Sensor/Raft Metrology Status

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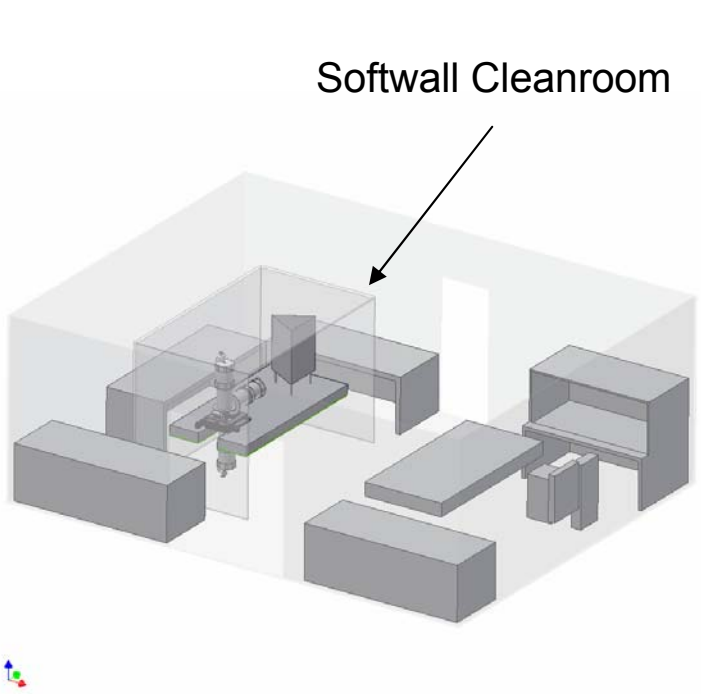
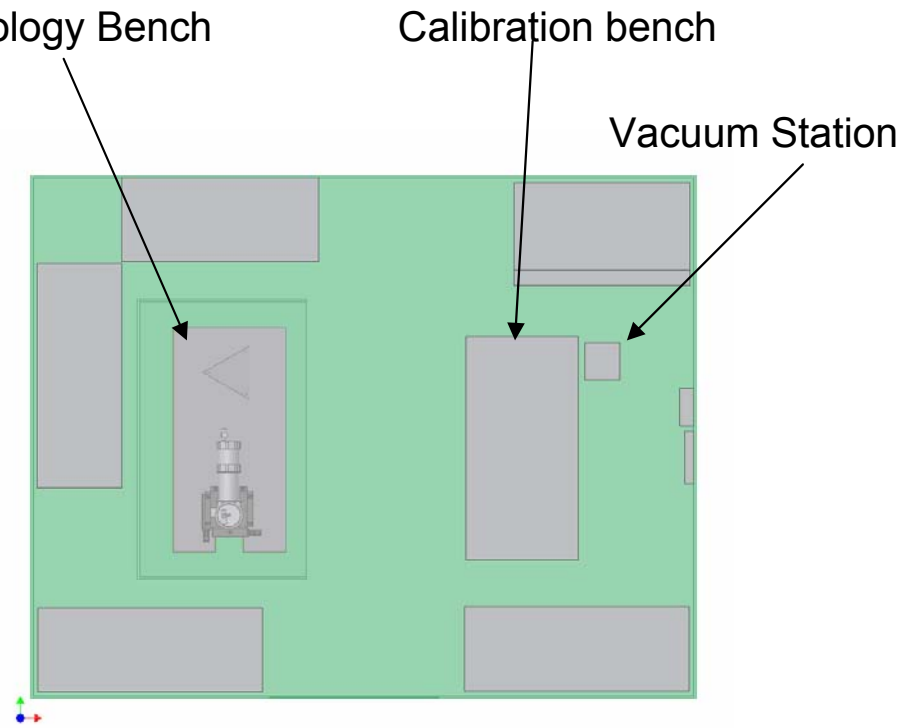
Sensor/Raft metrology - current status

- Laboratory space preparation near completion.
- Optical table on order - Kinetic Systems 4’x8’ w/cutout
- Softwall cleanroom on order - TerraUniversal 10’x6’x7’
- Detector QE uniformity calibration system - planning stages
- Fisba interferometer for flatness is operational.
- Keyence LT-9030M Displacement Gauge is operational.
  - Interface with x-y stage
  - Noise level is well below 0.1μm P-V
- Evaluating Aerotech X-Y stage with Keyence for height metrology.
  - See if roller bearing stage has sufficient accuracy and repeatability.
  - Preliminary results indicate marginal performance.

