DHCAL

Calibration and alignment

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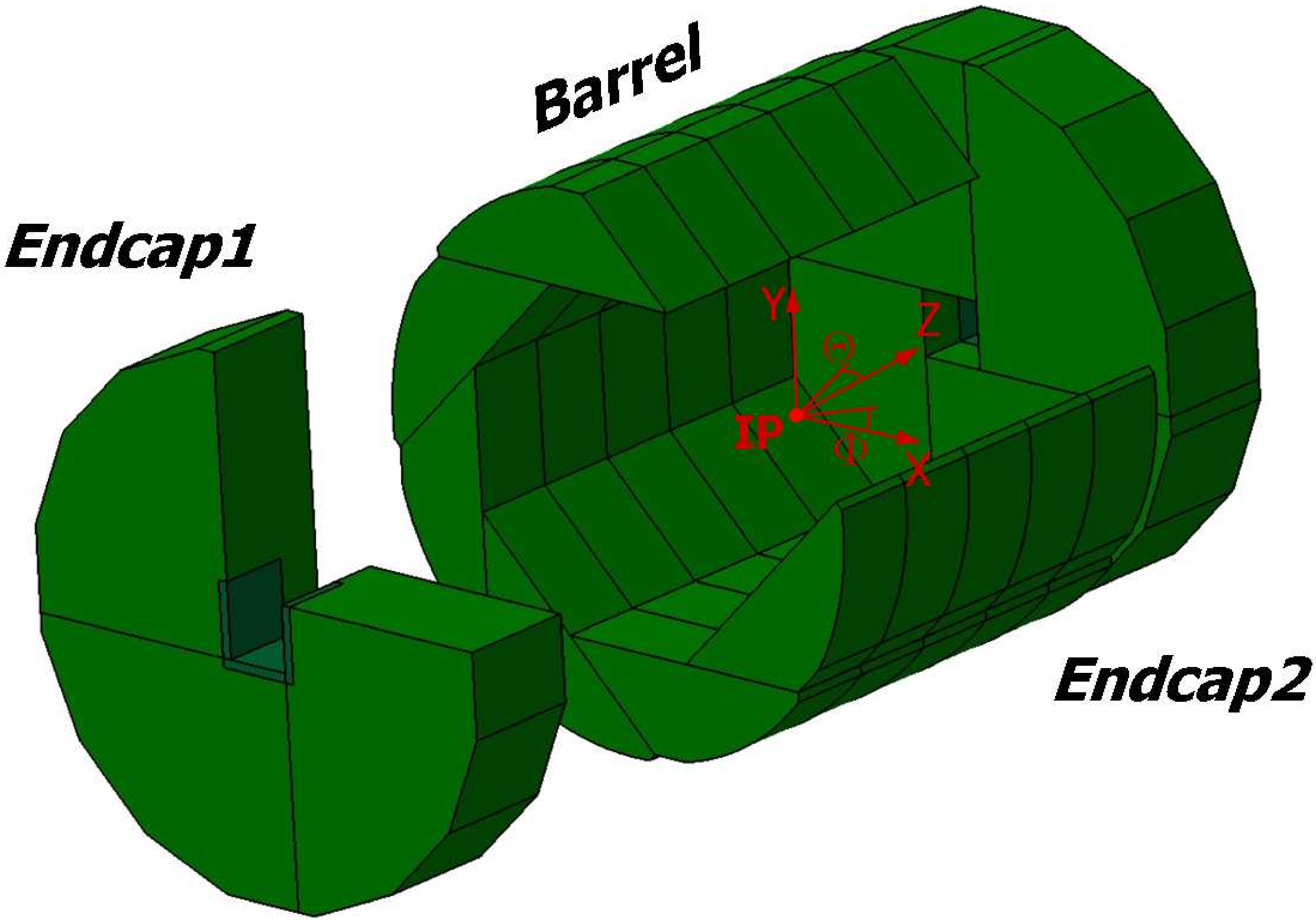
