TBTS data analysis

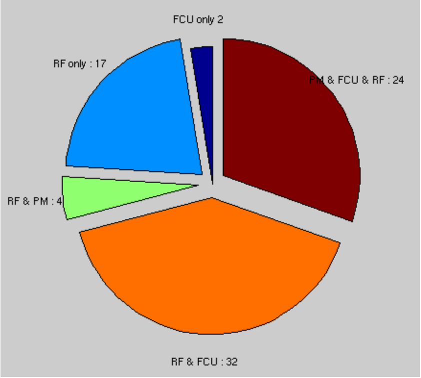
Overview of on-going studies

Disclaimer: All results are preliminary and not yet consolidated

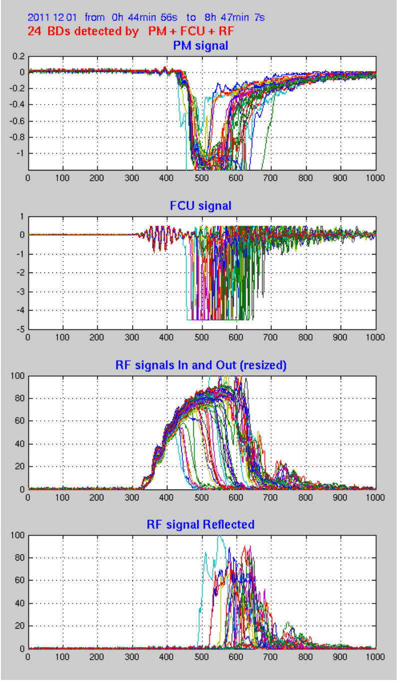
Contents

- Statistical analysis
  - Various BDs detection channels
  - BDR – overview of recorded experiments
  - BD's time distribution and Poisson law
  - RF exposure time before BD and time power law
- Signal processing analysis
  - RF signals without BDs
  - BDs signatures – RF input reaction
  - BDs locations – possible migration of BDs
- New diagnostics and possible improvements

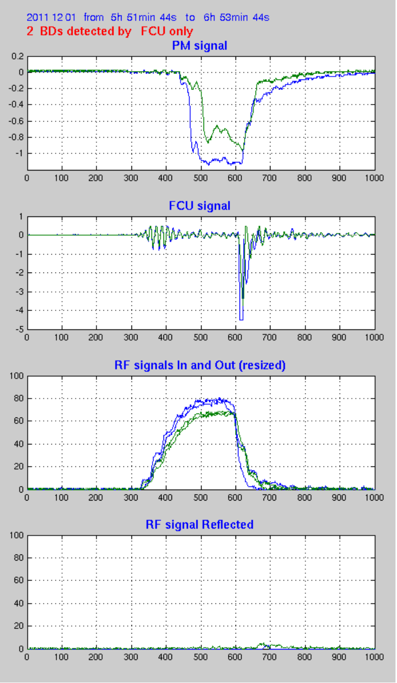
BDs detection triggering data storage



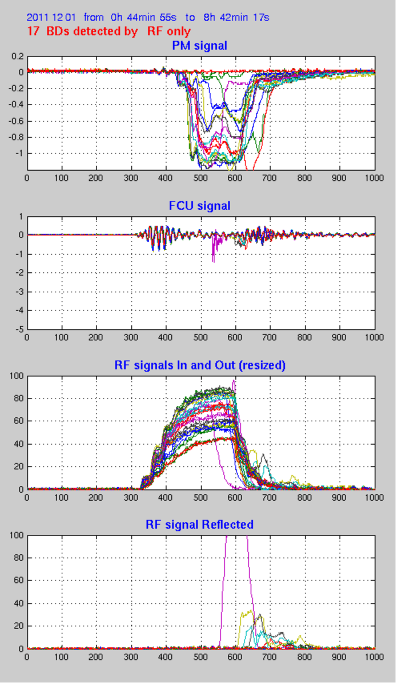
1st Dec 2011 record



3 diagnostics detection



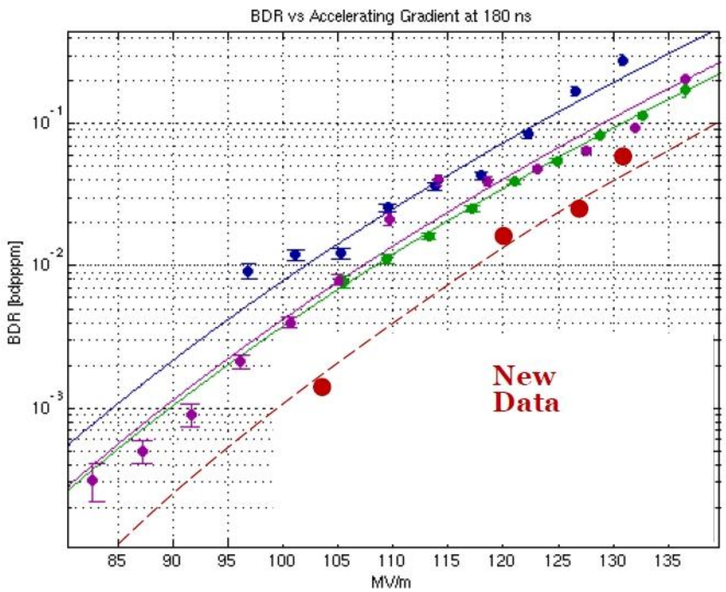
Rare cases of FCU detection only



RF detection only

- With the present instrumentation set, most of the BDs are detected by RF signals (Reflected RF and Missing Energy).
- PM is jammed by noise (dark current, X-rays ?)
- FCU is sensitive to RF noise (like BPMs) and not always inserted (probe beam)

BDR from the last experiments

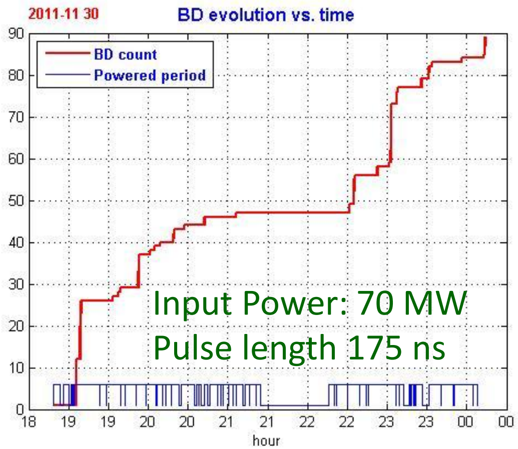


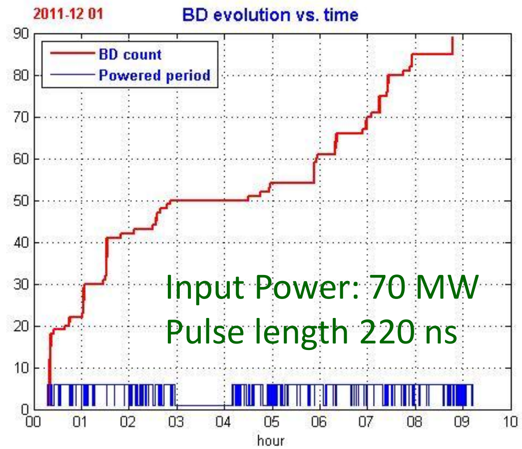
R. Corsini – CLIC Project Meeting, 9 Dec. 2011

