

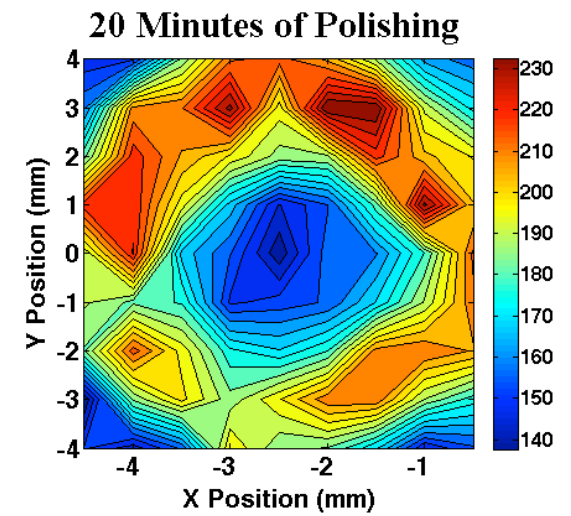
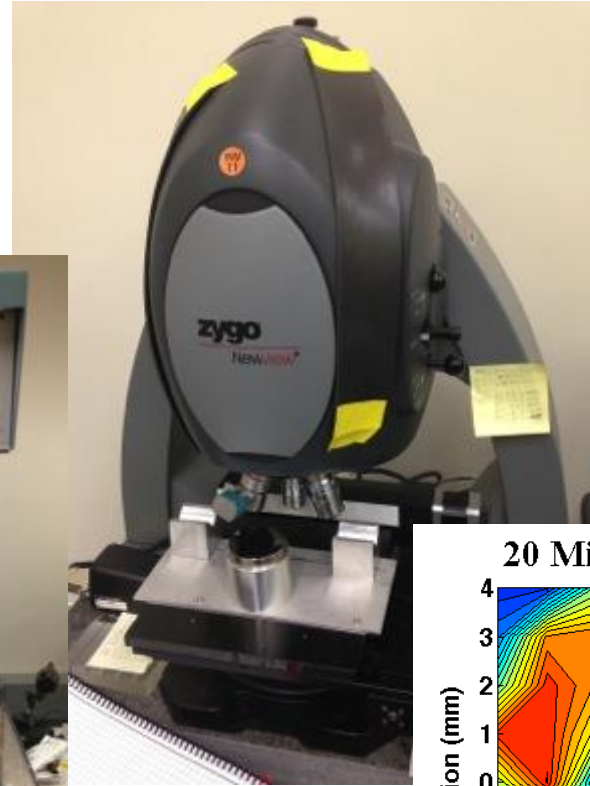
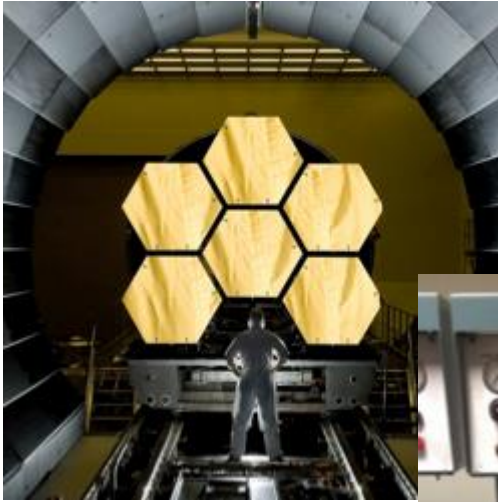
Measuring skew in average surface roughness as a function of surface preparation

Mark Stahl

MSFC NASA

April 21, 2015

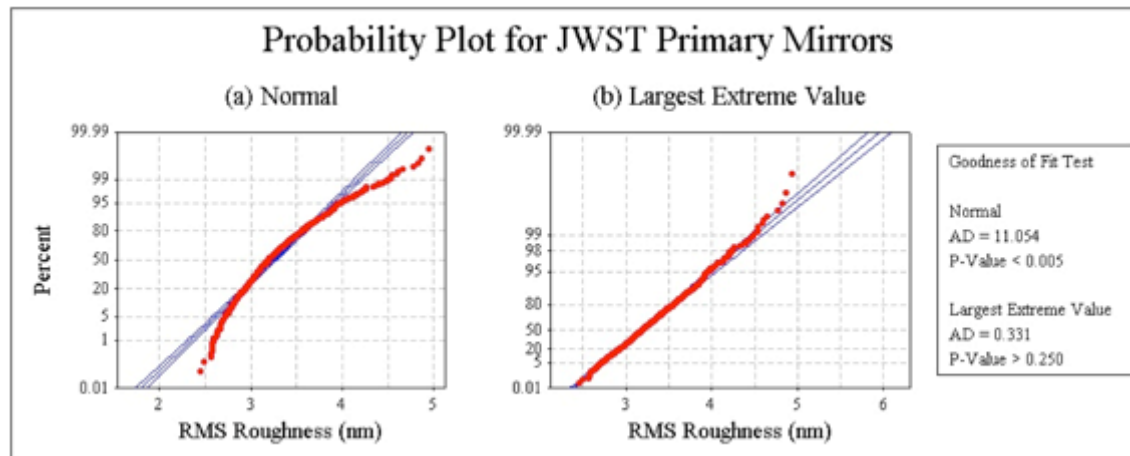
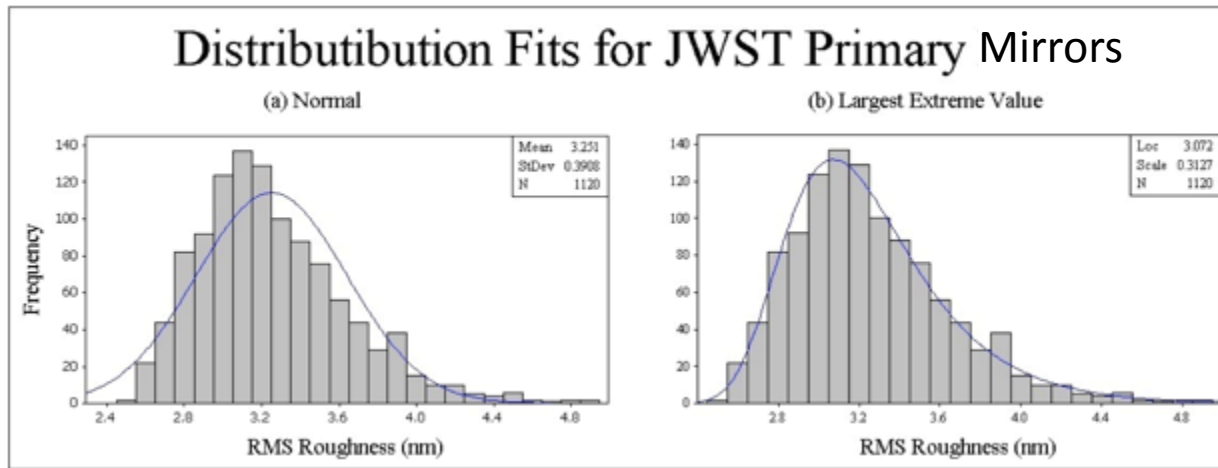
Outline



Motivation: Stray Light



Motivation: Distribution Fitting



Motivation: Why Does it Matter?

