

A compact TPC for high intensity beam tracking system at H8

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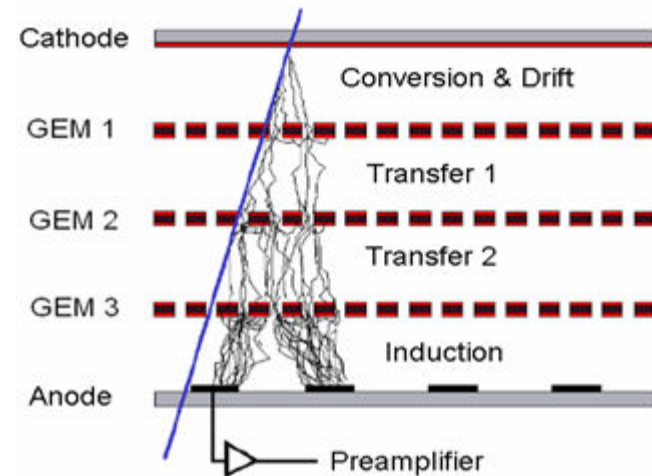
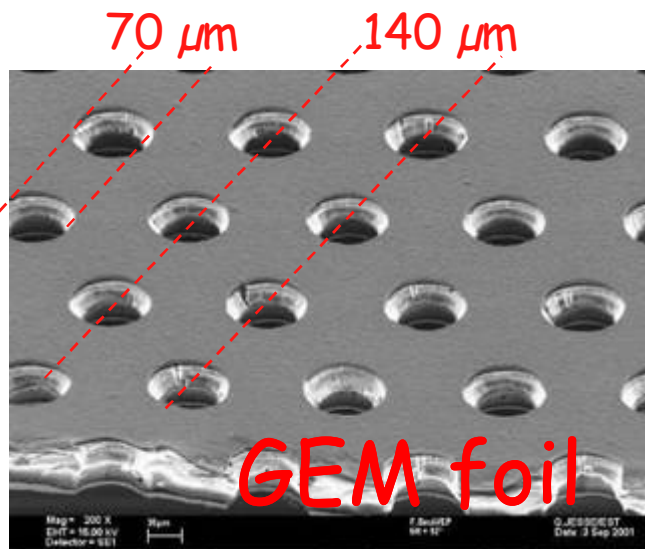
P.Valente
Sezione Roma INFN

- Triple GEM detector principia
- Monitors for Crystal experiment at SPS
- A compact Time Projection chamber with GEM

A triple GEM Chamber

A Gas Electron Multiplier (F.Sauli, NIM A386 531) is made by 50 μm thick kapton foil, copper clad on each side and perforated by an high surface-density of bi-conical channels;

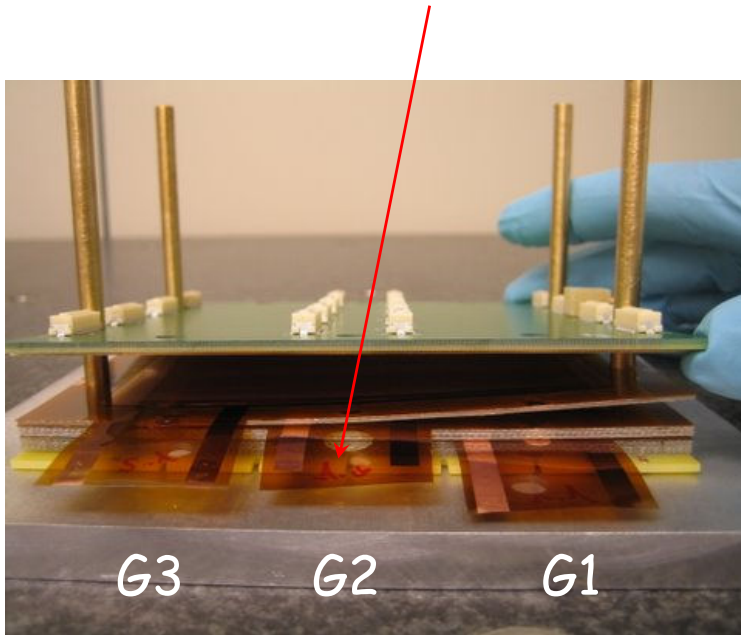
Head on particle impinging a GEM chamber



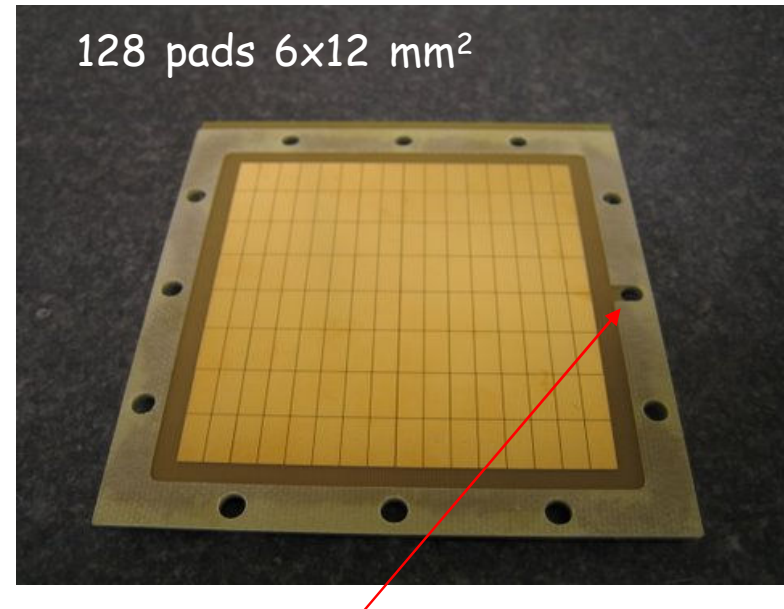
* M.Alfonsi et al., The Triple-GEM detector for the M1R1 muon station at LHCb, N14-182, 2005 IEEE NSS Conference, Puerto Rico

A Standard Triple GEM construction

The detectors described in this talk are built starting from the standard $10 \times 10 \text{ cm}^2$:
only one GEM foil has been modified to have central electrodes.



The GEM are **stretched** and a G10 frame is glued on top

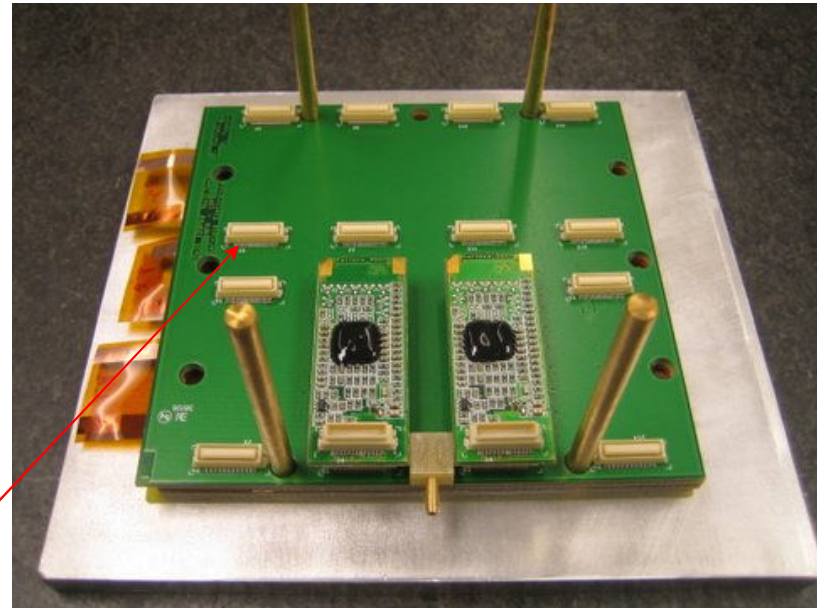
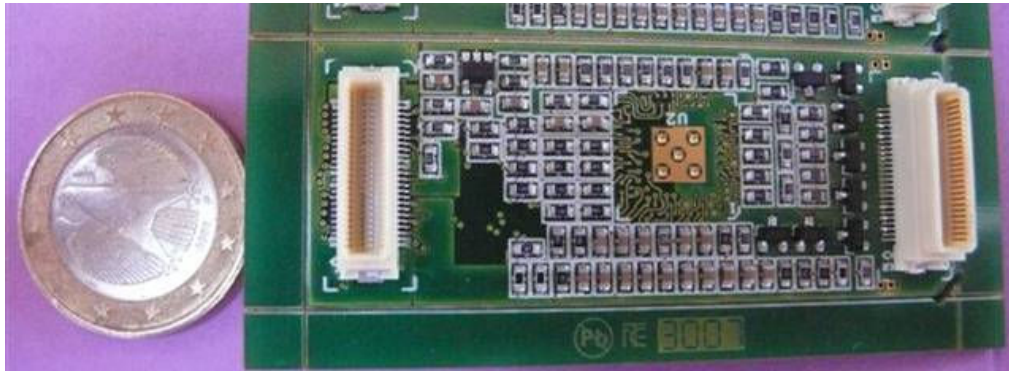


The frame for the G3 foil has been modified for the gas inlet

The FEE board used

The card is based on *Carioca Chip and has been designed and realized in Frascati by Gianni Corradi ; Total dimension : 3x6 cm²

16 channels for each card: channel density of 1 ch/cm²
Sensitivity of 2-3 fC; LVDS output (25 ns); Radhard;
Extremely modular and usable for GEM applications

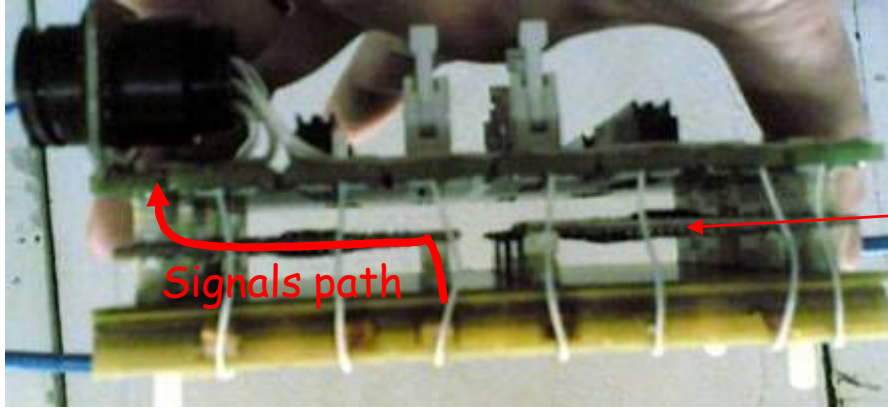


All the anode PCB have been designed with the same connector layout for a total of 128 channels