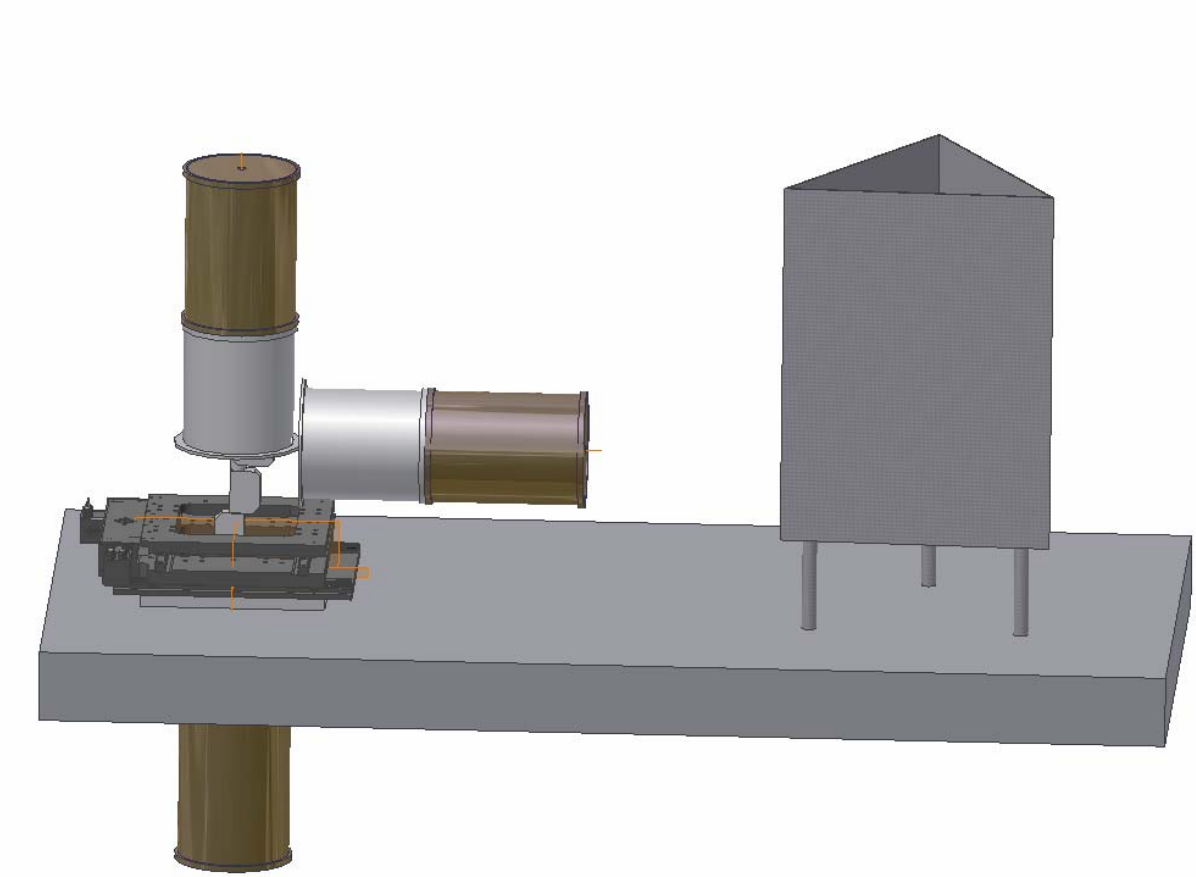
Detector Lab Layout





- Final work on floor installation.
- Items on order: Softwall cleanroom, Metrology table w/special cutout
- Identifying components for calibration system
- Dewars delivered. Vacuum pump delivered.

