SiD
Global Parameter Optimization using Pandora PFA

28.01.2007
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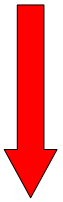
The Idea

- Use the current best Particle Flow Algorithm
  - PandoraPFA by Mark Thomson
- Start optimizing SiD
  - r,z,T,
  - layers, segmentation
  - material, technology



More Difficult

- Caveat : Only works within Marlin Framework
- No SiD detector model available in this framework
- Have to use a SiD look-alike, the SiDish

PandoraPFA

- Developed by Mark Thomson
- The world's best so far (V2.0 available)
- Pandora is monolithic
  - Calibration
  - Clustering
  - MIP/Photon Finder
  - Particle Flow
- Well tailored towards LDC00Sc and (most recent) LDC01_05Sc

The setup

- Use PandoraPFA 2.0 & LCPHYS
- Start of with LDC00Sc (Reference Point)
- Then go to SIDish
- Use track cheating
  - tracking shouldn't matter ... to first order
- Vary parameters
  - radius
  - Z
  - field
  - layers
  - ...

LDC00Sc

- Tracker radius=1.69 m
- Tracker Z=2.73 m
- ECAL SiW 30+10 layers, 1x1 cm tiles
  - 1.4 mm/4.2 mm W + 2.5mm Gaps
- HCAL Fe-Scint 40 layers 3x3 cm tiles
  - 18 mm Iron + 7.5 mm Gap
- 4 T Field
- Basically the old Tesla Design
- A detector that will never be build ...

The "SIDish"

- Tracker radius=1.25m
- Tracker Z=1.7 m
- ECAL SiW 20+10 layers, 1x1 cm tiles
- HCAL Fe-Scint 40 layers 3x3 cm tiles
- Same Calorimeter layout as LDC00Sc (besides 30+10->20+10)
- 5 T Field

The different variations

- Vary Field
  - 4,5,6 T
- Vary R
  - 1.0, 1.25, 1.5 m
- Vary Z
  - 1.5, 1.7,1.9 m
- Vary HCAL layers
  - 40,50,60 layers
- Vary ECAL layers
  - 30,40
- Vary HCAL Material
  - Fe,Cu
- We have too much phase space !

Summarize ...

Detector TAG	B-field	ECAL layers	ECAL cell size	HCAL layers	HCAL cell size	Tracker radius	Tracker length
LDC00	4	40	1x1	40	3x3	1690	2730
SIDish	5	30	1x1	40	3x3	1250	1700
SIDish_r10_z17	5	30	1x1	40	3x3	1000	1700
SIDish_r15_z17	5	30	1x1	40	3x3	1500	1700
SIDish_r125_z15	5	30	1x1	40	3x3	1250	1500
SIDish_r125_z19	5	30	1x1	40	3x3	1250	1900
SIDish_4T	4	30	1x1	40	3x3	1250	1700
SIDish_6T	6	30	1x1	40	3x3	1250	1700
SIDish_hcal50	5	30	1x1	50	3x3	1250	1700
SIDish_hcal60	5	30	1x1	60	3x3	1250	1700
SIDish_ecal40	5	40	1x1	40	1x1	1250	1700
SIDish_hcal_cu	5	30	1x1	40	1x1	1250	1700

- Done with different Mokka Version (slight inconsistency)

Current Status

- For each point
  - photons, hadrons, uds jets (45,100,250 GeV)
  - approx 45000 events per point
  - Check gear file is correct
  - for all points calibrate PandoraPFA
  - have photons, hadrons, uds jets for 45 GeV
- Simulation takes forever
  - 1000 Z->uds (45 GeV) ~ 44 hours
  - Couldn't change HCAL layers with Mokka 06-04-p03, so for 50, 60 layer version had to use Mokka-06-5-p02 (slight inconsistency...)

100, 250 GeV Jets

- These take really forever
- I have to split stdhep files somehow ...
- I am hitting a CPU time limit at 48 hours ..
- Ray was working on simulating chunks at SLAC
- I don't have large samples available at 100/250 GeV ...
- We'll have samples soon

The first result

- Have results for 45 GeV jets
- They are **PRELIMINARY**
- Numbers quoted are
  - cos(Thrust)< 0.7 : Barrel Events
- There are a set of caveats
  - Have to calibrate Response for each detector variation
  - Hadronic response is tricky ...
  - Can have an effect <1 % on 1/sqrt (e)
  - Calibration can be tuned with existing samples
  - Could use even more statistics
- So numbers could change slightly ...

