Status of Vertex Reconstruction Tests

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Vertex Reconstruction and D0 Comparisons

- Due to some strange behaviours of KFParticle reconstruction, it was decided that Vladimir Andreev and I work on parallel checks to converge on the best practice and clear confusions
- In last Physics & MC Meeting Vladimir presented comparisons of a number of diff. algorithms in primary vertex reconstruction for the ideal case (at (0,0,0) no smearing ,and PDG PID used)
- We also want to test for increasingly realistic scenarios
- SpdRoot current vertex reconstruction algorithm and KFparticle were tested for both primary and $D^0 \rightarrow \pi^+ K^-$ secondary vertex
- Two types of tracks used : a) regular fitted tracks b) fitted tracks extrapolated to a cylinder of radius 3 cm (to account for beam pipe)

Primary Vertex Fits : No Smearing

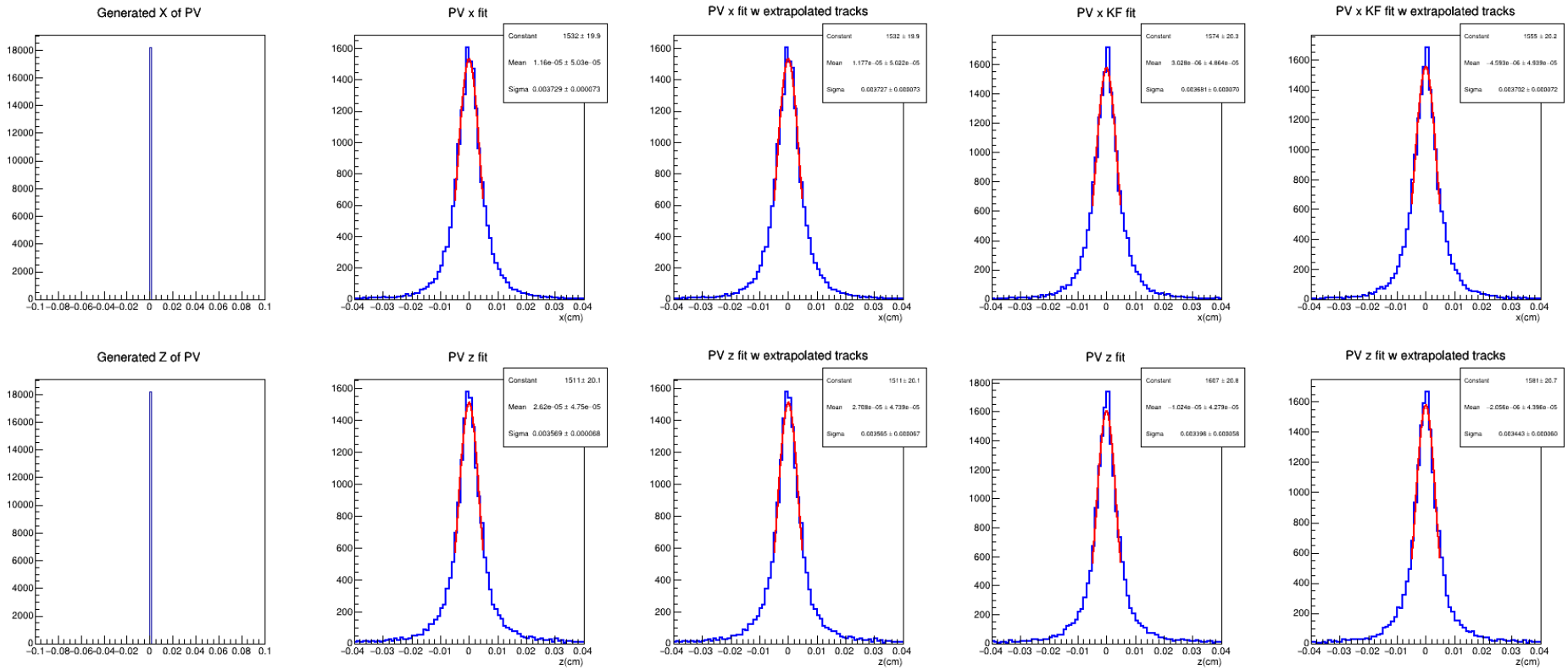


Figure 1: Primary vertex reconstruction, X (upper row) and Z (lower row). Column 1 generated, column 2,3 standard algorithm, column 4,5 KFParticle reconstruction

Primary Vertex Resolutions : No Smearing

1. std algorithm, std track : $\sigma_x = 37.3\ \mu m, \sigma_z = 35.7\ \mu m$
2. std algorithm, extrapolated track : $\sigma_x = 37.3\ \mu m, \sigma_z = 35.6\ \mu m$
3. KFParticle, std track : $\sigma_x = 36.8\ \mu m, \sigma_z = 33.9\ \mu m$
4. KFParticle, extrapolated track : $\sigma_x = 37.0\ \mu m, \sigma_z = 34.4\ \mu m$

Without smearing, KFParticles reconstruction of Primary Vertex is marginally better performing. Extrapolating tracks marginally worse.