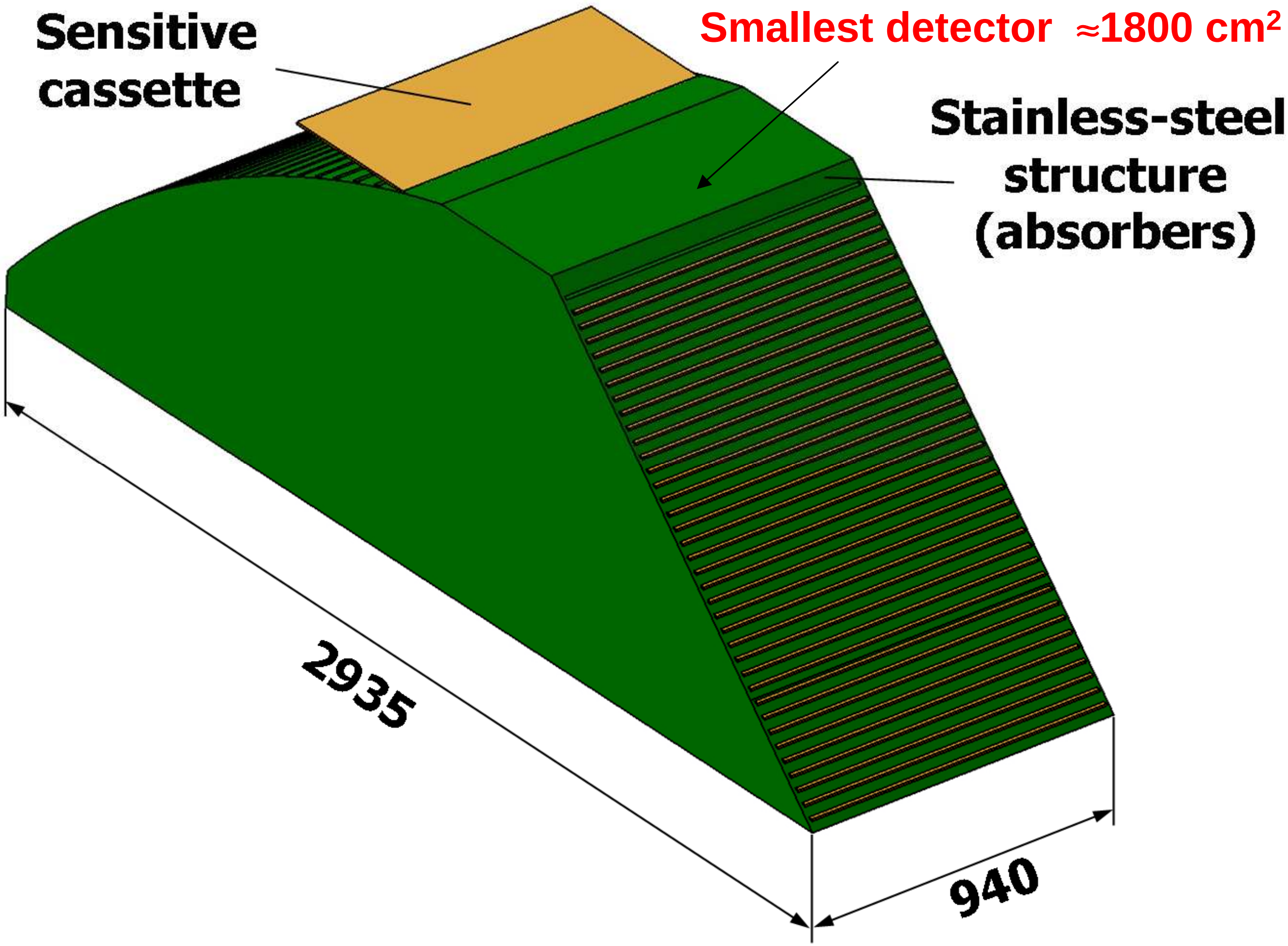
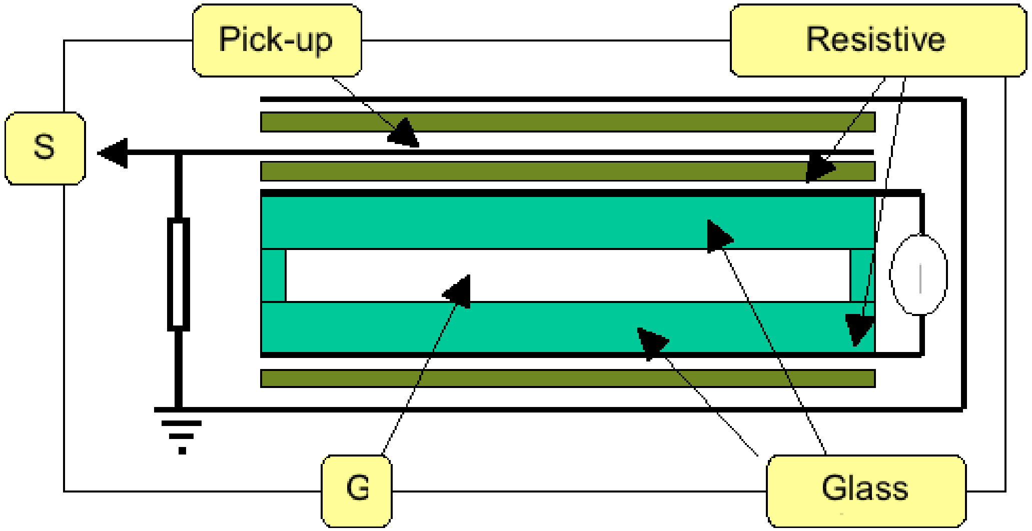
For th SDHCAL Working Group

