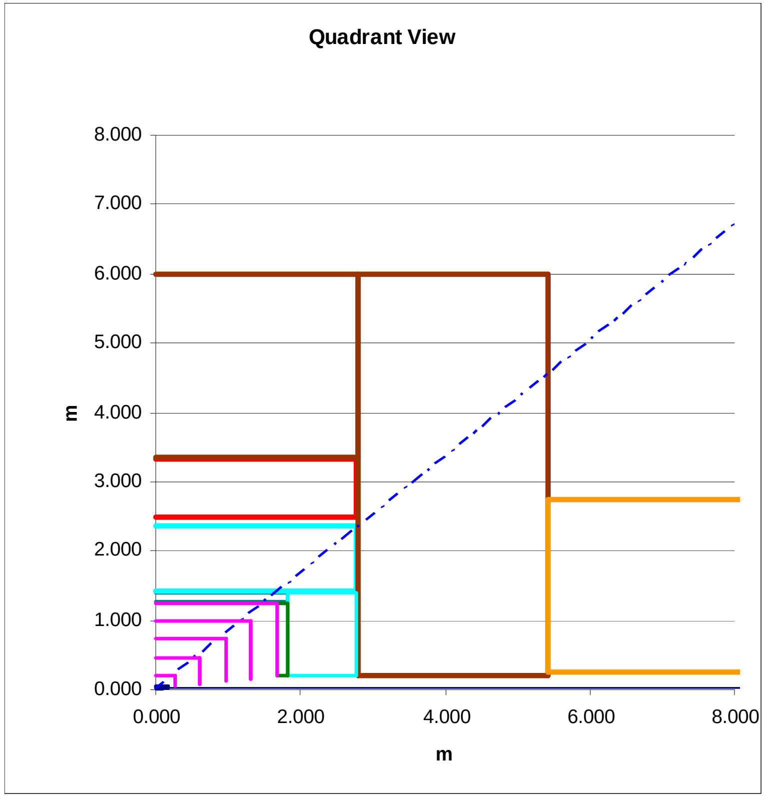
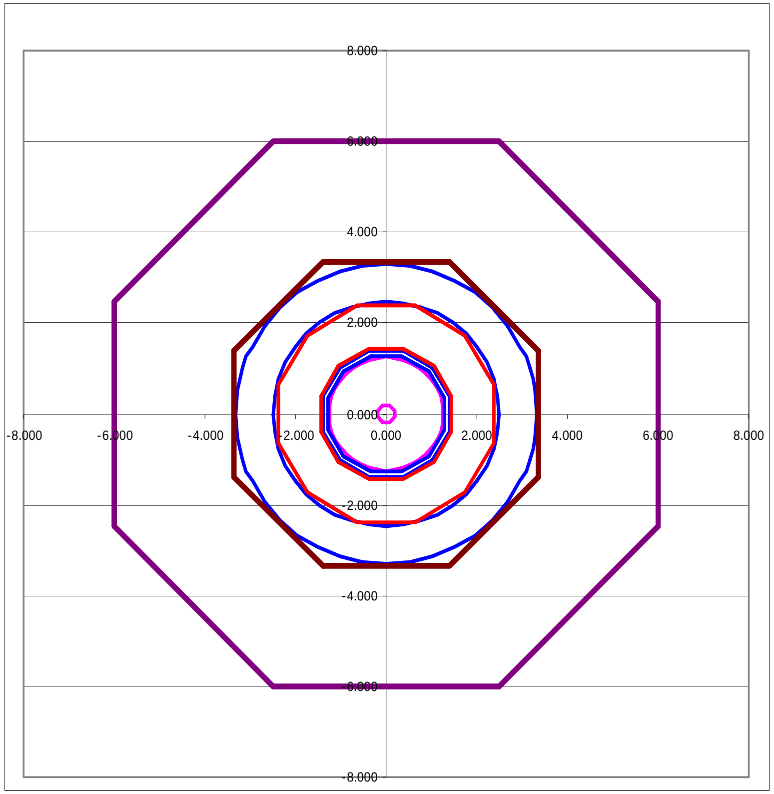
SiD Optimization

M. Breidenbach ALPCG 2007





Optimization – Definitions:

- The search for the best solution among alternatives, or the extreme value of a variable or a function.
- Finding the solution that is the best fit to the available resources. See tuning.
- The refinement process used to find the best solution to a problem. To solve an optimization problem computationally, one writes a program in such a way as to maximize or minimize the value of a cost function.

