GEM DHCAL Plans

Jae Yu

CALICE TB Review

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Why GEM's for DHCAL?

- Flexible configurations: allows small anode pads for high granularity
- Robust: survives $\sim 10^{12}$ particles/mm^2 with no performance degradations
- Fast: based on electron collection, ~few ns rise time
- Short recovery time ➔ can handle high rates
- Uses simple gas (Ar/CO_2) – no long-term issues
- Runs at relatively low HV (~400V across a foil)
- Stable and robust operations

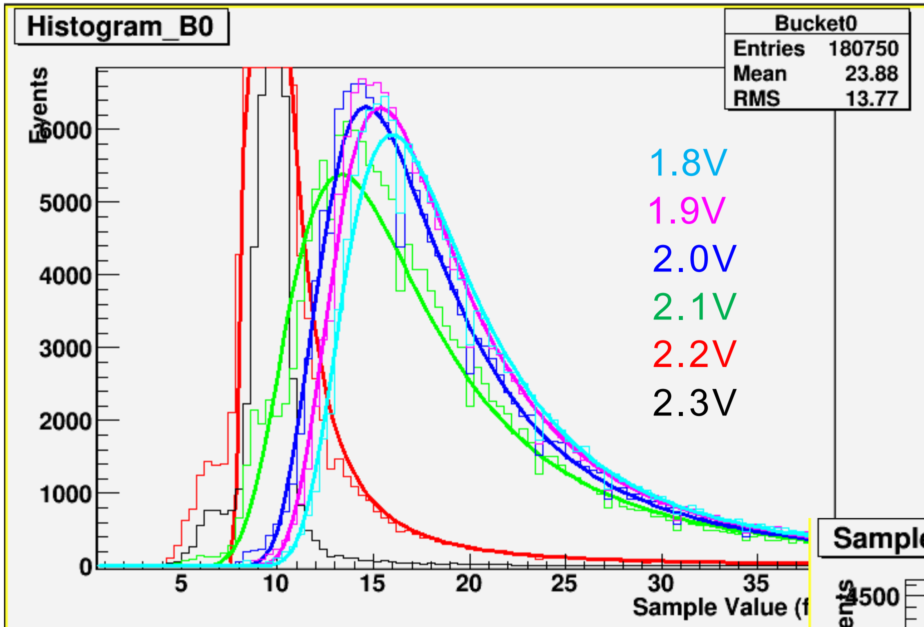
What have been done so far?

- Bench tested with various source and cosmic ray
  - Used QPA02 chip based preamp
  - Verified the signal shape, responses and gain
- Took a beam test at a high flux electron beam
  - First chamber built with 3M's 30cmx30cm GEM
  - Used QPA02 chip based preamp
  - Verified that the chamber can survive
- Took two beam tests at FNAL's MTBF
  - Used QPA02 chip based preamp
  - 8 GeV pion beams and 120GeV proton beams
  - Measured chamber responses, efficiencies and gain
- Multiple channel readout w/ Analog KPiX chips

