Results of the laser-polished sample B-5.5 test (preliminary)

D. Tikhonov, Authors

ARIES WP meeting

Presenter

Dmitry Tikhonov
Early stage researcher

Helmholtz-Zentrum Berlin
dmitry.tikhonov@helmholtz-berlin.de
+49-30-8062-12922

EASITrain – European Advanced Superconductivity Innovation and Training. This Marie Sklodowska-Curie Action (MSCA) Innovative Training Networks (ITN) has received funding from the European Union's H2020 Framework Programme under Grant Agreement no. 764879

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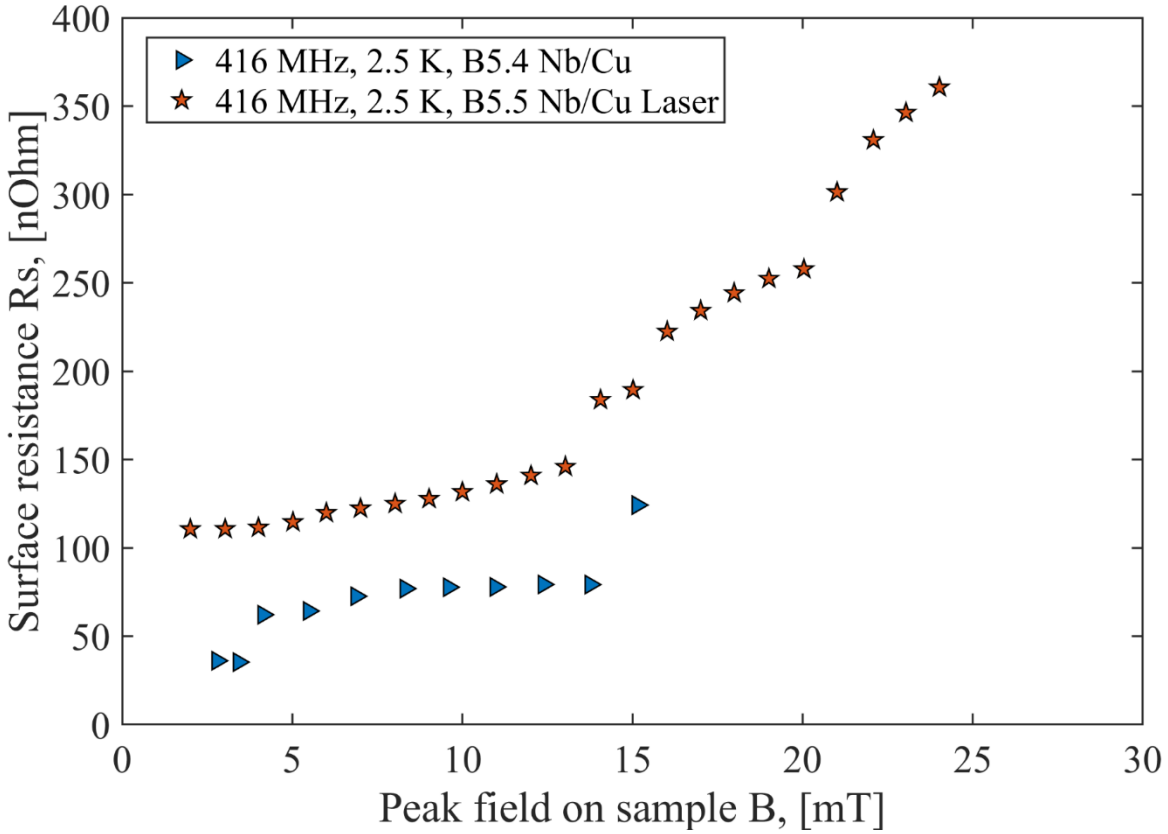
Results for pre-laser polishing and after for 2.5 K, ~400 MHz:



- Higher surface resistance

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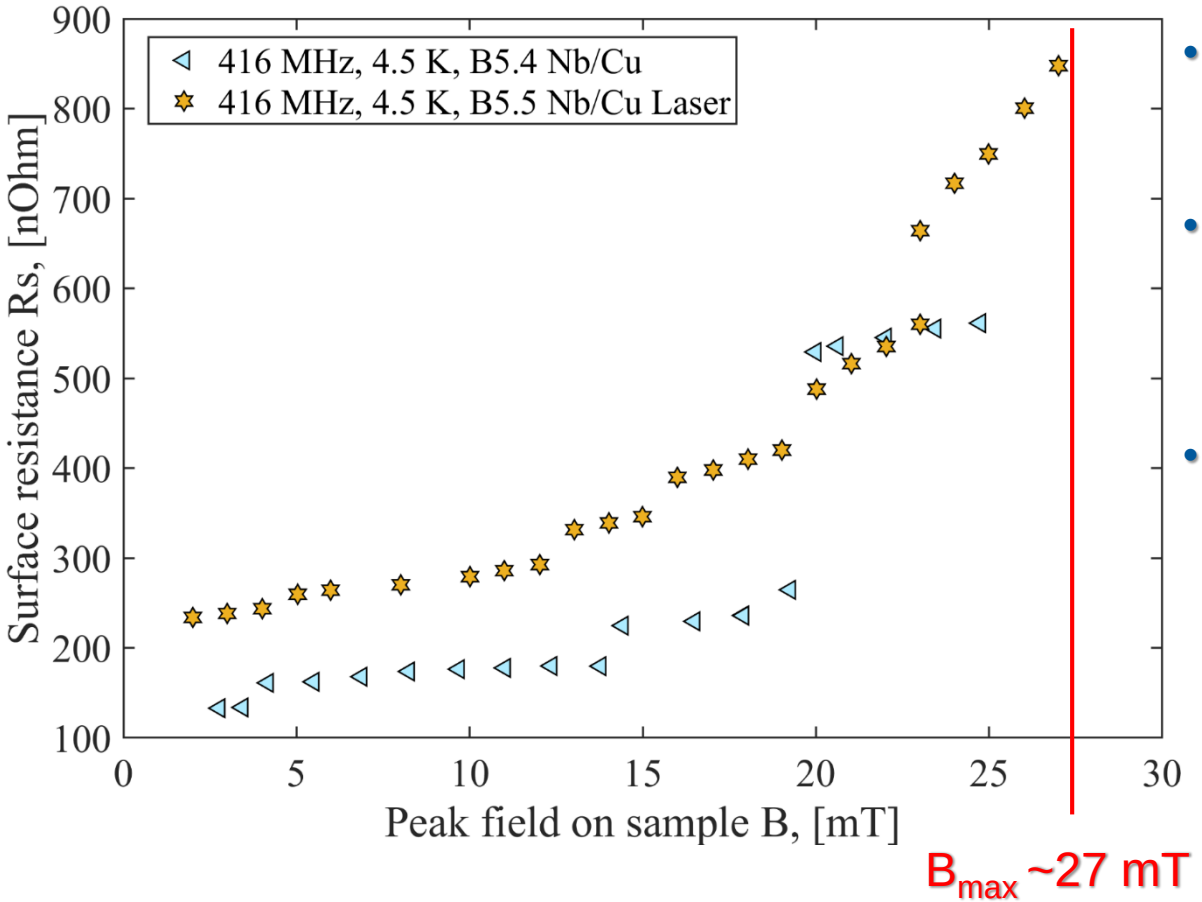
Results for pre-laser polishing and after for 4.5 K, ~400 MHz:



B_{max} ~27 mT

- Rs vs B is more “smooth”, one spot is better
- Possible problems: problematic spot could be at higher field region
- Maximum film is about same as previously tested (27 mT). Probably, problematic spot was not reached by laser.

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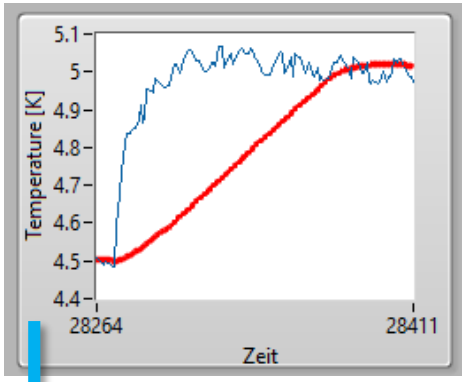
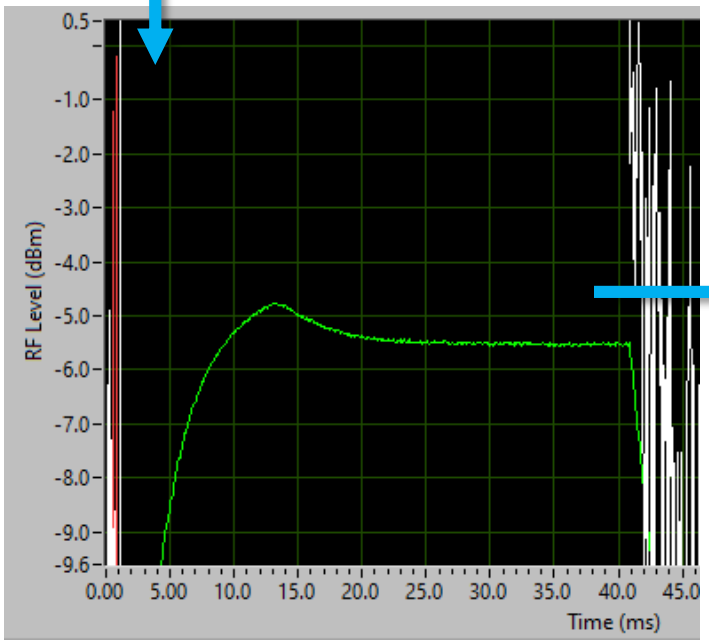
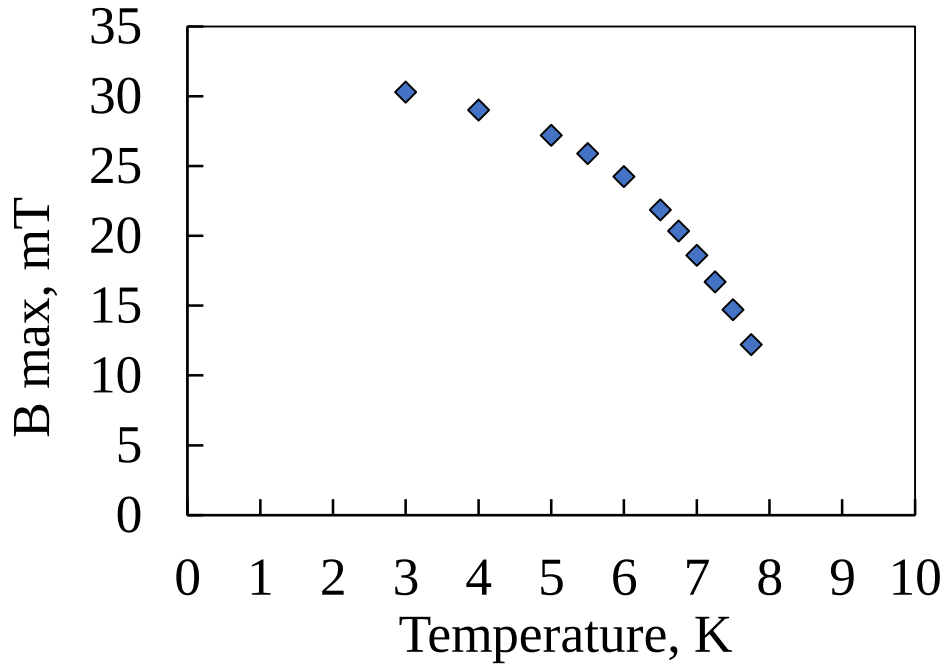


Pulse shape (transmitted)



- At max field 27 mT, 416 MHz: Temperature significantly increased (but not complete quench)
- Only part of the film quenched (not full film because temperature stays <9.3K)
- Quench field depends on temperature:



