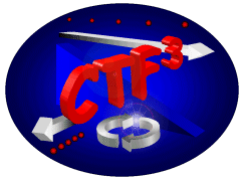


3 GHz SICA: Breakdown measurement in CTF

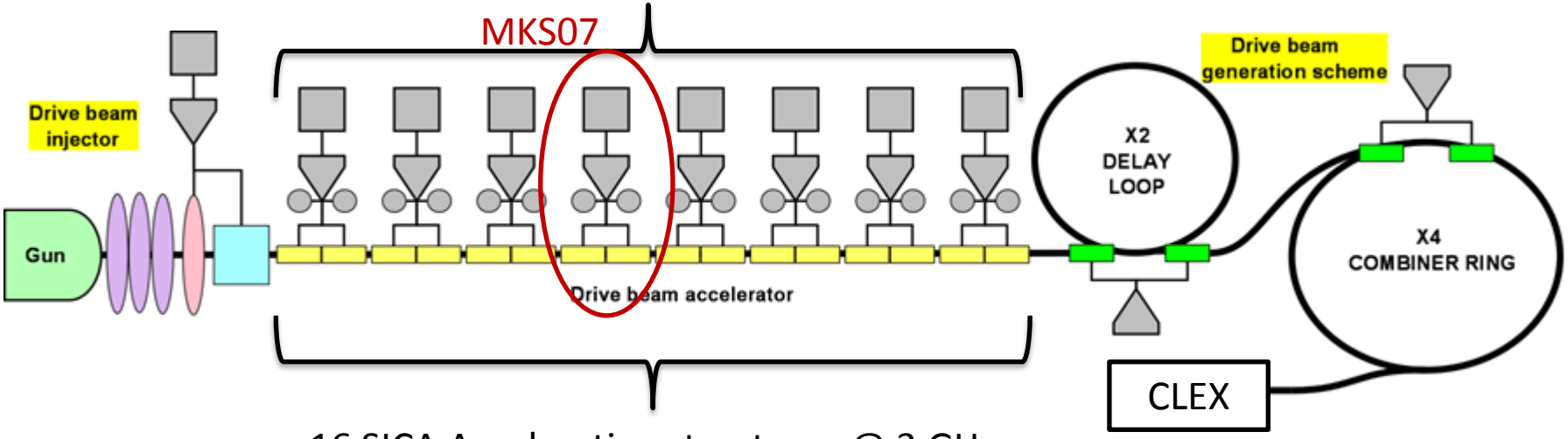
Alexey Dubrovskiy

CLIC Workshop

January 29, 2013

CTF3 Layout

8 Klystrons + RF compressors (LIPS and BOC) @ 3 GHz



16 SICA Accelerating structures @ 3 GHz

Linac is daily powered in order to accelerate an electron beam of 3.5-4 A upto 125 MeV for commissioning and studying the drive beam generation scheme and for performing beam based experiments in CLEX.

Drive beam is operated 200 days per year, 10-24 hours per day @ a rep. rate of 1-5 Hz:
16 ACS * 2Hz * 150 days ≈ **4×10^8 RF+beam pulses per year**

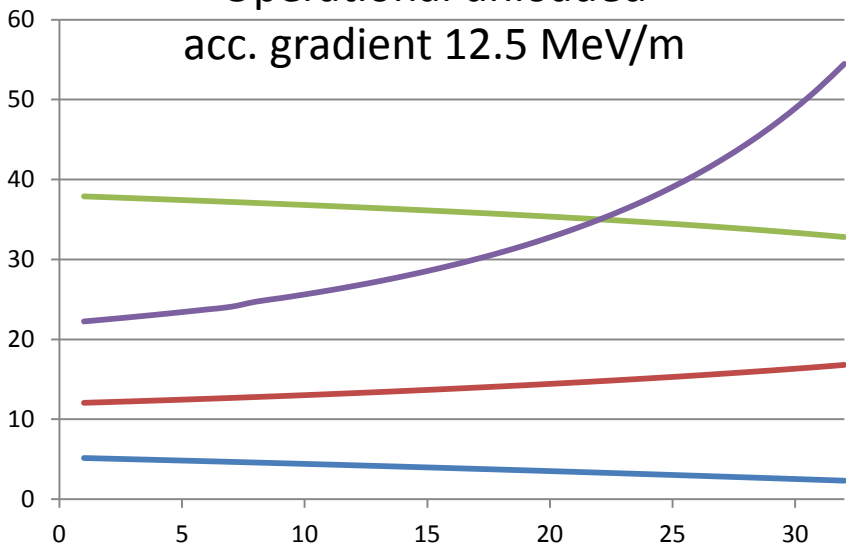
Klystrons are powered 200 days per year, 24 hours per day @ a rep. rate of 5-50 Hz:
16 ACS * 25 Hz * 200 days ≈ **7×10^9 RF pulses per year** ≈ *6 X-Boxes*