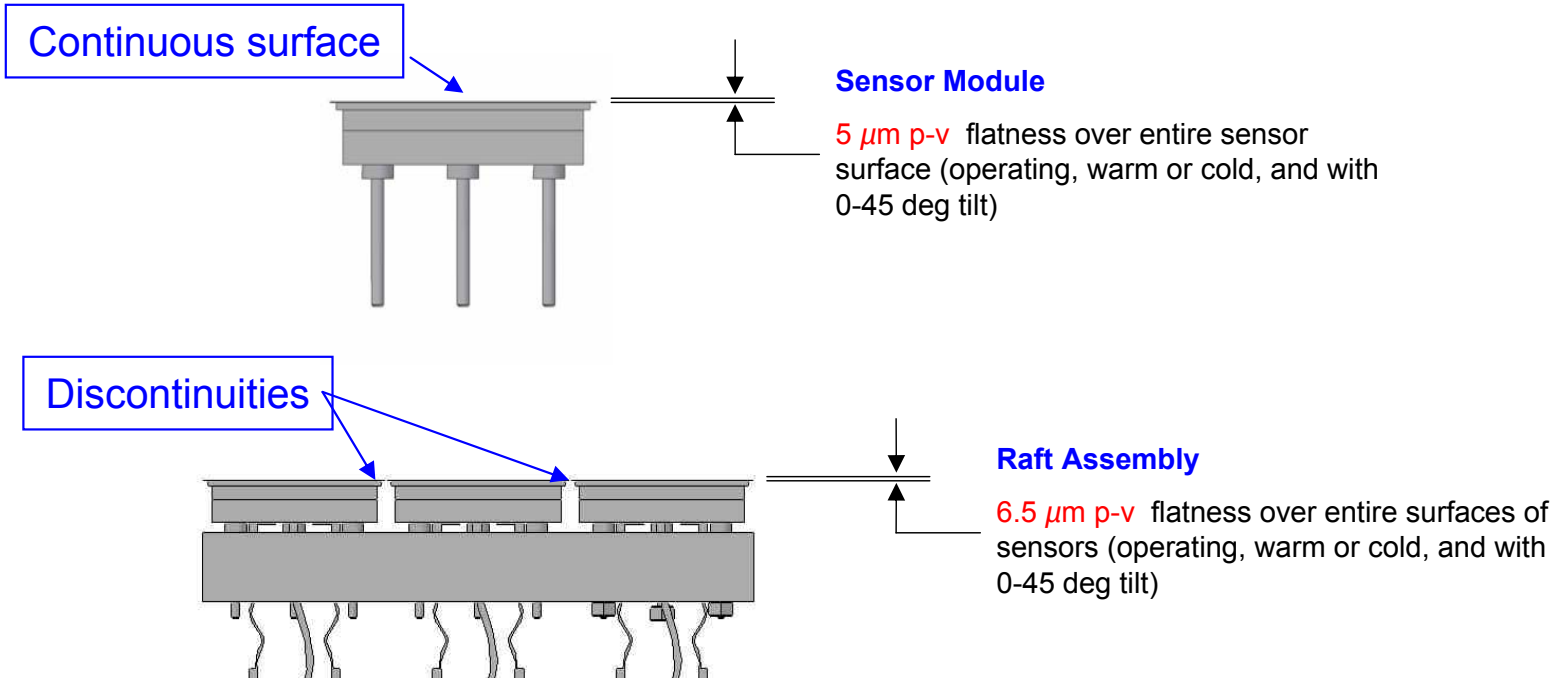
4’x8’ Metrology Table Layout



- Standard optical table
  - Fits under 10’ long softwall.
- X-Y scanner and Fisba fit easily
  - One vibration isolation system
  - Room for pre-assembly and setup of parts
- Plenty of room for dewar attitude fixturing
- Requires custom through-hole cutout.

