Measurements at NLCTA of Single Cell Breakdown Rate Dependence on Gradient and Pulse Heating

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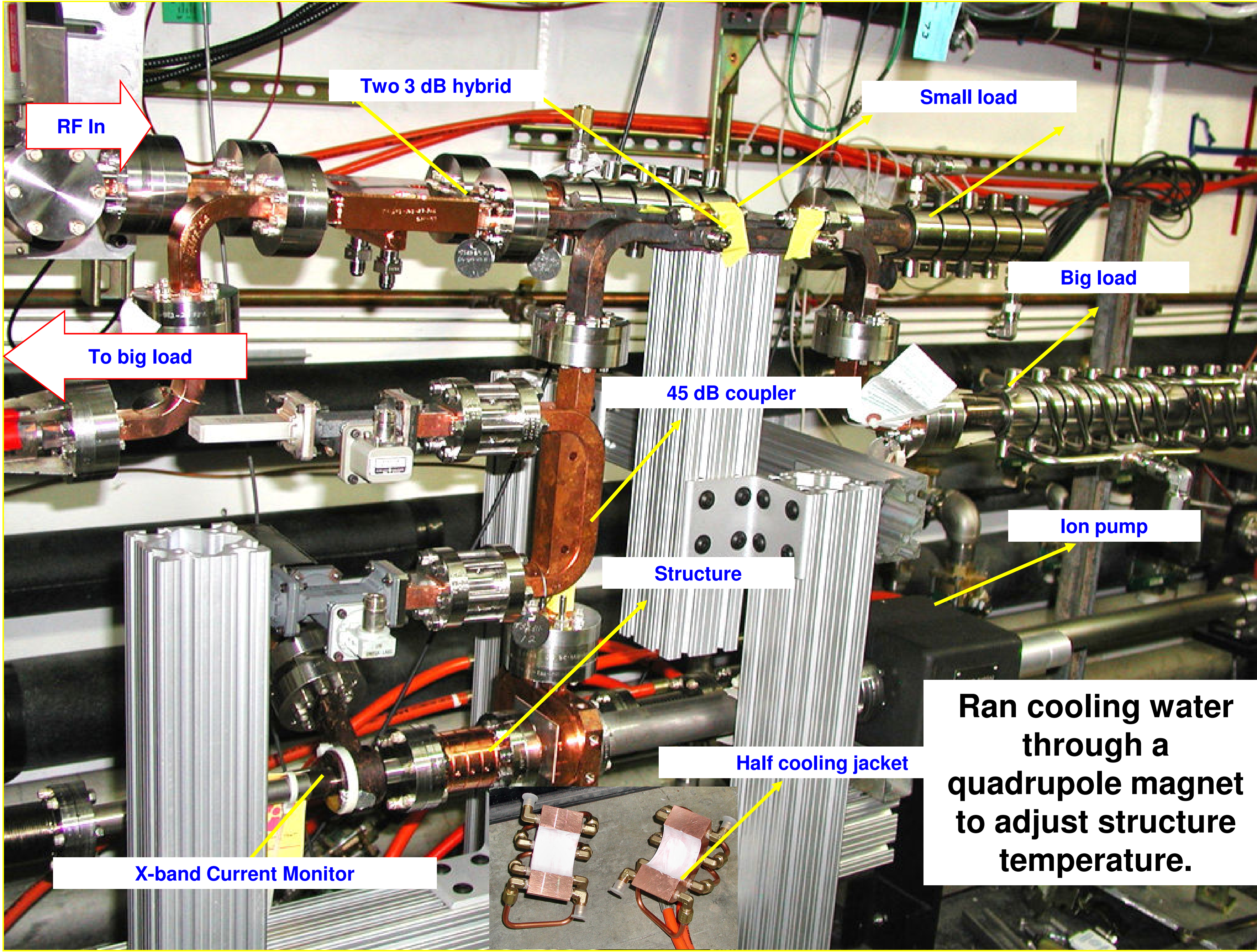
10-22-2009

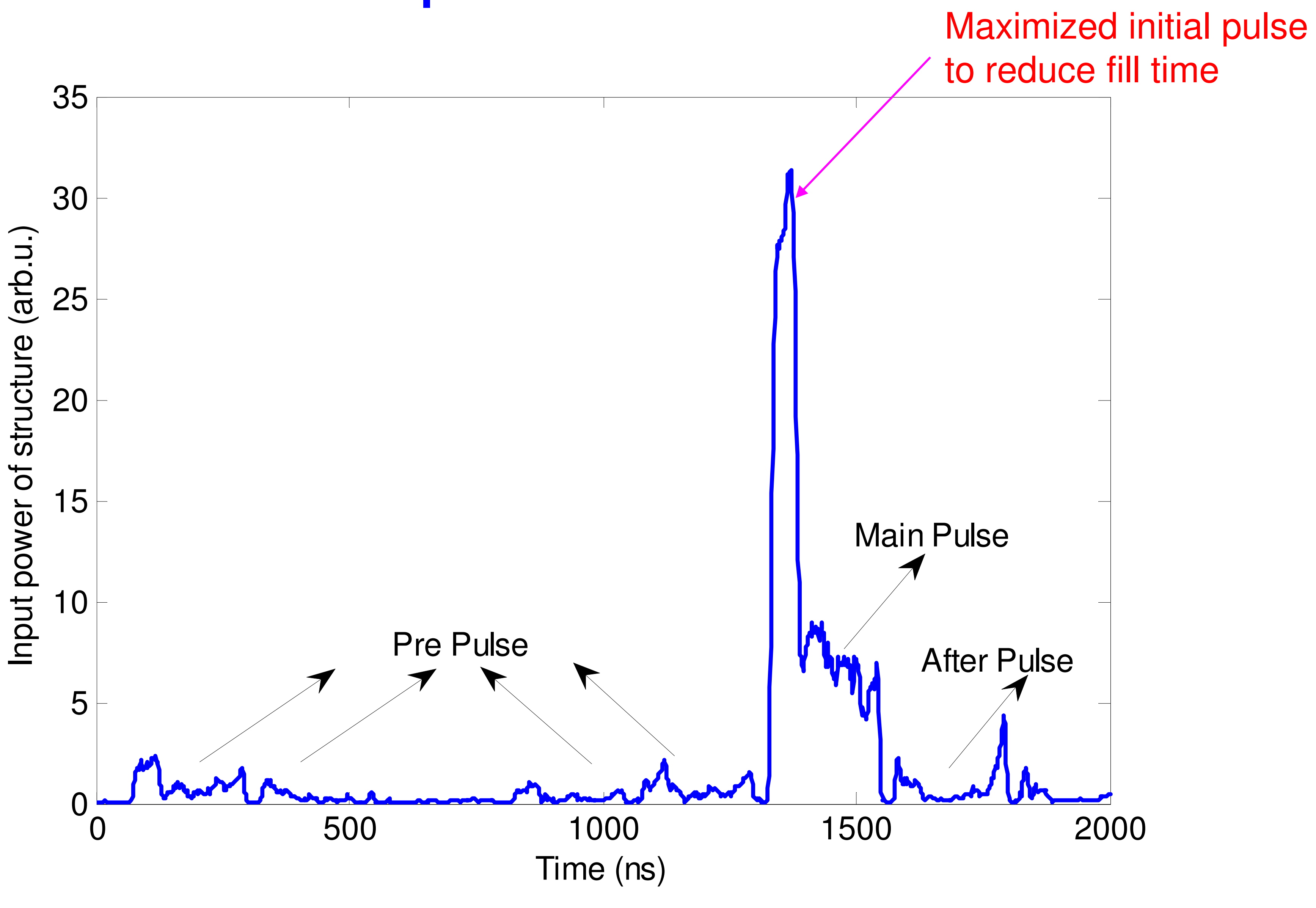
1C-SW-A3.75-T2.60-Cu6N-KEK Structure Parameters

Parameters	Unit	Value
Frequency	GHz	11.427 (Nitrogen, 20 ^{o}C)
Cells		1+matching cell + mode launcher
Q (loaded)		4660
Coupling		0.97
Iris Thickness T	mm	2.6
Iris Dia. a / λ	%	14.4
Phase Advance Per Cell	deg	180
E_s/E_a		2.03
Maximum surface electric field for 10 MW	MV/m	399
Maximum surface magnetic field for 10 MW	A/m	6.7e5
Peak pulse heating for 1 μs pulse with flat field of 100 MV/m	^{o}C	24

