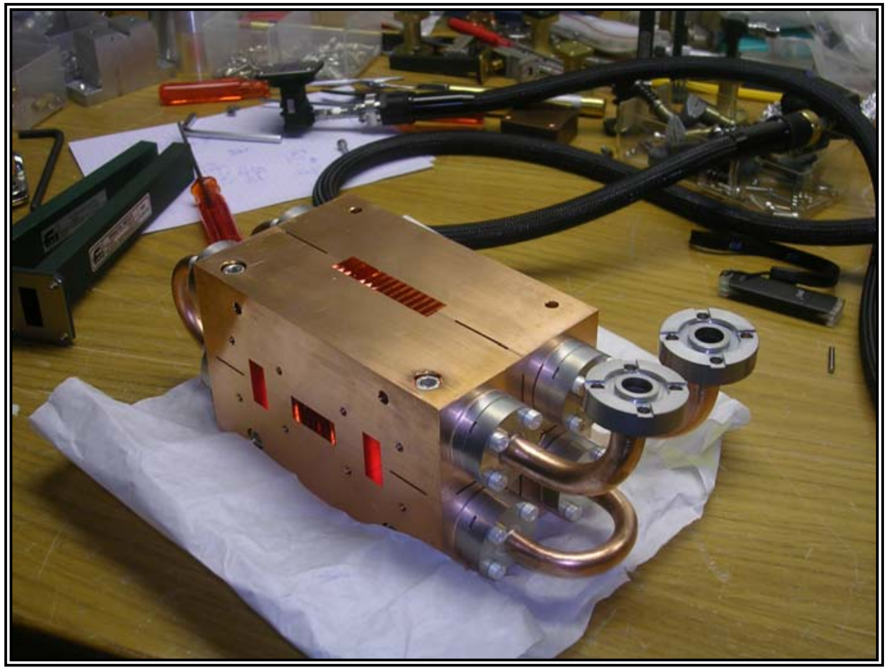
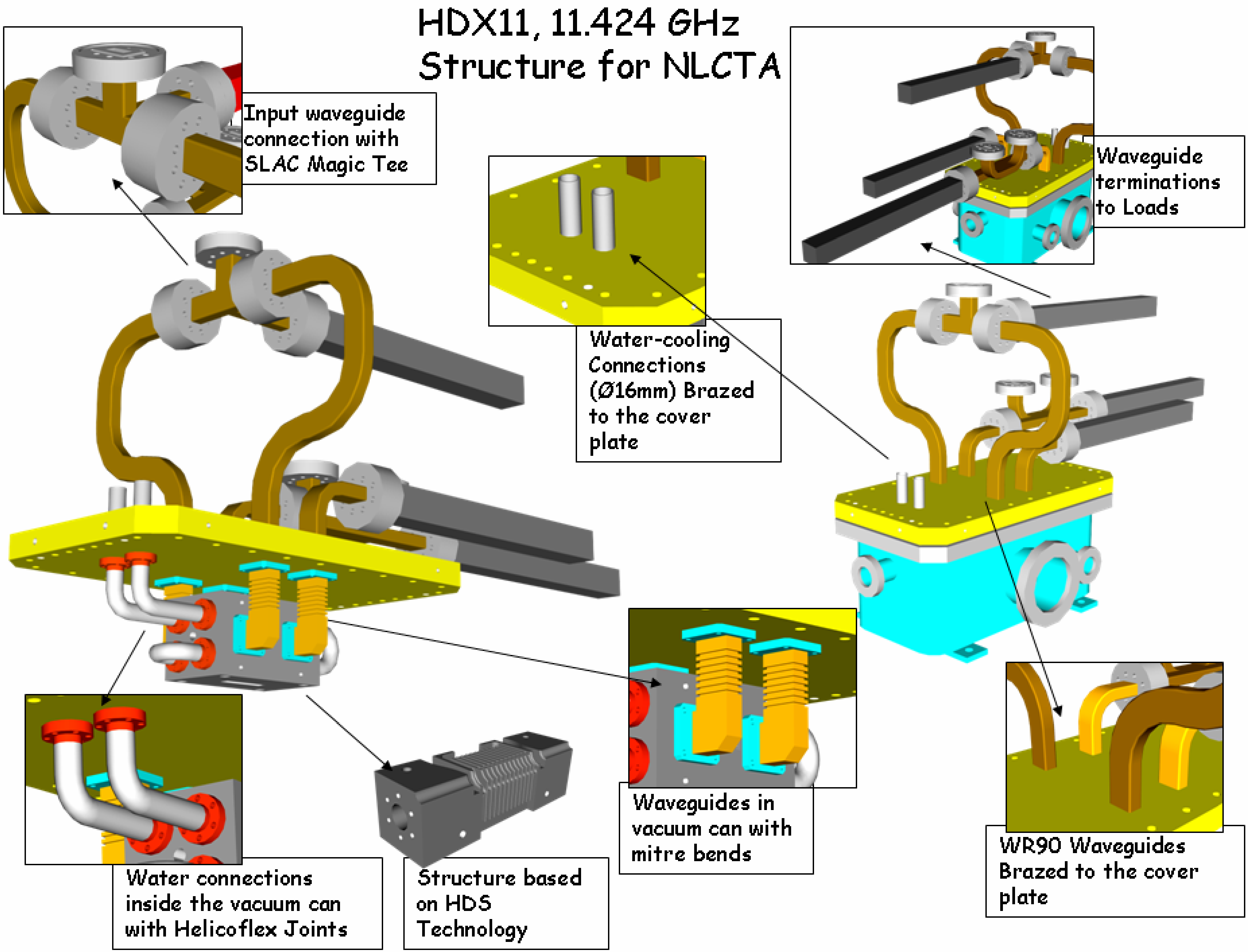
Results from the HDX11 high power test in NLCTA at SLAC

Scaled version of HDS11 small



f [GHz]	11.424
a/λ	0.19, 0.16
$\Delta\varphi$ [°], l_c [mm]	60, 4.374
$a_{1,2}$ [mm]	4.987, 4.200
$d_{1,2}$ [mm]	1.445, 1.445
$Q_{1,2}$	3820, 3760
$r/Q_{1,2}$ [LinacΩ/m]	11000, 13000
$v_g/c_{1,2}$ [%]	8.0, 5.1
for E_{acc} [MV/m]	150
$P_{1,2}$ [MW]	680, 370
$E_{s1,2}$ [MV/m]	270, 250
$\Delta T_{1,2}$ [K]	32, 28

