# Tracking on FRS and Super FRS

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GSI
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# Tracking on the FRS and Super FRS

Time projection chambers with C-pad read out

results and parameters

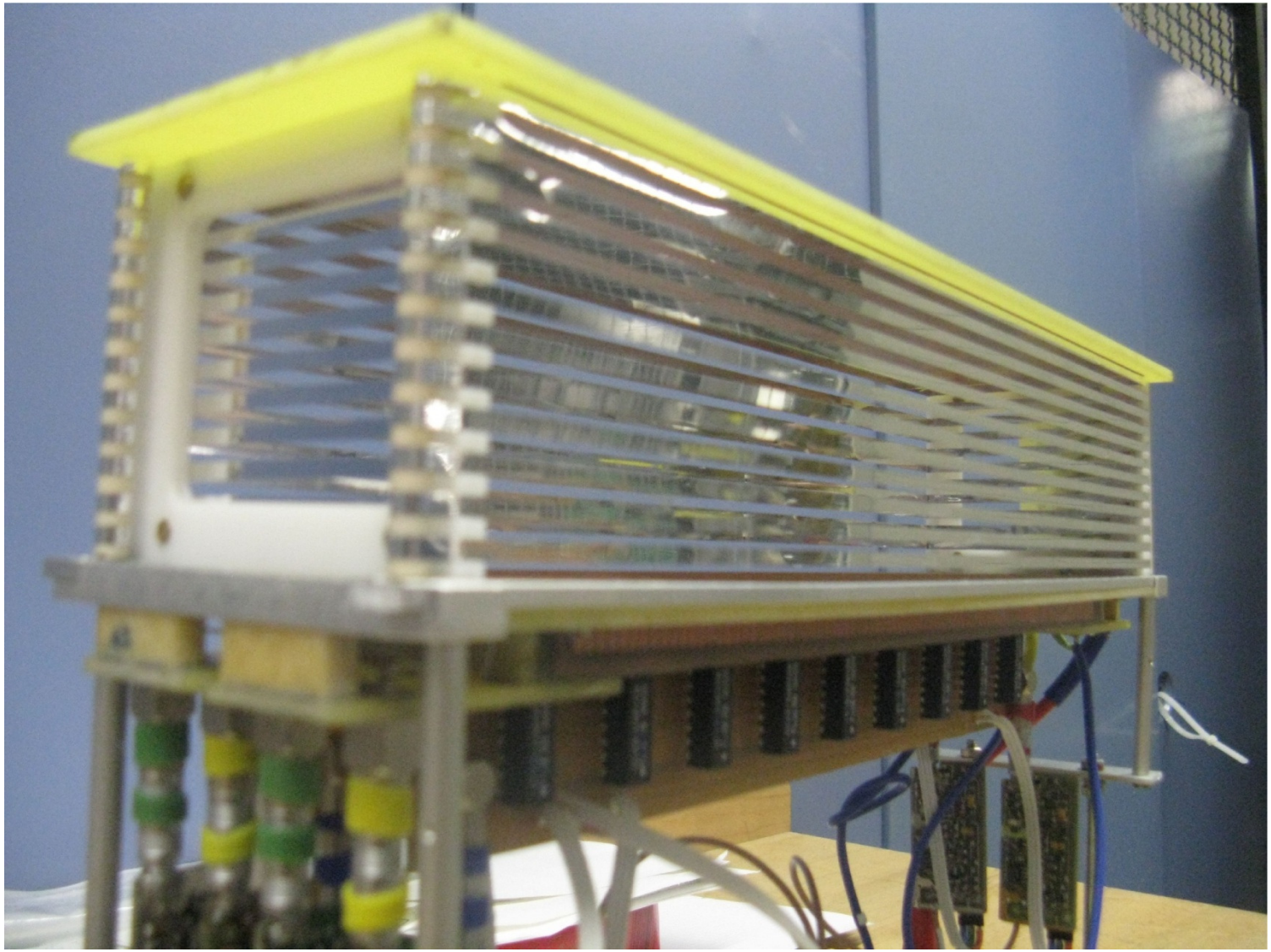
Beam profile measurements $10^6$ - $10^{12}$ ions / spill:

