August 24, 2021

Careggi and Labec beam tests: first analysis and comparison

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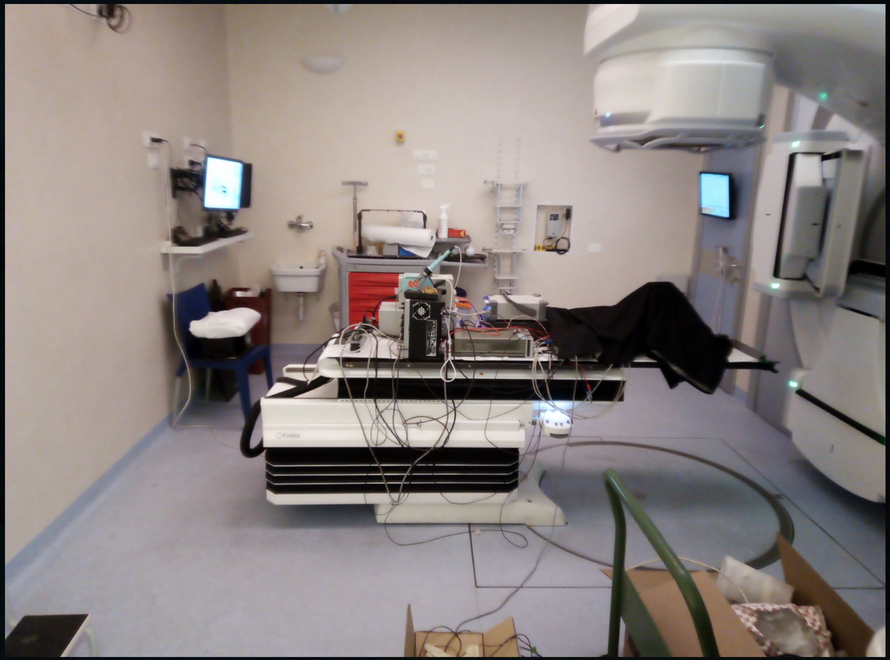
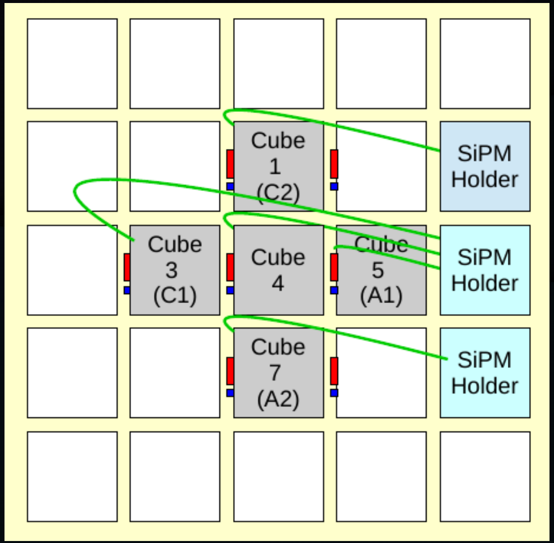
Beam test facility at Carggi

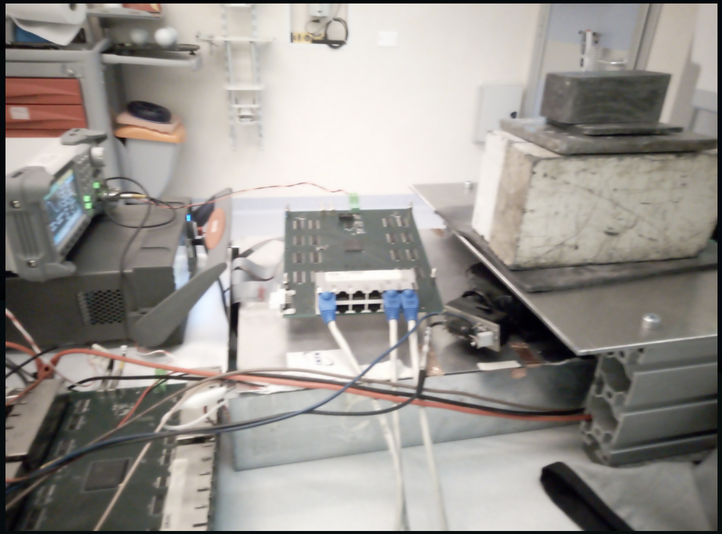
- Low energy beam with secondary photons
  - Obtained by 6 MeV electrons hitting a target.
  - Mean photon energy $\sim$ 2 MeV.
  - High multiplicity: typical dose in water $\sim$ 2Gy/min $\rightarrow$ (~10^8 photons)
  - Bunch time duration $\sim$ 2 us
  - Beam width $\sim$ 2*2 cm^2.
  -
- The beam saturates both LPD and SPD $\rightarrow$ we used Pb to attenuate the beam
  - Conf 1: $\sim$ 27.5 cm Pb
  - Conf 2: $\sim$ 20 cm Pb
  - Conf 3: $\sim$ 17 cm Pb



Layer tested at Careggi.

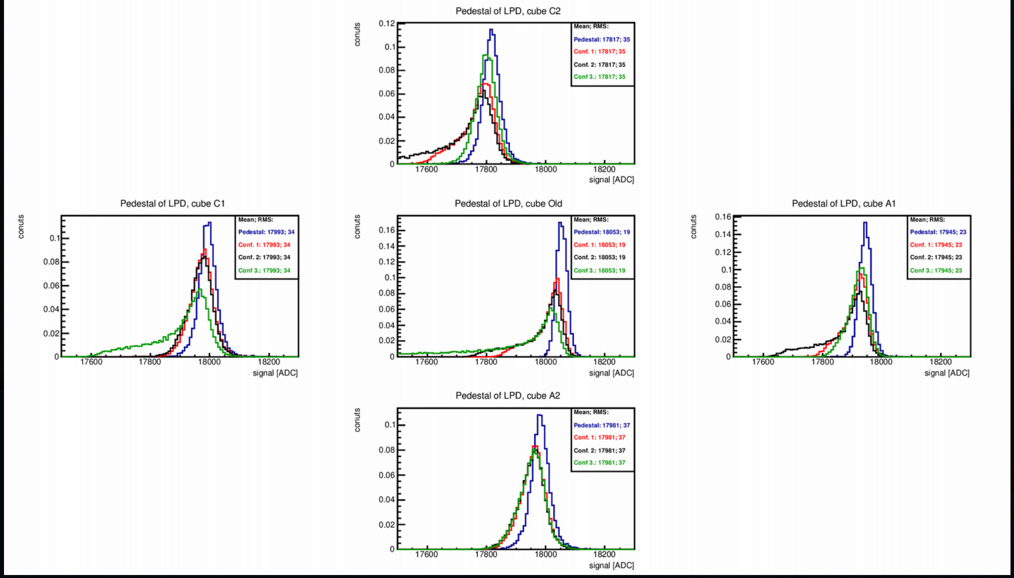
- A single layer was tested, it includes
  - 2 LYS0 provided by IHEP with the new PD package (named C1,C2), glue → EPOTEK
  - 2 LYS0 provided by Perugia with the new PD package (named A1,A2), glue → EPOTEK
  - 1 LYS0 provided by IHEP with the old LPD and SPD (named Old), glue → Silicone

