High Power test of T18_VG2.4_disk [2] at SLAC

- T18vg2.4_disk [2] results to date
- HDX11_electropolished_big grains post mortem inspection

Structure parameters

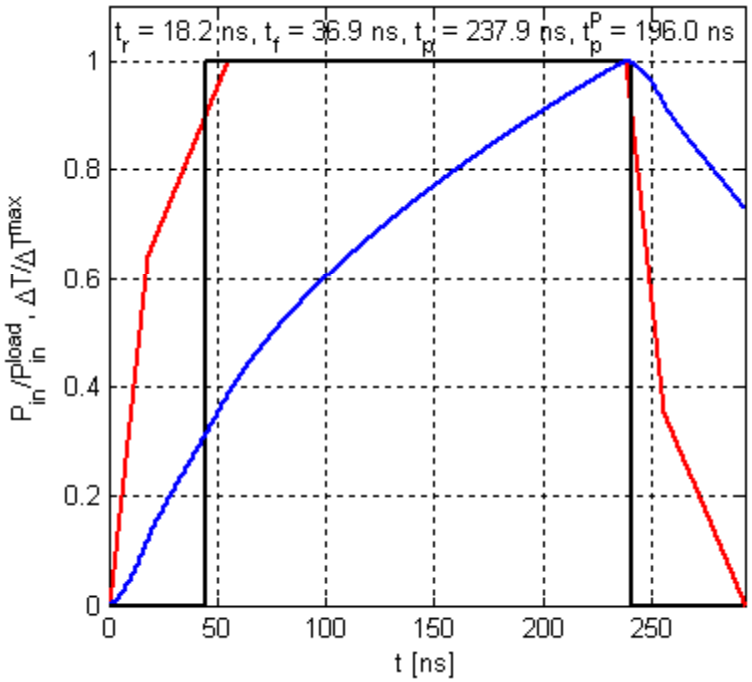
Name	**T24_vg1.8_disk**	**T18_vg2.6_disk**	**TD18_vg2.4_quad**	**TD18_vg2.4_disk**
Name	**11WNSDGCu**	**11WNSDvg1Cu**	**11WDSQvg1Cu**	**11WDSDvg1Cu**
N cell	**24**	**18**	**18**	**18**
$a_{in,out}$ (mm)	**3.307/2.467**	**4.06/2.66**	**4.06/2.66**	**4.06/2.66**
$Vg_{in/out}$	**1.82/0.93**	**2.61/1.02**	**2.41/0.92**	**2.24/0.87**
$T_{filling}$ (ns) (full structure)	**59**	**36**	**39**	**41**
P_{in} unloaded (MW) (100 MV/m) (only regular cells)	**42.9**	**53.9**	**55.5**	**58.1**
P_{in} unloaded (MW) (100 MV/m) (full structure)	**44.2**	**55.5**	**57.3**	**60.0**
Bunch population: N	**3.72*10^9**	**3.72*10^9**	**3.72*10^9**	**3.72*10^9**
Number of bunches/train	**312**	**312**	**312**	**312**
Nrf	**6**	**8**	**8**	**8**
P_{in} loaded (MW) (100 MV/m) (only regular cells)	**54**	**61.7**	**63.6**	**66.4**
P_{in} loaded (MW) (100 MV/m) (full structure)	**55.7**	**63.7**	**65.6**	**68.5**
Pulse length (ns)	**236.8**	**267.4**	**272.9**	**276.4**
P/c (Wu)	**14.7**	**15.0**	**15.5**	**16.2**
Efficiency (%) (no coupler included)	**30.5**	**17.7**	**16.8**	**15.9**

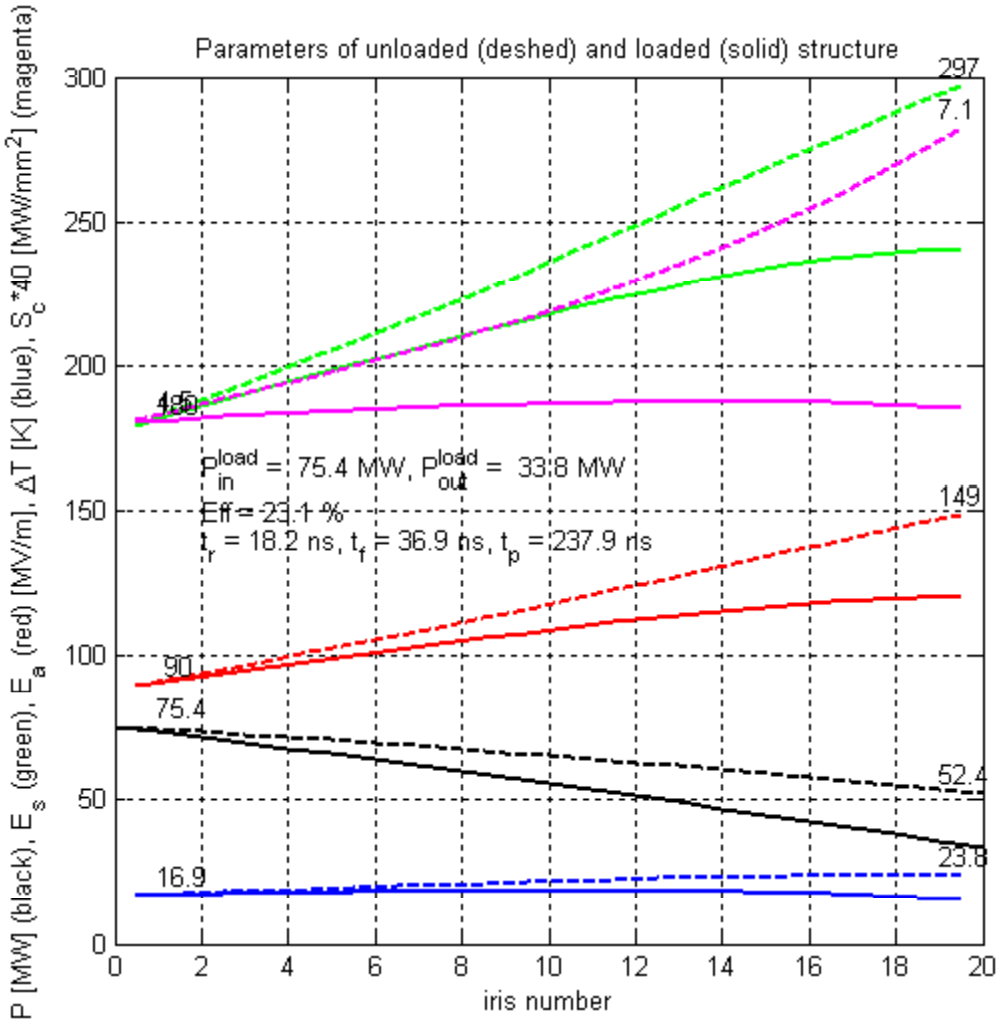
CLIC_vg1_undamped at 17.2Wu

N=5.25x1e9
N_s = 8 rf cycles
N_b is the same as in damped

S_c scaled to 100ns:
7.1*(196/100)^1/3= 8.9

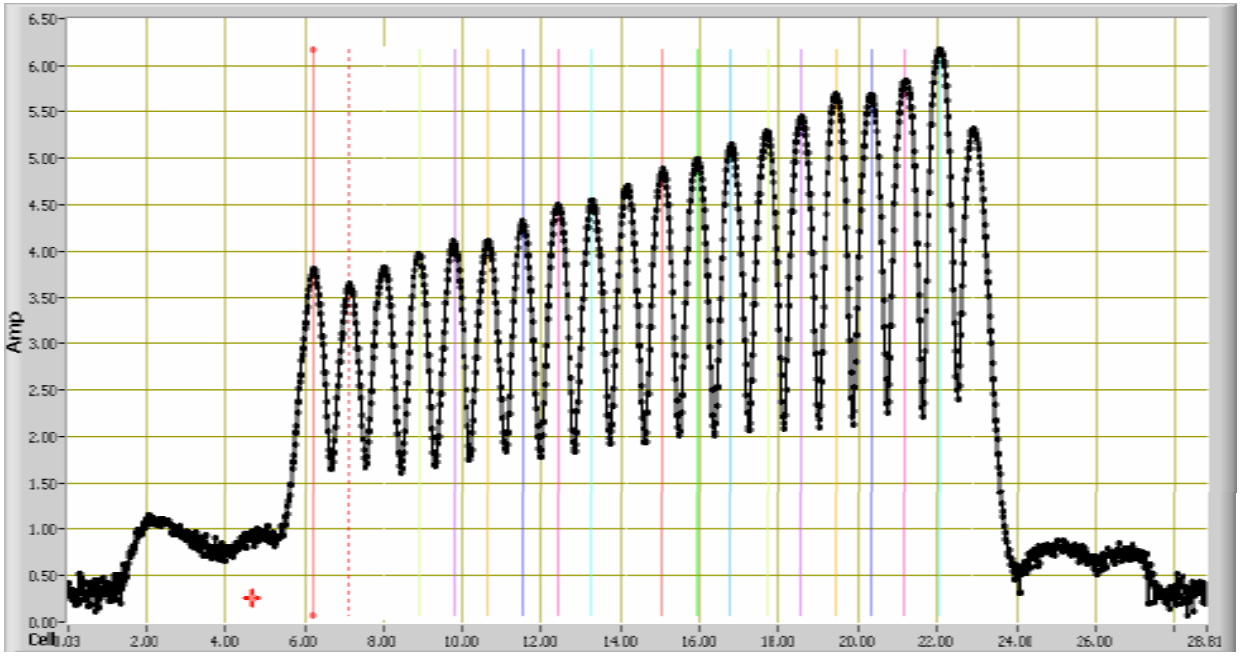
S_c: 8.9 => 6.2
t_p^{rect}: 196ns => 66ns

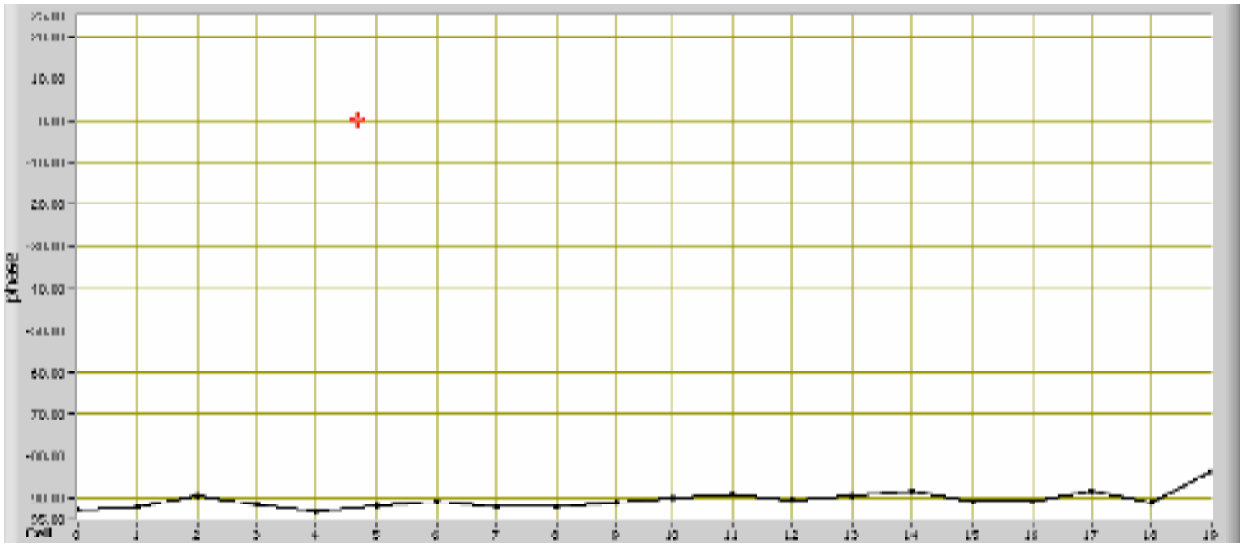




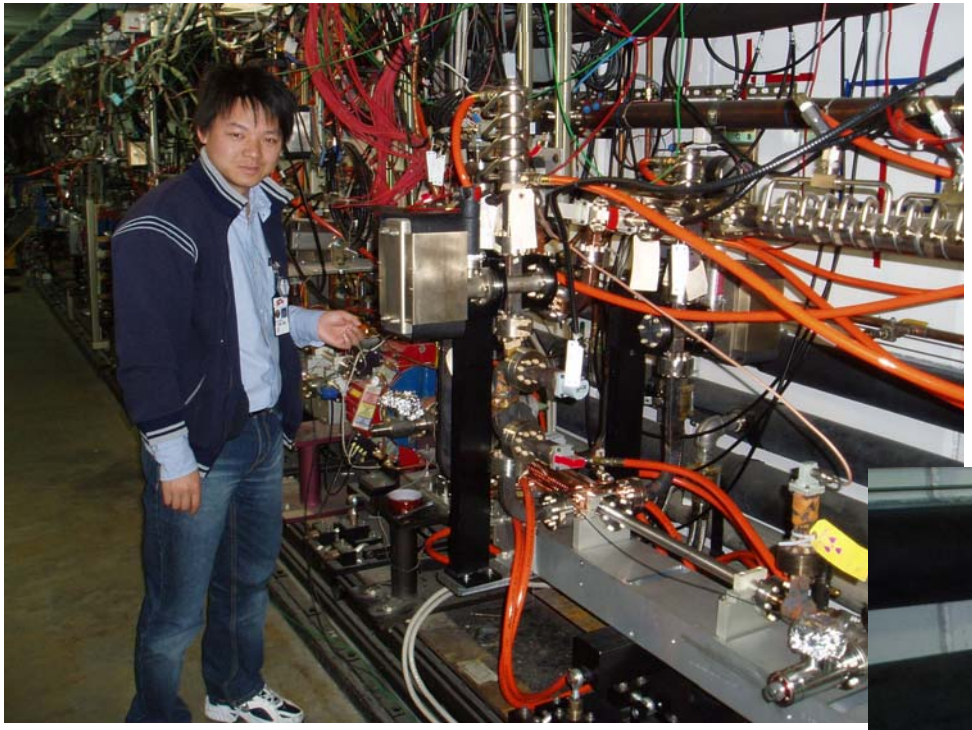
Prediction from S_c^{max}=6.2MW/mm^2:
Unloaded average gradient: ~114MV/m
P_{in}=75.4MW, t_p^{rect}=66ns, BDR=1e-6

