Deutsches Elektronen-Synchrotron
A Research Centre of the Helmholtz Association

Surface Analysis of the Quench Area Sample of Cavity Z111

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More as 60 CVs have been produced at DESY in last 5 Years

Cavities of productions No. 6: XFEL preparation at DESY after main EP at DESY or at the industry (110 or 140 µm) followed by

or

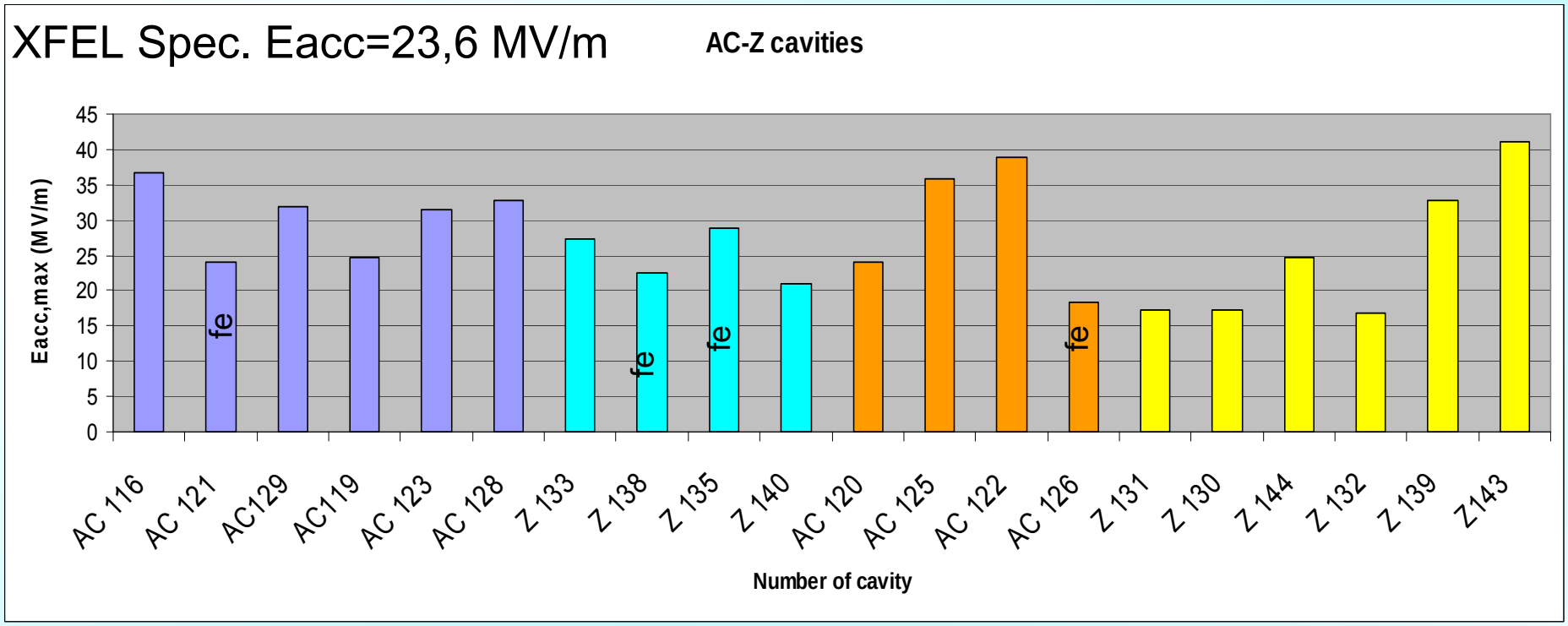
Fine Ep:
Tuning
Final ep (40 µm)
HPR
Installation of FMS
TI-cone rings welding
FM control/ tuning
Tank welding
Removal of FMS
Installation of probes
(HOM /Pick Up)
HQ Antenna (Fixed coupling)
HPR
120 C bake
Acceptance test @ 2K
Ready for module

or

Flash BCP:
Tuning
Installation of FMS
TI-cone rings welding
FM control/ tuning
Tank welding
Removal of FMS
Flash BCP (10 µm)
Installation of probes
HOM /Pick Up
HQ Antenna (Fixed coupling)
HPR
120 C bake
Acceptance test @ 2K
Ready for module

** FMS= field profile measurement system

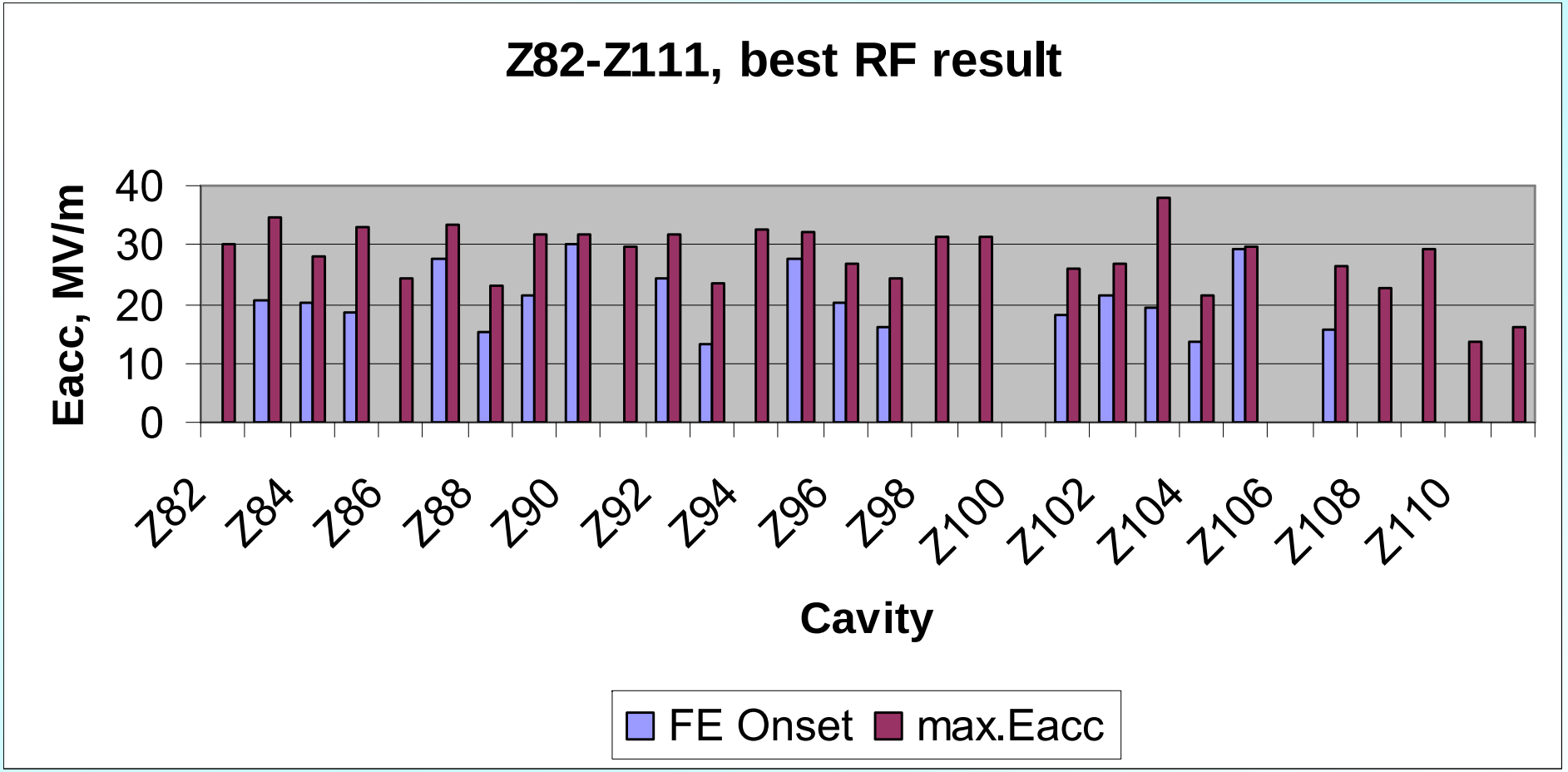
Cavities of productions No. 6



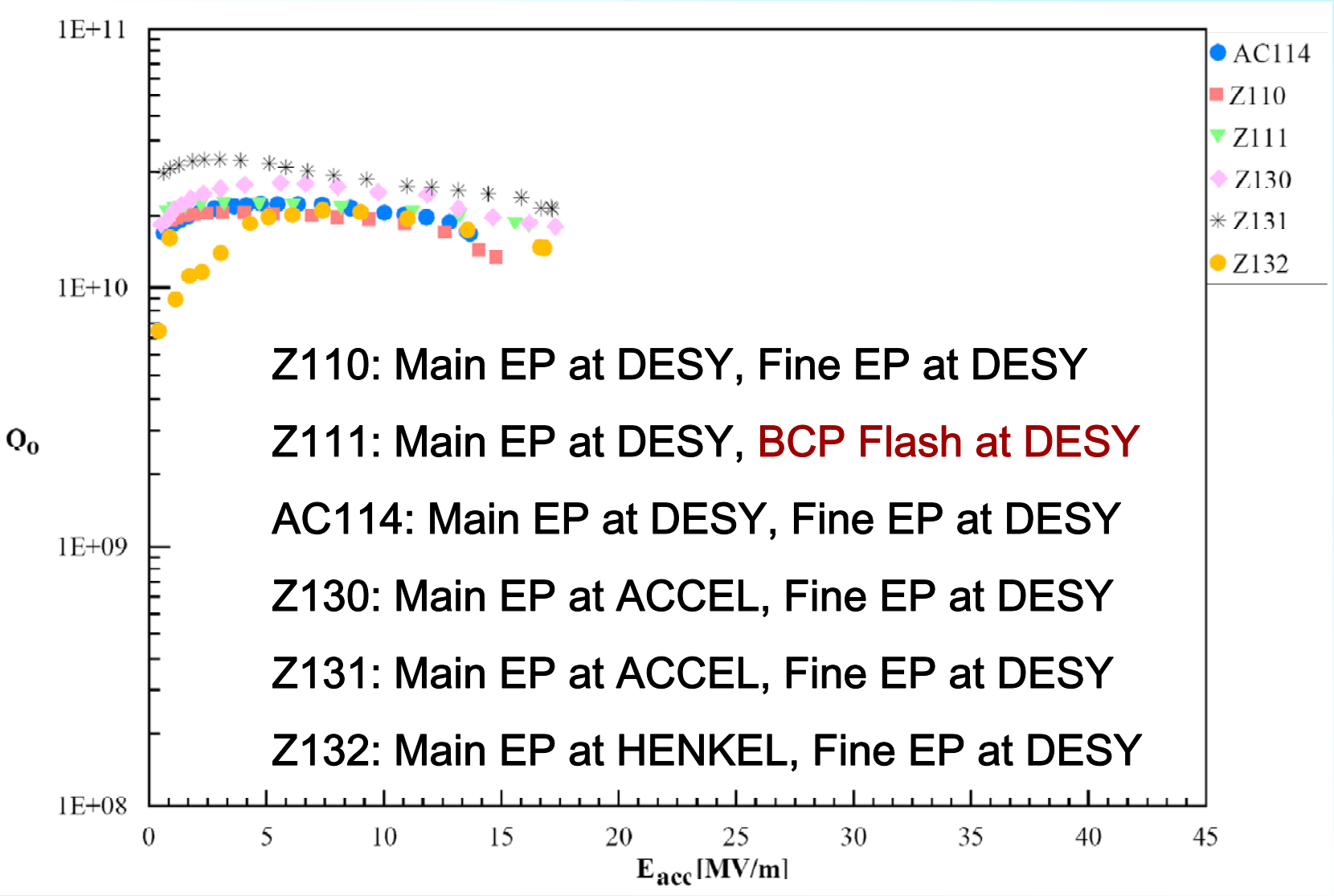
AC BCP Flash	Z BCP Flash	AC EP	Z EP
E_{acc}=30,2 +/- 4,9	E_{acc}=24,9 +/- 3,8	E_{acc}=29,3+/- 9,7	E_{acc}=24,9+/-4,4