Raft/Sensor metrology requirements

- Flatness requirements on individual sensors and on raft assemblies
- Raft assembly is not a continuous surface
  - Requires a combination of metrology methods

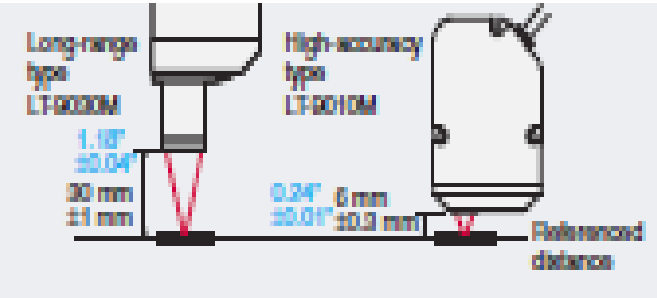


Fisba 200mm Interferometer

- Use for detector module flatness testing.
- Optimized for horizontal surface flatness measurement.
- Large working distance - view through dewar window.

- May be useful for monitoring raft flatness during cryotesting.

Keyence LT-9030M

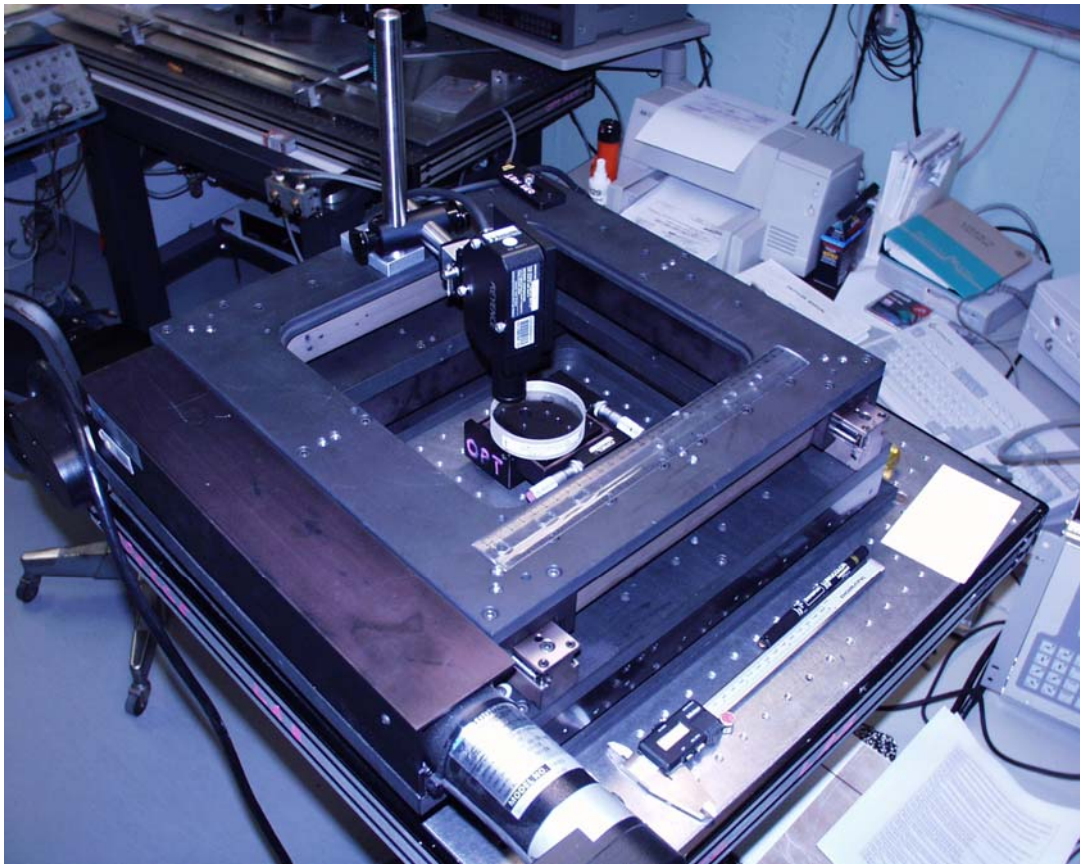


- Use for height measurement across discontinuities.
- 30mm standoff distance - useful through dewar window.
- Mount on XY stage with open base.
- Z-axis motion is not required.
  - ±1mm Z measurement range internal.
- Specified repeatability <0.1μm.
  - Actual repeatability appears to be much better.

