GEM Panel for LP1

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For CDC group

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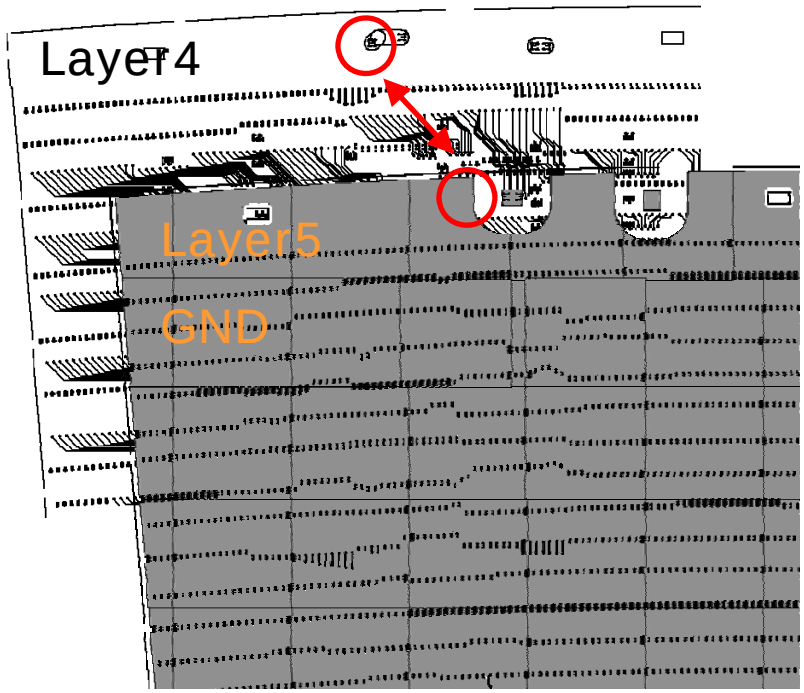
Design Principle

- Three requirements
  - two track separability in ϕ direction less than 2mm
  - Position resolution less than 150um with Ar-CF_4 based gas
  - survive under 1% occupancy (C. Damerell's comment at tracker review)

- PCB
  - Small pad size for two track separability and signal width of ~350um
  - every two rows staggered to resolve S-shape systematics
- GEM and Frame
  - Simple structure with thick double GEM
  - Defocusing capability
  - Minimization of dead space pointing to IP
- GEM gating
  - ion feedback probability less than a few x 10^{-4}
  - Easy mounting onto multiplication GEM

Feedback from the PrePrototype Test

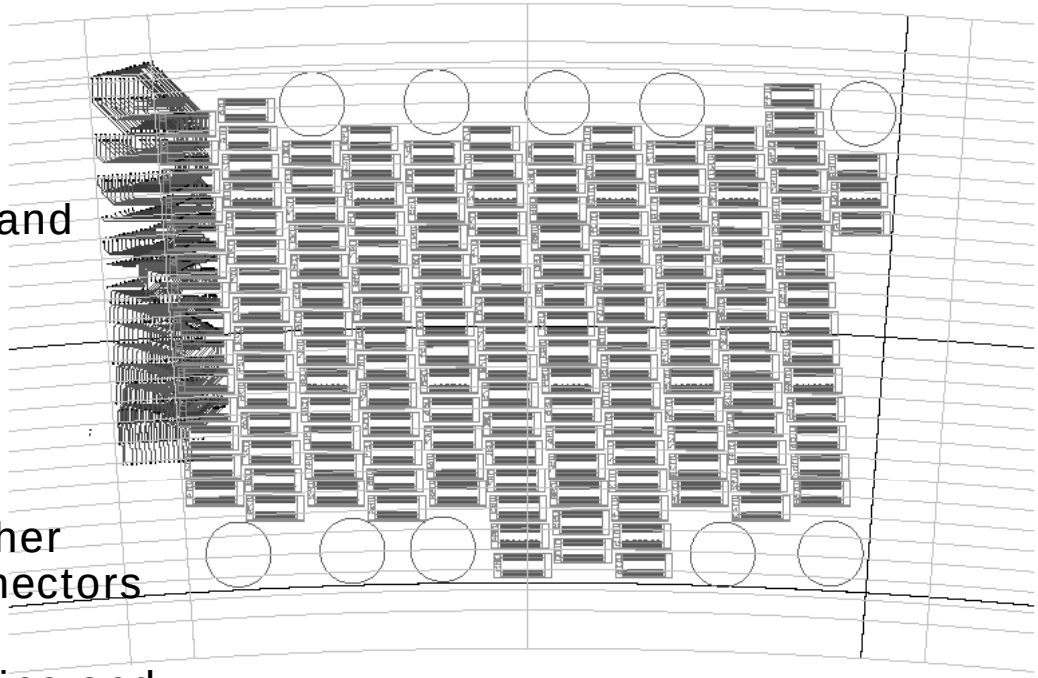
- Problems found to be fixed for LP1 panel.
- The biggest problem
  - Short btw HV line in PCB and GND or mount flange
    - Only single FR4 layer btw them
    - breakdown voltage for single FR4 layer (0.38mm) is 2.6kV.
    - → at least two FR4 layers btw them
- Minor problems
  - HV connector screw head easily broken
  - Aluminum bolts hard to solder
    - we planned to adhere it with conductive paste but it is too weak, so choose soldering.
  - No alignment mechanism btw panel and flange
  - No GND connector.