SiD Baseline

- R_{trkr}=1.25 m
- B=5T
- HCal λ=4.0
- Cos(θ_{trkr}) =0.8

- Will concentrate on here on HCal issues. (Not that there are no other issues, but IMHO this is the one that is most important)

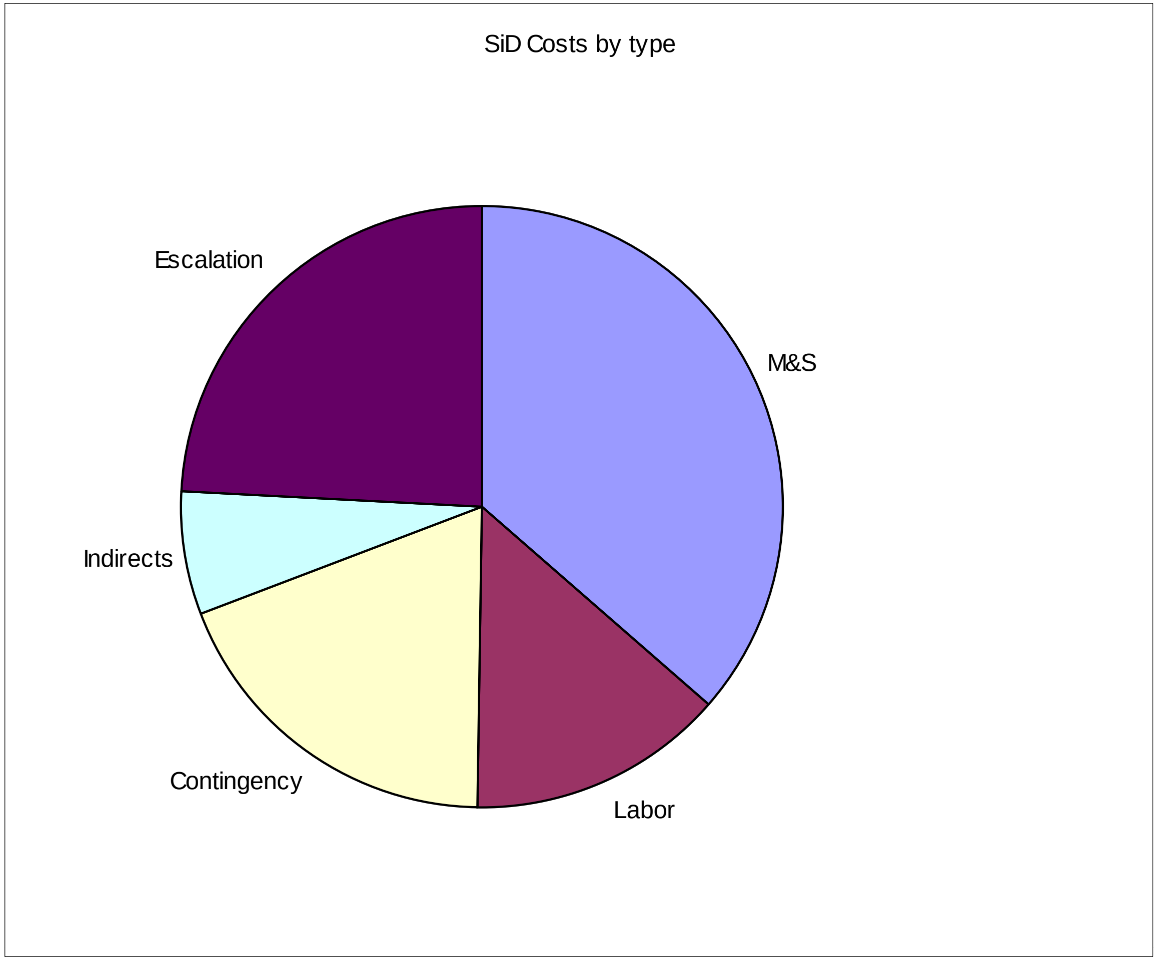
- HCal Major parameters (Baseline!!!):

- Stainless Steel Radiator
  - 2 cm = 0.12 I.L = 1.1 R.L. layers
  - 8 mm gaps
  - 34 layers
- RPC detectors
  - 2750 m^2 @ \$2000/m^2 (not including R.O.C.)

