Update on D^0 Measurements using Silicon

2007 AuAu ProductionMinBias Files

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In last Collab. Meeting we reported the following

✓ Full D^0 vertex-fit code (TCFIT) has been evaluated/debugged.

✓ On-going Simulation production of HIJING+D^0 using 'real' p_T (power law function) D^0s and central Hijing Au+Au Event)

✓ Showed some QA-Plots from Test Production of Au+Au Embedding

✓ Initial analysis of near FULL Production of Au+Au (Run 7) data.
(~ 35 Million minbias Events)

- ✓ A stable D0-signal was observed.
- ✓ The signal significance showed an increase with centrality

Since then we work on the following

- ✧ A new (re-)production of the Au+Au data set
- ✧ Signal Stability Studies on Real Data (2007 Au+Au MinBias)
- ✧ Cut Optimization via Multi-Dimensional correlation Plots.
- ✧ Preliminary look at the new Embedding sample.
- ✧ Extraction of D0/D0bar ratio from real Data

Au+Au data set re-production

✧ With D^0 and D^0-bar information saved.

✧ With D^0 azimuthal angle saved, for calculation of v2 (flow).

✧ Select only Triggered Events (Pile-up events are removed).

✧ Tracks with SiHits>1 are selected

✧ Radius of Silicon Hits added to the tuple.

✧ Track Momentum cut was incremented to 0.8GeV/c

✧ dEdx cut was modified: $|n\sigma_K|<2.5$ and $|n\sigma_\pi|<2.5$

✧ Released the cut on track pseudorapidity to $|\eta|<1.2$ and added a cut on rapidity of D0 (|Rapidity|<1).

2007 Production MinBias

- cut changed
- new cut

Cuts from Previous Production

EVENT level

triggerId : 200001, 200003, 200013
Primary vertex position along the beam axis :
|zvertex| < 10 cm
Resolution of the primary vertex position along the beam axis:
$|\sigma_{zvertex}|$< 200μm

TRACKS level

Number of hits in the vertex detectors :
SiliconHits>2 (tracks with sufficient DCA resolution)
Transverse Momentum of tracks:
p_T >.5GeV/c
Momentum of tracks:
p >.5GeV/c
Number of fitted:
TPC hits > 20
Pseudo-rapidity :**|η|<1** (SSD acceptance)
dEdxTrackLength>40 cm
DCA to Primary vertex (transverse),
DCA_{xy}< .1 cm

Cuts in New Production

EVENT level

triggerId : 200001, 200003, 200013
Primary vertex position along the beam axis :
|zvertex| < 10 cm
Resolution of the primary vertex position along the beam axis:
$|\sigma_{zvertex}|$< 200μm

TRACKS level

Number of hits in the vertex detectors:
SiliconHits>1
Transverse Momentum of tracks:
p_T >.5GeV/c
Momentum of tracks
p >.8GeV/c
Ratio TPC hits Fitted/Possible > 0.51
Pseudo-rapidity :**|η|<1.2**
dEdxTrackLength>40 cm
DCA to Primary vertex (transverse),
DCA_{xy}< .2 cm
Radius of first hit on track :
< 9 cm if number of silicon hits =2
< 13 cm else

Continued..

Cuts from Previous production	Cuts in New Production
	D^0 candidate **$\|y(D^0)\|<1$** **$\|\cos(\theta^*)\|<0.8$**
DECAY FIT level	**DECAY FIT level**
Probability of fit >0.1 && |sLength|<.1cm	**Probability of fit >0.01 && |sLength|<.1cm**
Particle ID : ndEdx : **$\|n\sigma_K\|<2$, $\|n\sigma_\pi\|<2$**	Particle ID : ndEdx : **$\|n\sigma_K\|<2.5$, $\|n\sigma_\pi\|<2.5$**

In both productions we made a pico file for further analysis.

Cuts Used for making a pico file

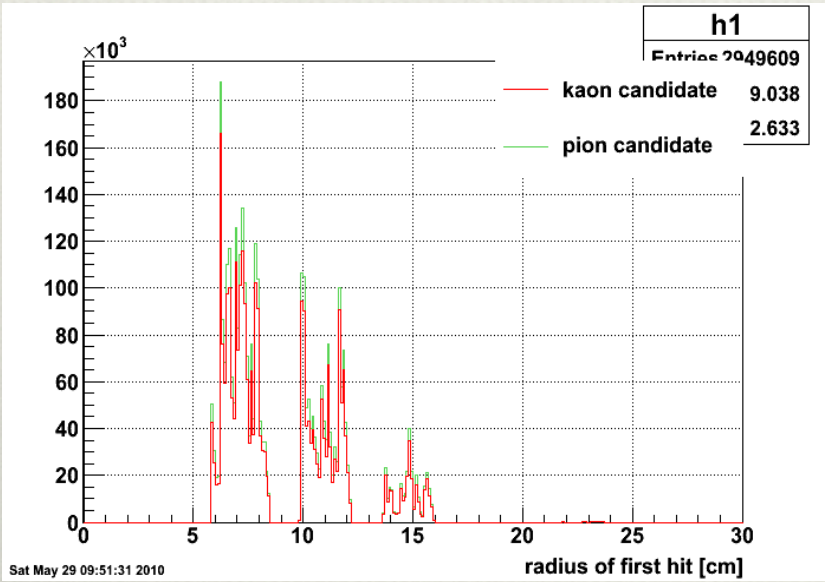
Previous Production	New Production
|D0Eta|<1.85 |Cos(θ*)<0.6	ndEdx : **$\|n\sigma_K\|<2$, $\|n\sigma_\pi\|<2$** $\|\cos(\theta^*)\|<0.6$ DCA daughters < 300 μm

Cuts on Hit radius

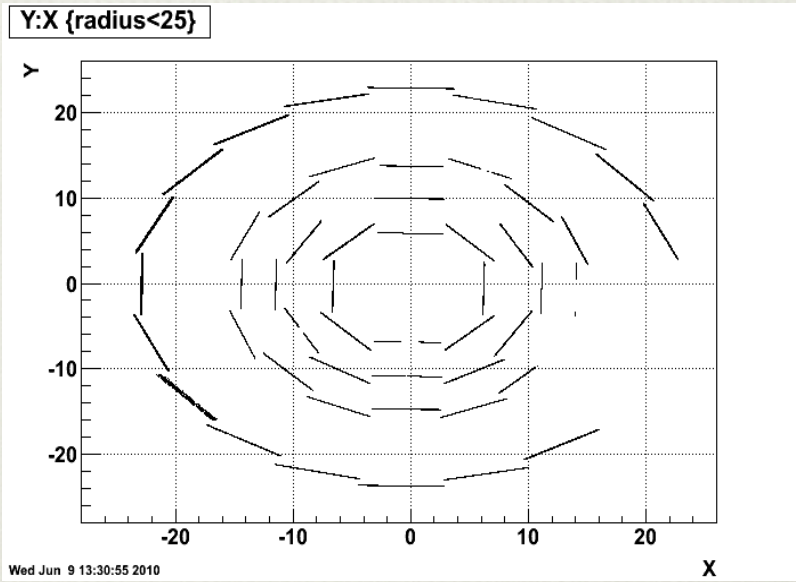
- Look at the occupancy of the silicon layers for run 7
- Motivation of the radius cut :
  - DCA resolution is driven by hits in SVT/SSD which are nearer the interaction point
  - tracks with only 2 silicon hits are poor tracks so we require that the first hit belongs to the SVT inner layer
- Method :
  - Loop over primary tracks (within events,vertex) cuts and take the global associate
  - Determine the radius of the first hit of tracks
  - Make selection (SVT inner layer, SVT intermediate layer, SVT outer layer, SSD) by cutting on the radius distribution

J. Bouchet

Radius of first hit on global track



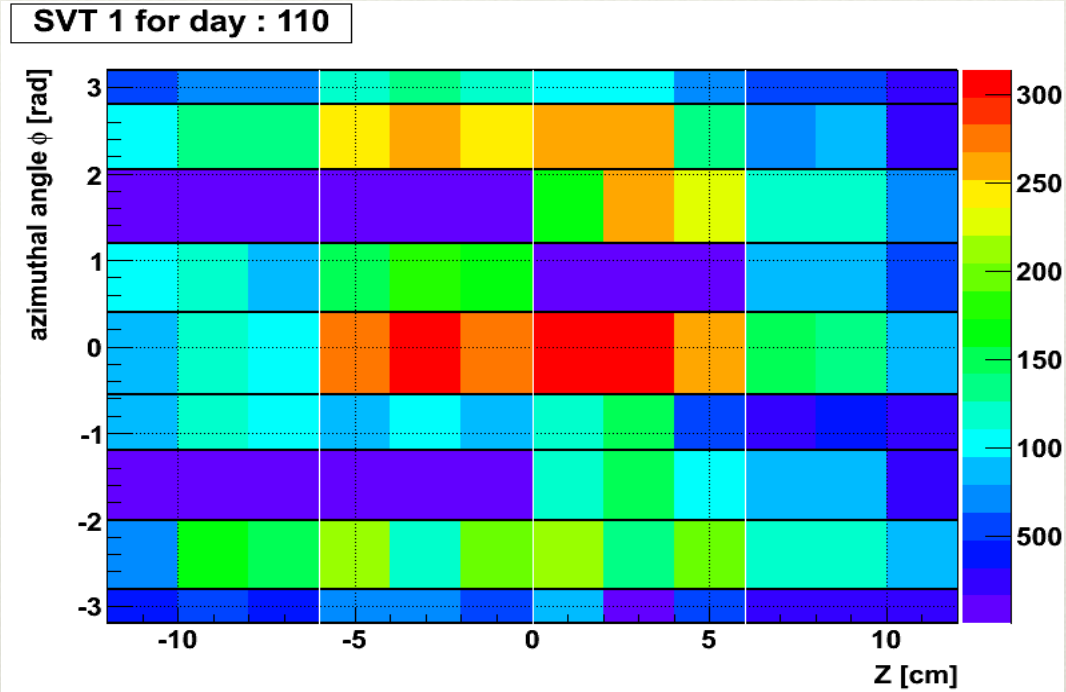
X vs Y of first hit



From this plot, the range in phi according to the (X,Y) position for each ladders of the SVT inner layers can be determined.

