Grating Assembly

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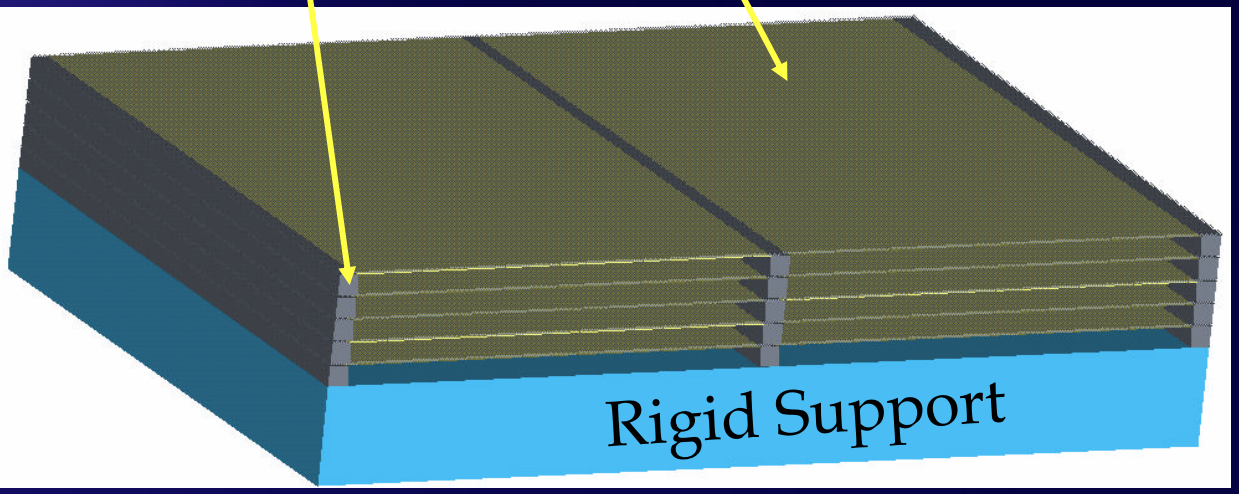
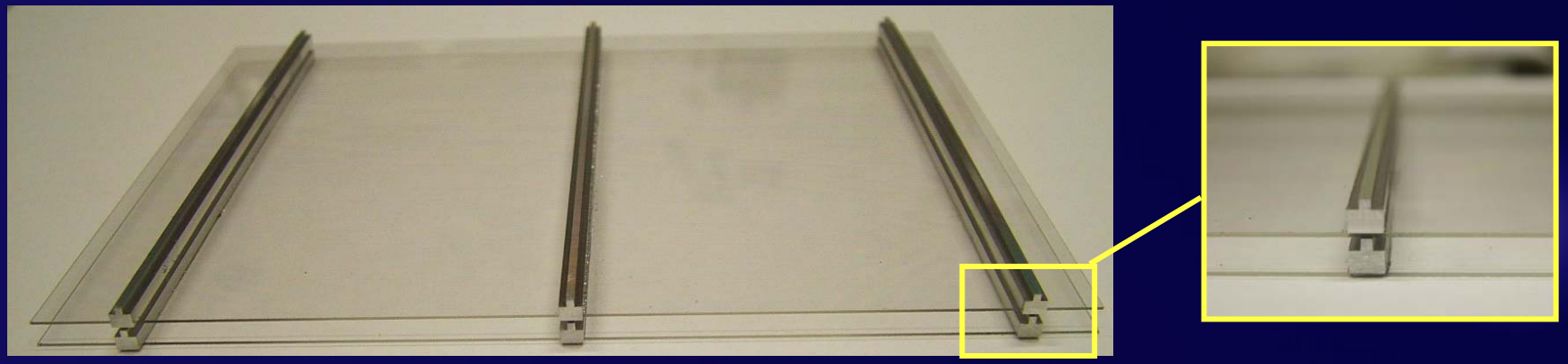
Grating Module Concept



- Minimal mass
- Rigid module with high resonant frequency
- Valid for in-plane & off-plane gratings



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MIT-Kavli Institute

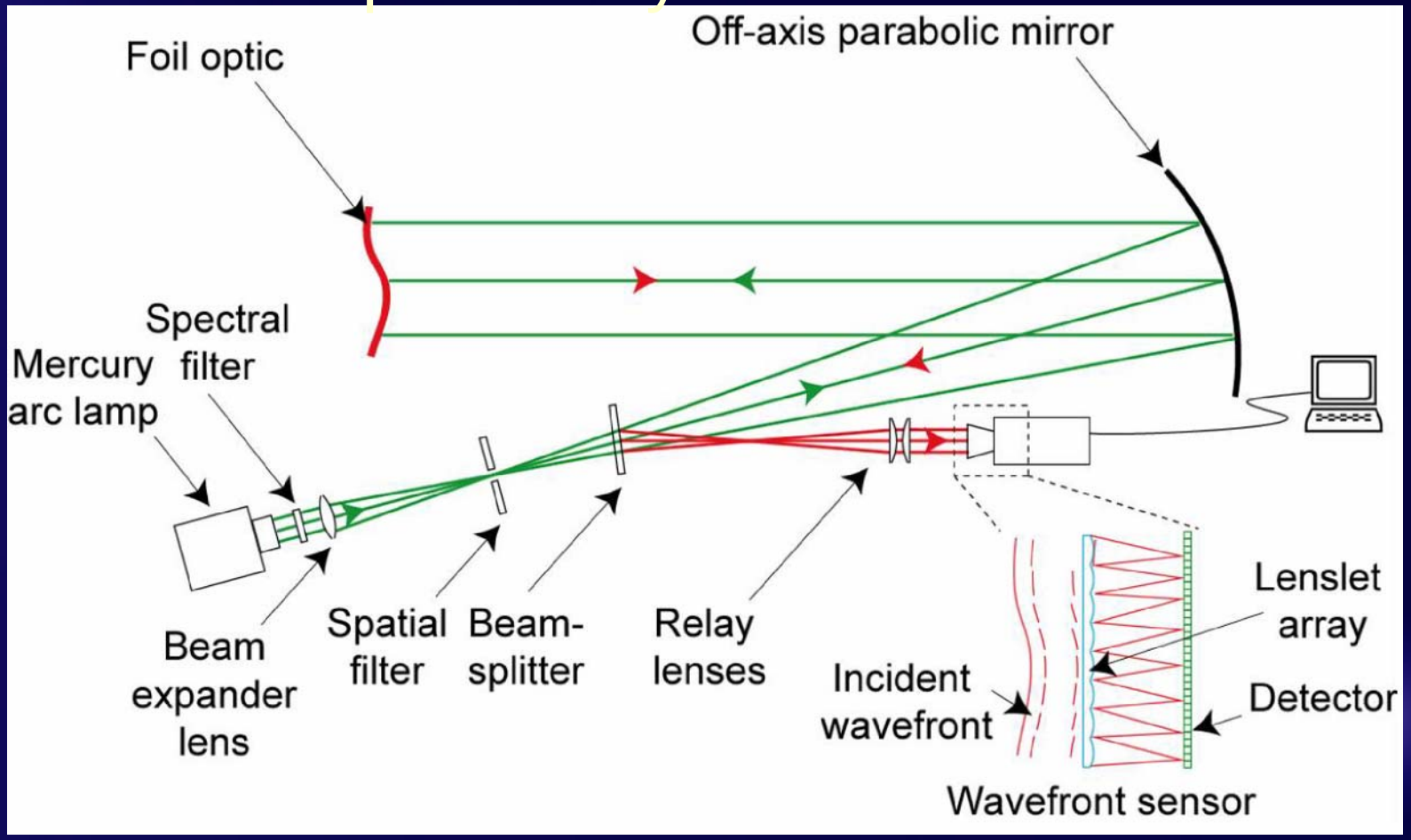
Overview

- Metrology
  - Shack-Hartmann metrology tool
  - Thin optic constraint
- Improving grating substrate flatness
  - MRF of silicon wafer at QED
- Assembly
  - Assembly parts
  - Assembly steps
  - Results

