Study of the GEM TPC PrePrototype

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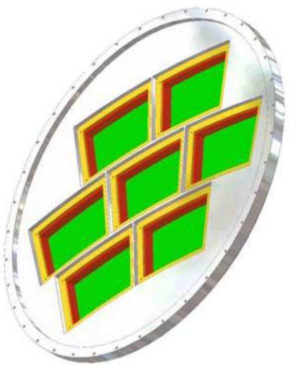
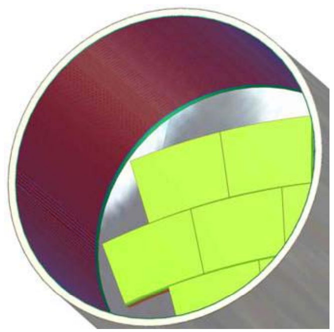
TPC Large Prototype Test (LP1)

- LC-TPC group will have a beam test for TPC Large Prototype (LP1) at DESY
  - To measure the performance and extrapolate it to real TPC
  - To clarify unknown problems
- With
  - multi MPGD panels (GEM, MicroMEGAS)
  - same field cage, endplate, readout electronics and analysis code for GEM and MicroMEGAS
  - PCMAG from KEK supplies 1 T magnetic field





- Asia Group will prepare GEM panels for the test
- In this talk, I will present a study of a GEM TPC Prototype for the LP1 Test (we call it as "PrePrototype").

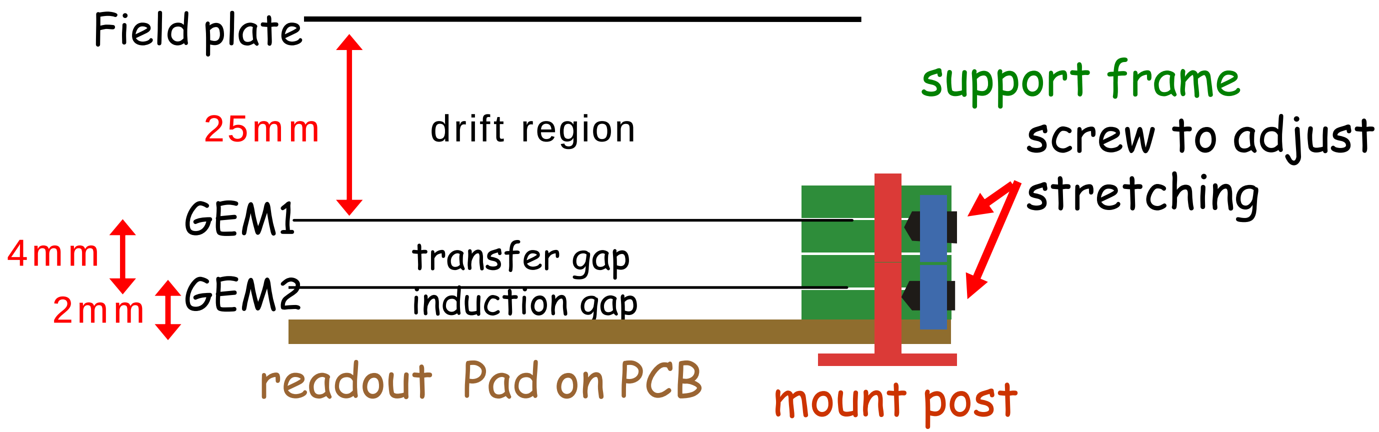
PrePrototype Test

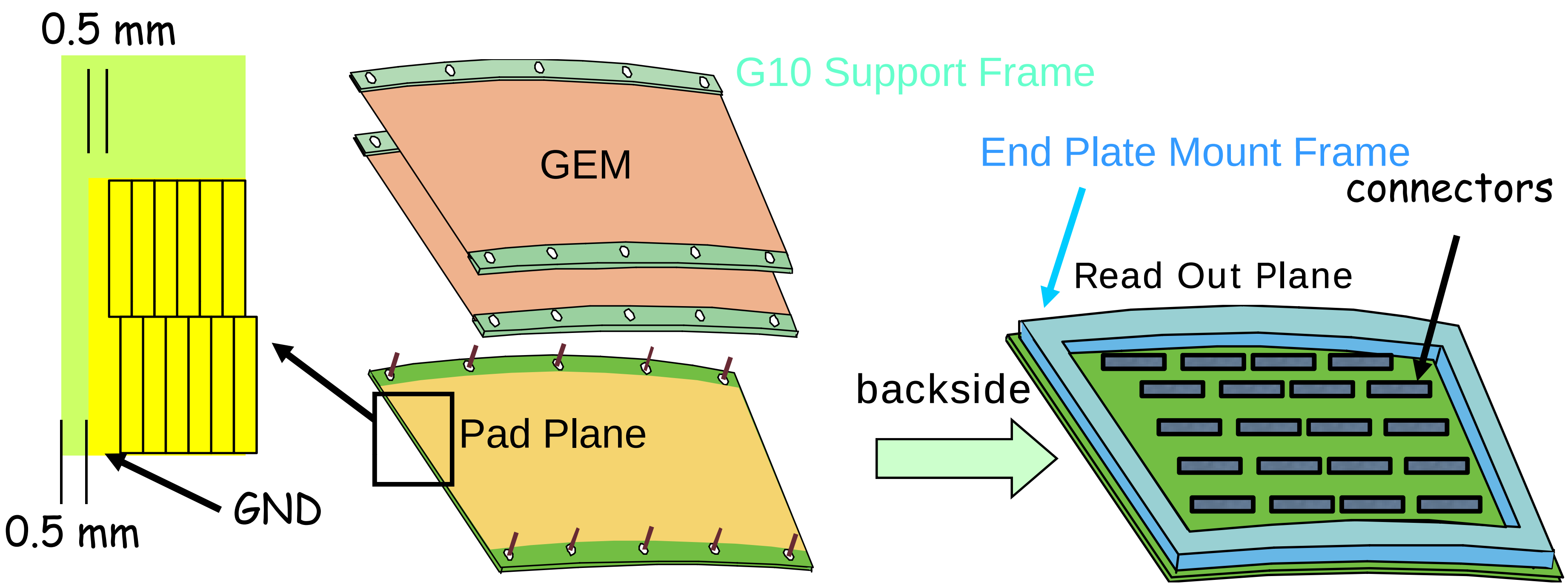
- Purposes of the PrePrototype test
  - Mechanical study
    - Frame gluing to GEM
    - GEM mount system onto PC board (flatness, dead space)
    - Panel mount system onto Endplate
  - Design study
    - Size of pads (related to signal width and size of readout connector)
    - Readout connector
    - PC board design, line pattern (cross talk)
    - HV line
  - GEM study
    - Segmentation and boundary
    - Gain uniformity

- The test does NOT cover
  - Uniformity of Pad Response Function (checked by Laser test)
  - Gating (important for GEM, not for MicroMEGAS??)

