Optimizing the SiD Detector

- mainly a calorimeter perspective

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SiD Advisory

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Where we are:

- Have been using a set of global parameters for some time:

r(tracker-outer) = 1.25m

ECal Si/W --- and 1λ thick.

HCal (40 layers, 20mm absorber, 3 gas, 1 scintillator options) ~4λ thick (actually 4.4λ with *all* material accounted for).

Prejudice that tail-catcher after 1λ coil will not help much (still to be checked for higher energy jets?)

- We have a SiD PFA that has gradually been improving performance -> dM/M ~4.37 GeV (RMS90)

- Goal (Mat at SiD RAL) is dM/M ~4.0%

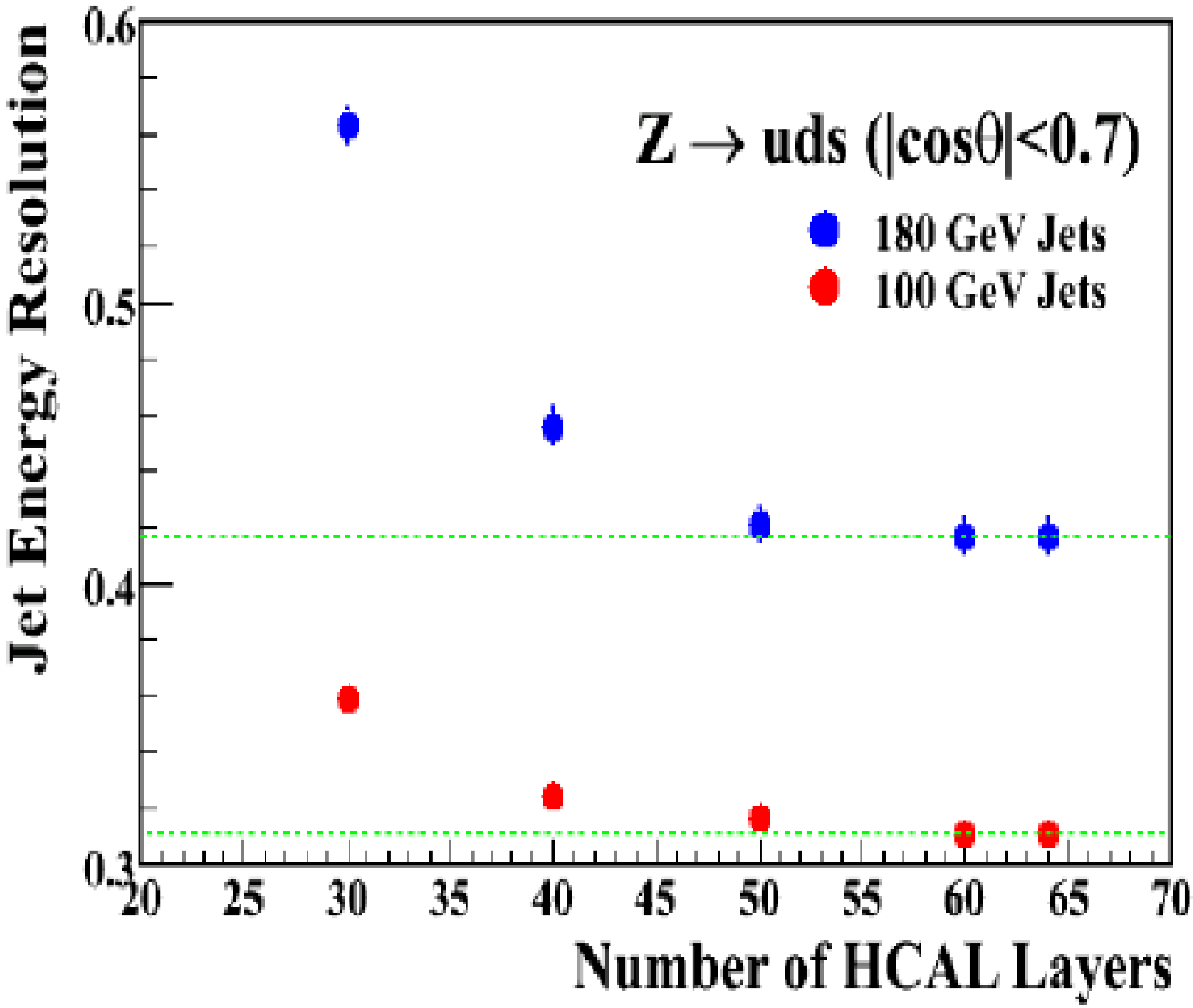
- Studies are underway to compare derivatives of PFA performance vs. basic parameters (r, B, nλ, …) for SiD PFA and PANDORA PFA. *If* the behavior of derivatives agrees, can we set aside offset in absolute PFA performances and use derivatives to optimize SiD? : this is our working assumption.

- We have results from PANDORA/PFA run for "SiDish" configurations.

