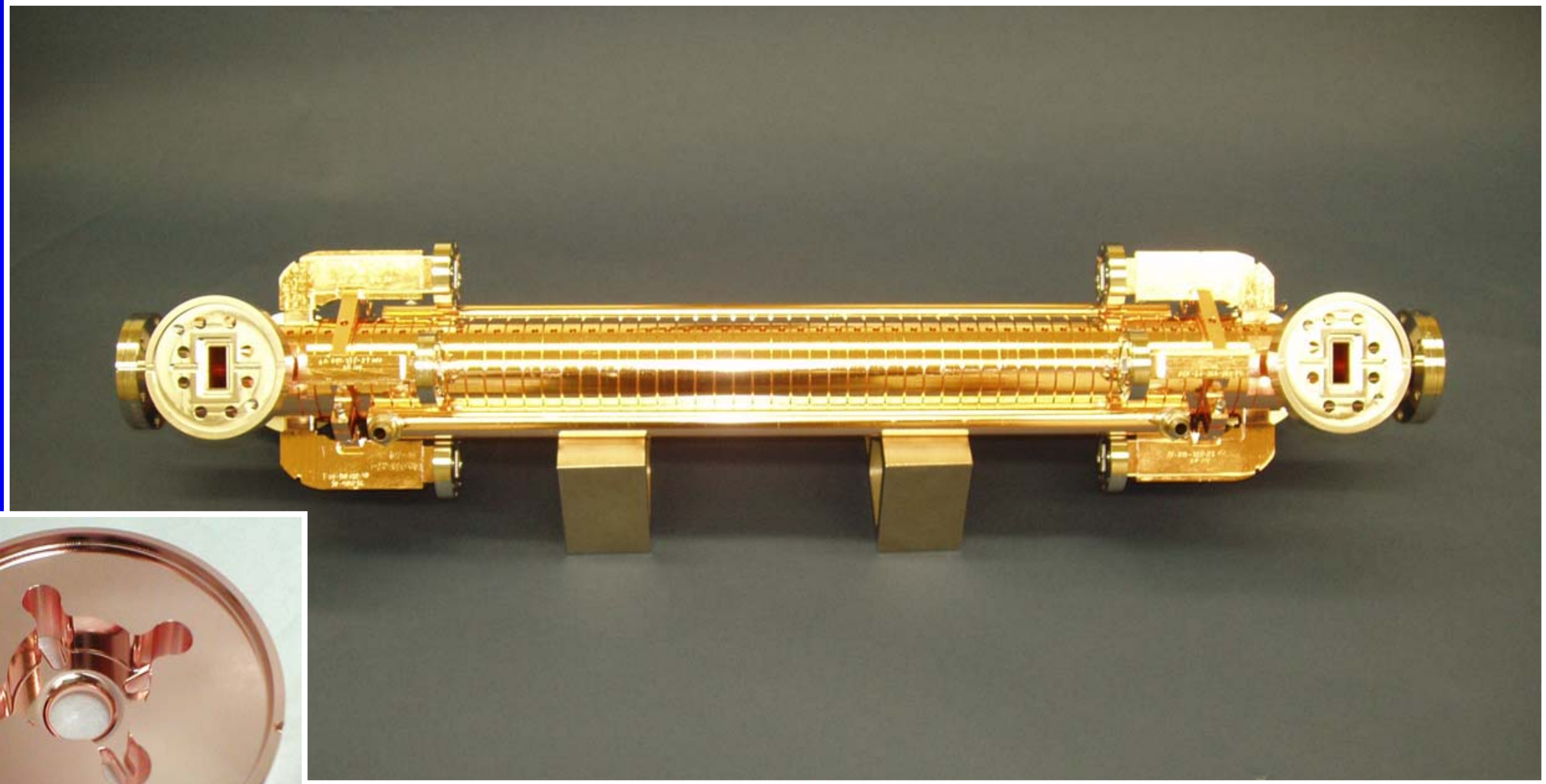
Structure working group

More x-band data

Steffen Döbert, AB/RF, 2007

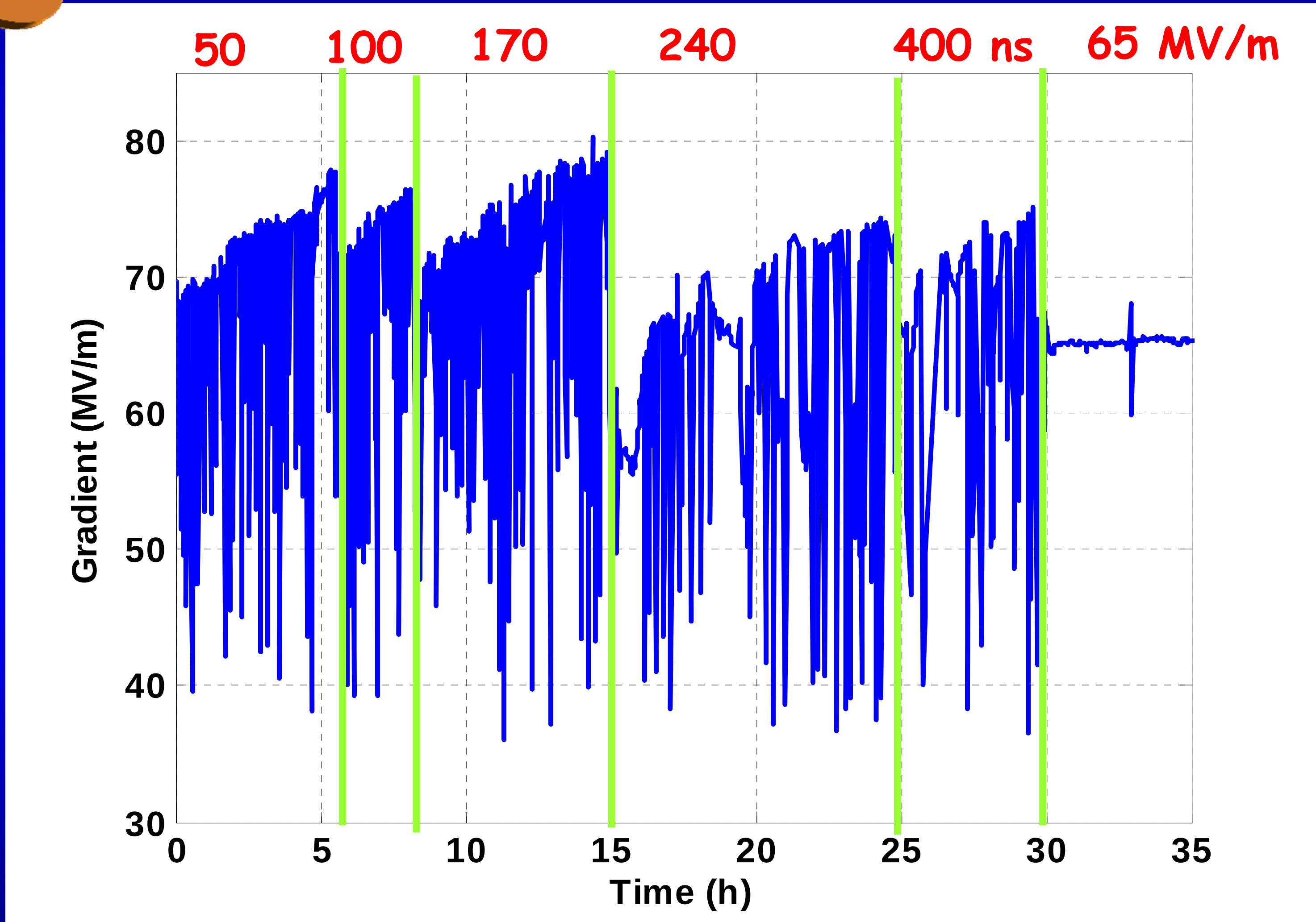
The state of the Art

NLC/GLC development by SLAC/KEK/FNAL



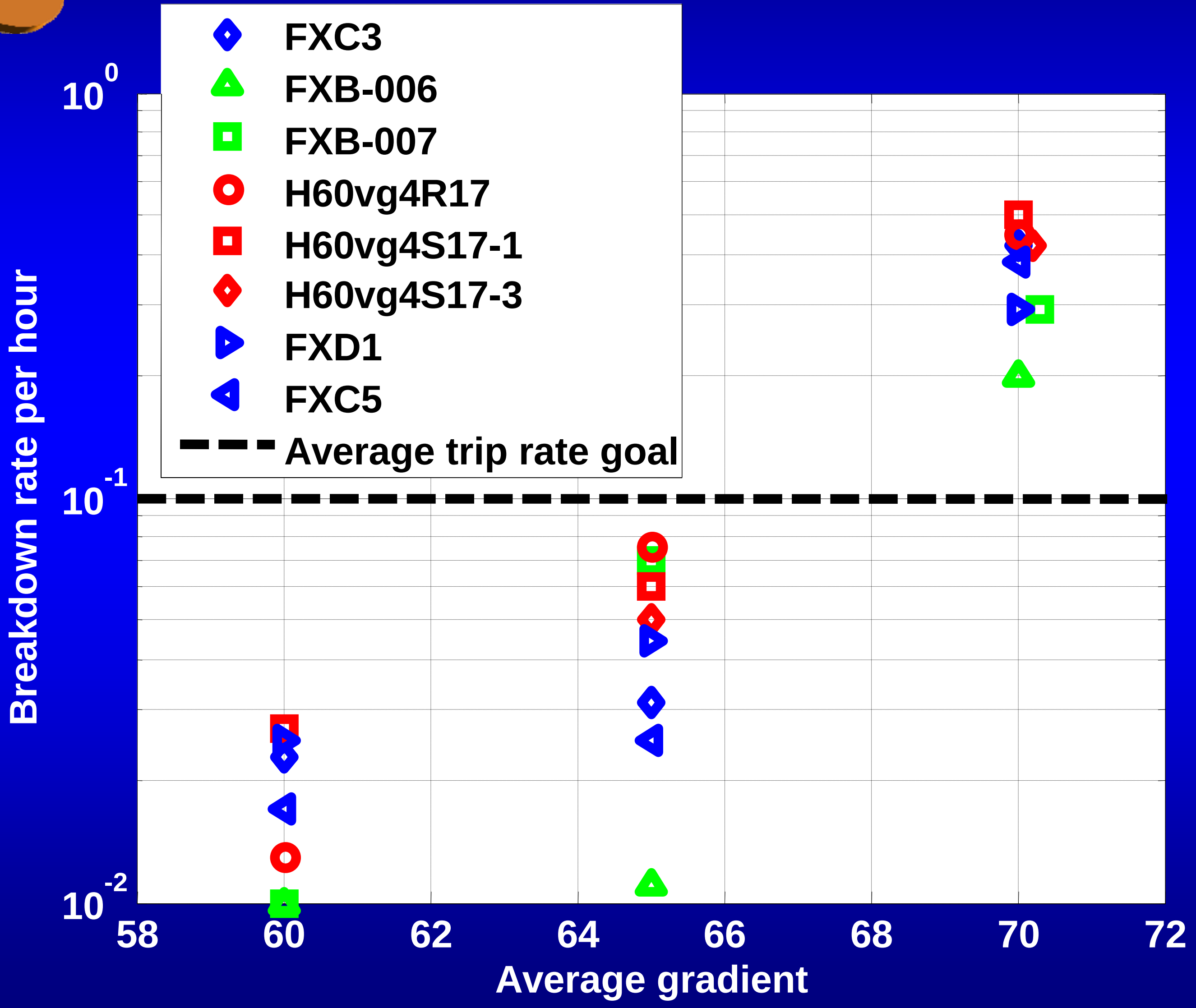
11 GHz, 65 MV/m, 400 ns, 1 trip in 10 h

Typical structure processing history

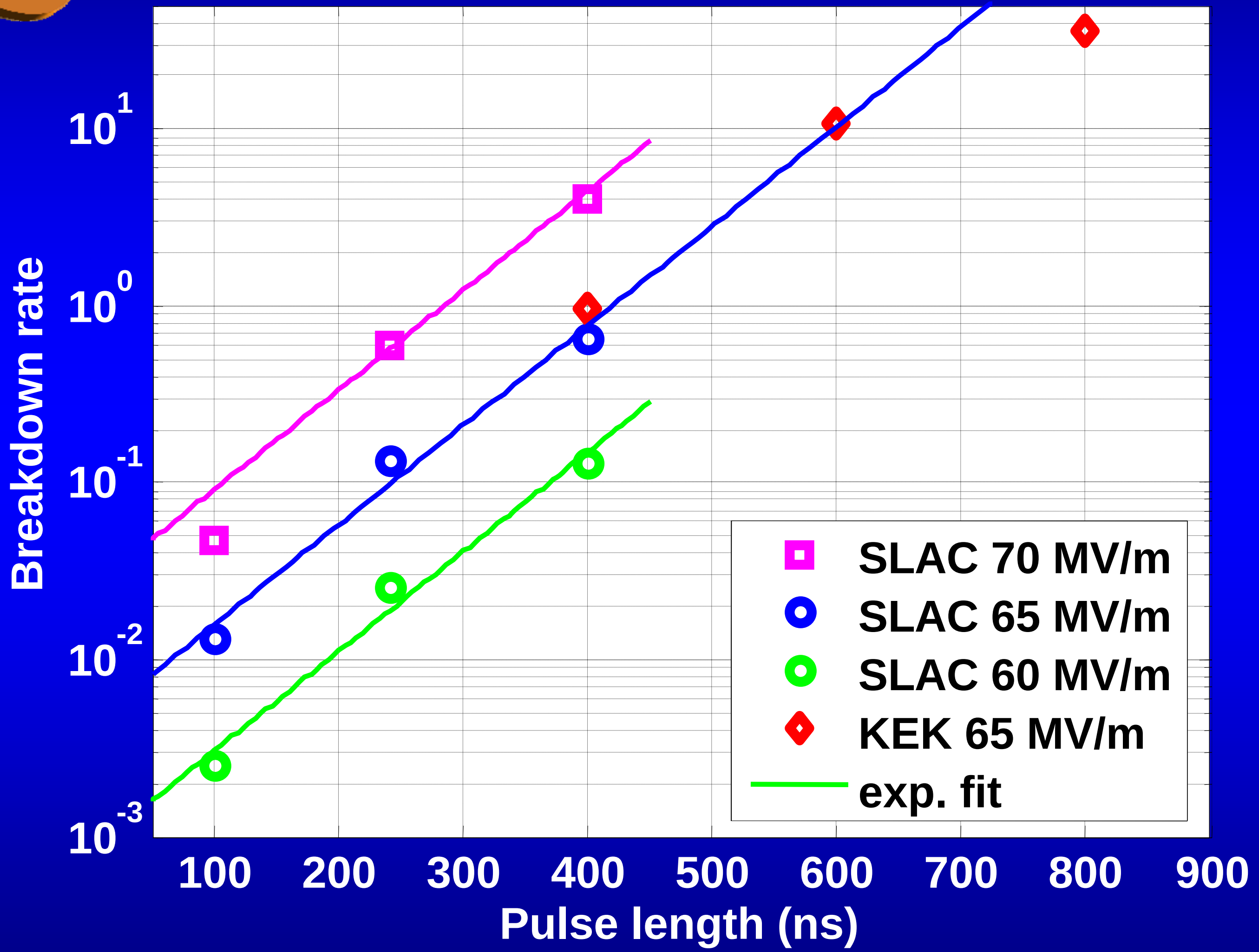


NLC working point: 65 MV/m, 400 ns, 1 trip in 10 hours

Performance of NLC/GLC structures



Breakdown-rates vs pulse length

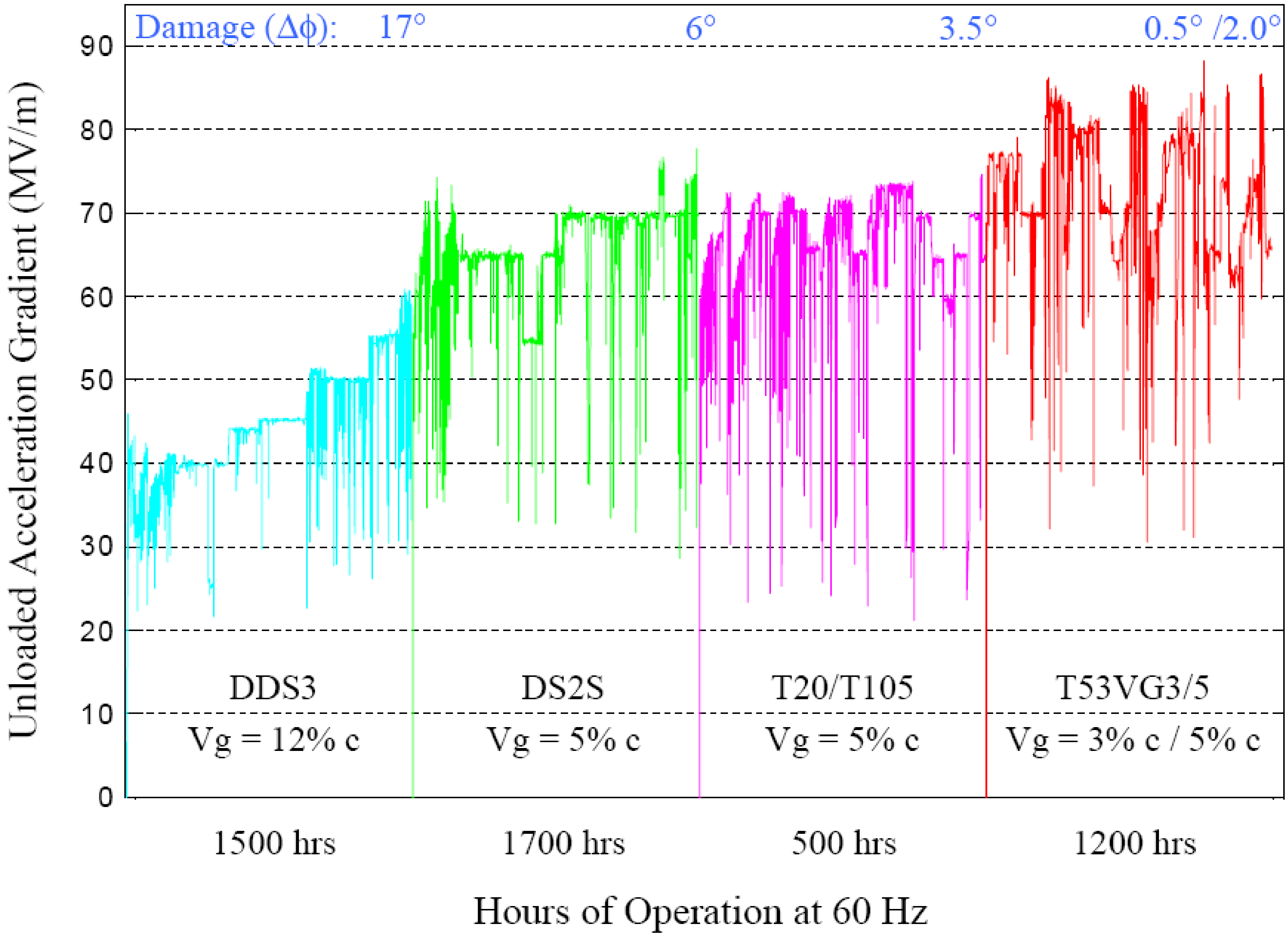


See also KEK poster: TPPT009

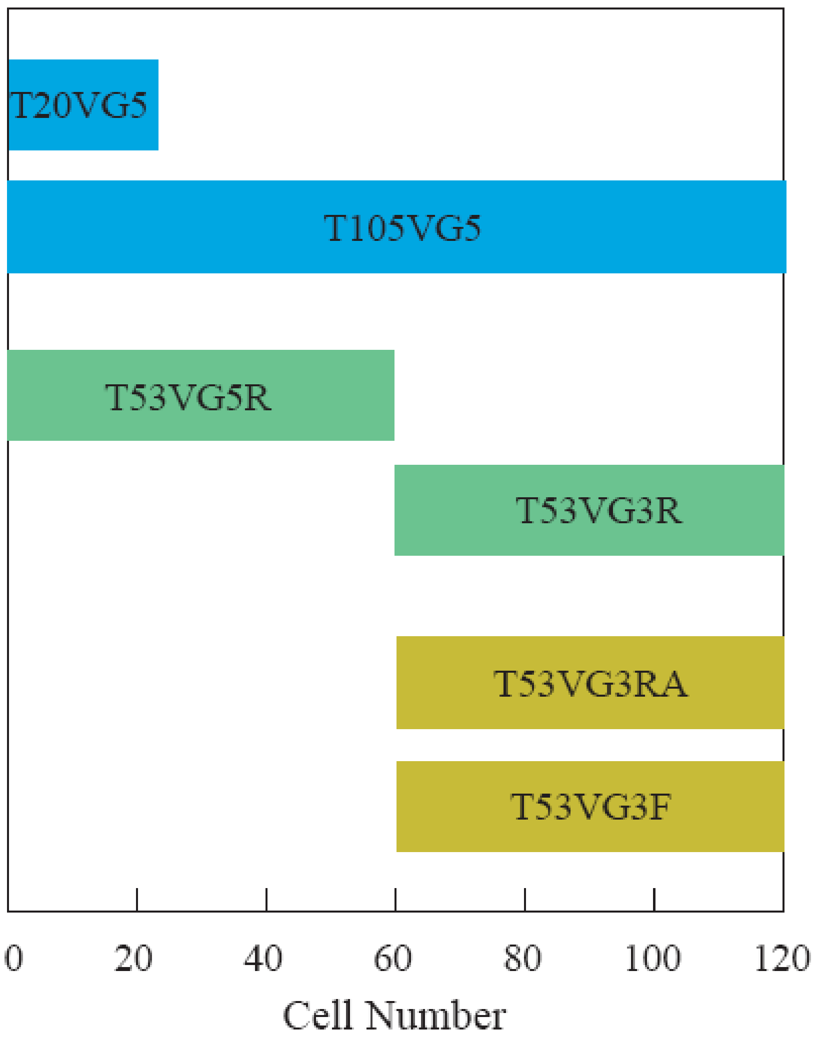
A few comments

- High temperature brazing results in very clean structures (machining, QC, etching, clean handling, brazing, sealed N_2)
- It seemed the grain size played role (bigger = better)
- Test of a bigger number of structures essentiel
- No difference between different copper suppliers
- No difference between diamond and conventional machining for high gradient test
