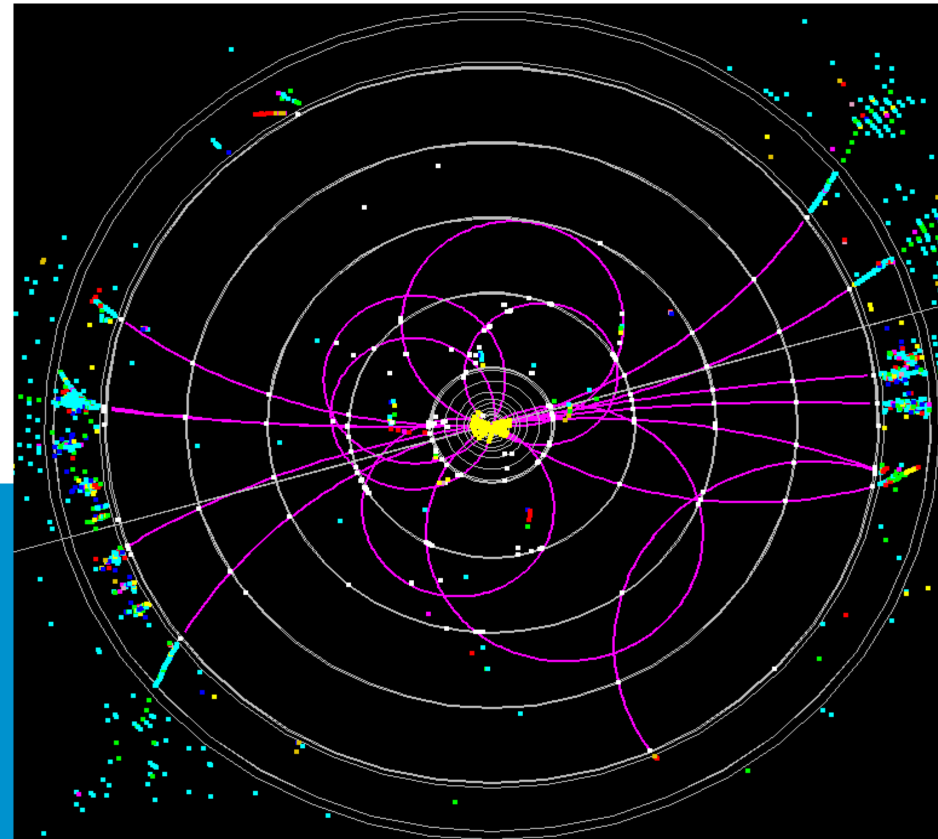
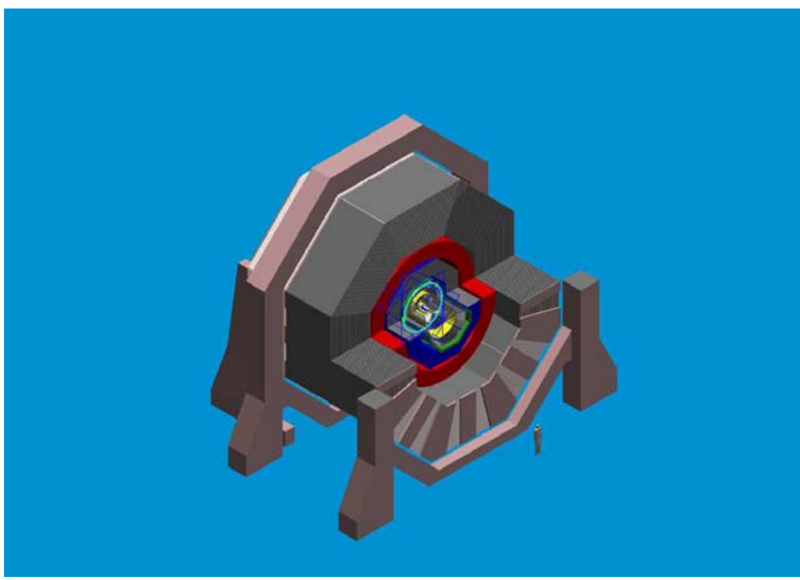
SiD
Expectations from the Design Study