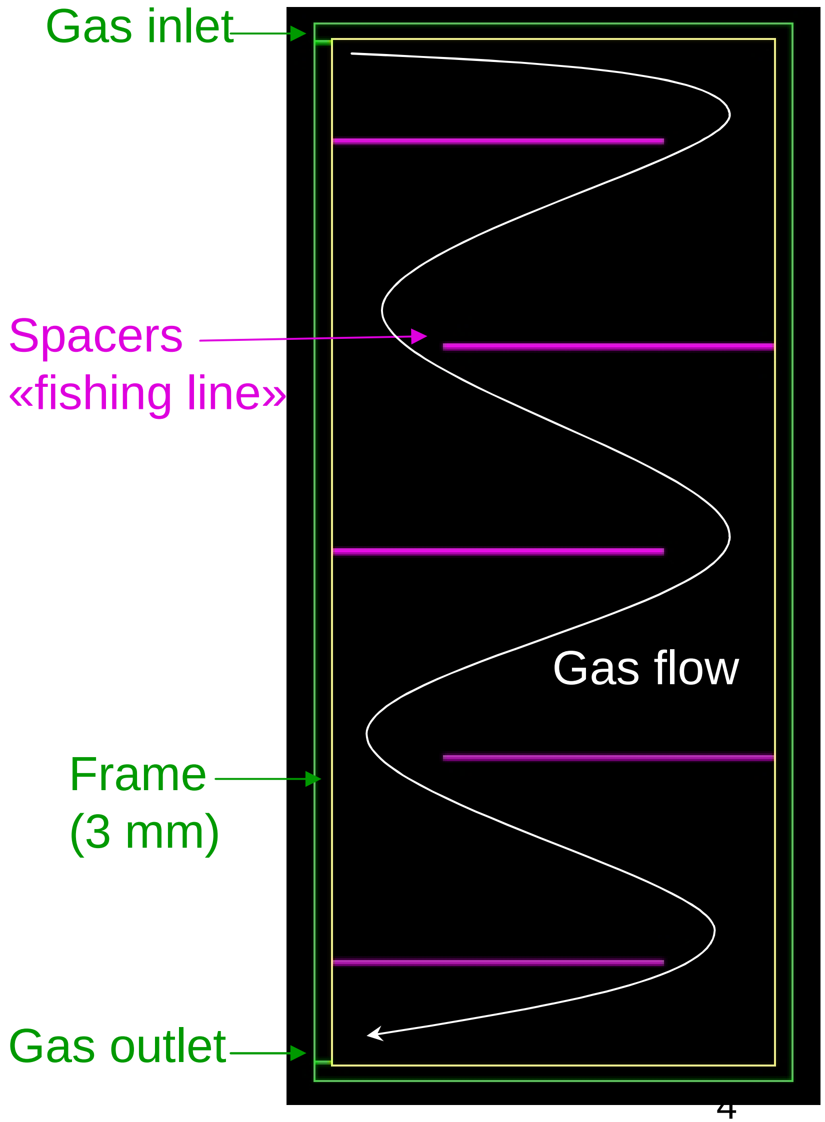

Barrel
Endcap1
Endcap2
Y
Z
X
IP
Θ
Φ


Sensitive cassette
Smallest detector ≈1800 cm²
Stainless-steel structure (absorbers)
2935
940

Resistive Plate Chambers : Gas detector

Homogeneity





Fishing lines can be replaced by tiny spacers
→ Increase efficiency and homogeneity

Calibration

1- Electronics :

Before installation : Calibrate all the channels

After installation : Check all the channels with a frequency to be determined by the ongoing tests

2- Detector :

Before installation : Use cosmics to measure local efficiency and homogeneity

After installation : Check the global efficiency as much as possible

Procedure for Electronics Calibration

Noise S-Curve :