- Max gradient, FE marked, if starts below 20 MV/m
- With He-vessel
- Without HOM pick up

Cavities of productions No. 4 (without He-Vessel)

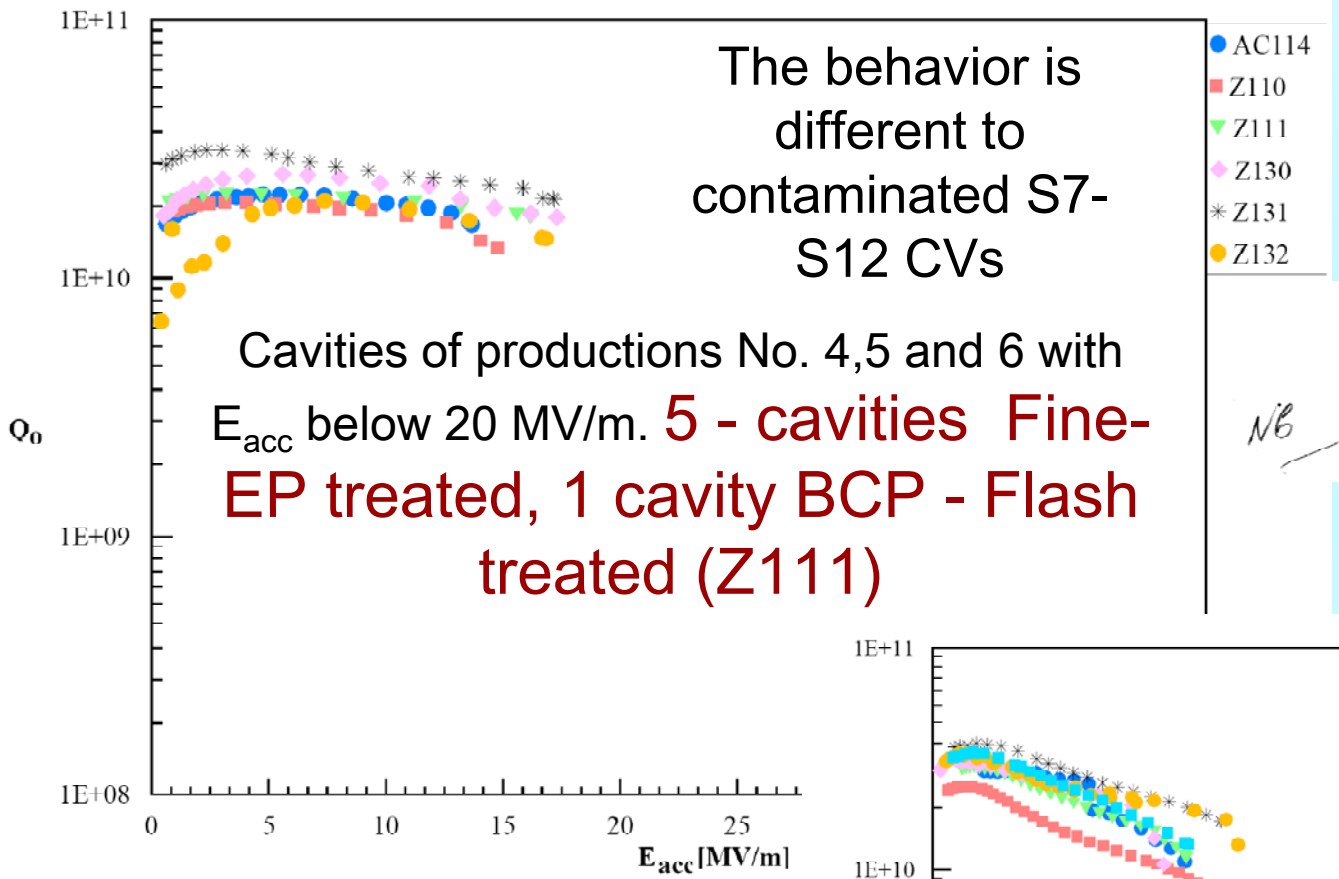


Statistic of the Eacc in the vertical test as best result



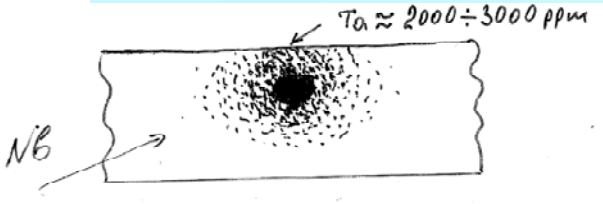
Cavities of productions No. 4,5 and 6 with E_{acc} below 20 MV/m. 5 - cavities

Fine-EP treated, 1 cavity BCP - Flash treated (Z111)

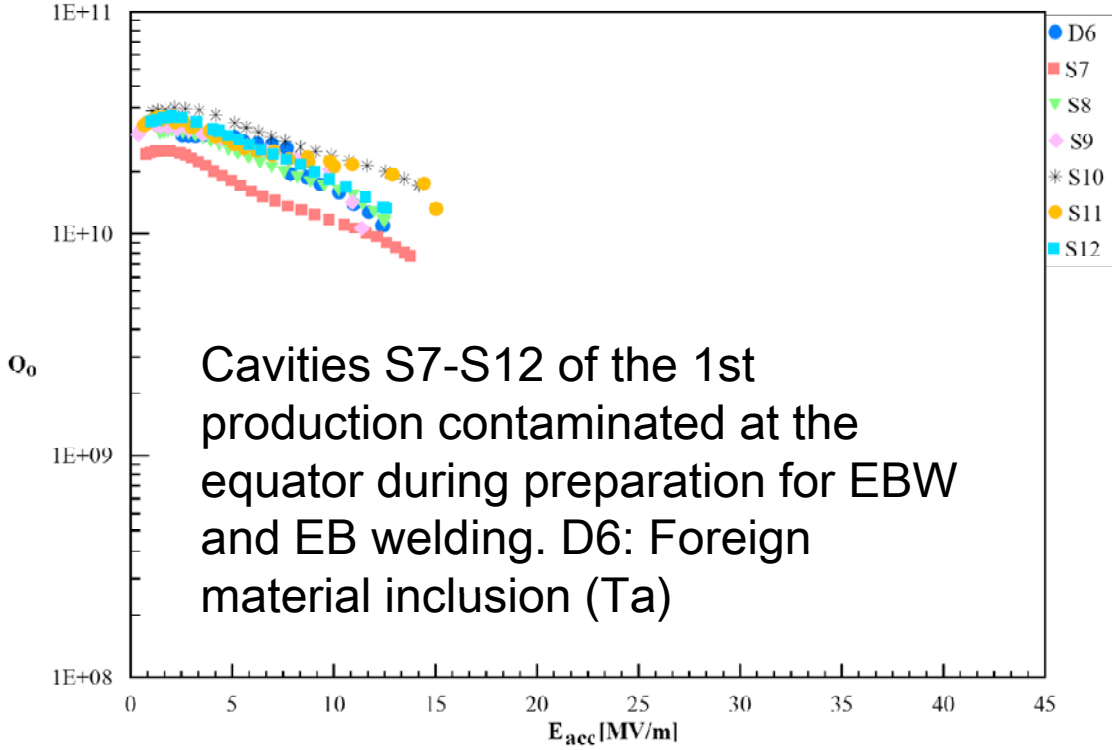


The behavior is different to contaminated S7-S12 CVs

Cavities of productions No. 4,5 and 6 with E_{acc} below 20 MV/m. 5 - cavities Fine-EP treated, 1 cavity BCP - Flash treated (Z111)