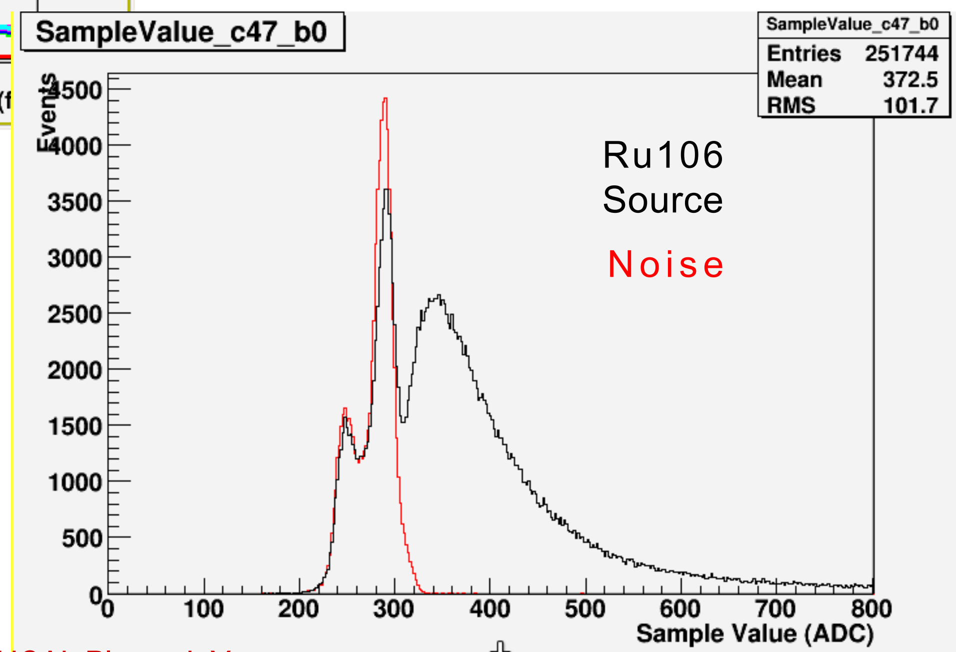
GEM DHCAL Status

- Have been working on getting the SLAC-Oregon KPiX analog chip working with GEM
  - KPiX modified to accommodate smaller GEM signals (>~20fC)
- Signal from source extracted using 64 channel KPiX v4
  - No external trigger acceptance
  - Basically a random trigger with respect to signal arrival
- A chamber with the updated KPiX v7 with external trigger capability working
  - Have been debugging the chip
  - Cosmic and source data taken and being understood
    - 7% duty factor a cosmic killer

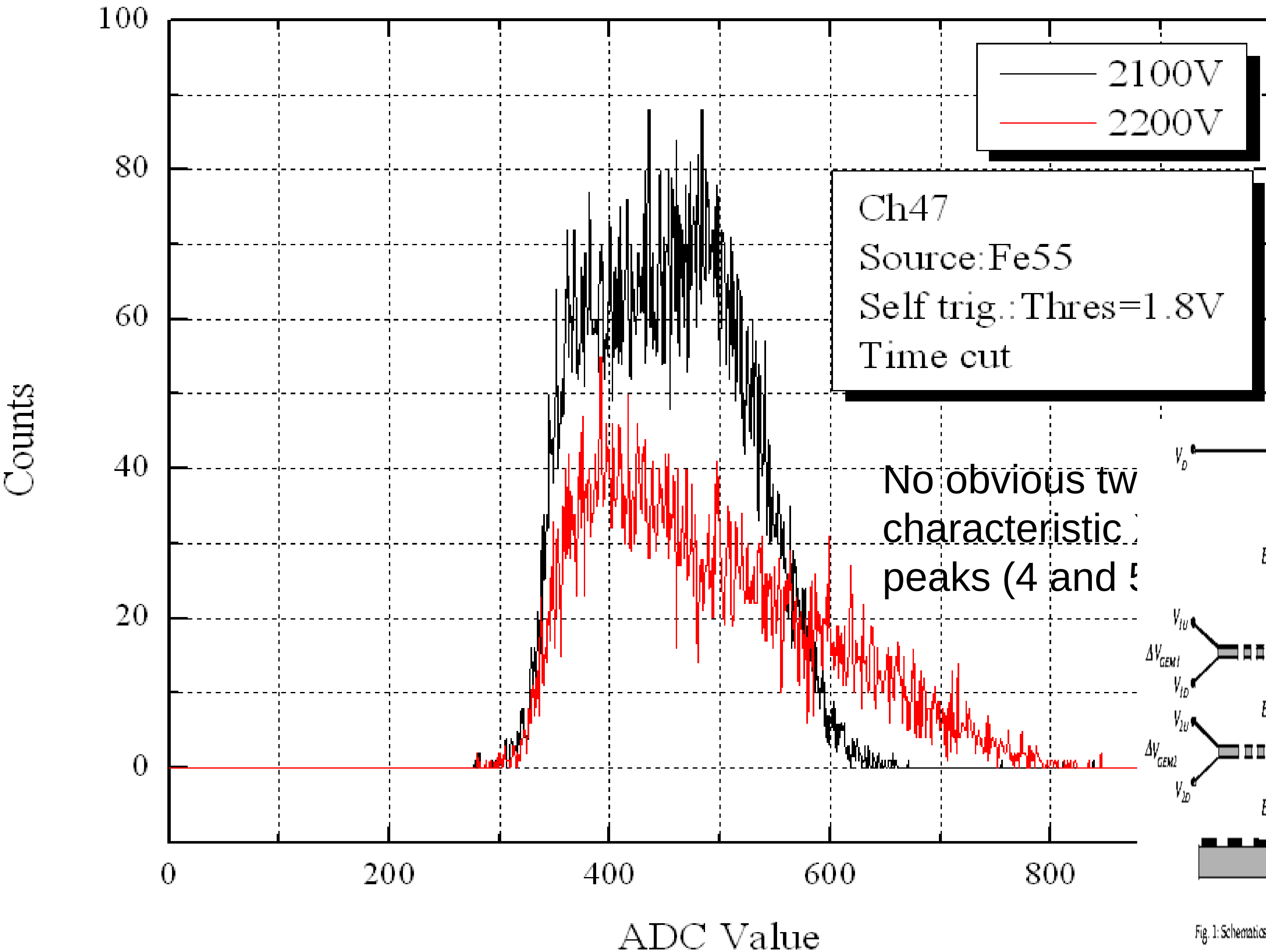
KPiX Self Trigger Threshold and Noise Scan



