

Assessment of a New Low Weight Mirror Fabrication Technique for Future EO Space Systems

Peter MacKay, Trevor Wood

Final Review Wed 20th March 2013

CEOI Fifth Open Call

Contract – 4500147597

Bonded Lightweight Mirror

Mirrors for space applications

- Light
- Stable
- Robust

Current production methods

- Risky
- Slow
- expensive monolithic structures

Proposed production method

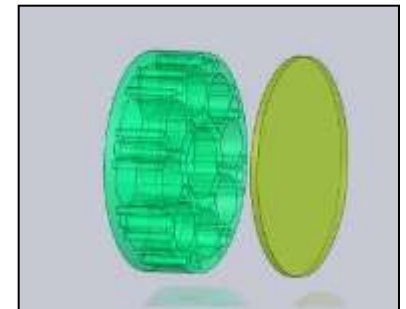
- Lower risk
- Quicker
- Lighter for same performance

Gooch and Housego (UK) Ltd

- Peter MacKay
- Fabrication and testing of components

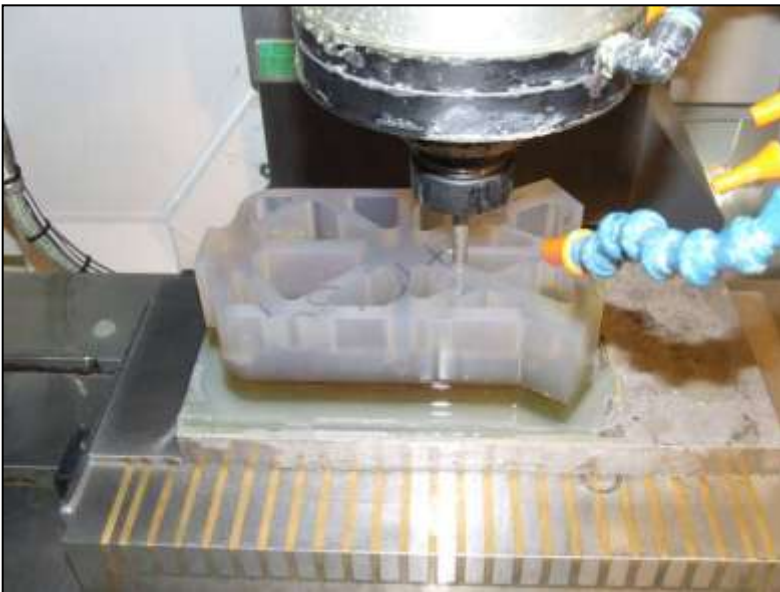
Surrey Satellite Technology Ltd

- Trevor Wood
- Design and modelling of components



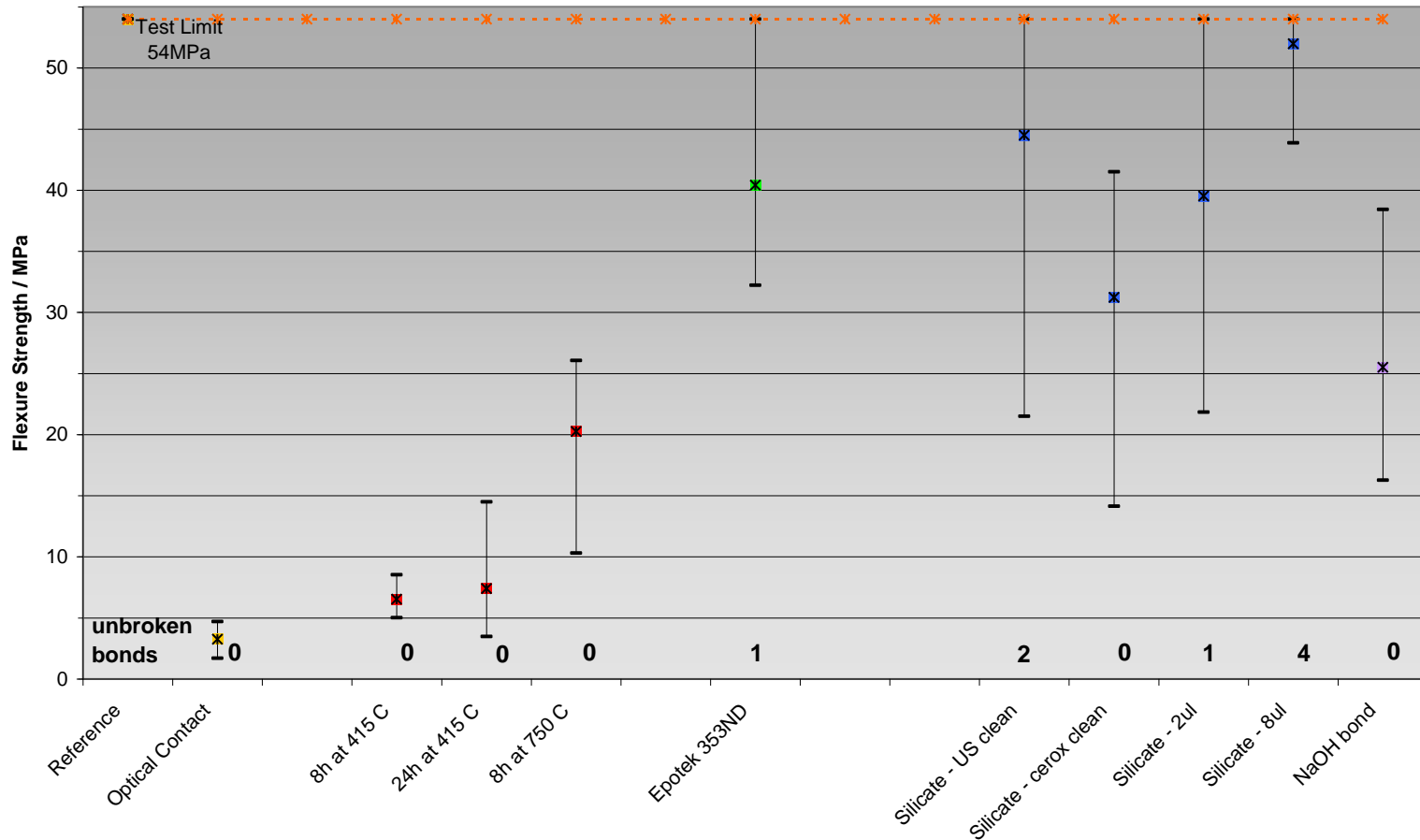
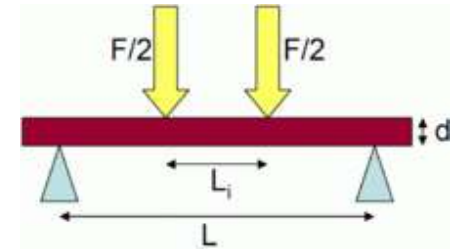
Project Background

- Large lightweight and stable mirrors required for many applications including space.
- Machining Zerodur into thin webs is high risk
- Last minute issues can write off expensive components
- G&H have been developing adhesive free bonding techniques in collaboration with University of Glasgow Institute of Gravitational Research.

