EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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*

Deadlines for submission of Experimental Reports

Experimental reports must be submitted within the period of 3 months after the end of the experiment.

Experiment Report supporting a new proposal ("relevant report")

If you are submitting a proposal for a new project, or to continue a project for which you have previously been allocated beam time, you must submit a report on each of your previous measurement(s):

- even on those carried out close to the proposal submission deadline (it can be a *"preliminary report")*,
- even for experiments whose scientific area is different form the scientific area of the new proposal,
- carried out on CRG beamlines.

You must then register the report(s) as "relevant report(s)" in the new application form for beam time.

Deadlines for submitting a report supporting a new proposal

- 1st March Proposal Round - **5th March**
- 10th September Proposal Round - **13th September**

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.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report in English.
- include the experiment number 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:** Charge correlations of CsV_3Sb_5 under high pressure at low temperatures	**Experiment number**: hc5263
Beamline: ID15B	**Date of experiment**: from: 18/04/2023 to: 22/04/2023	**Date of report**:
Shifts:	**Local contact(s)**: G. Garbarino	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

The recently discovered kagome metal CsV_3Sb_5 shows unconvential superconductivity at T_c=2.5K with a double dome like feature in the superconducting temperature under pressure and two charge density wave (CDW) transitions at T~92K and T~60K which coincides with the emergence of an anomalous Hall effect in CsV_3Sb_5.The CDW results in a superstructure deformation of the crystal lattice which mainly arises from the displacement of the vanadium atoms in the kagome layer. Understanding this structural derformations is a prerequisite for theoretical models.

We measured samples grown by different groups which show different charge ordering at the two transition temperatures. Both samples were laoded in the same diamond anvil cell to ensure the same conditions for both samples (see Fig. 1). We performed a measurement at room temperature as a reference up to 27GPa, where the material stays in the hexagonal space group and shows no CDW. At low temperatures both samples exibith a CDW. While the first sample ((1) in Fig. 1) shows a 2x2x2 superstructure, the other ((2) in Fig. 1) shows a 2x2x4 superstructure upon cooling below 90K. This can be nicely seen in the reciprocal space maps shown in Fig. 2. The order is flipped upon cooling below 60K. The difference in these two CDWs is mostly related to the stacking of a relatively stable

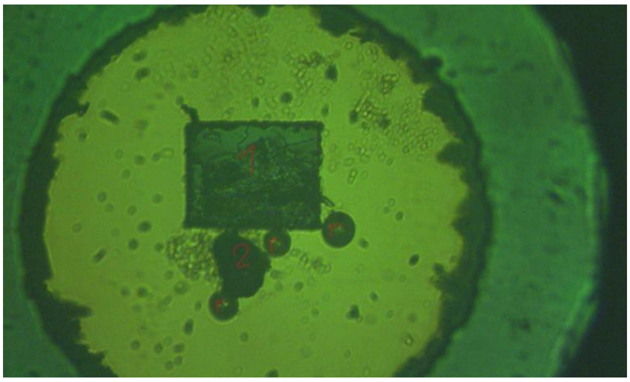

Fig 1: Pressure cell loaded with two CsV3Sb5 samples (1,2) grown by different groups and three ruby spheres (r) as pressure gauges. (1): KIT sample, (2) MPI sample.

in-plane superstructure. It is not yet fully clear why samples grown by different groups display different CDW stackings at ambient pressure and low temperature. However, upon increasing the pressure at temperatures below 40K a new phase appears regardless of the initial CDW stacking (see Fig 2.). This new CDW phase is identical in both samples, has a periodicity of two unit cells along the direction perpendicular to the layers and breaks the symmetry further. The onset pressure at which this new CDW emerges and the pressure at which it is finally supressed again correlates well with the two domes in the superconducting transition temperature and indicates an intimate interplay of the CDW and superconductivity in CsV_3Sb_5.

The transition into the new CDW phase seems fully reversible as it reappears upon lowering the pressure again. Finally, at ambient pressure the initial 2x2x2 and 2x2x4 CDW reappears, respectively.

