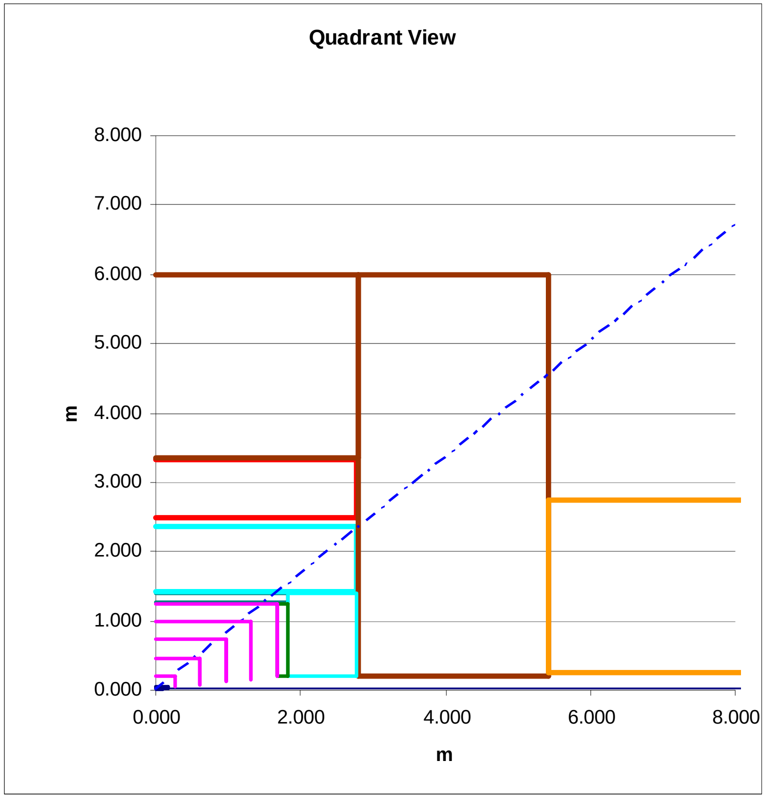
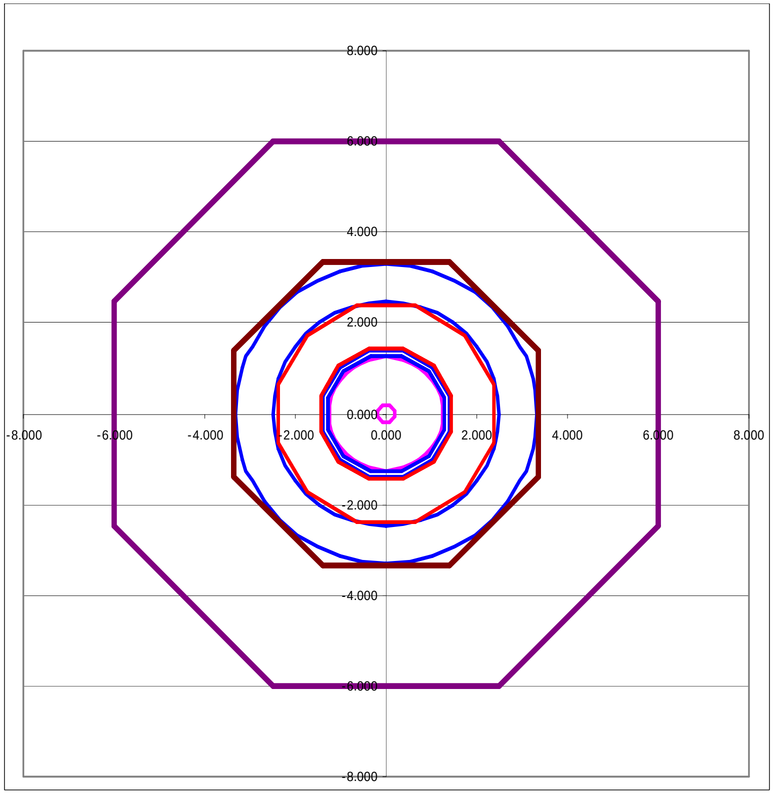
SiD Optimization

M. Breidenbach Oxford SiD Meeting

- Thanks to John Jaros for motivation and helping this effort!





