Optimizing SiD

some thoughts

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Background

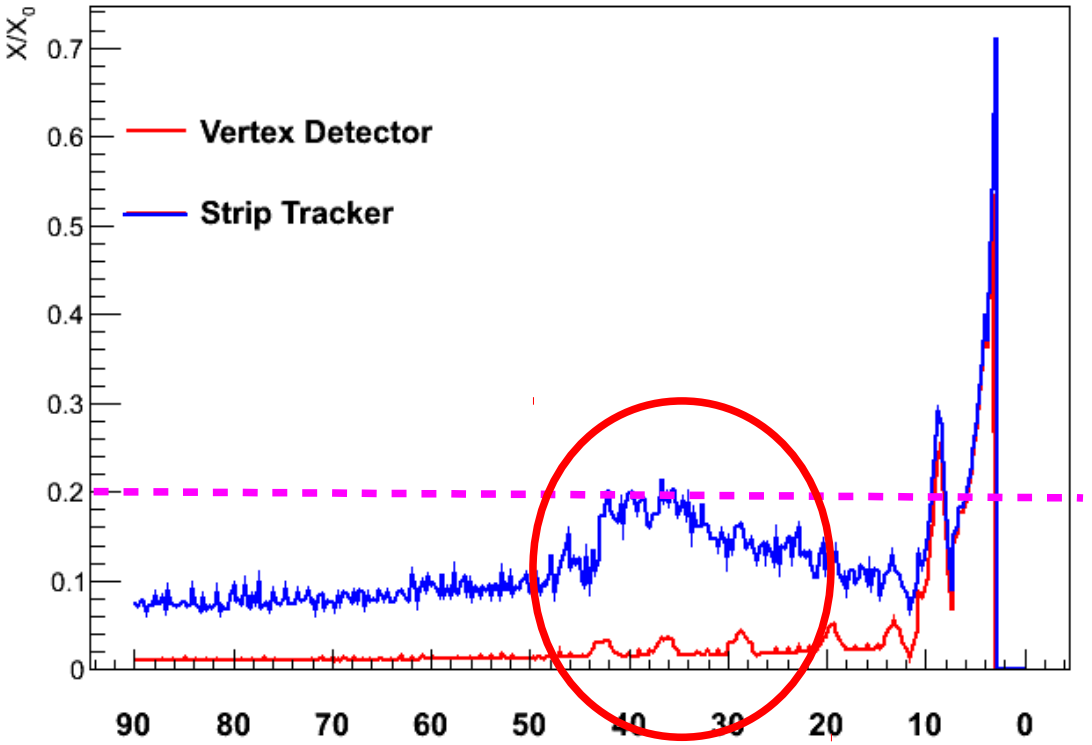
- DBD is done
- Time to review SiD
- Areas that come to mind
  - Aspect ratio
  - Tracker (is this optimal)
  - ECAL (can we pay this...)
  - HCAL (how many layers are required)

