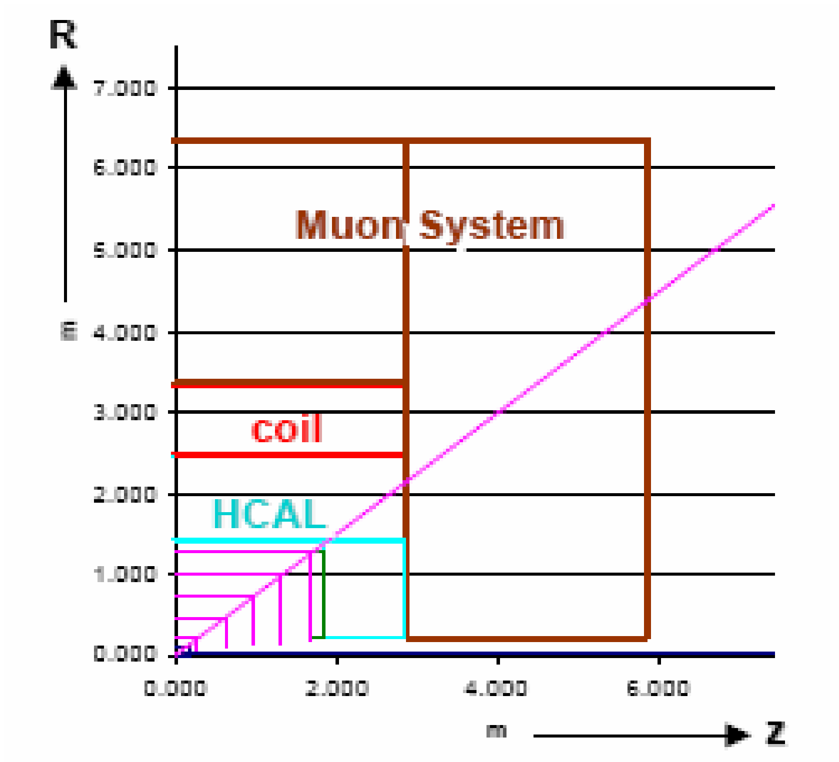
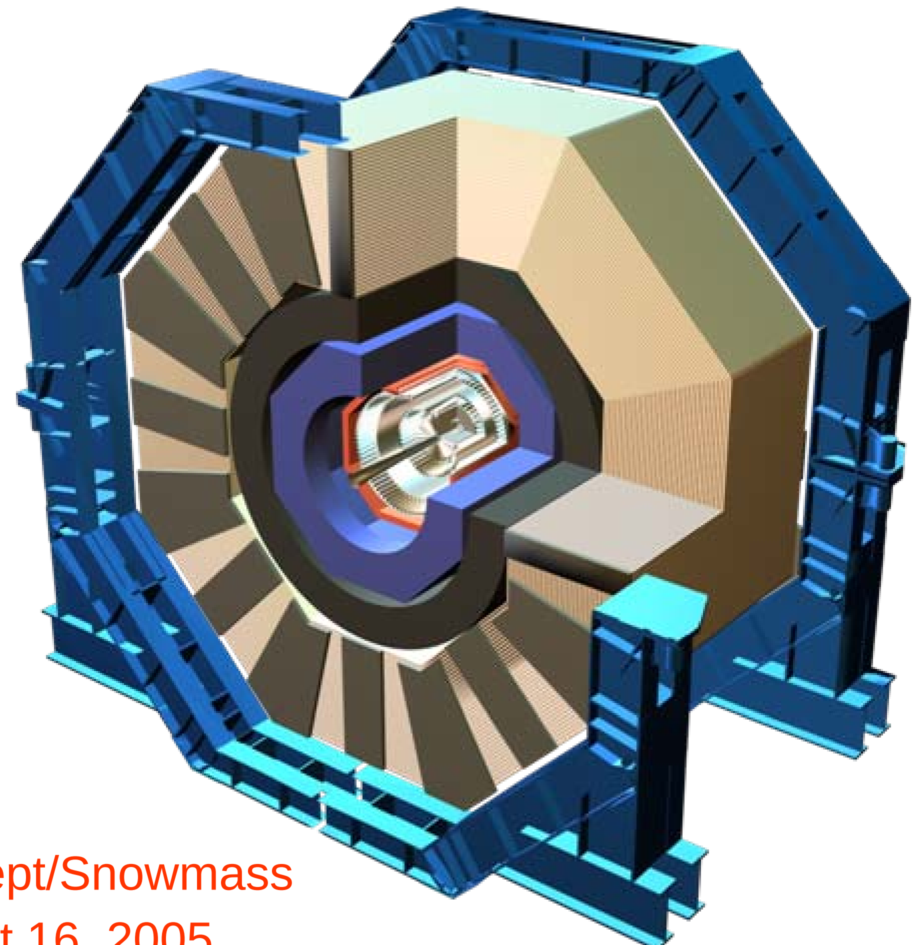
Optimizing SiD

getting from here…………………….to there





SiD Concept/Snowmass

August 16, 2005

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Many Facets of Optimization are Underway at Snowmass…

