R & D with GEMs and THGEMs at VECC, Kolkata

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(for the VECC Group)

APPLICATIONS

1. To build GEM cahmbers for Muon detection for CBM (Compressed Baryonic Matter at FAIR at GSI) experiment.

2. Medical Imaging

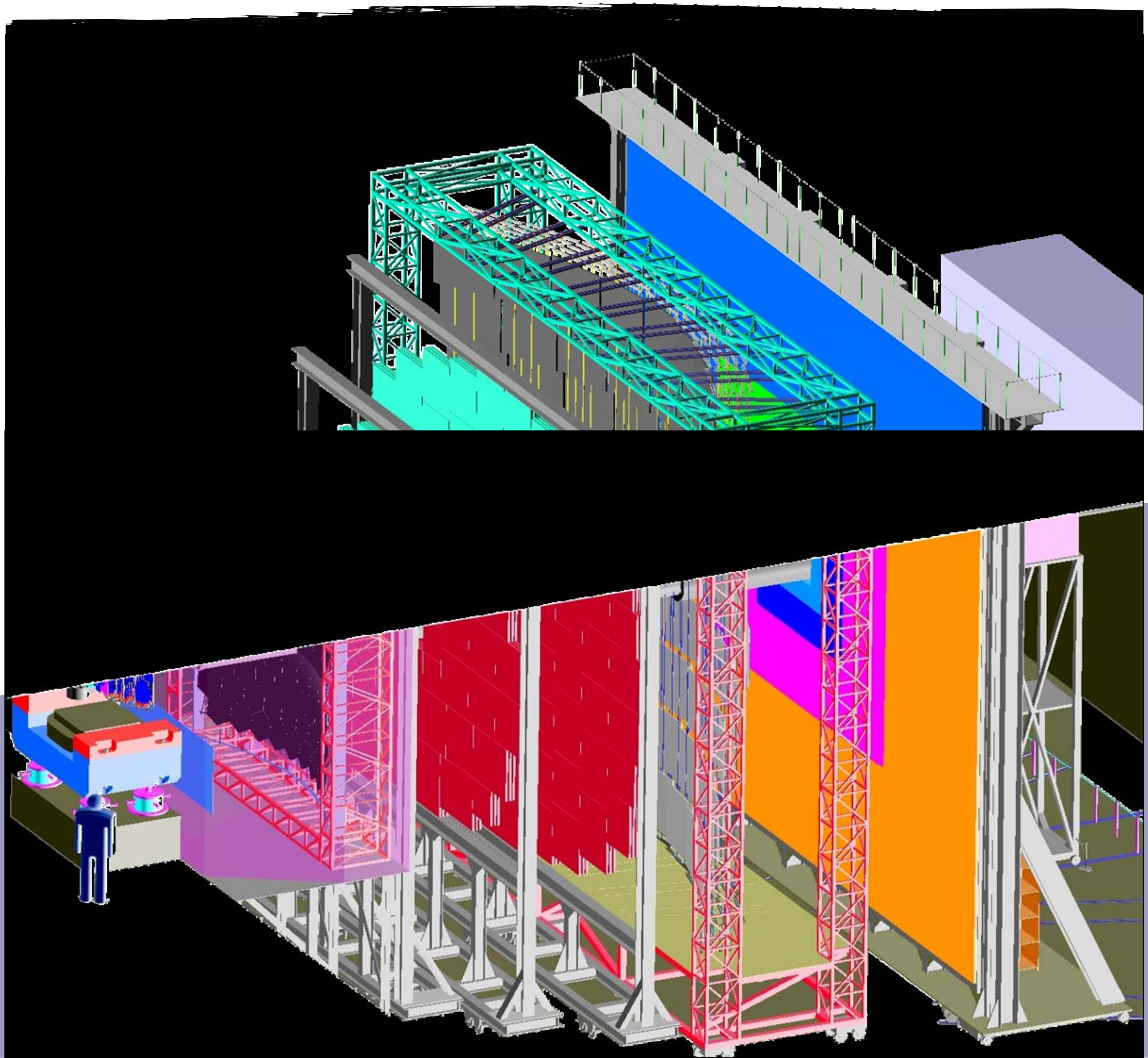
The CBM experiment at FAIR

-- the goal is to create a very high baryon density in nucleus collisions
-- to explore the properties of superdense nuclear matter, the in-medium modification of hadrons
-- to look for deconfinement phase transitions from dense hadronic matter to QGP phase.

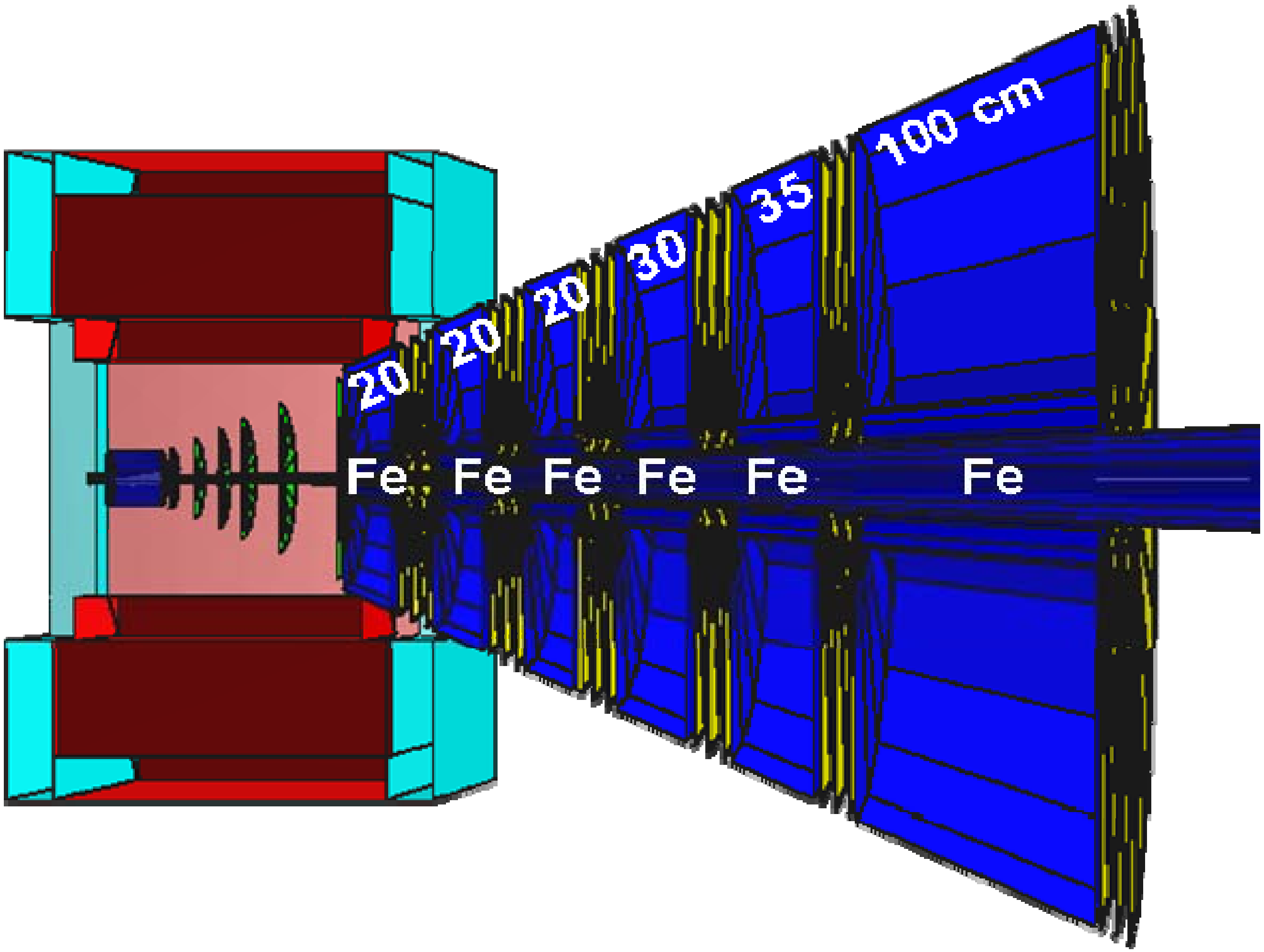
-- One of the key probe is decays of charmonium (J/ψ, ψ',etc.) to leptons. We focus at the muonic channel.

The Indian collaboration in CBM proposes to build <u>a large acceptance muon detector</u> system to address this particular issue.

CBM Experiment@FAIR



Geometry Used



MUCH Standard Geometry

(muon chamber)

Muon detector requirements:

Main issues:

-- The first plane(s) has a high density of tracks
detector should be able to cope up high
rate. ~ 10 MHz/cm^2

-- good position resolution

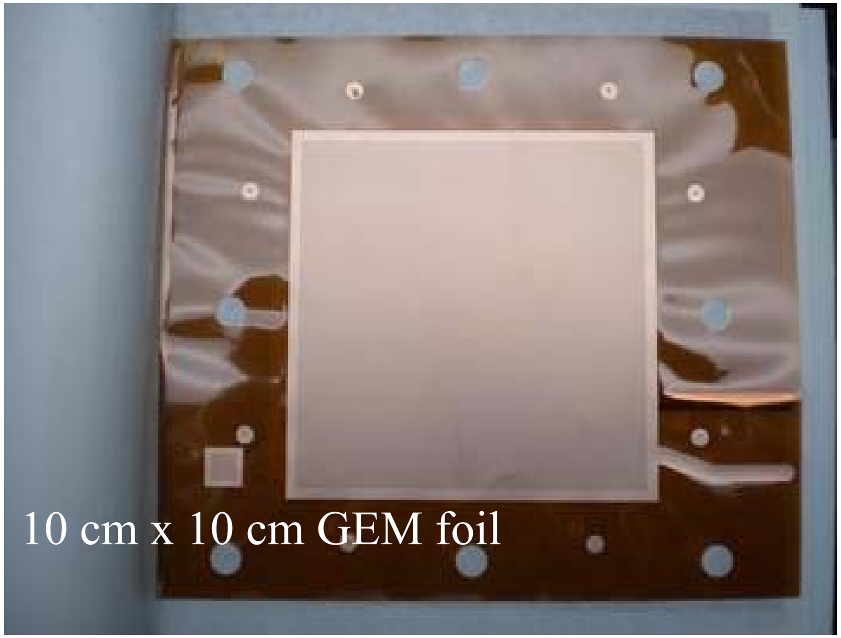
-- Should be radiation resistant

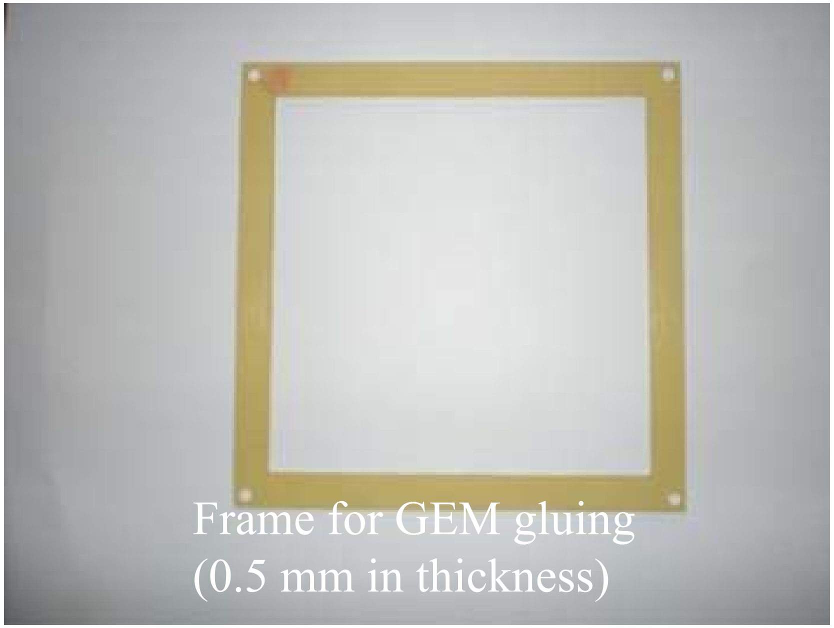
-- Large area detector – modular arrangement