SiD Optimization

Optimization –The search for the best solution among alternatives, or the extreme value of a variable or a function.

•In this context, will explore some issues of cost minimization for fixed values of PFA resolution for SiD, using the SiD Parametric Cost Model and Mark Thompson's parameterization of PFA performance.

Caveats

- These caveats are not pro-forma. They are all serious issues, and this talk *must be seen as an exercise in what could be done if most of the further caveats are resolved.*
- SiD Parametric Cost Model:
  - Many important unit costs are very uncertain, e.g. tungsten (for the EMCal); Si detectors (for the tracker and EMCal), and Iron (for the magnet).
  - Several technology decisions are not made. In particular there is no serious baseline choice for the HCal detector technology. RPC's with KPiX readout is assumed.
  - The costs have not been adequately reviewed by the engineering team. Many unit costs and assembly labor estimates are WAGs.
  - The costs have been developed in US dollars. The effects of the rapidly changing dollar/Euro ratio is not addressed.
  - There may still be errors!

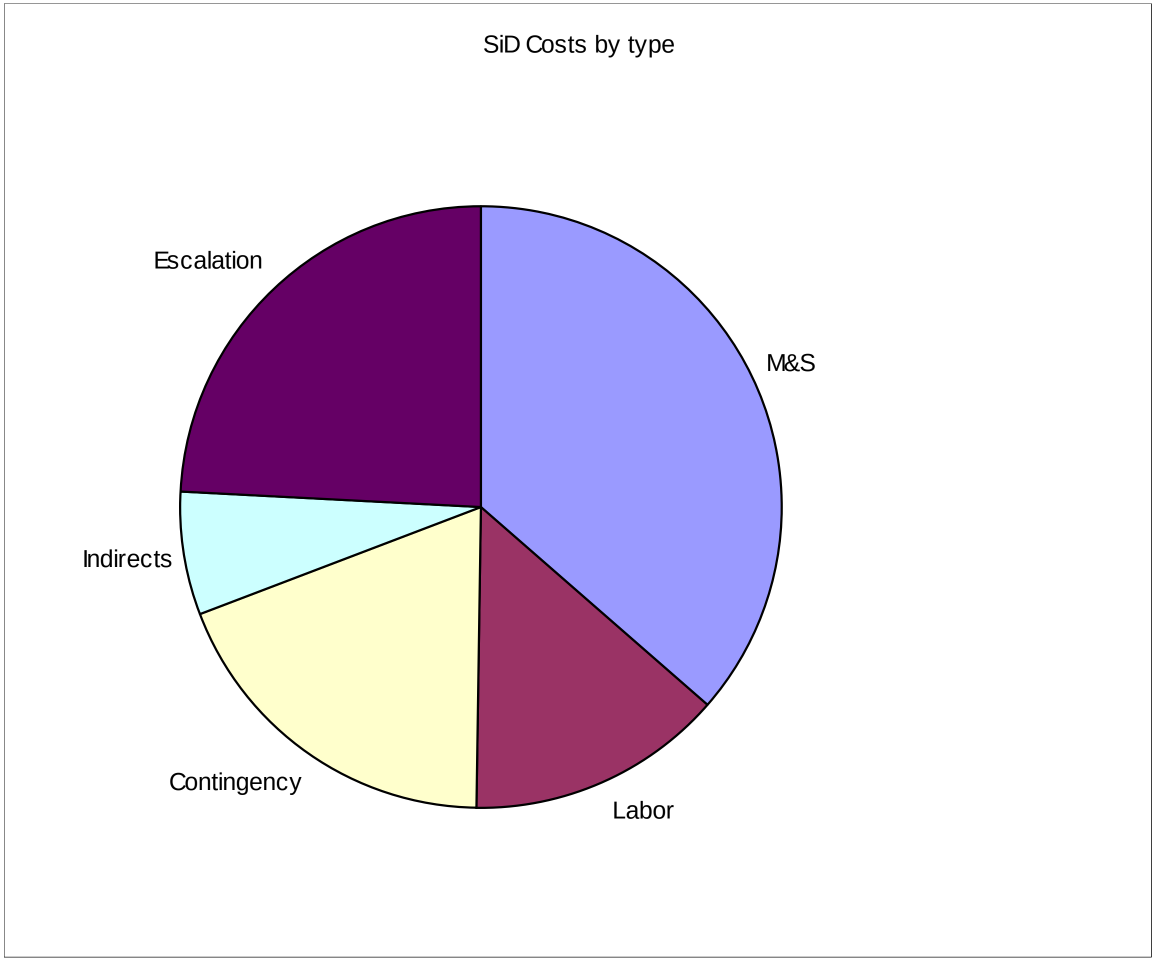
Caveats, continued

- PFA Parameterization:
  - The parameterization is taken from a talk by Mark Thompson – which itself had many caveats.
  - The parameterization was for a scintillator HCal. It is just assumed that RPC's are the same.