- Motivation
- What We Need!
- Technical efforts
- Status





SiD Motivation

- SiD is an attempt to interest the international HEP community in the experimental challenges of a LC.
- SiD represents an attempt to design a comprehensive LC detector, aggressive in performance but constrained in cost.
- SiD attempts to optimize the *integrated* physics performance capabilities of its subsystems.
- The design study should evolve the present concept of SiD towards a more complete and optimized design.

Nominal SiD Detector Requirements

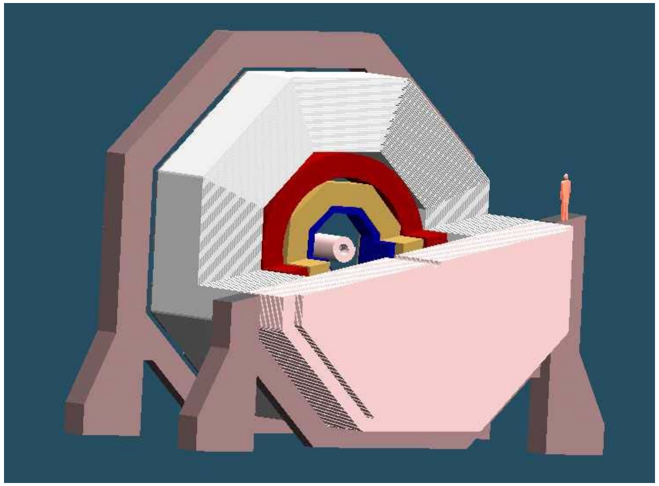
- a) Two-jet mass resolution comparable to the natural widths of W and Z for an unambiguous identification of the final states.
- b) Excellent flavor-tagging efficiency and purity (for both b- and c-quarks, and hopefully also for s-quarks).
- c) Momentum resolution capable of reconstructing the recoil-mass to di-muons in Higgs-strahlung with resolution better than beam-energy spread .
- d) Hermeticity (both crack-less and coverage to very forward angles) to precisely determine the missing momentum.
- e) Timing resolution capable of tagging bunch-crossings to suppress backgrounds in calorimeter and tracker.
- f) Very forward calorimetry that resolves each bunch in the train for veto capability.

- *This is the standard doctrine – is it correct and complete?*

SiD

- Conceived as a high performance detector for the LC
- Reasonably uncompromised performance

  But
- Constrained & Rational cost
  - Detectors will get about 10%
  - of the LC budget: 2 detectors,
  - so perhaps $600 M each

