



	<b>Experiment title:</b> Investigation of the element specific magnetism on a Tb <sub>0.5</sub> Dy <sub>0.5</sub> Cu <sub>2</sub> single crystal by resonant magnetic x-ray scattering in zero field.	<b>Experiment number:</b> HE-1074
<b>Beamline:</b> ID20	<b>Date of experiment:</b> from: 2001/04/11                      to: 2001/04/17	<b>Date of report:</b> 2001/08/26
<b>Shifts:</b> 18	<b>Local contact(s):</b> C. Detlefs	<i>Received at ESRF:</i>
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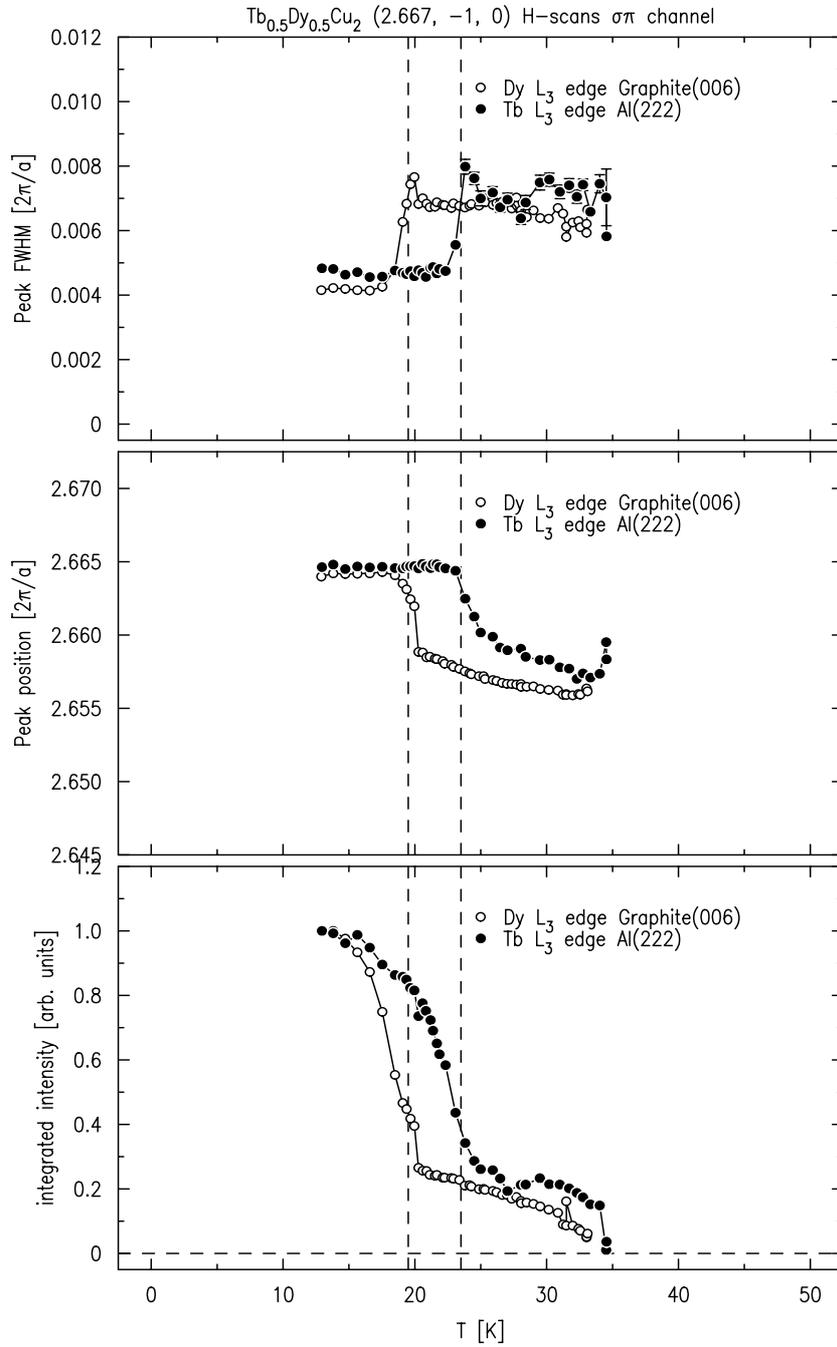
Report:

The  $RCu_2$  compounds crystallize in the orthorhombic  $CeCu_2$  structure (space group  $Imma$ ) which can be derived from the hexagonal  $AlB_2$  structure (space group  $P6/mmm$ ) by applying a small orthorhombic distortion and moving the atoms slightly out of the high symmetry positions. Magnetism in these compounds originates from the localized  $4f$  shell of the rare earth,  $R$ . The exchange interaction is strongly anisotropic. There is a rising interest in the interaction between the magnetism and the crystalline structure. This aspect of  $RCu_2$  magnetism is studied by mixing  $TbCu_2$  with magnetic (Dy) and non-magnetic (Pr, Y) ions on the rare earth site and investigated the crystalline and magnetic structures of mixed compounds with several methods.

The parent compounds  $TbCu_2$  and  $DyCu_2$  order with  $\tau = (\frac{1}{3} + \delta, 0, 0)$  at  $T_N = 55$  K and  $T_N = 27$  K, respectively. Upon further cooling they undergo lock-in transitions ( $\delta \rightarrow 0$ ) at  $T_{IC} = 47$  K and  $T_{IC} = 19$  K, coincident with the development of third order harmonics at  $3\tau = (1, 0, 0)$ . In both cases the magnetic moments were shown to lie along the  $\mathbf{a}$ -axis [1,2]. Given the similarity of their crystalline and magnetic structures, one would expect that the magnetic properties of partially substituted compounds  $Tb_{1-x}Dy_xCu_2$  are well described by a continuous interpolation between the two parent compounds.

A single crystal with nominal composition of  $Tb_{0.5}Dy_{0.5}Cu_2$  was cut to approximately  $3 \times 3 \times 3$  mm<sup>3</sup>. A surface perpendicular to the  $a$ -axis was mechanically polished under Acetone to avoid oxidation and depletion of the rare earths. The sample was then mounted in a closed cycle refrigerator with base temperature of approximately 13 K.

The diffractometer was used in the "super-phi" configuration with vertical scattering plane, so that the incident beam was  $\sigma$  polarized. For photon energies close to the Tb and Dy  $L_3$  edges the polarization of the diffracted beam was selected by Al(222) and Graphite (006) single crystal analyzer, respectively, which have scattering angles close to 90° for these photon energies.



The figure shows the variation with temperature of the full width at half maximum (FWHM) of  $H$ -scans (top), the peak position of  $H$ -scans (middle), and the integrated intensity of  $H$ -scans through the  $(3 - \tau, \bar{1}, 0)$  magnetic Bragg peak. Scans were taken at both, the Tb ( $\bullet$ ) and Dy ( $\circ$ )  $L_3$  resonances. The data were extracted by fitting a Lorentzian-squared line profile to scans along  $H$ -directions in reciprocal space. In the low temperature phase both resonances are observed at the same commensurate position. In the intermediate phase the Tb resonance stays commensurate while the Dy resonance shifts towards the incommensurate value  $\tau = (\frac{1}{3} + \delta, 0, 0)$ . In the high temperature phase both resonances are observed at incommensurate, but different positions. The presented data were checked for consistency especially in the temperature range  $19 \text{ K} \leq T \leq 24 \text{ K}$  by careful controlling of the measurement conditions and performing different self-contained scans.

#### References:

- [1] Y. Koike et al., J. Phys. Soc. Jap. **66** 4053 (1997).
- [2] V. Sima et al., J. Magn. Magn. Mat. **54-57** 1357 (19986).