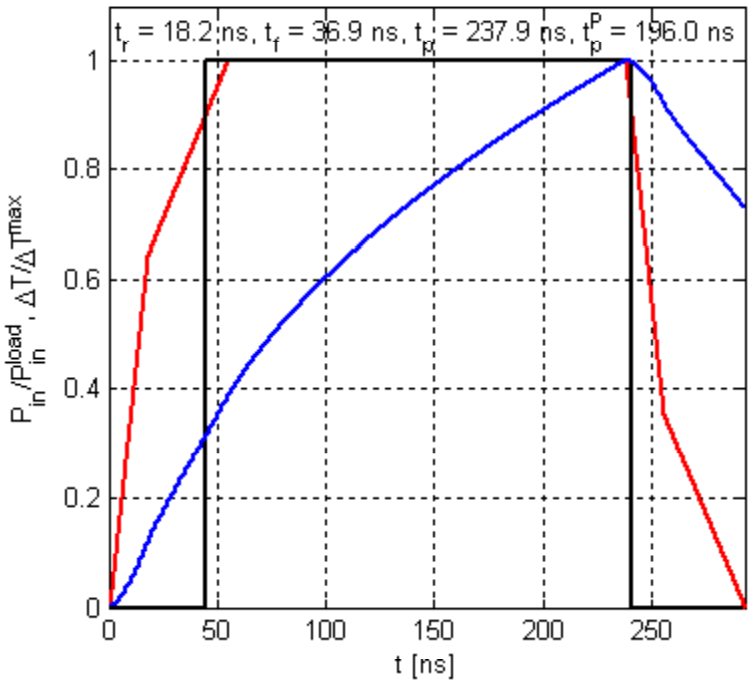
High Power test of T18_VG2.4_disk [2] at SLAC

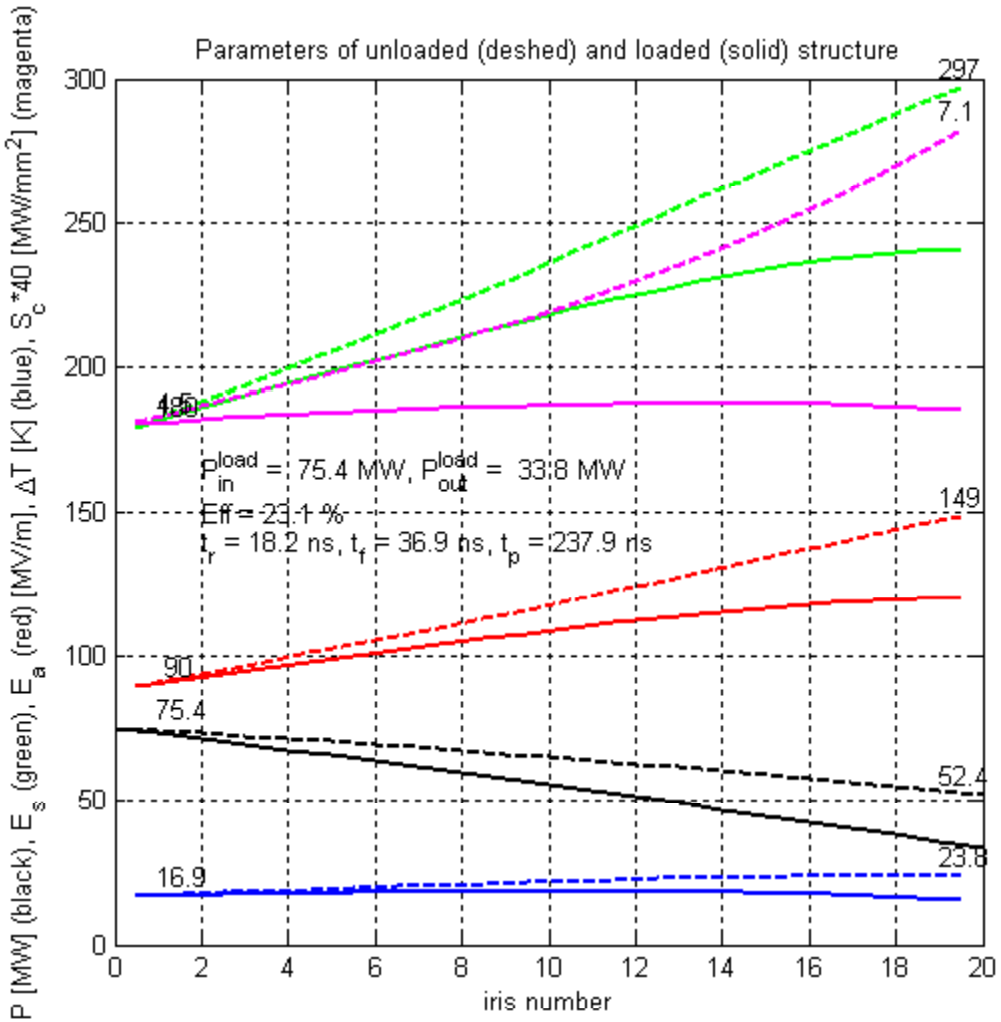
A truly remarkable result of a well working collaboration between our lab's !

