ESRF	**Experiment title:** Probing the Earth core: Nuclear ineleastic scattering on FeNi alloys at high P,T conditions	**Experiment number**: HE-2577
Beamline: ID18	**Date of experiment**: from: 25-01-08 to: 29-01-08	**Date of report**: 26-02-08
Shifts: 12	**Local contact(s)**: Dr. Aleksandr CHUMAKOV	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

B. Hewener*, J. Wolny*, K. Muffler*, V. Schünemann*

FB Physik, TU Kaiserslautern, Erwin-Schrödinger-Str. 46, 63638 Kaiserslautern, Germany

O. Narygina*, L. Dubrovinsky*, C. McCammon*

BGI, Universität Bayreuth, Universitätsstraße 30, 95447 Bayreuth, Germany

Report:

Mao et al. (2001) examined iron at pressures of up to 153 GPa by nuclear inelastic scattering of synchrotron radiation (NIS). Their compressional and shear velocities (v_p and v_s) were extrapolated to the pressure-temperature condition of the inner core and compared to shock-wave curves, yielding values slightly higher than the preliminary reference Earth model (PREM). The authors claim that an addition of 5 to 10% nickel would result in an alloy with sound velocities being in perfect agreement with PREM.

Within experiment number HE-2577 we therefore wanted to determine elastic and thermodynamic parameters of FeNi alloy phases at high pressures and high temperatures using nuclear inelastic scattering of synchrotron radiation (NIS) and nuclear forward scattering (NFS).

Figure 1a shows the iron density of states (DOS) obtained from NIS measurements of a $^{57}Fe_{0.9}Ni_{0.1}$ alloy at pressures up to 63 GPa. The measurements have been obtained in a wide bore diamond anvil cell which was equipped with the possibility to resistively heat the diamonds and the sample up to 1000 K. The corresponding NFS spectra taken at each pressure point are shown in Figure 1b. The NFS spectrum taken at 0 GPa exhibits a magnetic time structure which is caused by the ferromagnetic body-centred cubic structure of the $^{57}Fe_{0.9}Ni_{0.1}$ alloy. At higher pressures a NFS spectrum is observed which is characteristic for a non magnetic phase consistent with a hexagonal-closed-packed alloy phase (Mao et al. 1990; Dubrovinsky et al. 2001; Lin et al. 2003; Huang 1992).

Figure 2 shows the pressure dependence of the mean velocity of sound which was determined from the Debye-region of the iron DOS. Further experiments are needed to clarify whether there is a saturation behaviour of the velocity of sound above ~ 60 GPa.

In order to perform NIS measurements at high pressures and high temperatures a heat shield for the temperature sensitive avalanche photo diodes (APDs) has been developed and was successfully tested during HE-2577. Unfortunately we faced experimental problems when we wanted to perform NIS measurements at high temperatures. After heating the diamonds up to a temperature of app. 500 ^{o}C the diamonds cracked two times. The reason for this is that obviously mechanical stress is created by the resistively heated diamond sockets. We will change the design of the cell and hope to be successful in a future experiment.

In conclusion pure iron has already attracted substantial attention in high pressure studies, whereas work on the dynamic and electronic properties of Fe-Ni alloys under extreme conditions, which are obviously indispensable to understand the inner earth, are much more scarcer. Therefore we have determined the mean velocity of sound of Fe-Ni alloy at pressures up to 62 GPa and are currently in the process to determine more elastic and thermodynamic parameters of high pressure FeNi alloy phases including compressional and shear velocities.