Deep-UV Metrology

Shack-Hartmann metrology tool

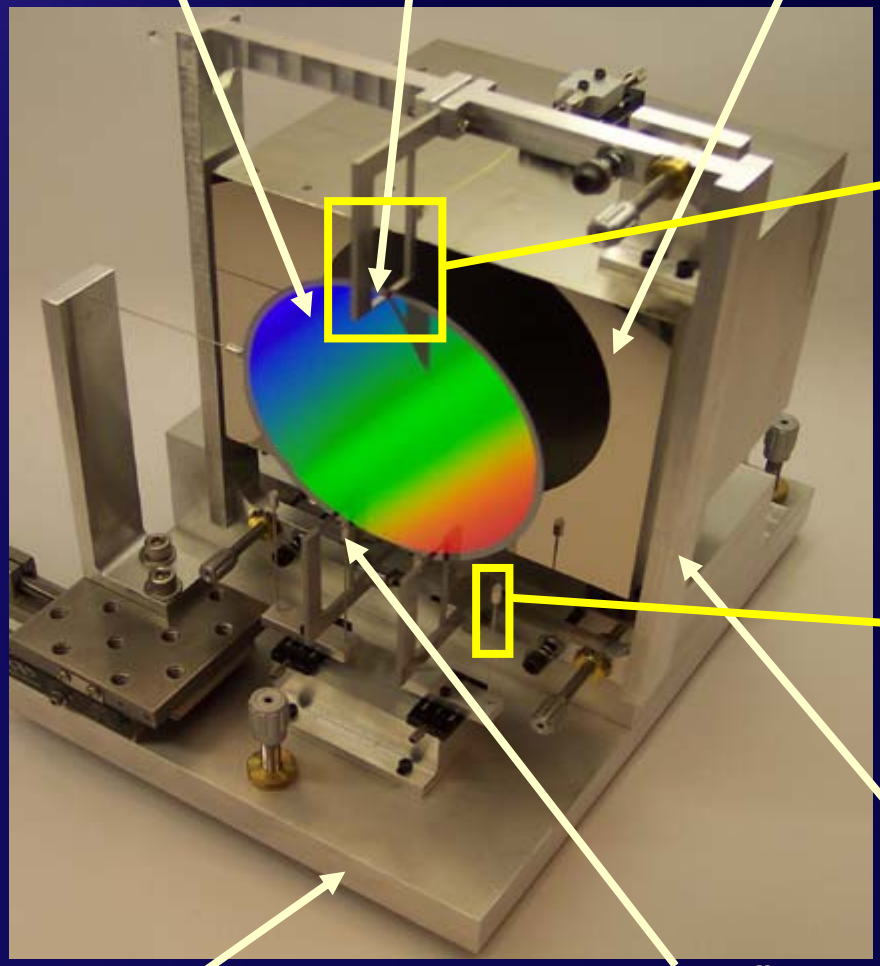
Repeatability ~ 0.4 arcsec

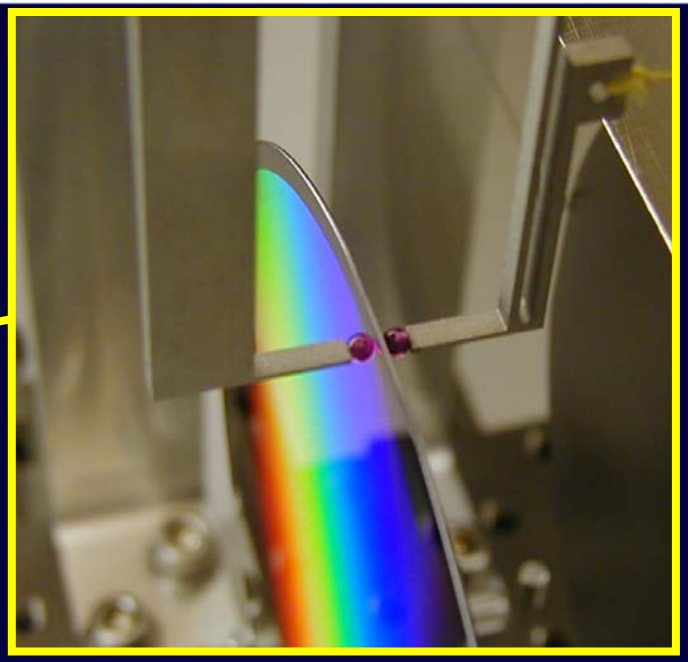


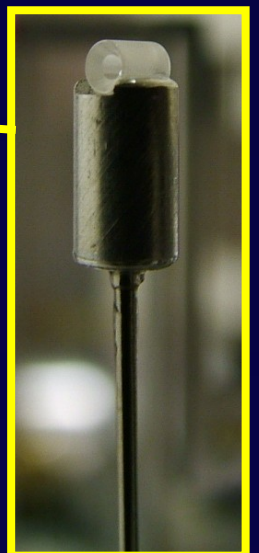
Metrology Challenges with Grating Substrates

- Gravity Sag (0.4 mm-thick substrates)
- Friction at mounting points
- Thermal expansion mismatch between optic and constraint

