Delivery to the Next Generation of Laser Systems – Astra Gemini and Vulcan 10PW

Chris Spindloe
Target Fabrication Group, Central Laser Facility, Rutherford Appleton Laboratory

CLF Target Fabrication

Science & Technology Facilities Council

Introduction

There are a number of large challenges that need to be solved to be able to provide targets for the new facilities that are coming online.

1. Higher shot numbers
2. More complex targets
3. More hostile environments
4. More facilities across the world.
5. Target costs are prohibitively expensive

Overview

1. Current activities at RAL
2. Delivery to first solid Target Astra Gemini Experiment
3. The Vulcan 10PW upgrade
4. Target delivery to Vulcan 10PW

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CURRENT ACTIVITIES AT RAL

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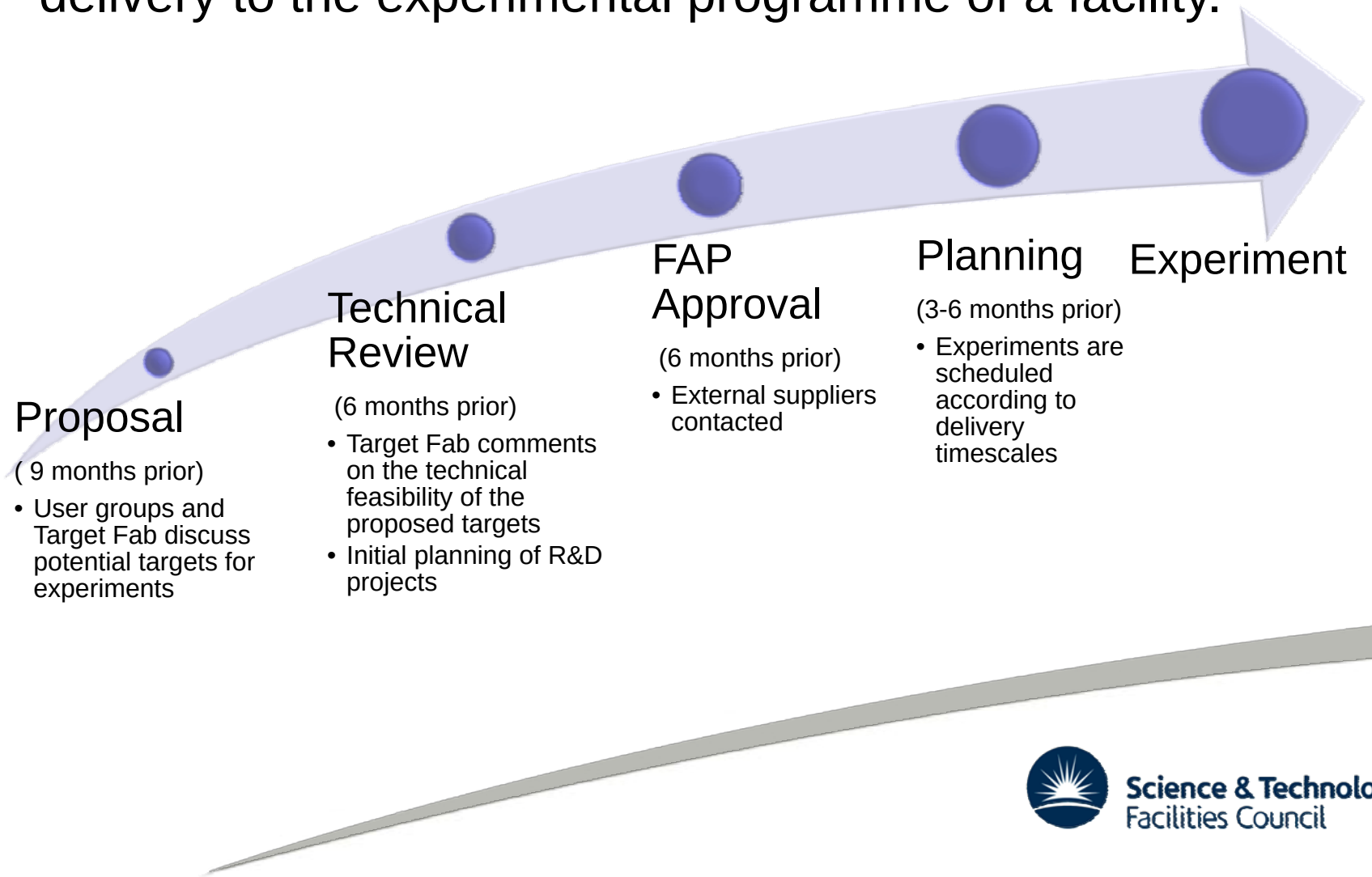
Delivery to Experiments

There is a huge difference between manufacturing a target and delivery to the experimental programme of a facility.



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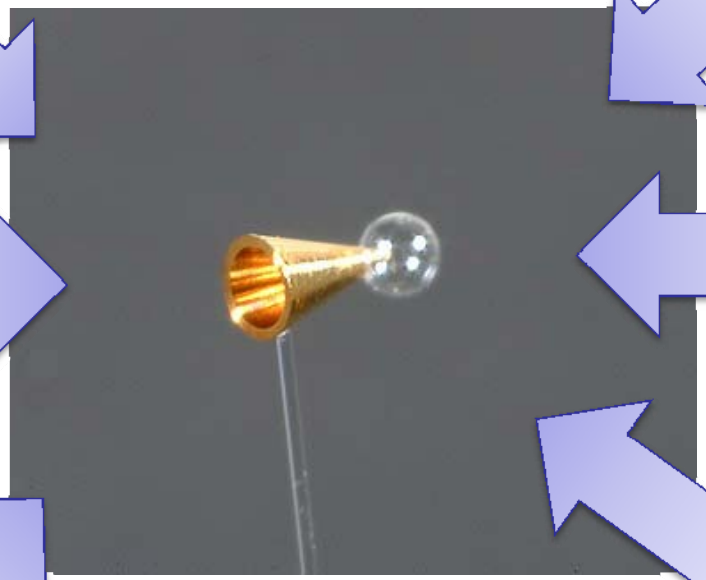
Integration of Technologies



Micro-Assembly

Micro-Machining

Thin Film Coating

MEMS

Characterisation

Experimental Planning

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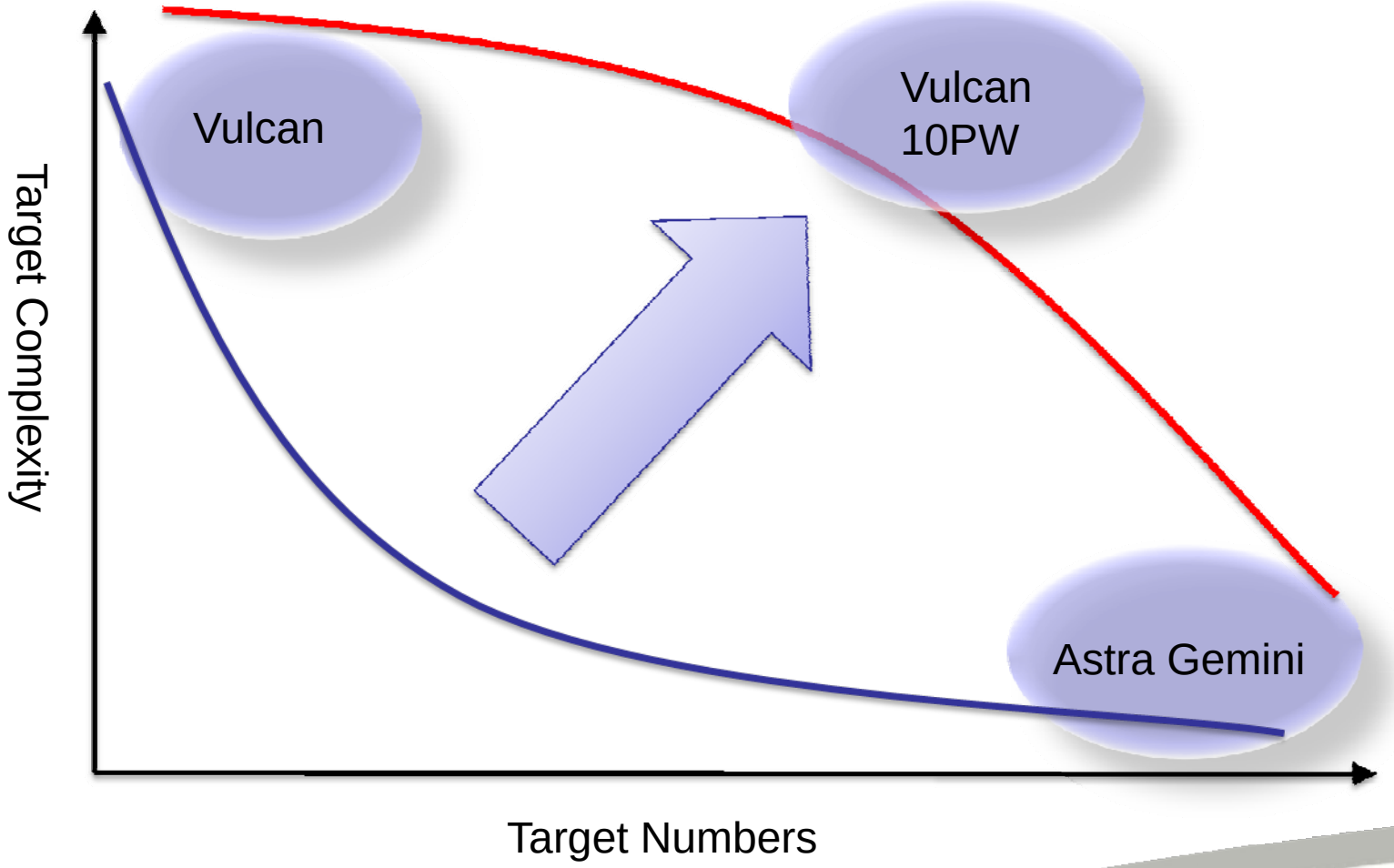
What are the Future Requirements



