Experiment title: In search of <kkk> ordering.		Experiment number: HE-1386
Beamline: ID20	**Date of experiment:** from: to:	**Date of report:** 20/1/2004
Shifts: 18	**Local contact(s):** Dr S. B. Wilkins	*Received at ESRF:*

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Report:

Multi-***k*** structures have stimulated much research since there first discovery in 1963 by Kouvel and Kasper. The work reported here primarily concerns materials which have the so-called triple-**k** structure where the complete star of (k 0 0) is simultaneously present in each volume element. Magnetic diffraction from such structures is sensitive to the Fourier components moment which for such a structure yields wavevectors of <k 0 0>, where the < .. > denotes a permutation over all indices. Previous studies however detected the presence of a <k k k> wavevector within the triple-**k** region of the material $UAs_{0.8}Se_{0.2}$. Such a modulation is forbidden by the magnetic structure factor and cannot be explained by conventional scattering theory. The aim of this experiment was to firstly verify the presence of such peaks in a new sample, to eliminate the question of sample stochiometry or impurities and secondly to undertake a similar experiment on the iso-structural compound $USb_{0.85}Te_{0.15}$ to verify whether these wavevectors appear in other type 1-A triple-**k** structures.

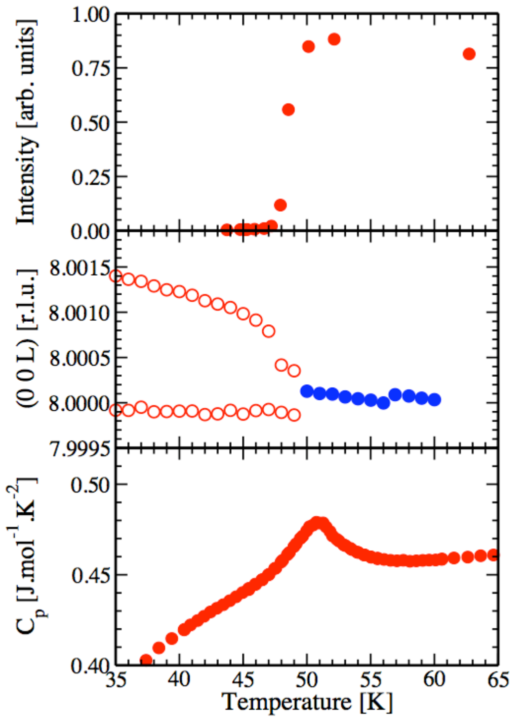

Figure 1 - Integrated Intensity of the (0.5 0.5 2.5) superlattice reflection as a function of temperature (top pannel). Tetragonal distortion as meassured on the (006) Bragg reflection (middle pannel). Specific heat as a function of

Experiments were carried out on beamline ID20 using the vertical scattering geometry with a closed cycle displex sample environment. The scattered x-ray beam's polarization was analysed along with the distribution in reciprocal space.

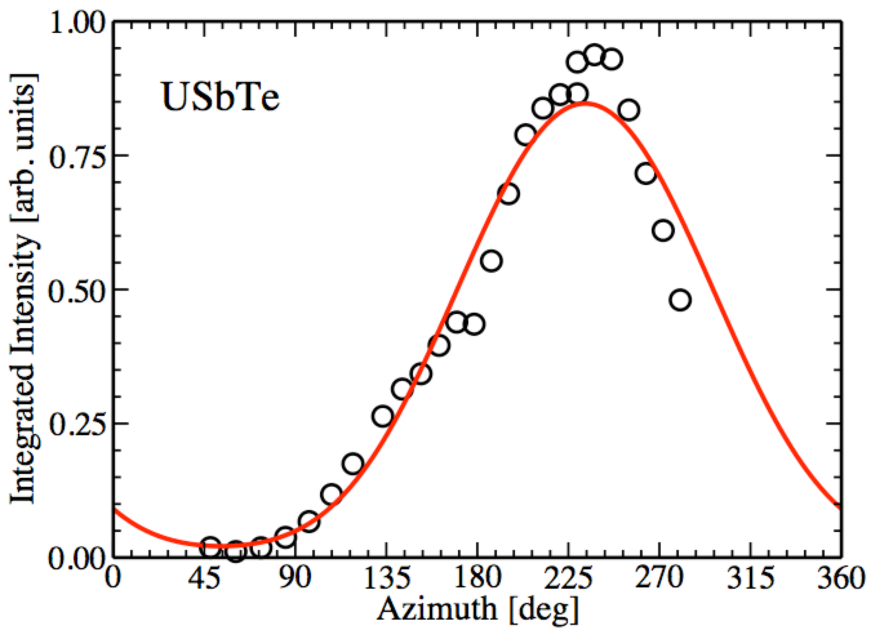

Figure 2 - Azimuthal dependance of the (-0.5 0.5 2.5) superlattice reference (measured at a temperature of 15 K) in $USb_{(1-x)}Te_x$. x = 0.15

The new sample of $UAs_{0.8}Se_{0.2}$ was cooled to 60 K and a search was undertaken for <kkk> type reflections. These were located and found to me of similar intensity to previous measurements. We can therefore conclude that such <kkk> reflections previously observed were not due to impurities or stochiometric variations. We also find that the drop of intensity observed at approximately 50 K of the <kkk> reflection coincides with the onset of a tetragonal distortion (see Figure 1) as measured on the (008) Bragg reflection. The onset of the tetragonal phase is accompanied by a transition into a 2-**k** phase in which the <kkk> reflection is not present. We can conclude, therefore, that these <kkk> reflections are only associated with the 3-**k** structures.

To confirm the above hypothesis, for the second half of the experiment a sample of $USb_{0.85}Te_{0.15}$ was measured in which previous work had determined the structure to be of the triple-**k** type. In a similar fashion to above the <kkk> peak occurring at (0.5 0.5 0.5) was found to exist and the azimuthal dependence was measured. Figure 2 shows the results of these measurements. The solid red line is a simulation of the azimuthal dependence assuming a moment direction along <111>. This is the identical result as observed in the $UAs_{0.8}Se_{0.2}$ above.

We can therefore conclude that the presence of these <kkk> reflections is not due to stochiometric variations or just particular to the $UAs_{0.8}Se_{0.2}$ system bus seems to be a general feature of the triple-**k** structures. It is likely that they are observed in uranium compounds by magnetic x-ray scattering due to the very high intensities of the magnetic scattering due to the large uranium M_4 resonance. It is clear that further theoretical work is needed to explain the origin of these reflections. The mystery continues ....