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

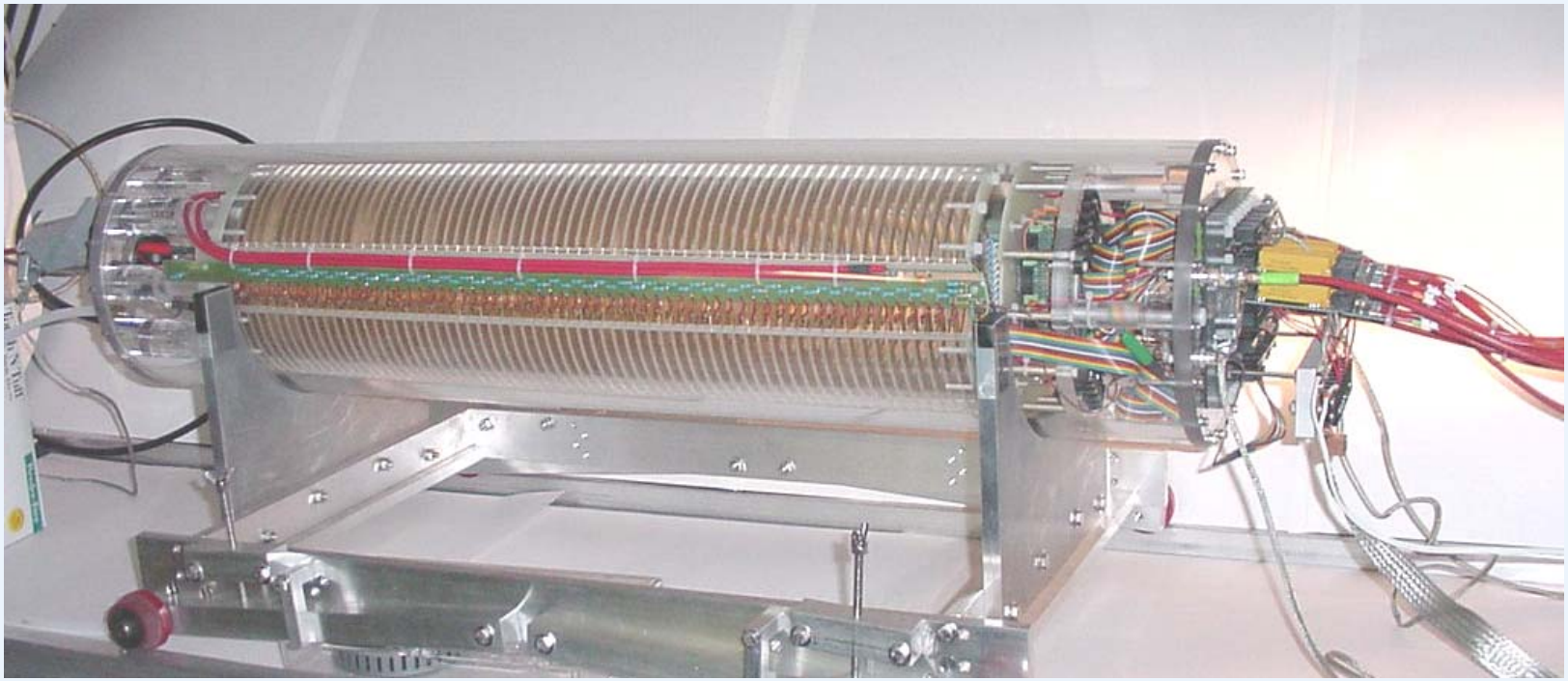
* this presentation: ALCPG Snowmass 23-August-2005
* presentation to LCWS05, Stanford 21-March-2005
* presentation to TPC mini-workshop, Orsay 12-January-2005,
* presentation to ALCPG at Victoria, 28-July-2004,
* presentation to ALCPG meeting at SLAC, 07-January-2004,
* presentation to TPC meeting at Berkeley, 18-October-2003,
* presentation to UCLC meeting at Santa Cruz, 30-June-2002,

This project is supported by the US National Science Foundation (LEPP cooperative agreement)
and by the US Department of Energy (Purdue base program)

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)

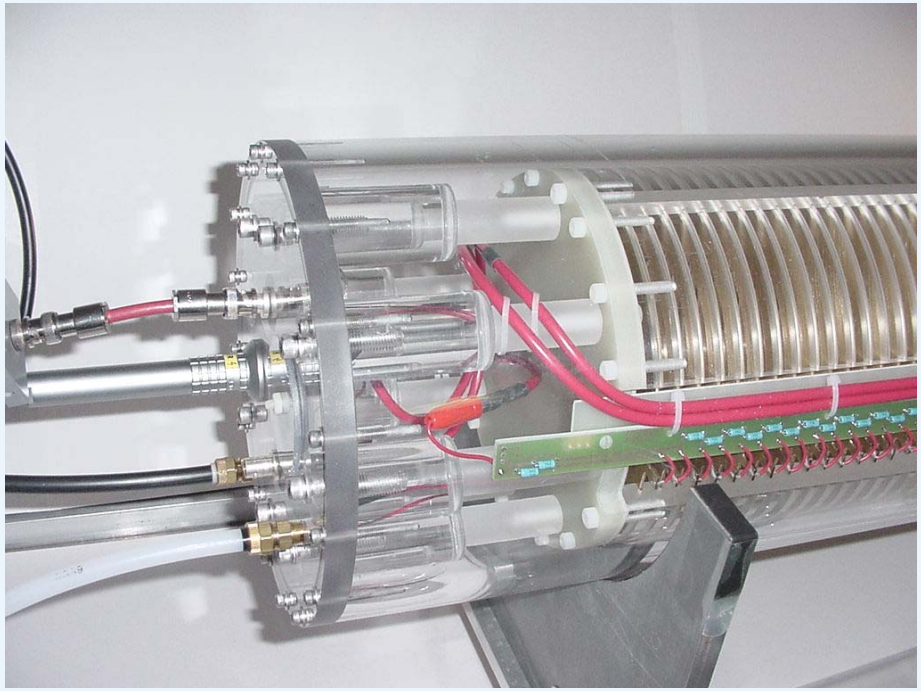


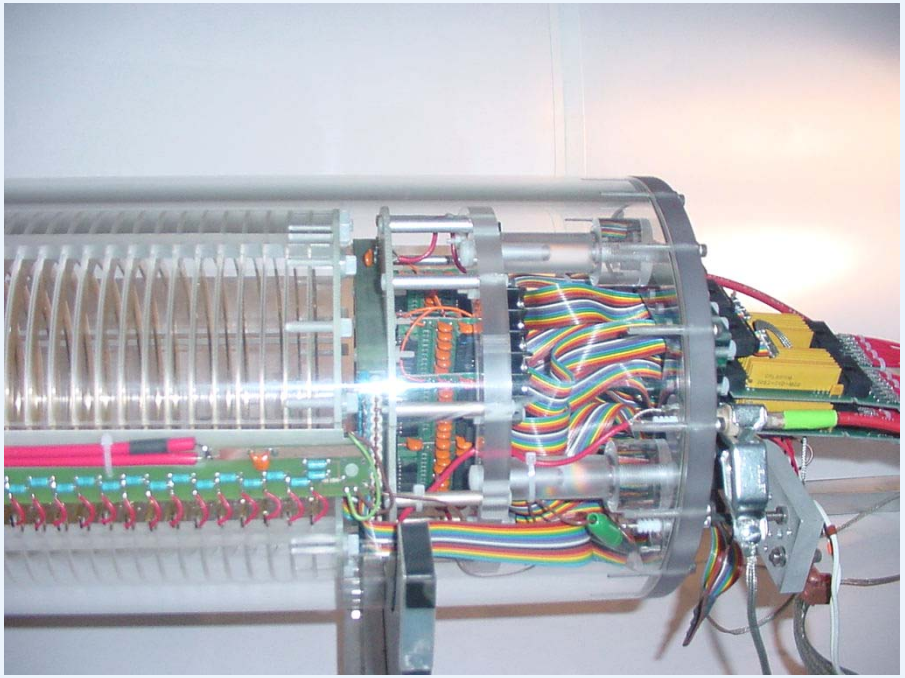
TPC details

High Voltage end:
- LEMO HV connectors
- SHV bias trimming connectors
- gas connections
- field cage HV distribution

