

HARPO: Measurement of polarised gamma rays (1.7 to 72MeV) with the HARPO TPC

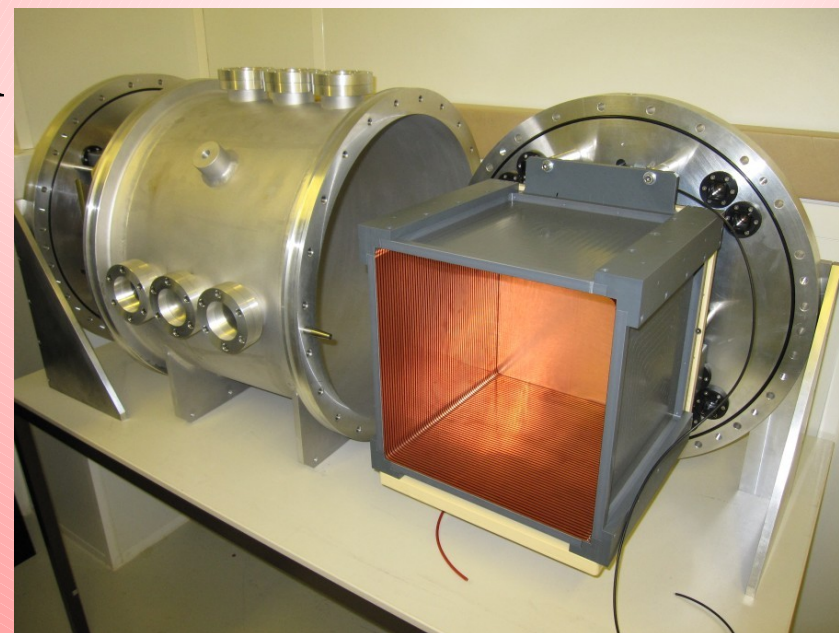
Philippe Gros
for the HARPO collaboration

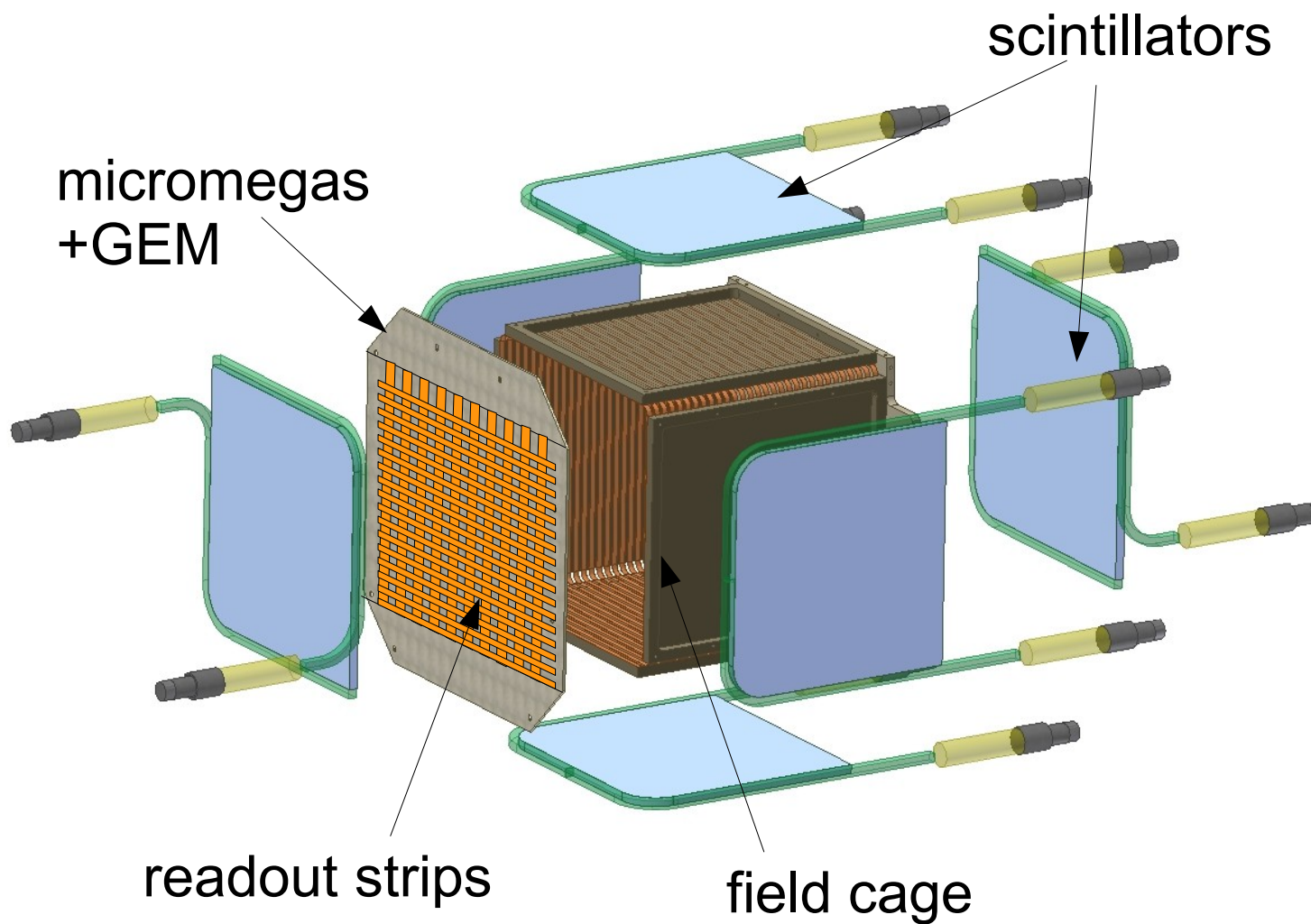


- The HARPO project
- Setup at the NewSUBARU photon beam
- Gas monitoring
- Trigger with micromegas signal
- Other experiences
- Conclusions

