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High Accuracy Microtargetry System (HAMS)

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10/10/13

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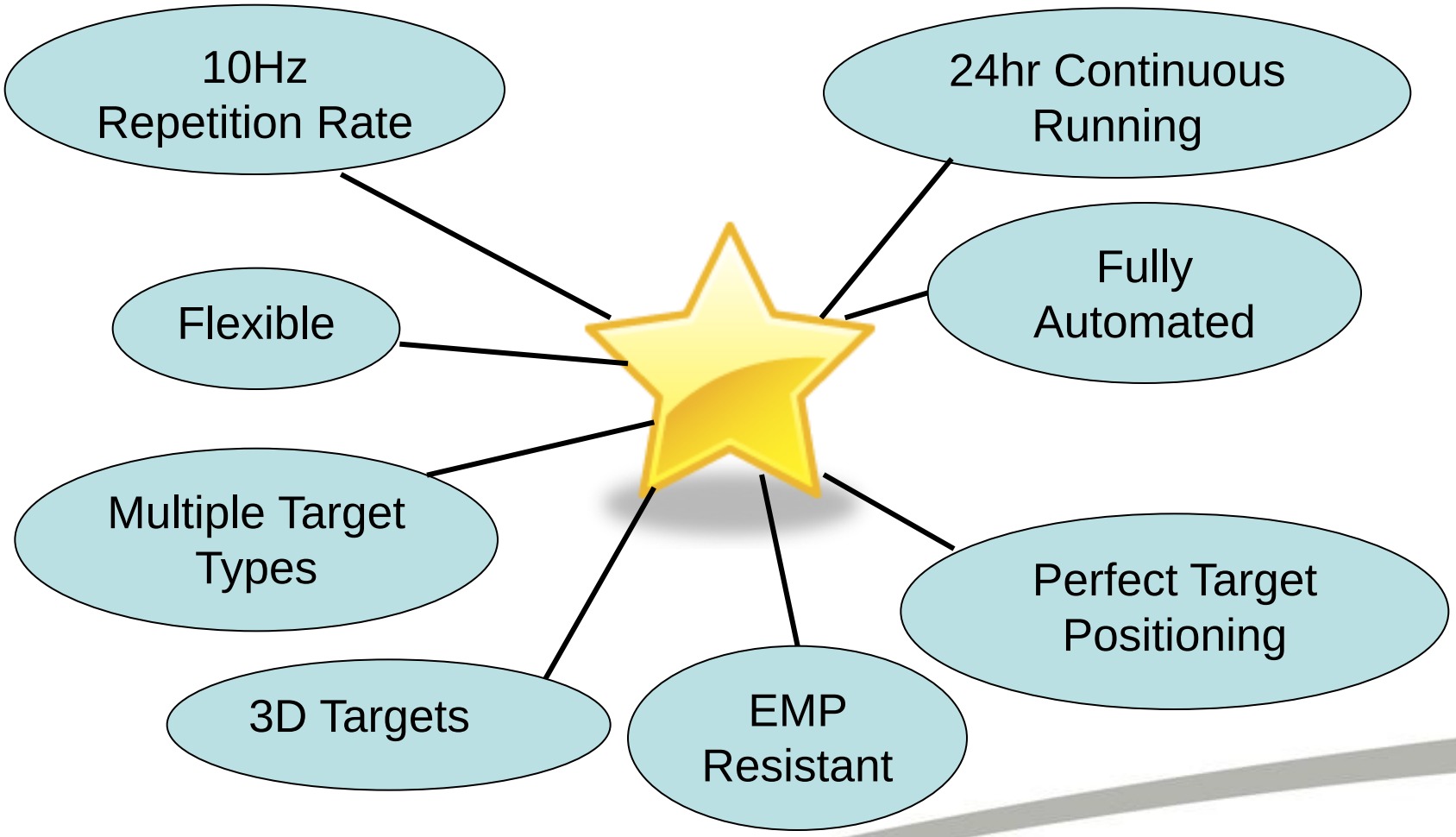
Ultimate Goal



