The Cornell/Purdue TPC

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Information available at the web site: http://w4.lns.cornell.edu/~dpp/tpc_test_lab_info.html

* this presentation: LCWS05, Stanford 21-March-2005
* presentation to TPC mini-workshop, Orsay 12-January-2005,
* presentation to ALCPG at Victoria, 28-July-2004,
* presentation to ALCPG meeting at SLAC, 07-January-2004,
* presentation to TPC meeting at Berkeley, 18-October-2003,
* presentation to UCLC meeting at Santa Cruz, 30-June-2002,

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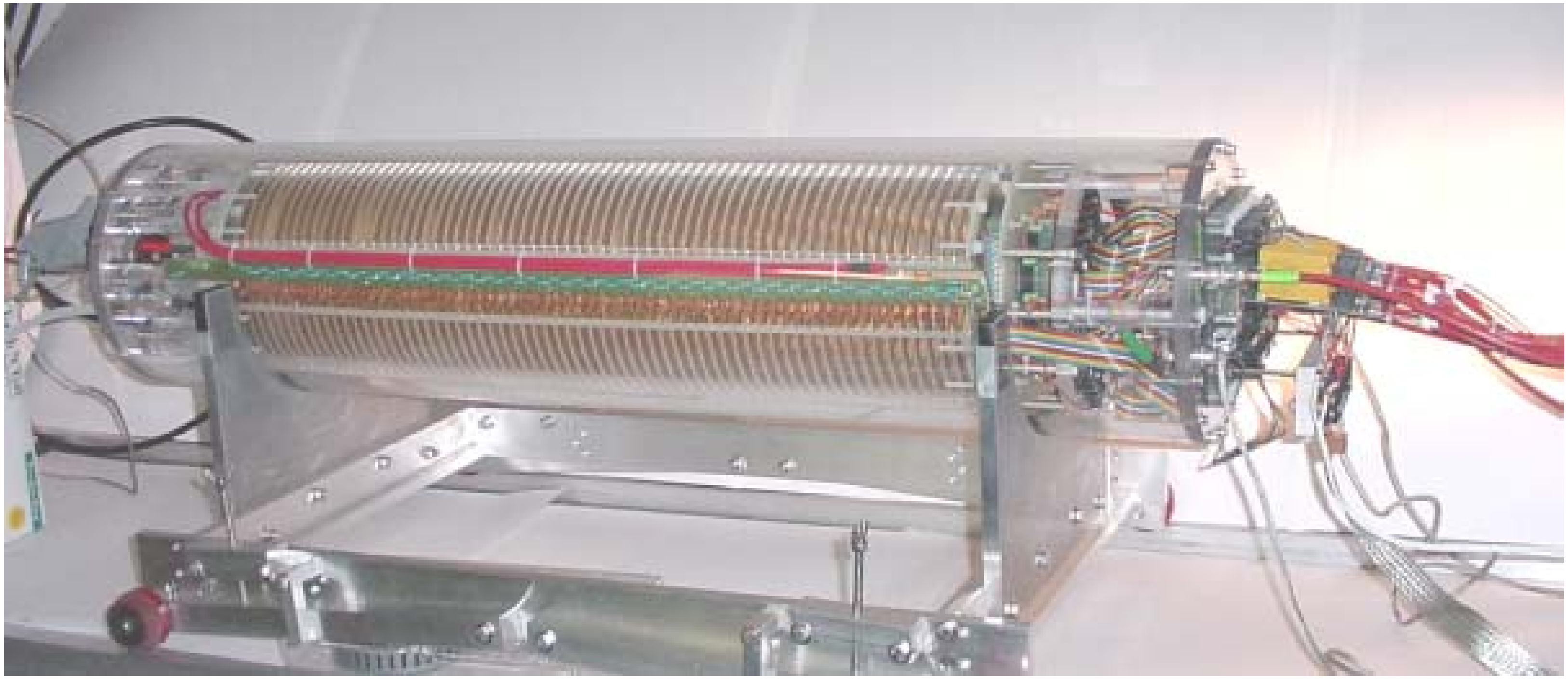
TPC

January 2005: construction completed, recorded first events

14.6 cm ID field cage - accommodates a 10 cm GEM
64 cm drift field length
22.2 cm OD outer structure (8.75 inch)



TPC details

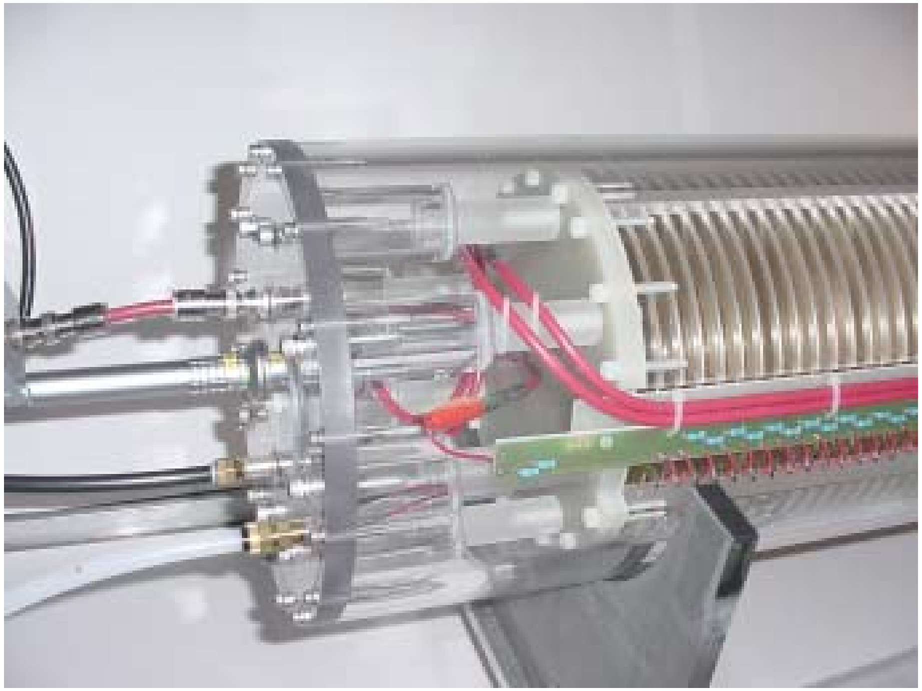
High Voltage end:

