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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

Reports supporting requests for additional beam time

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

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.

	Experiment title: Phason diffuse scattering in the InAgYb quasicrystal	**Experiment number**: 02-02-744
Beamline: BM02	**Date of experiment**: from: 17 July 2009 to: 24 July 2009	**Date of report**: 31/08/2009
Shifts:	**Local contact(s)**: Dr. Marc de Boissieu	*Received at ESRF:*

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Report:

Introduction:

The discovery of the first stable binary quasicrystal in the CdYb system has been a breakthrough [1]. Indeed in this system both the icosahedral i-$Cd_{5.7}Yb$ and the Cd_6Yb periodic cubic approximant, having almost the same chemical composition, can be synthetised. It has been shown that the quasicrystal and its approximant are built up with the same atomic cluster [2], packed on a quasiperiodic lattice or a periodic body centred cubic lattice. This knowledge together with a data collection carried out on the D2AM beamline of the ESRF and a 6D approach lead to the first accurate atomic model of a quasicrystal [3].

An isostructural quasicrystal can be obtained in the AgInYb system [4], where AgIn substitutes for the Cd atoms. Large single grains can be obtained in this system, and the purpose of the experiment was to evidence the possible presence of phason diffuse scattering [5]. Indeed the aperiodic long range order brings in new long wavelength excitations named phasons. As for the phonon, phason modes give rise to phason diffuse scattering located nearby the Bragg peaks and with a characteristic shape [5]. It has been evidenced in the AlPdMn quasicrystal [6] and in the ZnMgSc quasicrystal [7].

Exprimental data and results:

A large single grain was polished with a surface perpendicular to a 2-fold axis. Diffuse scattering has been measured using incoming x-ray energy equal to 18 keV. Systematic Q-scans along the high symmetry axes could be indexed with a primitive icosahedral lattice as shown on the figure 1 which displays a scan along a 5-fold axis. The maximul Qperp value necessary for indexing as been found to be equal to 5 ie smaller than for ZnMgSc quasicrystals [7]. The crystal quality has been found to be extremely good, with a FWHM width equal to 0.01° and with a small Q_{perp} dependence which has been found to be linear as shown figure 2. The slope is equal to 510^{-4}, i.e. similar to the best known quasicrystal so far [8]. Measurements were also carried out on a cleaved surface, and displayed the same results.

Systematic reciprocal space maps have also evidenced diffuse scattering as shown on the figure 3. The diffuse scattering displays a characteristic shape related to phason fluctuations. The determination of the phason elastic constant is underway but the elongation of the diffuse scattering along directions parallel to a 5-fold axis points towards a positive K2/K1 ratio. Attempt to measure the temperature dependence of the diffuse scattering between RT and 600K was unsuccessful due to a rapid oxidation of the sample, although it was under a secondary vacuum.

In conclusion we have shown that the InAgYb quasicrystal is of extremely high quality, but displays phason diffuse scattering.

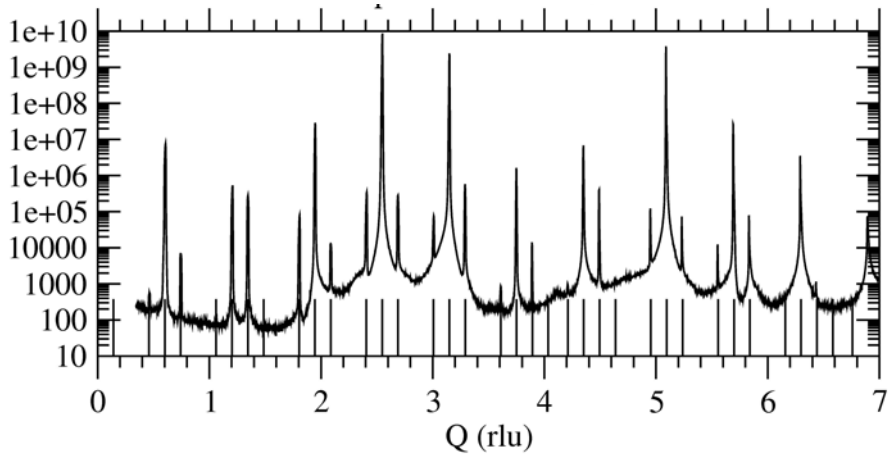

Figure 1: systematic Q-scan along a 5-fold axis. Vertical bars stand for the ideal position of icosahedral quasicrystal, using a primitive lattice and a value of Qperp smaller than 5.

