DE LA RECHERCHE À L'INDUSTRIE

PRODUCTION OF THIN RIBBONS OF SOLID HYDROGEN FOR LASER TARGET.

Denis CHATAIN - Stéphane GARCIA - Jean Paul PERIN

TARG2 Workshop,20-22 April Paris

www.cea.fr

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The Low Temperature Laboratory of the CEA

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GRENOBLE

The Low Temperature Laboratory of the CEA

46 permanents 5 PHD students + 2 Advisers
=> 75 workers

Average: 4 patents, 50 communications-publications/year

Organization:

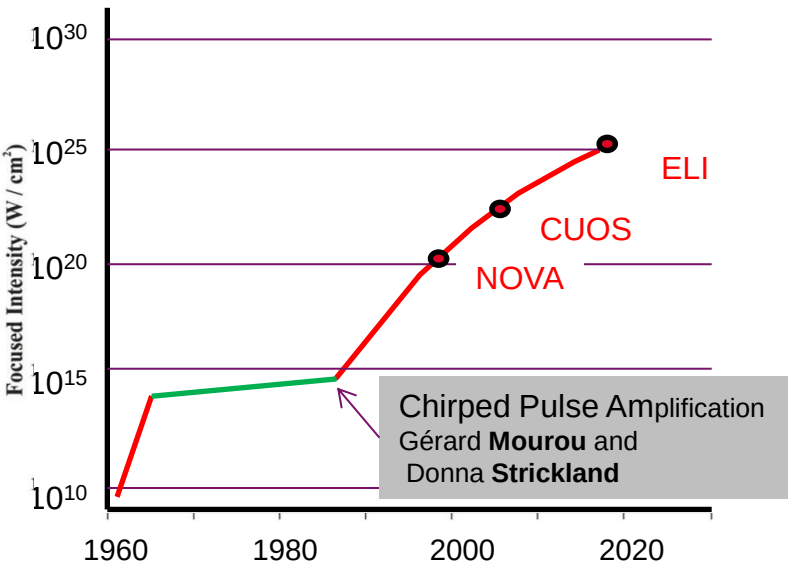
3 Thematic groups

. Cryogenics for space	. Cryogenics for large refrigeration	. Cryogenics for fusion

3 Support groups

.Electronic/Automatic	.Conception/Design	.Liquefact/Caracterization

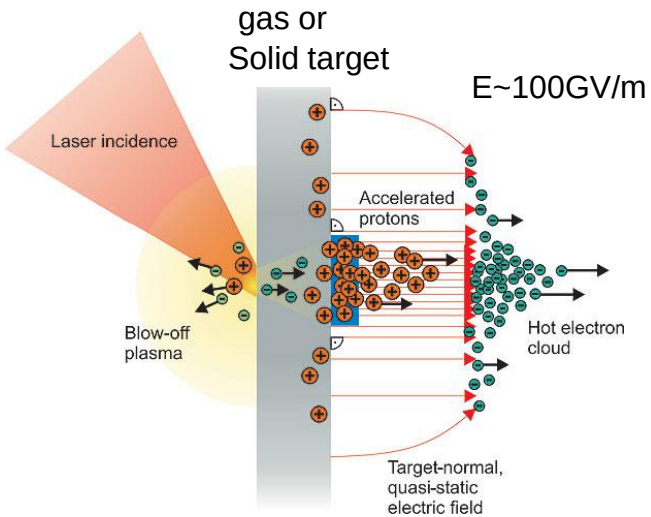
LASER/MATTER INTERACTION



Applications: laser/plasma accelerator

Electrons beams
Protons beams

ELI: 10PW 10 fs 100J 10^{24} W/cm²
- Electrons 100 GeV
- Protons >3 GeV



Very thin solid Hydrogen target could be interresting to produce protons beams of high energy

"Principles and applications of compact laser–plasma accelerators"
VICTOR MALKA et al. LOA. Nature physics VOL 4 JUNE 2008

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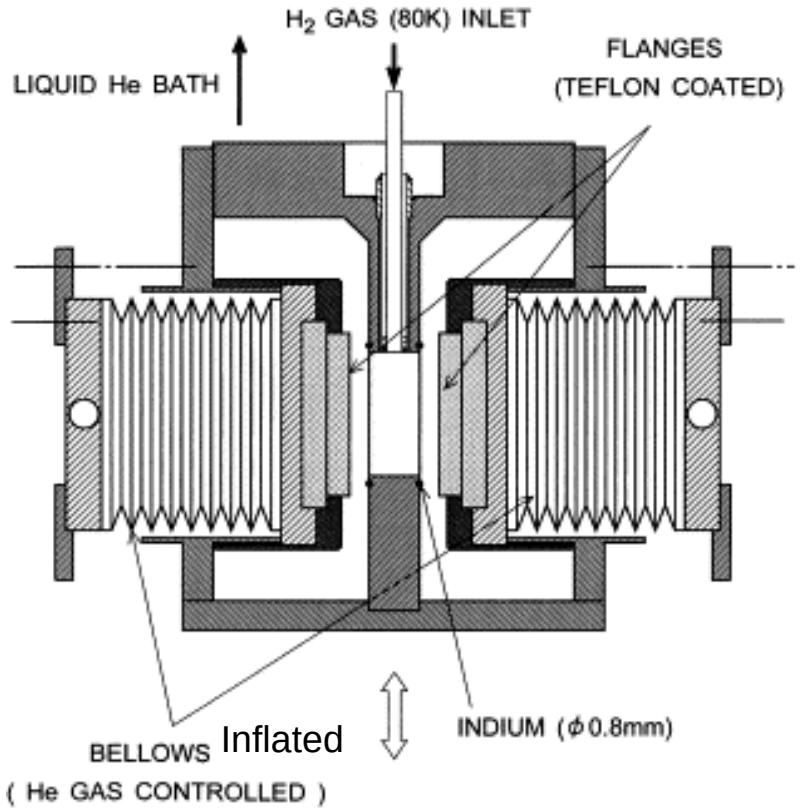
SOLID HYDROGEN TARGET

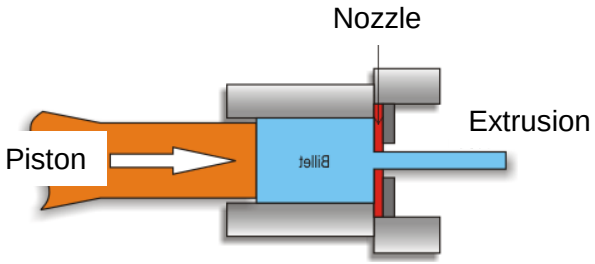


« ***Windowless solid hydrogen target*** » S Ishimoto et al.

