THGEM for DHCAL

Status report

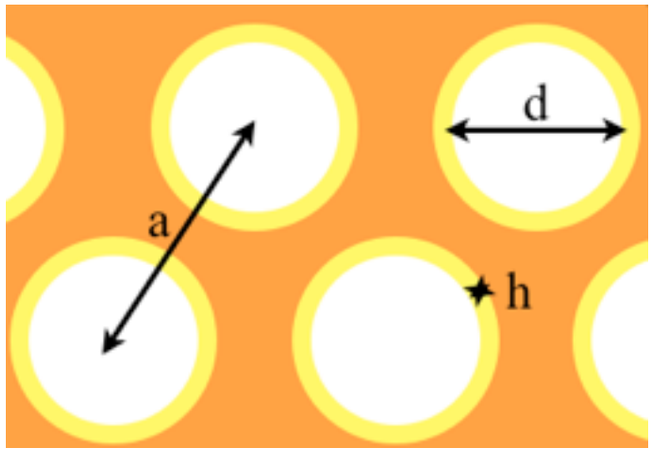
S. Bressler for WIS Aveiro and Coimbra

Outline

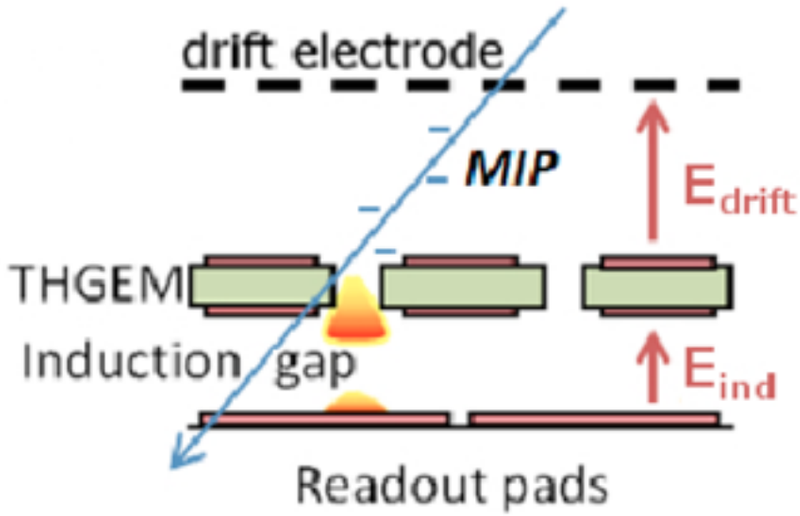
- THGEM: a quick reminder
  - THGEM structures
  - Rate limitations
- Progress since last year
- Future plans

THGEM: a quick reminder

- THick GEM (THGEM) is a 10 folded expanded GEM
  - Typical parameters: a ~ 1 mm, d ~ 0.5 mm, h ~ 0.1 mm
- Main advantages
  - Simple
  - Economic
  - Robust
  - It can be industrially produced over large area using standard PCB technologies

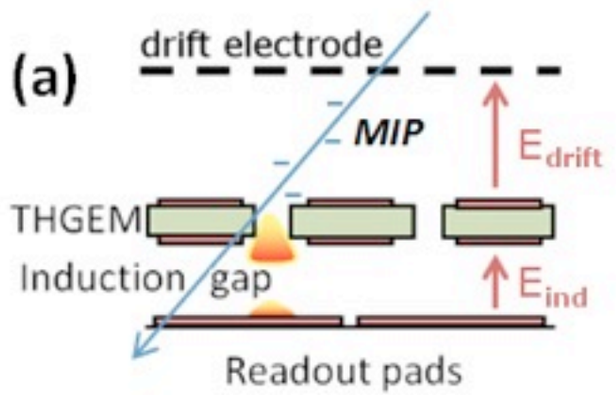


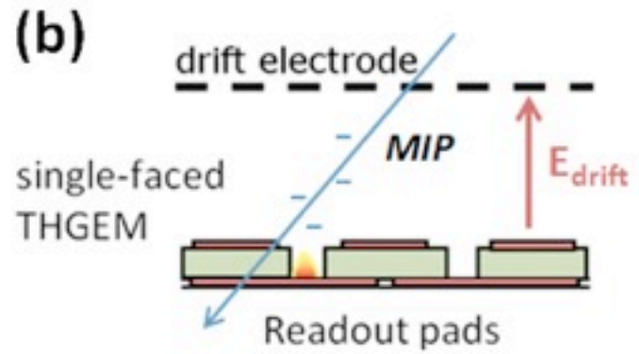
- Growing interest and experience with large scale detectors
  - COMPASS-RICH upgrade
  - ALICE-RICH upgrade

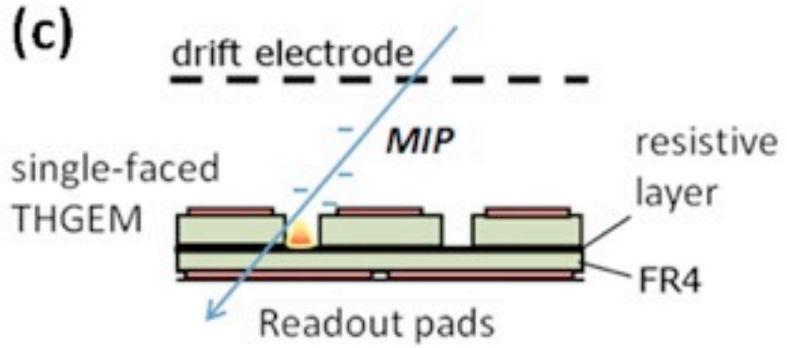


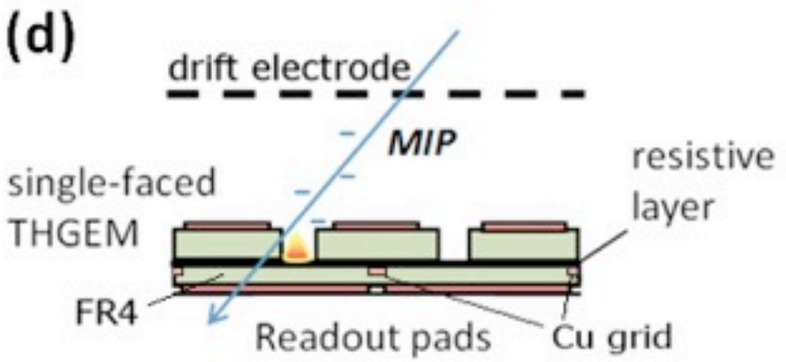
THGEM structures

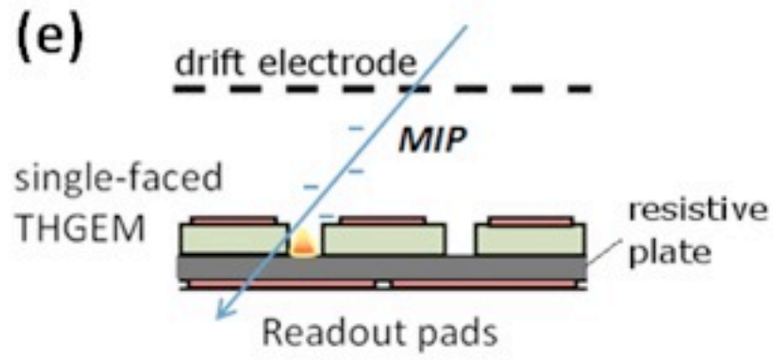
- Double sided - with induction gap
  - With or without gas multiplication in the induction gap
- Single-sided - WELL
  - Resistive layer
  - Resistive plate