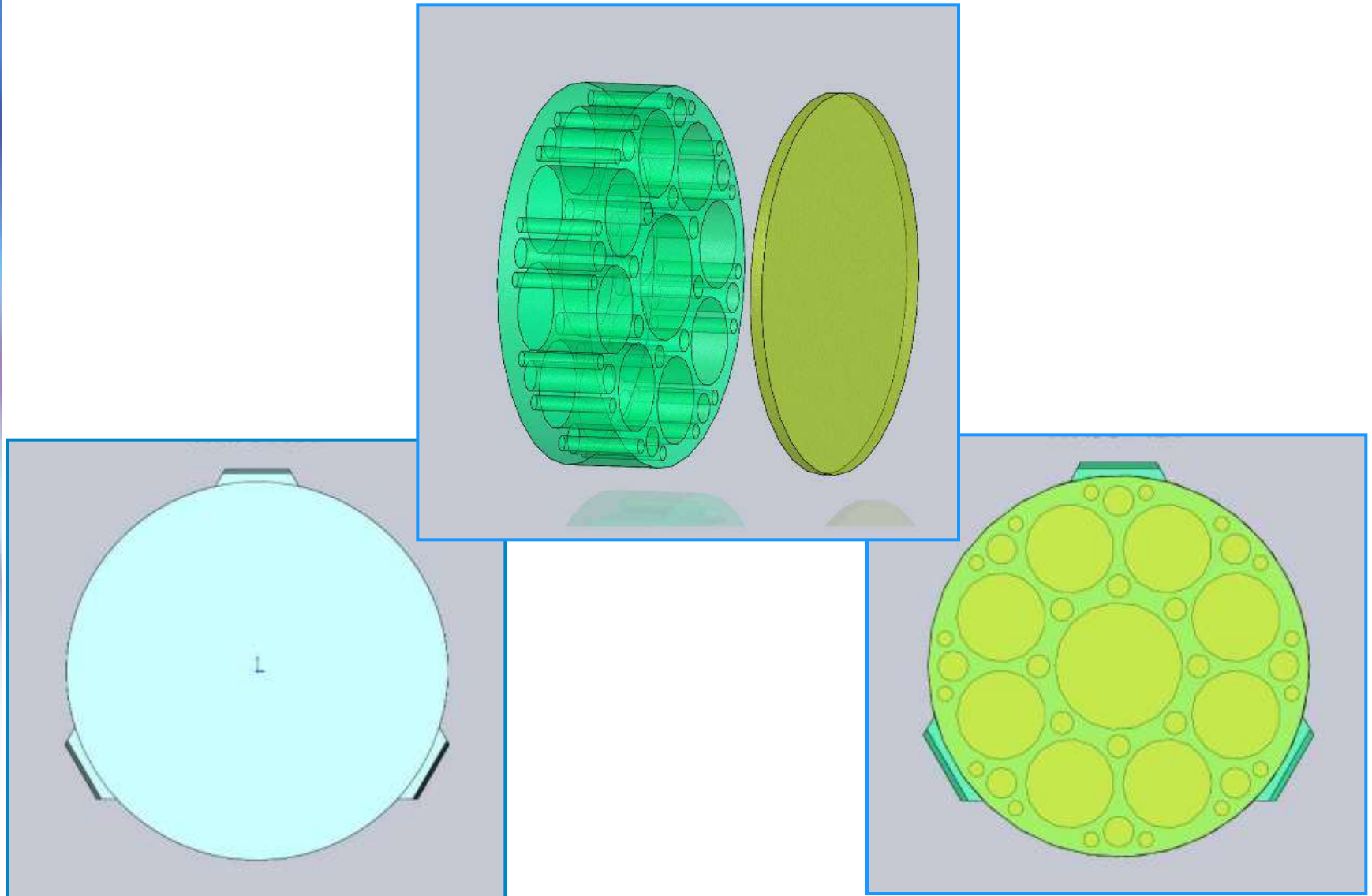


Bonding Method Selection

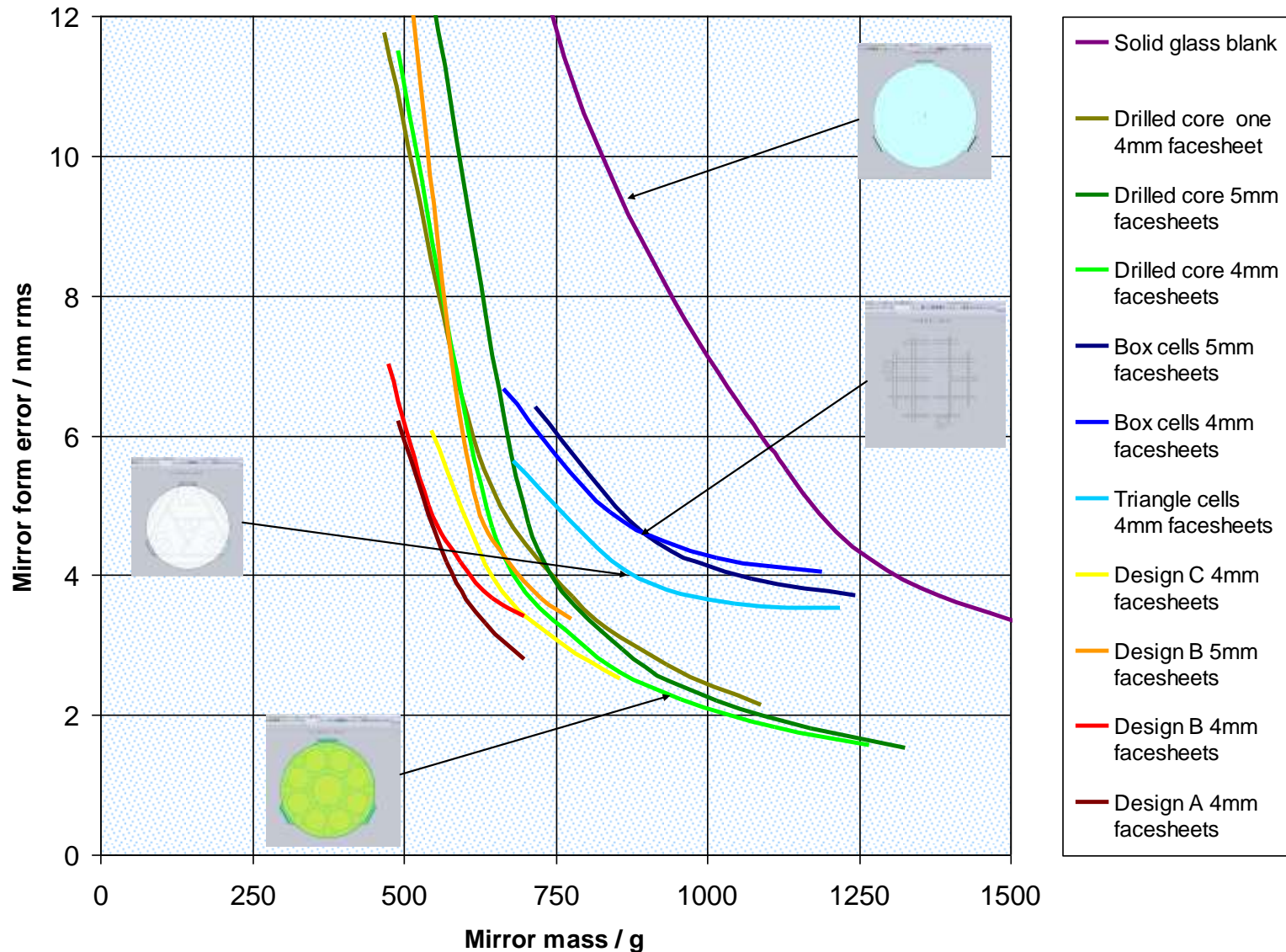
- 4 point flexure testing on 20x10x5 bonded test pieces
- Zerodur and ULE