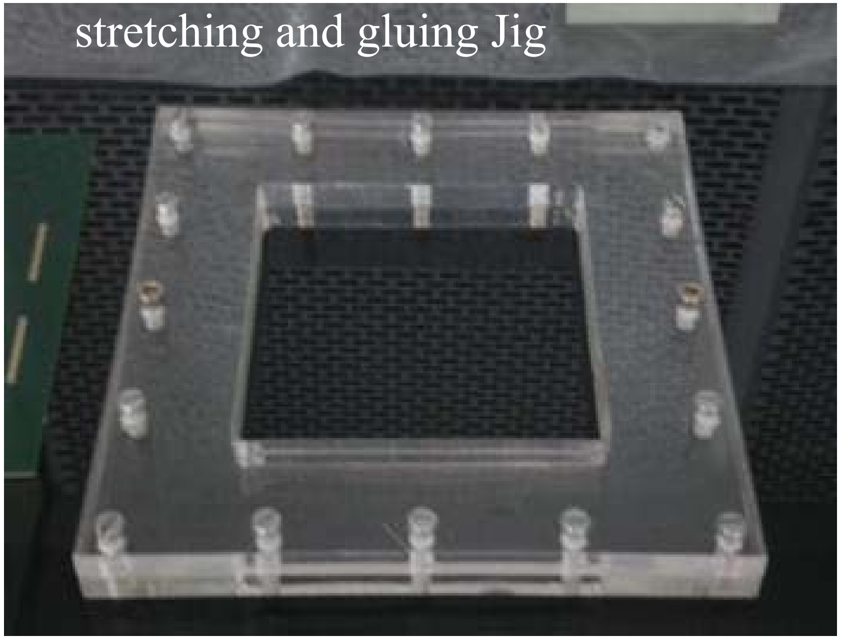
--Should be cost effective

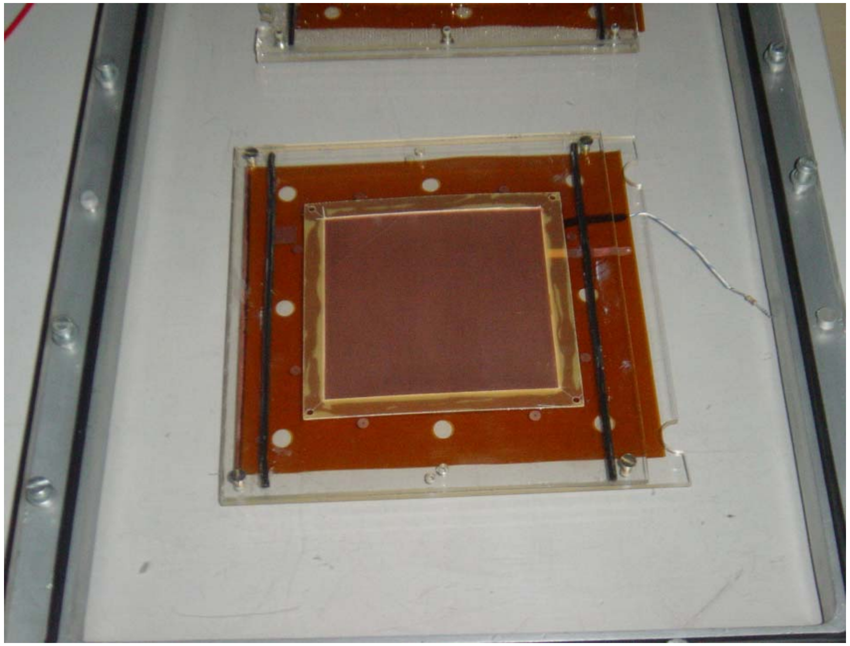
suitable option → micropattern gas detectors
GEMs, THGEM, micromegas

A 2-GEM ASSEMBLY at VECC – A FIRST ATTEMPT

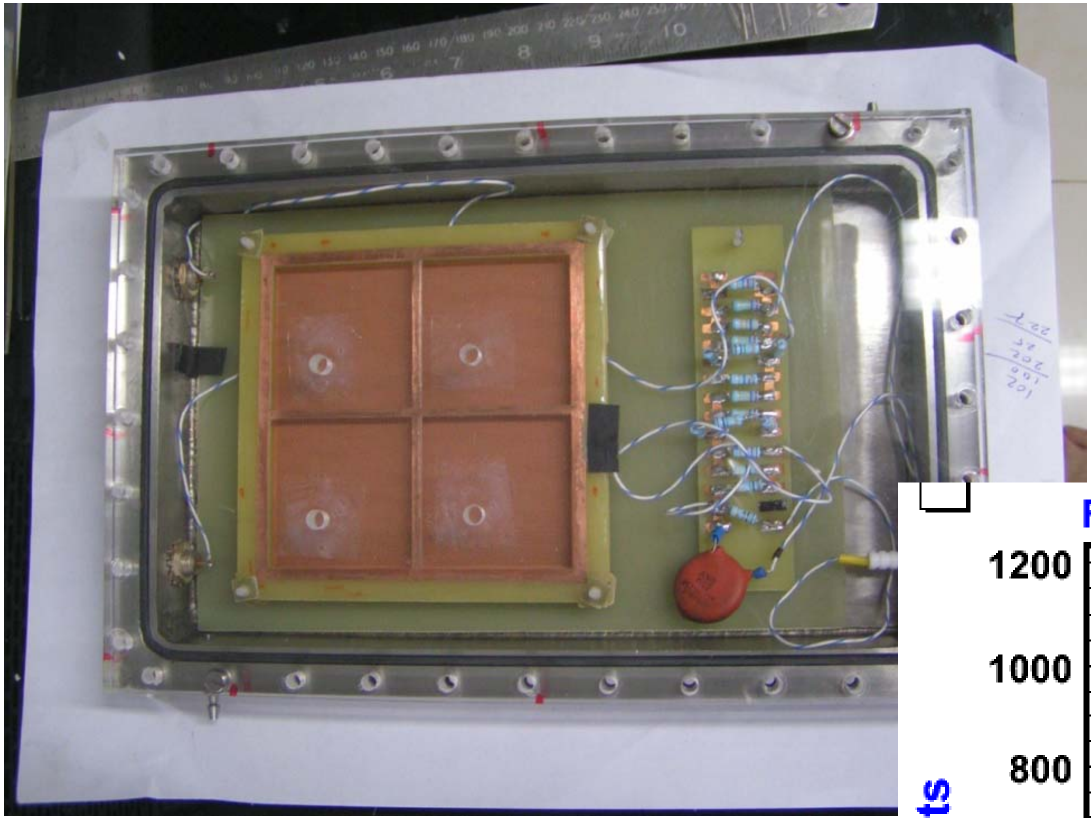

10 cm x 10 cm GEM foil

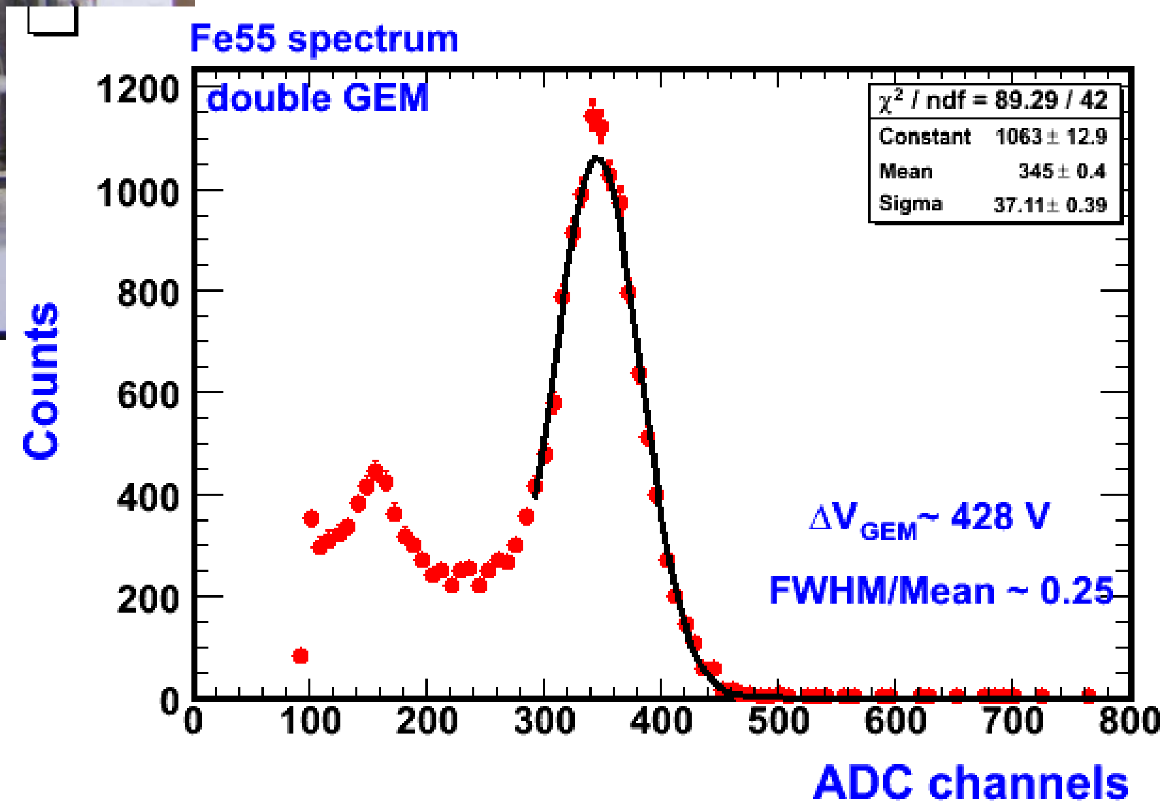

Frame for GEM gluing
(0.5 mm in thickness)


stretching and gluing Jig



Double GEM stack under test (at VECC)



