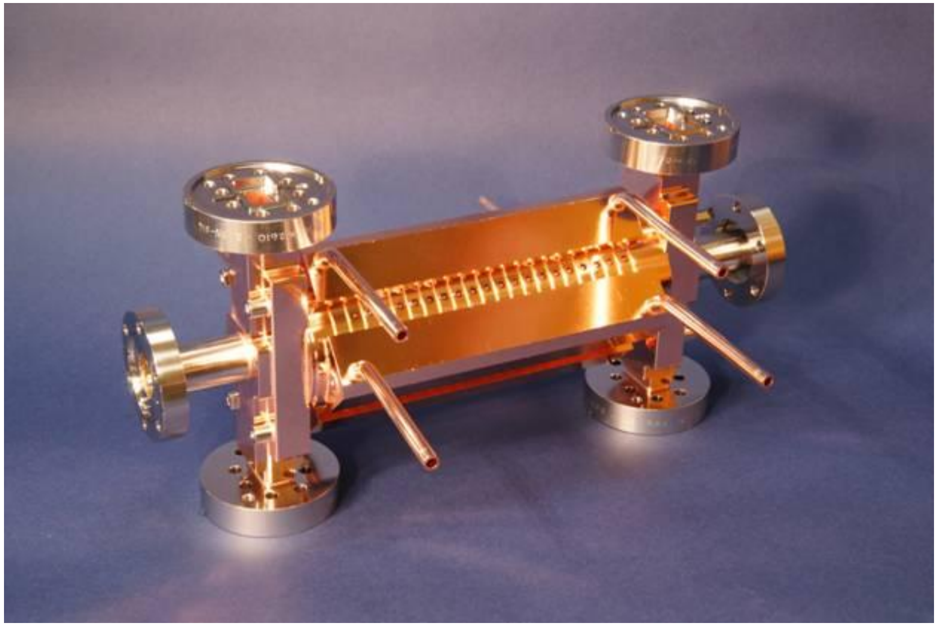

TD18 High Power Test Results

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Chris Adolphsen

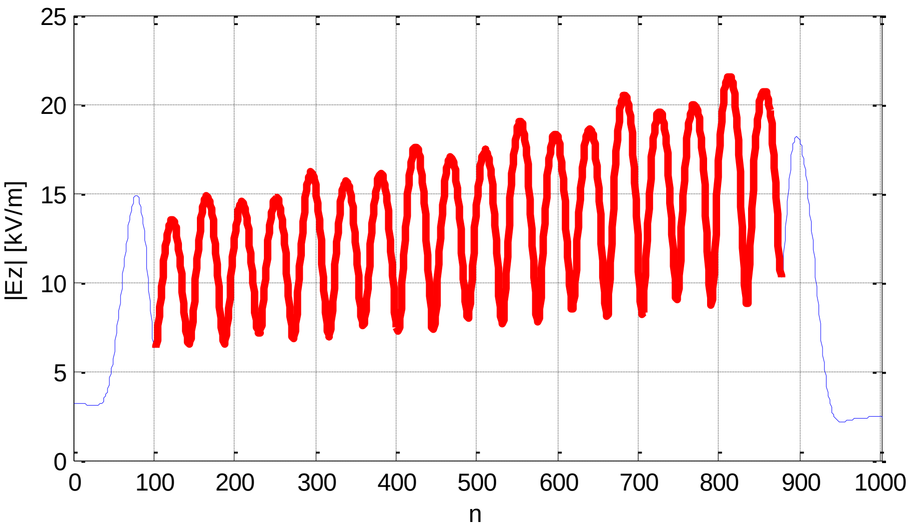
May 3, 2010

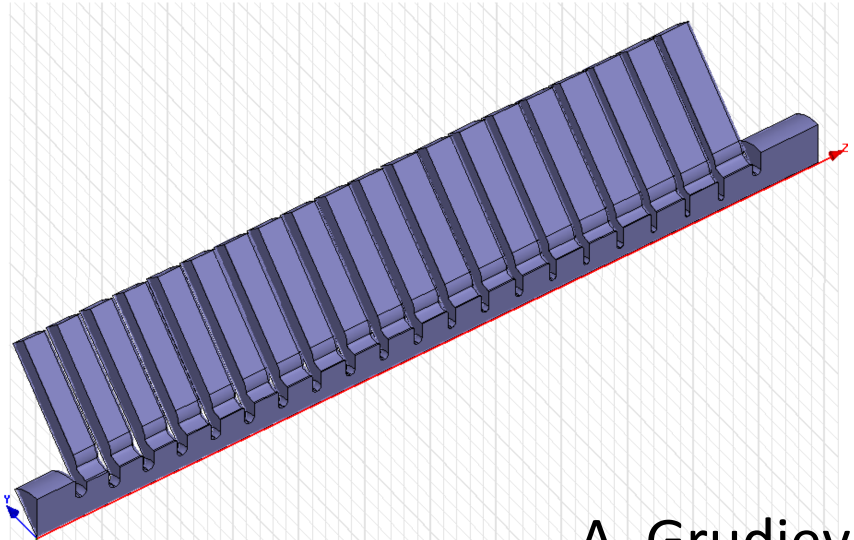
CLIC Disk Structure Tests

In NLCTA Beamline	Structure	Note	Performance
4/08 – 7/08	T18vg2.6-Disk SLAC_1	Cells by KEK, Assembled at SLAC	Good: 105 MV/m, 230 ns at LC BDR spec of 8e-7/pulse/m but hot cell developed
7/08 – 10/08	T18vg2.6-Disk SLAC_1	Powered from Downstream End	Good: 163 MV/m, 80 ns, 2e-5 BDR in last cell, consistent with fwd operation
12/08 – 2/09	T18vg2.6-Disk CERN_1	CERN Built, Operate in Vac Can	Very Poor: very gassy with soft breakdowns at 60 MV/m, 70 ns
Test at KEK 10/08 – 06/09	T18vg2.6-Disk KEK_1	Cells by KEK, Assembled at SLAC	Good: 102 MV/m, 240 ns at LC BDR spec – no bkd location info
7/09 – 8/09	T24vg1.8Disk CERN_1	CERN Built, Cells Pre-Fired	Poor: achieve < 60 MV/m after 100 hours with pulse lengths < 100 ns
5/09 - present	T18vg2.6-Disk SLAC_2	Cells by KEK, Assembled at SLAC	Good: after 280 hours, 97 MV/m, 230 ns at LC DBR spec – one hot cell
12/09 -4/10	TD18vg2.3-Disk SLAC_1	Cells by KEK, Assembled at SLAC	Fair: after 1000 hours, 81 MV/m, 230 ns at LC DBR spec – no hot cells

TD18 Parameters

	First	Middle	Last Cell
a [mm]	4.06	3.36	2.66
a/λ (%)	15.4	12.8	10.1
d [mm]	2.794	2.054	1.314
e	1.21	1.18	1.15
f [GHz]	11.424	11.423	11.424
Q(Cu)	5098	5364	5458
vg/c [%]	2.25	1.47	0.87
r'/Q [LinacΩ/m]	10195	12560	15034
Es/Ea	1.97	1.88	1.88
Hs/Ea [mA/V]	5.85	5.2	4.85
Sc/Ea^2 [mA/V]	0.52	0.39	0.3





