	Experiment title: Sound velocities in the Fe-Si-C alloys at extreme conditions: Si and C in the core	**Experiment number**: ES-1332
Beamline: ID18	**Date of experiment**: from: 03.05.2023 to: 09.05.2023	**Date of report**: 15.05.2023
Shifts: 18	**Local contact(s)**: Georgios Aprilis	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Ilya Kupenko* (ESRF, 71 Avenue des Martyrs, 38043 Grenoble, France)
Susanne Müller* (ESRF, 71 Avenue des Martyrs, 38043 Grenoble, France)
Xiang Li* (WWU Münster, Institut für Mineralogie, Corrensstr. 24, 48149 Münster, Germany)
Carmen Sanchez-Valle (WWU Münster, Institut für Mineralogie, Corrensstr. 24, 48149 Münster, Germany)

Report:

During the experiment, we performed nuclear inelastic scattering (NIS) and nuclear forward scattering (NFS) measurements on silicon and carbon-bearing iron alloys up to 120 GPa. Online laser heating was performed up to 1800 K at 81 GPa and up to 1900 K at 98 GPa and 119 GPa with a portable laser-heating system for diamond anvil cells. The two studied samples Fe-6wt%Si and Fe-2wt%Si-0.4wt%C were synthesis in advance at the WWU Münster employing a combination of the piston-cylinder and arc-melting techniques (Fe-6wt%Si) and sub-solidus sintering at low pressure (Fe-2wt%Si-0.4wt%C). The characterization and homogeneity of the samples were verified by the electron microprobe at the WWU Münster as well as Synchrotron Mössbauer Source spectroscopy measurements at ID18. Special diamond anvil cells, designed for laser-heating NIS experiments were used. Polycrystalline samples of each compound were loaded into the pressure chambers cut out in Be gaskets. KCl was added to the chamber as a pressure medium and thermal insulator.

Detailed data processing is currently in progress. In general, the aim is to calculate sound velocities (compressional wave velocity v_p and shear wave velocity v_s) for the compounds at conditions relevant for planetary cores. Therefore, the Debye phonon average velocity (v_D), which consists of 90% v_s, can be extracted from the partial phonon density of states of iron out of the obtained nuclear inelastic scattering spectra.
The nuclear inelastic scattering spectra (Fig. 1) are used to extract the partial phonon density of states. The Debye level is determined from the extrapolation of the reduced density of phonon states (rDOS, Fig. 2) to zero

energy, as the density of states close to zero energy is dominated by contributions from acoustic modes. Combined with density, the Debye level is required for the calculation of the Debye phonon average velocity (v_D). In Figure 2 the comparison between rDOS of Fe-2wt%Si-0.4wt%C and Fe-6wt%Si is shown. Besides the slight differences in the shape of the spectra, the Debye level of the carbon-bearing Fe-Si-allloy is much higher compared with the Fe-6wt%Si alloy which leads to lower v_D.

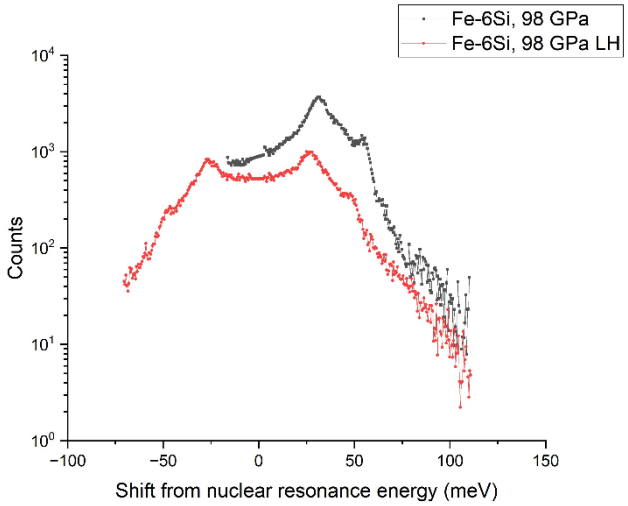

Figure 1: Nuclear inelastic scattering spectra for Fe-6wt%Si at 98 GPa and room temperature (black) and at 1900 K (red) The elastic lines are substracted.

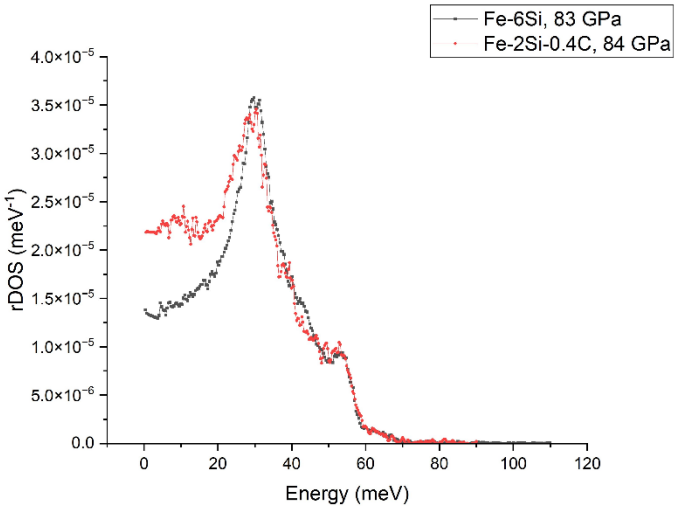

Figure 2: Comparison of reduced density of states between pure Fe-2wt%Si-0.4wt%C (red) and Fe-6wt%Si (black).