ILC Detector Work

** Cornell/Purdue TPC development program
Large Detector Concept
TPC Detector Response Simulation and Track Reconstruction
World Wide Study Detector R&D Panel

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)
The instrumented readout area is approximately 2 cm x 7 cm, with 32 pads.

The biased area is 10 cm square.

( This pad board allows 3 x 9 cm, 62 pads. )
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
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
MWPC event (typical)

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

Range = 1.0 mV = 820 counts

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

MWPC
ave=0.42

GEM
59% hits are 1 pad, charge cloud is contained in 41% of pad width, 2mm

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: Fine Segmentation Pad Board

We will increase the DAQ by 16 channels.

48 channels will allow …  
2 rows of 2mm pads  
plus  
4 rows of 5mm pads  
for track definition

Or..

1 row of 2mm pads  
4 rows of 5mm pads  
8 channels  
for positive ion measurement
Future: Ion Feedback Measurement

Positive ions are created in the amplification and drift back into the field cage. This is bad because the positive ions in the field cage can distort the drift field. The GEMs and MicroMegas should have reduced fraction of feedback. Measurements have been made using the current at the cathode. We would collect the positive signal on the field cage termination.
Ion Feedback Measurement

-2mm - 2mm - 5mm

GEM1  GEM2

2000V +
1000V +
610V +
106V +
V0
300V/cm
-150V
300V/cm

pulses to 900V/cm
pulses to -450V
0V/cm

readout pads

field cage termination (actually rotated 90 deg)

event trigger
new trigger disable
ion readout delay
ion readout stop signal
HV ramp "up" delay
HV ramp "up" enable
HV ramp "down" delay
HV ramp "down" enable

-1500
-900

electron signal
ion signal expected at 540 µs after electron signal

+80 µs end of electron readout
start grid readout
2000 µs
end grid readout
1 to 10 milliseconds

-1200V 100 µA
-900V 100 µA
ramp up enable
ramp down enable

Voltage shown above

D. Peterson, “ILC Detector Work”, Cornell Group Meeting, 4-October-2005
Other Activity

the WWSOC Detector R&D Panel
an international panel of 9 people
on which I agreed to serve
(I should have taken B.D.’s advice.)

https://wiki.lepp.cornell.edu/wws/bin/view/Projects/WebHome

the Large Detector Concept concept,
one of the 3 concepts recognized by the GDE.
thinking about magnetic field measurement requirements
< 10^{-5}
I agreed to
“take charge of the section on tracking performance”.
(Again, I ignored B.D. and will pay for it.)

“TPC response simulation and reconstruction efficiency”
- running DOIT on 3 million hits per event.