T080239_Report on visit to MIT (4th – 9th August 2008) as part of NP-type Monolithic Assembly Activity

Rev00: (R. Jones, A. Heptonstall AUG 08)

Introduction

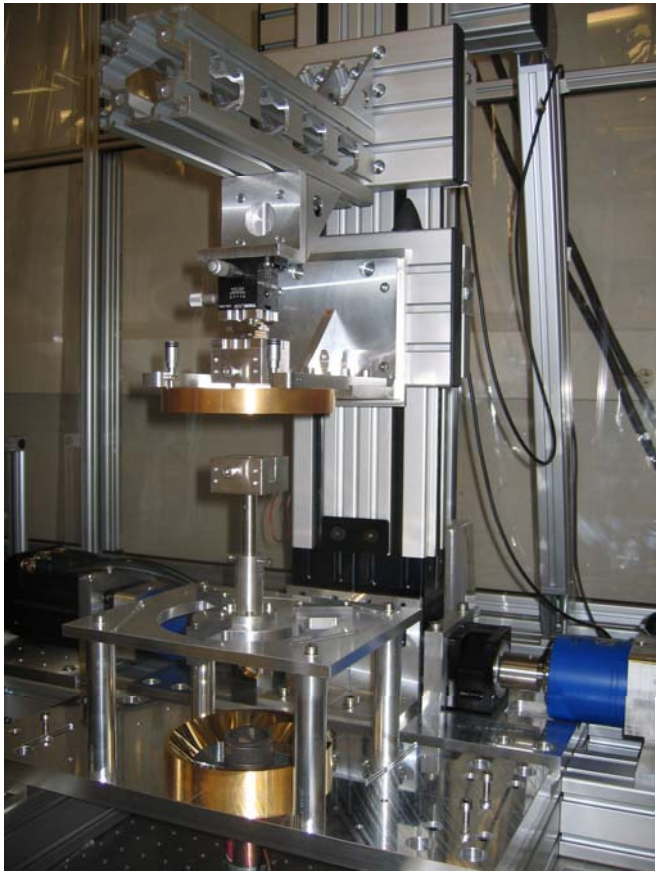
This document is a short visual record of the progress made with the NP-type Monolithic Assembly at LASTI during the week of the 4th – 9th August 2008.

Alastair Heptonstall made sure this work was summarised on the LASTI iLOG throughout the duration of the visit.

Acknowledgements

Rich, Myron, David, Gregg and Marie in particular for what was a very productive week.

CO2 Laser bench at LASTI: Co2 laser (left), Articulated arm and (galvanometer) "birdcage" (centre), Pulling Machine (right)



Pulling Machine (close-up)

Visit Goals and Summary

The purpose of the visit was as follows:

1. Compile TOOLING / ASSEMBLY EQUIPMENT CHECKLIST to check the status on all required parts for the Monolithic Assembly [**COMPLETED**]
2. Set-up and demonstrate the use of the storage set-up for the final fabricated silica fibres for the NP-type [**COMPLETED**]
3. Set-up and demonstrate the use of the Fibre Cutting Jig [**COMPLETED**]
    i. Cut a fibre
    ii. Perform/observe test welding: particular attention to the interface with the prototype Alumina Pusher
    iii. Transfer cut fibre (in bow) to structure and produce a weld from that set-up
4. *__OBSERVE THE WELDING APPROACH AND THE USE OF THE SUPPLIED TOOLING__* [**COMPLETED**]
    i. Directions of access
    ii. Interface issues / tools required – amendments needed? (recorded in the tooling list)
    iii. duration of task
5. Set-up the Global Welding screens – the final user protection barriers during the welding process [**COMPLETED**]
6. Walk through full Assembly procedure from tank to CO2 laser area and back: Make video records of critical processes and assembly routes [**COMPLETED**]
7. *Test the lever arm clamp [INCOMPLETE]

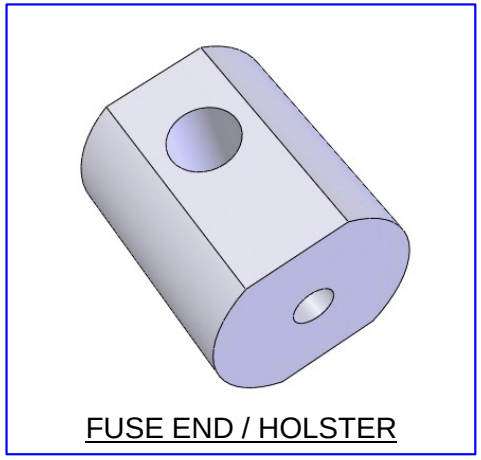
Each of these points will be taken in turn throughout this short report. Nearly all the required tooling from Glasgow has now been transferred to LASTI, and the majority has been tested. The tooling list is to be used as a common reference in the coming weeks, with a traffic light system identifying the low and high priority items. There are several items to be taken up with RAL with regards the tooling list. For example, it is a concern that the lever arm clamp was not tested on this visit, and that there are still arts missing. This will be treated as a top priority.

Videos / pictures / tooling checklist resulting from visit all available at:

http://www.physics.gla.ac.uk/~russell/MIT_4th-10thAugust_Tooling&Assembly_Checks/

(*remember to refresh web-link)

2) (i) Fibre storage concept (D080330)



FUSE END / HOLSTER

FUSE

FIBRE

FIBRE CARTRIDGE

Advantage:

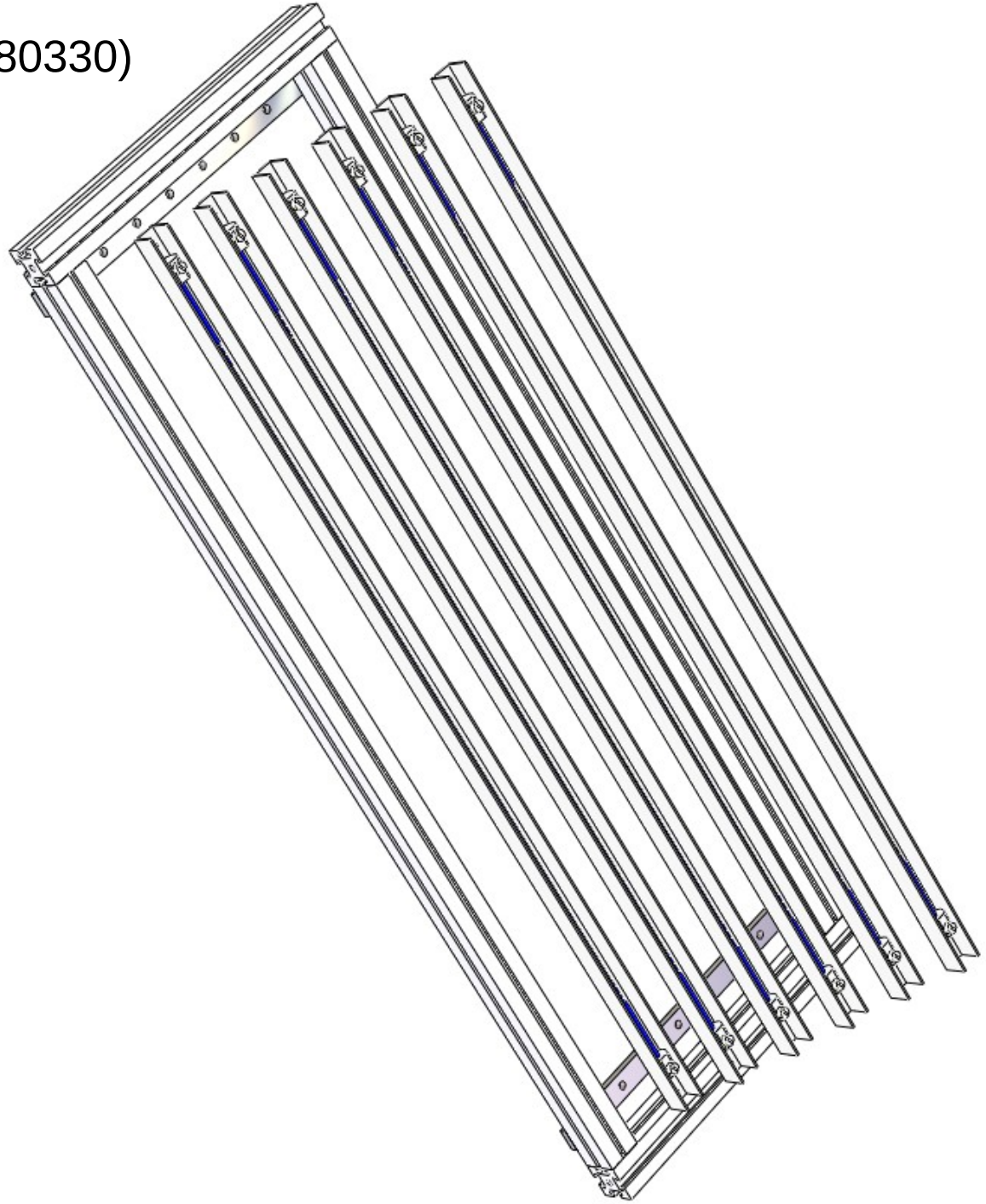
- Minimise handling of glass stock – pre and post fabrication
- Cartridge could be fully enclosed if desired for transportation

