Update on D^0 reconstruction using μVertexing (TPC+SSD+SVT)

1. Update on secondary μ-vertex fitting method
2. Report on tests performed using :
   a) Files on NFS/HPSS
   b) Files from Production/Production2 Minbias
3. Testing the code on strange particles
4. Summary

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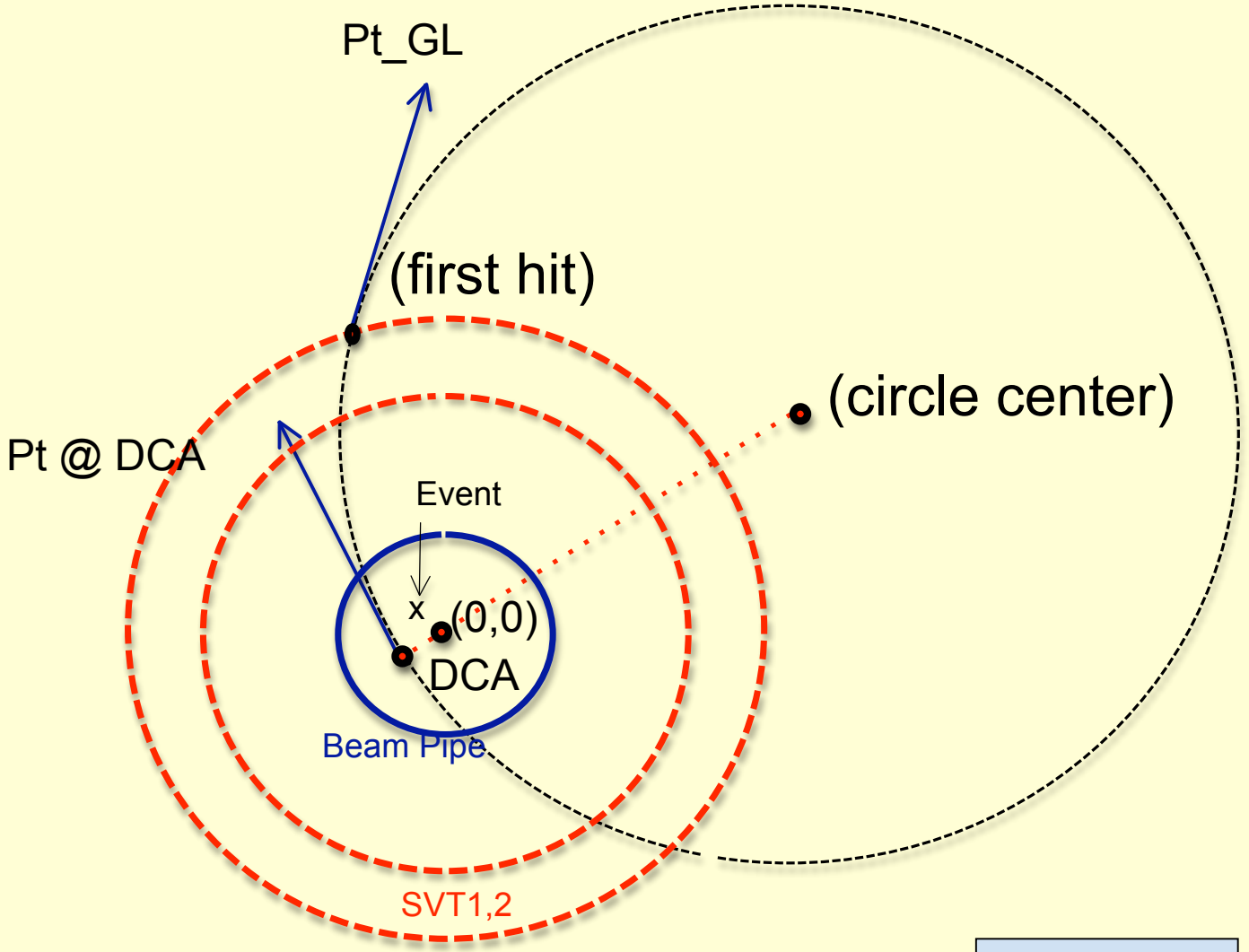
Fitting approaches for secondary vertices

- GOAL: To know with precision the position of secondary vertex of decaying particle to apply topological cut
→Challenging for charmed particles because of the small $c\tau$ (for D0, $c\tau$ ~122 μm)

- We are investigating 3-methods
  1. A Linear Fit approach : three lines fit with errors (two tracks plus a parent from the event vertex).
  2. A Helix swimming to DCA of the two track helices (V0-like) :
     a. using the global track parameters to reconstruct helices (StPhysicalHelix) of both tracks candidates
     b. using the parameters from StDcaGeometry
  3. A **Full Helix Fit** with errors (a.k.a. TCFit)
     - it will allow momentum dependent cut using the full track information

- RECENT :
  - Method 2. has been updated by Victor to remove some errors when the minimum DCA between helices is evaluated :
  - Victor also updated $STAR/StarRoot/TCFit.cxx with a V0-like test

