Preliminary Nov 2015 test beam results on active diamond target

PADME Collaboration Meeting

Federica Oliva

Frascati, 1st March 2016

Before starting…

Special thanks go to Emanuele Leonardi,

who helped us with the acquisition system at the BTF during the test beam in November and provide us with the data analysis framework.

OVERVIEW

- DETECTOR SETUP AND MAPPING
- CHARGE CALIBRATION
- RUN LIST
- CALO CHARGE
- DIAMOND CHARGE
- e-/e+   SEPARATIONS
- SIGNAL-TO-NOISE
- POSITION SCAN
- CCD ESTIMATION
- DIAMOND HV SCAN

DETECTOR SETUP AND MAPPING

- Diamond active detector (2x2 cm – thickness 50µm)
- Amplifiers box Cividec: 10 CSA(C6) and 10 RF(C2)
- 7 Single CSA (C6)

18x18 strips - 1mm pitch – 0.18 mm inter-gap dead space

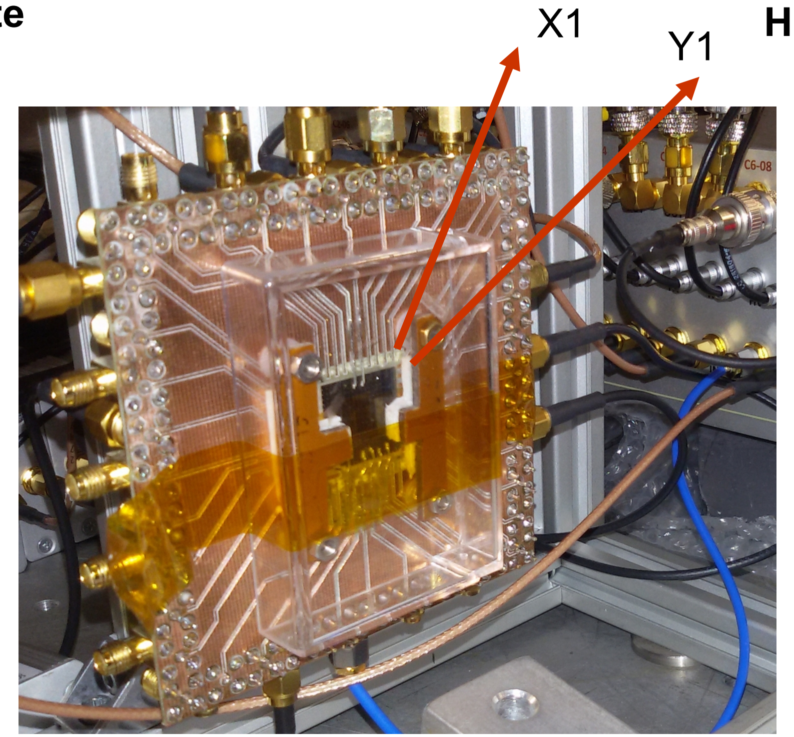
12 X strips connected to **CSA**

5 Y strips connected to **RF** and 5 to **CSA**

Vertical strips X coordinate

X1	C600
X2	C601
X3	C602
X4	C603
X5	C604
X6	n.c.
X7	C605
X8	C606
X9	C607
X10	C608
X11	C609
X12	n.c.
X13	C6HV0078
X14	C6HV0079

n.c.=not connected

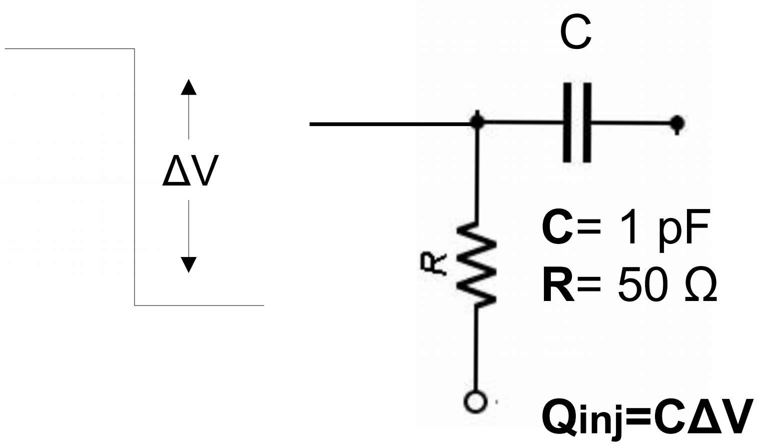


Horizontal strips Y coordinate

Y1	C6HV0055
Y2	C209
Y3	n.c.
Y4	n.c.
Y5	C6HV0056
Y6	n.c.
Y7	C208
Y8	C207
Y9	C6HV0057
Y10	n.c.
Y11	C206
Y12	n.c.
Y13	C6HV0106
Y14	n.c.
Y15	C205
Y17	C6HV0107

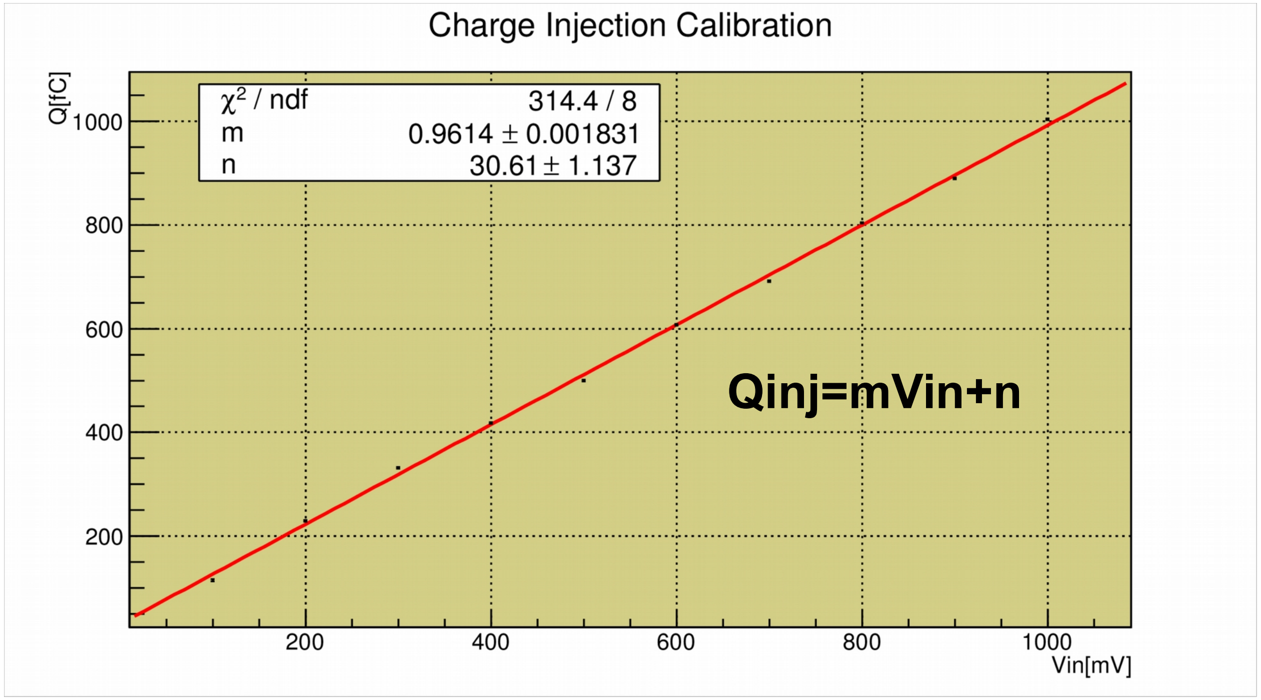
Calibration for each channel needed!

CALIBRATION TECHNIQUES



Characteristic of the reproduced signal:

Vhigh=1V
Vlow=0V
Width 10 ns
(duration of the **BTF** bunch).