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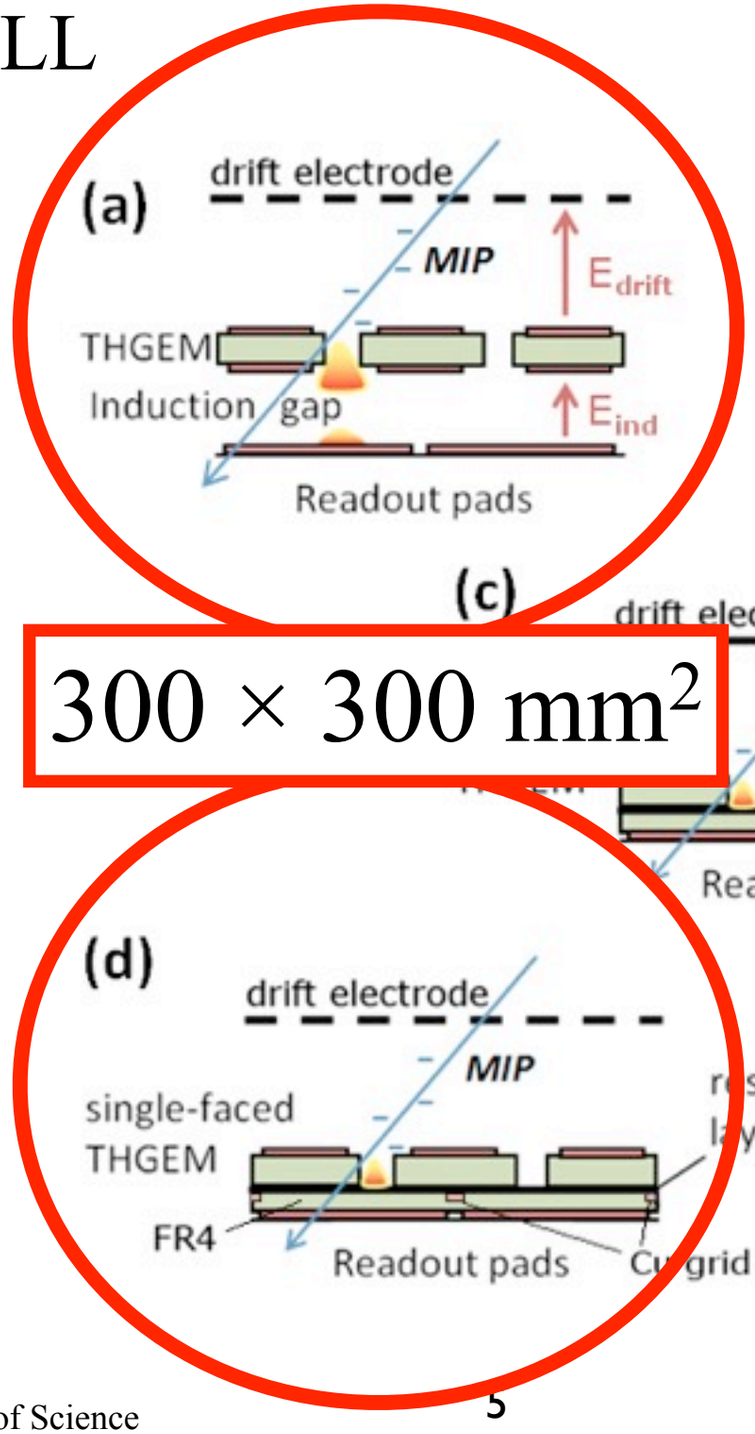
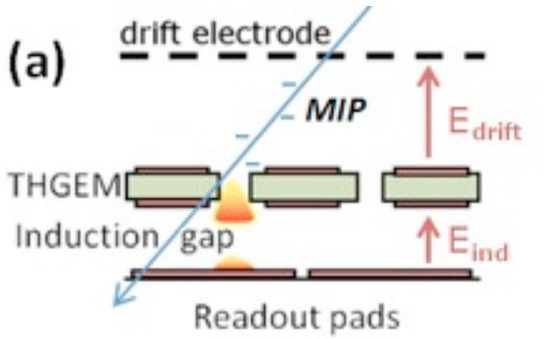
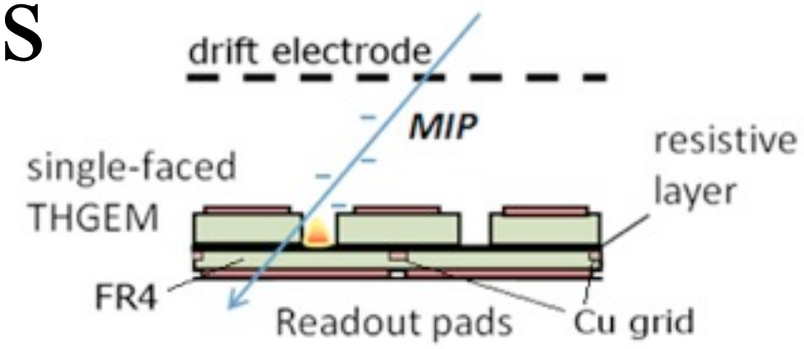