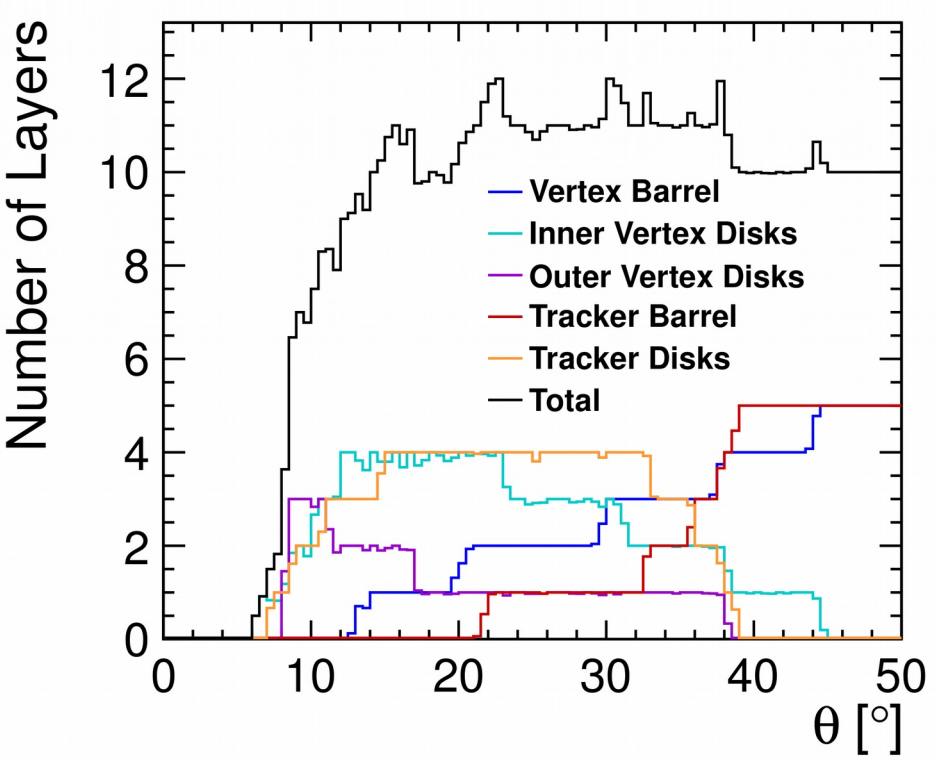
DBD baseline parameters

SiD BARREL	Technology	Inner radius	Outer radius	z max
Vertex detector	Silicon pixels	1.4	6.0	± 6.25
Tracker	Silicon strips	21.7	122.1	± 152.2
ECAL	Silicon pixels-W	126.5	140.9	± 176.5
HCAL	RPC-steel	141.7	249.3	± 301.8
Solenoid	5 Tesla	259.1	339.2	± 298.3
Flux return	Scintillator/steel	340.2	604.2	± 303.3

SiD ENDCAP	Technology	Inner z	Outer z	Outer radius
Vertex detector	Silicon pixels	7.3	83.4	16.6
Tracker	Silicon strips	77.0	164.3	125.5
ECAL	Silicon pixel-W	165.7	180.0	125.0
HCAL	RPC-steel	180.5	302.8	140.2
Flux return	Scintillator/steel	303.3	567.3	604.2
LumiCal	Silicon-W	155.7	170.0	20.0
BeamCal	Semiconductor-W	277.5	300.7	13.5

