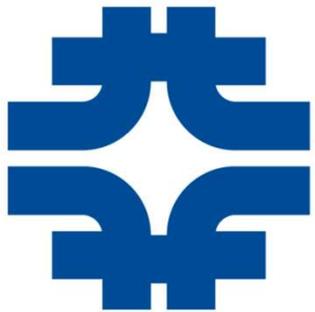


Exploring Silicon Molds in Nondestructive Surface Finish Testing

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Outline

- Background on ADMX
- Problem with higher frequencies
- Surface Roughness
- Moldstar 15

Background

What is the Axion?

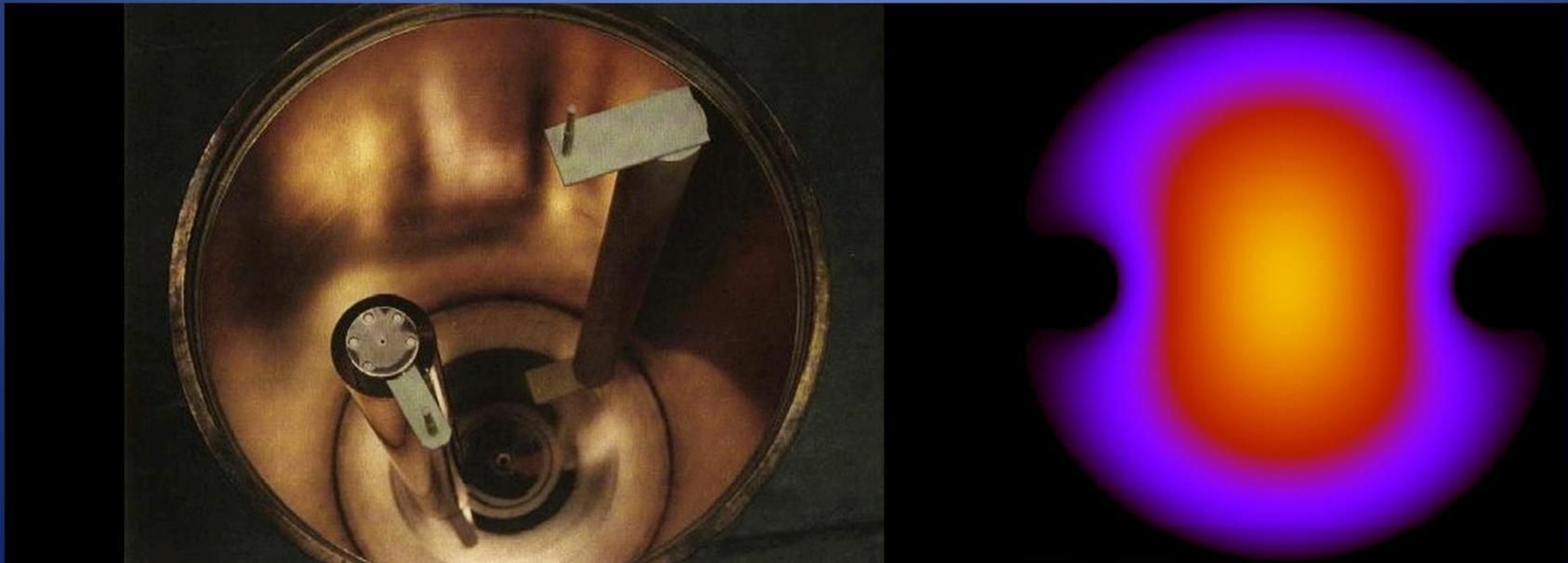
- Proposed particle by the Peccei–Quinn theory to resolve the strong CP problem in quantum chromodynamics.
- Possible dark matter candidate
- coupling to electromagnetism

How do we find it?

