

UTA GEM DHCAL Progress

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For GEM/DHCAL Group

VLCW06

- Introduction
- 30cmx30cm 3M GEM Foils
- 30cmx30cm Prototype GEM chamber
- KAERI electron beam exposure
- What next?
- Conclusions

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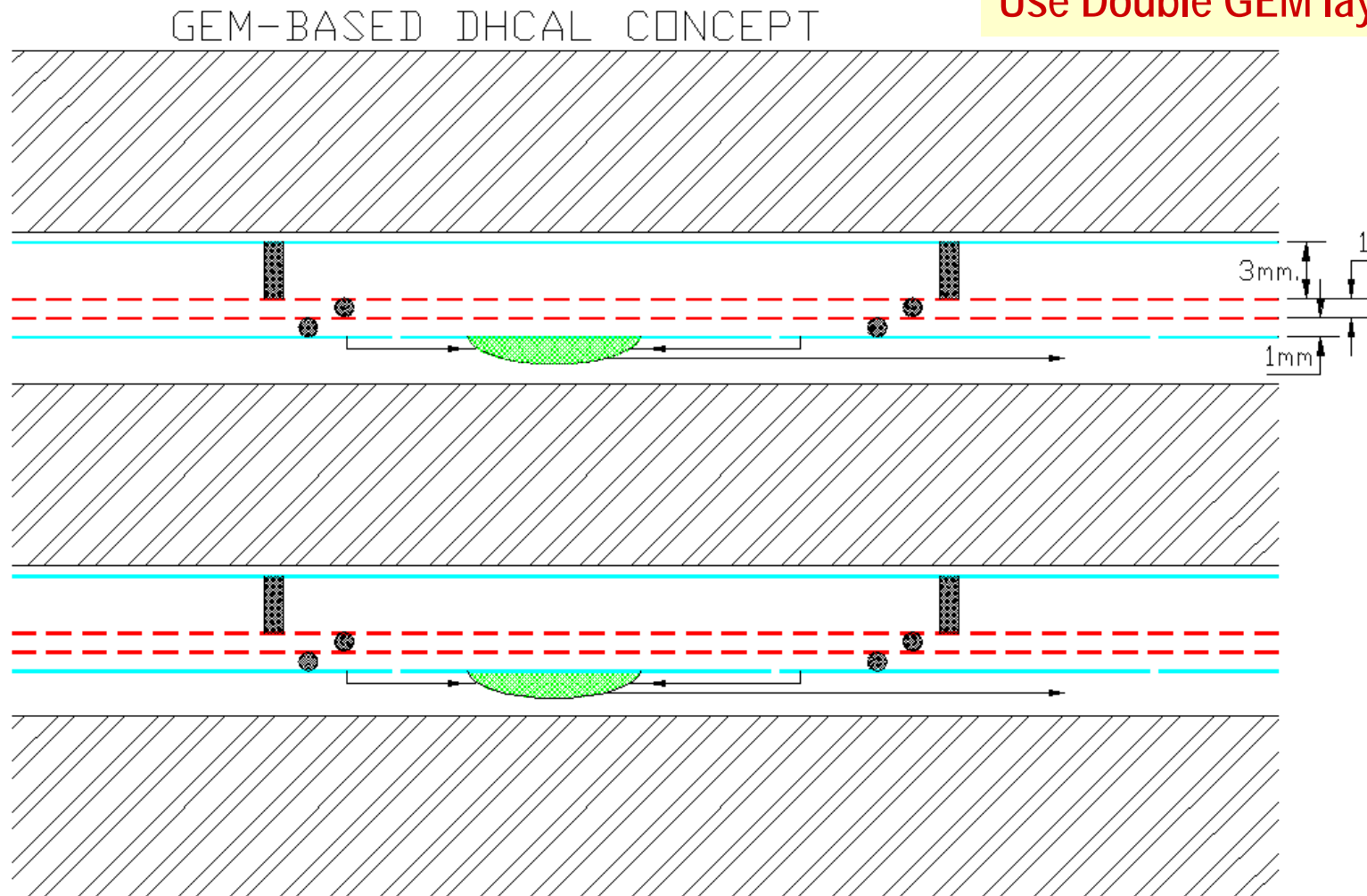
* UTA, U.Washington, Changwon
Nat.U., Tsinghua U.

Why GEM's?

- Flexible configurations: allows small anode pads for high granularity.
- Robust: survives $\sim 10^{12}$ particles/mm² with no changes.
- Fast: based on electron collection, \sim few ns rise time.
- Uses simple gas (Argon/CO₂) – no long-term issues.
- Runs at low HV (\sim 400V across a foil).
- Stable operation.

