GEM trackers for Super-Bigbite

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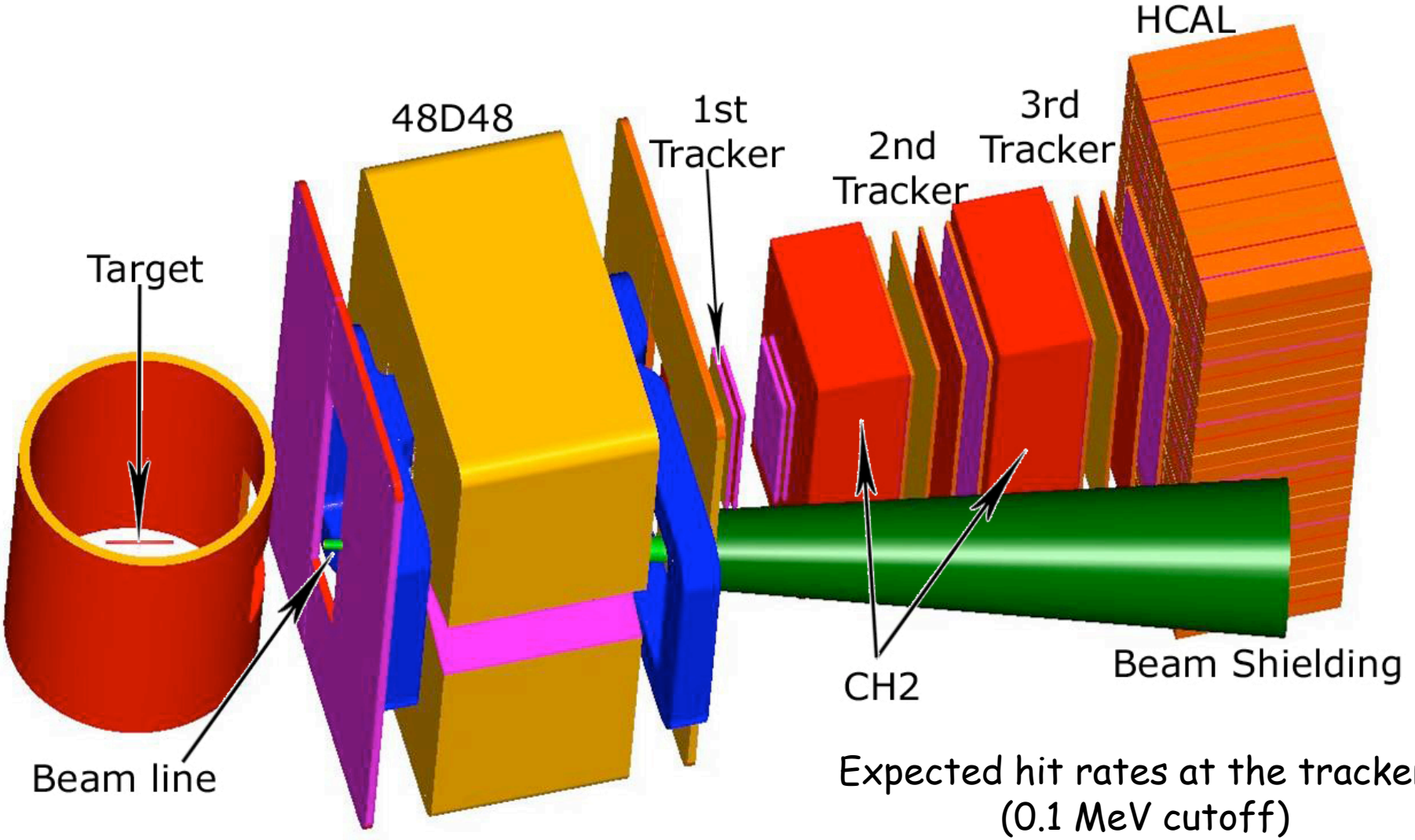
GEM trackers for Super-Bigbite



Expected hit rates at the trackers (0.1 MeV cutoff)

