

Noise prototype (etc) update

LSC, March 2007

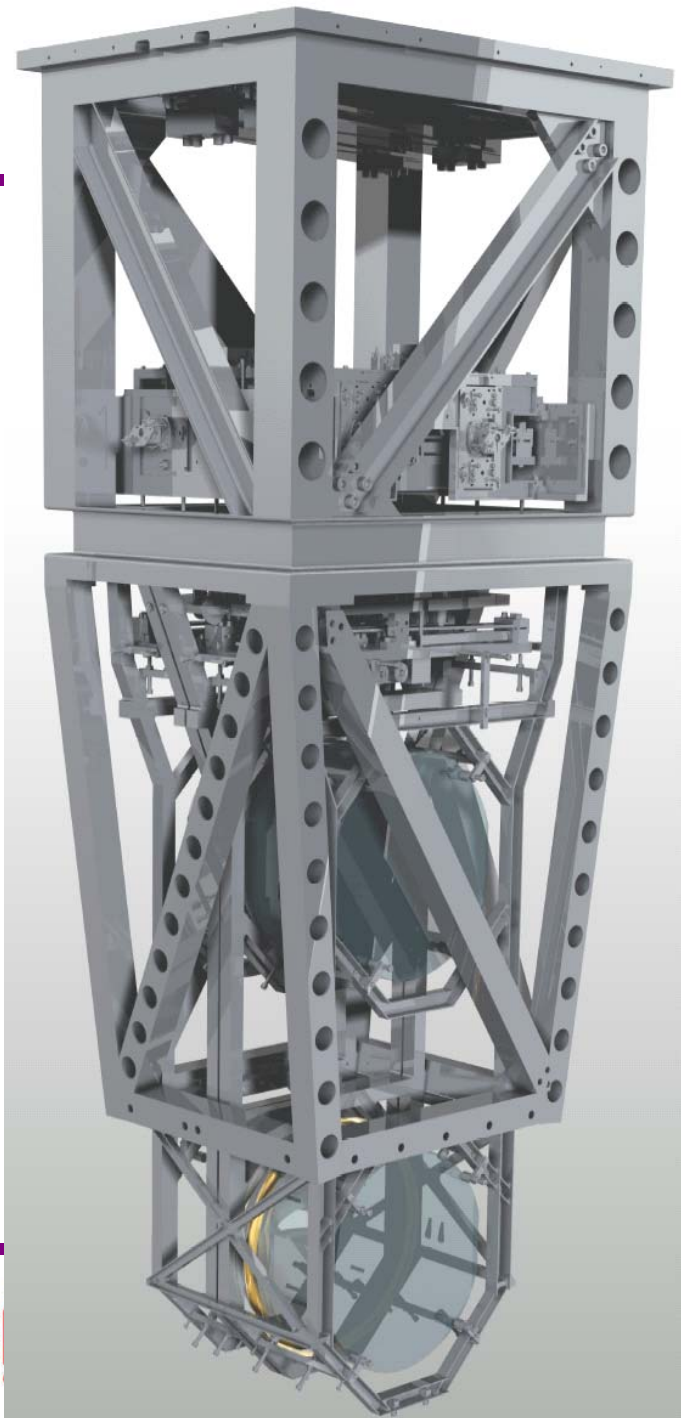
Justin Greenhalgh and suspensions team

G070061-00-K



Topics

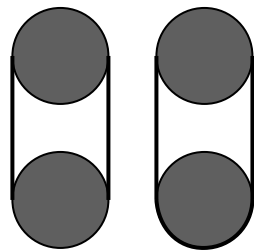
- Noise prototypes (ETM/ITM)
 - Non-metal masses etc (Glasgow)
 - Metal parts (RAL)
 - Electronics (Birmingham)
 - CP, baffles, ring heaters
 - Current thoughts on test plans
- Folding mirror + beamsplitter
 - Structures
 - Conceptual design
- Backup
 - Welding aluminium problems
 - Polishing glass problems



What are the UK noise prototypes?

- Two suspensions being built; ETM/ITM type quad suspensions
 - One dirty
 - All metal
 - Stays at RAL
 - Parts fit check and “test bed” for use if issues arise during LASTI tests
 - One clean
 - Delivered/assembled at LASTI
 - Will include full glass suspension
 - Configurable for
 - all metal or
 - ETM (with ERM and ESD) or
 - ITM (with CP)