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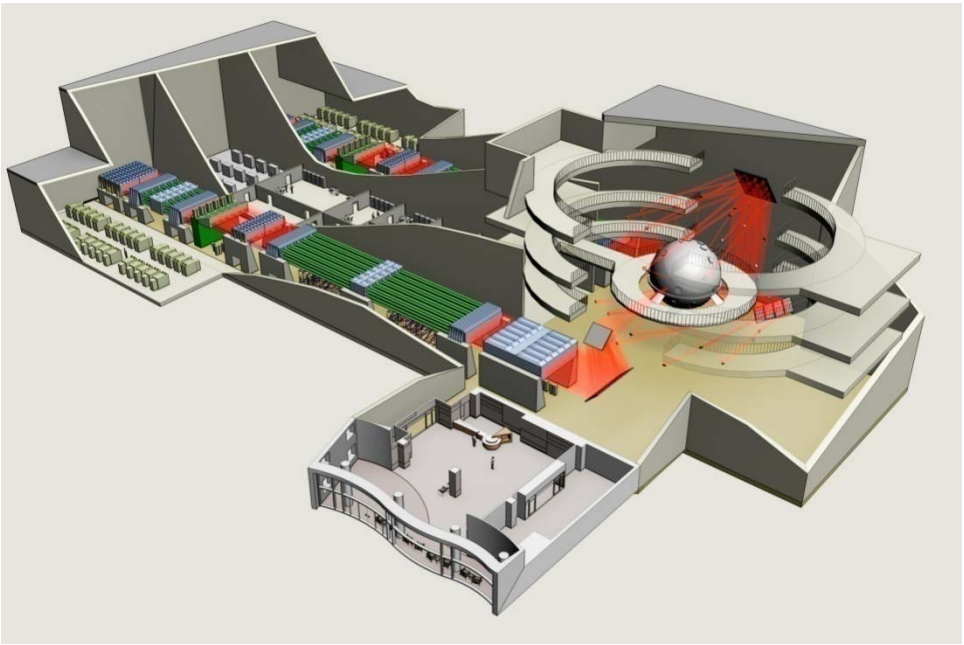
Long Term Goals



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DELIVERY TO ASTRA GEMINI HIGH REP-RATE EXPERIMENT

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Target Requirements

Over 3000 targets were delivered for the Libra Astra Gemini experiment.

Targets were thin foils

- Aluminium
- Copper
- Gold
- Plastic
- DLC
- Silicon Nitride

Other targets are more difficult to fabricate including for higher rep-rates

- Ultra thin Foams
- Aerogel
- Micro-spoke targets
- Wire arrays
- Limited mass (100um x 100um squares).

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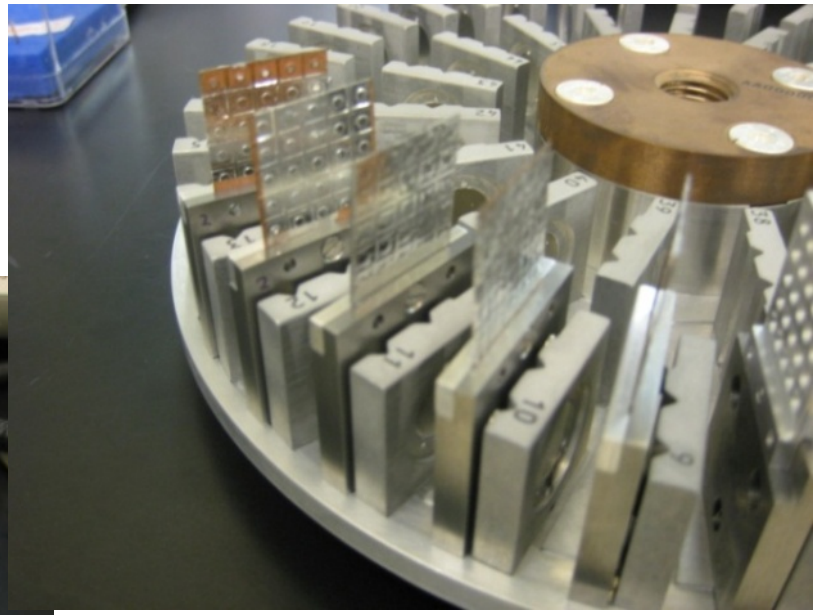
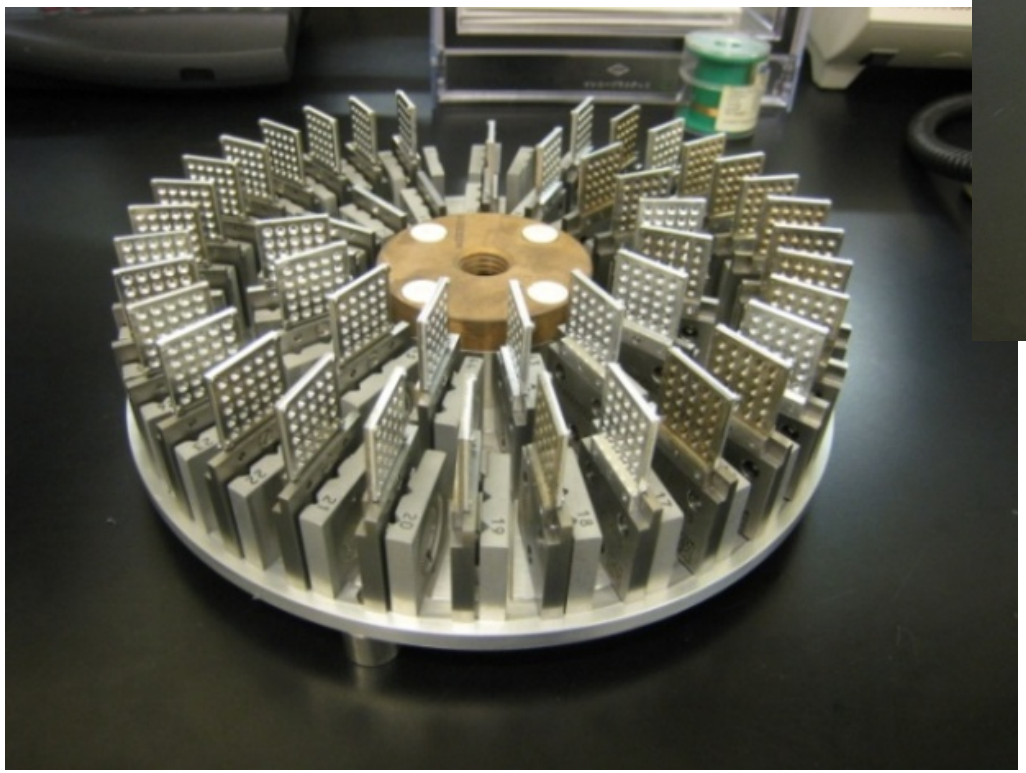
Thin Foil Targets

Targets were mounted on arrays held on marked and numbered target ‘pucks’





Each target can be individually tracked due to its unique identification number.