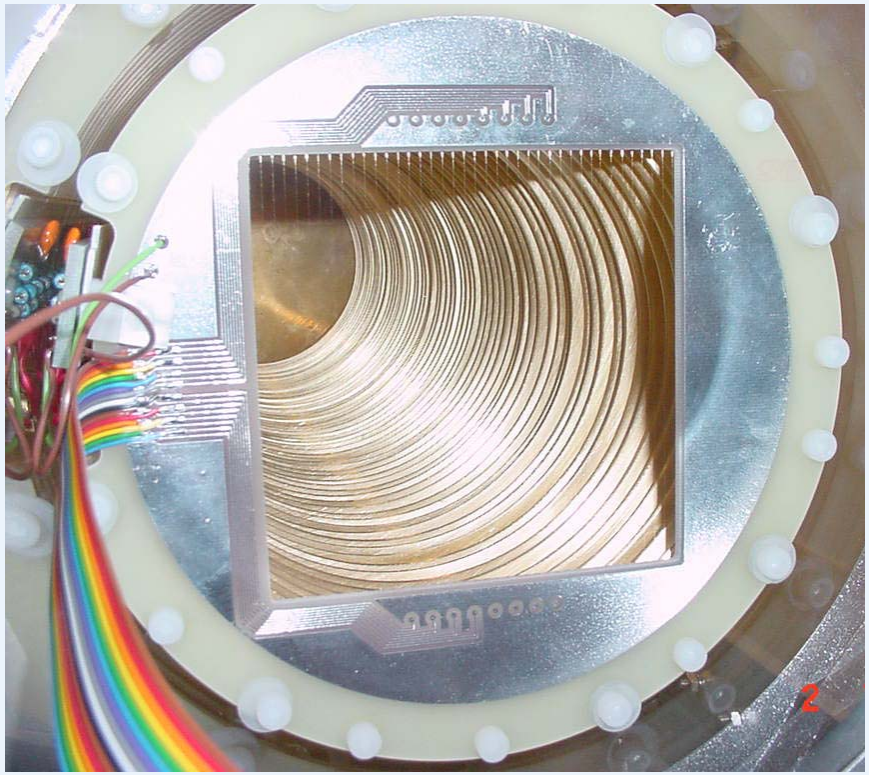
Read-out end:
- field cage HV distribution
- field cage termination
- **readout pad and amplification module**
- front end electronics
- CLEO II cathode preamps

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



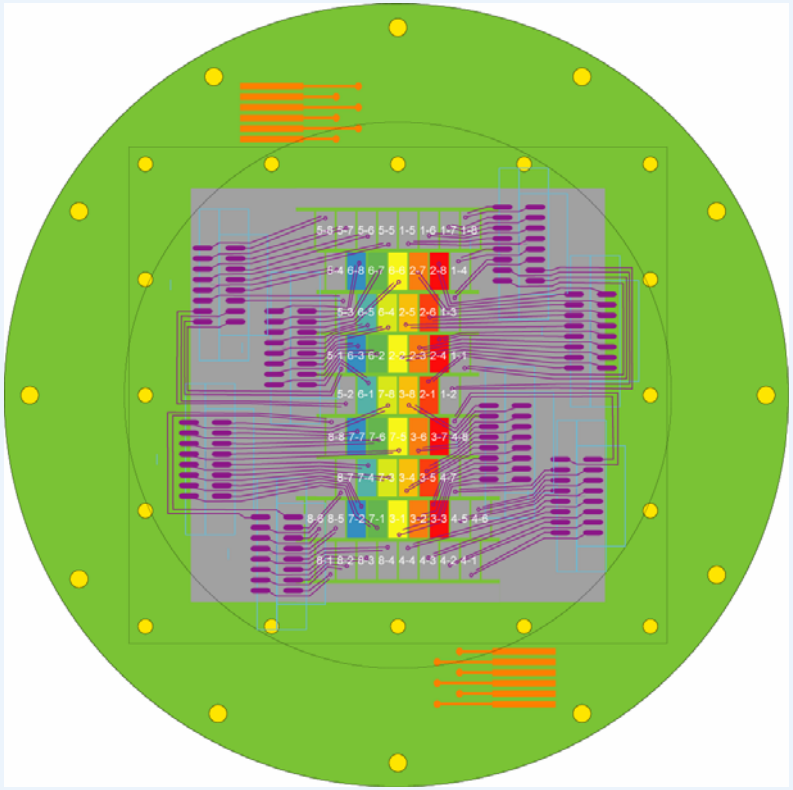


Field cage termination



10 cm

Field cage termination area is 10cm square

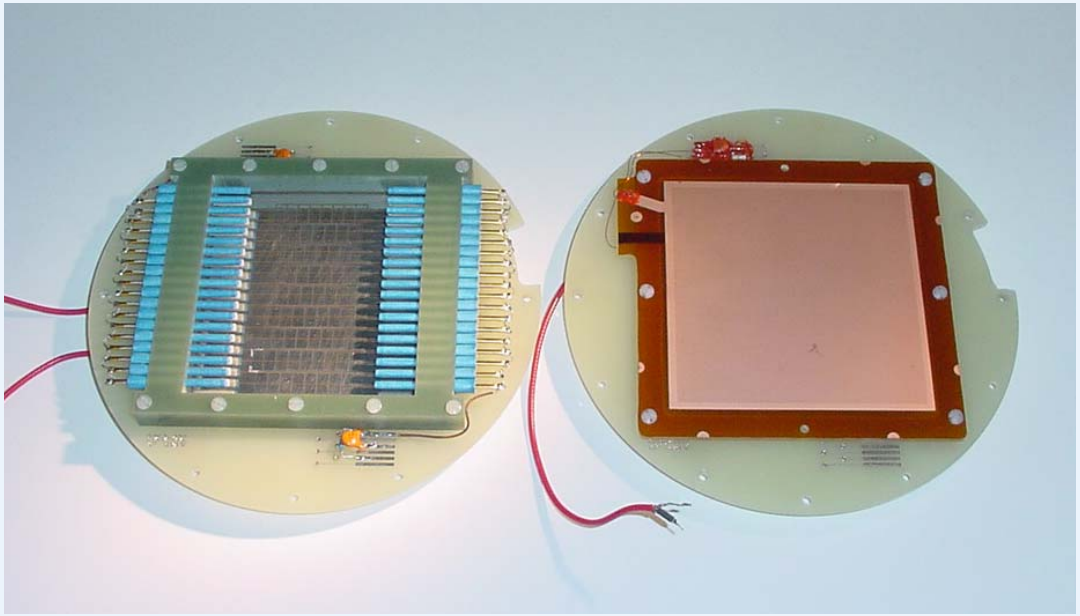


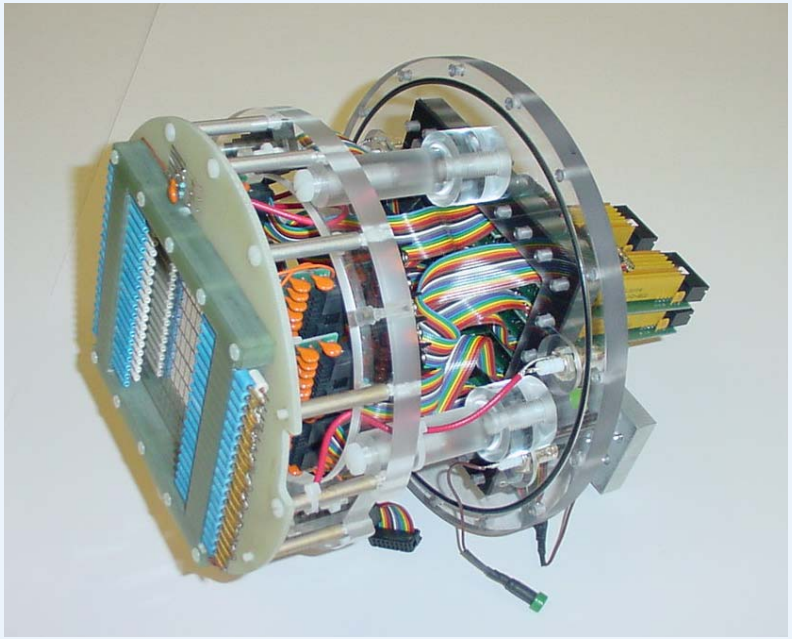
The instrumented readout area is
~2cm x7 cm , 32 pads.

The biased area is 10cm square.

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

MPWC and GEM amplification





10 cm

The readout module including the amplification device mounted on pad board

The instrumented readout area is
~2cm x7 cm , 32 pads.

The biased area is 10cm square.

