ESRF	**Experiment title:** Magnetic phase diagram under pressure of the novel Iron-based superconductor LaFeSiH	**Experiment number**: HC-4020
Beamline: ID18	**Date of experiment**: from: 28 November 2018 to: 3 December 2018	**Date of report**:
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Report:

The recent observation of superconductivity in LaFeSiH (1) is the first one for a silicide in the family of iron-based superconducting (IBS) materials and therefore represents a major breakthrough comparable to the discovery of superconductivity in LaFeSi(O1-xFx) or in FeSe. Very little is known of this novel family of IBS, as its discovery is recent. The calculations predict that superconductivity is close to an antiferromagnetic phase. As in iron based pnictide and chalcogenide superconductors, according to the same calculations, the magnetic order is supposed to be extremely sensitive to applied pressure, and, very interestingly, to be re-entrant, with a first magnetic phase disappearing above 16-20 GPa, i.e. at the same pressure range where the superconducting phase also disappear (1).

We performed the first experiment combining both low temperature, high pressure and high magnetic field at the Nuclear Resonance beamline (ID18, ESRF) using Synchrotron Mössbauer Spectroscopy (SMS), to test this phase diagram, with the following results, upon a preliminary analysis. We measured at ambient pressure 7 crystals, 2 with natural iron and the remaining 5 with 100% ^{57}Fe substitution. From these we selected 1 with 100% ^{57}Fe substitution and the 2 with natural iron for the high pressure measurements, and loaded them in a diamond anvil cell. We summarize here the main results. We do not find any measurable splitting of the nuclear resonance at ambient pressure (Fig. 1) nor at high pressure, up to ~ 19 GPa (Fig. 2) due to a possible hyperfine field. This put a higher limit of an ordered magnetic moment on Iron, in the hypothesis of a simple magnetic structure, below ~ 0.2 μB. Measurements under field gives a hyperfine field that corresponds to the applied field within error bars, up to 7 Tesla, both at ambient pressure and up to ~12 GPa. This rules out a disordered (paramagnetic) state with a large, ~ 1 μB moment. The present results can not, however, rule out a small moment and/or a very complex (and unusual) order that minimize the hyperfine field. Further investigation by muon spin rotation and possibly neutron scattering can clarify these possibilities.