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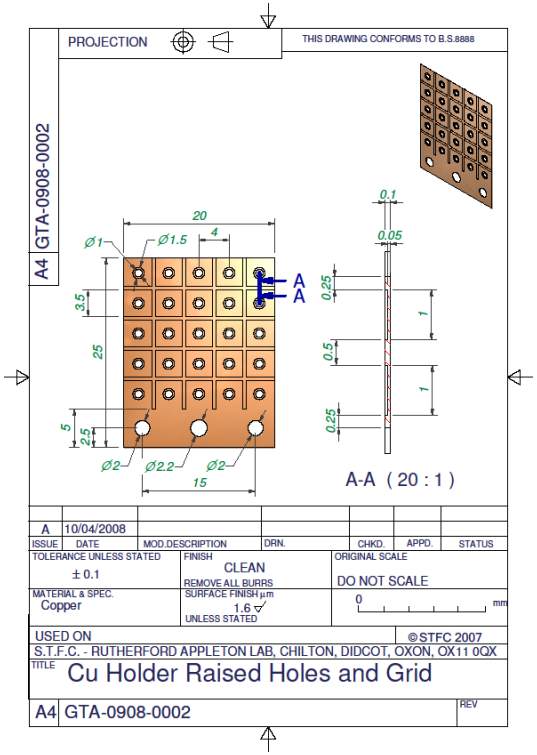
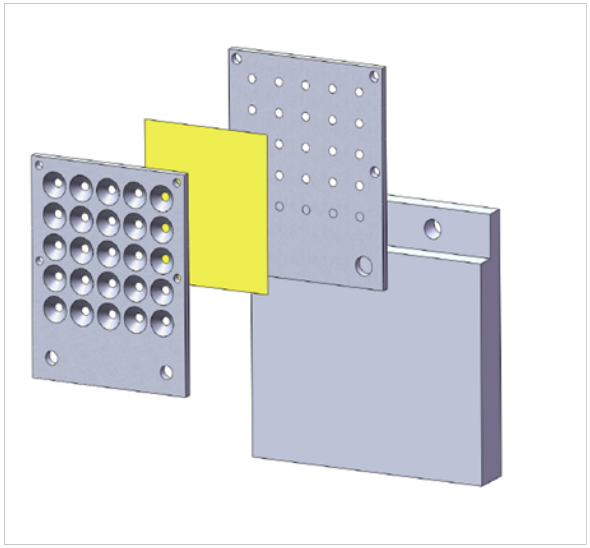
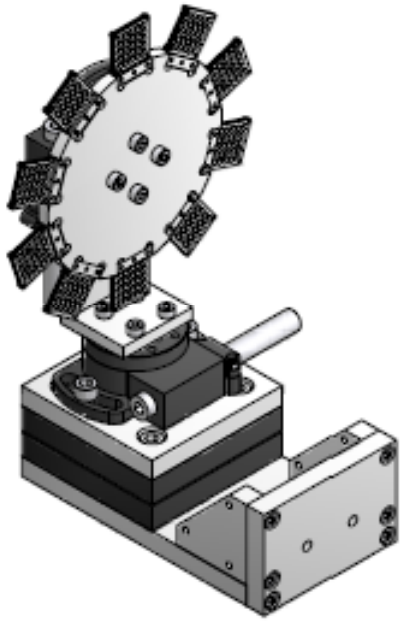
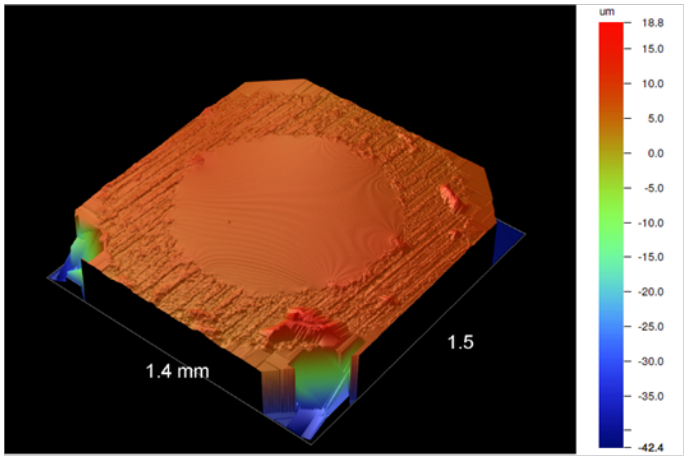
Thin Foil Targets









To allow maximum flexibility the target mounts were designed for use on

X-Y-Z stages

Carousel

Target Wheel

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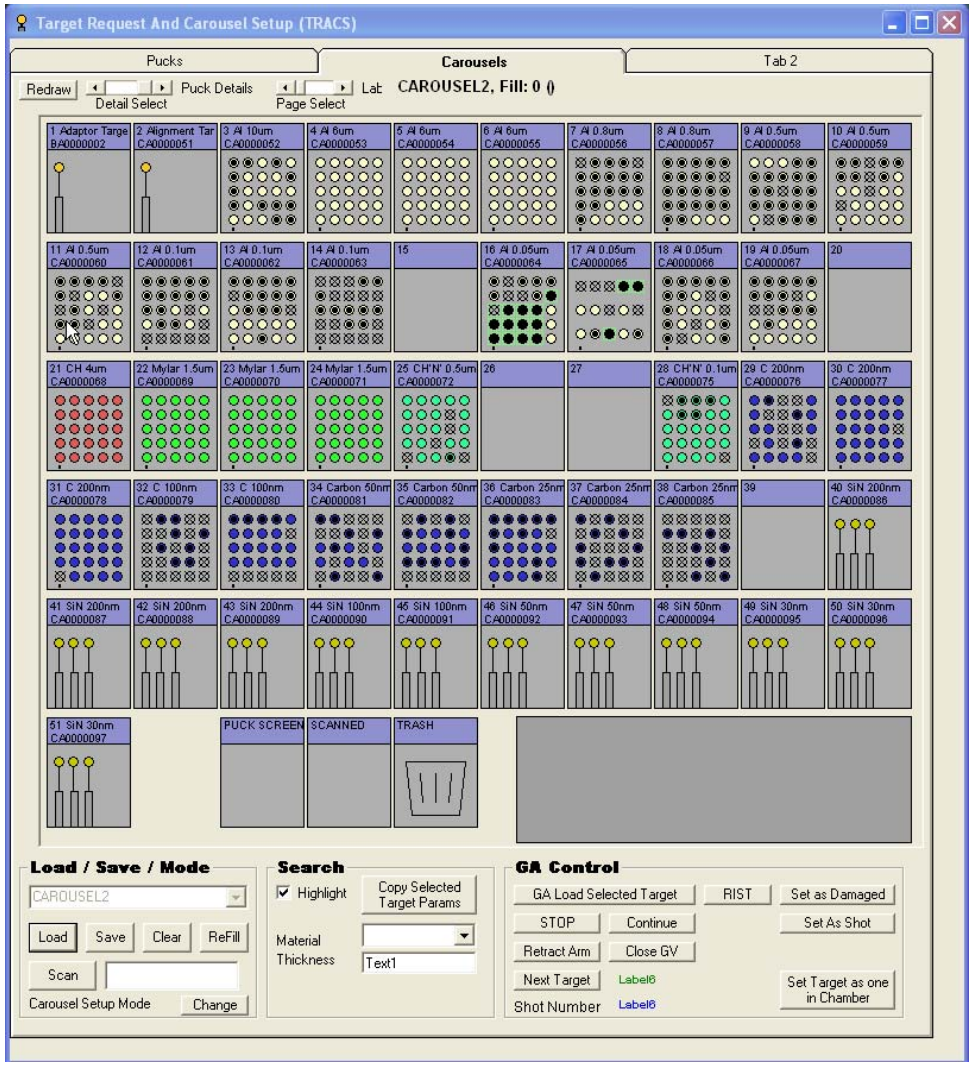
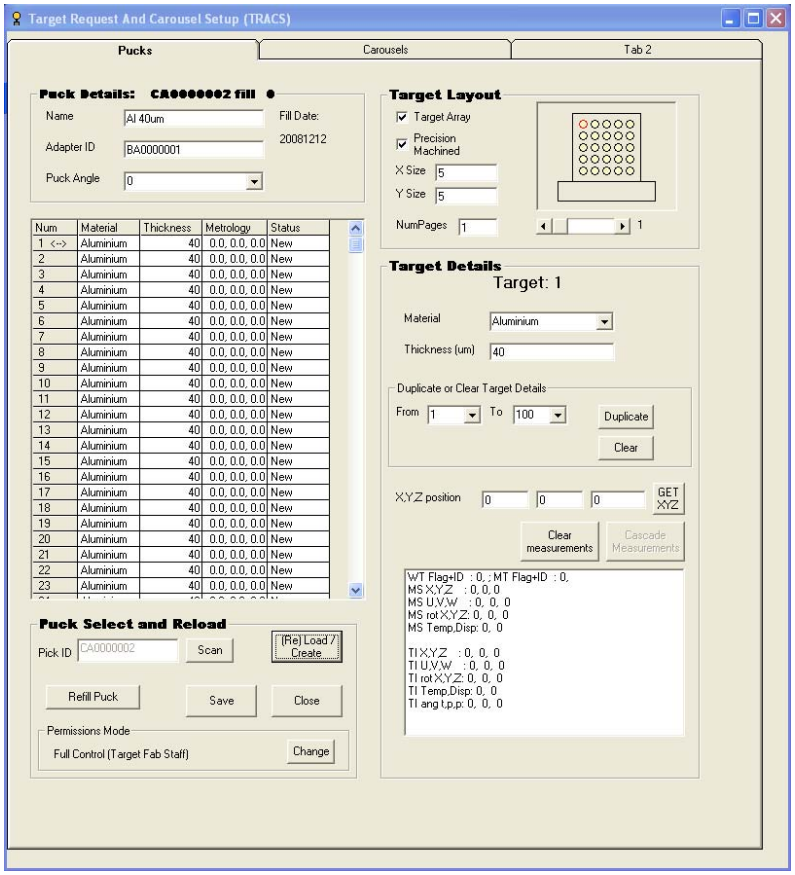
Target Tracking