- Exploit the coupling to electromagnetism
- Axions turn into photons in a magnetic field
- Must amplify the signal and reduce noise to properly detect (cryo, single photon detectors)

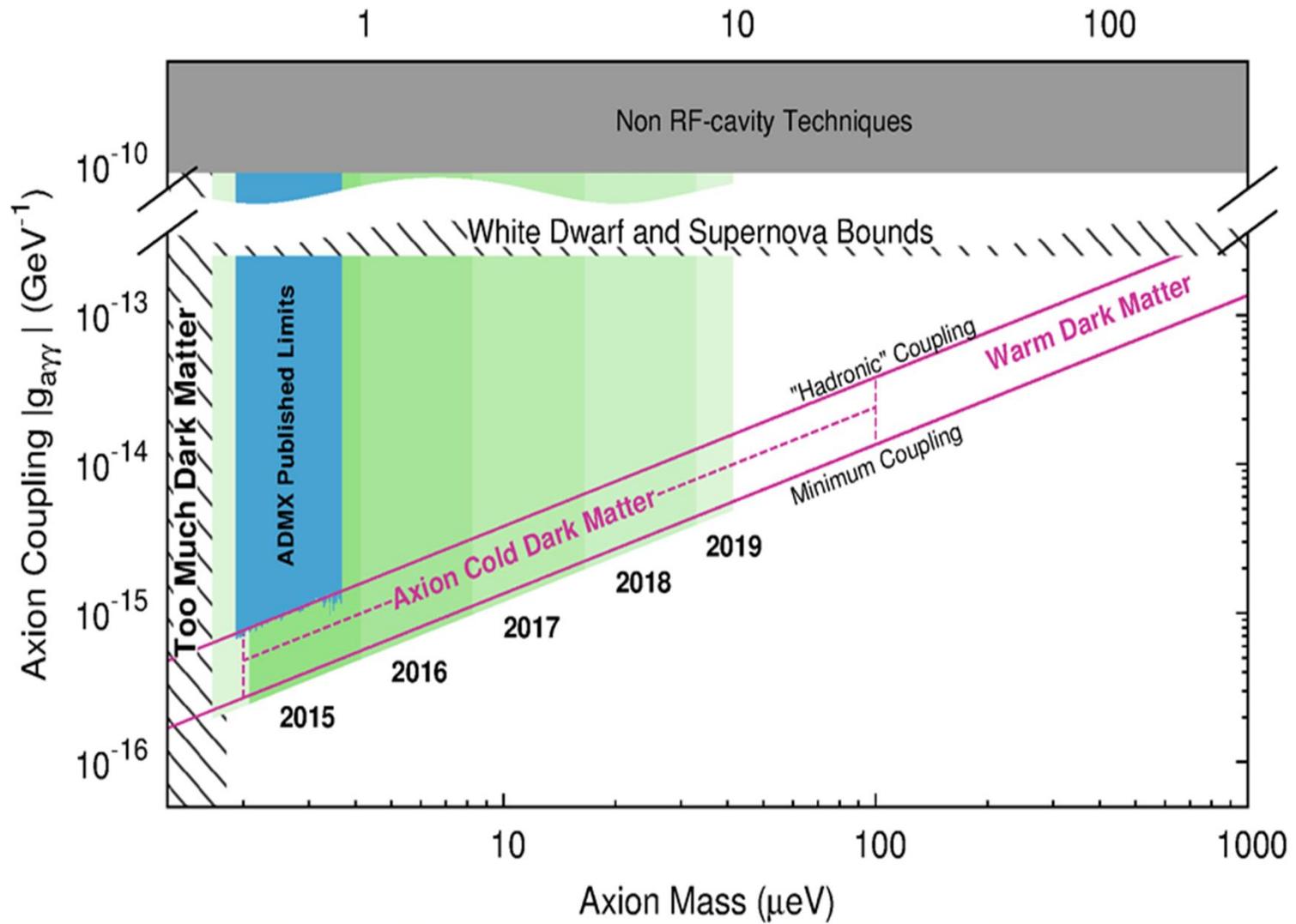
Axion Dark Matter eXperiment (ADMX)

- Microwave resonator in multi-tesla magnetic field
- Scan frequency range by tuning the fundamental frequency of the cavity



Gen 2 ADMX Projected Sensitivity

Cavity Frequency (GHz)