GEM-based Digital Calorimeter Concept

Use Double GEM layers



NOT TO SCALE

GEM – Operation

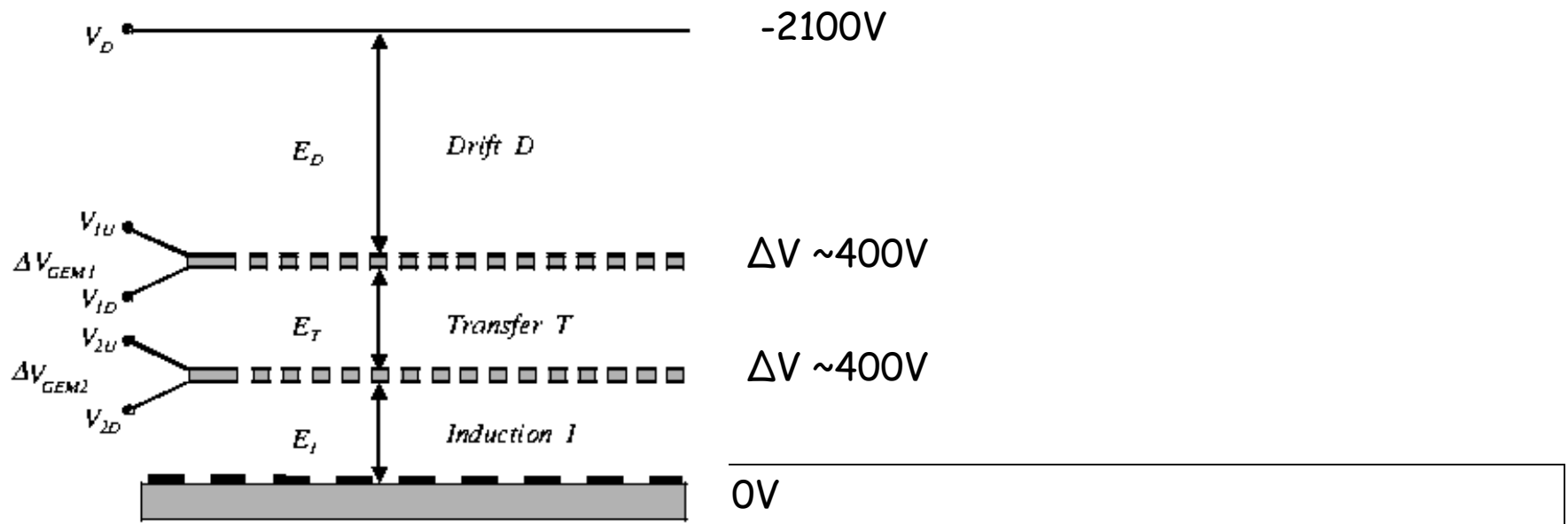


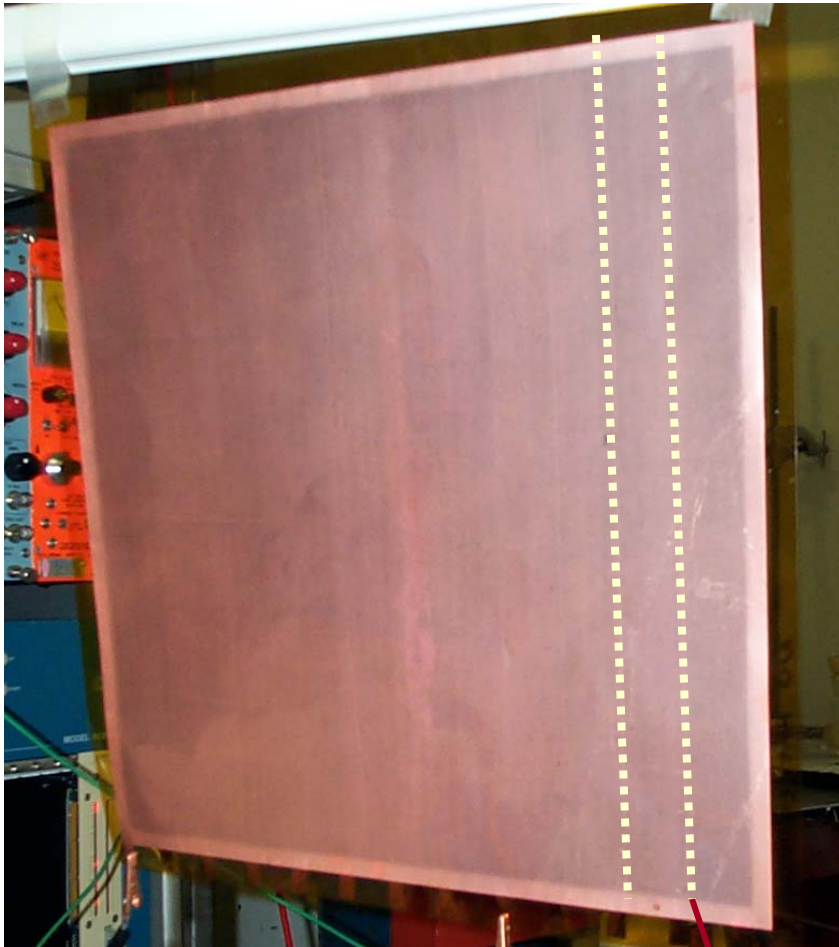
Fig. 1: Schematics of a double-GEM detector.

GEM Foils From 3M

- 30cm x 30cm foils made with three types of coating:
 - Bare copper
 - “organic polymer” coating
 - gold plating
- HV tests made on all three types
 - Prefer to use the uncoated foils.
- New 30cm x 30cm chambers will be built w/ uncoated foils
- 3M is setting up a formal internal project to develop larger foils for the 1m³ prototype stack
 - 30x30cm² foil did not require 3M process modification