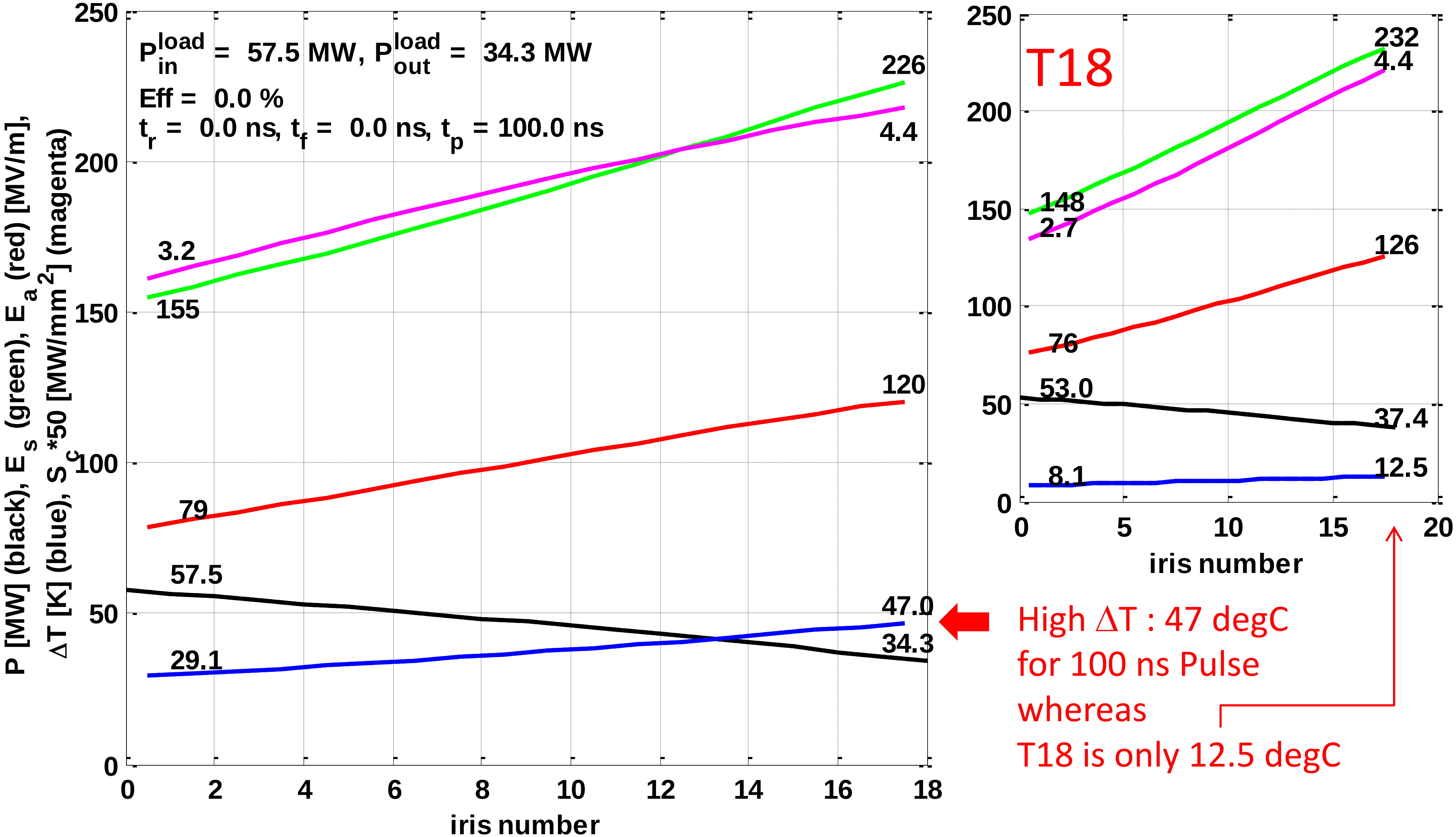
For regular cells

P = 59.8 MW for <G> = 100 MV/m

Active Length = 15.8 cm

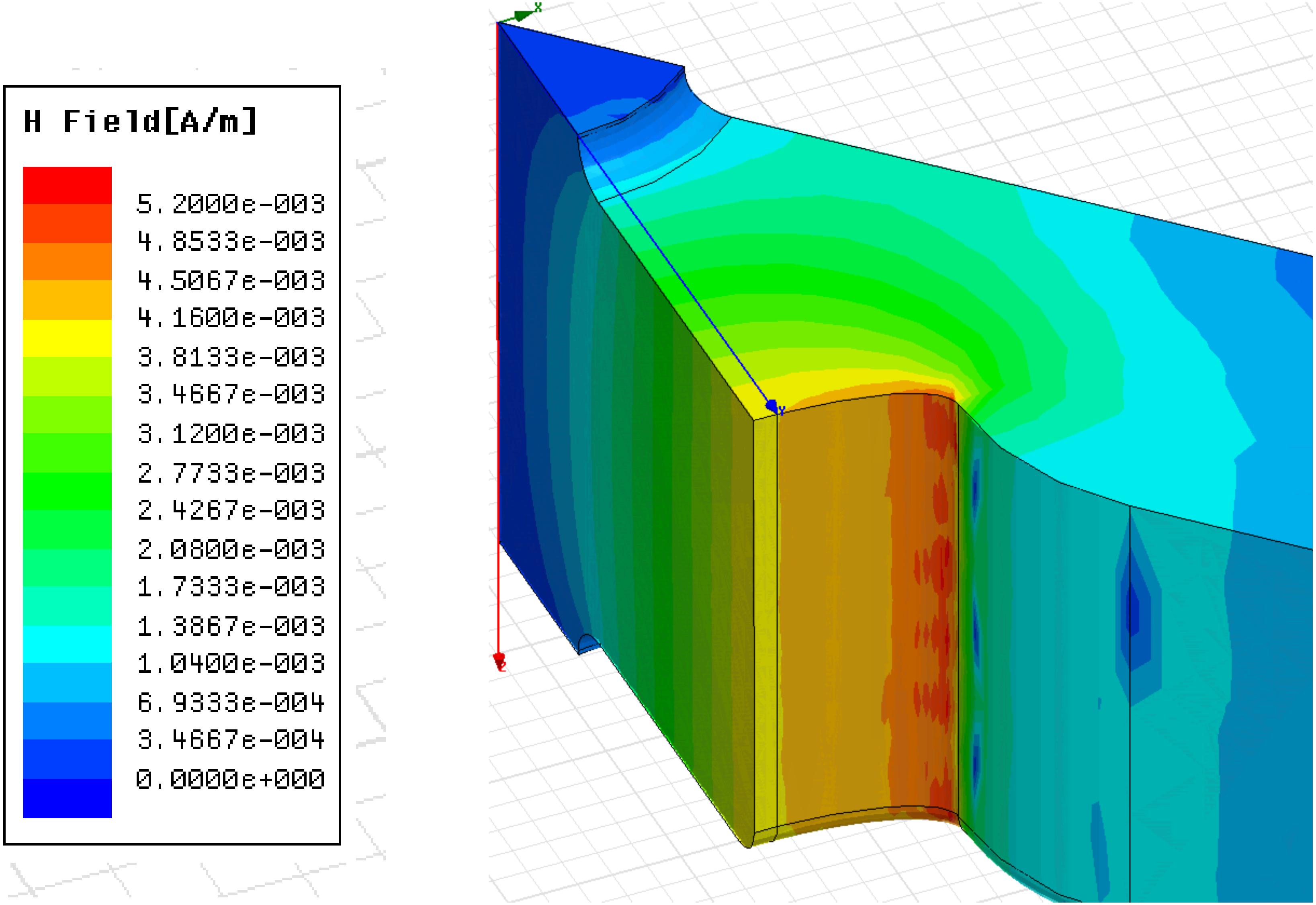
A. Grudiev

TD18 Parameter Plots for an Unloaded Gradient of 100 MV/m

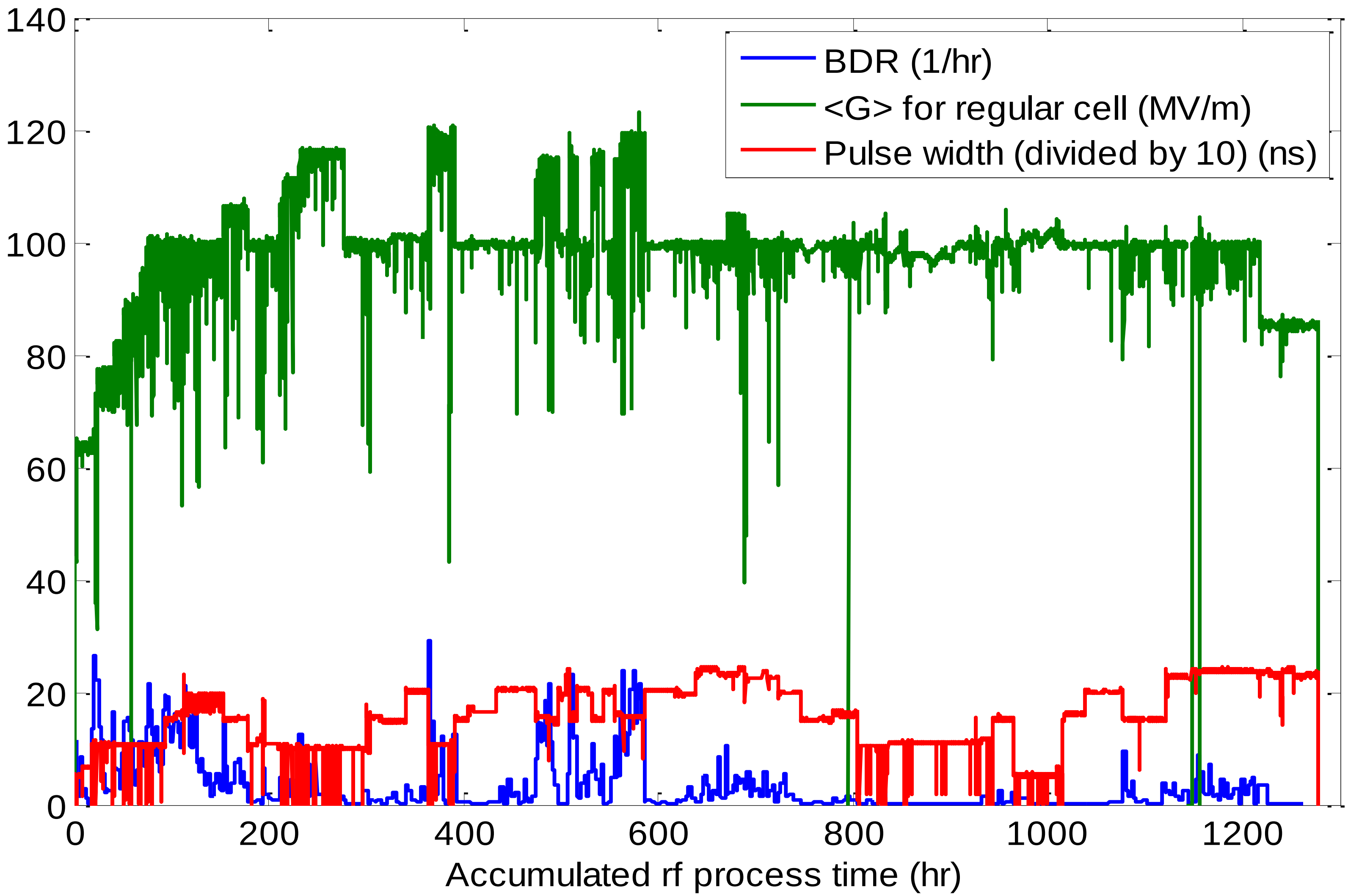


High ΔT : 47 degC