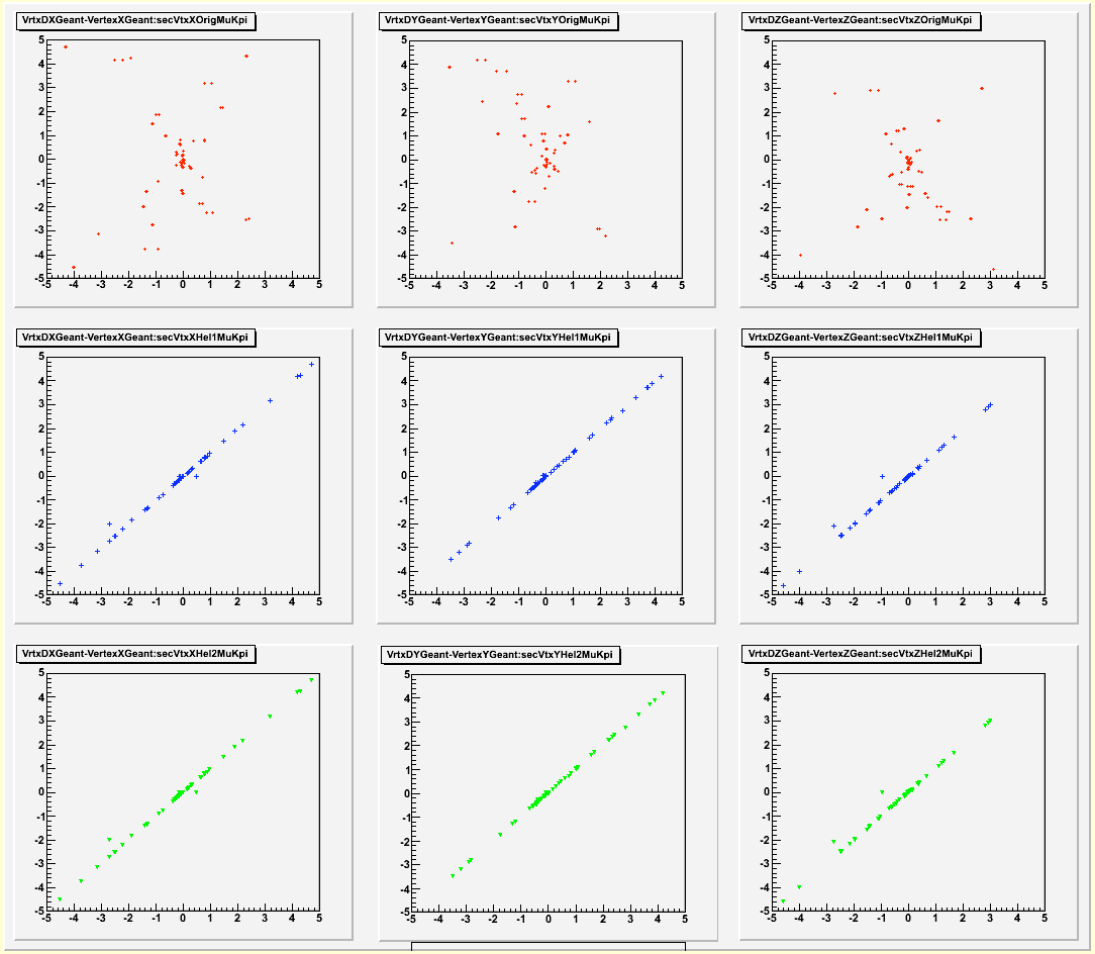
DcaGeometry



R-Φ plane

Previous discrepancy

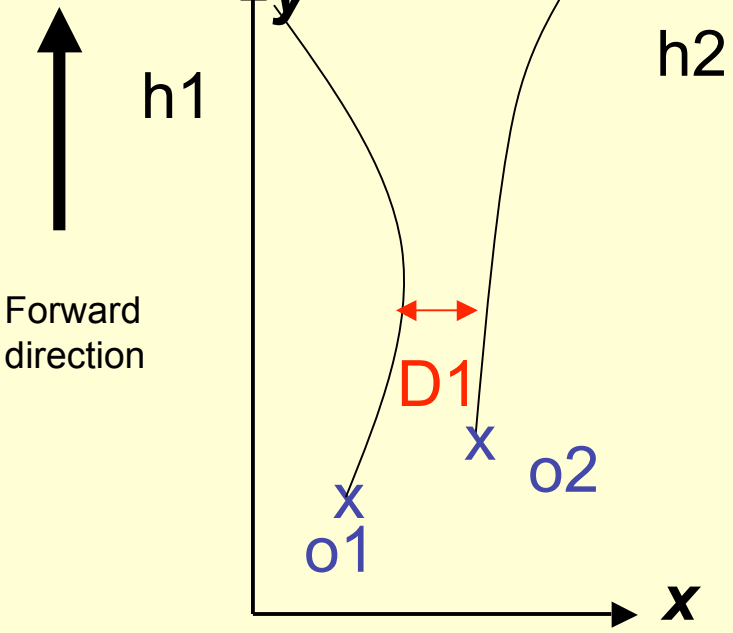
•At the last analysis meeting we reported(*) a discrepancy between the linear fit and the helix swimming with Global tracks parameter (StDcaGeometry parameters).