Ta inclusion in the cavity D6



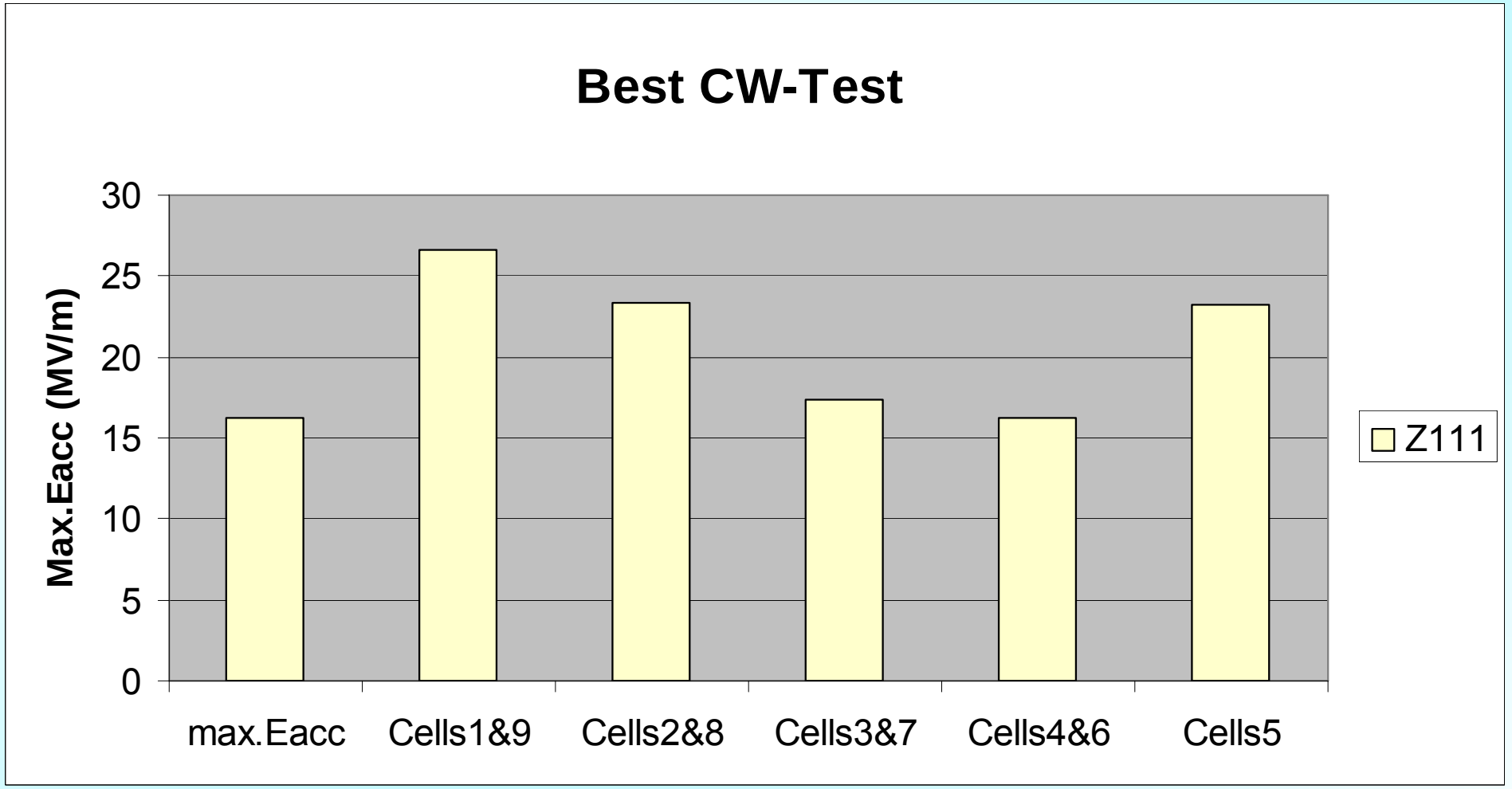
Cavities S7-S12 of the 1st production contaminated at the equator during preparation for EBW and EB welding. D6: Foreign material inclusion (Ta)

The phenomena for all five Z – cavities seems to be similar. Nevertheless the behavior seems to be different compare to S7-S12 cavities (abrasive particle imbedded), or D6 (Ta inclusion)

Z111 history from TTF database

Cavity Information				CW-Test Results						Power Rise Results											
														FE Onset							
Cavity	Production No.	Firm	Ingot No.	Removed Material [µm]	Cavity Status	Last HT [°C] before Test	Test Date	Test No.	Test Location	Max. Eacc [MV/m]	Q0 @ Max. Eacc	Temperature [K]	Limitation	@ 4E-4 [mGy/min]	@ 1E-2 [mGy/min]	Eacc @ Q0=1E+10	Lowest meas. Q0	Q0 @ Eacc=23.5 [MV/m]	Lowest meas. Eacc	Eacc @ (100W/9)*cell#	Lowest Loss> (100W/9)*cell#
Z111	4	Zanon	21	154.8	ep+	800	24.Nov.06	1	v1	16.15	1.8E+10	2	bd			16.15	1.8E+10				
										16.19	1.8E+10	2	bd			16.19	1.8E+10				
				Aim: test of cavity | first test						**Result:** not ok: LOw gradient without FE								**Remark:** No Q disease. Only 16.2 MV/m, Q=1.8E+10, limited by quench, without FE.Processing for 1.5 hour not effective.MM:all cells limited by quench, fields 16.2 (cells 4&6) to 26.6 MV/m (cells 1&9).Low x rays seen in modes 8/9 and 3/9 pi.					
				154.8	ep+	800	07.Dec.06	2	v1	16.03	1.6E+10	2	bd			16.03	1.6E+10				
				Aim: test of cavity | new test | Rotating T mapping mounted						**Result:** ok								**Remark:** Cavity is limited by quench at 16.0 MV/m,Q=1.7E+9, without x rays., like in previous test. T mapping done showed that quench is in cell 6 (like one could expect from previous modes measurement) at eqator area.New BCP or EP is proposed now for this cavity.					

