TTC High Q WG meeting -

Quench studies 9 cell cavities for LCLS-II prototype – Preliminary as of Feb 25th 2015

Round 1 - baseline recipe
Round 2 - rework to raise quench fields

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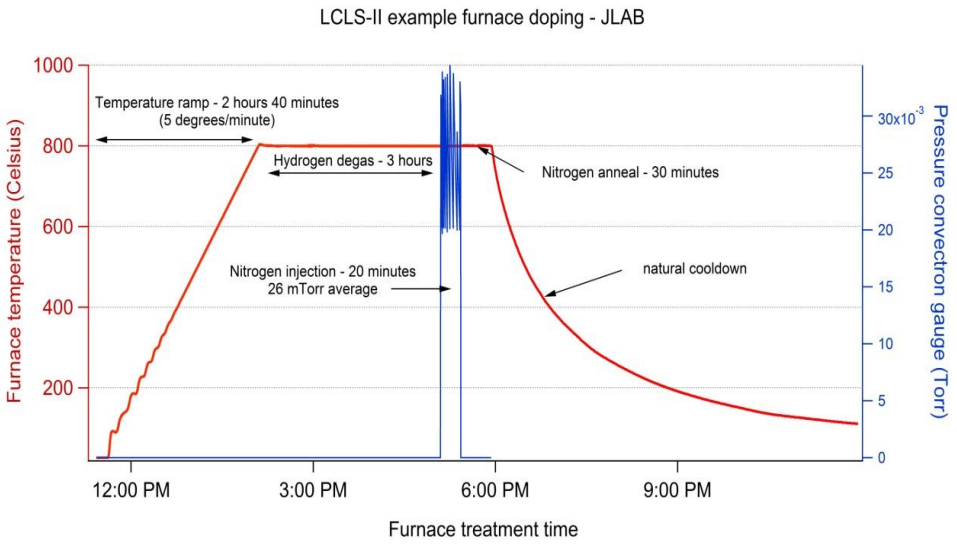
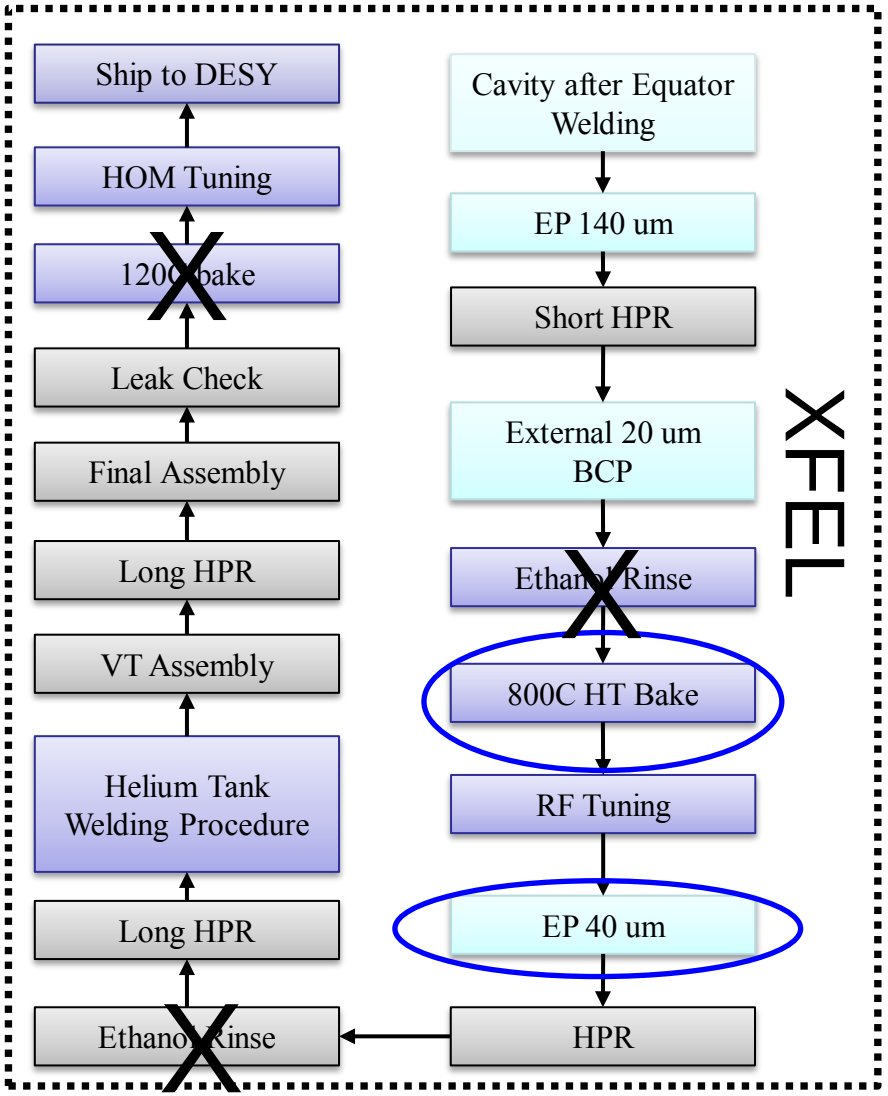
Doping treatment: small variation from standard XFEL/ILC processing recipe

Example from N20/A30 doping process:

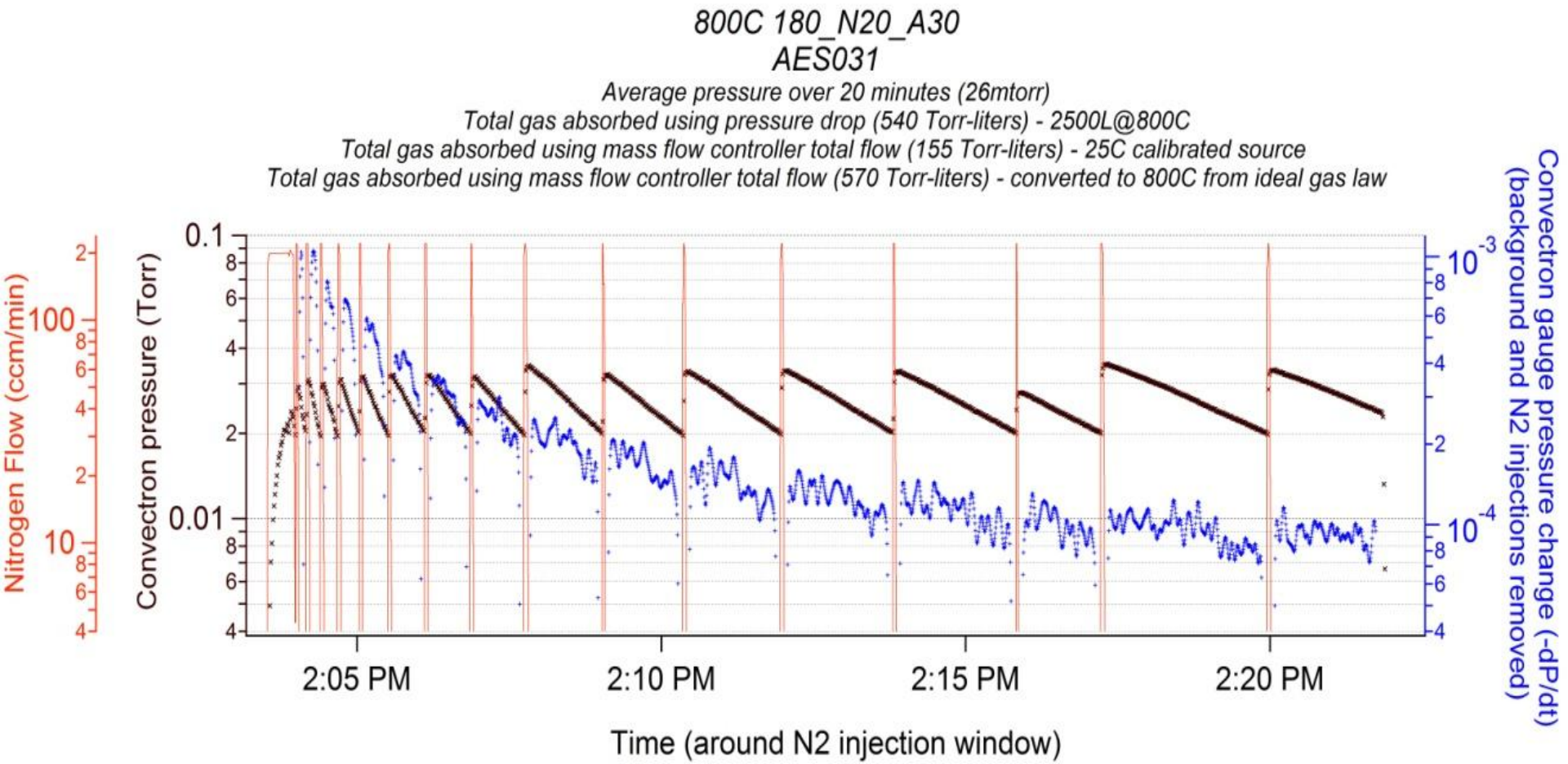
- Light BCP(internal) & Bulk EP (120)
- 800C for 3 hours in vacuum
- Nitrogen @ 26mtorr & 800C (diffusion)
- 800 C for 30 minutes in vacuum
- Vacuum cooling
- 16 microns EP