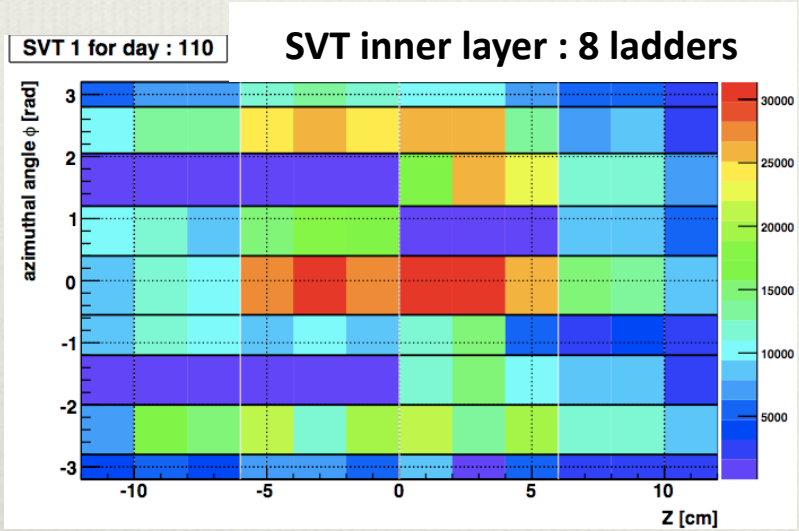
J. Bouchet

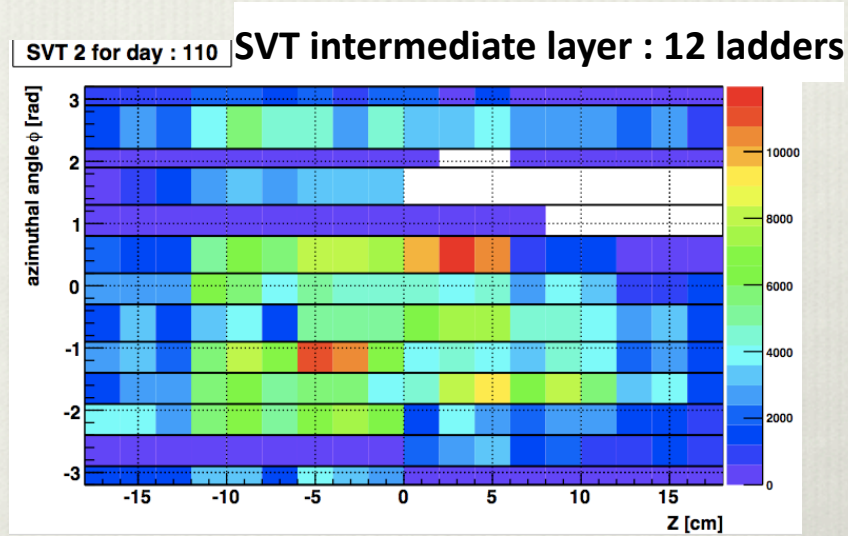
Phi vs Z of first hit (SVT inner layer)

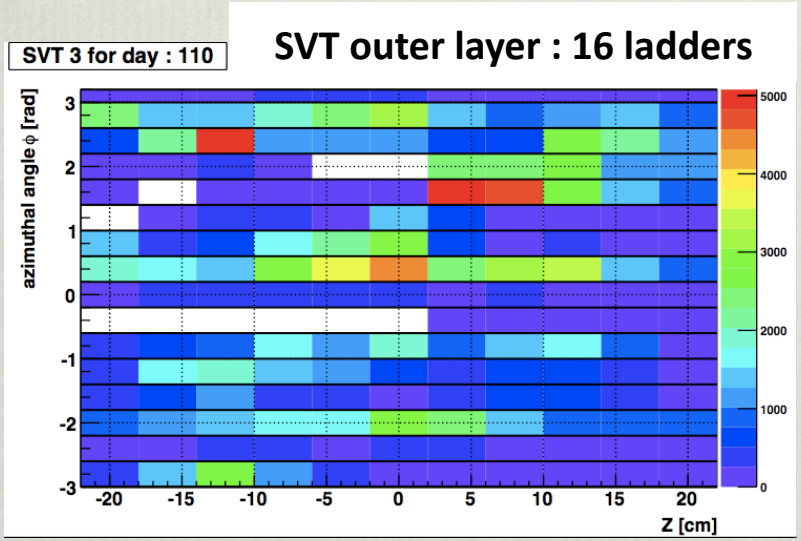


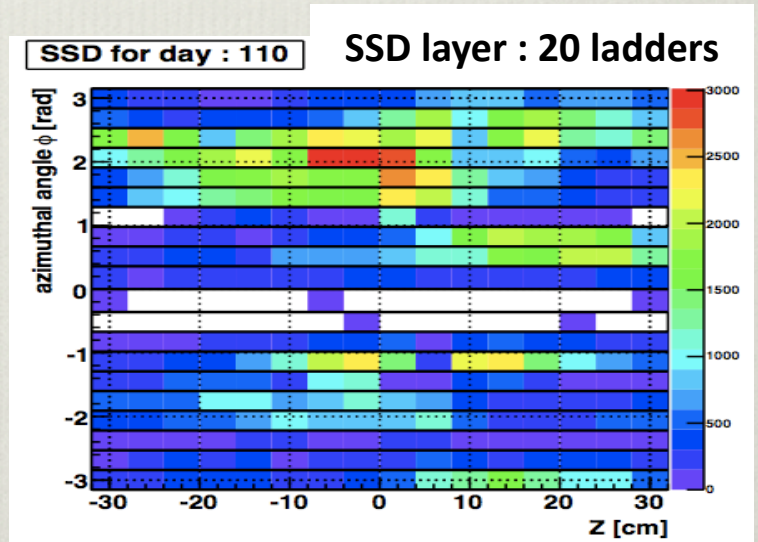
- Try to matched the wafers/sensors area
- Black line : phi ranges determined
- White line : just to guide the 'eye' since it seems to delimitate the wafers length in the Z direction
- There is 8 ladders (the plot shows 9 bins in phi) but one ladder has a phi range = {-3.2,-2.75}U{2.75.3.2}

For all silicon layers

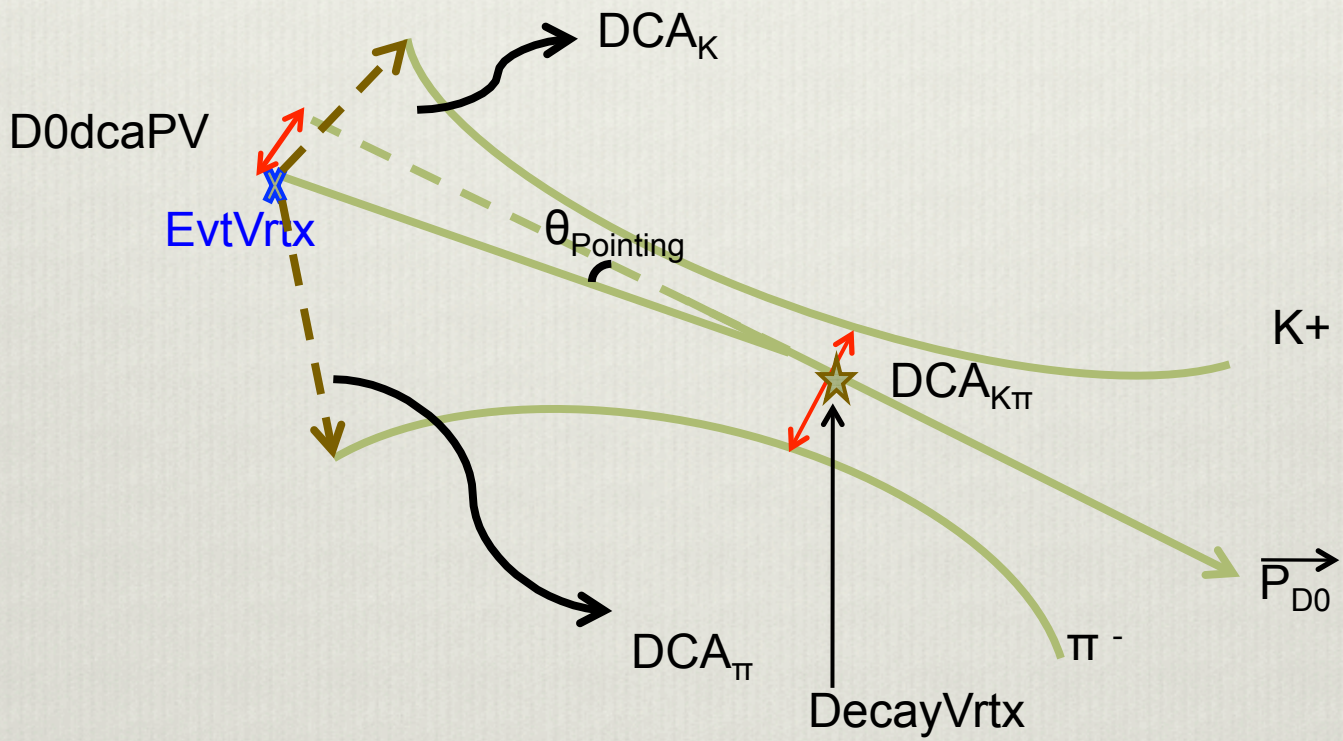








D0 Decay Topology with TcFit



cτ ~ 120μm

Signal Stability in Real Data (by varying Cuts)

K, π momenta > 0.7GeV/c
gRefMult > 50

} (Applied on all plots below)

Following are some of the cut values varied in the following slides:

- 50μm ≤ |Decay Length| ≤ 400μm(initial)
- -150μm < DecayLength < 400μm (avoiding extreme negative values)
- -200 μm<decaylength <400μm &&|decayLength| > 50 (adding a lower cut)

- |D0dcaPV| < 300um(initial)
- |D0dcaPV| < 400um

- trackDca < 200um(initial)
- trackDca < 300um

Data

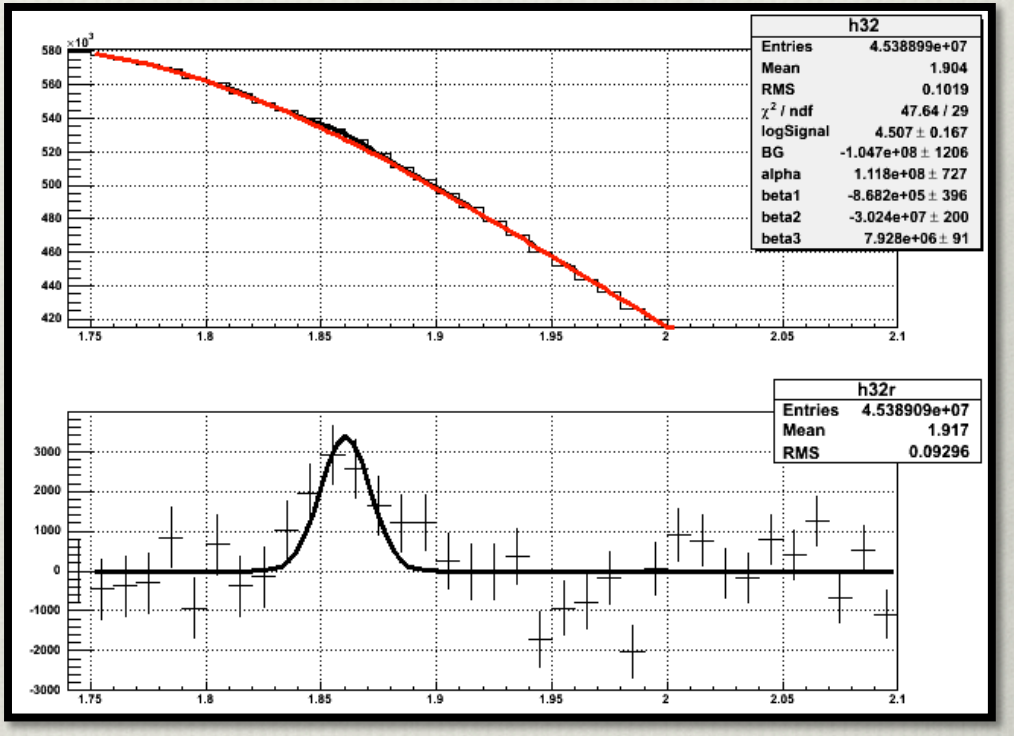
✓ 2007 AuAu Production MinBias.

Production Done over the whole DataSet

✓ Number of Events ~ 35Million

D^0 signal in 2007 Production Minbias

- Cuts(offline):
  - 50μm<|decaylength|<400μm
  - trackDca<200 μm
  - |dcaD0toPV|<300μm
  - p_T^{kaon}>0.7GeV/c
  - p_T^{pion}>0.7GeV/c



Fit: Breit-Wigner

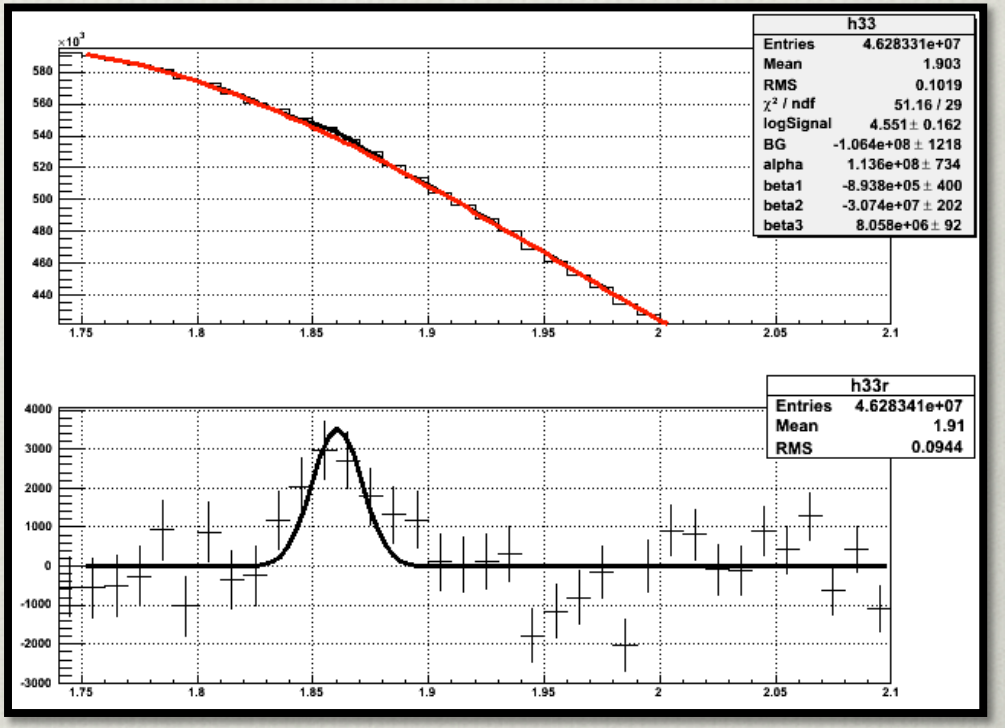
S/N ~ 5.98

Signal Stability by varying Cuts

Offline Cut Set 2:

• cut changed

- Cuts(offline):
  - 50μm<|decaylength|<400μm
  - trackDca<200 μm
  - |dcaD0toPV|<400μm
  - p_T^{kaon}>0.7GeV/c
  - p_T^{pion}>0.7GeV/c



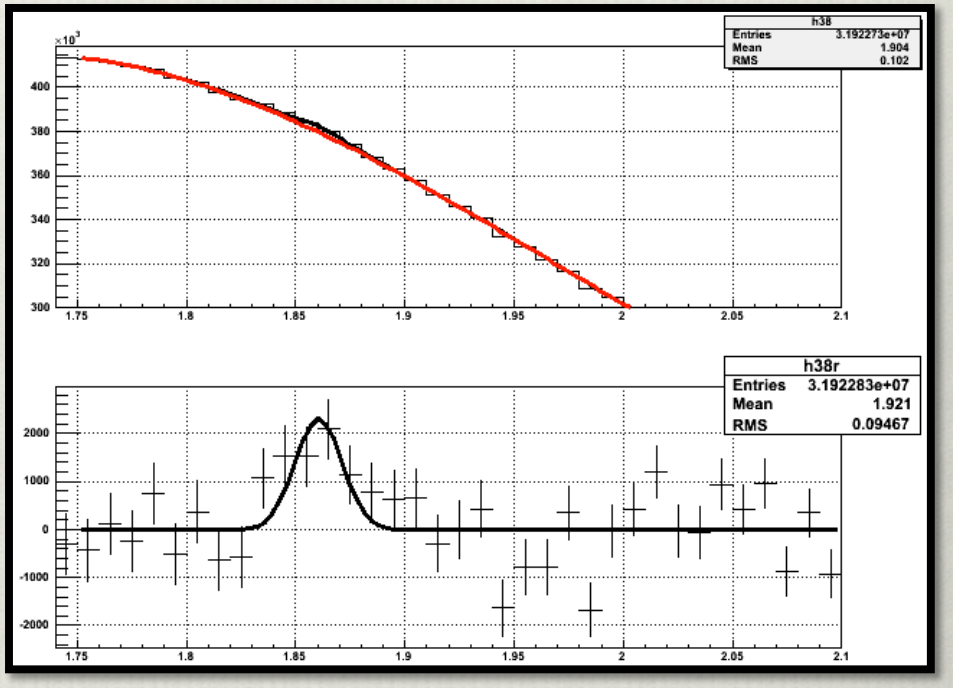
S/N ~ 6.18

Signal Stability by varying Cuts

Offline Cut Set 3:

• cut changed

- Cuts(offline):
  - -150 μm<decaylength <400μm
  - trackDca<200 μm
  - |dcaD0toPV|<300μm
  - p_T^{kaon}>0.7GeV/c
  - p_T^{pion}>0.7GeV/c



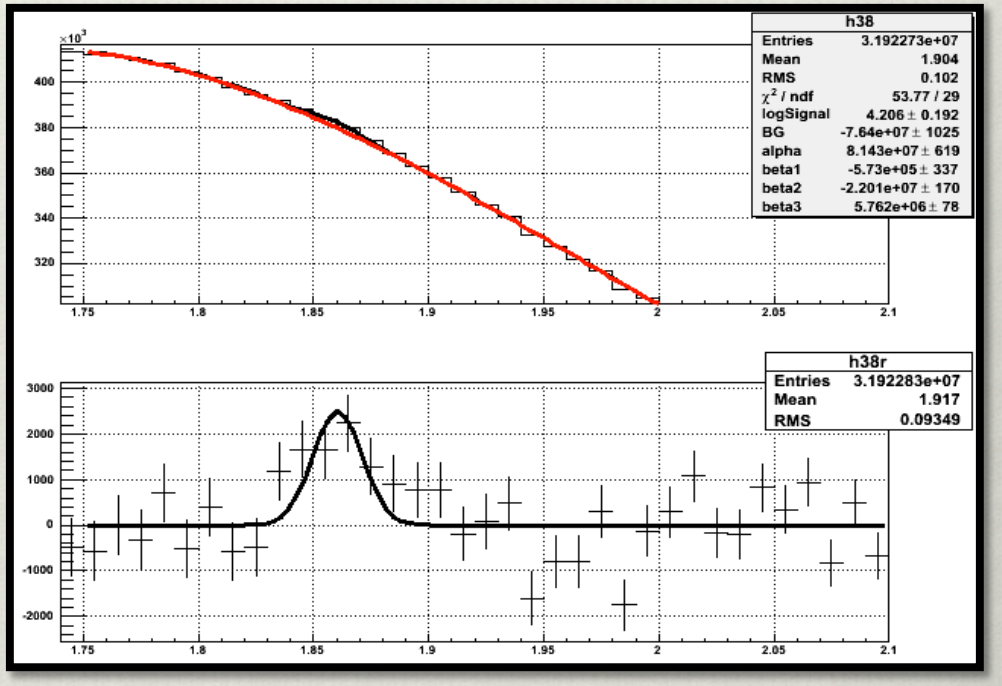
S/N ~ 4.84

Signal Stability by varying Cuts

Offline Cut Set 4:

• cut changed

- Cuts(offline):
  - -200 μm<decaylength <400μm &&|decayLength| > 50
  - trackDca<200 μm
  - |dcaD0toPV|<300μm
  - p_T^{kaon}>0.7GeV/c
  - p_T^{pion}>0.7GeV/c



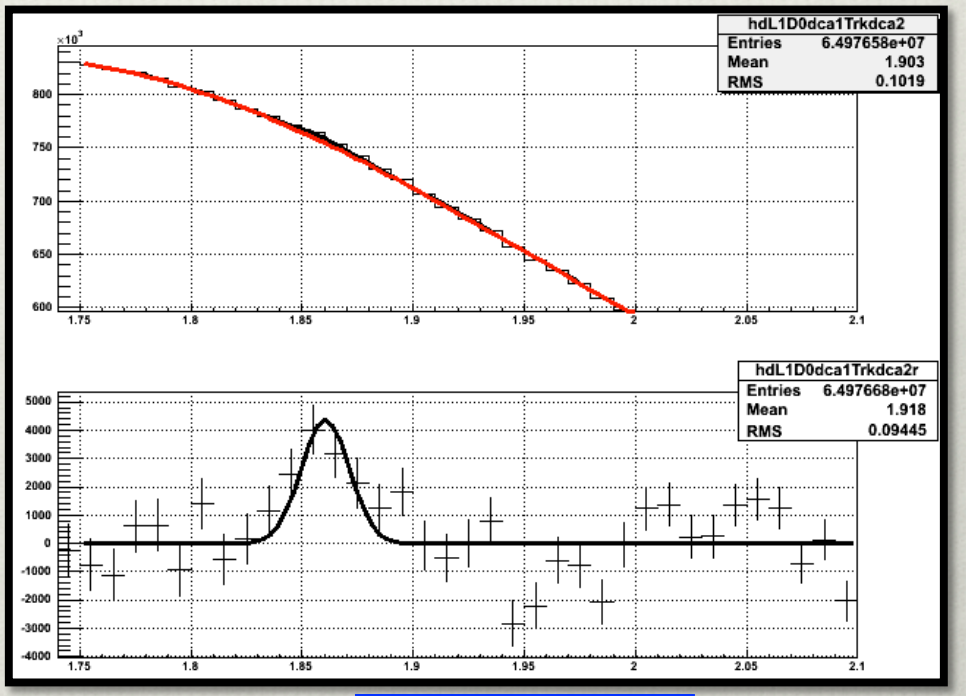
S/N ~ 5.21

Signal Stability by varying Cuts

Offline Cut Set 5:

• cut changed

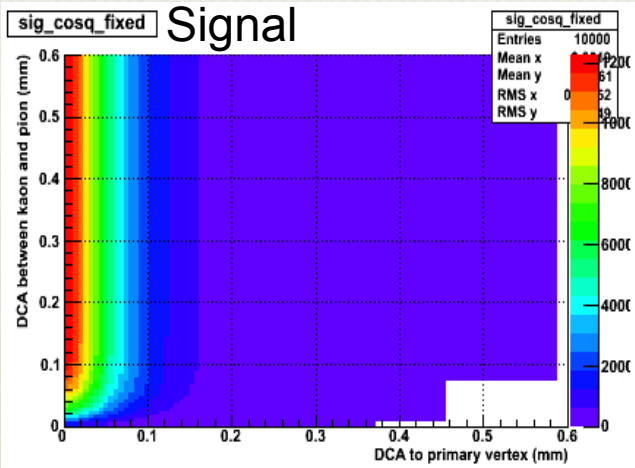
- Cuts(offline):
  - 50 μm<|decaylength| <400μm
  - trackDca<300 μm
  - |dcaD0toPV|<300μm
  - p_T^{kaon}>0.7GeV/c
  - p_T^{pion}>0.7GeV/c

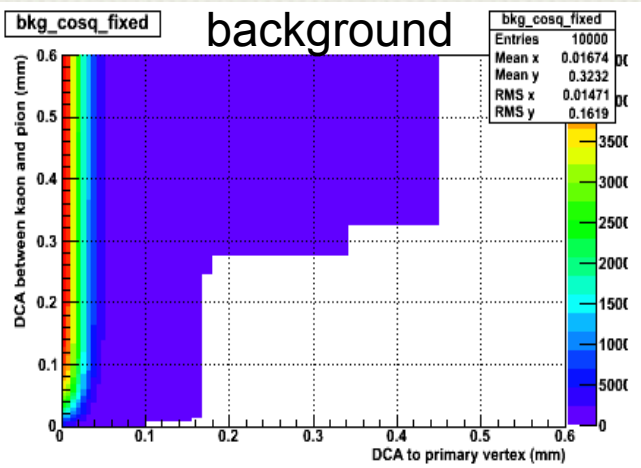


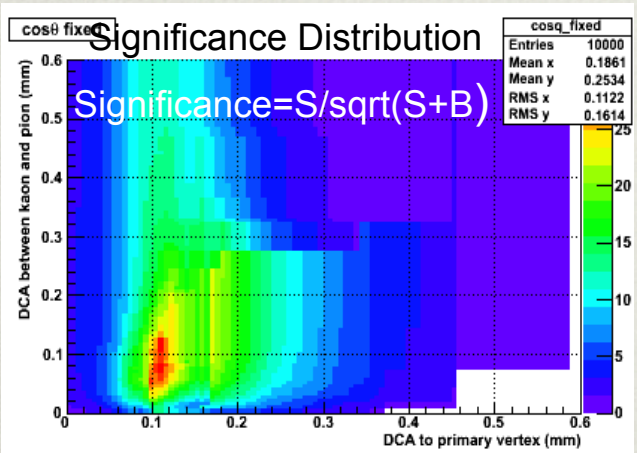
S/N ~ 6.48

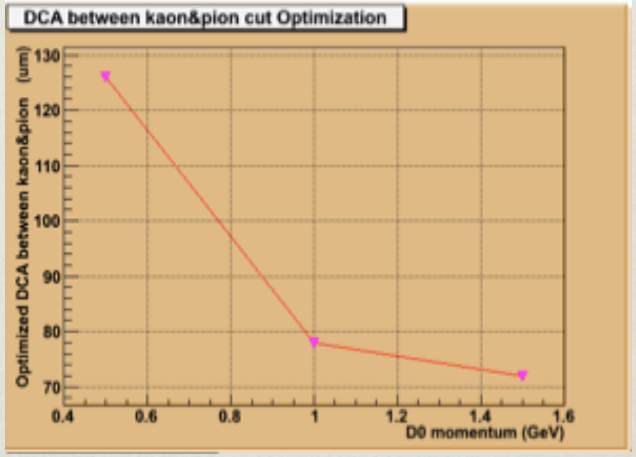
D0 signal appears to be consistent with various cut sets. This is an ongoing study.

Cut Optimization Studies – Example from HFT







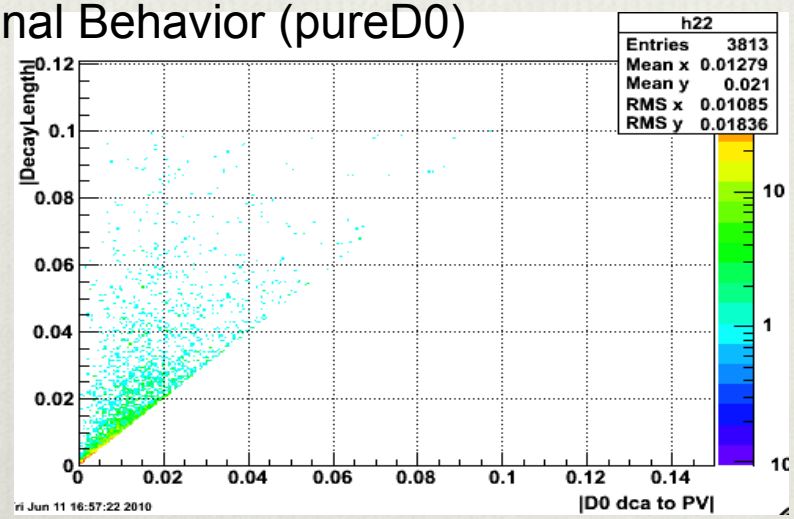


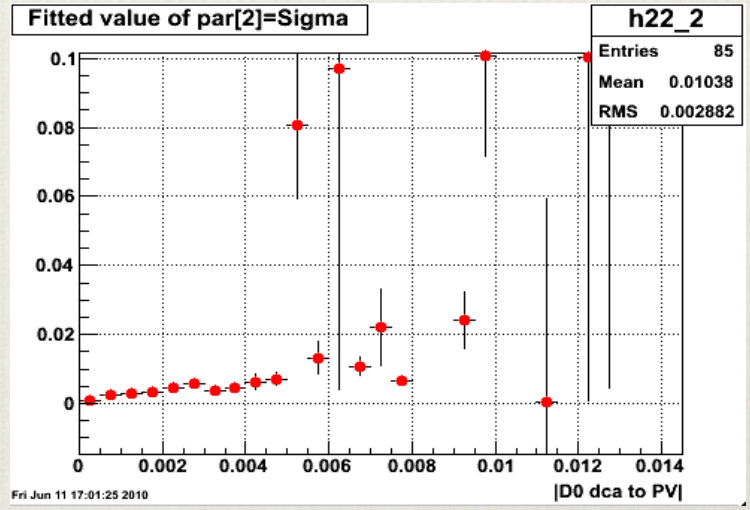
- After Cut Optimization the Significance Ratio is very high. The improvement in significance is a factor of 3.7 in 500MeV D0 and 2.2 for 1.5 GeV.
- We are working on a similar approach to optimize the cuts.