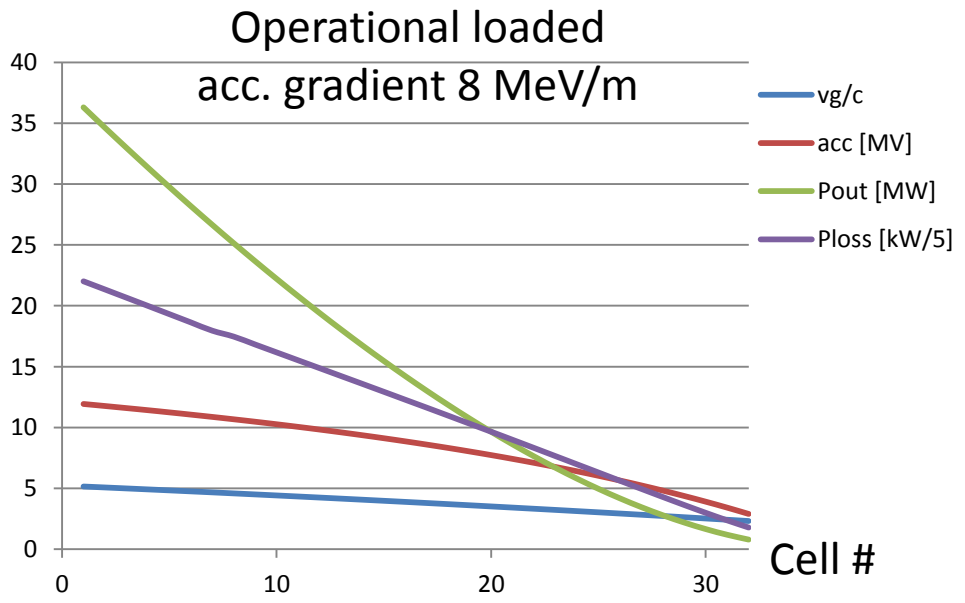
3 GHz SICA

CTF3 Drive Beam Acc. Structures (3 GHz) – SICA (Slotted Iris – Constant Aperture):

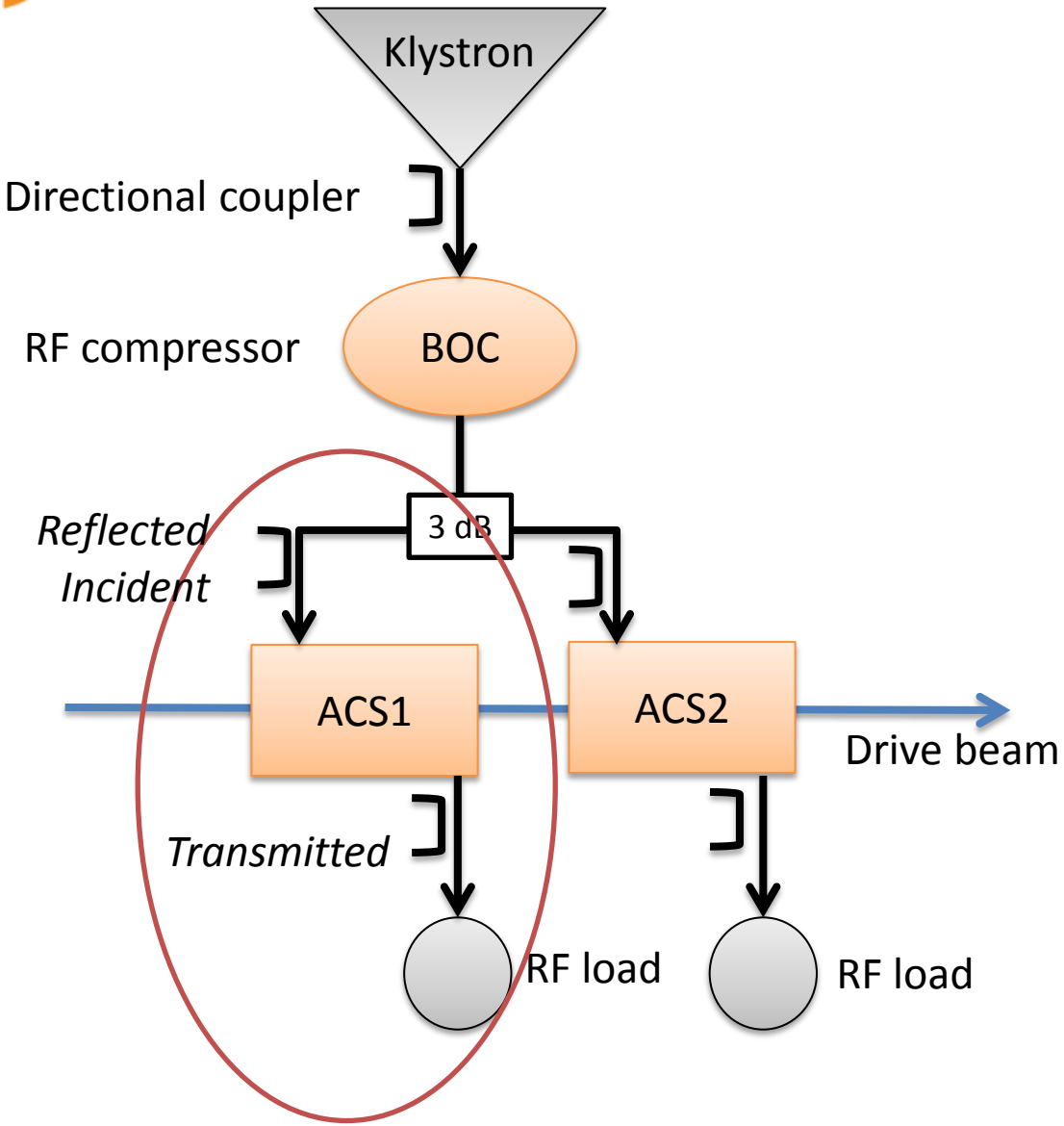
- 32 cells;
- 1.2 m long;
- $2\pi/3$ mode;
- HOM damping slots;
- 96% - theoretical maximum RF-to-beam efficiency.