* Development of the CARIOCA front-end chip for the LHCb muon detector.
W. Bonivento, et al NIM A491:233-243,2002

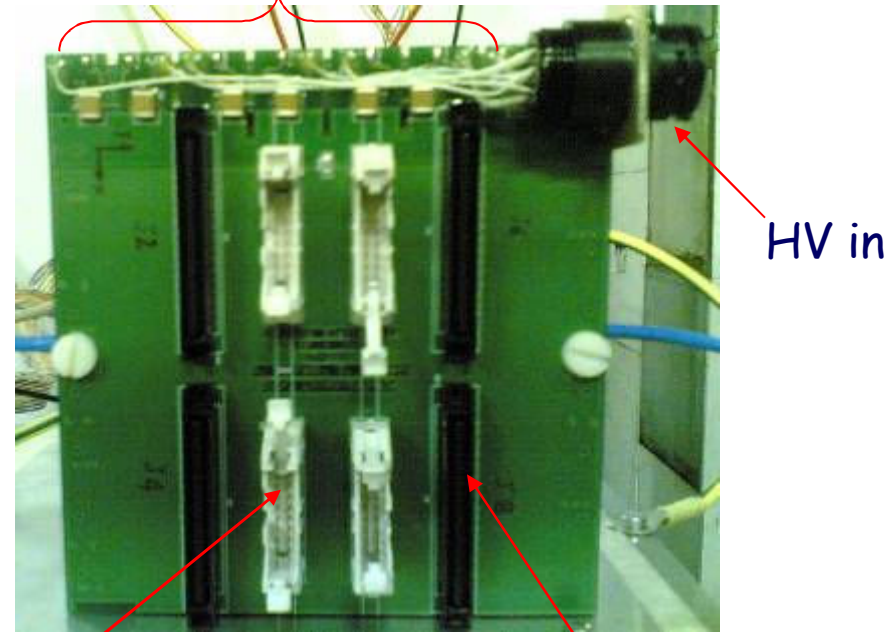
The mother board

On this mother board
HV and LV ground are connected
each other through a 10 K Ω resistor

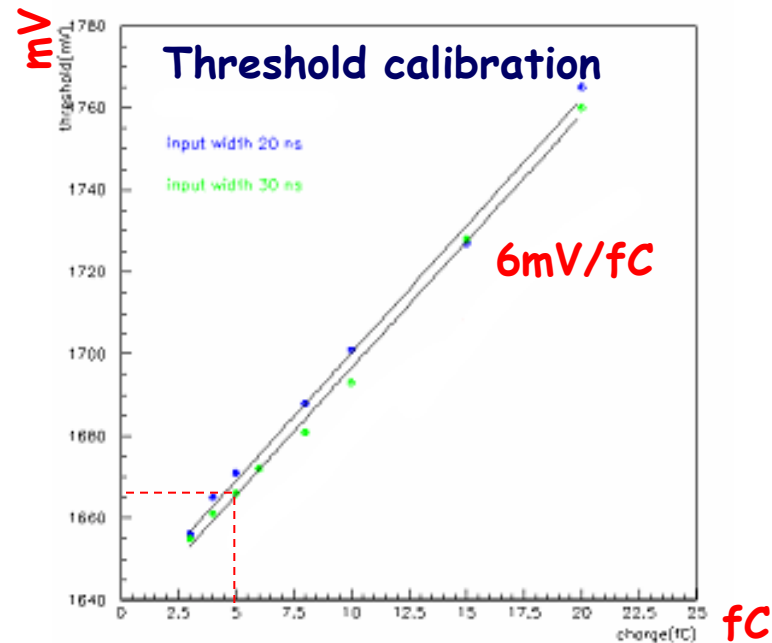


CARIOCA readout electronics

HV filters

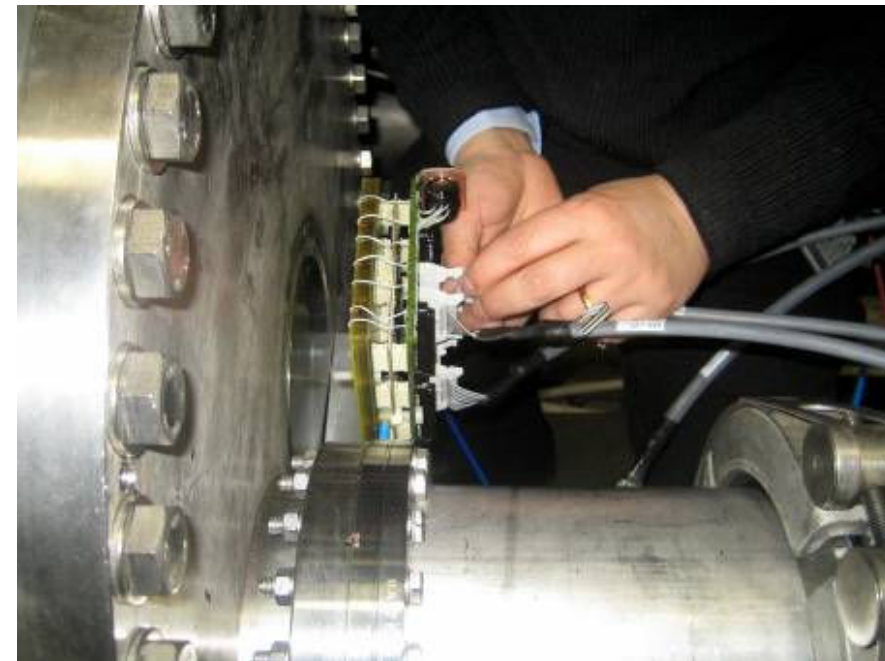
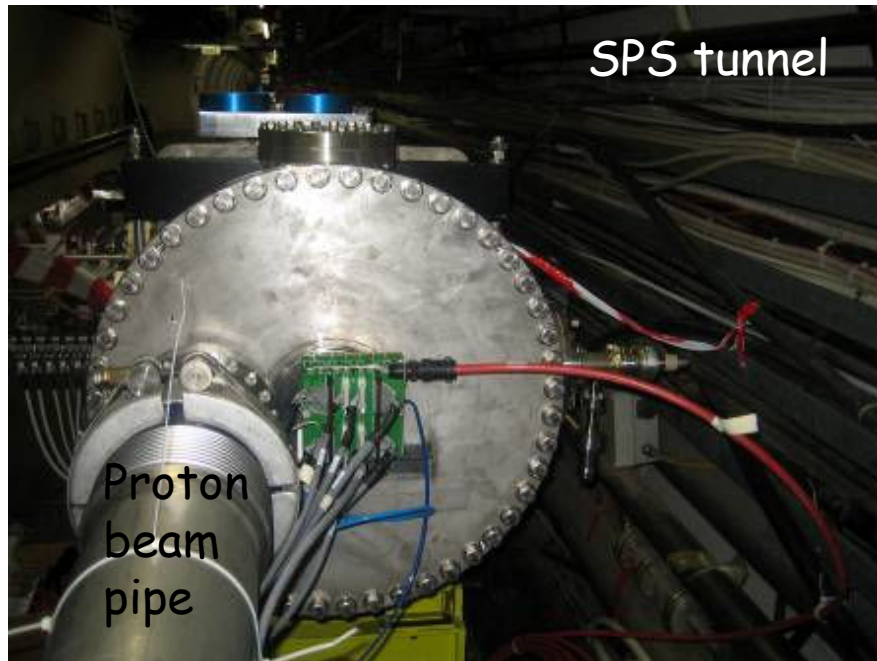
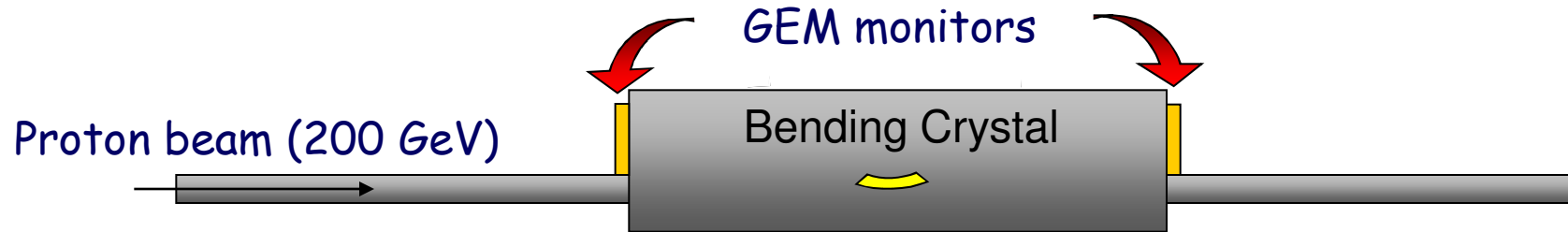


Threshold & LV in 4x32 LVDS signals out



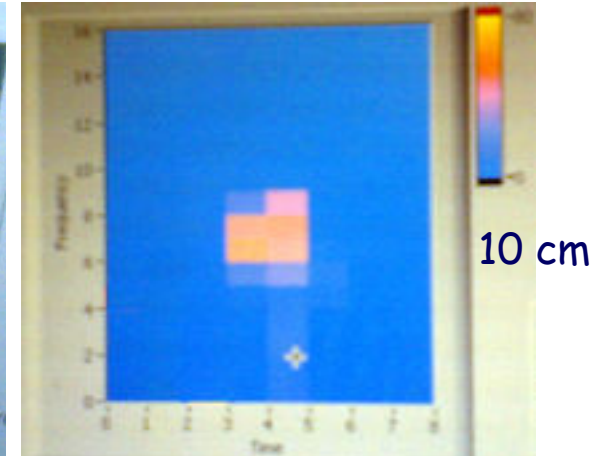
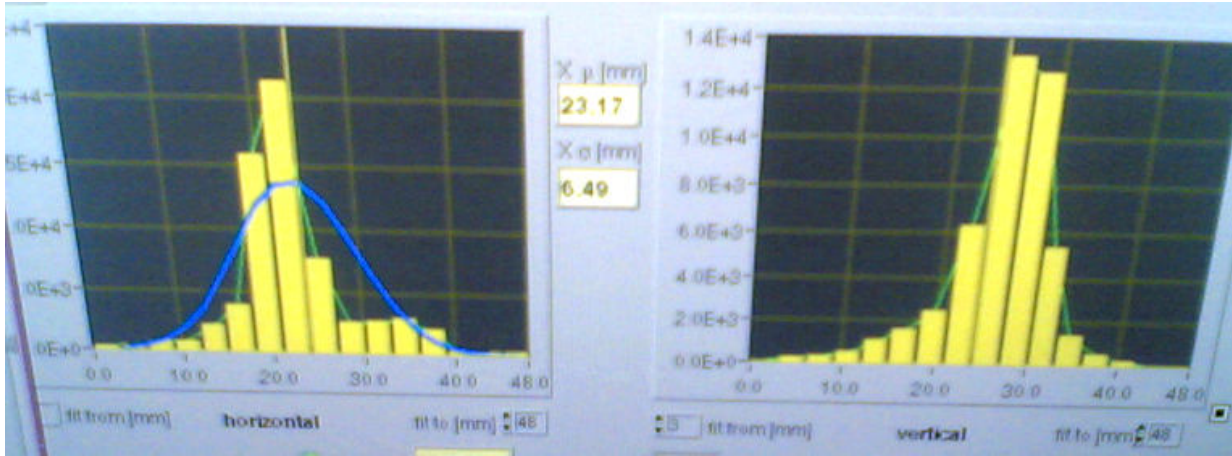
The GEM monitors at UA9