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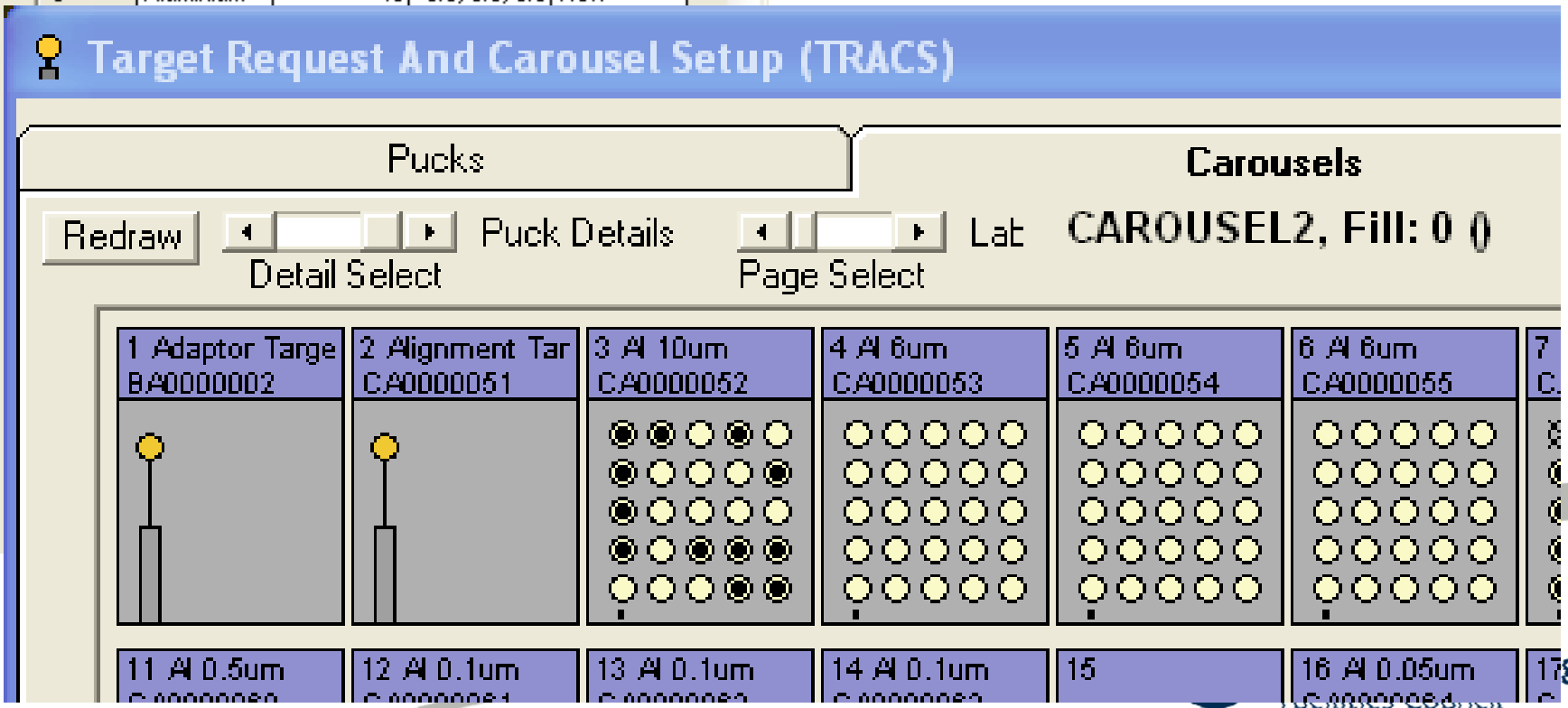
Target Tracking

Num	Material	Thickness	Metrology	Status
1 <-->	Aluminium	40	0.0, 0.0, 0.0	New
2	Aluminium	40	0.0, 0.0, 0.0	New
3	Aluminium	40	0.0, 0.0, 0.0	New
4	Aluminium	40	0.0, 0.0, 0.0	New
5	Aluminium	40	0.0, 0.0, 0.0	New
6	Aluminium	40	0.0, 0.0, 0.0	New
7	Aluminium	40	0.0, 0.0, 0.0	New
8	Aluminium	40	0.0, 0.0, 0.0	New
9	Aluminium	40	0.0, 0.0, 0.0	New

Target Data is accessible both in Target Fab and in the Experimental Areas



Target Type		Carriers	Targets
Basic Target Arrays		60	1500
Thin Foil Mounts	500nm and below	21	525
Ultra Thin Foil Mounts	50nm and below	26	650
Foam Array Targets		3	75
Layered Thick Coatings		4	100
Complex Wire Arrays		4	20
Complex 3D Assemblies		14	81
SiN chip Targets		5	24
Alignment Targets		3	3
		140	2978

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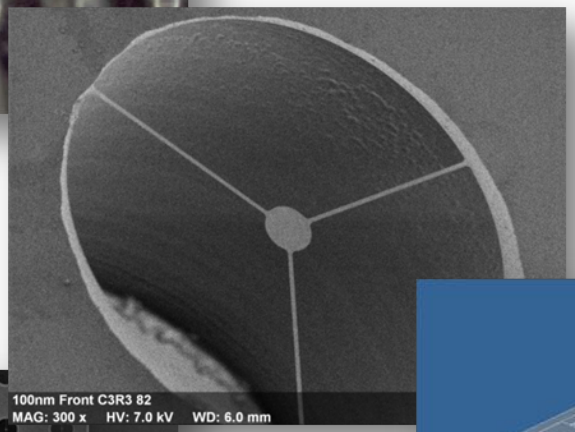
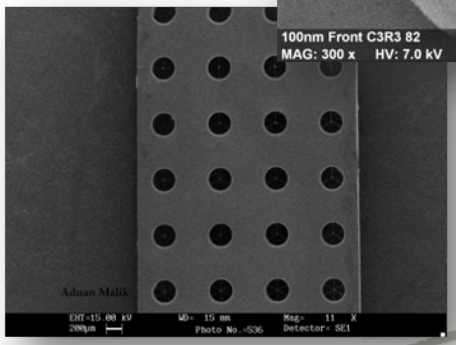
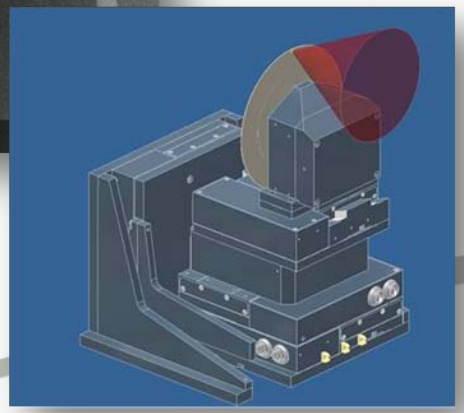
Mass Production Techniques







