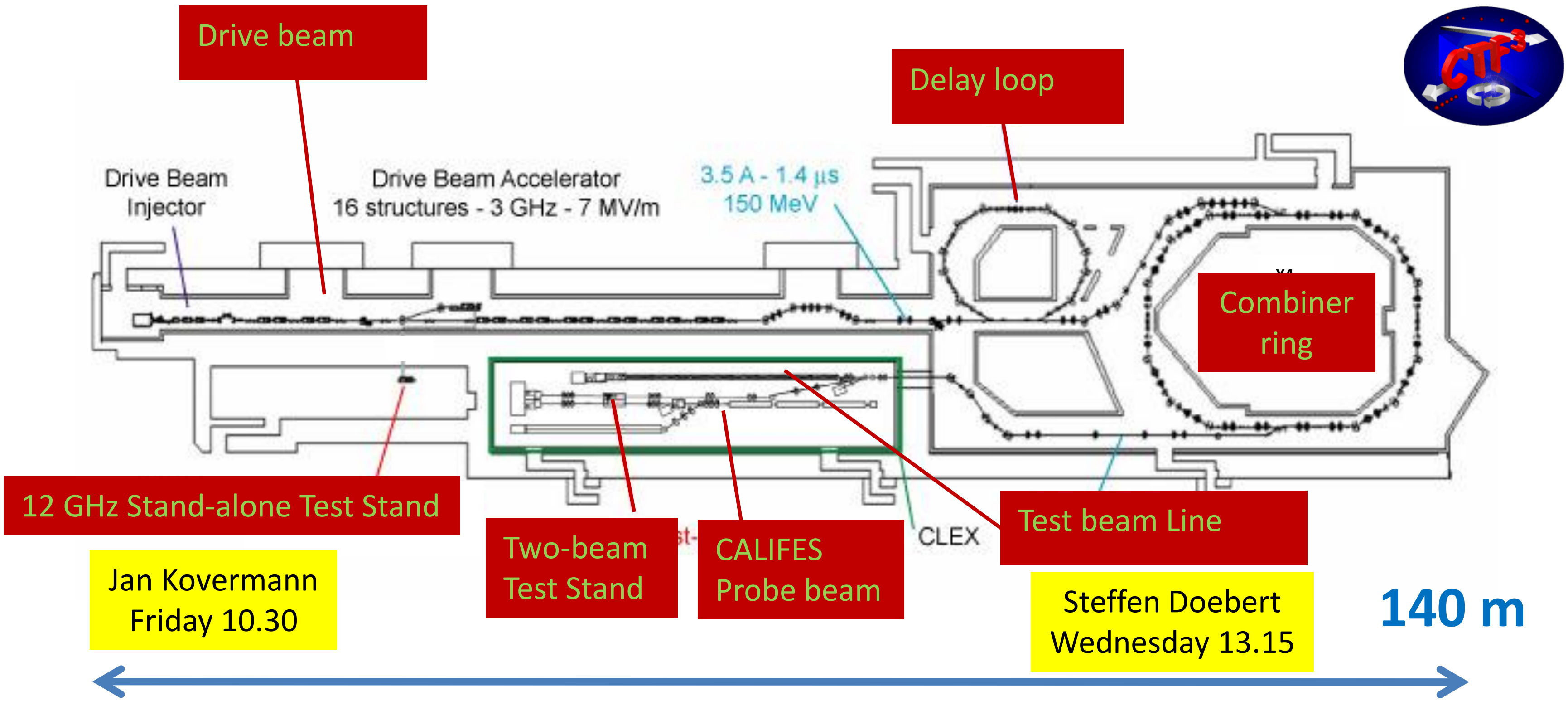
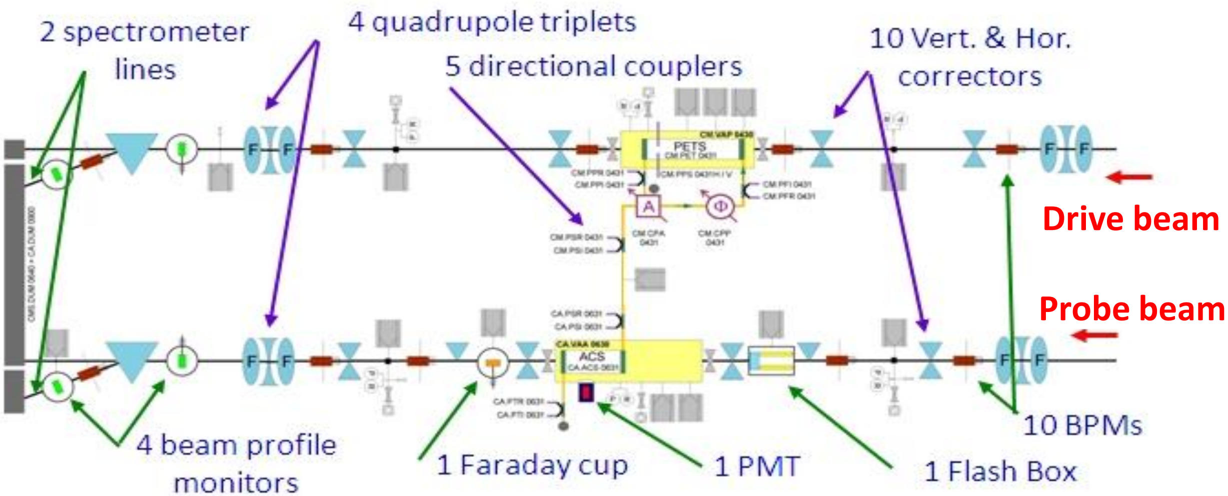
Some Results and Analysis from CTF3