Noise prototype configurations

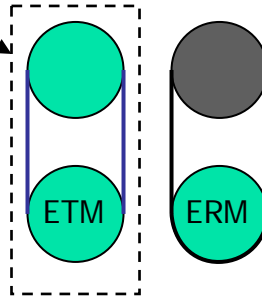


T R

All metal

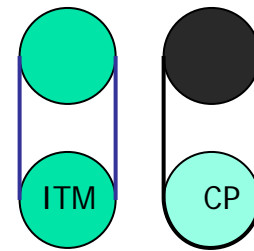


Monolithic
final stage



T R

ETM



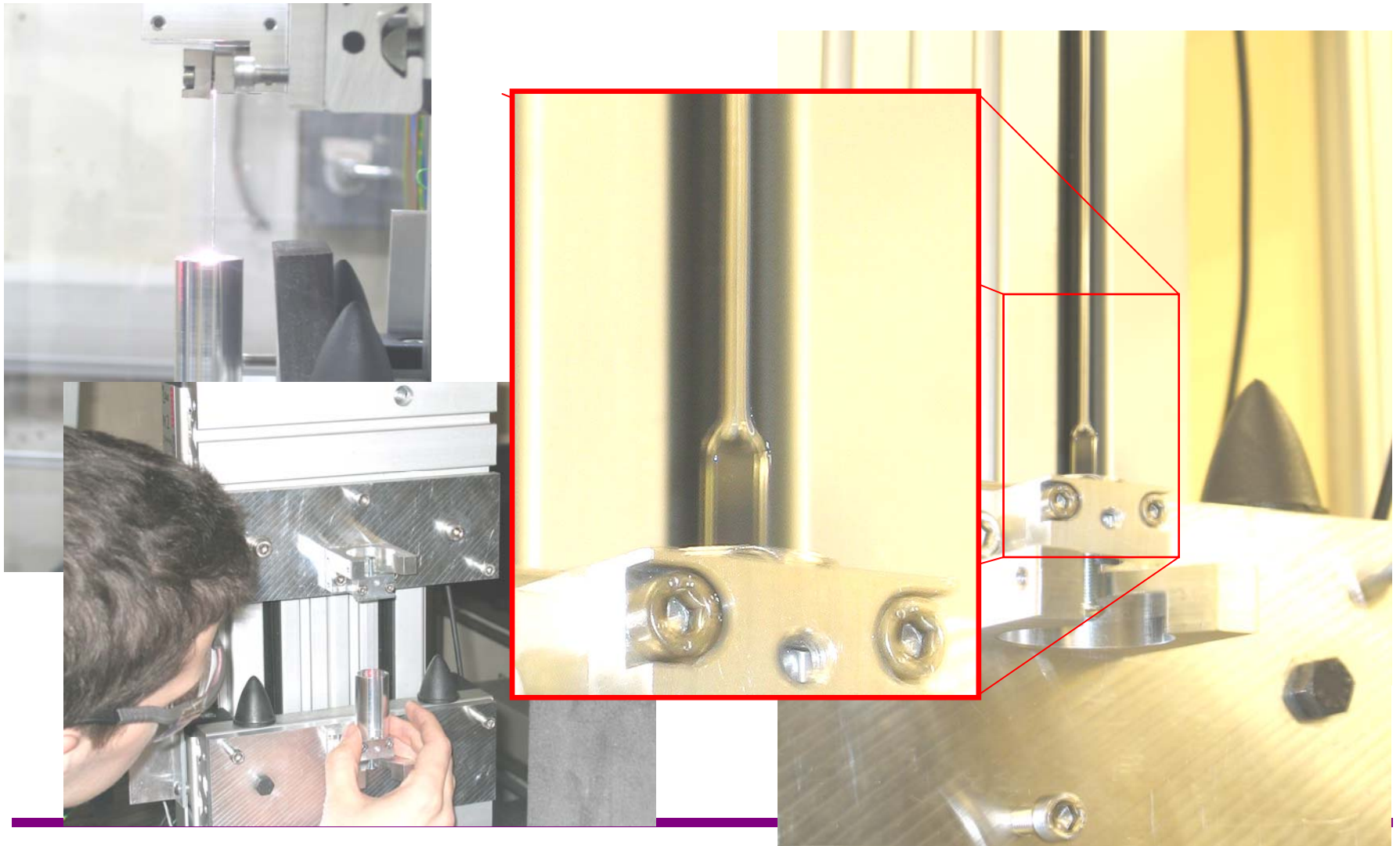
T R

ITM + CP

Progress on noise prototypes (Glasgow)

- Ribbon pulling and welding
 - Ribbon pulling had suffered setbacks especially from lack of stability in the laser.
 - New stabilisation system has made a big improvement
 - We are already confident we can make ribbons suitable for the noise prototype and work is focussed on refinements.
 - Welding results also promising

Noise P-Type ribbons being pulled at Glasgow



Progress on noise prototypes (RAL)

- Mechanical parts
 - Nearly all parts have been bought, dirty assembly is nearing completion at RAL
 - Missing parts are
 - the earthquake stops which require special materials, being produced in UK and US, will be ready in time for clean assembly at LASTI.
 - The “sleeve”; a welded aluminium part
 - Cleaning is progressing well, with most parts being cleaned in the UK and larger parts being checked in the US (too big for UK RGA facilities).
 - Latest estimate for delivery to LASTI is mid April