Cold measurements after tuning



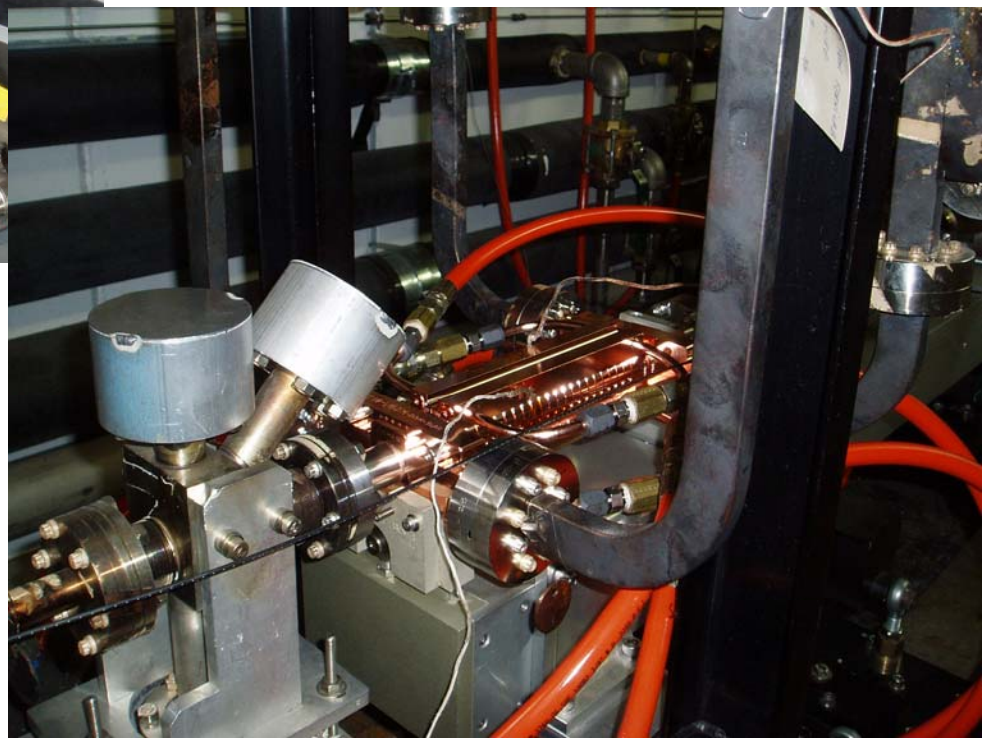


T18vg2.4_disk[2] installed in NLCTA

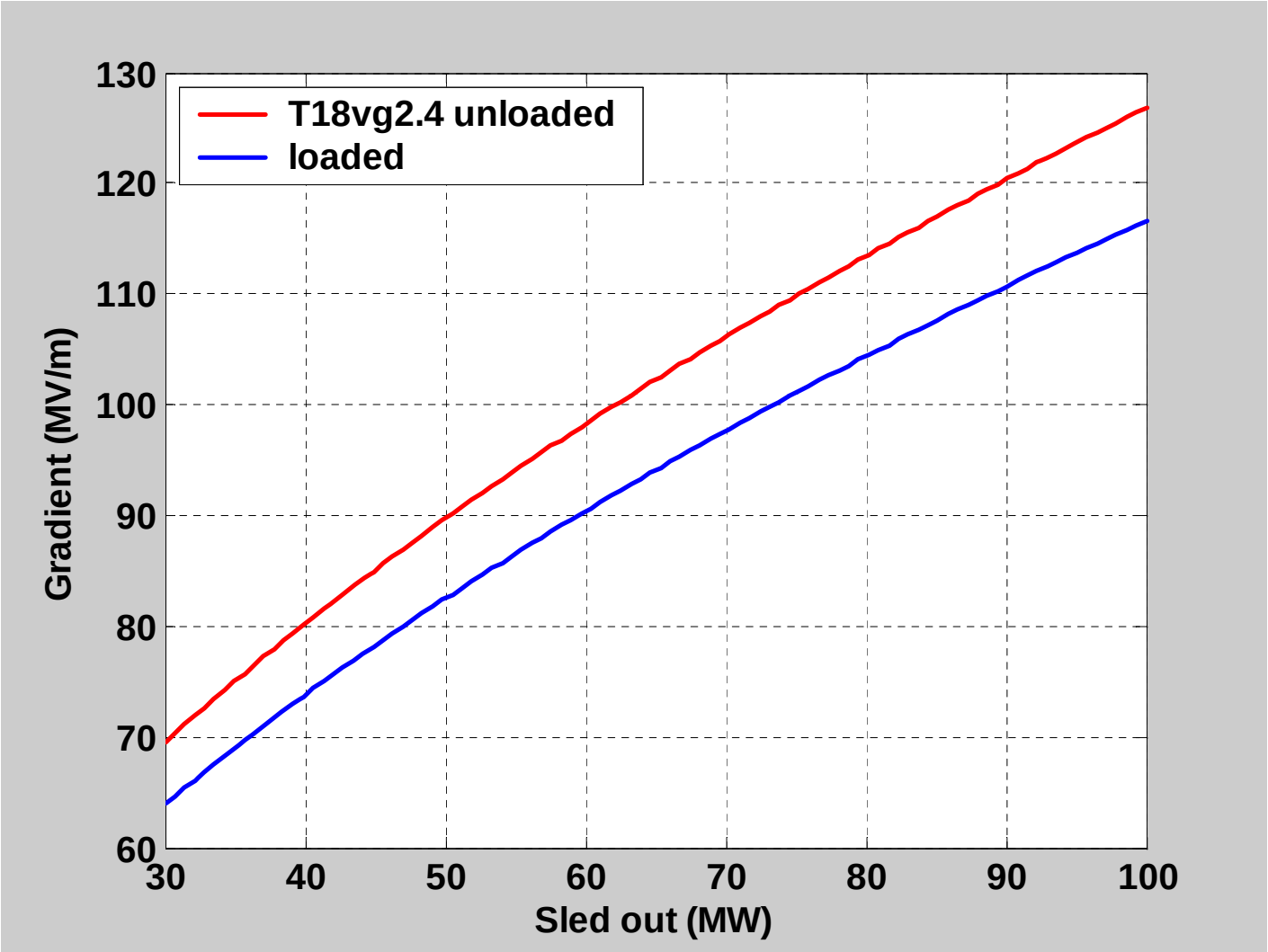


Faya Wang

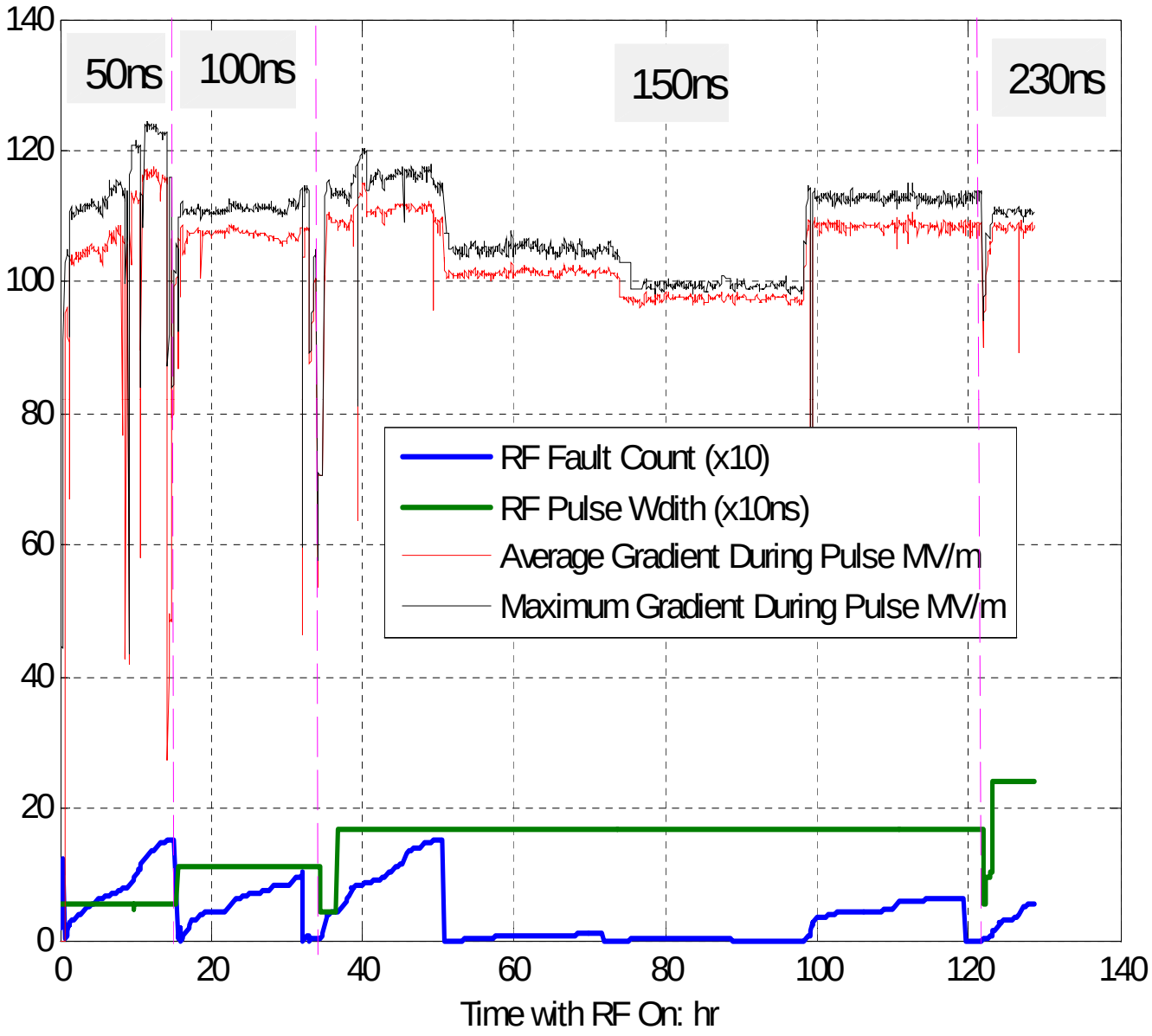
T18vg2.4_disk [2]