- Threshold at 2.0V most optimal
- Observe clear Landau distribution of β from Ru^{106}



HV dependence of Fe^{55} spectrum



No obvious tw
characteristic
peaks (4 and 5

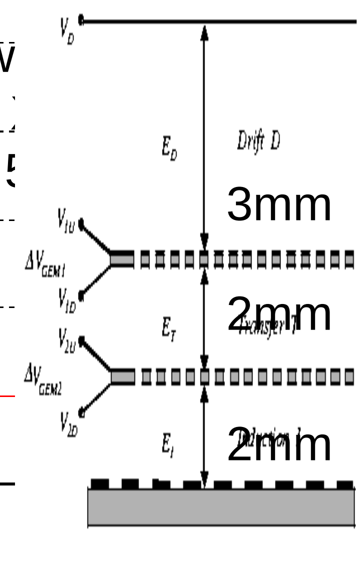
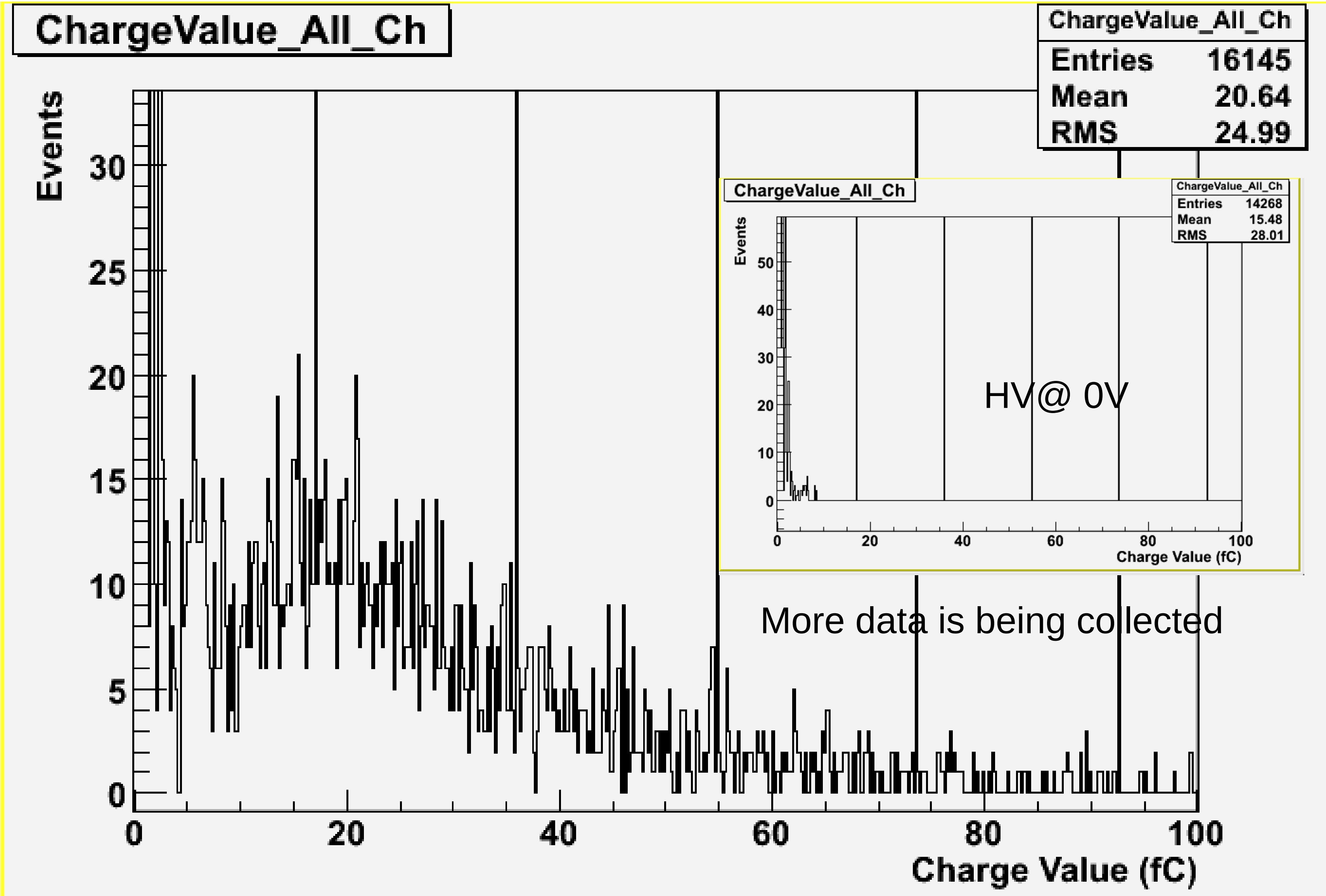


Fig. 1: Schematics of a double-GEM detector.

