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Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

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Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

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All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** **Nuclear scattering of Eu-151 21.5 keV -radiation: High-pressure studies of magnetism in CsCl-type EuS, EuSe, EuTe**	**Experiment number**: HE-592
Beamline: ID 18	**Date of experiment**: from: 27.03.99 to: 03.04.99	**Date of report**: 30.08.99
Shifts: 9	**Local contact(s)**: O. Leupold	*Received at ESRF:*

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Report: This experiment is a continuation of our proposal HE-289, where we performed the first high-pressure experiments with nuclear-forward scattering (NFS) of the 21.5 keV Mössbauer radiation of Eu-151 on a pressure-induced valence transition in $EuNi_2Ge_2$ [1] and magnetic studies of EuTe at various pressures and temperatures [2] (see also corresponding reports).

In the present study we extended our investigation of the magnetic behaviour in Eu(II)-chalcogenides to EuS and studied EuTe at higher pressures. In addition we used focusing optics to concentrate the synchrotron radiation (SR) on the small samples pressurised in a diamond anvil cell (DAC). The DACs were mounted in a new He cryostat with the option to apply an external magnetic field to the sample. By an external field one obtain much simpler NFS spectra and may, in addition, get information on the ferromagnetic (fm) or antiferromagnetic (afm) ordering type of the specimens [3, 4].

We measured NFS spectra to obtain isomer shifts (at 300 K with an EuF_3 reference absorber [1]) and magnetic hyperfine fields (at low temperatures) of EuS up to 27 GPa and of EuTe up to 22 GPa, reaching in both cases the pure CsCl-type high-pressure phase. Fig 1 (a) shows NFS spectra of EuTe at 22 GPa in a temperature range between 4 K and 100 K with an external field of 1 T applied parallel to the SR beam. The magnetic ordering temperature T_C at 22 GPa is derived from these spectra and from additional spectra measured without external field as 95 K (see Fig. 2). The simple beat pattern at low temperatures reflect a fully aligned magnetization by the external field along the SR beam. From this and from the values of the hyperfine fields $B_{hf}(T)$ observed with and without external field we deduce *ferromagnetic* ordering of EuTe in the CsCl-type high-pressure phase. Interestingly the value of B_{hf} observed at 4.2K, B_{hf}(CsCl, 22 GPa) = -22.3(2) T, is considerably smaller than those of EuTe in the the NaCl-phase, where B_{hf}(NaCl, afm, 0 GPa) = -26.3(2) T and B_{hf}(NaCl, fm, 0 GPa) = -31.5(2) T and B_{hf}(NaCl, fm, 10 GPa) = -34.2(2) T were observed with normal Mössbauer effect at high fields and/or pressures [5,6].

Fig 1 (b) shows magnetic NFS-spectra of EuS at 20 GPa (NaCl-phase) and at 27 GPa (CsCl-phase) at 4.2 K. The preliminary evaluation reveals again a considerably smaller value of B_{hf} in in the CsCl-phase than in the NaCl-phase. This indicates, as in the case of EuTe, different contributions to the B_{hf} values from the J_1 and J_2 exchange mechanisms in the CsCl phase.

Additional XRD studies performed after the NFS studies ensured that the EuS and EuTe had completely transformed to the CsCl-phase at the highest pressures.

Fig. 2 shows the magnetic phase diagram of EuTe. In the ferromagnetic CsCl-phase the magnetic ordering temperature increase strongly.