- Micro-machining
- Laser processing
- Micro-moulding
- Wafer based targets
- Liquid Droplets

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THE VULCAN 10PW UPGRADE

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Current Position

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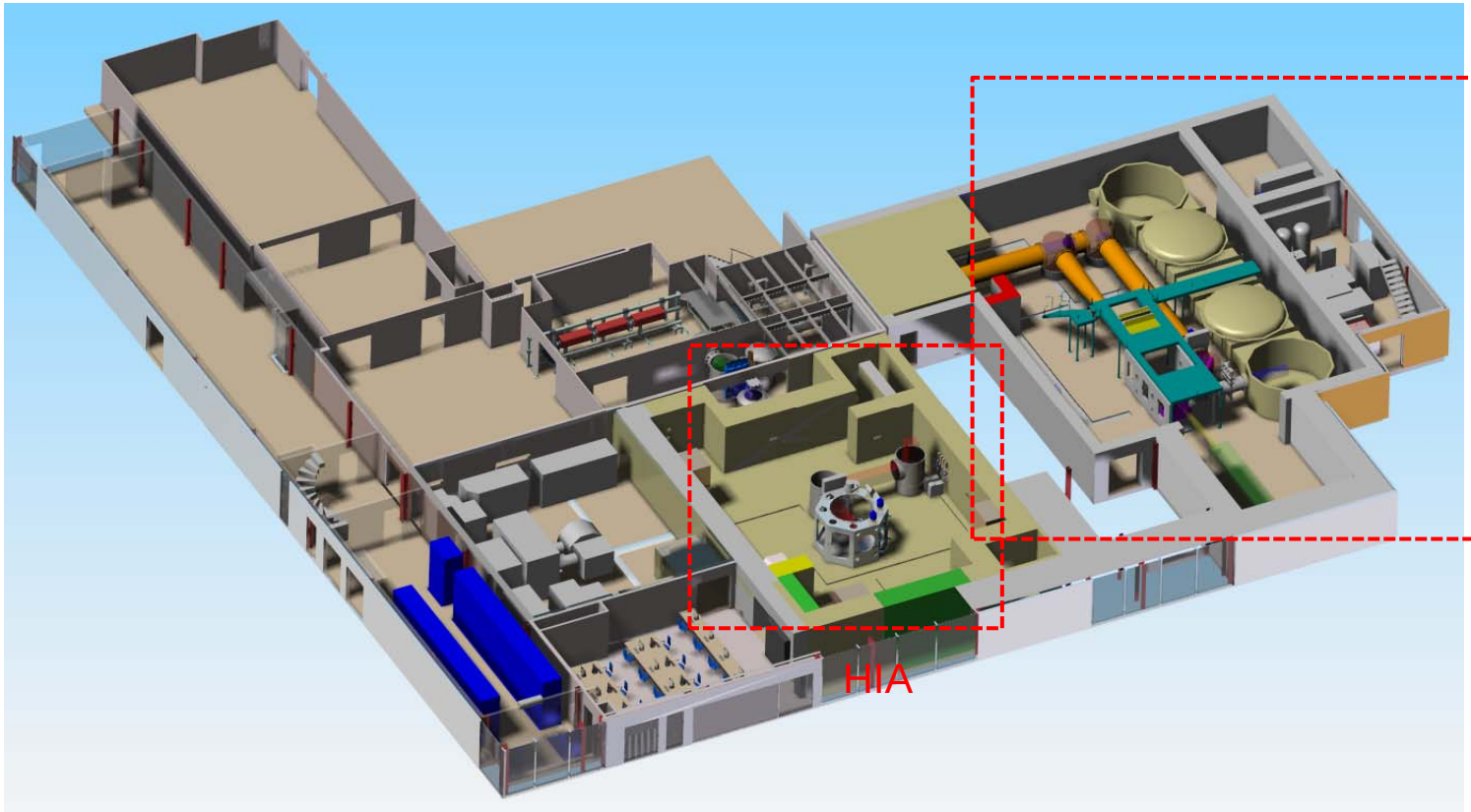
Building Design



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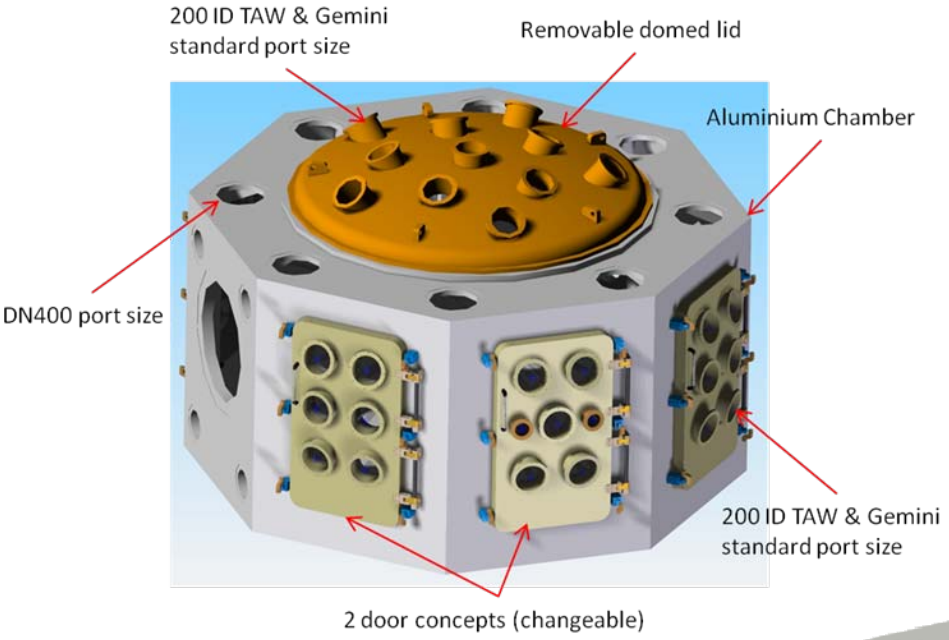
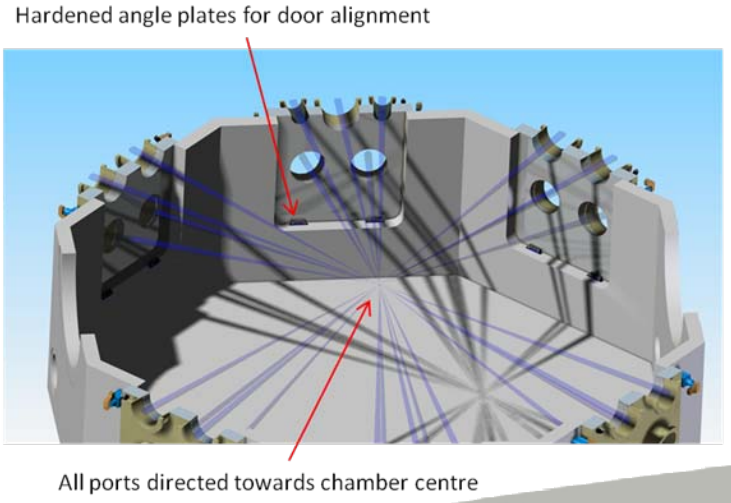
New Chamber

- 2 permanent “D” shaped breadboards around target
- 6 optional breadboards (inside each door)
- Concepts for Carousel target positioner – maximise shots with single pump & minimise target profile.





