CMP Conditioner and Pad Characterization‼

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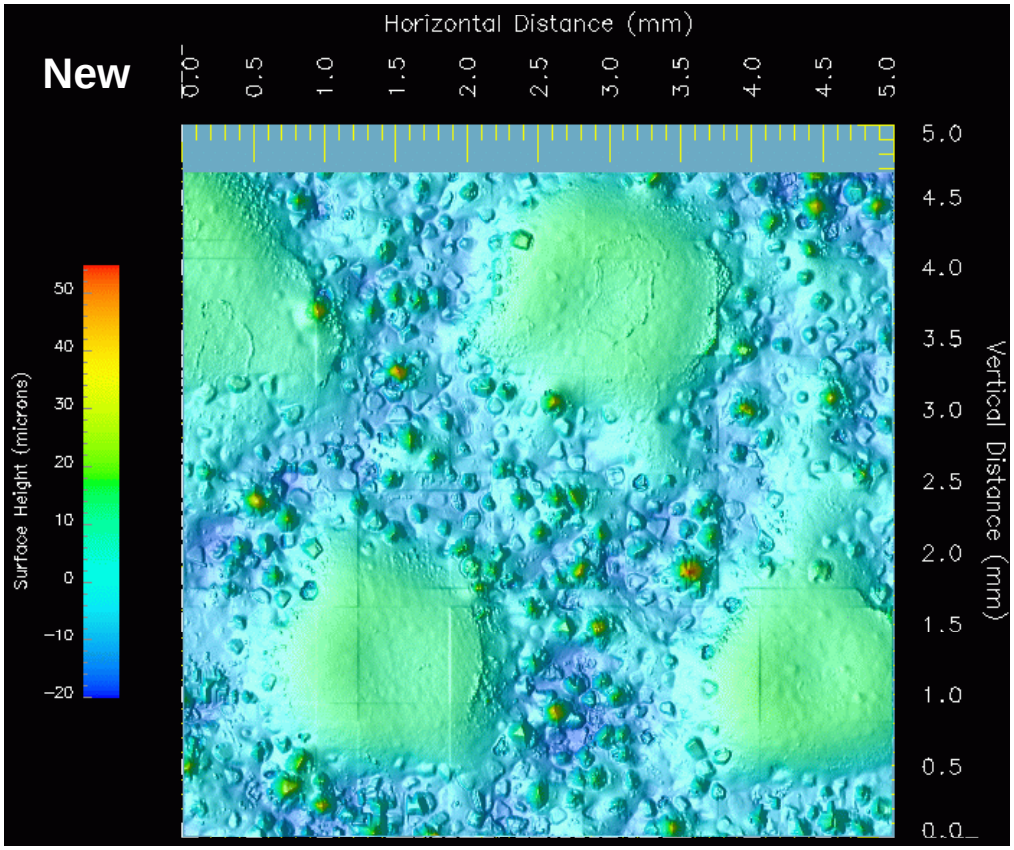
Araca Incorporated

Conditioner Characterization

Active Diamonds

Active diamonds, or working grit, are defined as those diamonds that modify a pad surface by cutting furrows.



Interferometry of an MMC Mosaic disc with a Teflon coating

PacRim 2005

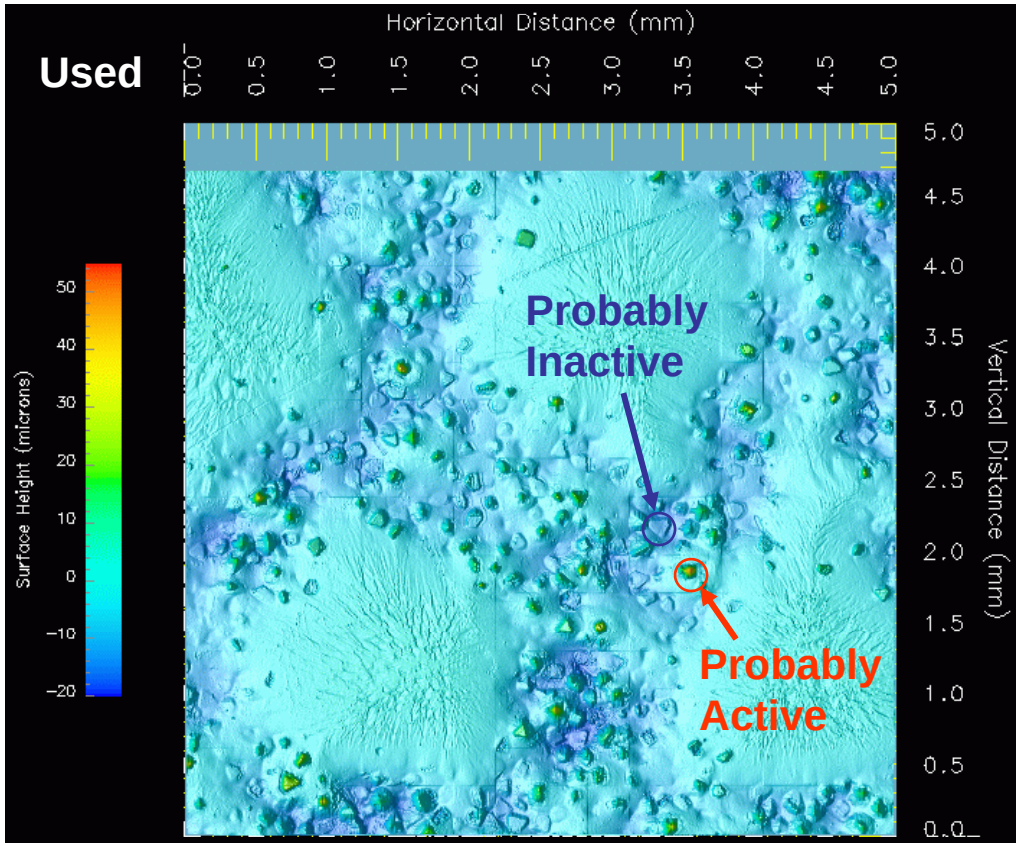
Active Diamonds

Active diamonds, or working grit, are defined as those diamonds that modify a pad surface by cutting furrows.

All diamonds that cut should wear

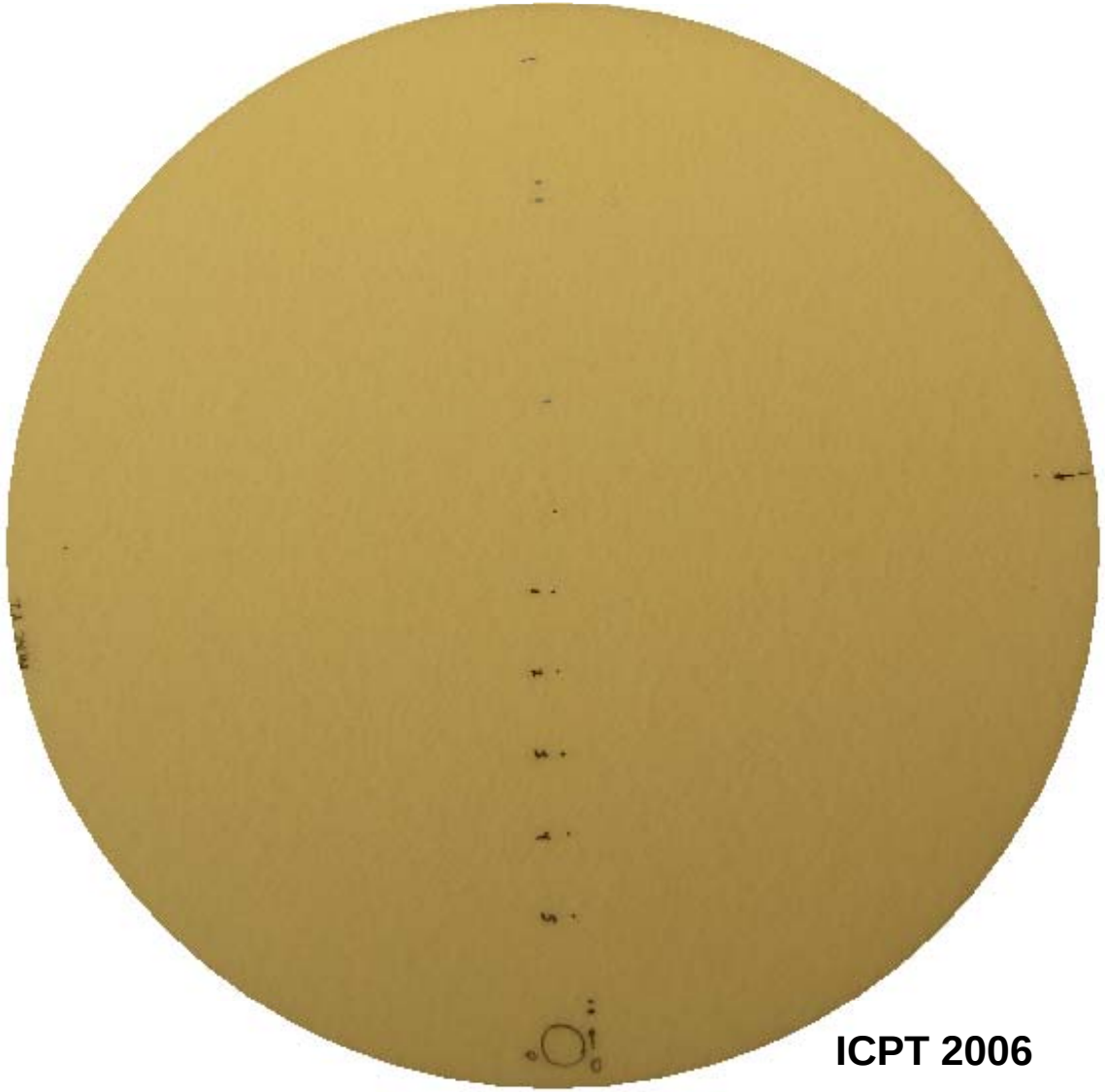
but

wear by itself is not proof of cutting.



Interferometry of an MMC Mosaic disc with a Teflon coating

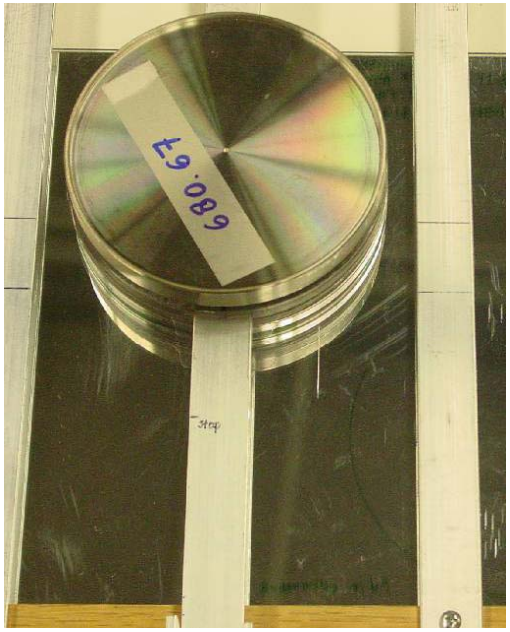
Furrows are hard to see on commercial pads