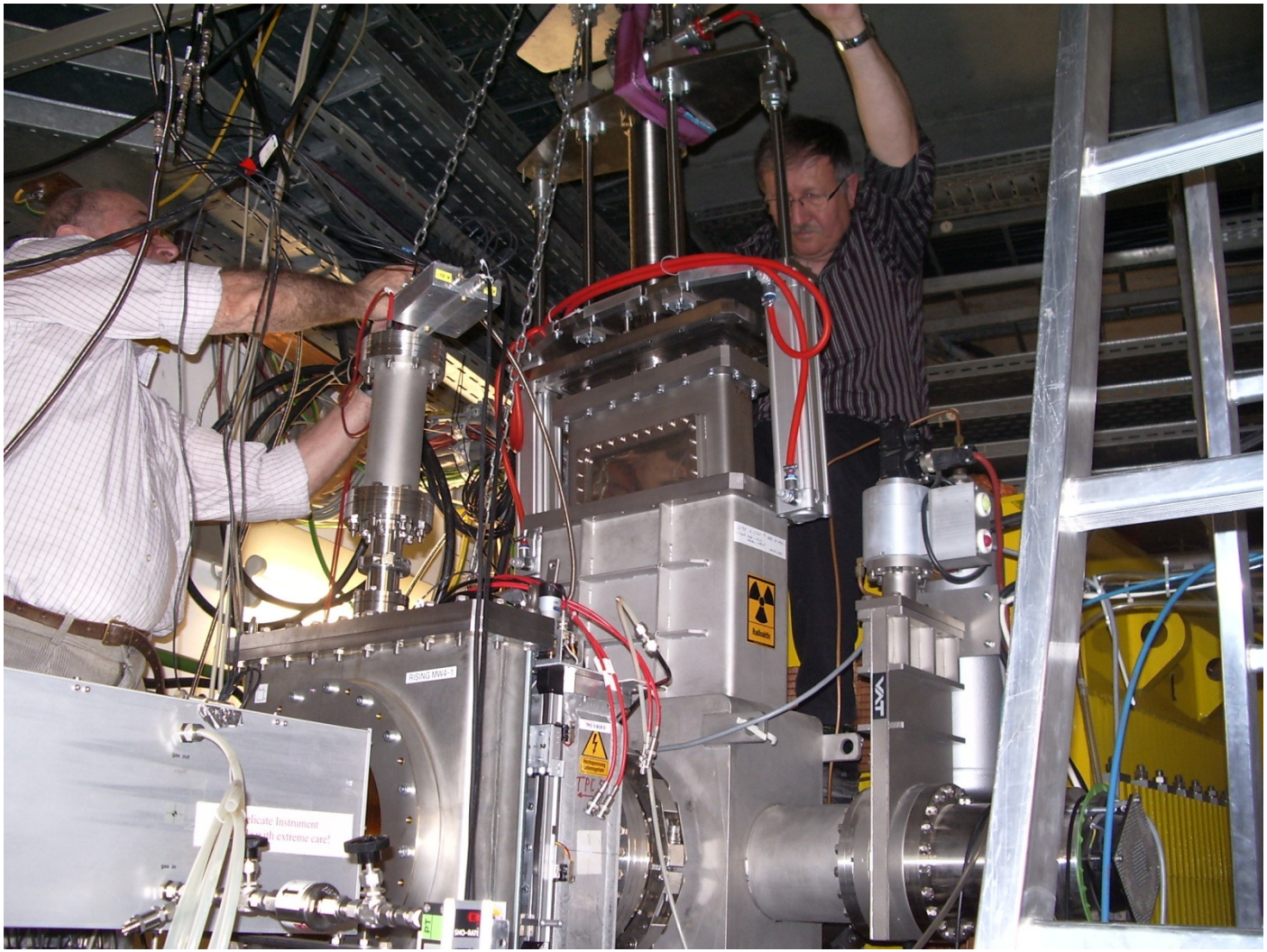
Low pressure Beam Profile Monitors

GEM TPC development and first results from FRS tests

Conclusions

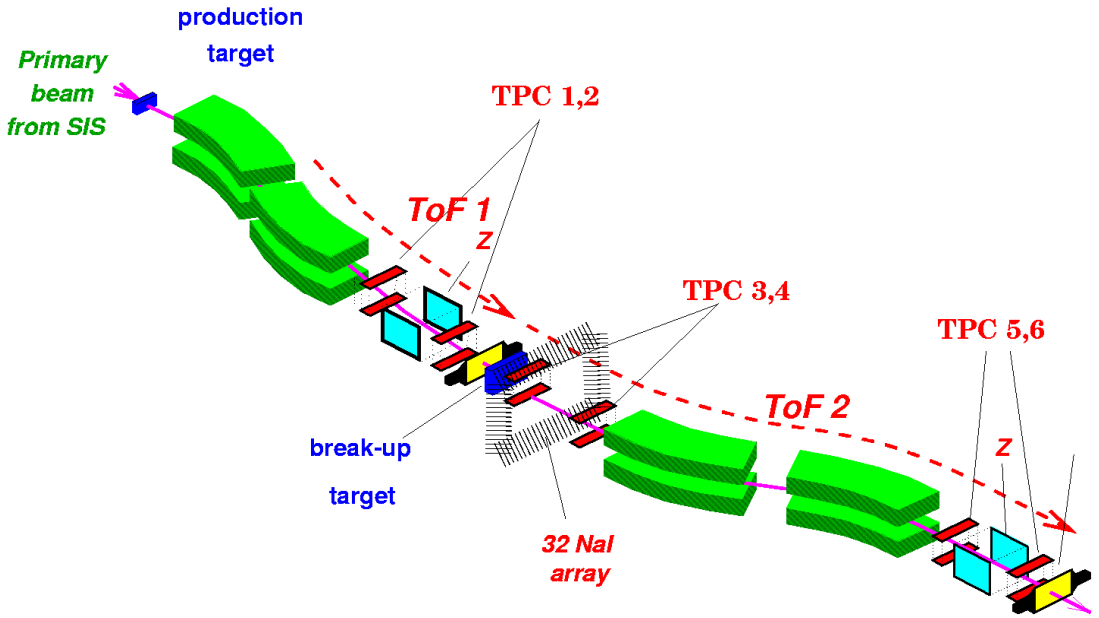
View of the TPC used on FRS



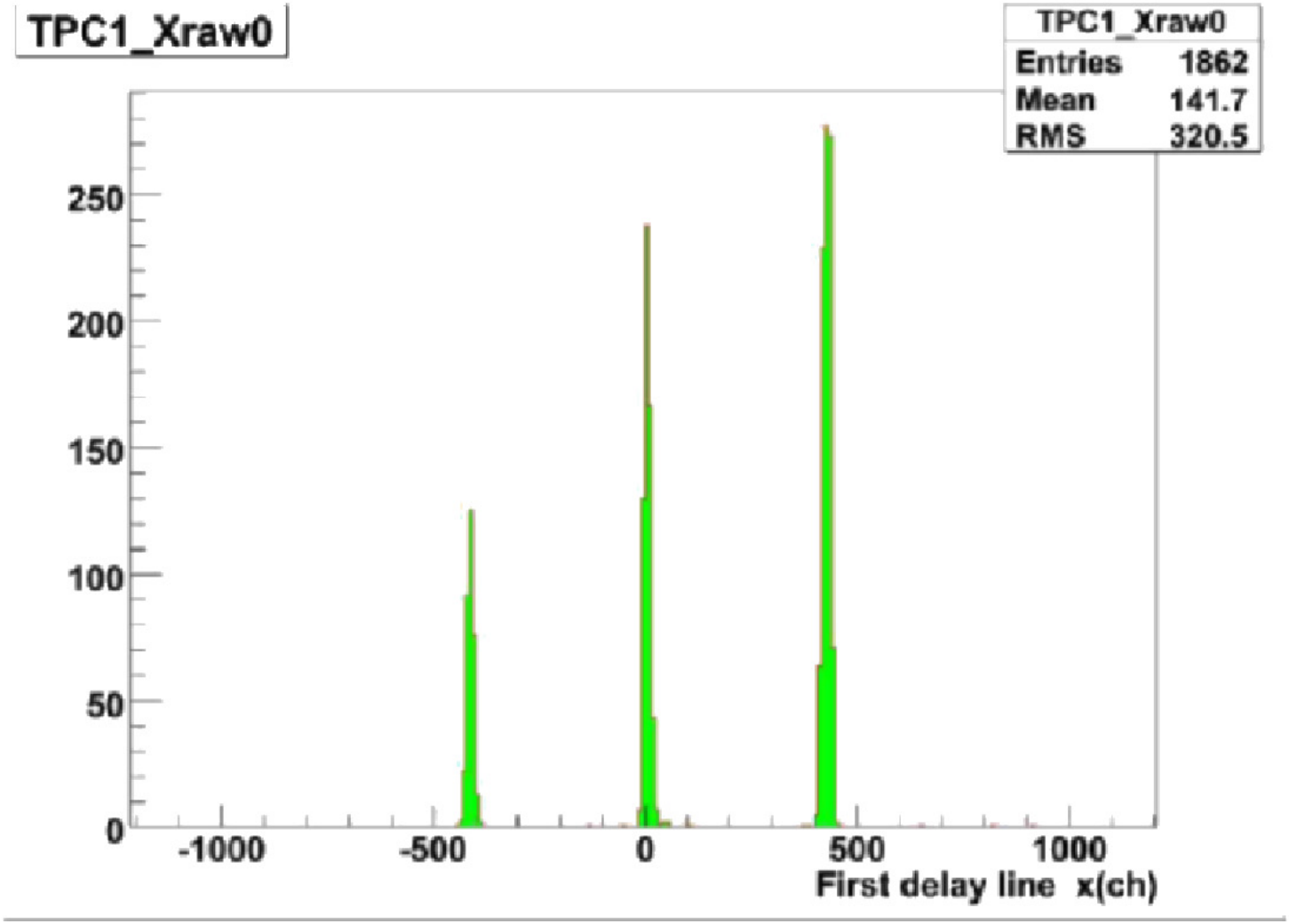

RISING MW41
VAT

# Integrated electronics for one TPC

# Schematic view of the Fragment separator

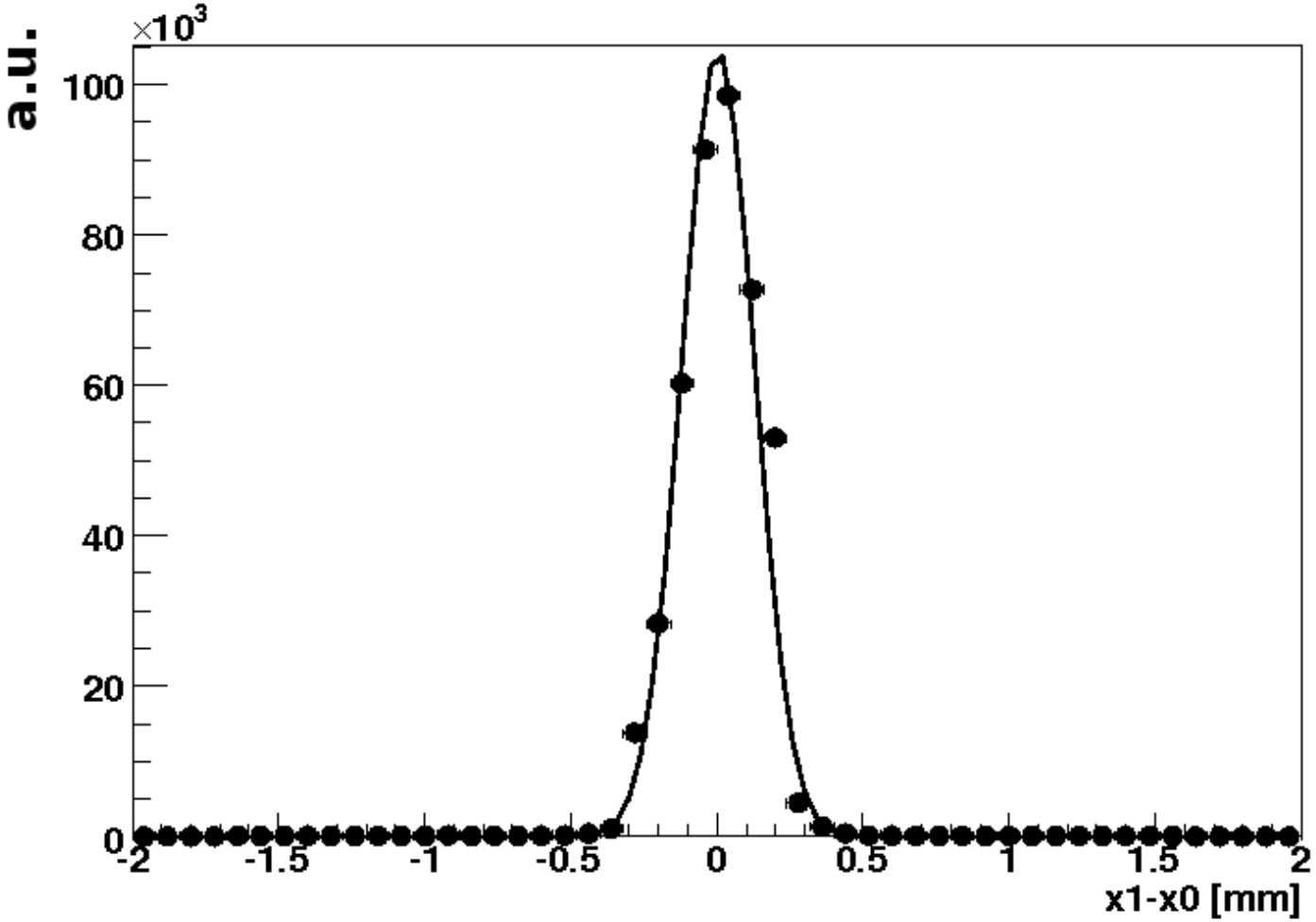


Calibration spectra using scintillator grid



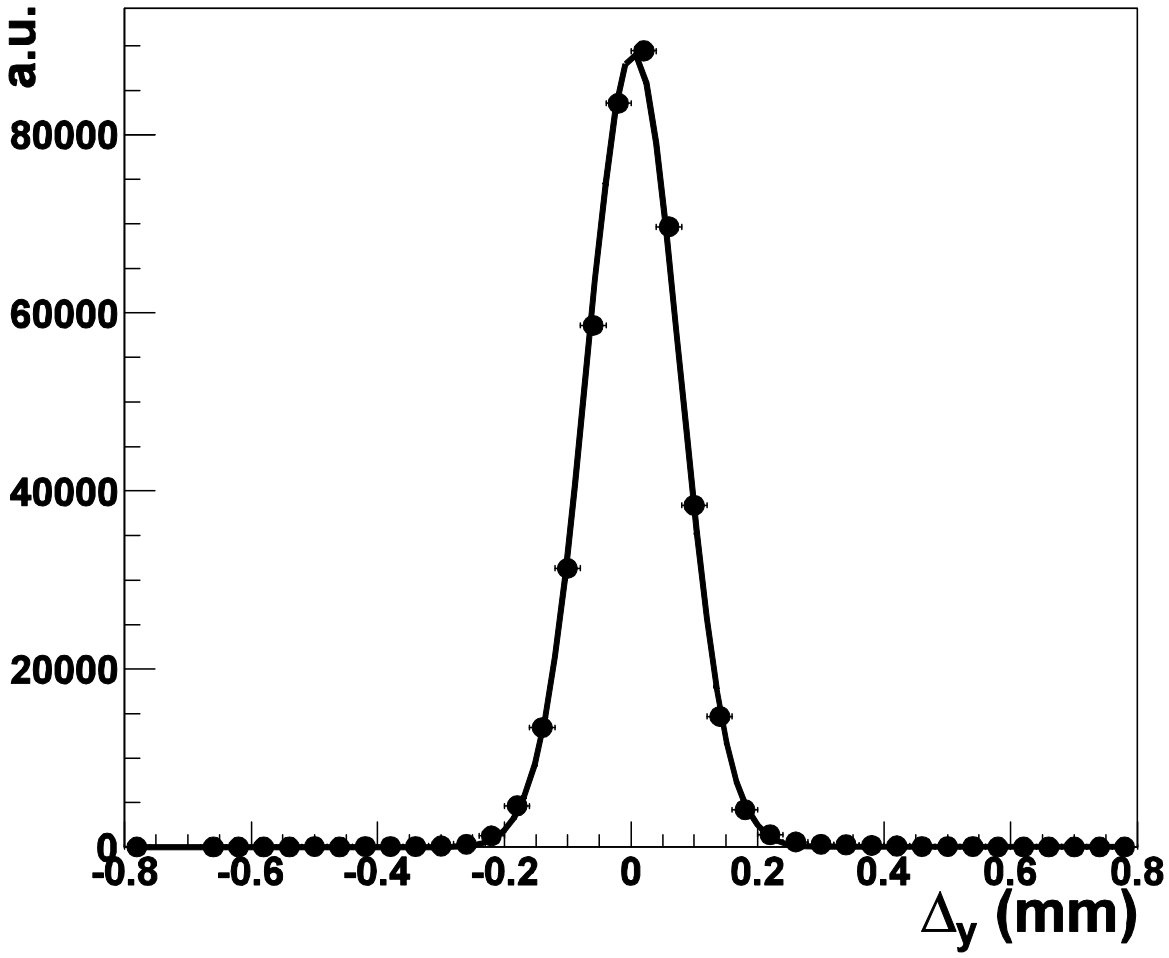
Internal resolution of TPC in x-direction for $^{40}$Ar ions