Better Measurement of Surface Roughness

Program Management:

Great, we can stop
polishing sooner saving
time and money!

Science: Great, we can get
better image quality!

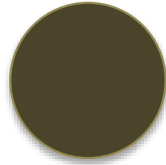
Design: Great, we have a
little slack in our design!

How big is an Å?

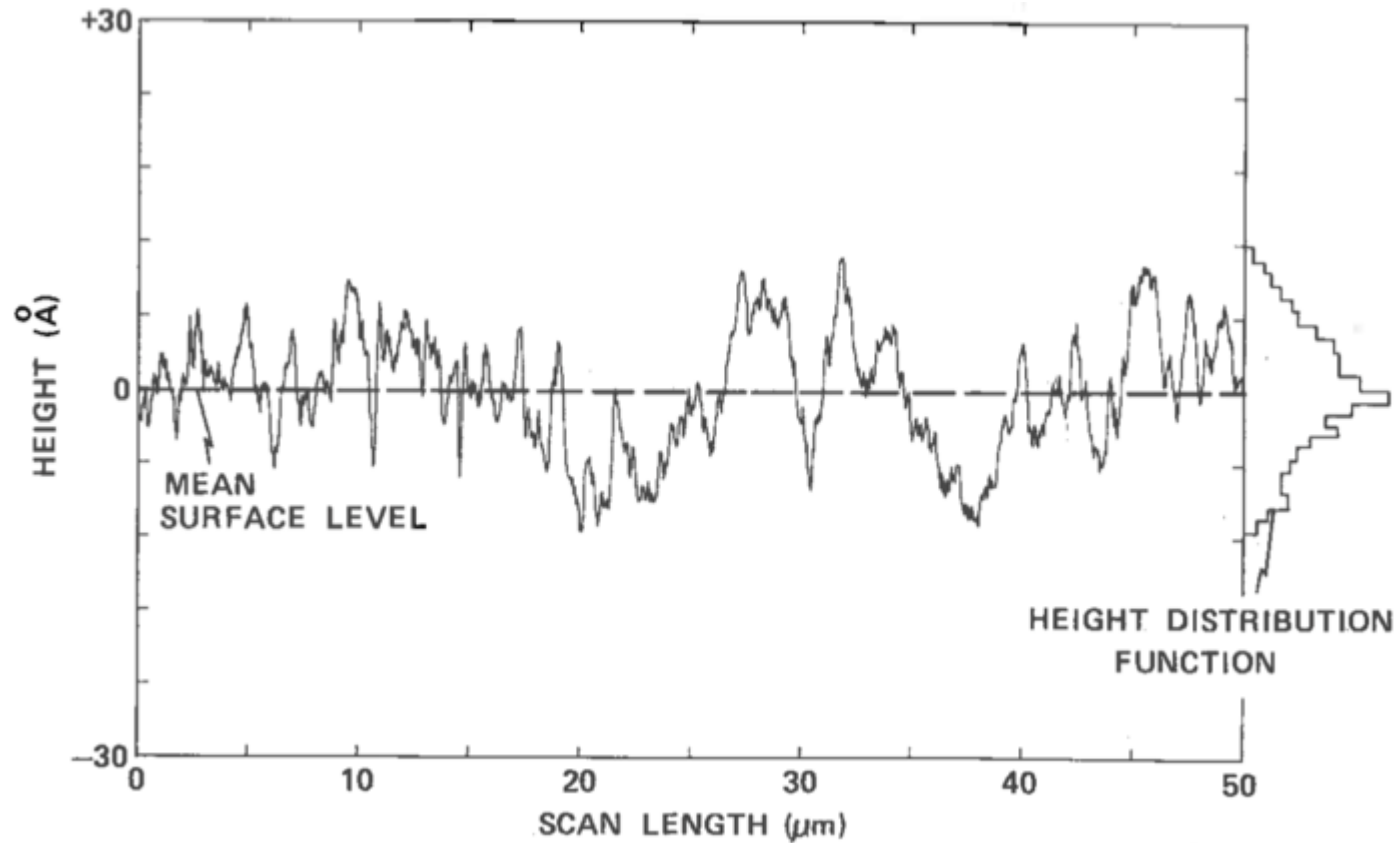
Earth's Diameter: ~12,742km

Hair's Diameter: ~50 μm

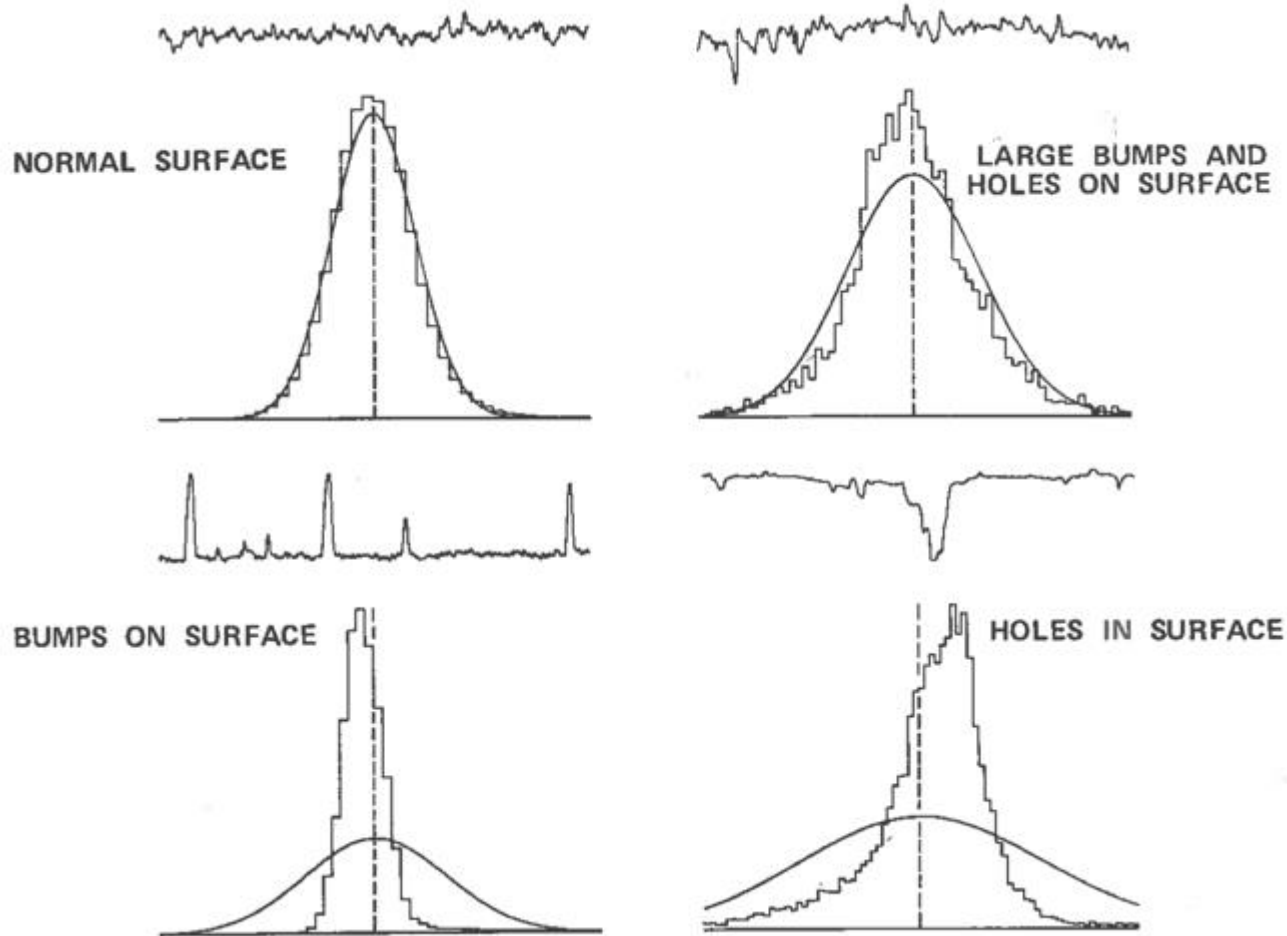
Å? $\Rightarrow$.



Motivation: Surface Profile



Motivation: Skew in Surface Profiles



Material: ULE

Corning's Ultra Low Expansion glass

- Silica doped with ~10% titanium dioxide
- Low coefficient of thermal expansion
- High resistance to thermal shock
- High temperature tolerant
- Mirror blank for Hubble