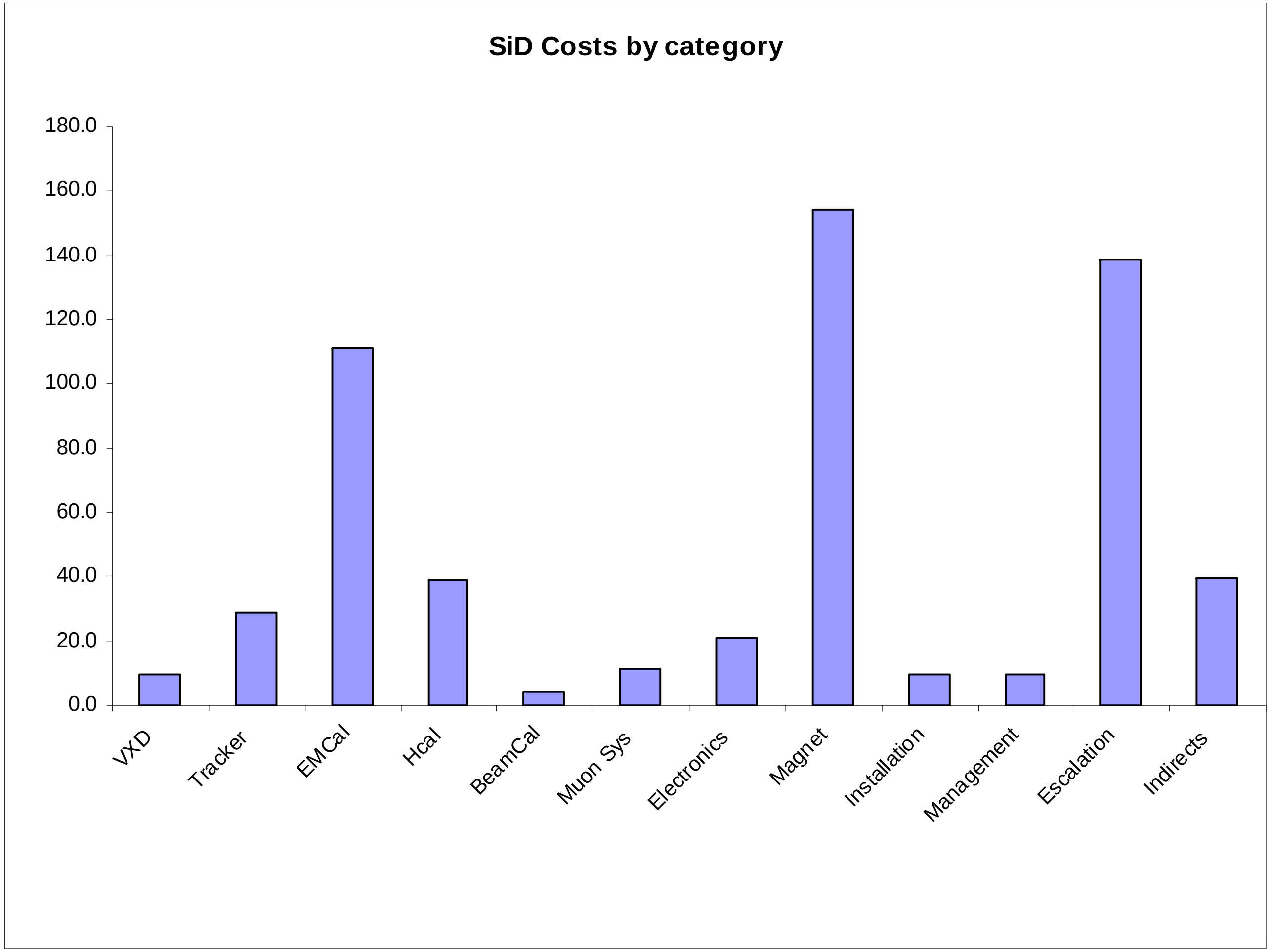
SiD Baseline Cost

- 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 Costs - Subsystems, Escalation, and Indirects