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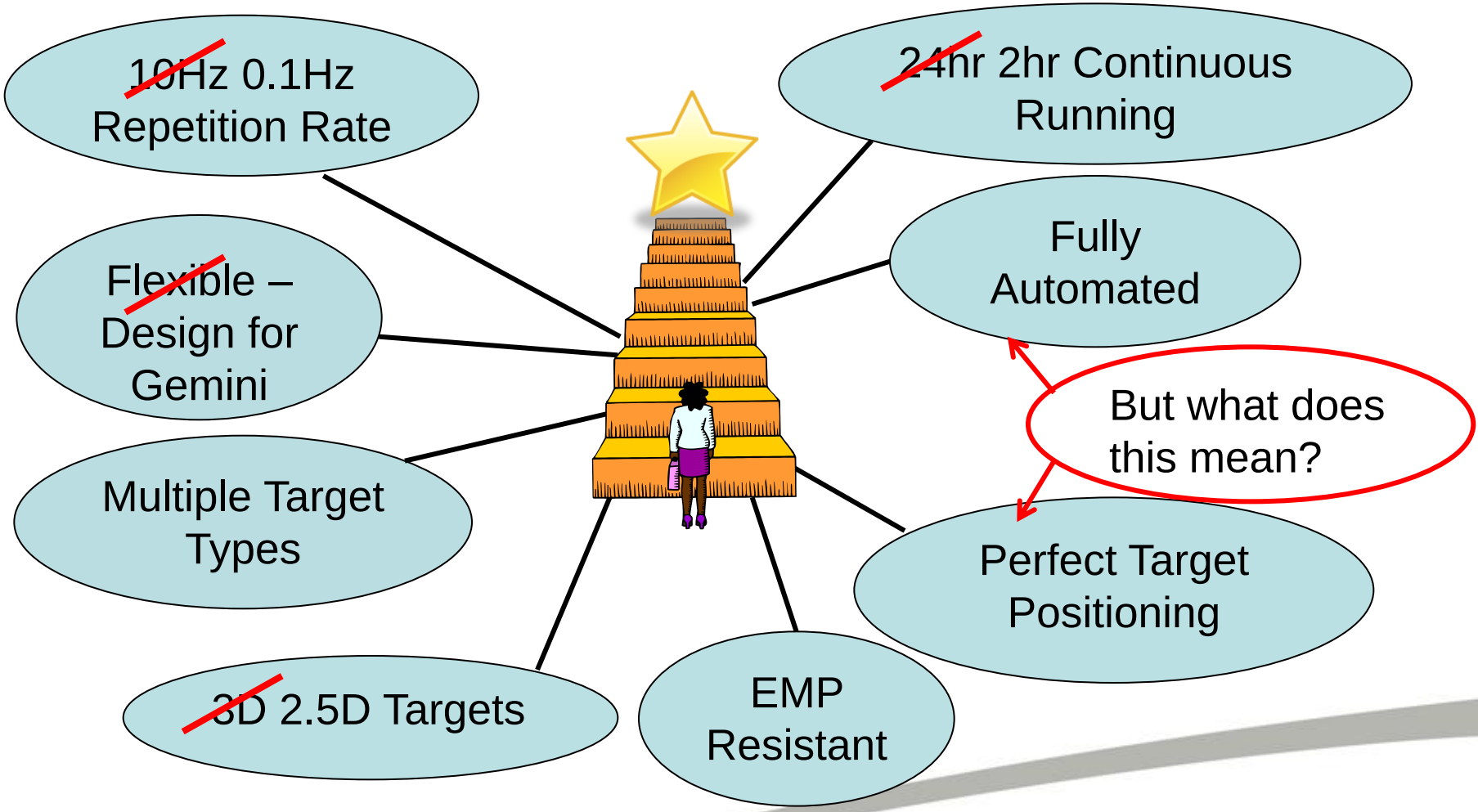
Step 1



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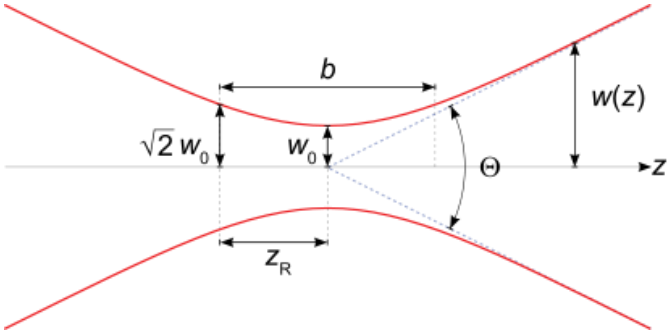
Z Positioning Specification

- F2 parabolic mirror
- 2 micron diameter spot size
- Z motion tolerance defined by the Raleigh range



$$z_R = \frac{2\omega_0}{\Theta}$$

- The tolerable range for the Z motion for each target is **±4µm**.

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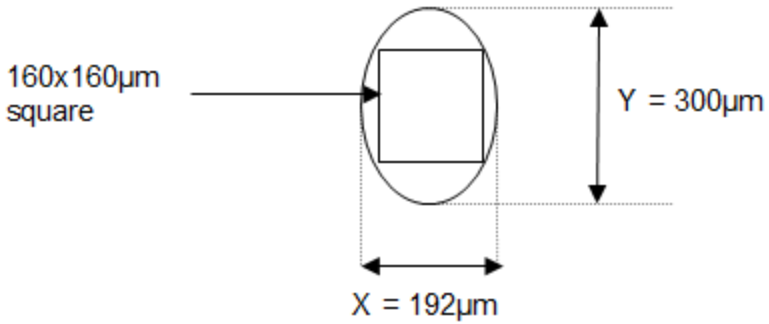
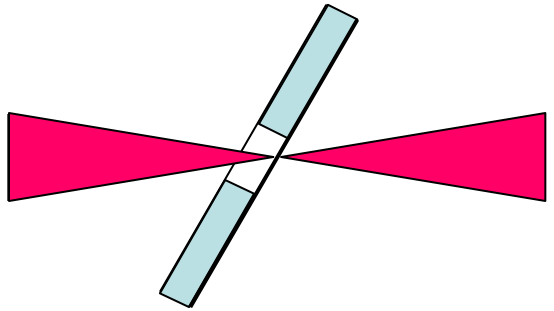
X, Y Positioning Specification

- Target Diameter 300 µm
- Angular offset to beam at least 30˚
- Target wafer housing should not interfere with interaction





- An X and Y tolerable range of **±10µm** is sufficient for each target.