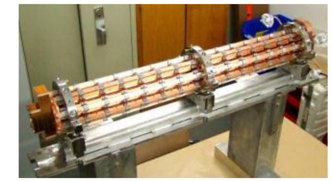
The CTF3 Facility

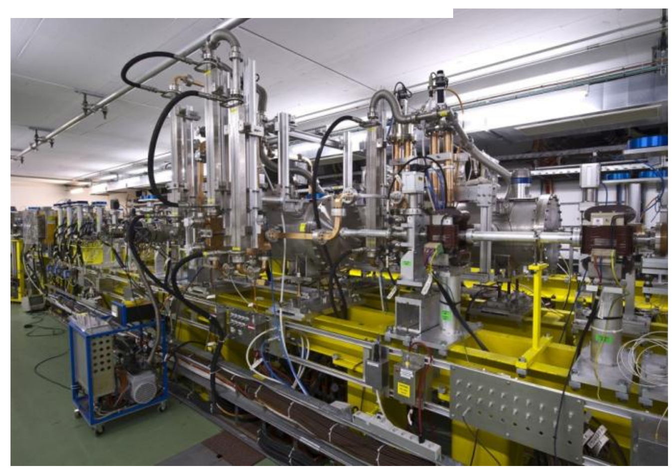


- An unique place where a beam is really accelerated at high gradient
- Great flexibility of RF production (power and pulse length)
- Highly instrumented Test Stand and beam lines
- Low repetition rate (5 Hz max. – presently 0.8 Hz)
- Complex to operate

The Two Beam Test Stand





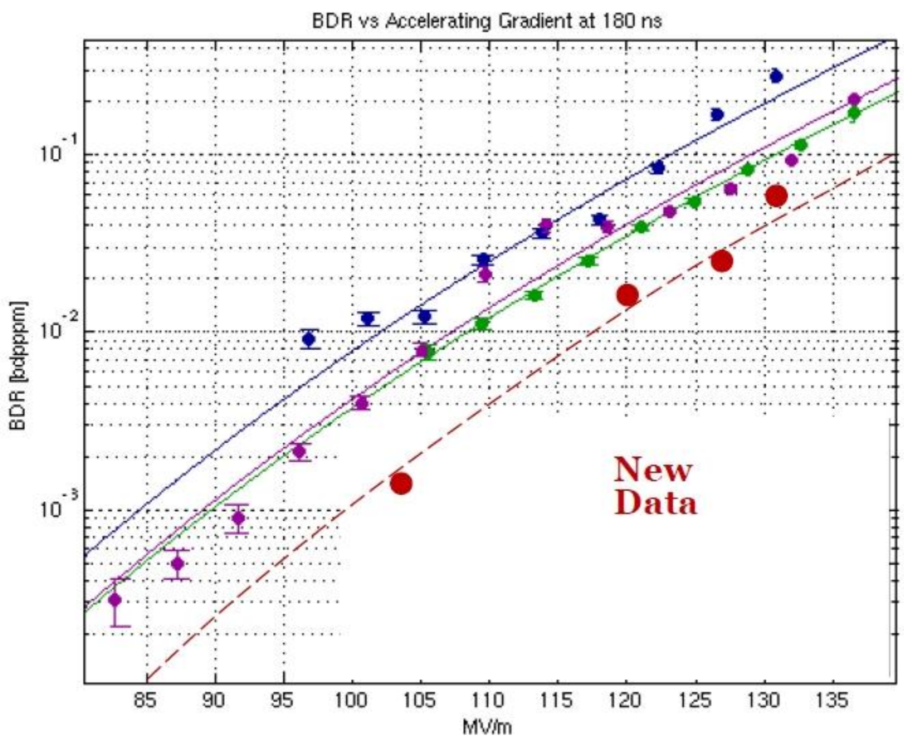


- Two lines hosting vacuum tanks for PETS and for ACS
- A complete set of diagnostics for beams, RF phase / power measurements and breakdown detection
- Quite a versatile RF layout

Contents

- Statistical analysis
  - 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
  - RF input reaction to BDs
  - BDs locations
  - Kick measurements during BDs
- New diagnostics and possible improvements

BDR from the last experiments



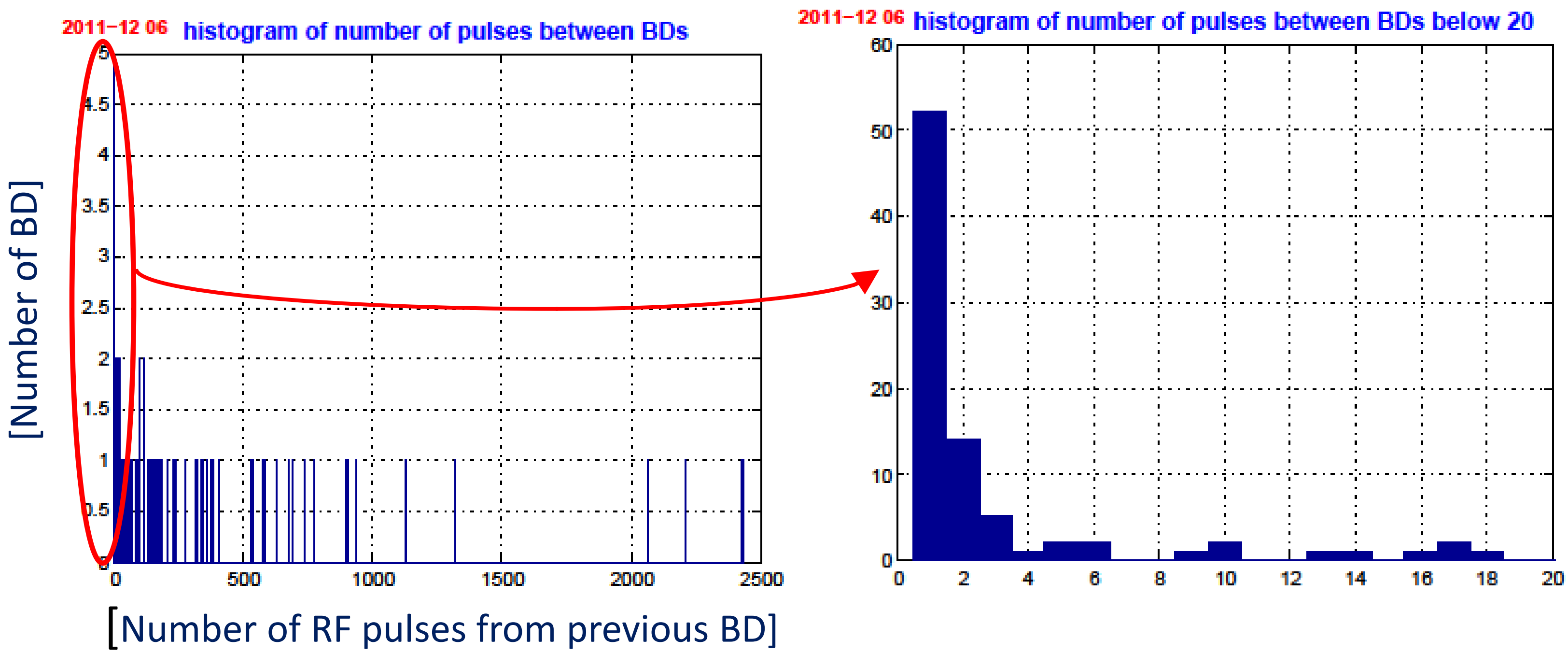
R. Corsini – CLIC Project Meeting, 9 Dec. 2011