- TPC for measurement of polarised gamma rays
 - e^+e^- conversion (MeV~GeV)
 - Various astrophysics applications (in space)
 - Low multiple scattering => high angular resolution
 - Sensitive to linear polarisation
 - High pressure gas for higher conversion probability
- Project LLR+Irfu, funded by P2IO and ANR

- Purpose
 - Assess challenges
 - Demonstrate performance in test beam
- Realisation
 - 30cm cubic TPC
 - Ar/iC₄H₁₀ 95/5 up to 5bar
 - micromegas+2GEM amplification
 - 2x288 strips readout (x&y),
1mm pitch
 - AETEP readout electronics





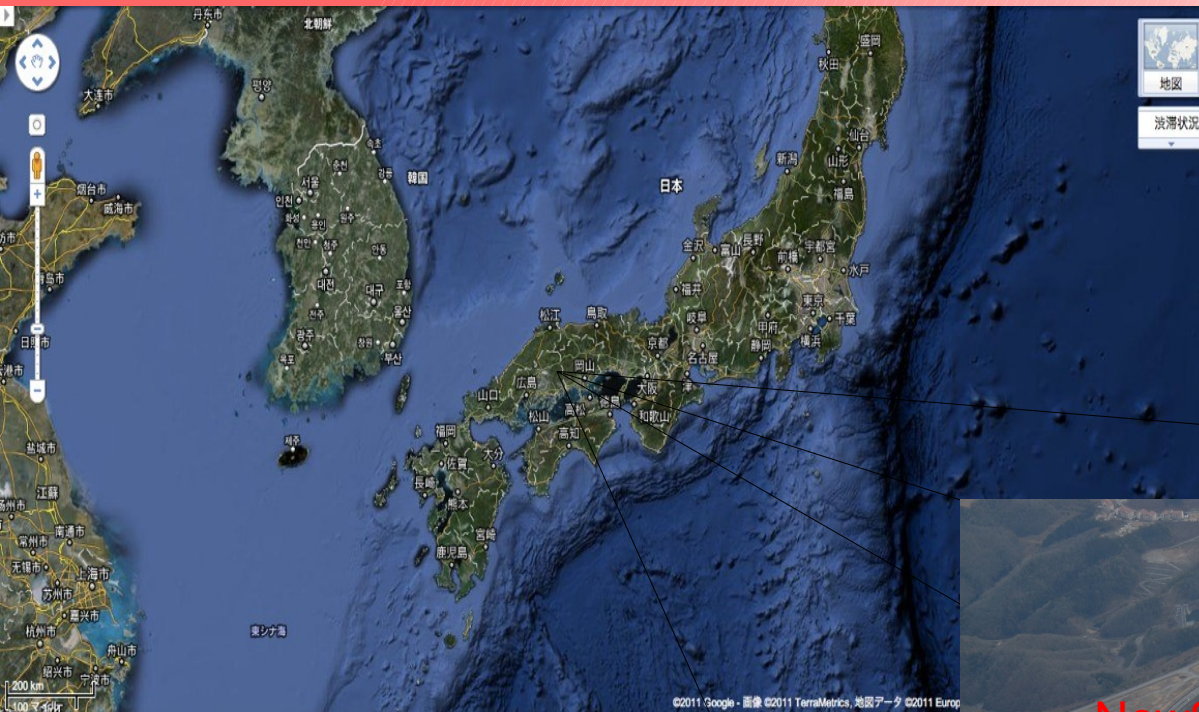
NewSUBARU photon beam



- Polarised gamma ray beam
 - Inverse Compton
 - electron beam 0.6, 1., 1.2 or 1.5 GeV
 - laser Nd (1ω or 2ω), Er or CO₂
=> polarised photons 1.71 to 72.3MeV
- Pulsed mode
 - Nd: 20kHz, Er:200kHz, CO₂: not



