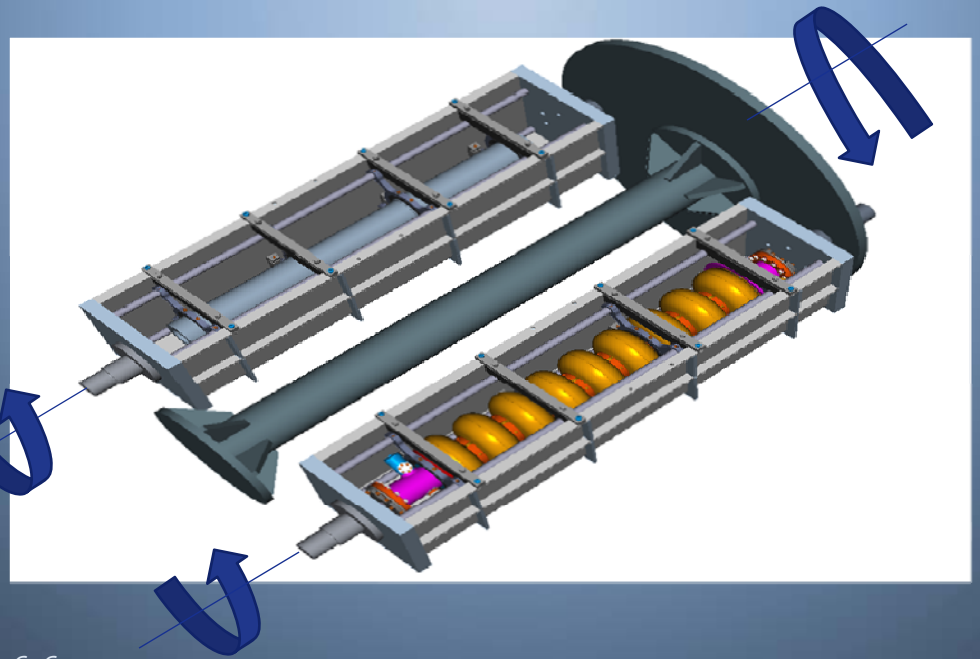
What is tumbling?

Tumbling is a mechanical polishing process in which the inside of the cavity is filled with abrasive material and then rotated at high speeds.

Tumbling materials include man made materials like plastics and ceramics and natural materials like corn cob or walnut shells.