Thin Optic Constraint



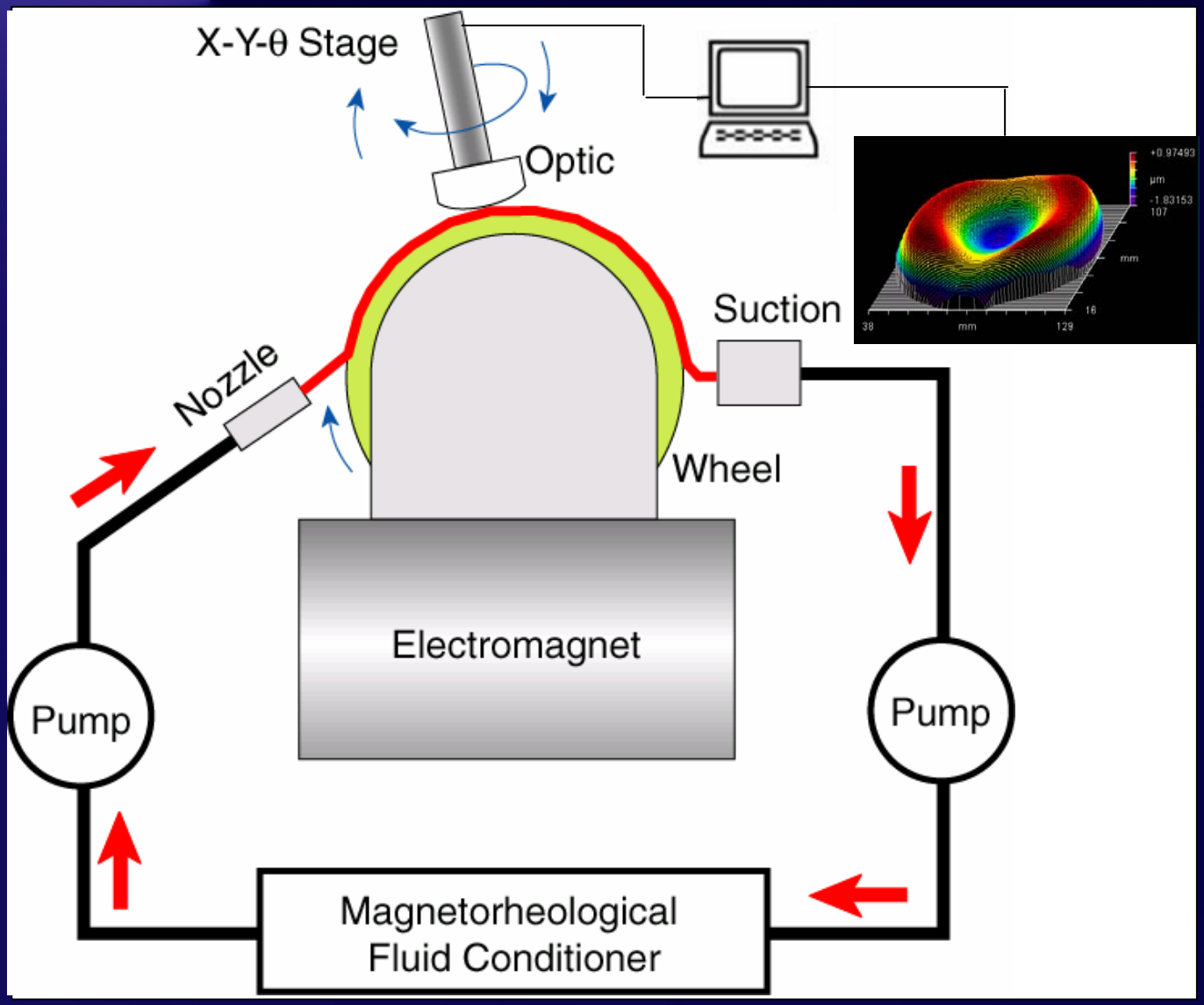




Repeatability

1 arcsec

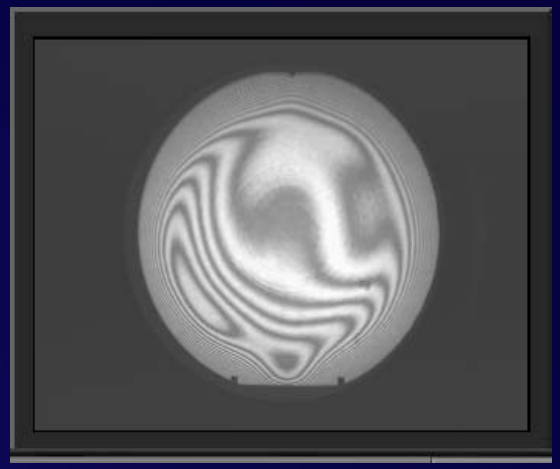
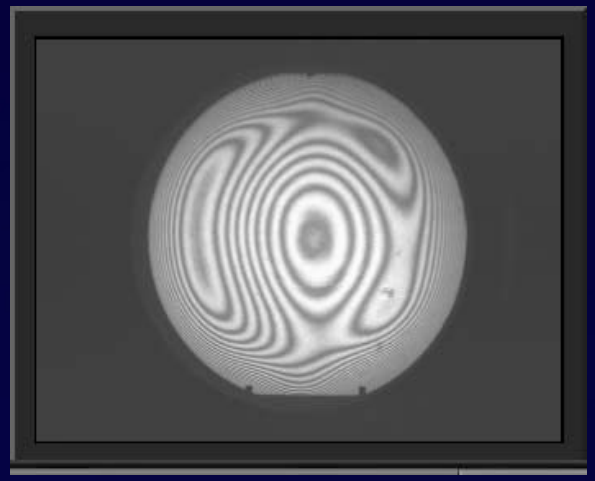
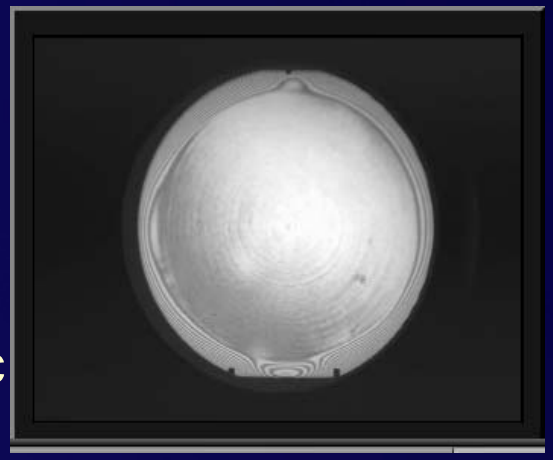
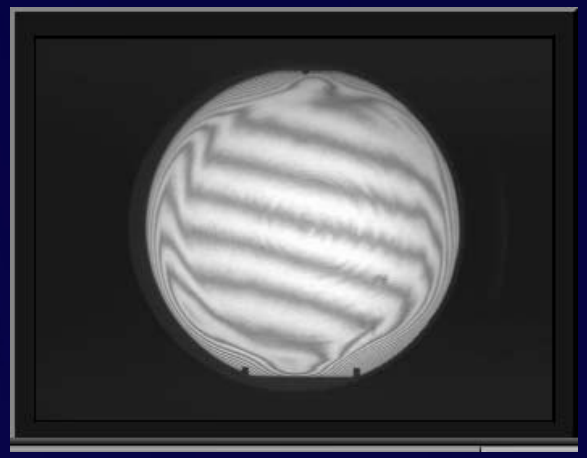
Magneto-Rheological Finishing