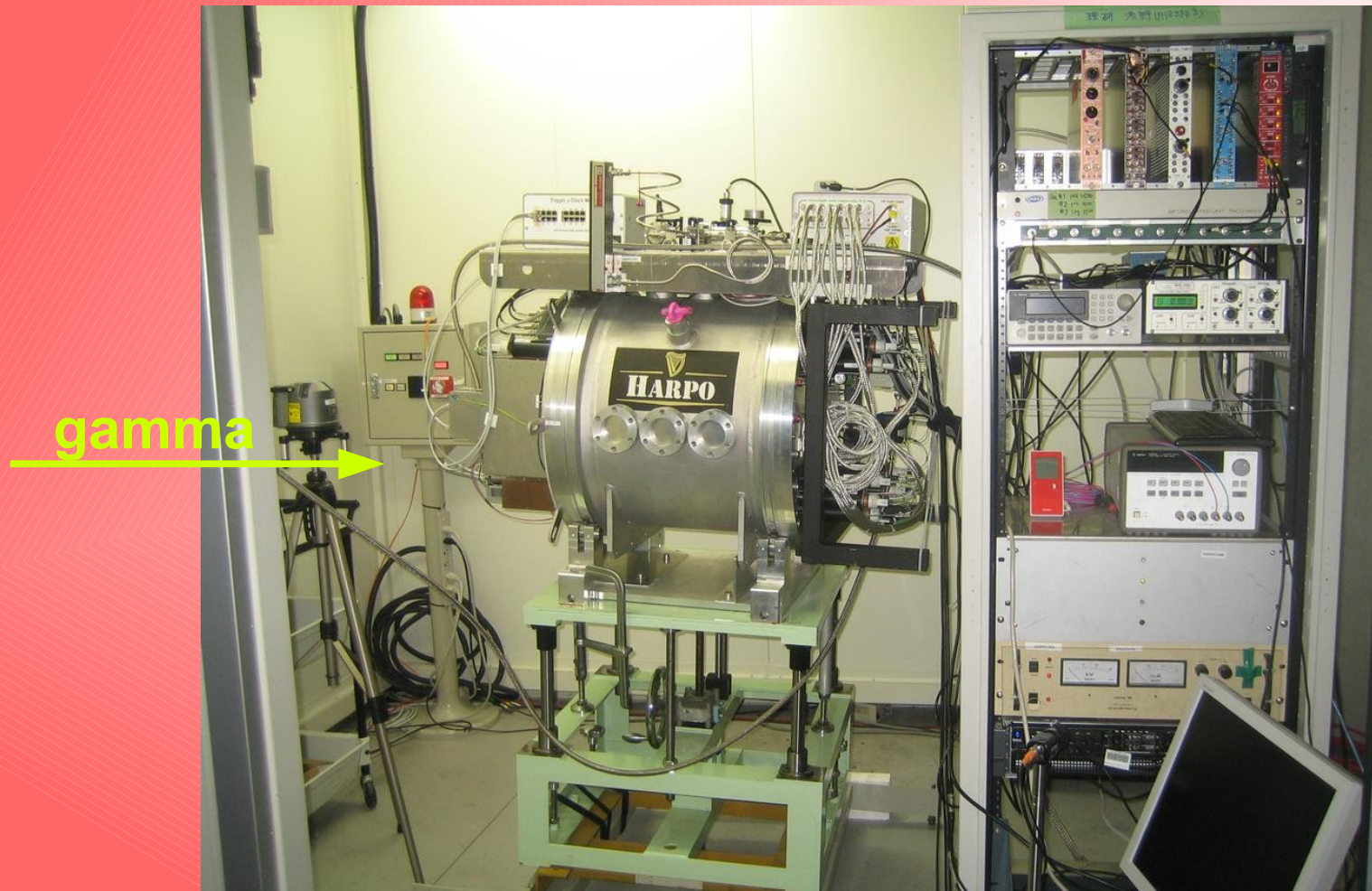
NewSUBARU

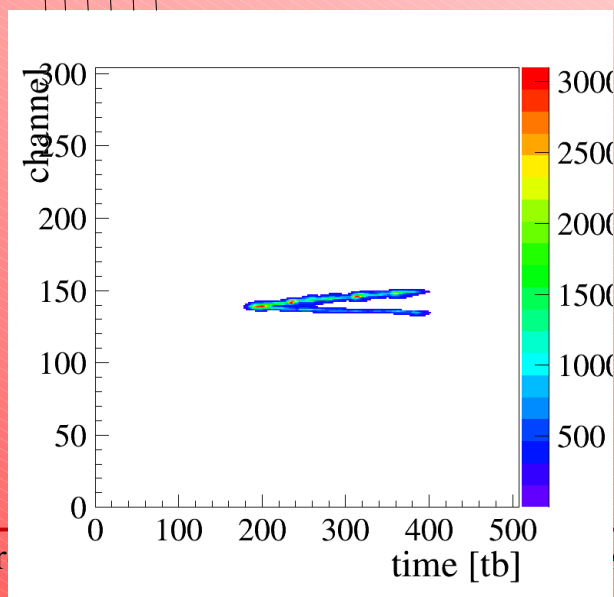
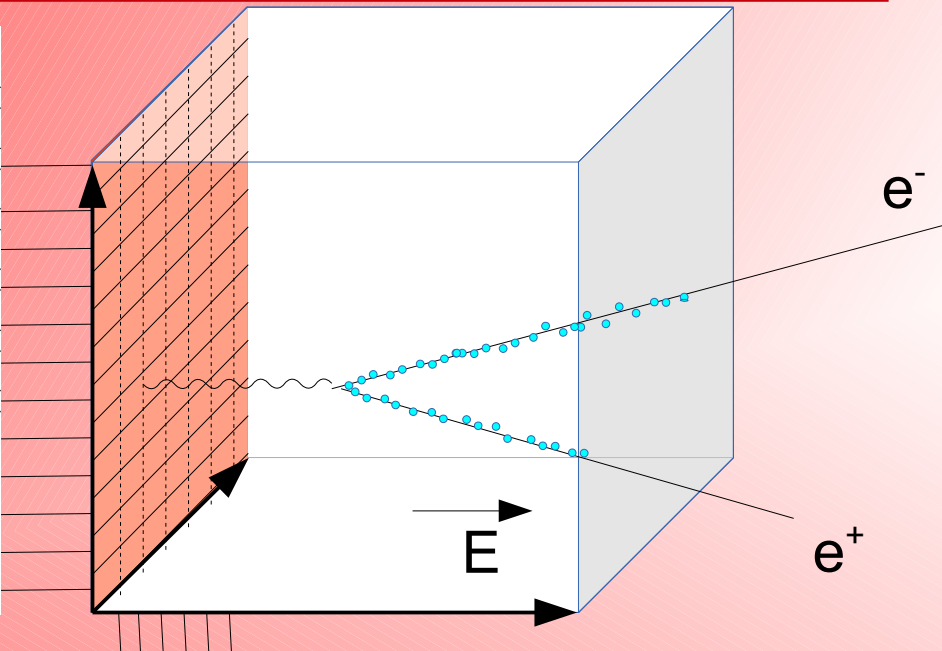
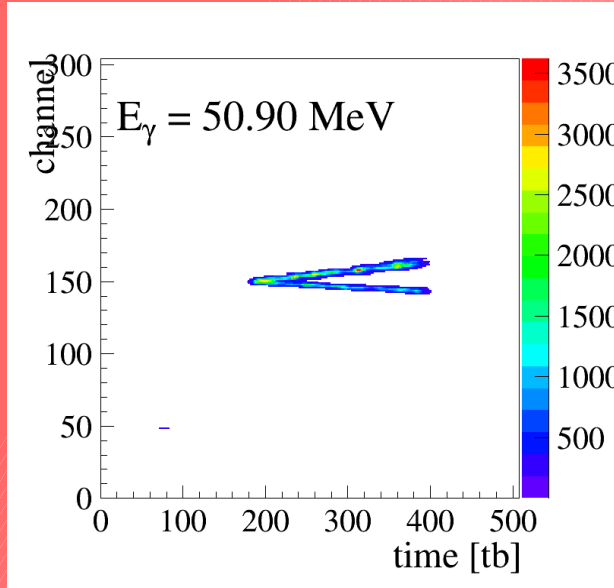