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TARGET DELIVERY TO VULCAN 10PW

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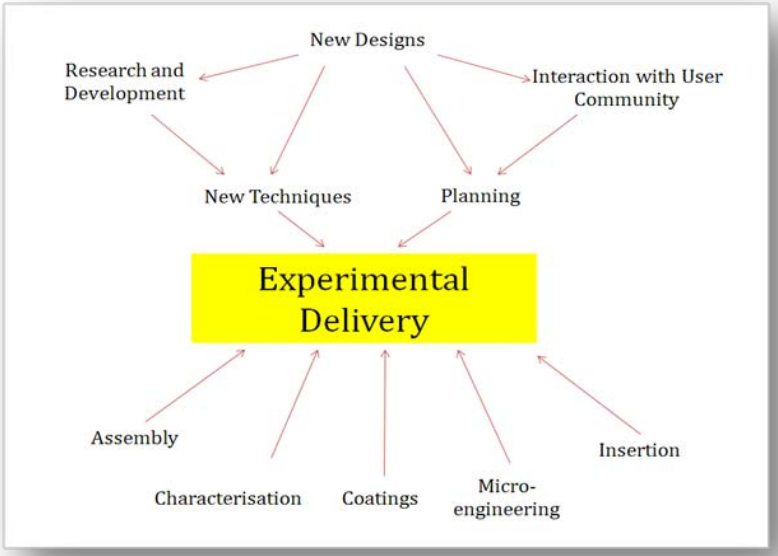
Aims

- More complex target designs to maximise scientific benefit from shots.
- Higher tolerances on targets
- Increase target-to-target reproducibility
- Flexibility of target assembly
- Enable multiple shots (~ 1 day) without the need for chamber access
- New material production capabilities
- Most importantly – to design integrated targetry solutions

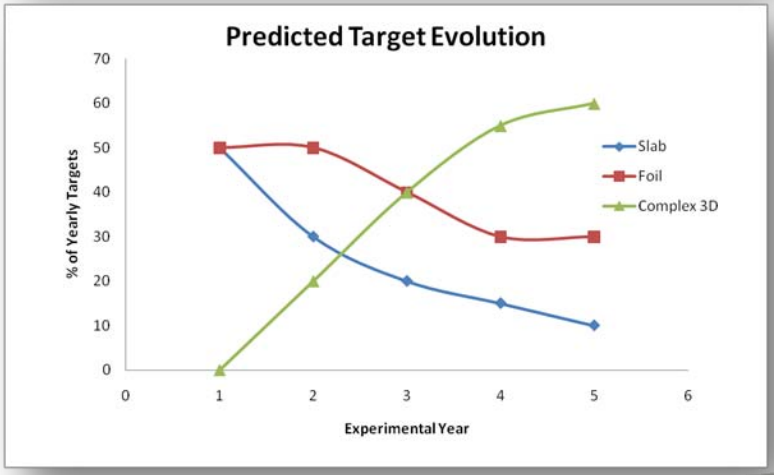
User Consultation

- First series of consultations carried out – some email responses returned
- Followed up by visits to Universities
- Expand consultation to wider community including Europe.



Initial Responses

- Interest in new materials such as Diamond-Like-Carbon
- Complex target clusters for proton probing
- High Z/Low Z target compositions
- Maximise shots without breaking vacuum



Have also looked at 1PW target usage from commissioning and predicted target usage for TAP10

HIA may have simpler targets

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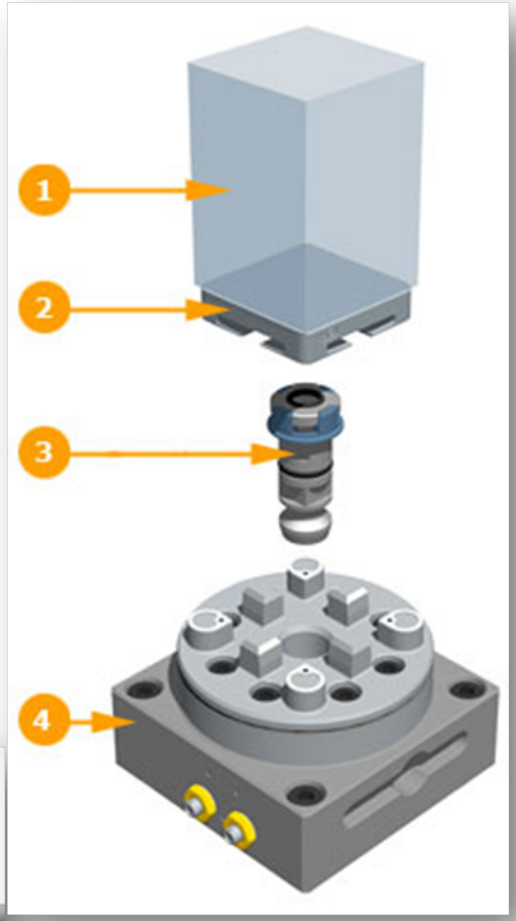
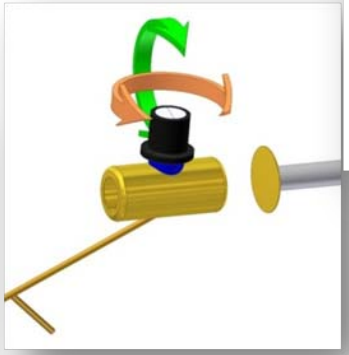
Target Assembly Station

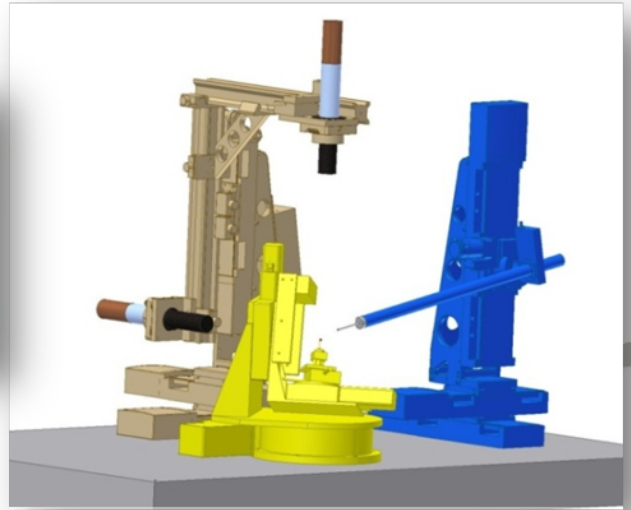
- Designs and initial parts list
- Plan to purchase components first for manual version
- Discussions with suppliers about motorising stages and manipulation
- Trial with existing rotary stage

Things to consider

- Weight considerations of System 3R tooling mount
- Cluster vs. Single target mount







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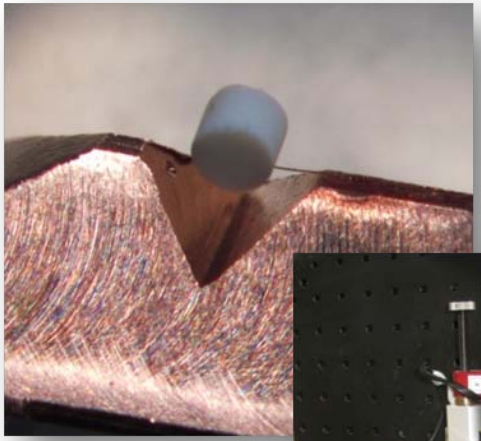
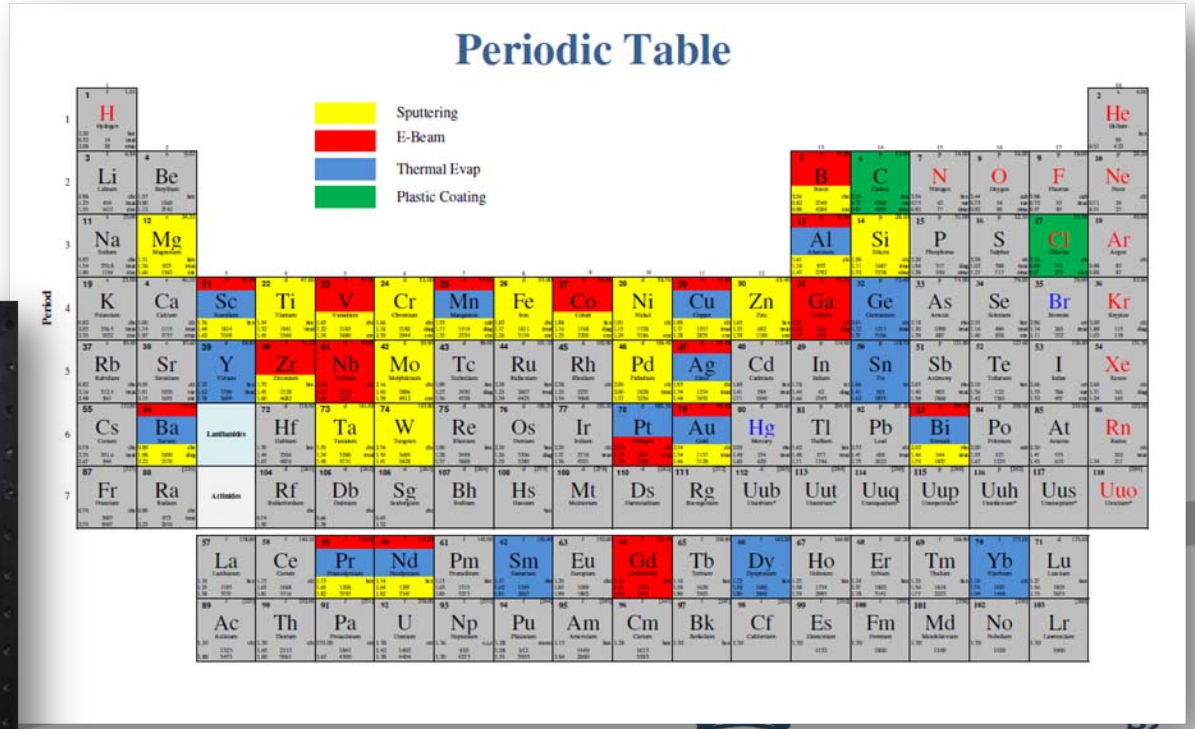
New Materials