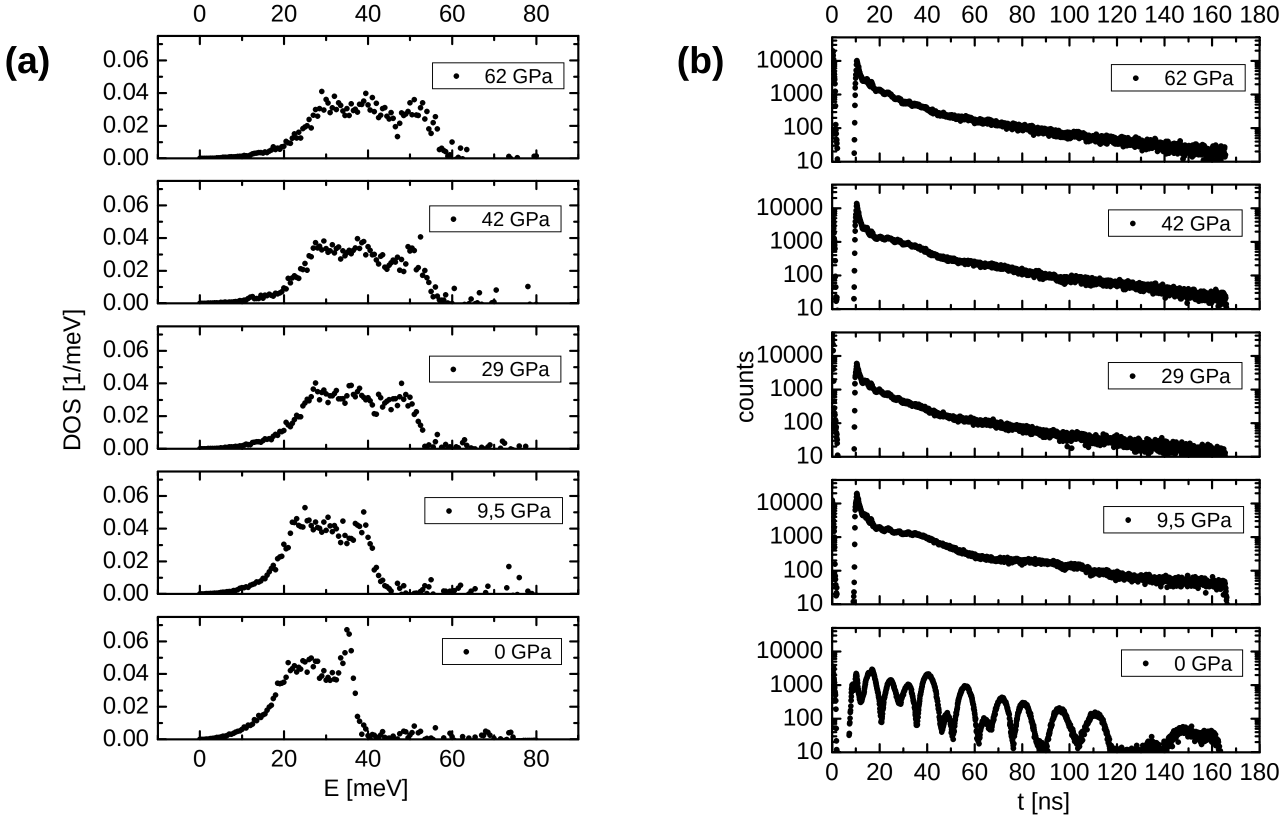

Figure 1: Iron density of states (DOS) obtained at room temperature and indicated pressures up to 62 GPa (a) and corresponding NFS spectra (b).

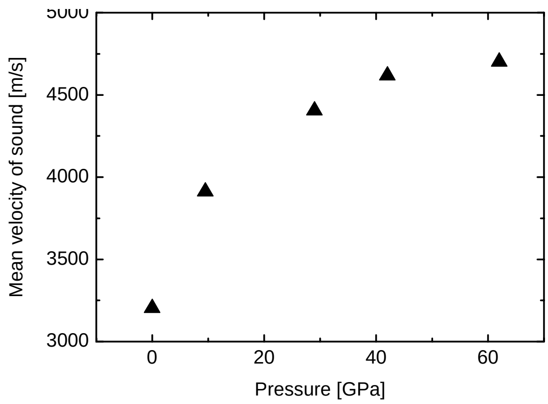

Figure 2: The mean velocity of sound of $^{57}Fe_{0.9}Ni_{0.1}$ alloy as a function of applied pressure (▲). The sound velocity was obtained from the Debye-region of the DOS shown in Fig. 1a.

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