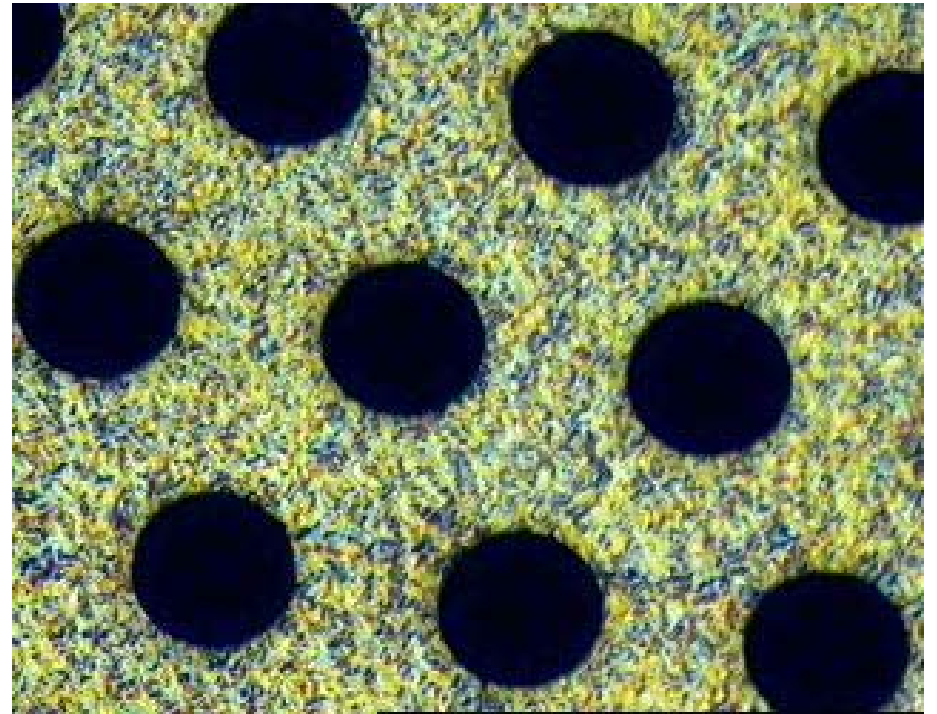
30cm x 30cm 3M GEM foils

12 HV sectors on one side of each foil.

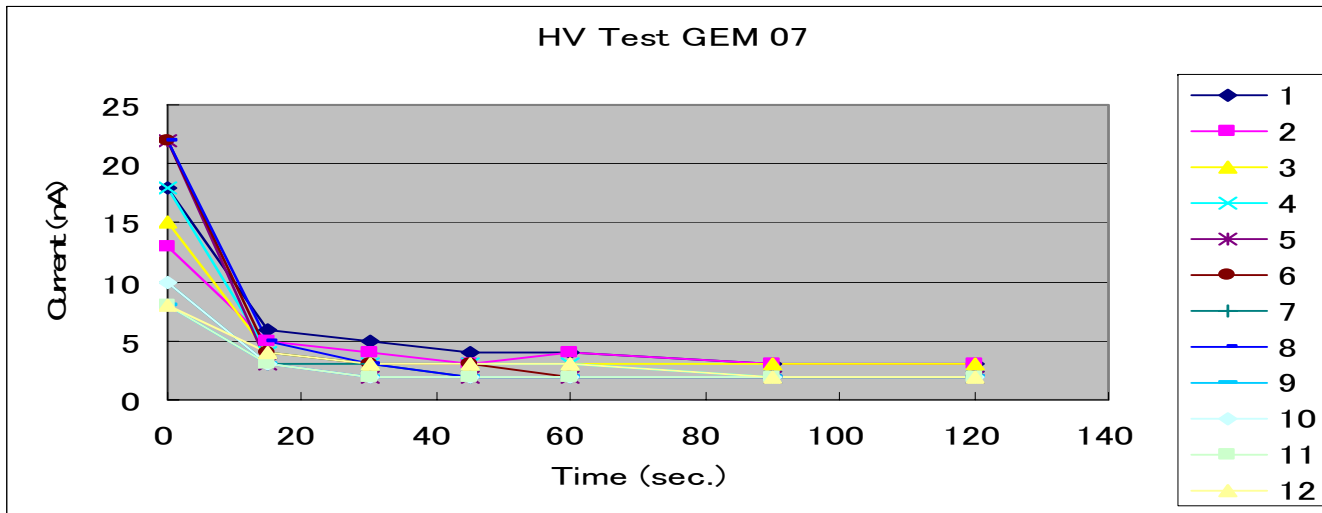


HV Sector Boundary

Magnified section of a 3M GEM foil.