Individual Barrels 115 RPM in opposite direction to main shaft



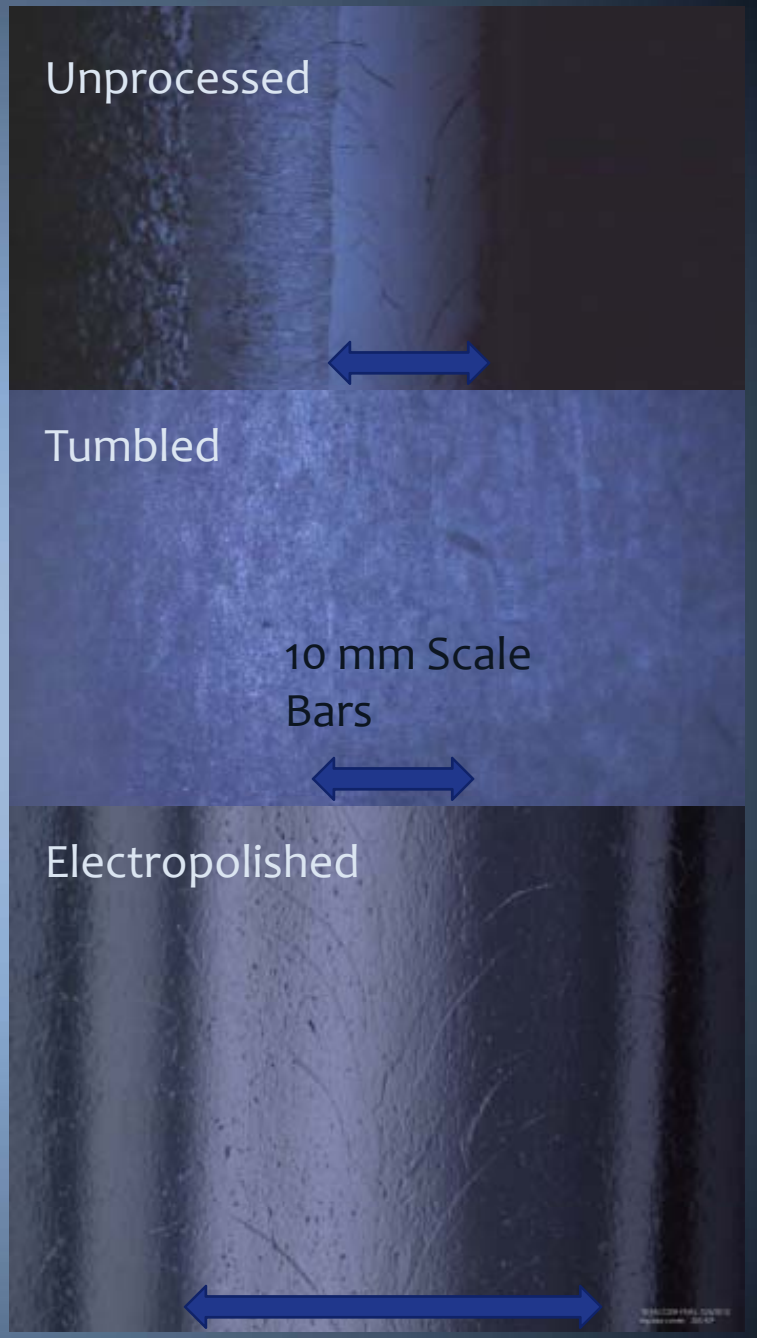
Main Shaft up to 115 RPM

Why do tumbling?

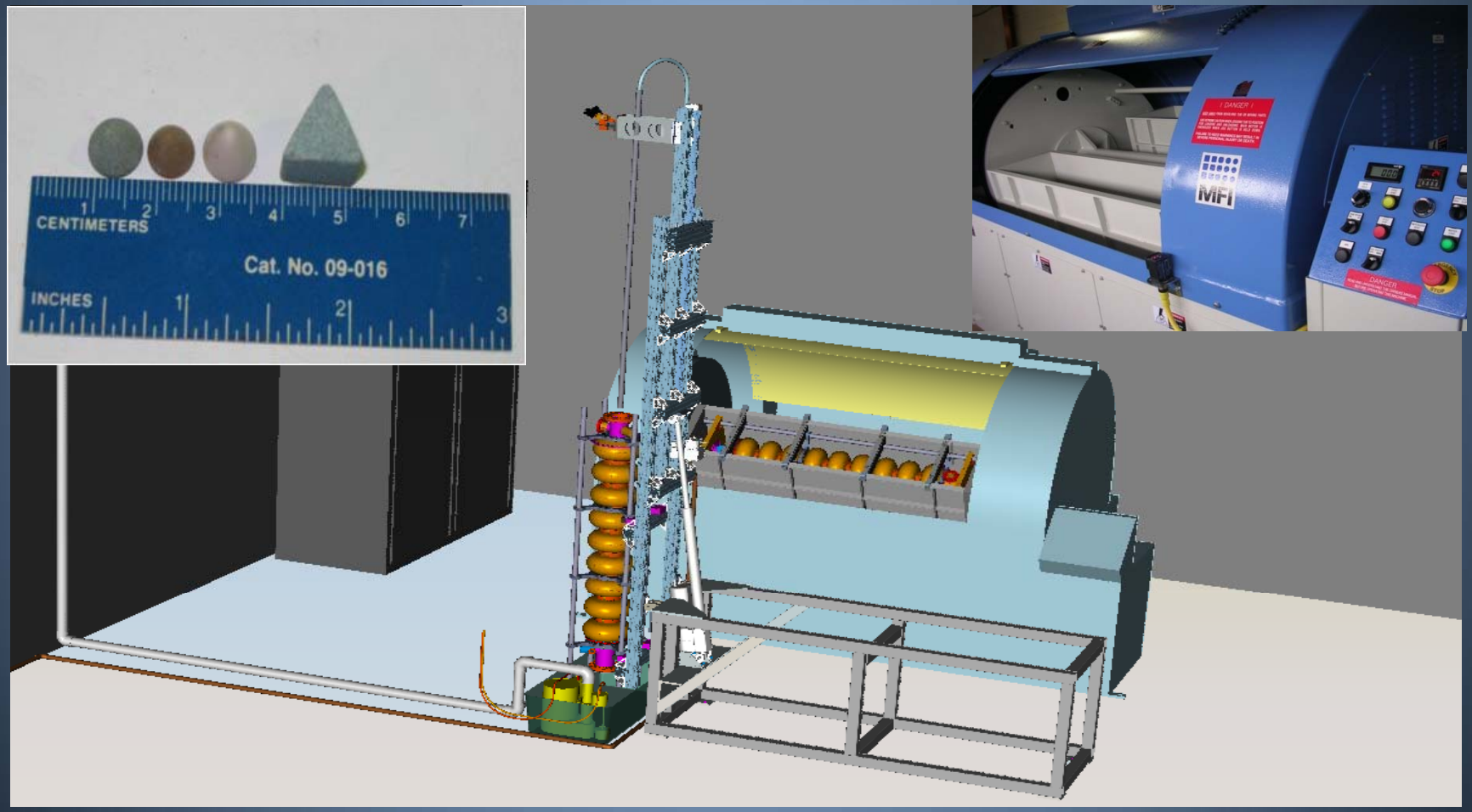
- Remove weld bead at equator cavity created from E-beam welding.
- Yields surface finishes(Ra) on the order of 10s of nanometers. Best by EP alone is 200 nanometers.
- Final finish from chemistry dependent on starting finish.
- Relatively fast process.
- Environmentally friendly.