Secondary Vertex Fits : No Smearing

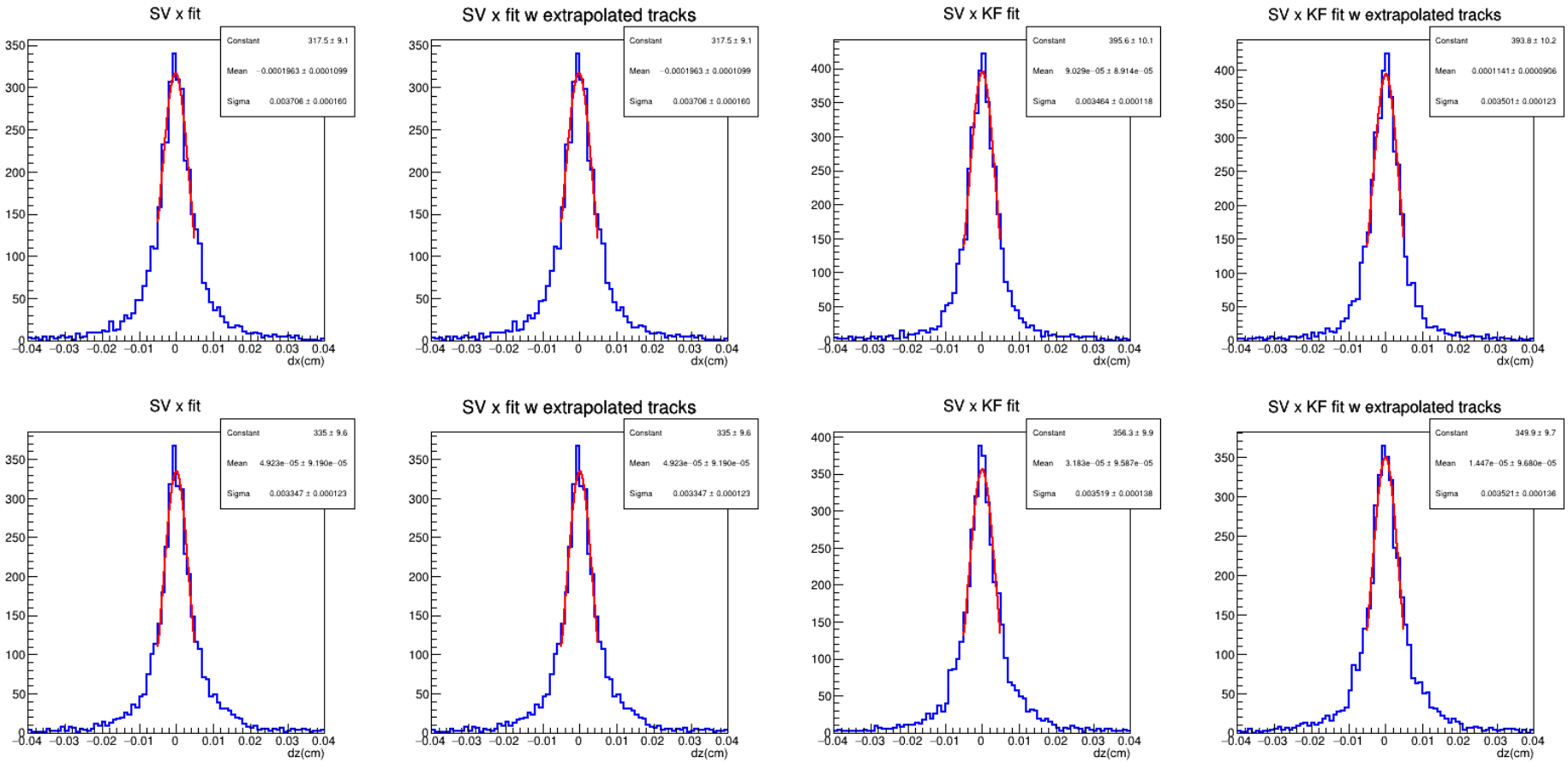


Figure 2: Primary vertex reconstruction, X (upper row) and Z (lower row). Column 1,2 standard algorithm, column 3,4 KFParticle reconstruction

Secondary Vertex Resolutions : No Smearing

1. std algorithm, std track : $\sigma_x = 37.1\ \mu m, \sigma_z = 33.5\ \mu m$
2. std algorithm, extrapolated track : $\sigma_x = 37.1\ \mu m, \sigma_z = 33.5\ \mu m$
3. KFParticle, std track : $\sigma_x = 34.6\ \mu m, \sigma_z = 35.2\ \mu m$
4. KFParticle, extrapolated track : $\sigma_x = 35.0\ \mu m, \sigma_z = 35.2\ \mu m$

Without smearing, KFParticles reconstruction of D0 Secondary Vertex is slightly (couple of microns) better performing. Extrapolating tracks does not make much of an impact for SV.