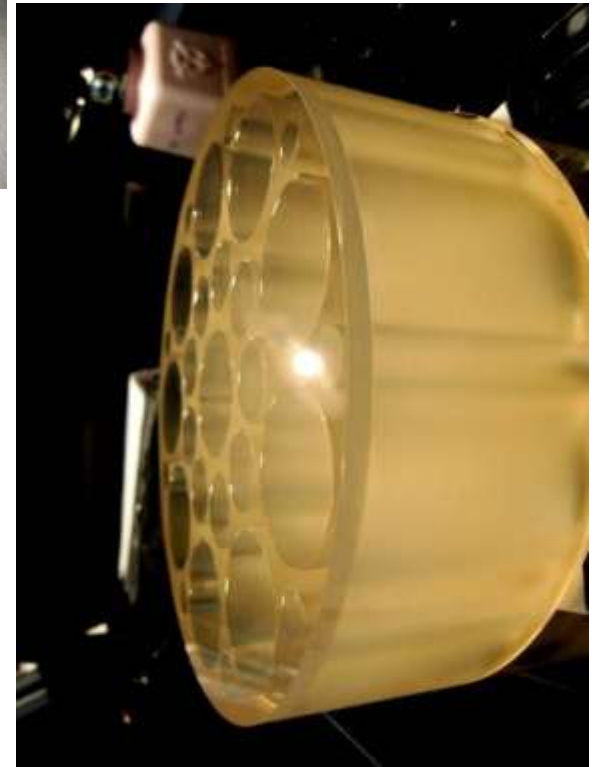
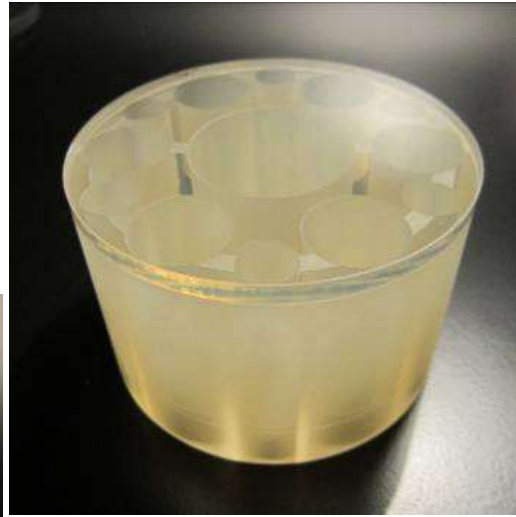
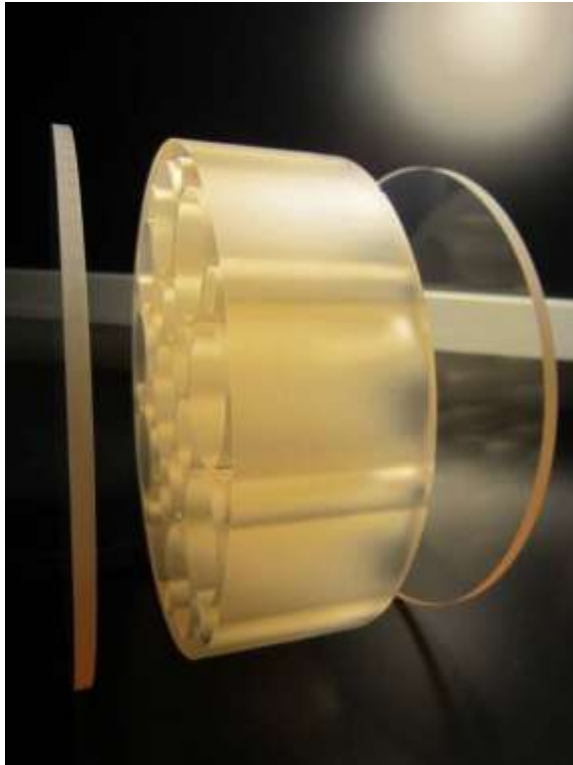
Design and Model Prototypes