2) (ii) Fibre storage concept (D080330)

STORAGE RACKS FOR INDIVIDUAL CARTRIDGES

(6 FIBRES PER RACK)

- PULLED FIBRES PROTECTED INSIDE INDIVIDUAL EXTRUSIONS
- FIBRES FIXED IN WITH SIMPLE BOLT / WING NUT
- RACKS CONSTRUCTED FROM BOSCH ALUMINIUM EXTRUSION



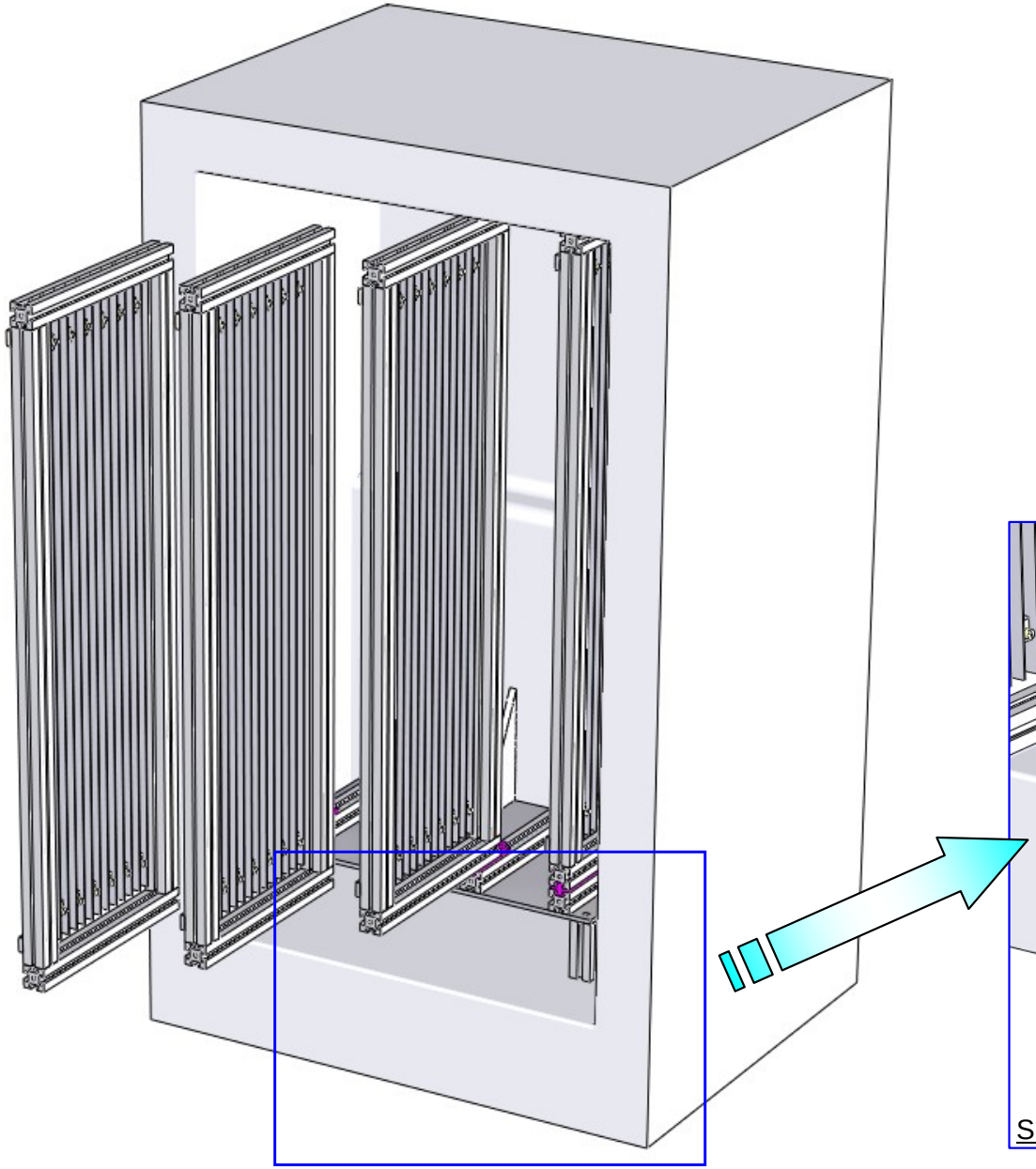
2) (iii) Fibre storage now set-up at LASTI (D080330)

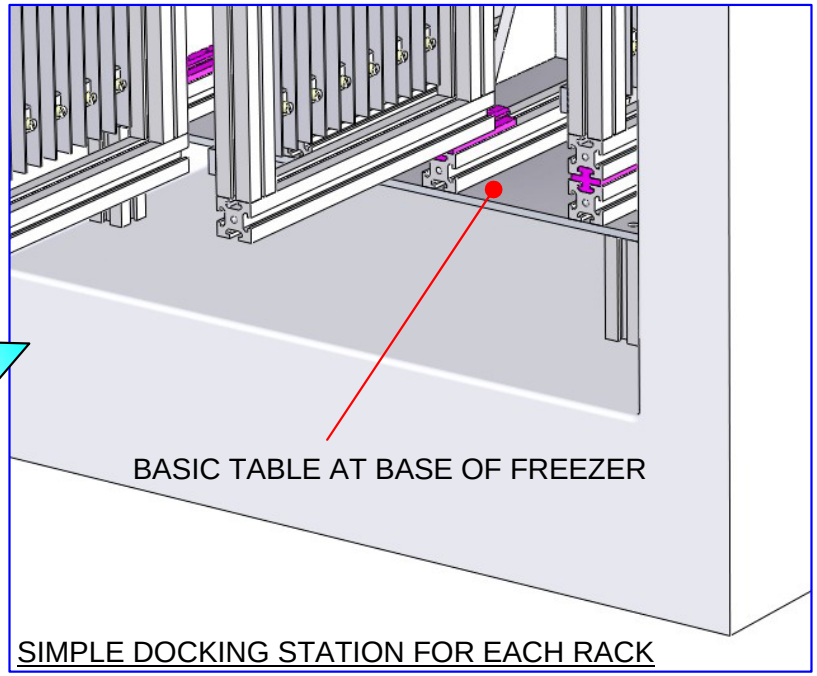
4 RACKS IN FRIDGE FREEZER (24 FIBRES MAXIMUM)

Videos of testing at:

http://www.physics.gla.ac.uk/~russell/MIT_4th 10thAugust_Tooling&Assembly_Checks/D_storage videos/

COMPLETED SET-UP AT LASTI





SIMPLE DOCKING STATION FOR EACH RACK

3) (i) Use of Cutting Jig (described by D080415 and T080169)

Cutting Jig in place beside Characterisation Equipment

Fibre bow: Cut fibre removed from Jig and ready for delivery to the structure for welding

Summary: Using T080169 as a reference, we walked through the use of the cutting jig, and cut an available fibre to length in readiness for transfer to structure for welding.

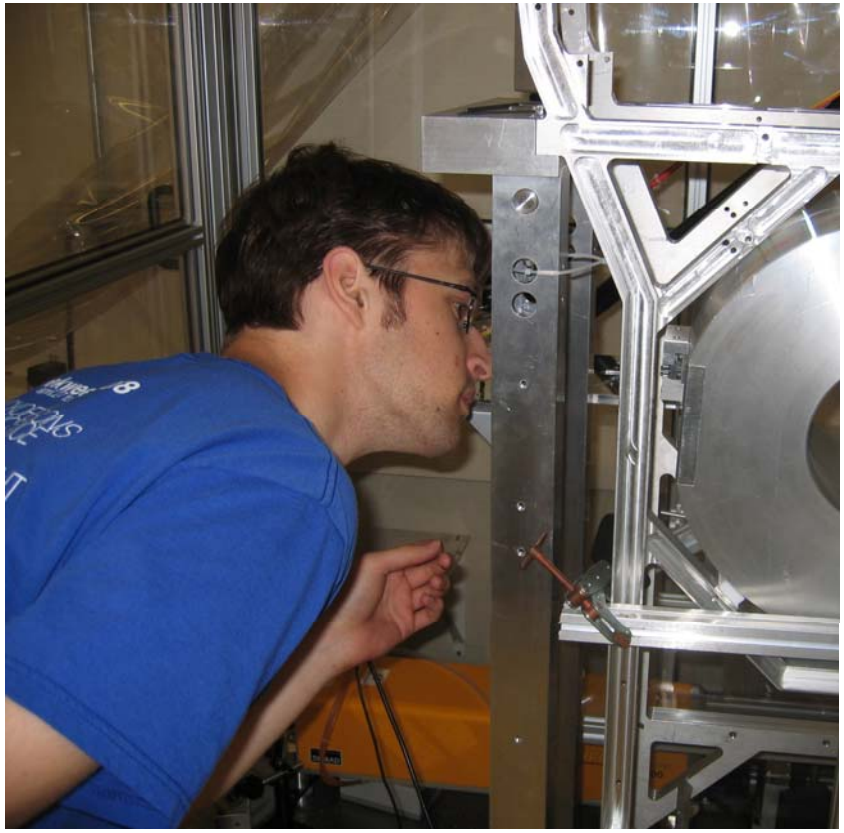
3) (ii) Observing welding in structure: testing the prototype Alumina Pusher