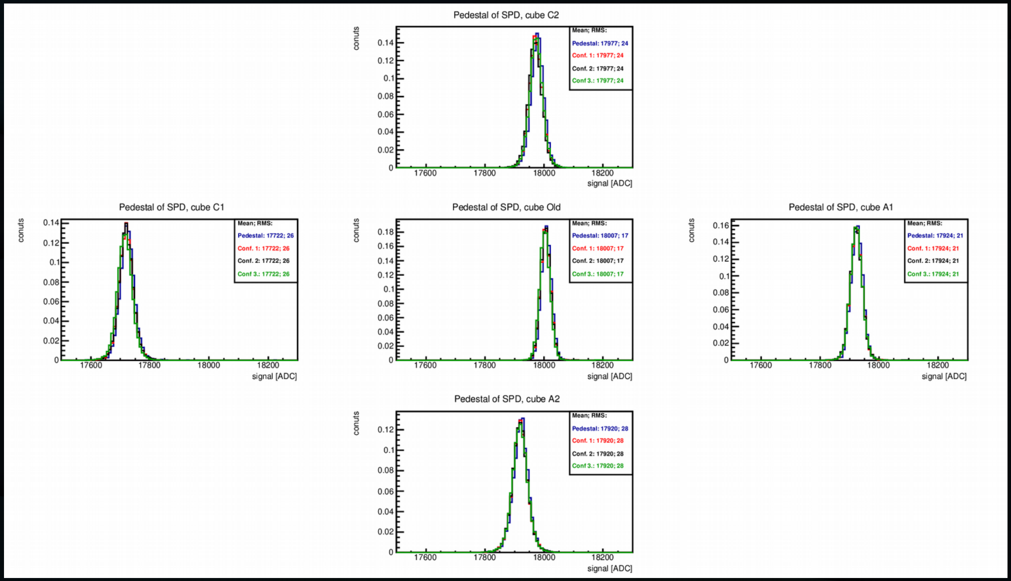




Pedestal check

- Comparison of pedestal distribution for the 3 configurations + beam off.



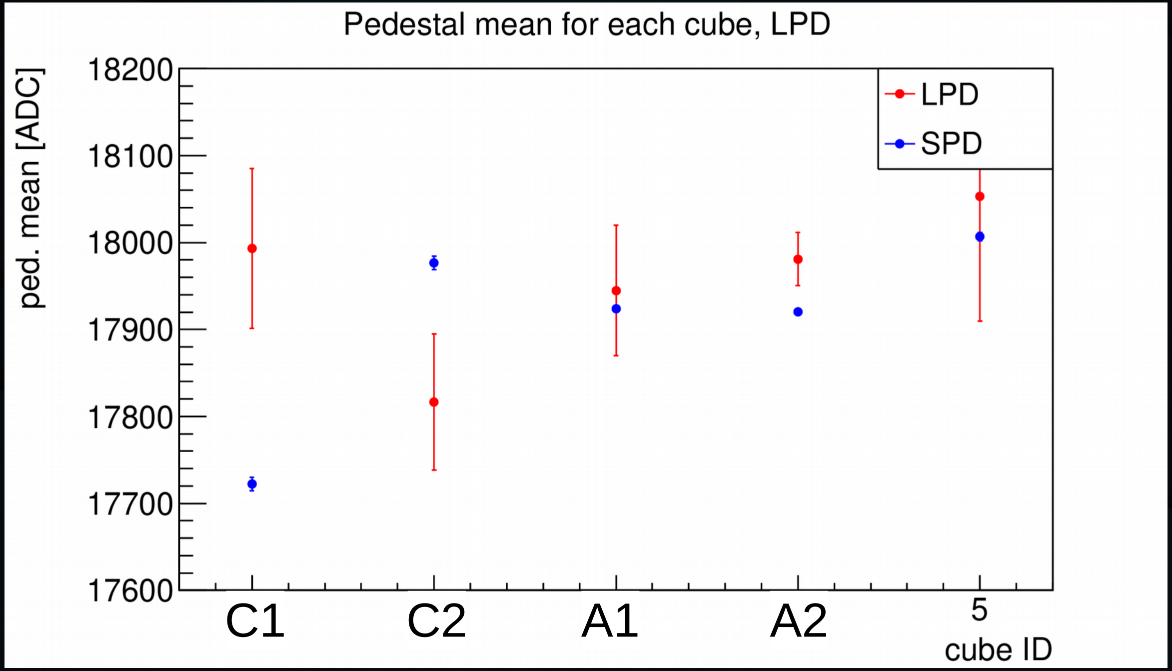


- Pedestal distributions are affected by pile-up due to input capacitance discharge.

Pedestal check: result

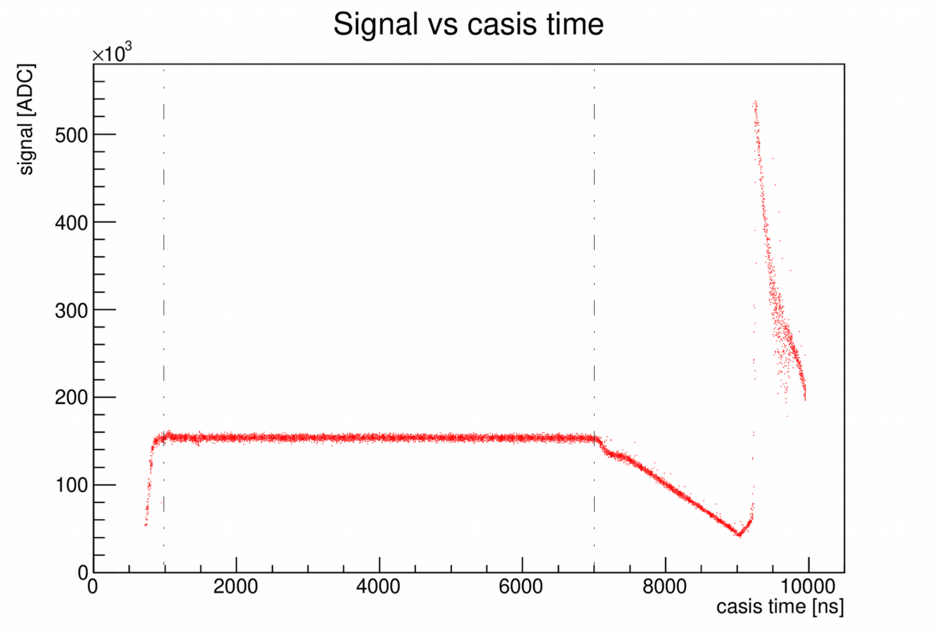
- The difference between pedestal means measured for different configurations is used as an estimation of the systematic error due to pile-up.