Date	Power (MW)	Pulse (ns)	BDR
21 Nov.	70	160	0.88
22 Nov.	60	240	1.7 10^{-2}
23 Nov.	70	220	1.9 10^{-2}
24 Nov.	80	200	1.3 10^{-2}
30 Nov.	70	175	7.4 10^{-3}
1 Dec.	80	220	4.0 10^{-3}
3 Dec.	50	220	0.3 10^{-3}
6 Dec.	80	220	5.8 10^{-3}
7 Dec.	>100	120	0.8
8 Dec.	>100	150	0.15

- Only few records are meaningful for statistics

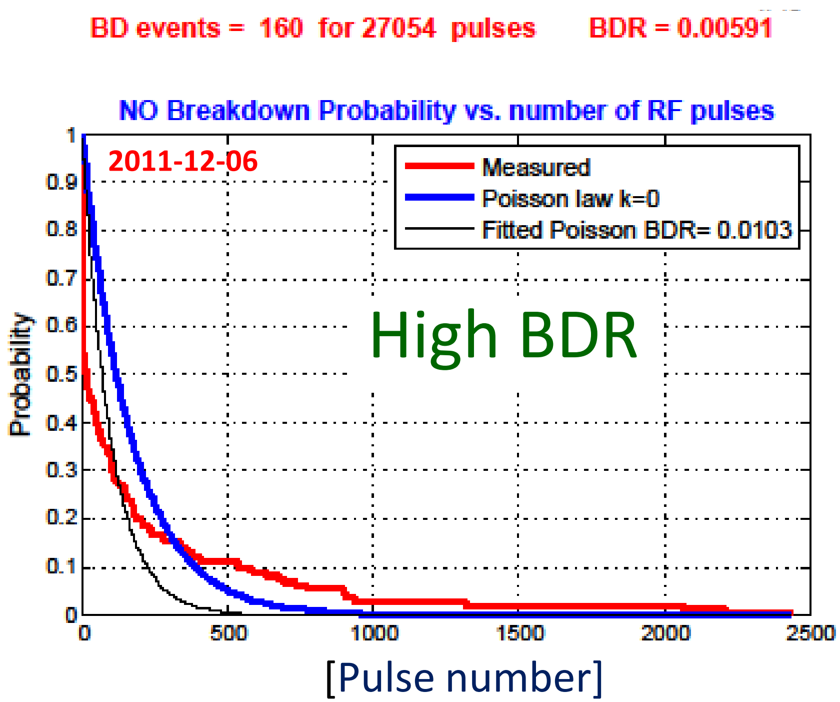
Numbers of RF pulses before a BD

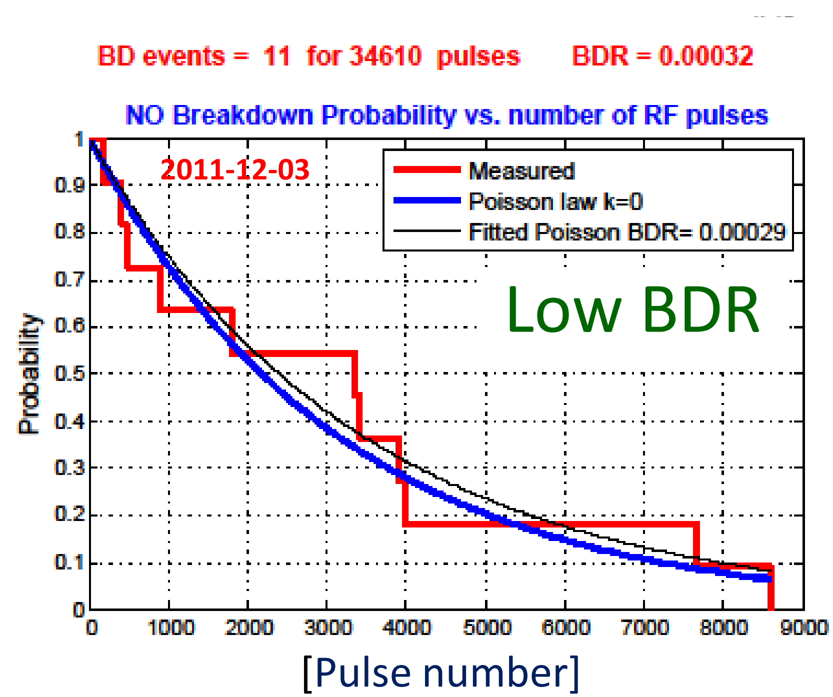
How far BDs occur randomly and independently of one another?



Histograms and zoom on bins below 20 pulses before BD showing the cluster effect.