Installation on Crystal Tank at SPS

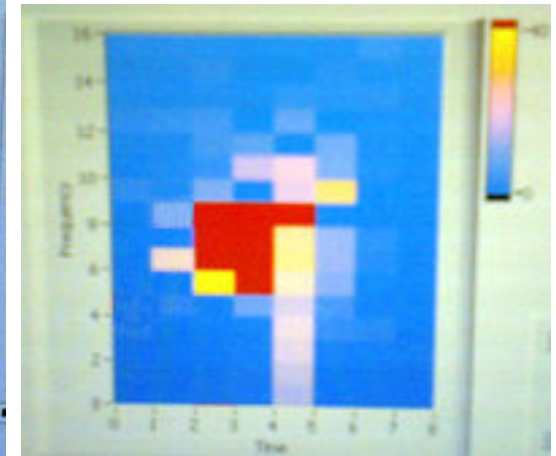
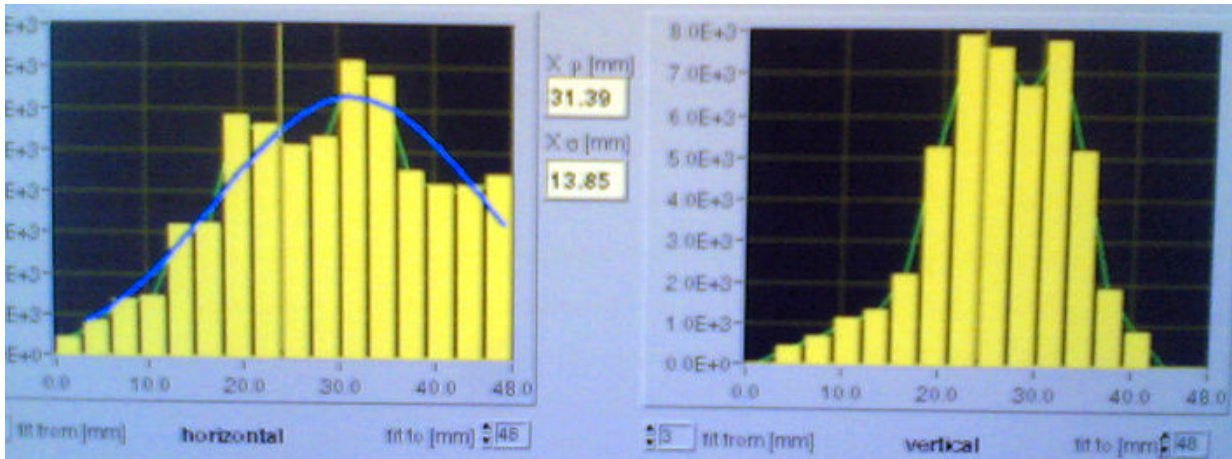


Beam monitor at BTF Frascati

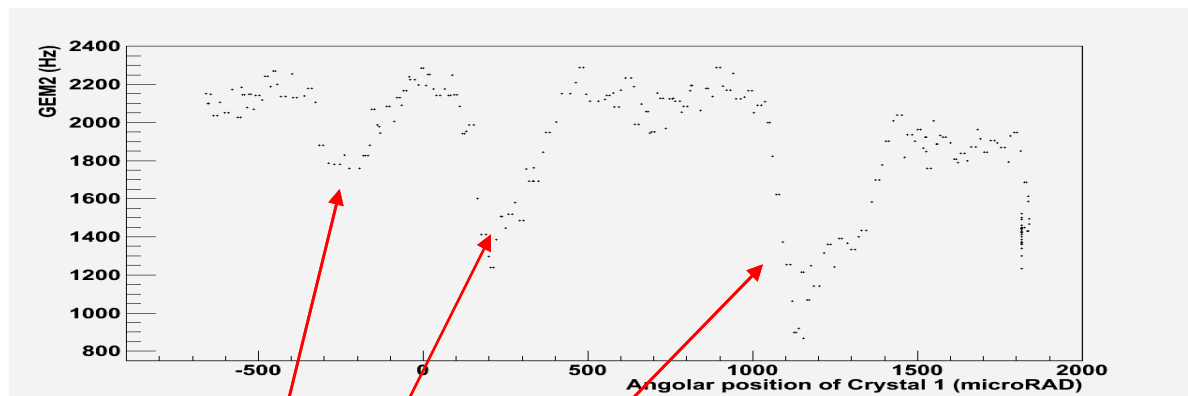
Beam profile at BTF in two configuration : narrow and wide beam



10 cm

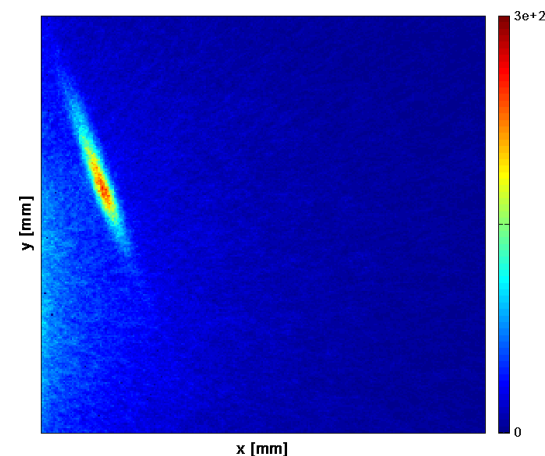


Channeling seen by GEMs at UA9



Crystal Angular Scan
MD on August 11th

Channeled Beam
seen by Medipix2

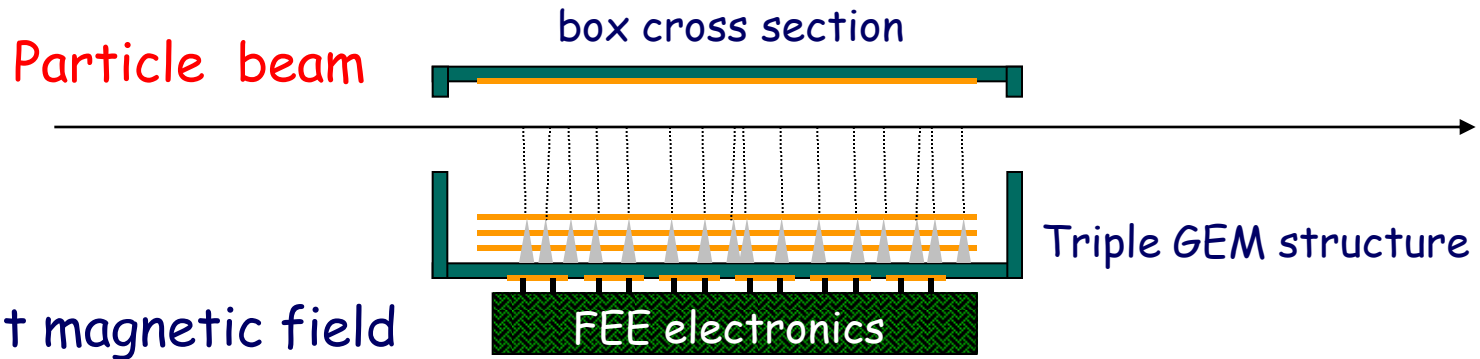


Decrease of beam halo scattering, due to channeling
GEM2 2 KHz signals perfectly correlated with scintillators
GEM1 rate is 20Hz (as expected being upstream of the crystal)

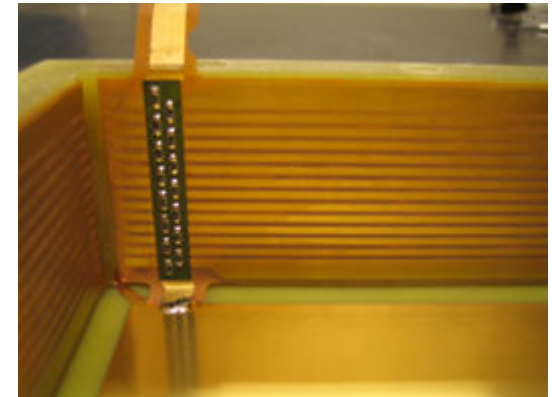
The GEM TPC

TPG for beam diagnostic

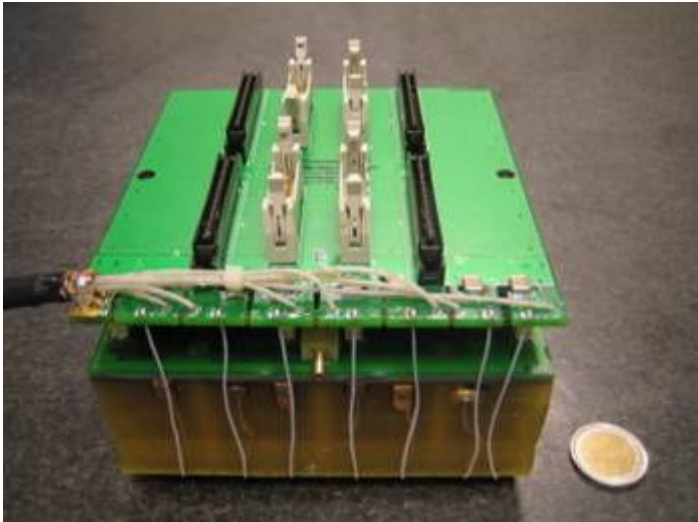
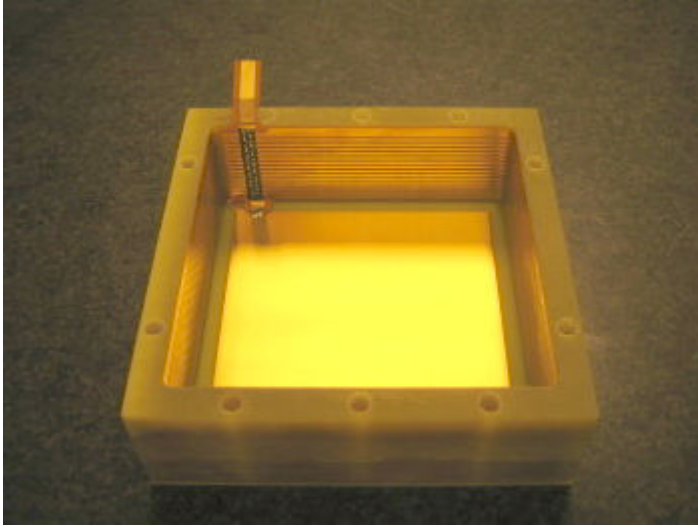
It's essentially a small TPC with a 4 cm drift and readout with triple GEM
In this way also high current beam can be monitored in position



