Update on AdvLIGO UK Project - UK Perspective

M. Barton for the ALUK team

LSC LIGO-VIRGO Meeting

23 October 2007

G070662-00

UK Scope

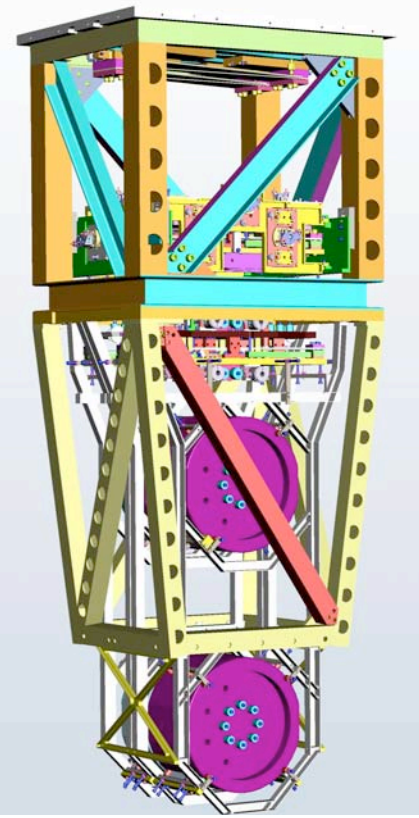
- Project management ("Work Package 1")
- Structures: ETM+ERM, ITM+CP, BS, FM (WP3)
- Most masses (WP5):
  - All upper/upper-intermediate masses (metal)
  - Penultimate masses for ETM/ITM ("PM", silica)
  - Reaction mass for ETM ("ERM", heavy glass)
  - Blanks for ETM and ITM
  - (Not BS, FM or CP)
- OSEMs, drive electronics (WP4)
- Monolithic stage for ETM/ITM (ears, ribbon pulling/characterization/welding suite; WP2)

Personnel

- Glasgow
  - M. Barton, C. Craig, L. Cunningham, A. Cumming, A. Heptonstall, J. Hough, R. Jones, I. Martin, N. Robertson, S. Rowan, K. Strain, C. Torrie, M. Van Veggel
- Rutherford Appleton Lab
  - J. Greenhalgh, T. Hayler, J. O'Dell, I. Wilmut
- University of Birmingham
  - S. Aston, R. Cutler, D. Lodhia, A. Vecchio
- University of Strathclyde
  - N. Lockerbie