BDs time distribution and Poisson law





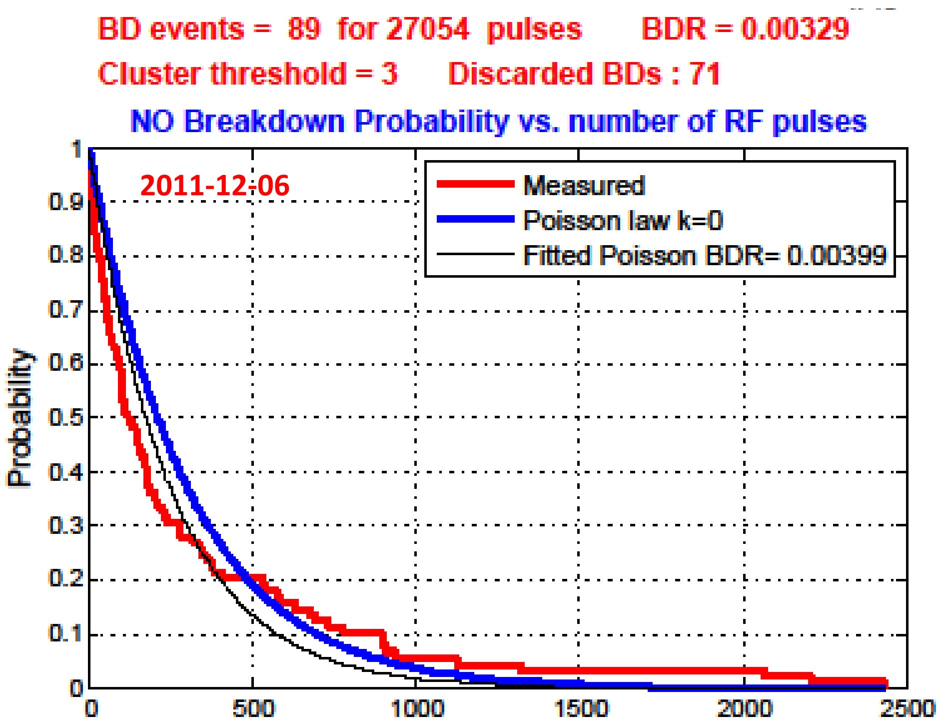
- Randomly distributed events should follow the Poisson law.

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

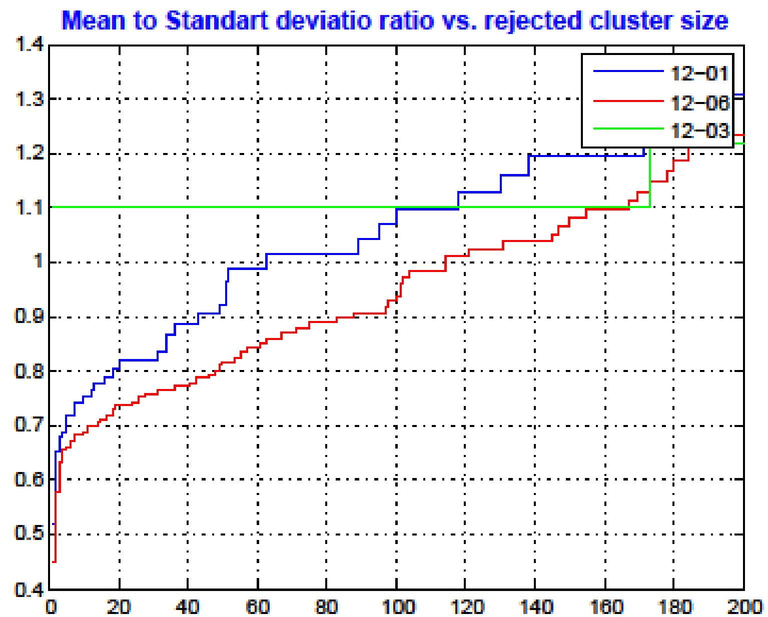
k : number of BDs, λ : BDR x number of pulses

- Clusters make the BD probability (BDR) non stationary

Discarding the cluster events



[Pulse number]



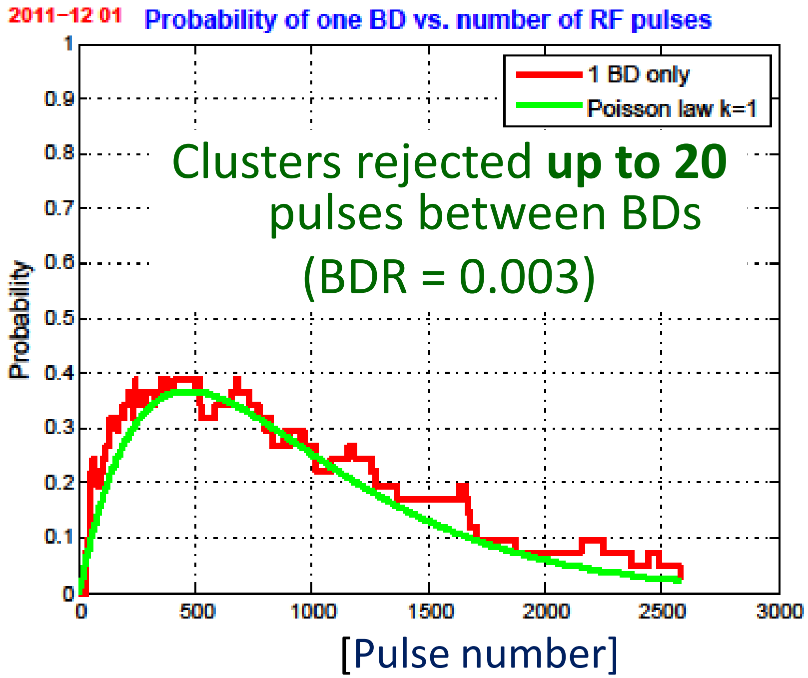
[Rejected cluster size]

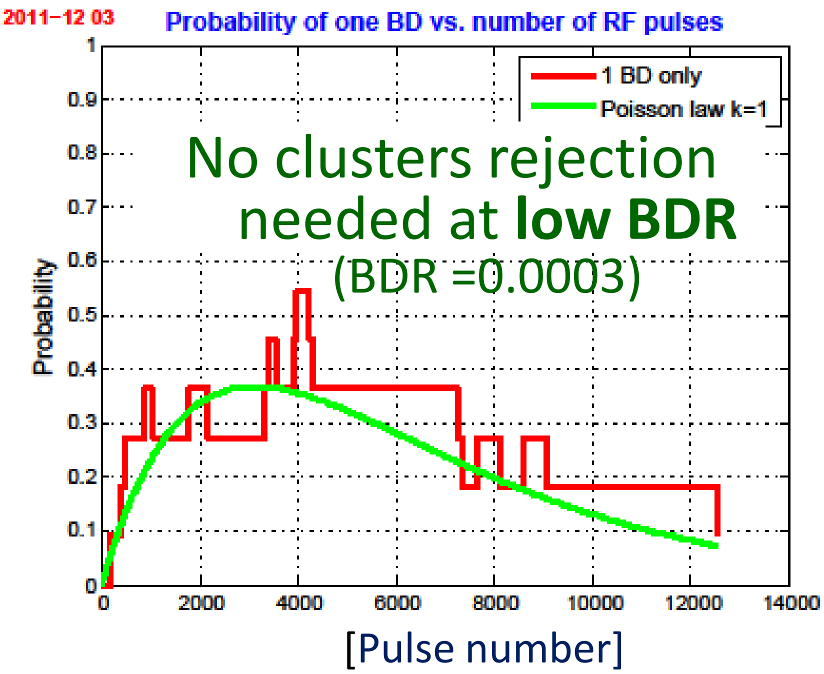
Rejecting clustered BDs leads the BDs events to be more "Poisson Like"