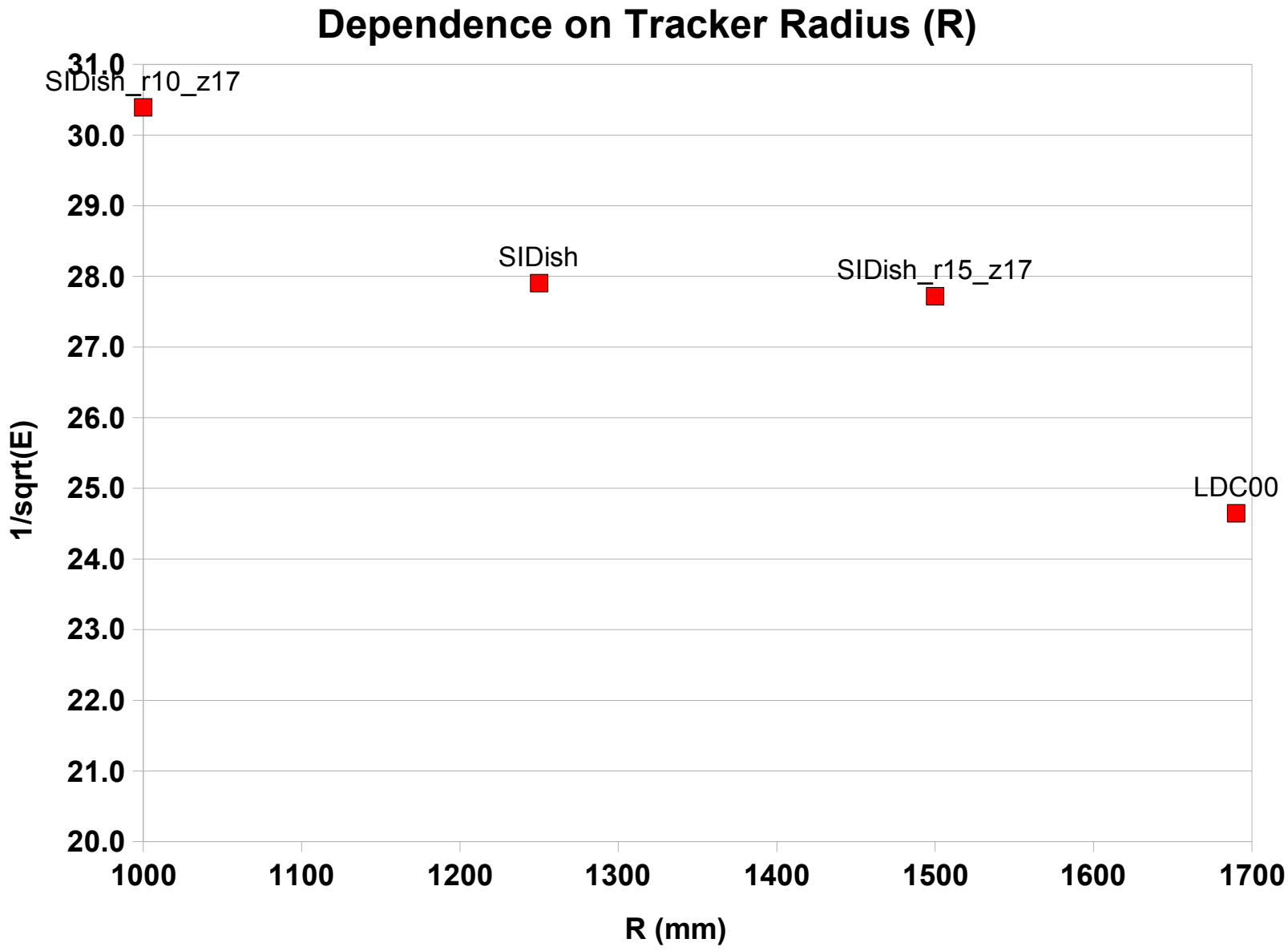
Preliminary Results

Detector TAG	B-field	Tracker radius	Tracker length	rms90 (uds45)	Error
LDC00	4	1690	2730	24.6	0.3
SIDish	5	1250	1700	27.9	0.4
SIDish_r10_z17	5	1000	1700	30.4	0.4
SIDish_r15_z17	5	1500	1700	27.7	0.4
SIDish_r125_z15	5	1250	1500	29.0	0.4
SIDish_r125_z19	5	1250	1900	28.5	0.4
SIDish_4T	4	1250	1700	28.9	0.4
SIDish_6T	6	1250	1700	28.6	0.4
SIDish_hcal50	5	1250	1700	28.7	0.4
SIDish_hcal60	5	1250	1700	28.7	0.4