3 Parameters of interest

- Magnetic Field (~ 10 T)
- Temperature (~ 10 mK)
- Q factor ($10^5 - 10^6$)

Current Experiment

- Uses Copper
- Works very well at lower frequencies
- May be limited at higher frequencies. Resistivity becomes significantly high due to skin effect
- Suggest using a different material for future experiments



Enter Aluminum

	Electrical conductivity (10.E6 Siemens/m)	Electrical resistivity (10.E-8 Ohm.m)	Thermal Conductivity (W/m.k)	Thermal expansion coef. 10E-6(k-1) from 0 to 100°C	Density (g/cm3)	Melting point or degradation (°C)
Copper	58,5	1,7	401	17	8,9	1083
Aluminium	36,9	2,7	237	23,5	2,7	660

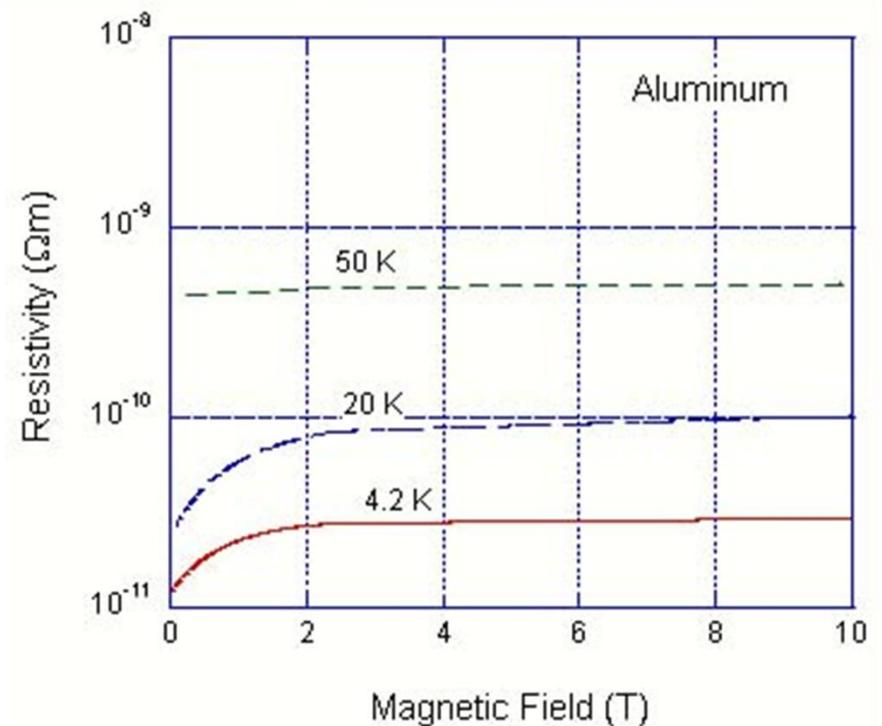
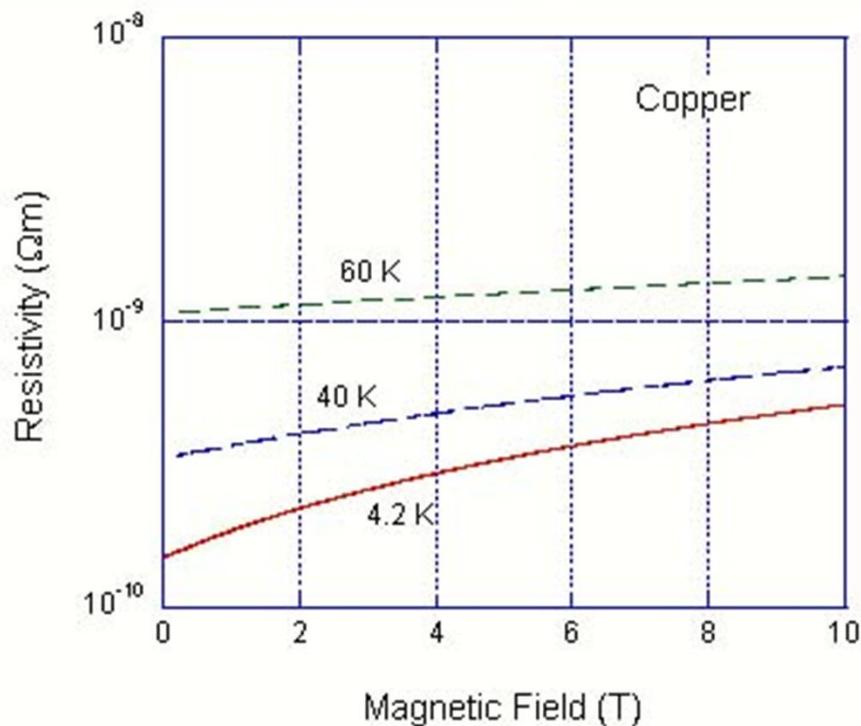
Conductivity: The degree to which a specified material conducts electricity