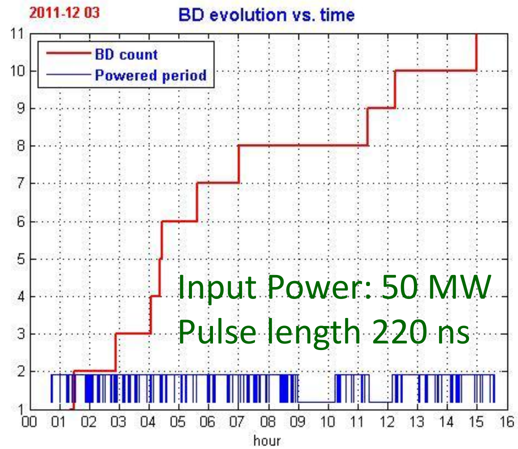
Date	Start time	Stop time	Power (MW)	Pulse (ns)	BDR
21 Nov.	22.24	22.26	70	160	0.88
22 Nov.	14.56	9.51	60	240	$1.7\ 10^{-2}$
23 Nov.	18.41	23.20	70	220	$1.9\ 10^{-2}$
24 Nov.	00.13	9.29	80	200	$1.3\ 10^{-2}$
30 Nov.	18.48	00.16	70	175	$7.4\ 10^{-3}$
1 Dec.	08.55	9.09	80	220	$4.0\ 10^{-3}$
3 Dec.	01.21	14.58	50	220	$3.0\ 10^{-4}$
6 Dec.	19.42	08.25	80	220	$5.8\ 10^{-3}$
7 Dec.	20.00	21.15	>100	120	0.8
8 Dec.	12.59	16.58	>100	150	0.15

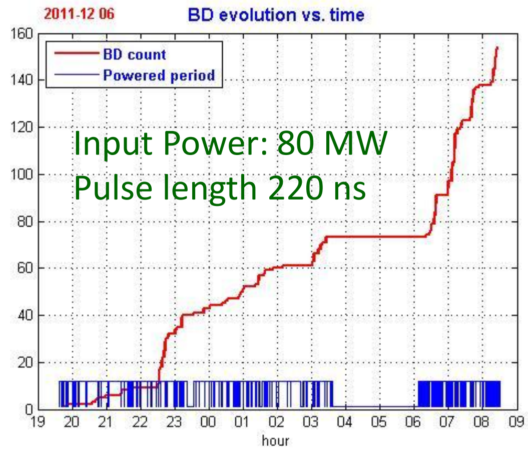
- Only few records are meaningful for statistics

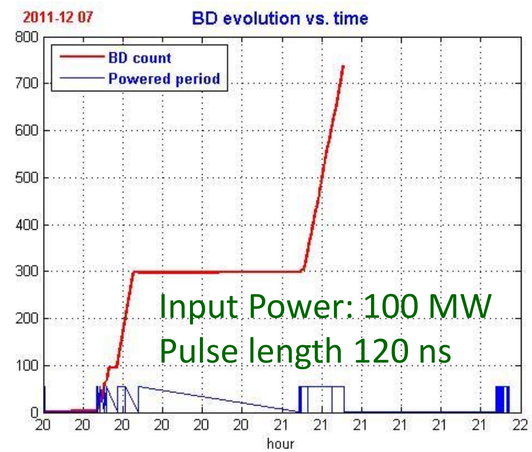
BD count vs. time





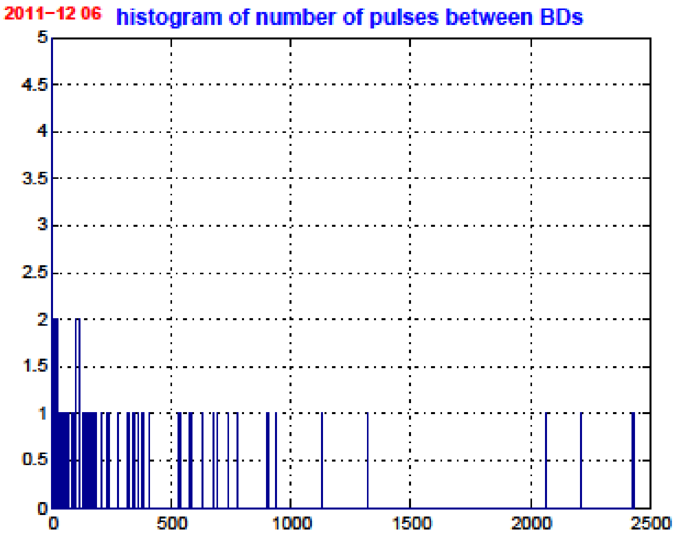


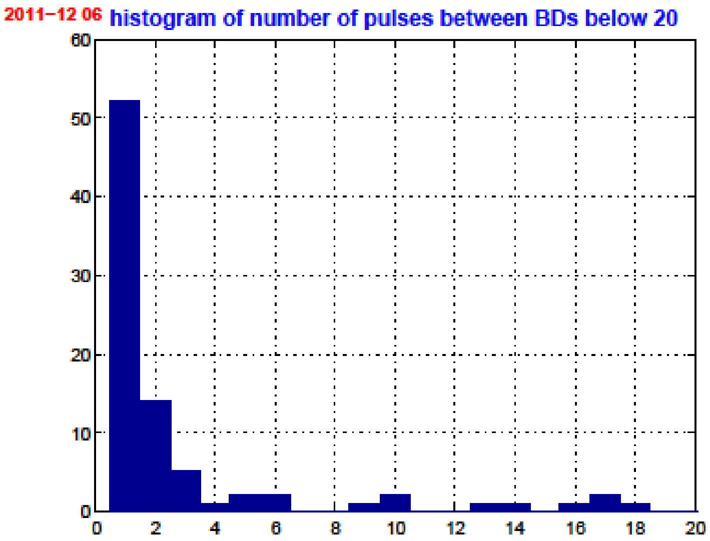




- Due to Drive Beam trips only *BDs count vs. "nominal" RF pulses number* is meaningful.

