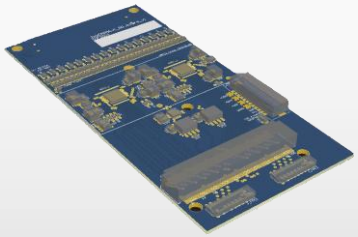
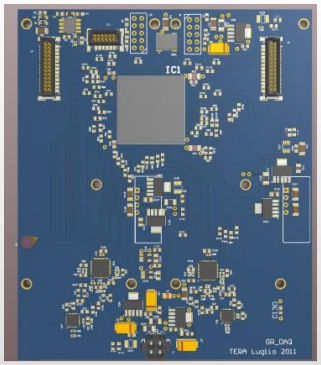
Progress with GEMROC front-end and fast DAQ part 2





Martina Bucciantonio

U. Amaldi, D. Bergesio, N. Malakhov,

R. Kieffer, F. Sauli, D. Watts

RD51 mini week

CERN

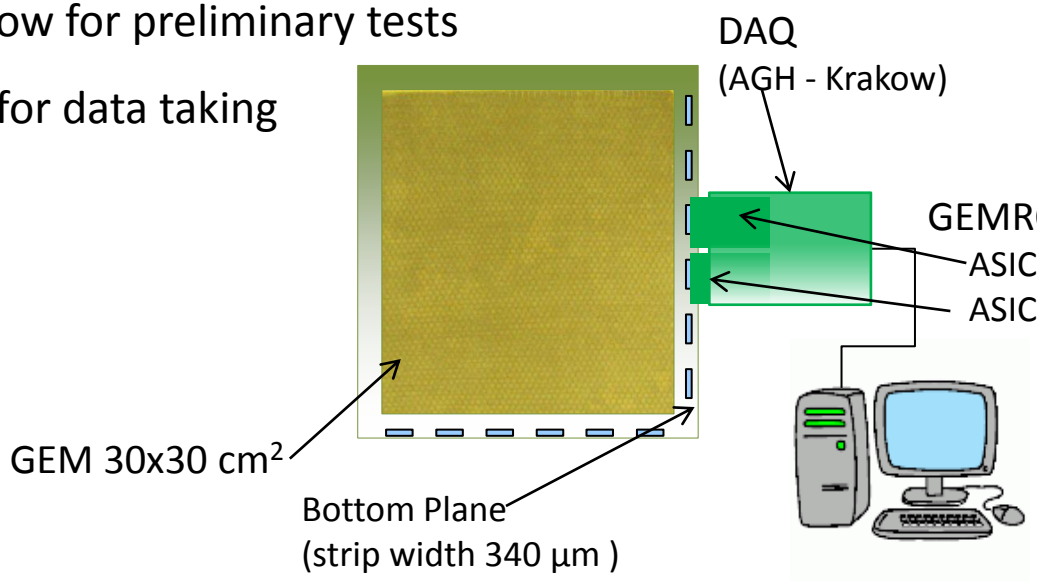
November 22th 2011

Outline

- GEM 30x30 preliminary tests with GEMROC front-end
  - Test setup
  - Noise characterization
  - 55Fe spectra and comparison with the GEM10x10 results
- TERA dedicated GEM 30x30 DAQ system
  - new GR_DAQ
  - Firmware status and software control interface

Setup

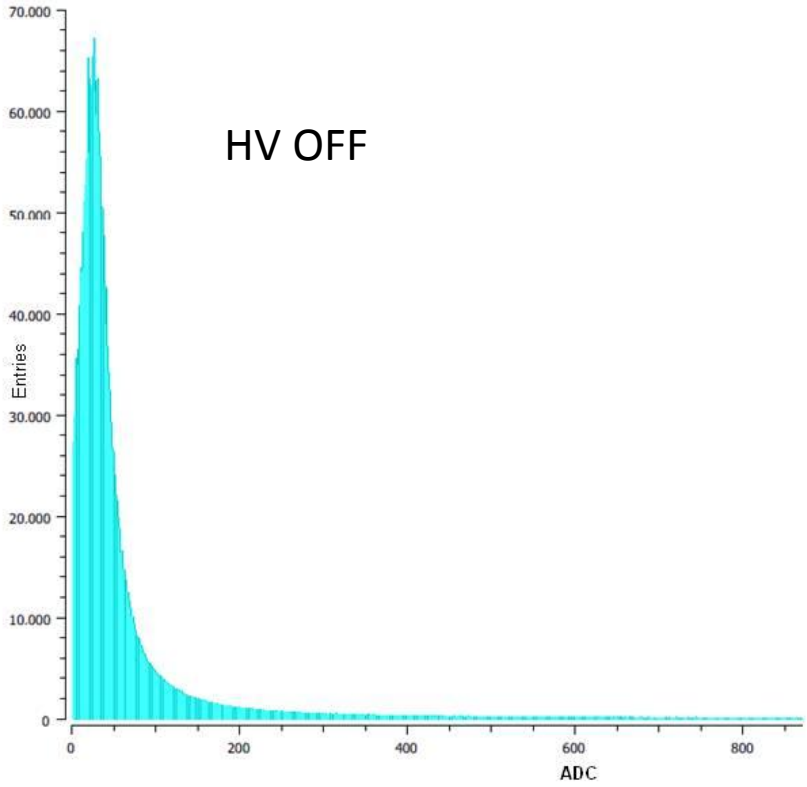
- GEM 30x30 cm^2 COMPASS style
  - Strips connected in pairs: 800 µm pitch
    ⇒ less signal/noise because of the large capacitance, but compensated by larger signals (shared between several strips)
  - Ar/CO_2 70/30 gas mixture
  - CAEN NIM HV module (N470)
- 2 GEMROC Front-End boards
- DAQ provided by AGH-Krakow for preliminary tests
- Computer control software for data taking
- ^{55}Fe source