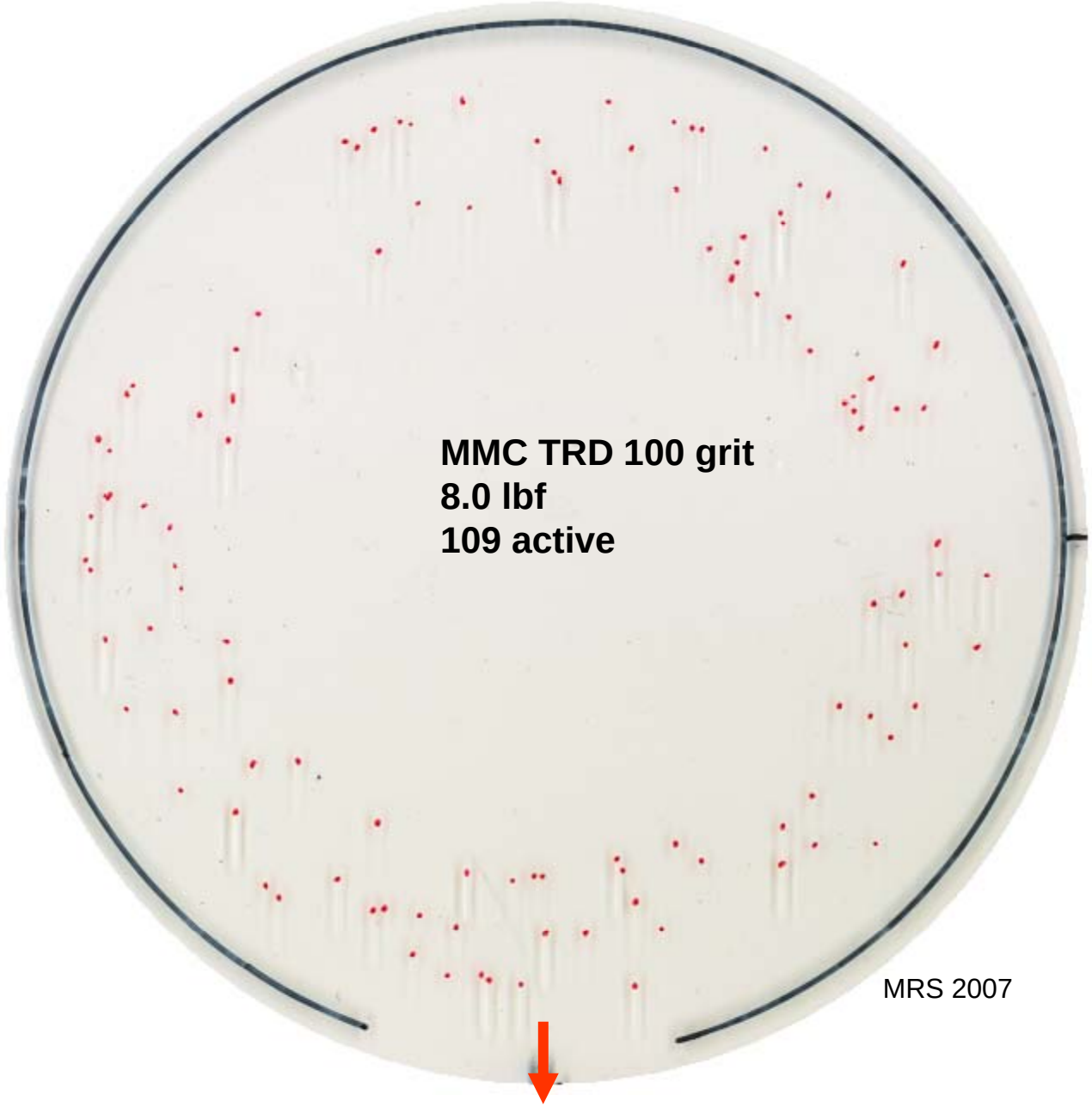
ICPT 2006

… but easy to see on polycarbonate

Conditioner Active Diamond Characterization



US and Foreign Patents



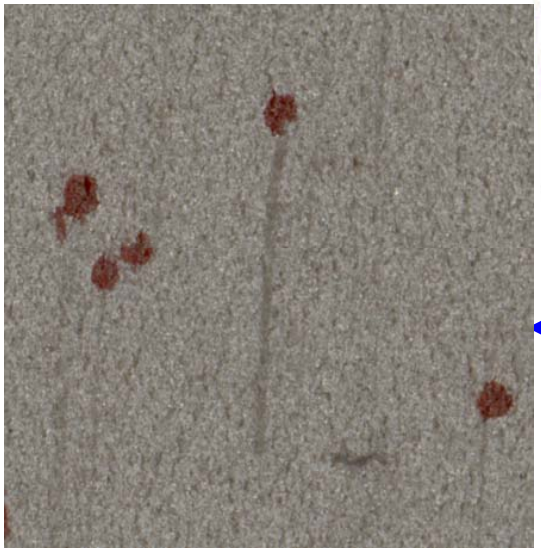
MRS 2007

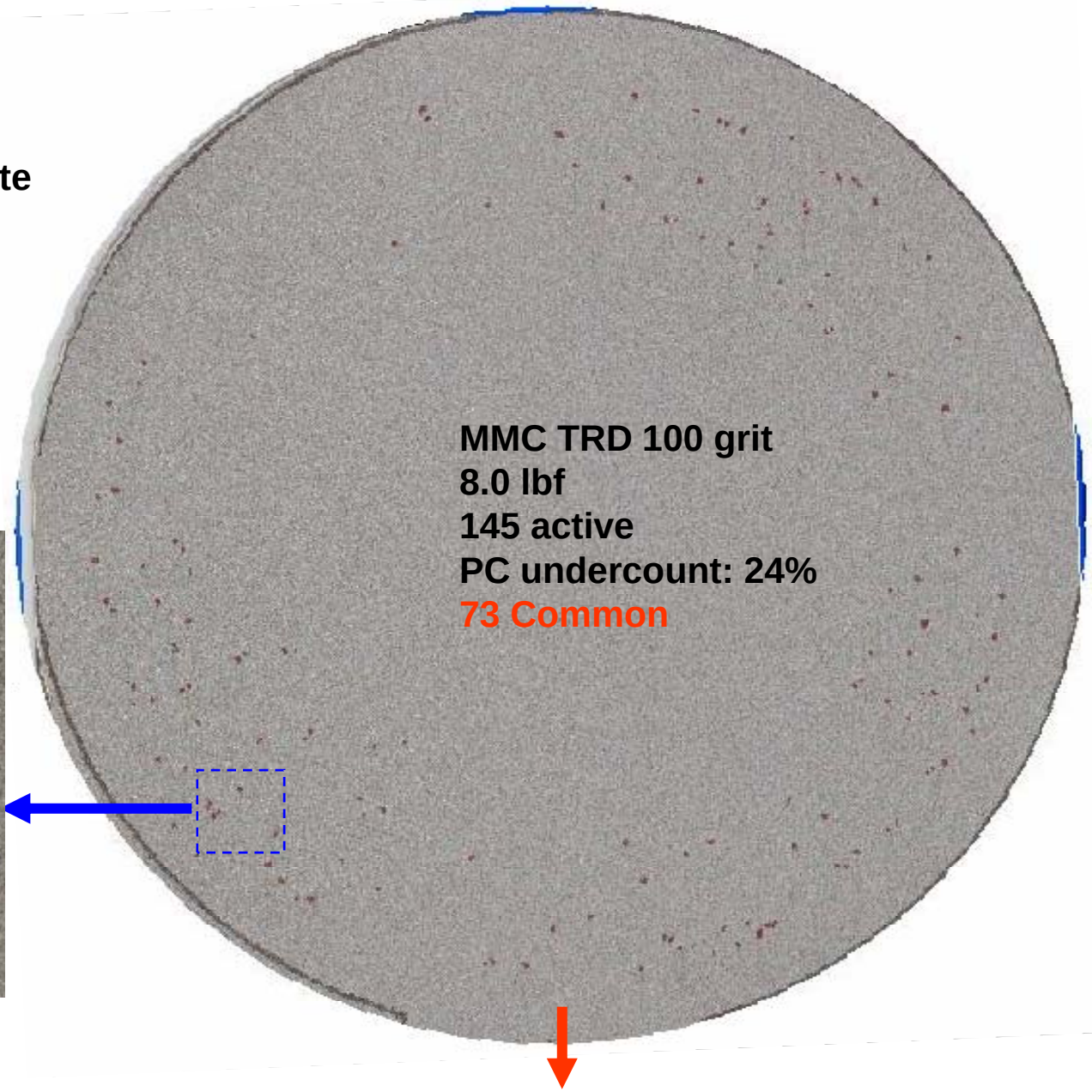
Active Diamond Locations on the Conditioner

Active Diamonds on IC-1000

IC-1000 pad, no grooves
Mounted on polycarbonate

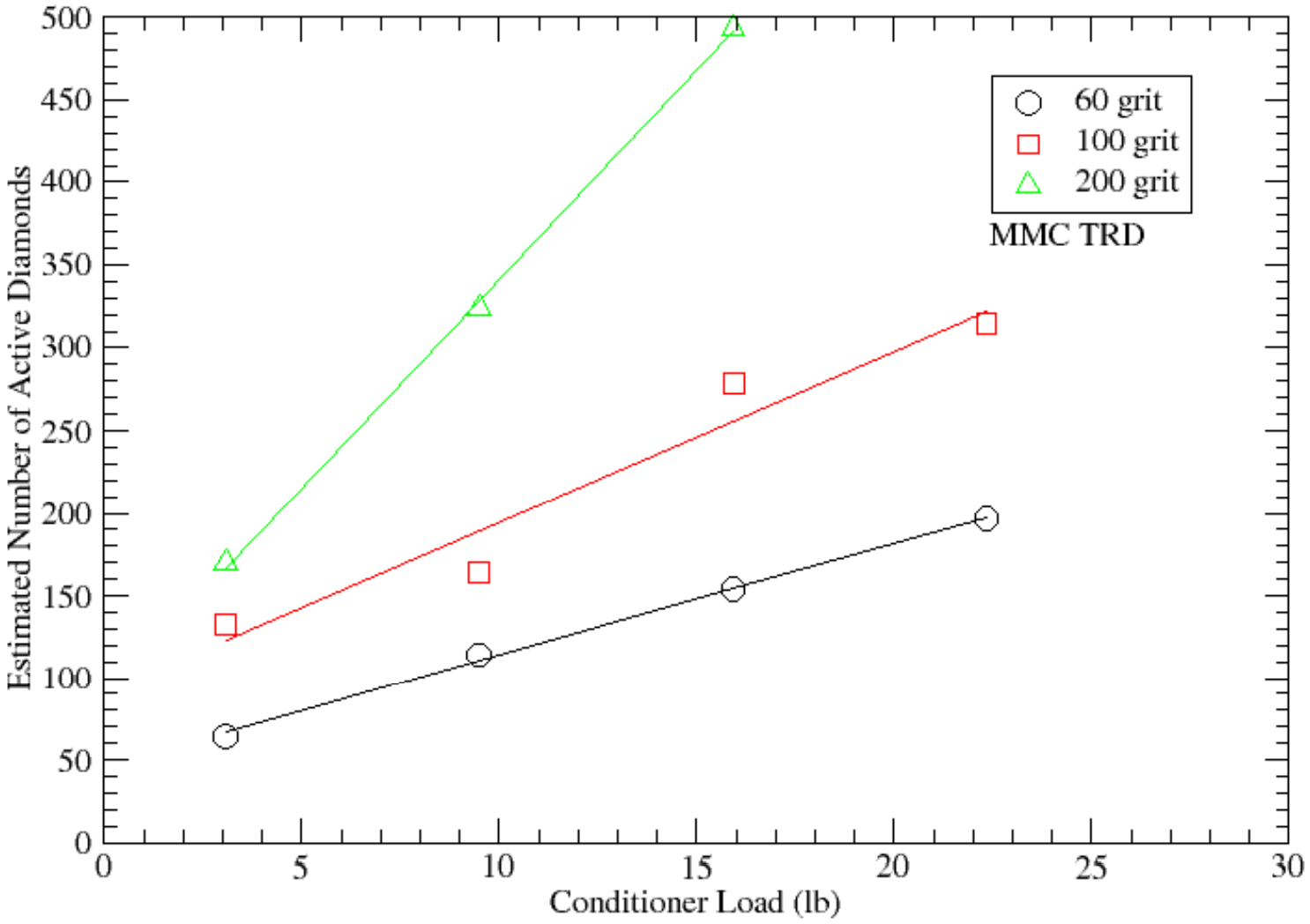
80 nm Cr layer
Deposited at 70 C



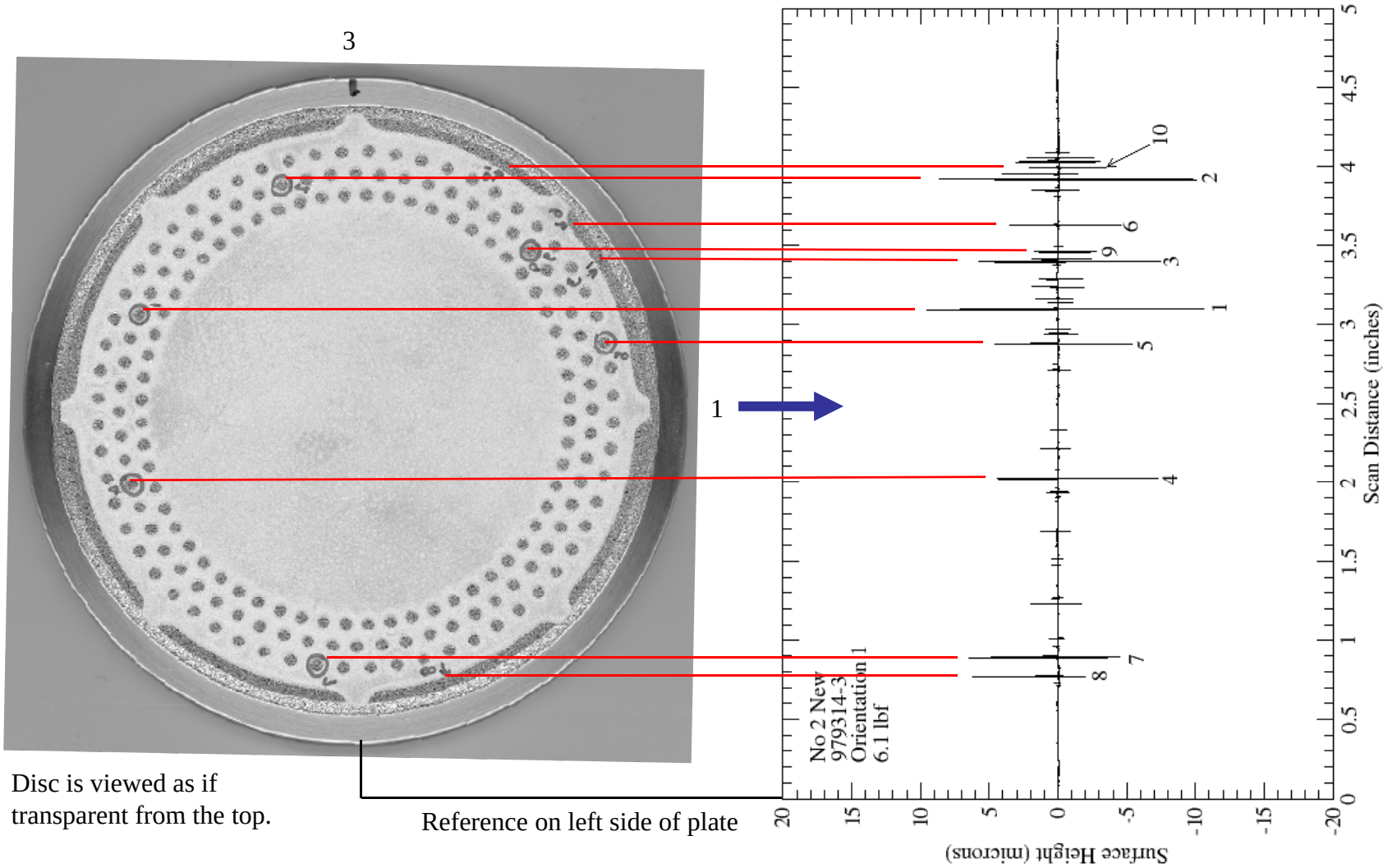


MMC TRD 100 grit
8.0 lbf
145 active
PC undercount: 24%
73 Common

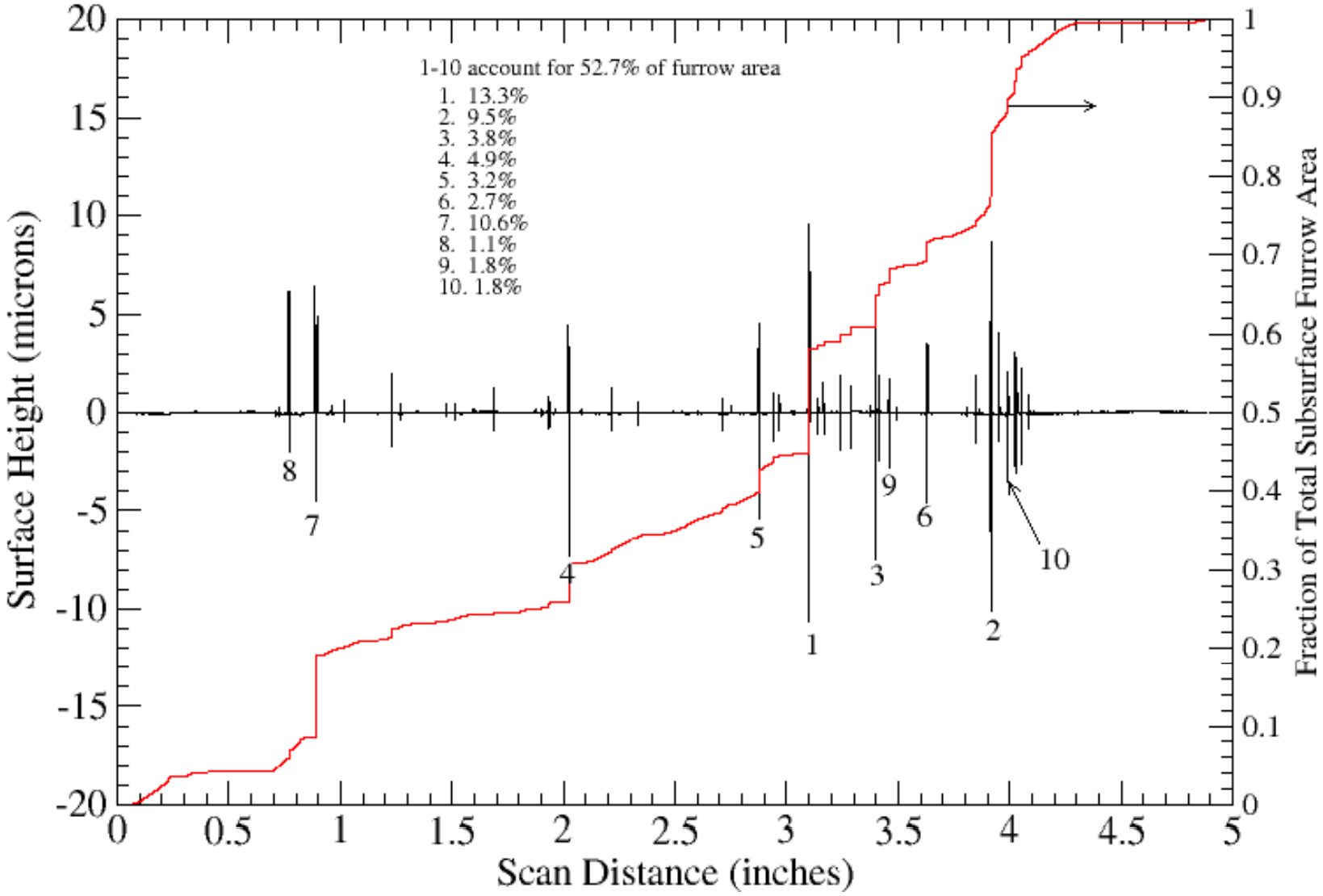
Active Diamond Count vs. Load and Grit Size