Manufacturing: Fine Grinding



Overarm spindle polisher

Iron tool



Manufacturing: Fine Grinding



Al ₂ O ₃ Grit Size	Material Removal
30 μm (microns)	90 μm
15 μm	45 μm
5 μm	15 μm

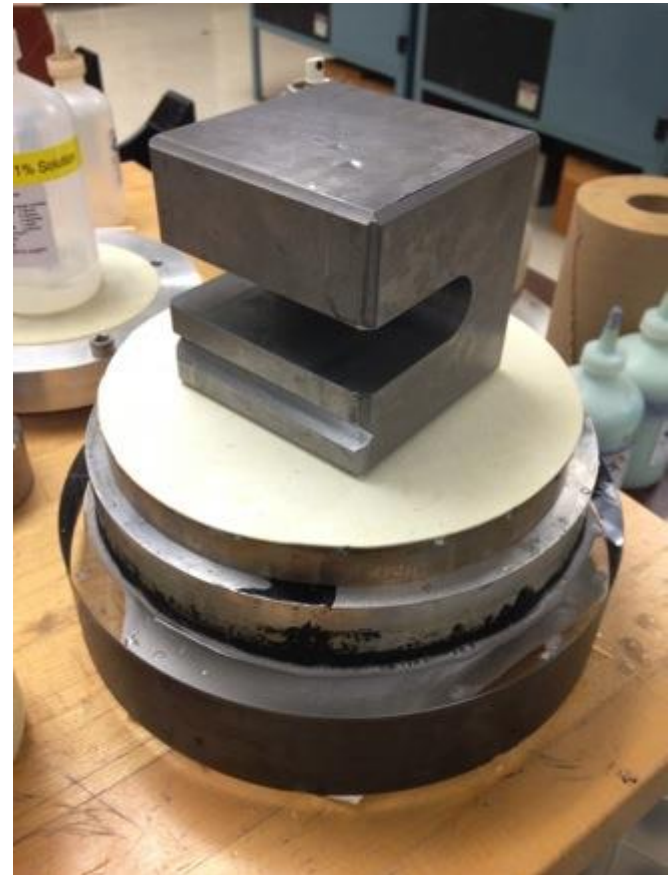


Manufacturing: Polishing



Source: John Mainstone
University of Queensland