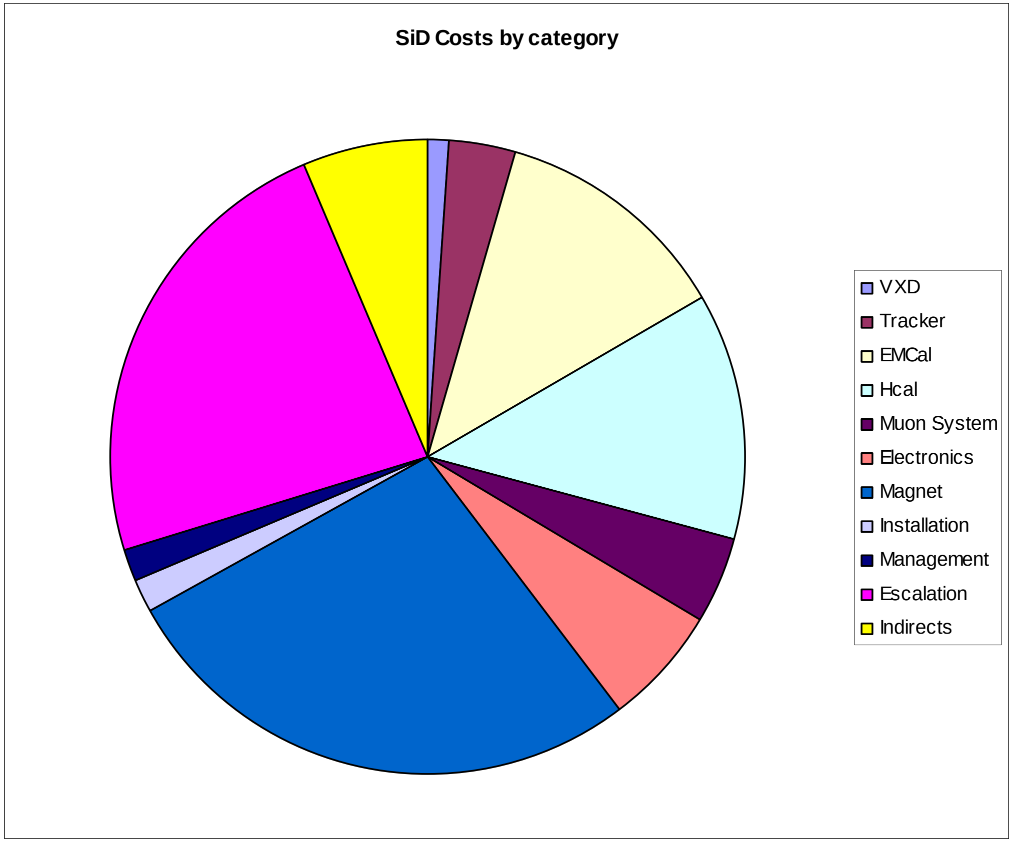


- *Accept* the notion that excellent energy flow calorimetry is required, and explore optimization of a Tungsten-Silicon EMCal and the implications for the detector architecture...

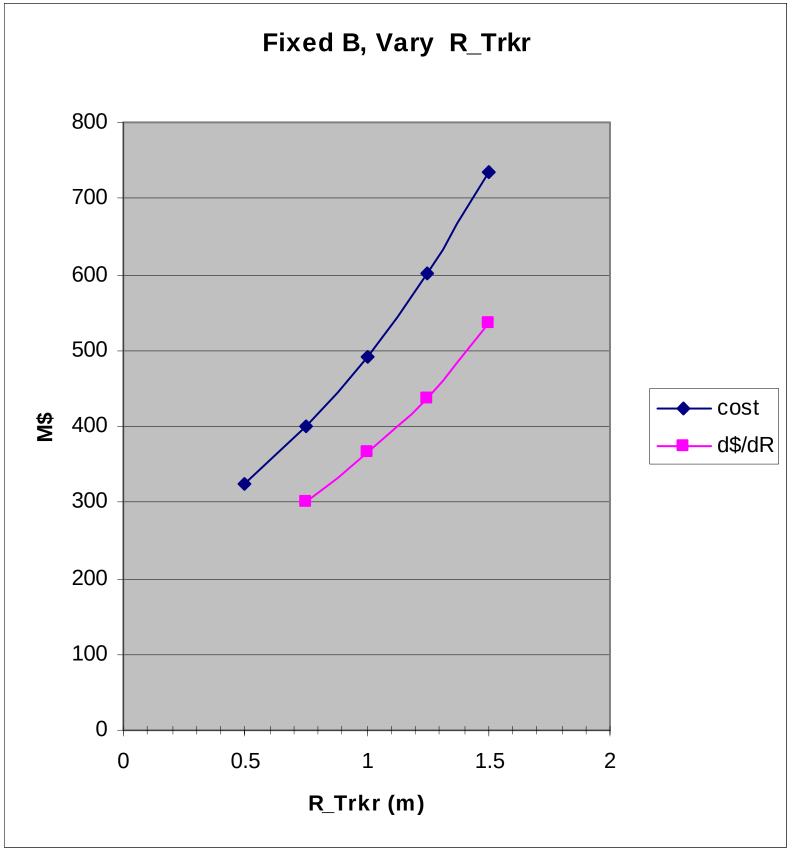
This is the **monster** assumption of SiD