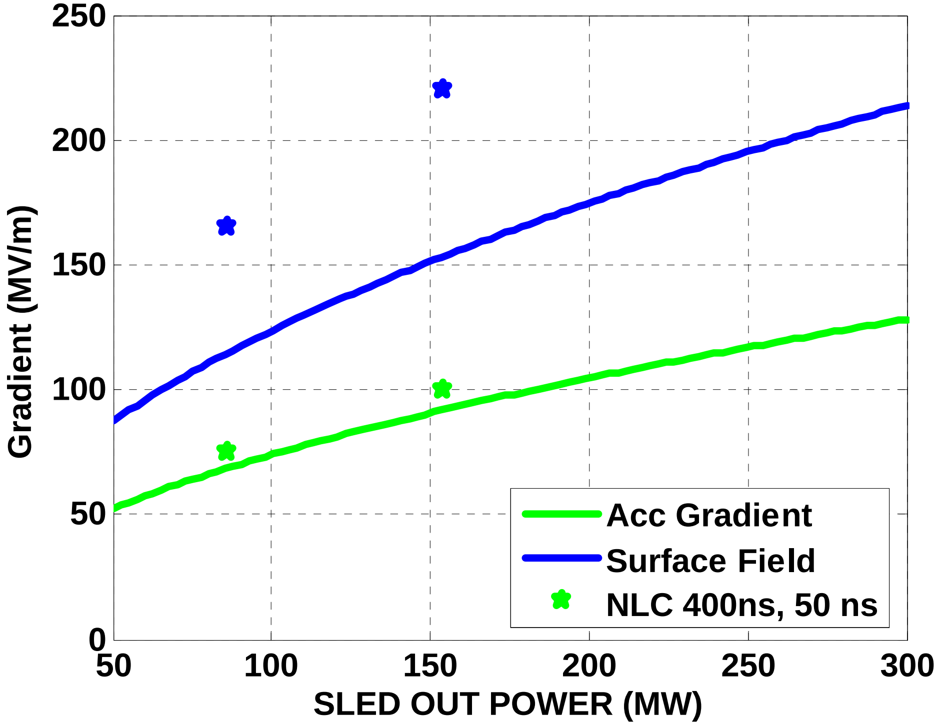

HDX11, 11.424 GHz
Structure for NLCTA
Input waveguide connection with SLAC Magic Tee
Waveguide terminations to Loads
Water-cooling Connections (Ø16mm) Brazed to the cover plate
Water connections inside the vacuum can with Helicoflex Joints
Structure based on HDS Technology
Waveguides in vacuum can with mitre bends
WR90 Waveguides Brazed to the cover plate

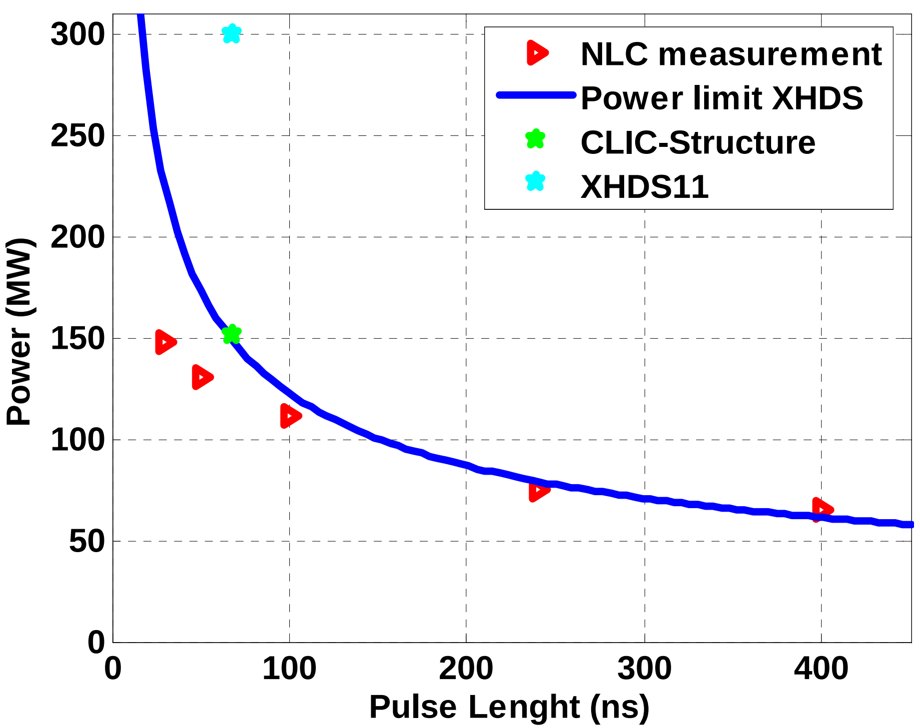
Scientific Motivation for the CLIC X-band proposal

- Test HDS geometry and technology at high power
  {low phase advance, slotted iris, 4 quadrant design}
- Test design optimization logic
  {constrains: surface field and Power*sqrt (pulse length)}
- Benchmark with well known NLC copper data
- Learn about material dependence (Cu vs Mo)
- Learn about frequency dependence
  {similar tests at 30 GHz in CFT3 in 2006}
- Get more statistics

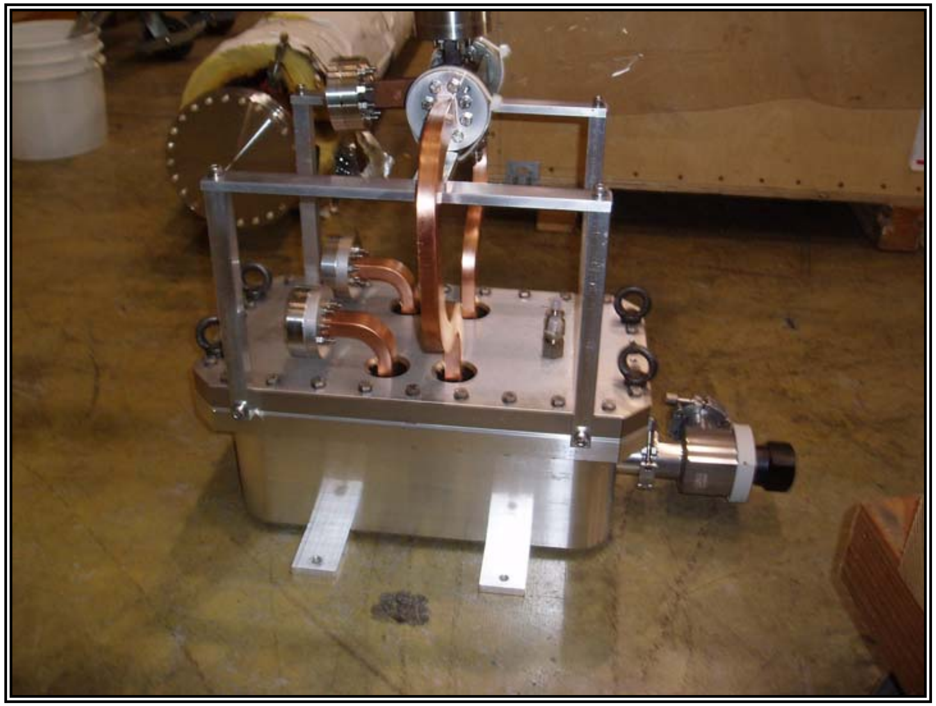
We are not aiming to demonstrate the CLIC structure
or the CLIC gradient at X-band with these experiments !