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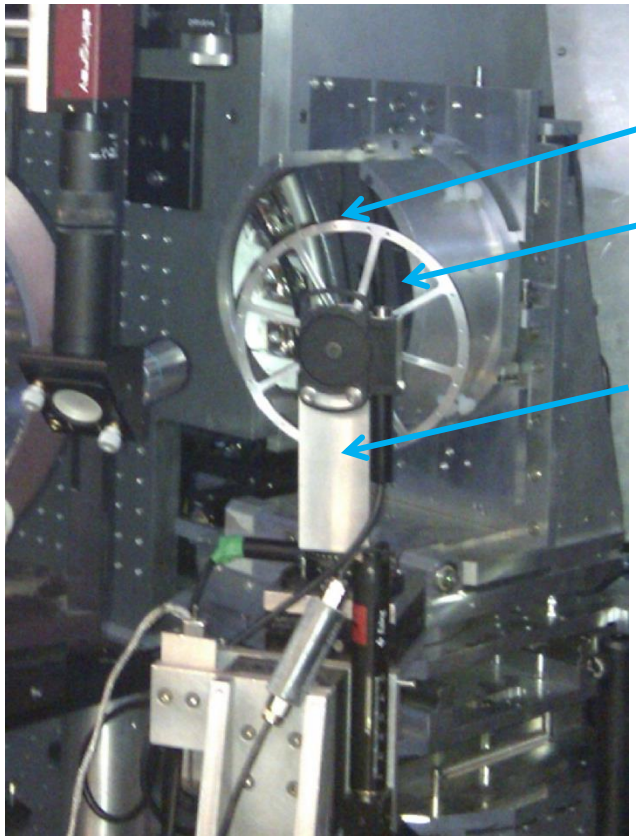
What prevents this occurring?

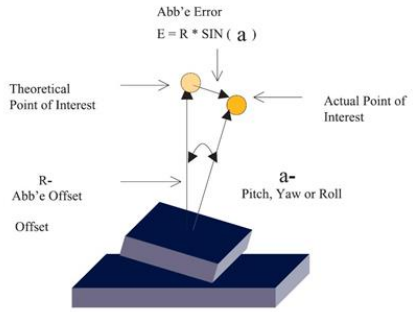
Accumulation of positional errors in:



Target

Mounting of Targets

Motion Control Stages



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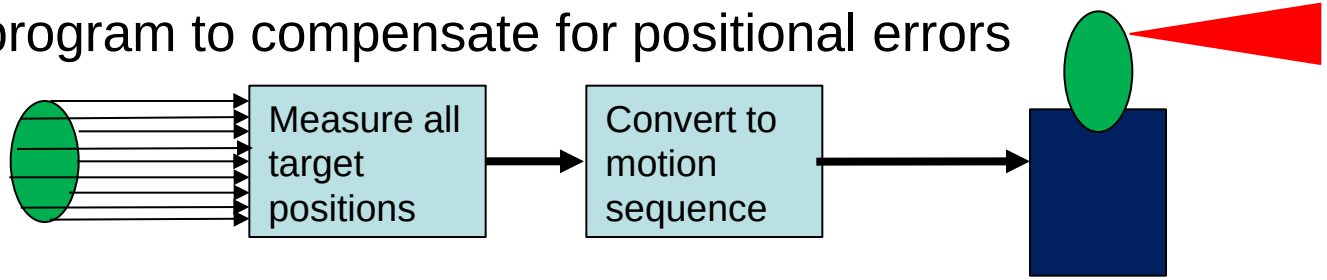
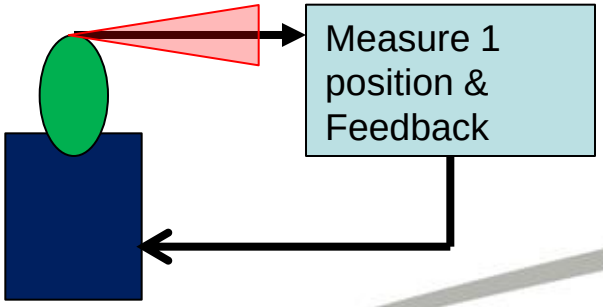
Approaches to Managing Errors

1) Minimise errors in all components and interfaces to a level below the specification tolerance

2) Characterise the position of targets prior shooting and run program to compensate for positional errors



3) Real time adjustment of target position between high repetition rate shots



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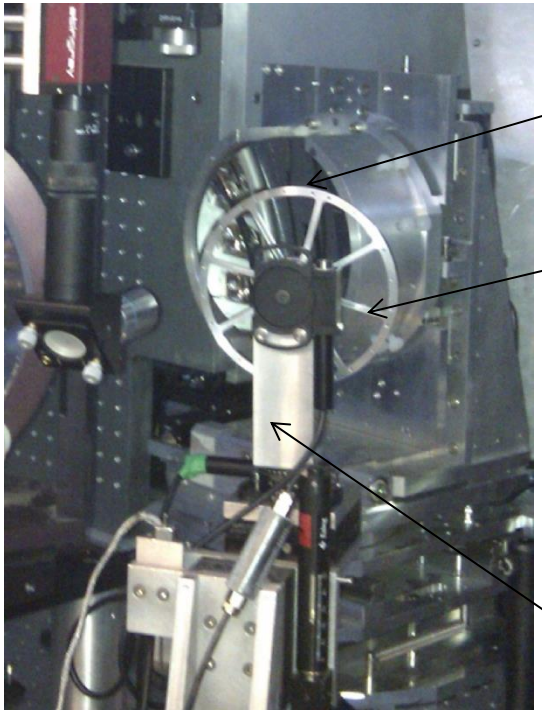
Reducing Sources of Errors



