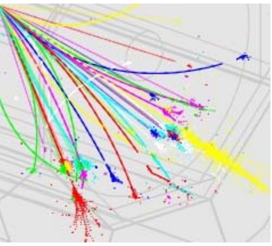
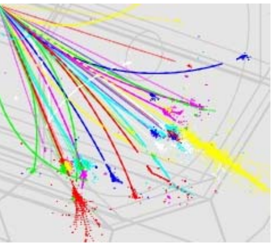


More results …

SiD PFA Meeting

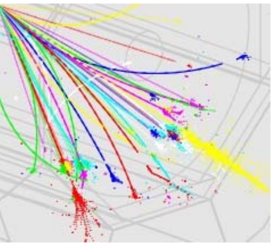
04.06.2008

M. Stanitzki



Segmentation studies

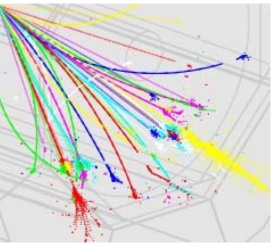
- First approach
  - keep the total HCAL thickness constant
  - vary steel thickness and number of scintillator layers
  - Detector tags SIDish_v2_hcal**XX** (XX= number of layers)
- Second approach
  - keep λ_{IronI} constant at n λ
  - vary steel thickness and number of scintillator layers
  - Detector tags SIDish_v2_hcal**XX_lYY**
    - XX= number of layers)
    - YY= number of lambda



The variants

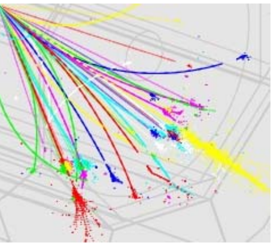
TAG	Layers	total thickness	Iron thickness	Scintillator thickness	HCAL thickness	λ
SIDish_v2_hcal30	30	32.7	26.2	6.5	980	4.92
SIDish_v2_hcal40	40	24.5	18.0	6.5	980	4.61
SIDish_v2_hcal50	50	19.6	13.1	6.5	980	4.45
SIDish_v2_hcal30_l45	30	31.7	25.2	6.5	951	4.75
SIDish_v2_hcal40_l45	40	25.4	18.9	6.5	1016	4.83
SIDish_v2_hcal50_l45	50	21.6	15.1	6.5	1081	4.91
SIDish_v2_hcal30_l50	30	34.5	28.0	6.5	1035	5.25
SIDish_v2_hcal40_l50	40	27.5	21.0	6.5	1100	5.33
SIDish_v2_hcal50_l50	50	23.3	16.8	6.5	1165	5.41

- Some Comments
  - different Mokka compared to all other studies
  - SIDish_v2_hcal40 is the “standard” SiDish !
  - λ done with λ_{Iron}=168 mm and λ_{Scint}=795 mm
  - note: there is some more material between HCAL and ECAL



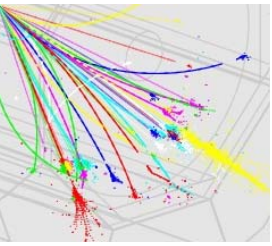
The results

Detector Tag	Layers	uds (91 Gev)		uds (200 GeV)	
		α %	Error	α %	Error
SIDish_v2_hcal30	30	30.5	0.4	40.5	0.7
SIDish_v2_hcal40	40	28.5	0.5	38.2	0.7
SIDish_v2_hcal50	50	28.6	0.4	38.8	0.8
SIDish_v2_hcal30_l45	30	29.6	0.4	39.9	0.7
SIDish_v2_hcal40_l45	40	29.3	0.4	38.7	0.7
SIDish_v2_hcal50_l45	50	28.2	0.7	36.7	0.7
SIDish_v2_hcal30_l50	30			40.6	0.8
SIDish_v2_hcal40_l50	40			38.1	0.7
SIDish_v2_hcal50_l50	50				