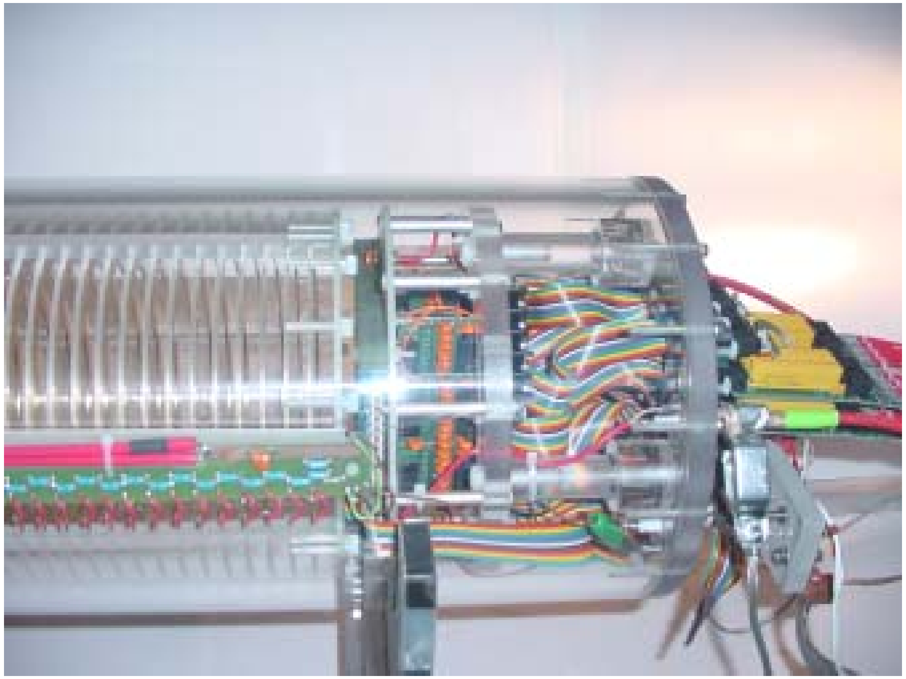
- LEMO HV connectors
- SHV bias trimming connectors
- gas connections
- field cage HV distribution

Read-out end:

- field cage HV distribution
- field cage termination
- **readout pad and amplification module**
- front end electronics
- CLEO II cathode preamps

The construction is influenced by our research goal: to compare the various amplification technologies in a common environment.



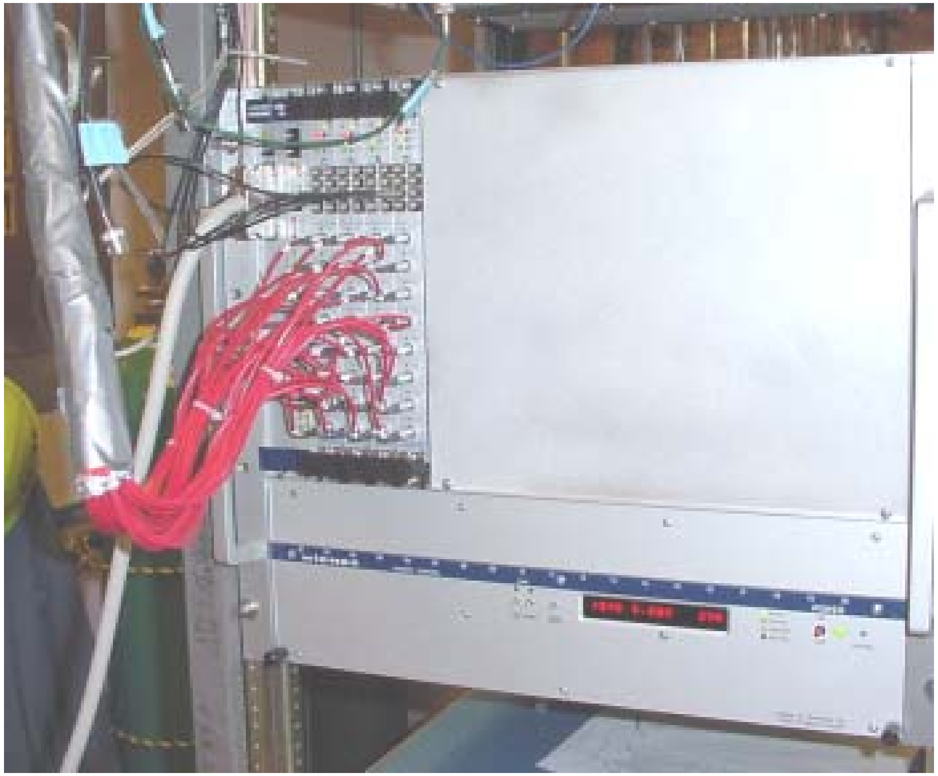


Electronics purchases

High voltage system:
- -20 kV module, 2 channels available
- -2 kV module, 4 channels available

(not part of interfaced system) +2 kV

Readout:
- VME crate
  - PC interface card
    - LabView
- Struck FADC
  - 32 channels (room for expansion)
  - 105 M Hz
  - 14 bit
  - +/- 200 mV input range
    - (least count is 0.025mV)
  - NIM external trigger input
  - circular memory buffer



TPC Readout End details

Visible:

field cage HV distribution
field cage termination
wire gas-amplification
pad board
pad biasing boards
signal ribbon cable

Biasing:

drift: 300V/cm
@ termination: -900V

(1.0 cm)

grid: -600V

(0.5 cm)

anode: +550V

(0.5 cm)