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

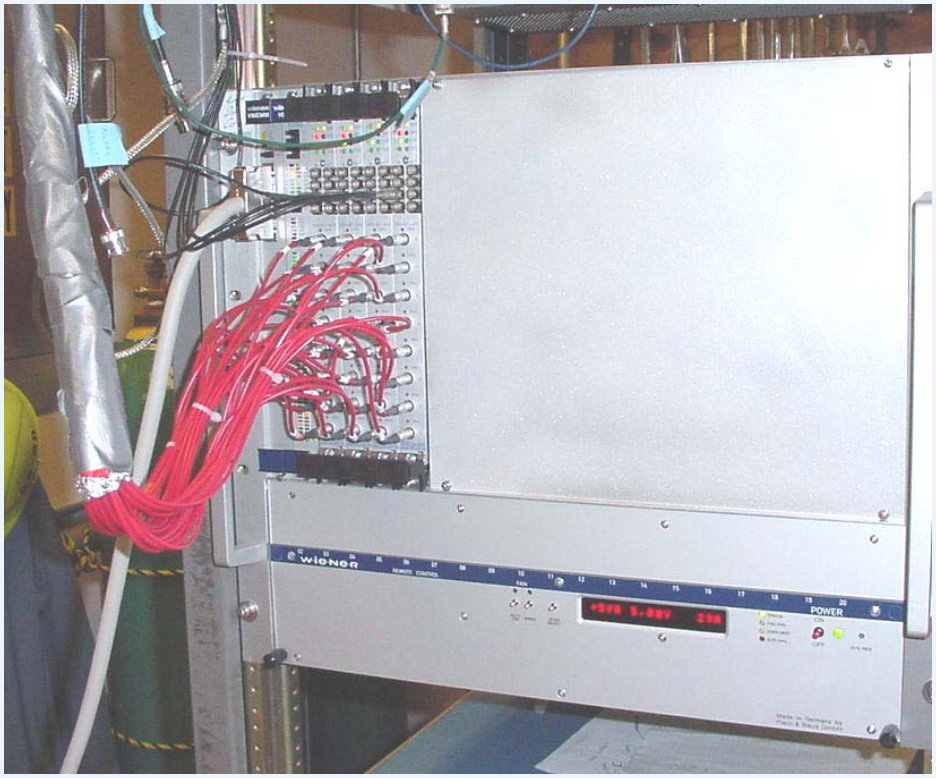
Electronics

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

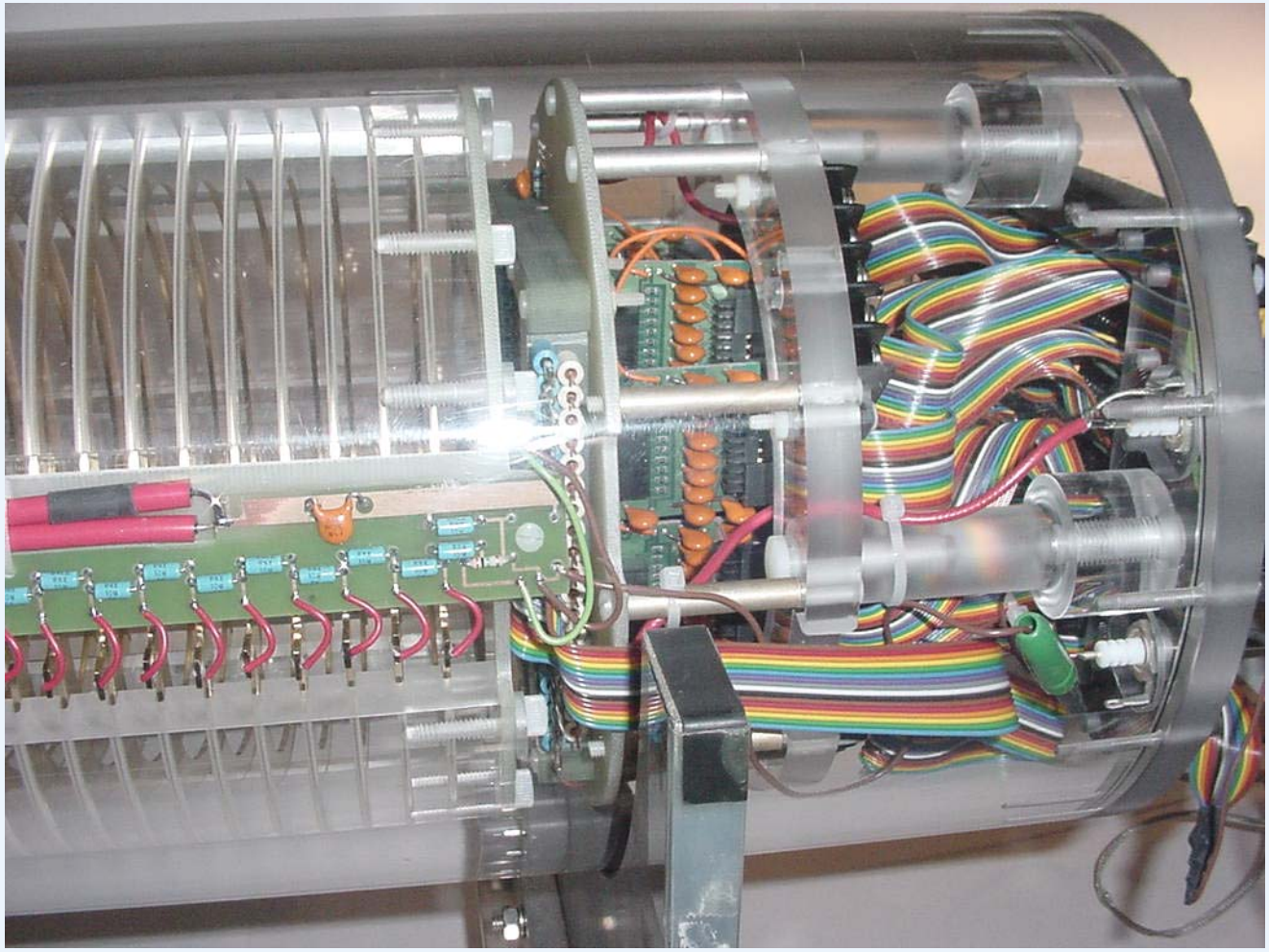
(not part of interfaced system) +2 kV

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

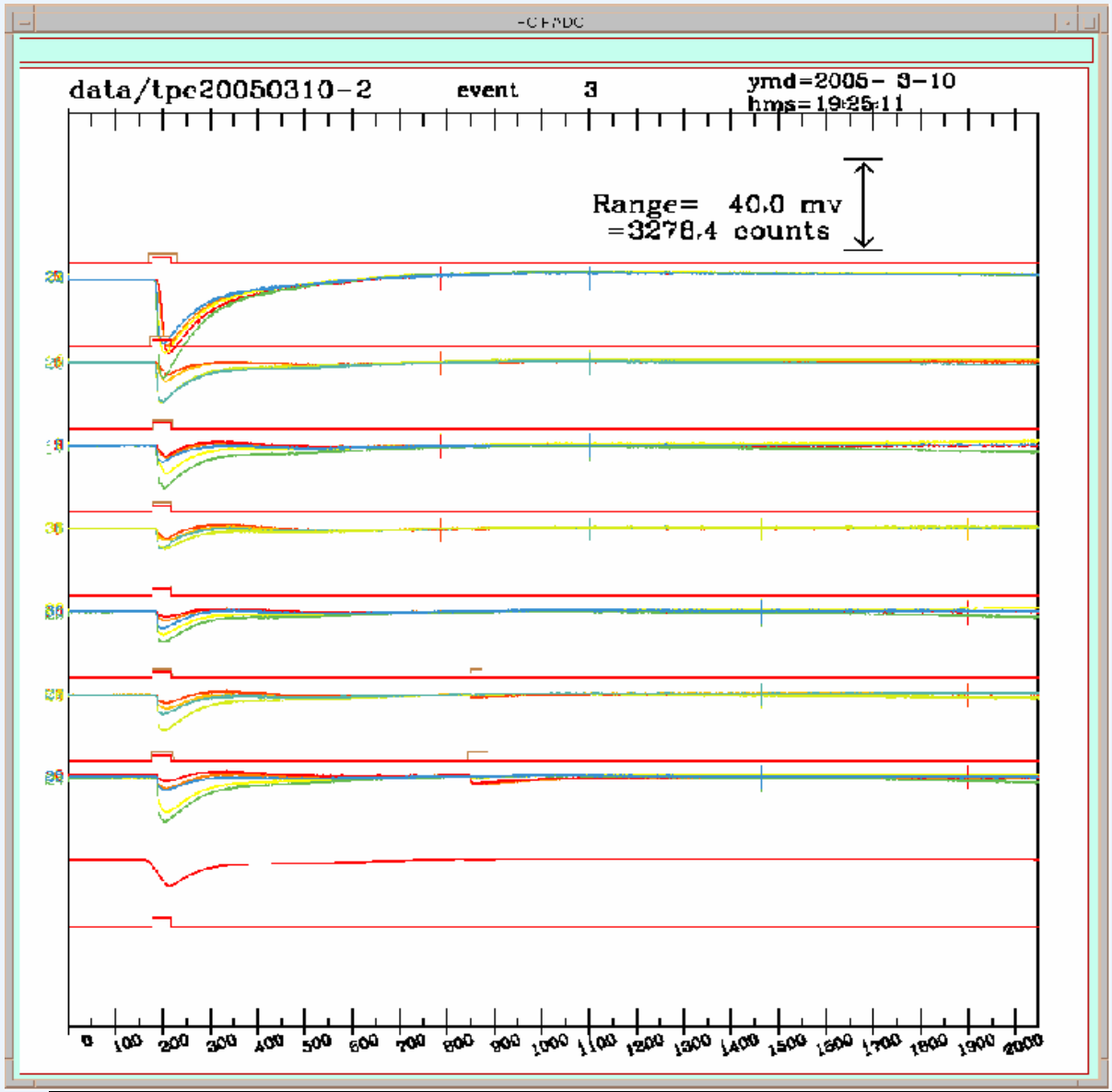
(0.5 cm)