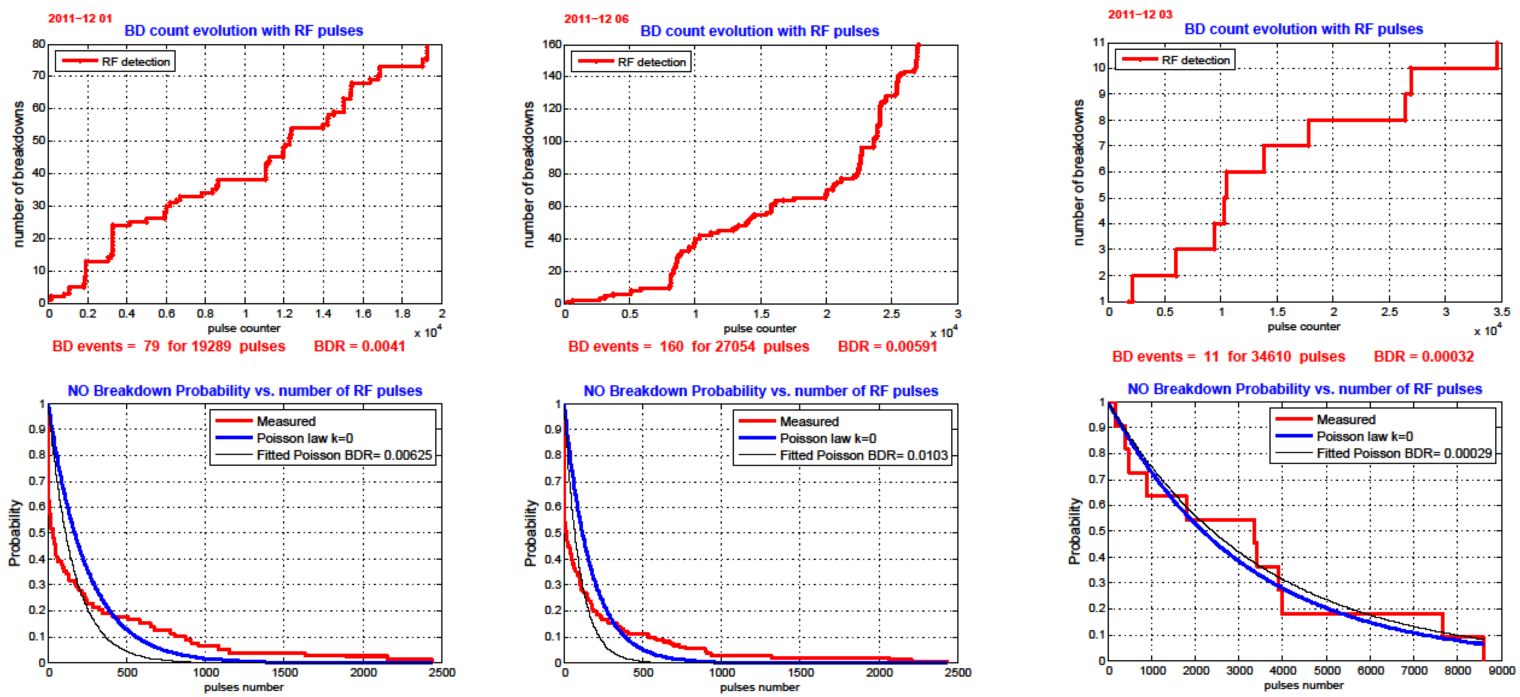
Numbers of RF pulses before a BD





Histogram and zoom on bins below 20 showing the cluster effect.

BDs time distribution and Poisson law



High BDR

Low BDR

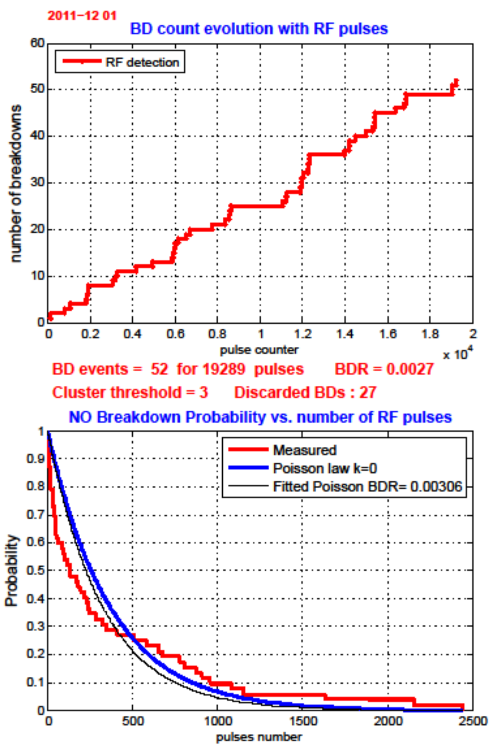
- Randomly distributed events should follow the Poisson law.

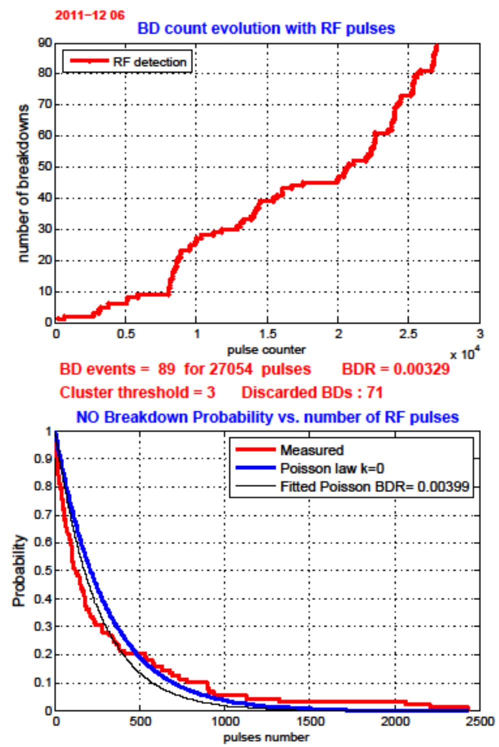
$$P(k,\lambda) = \frac{\lambda^k}{k!}\exp(-\lambda)$$

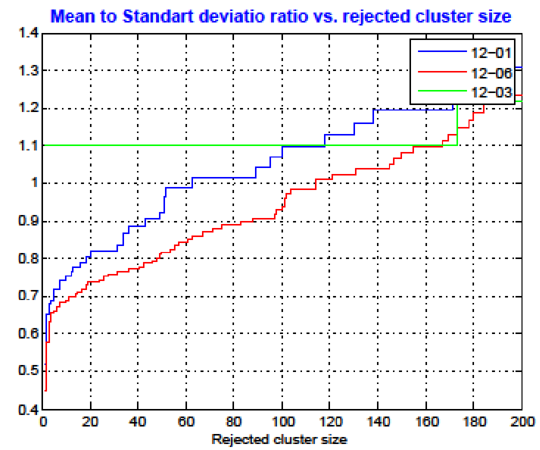
k : number of BDs, λ : BDR x number of pulses

- Clusters make the BD probability (BDR) non stationary

Discarding the cluster events





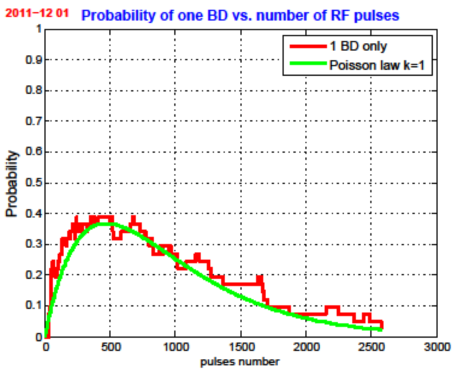


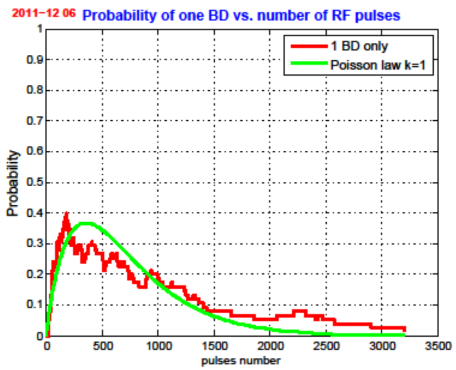
Evolution of mean/σ with the cluster size rejection