QED Technologies

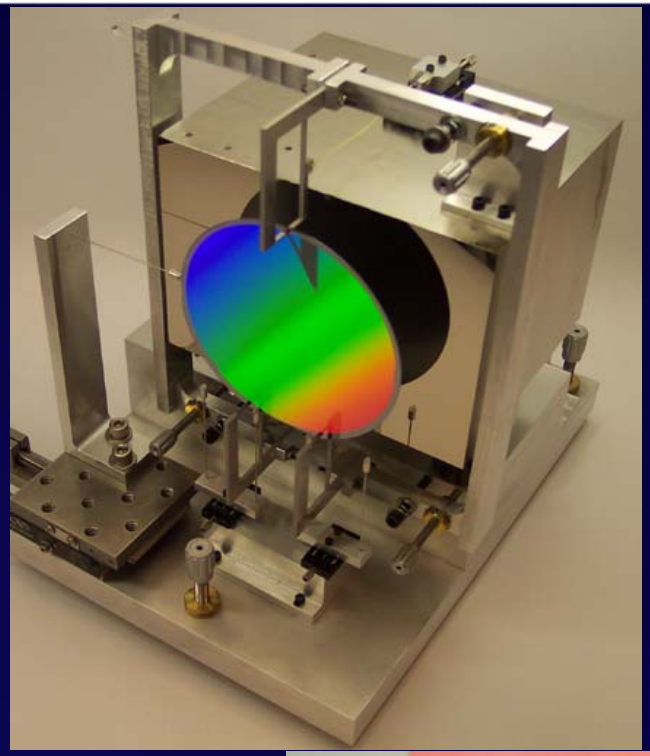
Rochester, NY

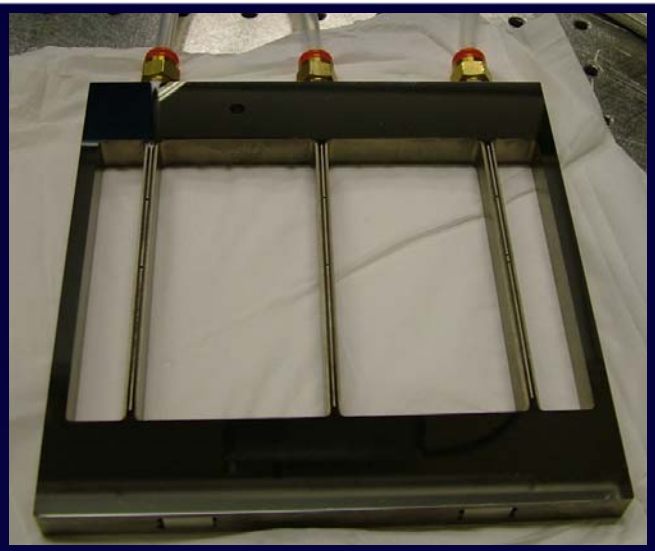
MRF Results

	Wafer A	Wafer B	
Before MRF P-V 3.14 μm RMS 0.40 μm RMS 35 arcsec			Before MRF P-V 2.81 μm RMS 0.56 μm RMS 20 arcsec
After MRF P-V 0.18 μm RMS 0.02 μm RMS 2.5 arcsec			After MRF P-V 0.07 μm RMS 0.01 μm RMS 4 arcsec
	Aperture 81 mm	Aperture 75 mm	