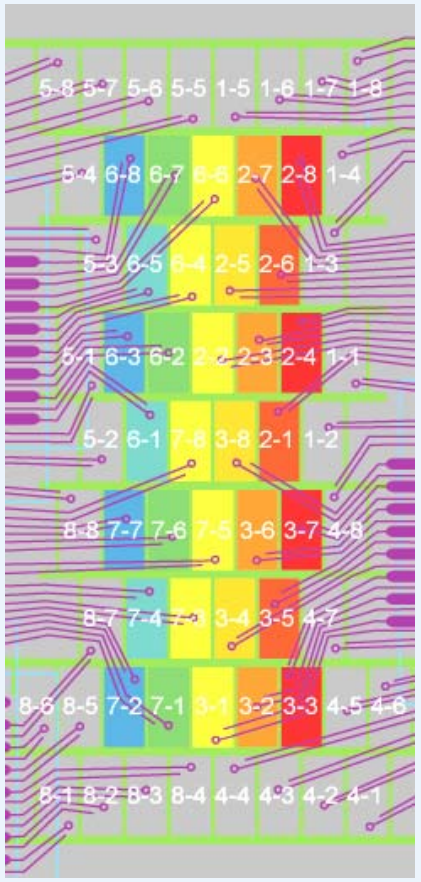
anode: +550V

(0.5 cm)

pads: -2000V

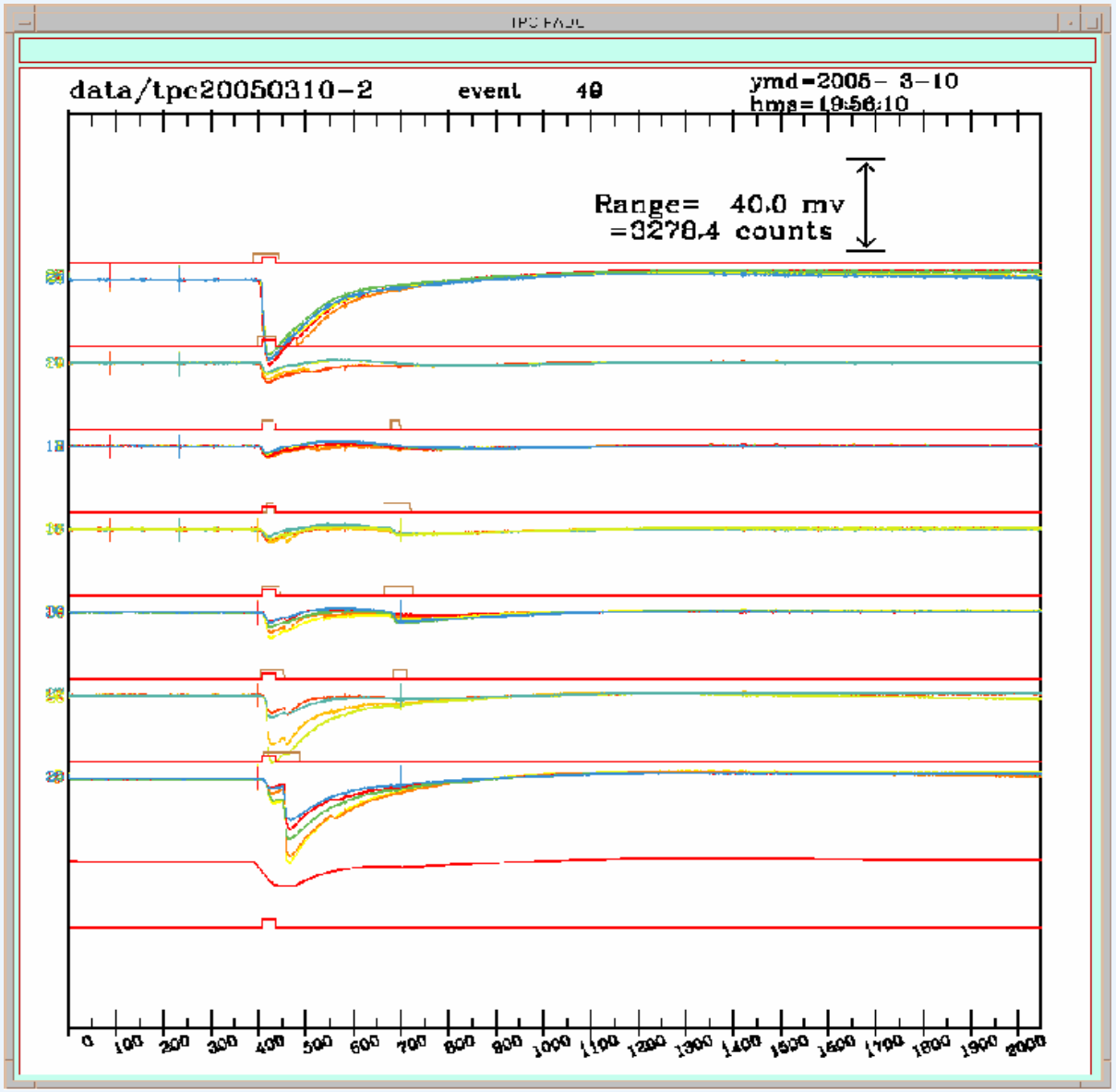
MWPC event (typical)



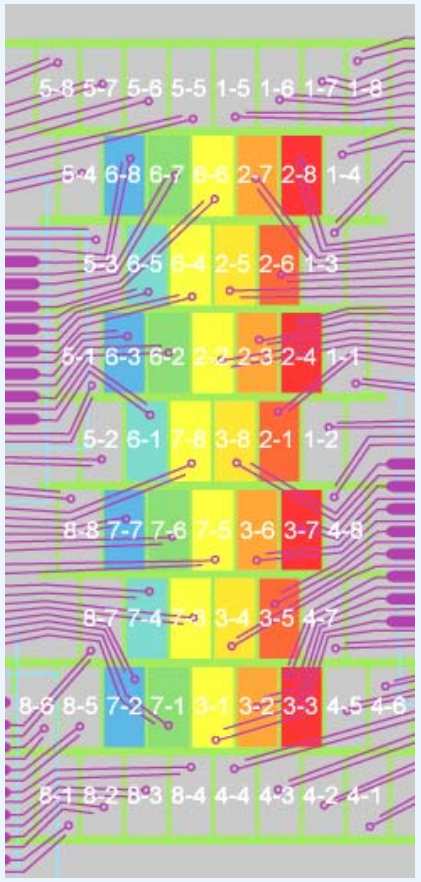


ArCO2 (10%) , 300V/cm
25 MHz , 40 ns
2048 time buckets (81.92 μs)

MWPC event (long drift)