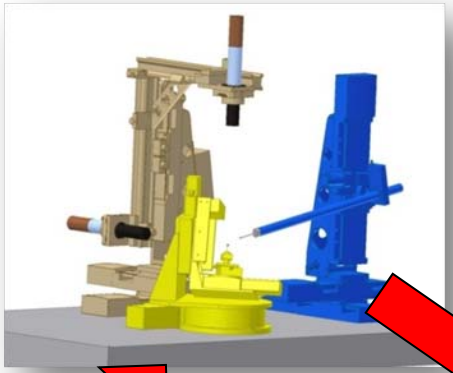
- Started discussions with Brunel and Bristol University about DLC and also Diamond Targetry
- Possibility of STFC capabilities for DLC coating.
- Pure hydrogen targets - Droplet, Cluster, cryogenics
- Foam and Aerogel equipment at RAL
- Collaborations with AWE/St Andrews

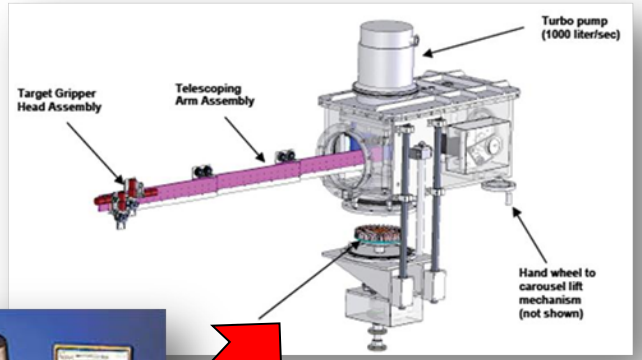




Integrated Target Fabrication Process

- Tooling and mounting solutions to cover, manufacture, assembly, characterisation, alignment and insertion/shots.
- Use commercially available mounting techniques to give ~1 micron repeatability across all platforms
- Design of an assembly station to increase target repeatability.





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Conclusions

- To meet the demand of target production for the next generation of laser systems all the people in this room would need to be working 24/7 365 days a year for one laser system

- There is a huge challenge and a large number of complimentary techniques and skills that will be required to solve these problems.
- As much as possible standardised target solutions will enable techniques to be transferrable across different laboratories and manufacturing facilities.

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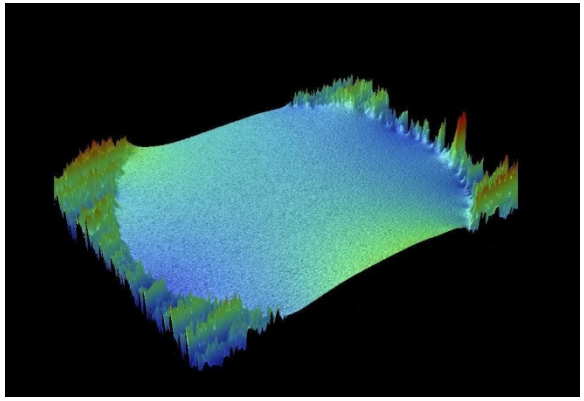
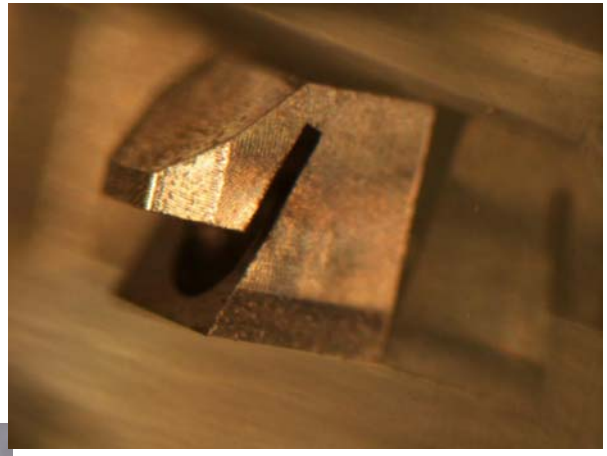
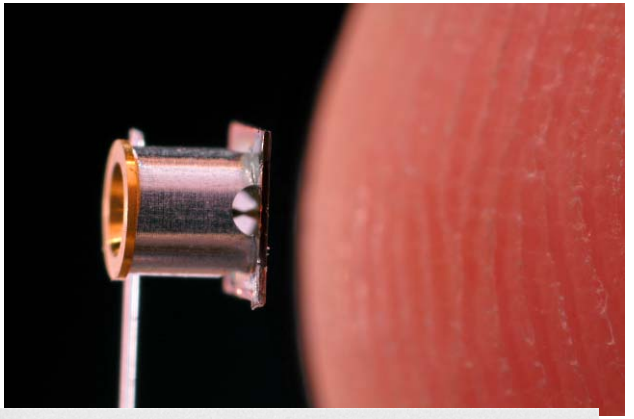
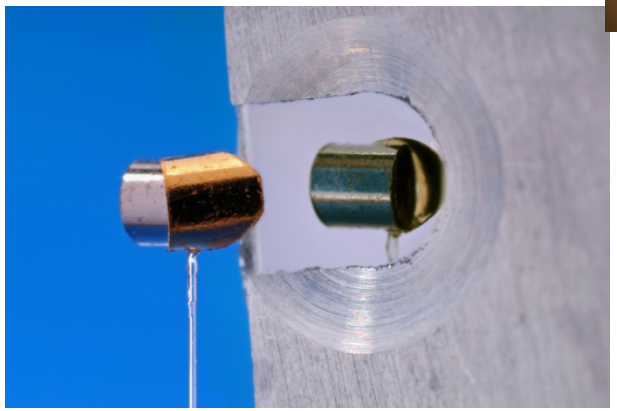
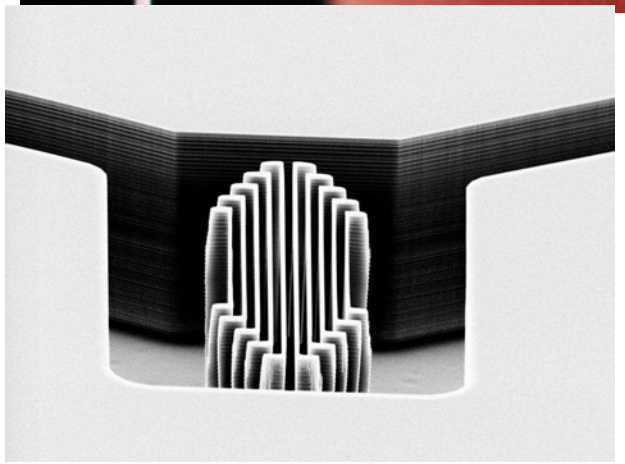


