A first look at proto-2

SuperB LNF meeting

Dec. 13th 2011

Marcello Piccolo

The menu

- Quick reminder of the expt'l setup
- Characterization of the device
- Using old analysis methods on new hardware
- Can we experimentally measure the generated number of clusters?
- Performances on energy loss.
- Conclusions

Expt'l apparatus

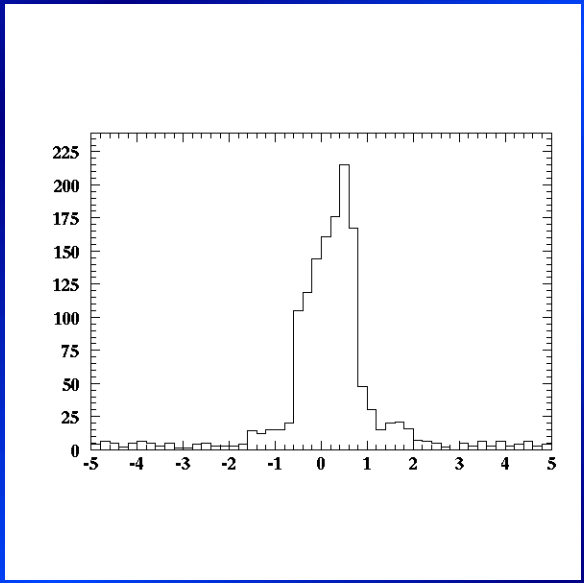
- Giuseppe has already shown the details of proto-2
- Is a realistic prototype of what we intend to build.
- The ~2.5 m. device is triggered by a couple of scint. counters and extrapolation into the proto is provided by a 3cm. diameter continuous cathode tubes. (52 in total)
- We trigger at about ~0.3 Hz. and write each of the 32 ch's from the CAEN SCA provided that a given threshold is exceeded for at least 3 times bins (1 nsec wide)
- The CAEN-SCA was integrated into a Linux DAQ system (courtesy of Riccardo) that writes on disk the SCA itself and a TDC providing external tracker info.

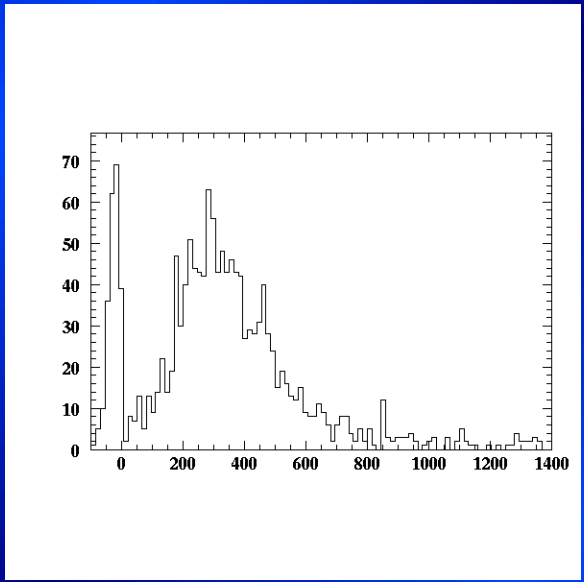
Trigger efficiency for data taking

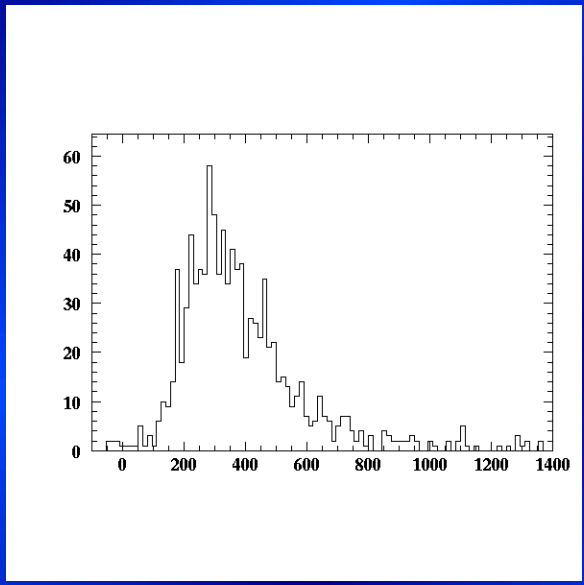
- The geometry of the setup has NOT been optimized yet for cosmic running : the tracker coverage is small compared to the proto length ; an upgrade is foreseen.
- A typical run of 25,000 trigger usually provides 1,000 good cosmic in each cell and takes the good part of a day.
- The external tracker, lately, did not provide the spatial resolution we were used to have; we are looking into the problem, but we haven't solved it yet.

Using the tracker

- Here is the distribution of the tracker impact for a cell that meets the “writing requirements” and the amplitude spectrum without and with the pointing to the given cell.