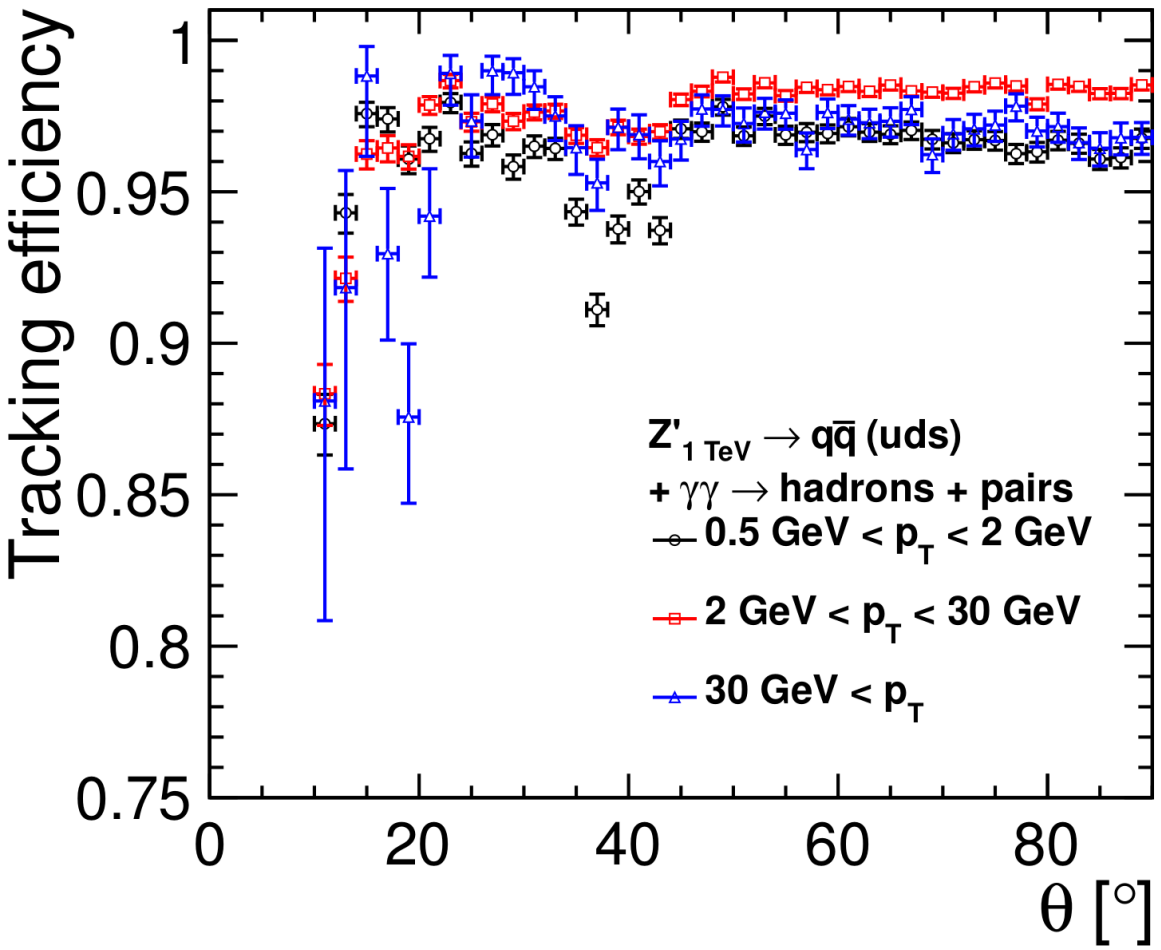
SiD Tracking System





- Track seeding and fitting uses entire tracking system
  - 7 hits required (6 in second pass)
  - Calorimeter seeding (V_0 finder)
- Forward region has biggest chunk of material
  - Small-Angle-Stereo → Replace with pixel disks ?
-

We are weaker in the forward ...