Evolution of mean/σ with the cluster size rejection

(1 for a Poisson distribution)

Probability of one single BD within a given number of RF pulses

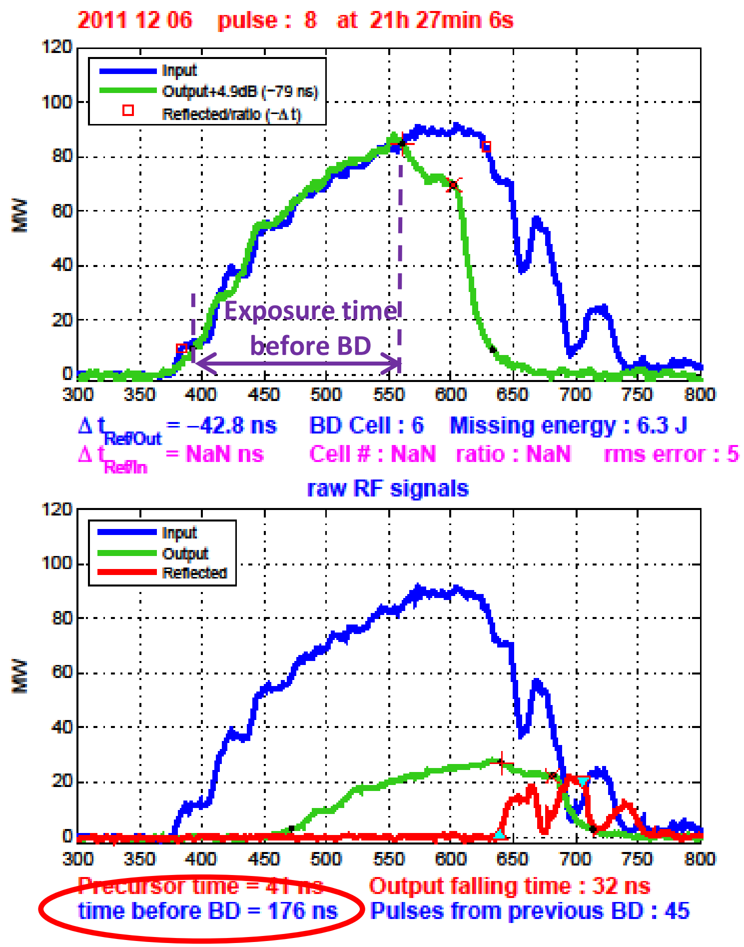


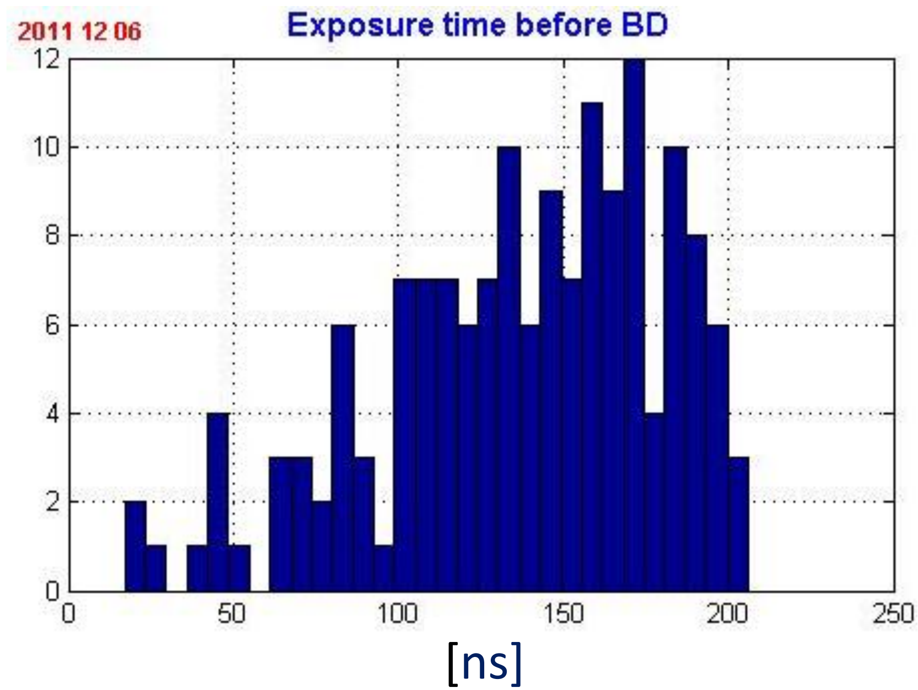


- Poisson law for k = 1 and λ computed using the raw BDR (not a fitted one)

