ESRF	**Experiment title:** Magnetic Compton scattering study of the amorphous Ferromagnetic system $Fe_{1-x}B_x$.	**Experiment number**: HE662
Beamline: ID15A	**Date of experiment**: from: 6/10/99 to: 13/10/99	**Date of report**: 6/2000
Shifts: 18	**Local contact(s)**: Dr J.E. McCarthy	*Received at ESRF:*

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Report: Amorphous ferromagnetic alloys in the series $TM_{1-x}B$ - P_x where TM is a ferromagnetic transition metal (Co Fe Ni) are of technological importance since they exhibit extremely soft ferromagnetism. However, it has been observed that the moment is not a simple function of metalloid content for the series $Fe_{1-x}B_x$ **[1]**. The magnetic structure of the amorphous phases of these alloys have been determined by neutron scattering **[2]** as a non-colinear ferromagnetic arrangement of Fe spins with a maximum canting angle of 45°. Our study was prompted by recent photoemsision work by the Leeds group **[3]** which suggested that a small moment, negatively polarised with respect to the moment on Fe, exists on the boron 2p orbital. Supercell LMTO electronic structure calculations **[4]** by Hafner et al. support this observation. The aim of this experiment was to determine the size and orientation (with respect to the Fe spin) of any induced spin moment present on the boron 2p orbital. Magnetic Compton scattering (MCS) is an established technique, and has proved useful for investigating the momentum distribution of the bulk spin moment of magnetic materials. MCS measures a 1D projection of the momentum density of the spin-polarised electrons in a material by the use of circularly polarised x-rays. It is an ideal tool for investigating spin polarised band structures. Melt-spun amorphous ribbons of the alloy were prepared in the composition of $Fe_{80}B_{20}$ and $Fe_{76}B_{24}$, and a polycrystalline sample of the alloy $Fe_{76}B_{24}$ was made by arc melting.

Room temperature magnetic Compton profiles of all three samples measured using, for the first time, a 13 element multidetector are presented in **Fig. 1**. The loss of 5 shifts due to beam loss, computer network problems and detector failure, resulted in a premature end to the experiment and lack of integration time for the normalisation data. The resultant profiles are of sufficient statistical quality to allow quantitative analysis despite an ESRF data acquisition macro error, only discovered in June 2000 which had the effect of reducing the statistical accuracy. Figure 1 shows the low momentum anisotropy between the polycrystalline $Fe_{75}B_{25}$ and the amorphous sample of similar composition, that is ascribed to structural disorder.

Because the characteristic momentum distributions of the boron 2p and the iron 3d orbitals are significantly different the magnetic Compton scattering method is an extremely sensitive tool for determining the magnitude and relative orientation of any induced spin moment resulting from the polarisation of the metalloid valance electrons. The magnetic Compton profiles were compared with a Fe profile scaled by an amount proportional to the Fe content of the alloy in order to determine any qualitative differences that may be attributed to a boron 2p like profile, the results are presented in figures 2 and 3.

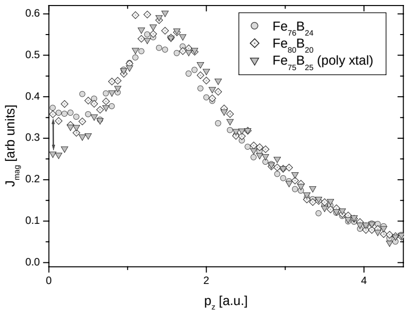

Fig.1.

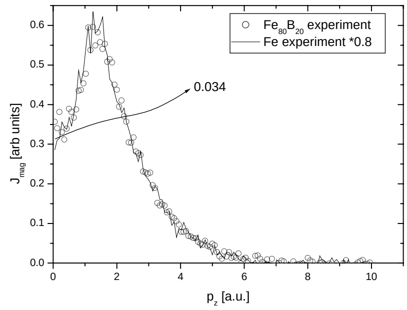

Fig.2.

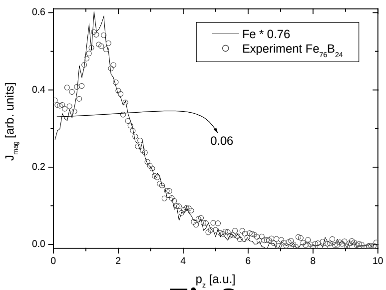

Fig.3.

It is clear that at low p_z (<0.5a.u.) a very slight difference between the scaled Fe and experimental amorphous alloy data is present, the magnitude of which is no more than $0.03\mu_B$ and $0.06\mu_B$ for the $Fe_{80}B_{20}$ and $Fe_{76}B_{24}$ samples respectively, however the momentum distribution of this difference is not similar to that for a boron 2p orbital. It is found that an acceptable fit is achieved by simply scaling the experimental Fe profile to match the Fe content of the respective sample.

There is no clear evidence for the existence of spin polarisation of the boron 2p orbital to the extent suggested by Hafner et al., i.e. boron 2p moments as large as 0.1 to $0.2\mu_B$. For these materials our analysis show that a boron moment as small as $\approx\pm0.05\mu_B$ would be resolved, further it is possible to extract the relative orientation of such a moment.

In conclusion this experiment has determined the maximum possible size of any induced bulk spin moment of the boron 2p orbital that may be present in the amorphous alloy $Fe_{1-x}B_x$. It is almost a factor of 10 lower that that suggested by surface studies and theoretical investigations. We hope to exploit this proven sensitivity of the MCS probe to study other amorphous metal-metalloid systems.

[1] Cowlam, N., and Carr, G.E., 1985, J. Phys. F: Met. Phys. **15**, 1109.
[2] Cowley, R.A., et al., 1991, J. Phys.: Cond. Matt., **3**, 9521.
[3] Xu, Y.B, et al., 1999, IEEE Trans. Mag., **35**, 3427.
[4] Hafner, J., et al., 1994, Phys. Rev. B., **49**, 285.