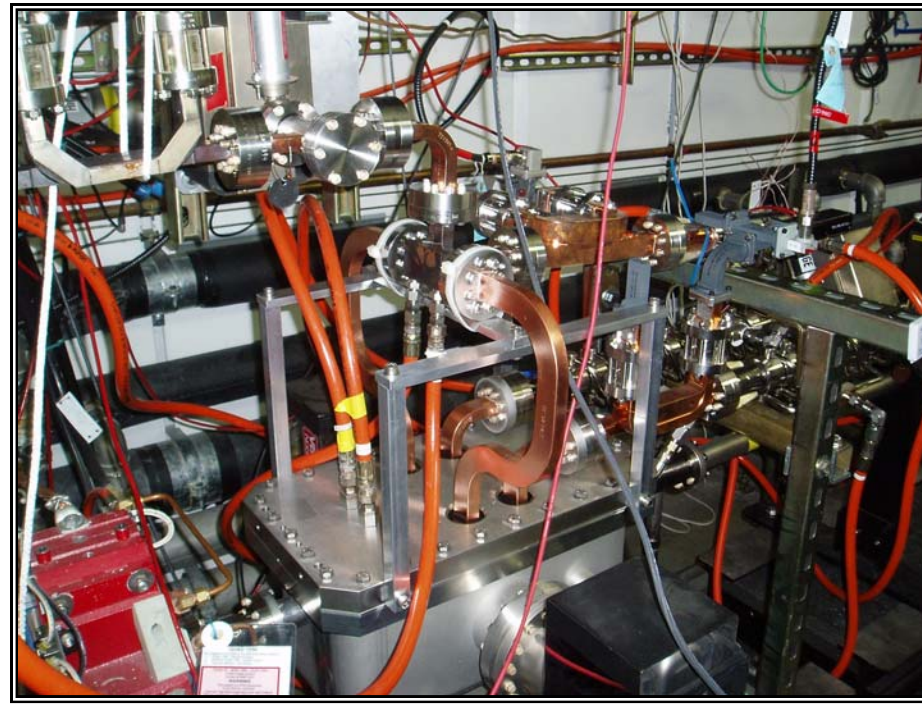
Scientific Motivation for the CLIC X-band proposal



