

**Experiment title:**Exploration of the phase diagram of europium intermetallics by temperature and pressure dependent resonant inelastic X-ray scattering at the Eu  $L_3$  edge**Experiment****number:**

HE-3688

**Beamline:**

ID16

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**Shifts:**

18

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**Report**

Aim of the proposed experiment was to explore the phase diagram of  $\text{Eu}(\text{Rh}_{1-x}\text{Ir}_x)_2\text{Si}_2$  intermetallics by studying the valence of the Eu ions as a function of pressure and temperature using Eu  $L_3$ - $L\alpha_1$  RIXS. In particular, we wanted to compare the effect of applying hydrostatic pressure onto the  $\text{EuRh}_2\text{Si}_2$  single crystal with the effect of chemical pressure, induced by gradual substitution of the Rh sites by Ir atoms [1].

The temperature-dependent part of the experiment was conducted successfully. We were able to measure the envisaged series of doped  $\text{Eu}(\text{Rh}_{1-x}\text{Ir}_x)_2\text{Si}_2$  ( $0 \leq x \leq 1$ ) single crystals. The valence as a function of temperature changed according to the phase diagram derived from our previous low-energy excitation measurements. In particular, we reproduced the evolution from stable valence to first-order valence transition with rising critical temperature to continuous valence change beyond a critical doping as the doping level  $x$  is increased. This data provide with substantial prove of our low energy excitation results [2] and a respective manuscript is currently under preparation. Most importantly, the data are to be combined with Eu  $M_{4,5}$  edge XMCD measurements carried out at ID08 and X-ray magnetic scattering data that will be collected at beamline P09, PETRA III, to determine the element specific magnetic moments and their complex orbital ordering in  $\text{Eu}(\text{Rh}_{1-x}\text{Ir}_x)_2\text{Si}_2$  single crystals.

Unfortunately, the pressure dependent measurements on the  $\text{EuRh}_2\text{Si}_2$  single crystals, which were supposed to be the main part of the experiment, could not be performed. The reason was a failure of the ID16 pressure cell cryostat, which had a dramatic He leak opening up when trying to cool down. This problem could not be resolved during the time of the experiment. We used the remaining time to extend the temperature dependent measurements on the  $\text{Eu}(\text{Rh}_{1-x}\text{Ir}_x)_2\text{Si}_2$  single crystals. Moreover, we added data to our previous measurements on the isostructural  $\text{Yb}(\text{Rh}_{1-x}\text{Co}_x)_2\text{Si}_2$  compound family and carefully measured several Yb and Eu reference samples to facilitate data analysis. It is envisaged to try to perform the pressure dependent measurements on  $\text{EuRh}_2\text{Si}_2$  single crystals at a later time again, as this was the main interest of the originally proposed experiment.

## References

- [1] K. Kummer *et al.* ESRF Proposal No. HE 3688.
- [2] S. Seiro *et al.* J. Phys.: Condens. Matter 23, 375601 (2011).