Single Particle Performance

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Topics

- Momentum Resolution by muon
- Impact Parameter Resolution by muon

Jupiter+Satellites
by AM & K.Yoshida

Mokka+MarlinReco
by S. Aplin

- Energy resolution by gamma
- Energy resolution by kaon_0L

Jupiter + Satellites/Marlin
by AM & T.Takahashi

Mokka+Marlin/Pandora
by M.Thomson

Tracking parameters of Jupiter/Mokka

		Jupiter	Mokka	Jupiter	Mokka	Jupiter	Mokka
Model Name		gldapr08	LDC-GLD_01	gldprim_v04	LDCPrime_02Sc	j4ldc_v04	LDC01_06Sc
B	T	3	3	3.5	3.5	4	4
TPC Drift Region Rmin	cm	43.7	37.1	43.5	37.1	34	37.1
TPC Drift Region Rmax	cm	197.8	193.1	174	173.3	152	151.1
TPC Drift Region HalfZ	cm	260	249.8	235	224.8	216	218.6
# pad rows		256	260	217	227	196	190

TPC point resolution

$$\sigma_{r\varphi}^2(\mu m^2) = P + QL$$

$$P \equiv 50^2 + 900^2 \sin^2\varphi \ : (\mu\mathrm{m})^2$$

$$Q \equiv (25^2/22)\times(4/B)^2 \sin\theta : (\mu m/\sqrt{cm}),\ \mathrm{B\ in\ Tesla}$$

$$L : \ \mathrm{drift\ length\ [cm]}$$

$$\sigma_Z^2(\mu m^2) = 40^2 + 8^2 \times L(cm)$$

Vertex Detector

				Jupiter			Mokka			
Model name				gldapr 08	gldprim _v04	j4ldc_v04	LDC_GL D_01Sc	LDCPrime_0 2Sc_p01	LDC01_0 6Sc	
Beam Pipe	IR		cm	1.5	1.4	1.3	1.55	1.40	1.30	
	Material			Be, 500mm^t						
VTX	Structure			Cylindrical, 3 double layers			Ladder			
	Layer Radius and HalfZ Length	L1	cm	1.75, 7.25	1.6, 7.25	1.5, 7.25	L1	1.65, 5.0	1.50, 5.0	1.40, 5.0
		L2	cm	1.95, 7.25	1.8, 7.25	1.7, 7.25	L2	2.6, 12.5		
		L3	cm	3.8,13.5	3.7,13.5	3.65,13.5	L3	3.7, 12.5		
		L4	cm	4.0,13.5	3.9,13.5	3.85,13.5	L4	4.8, 12.5		
		L5	cm	5.8,13.5	5.8,13.5	5.8,13.5	L5	6.0, 12.5		
		L6	cm	6.0,13.5	6.0,13.5	6.0,13.5				
	Thickness		X0	0.1% RL/layers						
	Resolution			Point Resolution : $\sigma_{r\phi}=\sigma_z=2.8\mu m$						

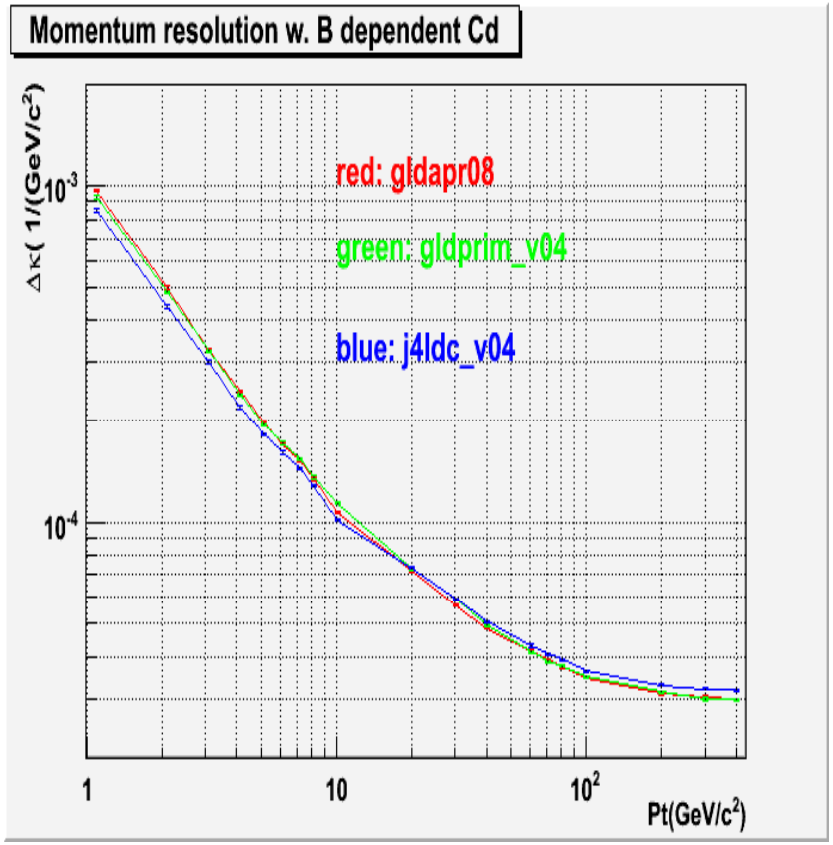
Intermediate(Silicon) Tracker- Barrel

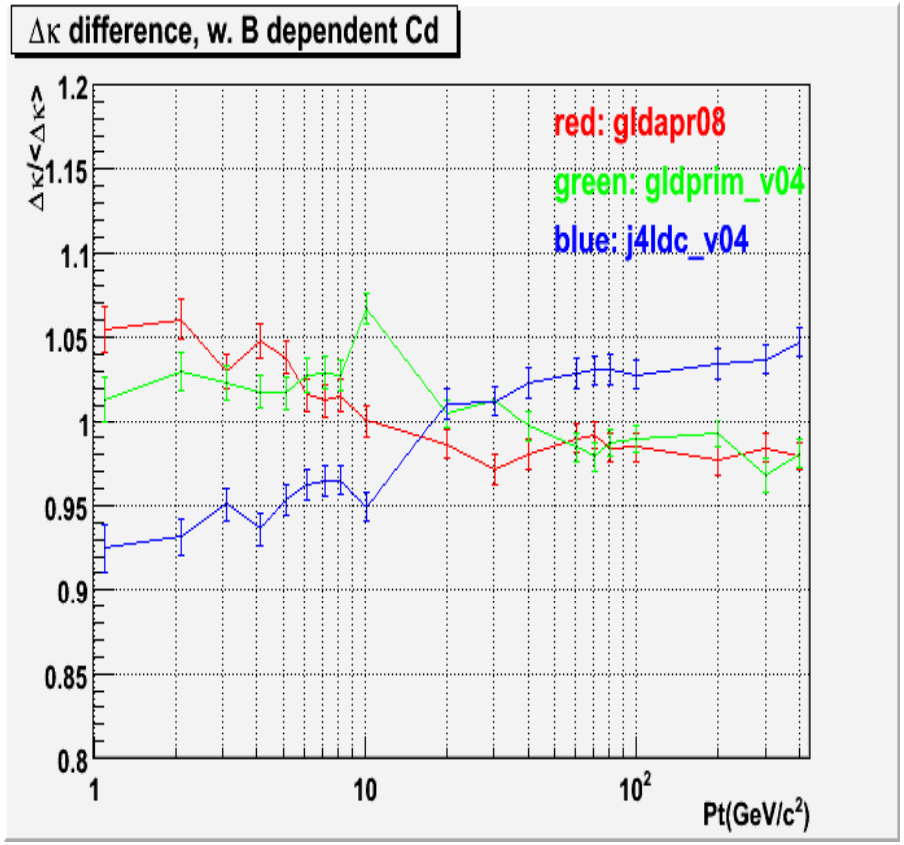
			Jupiter			Mokka	
			gldapr08	gldprim_v04	j4ldc_v04	LDCPrime_02Sc_p01	
Structure			Cylindrical			Cylindrical	
Layer Radius & HalfZ Length	L1	cm	9.0, 18.6		9.0, 18.5	L1	16.14, 38.0
	L2	cm	16.0, 33.0		16.0, 33.0		
	L3	cm	23.0, 47.5		23.0, 47.5	L2	27.01, 66.0
	L4	cm	30.0, 62.0		29.0, 62.0		
Thickness		X0	0.6% RL/layer			0.7%/RL/layer	
Point Resolution			$\sigma_{r\phi}=\sigma_z=10\mu m$			$\sigma_{r\phi}=3\mu m$, $\sigma_z=50\mu m$	