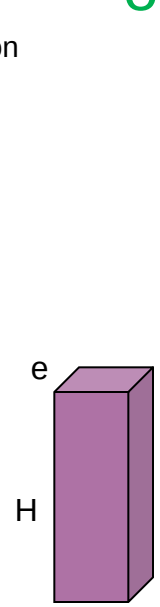
Nucl Inst & Meth Volume 480, Issues 2–3, 21 March 2002, Pages 304–314

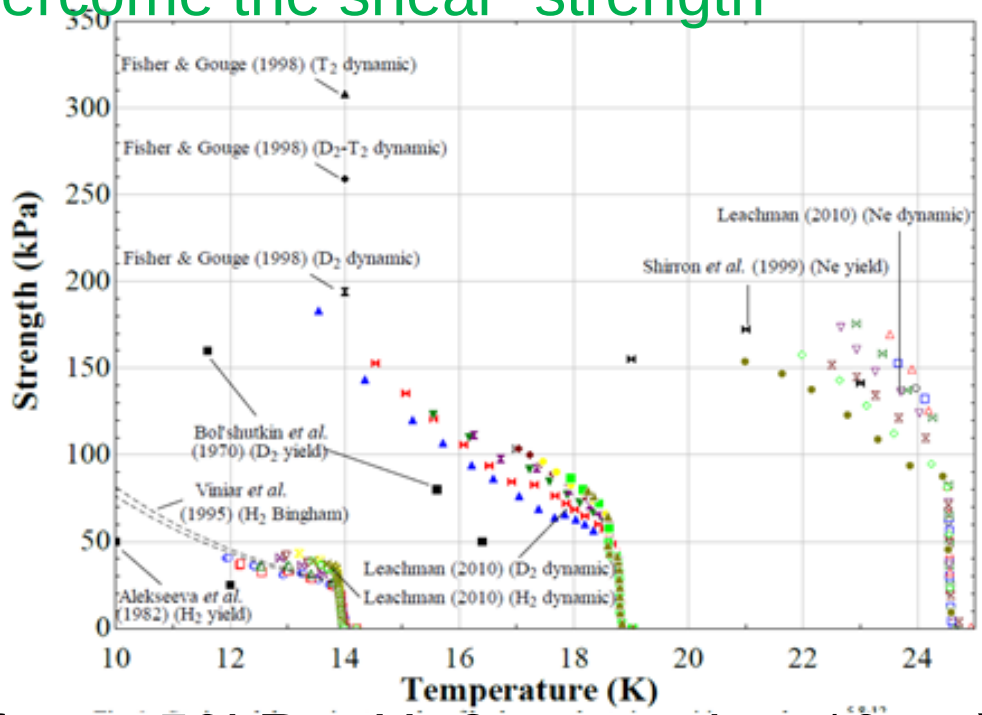
EXTRUSION

Thermomechanical process where a compressed material is forced to cross a nozzle having the section of the piece to be obtained.



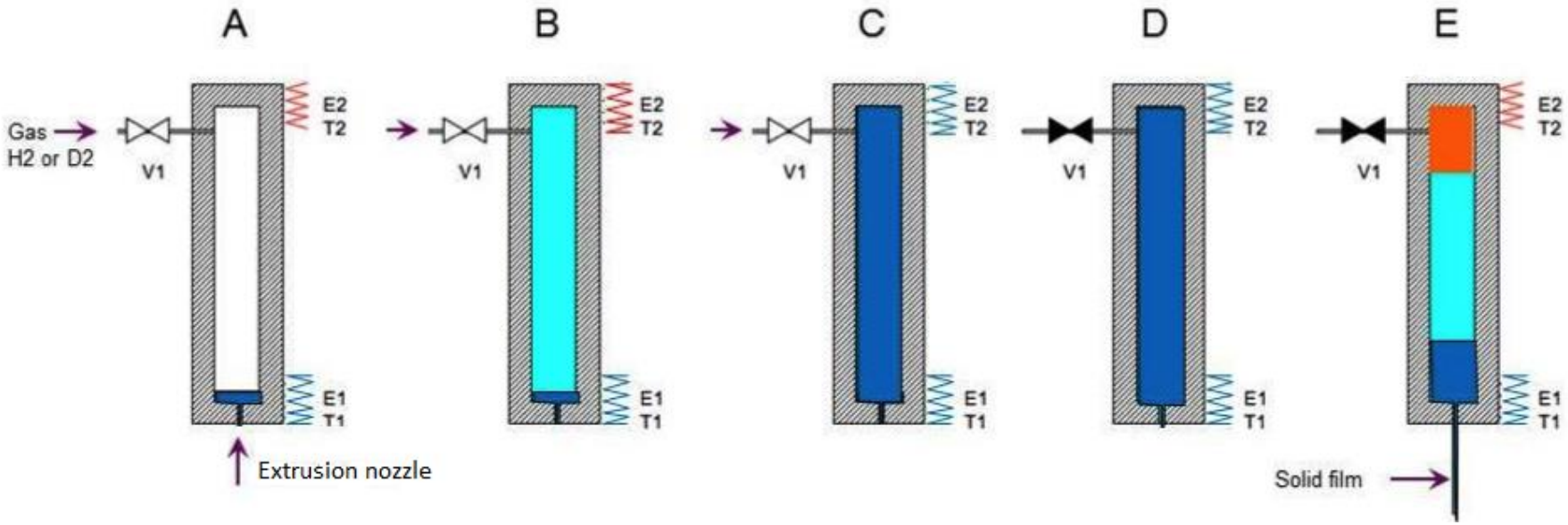
High pressures are required to overcome the shear strength





