

D0 analysis update with (μ -Vertex) code

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More info in these blogs/pages:

<http://drupal.star.bnl.gov/STAR/blog/bouchet/2009/jun/01/muvertexcode>

<http://www.star.bnl.gov/~agerom/d0/blog/>

<http://www.star.bnl.gov/~jai2006/jjoseph/index.htm>

http://cnr2.kent.edu/~vanfossen/MySTARPage/D0_uVertexing/D0_uVertexing.html

<http://phys.kent.edu/~margetis/theses/LaHurd.pdf>

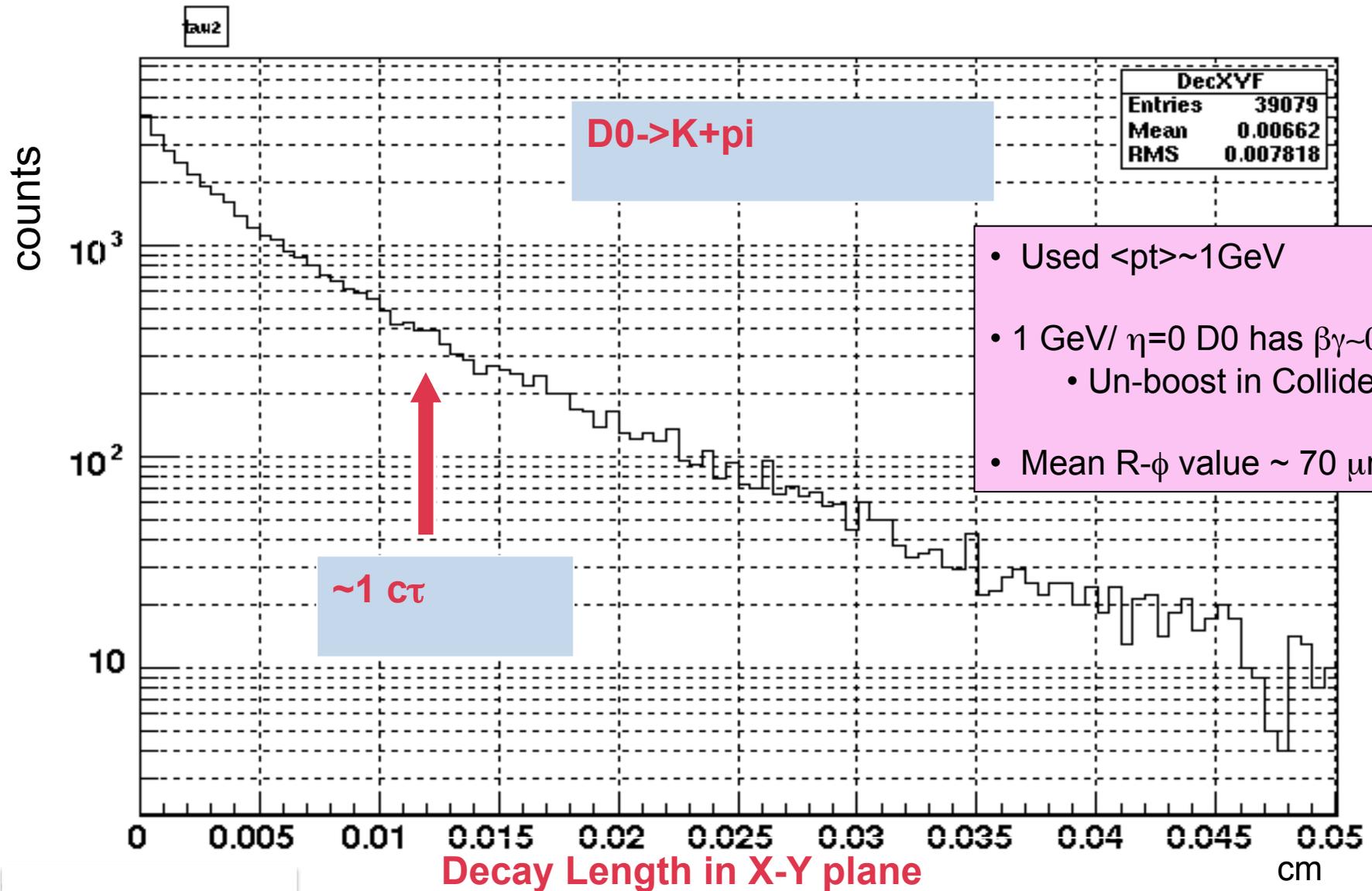
OUTLINE

- Why micro-Vertexing ?
- What is it? How is it implemented?
- Recent work
- What is next?

Why micro-Vertexing ?

- Very short lived particles
 - For a realistic D0 distribution at mid-rapidity ($\langle p_T \rangle \sim 1 \text{ GeV}/c$) the average decay length is 60-70 microns

D0 decay length



Why micro-Vertexing ?

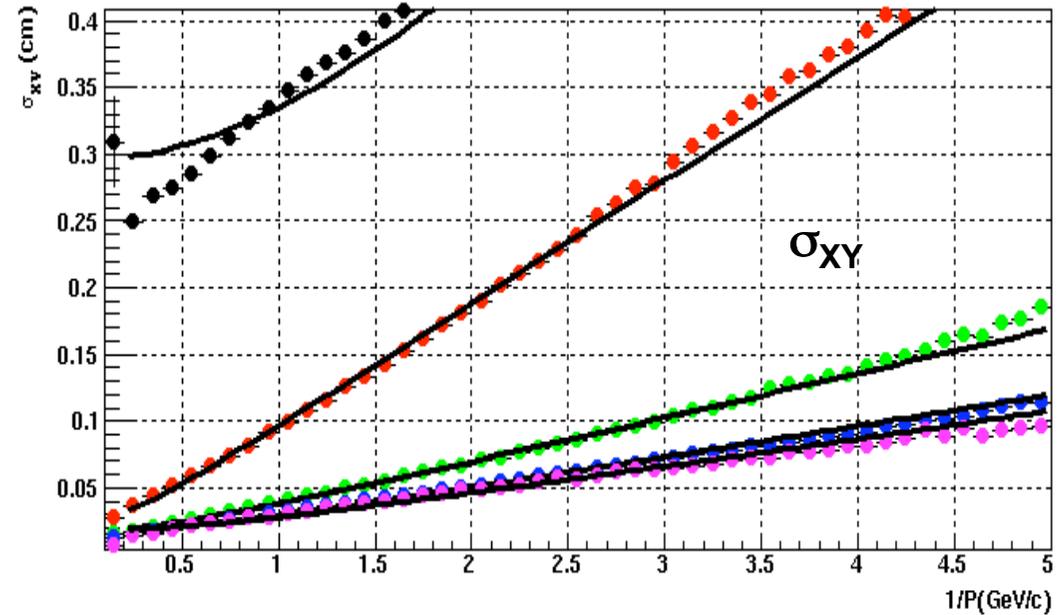
- Hard (fixed value) cuts are not optimal
 - Need to use momentum depended/correlated cuts otherwise one strongly biases result
 - One example is pointing (DCA) resolution

DCA resolution

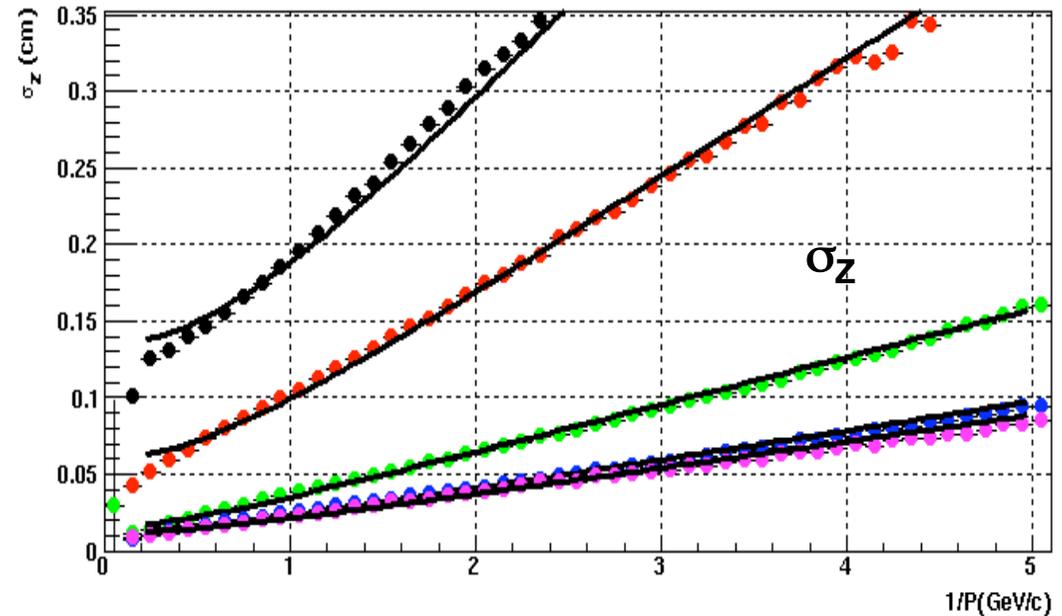
- Pointing (DCA) info is at least as important in μ Vertexing as dE/dx to PID people !!

Number of Silicon Points fitted to track	σ_{XY} @1GeV/c (μm)	σ_Z @1GeV/c (μm)
0 - ● TPC only	3350	1184
1 - ● TPC+SSD	967	993
2 - ● TPC+SSD+SVT	383	351
3 - ● TPC+SSD+SVT	296	232
4 - ● TPC+SSD+SVT	281	212

Sigma of dcaXY versus 1/p



Sigma of dcaZ versus 1/p



Why micro-Vertexing ?

- Need to use full track info
 - Full covariance/error matrix
- Need to have track info inside beam pipe
 - So that helix hypothesis is exact solution
 - So that error matrix is optimal w/out new-material terms
- This should be the way to do this analysis; it is in HEP
- This should be the way of the (HFT) future

What is it? How is it implemented ?

- TRACKING ('OLD')

- Find Global Tracks -> **Save info @ first measured hit**
- Find Vertex
- Fit/Find Primary Tracks

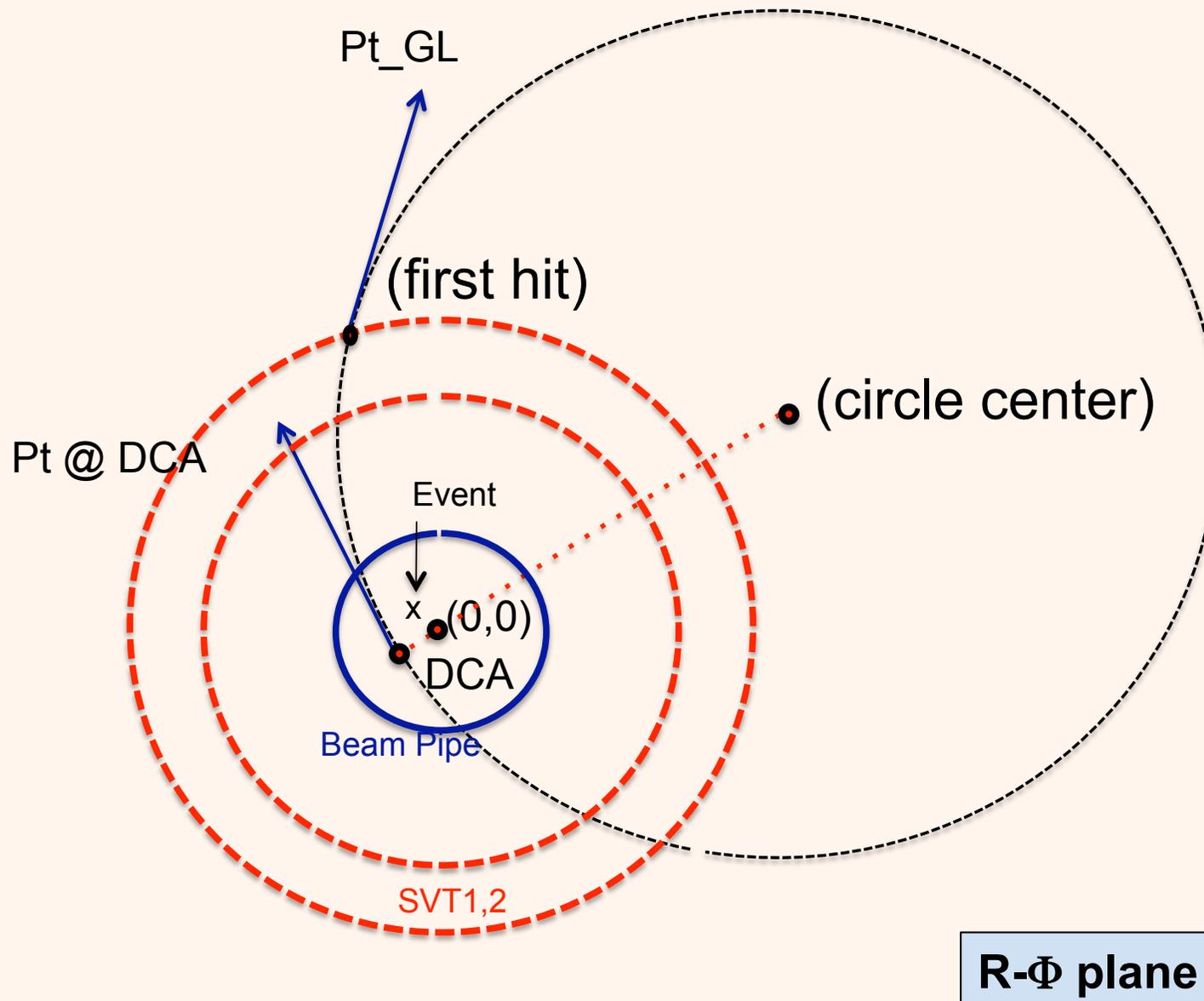
- TRACKING ('NEW')