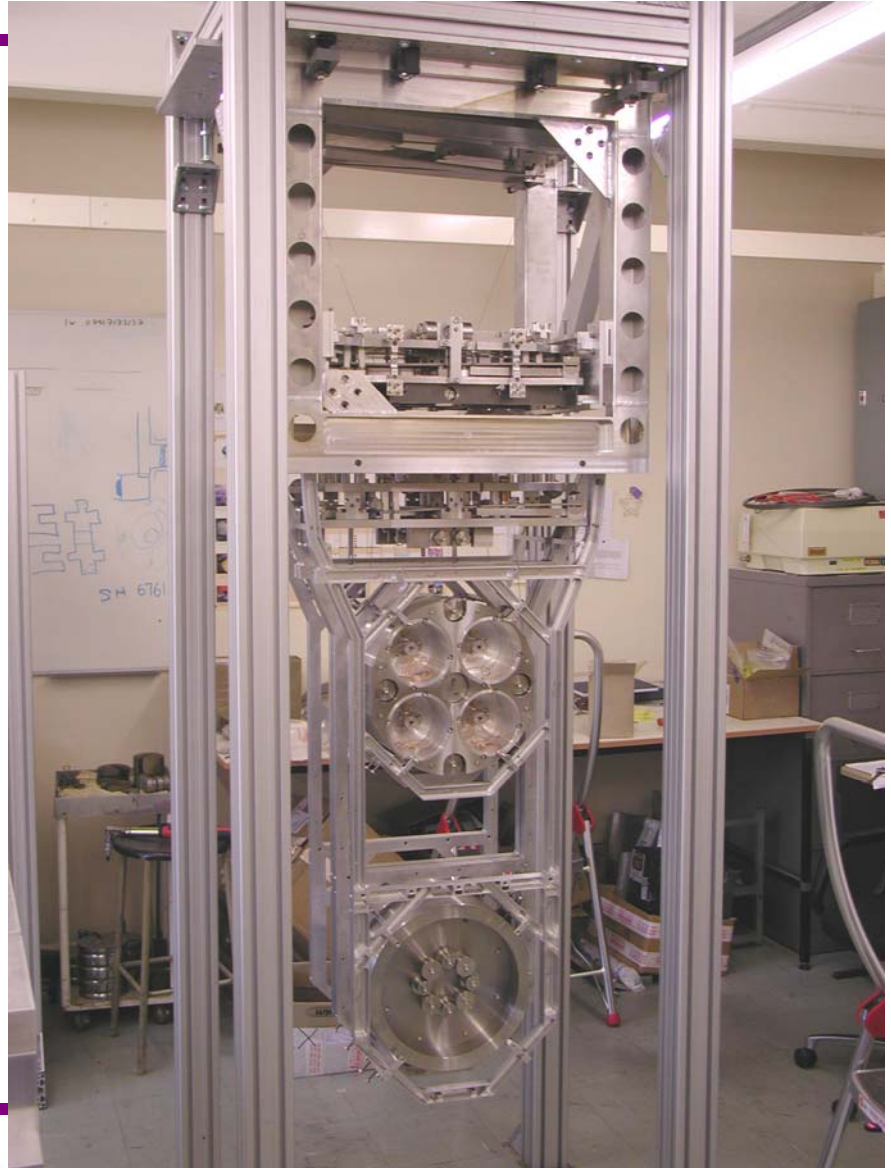
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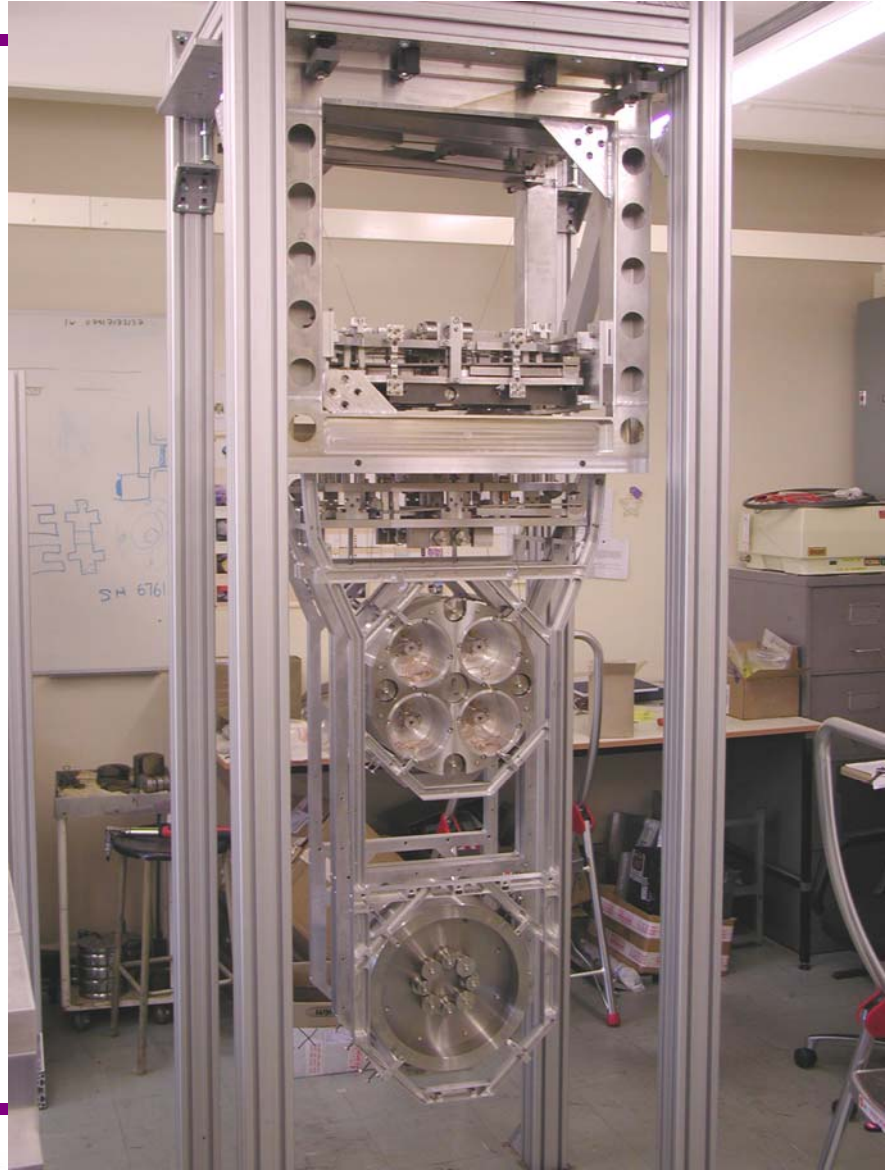
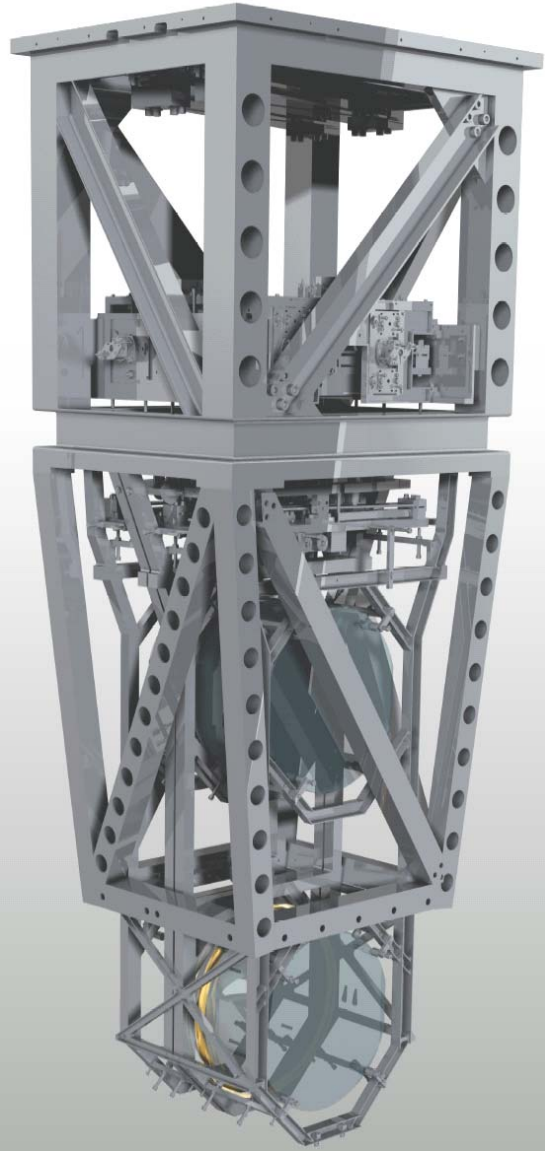
Noise P-Type "dirty" assembly at RAL



