

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

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CLF Target Fabrication



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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



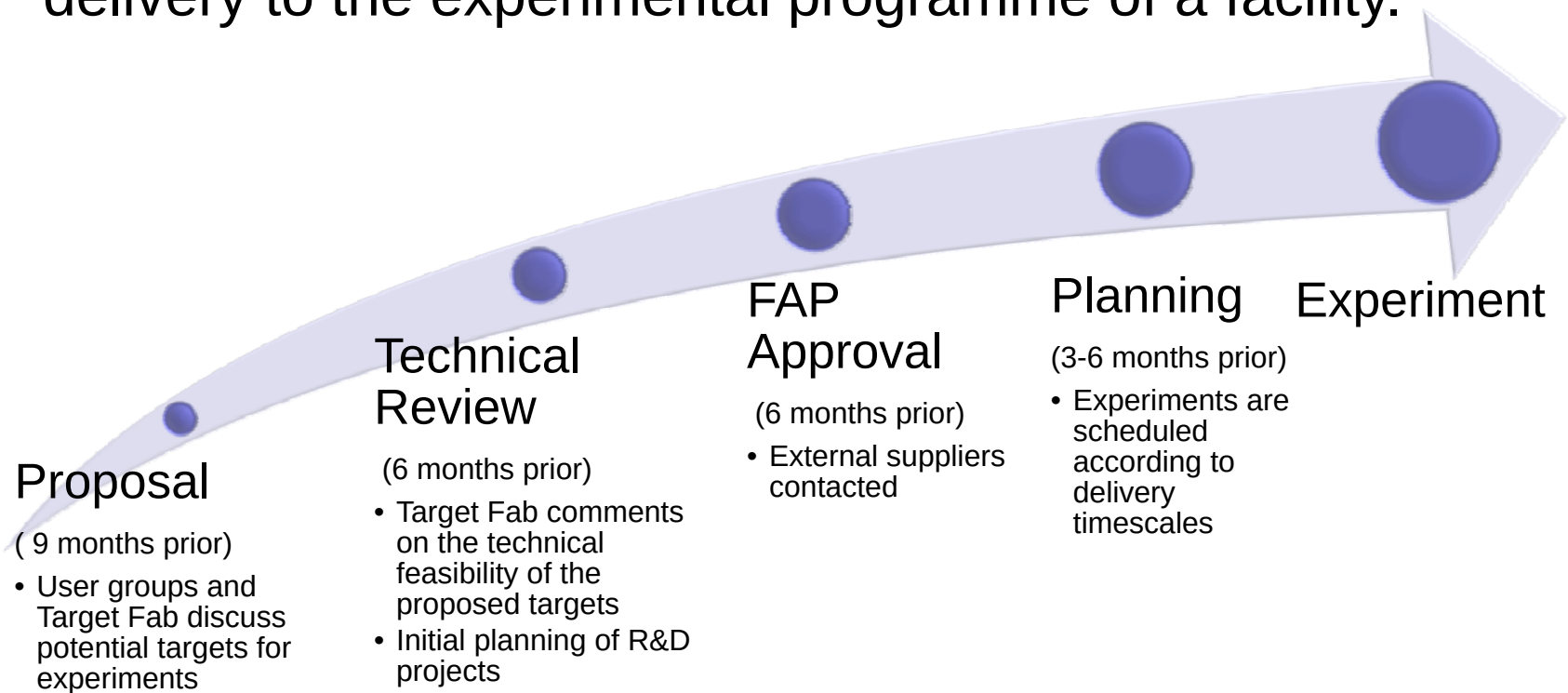
CURRENT ACTIVITIES AT RAL



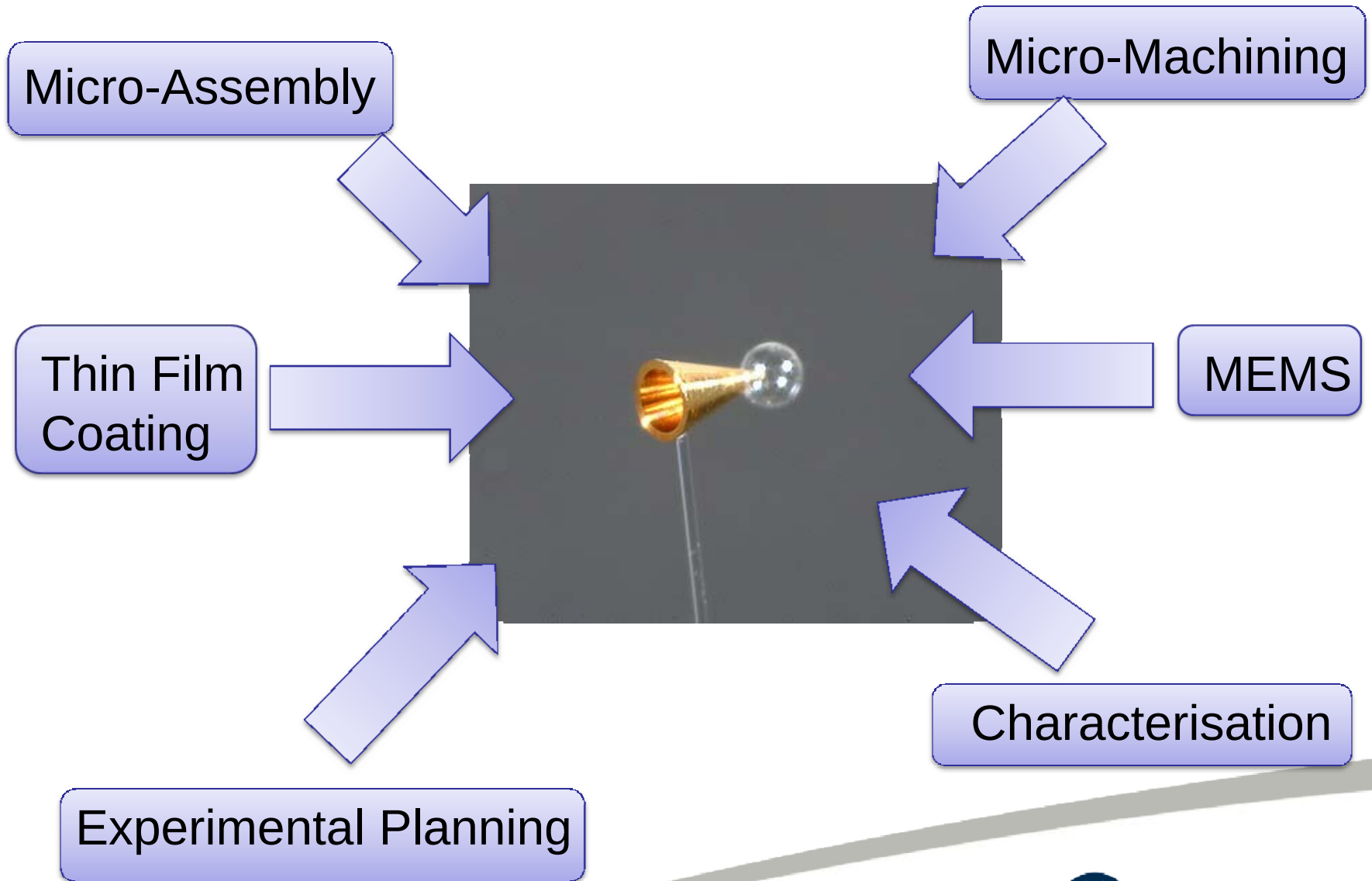
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Delivery to Experiments