Target

2.5D Targets, Silicon Wafer

Mounting of Targets

Target Arrangement, Materials, Design for Precision Machining, Machining Techniques, Assembly Devices

Motion Control Stages

Alignment Methodology, Stage Specification, Abbe Effects

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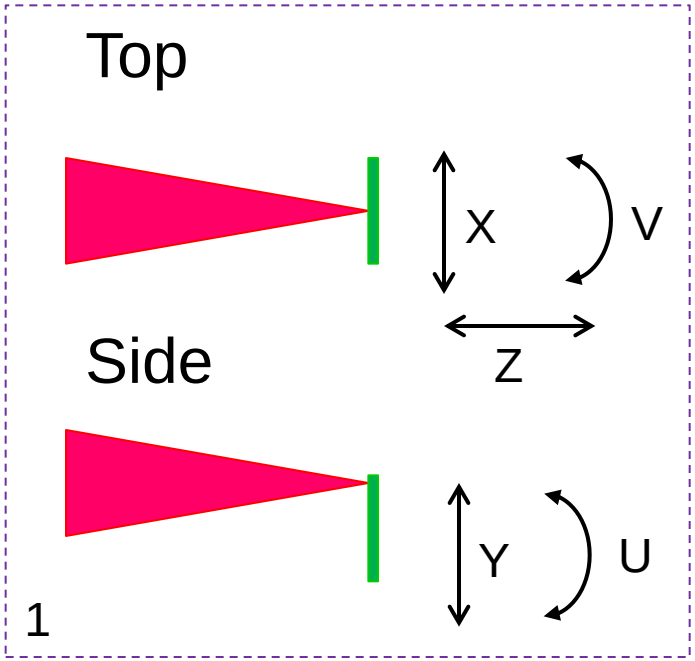
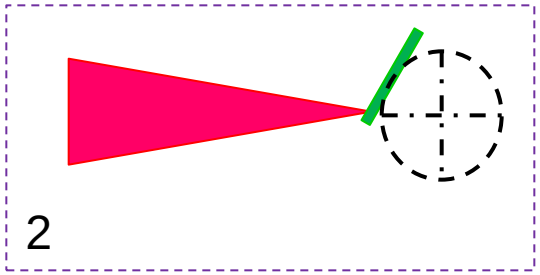
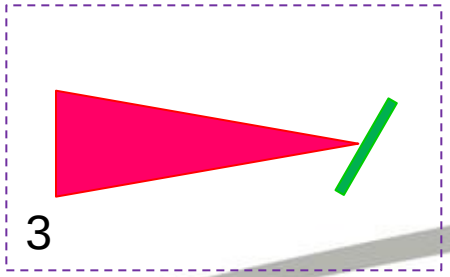
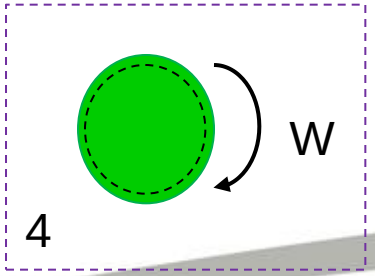
Alignment Methodology



1) Align target wheel to laser
   - Tip (U), Tilt (V), X, Y, Z
2) Turn target wheel to offset angle
   - V
3) Re position target to focal spot
   - X, Z
4) Turn target wheel in 1 degree steps
   - W







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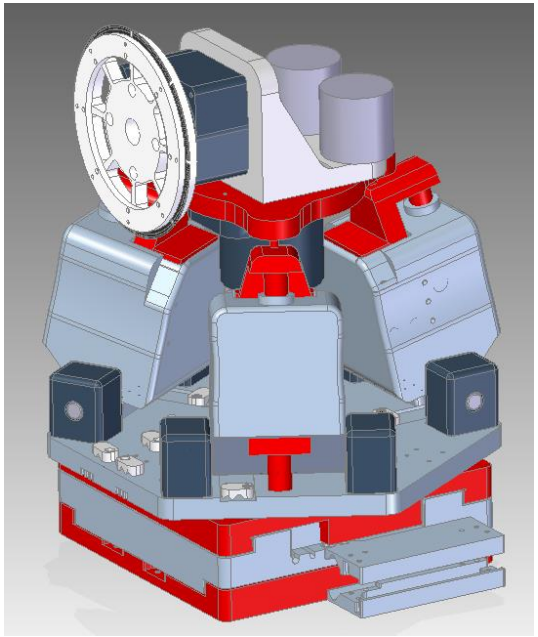
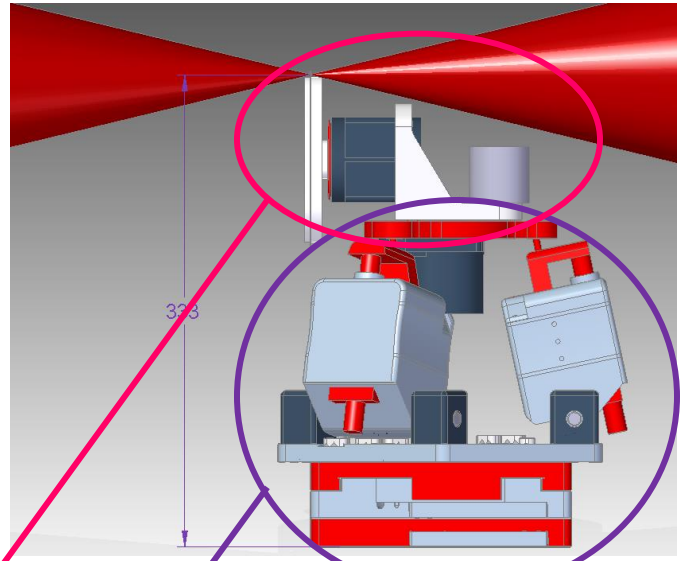
Motion Control Stages