- Find Global Tracks
- **Move them through all material to beam pipe center $(x,y)=(0,0)$**
- **Save FULL track/error info -> DcaGeometry**
- Use THIS for secondary vertex searches

- This info is in MuDst starting with Run-7 Au+Au data

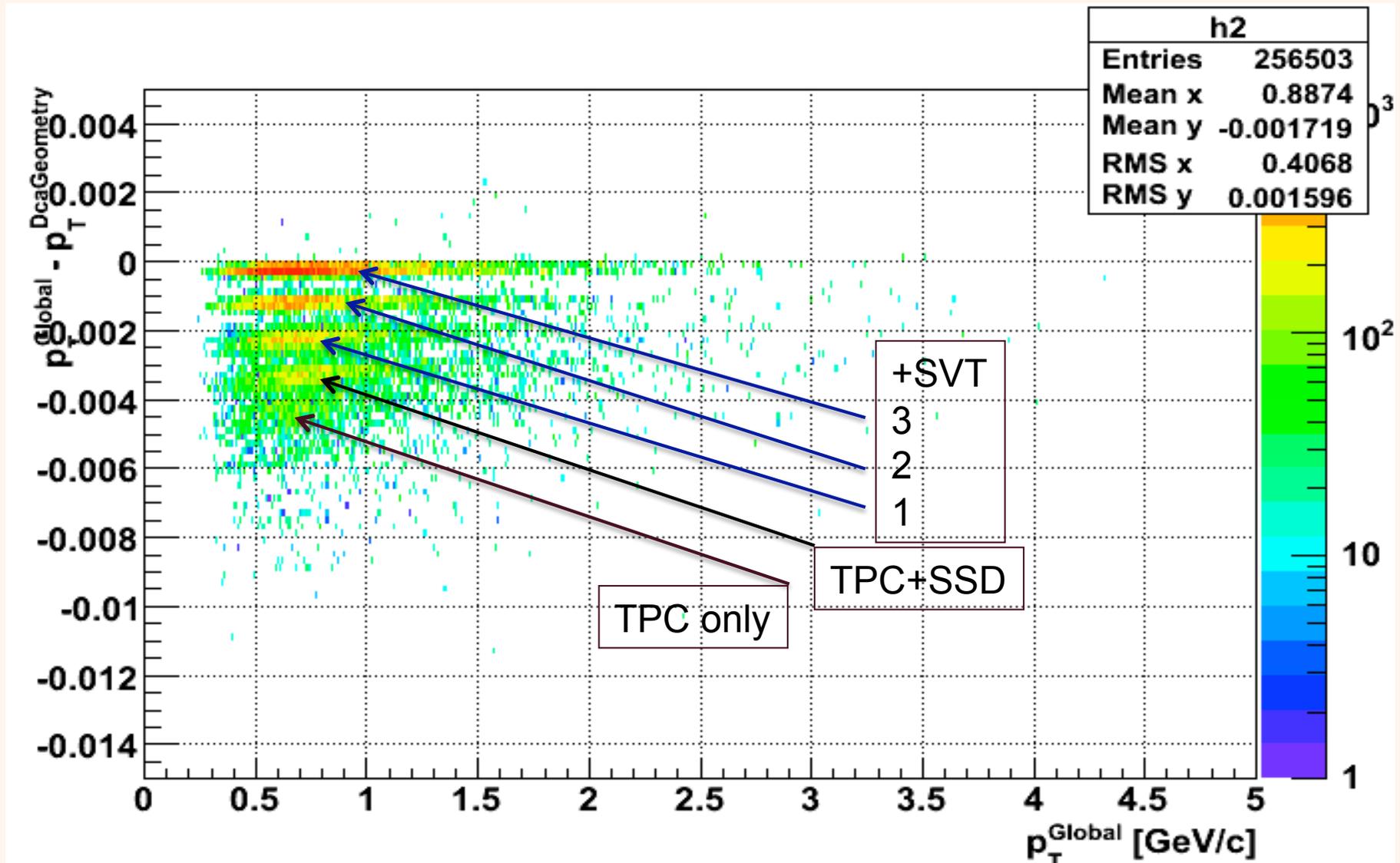
- For optimal silicon analysis
- We can always retrofit Cu+Cu

DcaGeometry



DcaGeometry

- P_T grows as we move backwards
- Errors/cov-terms change too
- No-huge but finite effect



Recent Work

- CUTS - CUTS - CUTS

- Detailed mapping of cut-variables distributions for Signal, Background
- + Resolution of variables (important when setting cuts)
- Important MC machinery and correlation/evaluation machinery developed
- This is the heart of the game...the smart cuts win it all !

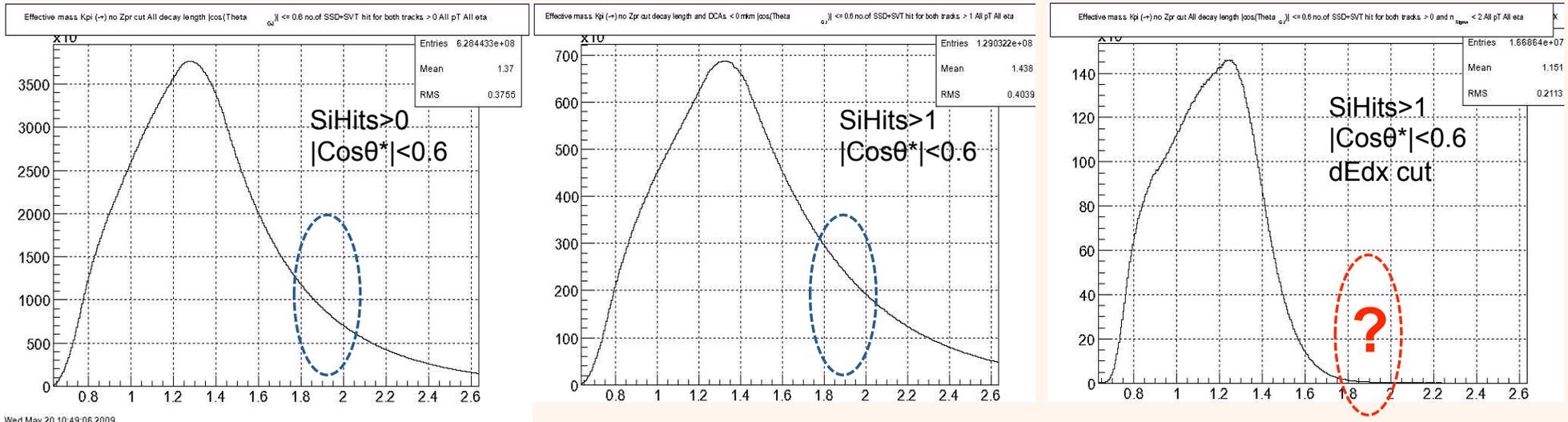
- Things we found while doing this

- dE/dx cut was too restrictive, conflicting kinematically with other simple cuts thus eliminating the signal even in pure/MC D0s !
- PID (dE/dx) inefficiency introduces signal (D0-D0bar) cross-talk
- Similar evidence that secondary vertex fit had similar problems. The use of simple signed decay length cuts resulted in signal elimination even in MC D0s !
- We decided to investigate further the full DCA/decay length machinery
- Since our expected resolution is ~ 200 microns and the decay vertices ~ 100 microns we boosted the lifetimes of MC-D0s by $\times 100 \rightarrow 1.2$ cm to be able to disentangle errors from resolution effects

Recent Work

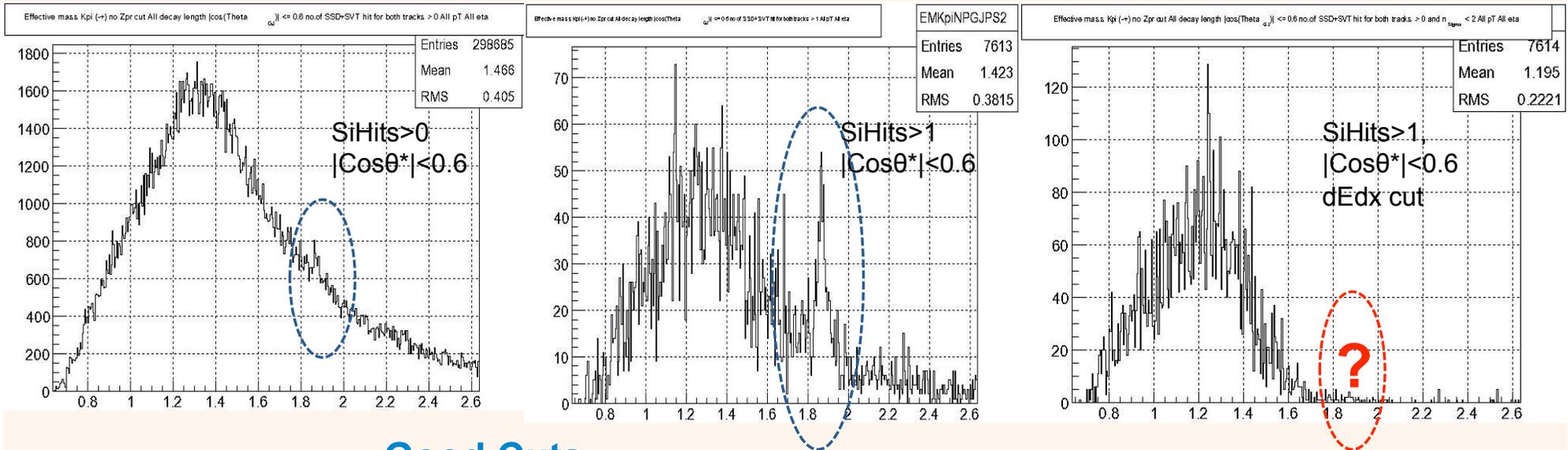
Examples of Previous D0 Reconstruction with MuKpi

Real Data - Full Statistics (50M):