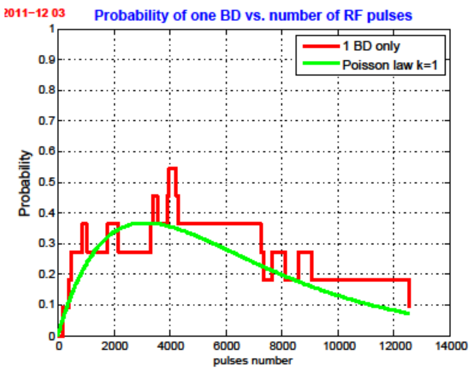
(1 for a Poisson distribution)

Rejecting clustered BDs leads the BDs events to be more “Poisson Like”

Probability of one BD within a given number of RF pulses







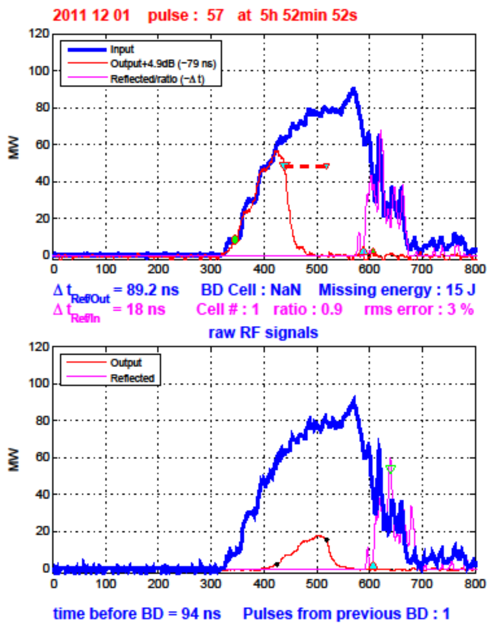
Clusters rejected up to 20 pulses between BDs

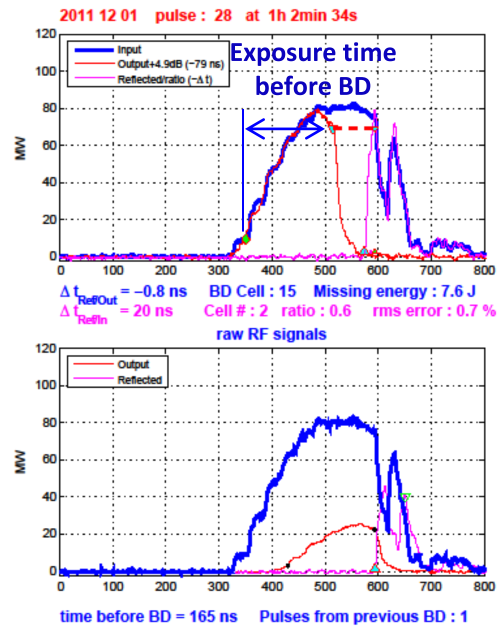
No clusters rejection needed at low BDR

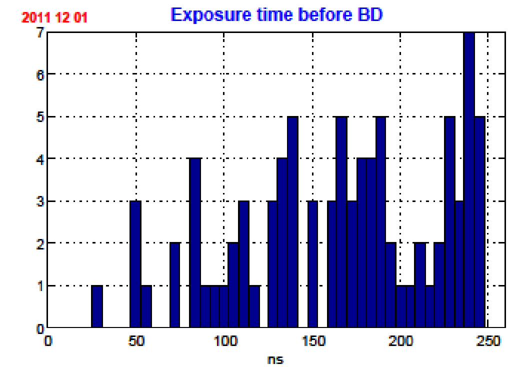
- Poisson law for k = 1 and λ computed using the raw BDR (not a fitted one)

$$P(k,\lambda) = \frac{\lambda^k}{k!}\exp(-\lambda)$$

RF exposure time before BD



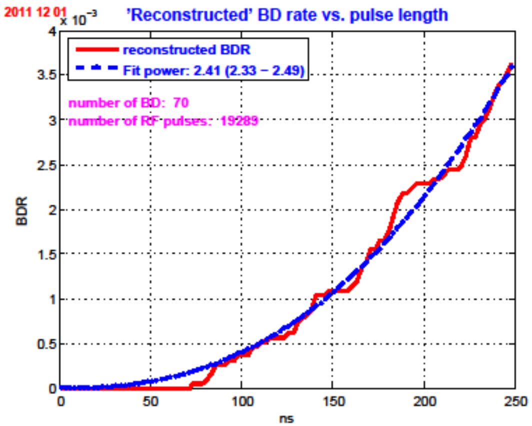


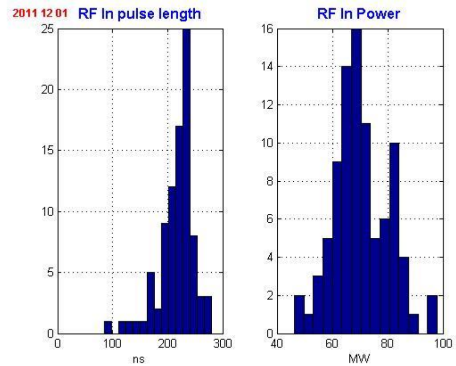


Histogram of exposure time before BD

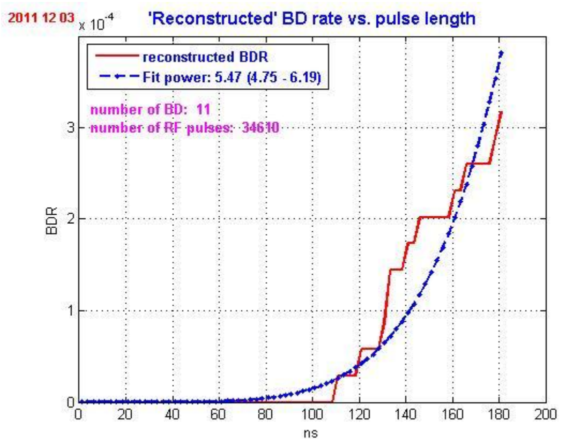
- Exposure time measured on RF transmitted
  - Dependent on edge definition (especially with recirculation pulse shape)

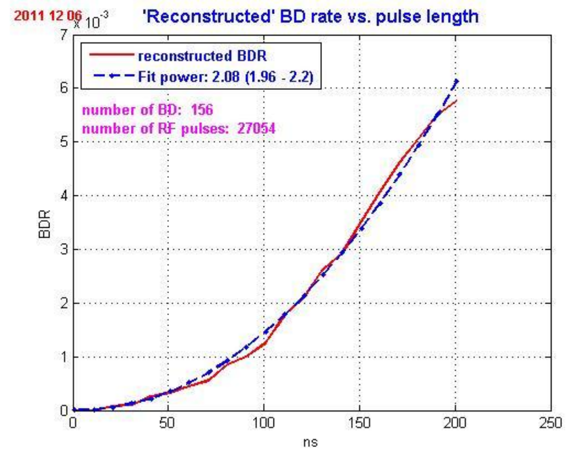
BDR as function of exposure time





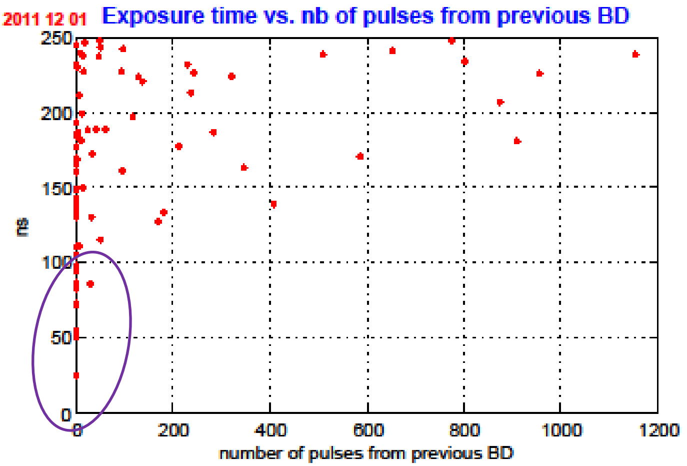
Pulse length and energy stability checking