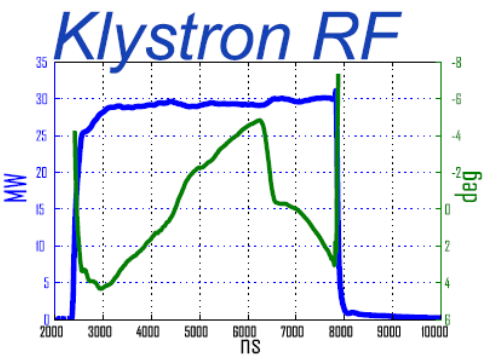
P_{in} = 38 MW, P_{len} = 1.4 μs, I_{beam} = 4 A

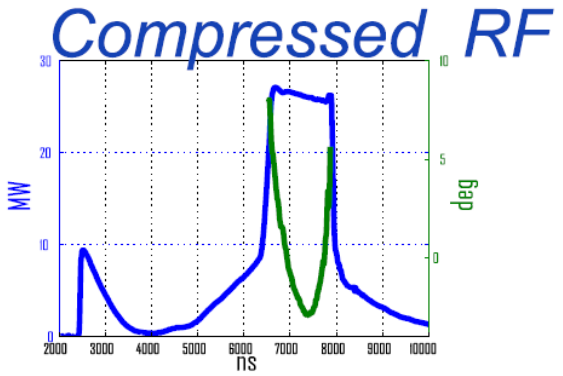




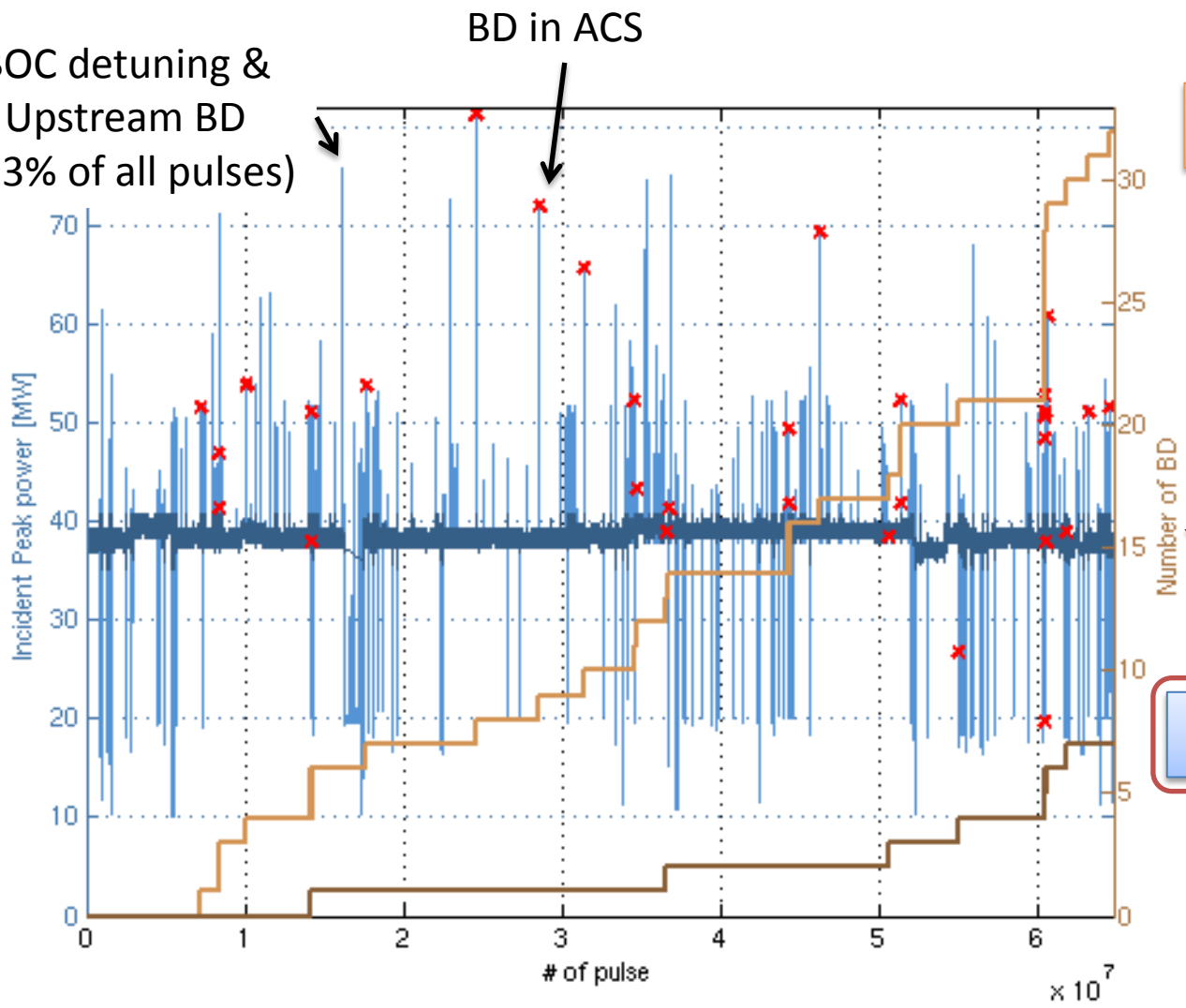
MKS07 setup


Klystron
Directional coupler
RF compressor
BOC
3 dB
Reflected
Incident
ACS1
ACS2
Drive beam
Transmitted
RF load
RF load