Error bars are the systematic error due to the pile-up

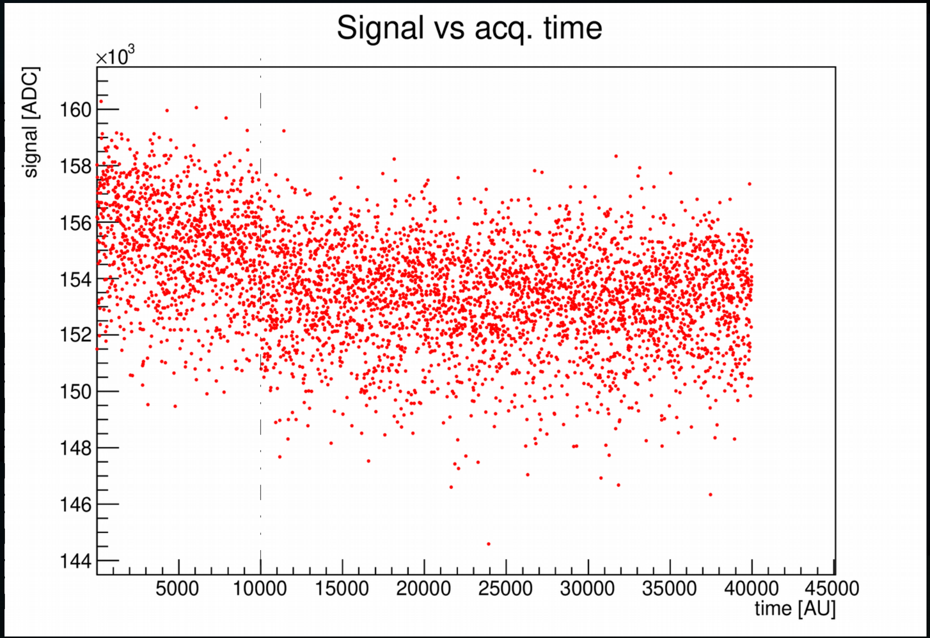


Event selection

- Selection on casisTime: >1.5 us & < 6.5 us

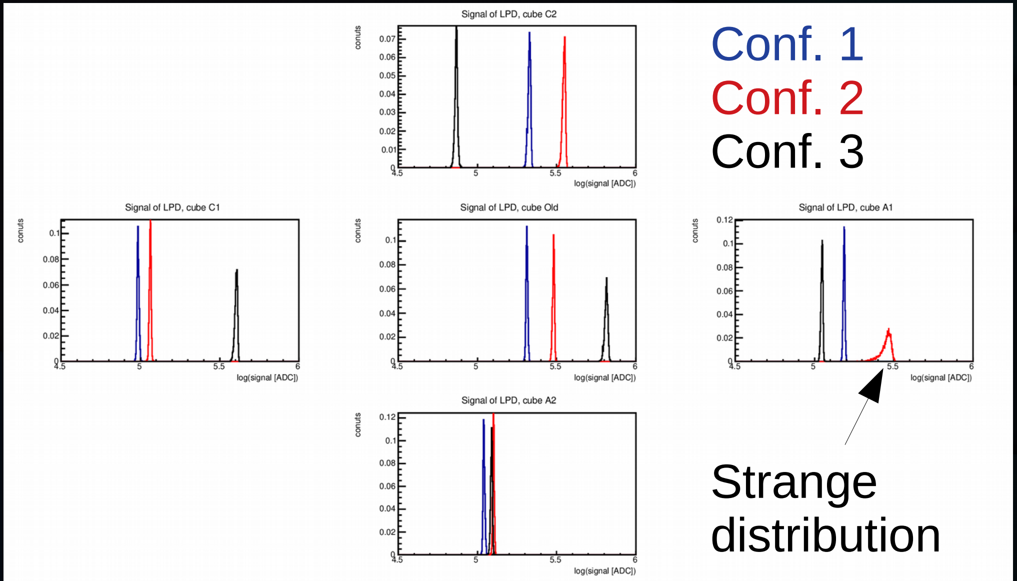


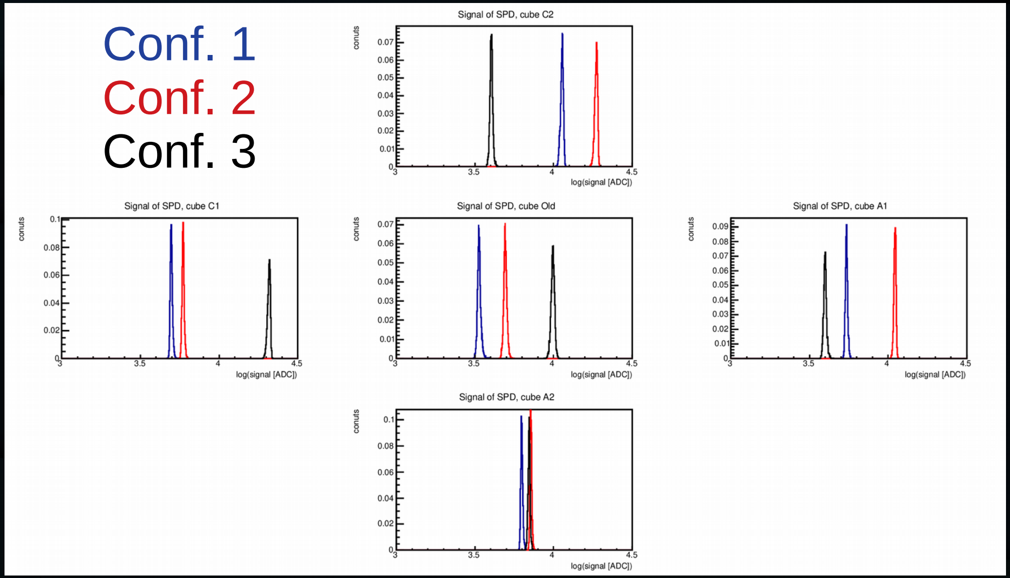
- Rejecting the first 1.5k events due to beam instability (in each configuration).



Signal distributions

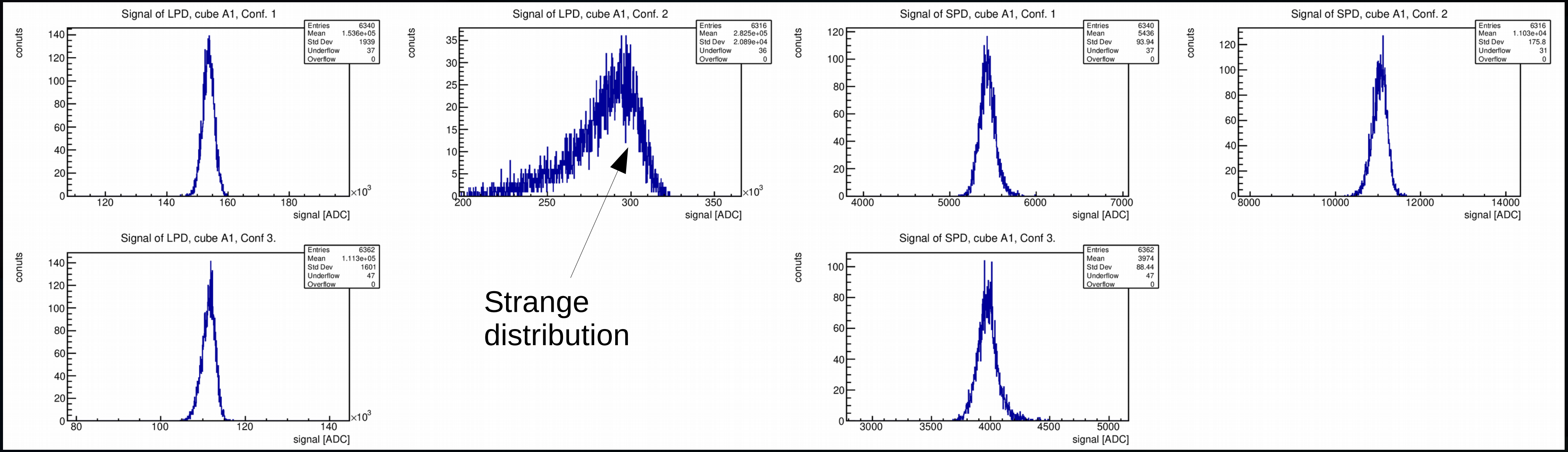
- Only the central cube is completely covered by the Pb: the energy deposit on lateral cubes depends on multiple scattered particles.