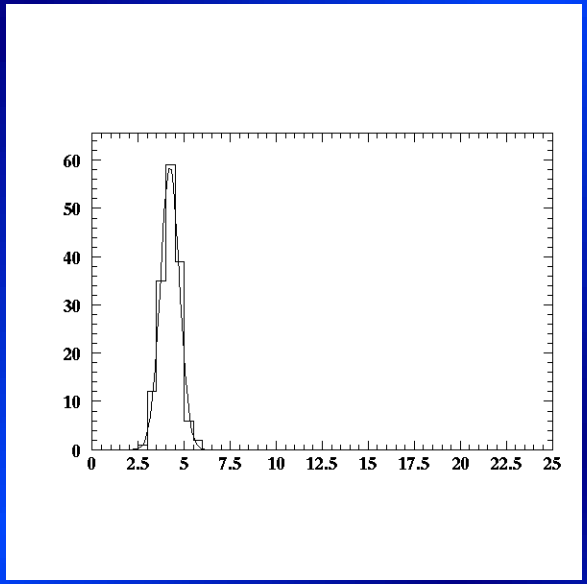






Few words on noise

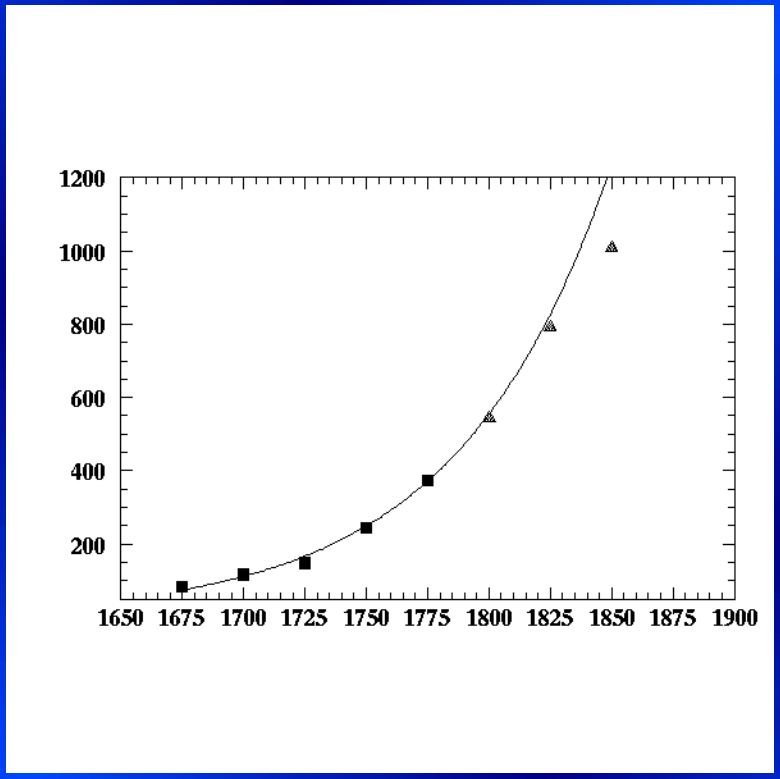
- With respect to the previous presentations , concerning continuous cathode devices , noise is higher; however not comparable directly to the previous data as the preamps we are using now are faster.



The plot shows the baseline r.m.s, with no pulse present, taken over 100 (time) bins.

Gas mix characterization

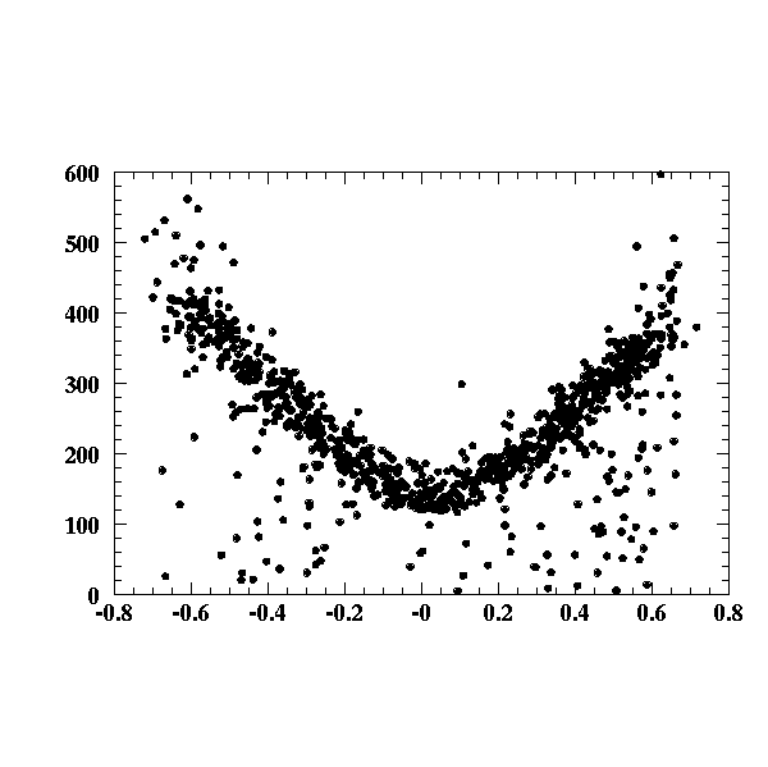
- We started collecting data with 90%-10% mix of He-Isobutene.



Here we have the most probable charge vs. H.V. for a middle cell.
The power law sketched is taken from the fit of the first five points.
A gain saturation is evident @ 1850 V.
The relative gain variation is 1.5%/V.