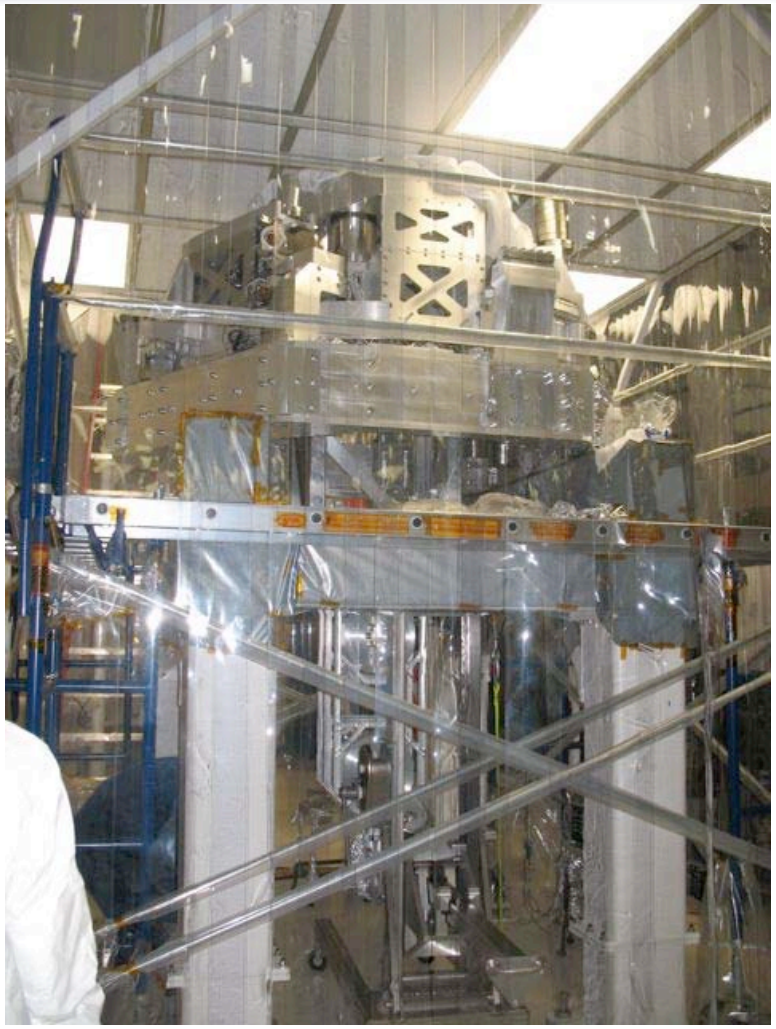
Structures (i) - TM Quad N-Ptype

- Design and initial tests of “dirty” all-metal build at RAL



Structures (ii) - TM Quad N-Ptype

- Clean all-metal build just now installed on ISI at LASTI

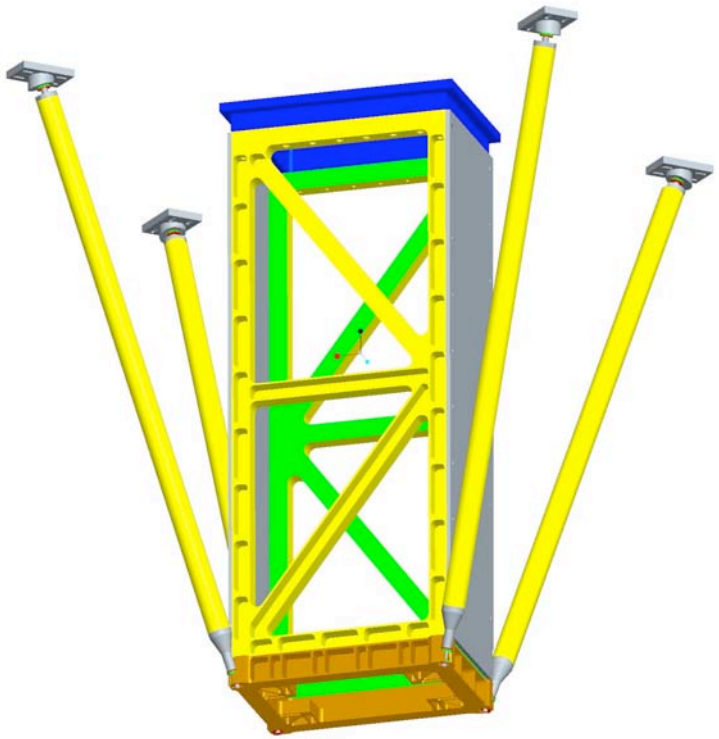


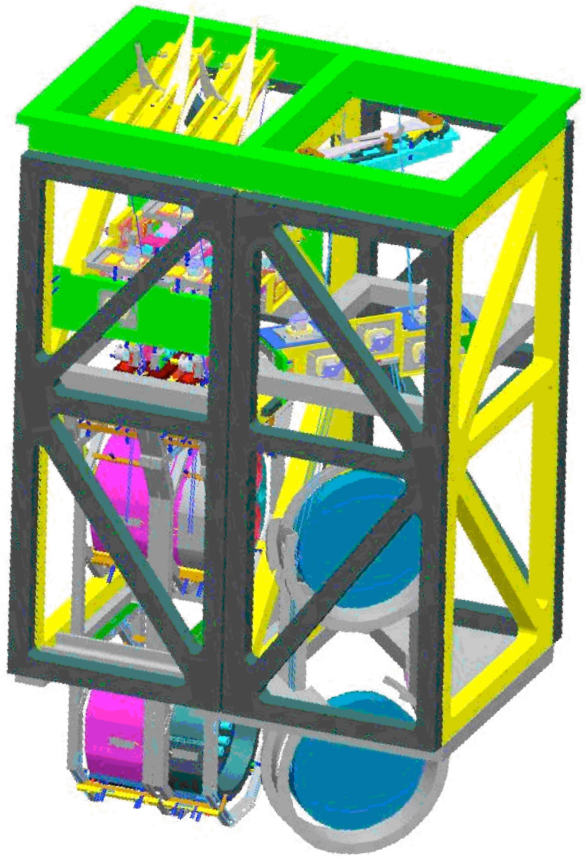
Structures (iii) - TM Quad N-Ptype

- Test plan:
  1. Use as test payload for ISI
  2. Characterize as all-metal version
  3. Fit monolithic stage (Feb 2009?)
- See talk by Justin Greenhalgh in SWG parallel session