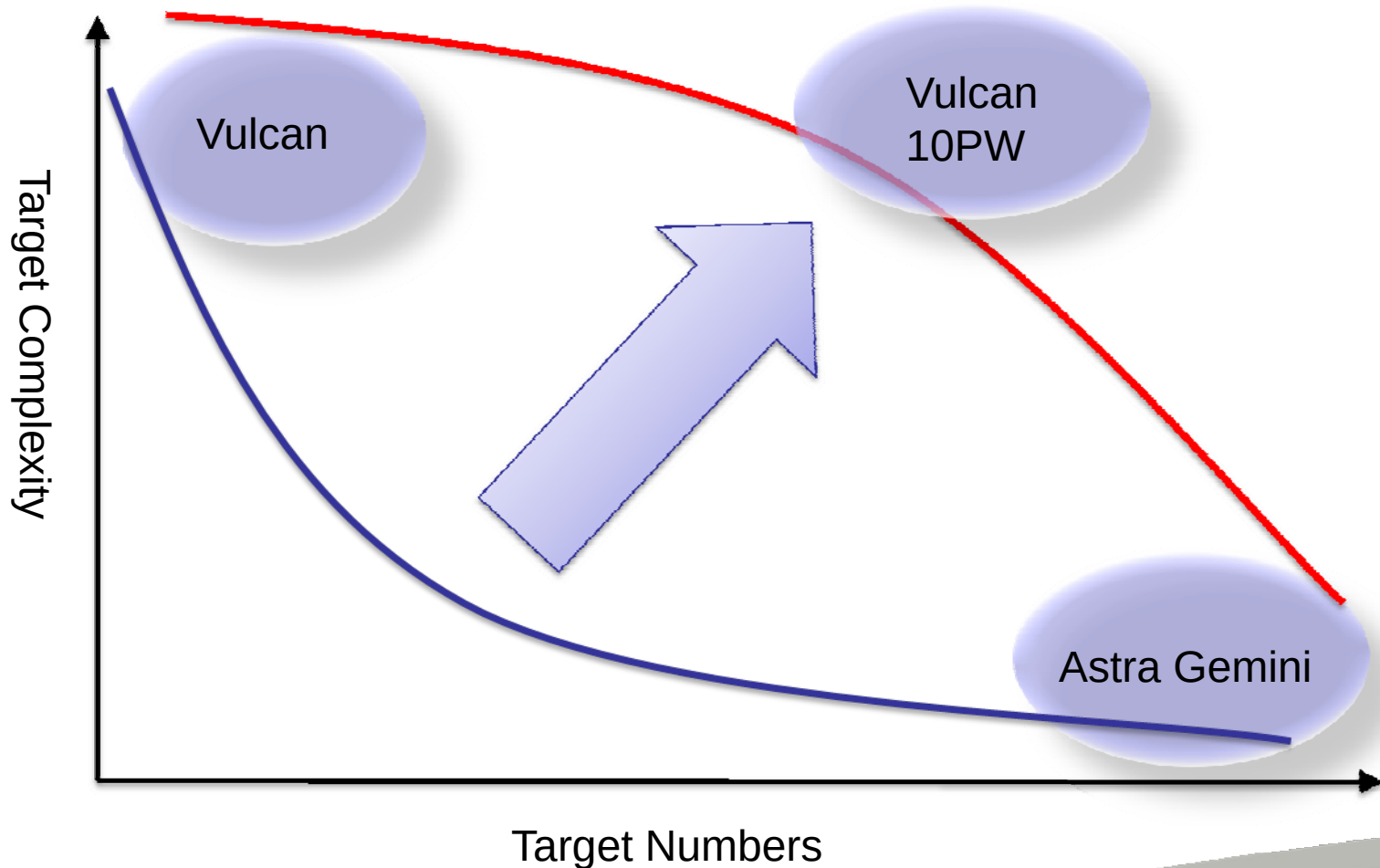
There is a huge difference between manufacturing a target and delivery to the experimental programme of a facility.