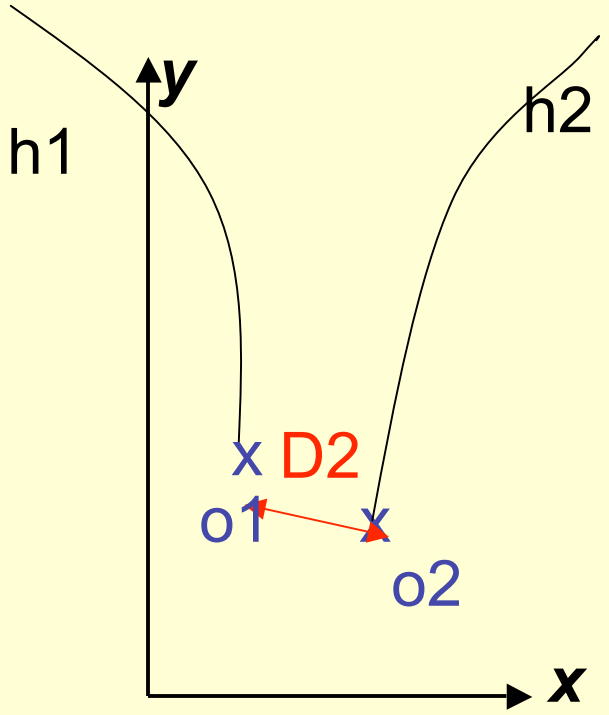
•Positions of secondary vertex reconstructed (x-axis) and from GEANT (y-axis)
•Used D^0 with 100x$c\tau$ to disentangle between errors and resolution effects.
•The linear fit failed to project on such distance 2 daughters tracks.
•Reconstructed helices matched GEANT results.

(*):http://cnr2.kent.edu/~vanfossen/MySTARPage/D0_uVertexing/Entries/2009/7/1_secVtx_Reco_w__JB_Helix_Methods.html

Example



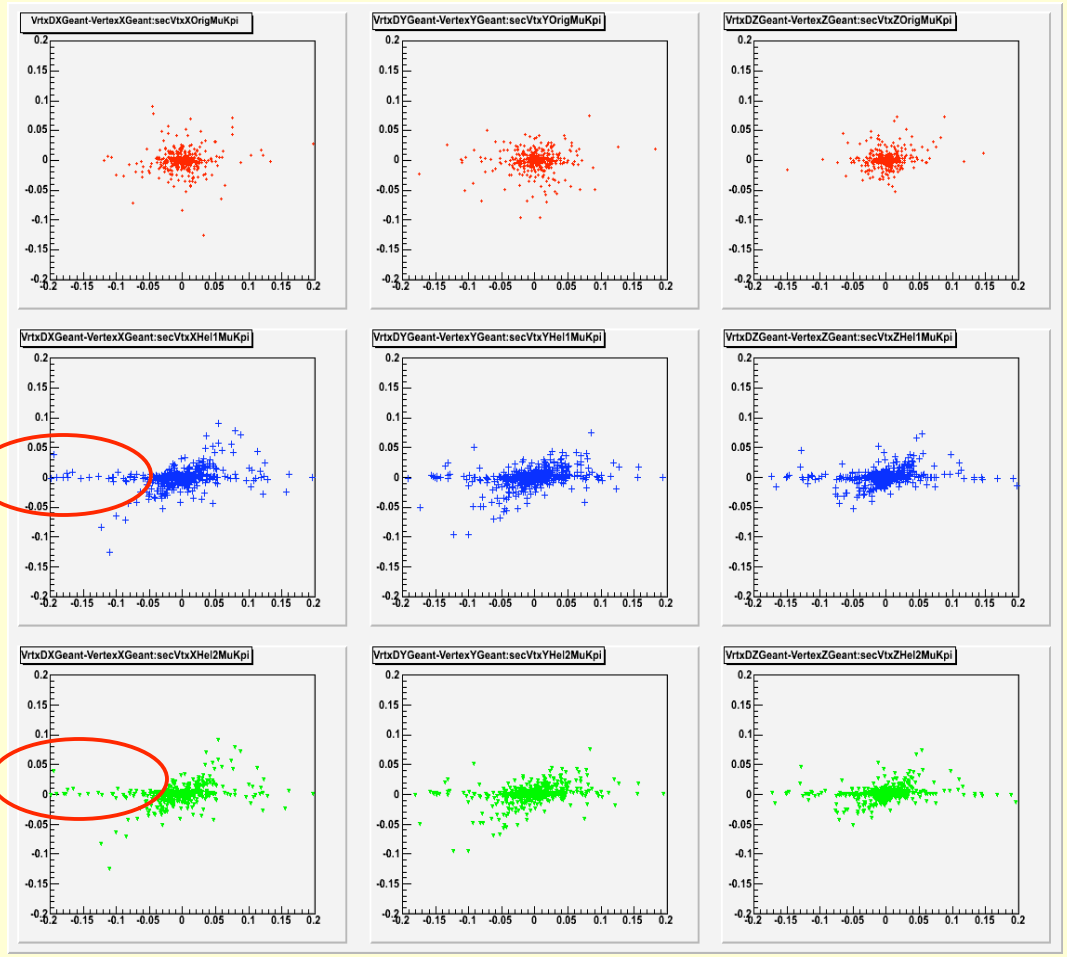
•o1,o2 = starting point of helices h1 and h2
•Start the scan with helix h1
•Search in forward direction
•D1 = minimal distance



•o1,o2 = starting point of helices h1 and h2
•Start the scan with helix h1
•Search in forward direction
•D2 = minimal distance
•But D2 is different from D1
•Should use Backward() in that case ?

Actual status (new discrepancy)

- A bug in finding two helix DCA still there.
- Here the D^0 sample used is D^0 with regular $c\tau$..