Structures (iv) - BS and FM

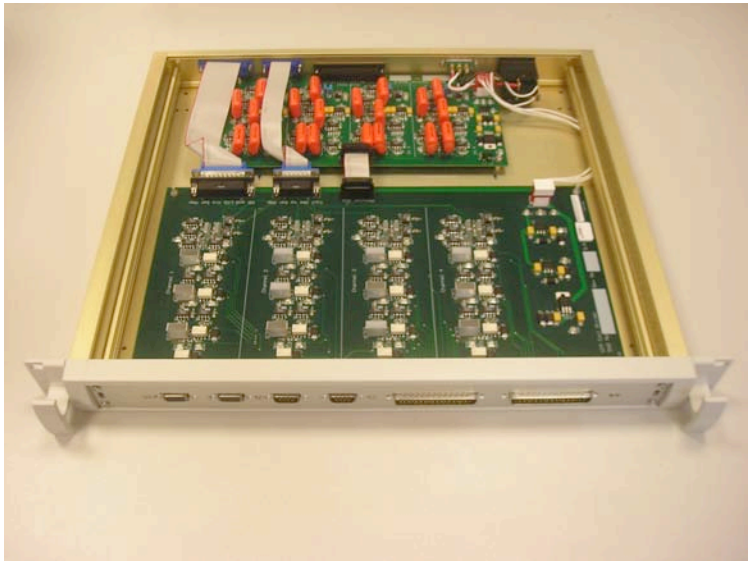
- Designs ongoing





Electronics

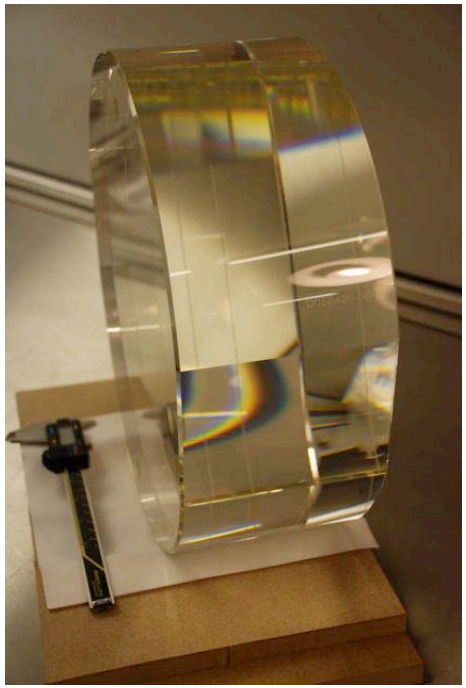
- Birmingham/Strathclyde
- LASTI OSEMs and electronics on schedule for Nov



- See talk by Justin Greenhalgh in SWG session

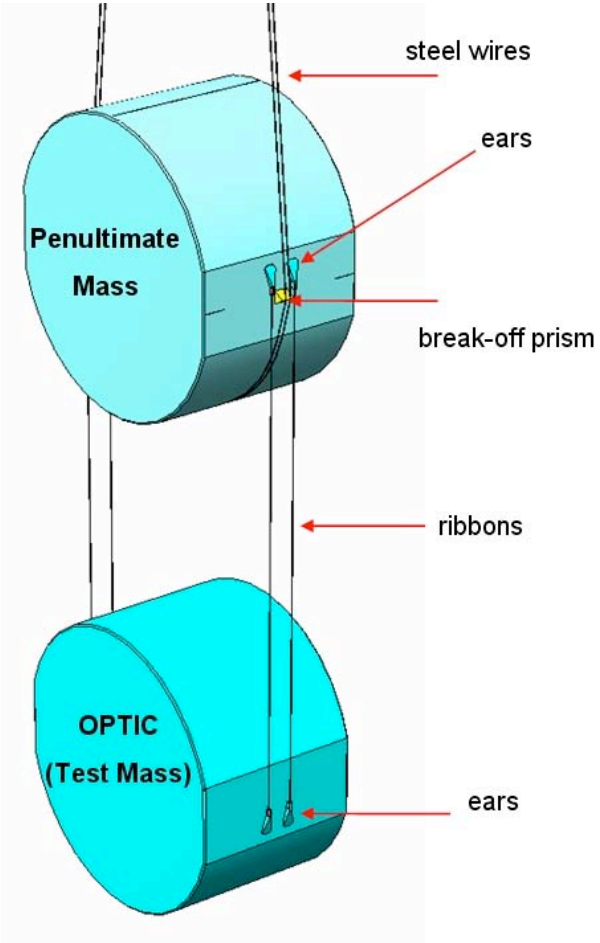
Masses

- Blanks acquired 2006 - TM sent to US, others polished in UK
- 11 months to polish PM1, PM2 and ERM1, and with minor chip in bevel of PM1!
- ERM2 (spare) deliberately left unfinished