Assembly Parts

Thin Optic Constraint





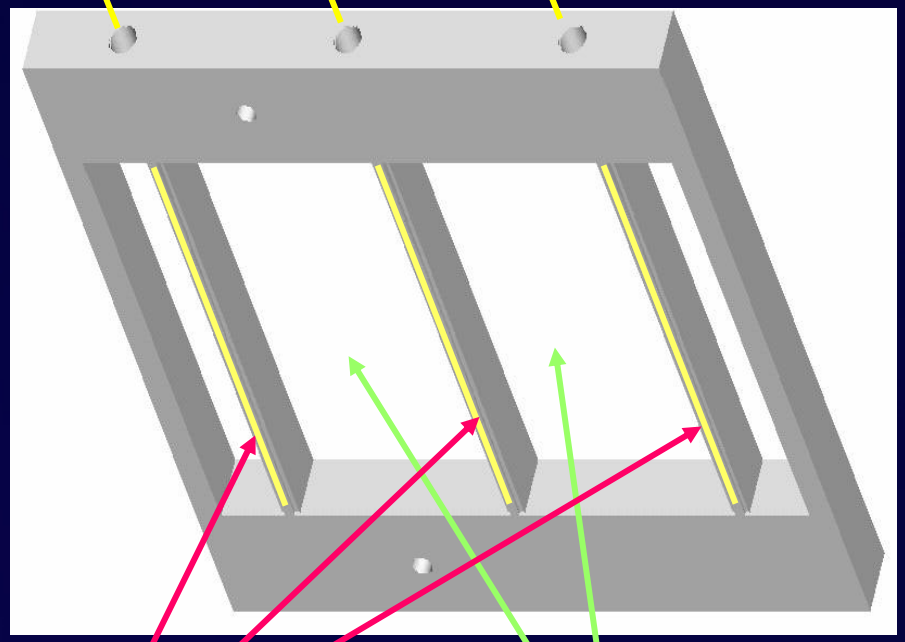
Vacuum Chuck

Support Structure with ribs

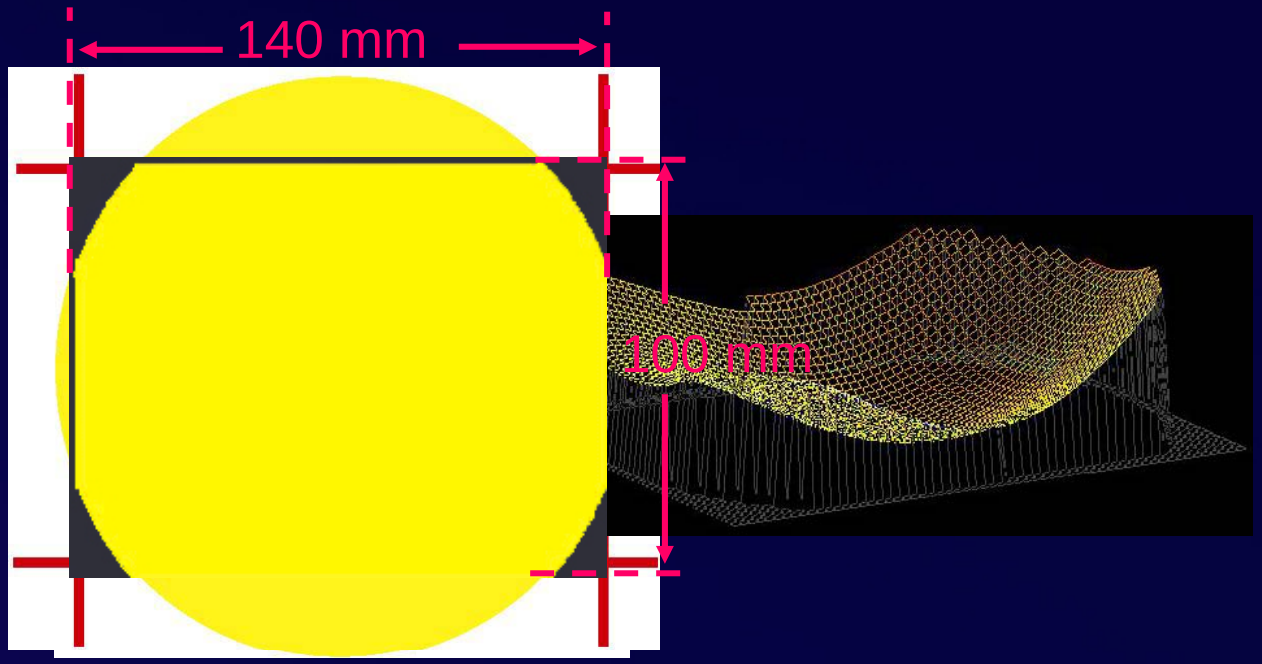
Vacuum Chuck

Functional Requirements

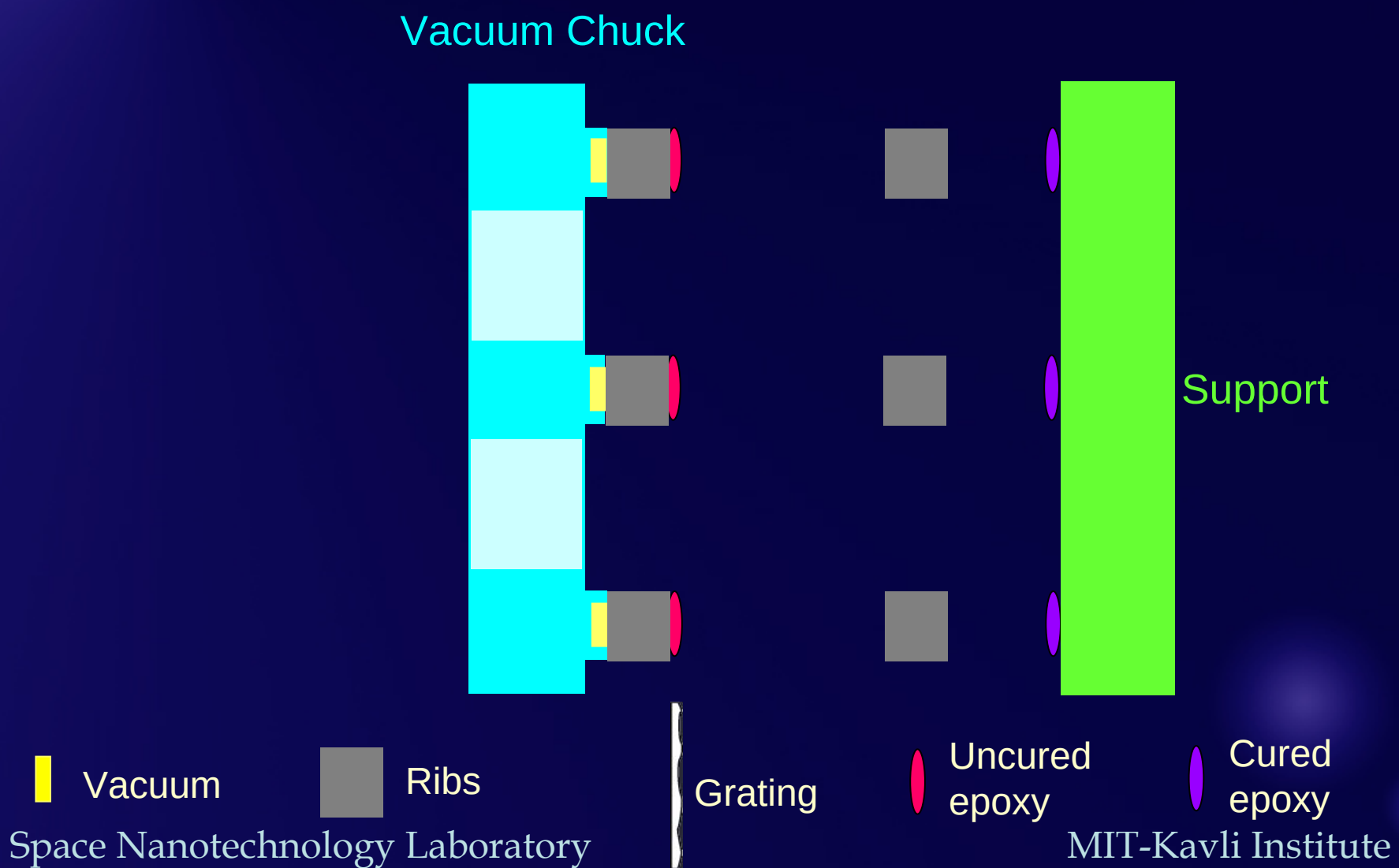
- Improve overall flatness of grating surface
- Allow for metrology of grating surface during assembly
- Allow for rigid constraint during grating maneuvering during assembly