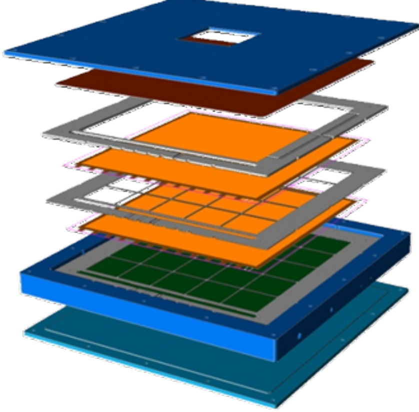
3mm
2mm
2mm

-2100 V
ΔV ~400 V
ΔV ~400 V

Cosmic Ray Data with External Trigger

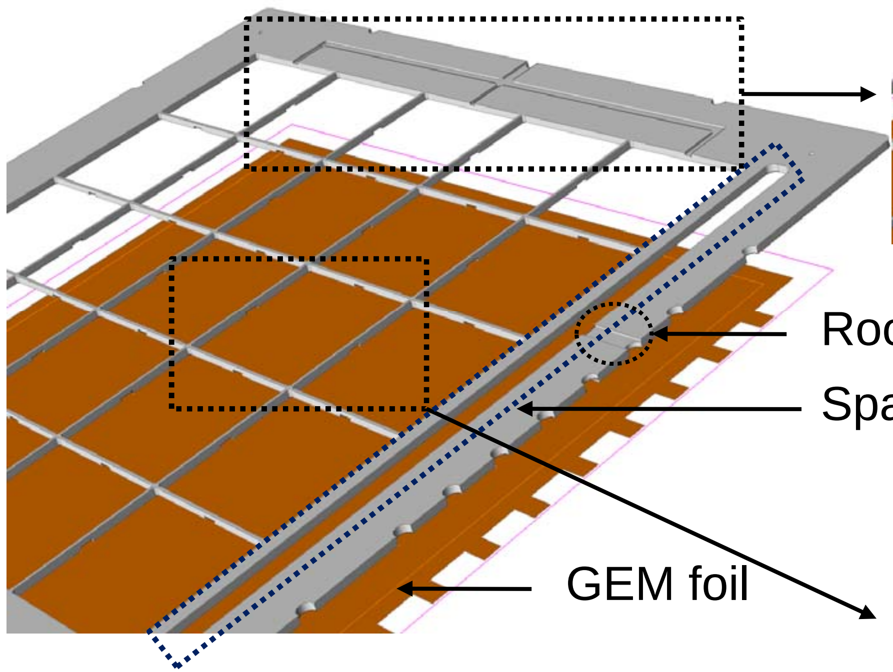


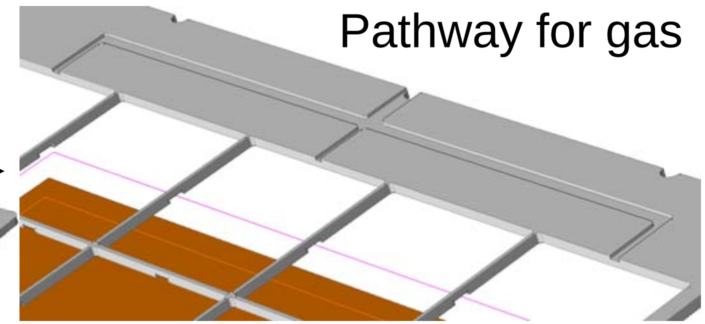
GEM DHCAL Plans - I

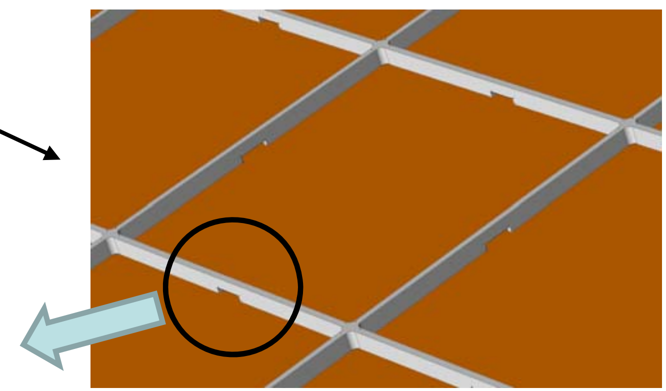


- Through Fall 2009
  - 30cmx30cm chamber
    - Construct a new chamber with optimal gas flow design
    - Complete characterization of the chamber with sources and cosmic rays using 64 channel KPiX v7
    - Characterize the chamber in particle beams
      - Responses, noise characteristics, efficiencies, gains, etc
  - 33cmx100cm unit chamber
    - Finalize 33cmx100cm (32cmx96cm active area) large GEM foil silkscreen design and submit to CERN GDD