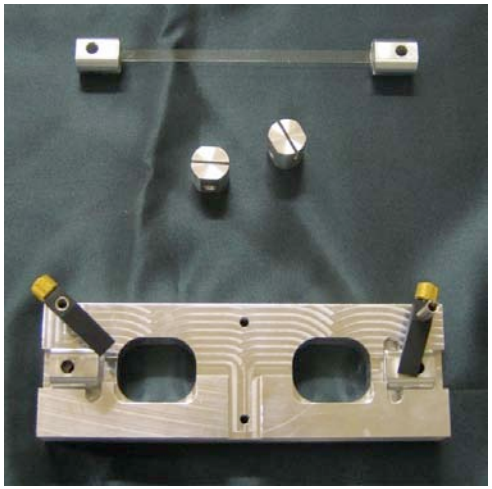
Monolithic Suite

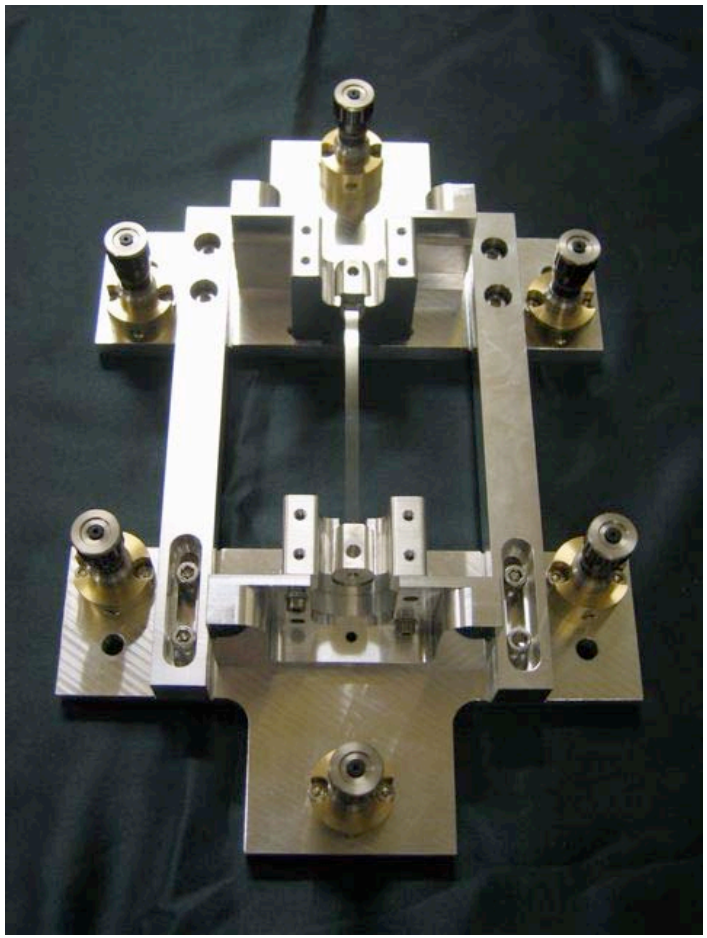
- Glasgow responsibility:
  - Ribbon fabrication slides
  - Pulling machine (with CO2 laser)
  - Profiler
  - Proof/bounce tester
  - Storage
  - Ear bonding
  - Prisms
  - Welding



Ribbon fabrication slides

- Slide cross-section is 5 * 0.5 mm
- Will be drawn down to 1.15 * 0.115 mm ribbon (19:1 linear reduction)
- Slide is laser fire-polished and cemented between two “holsters” to form cartridge that accompanies slide/ribbon until just before welding



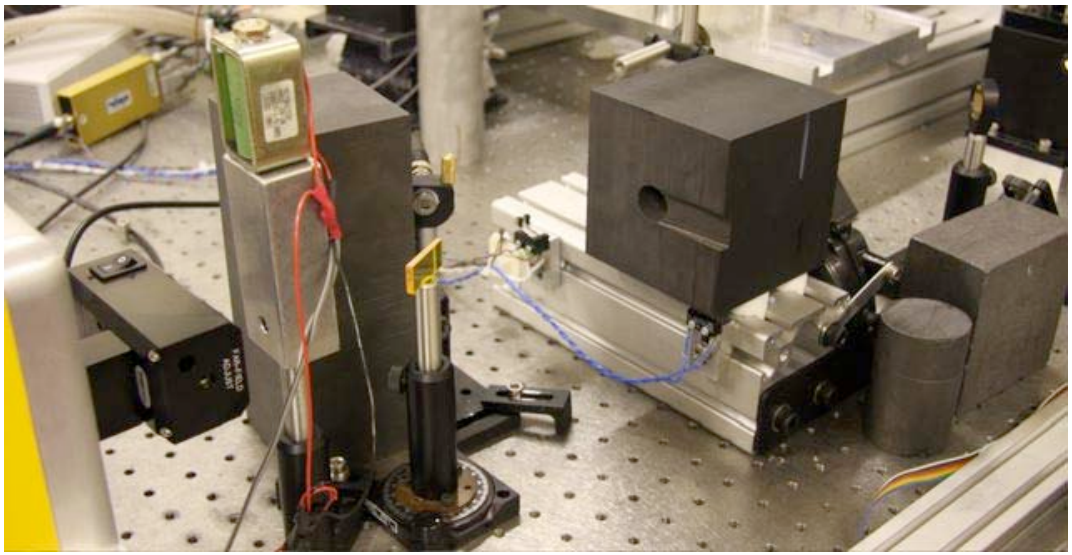


Pulling Machine (i) - Overview

- Adaptation of GEO fibre pulling machine
- Fabrication slide clamped between carriages on vertical track - bottom feeds, top draws
- CO2 laser heating
- Almost completely automated (with LabView)
- Linear encoder will monitor length of pull