Structure of the PreProtoType

- 100um thick Double GEM

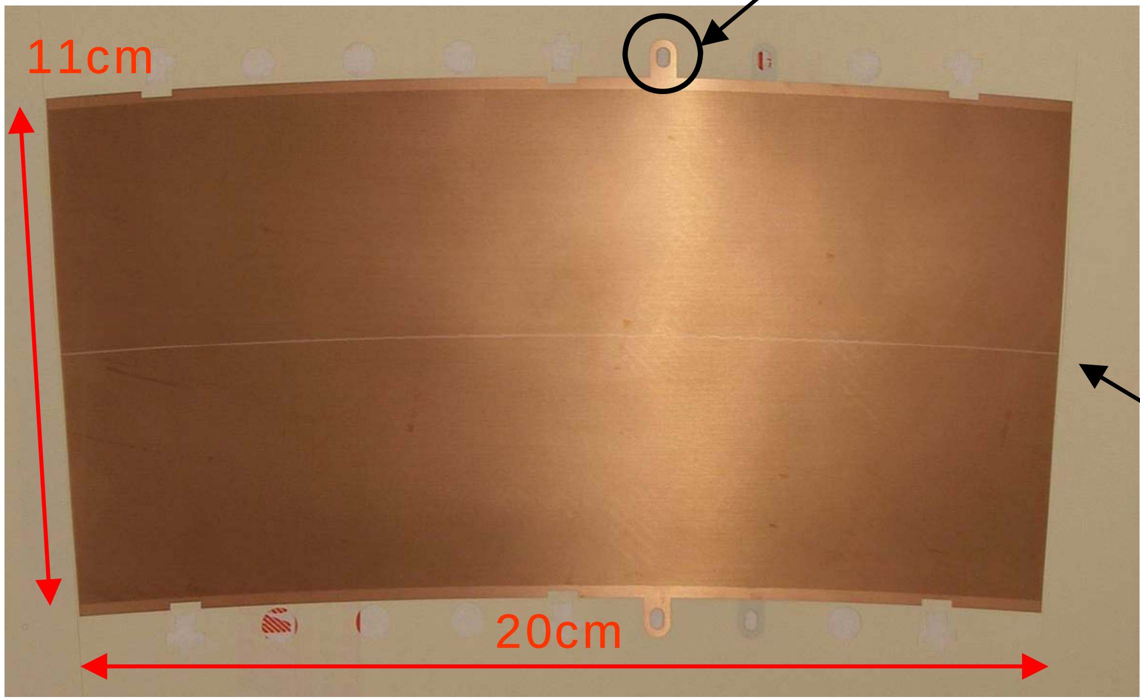




GEM

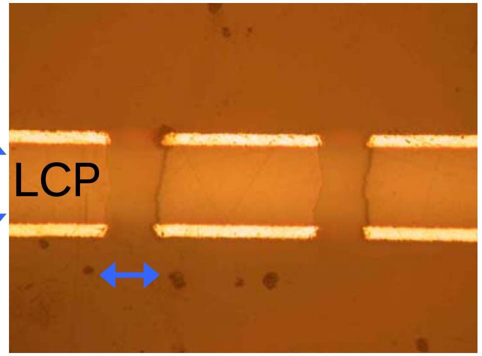
- 100um Liquid Crystal Polymer (LCP) insulator btw 5um Cupper electrodes by Scienergy Co..
  - 70um hole diameter, 140um pitch
  - cylindrical hole shape (CERN GEM : biconical)
  - size of active area ~20x11cm^2 (ϕ=9.3deg, r=128~139cm)
  - electrodes divided into two to keep the stored energy (capacitance) small enough