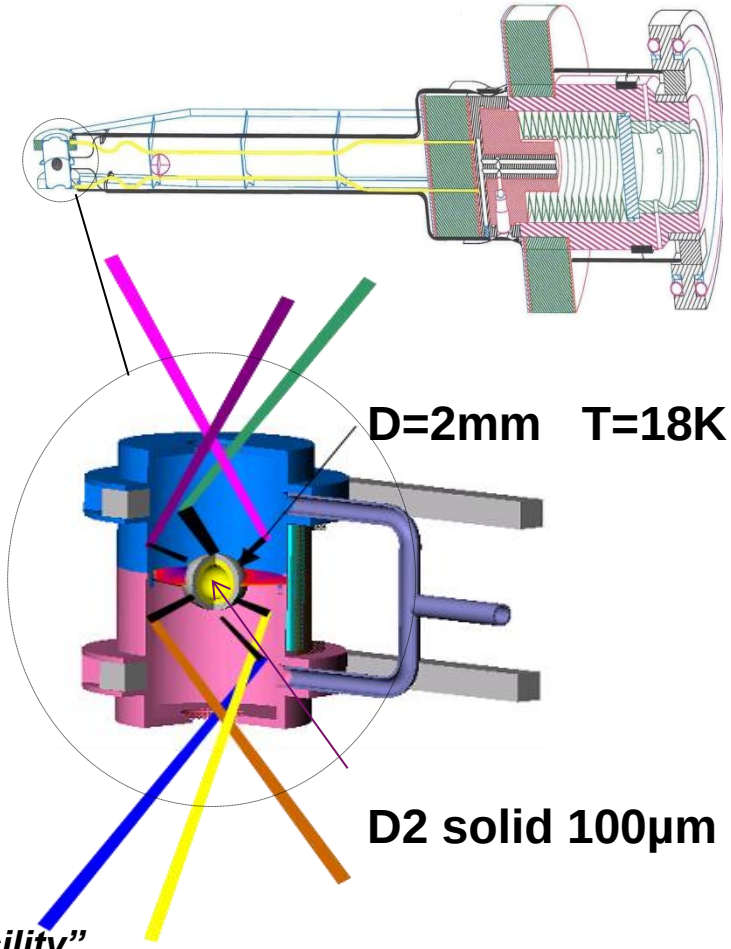
P=2*σ*H/e (200bars for σ=50kPa, H=2mm and e=10µm)

Extrusion: our concept



- Without mobile part
- Use of thermodynamic properties of the fluid
- Patented by CEA-SBT « EP 2 682 695 A1 »

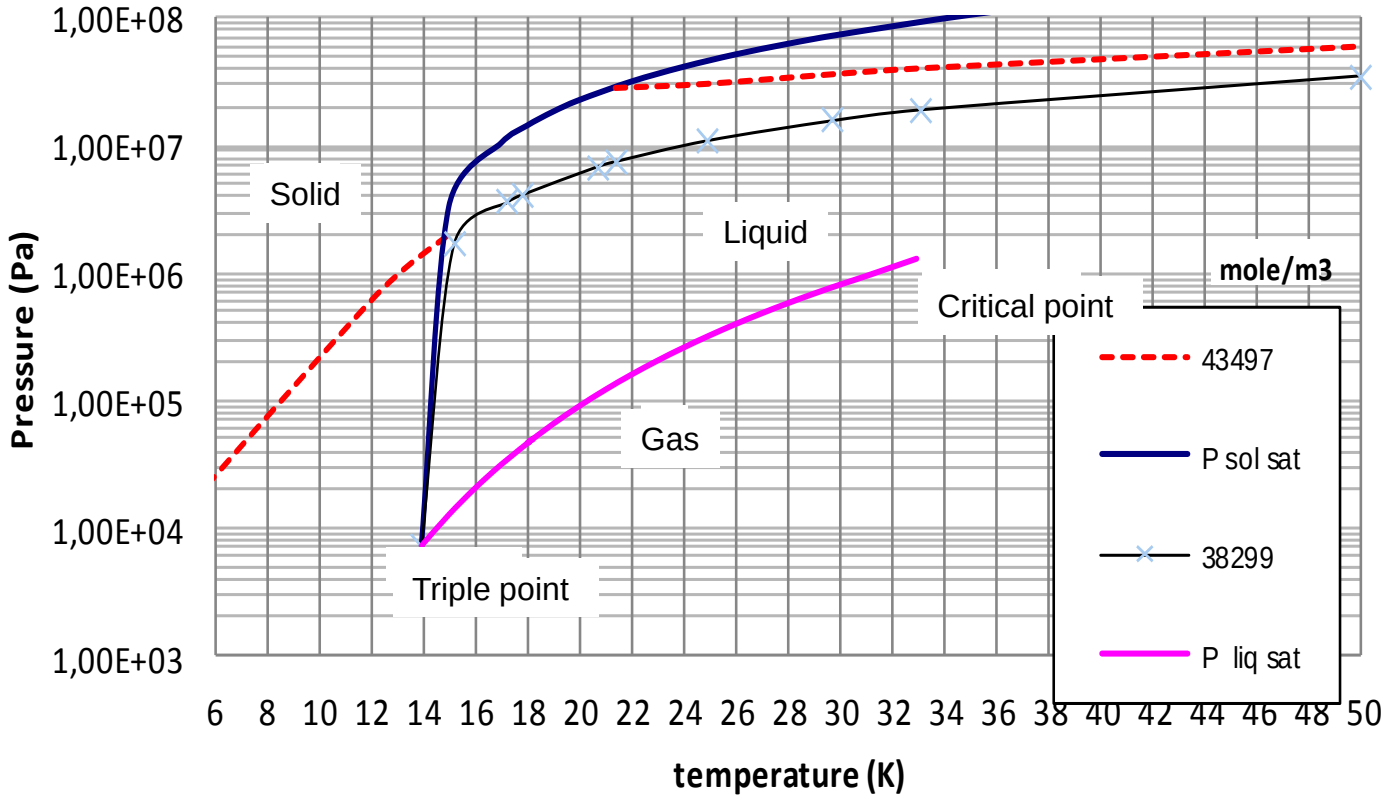
1300 BAR CRYOGENIC COMPRESSOR



"A 1300 bar cryocompressor for the Laser Megajoule Facility"
F.Viargues, D.Chatain, J.P. Périn, P. Baclet, E.Fleury. 14th TFM West Point 2001