*We want this large

Why Use Aluminum?

Motivation 1

- In High Magnetic field, Aluminum achieves a lower resistivity at low temperatures

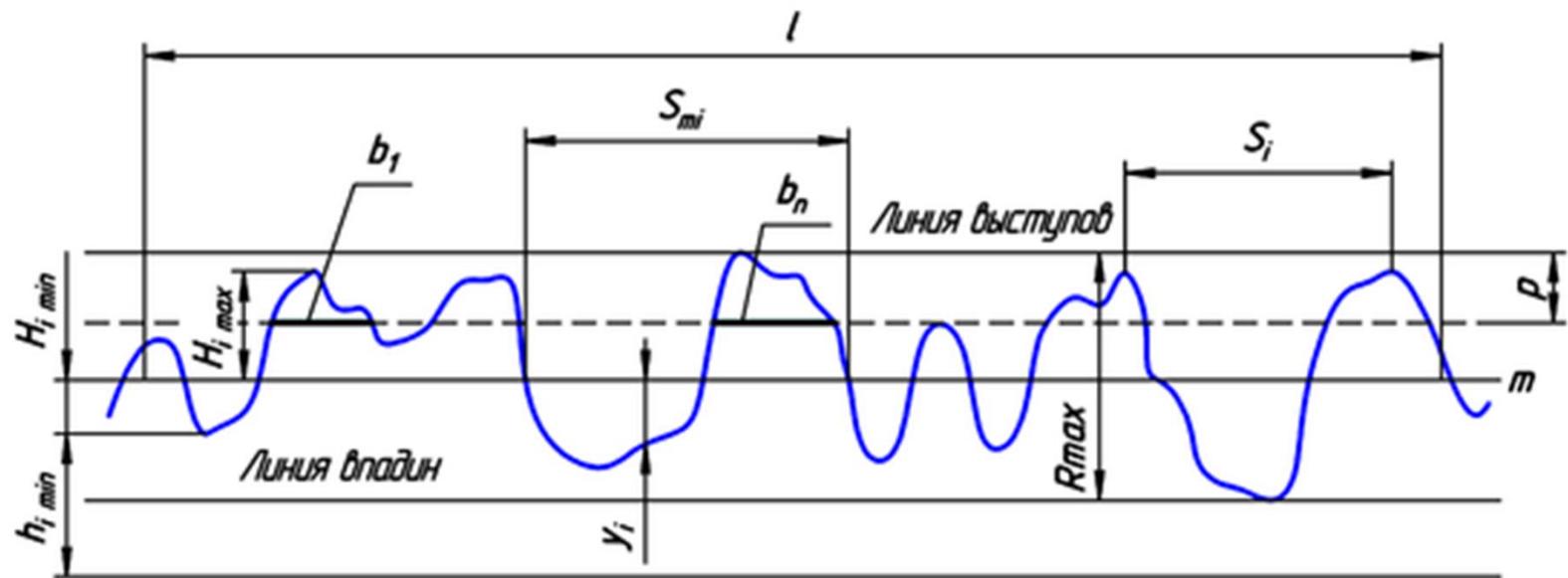


Systematic Comparison

- We wish to gather as much information about the behavior of aluminum to properly compare it with copper.

