The Oxford High Density Tunnel (HDT)

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- One of three high speed tunnels being installed and commissioned at the Osney Thermofluids Laboratory:
 - T6 Stalker Tunnel – High total enthalpy tunnel
 - High Density Tunnel – High Reynolds number
 - Low Density Tunnel – Rarefied tunnel
- Funded through National Wind Tunnel Facility (NWTF) scheme
 - Partnership between 7 universities and EPSRC/ATI
 - Allow for min. 25% access to outside bodies (academic or commercial) use of facilities and instrumentation.

- Originally developed at the RAE in United Kingdom in the 1960s
- Initially operated as a cold hydrogen driven shock tube
- Extended to include reflected shock tunnel mode. Operated in this mode until mid-1980s.
- Converted to a Ludwieg tube with the capability of using Light Piston Compression Heating (LICH, [1]).
- External heating and a fast acting valve added in the early 1990s.
- Used by Qinetiq to support the HyShot [2] and SHyFE [2] flight experiments.
- Acquired from Qinetiq in 2012 by The University of Oxford
- Currently undergoing installation with initial operation and commissioning expected in the second half of 2015

- Cold hypersonic flow facility for steady and unsteady aerothermodynamic testing
- Test durations up to 70 ms
- 6.5 m long, 152 mm diameter driver
- 17.4 m long, 152 mm diameter barrel
- Mach 3, 4, 5, 6, and 7 contoured nozzles

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- Three operating modes:
 - Ludwig tube mode
 - LICH mode un-heated
 - LICH mode heated
- Keep test gas above liquefaction at nozzle exit
- Ensure that the test section remains sub-atmospheric

Property	Mach 3	Mach 4	Mach 5	Mach 6	Mach 7
Operation Mode	Ludwig		Ludwig/LICH		LICH
Max. Total Pressure (bar)	30	95	100	90	90
Min. Total Temperature (K)	288	360	454	580	750
Max. unit Reynolds number (10 ⁶ /m)	493	694	326	120	58

- Designed by T. Jones circa early 1990s
- Allows fast turn around between experiments
- Sliding gate valve acts as a safety valve, allowing work on the experimental model while the facility is filled.

- Simulations completed in CFX
- Spalart-Allmaras turbulence model.
- Simulated a 120deg sector, 11.76 million cells
- Inlet condition: 95 bar, 400K (Mach 6)

Radial Profiles at the Facility Nozzle Exit (Mach 6)

Data Acquisition

- Separate NI PXI chassis, 64 channels @ 2 MHz each + 128 channels @ 2 MHz aggregate
- LeCoy 4 channel, 5 Ghz oscilloscope
- In-house free flight data acquisition for 6 channels up to 20 kHz

Probe measurements

- 16 x PCB-134 pressure transducer (up to 1 MHz)
- 24 x Kulite XTL-140M (up to 250 kHz)
- 48 channels of thin film signal conditioning up to 1 MHz
- DANTEC 3 hot wire anemometer up to 400 kHz
- Advanced thermochromic liquid crystal

Actuated traverse systems by Quadratic Ltd

- +/- 20 deg AoA. +/- 10 deg AoY

Optical equipment

- Specialised Imaging Kirana camera (up to 5 MHz)
- Photron Mini UX-100 camera (up to 1 MHz)
- LED light source up to 1 MHz
- Schlieren optics up to 300 mm

Laser Equipment

- Laser Quantum 671 nm DPSS laser (LIGTS)
- Oxium low noise 532 nm DPSS laser (FLDI)
- Continuum Powerlite 8000 Nd:Yag laser (PLIF)

- HDT is a (relatively) long duration, cold hypersonic flow facility
- Installation is actively underway; initial operation expected to begin in the second half of this year.
- The facility will extend the hypersonic testing capabilities of The University of Oxford and complement the high enthalpy T6 Stalker Tunnel (also under development).
- Fast acting plug valve and model re-orientation mechanism allows rapid turn around between experiments
- Preliminary numerical simulations show a large wake flow forms behind the plug valve body but that these damp out by the nozzle exit.

[1] T. V. Jones, P. Street, and M. Westby. Recent enhancement to the DRA shock tunnel. In *The European Forum on Wind Tunnels*, Southampton, 14 - 17 September 1992.

[2] T. Cain, R. Owen, and C. Walton. Hyshot 2 aerodynamics. In *Proceedings of the Fifth European Symposium on Aerothermodynamics for Space Vehicles*, number EAS SP-563-229C, Cologne, 8 - 11 November 2005.