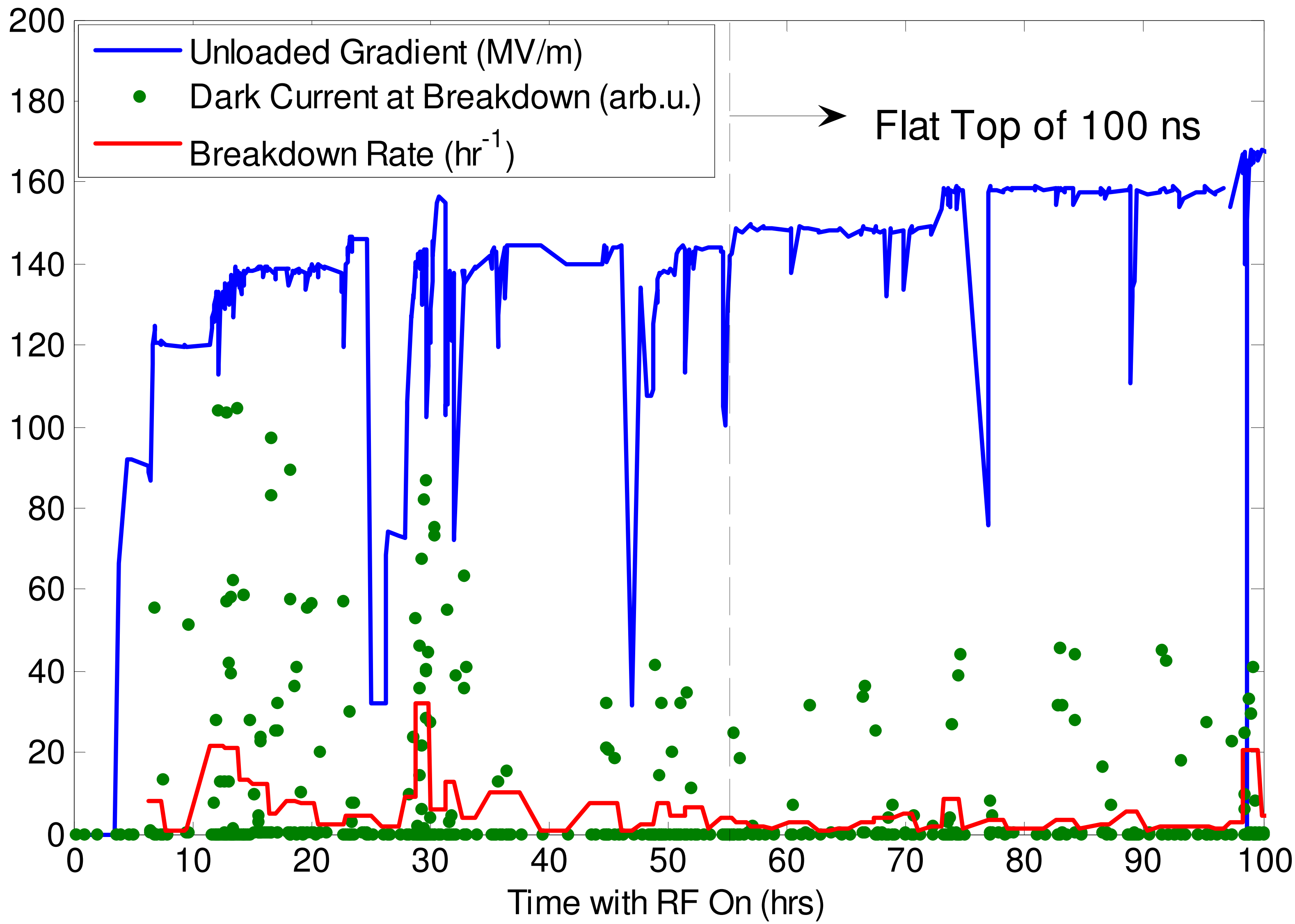
from Valery Dolgashev and James Lewandowski


RF In
Two 3 dB hybrid
Small load
Big load
To big load
45 dB coupler
Ion pump
Structure
Half cooling jacket
X-band Current Monitor
Ran cooling water through a quadrupole magnet to adjust structure temperature.

Input RF Pulse

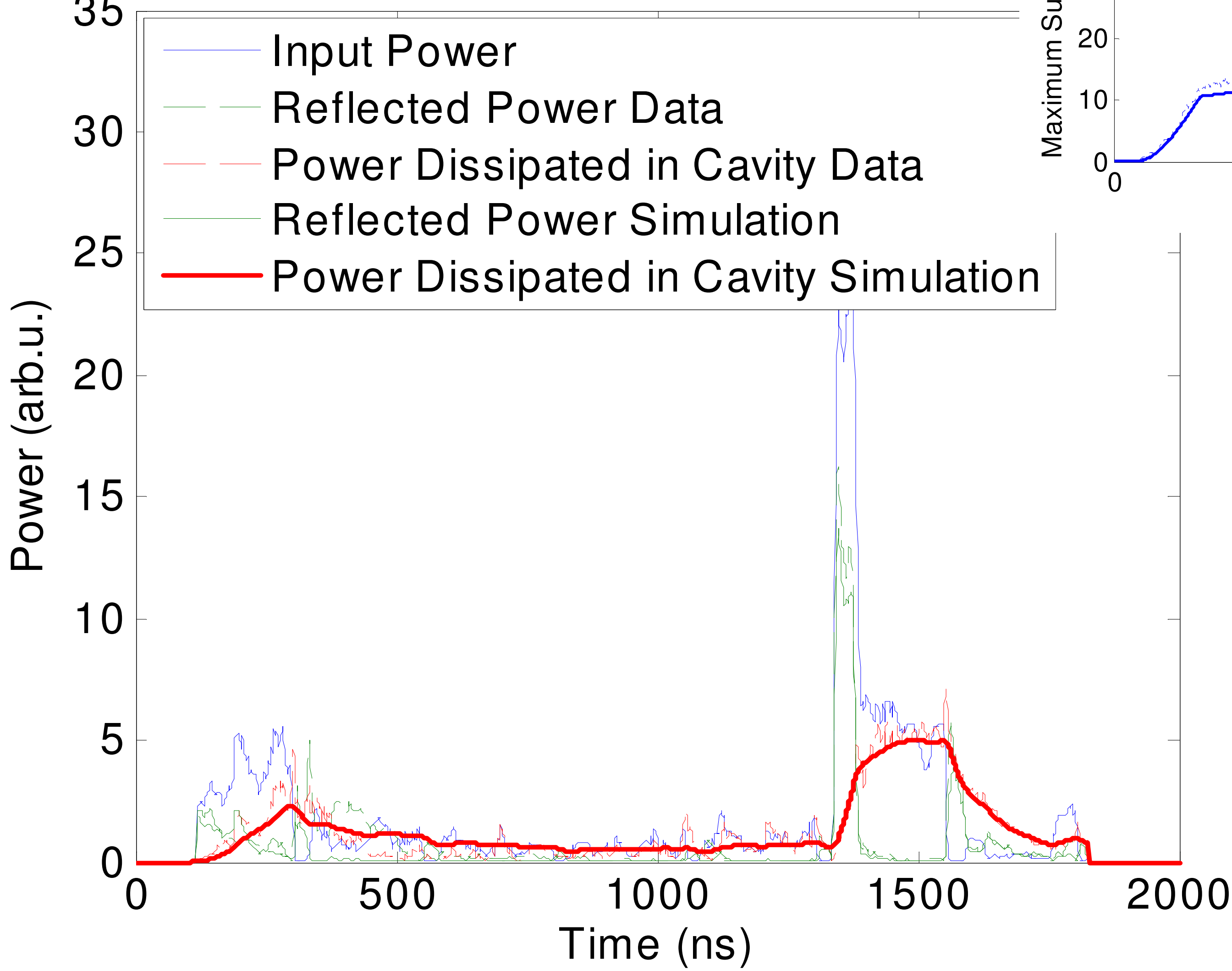


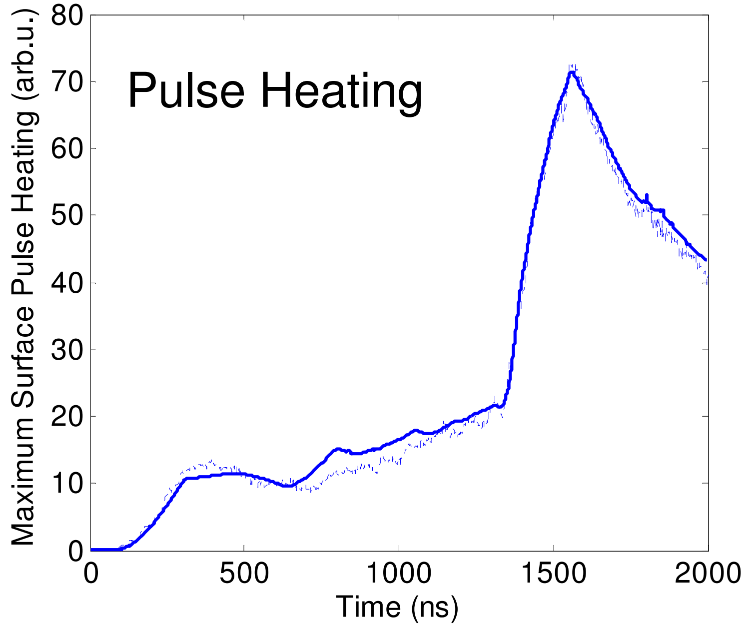
RF Processing History During First 100 Hours