Time width of a cell

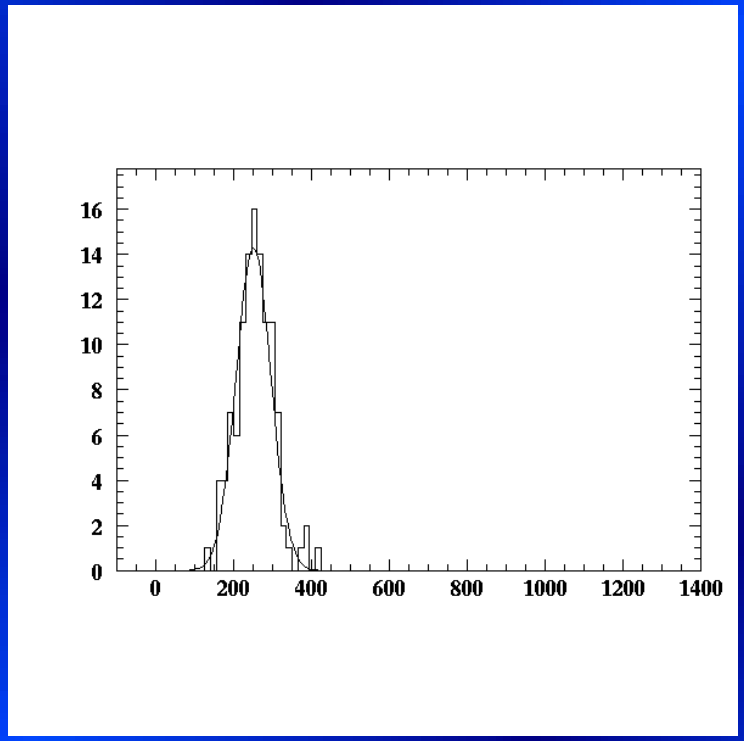
- The total (time) width of the proposed cell is acceptable (300 nsec.)
- Performances with 1.5 T magnetic field have to be checked.



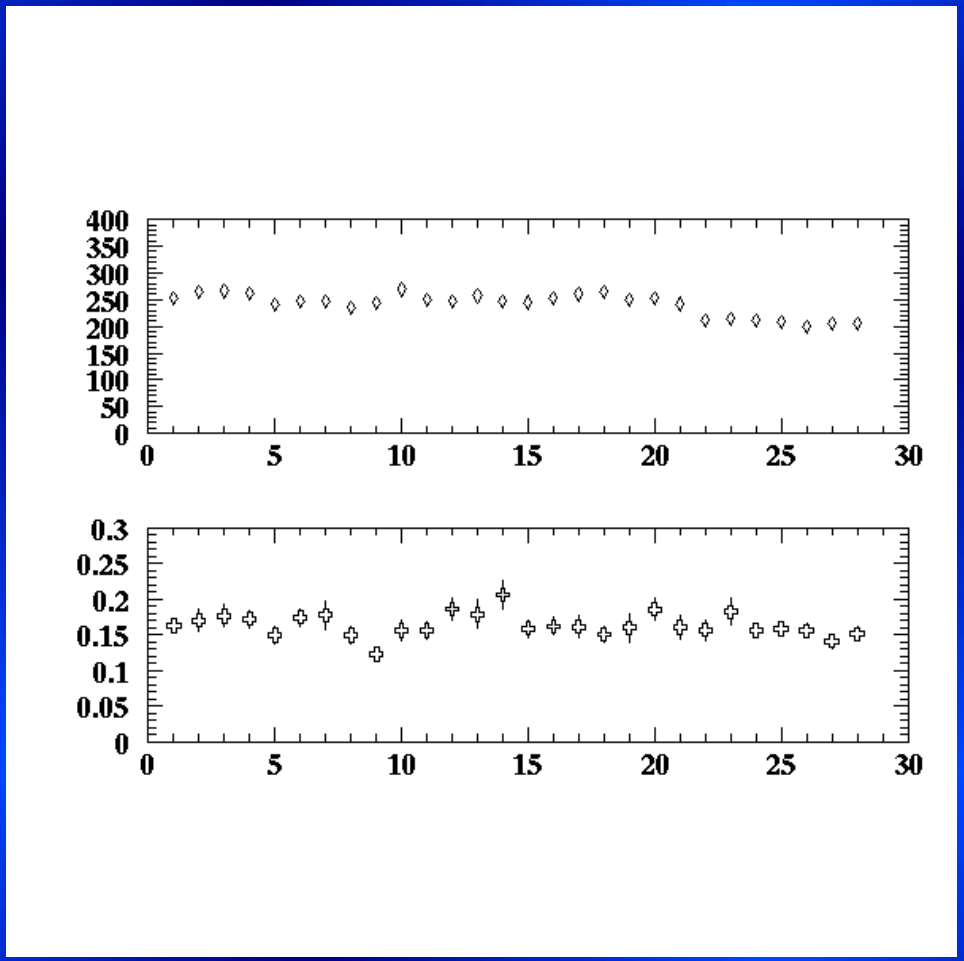
Traditional methods for dE/dx

- The energy loss resolution for a single cell can be evaluated using the truncated mean algorithm.
- Without attempting optimization @ 70% truncation we obtain the BaBar resolution.

With 10 cells the fractional resolution is 17%.