Initial observation was recorded in the following videos (watch in order), available at [link]:

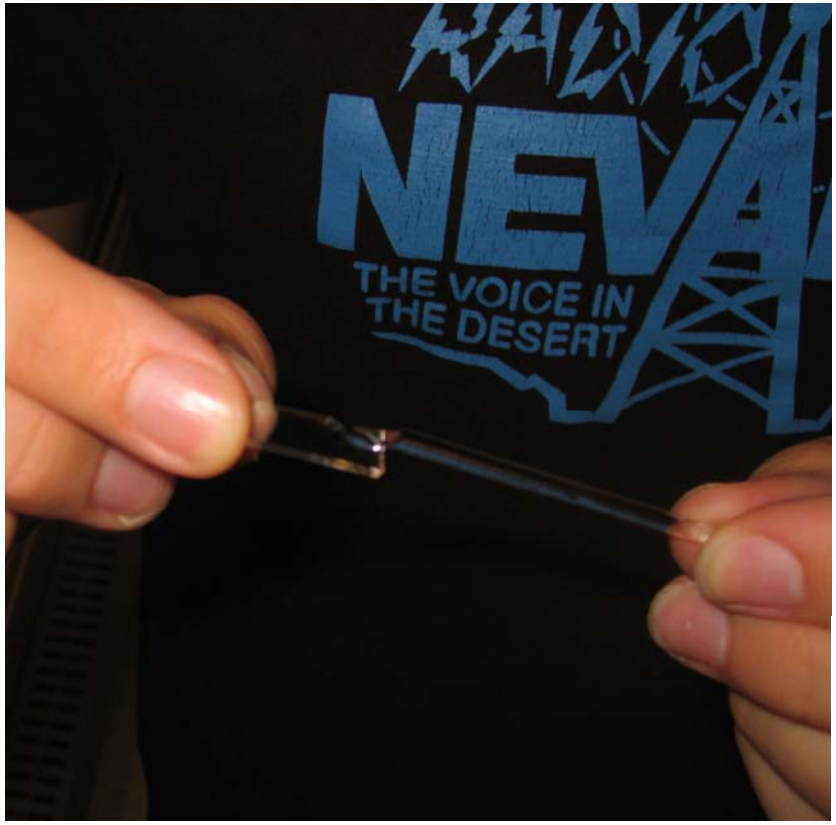
http://www.physics.gla.ac.uk/~russell/MIT_4th-10thAugust_Tooling&Assembly_Checks/C_Welding Videos/

Note: the Lower structure and its assembly tooling were mounted on the optics bench for these first tests of welding within the NP-type Lower Structure

1) A_Testing on Bench_Weld position 1_set-up
2) B_Testing on Bench_Weld position 1_0verview
3) C_Testing on Bench_Onscreen weld position changes_labview benefits
4) D_Testing on Bench_Moving A-Arm to weld position 2

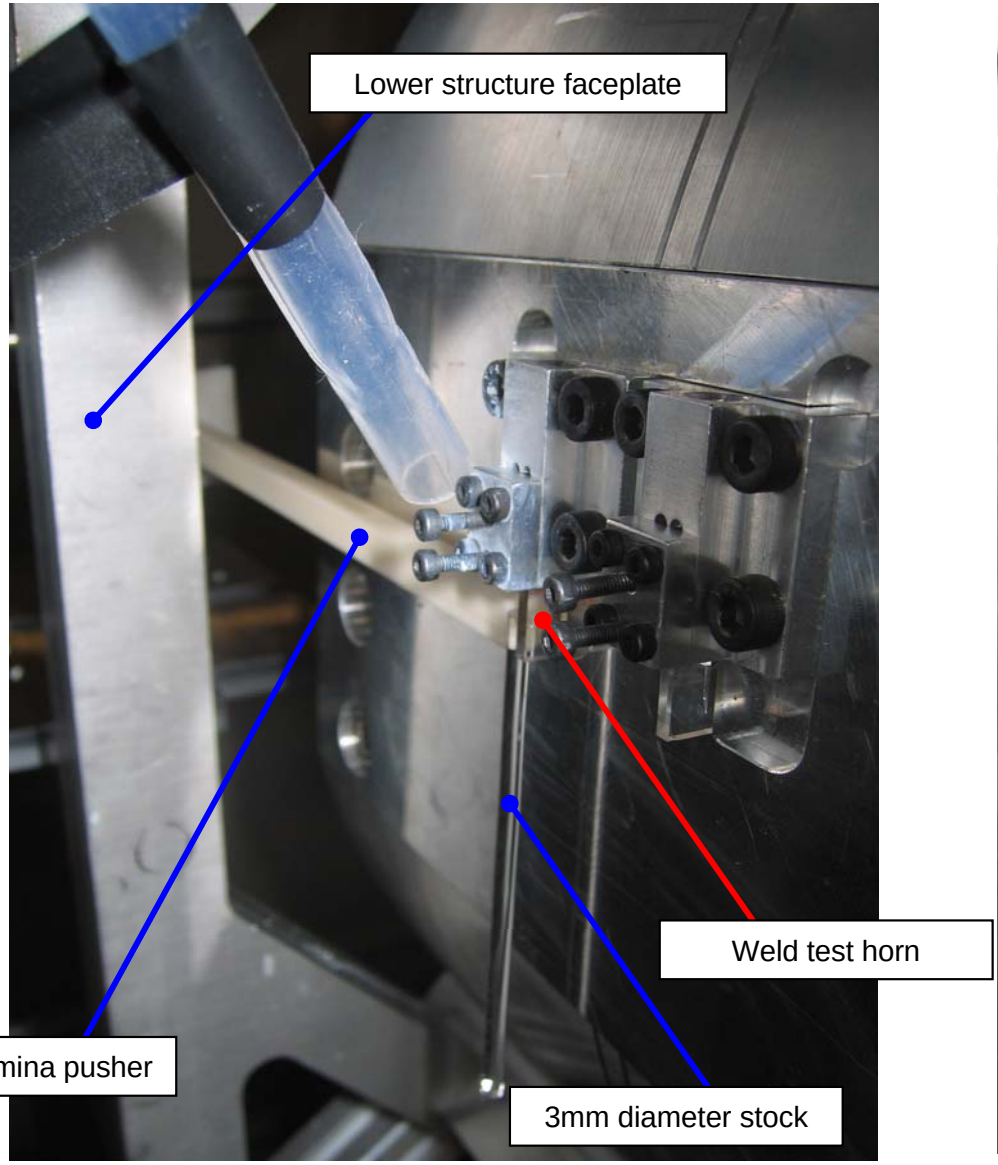


Weld assessment (David)



Welded sample: 3mm stock to a weld test horn (Alastair)