HV line



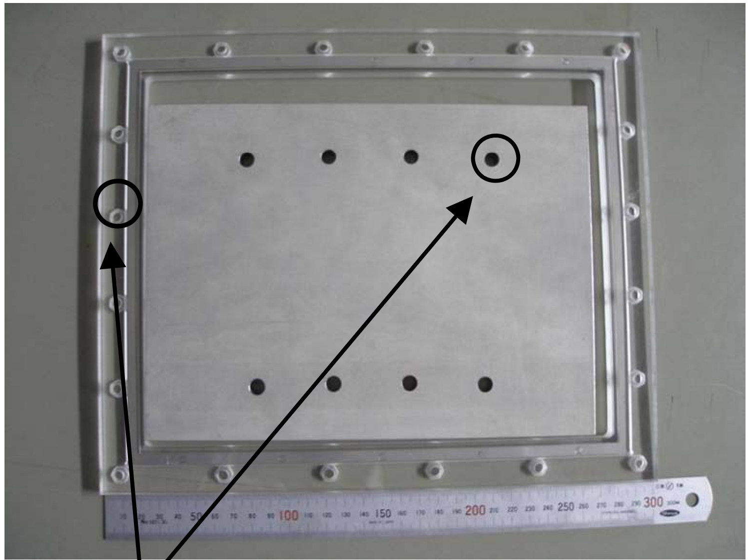
boundary

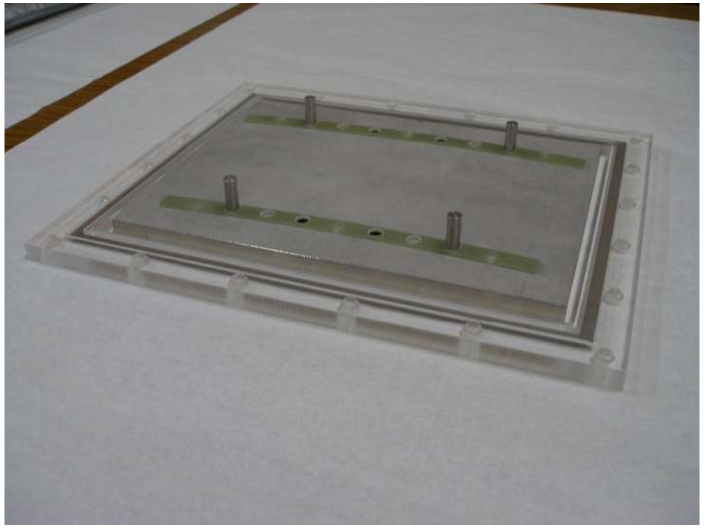
100um



70um

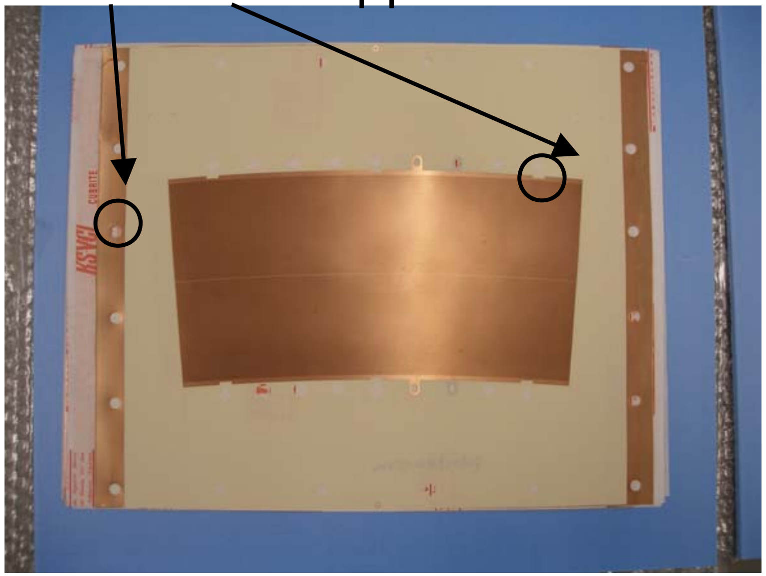
GEM Stretcher for Frame Gluing

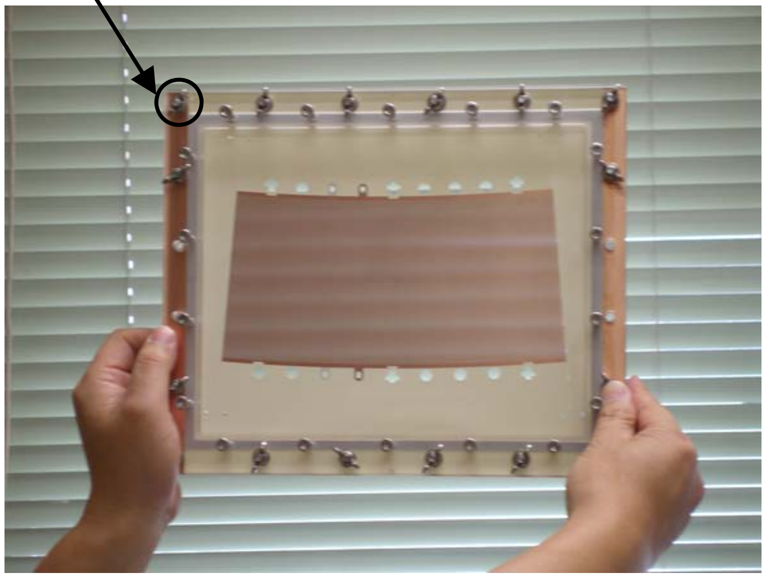




put pins in the holes to adjust GEM foil and support frame

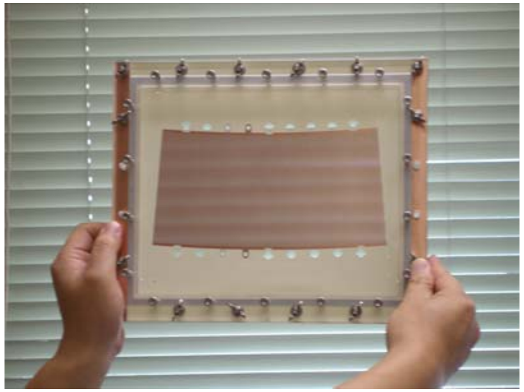
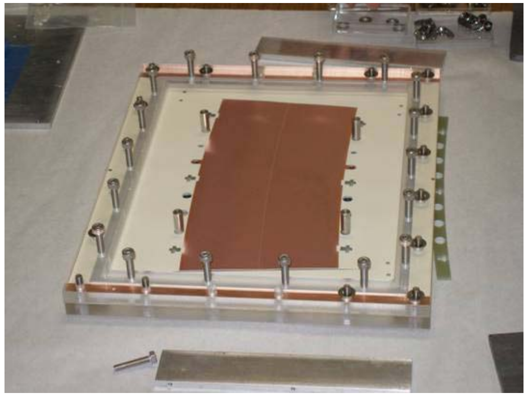
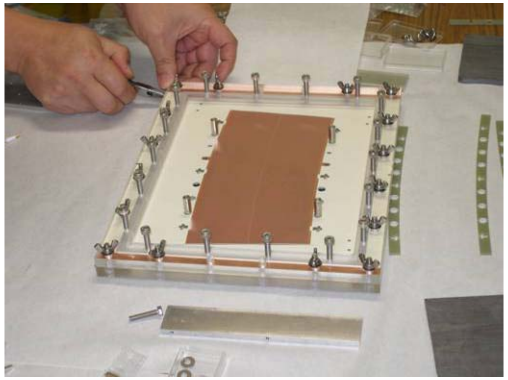
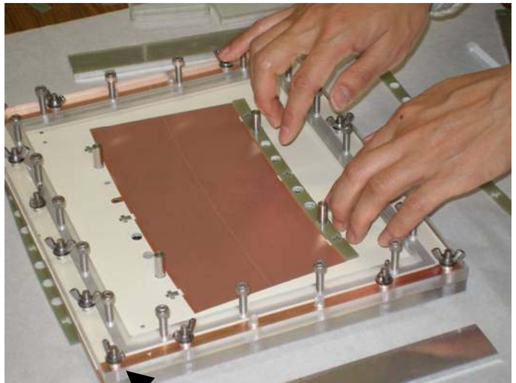
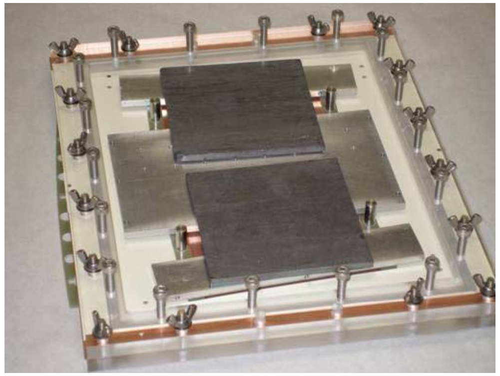
bolts to stretch GEM by screwing





Frame Gluing

- frame gluing with the stretcher

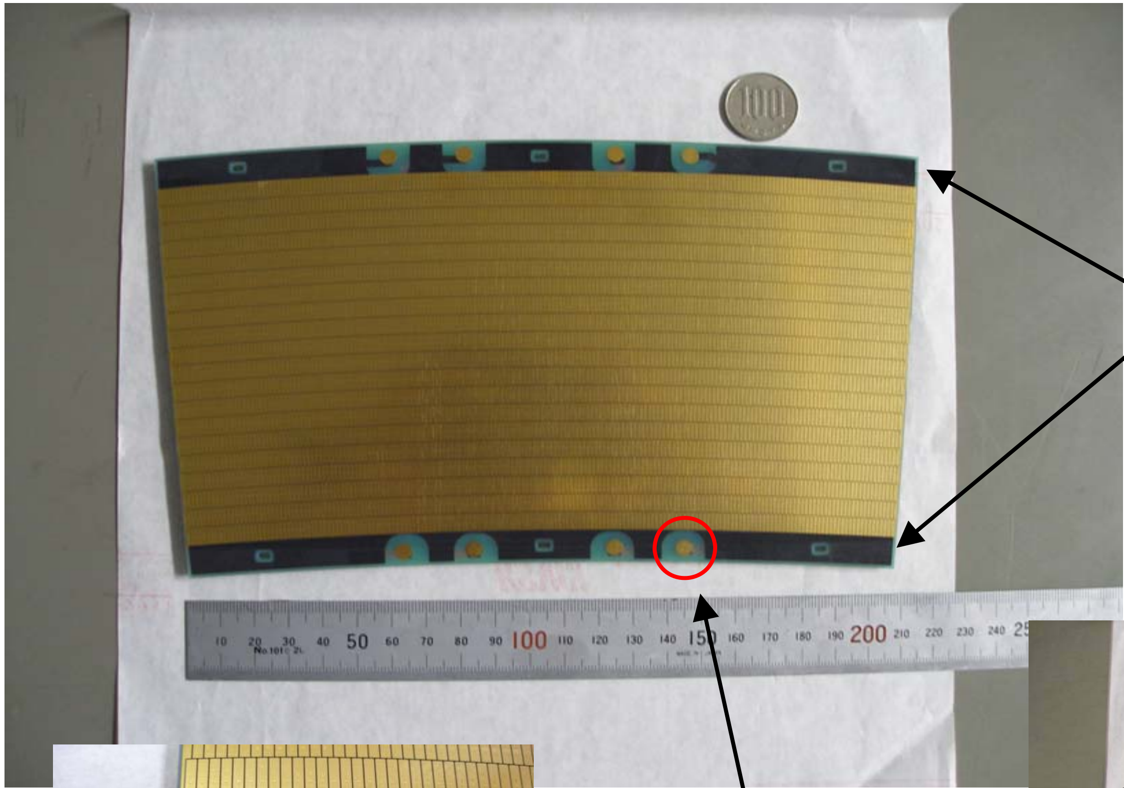







bolt

Frame gluing is established. No problems found.

3 GEMs/day is possible (Limited by adhesive induration time).

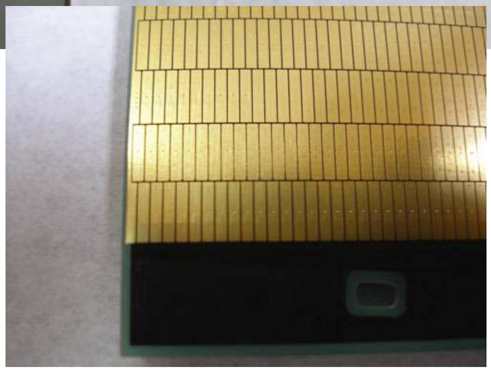
Readout PC board



R_{in}=1273mm
R_{out}=1404mm
ϕ=9.2deg
39 panels needed to cover 360deg

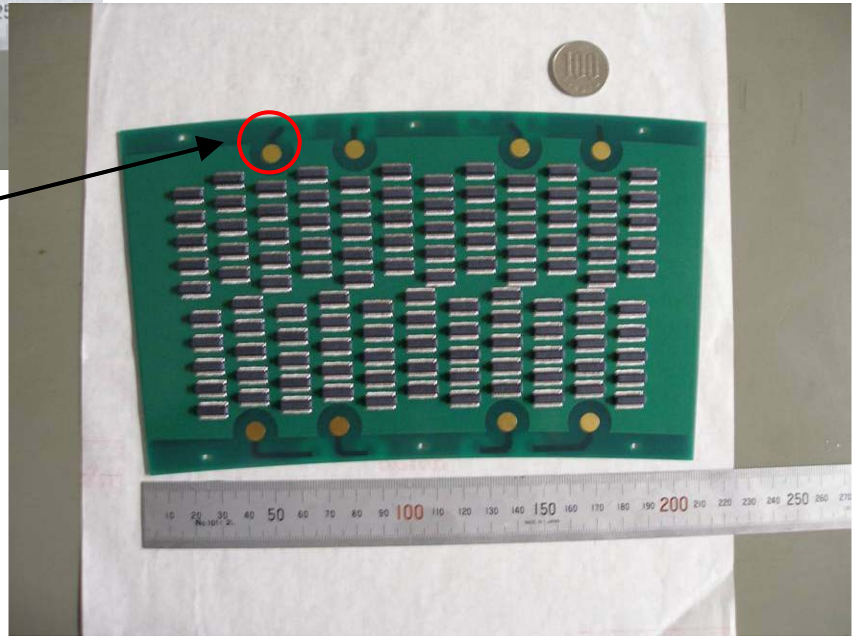
1cm dead space

Pad size ~ 1.1 x 5.5 mm^2
20 pad rows
192 pads (outer half row)
176 pads (inner half row)
in total 3680 pads