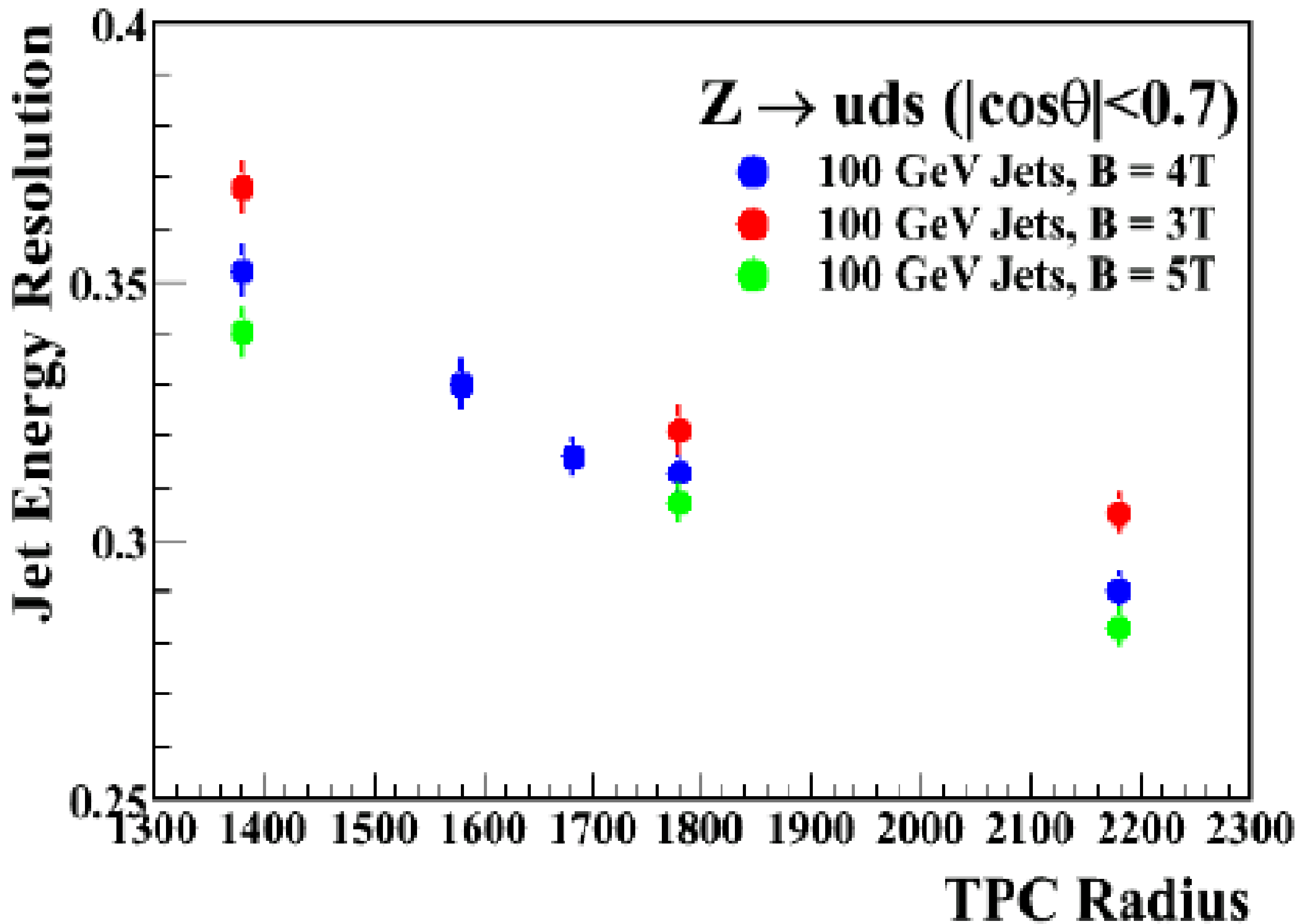
-This week we should have the first SiD PFA derivative results.

-Importance of using real tracking for SiD PFA (Mark Thomson at SiD RAL) – two high Pt tracks close together with one not found can be a big issue for PFA.