Primary Vertex Fits : With Smearing

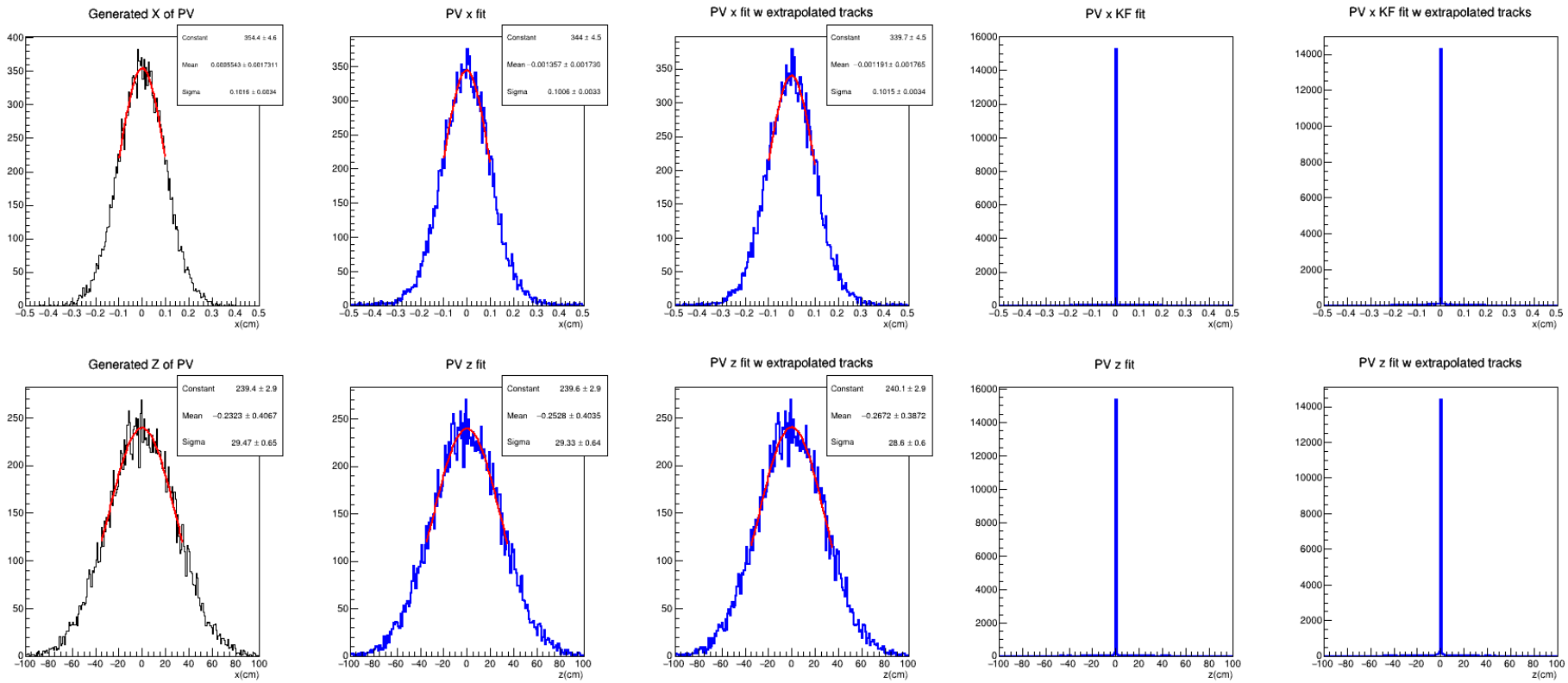


Figure 3: Primary vertex reconstruction, X (upper row) and Z (lower row). Column 1 generated, column 2,3 standard algorithm, column 4,5 KFParticle reconstruction. Generated with $\sigma_{x/Y} = 1mm, \sigma_z = 30cm$

