EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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.

	Experiment title: Imaging dielectric breakdown in solid-state materials	**Experiment number**: **MA-5781**
Beamline: ID01	**Date of experiment**: from: 21/11-2023 to: 24/11-2023	**Date of report**: *Received at ESRF:*
Shifts: 9	**Local contact(s)**: Edoardo Zatterin	

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Dielectric breakdown was induced in single crystals of $LiNbO_3$ (LNO) purchased from the Roditi corporation (Z-orientation: undoped, 5 mole-% MgO, 5.3 mole-% MgO and 5.6 mole-% MgO; X-Orientation and Y-Orientation: Undoped).

Dielectric breakdown was induced prior to beamtime at the Technical University of Denmark. A Van de Graaff generator connected to an Pt/Ir tip was used to apply up to 10 kV to the crystals, which had a thickness of 100 μm. This corresponds to fields of >100 kV/mm - well above the breakdown field of about 75 kV/mm. In order to ensure that the current did not pass through the air around the sample, the sample surface and Pt/Ir tip were immersed in an insulating silicone oil. This was a successful method for forcing the current path through the crystal, thereby inducing dielectric breakdown. The current passed through channels starting at the position of the Pt/Ir tip and going through the thickness of the sample to reach the back electrode. Examples of such channels can be seen in the optical images in **Fig. 1**.

For the beamtime, we had time to characterize two single crystals: Z-oriented doped with 5 mole-% MgO and undoped. We collected images as a function of mosaicity (2D scan of ϕ and rx) and strain scans (either 2D scan of (ϕ, ν) or coupled 1D scans in ϕ and ν). The results showed that the crystal both reorients and expands around the breakdown channel. This is suggestive of electromechanical effects occurring around the breakdown channel, e.g. crack propagation and fracture driven by piezoelectric and/or electrostrictive effects.

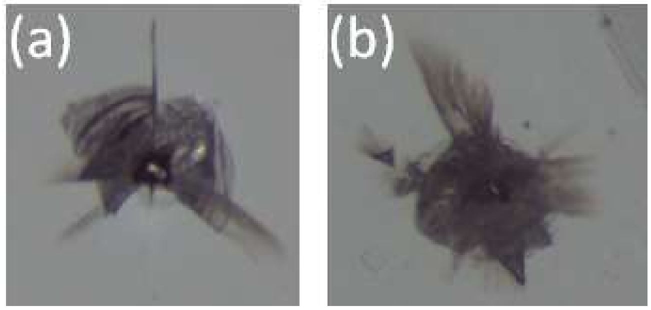

Figure 1: Optical microscope image of two breakdown channels formed at the position of the Pt/Ir tip in (a) 5 mole-% MgO doped and (b) Undoped LNO.

