MS27-1-2 In-situ characterization of liquids at high pressure combining X-ray tomography, X-ray diffraction and X-ray absorption using the white-beam station of PSICHE
#MS27-1-2

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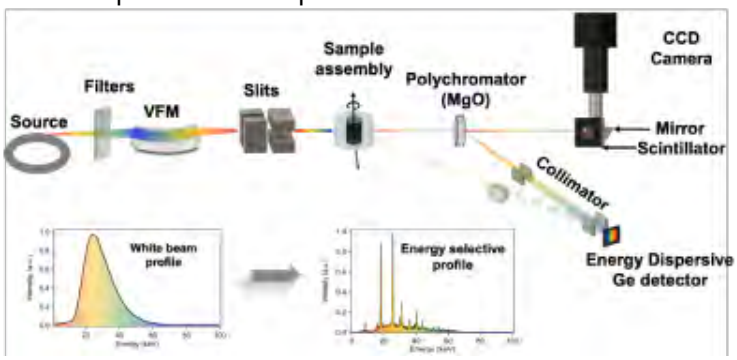
Abstract
Study of liquids at extremes conditions has shown a constantly growing interest over the last decades, whether regarding geological and planetary science or more specifically, for the study of polyamorphism in pure substances. The liquid (or amorphous state) is characterized by the lack of long range order. Consequently, characterization of the liquid state often requires to combine two or more techniques in order to obtain different macroscopic and microscopic properties. Among those, the determination of the density at extreme conditions of pressure and temperature may be one of the most widely used as it provides a straightforward diagnosis on elastic properties (such as bulk modulus) of the liquid.
In the early nineties, density measurements using synchrotron radiation and an absorption contrast method based on the Beer-Lambert law was proposed. This technique is designed as follows: two photodiodes are placed below and after the sample position and record respectively the incident and transmitted X-ray intensities as the sample is translated perpendicular to the beam. For a monochromatic X-ray source, the density is obtained through the Beer-Lambert law. The monochromaticity of the X-ray incident beam is of crucial importance as the mass absorption coefficient varies strongly with X-ray energy (e.g. low energies are more absorbed than high energies, far away from the absorption edges). This method is commonly used in the Paris-Edinburgh Press (PEP) and the Multi-Anvils press (MA). Here we describe a new technique allowing the measurement of density taking avantages of the intensity of the white beam. The experiments were carried out on liquid gallium at high pressure using the UToPEC (Ultrafast Tomography Paris Edinburgh Cell) on the white-beam station of the PSICHE beamline at Soleil. Figure 1 shows the experimental setup developed for the density measurements using X-ray white beam and figure 2 the results obtained on liquid gallium.
The strength of the technique is that it can be combined on the beamline PSICHE to other high speed techniques quasi-simultaneously: ultra-fast X-ray computed tomography (XCT), high-speed radiography for imaging and viscosity measurements, fast energy dispersive XRD that can be extended to combined angle and energy XRD (CAESAR [4]) for reliable structural measurements. Such a multi-technical approach, ideally suited to the study of liquid and amorphous materials, has already been described in the past [5], but the addition of this new technique allowing for independent density measurements as well as the speed of acquisitions give totally new options to experimenters.

Psiché experimental setup



a) XRD pattern of MgO b) absorption results