Gas Transparent Spacers



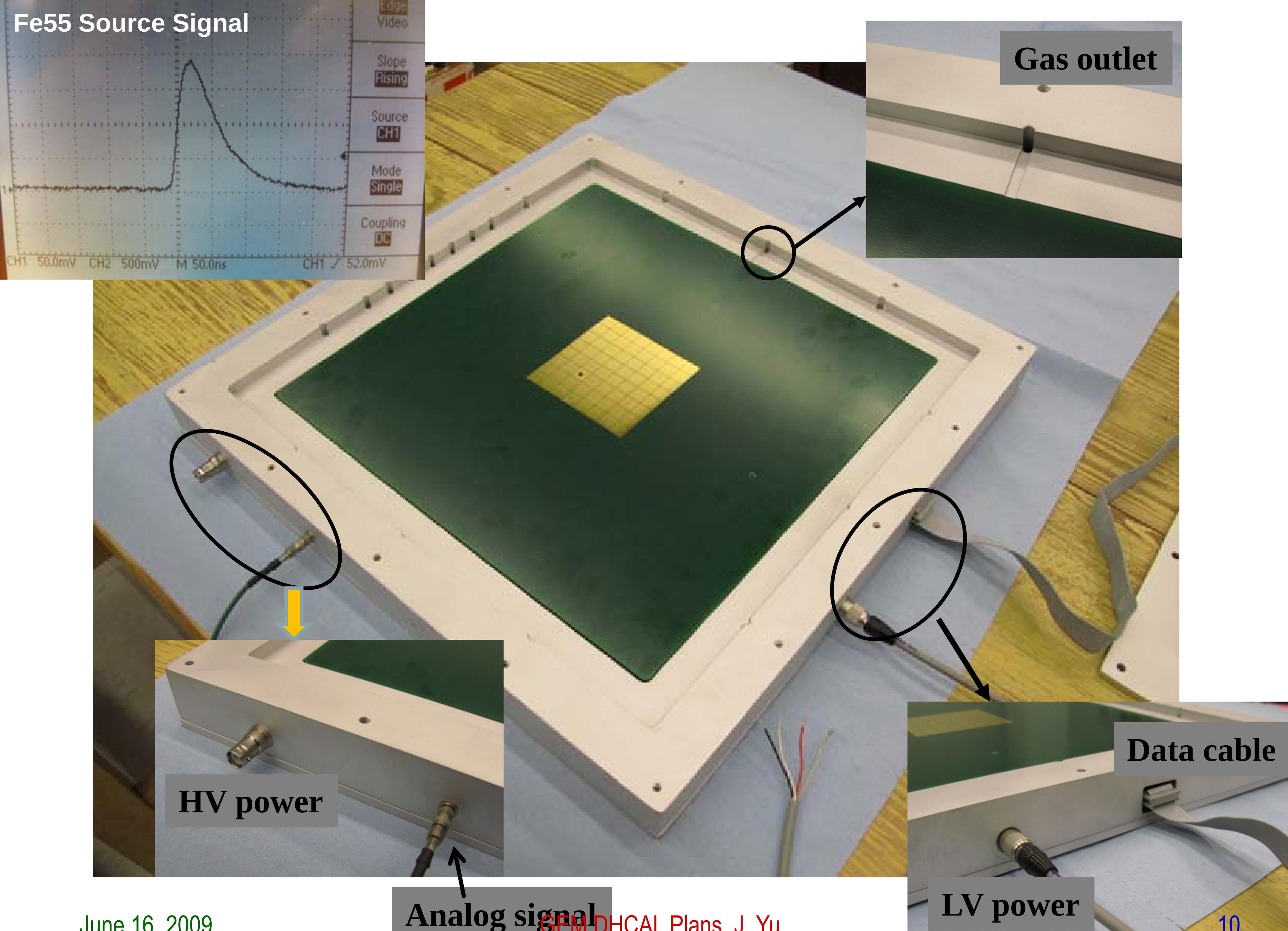




- ❖ Grid thickness: 1 mm
- ❖ Gas hole between adjacent cell:

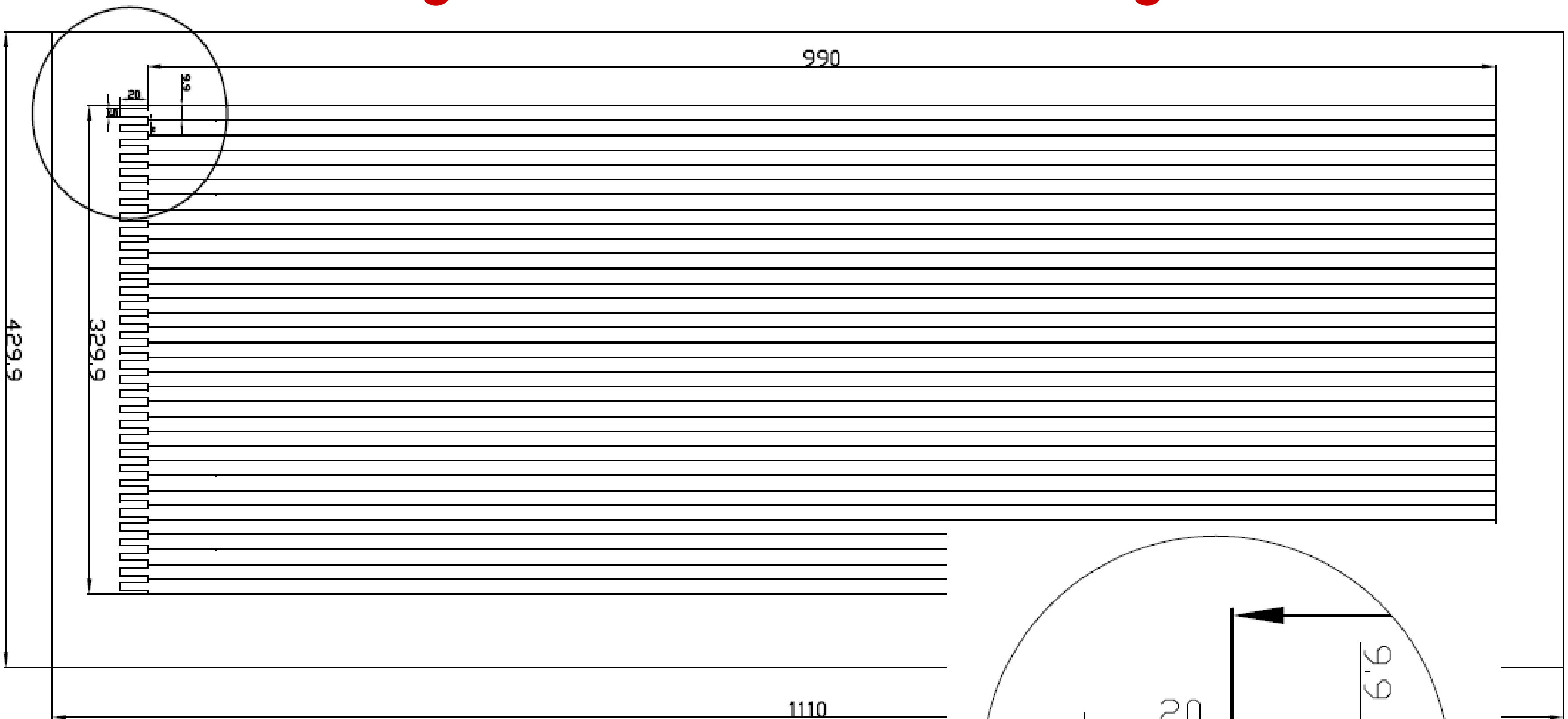
→5x1 mm^2 for 3 mm spacer

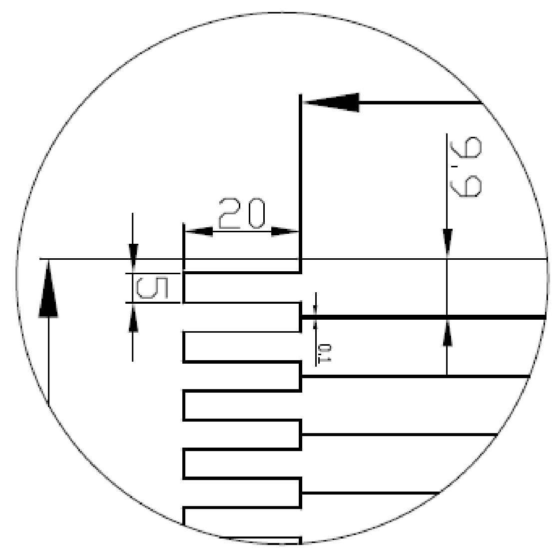
→5x0.5 mm^2 for 1 mm spacer



Analog signal

Large GEM Foil Draft Design





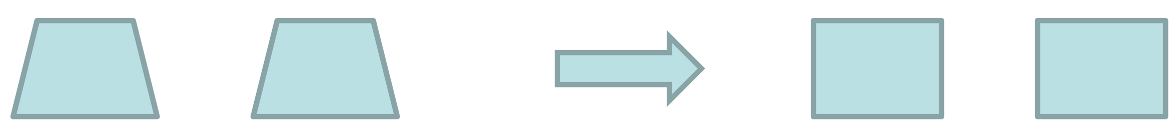
Active area = 990x329.9 mm^2

We need copper region and some markings for GEM alignment.