Record the electronics response when varying the threshold value. The result can be fitted by an error function/sigmoid function . The inflection point presents the noise level. The slope shows the electronics resolution

Gain correction procedure :

Injection in each channel a charge associated to the threshold_0 (ex. 100 fc)

A- produce S-Curve with gain 1→ take the average value of the inflection point of all the channels $\mathbf{I_0}$.

B- ProduceS-Curve with different gains to obtain the inflection point position as a function of the gain.

C- For each channel apply the gain needed to shift the n-channel inflection value obtained with gain 1 to the average value $\mathbf{I_0}$.

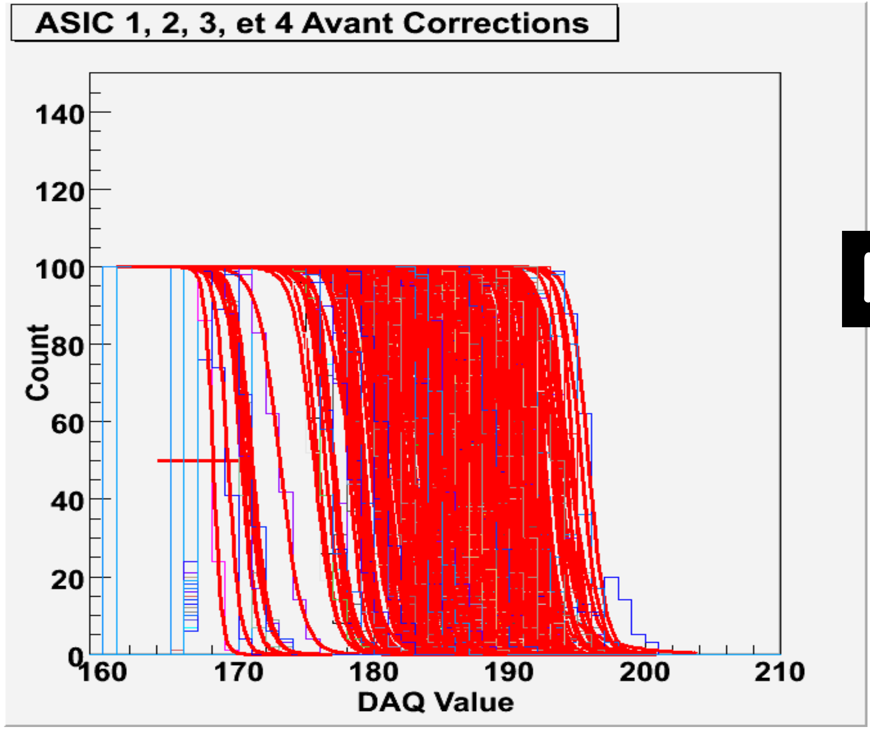
Determination of the conversion ratio DAQ/Charge

→S-Curve obtained by injecting 0 fc (pedestals) 100 fc, 200 fc.

