	Experiment title: On the nature of the dynamics in the glassy state: a wave vector dependence study.	**Experiment number**: HD607
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Report:

By means of X-ray Photon Correlation Spectroscopy (XPCS) we have measured the atomic dynamics in a $0.8SiO_2 – 0.2Na_2O$ glass former for different temperatures in the glassy state (T_g=749 K) and for different wave vectors values above and below the first sharp diffraction peak in the static structure factor, which is at Q~1.6 $Å^{-1}$ in this system. In this way we have been able to look directly at the atomic dynamics, a task which is not reachable with any other technique.
The data have been collected in a wide angle configuration by two bidimensional detectors placed vertically symmetric with respect to the incoming beam. In this way the two detectors were measuring simultaneously the signal scattered at the same wave vector, leading therefore to a better statistics and to faster measurements.
Sets up to ~2500 images have been collected with an exposure time of 3-5sec per image, depending on the investigated temperature.
A picture of the dynamics can be entirely captured by XPCS through the determination of the two-time correlation function G(t1, t2) (TTCF) which represents the instantaneous correlation of the intensity I at two times t_1 and t_2, being:

$$G(t_1,t_2)=\frac{\langle I(t_1)I(t_2)\rangle_p}{\langle I(t_1)\rangle_p\langle I(t_2)\rangle_p}$$

Here the average is done over all the pixels of the entire CCD.
Figure 1 shows a TTCF measured in the glassy state for T=698 K. This quantity represents the instantaneous correlation between two times. The main diagonal from the left bottom corner to the up right corner indicates the experimental time, while the intensity perpendicular to the main diagonal is proportional to the structural relaxation time. Surprisingly the reddish intensity line along the main diagonal remains constant with time and it is relatively thin. This means that the atomic dynamics in the glassy state is governed by a fast structural relaxation with a characteristic time of few hundreds of seconds.

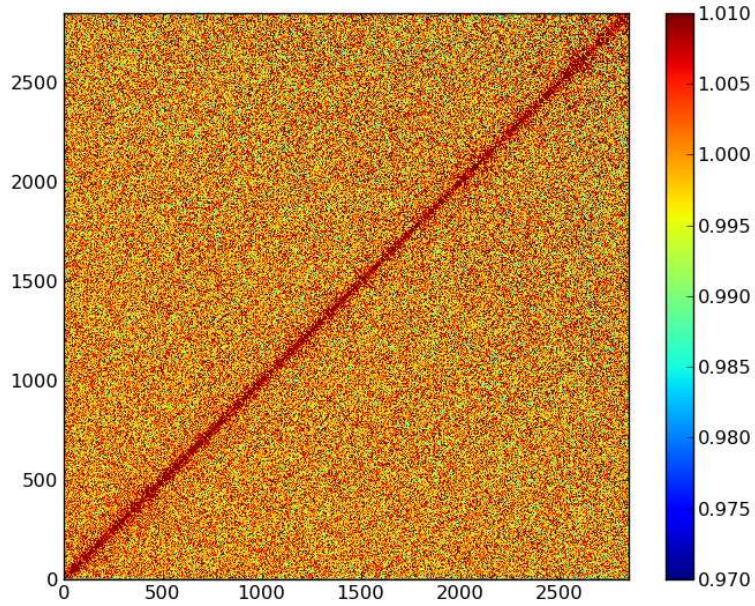

Figure 1: *Two times correlation function measured with XPCS in a sodium silicate glass, below the glass transition temperature. The axis corresponds to the number of collected images with an exposure time of 5 s each.*

A relatively fast dynamics and a similar decorrelation have been previously observed also in the case of metallic glasses. Differently from these systems, the dynamics in the sodium silicate glass does not show any signature of the fast exponential physical aging of metallic glasses which suggestes a different physical mechanism.
As previously anticipated during the experiment we have measured also the wave vector dependence of the observed atomic dynamics. Thanks to the high intensity coherent flux available on ID10, we maneged to measure the dynamics in a wide Q range around the maximum of the static structure factor.
Due to the interesting preliminary results on silicates, which appear to be very different from those found in metallic glasses, we decided to measure more accurately this system and finally we did not have enough time to explore also the q-dependence in metallic glasses. Notwithstanding we do still believe that a q-dependence study of the relaxation time in metallic glasses is fundamental in order to shed light on their remarkable out-of-equilibrium dynamics.