Structure calibration

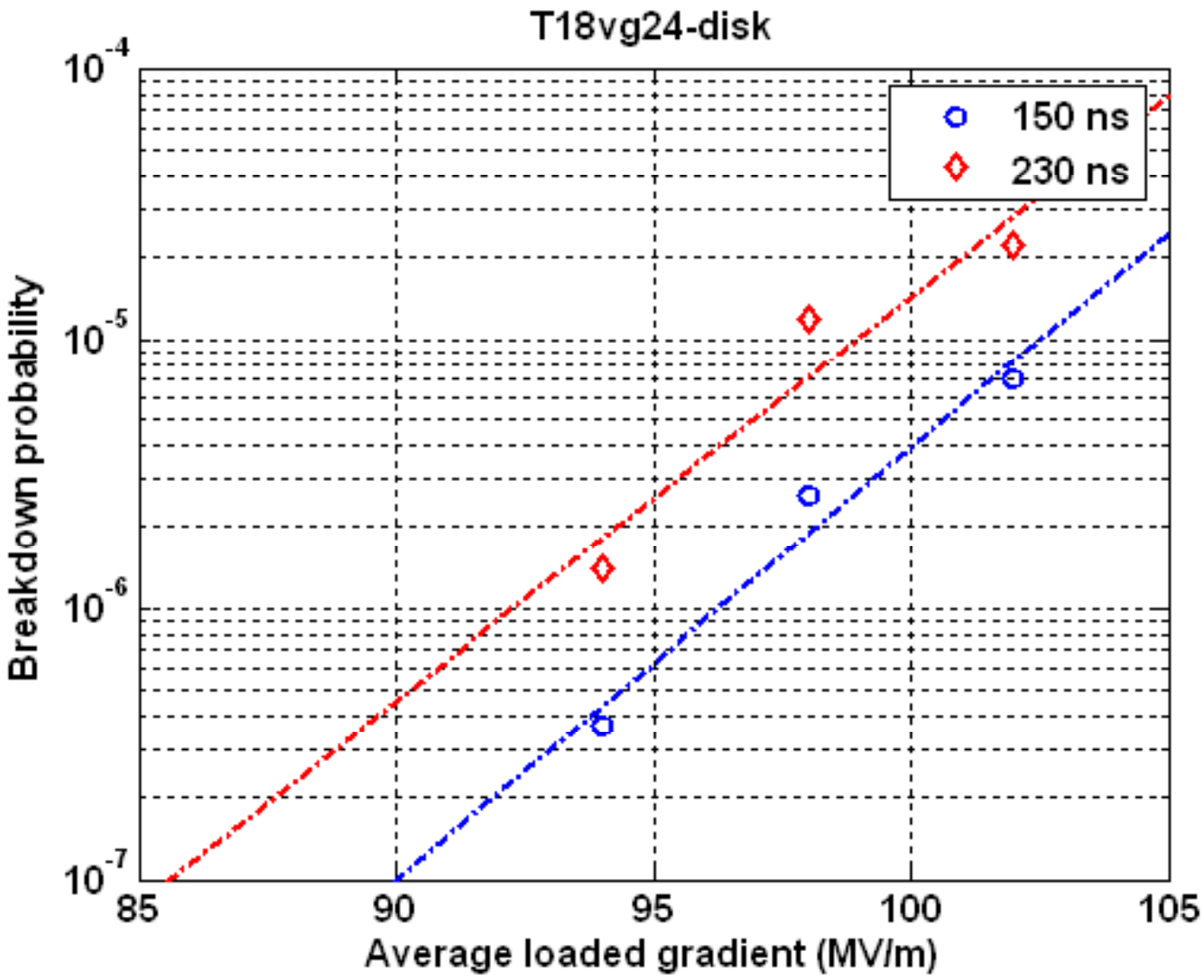


T18VG26_disk conditioning history

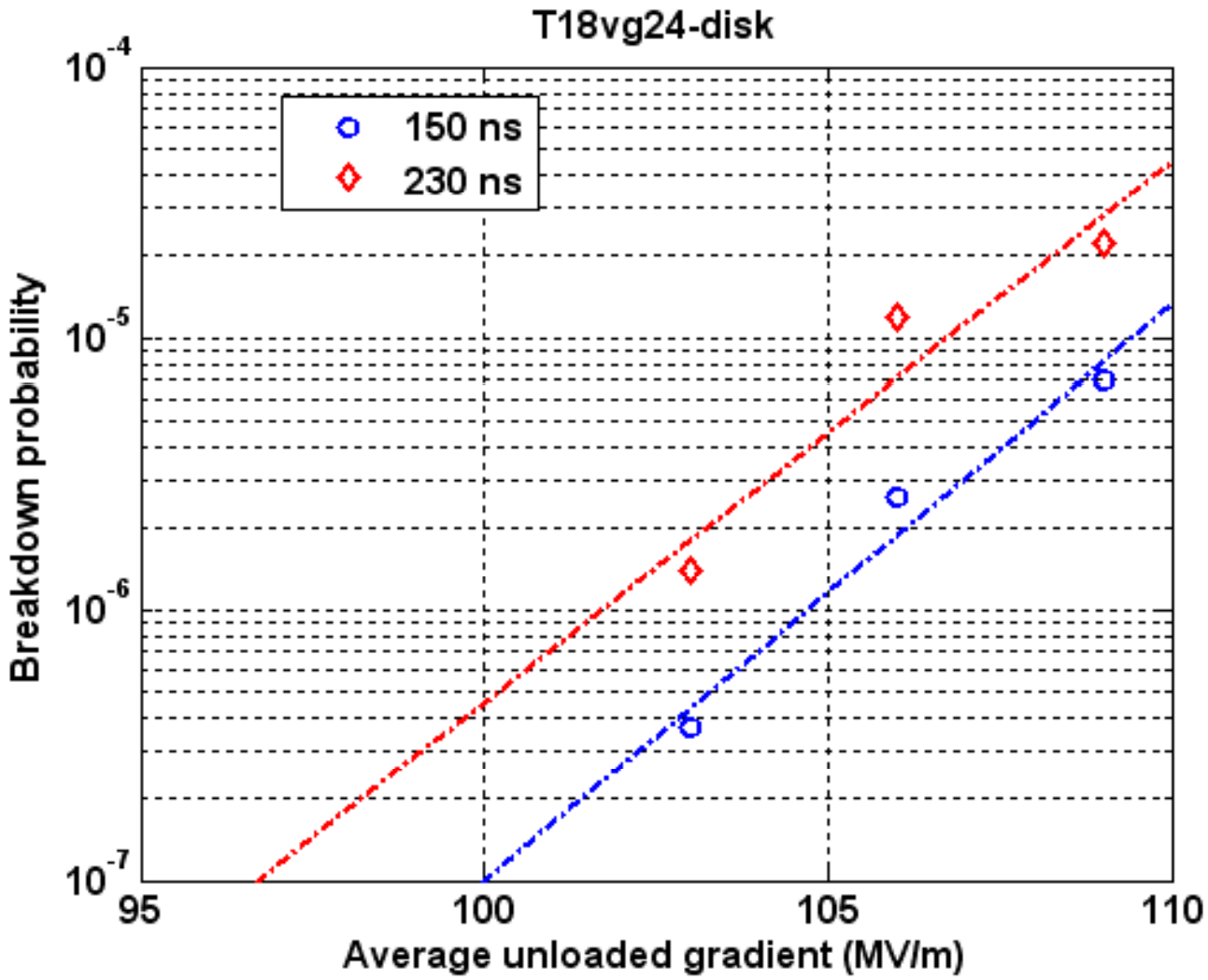


Modulator arcing

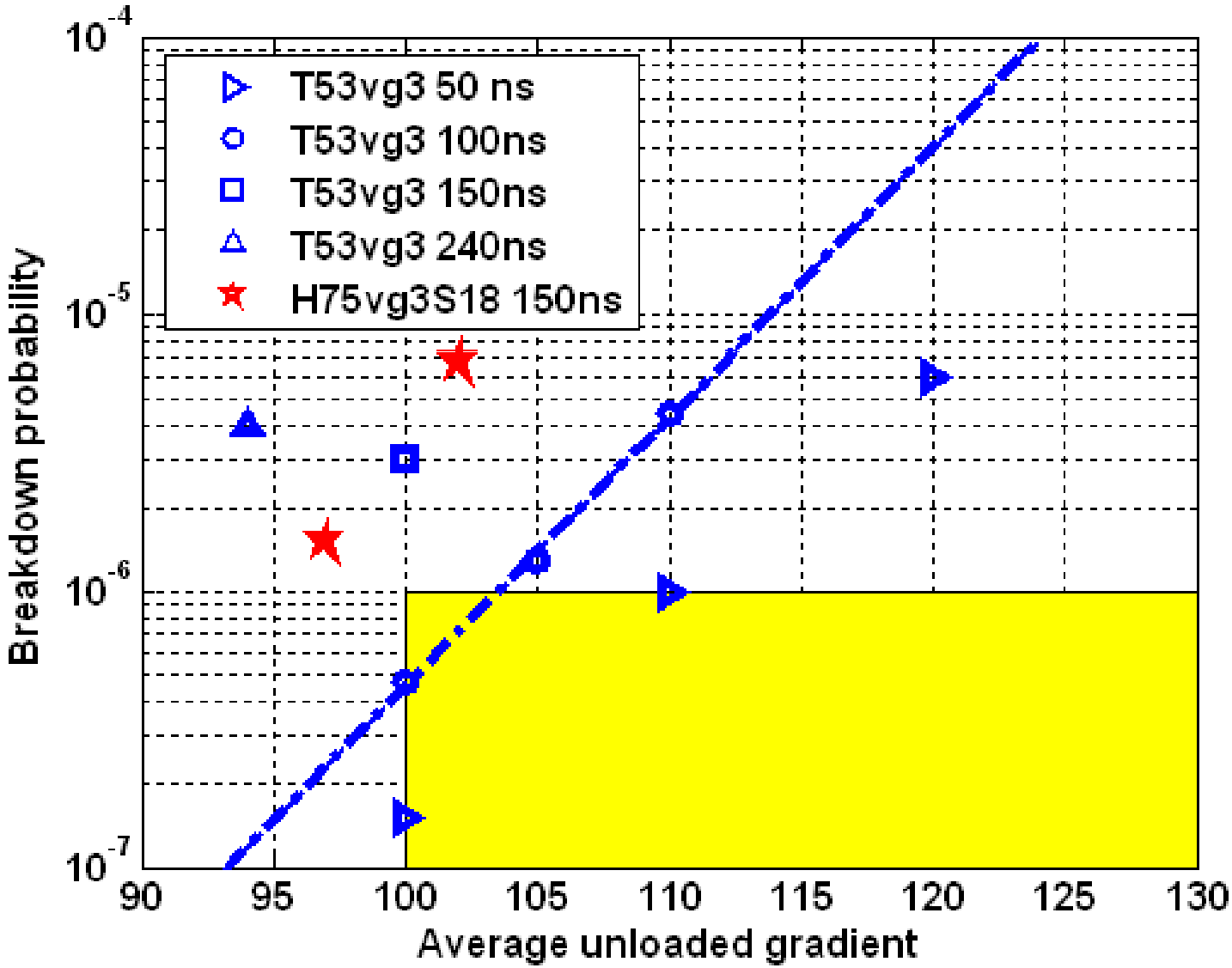
Break down rate vs gradient (loaded)



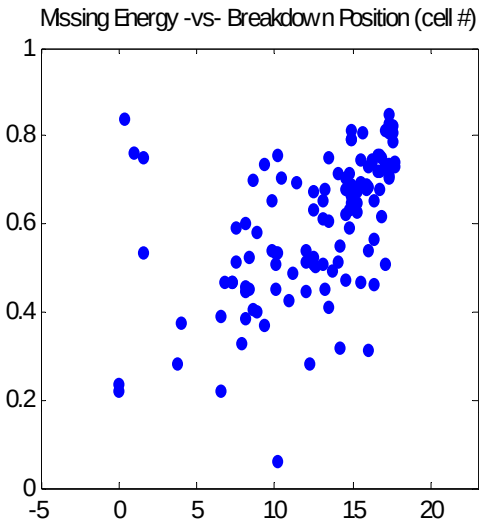
Break down rate vs gradient (unloaded)