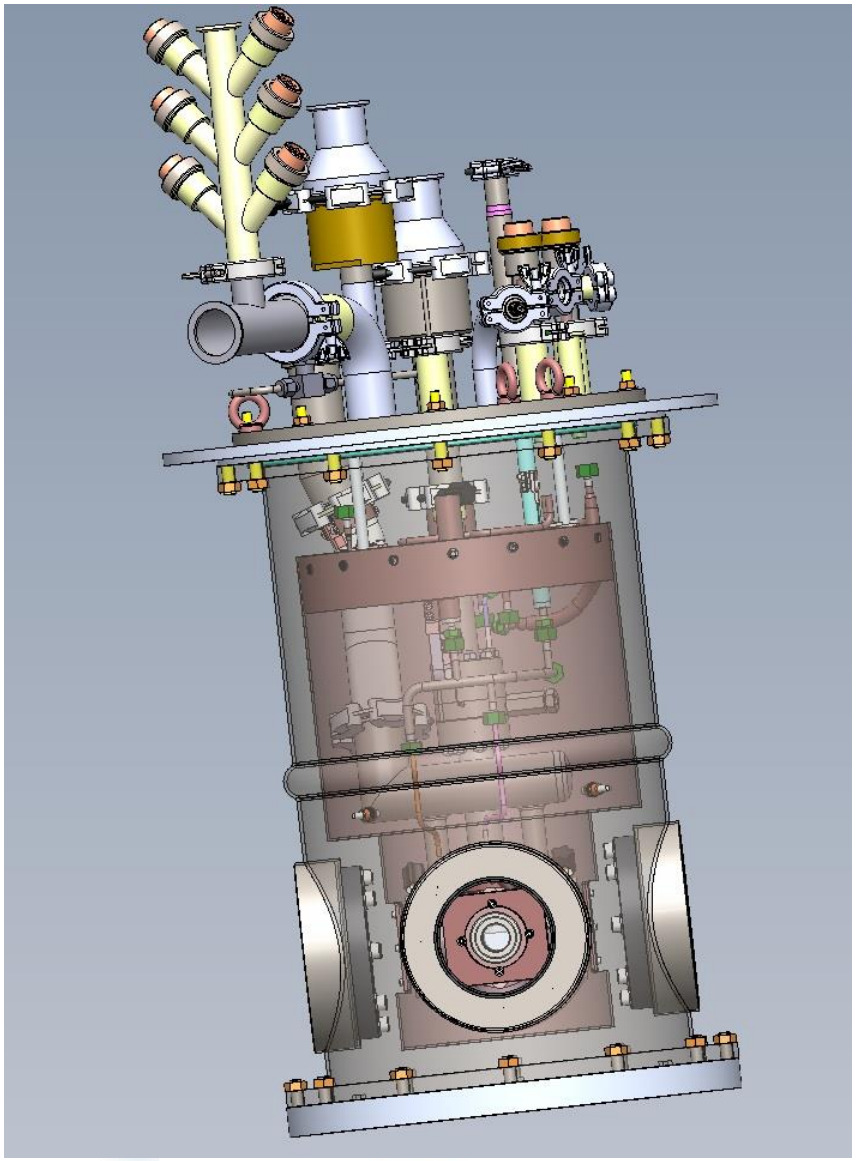
ACHIEVEMENT OF HIGH PRESSURE

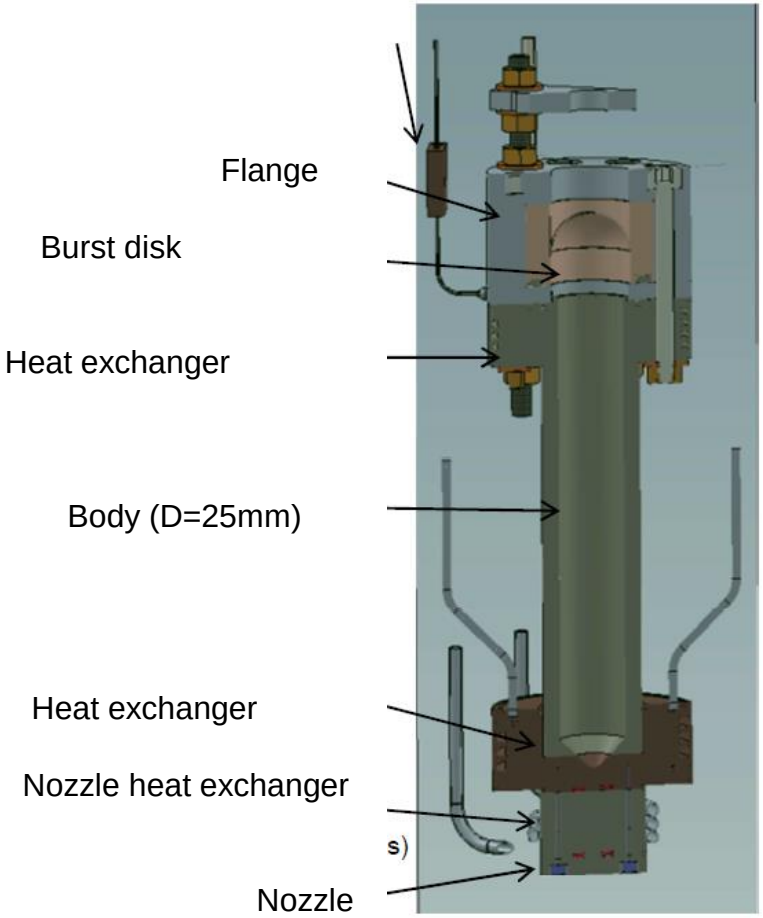
H_2 isodensity



Fabrication of the first prototype