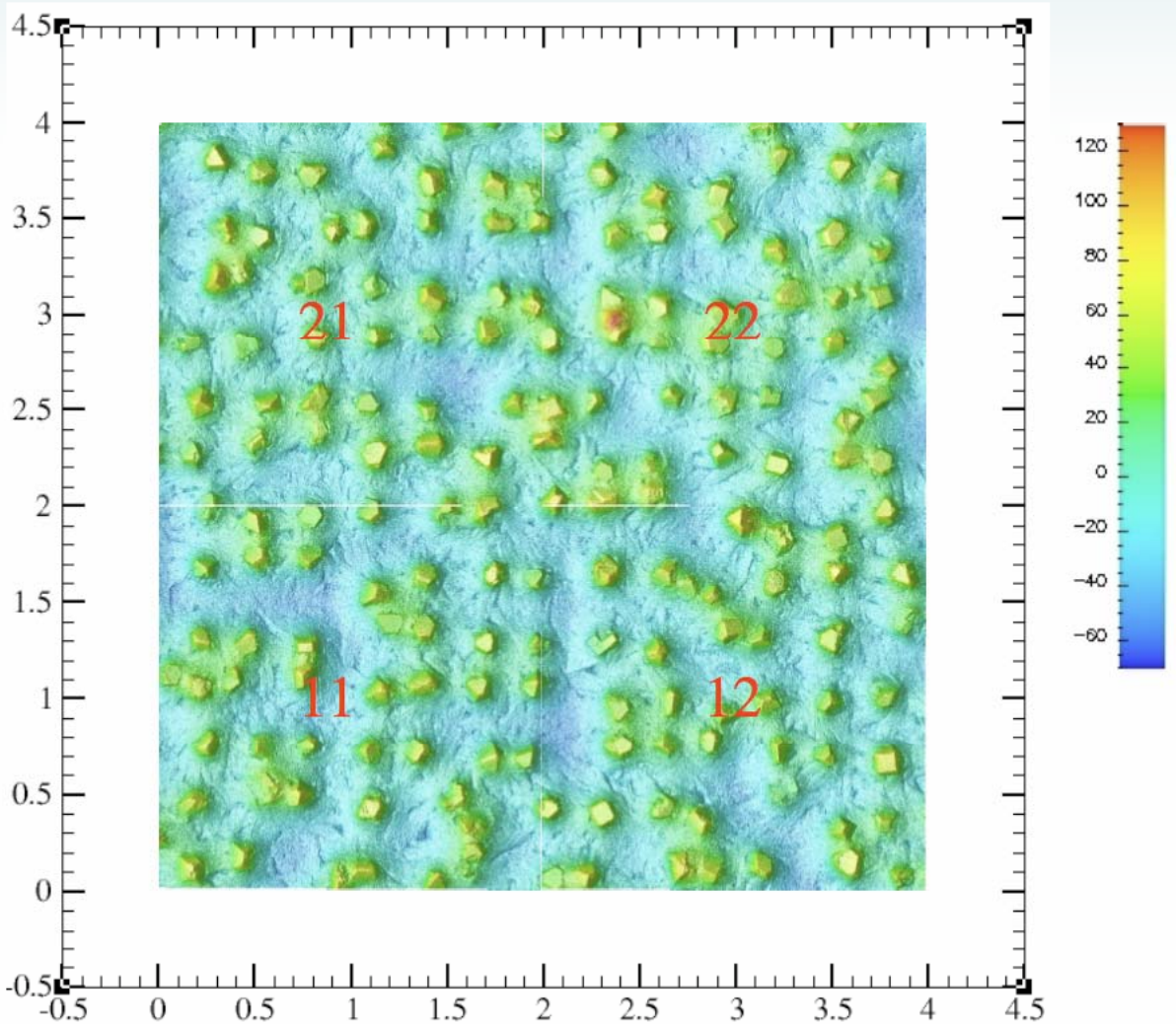
Aggressive Diamonds



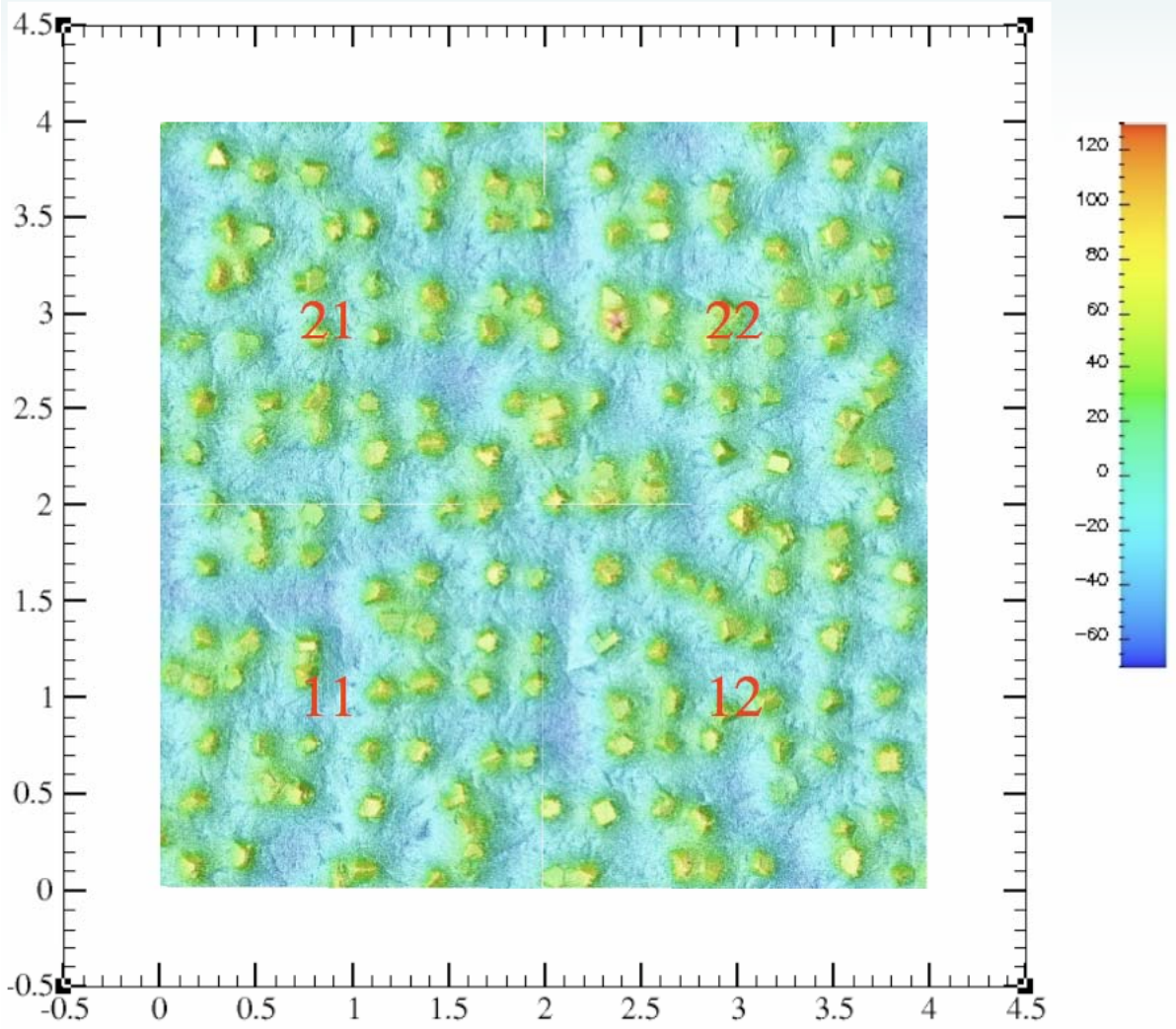
Characterization of Aggressive Diamonds



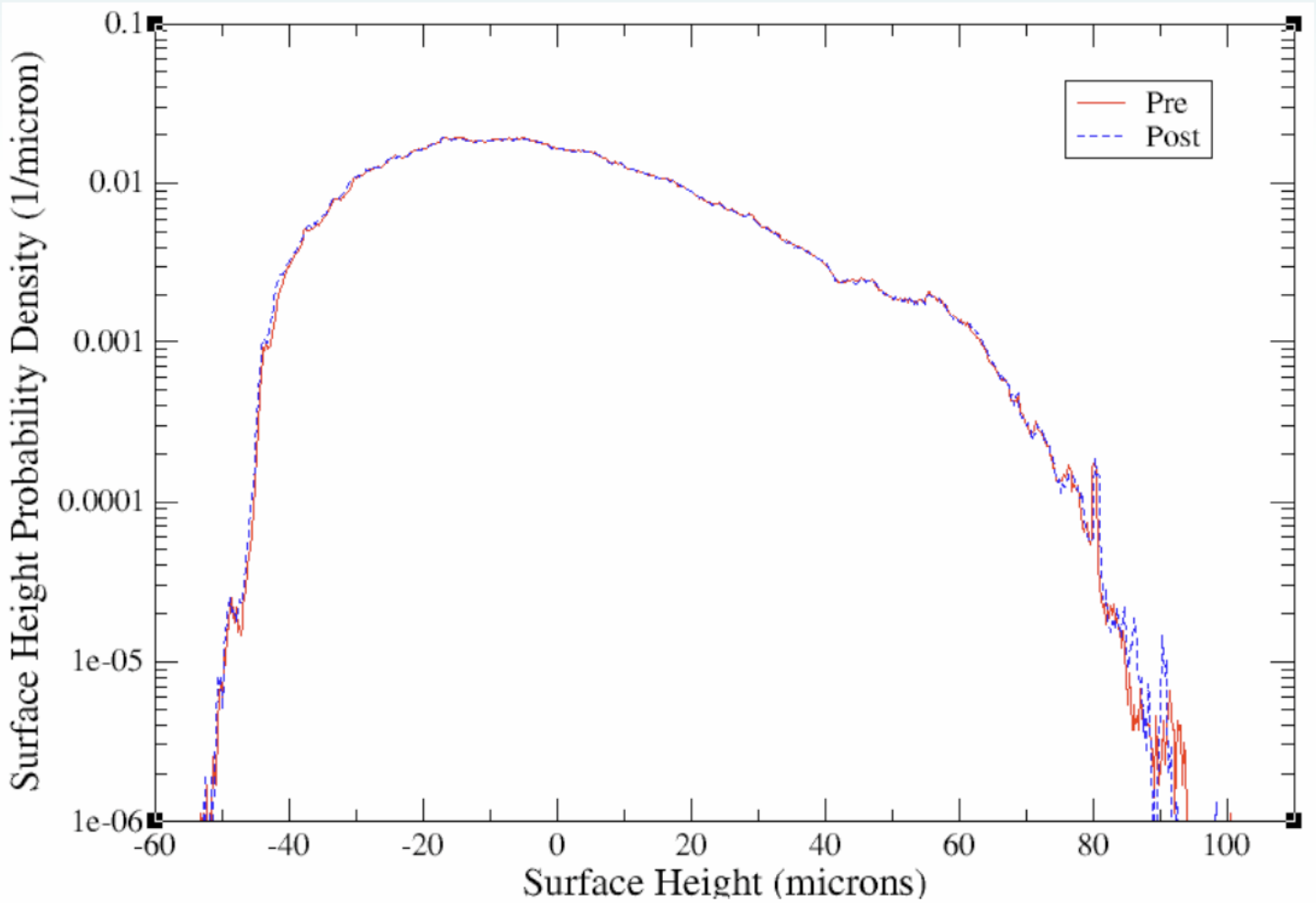
Matched 2D Image BEFORE Wear



Matched 2D Image AFTER Wear



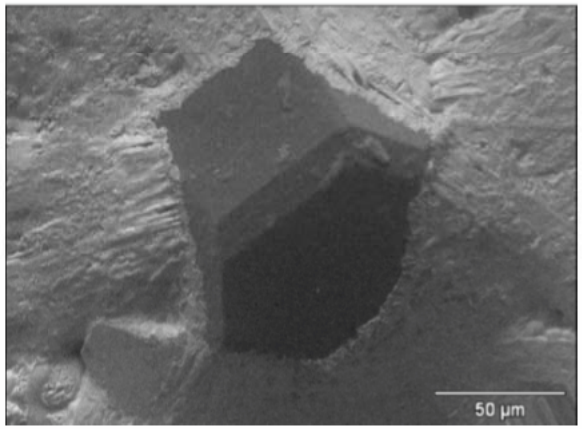
PDFs of Matched BEFORE & AFTER Images

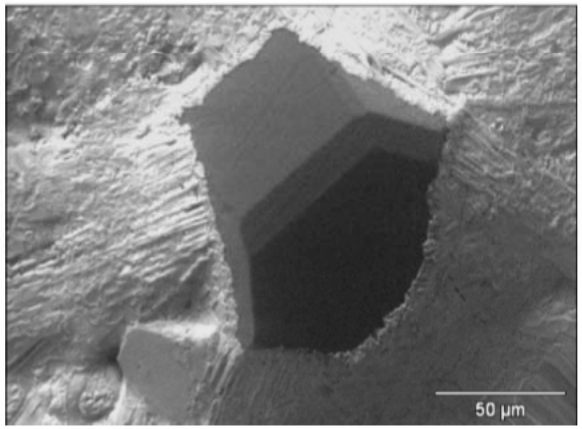


Preliminary 24 – hr Wear Results

Non-aggressive Diamond

Before



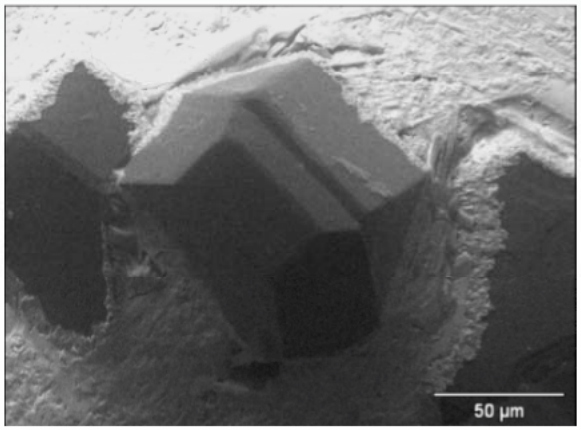


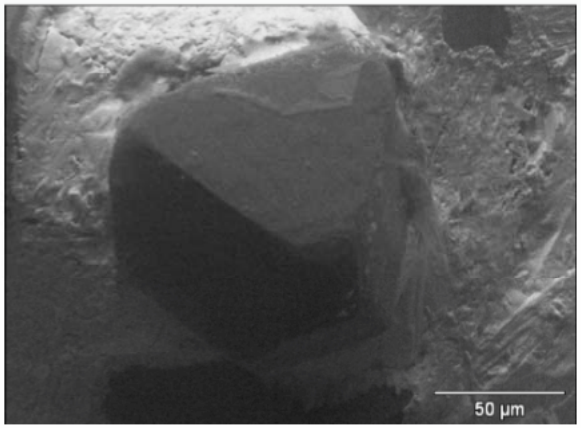
After

Preliminary 24 – hr Wear Results