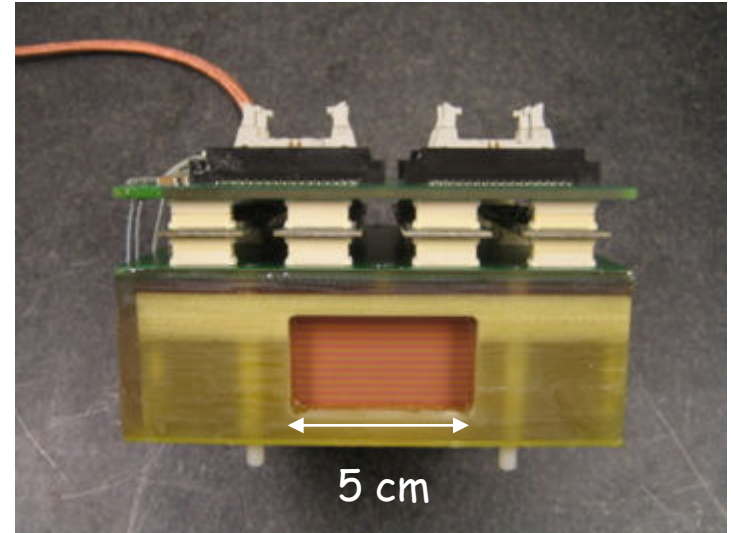
The material budget crossed by a particle is only two kapton foils ($<0.2\%X_0$)
used for the field cage necessary for the drift field uniformity



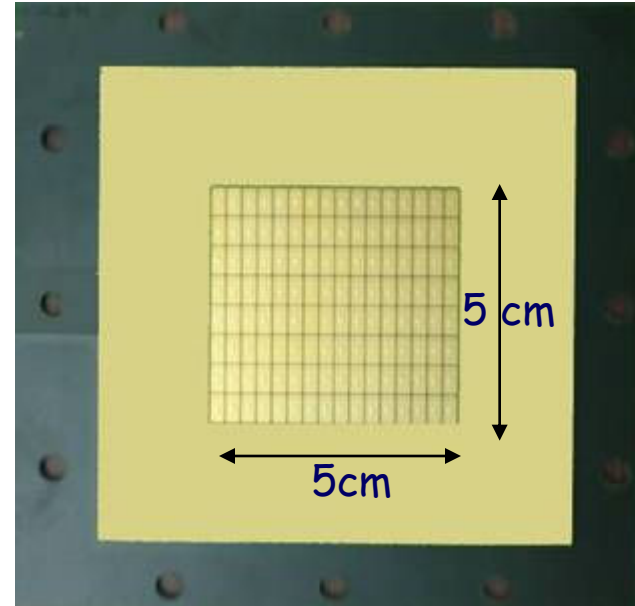
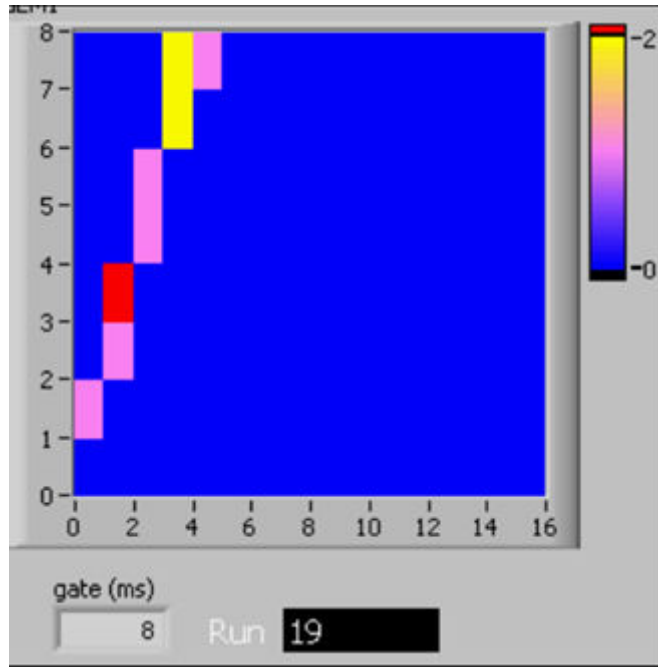
Assembling the TPG chamber



(M. Pistilli)



Cosmic rays in free running



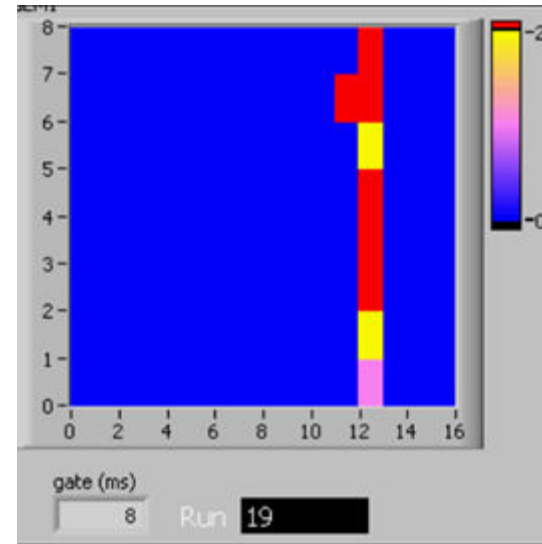
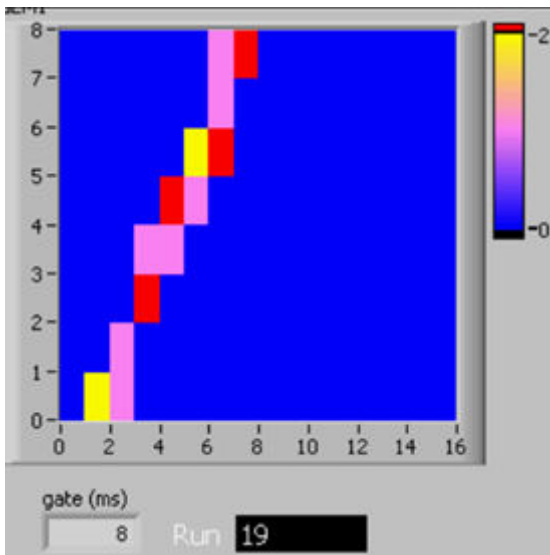
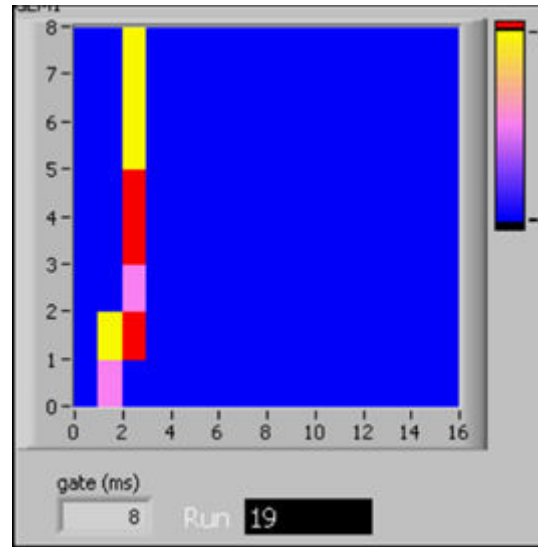
A gate of 8ms is open randomly
without an external trigger

Threshold set at about 7 fC
Gas mixture Ar CO₂ (70-30)
Triple GEM Gain at about 10⁴

For this type of monitor a new layout
has been designed for an active
volume of 5x5x4 cm³

Pad dimension 3x6 mm²
Threshold set at 7 fC
Gas mixture Ar CO₂ (70-30)
Triple GEM Gain at about 10⁴
Sub-millimetric precision

Some other cosmic rays



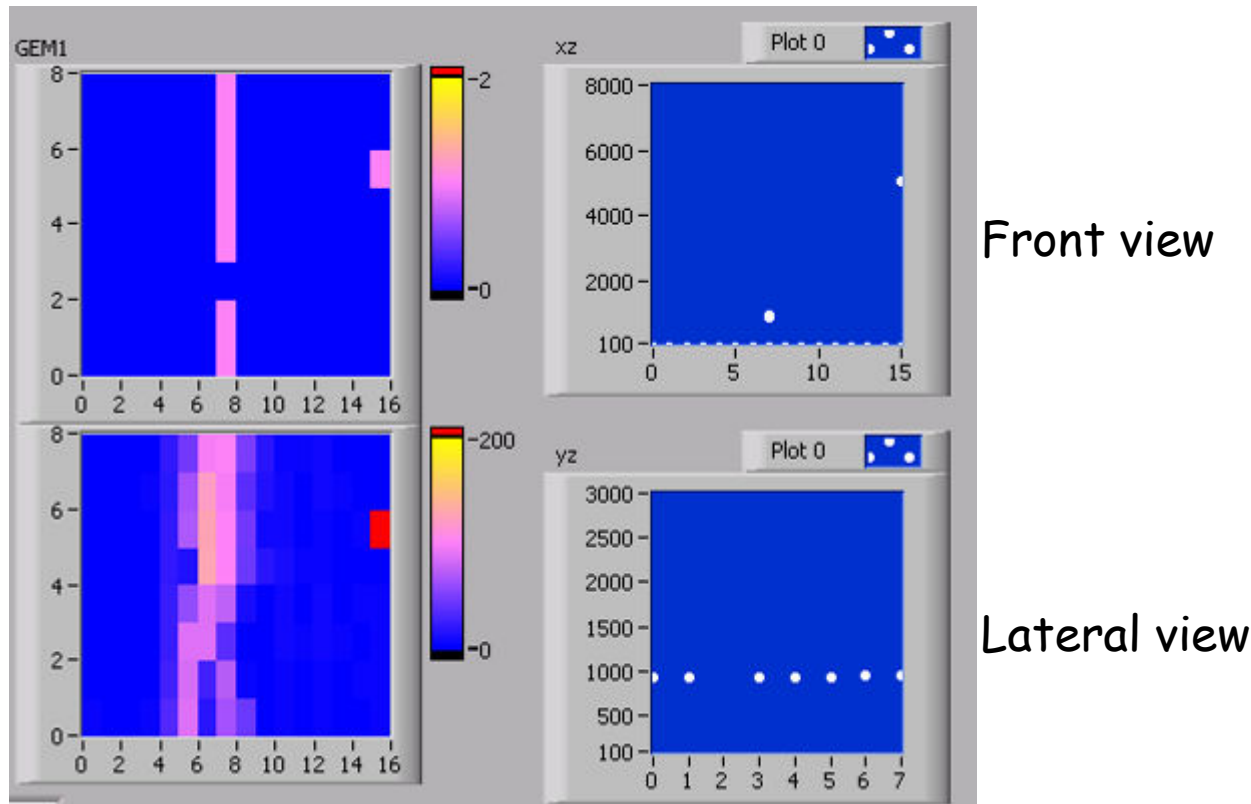
Test at BTF frascati

Online single event at Test Beam

One electron in 10 ns (trigger from linac)