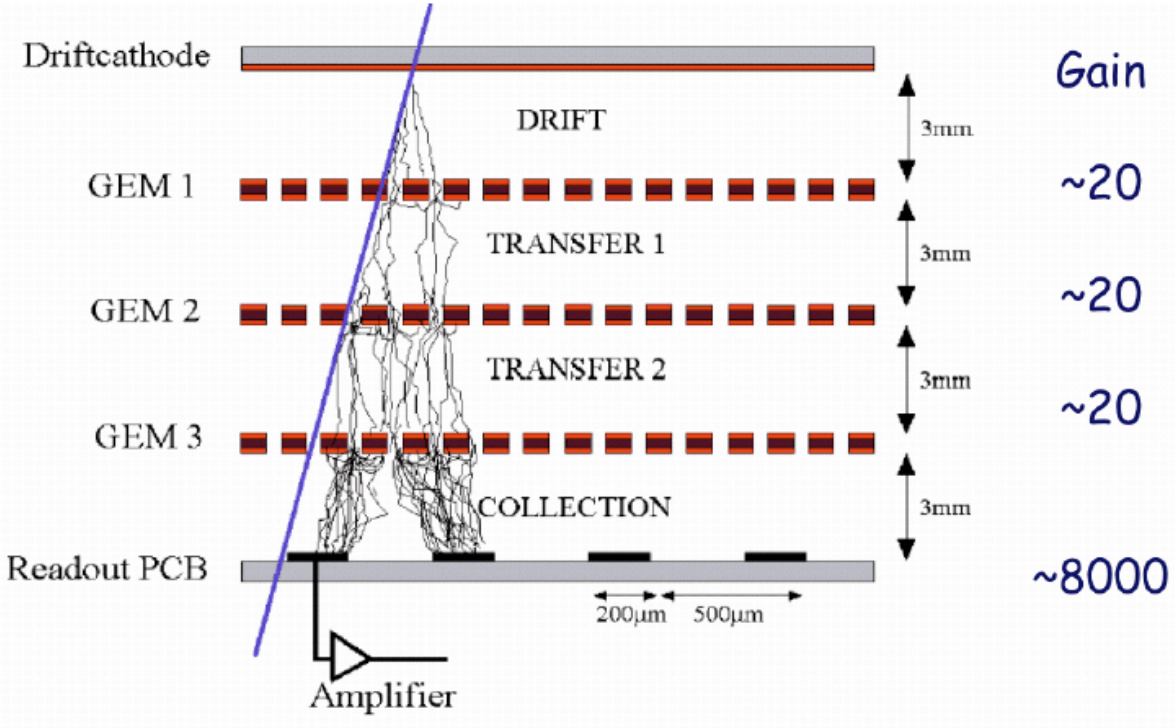
First Tracker	400 kHz/cm^2
Second Tracker	130 kHz/cm^2

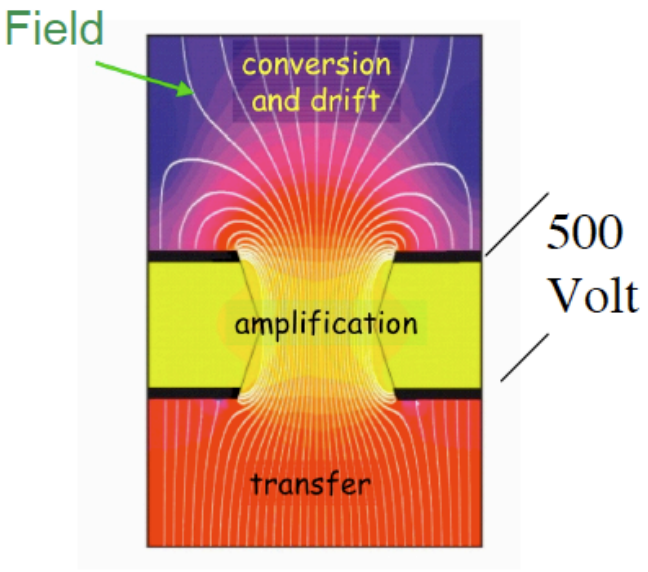
Requirements

- High rate capabilities: 400 kHz/cm2 for first tracker
  - GEM and Silicon strip detectors: up to 5 MHz/cm^2
- High resolution: 70 mm for the first tracker
  - GEM and Silicon strip detectors can do that
- Large area: 40 cm x 150 cm and 50 cm x 200 cm
  - Silicon strip detectors are too expensive:

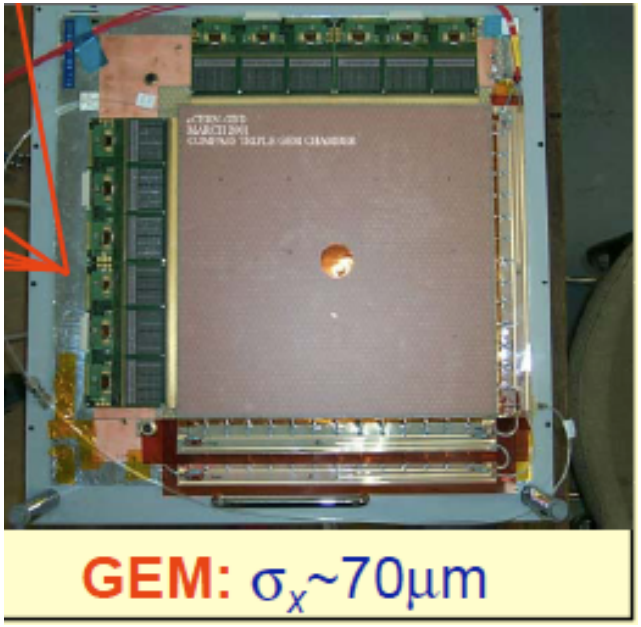
GEM is the clear choice.

Gas Electron Multiplier- GEM: technology



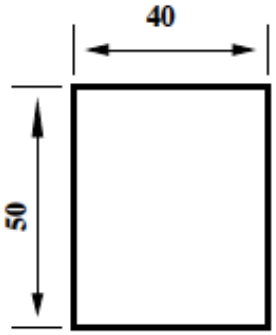


- Invented by Sauli in the nineties.
- Have been adapted for many applications since.
- Successfully used in COMPASS for a few years.
- Chosen for LHCb

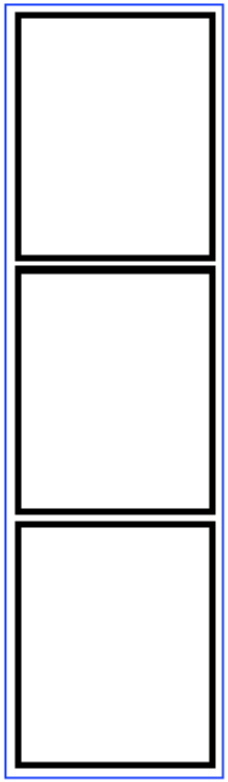


Main Challenge: large area

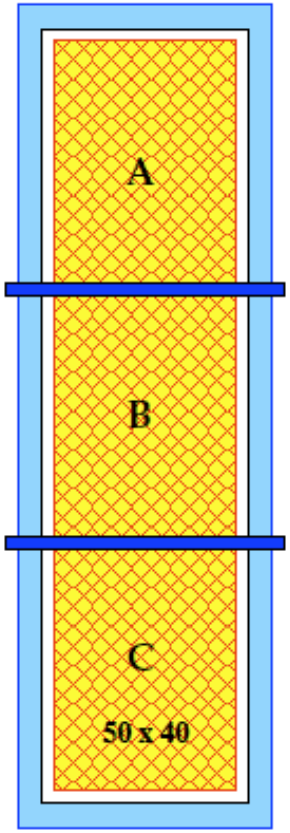
- COMPASS GEM chambers only 30 cm x 30 cm; we need much larger.
- Segmentation into 40 cm x 50 cm sections.
- With this not much of a problem.