Aggressive Diamonds Nos. 3 and 4

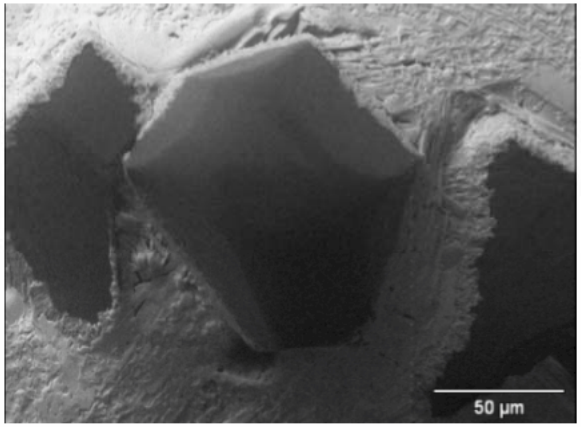
Before

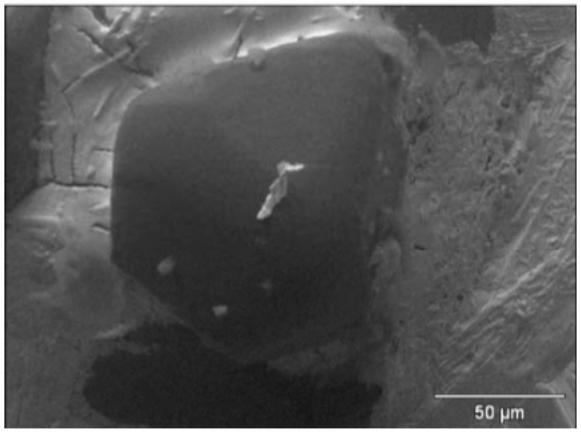




Before

After





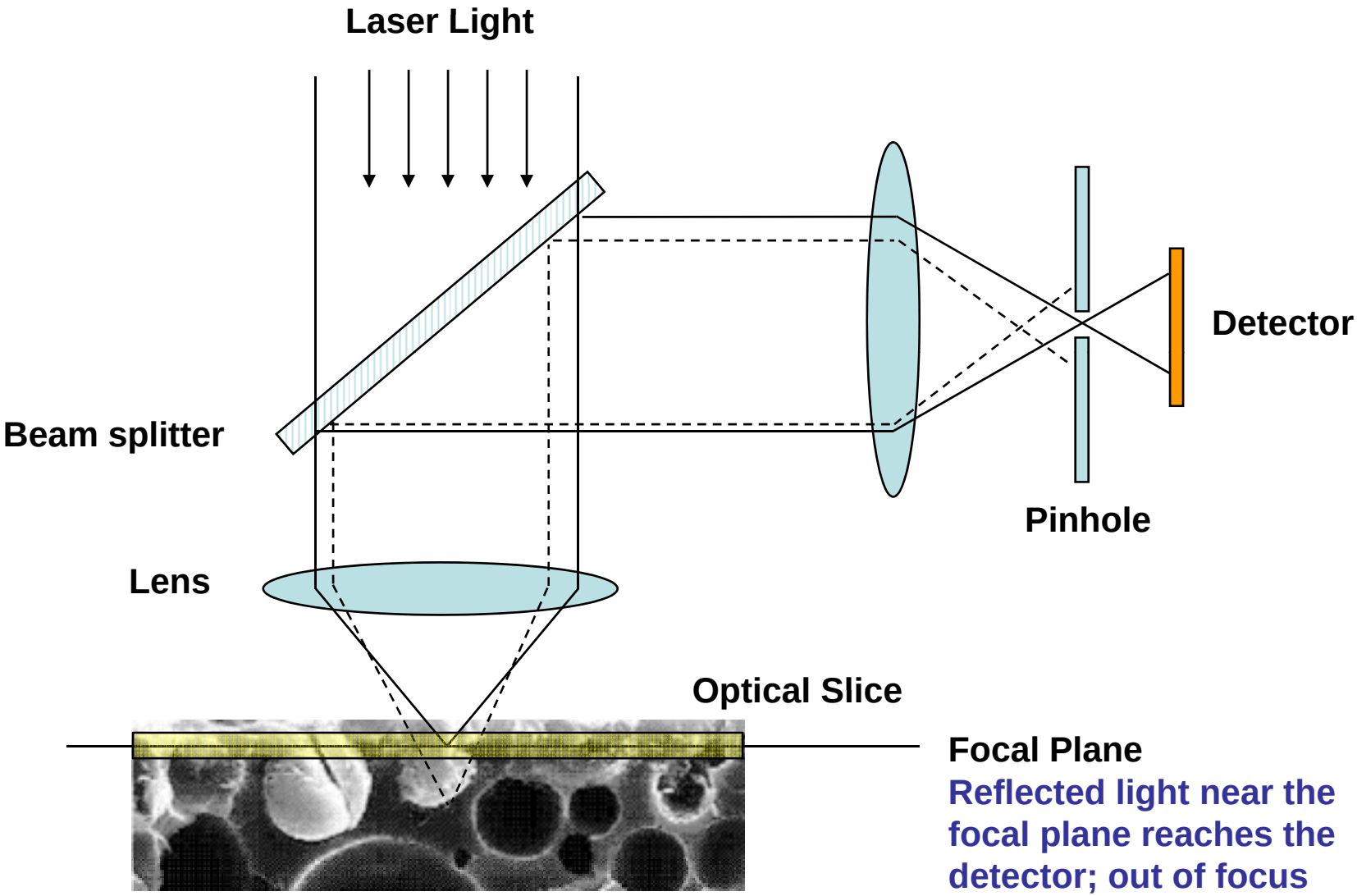
After

CMP Pad Characterization

Laser Confocal Microscopy

Zeiss LSM 510 Meta NLO

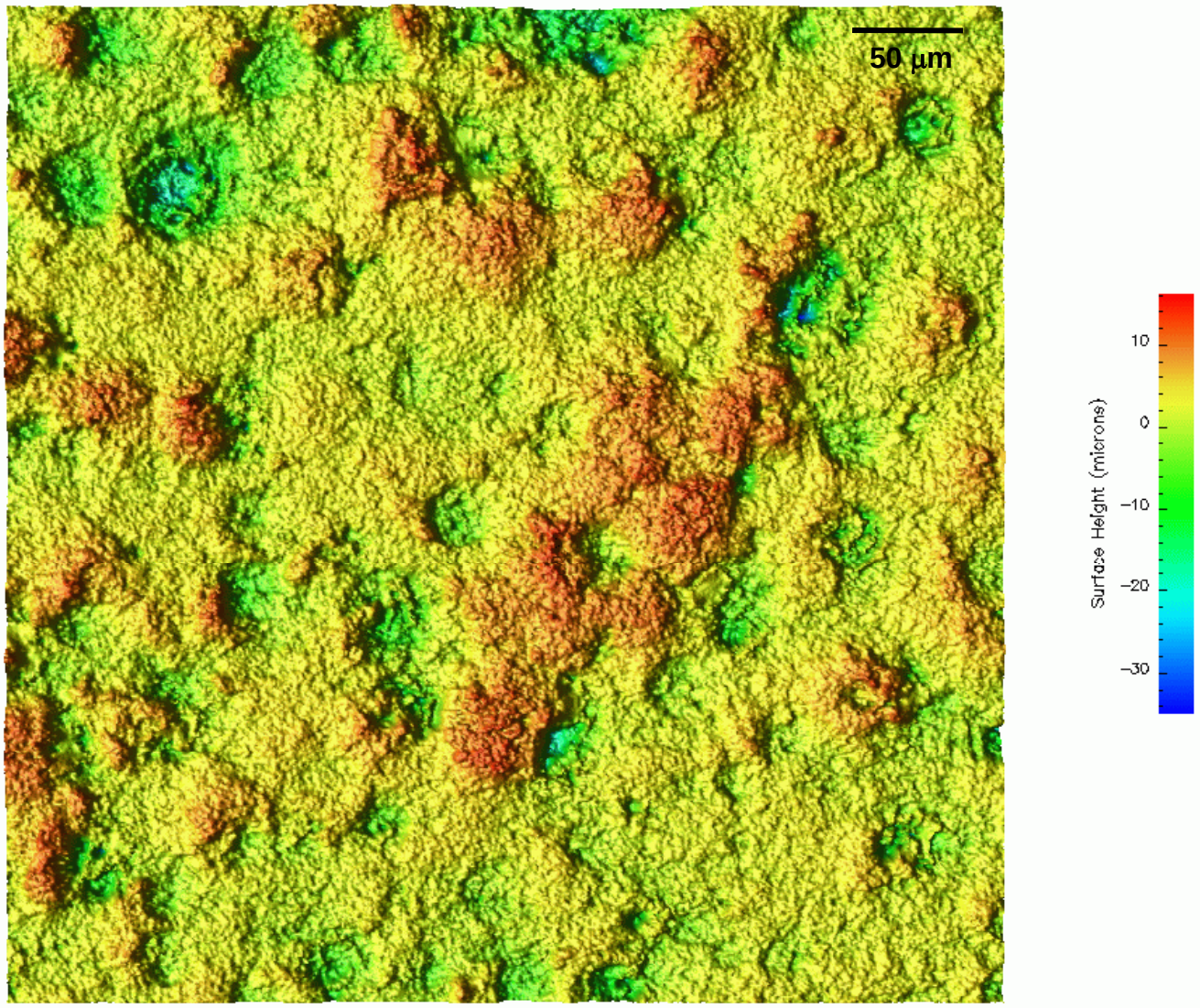
How a Laser Confocal Microscope Works



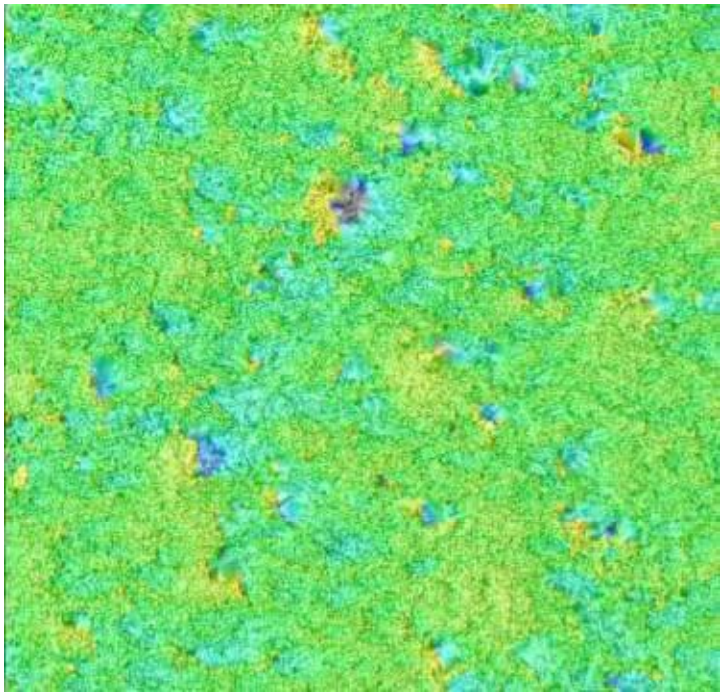
Topography with Confocal Microscopy

Pad Sample
IC-1000

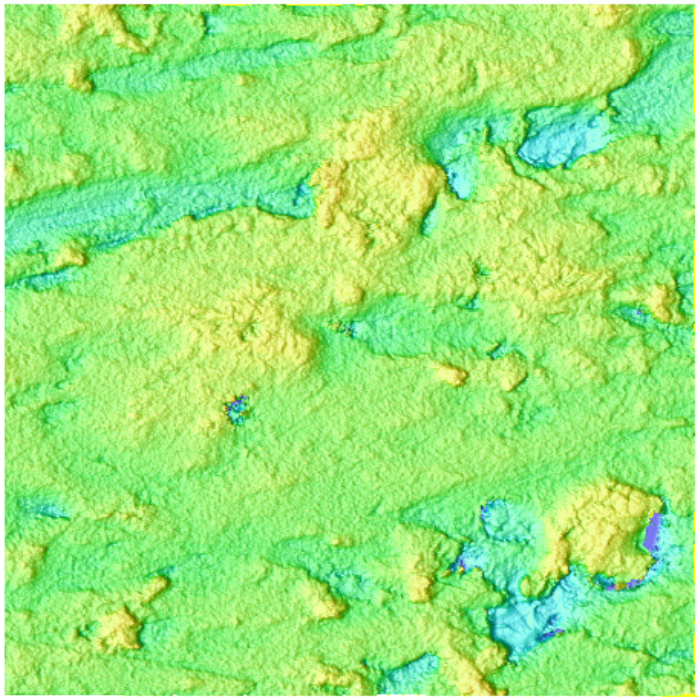
Imaging Conditions
20x objective
488 nm laser
450 gain
27 pinhole
512 x 512 resolution
450 x 450 μm image