Klystron RF
MW
deg
ns


Compressed RF
MW
deg
ns

Histogram



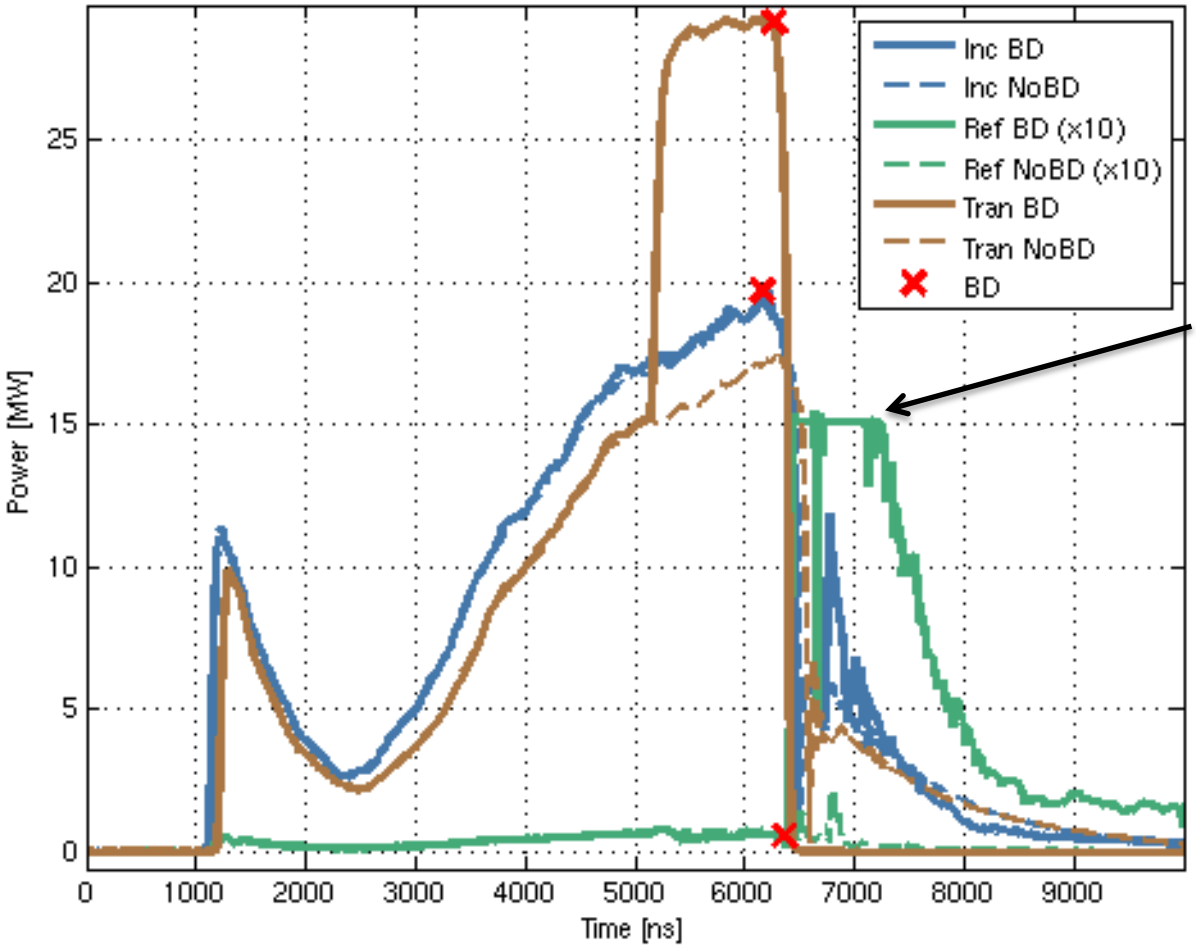
5×10^{-7} Total BD rate

38.4 MW Operational power (96% of all pulses)

1×10^{-7} Operational BD rate

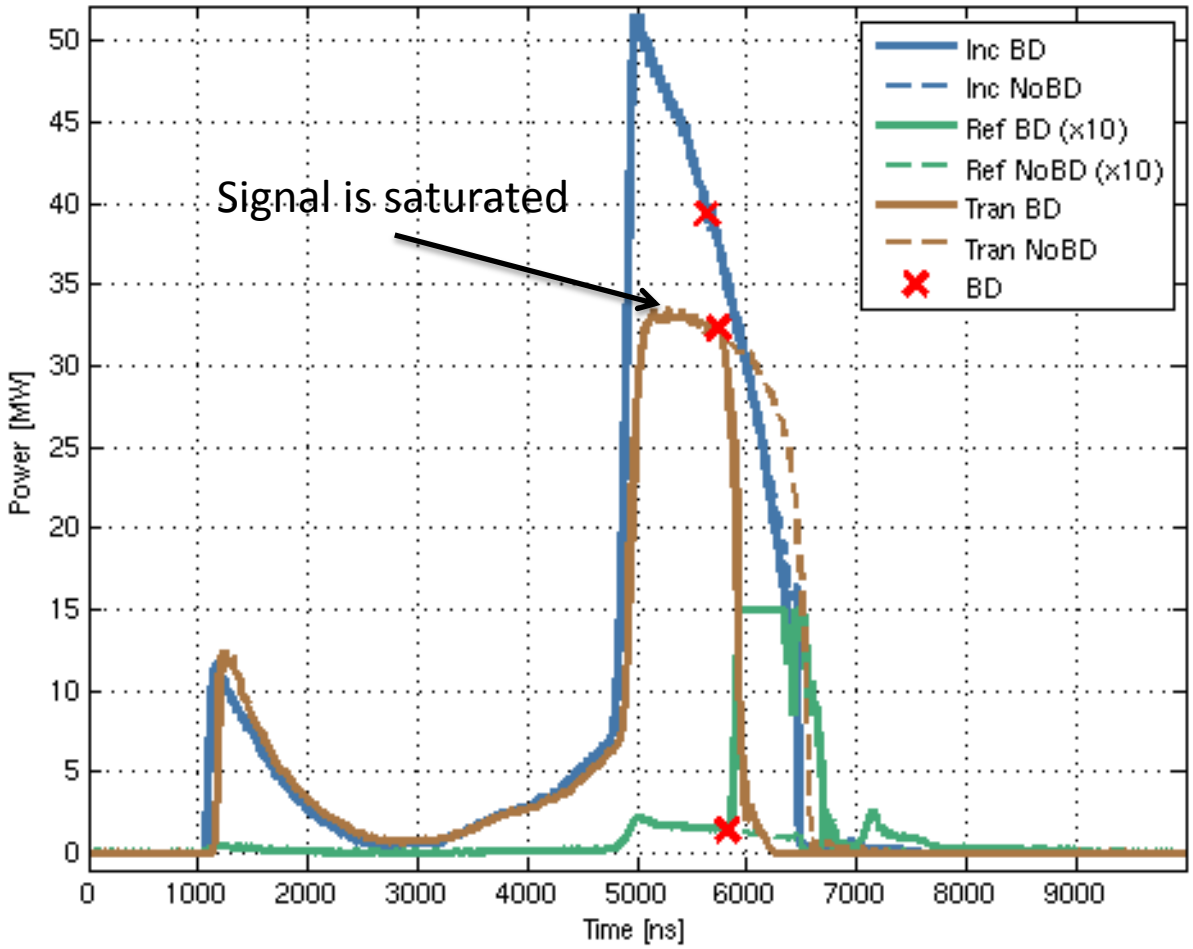
56 days, rep. rate = 25 Hz

BD as a result of the beam deceleration



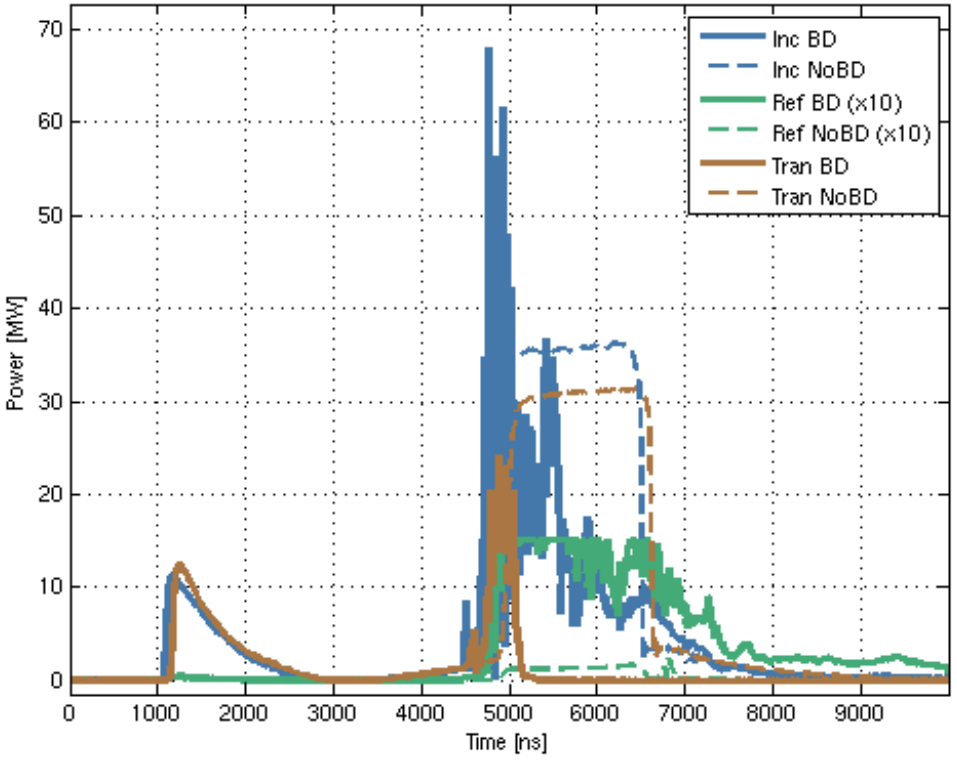
Signal is saturated

BD as a result of the BOC detuning