We can reduce the number of sectors. It's 33 currently.

Large GEM Foil Development with CERN-GDD

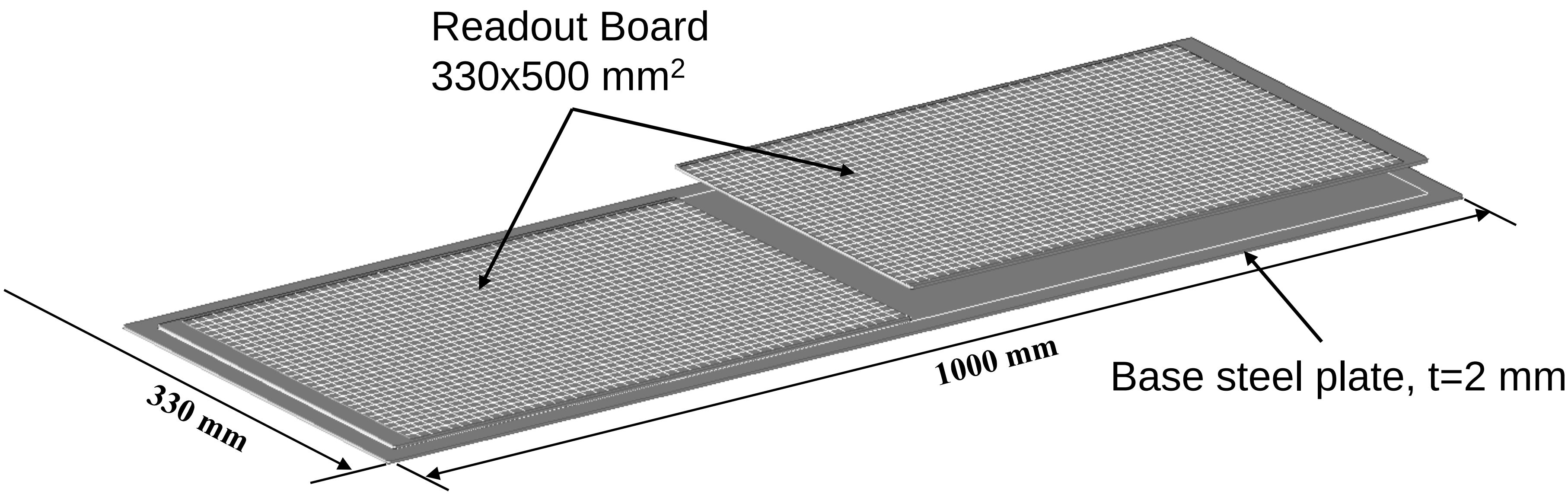
- The size of the foils are 33cmx100cm, the same as the physical size of the unit chamber
  - Active area is 32cmx96cm
  - Is this realistic to think of constructing a chamber with the same physical size foils?
- CERN GDD says that the foils will be delivered in eight weeks or so once the design is completed
- One-side hole etching technique is being improved
  ➔ Since gain shows factor two difference



GEM DHCAL Plans - II

- Fall 2009 – Late 2009
  - 33cmx100cm thin GEM unit chambers
    - Production and certification of 33cmx100cm foils
    - Characterization of 256 channel v8 KPiX chips
      - To be available in fall 2009
      - Use 30cmx30cm STP chamber
    - Begin construction and characterization of 33cmx100cm unit chambers
      - One with 256 channel V8 KPiX boards
      - Remainder with DCAL Chip
  - Large Thick GEMs
    - Working with Weizman institute on TGEMs
    - Certification of large TGEMs