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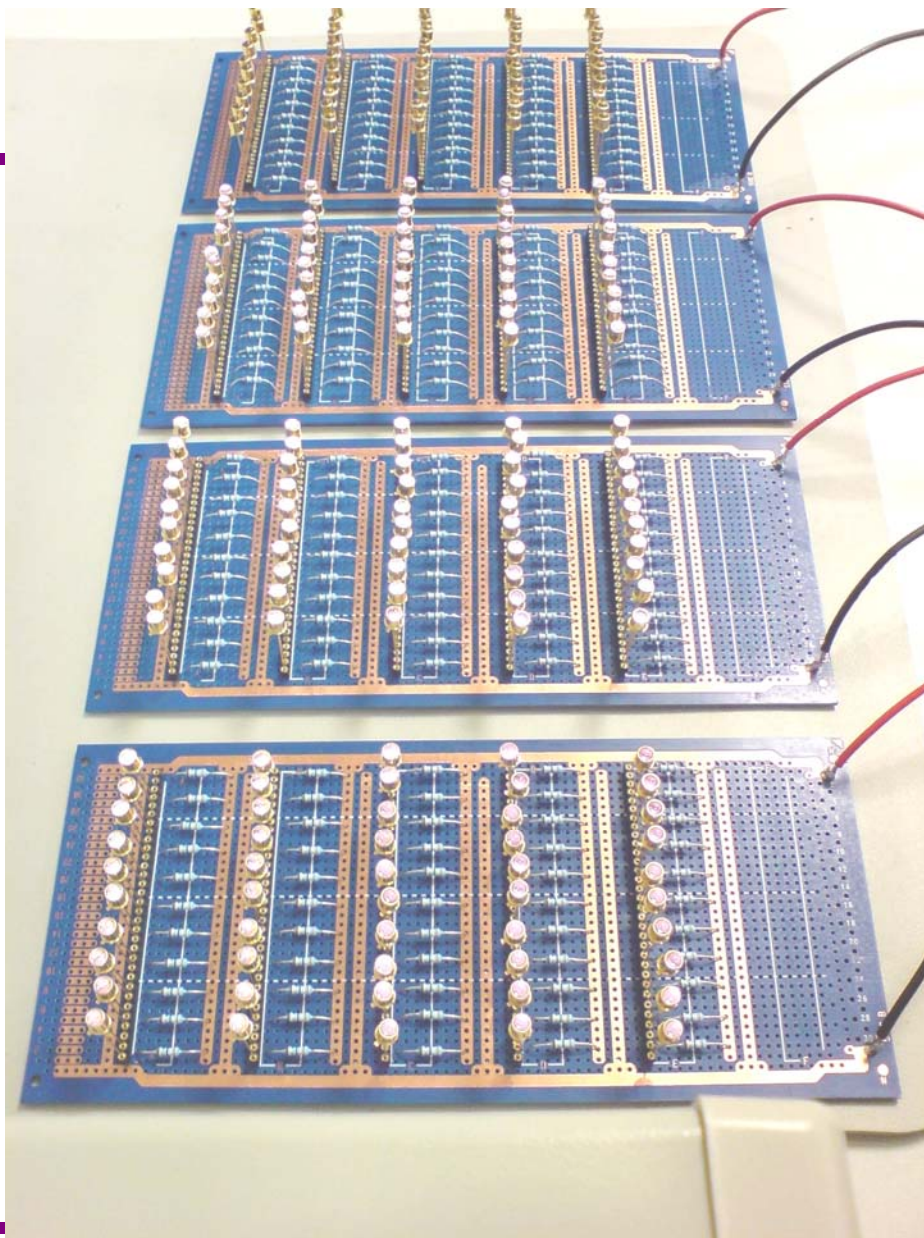
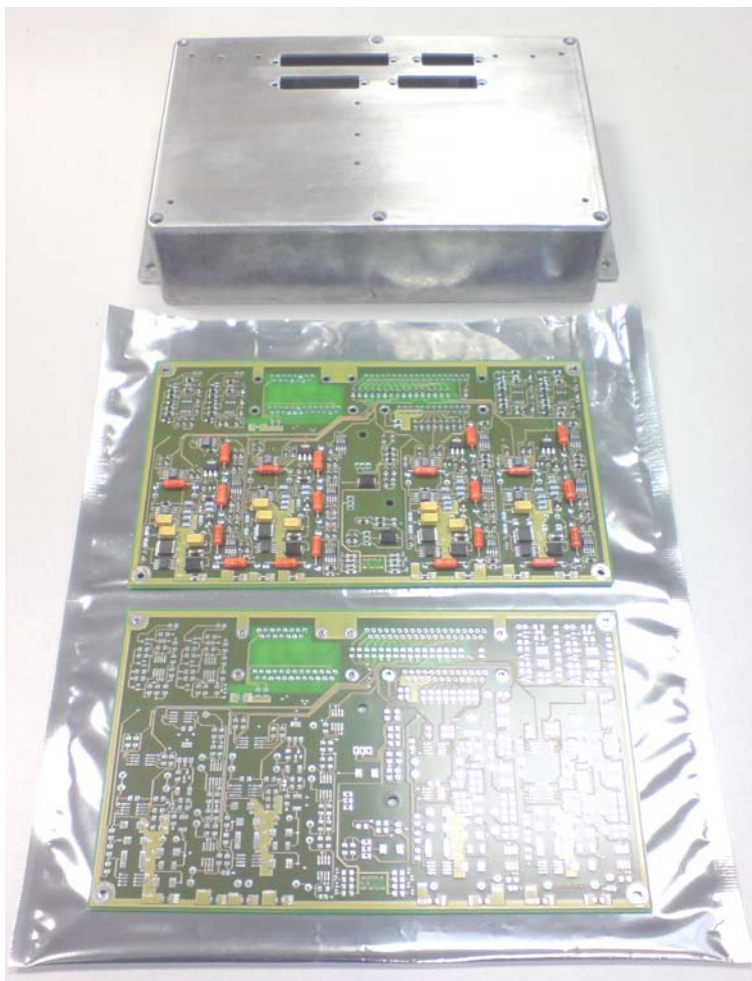
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Progress on noise prototypes (BHam)

- Electronics and actuators
 - OSEMs - all parts now bought
 - There has been a delay with the IRLEDs, which we required to come from a single batch in order to ease pre-selection. They have since arrived at Birmingham and burn-in for all units is day sfrom completion. Screening of parts is now underway.
 - “Satellite box” provides local amplification for the sensor signal
 - Layout complete and parts purchased, prototype assembled and testing underway; on track for LASTI tests
 - Coil driver electronics
 - Design nearing completion, weekly US/UK meetings; on track for LASTI tests
 - ESD electronics
 - Prototyping complete, final design complete; on track for LASTI tests.



Elect. pictures



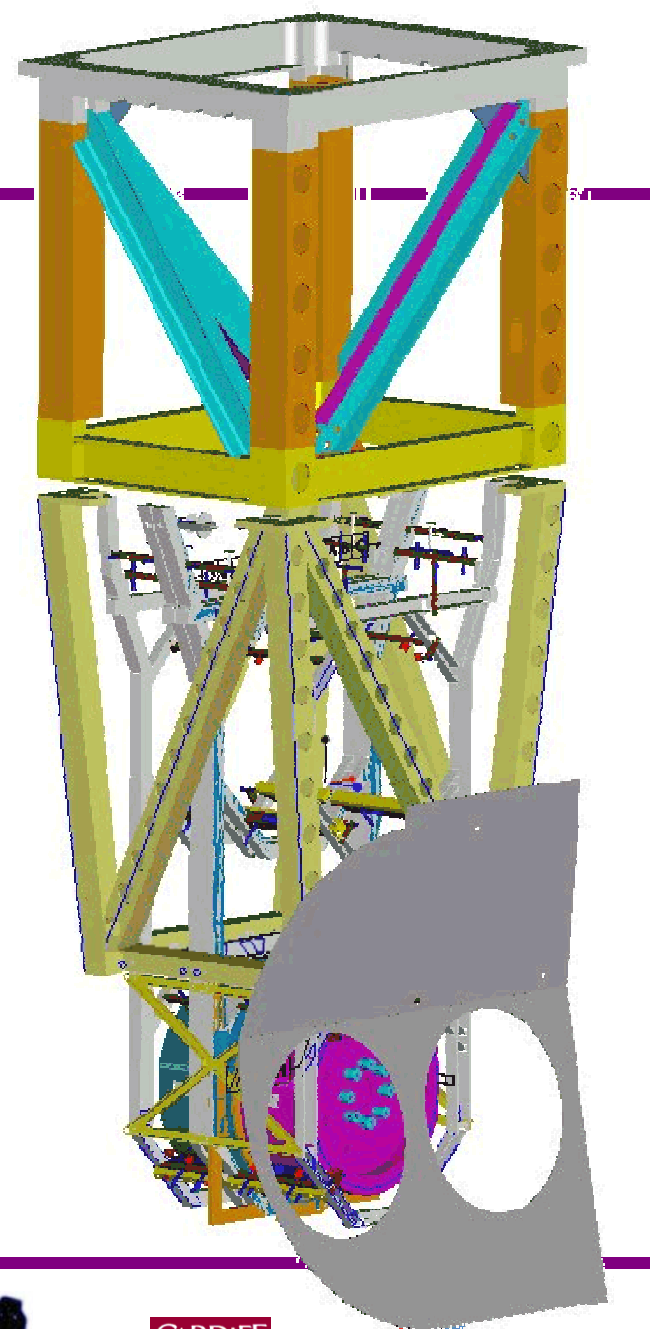
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Non-UK components

- Work in hand on CP production
 - Plan to deliver to LASTI in Oct/Nov 2007
- Baffles suspended on wires to avoid adding mass to the SUS structure (would lower natural frequency by ~6 Hz)
 - Plan to deliver to LASTI in July 2007
- Ring heaters now to be fitted on ETM
 - Issue about parasitic heating of SUS structure (causes dimensional changes)
 - Plan to deliver to LASTI by May 2007 (in time for all-metal assembly)
- Regular discussion of schedule at SUS meetings, next one due soon.