Momentum Resolution

Pt resolution

Single muon, produced at cosθ=0. by Jupiter+Satellites: TPC+IT+VTX fitting

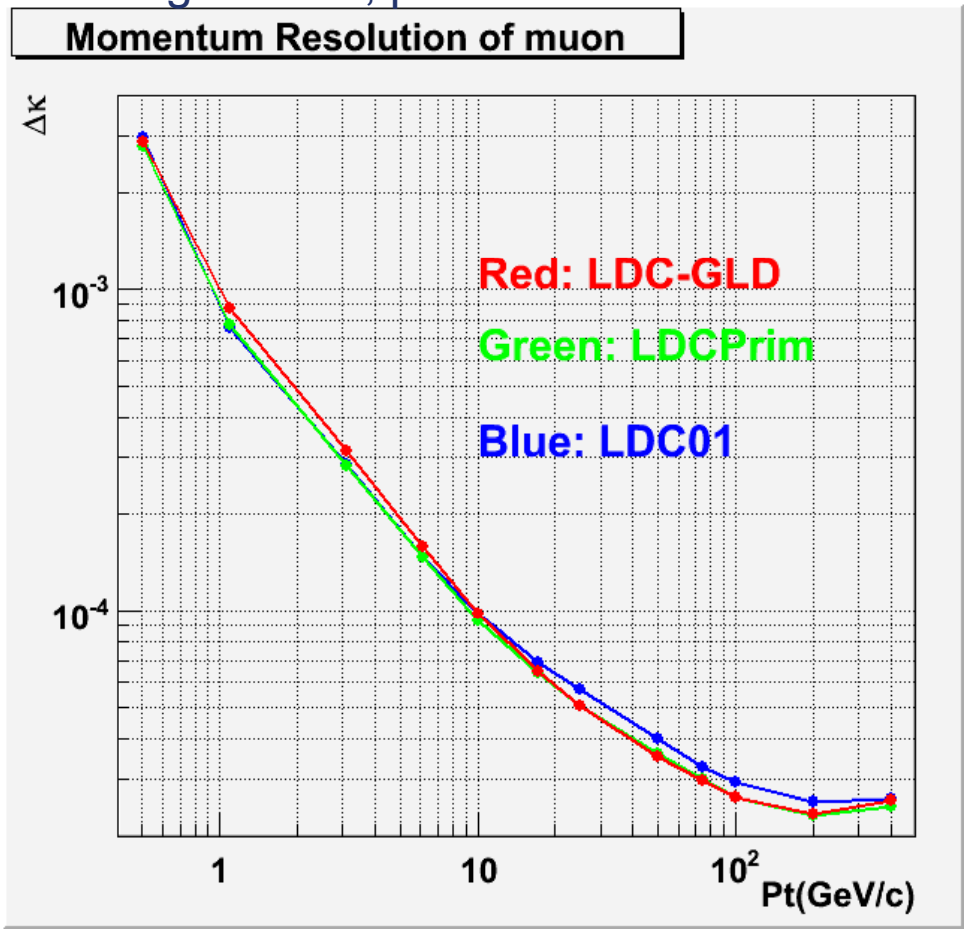


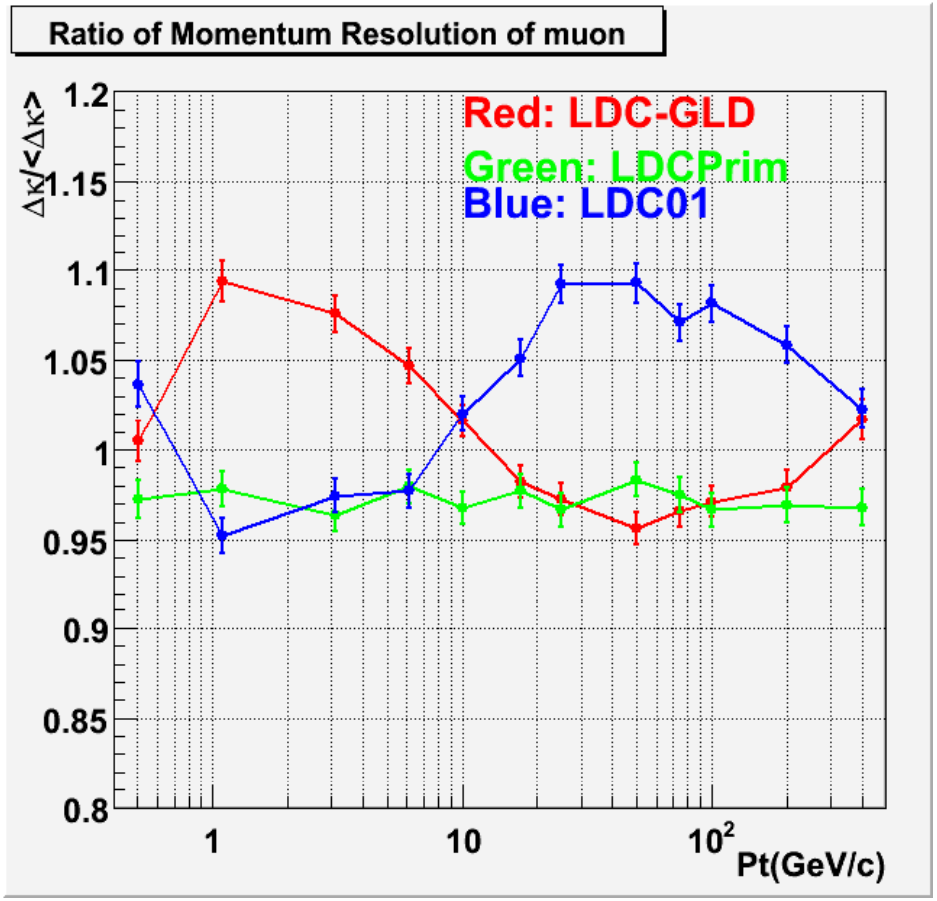


LDC : ~5% worse at high Pt ➔ Shorter Lever arm
GLD/GLD': ~10%worse at low Pt ➔ Lower B

Pt resolution – Mokka/Pandora

Single muon, produced at cosθ=0.

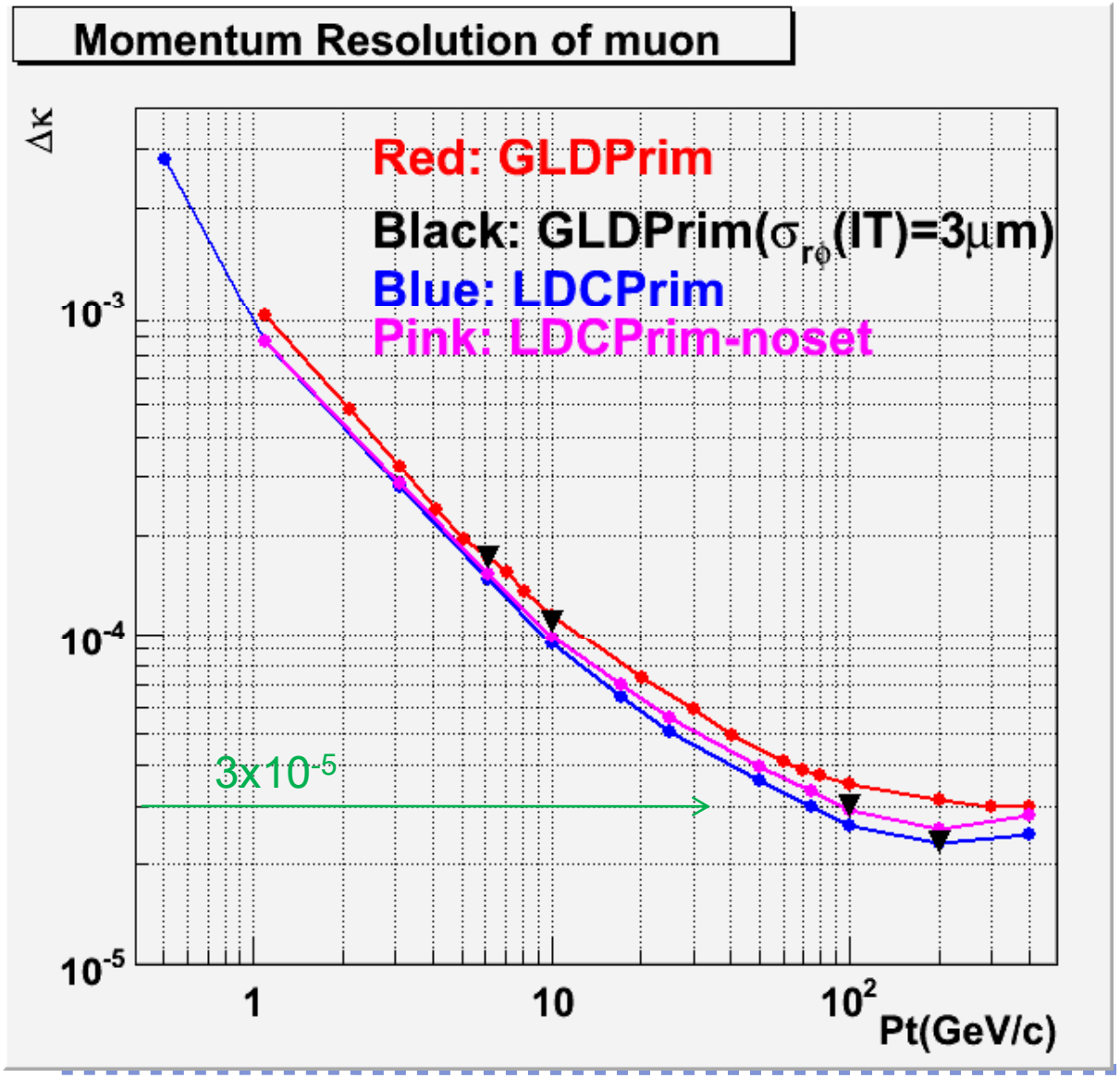




LDC01 : worse at high Pt
LDC-GLD : worse at low Pt

➔ Similar trends as Jupiter/Satellites

GLDPrim - LDCPrim



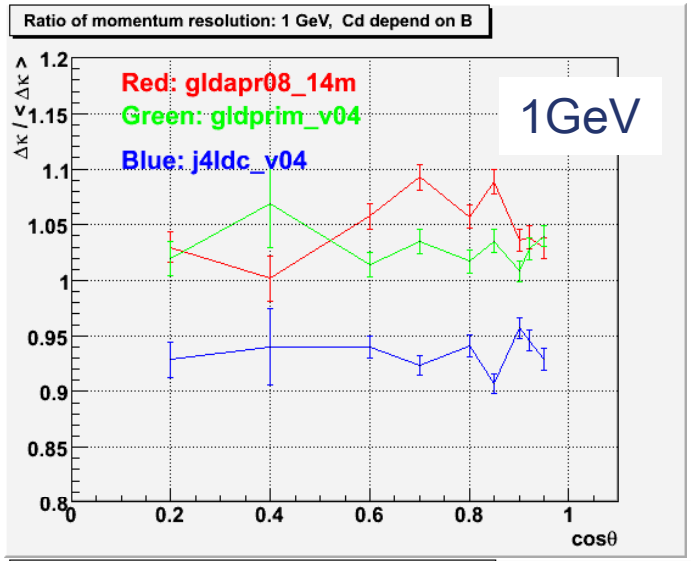
LDCPrim(Mokka+Pandora) is better than GLDPrim(Jupiter+Sattelites) by 15~30%.