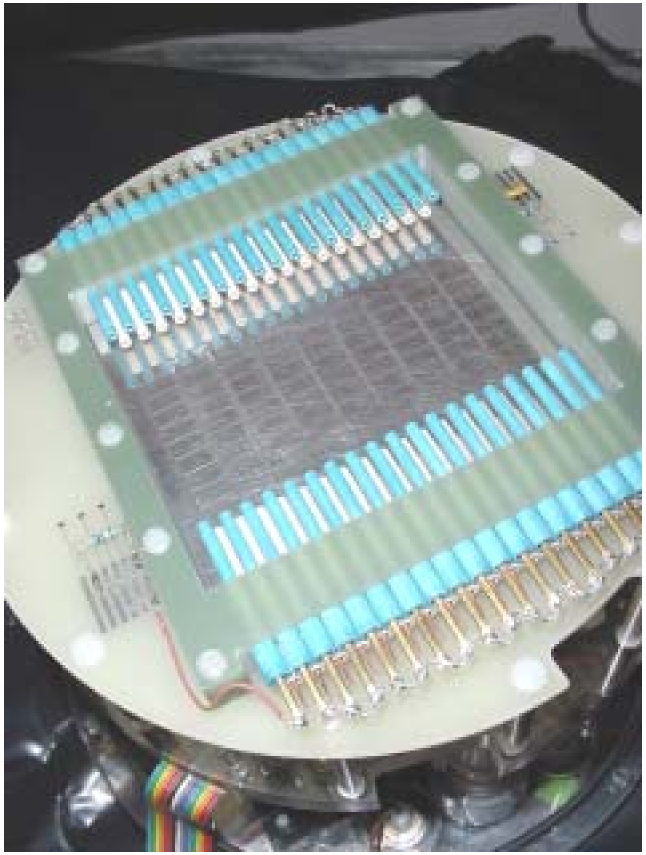
pads: -2000V

TPC Wire Gas-Amplification

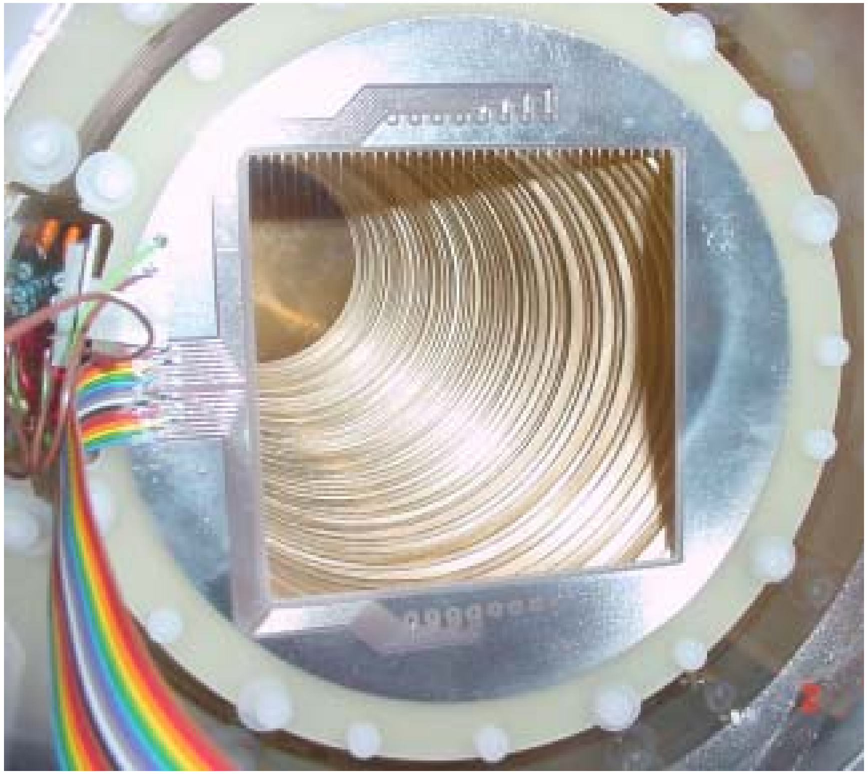
This is our first tested readout module. It is chosen to provide a well understood system for establishing a baseline and gaining experience in operating the TPC.

18 anode wires: 5mm spacing
anode-pad: 5mm
19 grid layer wires: 5mm spacing
grid-anode: 5mm