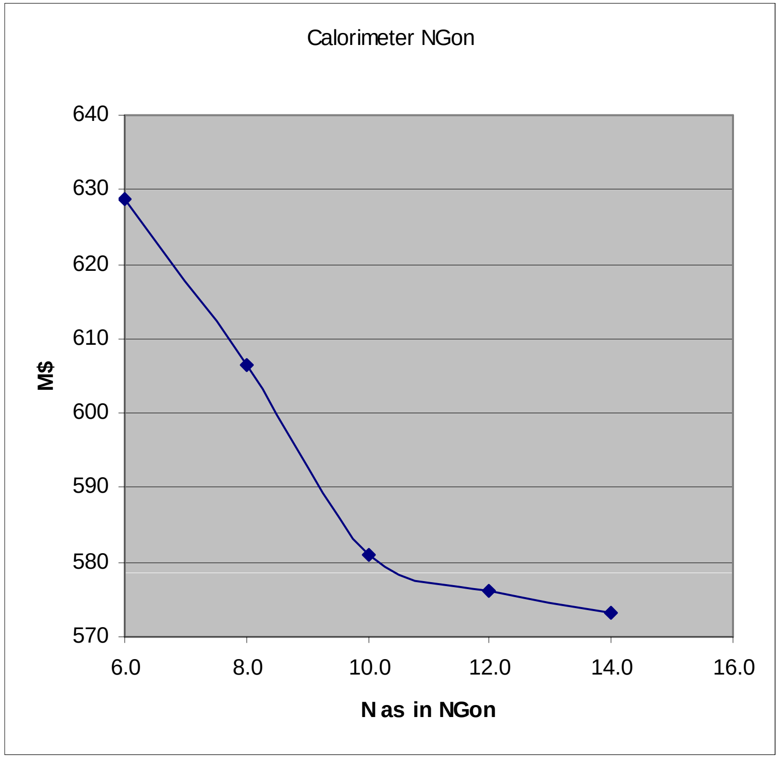
SiD Baseline

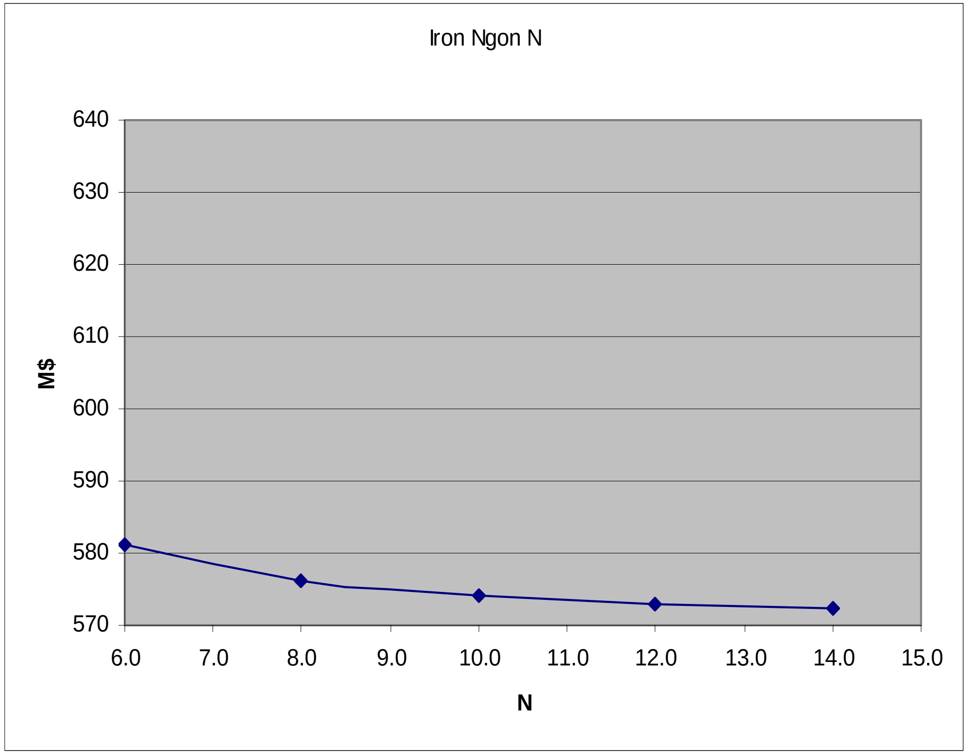
	M&S	Labor	Totals
Base	$209	$82	$290
Contingency	$79	$29	$108
Total	$288	$110	$398
Indirect rates	0.06	0.20	
Indirects	$17	$22	$39
Totals w indirects	$305	$132	$438

Either of these might be the "ILC Detector" Cost

Total in FYXXXX M$	2007		***437.5***
Start Year	2012		
Construction Duration	6	years	
Inflation	1.035	per year.	
Factor	1.317		
Total Escalation			138.6
Total, TYM$			***576.2***