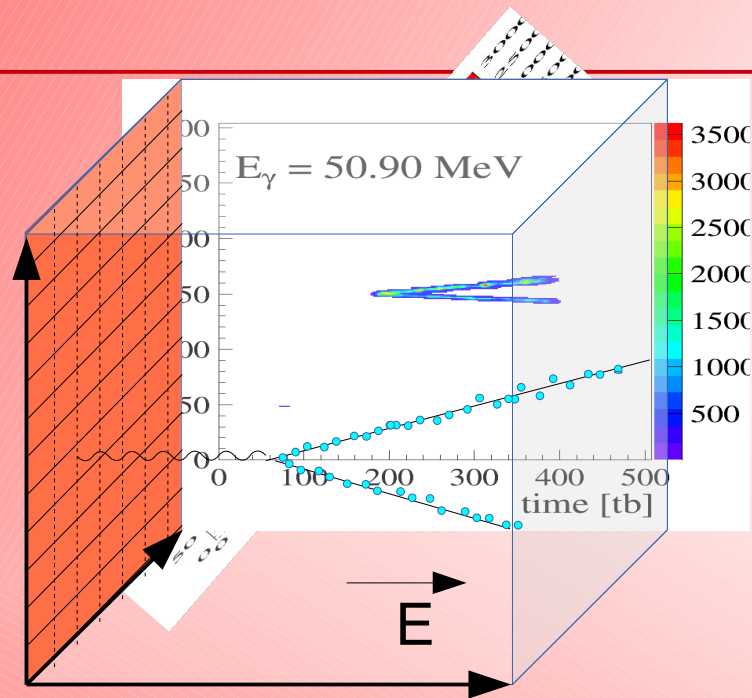
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Measurement of pol