Top view

Side view



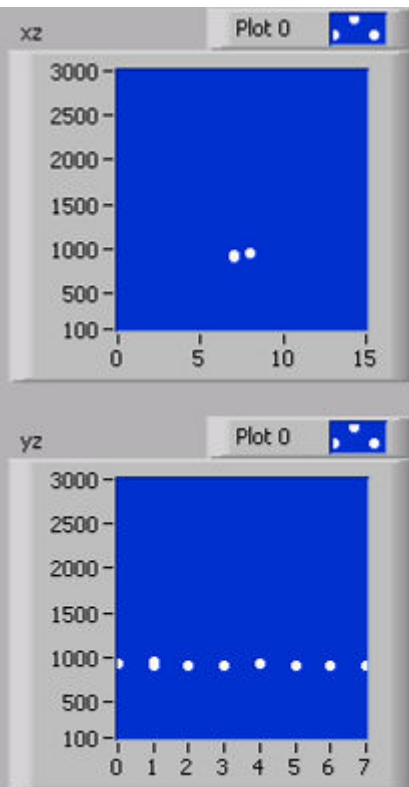
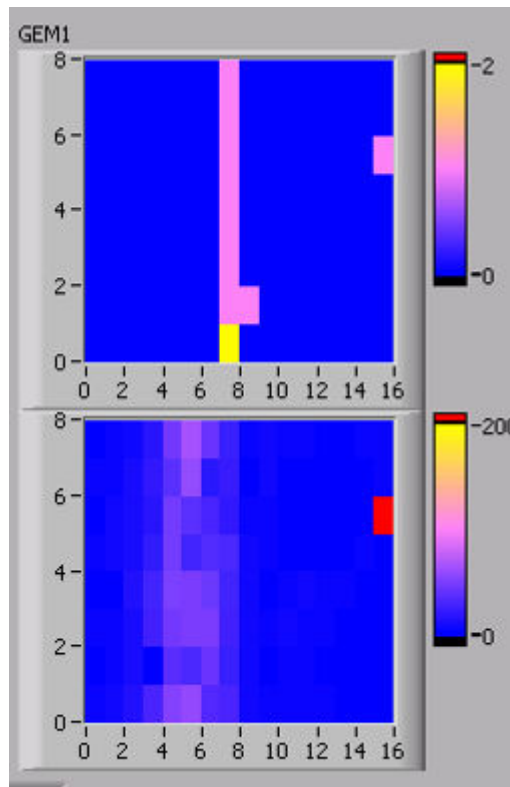
History view