  - The ILD detectors have a different aspect ratio than SiD. The differences are ignored here.
  - SiD is almost certainly pushing the parameterization beyond its range of applicability.
  - See the talk by Marcel Stanitski for some comparisons of his studies – which are closer to SiD – with the parameterization.

SiD Baseline Cost

- What is a cost?
  - For simplicity, there are two cost models – ITER and US DOE accounting.
  - ITER costs the M&S in currency units (ILC uses $ units) and the (in house) labor in time units.
    - ITER does not do contingency or escalation.
    - ITER may include indirects.
  - US DOE costs the M&S and labor in $. It includes contingency, indirects and escalation.
- SiD can convert between the two systems, but it is easier to work US DOE style.

The “other” costs are not small!



SiD Baseline

Rtrkr = 1.25 m

B = 5 T

HCal λ = 4.0

	M&S	Labor	Totals
Base	$206	$95	$301
Contingency	$78	$33	$111
Total	$284	$128	$412
Indirect rates	0.06	0.20	
Indirects	$17	$26	$43
Totals w indirects	$301	$153	$454

Either of these might be the "ILC Detector" Cost

Total in FYXXXX M$	2007		**454.4**
Start Year	2012		
Construction Duration	6	years	
Inflation	1.035	per year.	
Factor	1.317		
Total Escalation			144.0
Total, TYM$			***598.4***

This assumes 3.5%/year inflation and a 2012 construction start. The 2012 is presumably optimistic…

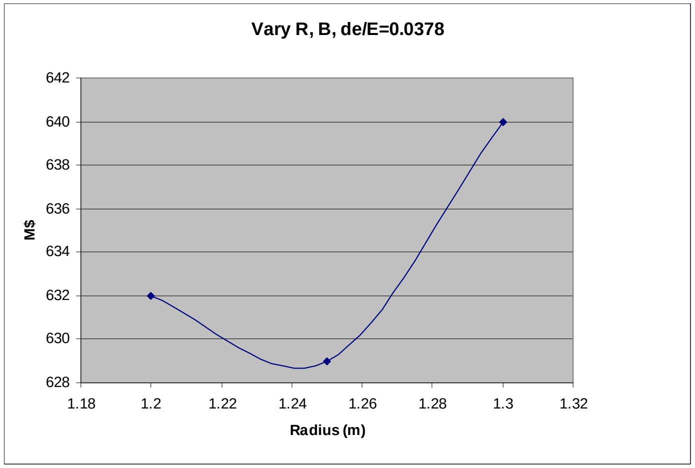
But this would be the bottom line!