Drift is 300 channels (t_0 ~ 100)
12 μs



ArCO2 (10%) , 300V/cm
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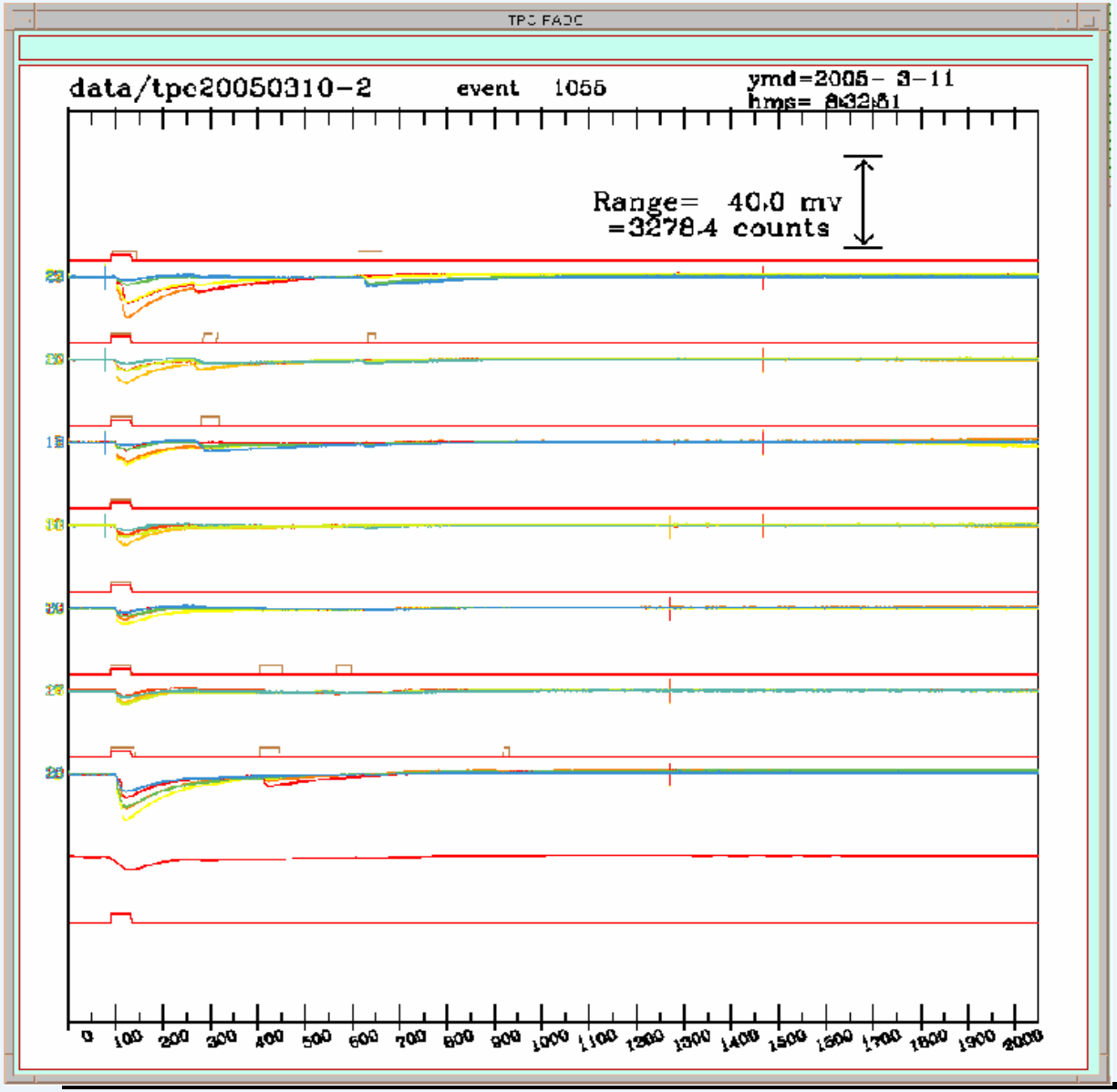
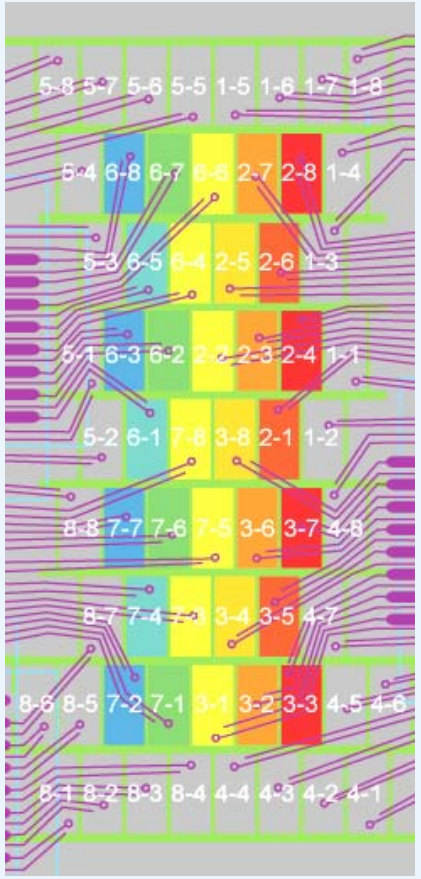
2048 time buckets (81.92 μs)

MWPC event (short drift)



Drift is -10 channels (t_0 ~ 100)
(inside MWPC ?)



ArCO2 (10%) , 300V/cm
25 MHz , 40 ns
2048 time buckets (81.92 μs)

single GEM

single GEM gas amplification

CERN GEM mounted, tested by Purdue

installed 11-March

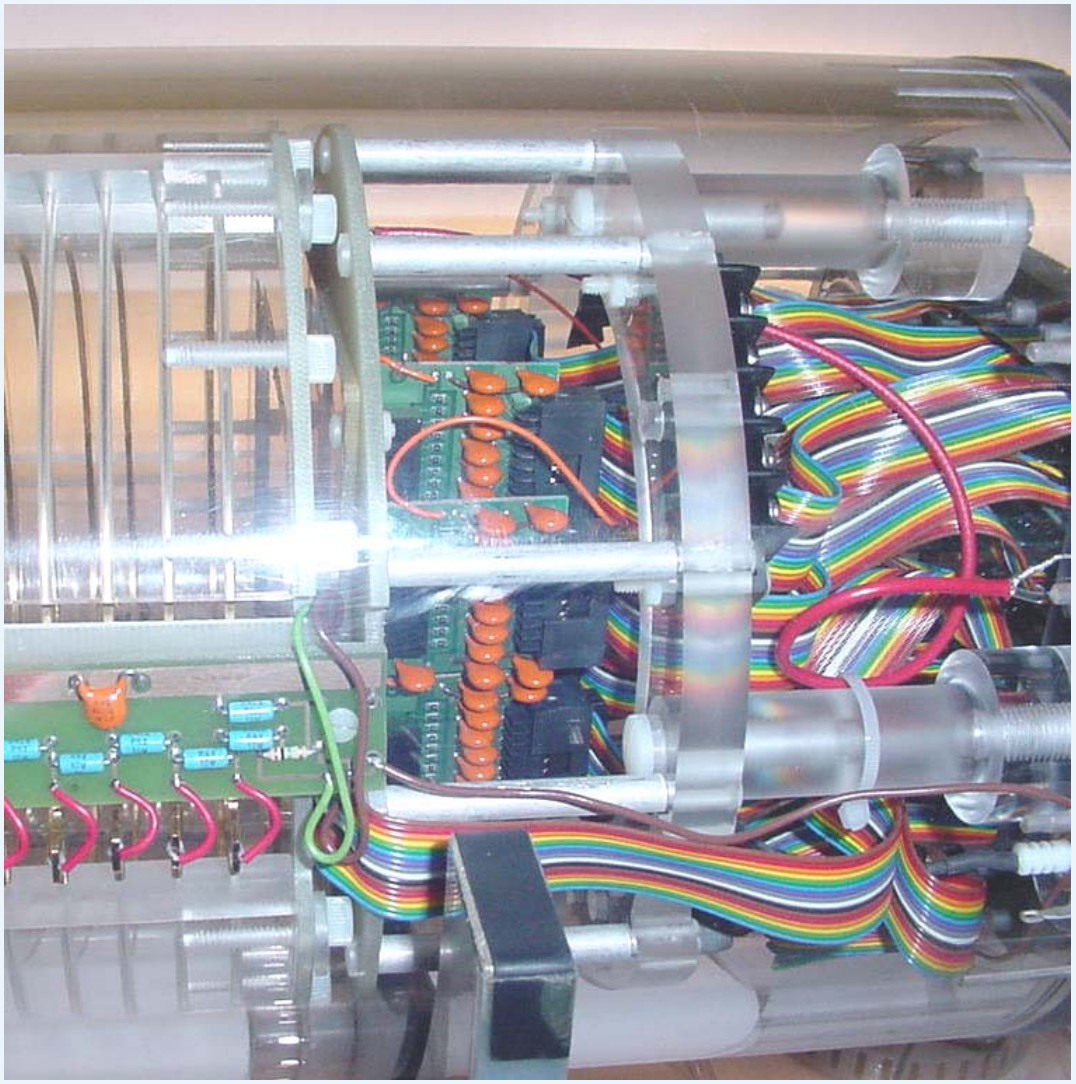
biasing:
field cage, -20kV, 300 V/cm
termination: -900V

GEM voltage: **-400V**
(GEM bottom: at ground)
(Gas amplification ~100.)