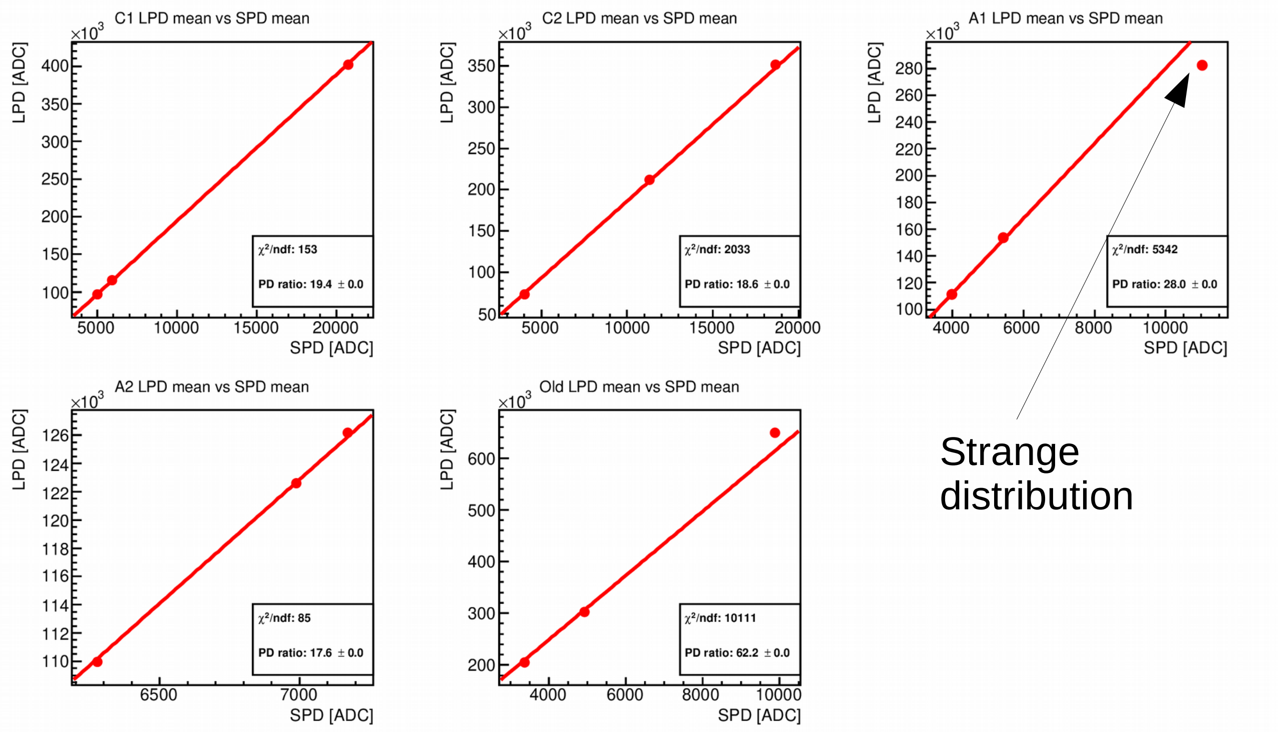
- The amplitude of the signals of lateral cubes is "strange"

A1 cube, linear scale



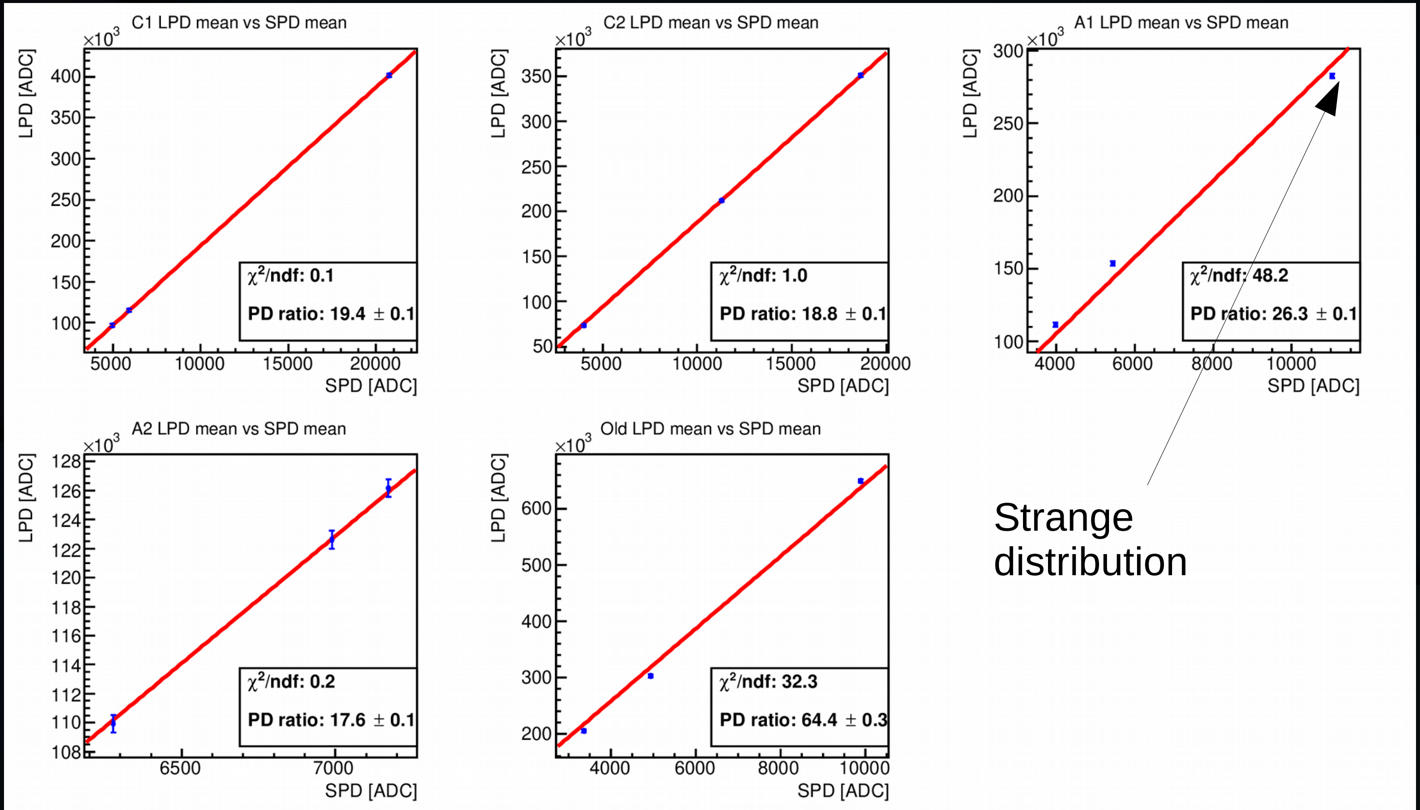
LPD vs SPD (stat error only)

- X axes: mean of SPD; Y axes: mean of LPD; Error: mean error for a Gauss (RMS/sqrt(N))
- Systematic errors are not included here.



LPD vs SPD (stat + sys error)

- Square sum of stat error and sys error due to pile-up (LPD sys is multiplied by 20, low gain...)

