ESRF	**Experiment title:** Unveiling the hidden order in URu2Si2 with non-resonant inelastic x-ray scattering	**Experiment number**: HC2252
Beamline: ID20	**Date of experiment**: from: 09.10.2015 to: 14.10.2015	**Date of report**: 01.03.2016
Shifts: 15	**Local contact(s)**: AL-ZEIN, Ali	*Received at ESRF:*

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Report:

The tetragonal heavy fermion superconductor URu_2Si_2 undergoes a hidden order (HO) phase transition at 17.5K which is still a mystery [1]. The ground state crystal-electric field wave function is closely linked to the HO order parameter and we have set out to determine this wave function with non-resonant inelastic scattering on ID20.

For the completion of the experiment we used the same experimental setting as during the experiment HC1533, and we continued measuring the U *O*-edge at the highest possible momentum transfer. We obtained more direction in ***q***-space so that the isotopic spectrum can be constructed and the orbital anisotropy was measured for several temperatures between 5 and 300 K. When adding up three analyzers, a counting time of 120s/point is required for adequate statistics. As with temperature we followed the largest anisotropy, 75s/point was sufficient to follow changes with T (see Fig. 2).

Figure 1 shows the temperature evolution of the NIXS spectra for **q**‖a and **q**‖c which yield the largest anisotropy. The data reflect the sum over the three analysers at same and highest |q| with a total counting time of is 75s/point (for T>25K). Within the statistical error bar of the experiment no changes of the scattering cross-section occur up to room temperature. Figure 2 shows the isotropic spectrum which is now constructed from several directions which we measured during this continuation beamtime (note an isotropic spectrum consist of more than three directions in the beyond dipole limit). The isotropic spectrum is used to determine the reduction factors for the atomic parameters of the full multiplet calculation (Quanty by M. Haverkort) and for optimizing the line shape parameters of the underlying multiplet structure. The red line is the best fit on the basis of an U^{4+} ($5f^2$) valence state. It seems that lower *f* occupations yield a better branching ratio.