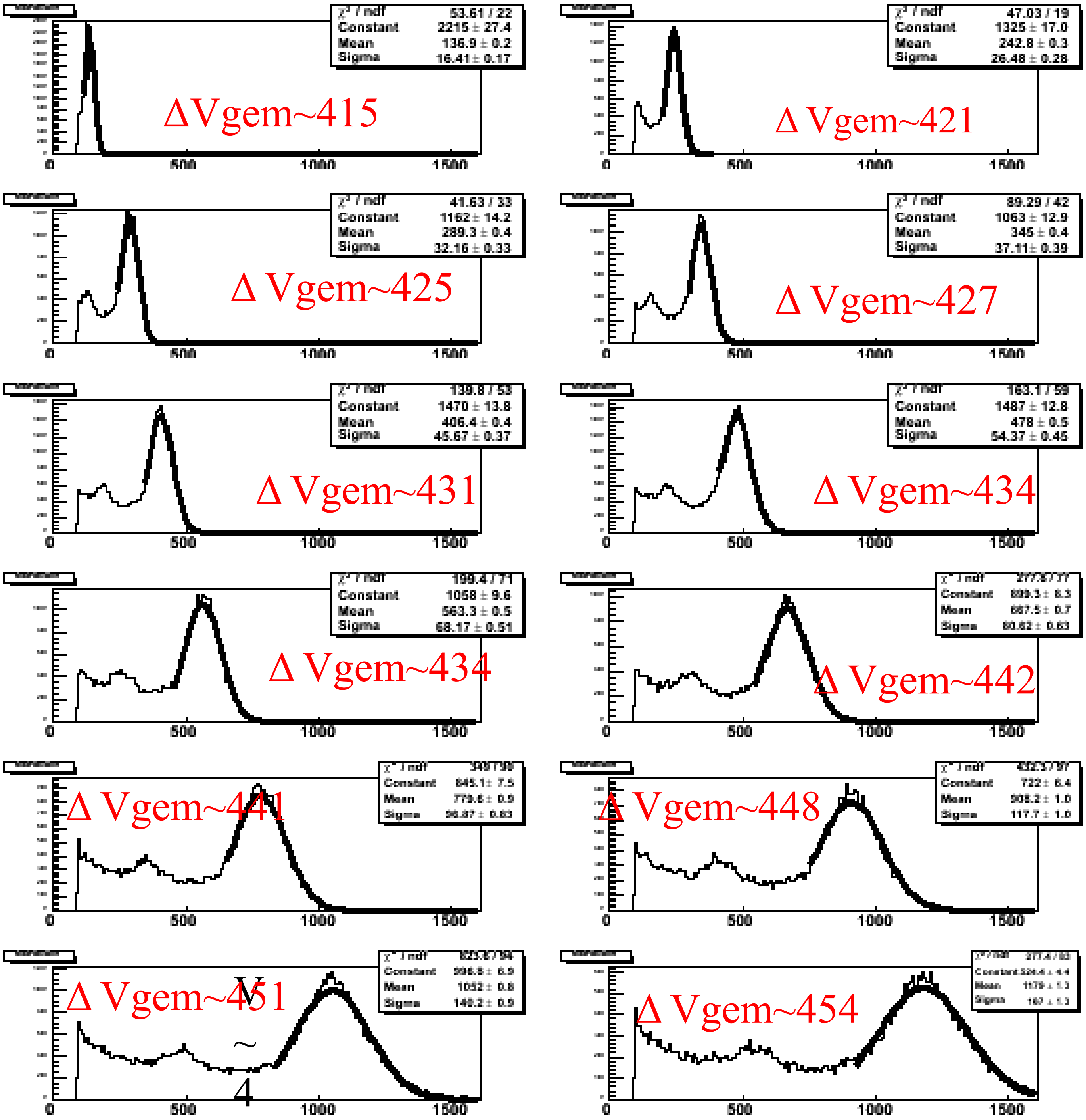


Gas mixture: Ar/CO2 – 70/30

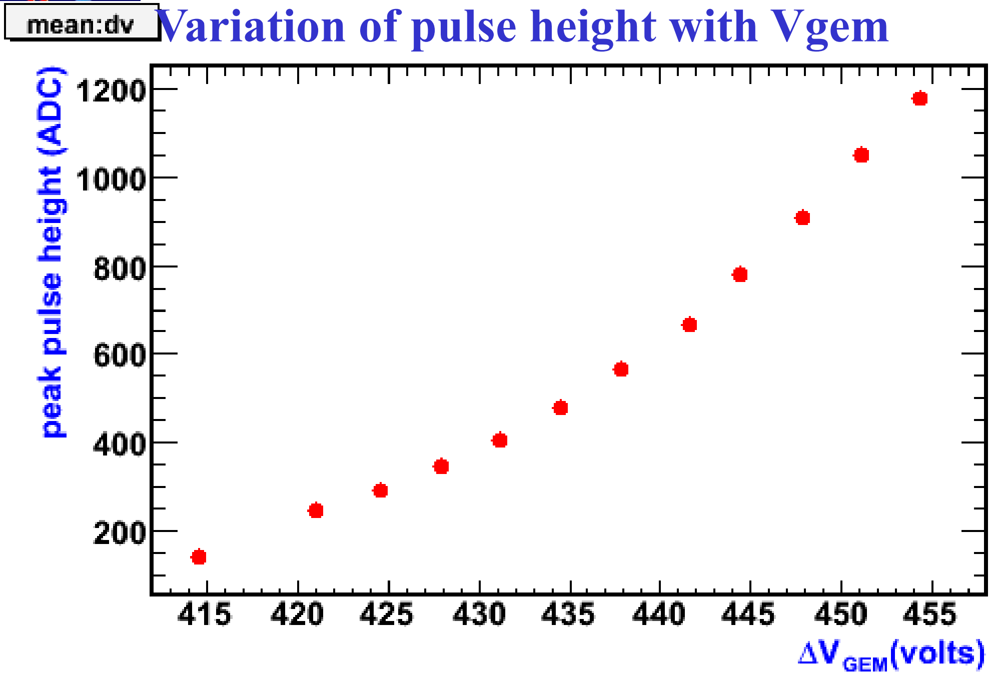
Readout : single pad 1cm x 1cm

Symmetric biasing scheme

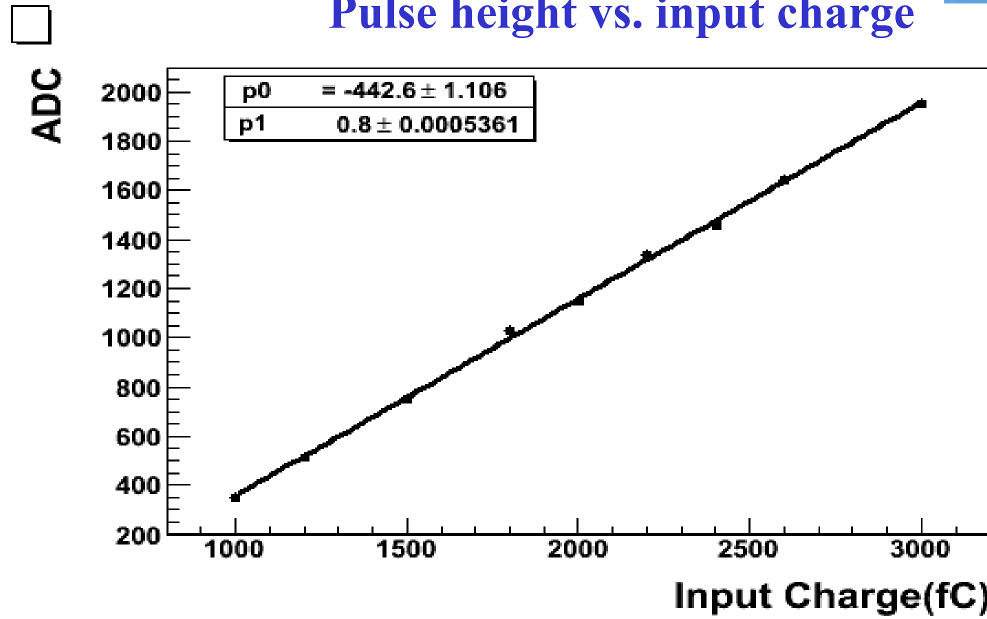
Fe-55 spectra at different ΔVgems



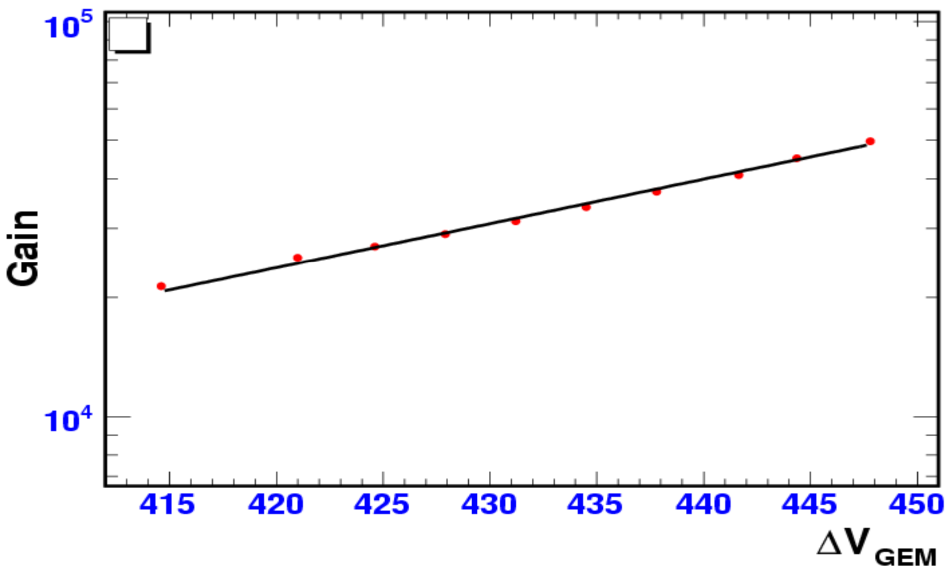
Variation of pulse height with Vgem



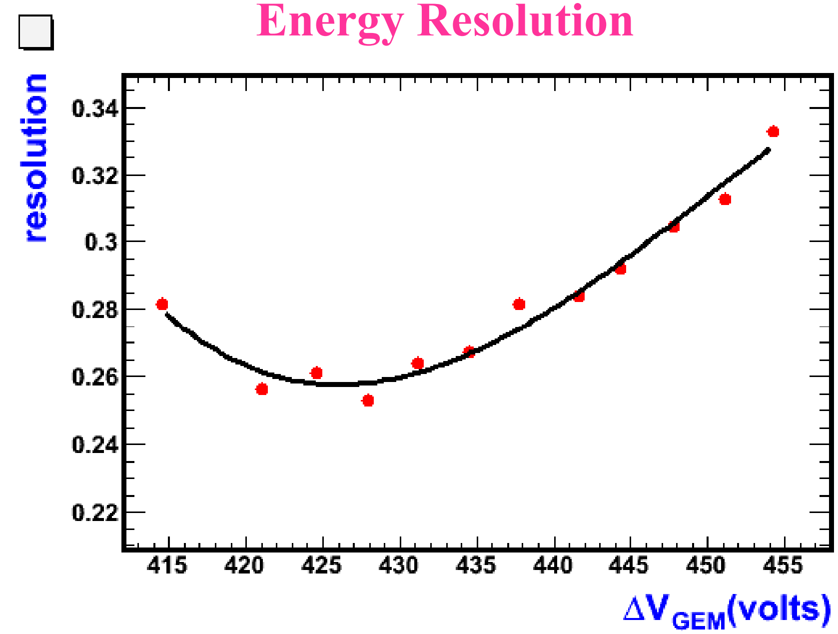
Pulse height vs. input charge



Variation of Detector Gain with GEM Voltage



Energy Resolution



Thick GEM (THGEM) first attempt in India

10 cm x 10 cm

THGEM – a thicker variant of GEMs with 0.3 mm holes and annular etching region of 0.1 mm

Main advantages:

-- Can be made from normal PCB's using simple mechanical drilling technique.
It "can" be **damn cheap** relative to GEMs !