Primary Vertex Resolutions : With Smearing

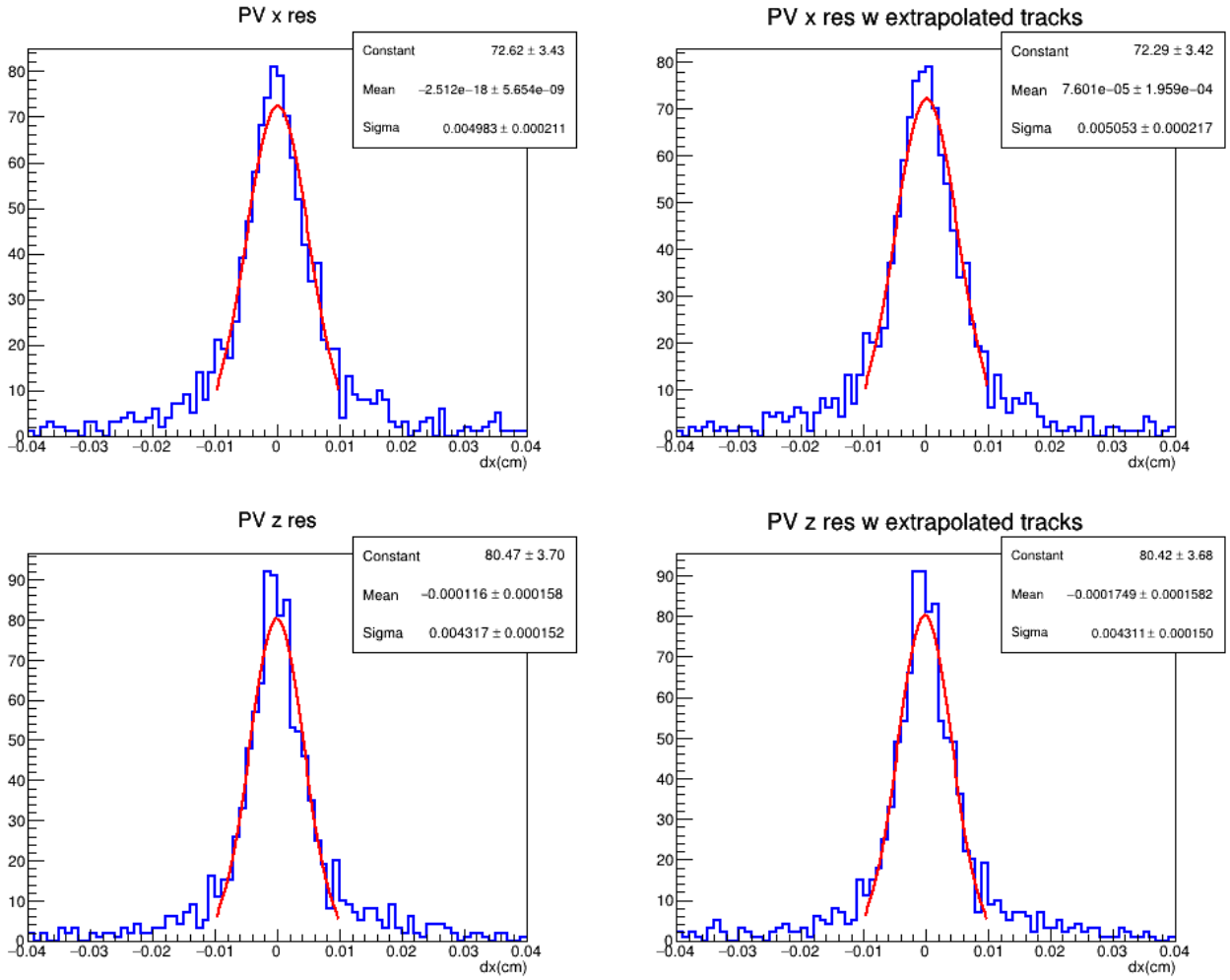


Figure 4: Primary vertex resolution, X (upper row) and Z (lower row)

Primary Vertex Resolutions : With Smearing

1. std algorithm, std track : $\sigma_x = 49.8\ \mu m, \sigma_z = 43.2\ \mu m$
2. std algorithm, extrapolated track : $\sigma_x = 50.1\ \mu m, \sigma_z = 43.1\ \mu m$

With smearing, KFParticles reconstruction of Primary Vertex fails. Vladimir Andreev might try to implement it in future. Standard algorithm is $\sim 35\%$ worse from ideal/no-smear case. Even this resolution is an unerestimation as the fit uses an ideal initial guess. We'll see in future how it works for more realistic case.

