

Optical inspection status

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DESY

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Many thanks to:

R. Geng (JLab)
D. Sergatskov (FNAL) and
K. Watanabe (KEK)

for providing input to this talk!

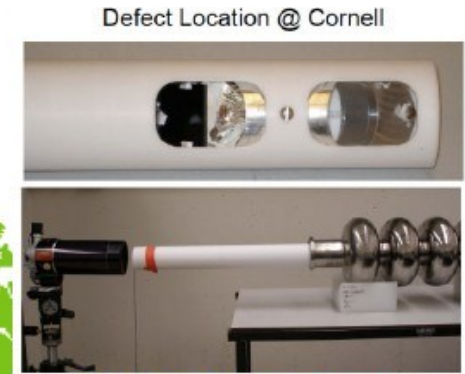
Optical inspection around the world



DESY : Kyoto Camera



FNAL : Kyoto Camera,
Questar long-distance microscope

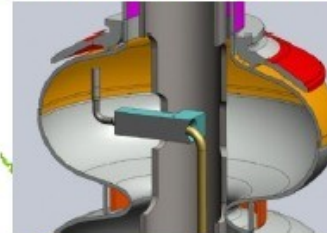


Cornell : Inspection
system

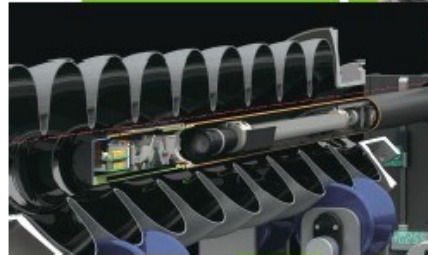
KEK (STF) : Kyoto



LosAlamos: Karl Storz videoscope



J-Lab : Lab cavity
inspection tool based on
long-distance microscope,
Kyoto Camera



High resolution camera system is generally used at many labs around the world for 1.3 GHz 9-cell cavities to understand the field limitation.

Original: K.Watanabe, SRF09
Updated: Y. Yamamoto, LCWS&ILC10

Inspection of 2-cell cavities at KEK

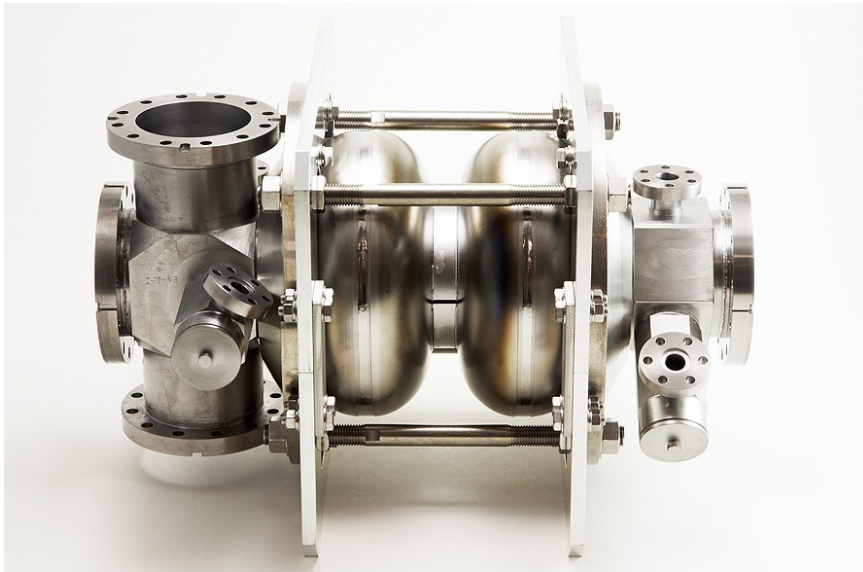
Proto-type model (fabrication in 2008)

ERL injector 2-cell cavity **#1** (KEK, made by MHI)

Four HOM coupler equipped beam pipe for strong damping.
(Two antenna type and two loop type HOM couplers)

1st V.T. with HOM pickup probe was done in April 2009.
(See TTC meeting in Orsay, June 2009)

2nd V.T. without HOM pickup probe was done in Feb 2010.



Proto-type model (fabrication at 2009)

ERL injector 2-cell cavity **#2** (KEK, made by MHI)

Five loop-type HOM coupler equipped beam pipe to obtain stronger damping for monopole modes.

1st V.T. without HOM pickup probe was done Mar 2010.

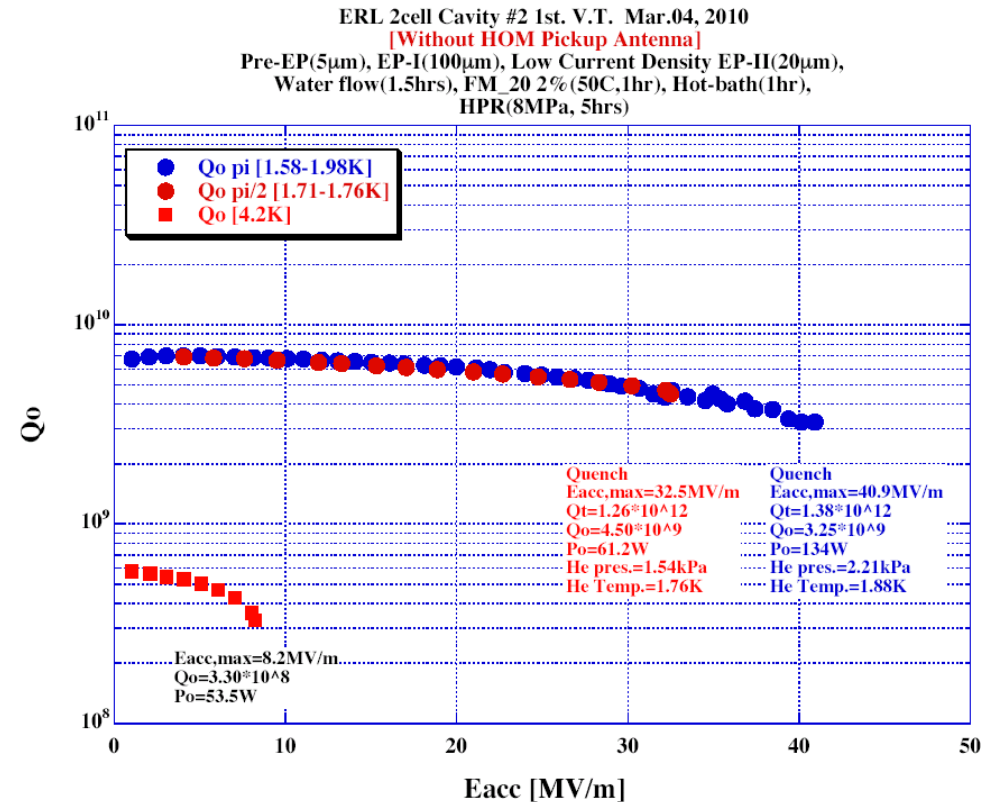
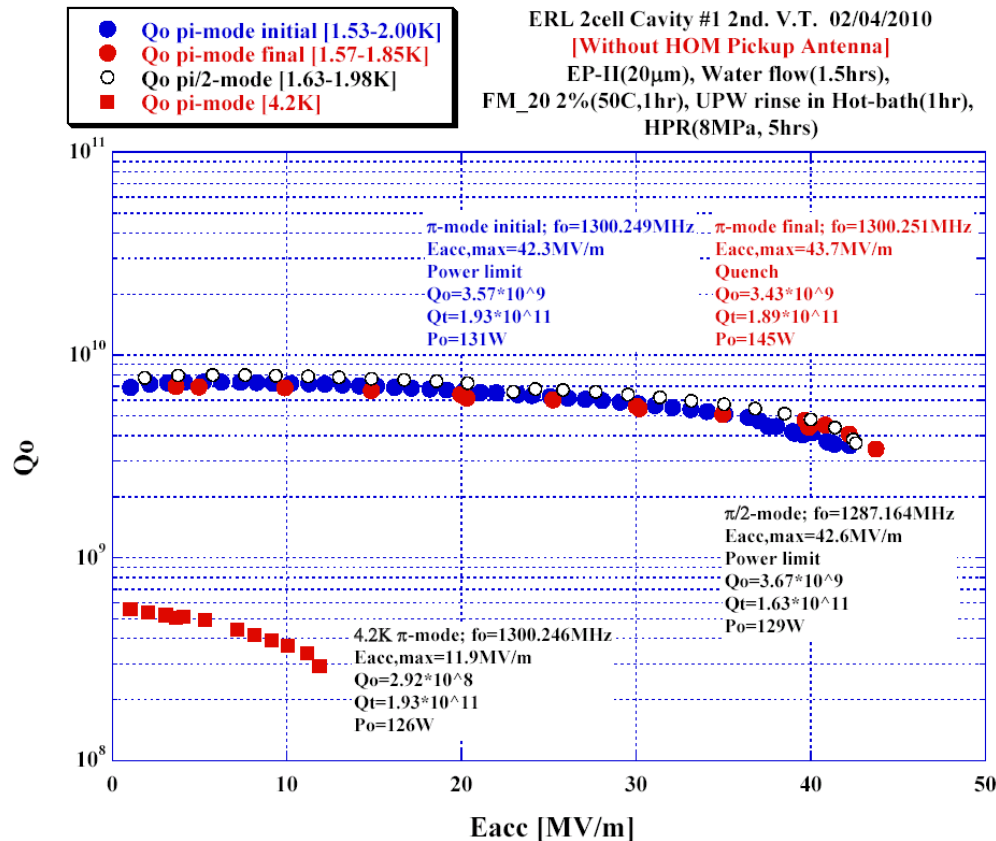
2nd V.T. with HOM pickup probe will be done April 2010.