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

Field quantities of T18_VG2.4



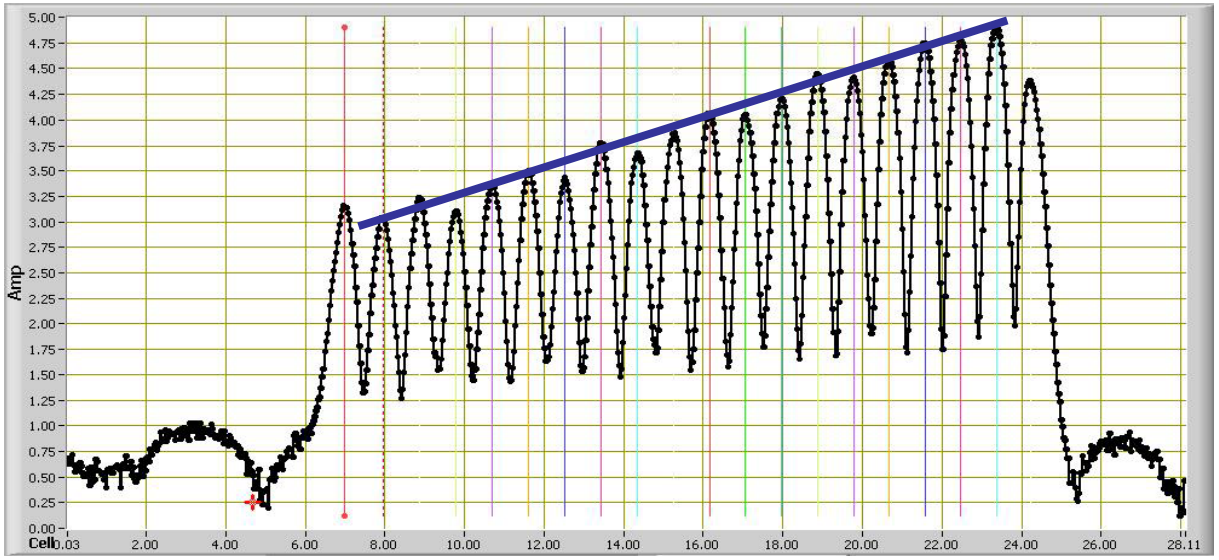


Alexej Grudiev

Cold measurements after tuning

T18_VG2.4_DISC Structure with SLAC Flanges

Field Amplitude

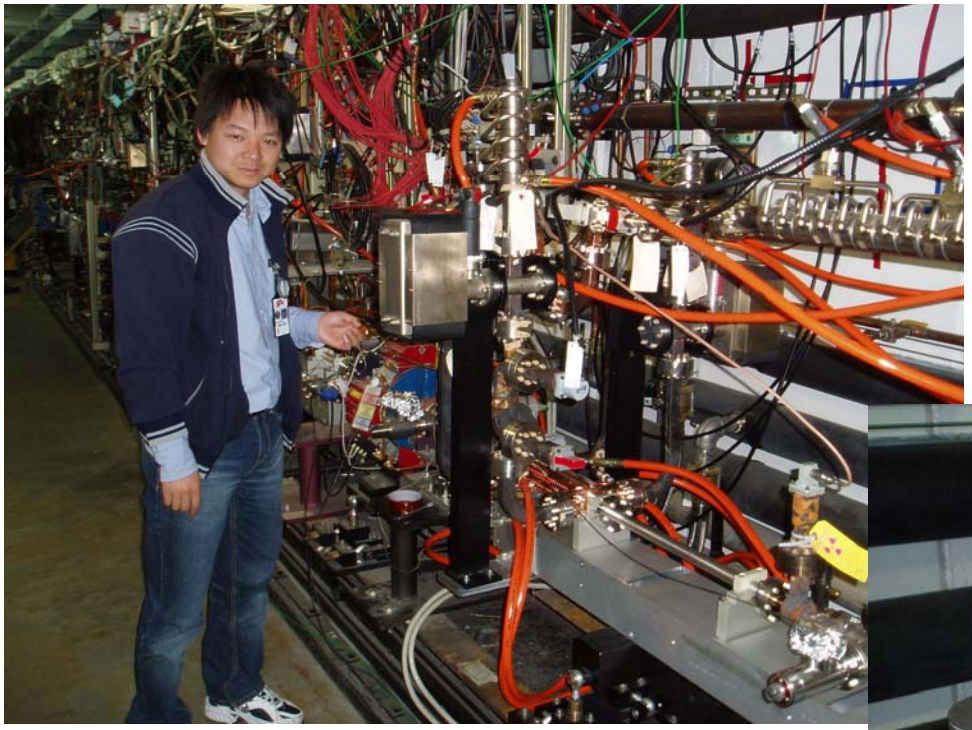


Cumulated Phase Change

120°

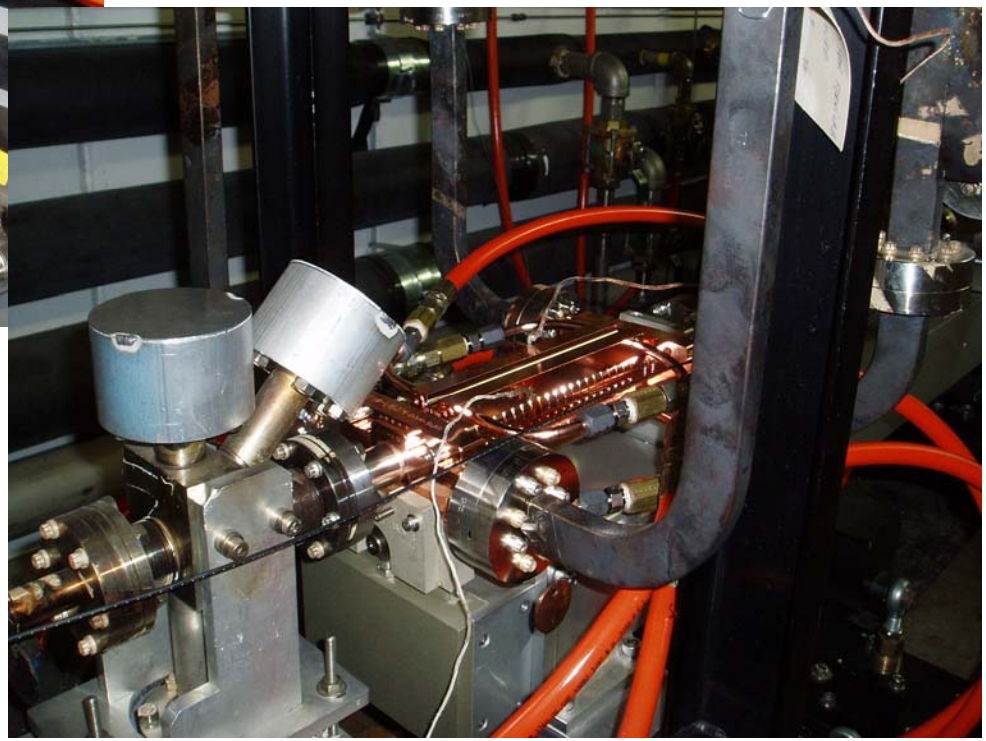
Juwen Wang

T18vg2.4_disk[2] installed in NLCTA

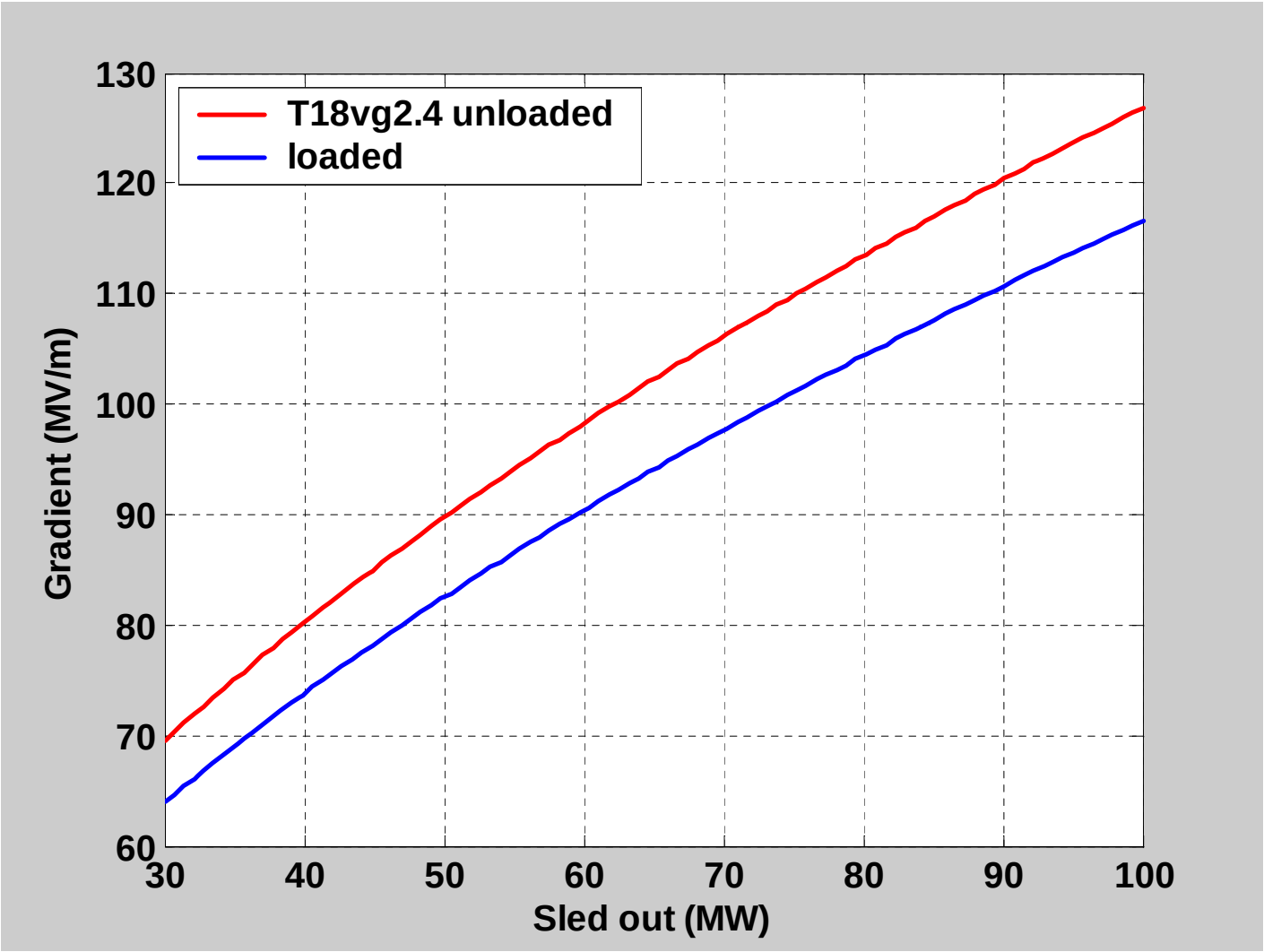


Faya Wang

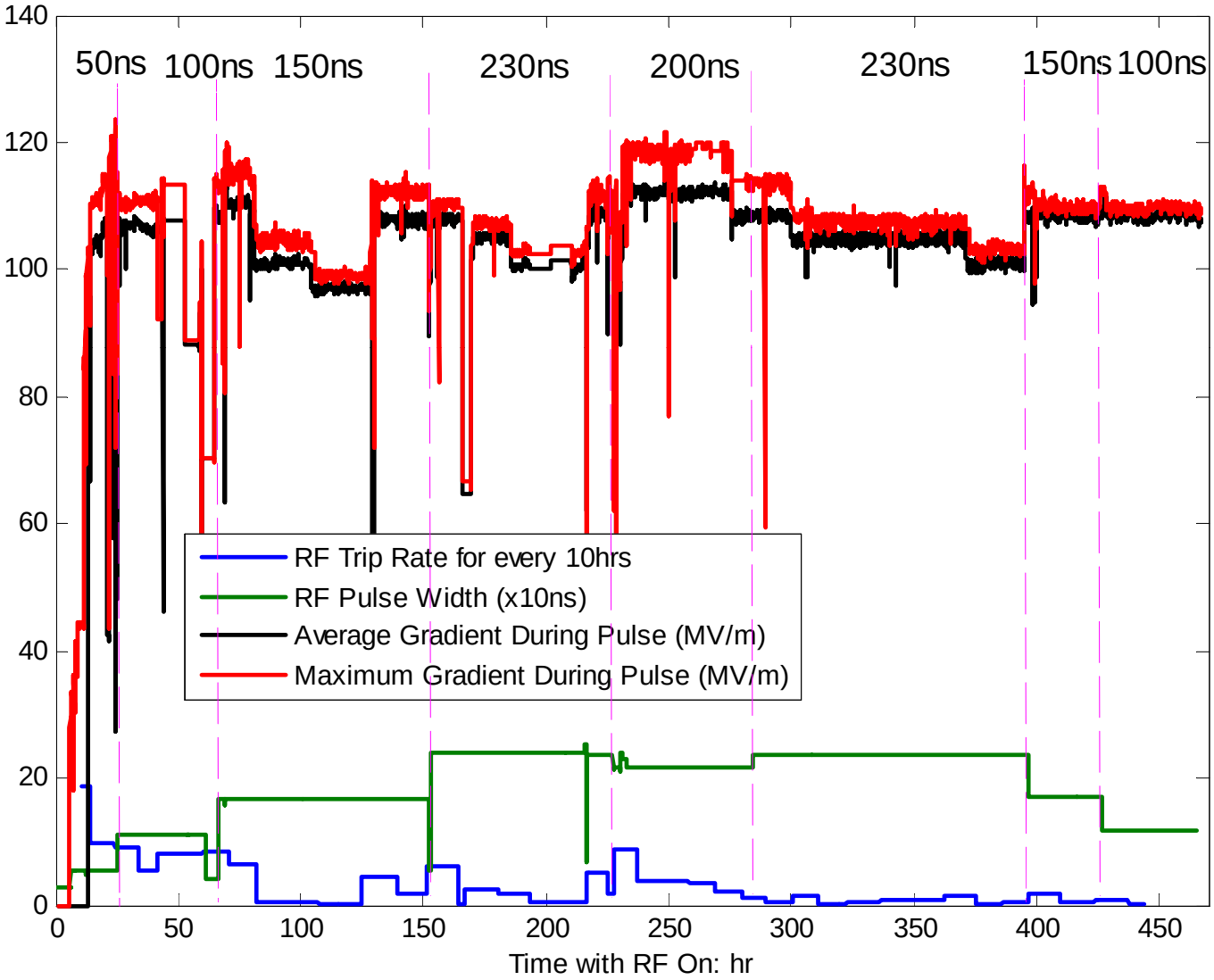
T18vg2.4_disk [2]