XM Sun

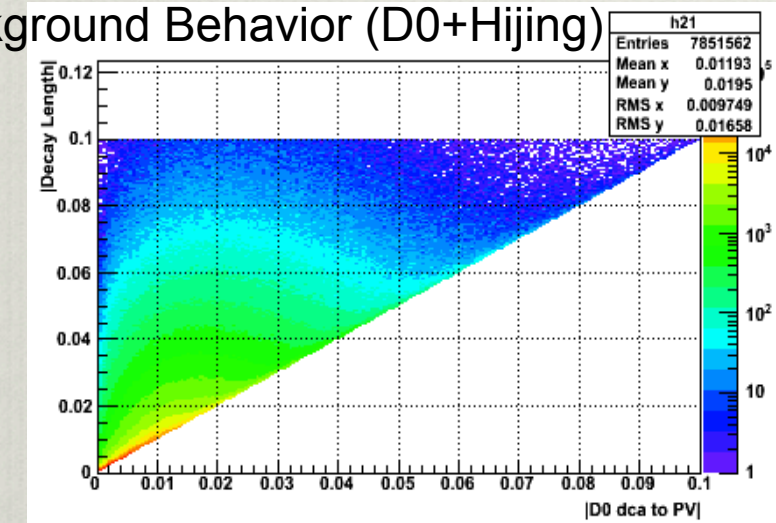
Correlated Quantities (SVT+SSD)

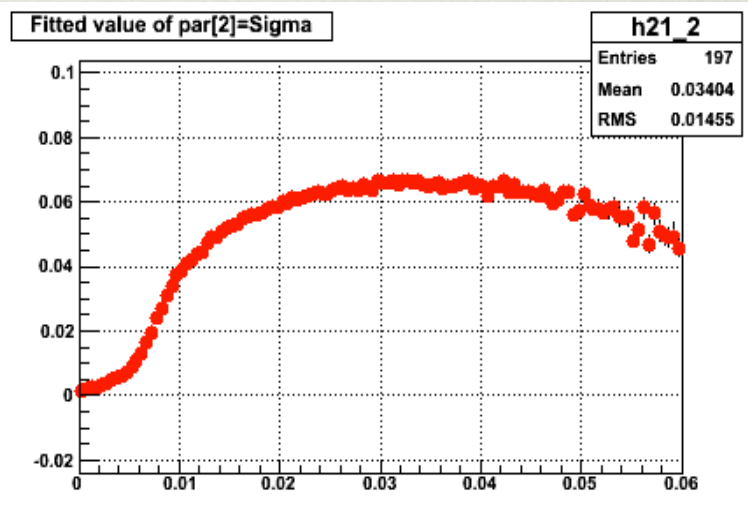
Signal Behavior (pureD0)





Background Behavior (D0+Hijing)

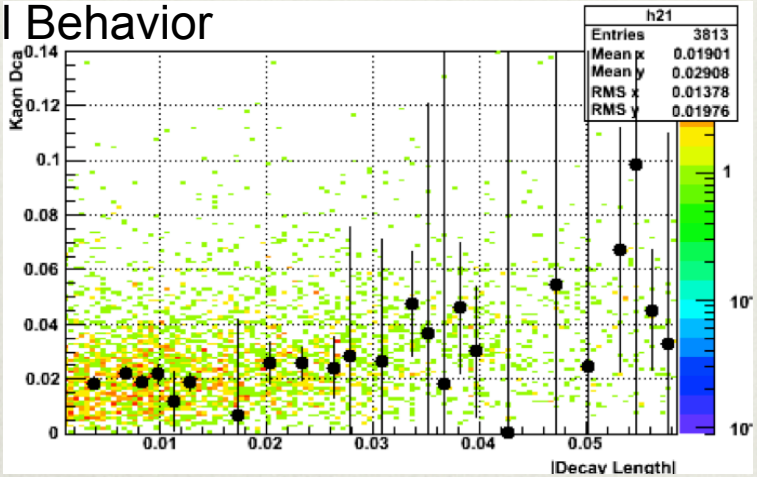


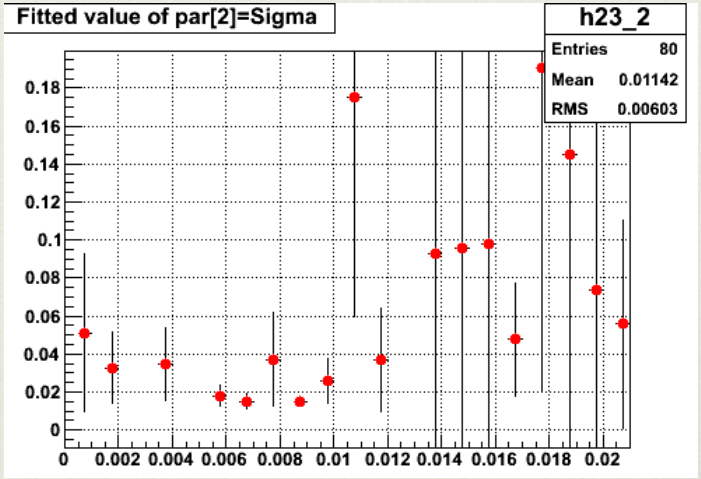


Need to make ratio plots and chose best cut values for low/high D0 pt

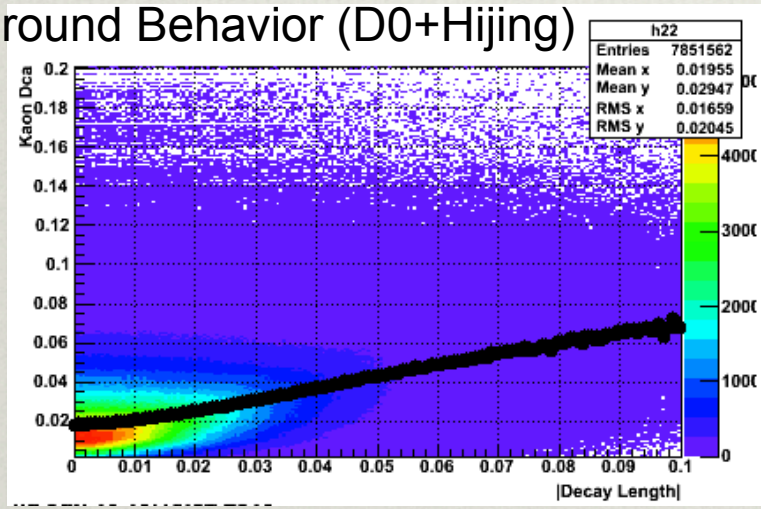
Correlated Quantities

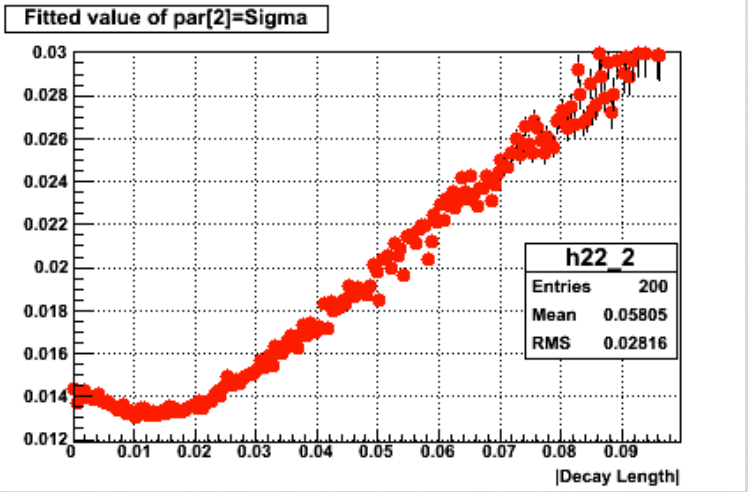
Signal Behavior





Background Behavior (D0+Hijing)





- ✓ The decay Length and D0 dca to PV are correlated, so is the Dca of tracks.
- ✓ The reconstructed quantities behave as expected within systematic errors.

Need to make ratio plots and chose best cut values for low/high D0 pt

Embedding Data

Sample: /eliza15/star/starprod/embedding/2007ProductionMinBias/

- Some QA done (see list for detailed comments from all parties)
- Preliminary results show that the Microvertex code is working as expected.
- Production over D0/D0bar Embedding data is running.