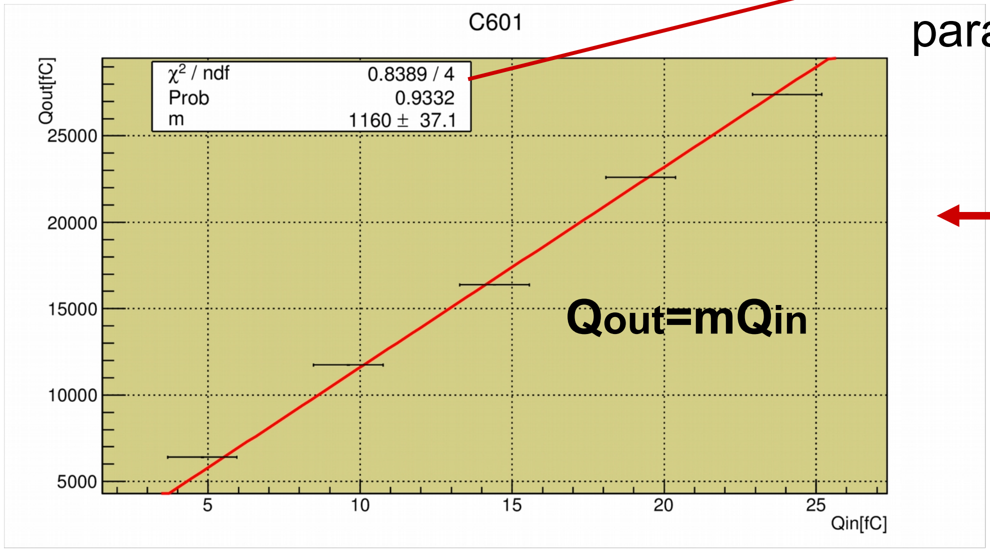
Qinj measured directly by a Lecroy Oscilloscope, using the integral of the output signal

LINEAR FIT

The charge injection for the calibration for each channel can be calculated, knowing Vin.

CALIBRATION RESULTS

An example of **CSA** calibration



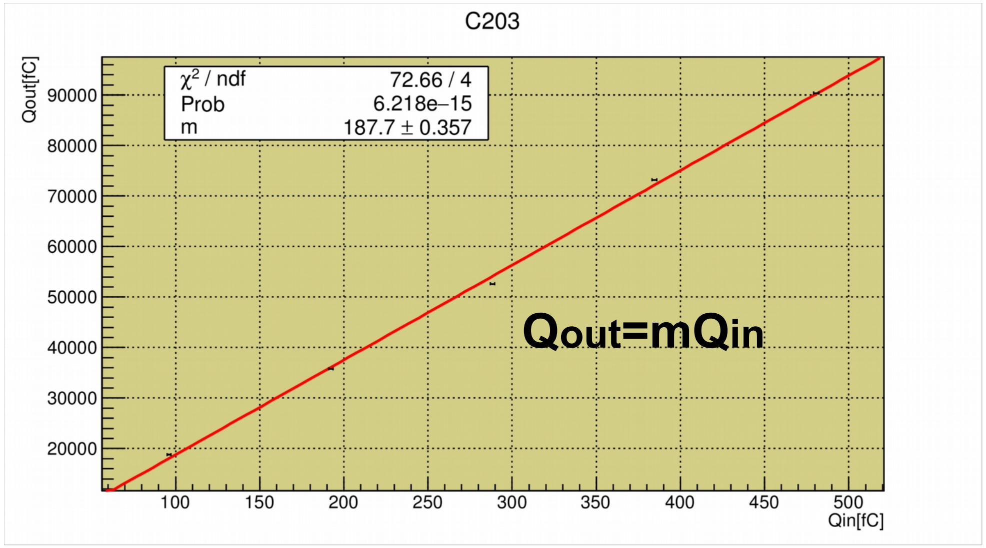
Calibration parameter

Amplificators box

CSA charge gain ≈ 1150 ± 40

RF charge gain ≈ 190± 1

An example of **RF** calibration



Single CSAs

CSA charge gain 1st set ≈ 650 ± 50

CSA charge gain 2nd set ≈ 1100 ± 85

RUN LIST

From RUN **91 final experimental setup**

From **92** to **100** first movement of the detector to study the signal

From **101** to **120 SCAN UP/DOWN HV POSITIVE**

From RUN **130** al **135 Detector position scan, X direction, 1mm step**

From **139** to **158 SCAN DOWN/UP HV NEGATIVE**

From RUN **161** 50 Ohm resistance inserted in **calo signal**!

From **164** to **165 Detector position scan, Y direction, 1mm step**

From **166** to **168 free run** → **RUN 167** taken as a reference run

From **191** to **193 position scans**

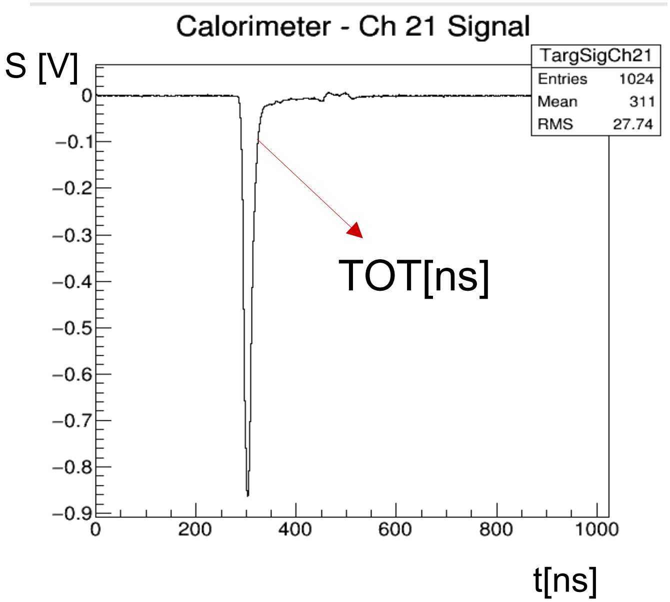
From **237** to **245 position scans**

..Many others runs to test the detector!

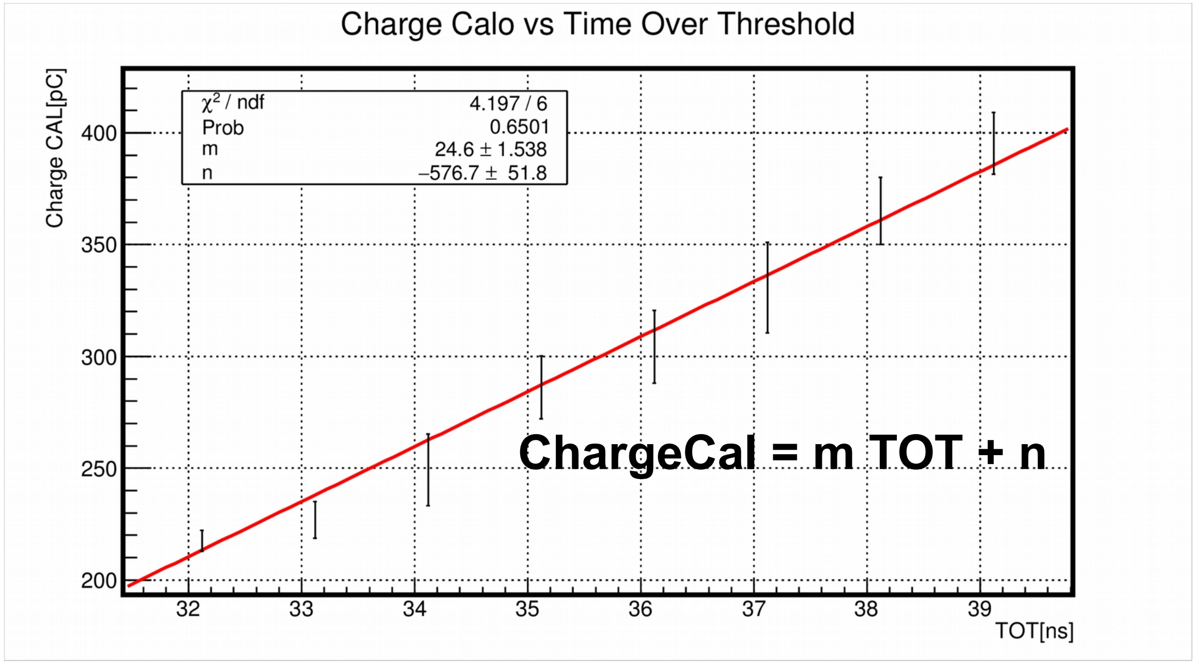
Several runs with 5 GHz sampling for timing studies.