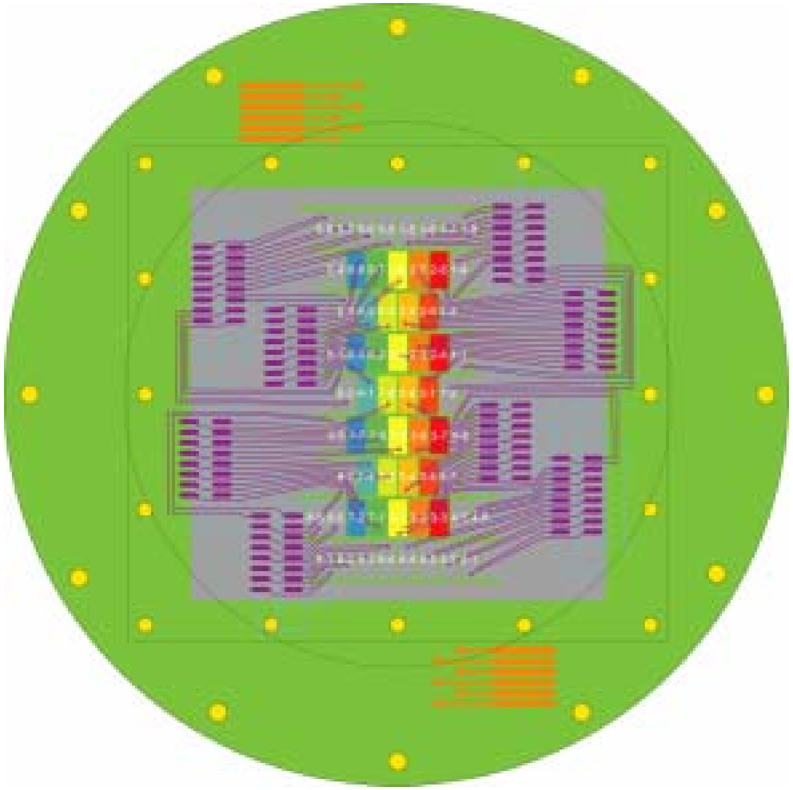
62 readout pads: 5mm x 10mm



Readout size



10 cm

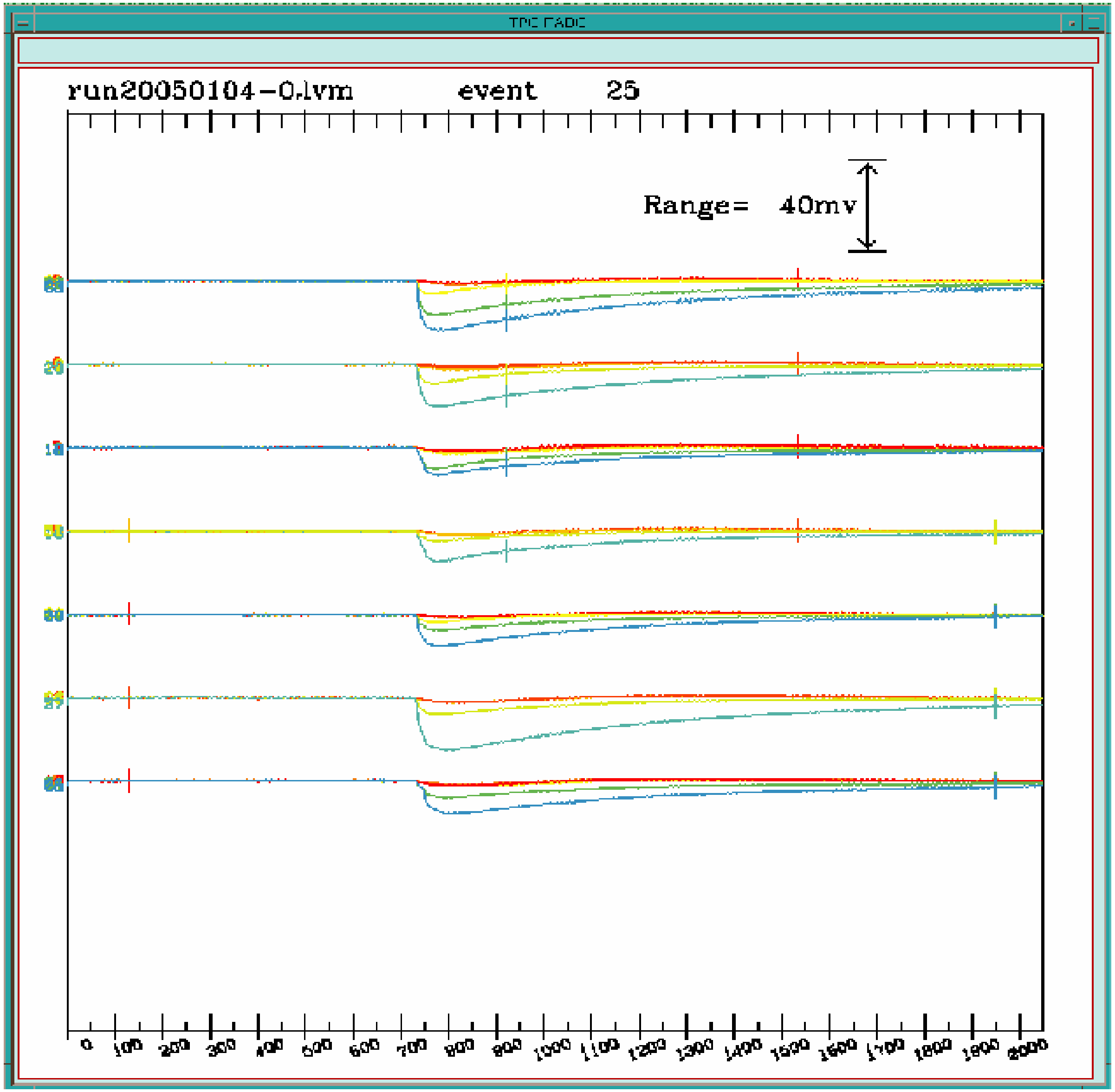


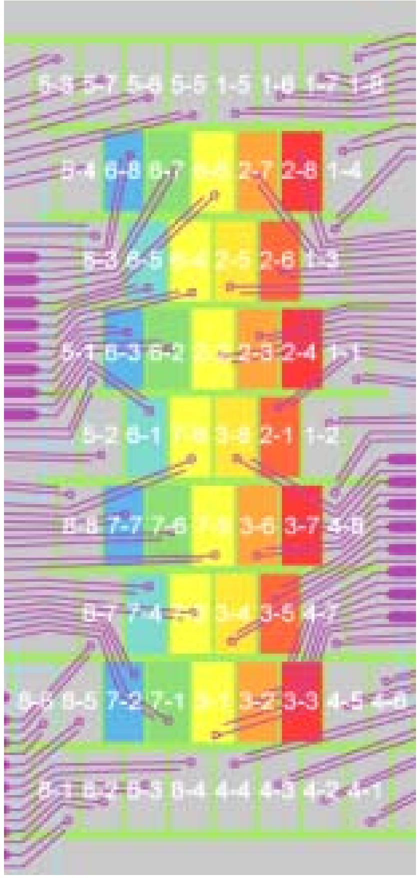
readout area is ~2cm x7 cm , 32 pads

(This pad board allows ~3 x 9 cm , 62 pads.)

track through the blue/green pads

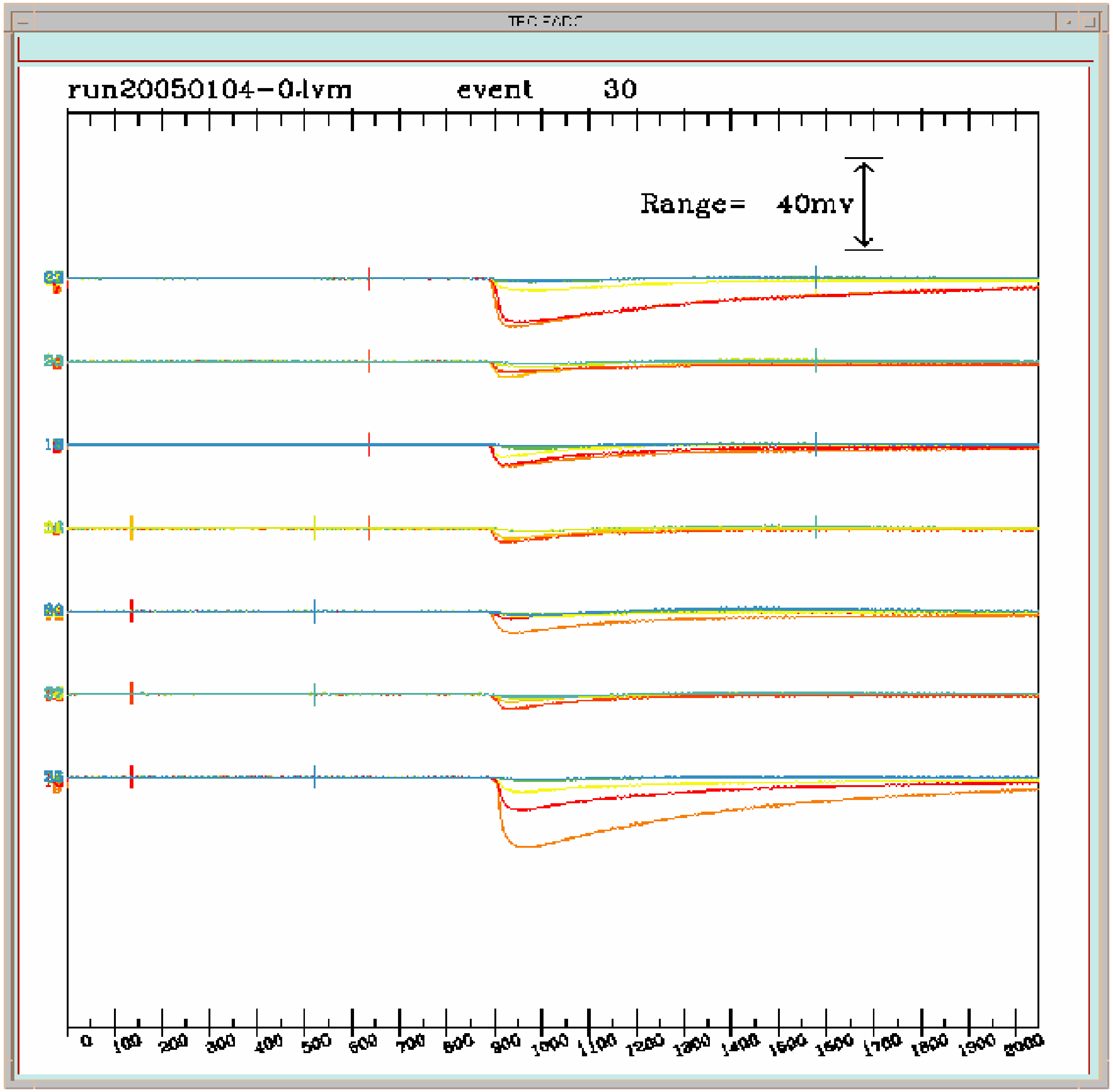
ArCO2 (10%) , 300V/cm
100 MHz , 10 ns
2048 time buckets (20.48 μs)