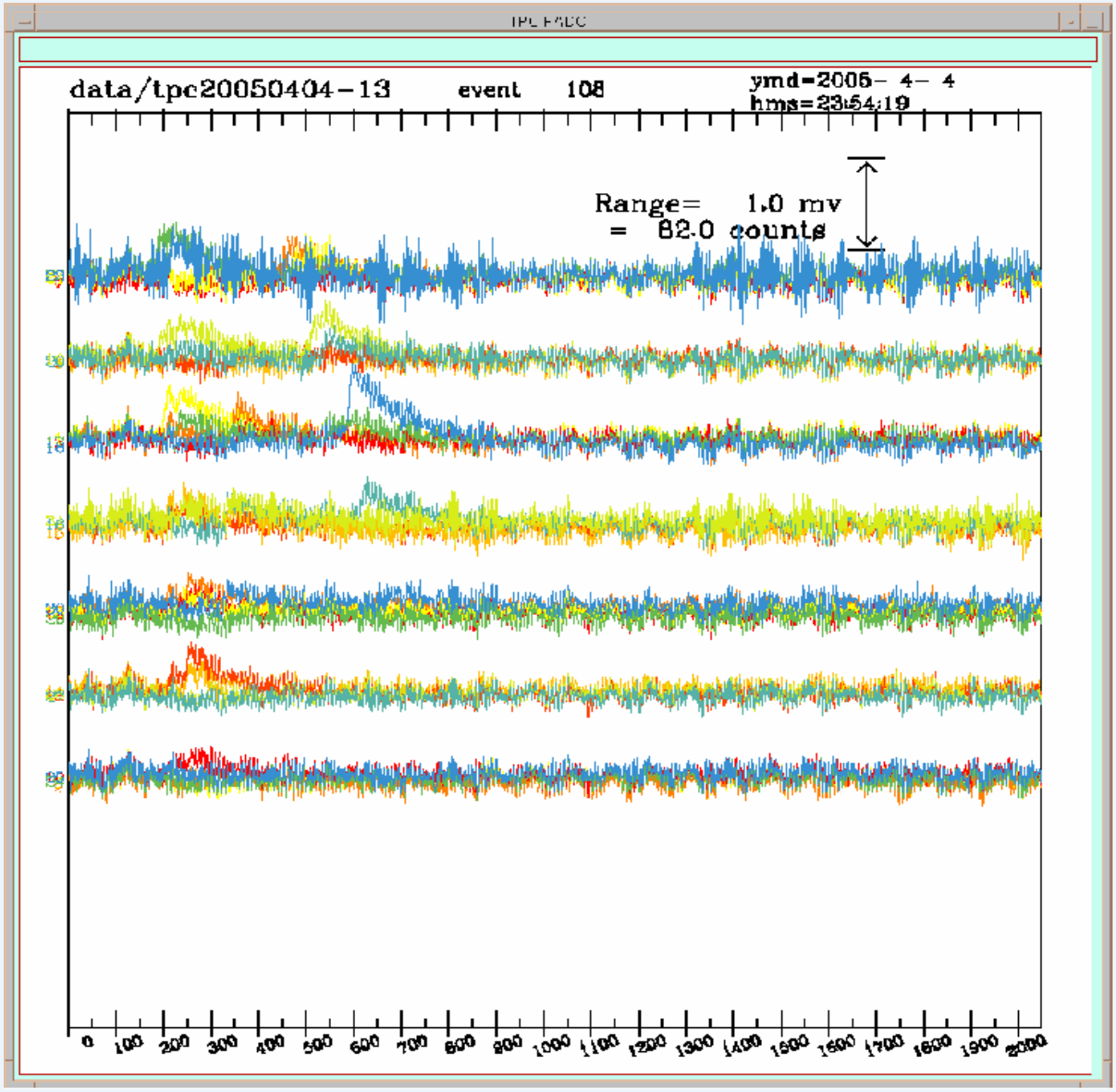
pads: +1500 V

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

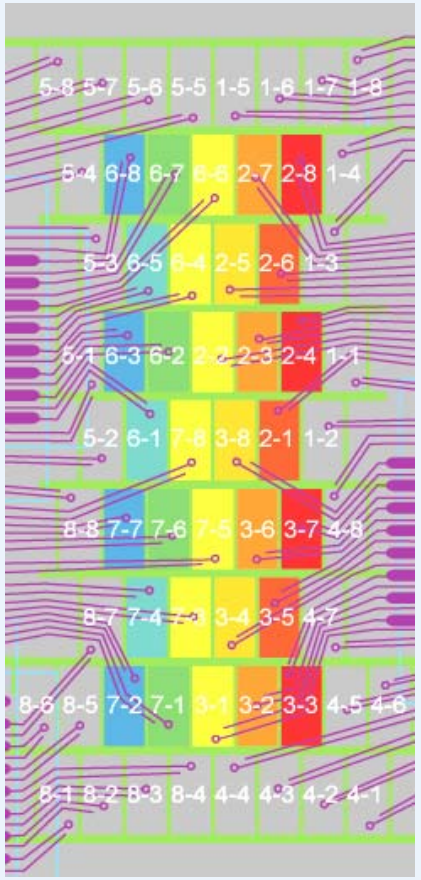
induction gap: 0.3 cm,
5 kV/cm



single-GEM event

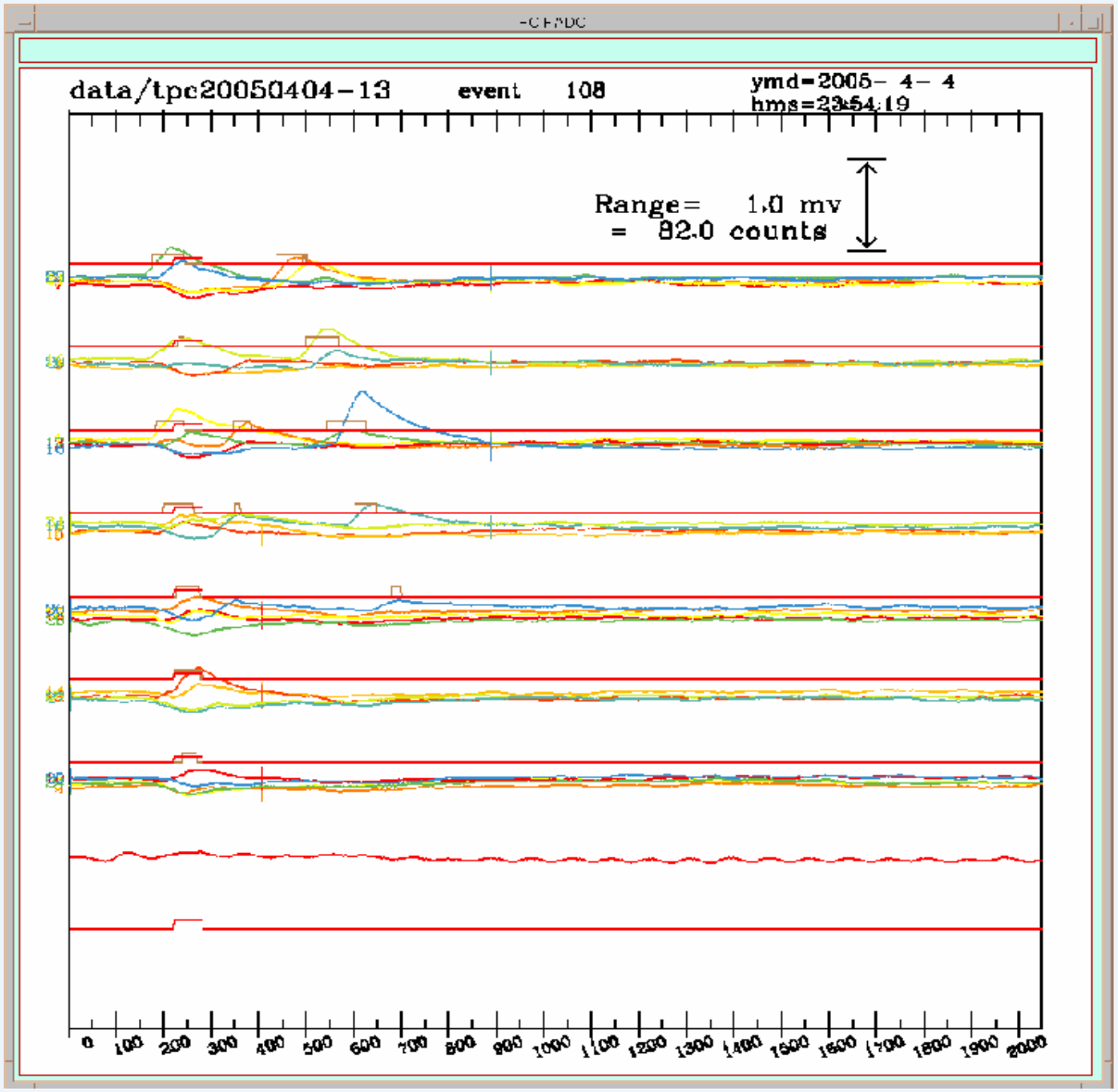


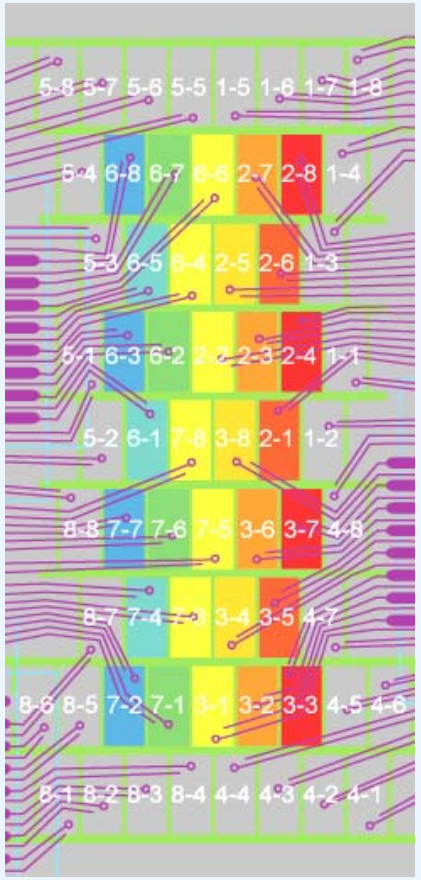
Note the 1 mv scale.
Gas amplification is about 100