Translation Stages
- X
- Z

Tripod
- U
- V
- Y

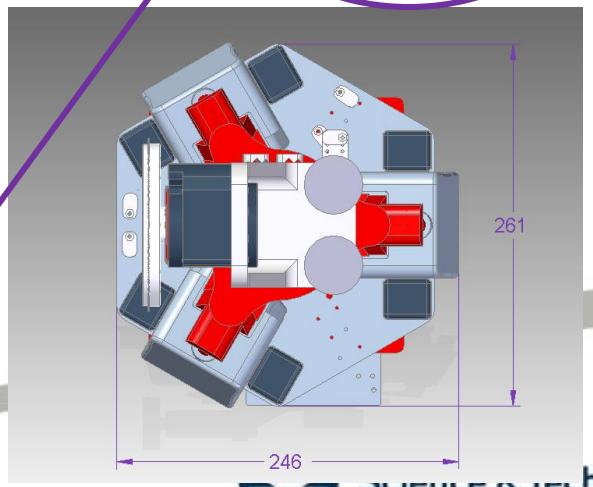
Rotation Stage
- W



- F2 Laser (top target)
- 337mm Max Height
- Objective Lens
- Line of Sight
- 260 x260mm Footprint

Designed to suit application

Common to any system



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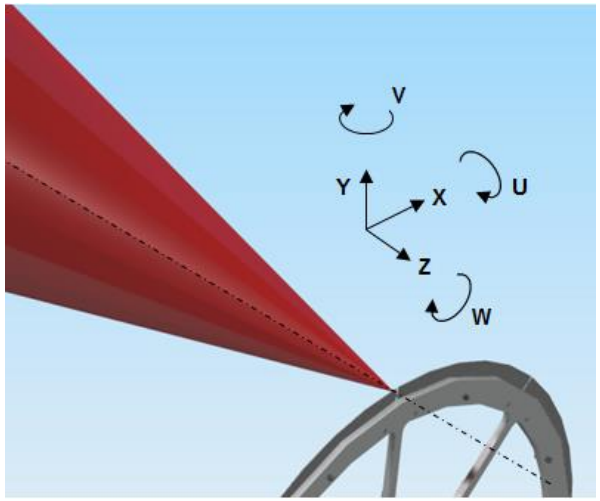
Motion Control Stages

Key Values

AXIS NAME	MINIMUM INCREMENTAL MOTION	TRAVEL	RESOLUTION		Repeatability	Accuracy
Z	< 50 nm	100 mm	~ 4.88 nm		< +/- 100 nm	+/- 2um / 25mm
X	< 50 nm	100 mm	~ 4.88 nm		< +/- 100 nm	+/- 2um / 25mm
Y	< 50 nm	24 mm	~ 4.88 nm		< +/- 100 nm	+/- 2um / 5mm
U	< 0.06 mdeg	+/- 4.4 deg	~ 0.02 arc-sec	(~ 0.006 mdeg)	< +/- 0.5 arc-sec	+/- 20 arc-sec
V	< 0.06 mdeg	+/- 4.4 deg	~ 0.02 arc-sec	(~ 0.006 mdeg)	< +/- 0.5 arc-sec	+/- 20 arc-sec
Vb	< 0.06 mdeg	+/- 35 deg	~ 0.04 arc-sec	(~ 0.011 mdeg)	< +/- 0.5 arc-sec	+/- 30 arc-sec
W	< 0.06 mdeg	360 deg cont.	~ 0.04 arc-sec	(~ 0.011 mdeg)	< +/- 0.5 arc-sec	+/- 30 arc-sec