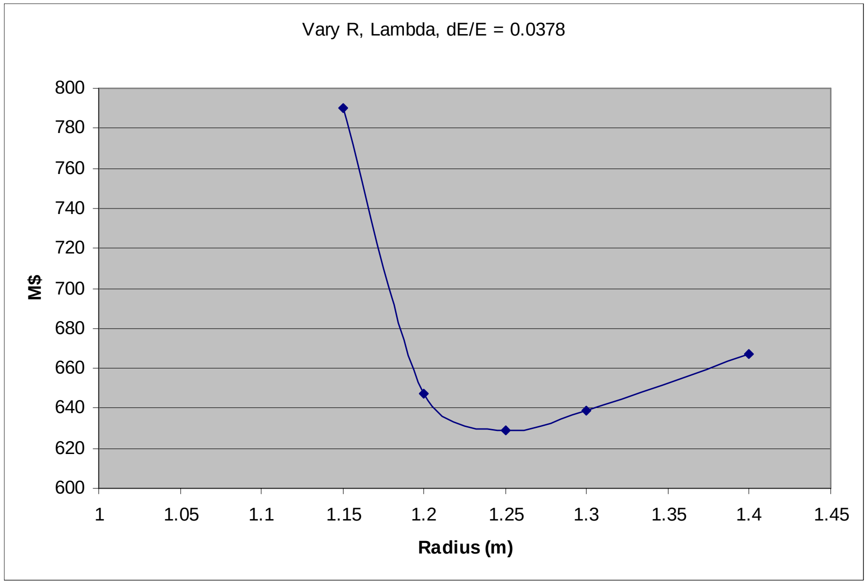
The Hard Problem – Global Optimization

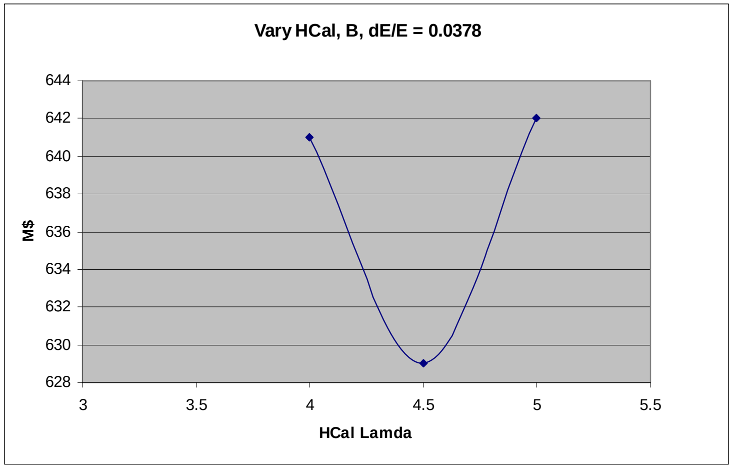
- Philosophically, SiD has "bought" Particle Flow, but we do not have a mature Particle Flow Algorithm (PFA). However, there is progress and Marcel's results are quite helpful.
- The exercise for today is to pick a several values of $\Delta E/E$(180 Gev) and cost optimize the major parameters of SiD for each case.
  - The parameters are constrained to keep B and the magnet hoop stress ~rational.
- This will give the resolution vs cost of the detectors.
- Caveat: See the previous caveats. They mean this is an exercise, not an answer!

SiD "Baseline"