Two step test for both cavities: (1) Without HOM pickup probe, (2) With HOM pickup probe.

To estimate the cavity performance (EBW) and the HOM coupler performance (RF design).

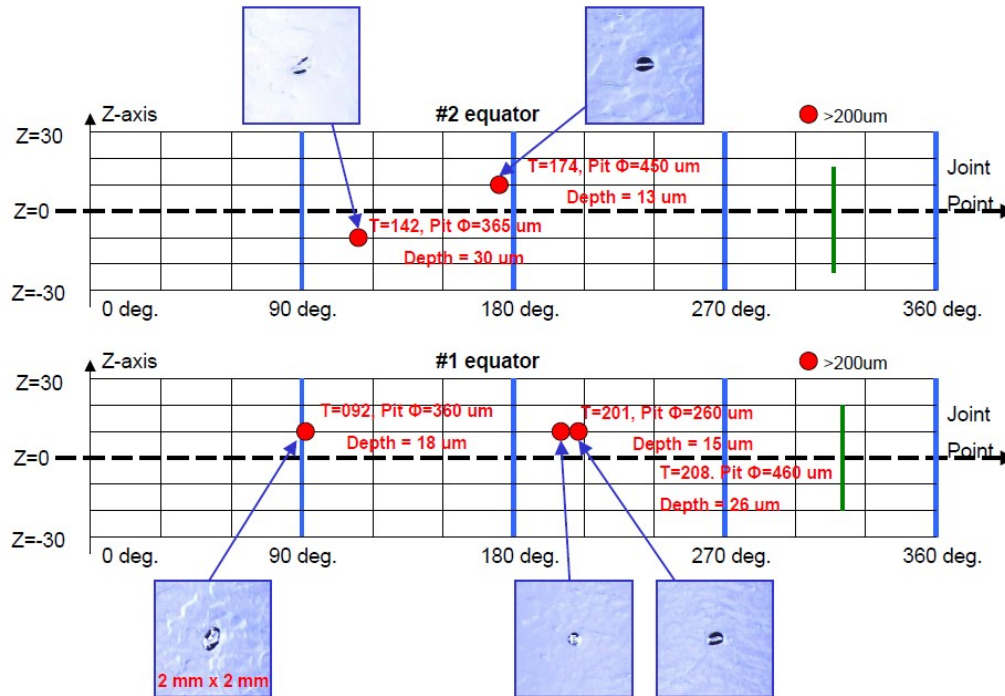
Vertical test without HOM pick-up



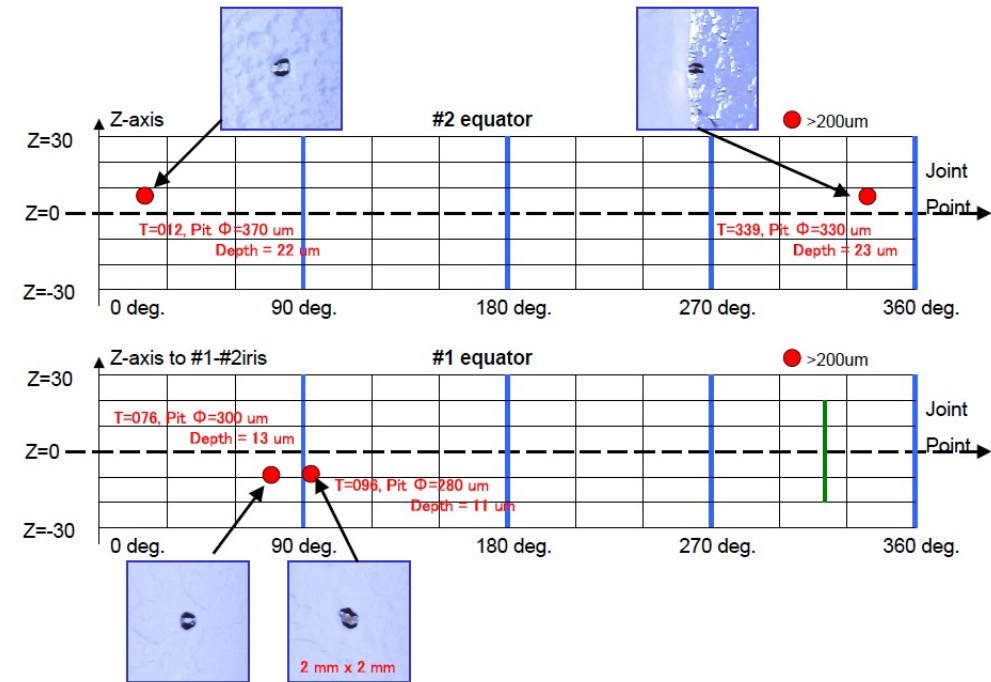
- Two ERL injector 2-cell cavities achieved $E_{acc} = 43.7$ MV/m (#1) and $E_{acc} = 40.9$ MV/m (#2) without HOM pickup probe.