Why not do tumbling?

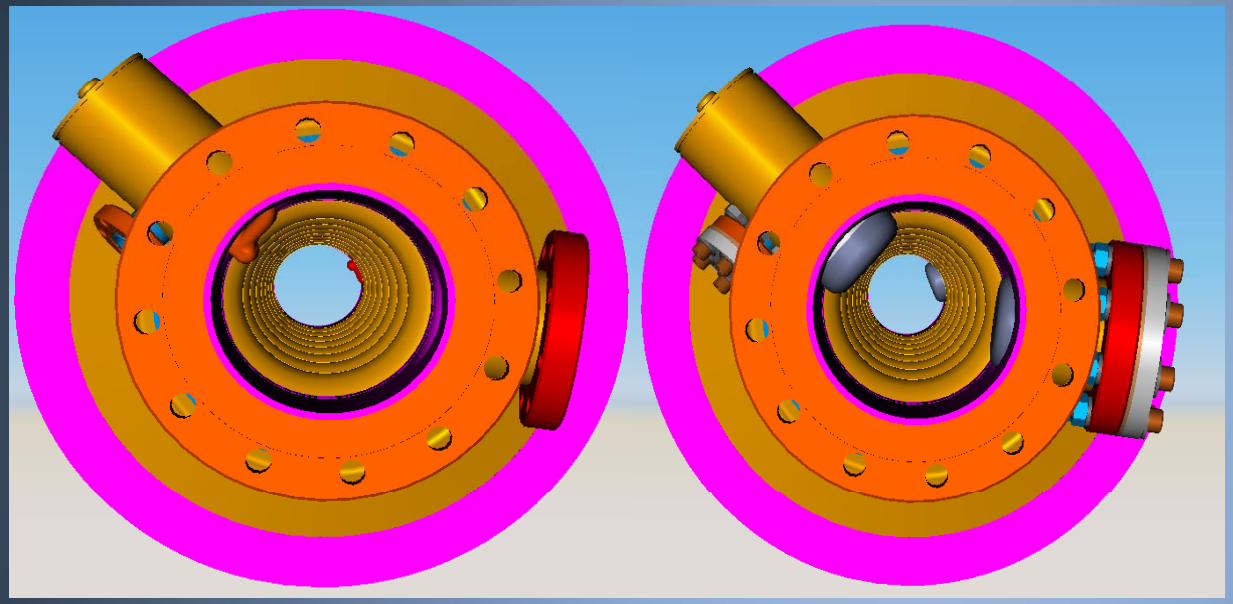
- Dirty!
- Dirty!