$\sigma_x$ = 88 μm

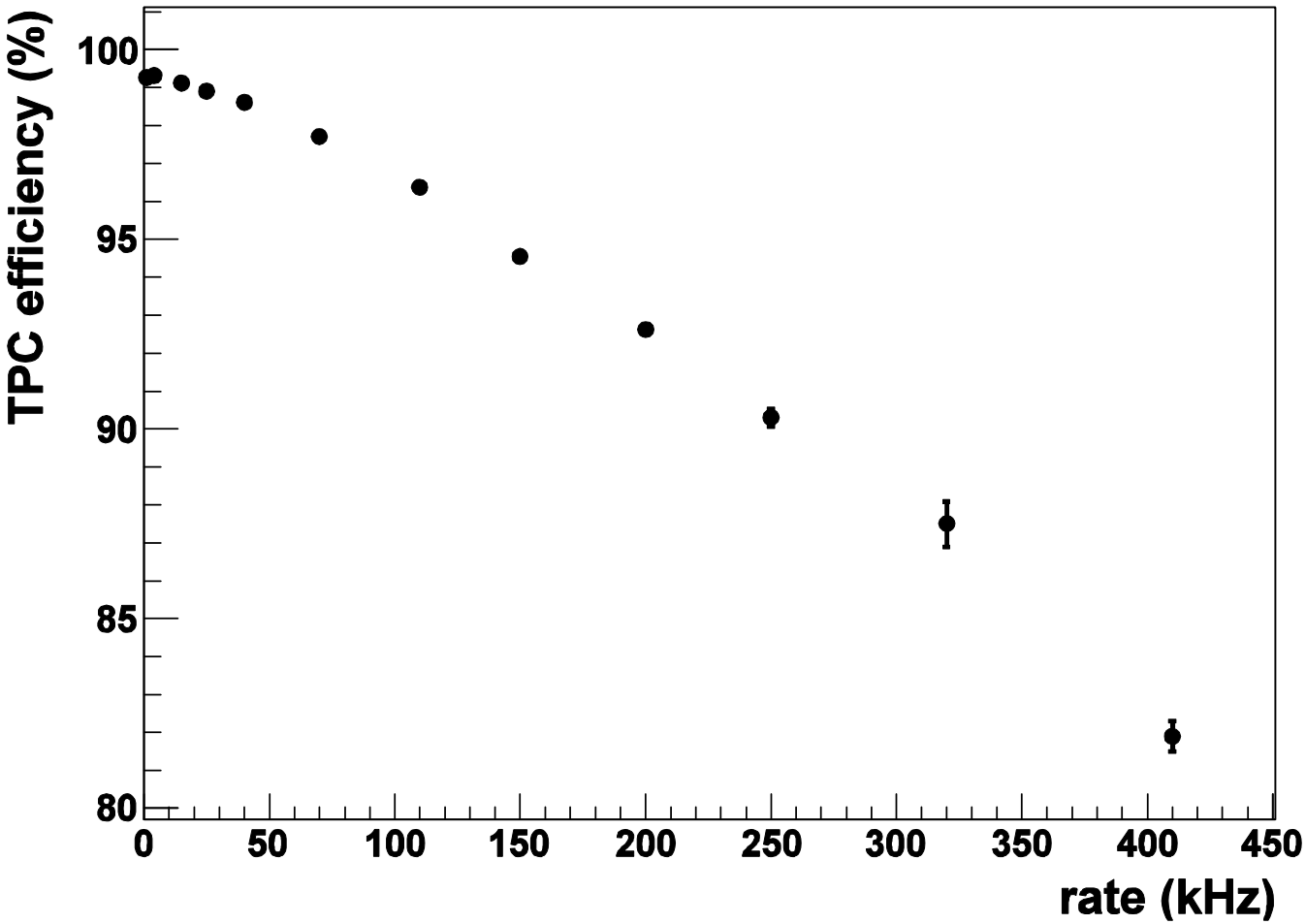


Internal resolution of TPC in y-direction for $^{80}$Kr ions

$\sigma_y$ = 38 μm



Tracking efficiency as a function of the intensity of $^{238}U$ ions at 1 GeV/u



# Conclusions on C-pad TPCs

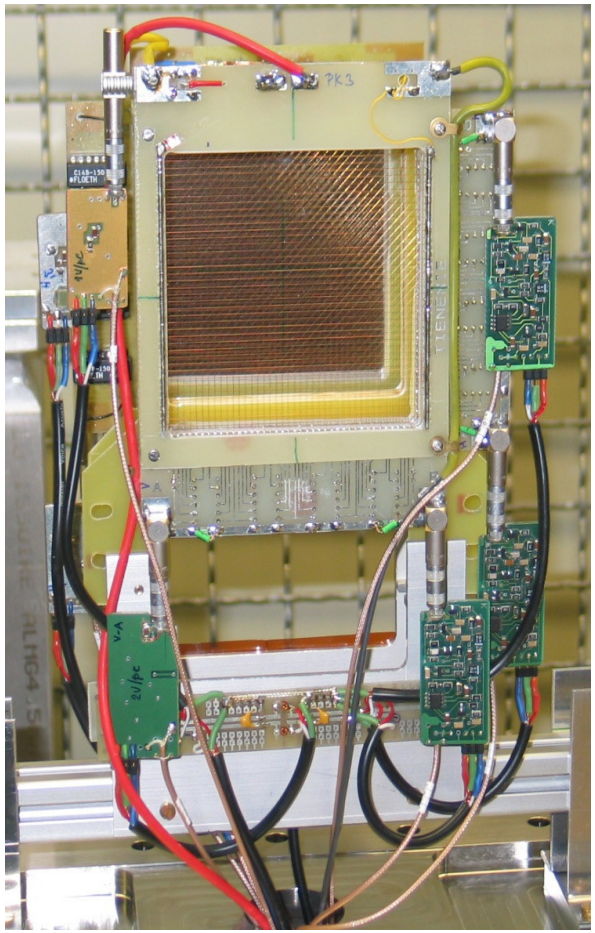
- TPC chambers with C-pad + delay line read-out are working reliably on the FRS
- TPC field cages of 24 cm wide and 6, 8, 10 or 12 cm high are available
- 7 TPCs with complete electronics are available on FRS for measurements on the air
- 3 TPCs are available on FRS for measurements in vacuum
- Precision remote controlled calibration is provided by scintillator grids on each TPC
- Internal resolution of TPC in x-direction of $\sigma_x$ = 88 $\mu$m has been reached
- Internal resolution of TPC in y-direction of $\sigma_y$ = 38 $\mu$m has been reached
- Tracking efficiency better than 97% for $^{238}$U ions at 1 GeV/u is available up to 100 kHz ion intensity

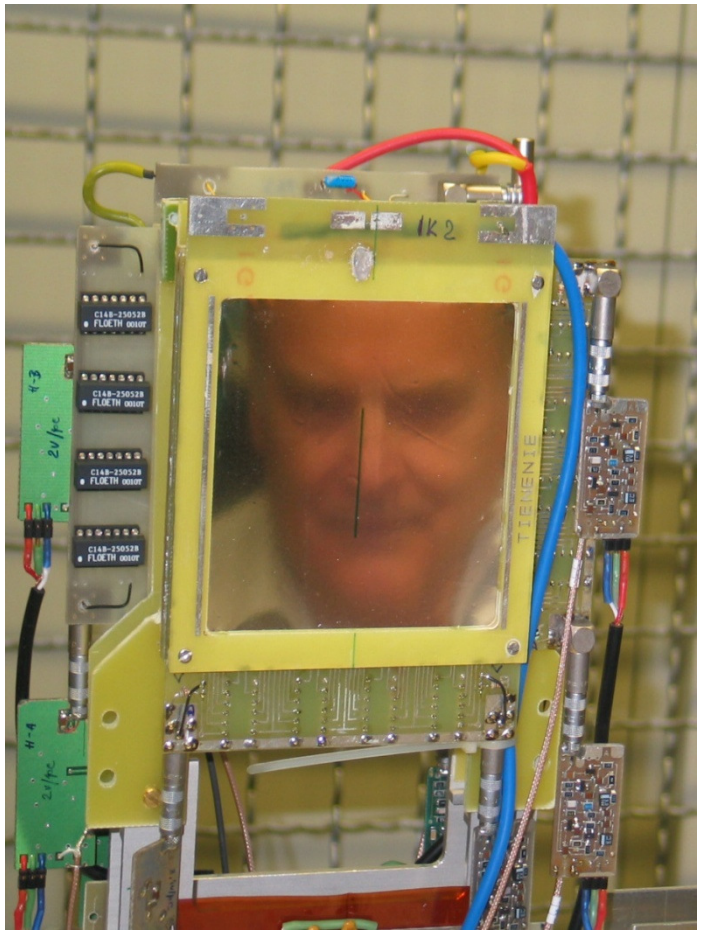
# Beam Profile Monitors

## Multiwire Proportional and Ionization Chambers

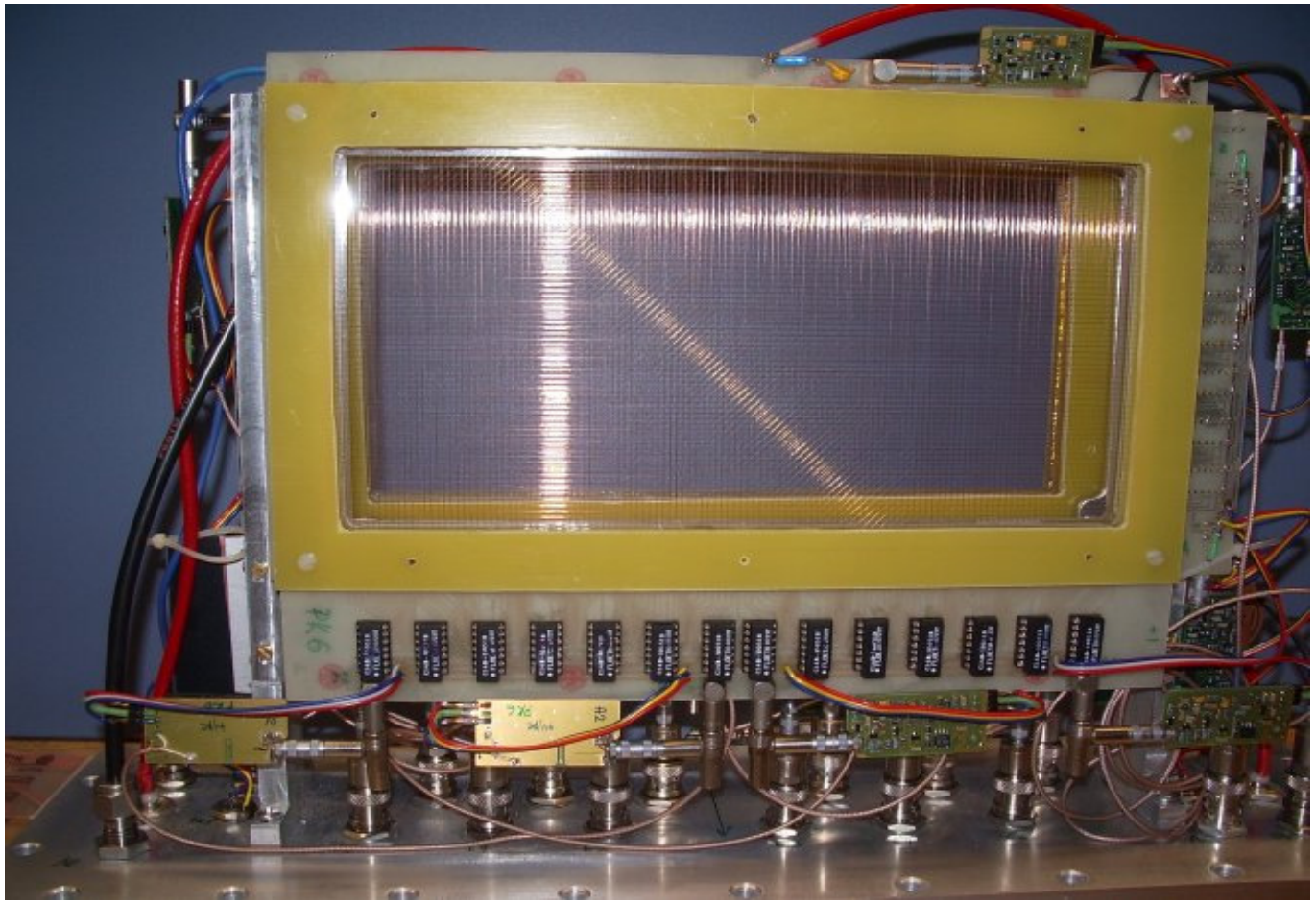
- Low pressure 0 – 1 bar
- Low amount of material in the beam area
- Delay line read-out

