HCal LOI Planning

Hiro's list – with annotations

A. White, Boulder, Sept 18, 2008

HCal planning for the LOI

Guidance from LOI editors for subsystems:

- Performance requirements, pointers to physics benchmarks

  Single $e^{\pm}$, $\mu^{\pm}$, $\pi^{\pm}$, π^0, $K^{\pm}$, K^0_s, γ, W, Z; $0 < |\cos\theta| < 1$, $0 < p < 500$ GeV

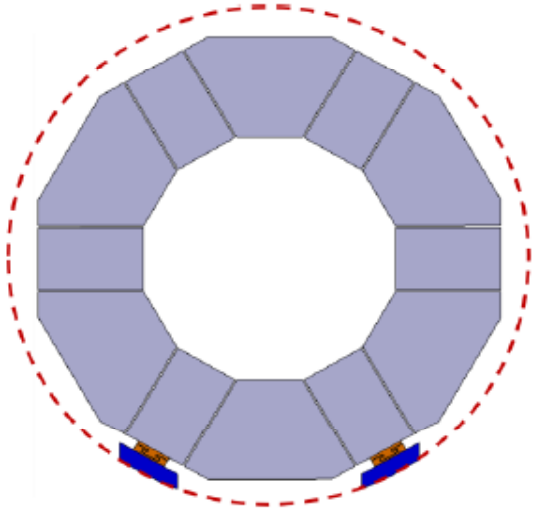
  $e^+e^- \to Zh$, $h \to b\bar{b}$, $c\bar{c}$, gg, $\tau^+\tau^-$, WW^*, $\gamma\gamma$, $\mu^+\mu^-$, $m_h = 120$ GeV at $\sqrt{s}$=0.25 TeV;

  $e^+e^- \to \tilde{\chi}^+_1\tilde{\chi}^-_1/\tilde{\chi}^0_2\tilde{\chi}^0_2$ at Point 5 at $\sqrt{s}$=0.5 TeV;

  ttbar

- Design outline, including engineering details, drawings

  Simulation HCal/Engineering HCal(s)



- Technology options – see detail later
- Baseline choice -
- Front-end electronics: ? KPiX ? Prototype electronics for test beam?
- Performance

Additional Questions from IDAG (Draft)

June 22, 2008

IDAG wishes the proponents of the 3 LOI's to address the following points in their LOI document:

- Sensitivity of different detector components to machine background as characterized in the MDI panel.
- Calibration and alignment schemes.
- Status of an engineering model describing the support structures and the dead zones in the detector simulation
- Plans for getting the necessary R&D results to transform the design concept into a well-defined detector proposal.
- Push-pull ability with respect to technical aspects (assembly areas needed, detector transport and connections) and maintaining the detector performance for a stable and time-efficient operation.
- A short statement about the energy coverage, identifying the deterioration of the performances when going to energies higher than 500 GeV and the considered possible detector upgrades.
- How was the detector optimized: for example the identification of the major parameters which drive the total detector cost and its sensitivity to variations of these parameters.

Subsystem issues

- Definition of subsystem/subgroup

  Hadron calorimeter, barrel and endcaps

- Name of subsystem: HCal

- Contact persons for LOI writing:

  Overall: Andy White, Harry Weerts

  Technologies:

  Jose Repond(RPC),

  Yannis Karyotakis(Micromegas),

  Andy White(GEM),

  Vishnu Zutshi(Scint/SiPM)??,

  Adam Para(Dual readout calorimetry)??

- Geometrical definition

  Table of (r,z) values, XML file(s)

Subsystem issues

Requirements - Overall:
- It must efficiently allow tracking of charged particles through its volume.
- It must have sufficient depth such that any energy loss in the coil, and/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 at all jet energies.
- It must have a sufficiently small cell size to allow true separation and association of closely spaced energy clusters with the correct tracks – at a level that does not significantly degrade the jet energy resolution.
- It must have a sufficient sampling so as not to significantly degrade the jet energy resolution via the sampling term.
- Its outer radius must limit the cost of the solenoid and muon system to reasonable levels – requiring the radial size of each active layer to be as small as possible.
- It must have sufficient rate capability so as not to lose information, particularly in the forward directions – using a change of technology, if necessary.

Subsystem issues

Performance criteria:
1) MIP Efficiency/pad
2) Hit multiplicity/MIP
3) Uniformity of response across active layers
4) Need for or ease of calibration
5) Recovery time after hit(s)
6) Recovery time after a "significant beam event"
7) Rate of discharges (gas)
8) Track-cluster separability
9) PFA jet resolution at a) Z-pole, b) 250, 500, 1000 GeV
10) Magnetic field issues – signal location offsets in barrel and endcaps (gas)
11) Response to neutrons

→ Need to discuss physics benchmarks that are "most relevant" for the HCal.

Subsystem issues

Technology issues:

1) Maturity and previous history
2) Reliability
3) Availability of components (in quantity)
4) Active layer thickness
5) Smallest readout unit size
6) Technical risk of approach
7) Ease of assembly/testing/installation/commissioning (often referred to as "scalability").
8) Effects of aging on performance

Description of the subsystem

Concept:

Highly segmented (longitudinally and transversely) digital(?) calorimeter system providing tracking/cluster determination for use with PFA, and of sufficient depth to contain high energy hadron showers.

Baseline design:

Gas-based (RPC) with steel plates.

Expected performance:

-> give a) standalone calorimeter performance on single particles (charged and neutral)/jets, b) PFA jet energy, di-jet mass resolution, + what we expect for the LOI benchmark processes.

-> Hard to talk about HCal in isolation – need to coordinate LOI sections with other subsystems in the PFA context.

Description of the subsystem

Illustrations/drawings:

-> overall location of HCal in Sid

-> r-phi view of the simulation version of HCal

-> non-projective crack engineering design option(s)

Options:

subsections on GEM, micromegas, Scint/SiPM, Compensating cal.

with descriptions of strengths, plus/minus,…

R&D roadmap

Issues:

need a subsection for each technology option discussing what needs to be understood, developed, tested etc. with respect

Milestones:

a) Before 2012: "Advance critical R&D": large plane development and testing for all technologies, $1m^3$ construction and testing,

b) After 2012: Technical prototypes for SiD (as opposed to detector prototypes)

Resources needed:

Funding, people, test beams, lab space, ...

Estimated construction schedule

-> Time table ???

-> Required human resources ???

Cost

Cost:
1) Overall HCal cost
2) Active layer cost as a percentage of total cost
3) System development costs
4) Costs for assembly and test

Organization of the HCal subsystem

Overall: Andy White, Harry Weerts

Technologies:

Jose Repond(RPC),
Yannis Karyotakis(Micromegas),
Andy White(GEM),
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