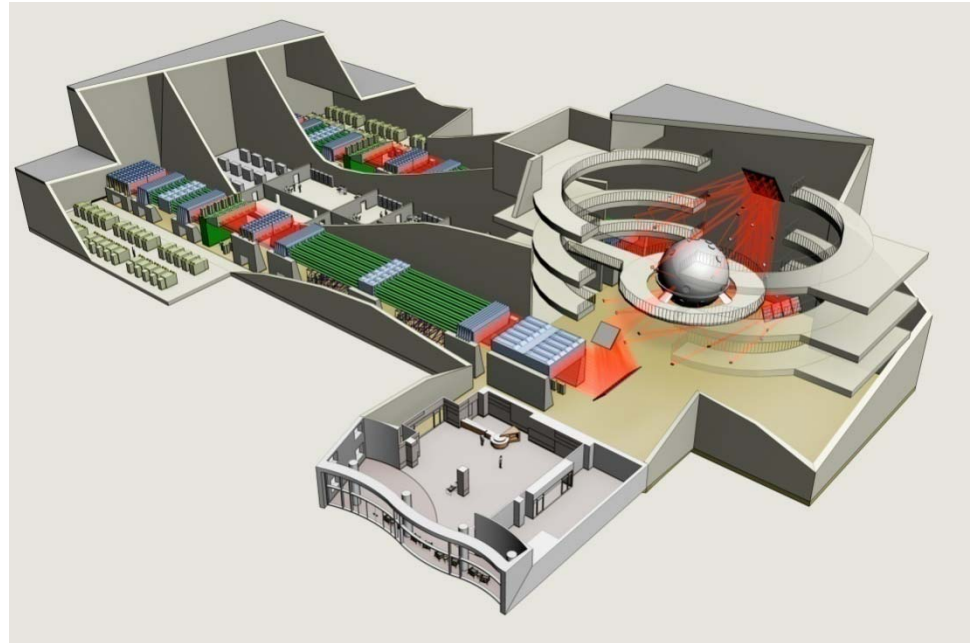
Integration of Technologies



What are the Future Requirements



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

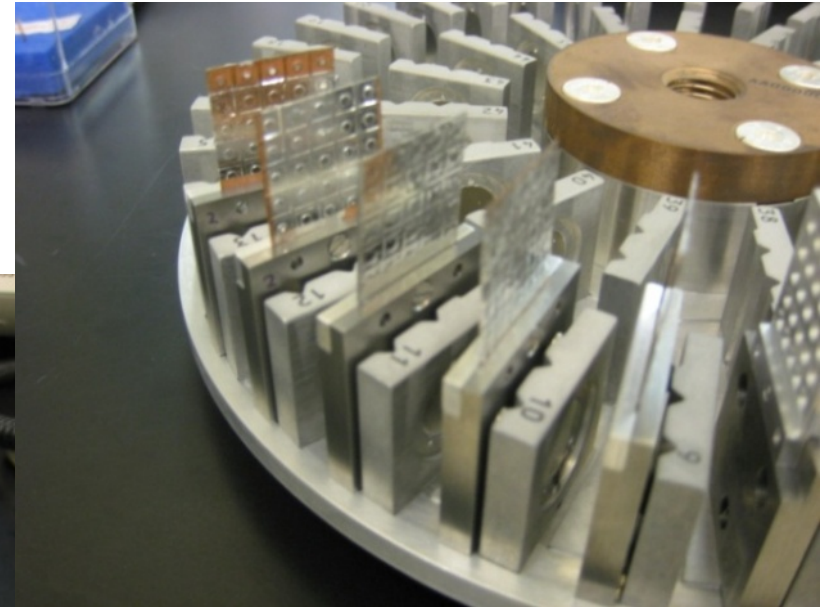
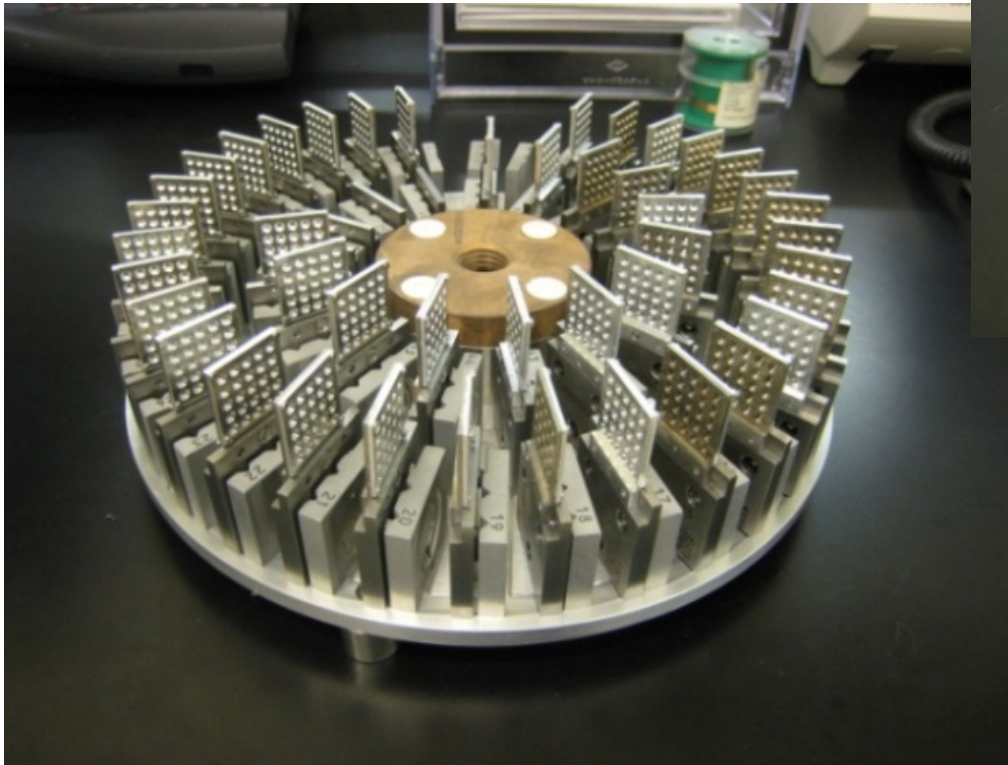
Other targets are more difficult to fabricate including for higher rep-rates

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



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.



PROJECTION

THIS DRAWING CONFORMS TO B.S.8888

A4 GTA-0908-0002

20

25

Ø1

1.5

4

3.5

5

2.5

Ø2.2

Ø2

15

A A

A-A (20 : 1)

0.1

0.05

0.25

0.5

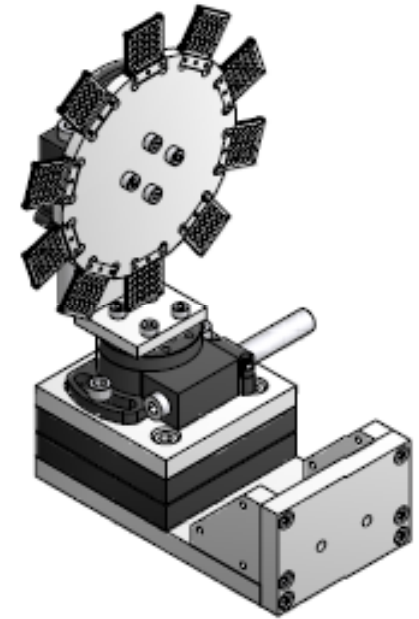
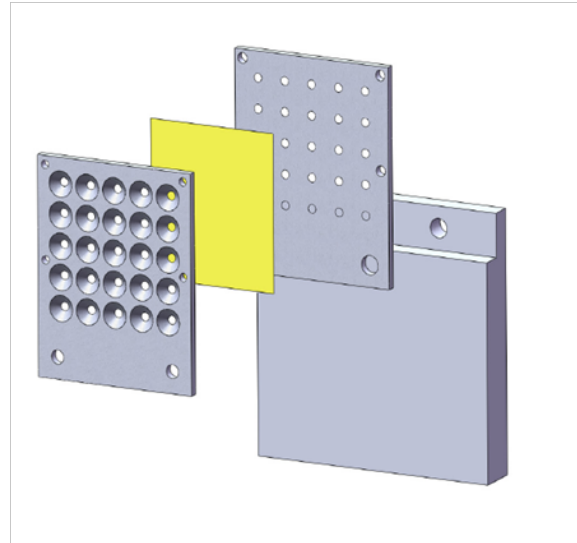
1

0.25

A	10/04/2008						
ISSUE	DATE	MOD DESCRIPTION	DRN	CHKD	APPD	STATUS	
TOLERANCE UNLESS STATED		FINISH	ORIGINAL SCALE				
± 0.1		CLEAN REMOVE ALL BURRS SURFACE FINISH μm 1.6 ✓ UNLESS STATED	DO NOT SCALE				
MATERIAL & SPEC. Copper		0 _____ mm					
USED ON S.T.F.C. - RUTHERFORD APPLETON LAB, CHILTON, DIDCOT, OXON, OX11 0CX						© STFC 2007	
TITLE Cu Holder Raised Holes and Grid							

A4 GTA-0908-0002

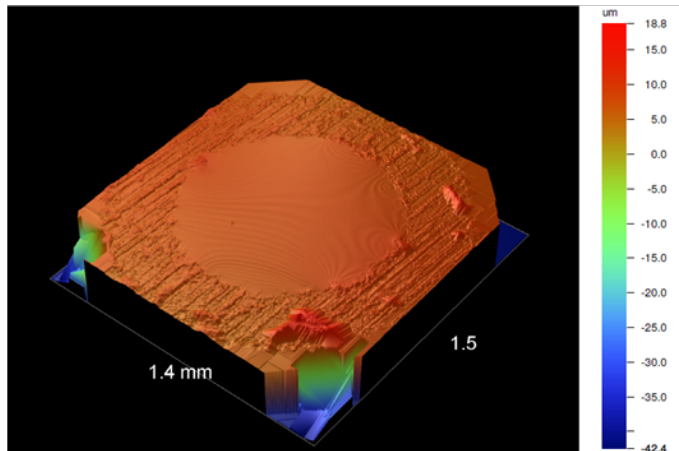
REV



X-Y-Z stages

Carousel

Target Wheel



Target Tracking

Target Request And Carousel Setup (TRACS)