Inspection after vertical test

ERL injector 2-cell cavity #1

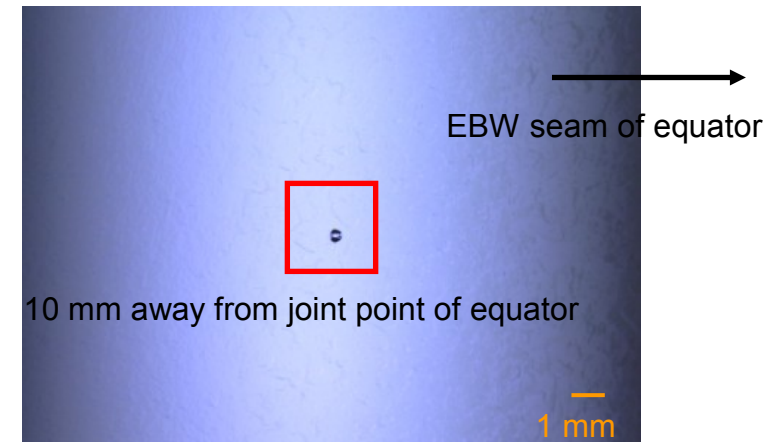


ERL injector 2-cell cavity #2

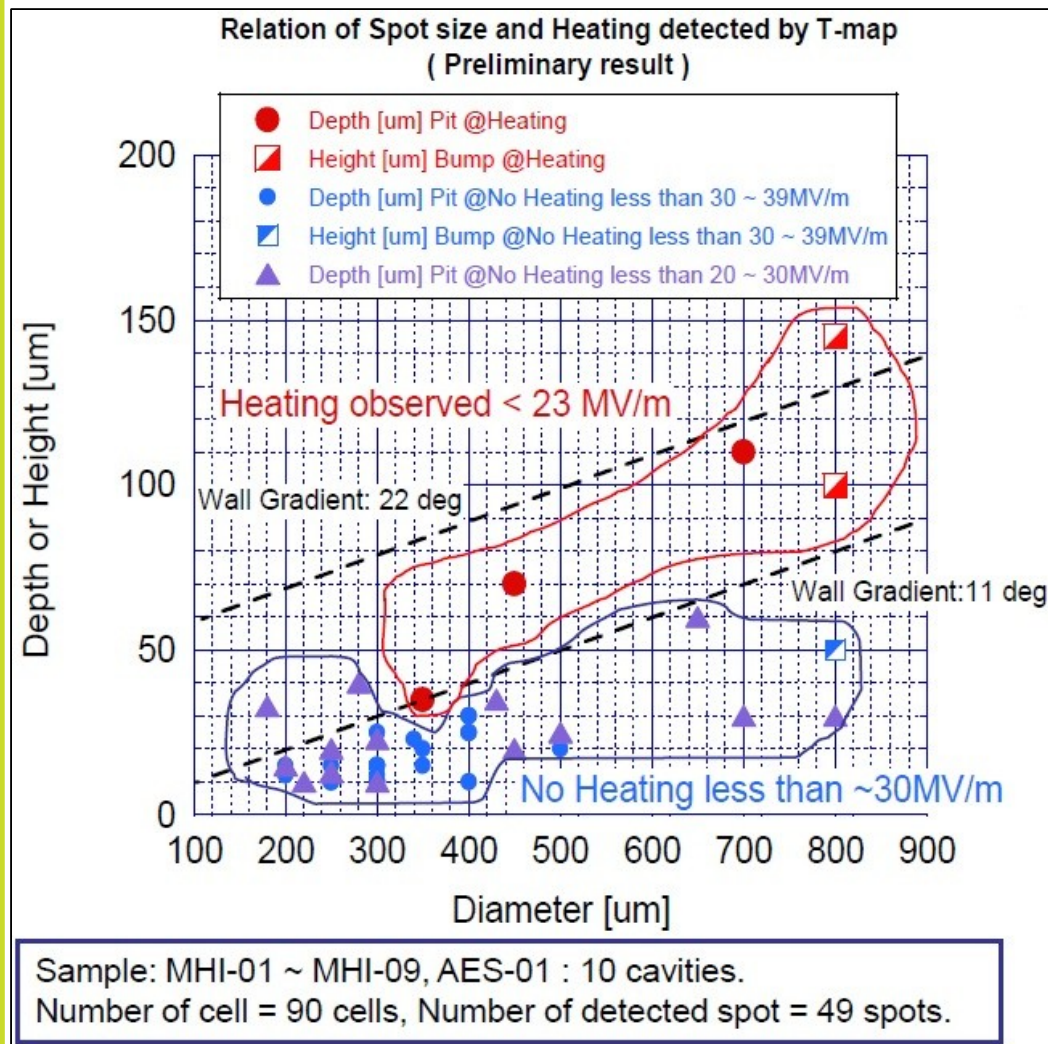


Both cavities have the suspicious spots outside the weld area.
But: these spots did not heat up to $E_{acc} = 41 \sim 43$ MV/m.

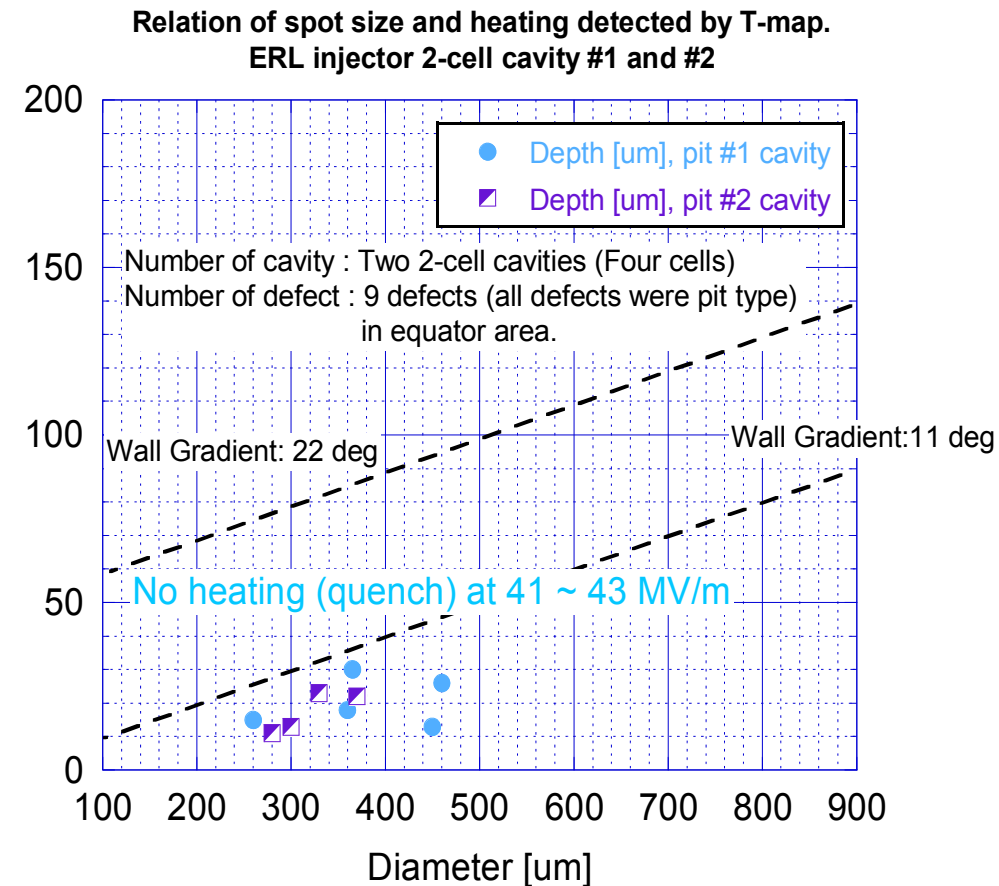
Example : #2 cavity, 1-cell equator, outside weld area, $t=076$ deg.



Correlation of geometrical spot size and heating (rough estimation)

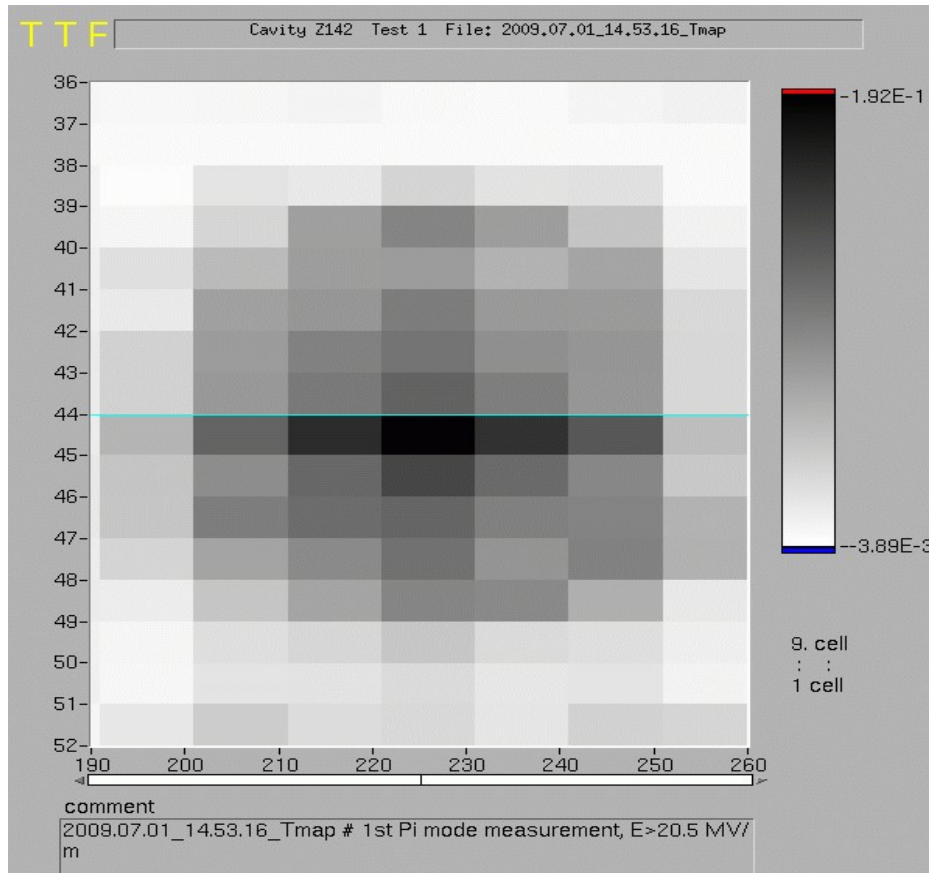


K.Watanabe, SRF09



The information of geometrical spot size and the field was updated.