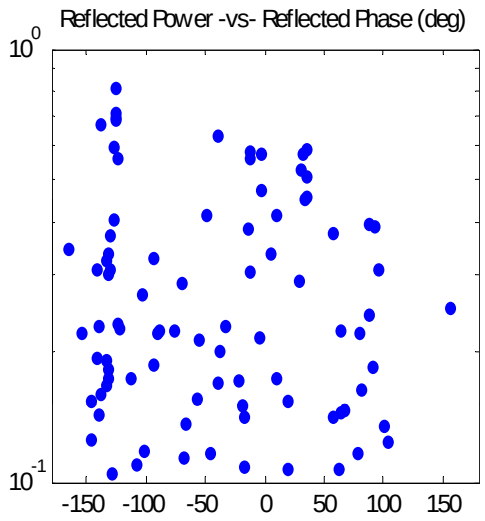


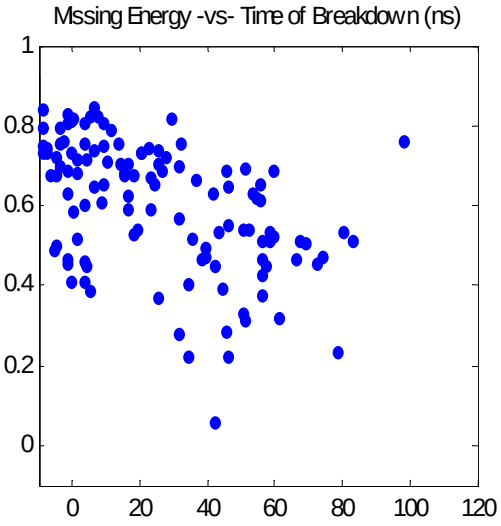
T53vg3 for comparison

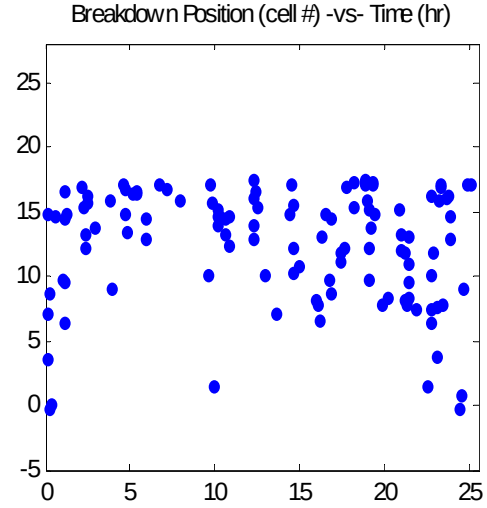


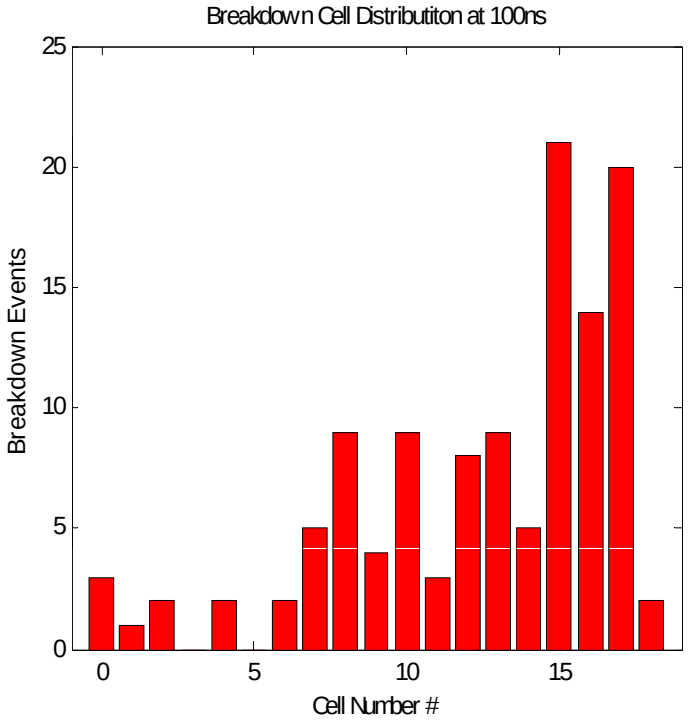
Break down analysis 100 ns

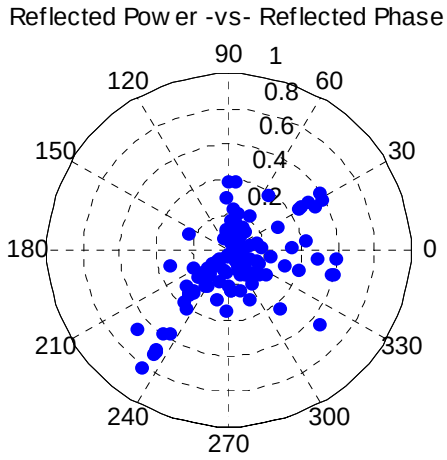




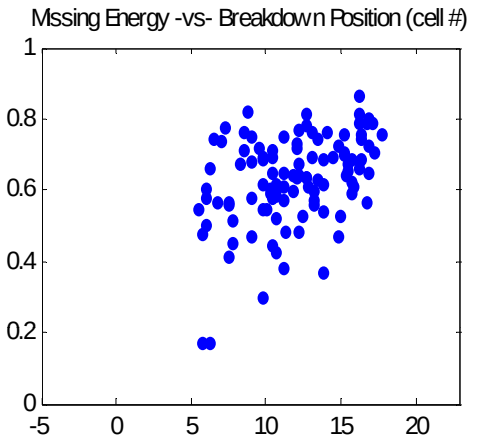


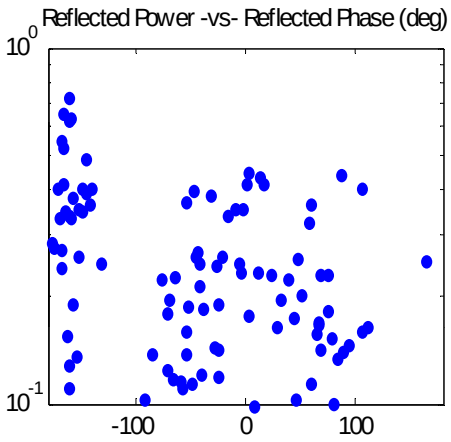


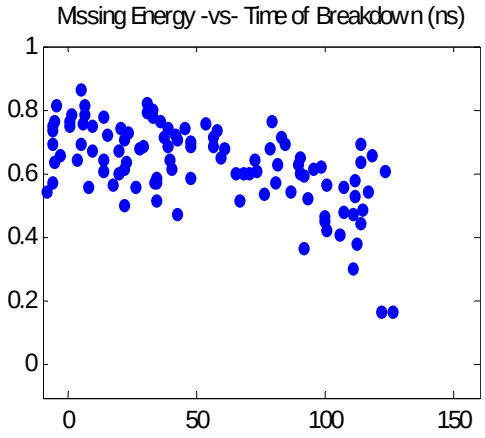


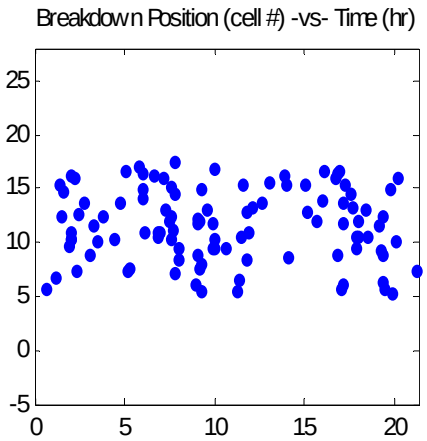


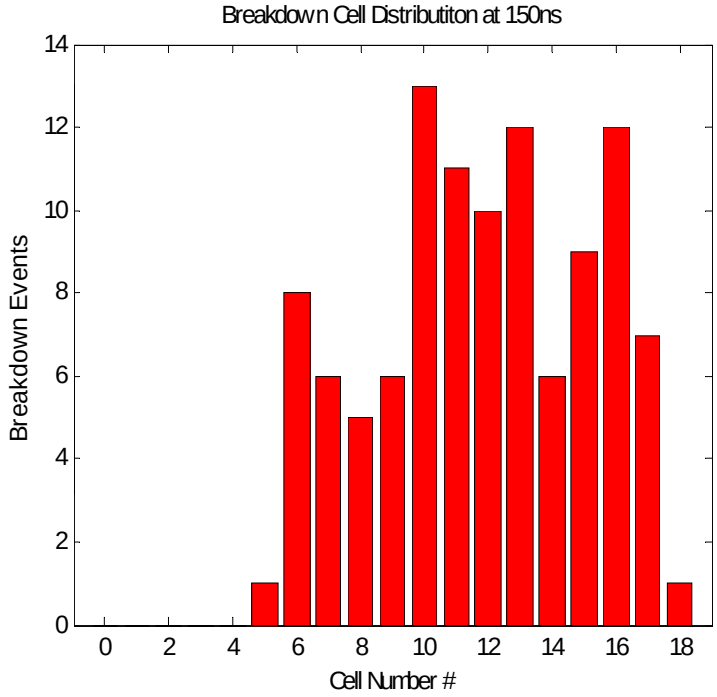
Break down analysis 150 ns

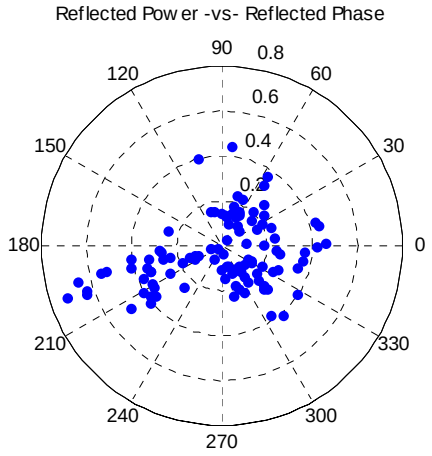




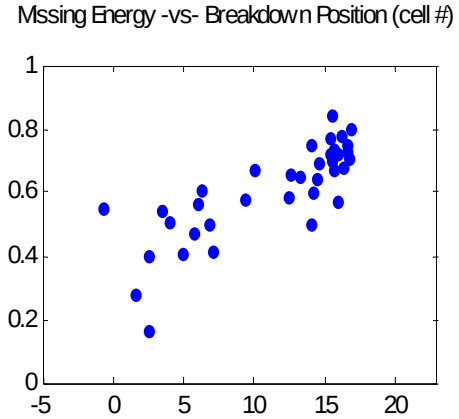


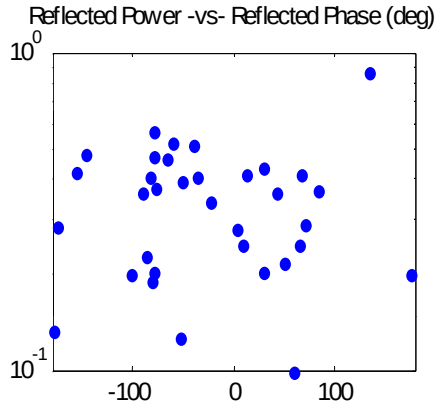


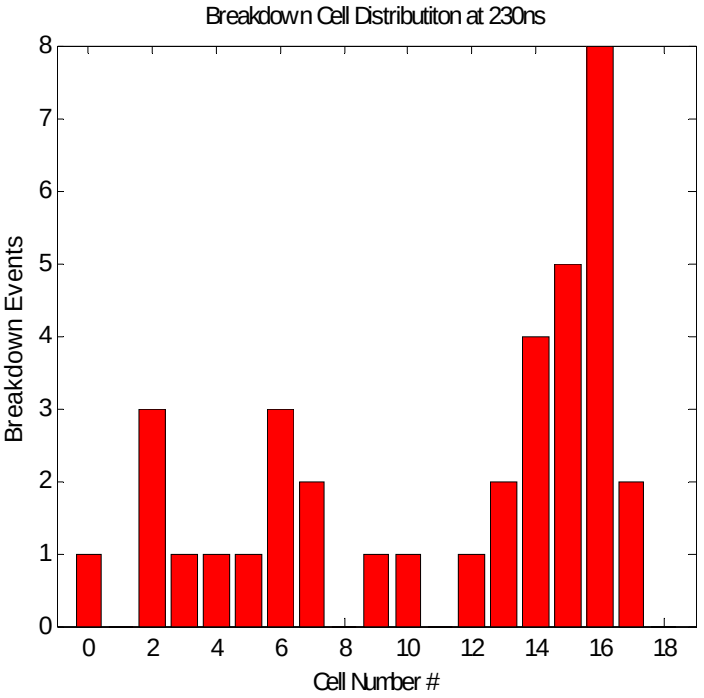


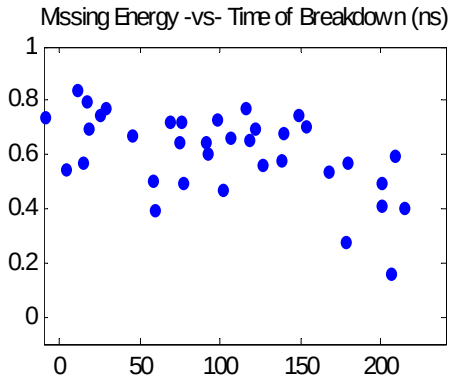


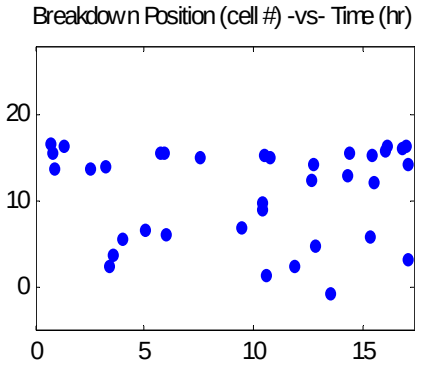
Break down analysis 230 ns

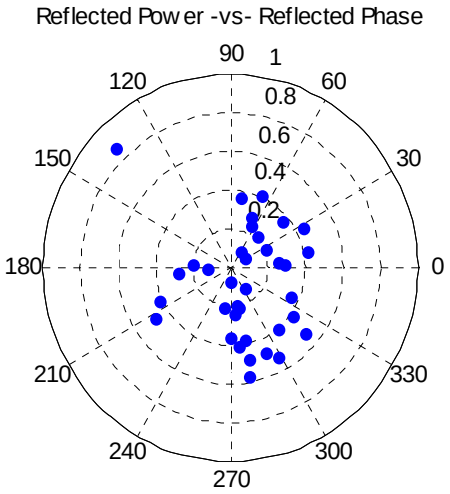




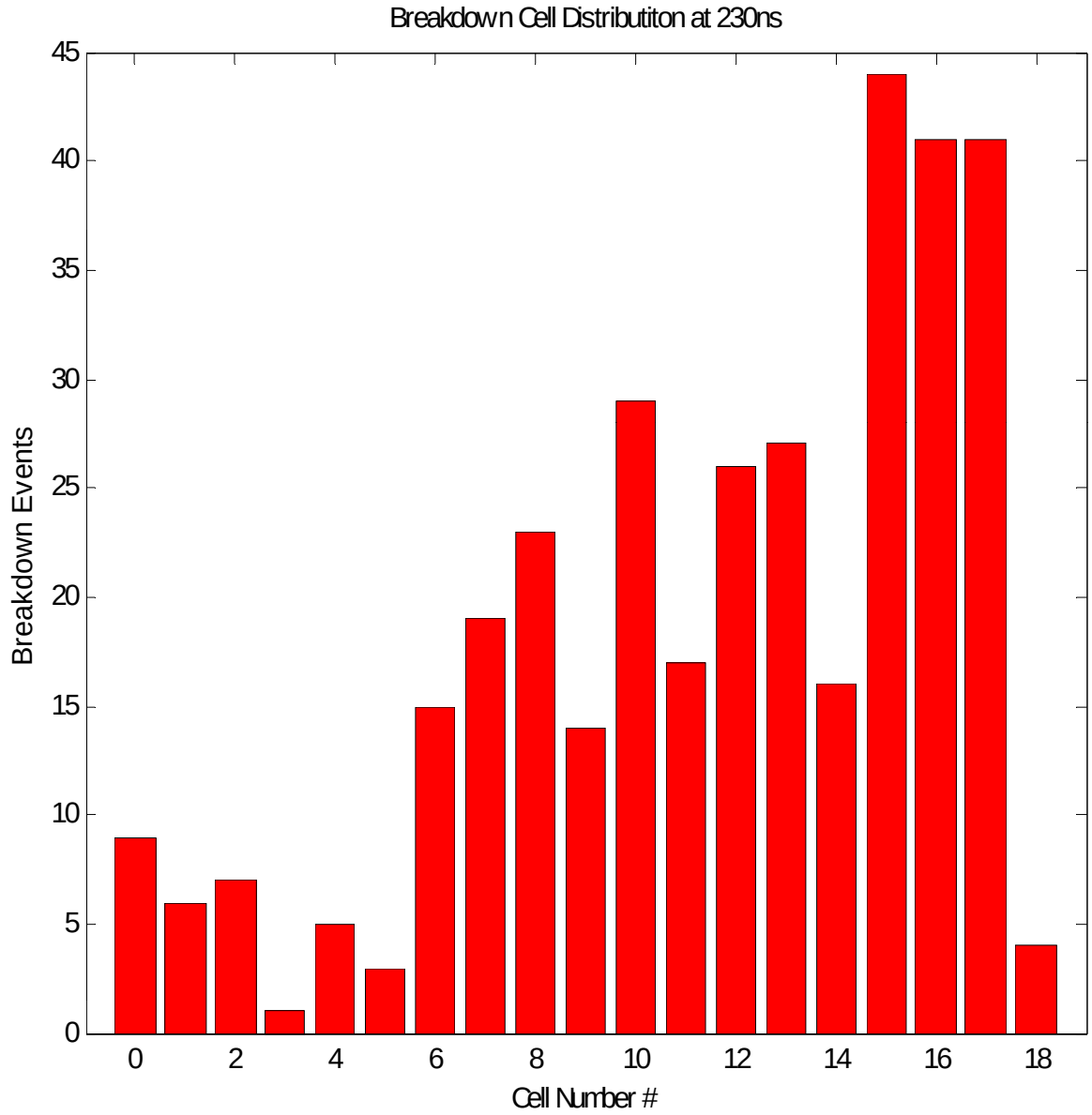








Break down position of all recorded events



Summary

Prediction of average unloaded gradient at rect. pulse length of 100ns and BDR=1e-6 based on the results achieved in T53vg3MC: 102.3MV/m at 100ns and BDR=1e-6:

19.5Wu or Sc=6.2MW/mm^2@100ns.

	CLIC_vg1	CLIC_vg1 undamped	T28vg2.4	T28vg2.4 damped	CLIC_G
$P/C*(t_p^{rect})^{1/3}$= 19.5Wu					
Average unloaded gradient [MV/m]	132	136	110	104	134