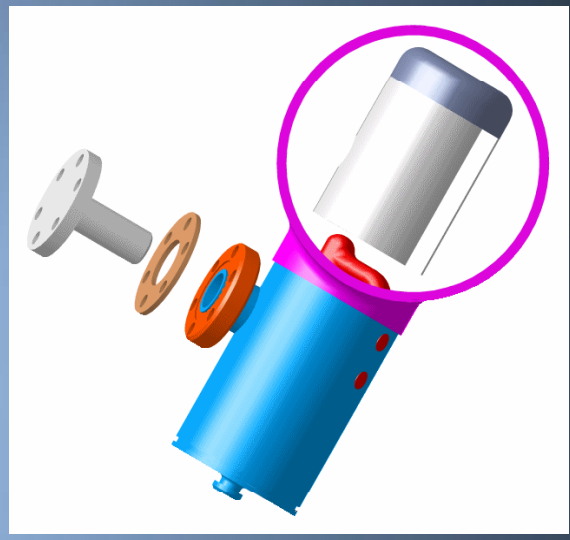


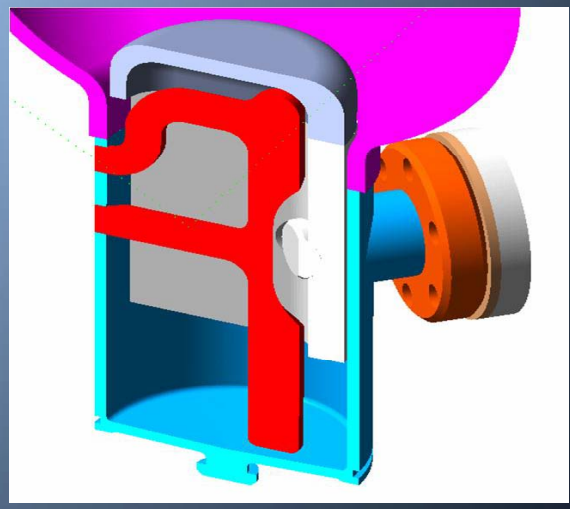
Tumbling Area



9 Cell Cavity Tumbling

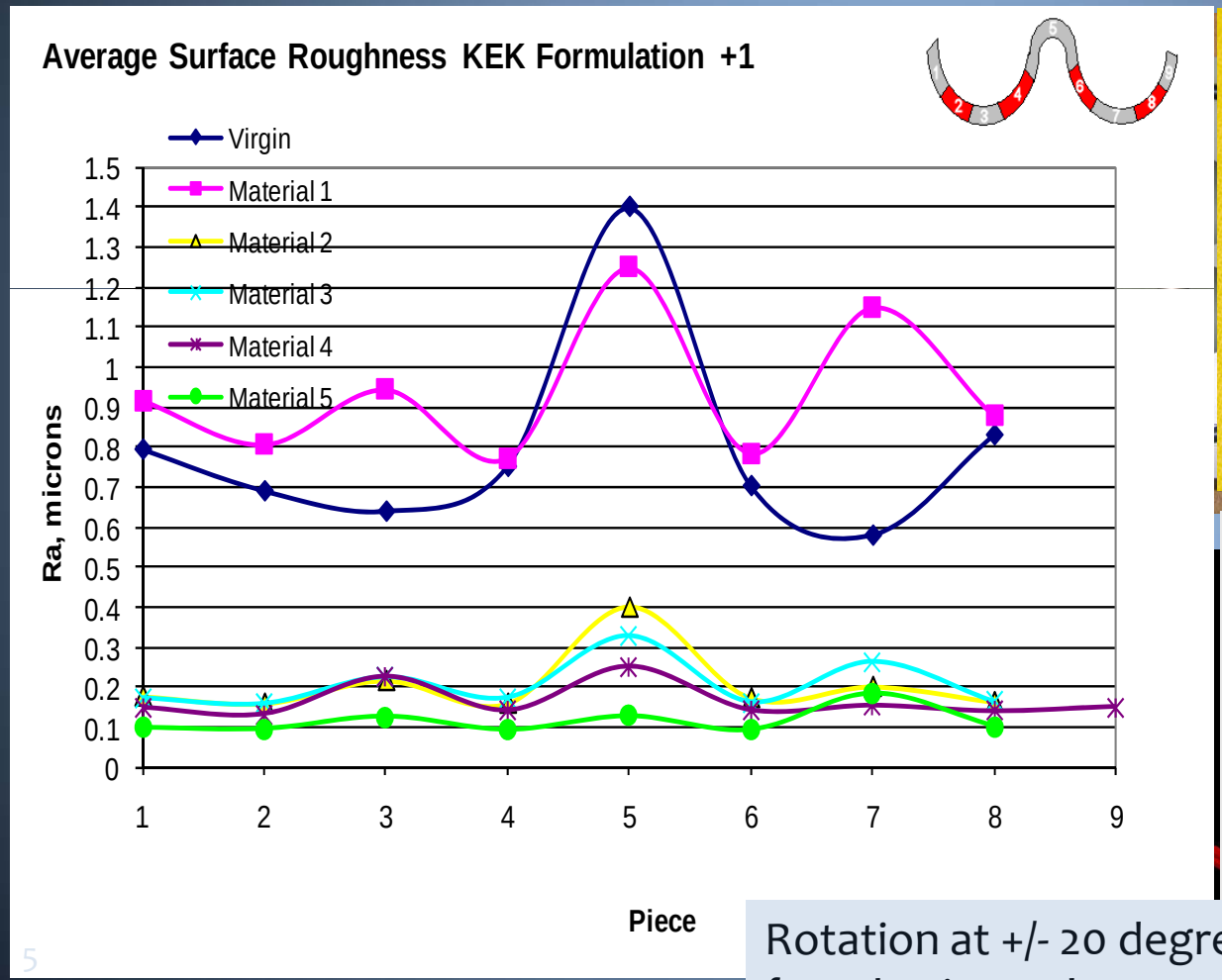


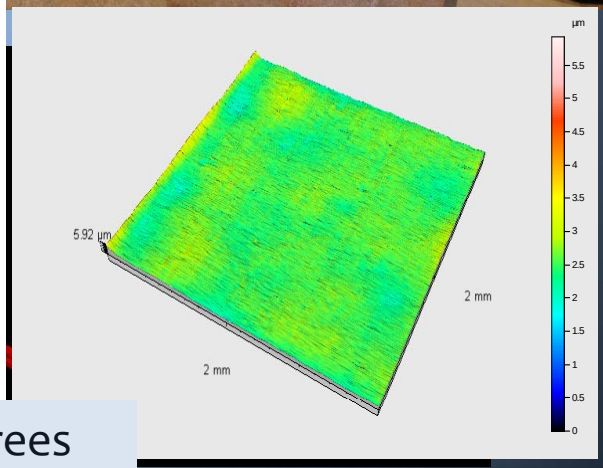




- HOM Can Must Be Protected or the Antenna Would be Destroyed.
- Caps are Made From Niobium to Avoid Contamination.