$300 \times 300\ mm^2$

R&D small protos

THGEM structures



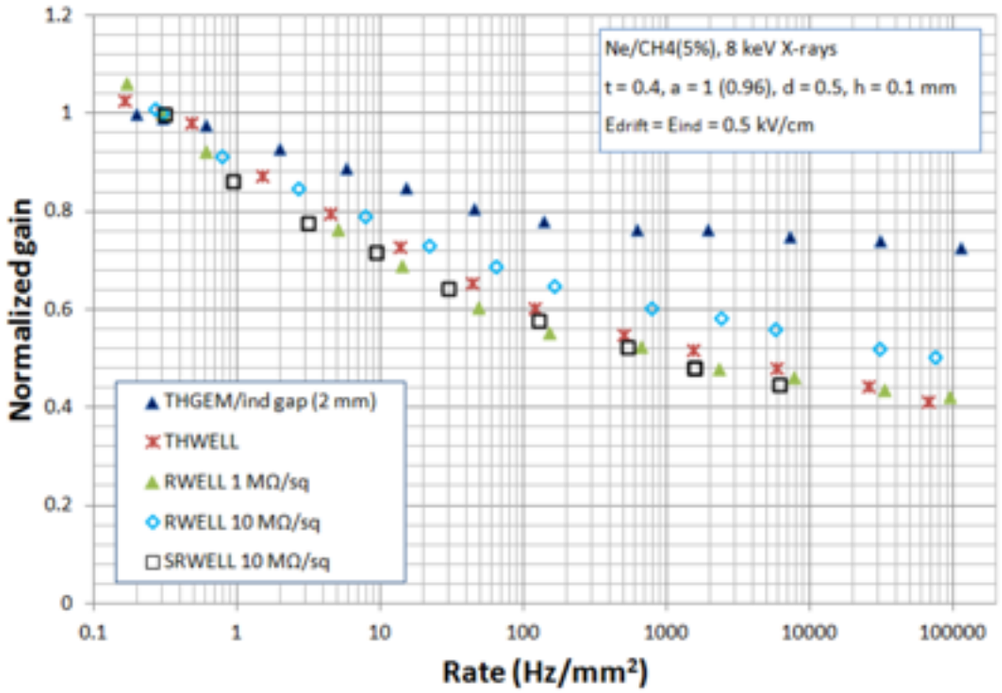


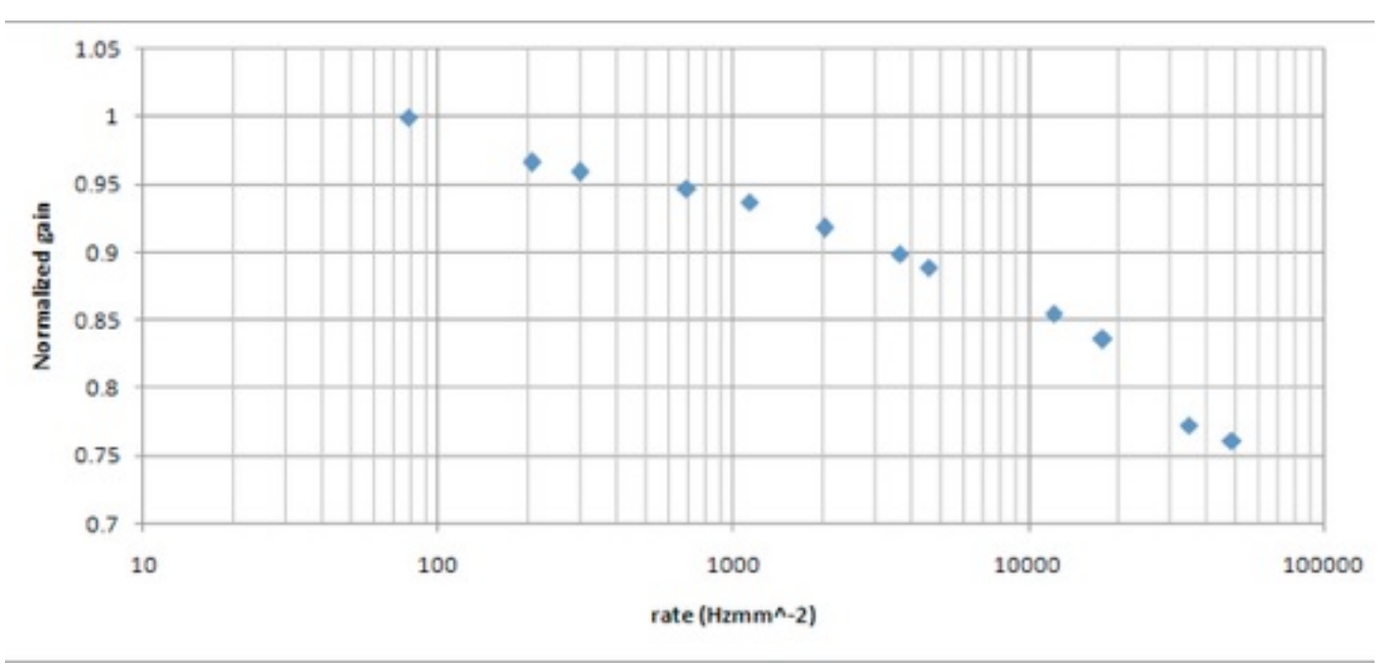
- Wide dynamic range when operated with multiplication in the induction gap

- Successful operation in muon beam
- Gain drop in pion beam - not reproduced at the lab

Rate limitations

- We measure the gain at rates in the range **10^{-1} - 10^{5} Hz/mm^2**
  - Double sided THGEM: total of 20 % gain drop
  - WELL with resistive layer: up to 40 % gain drop
    - Surface resistivity: 10 MΩ/square
  - WELL with resistive plate: ~25% gain drop
    - Bulk resistivity: 10^9 Ω.cm





Future plans - Towards 1 m^2 prototype

- Start with 300x300 mm^2 detector
  - Chamber, electrodes and a corresponding SRS anode should be ready soon
  - Solve technical difficulties
    - Maintain constant gaps and fields
    - Optimize segmentation to reduce the capacitance
    - ..
  - Repeat characterizations studies
    - Gain stability
    - Gain Vs. rate
    - Response to HIPs
    - ...
- Consider resuming to the use of Argon based mixtures
  - More primaries
- Studies in Israel and Portugal in parallel
- Test beams are foreseen (PSI / CERN / ?)