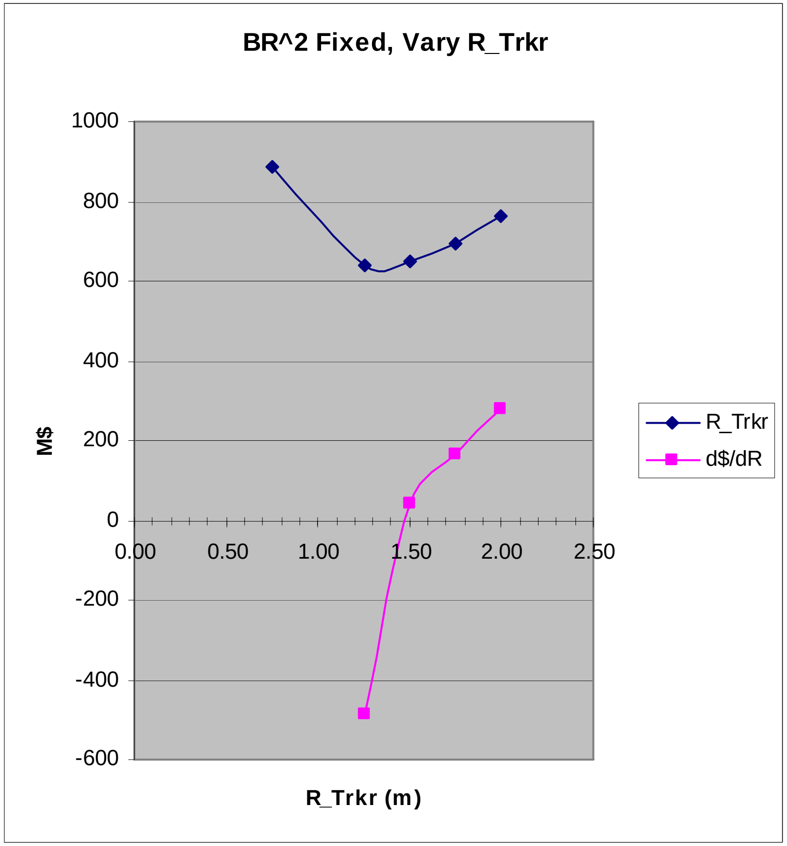
SiD Costs - as of Aug 05

Summary	
VXD	6.0
Tracker	19.9
EMCal	74.7
Hcal	74.2
Muon System	26.0
Electronics	37.5
Magnet	164.1
Installation	9.6
Management	9.4
Escalation	140.2
Indirects	38.5
Total	600.2