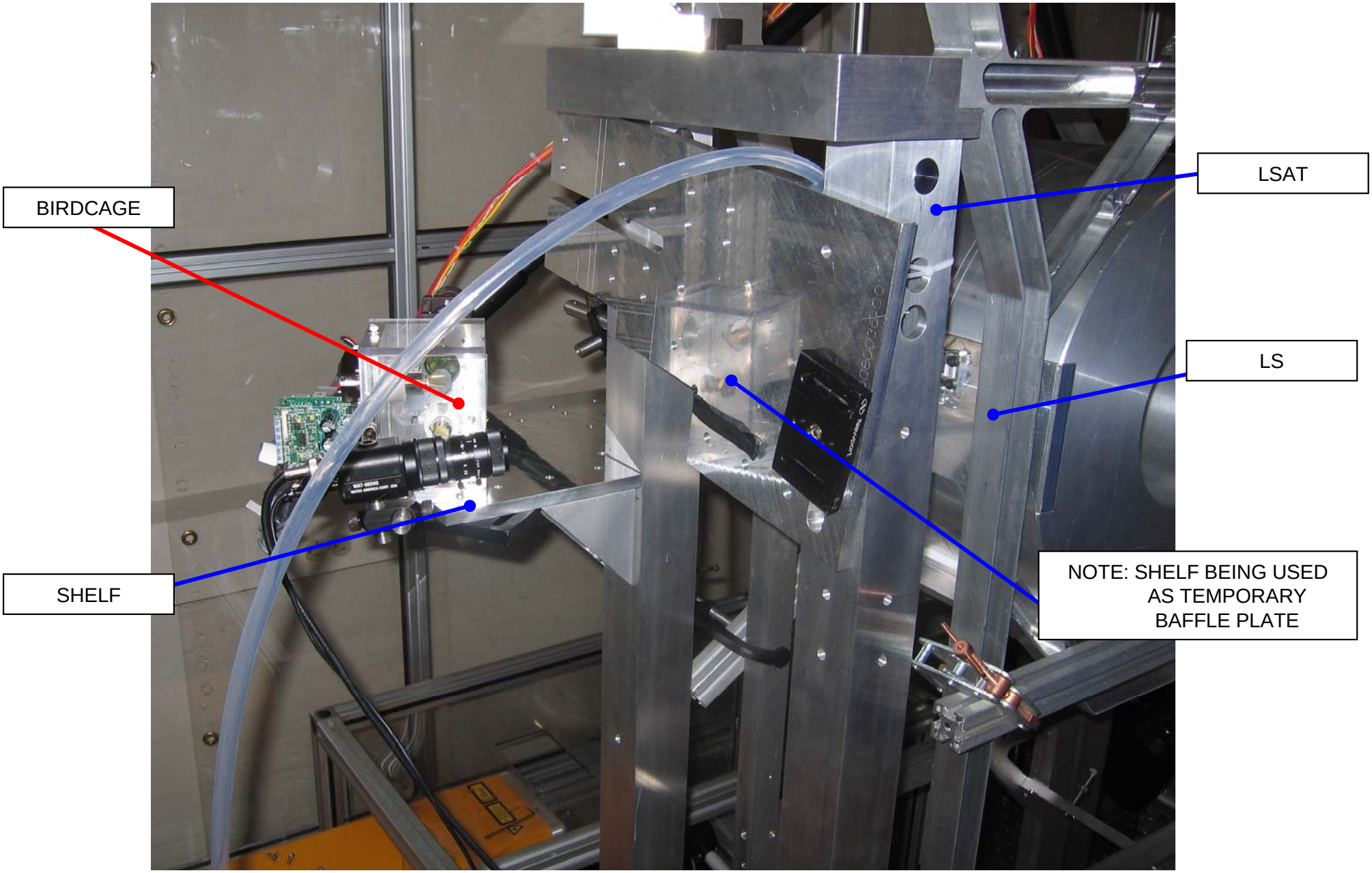
3) (ii) Observing welding in structure: testing the prototype Alumina Pusher (cont)



View through side of lower structure: Alumina Pusher holding 3mm rod onto edge of weld test horn on side of dummy penultimate mass (Extraction pipe in place.)

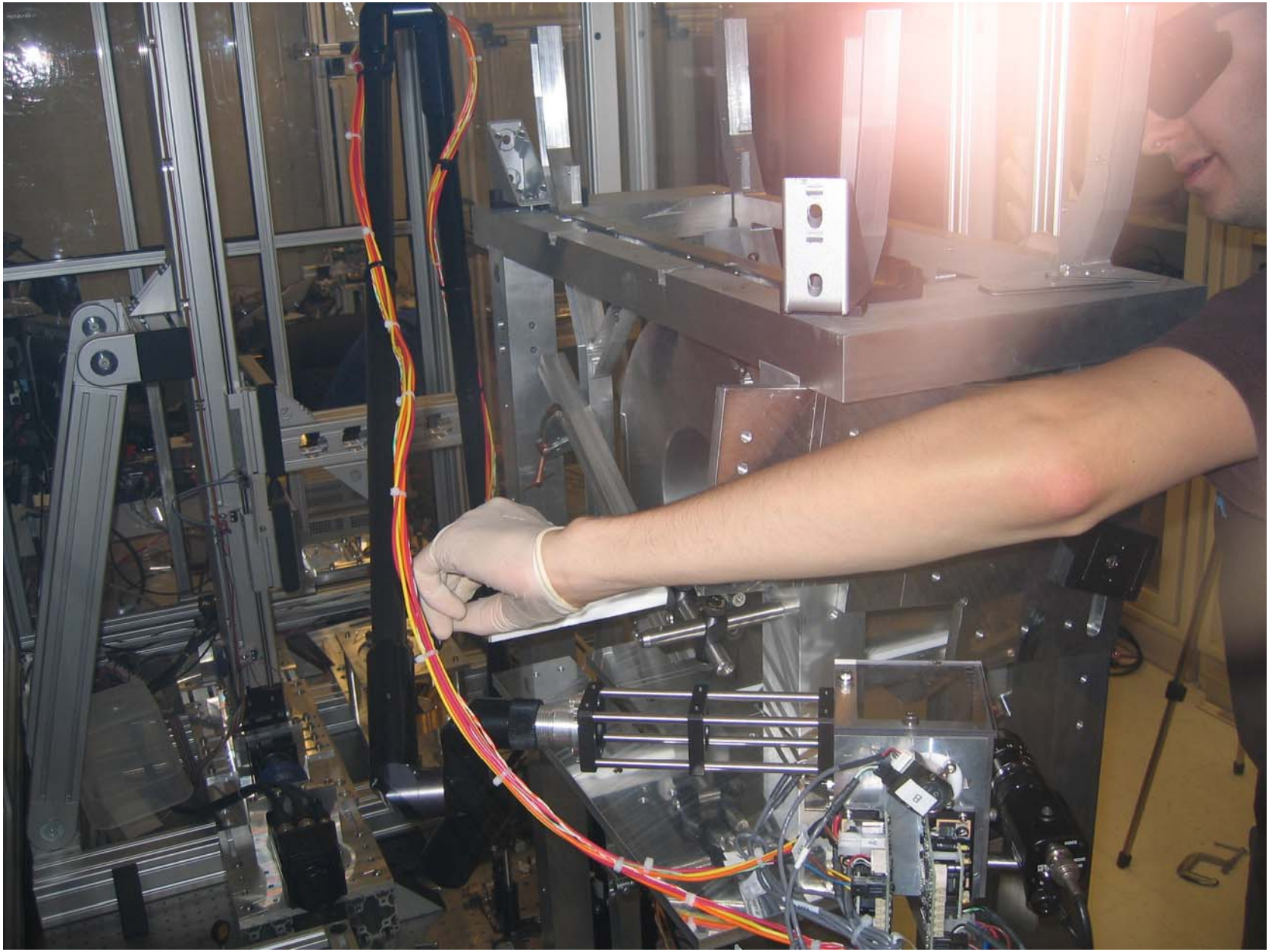
During welding from first welding position of the birdcage (shown on next slide). Extraction pipe and baffle in place.

3) (ii) Observing welding in structure: testing the prototype Alumina Pusher (cont)



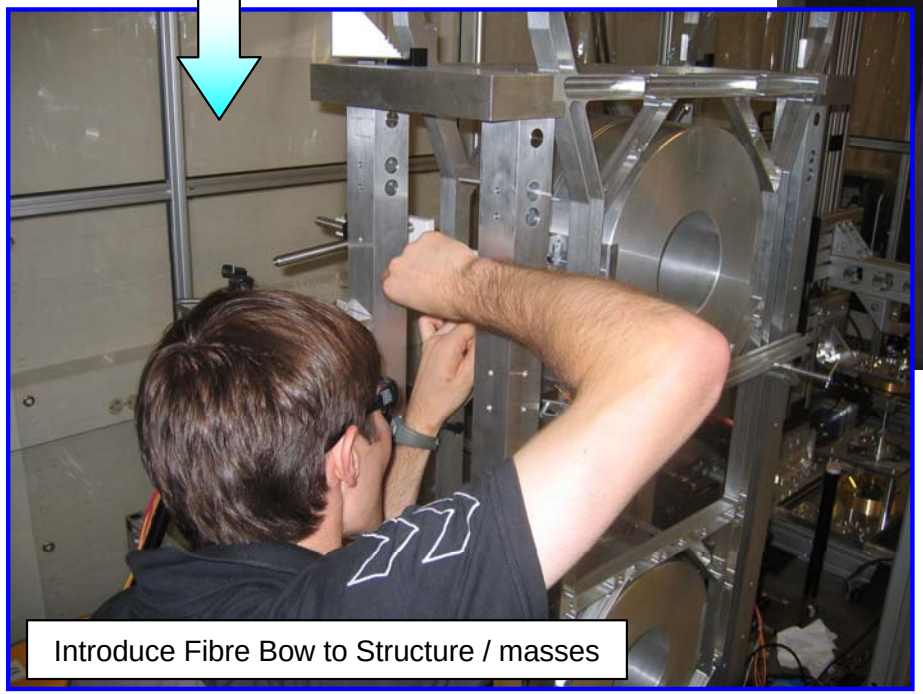
Weld position 1: Angled access through side of Lower structure (LS) / Lower structure assembly tooling (LSAT) to access weld location. Camera attached to Birdcage (D080040). Shelf strapped to LSAT to act as temporary baffle for stray reflections. [Note: birdcage sitting directly on shelf (D080036) so CO2 beam accesses weld location from slightly below horizontal]

3) (ii) Observing welding in structure: testing the prototype Alumina Pusher (cont)