CALO BTF SIGNAL

Calo signal in PADME digitizer was saturated for the first 160 runs.
50 Ω resistance inserted to avoid the saturation.
To analyze also the first 160 runs, a relation between the charge of the calorimeter and time over threshold(**TOT**) was considered.



Not saturated signal

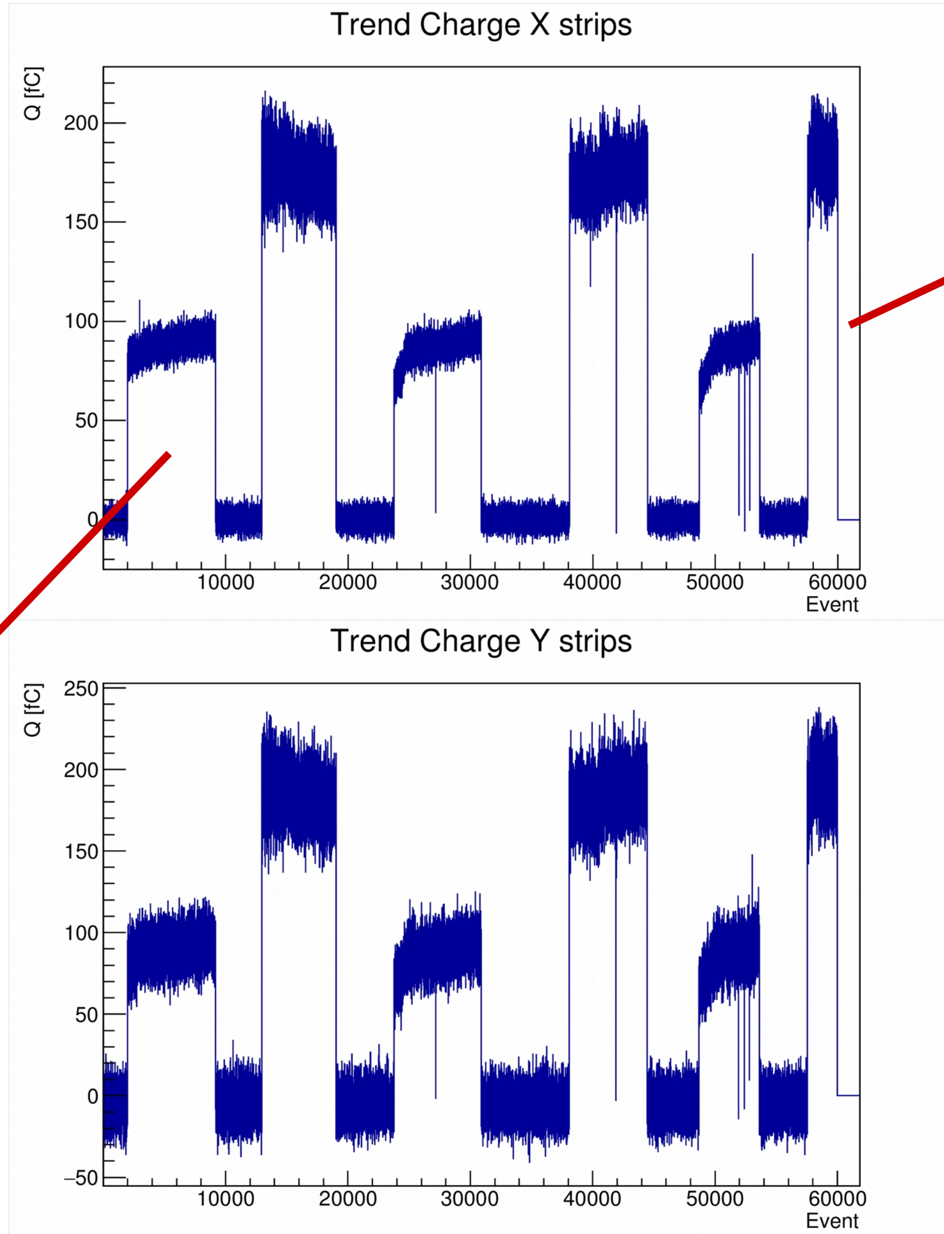


m, **n** fit parameters inserted in the macro analysis in order to obtain Charge Cal from TOT

