



# Production of micron-sized films and pellets of solid hydrogen and its isotopes

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## LABORATORIES : INAC, NEEL

Physicist studying laser-matter interaction are really interested in having very thin (10  $\mu\text{m}$ ) ribbons of solid hydrogen that could be used as a target. Indeed, during the interaction between a laser and such a target, a proton beam can be created. Hadrontherapy is one of the main potential uses. Huge particle accelerator could be then replaced by a laser and a cryostat, much smaller and cheaper. This PhD thesis was about developing a way to get such ribbons. A new extrusion process based on the use the thermodynamic properties of hydrogen (no moving part) has been studied. A cryostat working at 10K and 400 bar was built and first solid hydrogen ribbons 1 mm wide and 100 microns thick have been obtained in March 2014.

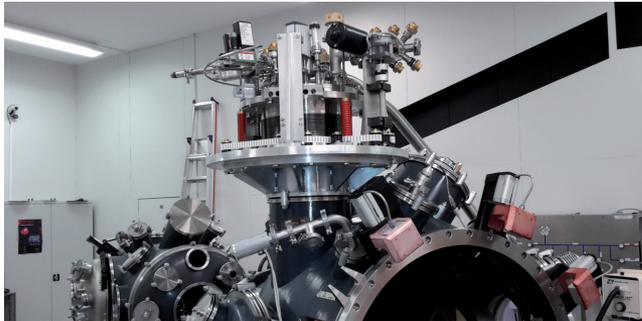


Fig. 1: A view of the cryostat installed on the laser PALS.

Several laser teams have shown a great interest for this kind of target and a collaboration contract has been signed with the laser PALS team (Prague) to install the cryostat in their vacuum chamber (Fig. 1) where first proton beams were obtained. Some experiments were also performed at LULI at Palaiseau in France on the laser ELFIE in 2015 and more recently, 50 MeV proton beams have been obtained with the PW laser VULCAN at the Rutherford Appleton Laboratory in England.

## OUTCOMES

- [1] Continuous production of a thin ribbon of solid hydrogen. Laser and particle beams, 32, 569 (2014).
- [2] Proton Acceleration Driven by a Nanosecond Laser from a Cryogenic Thin Solid-Hydrogen Ribbon, Phys. Rev. X 6, 041030 (2016).

**Oral presentations:** TFW5, Saint Andrews, Scotland  
INTDS2014, Tokyo, Japan  
21st TFM 2015, Las Vegas, USA

**Leverage:** This development has motivated several new collaborations and contracts with IOP (Prague, Czech) and HZDR (Dresden). New experiments were performed at LULI (Palaiseau) and at the Rutherford Appleton Laboratory (England).