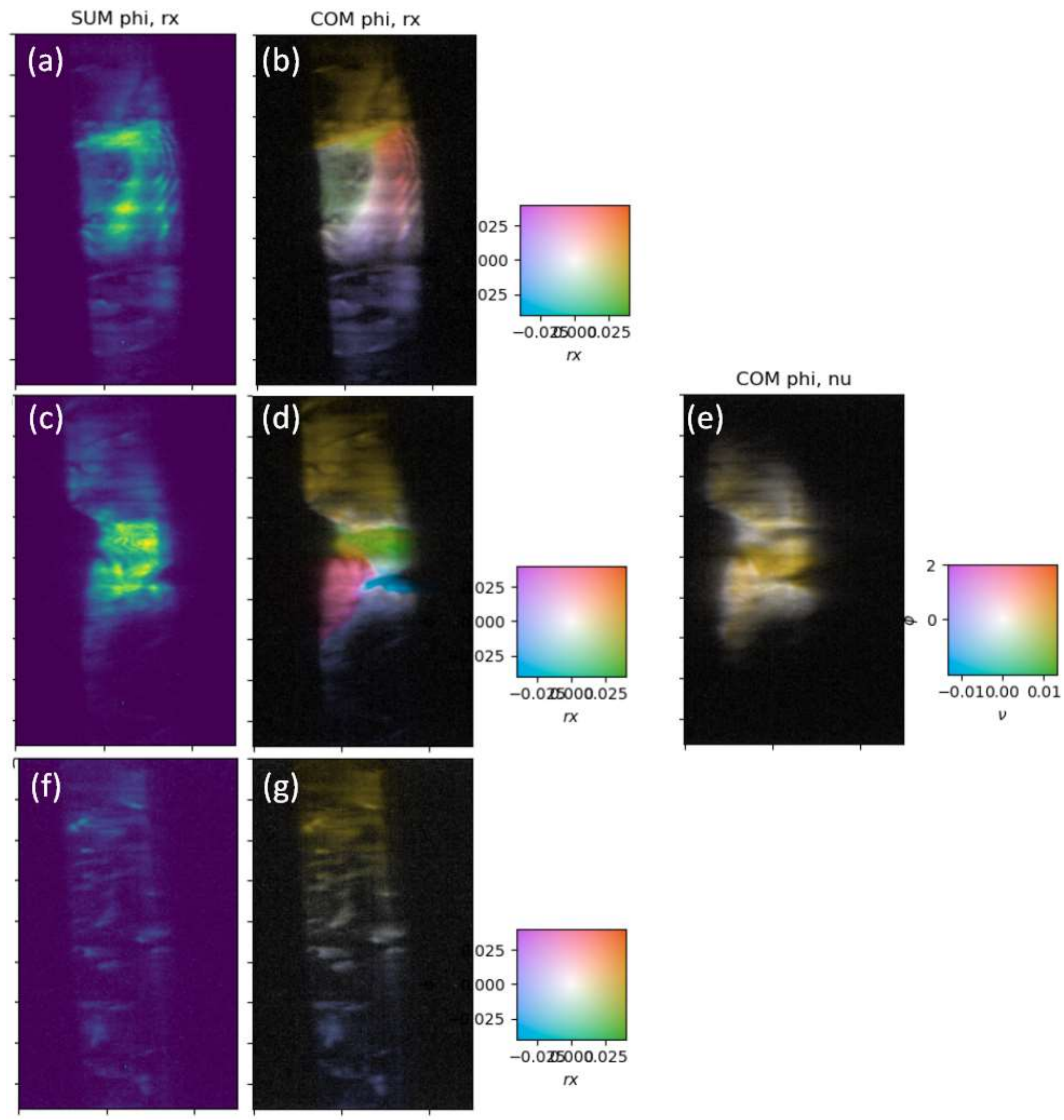

Figure 2: Data from 5 mole-% MgO doped Z-oriented LNO. (a,c,f) Summed intensity images. (b,d,g) Center of mass in (ϕ, rx). (e) Center of mass in (ϕ, ν). Images (a,b) are taken 150 μm to the side of the breakdown channel (the breakdown spot in Fig. 1 (a)). Images (c,d,e) are taken at the breakdown channel. Images (f,g) are taken 150 μm to the side of the breakdown channel.

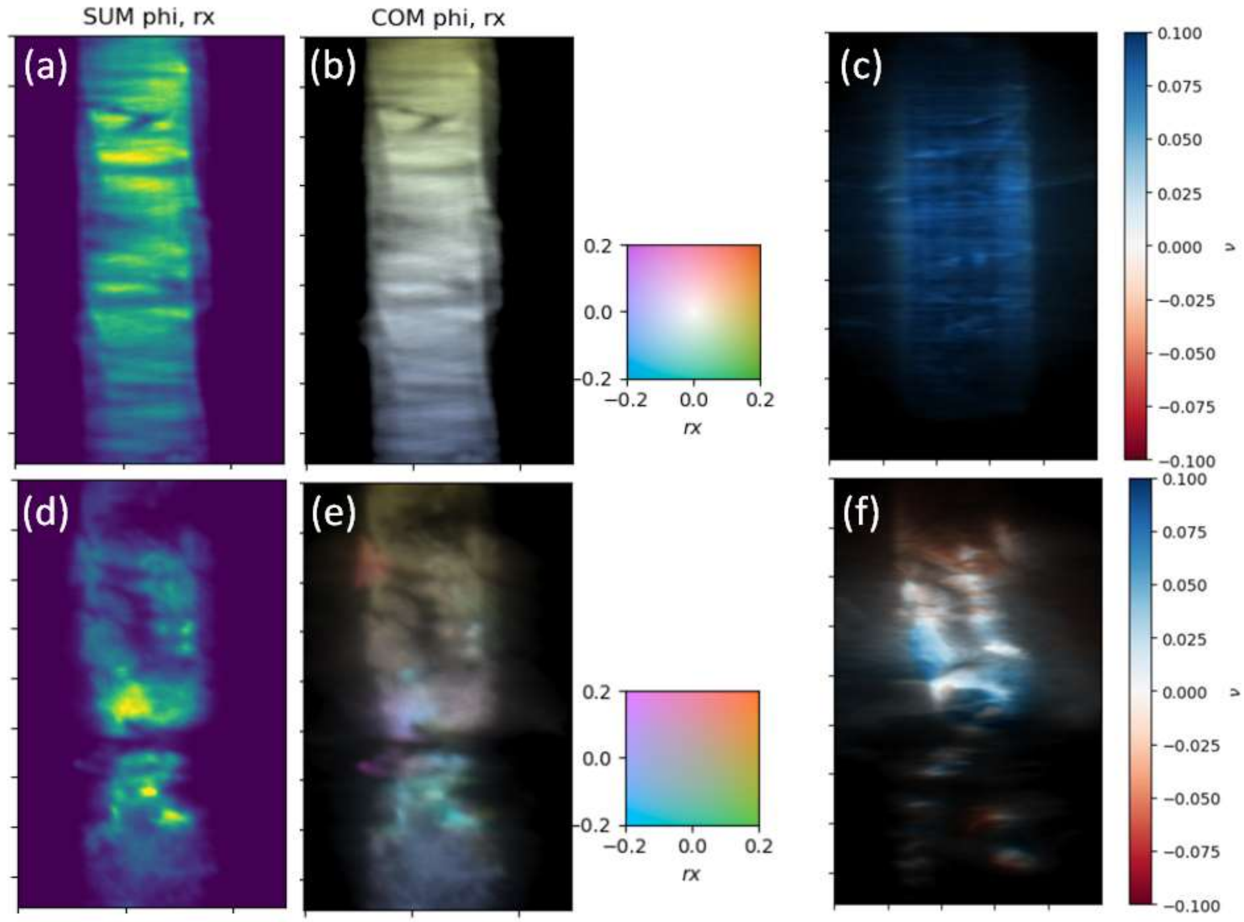

Figure 3: Data from undoped Z-oriented LNO. (a,d) Summed intensity images. (b,e) Center of mass in (ϕ, rx). (c,f) Coupled strain-scans in ϕ and ν. Images (a,b,c) are taken 150 μm to the side of the breakdown channel. Images (d,e,f) are taken at the breakdown channel (the breakdown spot in Fig. 1 (b)).