SOPHIE: SOlid Phase Hydrogen fIlm Extruder

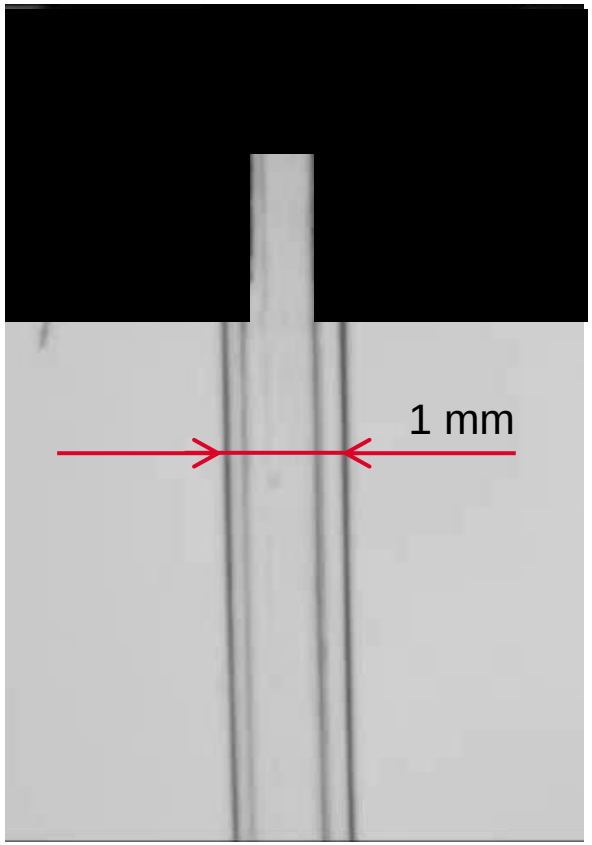


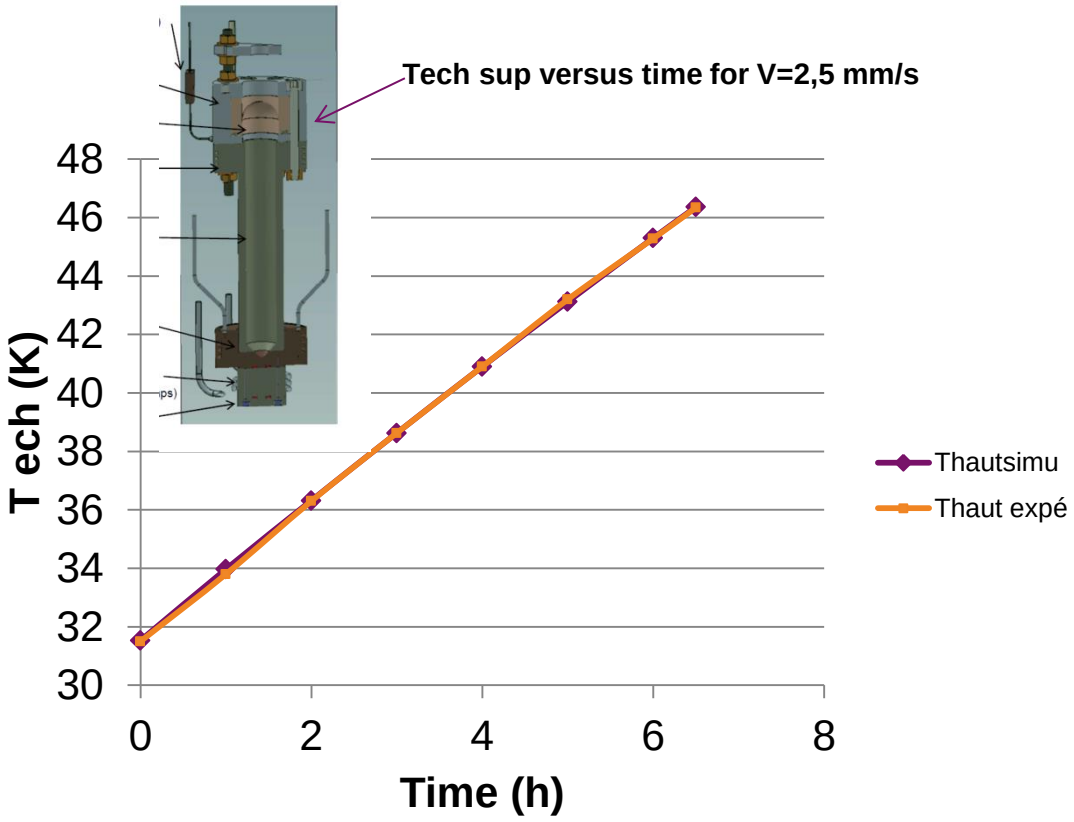


Fabrication of the first prototype

PHD (LANEF)
Stéphane Garcia