Mark Thomson – LDC00SC



Mark Thomson - R more important than B

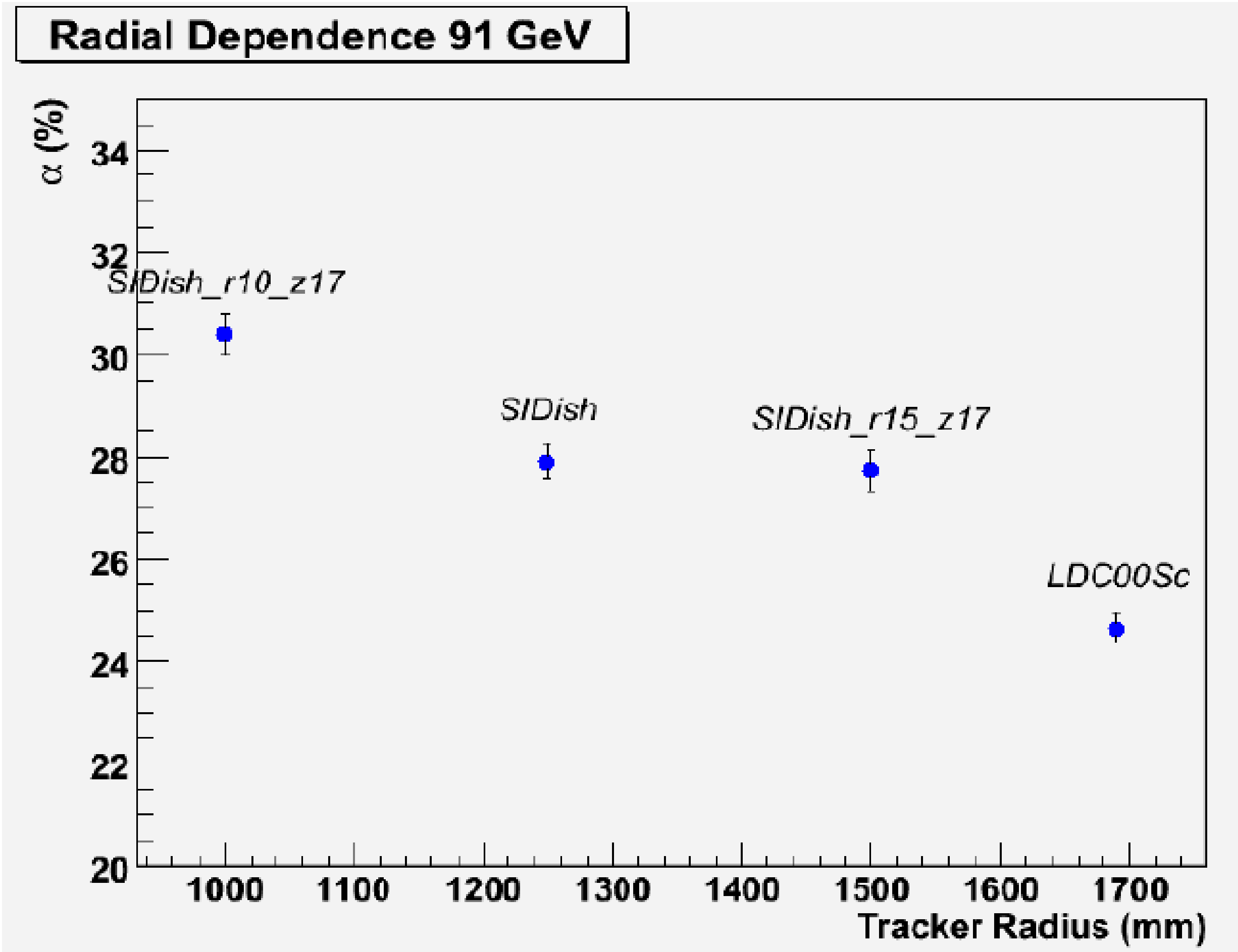


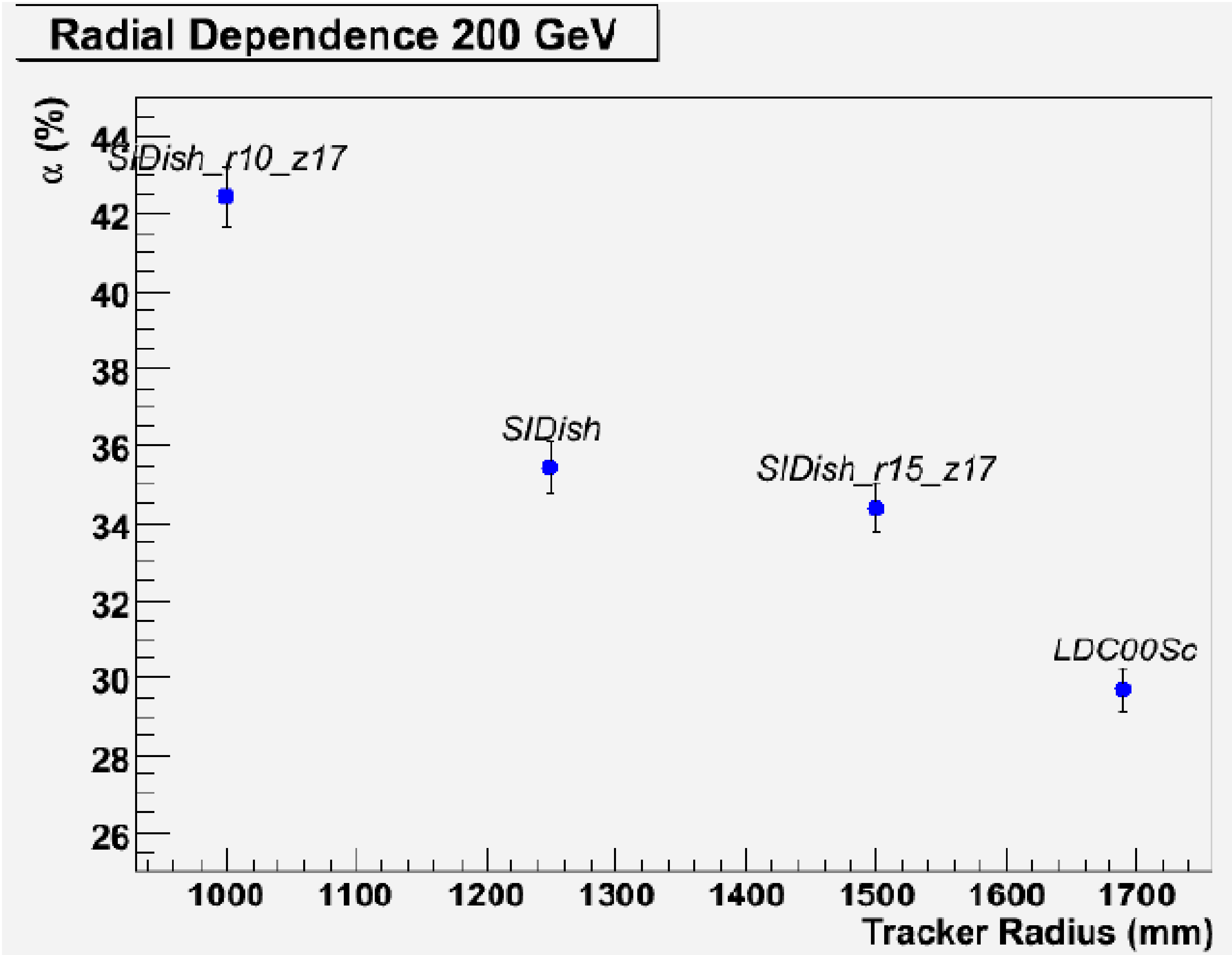
Marcel Stanitski – using PANDORA/PFA for SiD