- Rtrkr = 1.25 m
- B = 5 T
- HCalλ = 4.5
- ΔE/E(180 Gev) = 0.0378

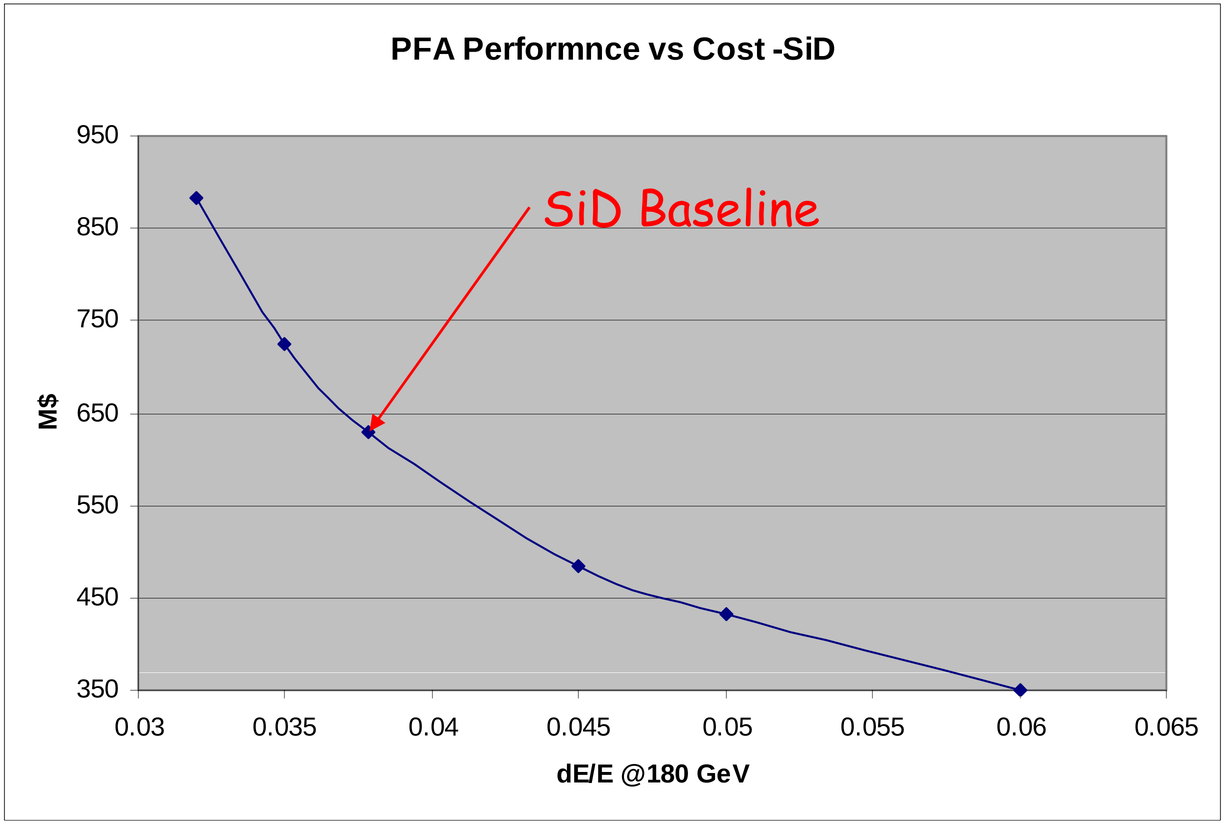




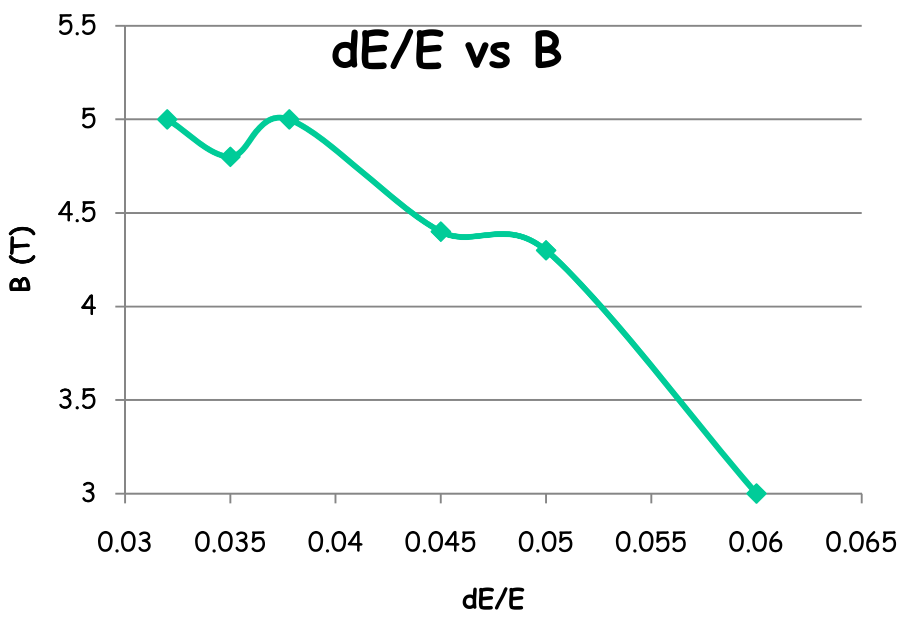


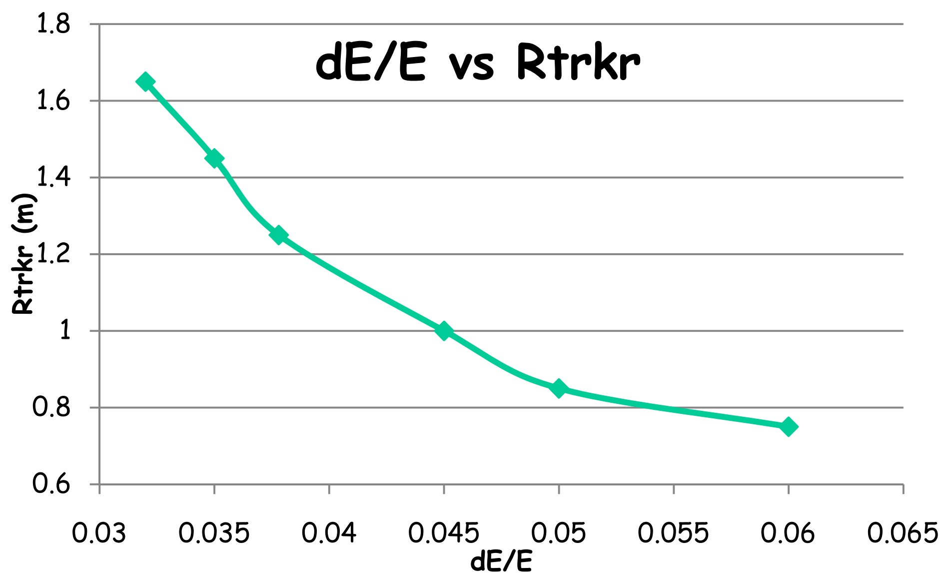
SiD "Baseline" is optimal for this value of ΔE/E(180 Gev)

A sequence of "Optimized SiD's"



Parameters of Optimized SiD's





Hcal Λ = 4.5 seems stable optimum. Rtrkr and B are soft. Some "structure" is due to assuming fixed thickness steel for the flux return and jumps in the number of layers. This will go away with further optimization.

Requirements for Jet Energy Resolution

Tim Barklow
SLAC
October 23, 2007

Analysis must be redone with $\frac{\Delta E_{jet}}{E_{jet}}$ that reflects current PFA status.

For now replot triple Higgs coupling error vs. $\frac{\Delta E_{jet}}{E_{jet}}$ using existing results with $\frac{\Delta E_{jet}}{E_{jet}} \equiv \frac{\alpha_{90}}{\sqrt{80}}$