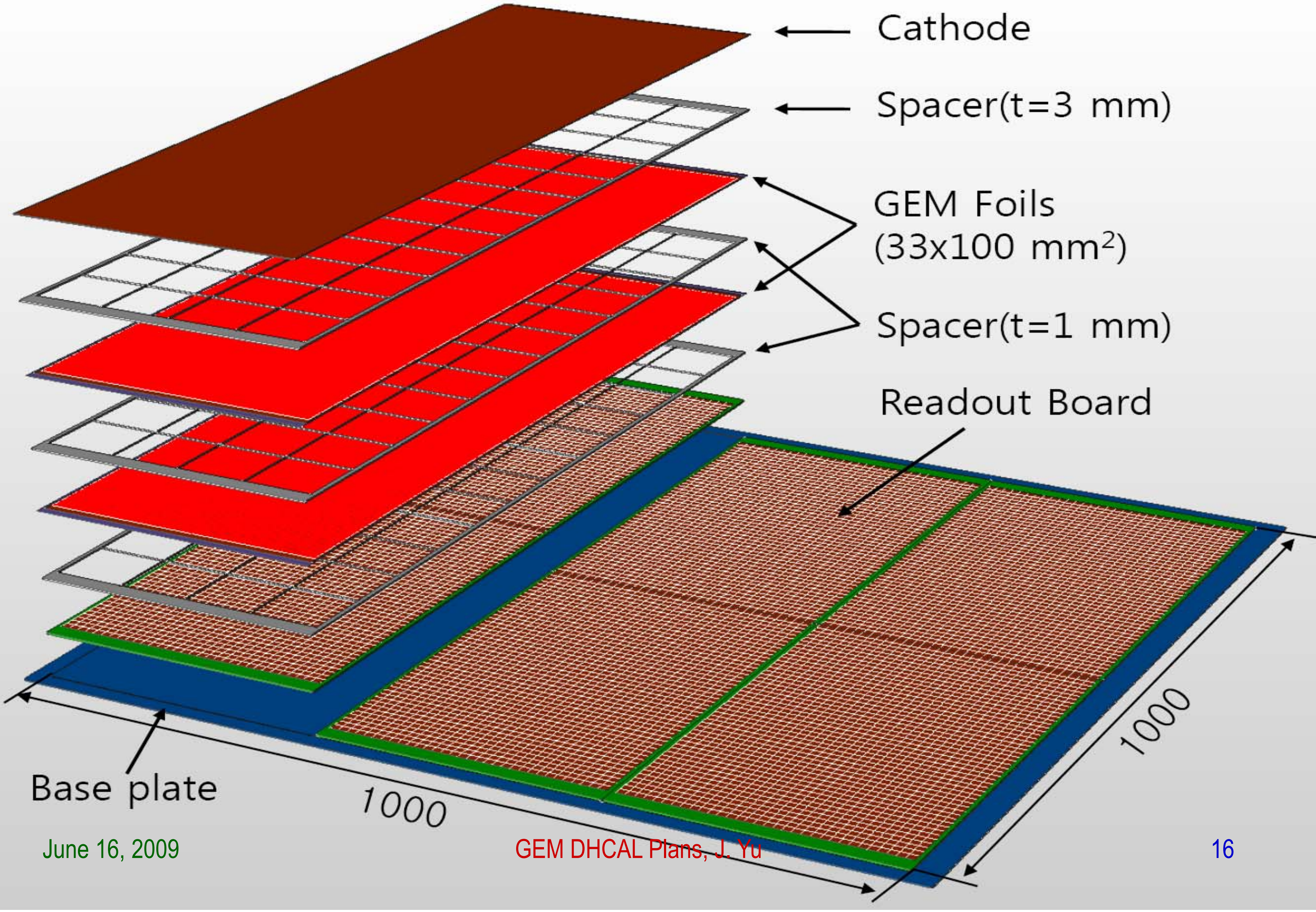
UTA's 33cmx100cm DHCAL Unit Chamber



GEM DHCAL Plans - III

- Early 2010 – Late 2011
  - 33cmx100cm thin GEM unit chambers w/ DCAL chips
    - Characterization with DCAL chip
    - Complete production of fifteen 33cmx100cm unit chambers
  - Construct five 100cmx100cm GEM DHCAL planes
    - Using DCAL III readout chips
  - Beam test GEM DHCAL planes in the CALICE beam test stack together with RPC
  - TGEMs and RETGEMs
    - Construction and characterization of a prototype chamber using an analog readout chip
    - Beam test of TGEM prototype chamber

UTA's 100cmx100cm Digital Hadron Calorimeter Plane



GEM DHCAL Beam Test Plans

- Phase I ➔ Completion of 30cmx30cm characterization
  - Fall 2009 at MTBF: using one plane of 30cmx30cm double GEM chamber with 64 channel KPiX7
- Phase II ➔ 33cmx100cm unit chamber characterization
  - Late 2009 – late 2010 at MTBF: Using 256 channel v8 KPiX chips and with DCAL chip
  - Possible beam test and characterization of TGEM prototype using 256 channel v8 KPiX chips
- Phase III ➔ 100cmx100cm plane GEM DHCAL performances in the CALICE stack
  - Late 2010 – late 2011 at MTBF
  - Five 100cmx100cm planes inserted into existing CALICE calorimeter stack and run with either Si/W or Sci/W ECALs and RPC planes in the remaining HCAL layers