Evaluate ATS-3220 X-Y stage

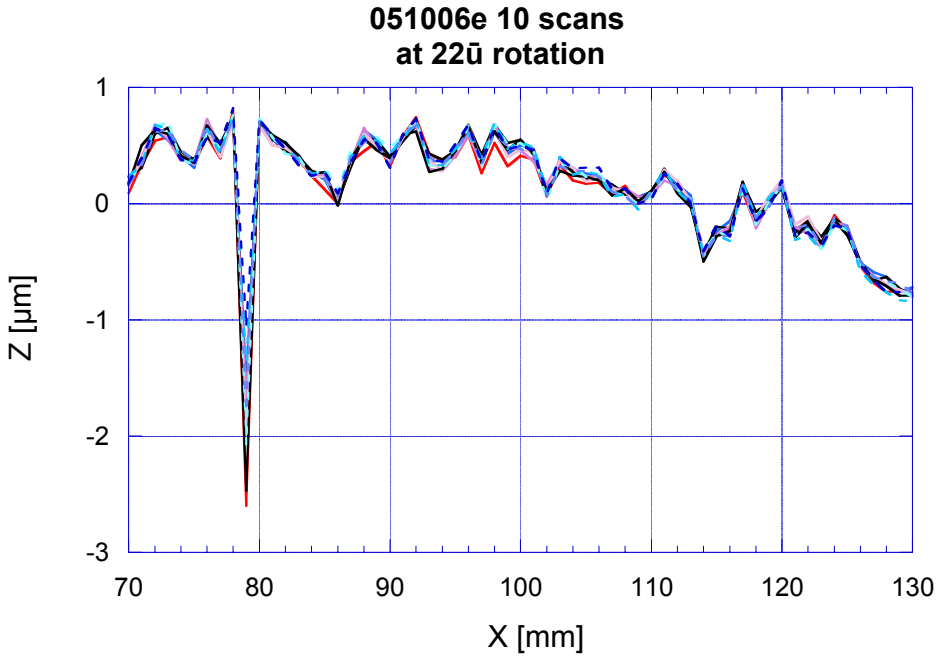
Aerotech stage from early 90's

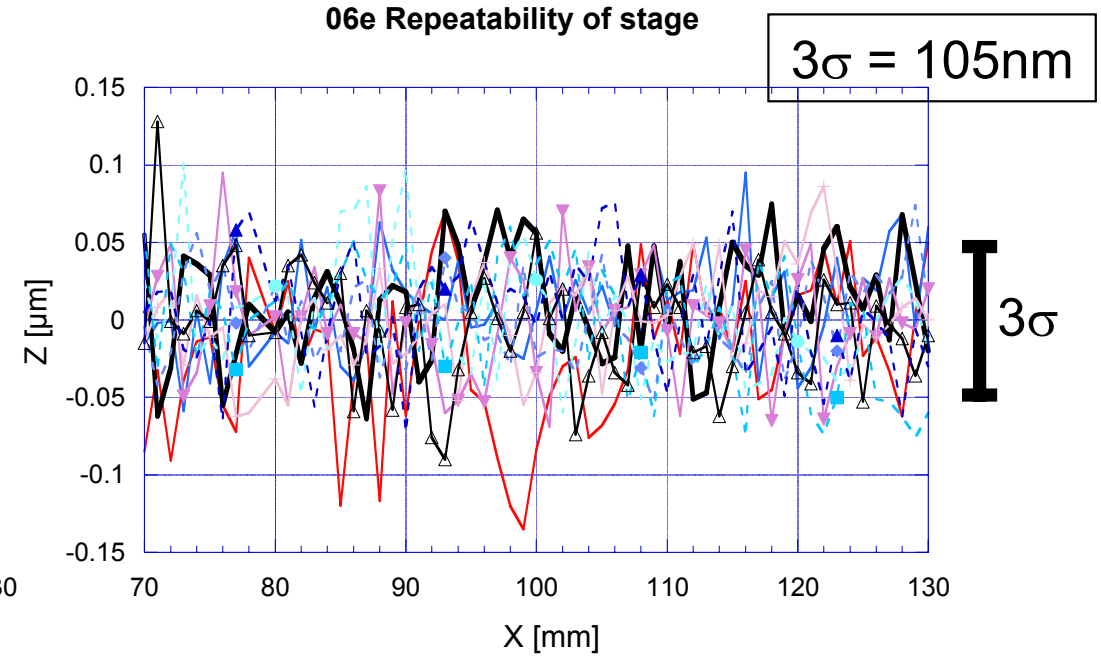
No linear encoder - only precision ball screw