Corresponding input power [MW]	107	107	103	103	82
S_c=6.2MW/mm^2 @ t_p^{rect}=100ns					
Average unloaded gradient [MV/m]	109	106	105	103	120
Corresponding input power [MW]	73.1	65.6	94.3	101	65.9

Preliminary Conclusions

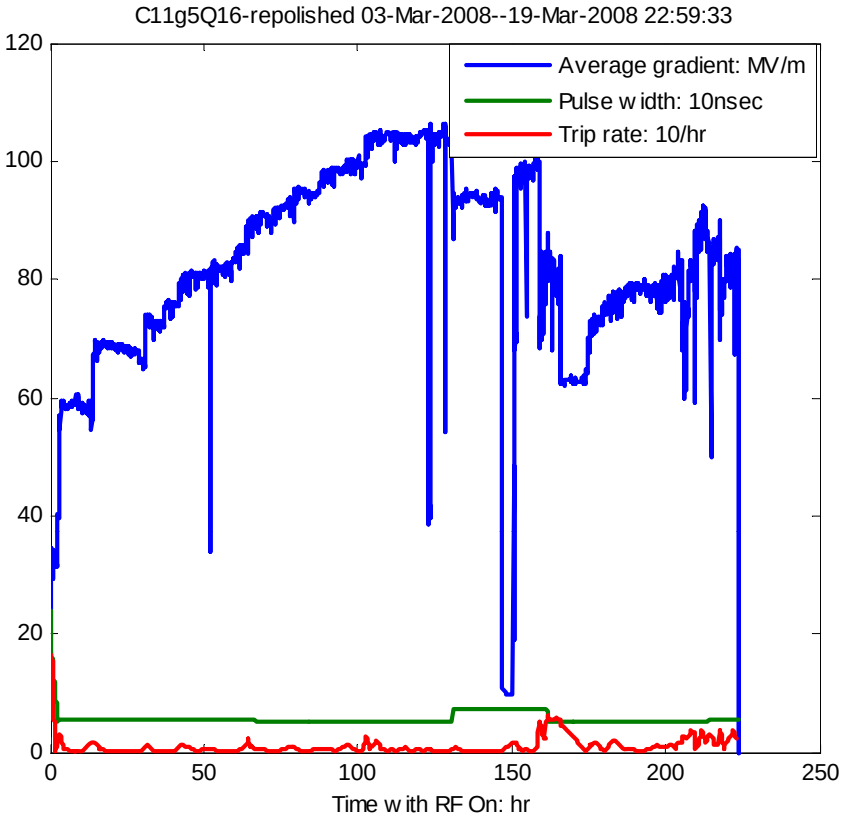
- We got a very nice data point towards CLIC !
- No doubts on NLC/GLC disk technology fast and smooth processing
- at 10^{-6} BD-rate, ~ 103 MV/m unloaded at 230 ns, 13.7 wue
  ~ 105 MV/m at 150 ns, 12.4 wue
- Structure might work between 80-90 MV/m for CLIC, damping, efficiency ?
- Breakdowns seem to happen more often at the end of the structure
- The 'S-parameter' prediction is pretty good, P/C not
- No significant dark current measurable
- T24vg1.7 seems the right next step towards a CLIC structure
- Experiment went very well, great support from SLAC

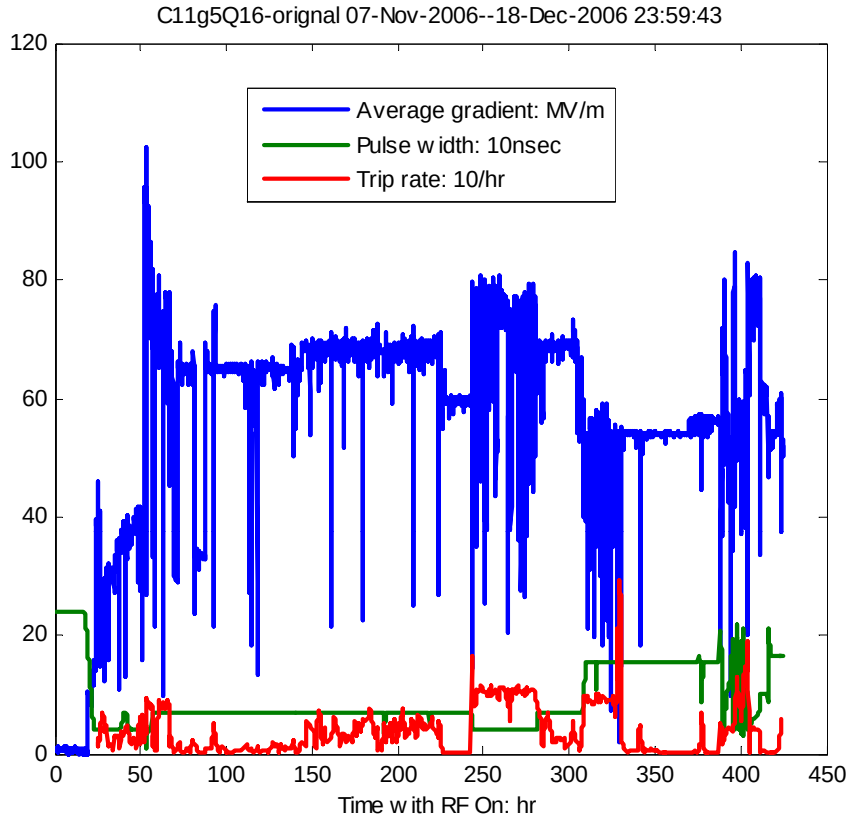
HDX11 revisited

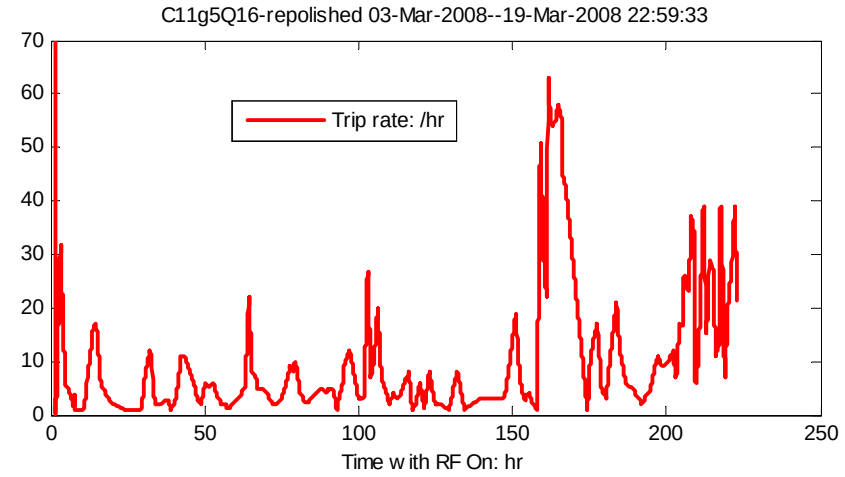
- Quadrants were electro polished, and high temperature (1000 deg) hydrogen brazed, followed by 650 deg vacuum bake
- Structure was tested turned around and had similar results after a very promising start
- Post mortem analysis with SEM

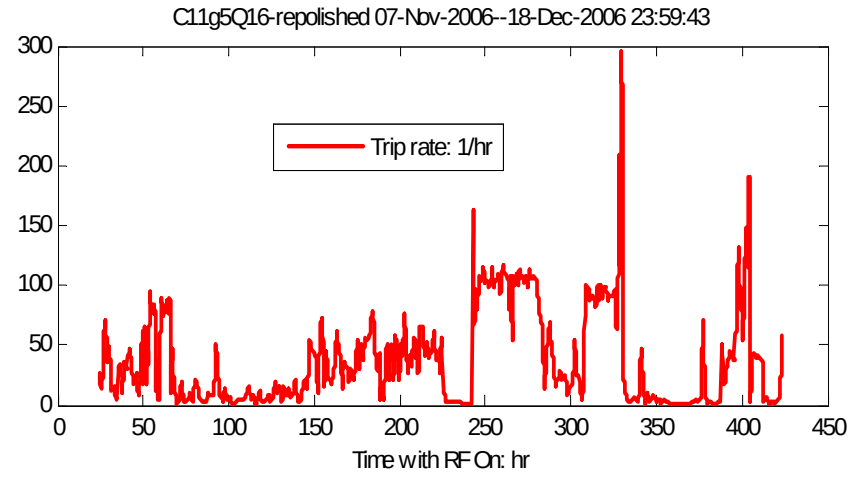
HDX11 before and after electro polishing