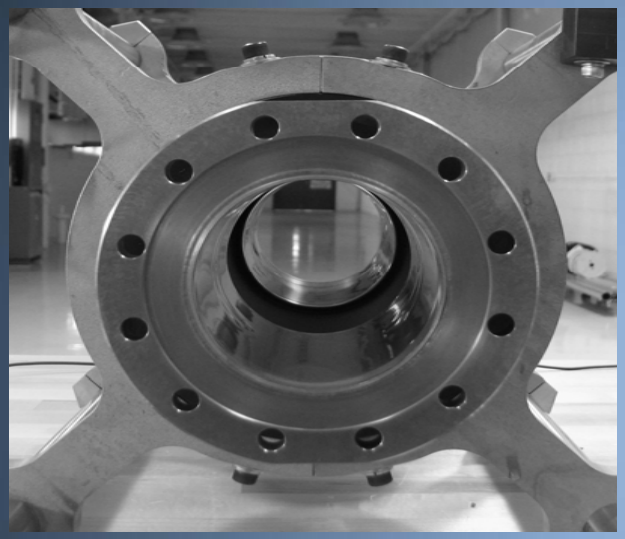
Coupon Tumbling 3.9 GHz Geometry



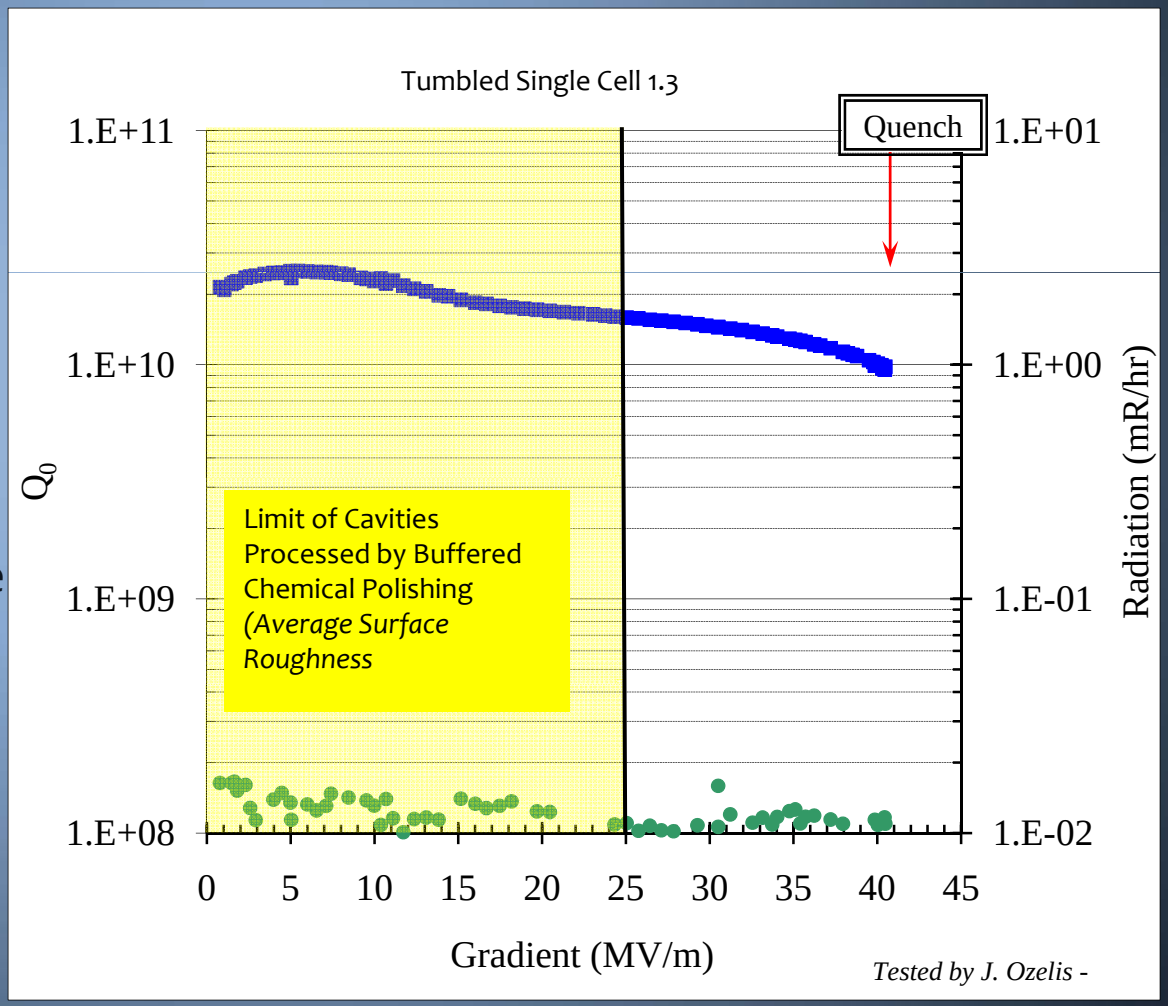