Simple Examples - N as in Ngons

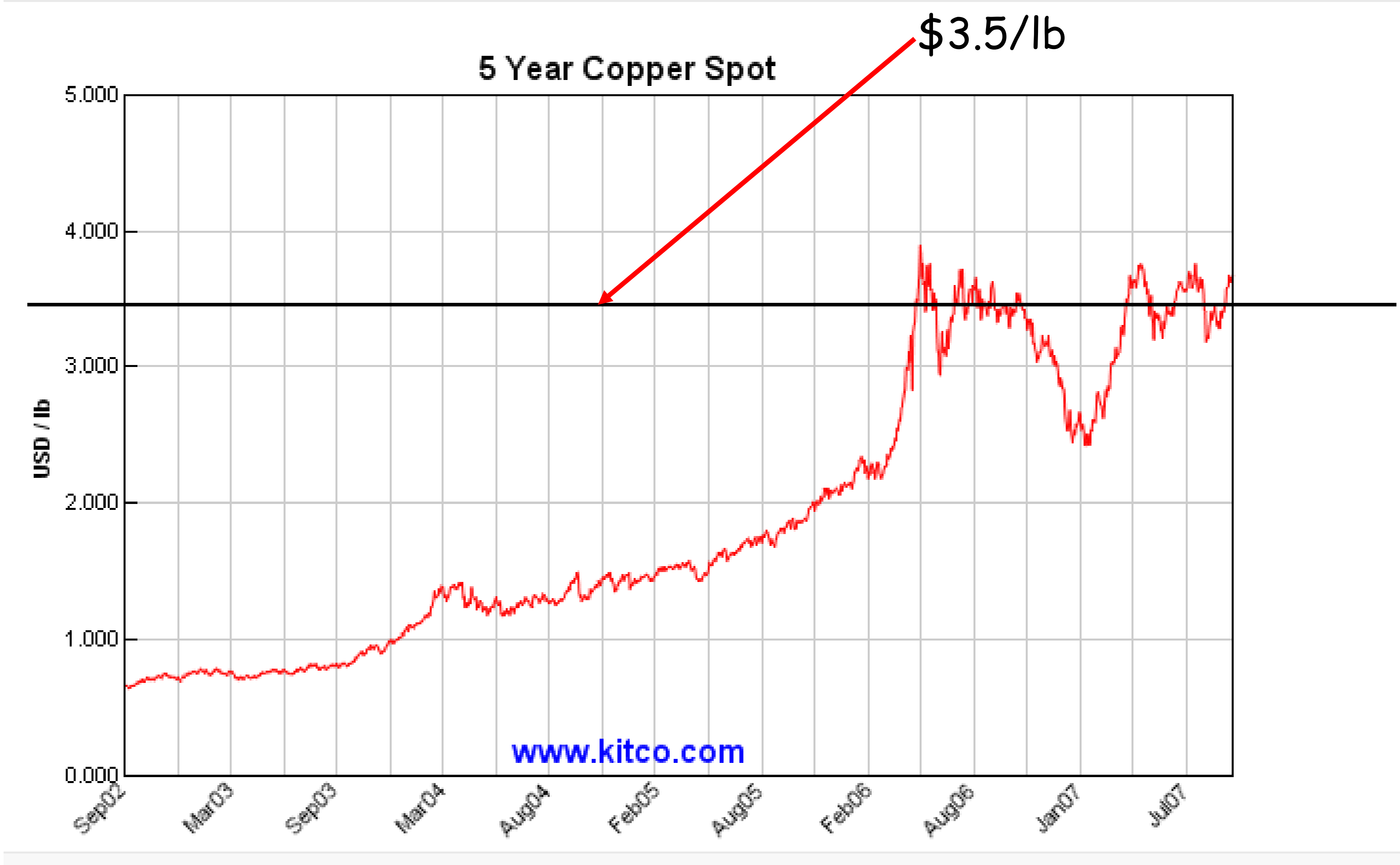




Relevant Example

Variation	Price (M$)	
Baseline	576	Fe, 20 mm = 1.1 X_0/layer; 38 layers
4.5 λ	614	
3mm HCal gap	570	
Silicon for HCal	743	(Nope!)
Back to RPC's	614	
Cu Radiator	601	15 mm = 1.0 X_0/layer; 45 layers
Cu Radiator	561	29 mm = 2.0 X_0/layer; 23 layers
3 mm gap	532	
Si again!	629	Probably crazy, but less obvious.

Attempt to estimate Cu price



Conclusions (for HCal Radiator)