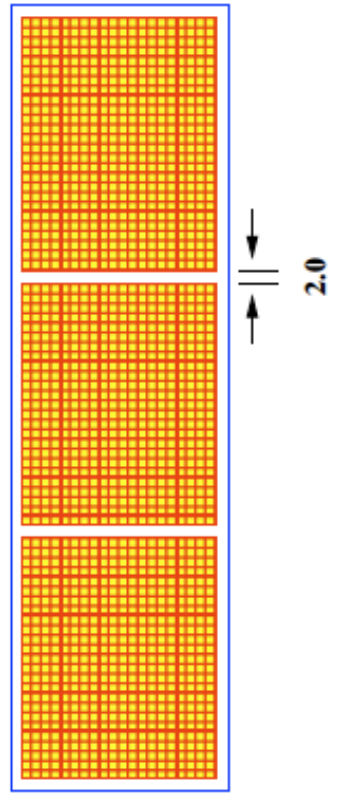
GEM



Frame

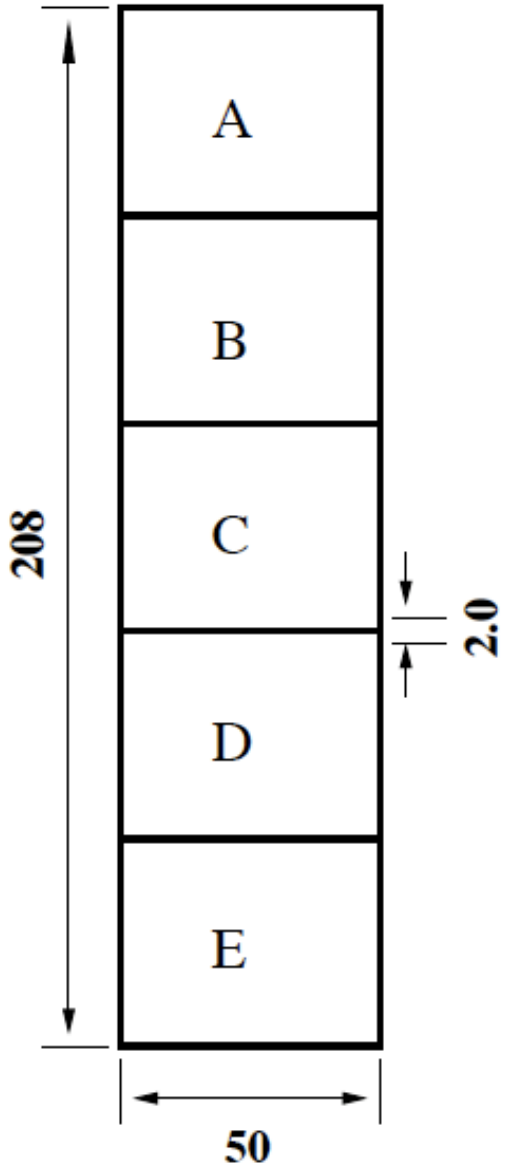


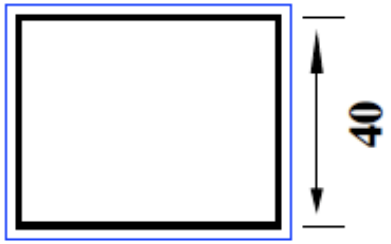
ROB U/V

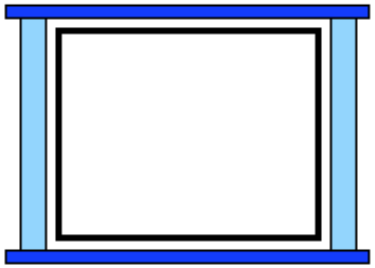


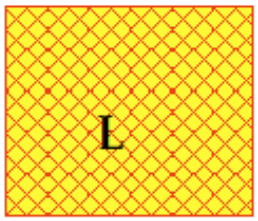
ROB X/Y

SBS FT proposed configuration

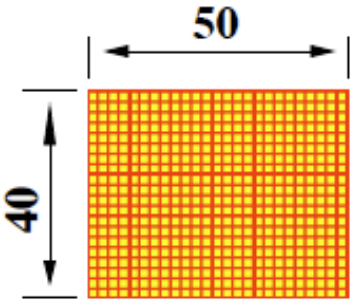








U/V ROB

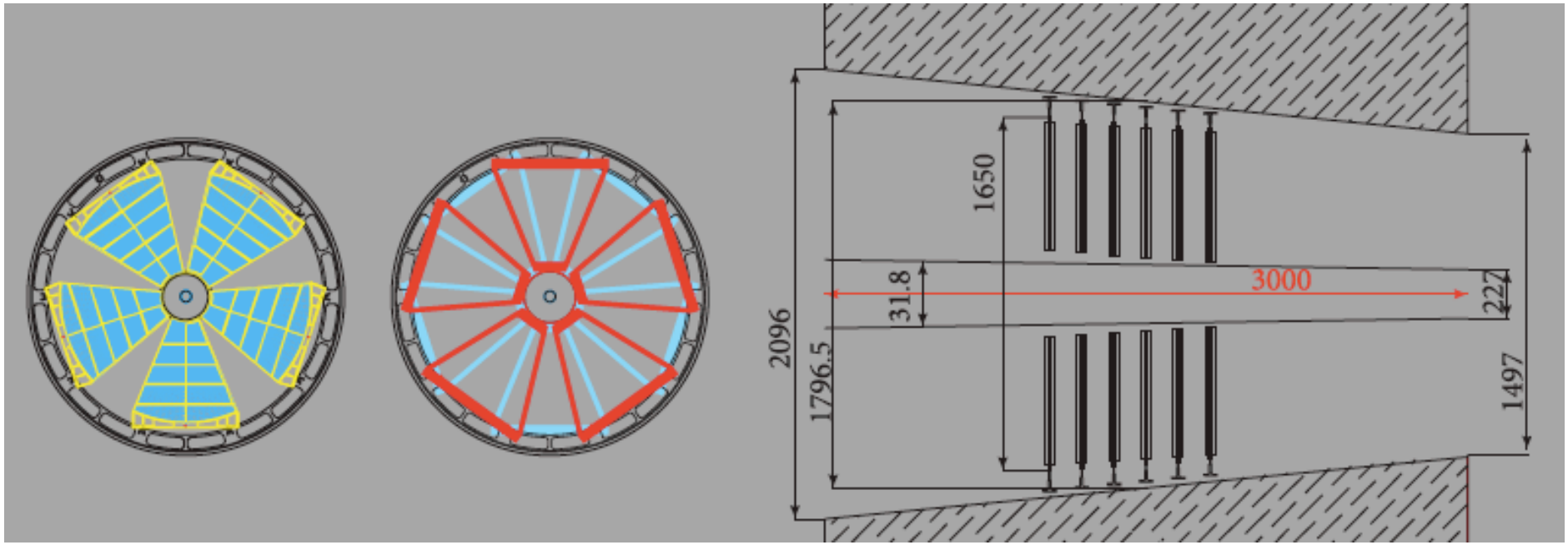


X/Y ROB

SBS ST and TT proposed configuration

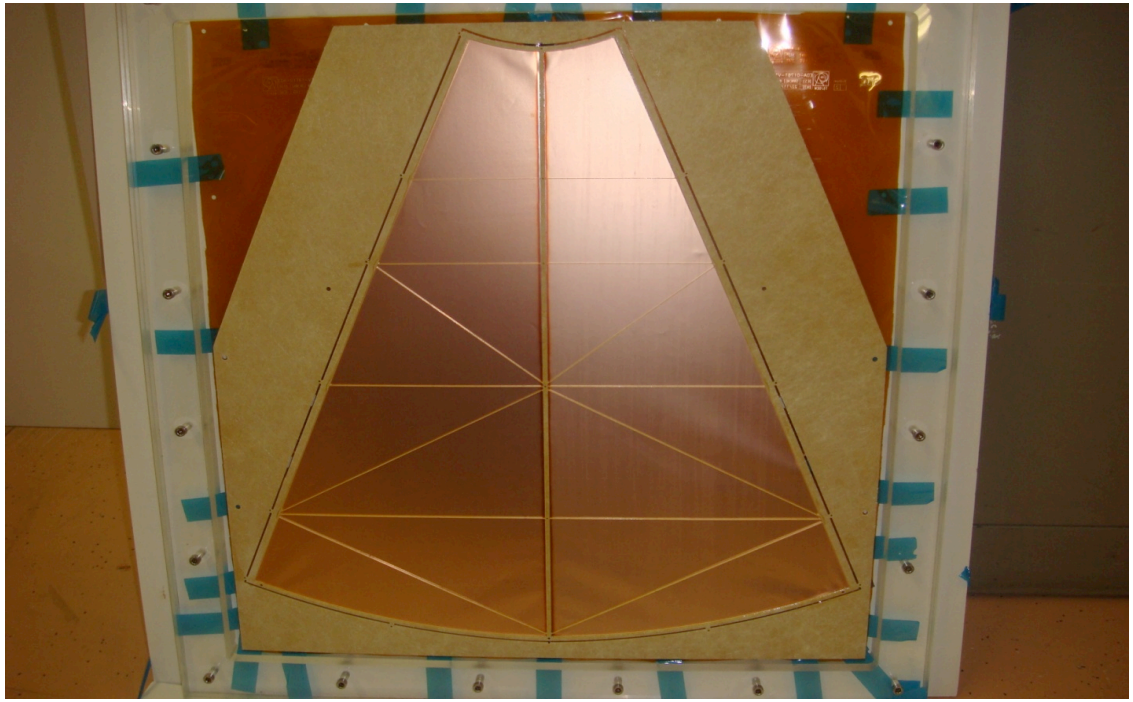
Main Challenge: large area

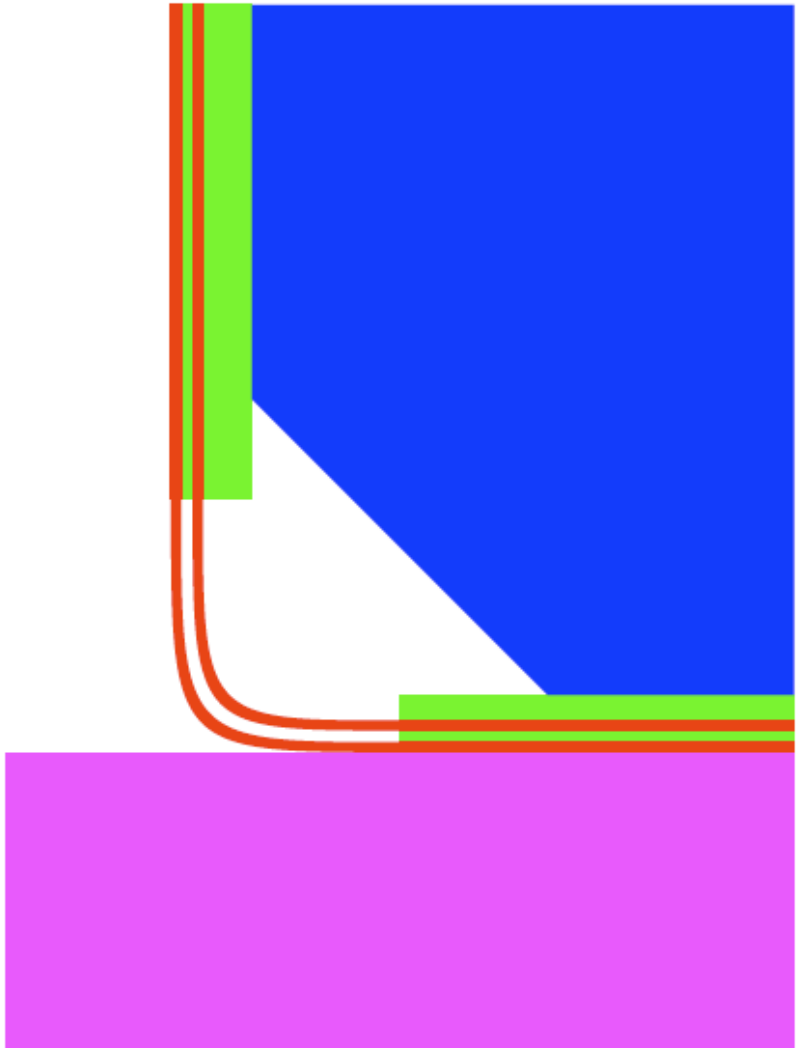
- GEM foil size is not a problem:
  - 0.4 m x 1 m foil will be available from CERN by next year.
  - Other large area chambers being constructed or designed.
    - STAR Front Gem Tracker (MIT, BNL, Yale, Indiana, ANL, Kentucky ….): 6 triple GEM disk of 40 cm radius