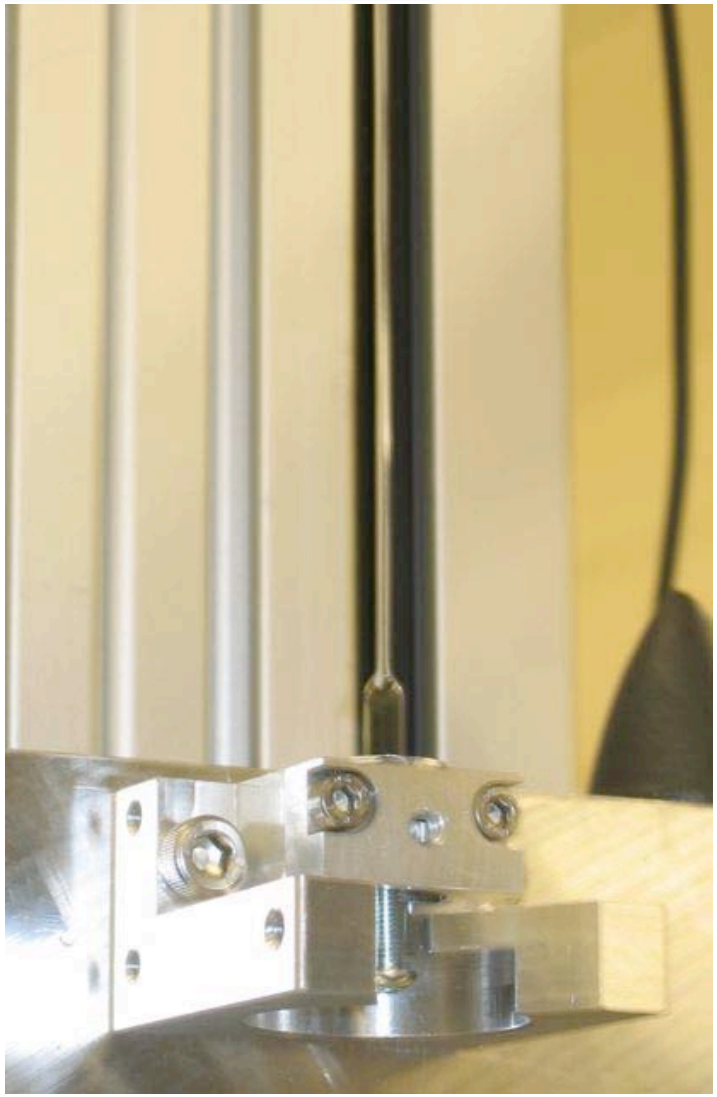
Pulling Machine (ii) - Laser

- 120 W Firestar CO2 laser
- Additional stabilization with HgCdTe sensor and LabView
- HeNe alignment beam
- Dithering mirror for tweaking heating profile
- Split cylinder around ribbon for confining heat

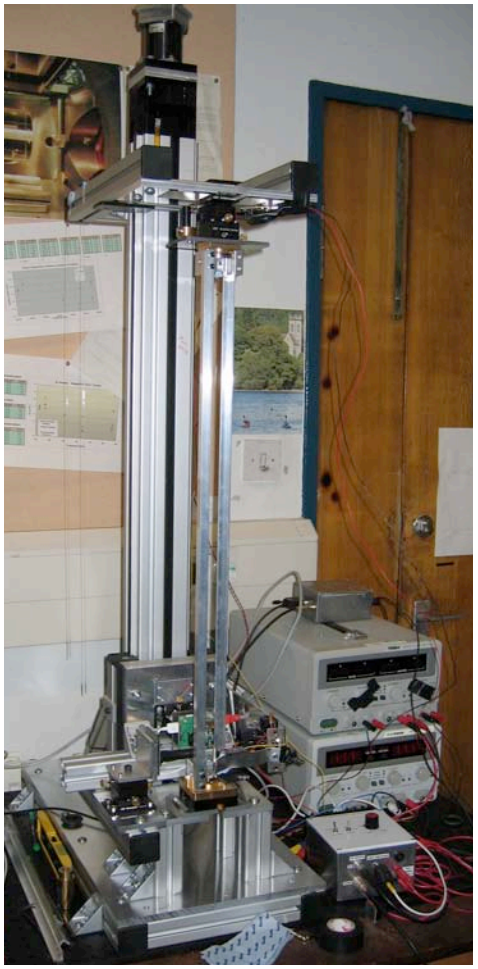


Pulling Machine (iii) - Operation

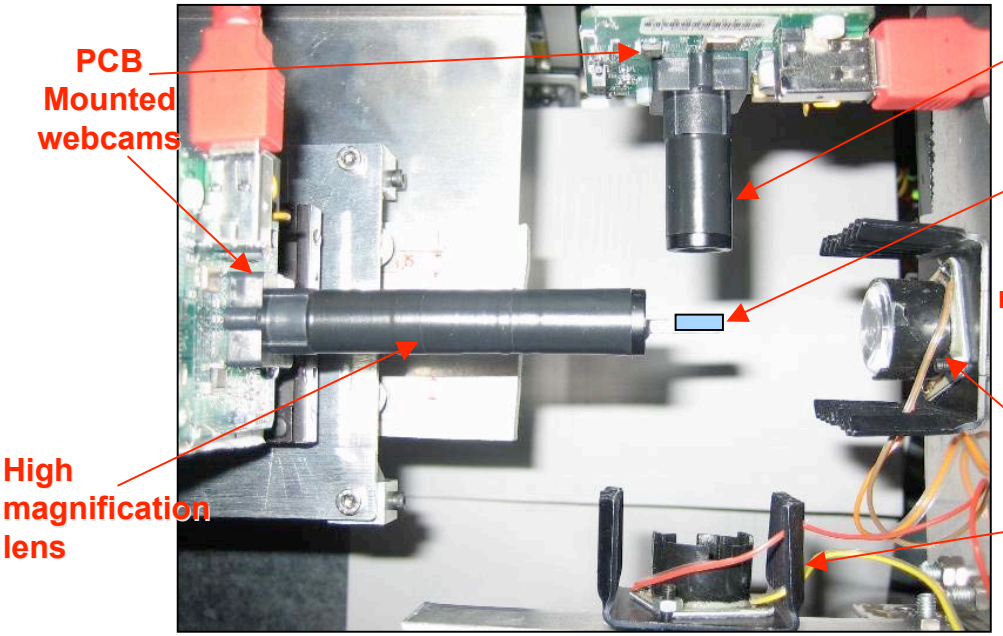
- Probably adequate ribbon recipe already obtained
- Potential improvements:
  - Strength
  - Better neck shape
- See also Alastair Heptonstall's talk in SWG parallel session.



