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Isentropic compression experiments on LIL and their applications to planetary physics[1]

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The recent discovery of extra-solar planets, especially earth-like ones open a new field of application for high energy lasers. Indeed the extreme conditions (330-1500 GPa, 5000-10000K) expected in the core of those objects make lasers as the only tool to be able to generate such high pressures. However traditional dynamical techniques to compress matter involve shock waves that overheat the sample relative to conditions occurring in planetary cores. To overcome this issue, we developed, following work done at Livermore a quasi-isentropic laser driven compression technique based here on direct drive interaction. Here, we report on recent measurements performed on the LIL (Ligne d'Intégration Laser) laser facility at CEA-CESTA in Bordeaux where we did used a dedicated ramp-tailored laser pulse (2-10 kJ, 20 ns). Two materials of interest for telluric planets (iron and quartz) were investigated. Visible diagnostics (VISAR and SOP) were used as main diagnostics giving both velocities and temperature of the sample. The analysis of our results leads to assess that we achieved conditions close to the iron melting curve in the whole range 200-1000 GPa on a single shot. Similar conditions were also achieved for quartz. This ability of using very high energy lasers opens a new route for planetary science especially when isentropic compression will be associated to x-ray sources inferring the microscopic structure of the sample. We will discuss the opportunities that will be possible in the next few years in this field.

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