# Beam Chambers for ion tracking

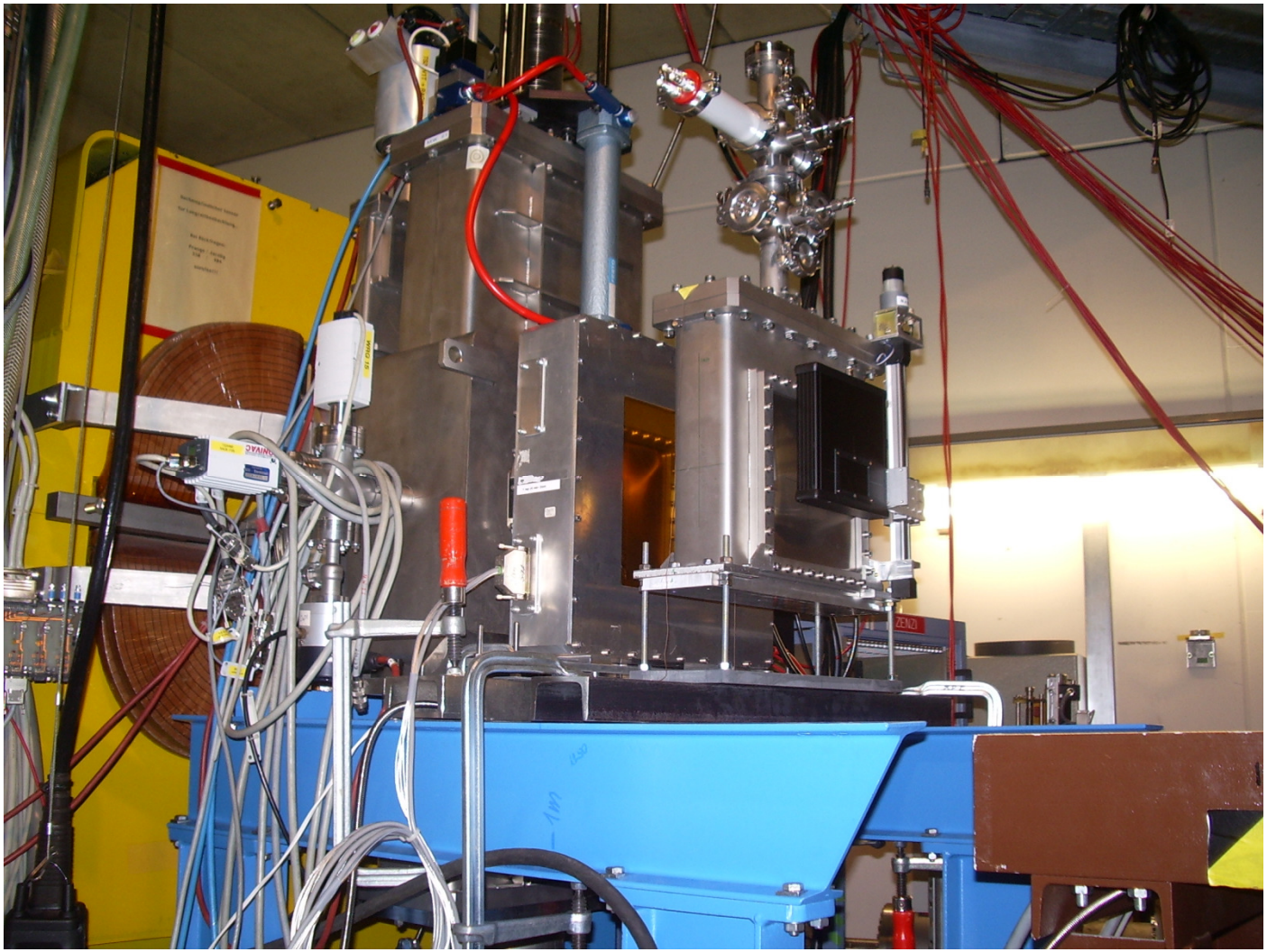




# Beam Profile Monitor

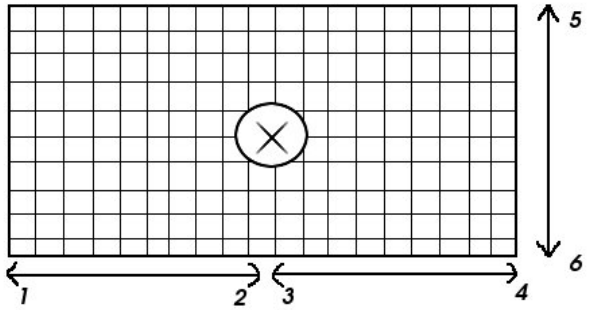


# Beam Profile Monitor installed on the FRS



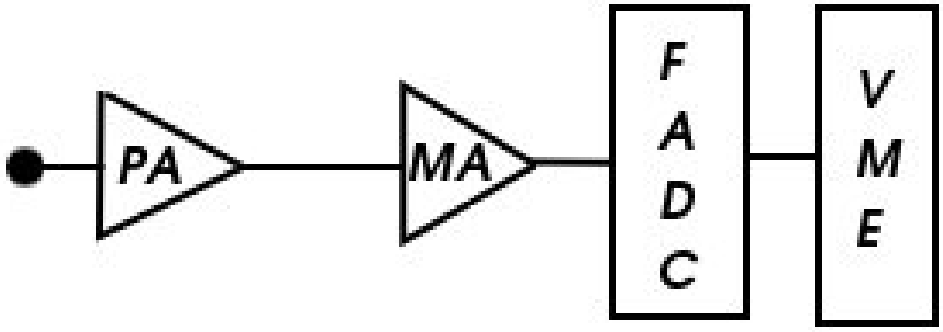
# Beam Profile Monitor

- active volume : 240 x 120 x 6 $mm^3$
- 120 x 120 mm modules




- delay lines read-out (7 channels)
- gas : Ar + 20% $CO_2$
- gas pressure: 1bar - 5mbar

# Electronics



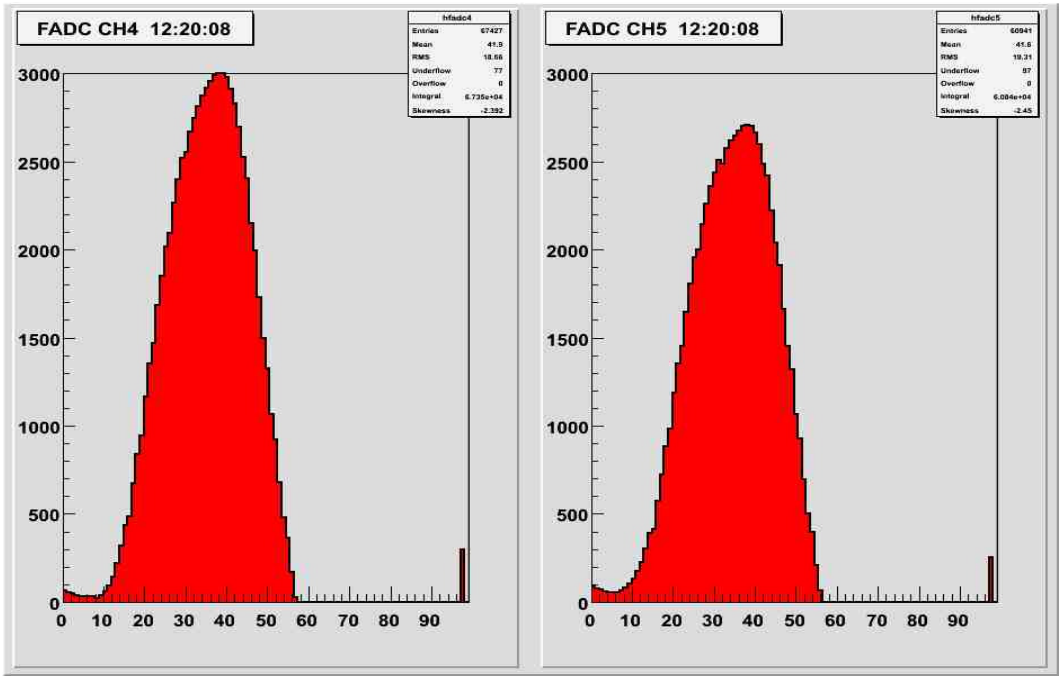

- preamps : 0.03V/pc and 4 V/pc
- main amp: 2-3x
- Flash ADC: 100MHz sampling rate
- VME: MBS readout  -> Go4

# Teststs  on the FRS

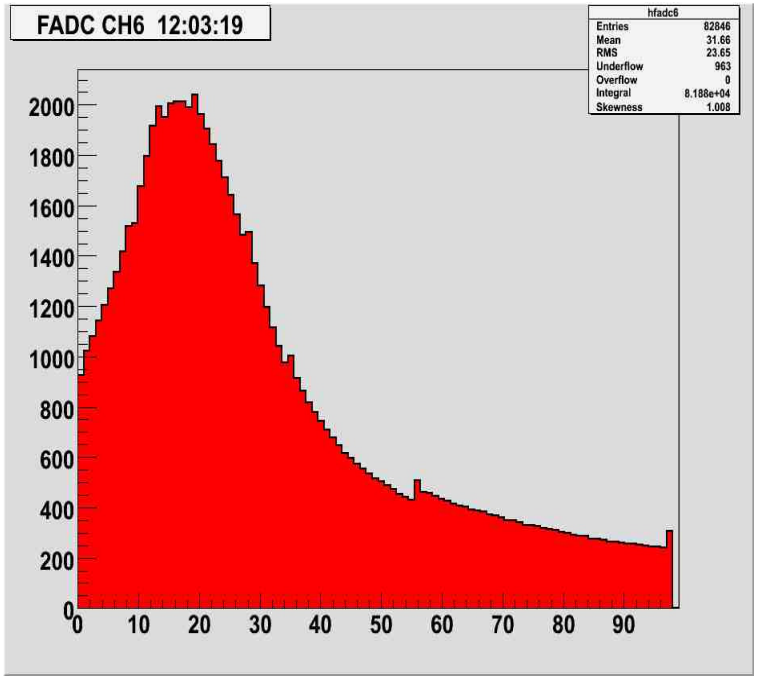
- fast extracted $^{12}C$ beam, energy  200-400MeV/u
- intensity: $10^4$ – $1.6*10^9$ part./spill

  spill length : 300ns

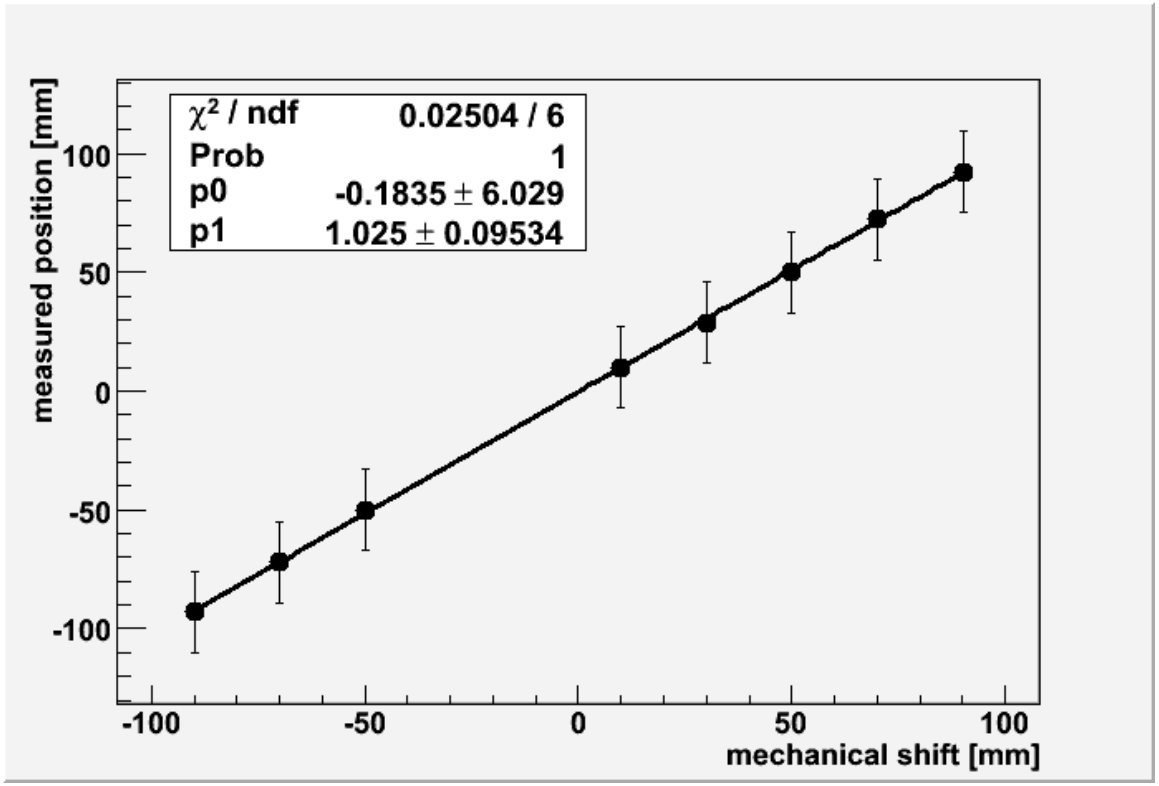
beam profile in X and Y directions




Z profile (spill structure)



# Test of the Beam Profile Monitor linearity



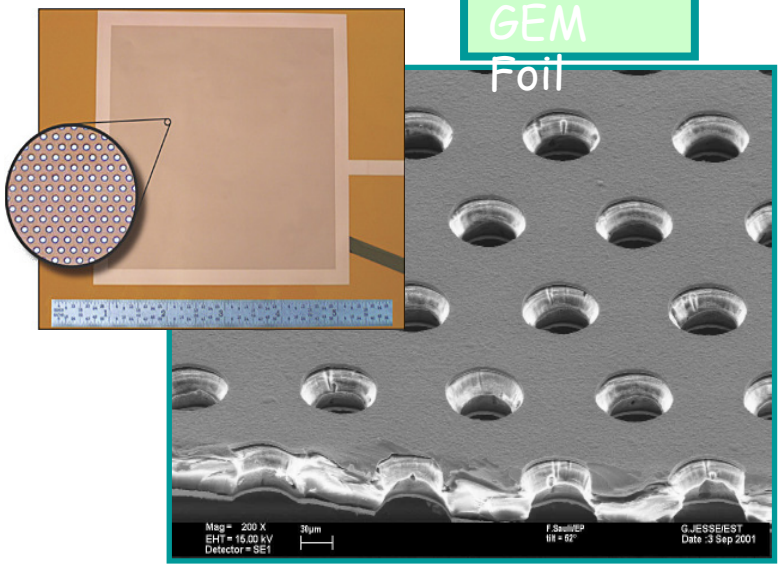

98 mbar, anode voltage 120V, grid 50V, $^{12}C$ intensity 1.5*10 $^{8}$, left module