Profiler

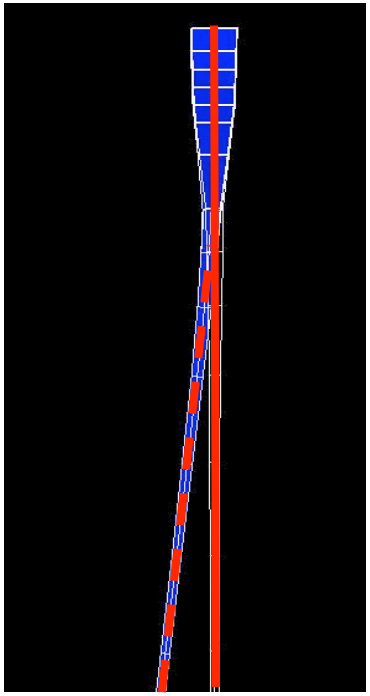


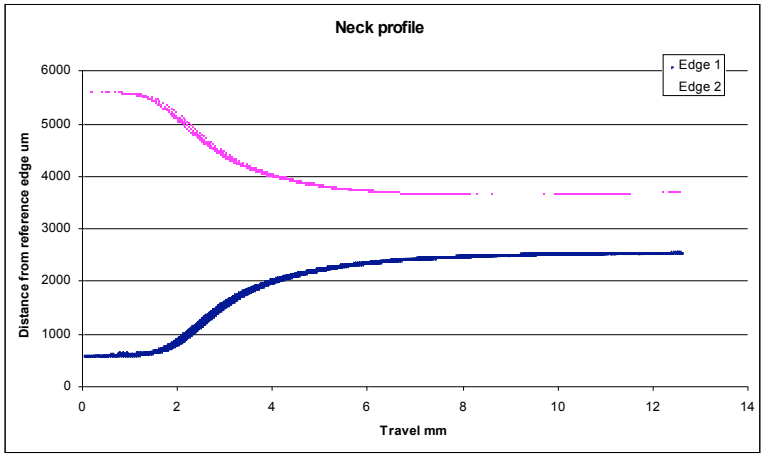
- 2 perpendicularly mounted cameras focusing on the thick/thin ribbon dimensions
- Cameras are mounted on moving platform on 1m long leadscrew tower allowing them to traverse length of ribbon
- Measurement and control performed by custom LabView program

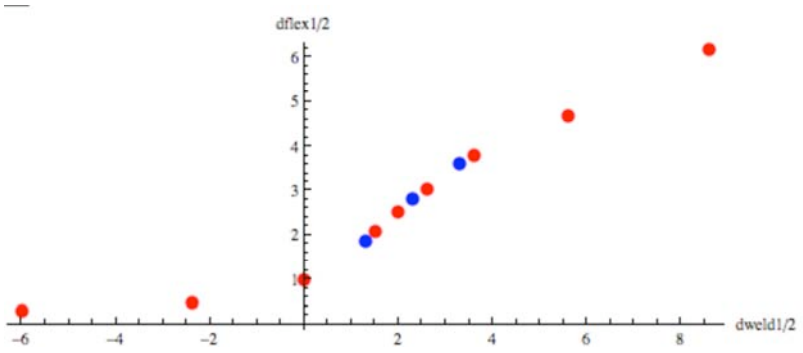


Profiler Data

- Ribbon neck measured in profiler, modeled in ANSYS
- Flexure point derived
- Ear position determined