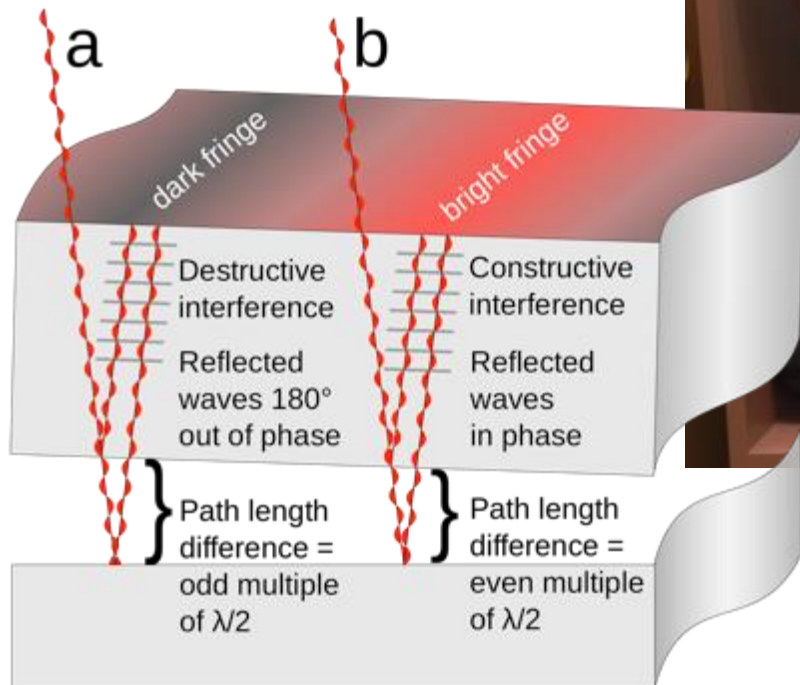
Manufacturing: Polishing



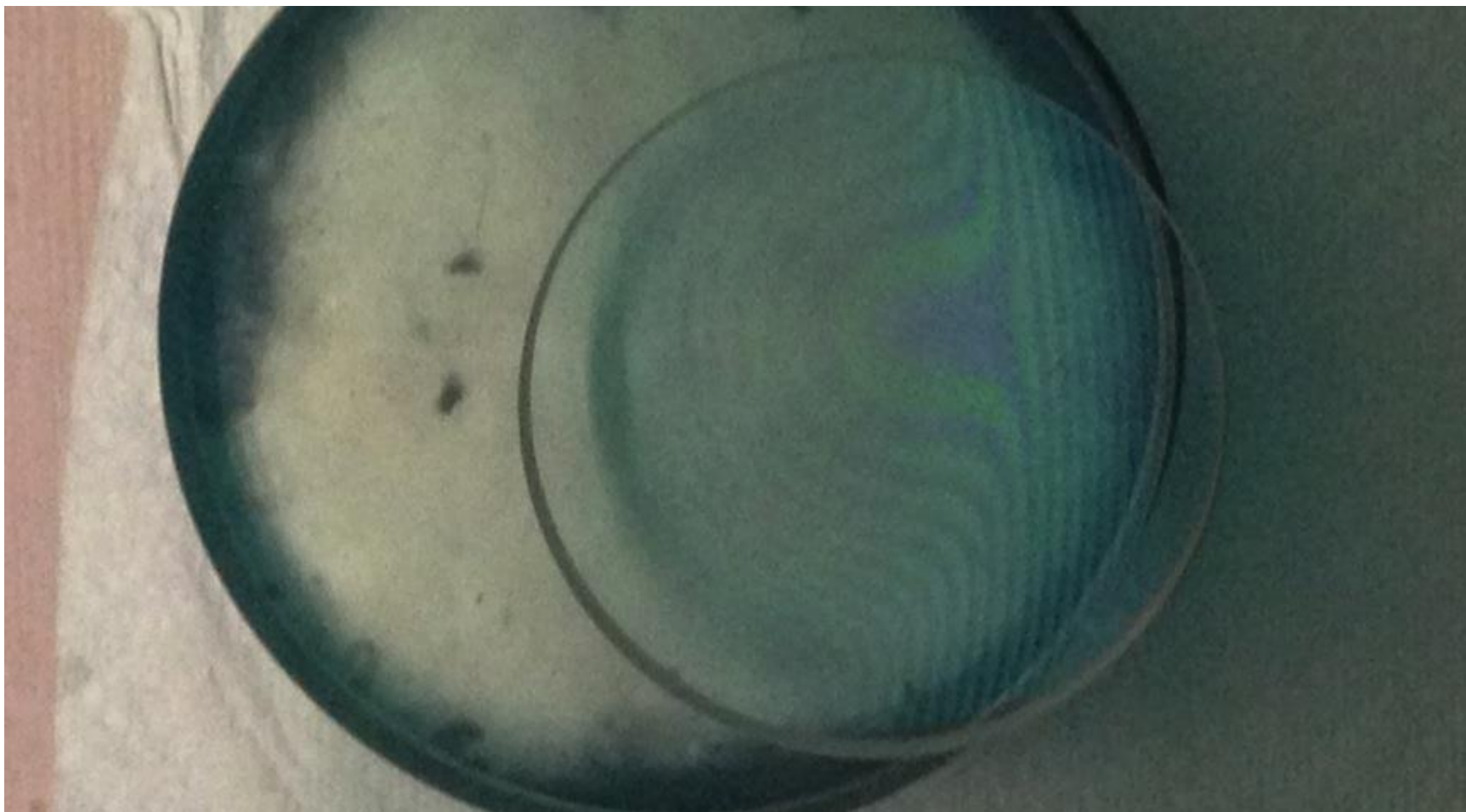
Manufacturing: Polishing



Optical Measurement

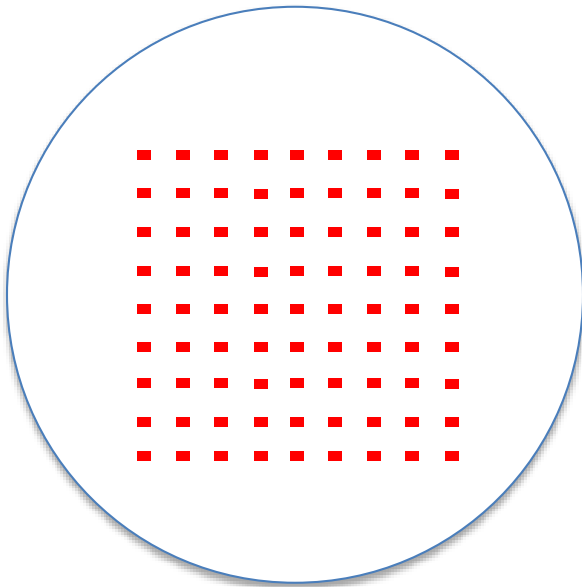


Optical Measurement



Optical Measurement

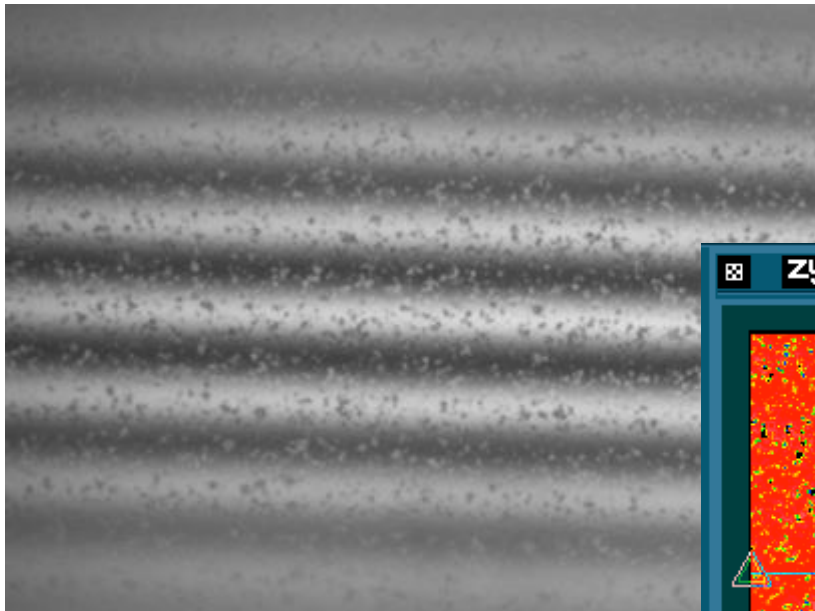
9 X 9 grid of 0.53mm x 0.707mm measurements