Features

- Can define the tool point
- Tested under EM Discharge 20kV

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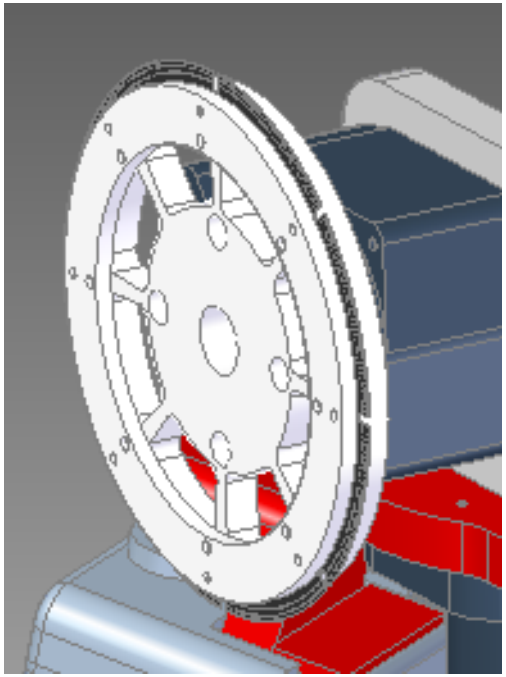
Target Mounting Design

- Disc shape – annulus of targets
  - Compact arrangement
  - One motion control stage for 360 targets
- Minimise diameter
  - Reduce offset errors
  - Reduce offset loads
- Sub-assembled target unit
  - Can be measured prior to installation in chamber



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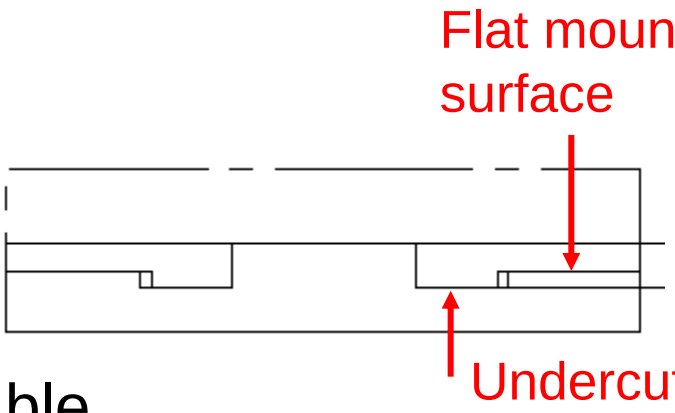
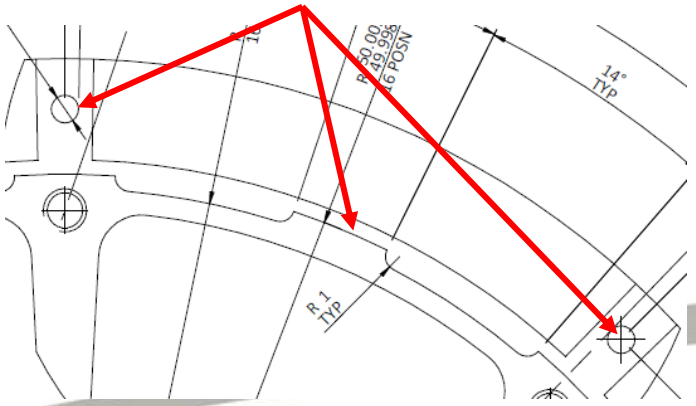
Design for Precision Machining

- Examples of design features
  - Minimal contact areas for precise location
  - Undercut perpendicular faces
- Features must also be measurable





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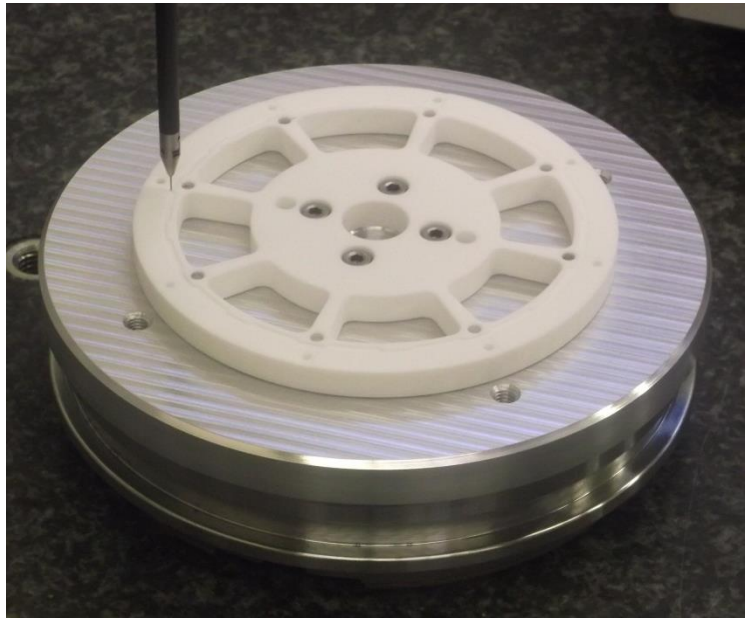
Precision Machining

- Material Considerations
  - Local heating by machine tool
  - Residual stresses
  - Vacuum compatible
  - Stable over time
- Material Parameters
  - Low co-efficient thermal expansion
  - High hardness – difficult to machine
  - Low porosity
- Glass Ceramic
  - Macor, Zerodur
- Machining Techniques
  - Vibration dampened work holding system
  - Lapping
  - Ultrasonic machining