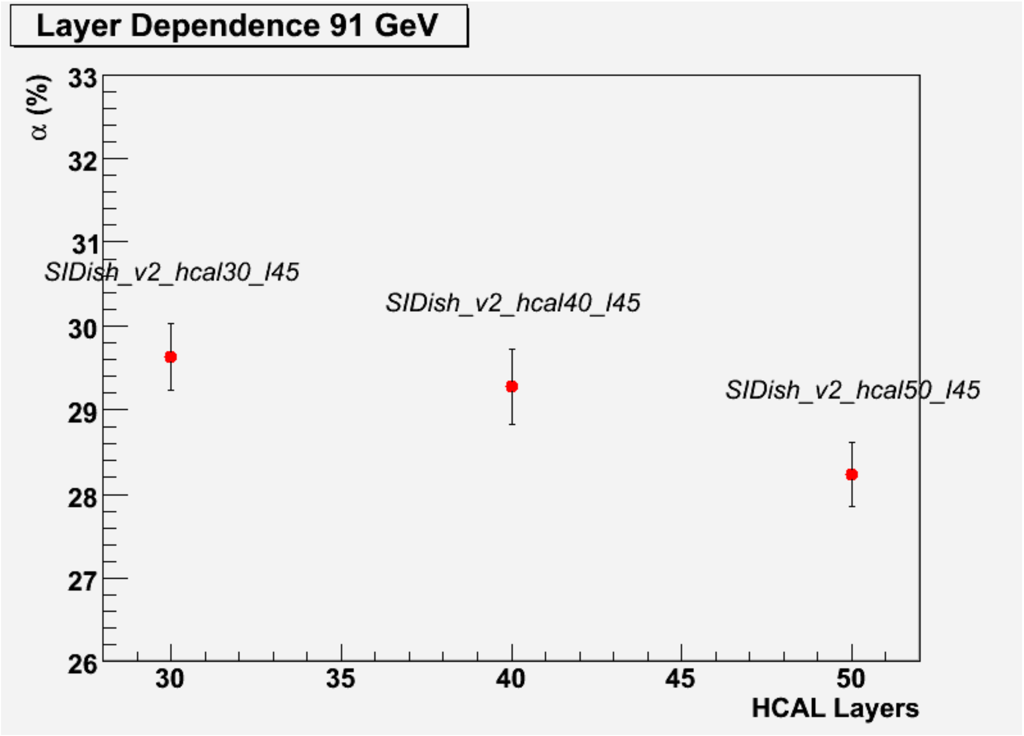


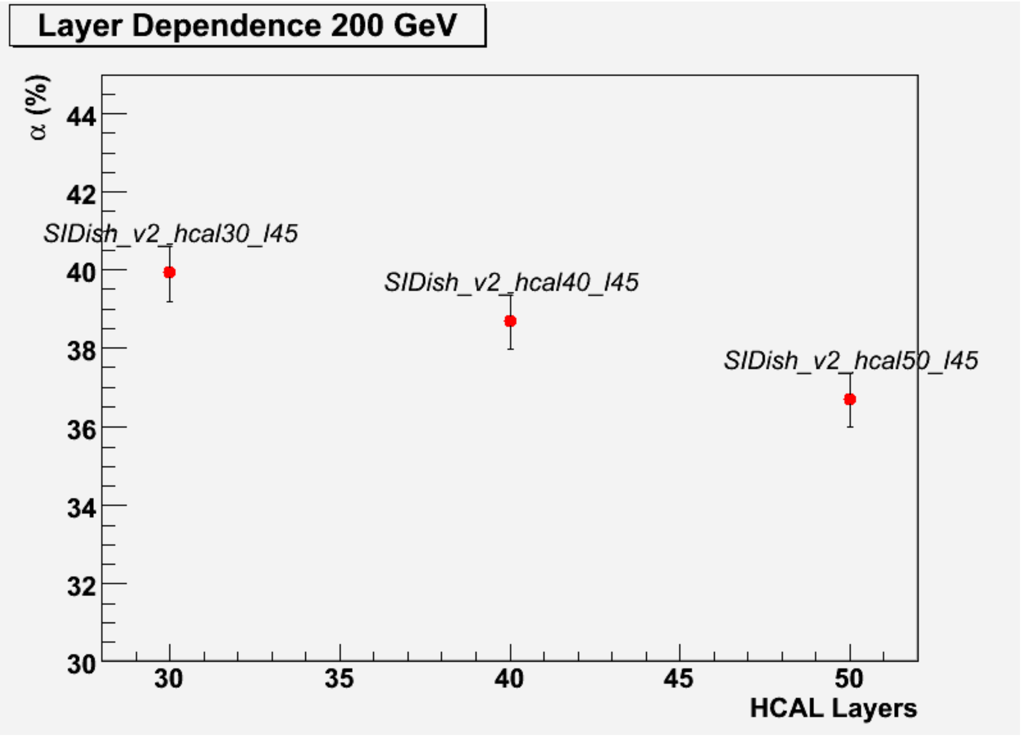
Fixed 4.5 λ_{Iron}

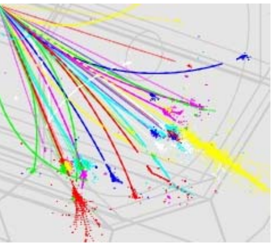
SIDish_v2_hcalXX_l45



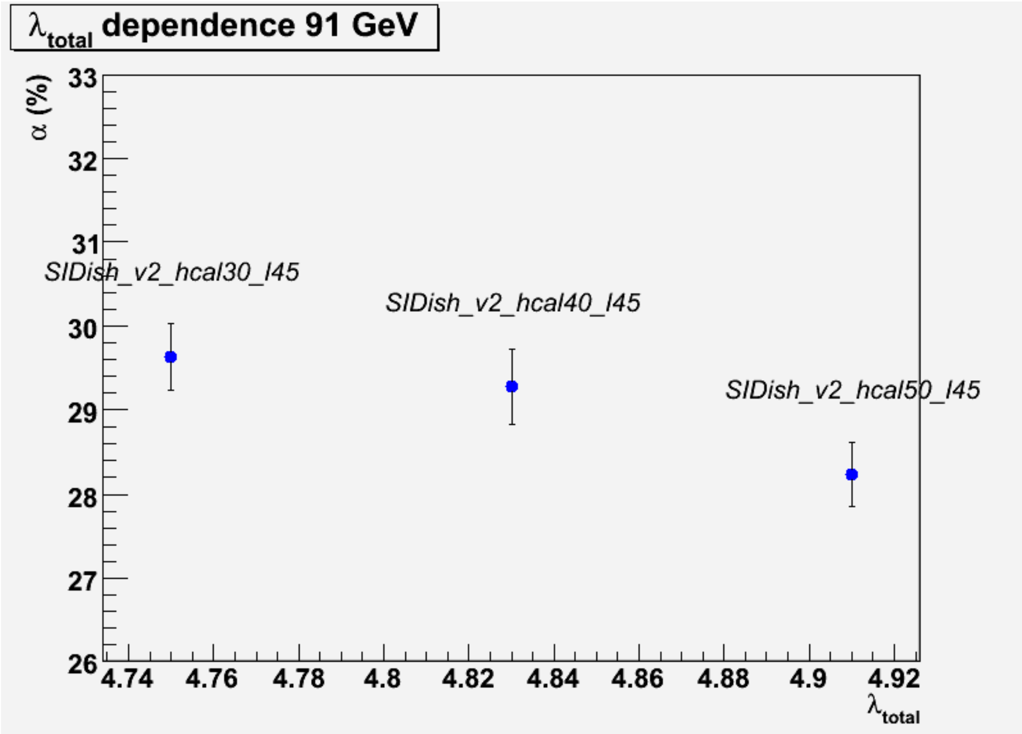
Number of layers

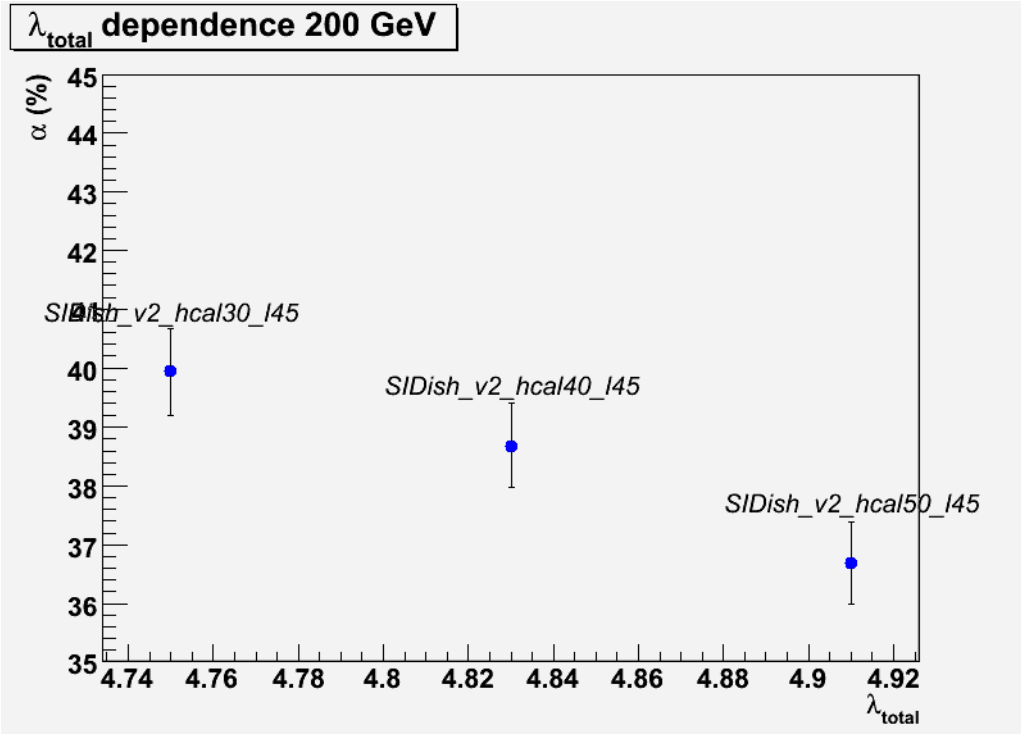


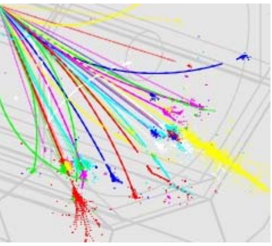




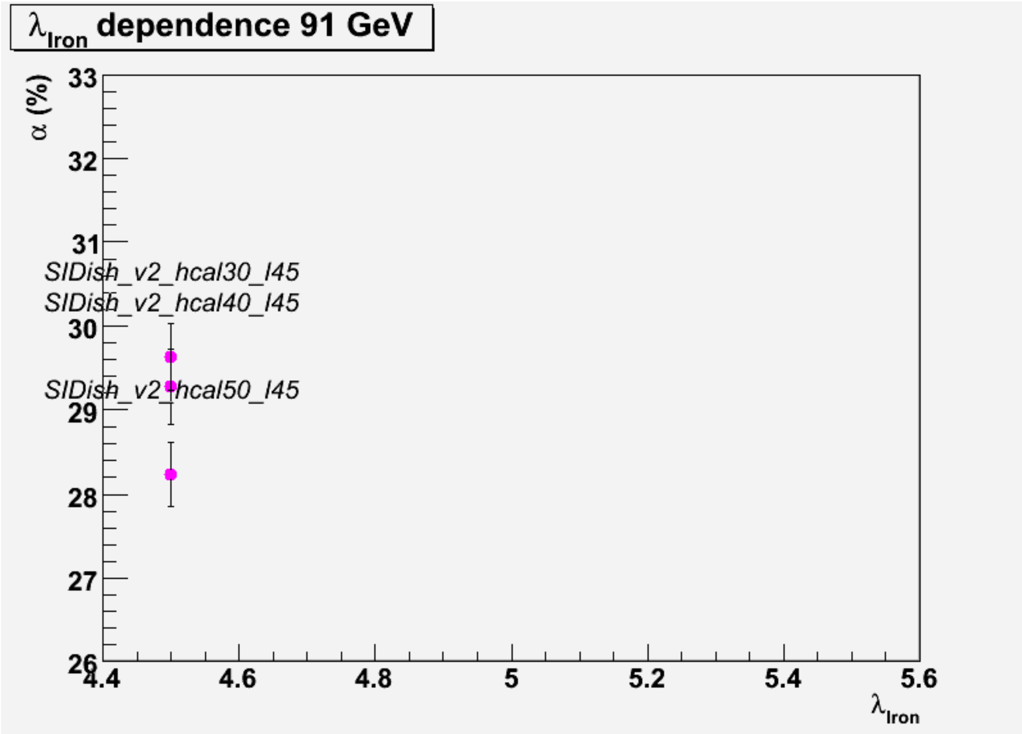
λ_{Total}



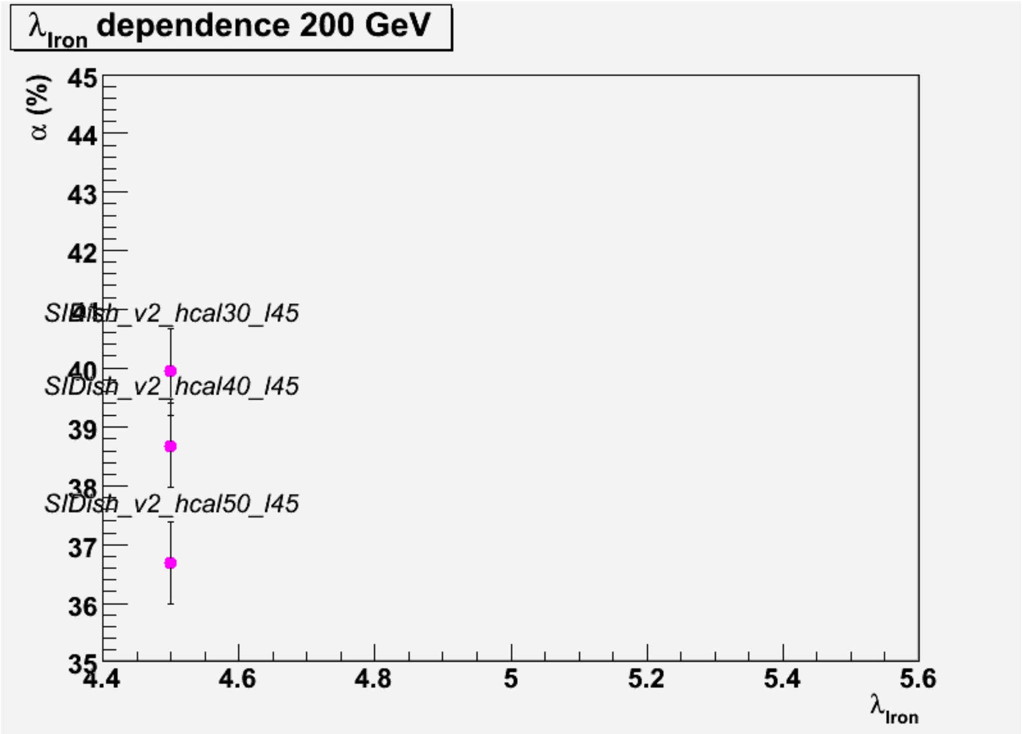




λ_{Iron}

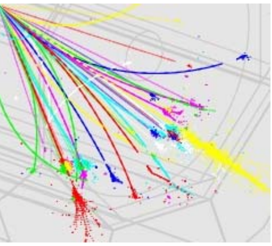


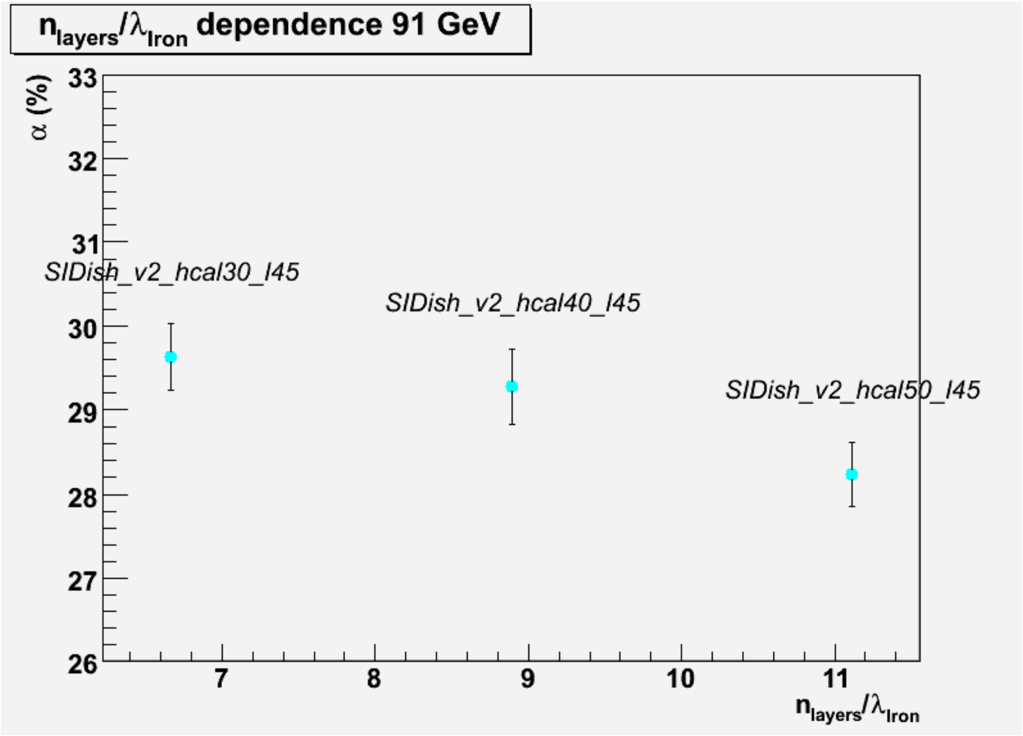
λIron dependence 91 GeV
α (%)
33
32
31
30
29
28
27
26
SIDish_v2_hcal30_l45
SIDish_v2_hcal40_l45
SIDish_v2_hcal50_l45
4.4
4.6
4.8
5
5.2
5.4
5.6
λIron

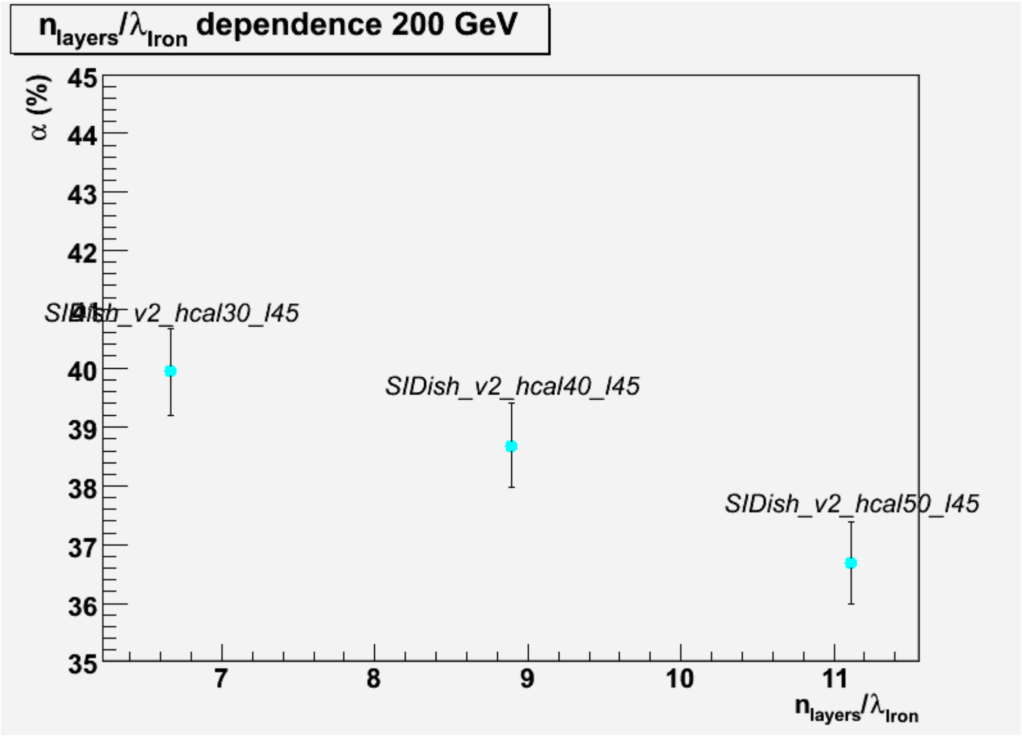


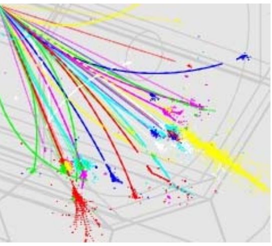
λIron dependence 200 GeV
α (%)
45
44
43
42
41
40
39
38
37
36
35
SIDish_v2_hcal30_l45
SIDish_v2_hcal40_l45
SIDish_v2_hcal50_l45
4.4
4.6
4.8
5
5.2
5.4
5.6
λIron