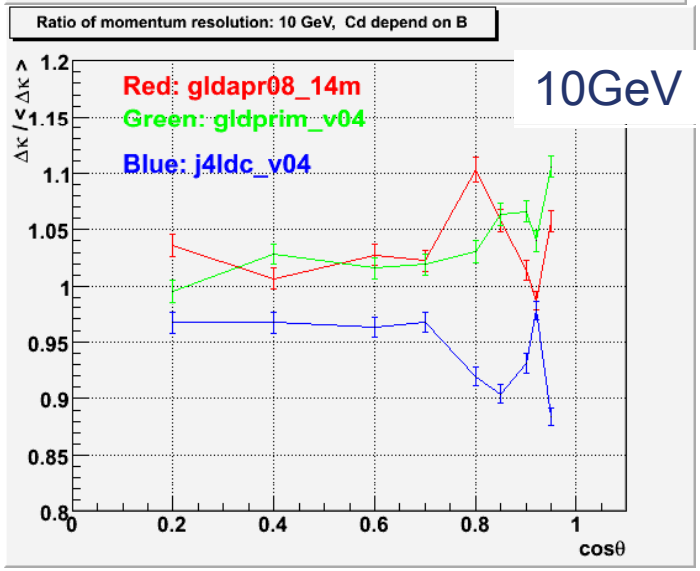
Possible source:

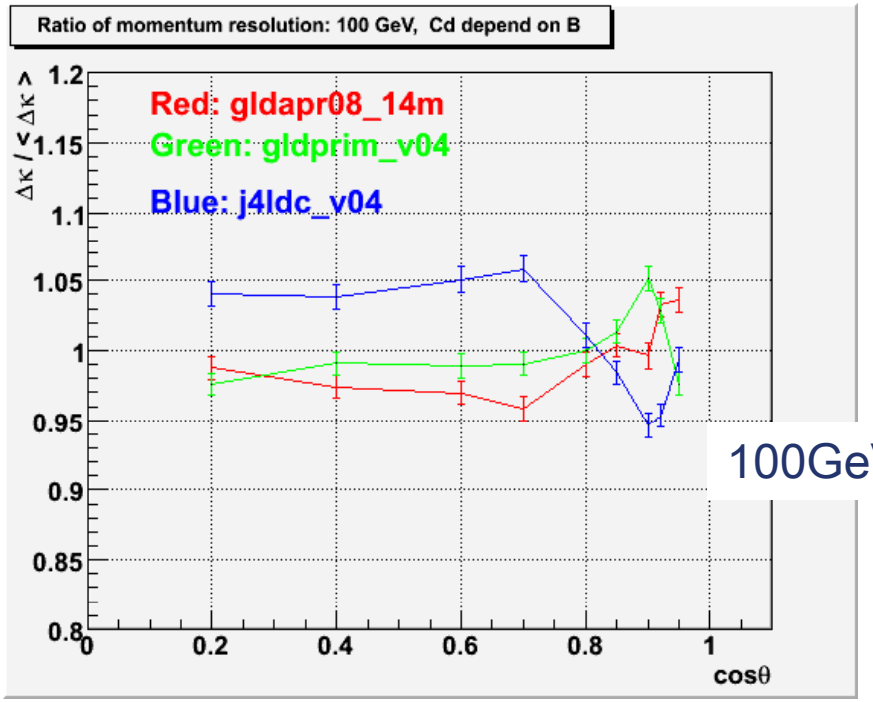
- $\sigma_{r\phi}$(IT) 3μm(LDCPrim) ⇔ 10μm(GLDPrim)
- Silicon External Tracker in Mokka

