ESRF	**Experiment title:** **Magnetic Studies of Iron at Megabar Pressures using Nuclear Forward Scattering**	**Experiment number**: HE-1035
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Shifts: 15	**Local contact(s)**: Bryan Doyle	*Received at ESRF:*

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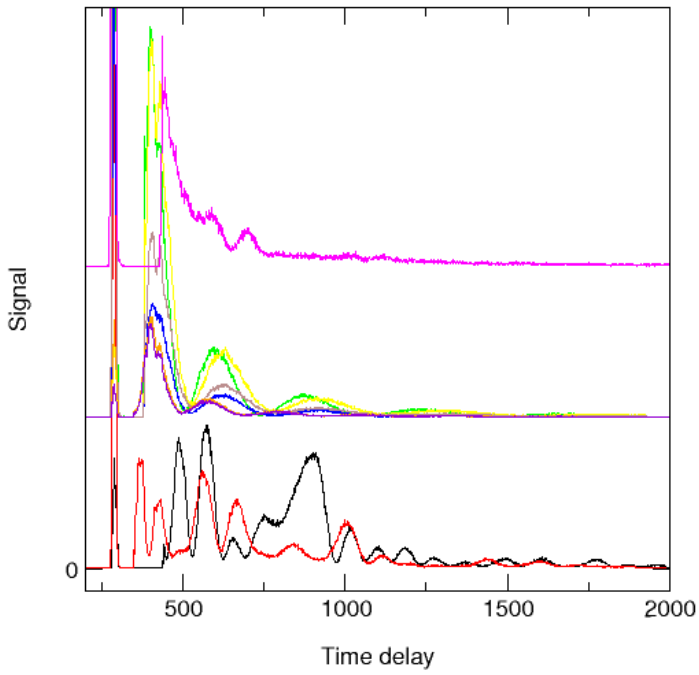
Report:

We have measured the delayed signal from the 14.4 keV nuclear excitation in ^{57}Fe from an iron foil (97% ^{57}Fe) under pressure up to 120 GPa. This experiment was to check if there is a reappearance of magnetism in iron at very high pressure. Indeed, α-iron (the room pressure room temeprature phase), which has a *bcc* structure, is ferromagnetic. As it is compressed, it undergoes a transition to a denser *hcp* phase at 15 GPa which has no magnetic moment. We measured some electronic properties in iron at very high pressure by x-ray emission spectroscopy and noticed that there was a gradual change in spin/spin—orbit coupling that started at 70 GPa and became intenseat 150 GPa. These changes hinted that some magnetic structure could possibly reappear in this pressure range.

In order to check this, we proposed this experiment. But NFS allows to detrmine the nature of the magnetic order if there is one, but it cannot easily separate between the non-magnetic and a paramagnetic (magnetically disordered state) states easily. For this, we use a very intense magnetic field around our pressure cell that would help allign the spins in case of a paramagnetic state. So with this experiment in conjunction with a magnetic field and a cryostat, one can probe for the reappearance of magnetism in iron.

The measured spectra are reported in the figure below. At each pressure point, the spectra were measured at room temperature, then at low temperature (between 28 K and 30 K), then at low temperature in the presence of a magnetic field (5 Tesla) to check for magnetic ordering of a hypothetical paramagnetic state.

The first two spectra (from the bottom) are those of Fe at 0 and 14 GPa, and are characteristic of the ferromagnetic phase. The next five spectra, from 28 to 105 GPa are characteristic of the *hcp* phase, as the exhibit no magnetism, even at low temperatures and with a magnetic field. The last spectrum (pink) is at 120 GPa and 30 K and shows a change in the magnetic ordering in the sample. But it is very difficult to interpret this as the quality of the spectrum is bad, and some of the information at lower delay times is missing.



We will write a proposal in order to get two or three more shifts (8 or 16 hours, should be enough) to do one more measurement in a cell that we will preload in the lab and take to pressures between 120 and 150 GPa, in order to obtain an answer and to see wether or not this experiment can answer this fundamental question about the state of magnetism in iron in the conditions of the Earth's core.