$n_{Layers}/\lambda_{Iron}$



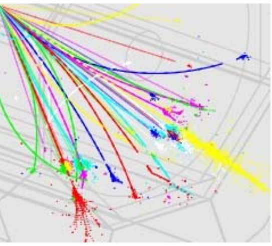




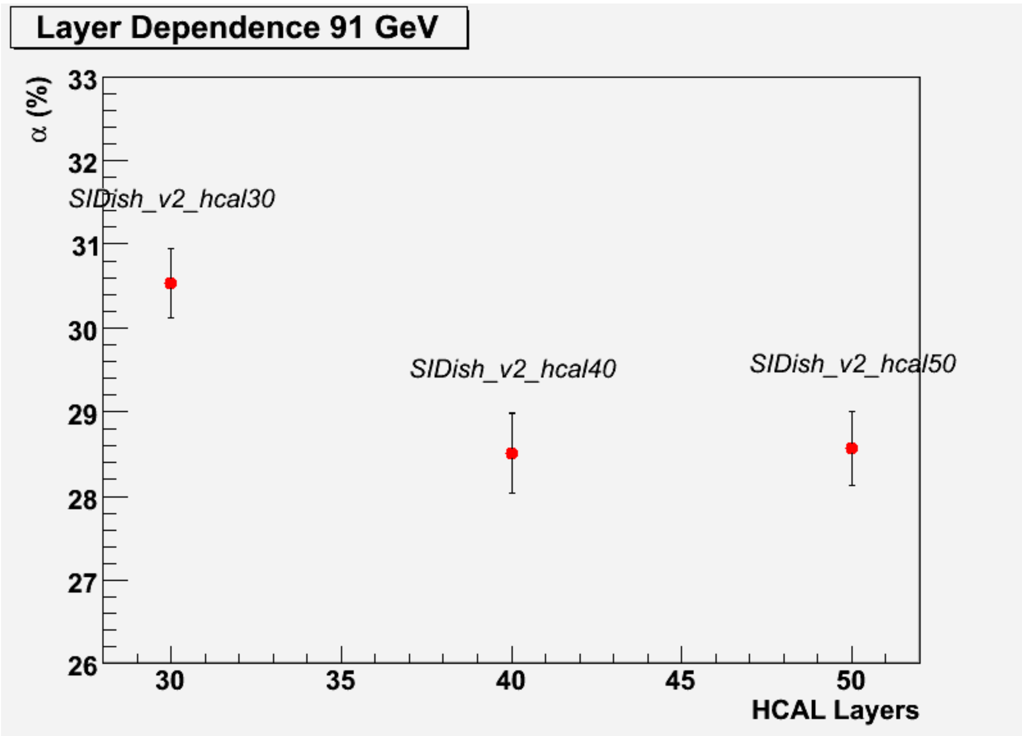


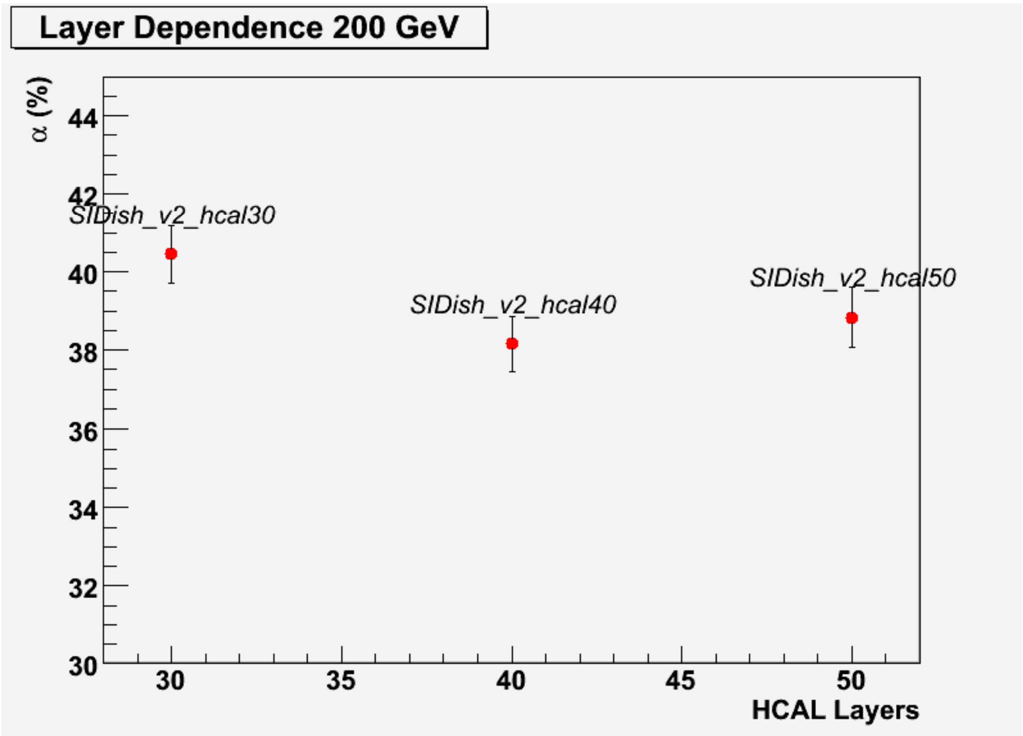
Fixed total thickness

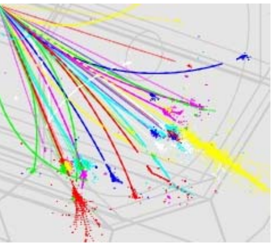
SIDish_v2_hcalXX



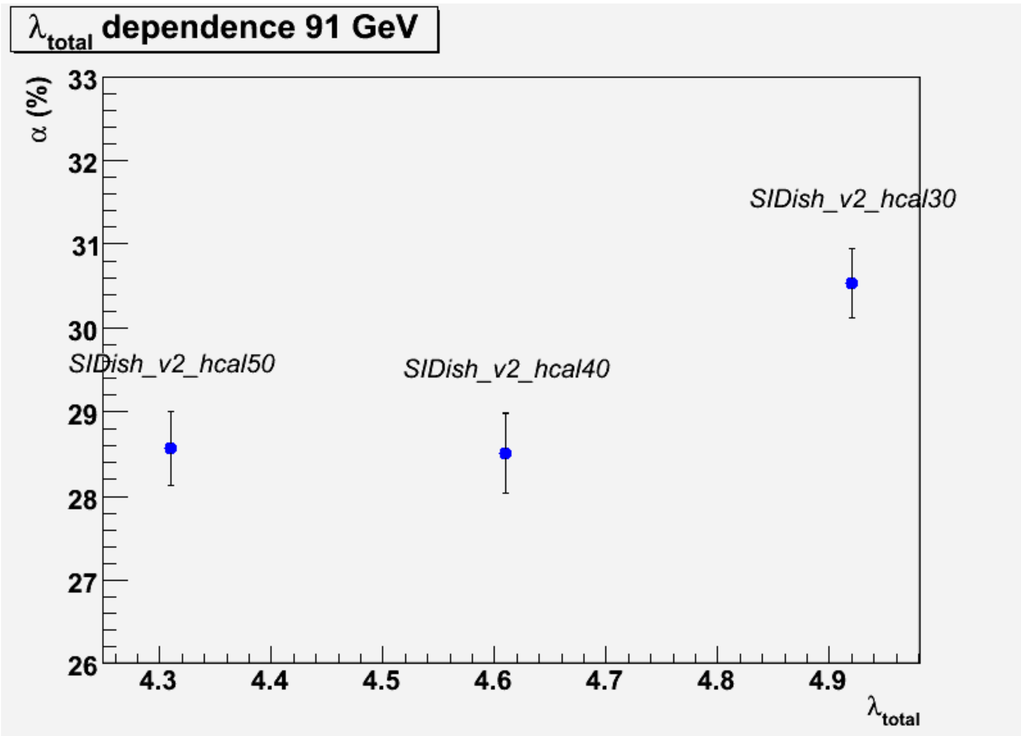
Number of layers

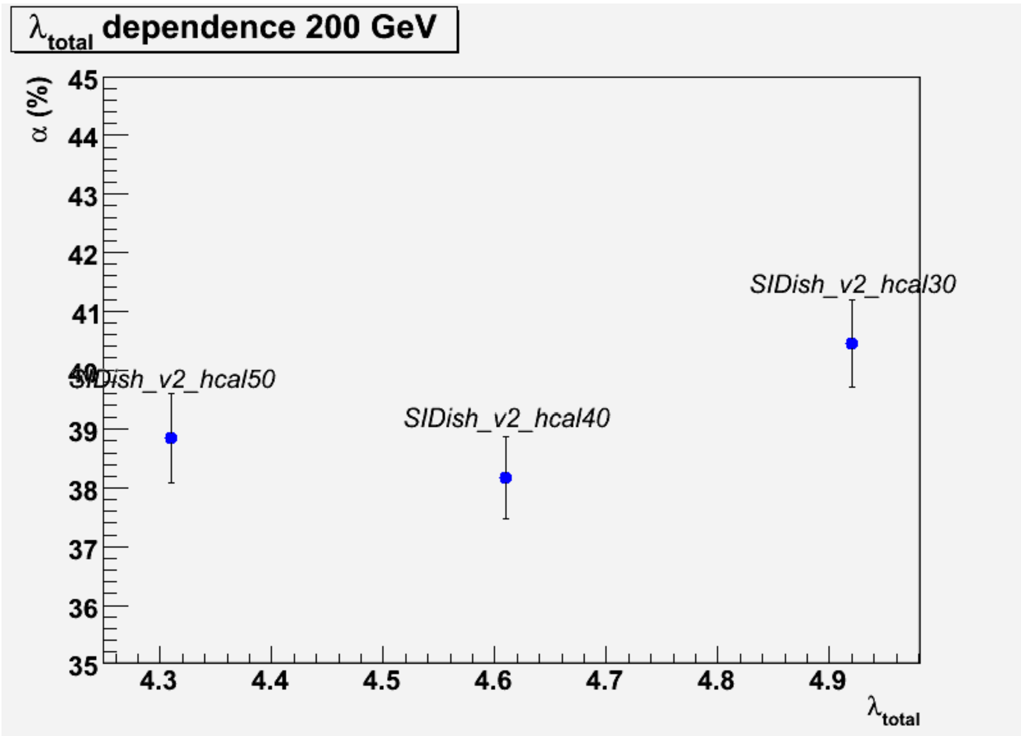


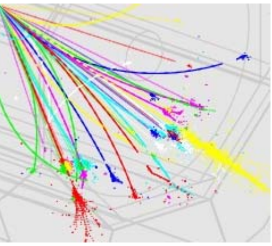




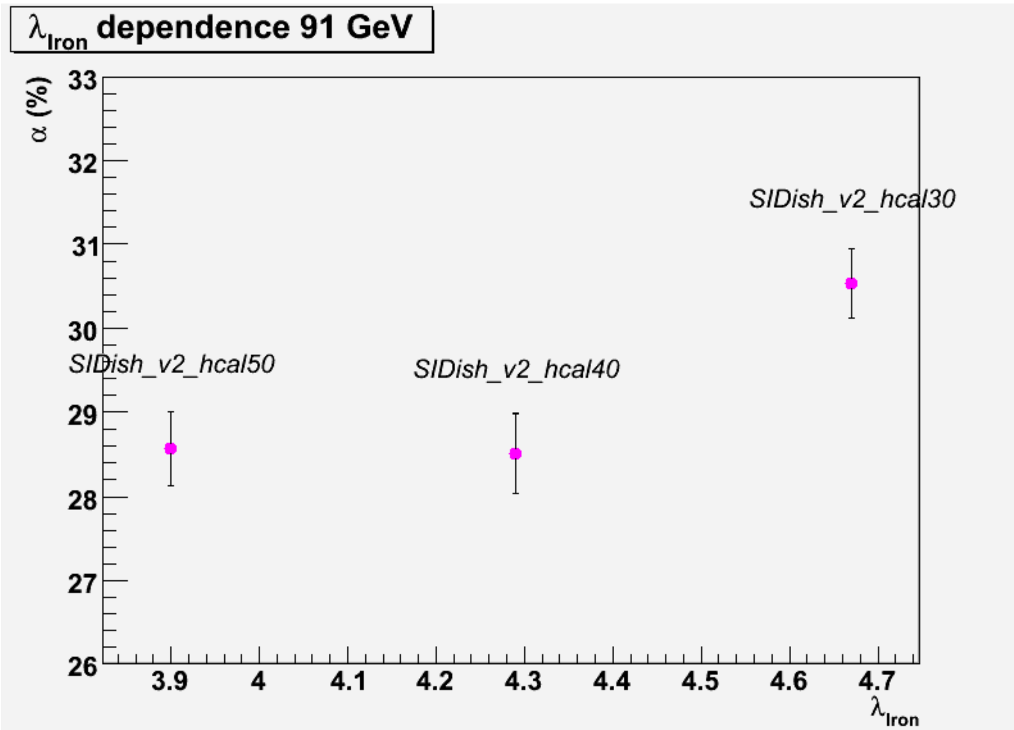
λ_{Total}



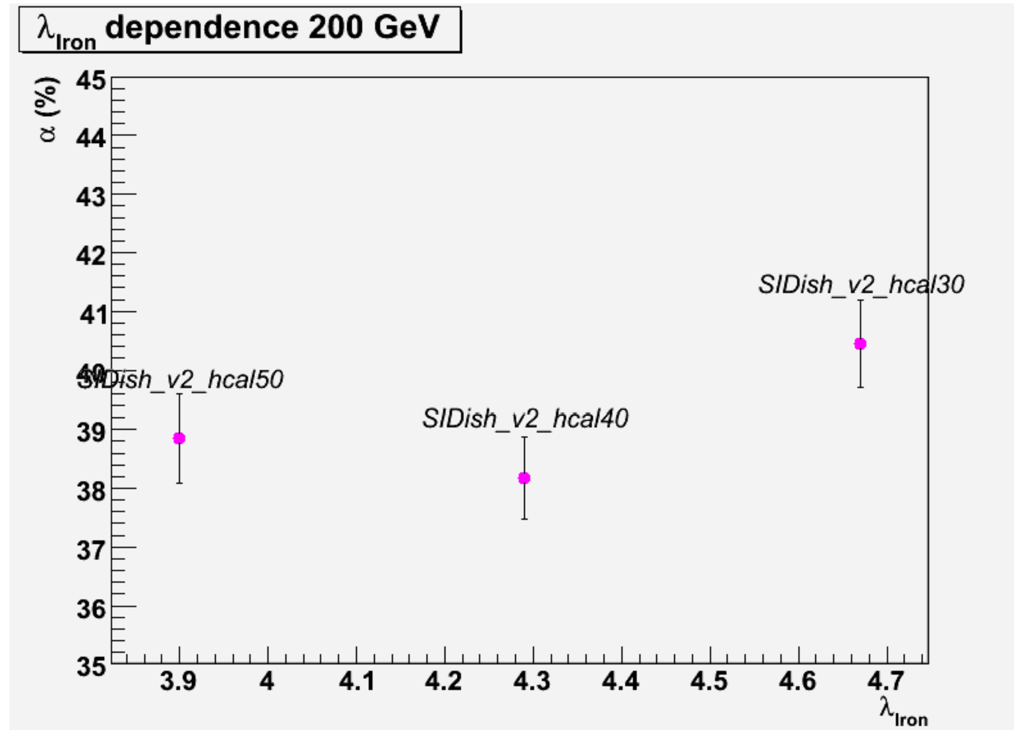




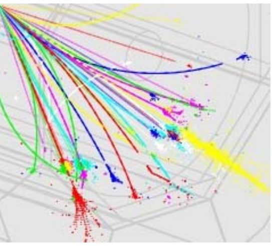
λ_{Iron}



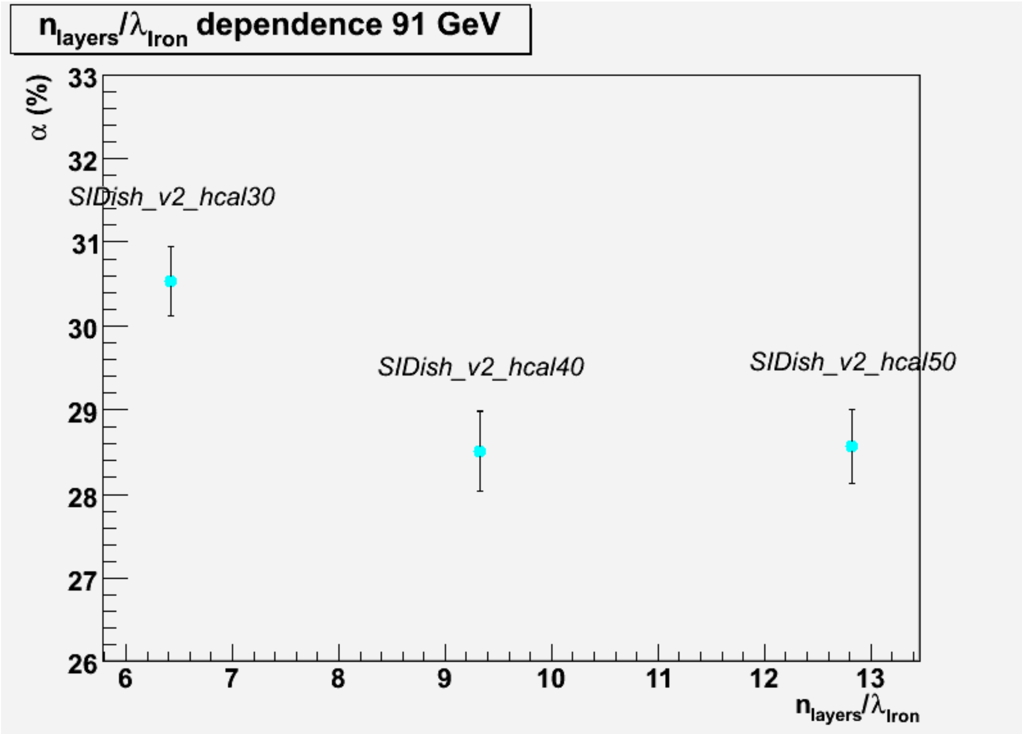
λIron dependence 91 GeV
α (%)
33
32
31
30
29
28
27
26
3.9
4
4.1
4.2
4.3
4.4
4.5
4.6
4.7
λIron
SIDish_v2_hcal50
SIDish_v2_hcal40
SIDish_v2_hcal30