- 200mm x 200mm scanning area.
- Open center.
- Keyence 2310M mounted on x-slide.
- Look at repeatability, straightness, and flatness.
- Multiple x-scans at fixed y-position.

XY Stage Repeatability

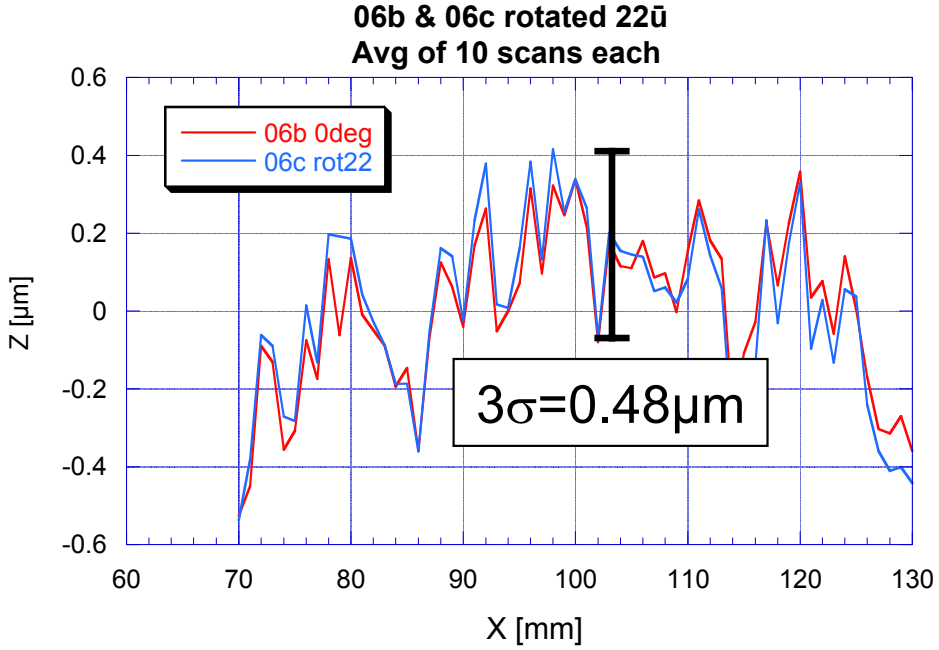


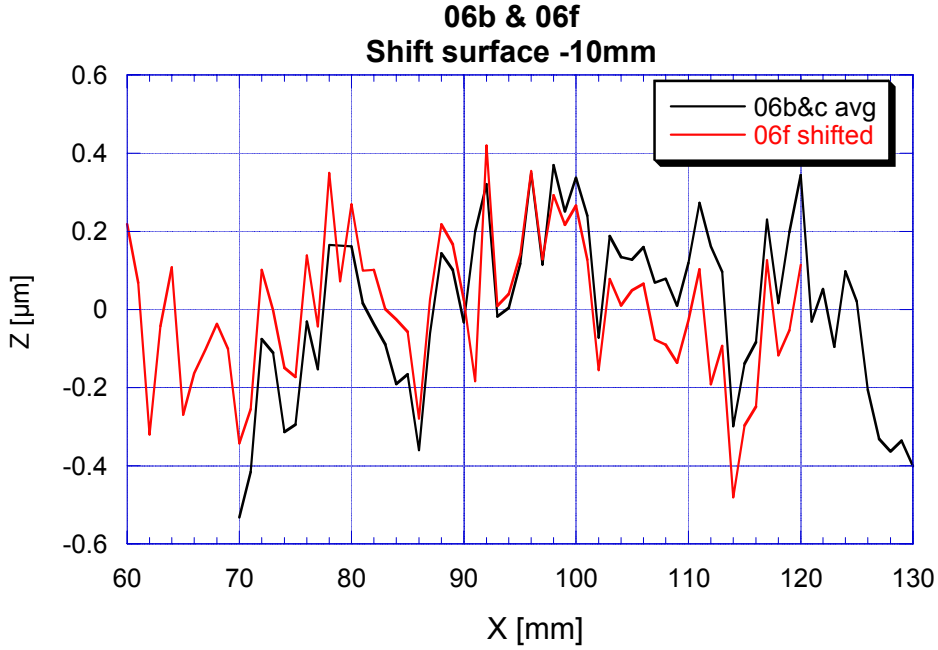


- 10 X-axis scans over same line: Subtract average from each
- Residuals: 1 std dev σ = 35nm, 3 σ = 105nm
- Includes combined errors from Keyence and the stage.

XY Stage Height Accuracy

- Keyence mounted on top of XY stage
- Average scans across λ/10 optical flat at 2 azimuths: 0˚ and 22˚
- Then shift flat 10mm left and scan over shifted x-range.





- See features at same x-axis location => errors in the ways, not the glass
- Remove 1 μm of curvature: residual has 1 σ = 0.16μm, 3 σ ≈ 0.5μm
- So we can expect up to 0.5μm point-to-point error in any measurement.

XY Stage Evaluation Summary

- Noise in Keyence is well below 0.1μm level, as advertised.
- Most error is result of mechanical stage errors - ball bearings
  - ~0.5 μm jumps between 1mm spaced points
- Can not do better with newer ball or roller bearing stage.
- S/N = 1 for $\Delta Z \approx 0.5\mu m$
  - Not good if <0.5 μm accuracy is desired.
- Errors are repeatable to better than 0.1μm.
- Possible to correct with lookup table???
  - Full area error mapping will be required.
  - Continue calibration after move into new lab - stable environment.
- Possible alternatives to mechanical stage:
  - Air bearing stage - much smoother ride.
- Use BNL Super Step for further scanner evaluation.