Sub-detector technology is more important than geometry

Δ(dPt/Pt) vs Cosθ Single Muon



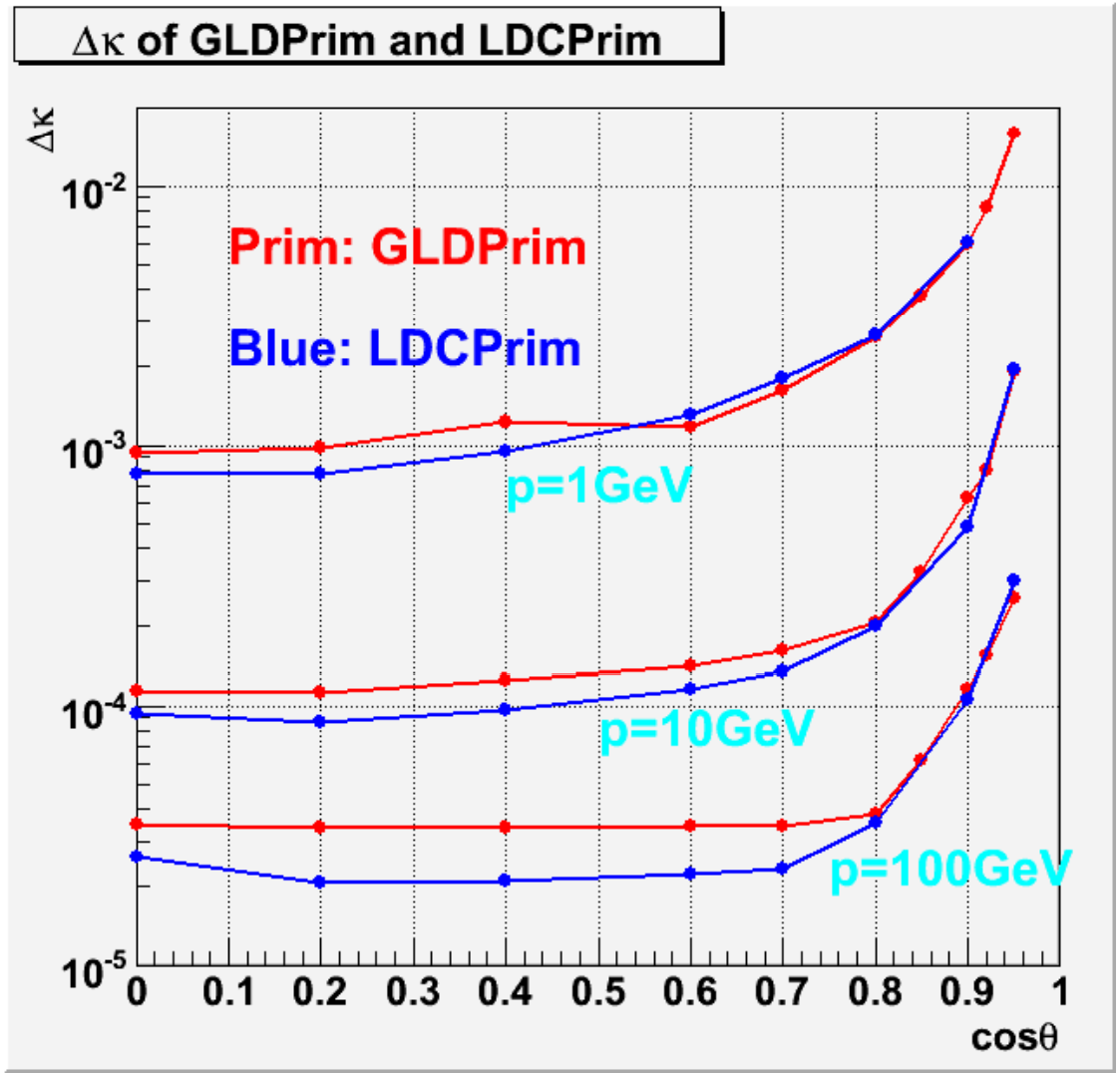




lowP → j4ldc better
highP → gld/gldprim better

±5 ~ ±10% differences

dPt/Pt vs Cosθ GLDPrim - LDCPrim

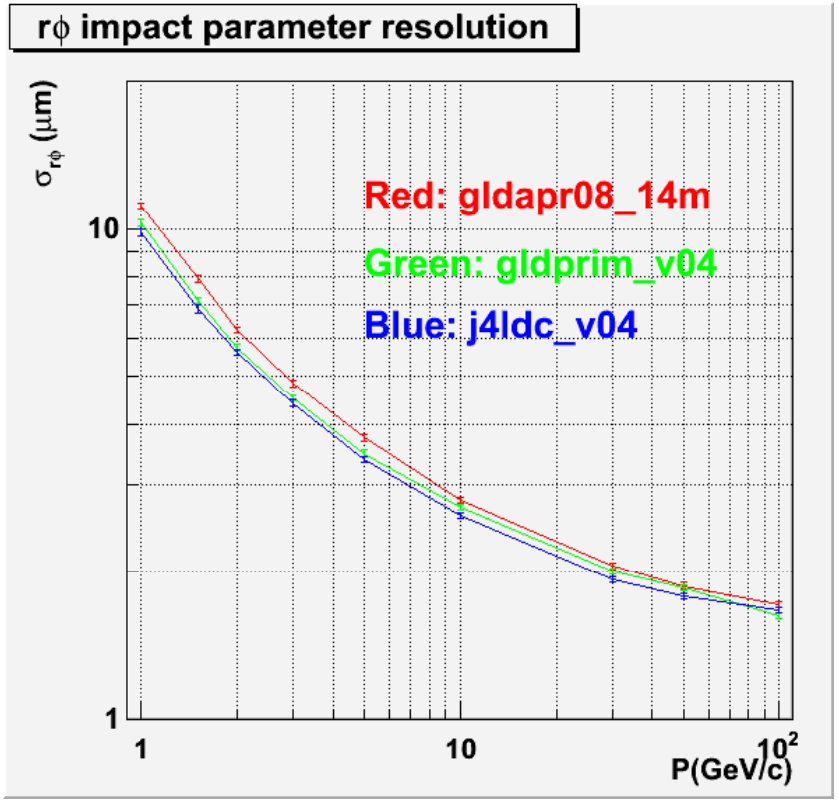


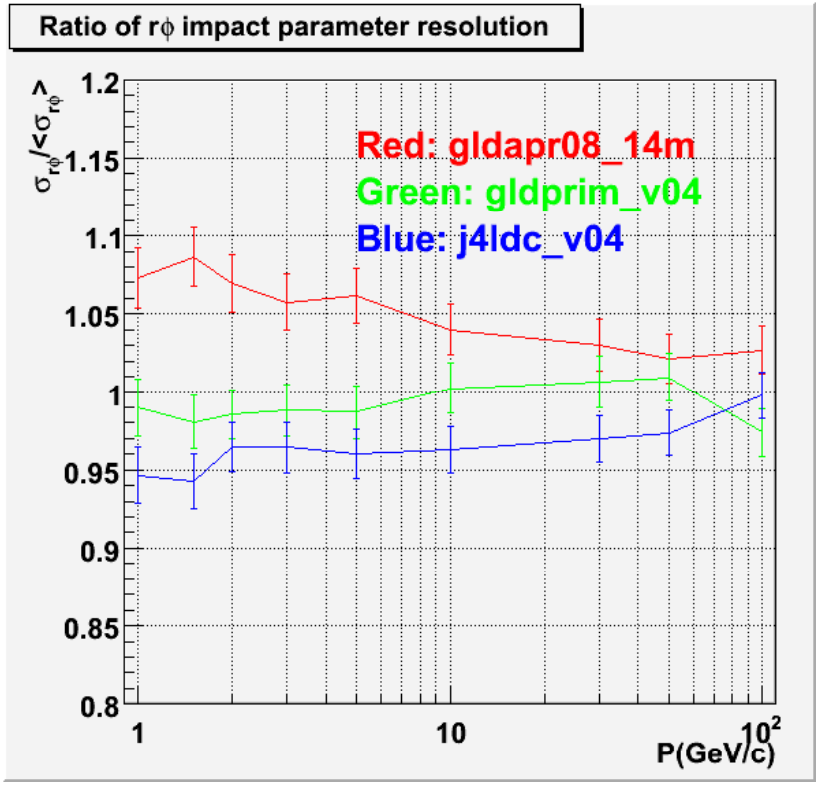
Difference smaller
in the forward region

Impact Parameter Resolution

Impact Parameter Resolution(P dep.)

Jupiter + Sattelites by K.Yoshida

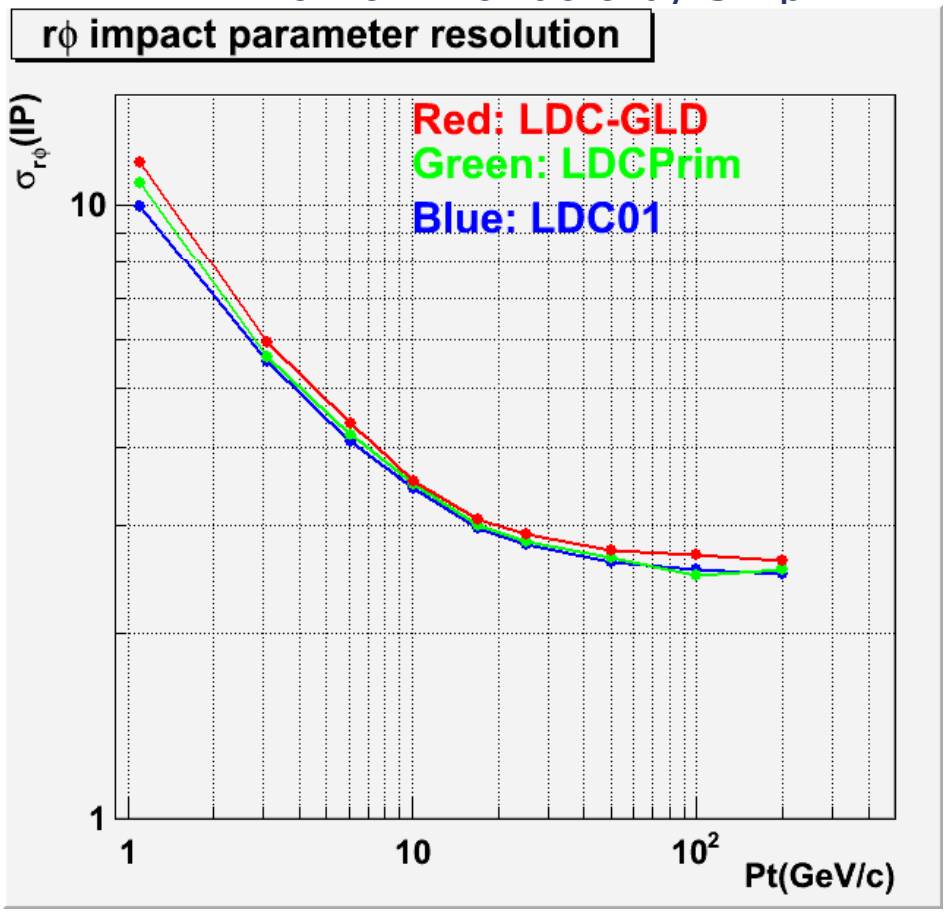


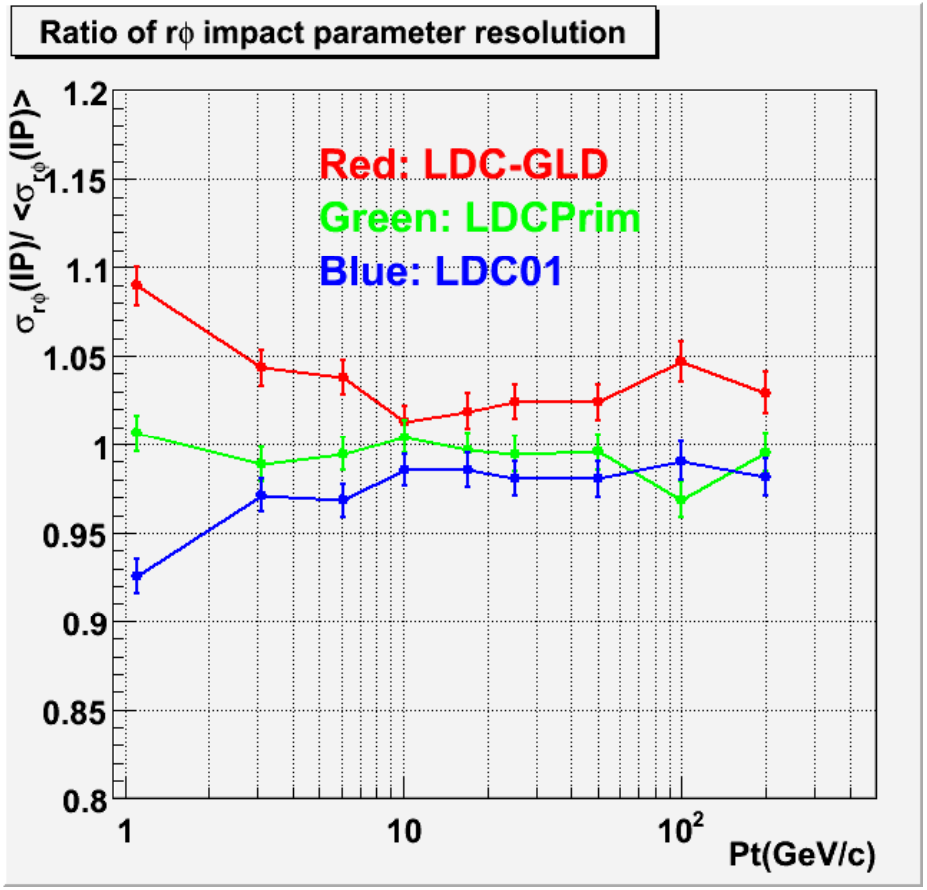


J4LDC is better by 5~10%, especially at low P.

Impact Parameter Resolution(P dep.)