Carousels Tab 2

Redraw Pucks Detail Select Puck Details Lat CAROUSEL2, Fill: 0 () Page Select

1 Adaptor Target CA0000002	2 Alignment Target CA0000051	3 Al 10um CA0000052	4 Al 6um CA0000053	5 Al 6um CA0000054	6 Al 6um CA0000055	7 Al 0.8um CA0000056	8 Al 0.8um CA0000057	9 Al 0.5um CA0000058	10 Al 0.5um CA0000059
11 Al 0.5um CA0000060	12 Al 0.1um CA0000061	13 Al 0.1um CA0000062	14 Al 0.1um CA0000063	15	16 Al 0.05um CA0000064	17 Al 0.05um CA0000065	18 Al 0.05um CA0000066	19 Al 0.05um CA0000067	20
21 CH 4um CA0000068	22 Mylar 1.5um CA0000069	23 Mylar 1.5um CA0000070	24 Mylar 1.5um CA0000071	25 CHN 0.5um CA0000072	26	27	28 CHN 0.1um CA0000075	29 C 200nm CA0000076	30 C 200nm CA0000077
31 C 200nm CA0000078	32 C 100nm CA0000079	33 C 100nm CA0000080	34 Carbon 50nm CA0000081	35 Carbon 50nm CA0000082	36 Carbon 25nm CA0000083	37 Carbon 25nm CA0000084	38 Carbon 25nm CA0000085	39	40 SIN 200nm CA0000086
41 SIN 200nm CA0000087	42 SIN 200nm CA0000088	43 SIN 200nm CA0000089	44 SIN 100nm CA0000090	45 SIN 100nm CA0000091	46 SIN 50nm CA0000092	47 SIN 50nm CA0000093	48 SIN 50nm CA0000094	49 SIN 30nm CA0000095	50 SIN 30nm CA0000096
51 SIN 30nm CA0000097	PUCK SCREEN			SCANNED		TRASH			

Load / Save / Mode

CAROUSEL2

Load Save Clear Refill

Scan

Carousel Setup Mode Change

Search

☒ Highlight Copy Selected Target Params

Material Thickness Text1

GA Control

GA Load Selected Target RIST Set as Damaged

STOP Continue Set As Shot

Retract Arm Close GV

Next Target Label0 Set Target as one in Chamber

Shot Number Label0

Target Request And Carousel Setup (TRACS)

Pucks Carousels Tab 2

Puck Details: CA0000002 fill 0

Name Al 40um Fill Date: 20081212

Adapter ID BA0000001

Puck Angle 0

Target Layout

☒ Target Array ☒ Precision Machined

X Size 5 Y Size 5

NumPages 1

Target Details

Target: 1

Material Aluminium

Thickness (um) 40

Duplicate or Clear Target Details

From 1 To 100 Duplicate Clear

XYZ position 0 0 0 GET XYZ

Clear measurements Cascade Measurements

Puck Select and Reload

Pick ID CA0000002 Scan (Re) Load / Create

Refill Puck Save Close

Permissions Mode Full Control (Target Fab Staff) Change

WT Flag#ID : 0, MT Flag#ID : 0, MS XYZ : 0, 0, 0, MS UVW : 0, 0, 0, MS rotXYZ : 0, 0, 0, MS TempDisp : 0, 0, TIXYZ : 0, 0, 0, TIUVW : 0, 0, 0, TIRotXYZ : 0, 0, 0, TITempDisp : 0, 0, 0, TI ang t.p.p : 0, 0, 0



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 Request And Carousel Setup (TRACS)