Something is Wrong

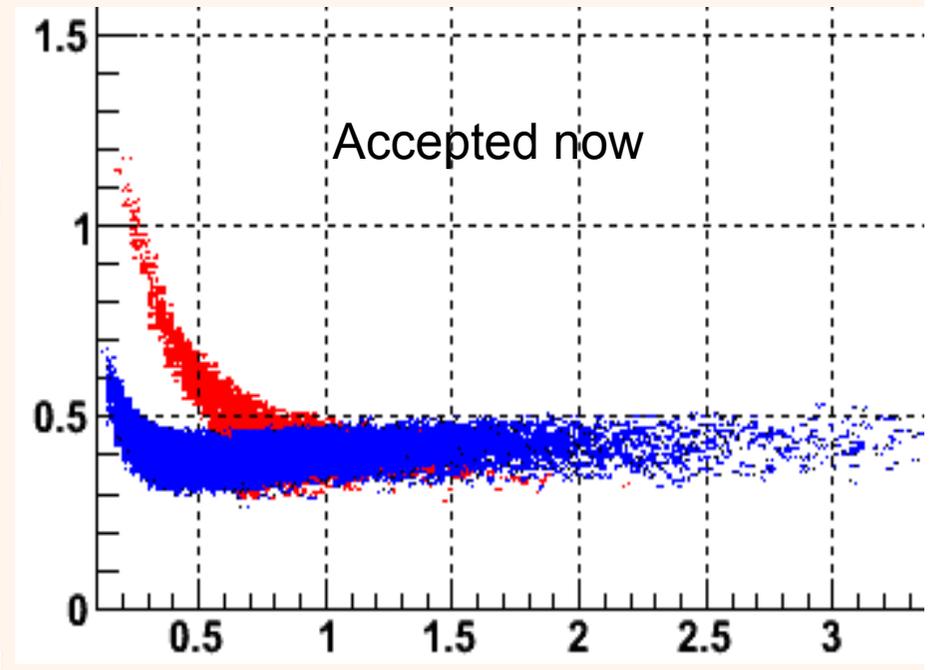
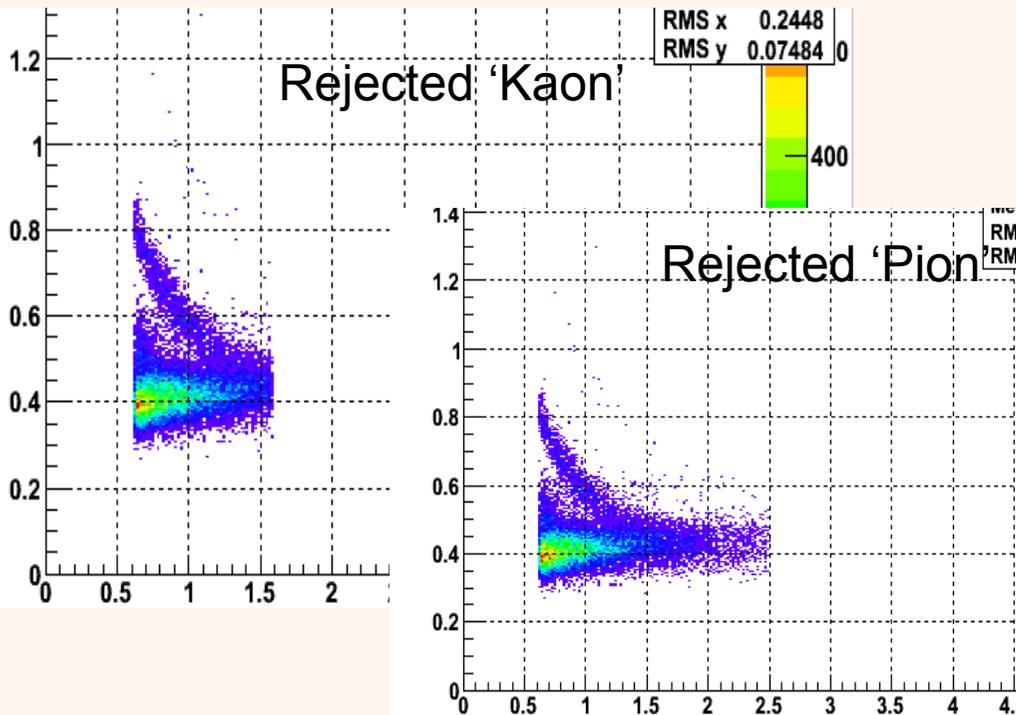
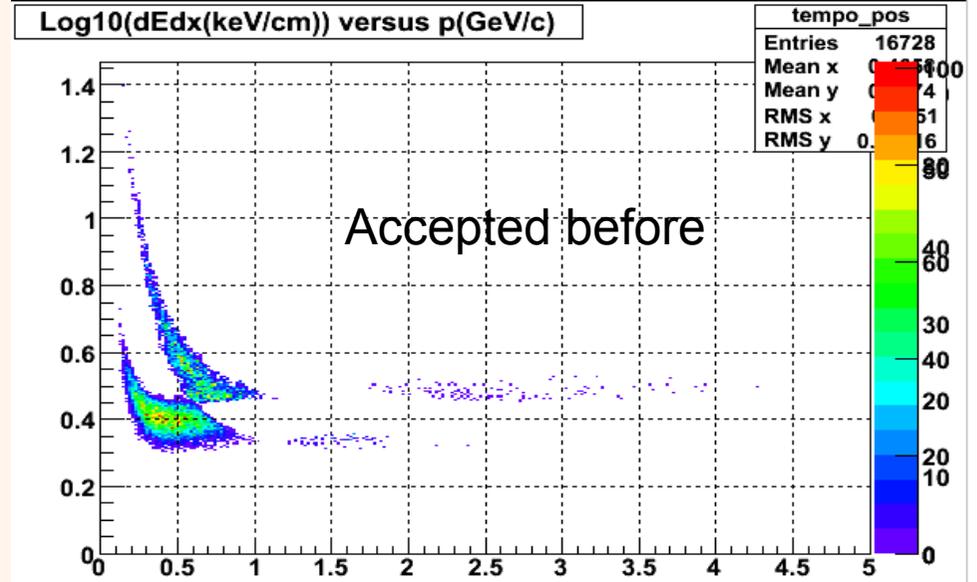
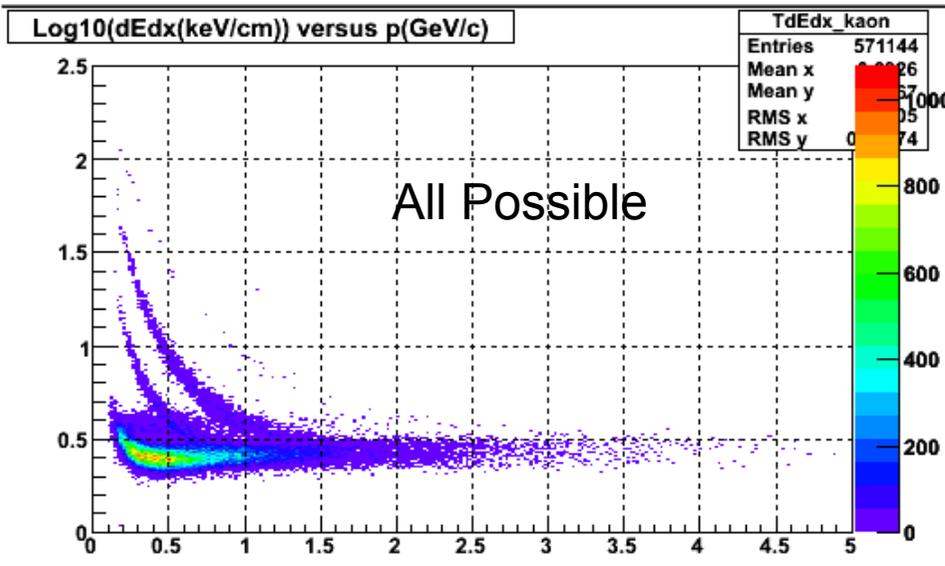
Embedded Data:



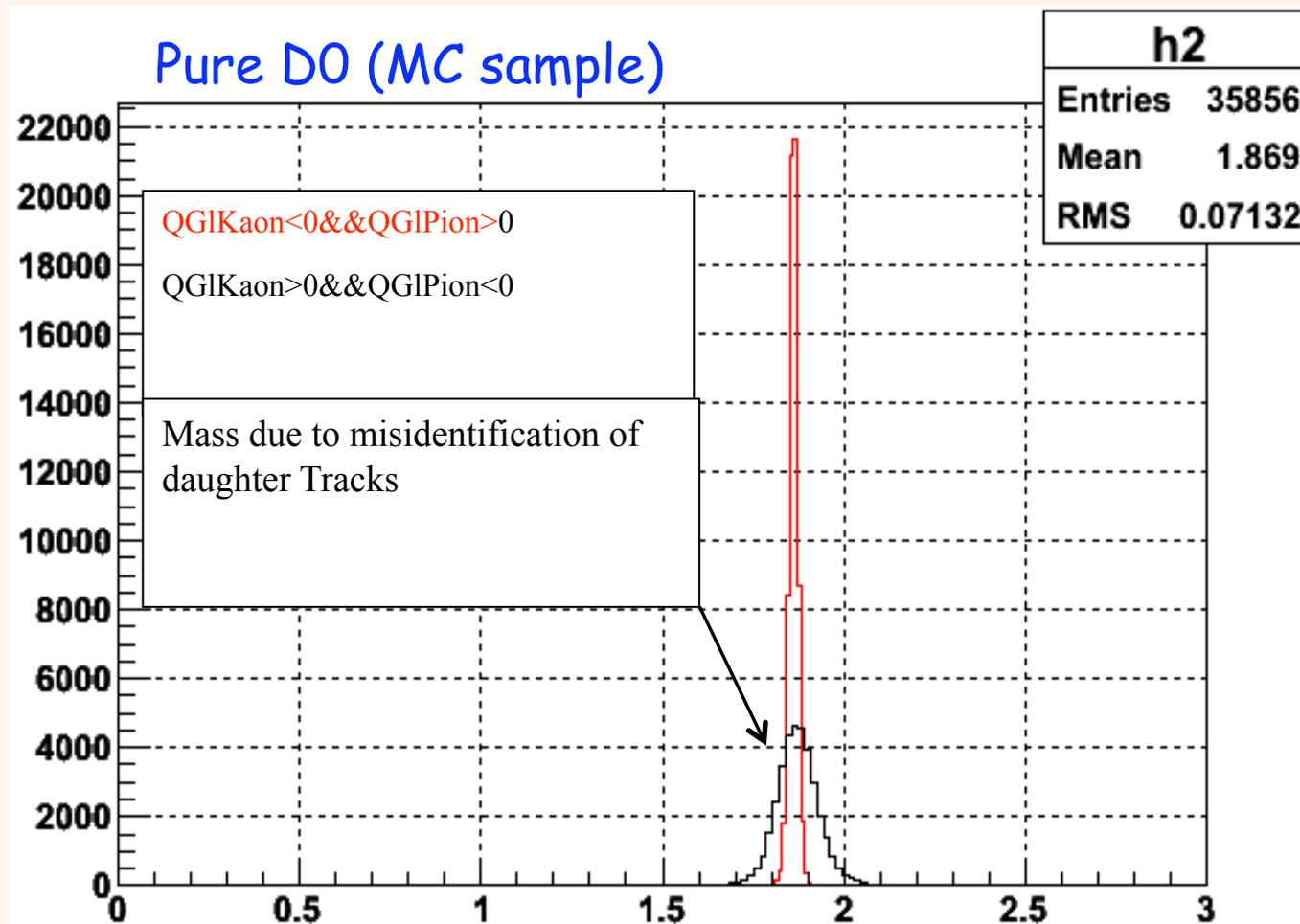
Good Cuts

Recent Work

Optimizing the dEdx cut



Recent Work

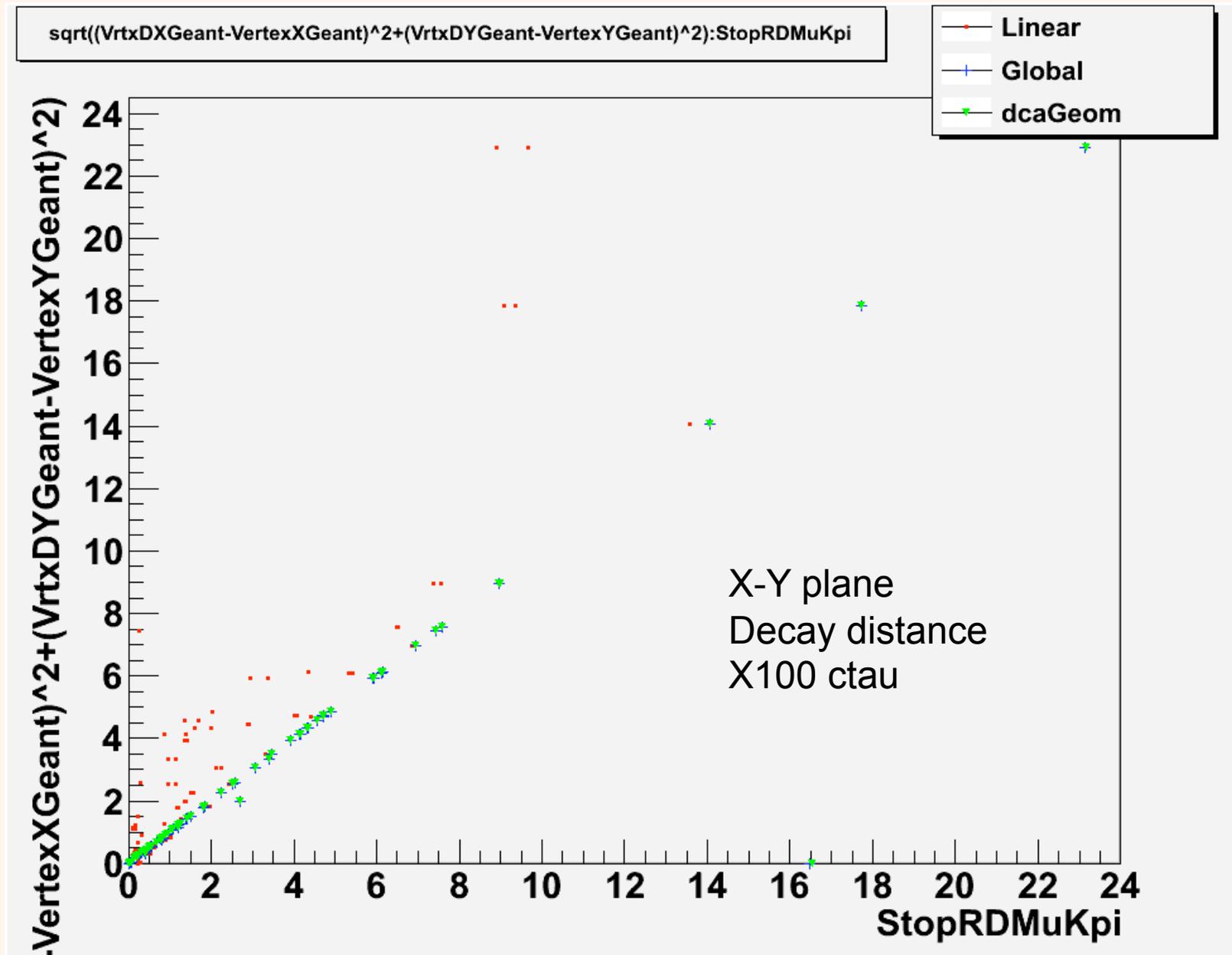


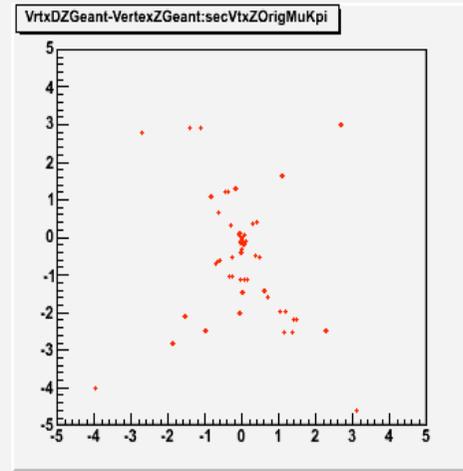
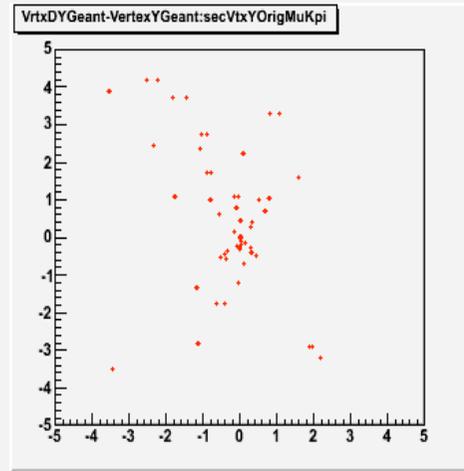
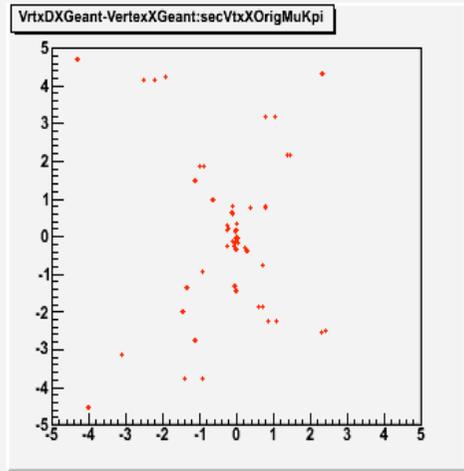
- PID mis-identification makes a D0->D0bar and vice-versa
- This introduces a pseudo-enhancement in signal region inv.mass
- Wider mass due to wrong kinematics
- Needs to be evaluated via Embedding

Fitting approaches for secondary vertices

- We investigated 3-methods
 1. A Linear Fit approach (default in MuKpi). Three-line fit with errors (two tracks plus a parent from the event vertex).
 2. A Helix swimming to DCA of the two track helices (VO-like)
 3. A Full Helix Fit with errors
- Things we found while doing this
 - Global track info is given at first hit point. This can be too far from real vertex for method-1 to be a good approximation. Method-1 should be fine if one uses the DcaGeometry info
 - Methods-2/3 are doing a good job even with regular global info. We expect them to do better with DcaGeometry info
 - We ultimately plan to use method-3 (and -2 as a backup) with DcaGeometry. The latter (-2) is already implemented and under testing. Yuri is going to adapt method-3 to DcaGeometry this month
- One this is done there is only full production and cut-playing left

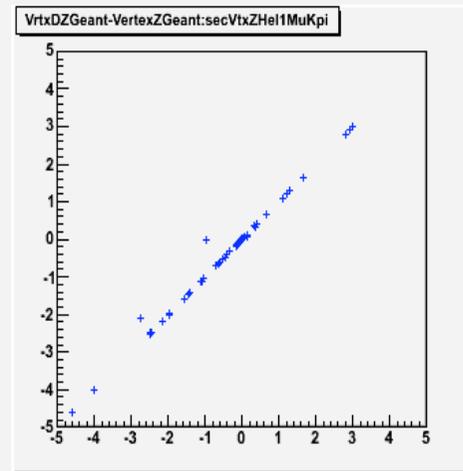
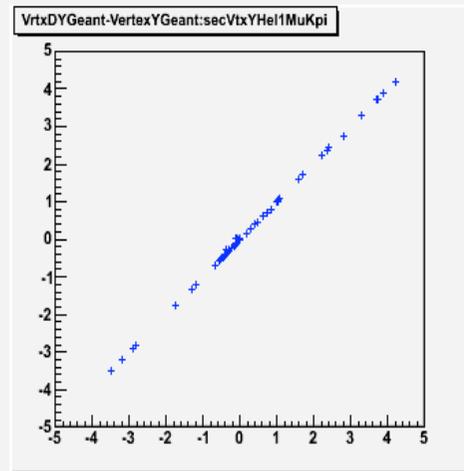
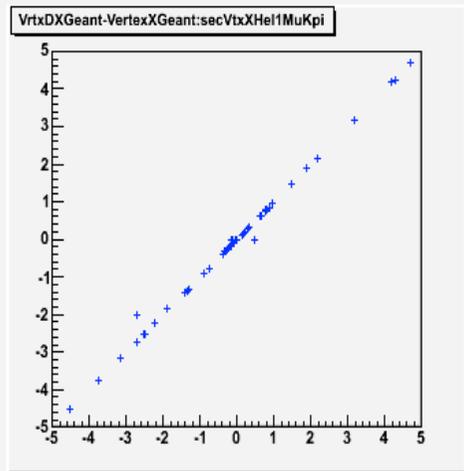
Secondary vertex resolution



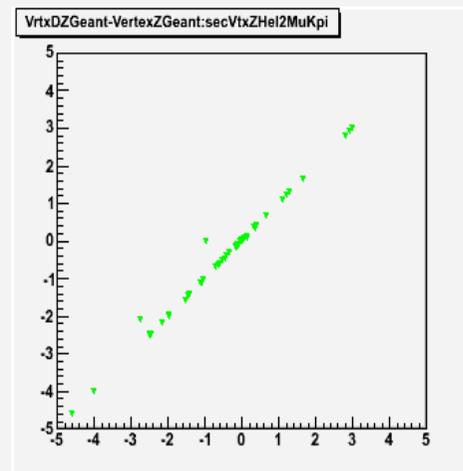
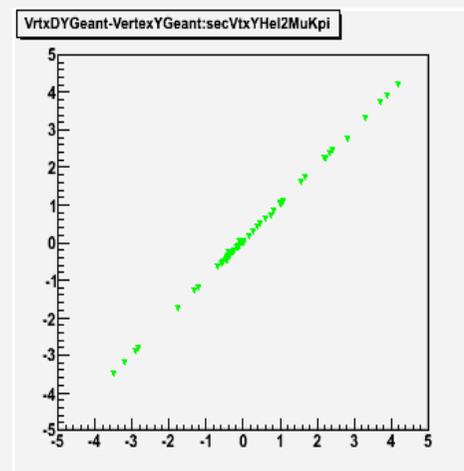
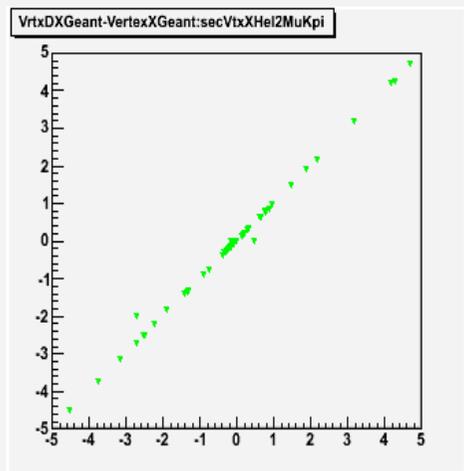


