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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.

ESRF	**Experiment title:** Inelastic X-ray scattering under pressure of the ferroelectric perovskite $BaTiO_3$.	**Experiment number**:
Beamline: ID28	**Date of experiment**: from 16/04 to 22/04 and from: 25/06/2008 to: 1/07/2008	**Date of report**: 9/2/2009
Shifts: 18 x 2	**Local contact(s)**: Dr. Moritz HOESCH	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Alain Polian* : Institut de Minéralogie et Physique des Milieux Condensés - CNRS UMR 7590, Université P. et M. Curie - Paris 6, France

Jirka Hlinka*, Martin Kempa* : Institute of physics, Praha, Czech Republic

Report:

The goal of this experiment was to perform Inelastic X-ray scattering (IXS) under pressure on $BaTiO_3$ in order to see the change in the dynamics as inferred from previous x-ray scattering and absorption measurements (Ravy et al., PRL**99**, 117601; Itié et al. EPL**74**, 706). This experiment took place in two parts. After the first run, it was realized that a slight misalignement of the beamline had reduced the incident intensity by a sizeable factor. The beamline staff kindly provided us with a second run in which much better results were obtained. These results are summarized here.

The energy scans have been performed around the (2 2 0) and the (3 -1 0) Bragg reflections, but the inelastic signal were found to be strongest around the (2 2 0) reflection. Figure 1 summarizes the explored reciprocal points.

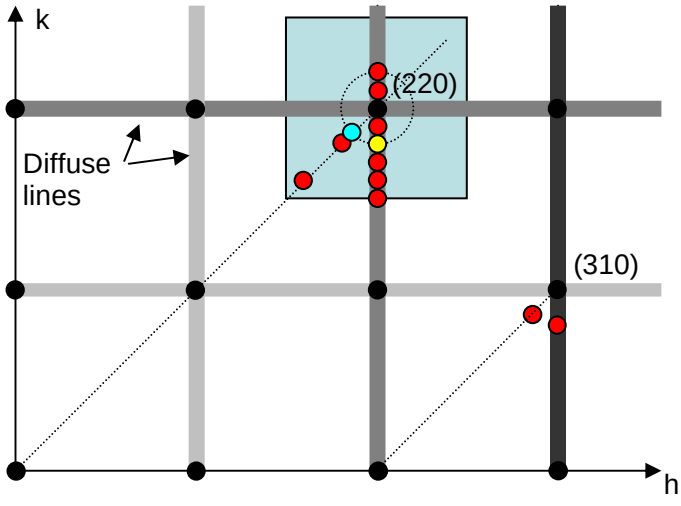

Figure 1: Schematic representation of the (hk0) reciprocal plane of $BaTiO_3$. The grey lines indicates the diffuse lines (the more grey the more intense). The green square indicates a Brillouin zone. The red points show the location where energy scans have been performed.
(22+δq0) δq=0.1, +0.2, -0.1, -0.2, -0.3, -0.4, -0.5
(2+δq 2+δq 0) δq=-0.14, -0.2,-0.4
(310)-(0.14,0.14,0), (310)-(0,0.2,0)

Typical scans are displayed on figure 2 and figure 3.
Figure 2 and Figure 3 show energy scans obtained at the (2 1.8 0) reciprocal position, i.e. **on the diffuse line** (yellow point on Fig. 1) and at the (1.86 1.86 0) position, **off the diffuse line** (blue point on Fig. 1) for different pressures. Along the diffuse lines the TA and LA modes are visible around 13 meV and 10 meV. Moreover two new features are clearly visible : a strong quasielastic line (i.e. around zero energy) and a strong additional inelastic scattering (AS) in between the QE and the LA modes.
At high pressure, the quality of the crystal degraded, which provided an non negligible additional elastic contribution to the spectra. Because of that, the pressure dependence of the AS was measured at the 3 meV energy. The insert of igure 2 shows that this scattering decreases to zero at about 10 GPa.

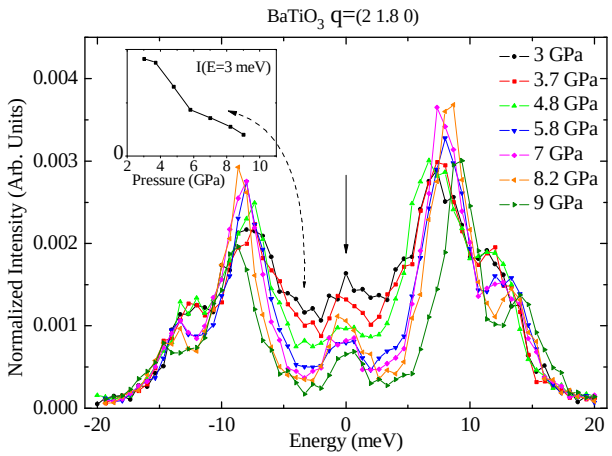

Figure 2: Energy scans for the pressure indicated, at the reciprocal position (2 1.8 0) i.e. **in the diffuse sheet**. Insert : Pressure dependence of the AS at Q=(2 1.8 0) and 3 meV.

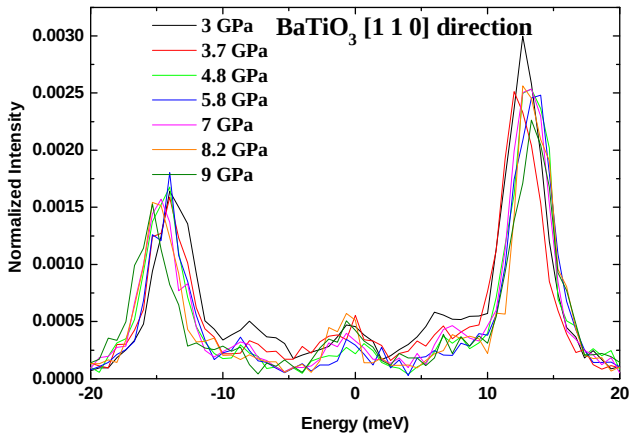

Figure 3: Energy scans for the pressure indicated, at the reciprocal position (1.86 1.86 0), **off the diffuse sheet**.

Because the QE and the AS are only visible on the diffuse sheets and that their intensity decreases the same way that the diffuse scattering under pressure (Ravy et al., PRL**99**, 117601), we conclude from this study that the diffuse sheets oberved by X-ray are due to the QE+AS scattering.

We suggest that this scattering is due to the relaxational mode recently measured by Hlinka et al. PRL101, 167402 (2008)**.**