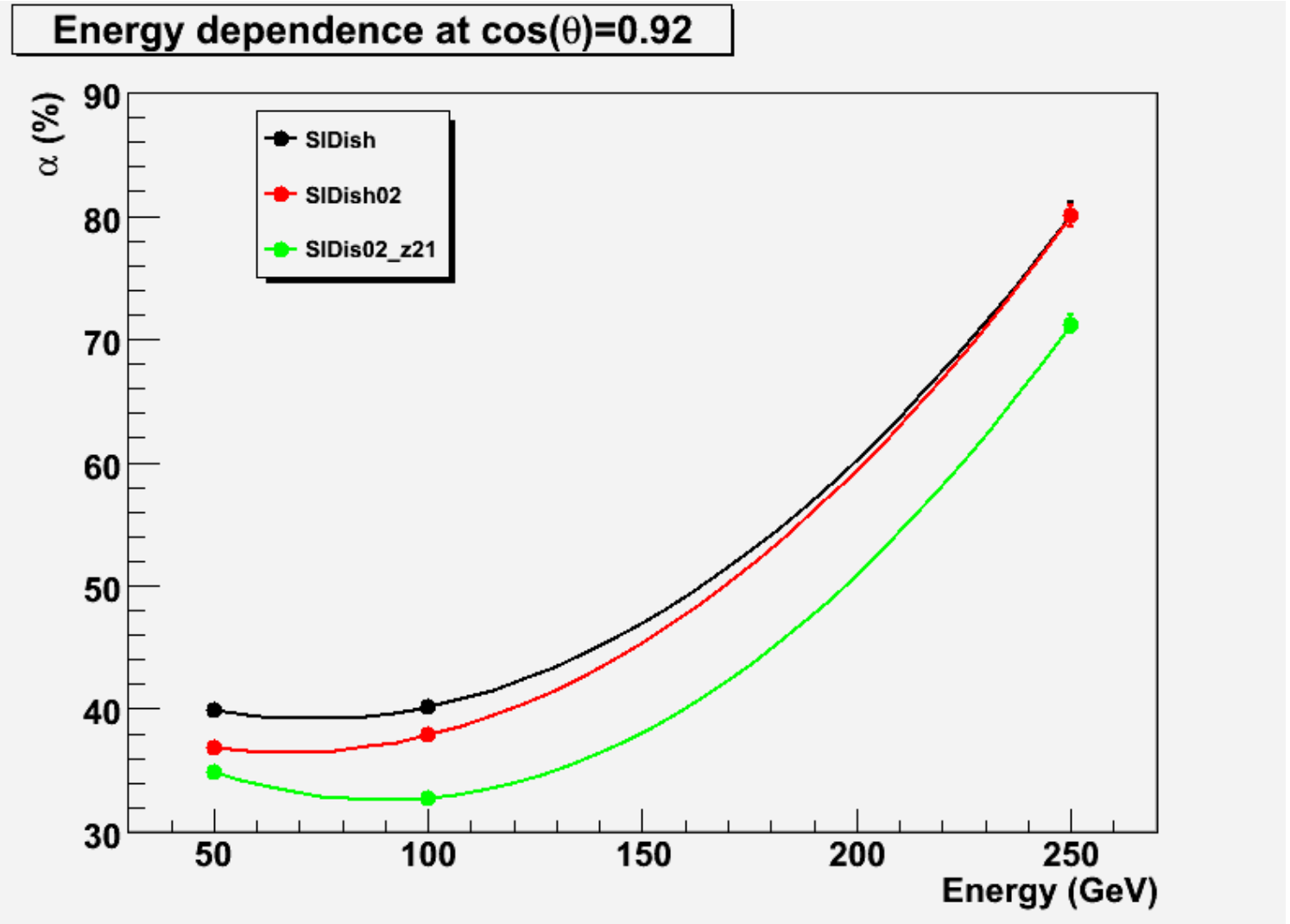


What is the impact on the PFA ?

Aspect ratios

- During LoI times
  - Make the barrel a bit longer ~ 30 cm
  - Moves material further down
- Cost impact at the time
  - Modest … but non-zero (+ ~10 %)
- Why not further considered at the time
  - Tracker mechanics and Tracking were not ready to support this

From 2008



Forward performance at cos (θ)=0.92 using a single u jet at 50,100,250 GeV

Some numbers

r	z	cos theta	M & S Costs (M US-$)
126.5	165.5	0.8	309
126.5	204.1	0.85	339
126.5	261.2	0.9	387
126.5	384.9	0.95	491

- Coming from Marty's cost tools
- So making SiD longer is about 10 % for the DBD detector

Tracker segmentation studies

- We have the a strip-tracker
  - Conservative
- Technology has moved on
  - Making MAPS that are wafer size
  - Lots of material in the endcap (SAS layers)
  - Do we need that many disks/layers
- Need to understand this