Weld position 1: Alastair adjusting spring resistance on alumina pusher

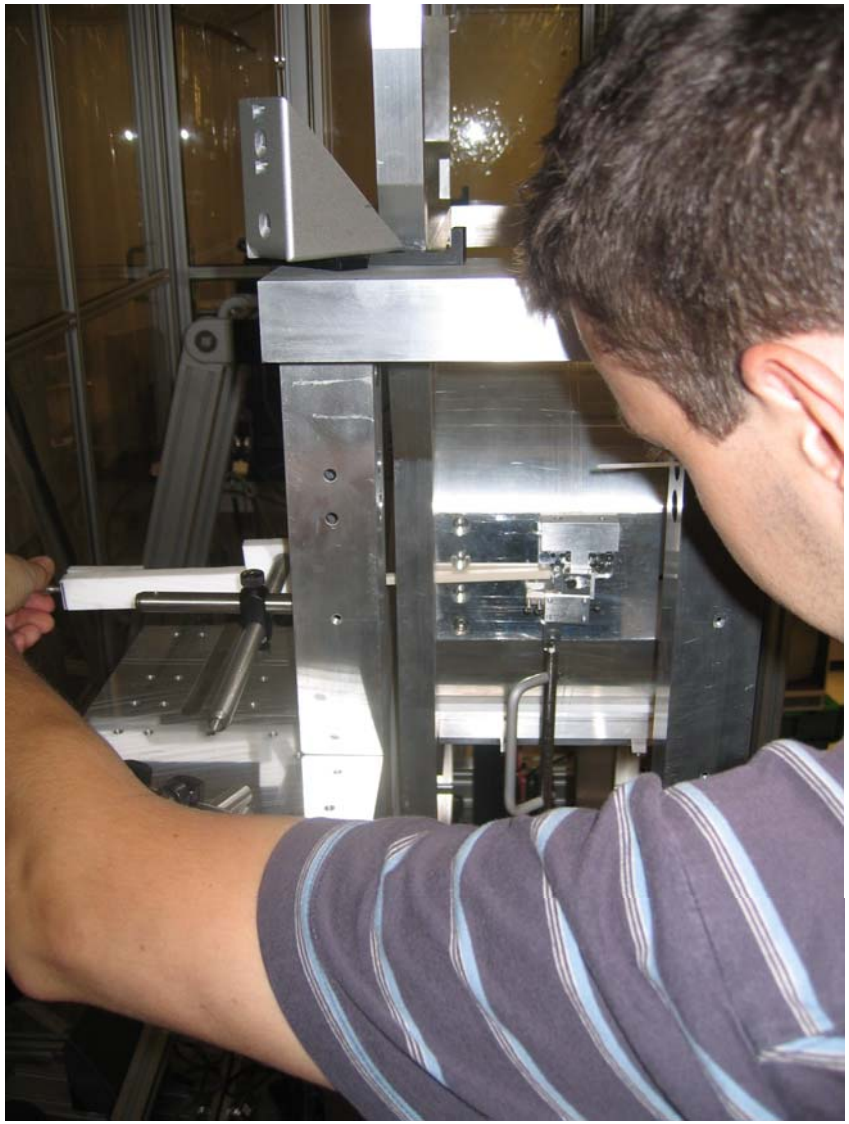
3) (iii) Advancement: transfer fibre bow from cutting jig to structure for welding

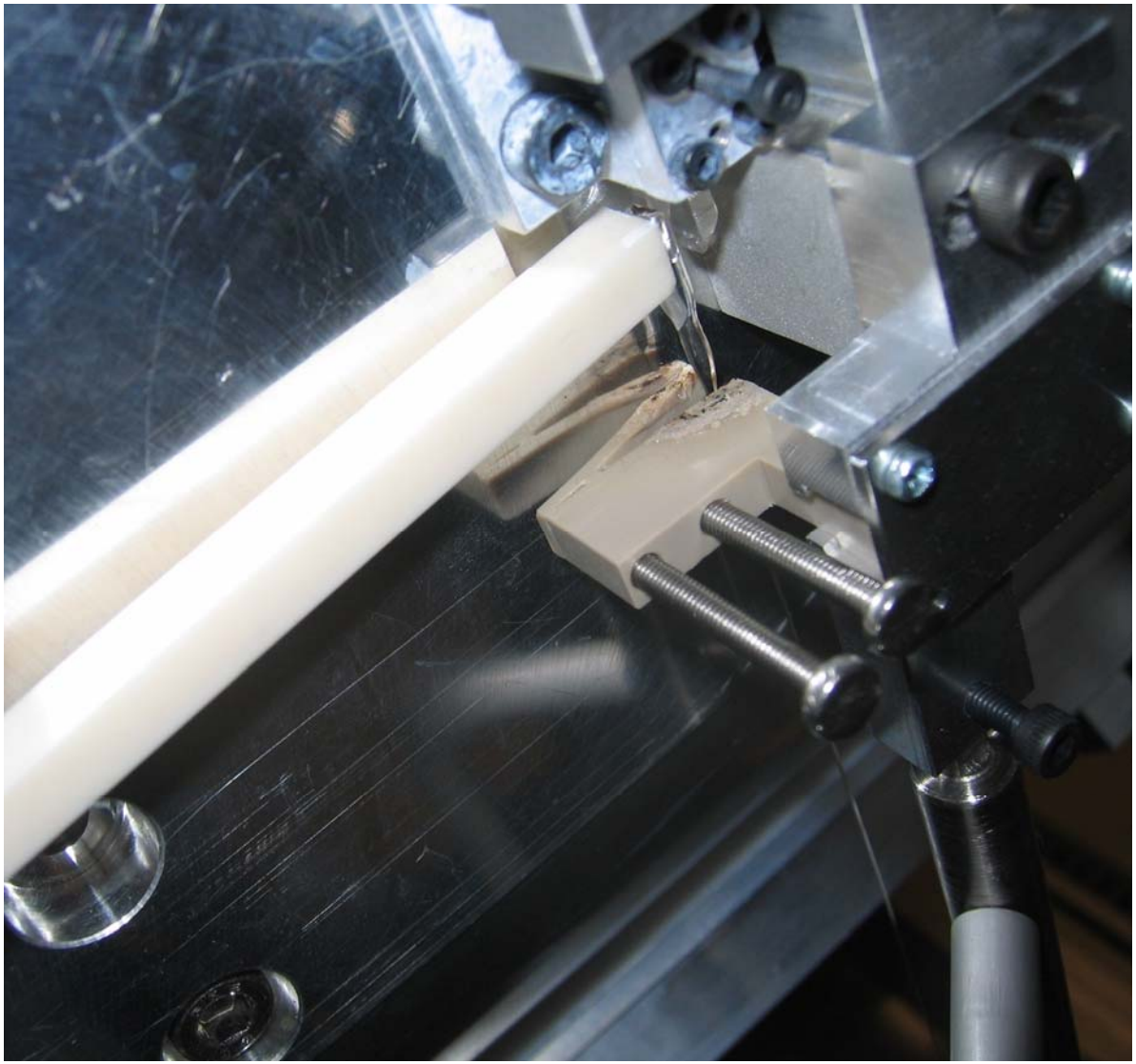


Introduce Fibre Bow to Structure / masses

Attach to welding baffles that mask the ears (or in this case, weld test horns.