Test plans

- Document in draft setting out what tests are to be done (NAR)
- Required before start of OJEU (tender) process
 - Fit check on clean metal assembly
 - Installation test
- Required before placing production contracts
 - Structure frequency measurements with SUS + ISI
 - Assembly with glass
 - Thermal test with ring heater
- Other tests for risk reduction downstream/minor production contracts
 - Pendulum frequency measurements
 - Functional electronics test (pigtail + OSEM + drive electronics + satellite box)
 - Damping tests, ECD test
 - Cavity tests

Short-term LASTI plans (work in progress!)

- Mid - end April
 - Delivery of mechanical parts to LASTI
- May
 - Assembly of all-metal SUS at LASTI (including ring heater)
- June
 - Assemble all-metal SUS to ISI, frequency tests
 - Bonding of ears (cure ~1month, during June)
- July
 - Install ISI + all-metal SUS to tank
 - Assemble monolithic final stage (ETM type)
 - BHam drive electronics available: functional test of electronics
- August/September
 - Install glass suspension to ISI, install to tank
- October
 - Test of ring heater



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Other UK Suspensions

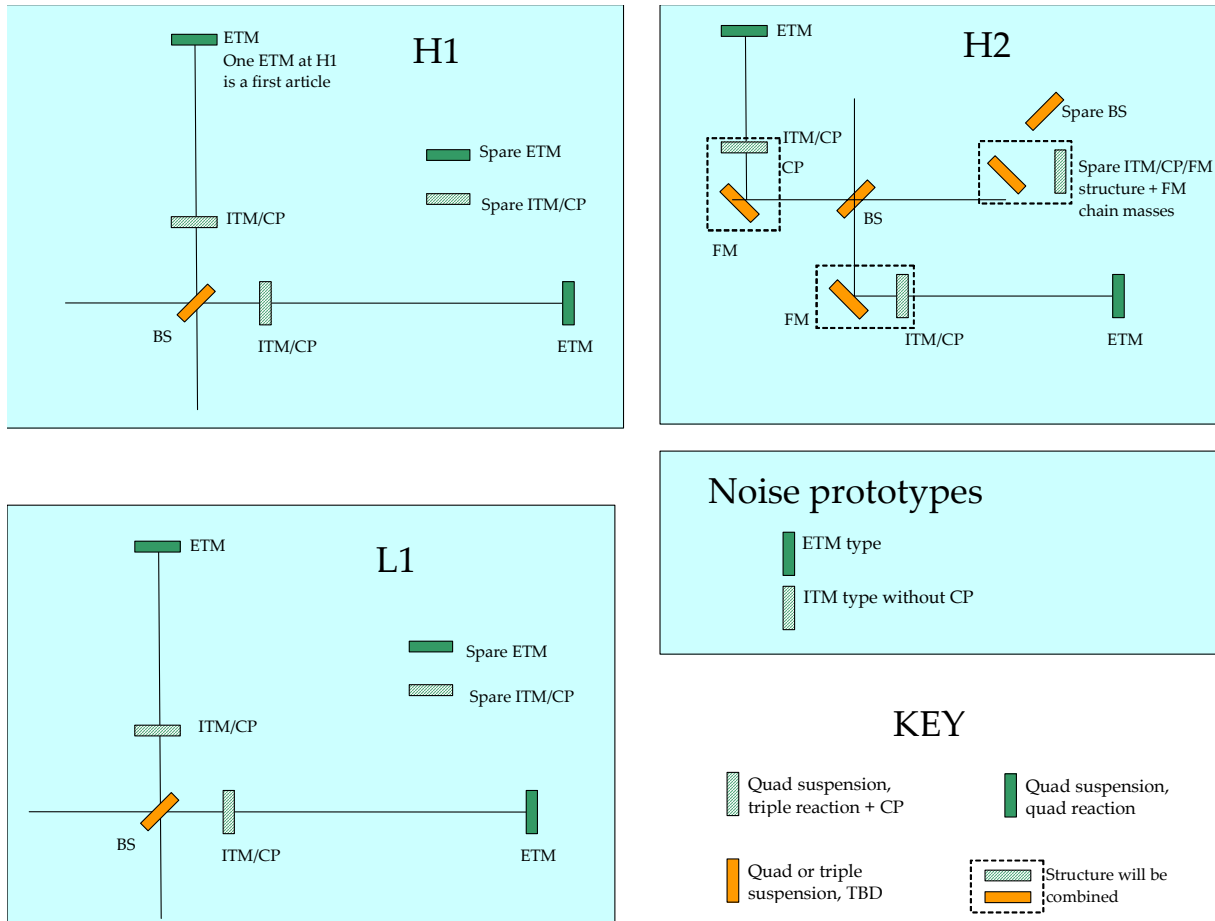