Crude Cost Trends





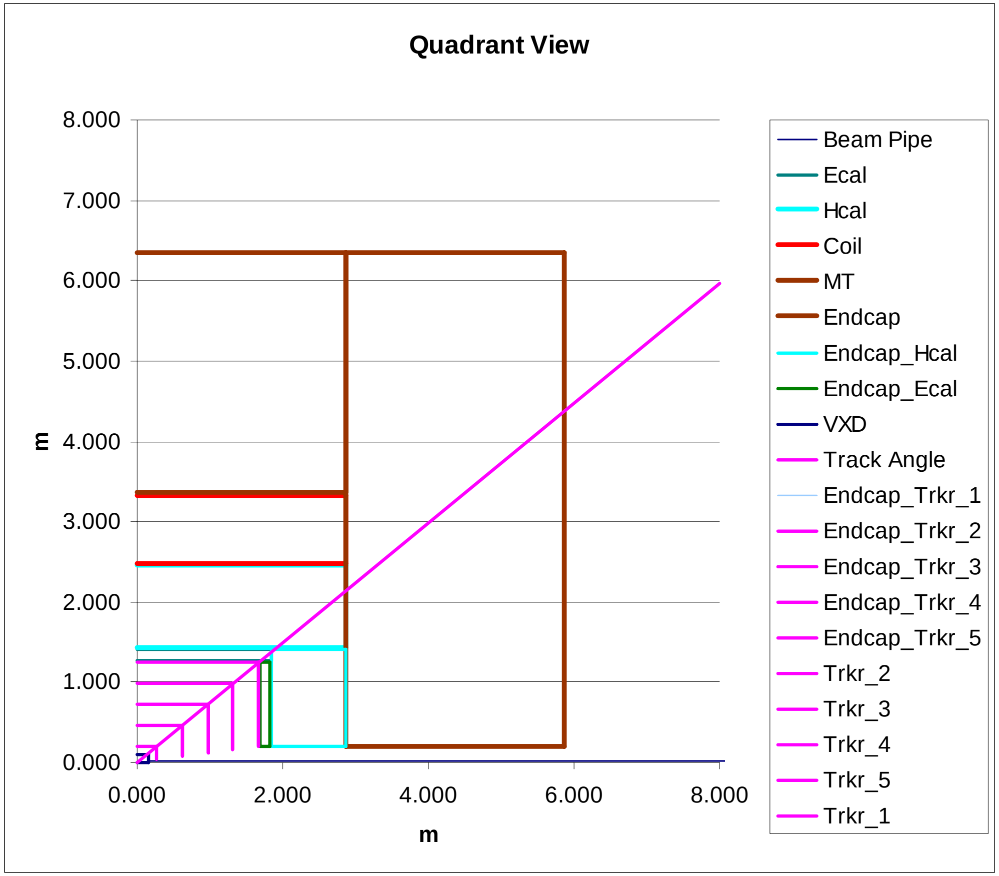
Architecture arguments

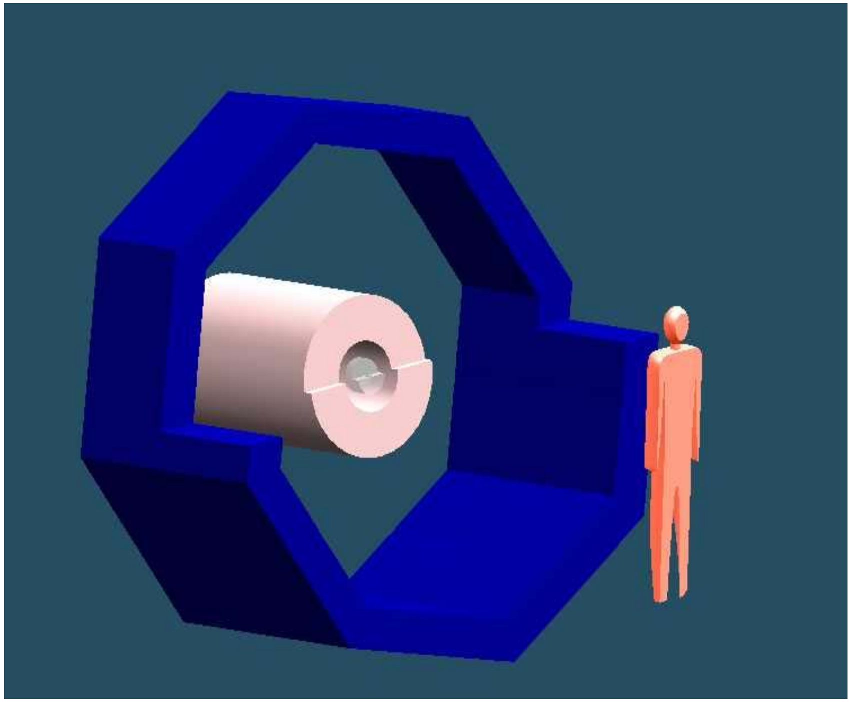
- Calorimeter (and tracker) Silicon is expensive, so limit area by limiting radius (and length)
- Maintain BR^2 by pushing B (~5T)
- Exquisite tracking resolution by using silicon strips
- Buy safety margin for VXD with the 5T B-field.
- Do track finding by using 5 VXD space points to determine track – tracker measures sagitta. Exploit tracking capability of EMCal for Vees.

