EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

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 via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can 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

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

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:** **Curium - a search for the antiferromagnetic structure**	**Experiment number**: HC-2379
Beamline: BM28	**Date of experiment**: from: 2-Nov-2016 to: 8-Nov-2016	**Date of report**: 15/02/17
Shifts: 18	**Local contact(s)**: S. D. Brown and D. Wermeille	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

We report a series of measurements on a **0.5 mg** sample of ^{248}Cm metal. SQUID measurements (at ITU) show it is magnetic with an AF transition at ~ 65 K, in agreement with earlier reports on *dhcp* Cm. XMCD measurements at the $M_{4,5}$ absorption edges (at ID12) show that the element has an orbital moment of ~ 6% of the spin moment, and the two are parallel. This confirms the predictions of intermediate coupling, which has already been suggested for Cm by other spectroscopies. During these measurements we have found that the application of a 17 T field at 2 K *changes* the nature of the susceptibility, which initially shows AF correlations developing around 65 K. The application of this high field results in an induced ferromagnetic state.

The challenge at XMaS was in trying to determine if either a portion of the sample was single-crystal in nature, or whether the polycrystalline nature of the sample could be detected. The initial difficulty was in locating the small sample. This was done by having the sample glued to a Si(111) wafer. By rastering the sample over a 1 x 1 cm area with the diffracting beam at the Si(444) Bragg reflection, we were able to locate the sample (of 1 x 0.8 mm^2) by the absorption of the beam by the curium over this area. This was successful.

Diffraction experiments were unable to determine the crystallinity of the sample – as shown by the diffractogram (Fig. 1) – suggesting that the sample may be partly amorphous due to its

preparation by splat cooling. *The H=0 ground-state antiferromagnetic structure remains unresolved.*

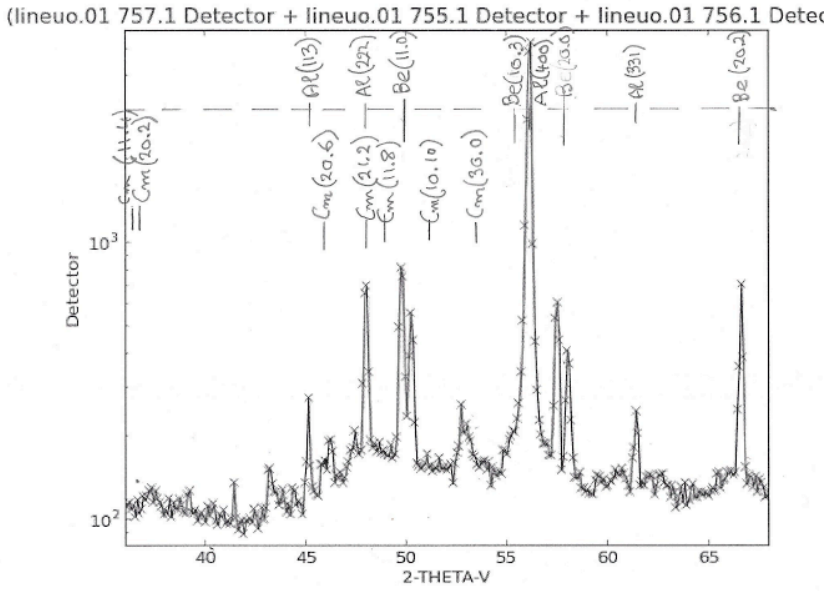

Figure 1
A diffractogram taken at T = 300K with E = 12.966 keV (λ = 0.9562 Å). Impurities lines from the Be (on top of the sample and in the cryostat) and Al (from the sample holder) may be readily identified, but no clear indication of polycrystalline Cm. Scan taken on the XMaS diffractometer at the ESRF.

Many other efforts were made to detect Bragg scattering from the sample, but were unsuccessful. The Be reflections in the above pattern are double because the walls of the cryostat are made from Be as well as the cover over the sample. The reflections from the walls of the cryostat are displaced in 2θ.

We can make a rough estimate of whether we should be sensitive to diffraction lines from polycrystalline Cm, based on the intensity from the 100 μm of Be covering the sample. At this energy (~ 13 keV) the Be ($\rho = 1.85$ mg/mm^3) is transparent to such X-rays, so the overall scattering mass from a volume of 0.1 mm thickness and a 1 x 1 mm^2 beam is 185 μg. For the Cm sample ($\rho = 13.5$ mg/mm^3) we take a penetration depth of 3 μm and a 1 x 1 mm^2 cross section to get a scattering mass of 40 μg. The effective scattering power (at $Q = 4$ Å^{-1} for example, here $2\theta = 35^0$) is proportional to the relevant scattering powers (squared) at this value of Q, which is ~ $(70/1.65)^2$, giving a factor of ~ 1800. The final result is a factor of ~ 10 in favor of Cm at $Q = 4$ Å^{-1}, so the scattering from Cm should be readily observed, and be about 10 times as great as that from Be, if the sample is polycrystalline.

Efforts are now underway to see whether the sample can be annealed to induce crystallinity. Turning this sample into a powder is not an option, as it is very rare, and in powder form there is the risk of losing some sample.

The ITU staff would like to thank Simon Brown and Didier Wermeille for their heroic efforts in trying to find reflections and determine the nature of the Cm sample in this experiment!