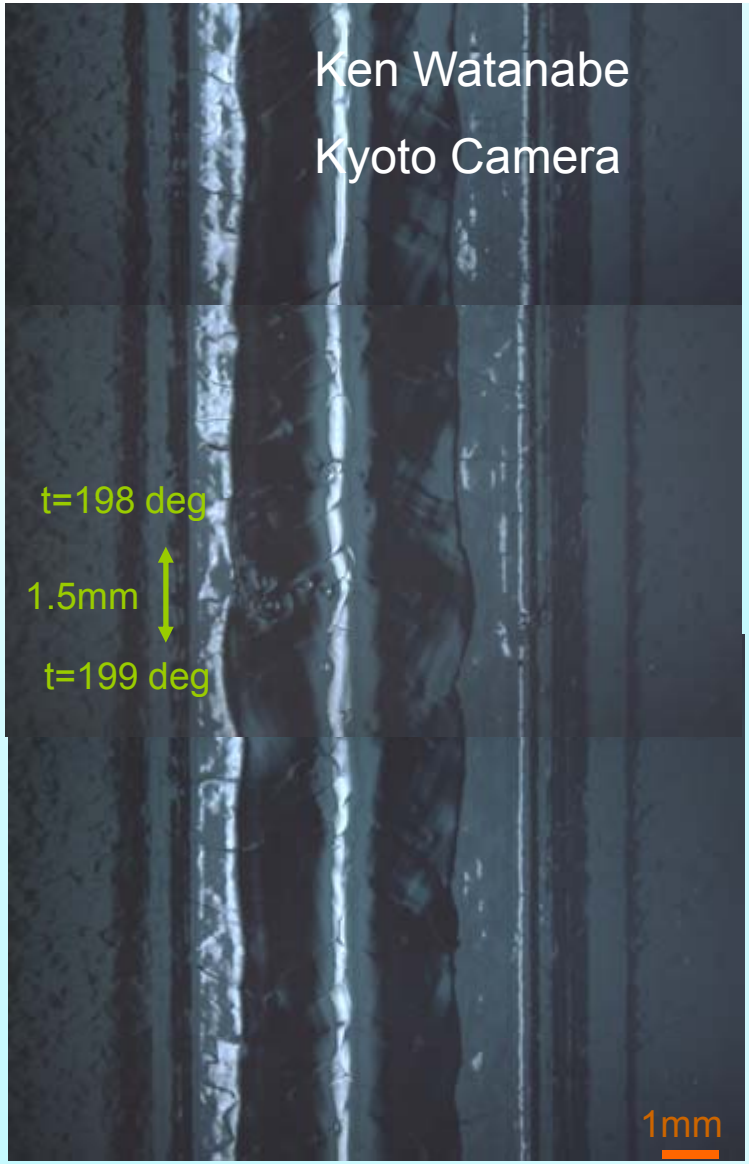
Totally 155µm removed



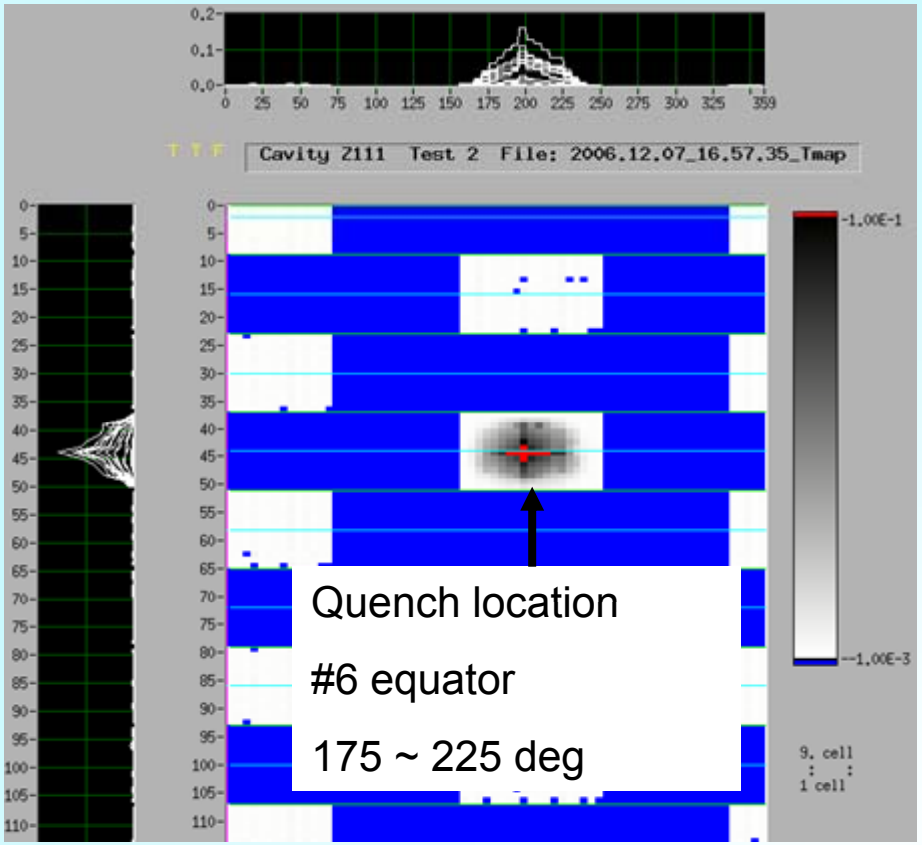
Mode measurement Z111; bd without FE

TESLA cavity Z111: #6 cell equator

#6 equator, t=193 ~ 204 deg



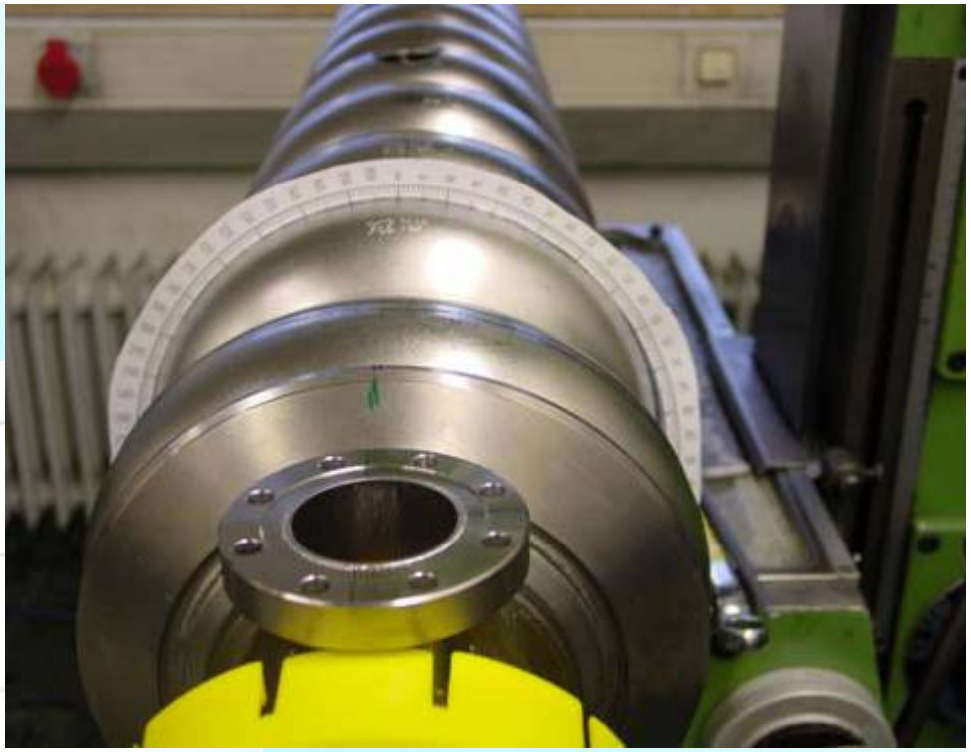
T-map data in test 2, 16.0 MV/m

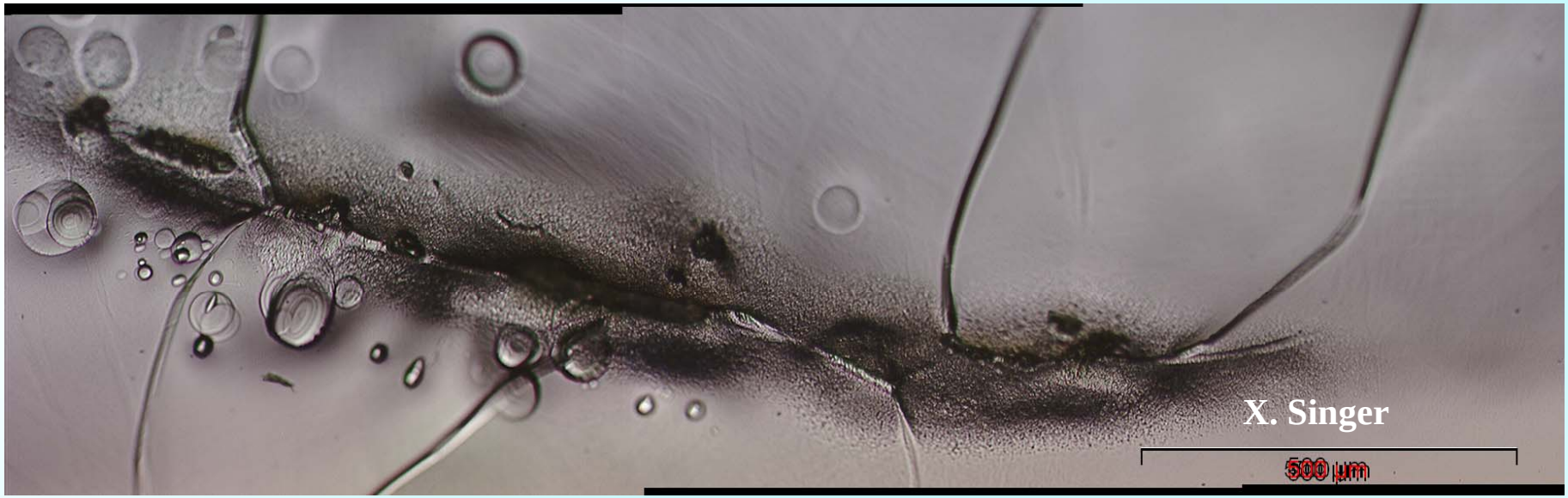


group of beads(?) with 1.5mm wide were observed.

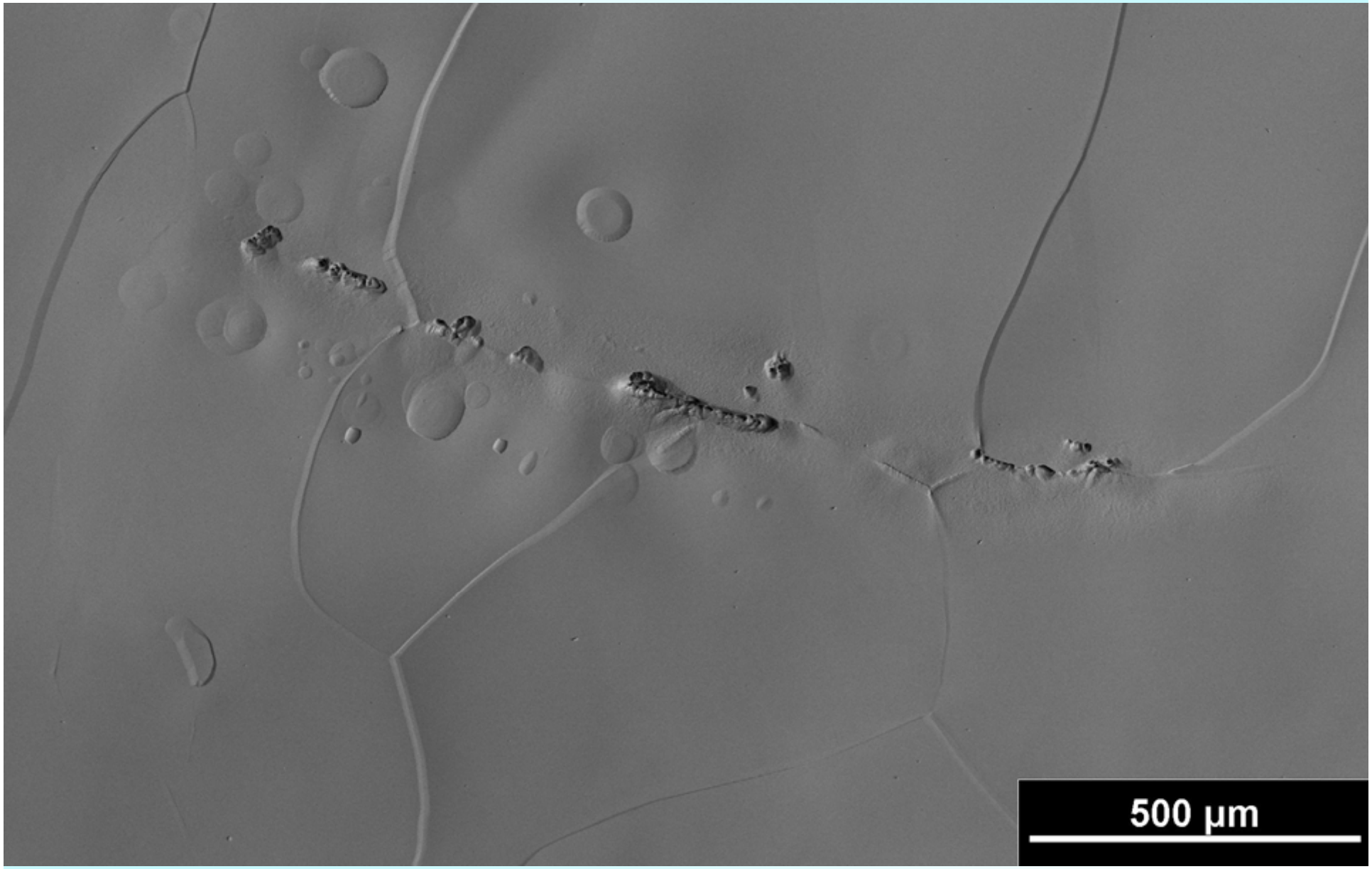
Z111, Cell 6, sample 1, 200°.

