



Contribution ID: 211

Type: **Talk**

Cool Pressure: Implementing cryogenic temperatures at the high-pressure instrument SAPHiR

Tuesday, December 8, 2020 5:35 PM (25 minutes)

SAPHiR is a 6-6 multi-anvil instrument in the new eastern neutron guide hall of FRM II dedicated to high pressure, high temperature neutron powder diffraction and radiography, which is currently operated offline. Pressures of more than 15 GPa are available, with an internal resistance furnace providing a temperature range between room temperature and ca. 2000 °C. However, experiments below room temperature have previously not been possible. Here, we present a new cooling system that is capable of cooling samples to ca. 120 K, thereby allowing controlled static and deformation experiments at variable P and T under cryogenic conditions to be performed. The system consists of cooling rings that enclose the base of each of the secondary anvils. The rings are flushed by liquid nitrogen, cooling the secondary anvils and the sample to 120 K in 40 min, which significantly undercuts the previous low-temperature record of multi-anvil presses by 100 K. Some applications of this new system include; static and deformation experiments of high pressure ices and clathrates suggested to exist in the interior of icy moons such as Titan; fundamental crystallography; mapping of phase diagrams; and material sciences. Neutron measurements will commence when the infrastructure is completed, but the instrument is already available for external users for offline test experiments.

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Session Classification: MLZ Users 2020 - Structure Research

Track Classification: UM: Structure Research