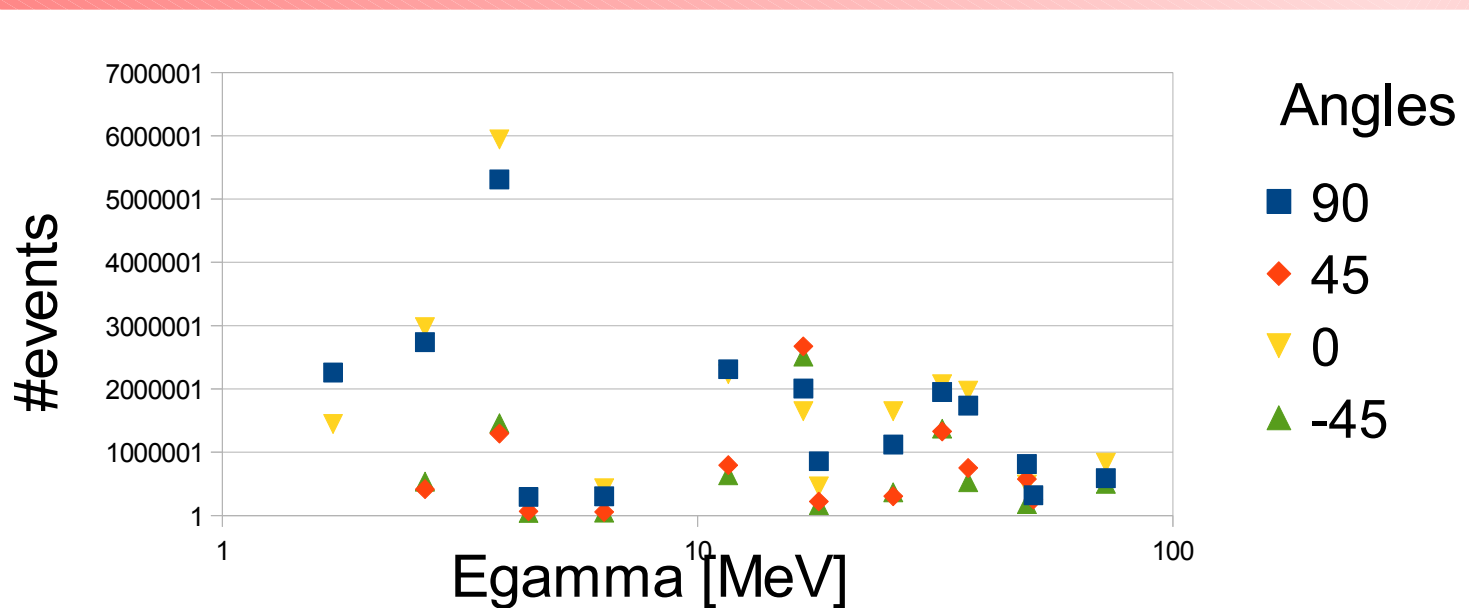
Philippe Gros, LLR







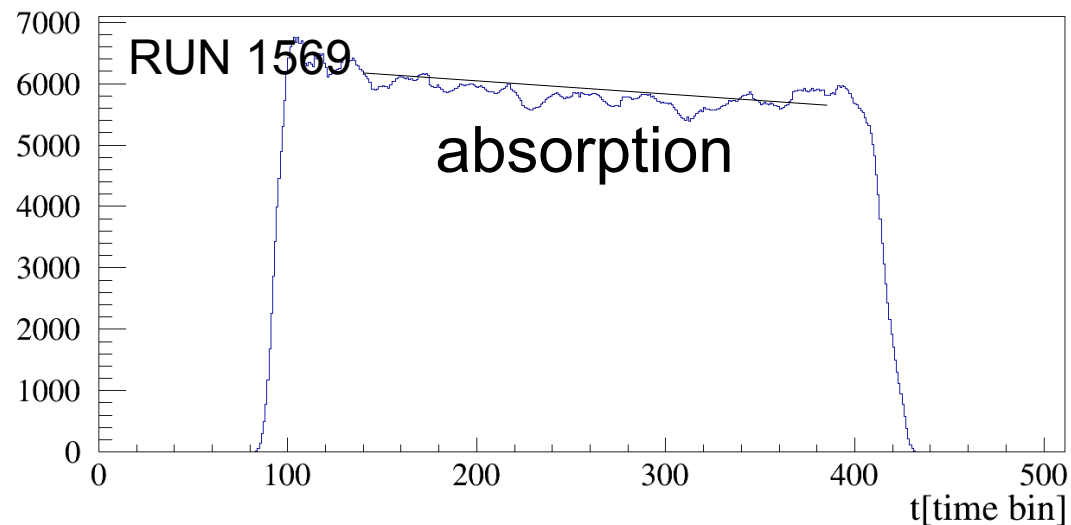
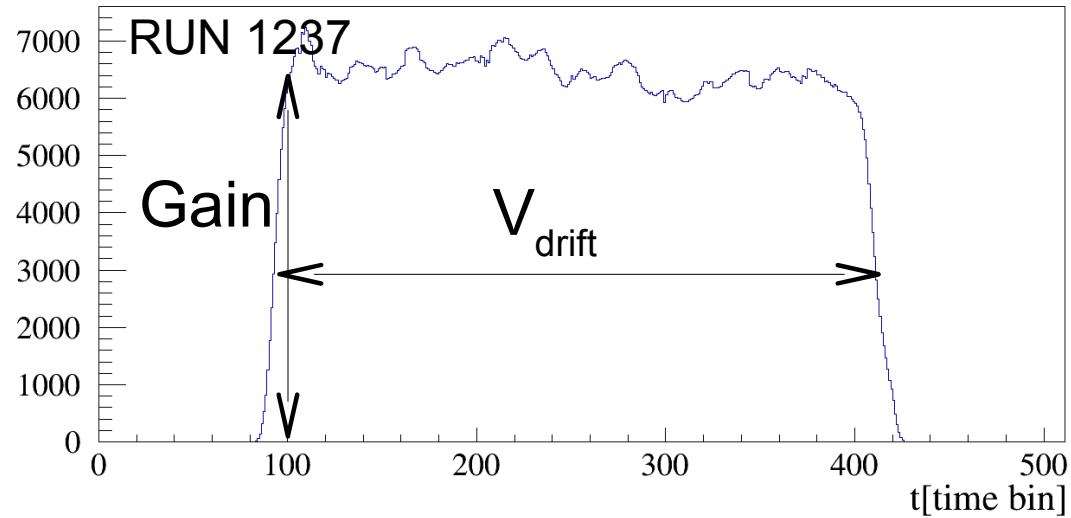
- ~20 of data taking
- 13 gamma energies, polarised or not
- 4 TPC orientation for angle systematics
- >60MeV events, >1TB of data
- probably >20% gamma converted in gas