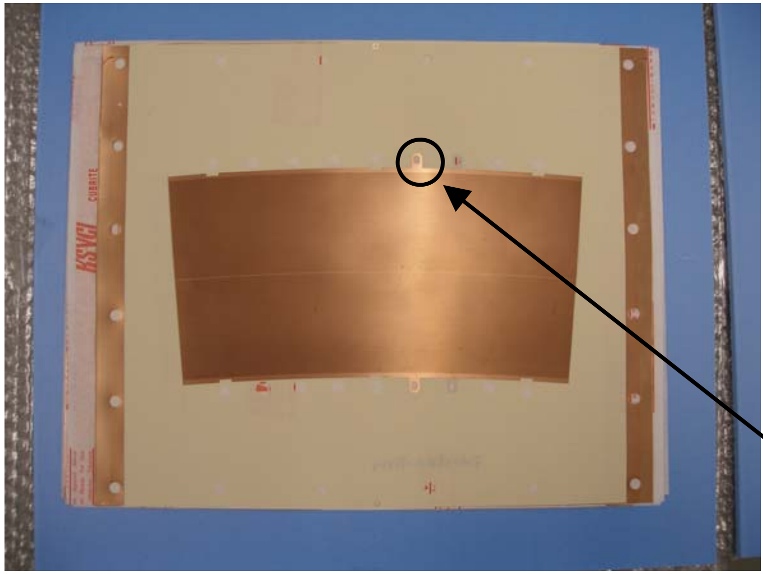


Staggered Pads

HV Line

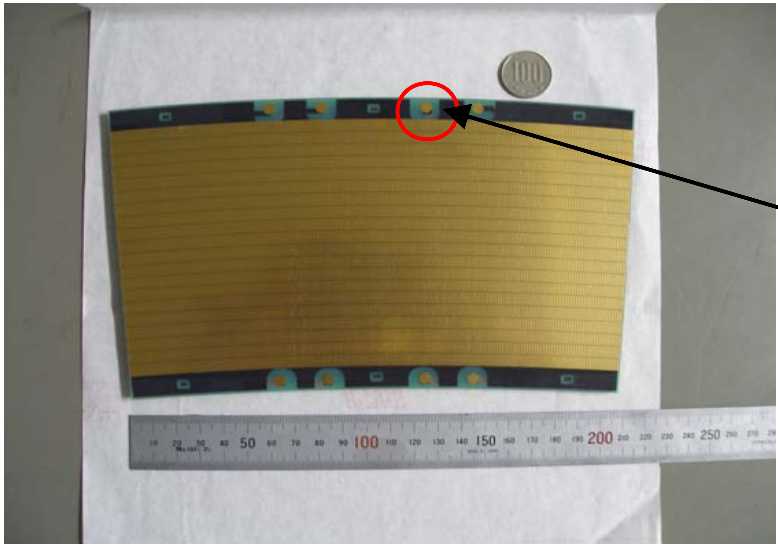


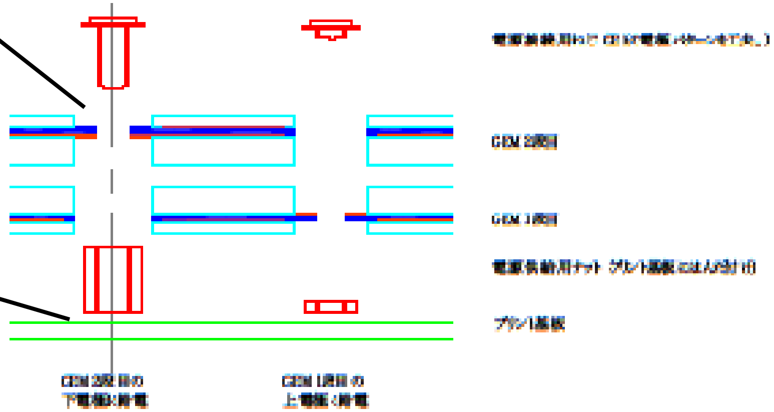
HV supply electrode



brass bolts and nuts

bolt and nut method

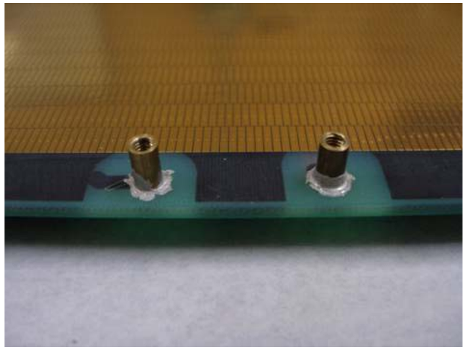




HV connector/nut adhesion

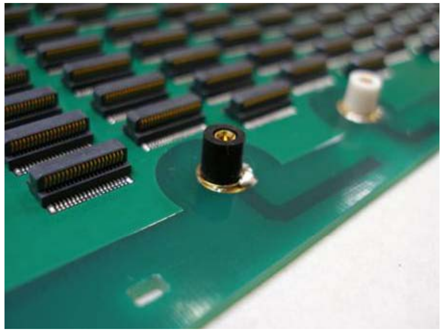
- Two methods are tried.
  - gluing and soldering

Pad plane side

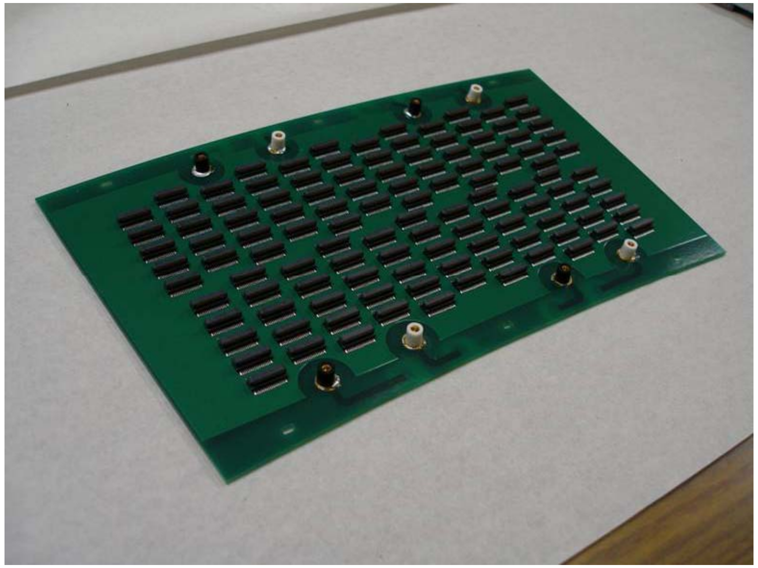


Gluing with dotite
(conductive paste)

Readout side



Soldering

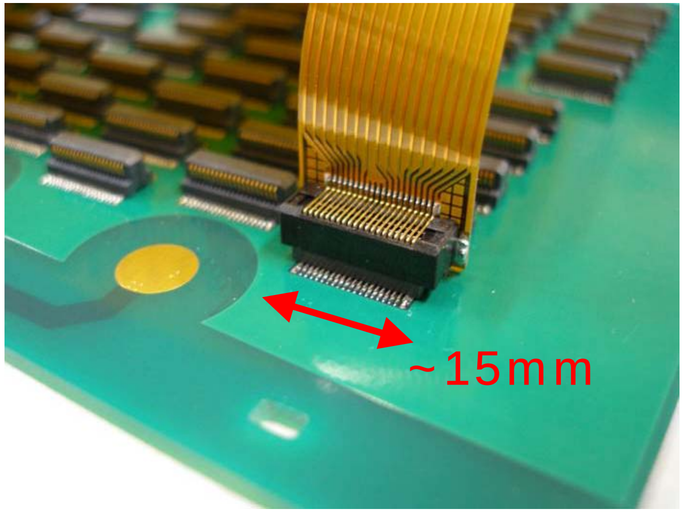


Soldering is much stronger than gluing. Further, dotite produces threads.