# GEM TPC development

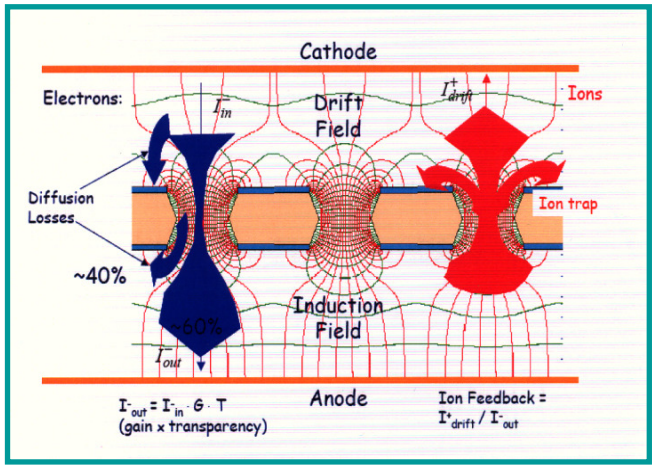
- 3 stage GEM stack has been developed and tested at Helsinki Lab.
- Field cage, gas box, chevron + delay line read-out and electronics has been developed and tested at Bratislava Lab.
- Tests with $^{55}Fe$ source were performed at Bratislava Lab.
- Tests on the ion beam were  performed on FRS at GSI

# GEM TECNOLOGY and CHARACTERIZATION

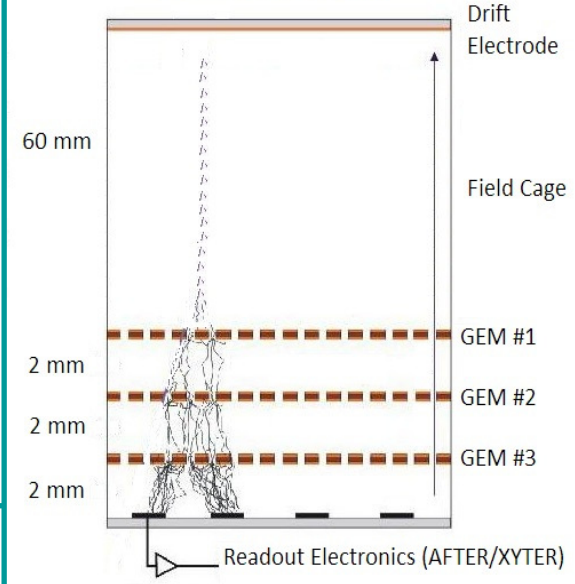
## GEM Foil



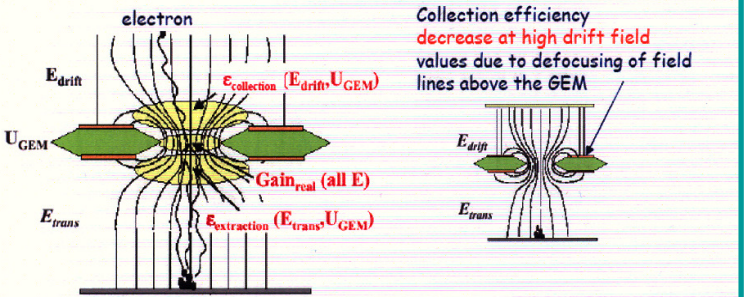

## GEM Operation

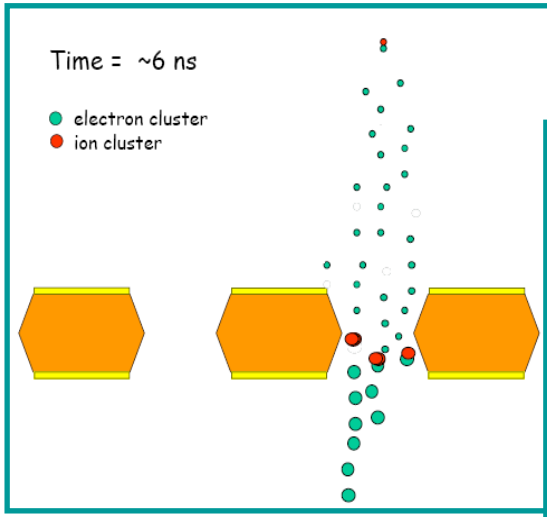



## GEM-TPC LAYOUT

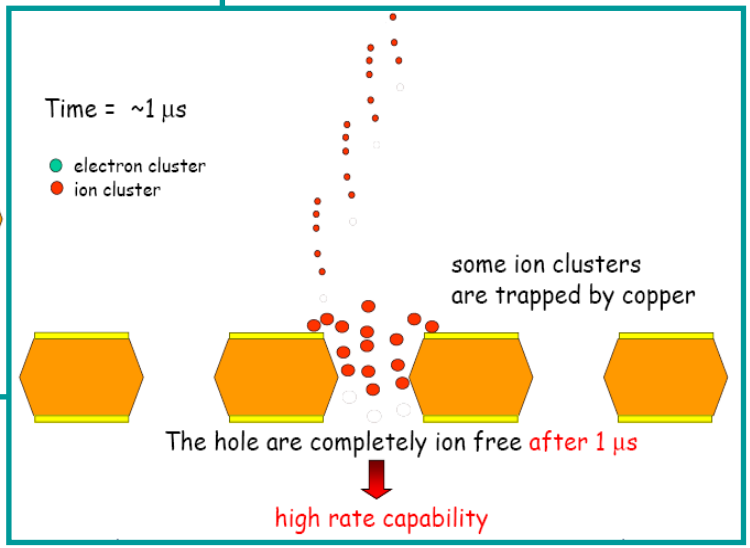



## Extraction of the Electron Cloud and Signal Induction



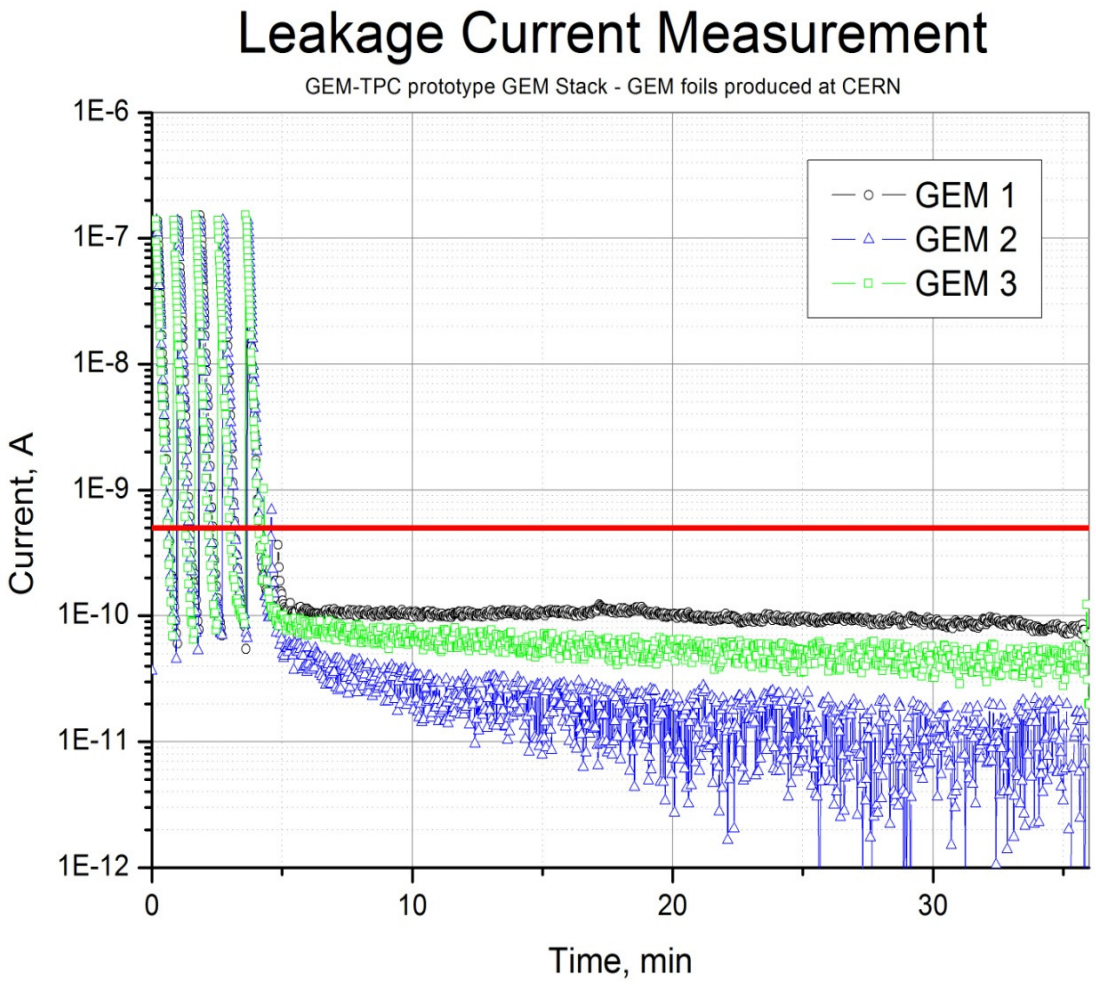

## Avalanche development in time domain

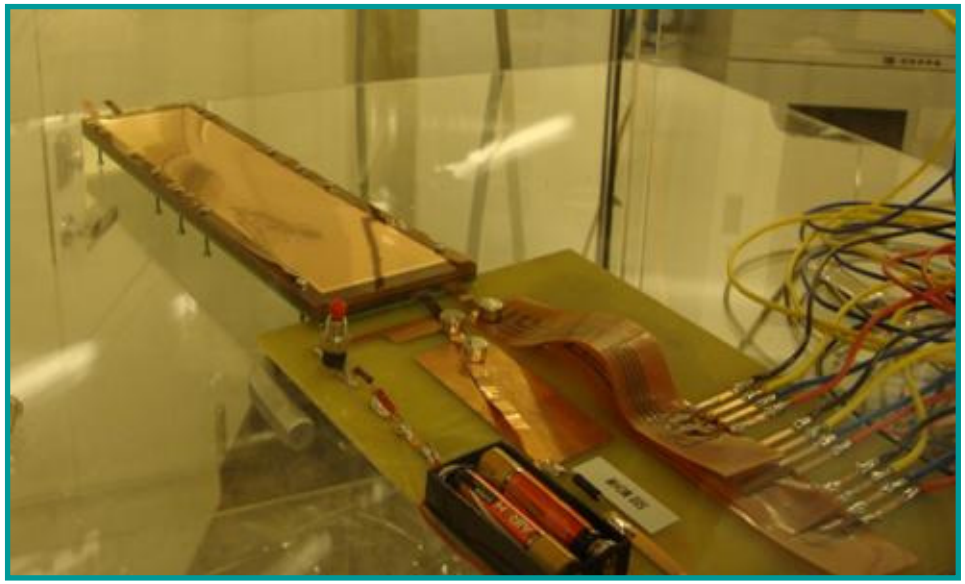


# GEM TECNOLOGY and CHARACTERIZATION (cont.)

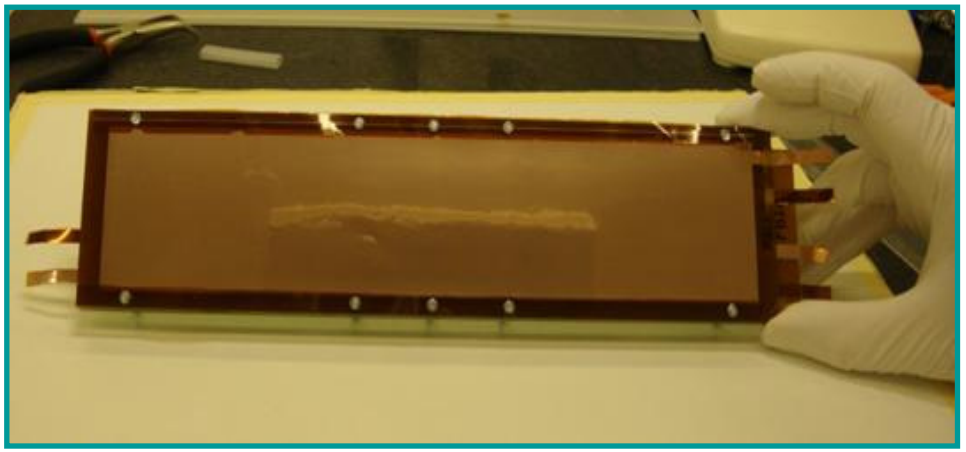
M Stack tests:

iple GEM leakage current measurements

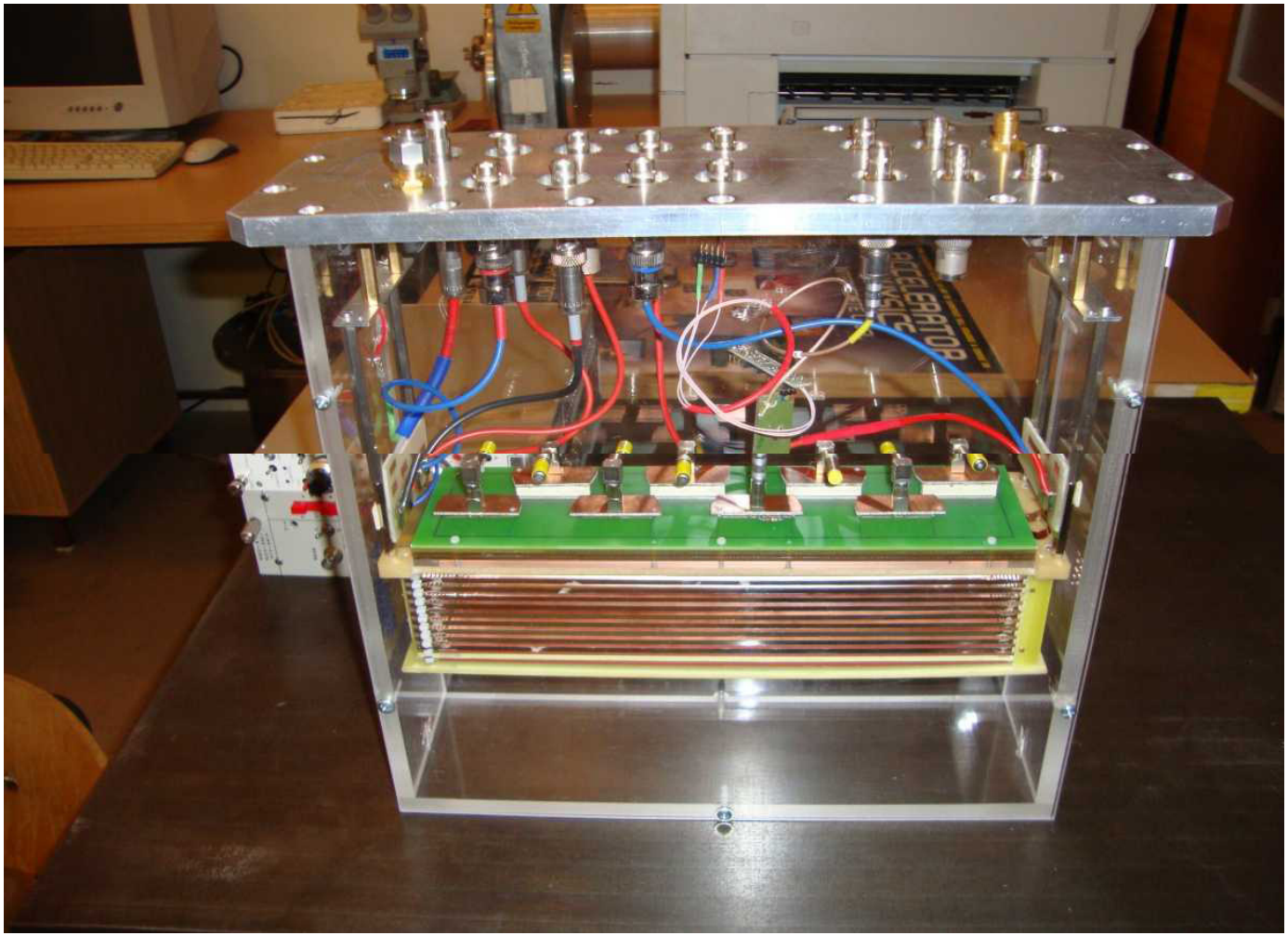


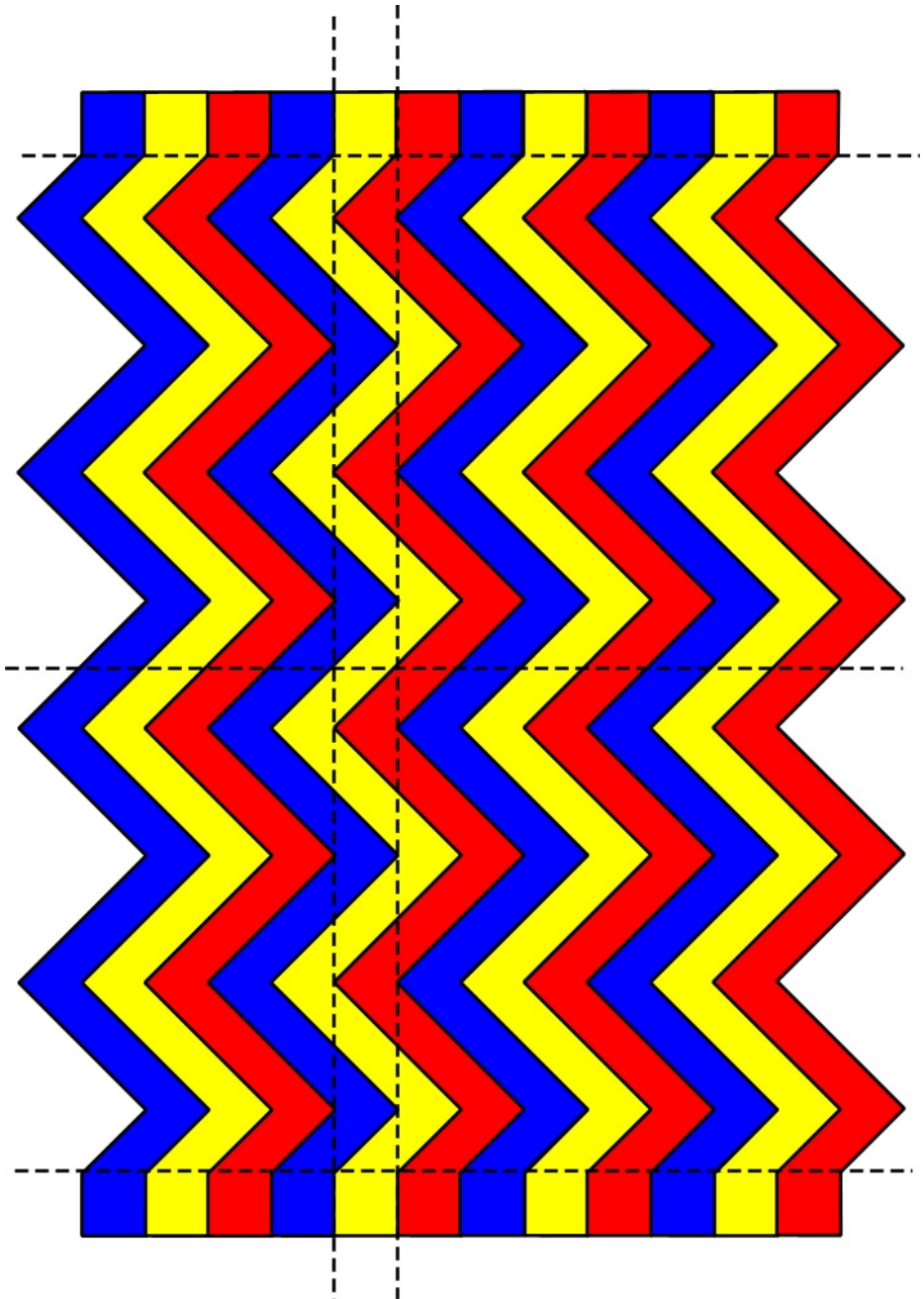
M Stack for the GEM-TPC prototype HB2



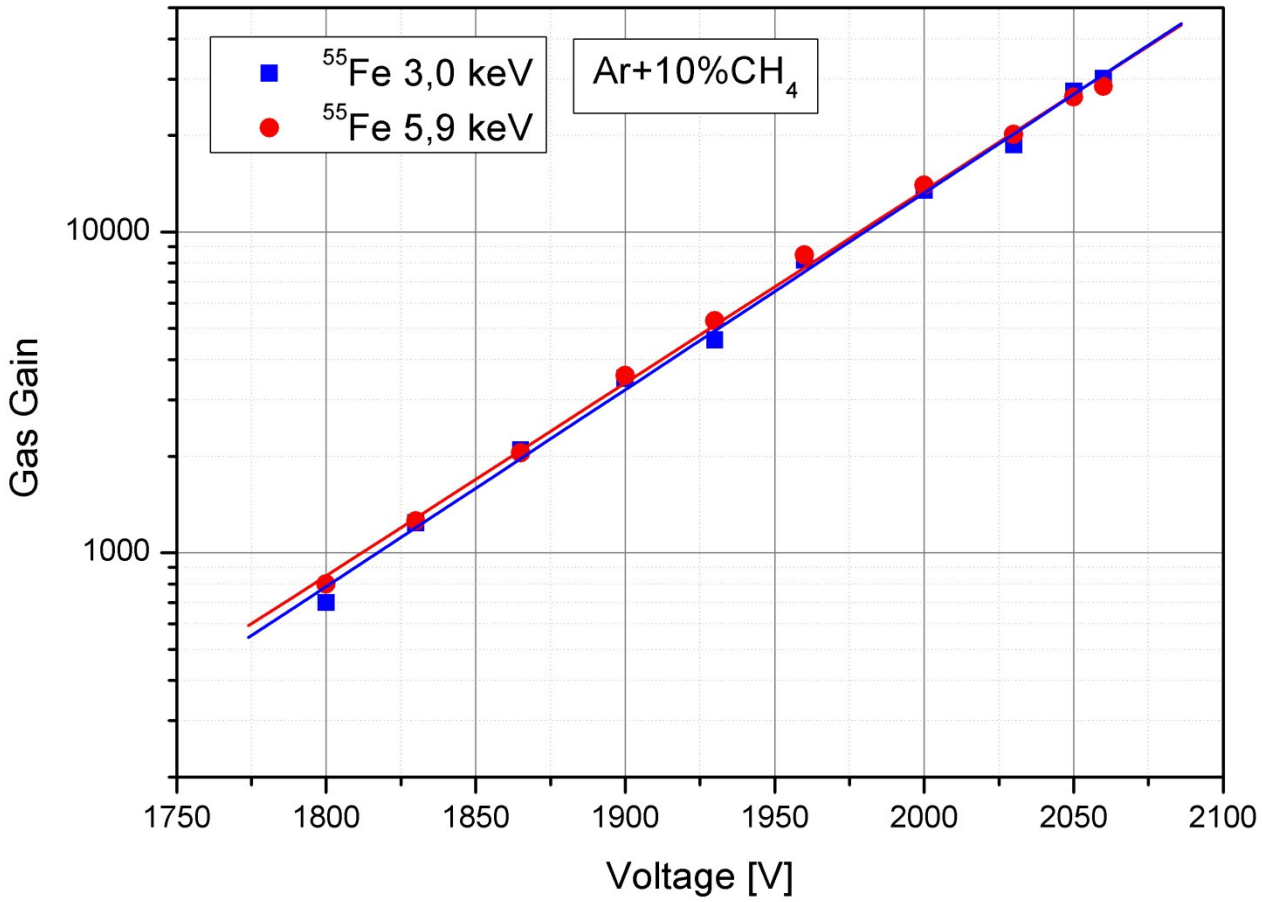
# GEM TPC prepared for laboratory tests



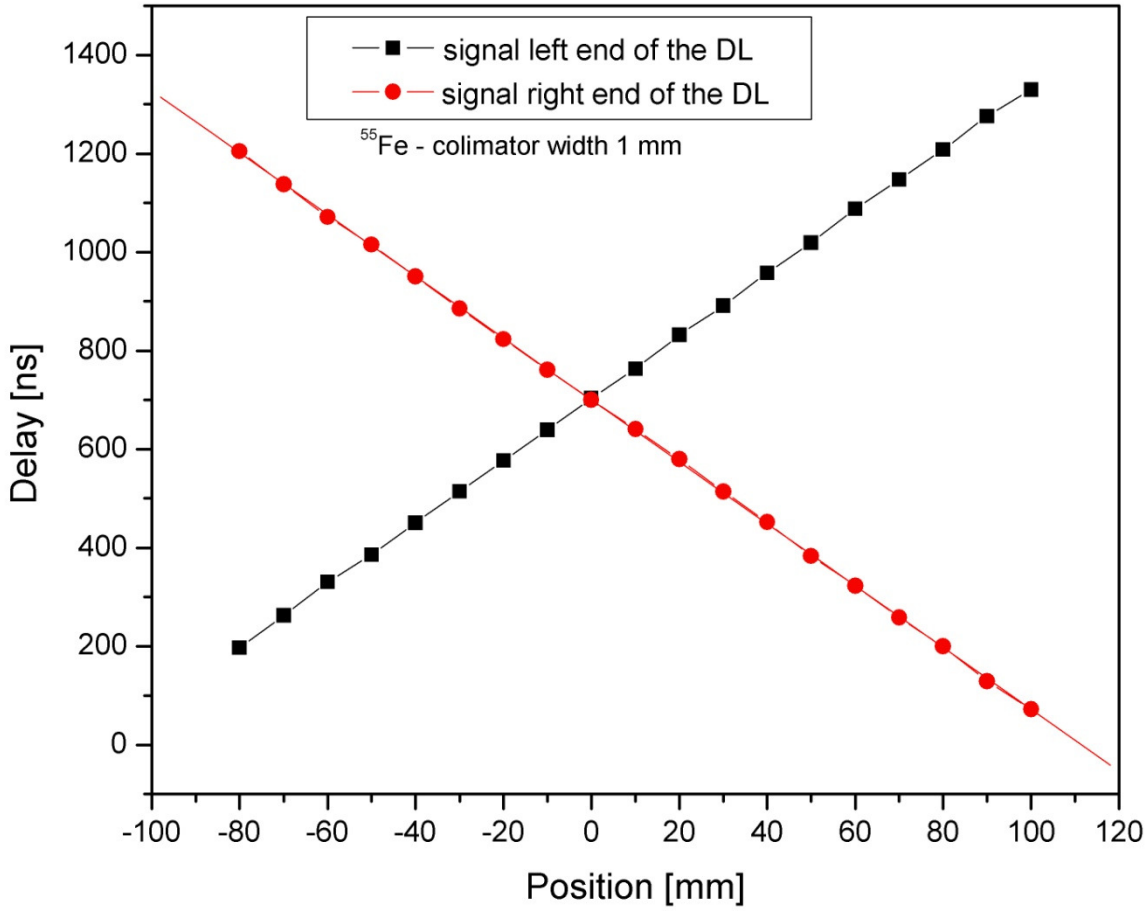