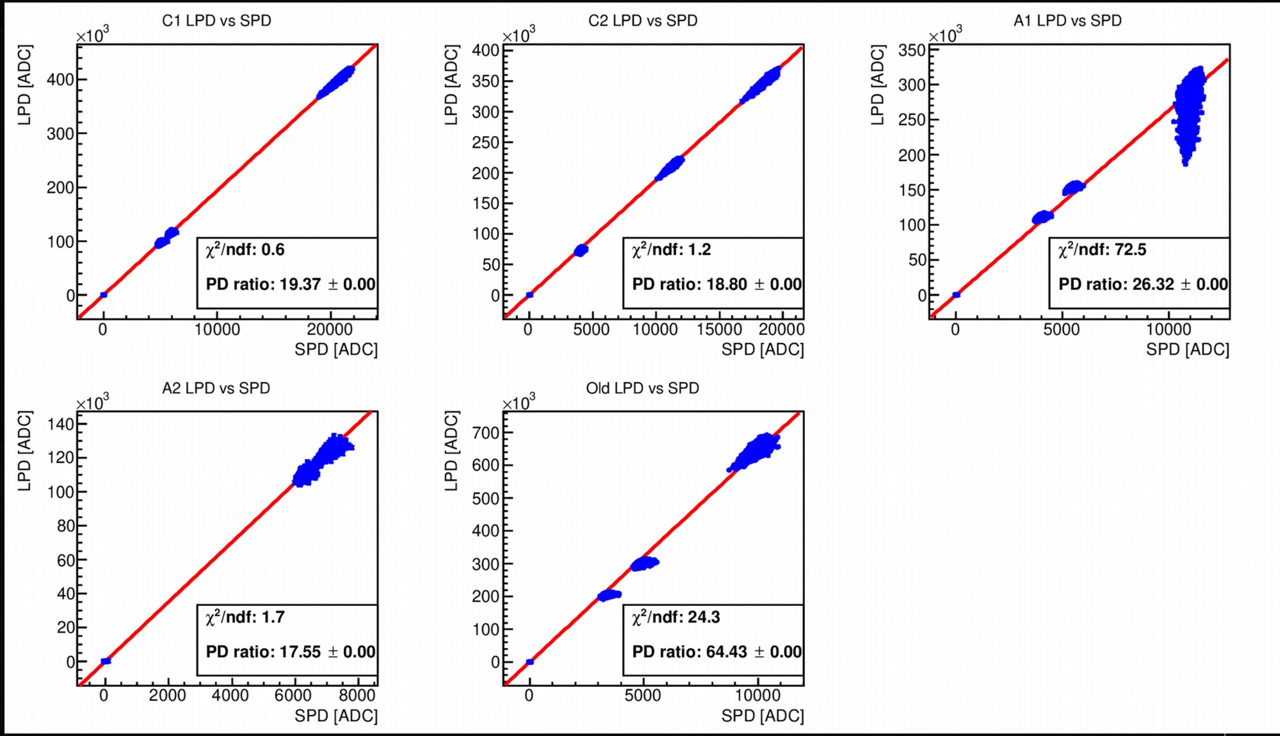


Using a scatter plot

- LPD vs SPD scatter plot, using all the events of the 3 configurations.
- For each point the errors are:

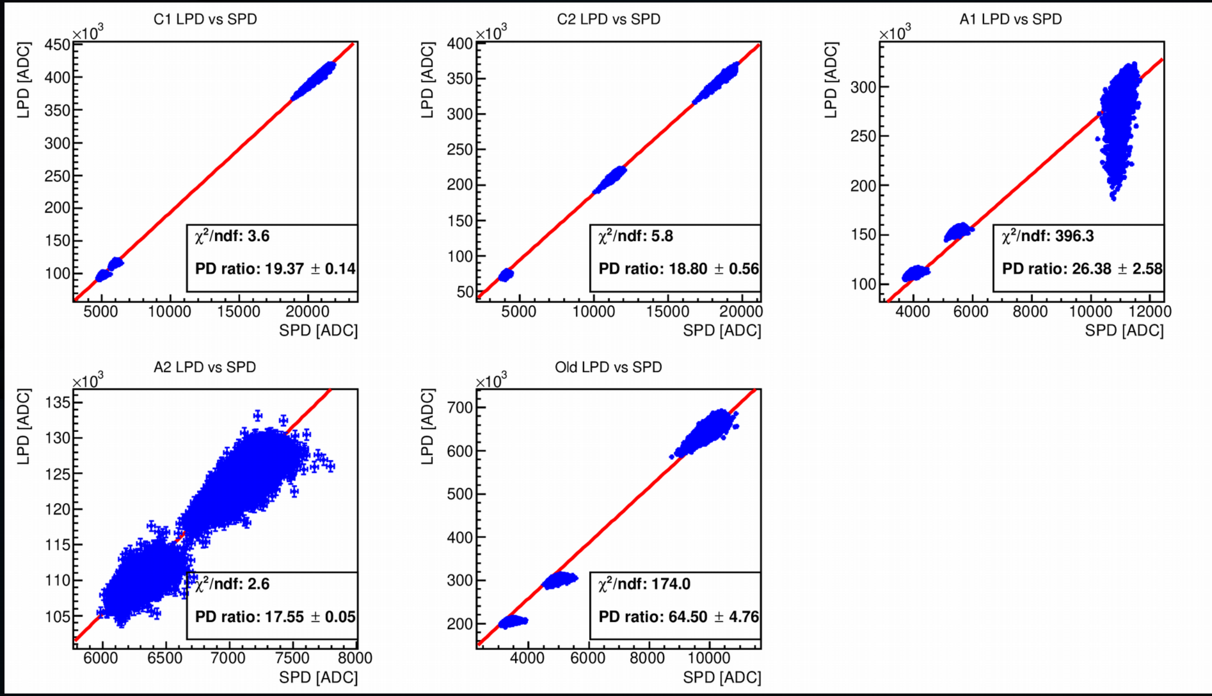
Xerror^2 = SPD_pedestal_RMS^2 +
SPD_pedestal_systematic^2

Yerror^2 =
(LPD_pedestal_RMS*20)^2 +
(LPD_pedestal_systematic*20)^2



Using a scatter plot: add sys error

- Fore each cube we fitted the scatter plot of each configuration: the maximum difference of the PD ratios is assumed as the systematic error



Method comparison

- Results are consistent.

Cube	Careggi (peak)	Careggi (scatter plot)
C1 central	19.4 +- 0.1	19.4 +- 0.1
C2 central	18.8 +- 01	18.8 +- 0.6
A2	17.6 +- 0.1	17.55 +- 0.05
A1	????	????

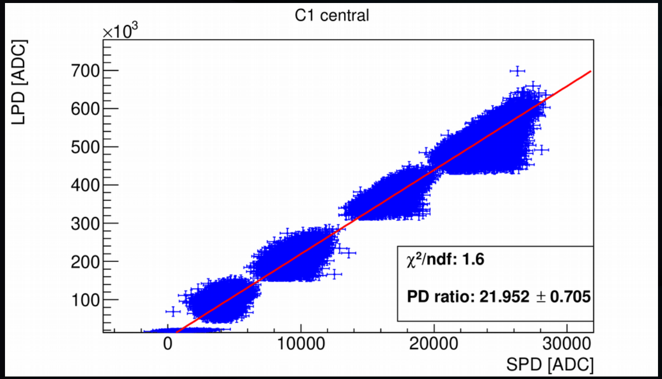
Review of Labec results by Pietro

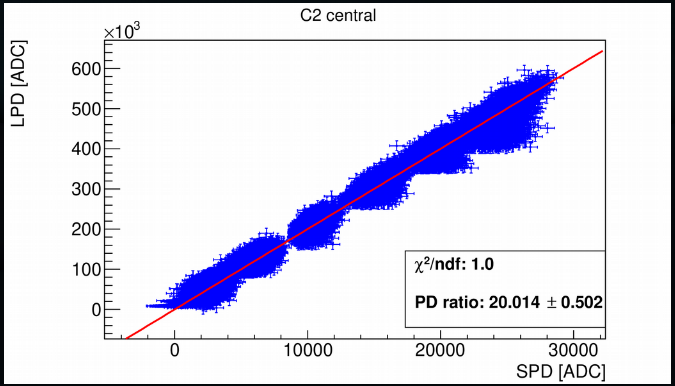
- Analysis done by using the first method:
  - Fit the LPD peak.
  - Fit the SPD peak.
  - Ratio of the peaks.
  - Systematic error due to the beam stability (see Pietro presentation)