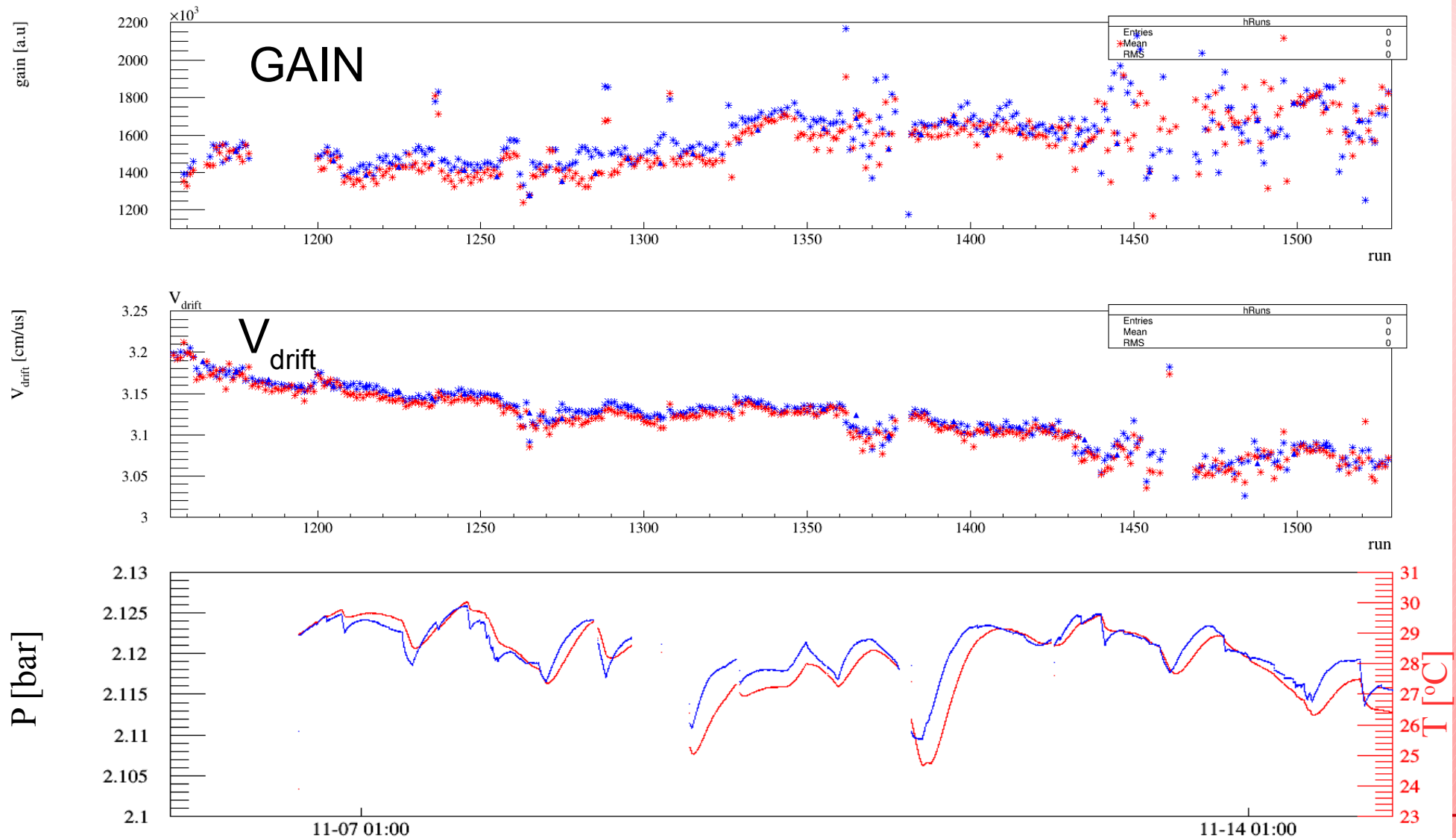
- Sealed vessel
- Leaks minimised in vacuum with He system
- Gas filling procedure
 - vacuum pumping ($<10^{-5}$ bar)
 - “rinsing” with gas mixture ~ 100 mbar
 - vacuum pumping ($\sim 10^{-7}$ bar)
 - 2 bar fill

- No direct measurement of the gas
- Monitoring with track data
 - High momentum traversing tracks in Z
 - \sim uniform energy deposition along Z (if corrected for angle)
 - Simple access to gain, drift velocity and absorption
 - Dedicated trigger line $\Rightarrow \sim 2\%$ of the events