Interferometry vs Confocal Microscopy



White Light Interferometry
~10-50% valid data

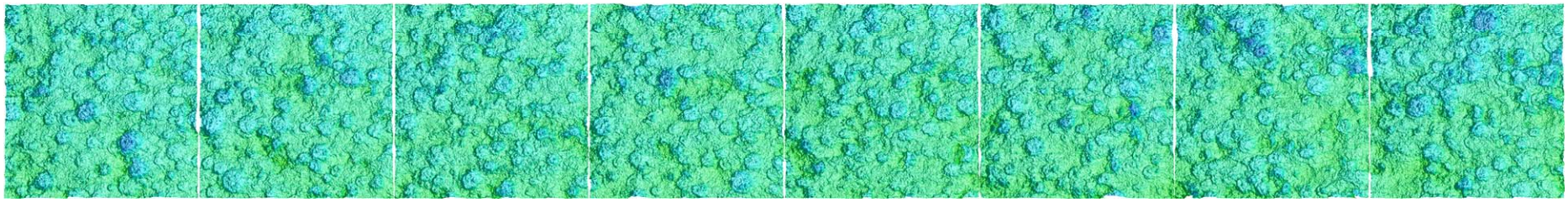


Confocal Microscopy
100% valid data

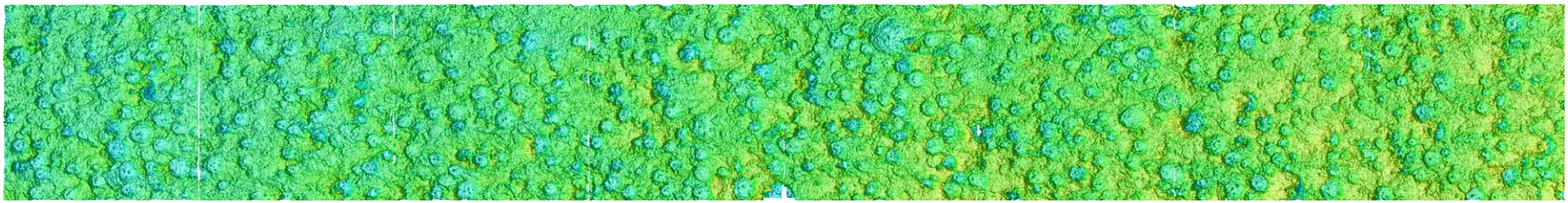
Raw Laser Confocal Topography Images

0.449 x 3.593 mm

IC
Less Aggressive Conditioner

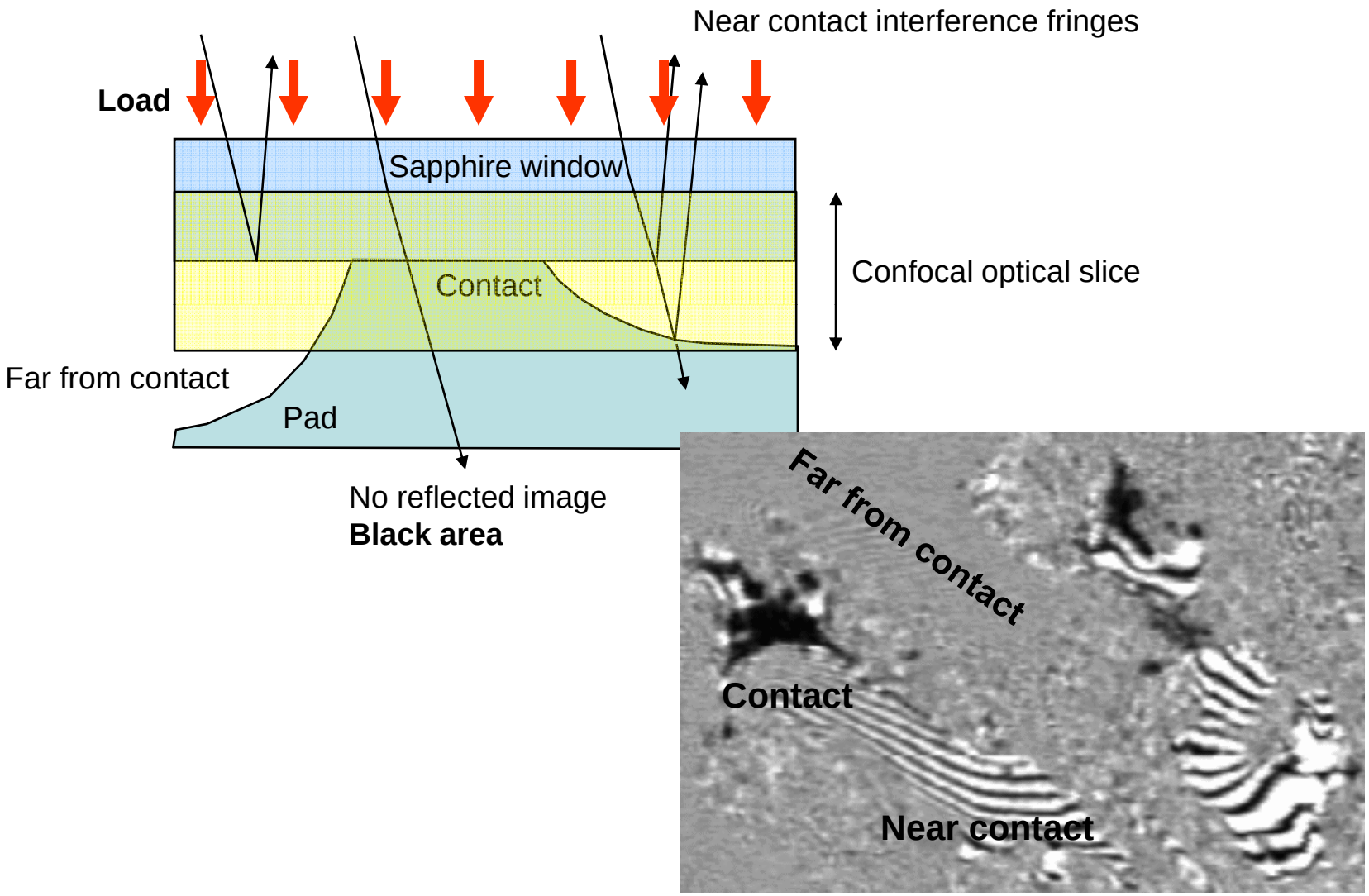


IC
More Aggressive Conditioner



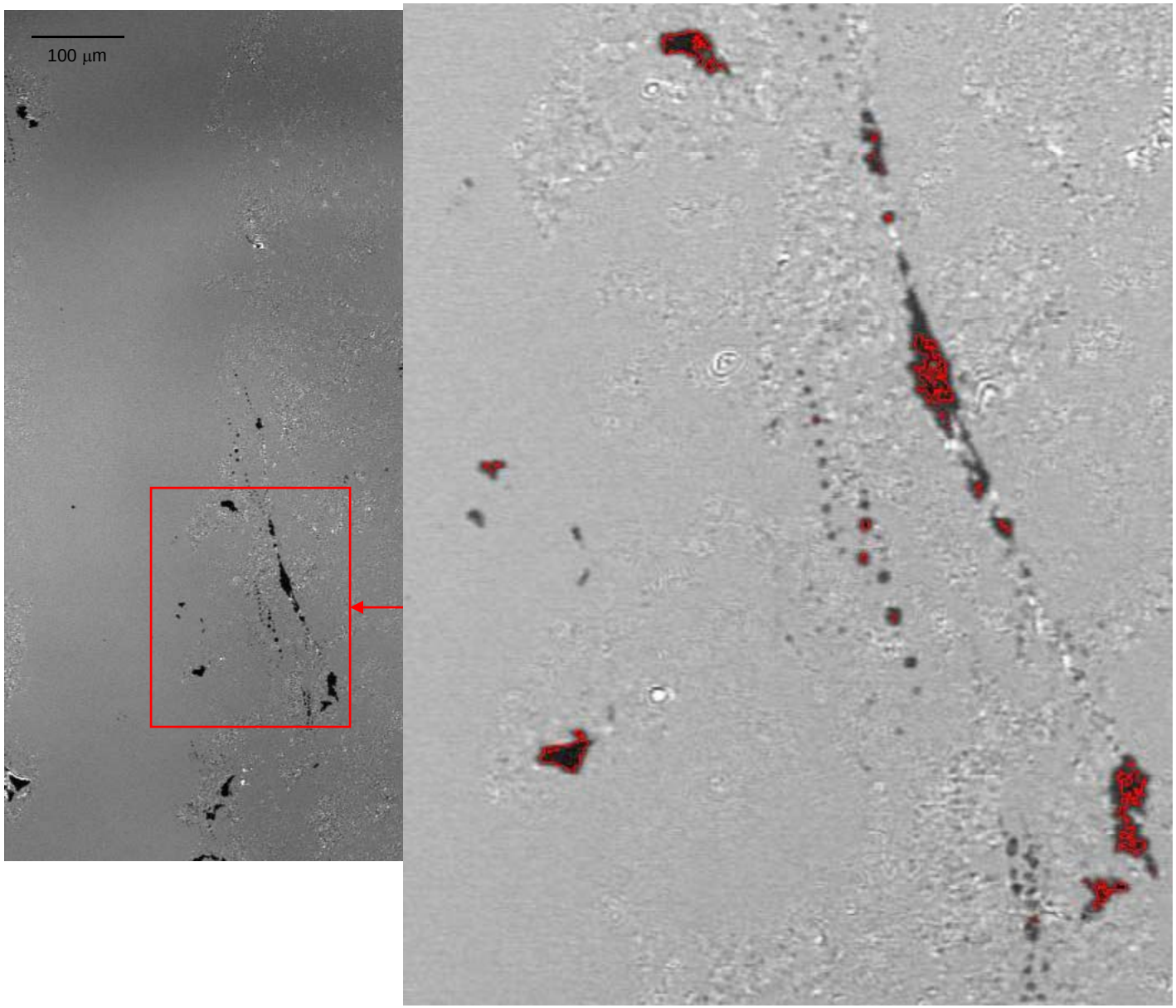
Direction of Pad Rotation

Confocal Contact Area Measurements

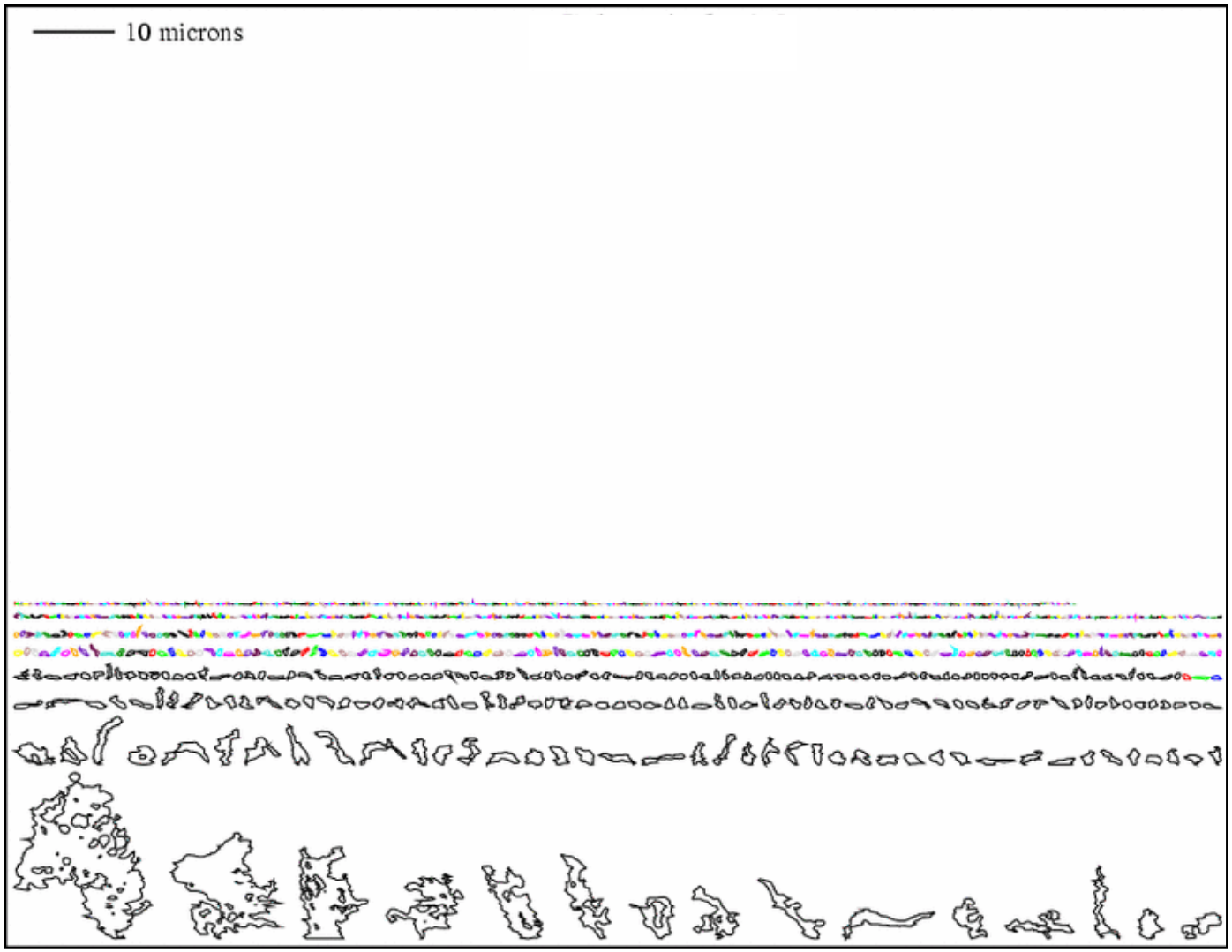


Confocal Contact Area Images