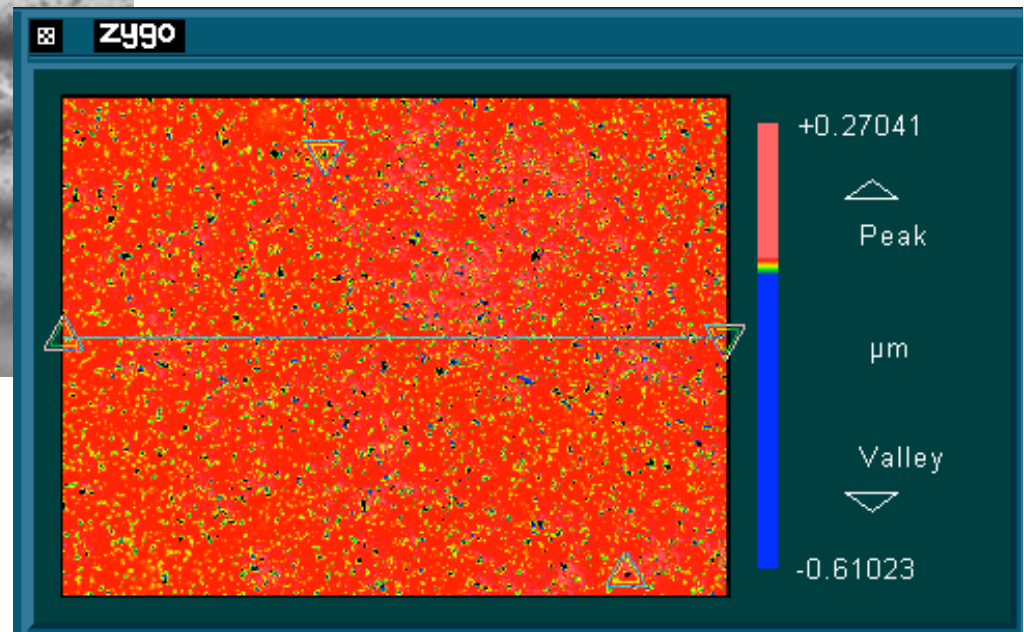
0.04% of surface measured



NewView White Light Interferometer

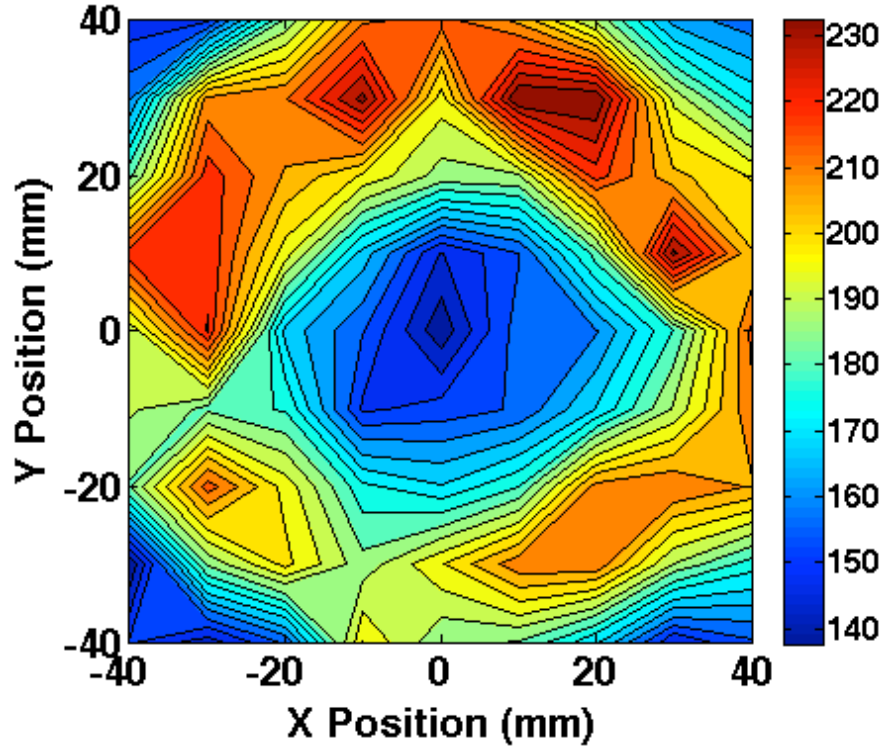


Measurement Size
0.53 mm X 0.707 mm

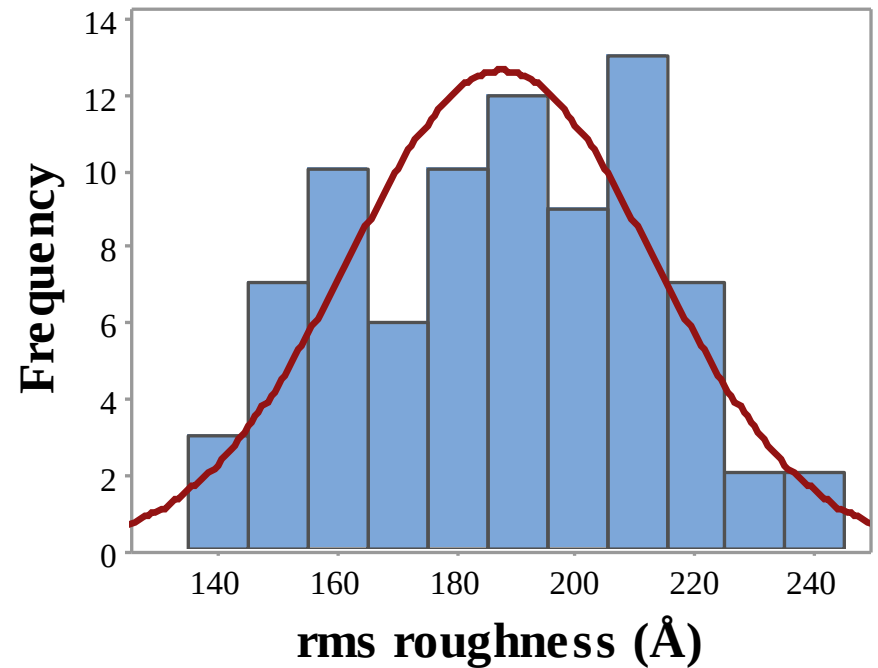


