ESRF	**Experiment title:** Observation of the solid-solid and liquid-solid phase transitions in Tin (Sn) at the µs-timescale	**Experiment number**: HC5293
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Report:

The study of non-equilibrium transition dynamics for structural transformations in the s-to-µs regime is an emerging field in high pressure research. It is made possible by the development of a new device, the dynamical-DAC. Phase transformations (liquid – solid, solid – solid) are often driven by diffusion mechanisms, a process occurring typically at intermediate timescales spanning from hundredth of µs to tenth of ms. Such timescale lies between the characteristic time of shock compression (~ nanoseconds) and of static compression (~ seconds). Discrepancies between these two types of compression have been observed and experiments at an intermediate timescale of µs-ms are now helpful to resolve these disparities. Also, there are now ample opportunities to discover new phenomena by positioning the time scale of the compression respectively to the nucleation rate, the motion of crystal defects or the crystal growth kinetics.
Tin (Sn) is an excellent textbook case to demonstrate the usefulness of the XRD d-DAC platform to disclose strain rate effects in compressed matter. Sn phase diagram has been much investigated under static and dynamic compression. Its phase diagram is shown in Fig.1. A transformation from the ambient β-Sn structure to the high-pressure body-centered tetragonal (bct) polymorph is known to take place at 9.8 GPa. The phase boundary has a negative Clapeyron slope up to the β-bct-liquid triple point at 3.8 GPa and 580 K. While the static high

pressure phase diagram is well established, the structural observation of each phase and their corresponding phase transition boundaries undergoing rapid dynamic compression is an ongoing challenge. Shock compression experiments using sound velocity measurements have shown that transitions are observed on compression at ~2 GPa higher, and ~1 GPa lower on release, than the static phase boundary

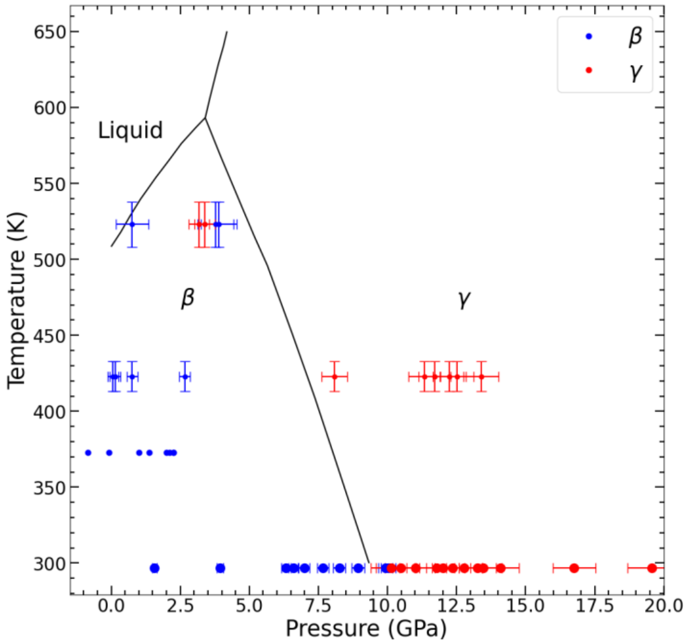

Figure 1: Pressure evolution in the sample extracted from the [111], [200] diffraction peaks of Cu and from the [110] diffraction peak of ice VII.

At ambient temperature, our results show no clear evidence of a displacement of the phase towards higher pressures while compressing the samples at compression rates in the order of 10-50 GPa/ms. At higher temperature we were able to observe the cristallization of the liquid in the beta-phase at the known static-pressure. However, a slight deviation from the static results seems to be observed concerning the beta-gamma phase transition at 520 K.

The combination of the piezo-driven dDAC and of the JUNGFRAU 1M detector using the burst mode now offers the unique possibility to perform time-resolved experiments on materials at very high compression rates with an excellent signal quality and a very good time resolution.