Quench location

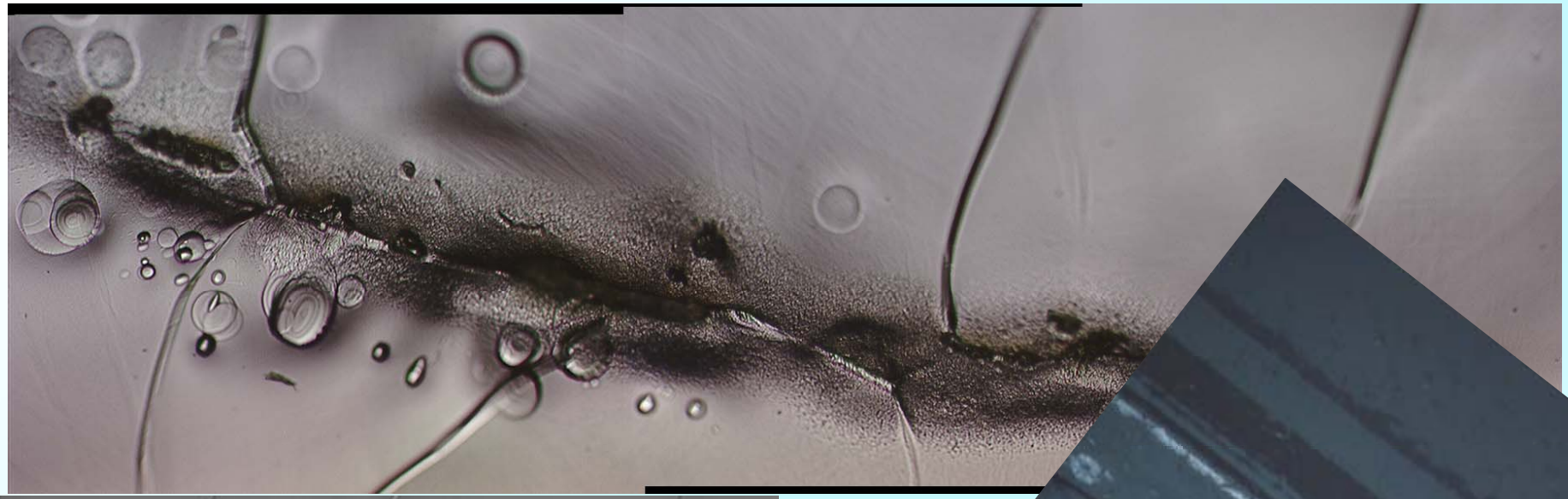




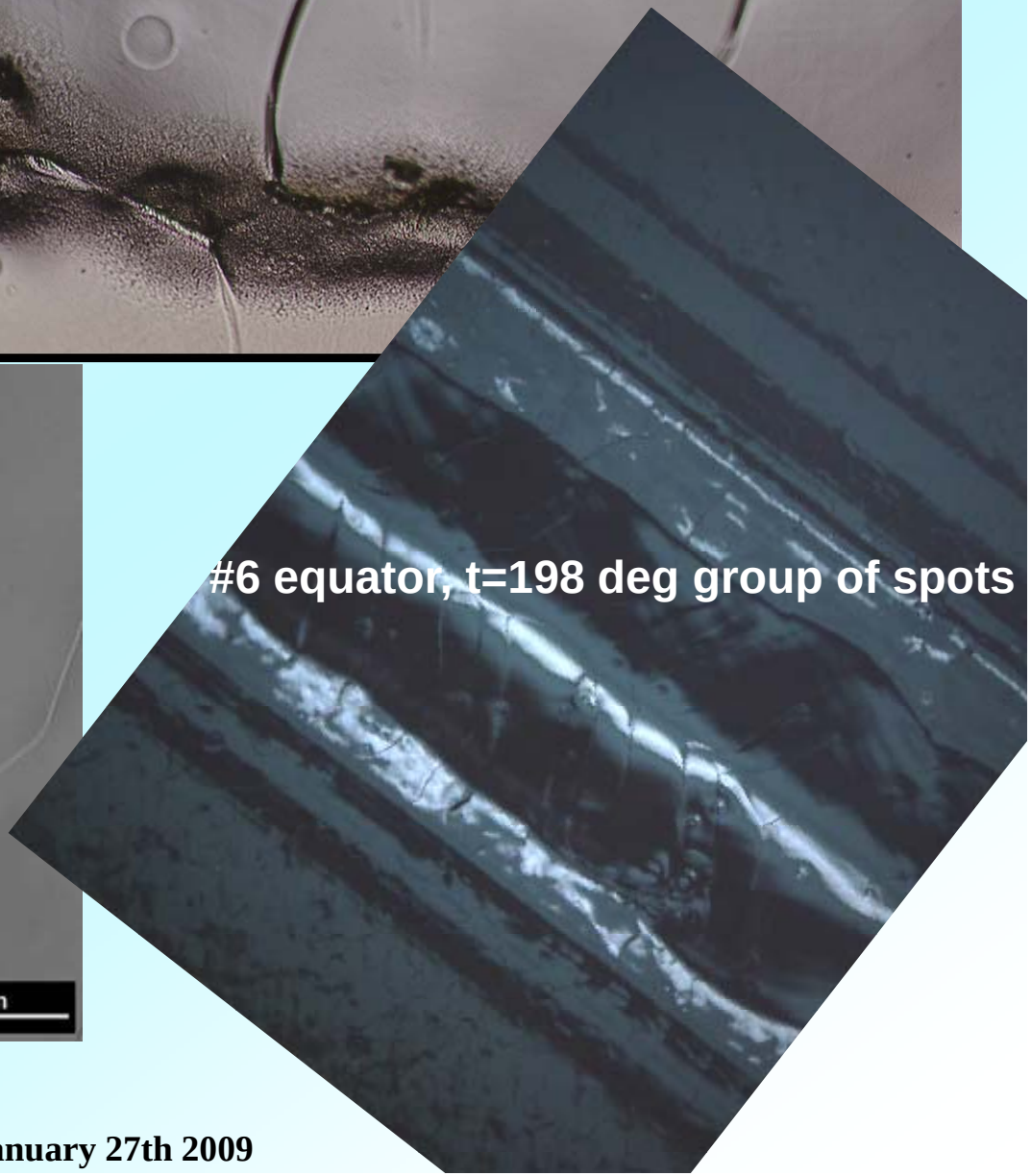
Light microscope. Quench location. Holes along grain boundaries. Cat's eyes.