Secondary Vertex Fits : With Smearing

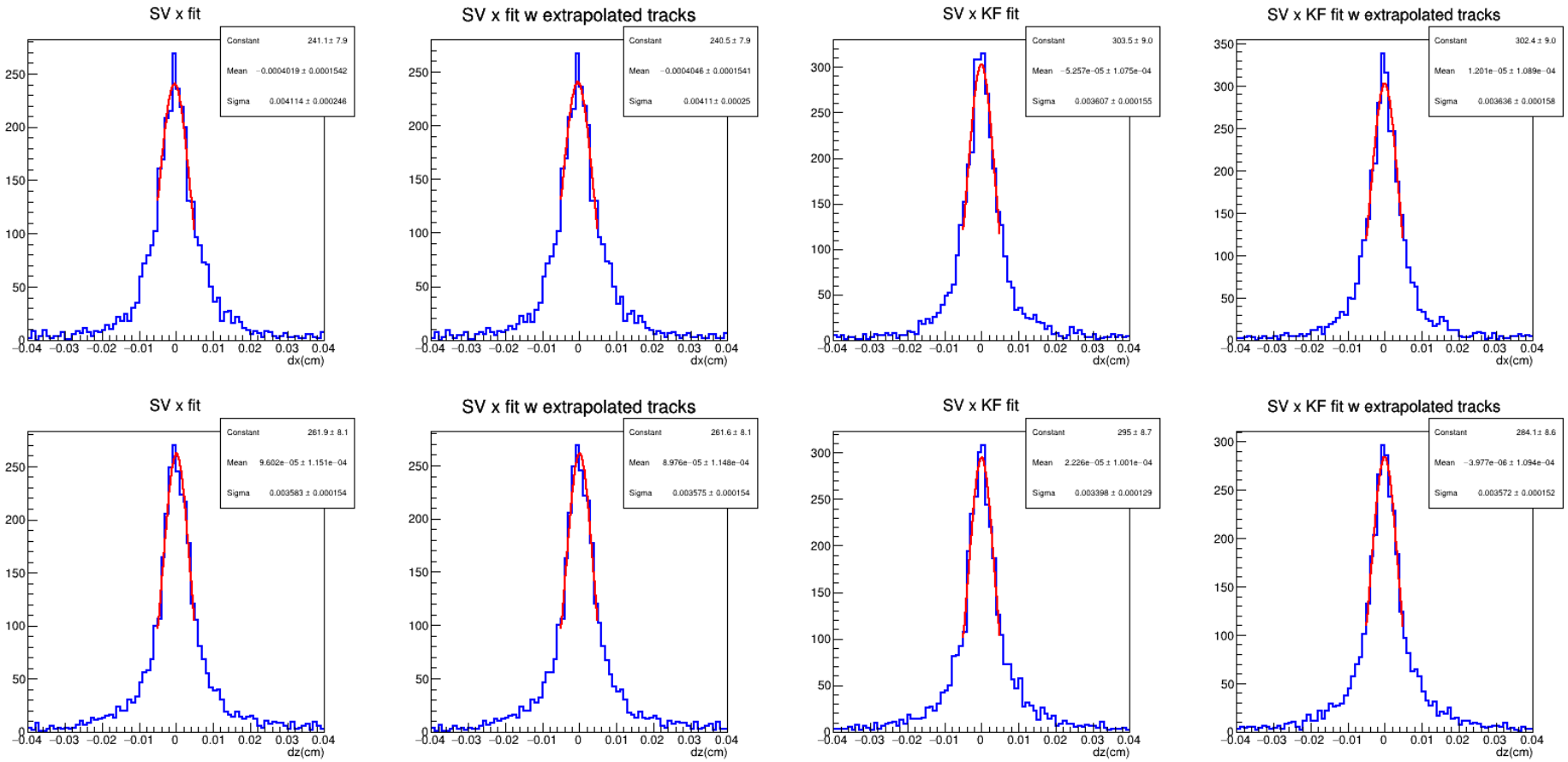


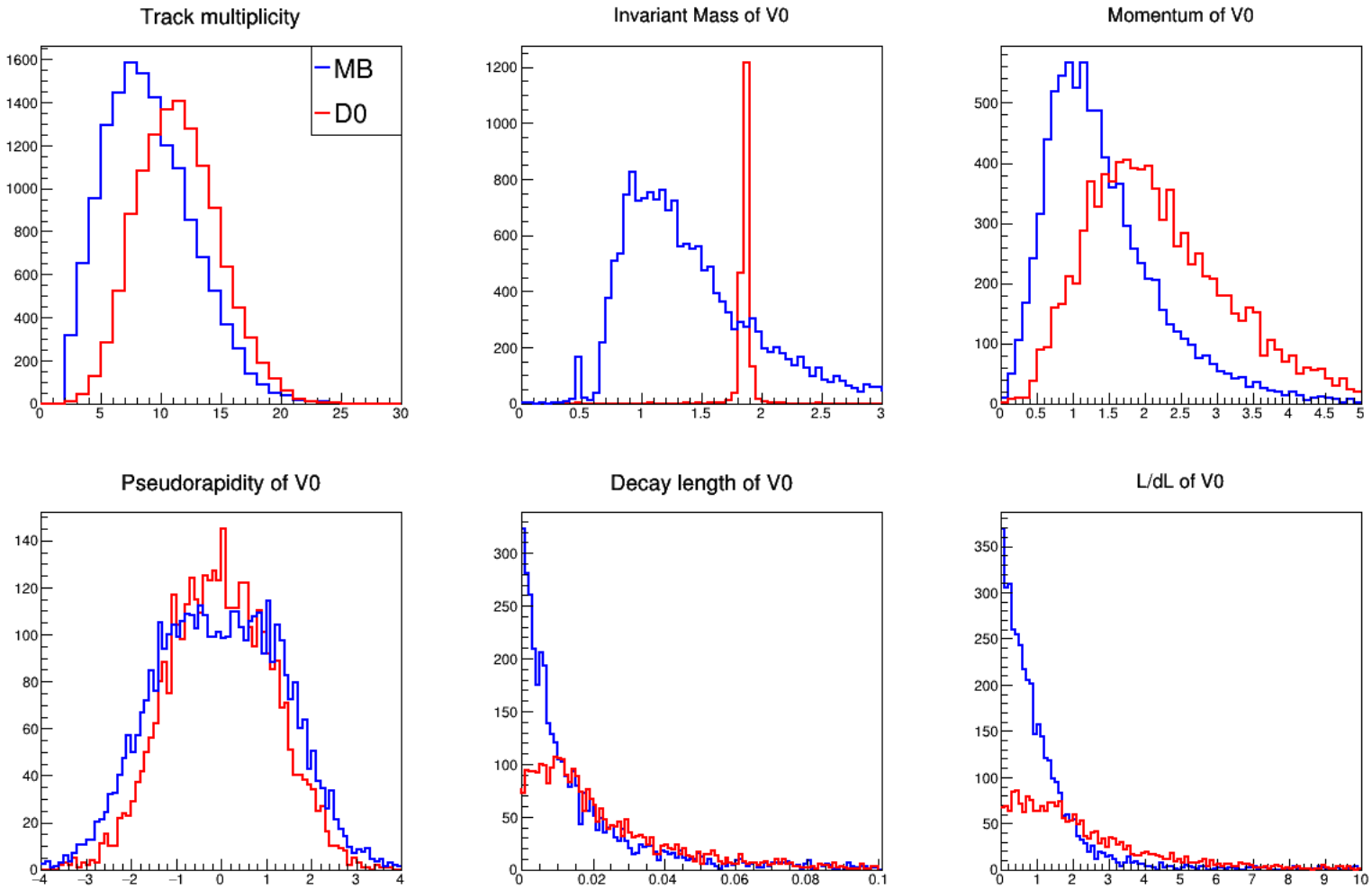
Figure 5: Primary vertex reconstruction, X (upper row) and Z (lower row). Column 1,2 standard algorithm, column 3,4 KFParticle reconstruction