CHARGE COLLECTION TRENDS

60000 EVENTS OF RUN 167

HV=150 V
X=280.7mm
Y=211.1mm

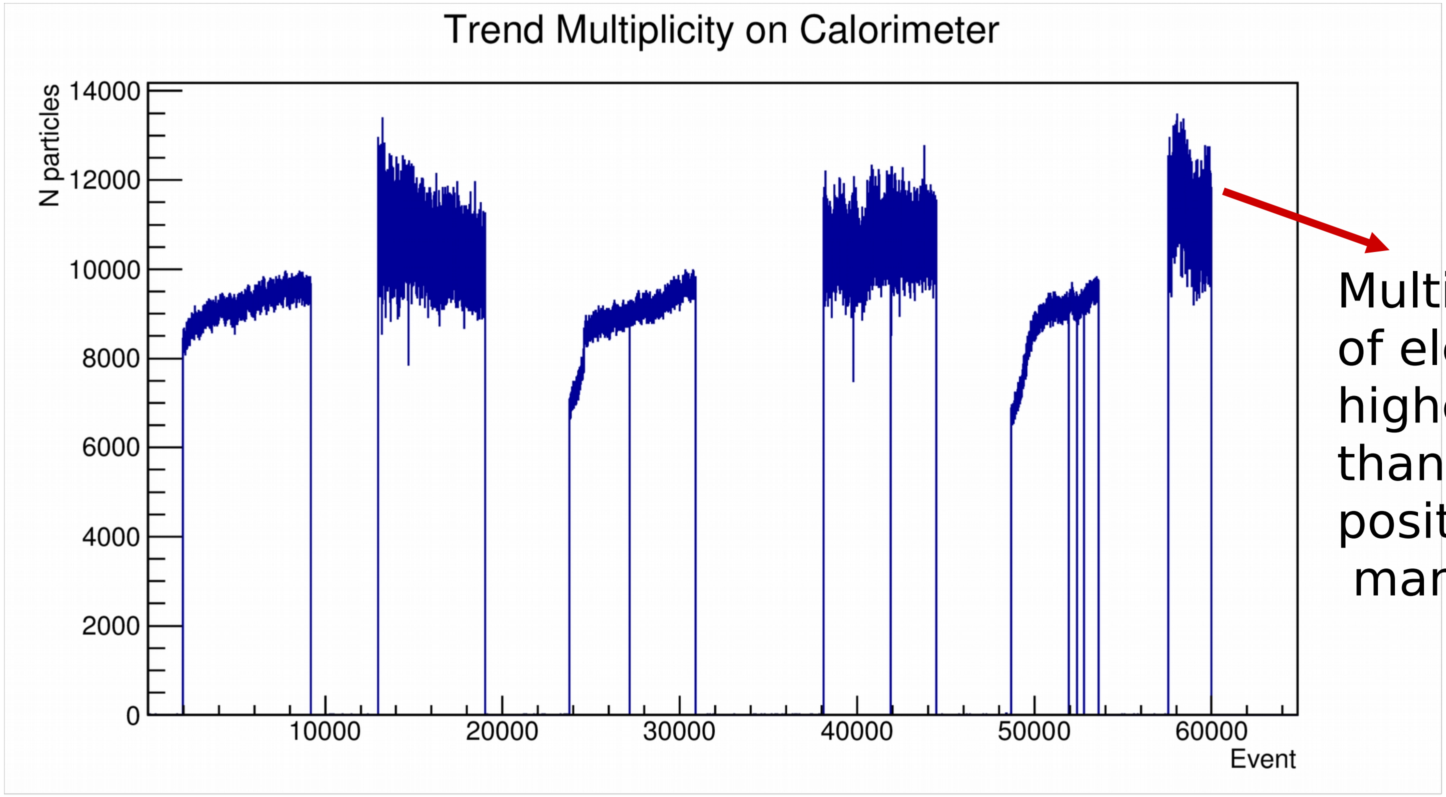


Events with higher released Charge

BUNCH OF ELECTRONS

Events with smaller released Charge

BUNCH OF POSITRONS

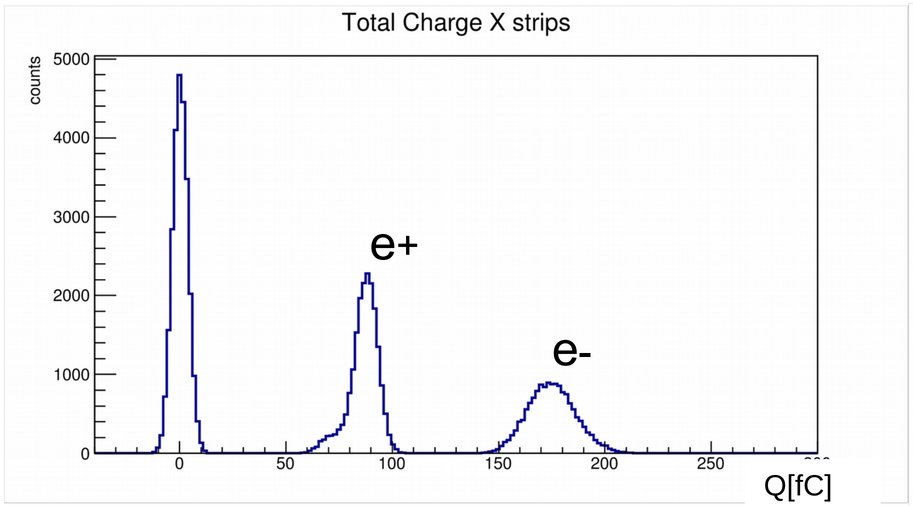


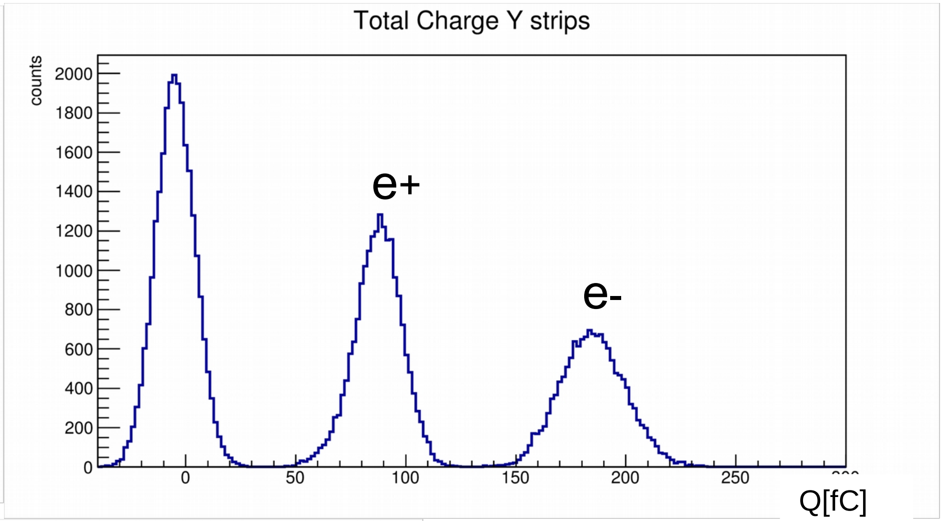
Multiplicity of electrons higher than that of positrons for many runs