Detector TAG	B-field (T)	ECAL layers	ECAL cell size	HCAL layers	HCAL cell size	Tracker radius (mm)	Tracker length (mm)
LDC00Sc	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_ecal40	5	40	1x1	40	3x3	1250	1700
SIDish_ecal_05x05	5	30	0.5x0.5	40	3x3	1250	1700
SIDish_45T	4.5	30	1x1	40	3x3	1250	1700
SIDish_55T	5.5	30	1x1	40	3x3	1250	1700

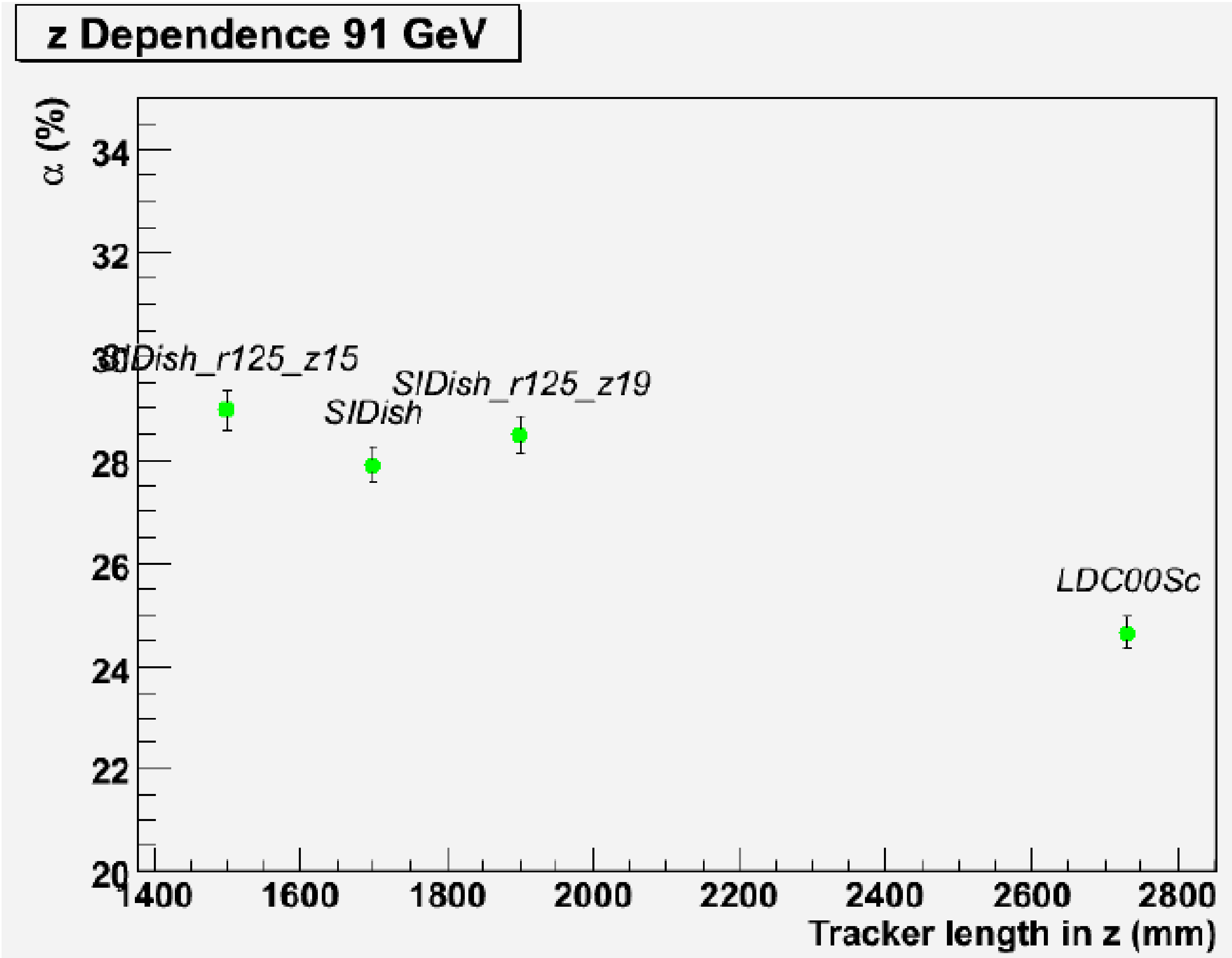
Marcel Stanitski – using PANDORA/PFA for SiD