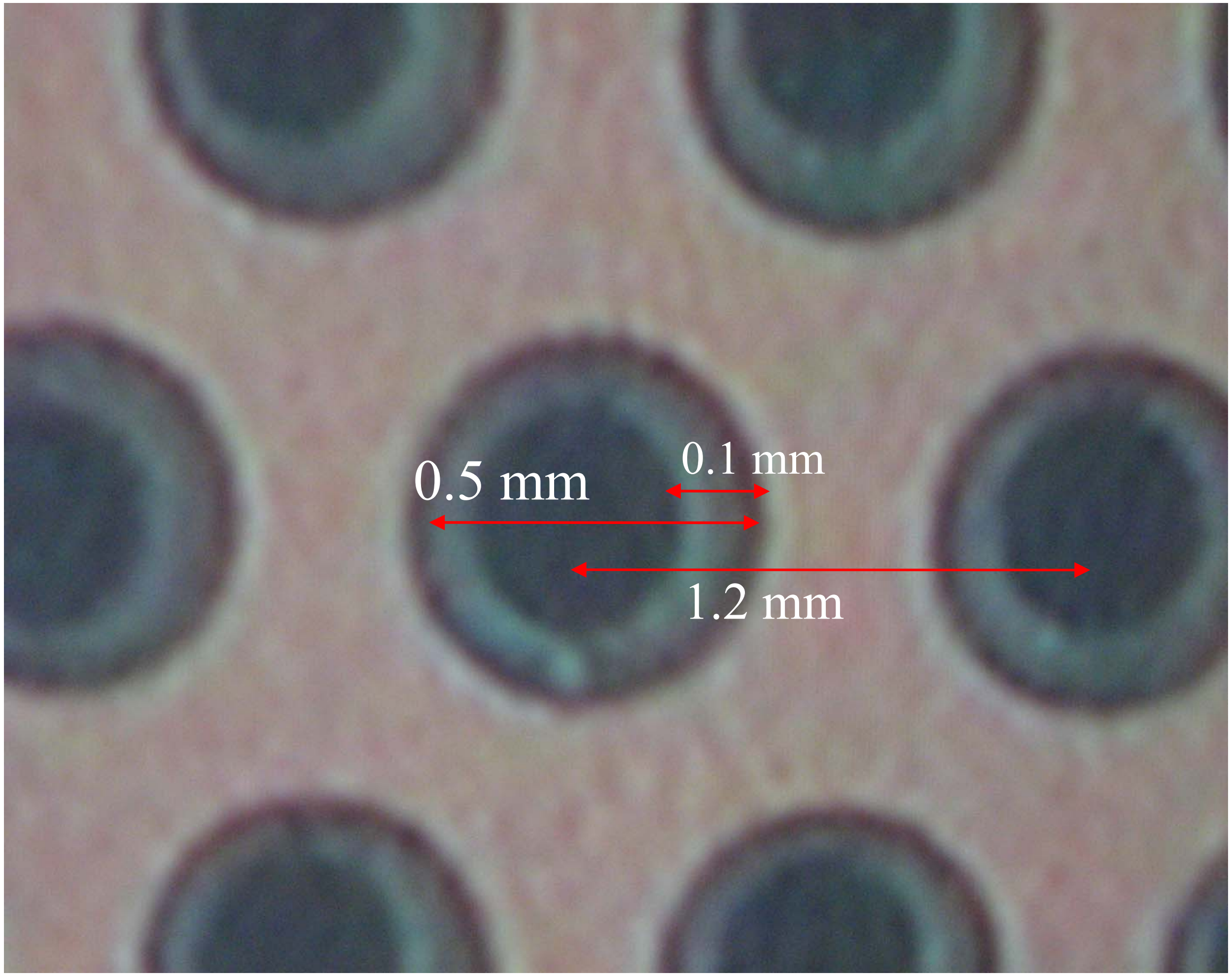
-- It is free from the complex operation of framing and stretching unlike thin GEMs

-- It is easy to handle and hence more robust

Constraints: position resolution ~ 500 microns

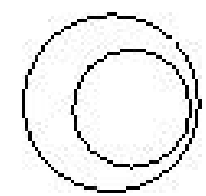
Obstacles: Accuracy in drilling holes and etching of the annular region

0.5mm thick double-sided copper clad FR4 material.
hole size is 0.3mm and the pitch is 1.2mm.
made locally.



A closer view of THGEM holes

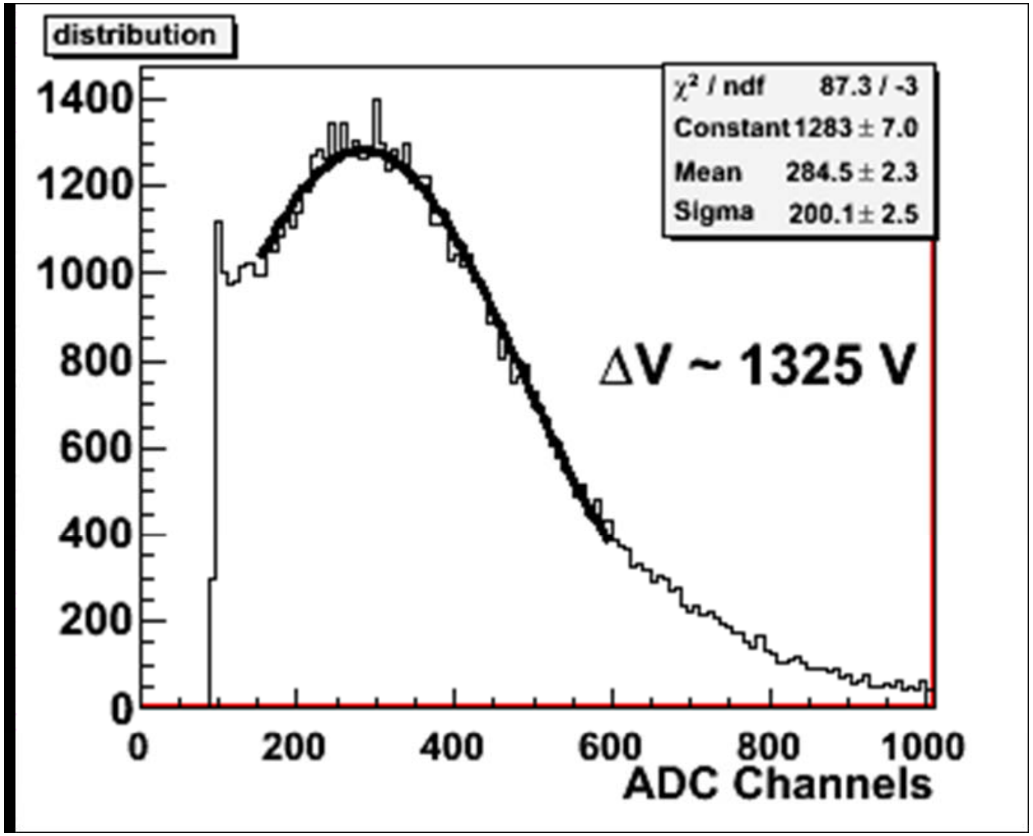
"eccentricity" problems



The position of the rim is not concentric with the G10 holes and the gap is too little at some places. **Lost few boards during tests**

Fresh Boards ordered – tests going on

Fe55 Signal from Double THGEM



Beam test of GEM chambers @GSI

First Test --- September 28-30, 2008, SIS 18

1. Testing of electronics --
   first test with n-XYTER readout chip –self triggered chip
   (neutron- x y Time and Energy Readout originally developed by DETNI collaboration)
2. Response to 3.5 GeV protons.
   --- Obtain MIP spectra
   --- efficiency of GEM assembly to charged particle detection
   --- gain uniformity
   --- cluster spread….granularity test
   --- variation with count rate