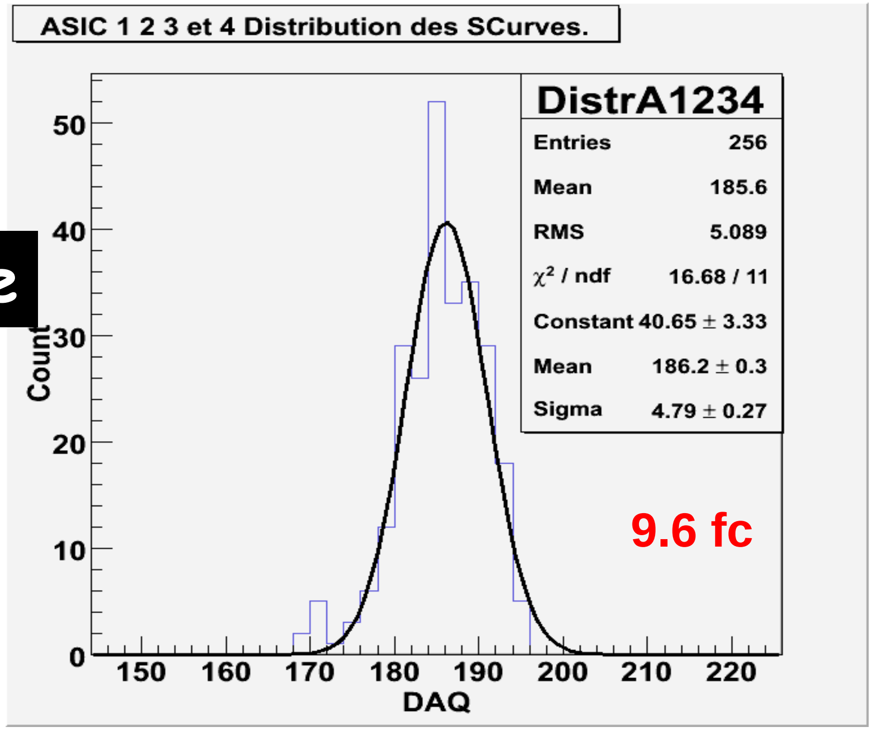
Response linearity :

→S-Curve obtained by injecting 0 fc (pedestals) 1 pc, 2 pc etc.