Figure 2 – SUS types in ALUK

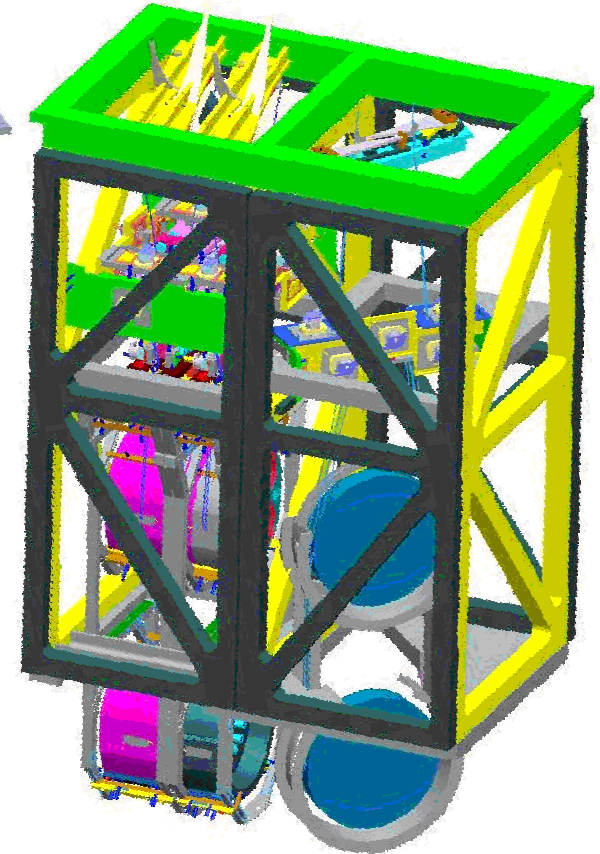
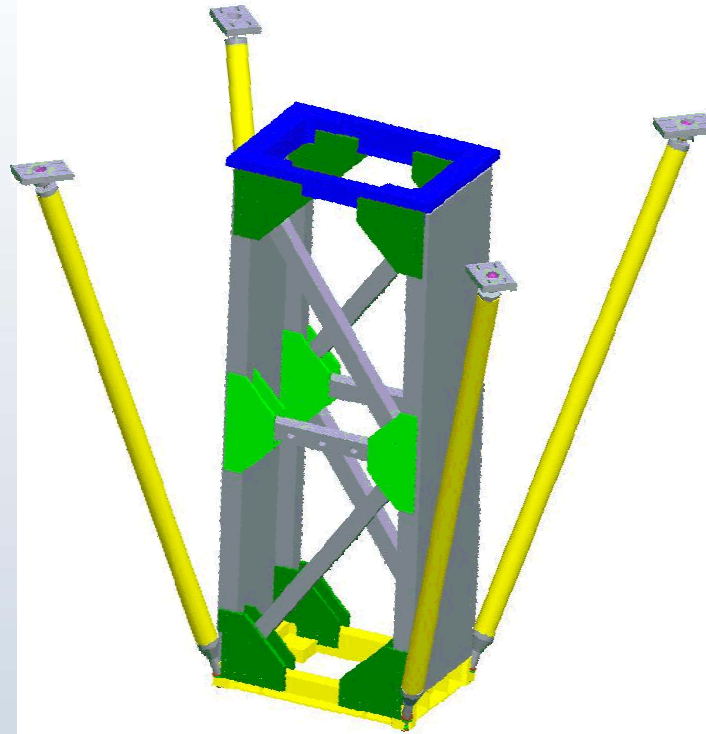
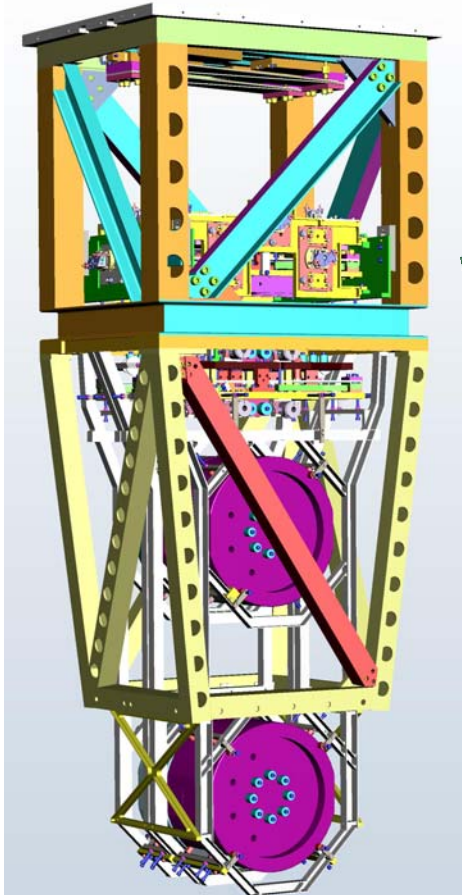
Note: non-metal masses spares are slightly different from the spare suspensions shown here. See addendum 4.

Folding mirror and beamsplitter design

- The requirement for the lowest structure natural frequency is between 70 and 80 Hz.
- Experience on ETM/ITM was that FEA predictions were optimistic by about 20-30%.
- We believe we understand some of the features (bolted joints and poorly-designed interfaces) that led to the difference.
- Bolted joints can be bad for stiffness but welded Al joints are hard to make with UHV compatibility.
- Current FEA predictions for the new structures are approximately 80-100Hz in each case.
- **NB Need closure soon on conceptual design of BS/FM!**

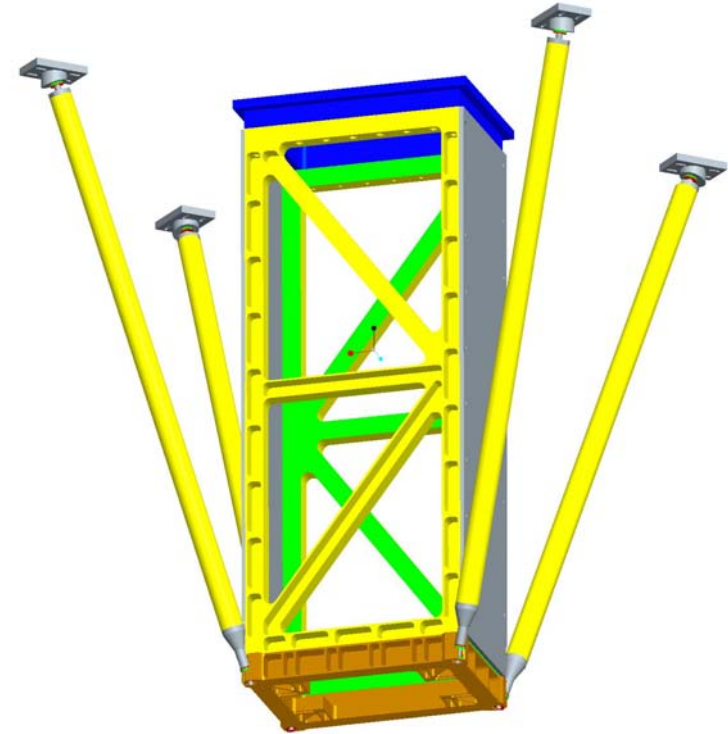


Images of ETM/ITM, BS and FM designs.



FM and beamsplitter tests

1. Frequency test structure for BS structure, featuring fully bolted structure
2. Frequency and assembly test for BS, featuring integrated side plates machined from solid (eliminates some joints)
3. Frequency and assembly test for FM, design influenced by results of tests above.