Structure calibration

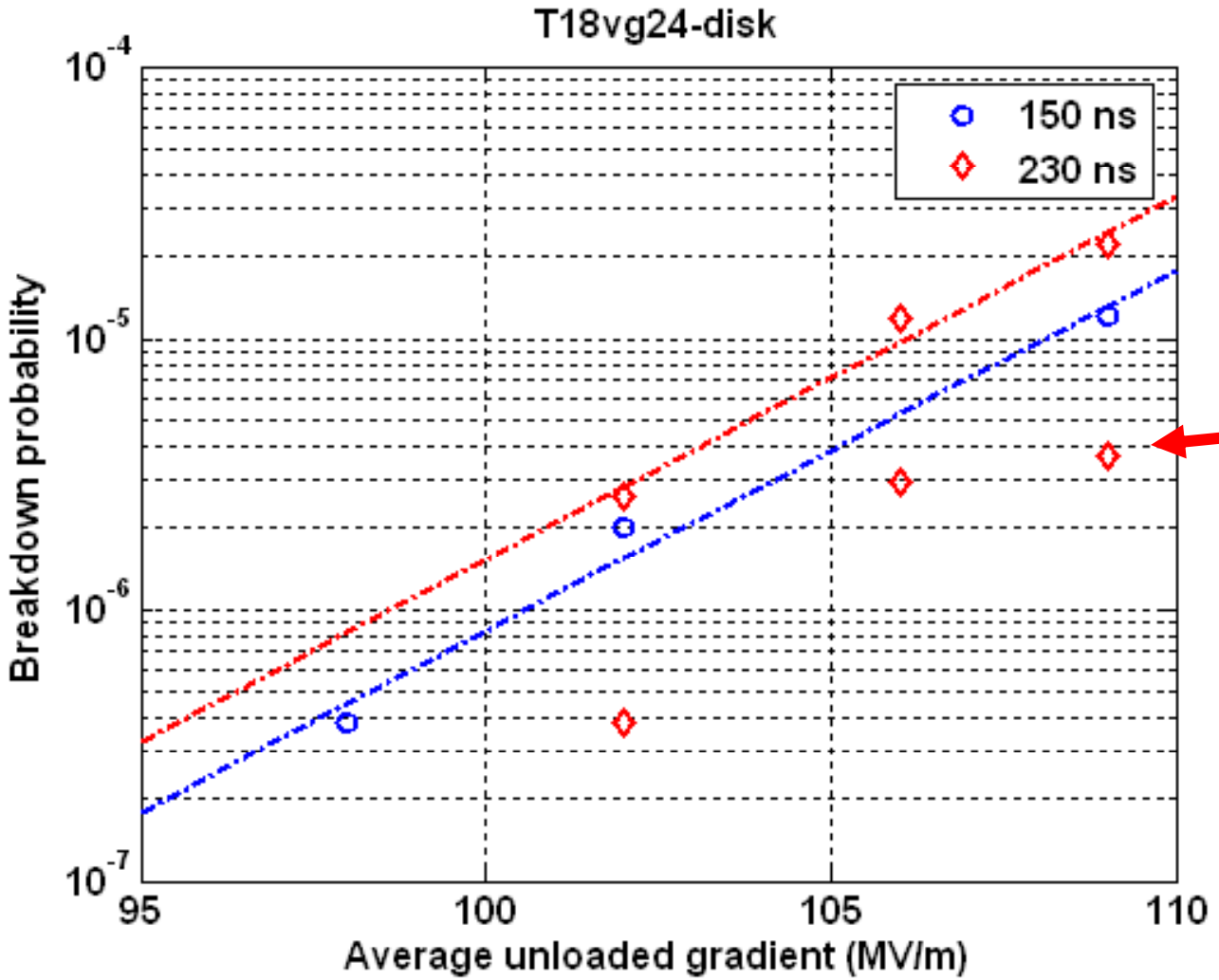


T18VG26_disk conditioning history



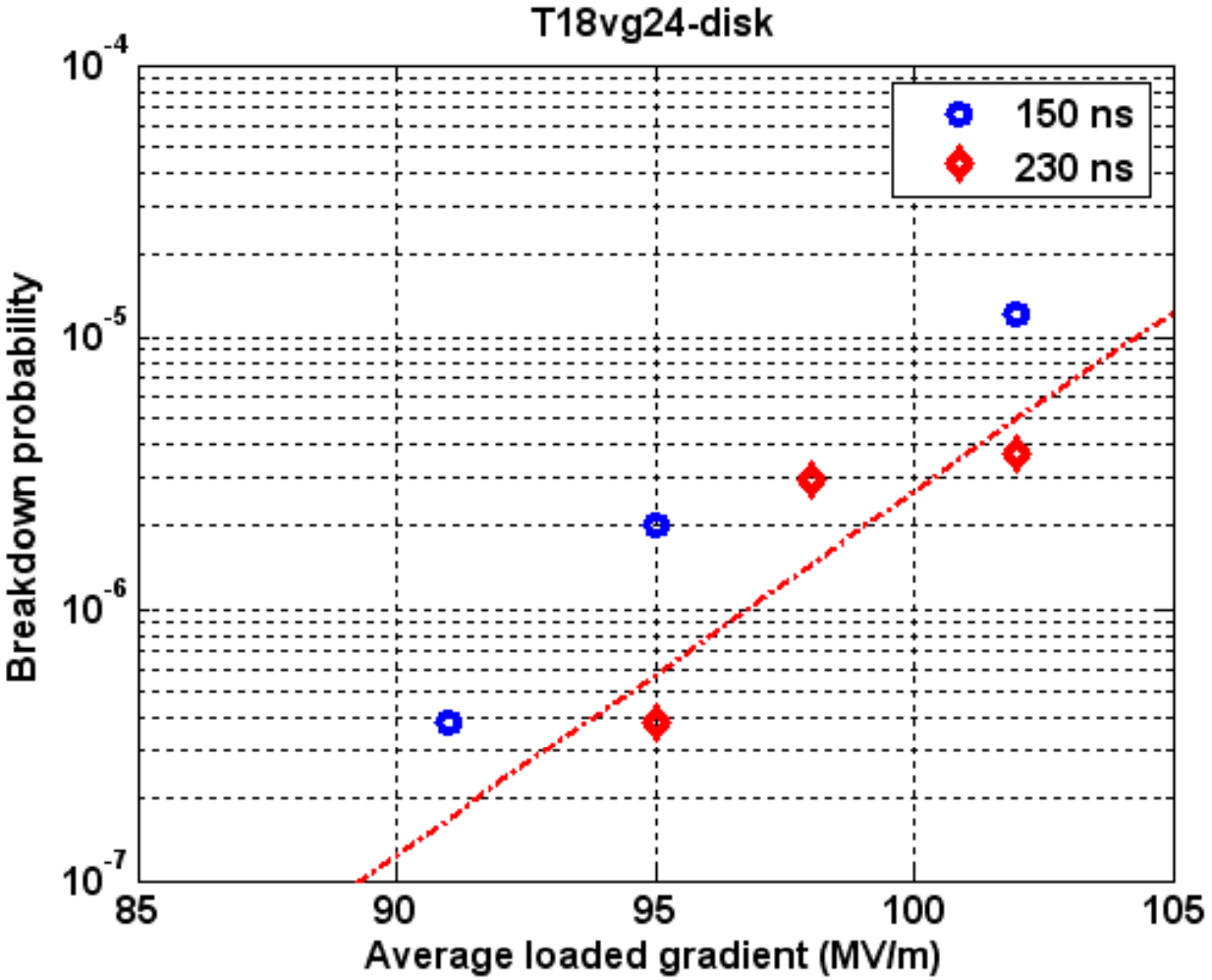
Faya Wang, latest data last Friday

Break down rate vs gradient (loaded)