Tmap \leftrightarrow Opt. Inspection: Z142

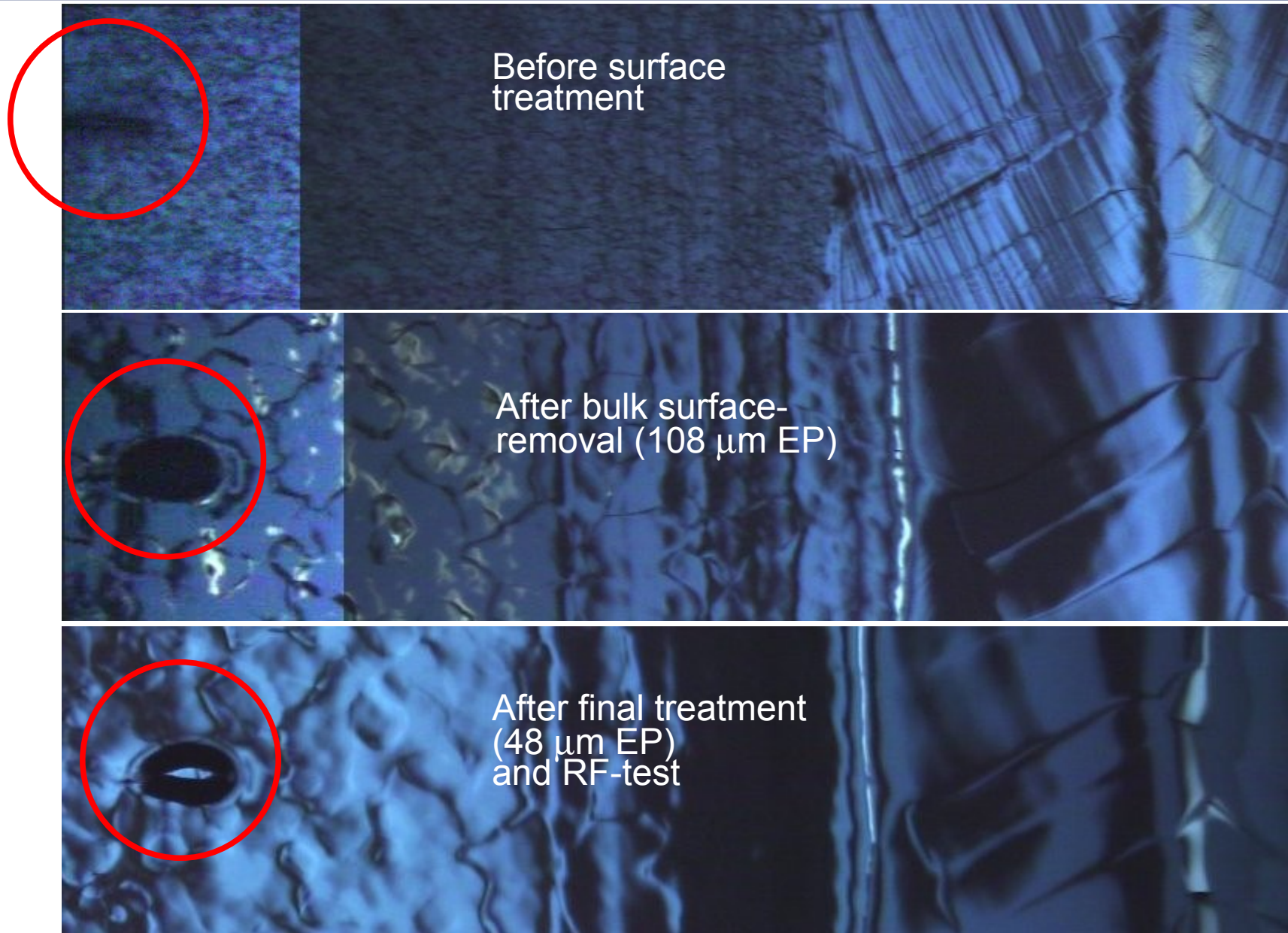


Hotspot during T-map
at equator 6 in π -mode,
Limited by quench
at 20.6 MV/m

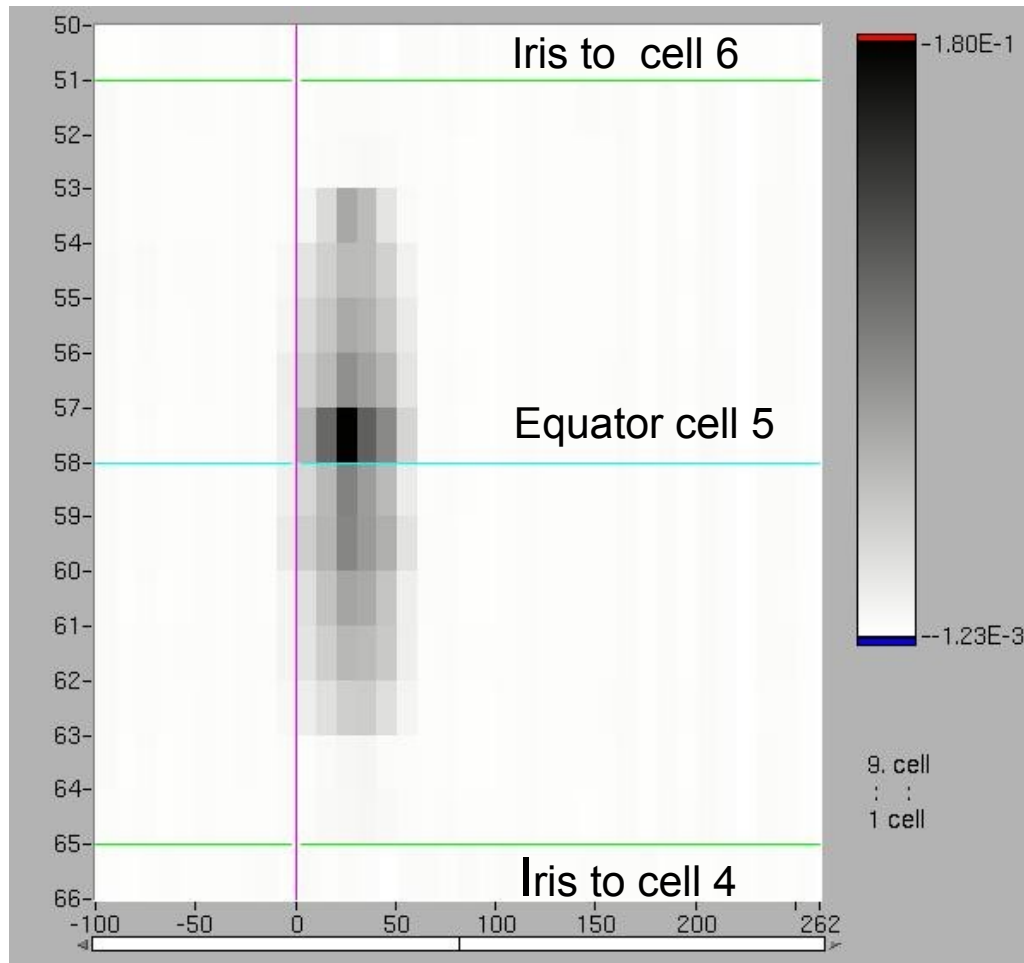


Same region inside cavity after
RF-test