$BR(H \to b\bar{b}) = 0.678$

$e^+e^- \to ZHH$

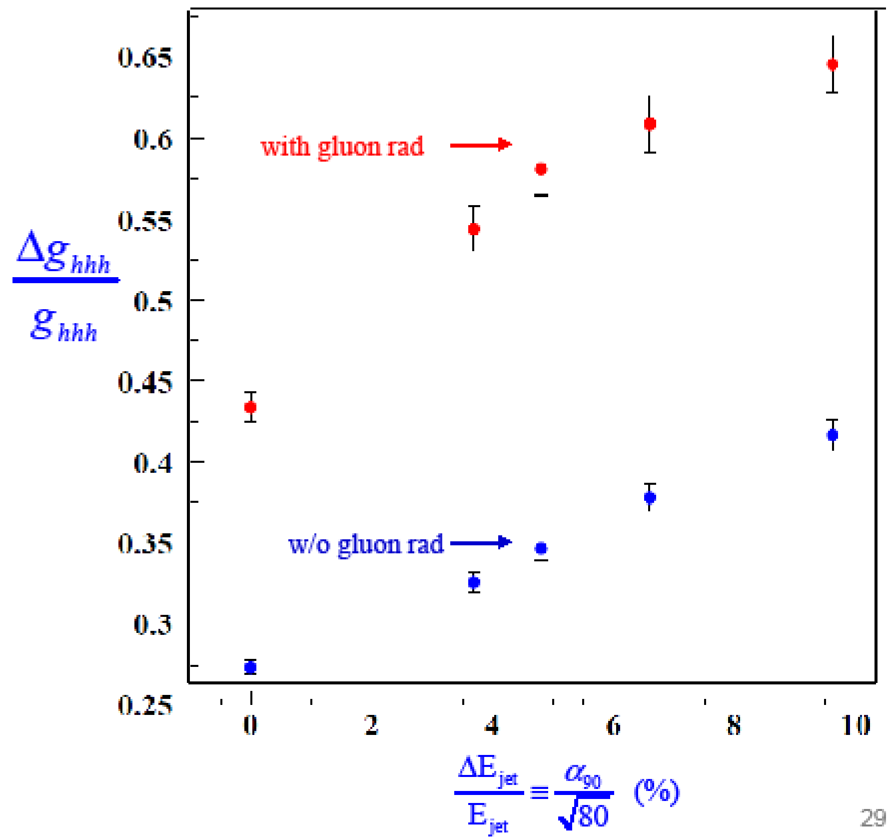
$\to qqb\bar{b}b\bar{b}$

$\sqrt{s} = 500\ GeV$

$L = 2000\ fb^{-1}$

$\Delta E_{jet}/E_{jet} = .067 \to .033$

equiv to $1.4\times$ Lumi



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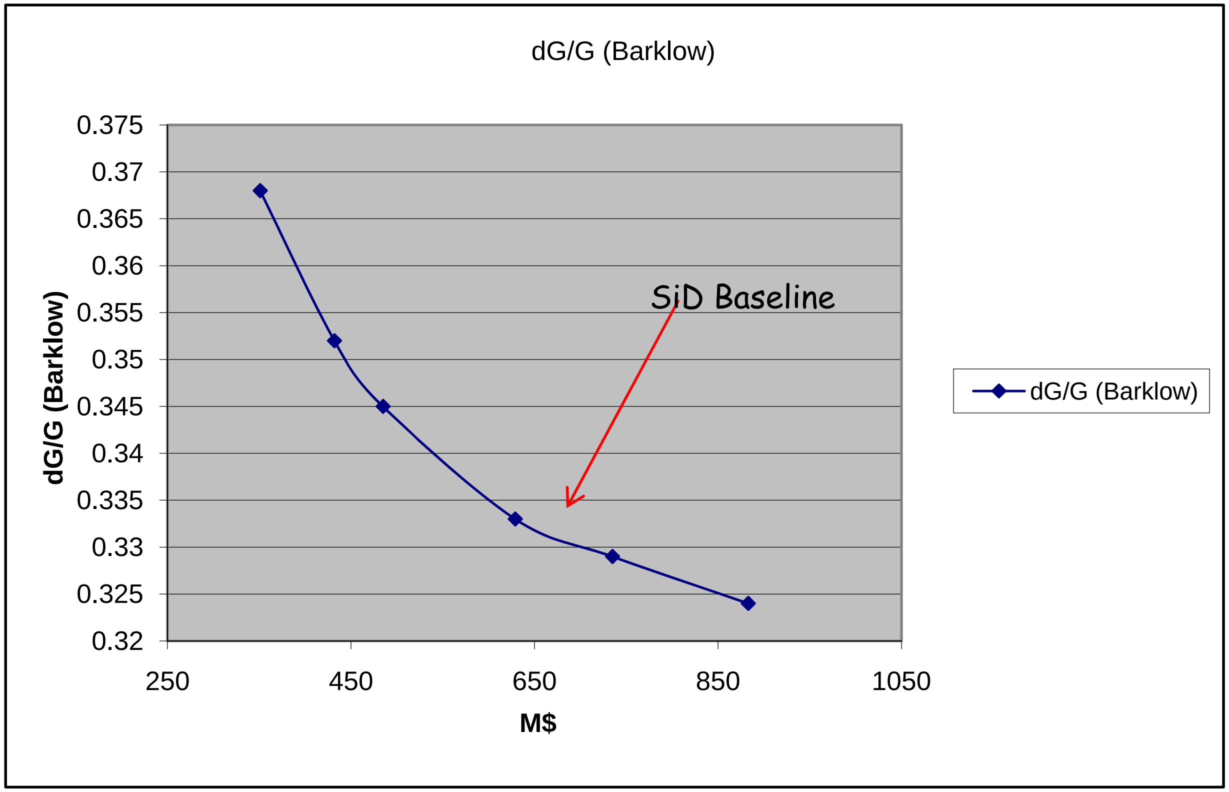
ZHH: w/o gluon radiation; Ecm = 500 Gev; L = 2000 fb^{-1};
ZHH $\longrightarrow$ qqbbbb.