Pucks

Carousels

Redraw

Detail Select

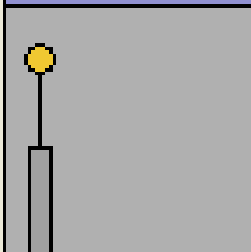
Puck Details

Page Select

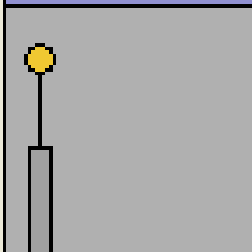
Lat

CAROUSEL2, Fill: 0 0

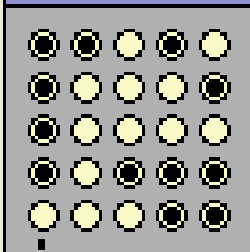
1 Adaptor Targe
BA00000002



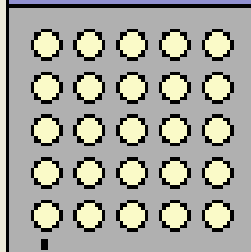
2 Alignment Tar
CA00000051



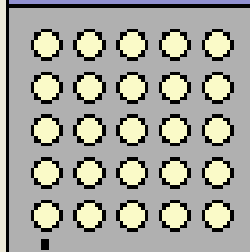
3 Al 10um
CA00000052



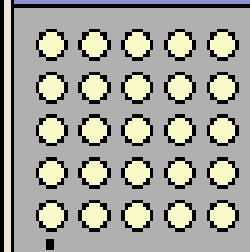
4 Al 6um
CA00000053



5 Al 6um
CA00000054



6 Al 6um
CA00000055



11 Al 0.5um
CA00000080

12 Al 0.1um
CA00000081

13 Al 0.1um
CA00000082

14 Al 0.1um
CA00000083

15

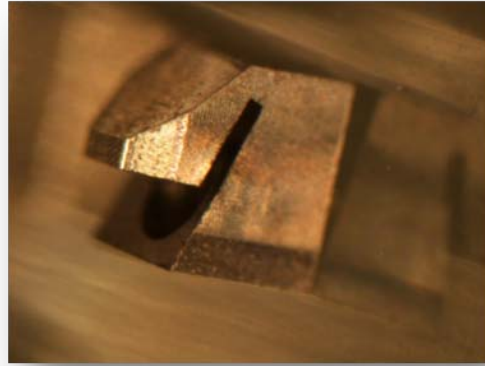
16 Al 0.05um
CA00000084

17gy

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



Mass Production Techniques



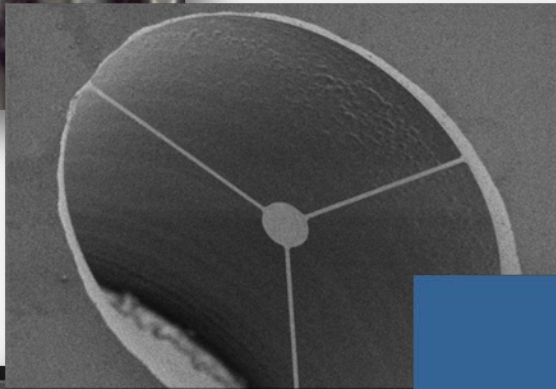
Micro-machining

Laser processing

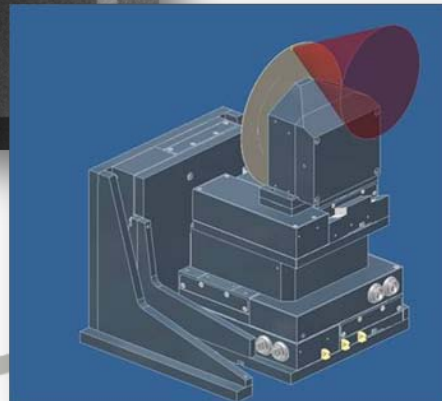
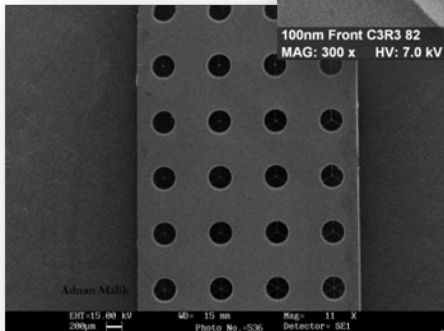
Micro-moulding

Wafer based targets

Liquid Droplets



100nm Front C3R3 82
MAG: 300 x HV: 7.0 kV WD: 6.0 mm



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THE VULCAN 10PW UPGRADE



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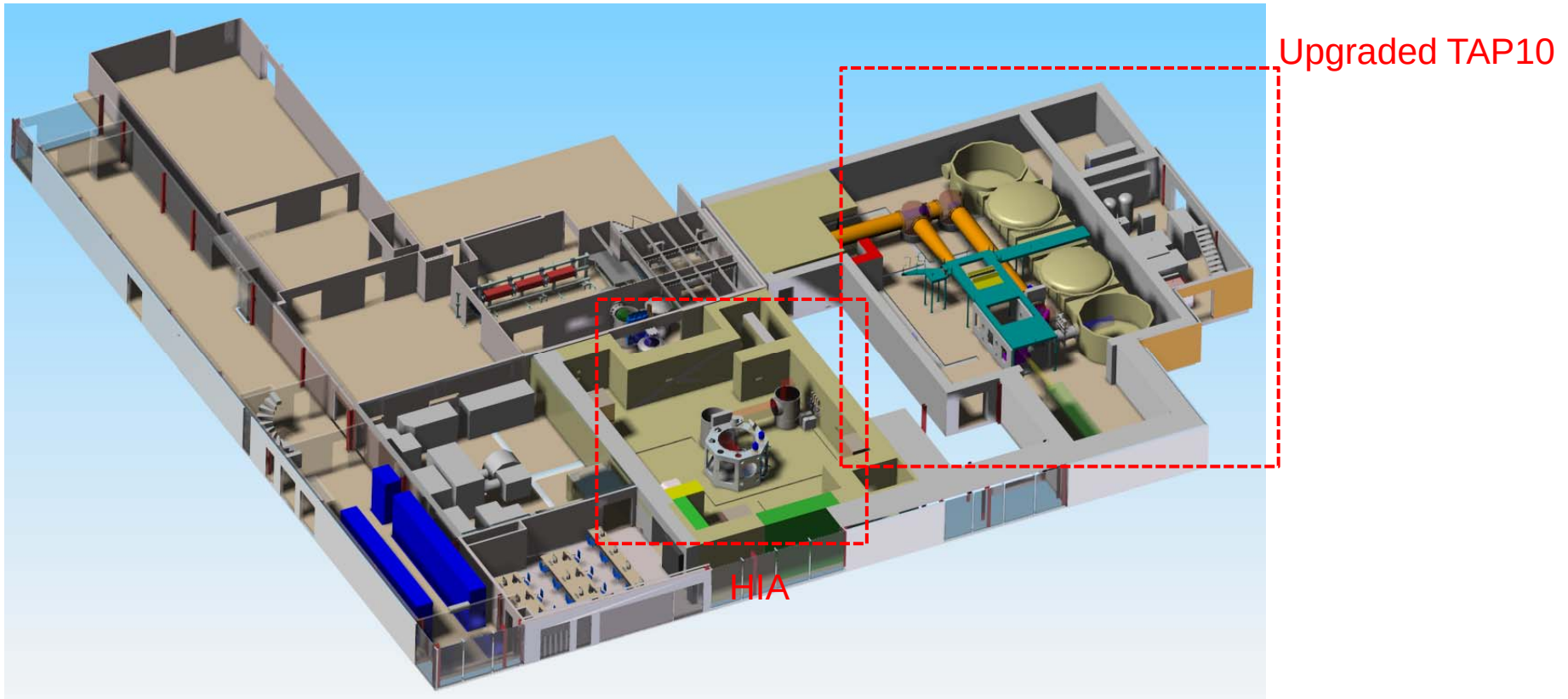
Current Position

Main work focussed towards the detailed building design



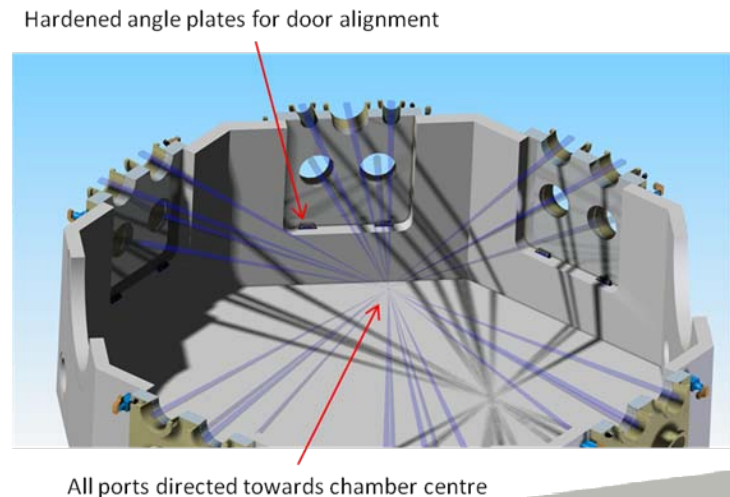
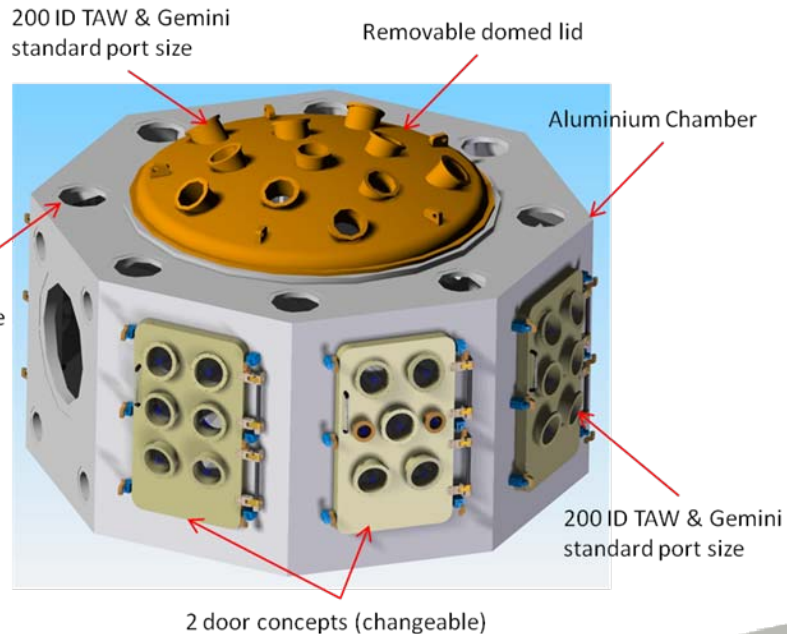
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Building Design



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.