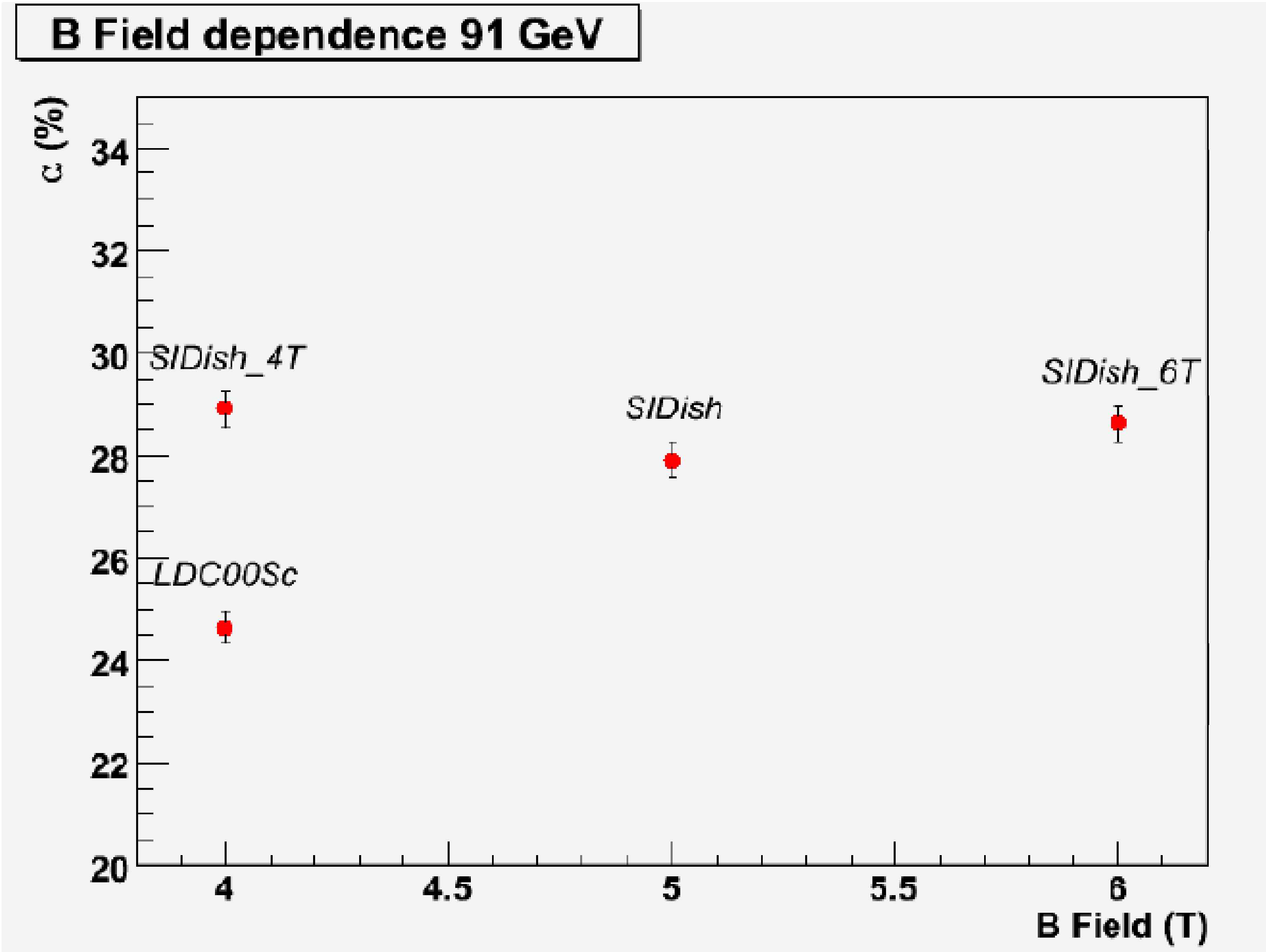
Detector TAG	rms90 (91 GeV)			rms90 (200 GeV)		
LDC00Sc	24.6	±	0.3	29.7	±	0.5
SIDish	27.9	±	0.4	35.4	±	0.7
SIDish_r10_z17	30.4	±	0.4	42.5	±	0.8
SIDish_r15_z17	27.7	±	0.4	34.4	±	0.6
SIDish_r125_z15	29.0	±	0.4	34.4	±	0.6
SIDish_r125_z19	28.5	±	0.4	36.4	±	0.7
SIDish_4T	28.9	±	0.4	39.4	±	0.7
SIDish_6T	28.6	±	0.4	34.2	±	0.6
SIDish_ecal40	27.1	±	0.3	33.9	±	0.6
SIDish_ecal_05x05	28.1	±	0.4	35.7	±	0.7