Online single event at Test Beam

One electron in 10 ns

Top view

Side view



Front view

Lateral view

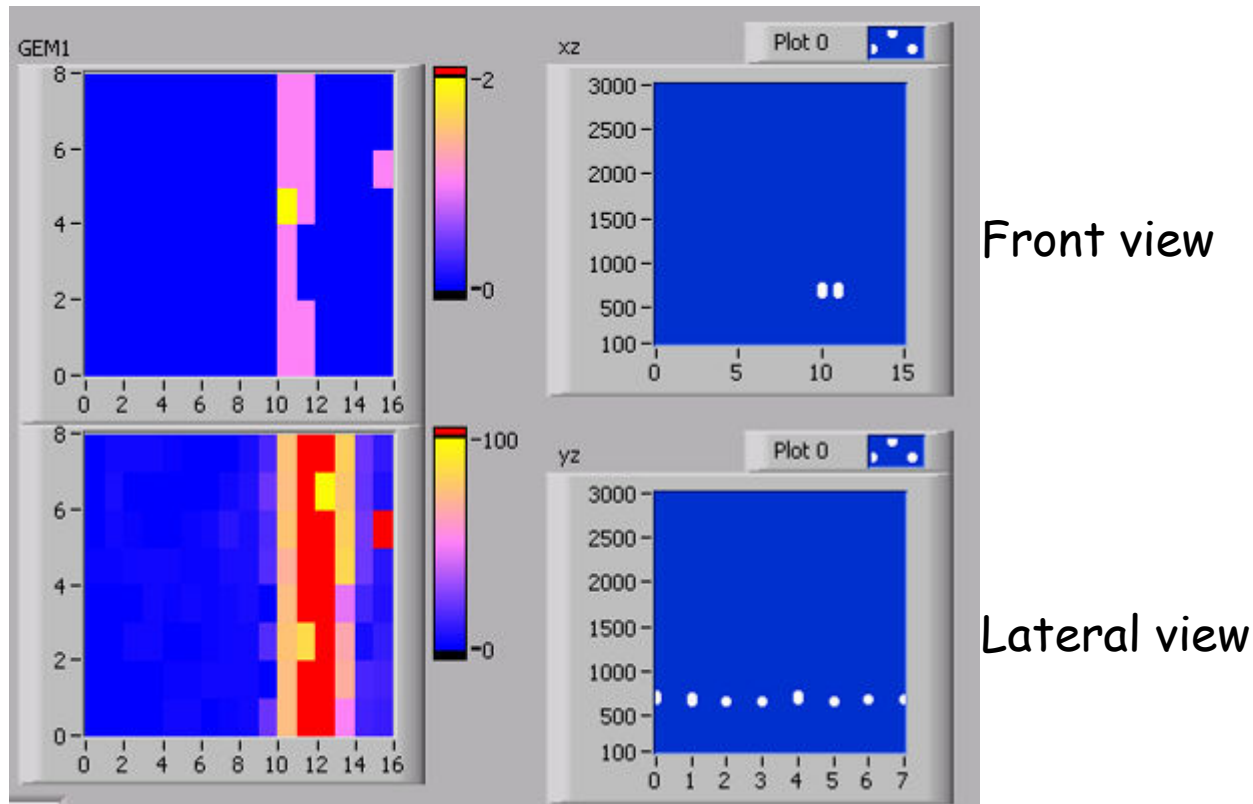
History view

Online single event at BTF

Two electrons in 10 ns

Top view

Side view



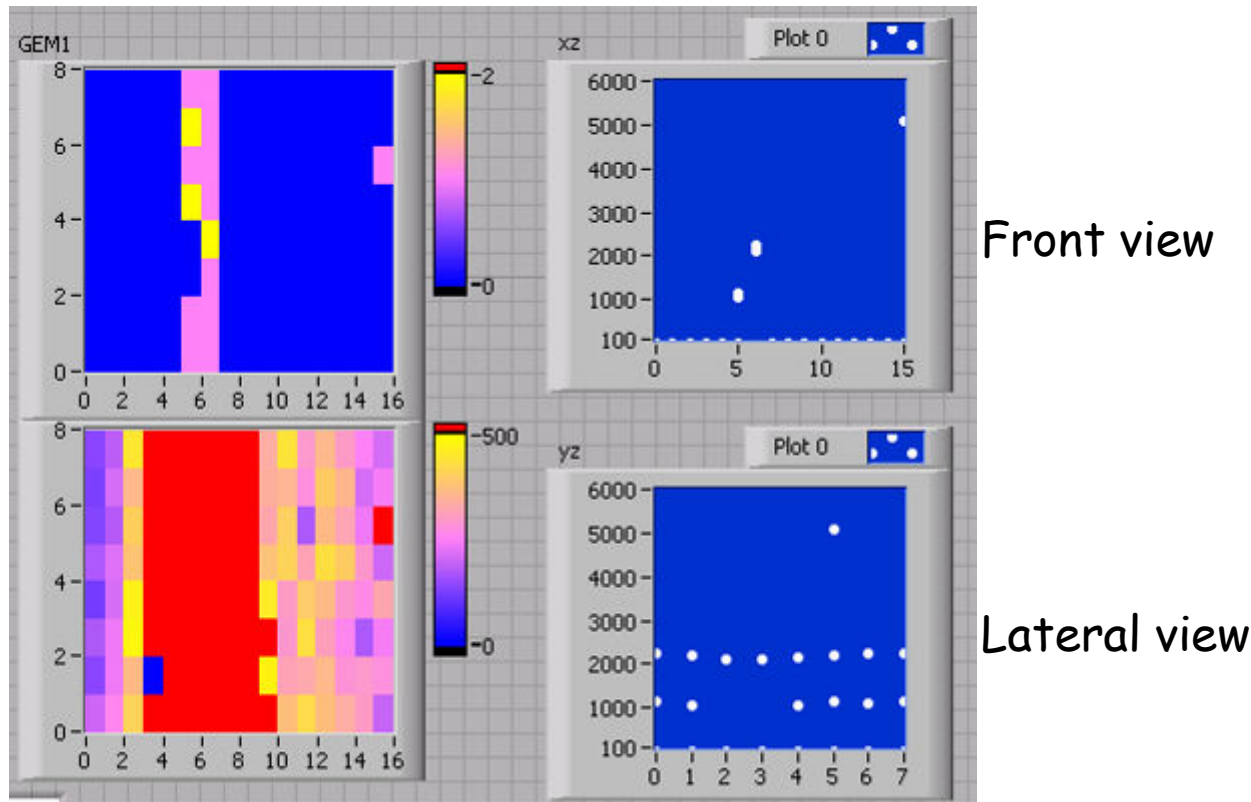
History view

Online single event at BTF

Two electrons in 10 ns

Top view

Side view

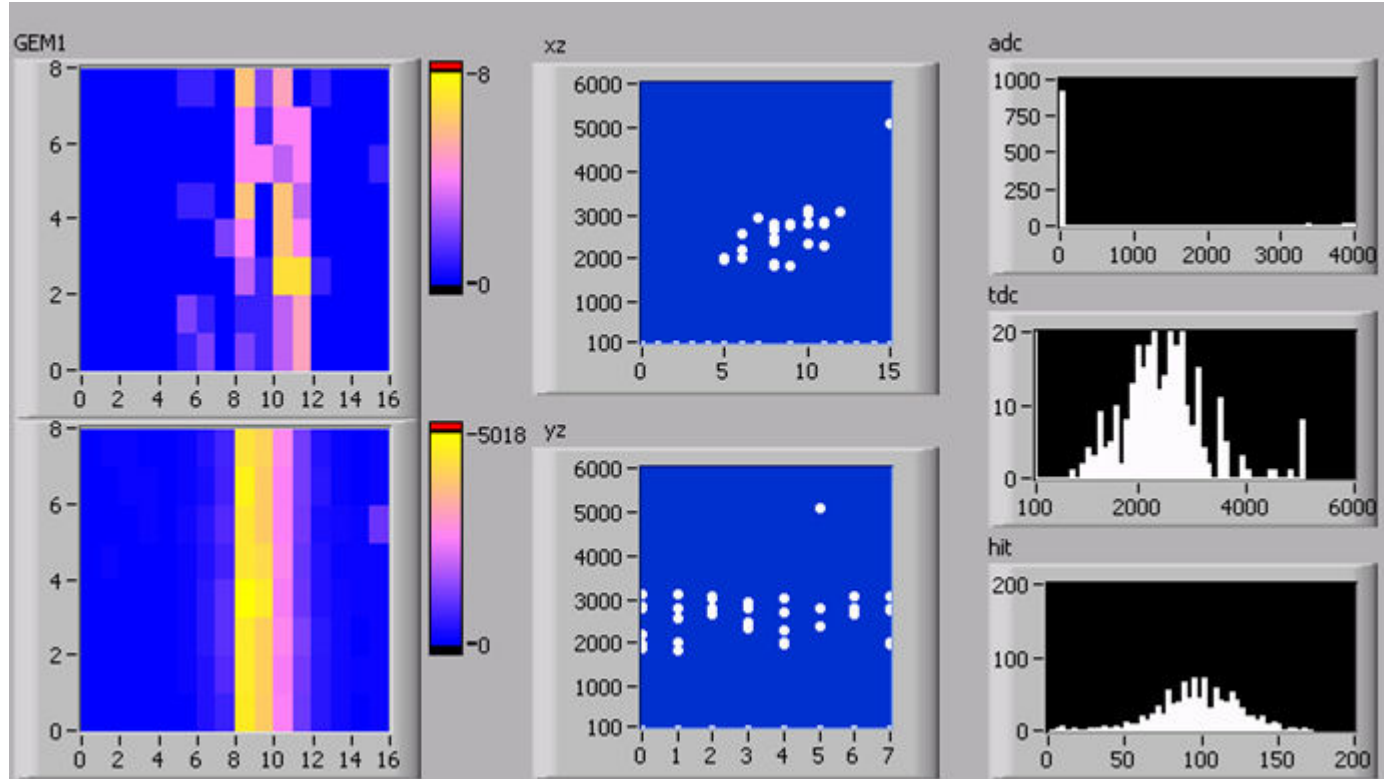


History view

High Intensity 250 electrons (in 10 ns)

Top view

Side view



z distrib.

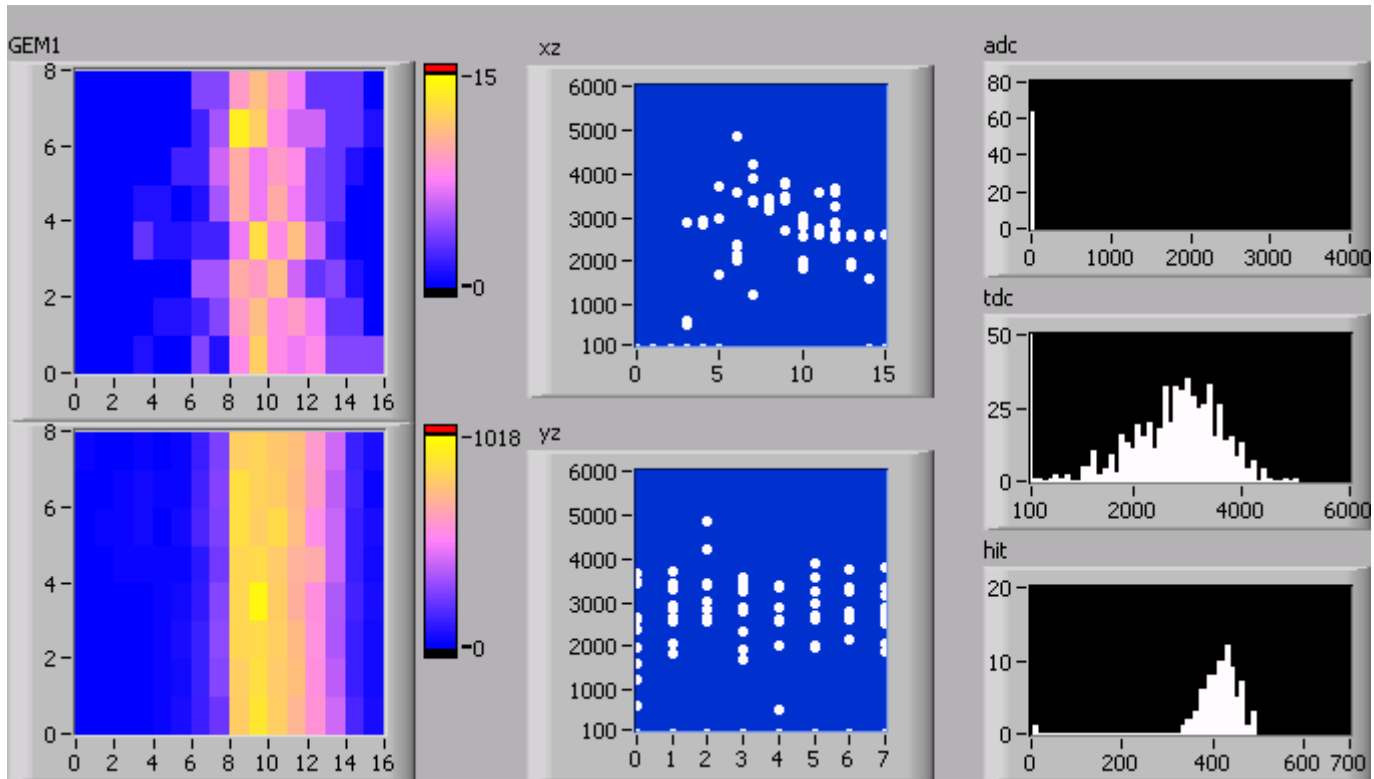
hits

History view

High Intensity 1400 electrons (in 10 ns)

Top view

Side view



z distrib.

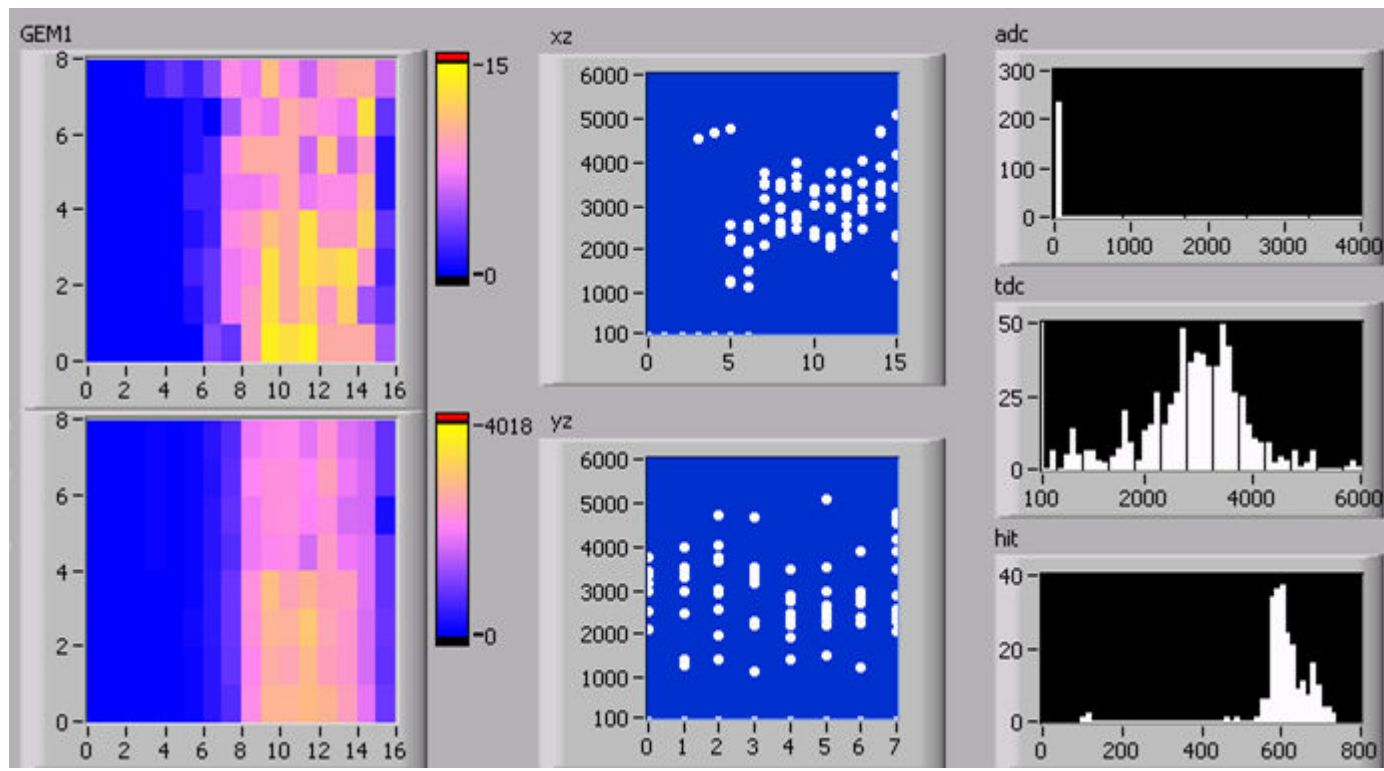
hits

History view

High Intensity 4400 electrons (in 10 ns)

Top view

Side view



z distrib.