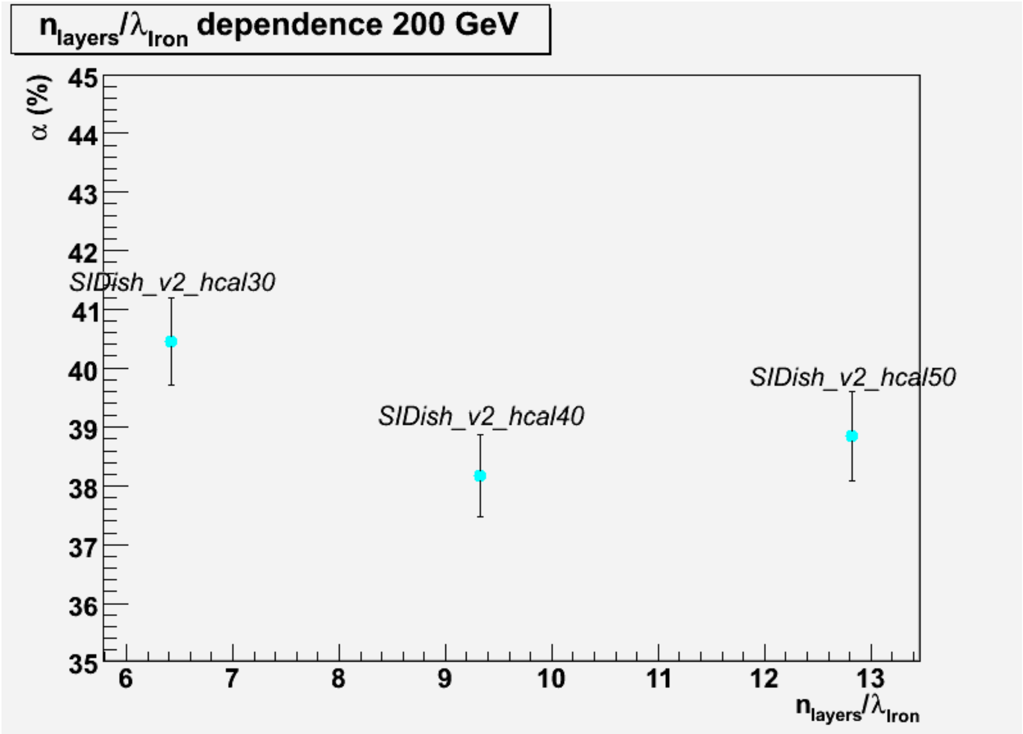


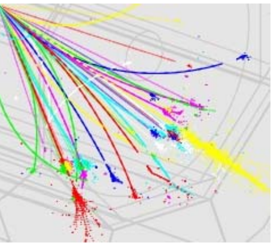
λIron dependence 200 GeV
α (%)
45
44
43
42
41
40
39
38
37
36
35
3.9
4
4.1
4.2
4.3
4.4
4.5
4.6
4.7
λIron
SIDish_v2_hcal50
SIDish_v2_hcal40
SIDish_v2_hcal30



$n_{Layers}/\lambda_{Iron}$

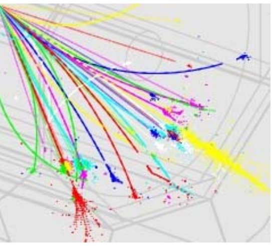


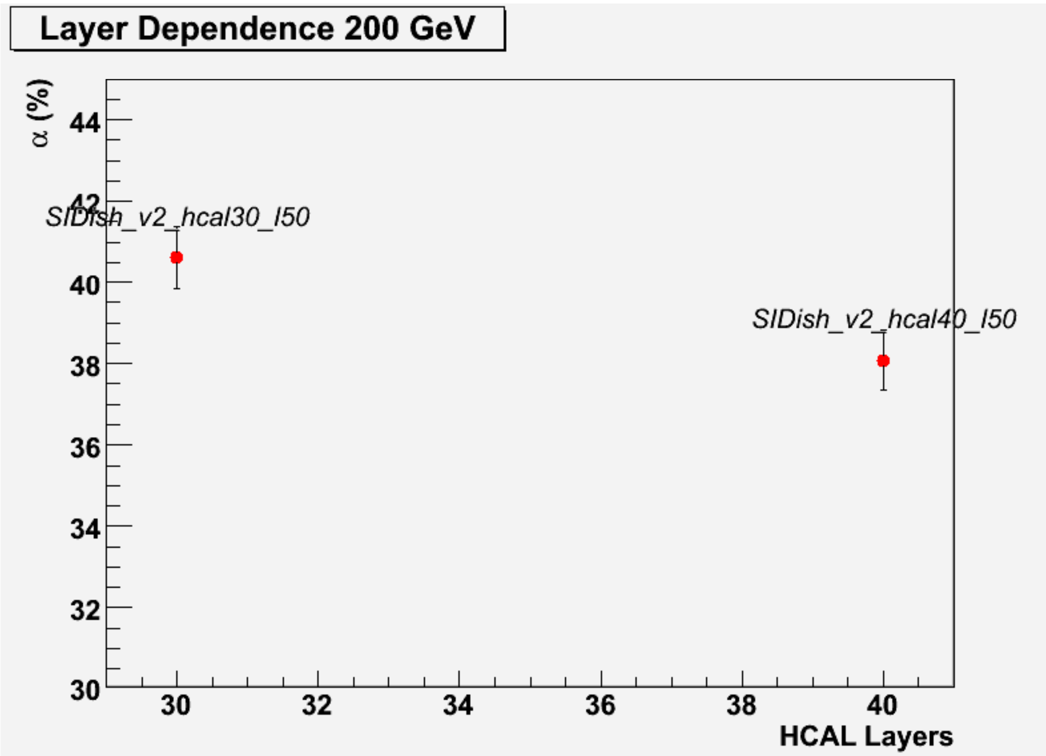


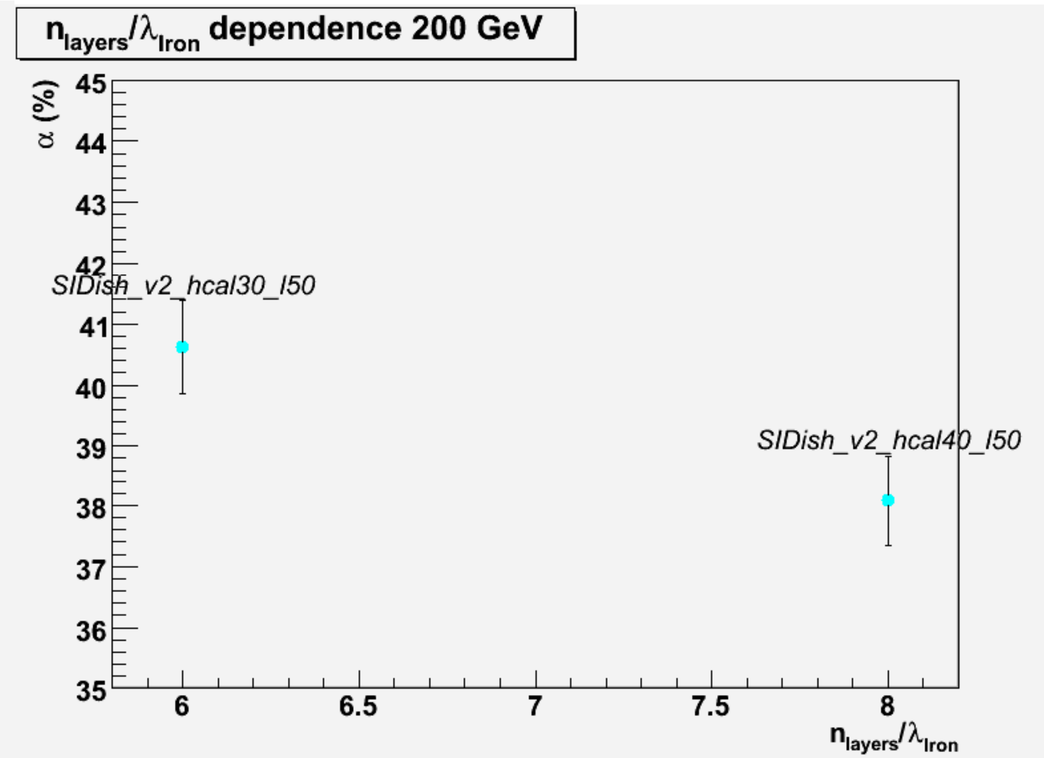


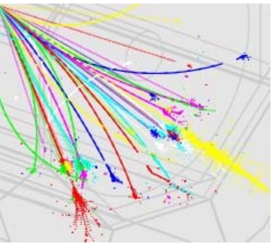
Fixed 5.0 λ_{Iron}

SIDish_v2_hcalXX_l45



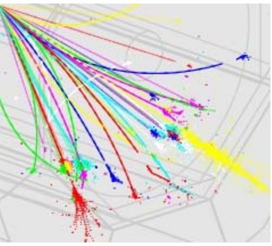

Layer Dependence 200 GeV
α (%)
SIDish_v2_hcal30_l50
SIDish_v2_hcal40_l50
HCAL Layers
30
32
34
36
38
40
42
44


$n_{layers}/\lambda_{Iron}$ dependence 200 GeV
α (%)
SIDish_v2_hcal30_l50
SIDish_v2_hcal40_l50
$n_{layers}/\lambda_{Iron}$
6
6.5
7
7.5
8
35
36
37
38
39
40
41
42
43
44
45



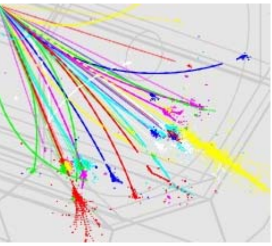
Playing with the ECAL

- Point raised by Harry, is the ECAL optimal ?
  - we see a benefit going from 20+10 to 30+10 layers
  - better segmentation helps ?
  - or just pure thickness ?
  - Effect is ~ 2 %
- Made a SiDish_ecal_q37
  - SiDish with 37 layers but same overall thickness
- Make a SIDish_ecal25_50
  - 20+10 layers
  - 2.5 mm /5.0 mm tungsten thickness and smaller gaps (1 mm)
  - will change global radius (very small effect)

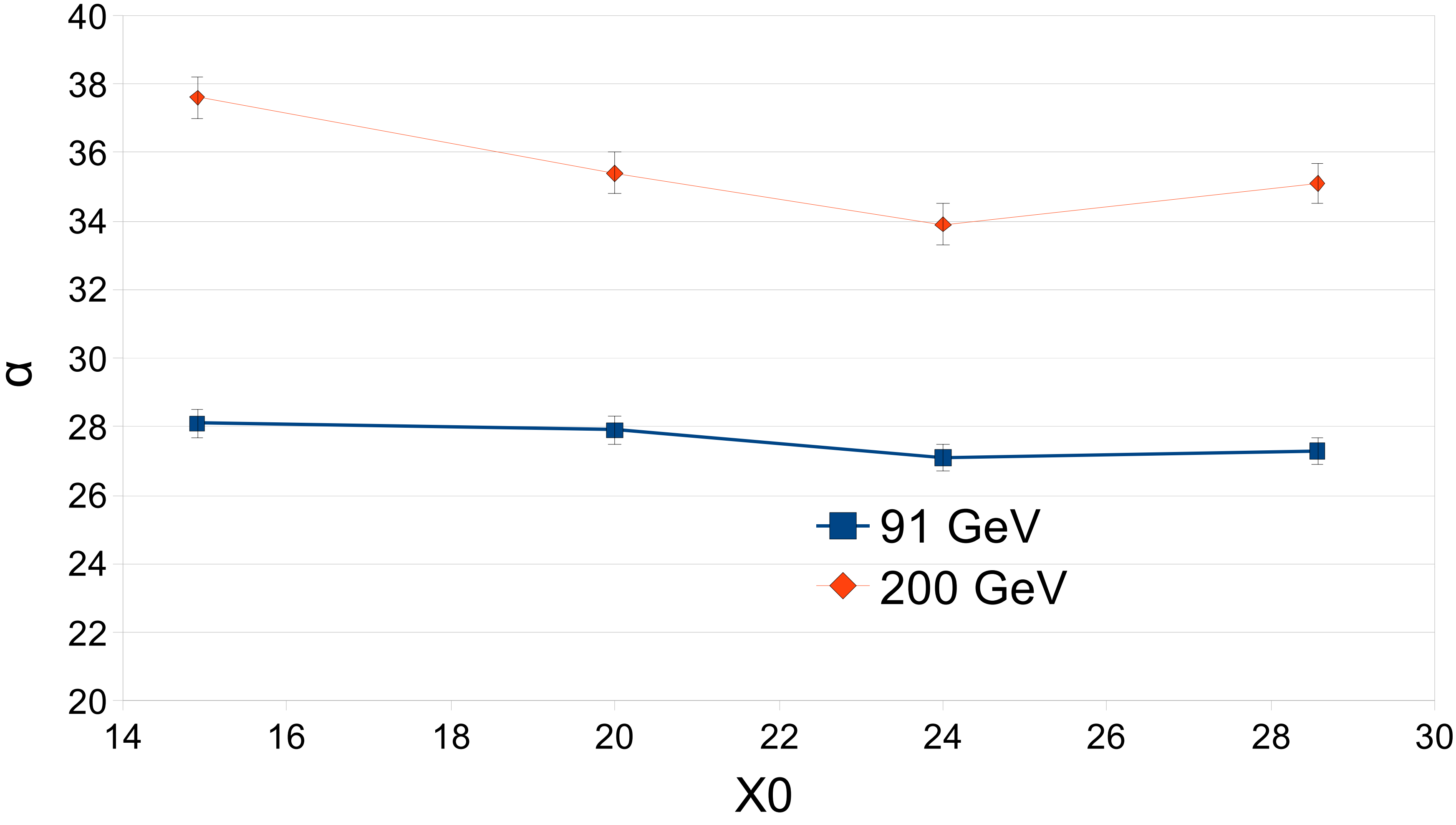


Some results

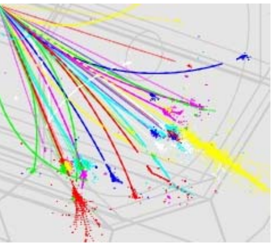
Detector Tag	Radiator Thickness	Layers	X_0	uds (91 Gev)		uds (200 GeV)	
				α %	Error	α %	Error
SIDish	1.4/4.2 mm	20+10	20	27.9	0.4	35.4	0.7
SIDish_ecal40	1.4/4.2mm	30+10	24	27.1	0.5	33.9	0.6
SIDish_ecal_eq37	1.41 mm	37	15	28.1	0.4	37.6	0.6
SIDish_ecal25_50	2.5/5.0 mm	20+10	29	27.3	0.4	35.1	0.6