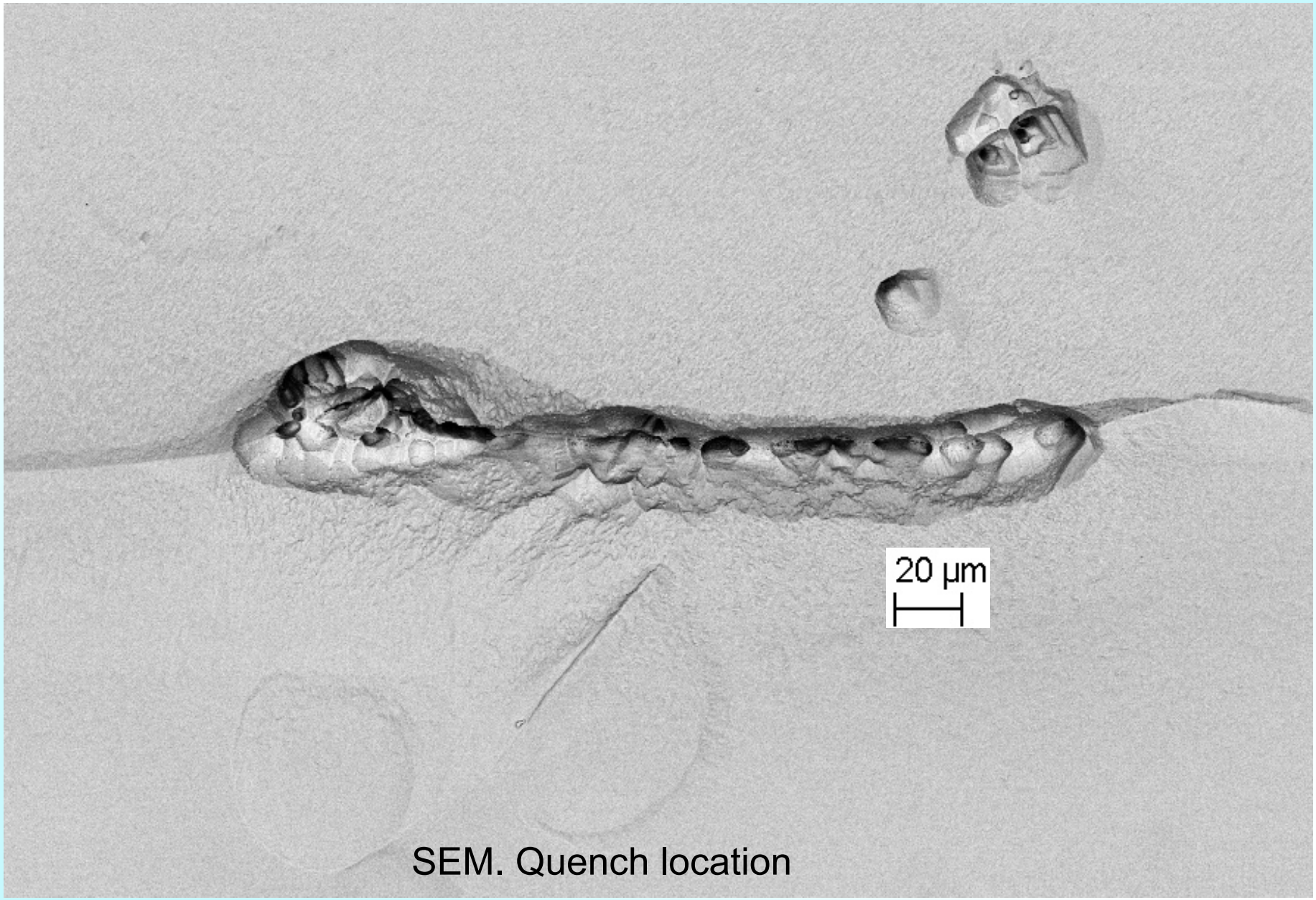


SEM. Quench location

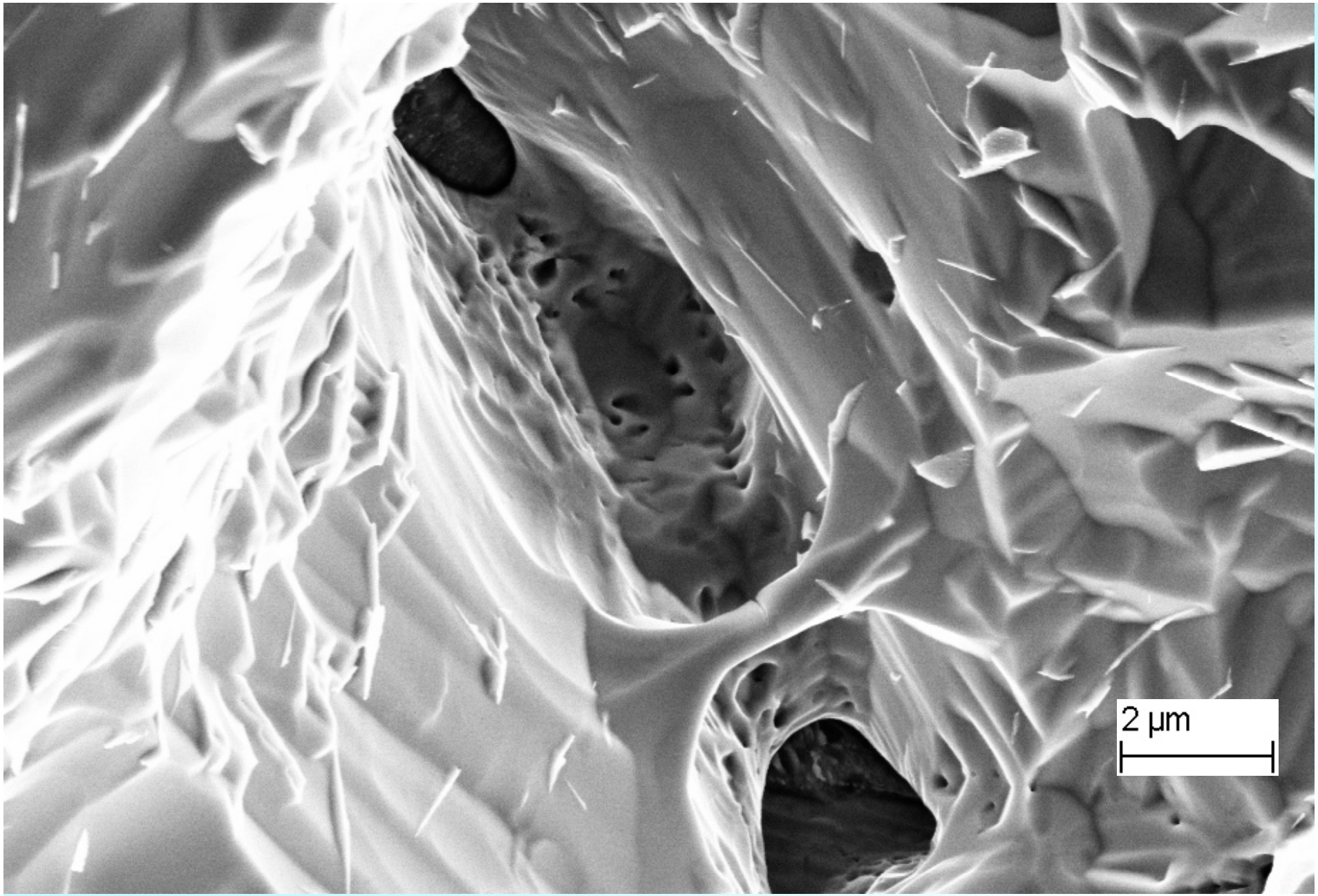



500 µm

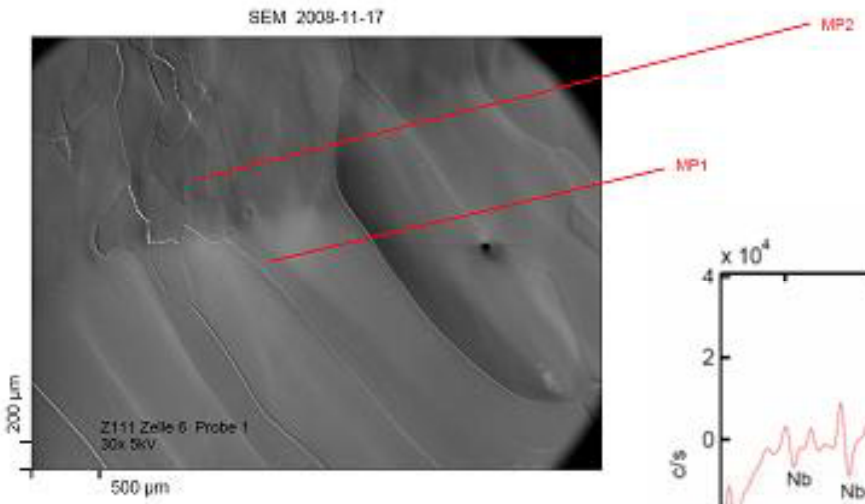

#6 equator, t=198 deg group of spots



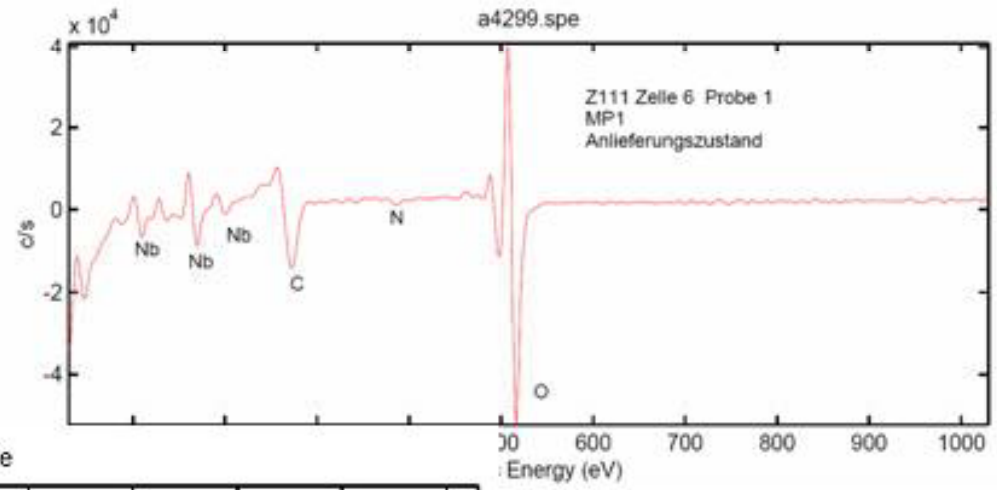
SEM. Quench location

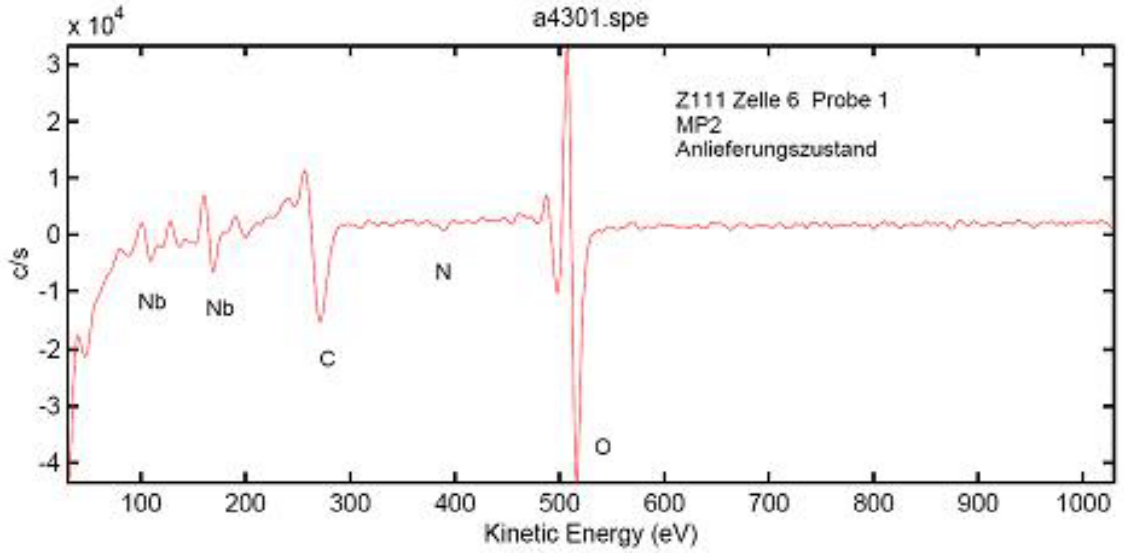


SEM. Quench location

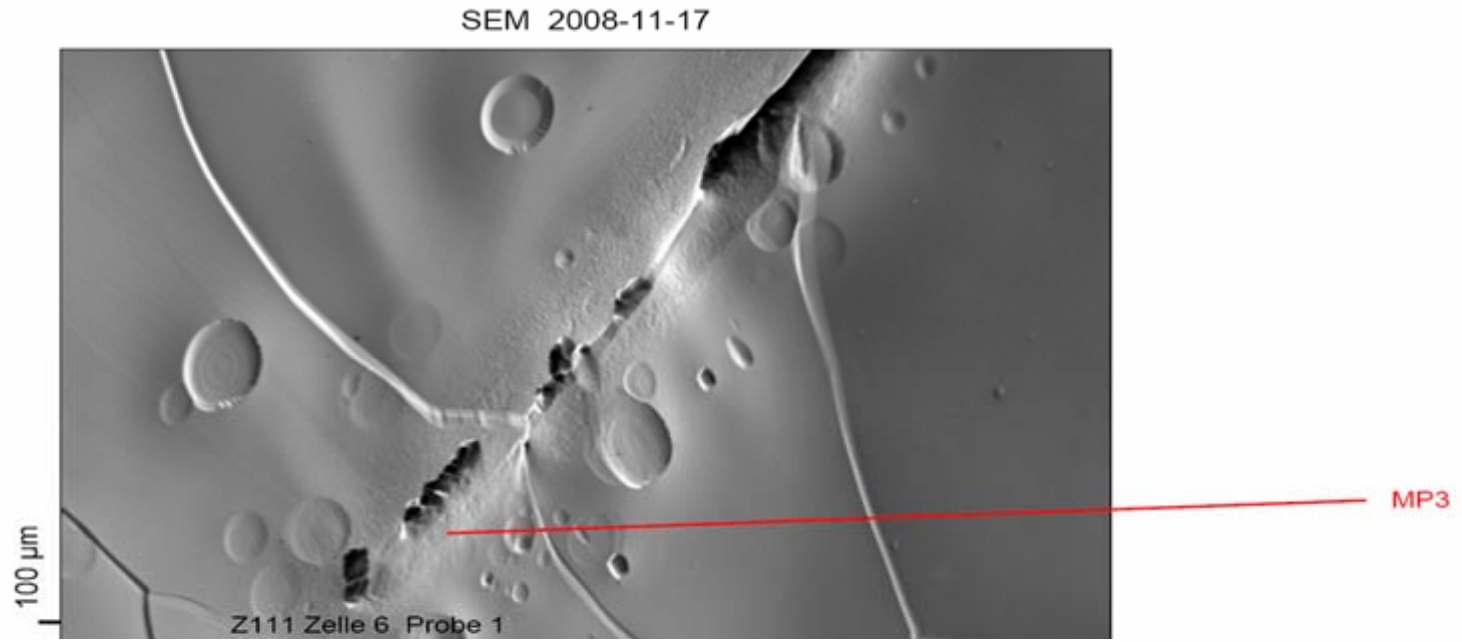