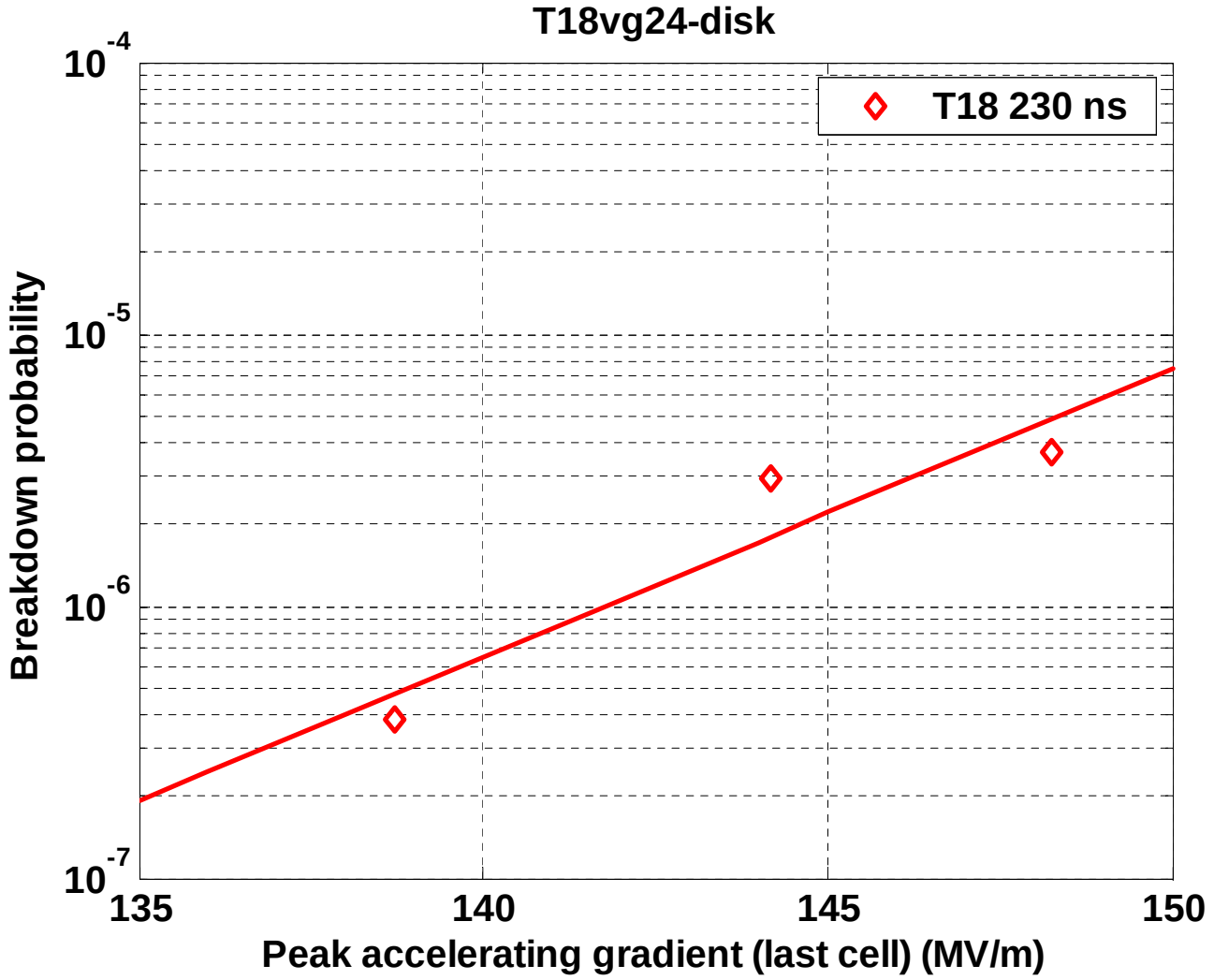


Latest data

Break down rate vs gradient (unloaded)

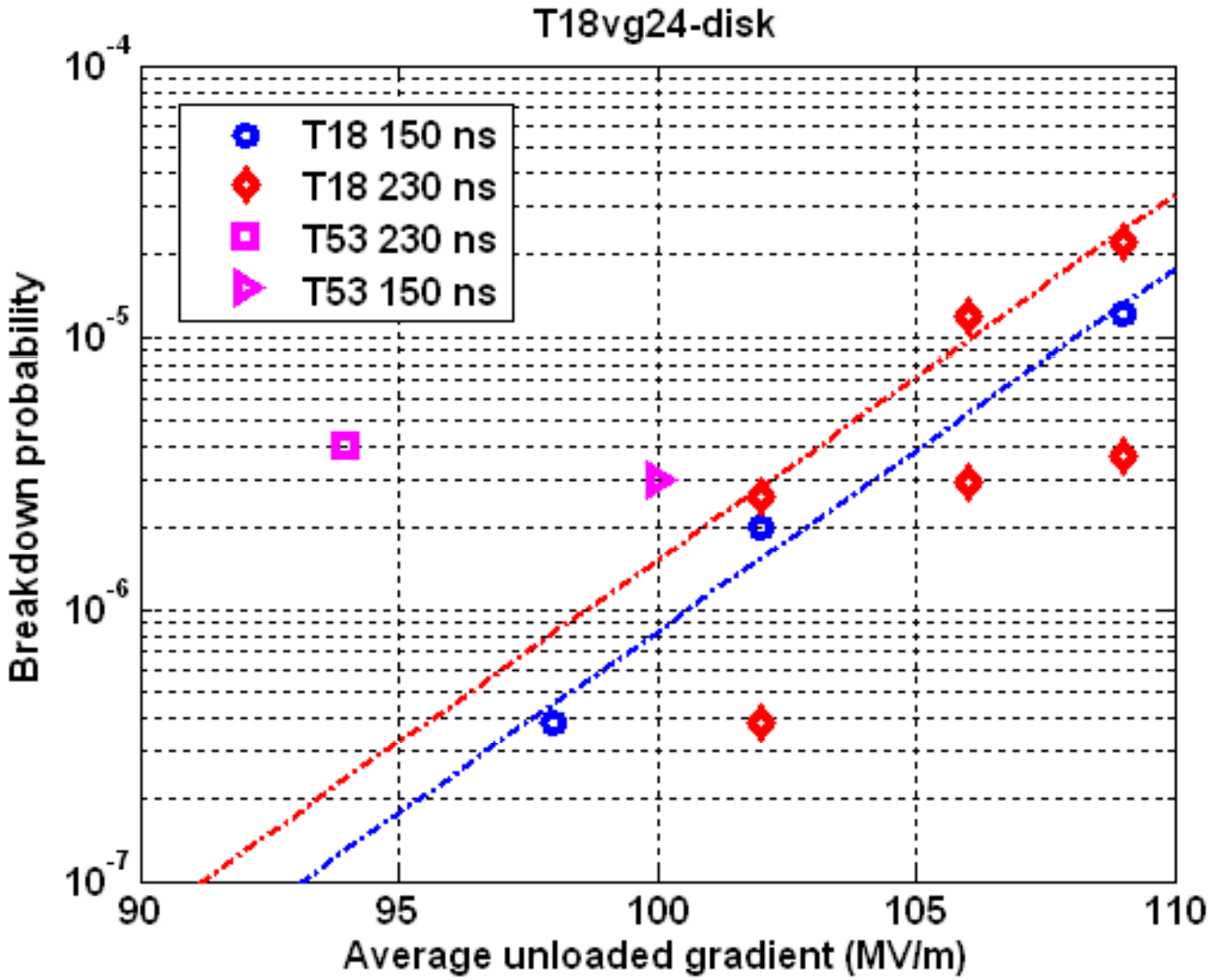


Break down rate vs gradient (last cell)