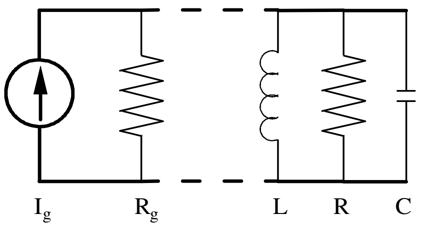


Detect breakdown from the large current produced (> 0.8 on above scale)

RF Power and Heating Measurements and Simulations

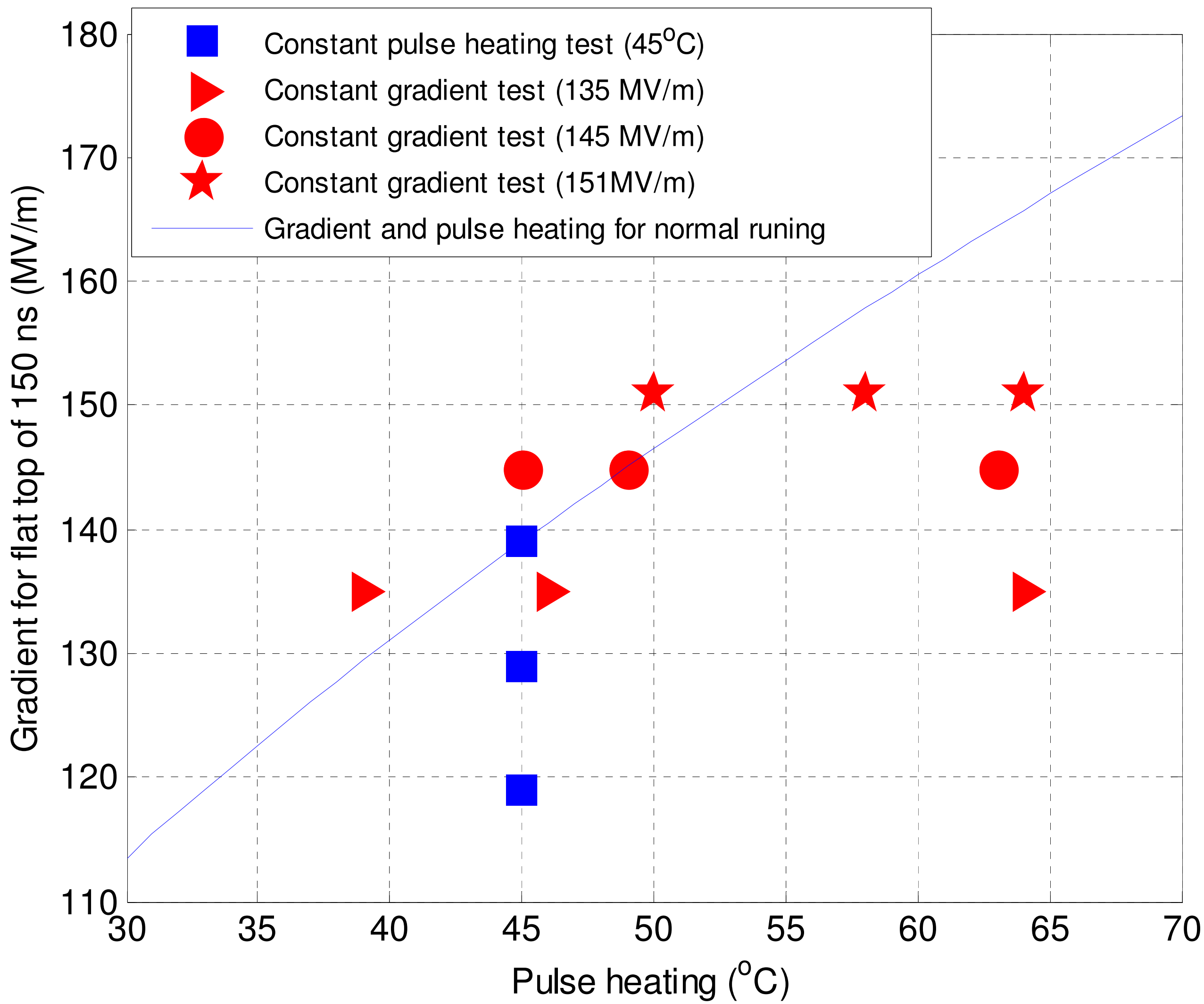




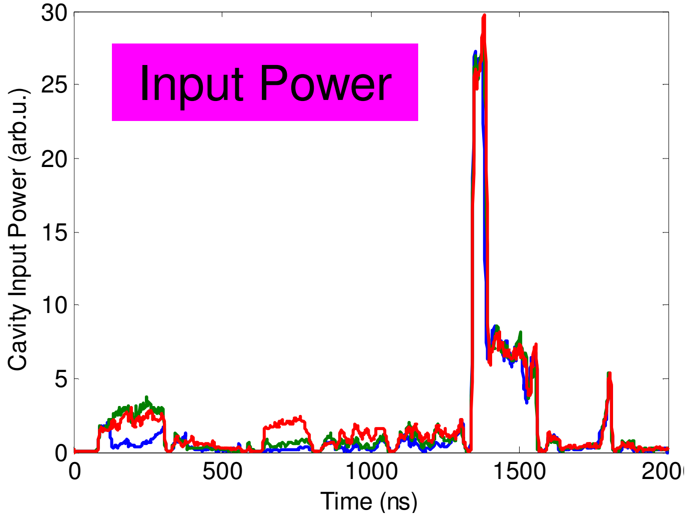


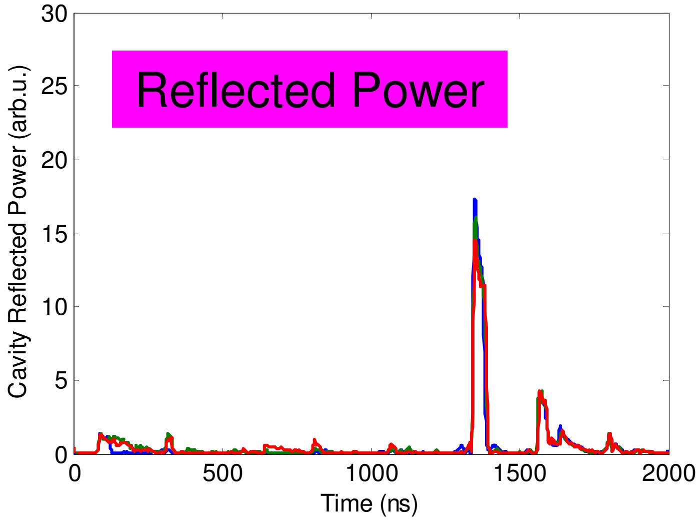
Simulations based only on measured input power