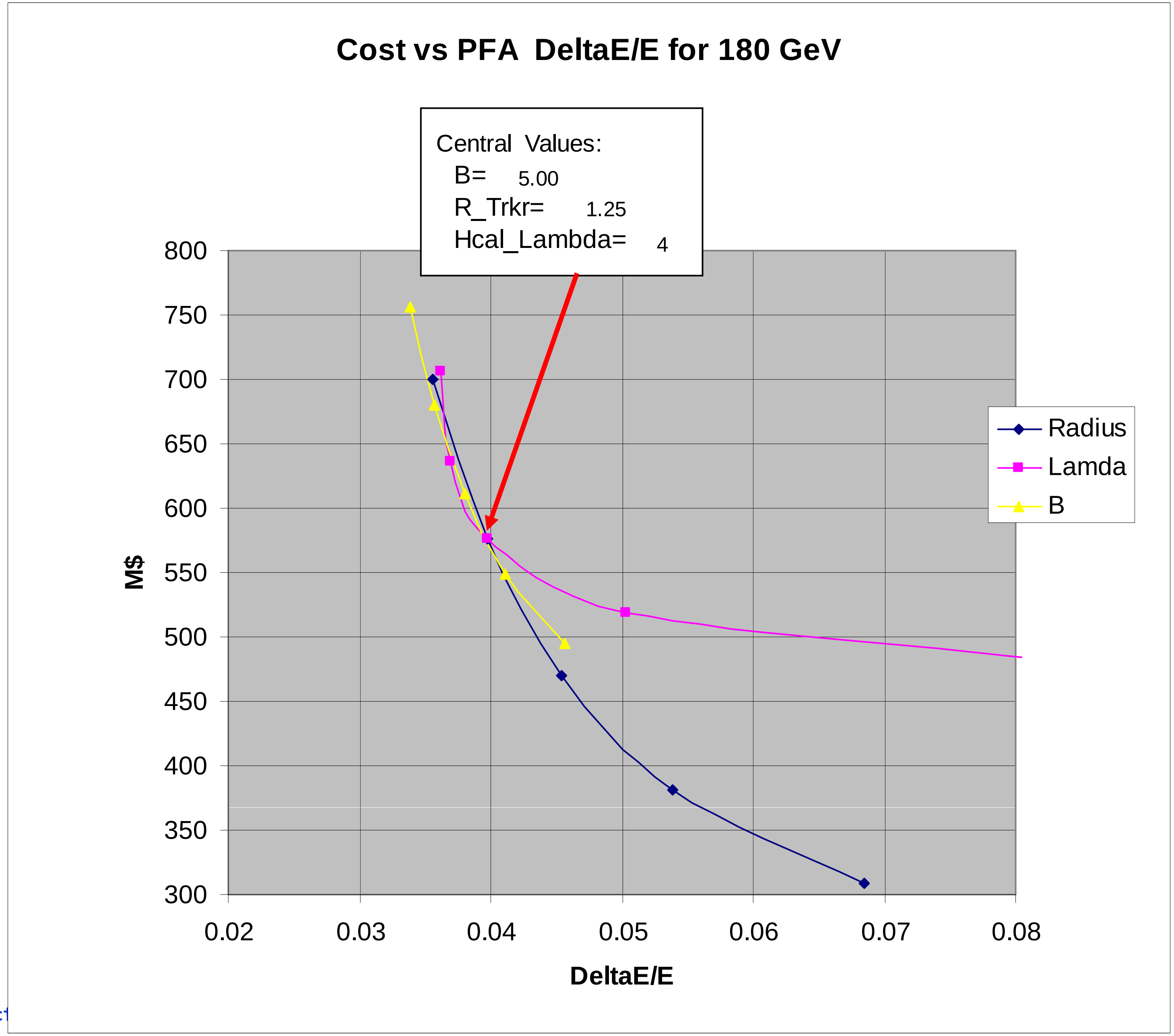
- Variation in a system can have major effects on the bottom line.
- We need to understand the options for the HCal radiator
- We need to understand the needed radiator thickness.
- We need to understand the total HCal thickness.
- We need to understand the gap.
- We need to understand the performance differences of plastic vs gas detectors.
- All of the above are coupled!!