ArCO2 (10%) , 300V/cm
25 MHz , 40 ns
2048 time buckets (81.92 μs)

GEM event after smoothing and common noise subtraction





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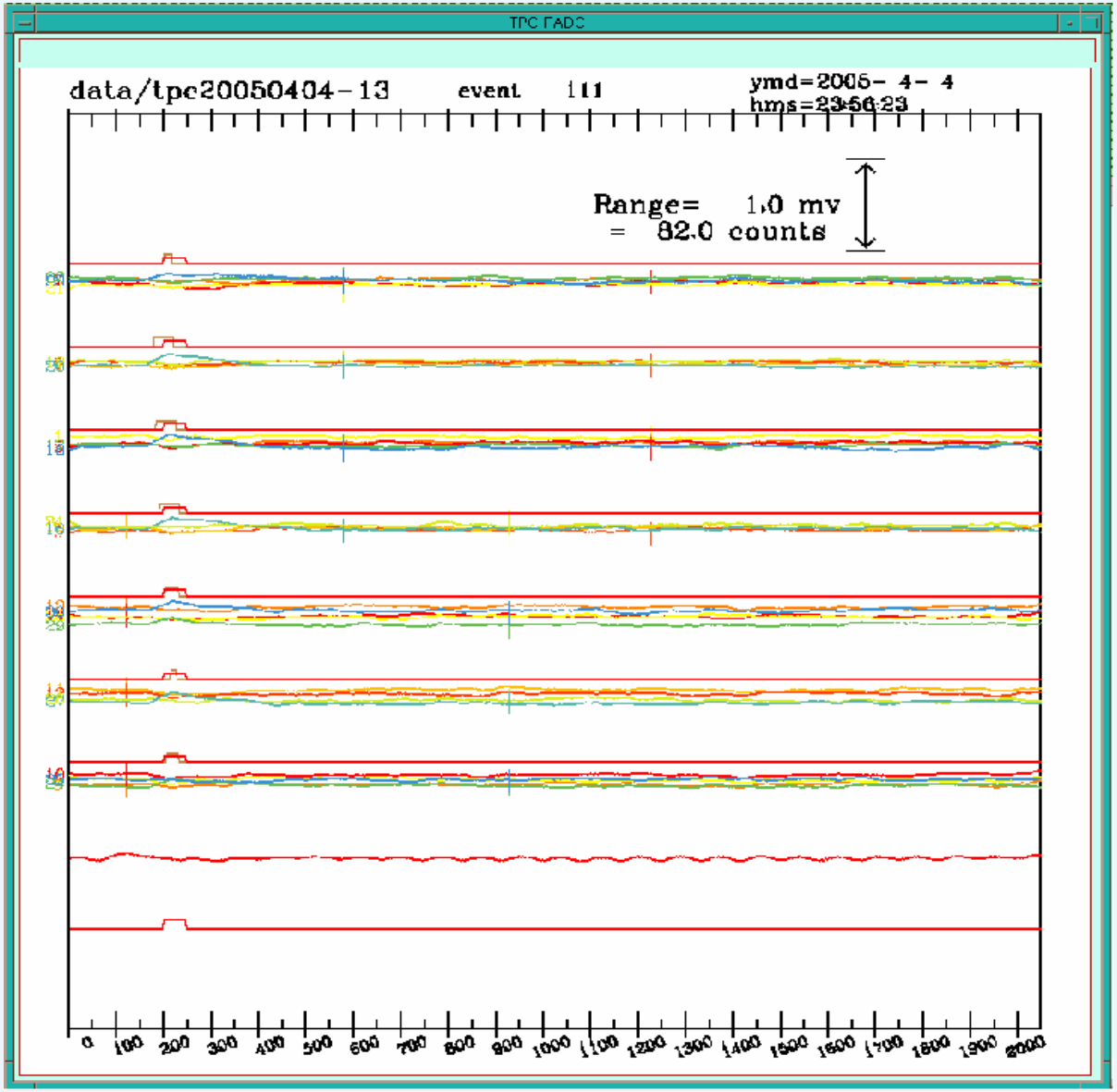
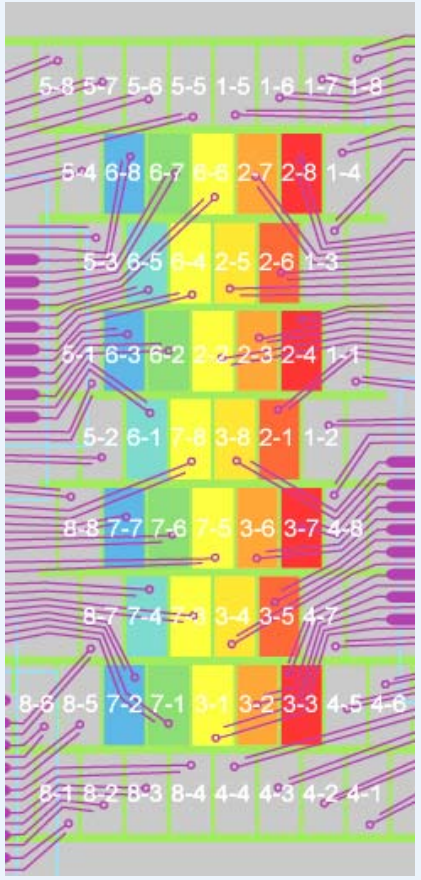
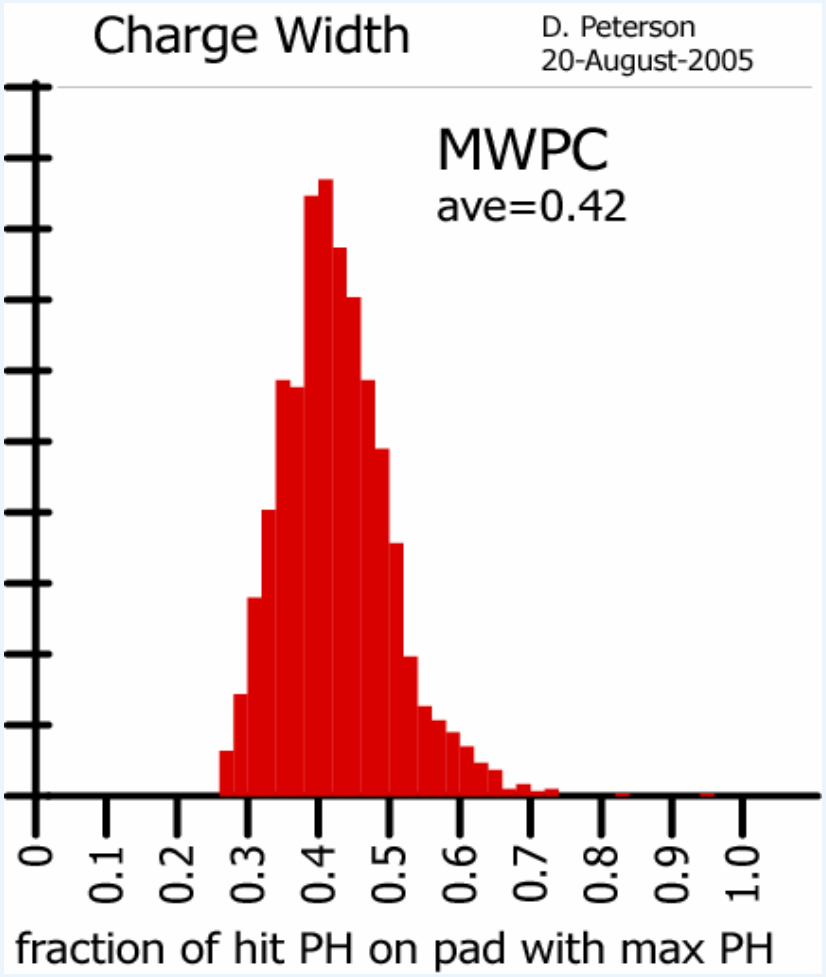
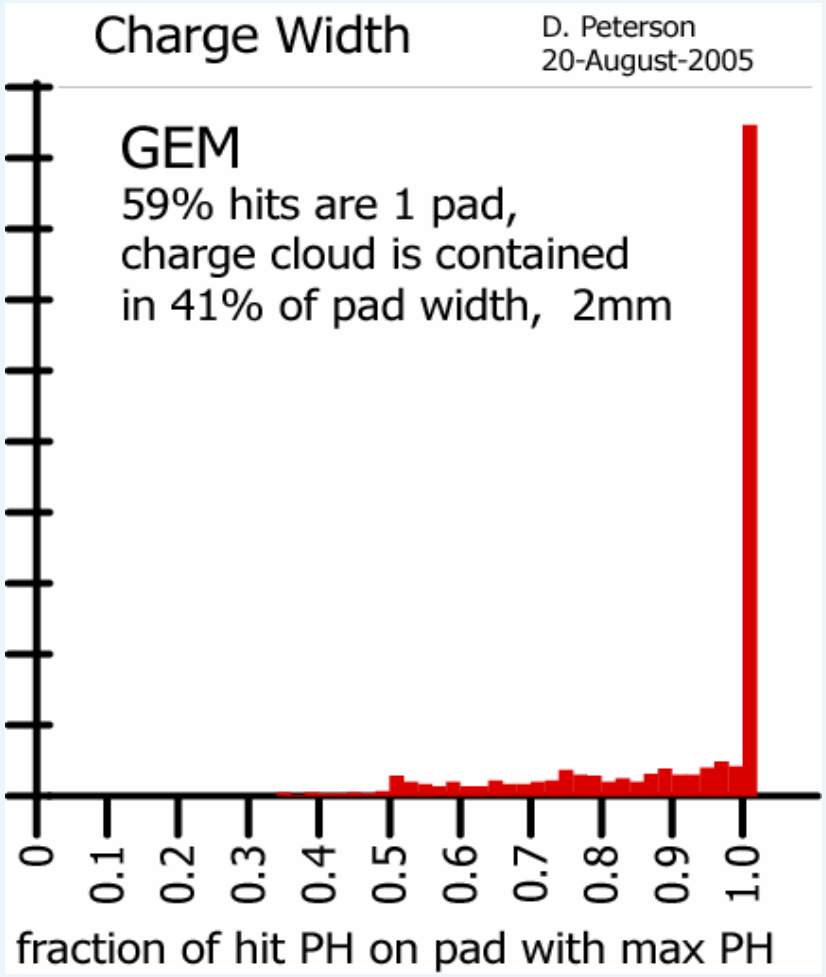