Cosmic rays

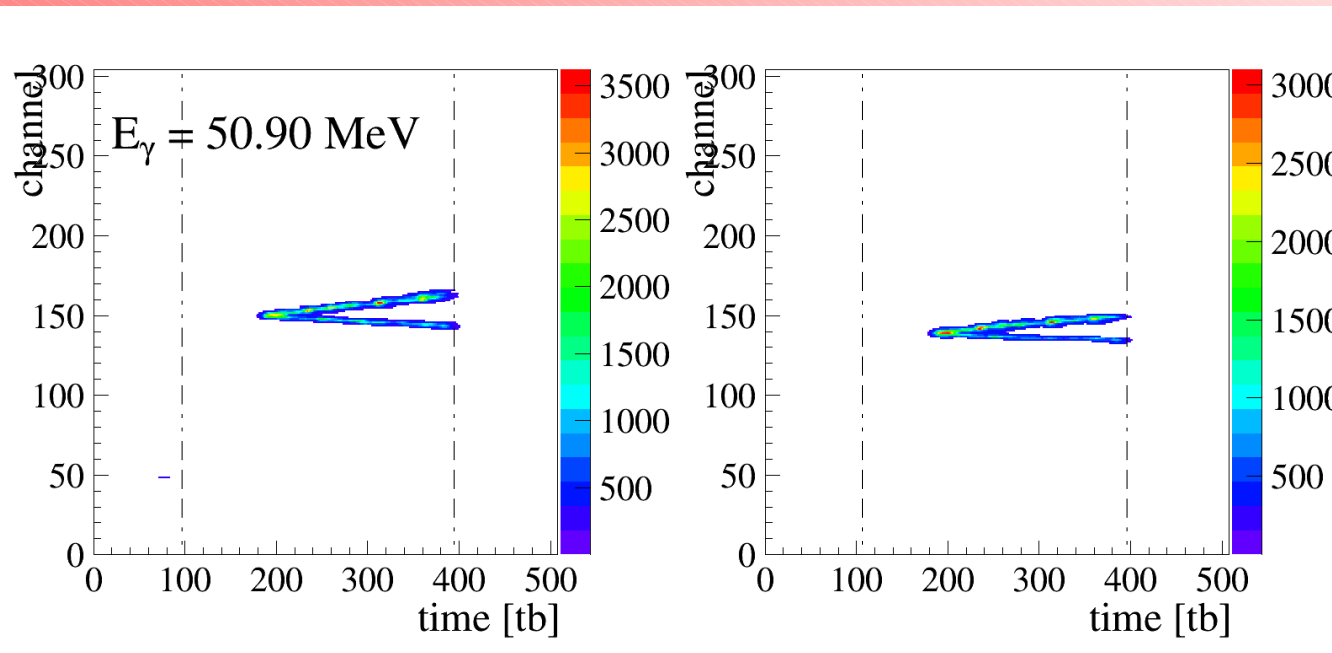


Time evolution

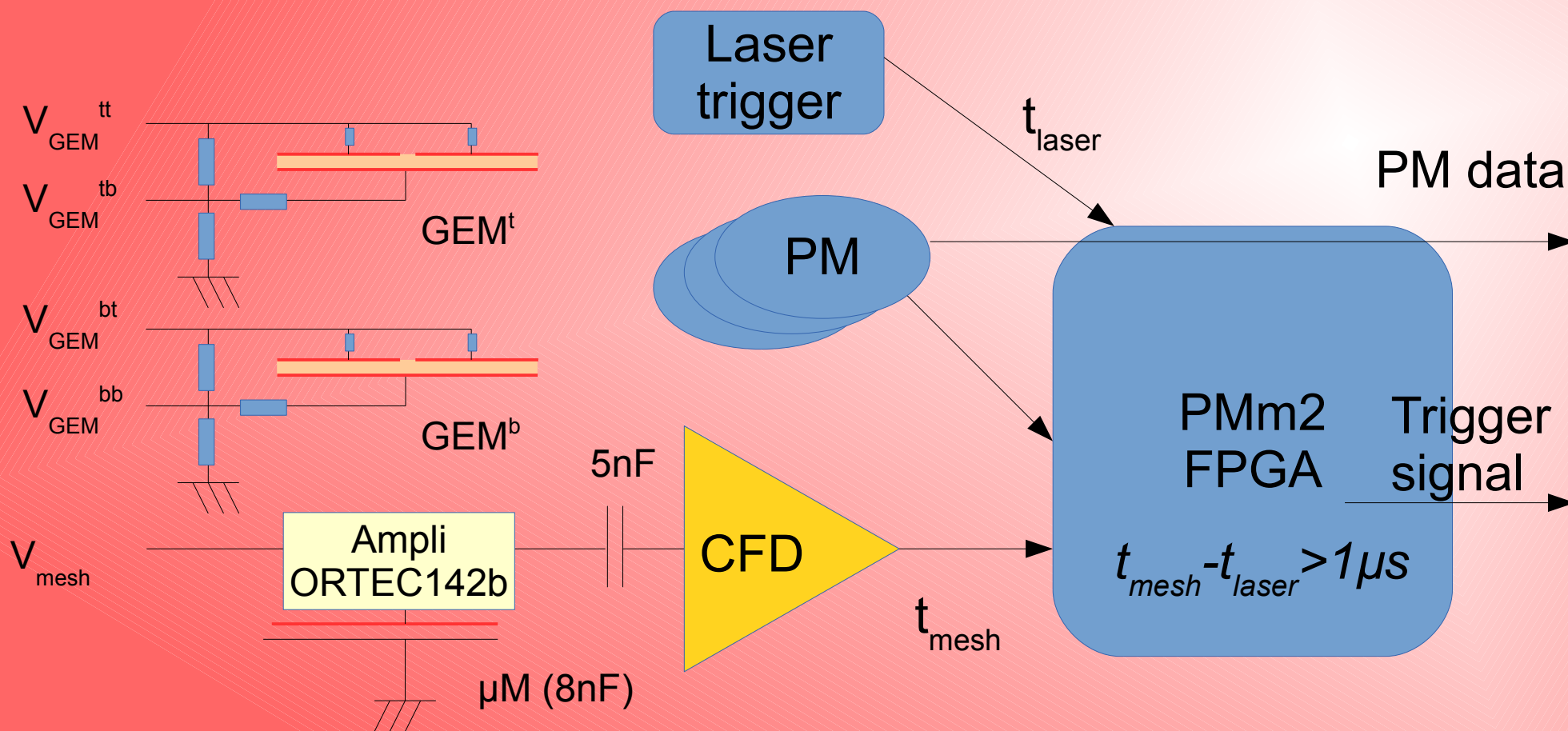


- 23 days in beam with same gas
- Almost no leak (no pressure loss)
- Slight decrease of Vdrift
- Stable gain
- Not much contamination (absorption). Longer analysis (with more statistics) necessary.

