ESRF	**Experiment title: Magnetic collapse in $Fe_{0.95}O$ at very high pressures**	**Experiment number**: HE889
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Report:

We have studied the magnetic state of wüstite ($FeO_{0.94}$) using Nuclear Forward Scattering (NFS) as a function of pressure, temperature and magnetic field in an attempt to resolve the debate on possible magnetic collapse above 100 GPa. A previous Mössbauer study by Pasternak *et al.* reported the existence of a low-spin state at 90 GPa and 300 K and extrapolated this to full magnetic collapse at 140 GPa (at 300 K) [1]. Following this study Badro *et al* measured up to 143 GPa (also at room temperature) [2]. Their X-ray emission spectra to 143 GPa showed no evidence for satellite-structure collapse indicative of an LS state and they assigned the previous measurements to a paramagnetic state due to a Néel transition. They also claimed that, in all probability, the magnitude of the magnetic moment is constant from ambient pressure up to 143 GPa (contradictory to theoretical work [3]). The strength of NFS in this regard is that application of a magnetic field to samples studied with NFS allows one to distinguish between a diamagnetic low-spin state and a paramagnetic state[1].

[1] The same is true of Mössbauer Spectroscopy, however this is technically very difficult with samples under high-pressure. In such cases, due to the necessary small source-sample distance, the magnetic field splits the emission line of the source resulting in a complicated spectrum that is difficult, if not impossible, to analyse.

The measurements were performed in 16-bunch mode at ID18. A nested high resolution monochromator reduced the energy bandwidth of the beam to 6.4 meV. The beam was focussed using compound refractive lenses and a silicon crystal bender to approximately 130 × 180 μm. The Cu-Be cell holding the sample was placed in the ID18 cryomagnet and the sample was measured between 5 and 300 K with and without a field of 5 T. Count-rates of between 1.6 and 270 Hz were achieved, depending on the temperature and pressure of the sample and thus its magnetic state. A highest pressure of 125 GPa was reached, after which cracking of a backing plate resulted in the destruction of the diamonds (approximately 4 hours before the end of the beamtime).

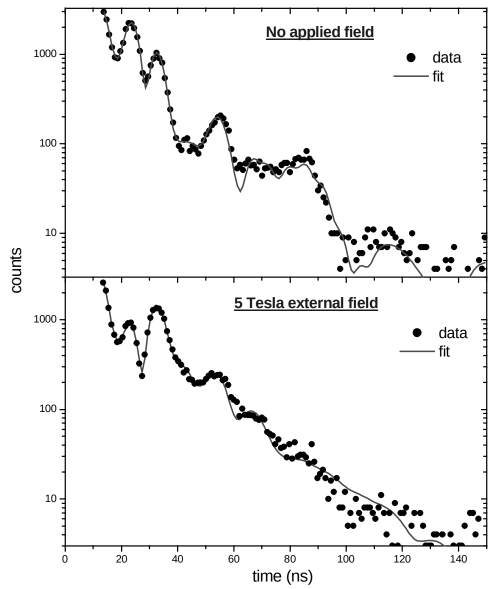

Figure 1. NFS spectra of $FeO_{0.94}$ at 125 GPa and 300 K (with and without an applied magnetic field of 5 T).

In Figure 1 the NFS spectra at the highest pressure with and without an applied field of 5 T can be seen (at a temperature of 300 K). Both spectra are fitted with a magnetic and two non-magnetic components. Application of the external field shows no evidence for a magnetic moment strongly suggesting that the sample is indeed in a low-spin and not a paramagnetic state. Analysis of the equivalent pressure but low temperature data is needed to confirm these results.

Thus at present it seems likely that the initial premise of Pasternak *et al.* is correct – above approximately 100 GPa there is the appearance of a low-spin, non-magnetic state in wüstite. This should be confirmed after the rather complex data analysis is completed. However it may be necessary to measure to even higher pressures to verify the total conversion to the non-magnetic state.

References:

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