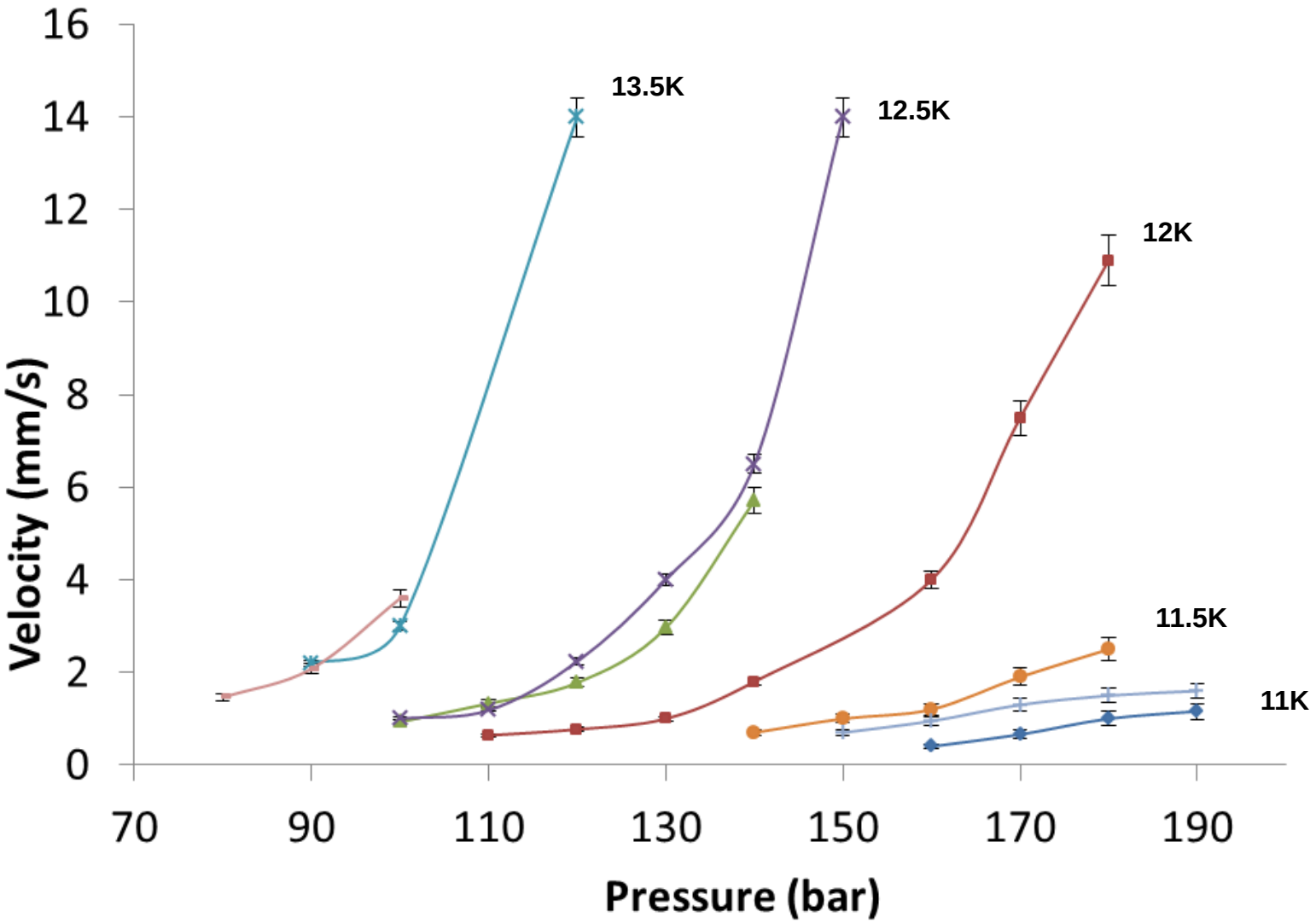
With 100 µm nozzle…



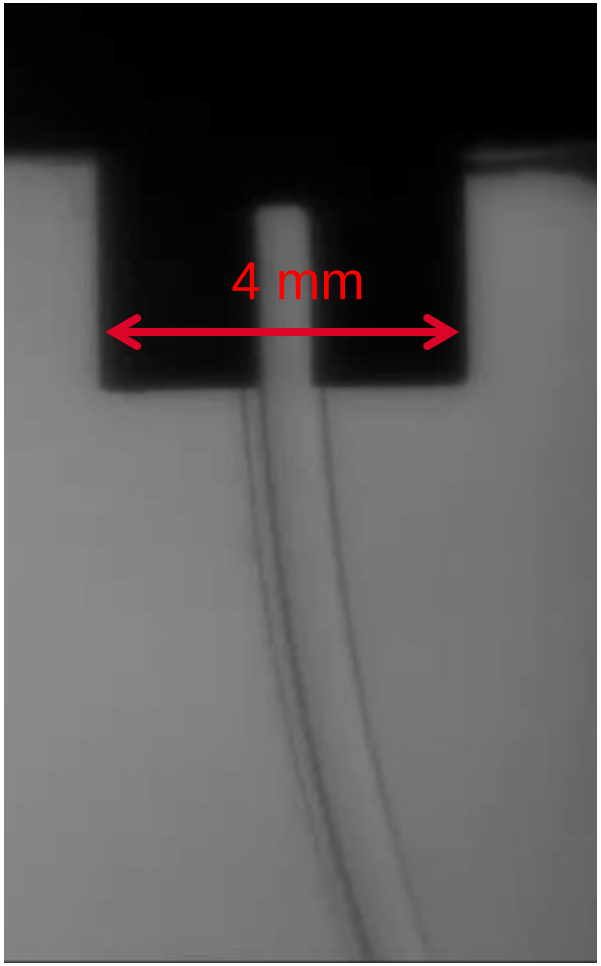


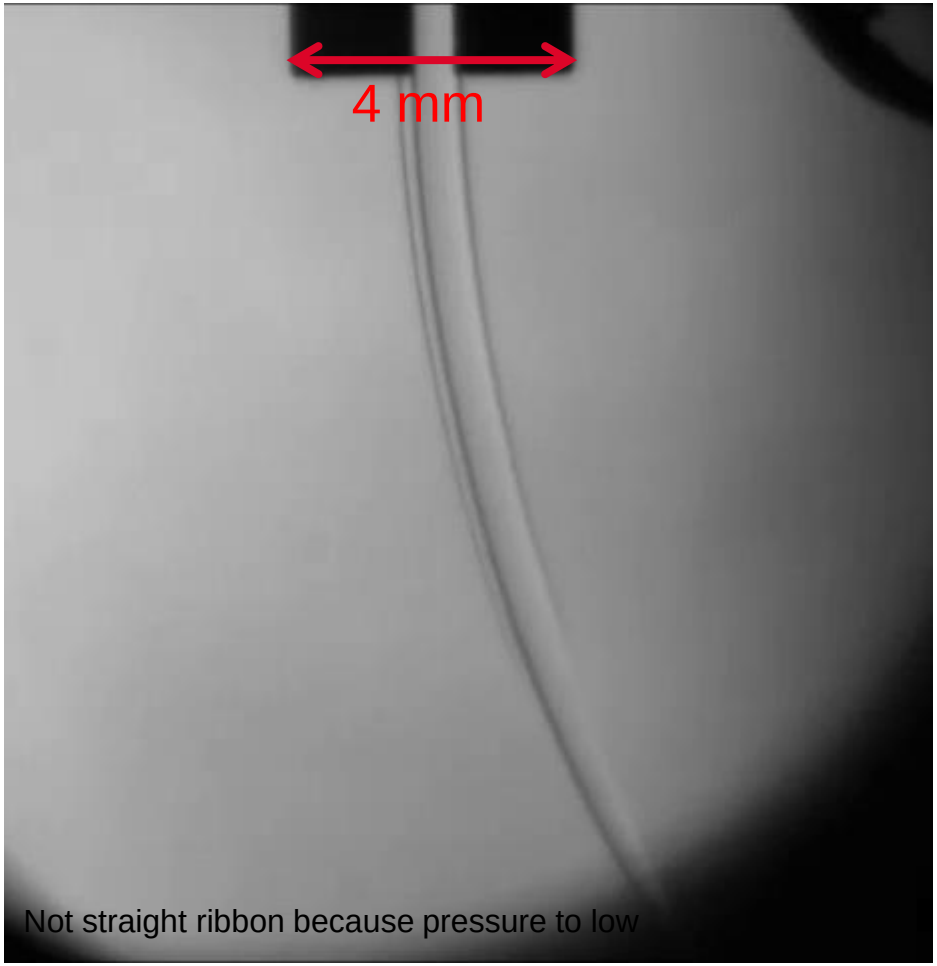
Ribbon 1mm x 100µm (0,9 mg/cm²)