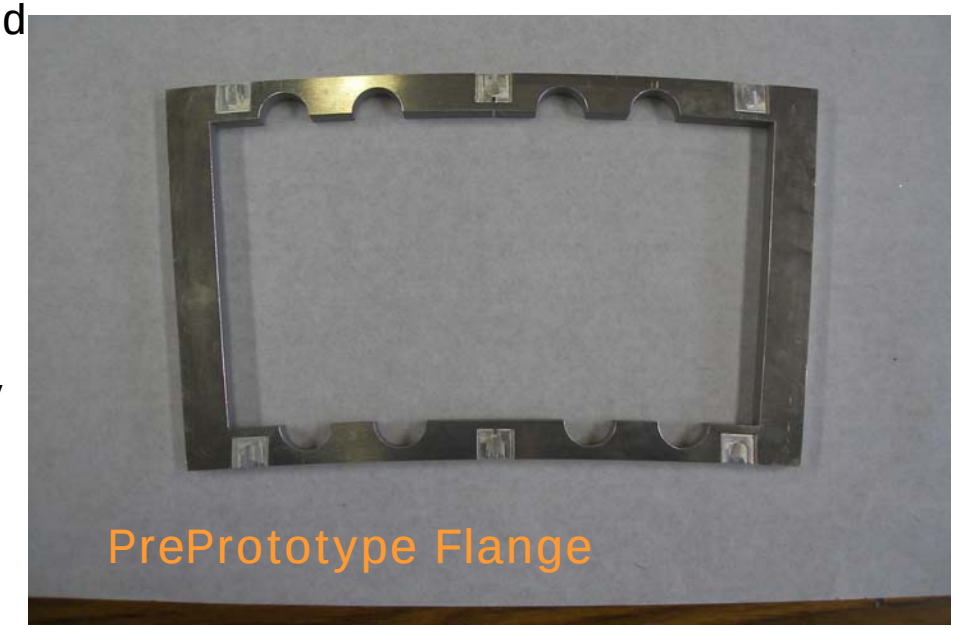


- No large modification for LP1 panel from PrePrototype

PCB

- 28 pad rows
- 176 and 192 channels for inner and outer half rows
- In total 5152 channels and 161 connectors
- every two rows staggered
- Pad size ~1x5mm^2
- Connector density is slightly higher than PrePrototype since HV connectors are inside bounding box
- At least two FR4 layers btw HV line and GND, signal line and flange to avoid short.
- Design for wiring btw pad and connector is on going at Tsinghua
- Design to be finalized by early Nov 2007
- Delivered in Dec 2007