Modelled Performance



Fabricated Mirrors



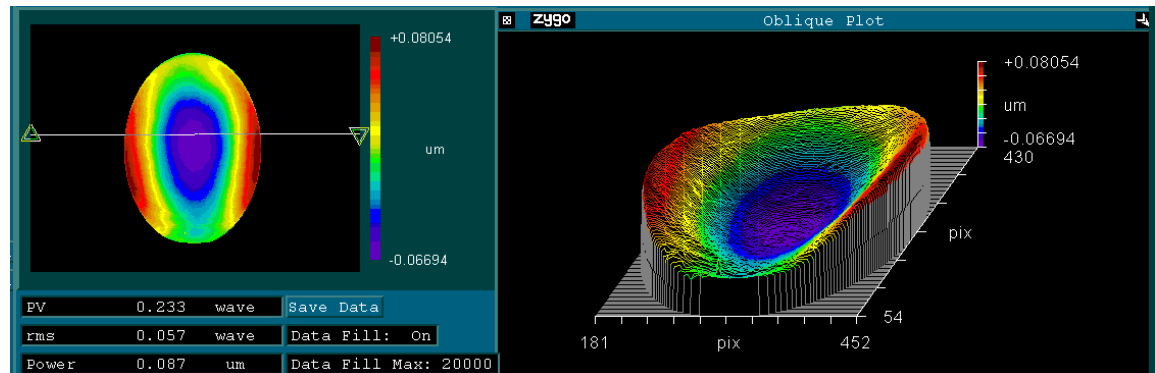
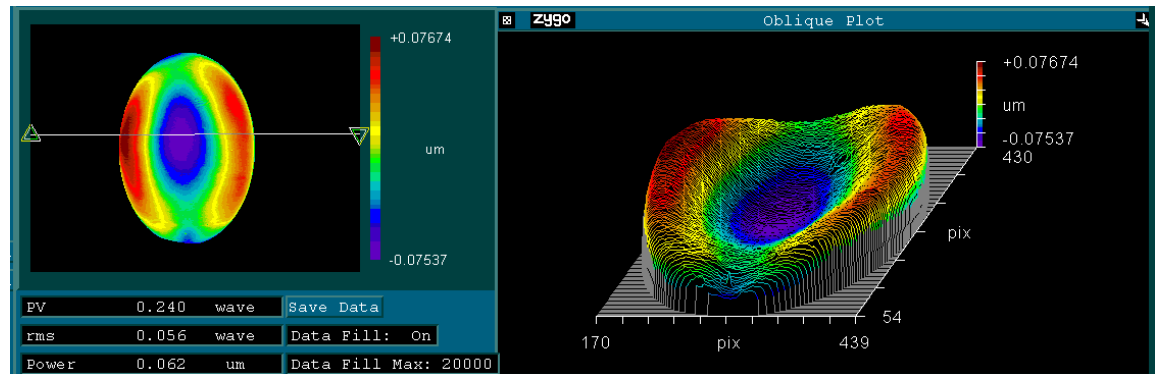
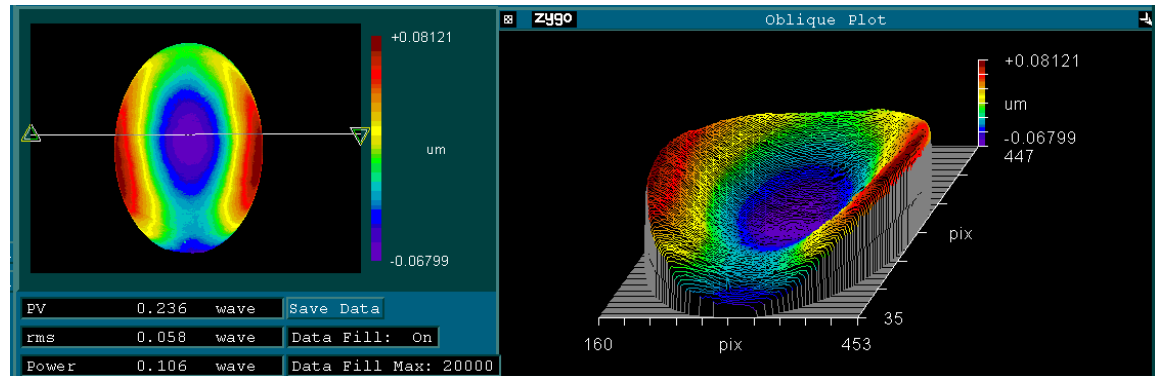
D150mm Mirror Performance