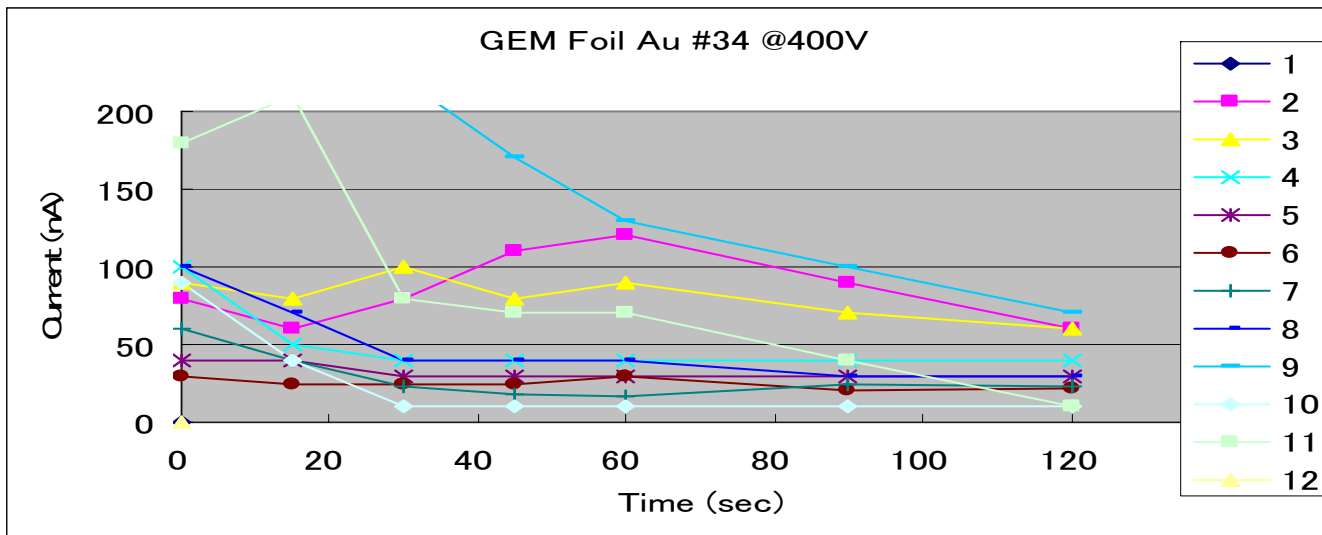


HV Tests on 30cmx30cm 3M GEM foils



Uncoated foils settle at below 5nA in less than 1 min

Gain variation at 6×10^{-4} /nA of leakage current



Au coated foils settle at 20 – 70nA and take longer to settle

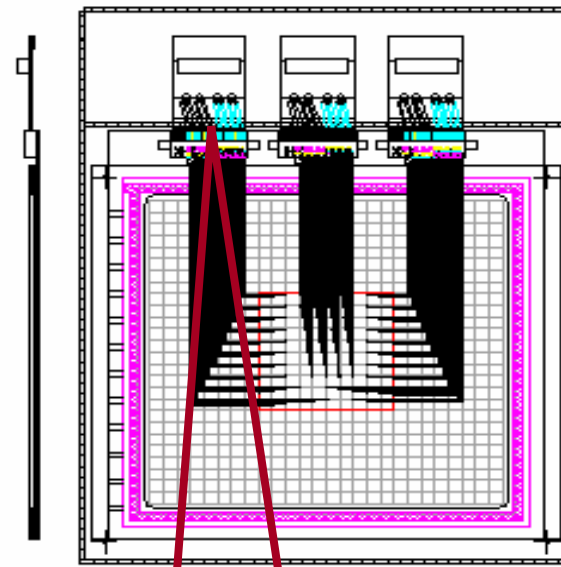
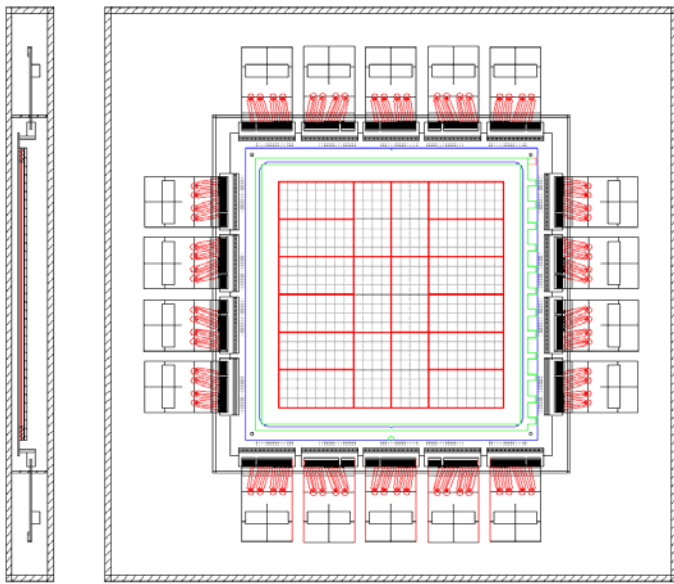
30cm x 30cm GEM Chamber Development

- All foils have been HV tested and certified
- Jigs made to mount foils, stack chamber
- Initial multilayer 30cmx30cm anode board made to work w/ Fermilab QPA02-based preamp cards
- Verified aspects of chamber operation:
 - Stability
 - pulse characteristics (cf. 10cm x 10cm chamber using CERN foils)
- Exposed to high intensity 10MeV electron beams at KAERI beam tests in May, 2006

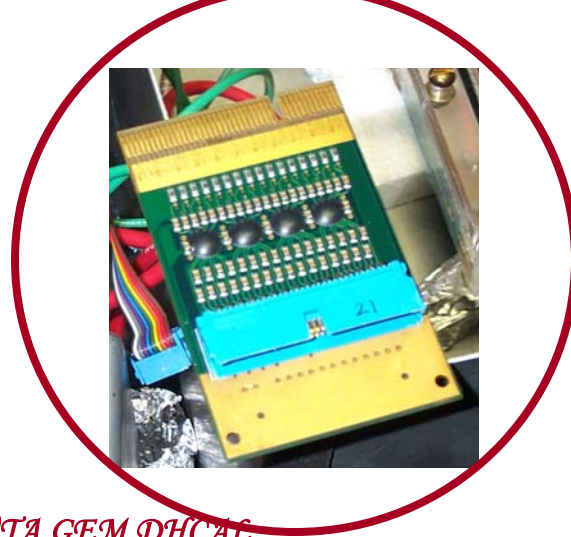
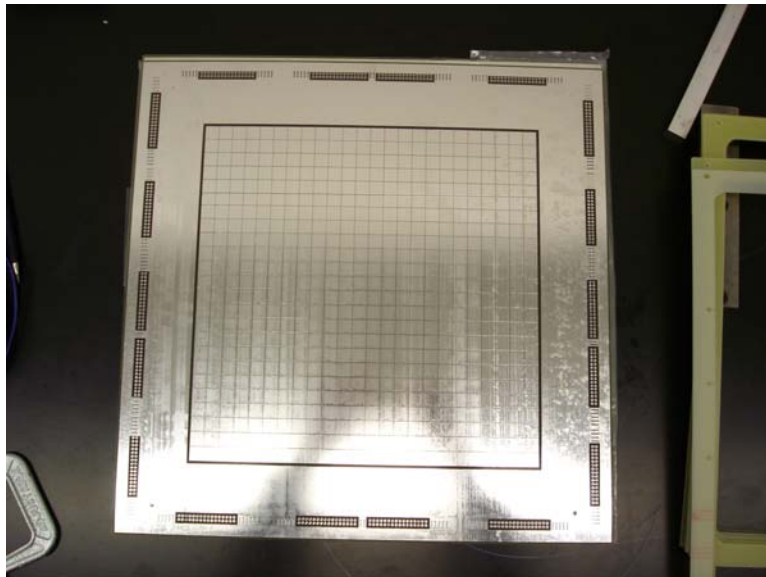
GEM Foil Frame Mounting Jig



