



Experiment title: Phonon dynamics in Al-Cu-Fe
quasicrystals

**Experiment
number:**

HS-440

Beamline:

ID18

Date of Experiment:

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Shifts:

9

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Report:

We studied the Vibrational Density of States (VDOS) of two $\text{Al}_{62}\text{Cu}_{25.5}\text{Fe}_{12.5}$ single-phase quasicrystalline powders. The experiment uses the inelastic scattering of γ -rays detected by nuclear resonant transitions (see ESRF Highlights, 1995/1996, pp. 40-41, Figs. 48 and 49). The high-resolution spectrometer yielded an energy resolution of 4.4 meV and the ring was in mixed mode. We measured both the forward and the scattered delayed (nuclear) signal in the range of ± 100 meV energy shift. (The forward signals serve to calibrate the instrument function.) The first sample contained highly enriched ^{57}Fe , so that the phonon density of states referred only to the iron site was measured (Fe-VDOS). The second sample contained natural iron (with only 2% ^{57}Fe). In this experiment, a ^{57}Fe foil was mounted on the detector in scattered geometry, so that the phonon density of states referred to all three components was measured, weighted by the relevant scattering powers (total-VDOS). Our results are: (1) The Fe-VDOS has a much lower cut-off in energy (ca. 40 meV) than the total-VDOS (60 to 80 meV) as measured by inelastic neutron scattering. This means that the higher-energy phonons involve principally the Al atoms. (2) The resolution (4.4 meV) was not sufficient to resolve details of the low-energy portion of the Fe-VDOS, very important in order to resolve discrepancies between specific heat and inelastic neutron scattering data. (3) The counting-statistics (mixed mode) was not sufficient to allow a numerical interpretation of the total-DOS measurement of the second sample, but we were able to estimate and test for the best sample thickness for later experiments (preferably in 16-bunch mode).