- Venting experiments showed very robust behaviour of copper structures

Operation History of Six Test Structures



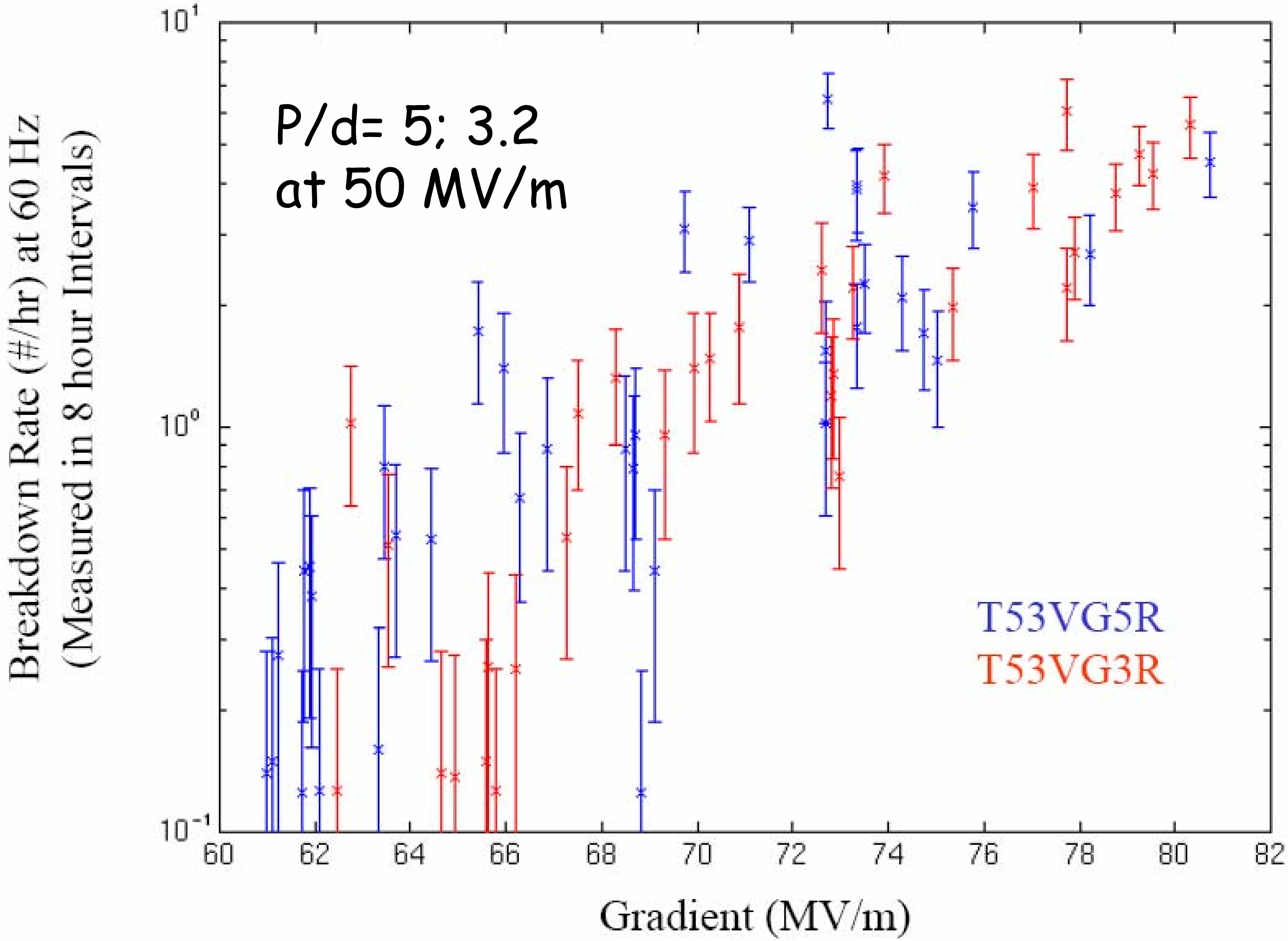
Number of Breakdowns to Process to ≈ 75 MV/m with 240 ns Pulses



Structure	Number of breakdowns	Cell Machining	Etch Depth for Cell Cleaning
T20VG5	4700	Diamond Turned	0.3 microns
T105VG5	3800		
T53VG5R	300	Conventionally Machined	3 microns
T53VG3R	350		
T53VG3RA	2500	Conventionally Machined	1.5 microns
T53VG3F	2400	Diamond Turned	No Etch

T53VG3/5 Breakdown Rate -vs- Gradient

(Last 500 hours of Run, 240 & 400 ns Pulse Widths, Raw Counts Summed)



Structure Breakdown Rate Comparison

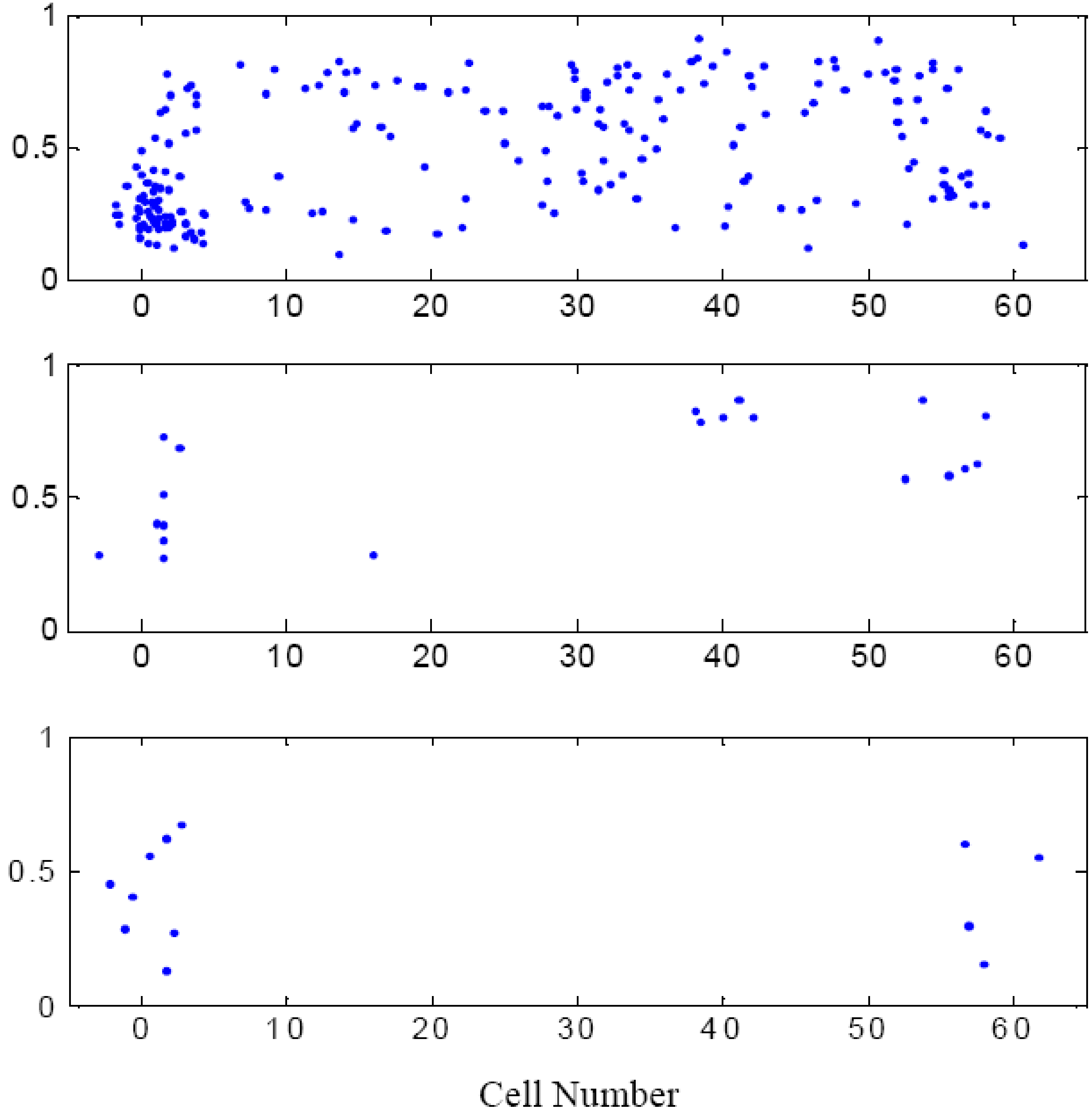
Structure	Gradient (MV/m) / Pulse Width (ns)	Input Coupler Rate (#/hr)	Body Rate (#/hr)	Output Coupler Rate (#/hr)
DS2S	70/240	4.7*	0.4+	< 0.1
T20VG5	70/240	1.1	0.9	1.1
T105VG5	70/240	1.7*	0.3+	< 0.1
T53VG5R	73/240	0.4	0.2	0.2
T53VG3R	70/480	0.7	< 0.1	0.3
T53VG3RA	73/400	5.2	0.2	0.3
T53VG3F	73/400	0.16	0.3	1.9