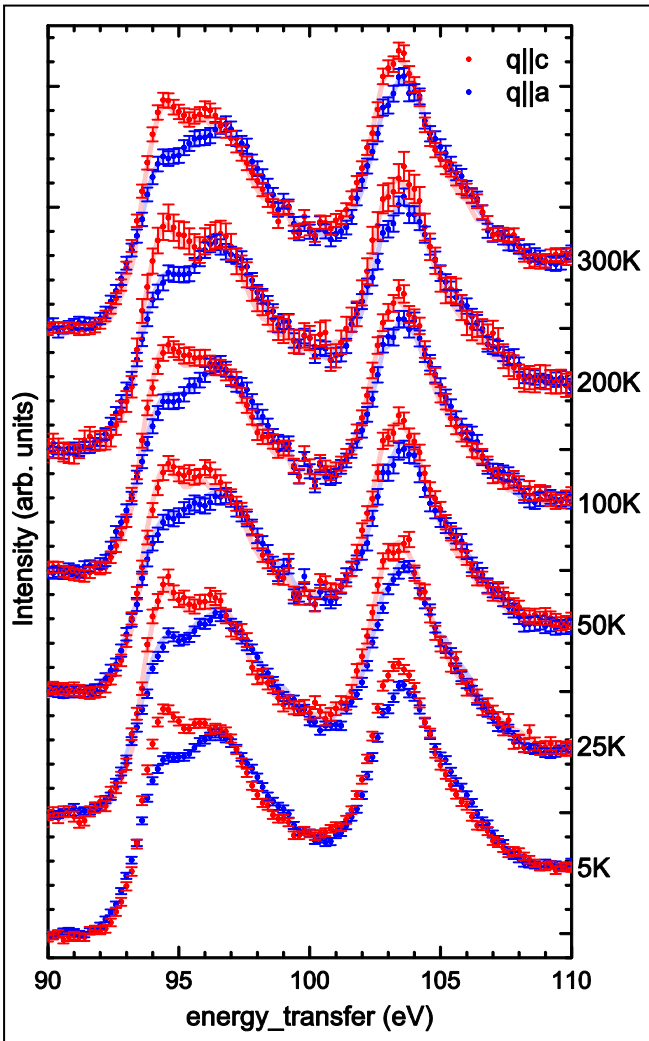

Figure1: Temperature dependence of q||a and q||c

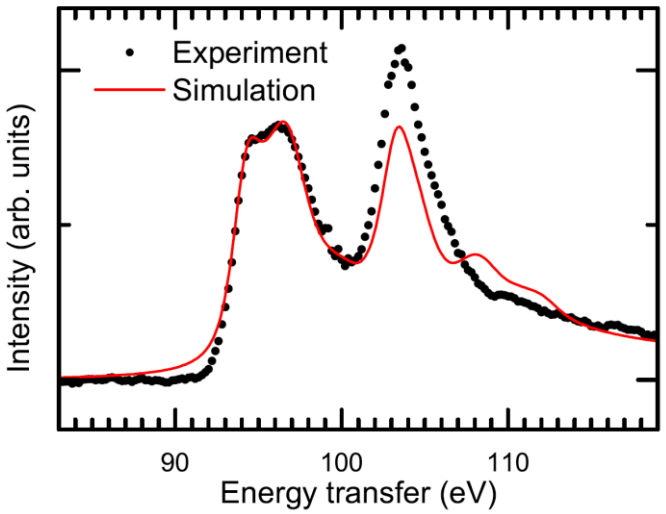

Figure 2: URu_2Si_2 low T isotropic spectrum fitted with a U^{4+} f^2 valence state

Fig. 3 shows some simulations of the *ac* asymmetry, also on the basis of an f^2 occupation. The ansioptroy is well described with a_2 and/or $a_1(90°)$ singlets. However, the ac anisotropy is also well described with a G_7 Kramers doublet when assuming the more itinerant picture of an f^1 occupation.

Before submitting a mansuciprt we therefore have to determine the *f* occupation in an independent measurement.

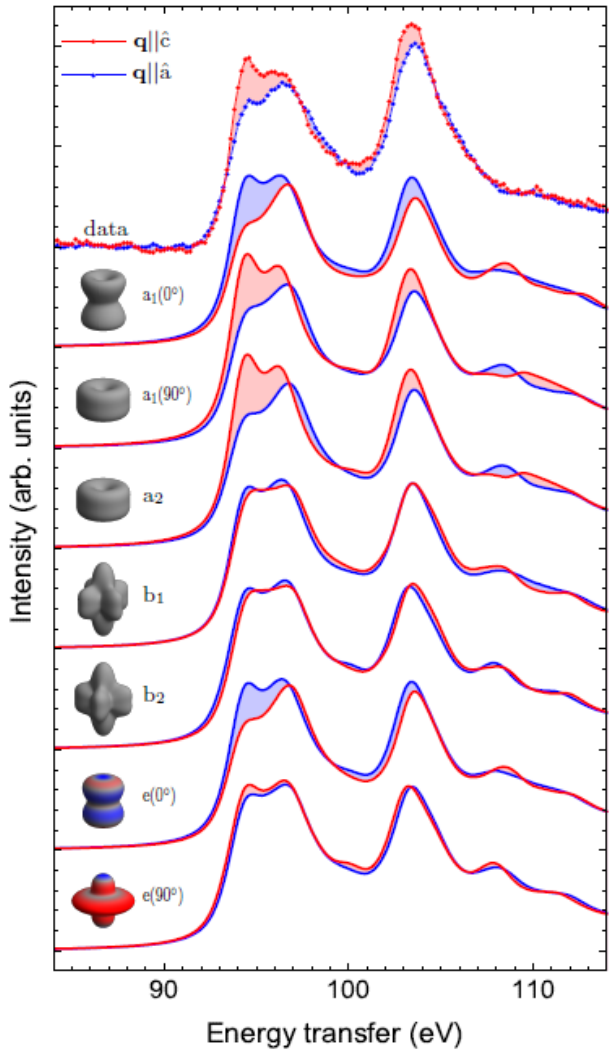

***Fig. 3** Simulation of anisotropy on the basis of an U^{4+} f^2 configuration.*

References:

[1] T.T.M. Palstra et al, PRL **55**, 2727 (1985)