→Soldering should be used for LP1 (thermal capacity should be small)

Readout Connector

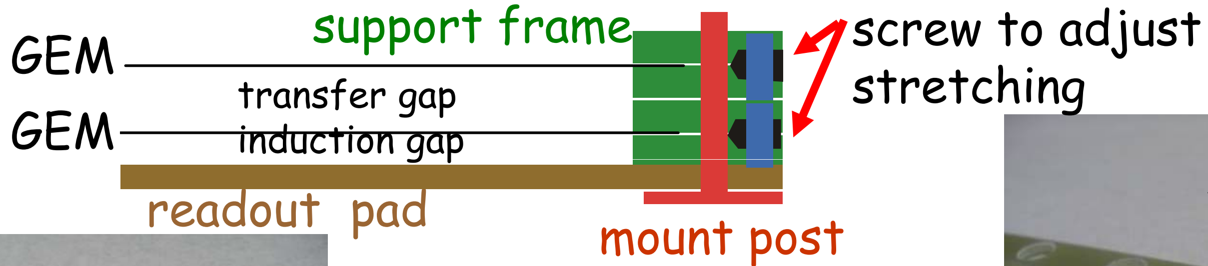
- smaller is better for small pads (1.1x5.5mm^2)
  - connector by JAE
    - size ~15x4mm^2
    - 20ch x2 = 40ch
    - signal 32ch, ground 8ch
  - easy disconnection. So support system is needed
    - readout preamp/flush ADCs boards are directly connected for LP1
    - so far, we do not have alternatives

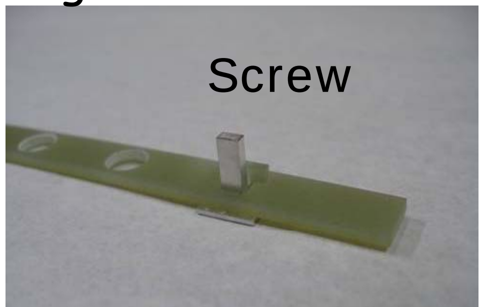


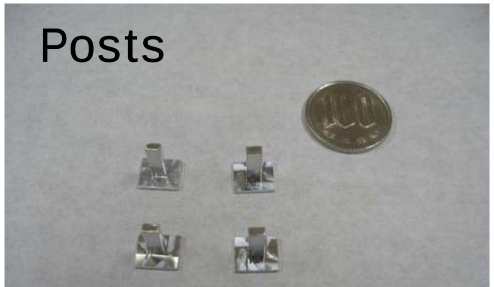
GEM Mount Post

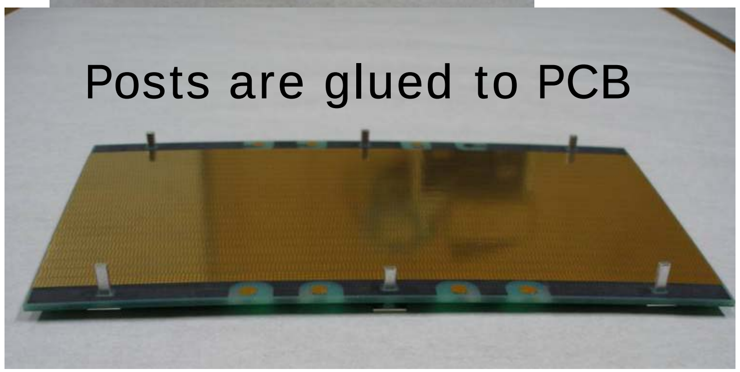
- GEM panels are mounted by screwing the bolts attached to the support frame
  - GEM panels are detachable
  - no gluing btw GEM support frame and PCB

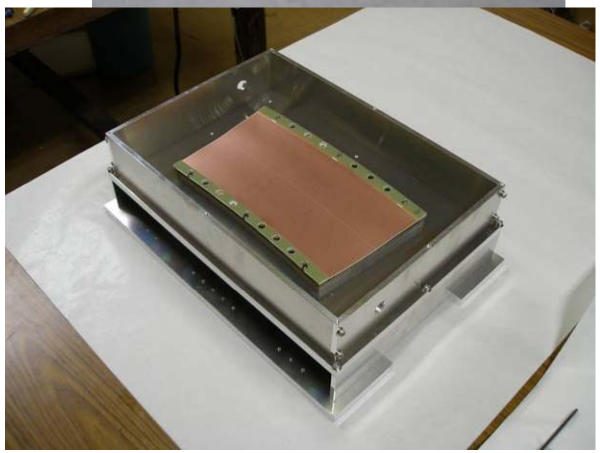
discussion : detachable or not for real TPC





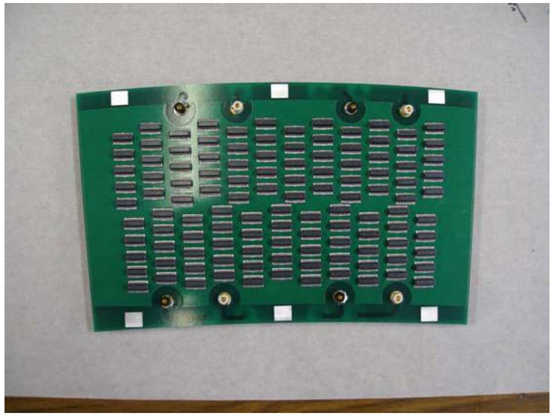


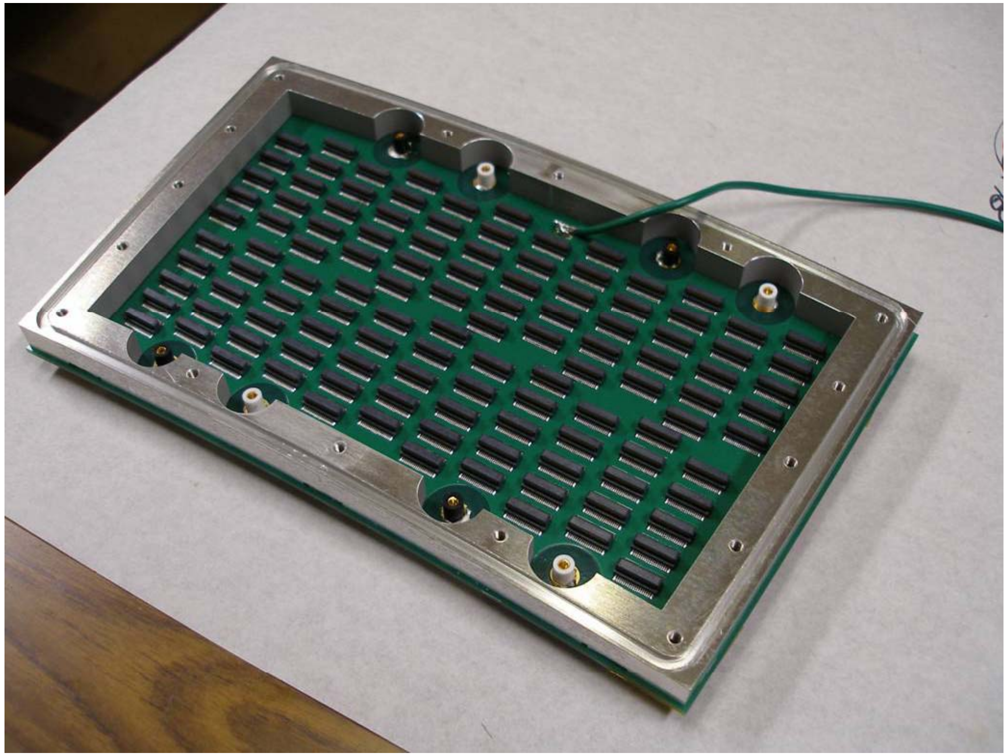




Support/Mount Frame for PCB

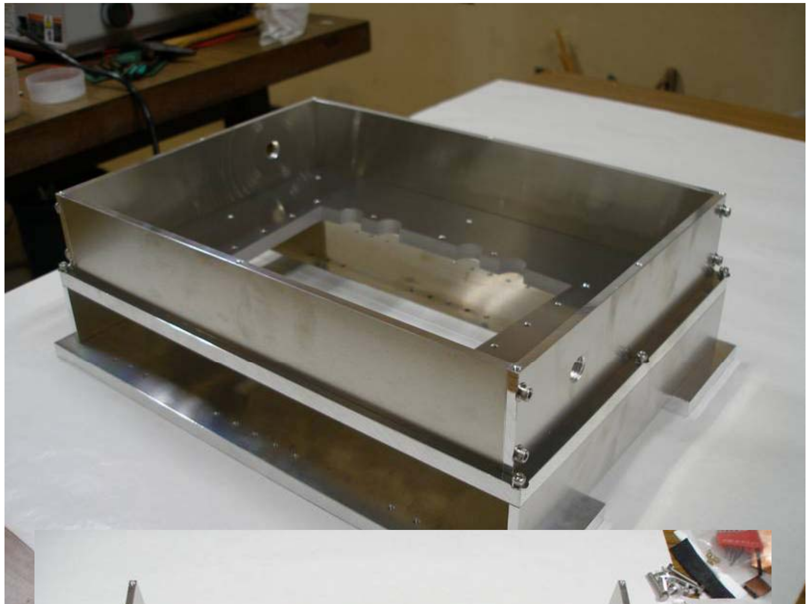
- 1cm thick Aluminum Frame with
- Glued with epoxy adhesive
- Alignment posts should be used for LP1
  - we aligned by hand this time
- Need to reduce material for real TPC