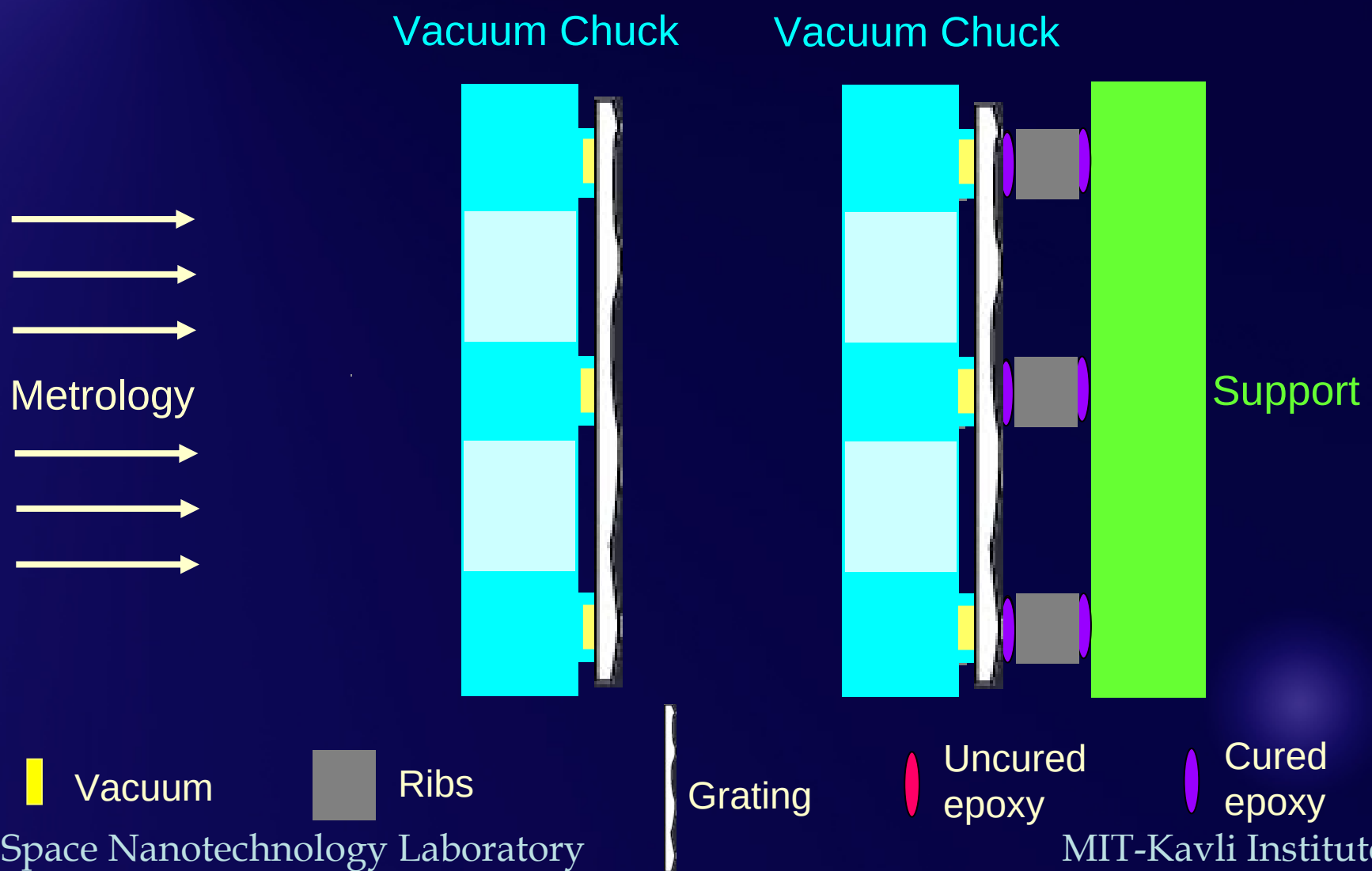
Assembly Steps



Assembly Steps

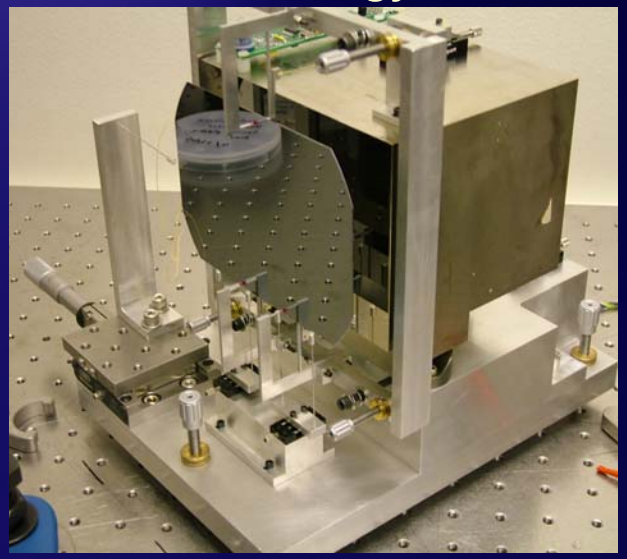


Assembly Steps

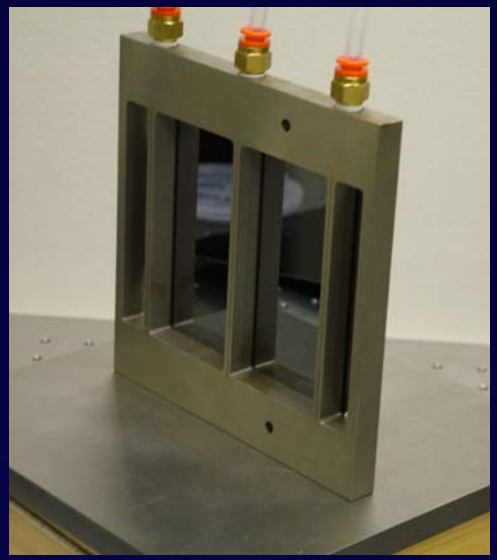


Assembly Hardware

Metrology

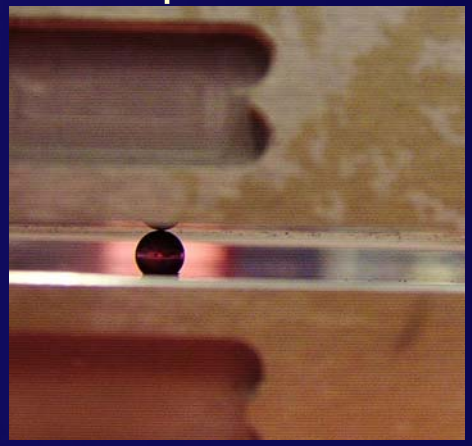


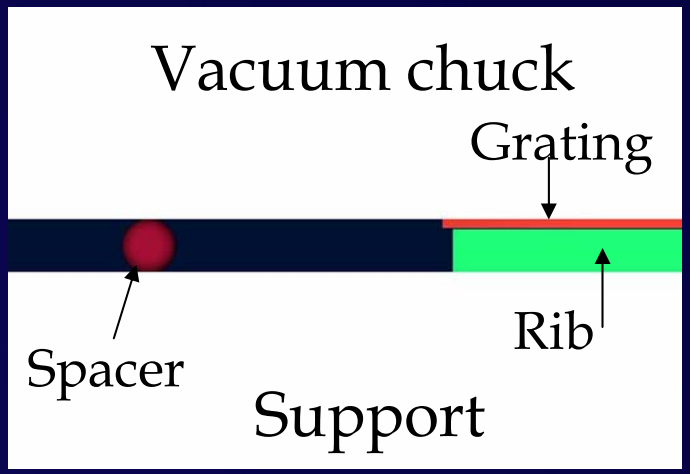
Vacuum Chuck Constraint



Epoxy Curing

Gap Control

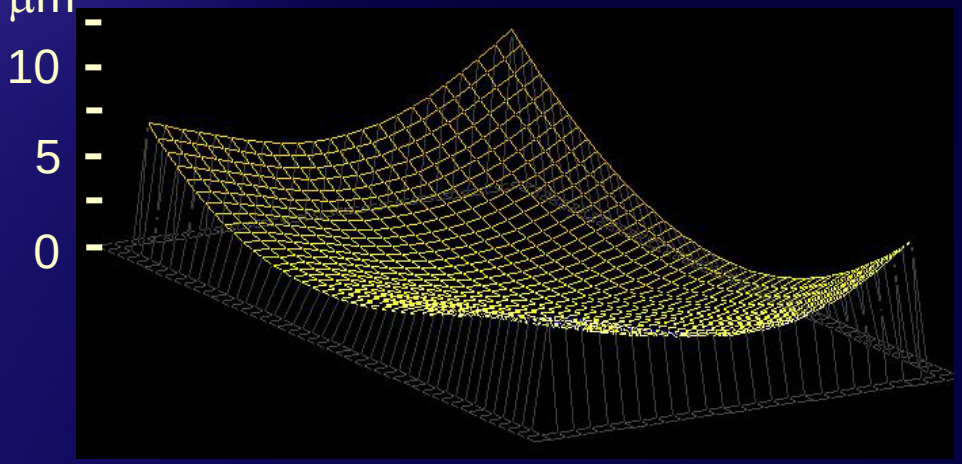




Assembled Grating