Anode Board & Preamp for 30cm x 30cm Chamber

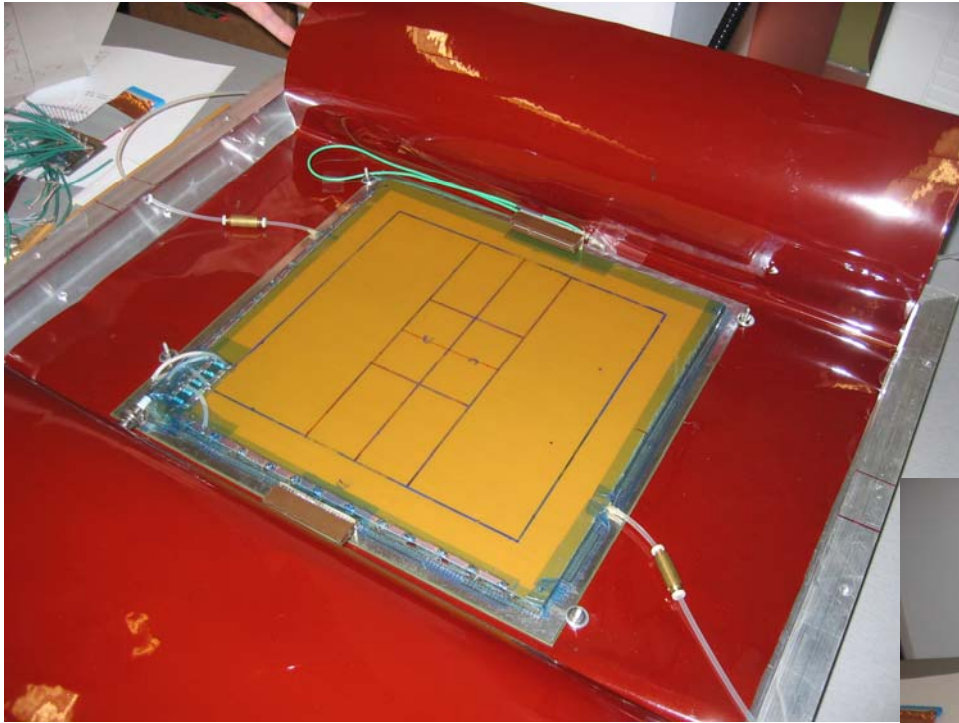


Anode boards designed to read 96 pads in the center



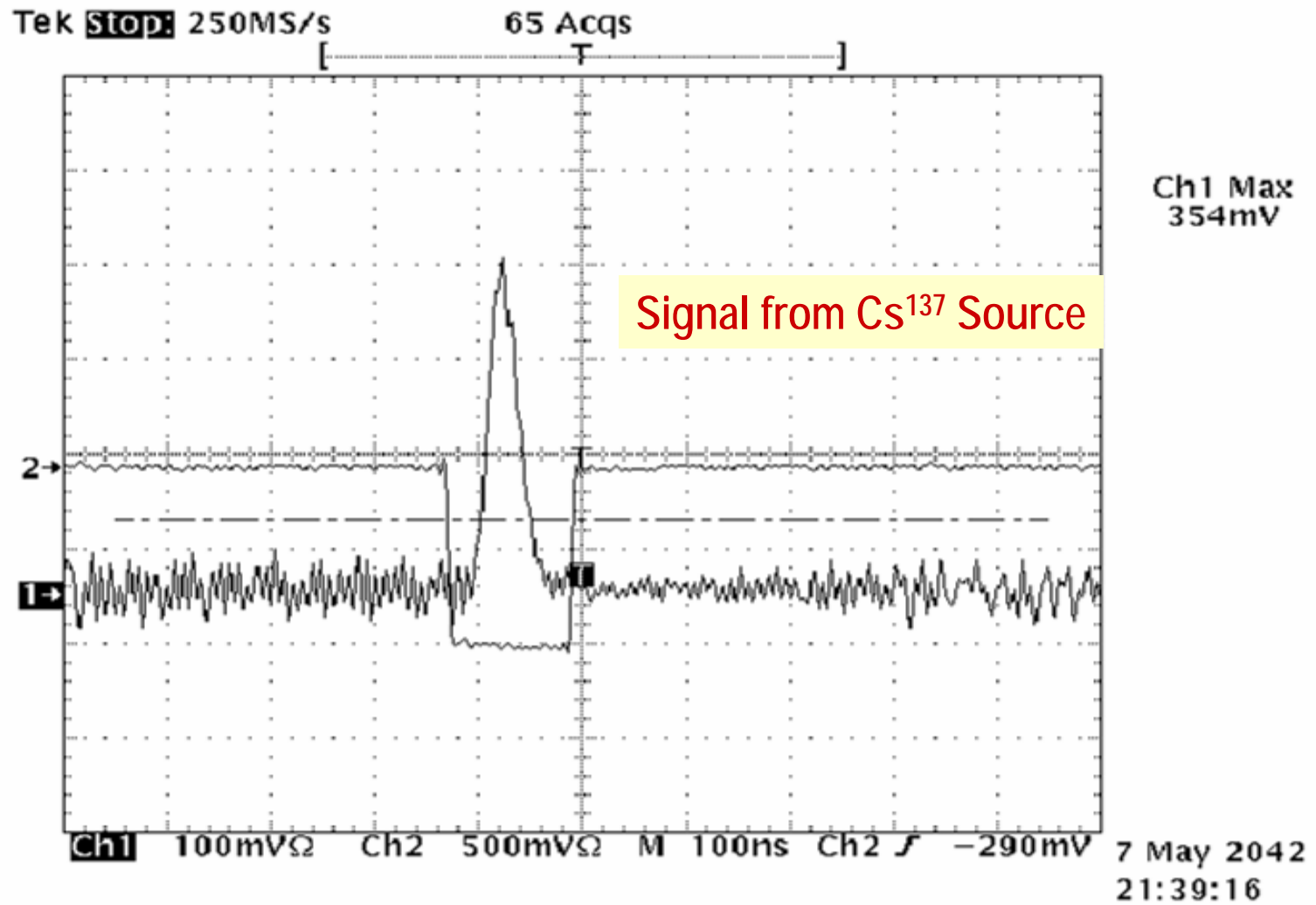
Use 32 channel FNAL preamps

30cm x 30cm GEM Chamber for KAERI Beam Exposure



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30cmx30cm D-GEM Detector Signal