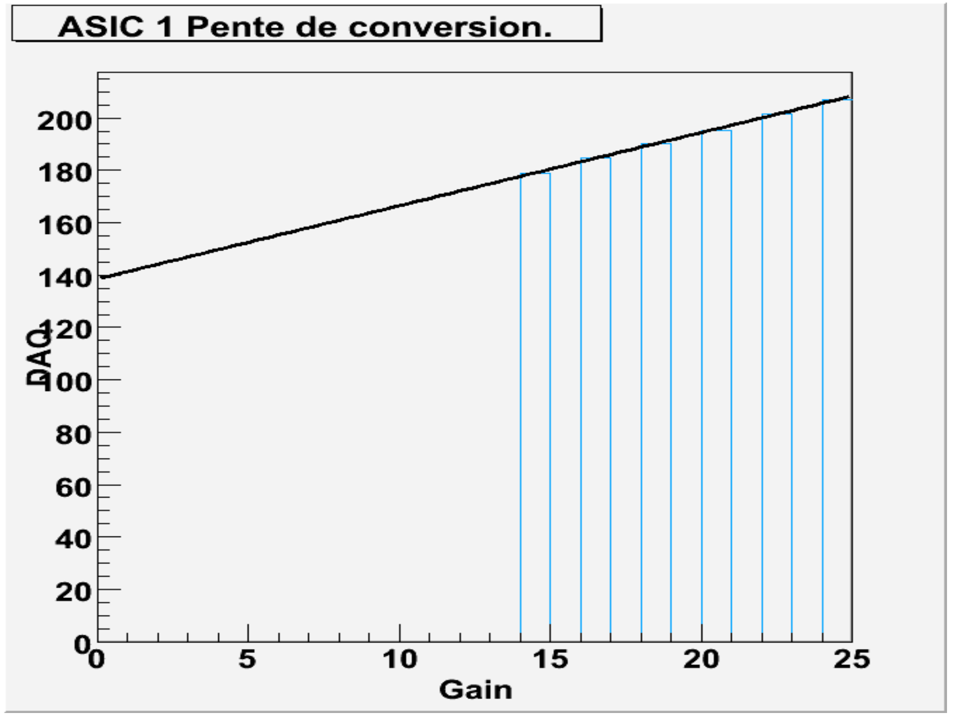
Gain correction



before



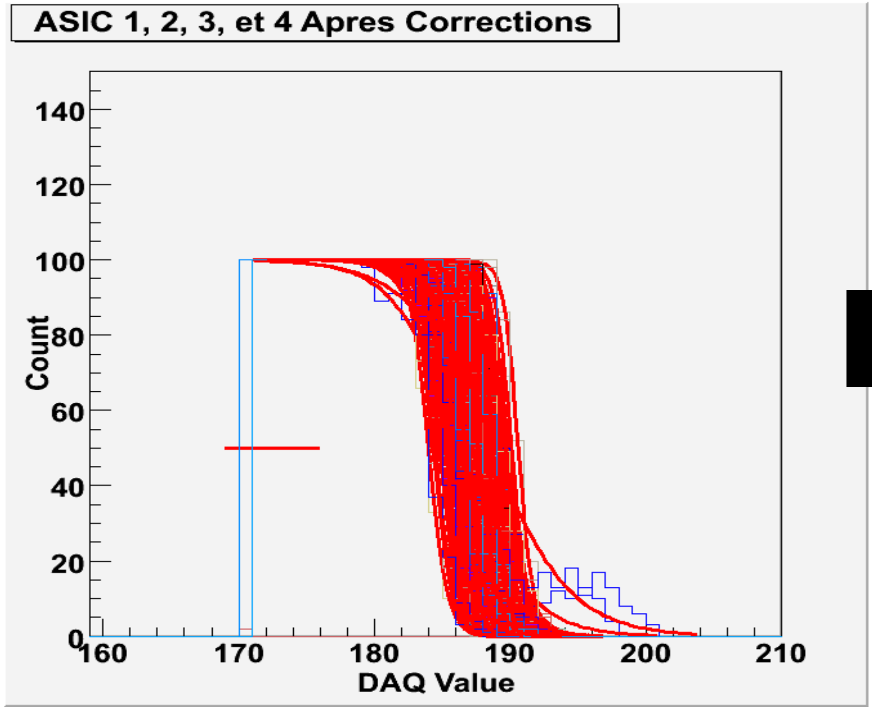
HARDROC1



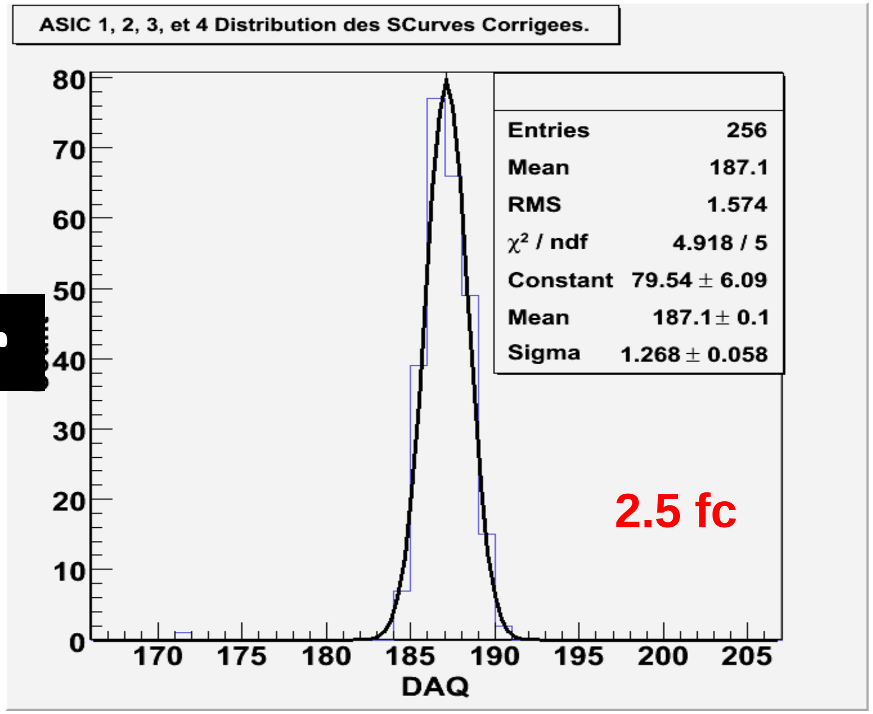
ASIC 1 Pente de conversion.
DAQ
200
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
Gain