IC Pad, Less Aggressive Conditioner

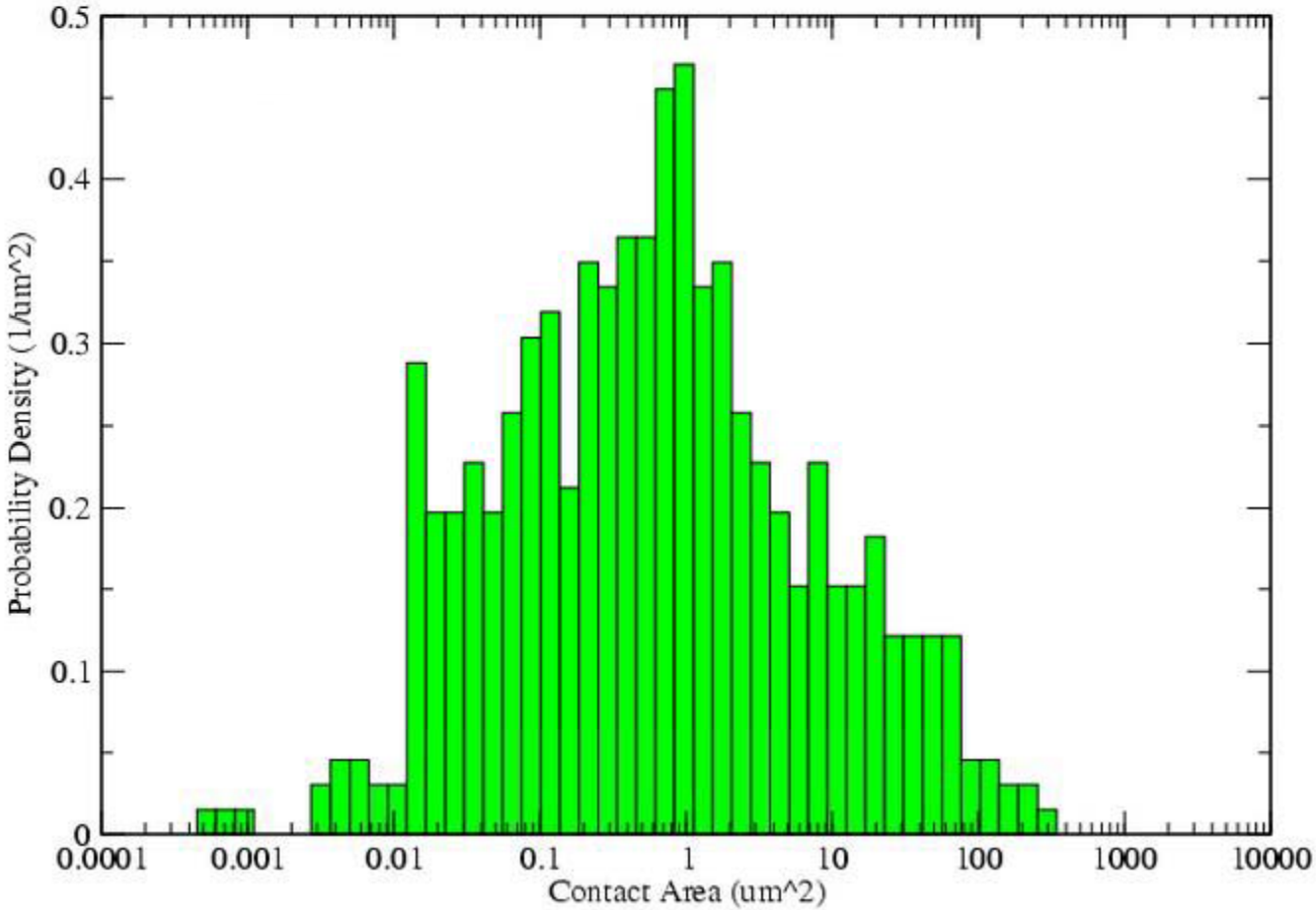


Contact Area Shapes



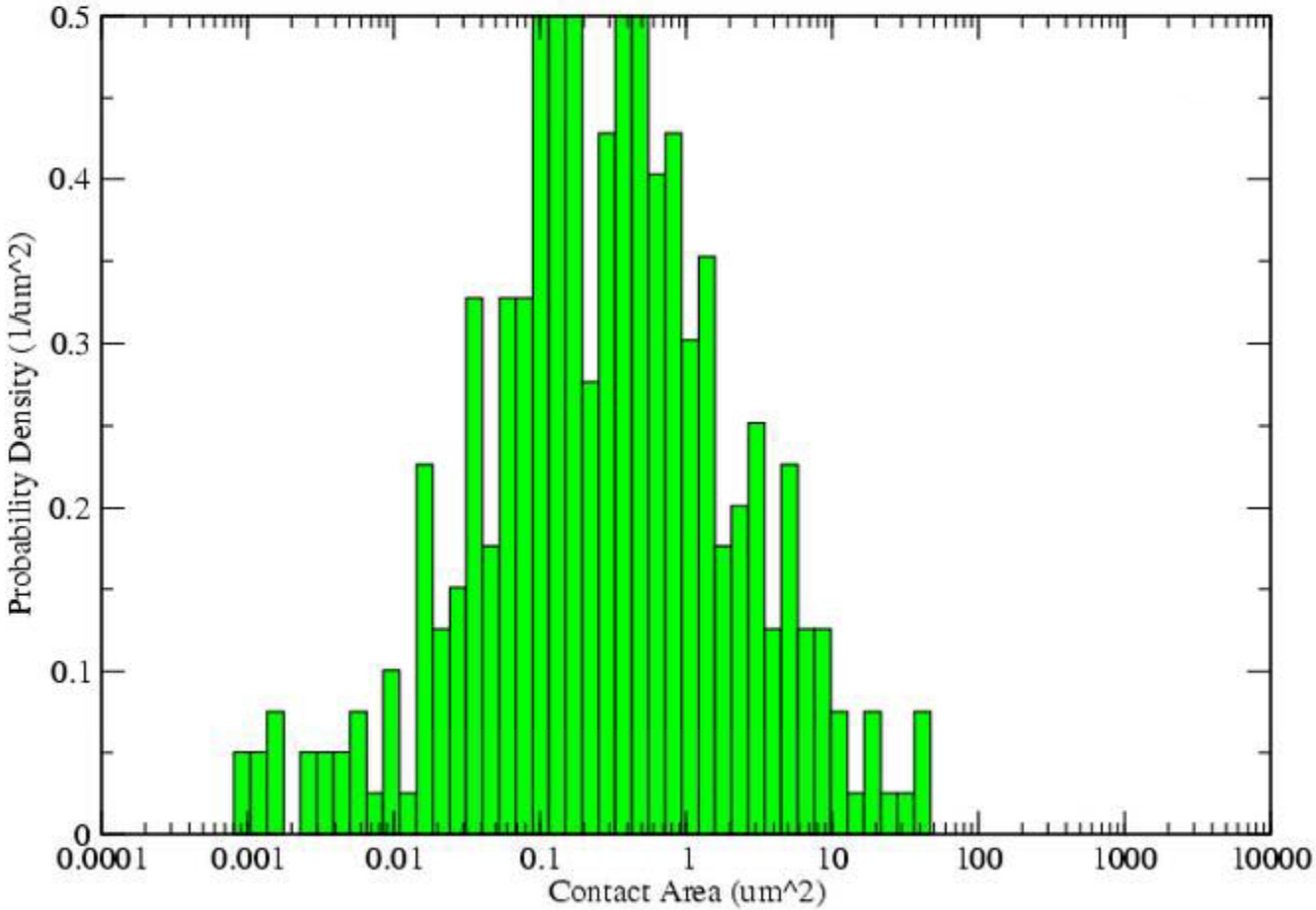
Contact Area Histogram

IC, Less Aggressive Conditioner



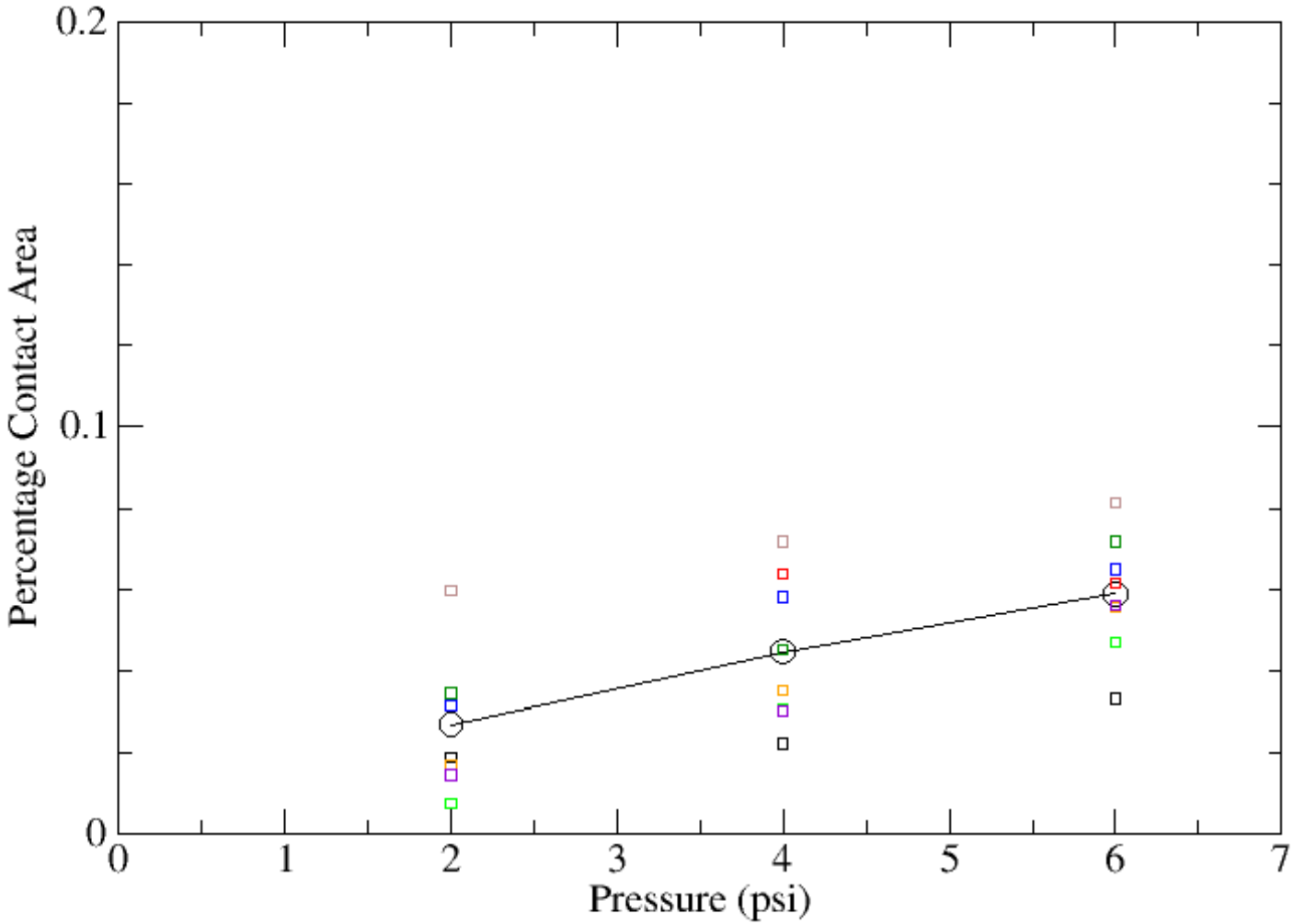
Contact Area Histogram

IC, More Aggressive Conditioner



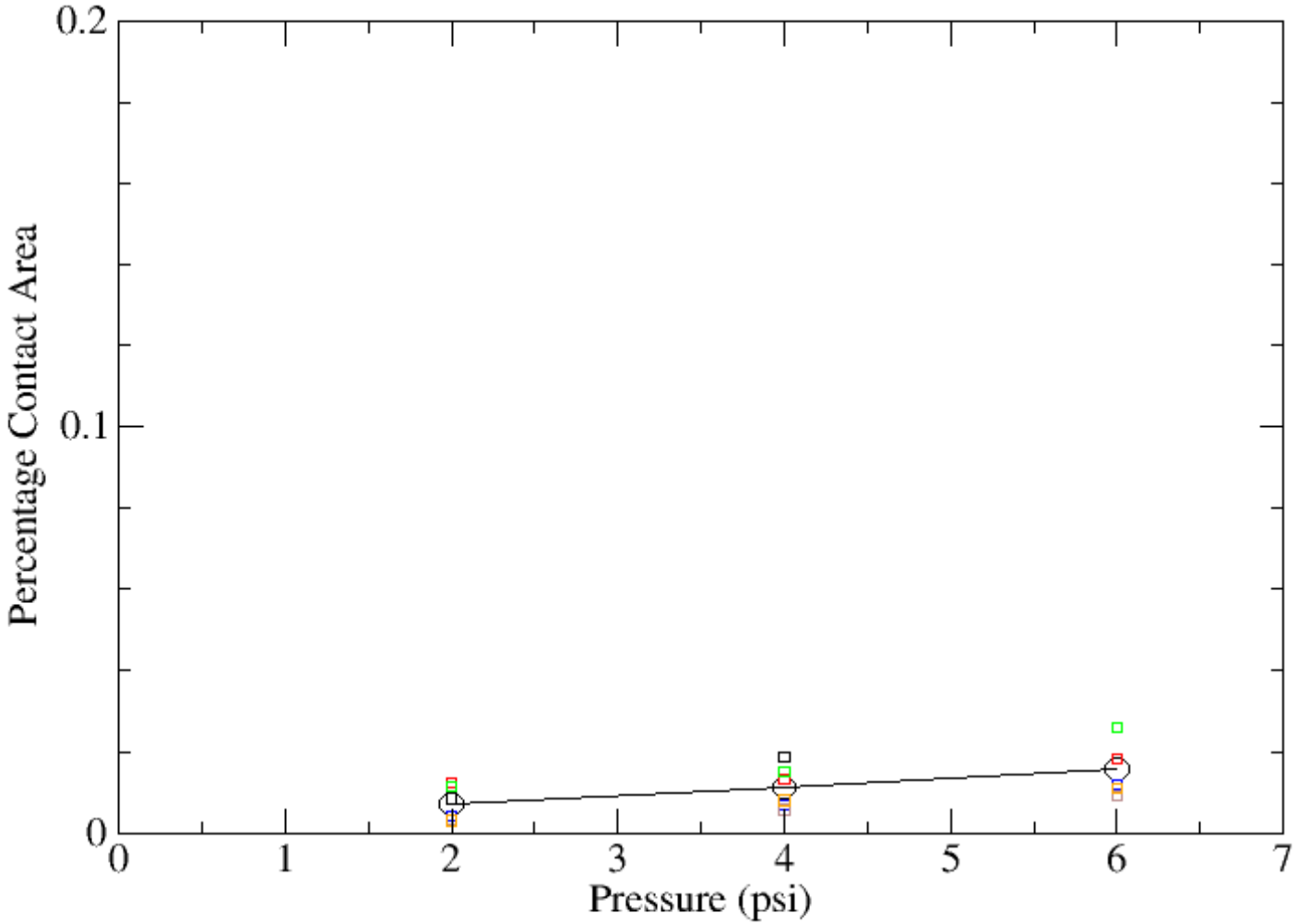
Contact Area Fraction vs. Pressure

IC, Less Aggressive Conditioner



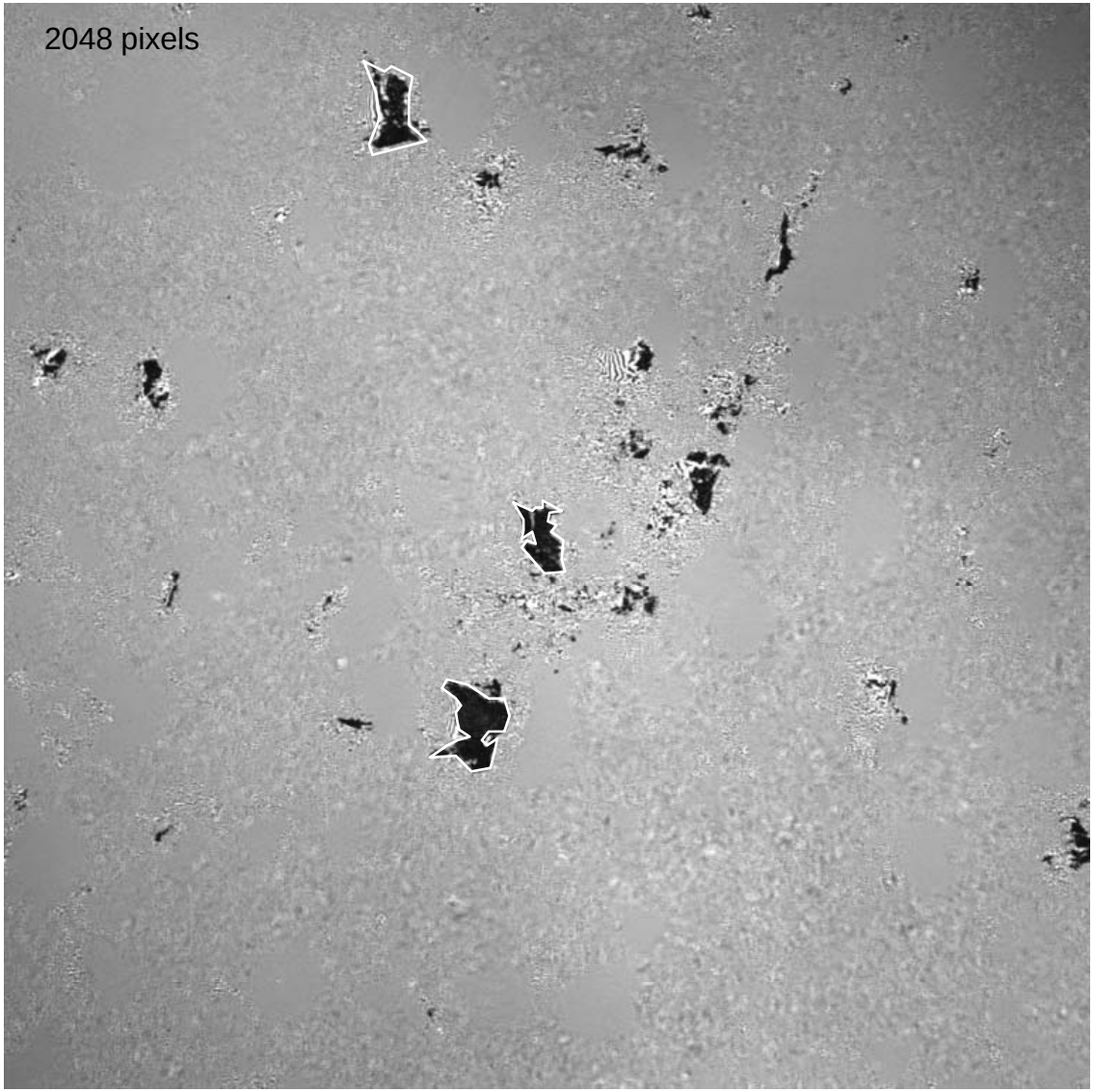
Contact Area Fraction vs. Pressure

IC, More Aggressive Conditioner

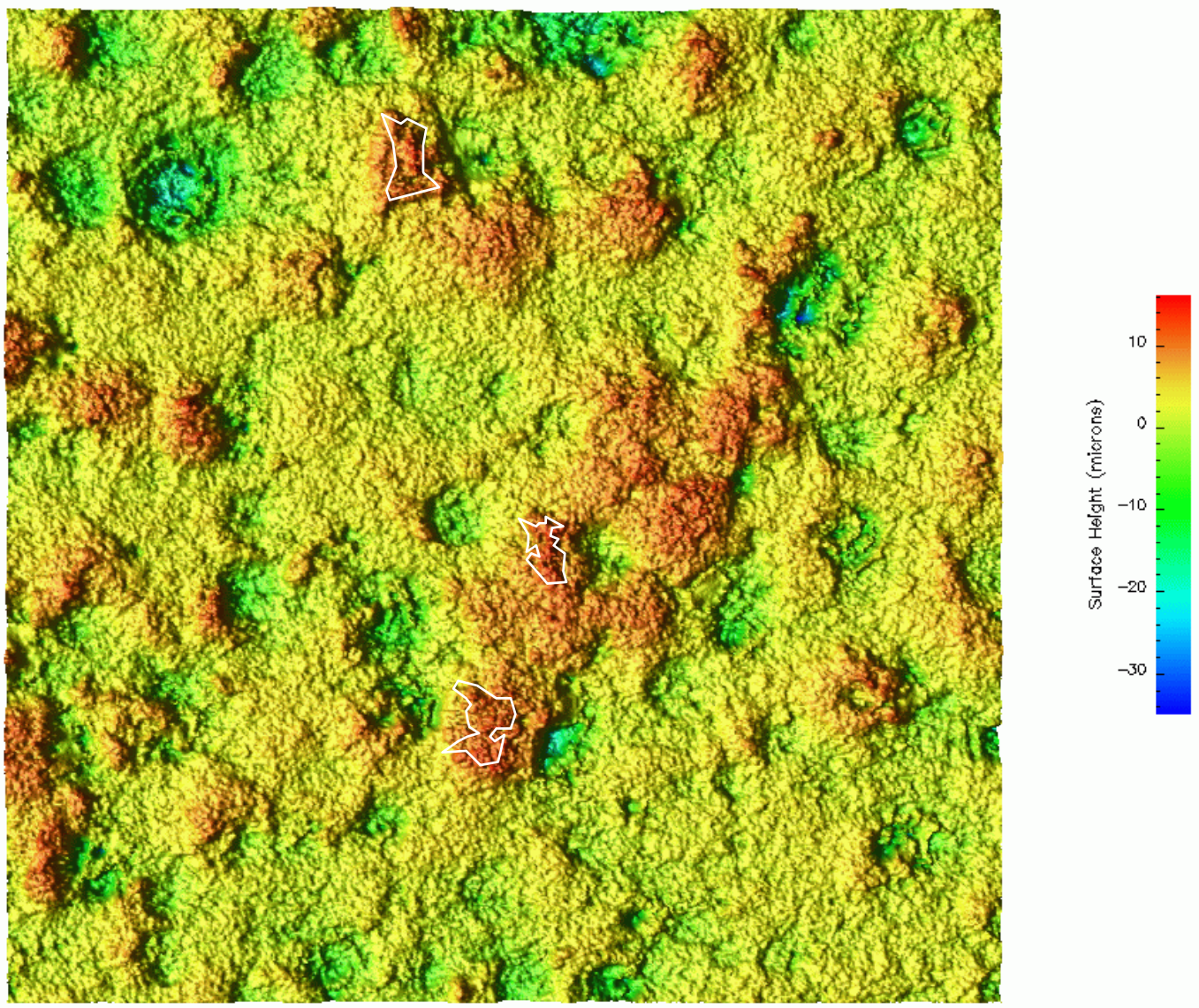