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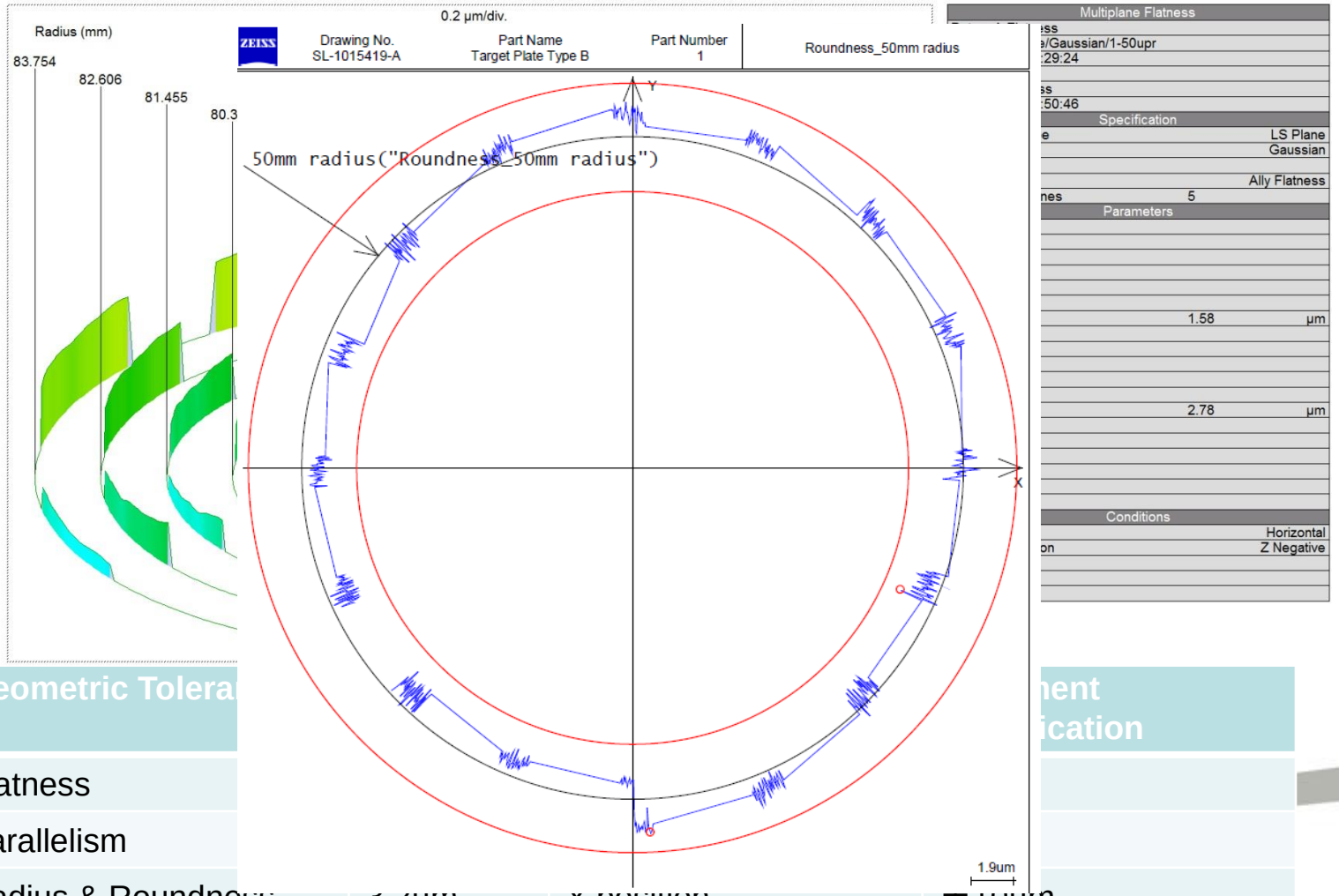
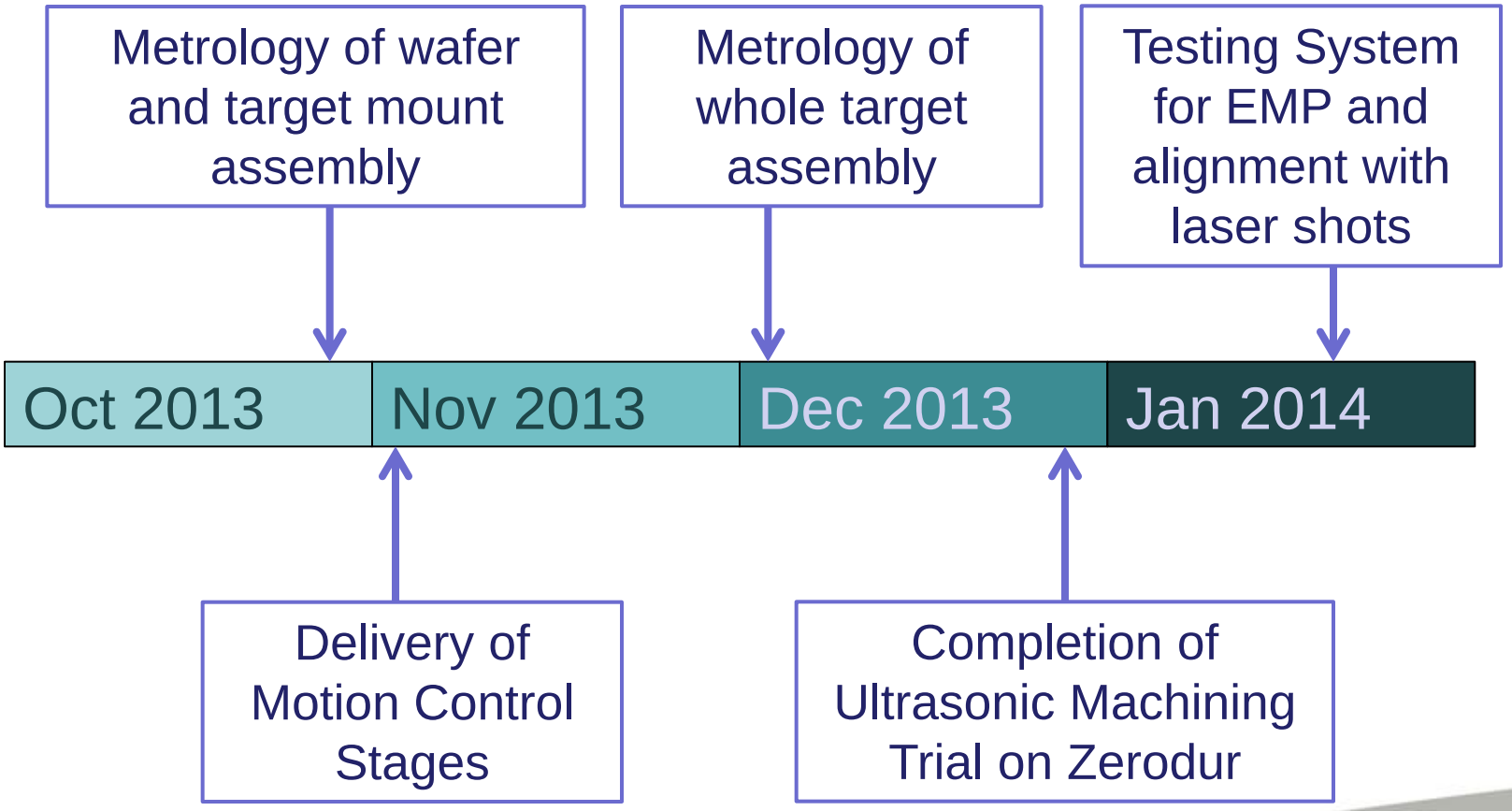
Metrology Results