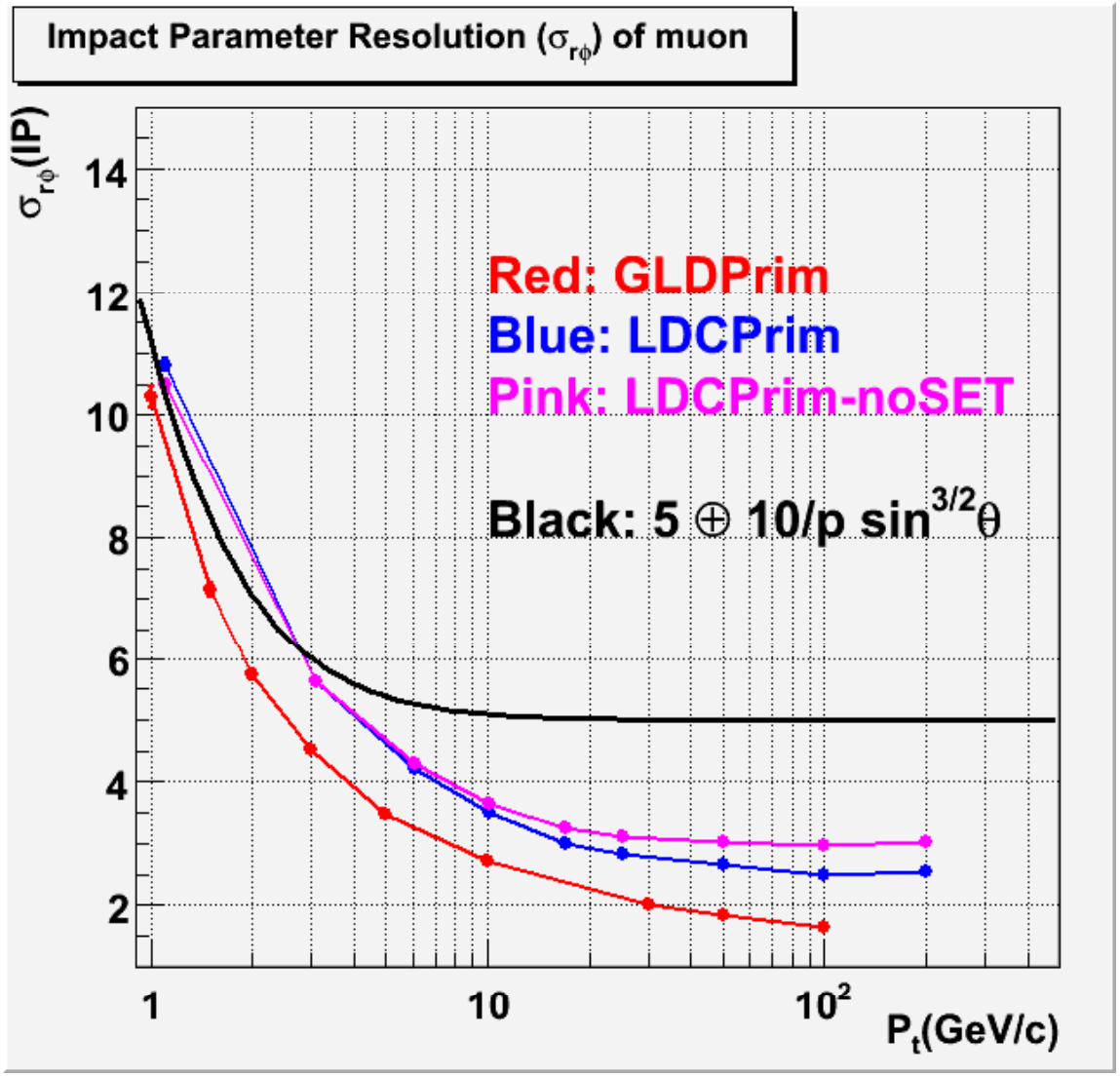
Mokka + Pandora by S.Aplin





Difference among models by Jupiter/Satellites and Mokka/MarlinReco are similar
LDC better by 5~10% at lowP.

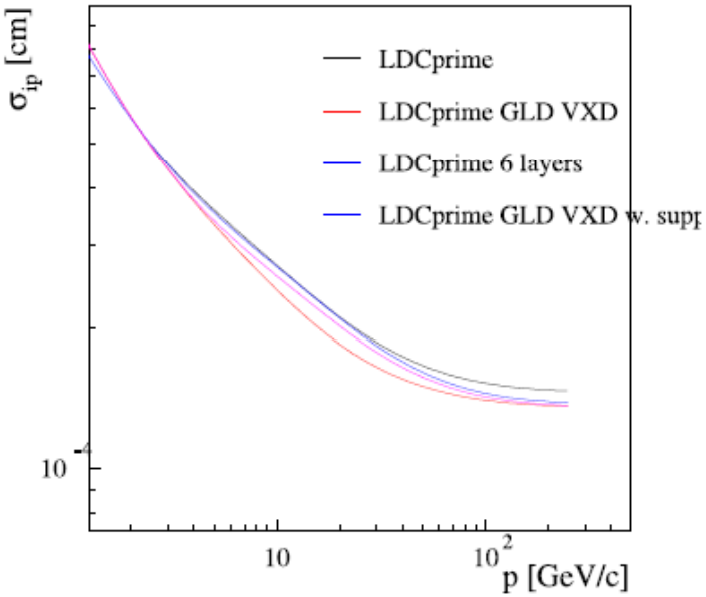
GLDPrim vs LDCPrim ($\sigma_{r\phi}$(IP))



■GLDPrim is better than LDCPrim ;

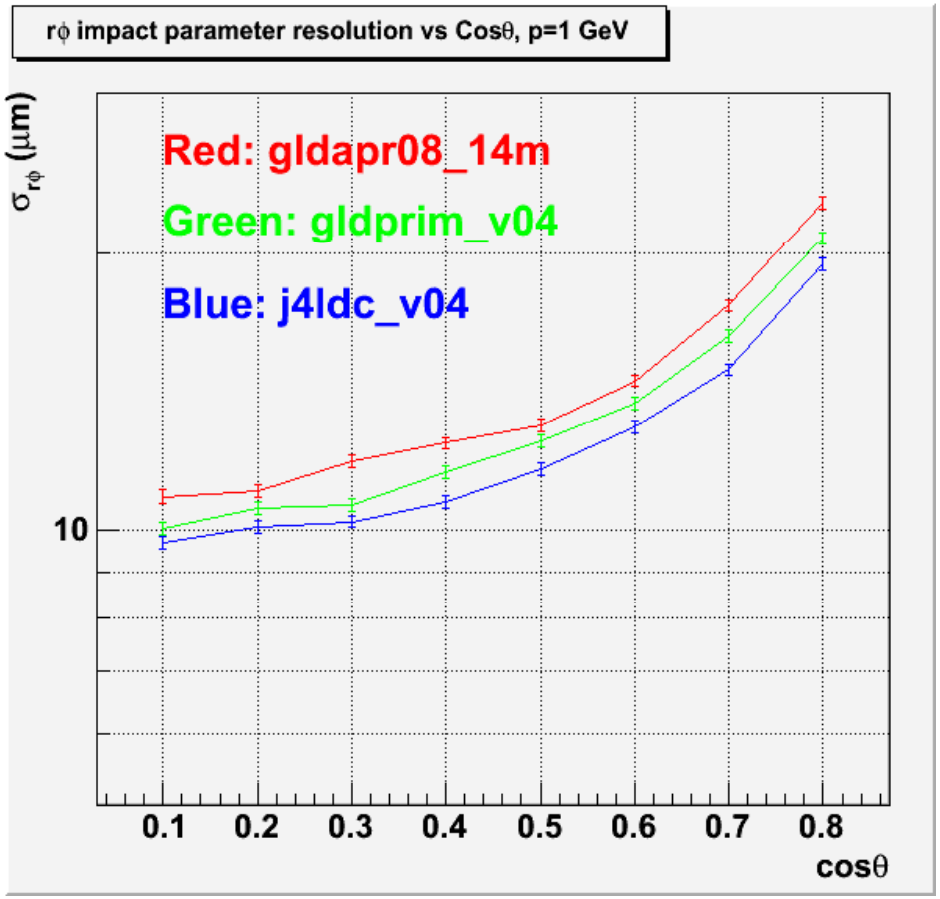
✓ 3 double layers vs 5 layers ?

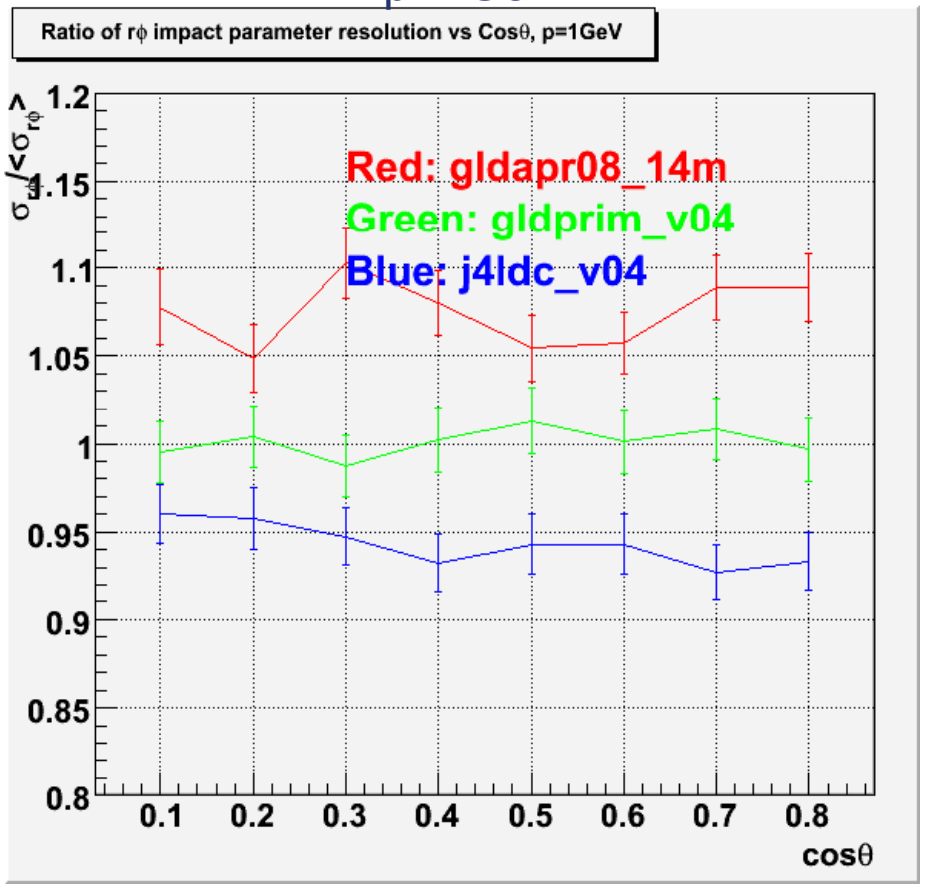
Fast sim. study by M.Berggren



Impact Parameter Resolution(θ dep.)