for 100 ns Pulse
whereas
T18 is only 12.5 degC

Last Cell Surface Magnetic Field



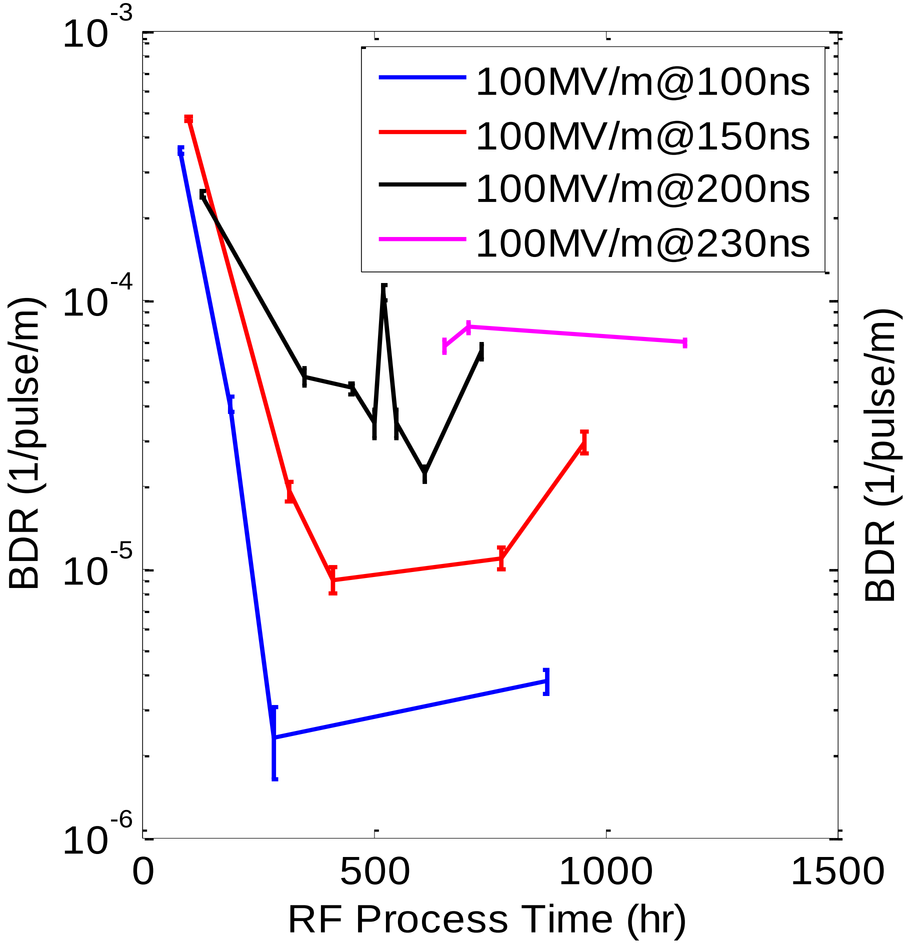
High Power Operation History

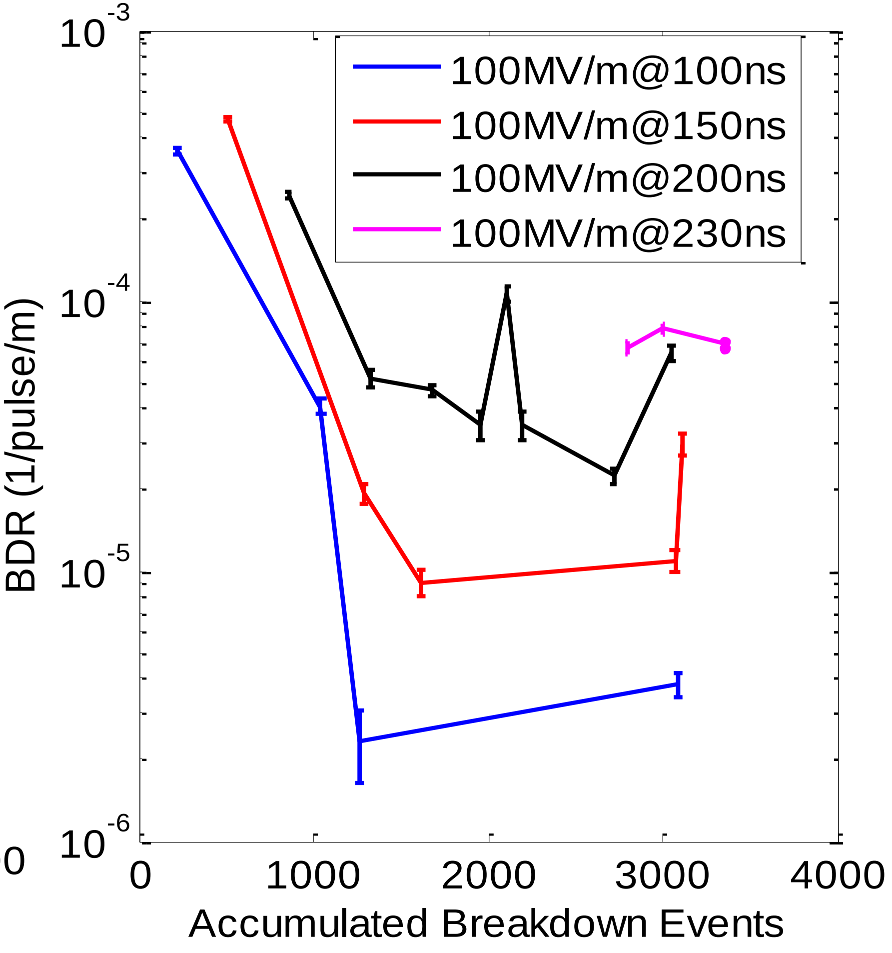


Final Run at 230 ns: 94 hrs at 100 MV/m w BDR = 7.6e-5

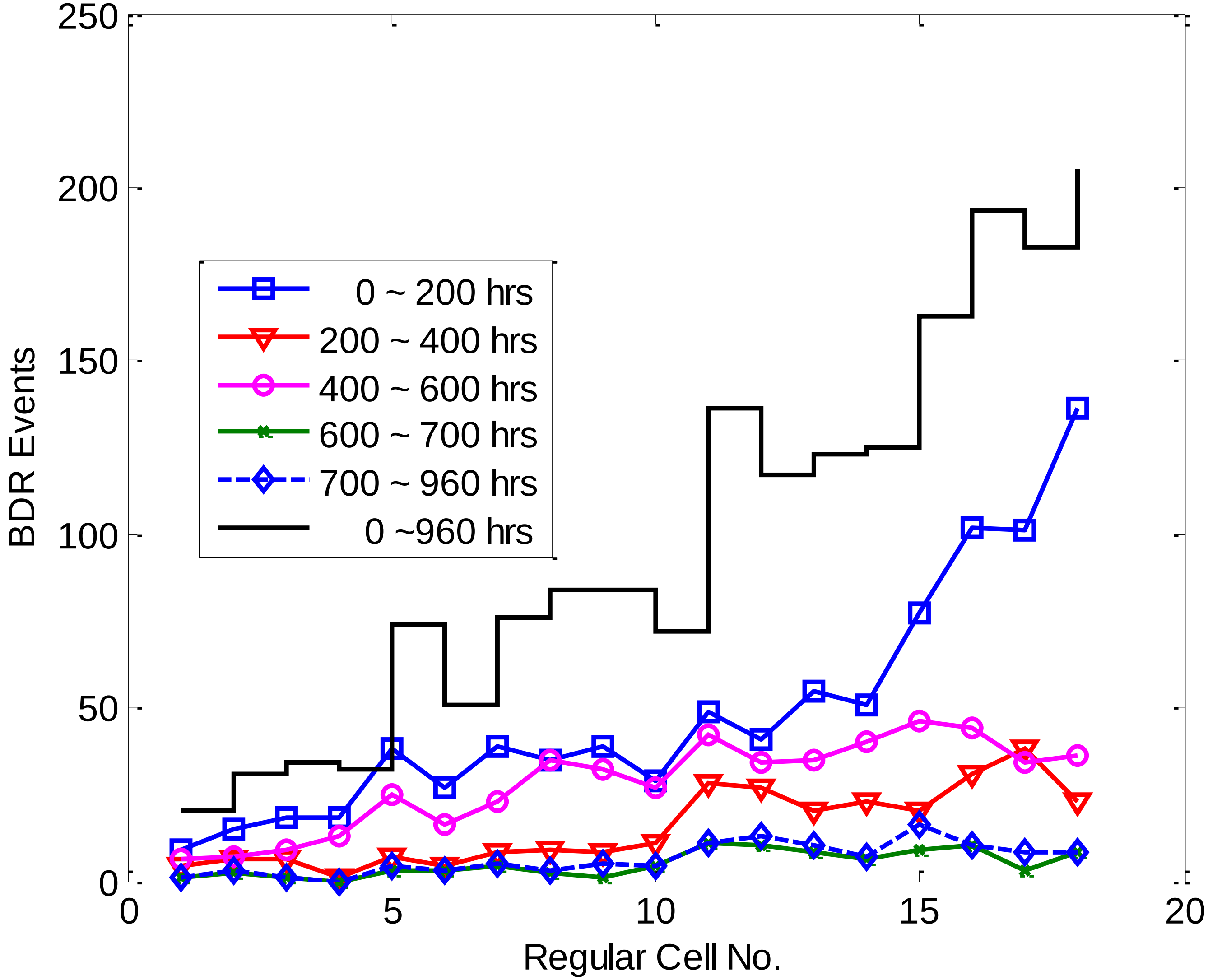
