	Experiment title: Time-lapse Diffraction Contrast Tomography for the Study of Snow Temperature Gradient Metamorphism	**Experiment number**: MA4053
Beamline: ID19	**Date of experiment**: from: 25 April 2018 to: 28 April 2018	**Date of report**: 1st March 2020
Shifts: 6	**Local contact(s)**: Paul Tafforeau and Wolfgang Ludwig	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

F. Flin *[1], R. Granger *[1,2], S. Rolland du Roscoat *[2], C. Geindreau *[2], A. Philip *[3]

1. Univ. Grenoble Alpes, Université de Toulouse, Météo-France, CNRS, CNRM, Centre d'Etudes de la Neige, Grenoble, France
2. Grenoble INP Institute of Engineering, 3SR, Université Grenoble Alpes, CNRS, Grenoble, France
3. Grenoble INP Institute of Engineering, IGE, Université Grenoble Alpes, CNRS, IRD, Grenoble,France

Report:

We applied in situ time-lapse Diffraction Contrast Tomography (DCT) on a dense (ρ = 476 kg.m^{-3}) snow sample subject to a controlled temperature gradient (TG) for 3 days (Fig. 1 & 2). More than 40 absorption and 15 DCT images were acquired at a pixel size of 6.5 µm, allowing us to follow the orientations of about 900 grains along with their microstructural evolution with time (Fig. 3). Faceted crystals appear during the metamorphism and exhibit more activity for grains whose c-axes are in the horizontal plane. This remains to the end of the experiment for sublimation, while it becomes equal for all orientations for deposition (Fig. 4).

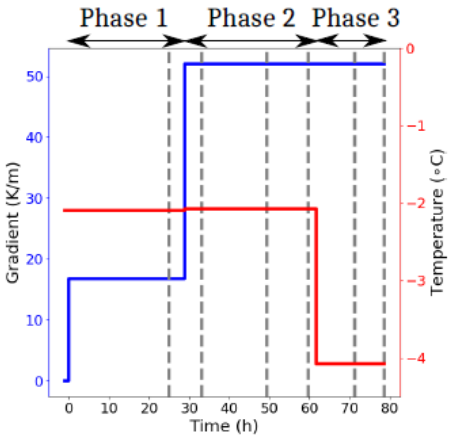

Fig. 1: Evolution of the thermal conditions imposed over the sample: mean temperature (-2 to -4°C and TG (17 to 52 K/m).

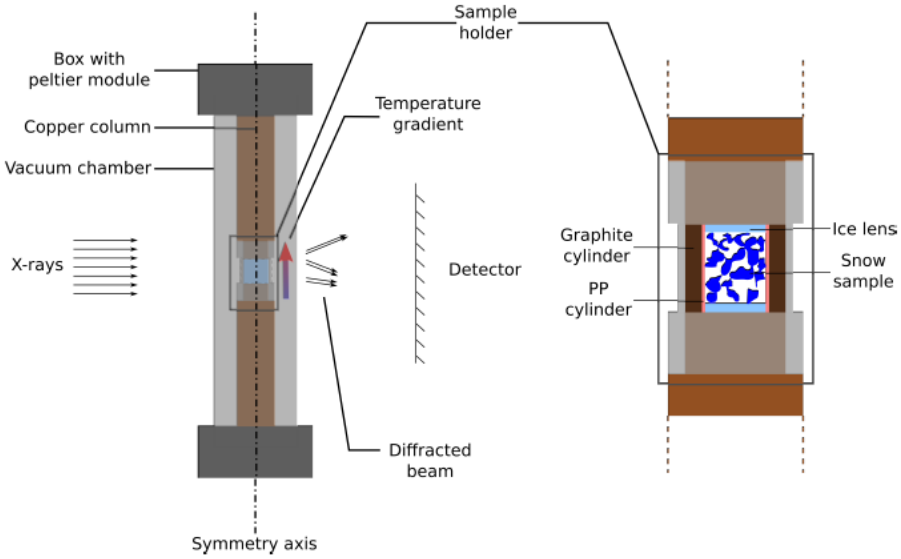

Fig. 2: Scheme of the cryogenic cell (CellDyM2) used for the sample's thermoregulation (precision of the temperature control ΔT = ± 0,02°C).

