X-ray absorption for the study of warm dense matter

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The progress of science in the sub-picosecond domain pushed forward our understanding of the ultrafast dynamics in material structures [1]. Recently, there has been growing interest in the investigation of extreme states of matter such as the so-called warm dense matter (WDM) regime [2, 3]. This transient state is defined as the region in a phase diagram where the density ranges from the solid density up to 10 times its value and the temperature varies from 0.1 to 100 eV. This covers a wide panel of research areas including high-pressure physics, applied material studies, astrophysics, geophysics, inertial fusion as well as several industrial applications. The main difficulty in studying such a regime lies in its short lifetime which asks for time-resolved measurements with picosecond temporal resolution. In this state, the matter is partially correlated and degenerate and its complexity poses the numerical and theoretical modelling [4-6] a tremendous challenge. This requires the collection of new experimental data to discriminate between the theories and validate the models which are developed. In this context, we have used based on a ‘pump–probe(x-ray)’ absorption spectroscopy to extract information and properties of WDM states. This diagnostic has been implemented on different experiments we have performed at the Laboratoire pour l’Utilisation des Lasers Intenses (LULI), devoted to probing the Al sample isochorically heated by laser or by protons. Measurement of absorption spectra, with spectroscopically indépandant measurement will be discussed.