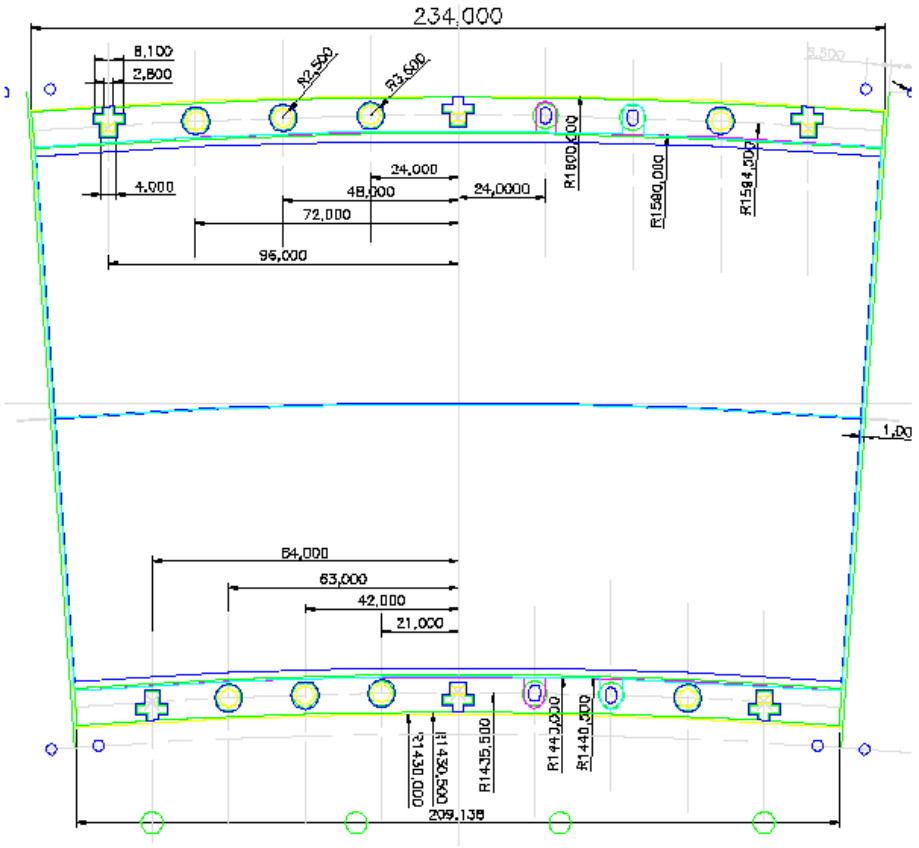


GEM and Frame

- Almost same as PrePrototype GEM

- 100um thickness
- Boundary at center of the GEM
- Size r=143~160cm, ϕ=8.39 deg, S=377cm^2

- 1cm wide and 2mm thick frames glued to inner and outer sides
  - 6mm gap for defocusing (4mm transfer gap + 2mm induction gap)



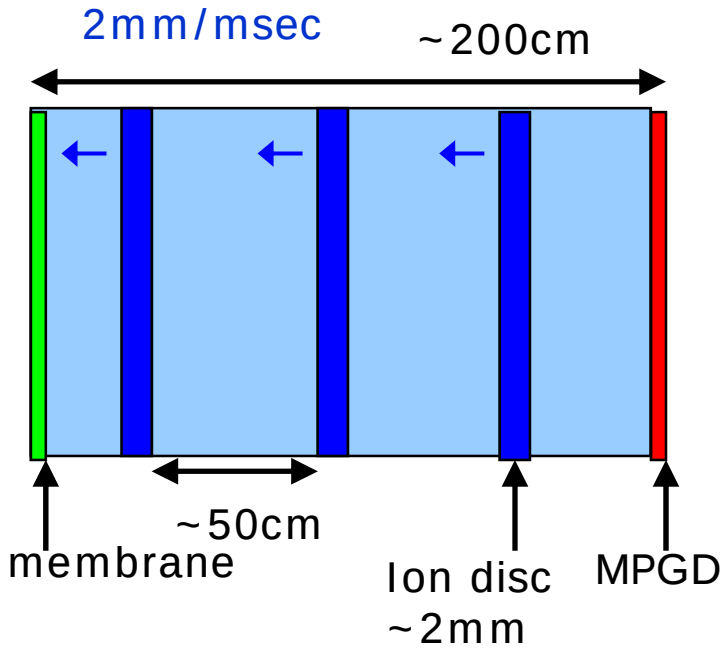
- Design was finalized
- Ordered to Scienergy
- Delivered in Dec 2007

Ion Density without Gating

- Gain ~ several x 10^3
- Self ion suppression capability of MPGD
  - a few x 10^{-3} : MicroMEGAS measured by Saclay
  - a few x 10^{-3} : optimized triple GEM measured by Aachen
  - a few x 10^{-2} : non-optimized double GEM naïvely estimated by Saga
- O(10)~O(100) ions/electron drifting from MPGD.