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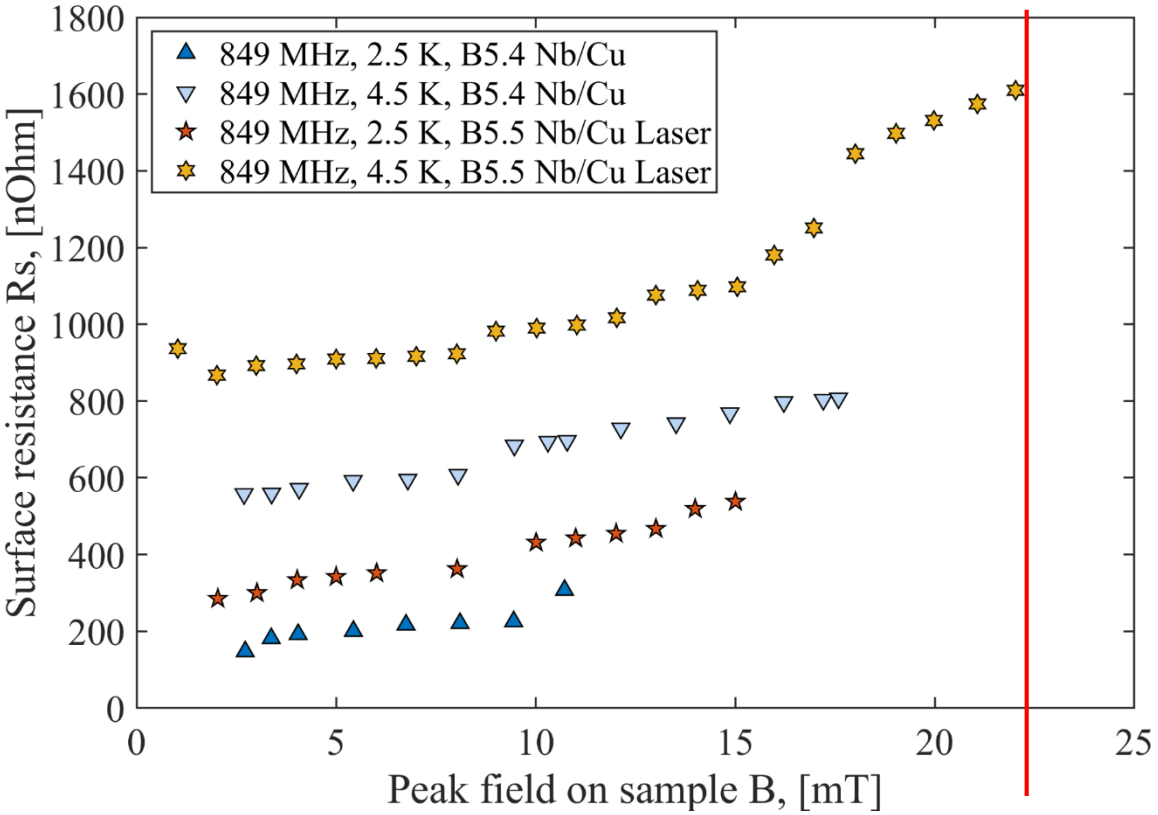
Results for pre-laser polishing and after for ~850 MHz:



B_{max} ~22 mT

- Maximum film is about 22 mT.

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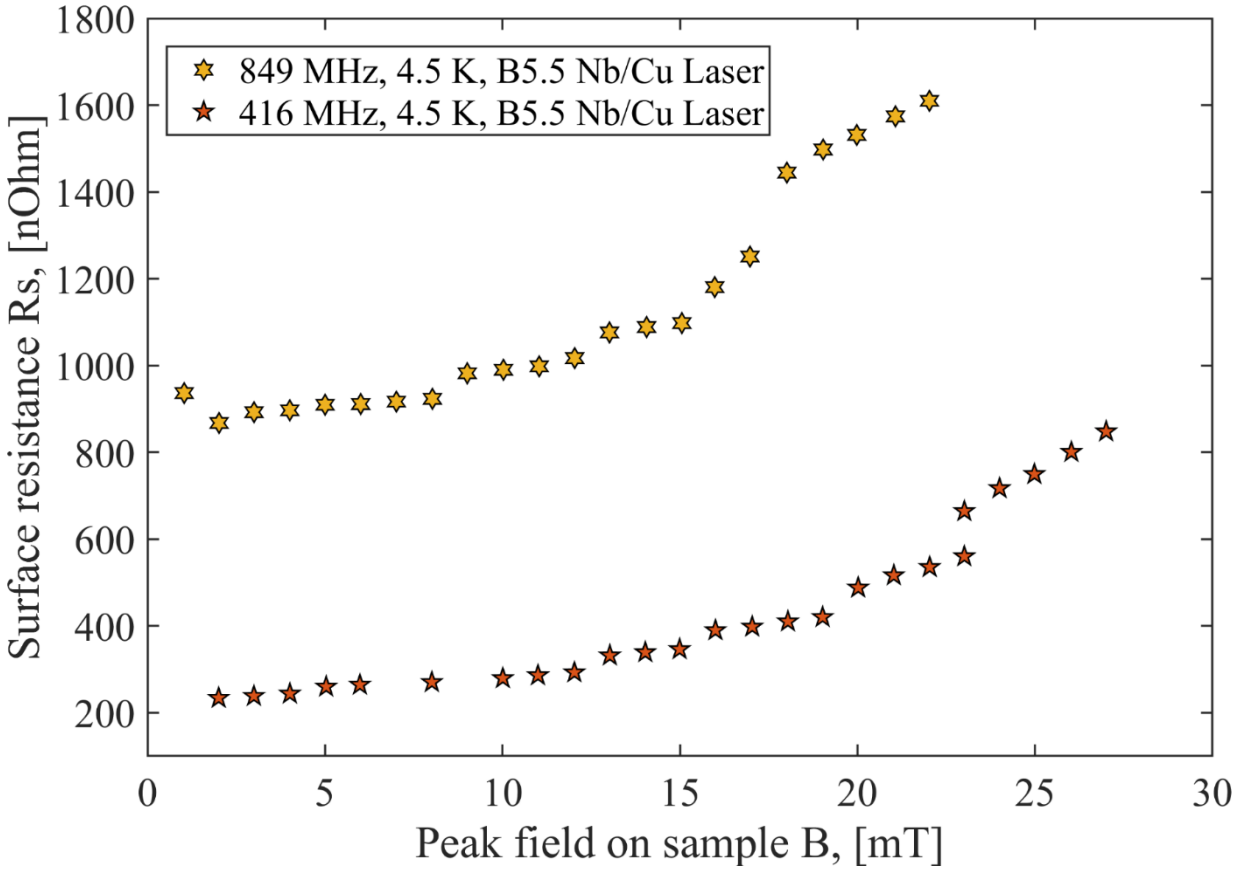

- Q1 vs Q2

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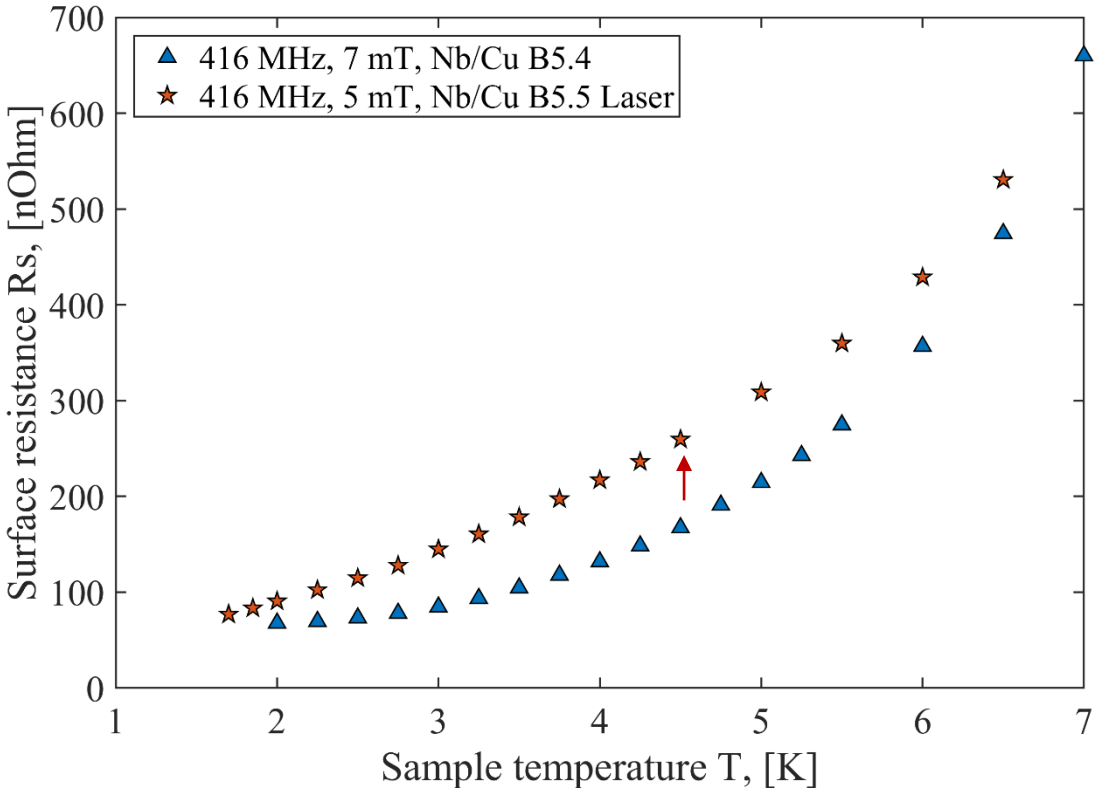
Rs vs T results for pre-laser polishing and after for ~416 MHz:



- Rs vs T: Most of the 'additional' resistance come from temperature-depend part
- Residual resistance is approximately same:

Residual resistance 'eye' estimation (416 MHz):

	R_{res}
B-5.4	~67 nOhm
B-5.5	~76 nOhm

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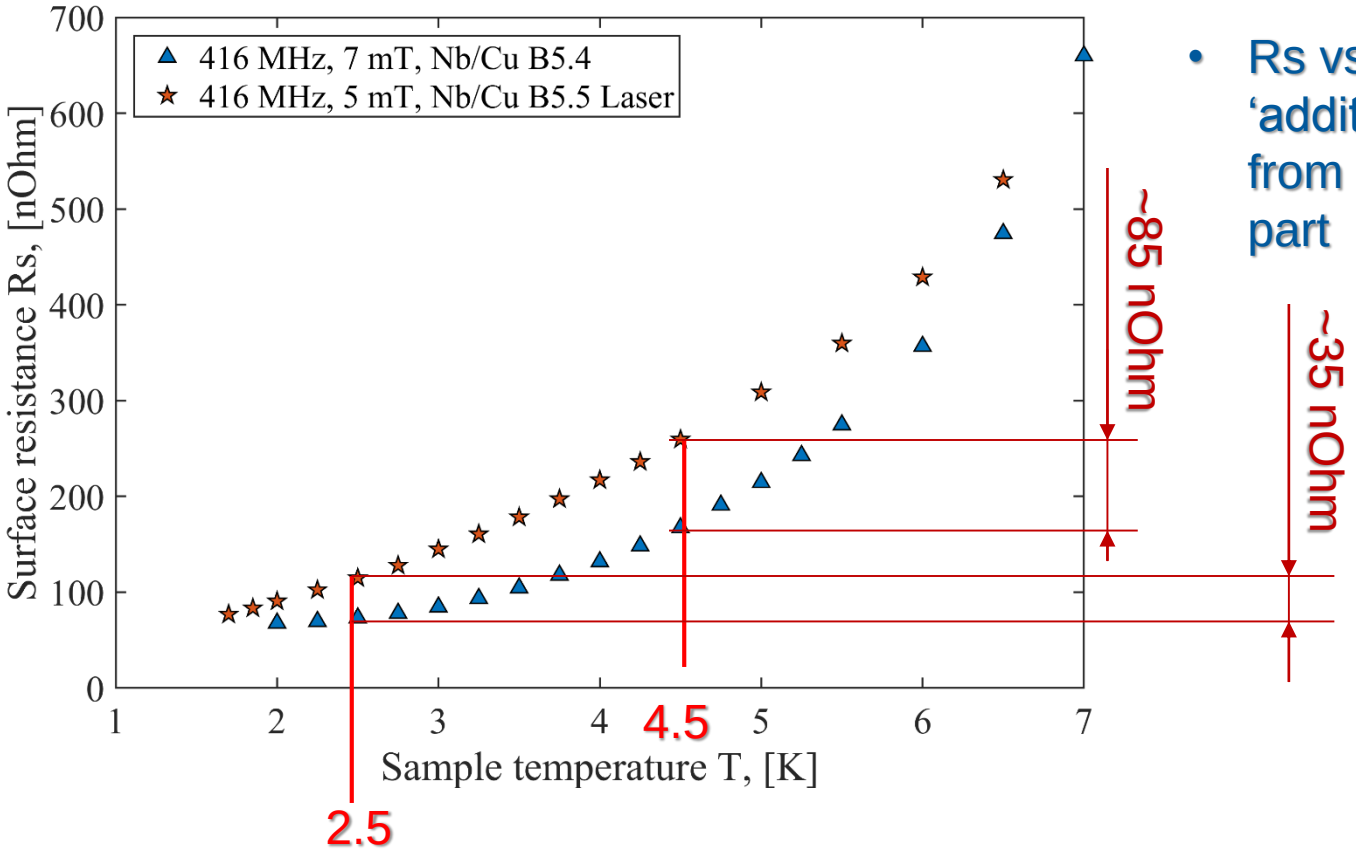