- Helix swimming show a correlation(diagonal bottom left- top right) which is expected :
->Position GEANT = Position reconstructed
- But it also shows an horizontal band, ie GEANT says that two tracks come from common point but helix swim finds large DCA at secondary vertex->not real minimum but something else.
- Looks like about 50% of cases are affected

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

Full Fit (TCFIT) Implementation (done by Yuri)

- Work in implementing a full secondary vertex fit with errors using track info inside the beam pipe is about to finish
  - We are currently testing/debugging the code
  - Tested it on D^0 and K^0_s by changing the initial parameters (as the K^0_s is a V0 decay)
  - We are currently evaluating the results

A comparative study of D^0 Signal in HPSS and NFS

•We were using files on NFS (~80Kevents) , prior the MIT analysis meeting to produce the D0 peak we showed

- •These files were all Mbias from Production2 (mostly for day 141)

•When we moved to a mini-production (~1Mevents) using HPSS data from Production2 and Production, we found a discrepancy:

- • The hint of a signal for the NFS 80Kevents did not scale (rather got weaker) on larger data sample
- •Discrepancy from Production2-MB and Production-MB on HPSS???
  - • quick answer - Still under investigation (need day by day comparison)

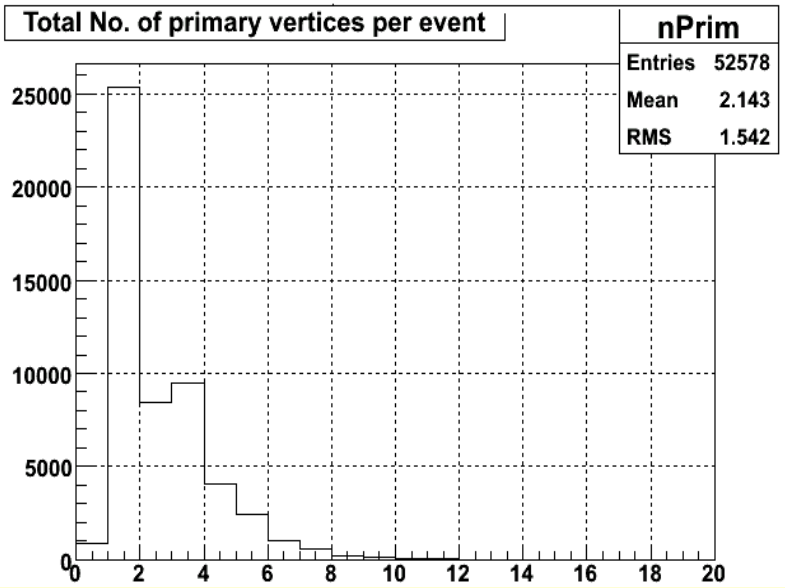
→We also looked at the difference between NFS and HPSS outputs (identical files) suspecting presence of MC info or other corruption

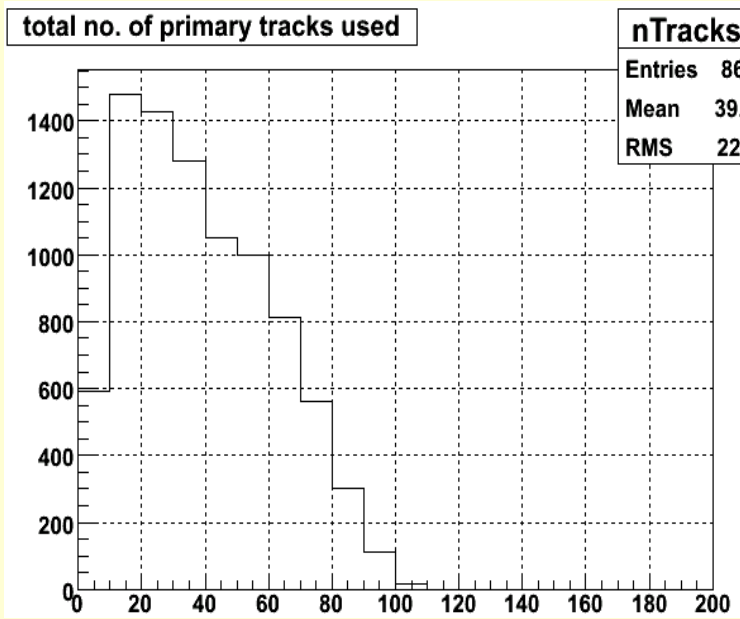
→ quick answer - Same files show same results

full comparison can be found at : http://drupal.star.bnl.gov/STAR/blog/jai2006/2009/sep/29/d0-signal-update

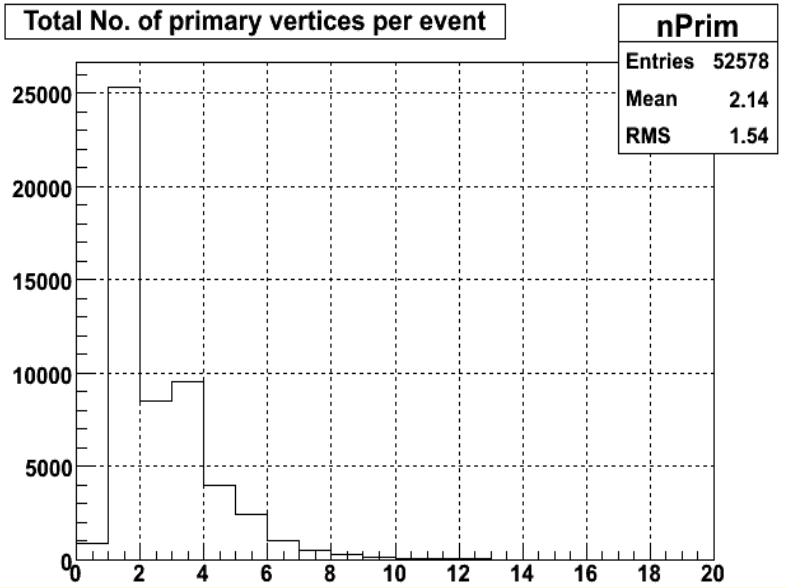
Comparing Identical files on NFS and HPSS