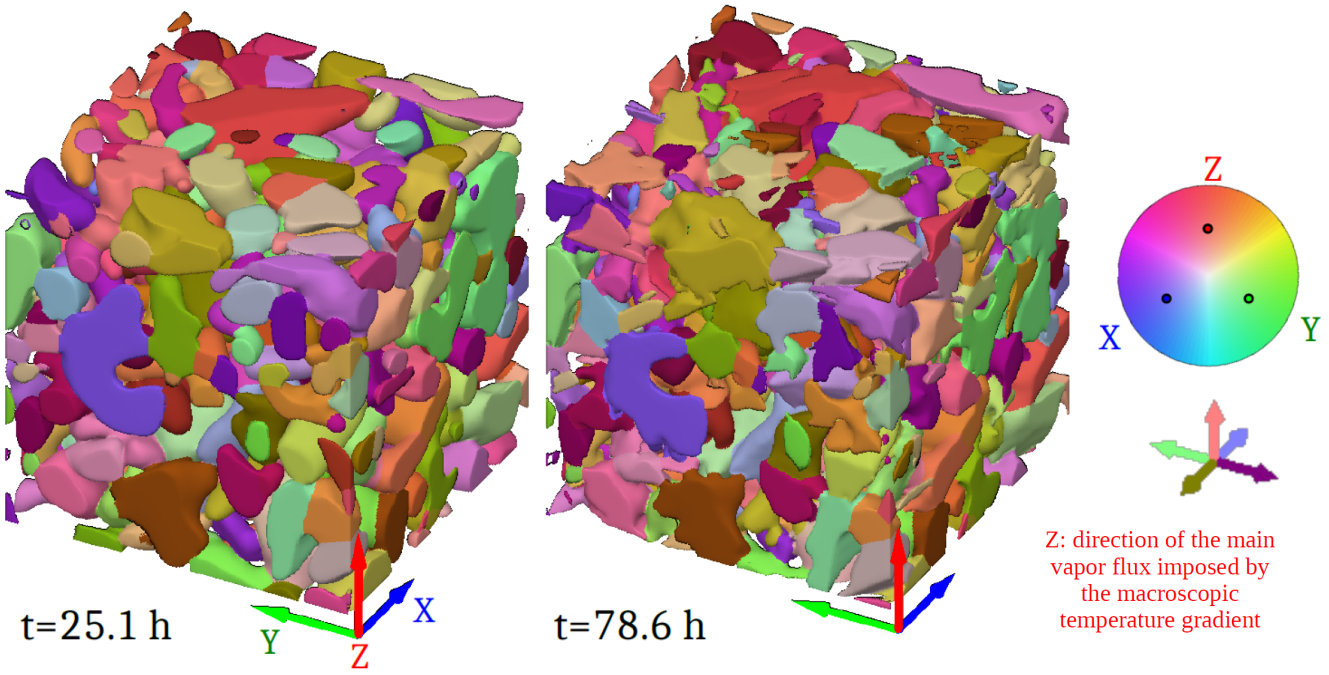

Fig. 3: Two time-lapse DCT images of subvolumes obtained after registration and image processing, exhibiting the ice grain evolution of the snow sample during TG metamorphism (hours correspond to time spend after the initiation of TG). Orientations of the c-axes are given by the color code depicted on the right hand side of the figure (i.e. pole figure+arrows). The edge length of the subvolumes corresponds to 2.34 mm.