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

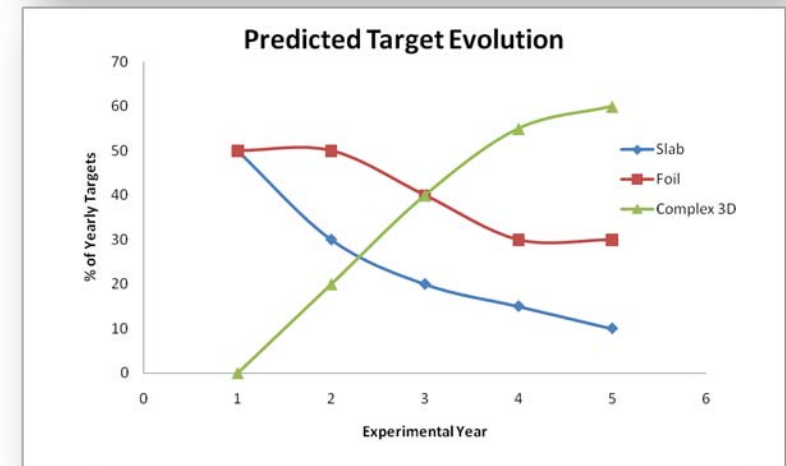
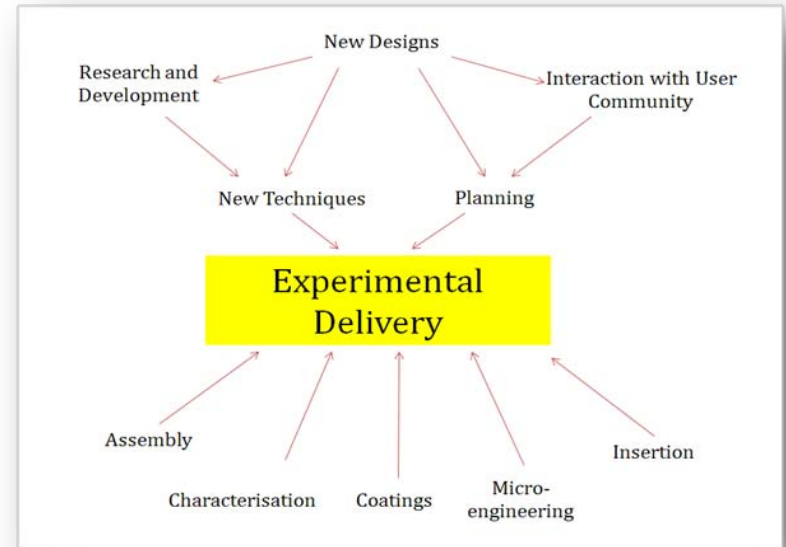
- First series of consultations carried out – some email responses returned
- Followed up by visits to Universities
- Expand consultation to wider community including Europe.

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

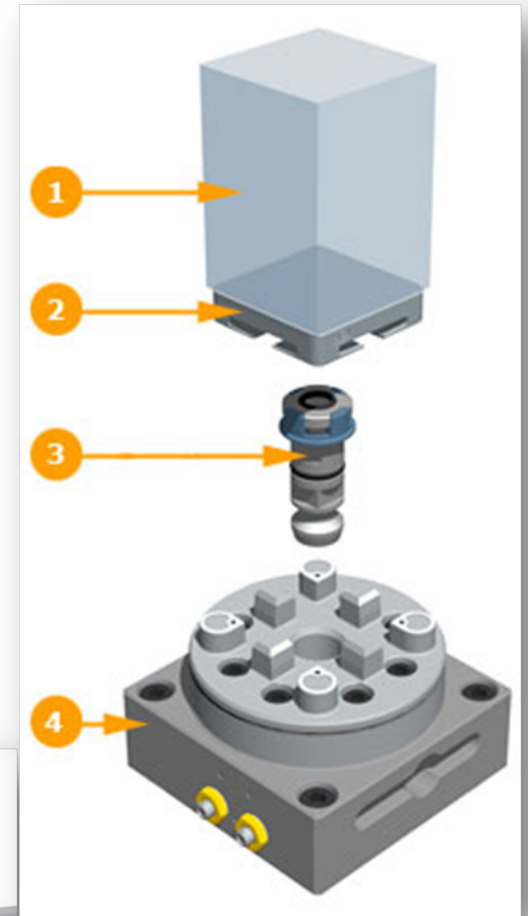
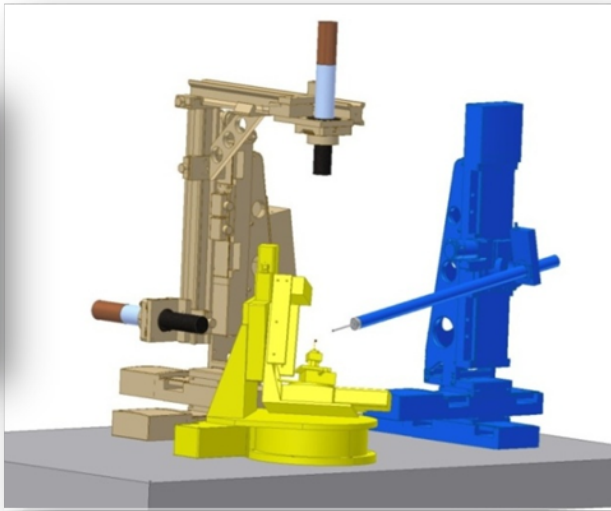