    - PANDA at FAIR: 3 half disks, radius up to 80 cm.
    - TOTEM T1 upgrade: 6 disks, 85 cm radius.



How to achieve segmentation without much dead area ?

- Use Polyglass frames: random glass fiber material, can be machined to very high precession.
- Frame sides can be 4 mm wide with sub mm cross ribs for rigidity.
- Method perfected at CERN for TOTEM T1 upgrade chambers.
- Use 90° flex-connectors to mount FEE perpendicular to chamber so that they are not in active area.
- Dead area limited to ~ 2%





Flexible circuit board

- 2 flexible circuit layers
- extend to FEE board
- FEE integral with readout layer
- FEE mounted at 90° with bracket

First Tracker

- Six triple GEM chambers
- Active area 40 cm x 150 cm: from three 40 cm x 50 cm sections
- Readout: U (45^o), V (-45^o) and X, Y directional with a pitch of 0.4 mm
- # of readout channels ~ 50 k
- Estimated cost ~ $ 1.1 M – Funded by INFN: funding already coming
- Will be constructed by INFN group.

Second Tracker and Third Tracker

- Four triple GEM chambers per tracker
- Active area 50 cm x 200 cm: from five 40 cm x 50 cm sections
- Readout: U (45^o), V (-45^o) and X, Y directional with a pitch of 0.4 mm
- But we only need ~ 1.6 mm pitch: combine 4 adjacent strips into a readout channel.
- # of readout channels ~ 30 k
- Estimated cost ~ $ 1.9 M – Funds will be requested from US-DOE
- Will be designed and constructed by UVa, W&M, NSU, and Jefferson lab,