Results for 100 µm nozzle



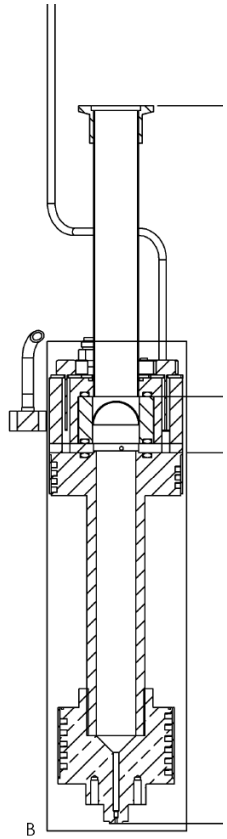
…and 50 µm nozzle

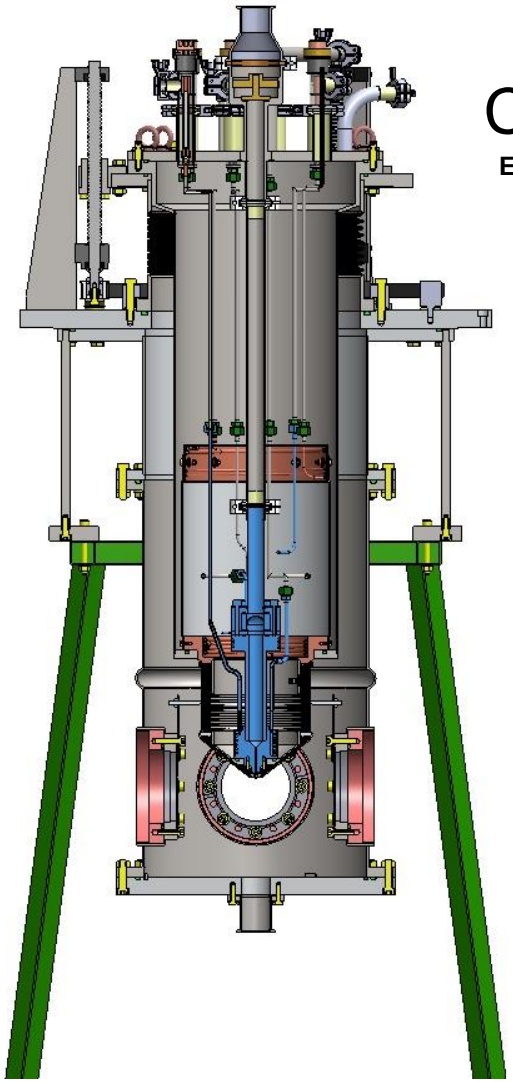




UPGRADE 400 BARS + LASER COMPATIBILITY

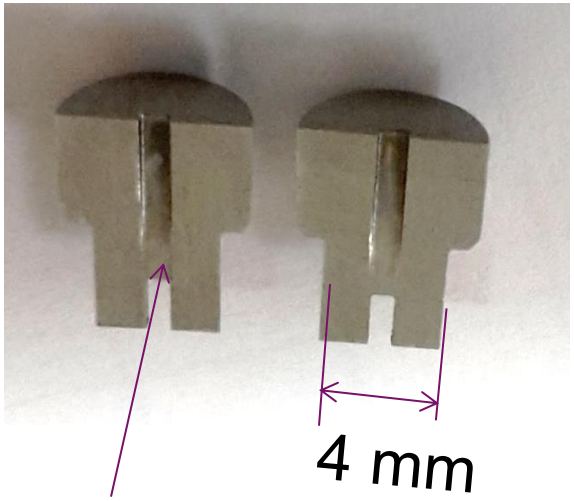
For 10µm in thickness, 400 bars are required





Cryostat “ELISE”