some plots



40
38
36
34
32
30
28
26
24
22
20
α
14
16
18
20
22
24
26
28
30
X0
91 GeV
200 GeV

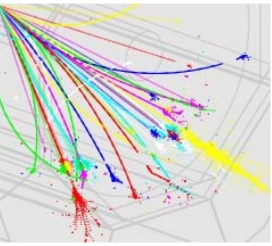


Z dependence

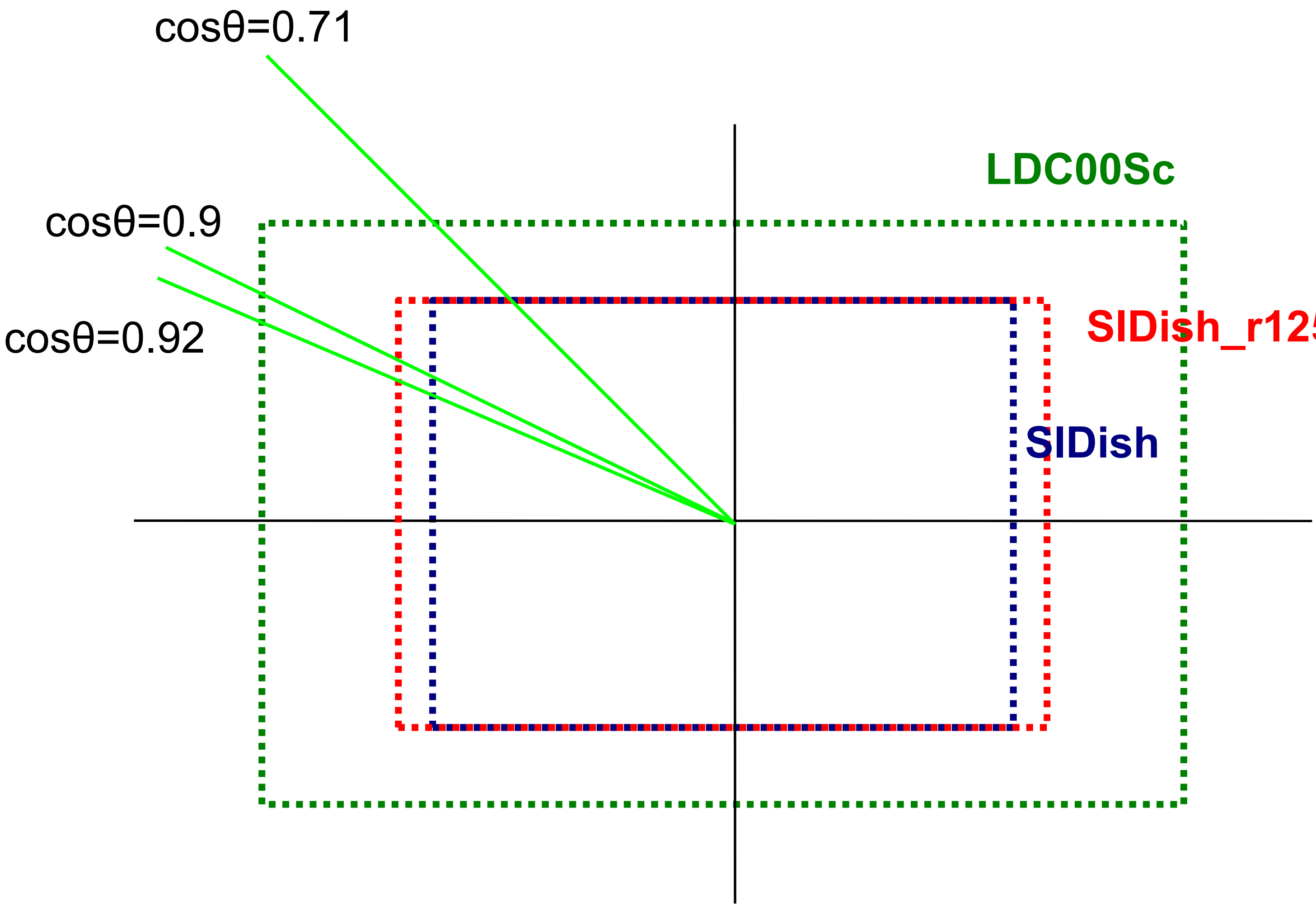
Taking the standard samples and looking in the forward ...
$0.9 < \cos\theta_{Thrust} < 1.0$, so integrating everything in that region

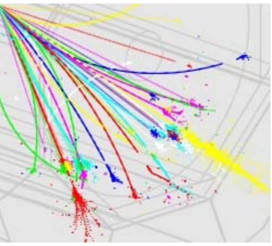
Detector Tag	B	Z	R/Z	uds (91 GeV)		uds (200 GeV)	
				α %	Error	α %	Error
SIDish	5	1.7	0.74	70.4	1.8	105.0	4.0
SIDish_r125_z15	5	1.5	0.83	76.1	2.1	110.5	4.2
SIDish_r125_z19	5	1.9	0.66	67.8	1.7	92.4	3.5
SIDish_4T	4	1.7	0.74	71.8	1.8	106.2	4.0
SIDish_6T	6	1.7	0.74	69.5	1.7	99.9	3.8
LDC00Sc	4	2.7	0.63	49.5	1.3	66.6	2.5

This is way less statistics plus there are two jets and not one well defined u-quark !

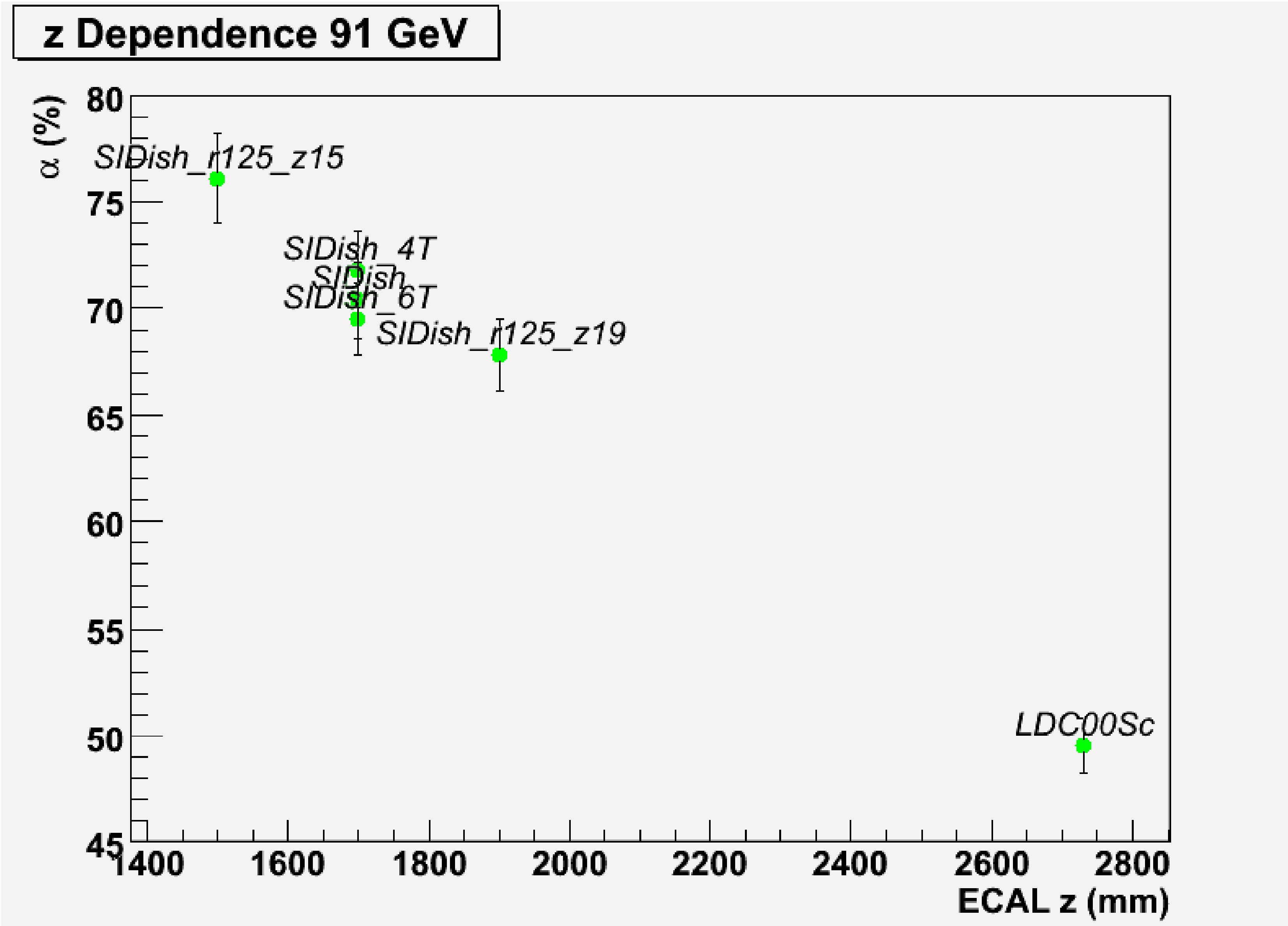


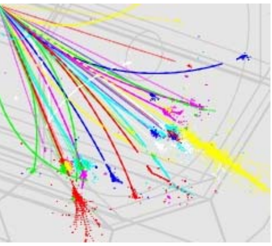
Some help ...



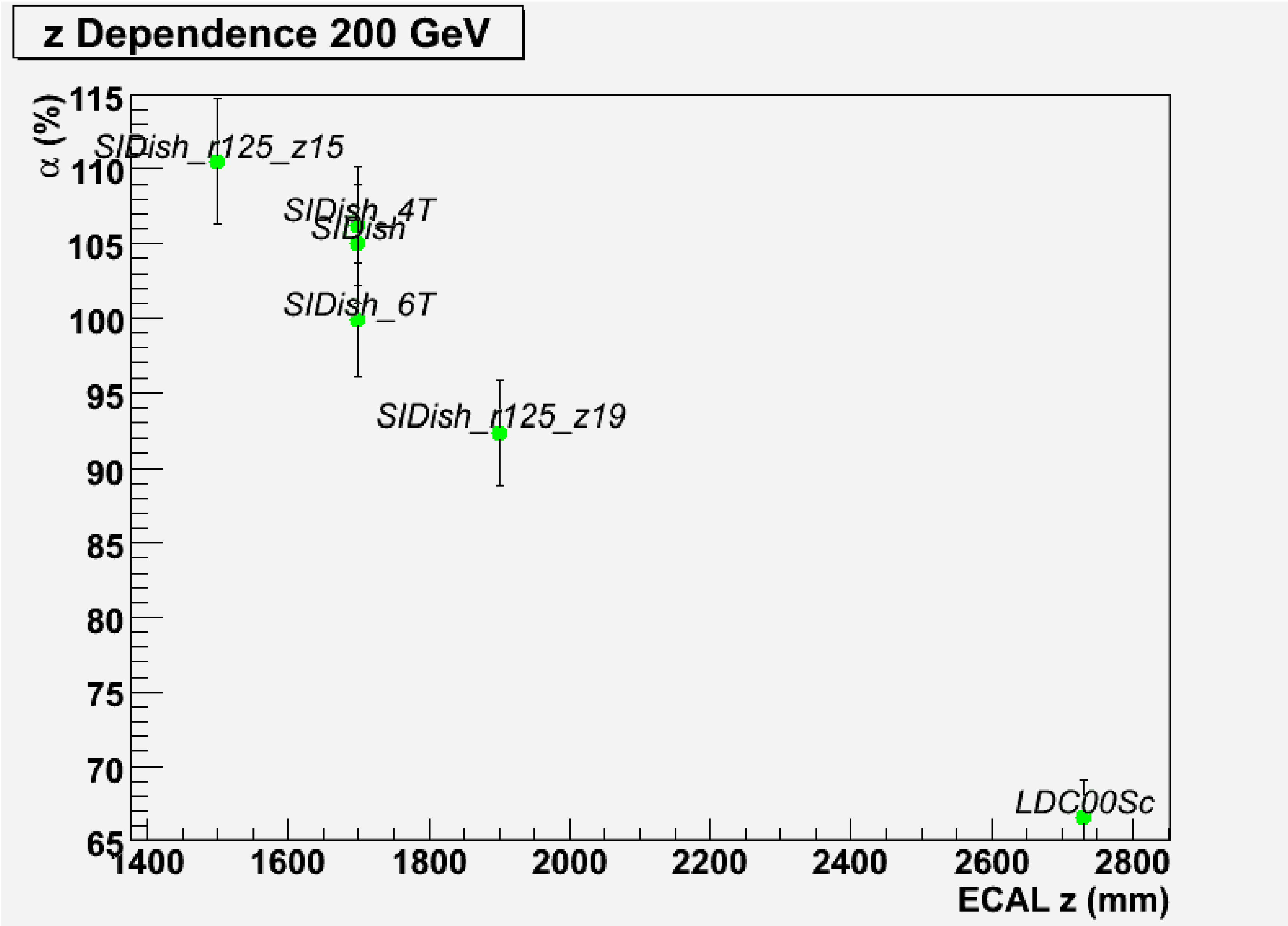


at 91 GeV

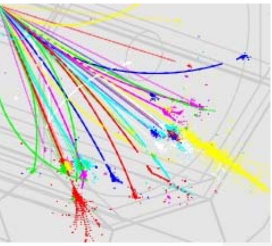

z Dependence 91 GeV
α (%)
80
75
70
65
60
55
50
45
SIDish_r125_z15
SIDish_4T
SIDish
SIDish_6T
SIDish_r125_z19
LDC00Sc
1400
1600
1800
2000
2200
2400
2600
2800
ECAL z (mm)



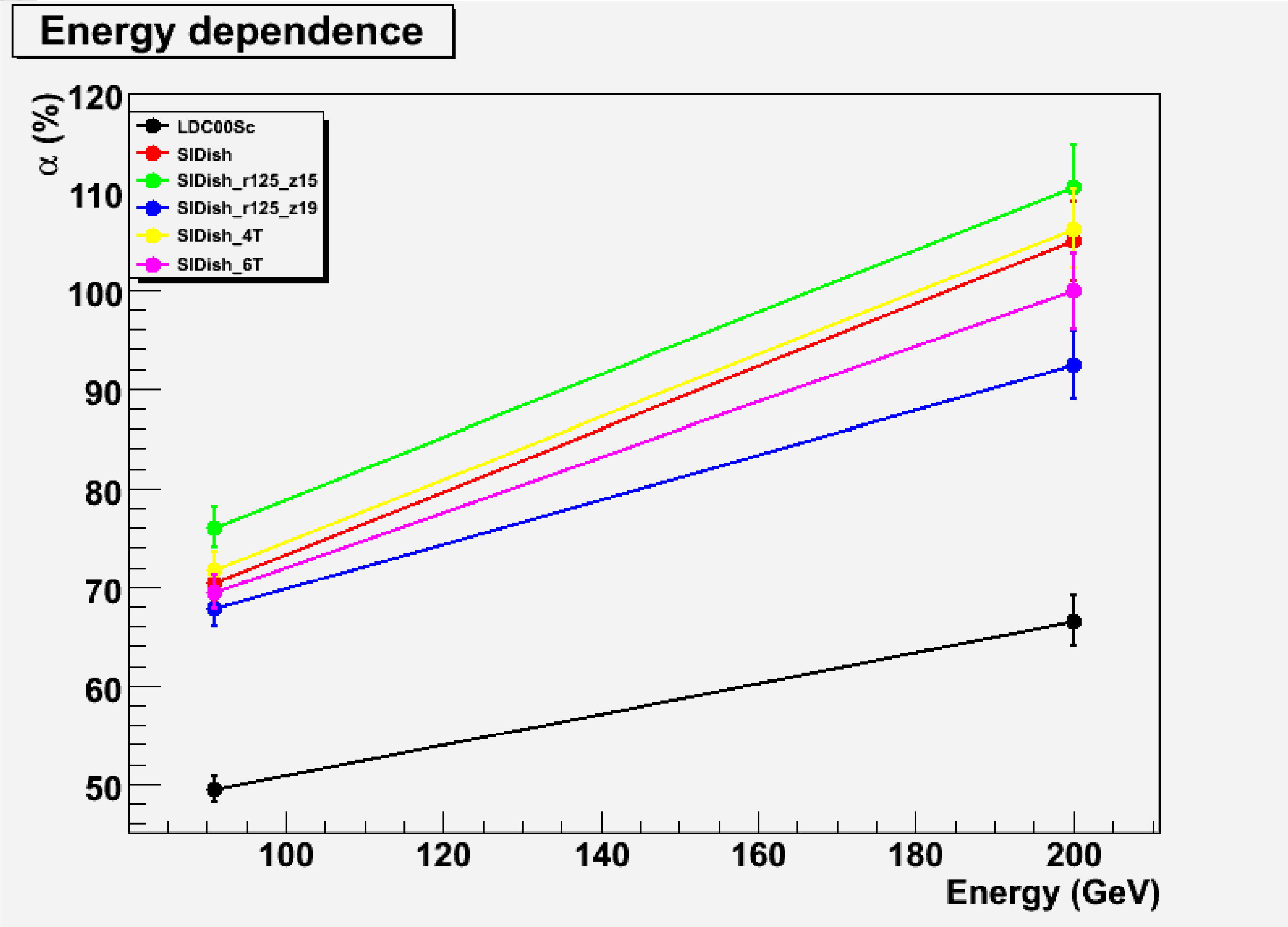
at 200 GeV

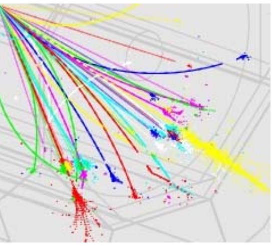


z Dependence 200 GeV
α (%)
115
110
105
100
95
90
85
80
75
70
65
SIDish_r125_z15
SIDish_4T
SIDish
SIDish_6T
SIDish_r125_z19
LDC00Sc
1400
1600
1800
2000
2200
2400
2600
2800
ECAL z (mm)