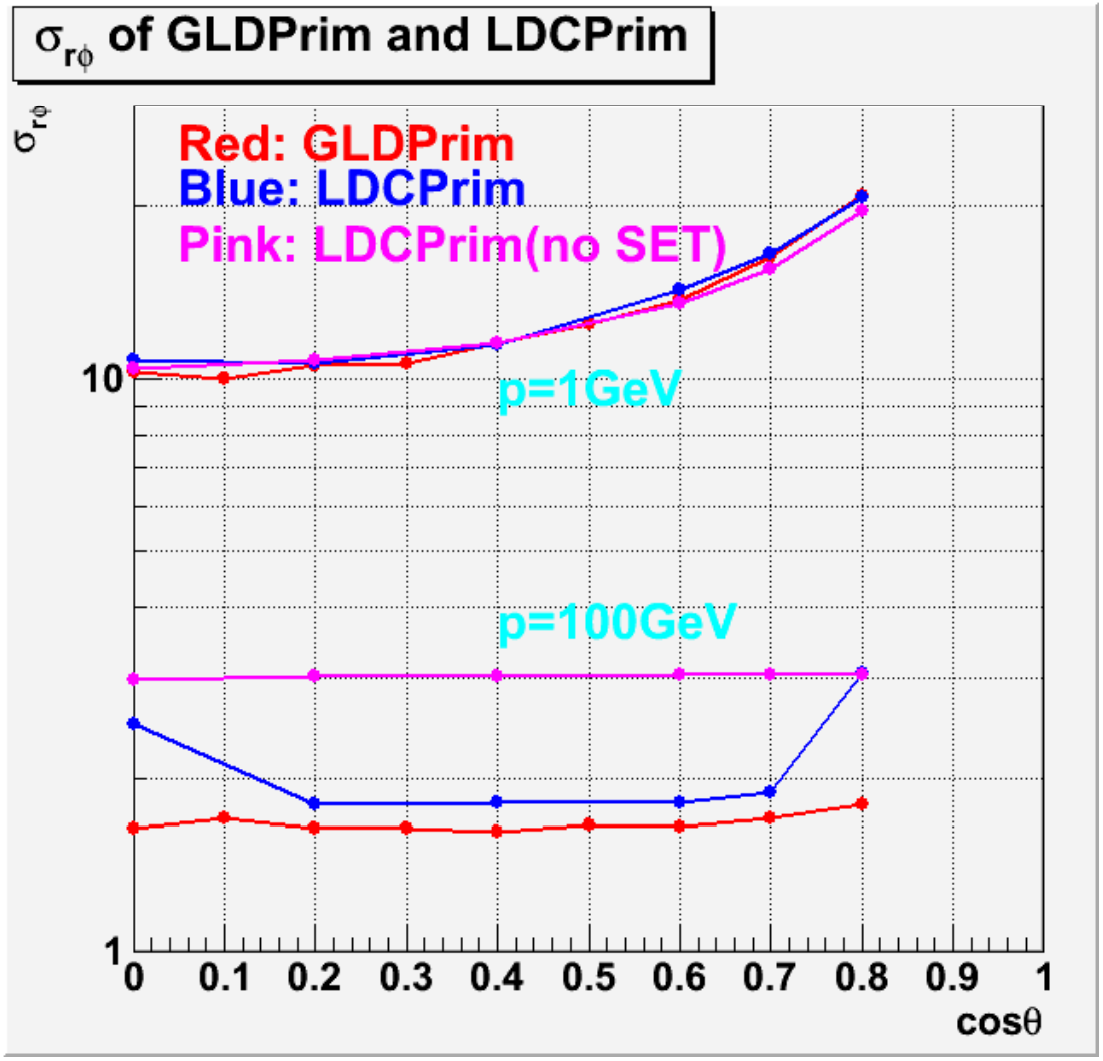
p=1GeV





Differences among gld/gldprim/j4ldc are ~15% at 1 GeV and smaller at H.E.

GLDPrim vs LDCPrim ($\sigma_{r\phi}$(IP))



At p=100 GeV, |cosθ|>0.0 less difference between GLDPrim and LDCPrim ??

Calorimeter
Energy Resolution

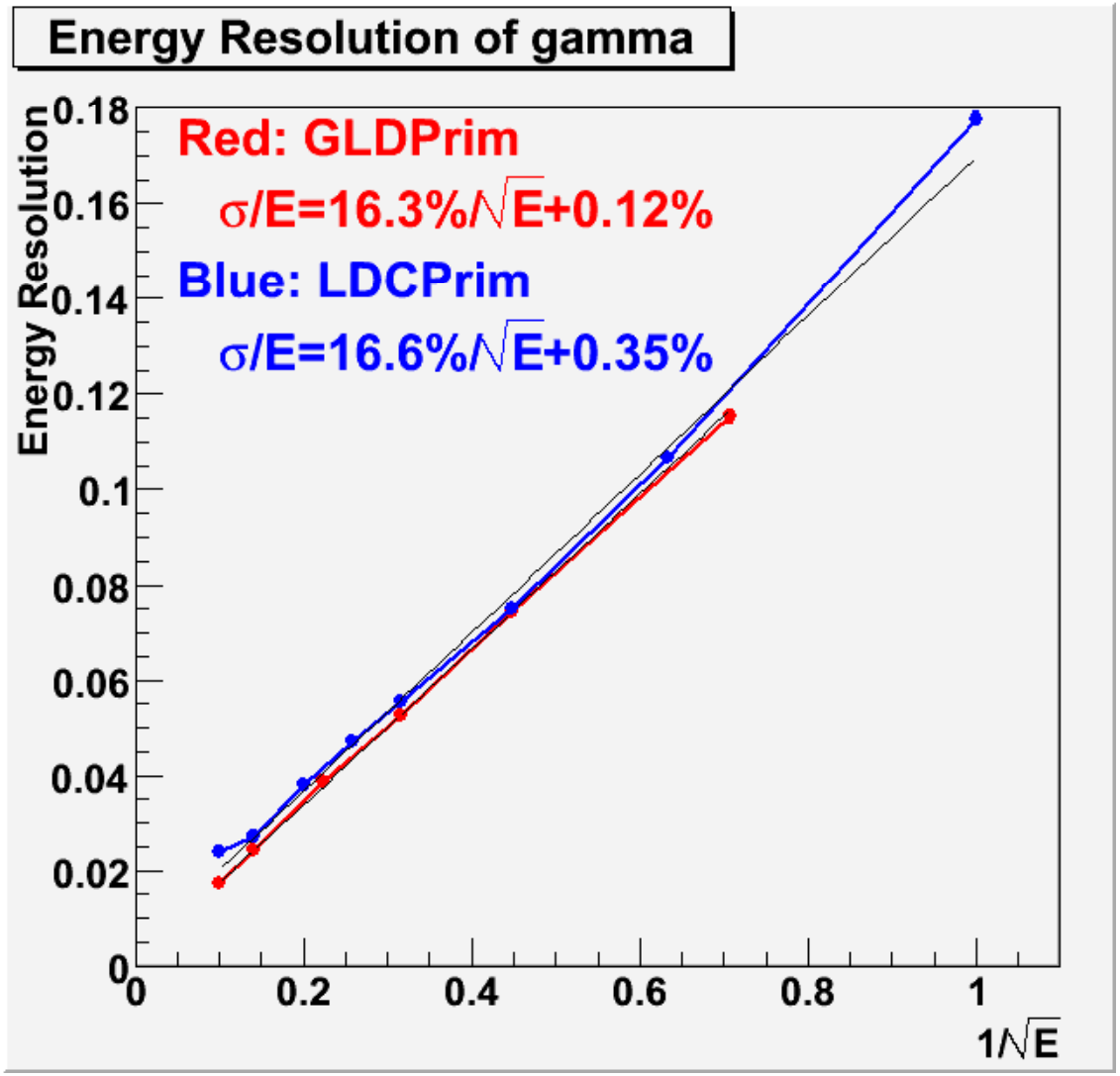
Jupiter/Mokka Calorimeter Parameters

		Jupiter	Mokka	Jupiter	Mokka	Jupiter	Mokka
Model Name		gldapr08	LDCGLD	gldprim	LDCPrime	j4ldc	LDC
B	T	3	3	3.5	3.5	4	4
ECAL Rmin	cm	210	2.02	185	182.5	160	161
ECAL # layers		33		33	20/9	33	
ECAL Rad.Length	X0	28.4		28.4	22.87	28.4	
HCAL # Layers		46		42	48	37	
Int. Length(Total)	λ	6.79		6.29	6.86	5.67	
HCAL Rmax		361.7		325.0	335.9	285.7	
Cryostat Rin		375		330	335.9	300	

ECAL(Jupiter): W(3mm) + Scinti.(2mm) + Gap(1mm), 12-sided no-gap
(Mokka):W(2.1mm/4.2mm)+Si(0.32mm), Gap(0.5mm), 8-sided, with-gap

HCAL(Jupiter): Fe(20mm)+Scinti.(5mm)+Gap(1mm), 12-sided, no-gap
(Mokka): Fe(20mm)+Scinti.(5mm)+Gap(1.5mm), 8(in)/8(out)-sided, no-gap

gamma Energy resolution



Same performance in all models.

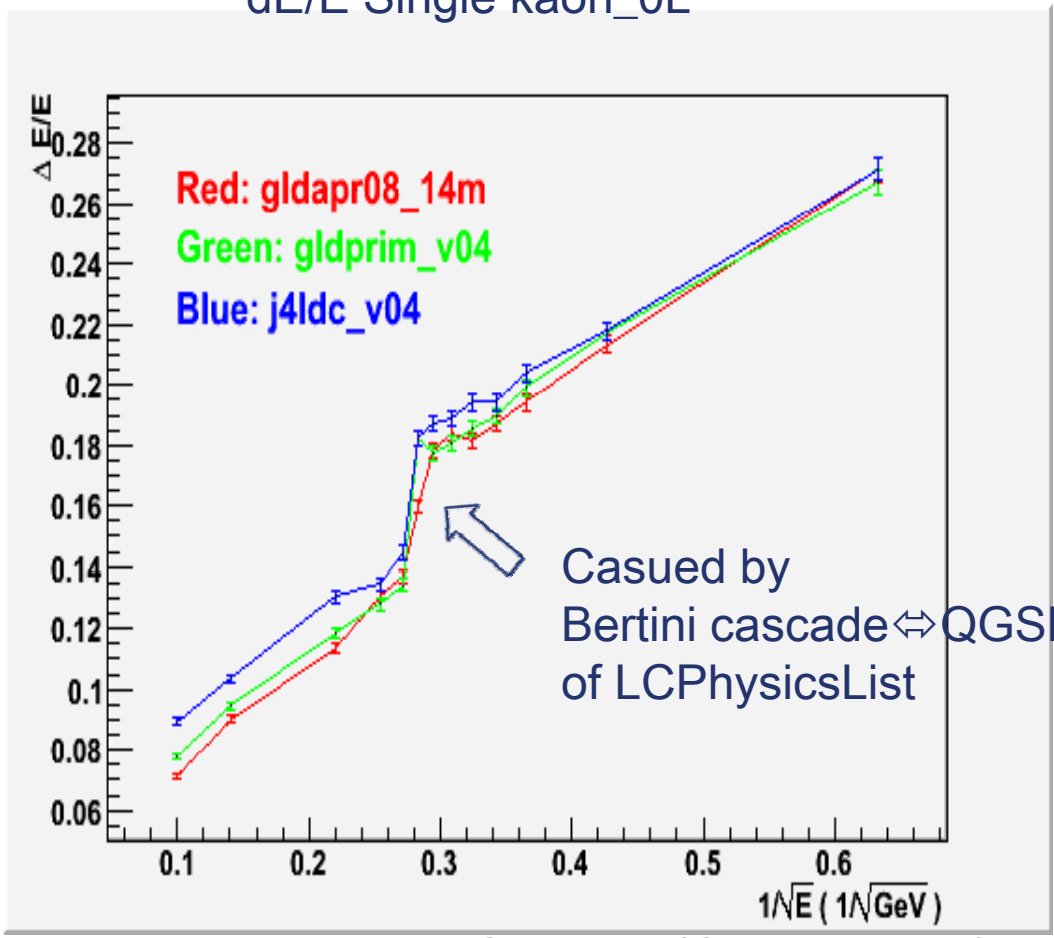
GLDPrim and LDCPrim same.