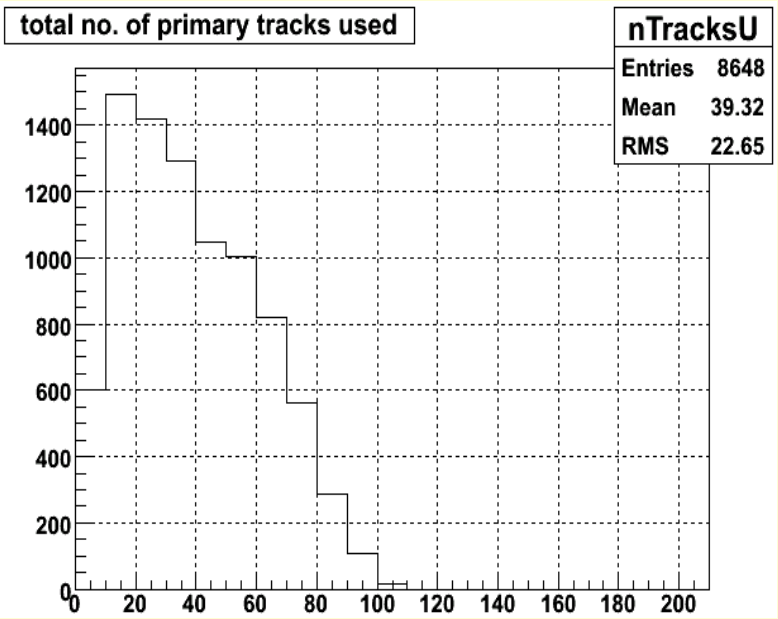
NFS



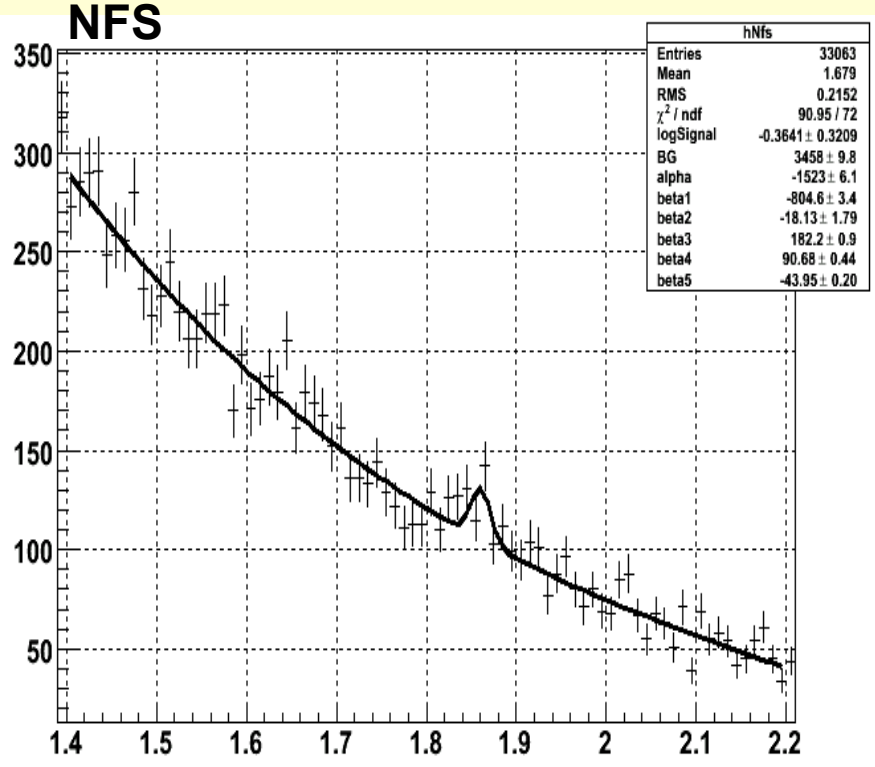


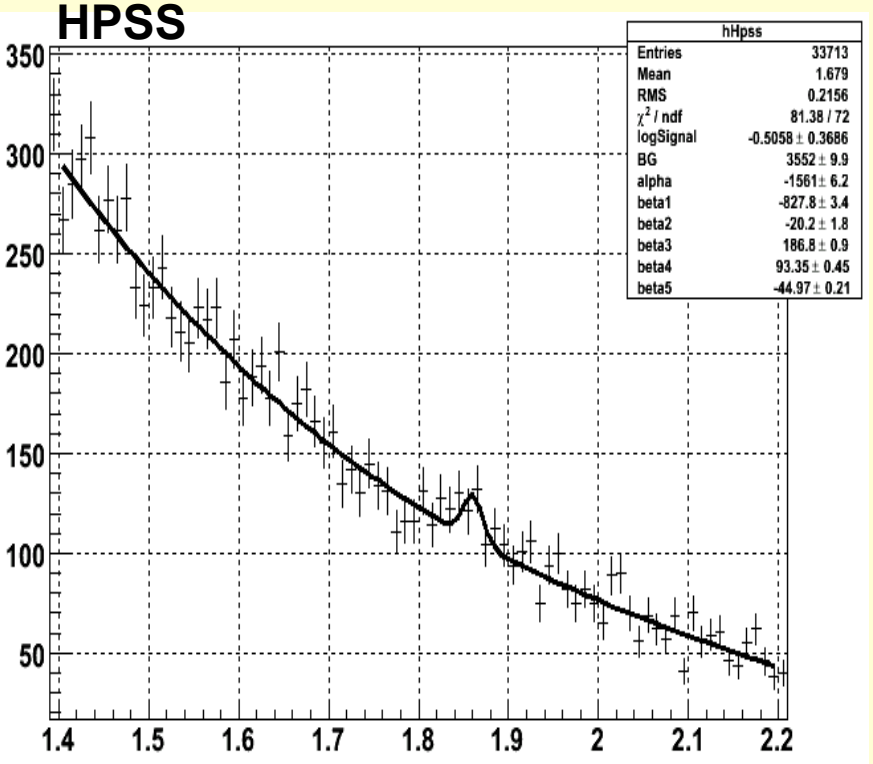
HPSS





D^0 reconstructed invariant mass





- Zvertex<30,nTracks<100,p_T>0.3,TpcHits>15,Eta in the SSD range,|NdEdx|<2, SiHits>0
- |cos(θ*)|<0.6, |eta|<1.85, decayXY<0.3, |slength|<1500μm

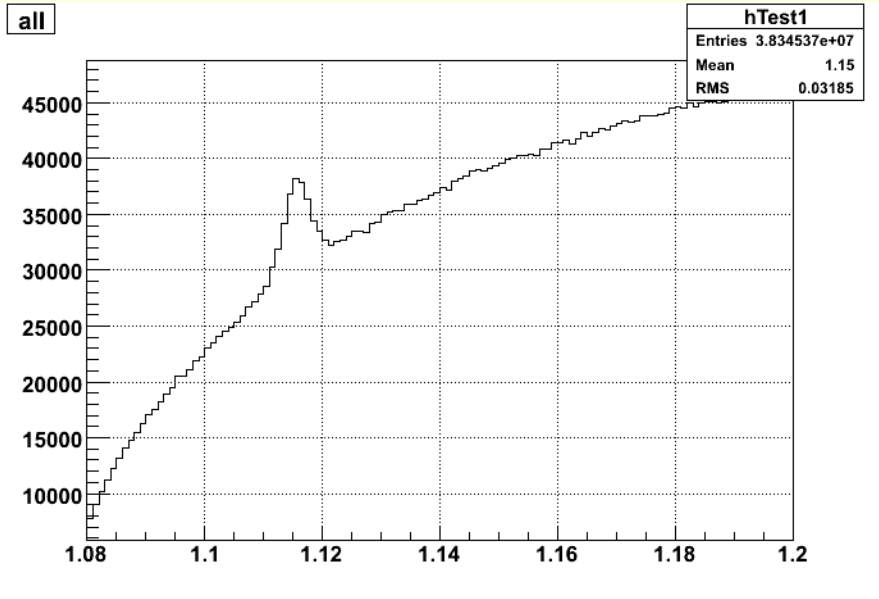
Comments:

- This analysis was done on the exact same files from NFS and HPSS.
- These files are from day141.
- Both of them show a clear D^0 signal. But they don't have any MC events in the .MuDst.root files, so we know that this is for real!