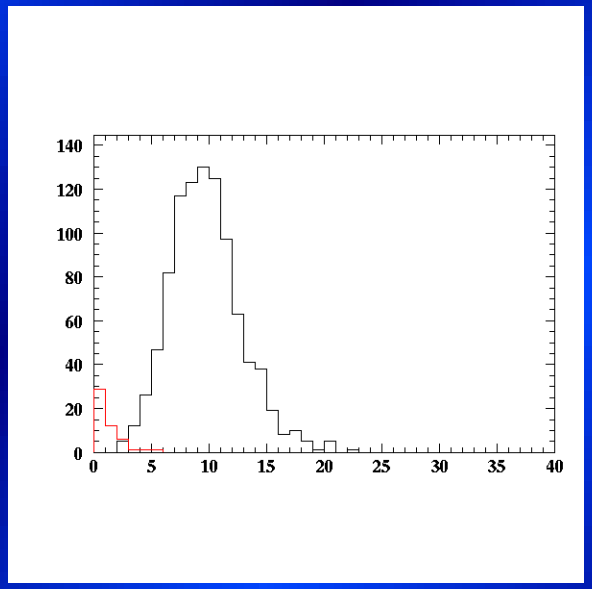
How about the entire proto ?



Most probable amplitude in pCoul (aver. 10, 70% trunc.) and fractional resolution.
H.V. 1750 V.

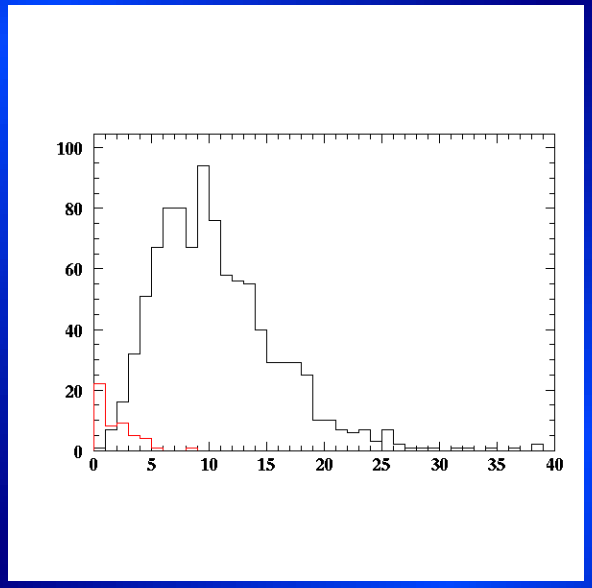
Let's now try to count clusters

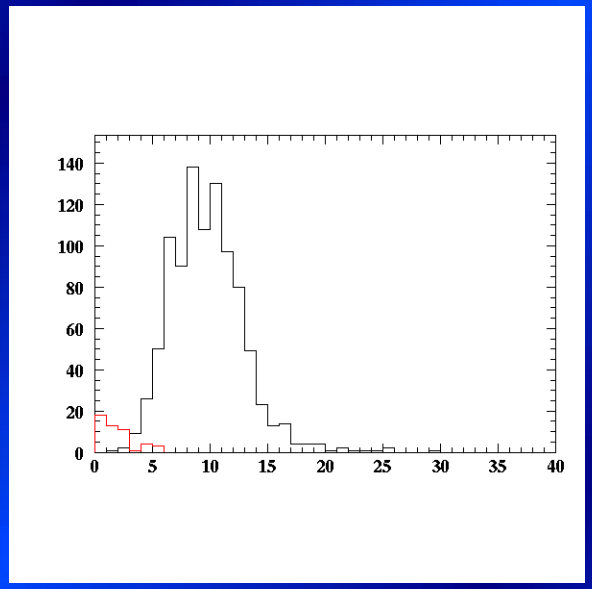
- The plots refer to the three algorithms: the running average on baseline, the differences and the derivative method.
- Tune threshold to count at most 1-1.5 clusters when none should be counted.