X-Y-Z Decay point
Geant vs Reco
X100 ctau

Linear



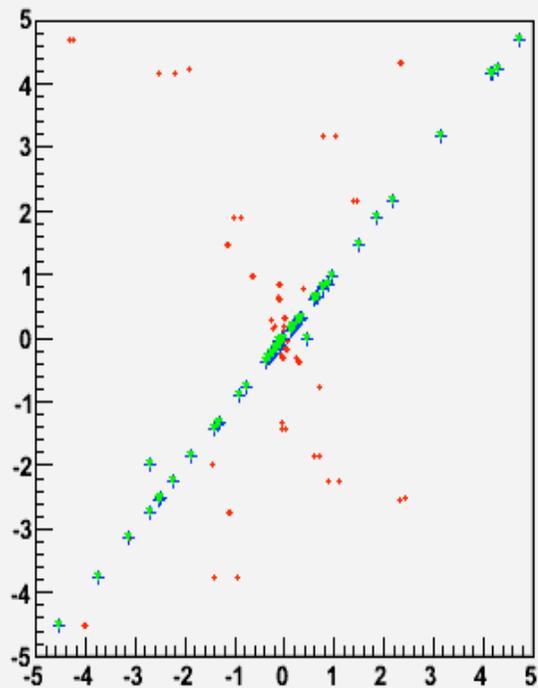
V0-like



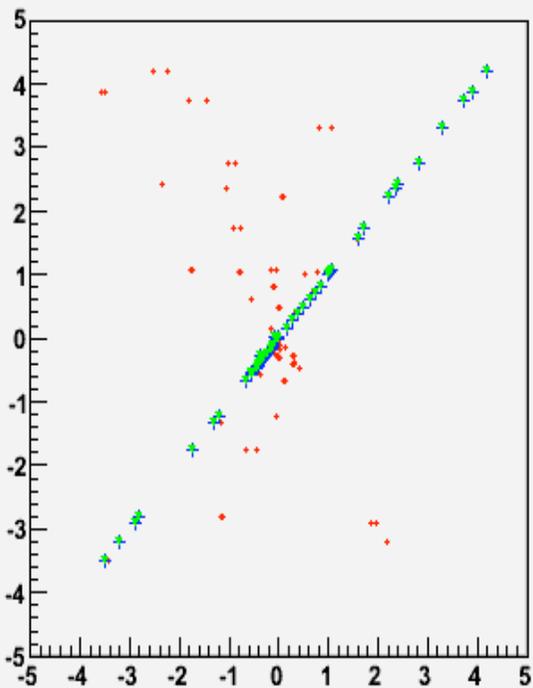
Helix DcaGeometry

Superimposed previous plots

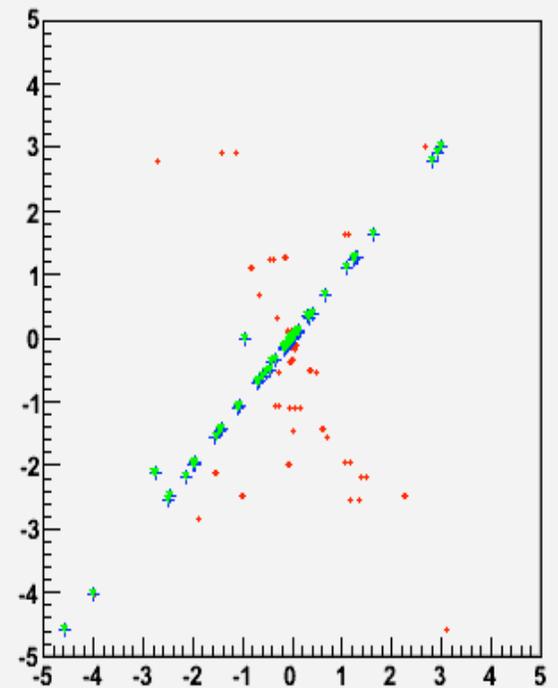
VrtxDXGeant-VertexXGeant:secVtxXOrigMuKpi



VrtxDYGeant-VertexYGeant:secVtxYOrigMuKpi

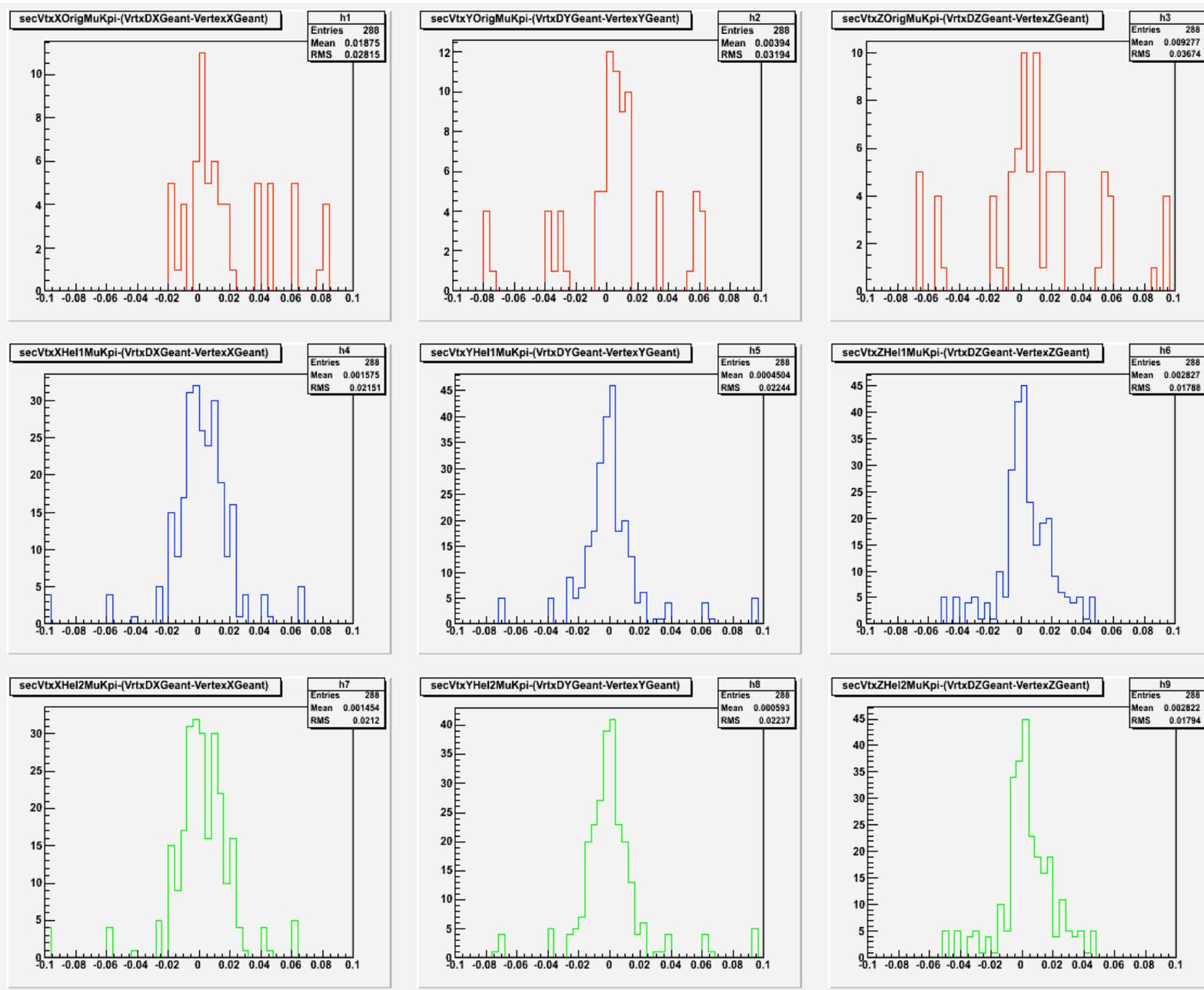


VrtxDZGeant-VertexZGeant:secVtxZOrigMuKpi



Recent Work

X-Y-Z Decay point
Resolution plots
X100 ctau



Linear

V0-like

Helix DcaG

Recent Work

MC sample

Data Used:

Embedded Data:-

D0 Particles are embedded into the MinBias AuAu Events.

Pt_D0 range: 0-5GeV

Eta_D0 in the SSD range

Total number of Events Processed (by us): 1165

Real Data:-

2007 Production2 FullField/P08ic

Total number of Events Processed so far: ~80,000 (out ~50Million)

Default Cuts Used:

Event:

nTracks < 100

|Z Vertex| < 20 (but other values possible too)

Track:

TpcHits > 15

Pt > 0.1

|dI| < 700 μ m (decay length)

Eta in the SSD range

dEdxTrackLength > 40

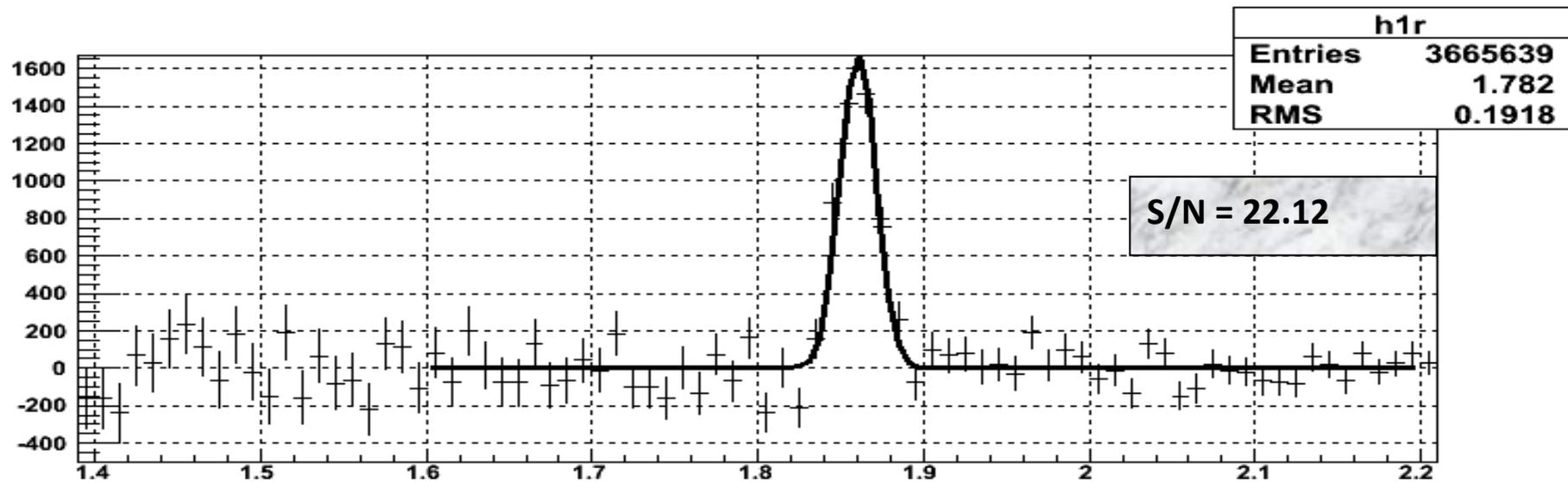
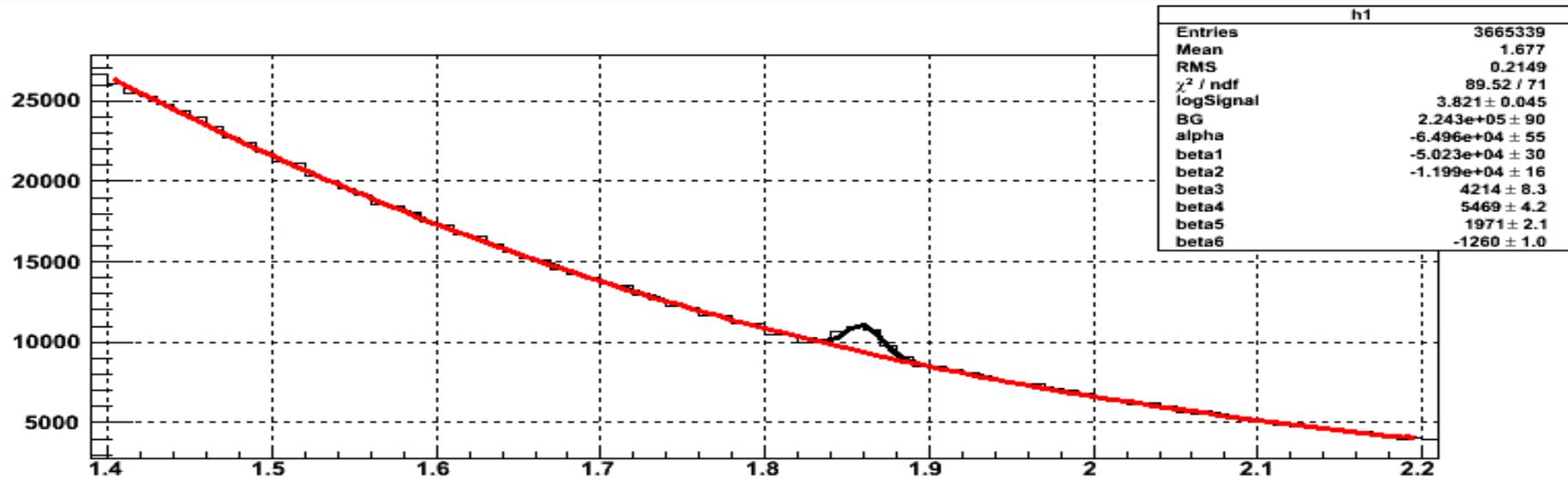
Charge_Kaon < 0 && Charge_pion > 0