# Chevron structure for a GEM TPC



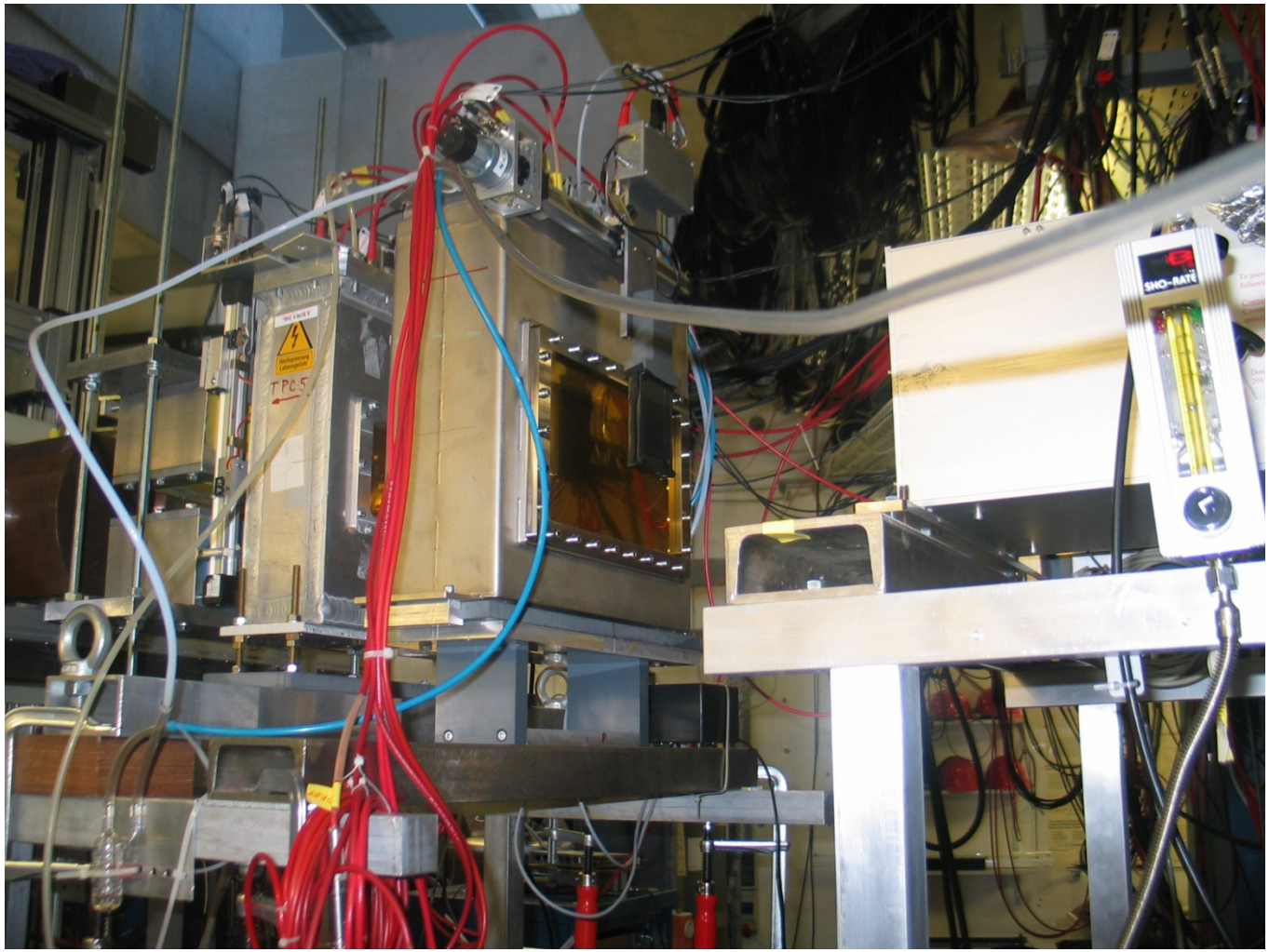
Gas gain as a function of the voltage on the 3 stage GEM structure



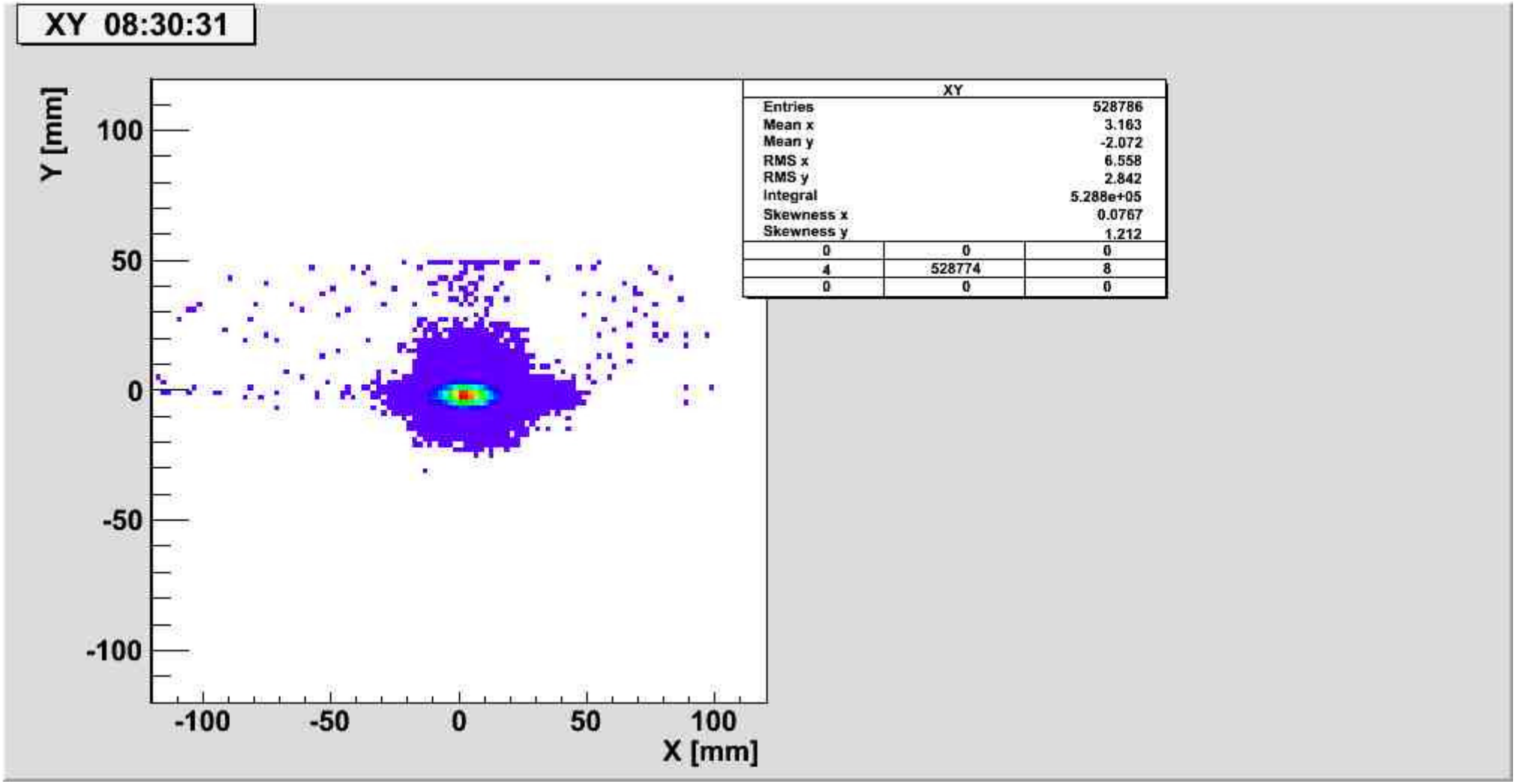
# Linearity of 3 stage GEM structure with chevron and delay line read-out