- Signal is very sensitive to cuts. We need to:
  - Fix DCA code
  - Run big production (many millions of events)
  - Apply REAL uvertex cuts (not done so far)

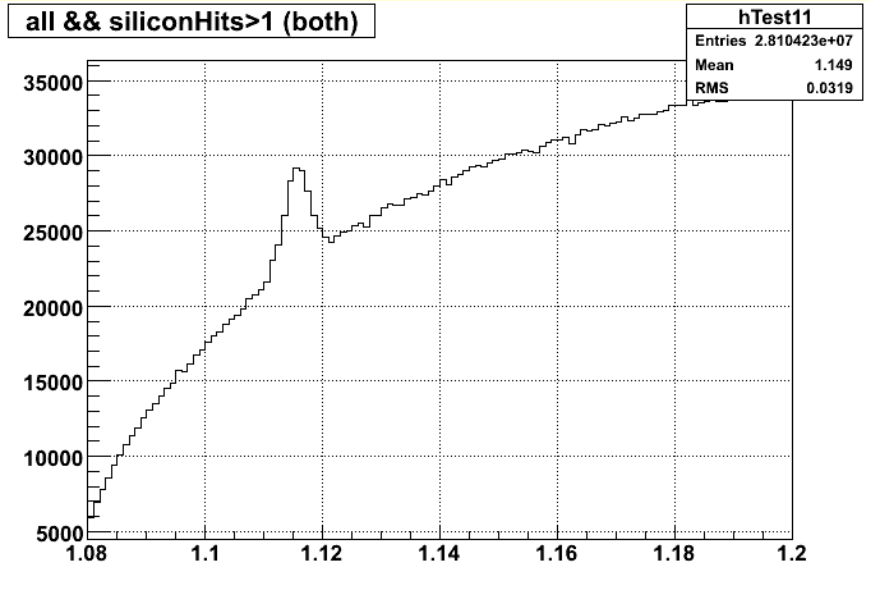
μ-vertex code : proof of principle

- We tried our current code on 'easier' decay particles : K^0_s and Λ
- Since their $c\tau$ is an order of magnitude higher (2.68 and 7.89 cm respectively), it may be a good test to see if decay length, etc … are in agreement
- Cuts by default :
  - Unlike sign pairs
  - Product of DCAtoPV from daughters candidates has to be <0
  - Silicon hits >0
- Use real data