Knees

- During the SSC era, the SSC PAC asked the detector collaborations to justify their design choices – where possible by understanding the quality of detector performance as a function of a critical detector parameter. Ideally, quantities like overall errors on an important physics process would flatten out as a function of, say, calorimeter resolution, and there would be a rational argument for how good the resolution should be.
- We need similar analyses for the major parameters of SiD – EMCal radius and B are probably at the top of the list, along with justifying E-Flow calorimetry.
- We need to select physics processes for this study.
- We are not constrained to design detector around these knees, but we should know where they are!

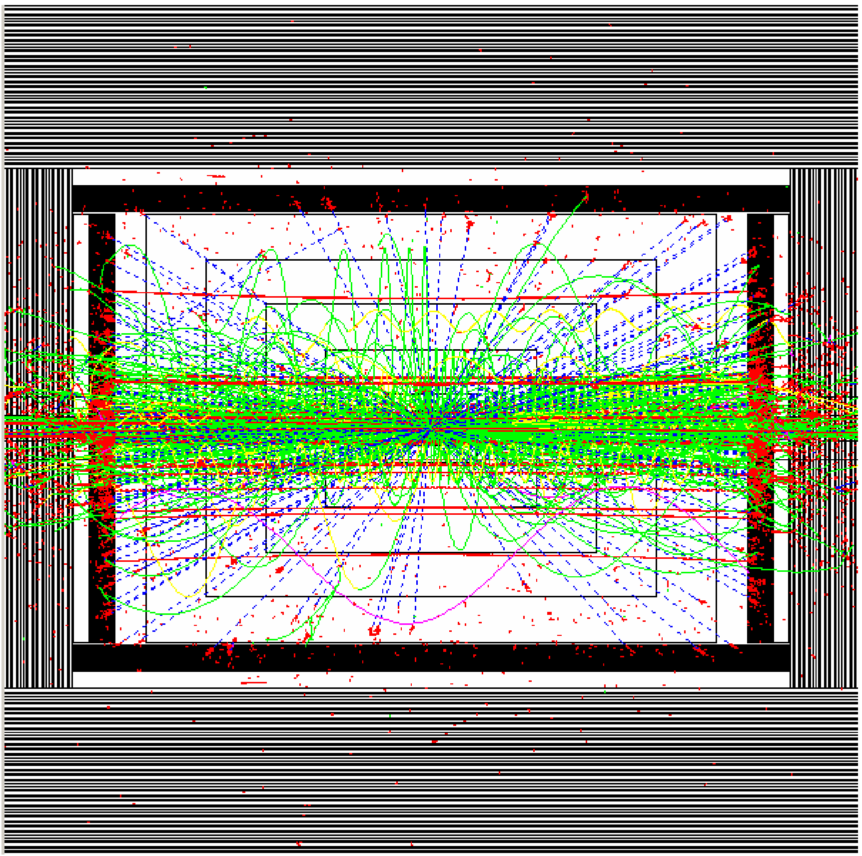
SiD Configuration

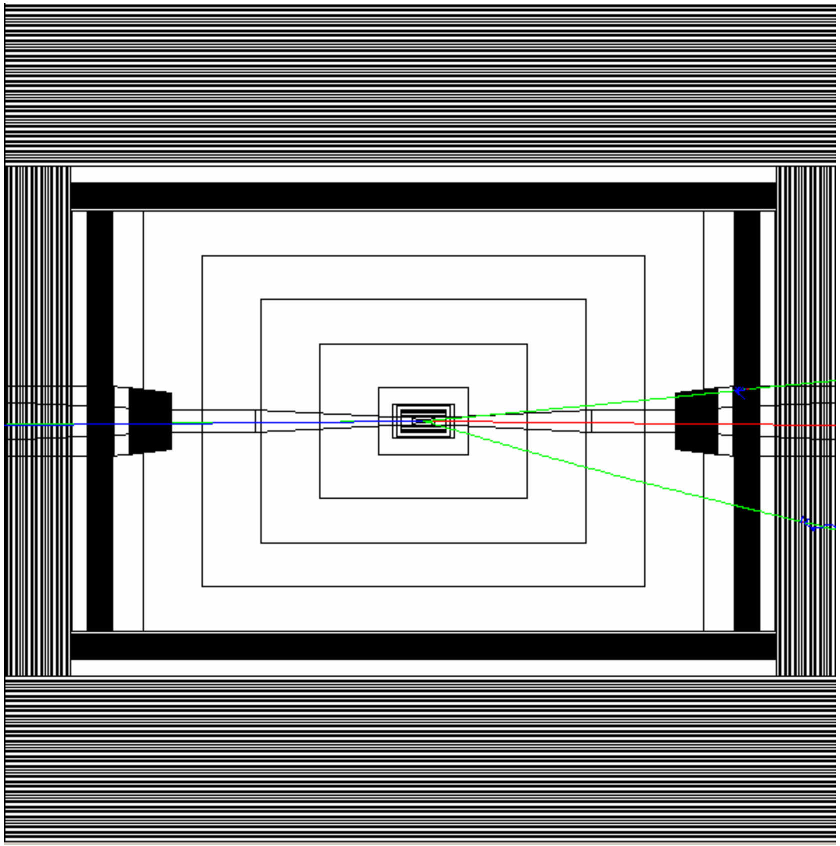




Scale of EMCal
& Vertex Detector

Illustration of bunch timing tag





Yellow = muons   Red = electrons   Green = charged pions
Dashed Blue = photons with E > 100 MeV

full train (56 events)
454 GeV detected energy
100 detected charged tracks

1 bunch crossing

T. Barklow

VXD Questions

- What is the VXD technology?
- What is the optimal geometry, considering readout electronics, cables, and cooling?

Momenter Questions

- Are there any serious problems with track finding (using VXD & EMCal)? (Barrel is 5 axial layers, segmented ~13 cm.)
- Is the 1.25 m radius optimal? What about the length?
- Is 5 T B optimal?
- Is there motivation to try to go thinner? Is there a knee in the physics performance vs multiple scattering?

EMCal Questions

- Is an (expensive) Si-W tracking EMCal justified by the physics? Does E-Flow really work? It gives good but not great energy resolution – what about an EMCal with crystals with superb energy resolution? Crystals with some longitudinal segmentation?
- Is there a useful Figure of Merit for E-Flow calorimetry? (My present favorite is $BR^2/\{(\sigma_m^{eff} \oplus \sigma_{pixel})^2 x (\sigma_m^{eff} \oplus \delta_r^{samp})\}$
- Is radius of 1.25 m optimal? Is 5T B optimal? Same question as before!
- Are there E-Flow performance issues in the forward direction? Are the end EMCals far enough from the IP?