T53VG3R: Fractional Missing Energy -vs- Breakdown Location

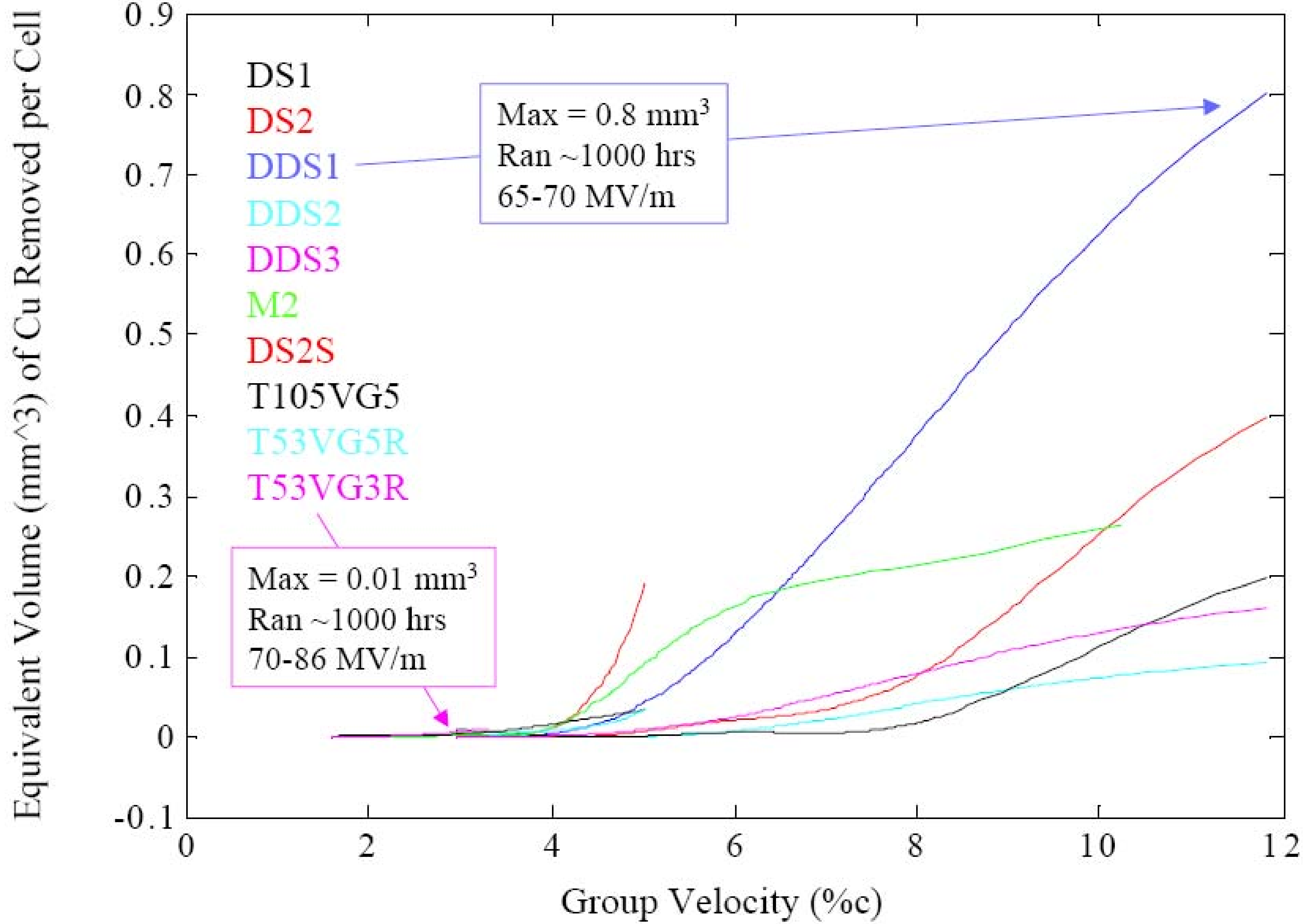
During Processing from
70 to 82 MV/m, 170 & 240 ns PW
RF on 60 hr

After Processing to 86 MV/m:
Run at 85 MV/m, 240 ns PW
RF on 7 hr

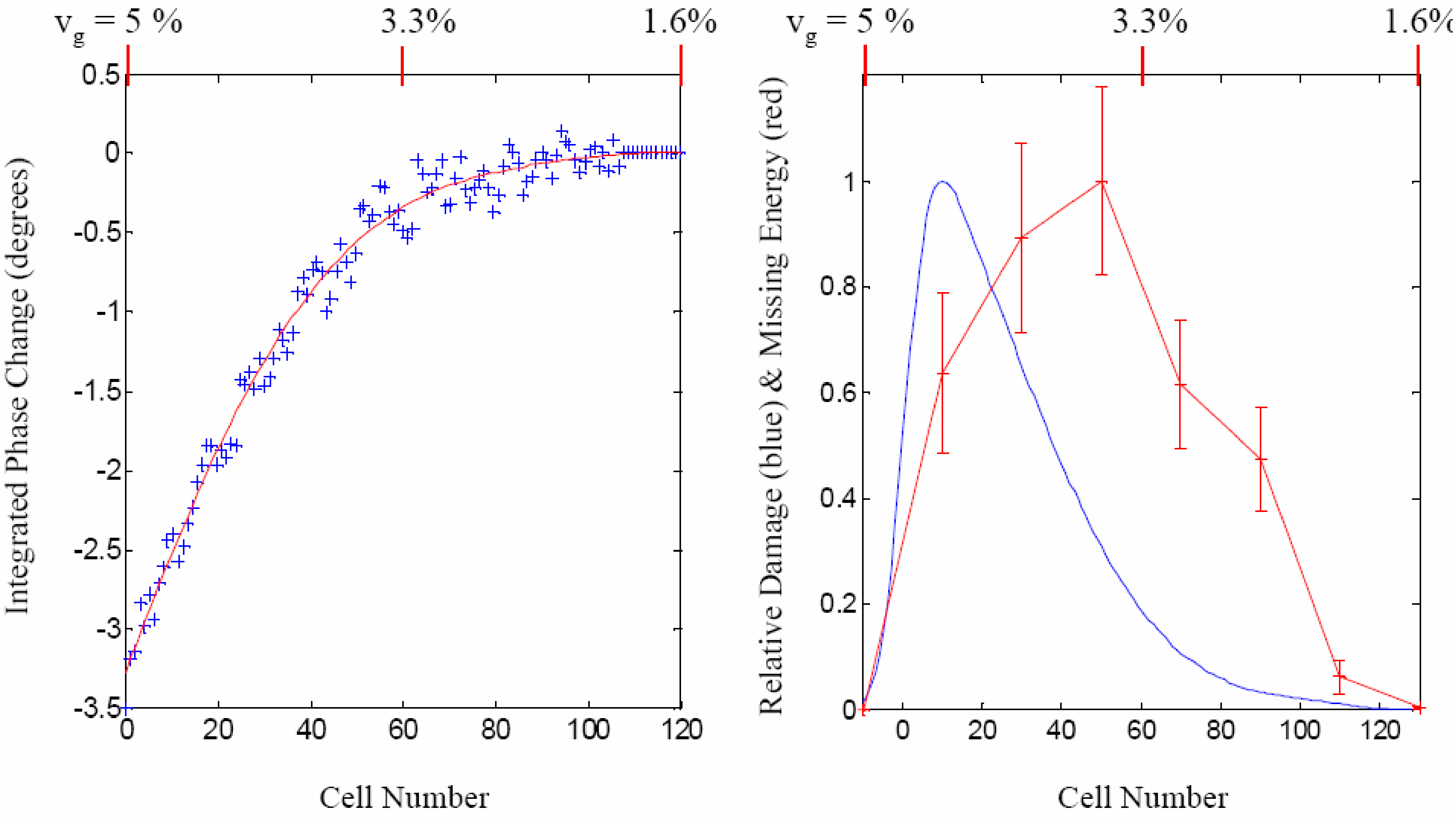
After Processing to 86 MV/m:
Run at 70 MV/m, 480 ns Pulse Width
RF on 12 hrs, Trip Rate = 1.1 / hr



Structure Damage



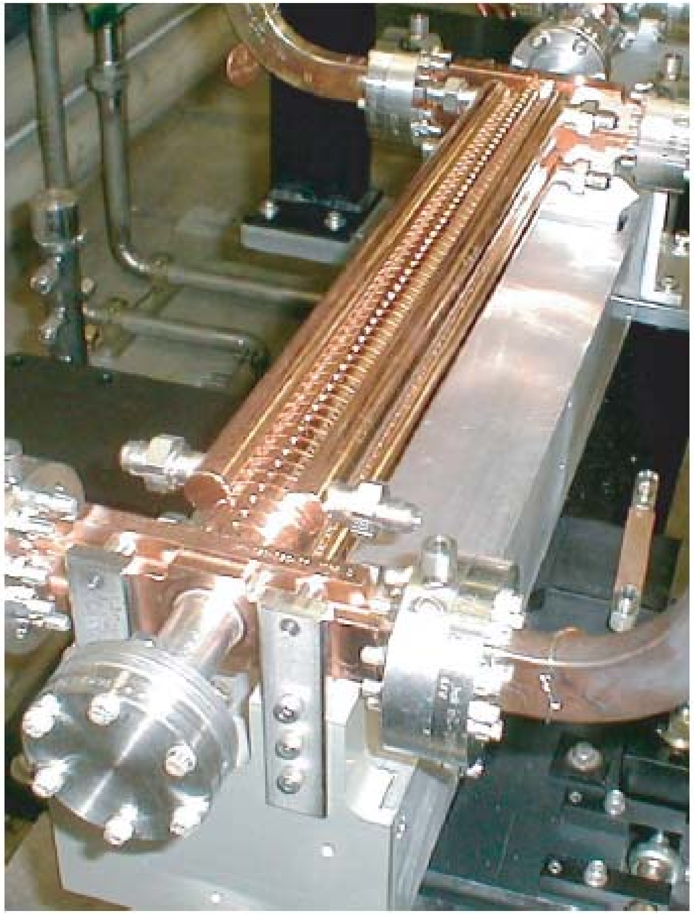
T105VG5 Damage and Missing RF Energy Distributions



T53VG3MC (Mode Converter) Structure

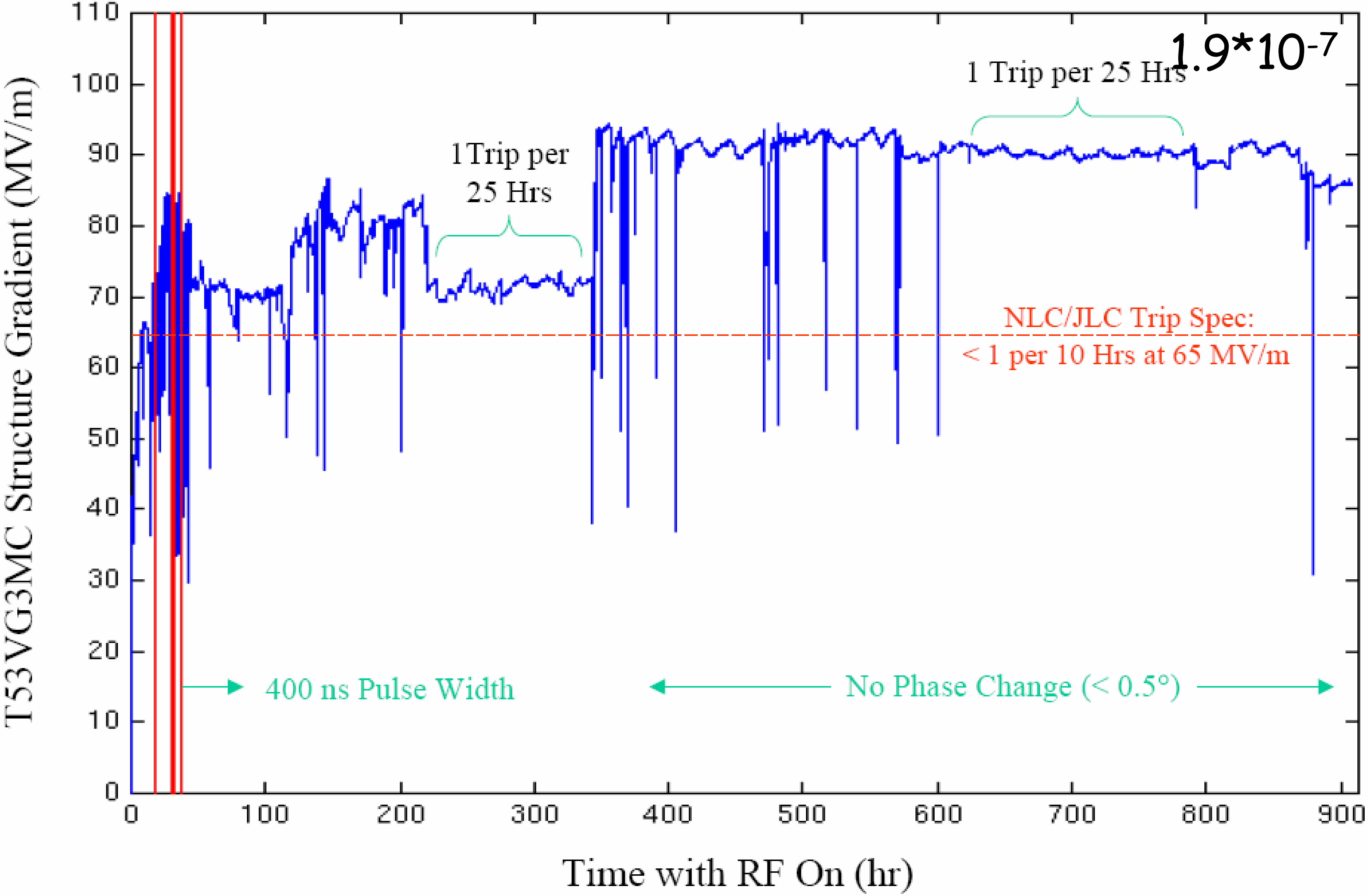
To Test Low Peak Magnetic Field Couplers, Use:

- T53VG3 Body Design
- Mode-Converter Input Coupler
- Fat-Lip Output Coupler

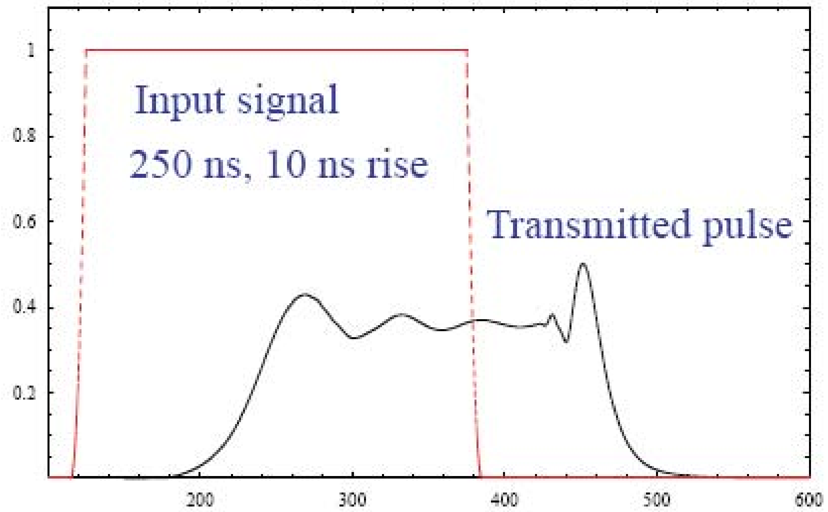


T53VG3MC Full Processing History

(Total Number of Trips = 1600)