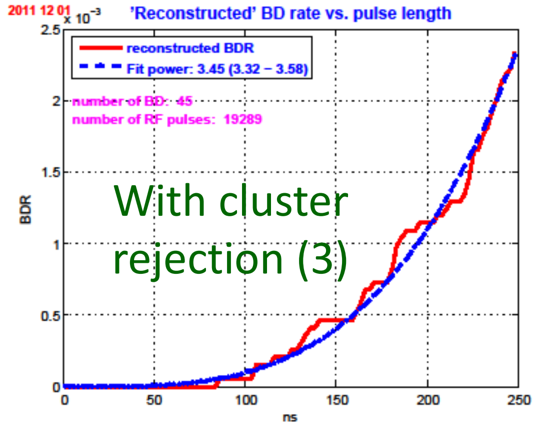


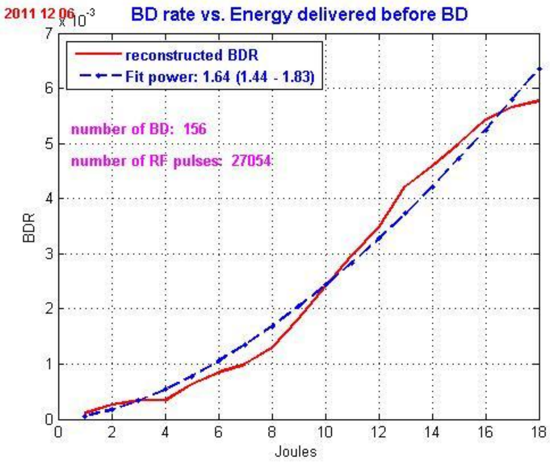
- Assumption : BDs occurred before a given time have the same statistic as if the pulse length would have been this time: NO MEMORY EFFECT CONSIDERED

Influence of clusters



All BDs occurring before 100 ns exposure time are inside clusters

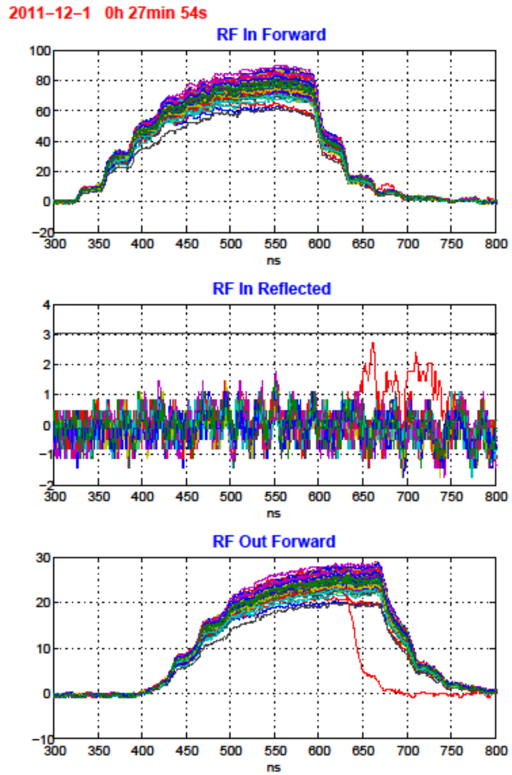




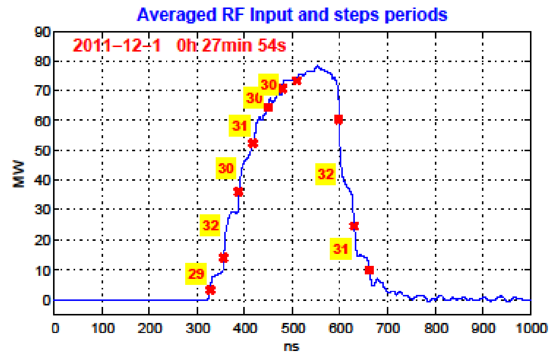
Alternative dependence law: "Energy delivered before BD" to avoid rising edge problem (thank to Jan Kovermann)

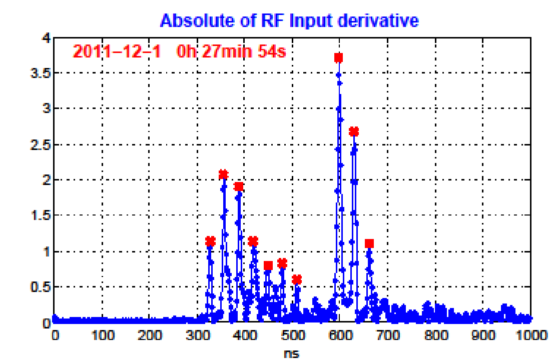
- It will be very interesting to draw the same plot at various pulse lengths *at low BDR* (checking a possible "fatigue" effect)

RF signals without BDs

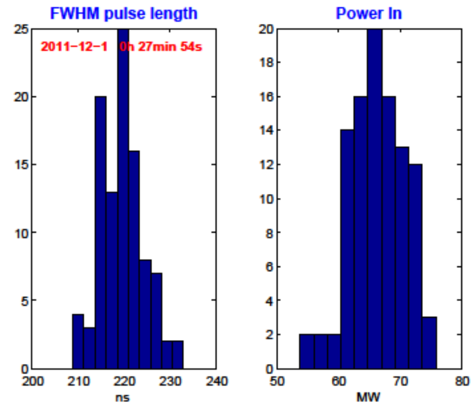


100 superposed signals including 1 BD

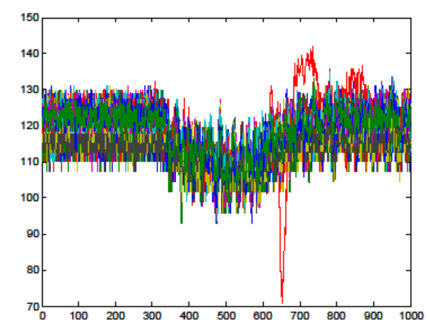




Average input signal and steps detection showing the recirculation loop delay of 31 ns