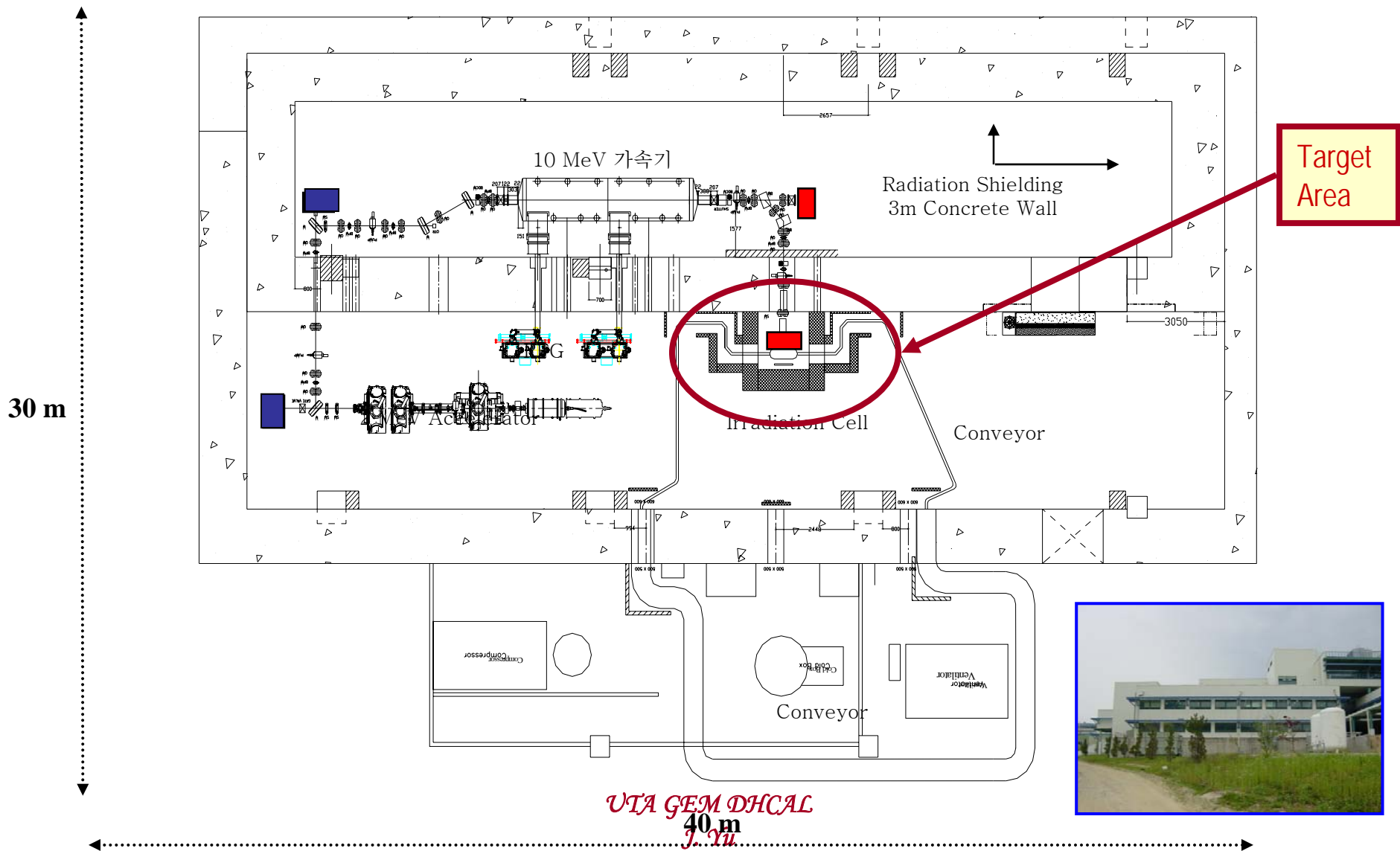


KAERI Low-Med E Exposure Facility

- 0.3~2 MeV
- 2~10 MeV

지하 : 330평
지상 : 170평

총 면적 : 500평

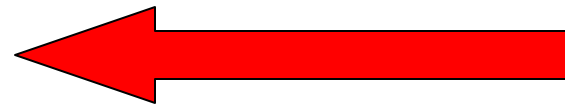


UTA GEM Chamber in KAERI Electron Beam

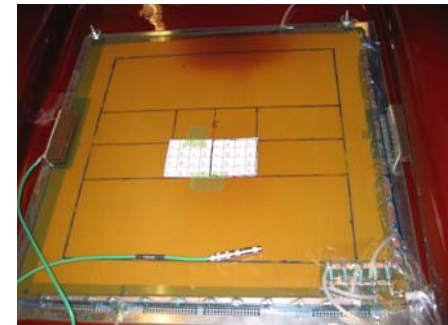
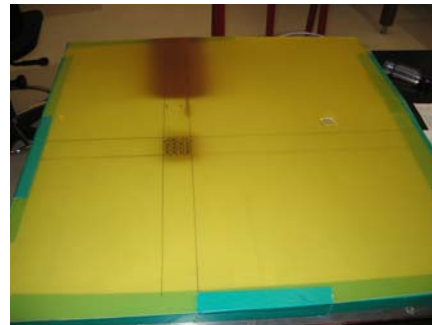


e^- beam: 10^{10} particles in 30ps pulse
~every $43\mu\text{s}$

Scans $4\text{cm} \times 60\text{cm}$ area every 2 seconds



4-pad area ($2\text{cm} \times 2\text{cm}$) exposed
to scanning beam for ~2000 sec.



G10 boards in the exposed area dis-colored.
But no damage to the GEM foils
Chamber working normally after the exposure

UTA GEM-DHCAL Beam Exposure

- Beam scans $\sim 600\text{mm} \times 40\text{mm}$ area every 2 sec, with 30ps pulse of 10^{10} e-/pulse over a 5 cm^2 area $\rightarrow \sim 10^9$ e-/sec on an anode pad.
- Total exposure $\sim 2000\text{sec}$
- \rightarrow Estimate $\sim 2 \times 10^{12}$ e-/pad ($\sim 1.6 \times 10^{-2}$ mC/mm²) accumulation
- \rightarrow GEM chamber continued normal operation.