60 hrs at 85 MV/m w BDR = 2.4e-6

BDR Evolution with RF Processing

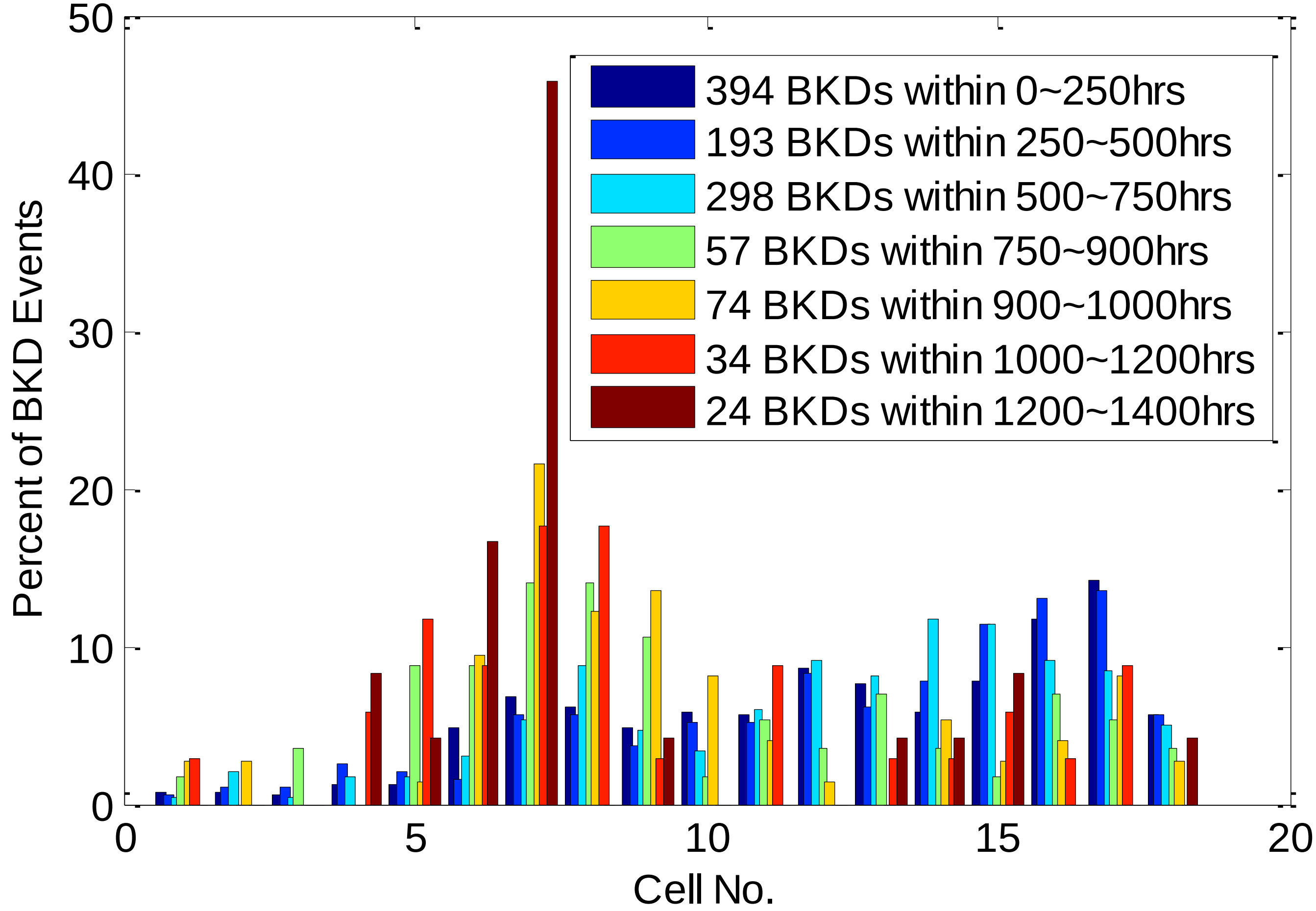




TD18 Breakdown Location Profile at Different Stages of Processing

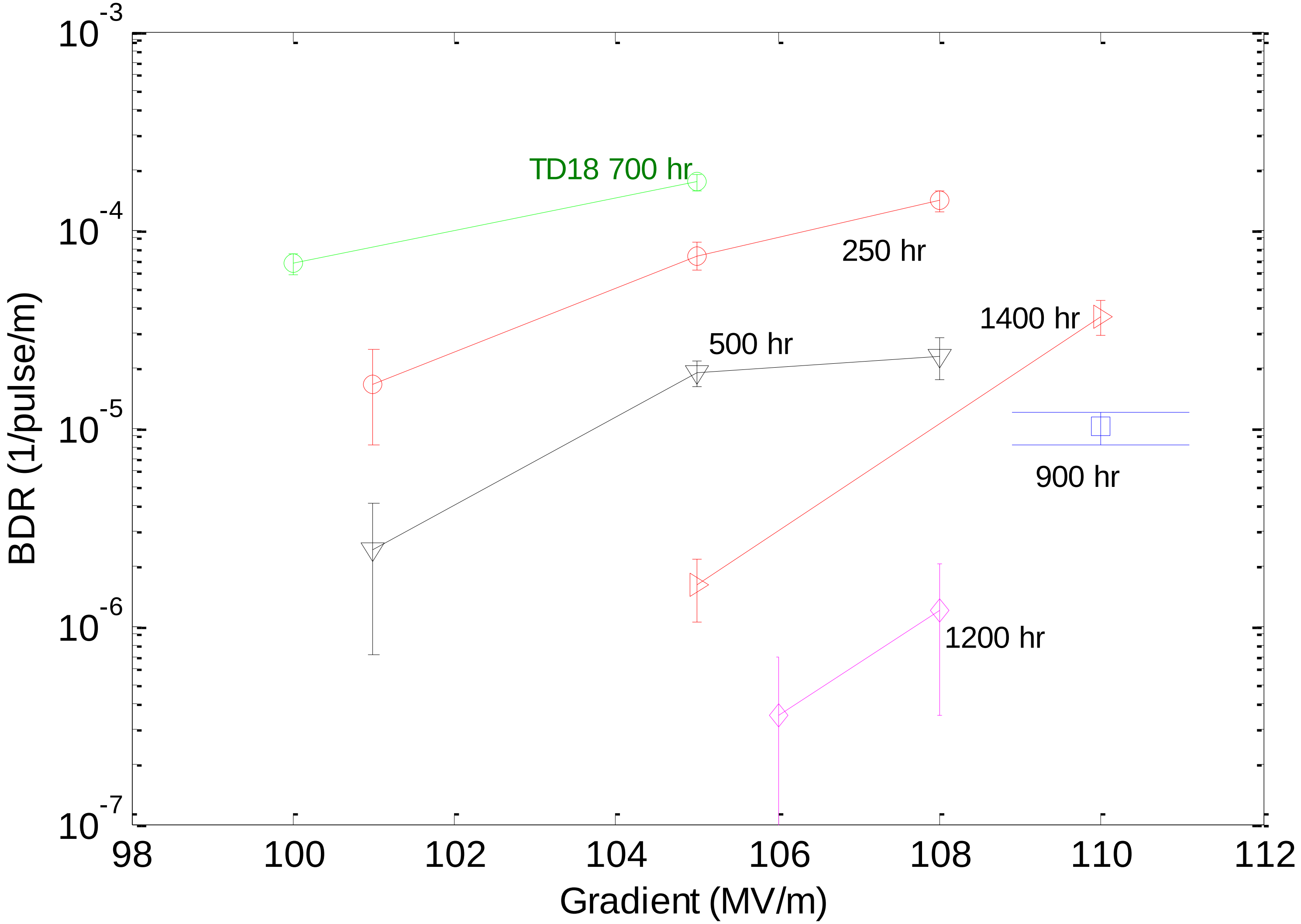


T18 Breakdown Location Profile at Different Stages of Processing