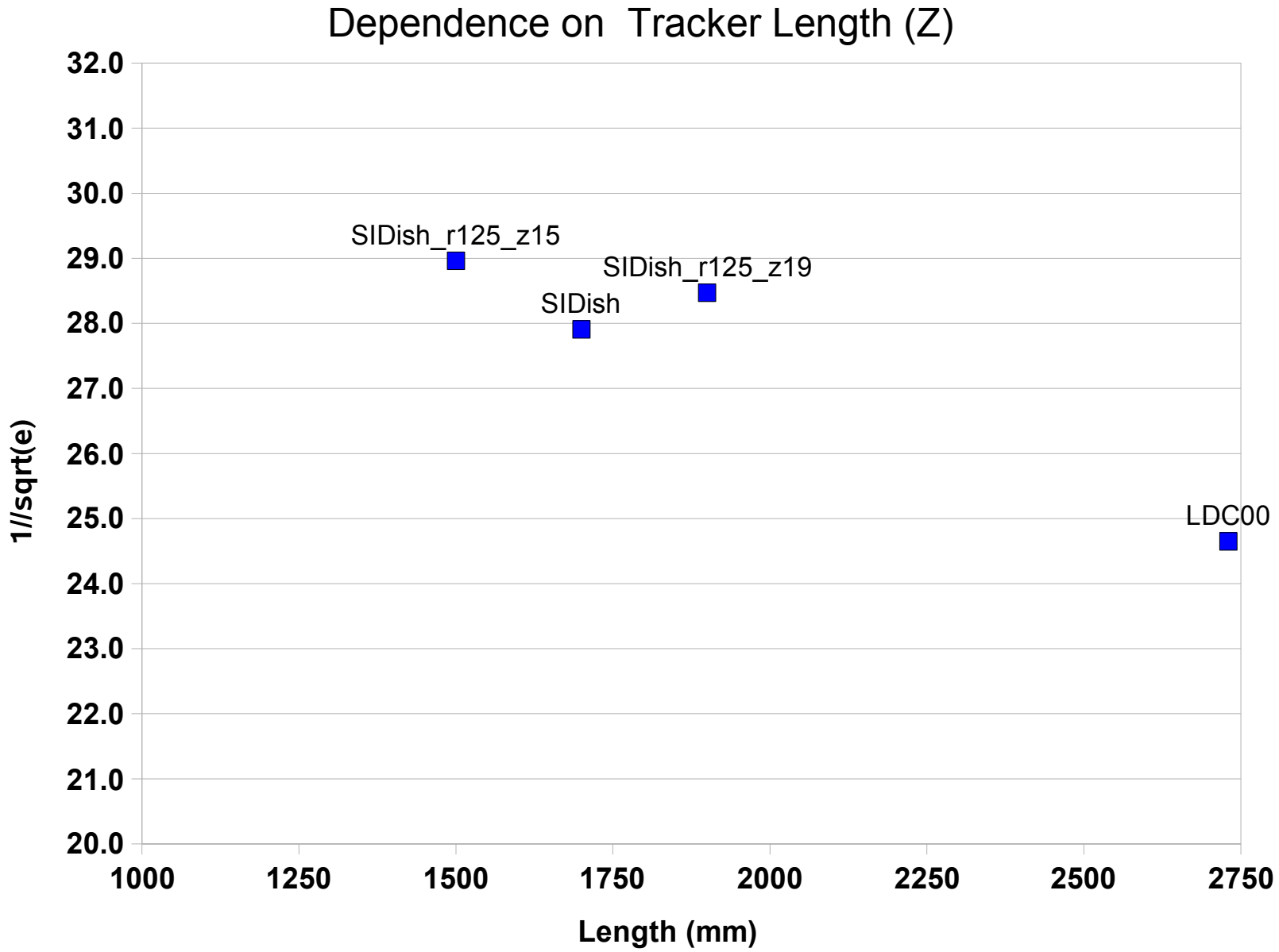
PRELIMINARY

- Done with different Mokka Version (slight inconsistency)

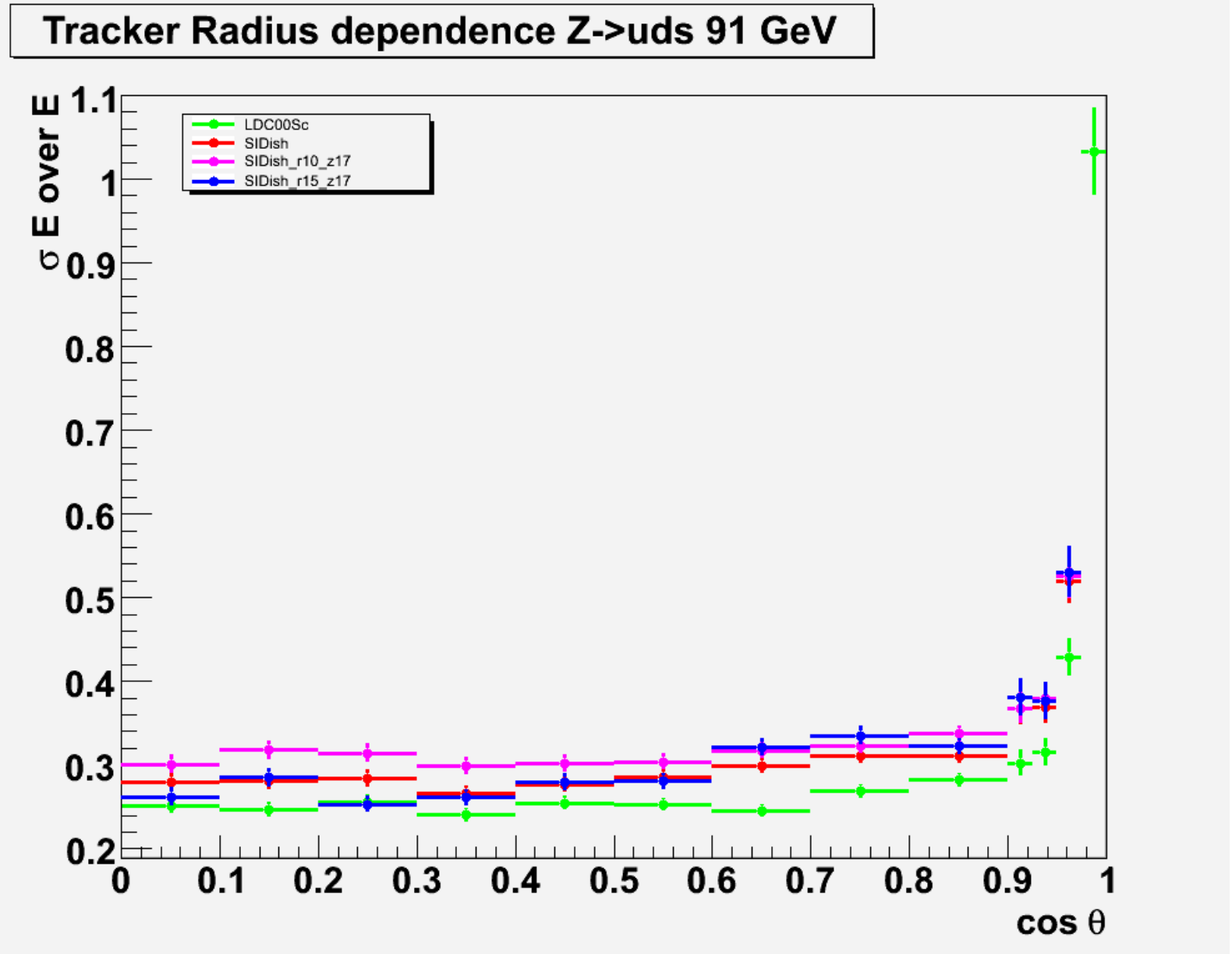
R dependence (Barrel)