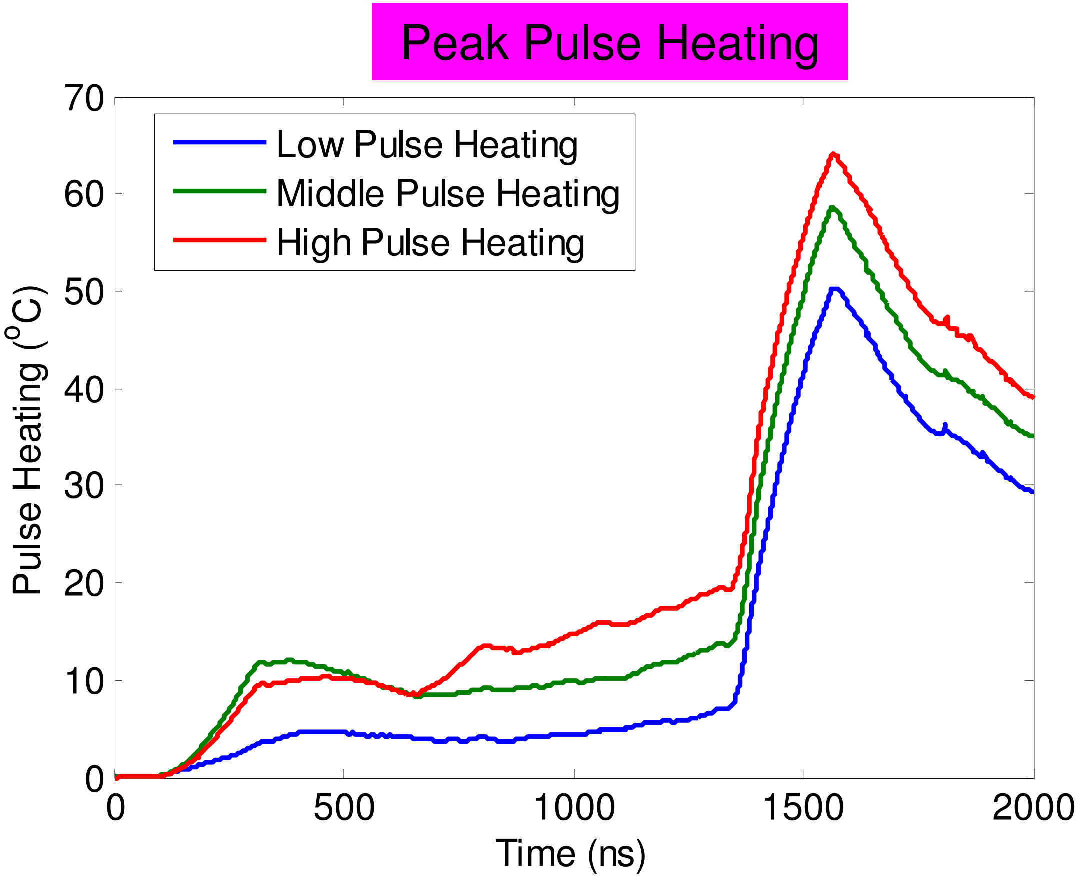
Measurement Points: Vary Either Pulse Heating or Gradient



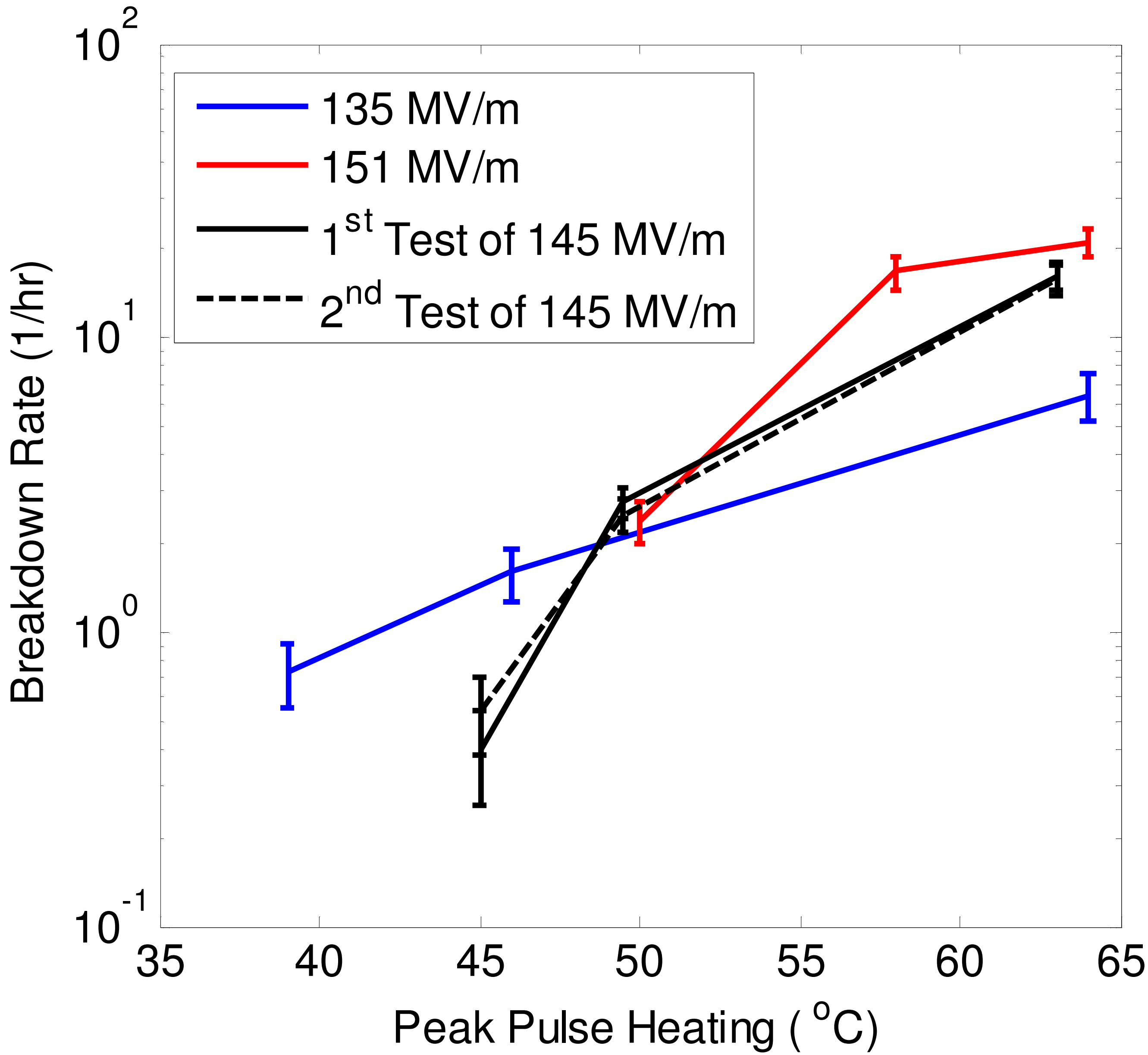
Breakdown Study with Constant Gradient but Different Pulse Heating from the Pre-Fill 'Warm-up'