Did not find visual evidence related to the hot cell in a post-run boroscope exam – typical of NLC/GLC structures, many of which had hot cells

Comparison with T18_SLAC1

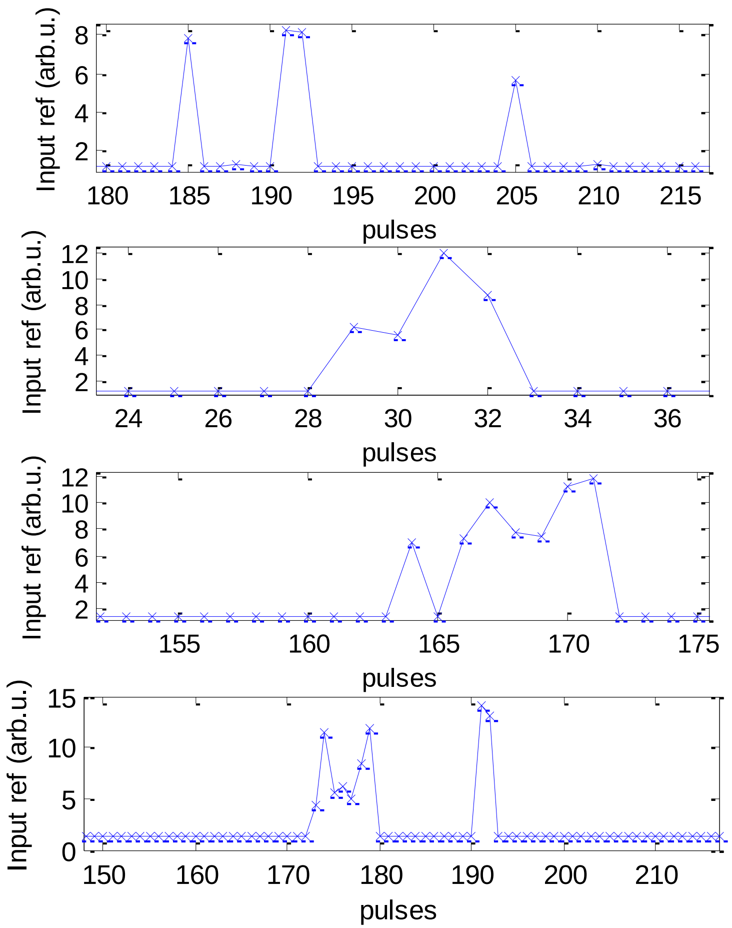


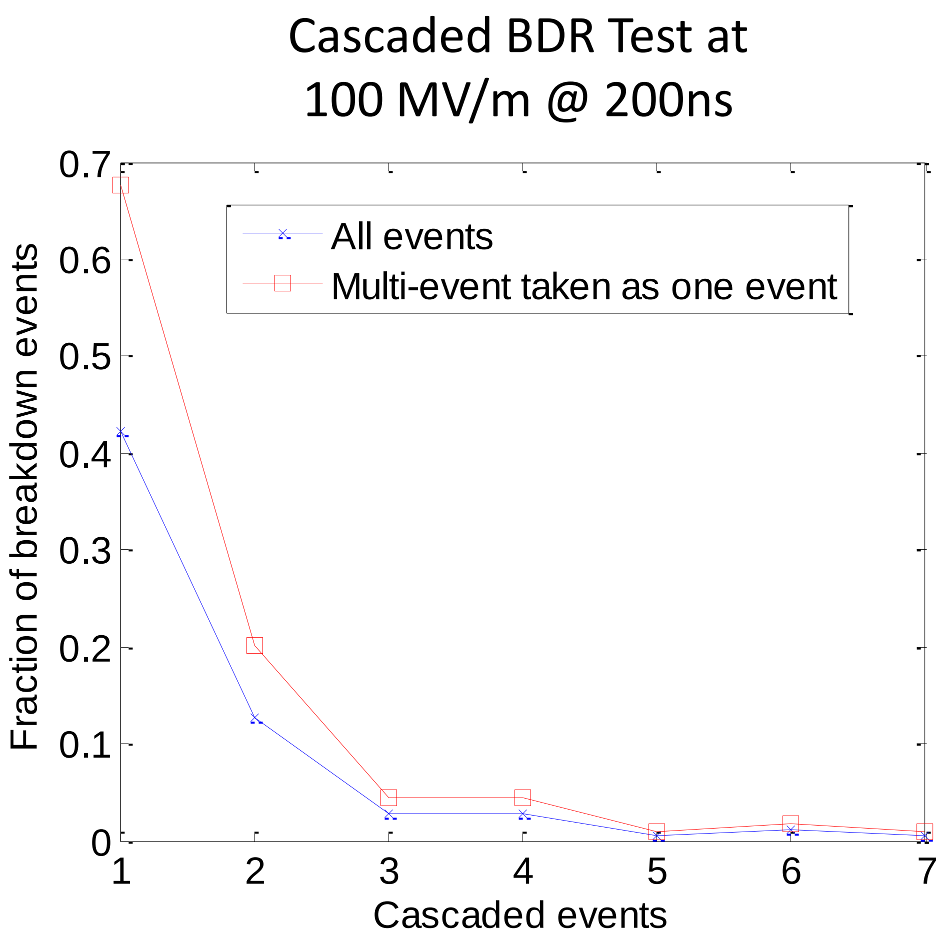
Pulse width 230ns: Green line for TD18, Others for T18