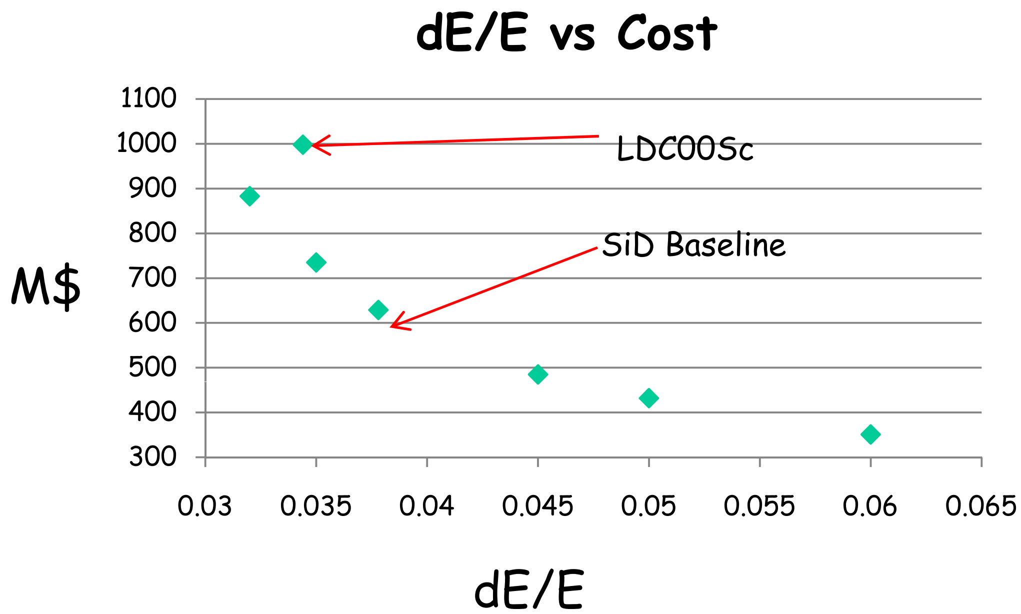
There are definitely ambiguities in going from Tim's analysis to the jet energy resolution used here. The resolution range covered in this plot is ~85% of that used by Tim - so this range covers an effective luminosity gain of ~35%.

SiD Comments

- SiD "Baseline" is sitting at ~ the knee of a physics performance vs cost curve.
- Rtrkr seems ~ right for excellent tracking resolution with Si.
- B seems ~ right for excellent background control for the vertex detector.
- Remember the caveats!

LDC00Sc

- LDC00Sc is a model studied by Marcel. Plugging its dimensional parameters into the SiD Parametric model, get dE/E = 0.034 and cost =$998.



Caveats: This is SiD with LDC00Sc dimensions – it is an Si Tracker, not a TPC; it has RPC w KPiX readout for the Hcal, not scintillator.

Comments

- PFA Issues
  - The Hcal is only parameterized here by its total thickness in Interaction Lengths. The next needed step is parameterization of the segmentation. The segmentation directly affects Hcal Δr, and has large cost effects.
  - The Hcal detectors have not been studied by simulation. One perhaps interesting handle that could be addressed is that gas detectors will necessarily have dead borders, and it possible that scintillator will not. Is this an issue?
  - The Hcal engineering is well into designs that eliminate projective cracks, but with increased complexity and cost. Can the benefits of non-projective cracks be quantified?
  - SiD now has multiple PFA efforts going, including Pandora. For the cost optimization of SiD, the necessary component is the parameterization of performance as a reasonably well behaved function of as many interesting parameters as possible, but at least Rtrkr, B, Hcal λ, Hcal Nsegs, and Z trkr.
  - The caveats must be addressed!!
- SiD
  - Subject to all the caveats, SiD baseline of Rtrkr = 1.25 m, B= 5 T, and Hcal λ seems pretty good!
  - If the cost is too high, there a graceful ways to back off.