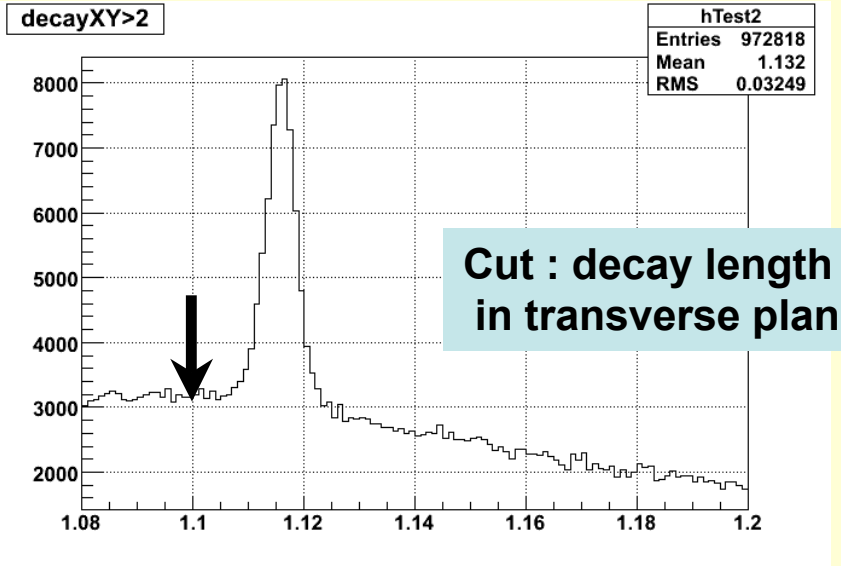
Λ inv. mass : no geometrical cuts



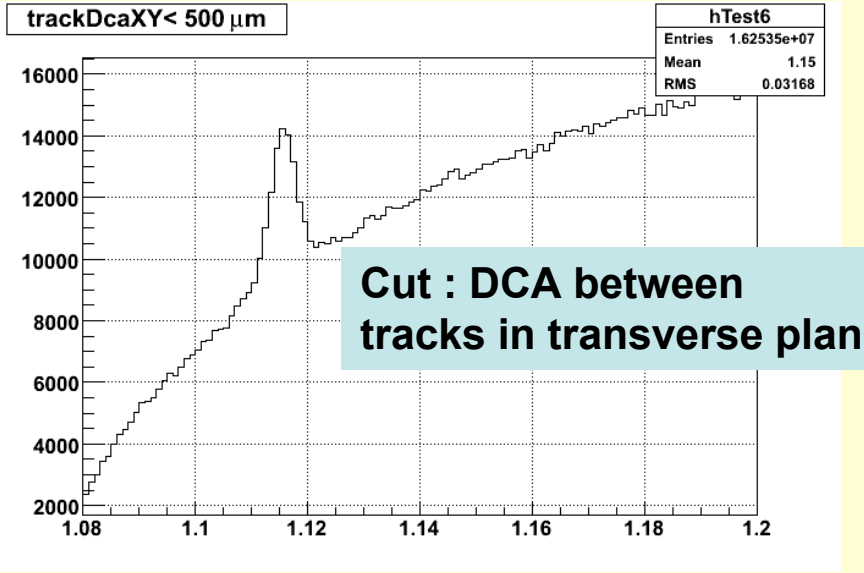
- With the cuts already in the macro to select 'good candidates', a clear peak at mass ~ 1.115 is seen