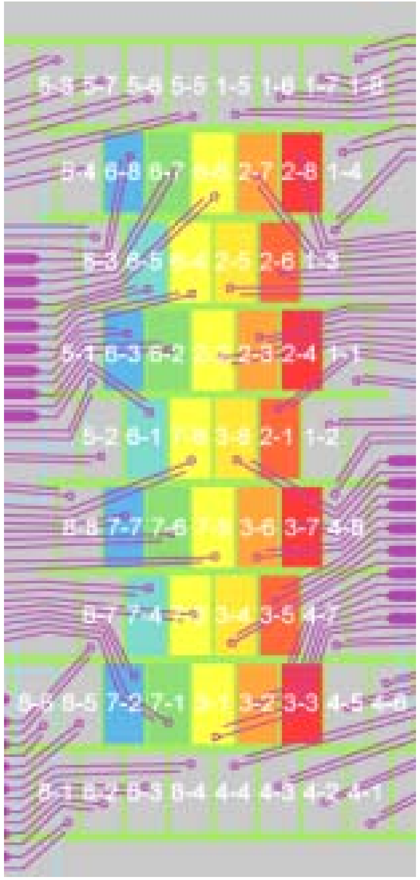




track through the red/orange pads

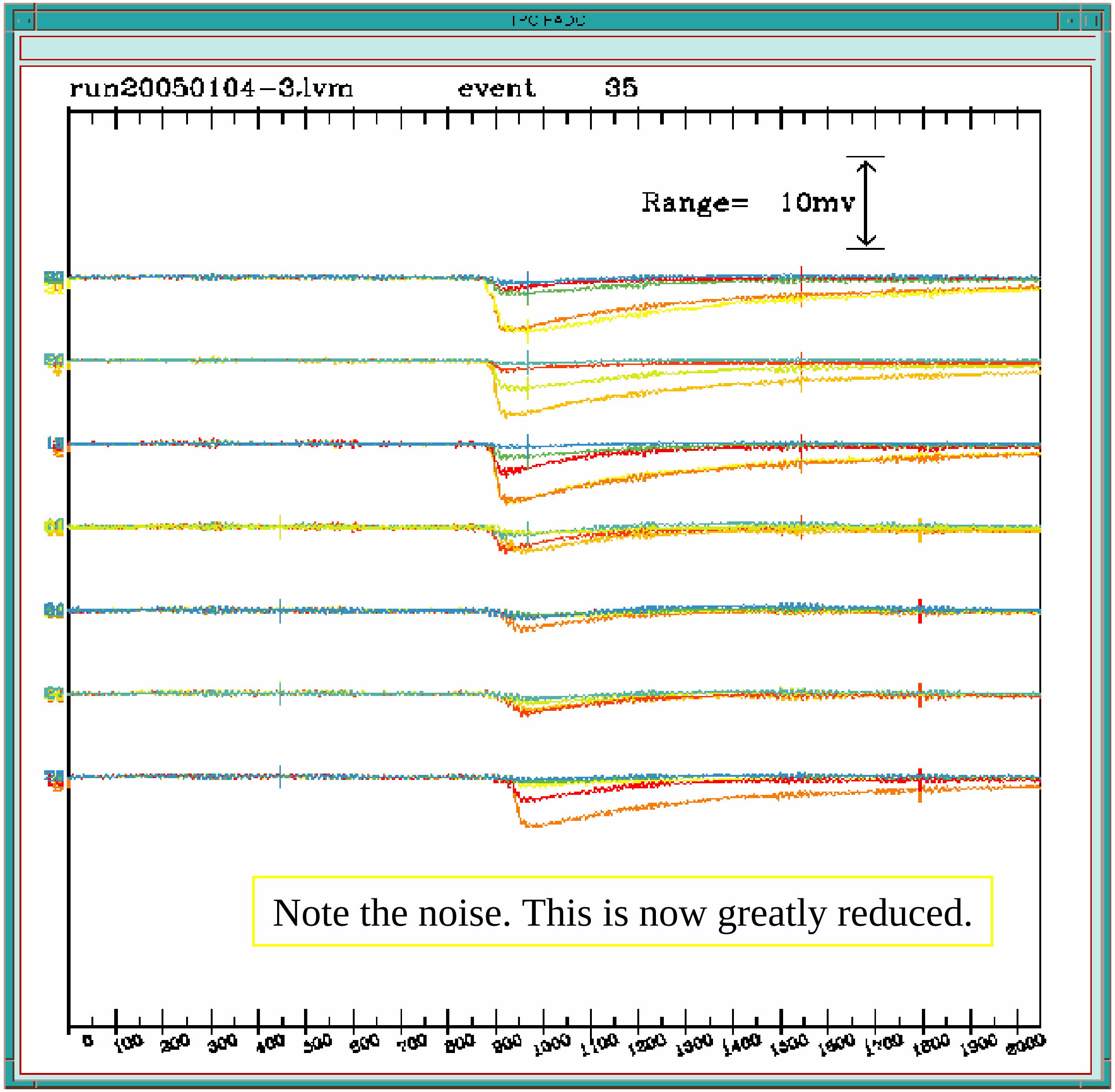
ArCO2 (10%) , 300V/cm
100 MHz , 10 ns
2048 time buckets (20.48 μs)



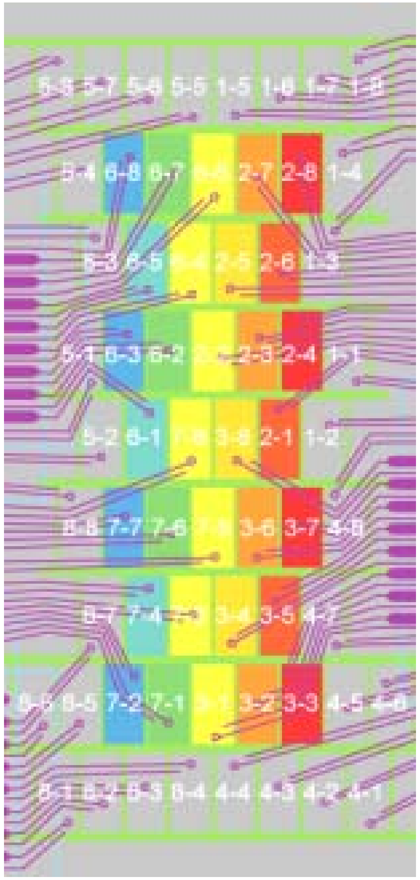


track through the yellow/orange pads

ArCO2 (10%) , 300V/cm
100 MHz , 10 ns
2048 time buckets (20.48 μs)