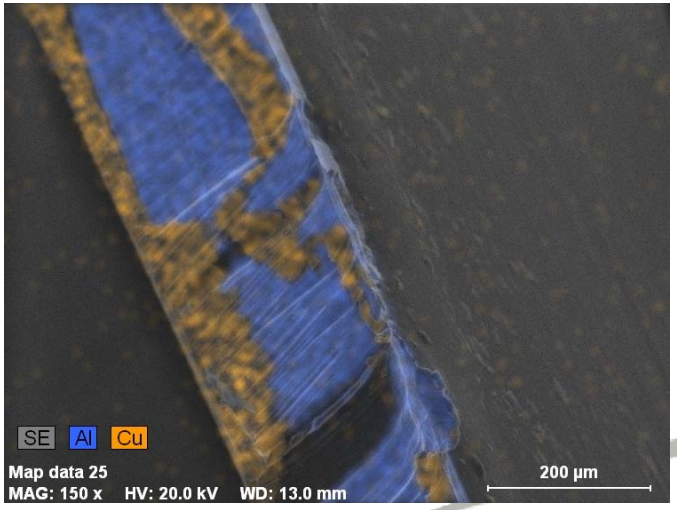


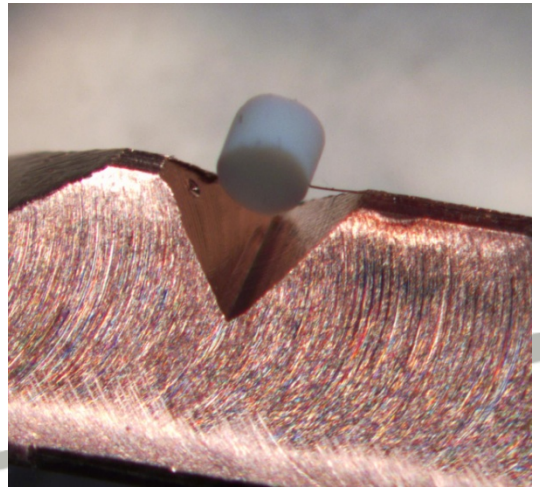


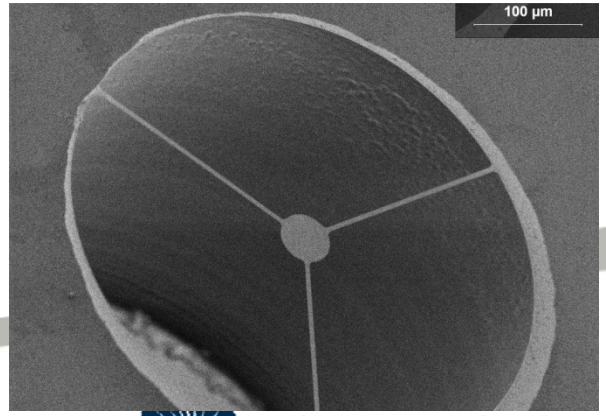


Thank you for listening









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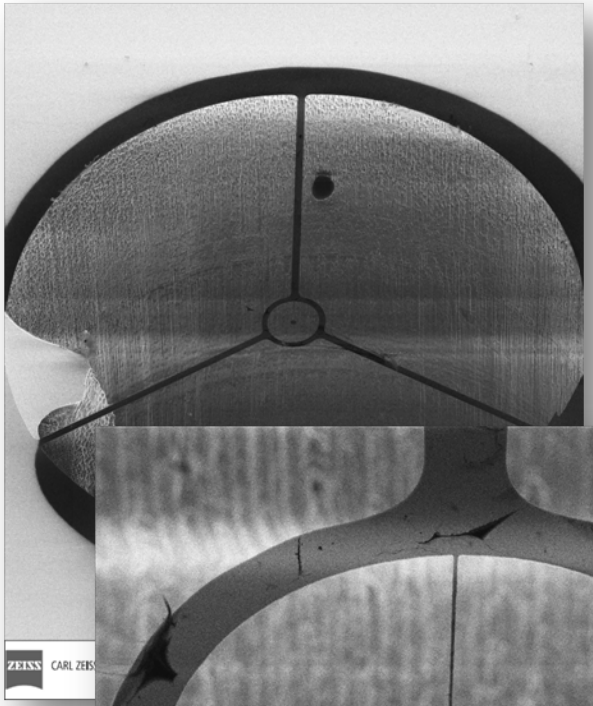
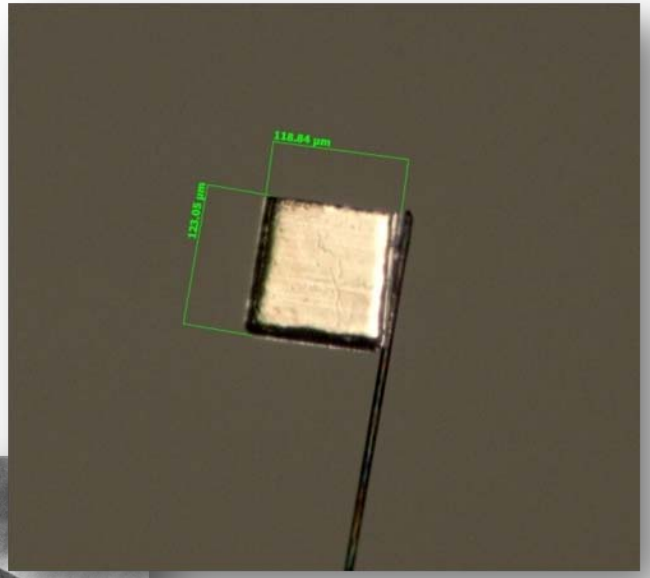
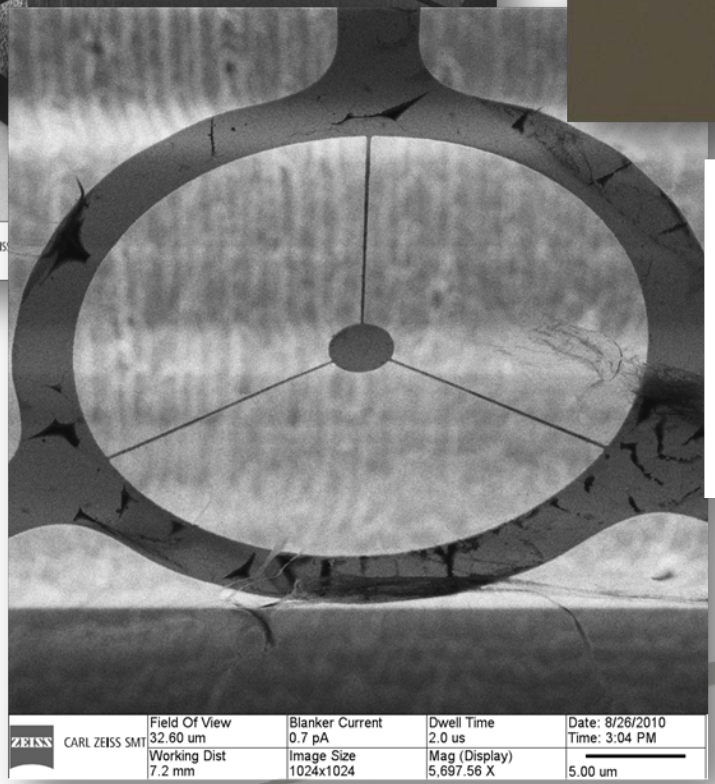
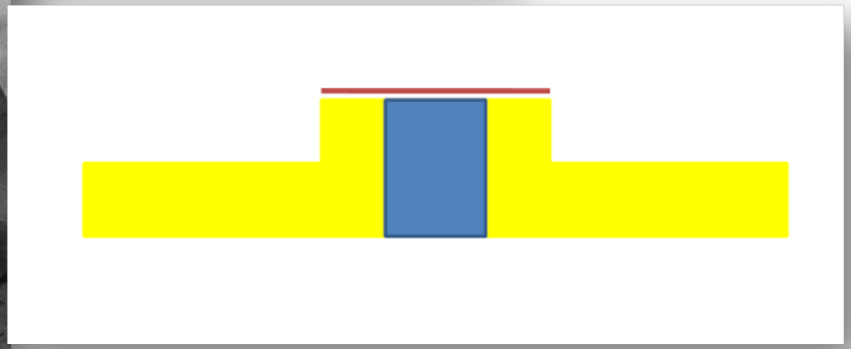
Complex Target Delivery









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