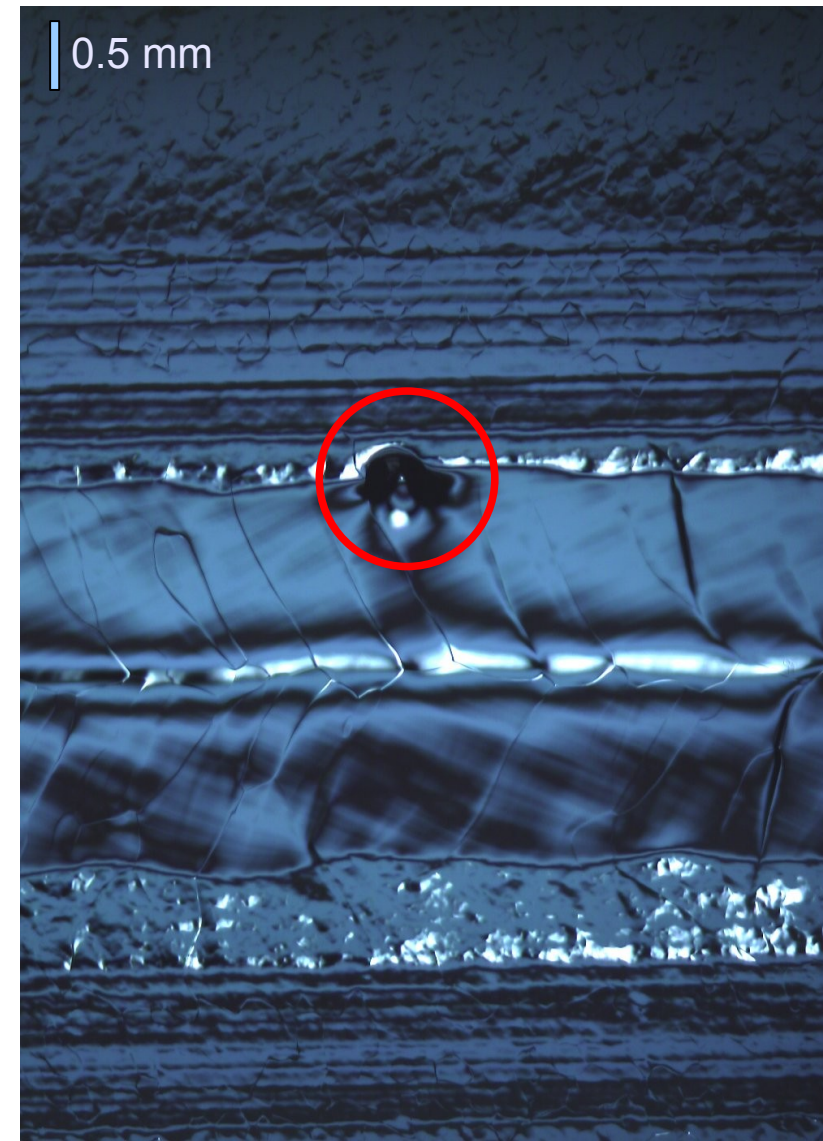
Evolution of defect in Z142



Comparison: Tmap \leftrightarrow opt. inspection



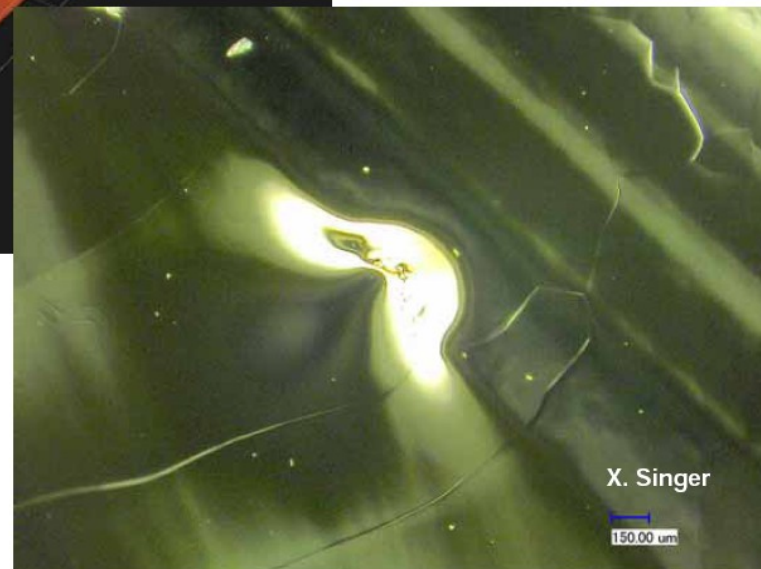
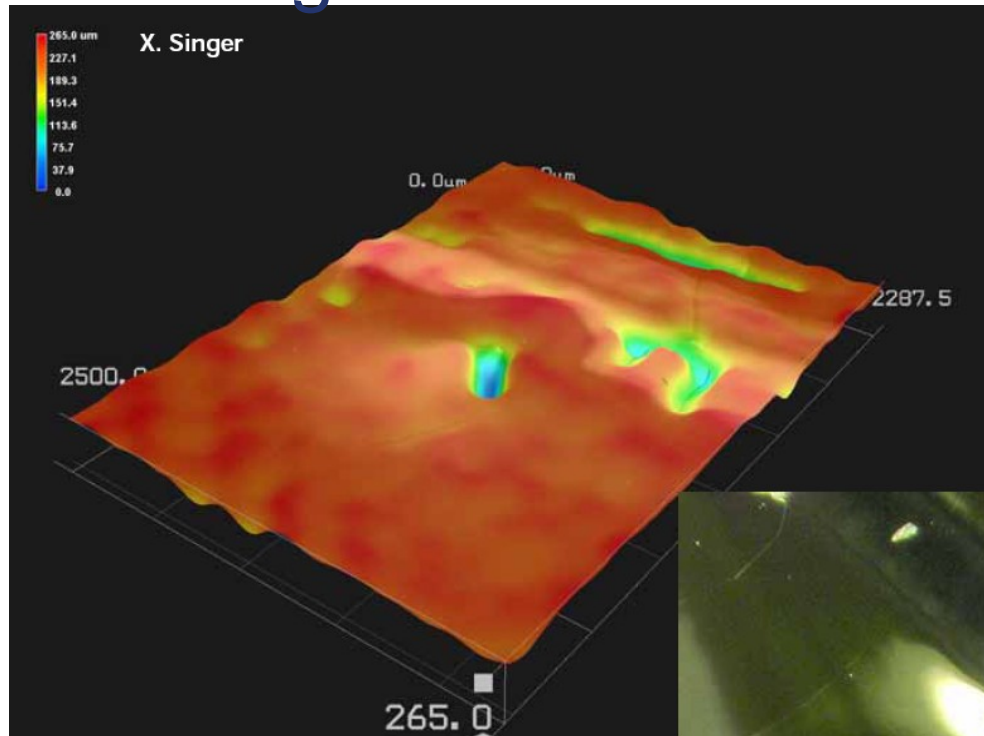
Z130: Quench in $3\pi/9$ -mode at
22 MV/m