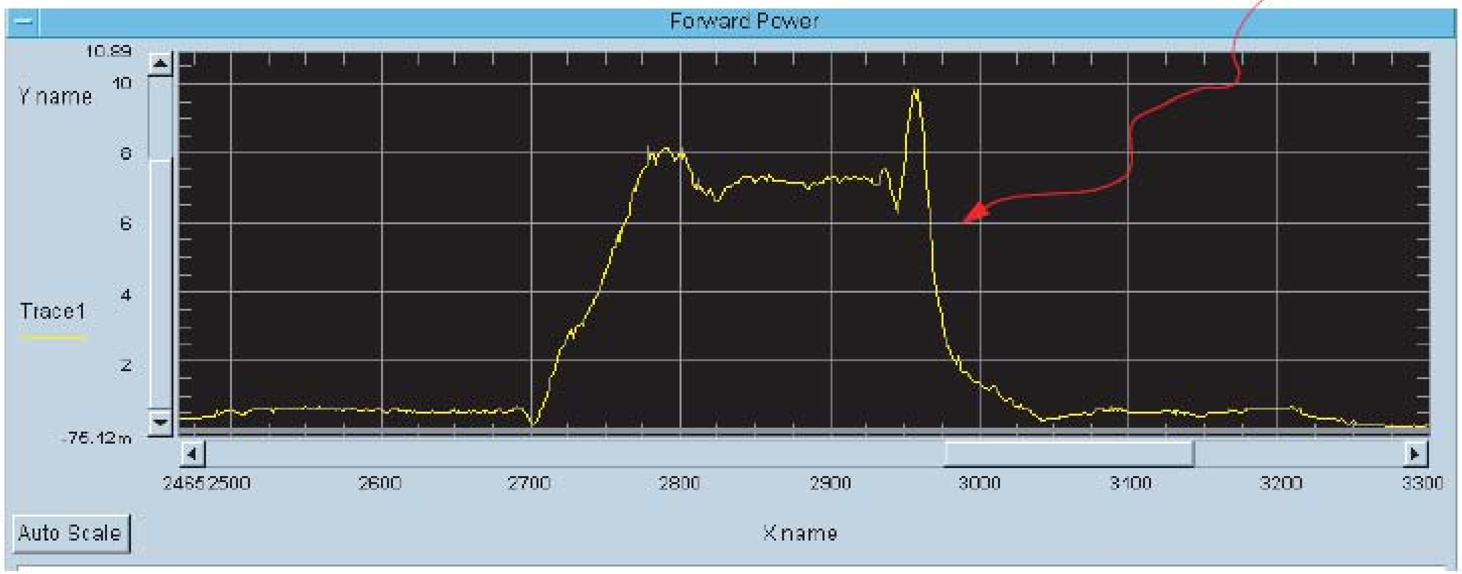


Effect of Dispersion on RF Pulse Propagation in H60VG3



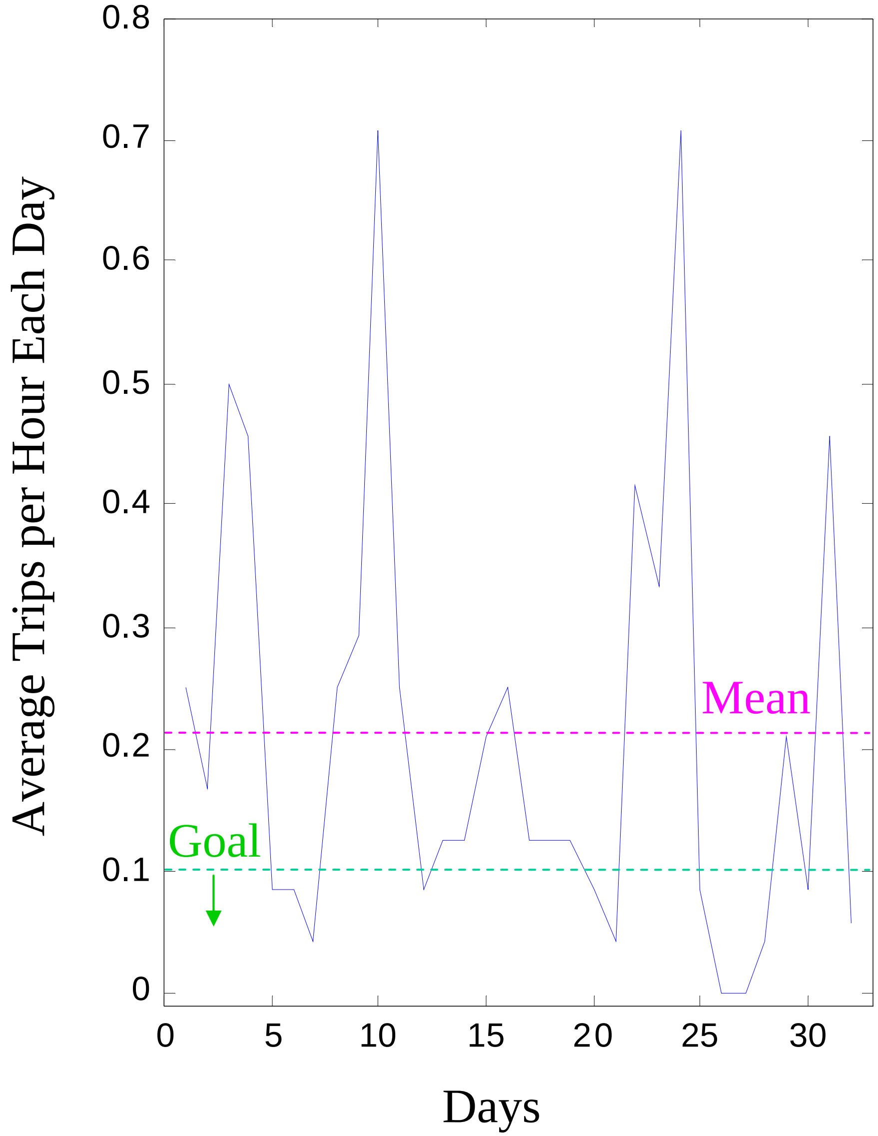
Comparison of
Computed vs. Exp.
Transmitted Power

|S21|^2 data from exp.