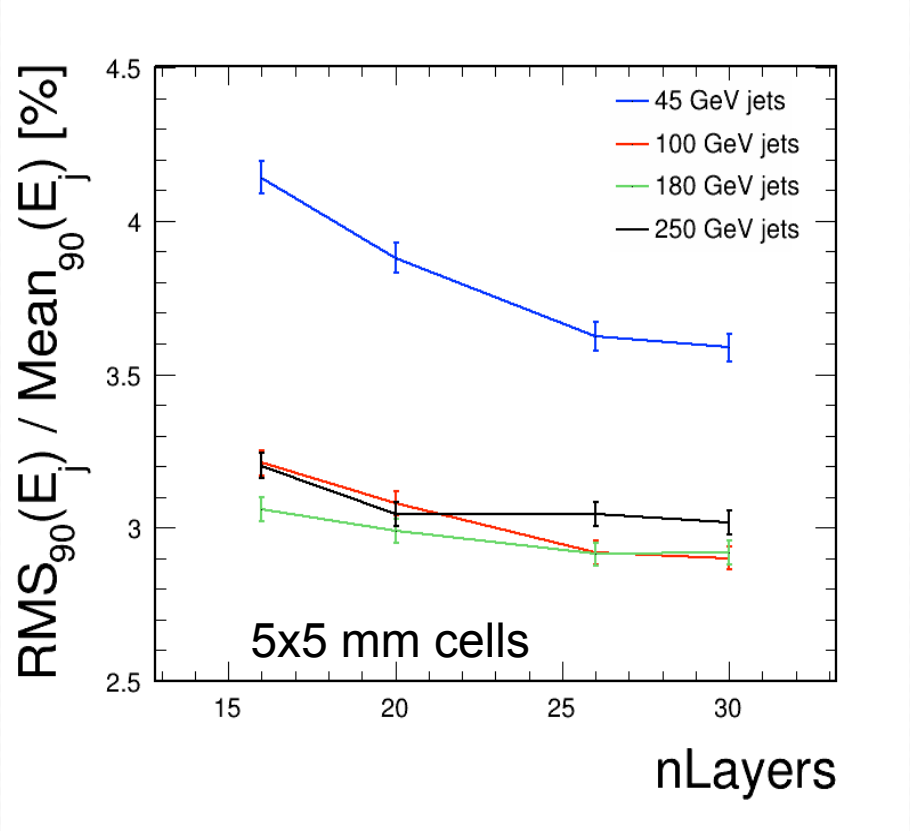
Detector variants to study

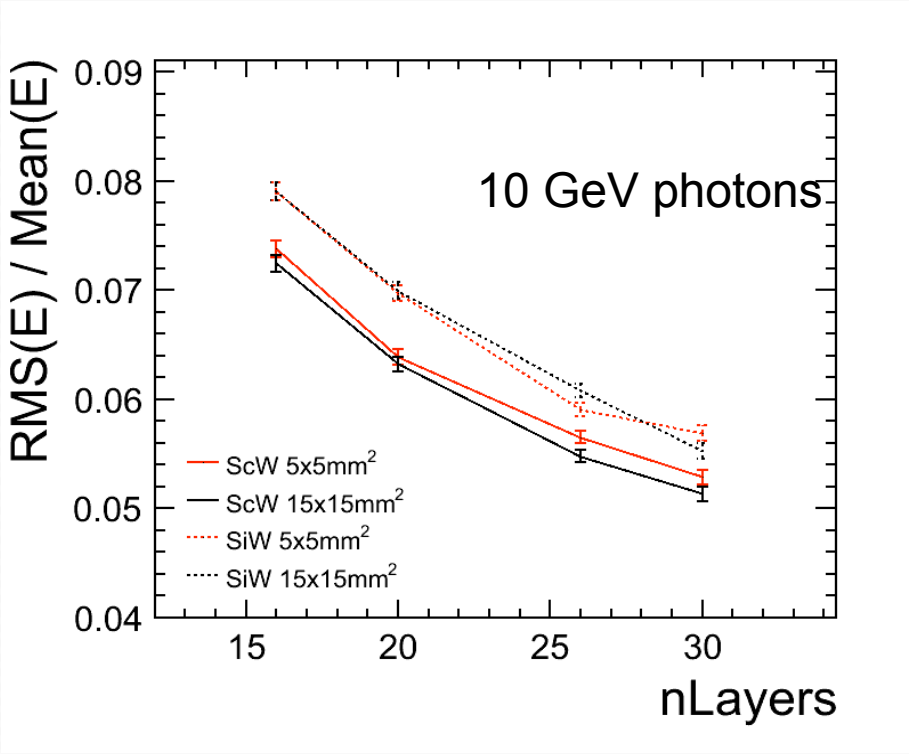
- Sidloi3 as basis
  - Make elongated sidloi3 (z =2 m)
  - Make version with pixel endcap disks
- Need to be done
  - new xmls (quite straight forward)
  - New tracking strategies
  - Support for pixel disks in tracking (no issue for SLIC), this has been done before

ECAL

- Studies by Mark Thomson and John Marshall indicate
  - ECAL may be too “generous” …
  - What would be the benefit of reducing the number of layers ?
- Impact of reducing segmentation not obvious
  - 1 wafer= 1 KPix ...