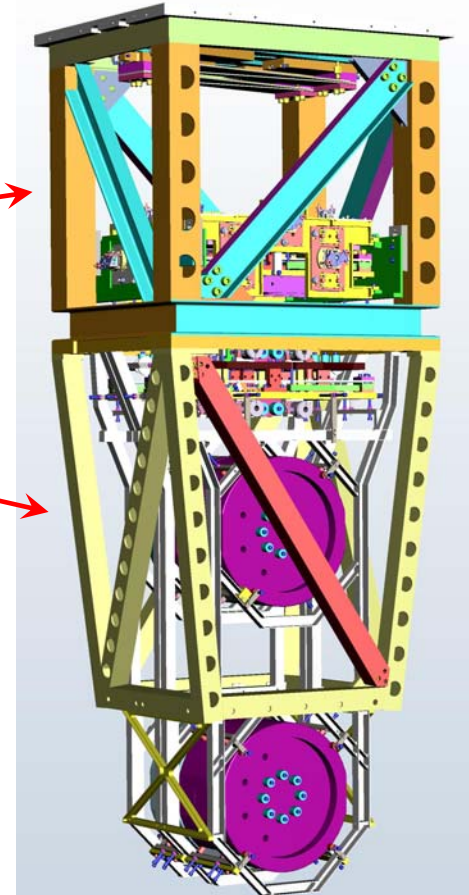
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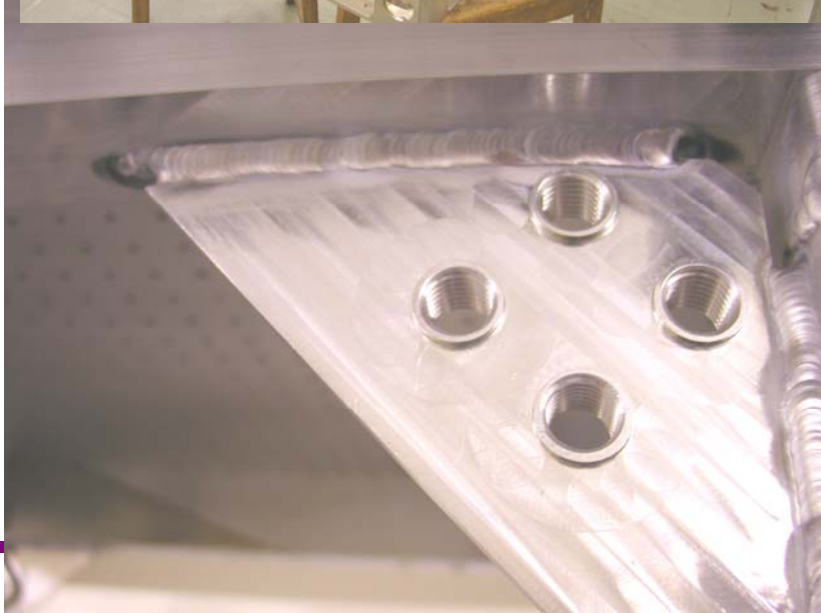
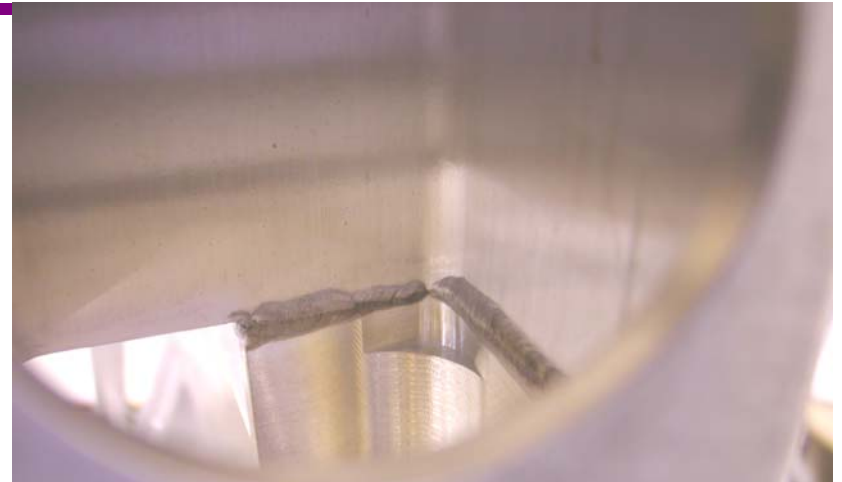
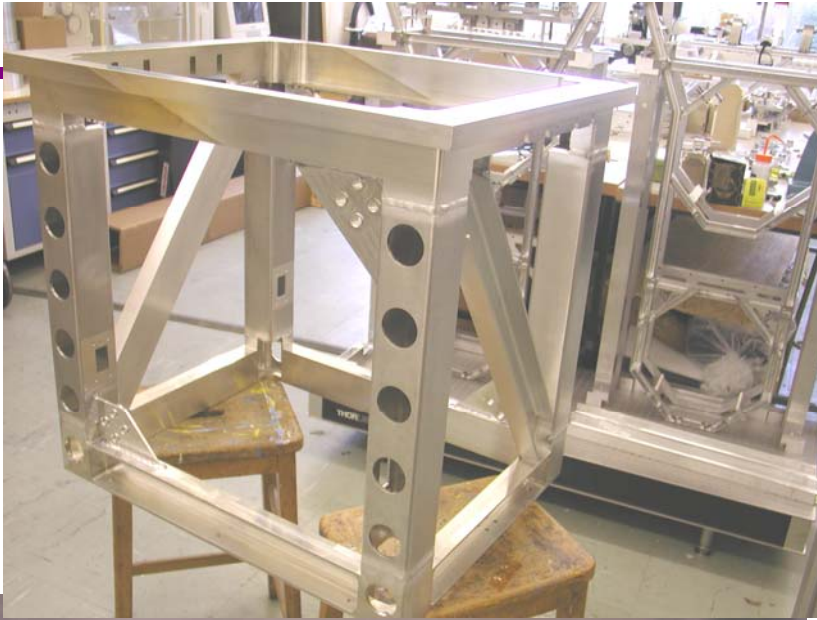