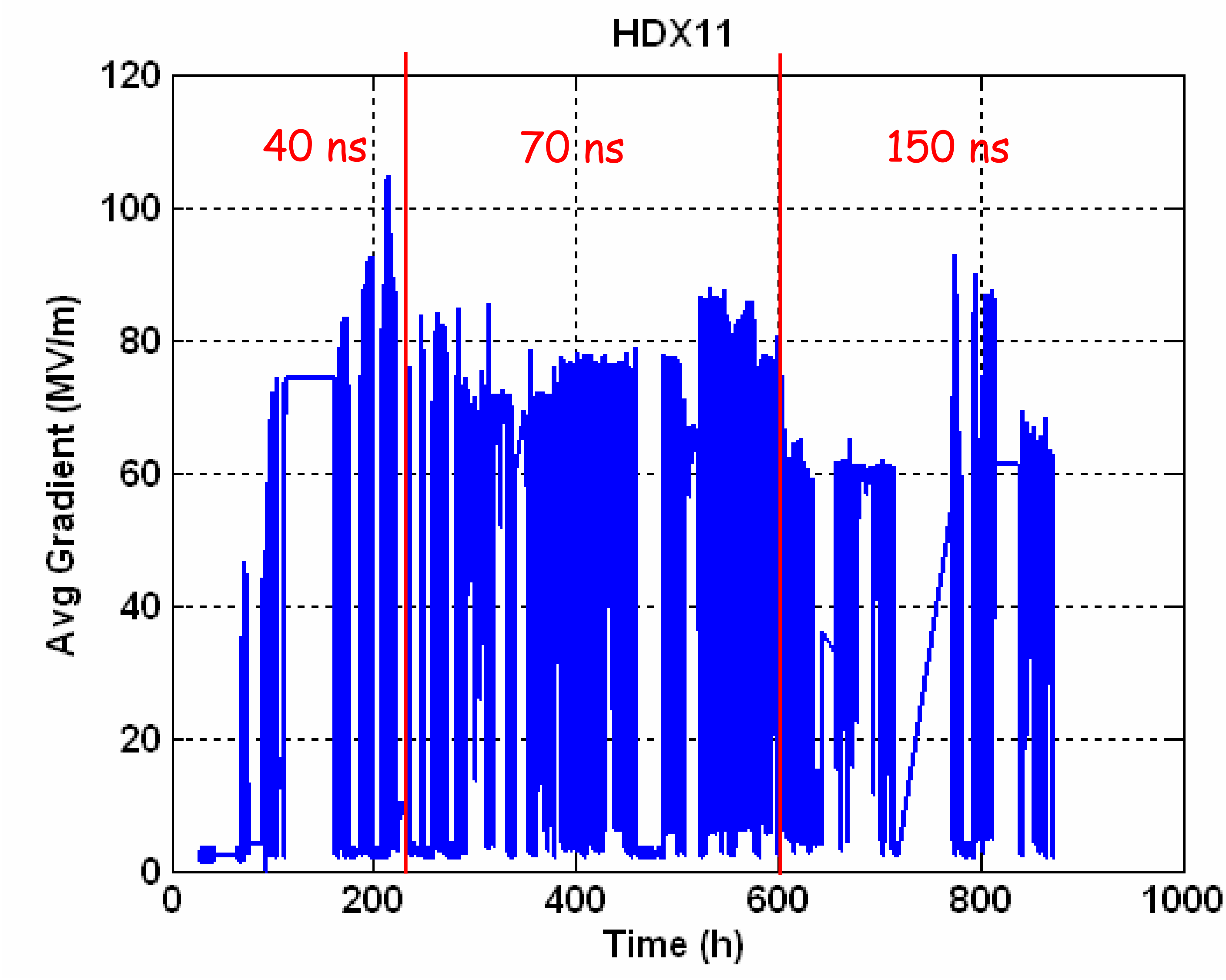


Some pictures

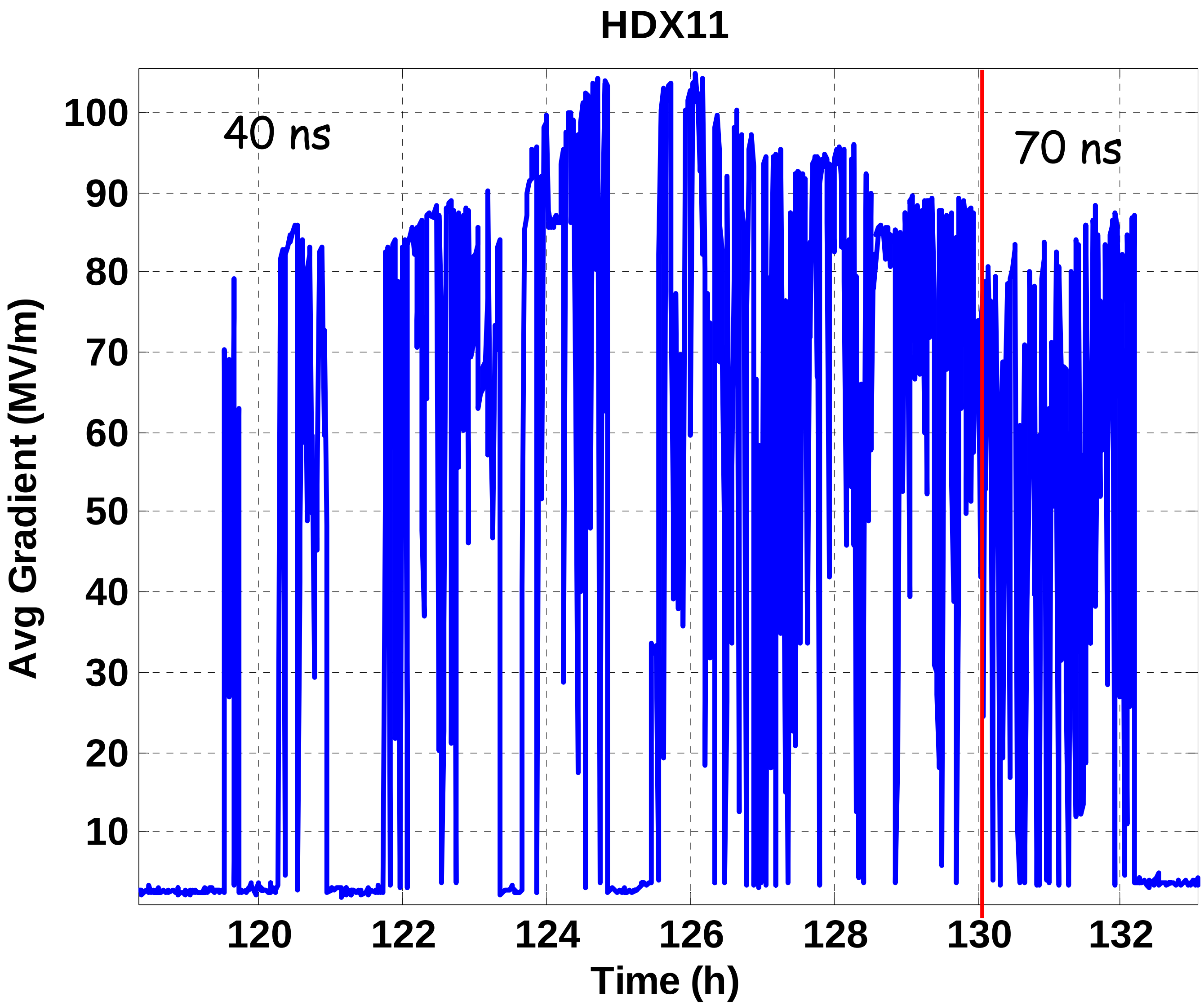




HDX11 conditioning



HDX11 conditioning



HDX11 conditioning statistics

Max Power: 200 MW at 40 ns (~26 wuensch)

150 MW at 70 ns (~23 wue)

~ 20000 Break downs

~ 50 hours initial conditioning

~ 600 hours total conditioning +experiment

Stable running: 60 MV/m; $2.5*10^{-6}$ at 70 ns (~9 wue)

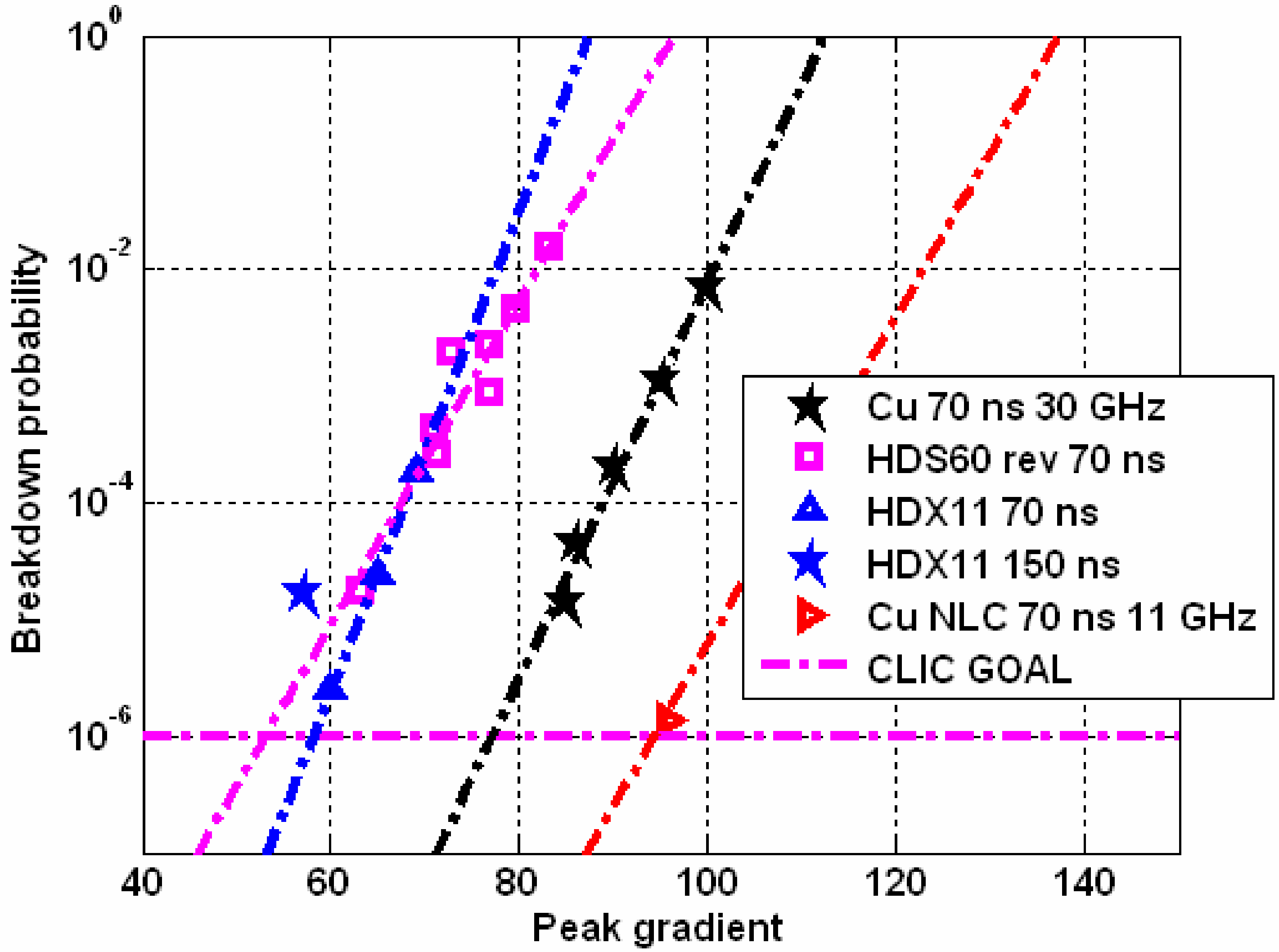
65 MV/m; $2.4*10^{-5}$ at 70 ns (~11 wue)