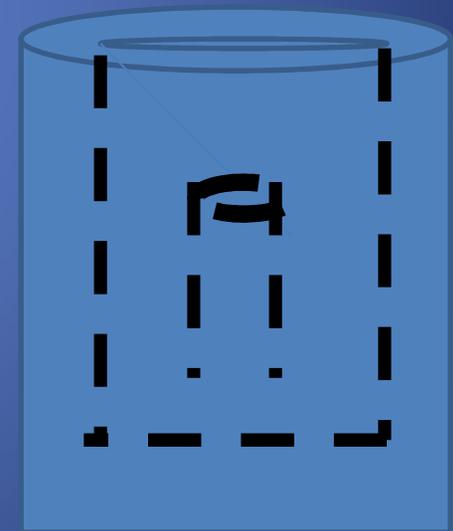
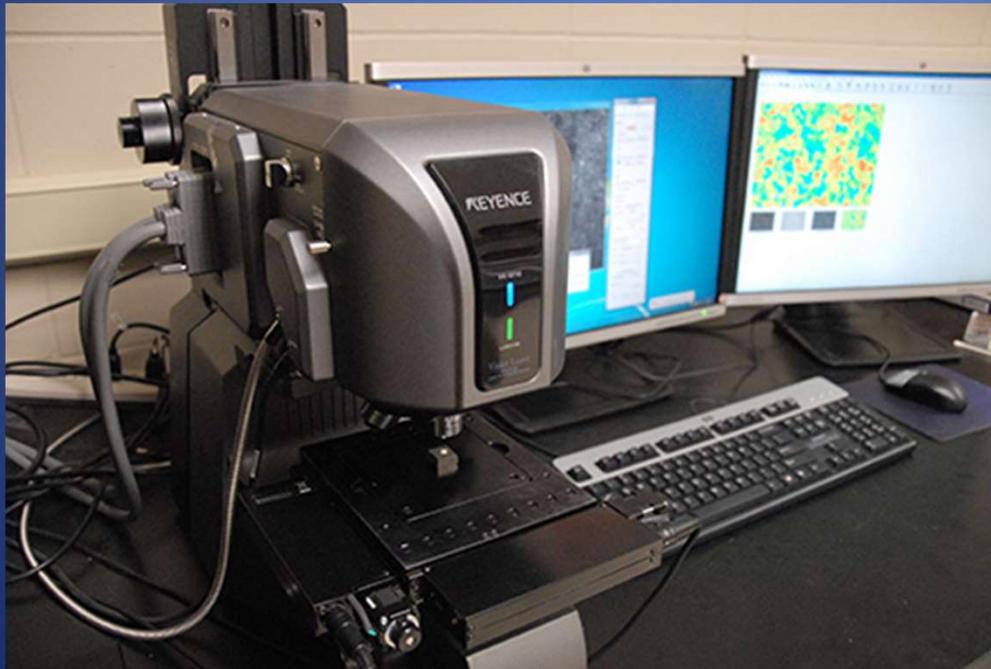
Surface Roughness

The deviations in the direction of the normal vector of a real **surface** from its ideal form. If these deviations are large, the **surface** is rough; if they are small, the **surface** is smooth.



How do we measure?

Keyence microscope cannot see inside the small cavity without cutting the surface.



Moldstar15

- We propose to make a silicon mold to allow us to measure and compare the inside surface roughness of the cavities without cutting into the cavity.