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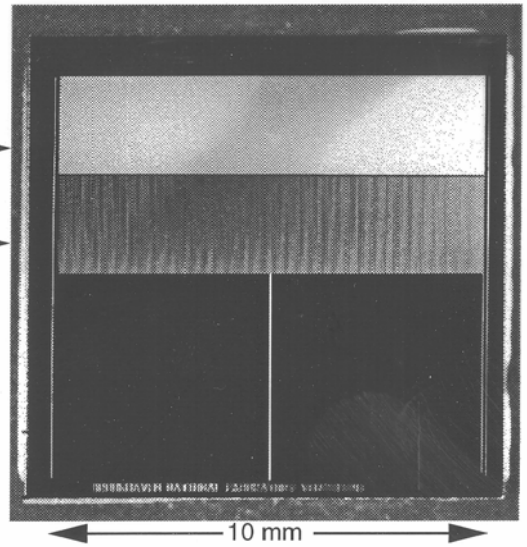
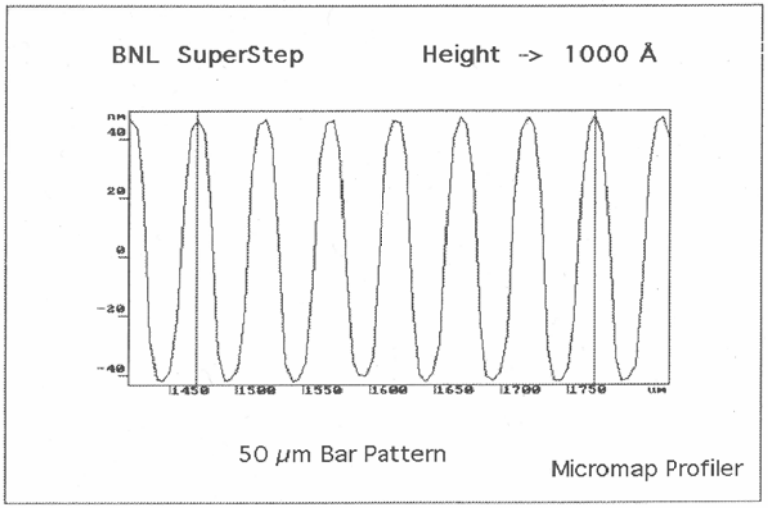
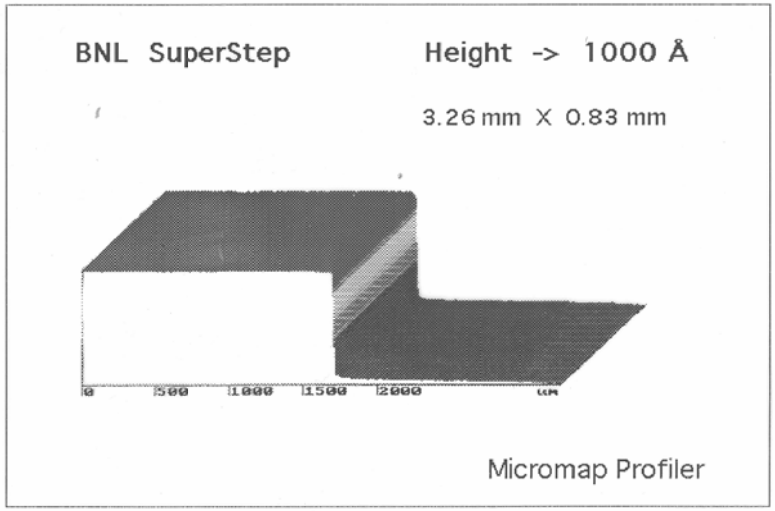
STEP HEIGHT STANDARD

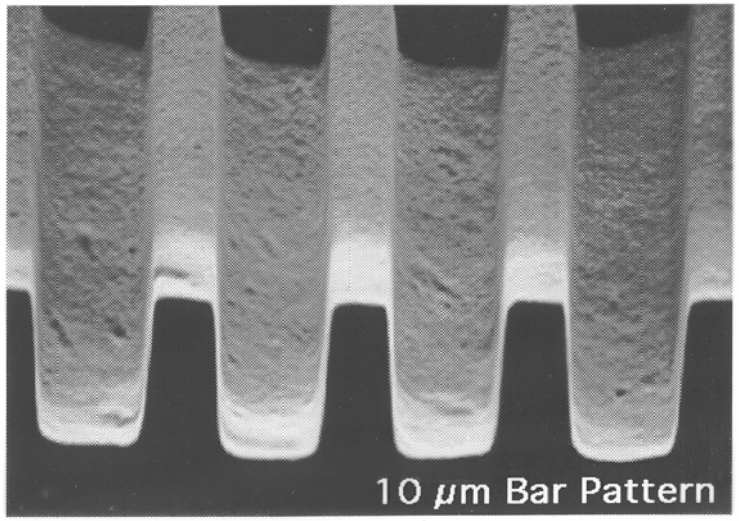


for AFM, STM calibration



for optical profiler calibration





Photon Tunneling Microscope Image
Courtesy of J. Guerra, Polaroid

BNL Super Step

- Use for evaluation of XY stage and calibration of Keyence scanner.
- Instrumentation Div lithography produces any desired step height.
  - Make several in range 1 - 10 microns.
- Etch pattern in resist; overcoat with Al opaque layer.