John Marshall's plots



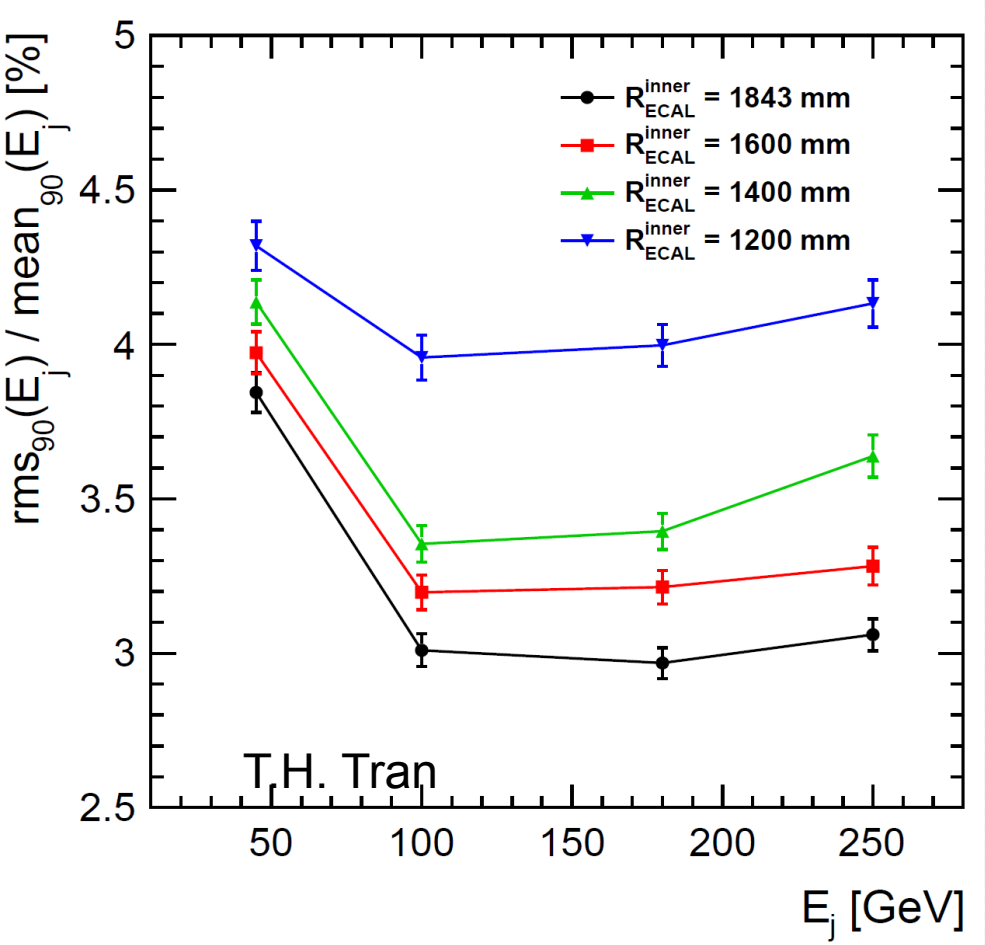


Proposed detector variants

- Sidloi3 has 20+10 layers
- Make versions with
  - 20 layers
  - 20 +5 layers
- Do we need to adjust HCAL as well ?
- Need new PFA calibrations

ECAL inner radius

- Studies by ILD
  - Examine smaller detectors
  - ILD performance is flat down to 1.4 m
  - Done with 3.5 T
- Need to look at radii …
  - 1.2 m,1.3 m, 1.4 m ?