Energy Dependence





Let's Play

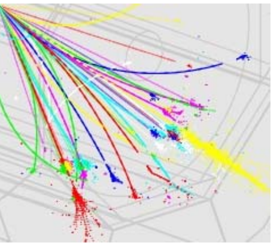
- Fit the z and B dependence for the forward region
  - Proposed function : $\alpha = n_1 Z + n_2 B^{n_3} + n_4$
- For 91 GeV Fit wants no B-Field Dependence:

$$\alpha = -0.021 \cdot Z + 106.533$$

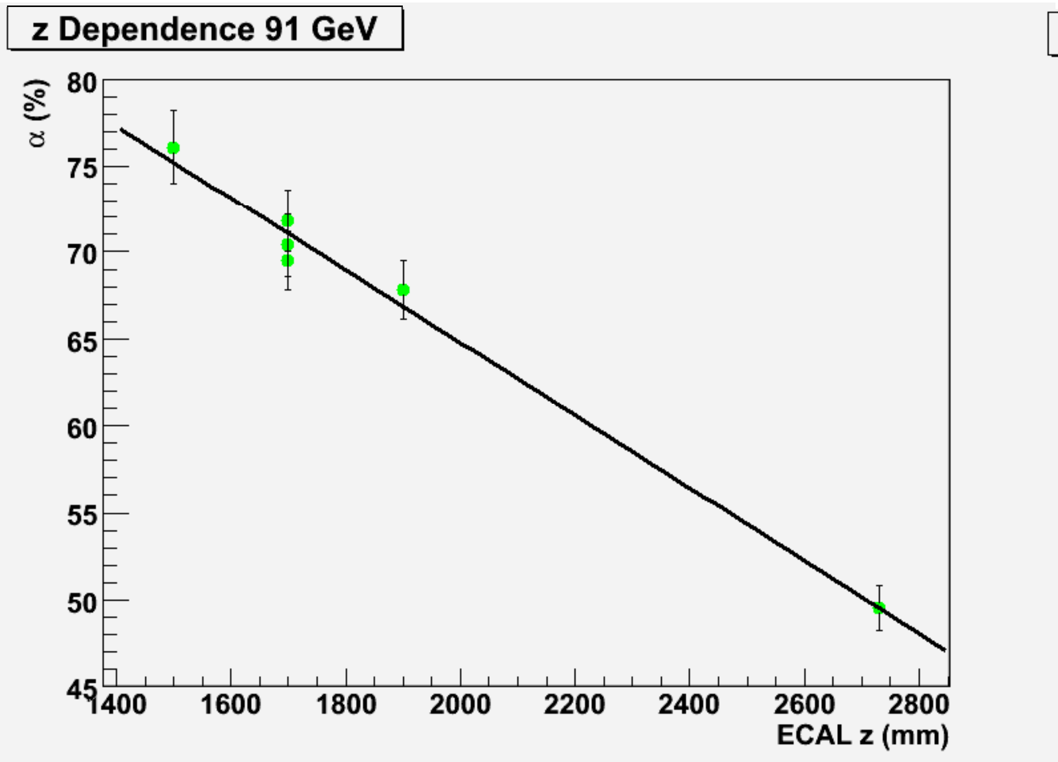
- For 200 GeV there is very weak B-Field Dependence (ignored)

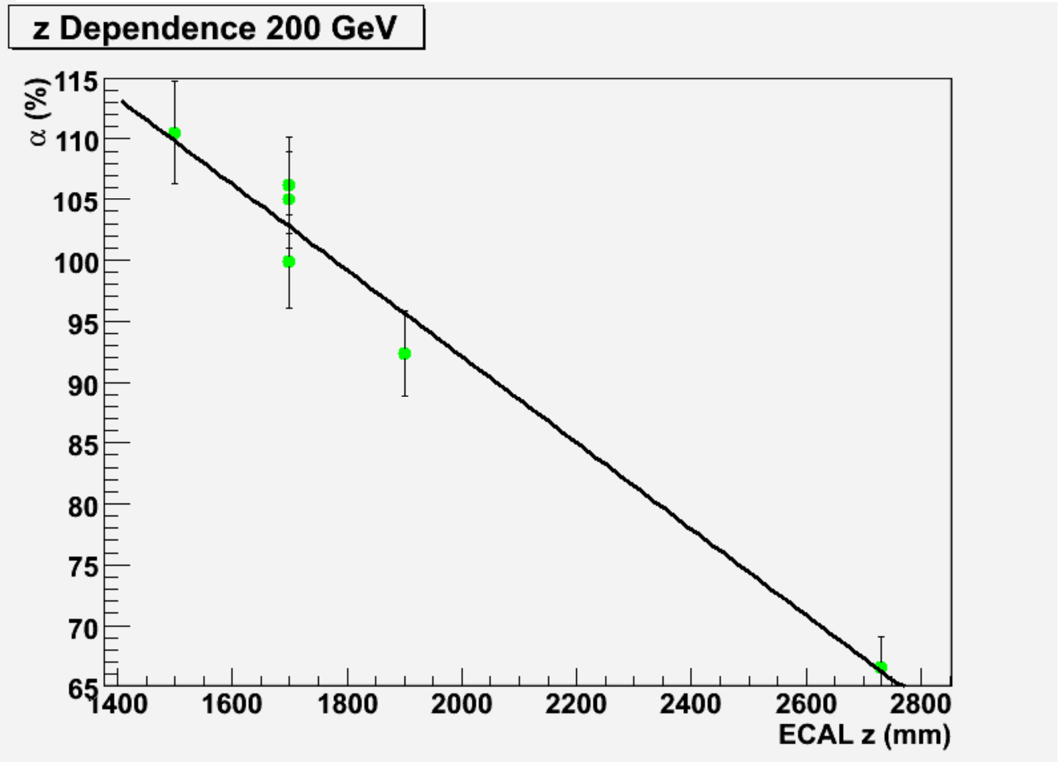
$$\alpha = -0.035 \cdot Z + 162.935$$

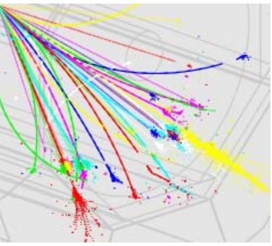
- suggests increase with $\sqrt{E}$
- May require a few more points



First result







Fitting z and Energy

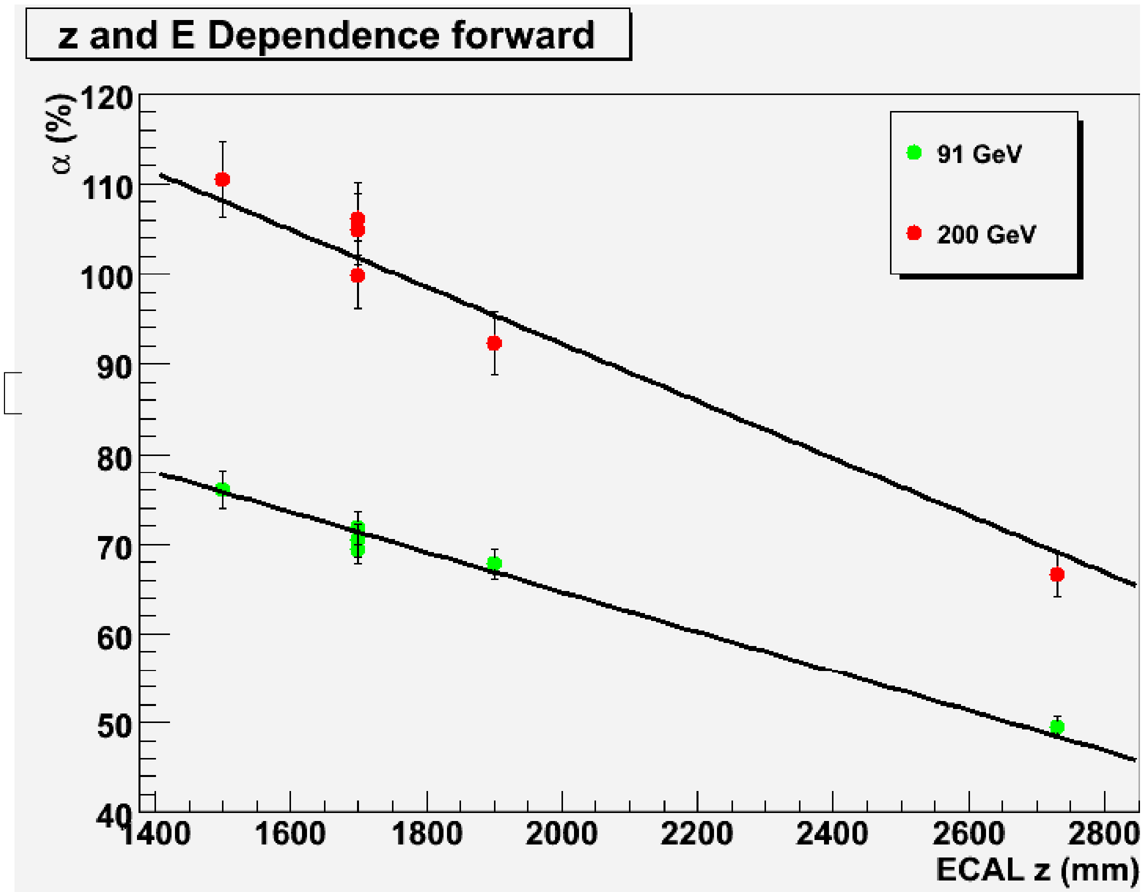
- Ignoring B ...

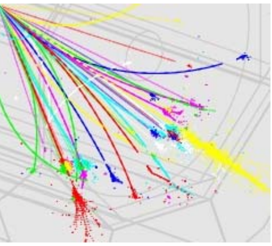
$$\alpha = \frac{1}{E^{n_1}} \left(n_2 Z + n_3 \right)$$

- Fitting again

$$\alpha = \frac{1}{E^{0.451}} \left(-0.003 Z + 14.243 \right)$$

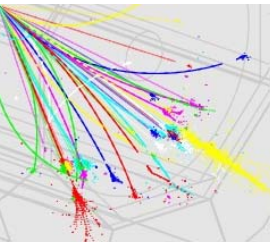
- need more points and statistics for
  - B field
  - Calorimeter impact
  - These Effects are in the noise so far



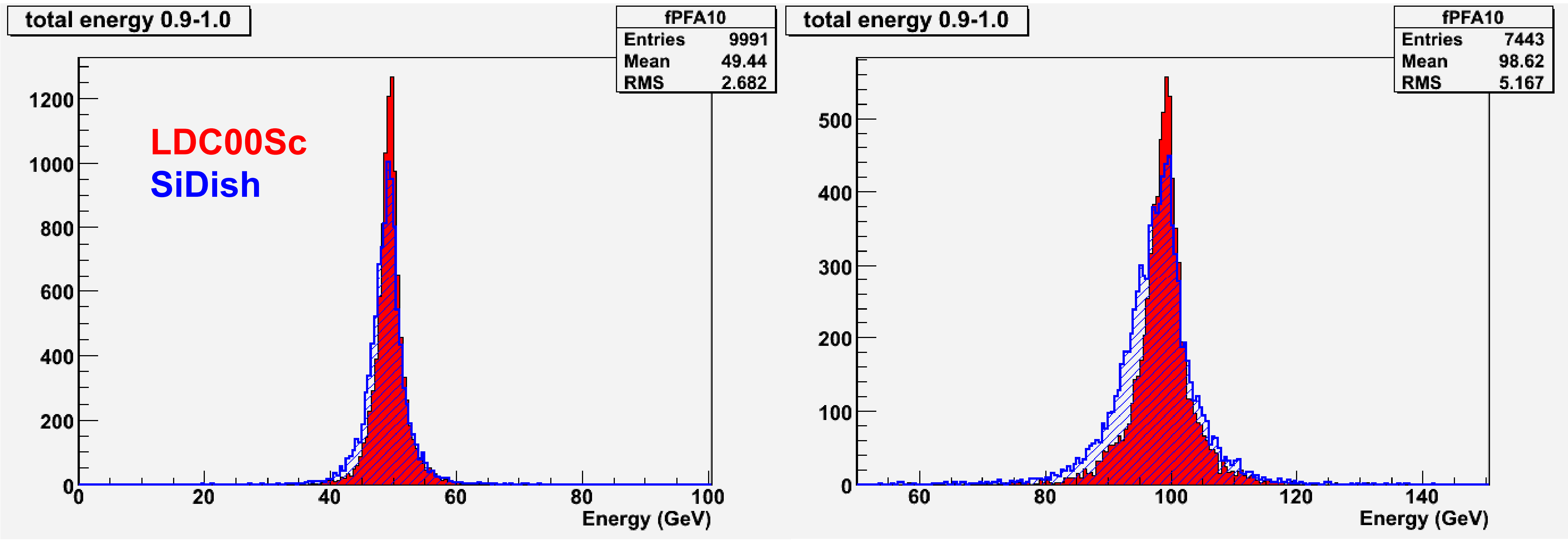


Z dependence (II)