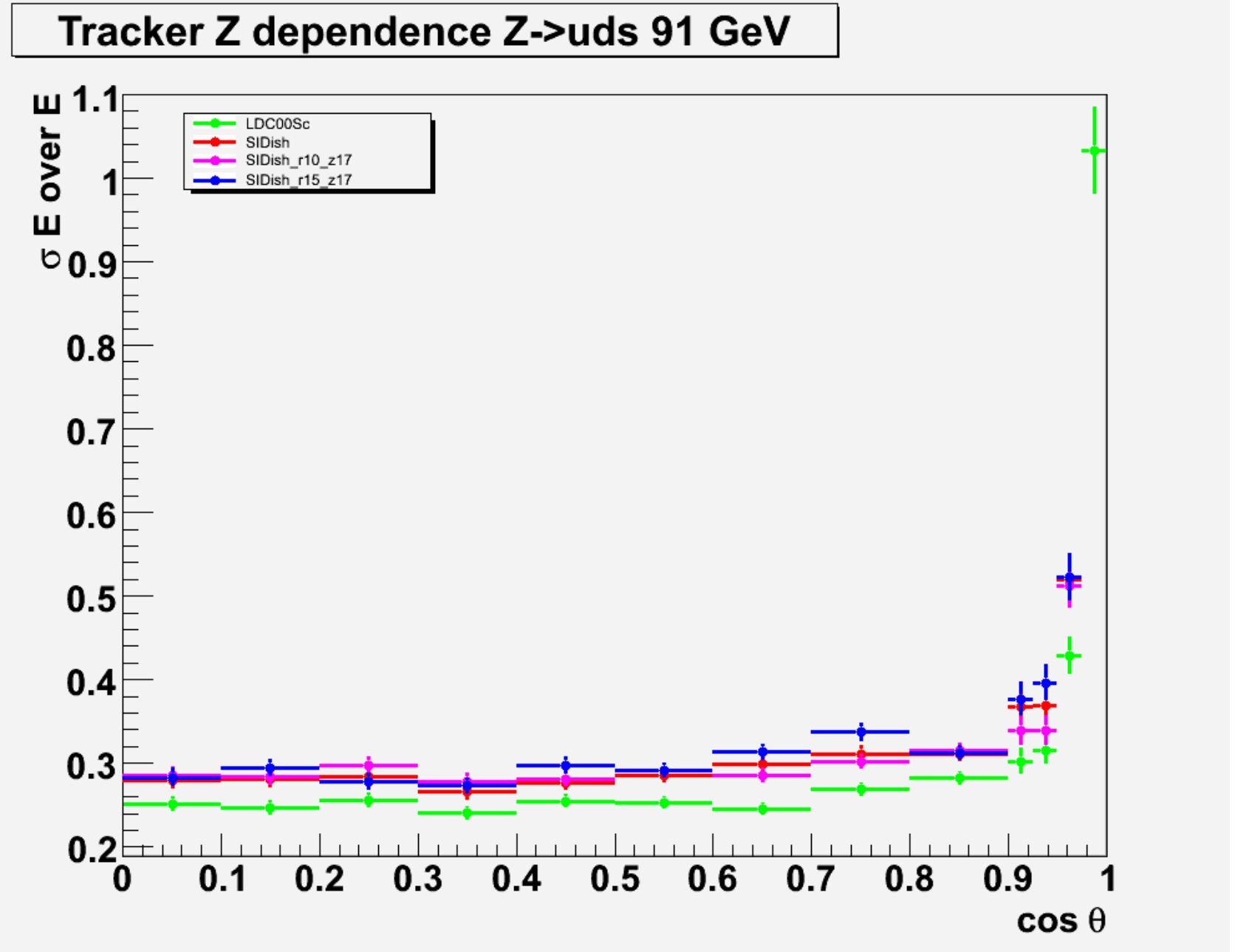
Z dependence (Barrel)