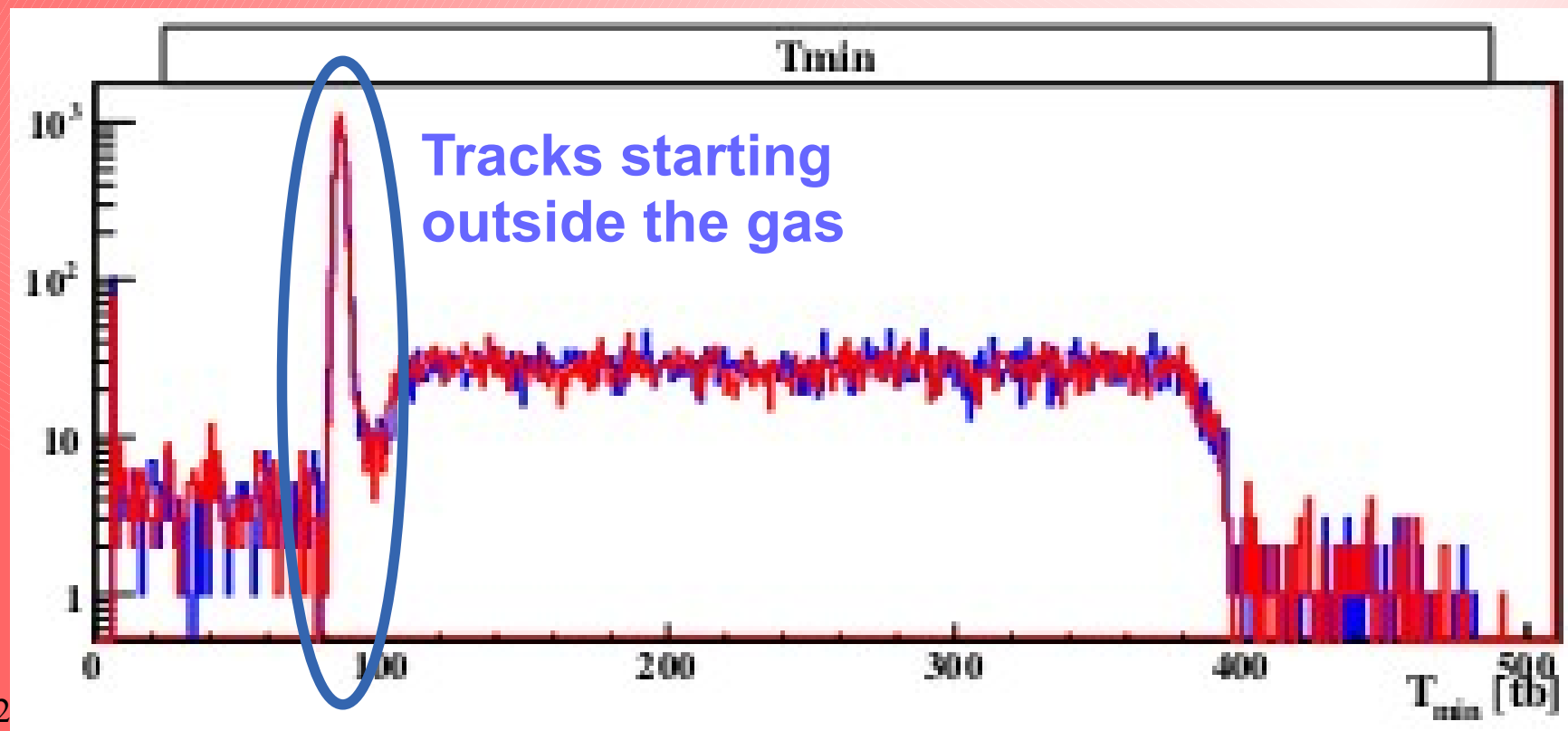
- Trigger on conversion in the gas volume
 - at least one scintillator (\Rightarrow timing + trigger information)
 - if available, laser trigger signal
 - mesh signal $> 1\mu\text{s}$ ($\rightarrow 3\text{cm}$) later



Micromegas trigger signal

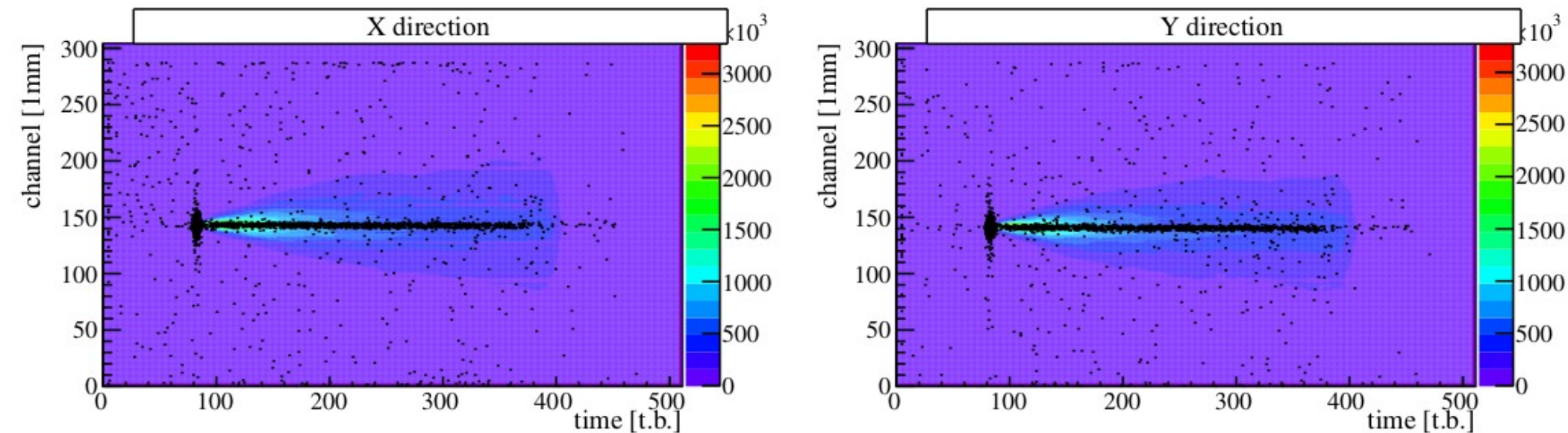


- Timing
 - With cosmic ray data
 - Confirmed in beam



- CFD threshold
 - with beam data
 - too low => many empty events (electronic noise)
 - too high => loss of good event
many traversing events

- Further analysis of course needed
- “By eye” it worked well
 - Most events originate on the beam



- One day dedicated to pressure scan
 - “Clean” gas at 1, 1.5, 2, 3 and 4 bar
 - Signal amplitude ($dE/dx \times \text{gain}$) ~fixed (Adjusted on the fly)
 - At high pressure, cathode voltage was limited
- Good running condition at all pressures
- Increasing micromegas current spikes at high pressure
 - matching GEM over current => physics?

- Observed signal loss at the center of the detector (beam axis)
 - Only at high rate
 - space charge? ballistic deficit? other?
- “Ballistic deficit”
 - shaping 116ns
 - tracks in Z direction => several μ s signals
- Improved by misaligning the detector



- Successful beam campaign with gamma rays
- Good gas stability over more than 20 days
- Good trigger performance
- Most issues related to high rate in beam
- Lots of work necessary for quantitative results...