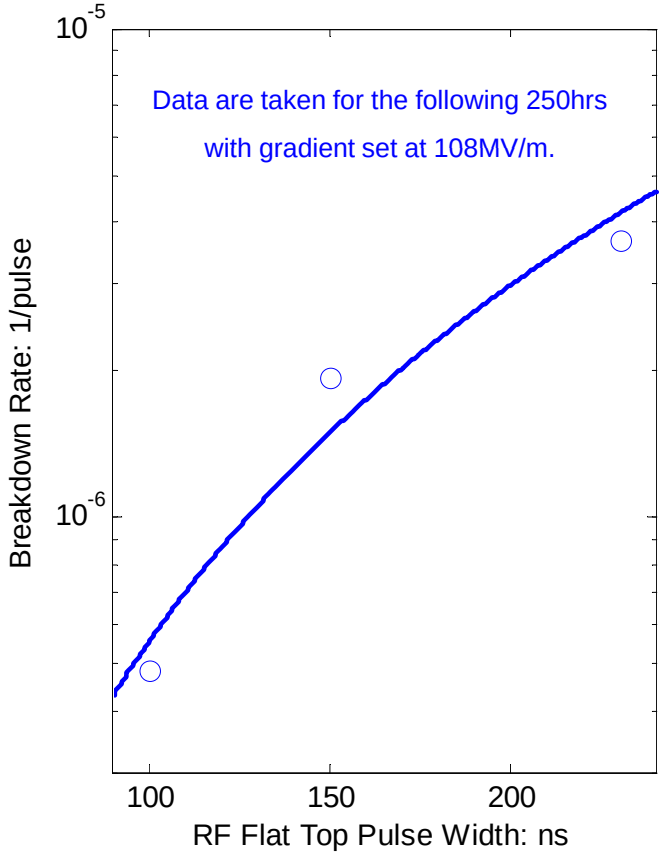


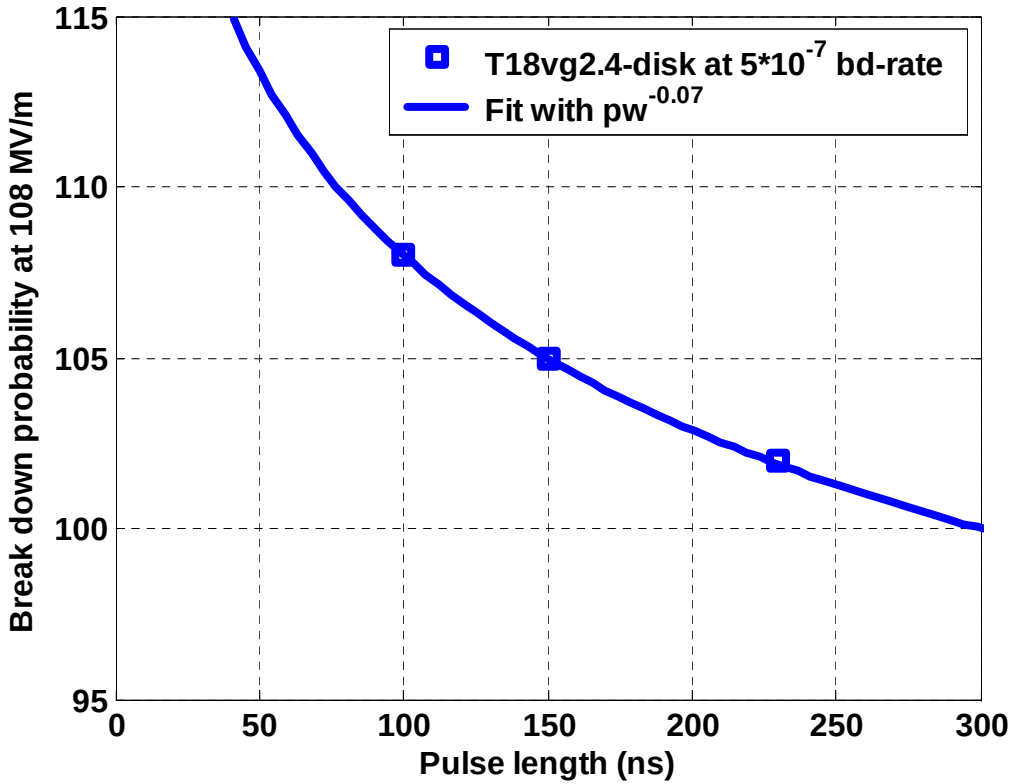
All break downs counted

T53vg3 for comparison



T18_vg2.4 pulse length dependence

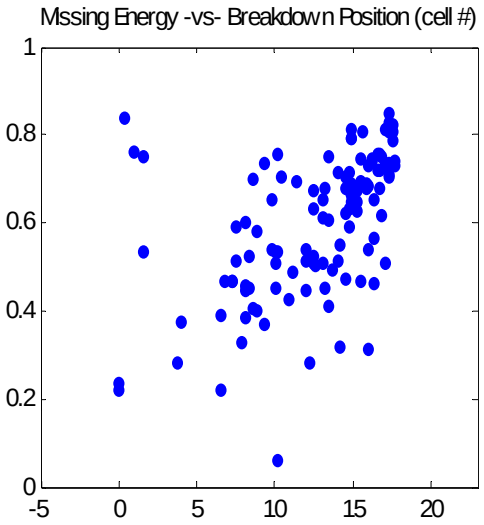


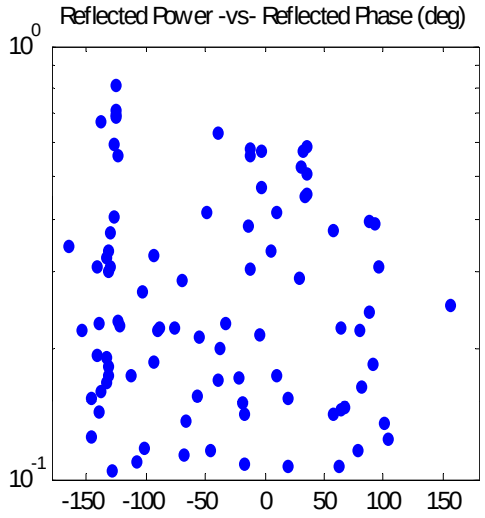


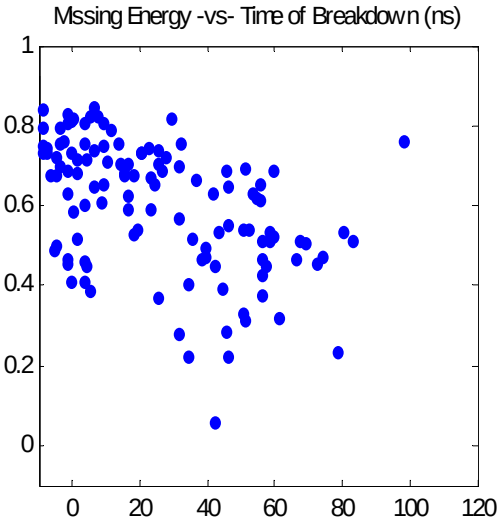
Breakdown rate has a gradient dependence ~ G^{32}