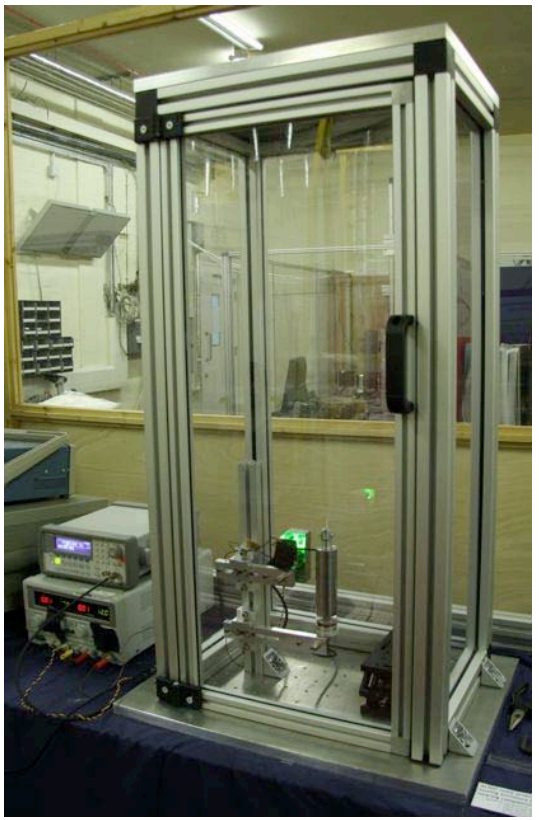






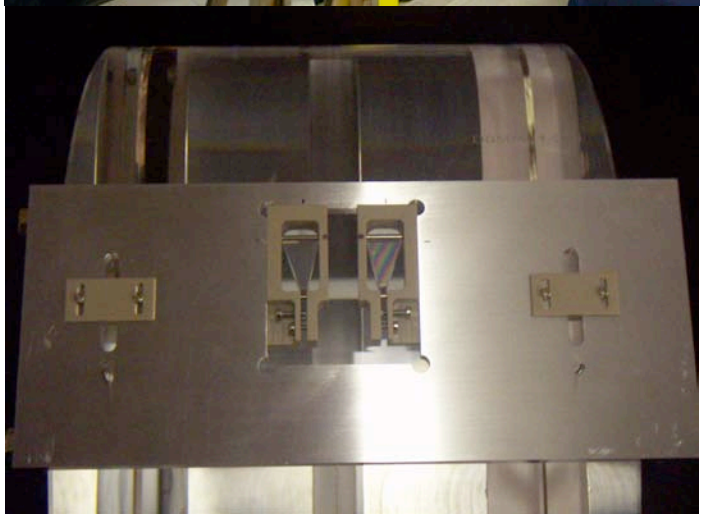
Proof and Bounce Testers

- Ability to withstand 15 kg load (50% safety factor)
- Net stretch under DC load
- Bounce frequency with 1 kg and 200 g loads -> longitudinal stiffness (with recoil correction)
- Shape of neck under load with upper support tilted (empirical check on flexure calculation)



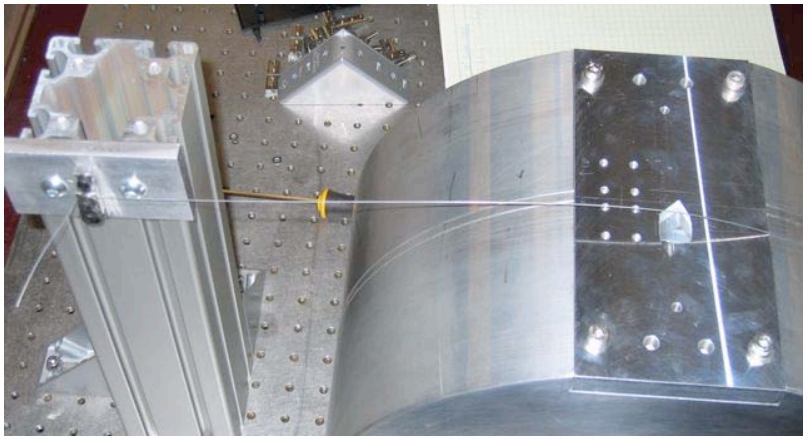
Bonding

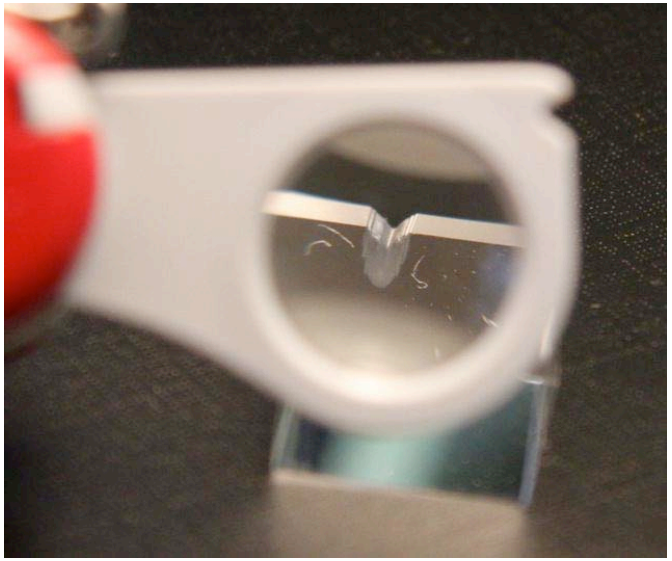
- Bonding jig clamps to side of mass
- Settable position relative to scribe lines
- Final position determined using profiler data for typical ribbon neck
- Ears bonded to LASTI TM and PM1 in Sep 2007 (PM2 to be done in Dec 2007)
- See talk by Mariëlle Van Veggel in later IS session