Secondary Vertex Resolutions : With Smearing

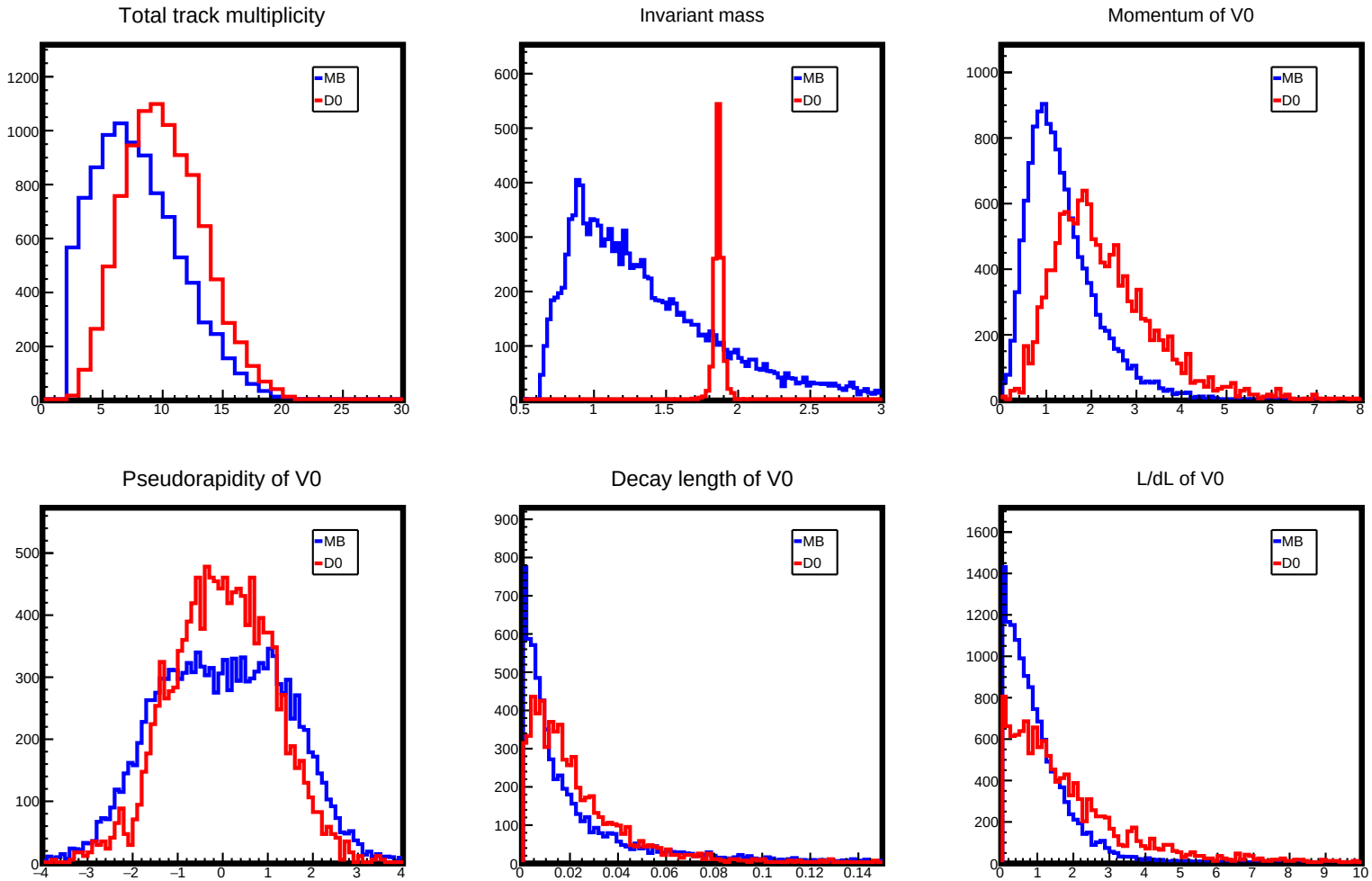
1. std algorithm, std track : $\sigma_x = 41.1\ \mu m, \sigma_z = 35.8\ \mu m$
2. std algorithm, extrapolated track : $\sigma_x = 41.1\ \mu m, \sigma_z = 35.7\ \mu m$
3. KFParticle, std track : $\sigma_x = 36.1\ \mu m, \sigma_z = 34.0\ \mu m$
4. KFParticle, extrapolated track : $\sigma_x = 36.4\ \mu m, \sigma_z = 35.7\ \mu m$