HARDROC1

Gain correction

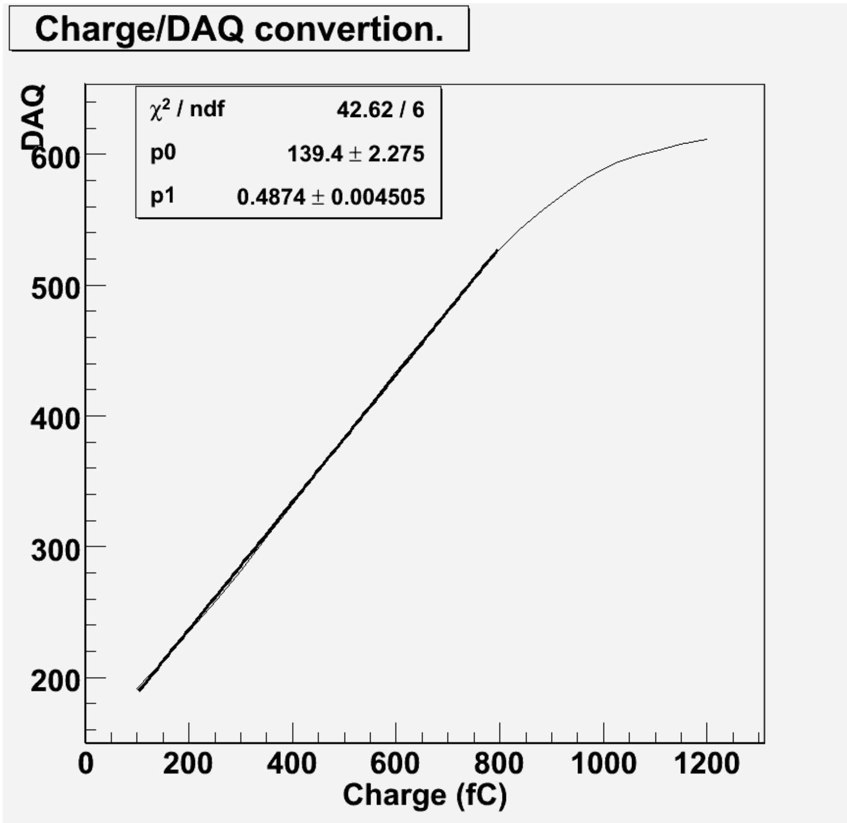


after



HARDROC1

Charge/DAQ Convertion



1DAQ=0,48fC

HARDROC1

Electronics Calibration

The electronics calibration will be done before installation and repeated after installation at time intervals to be determined from the R&D study

The whole procedure is now "almost" automated
The time needed to perform the operation should be optimized :

1- Reducing the number of injections, gain values…
2- Doing the procedure in clever way during data taking.