Enhancing **L**aser **I**on sources with **S**olid Hydrog**E**n targets



Groove
13 µm

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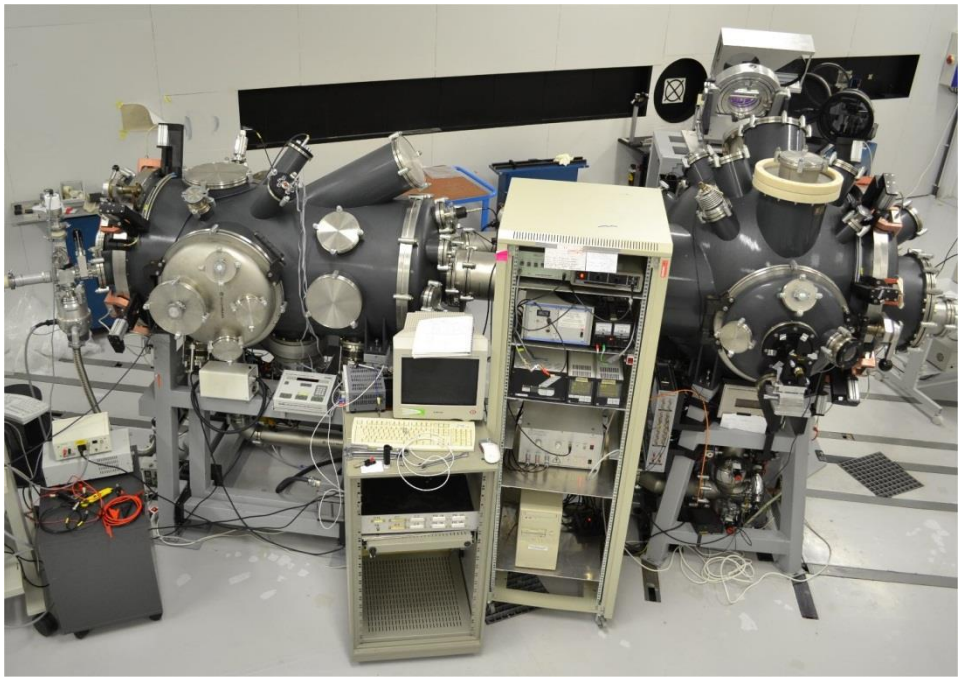
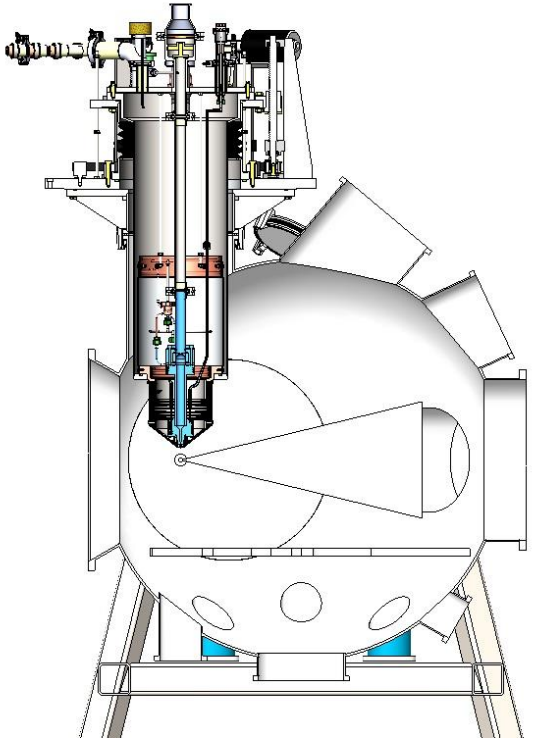
CRYOSTAT « ELISE »

NEXT STEP: PALS AT IOP

PALS: 1kJ, 3TW, 333ps, 25mn





Experiences scheduled in Sept 2015

Contact: Daniele MARGARONE and Jan PROKUPEK

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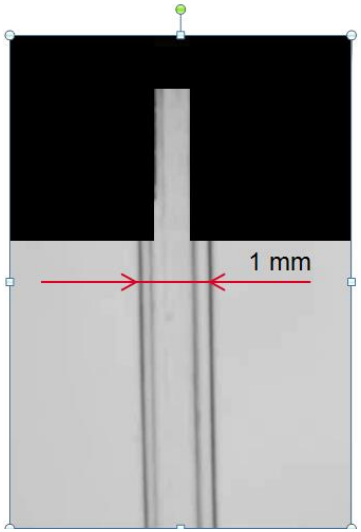
PUMPING SPEED

$$Q(l.s^{-1}) = \frac{S.V.\rho_{sol}}{M*P}.22{,}4$$

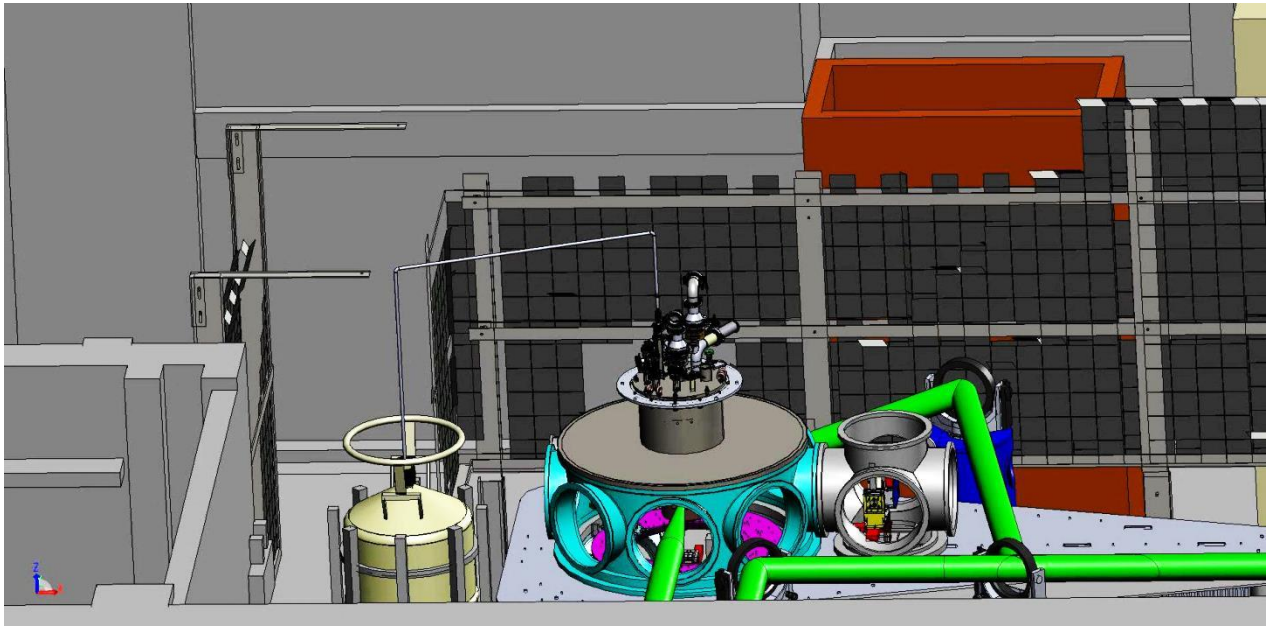


S	Ribbon section
V	Ribbon velocity
ρsol	Density of the solid
M	Molar mass
P	Pressure in bar

Example: for a H_2 ribbon of 1mm x 100µm having a velocity of 10mm/s, if the required pressure in the vacuum vessel is 10^{-4} mbar, one need a 8000 l/s pump

OTHERS EXPERIENCES

- Installation on ELFIE (*20J, 100 TW, 200 fs, 20mn)* at LULI then perhaps APOLON at Saclay.



Experiences scheduled in 2016

Contact: Julien FUCHS and Sophia CHEN

Future

- Find a physical model for the flow
- Realize precise measurement of the ribbon thickness
- prepare the installation at PALS
- prepare the installation at LULI
- Realize thinner ribbons (25 and 10 µm)

Thank you for your attention


Welcome in Grenoble