Rotation at +/- 20 degrees from horizontal

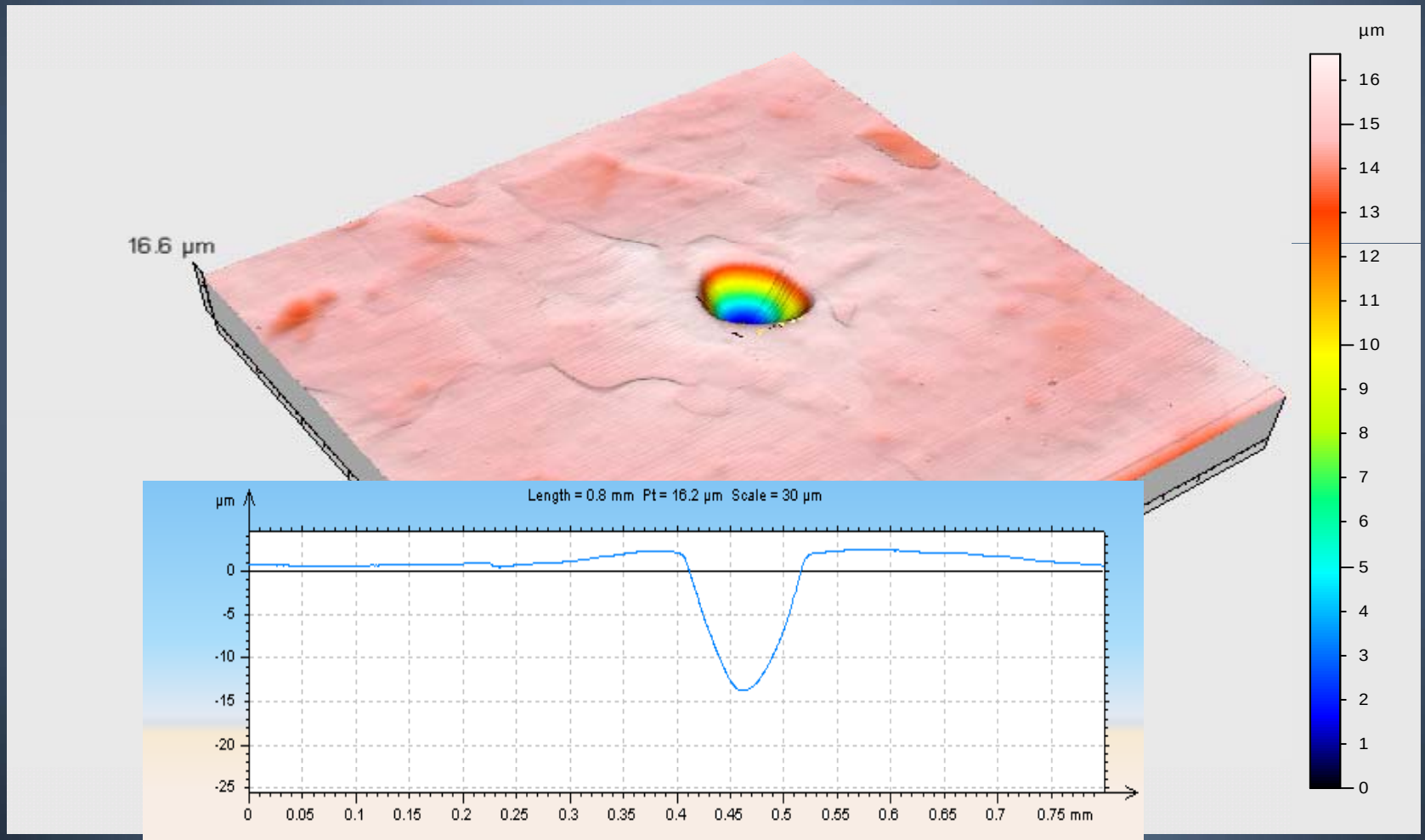
40 MV/m!