Second Test --- Aug 29th- Sep-7th 2009, SIS 18

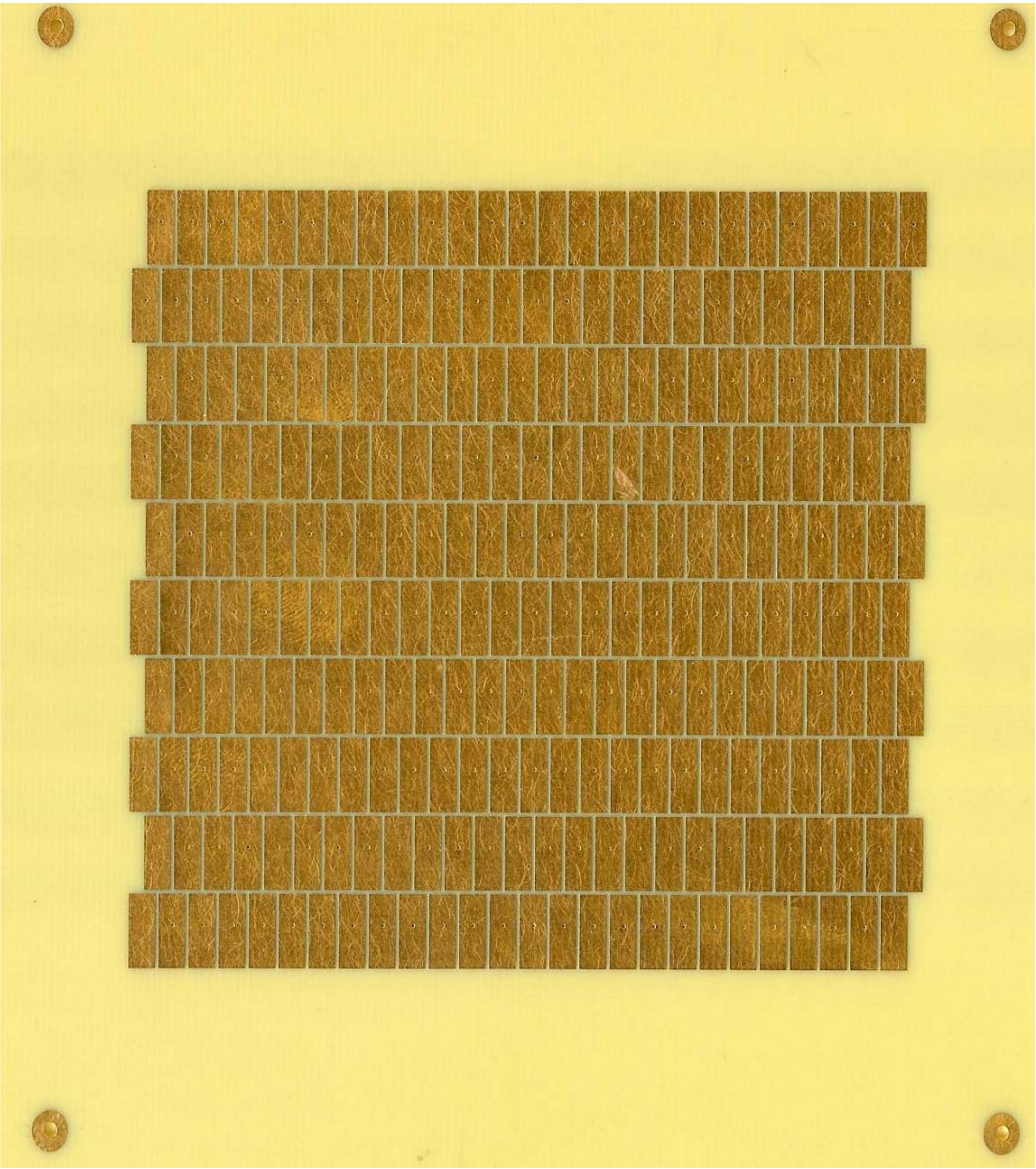
The readout PCB

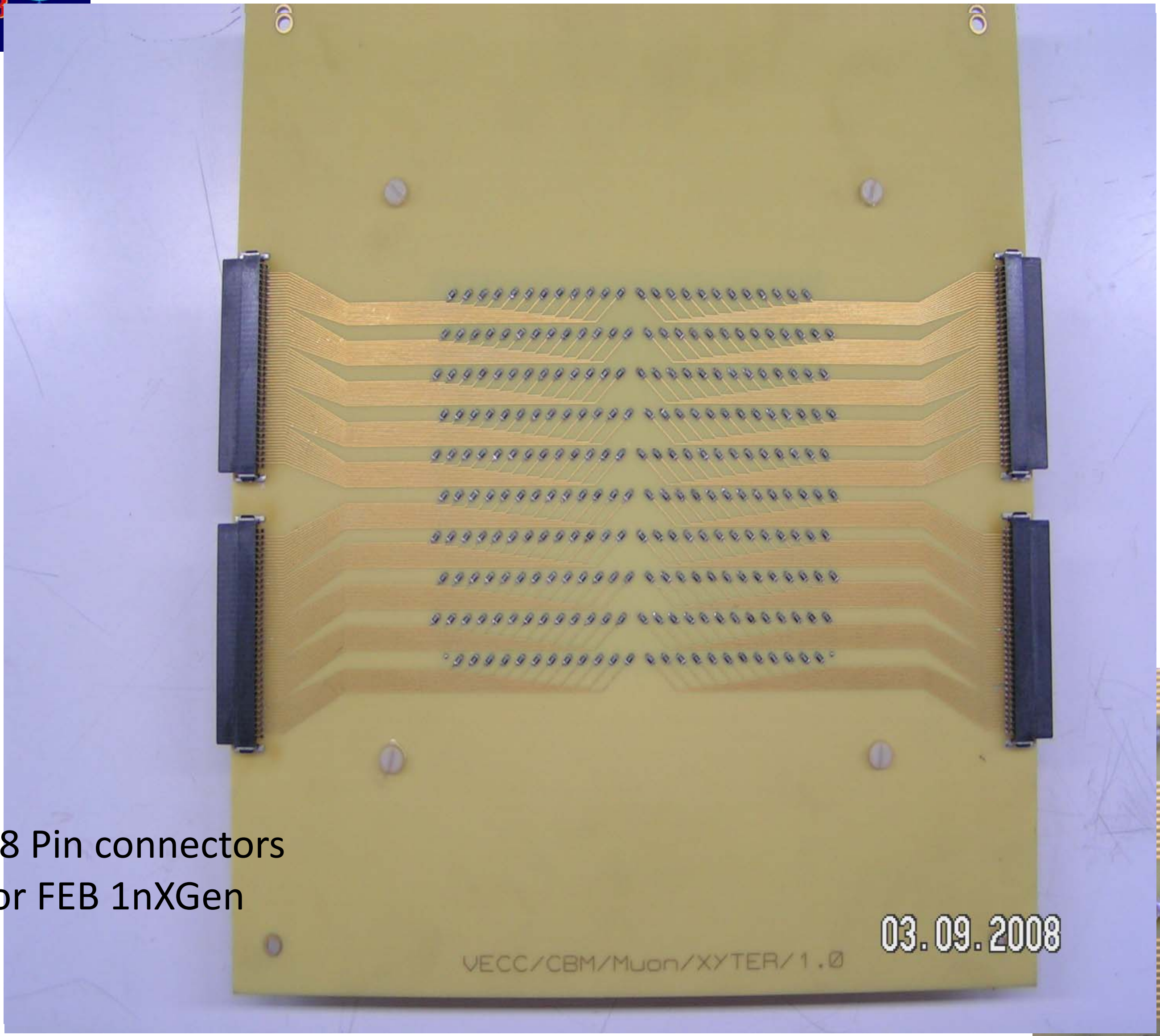
256 Pads with staggered layout
each pad 8 mm x 3.5 mm

GEM params:
Area: 10cm x 10cm

Double GEM:
Drift gap: 7mm
Inductive gap: 1.5mm
Transfer gap: 1mm

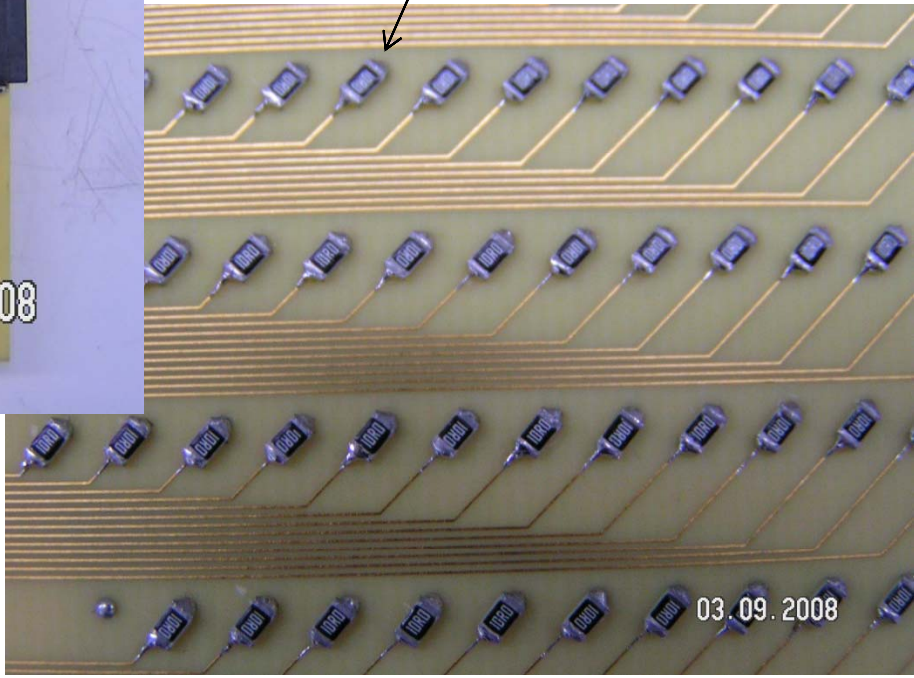
Triple GEM:
Drift gap: 6.5 mm
Inductive gap = 1.5mm
Transfer gap = 1mm