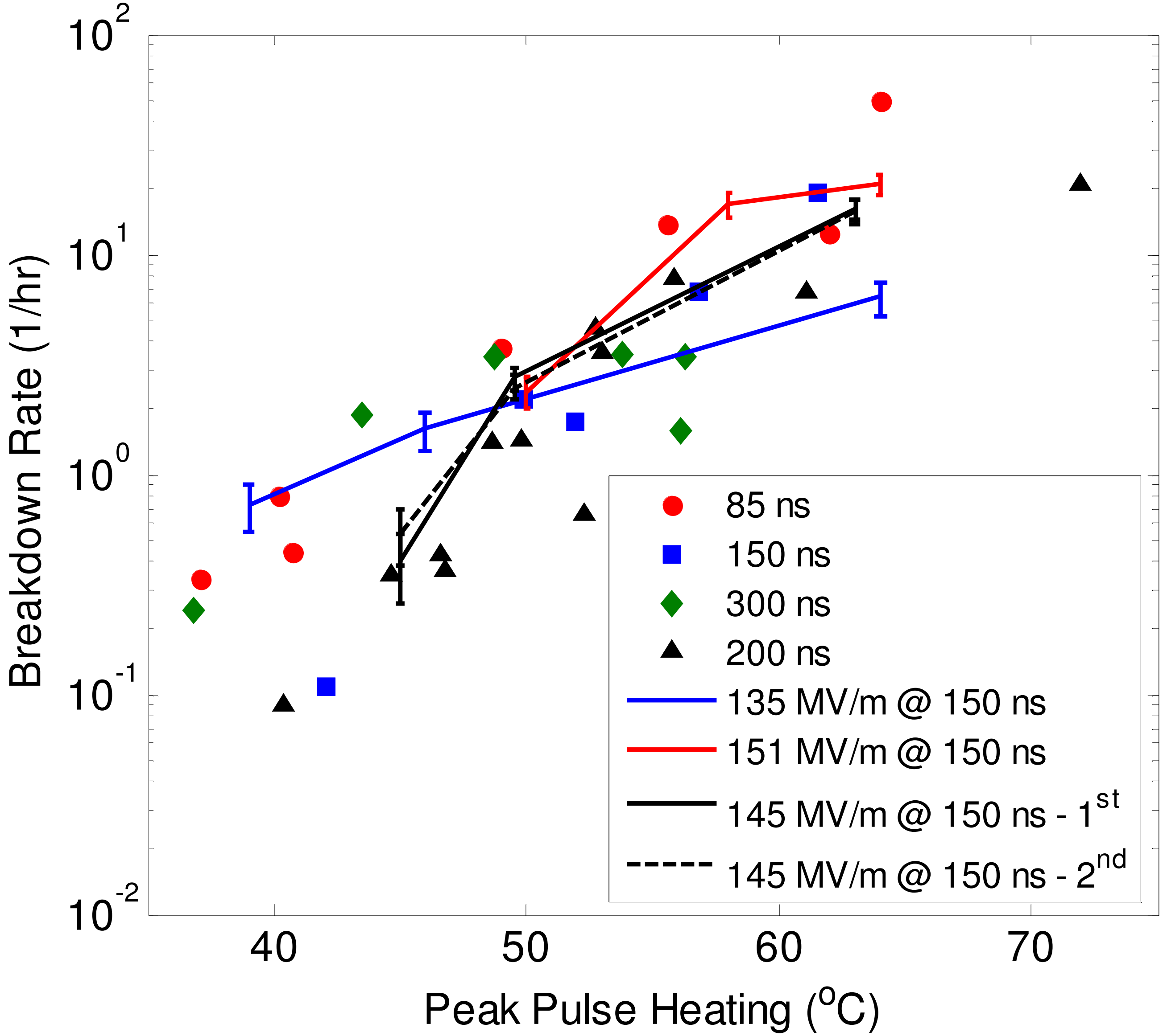




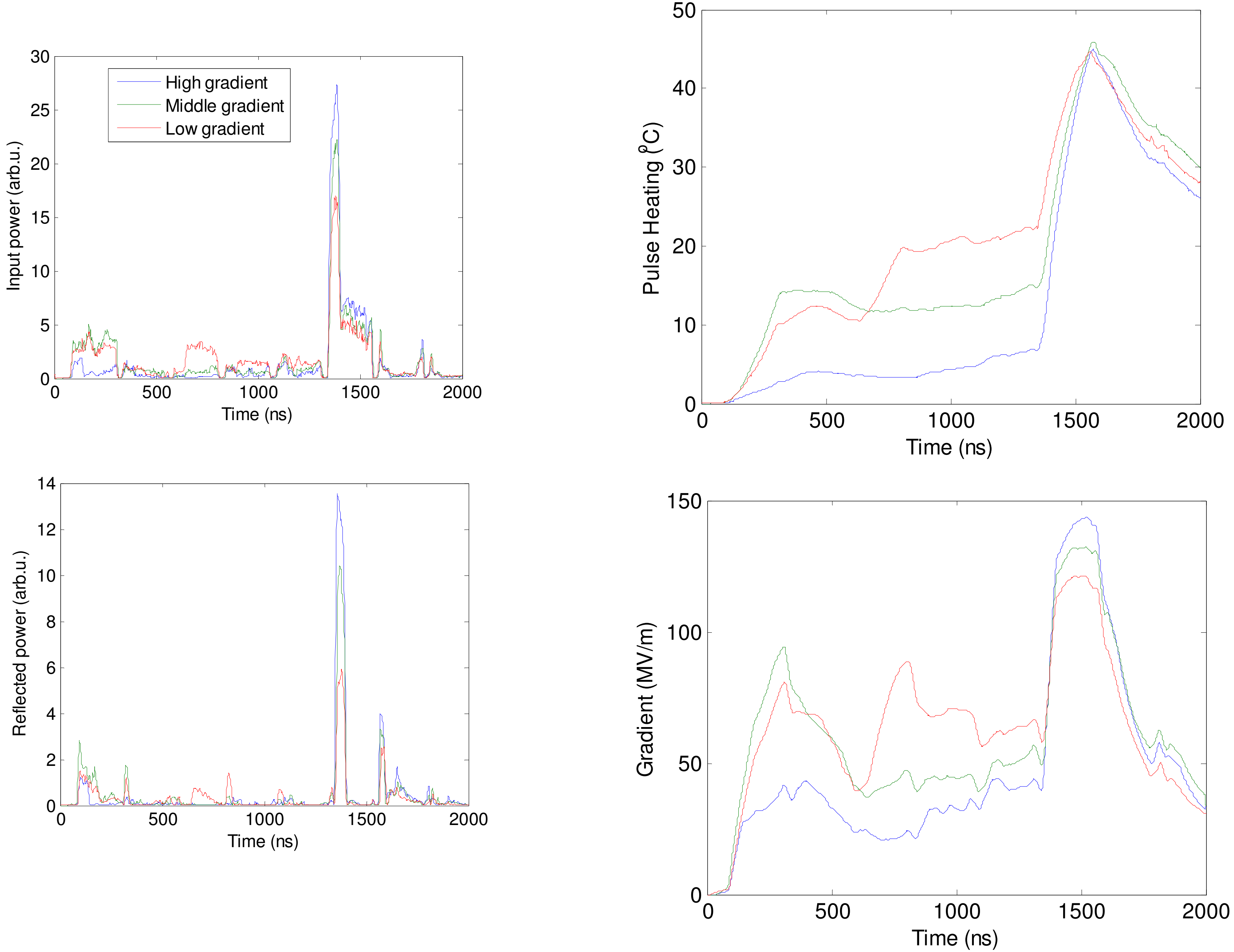
Breakdown Rate for Fixed Gradient



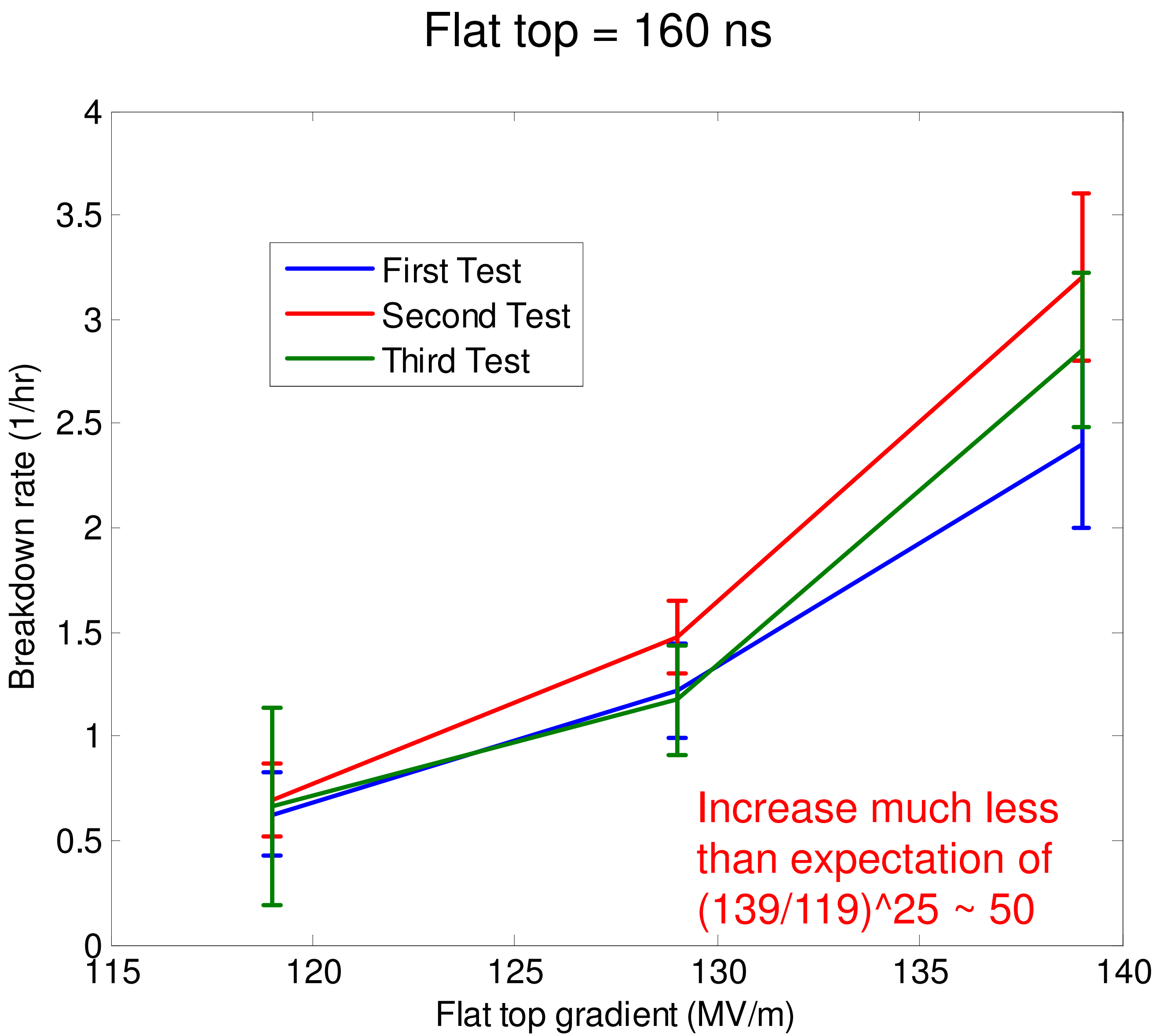
Comparison of these results with those from a similar structure (same a/λ) tested at the Klystron Test Lab where the pulse shape was fixed so the gradient varies with pulse heating