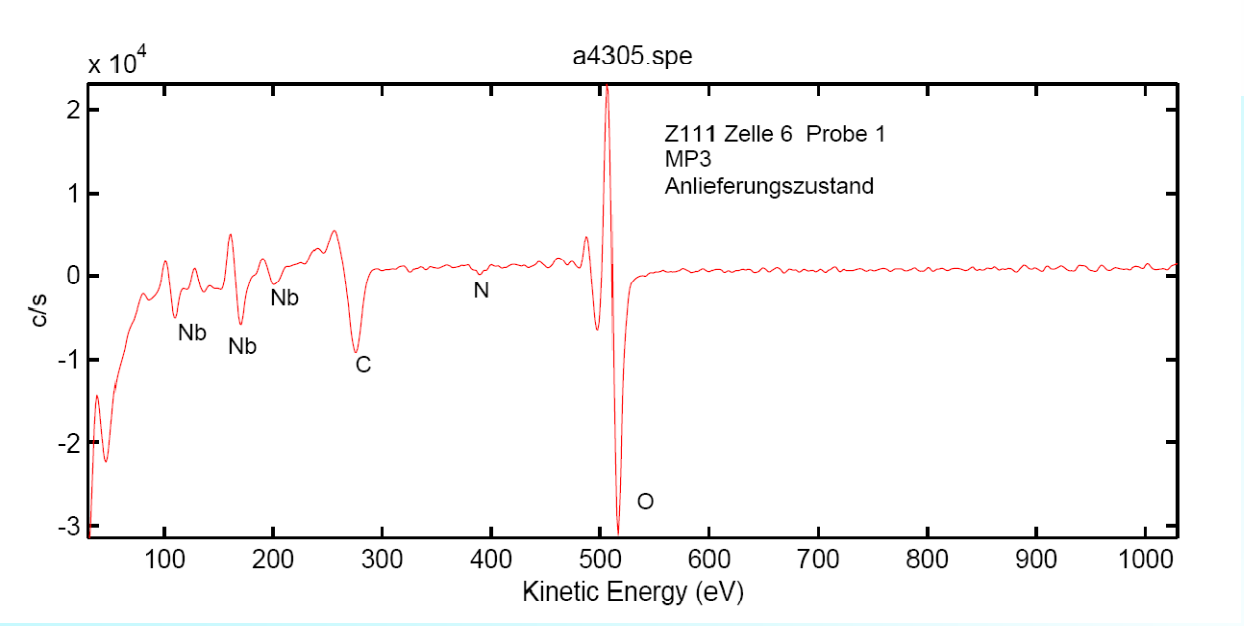
Auger analysis away from flaw areas



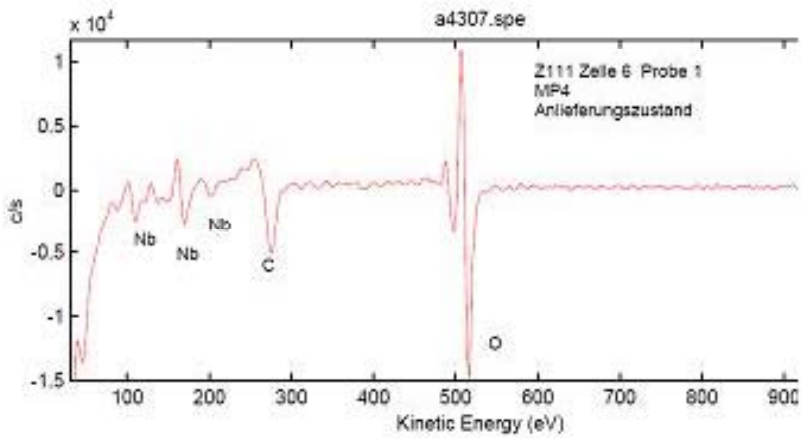


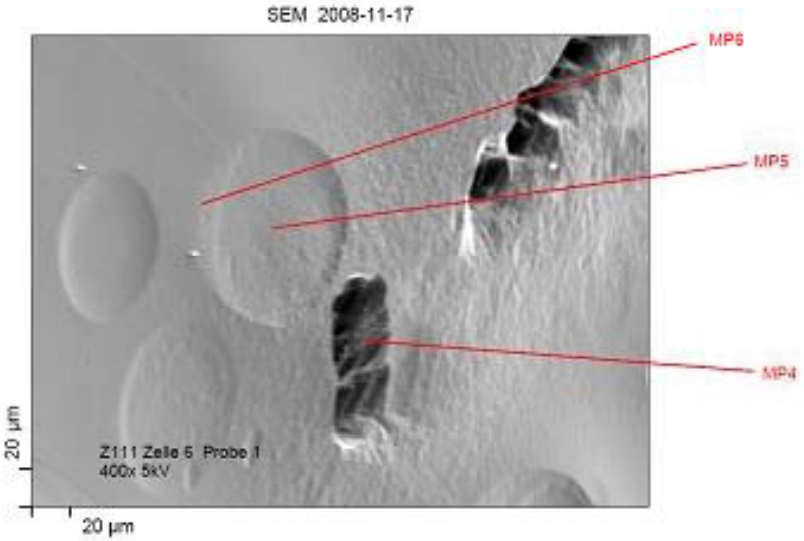
Dark and bright areas

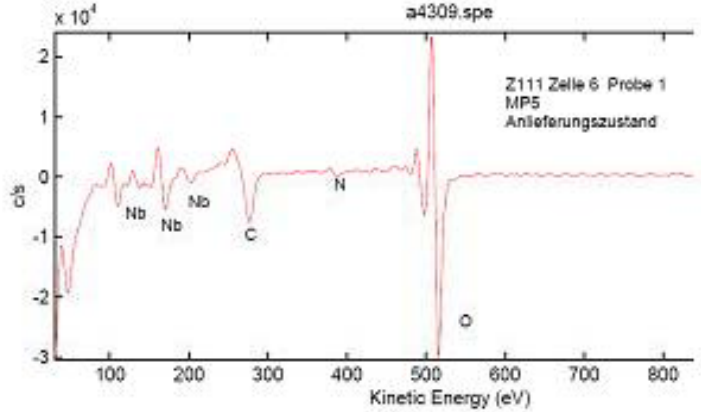


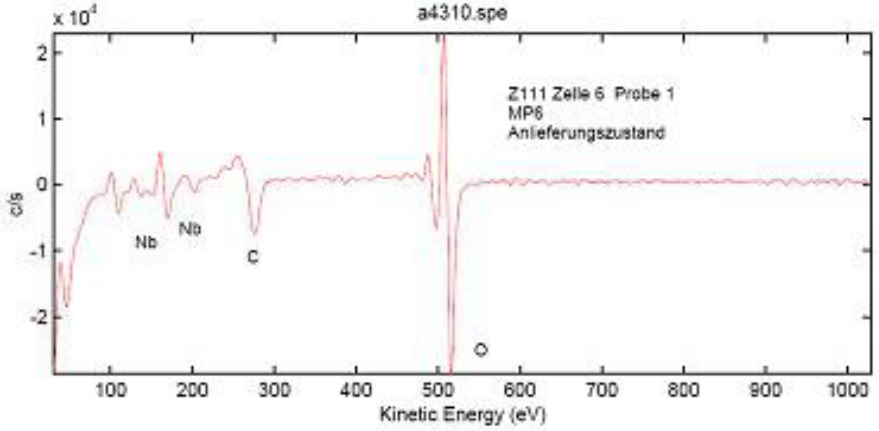


Auger analysis of the quench area (no foreign elements)