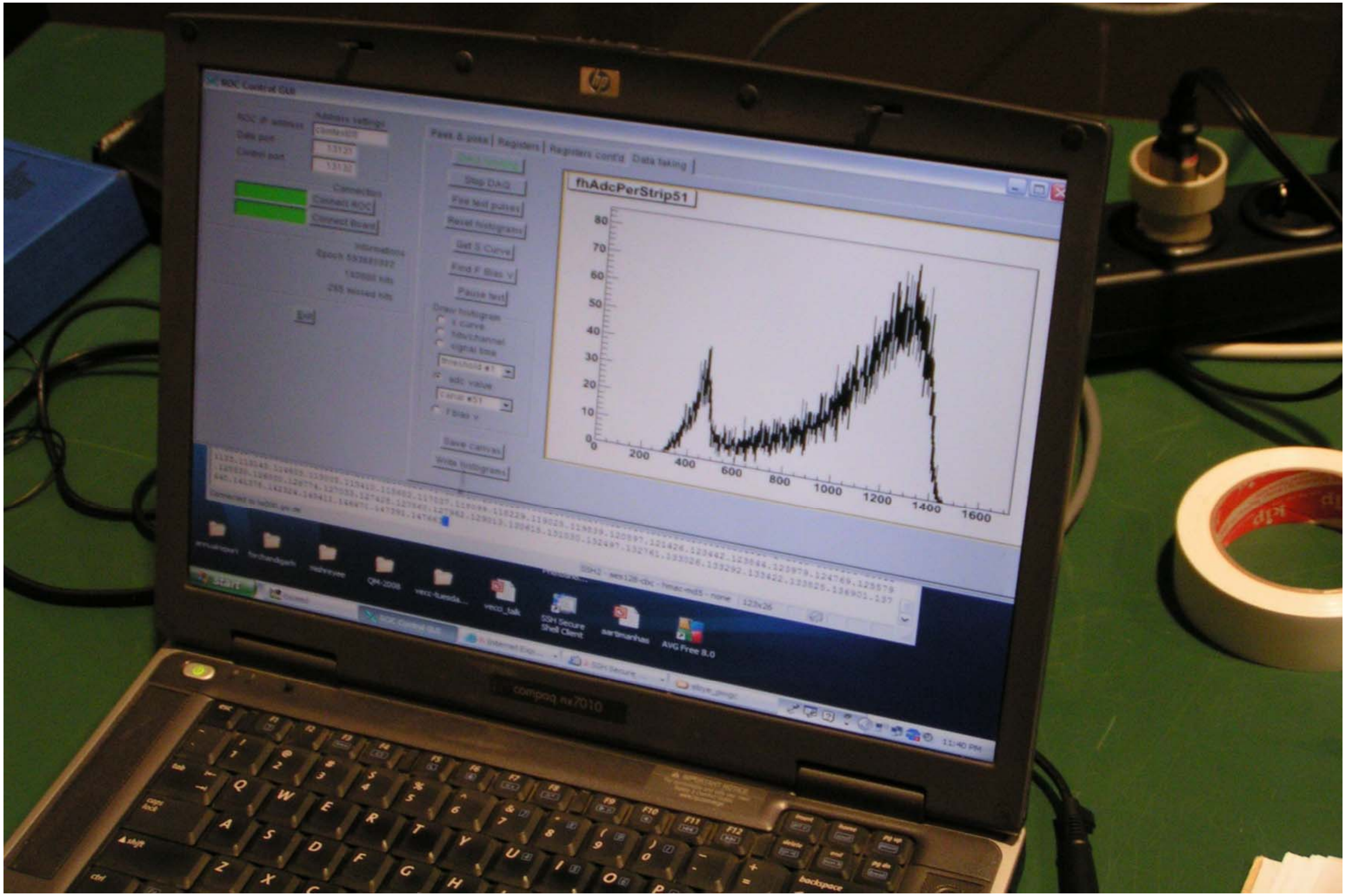


68 Pin connectors
for FEB 1nXGen

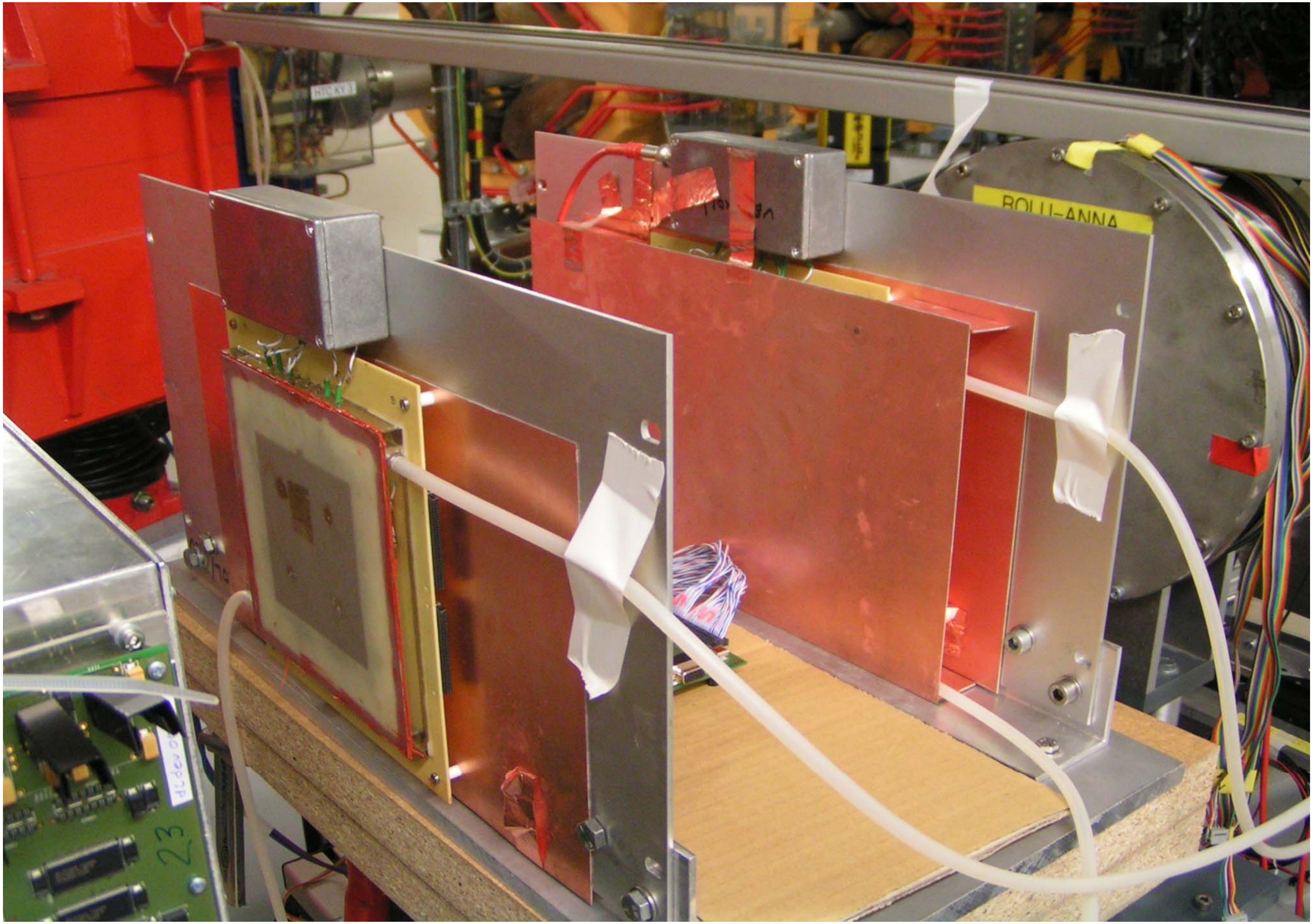
Resistors for protection

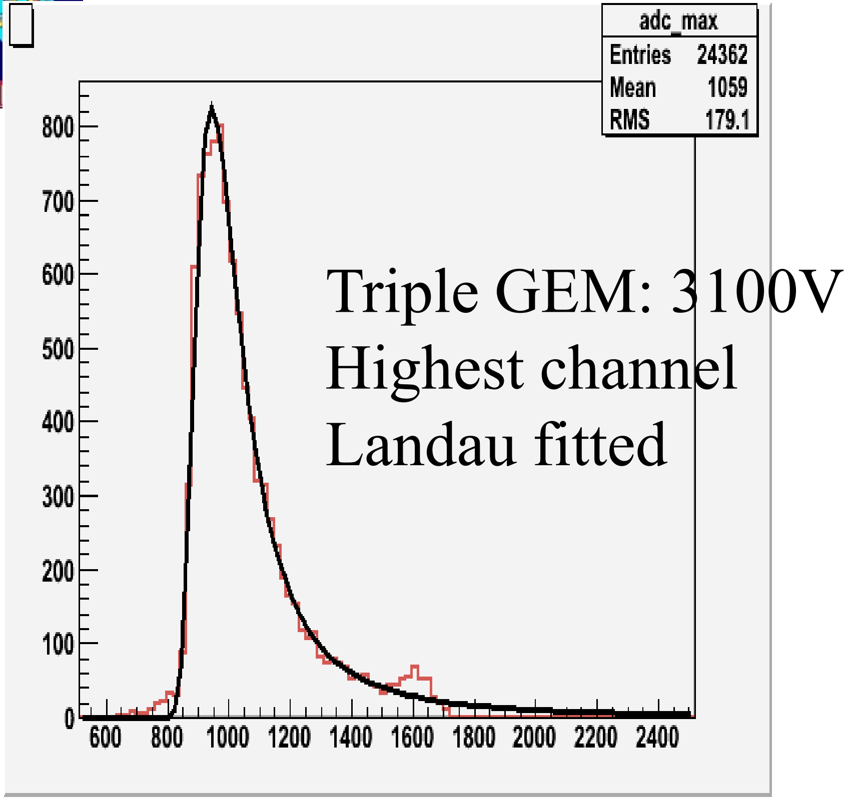


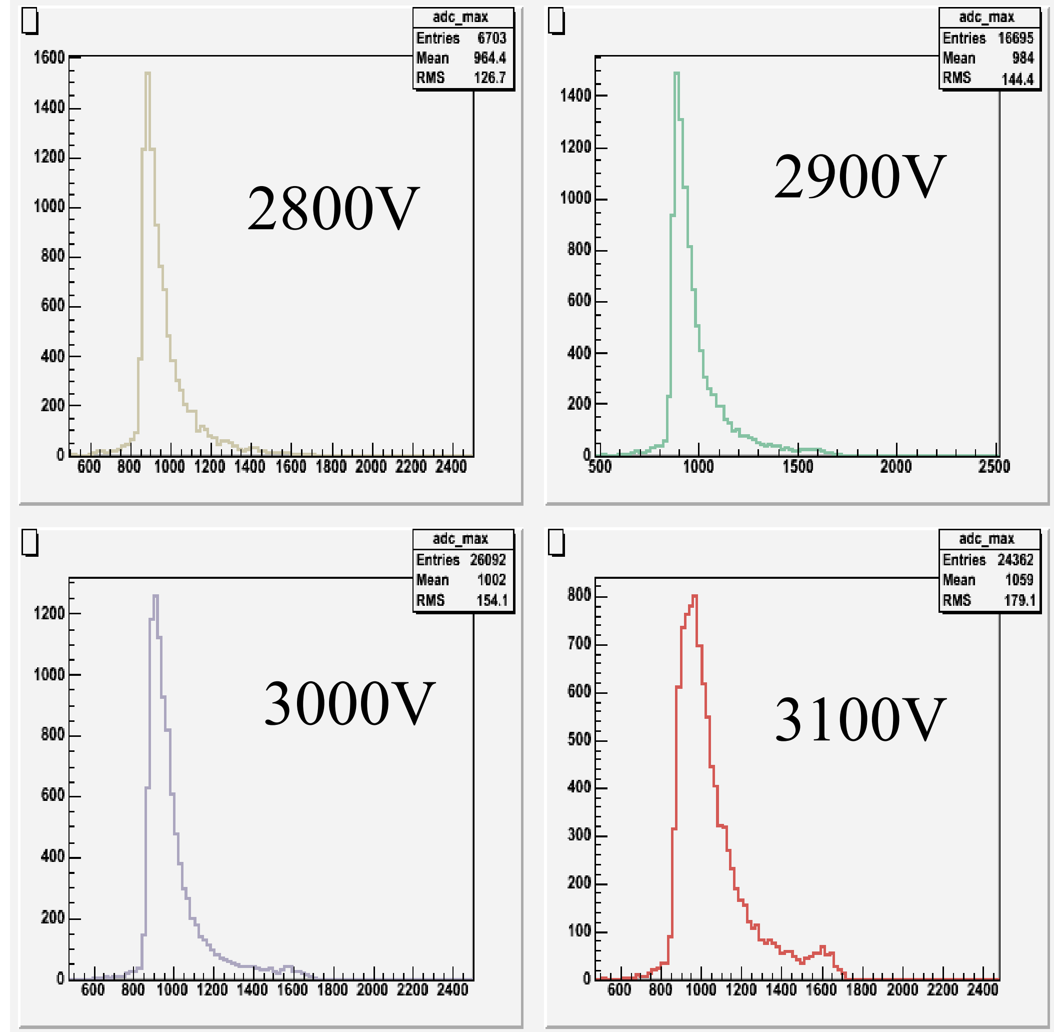
First Signal with n-XYTER
(using triple GEM) from Sr-90 source