- Rs vs T: Most of the 'additional' resistance come from temperature-depend part

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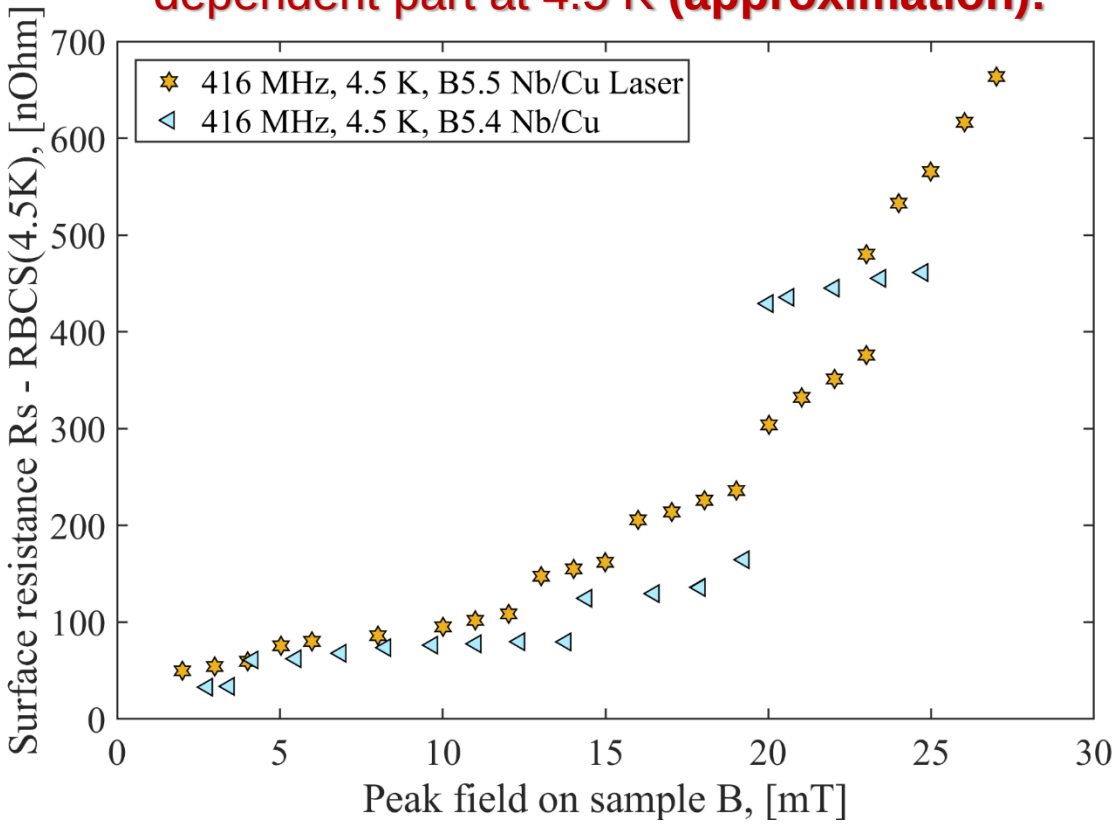
Rs vs B results for pre-laser polishing and after for ~416 MHz:

Rs with subtracted ~BCS temperature dependent part at 4.5 K **(approximation):**



- Probably increased BCS came from impurities and defects due to wrong polishing procedure
- With subtracted BCS contribution from both tests the field dependent part is more or less comparable except higher field ‘jump’

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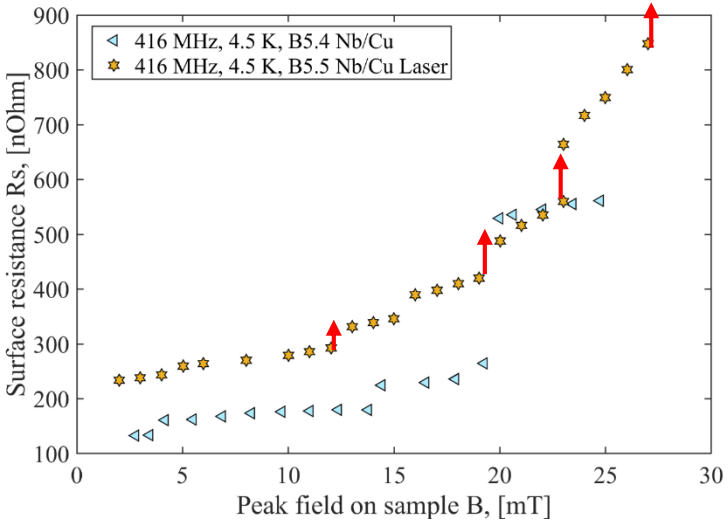
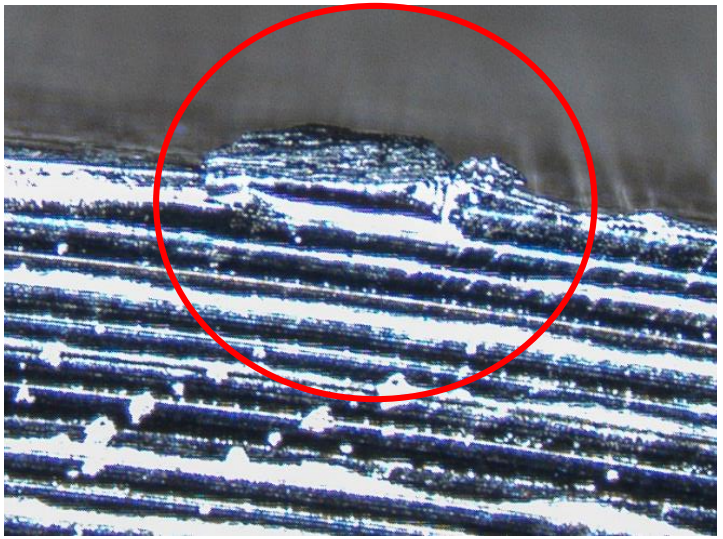
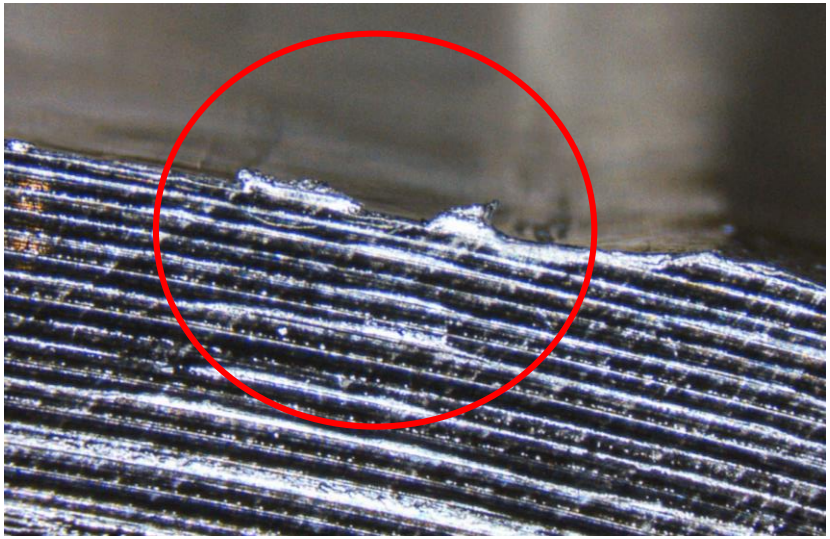
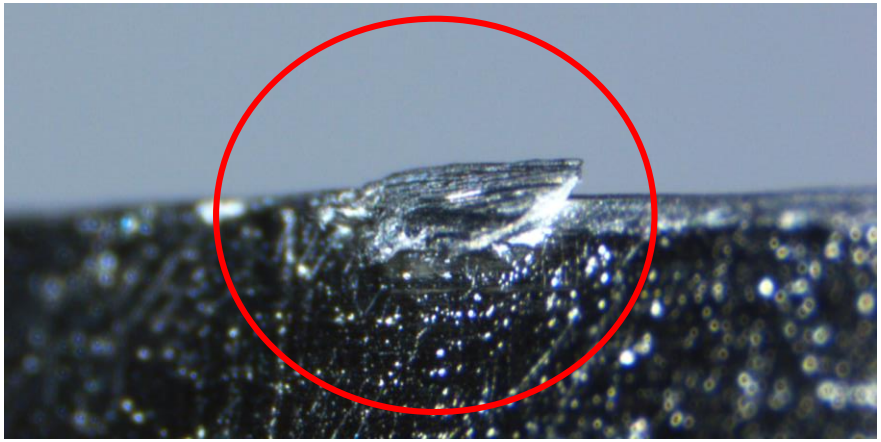
JUMPS IN SURFACE RESISTANCE: EDGES









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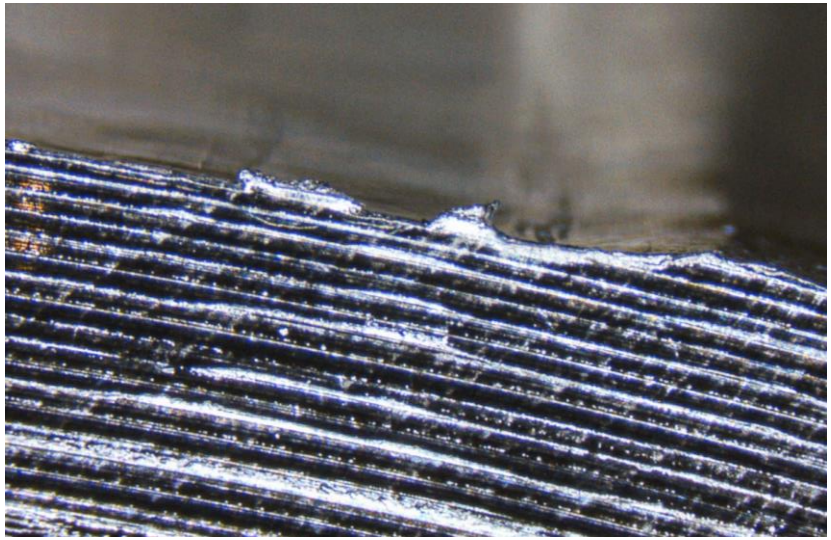

B-5
sample

B-4
sample

Conclusions:

For the reliable data, next samples should be treated same way (flash etching, etc) to remove sharp pieces of Nb from edges