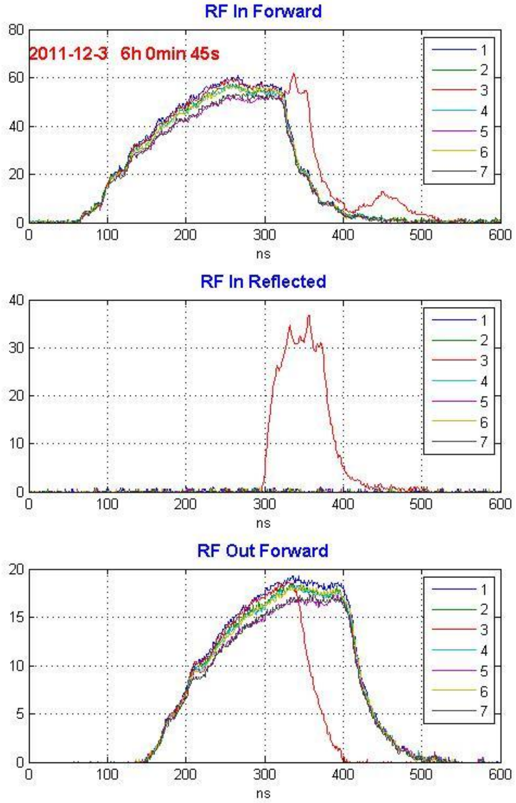
Quite stable pulse length and power characteristics



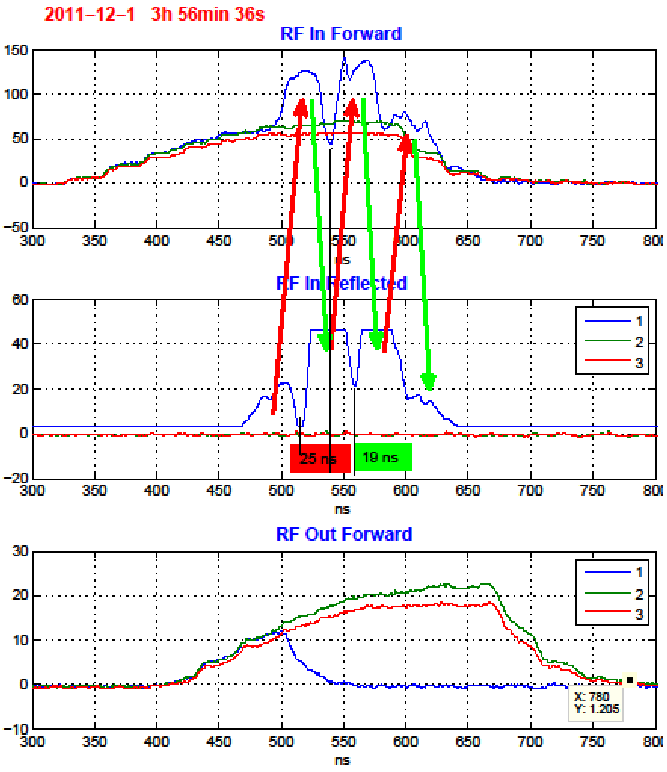
RF reflected phase

- Without BD all signals are quite stable: good RF power production by the Drive Beam

Evidence of ACS BDs effect on RF Input



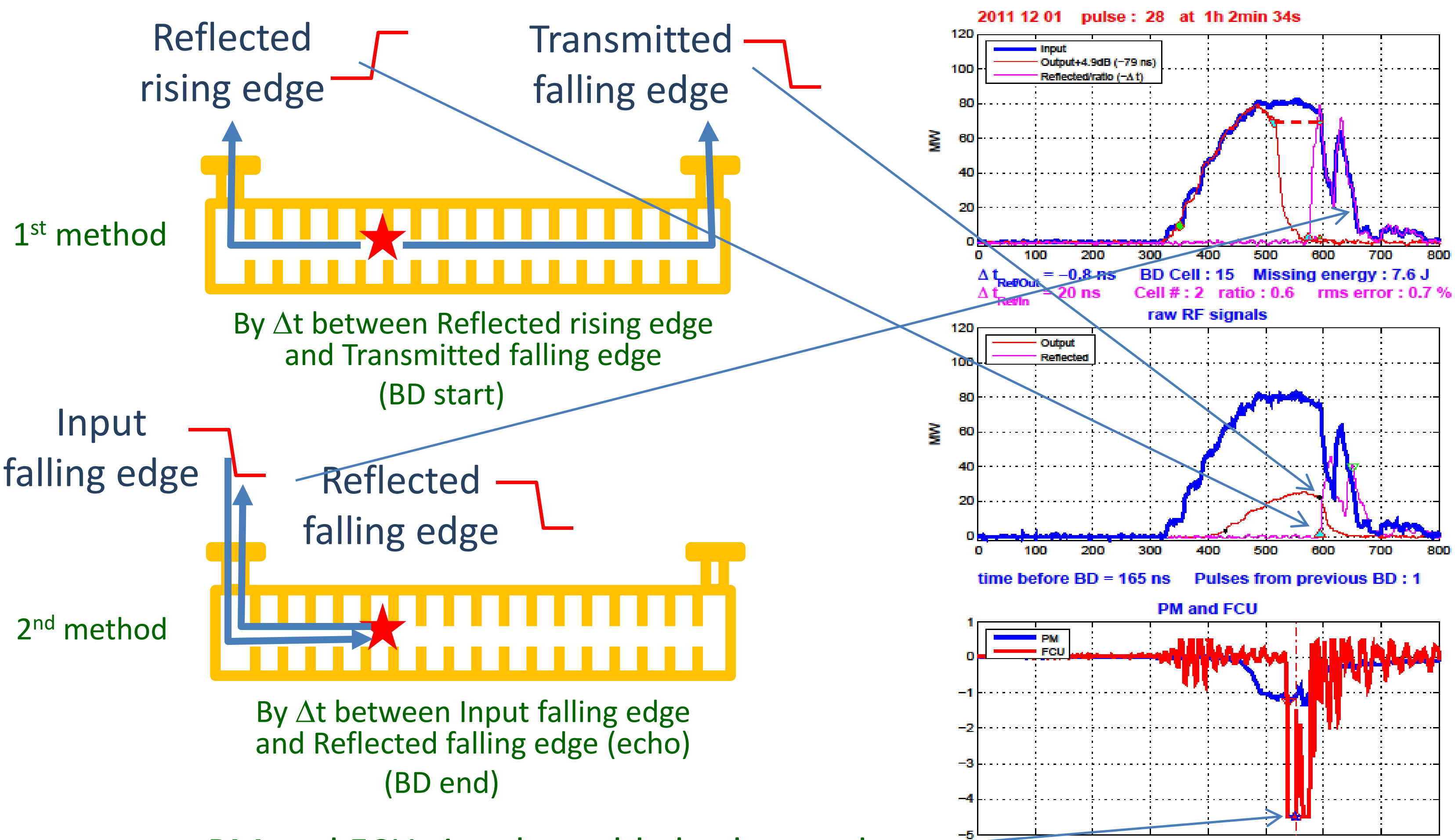
A BD in the ACS affect the PETS output



Possible bouncing of an early BD reflected power

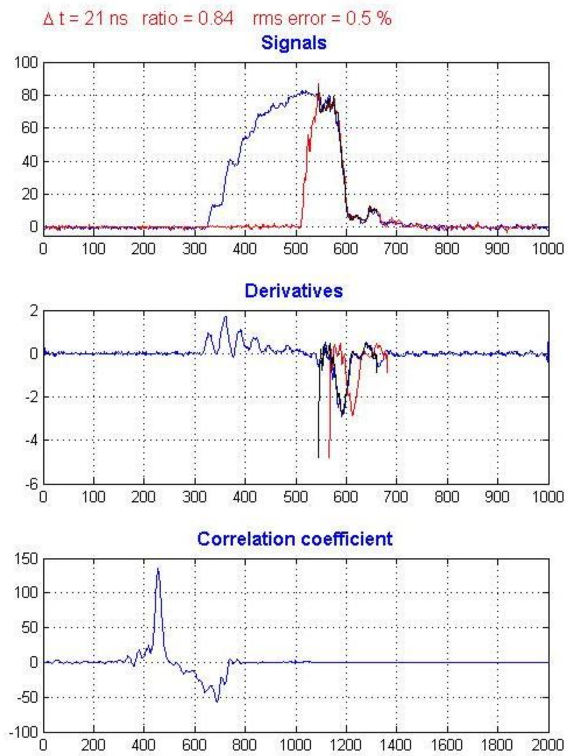
- The reflected power is likely to change the phase of the recirculation loop and consequently modify the PETS produced power