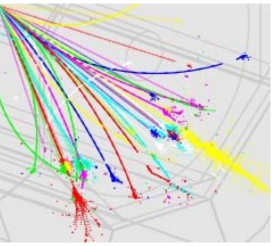
- Due to popular request by a single gentleman
- Norman kindly generated u jets going at cos(θ)=0.92 for three energies: 50, 100, 250
- 250 GeV done for LDC00Sc and SIDish
  - something funny, which needs cross-checking
  - it looks like they are all over the place not only at cos(θ)=0.92



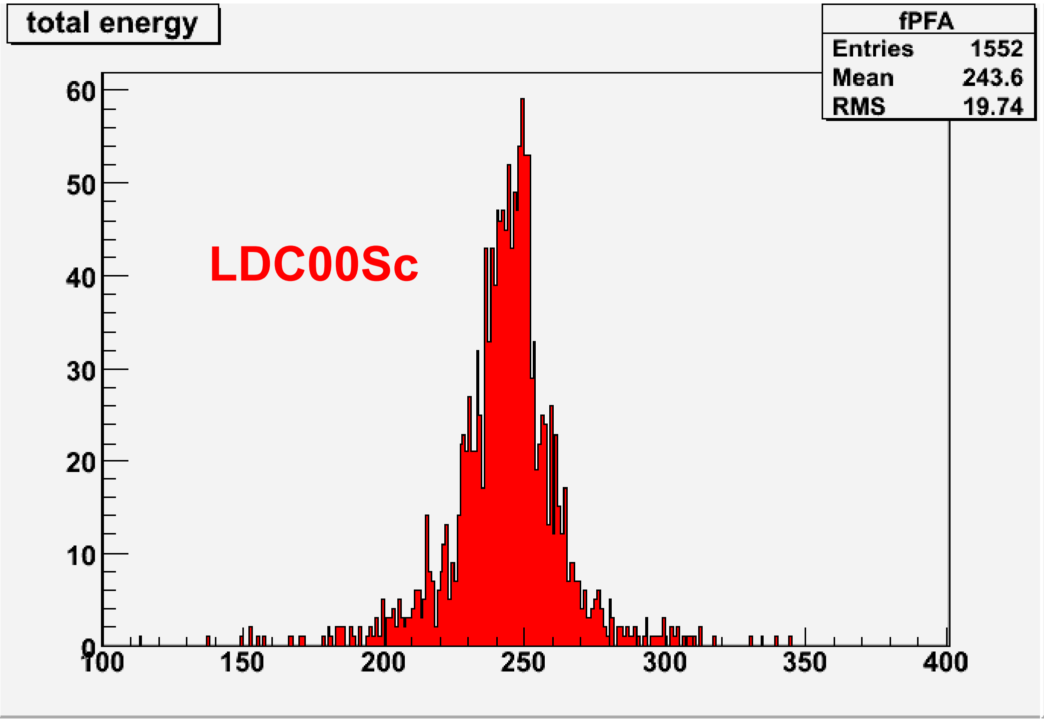
Some Plots

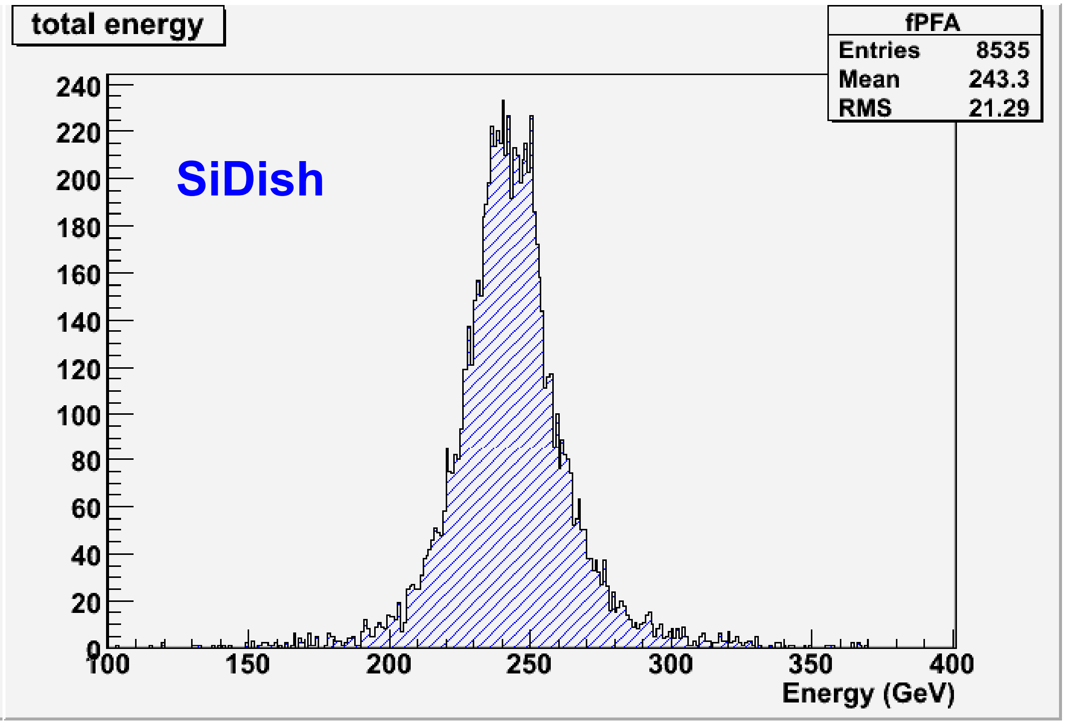


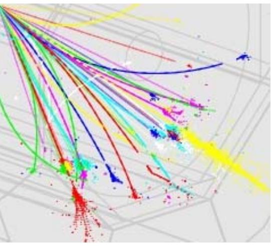
total energy 0.9-1.0
fPFA10
Entries 9991
Mean 49.44
RMS 2.682
LDC00Sc
SiDish
Energy (GeV)
total energy 0.9-1.0
fPFA10
Entries 7443
Mean 98.62
RMS 5.167
Energy (GeV)



250 GeV

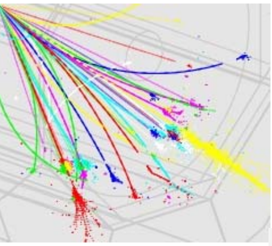

total energy
fPFA
Entries 1552
Mean 243.6
RMS 19.74
LDC00Sc
0
10
20
30
40
50
60
100
150
200
250
300
350
400


total energy
fPFA
Entries 8535
Mean 243.3
RMS 21.29
SiDish
0
20
40
60
80
100
120
140
160
180
200
220
240
100
150
200
250
300
350
400
Energy (GeV)

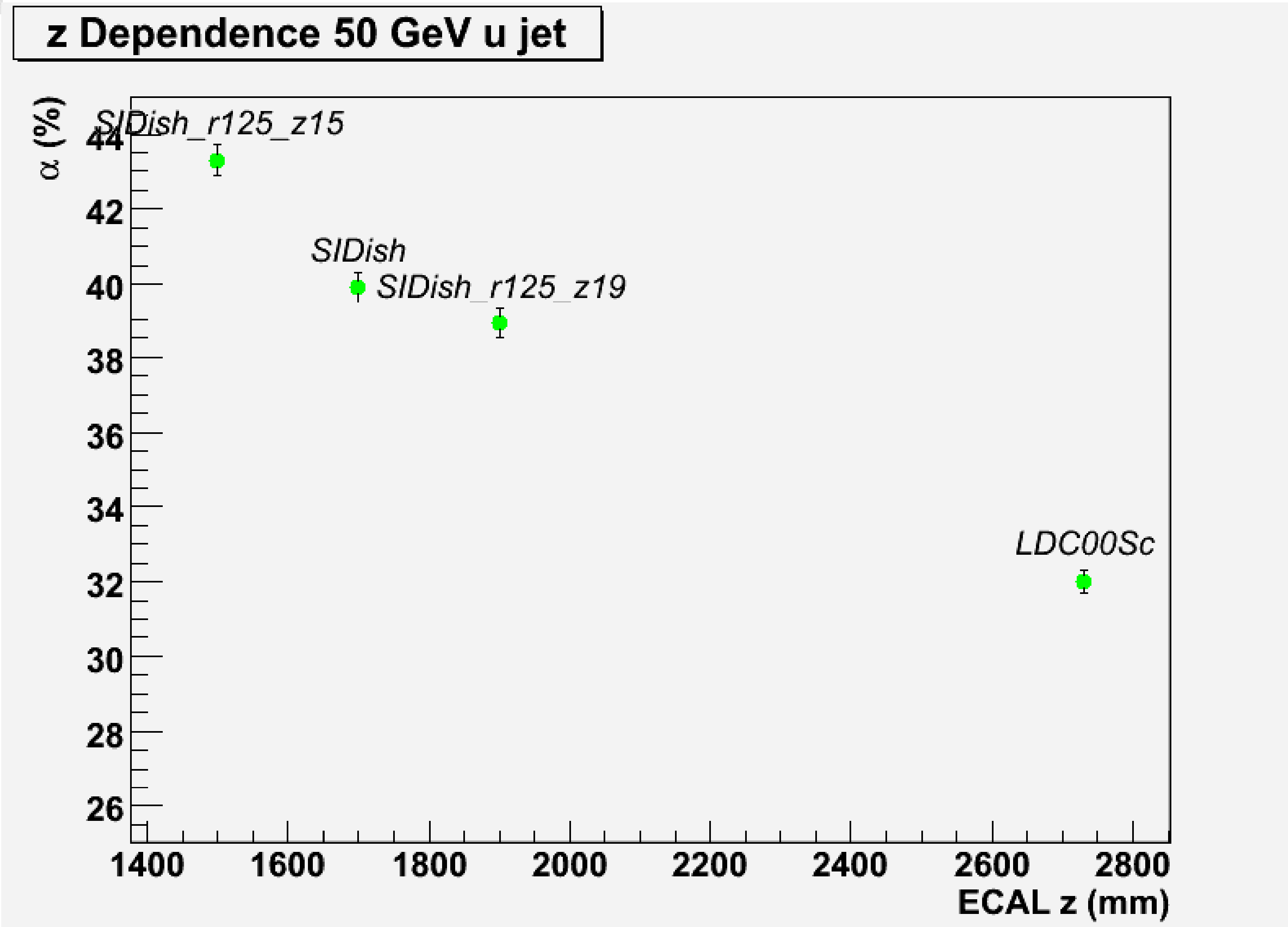


Results

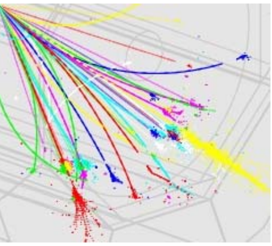
Detector Tag	u (50 GeV)		u (100 GeV)		u (250 GeV)	
	α %	Error	α %	Error	α %	Error
SIDish	39.9	0.4	40.2	0.4	69.1	0.2
LDC00Sc	32.0	0.3	29.6	0.3	79.8	0.8
SIDish_r125_z15	43.4	0.4	44.2	0.5		
SIDish_r125_z19	38.9	0.4	38.3	0.4		

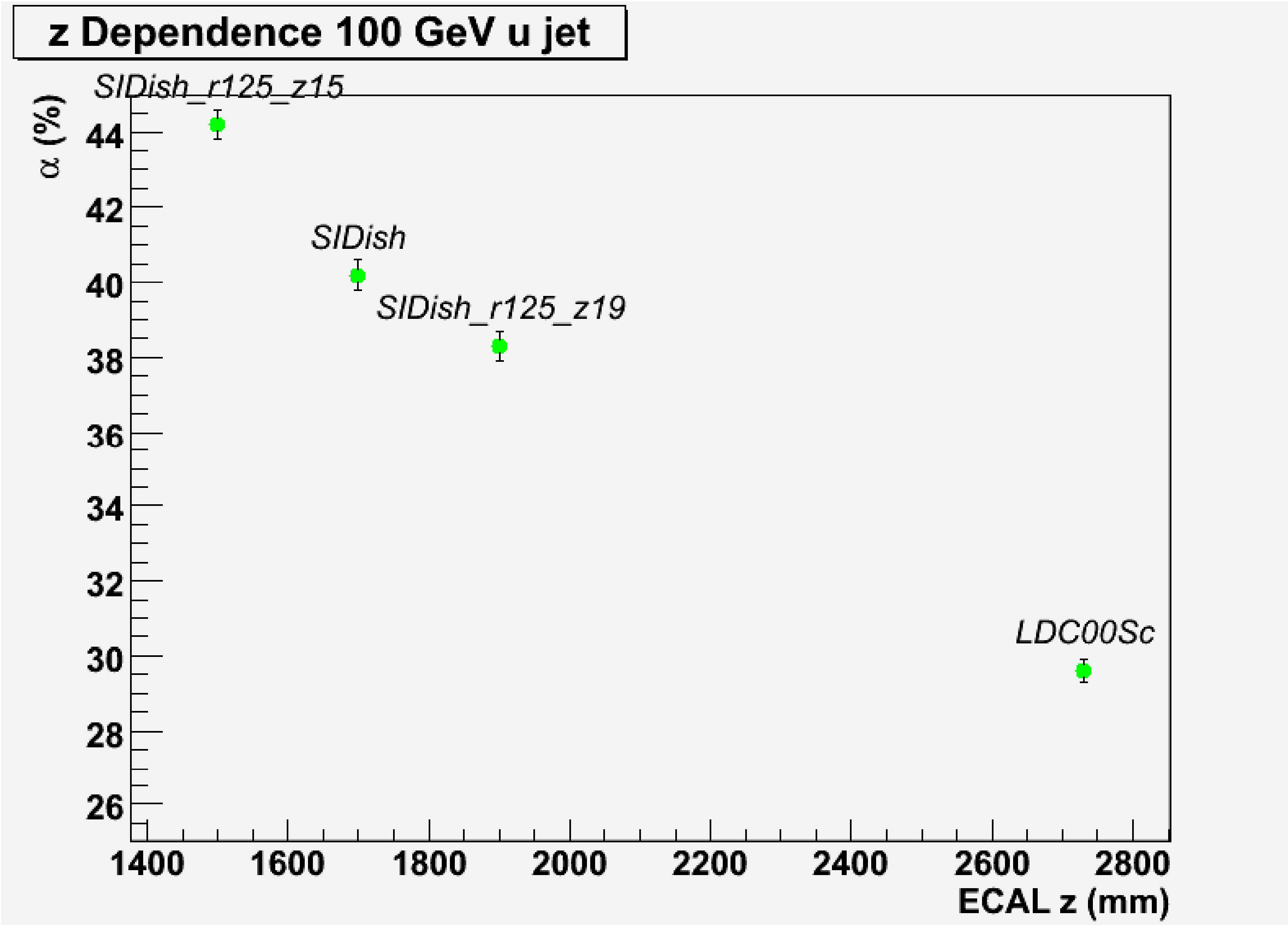


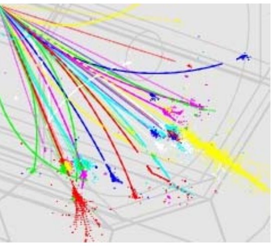
Some plots


z Dependence 50 GeV u jet
α (%)
SIDish_r125_z15
SIDish
SIDish_r125_z19
LDC00Sc
44
42
40
38
36
34
32
30
28
26
1400
1600
1800
2000
2200
2400
2600
2800
ECAL z (mm)