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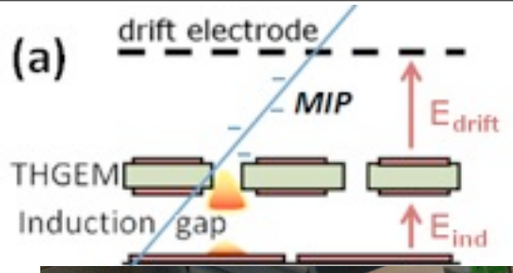
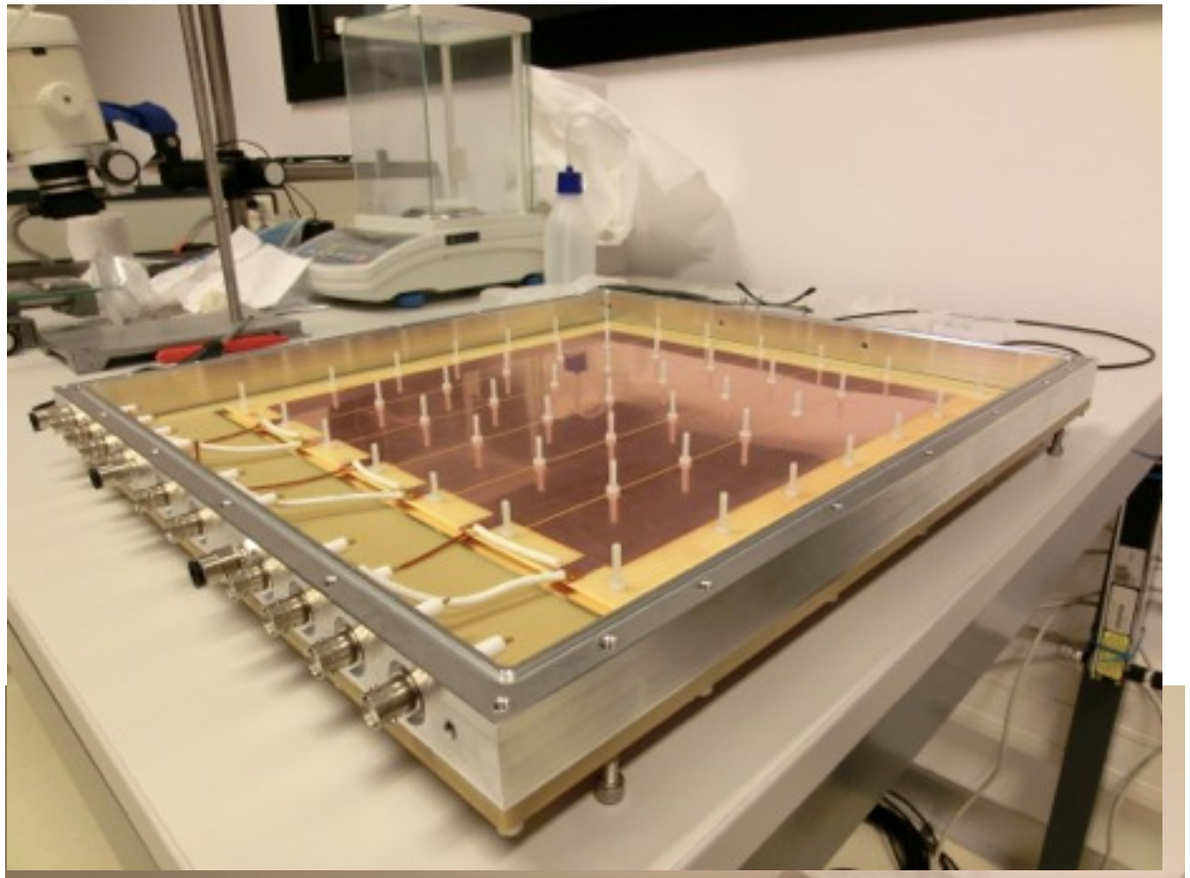
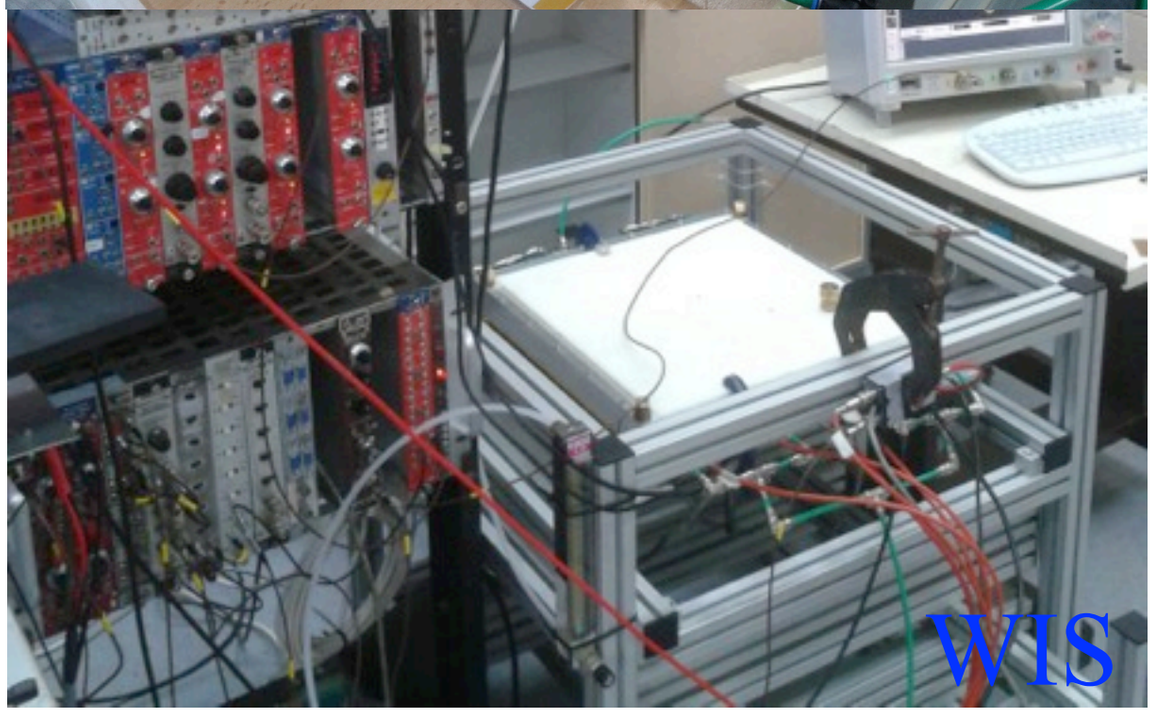
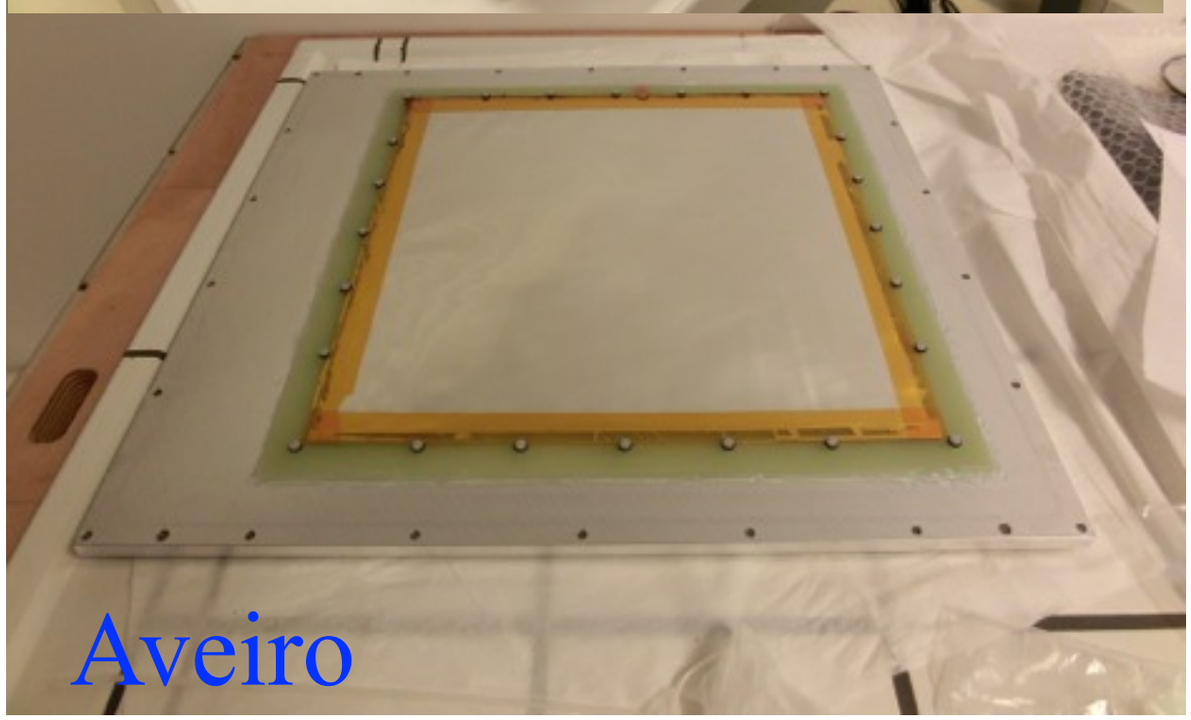
300×300 mm^2 protos