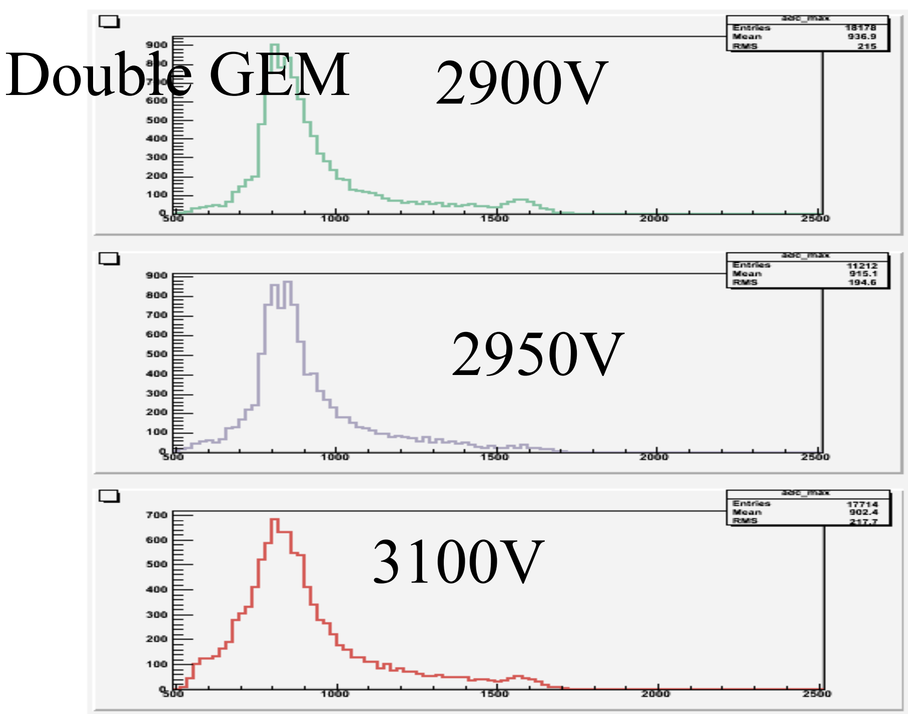


GEM chambers mounted in BEAM AREA (SIS 18)





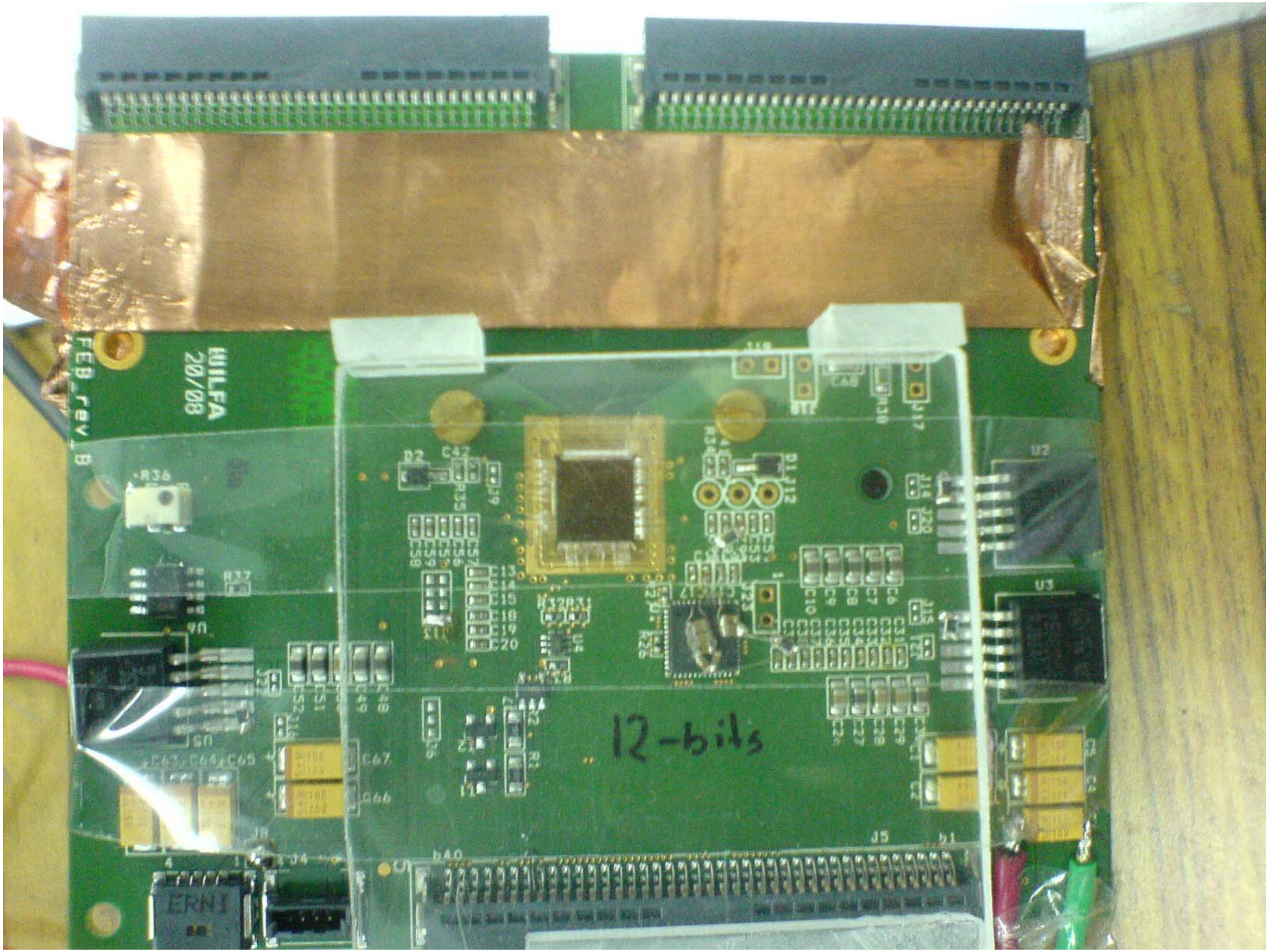




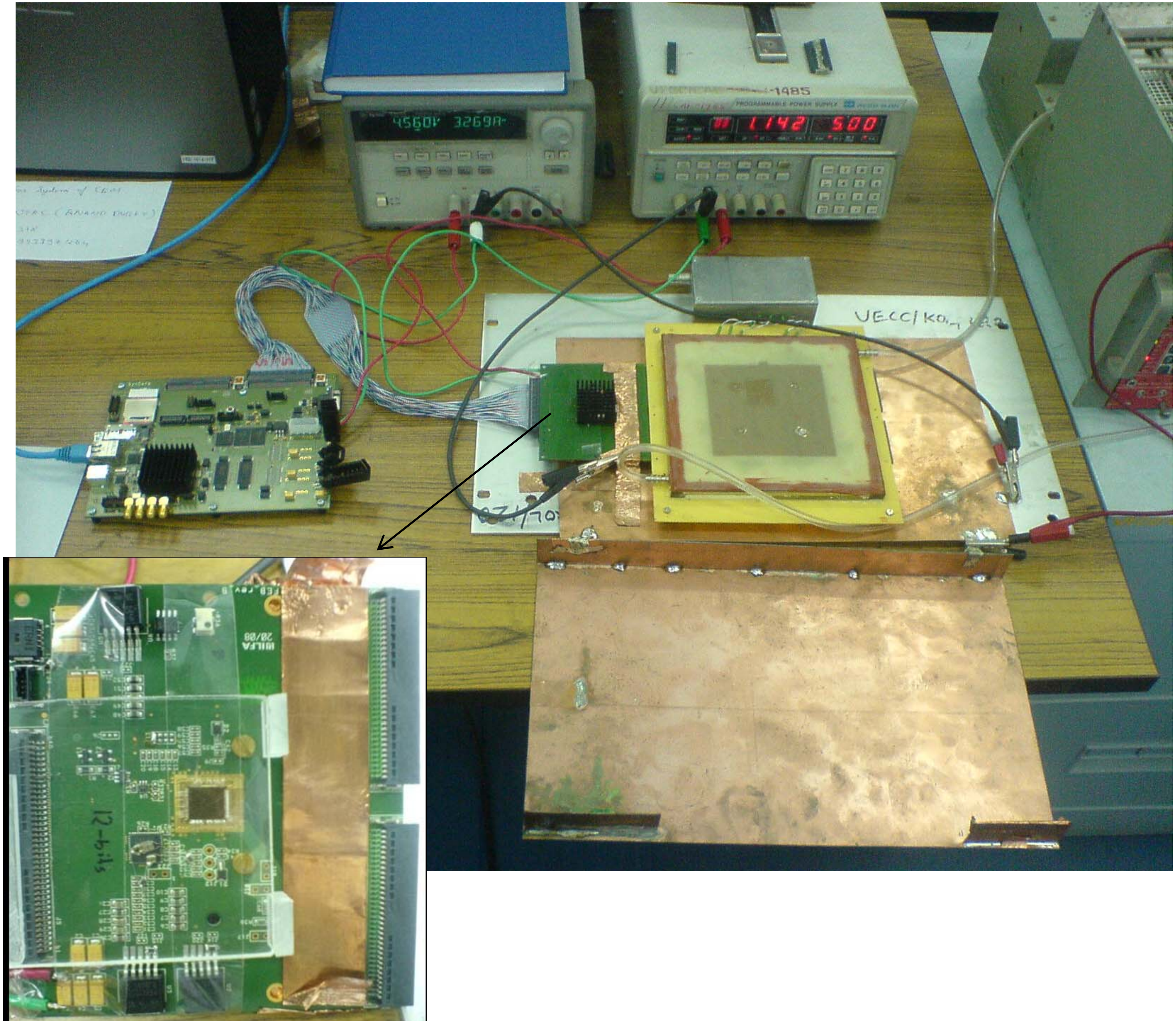
Triple GEM (4 different voltages)

MIP spectra looks Landau,
for double GEM slightly distorted

n-XYTER (32 MHz self triggerred chip)



Tests with n-XYTER at VECC, Kolkata



SUMMARY

- Main hardware hardware experience at VECC: PMD

- We are new to working with MPGD:
  CBM Muon detector requirements → MPGD
  -- Have successfully tested Double and triple GEMs with
  -- Radioactive sources and beam.
  -- More Optimisation underway.
- Medical Imaging -- the above activities are coupled.
- Future requirements :
  Segmented 30 x 30 GEMs
  A Large Size GEM – maybe ~ 50 cm x 50 cm or more

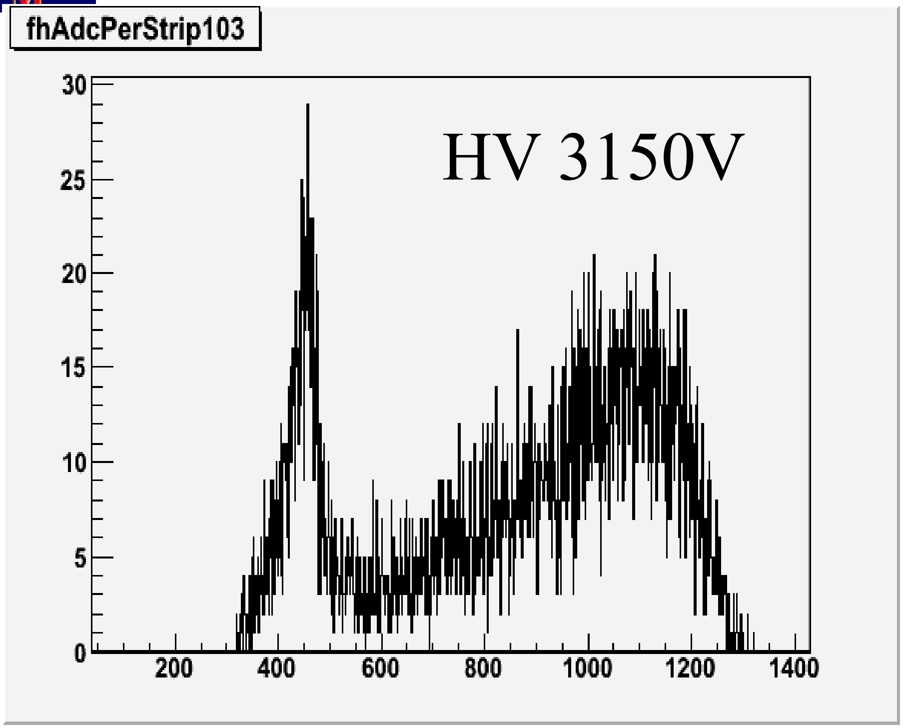
- Collaborating with RD51 experts would be extremely useful.
- Would like to take part mainly in WG2, WG3, WG4.