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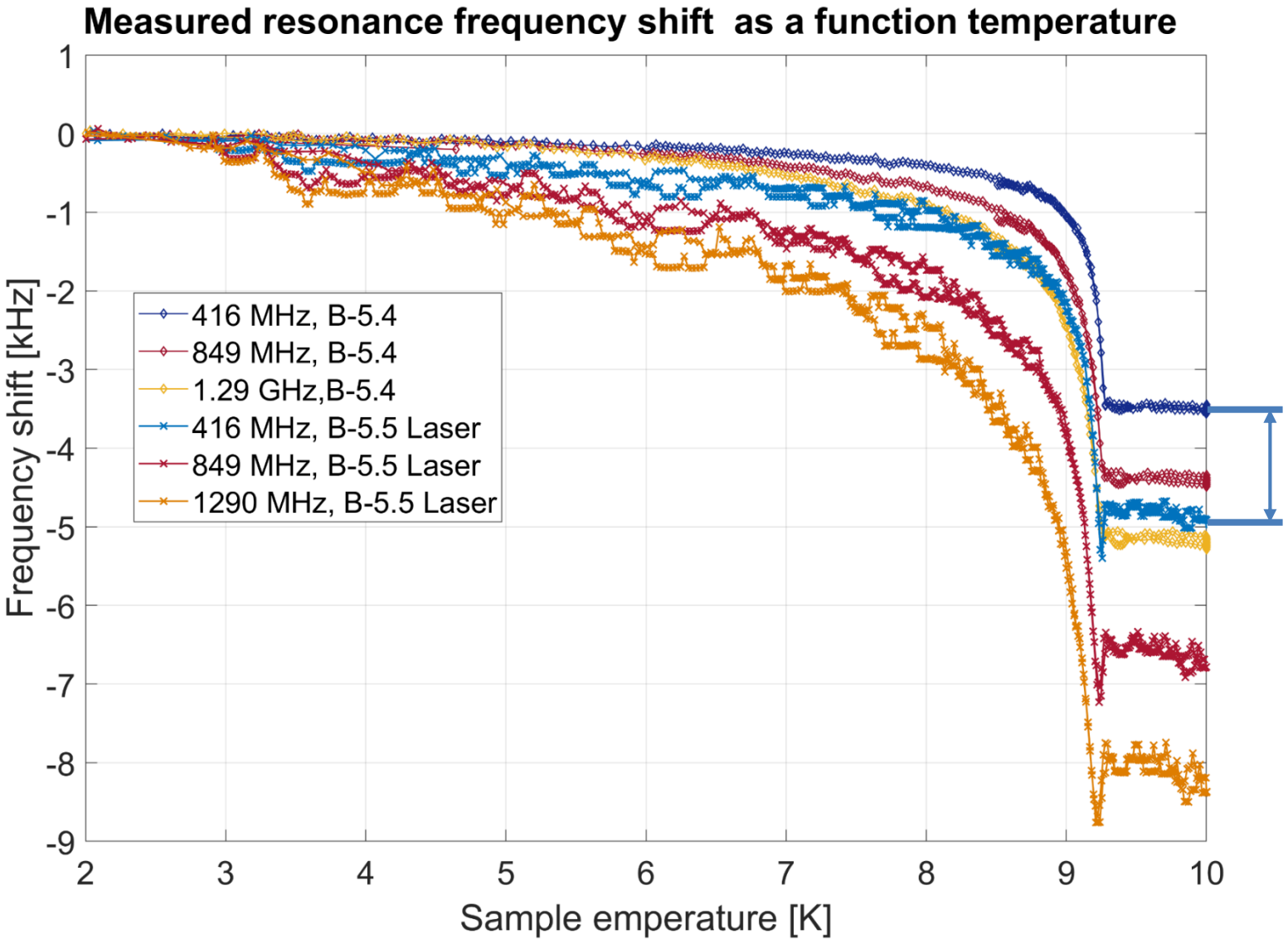

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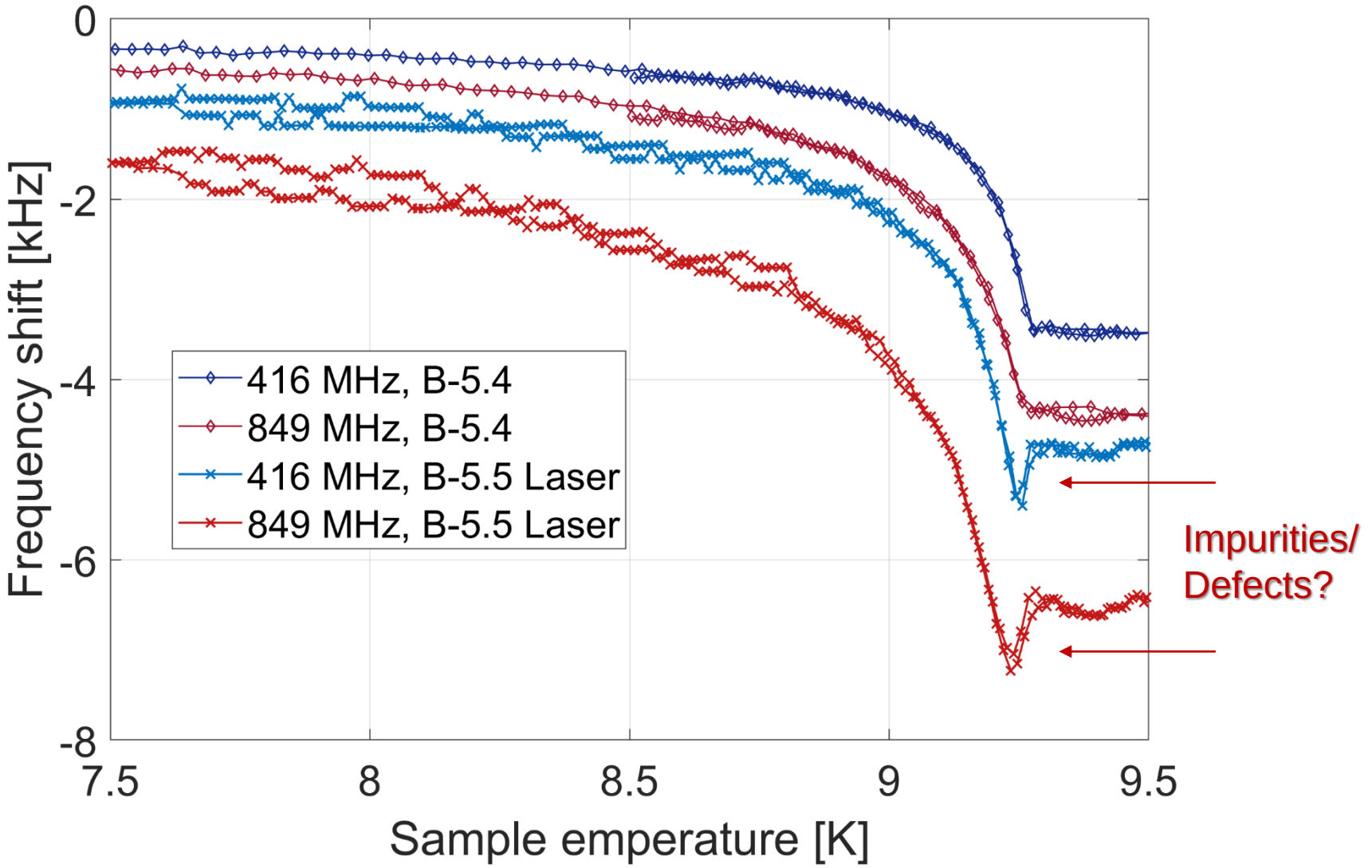
F VS T RESULTS FOR PRE-LASER POLISHING AND AFTER



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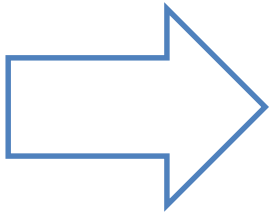
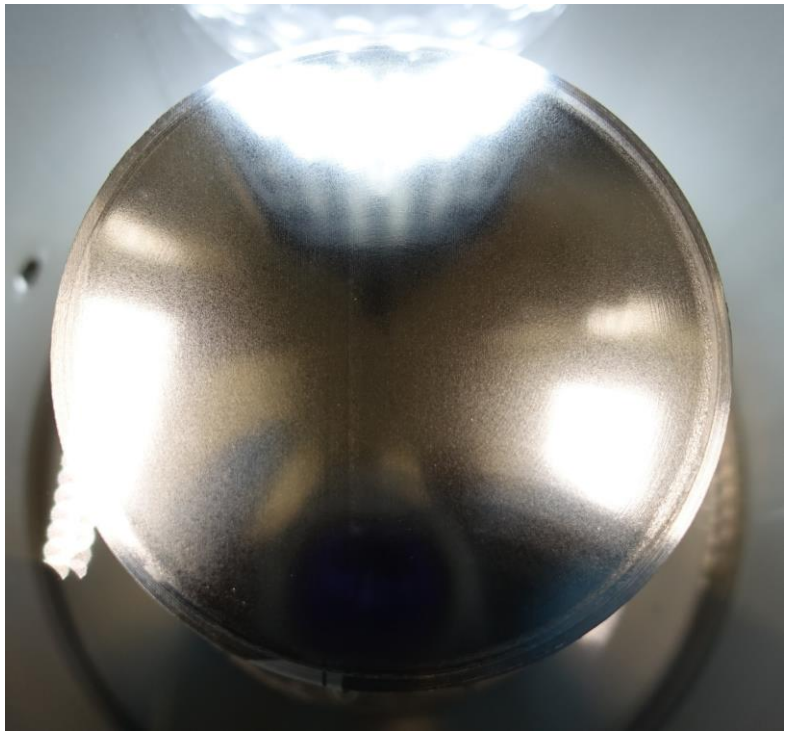
POST-TEST SAMPLE SCAN: COMPARISON





Pre LP:

Post LP:

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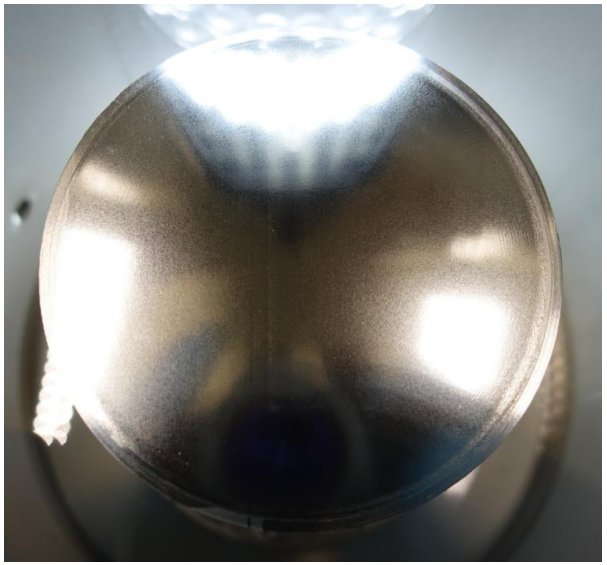
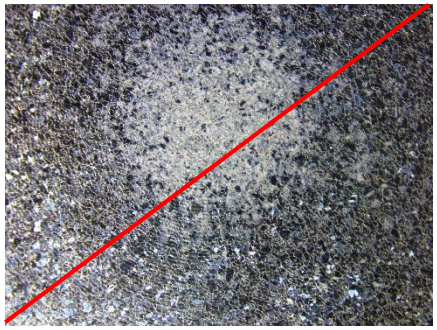
POST-TEST SAMPLE SCAN: COMPARISON

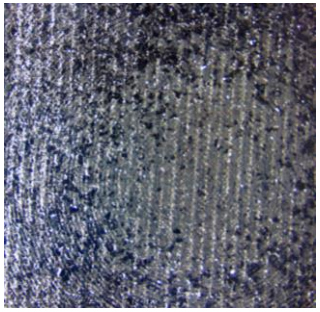
- Some defects removed or partially removed



Post LP:

Pre LP:





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POST-TEST SAMPLE SCAN: OVERVIEW

- Sample scanned with the laser microscope:
- Defects detection
- Roughness measurements
- *Full size JPEG picture (34 MB) and other data are on the CERNbox folder (note, that some features = dust)*

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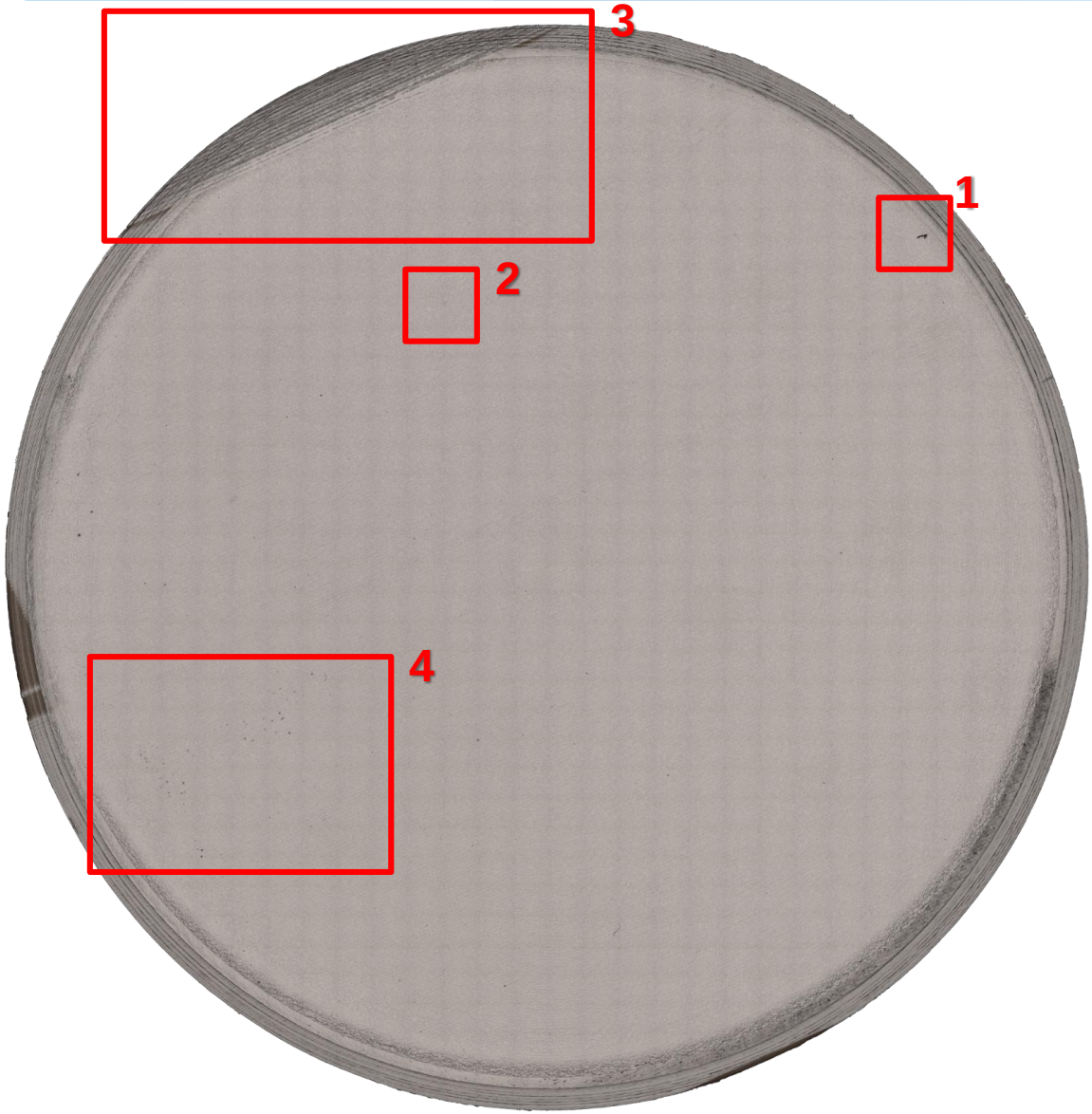

Some observed features:

1. Major defect near the edge
2. Minor craters in high field region
3. Laser traces (overpower?) near the edge
4. A “group of craters”

This pattern = effect of stitching

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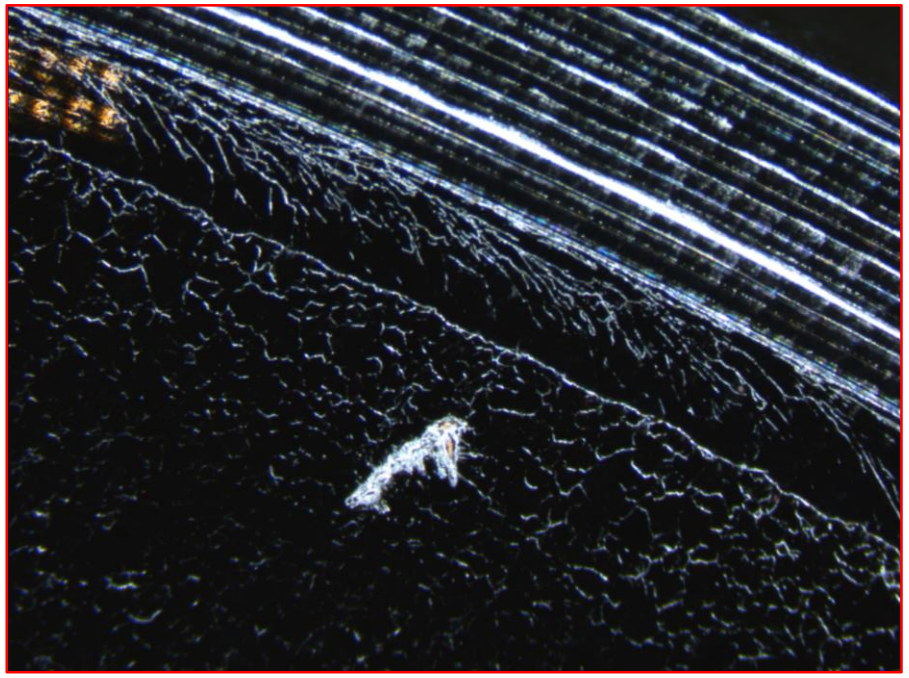
Defect 1 found near the edge:

Laser microscope view (5x):

Optical microscope view:



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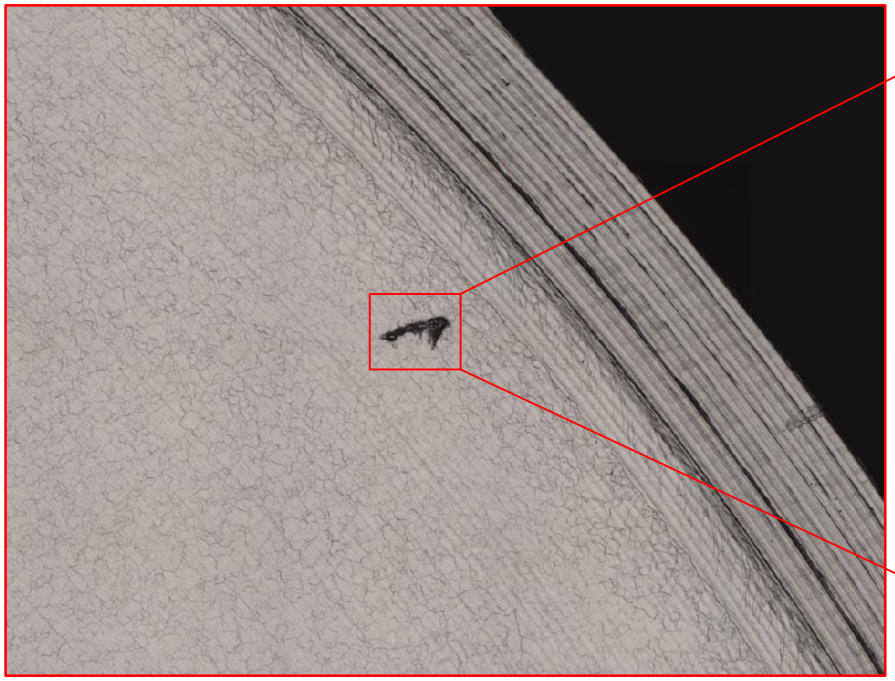
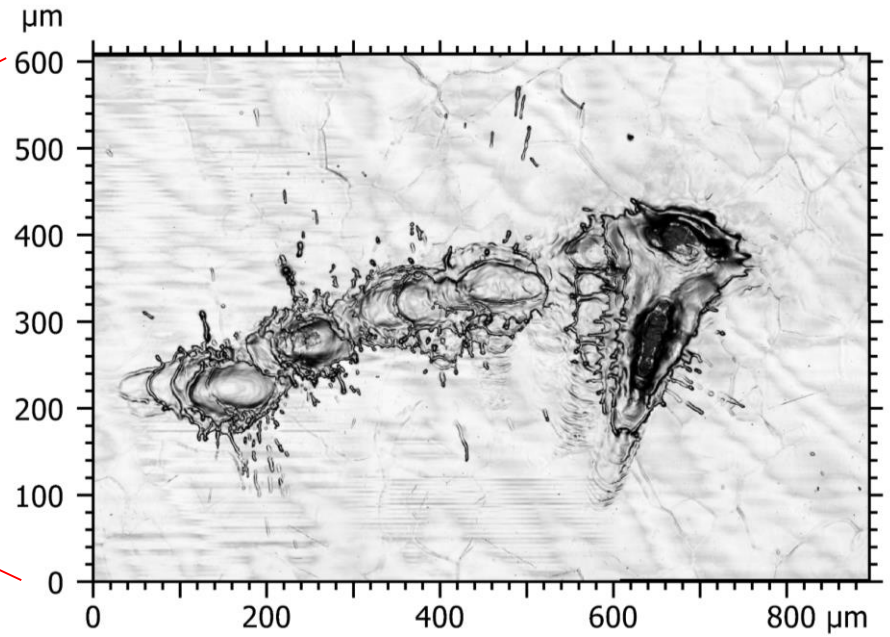
Laser microscope view (5x):



Laser microscope view (20x):