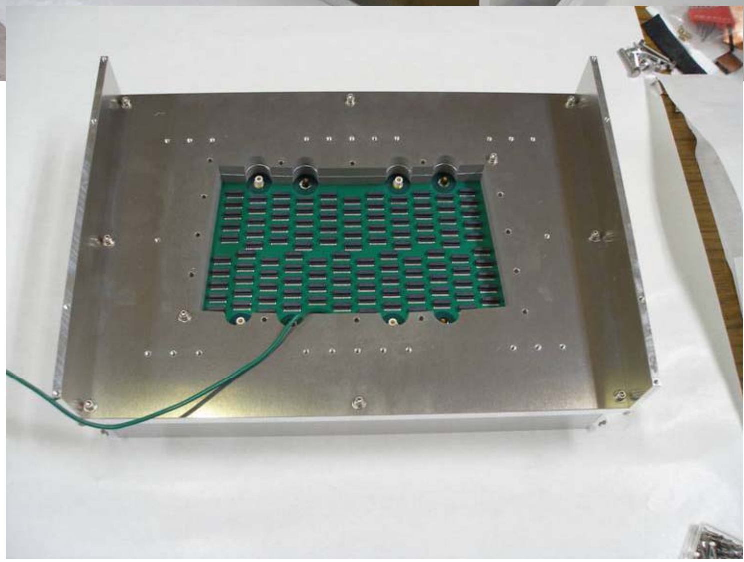


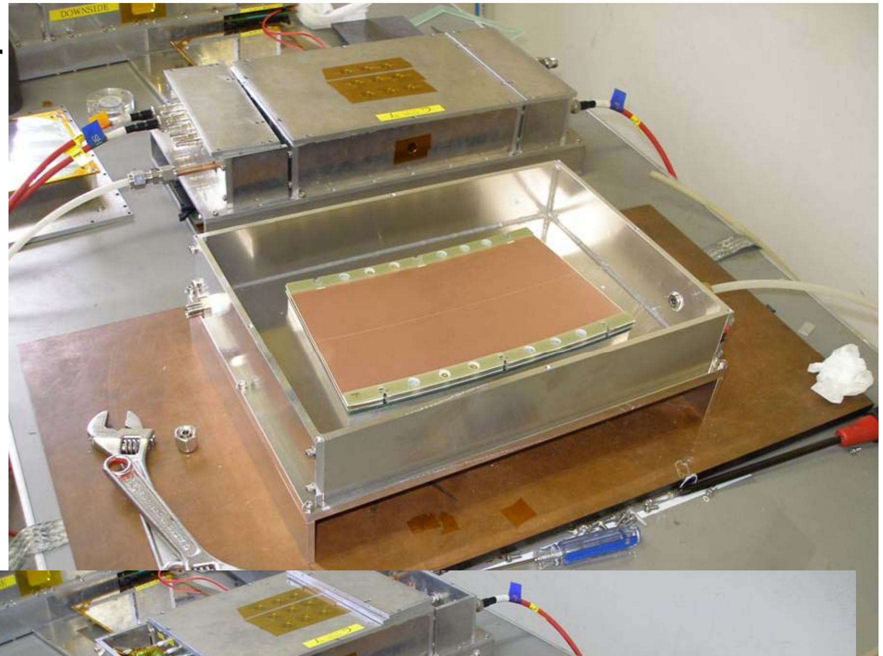


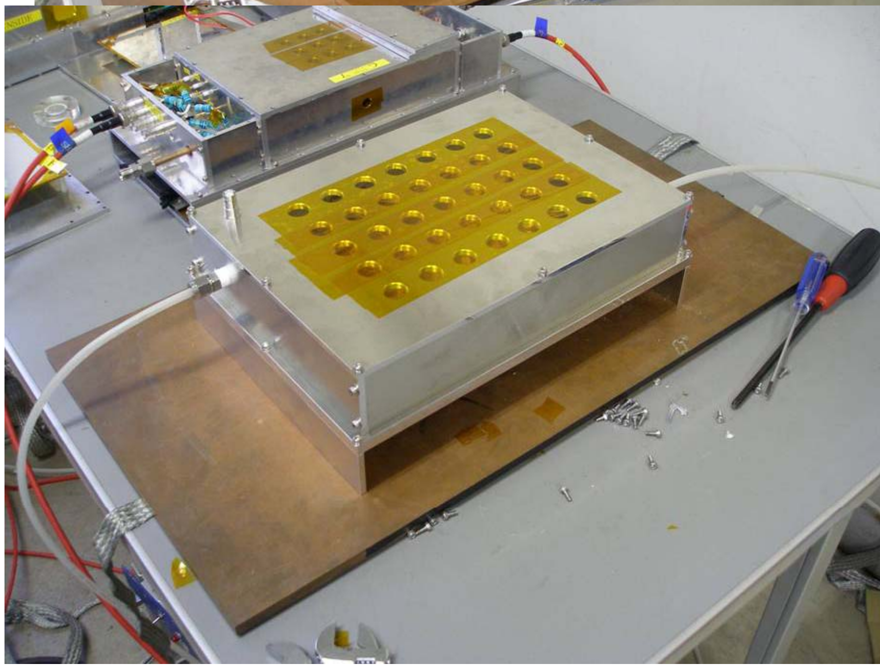
Gas Container

- A panel is mounted to gas container
- processing has done with N_2



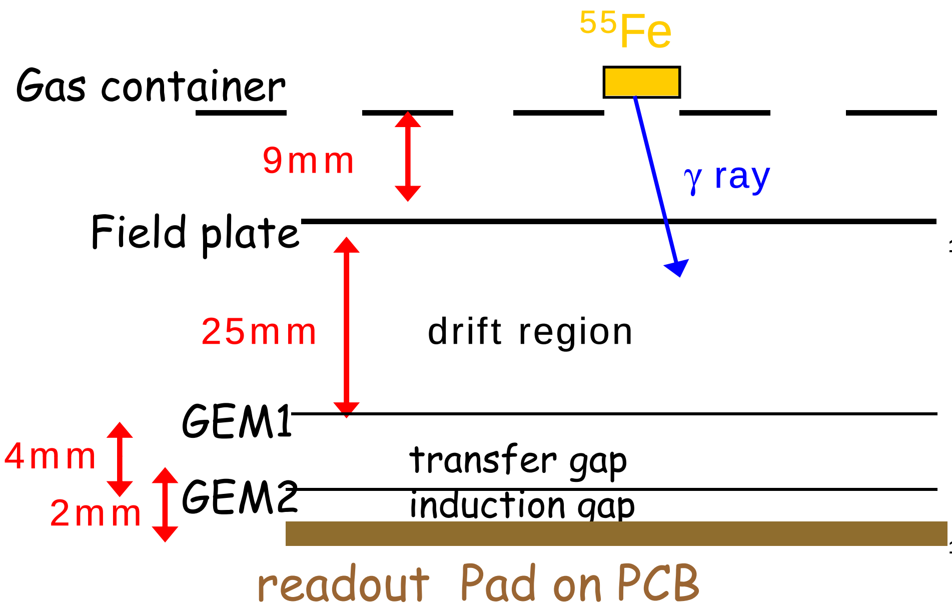


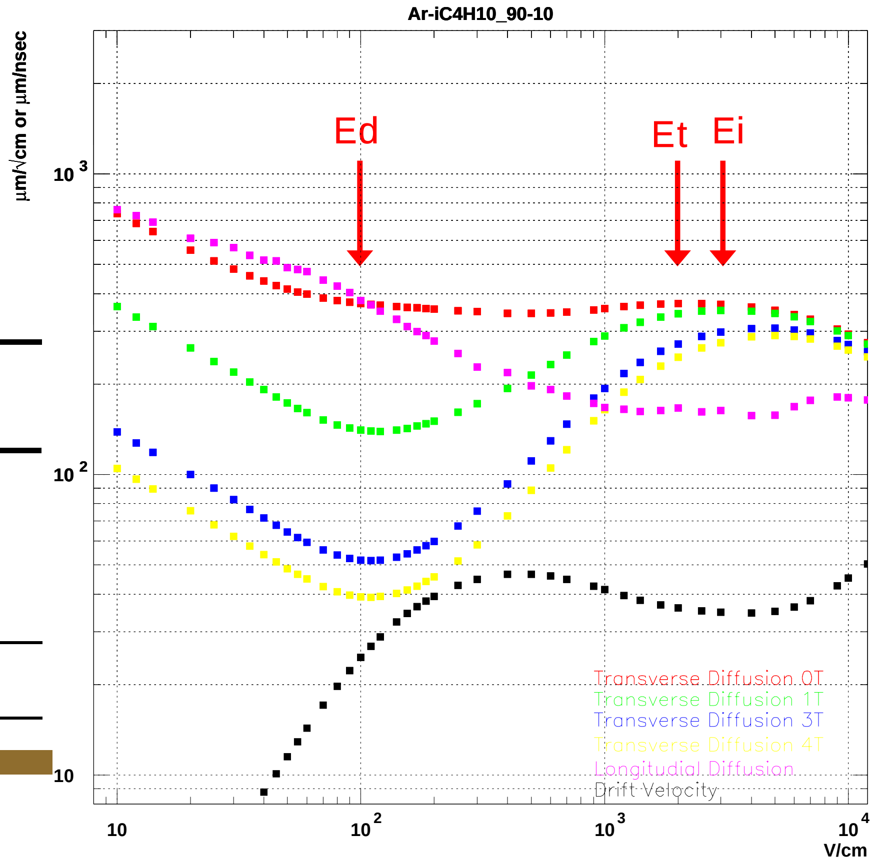




Measurement of Gain Uniformity over Panel

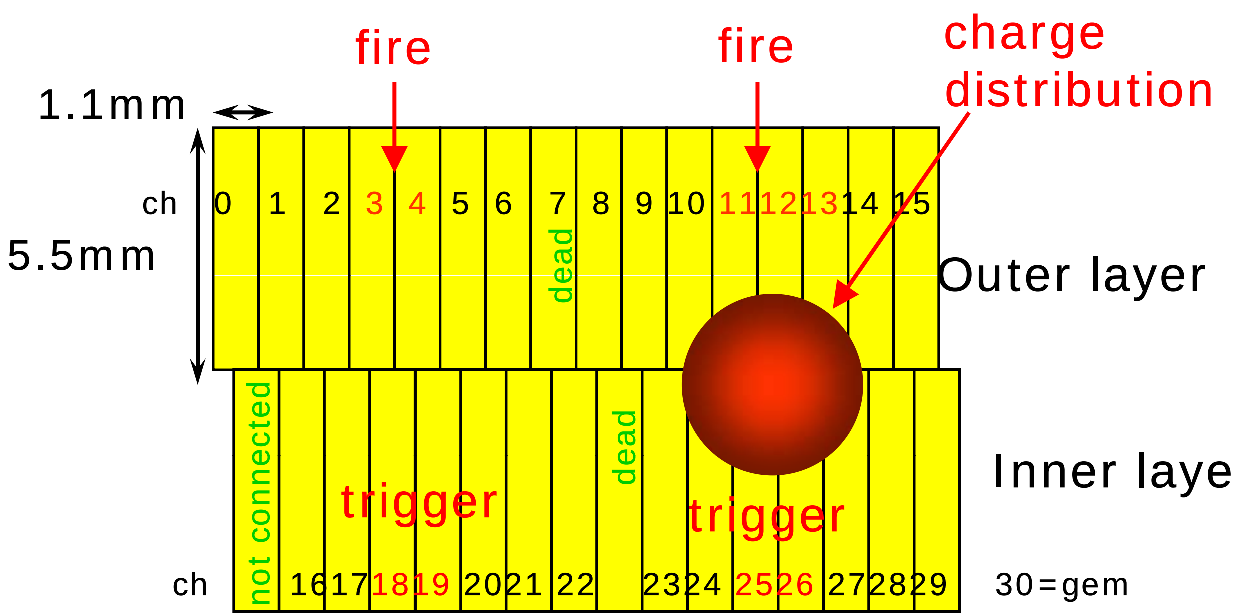
- We measure the gain uniformity over panel.
  - Data was taken just before I left Japan to come to DESY.
  - The result is very very preliminary
- Setup
  - Gas : Ar-Isobutane 90:10