Faya Wang

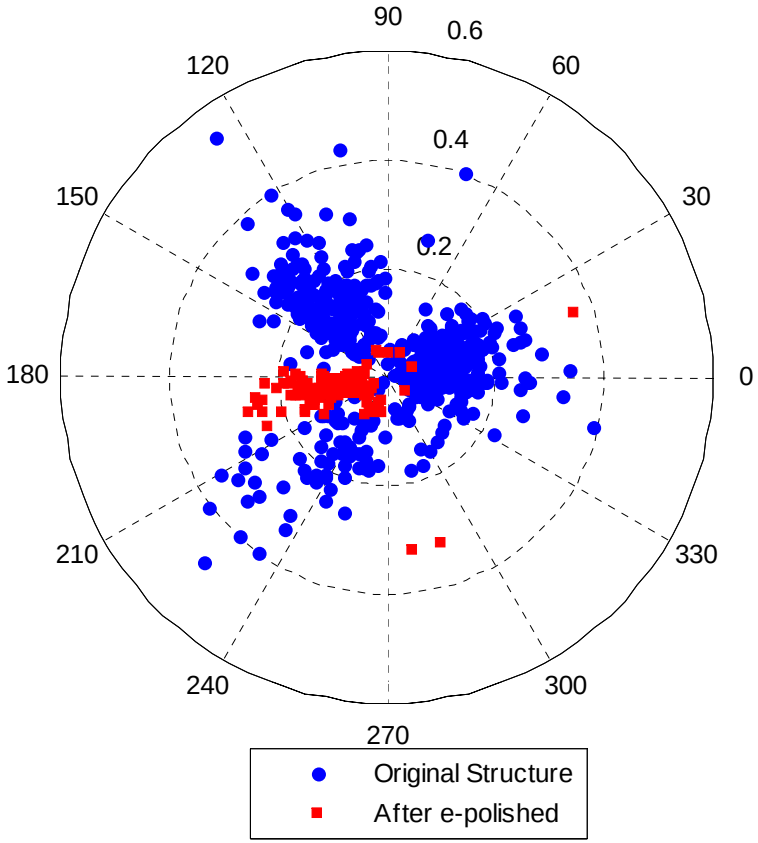




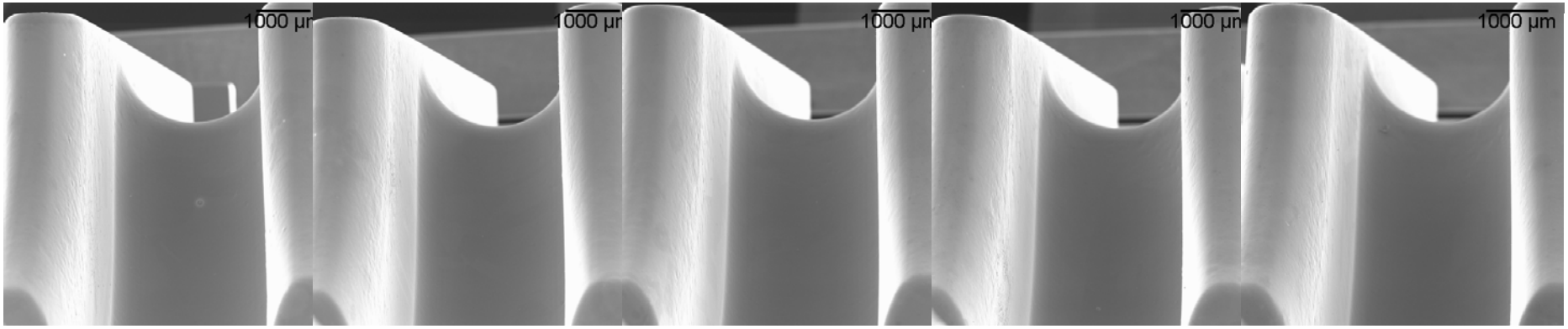




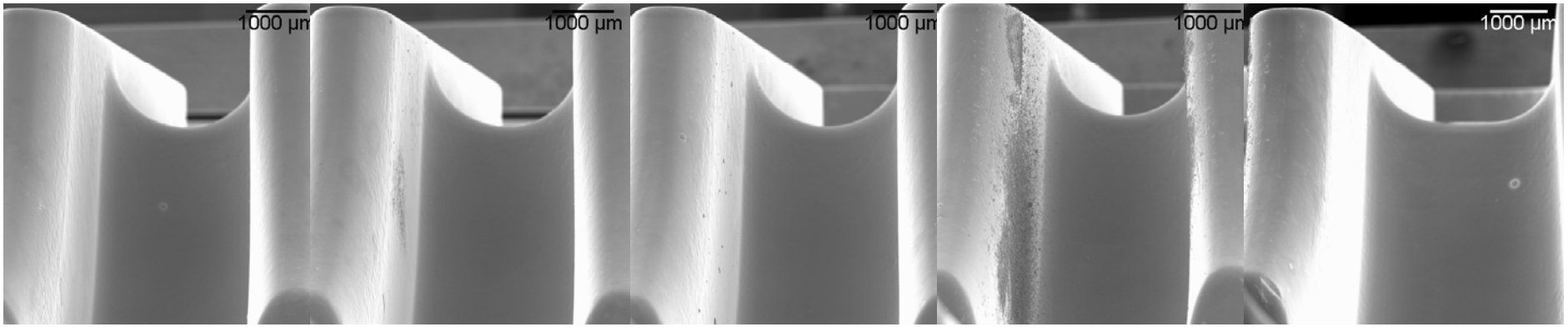
Peak Reflected RF Power (Fraction of Input Power) Versus Reflected RF Phase (Deg)



SEM pictures



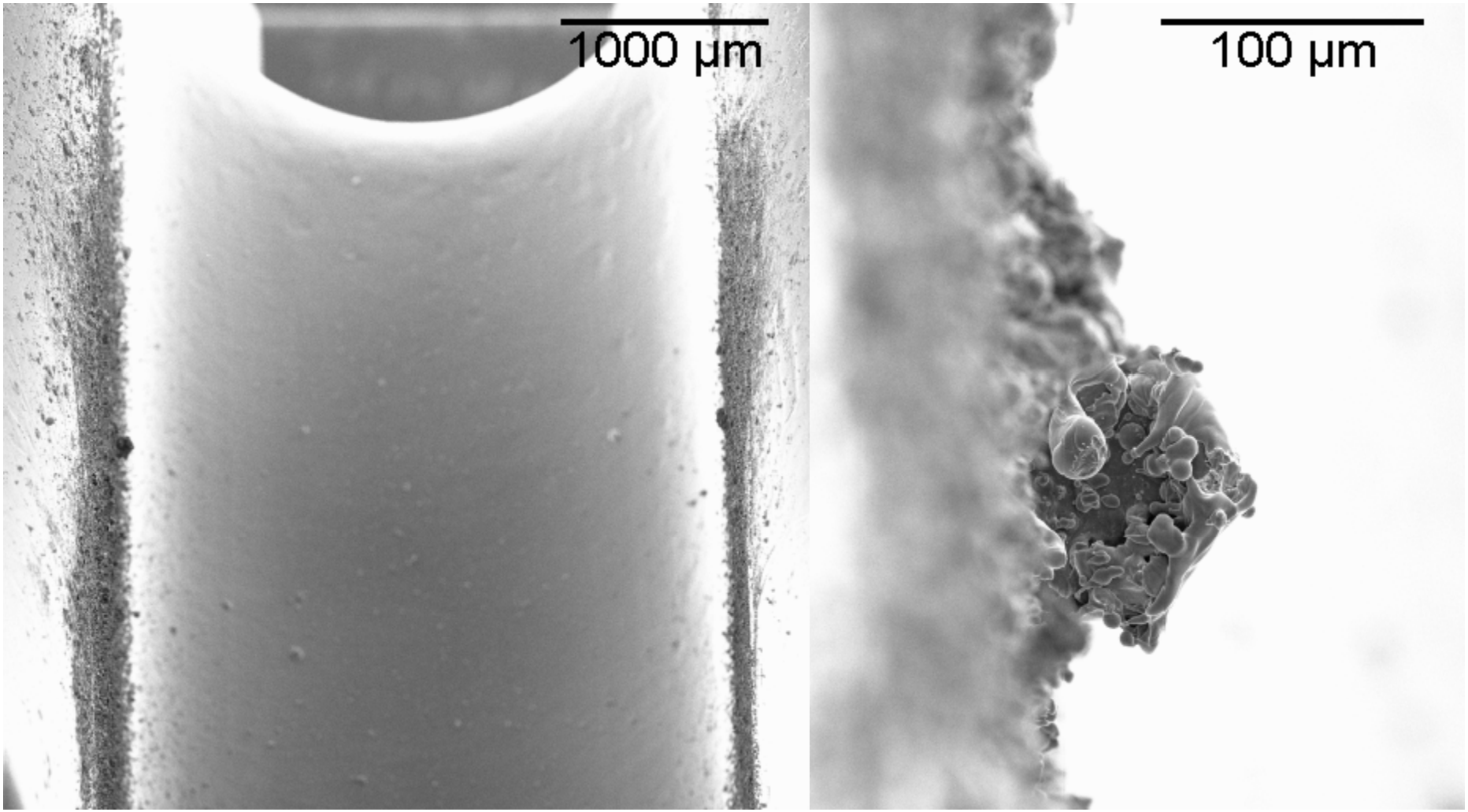
9 cell 8 cell 7 cell 6 cell 5 cell



4 cell 3 cell 2 cell 1 cell 0 cell

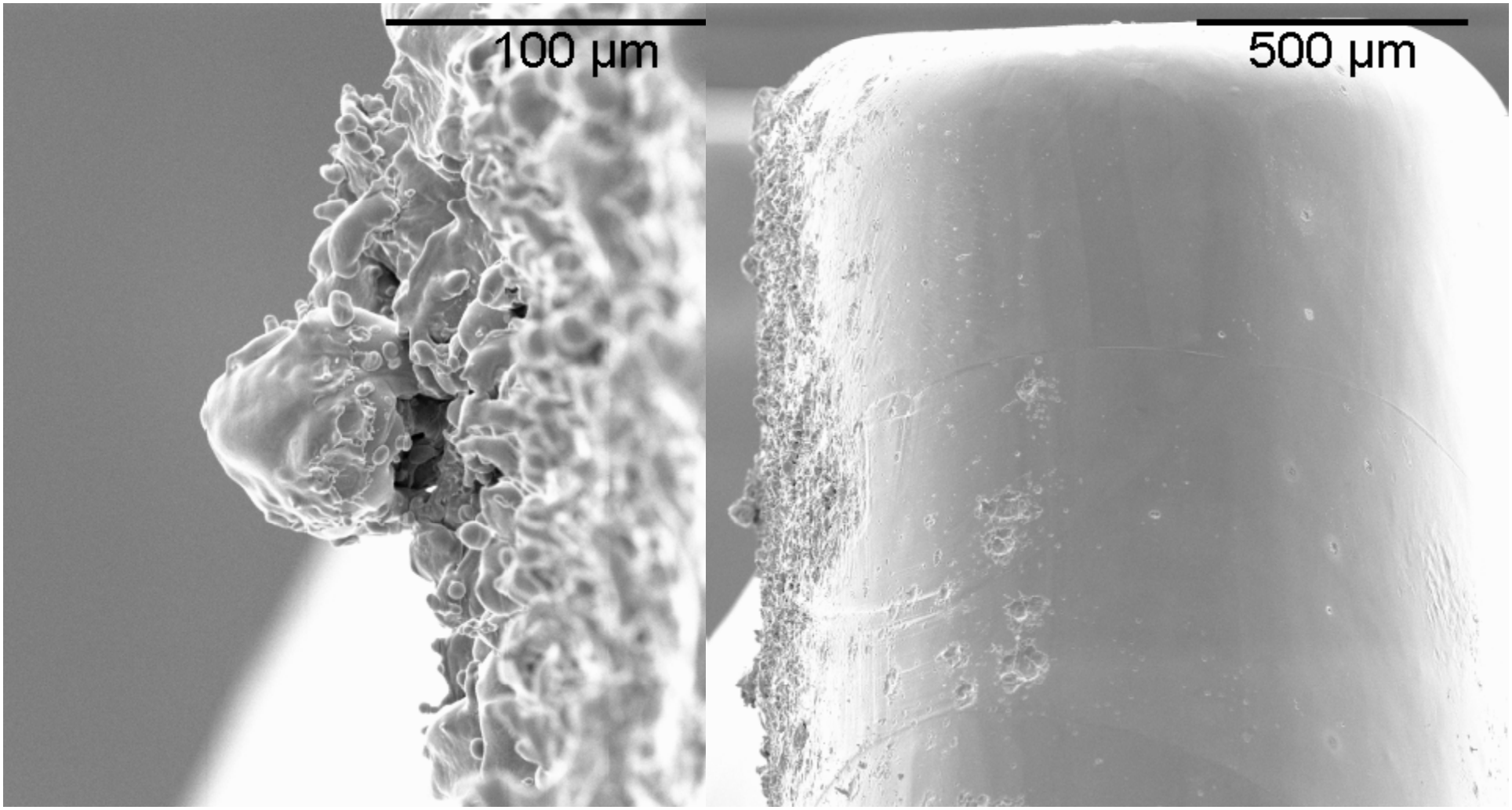
Mainly first regular cell damaged

SEM pictures



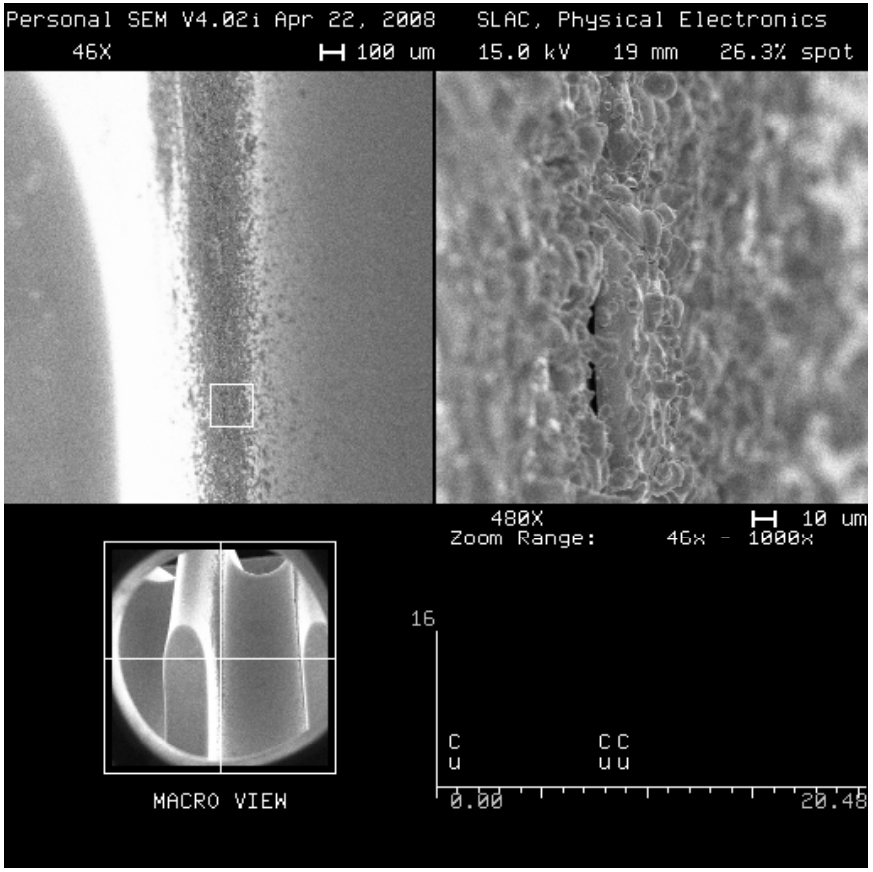
Cell No. 1 , growing tips
are they connected ?