Goals

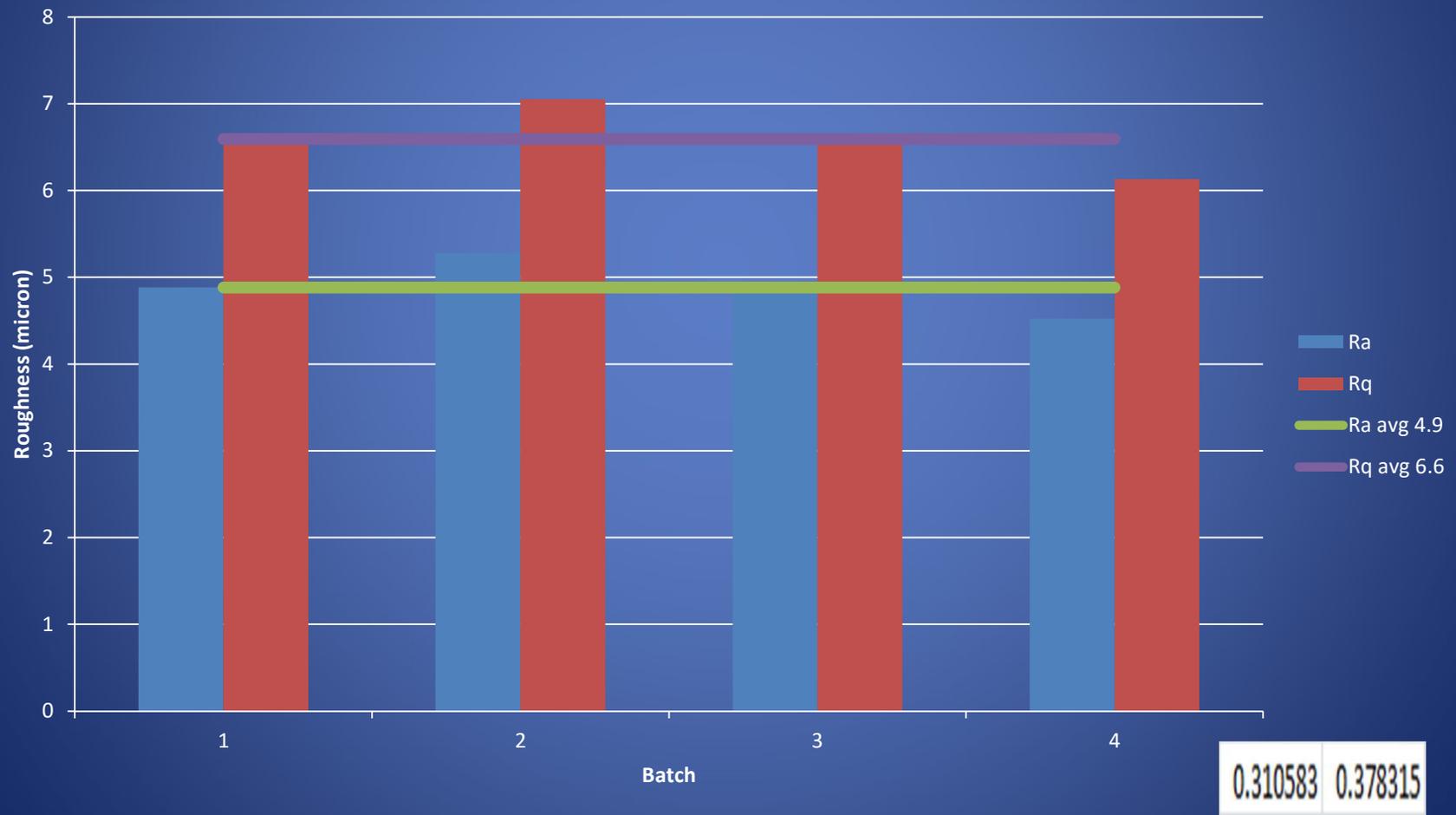
- Consistency between molds.
- Sensitive to changes in Roughness.
- Agreement with true roughness.

Results

- Mold sample standard deviations as small as 0.35 microns
- Changes in finish resulted in changes in roughness calculated.
- Mold measurements consistently more rough than true image

Consistency

Roughness vs Batch



Conclusions

- Moldstar 15 can reliably show changes in surface finish, but is not a good representation of the true roughness of the surface.

Future Work

- Resurface cavities and retest for Q factor to ascertain correlation between surface roughness and Q factor.



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Questions?