LC Breakdown Limits

- For NLC, the breakdown rate limit was chosen so that the 2% pool of spare rf units would rarely (once a year) be depleted assuming a 10 second recovery period after each breakdown. Operation with a 10 second recovery period has been demonstrated but longer times (30-100 sec) are typically used since the structure monitoring system has a 30 second sampling period. For 60 Hz operation at NLCTA, the breakdown rate limit translates to 0.1 per hour with the nominal 60 cm long structure design. This choice is somewhat soft in that a four-times higher rate would still provide 99% full-energy availability assuming a 5 second recovery time, which has also been demonstrated.
- For reference, at the 0.1 per hour limit, a breakdown would occur in one of the ~ 20,000 NLC X-Band structures once every 120 pulses. Such breakdowns will degrade the luminosity from that pulse, but the beam kicks from the breakdown fields should not inhibit beam operation.
- To 'translate' this limit, for one bkd in 10 hours in a 0.6 m structure at 60 Hz, the rate is 4.6e-7/pulse/structure or 7.7e-7/pulse/m. For CLIC 3-TeV, this same limit gives 1 bkd per 40 pulses, but because of the smaller beam emittance (and hence a smaller collimator aperture), the kicks are more likely to hit the collimators. The bkd kick distribution measured at NLCTA has values as large as 30 keV/c - this level is < 1/10 of the amount needed to hit the collimators at NLC.

Can TD18 Run with no Recovery Period ?