BD location determination



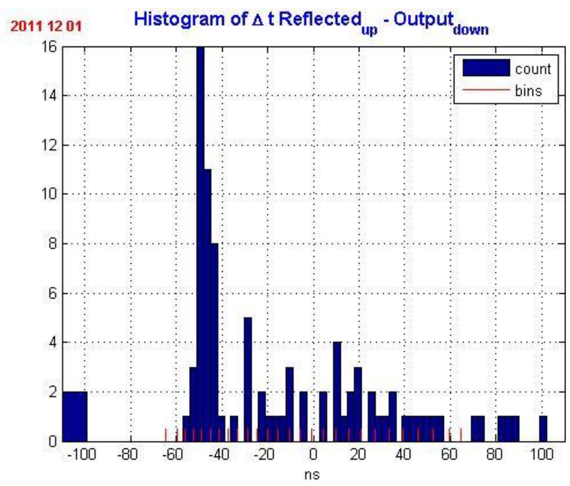
PM and FCU signals could also be used

Edge correlation Input - Reflected

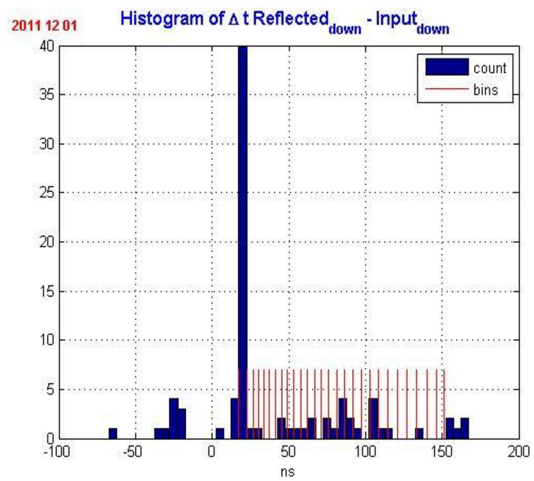


- Use cross-correlation of the derivatives of the falling edge area to accurately determine the Δ time
- Then fit the amplitude minimizing rms difference between shifted signals to determine the attenuation