ArCO2 (10%) , 300V/cm
25 MHz , 40 ns
2048 time buckets (81.92 μs)

charge width





This is influenced by the common “noise” subtraction.)

hit resolution (5mm pad)

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

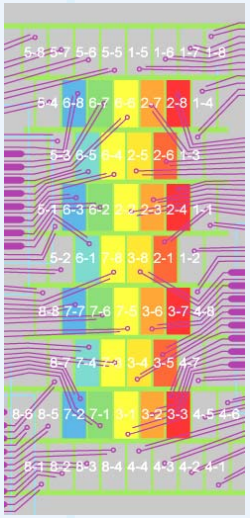
require 5 layers with interior hits
(Max. ph pad is NOT on the edge.)

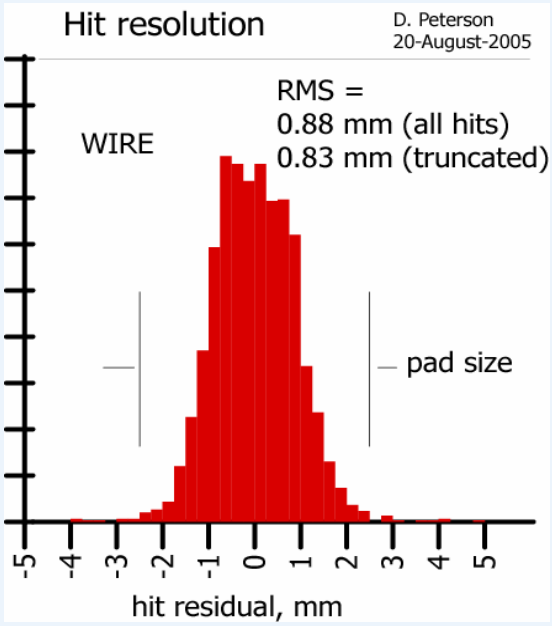
fit to a line

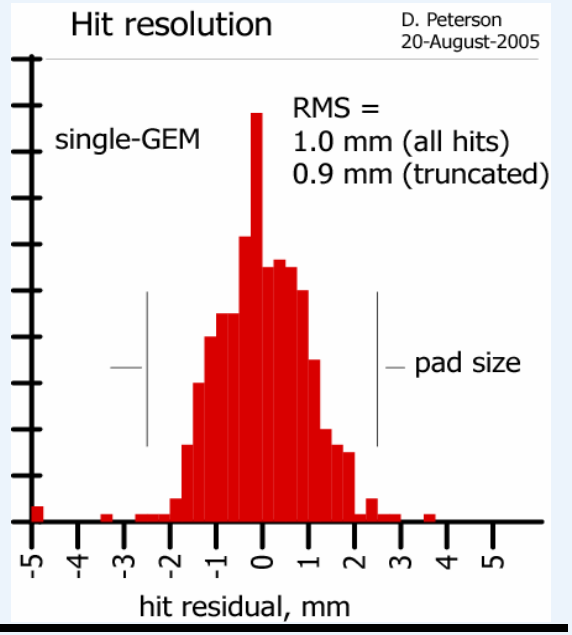
may eliminate 1 hit with residual > 2.5mm
(Still require 5 layers with interior hits.)

refit

resolution is ~ 900 μm, 0 to 40cm drift







Future Funding

This project was previously funded by the LEPP NSF cooperative agreement.

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

Our project requests:

Cornell: first year
- expanded readout
- new preamps
- positive HV supply
- instrumentation for ion feedback measurements
- gas

Purdue:
- student support

DOE/NSF action June 1, 2005. This project was partially funded.

Next 1 year

Cornell: Minor equipment expansion -

Purchase low noise, positive HV supply for the anode

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.

Switch to TESLA TDR gas.

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 CERN single-GEM.

A CERN double-GEM is next.

Carleton: The Carleton group (Alain Bellerive and Madhu Dixit) will prepare gas-amplification devices on the Cornell readout board for mounting in the Cornell/Purdue TPC.

This will include resistive charge dispersion read-out stages.

The groups will share in data-taking and developing a common analysis.