Picture of same location

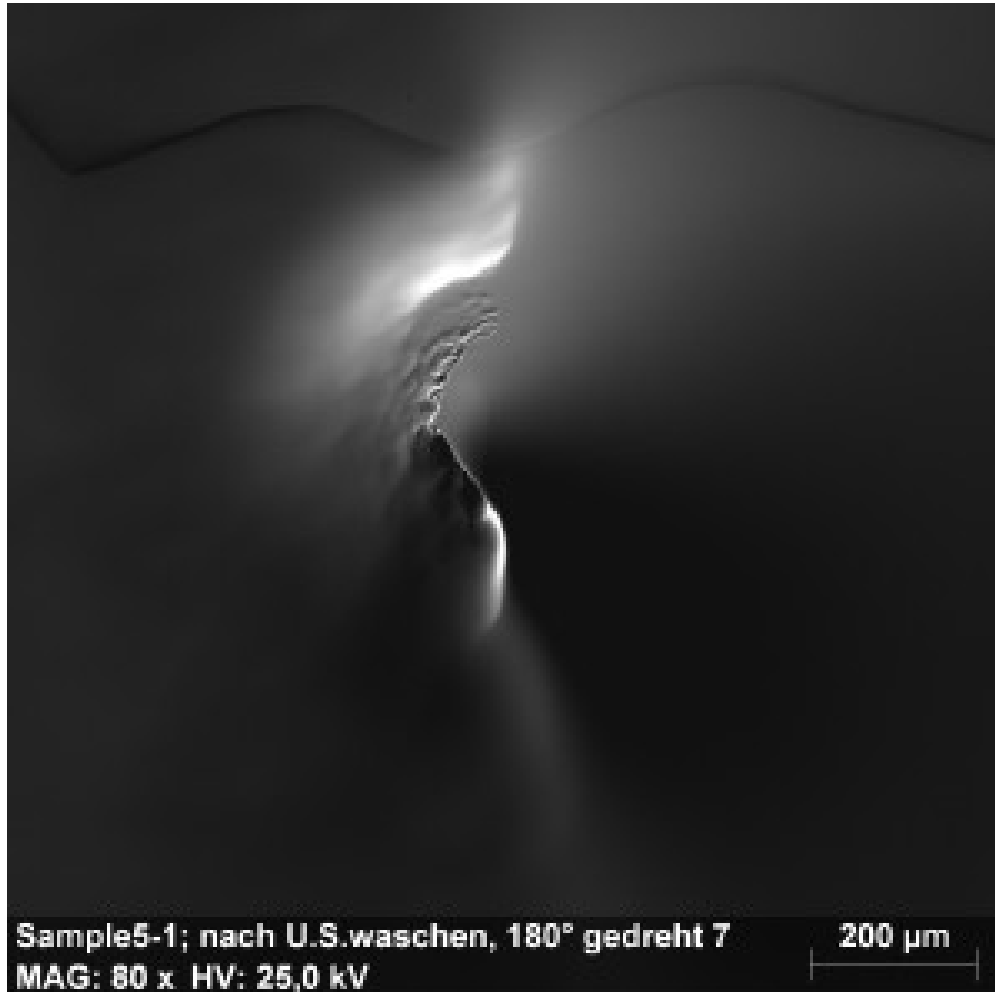
Defect in Z130

- Cavity has been cut for further investigation
- EDX: no foreign material

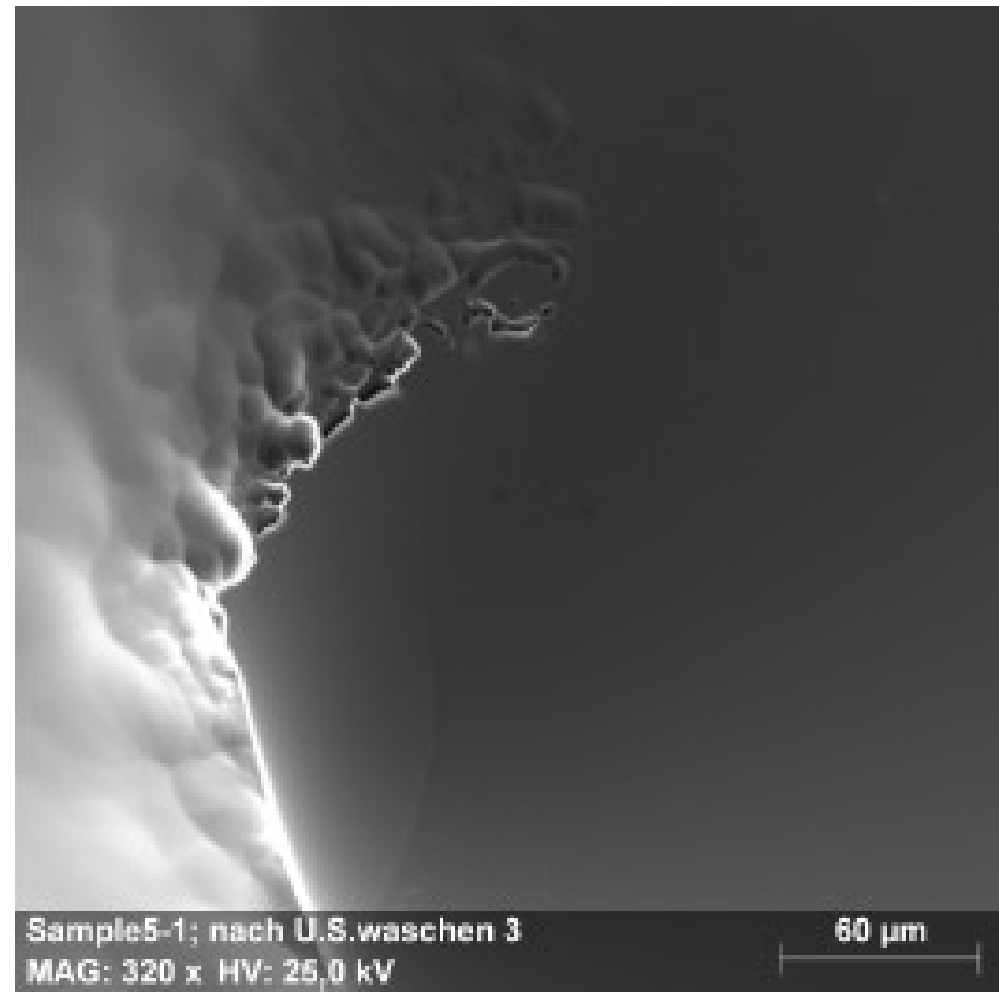


W. Singer, X. Singer, A. Ermakov

