ESRF	**Experiment title:** Topography characterization of snow grain boundaries	**Experiment number**: MA 744
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The objective of the experiment is to characterize grain boundaries of dry snow. The first part of the experiment was to perform X-ray diffraction topography in order to observe microstructural defaults in crystalline grains especially near to the grain junction. Polychromatic light was used because the white beam provides for all the grains reflections on different crystallographic planes. Because we are interested by the junction between grains, section topography were done: the separation of the diffracted beams from surfaces and bulk is obtained by using an absorbent device letting a 200µm x 8mm slit in front of the incident beam. The horizontal (then vertical) slit was translated to obtain diffraction spots at a spatial step of 200µm. Both the incident and diffracted beams were recorded on films (SR-Kodak film).

The second part was on the same snow samples to perform diffraction contrast tomography (DCT). This monochromatic X-rays technique allows to obtain the 3D geometry as well as crystallographic orientations by capturing simultaneously the transmitted and the diffracted beams. An optical set-up of 12 µm and a Frelon camera were used to acquire the data. The diffracted spots and the absorption beam were recorded for 7200 different angular positions evenly distributed over 360 degrees rotation of the sample.

Three different samples with different grain size were tested: two samples with grain diameter between 0.5mm to 3.5mm and one with all the grains smaller than 1mm. In order to avoid sublimation during the X-ray experiment, the snow samples were put in an airtight plastic box. Then, both were placed in a cold cell regulated at -10°C specially designed for these tests.

The crystalline quality can be evaluated both by section topography and by DCT. In the case of DCT, an ideally perfect crystal aligned for Bragg diffraction would produce a complete diffraction spot in a very narrow interval of rotation angle, on the contrary, in a crystal with mosaicity (namely distorted crystal) different areas diffract at different positions of the sample (namely different rotation angles of the sample). For the snow sample shown on Figures 1 and 2, the grains do not have the same mosaicity. The minimal distortion is 0,055° and the maximal distortion is obtained for grains glued on the holder (namely 0,7° for the grain labelled as 2).

Using white beam section topography, the crystal distortion can be observed by the diffracted beam breadth. If the spreading is larger than the incident beam size corrected by the projection of the crystal width then some mosaicity exists. We observed for the studied snow samples that distortion is much more important near gain boundaries than in the crystal bulk.

In Figure 1a, the 3D geometry of a snow sample containing 10 grains is presented and Figure 1b shows a section with grain crystallographic orientation represented by different colors. Both are obtained by DCT. In Figures 2a and 2b show the diffracted beams of a 200µm slices, for the grain labelled as 1 in Figure 1b, for two areas near a boundary and in the bulk.

In conclusion, during this experiment, a study of the microstructure of snow samples at a very fine scale was performed. The information obtained by DCT allows obtaining the 3D geometry and the mean crystallographic orientation of each grain as well as its global mosaicity. Section topography allows localizing more precisely the distortions inside the grains. It was observed that mosaicity is much more important at grain boundaries and in the grains in contact with the sample holder. However, further experiments should be thought of to better quantify mosaicity and bond geometry in the vicinity of a grain boundary. Because snow is made of ice, and because ice is a very anisotropic viscoplastic material, both the accurate crystallographic orientation and the precise 3D geometry of grain bonds are essential to understand the mechanical behaviour of snow.

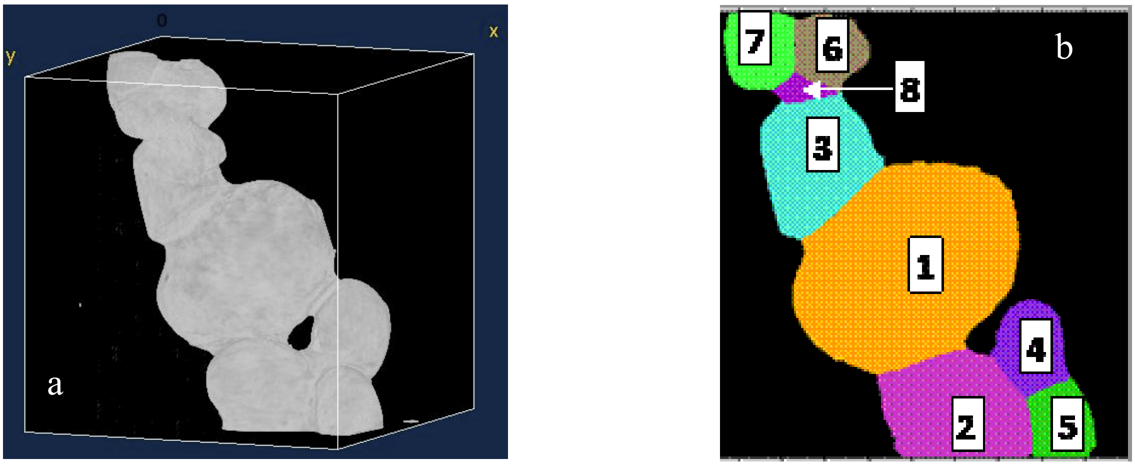

Figure 1: Snow sample : a) 3D geometry reconstruction,
b) Each colour corresponds to a given crystallographic orientation

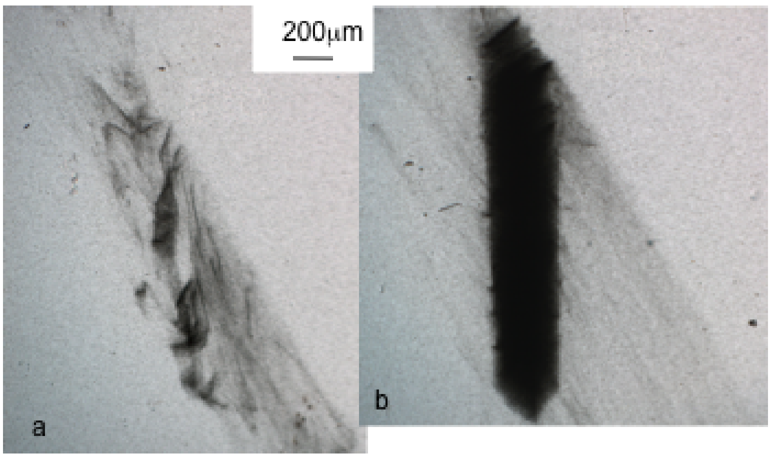

Figure 2: Diffracted beam of one grain (Grain 1 in Figure 1b) obtained by section topography a) near the grain boundary, b) in the bulk crystal.