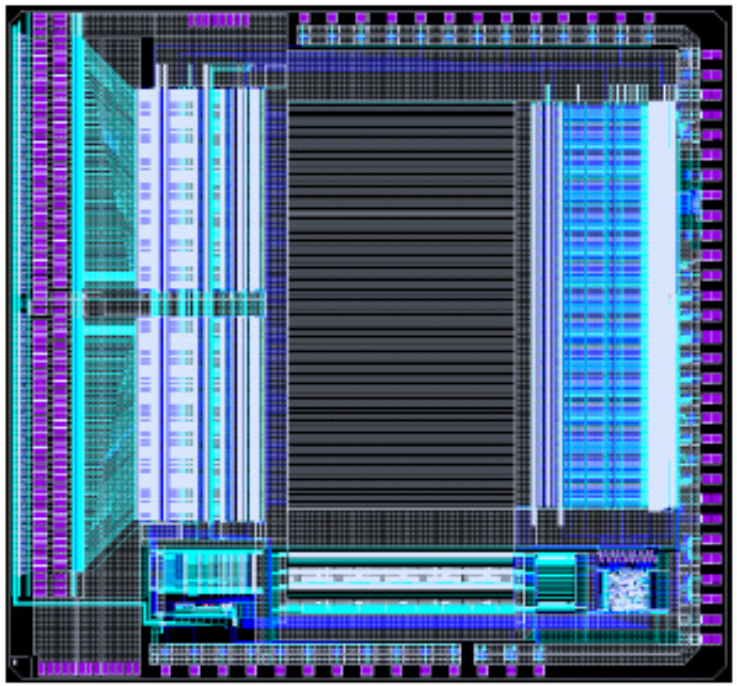
Readout Electronics:

APV-25 CHIP (128 Amplifiers, Analog Circular Buffers, etc)

Fast, Pipelined readout

128 Channels

All the FEE is based on this chip.



