ESRF	**Experiment title:** **Is there in glasses a characteristic correlation length for the elasticity?**	**Experiment number**: SC-4955
Beamline: ID18	**Date of experiment**: from: 01/10/2018 to: 08/10/2018	**Date of report**: 17/03/2020
Shifts: 18	**Local contact(s)**: **Dimitrios Bessas**	*Received at ESRF:*

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Report

Glasses at low temperature (below 10 K) display thermal and vibrational properties markedly different from those of crystals [1]. In glasses, long-wavelength phonons (~GHz) are considerably more damped because of the presence of disorder in the elastic constants. In particular it has been recently argued that this elastic disorder in glasses should be characterized by **long-range correlations [1]**.

These correlations are expected to give rise to a logarithmic correction to the **Rayleigh** ($\Gamma_p \propto E^4$) term expetected in case of scattering from uncorrelated hetereogeneous elastic disorder [2]. Directly accessing the relevant frequency range to test this hypothesis is at present impossible on bulk samples. An alternative route is to study the low frequency (< 1 meV) tail of the vibrational density of states (DOS), which is directly related to sound attenuation [2].

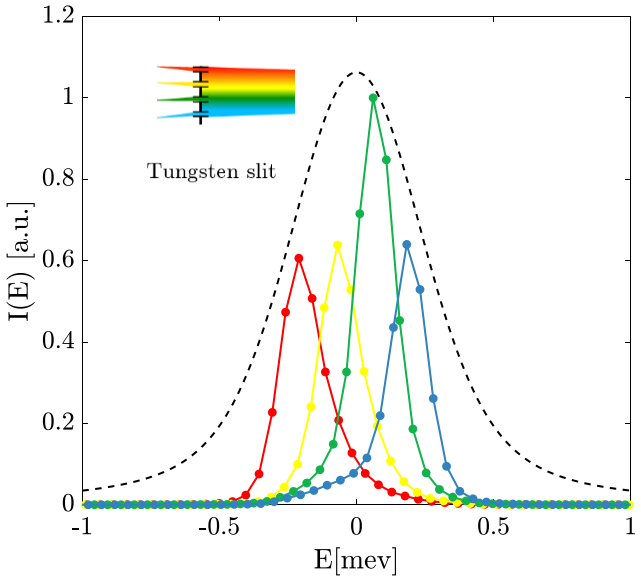

Figure 1: Intrumental response of the spectrograph: from the dispersed beam four "colors" are selected using a tungsteen slit.

The aim of this experiment was to measure the low-energy part of the DOS of the prototypical glass-former SiO_2 expoliting the very high energy resolution of the Hard X-ray spectrograph

recently developed at the beamline ID18 [3] combined with high resolution inelastic X-ray scattering with nuclear resonant analysis (NRAIXS) [4]. More in detail, the employed spectrograph is able to disperse photons at different energies into distinct spatial locations. Using a tungsteen slit we could select four different beams, each of them with an energy resolution of roughly 150 µeV (FWHM, see Fig. 1), which were then used to 'perform' 4 inelastic scattering experiments in parallel. In this way the efficiency of the measurments is increased as the total energy spectrum is obtained from the average of the four ones collected exploiting the different "colors" emerging from the spectrograph. The inelastically scattered intensity was then analysed using an α-^{57}Fe foil, achieving a total bandpass in detection of 0.5 µeV [4]. The overall energy resolution for the measured inelastic spectra was therefore fixed by that of the incident beam.
The inelastic spectra were measured integrating the scattered radiation over a large range of scattering vectors q= $1.4 - 14$ Å^{-1} to ensure the validity of the incoherent approximation [5] and an appropriate integration of the vibrational states: both are required for the extraction of the DOS. The vibrational dynamics of SiO_2 was investigated at two different temperatures: T=150 and 300 K. Fig. 2 shows the inelastic X-ray scattering spectrum of SiO_2 at 300 K (blue curve), along with the total instrumental response. The extracted spectra are characterized by an energy resolution of 170 µeV. The data analysis process is basically completed and we succeeded to extract the DOS of SiO_2 down to energies of 300 µeV at both the investigated temperatures. We are now starting to prepare a paper to present the obtained results [6].

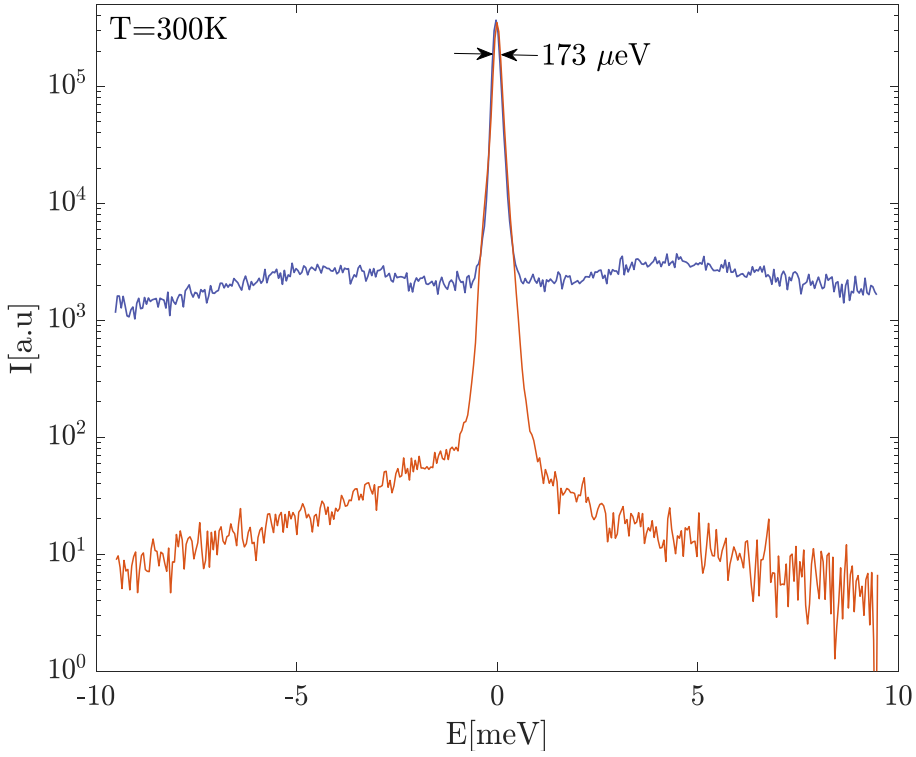

Figure 2: Energy spectrum of the inelastic X-ray scattering from SiO2 (blue line) and instrumental response (orange line).

References

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