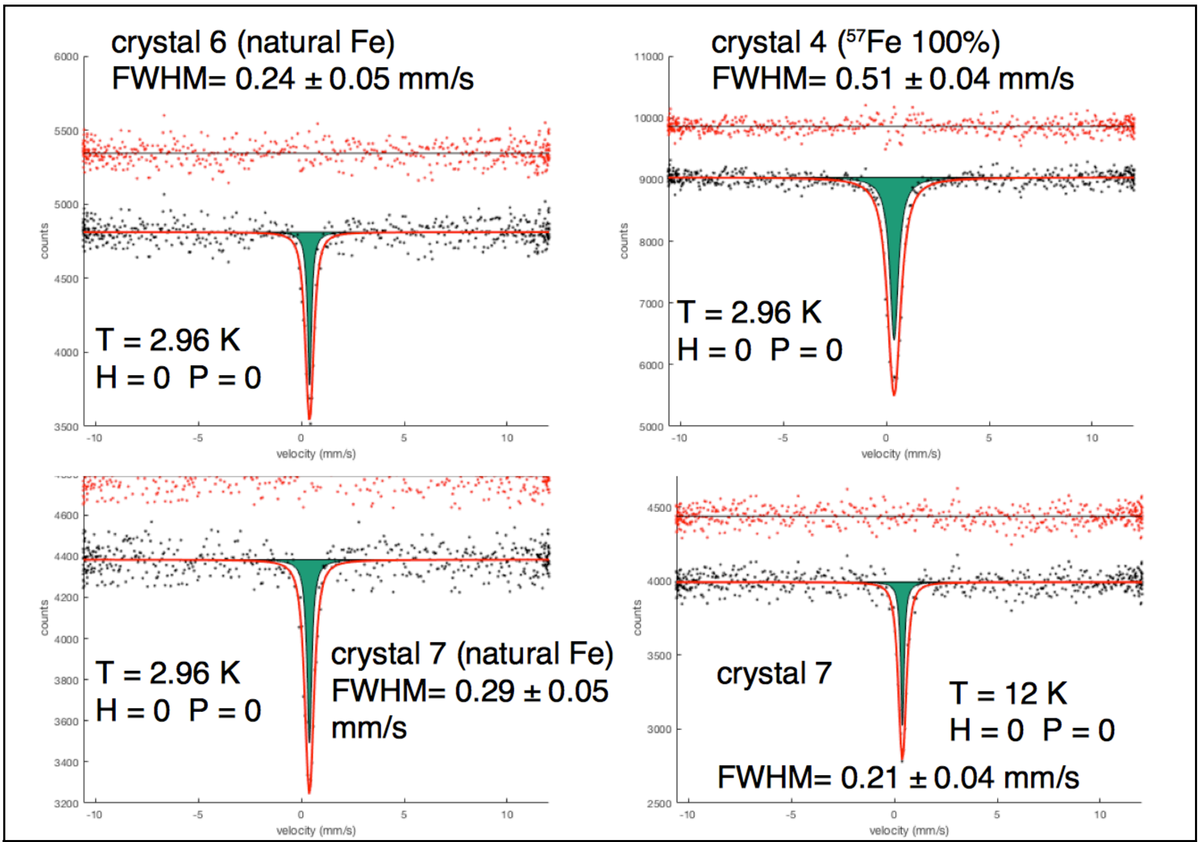

Fig. 1: *Syncrotron Mössbauer Spectra on different crystals at the lowest measured T (3 K), and just above the superconducting transition (12 K), at ambient pressure and zero field.*

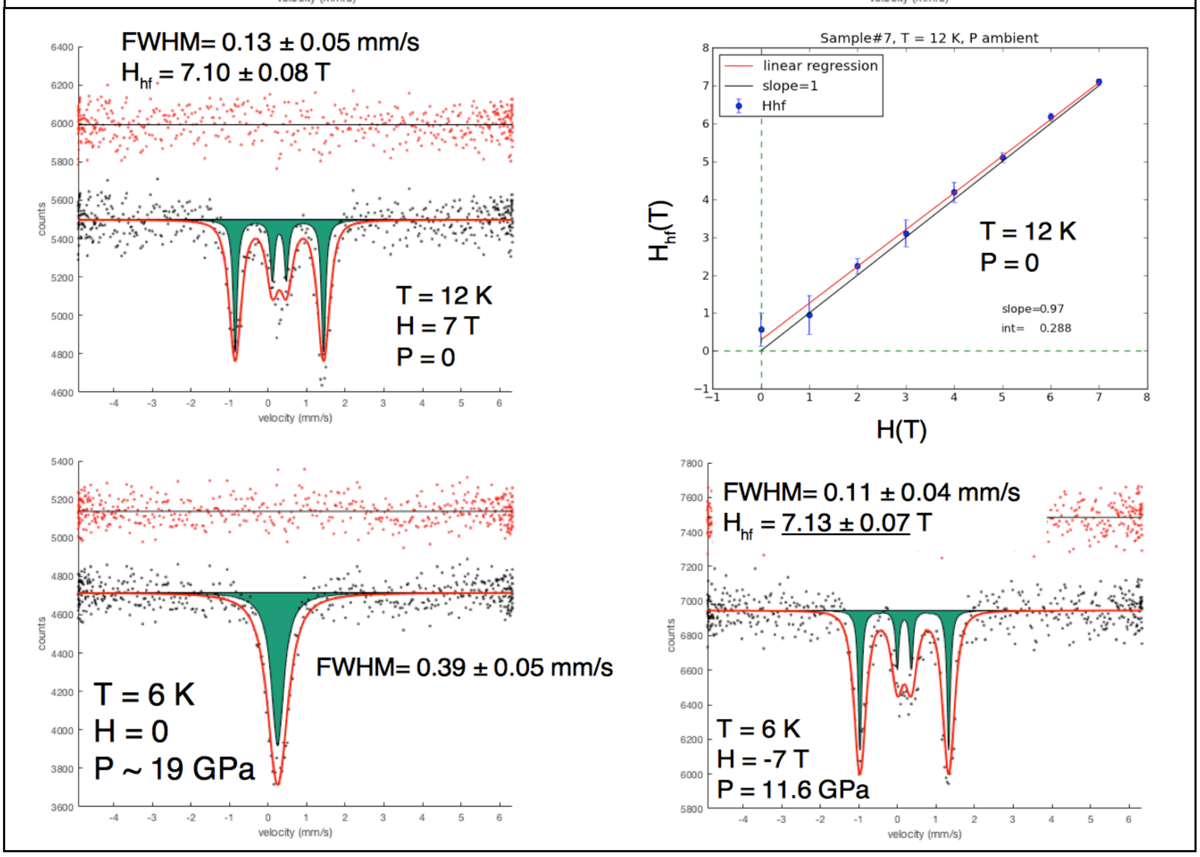

Fig. 2: *Syncrotron Mössbauer Spectra on crystal 7: top panels, as a function field at 12 K, ambient pressure, and bottom panels, at high pressure, 6 K.*

References

1) F. Bernardini, G. Garbarino, A. Sulpice, M. Núñez-Regueiro, E. Gaudin, B. Chevalier, M.-A. Méasson, A. Cano, S. Tencé, *Phys. Rev. B.* **97** (2018) 100504(R).