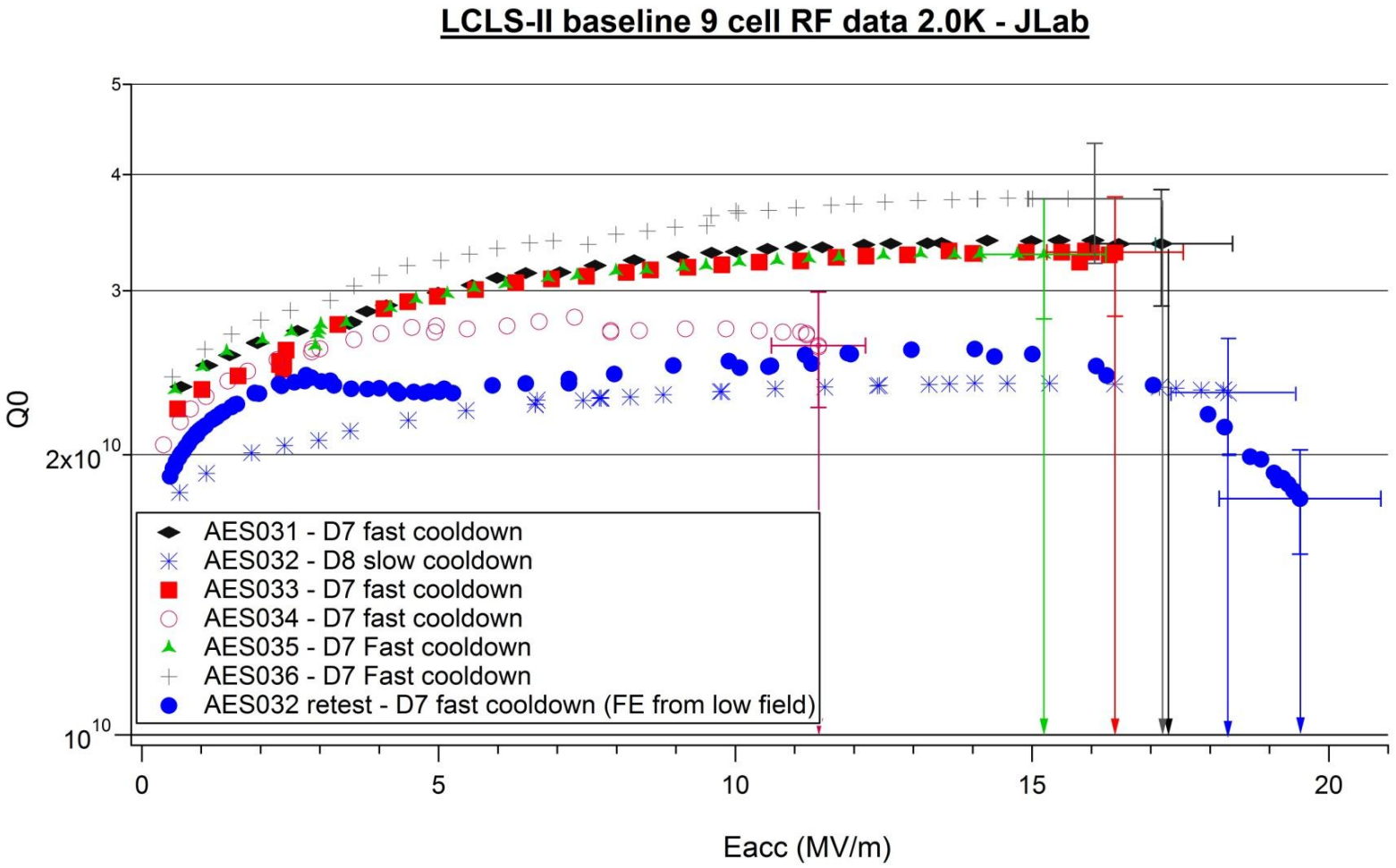
Thanks - Anna Grassellino FNAL

Doping example and analysis



Round 1 - 9 cell tests

Nitrogen @ 26mtorr - 20min, Diffusion @ vacuum 30min + 16 microns EP

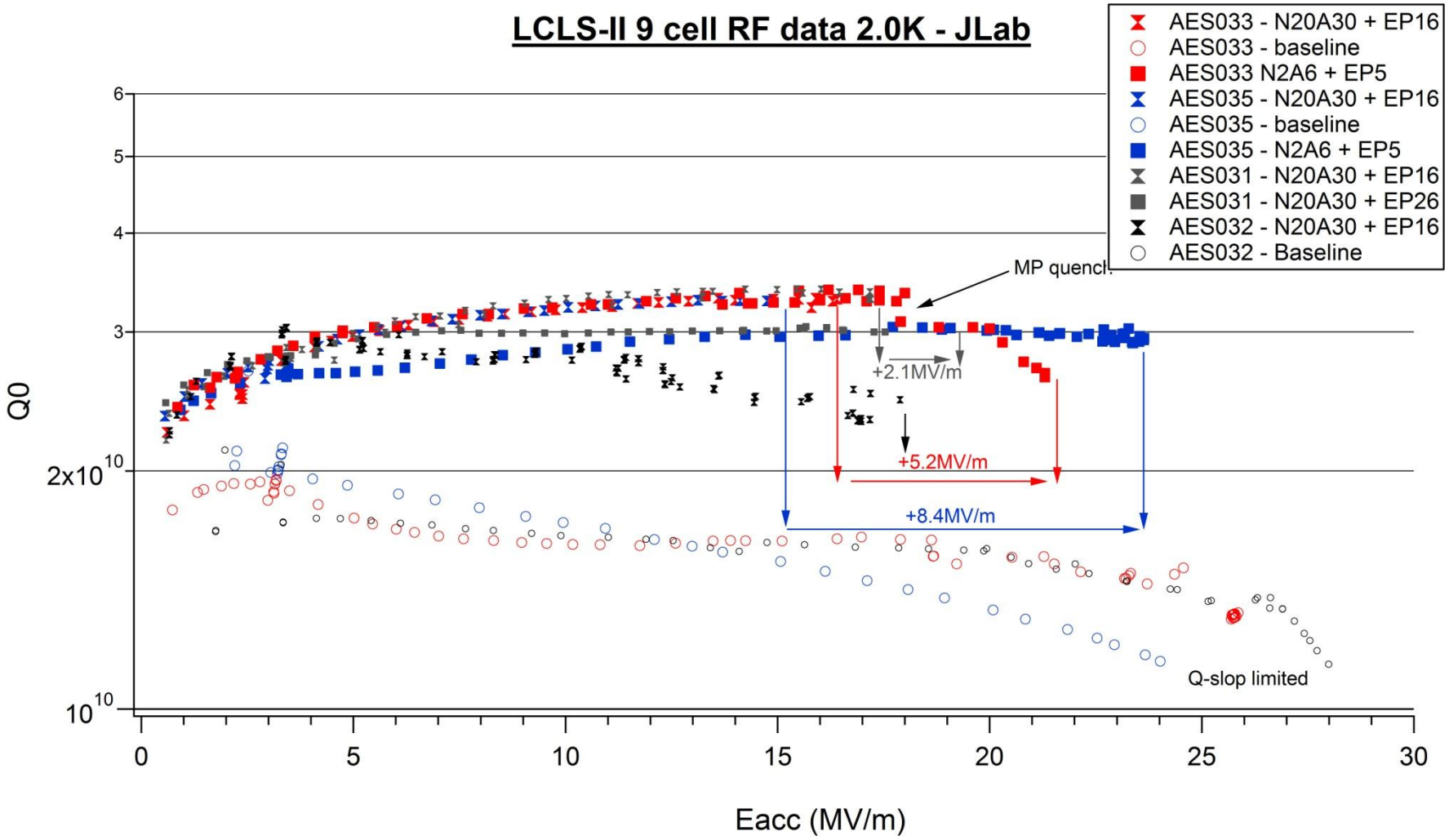


Reason for round 2

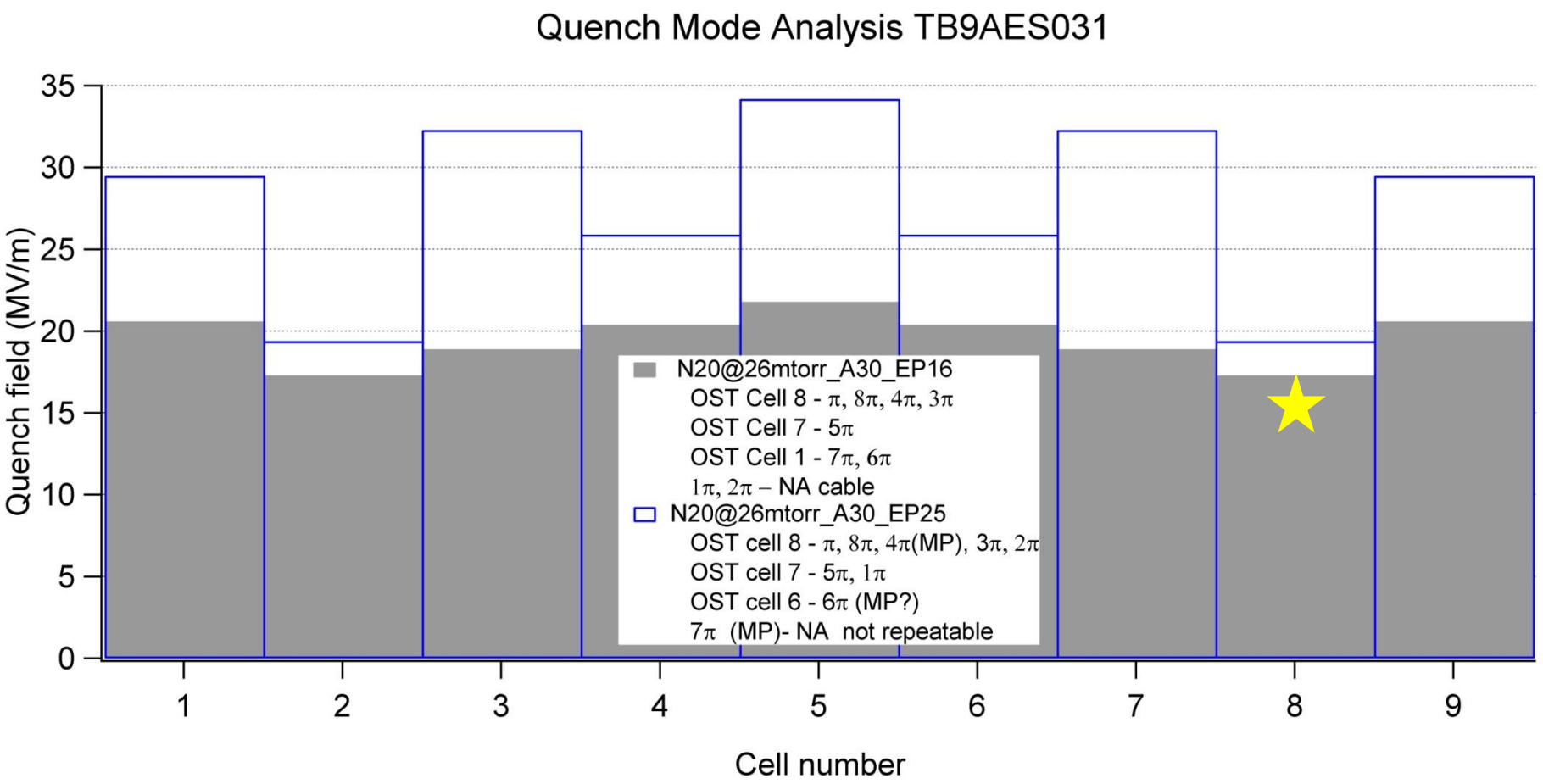
- 4 of 6 cavities “made spec”, while one had a lower than expected Q0 (FE), and one quench at low field (TB9AES034)
- Quench fields too close to operating gradients, so all cavities would be reworked with new lighter doping to raise quench fields (single cell results from FNAL, JLab, Cornell and multi-cell results from FNAL results suggest this)

Cav ID	Round 1 parameters	Surface reset	Round 2 parameters
TB9AES031	N20 A30 + EP16	none	+EP10
TB9AES032	N20 A30 + EP16	EP50	N2 A6 EP5
TB9AES033	N20 A30 + EP16	EP50	N2 A6 EP5
TB9AES034	N20 A30 + EP16	CBP100 + EP50	N2 A30 EP10
TB9AES035	N20 A30 + EP16	EP50	N2 A6 EP5
TB9AES036	N20 A30 +EP16	EP50	N2 A6 EP5

Round 2 - 9 cell tests (partial)