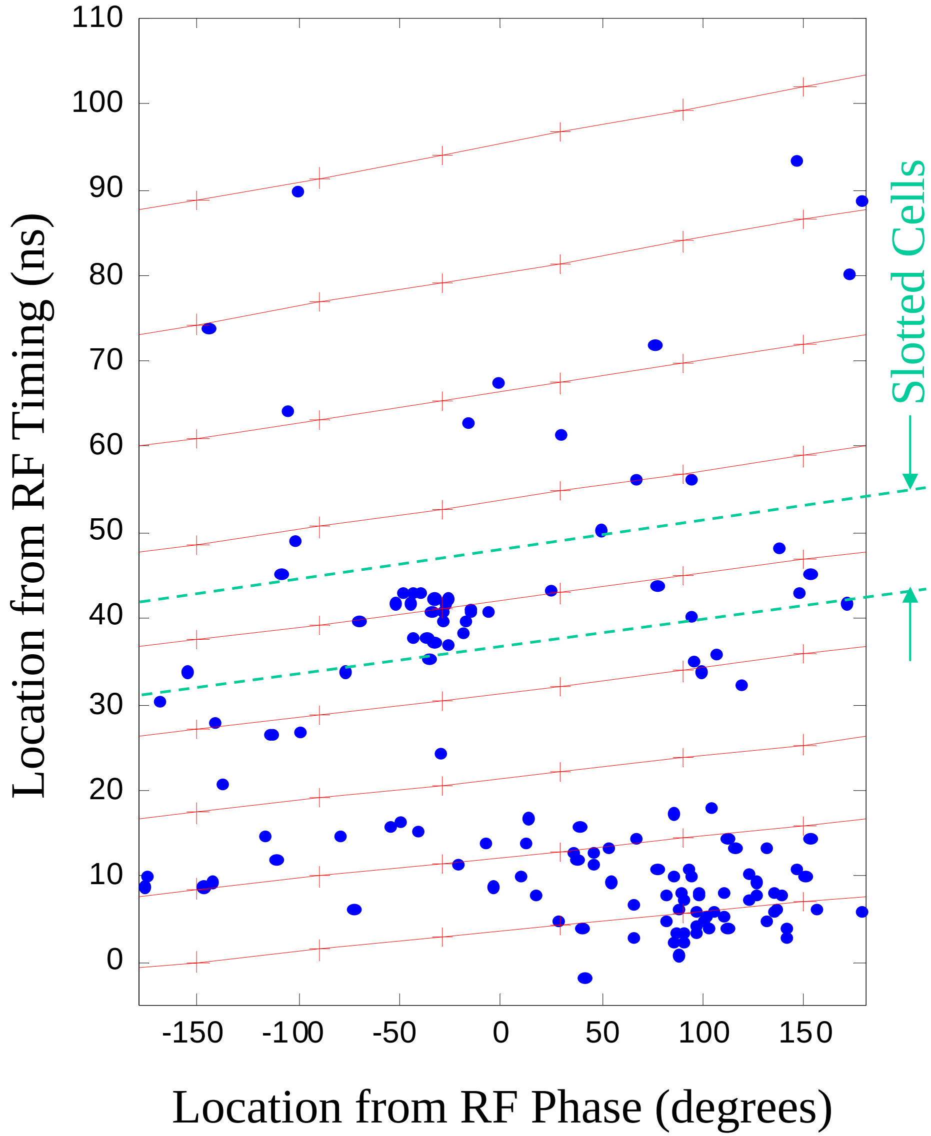


Breakdown Statistics for H60VG3-6C at 65 MV/m, 400 ns

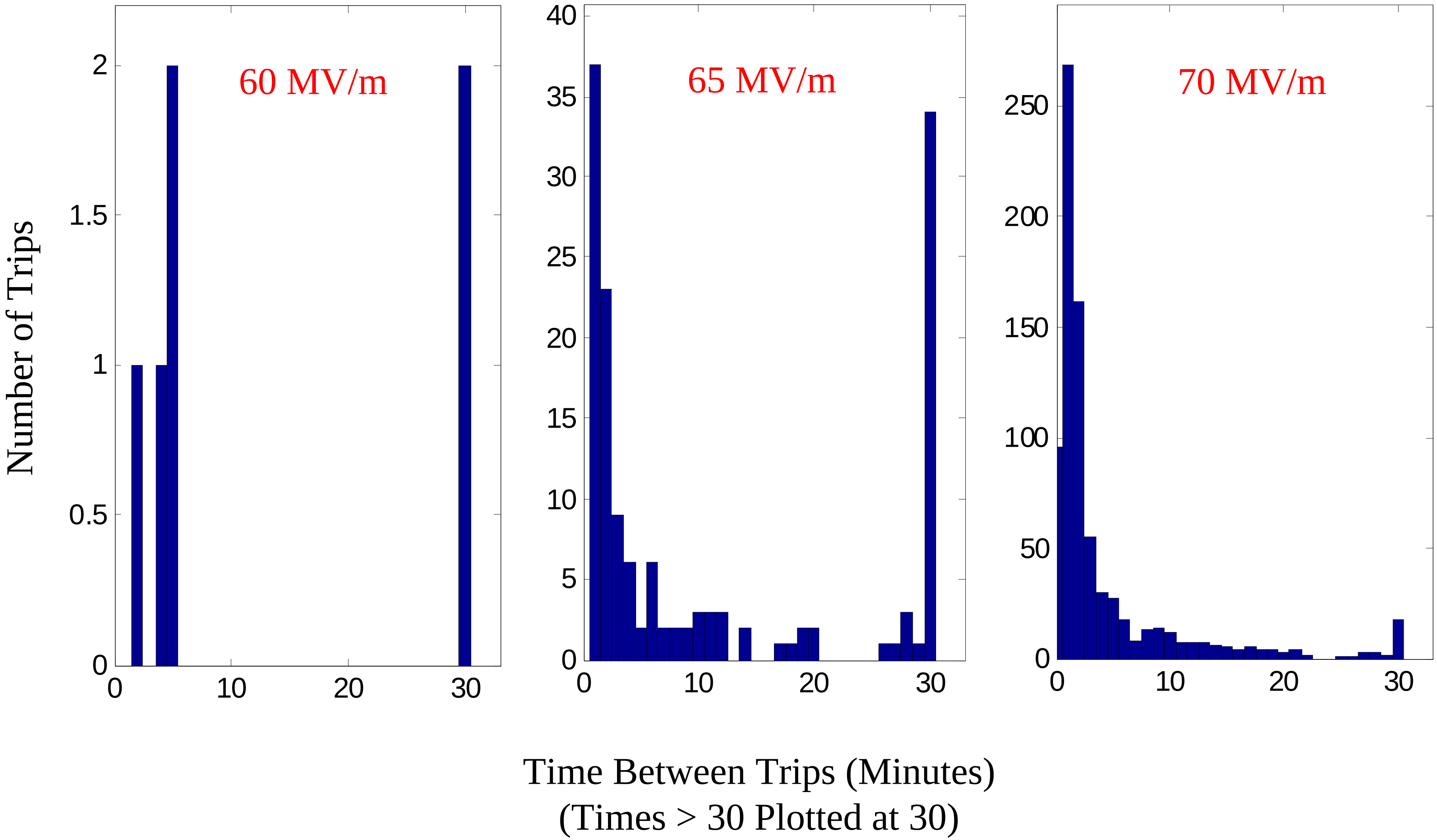
Breakdown Rate



Breakdown Location

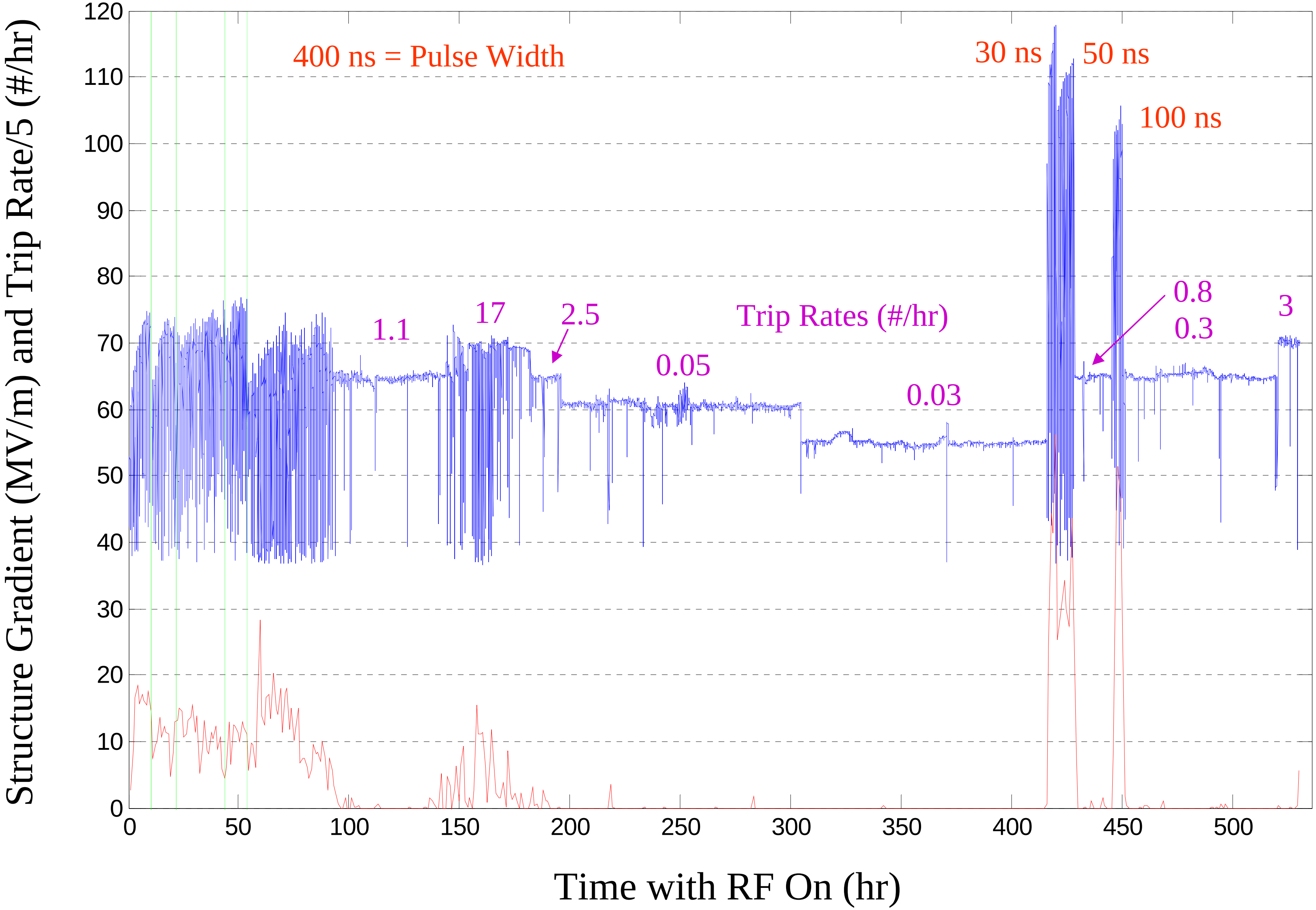


‘Spitfest’ Statistics for H60VG3S18 at 400 ns

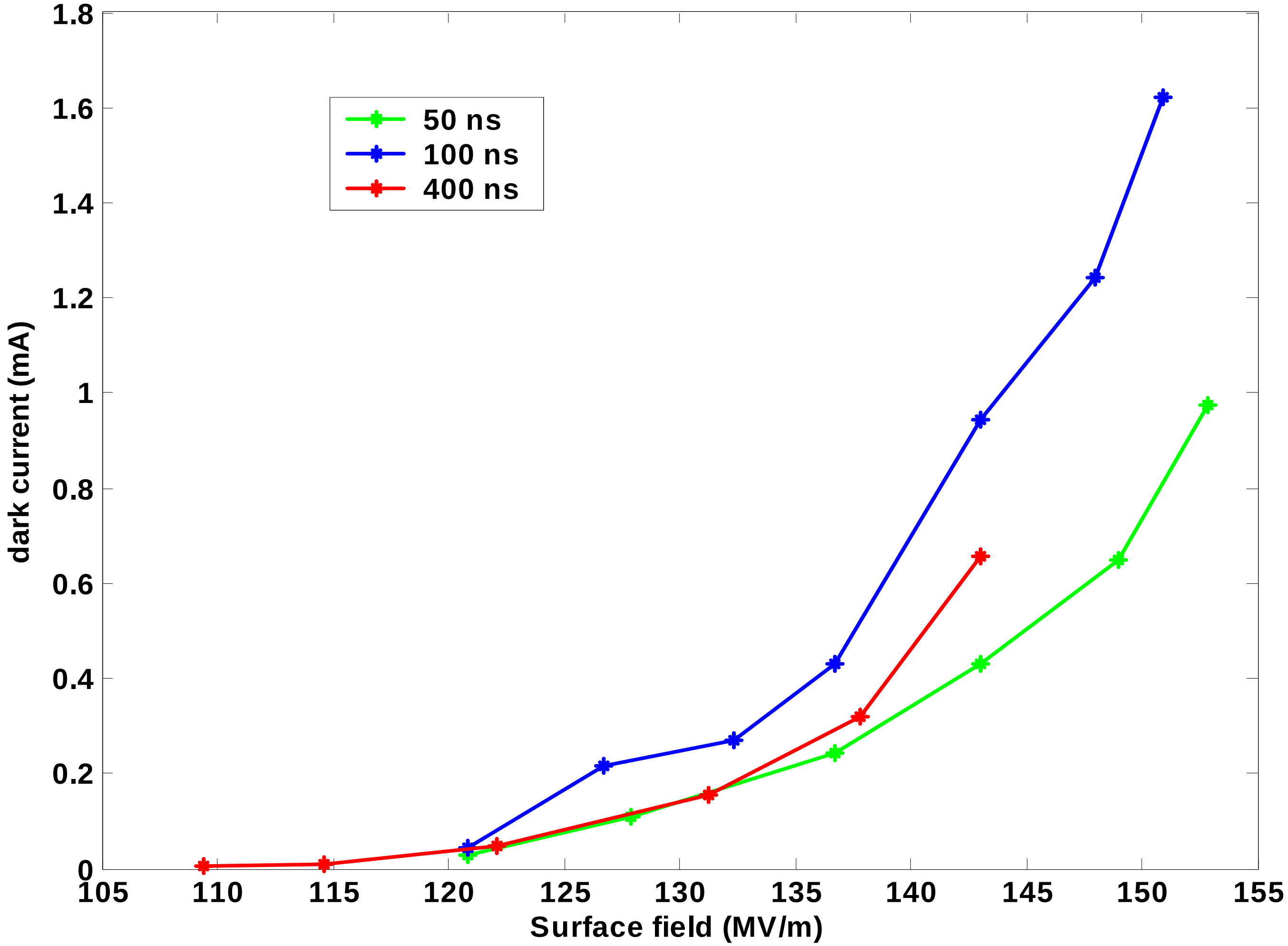


H60VG3R17 Full Processing History

(9200 Breakdowns)

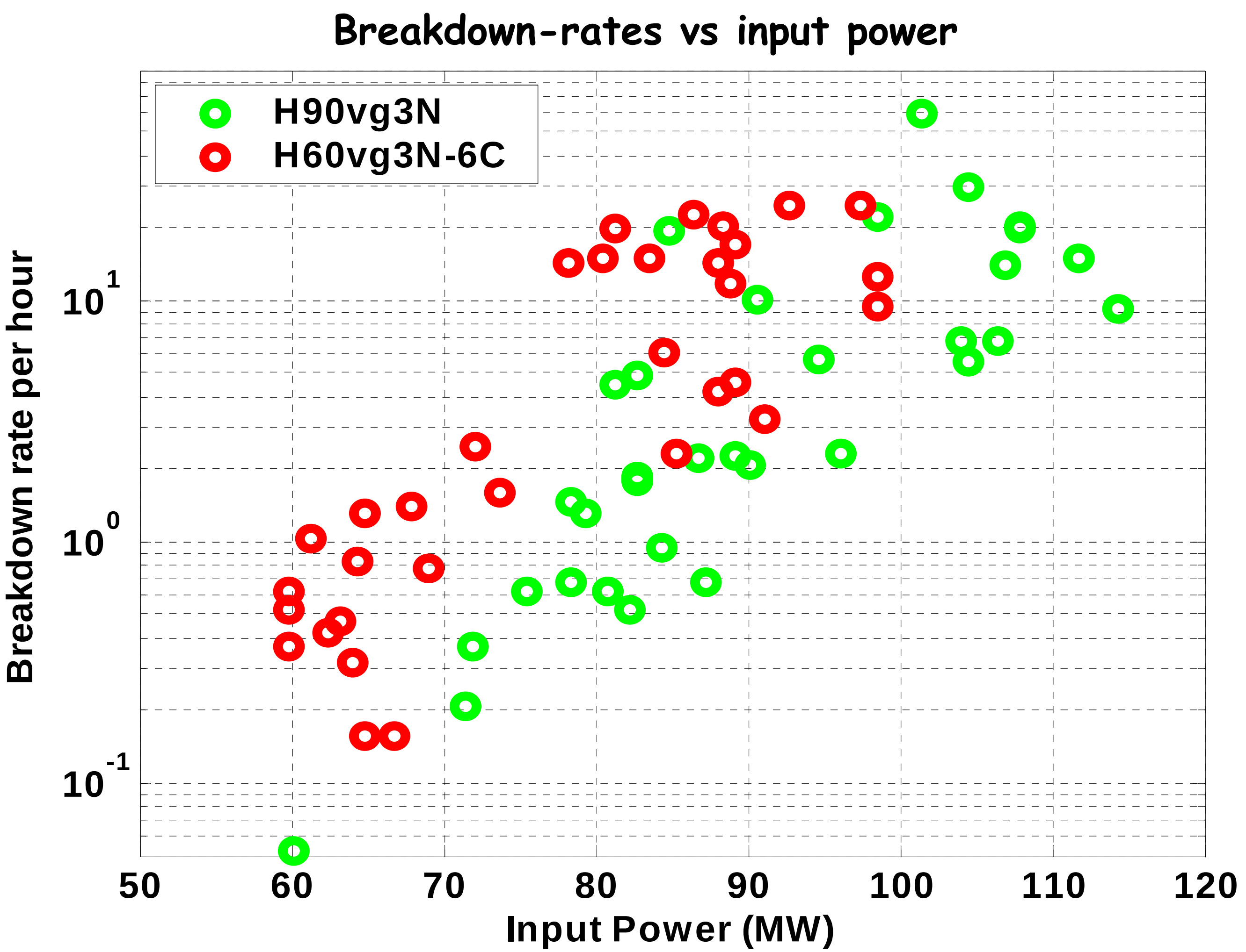


Dark-currents



NLCTA
Next Linear Collider
Test Accelerator

Input Power



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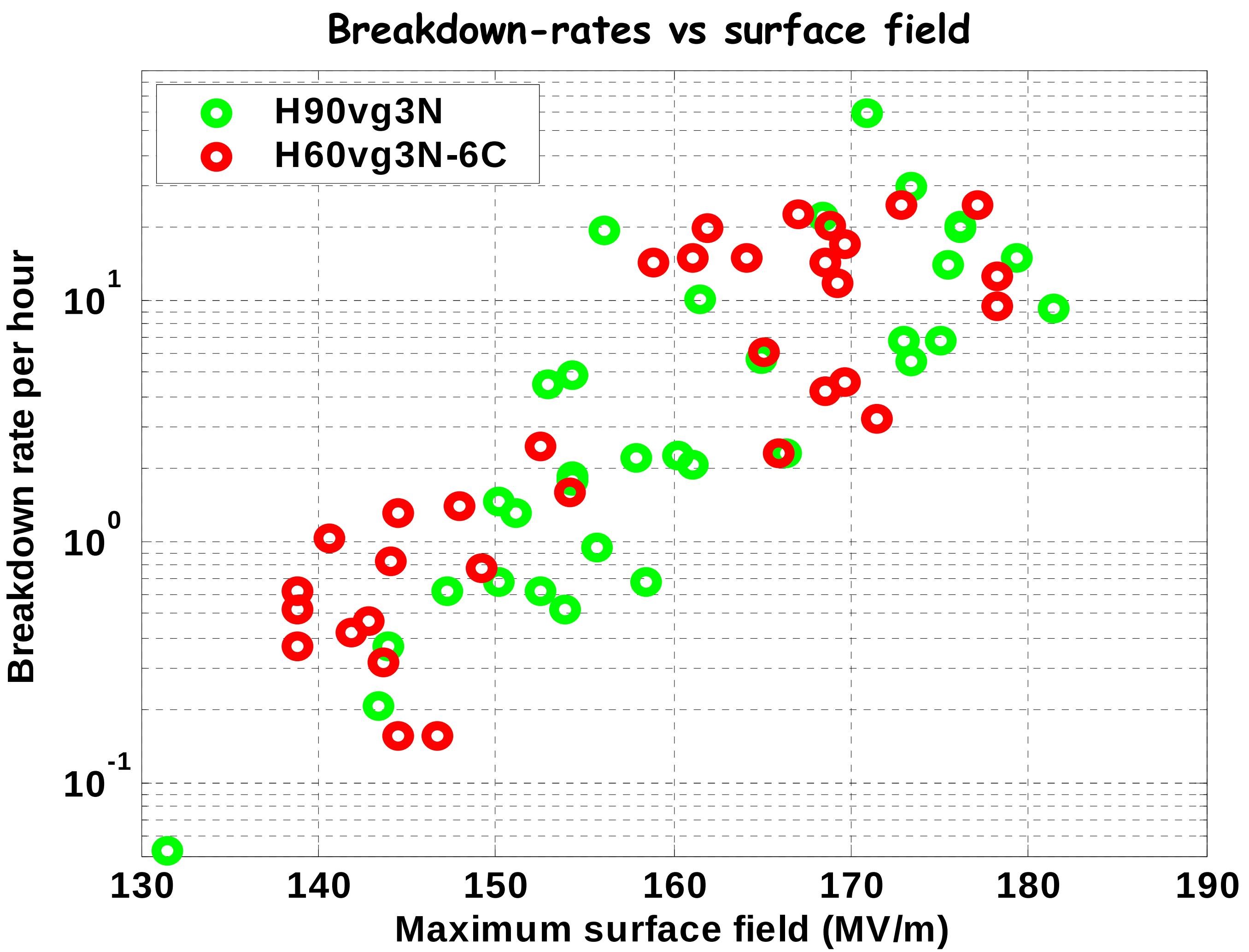
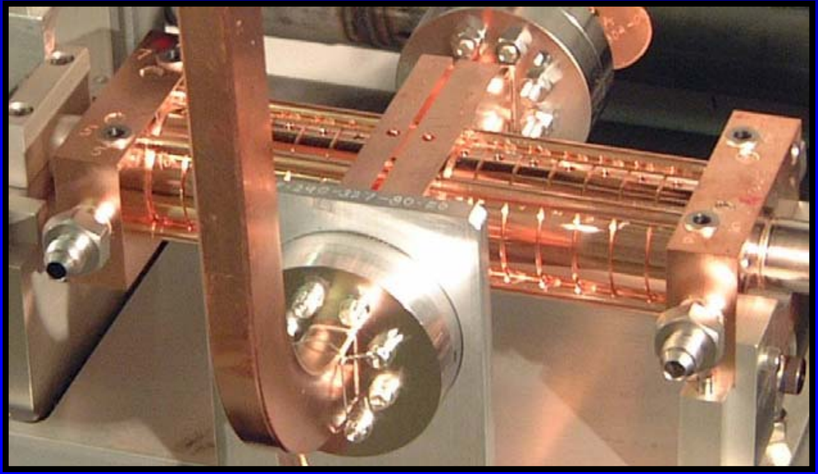
Surface Field



SW20a375

Next Linear Collider
Test Accelerator



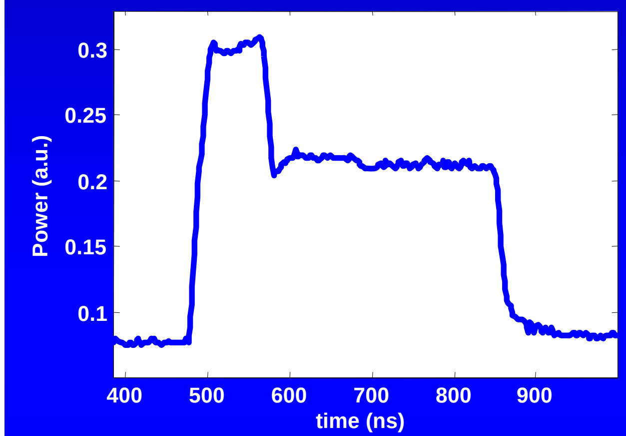
Standing wave structures

Length:	2x20 cm
Phase advance:	180 deg
Es/Eacc:	2.05
P_{in} (55 MV/m):	9 MW
Coupler:	rounded
Preparation:	H_2-bonding/brazing Vacuum bake