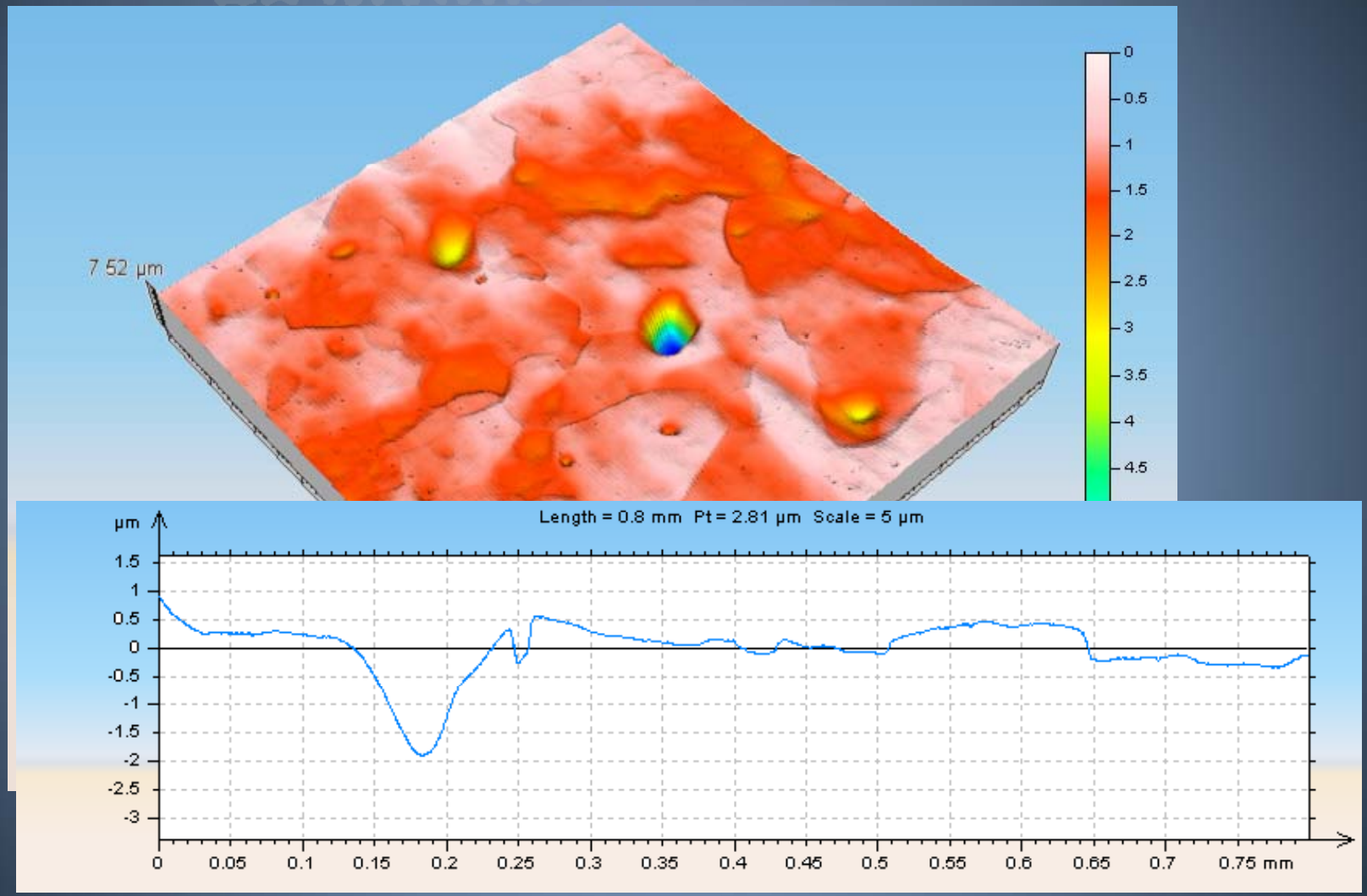
- ACCELL manufactured single cell 1.3 GHz Cavity
- 100/120 micron tumbling
- 40 micron EP at Argonne
- 3 hour 800 C bake at JLab
- 20 micron EP at Argonne
- HPR at Argonne