57 MV/m; $1.7*10^{-5}$ at 150 ns (~11 wue)

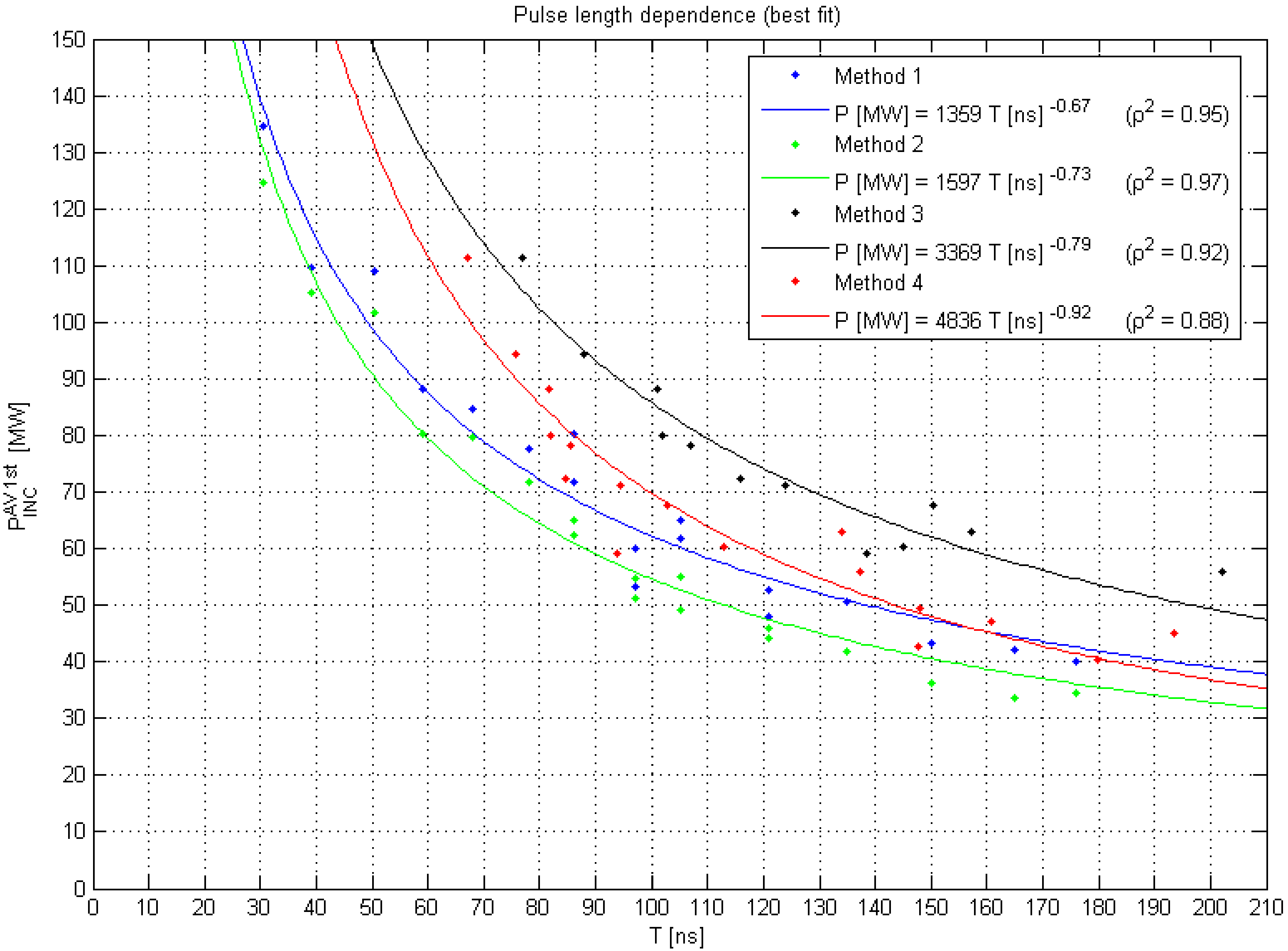
7.11 – 19.12.2006 (6 weeks)

5 weeks experiment (840 h; 70% uptime)

HDX11 breakdown rate vs gradient

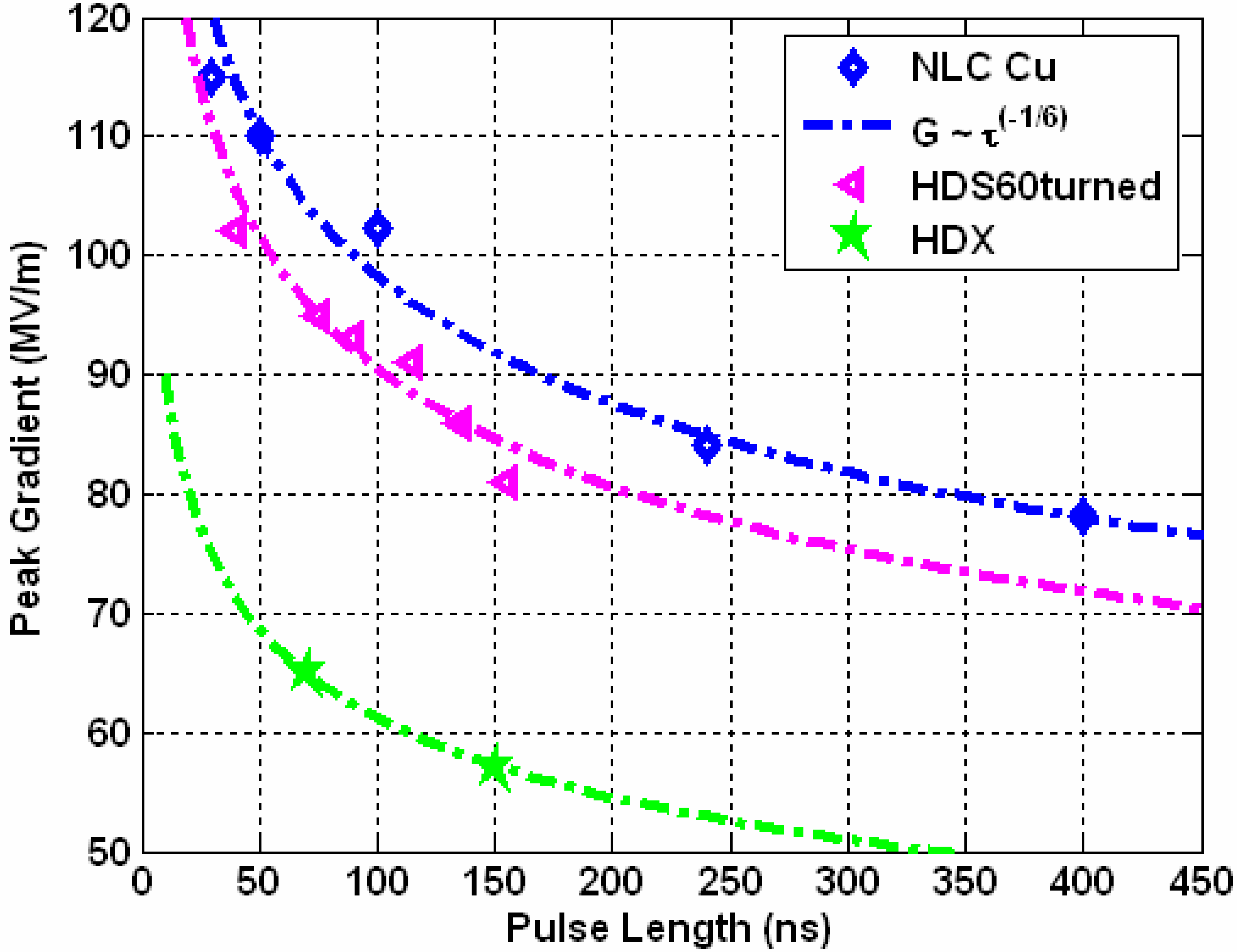


HDX11 pulse length dependence (Alberto)