We also performed pressure depended measurements at 80K, 70K, 40K and 10K to derive a full electronic pressure-temperature phase diagram.

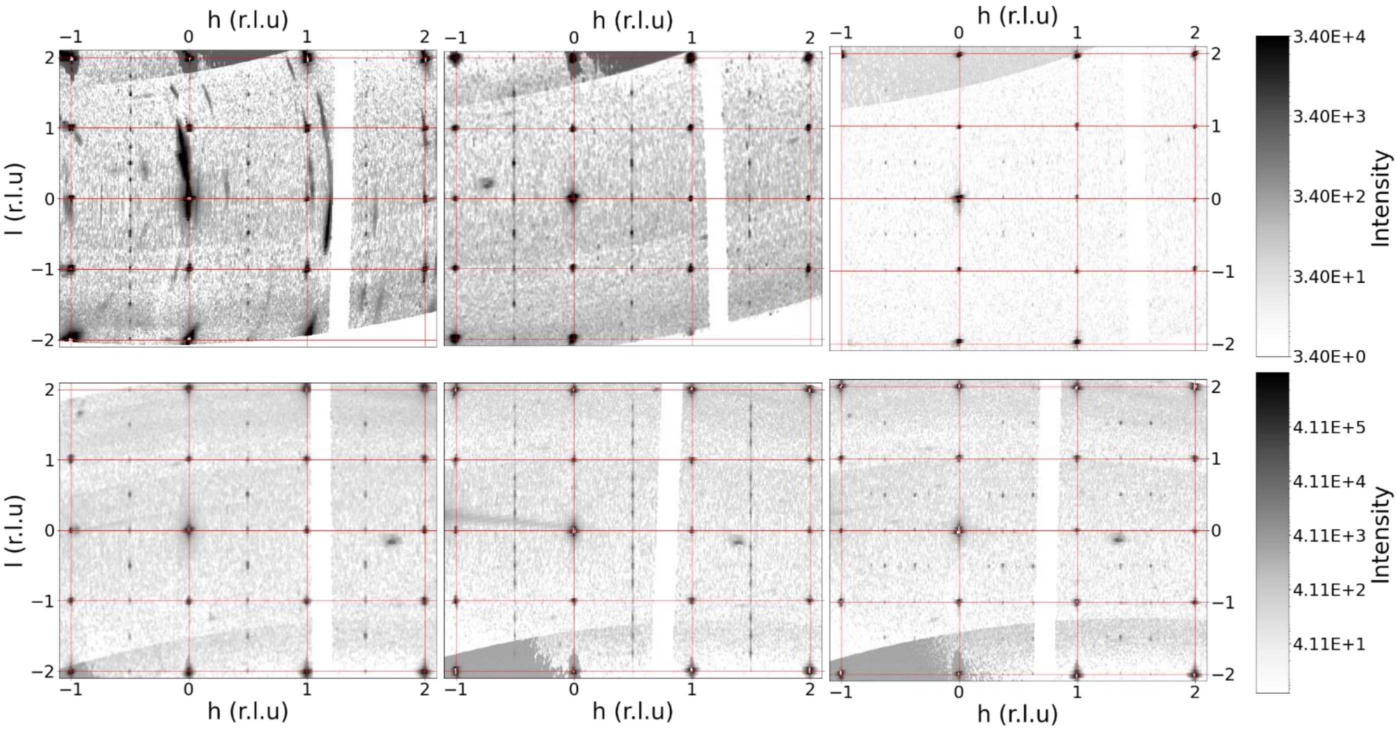

Fig 2: Reciprocal space map of the (h3l)-plane:Top row: MPI sample (a) 80K and 0.26GPA, (b) T=40K and 0.18GPa (c) 40K and 1.00GPa. Bottom row: KIT sample (d) 80K and 0.26GPA, (e) T=40K and 0.18GPa (f) 40K and 1.00GPa. While the MPI sample shows a 2x2x4