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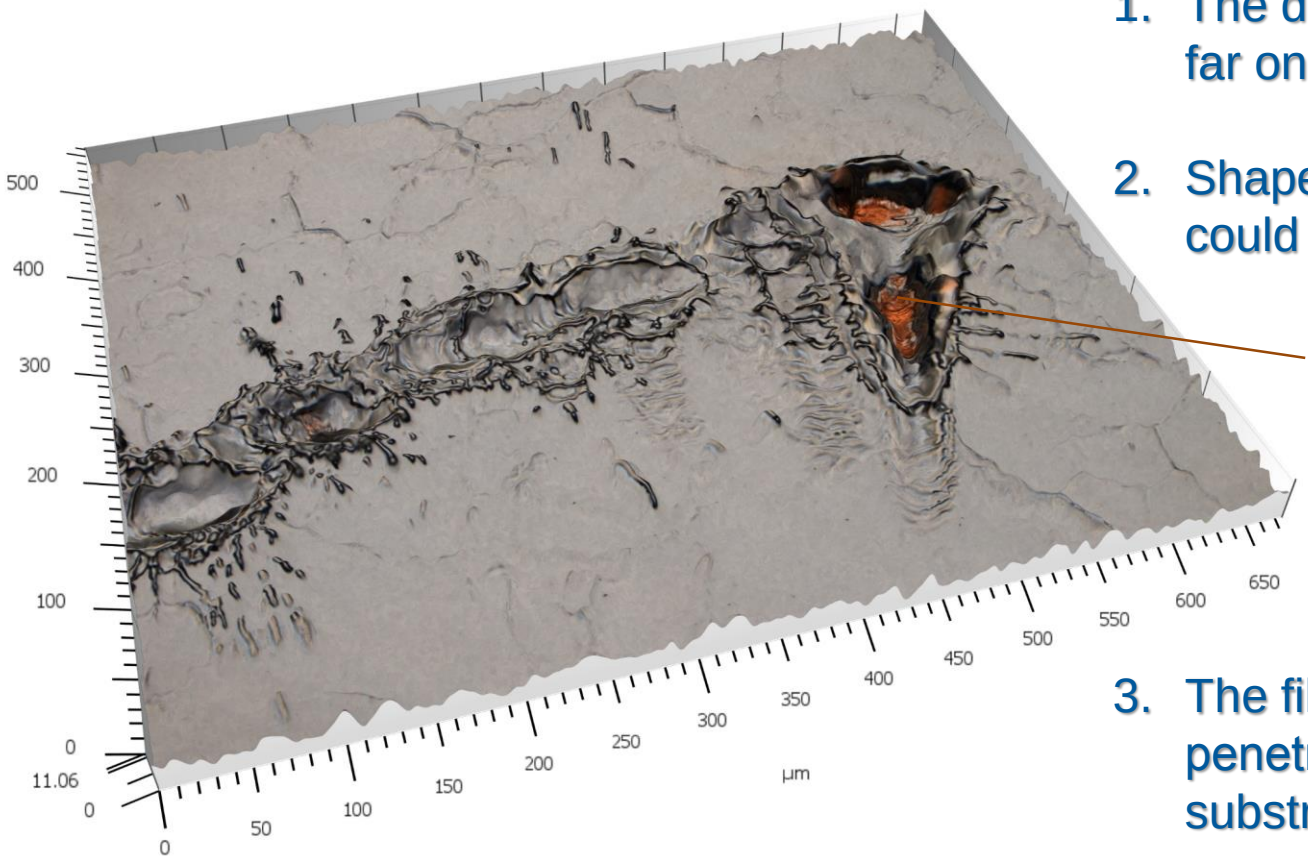
Defect 1 view from optics in 3D:



1. The defect was not found so far on pre-laser coated sample
2. Shape of the defect: the laser could give overpowered pulse

Cu?

3. The film is completely penetrated by the “shot”, substrate is exposed to RF

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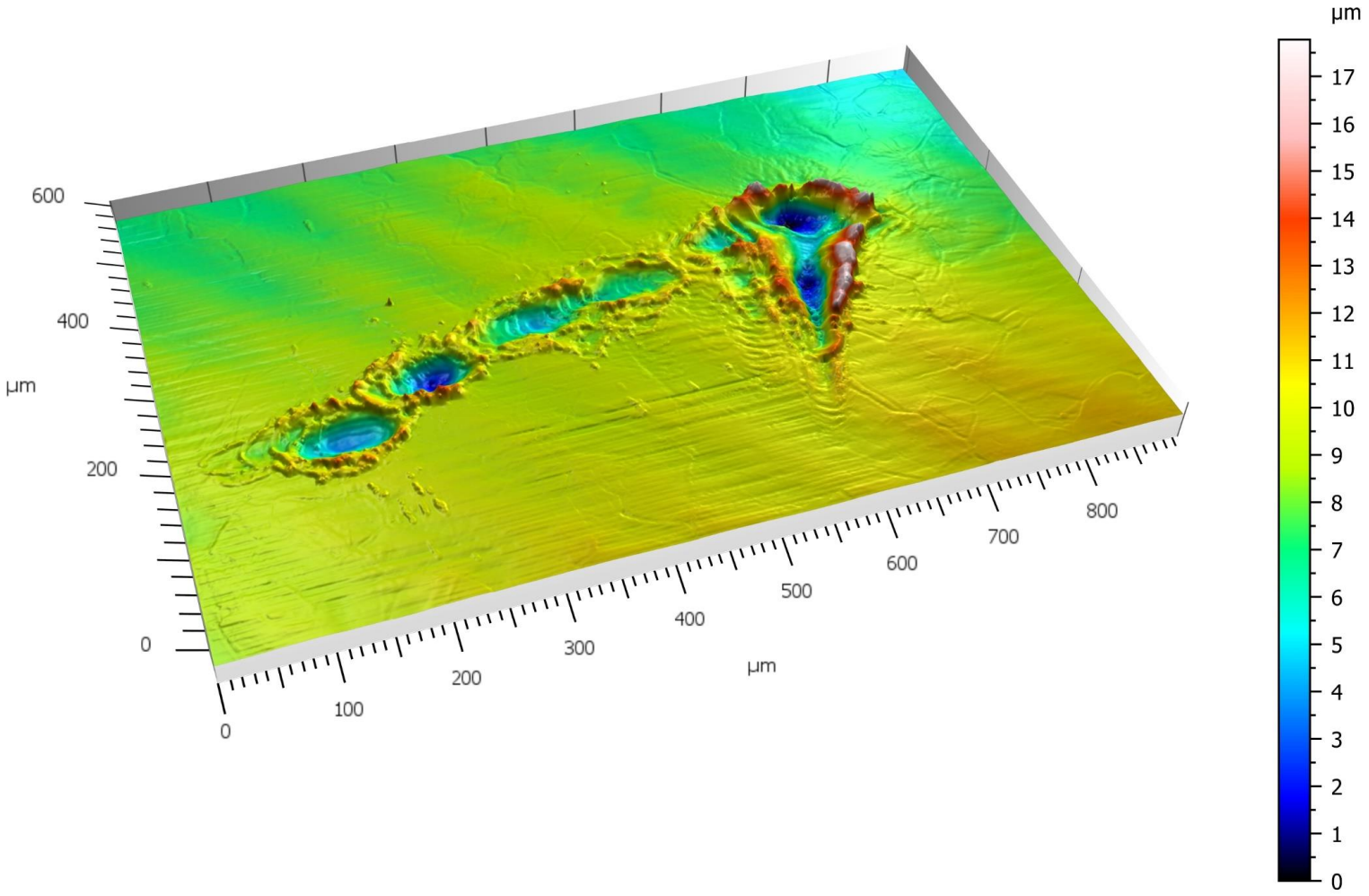
Defect 1 view in 3D:



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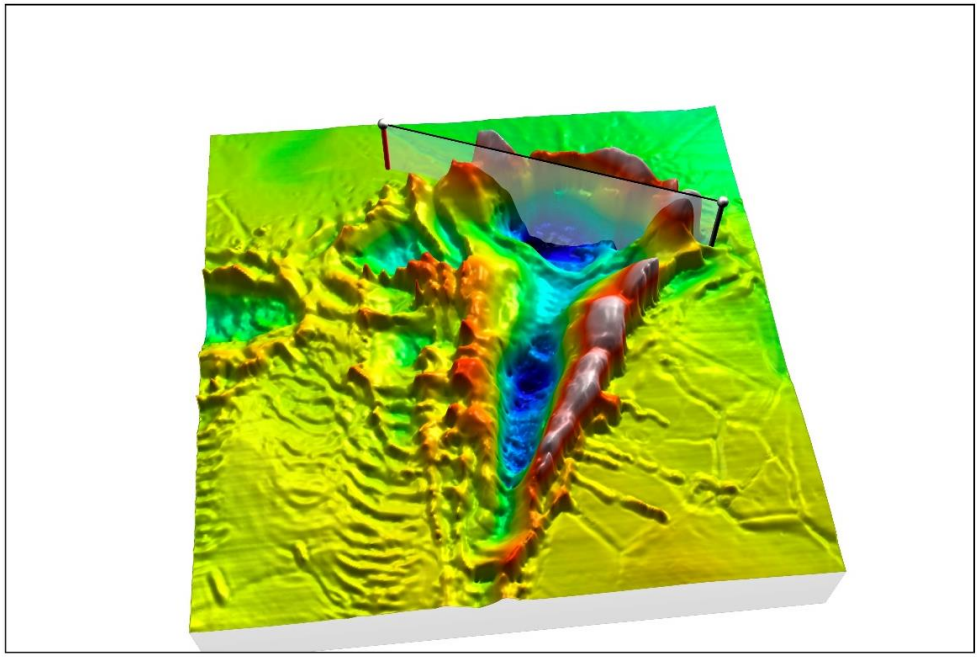
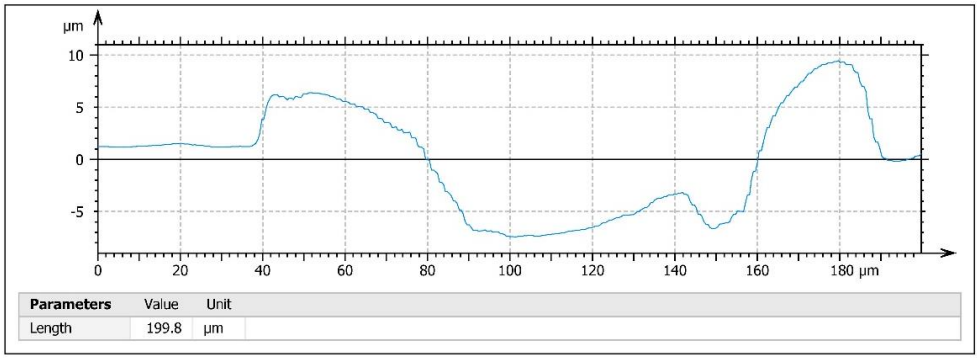
Defect 1 view in 3D:





Parameters	Value	Unit
Length	199.8	µm

- The film deepness can be estimated about 5 mkm

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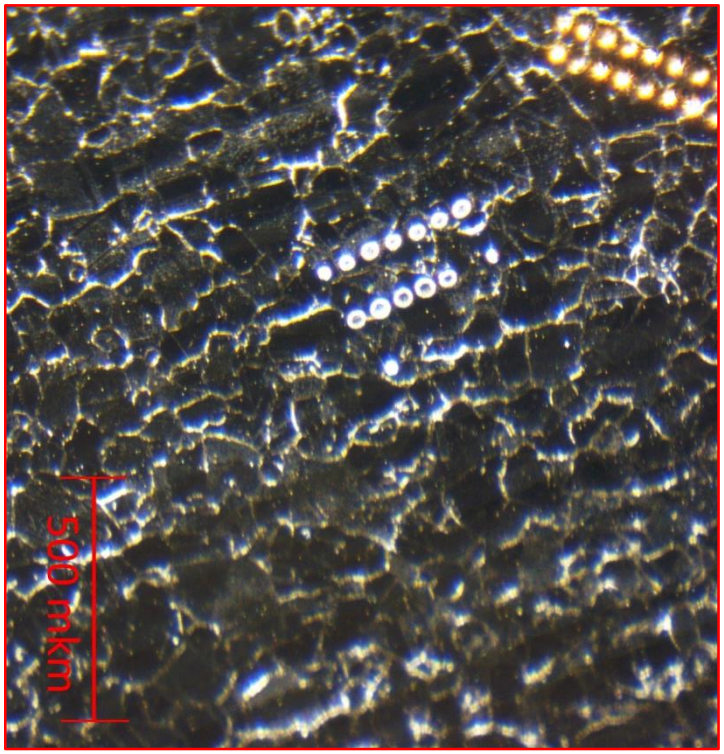
Defect 2 found in the high RF field region:

Laser microscope view (5x):

Optical microscope view:



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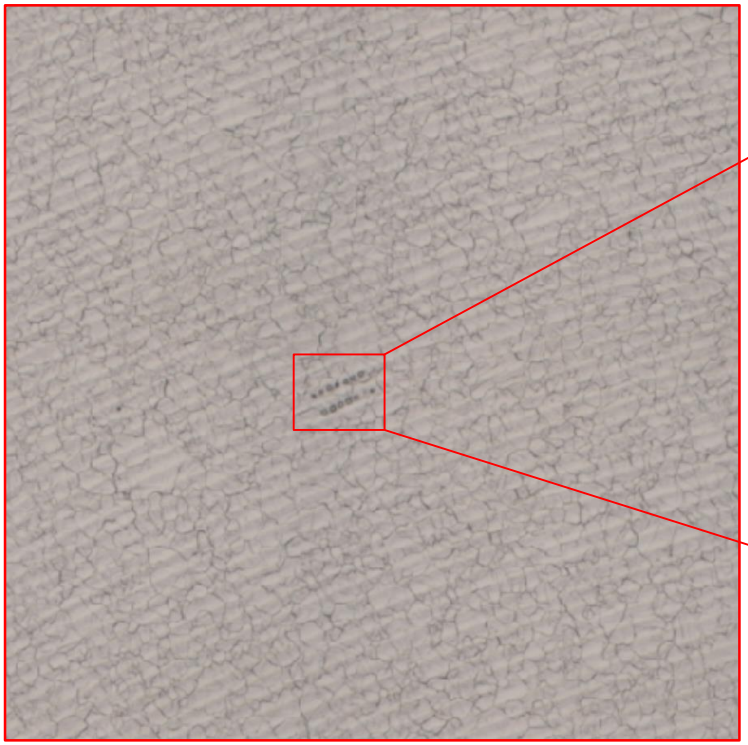
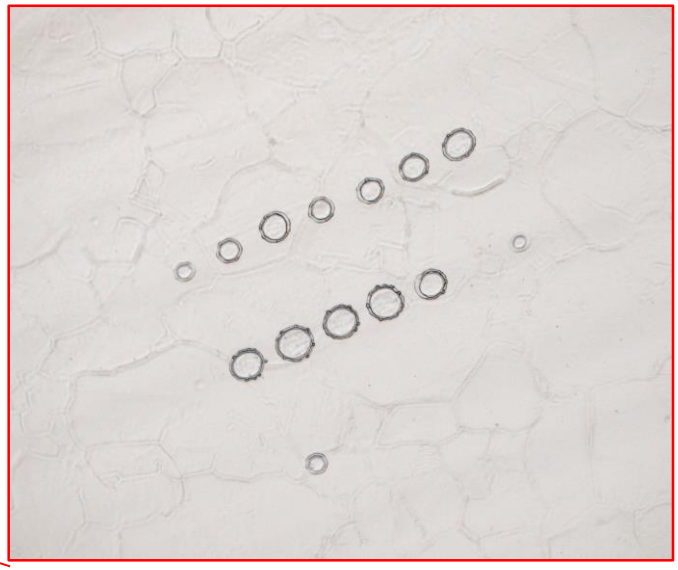
Defect 2 found in the high RF field region:

Laser microscope view (5x):



Laser microscope view (20x):



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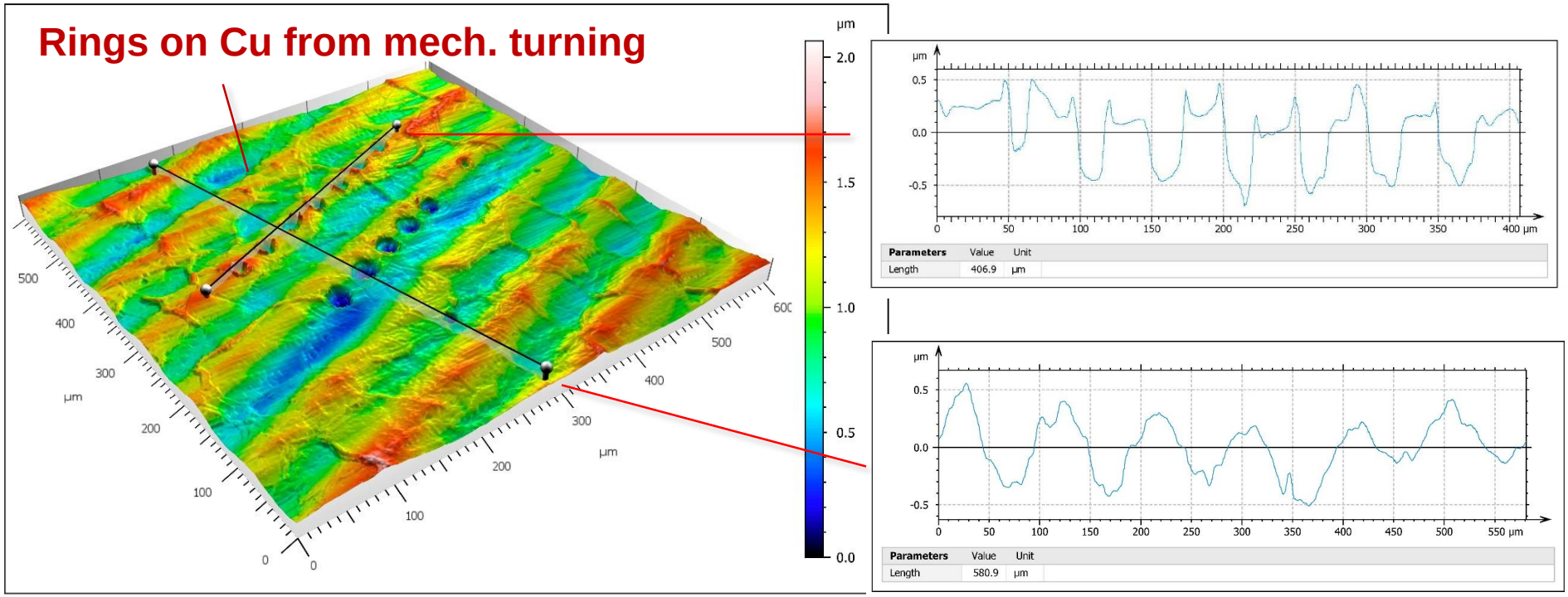
Defect 2 found in the high RF field region:

- Defect again looks like a crater (series of craters), deepness up to 1 mkm
- Roughness from substrate shape (due to mechanical production) is about 1 mkm



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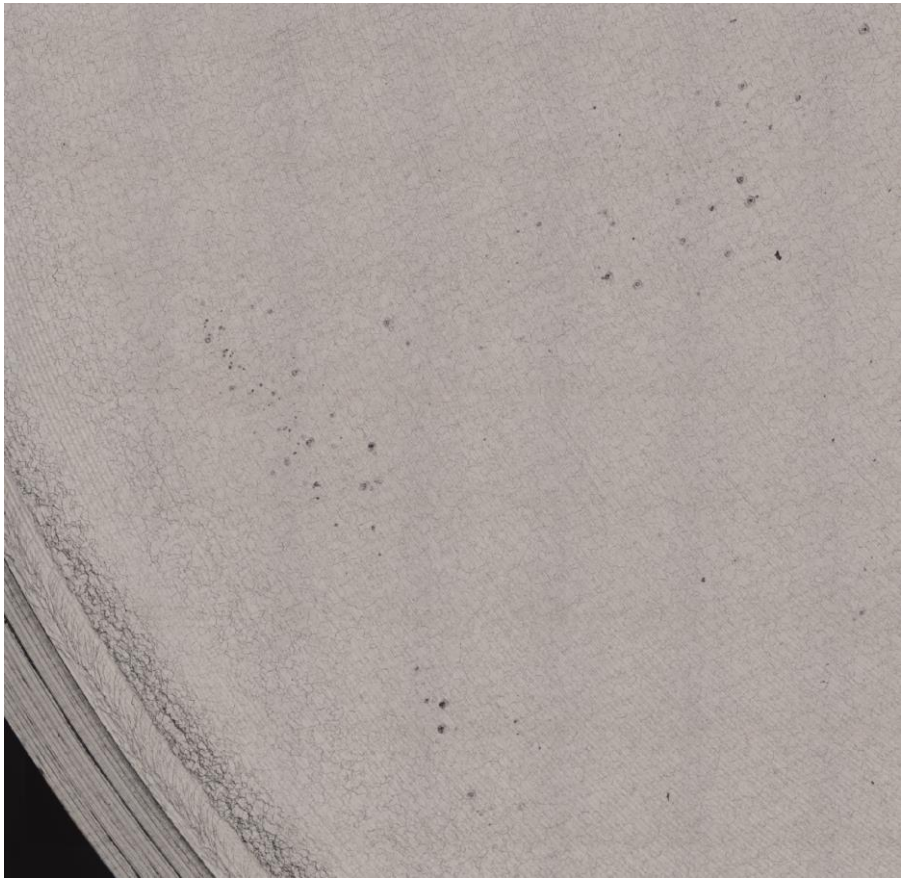
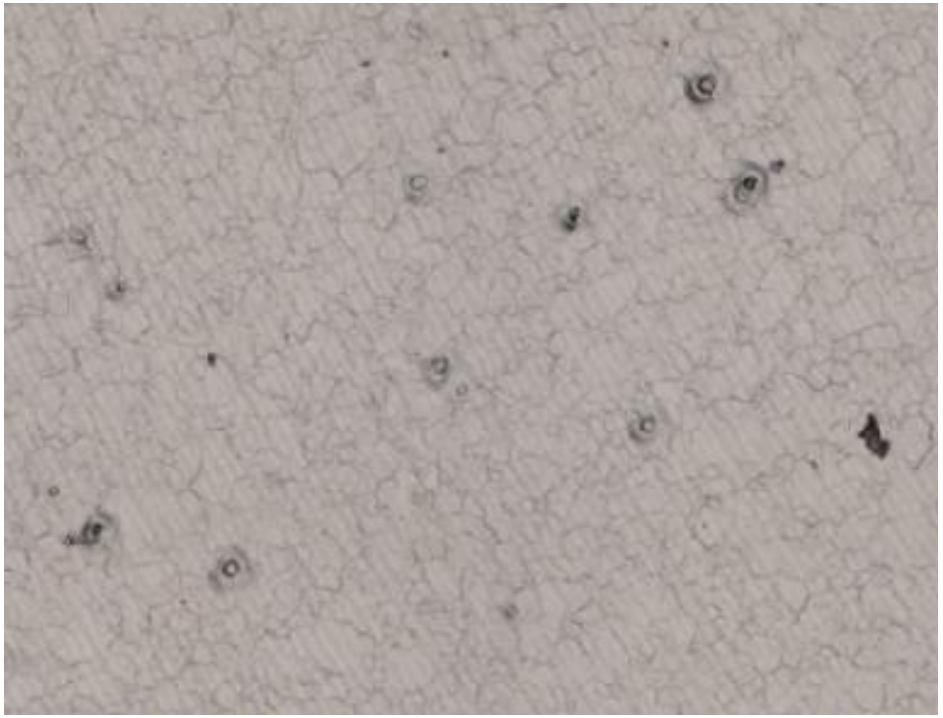
Laser microscope view (5x):



- Craters again?