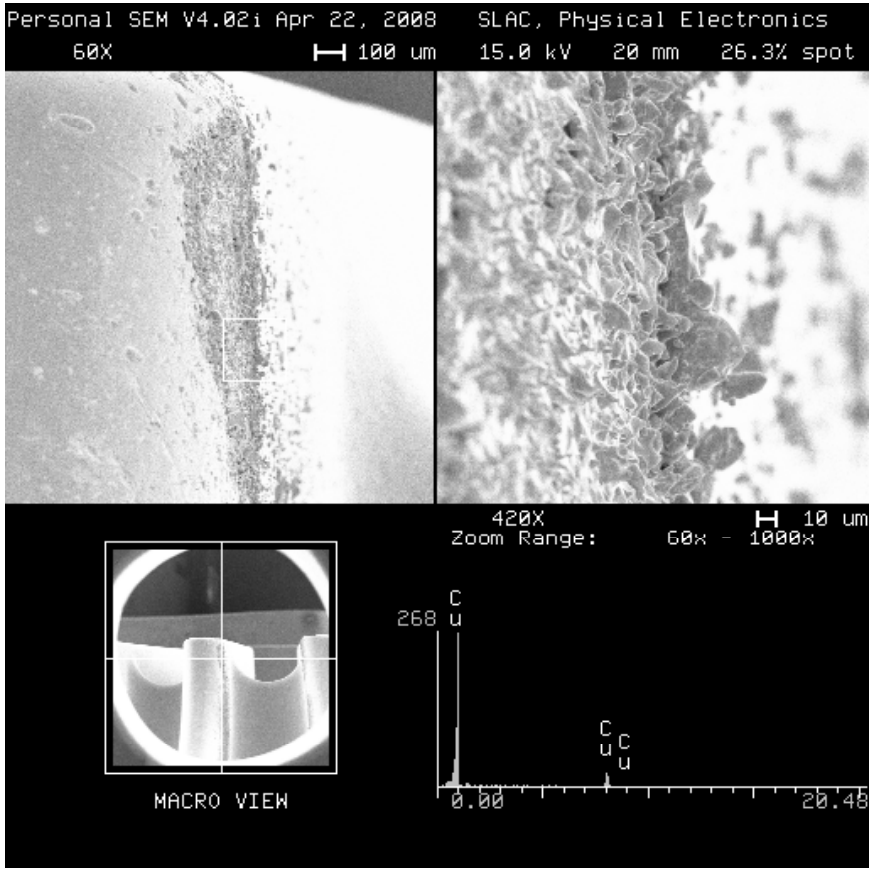
SEM pictures



Cell No. 1 , growing tips

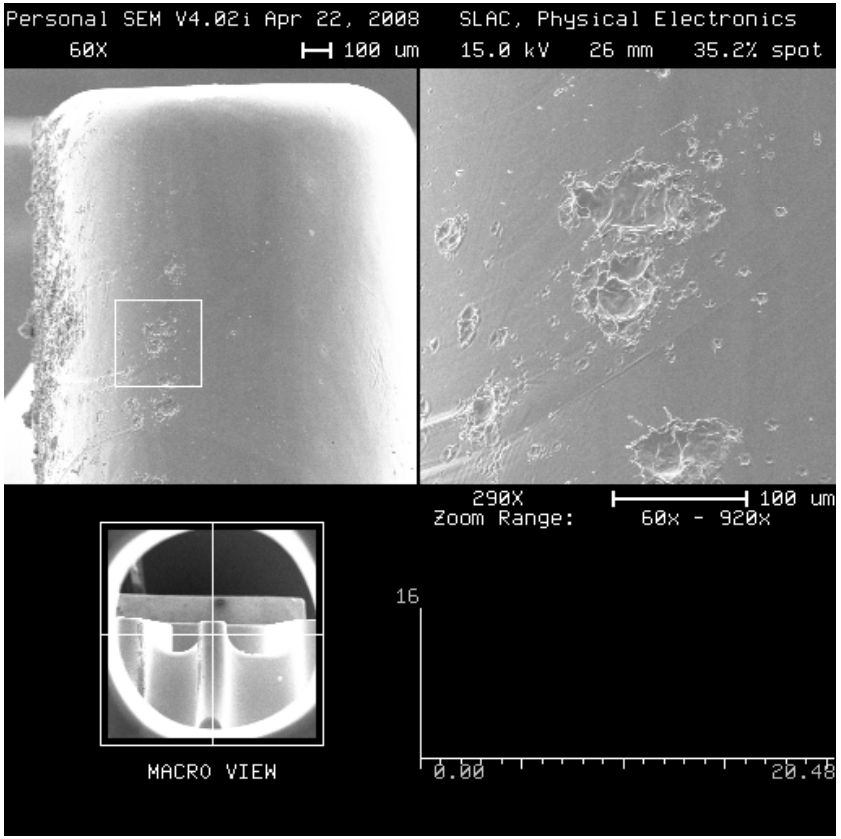
SEM pictures

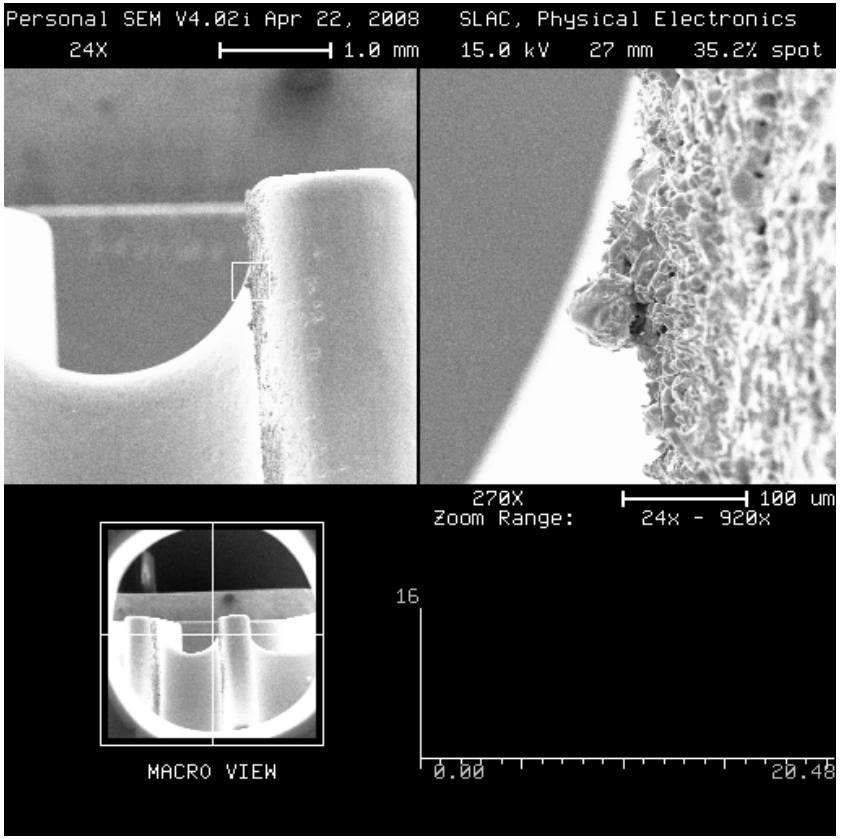




Cell No. 1 , voids and cracks ?

SEM pictures

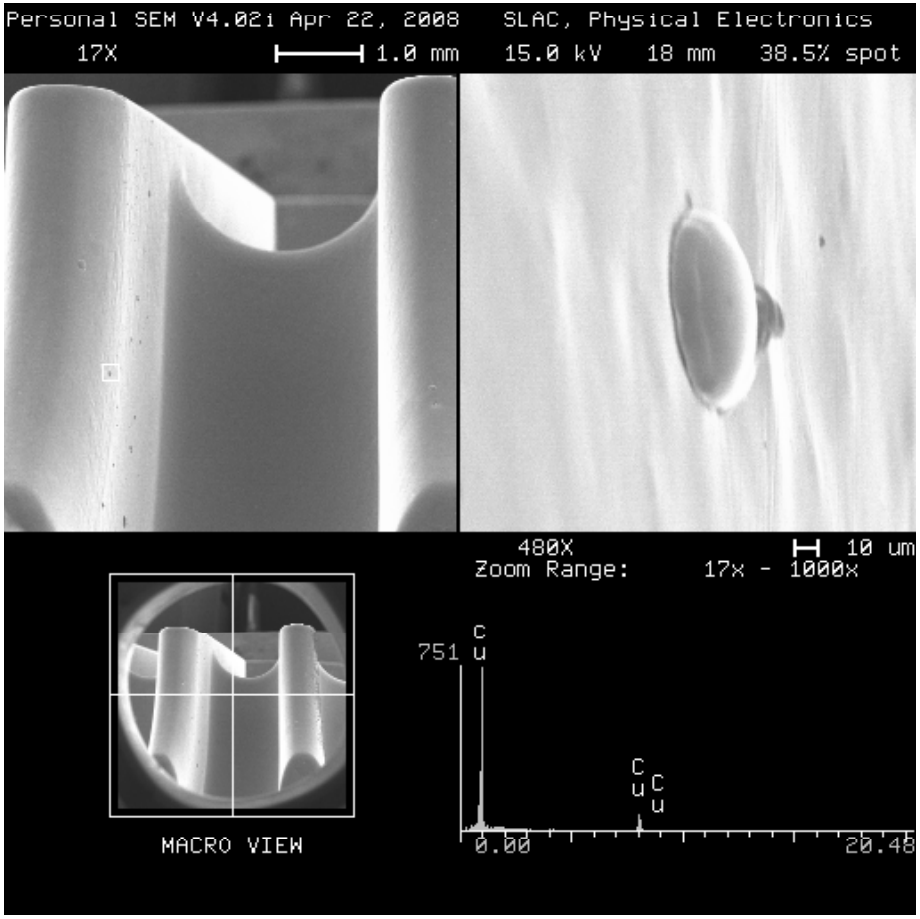


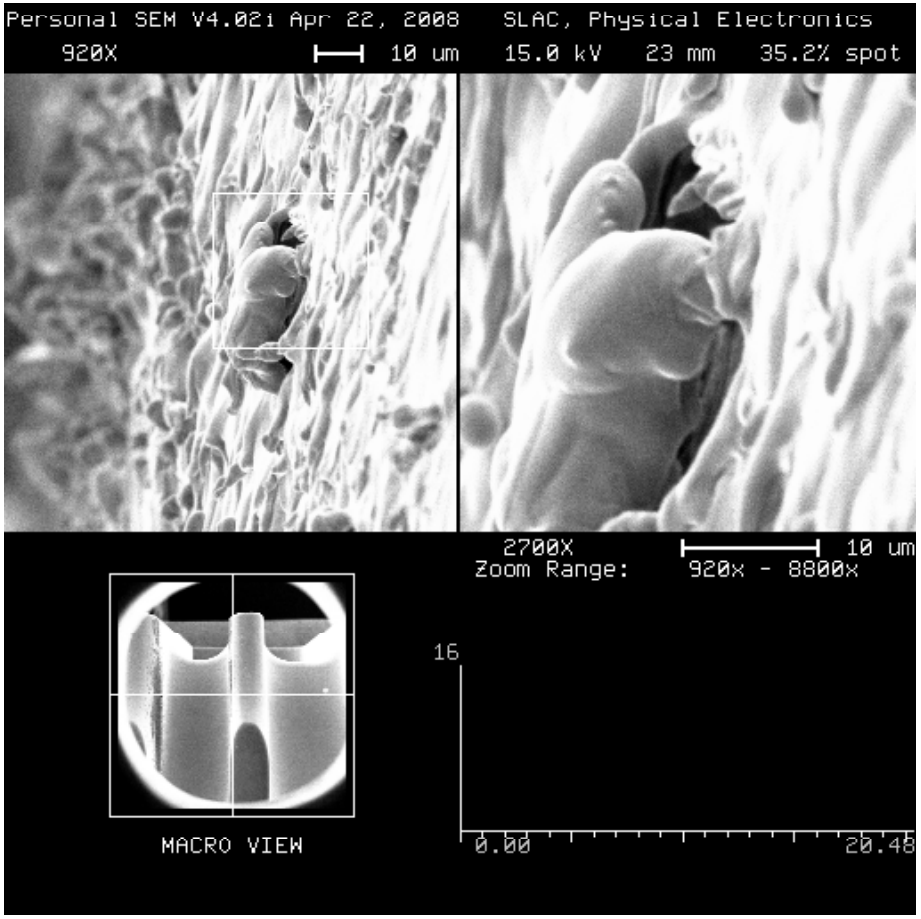


Cell No. 1 , damage craters vs lava field

Is this just more of the same or a new quality ?