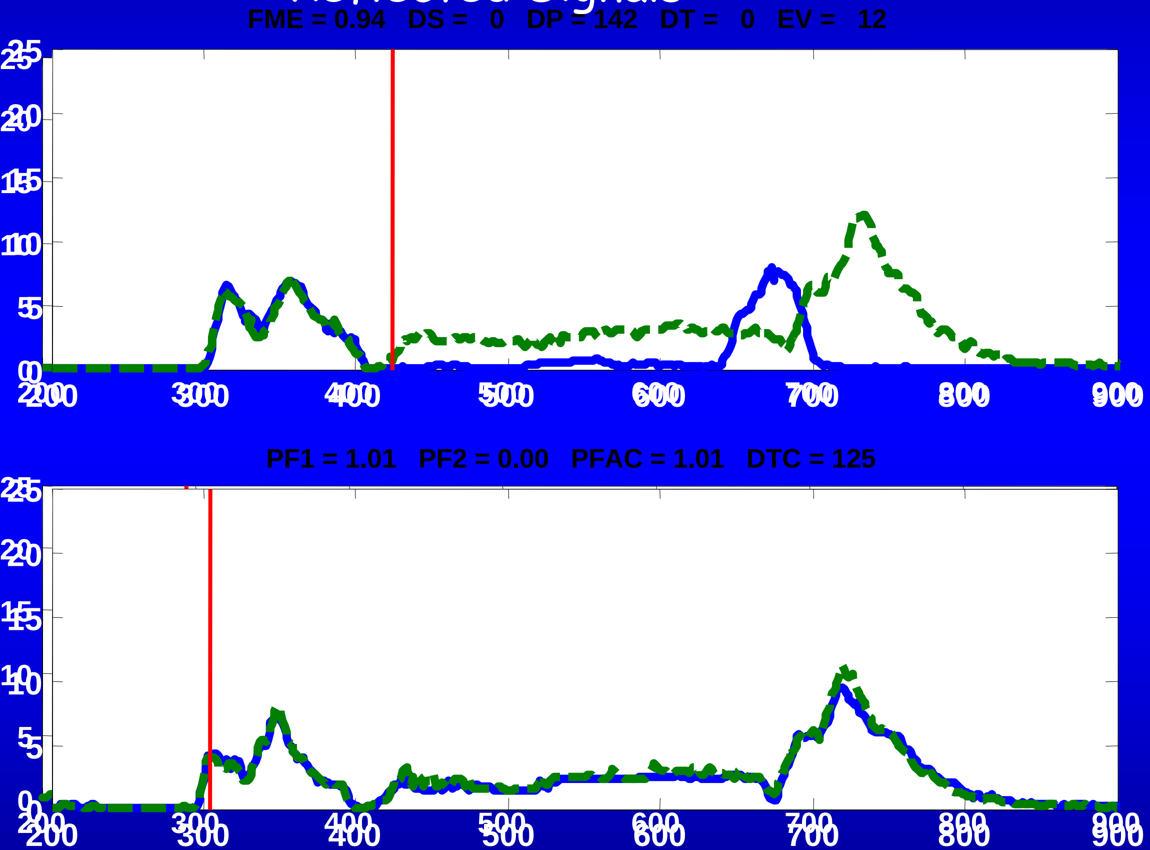
Next Linear Collider
Test Accelerator

Results - SW20a375

Input RF pulse



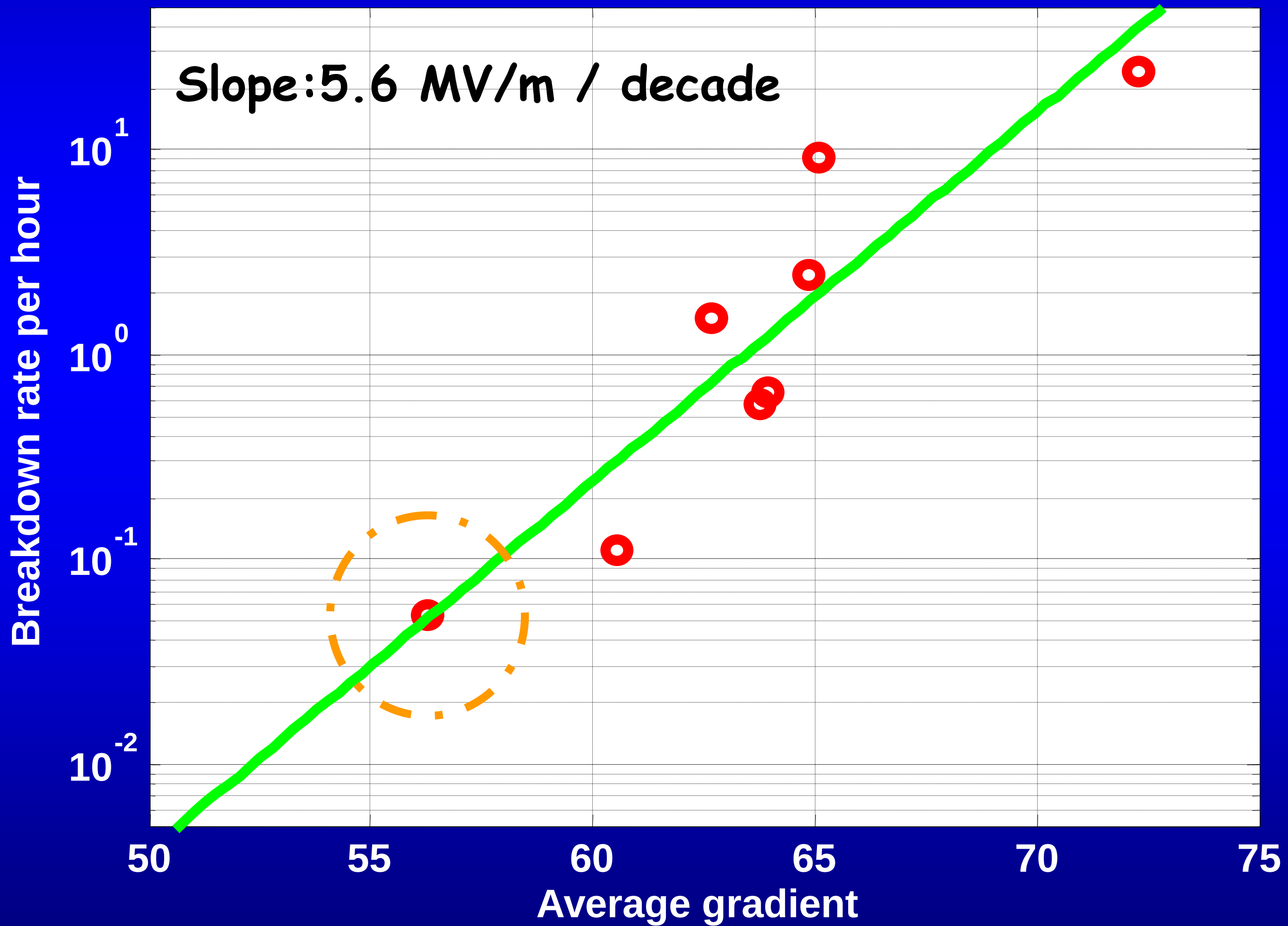
Reflected Signals



BD-rates - SW20a375

Next Linear Collider Test Accelerator

NLC-goal achieved at 55 MV/m !



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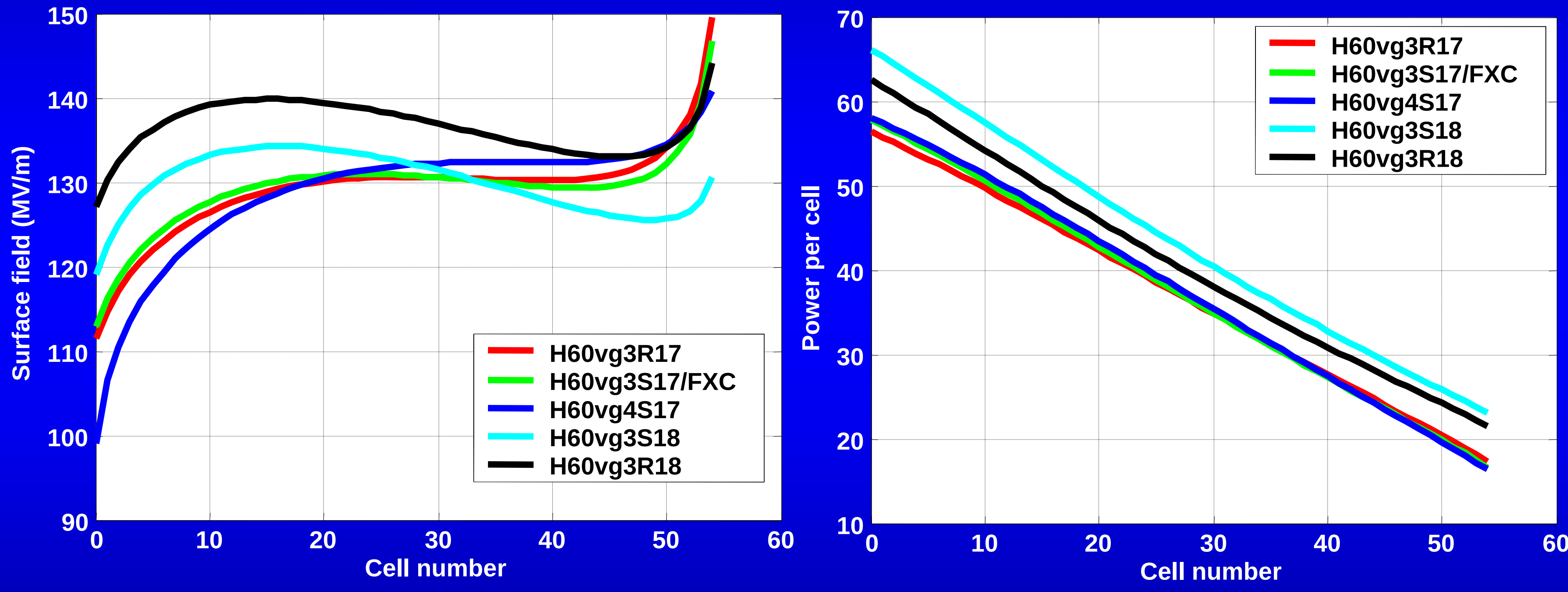
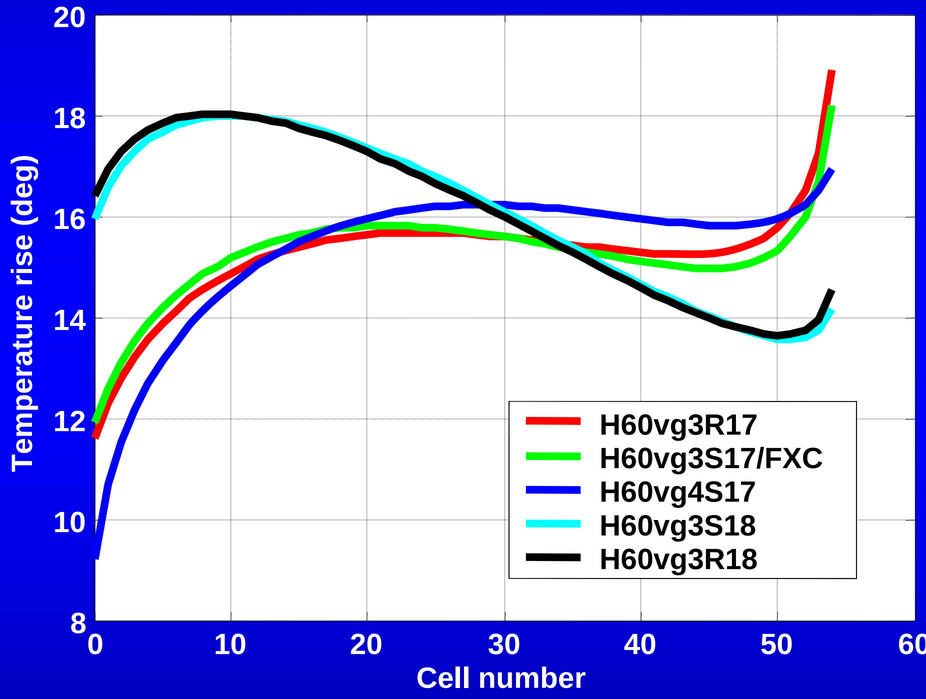
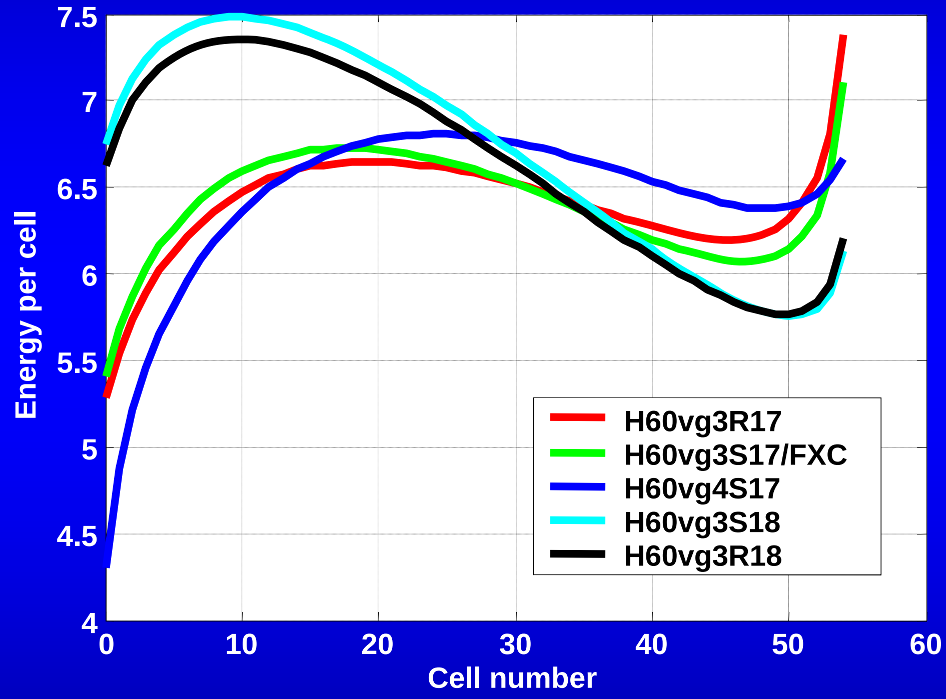
Recent structure parameters