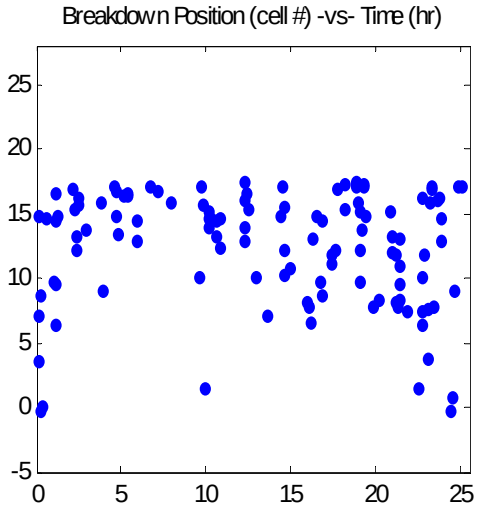
and pulse width dependence ~ $PW^{2.4}$

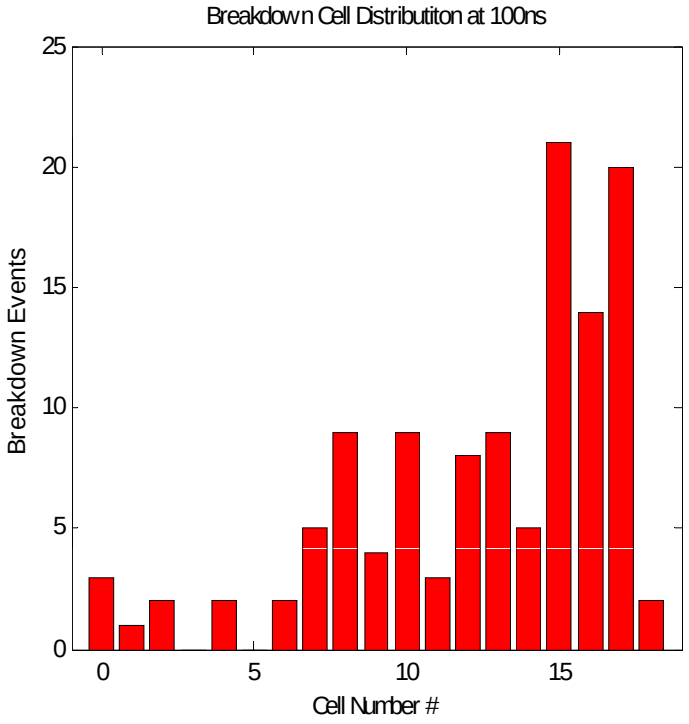
Break down analysis 100 ns

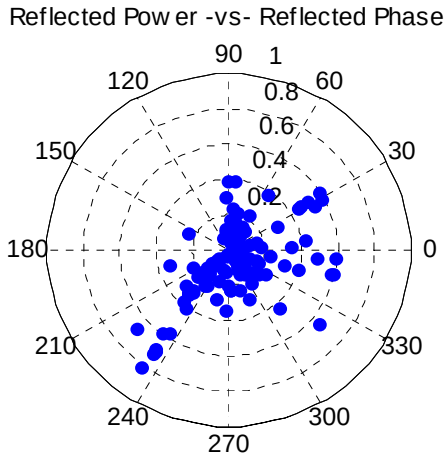












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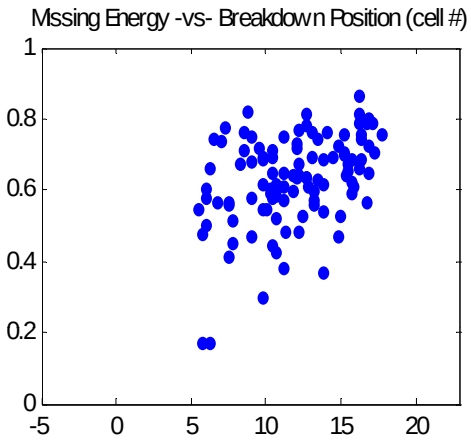
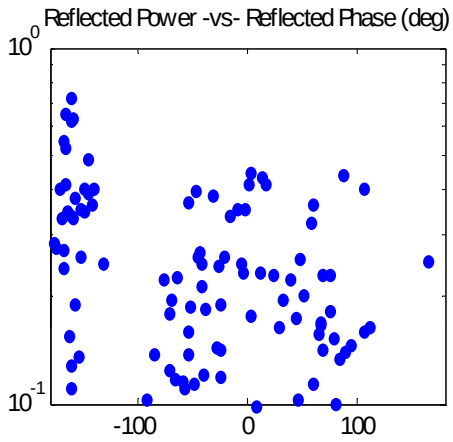
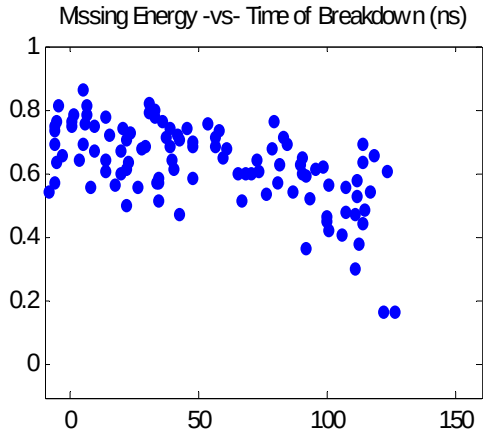
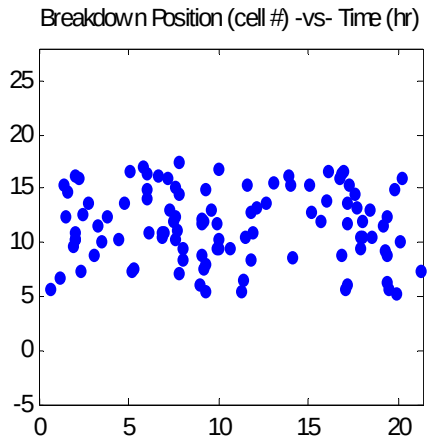
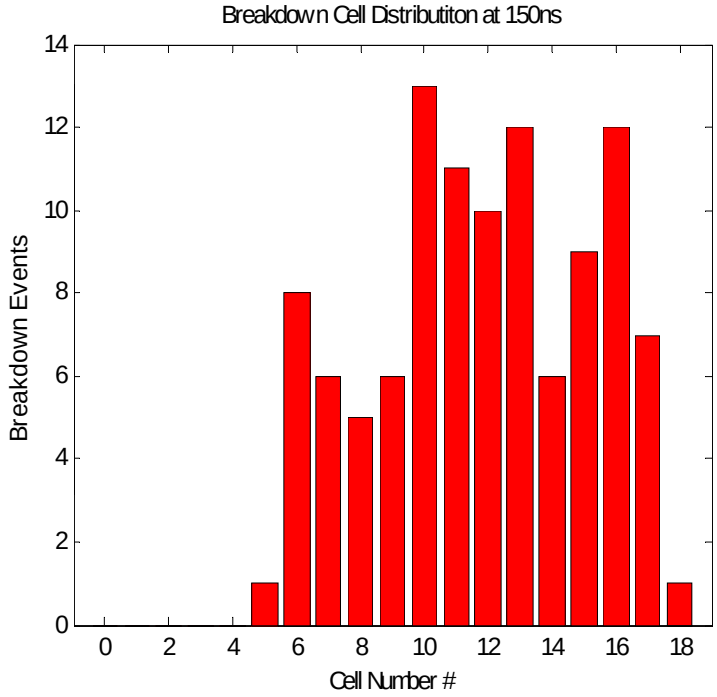
Break down analysis 150 ns

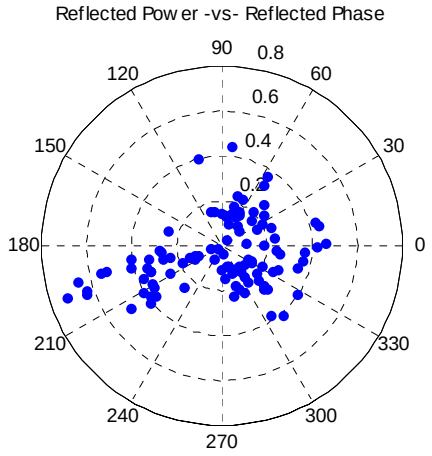












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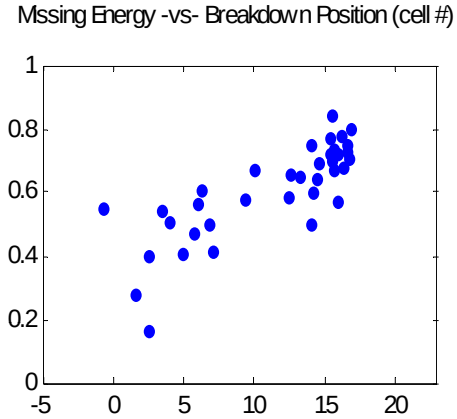
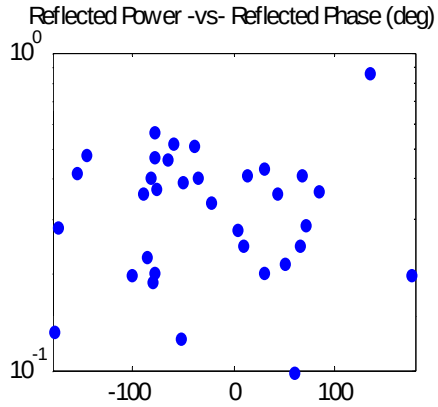
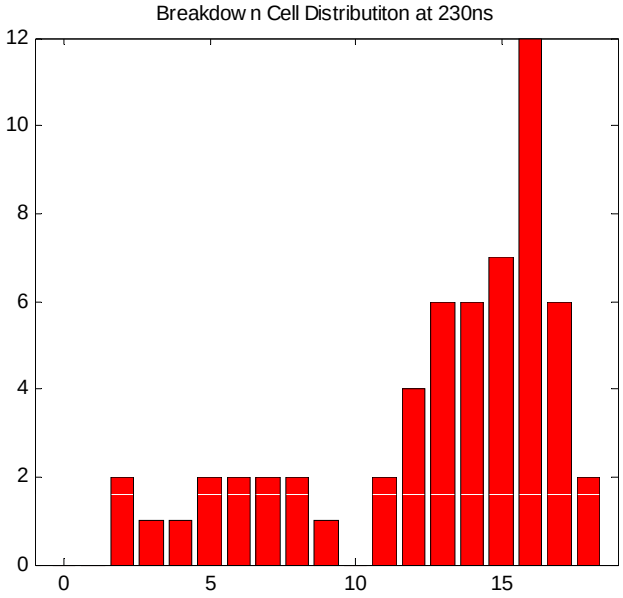
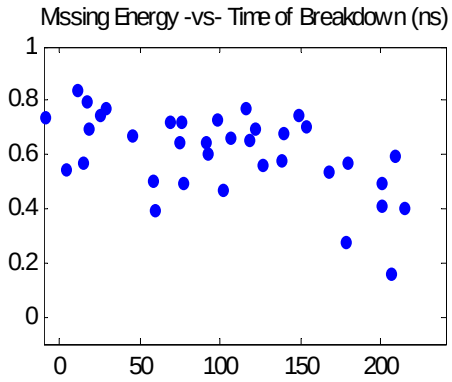
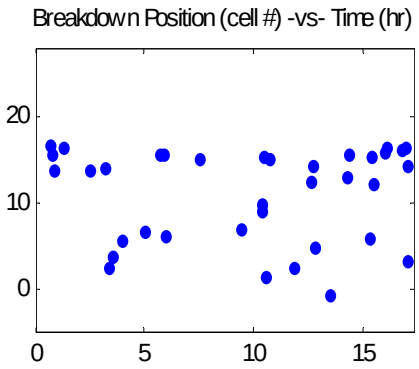
Break down analysis 230 ns