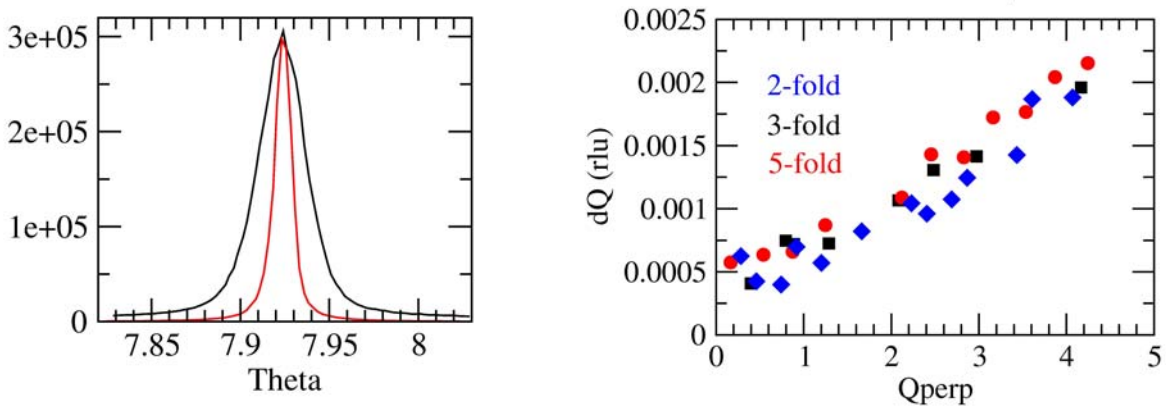

Figure 2: Rocking curves for two Bragg peaks with different Qperp component. The red curves has a 0.1° FWHM. Right, Qper depenedence of the FWHM for peaks measured along 2-, 3, and 5-fold axis.

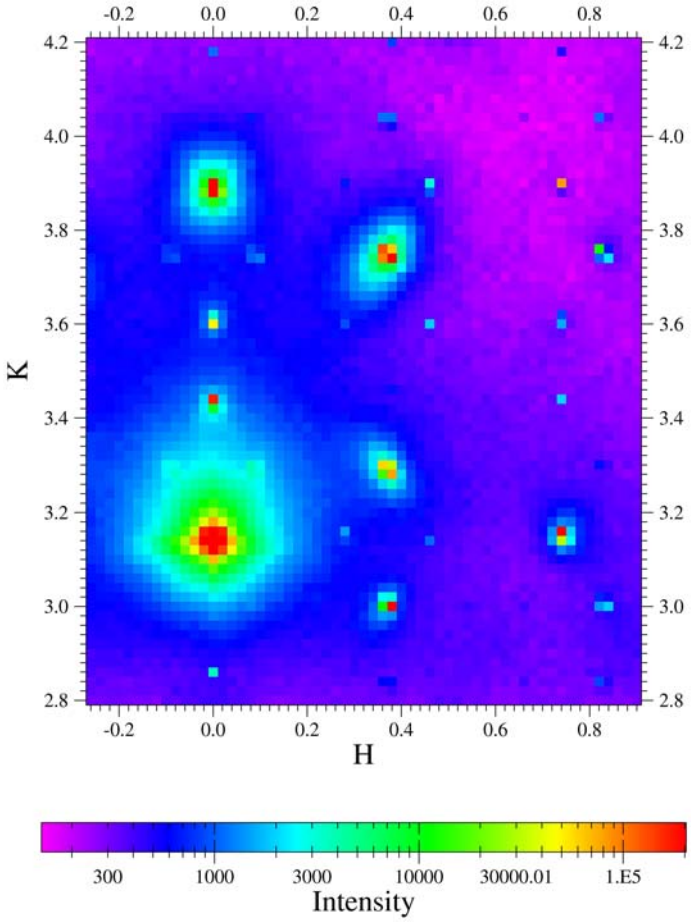

Figure 3: Diffuse scattering measured in a 2-fold plane.

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6 . de Boissieu M, Boudard M, Hennion B, Bellissent R, Kycia S, Goldman A I, Janot C and Audier M 1995 Phys. Rev. Lett. **75** 89.

7 . de Boissieu M, Francoual S, Kaneko Y and Ishimasa T 2005 Phys. Rev. Lett. **95** 105503\1.

8 . Letoublon A, Yakhou F, Livet F, Bley F, de Boissieu M, Mancini L, Caudron R, Vettier C and Gastaldi J 2001 Europhysics Letters **54** 753.