Geometric Tolera			ment ification
Flatness			
Parallelism			
Radius & Roundness	3.2µm	Y position	±10µm
Angle	0.5mº	X position	±10µm = ±9mº

Step 1 Status and Further Work



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Step 2

Integrate with sub micron accuracy target alignment systems being developed in parallel in CLF

Investigate system limits on repetition rate

Develop closed loop feedback system for real time automatic positioning

Increase number of targets between manual mounting

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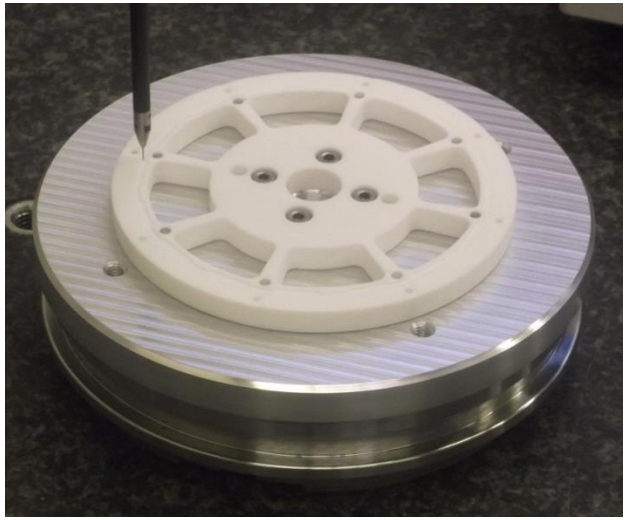
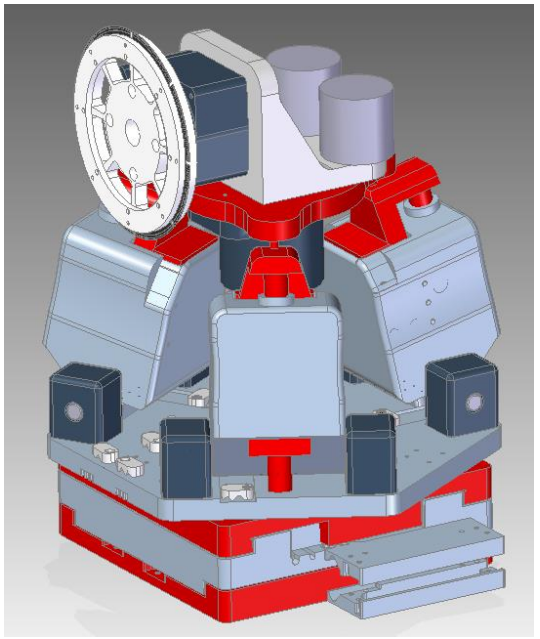
Any Questions?





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