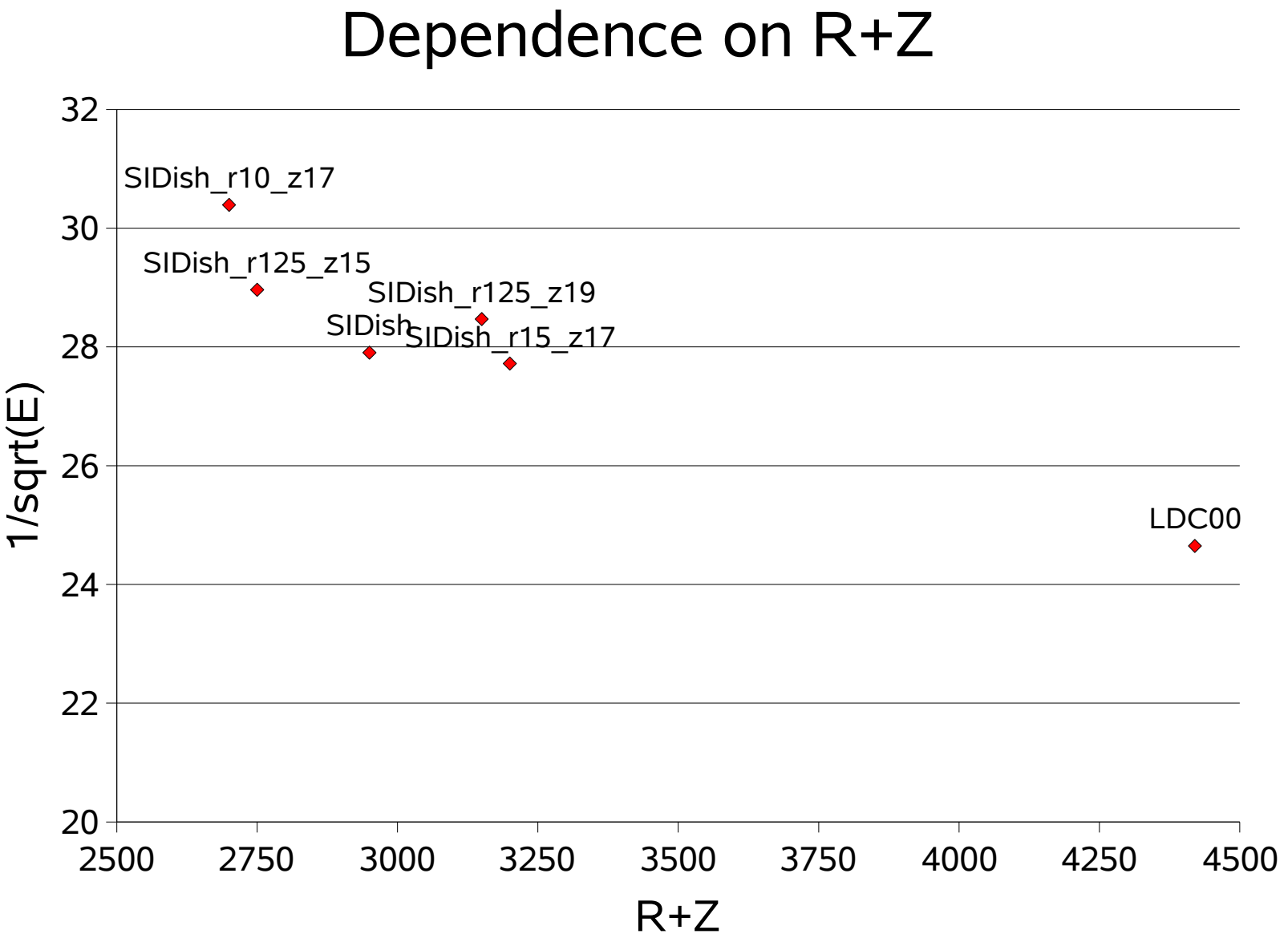
$\cos(\theta_{thrust})$ for R



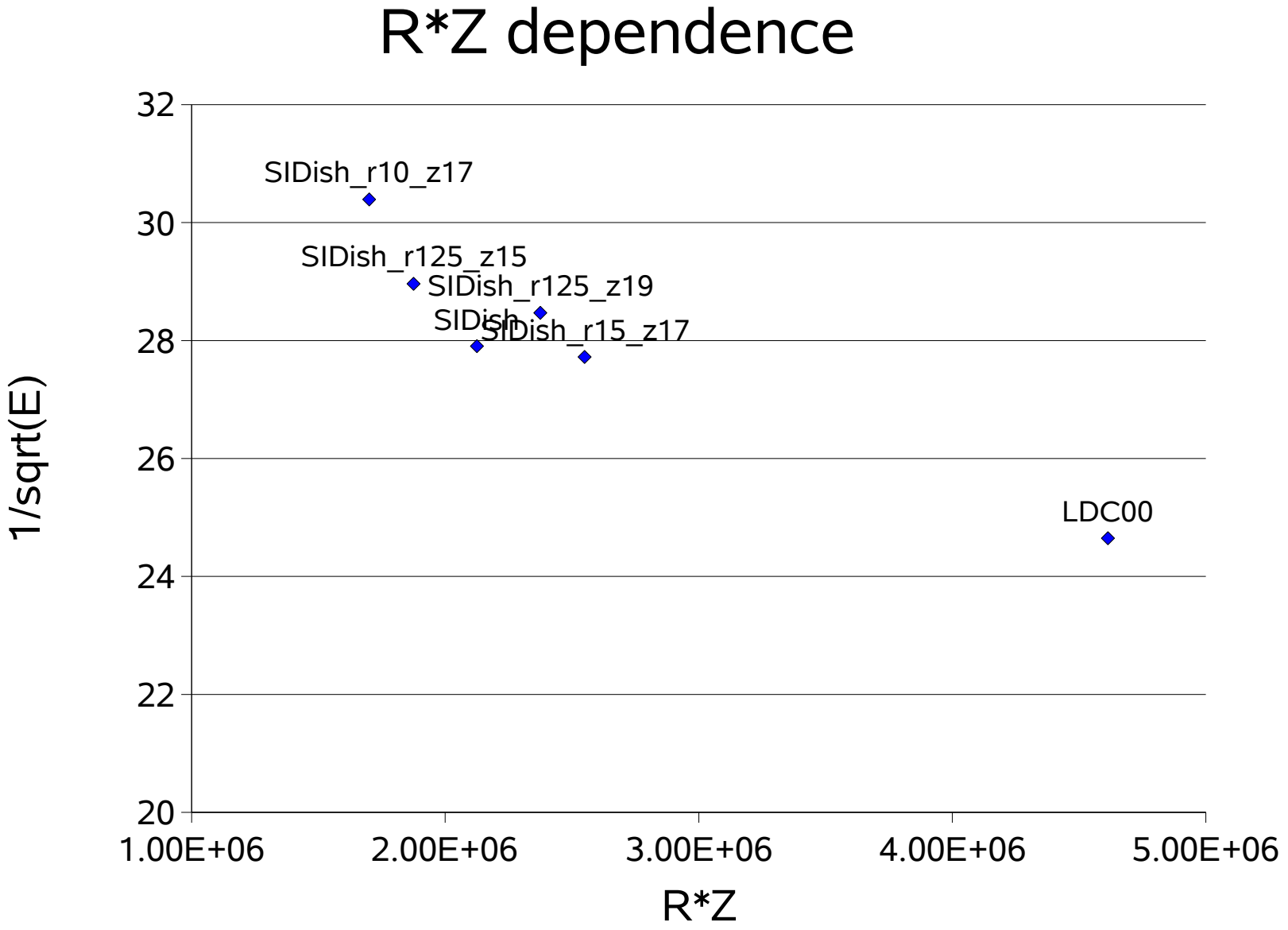
$\cos(\theta_{thrust})$ for Z



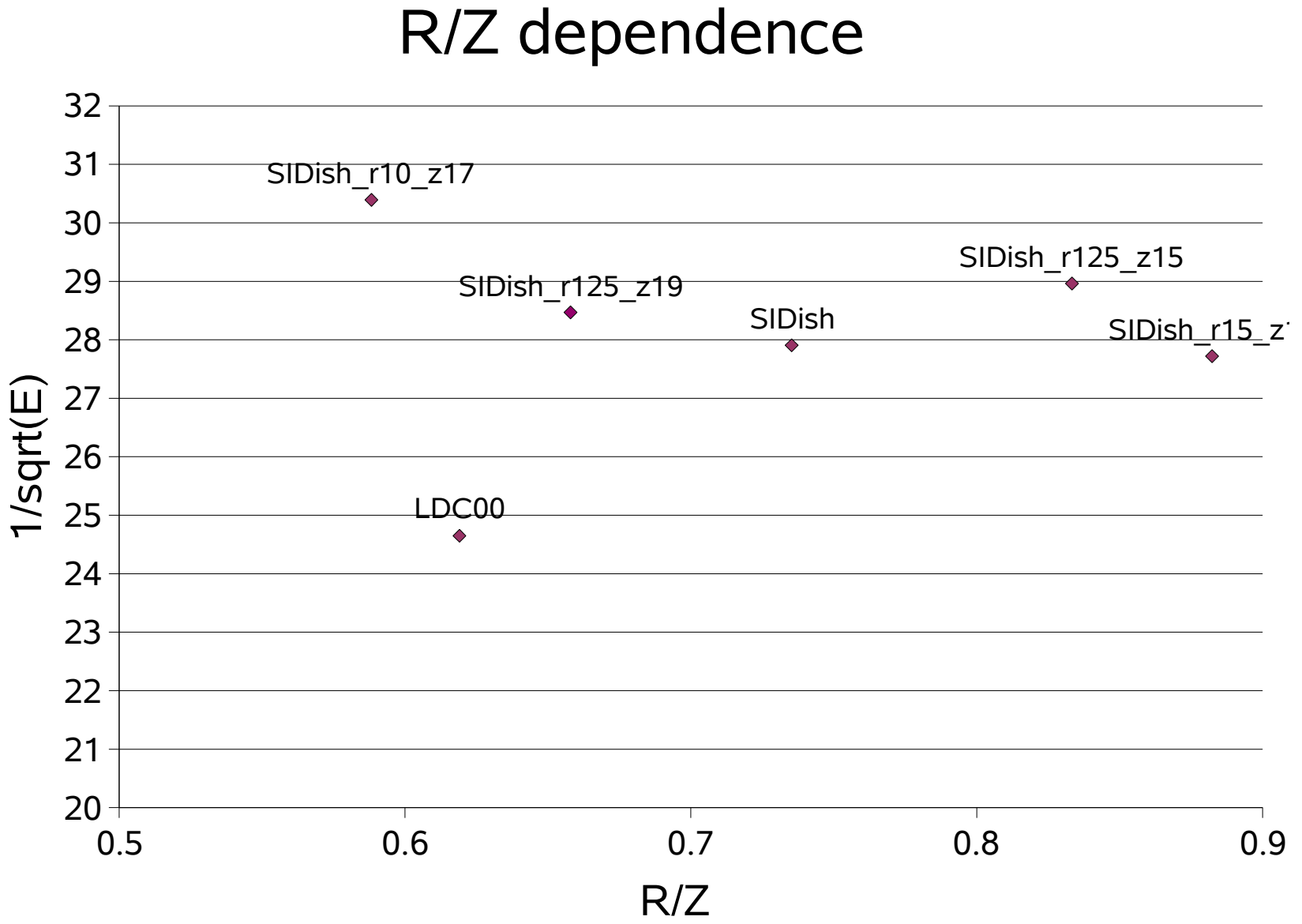
What is up with R and Z



Another parametrization



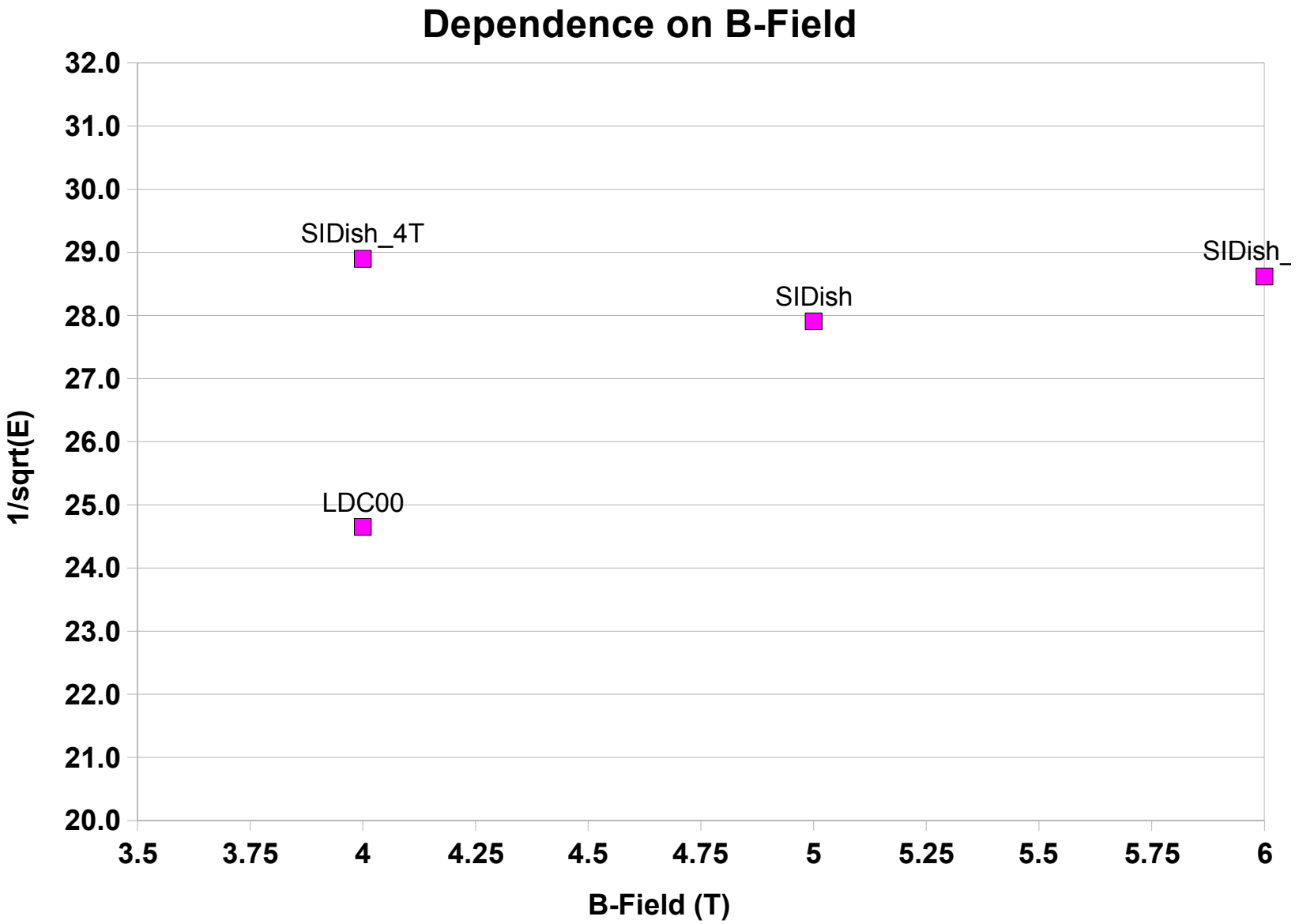
And a last one



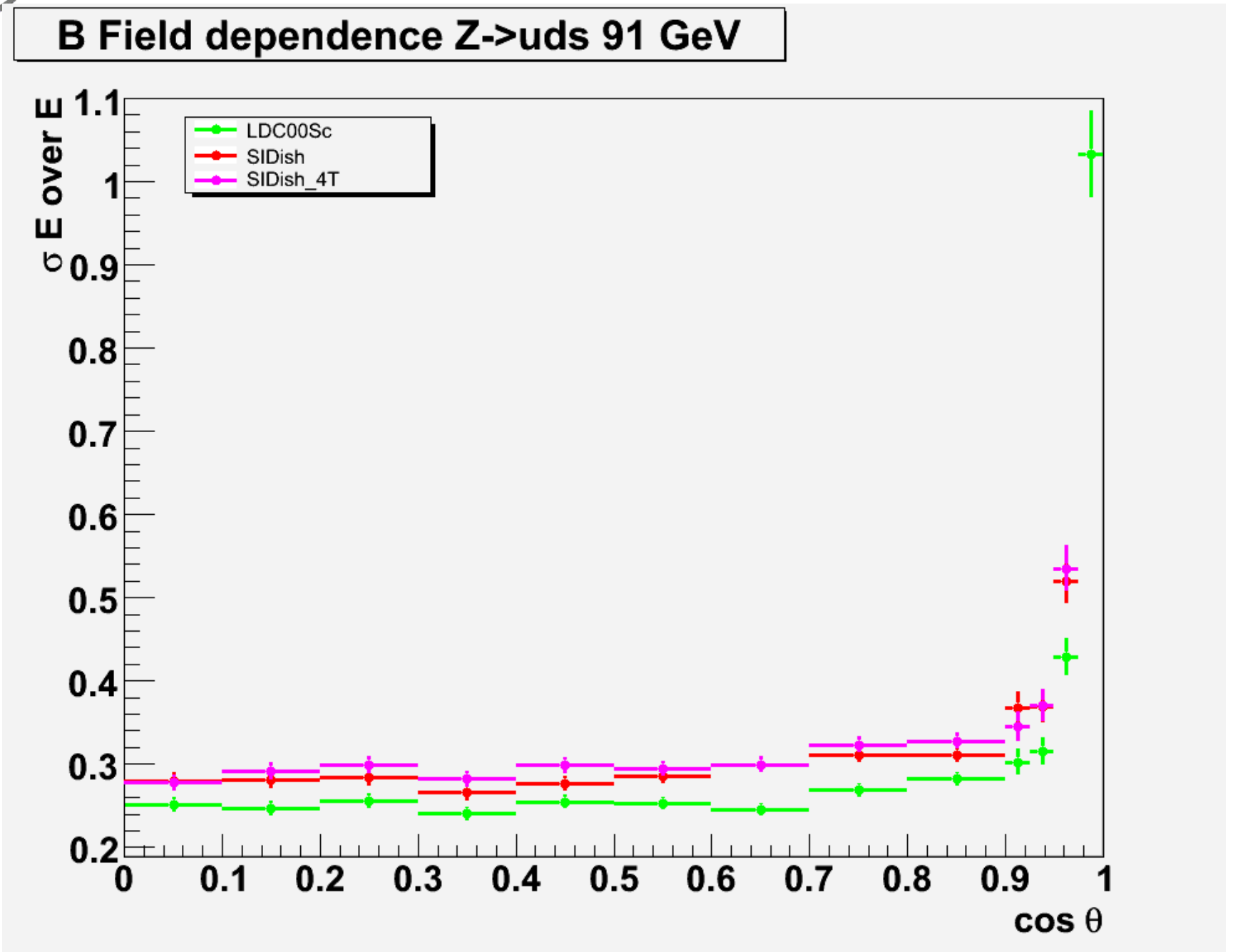
Some comments

- It is clear, that making R bigger does help
- Z is less obvious
- Are we asking the right question ?
- Probably we should scale Z and R at the same time
- We'll learn much more with higher energy jets

B field dependence (Barrel)



$\cos(\theta_{thrust})$ for B



Comments

- 5T seem to be a sweet spot ...
  - could be coincidence
  - We need more points 4.25, 4.5, 4.75, 5.25, 5.5 ...
  - Just a few 10 GB more ....