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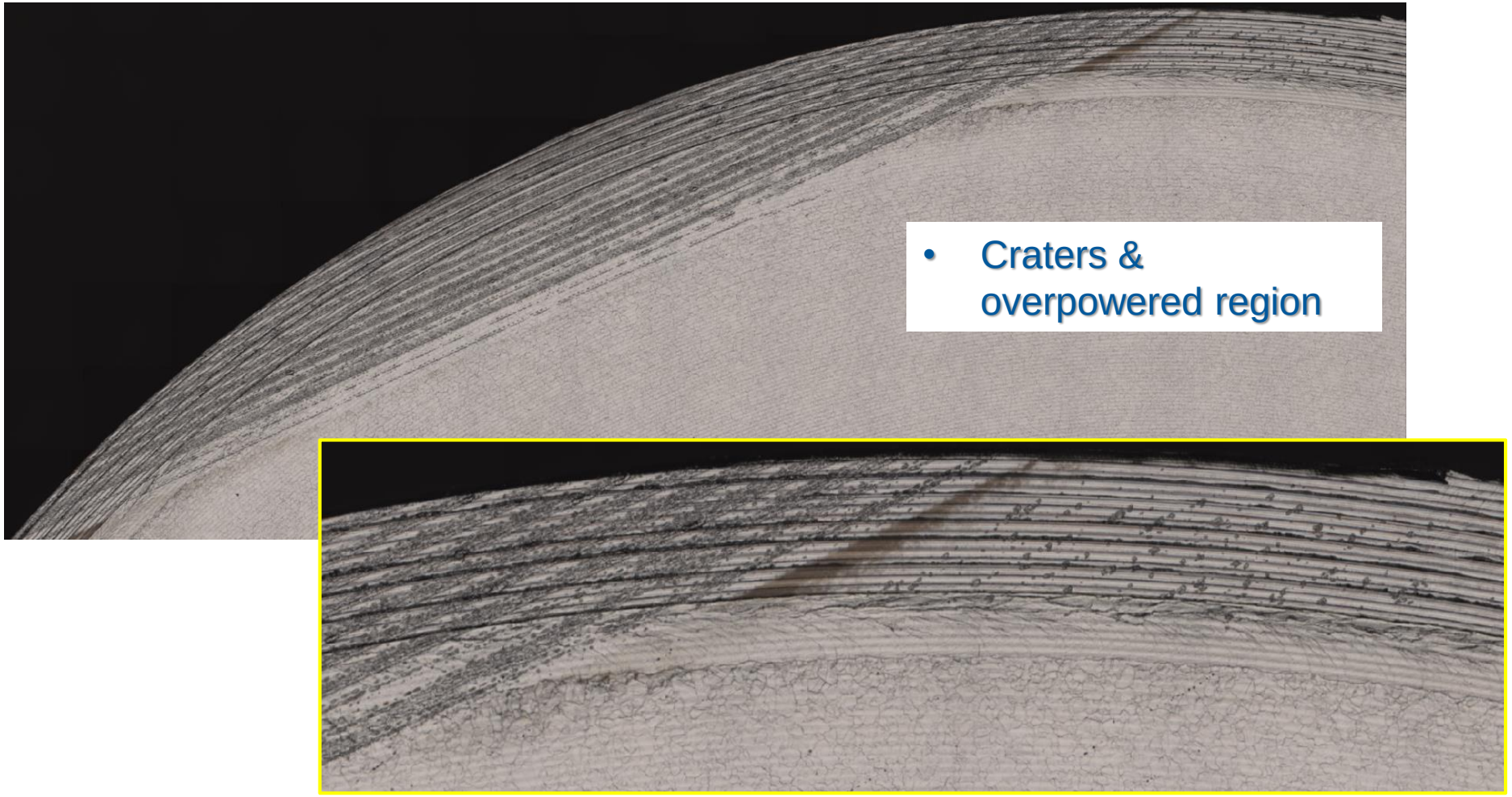
Laser microscope view (5x):



- Craters & overpowered region

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CONCLUSIONS

- Laser polishing practically can work
- Minor improvements at Rs vs B behavior. The problem with the rough edges is still present, and % of contribution of it to the final result is not clear.
- Film (probably) got some contaminations and defects during the process (conclusion from R_{BCS} and FvsT data).
- The process needs to be adjusted and surface analyzed more carefully.

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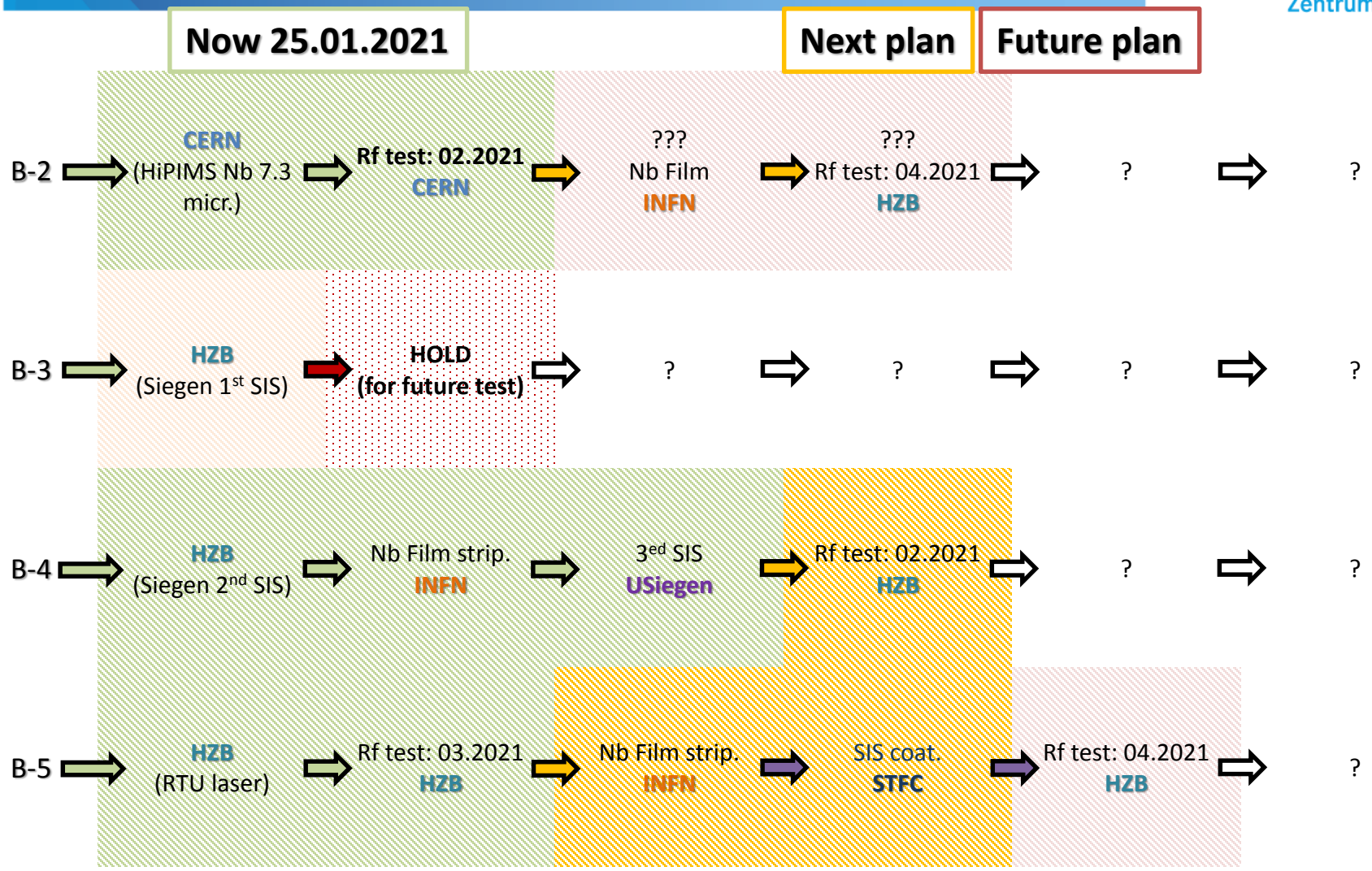
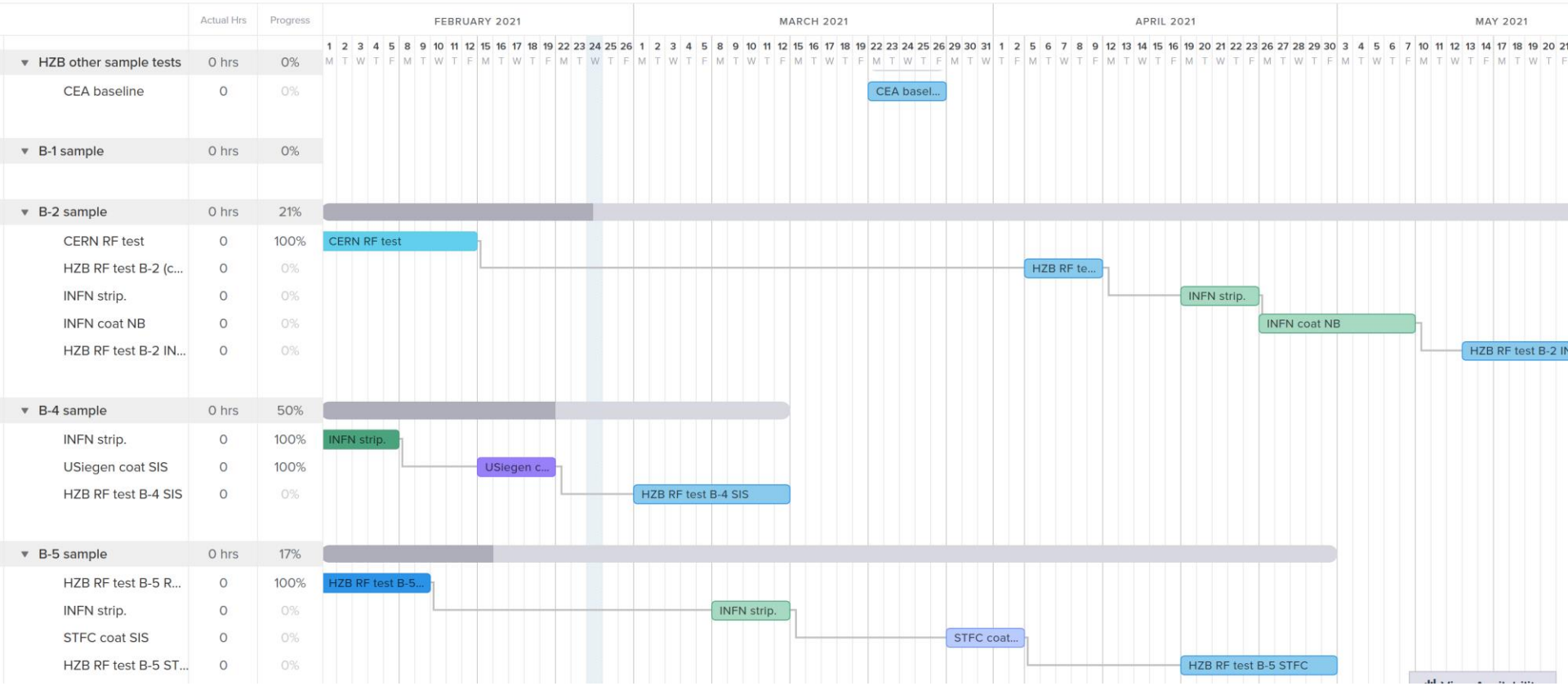

Now 25.01.2021
Next plan
Future plan
B-2
CERN
(HiPIMS Nb 7.3 micr.)
Rf test: 02.2021
CERN
???
Nb Film
INFN
???
Rf test: 04.2021
HZB
?
?
B-3
HZB
(Siegen 1st SIS)
HOLD
(for future test)
?
?
?
?
B-4
HZB
(Siegen 2nd SIS)
Nb Film strip.
INFN
3ed SIS
USiegen
Rf test: 02.2021
HZB
?
?
B-5
HZB
(RTU laser)
Rf test: 03.2021
HZB
Nb Film strip.
INFN
SIS coat.
STFC
Rf test: 04.2021
HZB
?


Actual Hrs
Progress
FEBRUARY 2021
MARCH 2021
APRIL 2021
MAY 2021
HZB other sample tests
0 hrs
0%
CEA baseline
0
0%
CEA basel...
B-1 sample
0 hrs
0%
B-2 sample
0 hrs
21%
CERN RF test
0
100%
CERN RF test
HZB RF test B-2 (c...
0
0%
HZB RF te...
INFN strip.
0
0%
INFN strip.
INFN coat NB
0
0%
INFN coat NB
HZB RF test B-2 IN...
0
0%
B-4 sample
0 hrs
50%
INFN strip.
0
100%
INFN strip.
USiegen coat SIS
0
100%
USiegen c...
HZB RF test B-4 SIS
0
0%
HZB RF test B-4 SIS
B-5 sample
0 hrs
17%
HZB RF test B-5 R...
0
100%
HZB RF test B-5...
INFN strip.
0
0%
INFN strip.
STFC coat SIS
0
0%
STFC coat...
HZB RF test B-5 ST...
0
0%
HZB RF test B-5 STFC

SUGGESTED NEXT STEPS

- If possible (not at HZB): Any analyses regarding molecular components of the film and/or SEM microscope scan

- Suggestions: Stripping of the top layer of the film and retesting to see if the contaminations are removed?

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