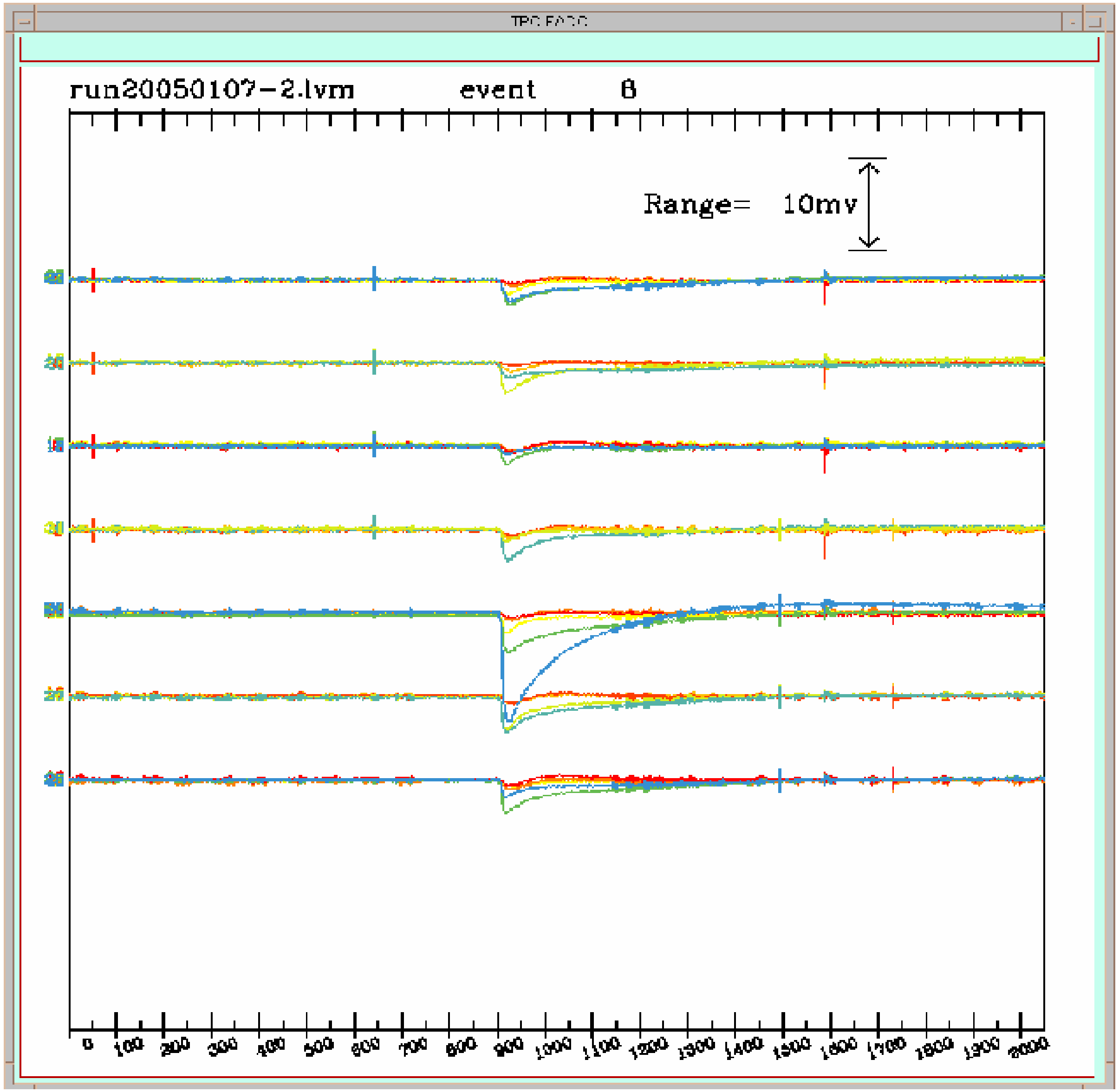


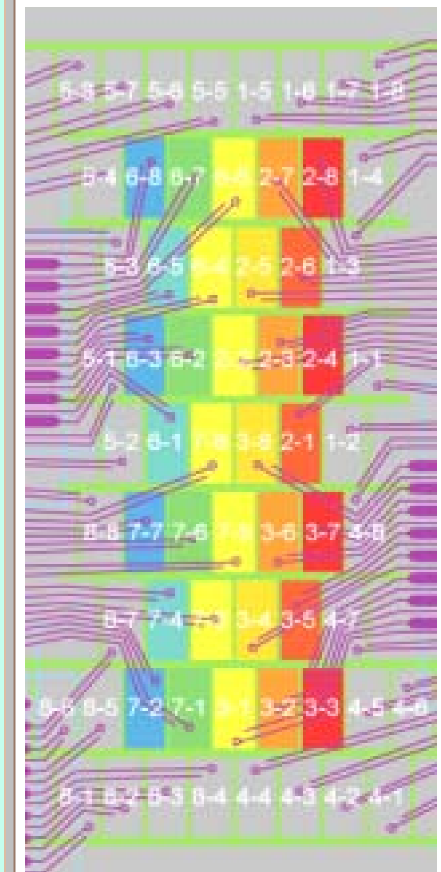
Note the noise. This is now greatly reduced.



track at 54 cm drift

ArCO2 (10%) , 300V/cm
25 MHz , 40 ns
2048 time buckets (82 μs)