dEdx cut – will be discussed later

Recent Work

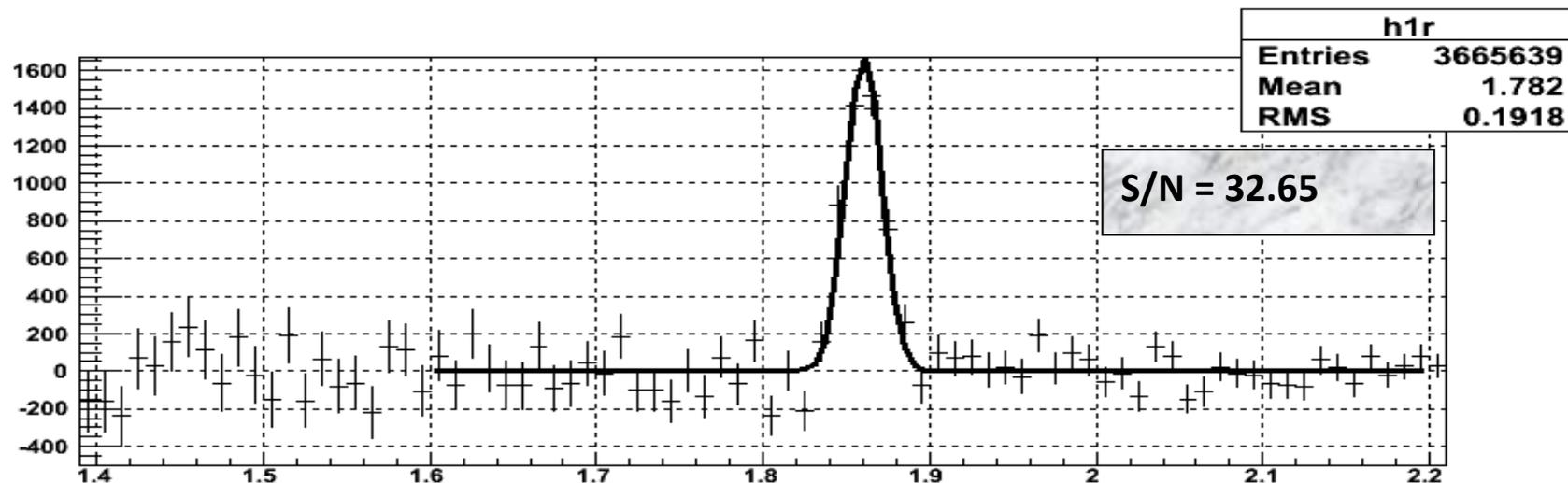
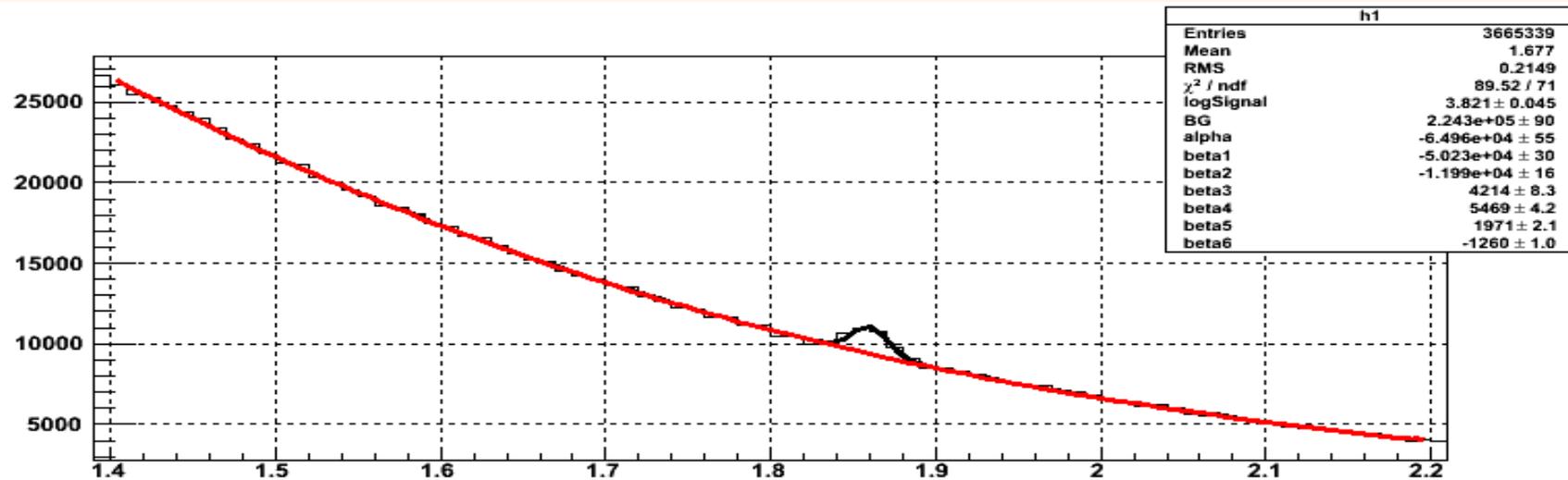
D0 + Hijing Events

Cuts(default cuts + SiliconHits>0 for positive and negative daughters, ChargeKaon<0,ChargePion>0)



D0 + Hijing Events

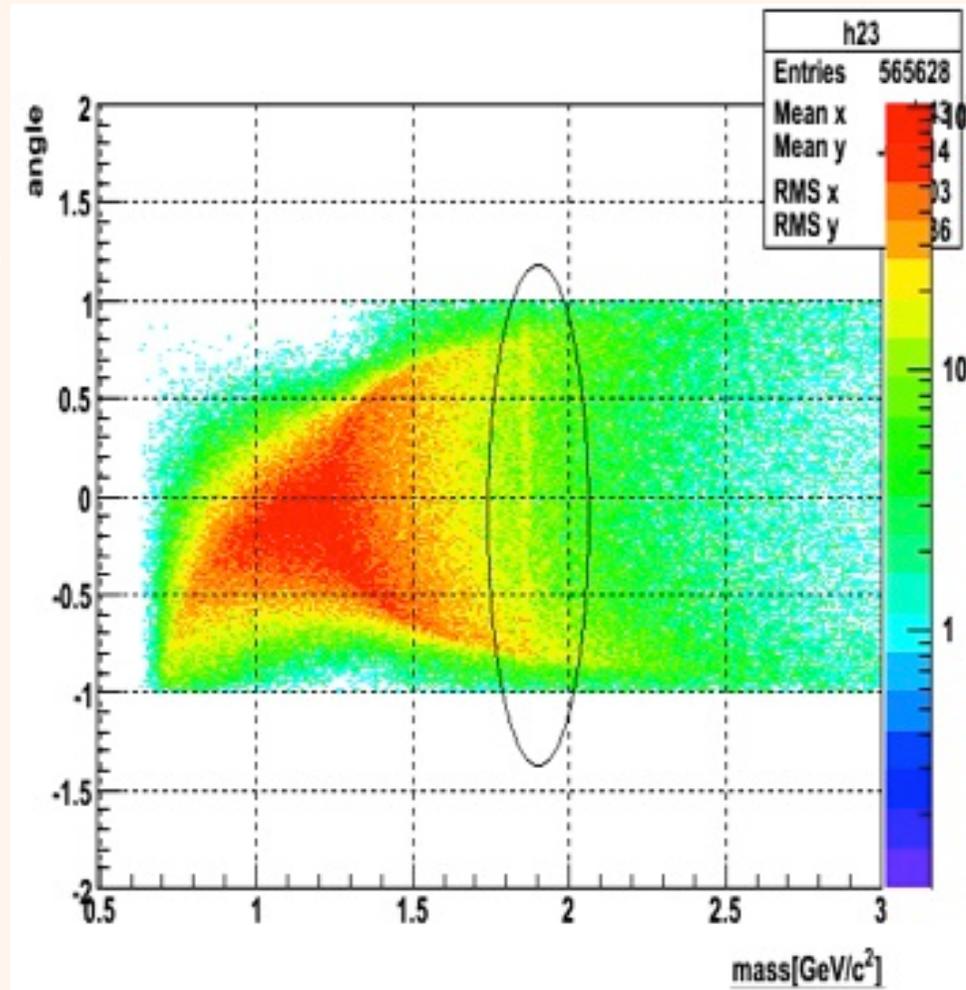
Cuts(default cuts + # of Prim Tracks <100, SiliconHits>0 for positive and negative daughters, ChargeKaon<0,ChargePion>0)



Recent Work

DATA

Kaon decay angle
In cm frame

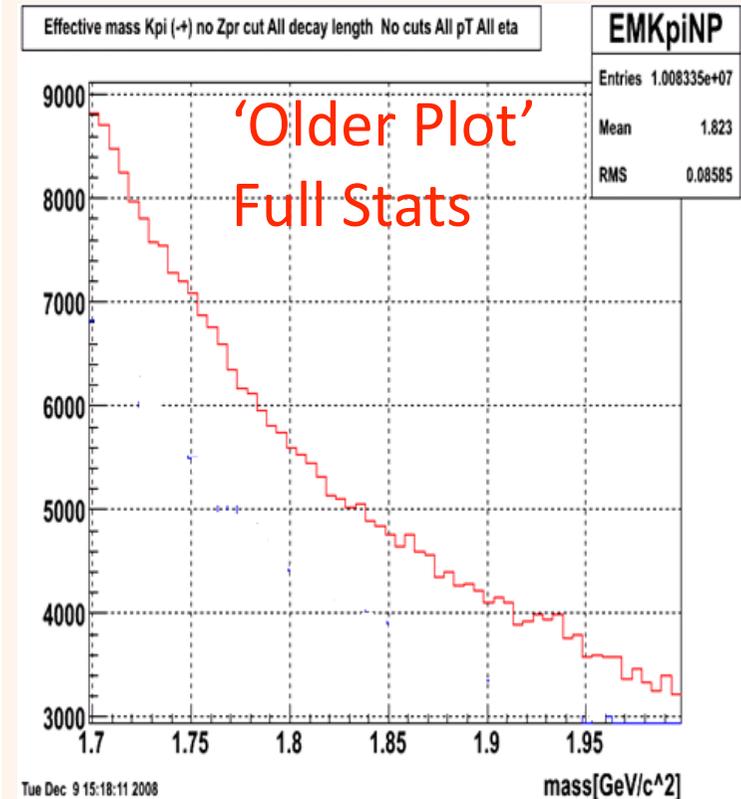
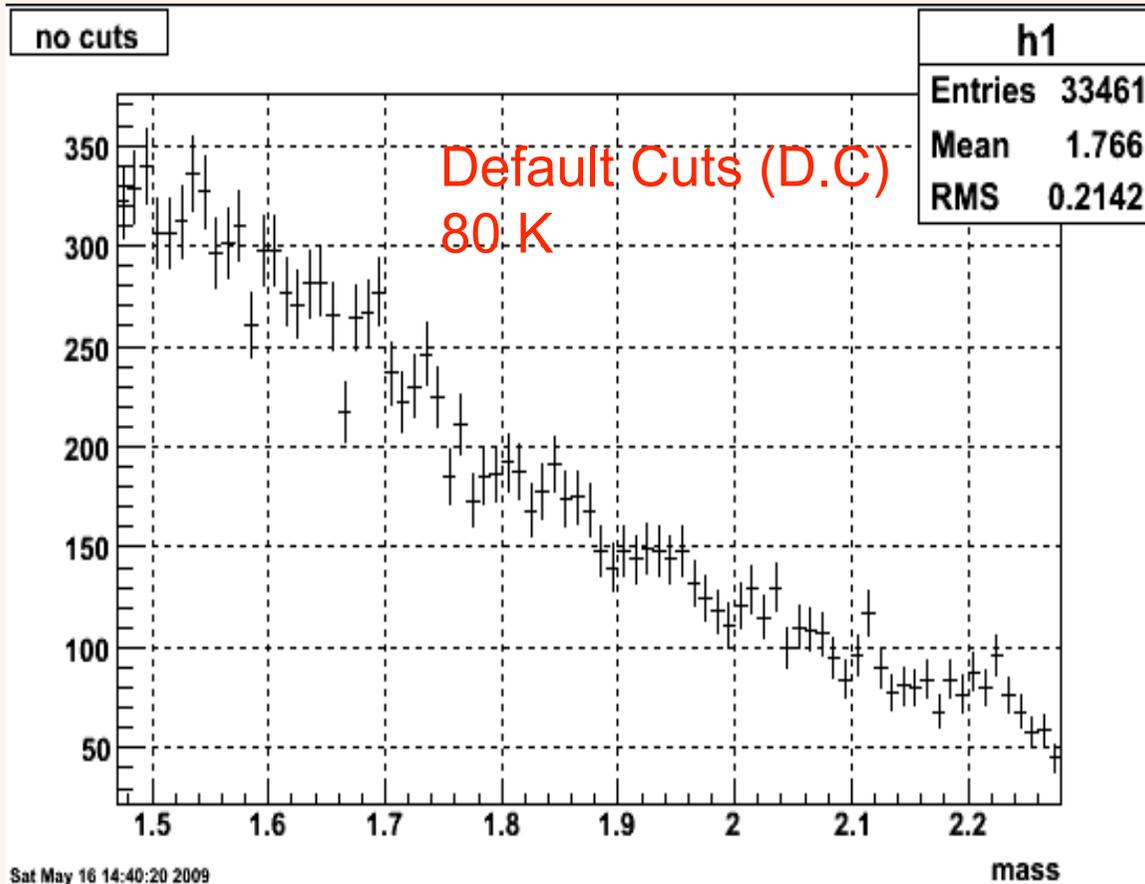