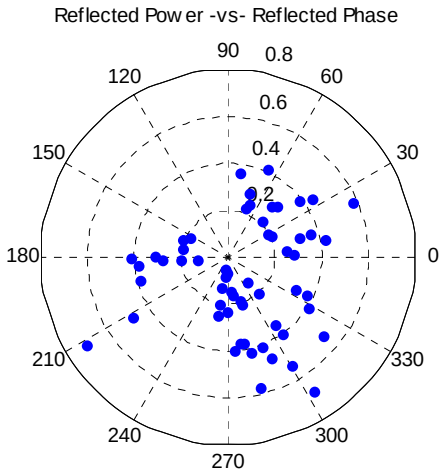












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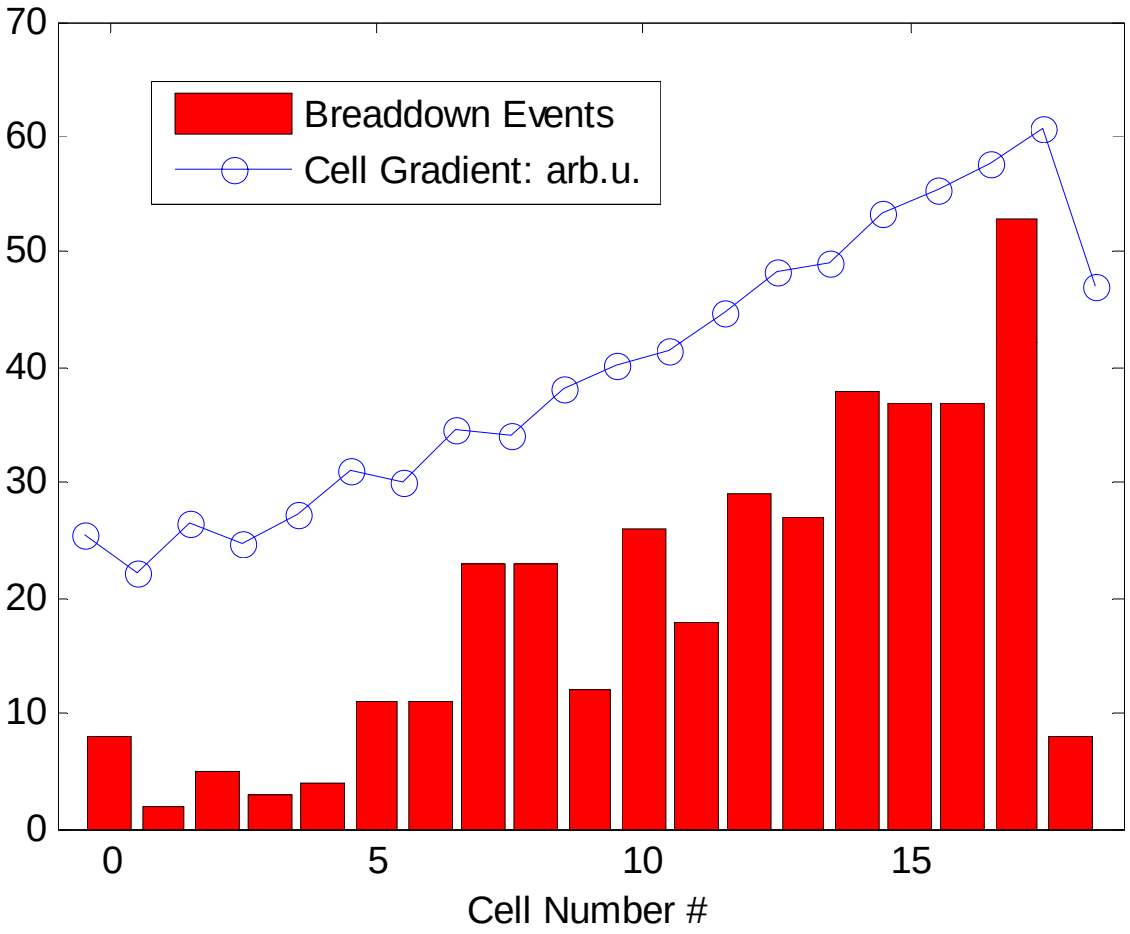
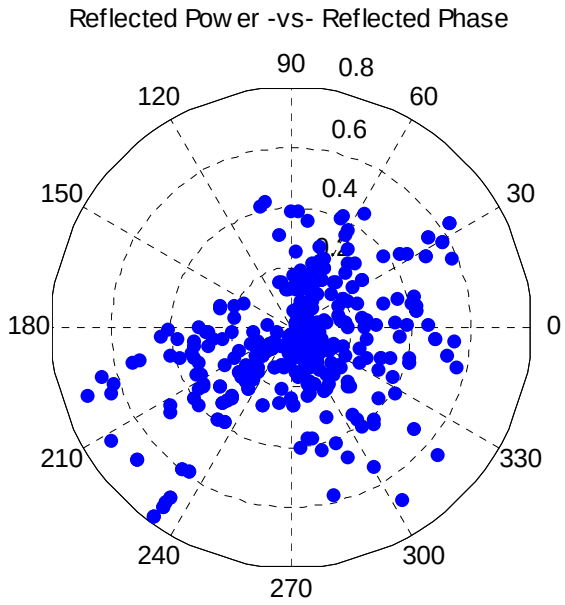
Based on all the breakdown events





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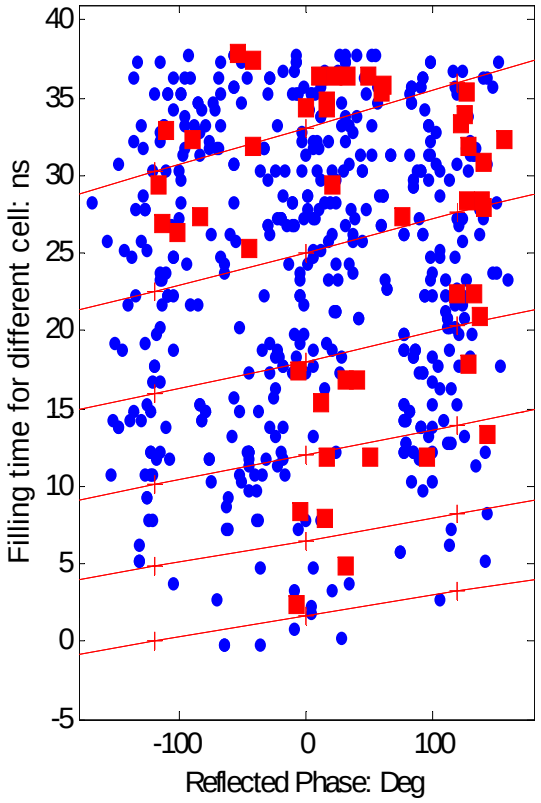
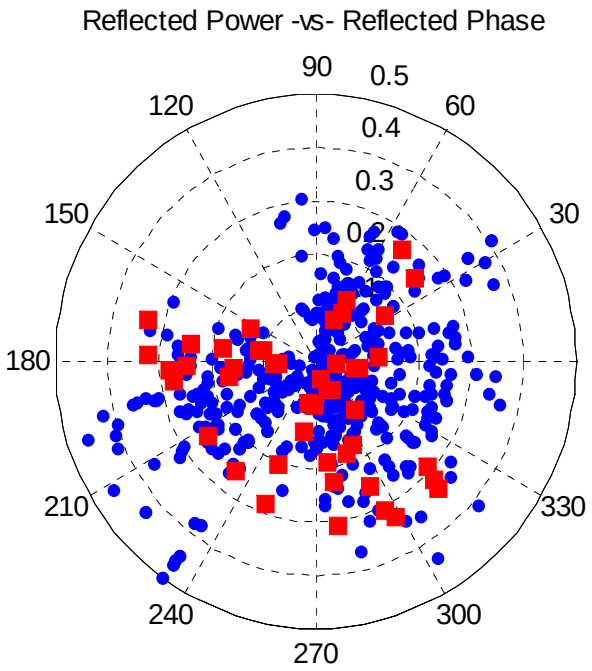
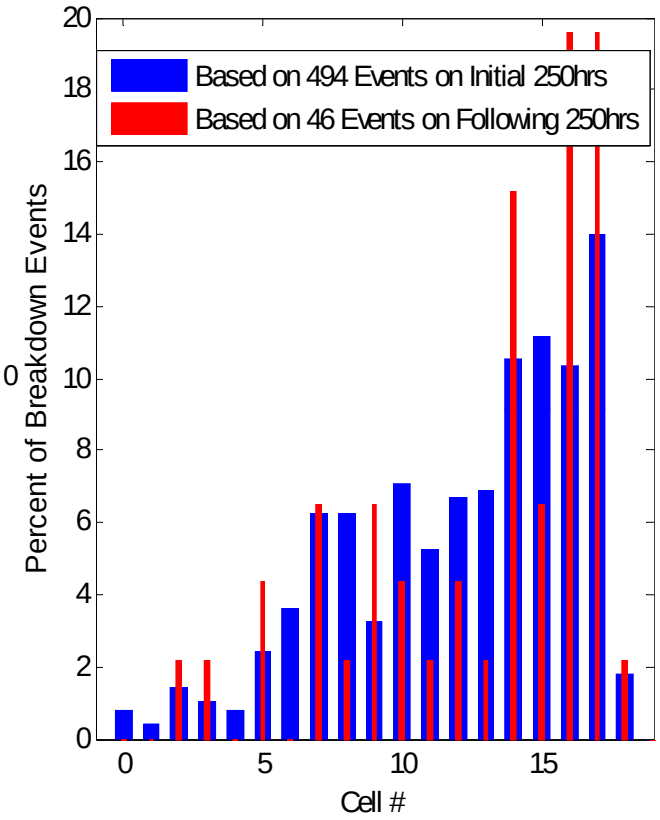
Breakdown distribution in the structure