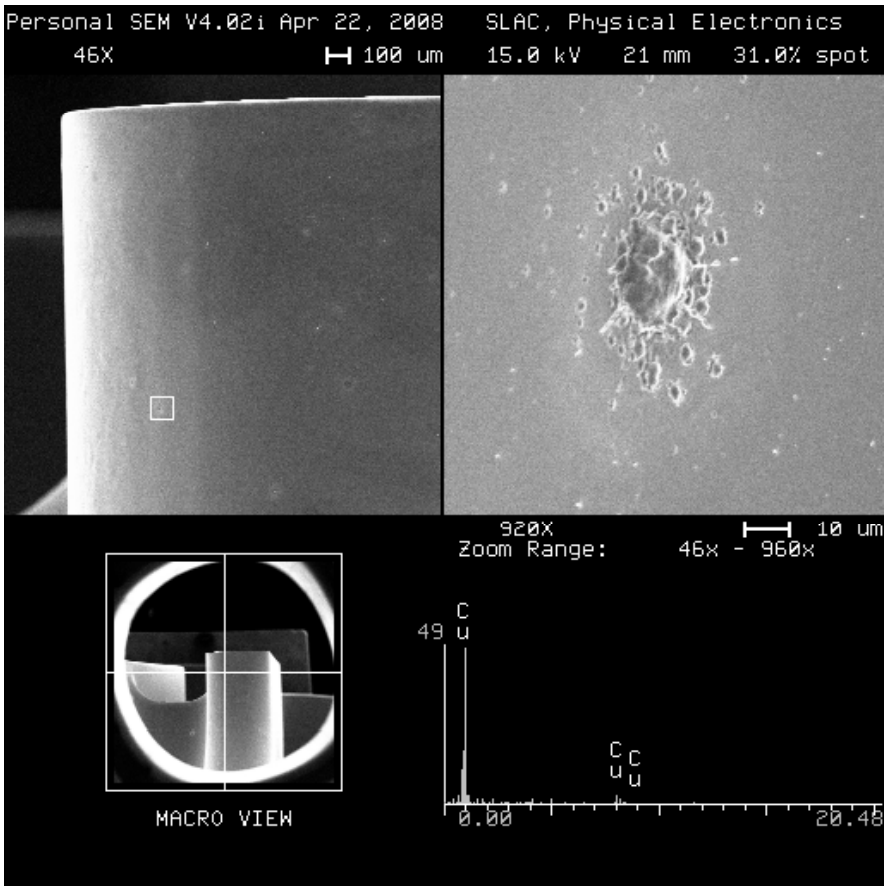
SEM pictures

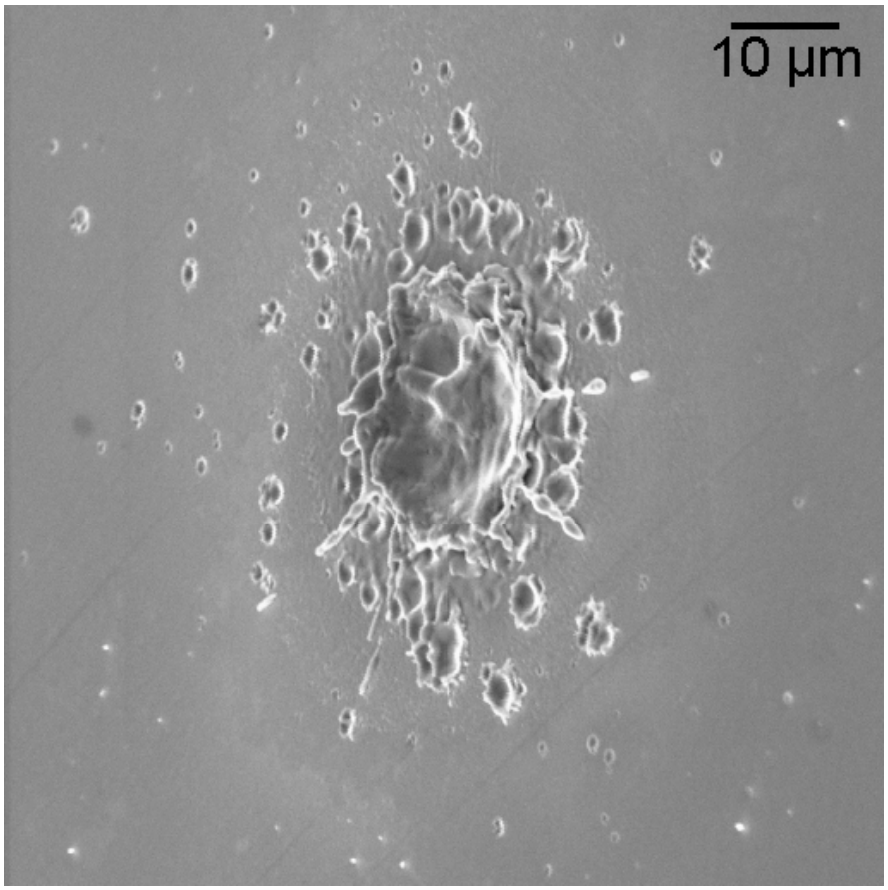




Curiosities

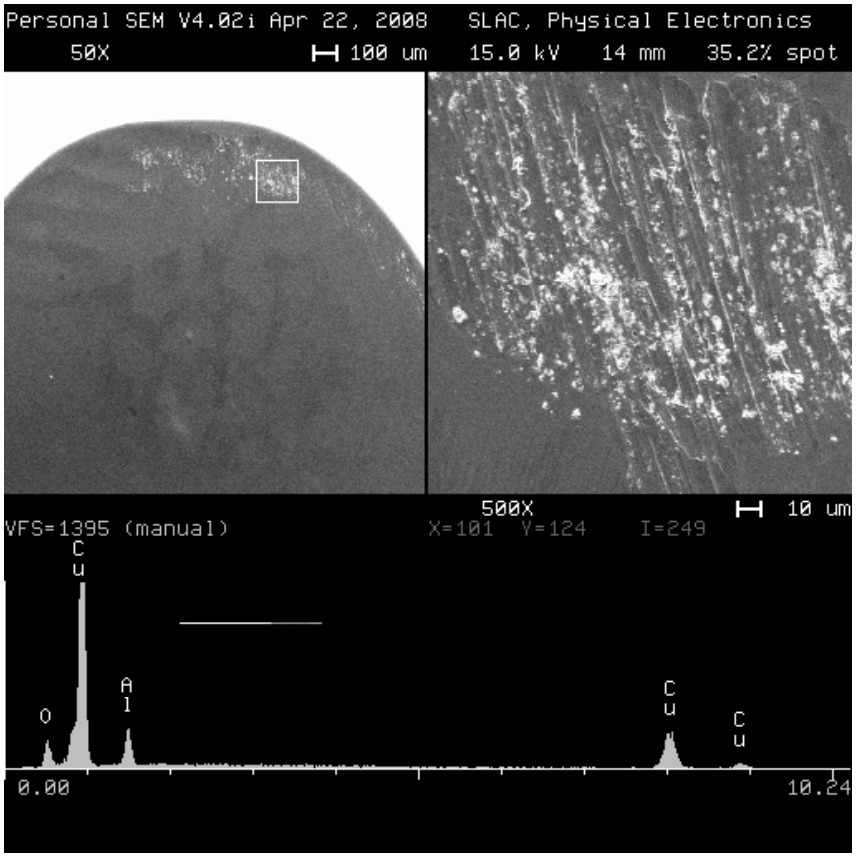
SEM pictures

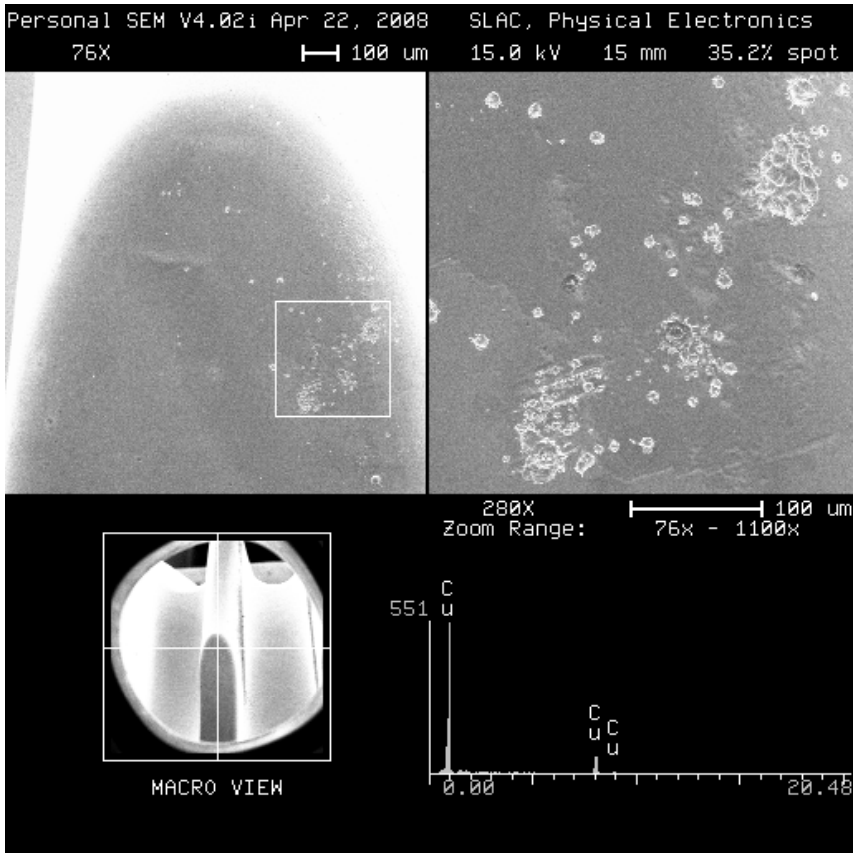




Splash, mechanism, where does it come from

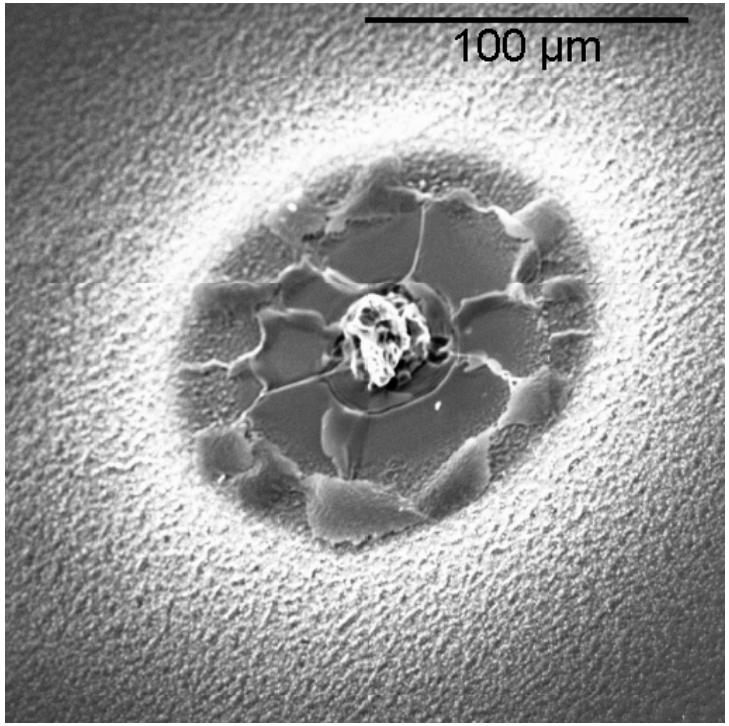
SEM pictures



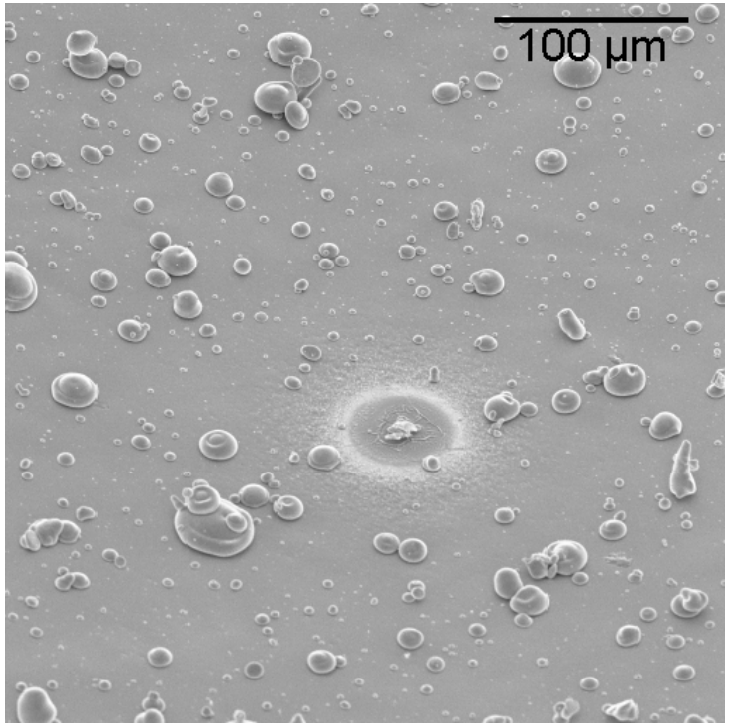


Slot activity, there are fields high enough to melt Copper

SEM pictures



A nice particle, most likely before baking



Droplets on the cell bottom

HDX11 possible conclusions

- Special surface treatment had minor effect or it is masked by more fundamental problems
- Wrong material (CERN copper) ?
- Quadrants have a fundamental problem
- Structure geometry does not work (short phase advance) (what about the 150 deg at 30 GHz)