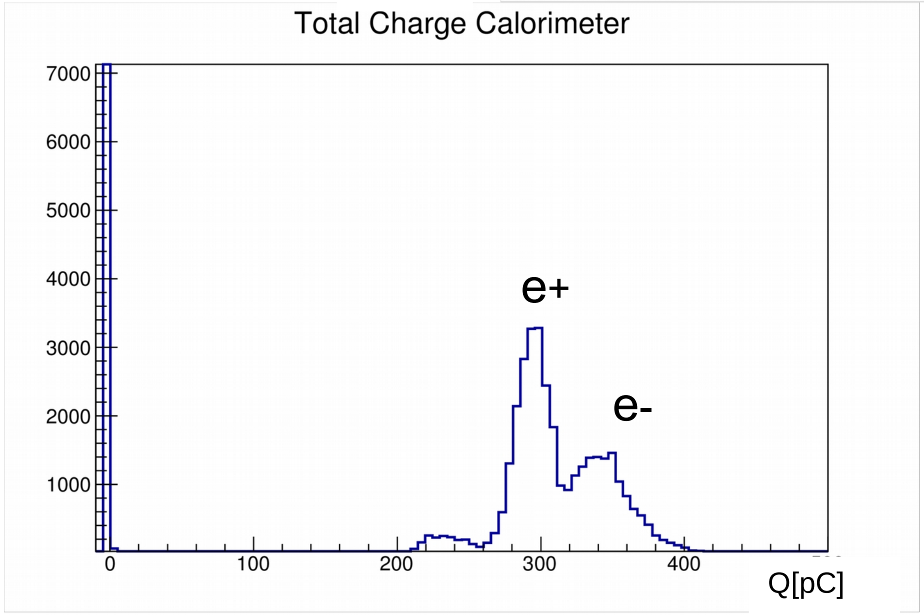
From event 4000 to 6000 → only **positrons**
From event 15000 to 17000 → only **electrons**

TOTAL CHARGE DISTRIBUTIONS

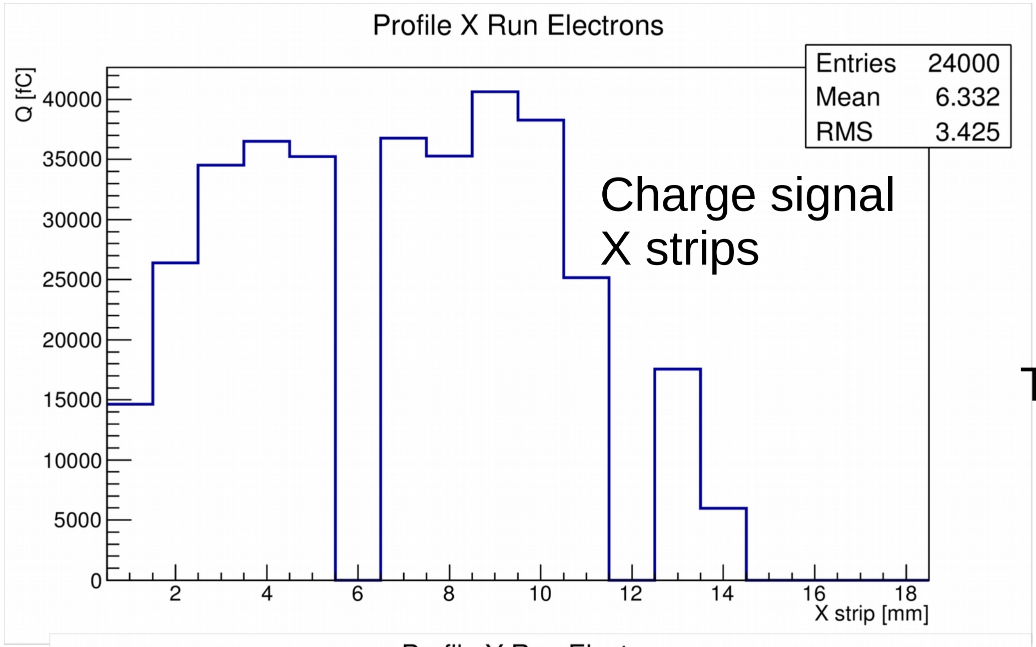
As seen before, electrons and positrons bunches give different charge production.
Thanks to the charge distribution and trends is possible to discriminate between e-/e+.