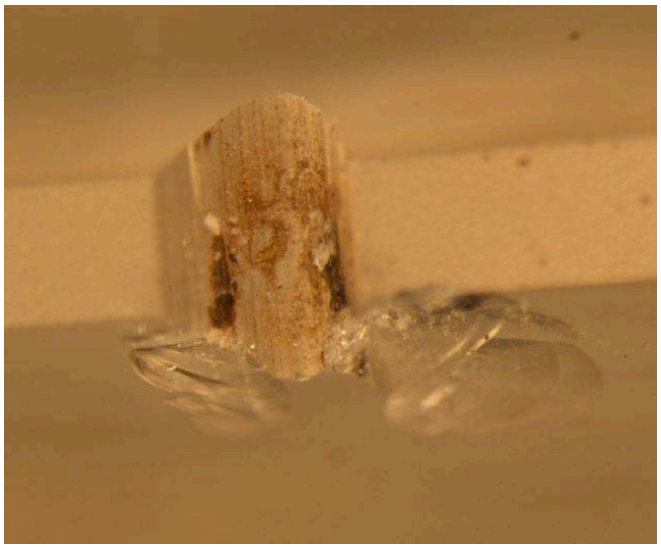


Prisms

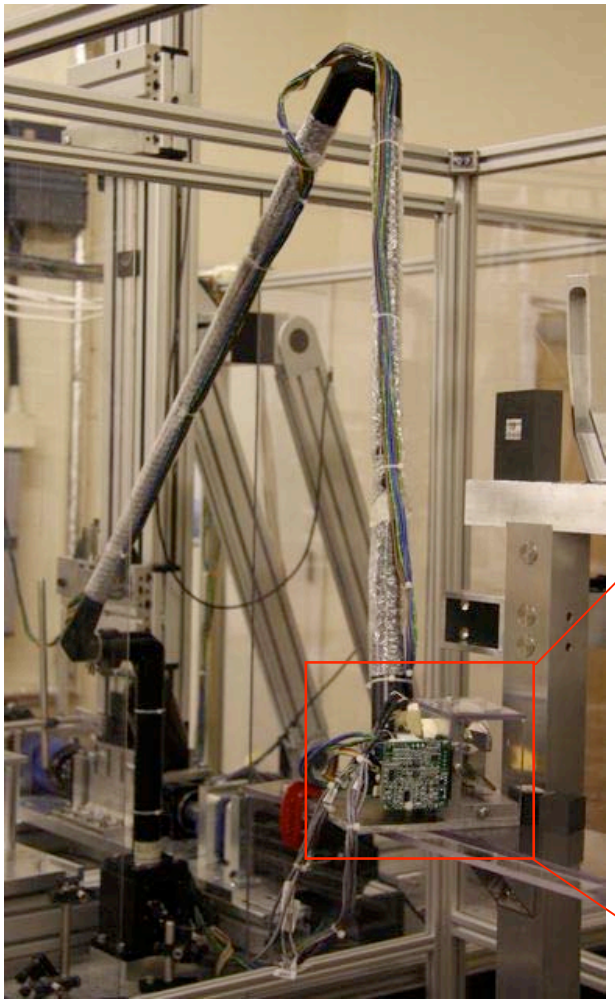
- Initial concept was triangular prism with notch
- Failed stress test unless flame-polished to the point of obliterating notch
- Fallback design in metal
- With TOPS group at Strathclyde, exploring suggestion of Steve Penn to use laser ablation
  - More control of groove shape
  - Fire-polished for free



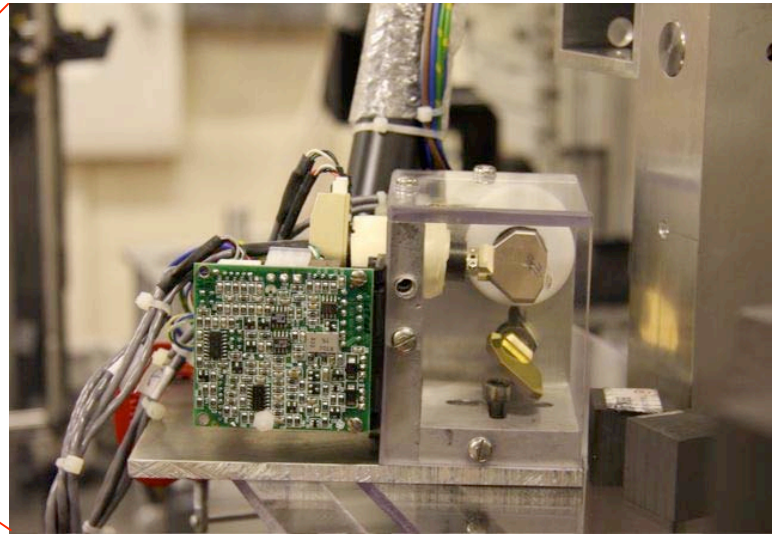




Welding



- Same CO2 laser (at least for LASTI)
- Articulated arm
- “Birdcage” with steering mirrors under joystick control
- Tantalum foil to protect optic and reflect beam into difficult to reach areas
- Ribbon ends held by silicate tack-bonding to silica rods



Status

- Pulling machine, profiler, proof/bounce testers now mostly mature
- To do:
  - Install pulling machine at LASTI
  - Design final welding tooling, refine welding procedure
  - Decide prisms: metal (fallback) or glass
  - Bond ears to PM2, prisms to TM, PM2 and ERM
  - Design desiccant storage for ribbons
  - Install rest of monolithic suite
- Goal: monolithic stage by Feb 2008