D^0/D^0bar Ratio

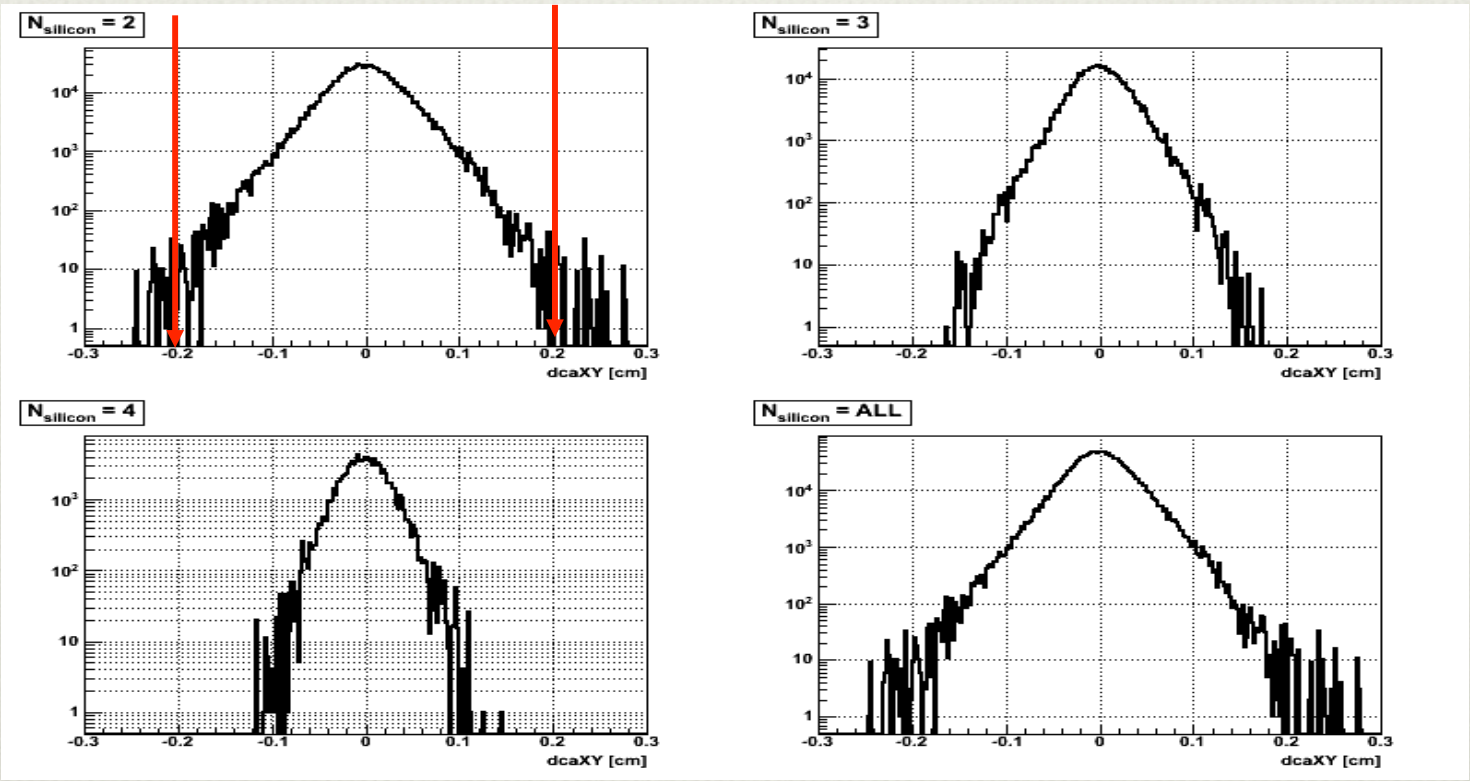
'In progress,
Initial result compatible with a ratio close to unity'

Summary

- We carefully optimize, check, fine-tune parameters
- All Embedding will soon be done
- We have asked for re-generation of Cu+Cu 60/200 MuDsts
- This is the end game of this analysis

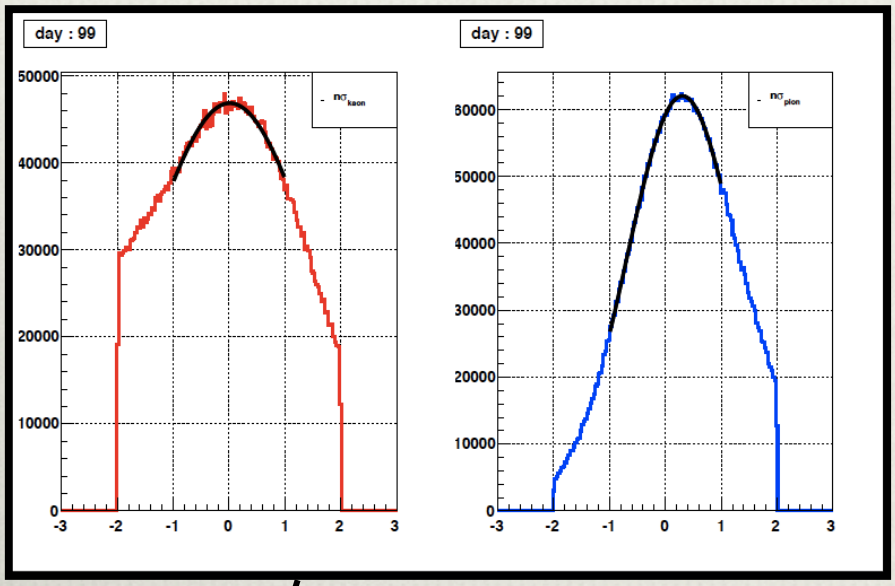
Back-Up Slides

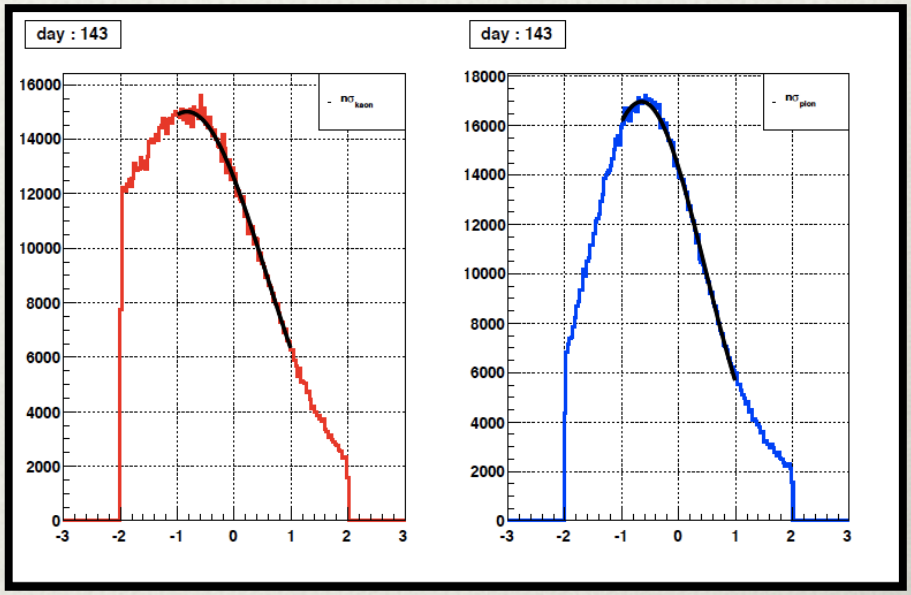
Cut on DCA of tracks (dcaXY<0.2cm)

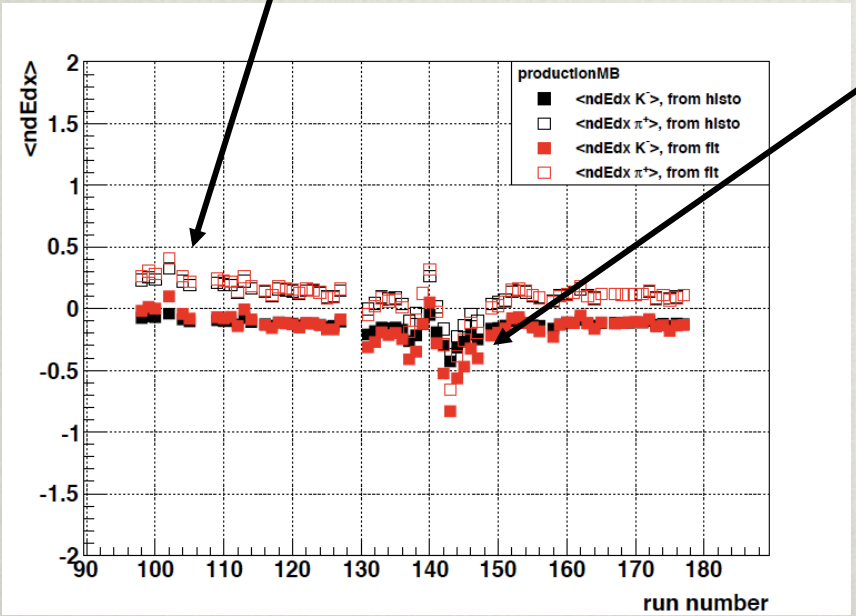


• From this plot, we can set an upper limit on DCA of daughters tracks to primary vertex at 2 mm