Data Analysis

20 Minutes of Polishing



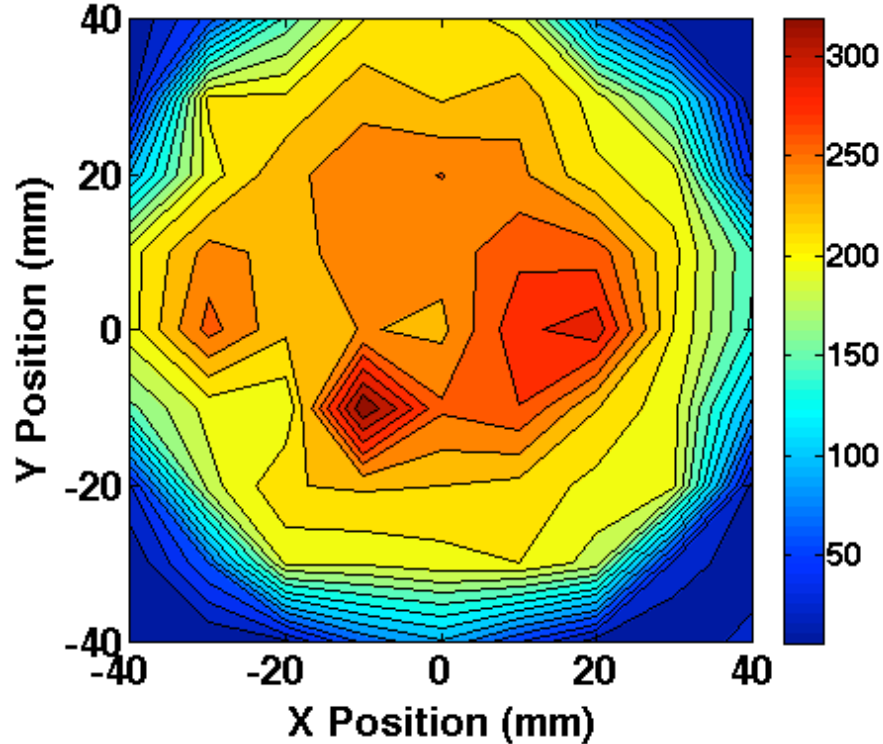
Normal Distribution



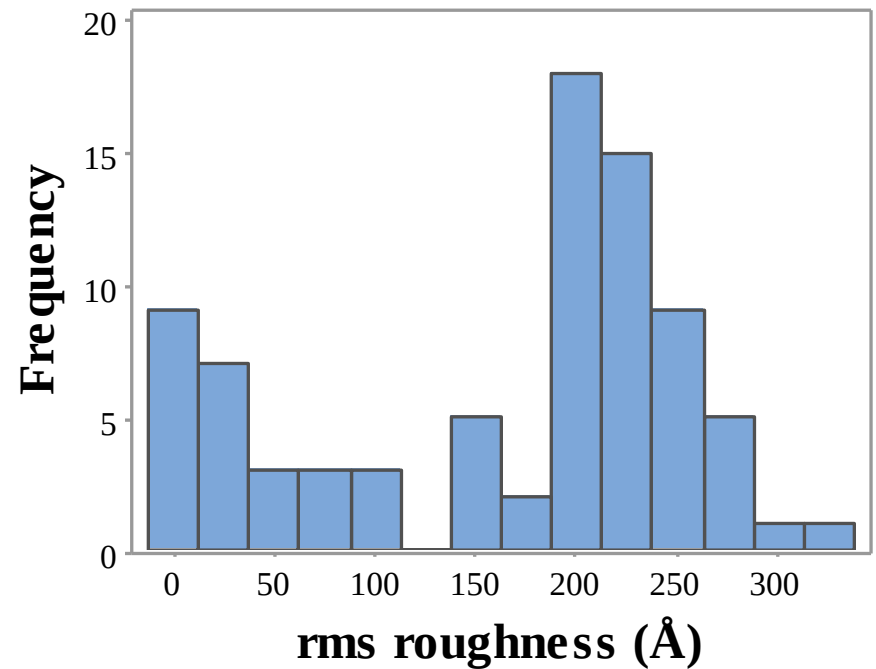
Data Analysis

Circular masking may alleviate this issue.