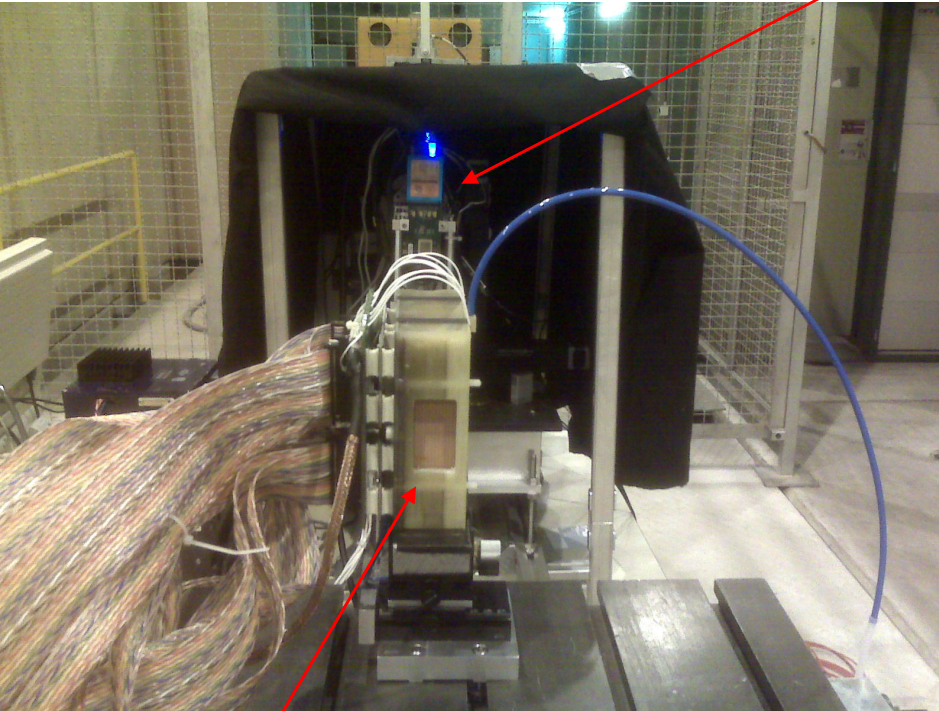
hits

History view

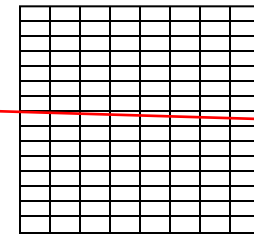
Test at H8

Test beam setup

Medipix array



8 columns

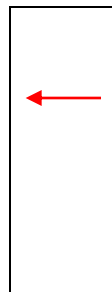


16 rows

particles

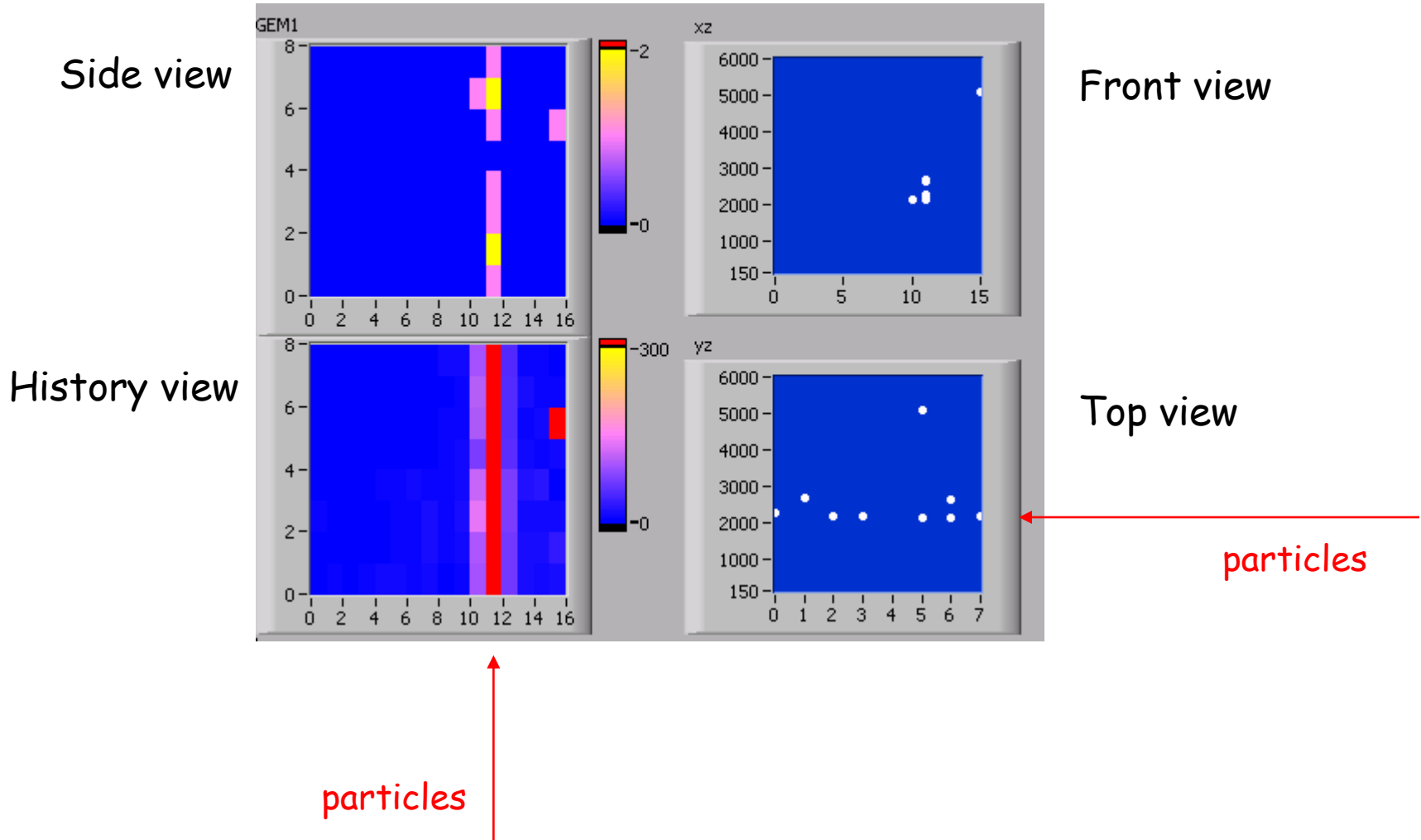


TPG chamber



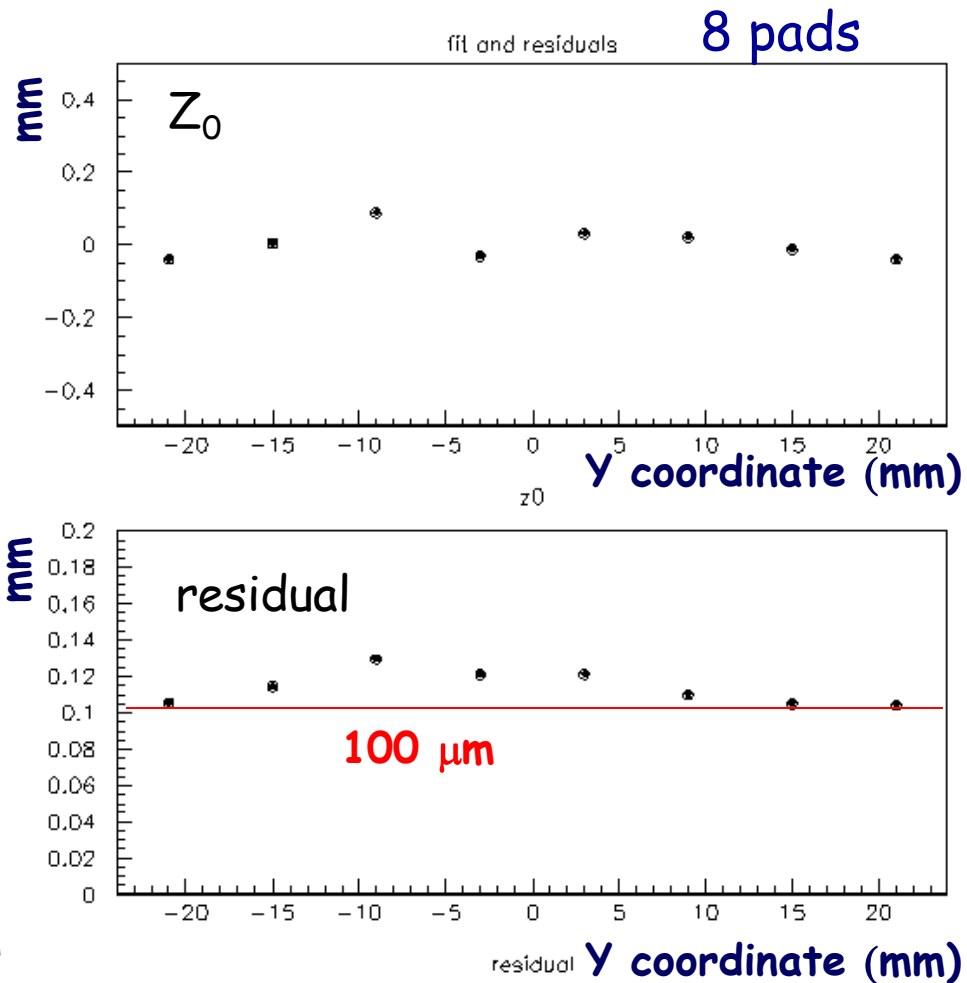
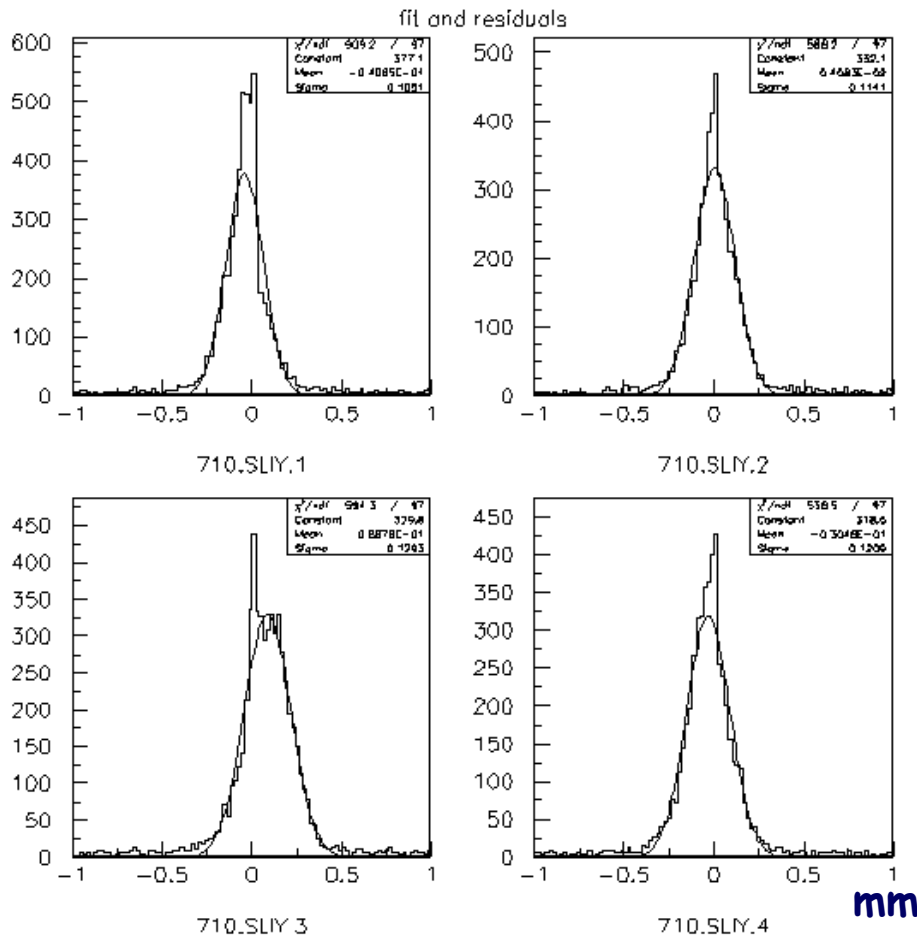
Electron drift