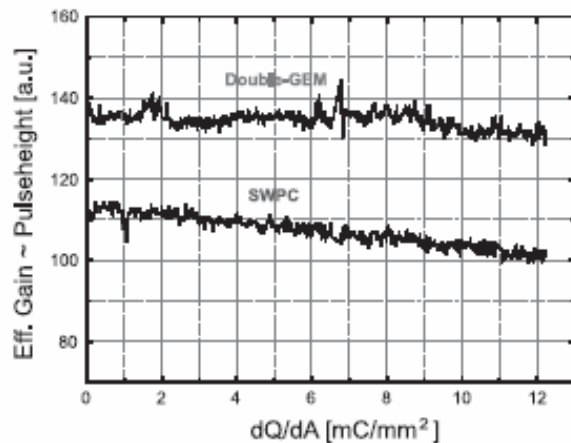


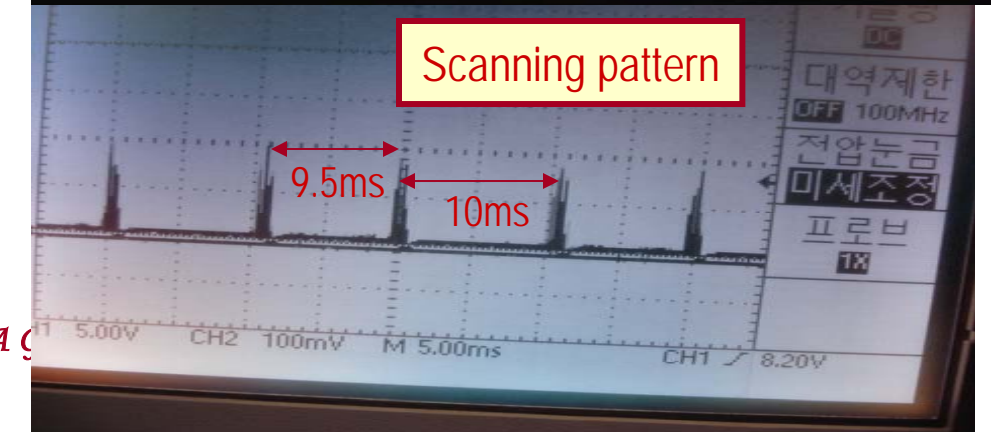
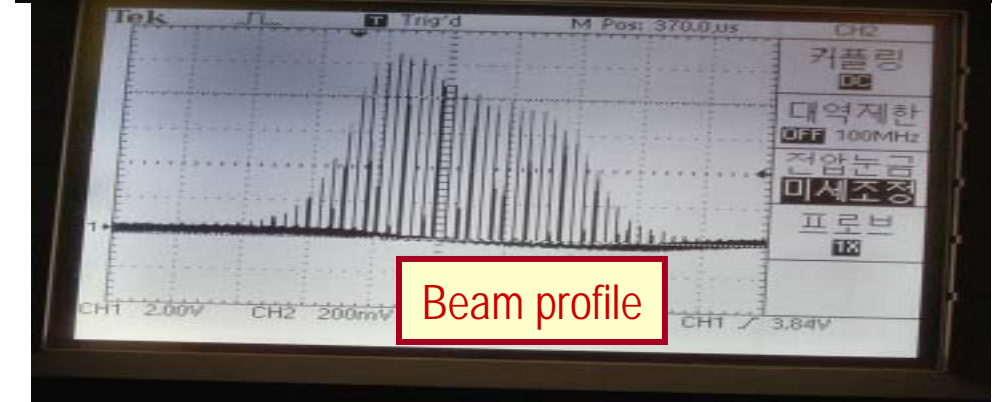
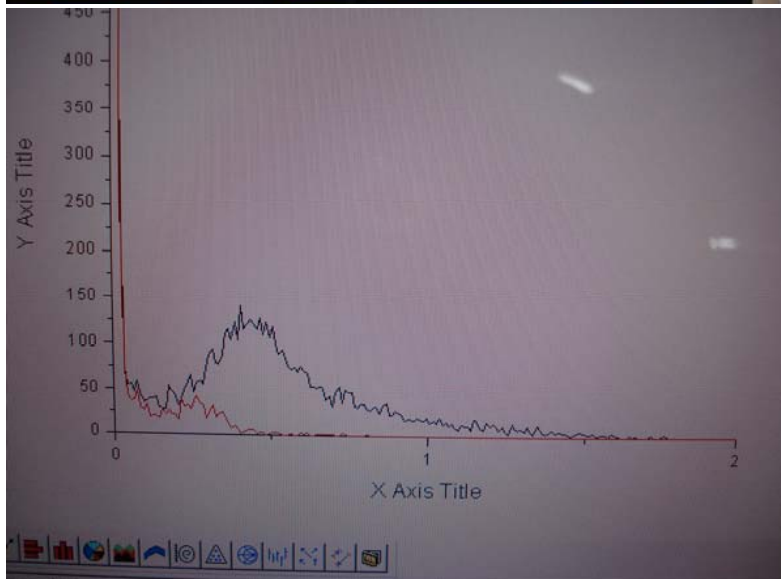
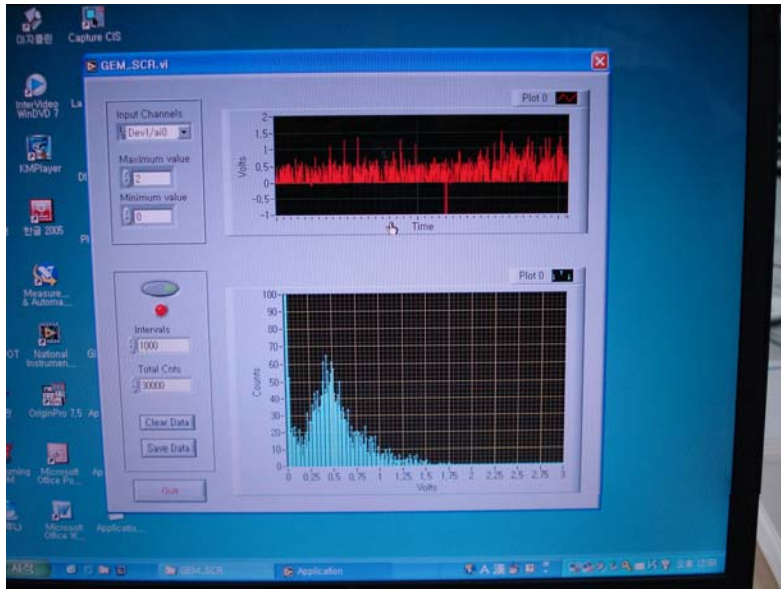
Fig. 3. Previous aging measurement of a double-GEM detector with Ar-CO₂ (70:30): effective gain versus accumulated charge dQ/dA .

- Much above total hits/10y/pad at ILC
- Much below any damage region for decrease in gain.