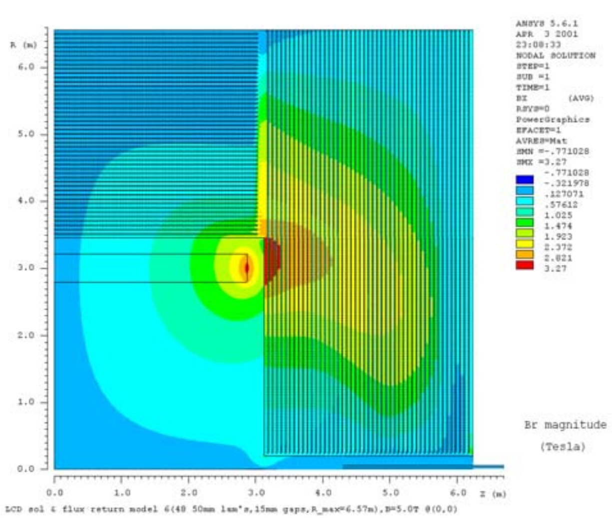
HCal Assumptions and Questions

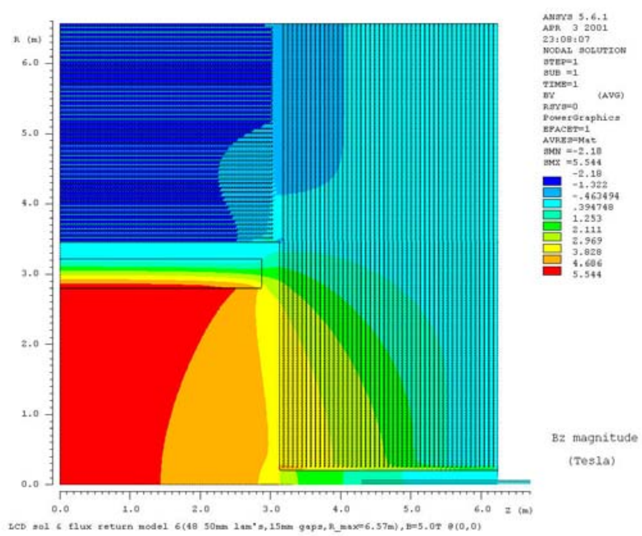
- Understanding of the HCal (in simulation and perhaps requiring beamtests) may well be necessary for serious development of the PFA.
- Gaseous detectors probably are less expensive and will have better segmentation than scintillator, but scintillator is a better detector for soft γ's and neutrons. Is this important? Should an R&D attempt be made to make the gaseous detectors more sensitive – e.g. plastic walls?
- What should HCal radiator be – Tungsten? Stainless? Tungsten costs more but brings overall detector cost down (HCal Δr is less, moving in coil). Is 4 Λ enough?
- The HCal detector gap should be small – costs and shower spreading. Does this affect a detector choice?
- Note that HCal is inside coil. This seems to have gone away as a question.

Coil and Iron

- Solenoid field is 5T – 3 times the field from detector coils that have been used in the detectors. - CMS will be 4T.
- Coil concept based on CMS 4T design. 5 layers of superconductor about 72 x 22 mm, with pure aluminum stabilizer and aluminum alloy structure. The aluminum alloy structural strips are beefed up relative to CMS.
- Coil Δr about 85 cm
- Stored energy about 1.5 GJ (for Tracker Cone design, R_Trkr=1.25m, $\cos\theta_{barrel}$=0.8). (TESLA is about 2.4 GJ) [Aleph is largest existing coil at 130 MJ]
- *Is 5T right? And is it buildable? We need a "pre-conceptual" design!*

B_r





B_z

Coil/Flux Return/Muon Tracker

- Previous questions as to the viability of a 5T coil seem to have gone away. Concept based on 6 layers of the CMS conductor is evolving.
- Iron "baseline" is 10 cm slabs with 1.5 cm gaps for detectors. Any muon identification concerns?

~ Not Worried about yet

- Small angle systems – forward tracking & calorimetry, Luminosity monitor
- Vibration Control & quad supports
- Crossing angle correctors
- And many others!

- All are important, and must be done “right” but unlikely to be design drivers in the class with E-Flow, B, Rcal.

Timing Analysis!

- We need answers to these questions to get to a credible conceptual design in 2006!
- We need answers to these questions to compare performance with the TPC based detectors!