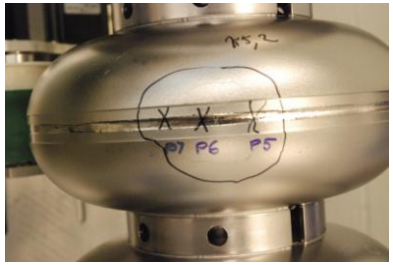
TB9AES031

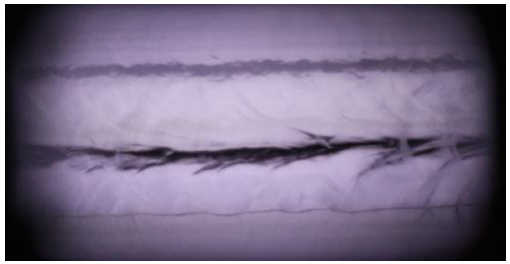


Same quench location in Pi mode for both tests

Optical inspection TB9AES031

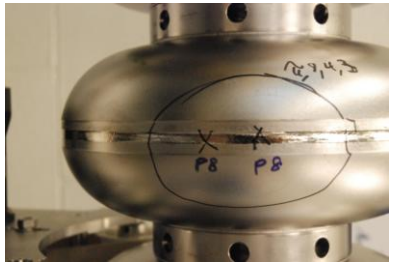
Cell 7





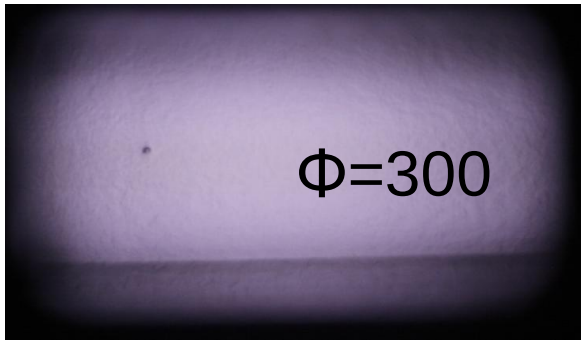
No defect found

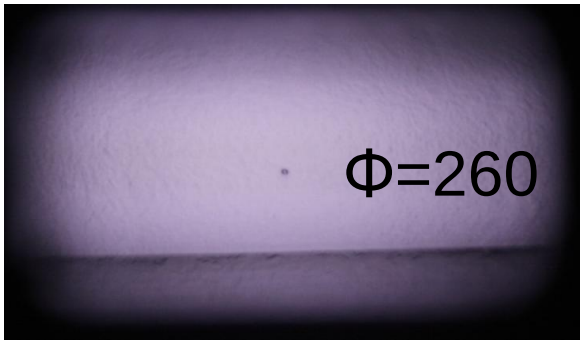
Cell 8



No defect found

Cell 6

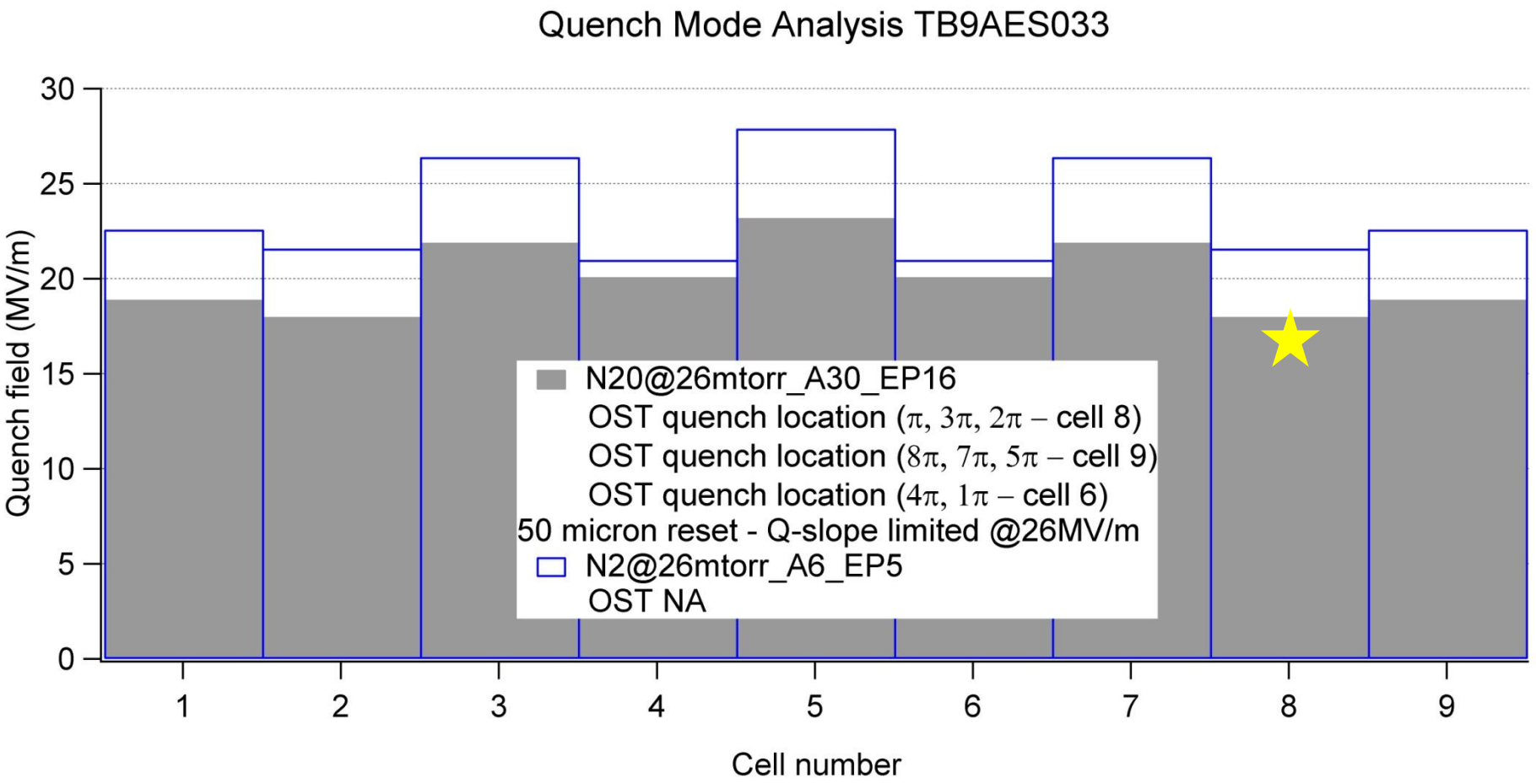




~ cell 6 quench location after second EP

Inspection Courtesy of R. L. Geng before second EP

TB9AES033



Low filed quench cell appear similar between doping even after bulk removal - maybe

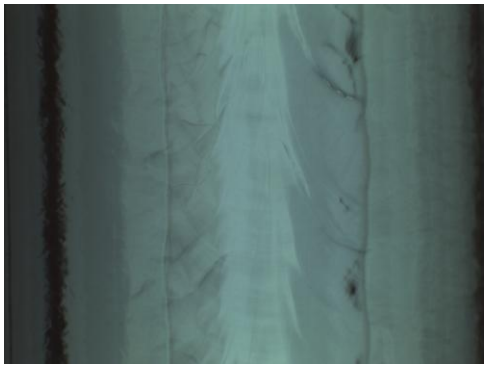
Optical inspection TB9AES033

Cell#8, fusion zone, inside OST circle
angle = 280 degree

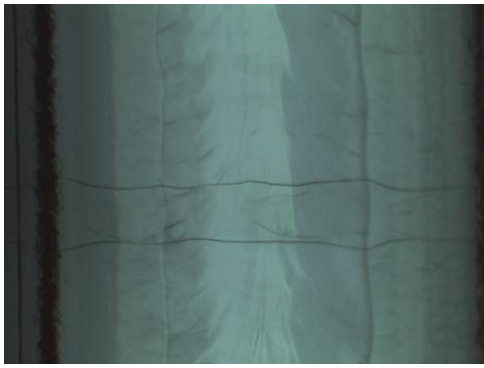
No defect found

Cell#8, fusion zone
angle=150 degree
stain away from quench (benign)