SEM-Picture of the defect



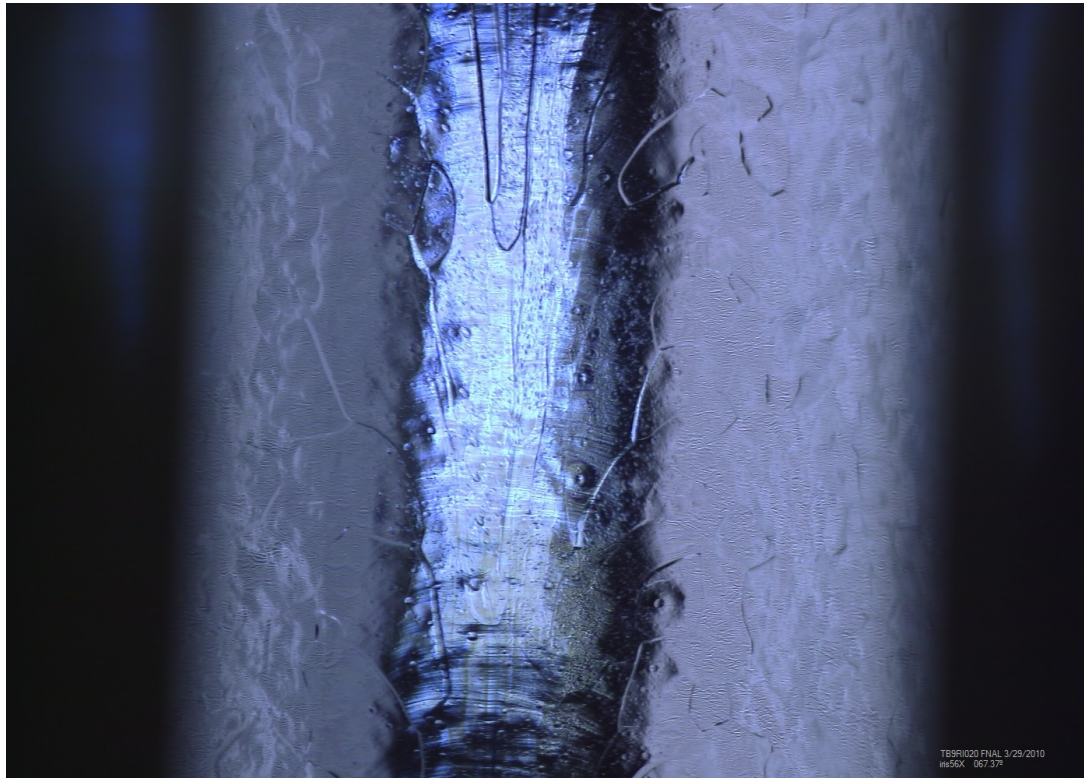
[D.Reschke]



Sharp ridges at edge of defect

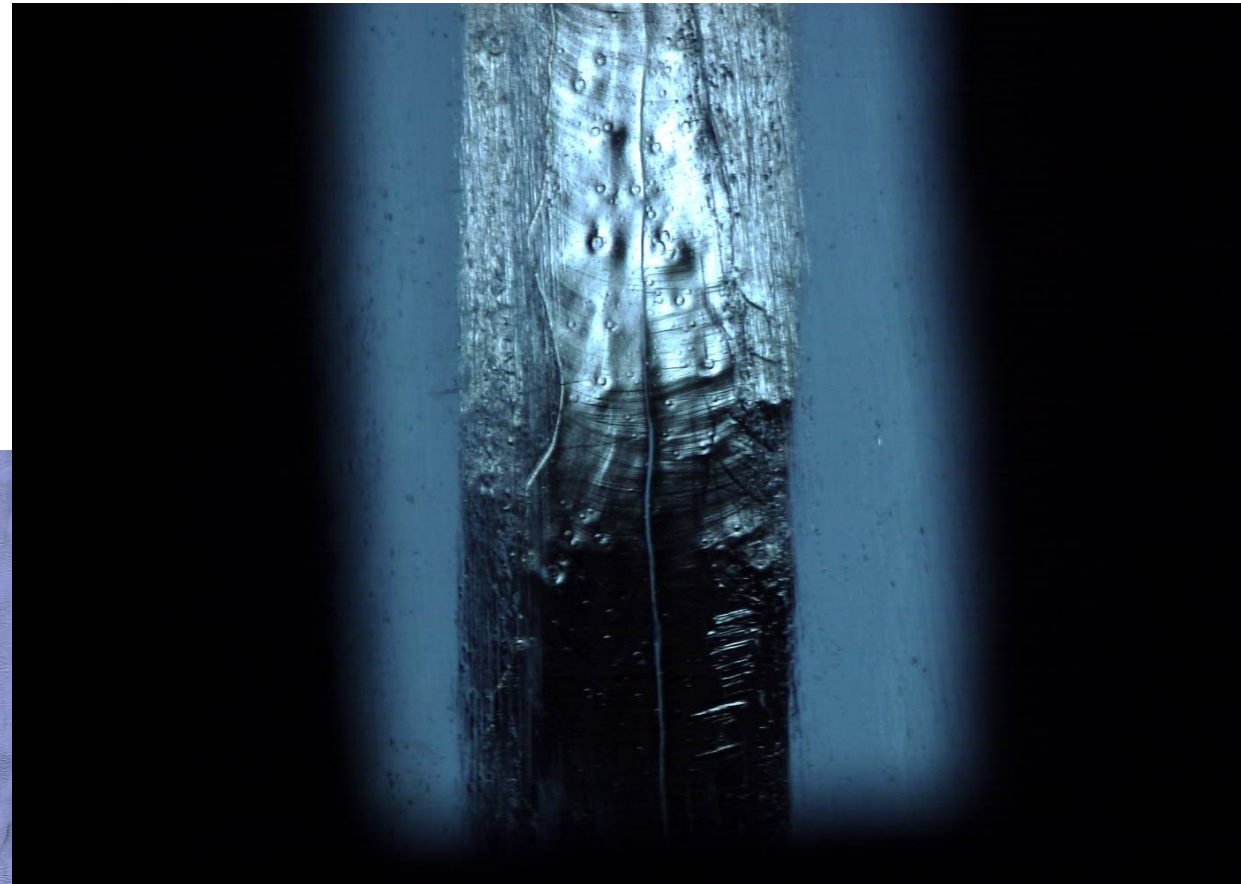
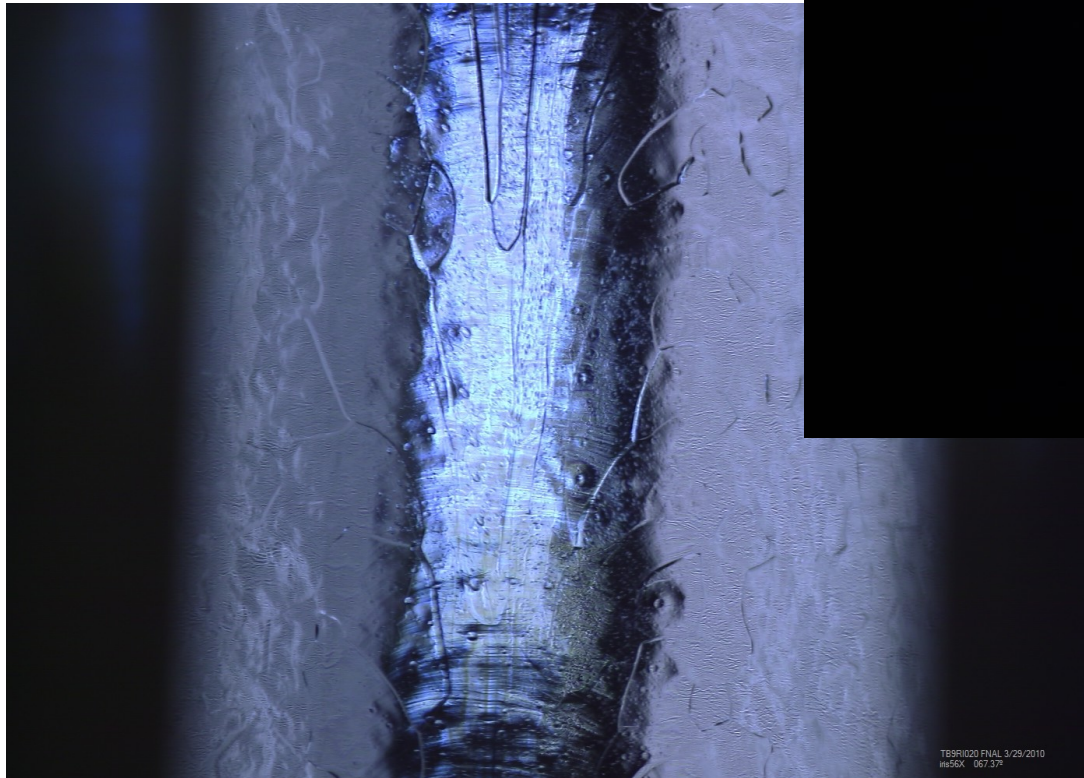
Iris in „as received“ condition