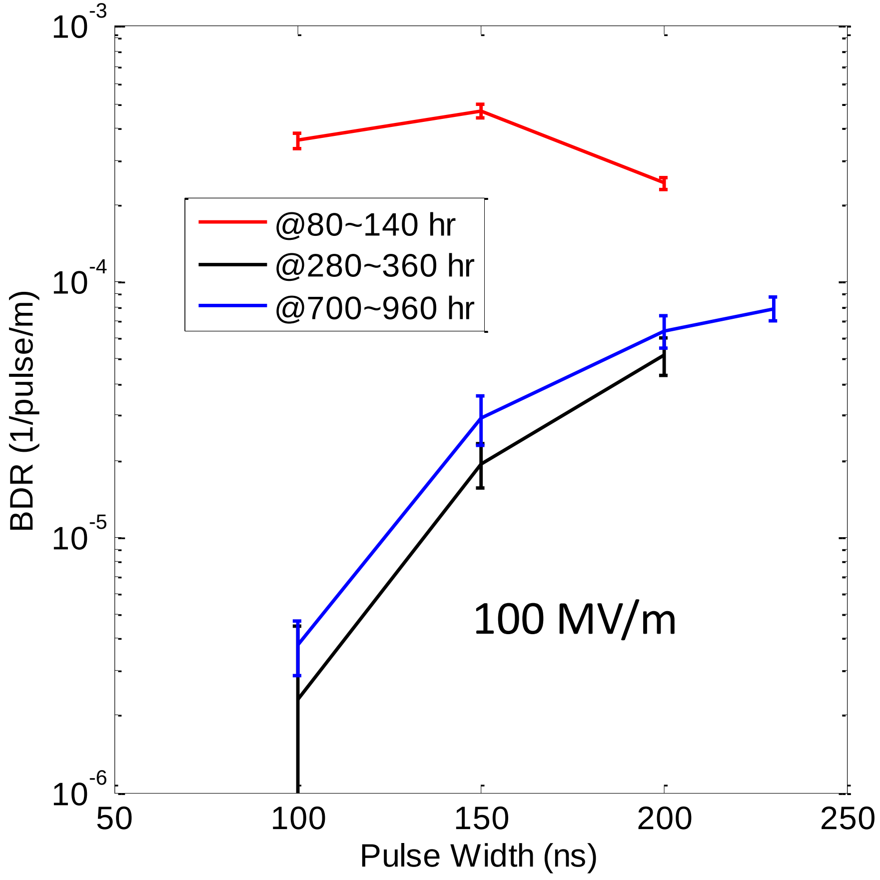


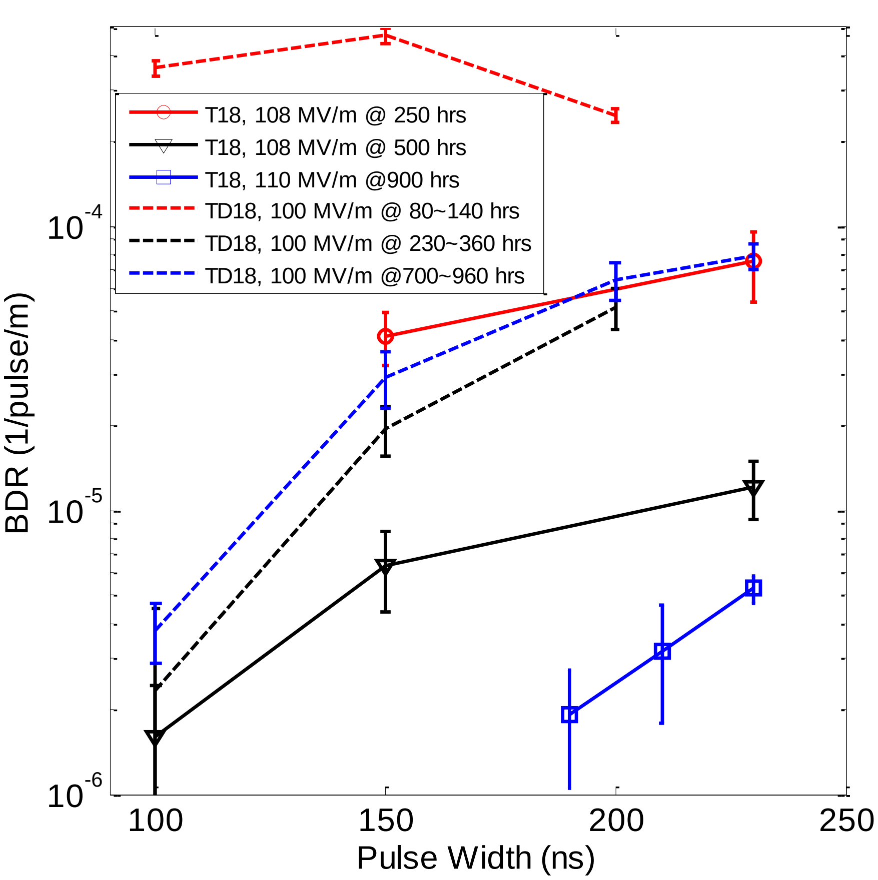


33 Hour Test Period

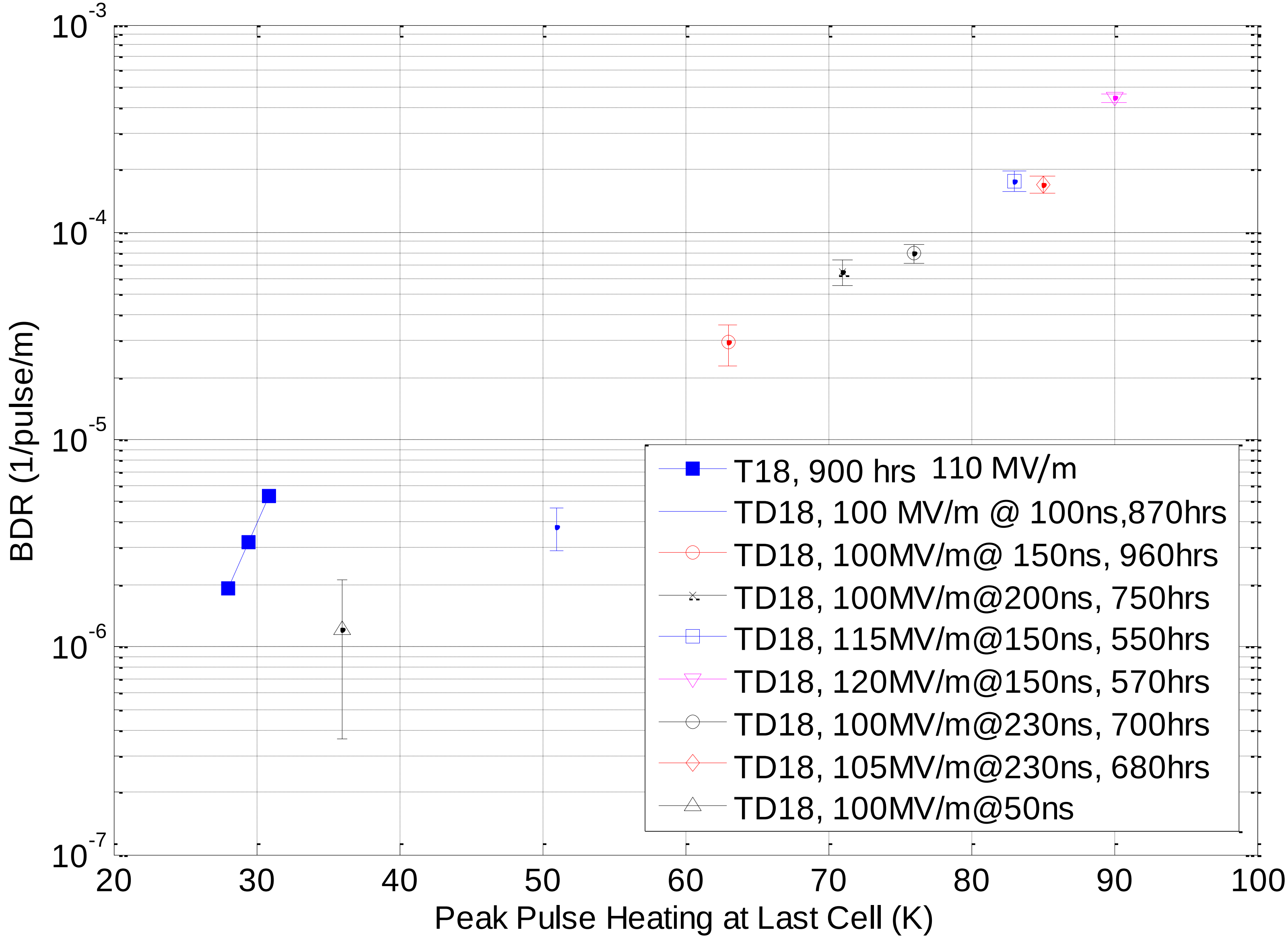
Type	1	2	3	4	5	6	7
Events	77	23	5	5	1	2	1