Cut on ndEdx



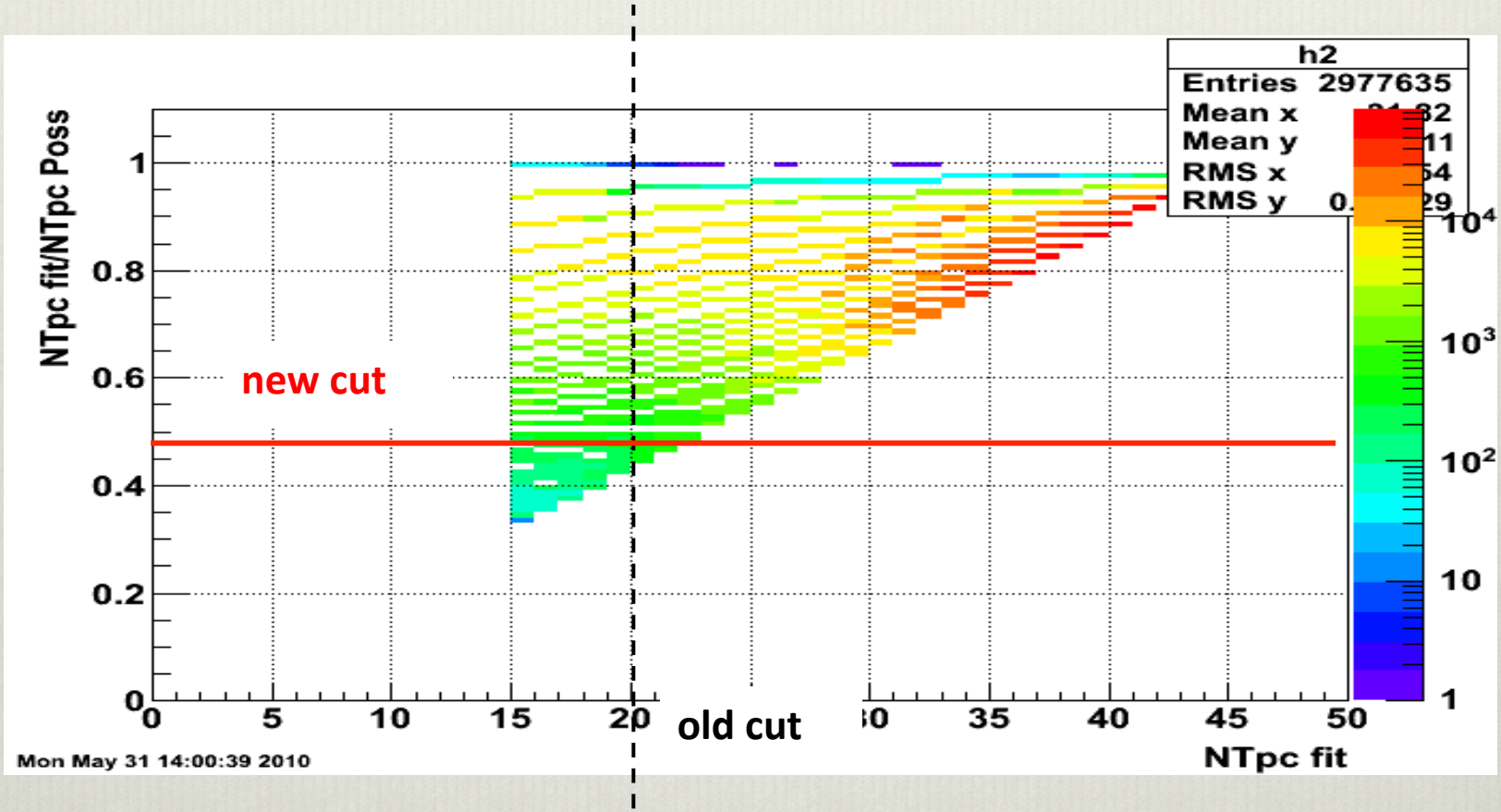




- We've changed the cut on ndEdx from 2 to 2.5 because we've observed a slight shift during the run 7

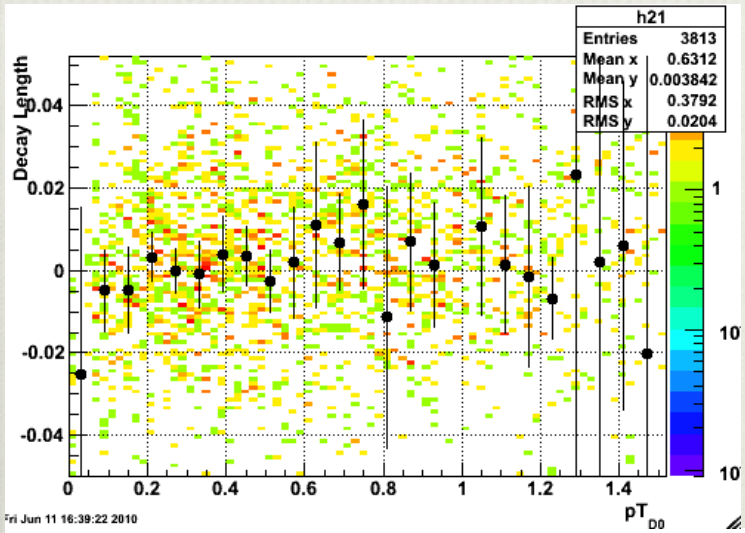
➔the original cut (|ndEdx|<2) was too strict

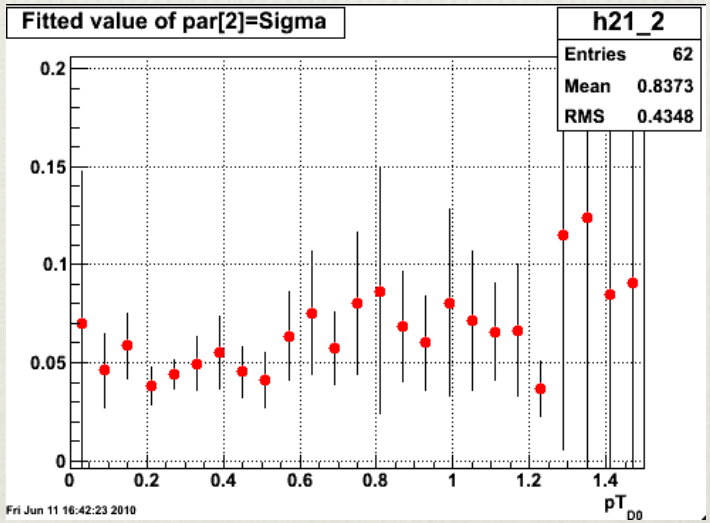
Cut on TPC hits



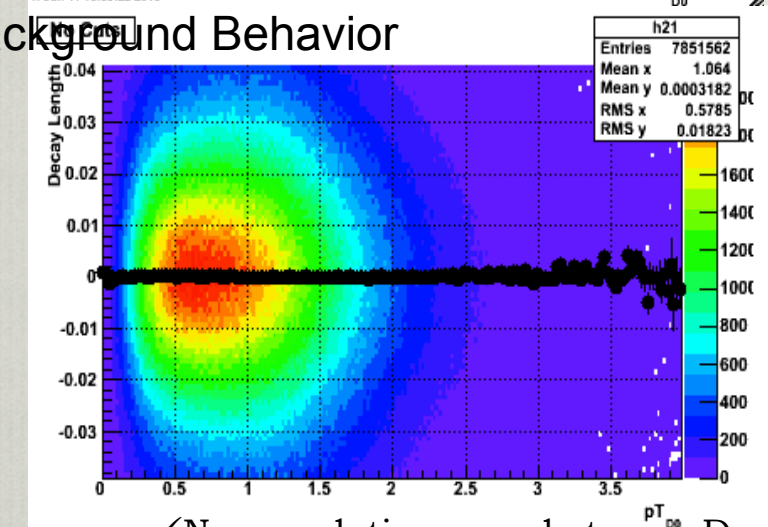
Reconstructed quantities- Signal & Background Distributions

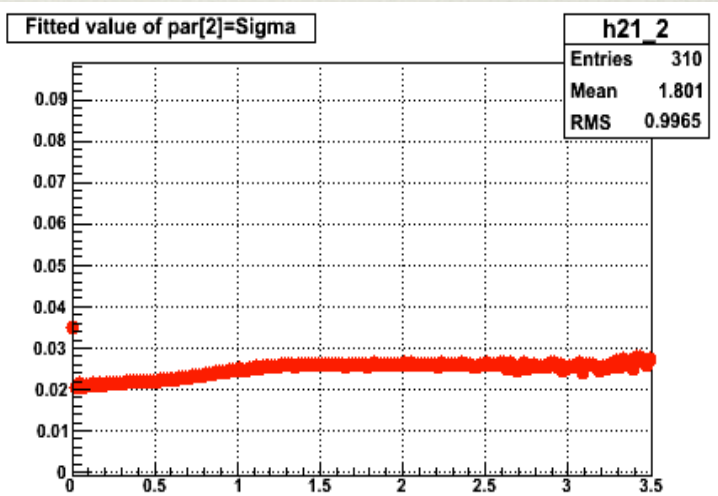
Signal Behavior





Background Behavior





✓No correlation seen between Decay Length and pT due to resolution.

✓The resolution is of the order of the resolution of (SVT+SSD)

Cut Studies Using Hijing and "real" pT D0

Data

✓ 1D0+AuAu central Hijing Events, D0s used have "real pT"(not flat) spectra.

The pT distribution is generated with a power law function :$d^2N/dpTdy= A[1+pT/p0]^n$

✓ Number of Events ~ 6.5K

Cuts

Event Level

|ZVrtx|<10

σVz < 200μm

Track Level

TpcHits >15

pT > 0.5

|Eta| < 1.0

SiliconHits ≥ 2

dEdxTrackLength > 40

chargeK*chargePi >0

decayLength < 0.1

Probability_tcfit > 0.1

DcaXY < 0.1

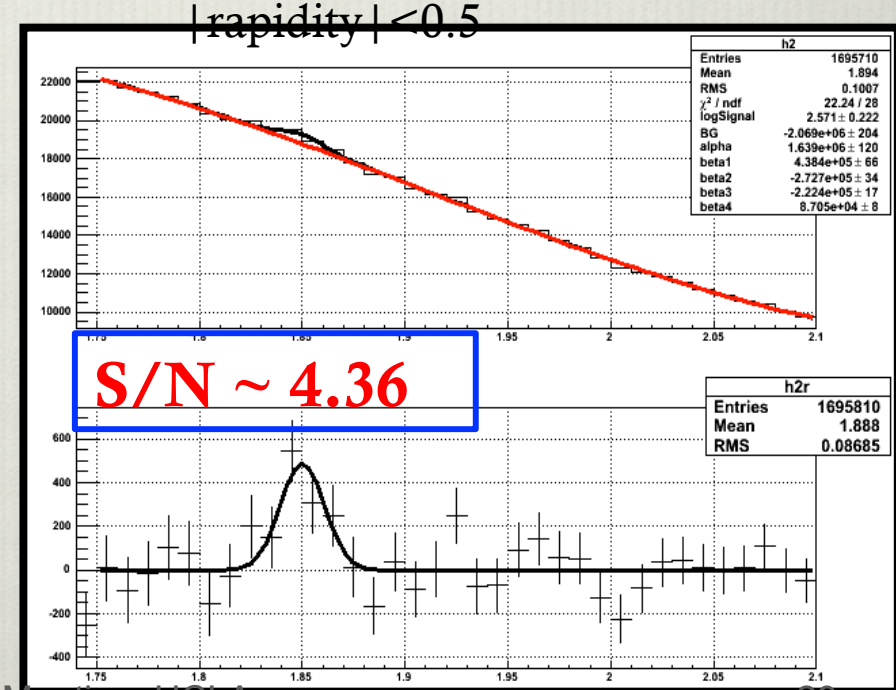
Offline Cuts:

pPi, pK>0.7, SiHits>2

$|D0\ dca\ to\ PV| \leq 400\ \mu m$

$|dl| \geq 50\ \mu m$, $-150\ \mu m \leq dl \leq 400\ \mu m$

$|rapidity| < 0.5$

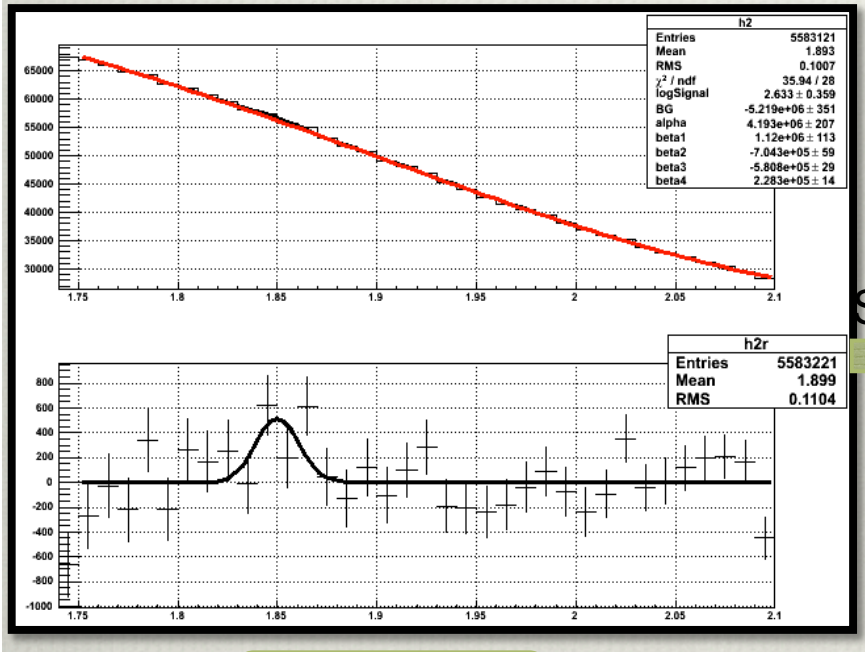


Realistic Mass Plots from D0+Hijing

In addition to the cuts mentioned on the previous plot, there is a cut on the Cosine of the Angle made by Kaon in the CM frame, Cos(θ *) and | η_{D0} |

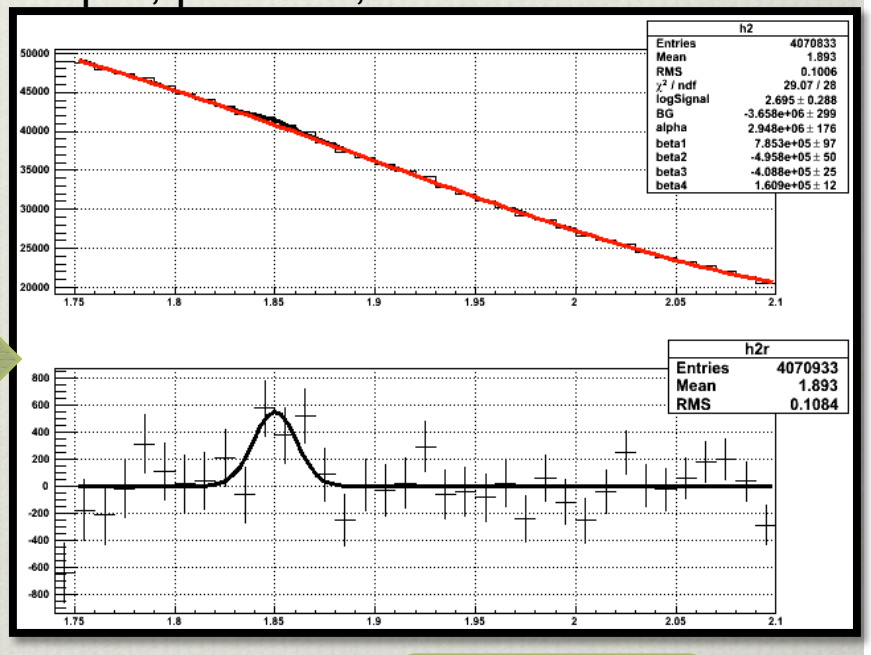
$|\cos(\theta^*)| < 0.6$
$|\eta_{D0}| < 1.85$

pPi, pK > 0.7GeV/c2



SiHits>2

pPi, pK > 0.7, SiHits>2



S/N ~ 2.79

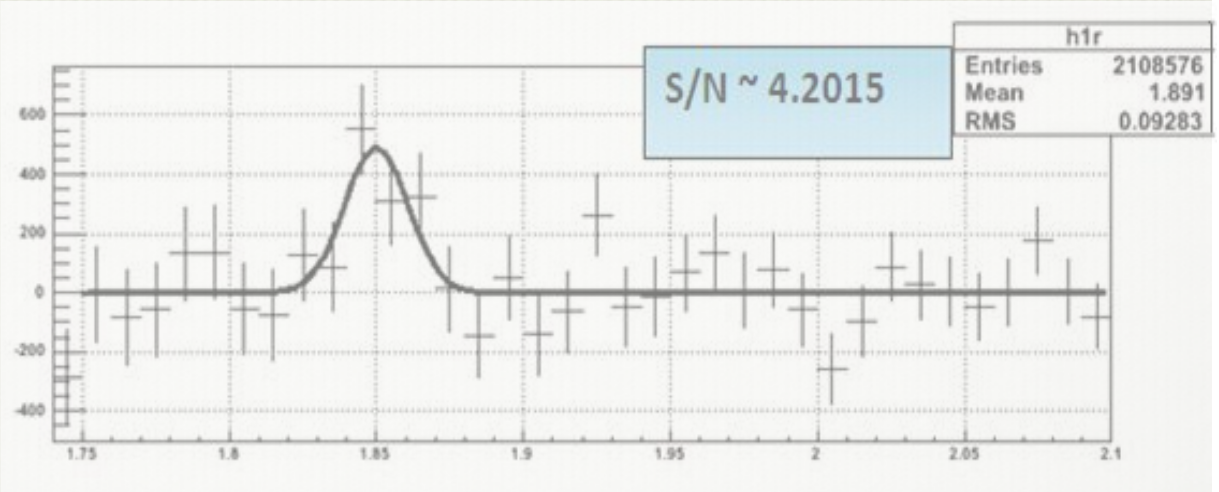
Silicon Hits are Important!

S/N ~ 3.48

Cut Variation studies in D0+Hijing Data

Offline Cuts

$|\cos(\theta^*)| < 0.6$
$|\eta_{D0}| < 1.85$
Track momentum > 0.7GeV/c
SiliconHits >2



D0 dca to PV	S/N
< 100 μm	3.2194
< 150 μm	3.3977
< 200 μm	3.3491
< 300 μm	3.2698
< 350 μm	3.2155
< 400 μm	3.2358

Decay Length	S/N
50μm <|dL< 400μm	3.6353
0 <dL< 400μm	2.6191
-100μm <dL< 400μm	3.3632
-100μm <dL< 400μm&&|dL|> 50μm	3.5911
-150μm <dL< 400μm&&|dL|> 50μm	4.2015
-200μm <dL< 400μm&&|dL|> 50μm	4.1334

Removing extreme negative decay Lengths helps to improve Signal!

Cut Sets - Continued..

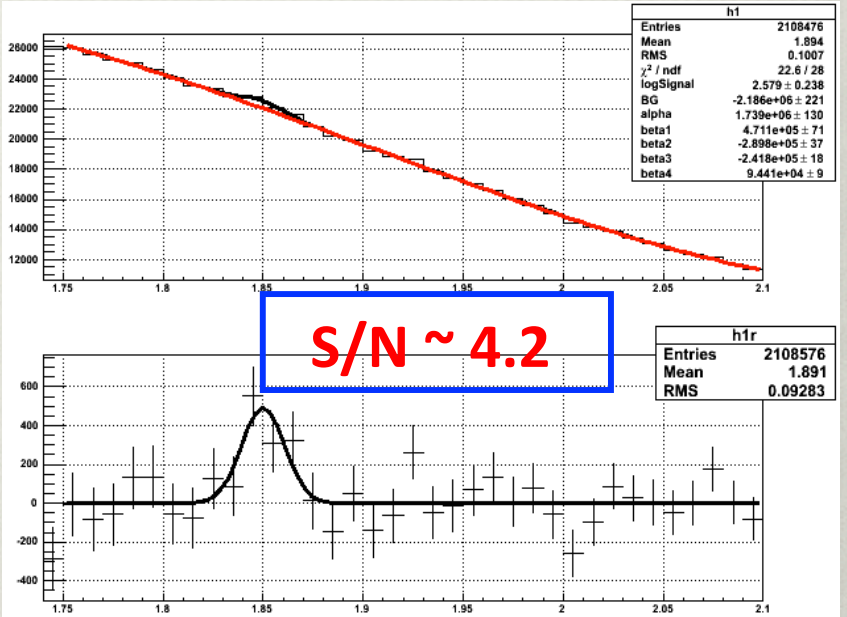
Combined with cut:
-150<dL< 400&&|dL| >50

Combined with cuts:
-150<dL< 400&&|dL| >50
|D0dcaPV| < 400

-150μm<dL<400μm&&|dL|>50μm
D0 dca to PV < 400μm

D0 dca to PV	S/N
< 300 μm	3.9528
< 400 μm	4.2015
< 500 μm	3.2015
< 600 μm	4.2015

DCA of Tracks	S/N
< 300 μm	3.027
< 400 μm	3.4322
< 600 μm	3.8587
< 800μm	4.2015
< 1000 μm	4.2517



More Cut studies can be found at: http://www.star.bnl.gov/~jai2006/jjoseph/19thApril2010-NewInvMassPlots_Hijing.htm