REVIEW OF LP1 WORK TO DATE

D. Karlen

LCTPC meeting

21-Sept-2009

Purpose

- Provoke and facilitate discussion
  - honest/frank discussion of what has transpired to date:
    - what worked
    - what did not
    - what does not make sense
  - focus on the latter 2 points
    - presentation is deliberately provocative
      - please interrupt and explain why my comments are wrong!
      - please interrupt to bring up related concerns

Facility

- What worked:
  - DESY group delivered on major aspects (FC, gas, HV, …)
  - Other groups delivered their elements (KEK magnet and Cornell endplate, in particular)
  - Joint design and construction was a success
- Problems
  - Central cathode
    - design is not suitable for ILC TPC
    - small gap to ground surface limits drift field to about 220 V/cm
    - mirror image of intended aluminum pattern

Facility

- Problems (cont.)
  - Test beam
    - intensity is modest and beam pulse length is too broad to make studies on the effects of positive ions relevant to the ILC
- Overall the LCTPC facility is very suitable for the intended purposes
  - studying tiled layouts in a larger TPC
  - understanding and correcting field distortions

Calibration system

- Two systems proposed:
  - dot pattern on cathode produce photoelectrons when flashed by UV laser
    - success in getting system to work
    - 1 faulty fibre – the other one illuminates sufficiently
    - opposite polarity pulses with MM needs to be corrected
  - laser beams that directly ionize the gas
    - last minute idea
    - not yet deployed (perhaps never will be)

Calibration system

- Major problem:
  - no manpower identified for analysis of calibration data
    - so far, only qualitative analyses
    - wealth of information could be acquired:
      - drift velocity
      - total system gain
      - drift distortions
  - without an active participant operating the system and looking at the calibration data, this system will not live up to its potential
    - UVic resources are currently tied up with T2K – any assistance that others could provide would be welcome

Asian GEM module tests

- Attempt at design than minimizes phi gaps
  - GEM frames only on radial sides, but found to be difficult to keep flat
    - GEMs are very stiff and therefore difficult to stretch to make flat without large rigid frames
  - If one wants to limit the amount of frame material, I think the flatness criteria must be relaxed
    - a wire plane can be added to terminate the field properly and act as a gating grid – eliminating the need for very flat GEM surfaces
    - I do not understand the benefit of using a GEM gate

Asian GEM module tests

- Very small pad sizes
  - large number of pads hit per row – not needed for B=1 operation
- Very large electrostatic distortions seen:
  - If you can see the distortion by eye on an event display (mm scale), it is unlikely that the setup will be useful for developing a design that requires distortions to be at the 10 μm scale
  - is it worth the time to develop sophisticated corrections?

Asian GEM module tests

- Developing a Kalman filter tracker software package
  - at ILC, the energy loss in a gaseous TPC is not important – is a Kalman filter useful?

Altro electronics

- A demonstration of higher density electronics, but not in a configuration that would be appropriate for an ILC TPC

- Small connectors make this a very convenient for use with a variety of detectors and pad layouts – so far only one detector system has used the electronics

GEM + Timepix

- Timepix is an interesting technology to bring in unprecedented segmentation of TPC readout
  - potential improvement in performance with cluster counting because a reduction in variance in the signals arising from
    - ionization fluctuations
    - gain fluctuations
  - improvement in dE/dx and tracking has not been demonstrated in a device or in detailed simulation, as far as I know

GEM + Timepix

- Cluster counting is more difficult with GEMs than with MM, because of the diffusion in the induction gaps
  - INGRID concept a better match to cluster counting?
- Large gains are required to resolve single primary electrons
  - problem is worse with GEM diffusion
  - can large area micropattern detectors operate reliably for long periods at such high gain?

GEM + Timepix

- Comment on slide 15:
  - "Primary electrons with longer drift can be better separated"
    - Cluster counting is different from primary electron counting
    - With diffusion the electrons from a cluster will separate from each other, but it will be incorrect to count them as separate clusters

MM + T2K electronics

- An alternative electronics design based on the AFTER ASCI that has SCA analog buffer
  - such electronics are not compatible with the continuous DAQ concept under consideration for ILC detectors
- Significant cost/effort to make custom boards to allow readout of multiple modules on LP1
  - not clear if this is worthwhile, now that ALTRO based electronics is available
- Resistive anode MM looks promising

TDC based electronics

- ASDQ chip shaping time is too short
  - not appropriate for TPC readout with drift distances of a few cm or more

What has been learned?

- The groups have gained experience in building and operating their components
- The key goals are only starting to be addressed:
  - precision tracking across multiple modules
  - monitoring and correction for field distortions
- A significant increase in software development and data analysis effort is needed