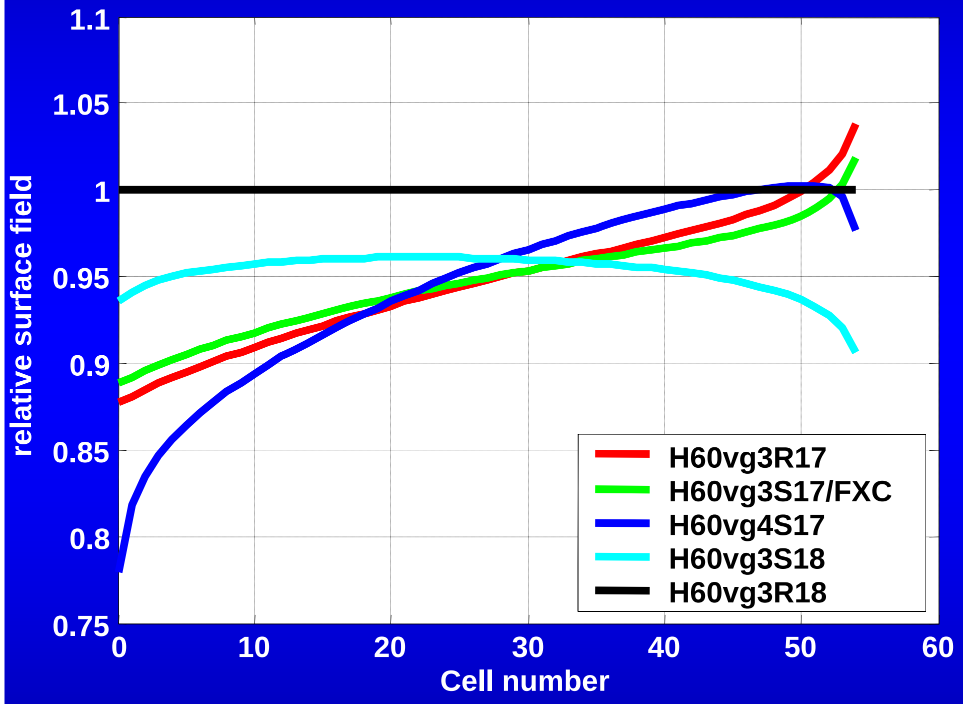


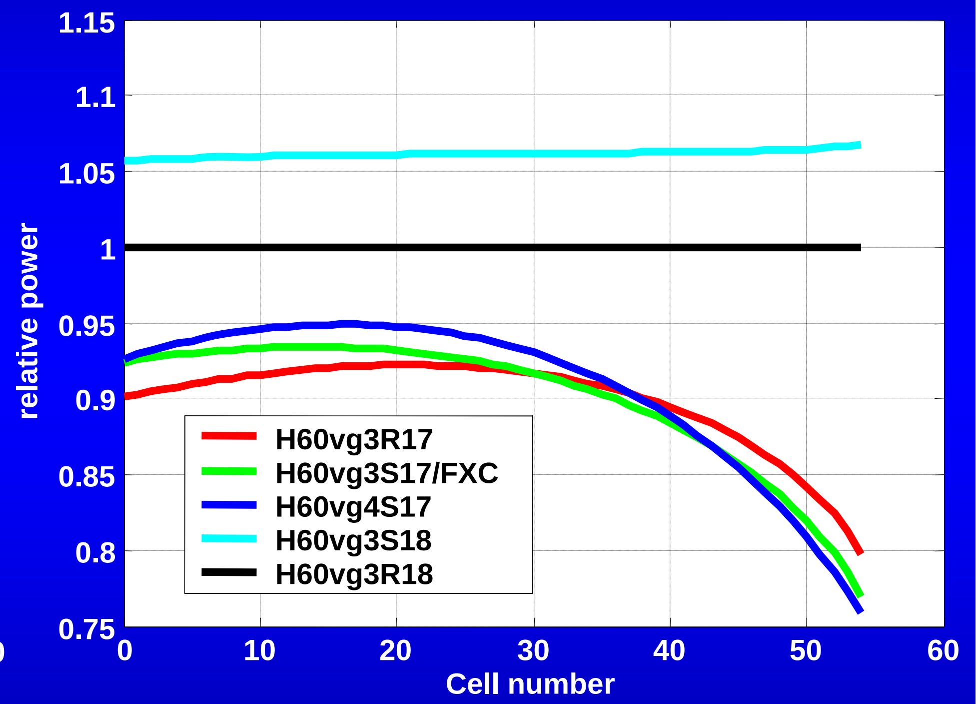
Recent structure parameters





Relative structure parameters

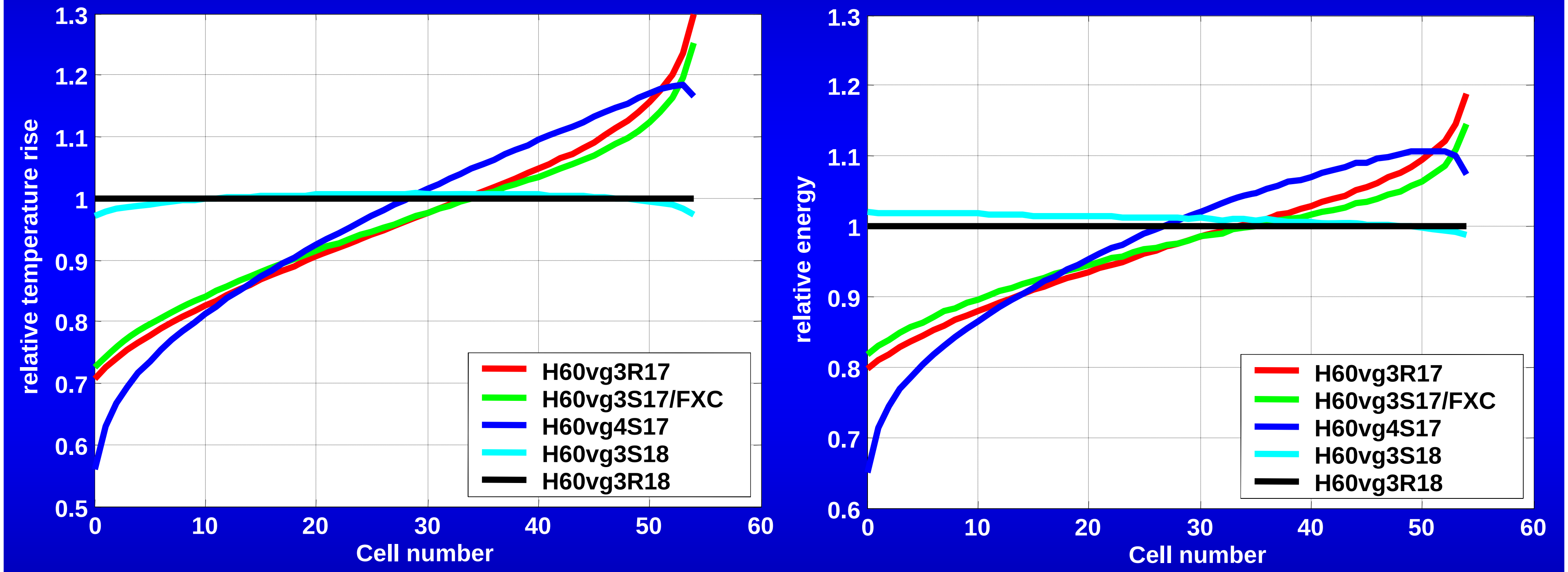




NLCTA

Next Linear Collider Test Accelerator

Relative structure parameters



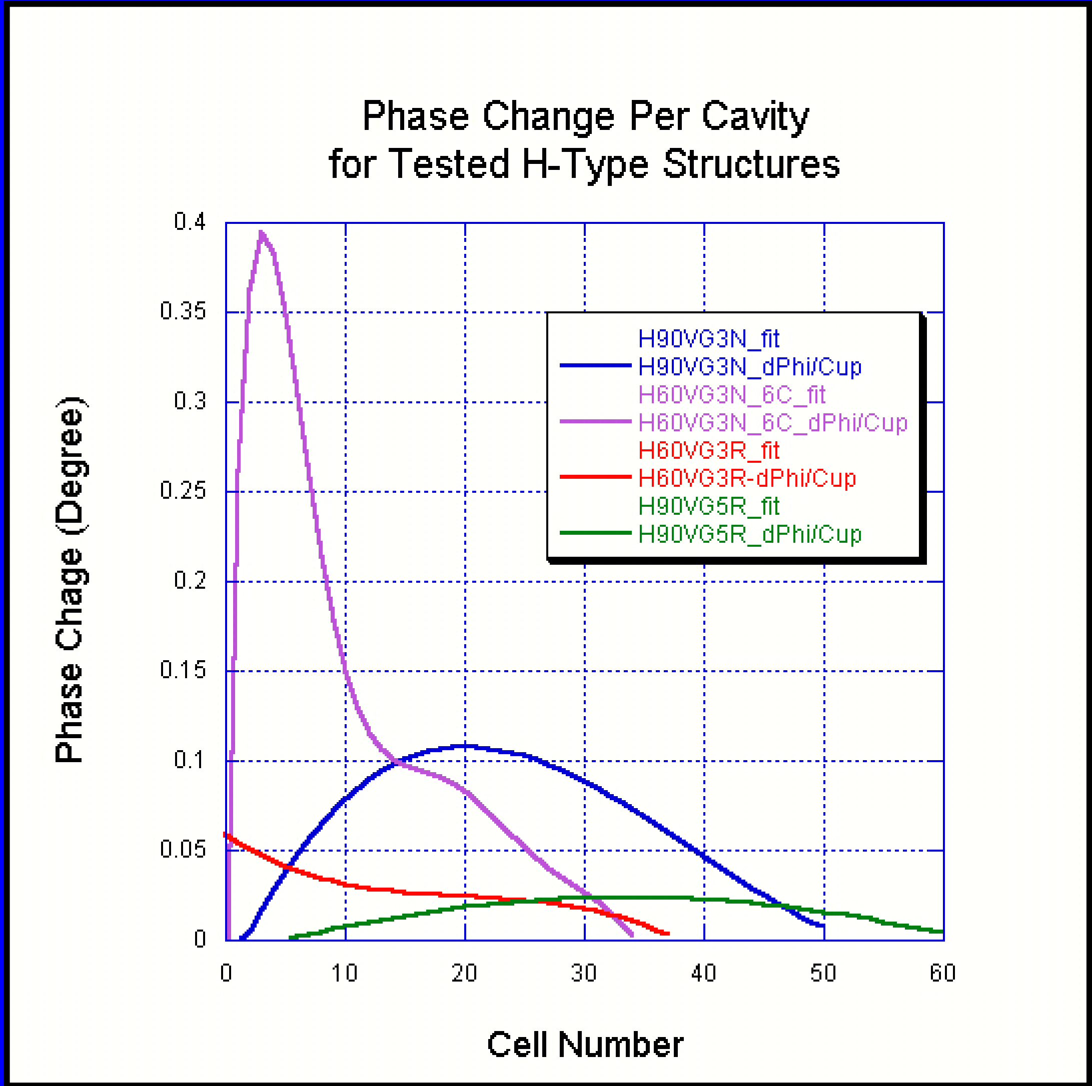
H-type-performance Damage

Next Linear Collider
Test Accelerator

Preliminary results !

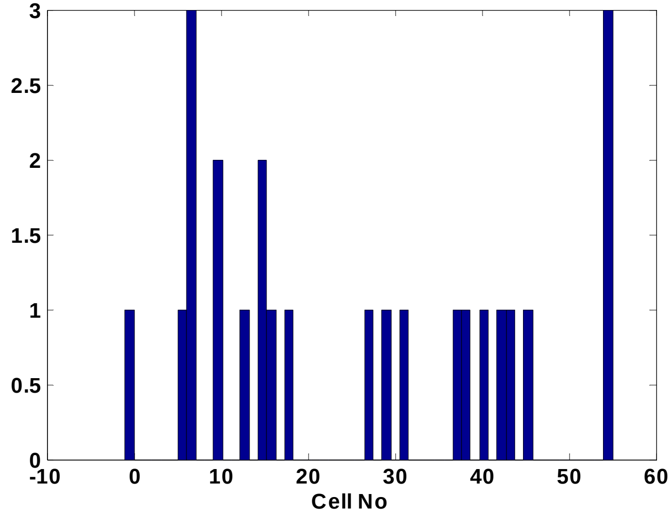
- Inline taper helps
- Damage appears correlated to surface field distribution