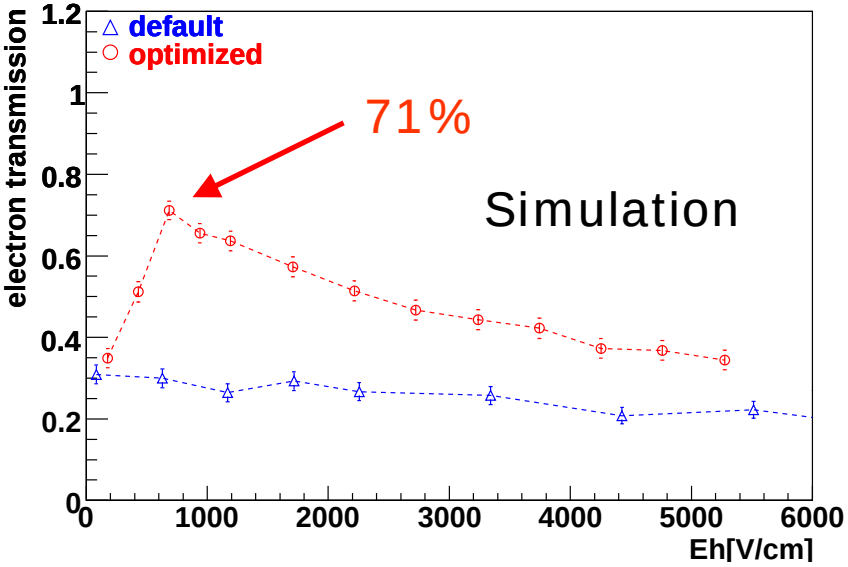
- If we assume
  - Averaged Occupancy 1%
  - Pad size 1x5mm^2
  - Time bucket 25nsec
  - 4 electrons/fired voxel
  - Ion drift velocity 2mm/msec
- Averaged ion density for ion disc is O(10^3)~(10^4) ions/mm^3

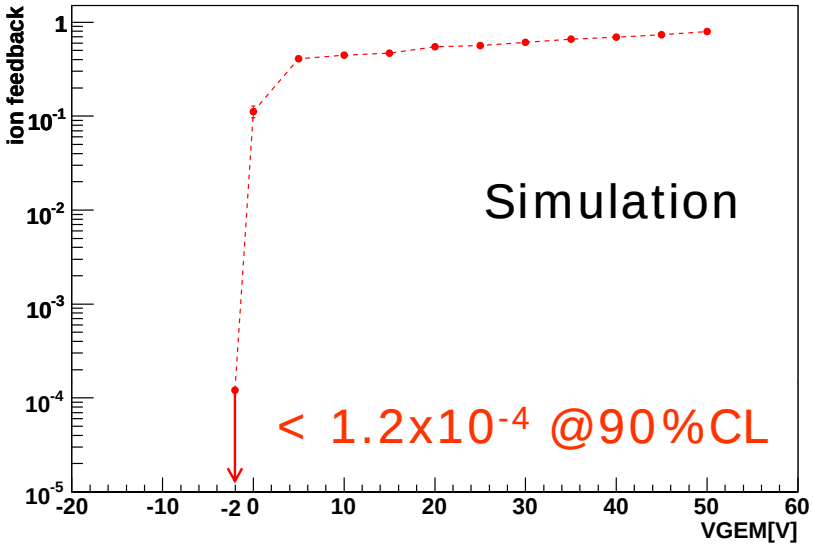
- Can we survive without gating?



GEM Gating

- Thinner and larger hole GEM, and lower drift field
  - 12.5 um^t insulator and 1 um^t electrode (50um^t and 5um^t for nominal GEM)
  - 100 um hole diameter (70um for nominal GEM)
  - Ed=120 V/cm (diffusion minimum)
  - 71% electron transmission
  - < 1.2 x 10^{-4} ion transmission at 90% C.L. (simulate only 20k ion events)
  - < a few x 10^{-6} including self ion suppression of double GEM
- Insulator material, electrode thinning and etching method are being studied by Scienergy.
- Hope to finish the study by May 2008 → delivered in July 2008