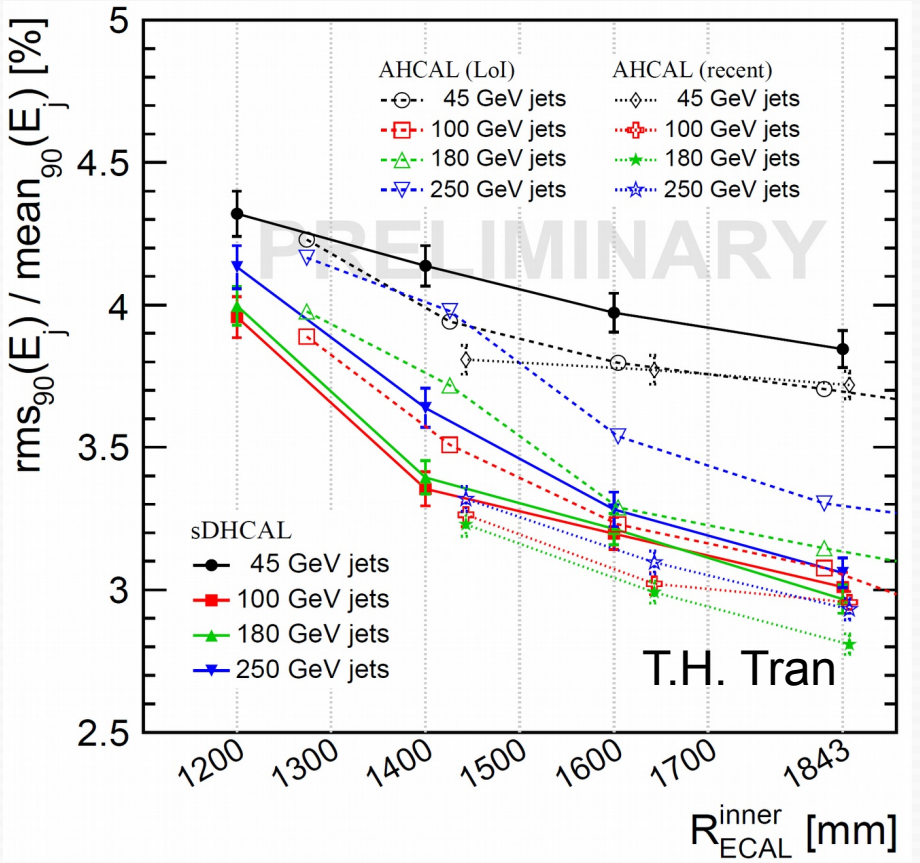
This is where the money is

$r_{Tracker}$	M & S Costs (M US-$)
1.25	309
1.30	332
1.35	348
1.40	365

- Making SiD larger in radius is expensive
- Need to know what the gains are for SiD
  - 5 T is very different than 3.5 T

HCAL technologies

- Make a variant with scintillator
- Simulation
  - RPC multiplicities ..
  - PFA with a DHCAL
- Any other ideas ?
  - Vary pad sizes ?
  - 1x1 cm for RPC
  - 3 x3 for Scintillator



HCAL depth

- 40 layers is lower limit
  - Maybe a bit to shallow already for 1 TeV
- Suggested variants
  - Sidloi3 with 30, 50 layers
  - Testing extremes …
  - How close to the knee are we

What we need for each detector model

- $Z \rightarrow$ uds events at various energies (jet resolution)
- Muon events (for tracking)
- Physics benchmark event samples
- Have the same events for all ...

What physics benchmarks

- Should be simple
  - Cuts well documented → repeatable
- My ideas
  - W/Z separation ….
  - Higgs recoil with dijets
  - Recoil mass with muons
  - Photons, Taus (any ideas?)

Summary

- Three main areas for overall parameters
  - Tracker layout
  - ECAL depth
  - HCAL depth
- Probing technologies
  - Tracker Pixel disks
  - HCAL readout technologies
- Total
  - ~7 new detectors to look at