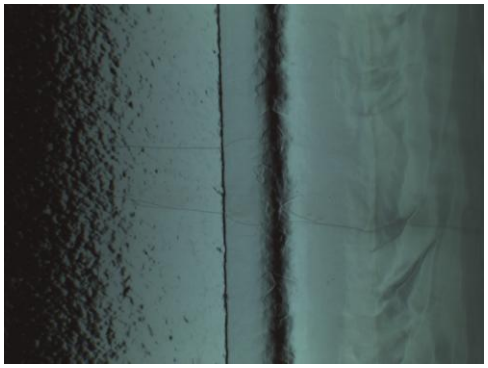
Cell#6 quench site
angle=190 degree



No defect found



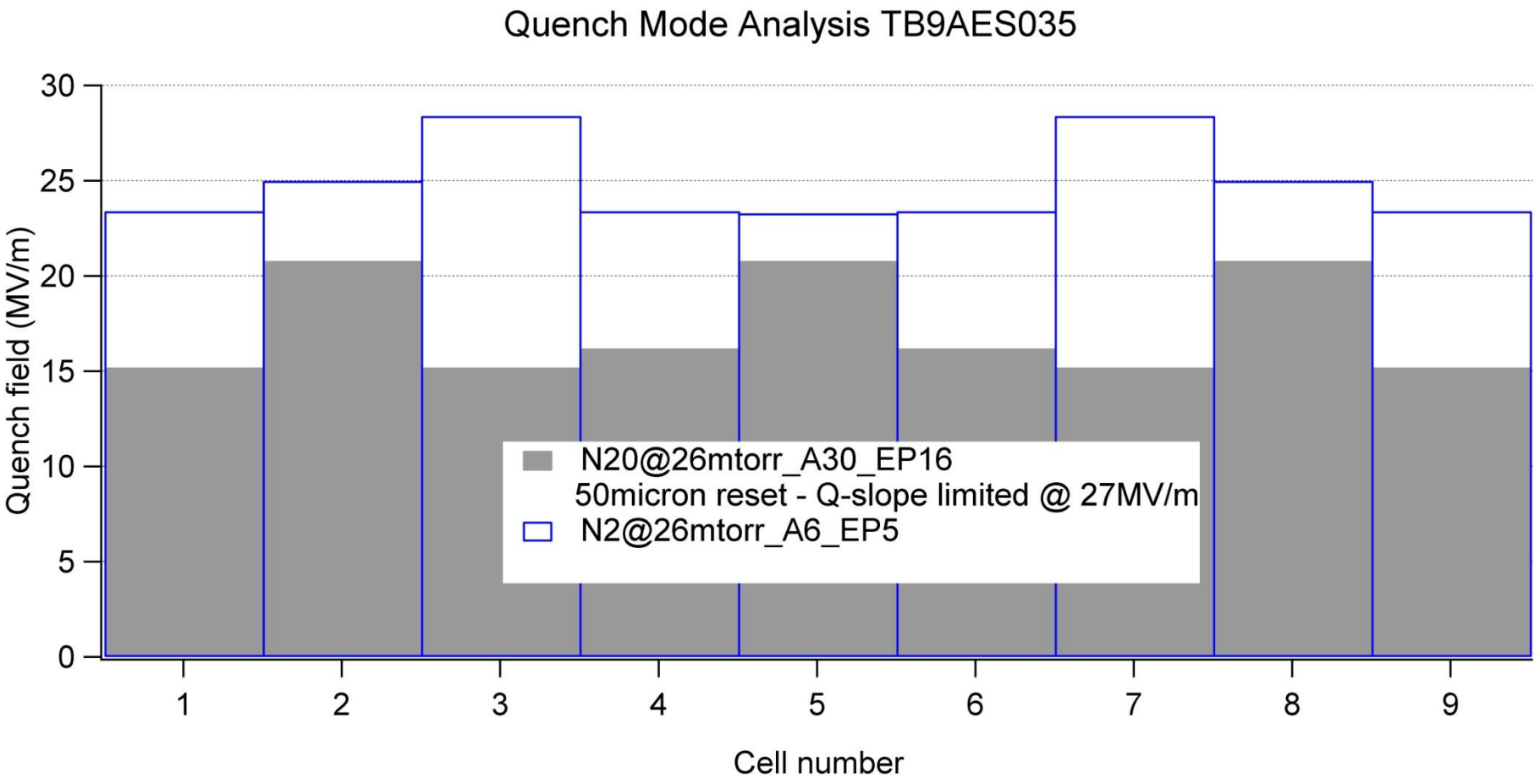
Cell#9 quench site,
Machining line edge
angle=170 degree