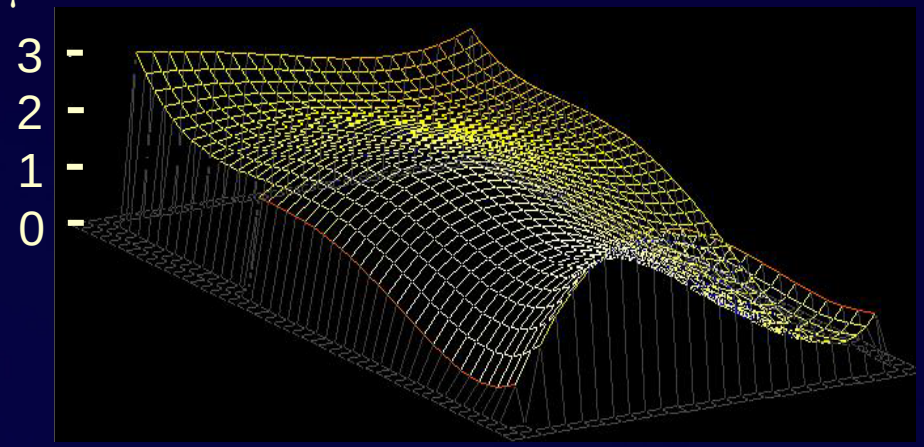
Results

Free wafer



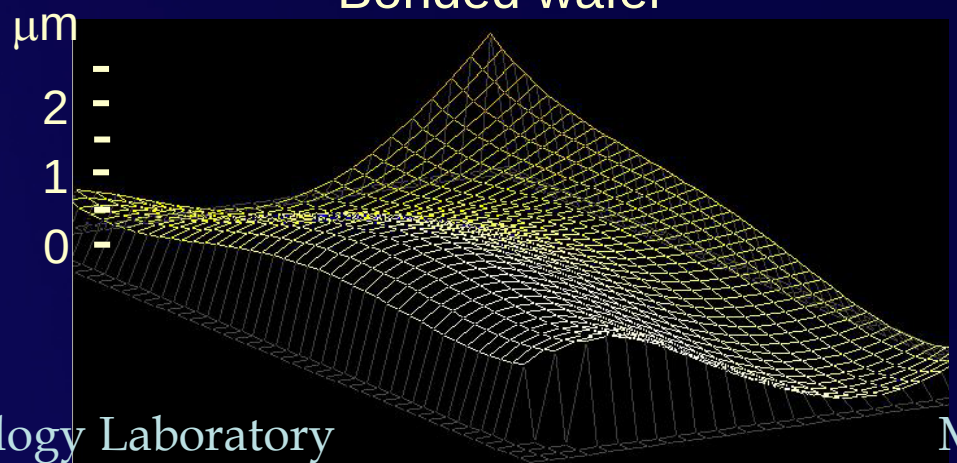
P-V 9.39 μm
Avg -3.29 μm
RMS 1.68 μm

Chucked wafer



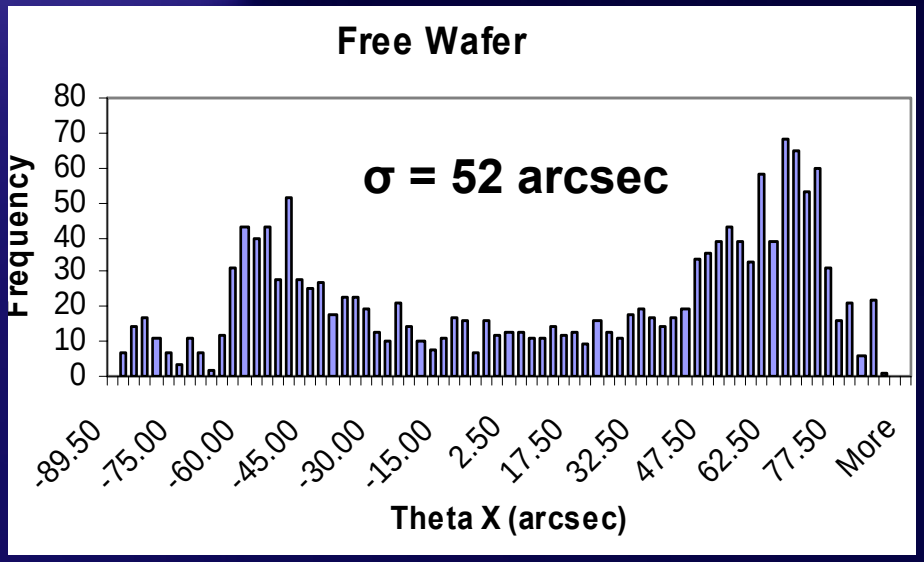
P-V 3.11 μm
Avg 0.38 μm
RMS 0.59 μm

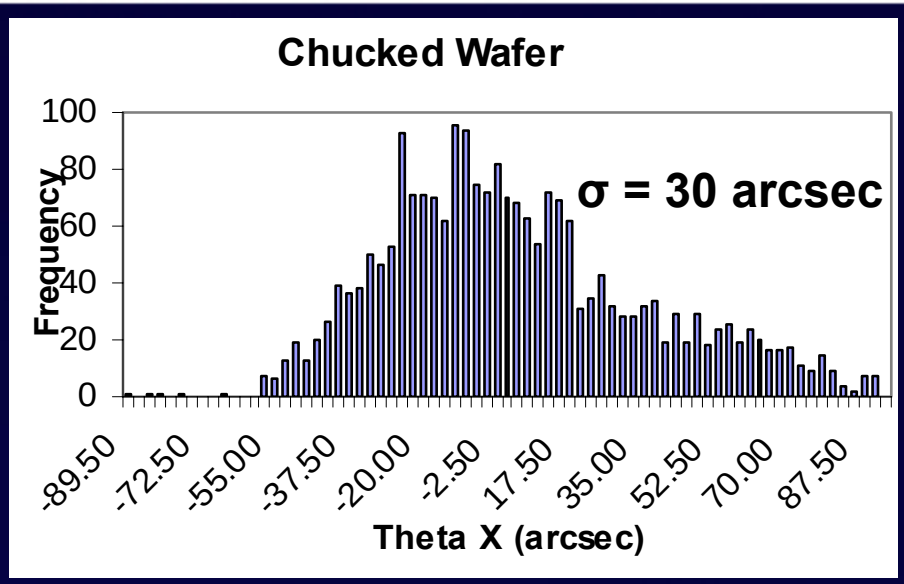
Bonded wafer

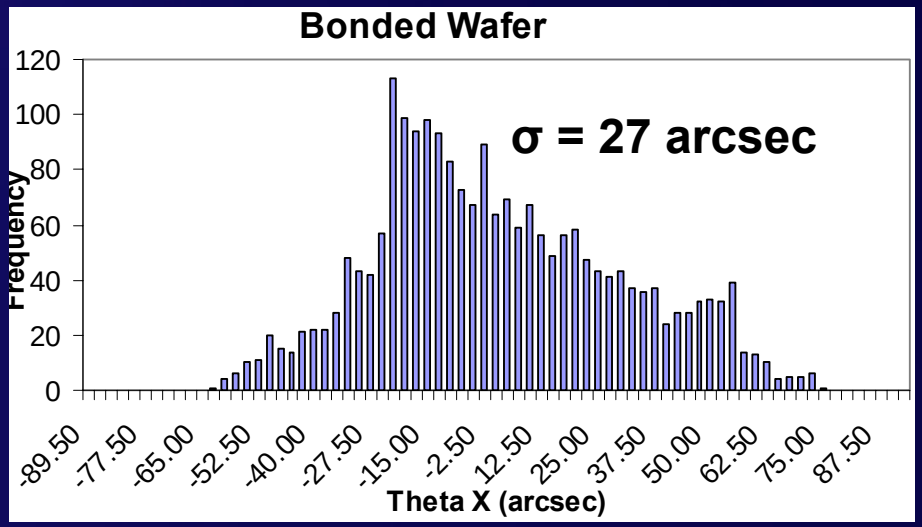


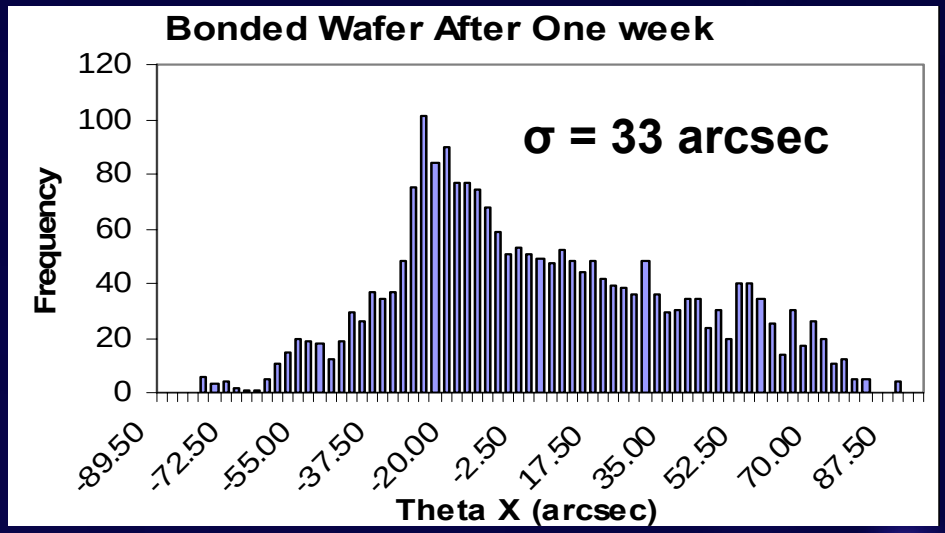
P-V 2.39 μm
Avg 0.39 μm
RMS 0.47 μm