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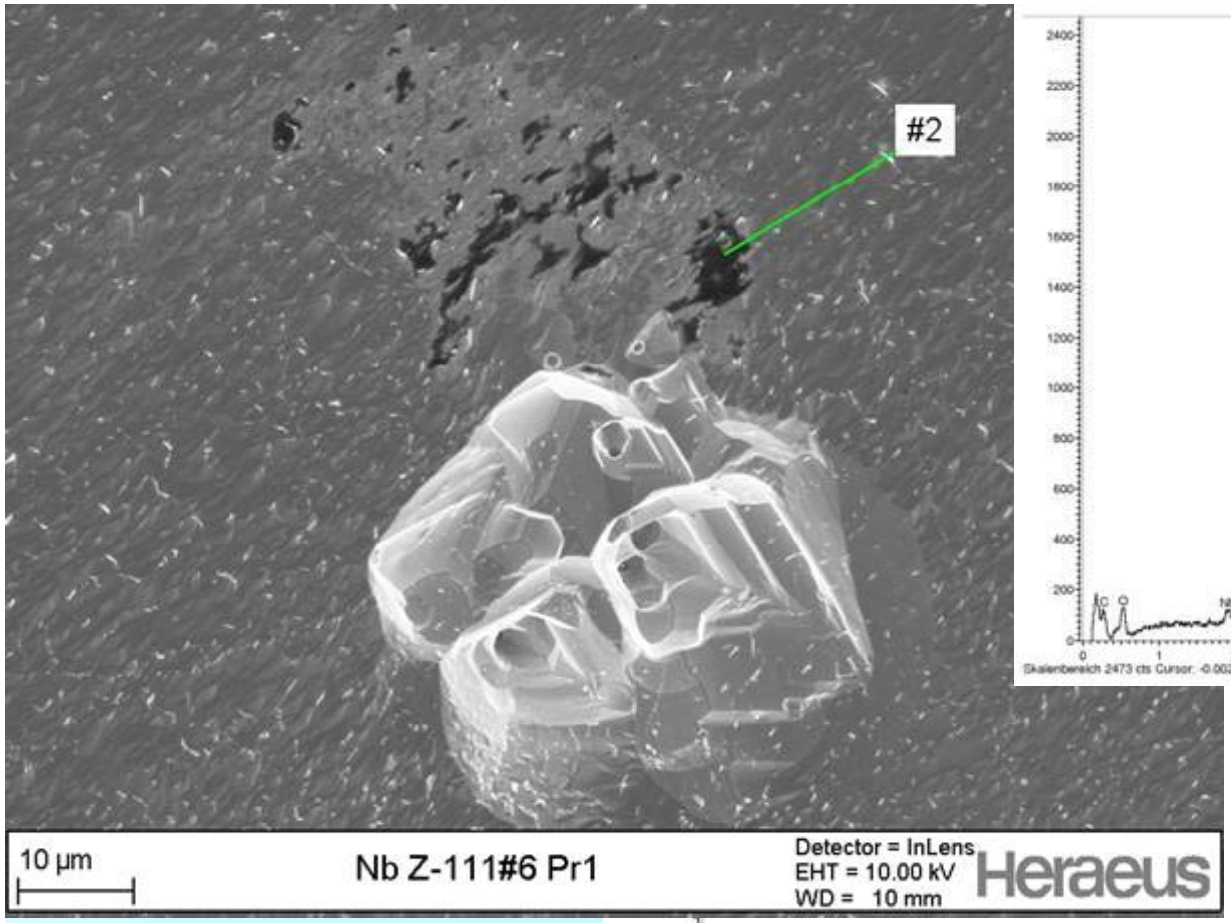
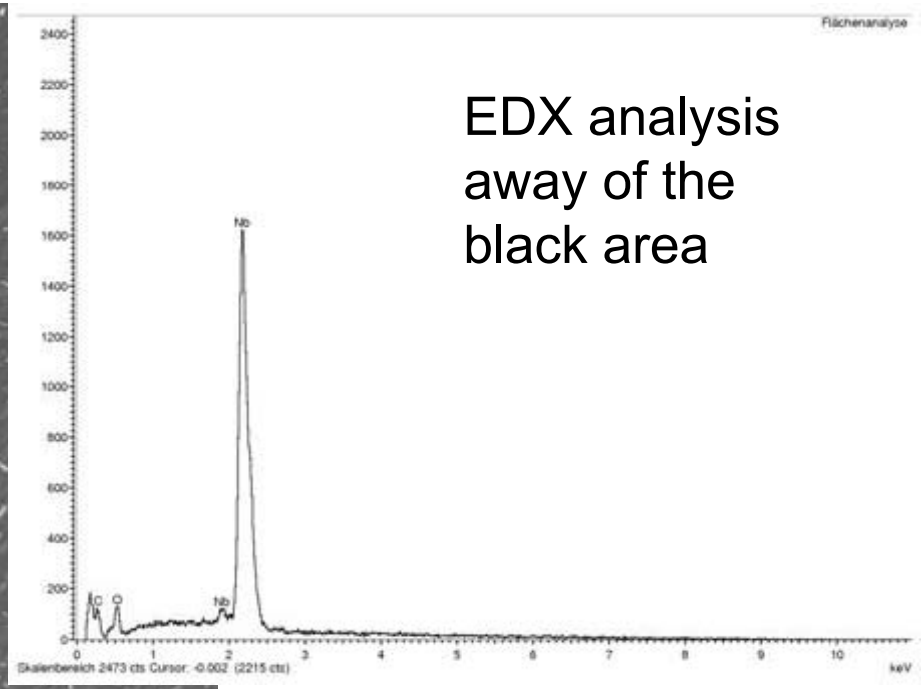
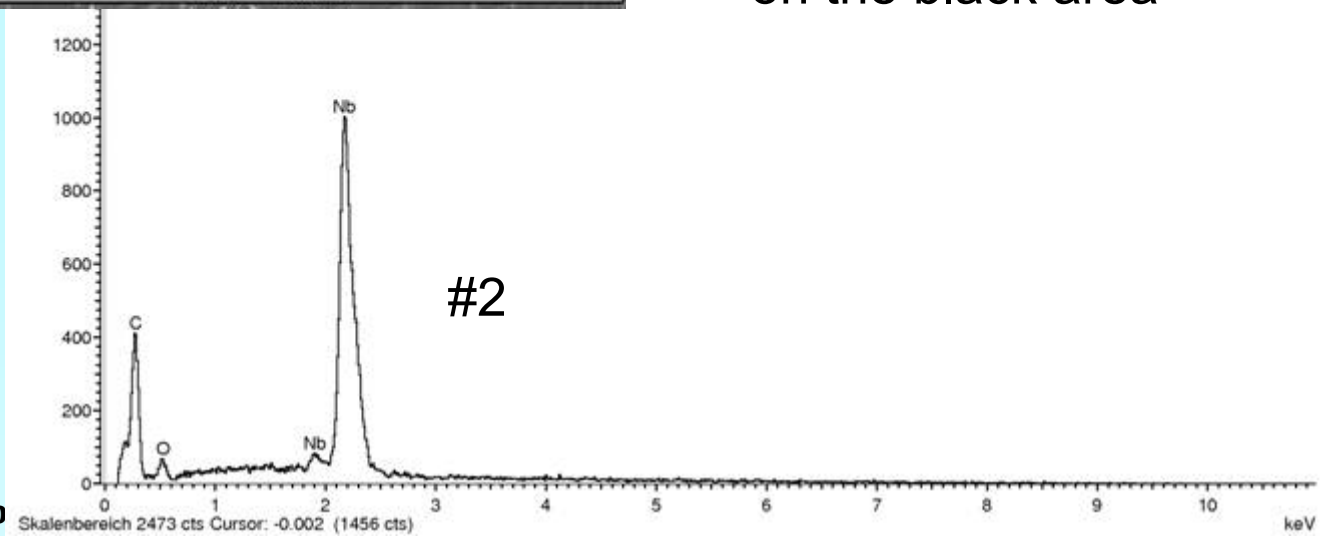




EDX analysis away of the black area

EDX –Analysis

on the black area



#2

Conclusions:

Quench area (Cell 6, Sample 1, 200°)

- Several holes along the grain boundaries are detected on the quench area by SEM
- Holes have sharp edges and looks like corrosion holes
- Several pits observed around the holes
- Auger analysis did not show any indication of the foreign material inclusions on the quench area
- Small black spots close to quench area have been observed. EDX analysis has shown increased content of carbon in these spots
- It is very difficult to imaging that the holes appeared during EB welding. Most probably holes appeared during subsequent treatment

EP: Speculation: how the corrosion holes can appear?

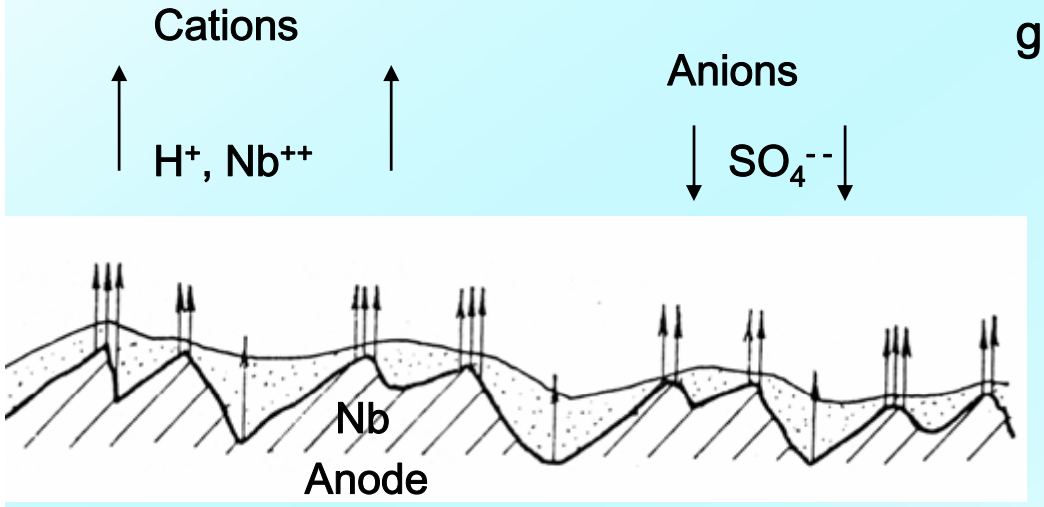
EP: Short circuit (Kurzschluss)??

Electrochemical dissolution of Nb anodes

$2Nb+5SO_4^{2-}+5H_20 \rightarrow Nb_2O_5+10H^+ +5SO_4^{2-}+10e^-$

$Nb_2O_5+6HF \rightarrow H_2NbOF_5+NbO_2F{\cdot}0{,}5H_2O+1{,}5H_2O$

$NbO_2F{\cdot}0{,}5H_2O+4HF \rightarrow H_2NbOF_5+1{,}5H_2O$



Recipe:- mixture of hydrofluoric and sulfuric acid (10% HF(40%), 90% H_2SO_4 (96%) **KEK)**

A several µm thick viscous layer of anodic dissolution products is formed: Respect to the bulk of the electrolyte, this layer has **higher viscosity** and **greater electrical resistivity**

- What will happened, if in some locations (roots) the viscous layer will not be produced? (zero resistivity, maximal current).

Corrosion is possible

Thank you very much to the colleagues of the Fa. W.C. HERAEUS for the efficient support

F. Schölz

M. Hoss

D. Watzel