Possible stain

Inspection Courtesy of R. L. Geng before EP

TB9AES035

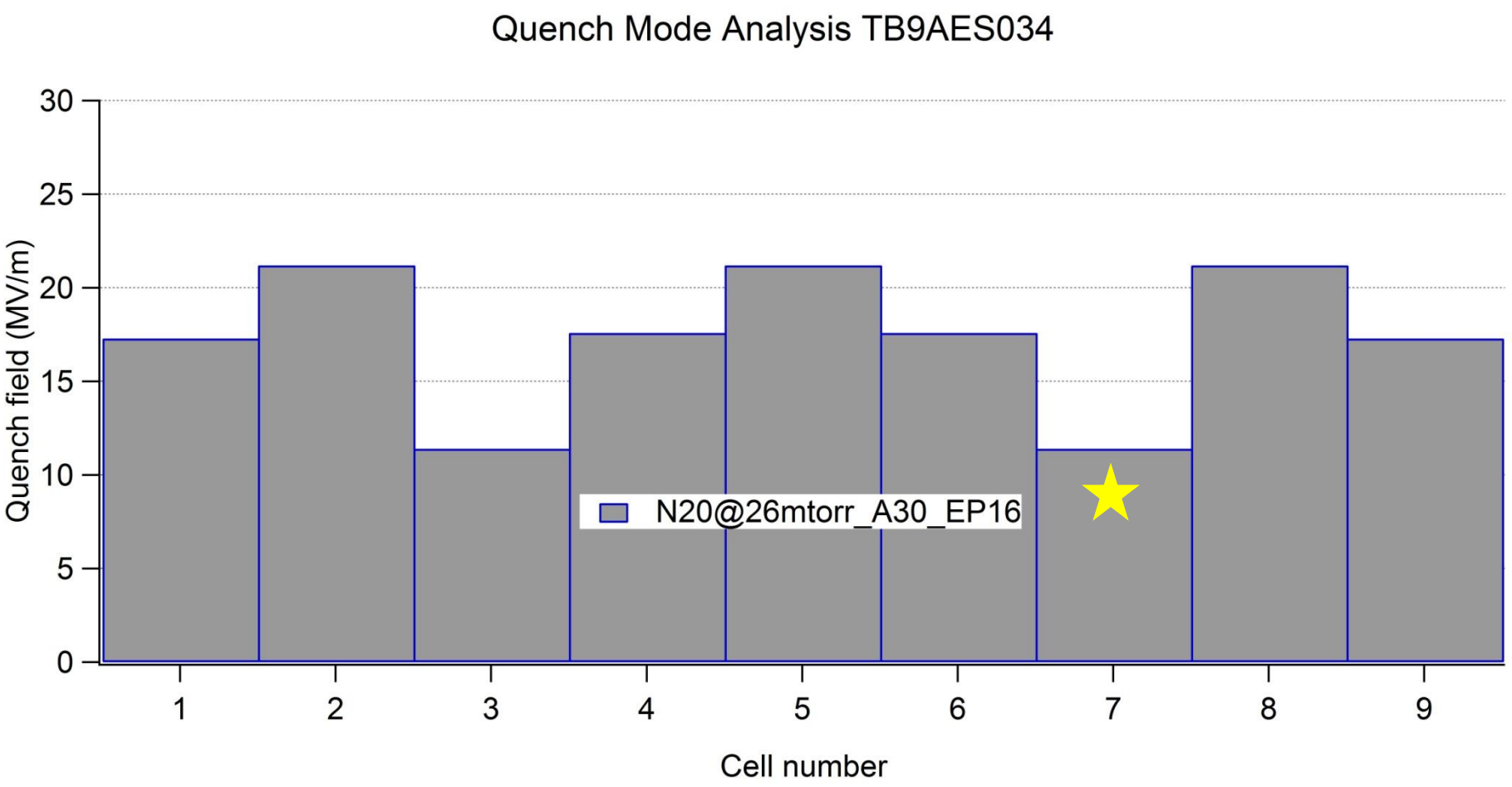


No clear pattern for quench location, appears random after bulk reset and re-dope

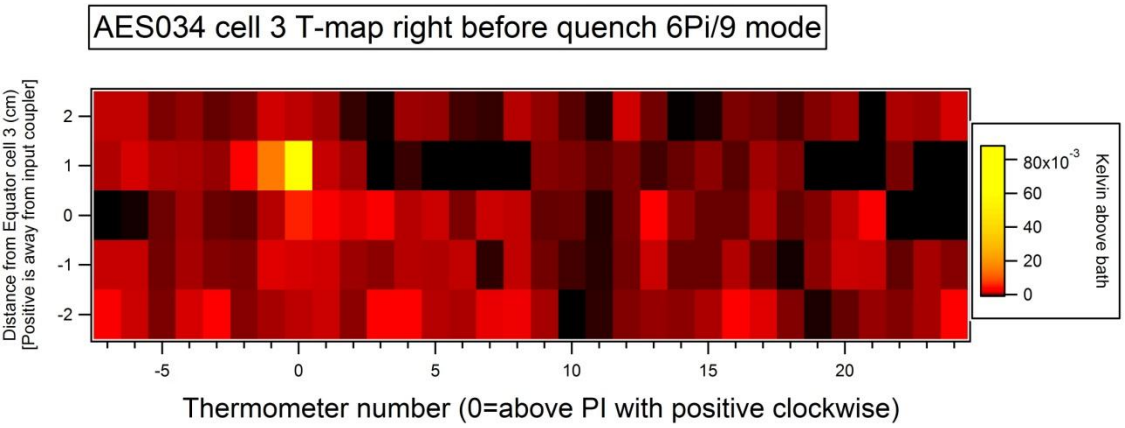
TB9AES035

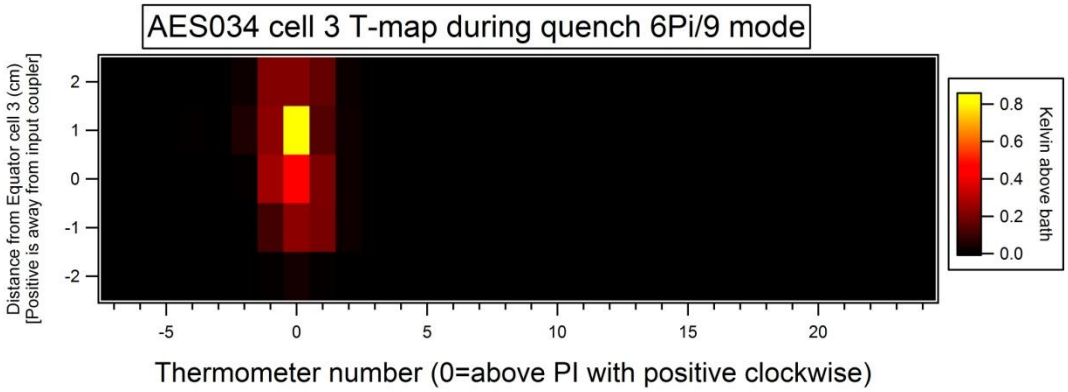
No inspection done after either round and in helium vessel now