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

RF exposure time before BD

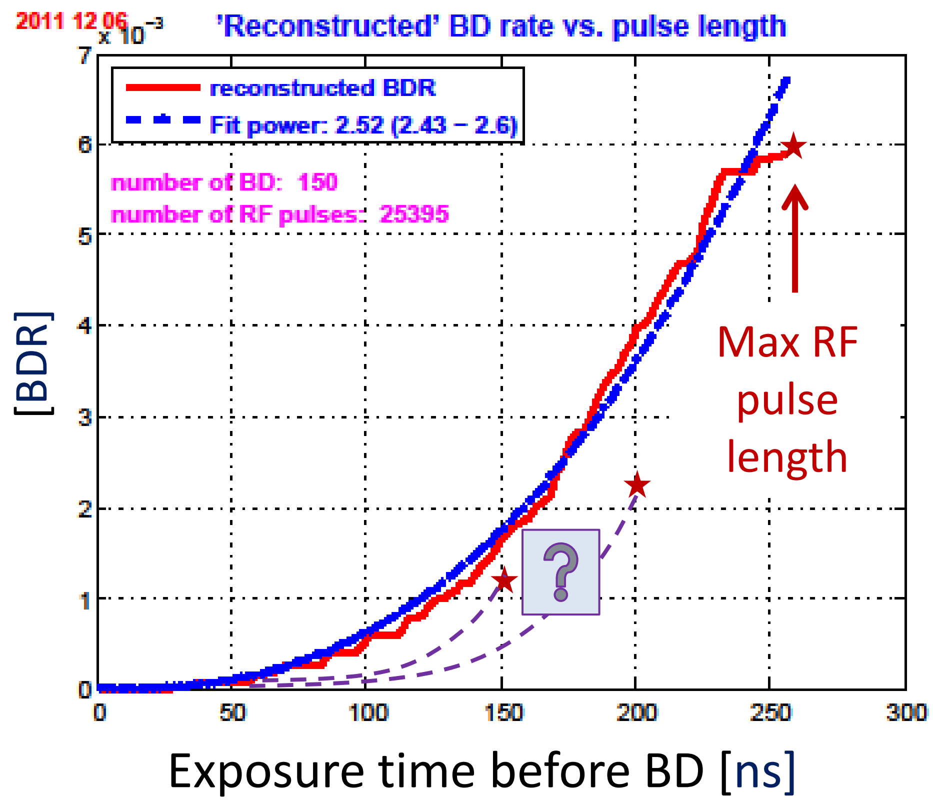




Histogram of exposure time before BD

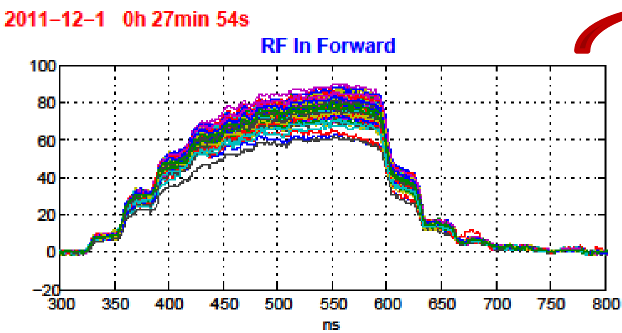
- Exposure time = RF transmitted pulse length
  - Dependent on edges definition (especially with recirculation pulse shape)

BDR as function of exposure time

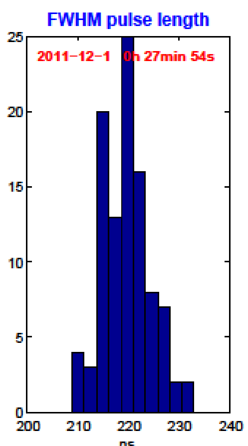


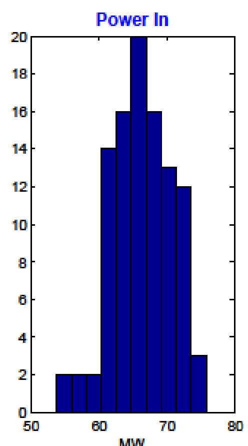
- Hypothesis : BDs occurred before a given time have the same statistic as if the pulse length would have been this exact time.
- It will be very interesting to draw the same plot with various pulse lengths (looking for a possible “fatigue” effect)