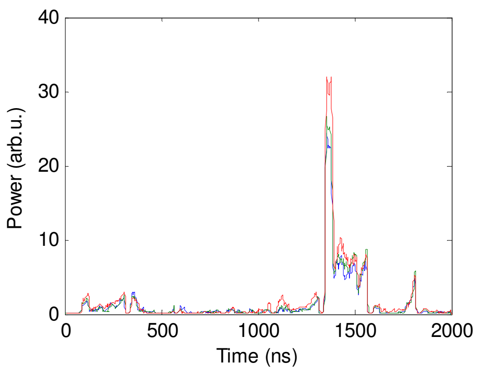
Breakdown Study with Constant Pulse Heating

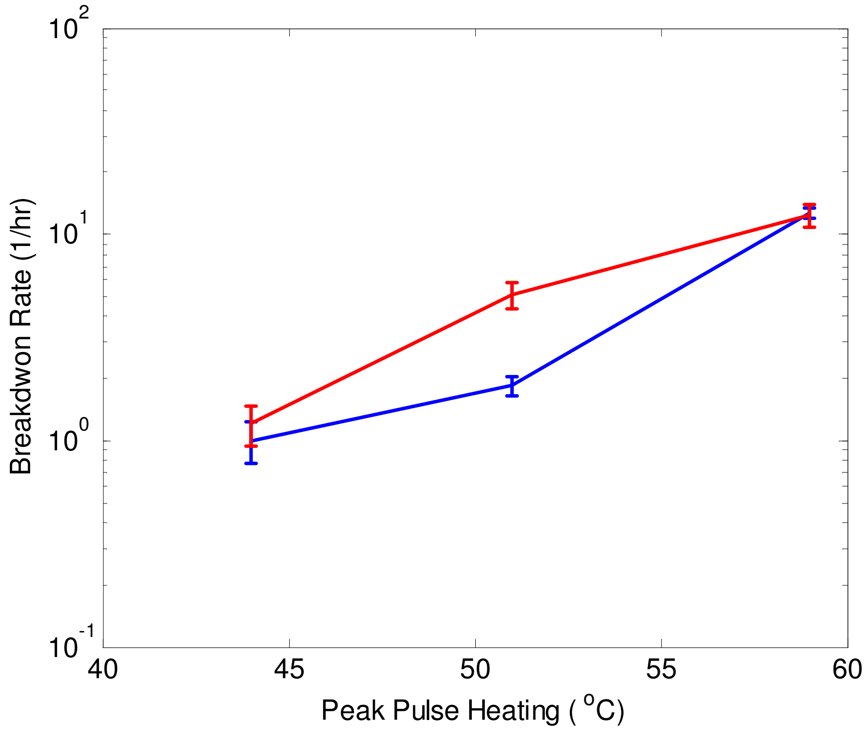


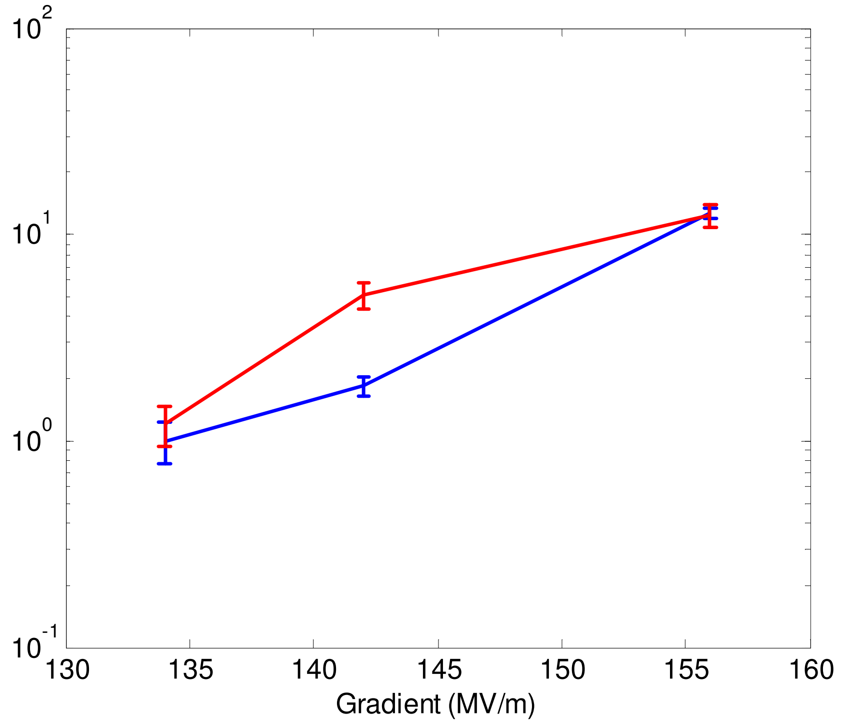
Breakdown Rate for Fixed Peak Pulse Heating