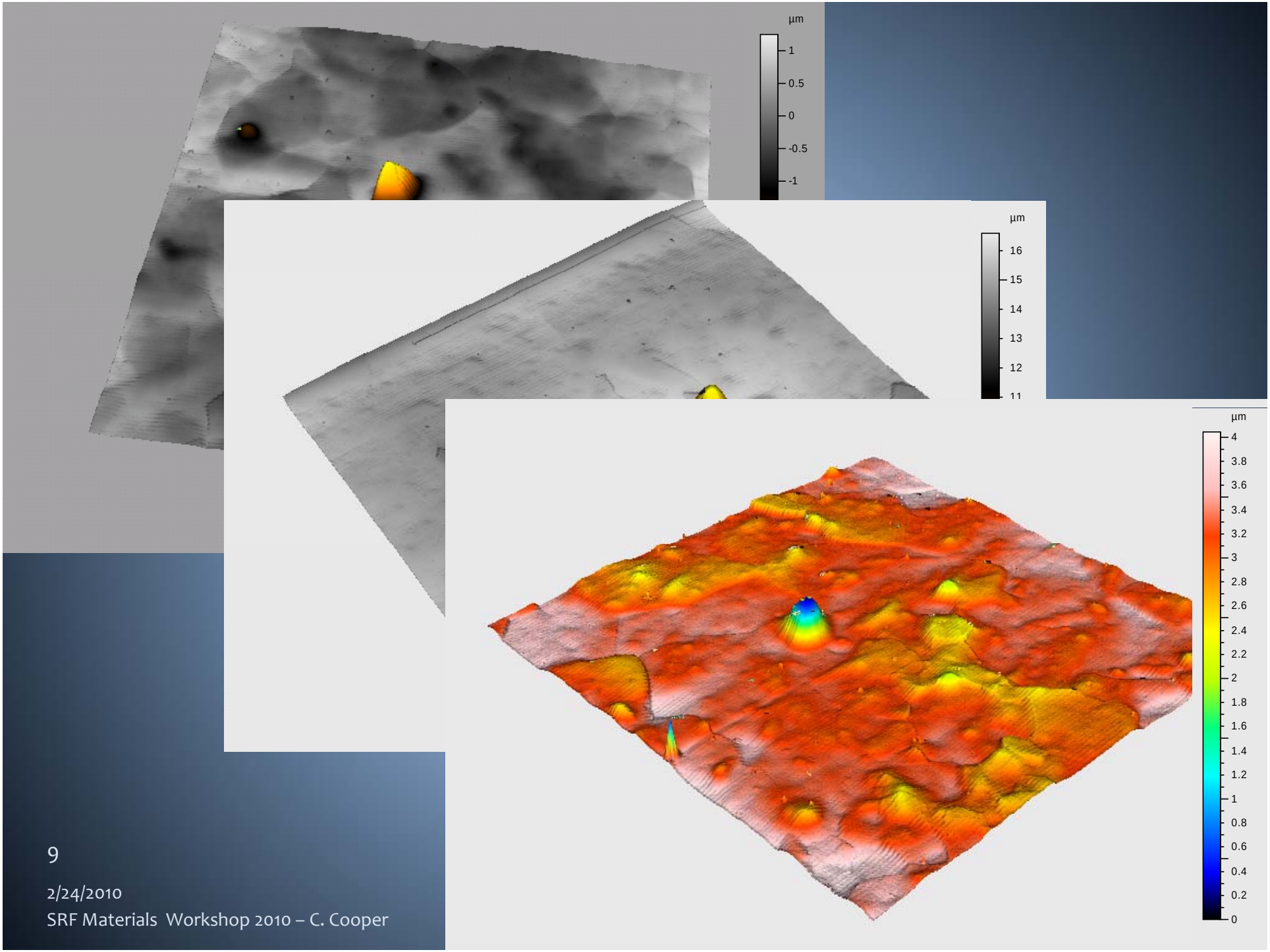


40 MV/m?


16.6 µm
µm
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Length = 0.8 mm Pt = 16.2 µm Scale = 30 µm
µm
0
-5
-10
-15
-20
-25
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 mm

40 MV/m?


7 52 µm
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Length = 0.8 mm Pt = 2.81 µm Scale = 5 µm
µm
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75 mm


µm
1
0.5
0
-0.5
-1
µm
16
15
14
13
12
11
µm
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0