Form error in waves PV

RT \rightarrow 0.236

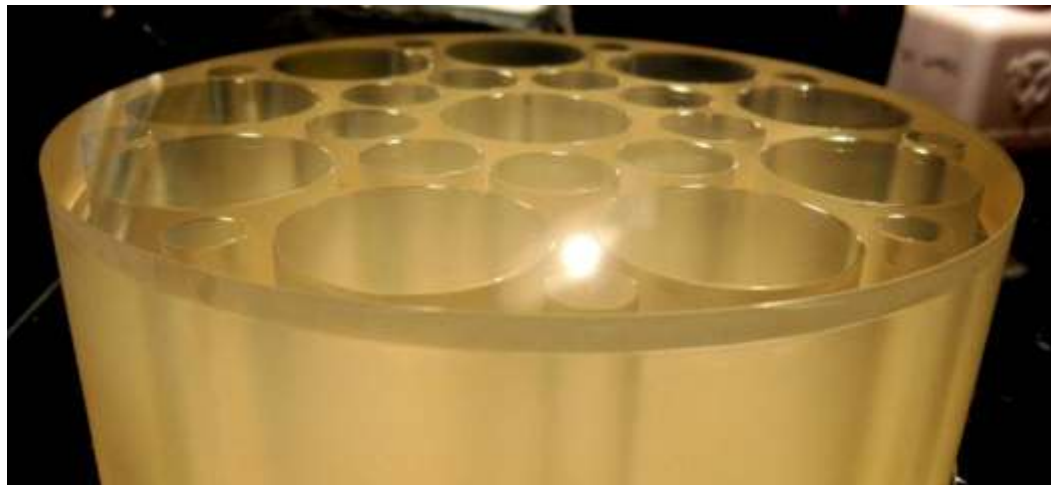
50°C \rightarrow 0.240

Temp Cycled
+50°C/ -20°C
 \rightarrow 0.233



Achievements against Goals

- Selected the best bonding method
- Proven the strength of the bonds
- Fabricated various prototype mirrors up to D150mm
- Proven stability of bonded mirrors
- Third design in production



Issues during Project

- Delayed start was problematic in such a short project
- Capacity issues in G&H's CNC dept (now solved)
- Modified design to allow fabrication to progress
- Third design of mirror - production ongoing

Dissemination and IP

- Poster presentation “Low Weight Bonded Mirror Structures” at the “NCEO/CEOI Joint Science Conference 2012” on 17/20th September in Nottingham.
- Contributed to ESA Technology Harmonisation 1st Semester, Mirrors and Stable Structures, February 2013
- Talk, “Bonding with Industry” at University of Glasgow’s Industry Day 28th Feb 2013
- Poster, “From University to Industry: Fabricating Lightweight Spacecraft Components” SET for BRITAIN 2013, Houses of Parliament, 18th March 2013
- Paper, “Characterisation of a low temperature and adhesive free bonding technique for optical materials”, SPIE Optics and Optoelectronics, Prague 17April 2013
- Paper, “Fabricating monolithic structures from separate piece parts”, EOSMOC, Munich, 13-15 May 2013.
- Gooch and Housego is in the processing of drafting a Patent with regard to the design features developed during WP3.

Achievements and Roadmap

- Based on STFC funded project at Institute of Gravitational Research
- Project provided an additional market to existing KTP project commercialising bonding.
- Gooch and Housego competing with very few companies worldwide offering adhesive free bonding.
- Many potential applications for technique in space, industrial, big science and other market spaces

Roadmap

- Vibration testing of existing design
- Build further prototypes
- SSTL and G&H investigating funding options