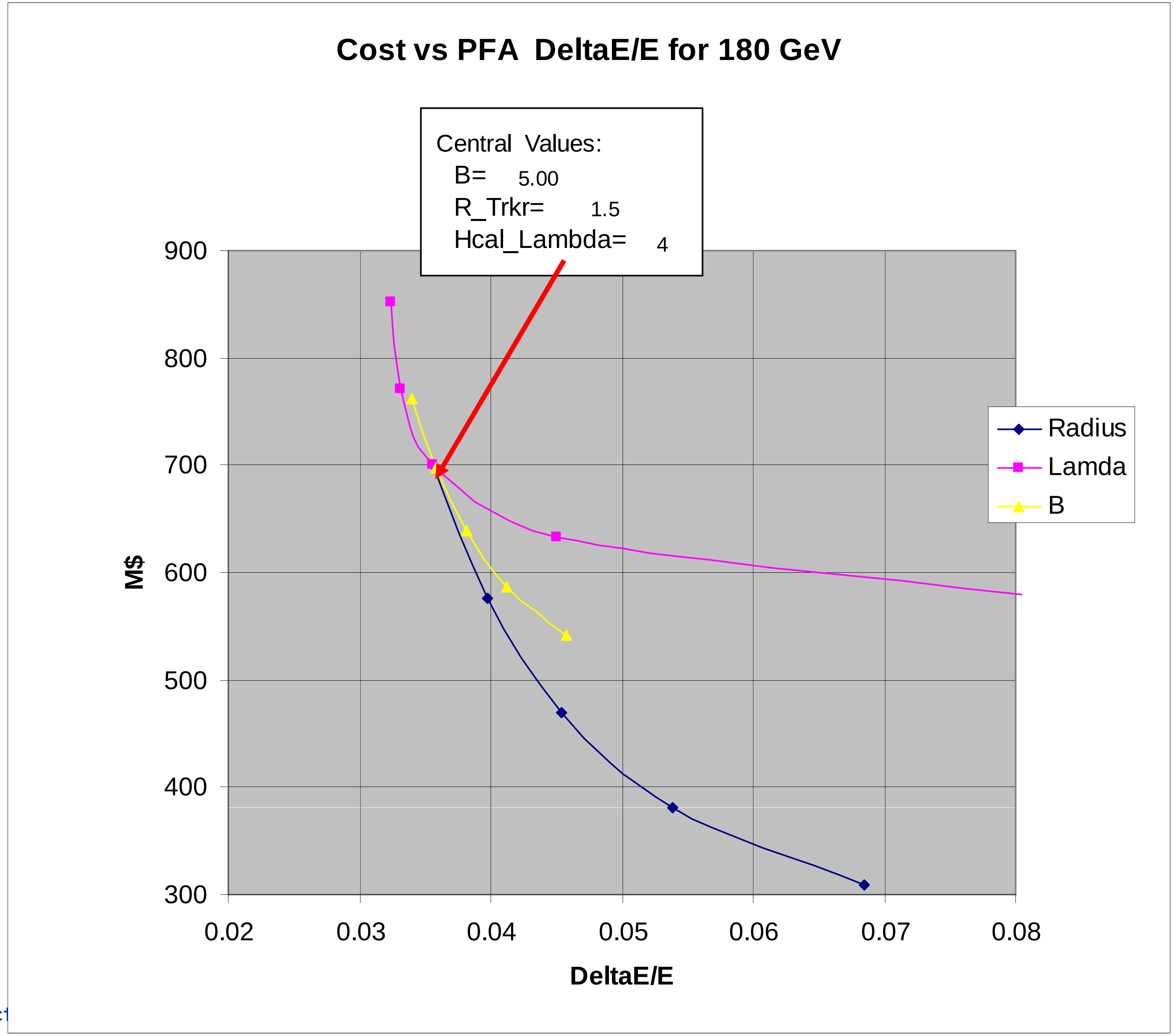
The Hard Problem – Global Optimization

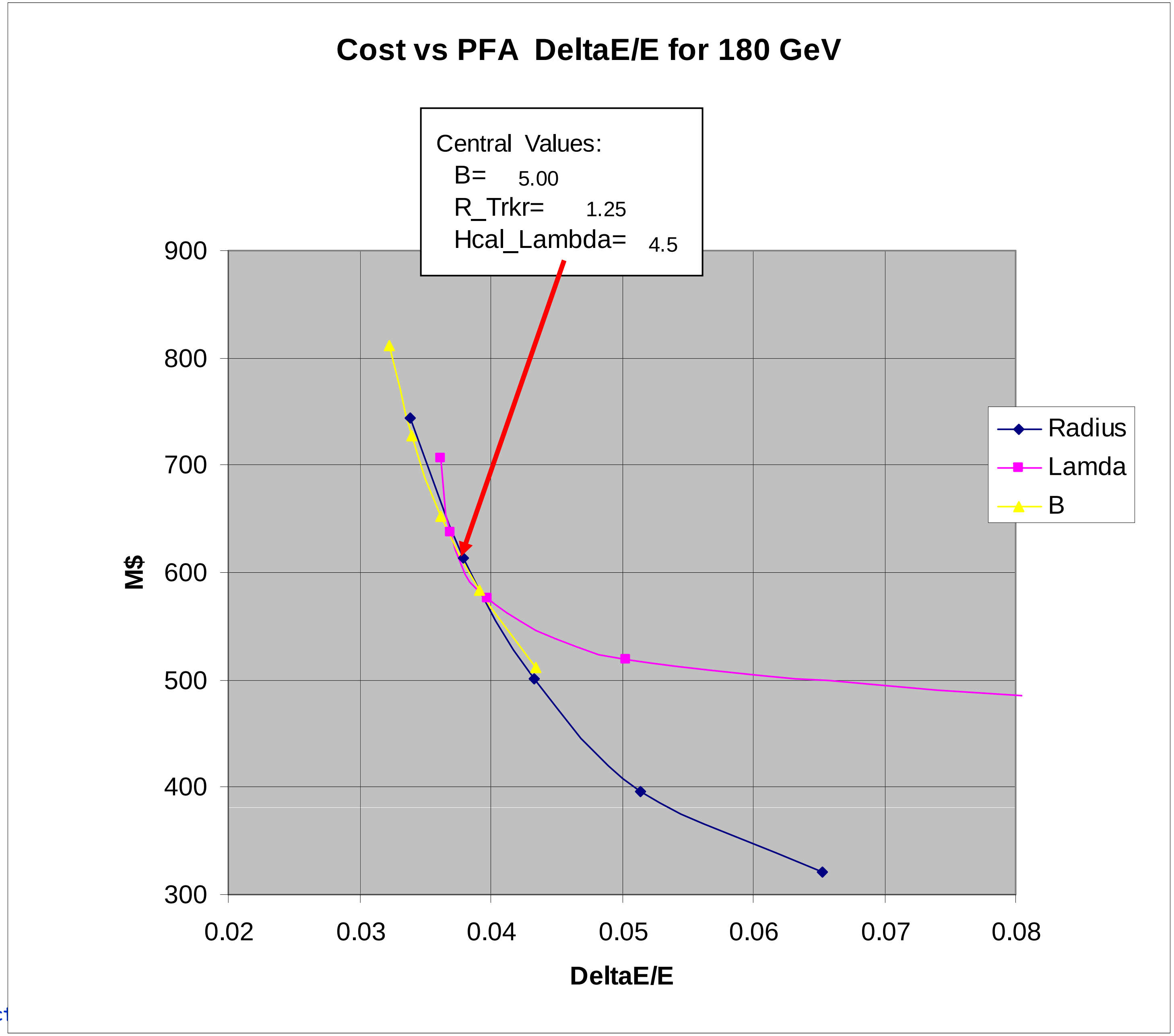
- Philosophically, SiD has "bought" Particle Flow, but we do not have a mature Particle Flow Algorithm (PFA), and what we have appears to yield substantially larger resolutions than Pandora (x2??).
- "The Plan" was to use a trusted, tuned, believed PFA in benchmark physics reactions to adjust R_{trkr}=1.25 m, B=5T, HCal λ=4.0, and $Cos(\theta_{trkr})$ =0.8 to an optimum tradeoff between performance and cost.
- That now seems, at least for the "Letter of Intent" (due in less than 12 months), overly ambitious, and the "New Hope" is to use (same adjectives) PFA to achieve a jet resolution goal, e.g. $\Delta E/E \leq 4\%$ at 180 GeV.
- This requires a parameterization of the resolution in terms of the major parameters, which then can characterize the SiD cost as a function of the resolution.

PFA Parameterization

- Mark Thompson has produced such a parameterization from Pandora. This code assumed plastic scintillator for the HCal, and *the parameterization comes with many caveats*.
- The parameterization is in B, R_{trkr} and N_{layers} of HCal. It does not address the detector aspect ratio - $\cos(\theta_{trkr})$. The N_{layers} can be translated roughly into HCal thickness, but all the subtleties of the thickness per layer are lost.