Topography-Contact Area Matching

50 μm

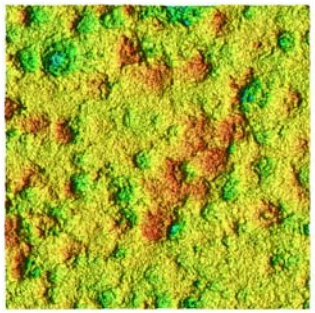


Topography-Contact Area Matching

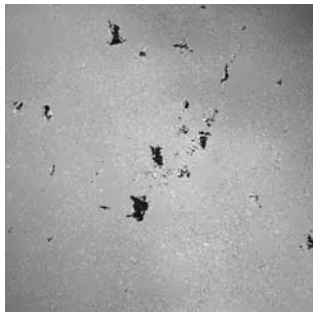


Pad Surface Properties

Pad Topography



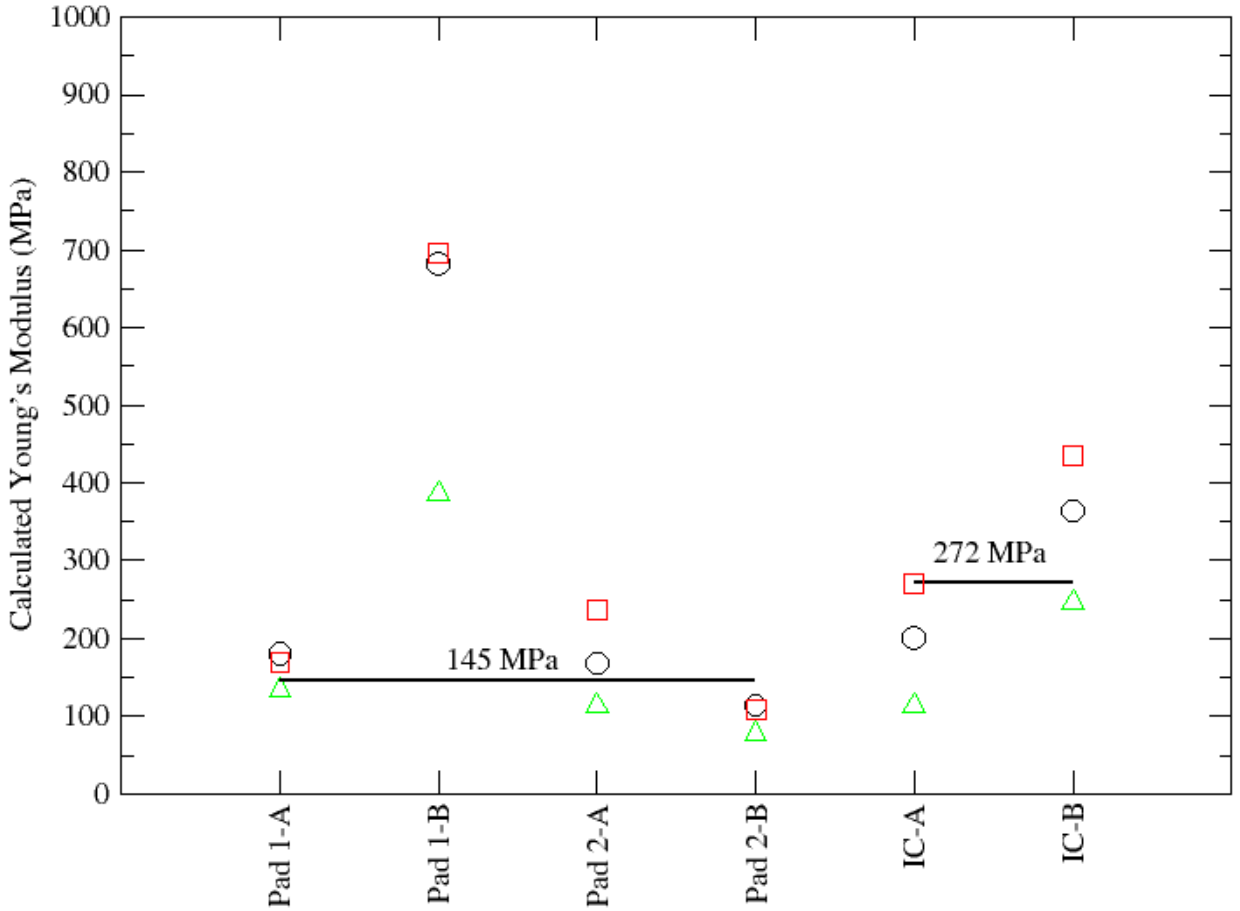
Contact Area



Materials Model

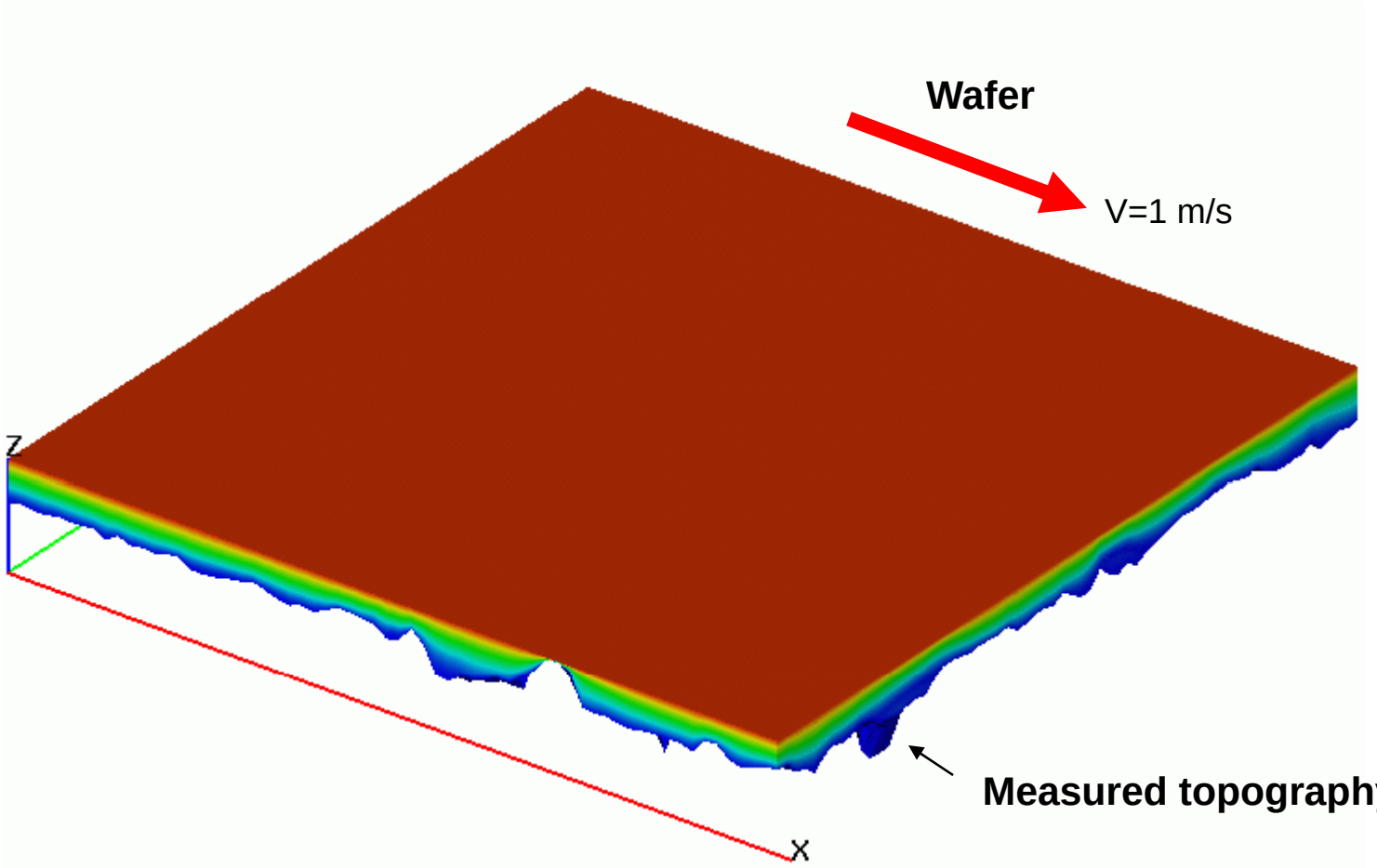
$$\frac{\partial \sigma_{ij}}{\partial x_j} = 0$$

$$\sigma_{ij} = \lambda \varepsilon_{kk} \delta_{ij} + 2\mu \varepsilon_{ij}$$



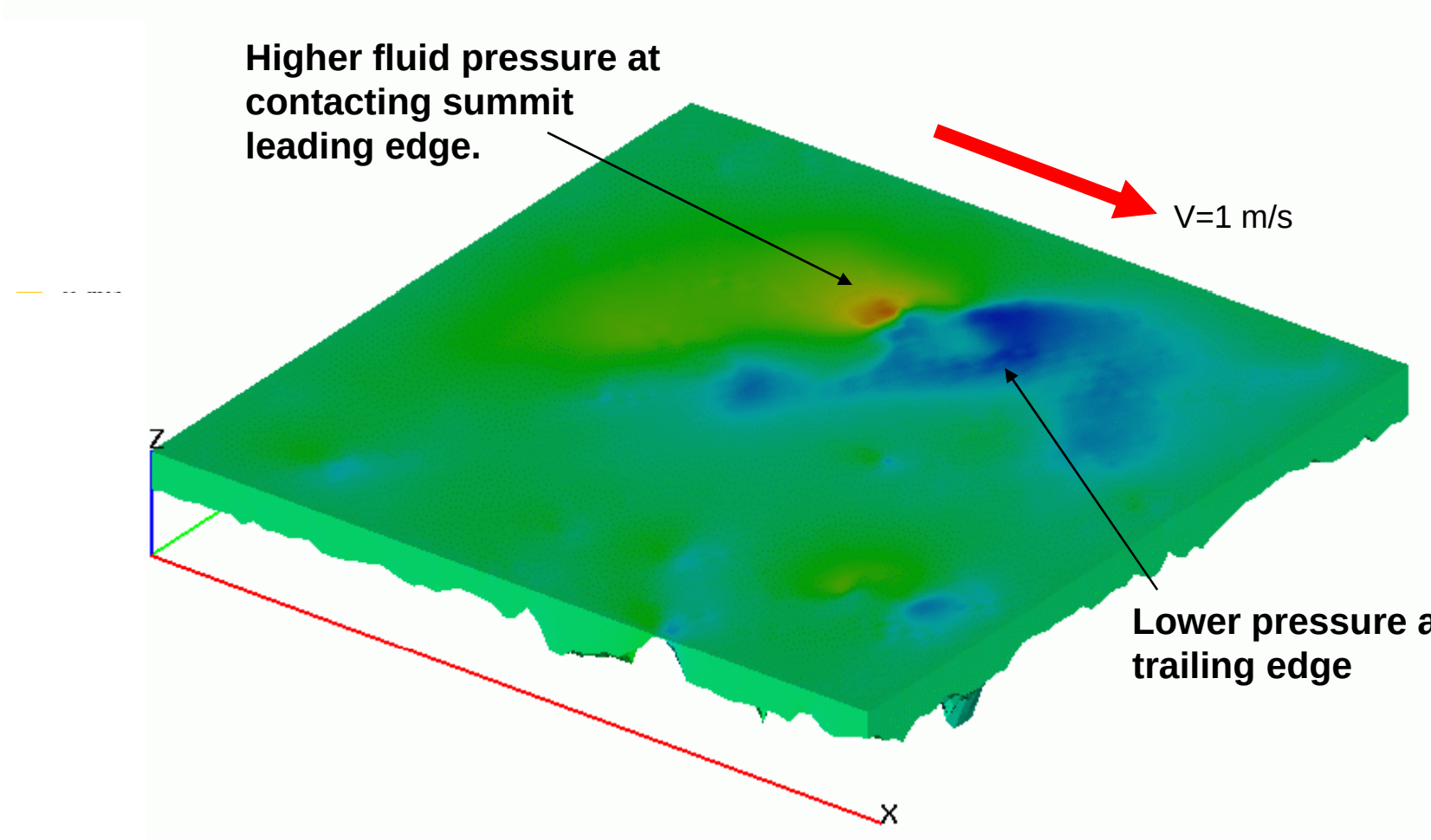
Navier-Stokes Solution for Flow over Topography