Angle Histograms

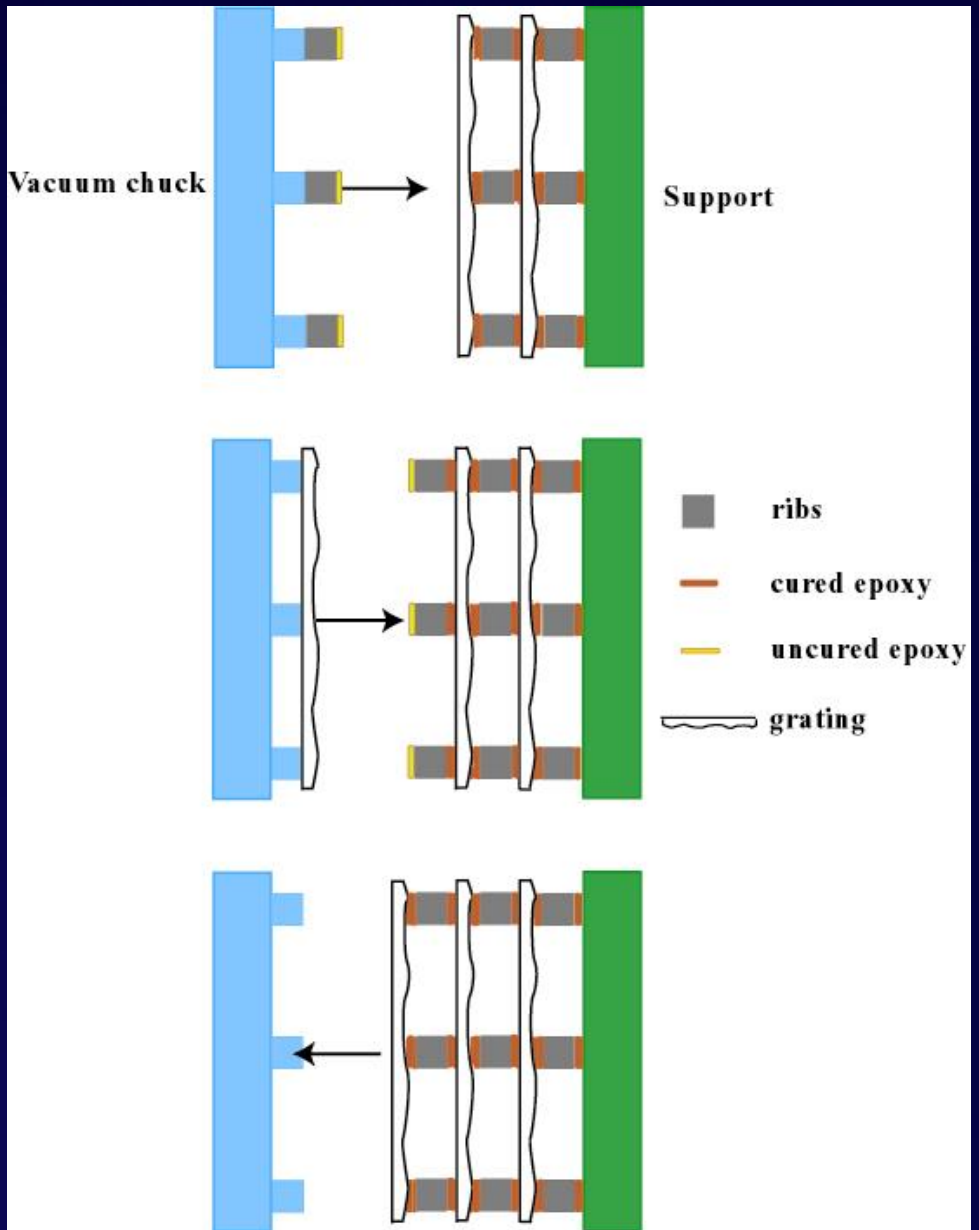








Conclusion

- Developed a metrology truss with a repeatability of **1 arcsec**
- Improved silicon wafer surface flatness to **2.5 arcsec** RMS using MRF
- Developed assembly scheme that loosens tolerance on free-grating flatness (Improved flatness by ~ **20 arcsec**)
- Ready to go into assembly of multiple levels of gratings

Assembly Steps Back up