Radial Dependence 91 GeV
α (%)
34
32
30
28
26
24
22
20
SIDish_r10_z17
SIDish
SIDish_r15_z17
LDC00Sc
1000
1100
1200
1300
1400
1500
1600
1700
Tracker Radius (mm)

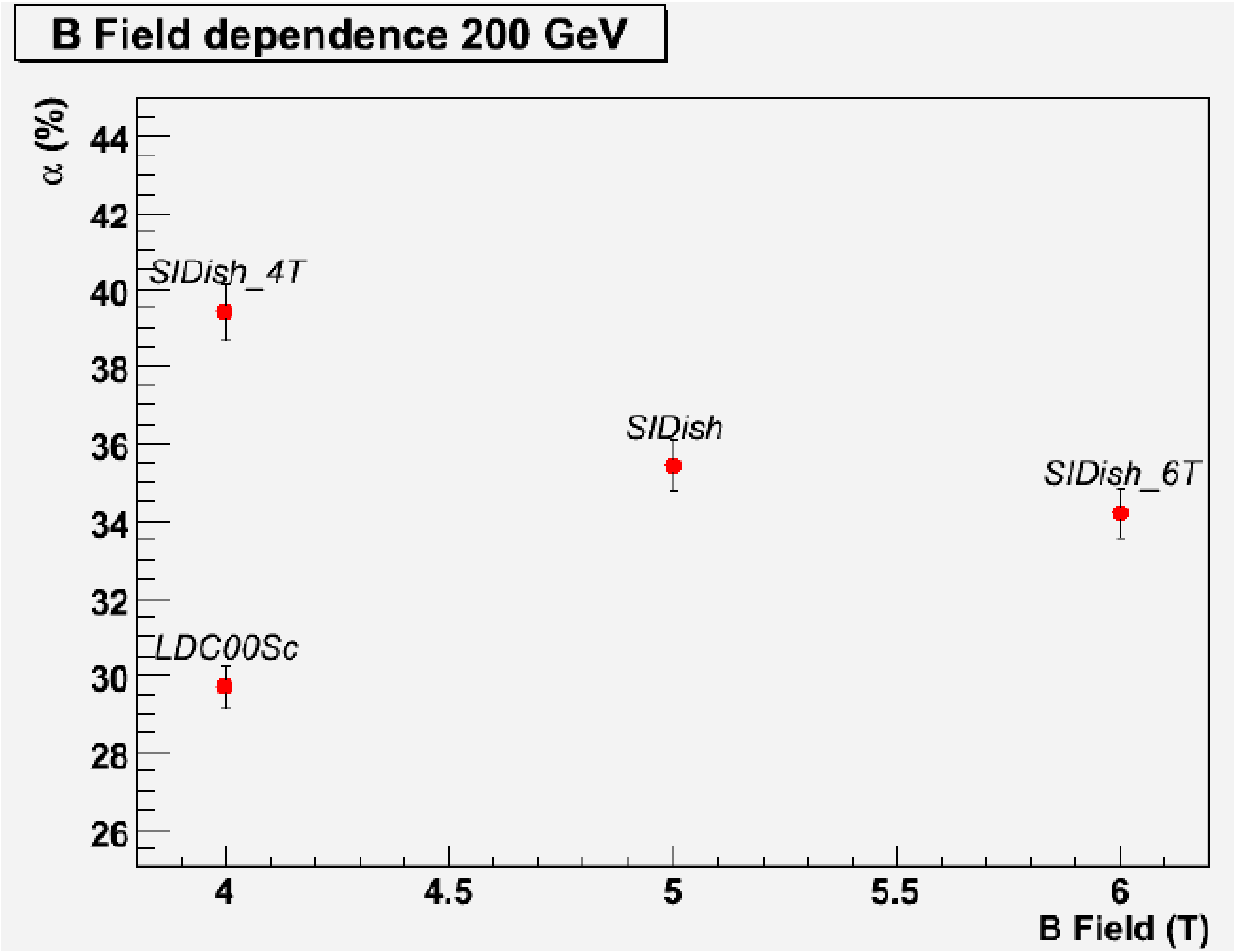


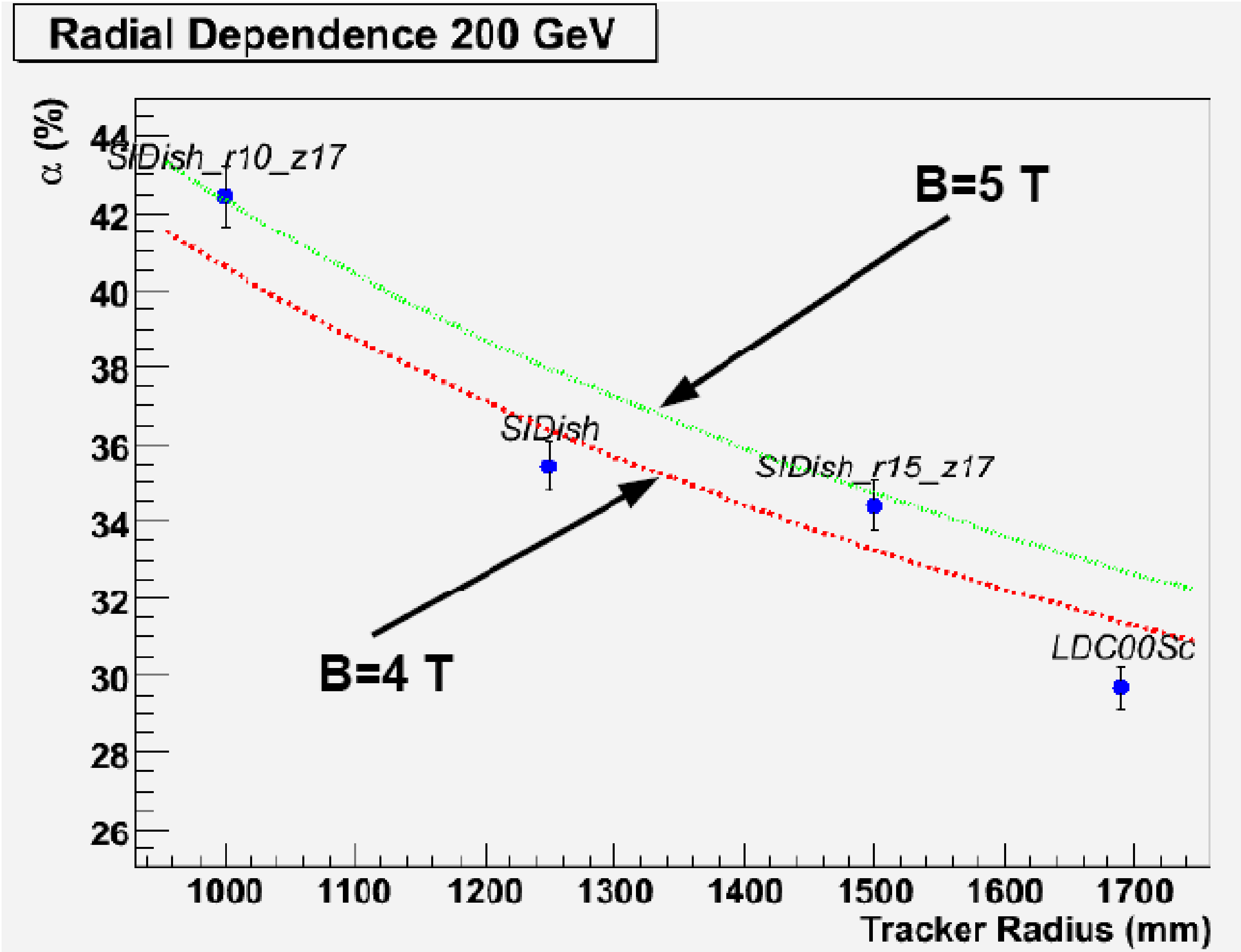
Radial Dependence 200 GeV
α (%)
44
42
40
38
36
34
32
30
28
26
SIDish_r10_z17
SIDish
SIDish_r15_z17
LDC00Sc
1000
1100
1200
1300
1400
1500
1600
1700
Tracker Radius (mm)


z Dependence 91 GeV
α (%)
34
32
30
28
26
24
22
20
SIDish_r125_z15
SIDish
SIDish_r125_z19
LDC00Sc
1400
1600
1800
2000
2200
2400
2600
2800
Tracker length in z (mm)