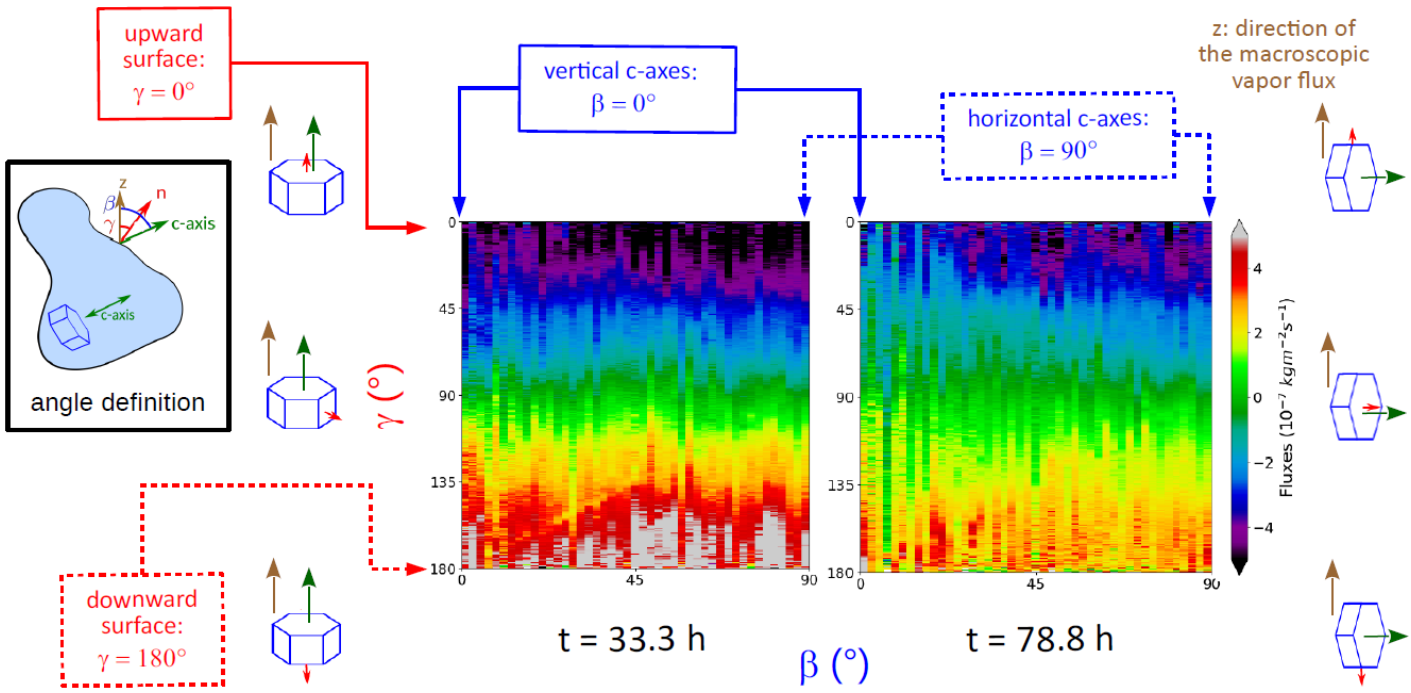

Fig. 4: Analysis of the sublimating and depositing vapor fluxes at the ice-air interface: the surface reactivity is enhanced for crystals whose c-axes are horizontal. This effect decreases with time, especially for deposition sites. This is probably due to geometrical effects between grains.

Communications on this experiment:

Granger, R., F. Flin, W. Ludwig, I. Hammad, C. Geindreau, S. Rolland du Roscoat, A. Philip, F. Lahoucine, P. Lapalus, L. Pézard, J. Roulle, A. Burr, A. Dufour, P. Hagenmuller, I. Peinke and P. Tafforeau. Time-lapse Diffraction Contrast Tomography of snow temperature gradient metamorphism, International Conference on Tomography of Materials & Structures (ICTMS), Cairns, Australia, 22 - 26 July, 2019, oral presentation. https://currinda.s3.amazonaws.com/ann/Abstrakt-FullPaper/162/5c7934e69b490-DCT_snow.pdf

Granger, R. Crystal growth physics in dry snow metamorphism: characterisation and modeling of kinetics effects, UGA PhD Thesis (defended on December 17, 2019).

Granger, R., F. Flin, W. Ludwig, I. Hammad, C. Geindreau et al, Orientation selective grain activity in snow under temperature gradient metamorphism observed with Diffraction Contrast Tomography, *The Cryosphere*, in preparation.