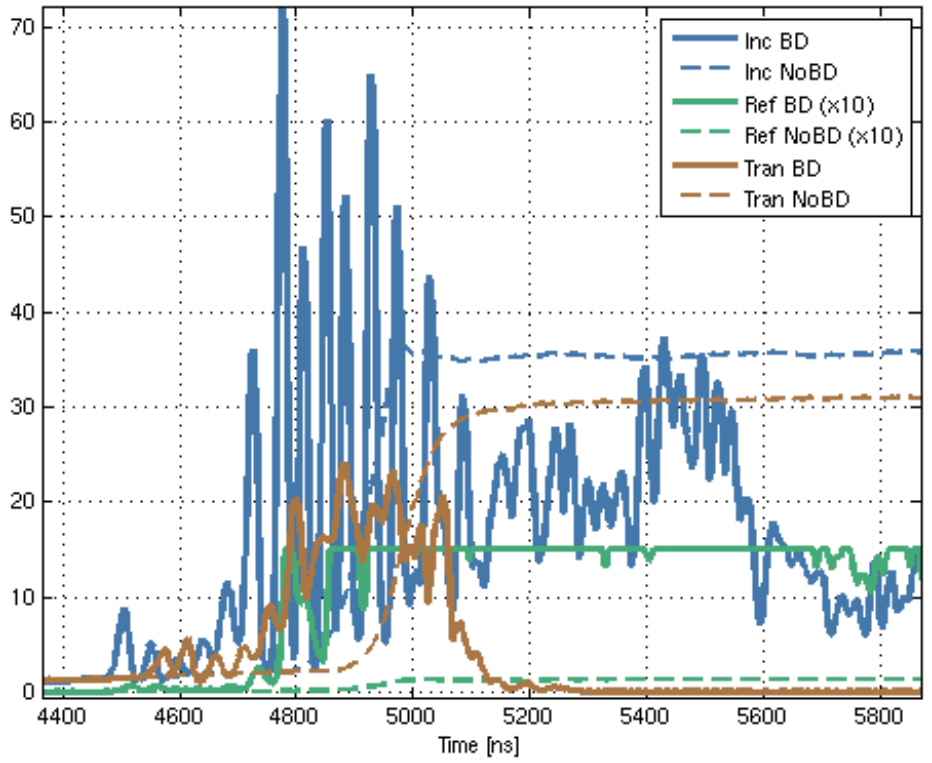


BDs in ACS as a result of upstream BDs

Full waveforms

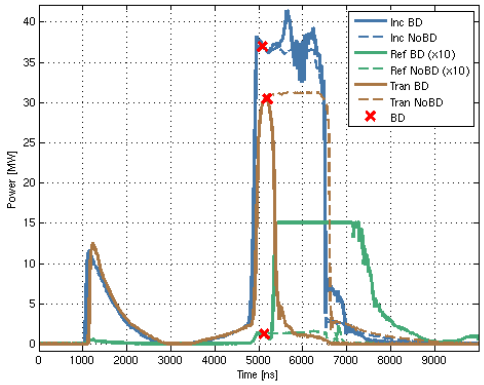


Zoomed waveforms

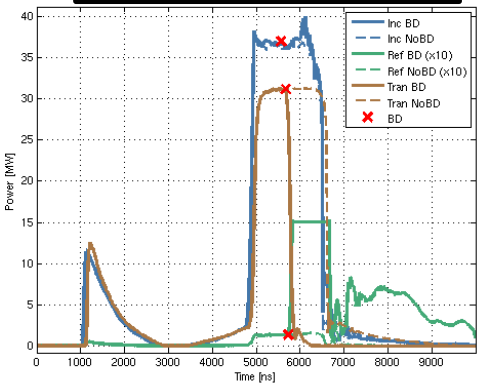


Cluster of BDs

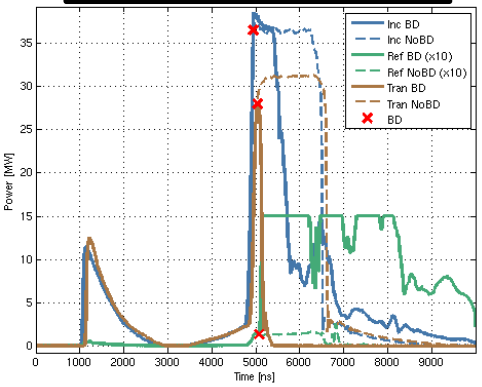
Pulse# 1. Cell# 8



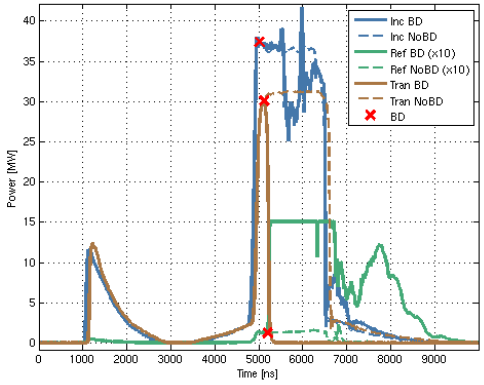
Pulse# 2. Cell# 28



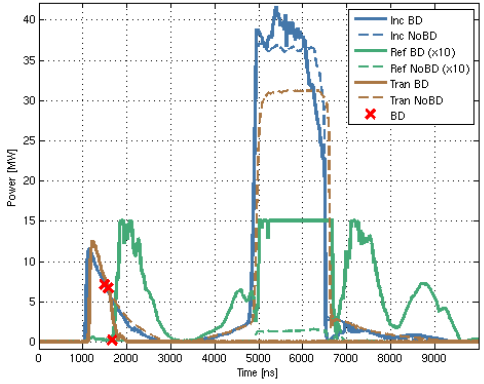
Pulse# 3. Cell# 24



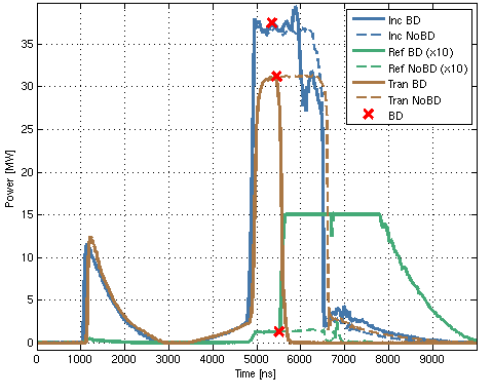