With smearing, KFParticles reconstruction of D0 Secondary Vertex is $\sim 5 - 10\%$ worse than the ideal/no-smear case. And KFParticle algorithm is also slightly better than standard refit of tracks.

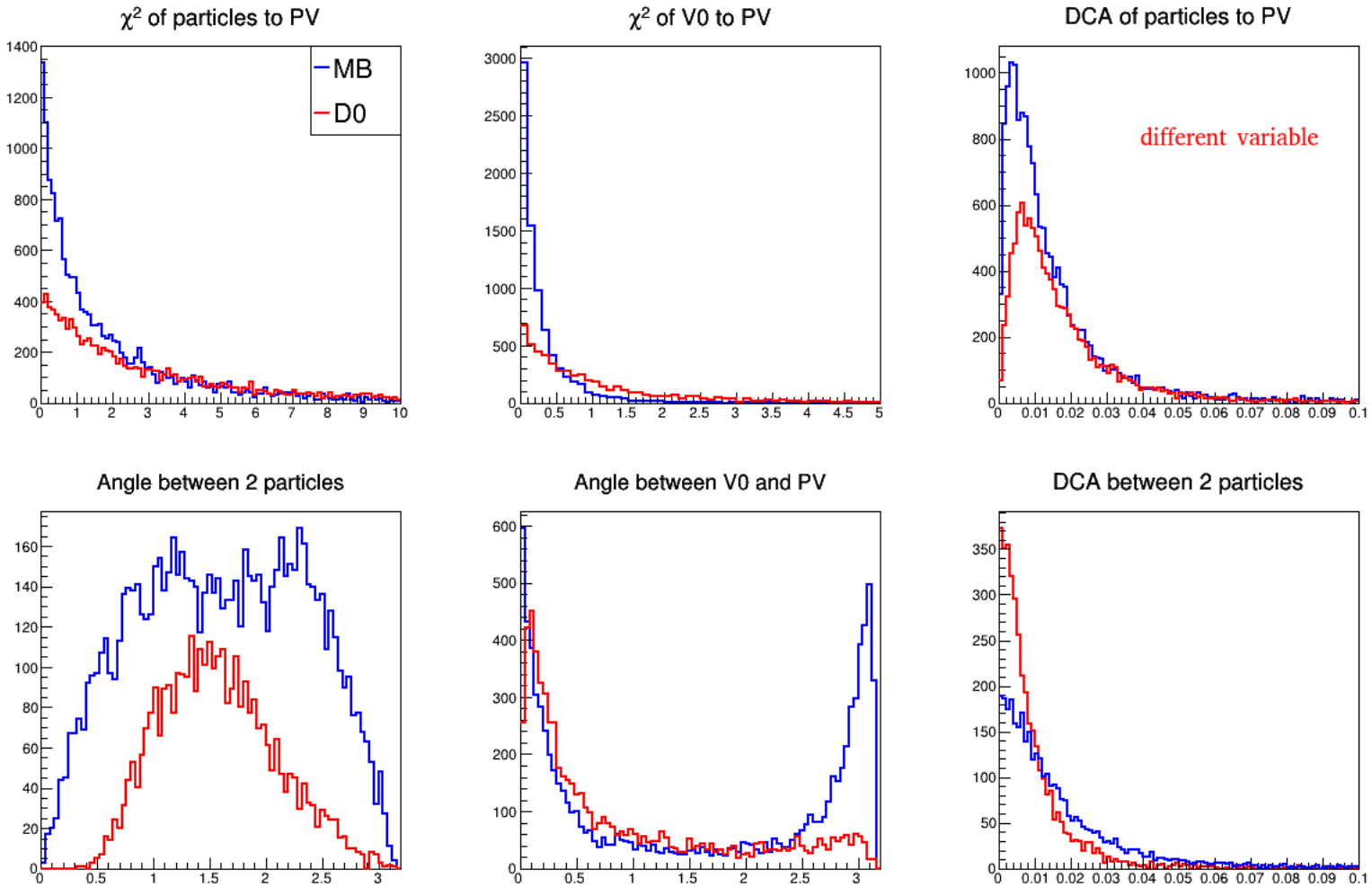
Comparison of D0 Signal and Background 1 : No Smearing