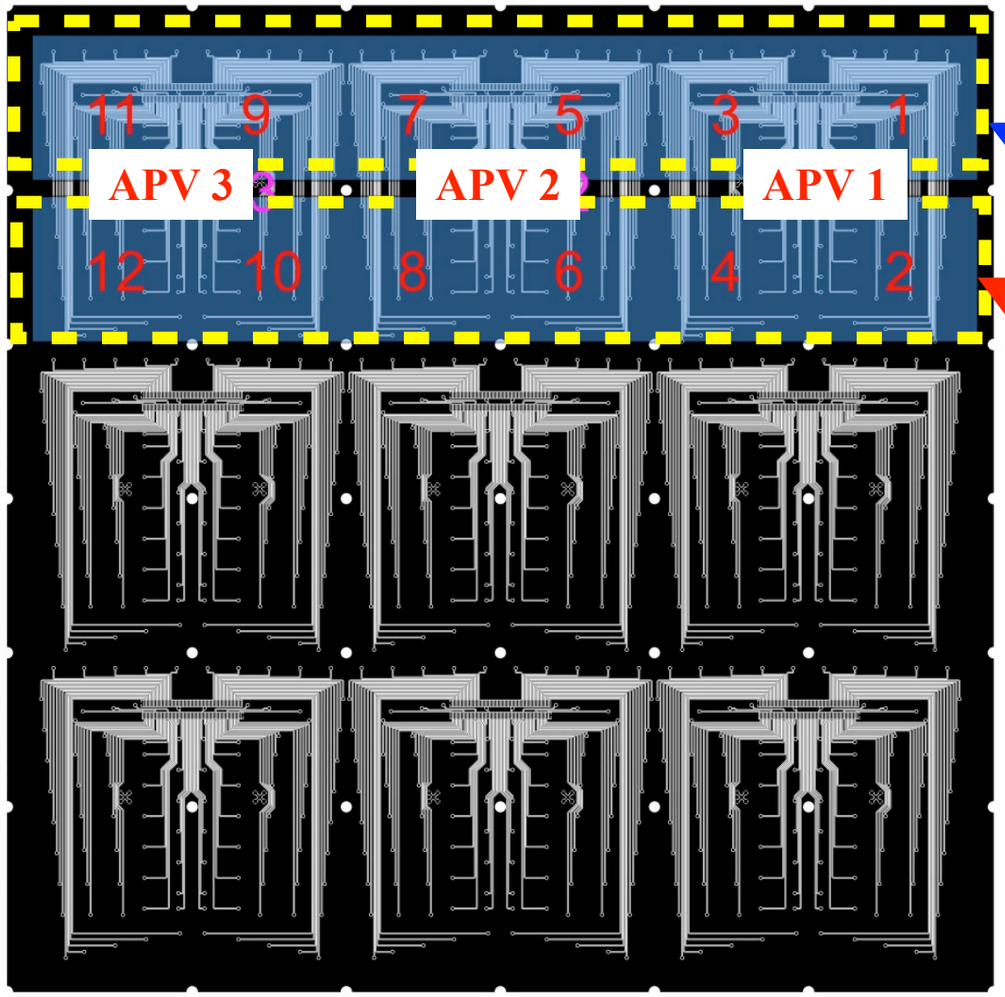


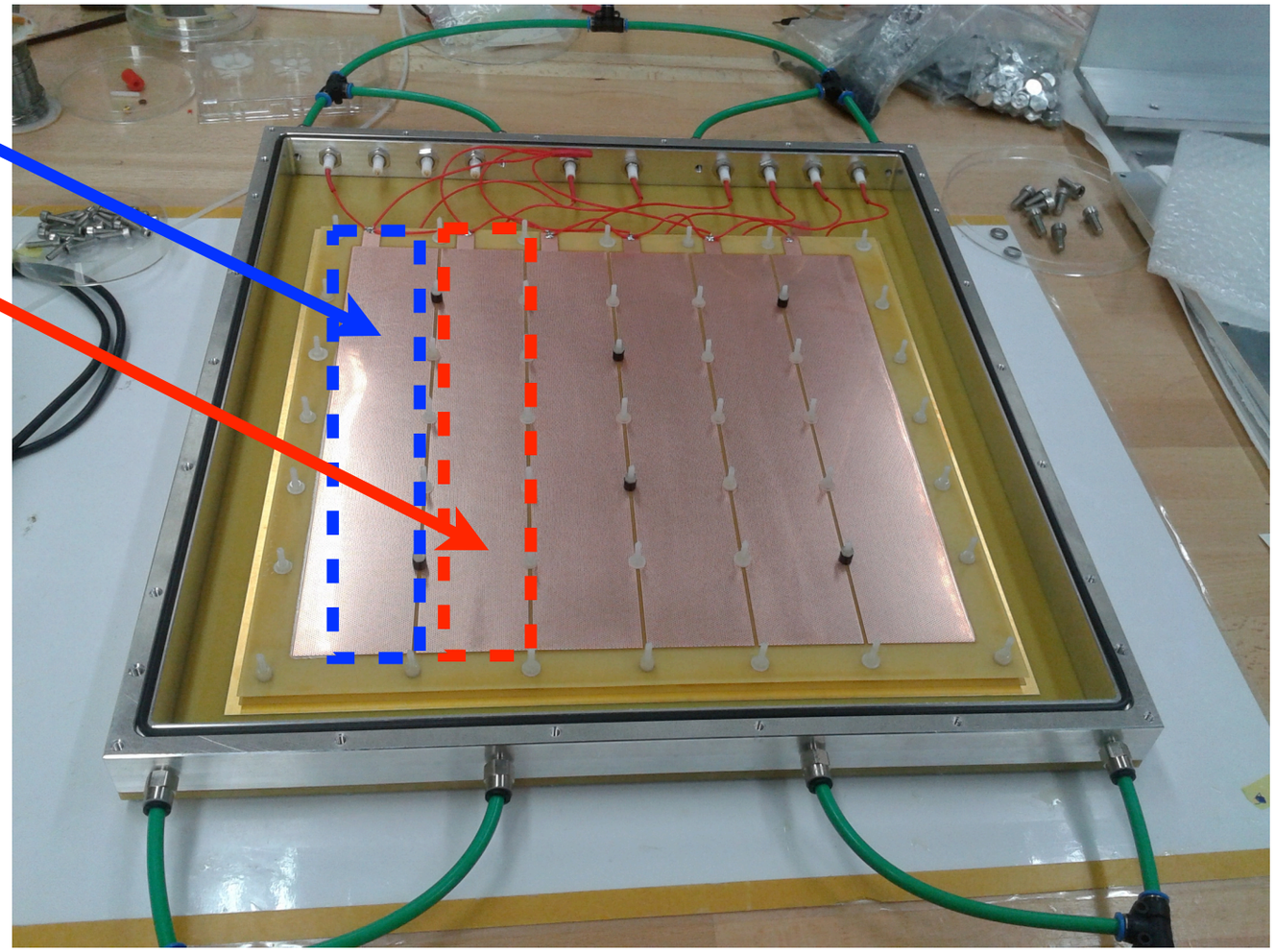




300×300 mm^2 protos

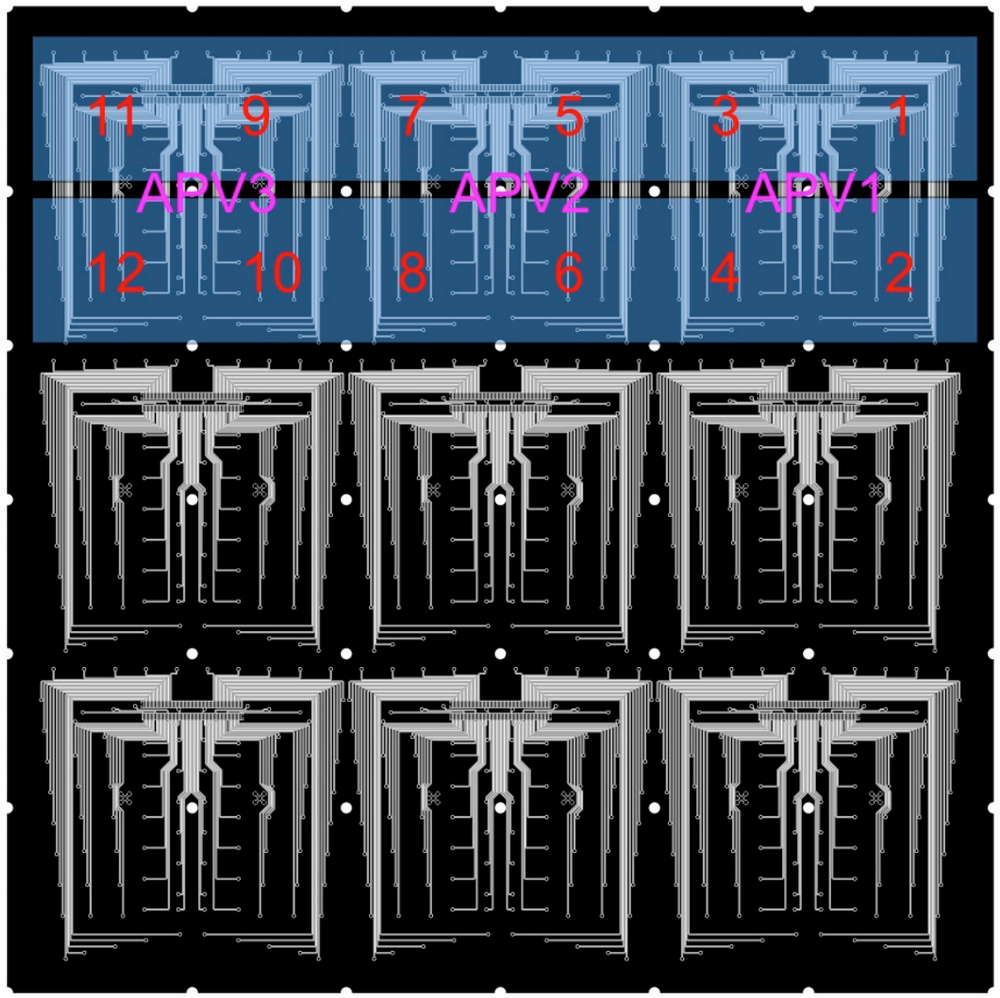
- ^{55}Fe spectra

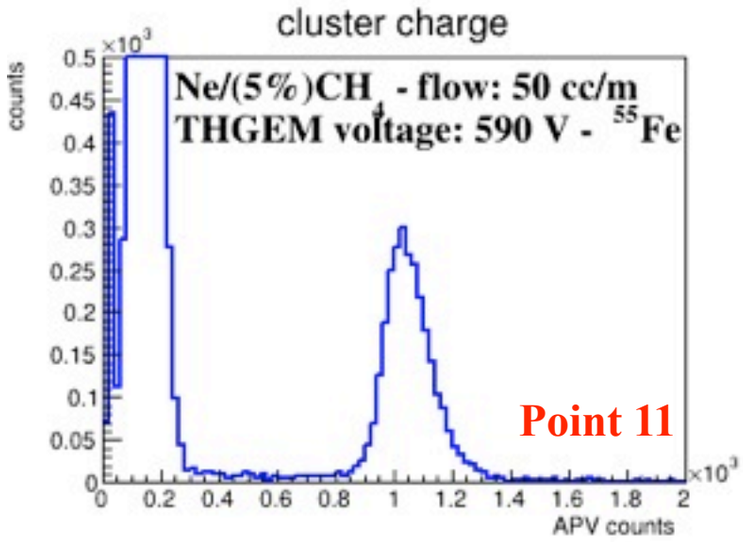