BDR Pulse Width Dependence

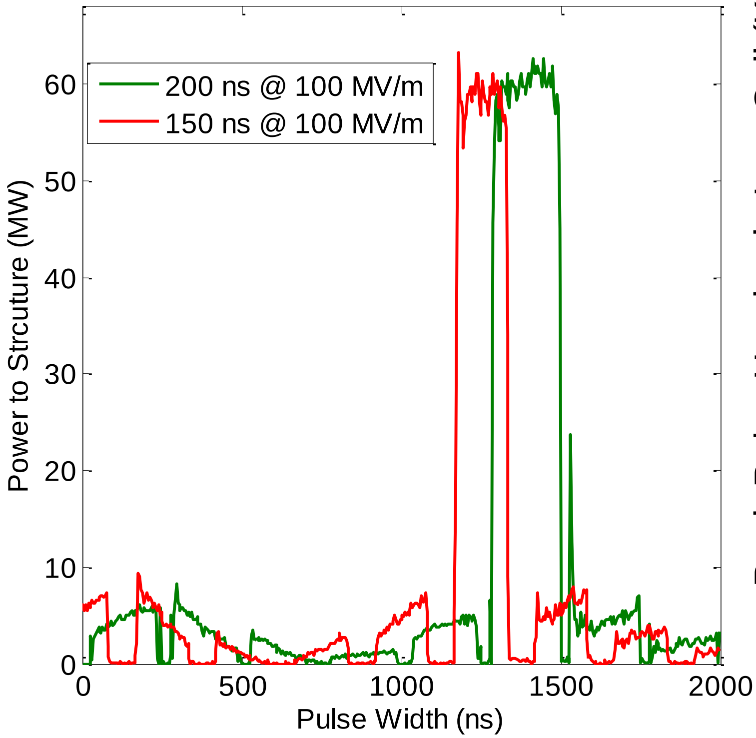


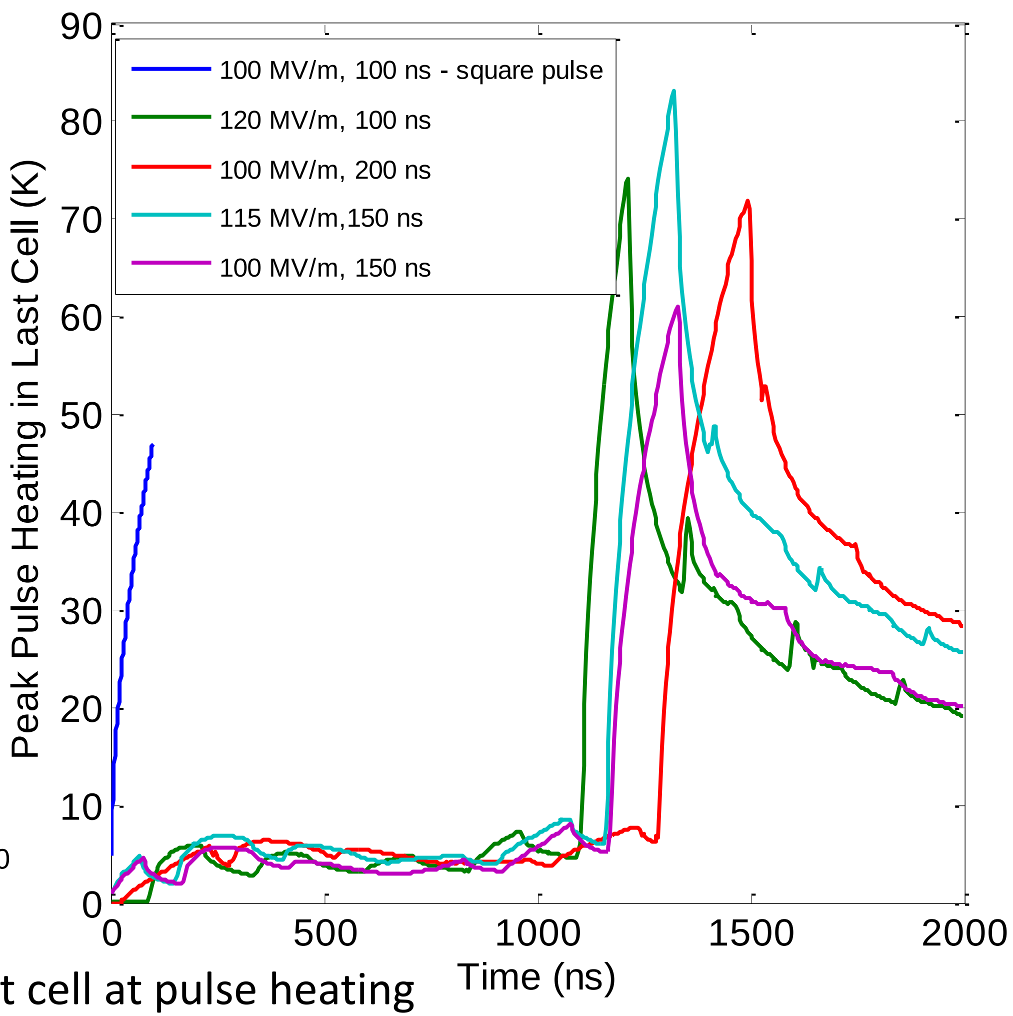


BDR Pulse Heating Dependence



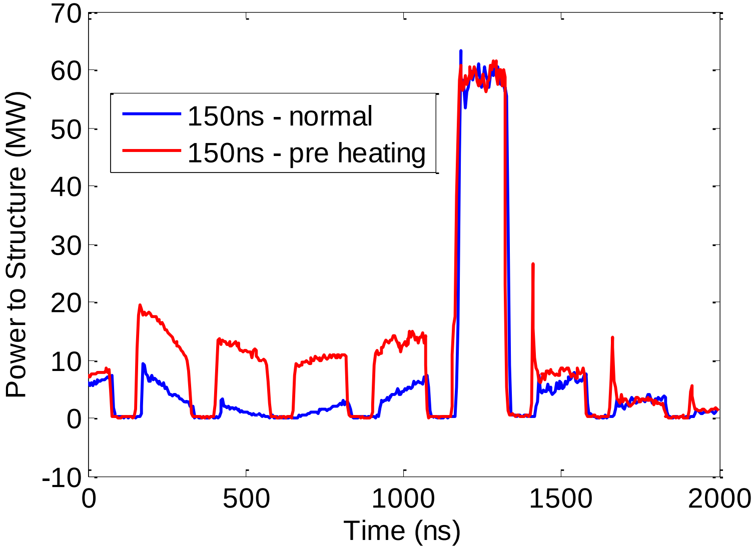
Pulse Heating under Different Conditions

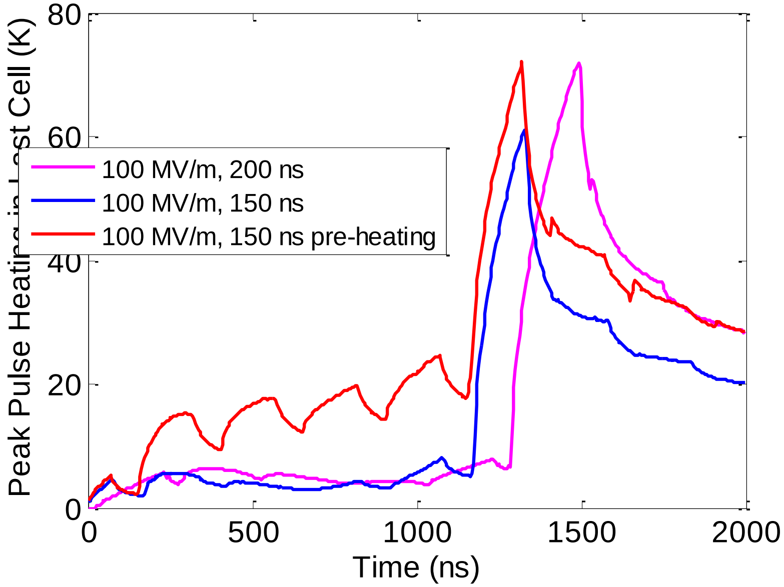


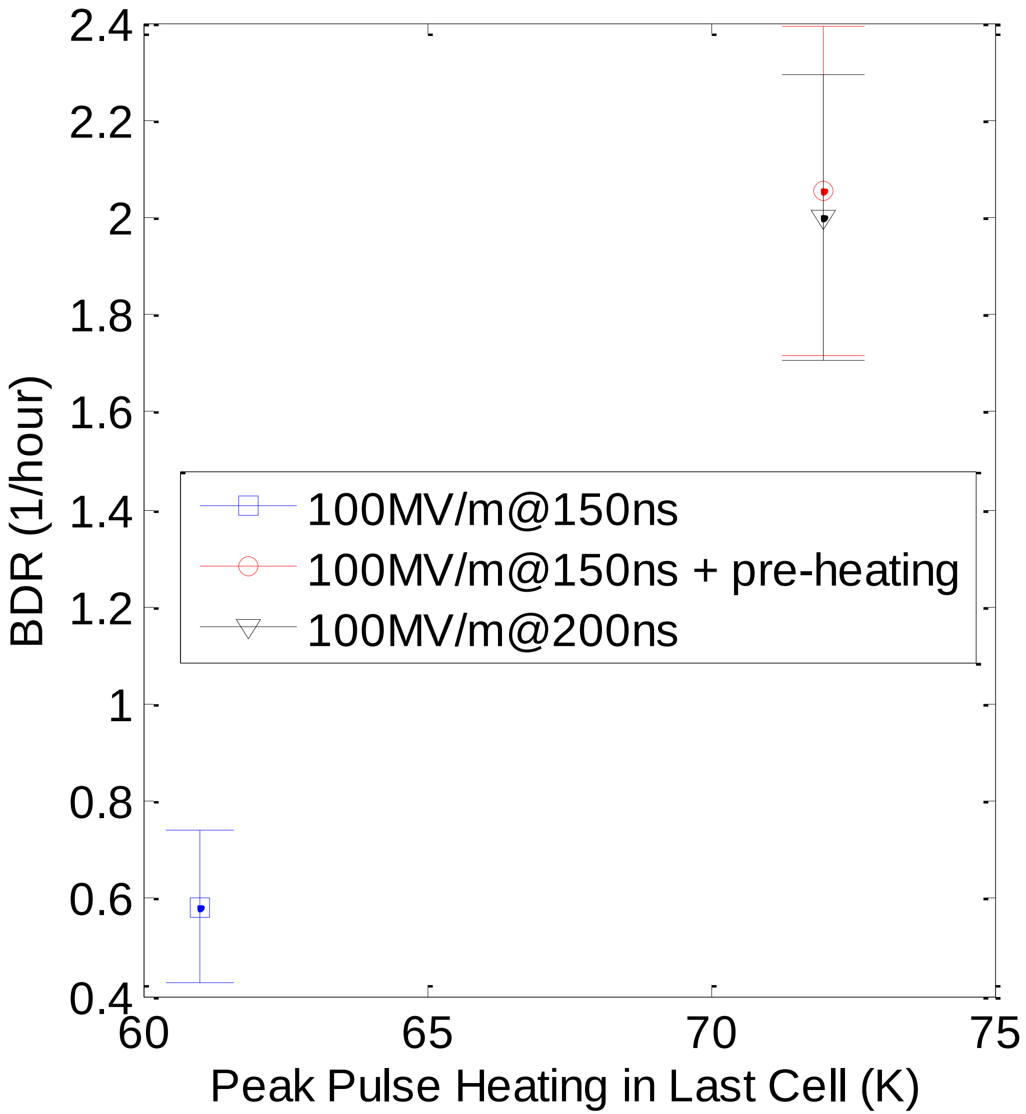


1st cell 62% of last cell at pulse heating

Pulse Heating BDR Test







TD18 Summary

- Structure performed worse than T18 even though it did not have any hot cells. TD18 bead pull data also shows a large phase advance change unlike that for T18 where no change is observed (see Juwen's talk).
- BDR pulse heating dependence suggests that operation above 50 degC may be a factor (as it appears to be in single SW cell data)
- Pre-heating test at constant gradient confirms the pulse heating sensitivity (although the statistics are low)
  - Factor of ~ 3 BDR increase similar to that seen with no pre-heating for the same temperature range.
- Perhaps should not draw too strong of conclusion given that this is just one structure, and the KEK TD18 results are even more puzzling.