Calorimeter Energy Resolution for kaon_0L

Energy Resolution of kaon_0L

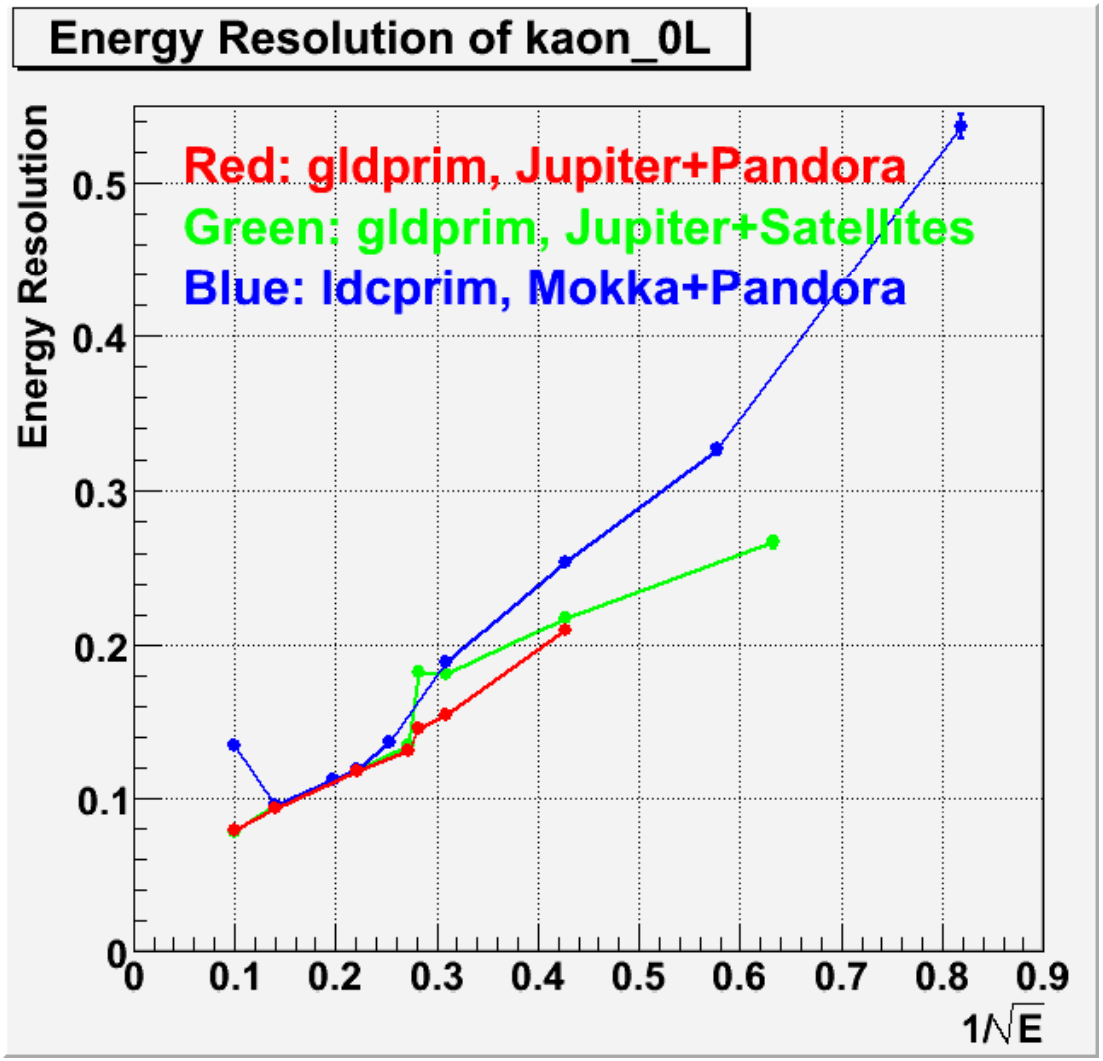
$|\cos\theta| < 0.5$

dE/E Single kaon_0L



Jupiter + Sattelites(Cheated PFA)