# GEM TPC during the tests on FRS

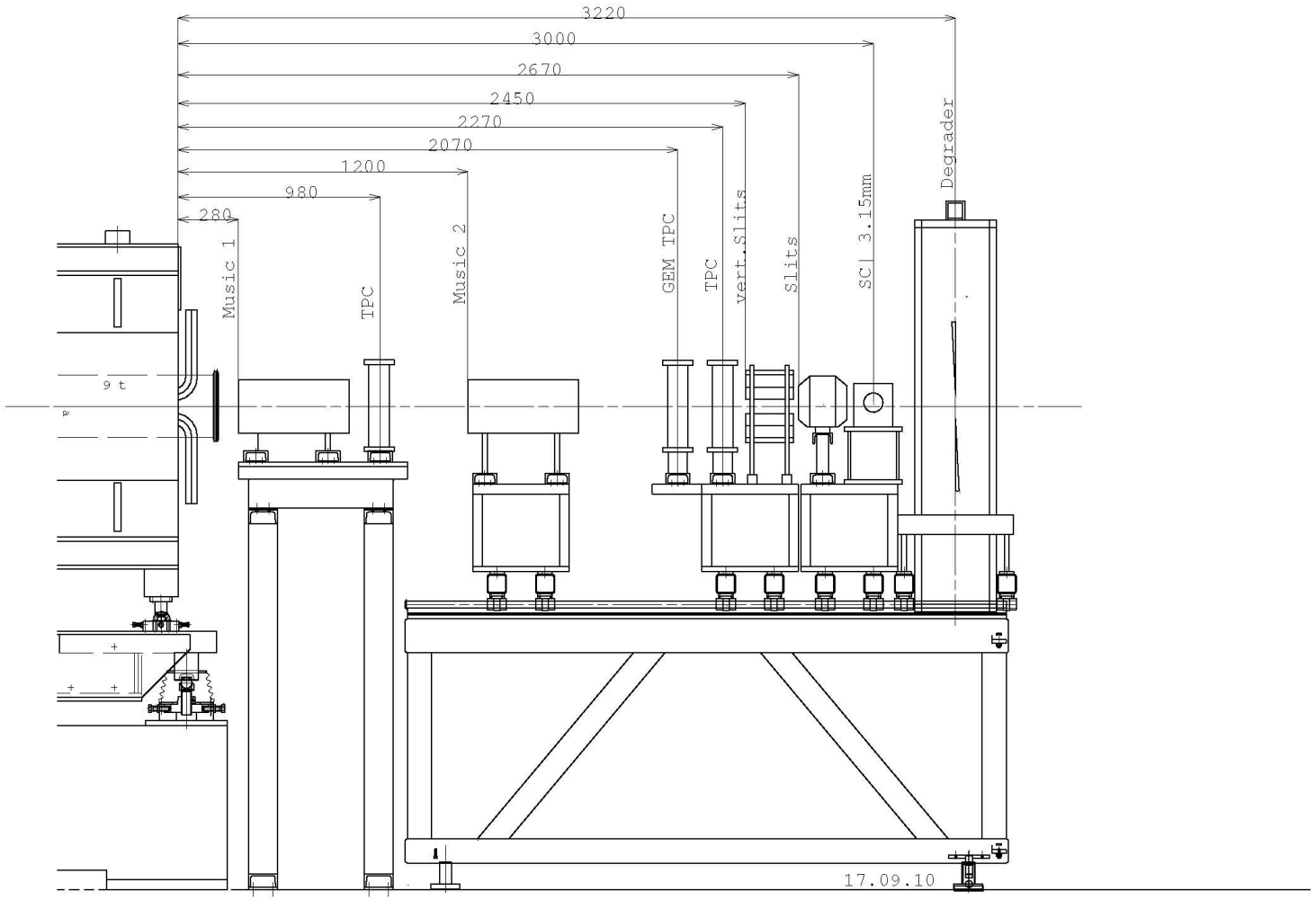


# Beam profile measured by GEM TPC on FRS



# Detector lay-out in S4 of FRS

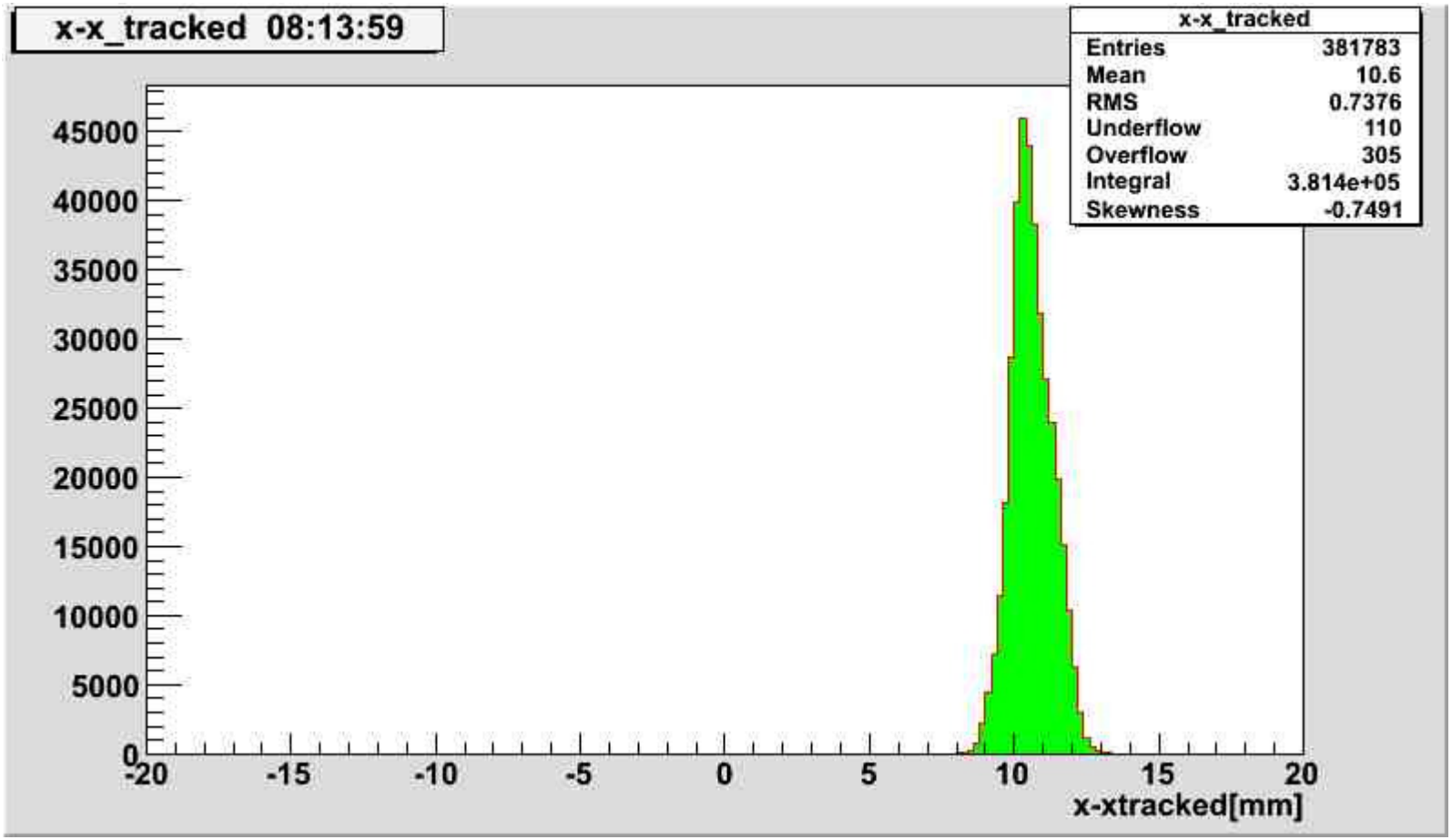
bruenle FRAME 1 SEPTEMBER 17, 2010 12.27.34




S363, 64Ni, 600 MeV/u, 1e7/spill, Bentley/Gerl, Sept.2010

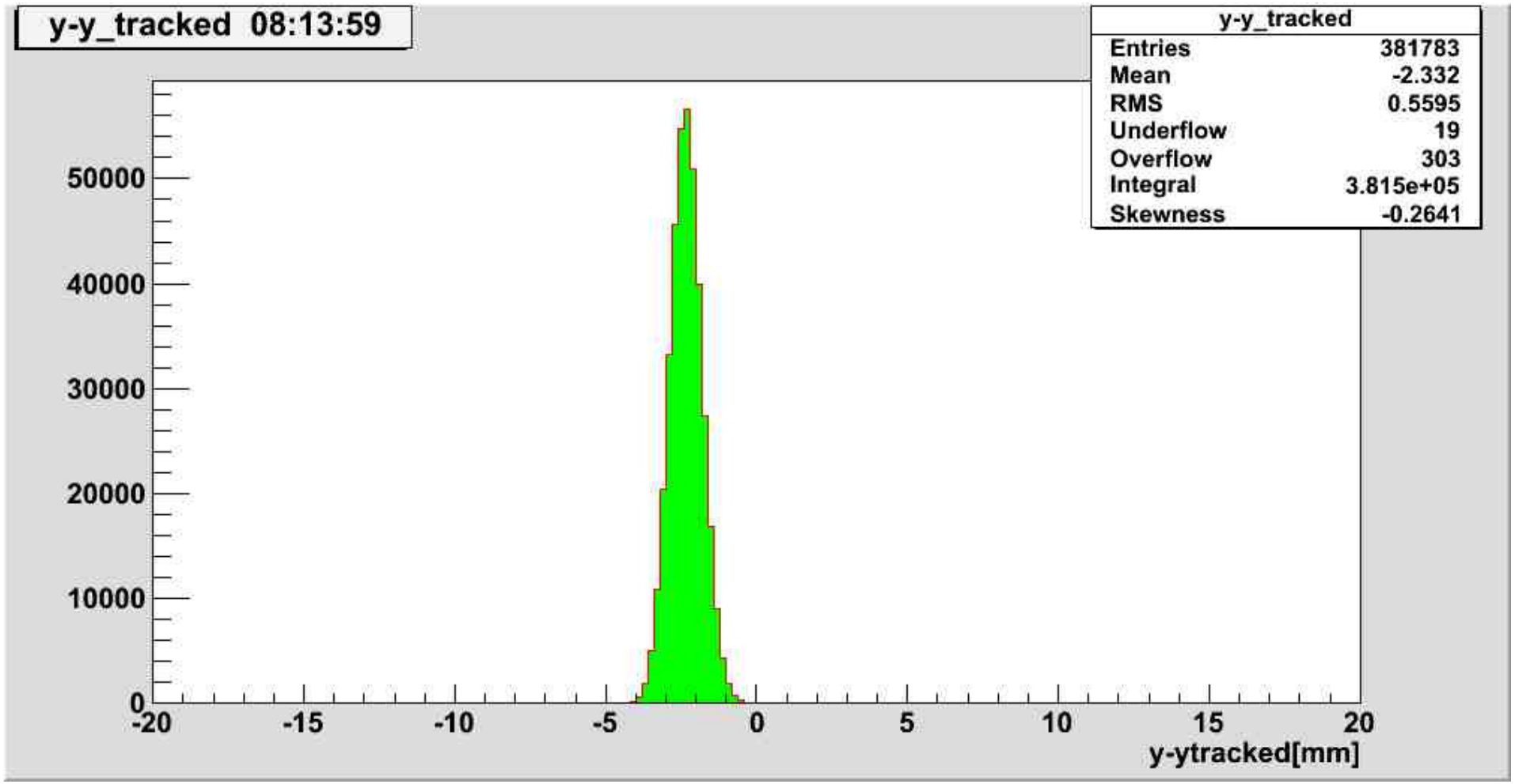
External resolution of GEM TPC in x-direction for $^{64}$Ni ions

$\sigma_x \approx 400\ \mu m$



External resolution of GEM TPC in y-direction for $^{64}$Ni ions

$\sigma_y \approx 300$ μm



# OPEN QUESTIONS

- Characteristics of the GEM foils defects and its uniformity
- Field cage optimisation, different strips pitch, strips widths and for single and double strips versus different field gradients
- Field cage with larger Drift length
- Studies on the Ion feedback – simulations and experiment
- Calculations of Charge up effects and Gain from simulations
- Readout electrode geometry optimizations for different ions types, momenta and count rate
- Signal induction for different type of gases based on $ArCO_2$ with $CF_4$ and other gas mixtures.

# Further development for Super FRS

- TPC with C-pads is a proper tracking detector for the FRS up to the ion intensities of 100 kHz
- TPCs are working also inside vacuum part of the FRS
- GEM TPCs for intensities up to 10 MHz should be developed and tested
- Tests on existing TPCs
- Large TPCs for Super FRS will be designed, built and tested in 2011/2012
- New electronic of XYTER, SPADIC or AFTER type
- Bottleneck – electronics and testing