System overview:

- Sumitomo RP-0828 pulse tube cryocooler allows 5K minimum temperature at coldhead.
- Automated mass flow and Lakeshore 336 temperature control systems (LabVIEW compatible)
- Motor driven growth chamber sealing/exposure mechanism
- 4-sensor temperature readout with surface and volumetric mountings
- 3-stage radiation shielding (and superinsulation blanketing)
- 150W heating power. Coldhead from 5k to 393K in 30mins.
- 2x27000rpm roughing pump.

Growth chamber:

- Copper target mount/foul
- Stainless steel growth chamber with sapphire glass optical windows
- Motor drive mechanism
- Gas injection capillary
- Temperature sensors

Growth Procedure for hydrogen targets:

Following the phase diagram, there are five relevant stages within the growth procedure of solid hydrogen:

1. Regulate temperature above H₂ boiling point (~20K)
2. Hydrogen gas injection: gas bled into chamber until pressure reaches ~500-20mbar
3. Temperature dropped and gas bled in for pressure regulation
4. Liquefaction occurs and liquid flows over extended target foal aperture.
5. Further cooling below 13.8K freezes the hydrogen into a thin solid membrane.

Target survivability:

- Target sublimation upon exposure to low pressure environment decreases with lower base temperature (thus increasing target survivability).
- Further modelling work shows that thermal radiation is main contributing factor.
- An in-depth study into the effects of thermal radiation on target survivability was undertaken.

Abstract:

A progress review of the cryogenic target system being developed at the Central Laser Facility for high-power laser experiments.

A progress review of the cryogenic target system being developed at the Central Laser Facility for high-power laser experiments.

Experimental beamtime (TAP November 2015):

Around 10 shots incident on cryogenic deuterium were delivered over a period of two weeks.

Many issues from the previous experiment had been addressed to allow for better survivability, thinner targets and better characterisation.

Target survivability:

- Through vastly improving the thermal radiation shielding, deuterium targets have been produced which can survive on the order of days rather than seconds.

Decreased target thickness:

- Target growth substrate reduced by a factor of 30 from 3mm to 100um, reducing the overall ice thickness from ~4nm (estimated) to under 400um.

Experimental beamtime (TAP January 2016):

Deuterium gas jet modification:

- System modified to allow for spray deposition of tens of nanometres of deuterium gas onto micron thick gold foils.
- Adjustable trigger system for gas jet installation (nominally ~250ms prior to laser pulse)
- Gas jet and subsequent deposition manipulated by varying backing pressure of deuterium and trigger time.
- Dual target foils installed for higher shot rate.

Gas jet parameter calibration:

- Using the principle of thin-film deposition monitoring systems the CLF have developed a cryogenically compatible quartz crystal microbalance (QCM).
- Able to detect deposition of deuterium after triggering as a method of calibrating gas jet parameters.

Future work:

- Repetition rate improvements:
  - Damage mitigation of target foil – extended target stalk, retractable mount.
  - Decreasing warmup time
  - In vacuum replacement of target foil
- Characterisation:
  - Further research into integrating confocal chromatic sensors.