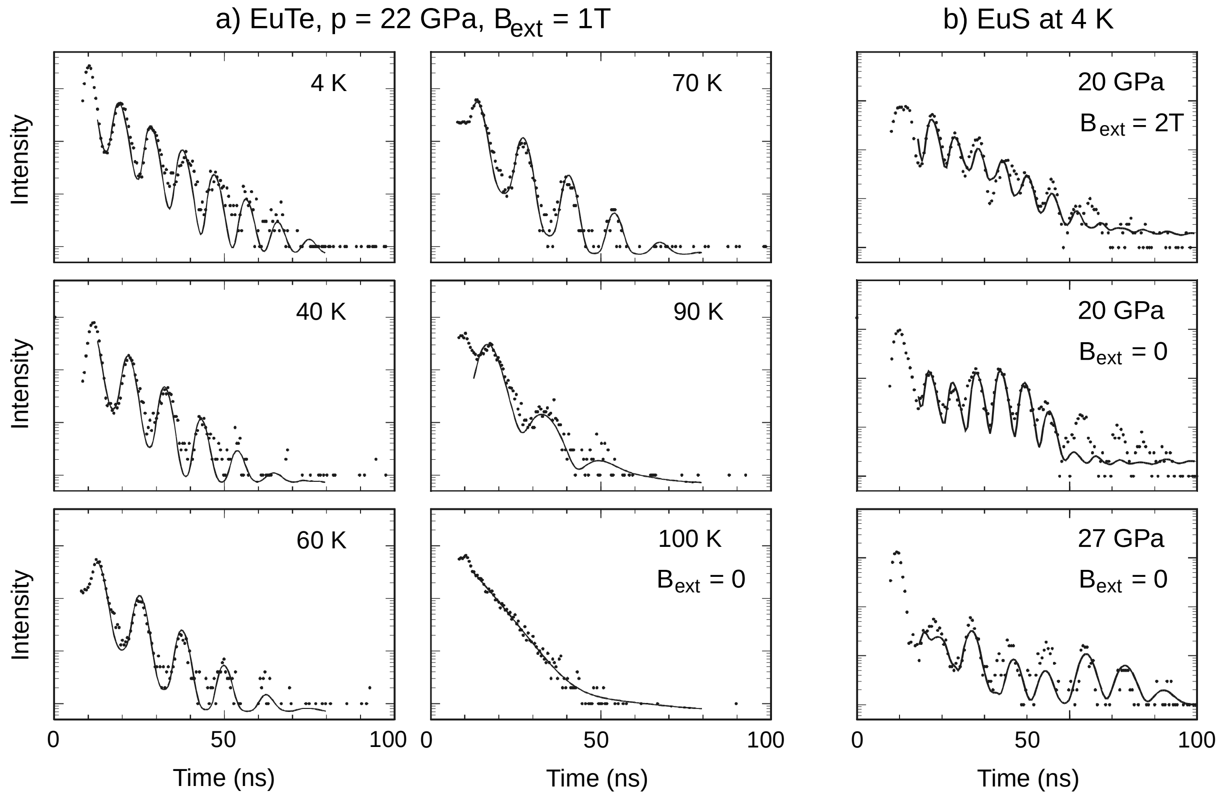

Fig. 1: (a) Eu-151 NFS spectra of CsCl-phase EuTe at 22 GPa and various temperatures with an external field of 1T applied parallel to the synchrotron beam. The ferromagnetic ordering temperature is amount to 95 K.(b) Magnetic NFS spectra of NaCl-phase EuS at 20 GPa and of CsCl-phase EuS at 27 Gpa. The solid lines are fits adopting the dynamical theory of nuclear resonance scattering.

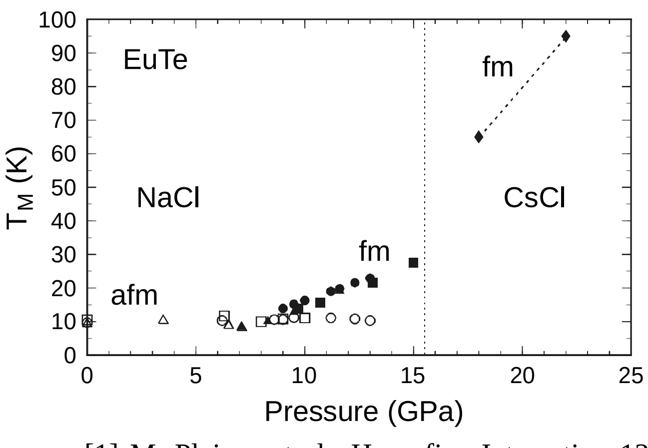

Fig. 2: Magnetic phase diagramm of EuTe. The open symbols exhibit the antiferromagnetic Neel-temperature T_N and the closed symbols the ferro-magnetic Curie-temperature T_C.
The vertical dashed line indicates the middle of the (broad) NaCl - CsCl phase transition at about 16 GPa [7]; deduced from: ME (○, ●) [6], neutron diffraction (□,■) and present NFS study (◆).

References: [1] M. Pleines et al., Hyperfine Interaction 120/121, 181 (1999). [2] R. Lübbers et al., Hyperfine Interactions 120/121, 49 (1999). [3] O. Leupold et al., Europhys. Lett. 35, 671 (1996). [4] O. Leupold et al., ESRF Highlights 1997/98, p. 36. [5] Ch. Sauer, A.M. Zaker W. Zinn, JMMM 38, 225 (1983). [6] J. Moser, G. Wortmann, G.M. Kalvius, unpublished results. [7] K. Rupprecht et al., unpublished results.