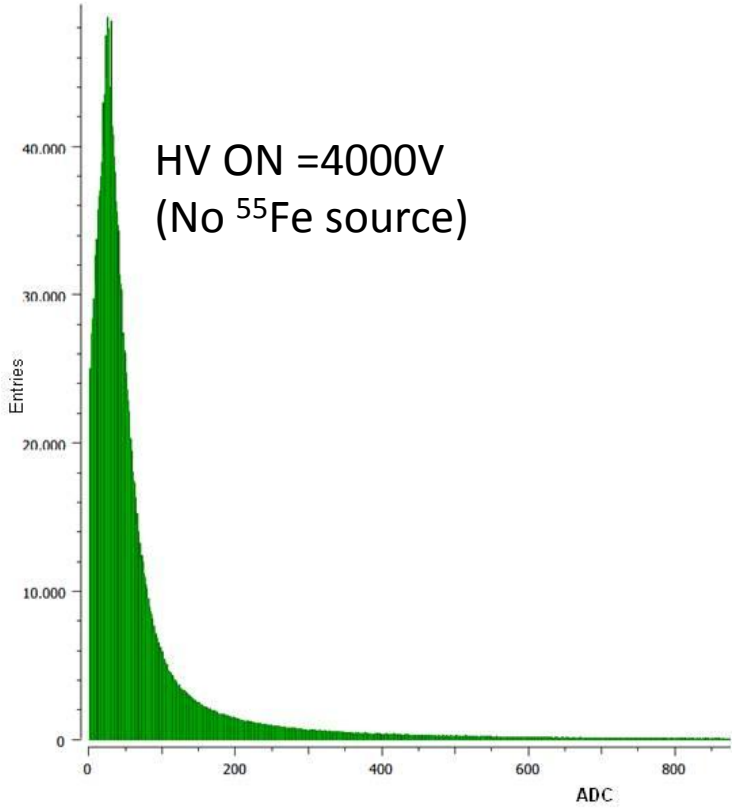
GEM 30x30 preliminary tests with GEMROC

Noise spectra

- ASICs 8-9 and 10-11 connected
- threshold 50LSB



HV OFF



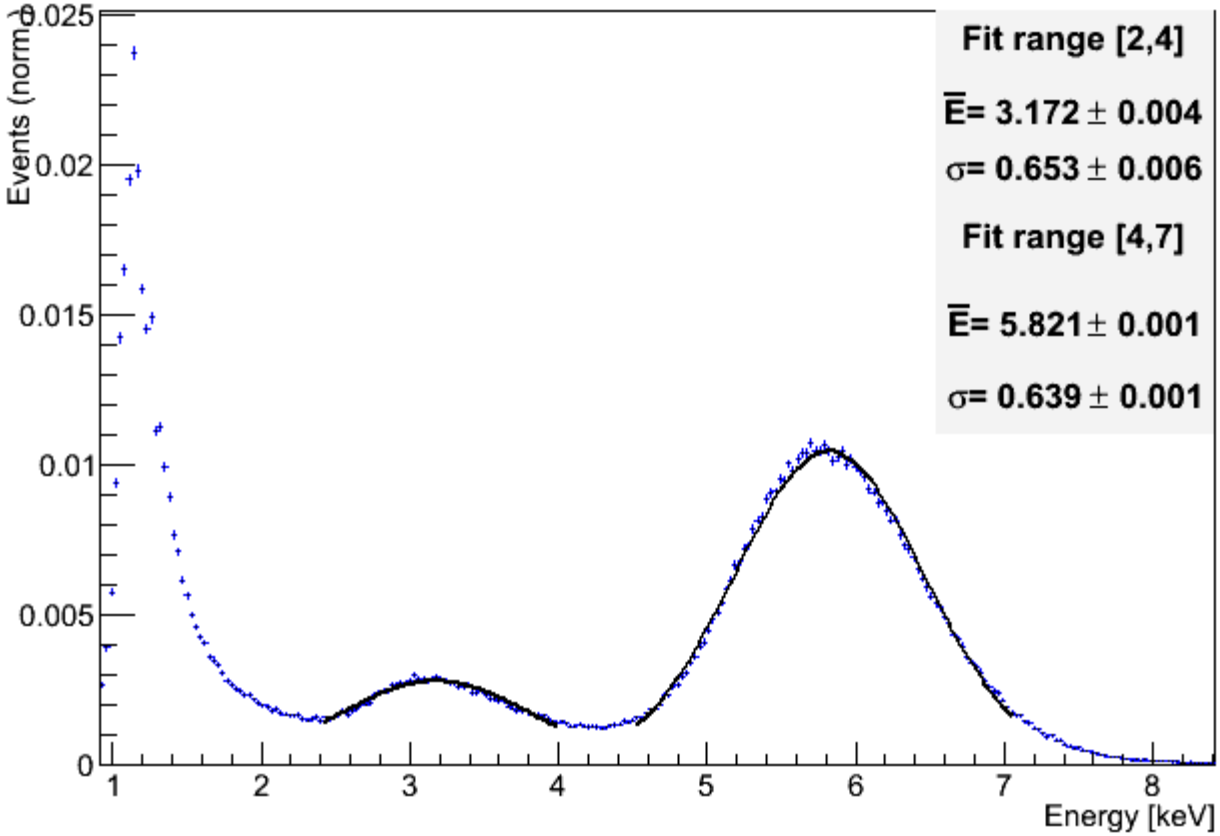
HV ON =4000V
(No ^{55}Fe source)