RF signals without BDs

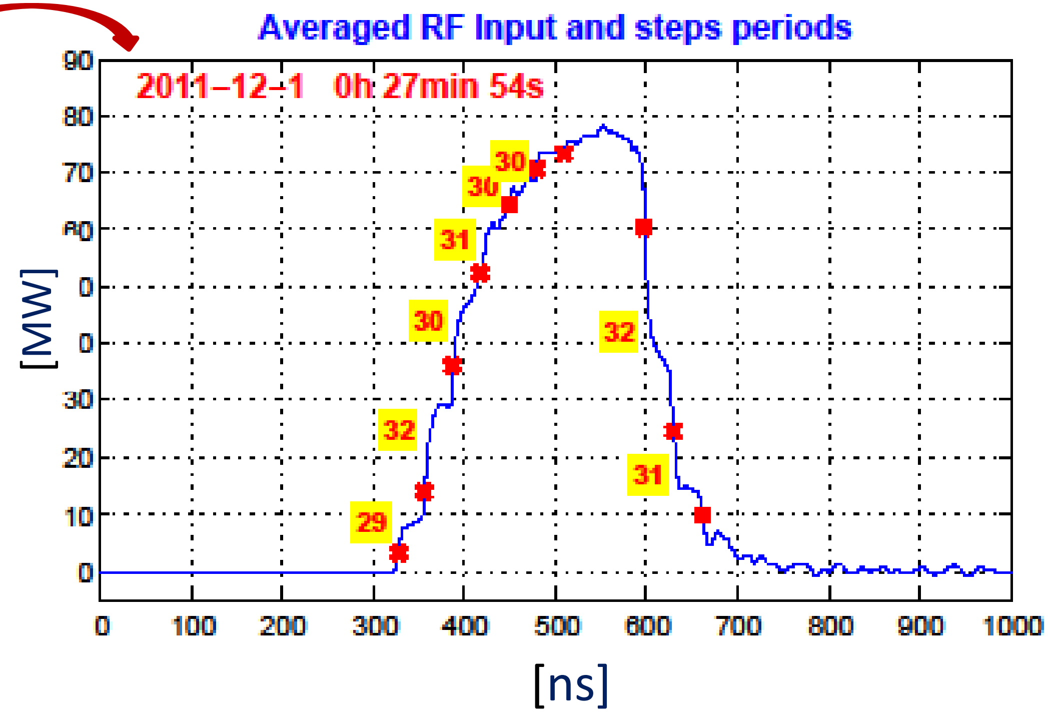


100 superposed signals





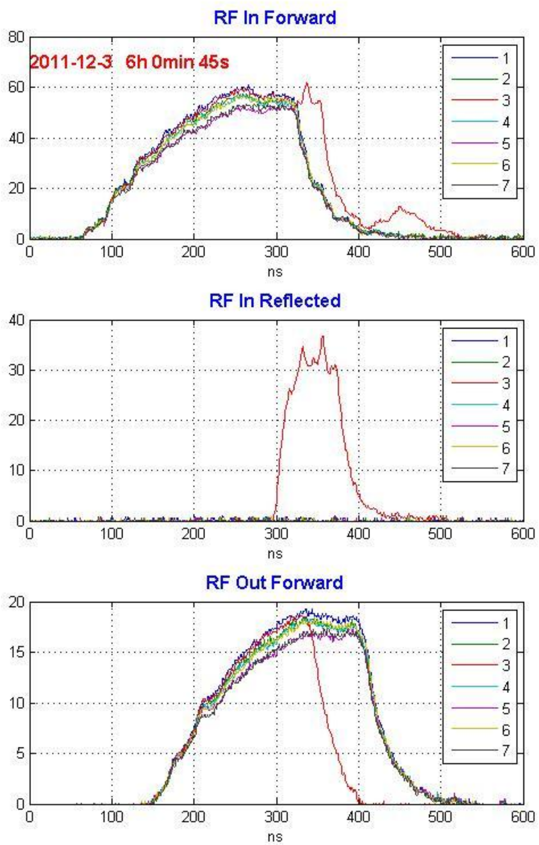
Quite stable pulse length and power characteristics

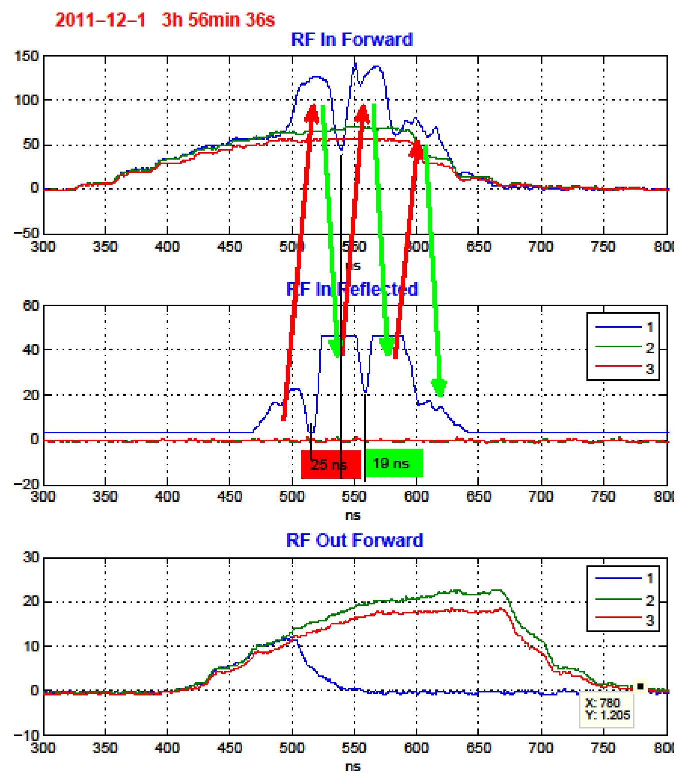


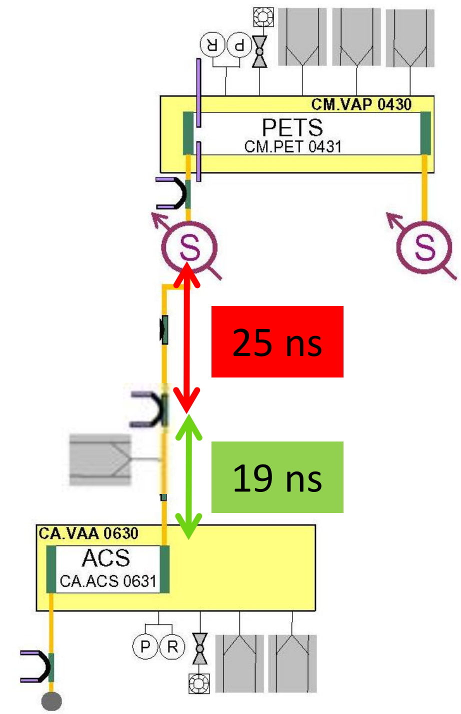
Average input signal and steps detection showing the recirculation loop delay of 31 ns