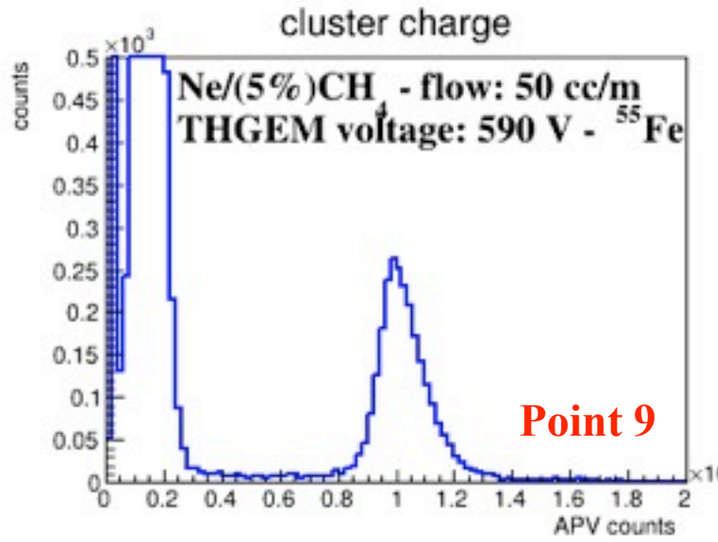


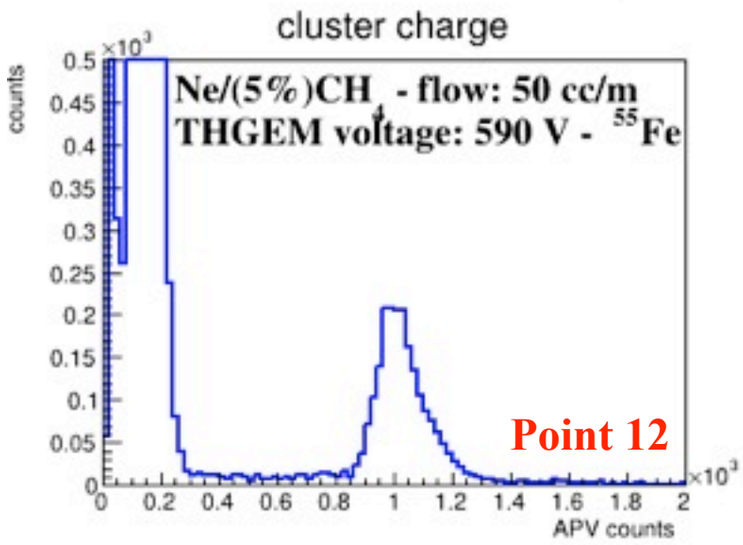
300×300 mm^2 protos - uniformity

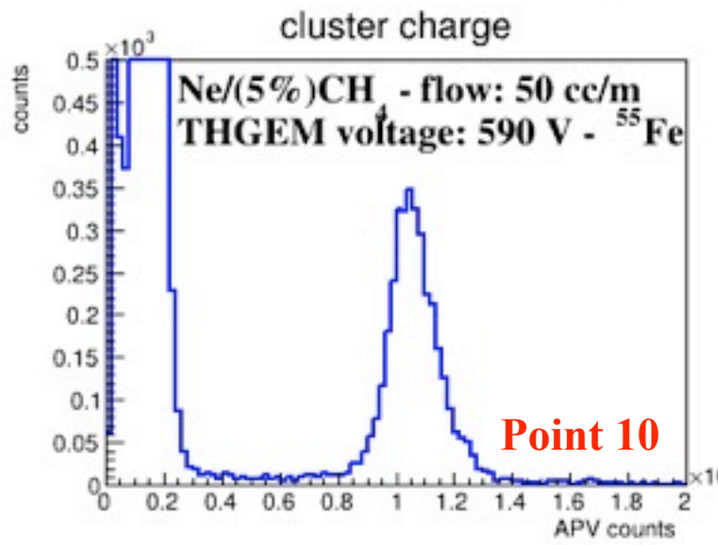
- ^{55}Fe spectra