- For practice, we have boldly proceeded with evaluating the cost versus these parameters and thus $\Delta E/E$.
- Can not just “solve” for cost minima for fixed $\Delta E/E$ because the cost function is not well behaved, and wants to push the radius down and B (way) up!
- *Caveat: This is in no way a substitute for an SiD “owned” PFA!!!!*


Cost vs PFA DeltaE/E for 180 GeV
Central Values:
B= 5.00
R_Trkr= 1.25
Hcal_Lambda= 4
800
750
700
650
600
550
500
450
400
350
300
M$
0.02
0.03
0.04
0.05
0.06
0.07
0.08
DeltaE/E
Radius
Lamda
B


Cost vs PFA DeltaE/E for 180 GeV
Central Values:
B= 5.00
R_Trkr= 1.5
Hcal_Lambda= 4
900
800
700
600
500
400
300
M$
0.02
0.03
0.04
0.05
0.06
0.07
0.08
DeltaE/E
Radius
Lamda
B



Cost vs PFA DeltaE/E for 180 GeV
Central Values:
B= 5.00
R_Trkr= 1.25
Hcal_Lambda= 4.5
900
800
700
600
500
400
300
M$
0.02
0.03
0.04
0.05
0.06
0.07
0.08
DeltaE/E
Radius
Lamda
B

Comments

- Remember the caveats! Remember that it is a parameterization for scintillator – and we don't know if gas is better or worse, or needs more or less radiator.
- The indication is that SiD baseline does $\Delta E/E < 4\%$, and that 4.5 λ is somewhat more conservative without going cost crazy.
- It is probably technically unwise to push B up – 5T is enough of a test. Similarly, r can not go up much without the coil hoop stress being a problem.
- Considering costs, and momentarily believing Pandora, the SiD baseline may be quite reasonable. *But we desperately need to prove this.*