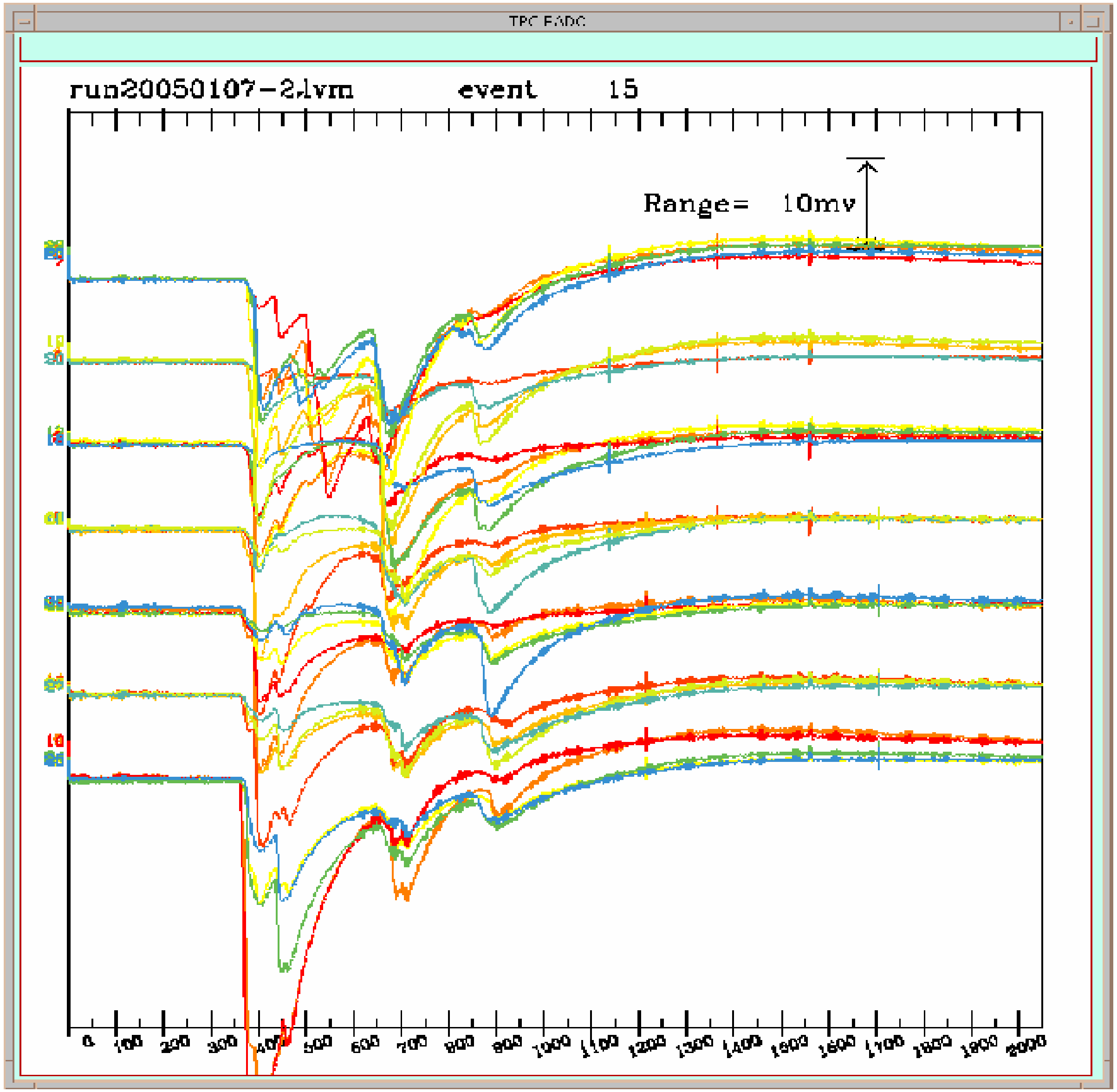


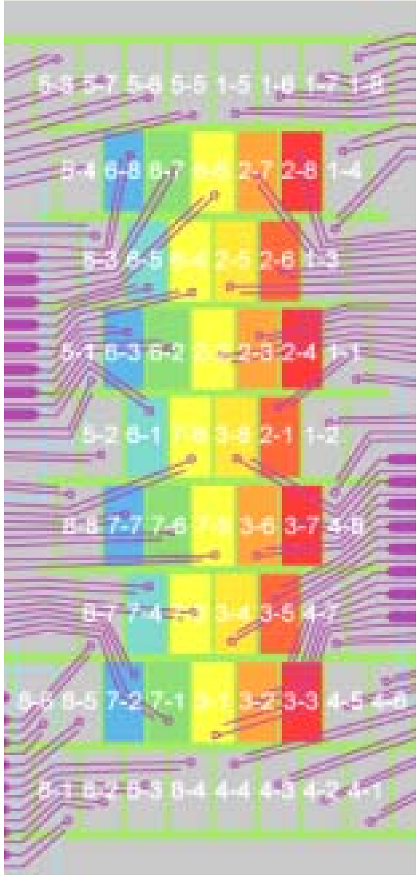


(The trigger counters are moved to expose the longer drift distance.)

shower

ArCO2 (10%) , 300V/cm
25 MHz , 40 ns
2048 time buckets (82 μs)





The events displays show that the chamber works.
However, progress in comparing amplification technologies is limited until we expand the readout capability.

"progress" since January

High voltage problems in the field cage HV distribution have been greatly reduced.

The LabView readout control is more efficient and now writes to a binary file. (L Fields)

The CAEN HV system is now interfaced to the LABVIEW. (P. Onyisi)
HV trips now stop the data taking.

We have taken sufficient data to measure hit resolutions.
(follows)

We have mounted a GEM gas-amplification stage in the TPC. (G. Bolla)

Increased shielding of the signal cables has reduced noise from about +/- 0.5 mV to +/- 0.1 mV .
This improves our sensitivity to low signals. (The noise is now ~ 4 counts.)

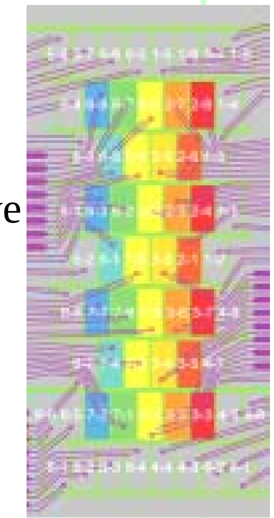
hit resolution, wire amplification

find tracks - require coincident signals in 6 layers

locate maximum PH pad in each layer

find PH center using maximum PH pad
plus nearest neighbors

(2 or 3 pads in the “hit”)



require the hit pulse height sum to have
70% of layer pulse height sum

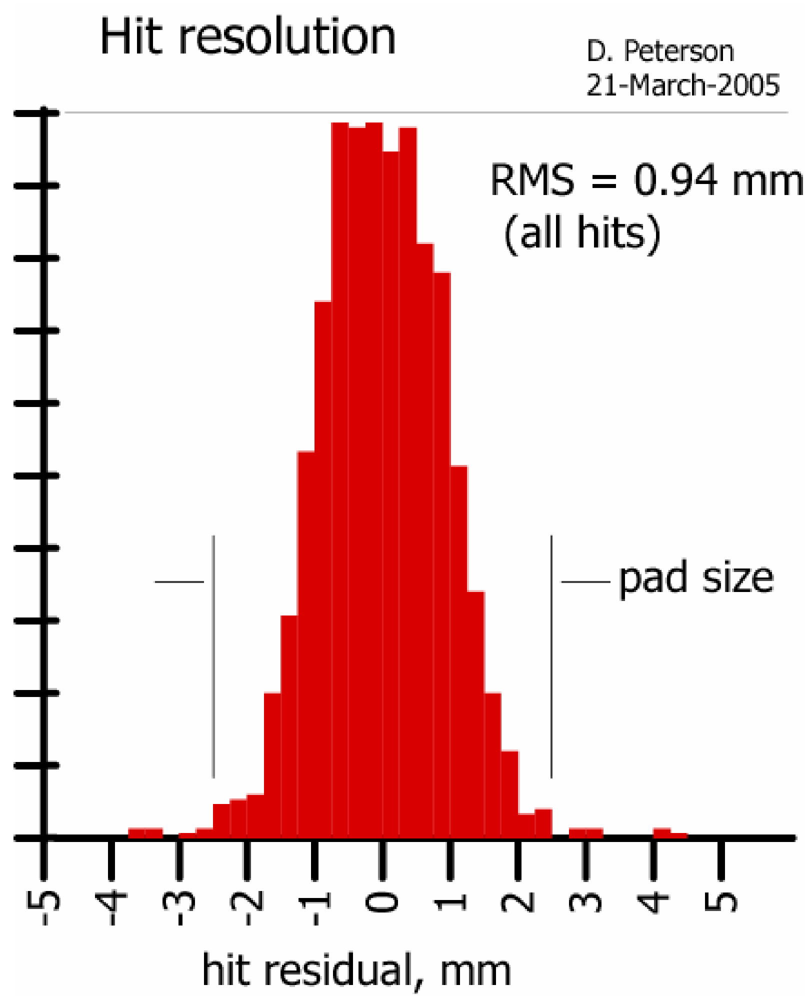
require 5 layers with interior hits
(Max. ph pad is NOT on the edge.)