- Also higher energy jets will help us a lot to understand the dependence

Segmentation ?

- For the HCAL need to hack Mokka, it seems
- Can be done
- For the ECAL it seems to be a simple study
- Jobs are running
- Changing segmentation has an impact on Pandora
  - MIP finding, Clustering ...
- Digital vs. Analog ...
  - That is a completely different question...
  - Also requires algorithm changes/Optimization
  - Has been done for the MAPS once ...
  - Need to revive these patches to Pandora

Material choice

- In principle can change between Fe, W, Cu for HCAL
  - already hacked that
- For the ECAL we are happy with W ...

RPC/GEM/Scintillator HCAL

- This is hard ....
- No model for GEM's afaik
- RPC is existing ... at some level
- This will need real work
- Running Digital HCALs is possible

Questions for Discussion

- I will ignore costs ... Marty will cover that !
- These are some points of the phase space we need to consider
- Feel free to add more ...

Question B

- We find that we need a deeper Calorimeter or a larger tracker for PFA
- The maximum for 5 T coil is around 1.5 m tracker radius (Marty can correct me)
- We could lower the field by 0.5 T
- Can tell impact on PFA, but
  - What is the impact on Vertexing
  - Beam Backgrounds
  - What is the critical value here for SiD ?

Question T

- How does Tracking & Material budget influence PFA ?
- I can't answer that !
- We need full tracking
- Doesn't look feasible with MARLIN
  - There is full tracking code release
  - Centered around a TPC
- A study that needs to be done

Using SLIC ...

- For changing detector geometries/materials etc. SLIC is much better
- Using SLIC in Pandora ?
- We would need
  - Layer decoding (easy)
  - TrackerHit, CalorimeterHits (Running SiD Reco)
  - LCIORelations to the corresponding SimHits (???)
  - A GEAR XML description (tricky getting it right)
  - Time and ManPower
- Do we want to go down that path ?

Summary

- Machinery in place
- We have about 150 GB of simulation right now
- Thanks to
  - Steve Worm submitting jobs
  - Ray Cowan for setting things up at SLAC and taking on the 250 GeV samples
- We are still CPU limited ...
- Book-keeping is becoming challenging ...
- Stay tuned

The Setup

- CLHEP 2.0.2.2
- LCIO v01-09
- ROOT v5.16.00
- GEAR v00-08
- GEANT 4.9.0.p01
- Mokka 06-04-p03
- Marlin v00-09-10
- MarlinUtil v00-05
- MarlinReco v00-05
- PandoraPFA v02-00