Target Assembly Station

- 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

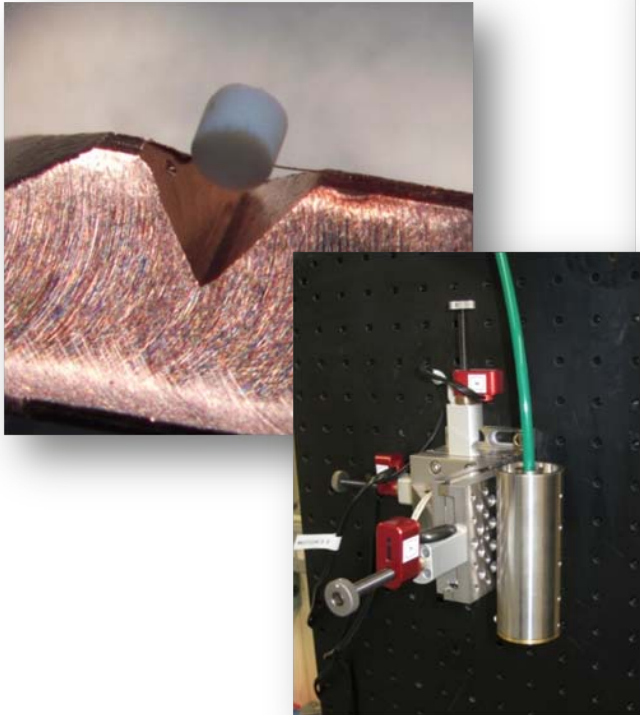
Things to consider

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



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



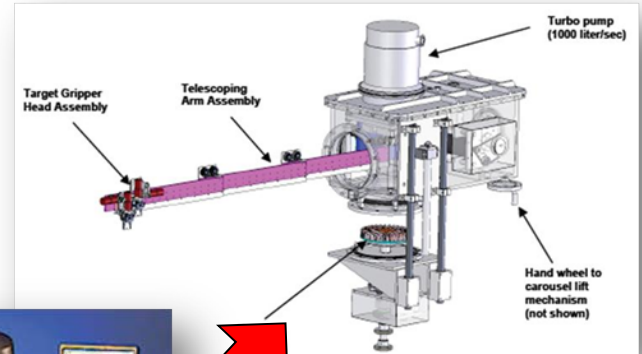
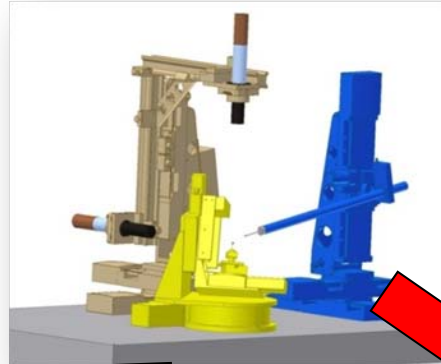
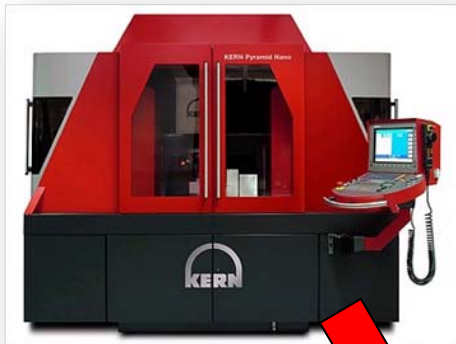
Periodic Table

Sputtering
 E-Beam
 Thermal Evap
 Plastic Coating

1	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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Integrated Target Fabrication Process

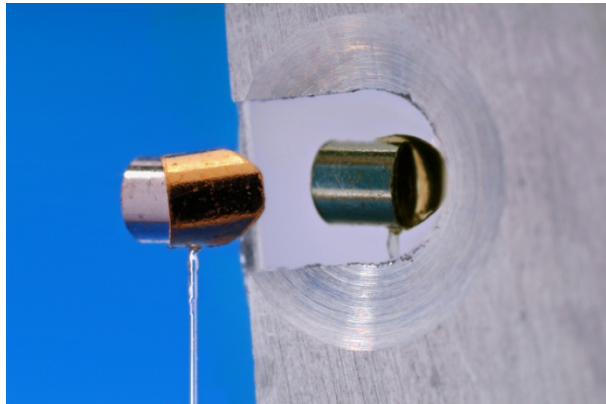
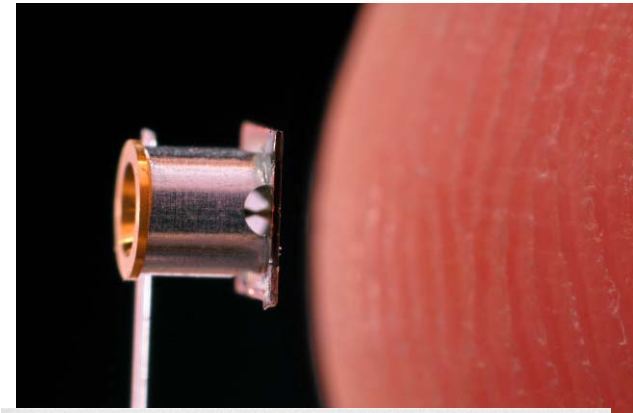
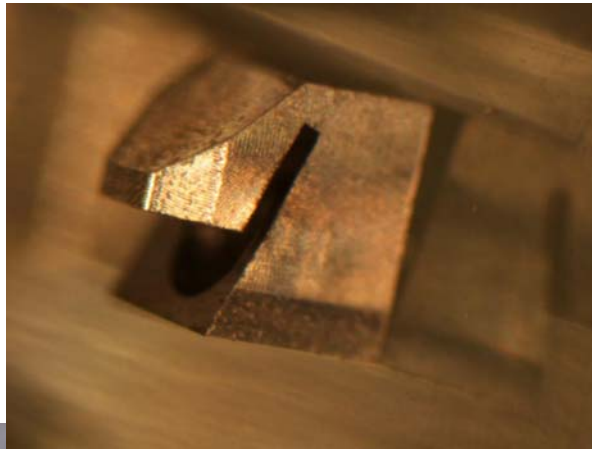
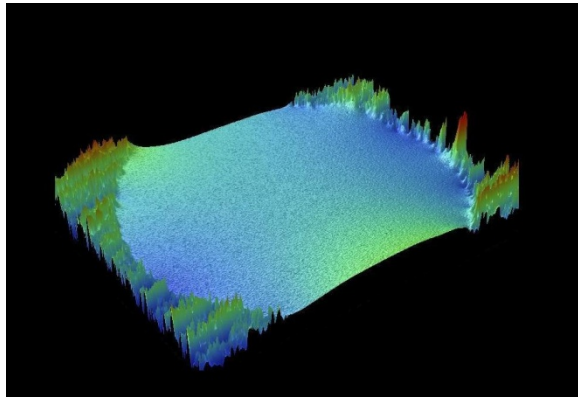
- Tooling and mounting solutions to cover, manufacture, assembly, characterisation, alignment and insertion/shots.
- Use commercially available mounting techniques to give ~1 micron repeatability across all platforms
- Design of an assembly station to increase target repeatability.