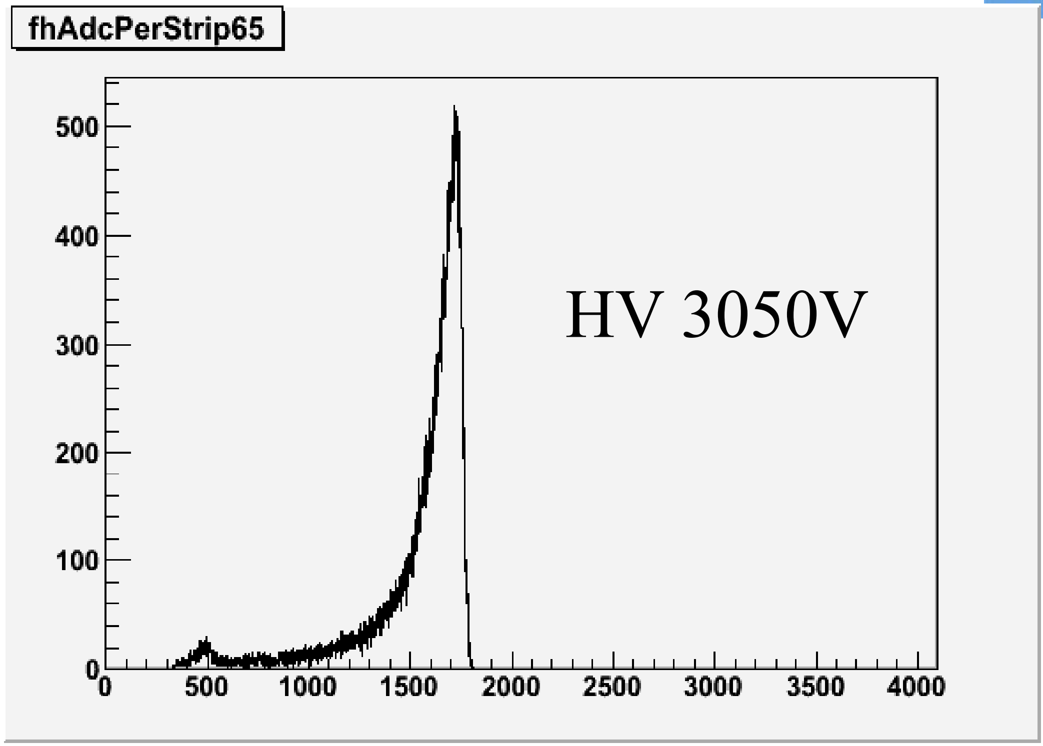
- An MoU for joining RD-51 collaboration would be signed by our VECC director, sometime this month. All necessary paper work done.

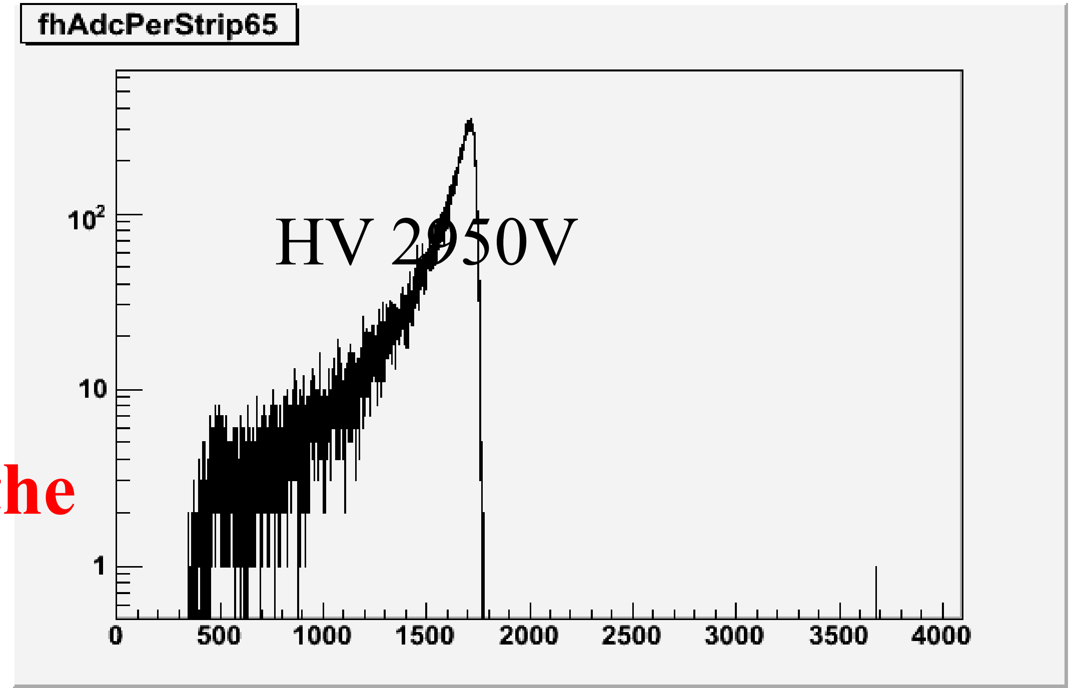
Thanks For Your Attention

BACKUPS

Different HV and saturation



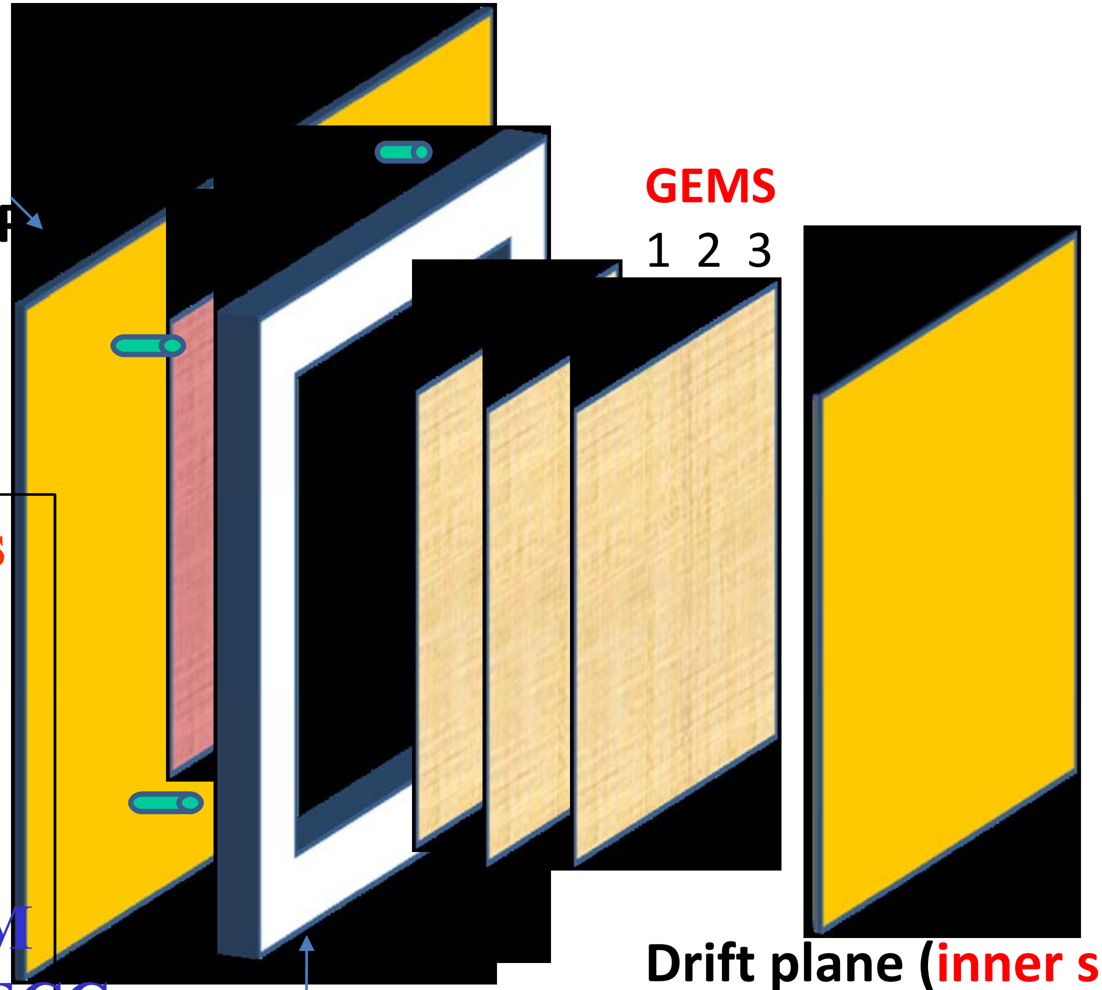




Saturation goes Away with lowering HV

WARM UP OVER and the detector is ready to take on the proton beam !

Schematic of Chamber assembly



5 new GEM foils
Obtained from
CERN

One triple GEM
One double GEM
Assembled at VECC

Comparison of available options

	MWPC	GEM	Micromegas
Rate capability	10^4Hz/mm^2	**>5x10^5Hz/mm^2**	10^6Hz/mm^2
Gain	High 10^6	**low 10^3 (single)** **> 10^5 (multi GEM)**	High > 10^5
Gain stability	Drops at 10^4Hz/mm^2	**Stable over 5*10^5Hz/mm^2**	Stable over 10^6Hz/mm^2
2D Readout ?	Yes	Yes	Yes
Position resolution	> 200 μm	**50 μm**	Good < 80 μm
Time resolution	~ 100 ns	< 100 ns	< 100 ns
Magnetic Field effect	High	Low	Low
Cost	Expensive, fragile	Expensive(?), robust	Cheap, robust, but….

Suitable Options : Micropattern gas detectors:

GEM (Gas Electron multiplier)

MICROMEGAS

more recently THGEM