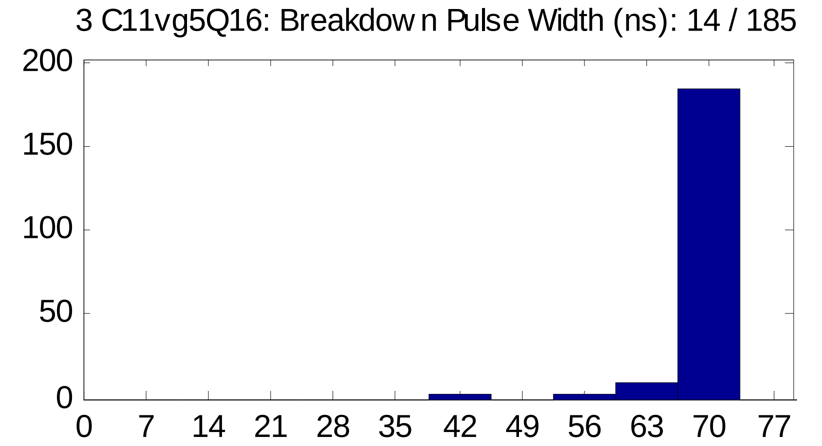


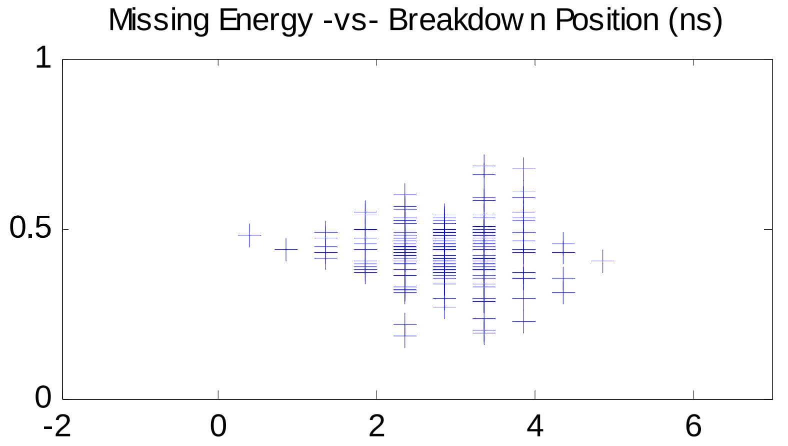
More pulse length dependence

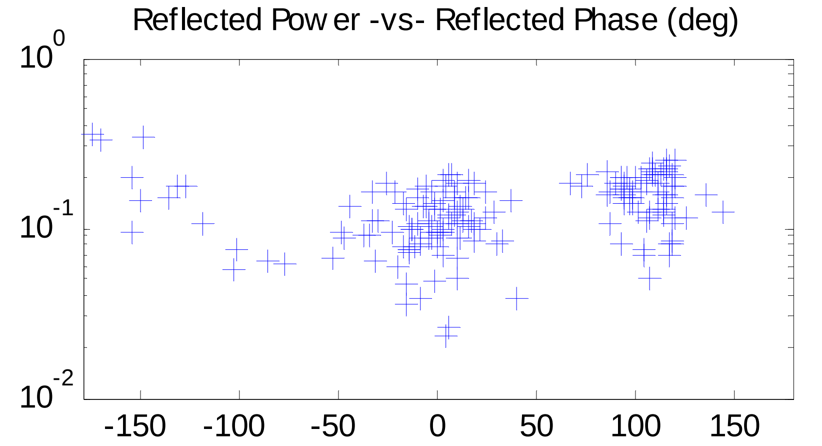
(breakdown rate data)