Using the experience with the **$1m^2$** :

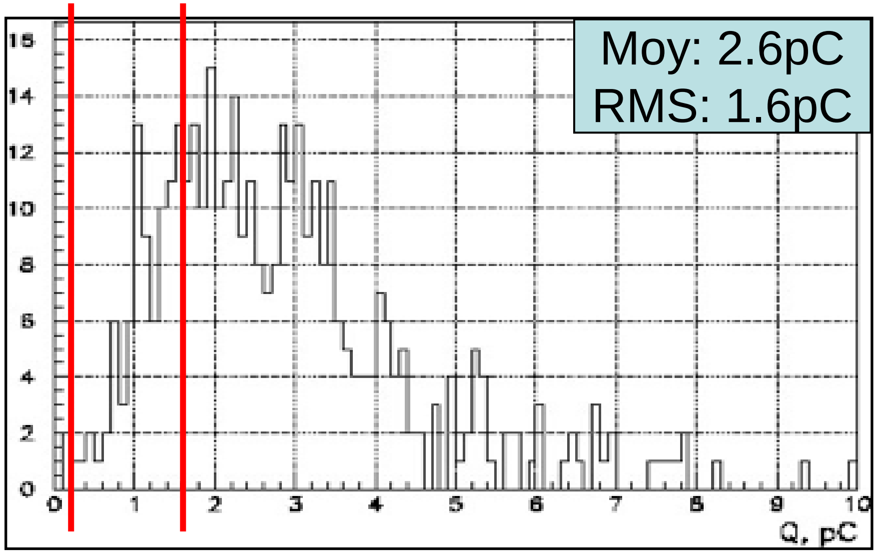
→10-20 minutes for the noise S-Curve

→200 minutes for gain correction : One channel/ASIC at a time to eliminate X-talk. 3 gains and 100 injections for each of 50 thresholds. Limitation comes from the total charge that can be delivered by a generator through the DIF

Detectors Calibration

Before installation all the GRPCs will be studied using cosmic rays.

To obtain an efficiency measurement for each cm^2 with uncertainty < 1% at least 600 evts/cm^2 are needed.



MIP Charge spectrum

Cosmics bench hosting more than 5 GRPCs can be used. At the see level the cosmic rays rate is 1/mn/cm^2. About 5000 h are needed for the whole detector (with 5 GRPCs/bench).

Remarks:

Less time for more than 5GRPCs/bench.

The homogeneity is controlled by comparing the local efficiency.

Detectors Calibration

After the installation the calibration of the semi-digital gaseous detector can be achieved by using MIPs to control the global efficiency and multiplicity evolution with time (for the three thresholds) .

The smallest GRPC detector determines the needed time to achieve the global efficiency measurement.

1- Cosmics : Barrel essentially. This depends on the detector depth and the GRPCs inclination. Suffers from the power pulsing.
(at see level and for horizontal GRPC 60 minutes are needed)

2- Halo muons : Endcaps essentially. Depends on the protection system. Present scheme :660/s. Few seconds will be enough to control the Endcaps GRPC's

3- Long tracks MIPs within hadronic shower (Hough transform). Few by shower. At the nominal luminosity and cms energy, one roughly expects 2000 mip hits/s.

4- Muons in the GigaZ scenario (2.1 Mfb). 6.8 tracks/s. 19 hours are needed

Detectors Calibration

Semi-digital specific control:

$E = c_1\ Nhit_1 + C_2 Nhit_2 + C_3 Nhit_3$

Evolution of the average $Nhit_1/Nhit_2/Nhit_3$ are important in case of the semi-digital readout.

Additional controls:

Leakage current, gas residue analysis are important elements to control aging and efficiency

Homogeneity control :

Radioactive gas can be used to control the homogeneity of the detector If needed:

^{133}Xe (ß decay) and/or ^{222}Rd (α decay)

Conclusion

- The homogeneity of gaseous detector is a big advantage for calibration in situ. It should however be controlled before installation by measuring local efficiency.
- Global efficiency (per detector) control should be enough → Less tracks are needed. Tracks sources are identified
- Electronics calibration procedure is well established and will be fully automated All channels to be controlled before. A strategy to control them in situ is under study to minimize time consumption.
- Detector homogeneity control is also possible using radioactive gas when needed.
- Alignment can be controlled using the same sources of detector control