GEM 30x30 preliminary tests with GEMROC

^{55}Fe spectra

-HV 3980V
- ASICs 8-9 and 10-11
- High gain (0.8mV/fC)
-threshold 50LSB

Normalized events

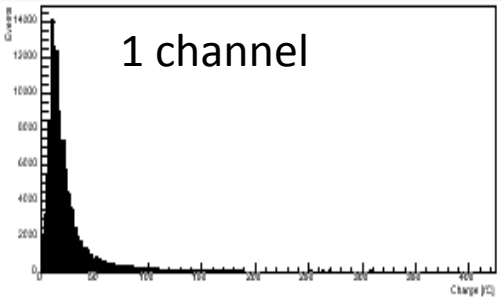


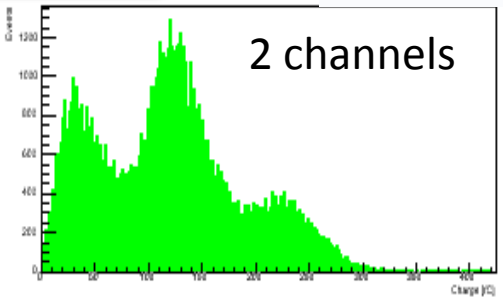
GEM 30x30 preliminary tests with GEMROC

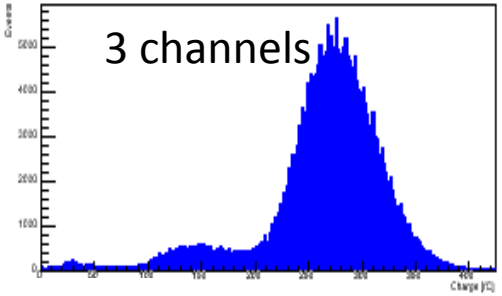
^{55}Fe spectra

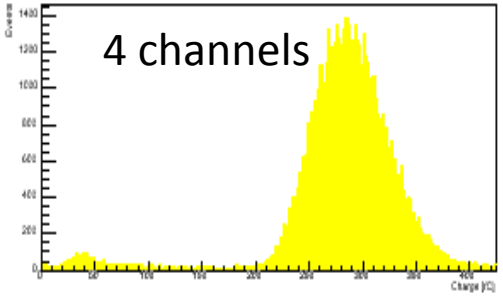
Channels over threshold distribution

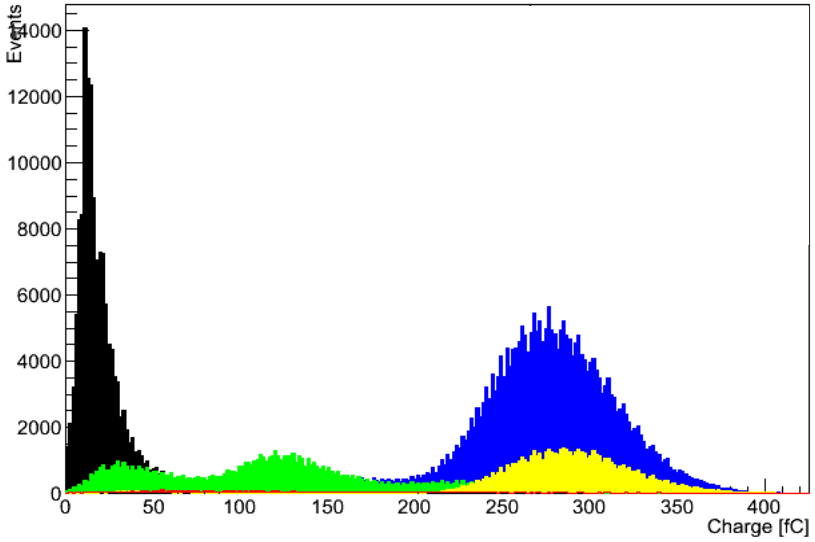
-HV 3980V
- ASICs 8-9 and 10-11
- High gain (0.8mV/fC)
-threshold 50LSB