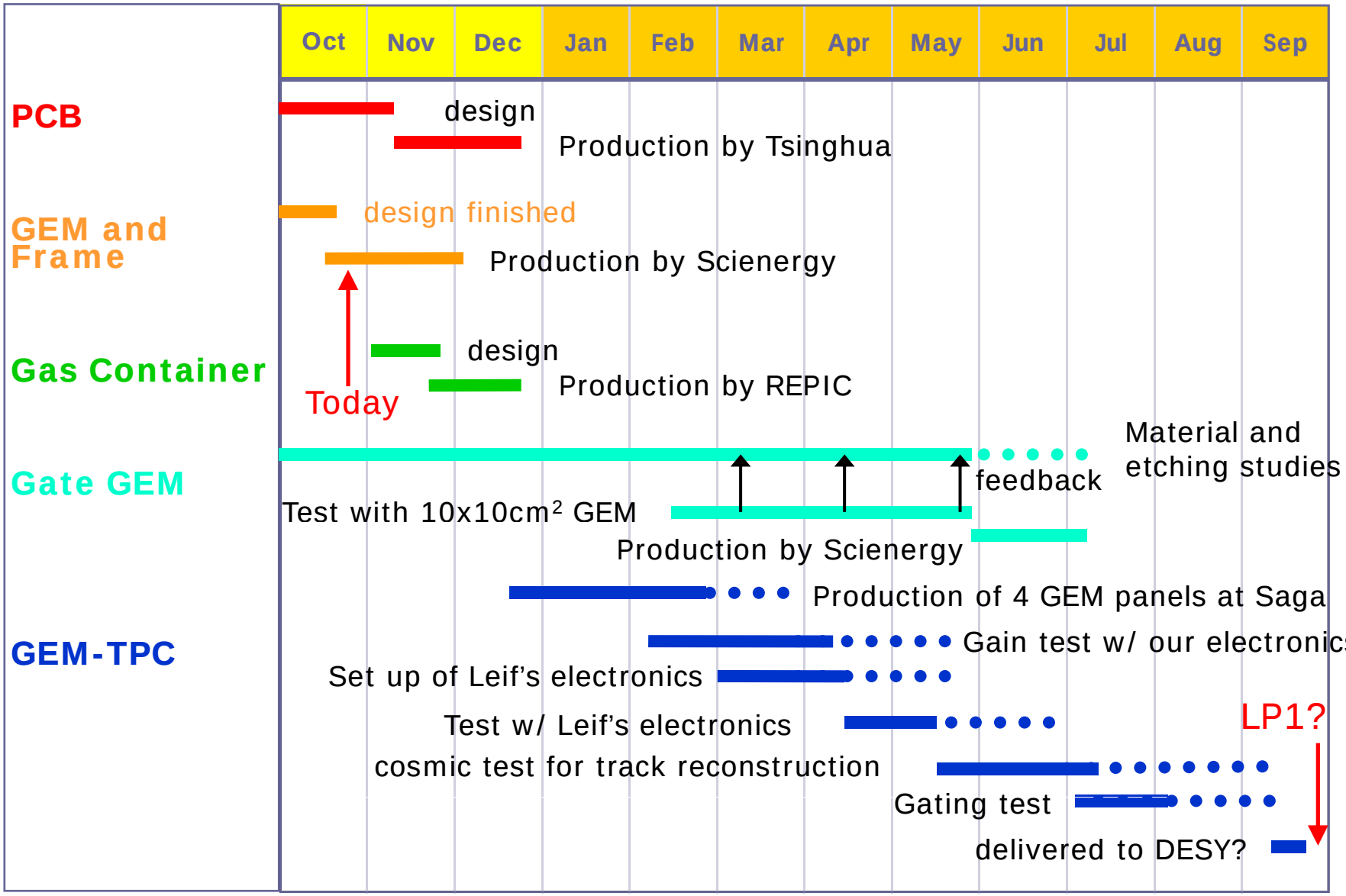




Other Items Needed to Test GEM Panels

- Flange for panel mounting on End Plate/Our Gas Container.
  - To be supplied by Dan.
- LP1 Electronics
  - To be supplied by Leif.

Schedule


Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
PCB
design
Production by Tsinghua
GEM and Frame
design finished
Production by Scienergy
Gas Container
design
Production by REPIC
Today
Gate GEM
Material and etching studies
feedback
Test with 10x10cm² GEM
Production by Scienergy
GEM-TPC
Production of 4 GEM panels at Saga
Gain test w/ our electronics
Set up of Leif's electronics
Test w/ Leif's electronics
LP1?
cosmic test for track reconstruction
Gating test
delivered to DESY?