Running baseline

Difference meth

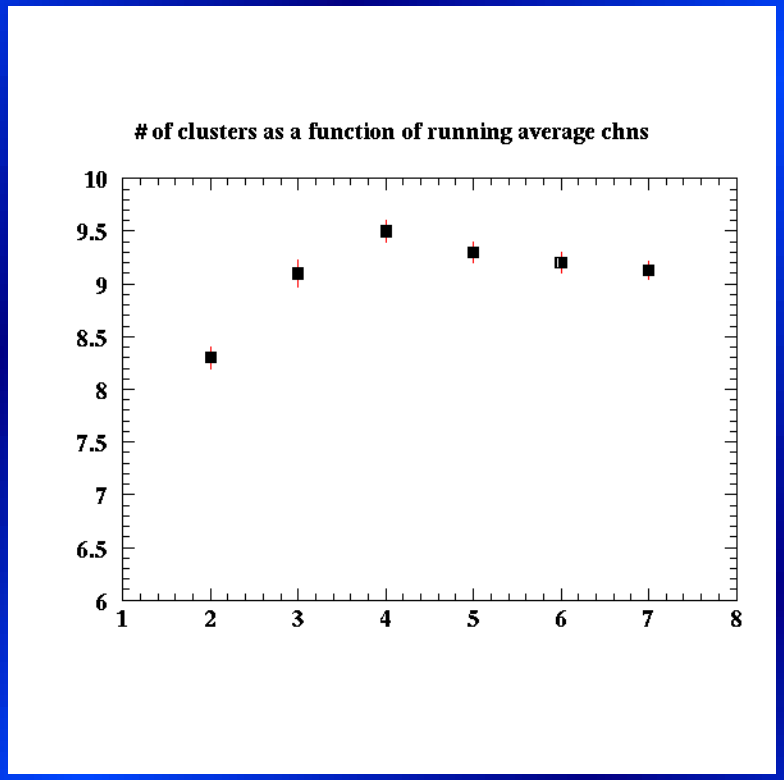


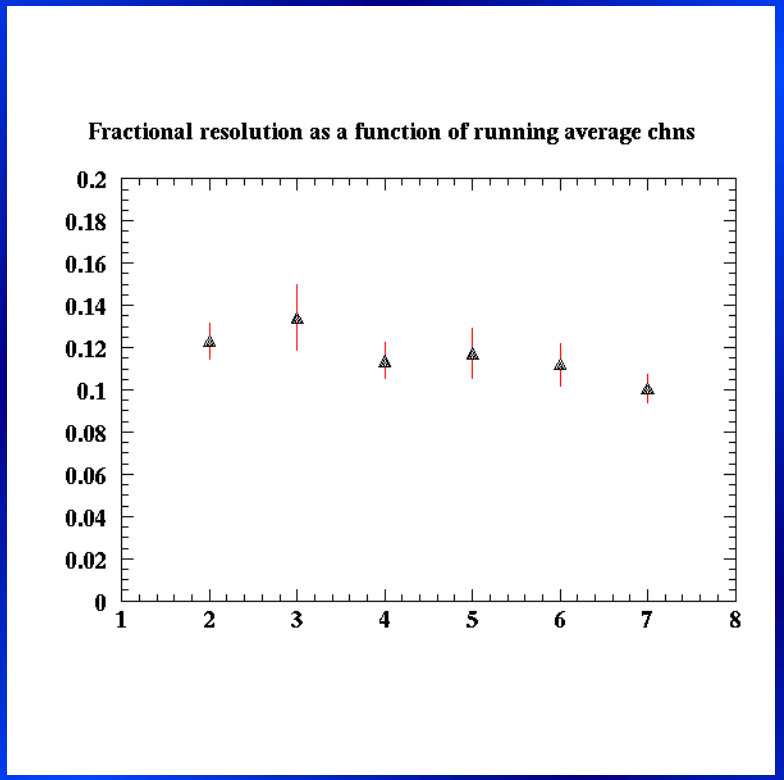


derivative

Changing cluster search parameters

- As an example, I show how sensitive are the measured quantities to the analysis details. Here is the sensitivity to the running average # of chns.

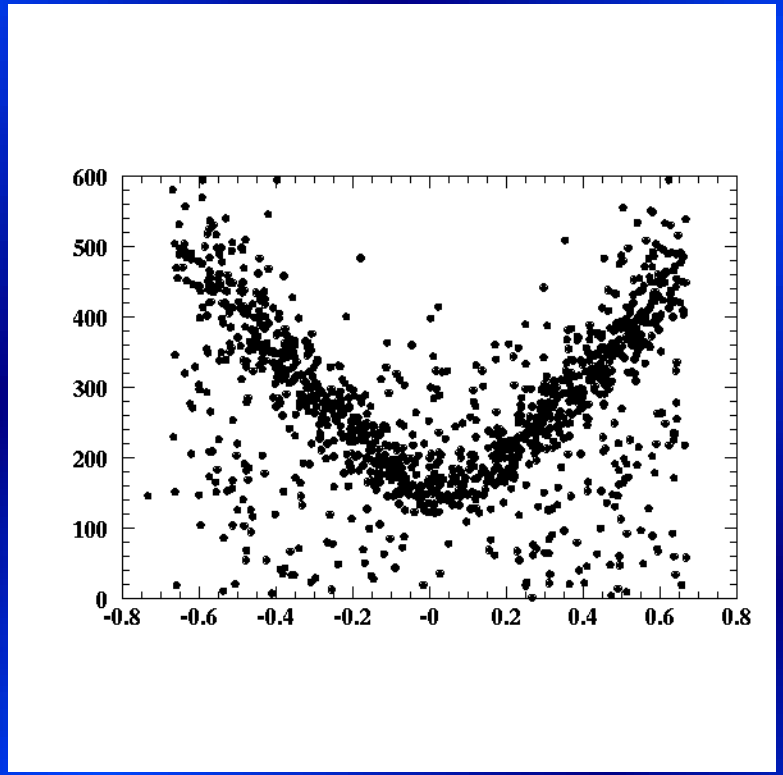




Changing the quencher content

- Even if the gain in $X_{0,}$ reducing the quencher amount is not paramount, we tried to use a lighter mix (95-5 He-Isob.) to check performances.