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

Evidence of ACS BDs effect on input power





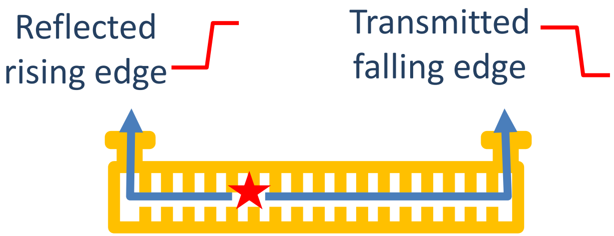


A BD in the ACS affects the PETS output

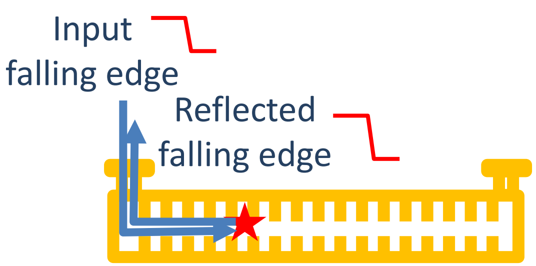
Bouncing of an early BD reflected power

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

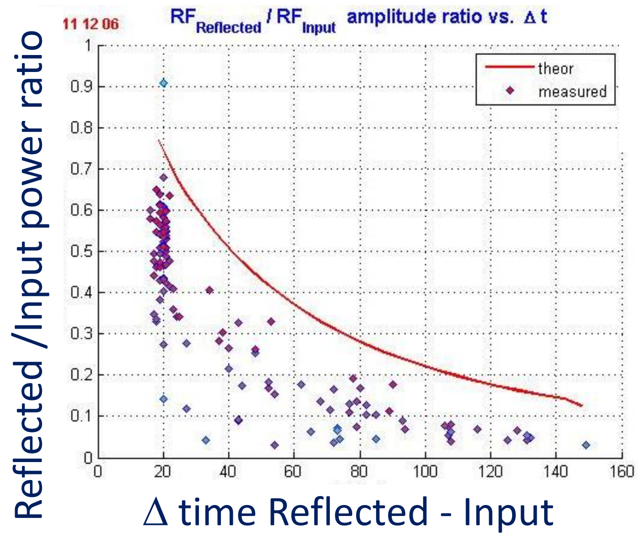
BD location determination

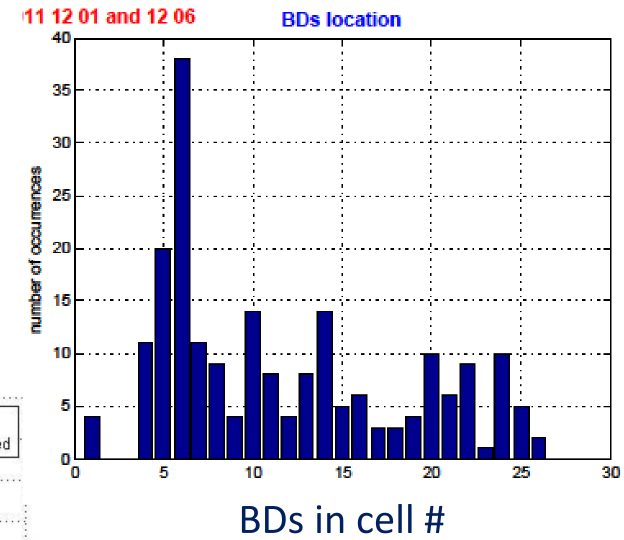


1st method (transmission): looking at BD position when BD strikes



2nd method (echo): looking at BD position when RF pulse stops

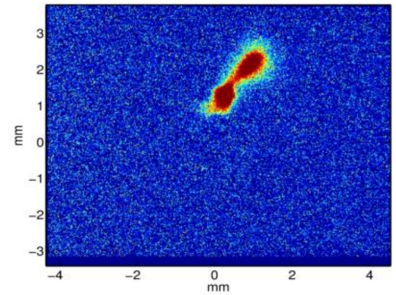


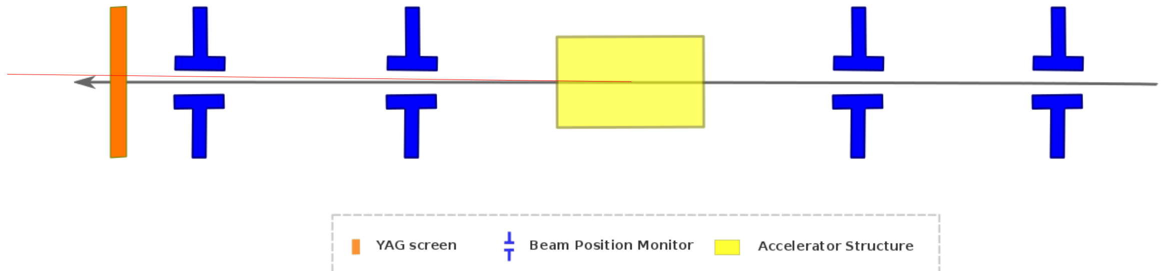


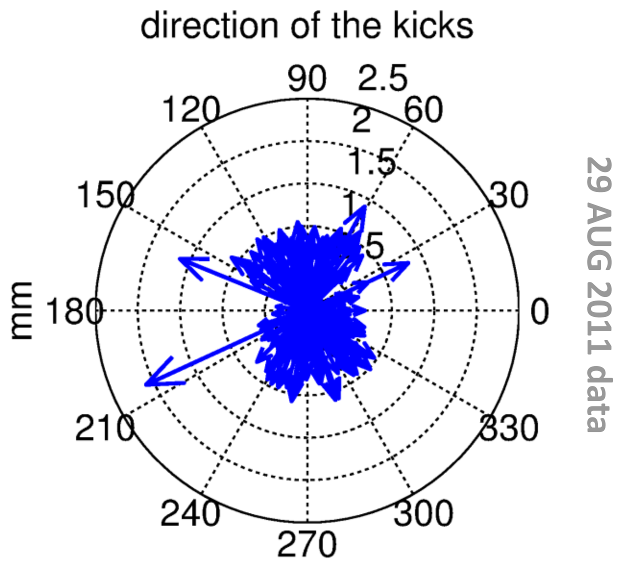
Cells 5-6 are the most affected by BDs

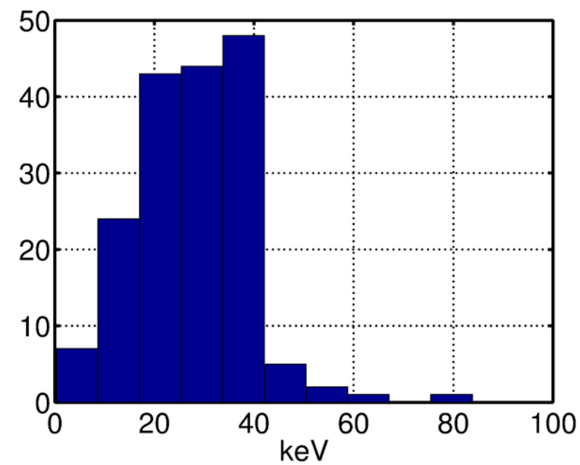
- Using the Reflected power signal is likely to introduce a bias in the BD cell position detection
- Attend to use PM and FCU signals instead (not fully successful up to now)

Kick Measurement









preliminary result (to be confirmed);

- Analysis on ~170 BD events, 2-Gaussian fit on the screen
- kicks corresponding to a transverse momentum between 10 and 40 keV/c (measurements at NLCTA within 30 keV/c, cfr. Dolgashev, SLAC-PUB-10668)

The next run...

- Collect more data about beam kicks
- Use the RF phase information
- Collect more BDs data at reasonable BDR
  - Long shift at stable power characteristics
  - Higher repetition rate
- Additional diagnostics used
  - PM looking inside the TD24 through FCU mirror
  - New re-entrant cavity BPMs
  - Flash Box,
  - Wakefield monitor
- Apply new ideas exchanged during HG 2012 in KEK