Breakdown Rate with Varying Gradient and Pulse Heating

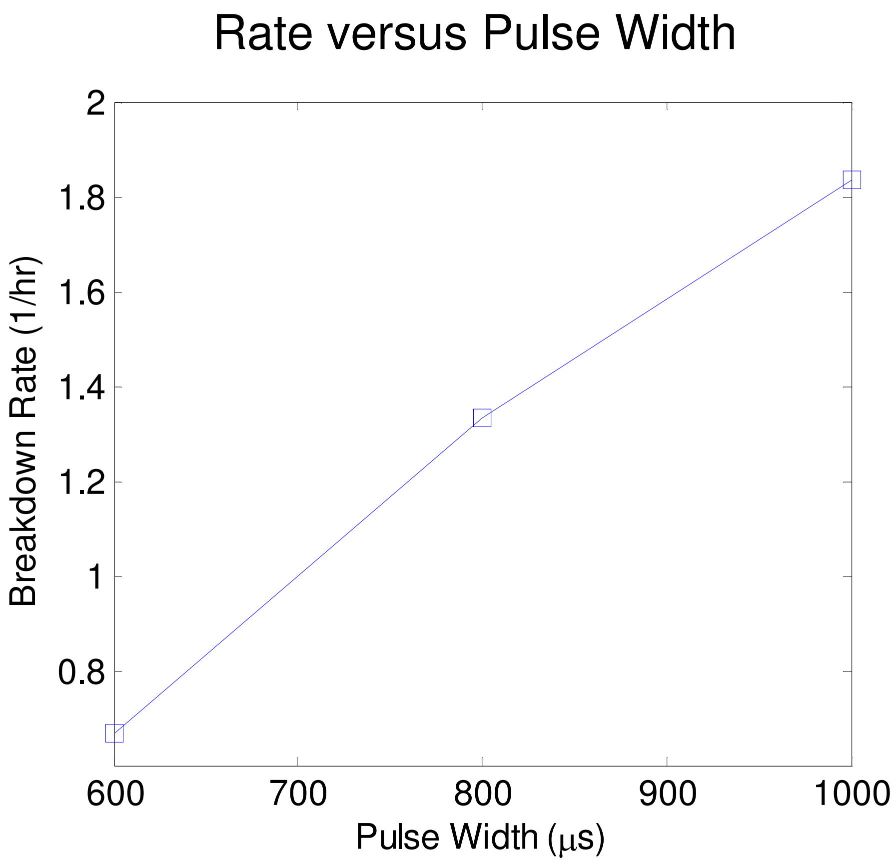


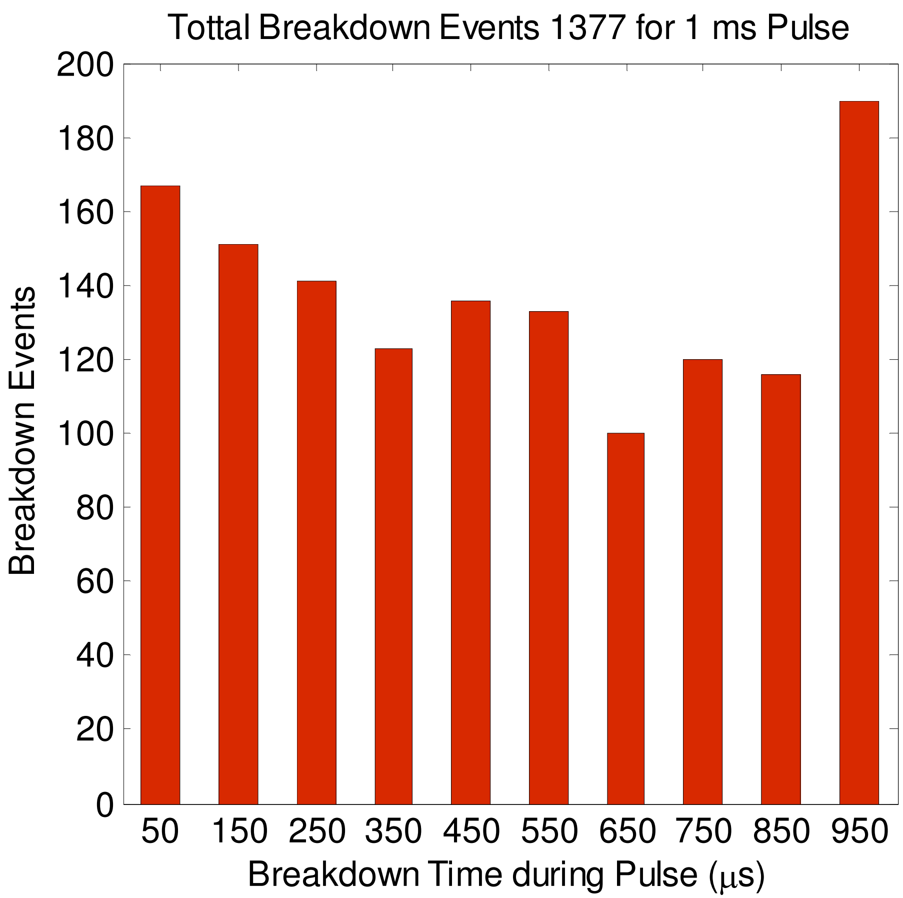




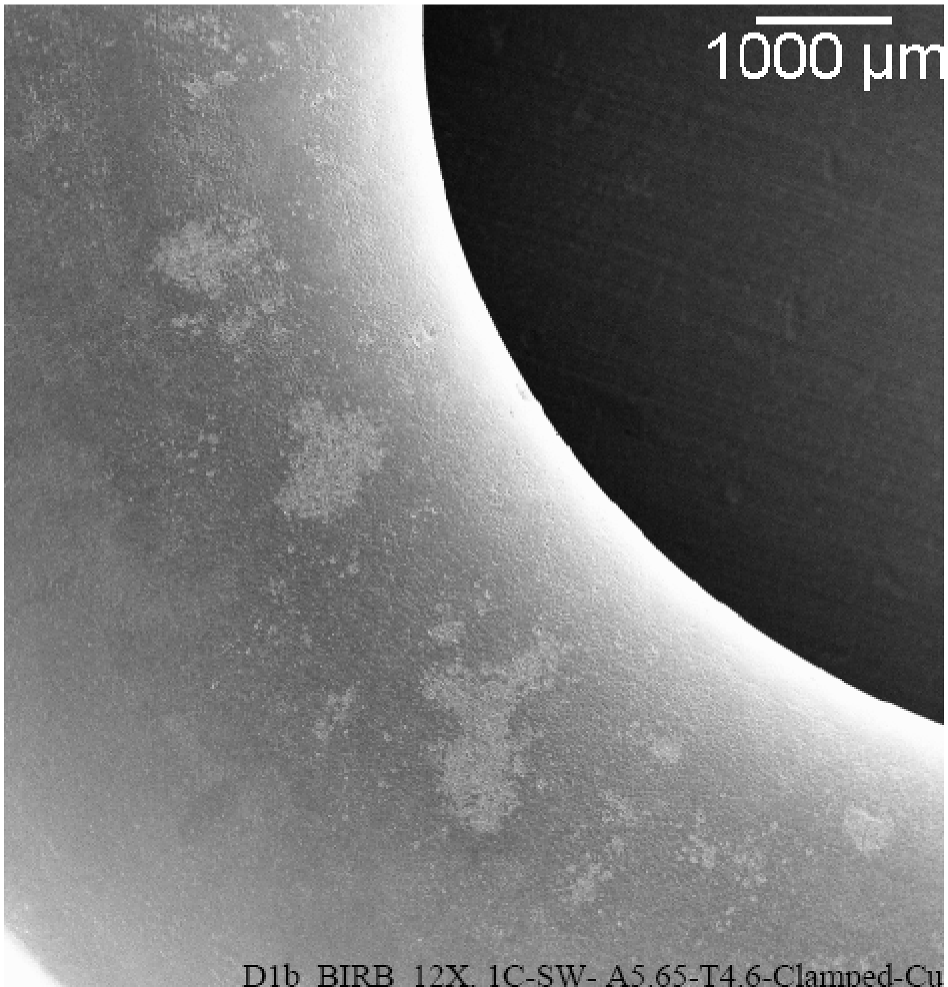
Blue for the 1st test and Red for the 2nd test.

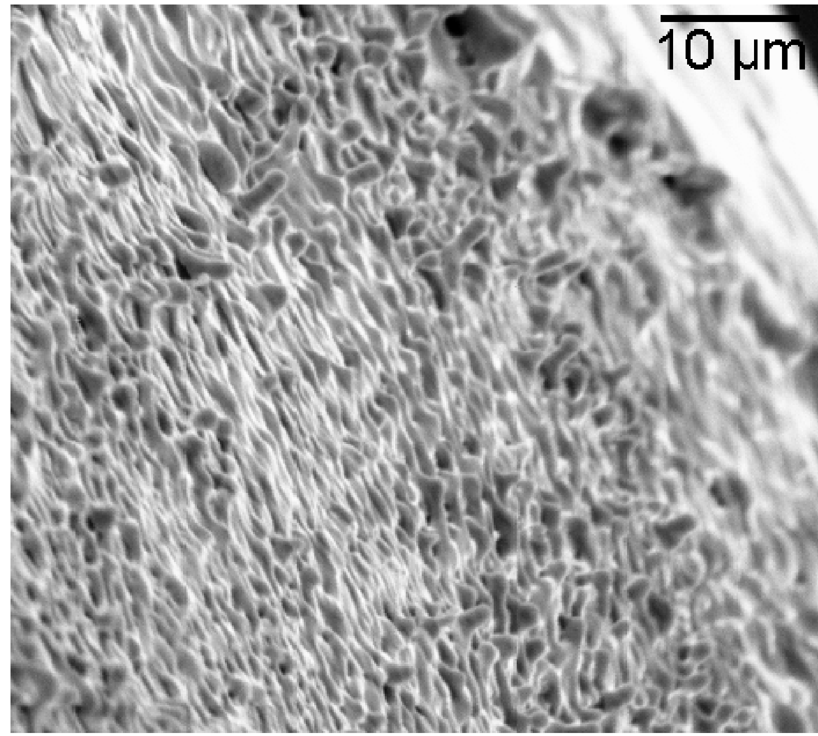
Breakdown Data for a 5-Cell L-band Standing Wave Cavity Running at 13.5 MV/m, 5 Hz with up to 1 ms Pulse Lengths





Damage to Single Cell Irises





V Dolgashev, L Laurent

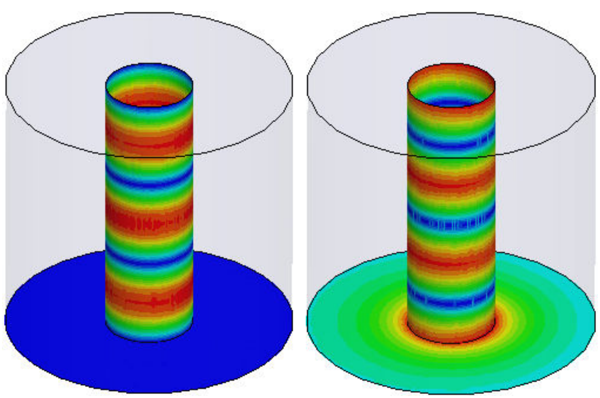
A Coaxial Two Mode Cavity is Being Designed to Study E and B Effects Somewhat Orthogonally

A coaxial cavity resonant with 11.424 GHz TEM_3 and TE_{011} would be excited by two rf sources, one coupling to each mode.