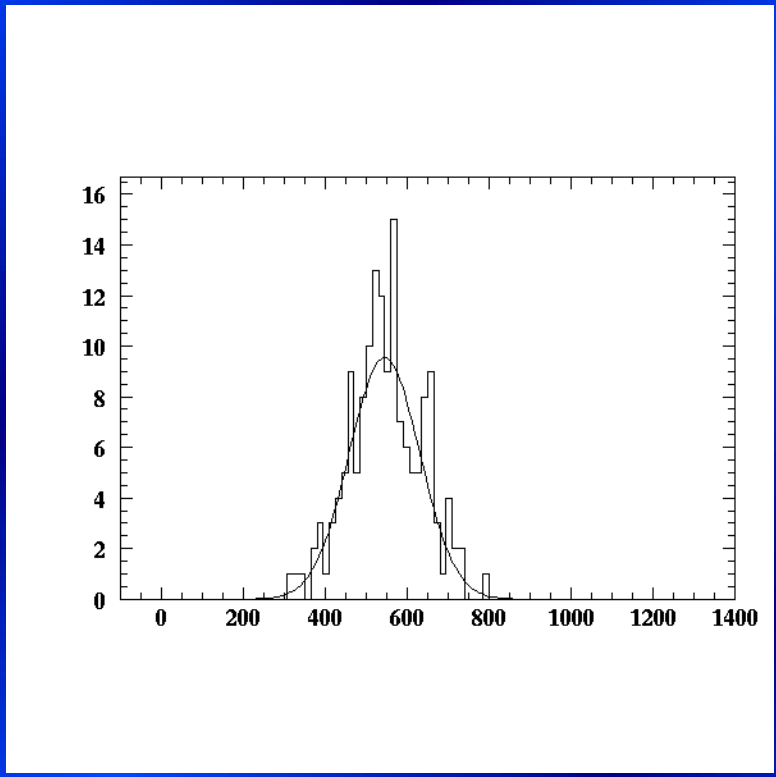
The time with of the cell is increased by roughly 30%



Changing the quencher content (cont.)

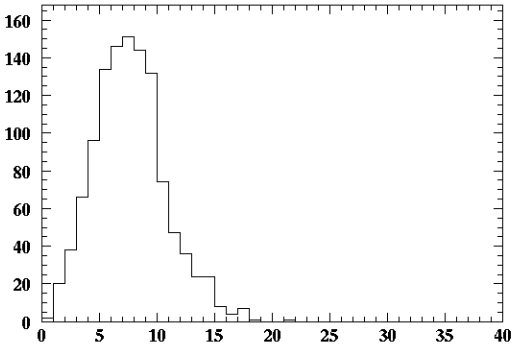
- The performances on dE/dx are also worsened, and, to a first look ,the gain variation vs. H.V. seems to be three times bigger than the 90-10.

The 70% trunc. resolution on 10 cells is about 22%
It was 17% with 90-10.



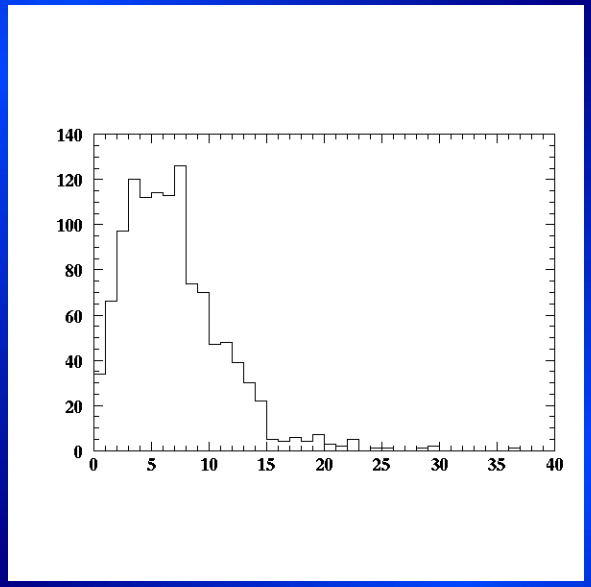
Changing the quencher content (cont.)

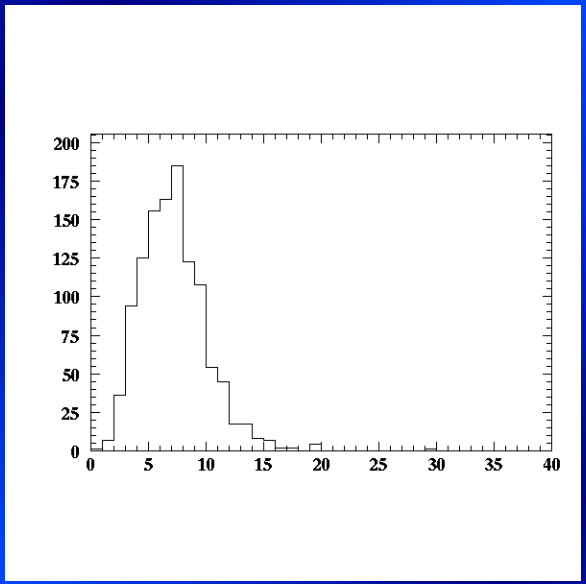
- As one might expect the detected # of cluster is lower as it is lower the # of generated clusters.



