	Experiment title:	Experiment number:
ESRF	**Microscopic investigation of the Johari-Goldstein relaxation in metallic glasses**	HC-3975
Beamline: ID18	**Date of experiment:** from: 28/12/2018 to: 03/12/2018	**Date of report:**
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Names and affiliations of applicants (* indicates experimentalists):

Federico Caporaletti[1,*]
Wei-Hua Wang[2]
Beatrice Ruta[3,*]
Francesco Dallari[4,*]
Giulio Monaco[1,*]

[1]Dipartimento di Fisica, Università degli studi di Trento, Trento, Italy.
[2] Institute of Physics, Chinese Academy of Sciences, Beijing, 100190, China.
[3] Univ Lyon, Université Claude Bernard Lyon 1, CNRS, Institut Lumière Matière, Villeurbanne, France.
[4]Deutsches Elektronen-Synchrotron (DESY), Notkestraße 85, 22607 Hamburg, Germany.

Report:

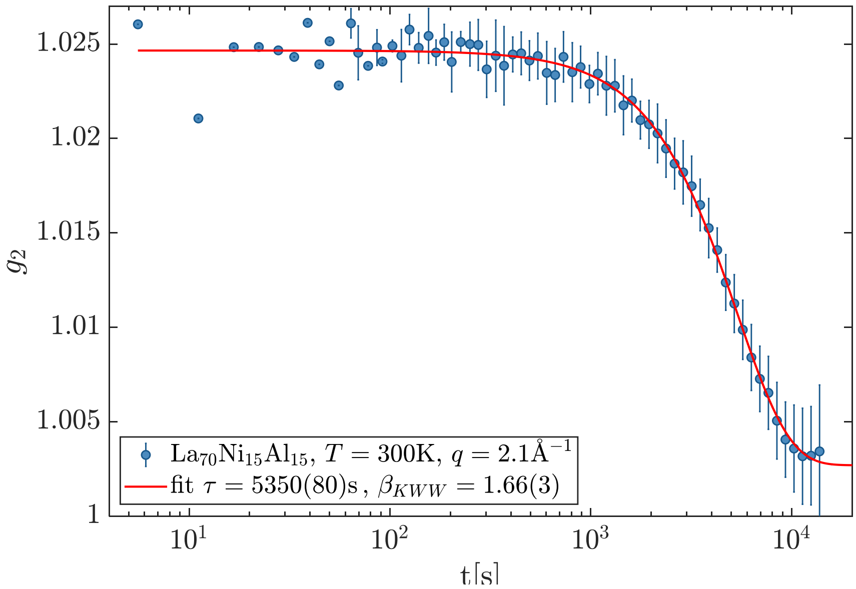

Figure 1: Correlation function probed by XPCS on "hyper-quenched" $La_{40}Ni_{15}Al_{15}$ sample at T=300 K and q=21 nm^{-1}: a clear compressed (that is faster than exponential) decay, sign of stress-driven dynamics, is clearly visible.

The aim of the experiment was to use wide-angle X-rays photon correlation spectroscopy (XPCS) to investigate the microscopic dynamics of the rare-hearth based MG $La_{70}Al_{15}\ Ni_{15}$, which is known to have a pronounced Johari-Goldstein (JG) relaxation [1], at least according to macroscopic measurements. We decided to employ XPCS for our investigations because it has been recently established the capability of photon correlation spectroscopy experiments with visible light to measure the JG relaxation [2] and we wanted to extend this observation to the microscopic length scale using synchrotron radiation.

Furthermore XPCS allows to follow slow microscopic dynamics (>1s) and so it is more than suitable to adress relaxation processes at and below the glass-transition temperature. In fact the only microscopic information available on the JG-relaxation are at the ns-us timescale [3]. The XPCS measurments were performed well below the glass-transition temperature T_g (473 K) and in both as-cast and annealed samples. The JG-relaxation is indeed extremely sensitive to the thermal history of the sample [4]. In other words we aimed, with such thermal protocol to reduce the internal stresses and increase the associated relaxation time, so that the Johari-Goldstein could be observed inside the probe time-window.

However, we did not succeed to slows down enough the stress driven dynamics.

In fact, as it is shown in Fig. 1 and Fig. 2, we noticed that, indepentently of the thermal protocol, the sample dynamics was still stress-driven, as signaled by the “compressed” (faster than exponential) decay of the extracted correlation functions [5]. Therefore it was not possible to observe the quasi-equilibrium dynamics associated to the glass-transition. The stress-driven, intermittent dynamics of the sample was instead investigated in detail in a wide range of scattering vectors and temperatures across the liquid-to-glass transition region. The data-analysis is still on-going and, in particular, we are working on the extraction of high-order correlation functions in order to characterize the intermittent dynamics characteristic of metallic glasses below their glass-transition temperature.

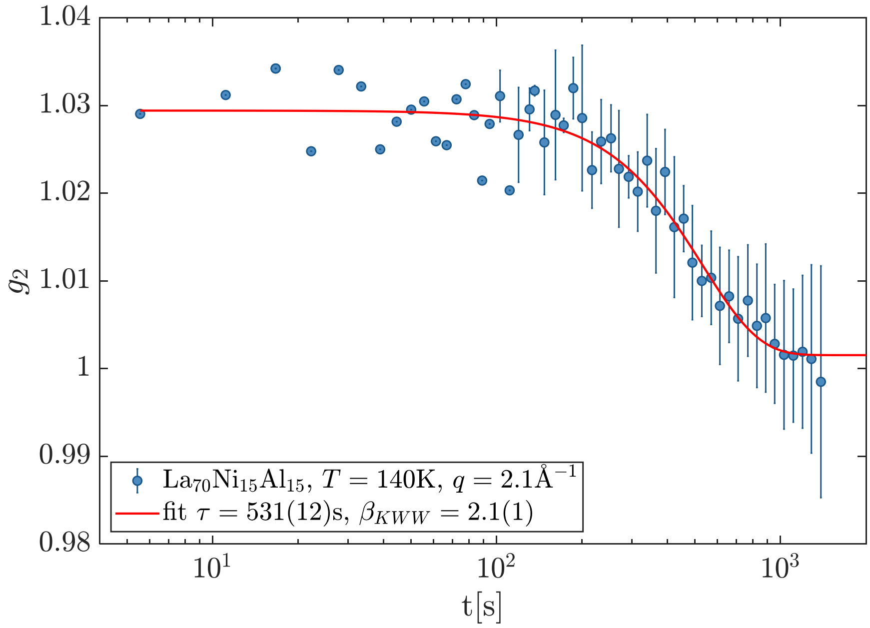

Figure 2: Correlation function probed by XPCS on an “annealed” $La_{40}Ni_{15}Al_{15}$ sample at T=300 K and q=21 nm^{-1}: a clear compressed (that is faster than exponential) decay, sign of stress-driven dynamics, is again clearly visible.

References:

[1] G. P. Johari *et al.*, J. Chem. Phys, 53, 2372 (1970);
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[3] F. Caporaletti et al., Sci. Rep. 9 (1), 1-10 (2019);
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[5] Z. Evenson, Phys. Rev. Lett. 115, 175701 (2015);