ESRF	**Experiment title:** X-ray-weighted lattice dynamics in amorphous and quasicrystalline Al-Cu-Fe films	**Experiment number**: HS 2211
Beamline: ID28	**Date of experiment**: from: 08 October 2003 to: 11 October 2003	**Date of report**: 3/2/2004
Shifts: 9	**Local contact(s)**: Dr. Alexei BOSSAK	*Received at ESRF:*

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Report:

For this experiment, we studied two free-standing samples of $Al_{62}Cu_{25.5}Fe_{12.5}$, using inelastic x-ray scattering. One sample was prepared in Chemnitz using evaporation on a Si wafer substrate at room temperature. To improve the film continuity, thick layers of AlCuFe were separated by thin Al_2O_3 layers, also produced by evaporation. The resulting composite film was thick enough to be peeled off of the wafer. This sample was produced from a sample containing pure ^{57}Fe, to enable us to use the same sample for the ^{57}Fe inelastic nuclear-resonant absorption experiment (HS2080). The second sample was one of the previous quasicrystalline (QC) i-$Al_{62}Cu_{25.5}Fe_{12.5}$, which had been prepared by Y. Calvayrac (Vitry). We measured the static structure factor of the amorphous sample both on the instrument (channel plate detector) and using electron diffraction (thanks to Marc Audier, INPG Grenoble, for these studies). We showed that the film from Chemnitz is truly in an amorphous state, and that the static structure factor shows maxima at the same Q values as important reflections of the quasicrystal. Thus the amorphous structure has a similar local order as the quasicrystalline one. Unfortunately the first inelastic measurements showed that the counting rate in the foreword direction to be too low to study the dispersion curve of the amorphous sample in a convenient way in the allotted time, so that we decided to do a different experiment. By measuring at 5 different large Q values (chosen so as to avoid the maxima of the static structure factor), and summing up the inelastic spectra, we made a type of vibrational density of states (DOS) in the incoherent approximation, well known in neutron scattering. In order to correctly compare the result for the amorphous state with the quasicrystalline one, we measured the previously prepared i-$Al_{62}Cu_{25.5}Fe_{12.5}$ sample under identical conditions. The resulting DOS curves g(E) are shown in the first diagram to the

right. In the upper panel, g(E) vs. E is shown. The main difference between the amorphous (a-) and the QC states (i-) is that the former is somewhat broader, and the single maximum at slightly lower energy. In the lower panel we show $g(E)/E^2$ vs. E^2. This plot is chosen to emphasise any low energy deviation from a Debye law (which would be a constant). We see a much larger deviation for the amorphous state than for the QC one. As we discuss below, actually obtaining the x-ray weighted DOS actually facilitates comparison with the companion experiment HS2080.

In addition, we obtained a small (ca. 1 mm) single grain sample of i-Al62Cu25.5Fe12.5, which we used for (preliminary) measurements of the transversal and longitudinal acoustic modes (QCs posses only two different sound velocities, independent of direction). Due to time limitations, it was not possible to extend the range of energies to test the presence of optical modes (as previously found for isostructural i-AlPdMn and i-MgZnY as well). The first studies are shown in the figure to the left, compared with the published sound velocities.

This experiment measures the x-ray-weighted vibrational DOS. The companion experiment using inelastic nuclear-resonant absorption to obtain the iron-partial vibrational DOS shows smaller deviations from Debye behaviour, both for the amorphous and the QC states. Thus the main differences in vibrational behaviour reside on the Al and Cu sites.