Running baseline

differences





derivative

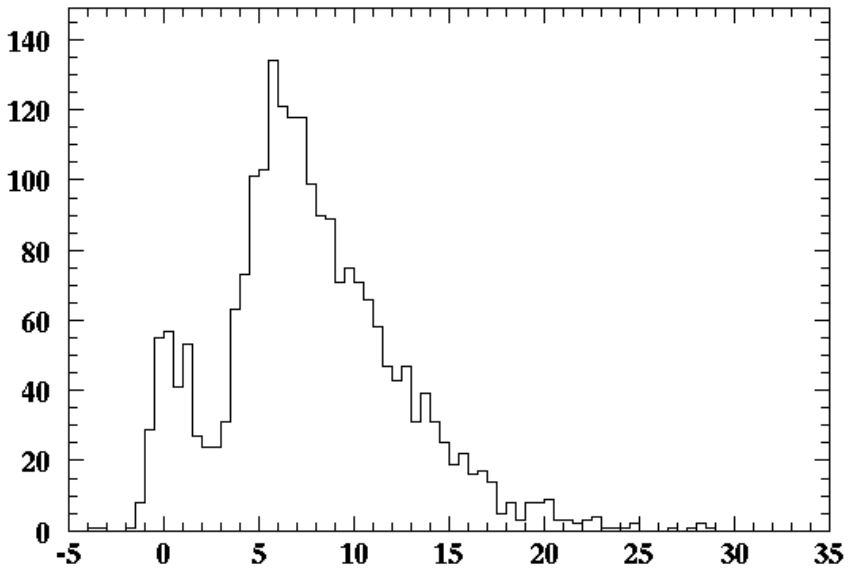
Evaluating the cluster counting efficiency

- The cluster detection efficiency is a crucial parameter in the analysis and, in order to determine it, one needs to know the generated # of clusters.
- This number, if one checks the literature, is quite foggy, so I decided to try to measure it.
- What I was able to come out with, is actually the # of single electrons generated, which in turn, should be corrected by the cluster multiplicity; the latter, however, seems to be better behaved and not so wildly different for different gases….

Evaluating the cluster counting efficiency (cont.)

- So, the idea is to find isolated clusters, starting from one of the cluster finding algorithms described previously.
- An isolated cluster is defined as a cluster for which the baseline is quiet 20 nsec before the start of the pulse and 20 nsec after the pulse has ended.
- For such *spikes* one evaluates and plots the charge, integrating the pulse from t_i-5nsec to t_i+15nsec.
- The integration limits are set by the preamp shaping times.
- The ratio of the most probable *spike* charge to the most probable total charge of the pulse yields the total # of electrons generated.

The single cluster charge spectrum



The most probable charge turns out to be 6.7±0.2 pCoul.

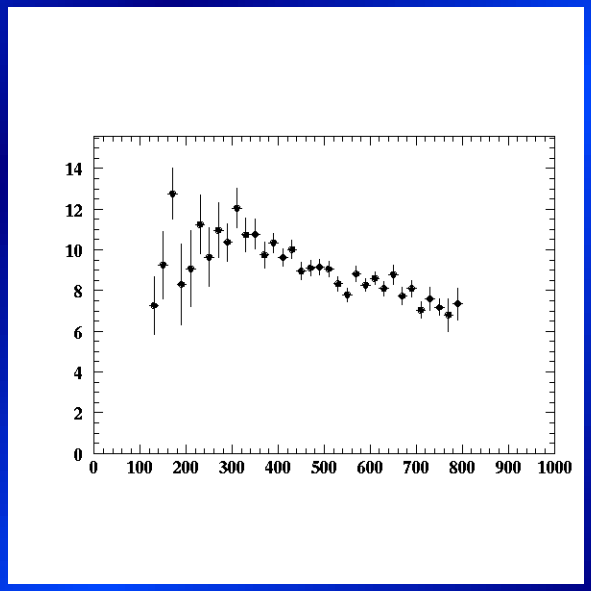
When compared with the most probable total charge (209 ±2 pCoul.), one counts 31±1 electrons

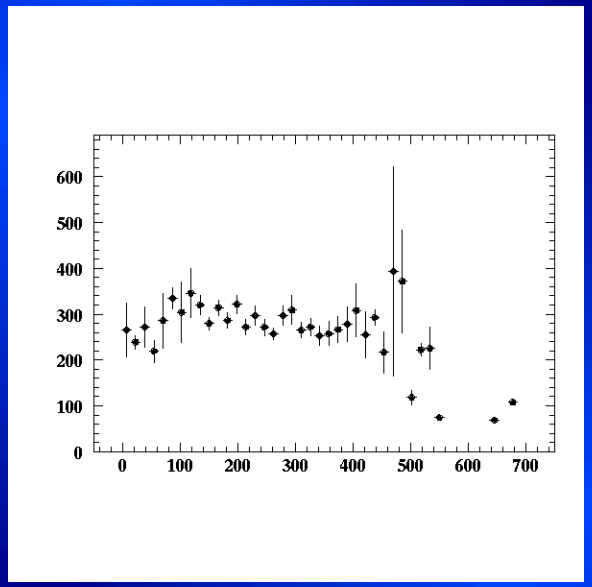
Assuming a total multiplicity of 2, both Helium and isobutene are rated at this (same) total multiplicity , one ends up with a total cluster count in our cell of 15.6 ±0.5 primary cluster.

Single cluster charge

- Measure gas gain 90-10 @ 1750 : g.g.= (9±0.5) 10^4
- Look at averages vs. time
  - Find saturation evidence (?)