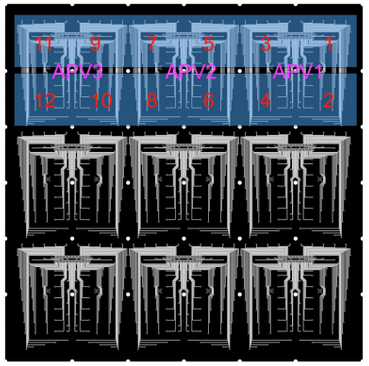








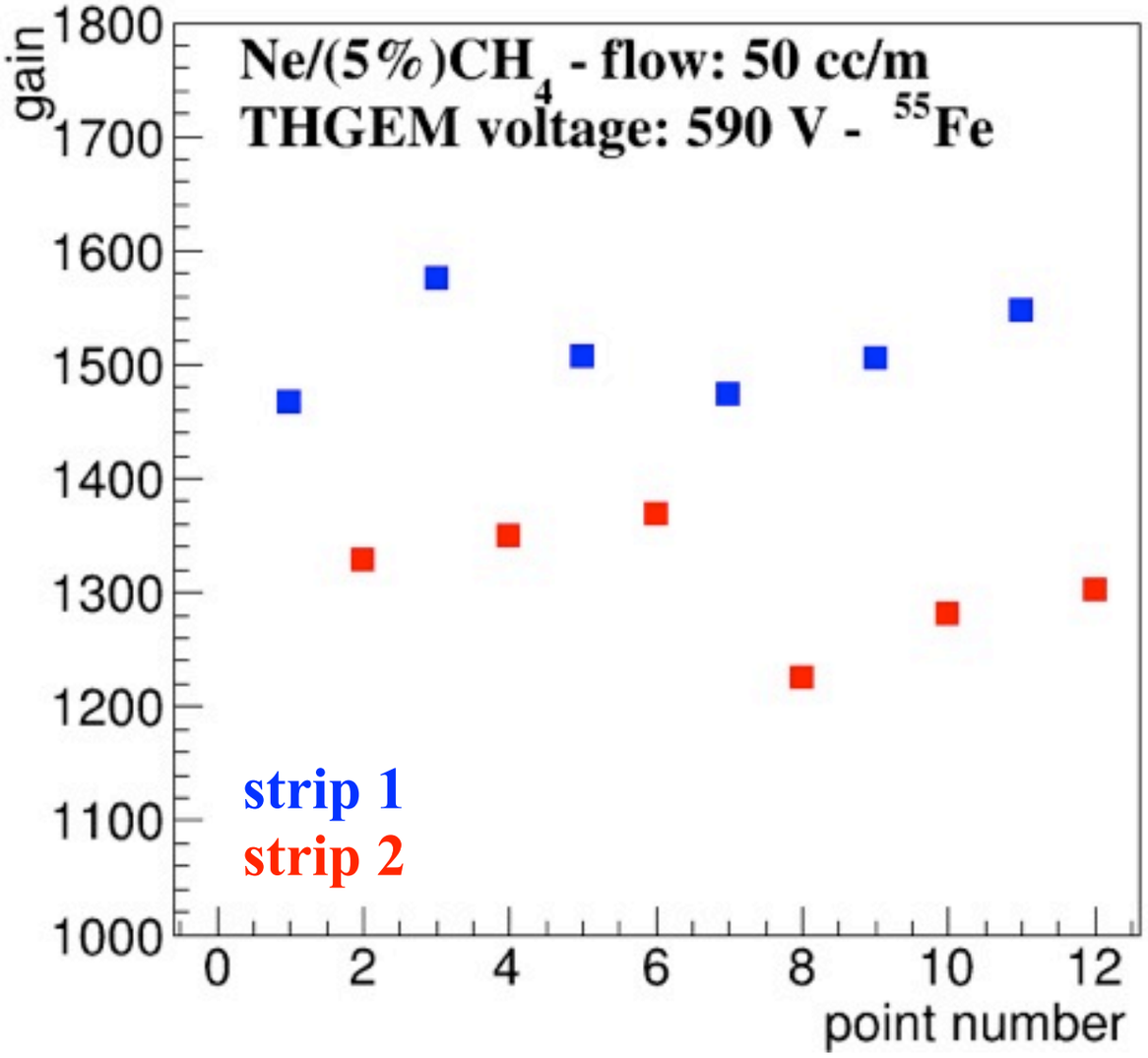
300×300 mm^2 protos - uniformity



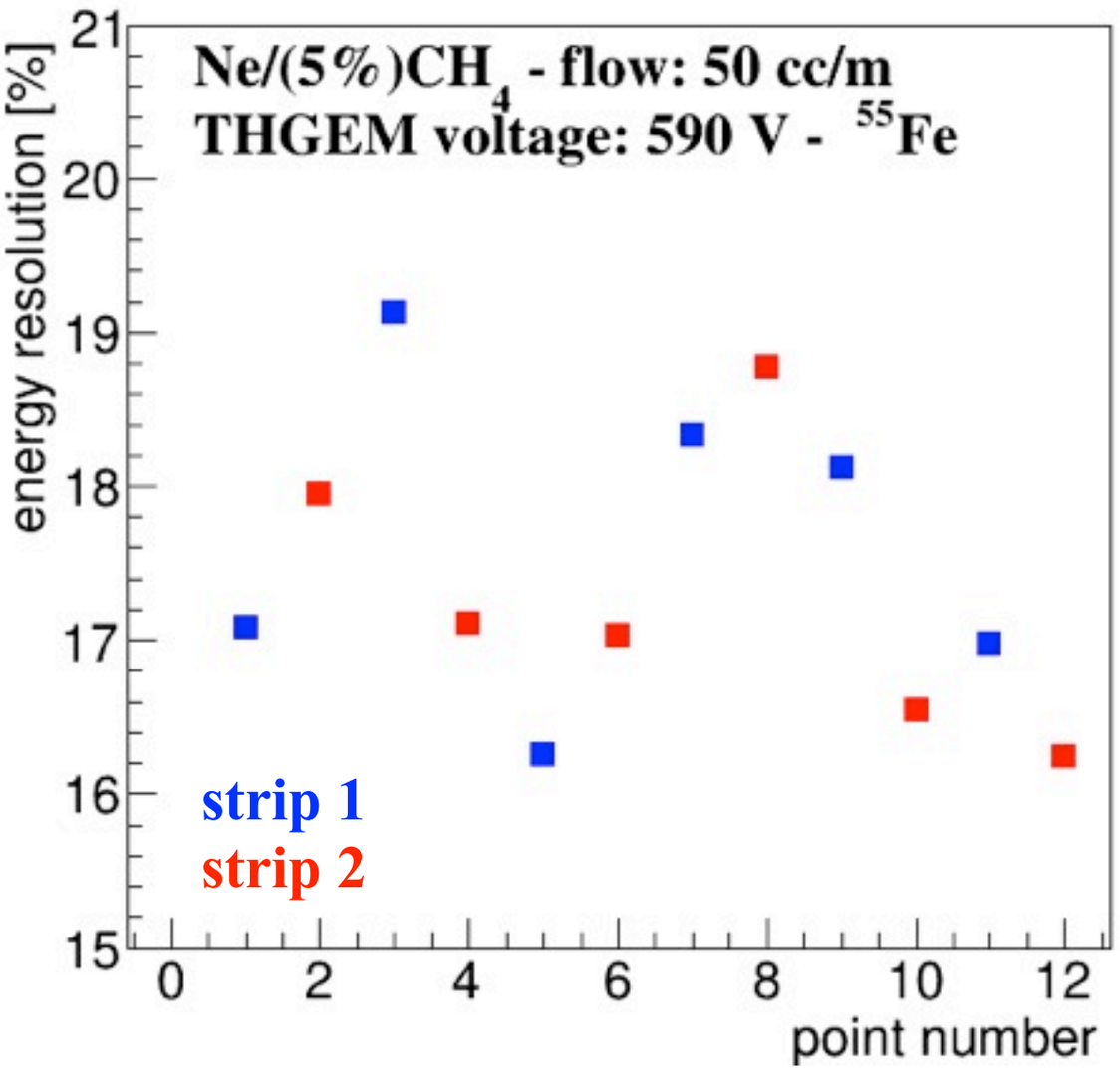
- ~10% gain variations
- ~10% energy resolution variations