The high E field on the center conductor is determined solely by the TEM_3 excitation, with the peaks at the zero points of the H field.

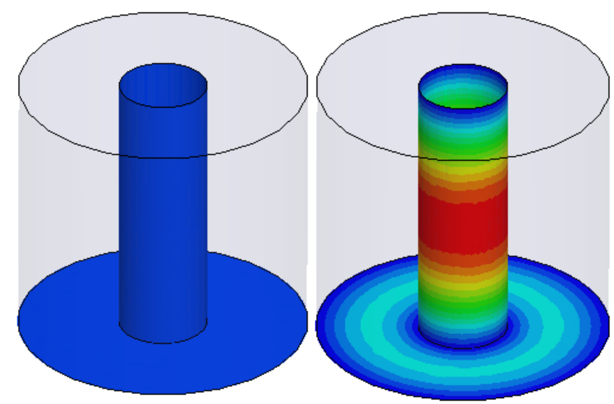
Adding TE_{011} increases the H field, preferentially around the central E field lobe.

TEM_3



$|E_s|$ $|H_s|$

TE_{011}



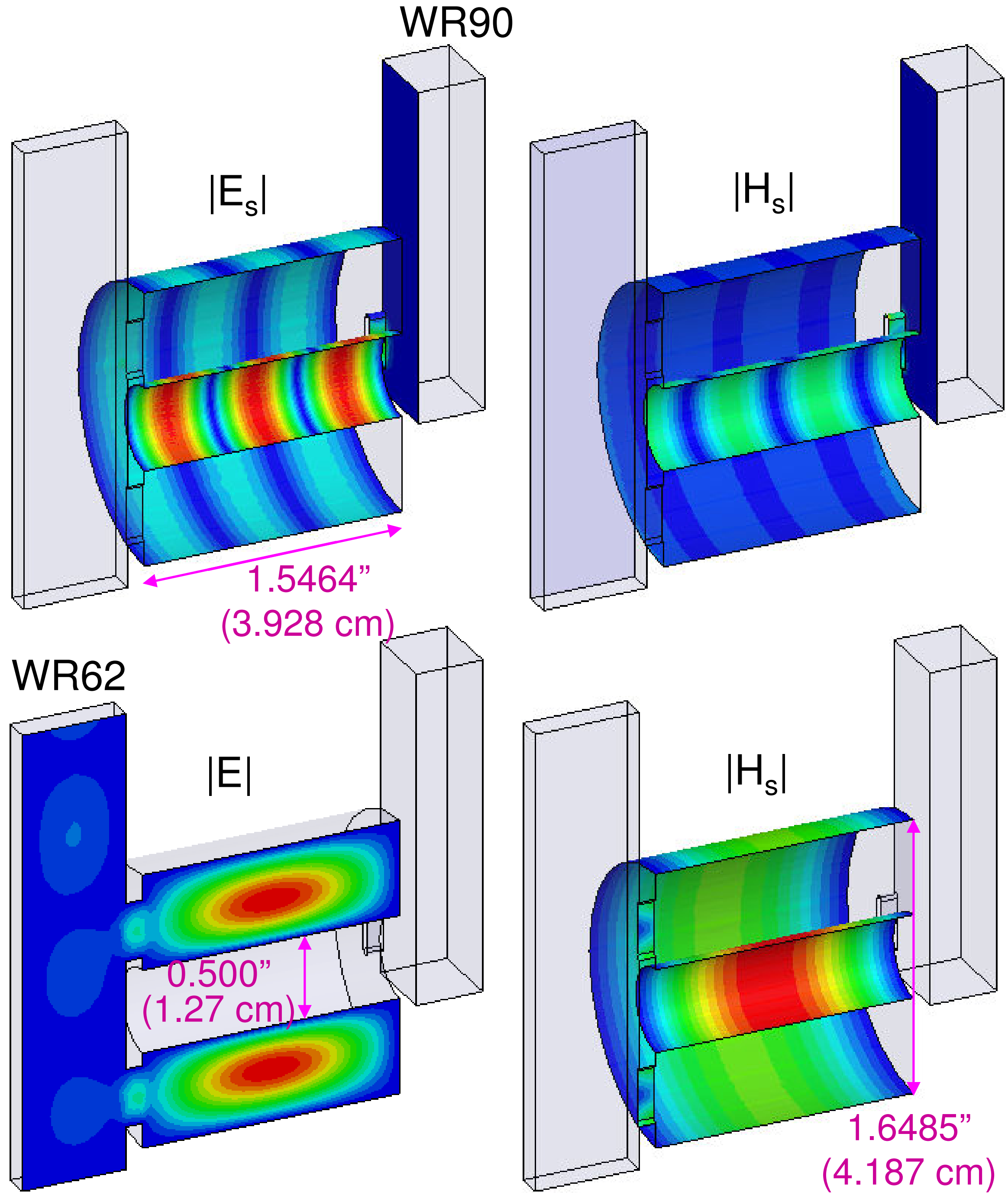
$|E_s|$ $|H_s|$

Center conductor:
r = 0.635 cm

C. Nantista

COUPLING:

TEM_3 can be magnetically coupled through slots in an end wall to the sides of the broad wall of a WR90 waveguide.



TE_{011} can be magnetically coupled through radial slots in the other end wall to the narrow wall of a WR62 waveguide (for increased λ_g).

SOME NUMBERS:

TEM$_3$

$Q_0 = 11{,}813.5$

critically coupled: $Q_L = 5{,}907$ $\tau = 165$ ns

$\Delta\omega_{FWHM} = 1.93$ MHz

$U/|E_m|^2 = 2.4897\times10^{-17} Jm^2/V^2$

$|E_m|/|H_m| = \sim359$ V/A

$|E_m| = 200$ MV/m → $P = \sim12.1$ MW

$|H_m| = 529$ kA/m

TE$_{011}$

$Q_0 = 14{,}020.3$

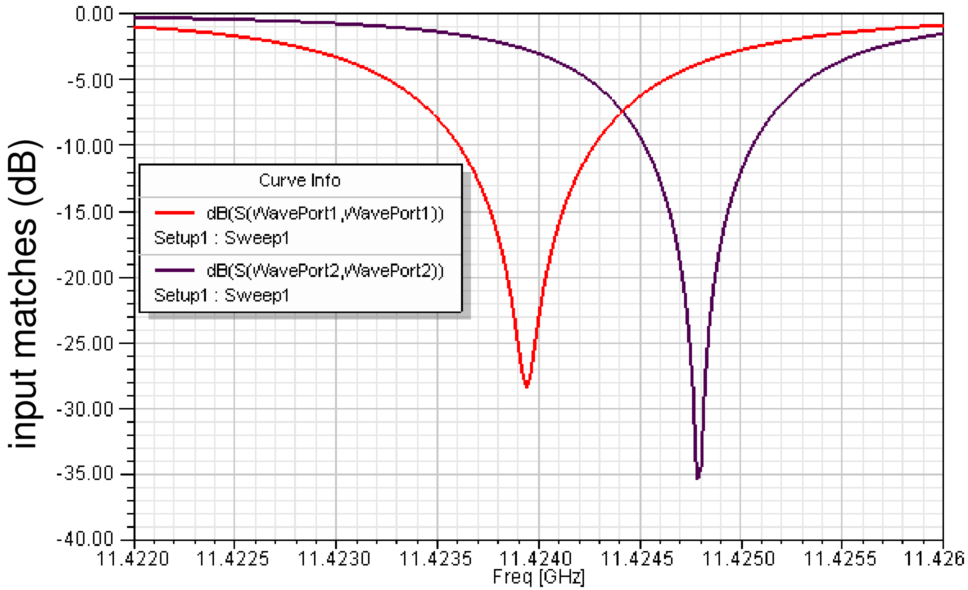
critically coupled: $Q_L = 7{,}010$ $\tau = 195$ ns

$\Delta\omega_{FWHM} = 1.63$ MHz

$U/|H_m|^2 = 2.3414\times10^{-12}\ Jm^2/A^2$

for equal H amplitude, we need

$|H_m| = 529$ kA/m → $P = \sim6.71$ MW



Due to their narrow resonances, it’s difficult, even in simulation, to tune for both modes.

Separate fine-tunable sources are desirable for this as well as to vary relative amplitude.