  - HV : VGEM=410V, Ed=100V/cm, Et=2050V/cm, Ei=3075V/cm
    - signal spread ~550um
    - Gain : ~2x10^4
  - ^{55}Fe source





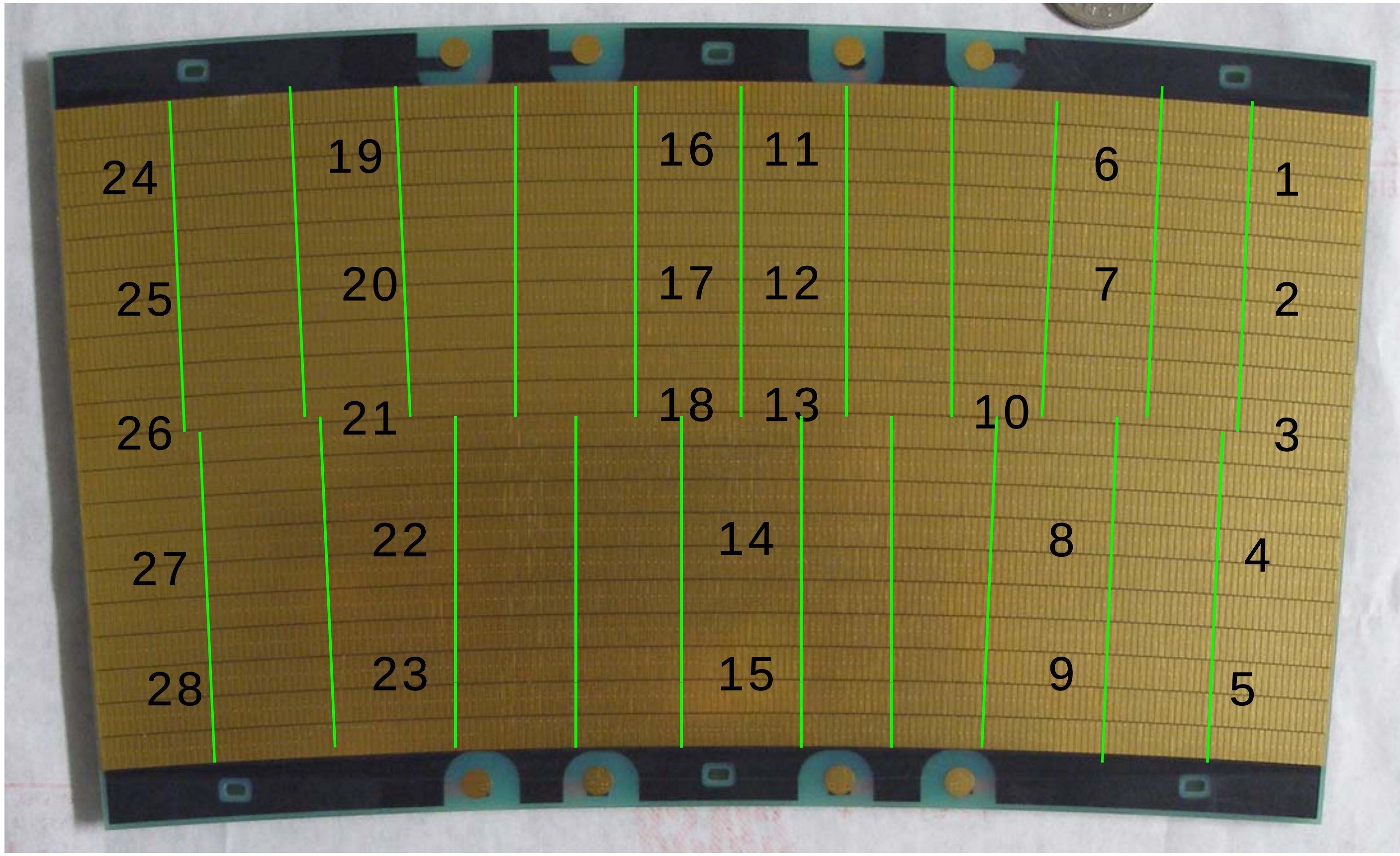
Measurement of the Energy Distribution

- Signal spread is about ~550um
  - → 3~4 Pads are fired in same pad layer.
  - → charge is sometimes shared by 2 layers.
- We have 2 postamps with 32ch (31 alive ch, 1 dead ch)
  - trigger 18, 19, 25 and 26ch
  - Require charge sharing btw two layers (ex. (25||26)&&(11||12||13))
  - Sum charge for each layer, in total 10 pads' charge.