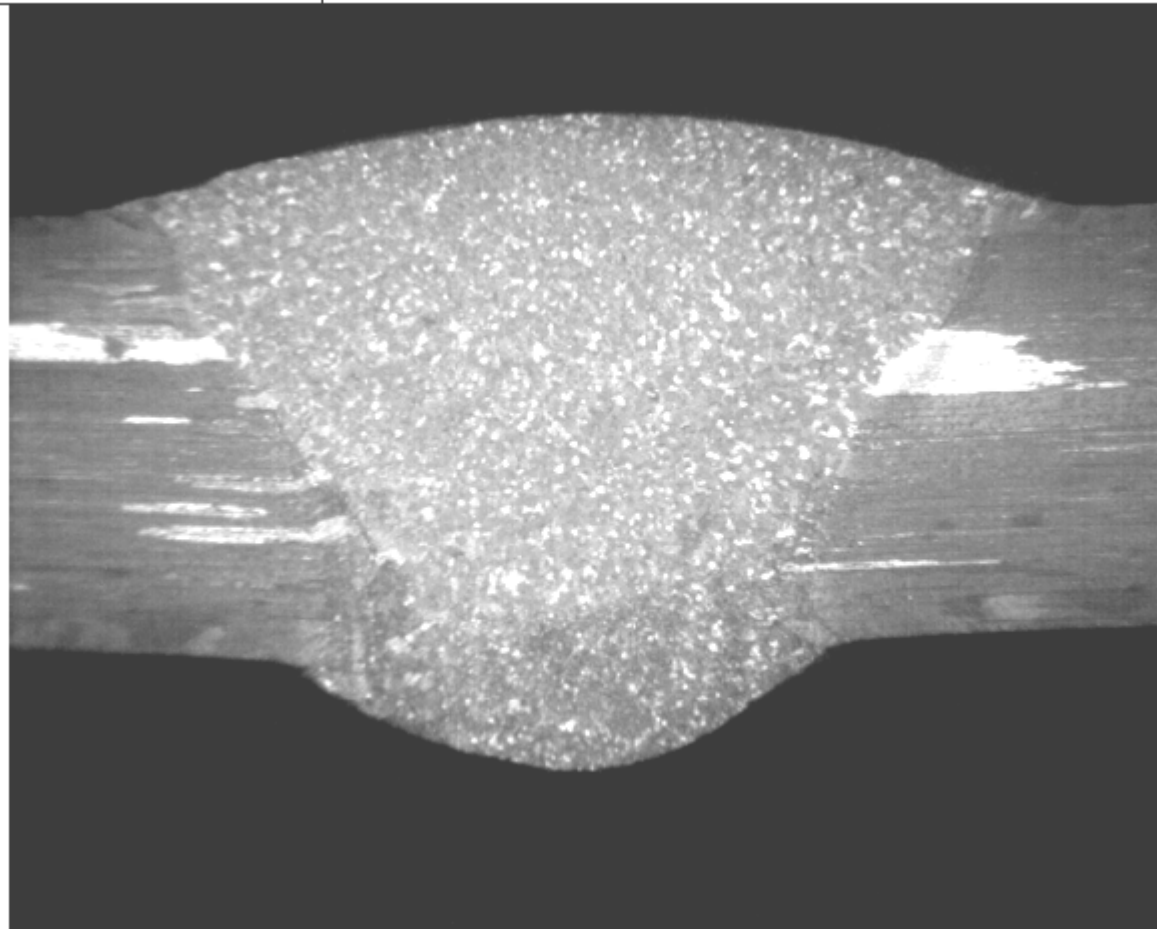
Problems with welding aluminium

- Note there are two weldments in the ETM/ITM structure
- The upper structure
- The sleeve



Weld details - *first* UK structure





F
M
E

Weld Macrosection

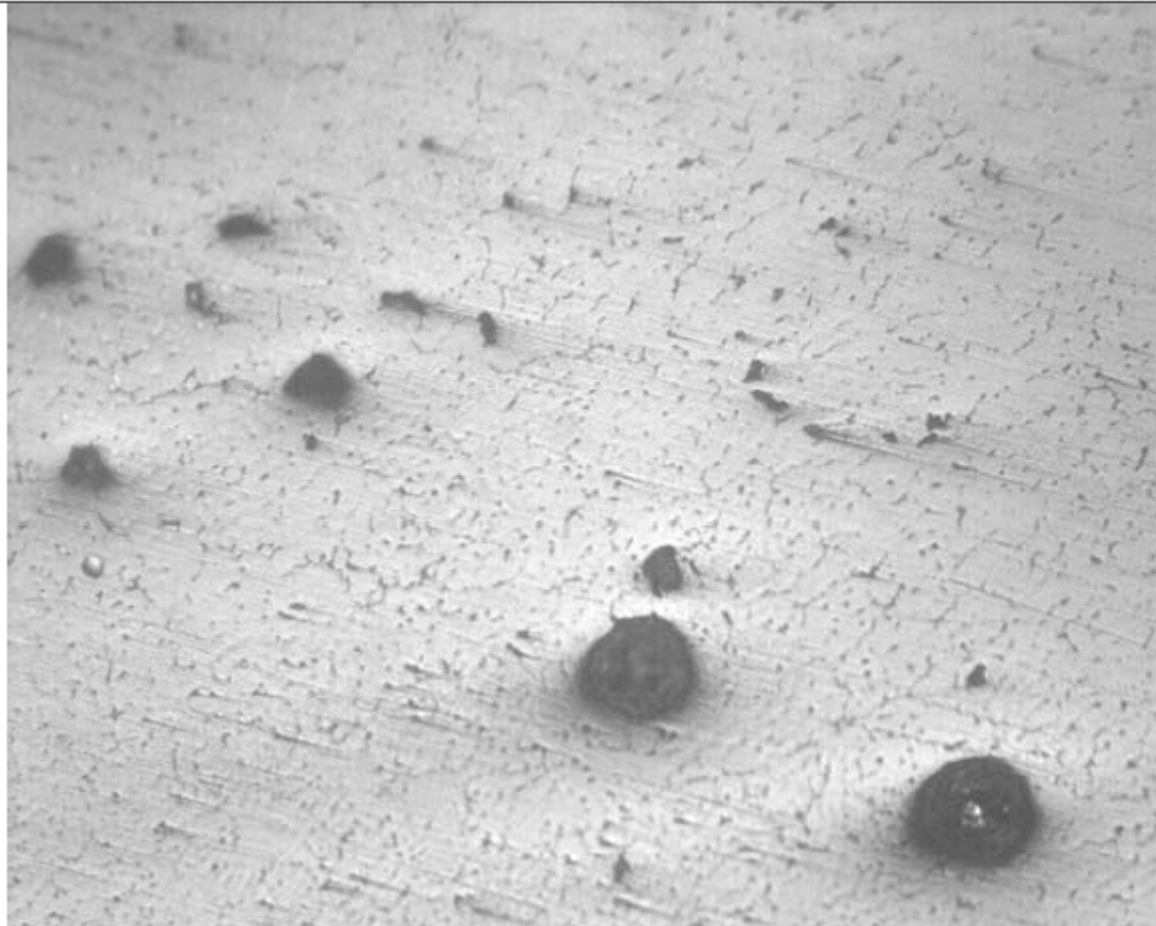


Figure: 2

Magnification: 100

Etch: Kellers Reagent

Weld Microsection - Gas Voids present in the root – Max pore size = 0.08mm

Polishing issues

- Identity of non-metal masses
 - The penultimate (PU) mass fits above the test mass. It is supported by wires and it supports the test mass on ribbons, for which it must have bonded ears. There are two types: the ETM/ITM type and the BS/FM type.
 - The end reaction mass (ERM) is at the end of the reaction chain on the ETM. The ITM, FM and BS do not have reaction masses.

Polishing issues (2)

- Procurement of non-metal masses for the noise prototype
 - The quotations for the small quantities required for the prototypes were high, due to increased costs of final shaping and polishing.
 - Due to the high finishing costs, we negotiated with LIGO to leave the spare for the less-critical reaction mass only partly finished. It was realised that at the higher cost it was not reasonable to use glass masses for welding tests at Glasgow, and metal masses having silica inserts have been procured instead.



Polishing issues (3)

- We are currently analysing the implications of the cost increases.
 - The company carrying out the finishing will feed back information on cost drivers. We remain in weekly contact.
 - Cost drivers are being examined to ensure nothing is over specified, and to allow minor changes that will lower cost for the main production run.
 - The ERMs are already being simplified to reduce the cost of 9 out of a total 32 masses.
 - Until the full analysis is complete we are reporting a moderate risk of incurring a large cost increase on the PMs.
 - We expect both cost and uncertainty to decrease in the coming months.