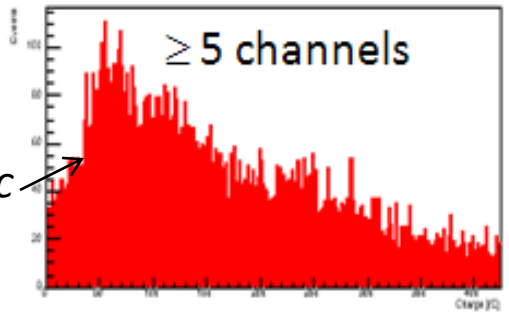








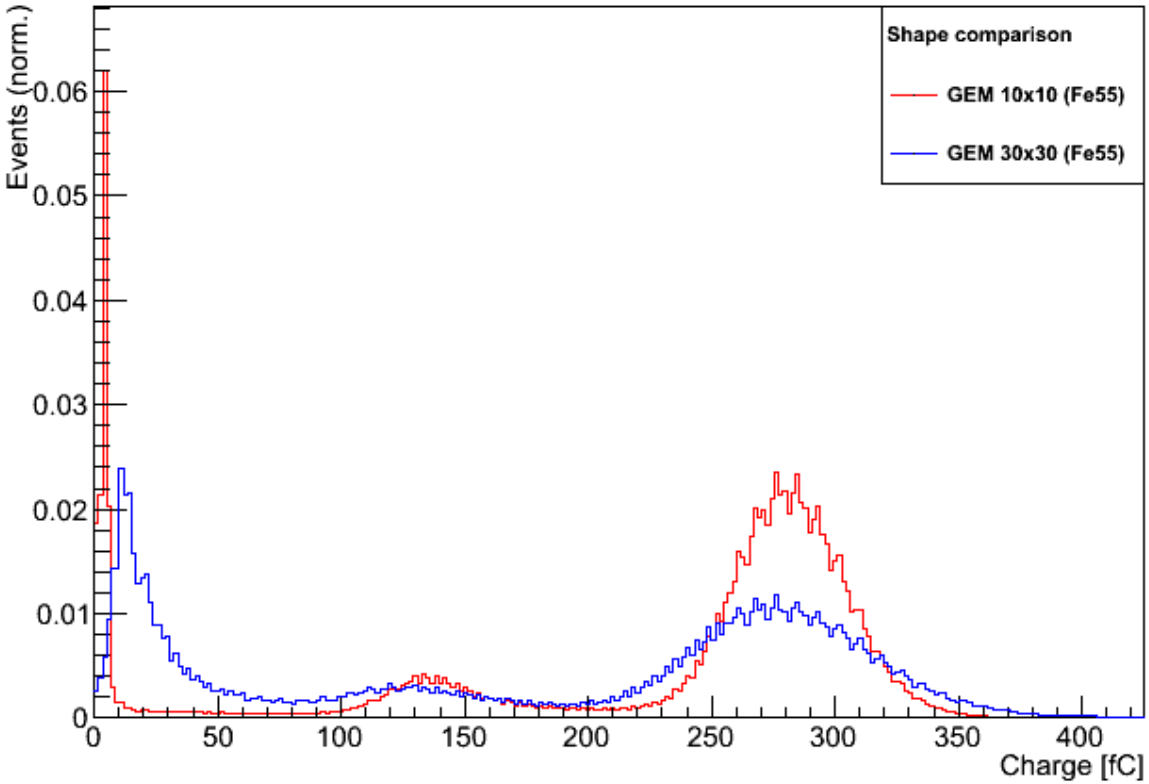




external electromagnetic noise

better shield required

GEM 30x30 vs GEM 10x10

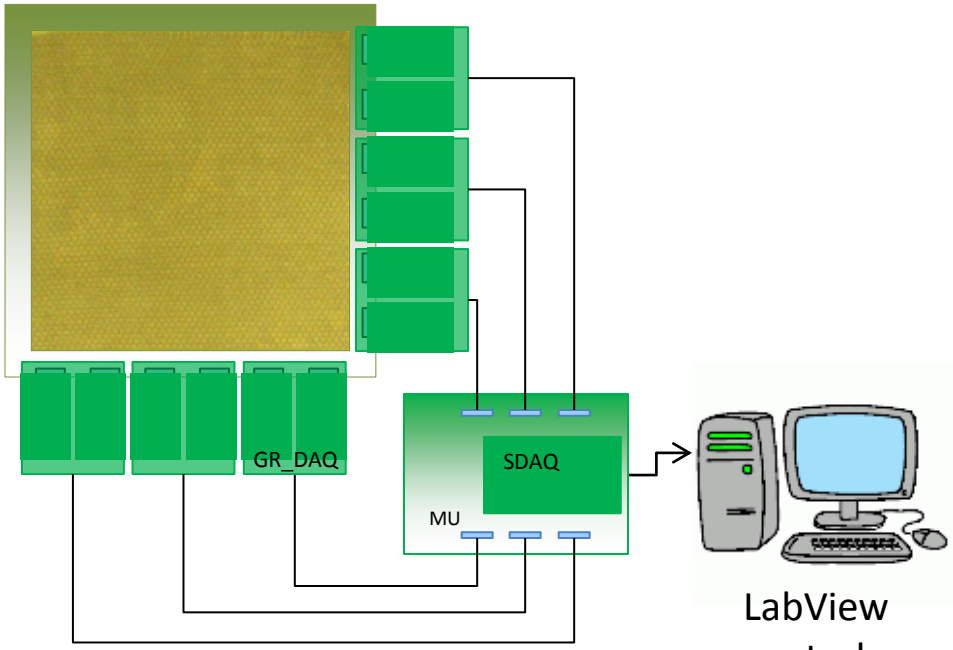


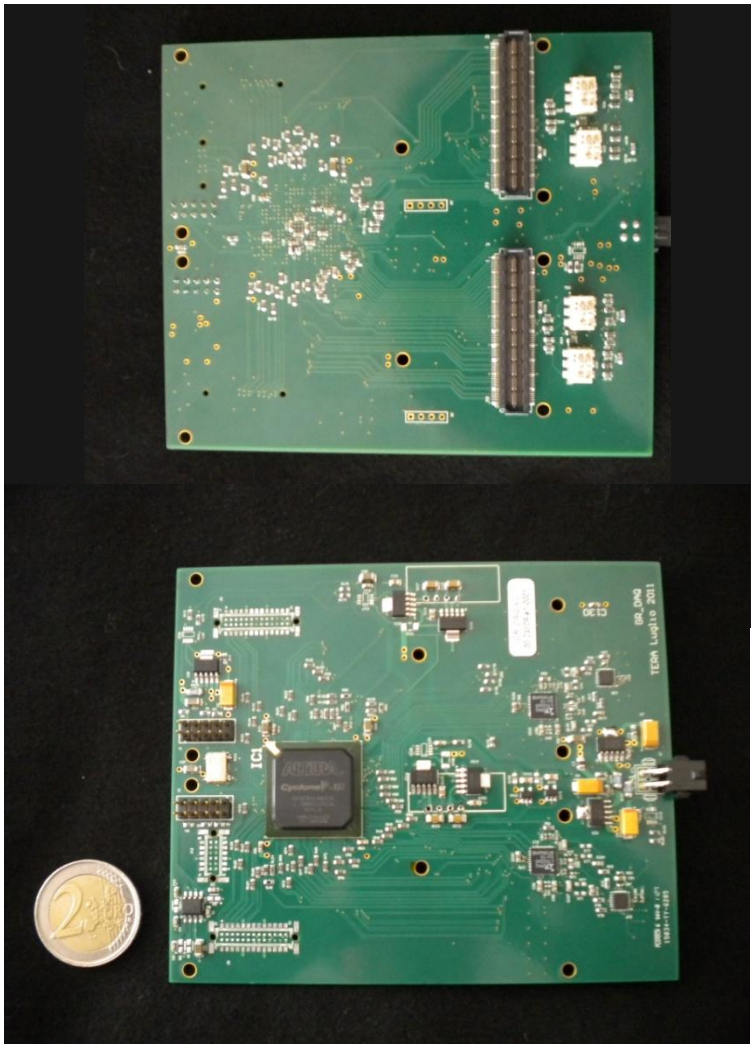
Parameters	800 µm pitch GEM 30	800 µm pitch GEM 10
Inter-strip C		
Top plane	2 pF	1 pF
Bottom plane	15 pF	6.5 pF
C of strip to other readout plane		
Top plane	54 pF	19 pF
Bottom plane	62 pF	18 pF
Total strip C for the total length		
Top plane	58 pF	21 pF
Bottom plane	**92 pF**	**31 pF**

- Affordable signal/noise discrimination
- Preliminary test in good agreement with the design requirements:
  - low threshold : **~ 10fC** for all the voltages (6fC on GEM10x10)
  - worste resolution and more sensible to the external noise
- DAQ speed to be increased for quick data taking run (aim of the PRR project by TERA)

GEM 30x30 Final Readout

- 12 GEMROC front-end boards
- 1 DAQ system (6 GR_DAQ + 1 MU+SDAQ)





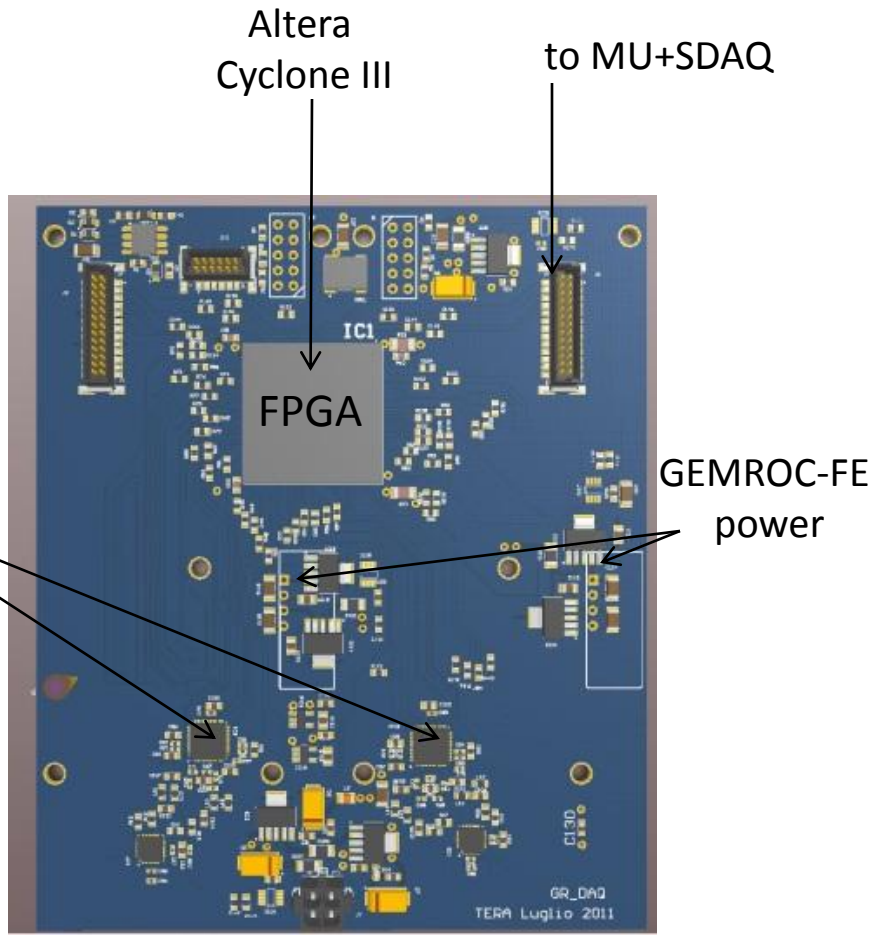
GR_DAQ

• provides biases and thresholds for the GEMROC chips and holds the front-end cards mechanically