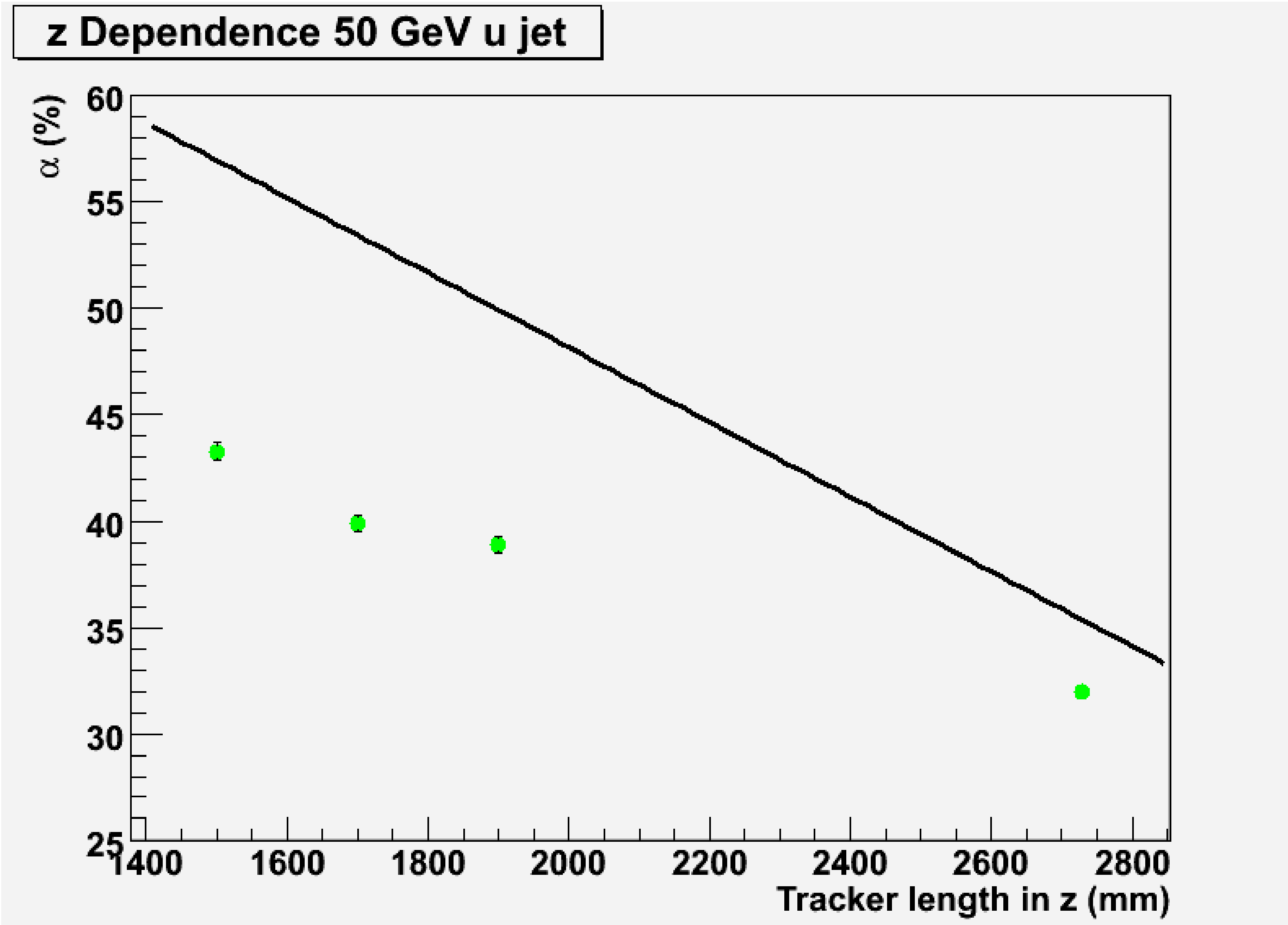
Some plots (II)



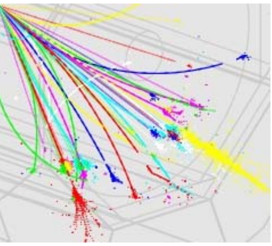




Using the other fit model



Doesn't really work so well, but didn't really expect it to either as we are having 1 jet vs. two jets etc....



Start from scratch

- Use same model as before

$$\alpha = n_1 Z + n_2 B^{n_3} + n_4$$

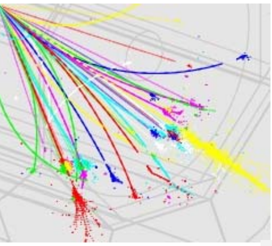
  - B dependent term set to 0

- For 50 GeV Jet Fit

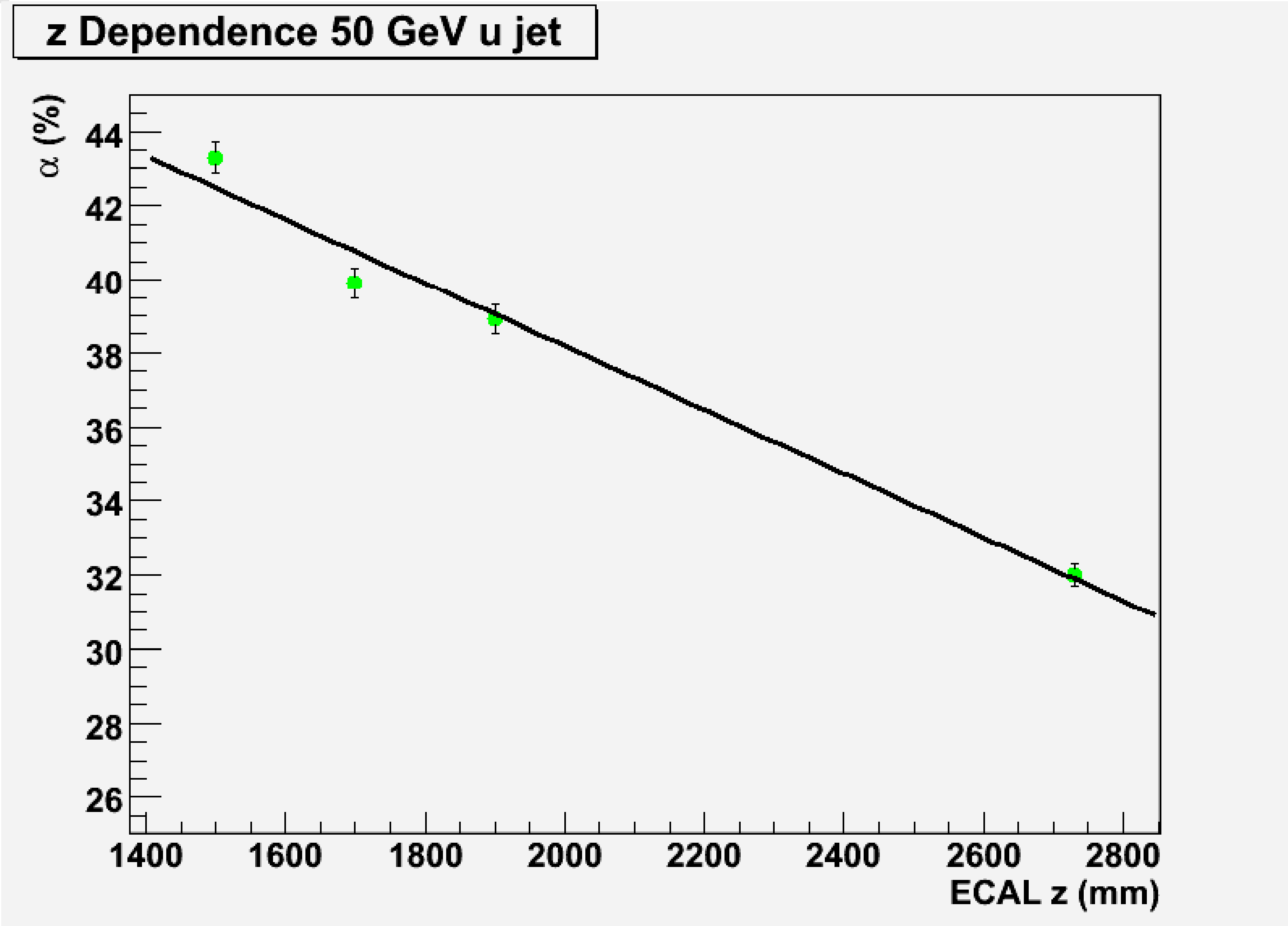
$$\alpha = -0.0086 \cdot Z + 55.360$$

- For 100 GeV Jet Fit:

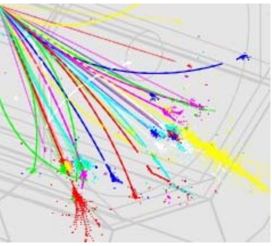
$$\alpha = -0.0108 \cdot Z + 58.995$$



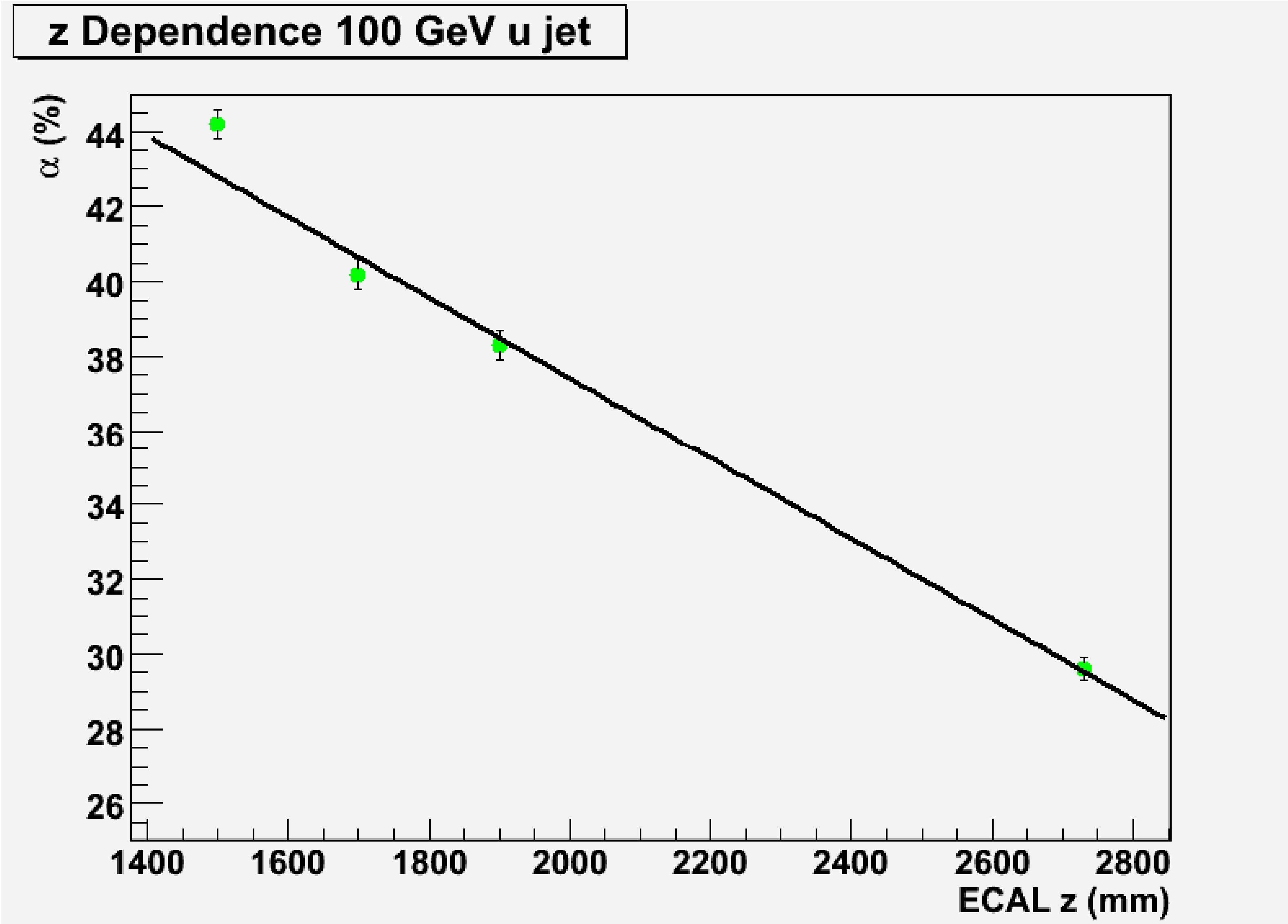
Results



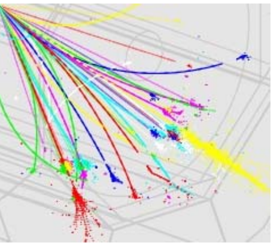
z Dependence 50 GeV u jet
α (%)
44
42
40
38
36
34
32
30
28
26
1400
1600
1800
2000
2200
2400
2600
2800
ECAL z (mm)



Results (II)

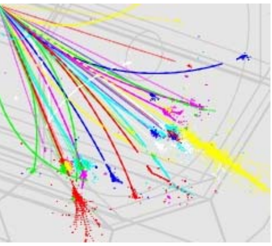


z Dependence 100 GeV u jet
α (%)
44
42
40
38
36
34
32
30
28
26
1400
1600
1800
2000
2200
2400
2600
2800
ECAL z (mm)



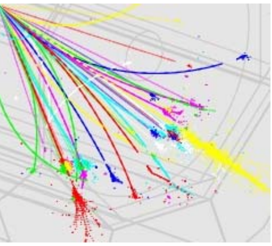
Z dependence

- There is a linear dependence between energy resolution and z
- Both studies tell the same story
  - a longer SiD is better
  - For physics with two jets effect is more pronounced
- B field has little impact
  - one wouldn't expect
- Ron's comment from Monday
  - segmentation, radius and B field all add up here
- Don;t really understand the small differences between 50 and 100 GeV jets ...



Plans

- for 4.5/5.0 λ generate a 60 layer version to see a turnover effect (like for the fixed total thickness)
- Generate another set
  - 5.5 λ_{Iron} 30,40,50,60 layers
  - 3.5 λ_{Iron} 30,40,50,60 layers
- That should cover it
- Run a few points using 180 GeV Jets ...



Conclusions

- HCAL seems to say
  - layers/λ_{Iron} is important
  - need more samples
- ECAL prefers fine segmentation
  - in the first layers
- Depth is a good thing
- A longer detector is better ...