- Small gain difference between the two strips - to be understood and resolved

gain

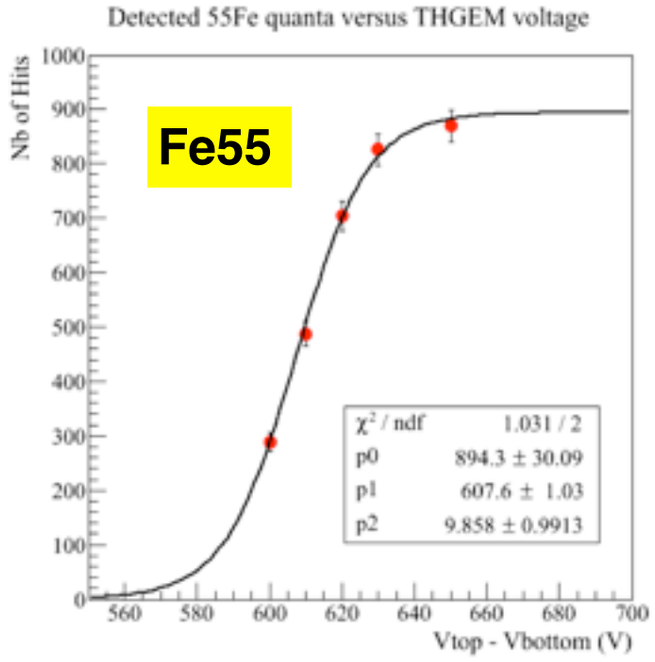


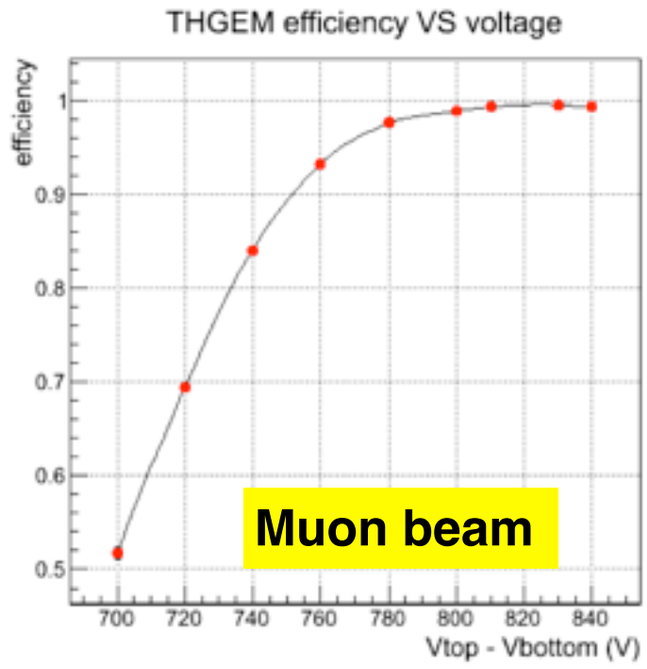
energy resolution

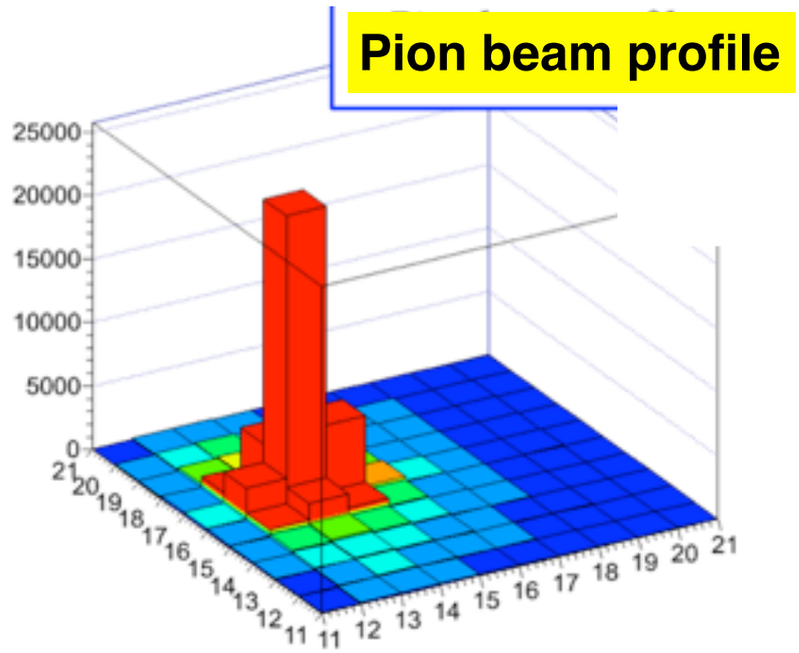


THGEM / MICROROC - Old results

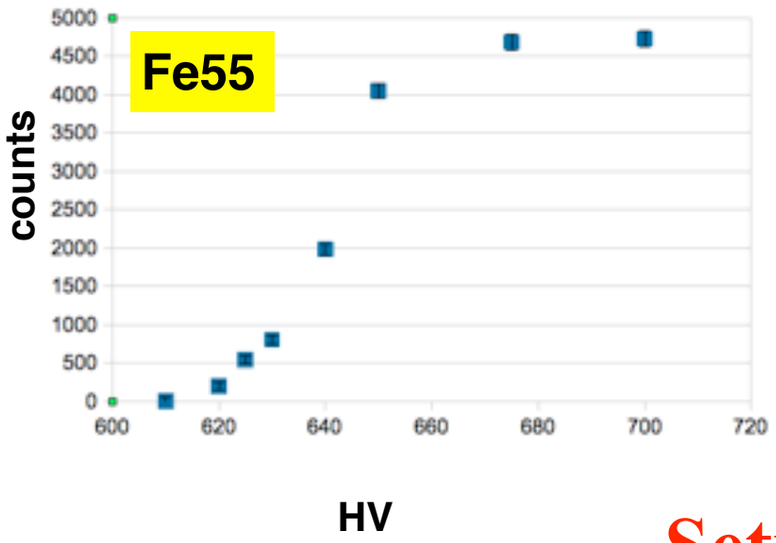
- Standard THGEM: performance similar to MM







- WELL THGEM:



- The THGEM was operated in 150 GeV pion shower behind a 2λ Fe block in a very stable way
- THGEM chamber could be included in the DAQ of the 4 1x1 m^2 during the RD51 test beam

Setup assembled in WIS lab - study to be resumed

Future plans - Towards 1 m^2 prototype

- 300 × 300 mm^2 detectors - SRS readout (analog)
  - Optimize: segmentation, gap, HV configuration, resistive layer...
  - Characterize: uniformity (gain, energy resolution), proportionality
  - Test in beam
- THGEM/MICROROC
  - Study to operate
  - Optimize
  - Test in beam

- R&D on small protos
  - Long term operation: understand apparent gain variations
  - New resistive concepts
  - Resistive plate WELL with lower bulk resistivity