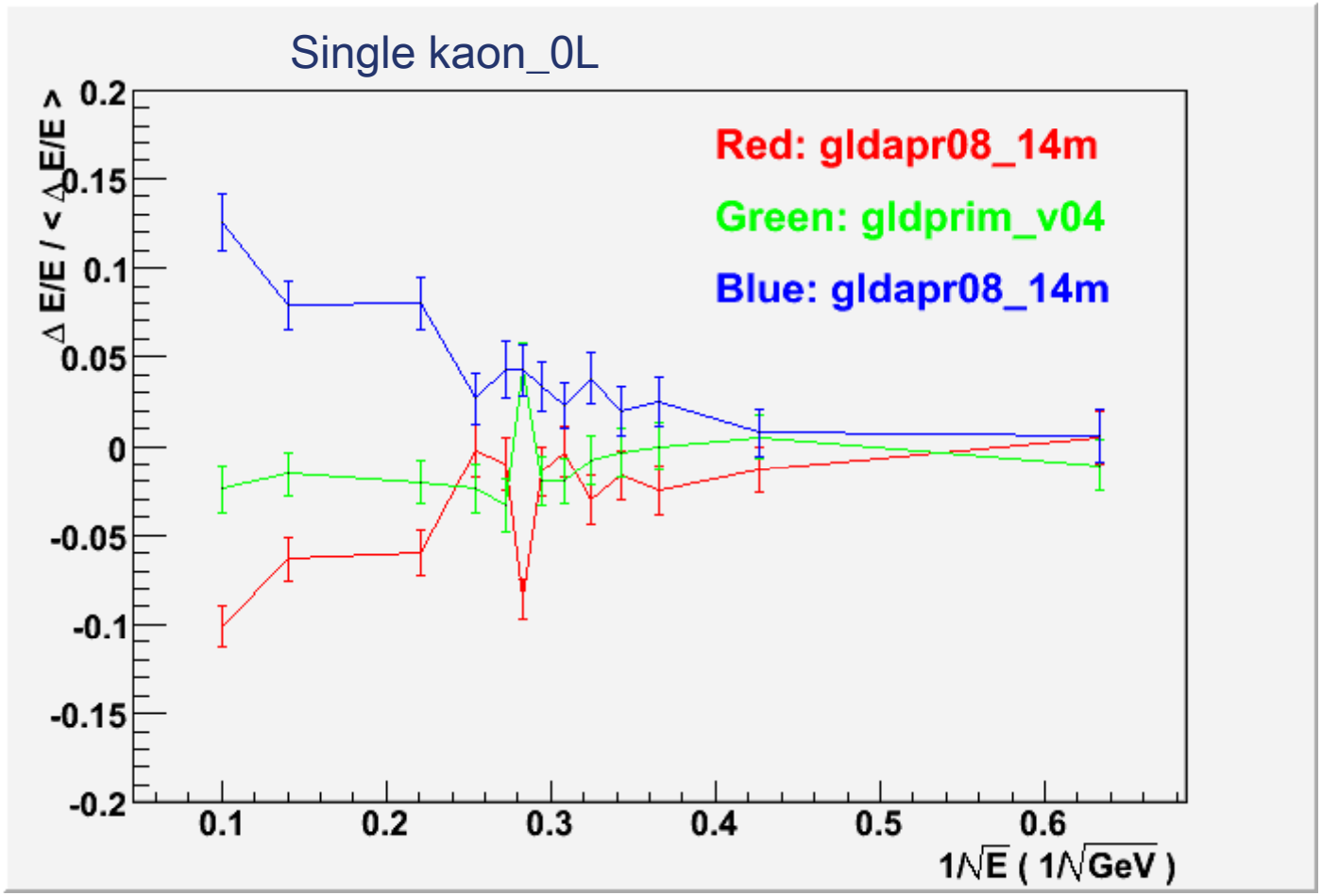
kaon_0L Energy Resolution



Not conclusive result.
- 12~13 GeV
- LE/HE behaviour

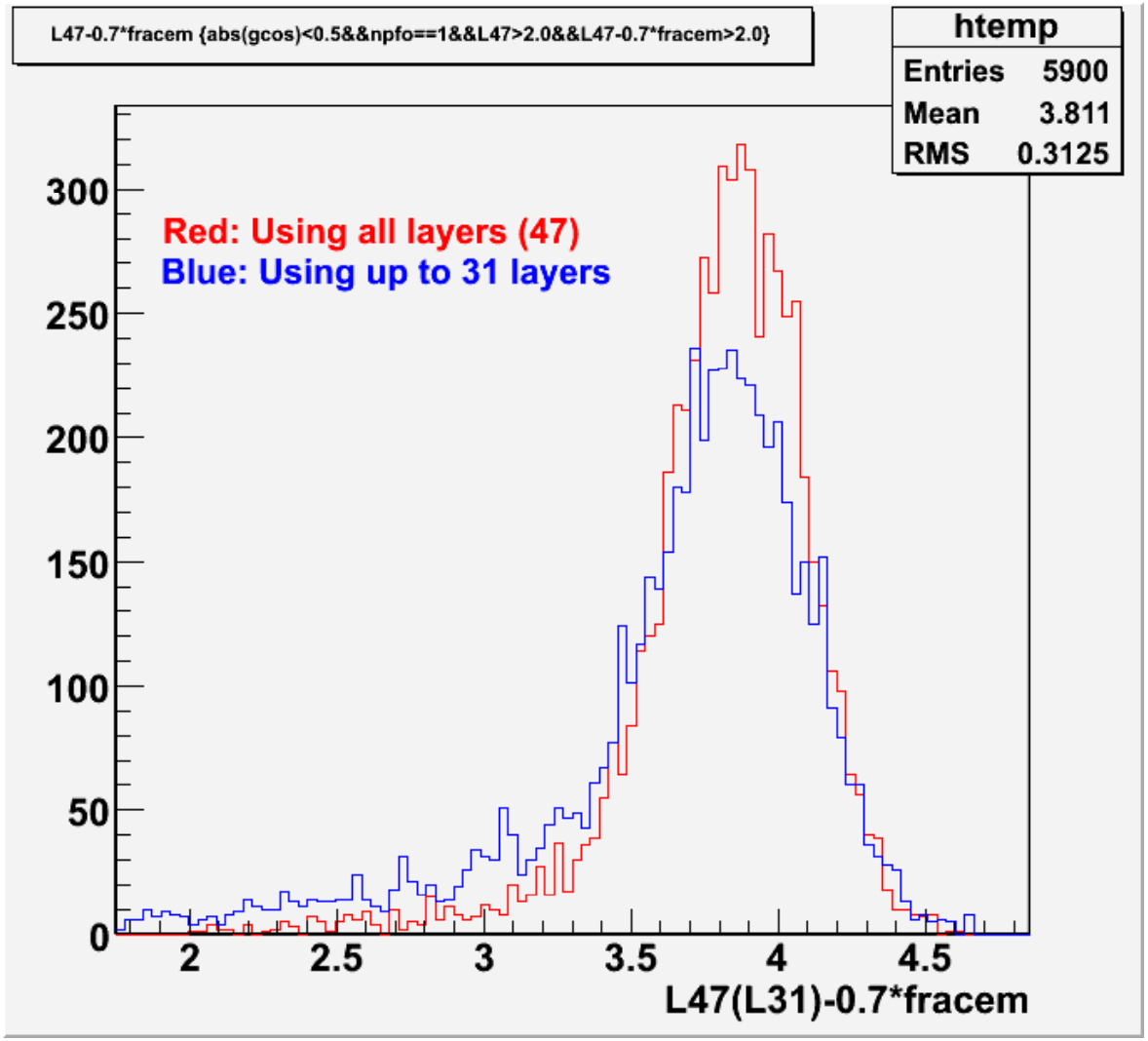
Clustering Algorithm ?

Point-by-point comparison



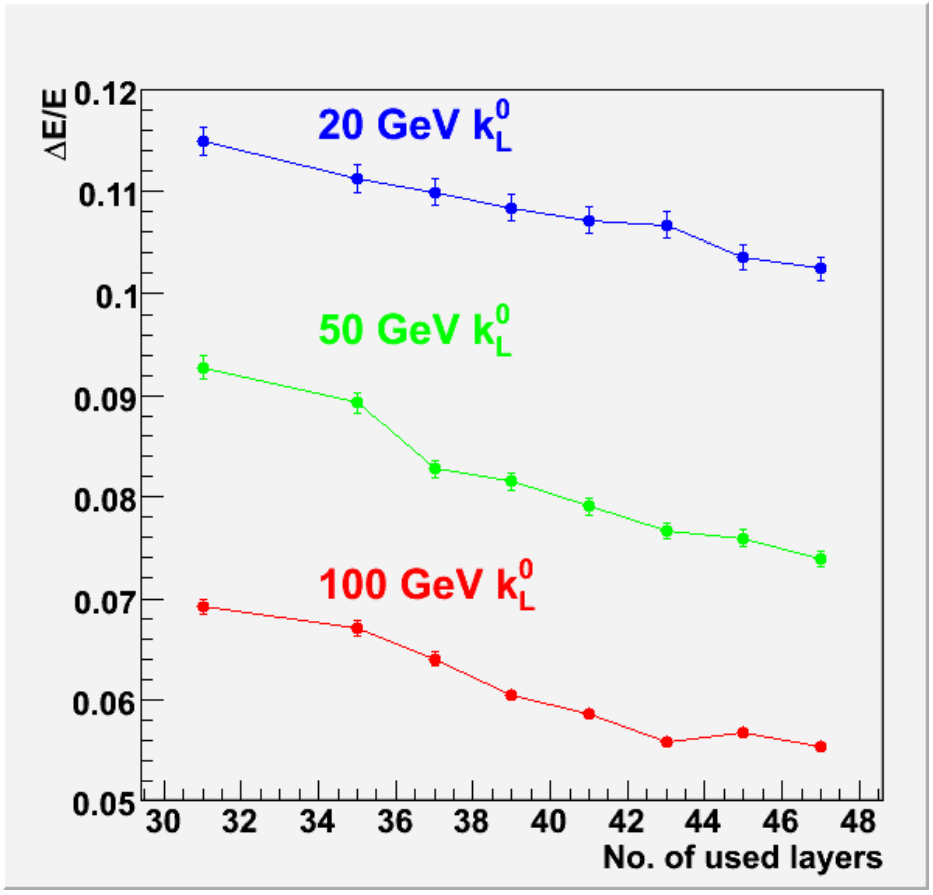
Same below ~ 10 GeV, difference at high energy → shower leakage

Pulse height distribution: All layers vs up to 31 layers (GLD)

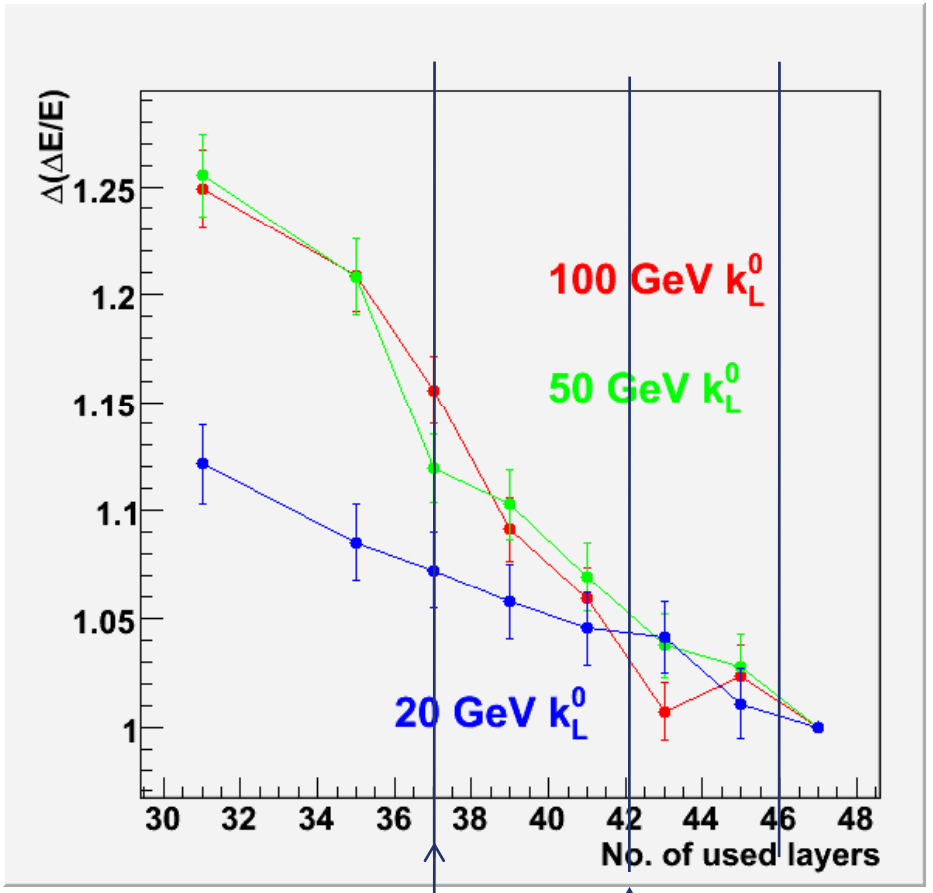


HCAL thickness

Resolution vs
used layers



Resolution relative to all layers



k0L, using gldapr08_14m data.

j4ldc
37 layers

gldprim
42 layers

gld
46layes

Summary

- Momentum Resolution of single muon
  - Mokka+MarlinReco and Jupiter+Satellites show similar trend.
    - 4T model is about 10% better than 3.5T/3T model below ~ 10 GeV.
    - 3T(3.5T) models is 5~105% better than 4T model above 10~ 50 GeV.
  - Sub-detector technologies are more important than geometry
    - LDCPrim is better than GLDPrim by 15 ~ 30%
      - w./w.o SET, $\sigma_{r\phi}$ of IT, … matters

- Impact parameter Resolution
  - Mokka+MarlinReco and Jupiter+Satellites show similar trend.
    - At 1GeV (100GeV), 4T model is ~15%(~5%) better than 3T model, 3.5 is in between
  - GLDPrim is better than J4LDC at $\cos\theta=0$.
    - Source of difference : 3 double layers better than 5 layers ?

Summary (cont.)

- Calorimeter by single particle.
  - Energy resolution of single γ:
    - Difference among gldapr08, gldprim_v04, and j4ldc_v04, LDCPrim are negligible
  - Energy resolution of k^0_L;
    - Resolution can not be determined by fit due to LCPhysicsList feature
    - By point-by-point comparison,
      - differences among gld/gld'/j4ldc below ~20 GeV is $\pm$5%
      - at 100 GeV, it is ~20% and can be explained by different interaction length
        GLD(6.79λ) ➔ J4LDC(5.67λ)