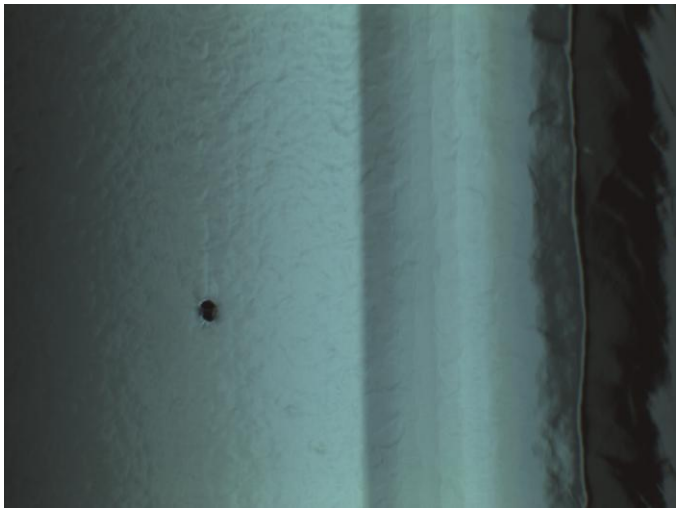
TB9AES034


Quench Mode Analysis TB9AES034
Quench field (MV/m)
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
Cell number
N20@26mtorr_A30_EP16

Optical inspection and T-map TB9AES034







Most outstanding feature
200 micron dia. Deep pit
Leading candidate defect for quench at 11 MV/m
during vertical test

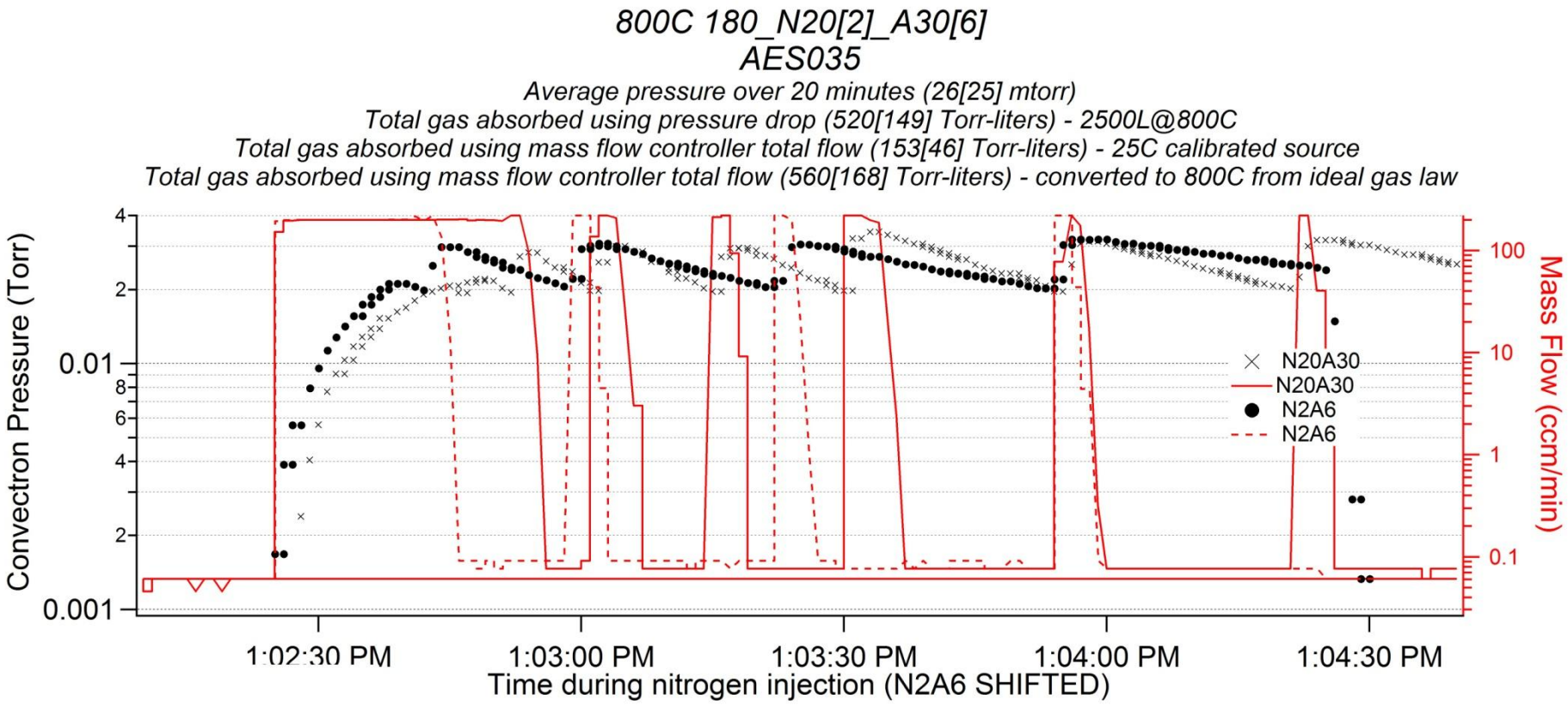
Multiple other defects found – sent for CBP ~ 120micron

Inspection Courtesy of R. L. Geng before EP

Conclusions - Preliminary with N=1,2 data

- Large pit like defects will show a larger Q-drop at lower quench fields than standard cavities (TB9AES034)
- For heavy doping quench location appears to be random at this point, especially compared to un-doped cavities – i.e. no defects, multiple quench location at ~ same field (TB9AES033, TB9AES033)
- Bulk re-rest of surface appears randomize quench location after re-doping (TB9AES035, TB9AES033?)
- Light doping after reset produces a higher quench field on average (TB9AES033, TB9AES035)
- Light EP after baseline heavy doping raised the quench field (small amount) but not likely to change quench location (TB9AES031)

Side note - Re-doping Furnace data



Outside of cavity already was heavily doped so absorption rate in second round is less (first two minutes)