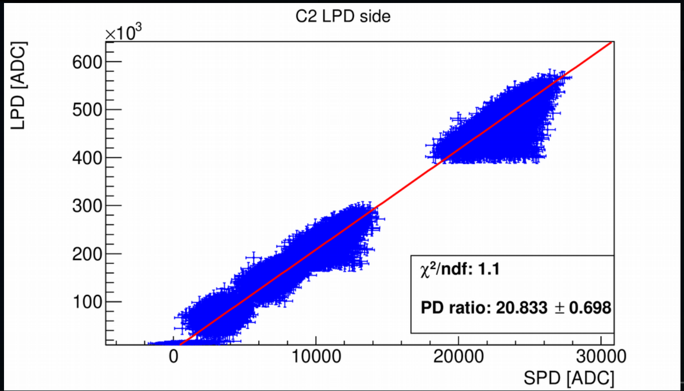
Nmis	Configuration	Ratio	Err
1	C1 central	22.4	1.1
2	C2 SPD	19.0	1.2
3	C2 central	20.6	0.4
4	C2 LPD	21.0	1.1

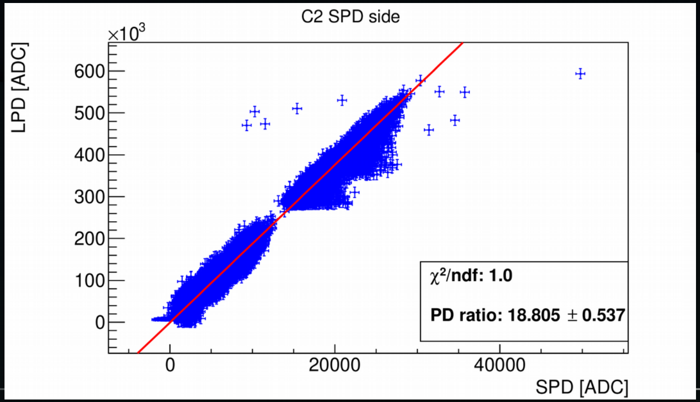
Using scatter plot to Labec data

- Scatter plot method applied to Labec data (systematic error is described in next slide)



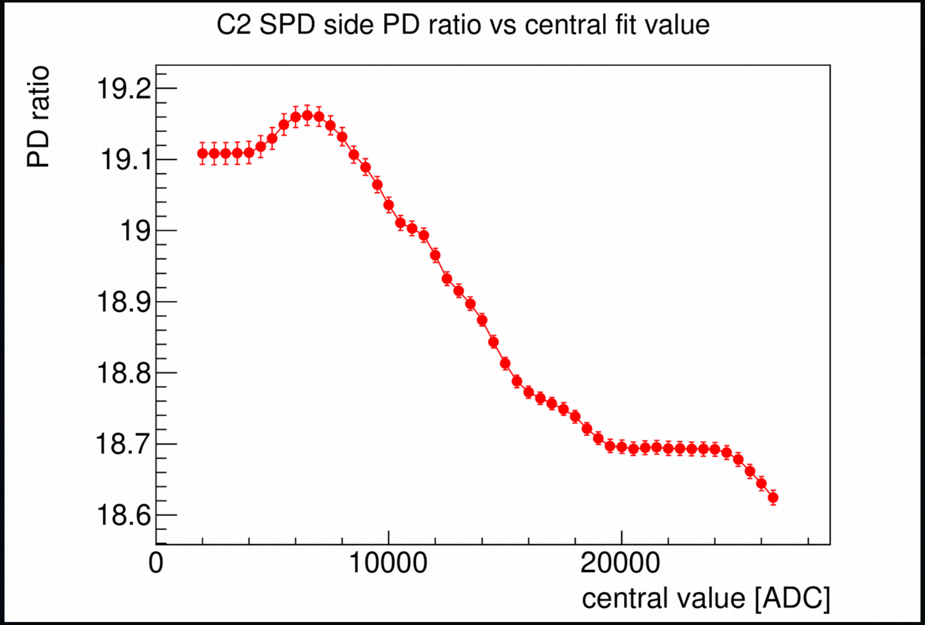


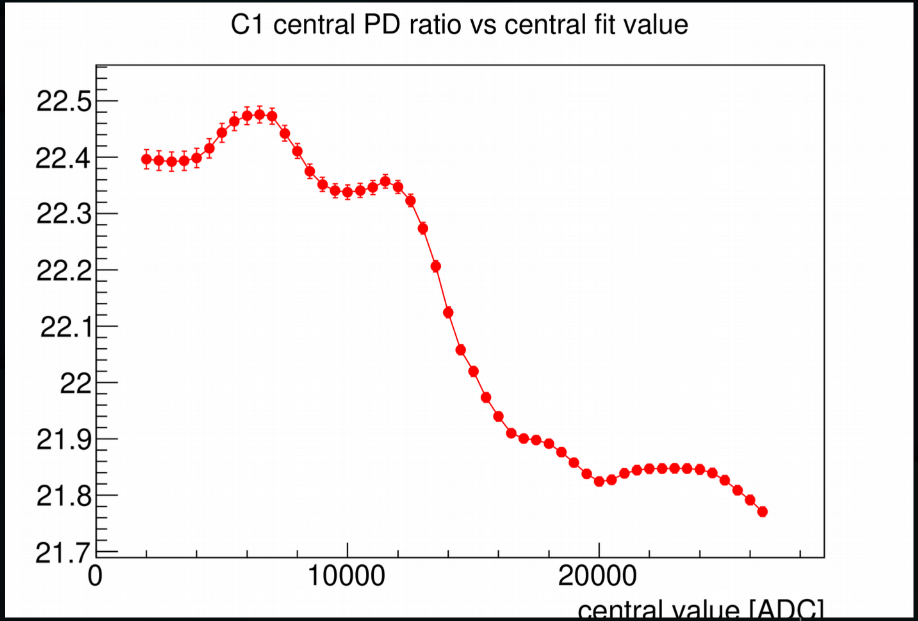




Using scatter plot to Labec data

- Systematic error: the fit is done several time by changing the fitting range.
- The maximum difference is the estimation of the systematic error.
- Fitting range width = 20 kADC





Method comparison

- Results are consistent.

Cube	Labec (peak)	Labec (scatter plot)
C1 central	22.4 +- 1.1	22.0 +- 0.7
C2 central	20.6 +- 0.4	20.0 +- 0.5
C2 SPD	19.0 +- 1.2	18.8 +- 0.5
C2 LPD	21.0 +- 1.1	20.8 +- 0.7

- Cross-check between Labec, Careggi and lab test with showers are in next presentation.

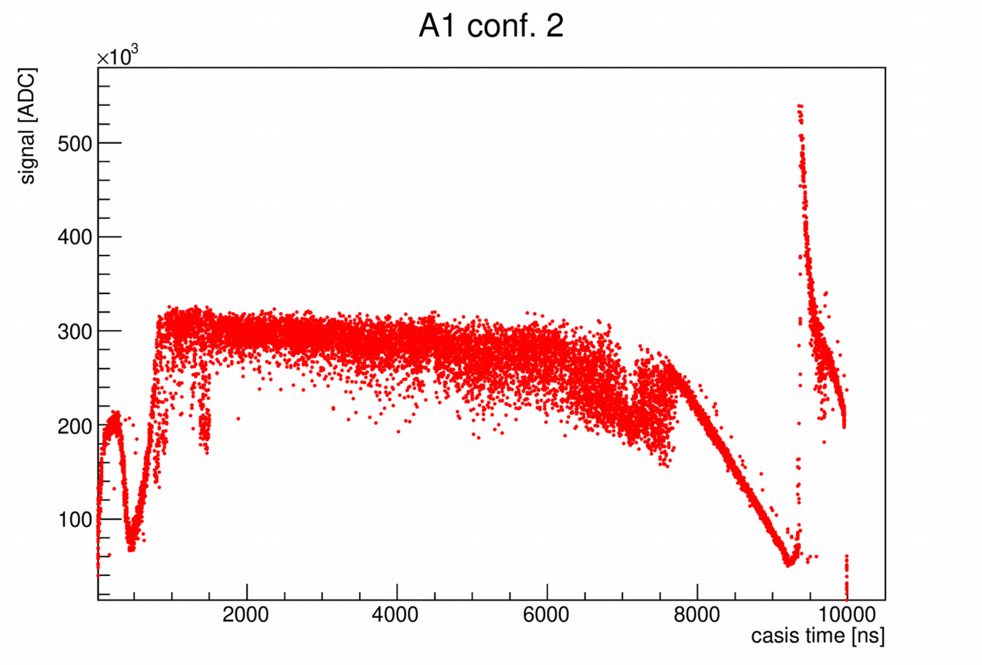
Backup: beam description, A1 cube, casis time dependence.