FNAL: TB9RI020, iris 5-6



Iris in „as received“ condition

FNAL: TB9RI020, iris 5-6

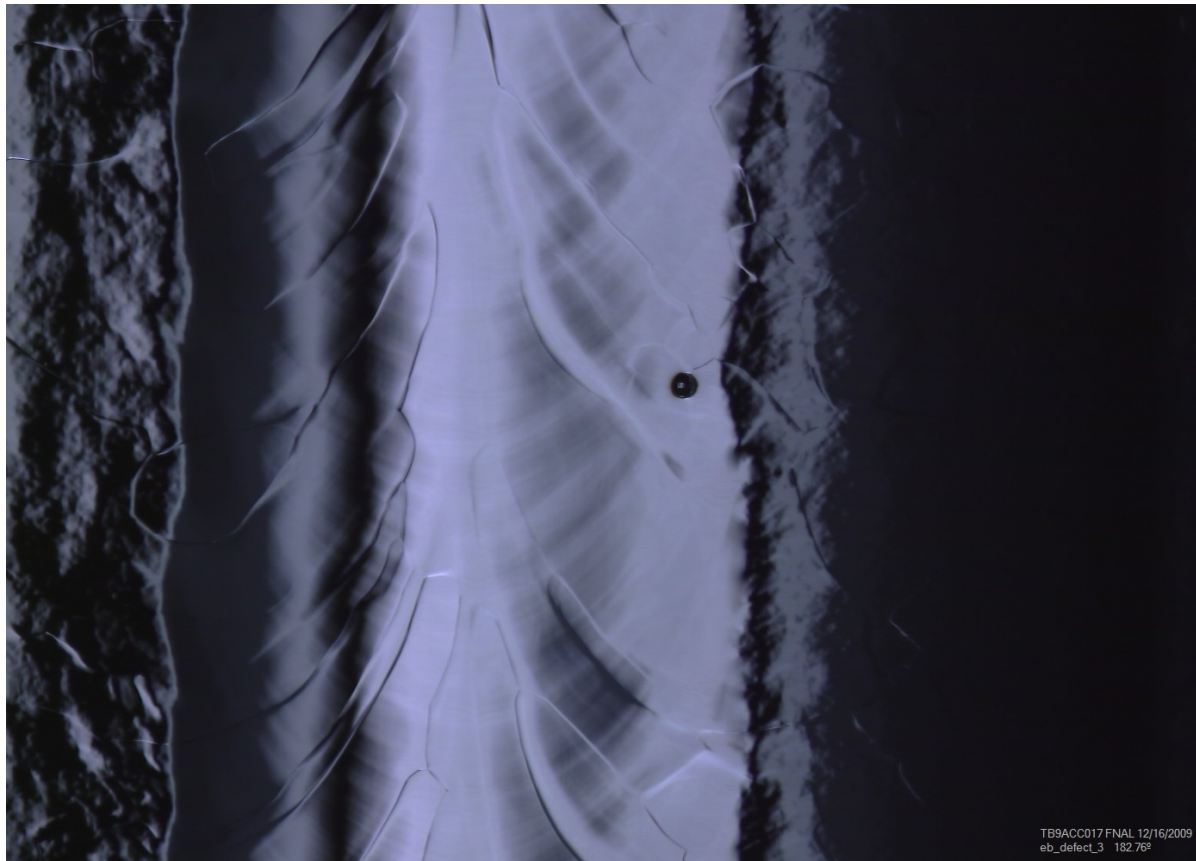


DESY: AC156, iris 3-4

„Pimples“ observed before
chemical treatment

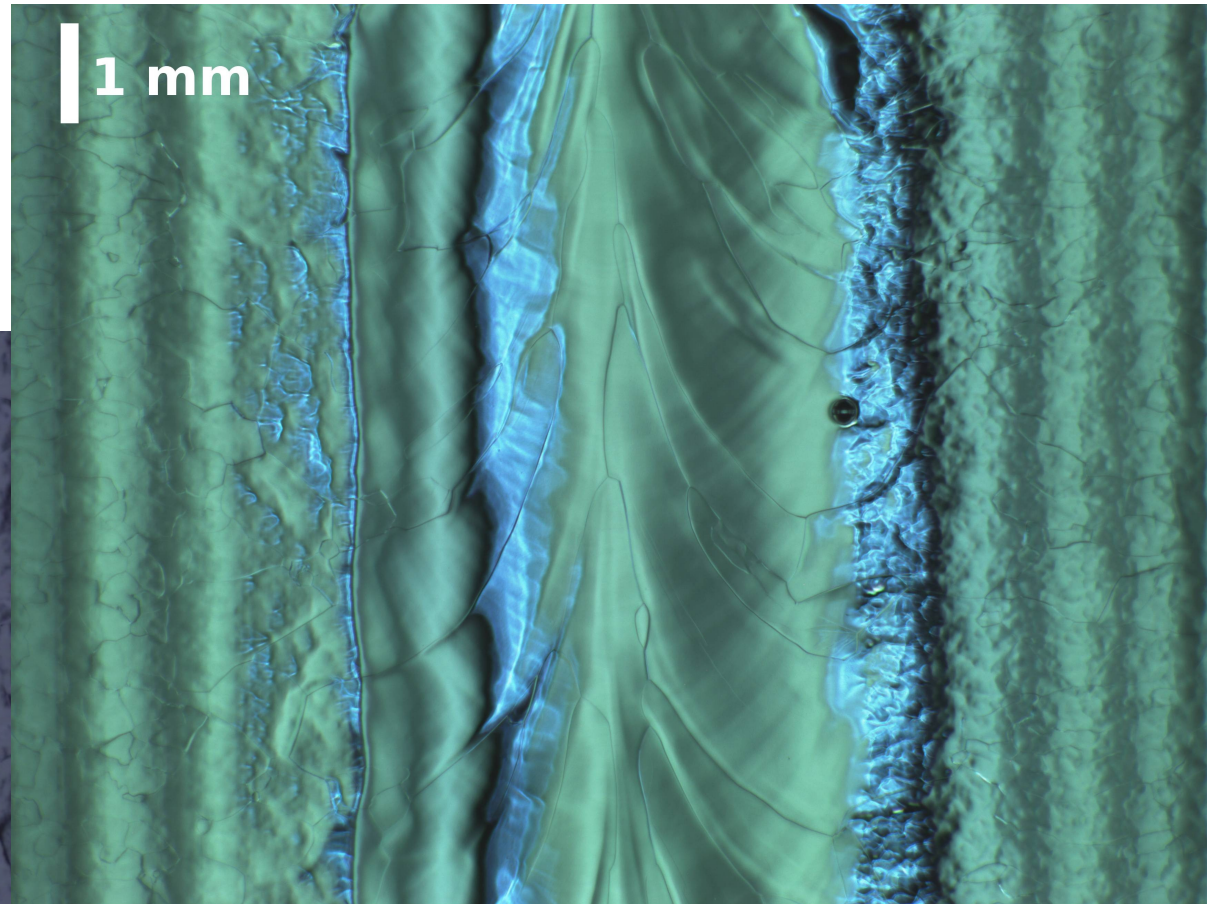
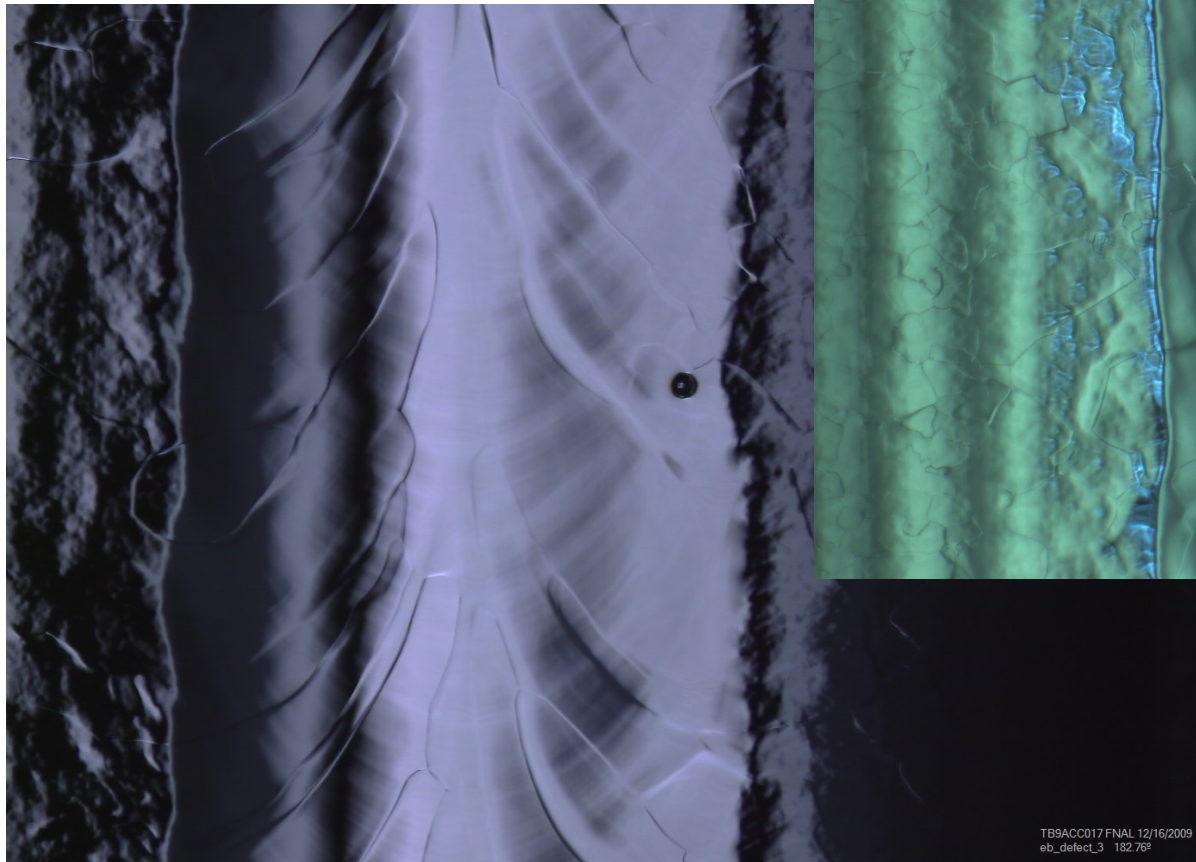
Defects at edge of welding seam

FNAL: TB9ACC017,
quench location



Defects at edge of welding seam

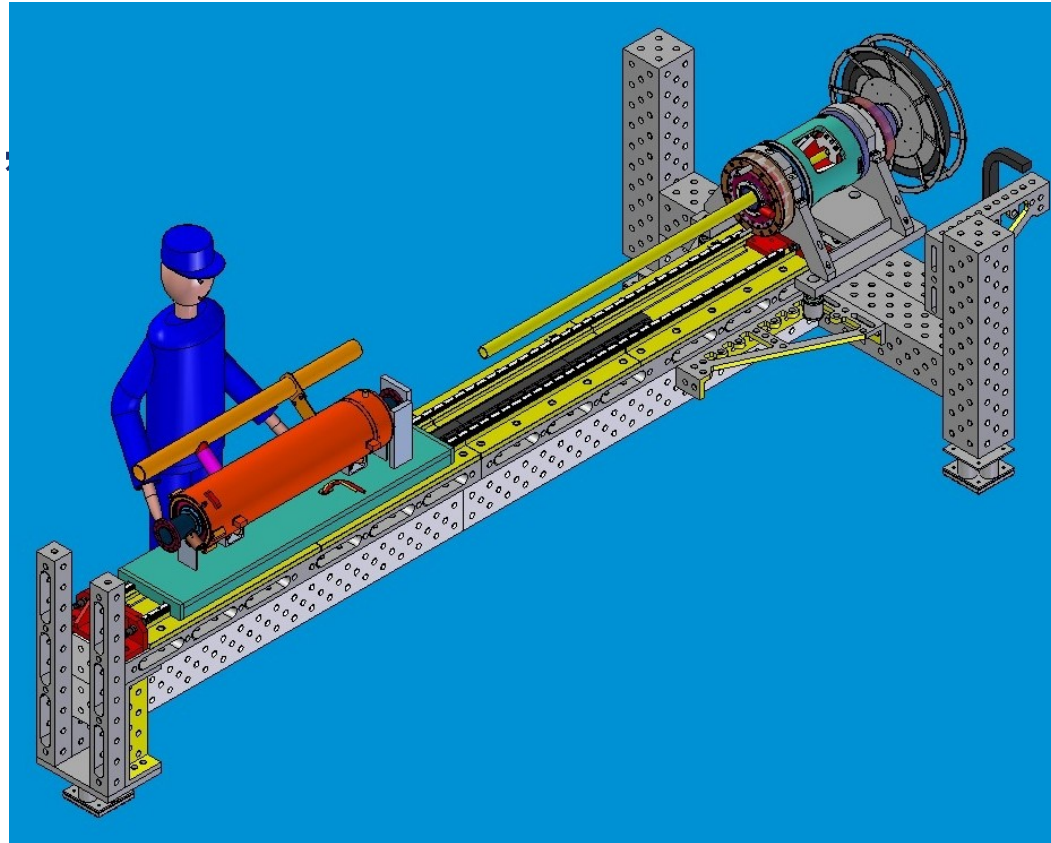
FNAL: TB9ACC017,
quench location



DESY: AC120, no
Tmap done yet

Automated optical inspection

- Inspection of welding seams of a 9-cell cavity:
 - ~1500 pictures
 - „manual“ inspection takes up to 2 working-days
- Design of automated setup at DESY
- High precision positioning, high reproducibility
- High speed: ~2-3h/cavity
- Easy to operate
 - Possible application in production environment



Summary

- Optical inspection in good use at labs around the world
- Increasing data-set of inspected cavities available
- KEK-analysis hints for shallow pits/broad bumps to be less harmful
- Inspection in consecutive preparation steps
→ formation and evolution of defects
- „Pimples“ observed on some irises before chem. treatment
- Automation expected to speed up and facilitate inspection process
- Tendency for defects to sit on the edge of welding seam?
 - Possible explanations?