Single event at H8



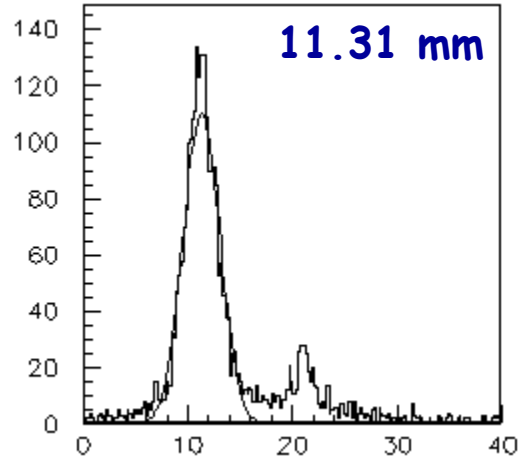
Residuals (events with >2 hits)

Residual measured by each pad

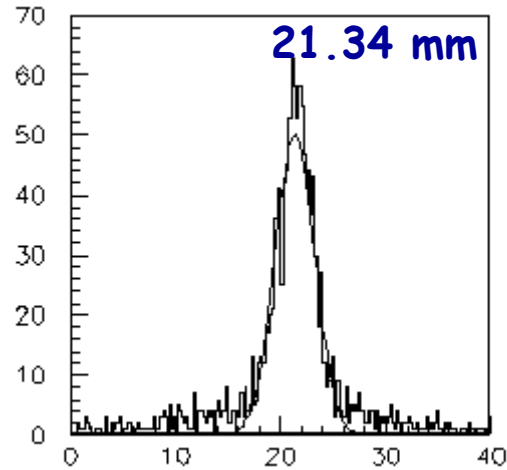


50 μm in track position resolution

Chamber calibration

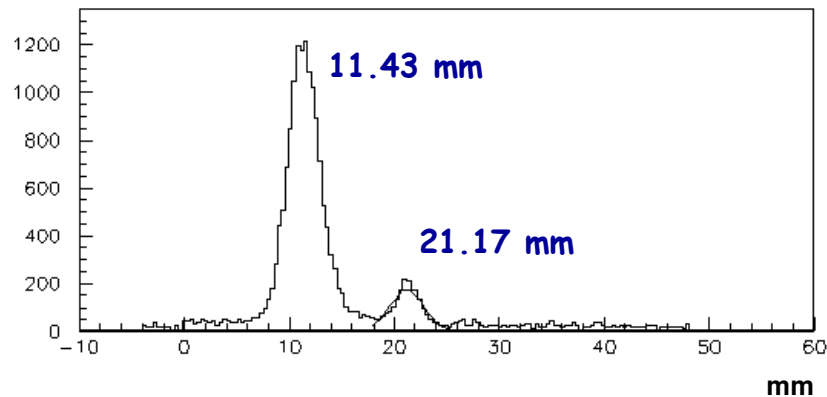


Electron drift (mm)

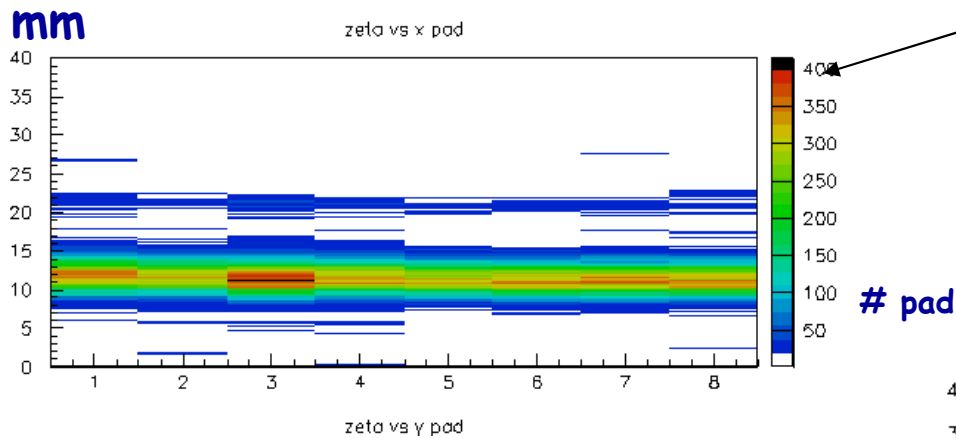
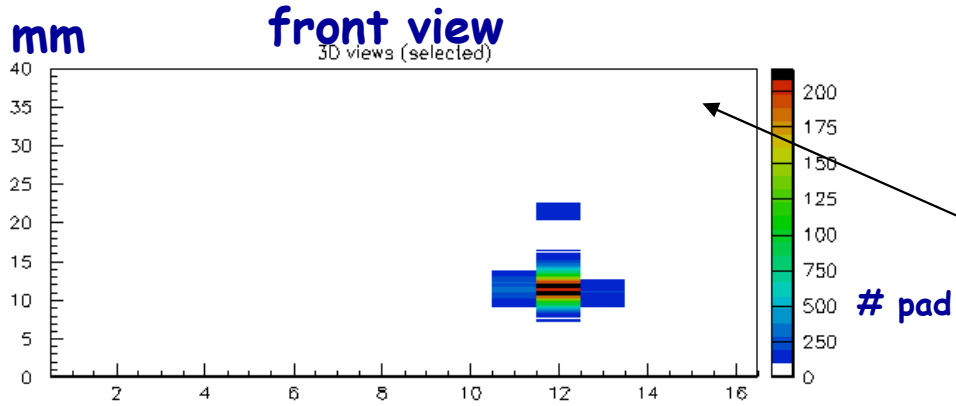


Electron drift (mm)

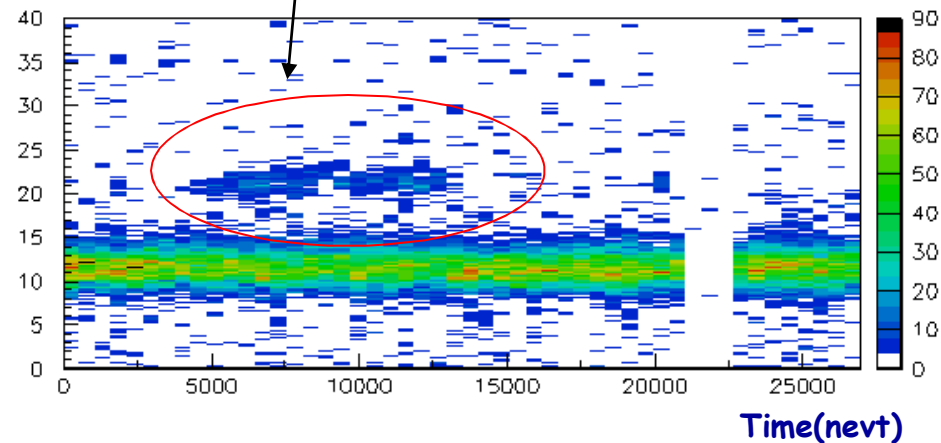
Beam position with a chamber displacement of 1 cm



Channeling at H8

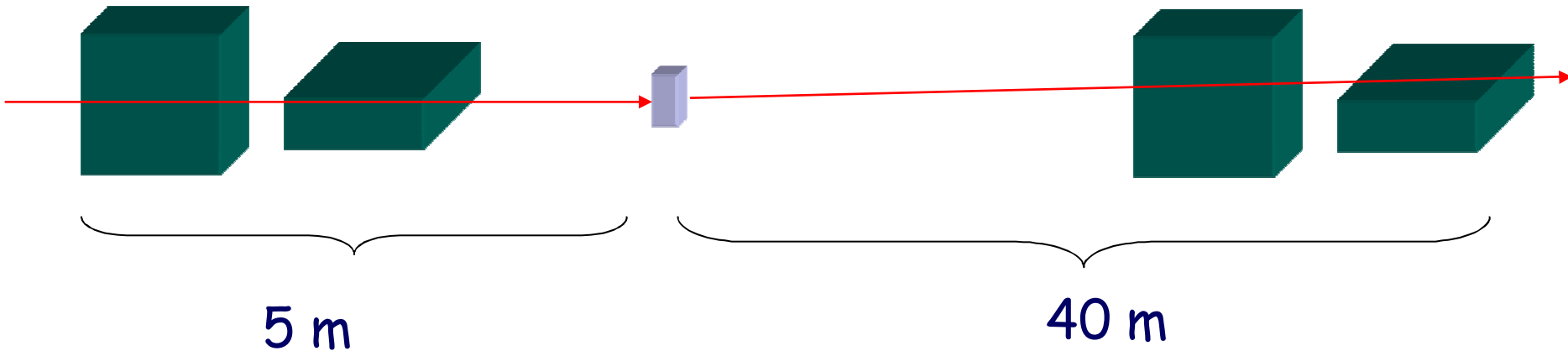


top view



Tracking system at H8

A tracking system with 50 micron resolution on both views using **four** TPCs (two before and two after the crystal)



This system could be used also for high intensity beam and ion beam