• performs serialization and digitalization of the GEMROCs analog output buffer through the pipeline 12-bit ADC , serial LVDS output(Linear Technologies LTC2265-12)
1 ADC/GEMROC-FE board

• sparse readout: records only the channels with a trigger and their neighbors (increasing the readout speed)

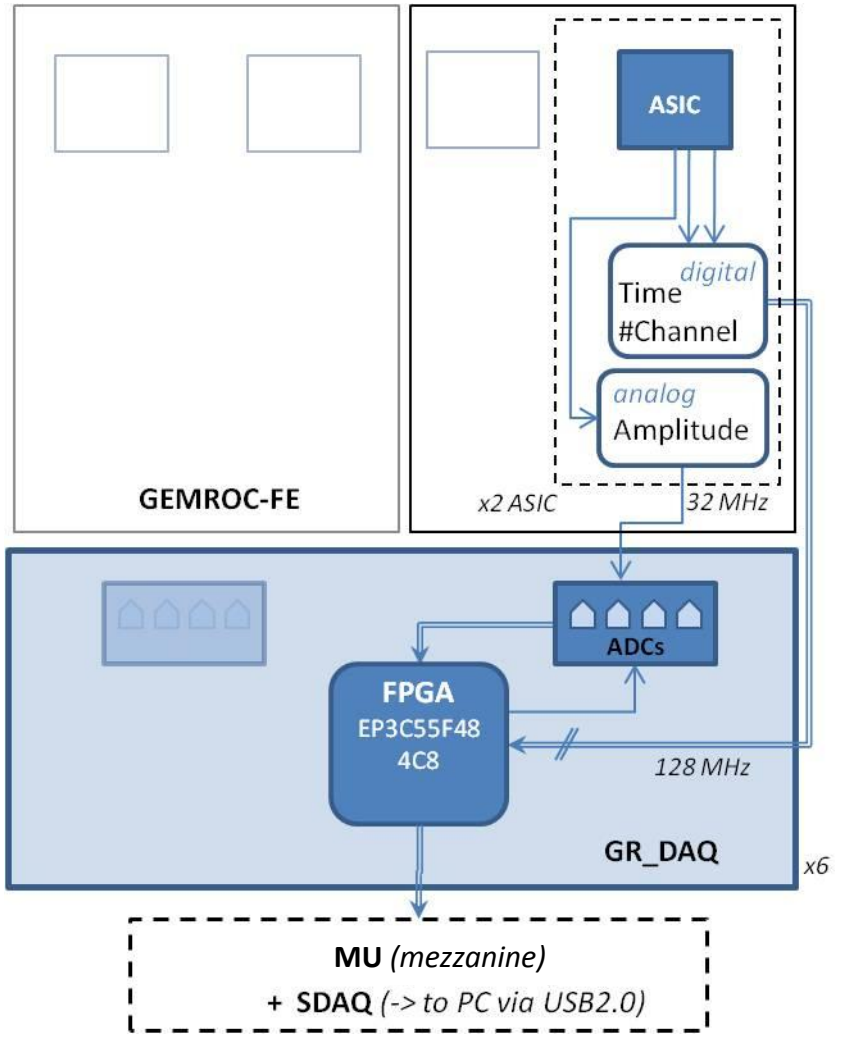
• Final aim: <u>~ 1 MHz DATA THROUGHPUT</u>



Connectors for GEMROC-FE boards on the bottom side

GR_DAQ Firmware

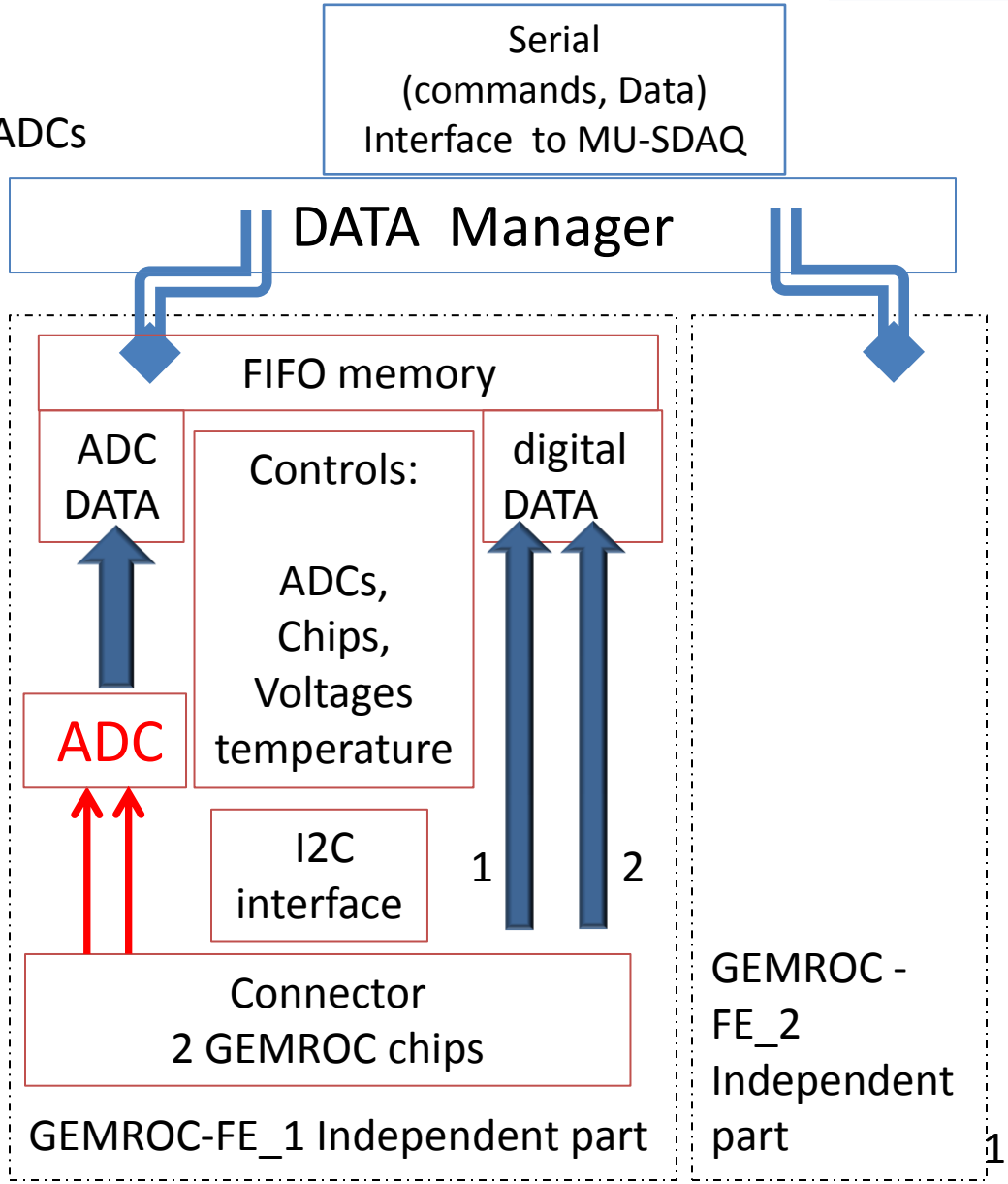
- parallel processing of 4 GEMROC ASICs per each GR_DAQ
- reading out digitized analogue amplitude using 12bits ADCs incoming at 32MHz
- time stamp, channel IDs out from GEMROC at 128 MHz , properly delayed and merged with the analog data (64 bits raw hits frame to PC)