fit to a line

may eliminate 1 hit with residual > 2.5mm
(Still require 5 layers with interior hits.)

refit

resolution is ~ 900 μm, 0 to 40cm drift



single GEM

single GEM gas amplification

CERN GEM mounted, tested by Purdue

Very preliminary, no events.

installed 11-March

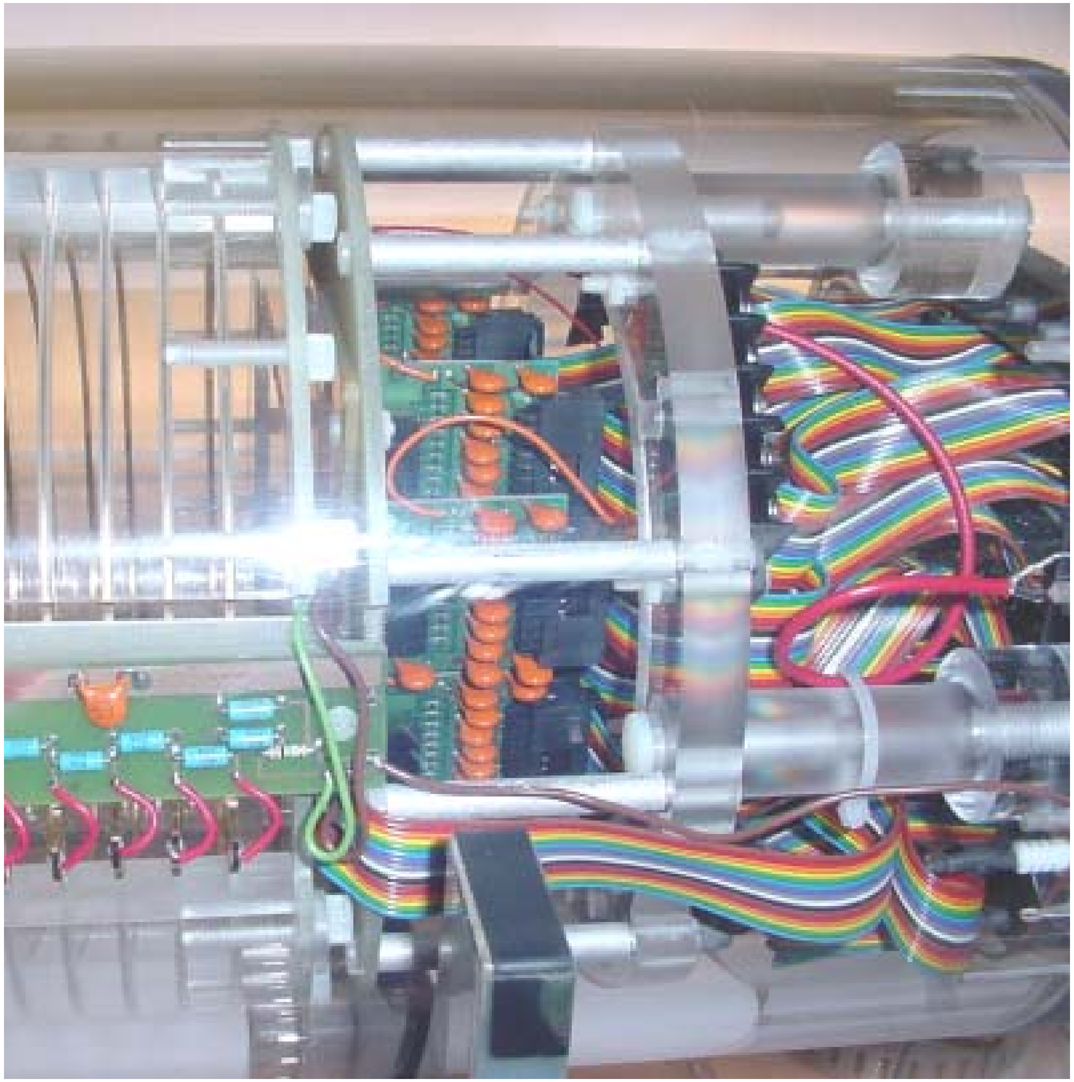
biasing:
field cage, -20kV, 300 V/cm
termination: -900V

GEM voltage: **-420V**
(GEM bottom: at ground)

pads: +1500 V

Electric field:
field termination – GEM top: 0.5 cm ,
0.96 kV/cm

induction gap: 0.3 cm,
5 kV/cm



Linear Collider Detector R&D Proposal

The current round of joint DOE/NSF Linear Collider detector R&D funding had project proposals due: 21-January-2005.

These proposal are presently in review.

DOE/NSF action expected in May-2005

Our project requests:

Cornell: first year

- expanded readout
- new preamps
- positive HV supply
- instrumentation for ion feedback measurements
- gas

Purdue:

- student support

Next 1 year

Cornell:

Expand the readout system; implement rows of small pads.
Large pads, similar to the present pads, will be used for track definition.

Compare GEM, MicroMegas, and Wires within the same TPC.

Compare multiple assemblies of "identical" gas-amplification stages.

The present wire gas-amplification, with 20 μm wire and 5mm anode-to-pad distance, requires an anode-pad potential of 2550V.
We can construct a new wire stage, 8 μm wire and 3mm anode-to-pad, which will operate at lower potential.

Measure resolution vs. drift distance, details of biasing, gas, (location on pad).

Measure ion feedback with the various gas-amplification stages.

Purdue:

Mount and test single, double, triple GEM, and MicroMegas on standard pad boards.
We have installed a single CERN GEM. A 3M MicroMegas is next.