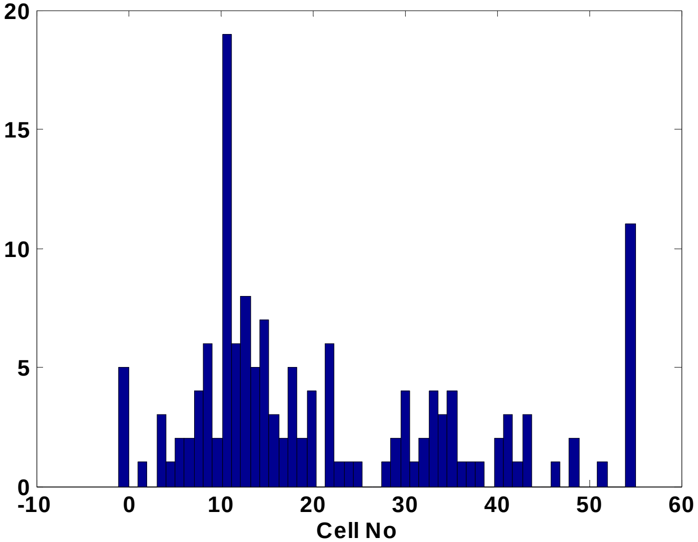
Hot topic in working group

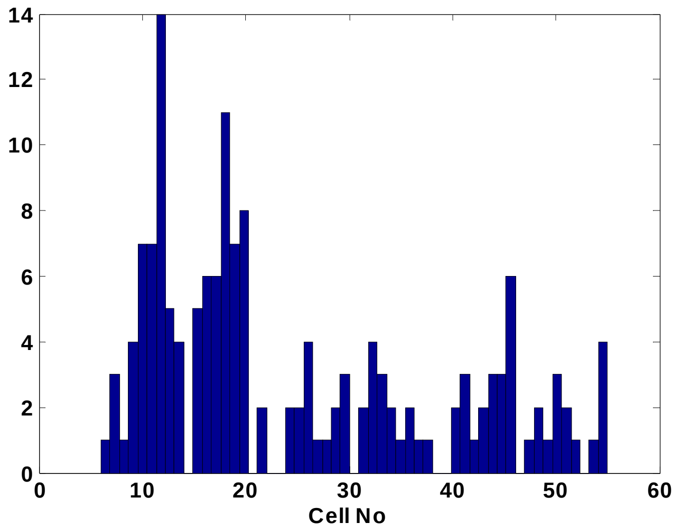


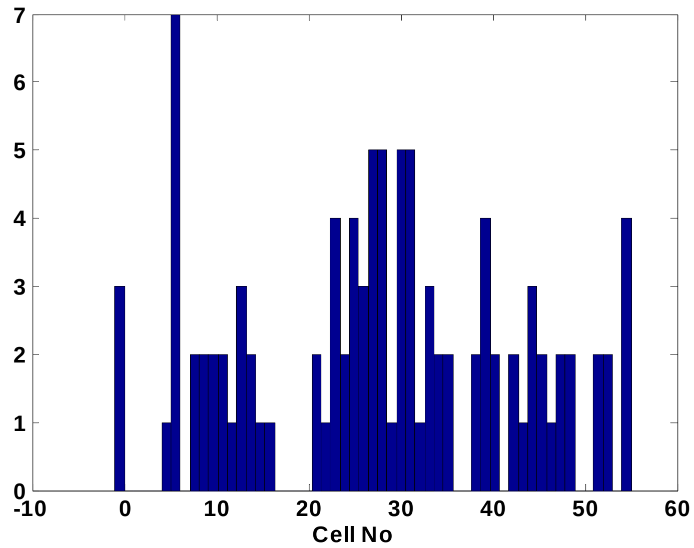
Steffen Döbert, SLAC/NLC

Breakdown location 8-pack

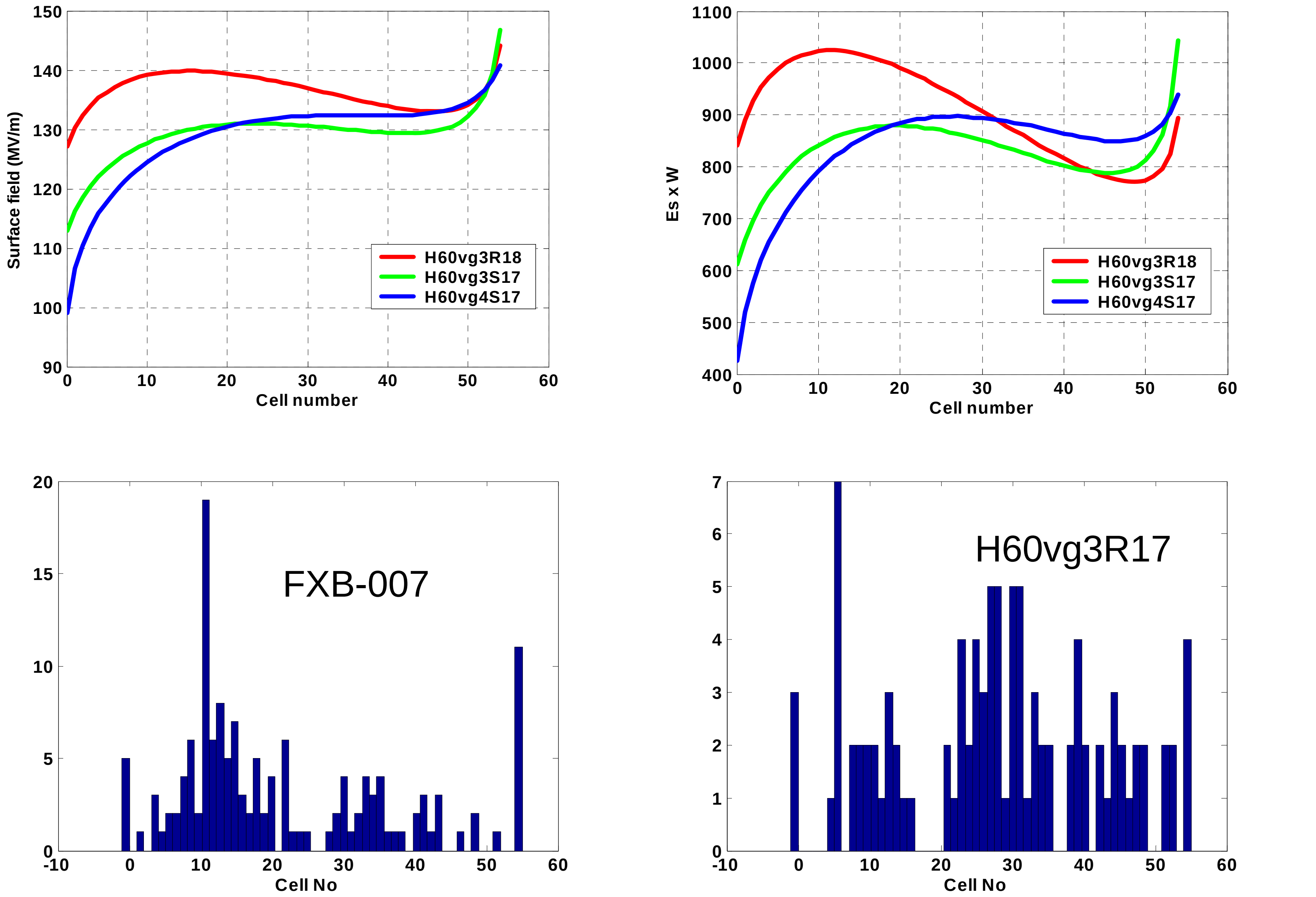




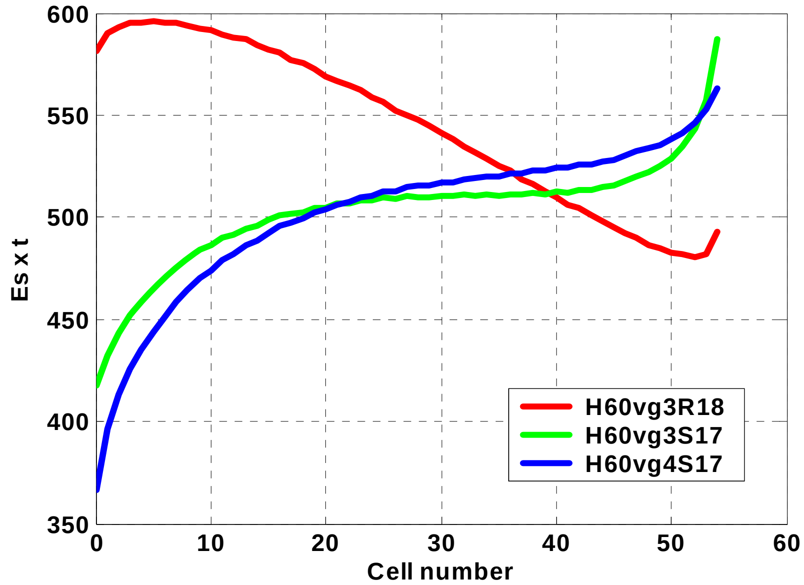


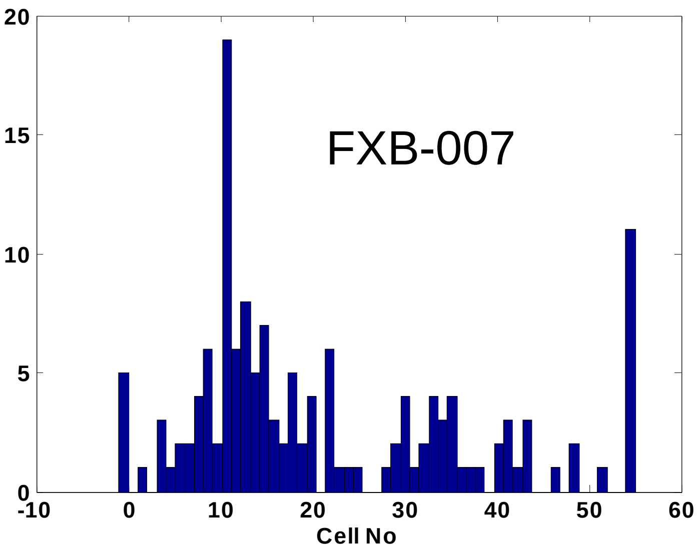


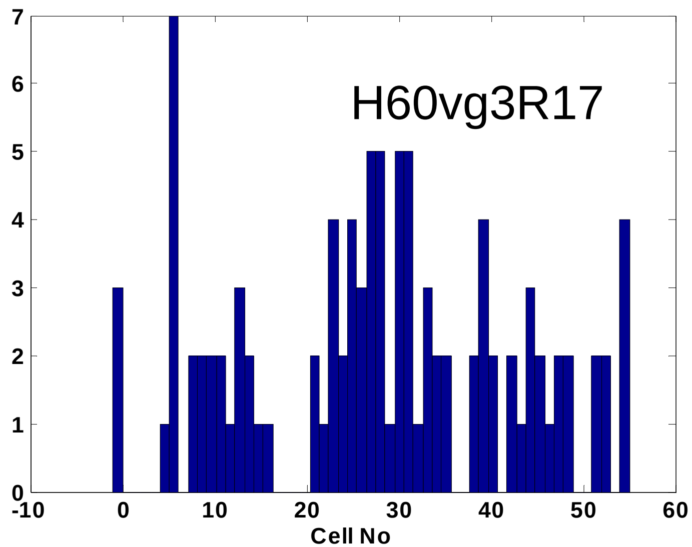
Breakdown location 8-pack



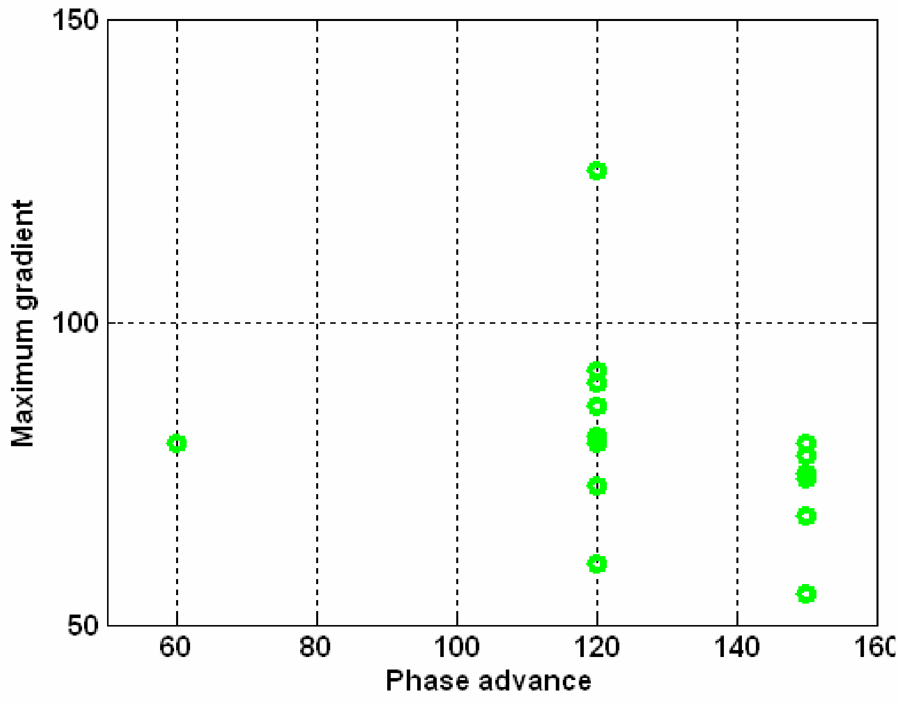
Breakdown location 8-pack

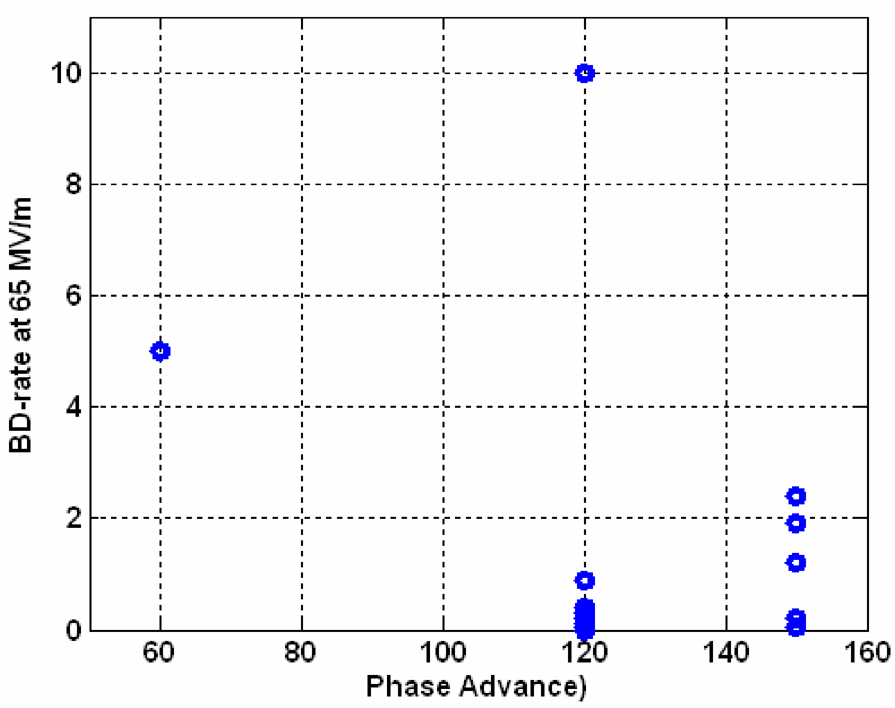




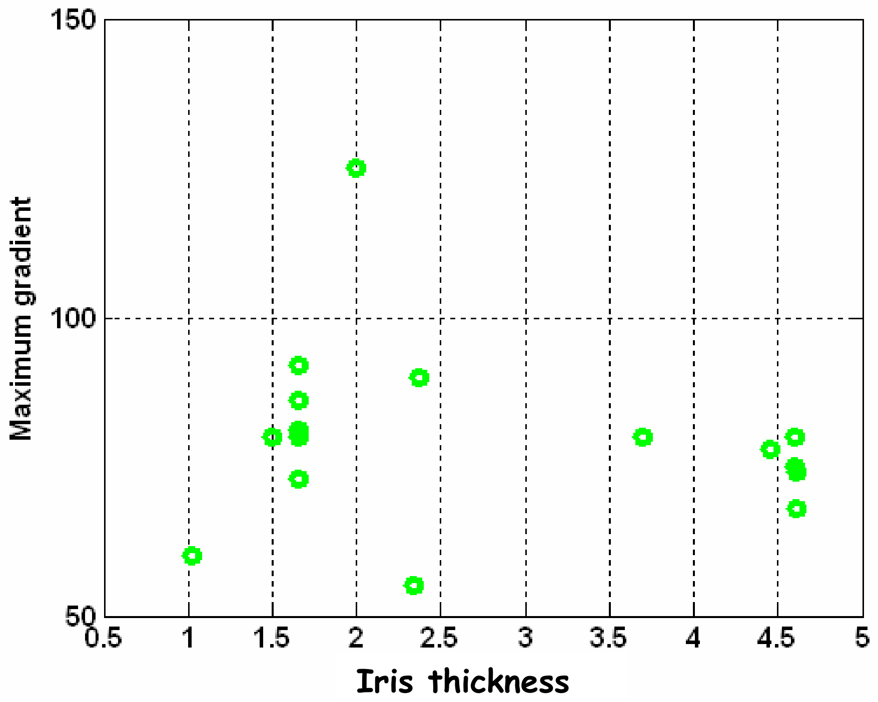


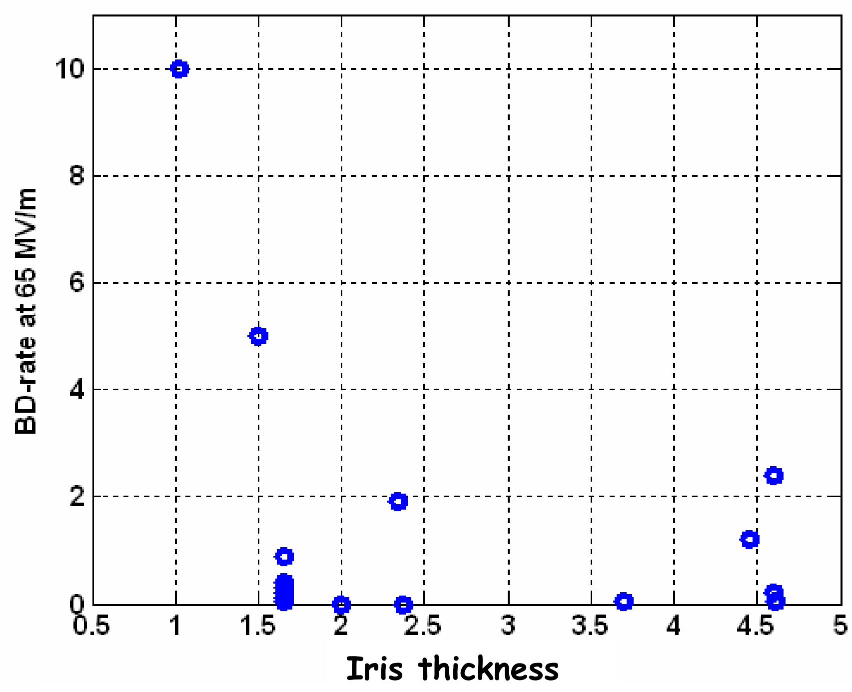
Phase advance



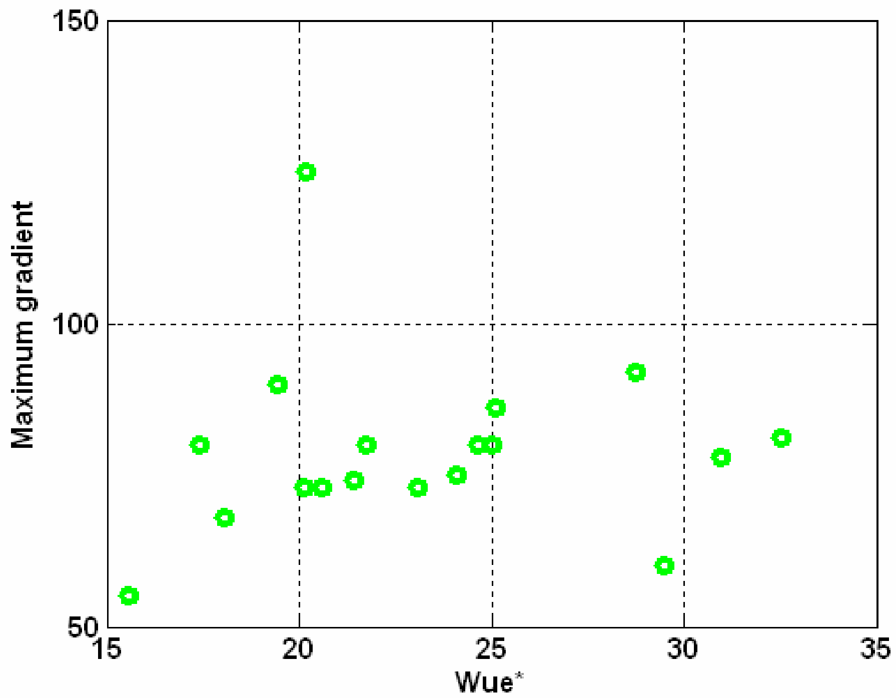


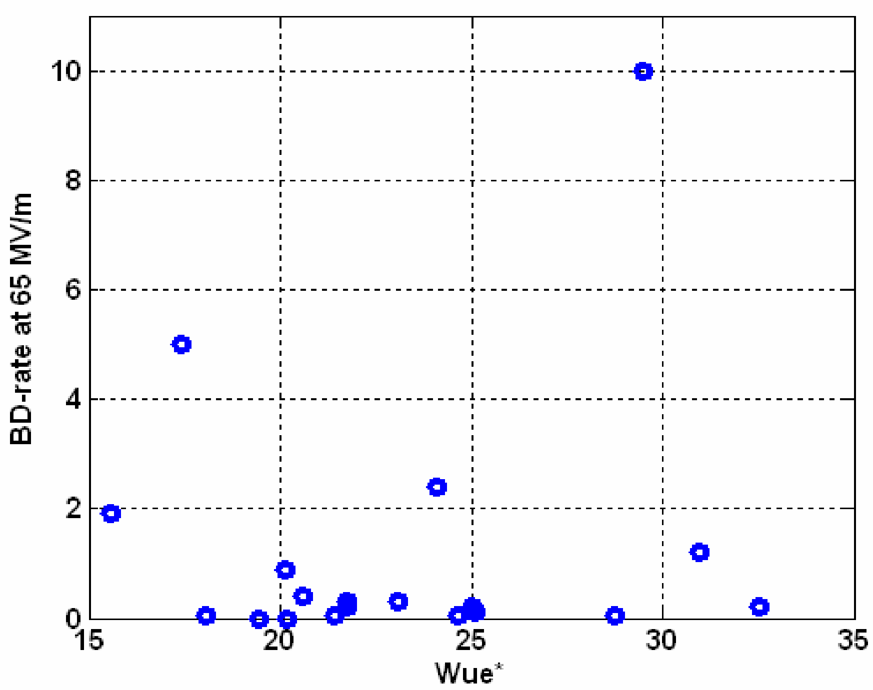
Iris thickness





Average Wuensch factor





T53's efficiencies with simple beam loading

Structure	Pin (MW)	Emax (MV/m)	Eavg (MV/m)	N 10^9	Nb	pL (ns)	η %
T53 correct (Alexej)	135	120	80	7.4	34	101	11.6
T53 const impedance approximation	135	115	78	7.4	34	101	12.3
Same as above	135	115	100	3.1	34	101	6.6
Same as above	135	115	100	3.1	80	124	12.5
T53 of 0.3 m same average vg	135	125	102	7.4	100	103	26.1