- Previous studies showed that $|\cos\theta^*| < 0.6$ cuts most background
- It also avoids kinematical edges (soft kaon/pion)

Real Data

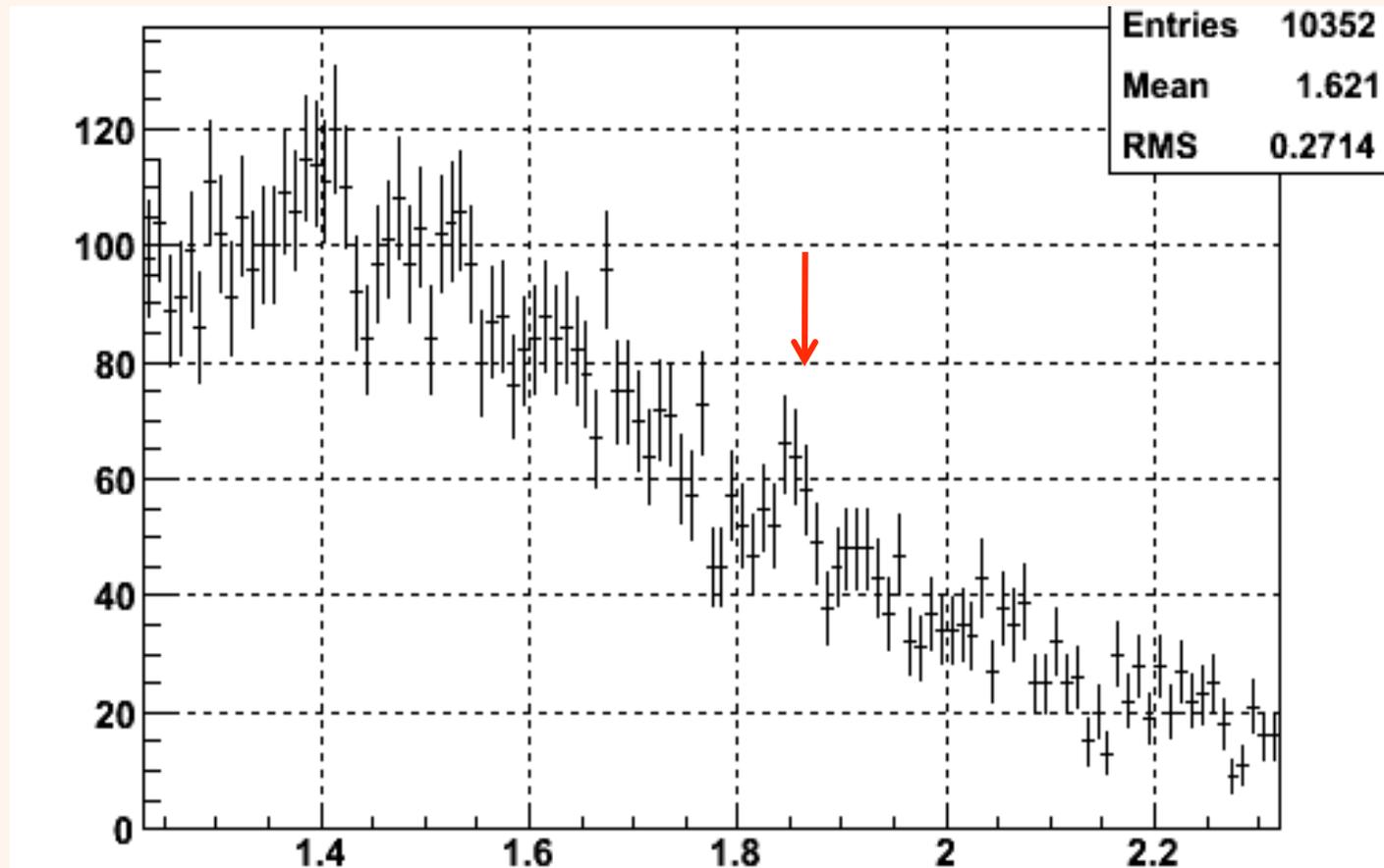
Number of Events Processed: 80782

(Zvertex<20,nTracks<100,pT>0.1,TpcHits>15,Eta in the SSD range, |slength|<700μm,dEdxCut,QGI[kg]<0&QGI[ig]>0+the new DCA code)