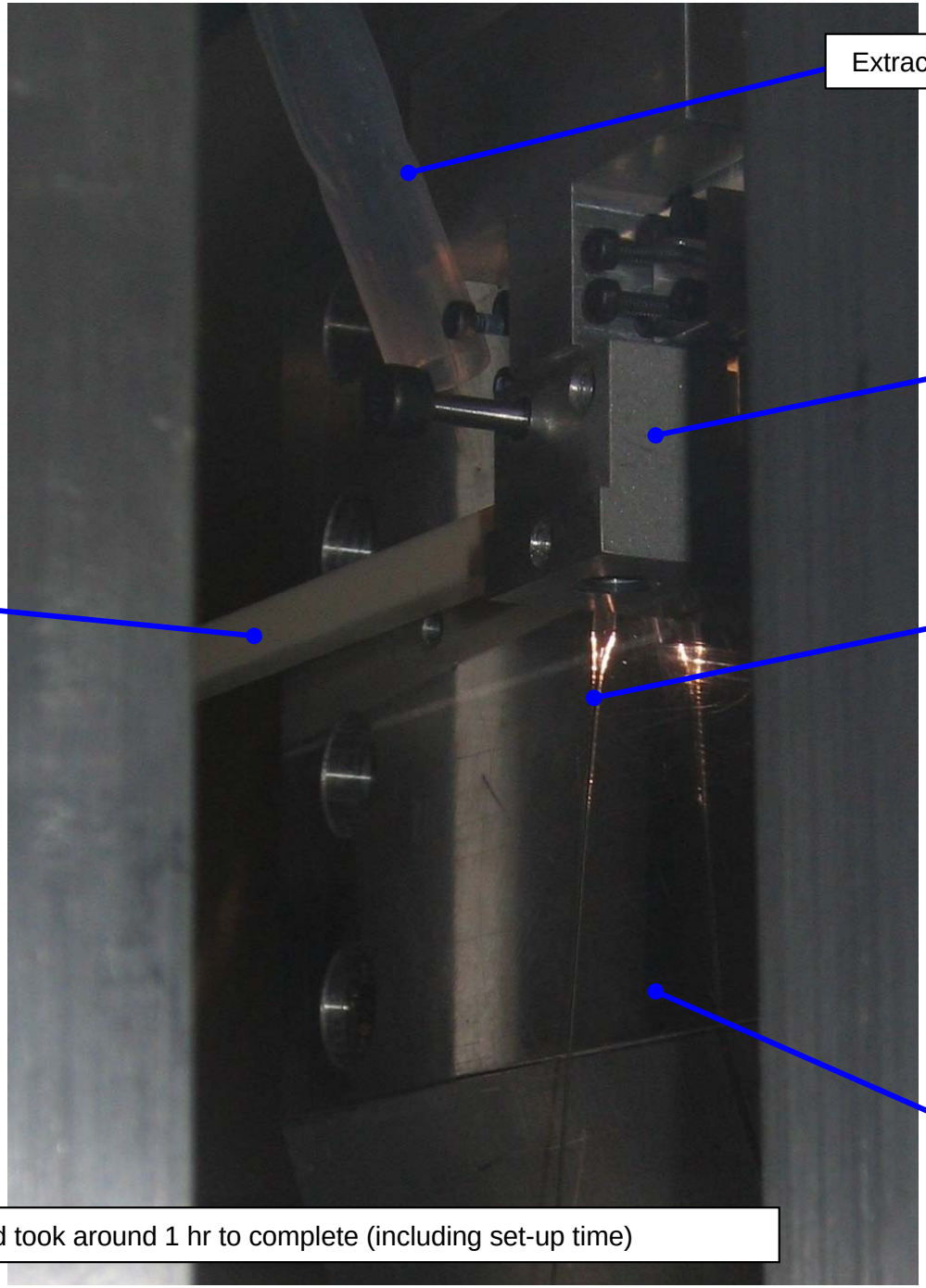
3) (ii) Install Alumina Pusher, and remove bow (cont.)





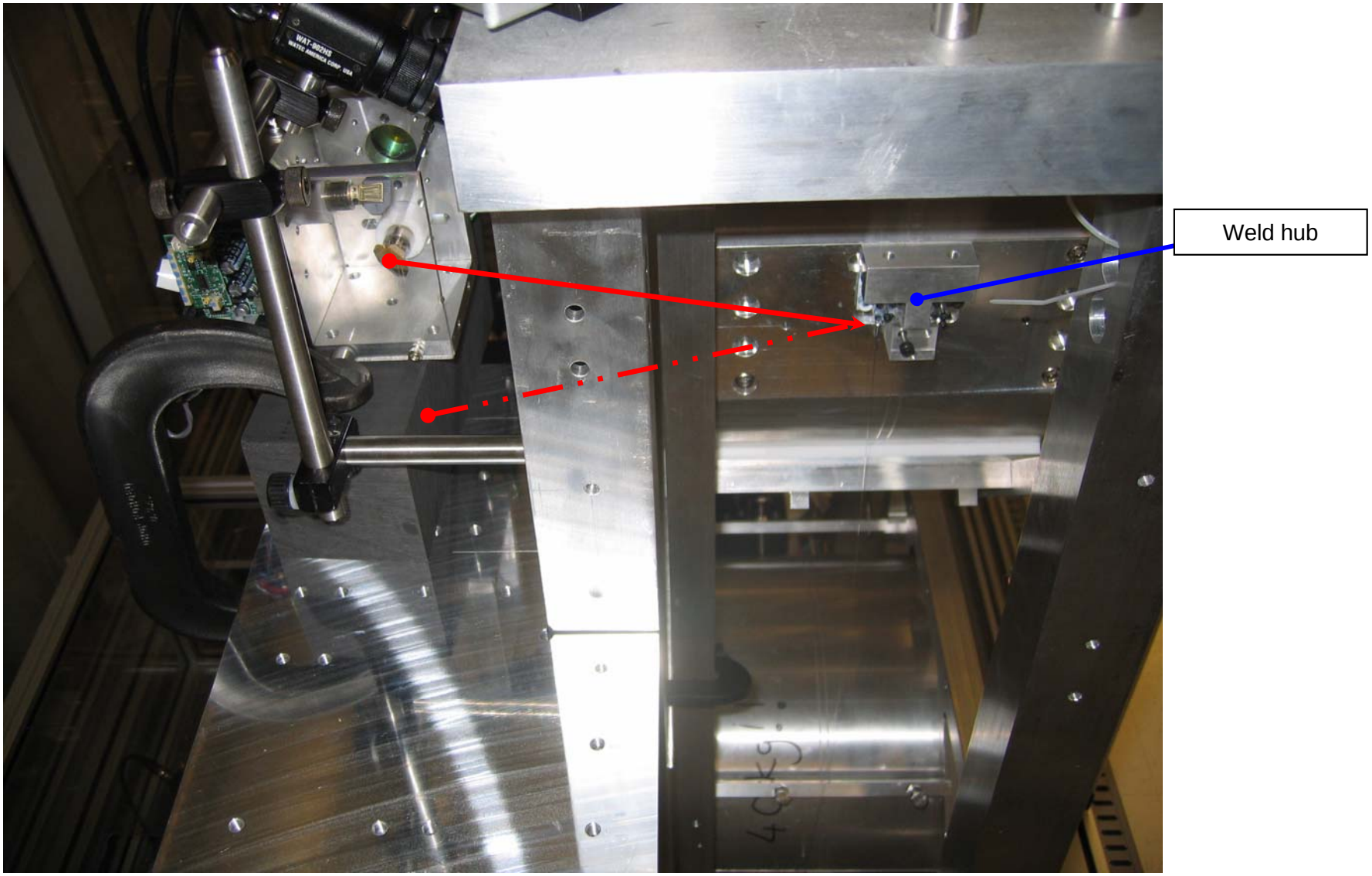
[1] Add alumina pusher to force contact between fibre end and ear, and [2] retract Peek holder prior to welding

3) (iii) Deliver beam for welding



Note: Each individual weld took around 1 hr to complete (including set-up time)

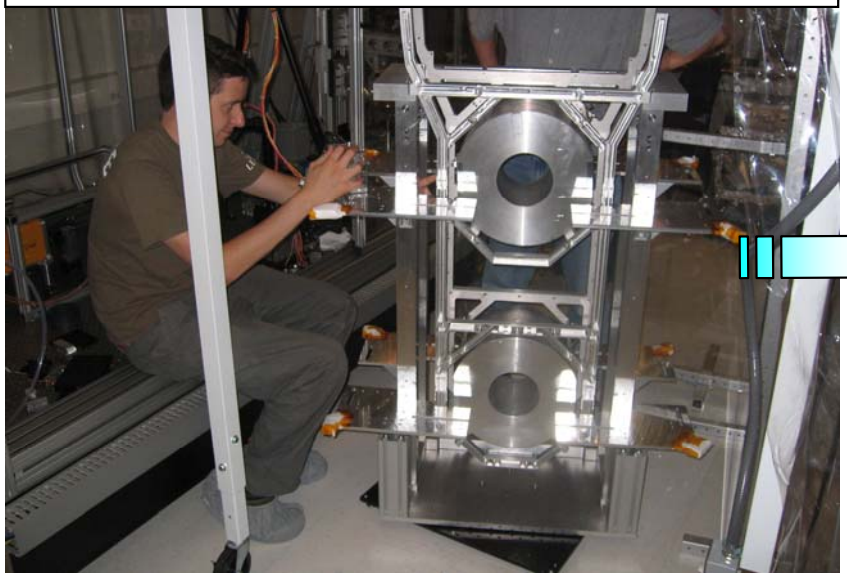
3) (iii) Observing welding in structure: weld position 2, Alumina Pusher removed



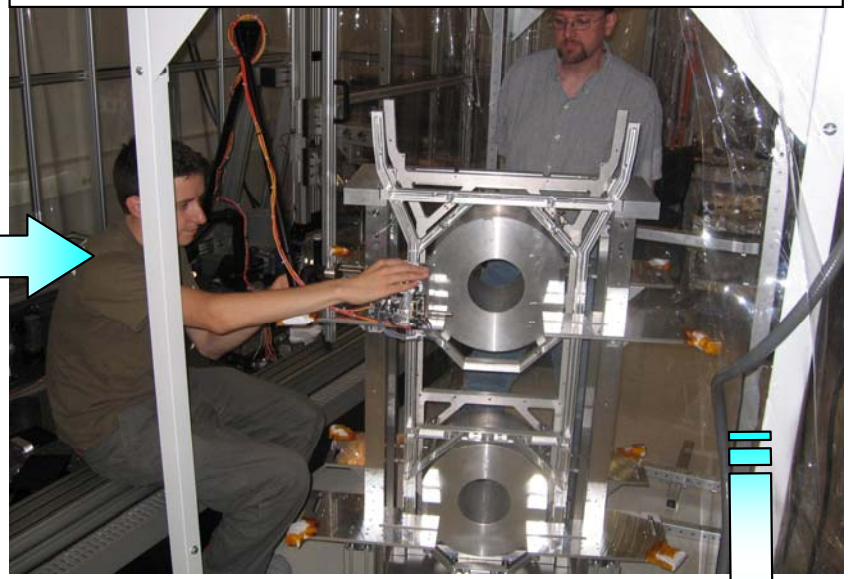
Weld position 2: alumina pusher removed, tack weld achieved from position 1, access of laser beam through the side of the structure. Beam directed at weld from above so that stray reflections can be caught below the birdcage.