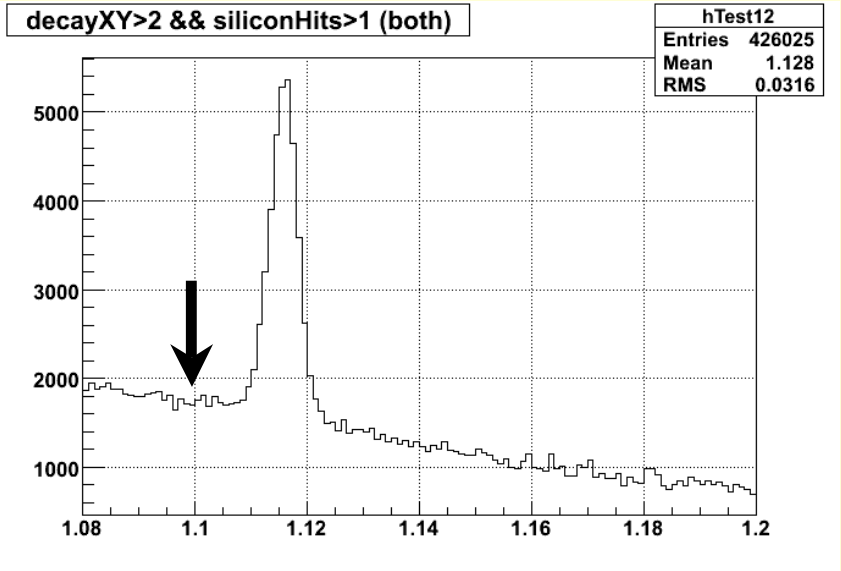
Test of cuts

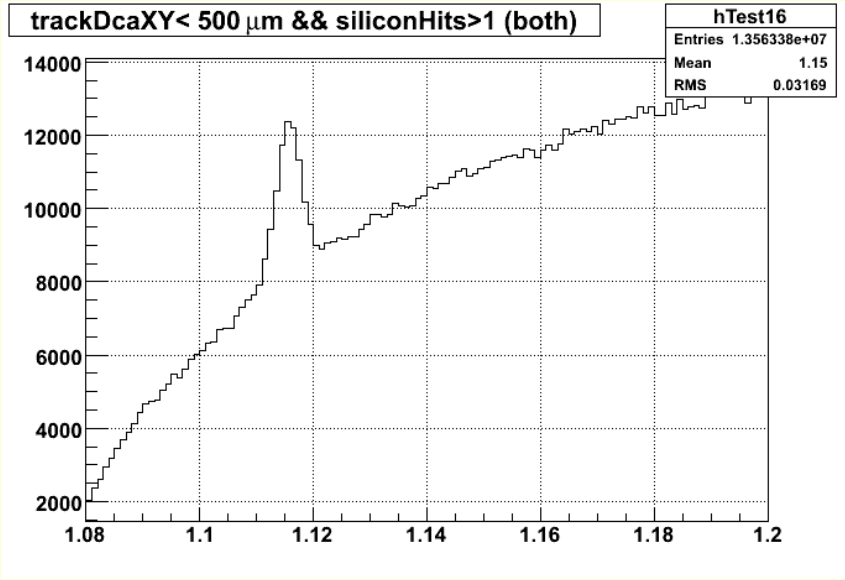


Cut : decay length in transverse plan



Cut : DCA between tracks in transverse plan



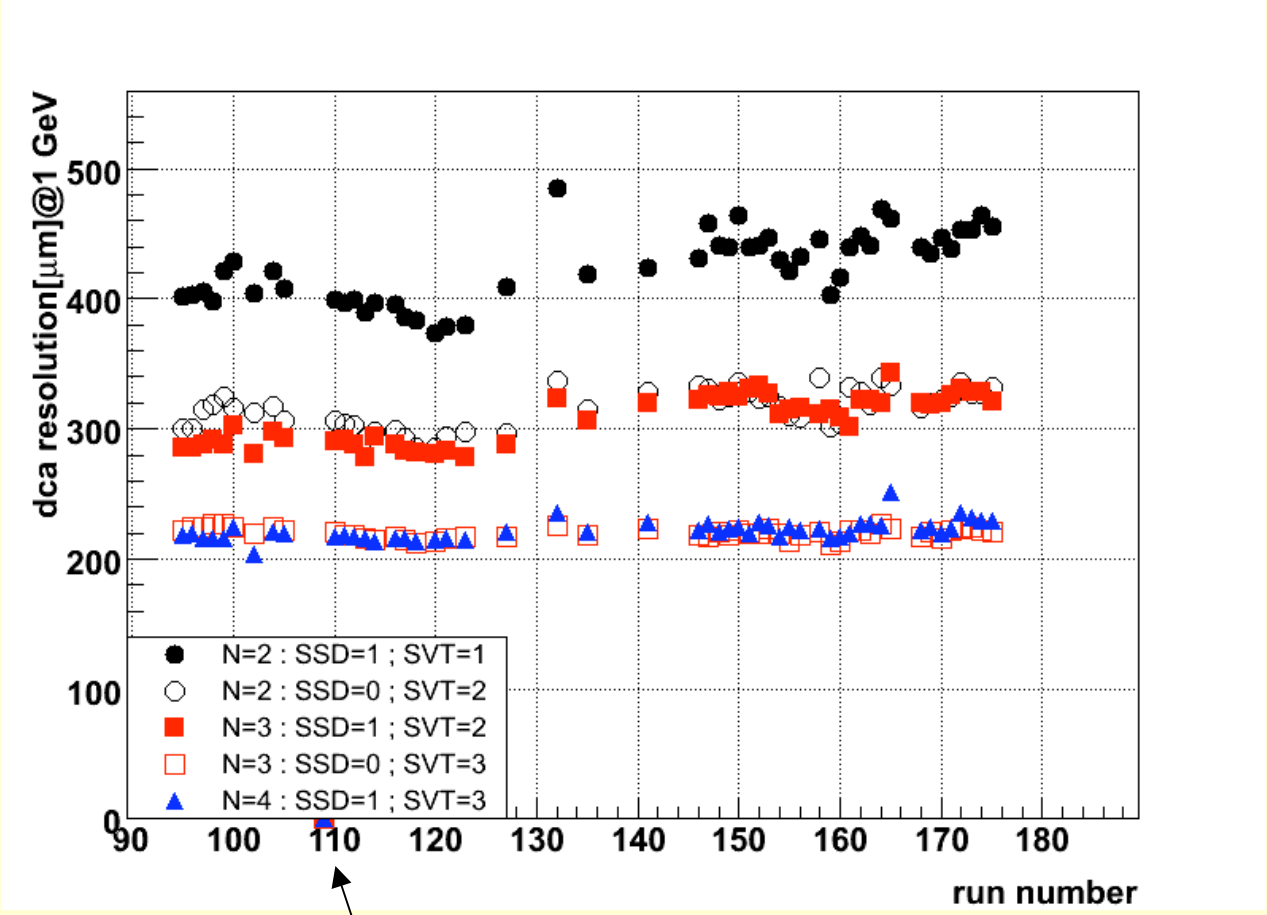


Summary

- Code development and debugging is moving well
  - Un-anticipated bugs and glitches are being fixed
- Real/full production is pending on good DCA/μ vertex info
- Code testing on strange particles in progress
  - Comparison with V0Maker for evaluation of u-vertex techniques

DCA resolution vs run number

- In general, DCA resolution stable vs time.
- Expected since it depends only on the hit location near the vertex
- DCA resolution slightly increases during run 7 (mostly when tracks with SSD are taken into account)
- Tracks with SVT=3 seems stable
- Dca resolution for N=2 (no ssd) is similar as dca resolution N=3 (ssd=1 +svt=2)
- Period where SSD has bad dca resolutions



run 109 has no SVT