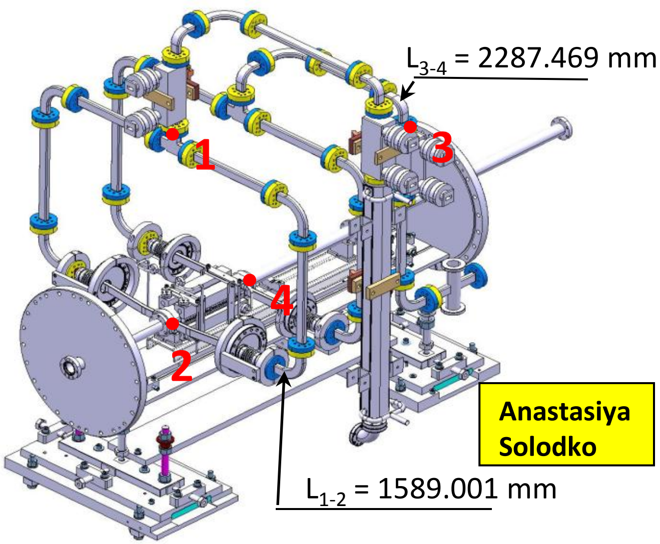
BDs location histograms



1st method : cell #5 seems more affected

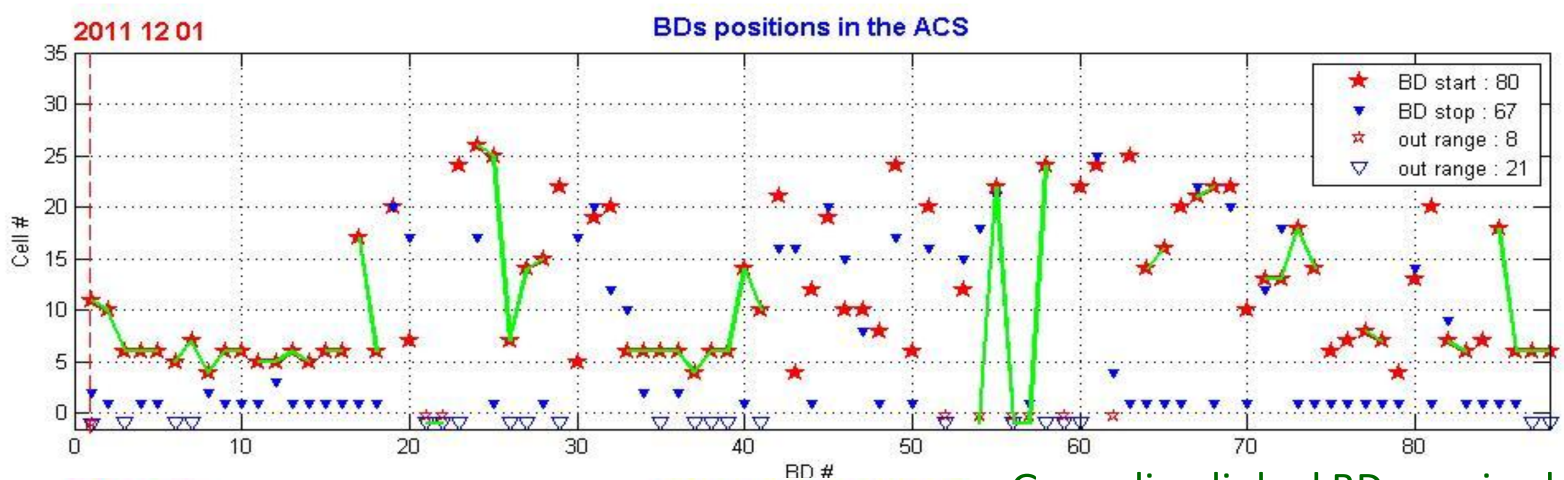


2nd method : cell #1 seems more affected

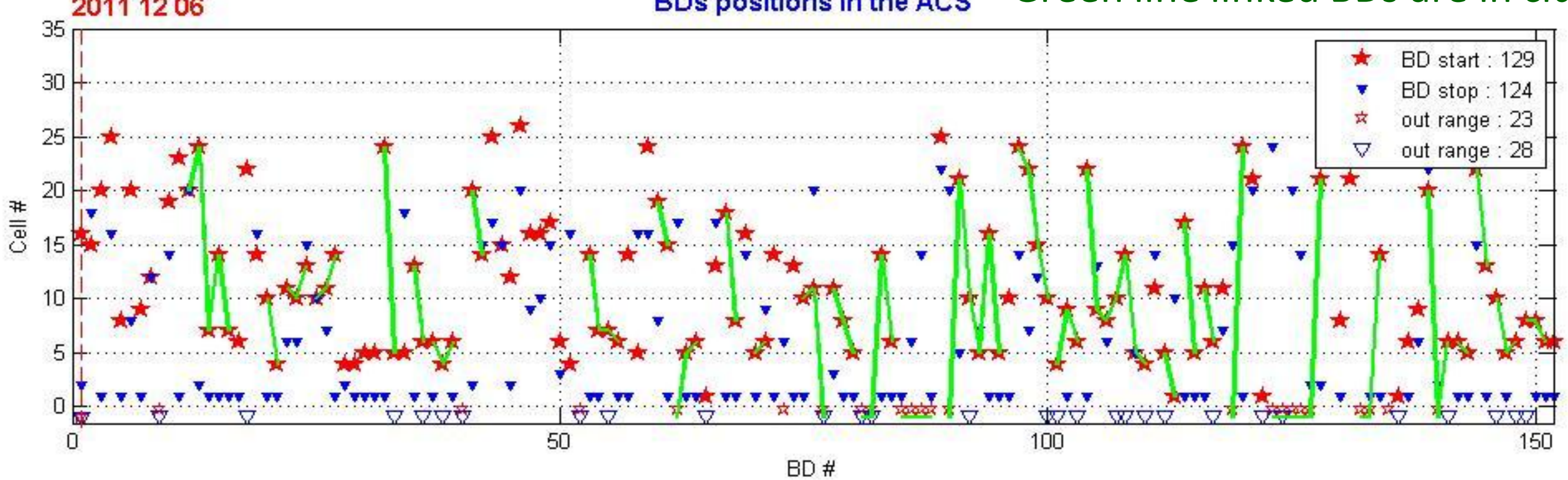


- Cells bins determined by installation and TD24 characteristics
  TD24_vg1.8_disk 12WDSDVG1.8 CLIC_G disk at 12 GHz A.Grudiev, 25/03/10

BDs location chart

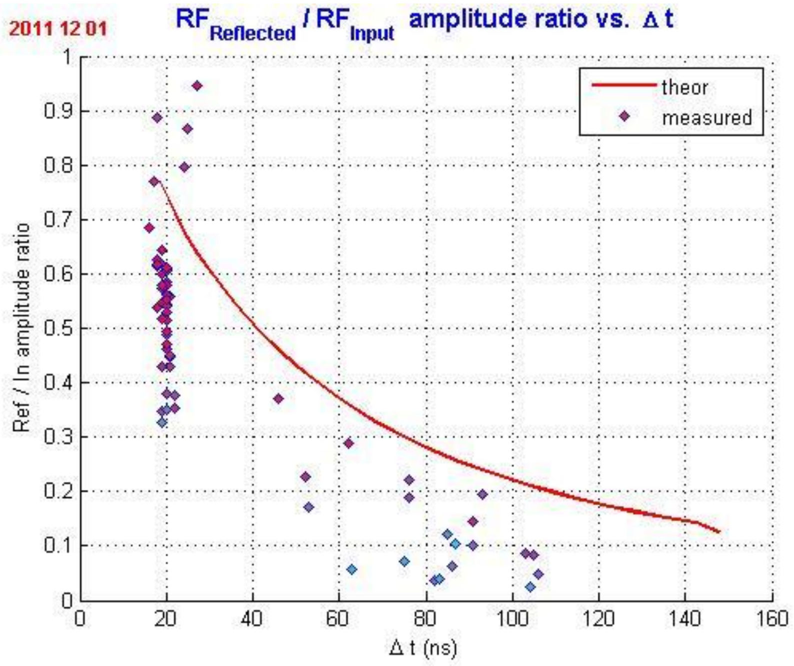


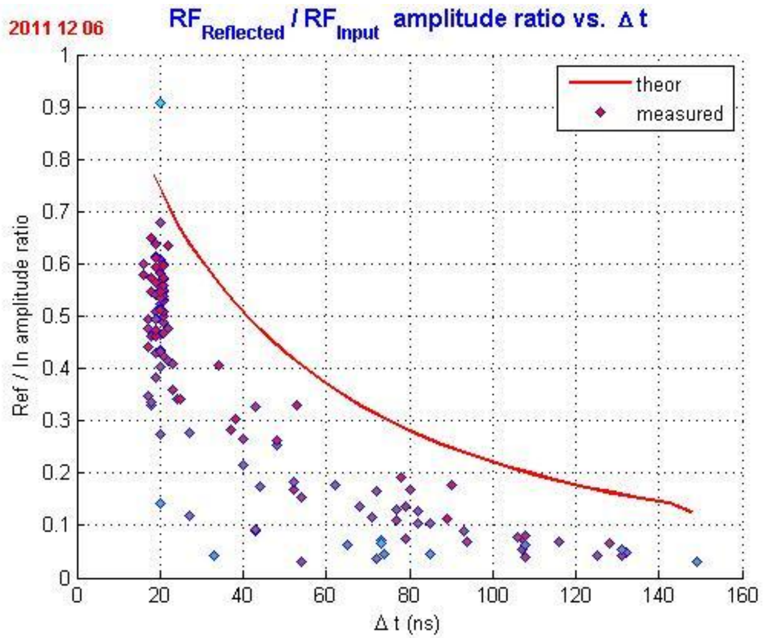
Green line linked BDs are in clusters



- BDs seems to migrate from the initial position to the first cell (from red star to blue triangle)

Attenuation vs. BD location

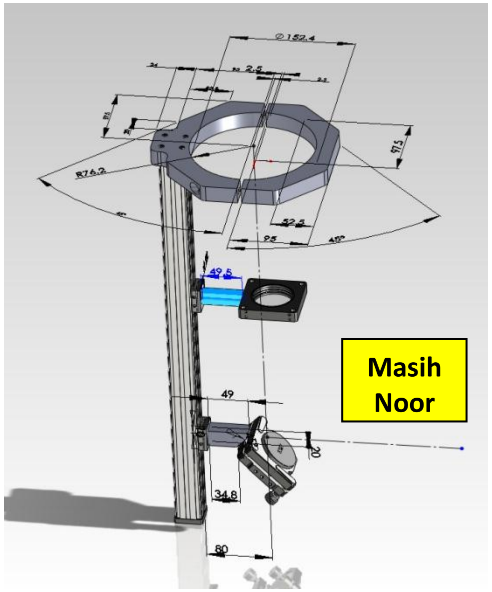




- Reflected power is consistent with the detected position of the BD

The next run…

- Merge Beam Kick measurements with RF characteristics
- Use the RF phase information
- Collect more data at reasonable BDR
  - Long shift at stable power characteristics
  - Higher repetition rate
- Additional diagnostics
  - PM looking inside the TD24 through FCU mirror
  - New re-entrant cavity BPMs
- Use of
  - the Flash Box,
  - the Wakefield monitor
  - …



PM optical line