Blue round point for initial 250hrs based on 494 events

Red square for the following 250hrs based on 46 events

Faya Wang

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

Alexej Grudiev

We got ~ 110 MV/m at 10^{-6}

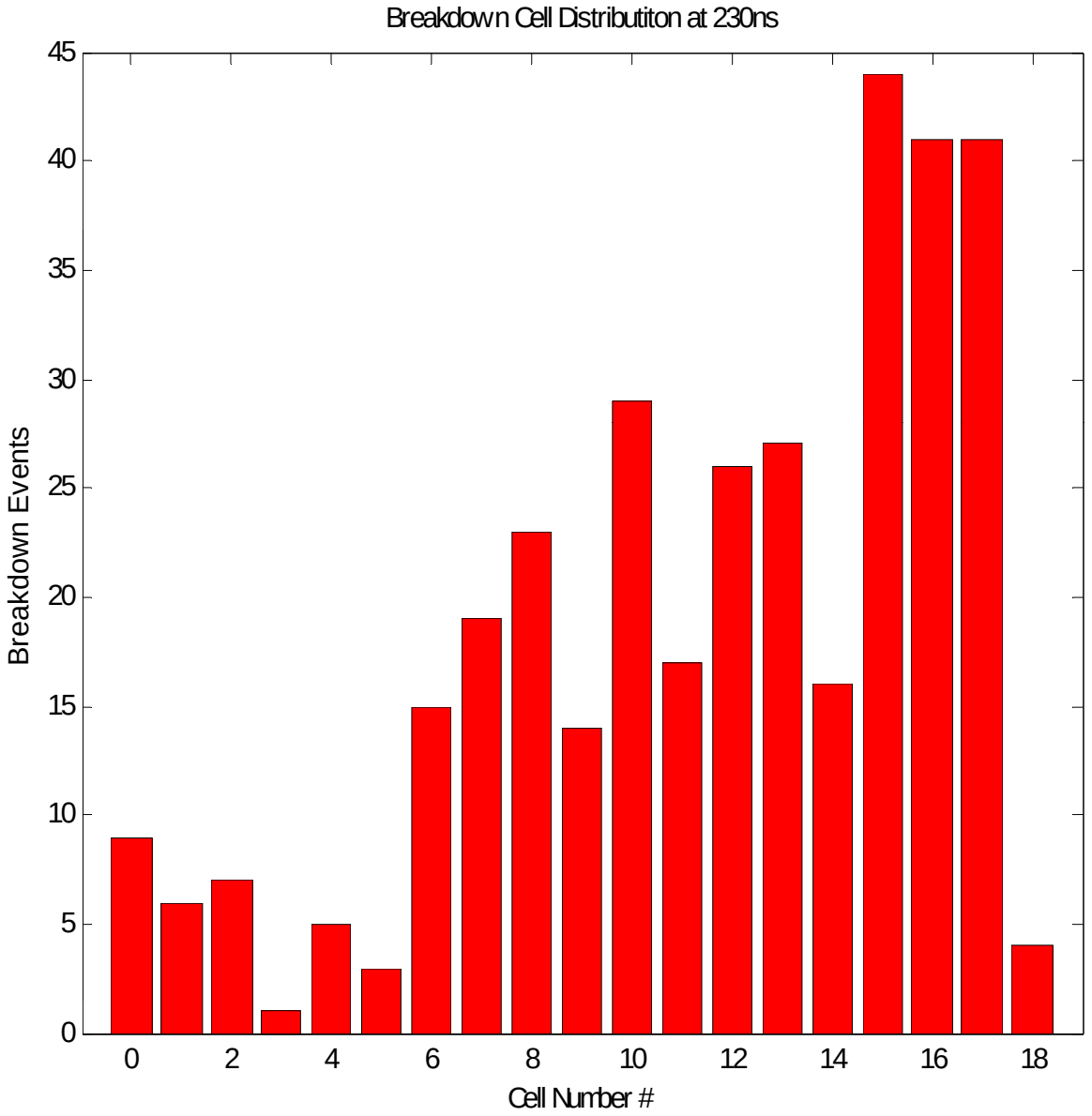
Preliminary Conclusions

- 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
  at 10^{-7} BD-rate, ~ 100 MV/m at 150 ns,
- 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 'Sc-parameter' prediction is pretty good, P/C less good
- No significant dark current measurable
- T24vg1.7 seems the right next step towards a CLIC structure
- Experiment went very well, great collaboration result

The End

Spare slides

Break down position of all recorded events



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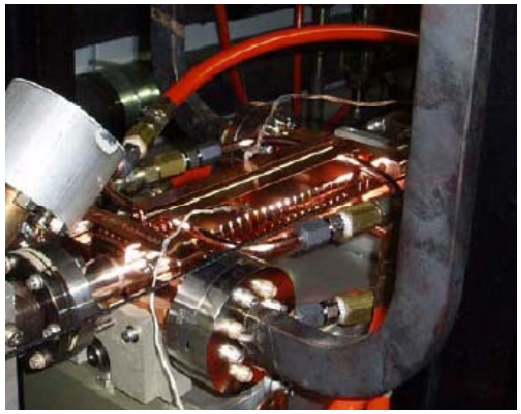
T18_VG2.4 DISC-SLAC with SLAC flanges

Frequency.	11.424GHz
Cells	18+input+output
Filling Time	36ns
S11	-30dB
S21	0.8
Phase	120Deg
Average Unloaded Gradient over the full structure: MV/m	55.5MW→100MV/m



RF Conditioning Statistics

Max Unloaded Gradient: 108MV/m at 100ns (*137MV/m)

108MV/m at 150ns (*137MV/m)

112MV/m at 200ns (*142MV/m)

108MV/m at 230ns (*137MV/m)

~1300 breakdowns

*:Max gradient in the structure

~500 hours total conditioning till 09-May-2008

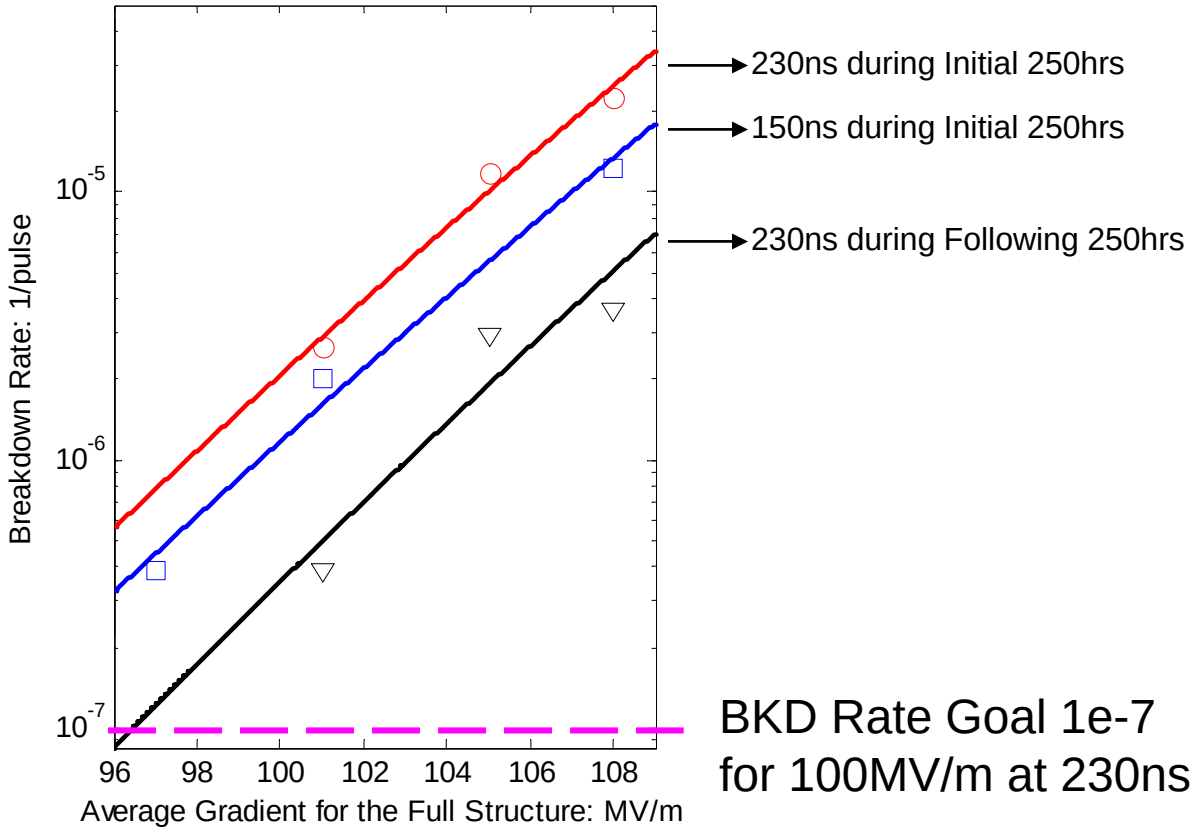
Summary of Breakdown Rate at Different Condition

Flat Top Pulse Width: ns	Gradient (MV/m)	Time: hr	BKD Events	BKD Rate (1/pulse)
150	97	24	2	3.858e-7
150	101	23	10	2.013e-6
150	108	23	61	1.228e-5
230	101	7	4	2.644e-6
230	105	16	41	1.186e-5
230	108	13	63	2.24e-5
230	101	24	2	3.86e-7
230	105	69	45	2.92e-6
230	108	24	19	3.67e-6
150	108	24	10	1.93e-6
100	108	38	4	4.87e-7

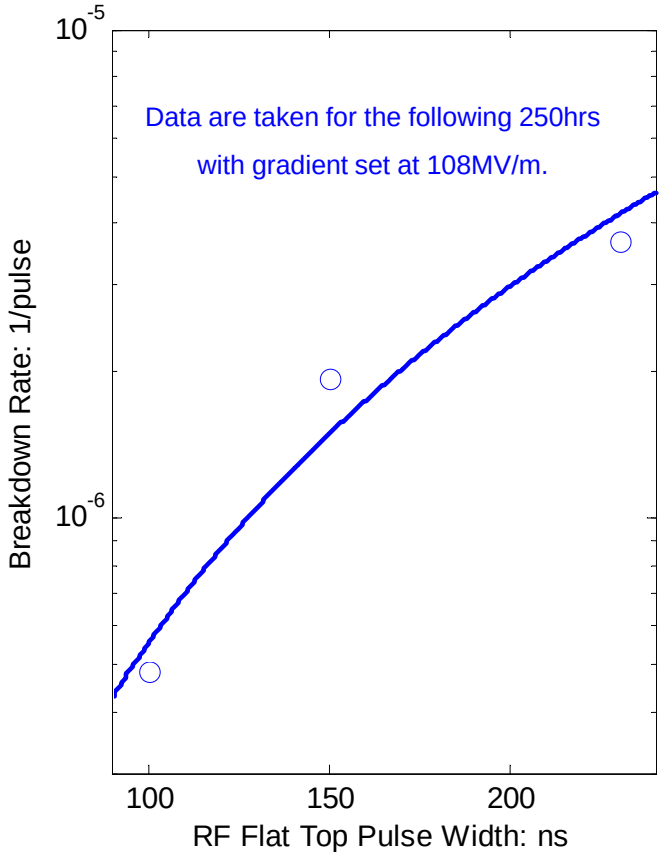
Initial 250hrs RF Process

Following 250hrs RF Process

The gradient is the average unloaded gradient for the full structure.



BKD Rate Goal 1e-7
for 100MV/m at 230ns



Breakdown rate has a gradient dependence ~ G^{32}

and pulse width dependence ~ $PW^{2.4}$

T53vg3 for comparison