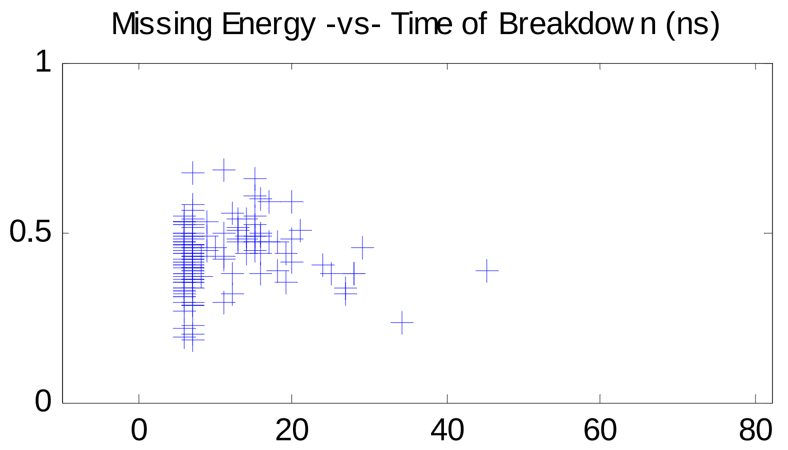


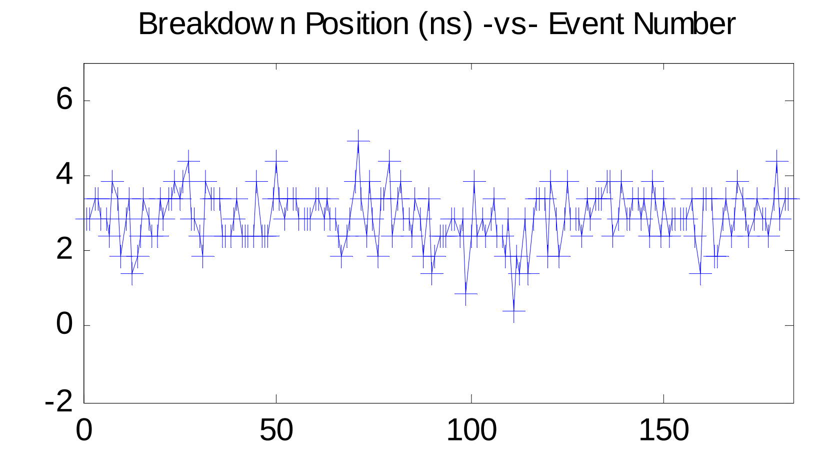
C11vg5Q16
Event Summary
69 MV/m, 70 ns



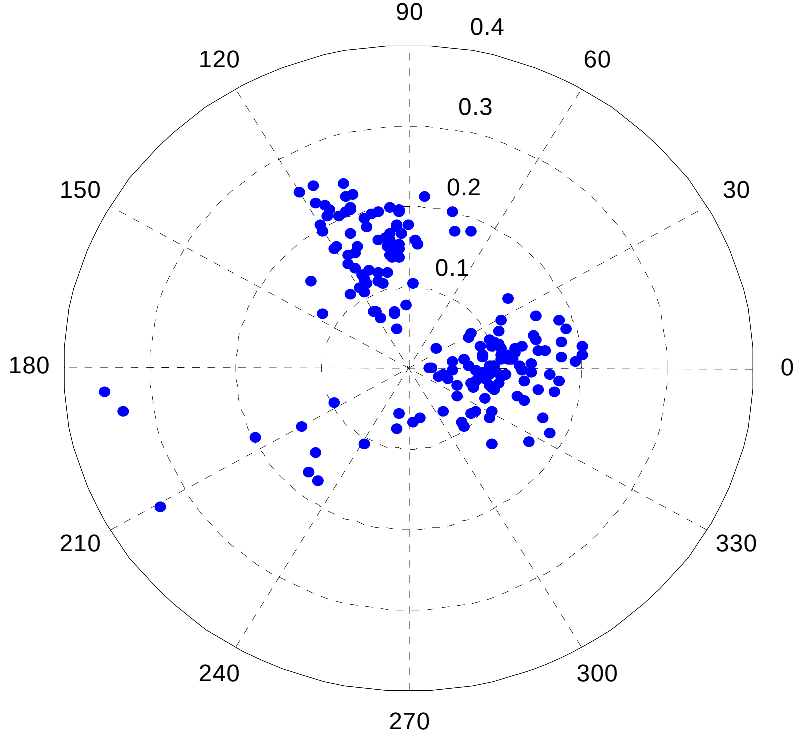






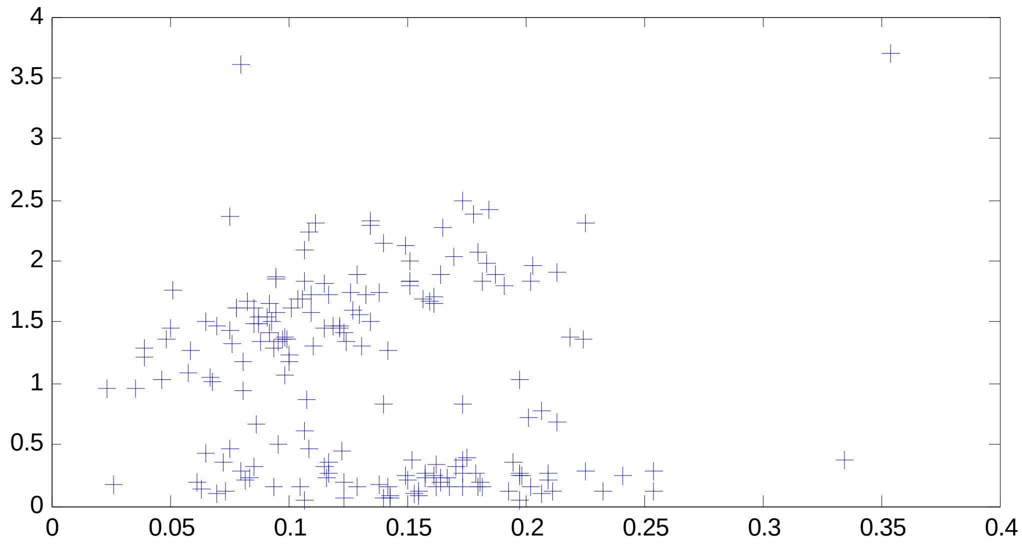


Peak Reflected RF Power (Fraction of Input Power) Versus Reflected RF Phase (Deg)



Note the 120 deg events have significantly higher reflected power than those at 0 deg (for reasons unknown – the one-cell round trip attenuation cannot be that large, although it could be dispersion if the 0 deg events are coming from the second regular cell)

Relative Asymmetric Power Versus Peak Reflected Power (Fraction of Input Power)

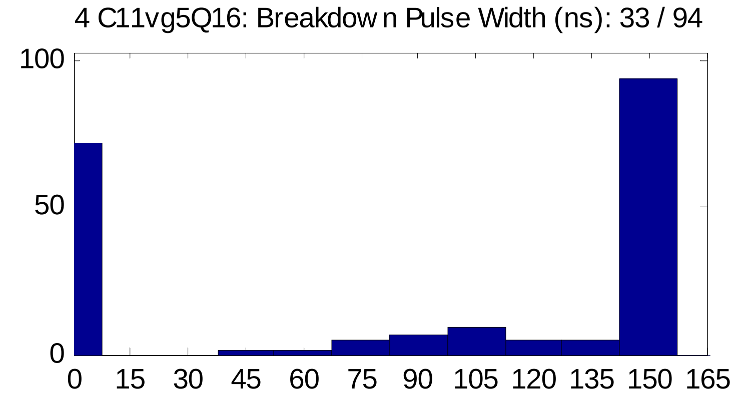


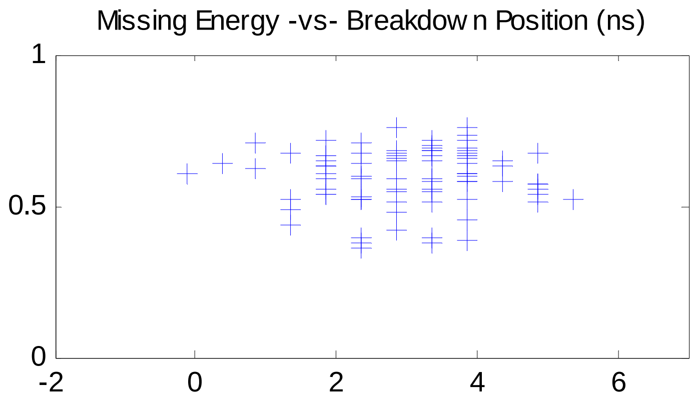
To see if breakdowns are occurring in the input coupler, the signal from the asymmetric arm of the magic tee was rectified (diode) and recorded. A non-zero signal is present in non-breakdown pulses due to match imperfections – the reflected signal from a breakdown will also show up due to this miss-match, and the net diode signal will depend on their relative phase. The vertical axis is the peak diode signal difference: (bkd – normal)/normal. The top cluster of events are at 0 deg reflected phase and the bottom are at 120 deg: the former seem to be in-phase and the latter mostly out-of-phase with the incident signal. Thus it does not appear the coupler is breaking down – otherwise the size of the bkd signals would be much larger.

