How to Decide on SiD Calorimetry in 12 months?

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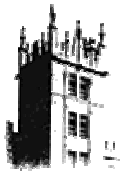

NORTHERN ILLINOIS
UNIVERSITY

SiD Workshop
April 9-11, 2007
Fermilab

Time Frame/Constraints

- **Since Valencia (Nov 06) WWS urging two detector "down select"**

  CDR 2008 →

  Intense 2 year engineering period →

  EDR 2010.

- **In addition DOE requesting 5 year plans**

SiD challenge: About 18 months to decide on HCAL technology & draft a CDR consistent with DOE constraints!

Preliminaries

- ECAL not at issue:
  - W/Si a singular, distinguishing feature of SiD.
- Ensure full BCAL and FCAL integration
  - Mostly a note to myself/management
- Main issue/focus is HCAL:
    - Specifications
    - Multiple technologies (GEM, RPC, Scin/SiPM and Micromegas)
    - Limited funds & time scales
- This is meant to be a proposal and to elicit discussion.
  - Discussed with SiD Executive and Advisory Boards.
  - Document now in circulation now nine pages
  - At this point a technical emphasis, needs "benchmarking"
  - What follows are highlights

Basic HCAL Requirements

- **Tracking:**
  - **Efficiently allow tracking of charged particles through volume.**
- **Jet Resolution:**
  - **Sufficient depth such that any loss in the coil or energy measured with degraded resolution (relative to the HCal) in the outer detectors (such as a TCMT) does not significantly impact jet energy resolutions.**
  - **Sufficiently small cell size to allow true and efficient separation and association of closely spaced energy clusters with the correct tracks.**
  - **Sufficient sampling so as not to significantly degrade the jet energy resolution via the sampling term.**
- **Cost:**
  - **Outer radius must limit the cost of the solenoid and muon system to reasonable levels.**
- **Rate:**
  - **Sufficient rate capability so as not to lose information, particularly in the forward directions**

Performance Criteria

- MIP Efficiency/pad & Hit multiplicity/MIP
- Uniformity of response across active layers
- Need for or ease of calibration
- Recovery time after hit(s) and after a significant beam event
- Rate of discharges (gas)
- Track-cluster separability
- PFA jet resolution at a) Z-pole, b) 250, 500, 1000 GeV
- Magnetic field issues – signal location offsets in barrel and endcaps (gas)
- Response to neutrons

Technology Issues

- Maturity and previous history
- Reliability (Stability)
- Availability of components (in quantity)
- Active layer thickness
- Smallest readout unit size
- Technical risk of approach
- Ease of assembly, testing, installation, and commissioning (“scalability”).
- Effects of aging on performance

Cost

- Overall HCal cost
- Active layer cost as a percentage of total cost
- System development costs
- Costs for assembly and test

Five Steps Forward

- **Step 1:**
  - **Initial prototyping complete on small scale systems complete**
  - **Short April reports addressing performance criteria & technological issues.**
- **Step 2:**
  - **Analysis of CALICE tests at CERN 2006 and comparison with MC**
  - **Initial results on direct scintillator/SiPM coupling**
  - **Results from current GEM/RPC Slice Tests**
  - **Reports at LCWS07**

- **Step 3: Late 2007 SiD Review**
  - **Evaluate in parallel**
    - **Three technologies**
    - **Simulations/PFA to "benchmark" performance**
    - **Generic engineering design.**
  - **Establish the next phase of the SiD calorimeter development to deliver the necessary input to enable a unique choice of HCal technology, or leading candidate plus alternate(s)**
  - **Unfortunately, with pre-HEPAP schedule, decisions for technical choice(s) to be included in the SiD CDR may be based solely on simulation/PFA and small or partial prototype results.**
  - **Procedure yet to be established but must be based on criteria and transparent.**

- **Step 4:**
  - **Build a full stack (gas) or partial ILC prototype (gas or scintillar) as soon as possible to verify performance for inclusion in the SiD CDR (if possible) or EDR.**
  - **Mid 2008 Review to decide on CDR technology choice and further R&D while writing EDR.**
- **Step 5:**
  - **Two-three year testing period of ILC prototypes for completion of EDR.**

The Elephant in the Room

- The current externally imposed schedule is clearly compressed
- Even if funding available likely little information will be available from the actual ILC prototypes
- Response:
  - Although expensive and inefficient we may need to mitigate the risk by carrying forward more than one choice.
  - We'll need to stay alert to external signals!

The Second Big Issue

- **Should we reconsider the degree to which PFAs drive specifications?**
  - **Great and impressive progress, but a difficult problem!**
  - **With an honest, statistical assessment haven't yet achieved 30%/sqrt(E) goal. High energy jets now a principal challenge**
  - **The detailed interplay between optimization and technology choice does not lend itself to predictable progress.**
- **Should we revaluate resolution requirements?**
  - **Is the metric correct? Does it need to be so ambitious?**
  - **Some thought it should be a flat 3-4% rather than 30%/root(E)?**
  - **If still challenging, should we consider other innovations such as dual-readout?**
  - **If less challenging, would traditional calorimetry serve as a solid base? And, if so, can PFA-like algorithms "boost" performance as done at HERA & Tevatron?**

Summary Steps Forward

- April, 2007: Technology Status/Reports
- June, 2007 (LCWS07):Extended Reports
  - GEM/RPC Slice Test
  - CALICE analysis and Scintillator/Tile Direct Coupling
- Late 2007:
  - PFA review and report
  - Completion 1st pass generic engineering study
  - Decision on next prototype step
- Mid 2008: Technology choice(s) CDR