APV-25 is used in

- Compass Triple GEM

- CMS Silicon

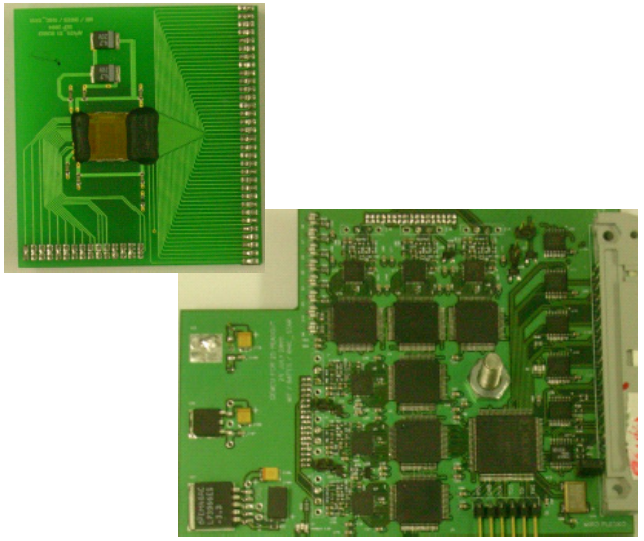
•Also has been adapted for STAR GFT

•Will be designed and fabricated at INFN

• Similar architecture for both trackers

•Enough Chips available

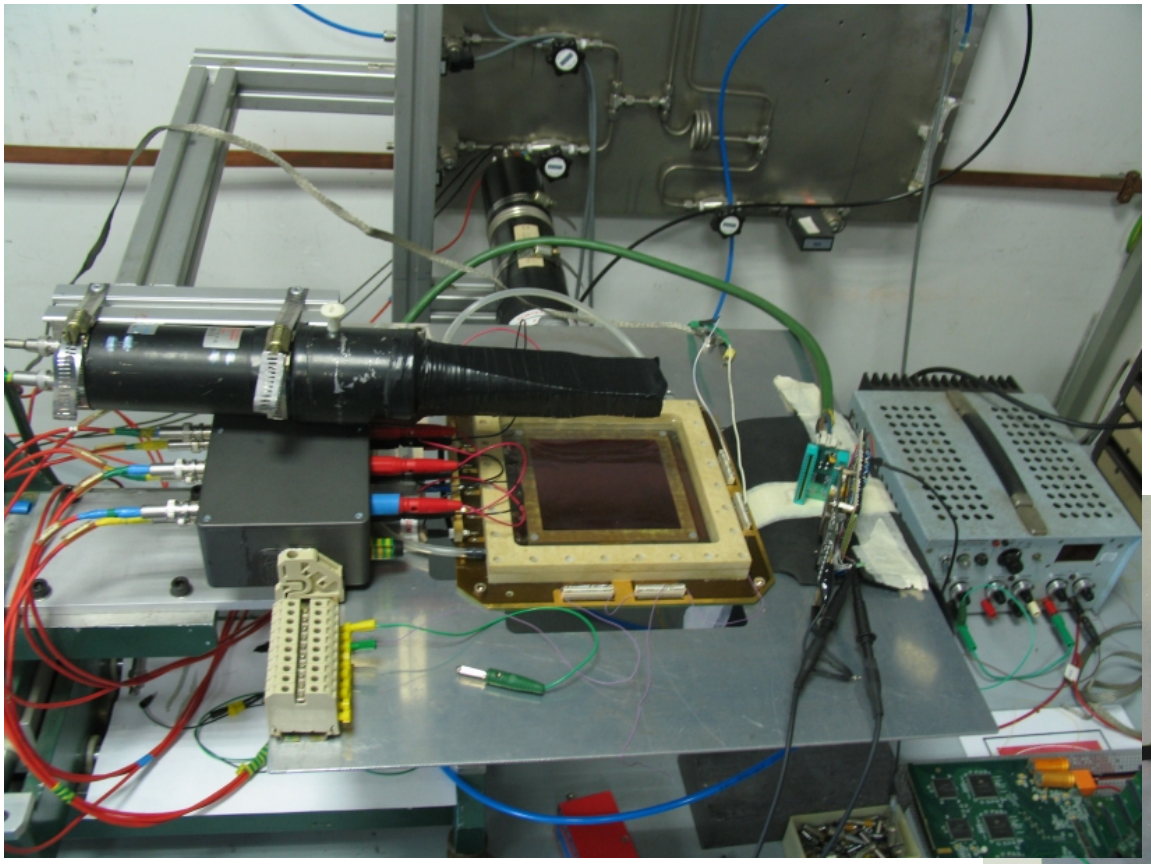
• Estimated cost ~ $10/chan



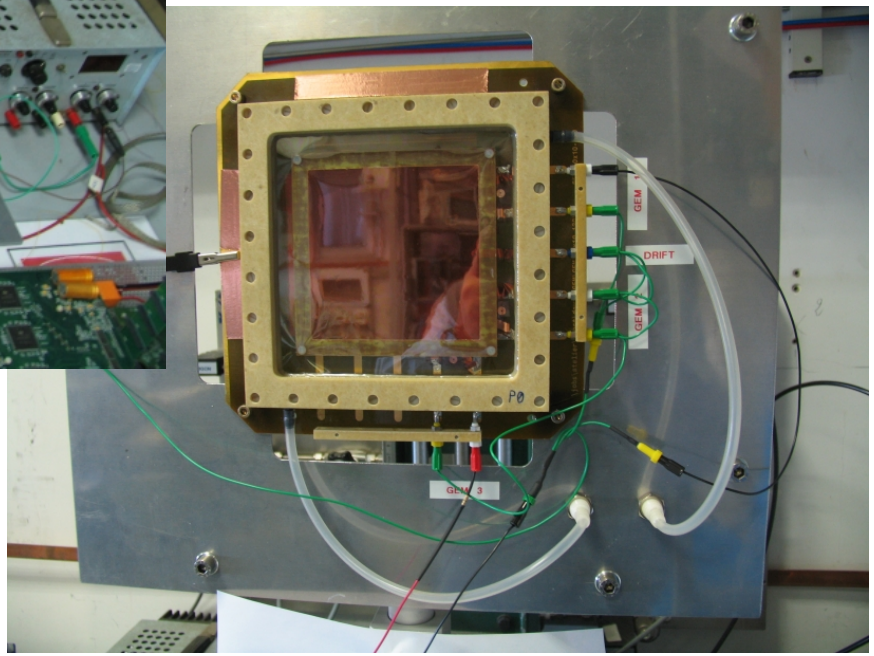
Time Line

- 2008 - 2009: Preliminary Studies
  - Preliminary design
  - small, 10 X 10 prototypes: already being tested
  - high rate capability studies
  - tracking simulations
- 2010
  - construct and test a full-size prototype
  - Finalize design
  - Order components
  - FEE design and testing
- 2011 – 2012
  - Fabricate GEM trackers
  - FEE fabrication
  - Move finished trackers to Jefferson lab
- 2012-2013
  - Installation of trackers in spectrometer
  - Beam tests and commissioning.

Real Prototype 0



- First 10x10 prototypes under test in Europe
- Using 70/30 Ar/CO2 gas mixture
- 7 Independent HV levels up to about 4200 V



Bought about 620 APV25 analog chips for the final electronics (about 80000 channels)
Prototype readout boards will be ready for testing soon.