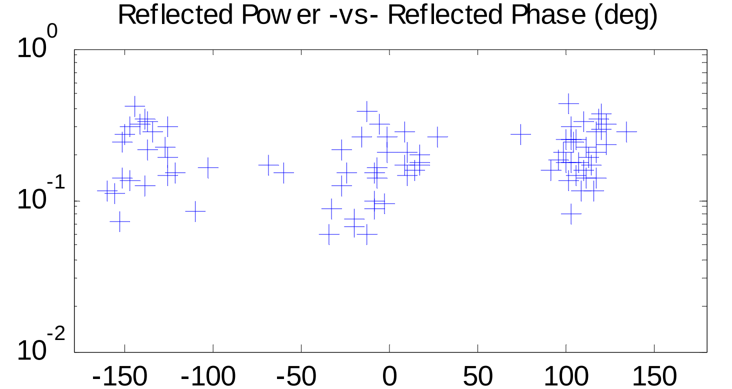
C11vg5Q16

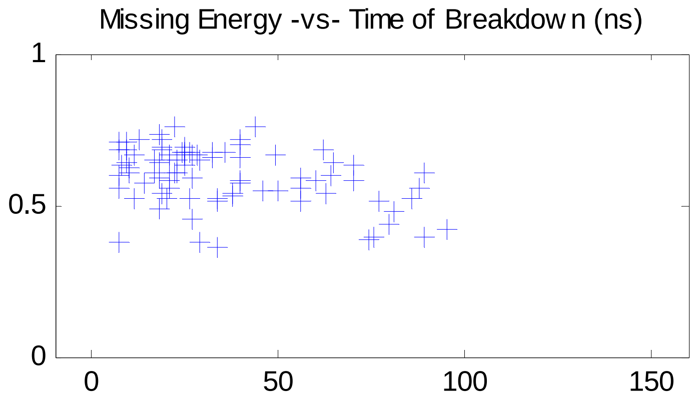
Event Summary

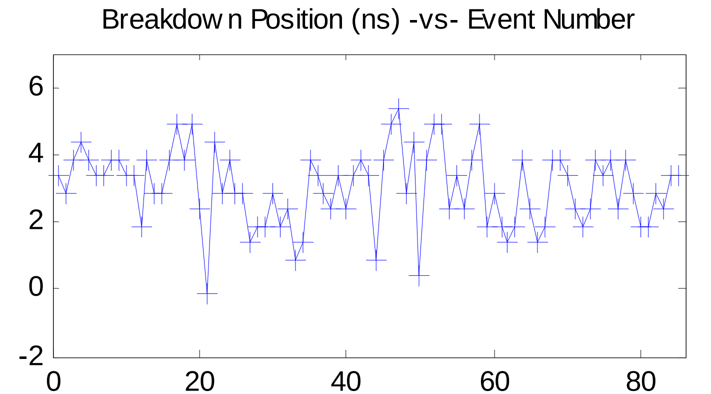
54 MV/m, 150 ns



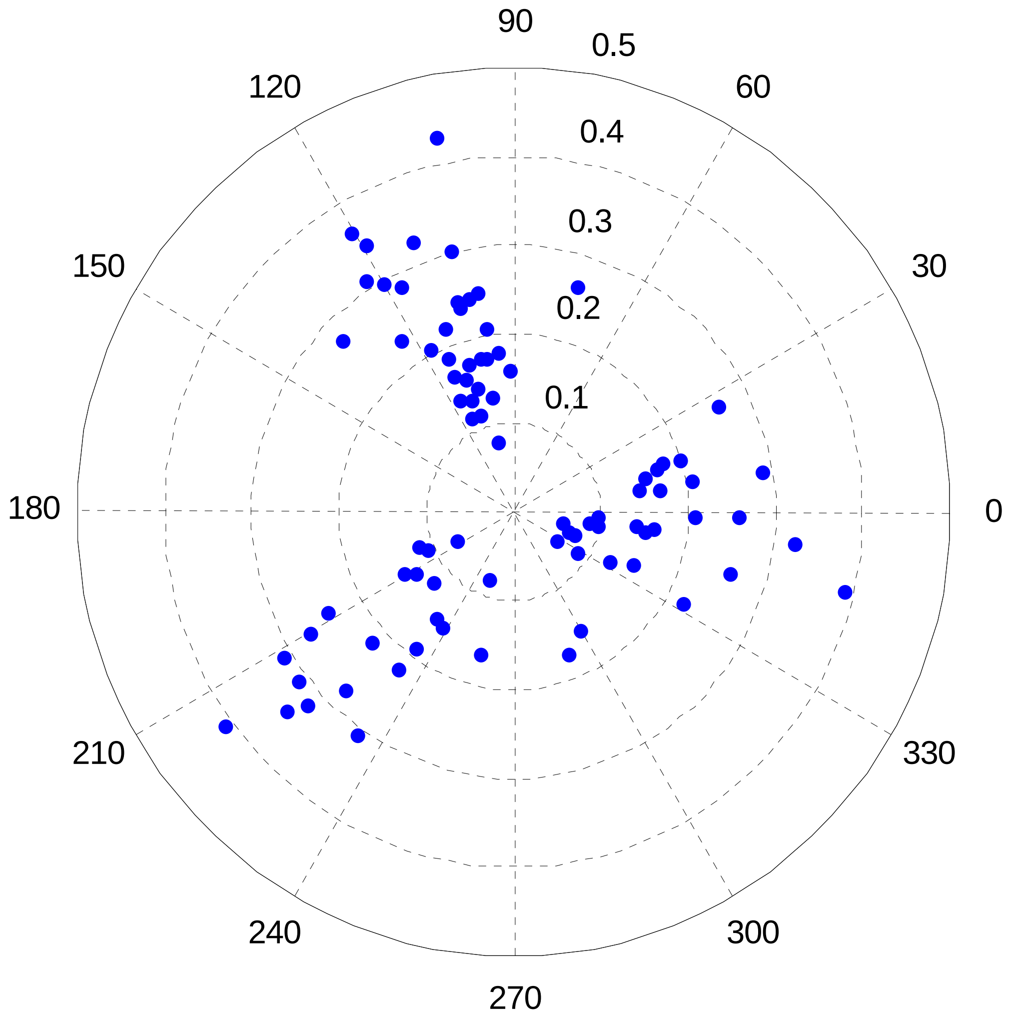








Peak Reflected RF Power (Fraction of Input Power) Versus Reflected RF Phase (Deg)



Conclusion and Outlook

- HDX successfully build and high power tested
- Fast conditioning (2 days), normal for copper
- Initial conditioning more promising than later performance (damage ?)
- Performance significantly worse than NLC structure (H75vg3S18) (60% in gradient, > factor 2 in Power)
- No particular problem found during experiment
- Unusual pulse length dependence
- HDS principle still needs more data

o Structure will be opened up and inspected by SLAC this month

o Molybdenum version under production and could be tested ~April (Bd-slope, fast conditioning, Cu vs Mo)

Very good support by SLAC and NLCTA people, despite some inefficiencies due to safety and not running the equipment for long time

More collaboration with SLAC in the future