Pulse# **4**. Cell# 31



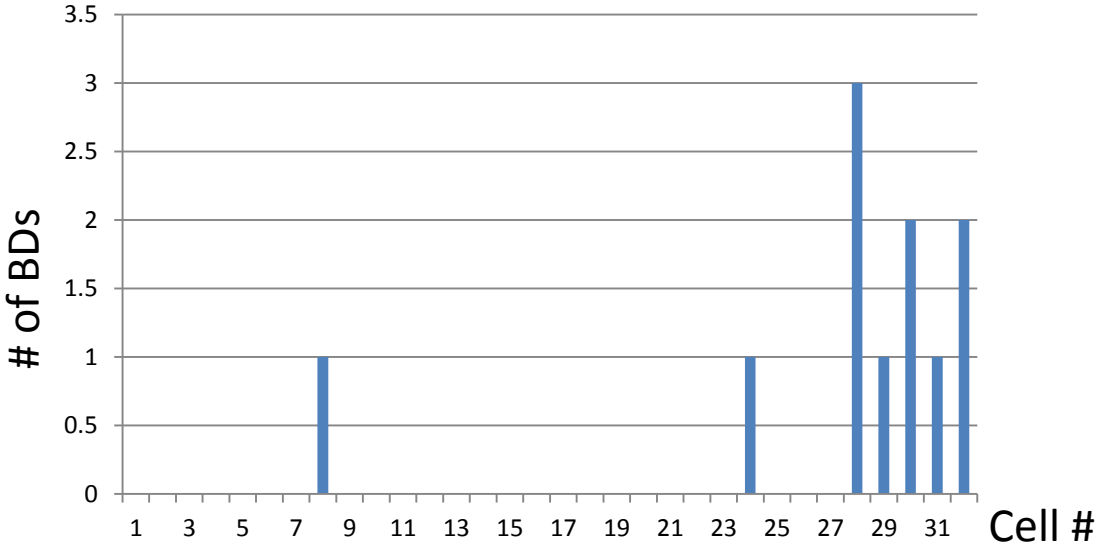
Pulse# **7**. Cell# 32

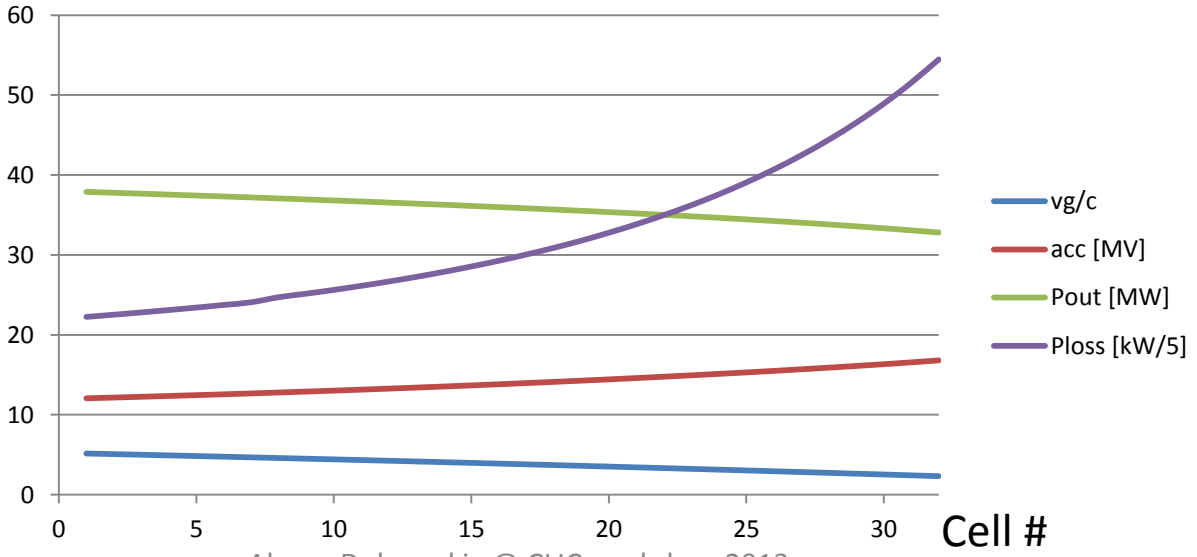


Pulse# **13**. Cell# 28

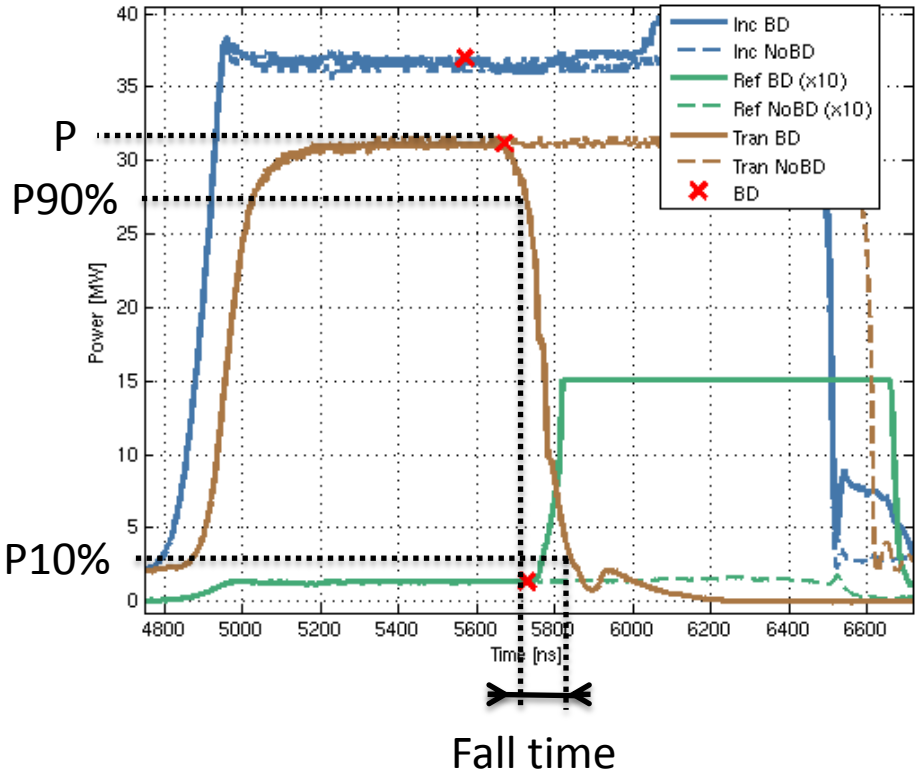


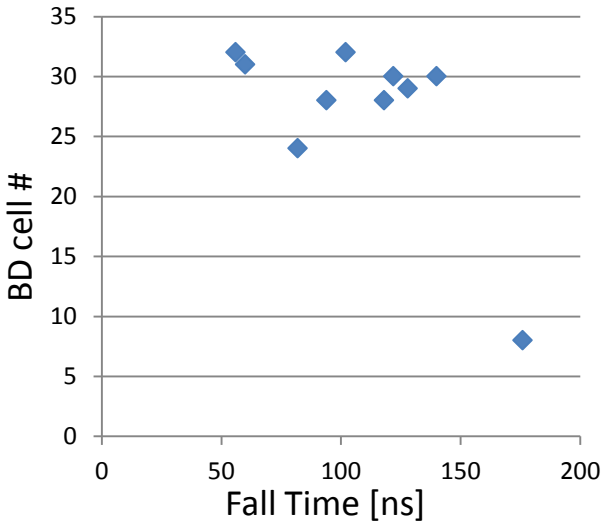
BD locations





Fall time of the transmitted power





Time [ns]	Cell #
56	32
60	31
82	24
94	28
102	32
118	28
122	30
128	29
140	30
176	8

- Avg. fall time is 110 ns
- No precursors observed

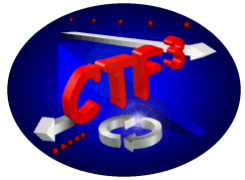
Summary of fall times

Test	Frequency	Measurement	Fall Time
Simulation	DC		0.25ns
CERN/ New DC System	DC	Voltage	12-13ns
Swiss FEL (C-Band)	5.7 GHz	Transmitted Power	110–140 ns
KEK T24 (X-Band)	12 GHz	Transmitted Power	20-40 ns
CTF/TBTS TD24 (X-Band)	12 GHz	Transmitted Power	20-40 ns
CTF SICA (S-Band)	3 GHz	Transmitted Power	60-140 ns

** Nicholas Shipman, "High-repetition rate dc spark experiments" on 30 Jan 2013*

Summary

- The possibility of measuring BDs in 3 GHz SICA has been demonstrated ;
- The “unloaded” BDR was measured in the order of 10^{-7};
- Most of BDs occur in the last cells;
- The avg. fall time of the transmitted power is about 110 ns;
- In the normal conditions 6 out of 7 BDs appeared as a single BD. 1 BD appeared as a cluster of 6 BDs during 15 RF pulses.


CTF3

RF calibration