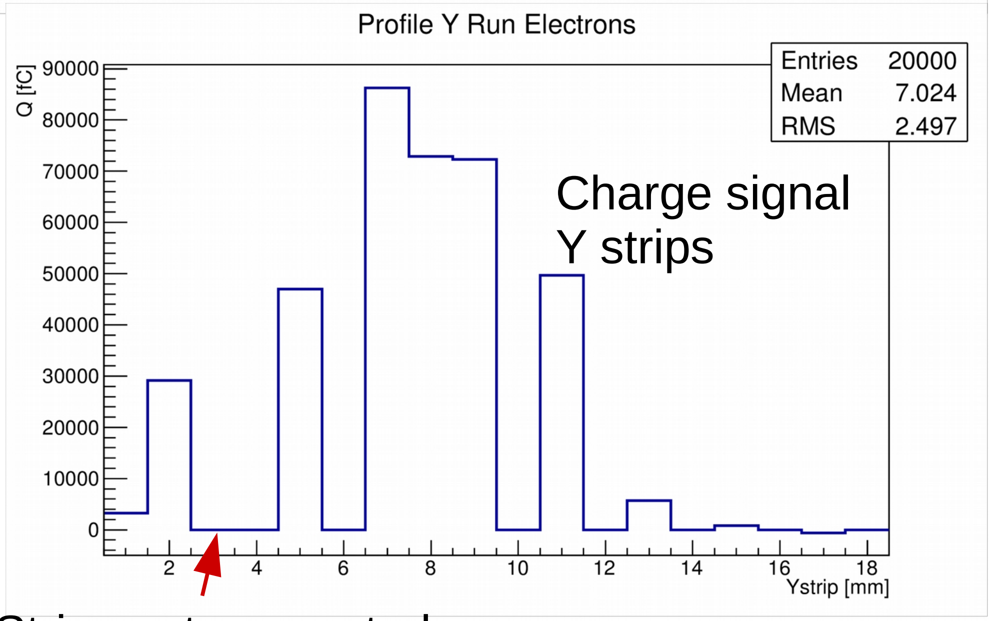






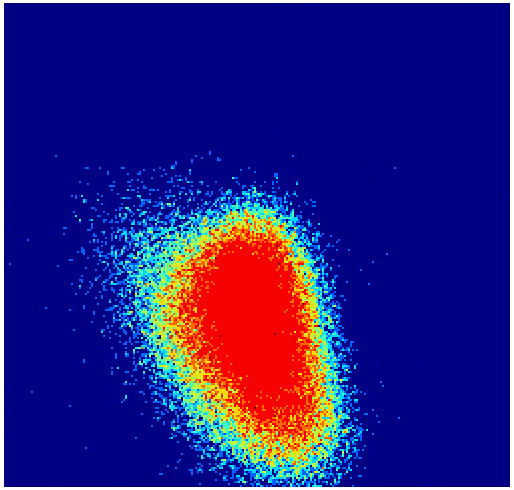
X-Y PROFILES - ELECTRONS





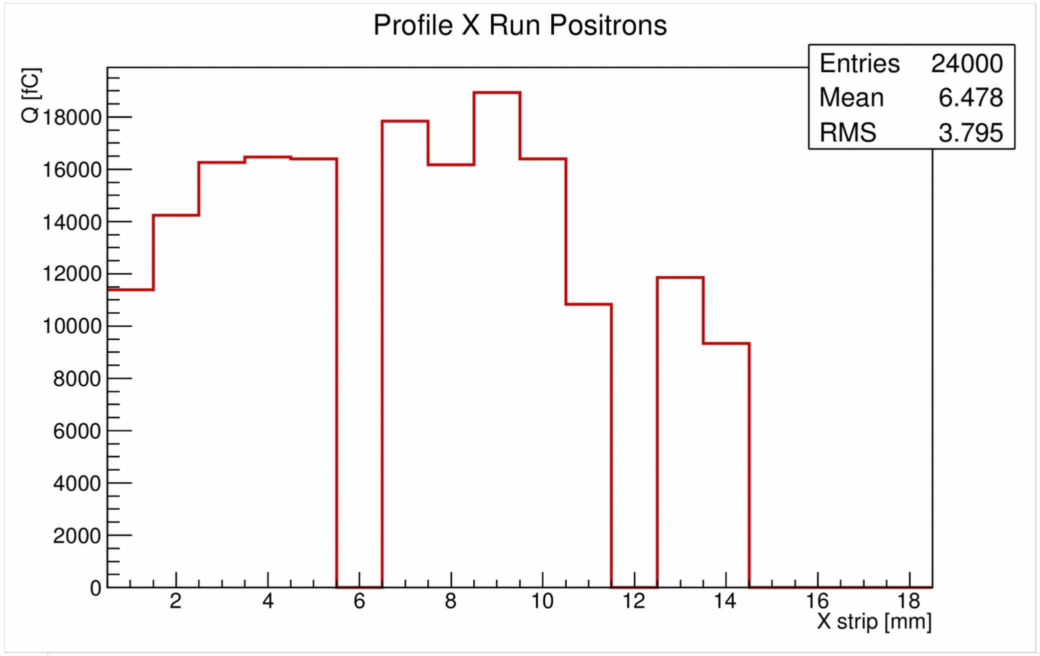
Strips not connected

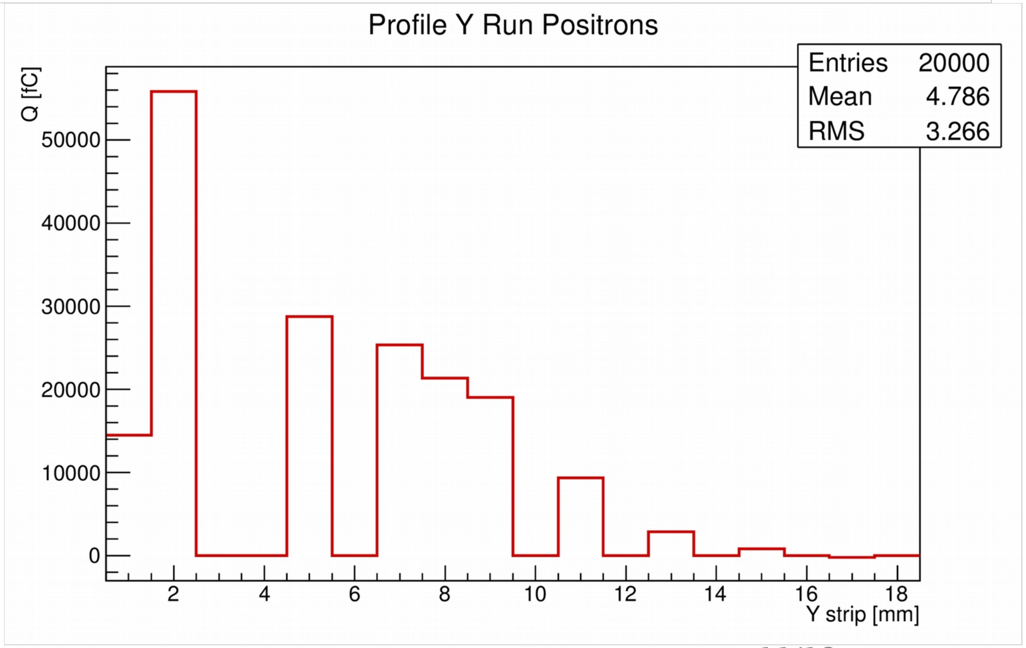
Typical beam shape for electrons



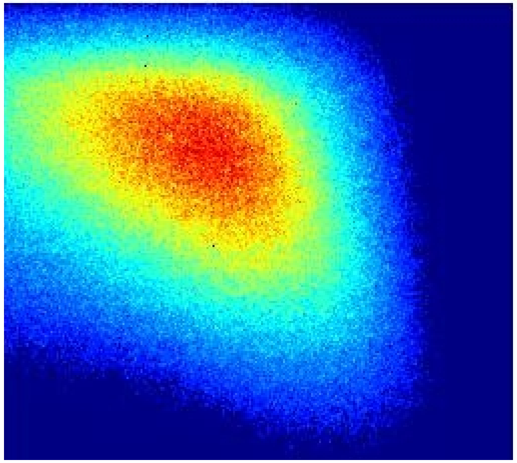
Medipix pic

X-Y PROFILES - POSITRONS





Only few vertical strips give high signal because beam of positrons is upper than the one of the electrons.

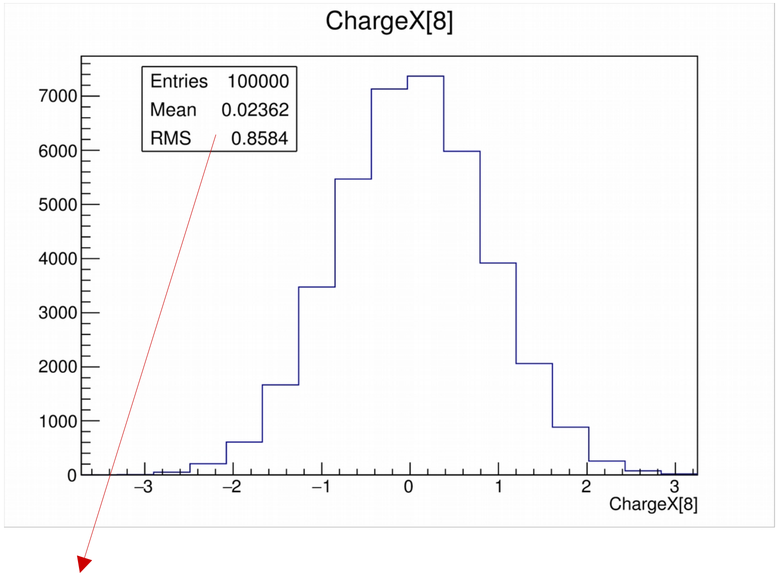


(medipix pic)

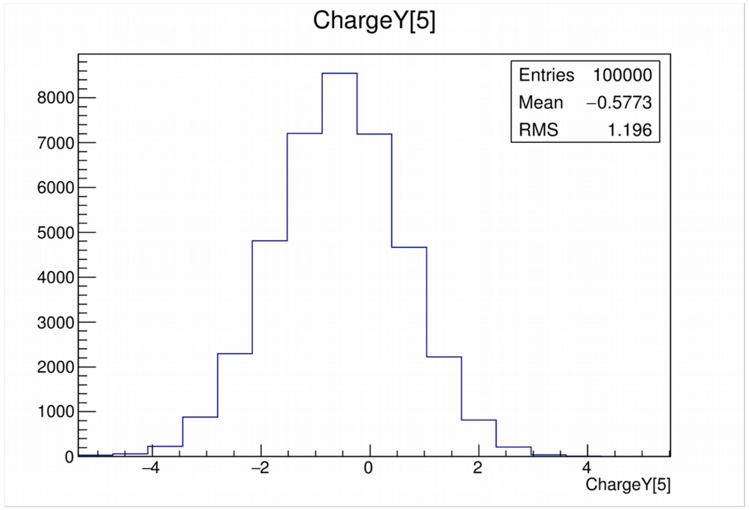
SIGNAL/NOISE

For a generic run the ratio signal/noise for the central strips has been calculated.