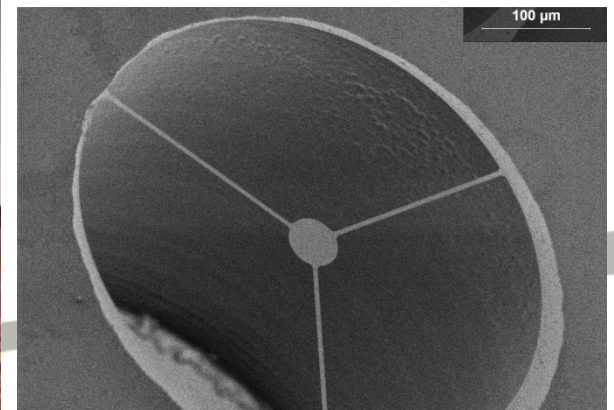
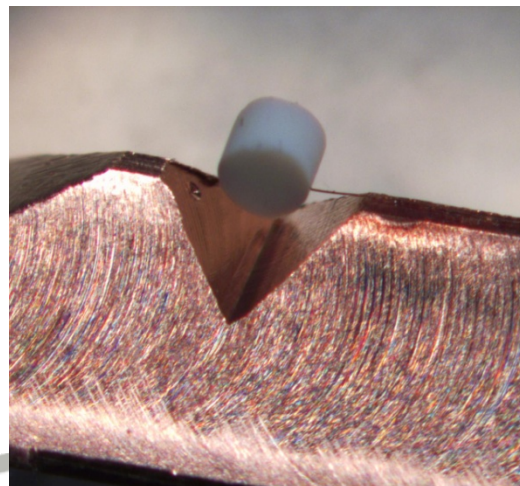
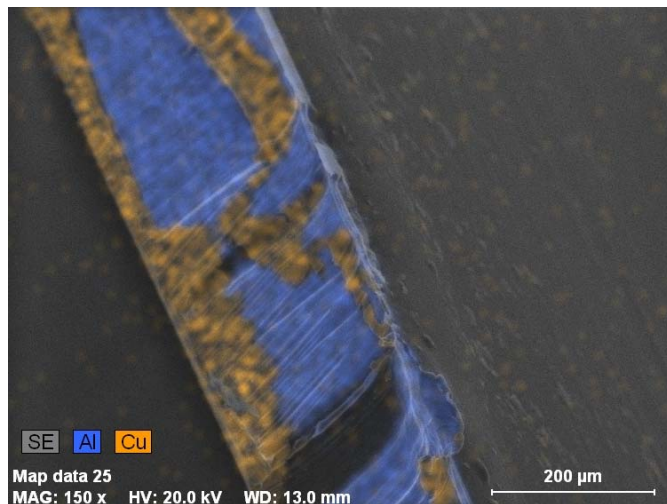
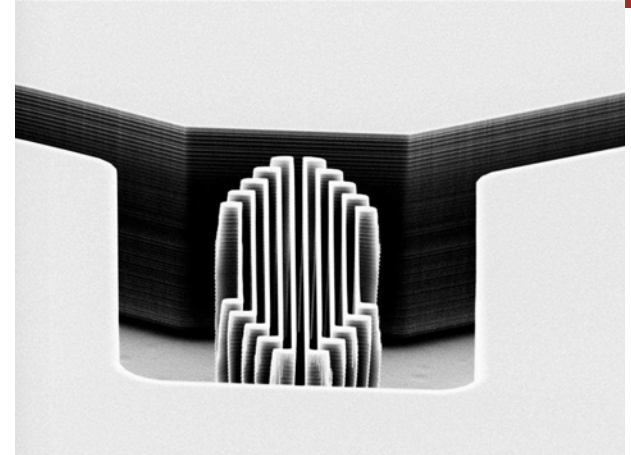
Conclusions

- 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.



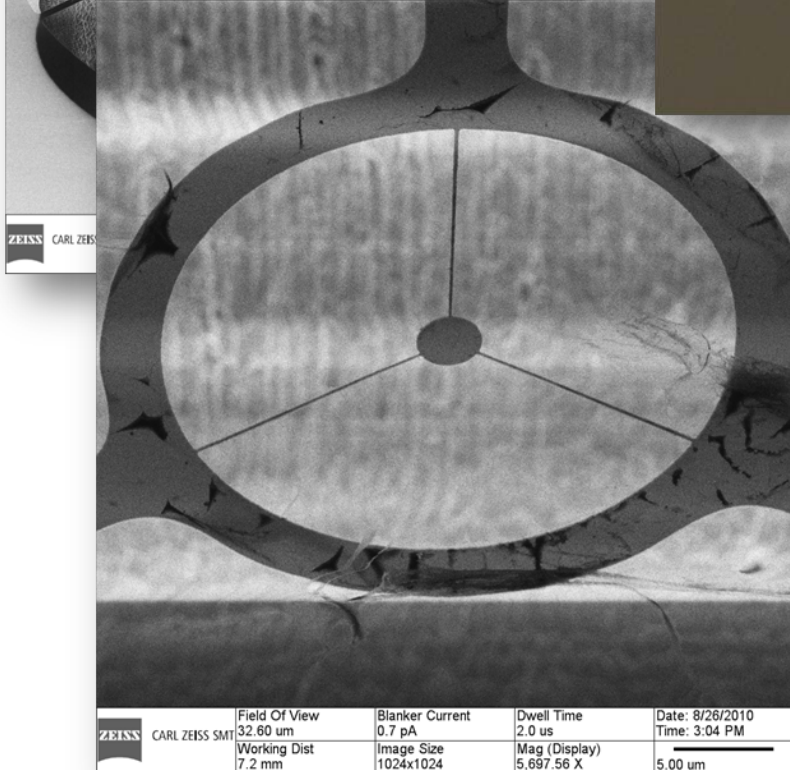
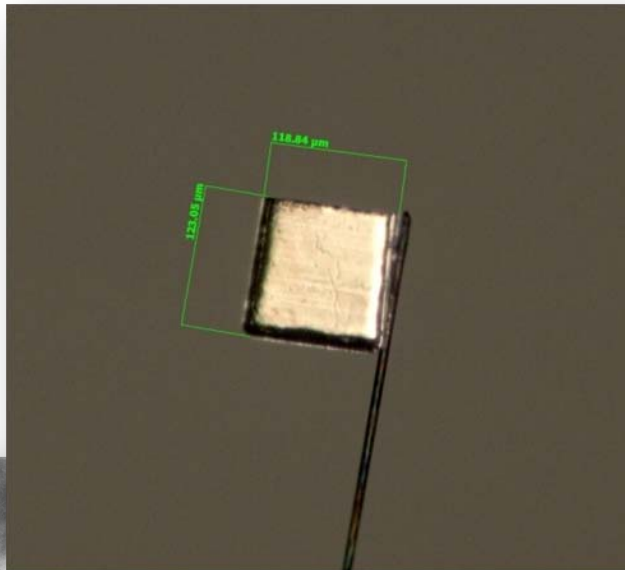
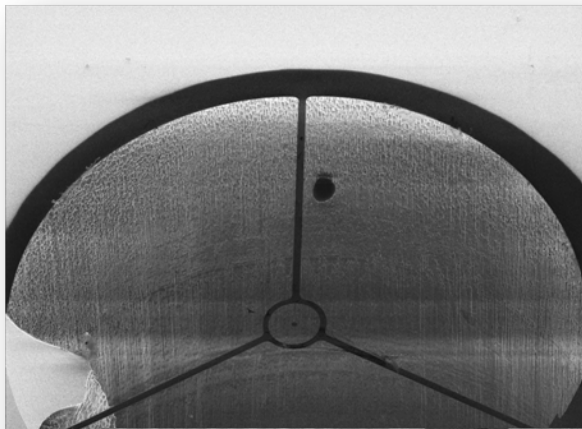


Thank you for listening



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Complex Target Delivery



ZEISS	CARL ZEISS SMT	Field Of View 32.60 µm	Blanker Current 0.7 pA	Dwell Time 2.0 us	Date: 8/26/2010 Time: 3:04 PM
		Working Dist 7.2 mm	Image Size 1024x1024	Mag (Display) 5,697.56 X	5.00 µm



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