GR_DAQ Firmware

- Clock distribution for GEMROCs and ADCs
- Control ADCs, Chips,
  voltages ,temperature
- acquisition from ADCs (SPI protocol)
  with the proper delay
- Parallelization
- I2C protocol

~ 400kHz DATA THROUGHPUT
(debug ongoing , then speed up to 1MHz)

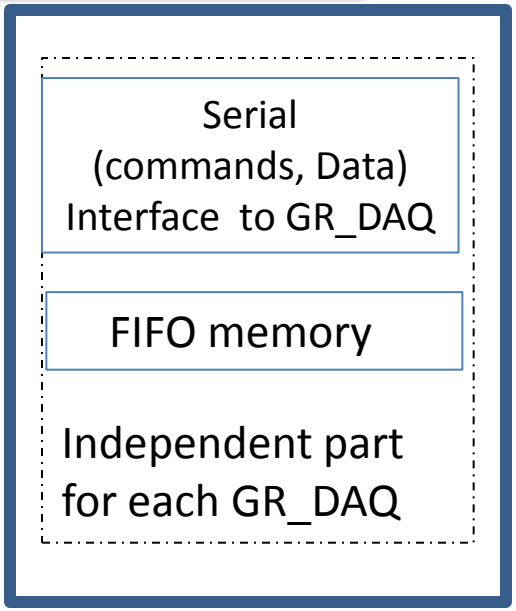


GEM 30x30 Firmware Status

Mu+SDAQ :

generic DAQ , flexible for different read-out applications (ALTERA Cyclone III FPGA)

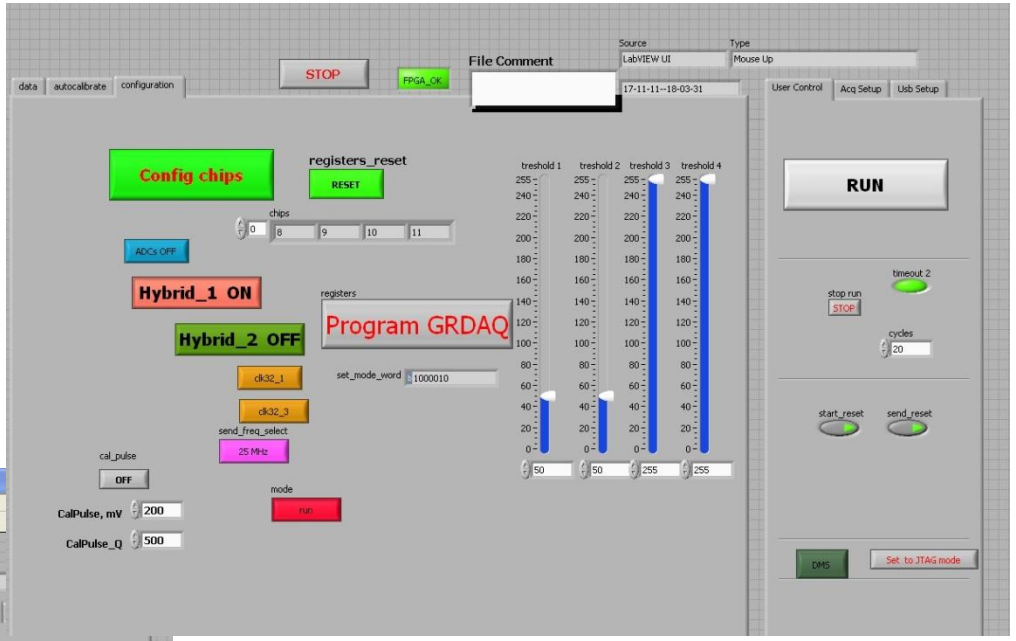
- data from the 6 GR_DAQs
- Voltage, temperature controls
- programmed by and communicate with PC via a QuickUSB Module (Bitwise Systems)
- embedded I2C interface (transfer data rate up to 30 Mbytes/s)