Velocity magnitude, slurry flow over measured pad topography



Navier-Stokes Solution for Flow over Topography

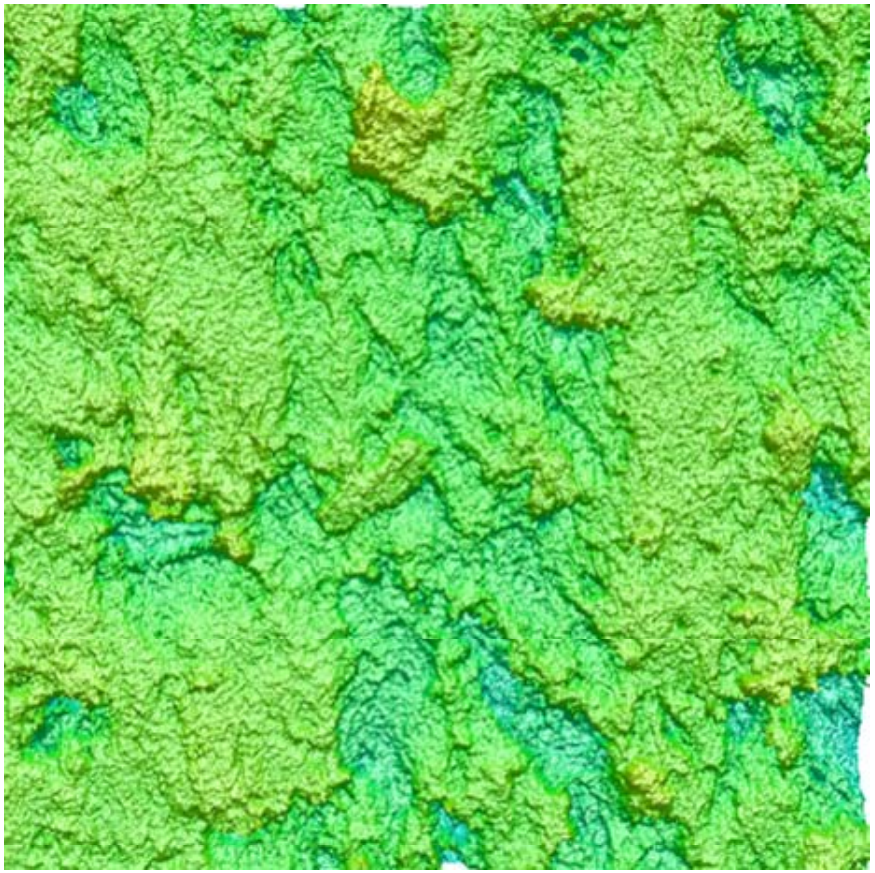
Fluid Pressure



Localized fluid pressures induced by topography may influence the rate

Example Contact and Fluid Dynamics Analysis

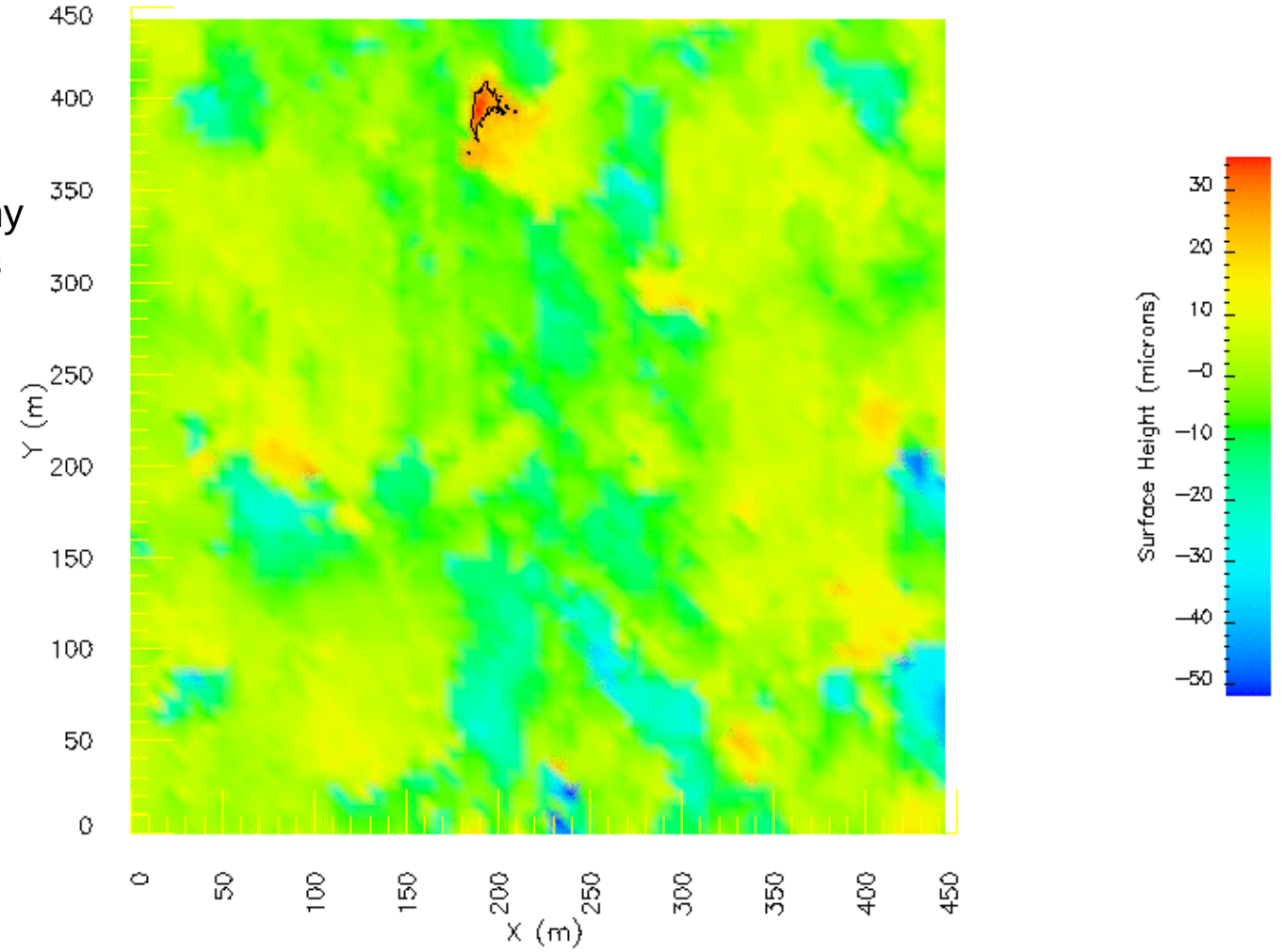
Measured
Topography



Example Contact and Fluid Dynamics Analysis

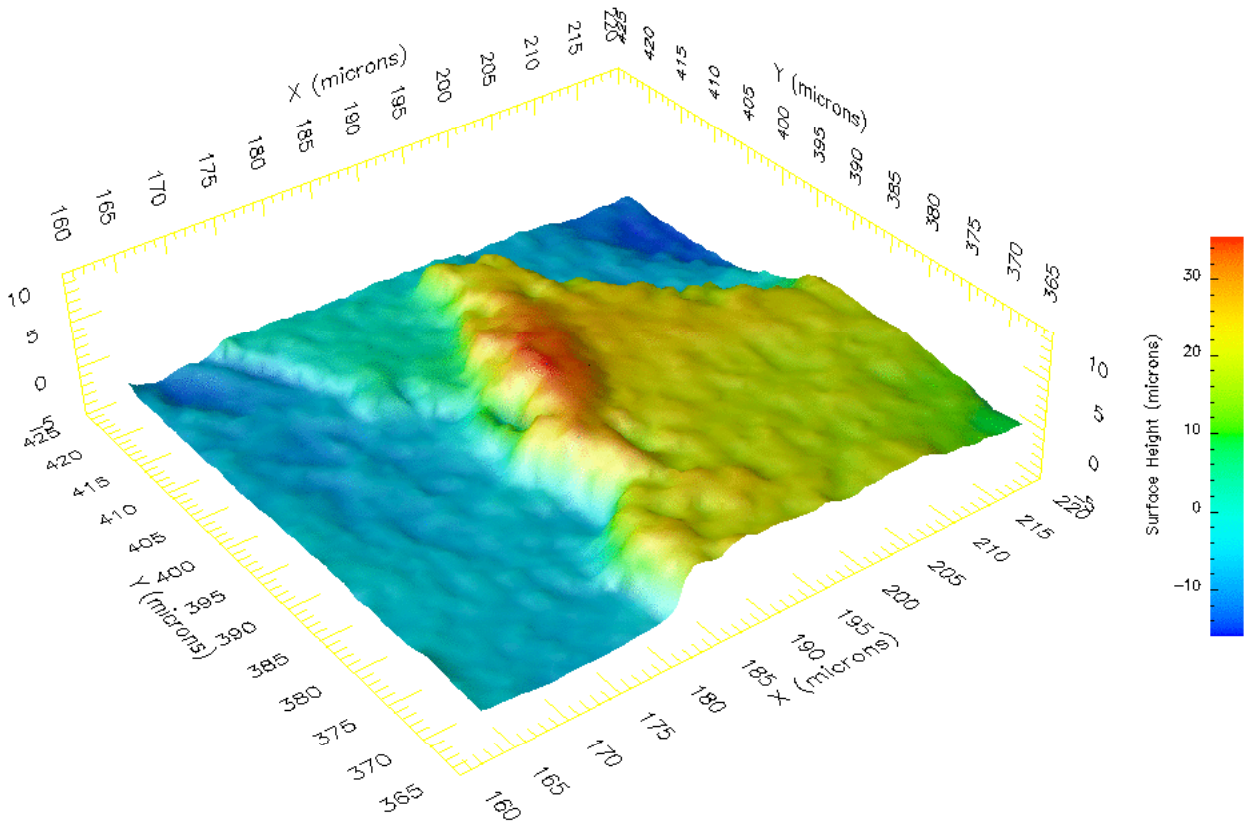
Contacting Summit.

The topography is the same as the previous slide except it is depicted using a color contour map rather than a relief map.



Example Contact and Fluid Dynamics Analysis

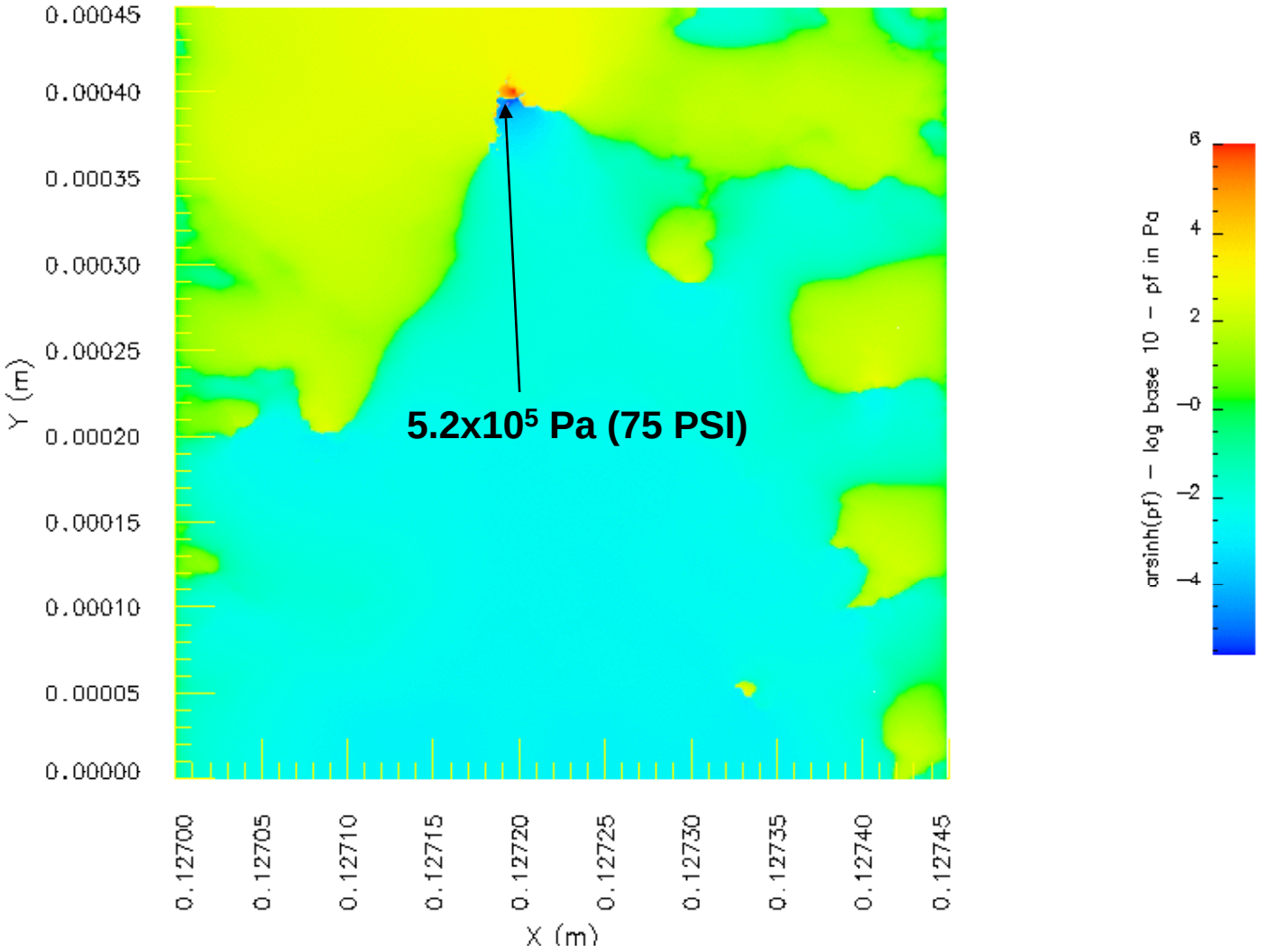
Close-up of Region in Contact



Example Contact and Fluid Dynamics Analysis

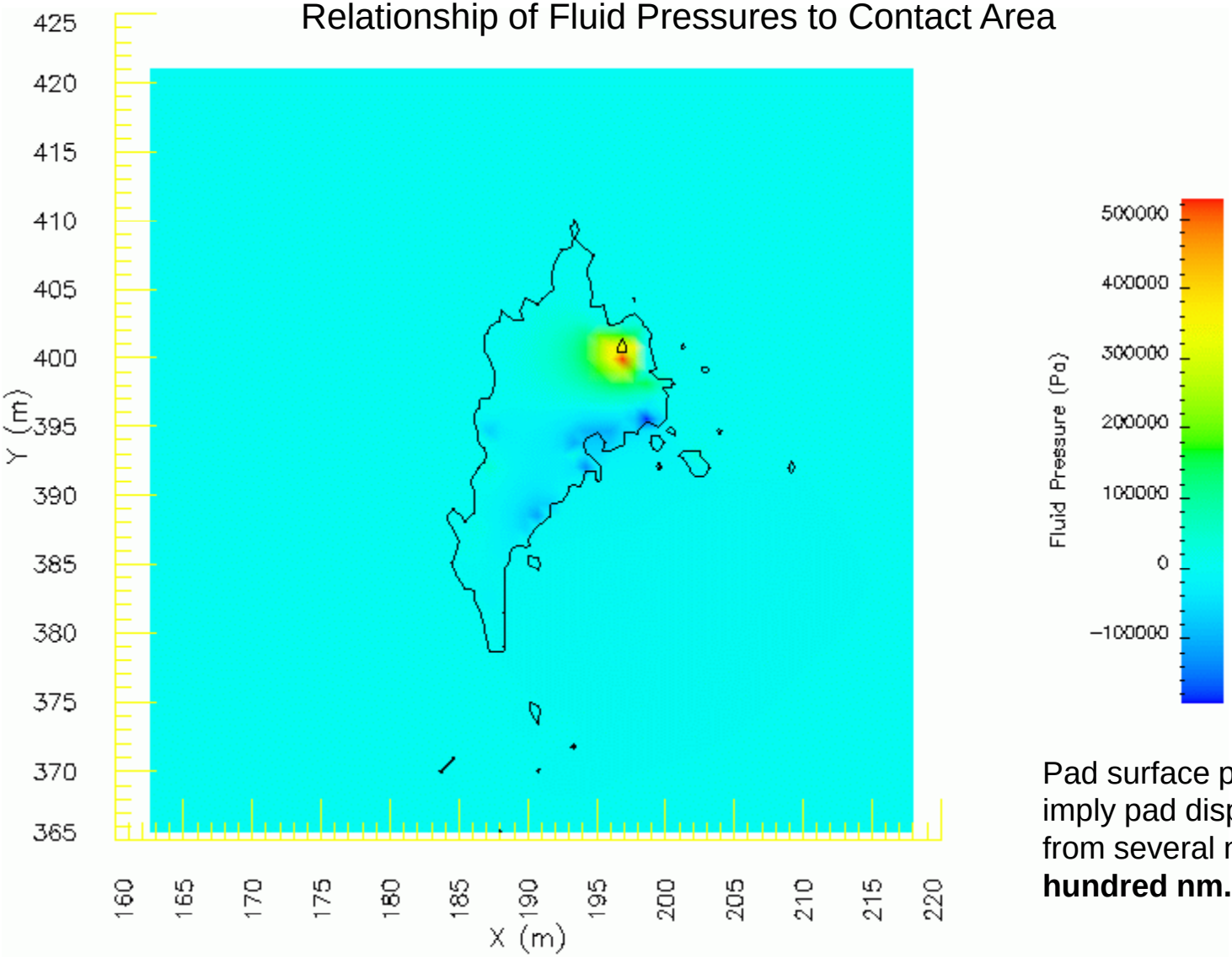
Fluid Pressure Field (log scale)

Reynolds Equation



Example Contact and Fluid Dynamics Analysis

Relationship of Fluid Pressures to Contact Area



Pad surface properties imply pad displacements from several nm to **several hundred nm.**