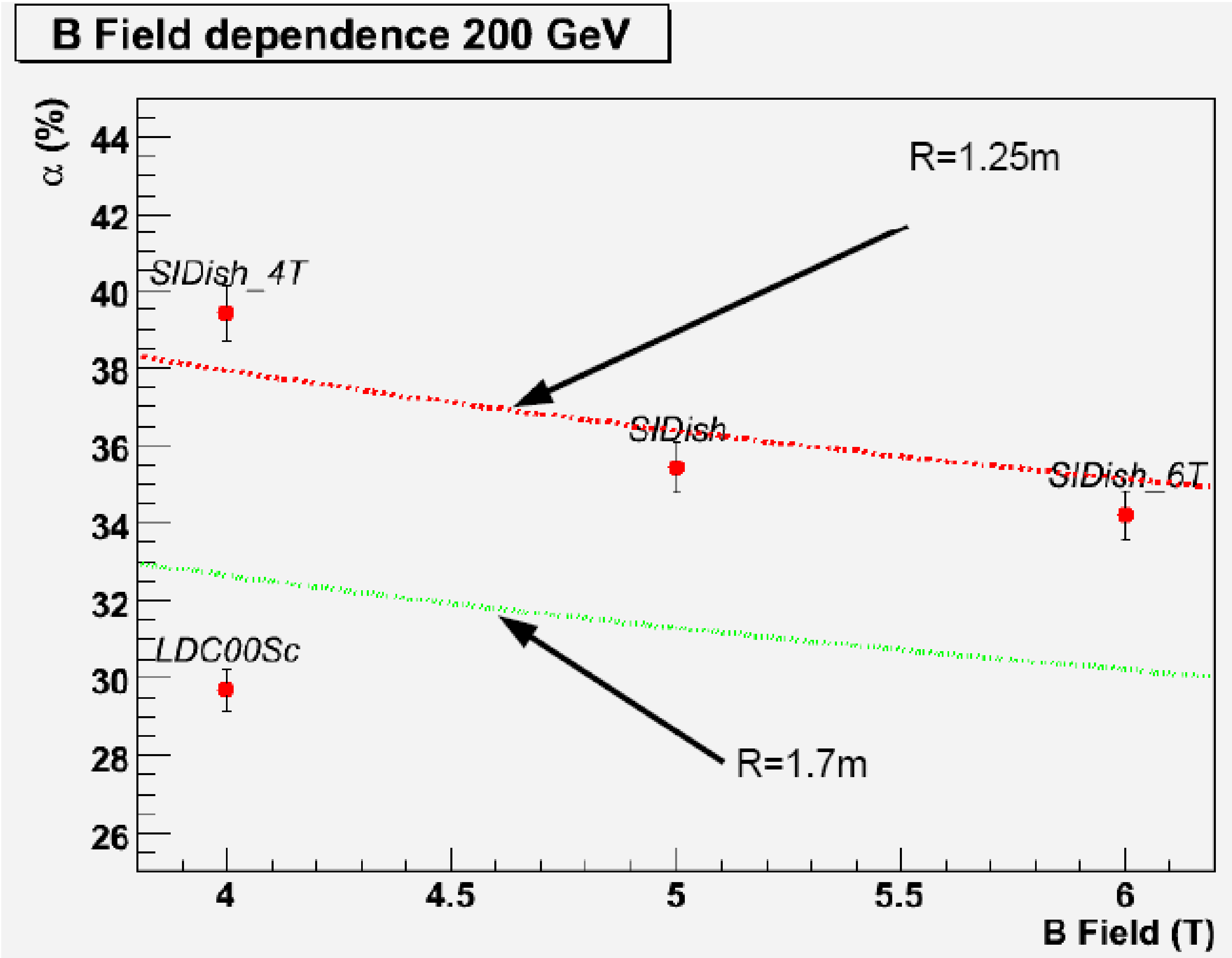


B Field dependence 91 GeV
c (%)
34
32
30
28
26
24
22
20
4
4.5
5
5.5
6
B Field (T)
SIDish_4T
LDC00Sc
SIDish
SIDish_6T


B Field dependence 200 GeV
α (%)
44
42
40
38
36
34
32
30
28
26
SIDish_4T
SIDish
SIDish_6T
LDC00Sc
4
4.5
5
5.5
6
B Field (T)



Radial Dependence 200 GeV
α (%)
SIDish_r10_z17
SIDish
SIDish_r15_z17
LDC00Sc
B=5 T
B=4 T
44
42
40
38
36
34
32
30
28
26
1000
1100
1200
1300
1400
1500
1600
1700
Tracker Radius (mm)


B Field dependence 200 GeV
α (%)
44
42
40
38
36
34
32
30
28
26
4
4.5
5
5.5
6
B Field (T)
R=1.25m
R=1.7m
SIDish_4T
SIDish
SIDish_6T
LDC00Sc

Marcel: SiD @ RAL

- It is clear, that making R bigger does help
- Z is less obvious
- Probably we should scale Z and R at the same time
- B field only has an impact at higher energies
- What should we focus on for discussion:
  - Make the calorimeter deeper
  - move out the ECAL (1.25 to 1.5 meters ...)
  - Is 4 or 4.5 T sufficient ?

- We have period until ECFA/Warsaw to fix global parameters for first presentation of SiD detector concept to IDAG.

- We have until ~ end of Summer to finally fix all parameters so that the physics studies for LOI can begin with final simulated datasets.

- However, it will not be possible to have a set of parameters fully optimized over a range of physics processes on these short time scales – the best we can do is PFA(s) to optimize on the basis of jet energy resolution, dijet mass resolution, etc.

- If we care about the estimated cost of SiD for the LOI, there is a potential conflict between parameter optimization and cost containment. How should we use the cost estimates/derivatives? Ignore cost; compromise between cost and performance on the basis of a perceived maximum desirable cost?

- We need to limit the space of all possible studies.

- Fix each major parameter as soon as possible – e.g. we need to confirm the extension of the HCal depth to 5λ and move on with this *fixed*.

- How much optimization can we achieve e.g. for segmentation of the HCal if we decide that we need 5λ and we cannot allow a change in segmentation to inflate the HCal outer radius further?

- Some parameters may be optimized from other directions e.g. it appears that the z-dependence of the PFA performance does not have a large impact for fixed radius – but forward systems design surely will have an impact here…?

SiD Optimization – bottom line

- Get first round of derivative results from SiD and PANDORA (SiDish) PFA's as soon as possible.

- Fix each major parameter as soon as we have a reasonable reason to do so and move on.

- Pick one or two critical physics processes to check that a choice of global parameter has not serious bad effect.