4) OBSERVATION: Testing the range of the Articulated Arm and Birdcage with respect to the LS/LSAT - Welding of fibre 1

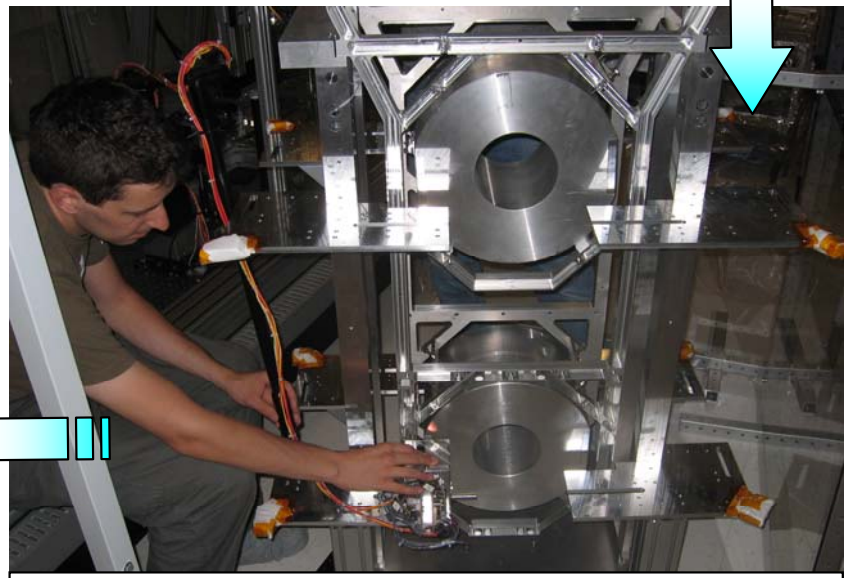
Fibre 1, weld 1: at top from *side* of structure



Fibre 1, weld 2: at top from *front* of structure



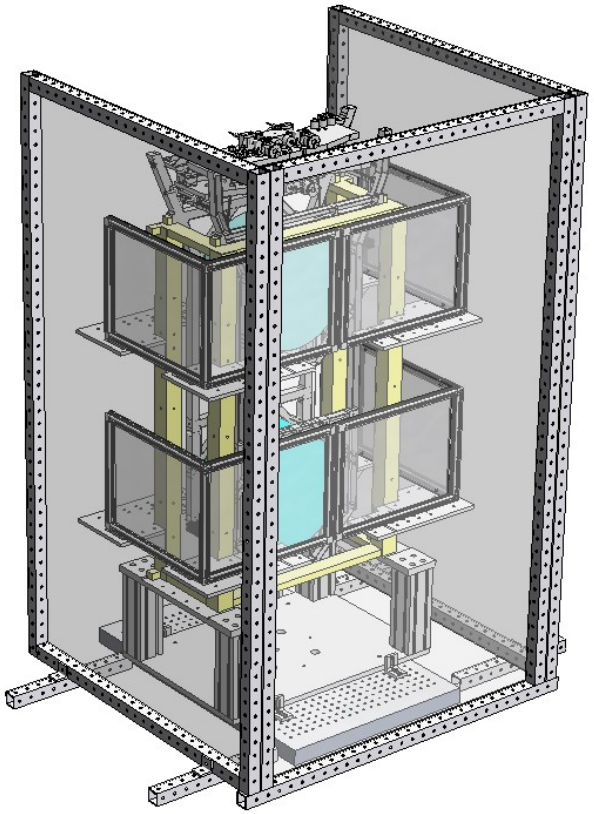
Fibre 1, weld 3: at bottom, from *side* of structure

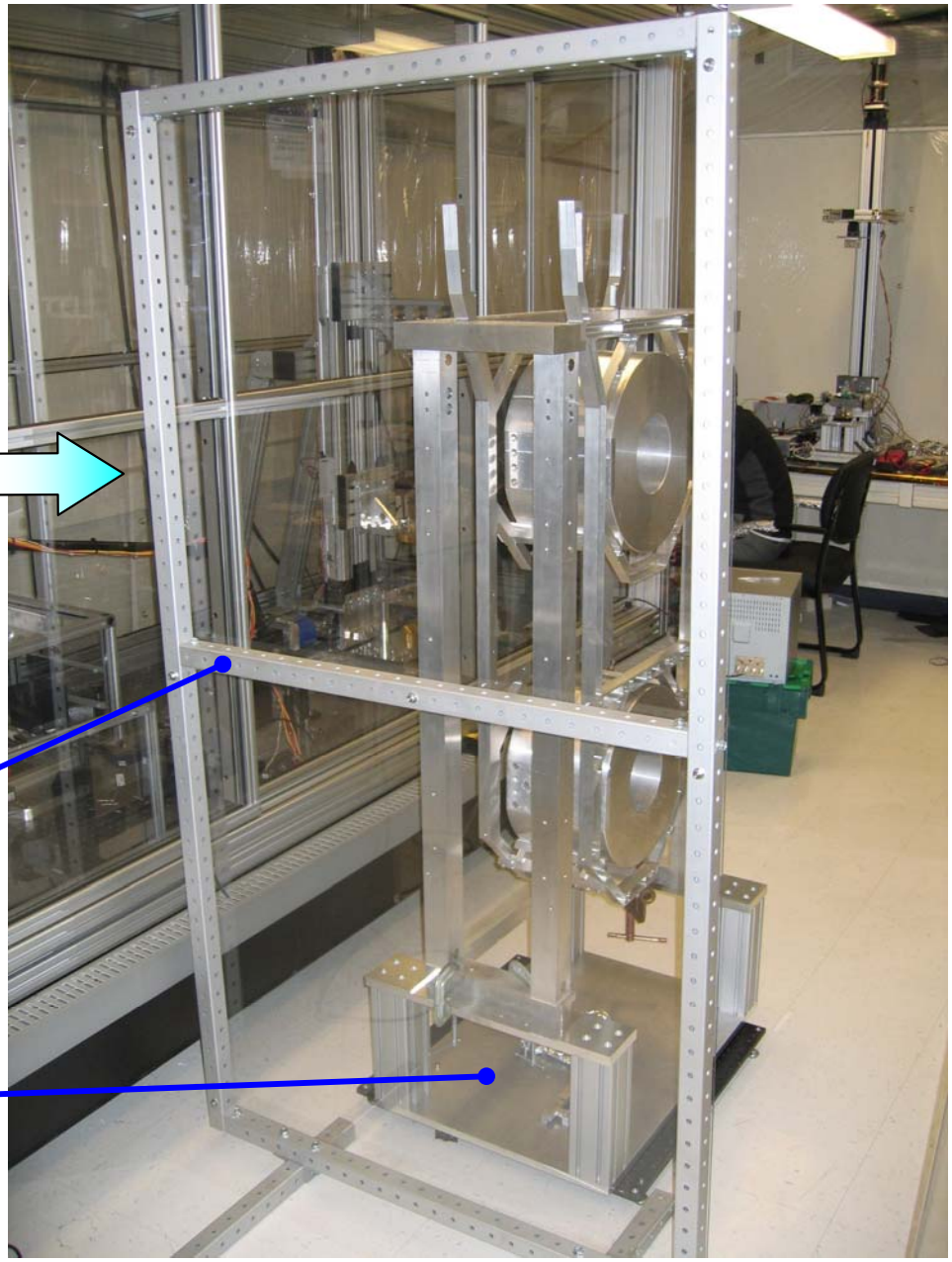


Fibre 1, weld 4: at bottom, from *front* of structure

NOTE: Structure is sitting next to CO2 bench on the welding turntable in the photos above. Look a video: […]

5)(i) Global weld screens: set up and ready for use





Global welding screen

Welding Turntable

5)(ii) Global weld screens: checked in context of portable clean room

NOTE: Space is tight when it come to using the screens inside the clean room tent. Clearances are *just* acceptable and were chosen to be so. Size were chosen to maximise protection to laser operators when welding fibres off the bench (firstly when the clean room tent was not in play).