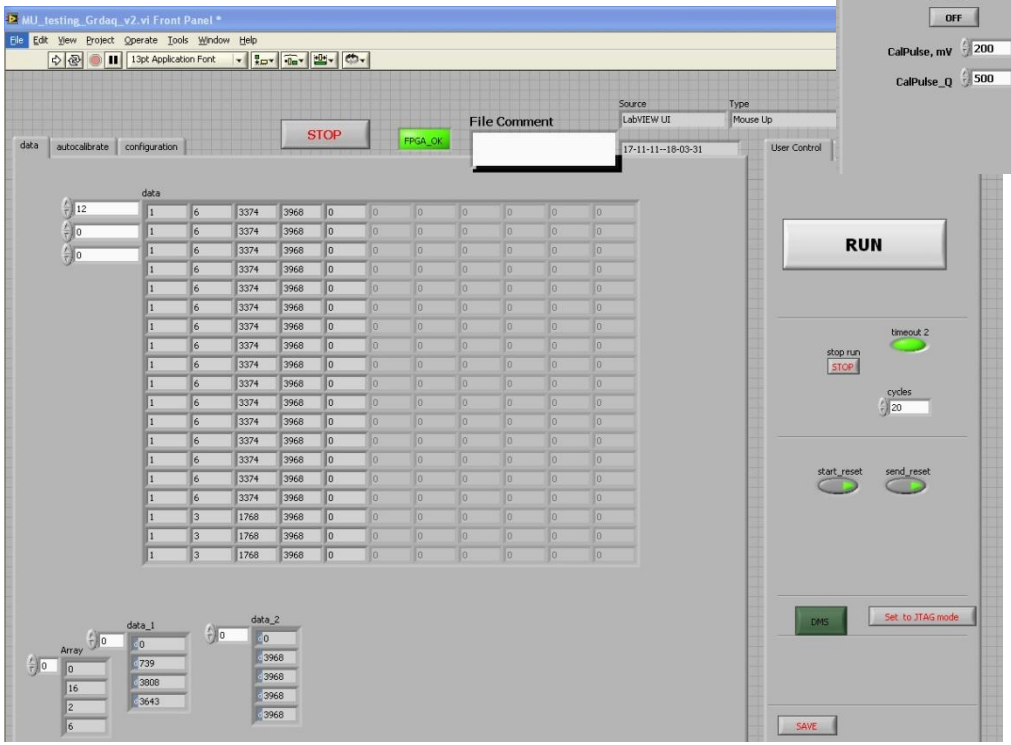


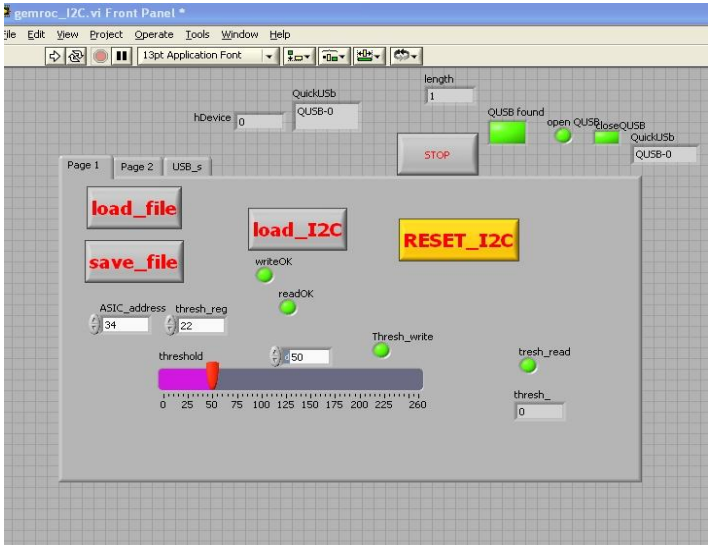
Software interface

LabView programs for:

- config GemROCs
- readout program
- I2C control



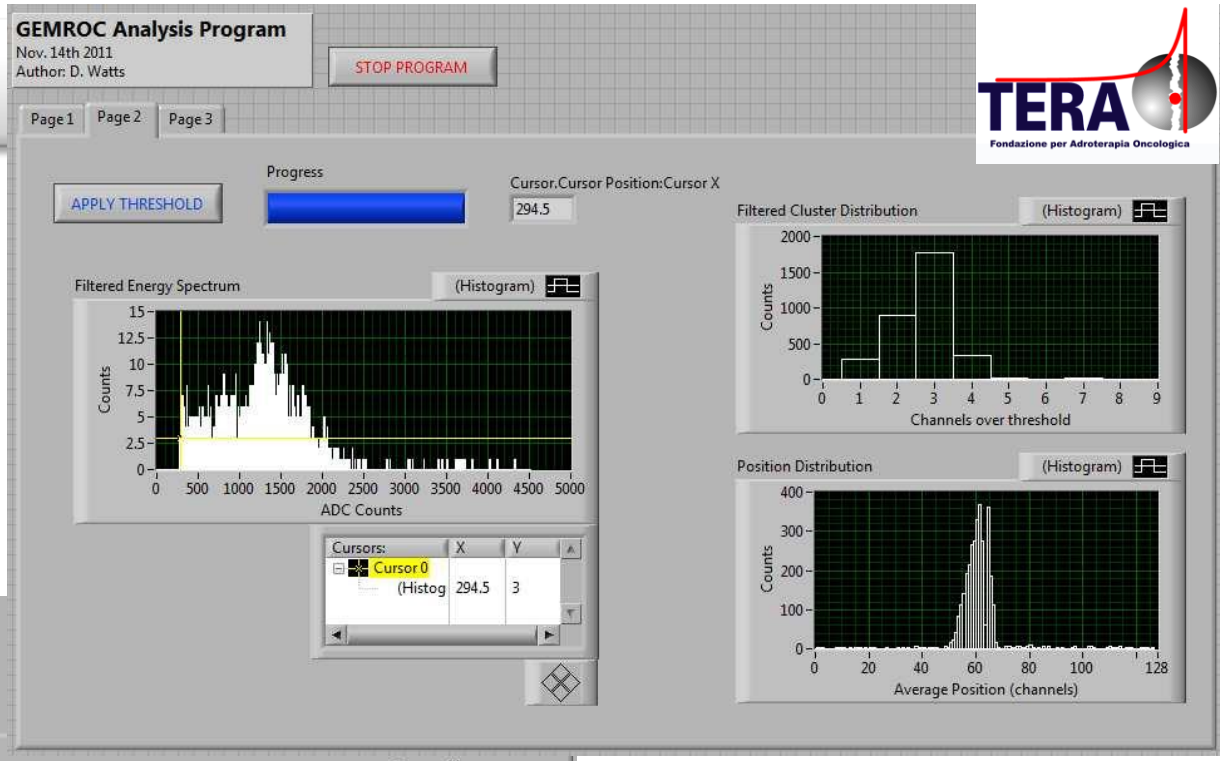


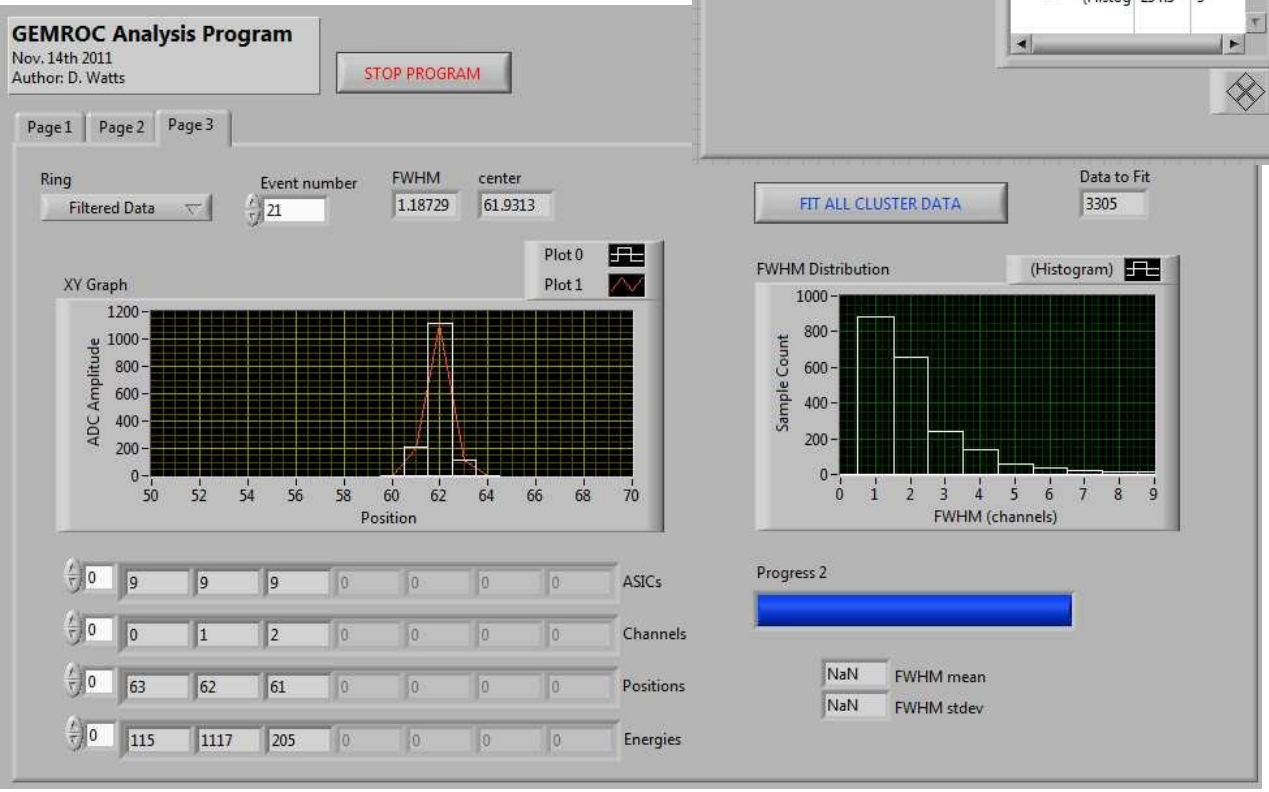


GEM data analysis

LabView programs for:

- Data analysis





Conclusions and future perspective

GEMROC on GEM 30x30:

- good signal/noise discrimination
- preliminary test in good agreement with the design requirements
  - low threshold : < 10 fC for all the voltages
- analogue parameters, gain, offset spread, time resolution, high count rate capability as expected

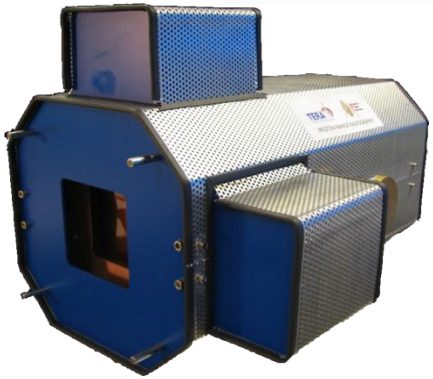
GEM 30x30 DAQ:

- complete GEM 30x30 readout ongoing
- parallel processing of 4 GEMROC ASICs /GR_DAQ
- reading out digitized analogue amplitude using 12bits ADCs
- time stamp, channel IDs properly delayed and merged with the analog data (64 bits raw hits frame to PC)
- Labview control and analysis softwares
- increase the DAQ speed ~ 1 MHz DATA THROUGHPUT

Aim of the Proton Range Radiography project by TERA:
for 1x1 mm^2 pixel and an image size of 30x30 cm^2 (10^5 pixel)
$\sim 10^7$ proton tracks (250 MeV proton beam) to be recorded
(achievable in 10 seconds @ 1 MHz)

Thanks for your attention

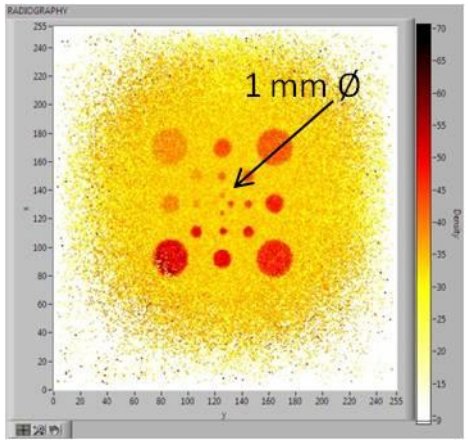
PRR



PRR10

Good spatial resolution and density resolution performances tested at the PSI (June 2010)

- some improvements apported (temperature sensors, fans, new GEM HV power supply, software user-friendly)
- delivered at CNAO (Pavia-IT) – test beam in June 2011

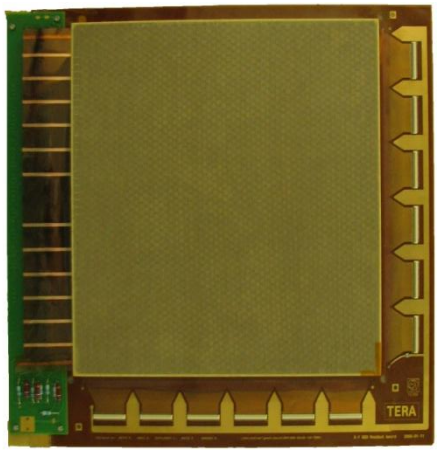


Real size proton radiography
(first step toward a complete protonCT)

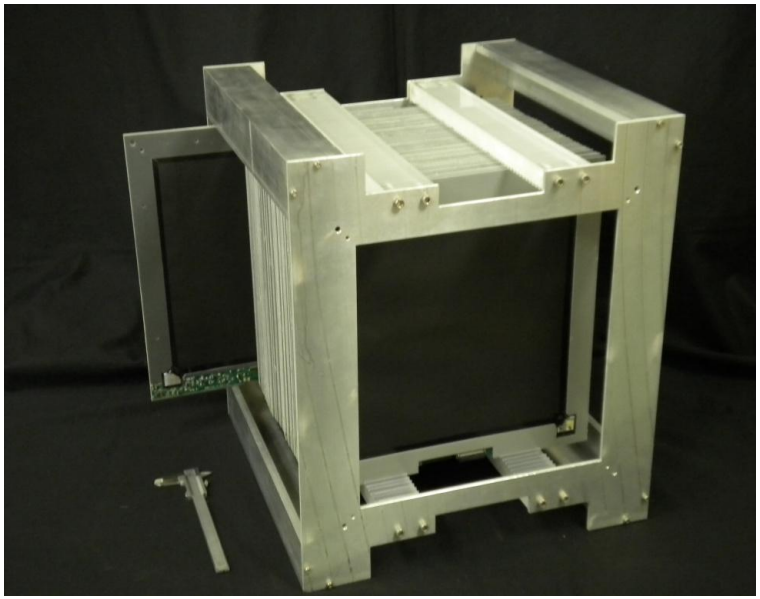
PRR30 *under construction*

Same design
Bigger dimensions
48 scintillators
Faster GEM- electronics from ≈ 10 kHz to 1 MHz

Looking forward to the PRR30



2 GEMs detector :
1 GR_DAQ prototype tested
Main DAQ -> ready for 1 GEM
DAQ –FPGA firmware ->ADC debug ongoing
12 GEMROC_FE boards /GEM
Mechanical frame ready



SCINTILLATORs:
48 assembled and tested
(SiPM readout electronic included)
mechanical frame ready
DAQ board-firmaware ready for 30 scintillators

SOFTWARE:
ongoing from PRR10 to PRR30