Measured Positions

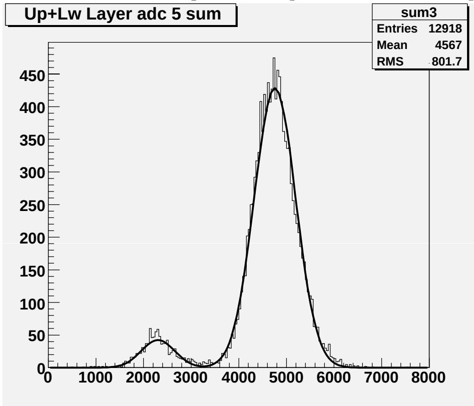
- 28 positions described below
- neighbor channels are connected to ground to avoid field distortion due to charge-up.

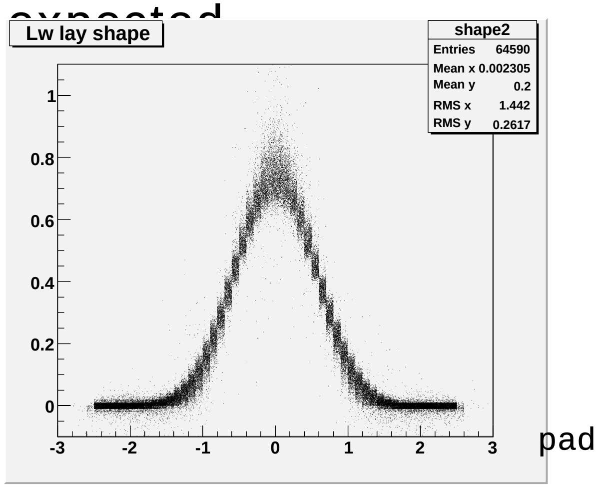


Charge Distribution

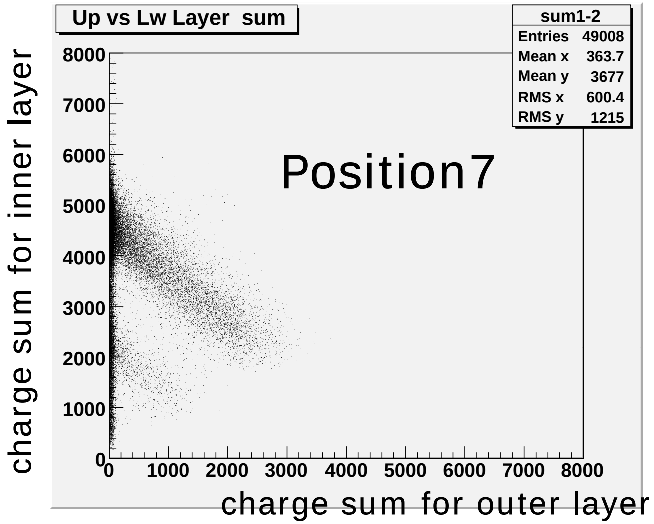
- Both main and escape peaks can be seen
- Signal width is ~0.5 pad(550um) in sigma as expected

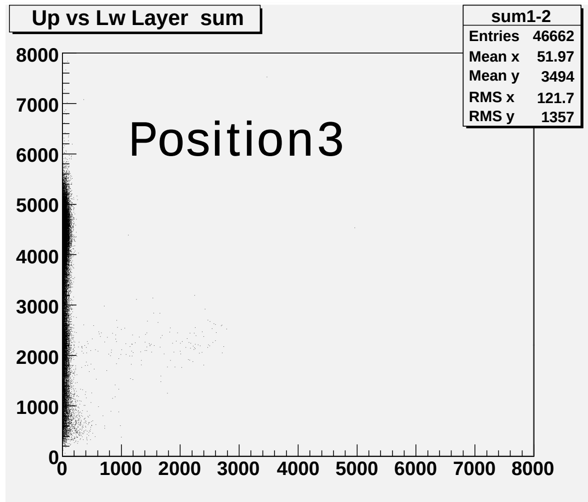
Position7





- No charge sharing for positions 3, 10, 18, 21 and 26.
  - due to GEM electrode boundary?
  - Charge sharing is not required for these positions.

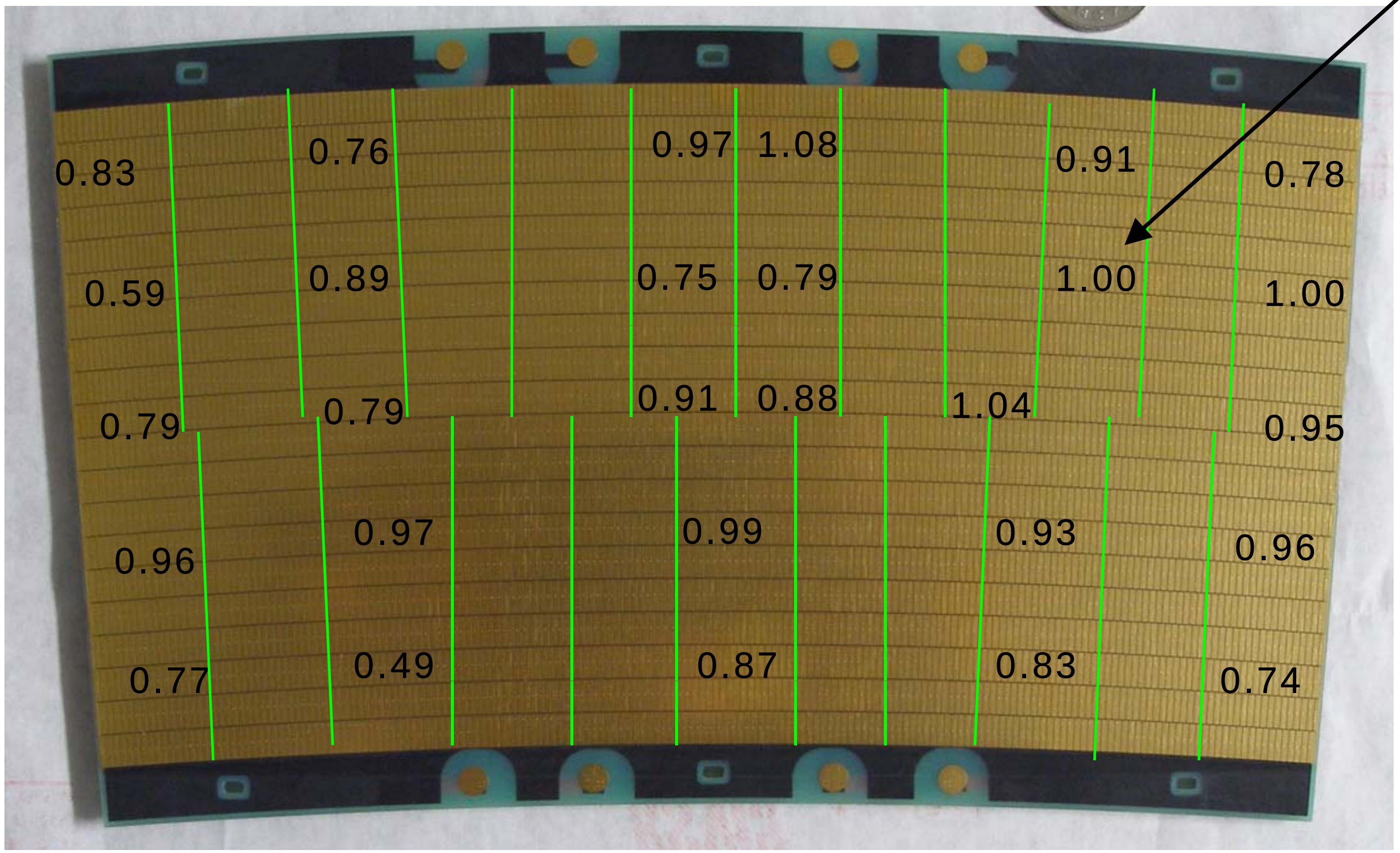




Result

- Gain uniformity is not so good
  - field shaping?
    - grounding for all unused channels.
    - field shaper for side of the panel.
    - field shaping electrodes for support frame.
- Very very preliminary result. we need further investigation.

normalized to
this position



Summary

- We have made a GEM TPC PrePrototype.
- We found (minor) problems for LP1 panel construction.
  - Readout connector is easily disconnected
    - support system should be considered
  - GEM panel mounting : detachable or not (glued to PCB)
    - need further discussions
  - alignment of support frame for PCB
    - alignment posts should be added

- We measure the Uniformity over panels
  - uniformity is not good
  - field shaping is not good?
  - we need further investigation