Example of noise for a generic X strip



Example of noise for a generic Y strip

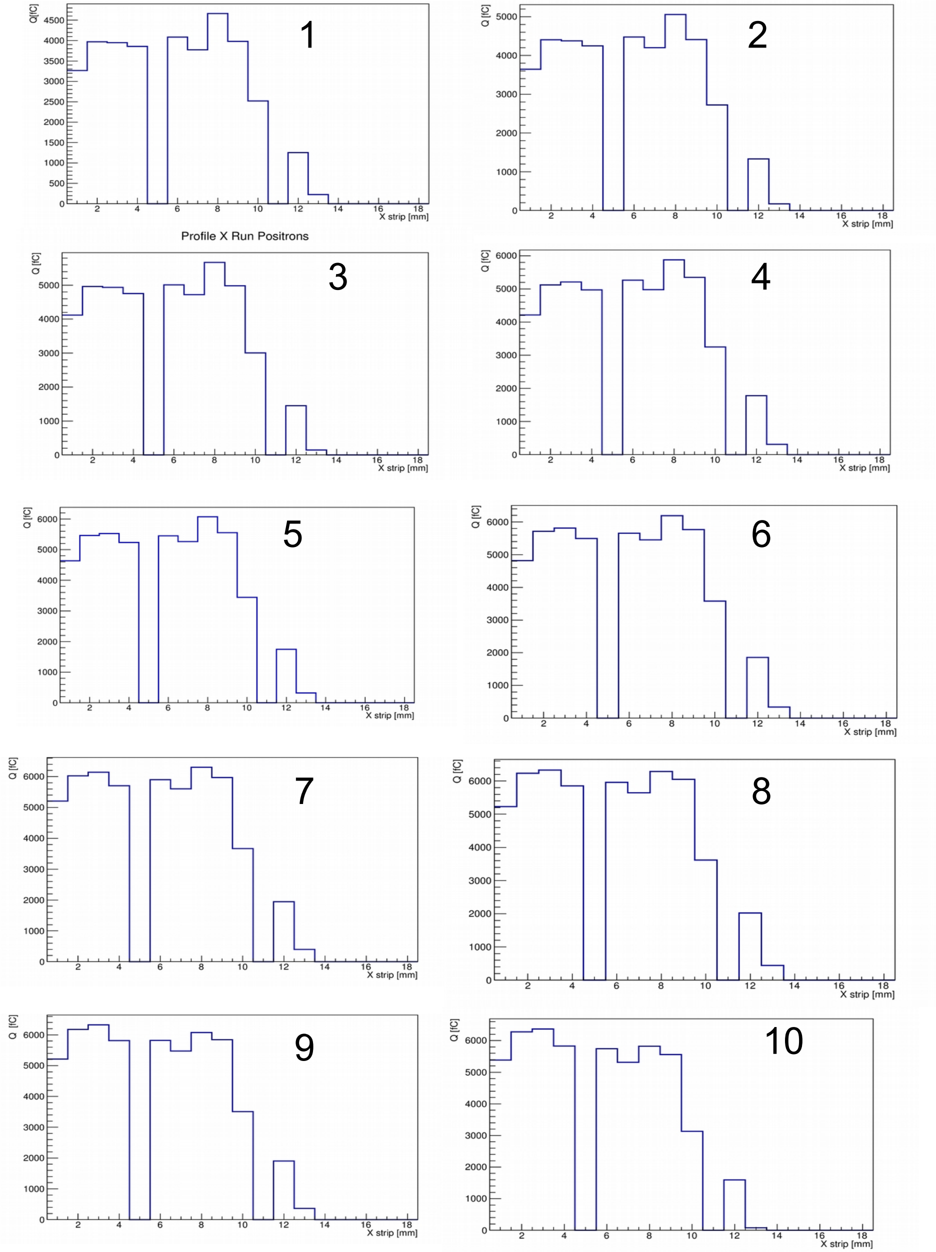


NOISE

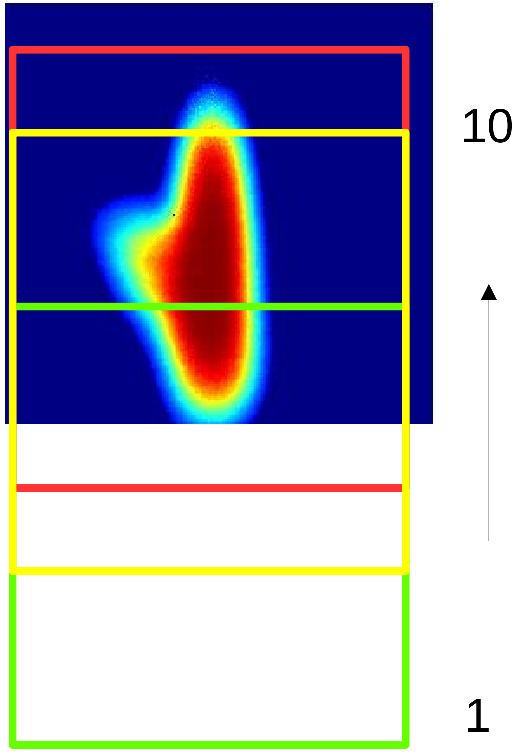
S/N ≈ 20

for a central strip and bunch multiplicity of 10000 particles

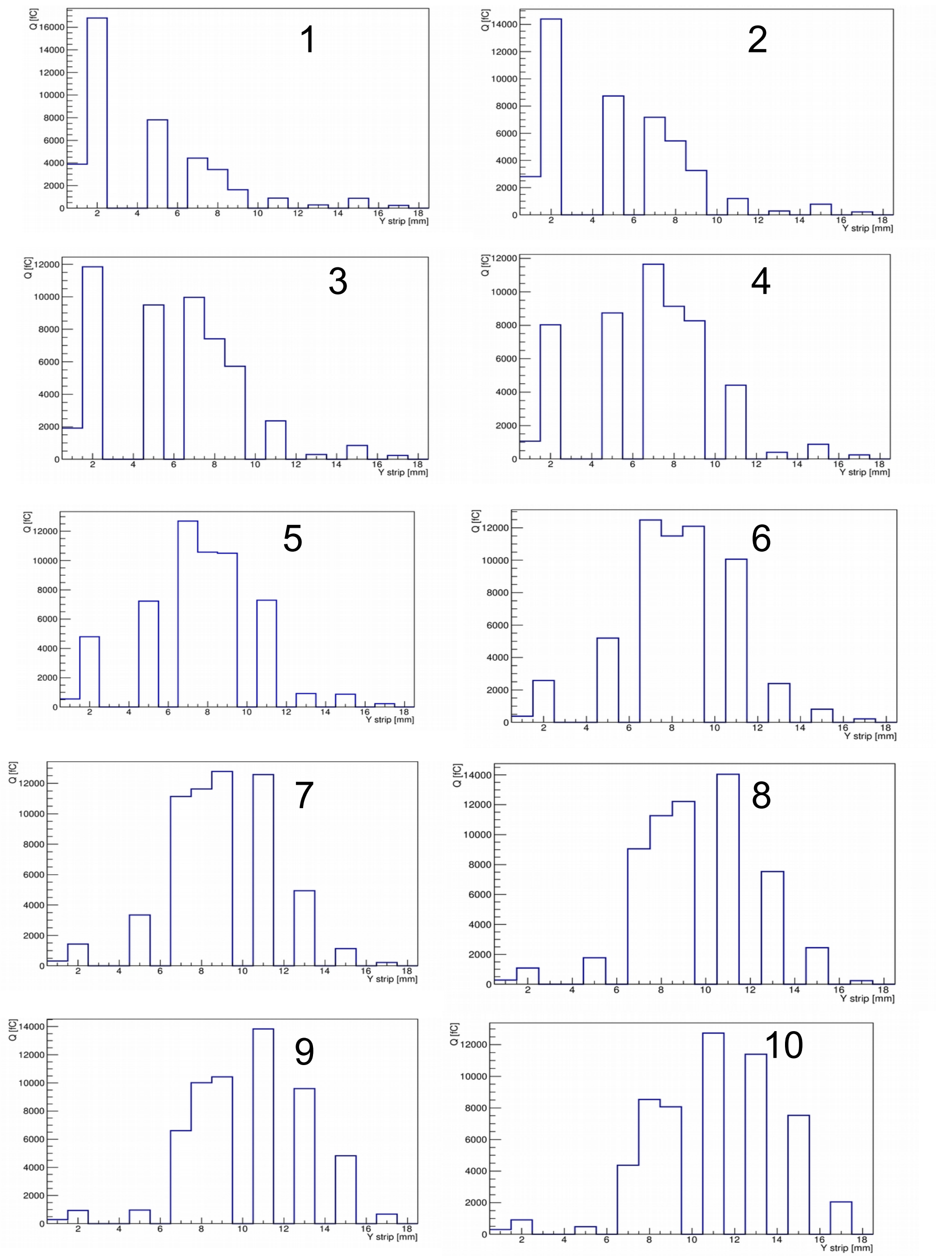
X-PROFILES FOR Y SCAN



The detector has been moved up in steps of 1 mm to scan vertically the detector



Y-PROFILES FOR Y SCAN



Barycenter of charge was calculated using:

$$\textbf{Bar Qx} = \frac{\Sigma Qxi\, xi}{\Sigma Qxi}$$

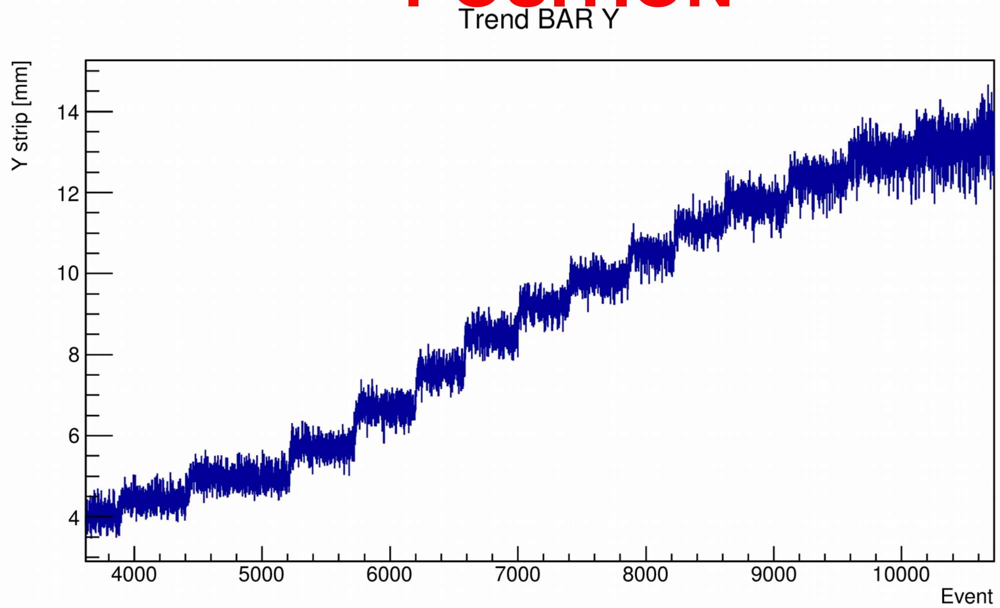
for X strips and

$$\textbf{Bar Qy} = \frac{\Sigma Qyi\, yi}{\Sigma Qyi}$$

for Y strips.