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KAERI Beam Exposure Results

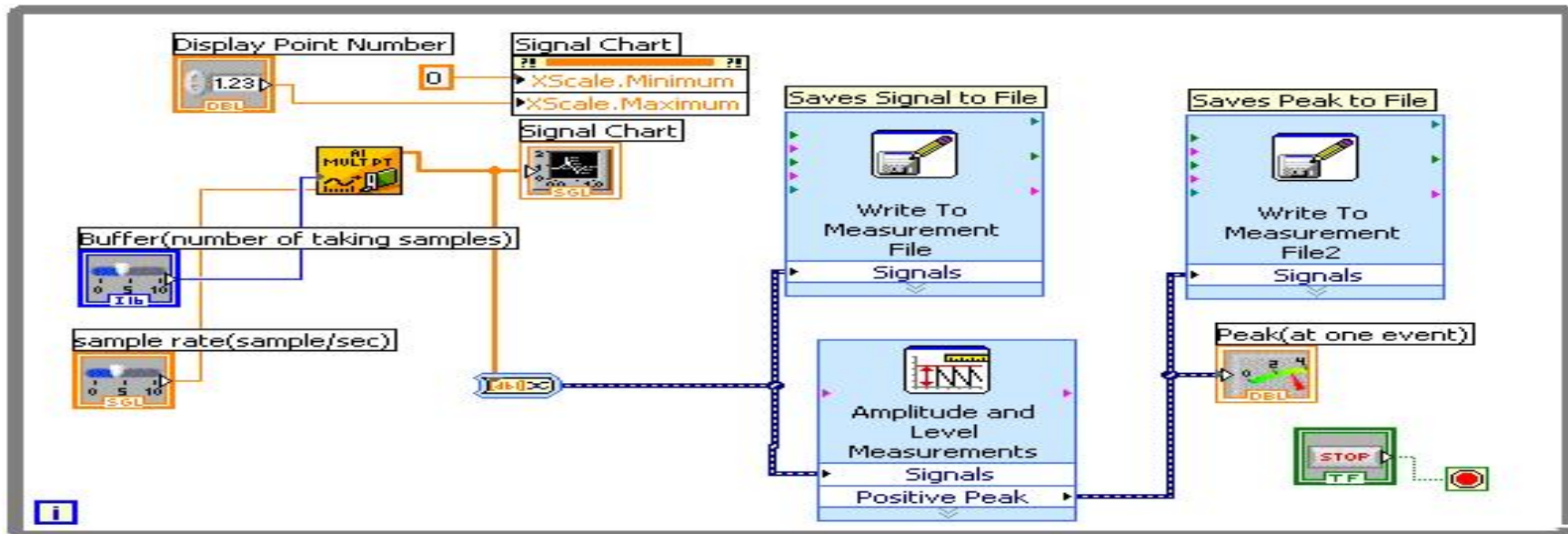
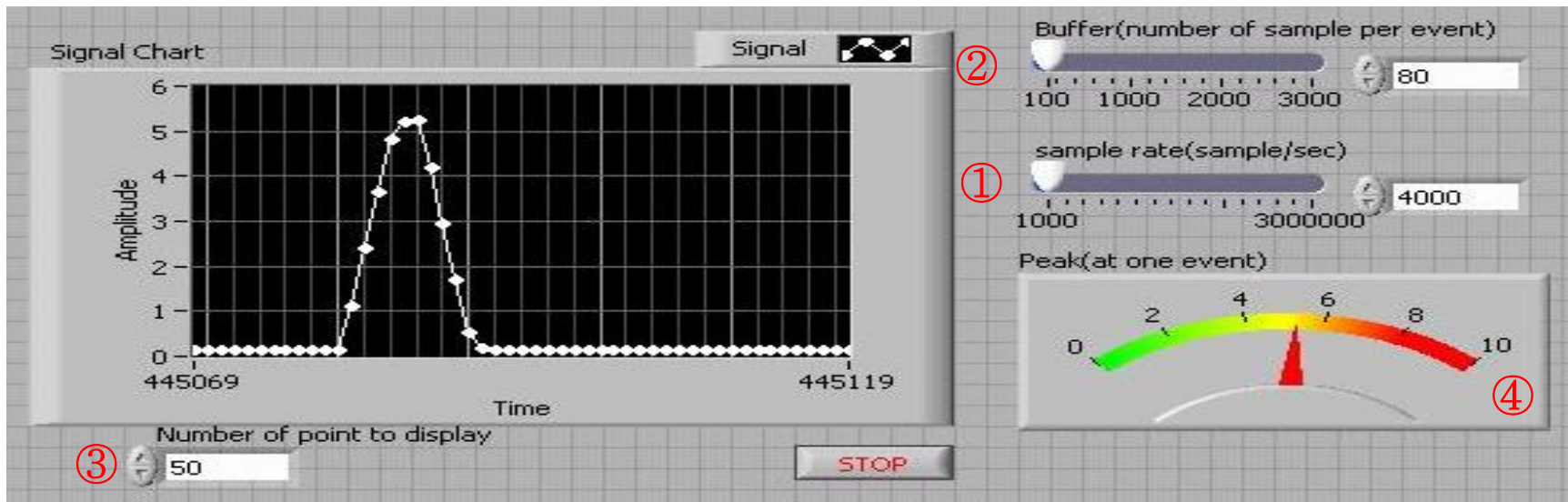
CNU Chamber Labview output



What next?

- Fall 2006: 30cmx30cm chamber prototype test at FNAL
 - Chamber characteristics: gains, HV dependences, rates, mip, responses to hadrons, etc
 - Much reasonable beam intensity
 - One new 30cmx30cm chamber
 - Use FNAL preamp+100channel PCI based ADC and shaper
 - Labview software interfacing in its final stretch
 - This system can be used for continued, multi-channel tests at UTA
 - Develop 1mx30cm foils for sections of 1m³ prototype

LabVIEW Interfaced DAQ Software



What next?

- Early 2007: Slice test at FNAL
 - Joint with RPC
 - Operations with close to actual FE readout chips
 - Read out using DCAL and SLAC KPix chips
 - Use one to two 30cmx30cm chambers
 - Develop construction techniques for 1m³ prototype and build unit chambers

Proposed Initial 3M 30cmx100cm Foil Design

Repeat of three 30cmx30cm foil units



Can be produced in 6 weeks after the final specification

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What next?

- Mid 2007
 - Test large 1mx1m units
 - Produce and test large anode boards for units chambers of 1m³ prototype
 - Start producing GEM chambers for 1m³ prototype if funding allows
 - Numerous tests, including beam tests, as large chambers get produced
- Late 2007/early 2008
 - Completion of 1m³ stack
 - Beam test w/ full depth in 2008

Conclusions

- UTA 30cmx30cm chamber built and exposed to low energy electron beam in May 2006
 - First operation of the chamber in beam
- Larger foil (30cmx1m) development on going with 3M
 - First set available in this Fall
- Additional beam tests in Fall 06 and early 07
 - Facilitates understanding chambers
- 1m³ prototype test in 2008 w/ available funding
- Some additional manpower for chamber development and beam test runs
 - A new visiting professor from CNU joining us this weekend
 - CNU will send a postdoc and/or Ph.D students to help TB
- Need to pick up on simulations and algorithm development