6) Assembly walk through

Short video records were taken of the route from the CO2 area through to the set-up area in the high bay. There are two files overview files available at [weblink]:

http://www.physics.gla.ac.uk/~russell/MIT_4th-10thAugust_Tooling&Assembly_Checks/A_Lab layout and route planning videos/

More specific videos summarizing steps and equipment usage are available at:

http://www.physics.gla.ac.uk/~russell/MIT_4th-10thAugust_Tooling&Assembly_Checks/B_Tooling and assembly videos/

The tooling checklist (example below) was created to make sure all necessary equipment was present and accounted for, and anything missing could be immediately chased up such that there are no delays to the continuation of the development activity in the CO2 lab space.

TOOLING LIST FOR NP-type MONOLITHIC ASSEMBLY:- CREATED/UPDATED DURING RJ VISIT TO MIT (4th August - 10th August 08)

References: MONOLITHIC ASSEMBLY SCHEDULE, T060040 NP-type Assembly Procedure, T060132 Overview of tooling [Also, T080132 List of things needed for glass]

** Traffic light system: GREEN (all go), AMBER (almost ready), RED (PRIORITY: Work/confirmation required)

[No.]	Tooling required for Monolithic build	DCC Number	Location / Required for	Status at LASTI	Comments
1	**CO2 Laser Pulling machine**	-	CO2 Lab space / Fibre production	Fully installed and operational	**SUS telecon 30th Sept: 2mm diameter stock suggested as the baseline for the NP-type due to ease of pulling and welding**
2	**CHARACTERISATION setup (PROFILER/PROOF/BOUNCE)**	-	CO2 Lab space / Fibre testing	Fully installed and operational	-
3	**Fibre Storage**	D080330	CO2 Lab space / Stock pile of fibres	Fully installed and operational	-
4	**Arfticulated arm + Birdhouse (Birdcage)**	D080040	CO2 optics bench / CO2 Beam delivery for welding fibres	Fully installed and operational	Working very nicely with labview/keyboard control + video
5	**Fibre Cutting Jig**	D080415 (T080169)	Pre-process in CO2 Lab space / Setting the correct fibre length and transferring to the LS	Operational	Spare Peek fibre holders (5 off) delivered to LASTI,Spare Bow (2 off) complete and due to be sent from Glasgow in coming weeks.
6	Welding Hub and Scaffolding	D070517	Within LS and LSAT / Isolating weld areas and protecting prisms during welding	(2X) Welding Hubs now at MIT. Scaffold now at LASTI, though not yet assembled - assembly not required until we use the disc inserts.	Shall be at LASTI well before AH returns from Caltech in mid September. More tantalum reflectors constructed, plus some equivalent parts in Tungsten. Additional Baffle plate to be added to catch back reflections when welding from through the side of the lower structure: RJ is doing drawings for this now following MIT visit 21-27 Sept.
7	Welding Camera	-	Attached to Birdcage / Remote visualisation of weld process for the welding operator	Fully installed and operational	-
8	Extraction system	-	Attached to welding scaffold / Misimising the effects of evapotated silica on suspension components	Operational (AH, any further ammentments required?)	We plan to strap this to the welding scaffold - use same parts as are in use now?
9	Lower Structure Assembly Tooling (LSAT) + Lower Structure (LS)	D060305 / ...	Testing and fit checks. All areas and all processes	"IN USE"	**Amanda to make additions to constrain the pendulum effect of the LS in the LSAT.**
10	**Class A clean LSAT + LS**	**D060305 / _**	**FINAL CLEAN GLASS ASSEMBLY**	**now at LASTI - critical issue to be resloved in relation to drawings**	**!!AMANDA: Check drawings as necessary holes required for shelving appear to have been omitted from drawings!!** AMANDA: Check also with Justin whether spare UIM is part of the deal (?)
11	**WELDING SPACERS**	D060450	Below the test mass in the LS / setting the position of the Optic wrt the fixed PM during welding	Ready and available	Found and ready to test - thanks Brett.

6)(i) Assembly walk through: Moving the structure from CO2 area to High bay and back

We used the available Orange Trolley (Lift cart) only to test the journey to and from the high bay due to its availability, manoeuvrability and also stability.

Discussions since this visit regarding tooling have confirmed that we will use the specialist lift cart designed by Ken Mailand for this journey.

General comment on ergonomics: Two people job to move/guide between assembly areas. LSAT needs to be clamped down to trolley. Orange platform in slightly raised position gives good isolation during travel between assembly areas.

Blue Genie (available at LASTI): Lacks manoeuvrability and worsens the pendulum effect of the lower structure within the assembly tooling during transport, but is adequate for the basic lifting/lowering of the LSAT during transferral between assembly locations. (e.g. Turntable to trolley, Pallet to Trolley…etc.)

6)(ii) Testing the Blue Genie with the portable clean room and welding turntable/pallet: **Installing/removing the LS/LSAT to/from Welding Turntable**

Images taken of the portable clean room tent in position in the CO2 welding area. We used the Genie to introduce, then remove the lower structure (LS) / lower structure assembly tooling (LSAT) from the Welding Turntable.

This worked well enough but space is limited so great care will be required when doing this when the glass is installed.

Conclusions

A lot of work was accomplished this week and with the resulting NP-type monolithic tooling checklist (for LASTI), any missing items and any areas of concern shall be dealt with in the coming weeks in preparation for the next stage of welding activity (working of the bench: fit checks on welding equipment).

Important items requiring attention include:

1) *There appears to be a missing item which we think is needed for final assembly: rail system for splitting the two halves of the lower structure. *(*Follow up email attached to report as Appendix A)*
2) Lever arm clamp – source missing components and test as soon as possible.
3) Need to locate the welding spacers (D060450) which are known to be completed but their whereabouts is unclear
4) Check status of the clean lower structure and lower structure assembly tooling needed at LASTI for the final monolithic assembly: this has not yet arrived at LASTI

Tasks completed successfully this week were:

- Transfer of storage solution
- Set-up of global weld screens
- Observation of welding approach on the bench. The birdcage/articulated arm combined with the LABVIEW control of the mirror galvanometers was versatile and impressive, so this is a big plus point.
- Testing of articulated Arm reach/extension from bench to the appropriate locations for welding
- Testing of welding Turntable next to CO2 bench
- Testing of cutting jig – though more testing is required in the next stage of fit-checks before the design can be considered a success.

APPENDIX 1: Email to Amanda Brummit (RAL), "Tooling Question discussed at today's telecon" (15/08/08, 20:52): follow up on approach to splitting the lower structure

Dear Amanda,

As promised at today's meeting, I attach a web link to videos of our work last week on lab layout/route planning, welding and tooling assessments.

http://www.physics.gla.ac.uk/~russell/MIT_4th-10thAugust_Tooling&Assembly_Checks/

I have labeled the folders in the order you should look at them, and folders "A_Lab layout..." and "B_Tooling and assembly videos" are of most interest. In particular the following videos are worth watching:

* Both files in folder A

* Particularly E,F and G in folder B

* The approach the the use of the articulated arm with the structure (during welding) in folder C ["VERY_IMPORTANT_MAIN WELDING APPROACH_OVERVIEW.avi"]

A draft tooling checklist constructed whilst I was at MIT is also available in the top level of the folder structure. The biggest issues for your attention are items 11(in hand), 12 (in hand), 19 (in hand), and *21 (needing attention - relates to the tooling required to split and recombine the structures).

The baseline seems to be to assemble (and disassemble) the Lower Structure/Lower Structure Assembly Tooling on the floor using the genie/fork truck - I am querying this as it does not seem ideal.

I refer to the following documents:

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1) **T060040-05 NP-type Assembly Procedure (p.5 section 4, point 9: "Separate halves of lower structure" - missing description of approach)

(*Note: please confirm the revision number you are referring to from.)

2) T060132-02 Overview of tooling (table in section 3, then note 3.10)

If you look to folder "Questions_tooling to split&re-combine LS" at the web link, you will see 5 photos taken in the high bay last week:

1)"SET UP AREA_ High Bay.JPG": showing two available pallets could be adapted to deal with the process of splitting the structures

2) "Main chain on pallet base_assembly ready.JPG": the main chain of the LSAT where it would go - if the set-up was properly adapted.

3) and 4) Close ups of the pallets.

5) Conveyor wheels/rails.

We will need two setup areas (in the high bay - beside the granite table on the side of the BSC chamber) such that when we split the structures, the main chain and reaction chain can can be worked on simultaneously. The pallets may be ideal for this, and the rail system used in the CP-type looks like it can be used adapted* for our needs if required.

(*Note: I have cc'd to Norna and Calum here as well, as any request to use/adapt that tooling is I think best made to them.)

Main questions:

- How successful was this step of splitting/re-joining the halves of the LSAT for previous NP-type assemblies?

(Particularly with respect to alignment when the shielded magnet assemblies are attached to the back of the penultimate mass when re-combining the two halves)

- Can you confirm this is how you plan to do this, and that this wouldn't present a risk to a welded monolithic assembly (e.g. no risk of magnet assemblies becoming unattached/damaged/falling off and threatening the fibres?)

As suggested, I shall call to your office at 2pm on Monday in to discuss this and any other issues you have,

Best regards,

Russell.