- **Answer SiD's Critical Questions.**
  See http://www-sid.slac.stanford.edu/
- **Fully specify detector details.**
  See http://lcsim.org/detectors/index.html
- **Pre-engineer Mechanical Designs.**
- **Select/Limit subsystem technology choices.**

But, some aren't…

- **Optimize "global" parameters: R_{ecal}, Z_{ecal}, B.**

Focus here on Optimizing R,Z,B

- Changing R, B, and Z **influence the effectiveness of Particle Flow Algorithms**, jet energy resolution, and physics performance. Need PFAs and full MC to evaluate.
- Changing R, B, and Z will also **impact the charged particle momentum resolution**, and how it varies with polar angle. Analytic approximation is a good start.
- Systems other than cal and tracking are only impacted in second order. Ignore them for now.
- Many detector costs depend on RZ; magnet costs depend on R^2B^2Z. Marty's cost model can provide an estimate.
- **We need to know how physics performance depends on R, B, Z.**

Timetable for Optimizing SiD

- WWS wants the “Detector Outline”, a ~100 page pre-conceptual design report, in time for LCWS Bangalore, March ’06.
- Detector Outline will include a full detector description, sub-system technology preferences, R&D needed, physics performance and a cost estimate.
- We should improve upon the SiD baseline during Snowmass and Fall ’05, and take the next SiD design step before the Detector Outline.

Benchmark Matrix

- ***Circa LCWS05***
  We discussed optimizing SiD by evaluating the physics performance for a set of benchmark reactions, over a set of SiD variants, including the present baseline detector.

- ***SiD baseline***
  Described in lcsim.org as SiDMay05. Si tracking; Si/W Ecal; Fe/RPC Hcal; 5T Solenoid & Flux return.
  R_{ecal}=1.25 m; Z_{ecal}=1.67 m.

- ***SiD Variants***
  a) Change $R_{ecal} \rightarrow$ 1.0 m
  b) Change $Z_{ecal} \rightarrow$ 2.0 m
  c) Change B $\rightarrow$ 4.0 T

Ideally,…

- Calorimeter Performance characterized by Particle Flow Algorithms working on full Geant4 Monte Carlo.

  Prototype PFA's should be available for study at Snowmass. Ready for prime time?

- Tracking and vertexing Performance characterized with pattern recognition code working on full Geant4 Monte Carlo.

  Full pattern recognition code is available for study at Snowmass; detector digitization being prepared, not yet in standard package.

- Costing

  Marty's Excel spreadsheet is available; Magnet group is evaluating costs of baseline and variant.

Can we get started optimizing SiD's R, Z, B with the available tools?

Proposal: Snowmass Exercise

- Parameterize Calorimeter performance for Fast MC using PFA's on full MC as input.
- Characterize Tracking performance with analytic approximation for Fast MC.
- Analyse several benchmark physics measurements M for the SiD Baseline and Variants, determining measurement error ΔM for some standard luminosity.
- Model costs for SiD Baseline and Variants.

Output of Exercise:
For each detector option: ΔM/M and Cost

What Could We Learn from this Exercise?

- Exercise tells us how Performance P and Cost C vary with R, Z, B. We learn all the partials:

  $\partial P/\partial R$, $\partial P/\partial Z$, $\partial P/\partial B$,

  and $\partial C/\partial R$, $\partial C/\partial Z$, $\partial C/\partial B$,

  evaluated around the baseline.

- If we assume P and C depend linearly on R, Z, and B for relatively small excursions around the baseline, we can evaluate:

  Optimal R,Z,B (=best performance) for given Cost.

  Optimal Performance vs Cost and look for knees.

Caveats

- Answers are only as good as the inputs. The critical input is the parameterization of the PFA response. Answers will be token until PFA is believable and the parameterization is accurate.

- Answers depend on the detector model we have evaluated and may vary assumptions different from the baseline. We will eventually have to look at a larger set of variants, e.g. different ecals or hcals.

Benefits

- Start benchmarking SiD. Integrate physics analyses into the SiD Design Study.
- Compare prototype PFA performance for all the SiD variants.
- Prototype the optimization procedure. Get some bugs out. Prepare for full MC analyses. Learn how to use the results!