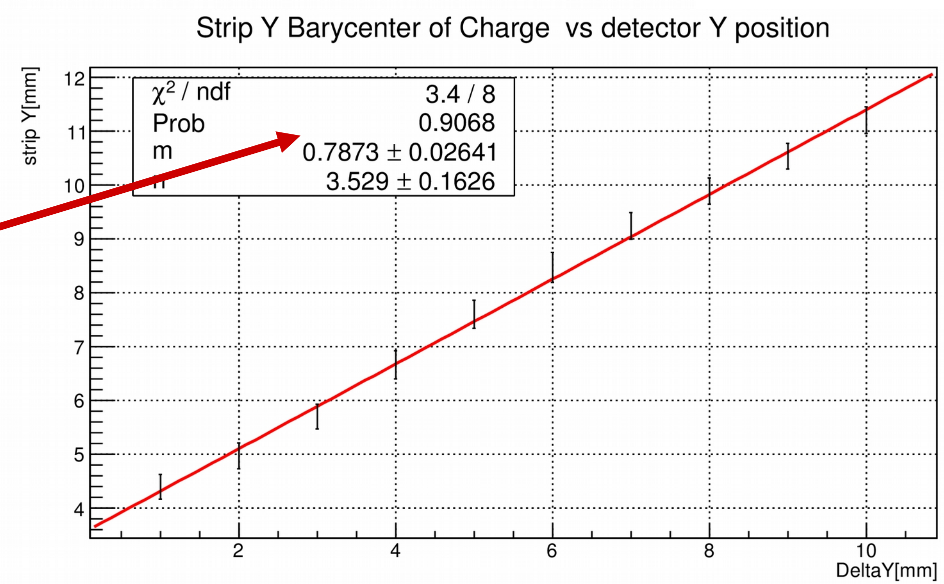
Missing strips charge is estimated interpolating the charge signal of the adjacent ones.

MEASURED AVERAGE BEAM POSITION VS TRUE Y POSITION



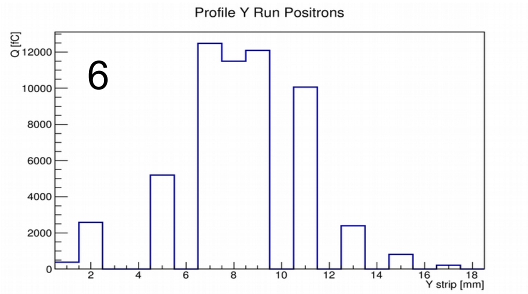
Expected variation of average beam position along y about 1 mm..

..but only 0.8 mm measured !!!!



CCD

Centering the beam with the diamond, it could be useful to calculate the total released charge for Y strips, for example in the situation 6.



In this particular position:

Sum of Charge Y ≈200 fC

Nparticles on calo ≈ 11000

$$\textbf{CCD} = \frac{\Sigma Qy \cdot 6250}{36 \cdot Nparticles} \frac{1}{\%active\ region}$$

The dead area is evaluated estimating the charge of the unconnected X and Y strips by interpolation from the adjacent ones.

$$\%\ \text{active region} = \frac{Qdetected}{Qtotal}$$

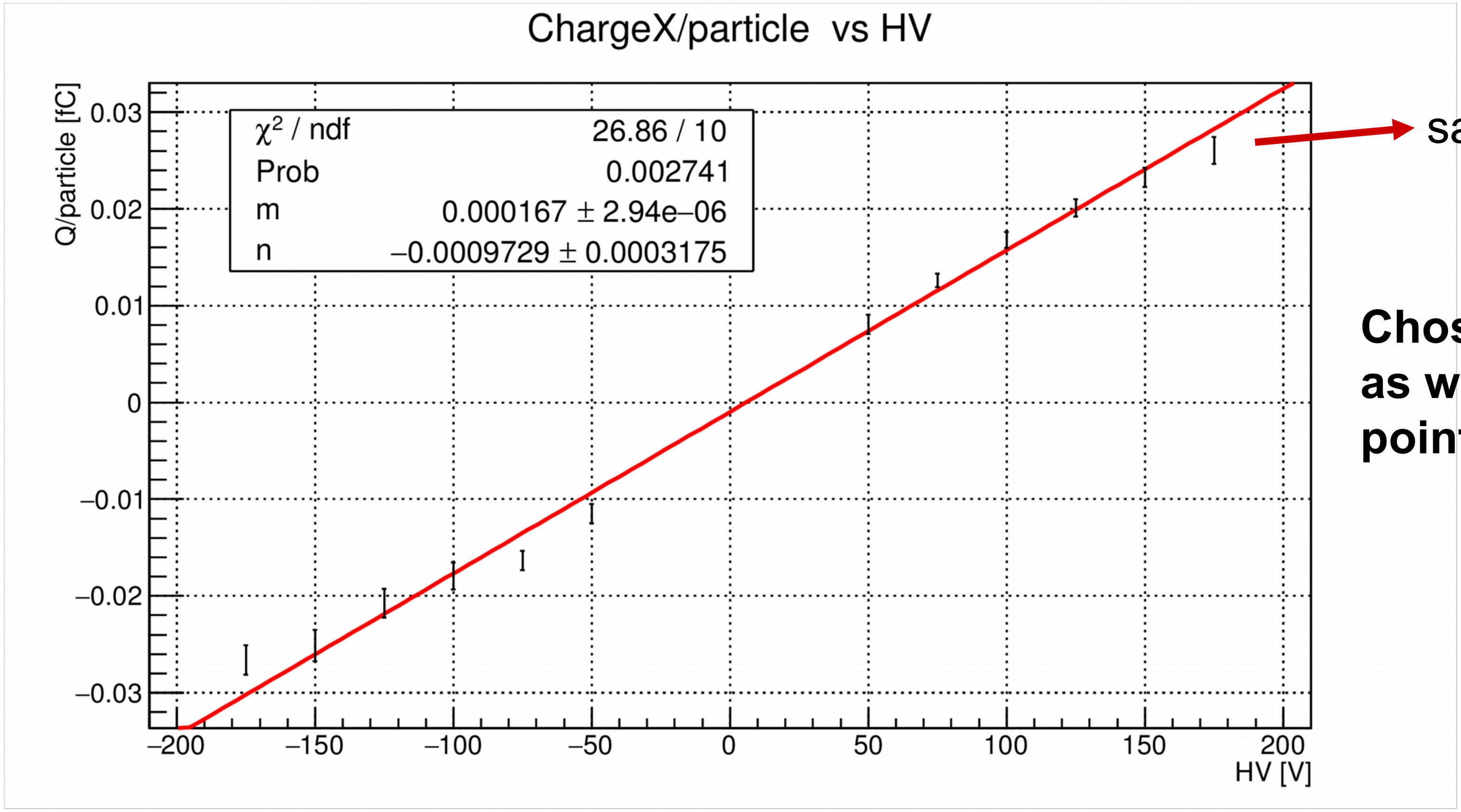
Active region for X strips=0.86
Active region for Y strips=0.6

To know the real % of the active region, the gap between the strip of about 0.18 mm had to be considered, which cause a further dead area of 18%.

CCD ≈ 10.4 μm

HV POSITIVE AND NEGATIVE SCAN

From -150 V to 150 V



saturation

Chosen 150 V as working point

The plot is symmetric (no polarization)!

CONCLUSIONS

The first very preliminary analysis of November 2015 test beam data show promising results.

- Average beam position resolution should be about 0.25 with bunch multiplicity of about 10000.
- The S/N for the central strips is around 20 with bunch multiplicity of about 10000 and far away front-end electronics.
- The CCD value is according to the expectation of about 10 um without beta pumping (should increase about 40 % with pumping)
- Correlation between real beam profile and detector strip profile under investigation.