430 Minutes of Polishing

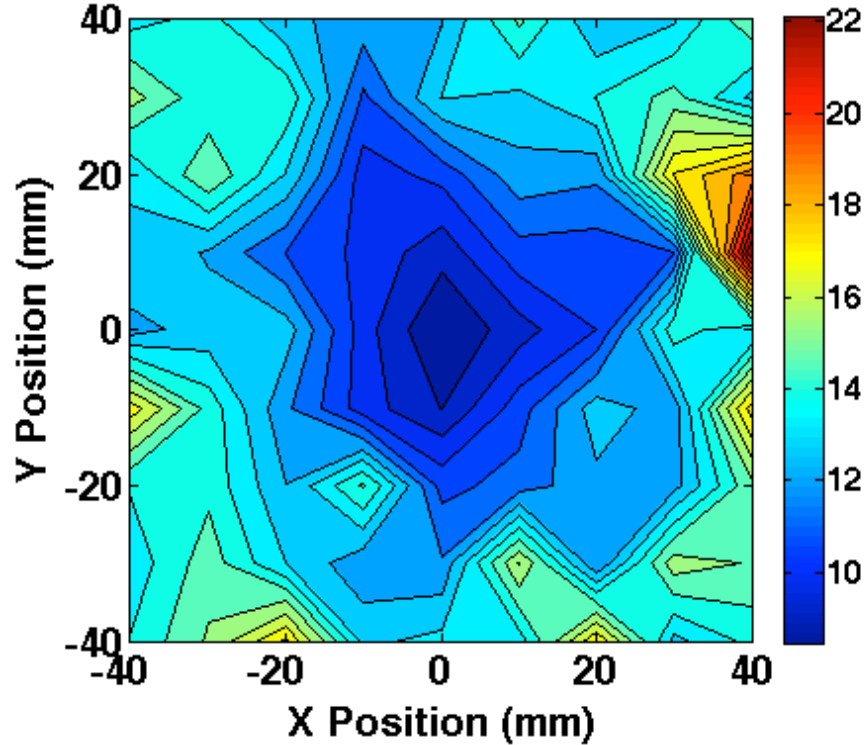


Bimodal Distribution

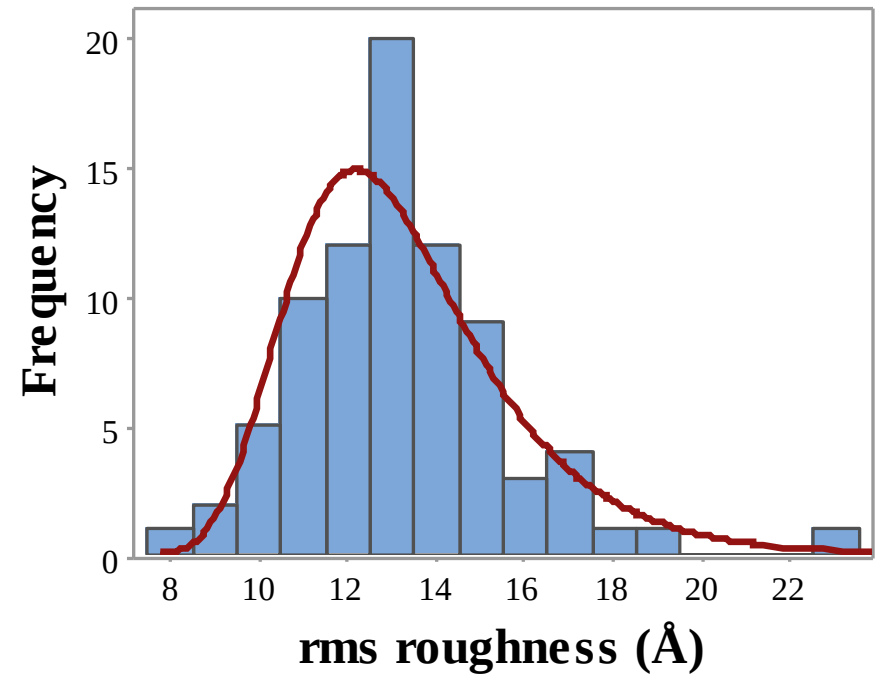


Data Analysis

730 Minutes of Polishing

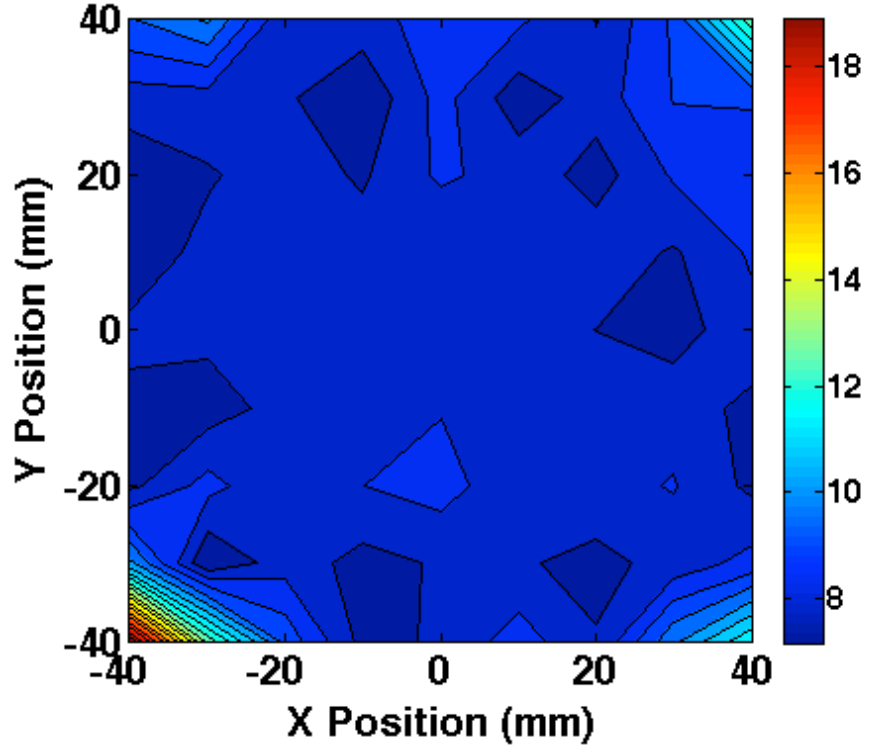


LEV Distribution

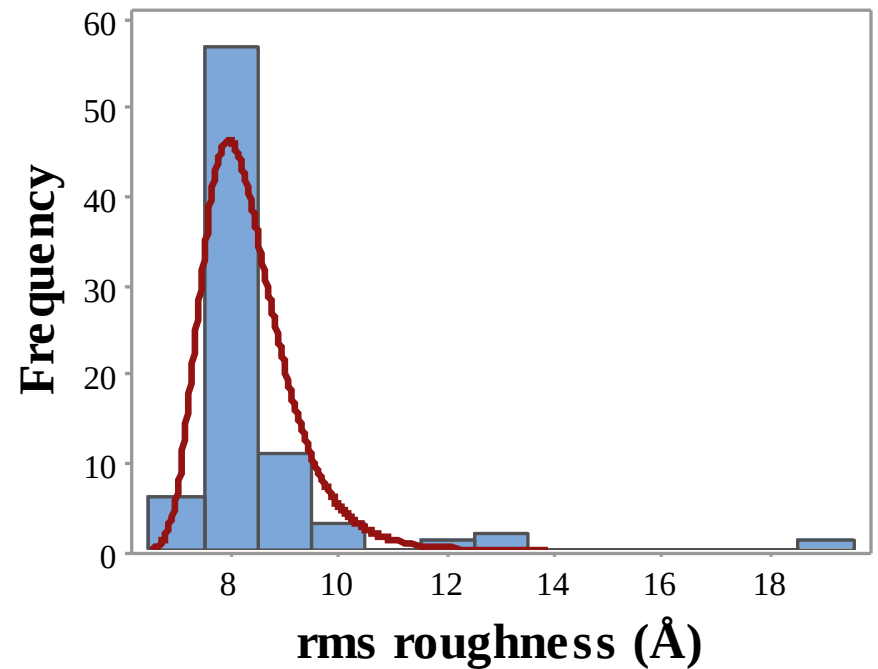


Data Analysis

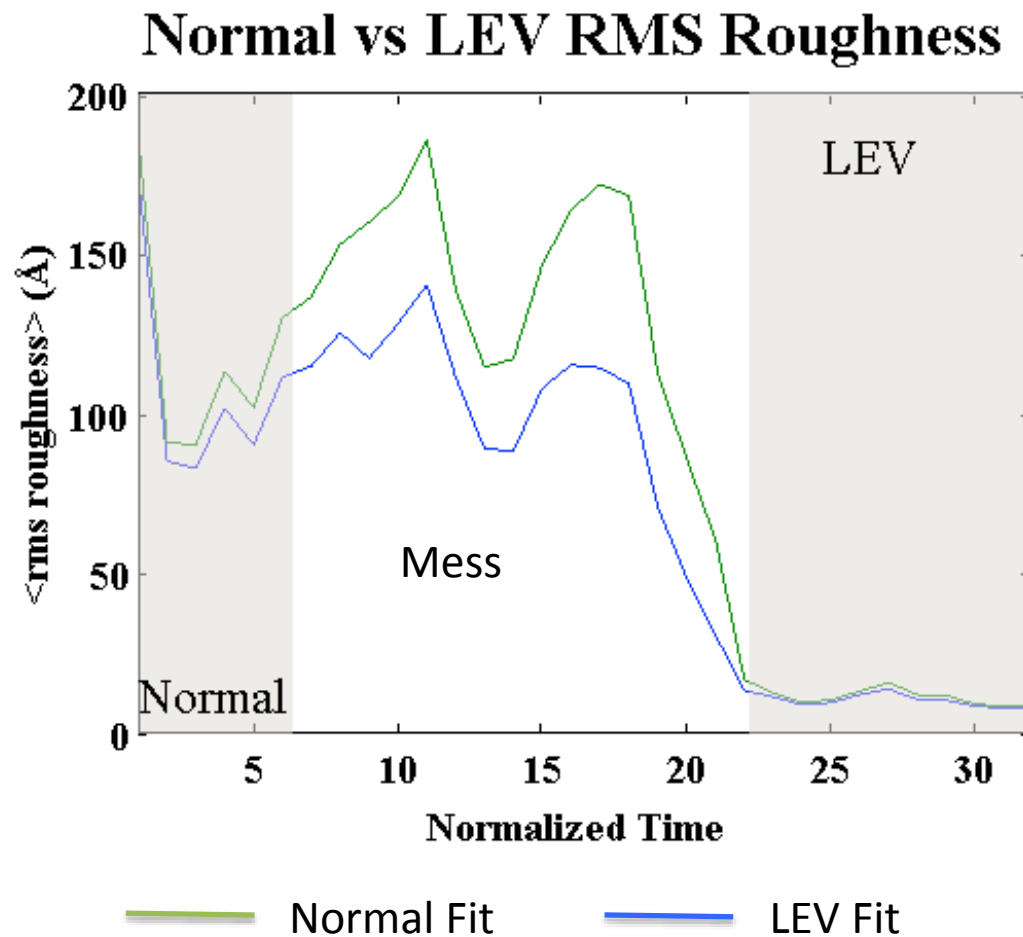
910 Minutes of Polishing



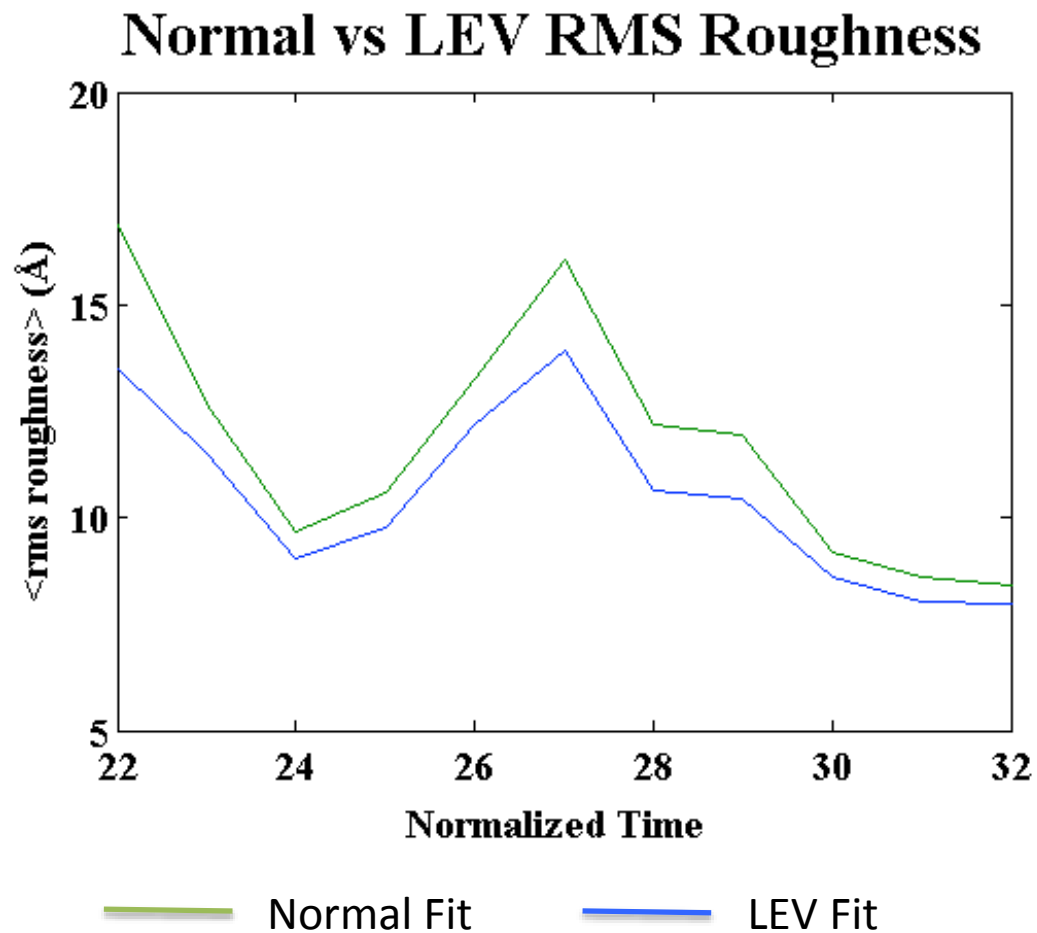
LEV Distribution



Data Analysis



Data Analysis



Conclusion

- RMS roughness distribution is a function of polishing time and process
- Largest Extreme Value distribution verified as a good fit for highly polished surfaces.
 - Saving money, time / improving science constraints
- Surface roughness measurement during figure manipulation may have little value.

Future Work

- Additional materials will be tested
 - Zerodur
 - BK7
 - Fused Silica
 - Silicon Carbide
- Evaluate Abbott-Firestone statistics for merit

Questions?