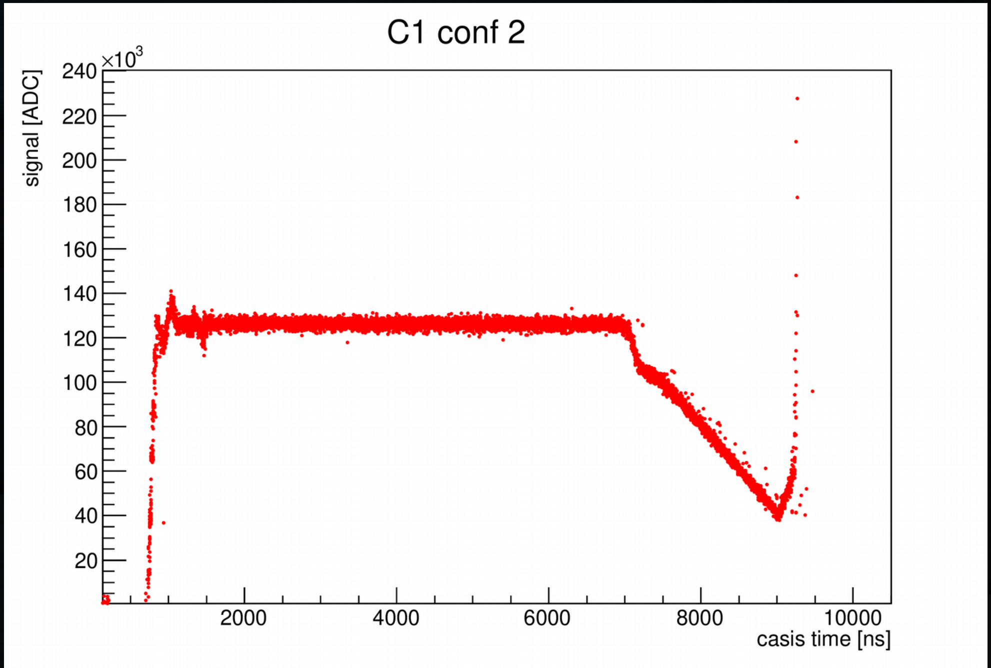
Note sul fascio

I FASCI HANNO ENERGIA MAX DI 6MeV OPPURE 10MeV, INTENSITà DI CIRCA 2 10^12 FOTONI PER M^2 fasci di fotoni con spettro energetico di frenamento energia Max 6MeV 10MeV 18MeV e quindi possiamo considerarli di energia 2, 3, 6 MeV.
Il fascio viene generato con pacchetti di elettroni della durata di 5 microsecondi e un periodo di 3ms. All'interno del pacchetto gli impulsi hanno un'ampiezza costante e si succedono ad intervalli di ns.
2 10^12 fotoni/m^2 vuol dire 2 10^8 fotoni/cm^2 per 1cGy, sqrtN= 1,4 10^4
deltaE circa 1,4 10^4 2 MeV = 2,8 10^4 MeV che equivalgono a circa 2,8 10^10/33 =8,5 10^8 elettroni. La slide di Mara contiene le informzioni che ti avevo già scritto nella mail del 7 febbraio, "Il fascio viene generato con pacchetti di elettroni della durata di 5 microsecondi e un periodo di 3ms. All'interno del pacchetto gli impulsi hanno un'ampiezza costante e si succedono ad intervalli di ns."
per abbassare l'intensità possiamo fare in due modi: lavorare sulla pulse repition frequency e sistemare il vostro rivelatore il più basso possibile rispetto alla sorgente.
I valori di intensità che ti ho dato sono riferiti ad un metro dalla sorgente ma noi possiamo andare più bassi con il lettino. Per quanto riguarda il collimatore io posso collimare un campo di 0,5x0,5 cm2 ad un metro dalla sorgente quindi se ti puoi far fare dall'officina uno schermo di piombo con un foro di 1 mm^2,sarebbe la cosa migliore.

A1 config. 2

- A1: strange casis time dependence (no dependence on acq. time, ped. distribution is as usual.

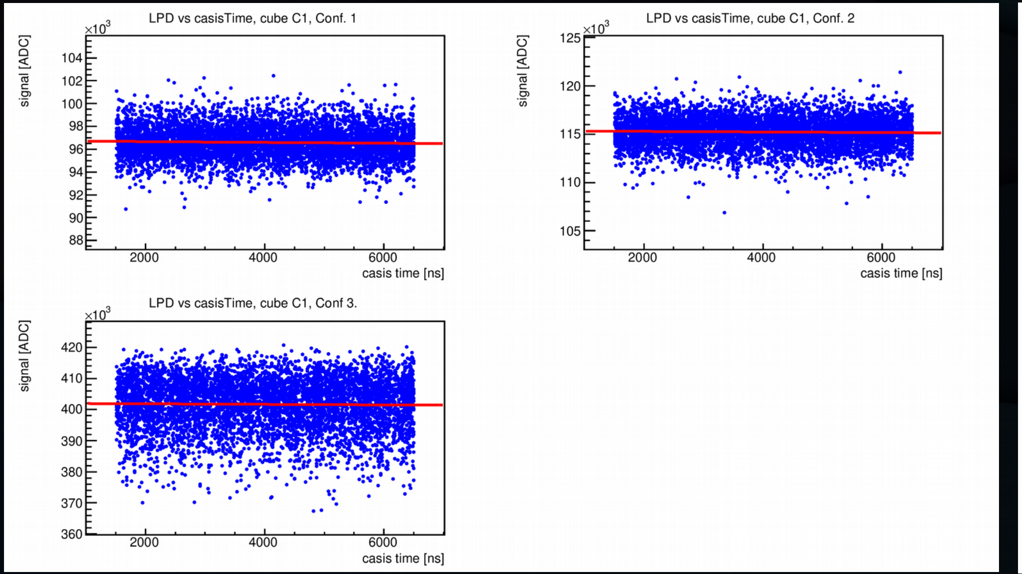


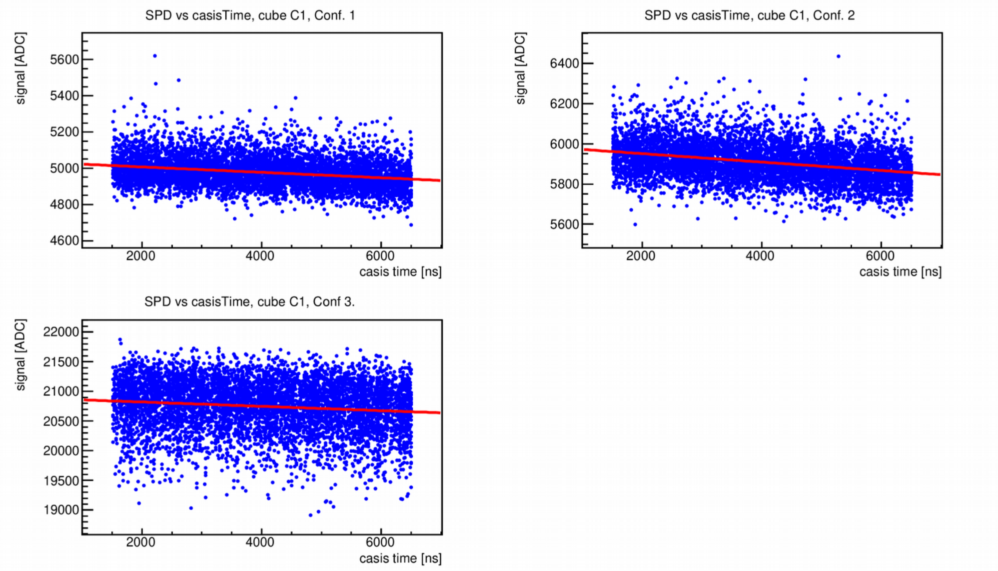


- This problem is present with A1 and conf 2 only.

