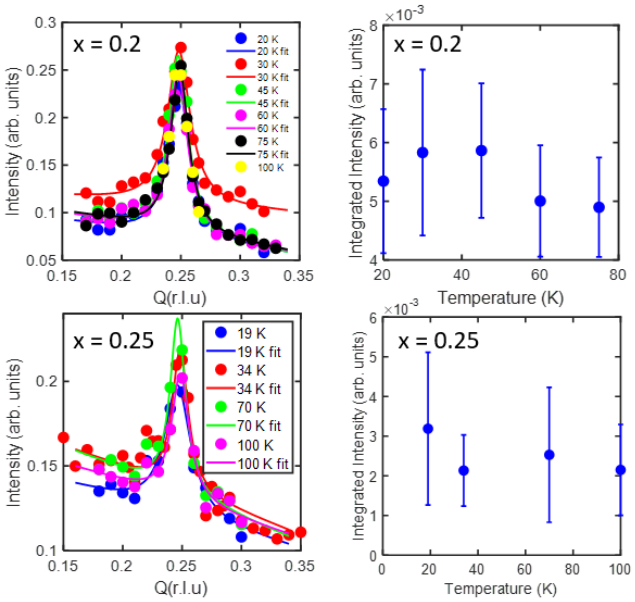

Fig. 2: Temperature dependence of the charge order peaks in x = 0.2 and 0.25.

Further investigations including measurements of a more detailed temperature dependence up to room temperature, as well as measurements of additional doping levels are planned for an upcoming resonant x-ray scattering beamtime on the very same films at BESSY, Berlin. Overall the HC5041 beamtime was extermely successful, with clear charge order signals observed at doping levels significantly higher than previosuly reported for La-based cuprates. Moreover we clearly observed a paramagnon peak at all investigated doping levels. Future RIXS experiments shall focus on the inelastic part of the spectra and in particular on these magnetic excitations which survive well into the highly overdoped regime at doping levels never studied before. Since the focus of this beamtime was a quasi-elastic charge signal we used sigma polarization for the incoming beam and we collected only limited statistics, *i.e.* not ideal conditions to make systematic conclusions about paramagnons and their nature in these ultraoverdoped films.

[1] G. Kim *et al.*, PNAS 118(30), e2106170118 (2021)