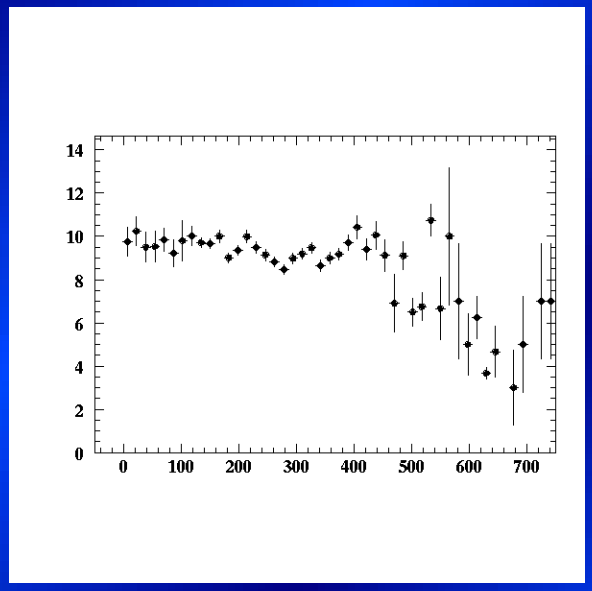
Single cluster charge





amplitude

Total # of clusters

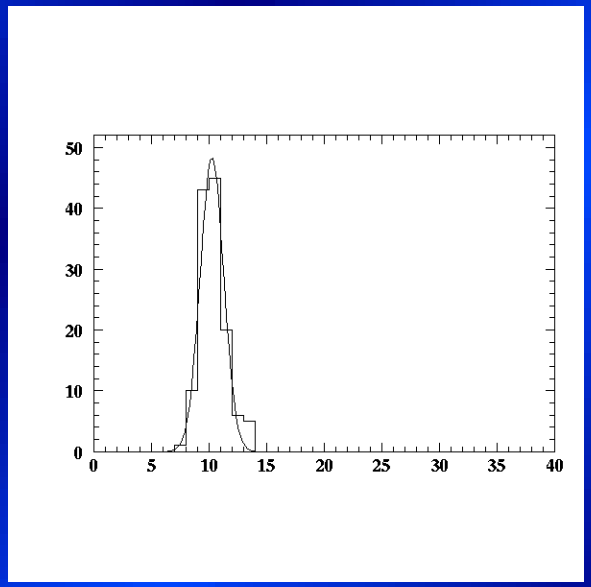


Cluster detection efficiency

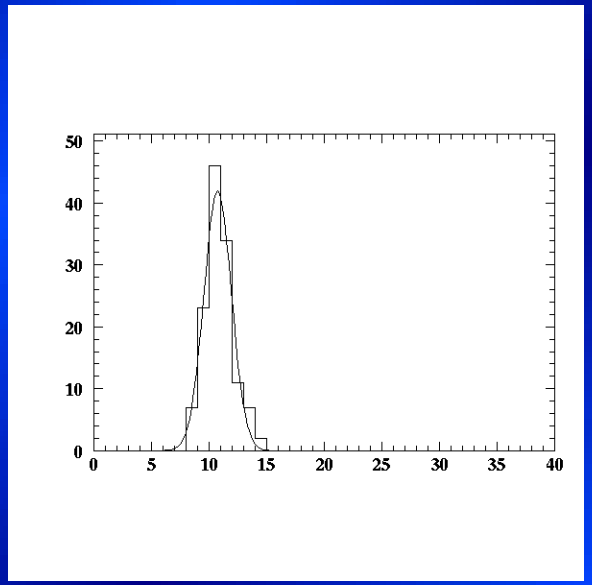
- Putting all together one finds:
  - 90-10 @1750 V
    - $\varepsilon = 0.6 \pm 0.05$
- Data base, as of now, not big enough to check other H.V. setting.

Resolution for # of detected clusters

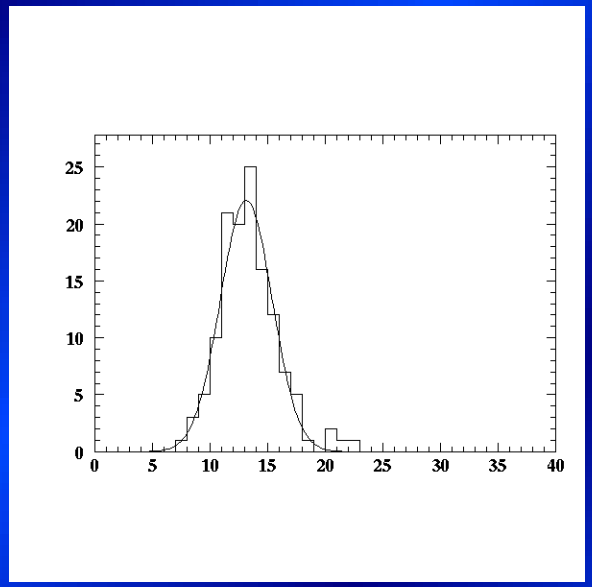
- Here we have a typical resolution plot for # of detected clusters averaging 10 tracks on a single cell.



Running baseline



derivative



differences

Conclusions

- Proto-2, a very realistic prototype for the SuperB DCH, is up and running.
- Cosmic data are trickling in; it would be nice to collect beam data (will have 2 weeks starting January 30th) and/or speed up trigger rate for cosmic.
- Resolution on # of cluster of the order of 30% per 1.4 cm. cell have been achieved.
- dE/dx resolution improvements of the order of 40% with respect to the traditional methods are on hand as of now.
- Cluster finding efficiency of the order of 60% have been measured on cosmic ray data.