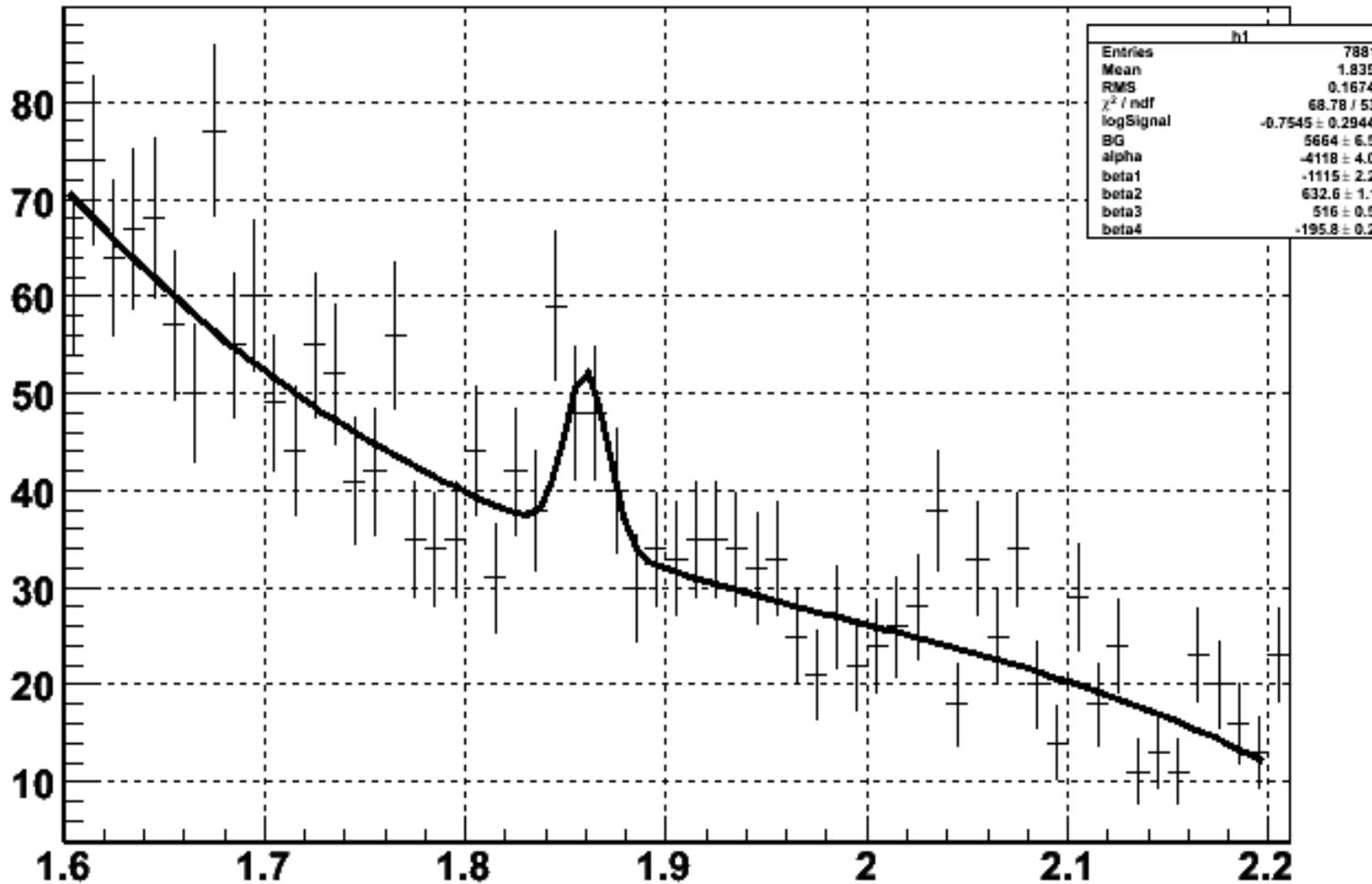
Recent Work

+ at least one SiliconHit for pos & neg Daughter



Nice peak start appearing-Silicon presence important

Best shot with this data sample

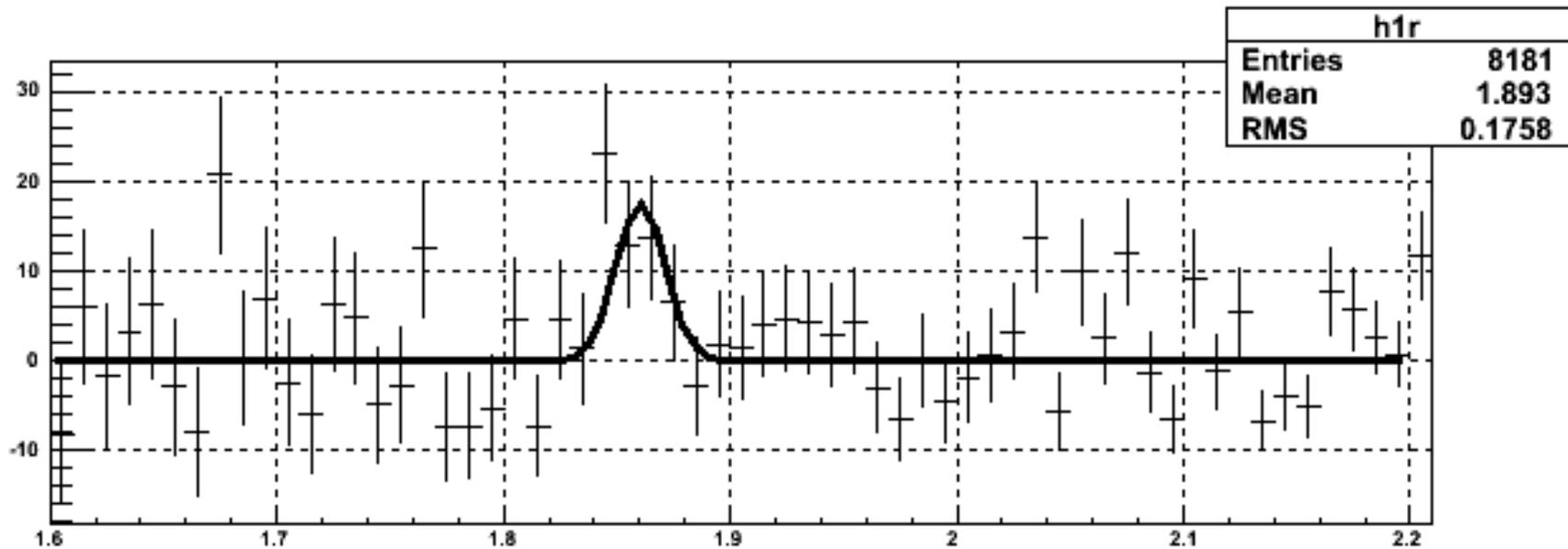
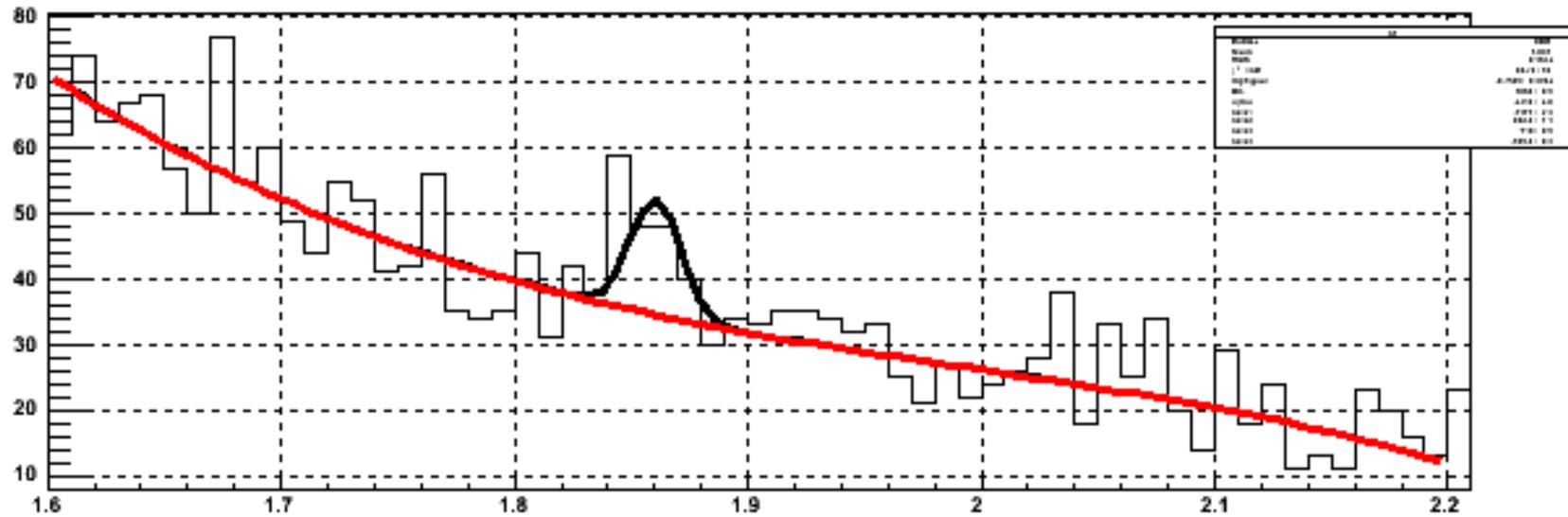


Fri May 22 15:58:05 2009

B.W. fit. S/N=3.4

SiliconHitsPos>0&&siliconHitsNeg>0&&
pTPos>0.3&&pTNeg>0.3&&
TMath::Abs(ZVrtx)<10&&TMath::Abs(eta)<1.8

Best shot with data sample

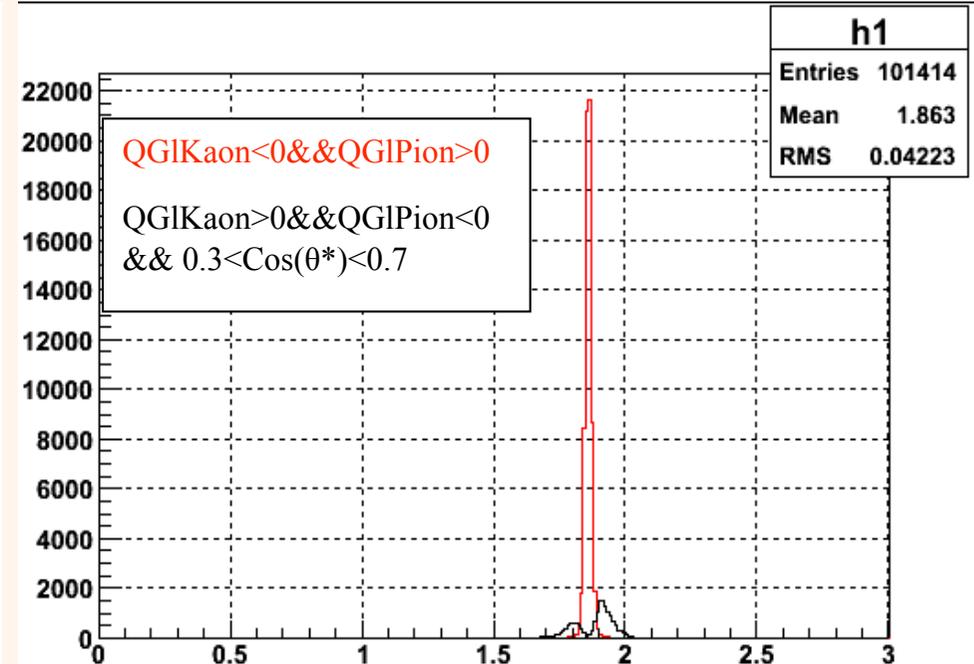
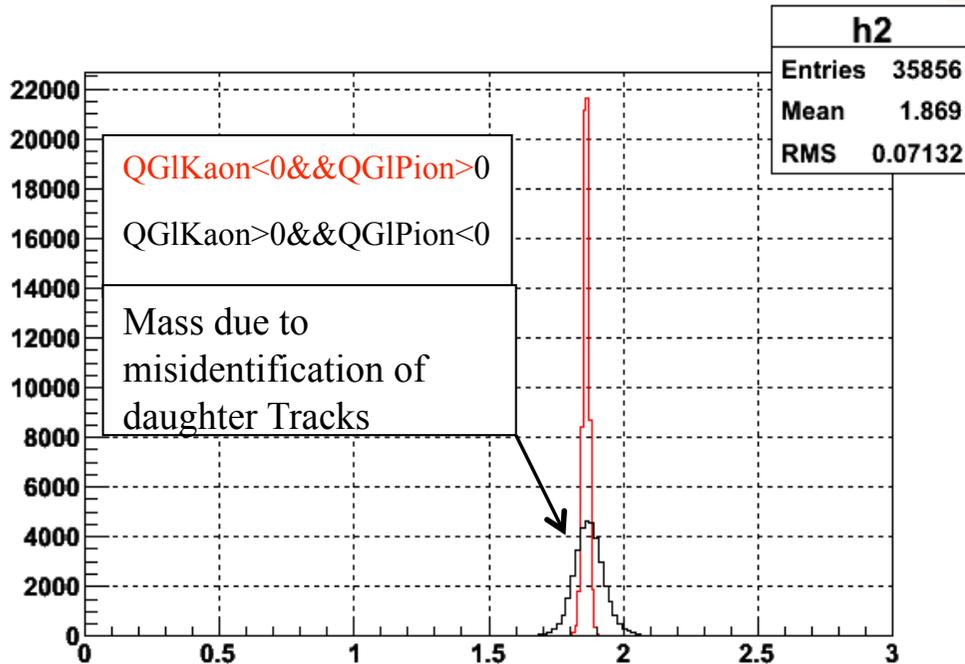
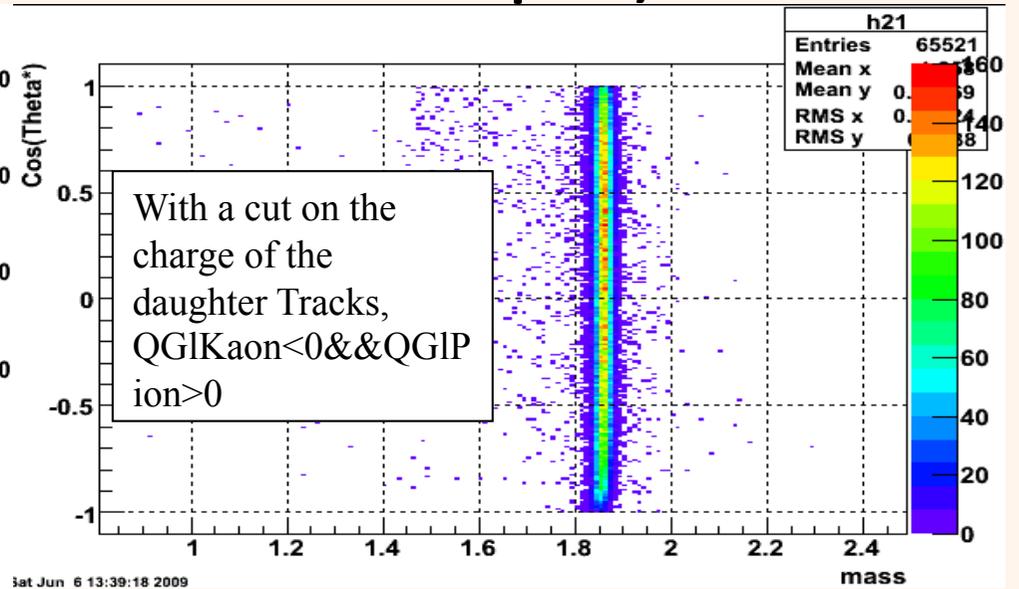
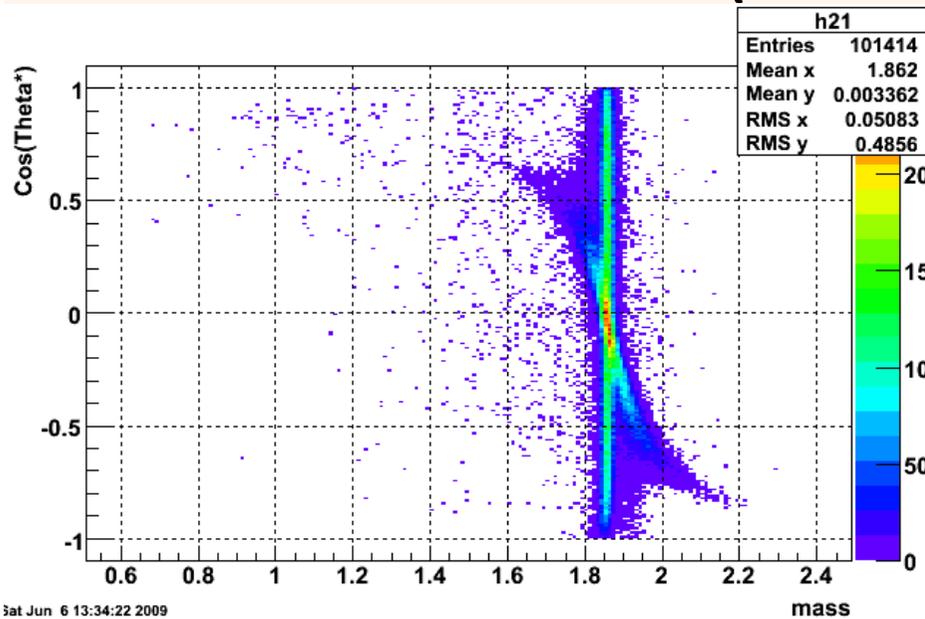


What is next?

- Currently we are implementing/checking the DCA, decay-length code (1-2 weeks).
- Then we will continue work on optimization of cuts
- We expect first estimates on x-section by end of summer

Back-ups

Pure D0(Monte Carlo sample)



D0+hijing Events