Backup: signal vs casis time, few cubes

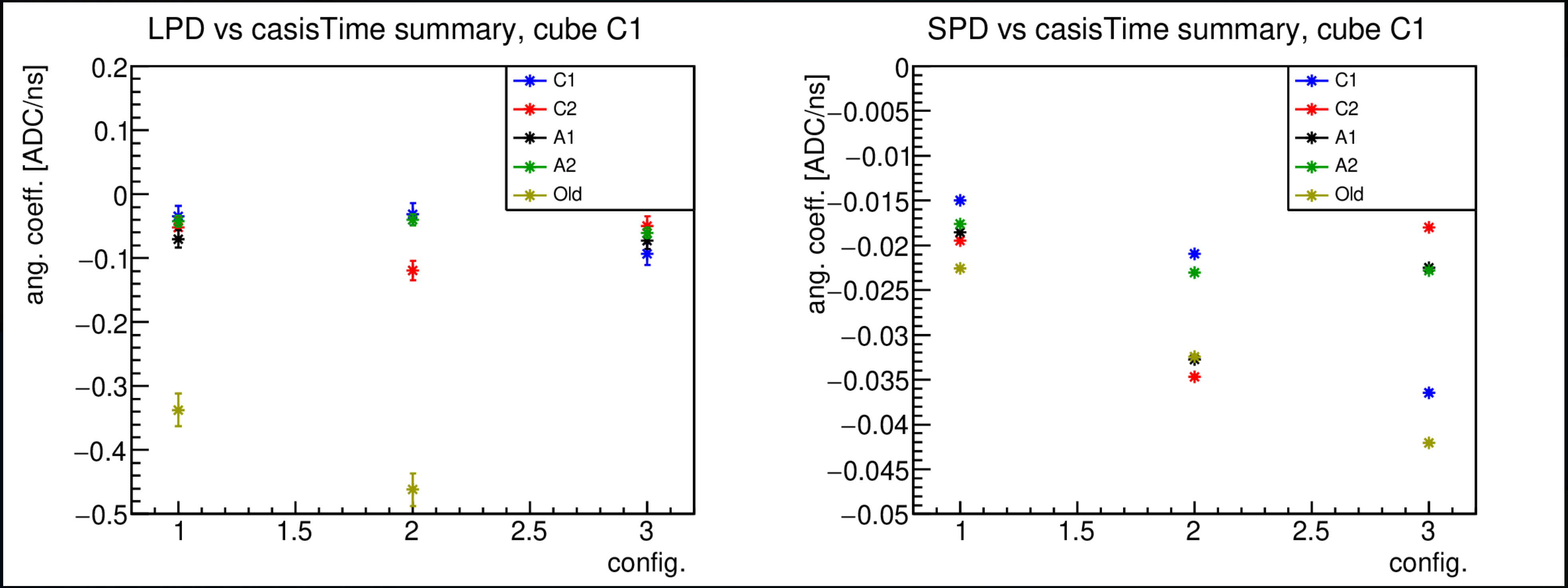
- A small dependence of the signal with casis time is present for each cubes
- Here few examples:





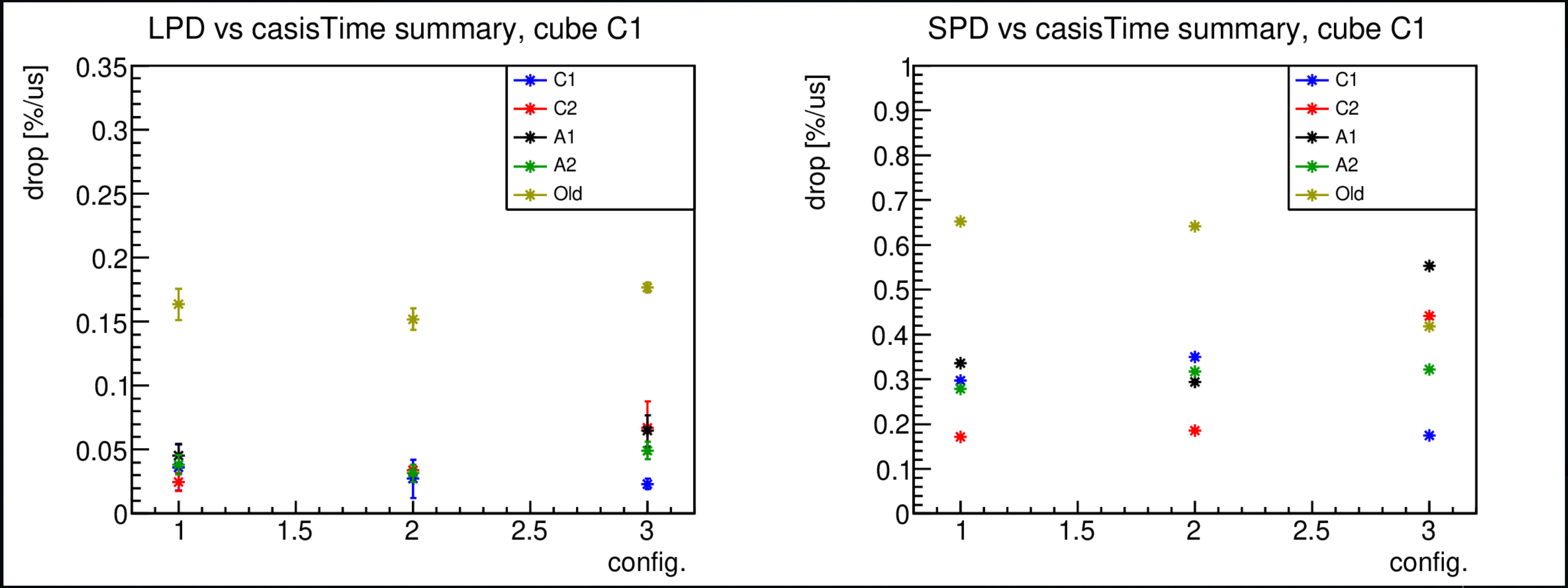
Backup: casis time fit: absolute value

- Angular coefficient obtained by fits.



Backup: casis time fit: %

- Angular coefficient obtained by fits divided by the mean signal (%)



Summary and comparison with Labec

Cube	Labec (peak)	Labec (scatter plot)	Careggi (peak)	Careggi (scatter plot)
C1 central	22.4 +- 1.1	22.0 +- 0.7	19.4 +- 0.1	19.4 +- 0.1
C2 central	20.6 +- 0.4	20.0 +- 0.5	18.8 +- 01	18.8 +- 0.6
C2 SPD	19.0 +- 1.2	18.8 +- 0.5	\\	\\
C2 LPD	21.0 +- 1.1	20.8 +- 0.7	\\	\\
A2	//		17.6 +- 0.1	17.55 +- 0.05
A1	//		????	????