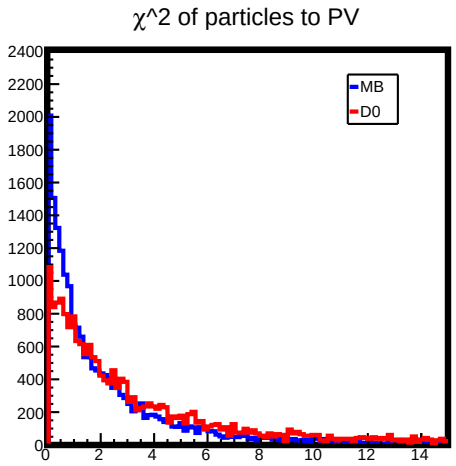
Independent Cross-check with V. Andreev

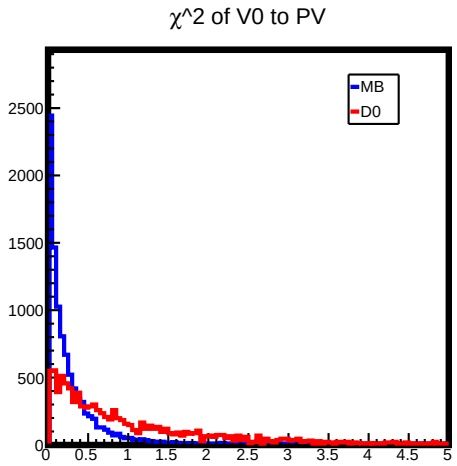


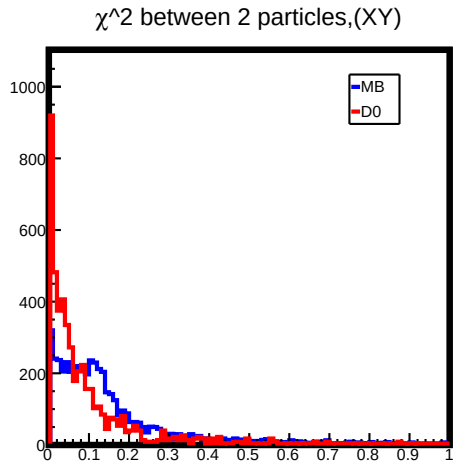
Comparison of D0 Signal and Background 2 : No Smearing

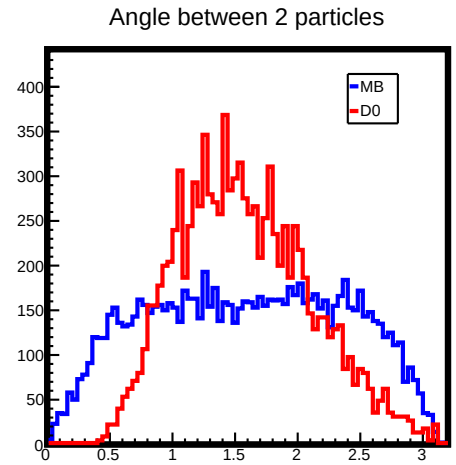


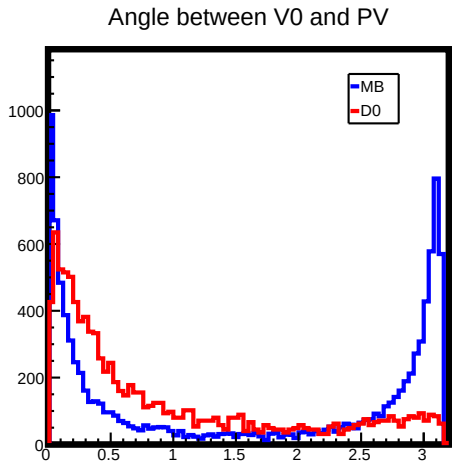
Independent Cross-check with V. Andreev

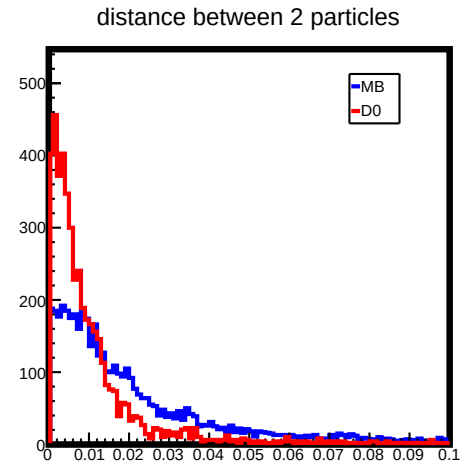












Open Issues : 1

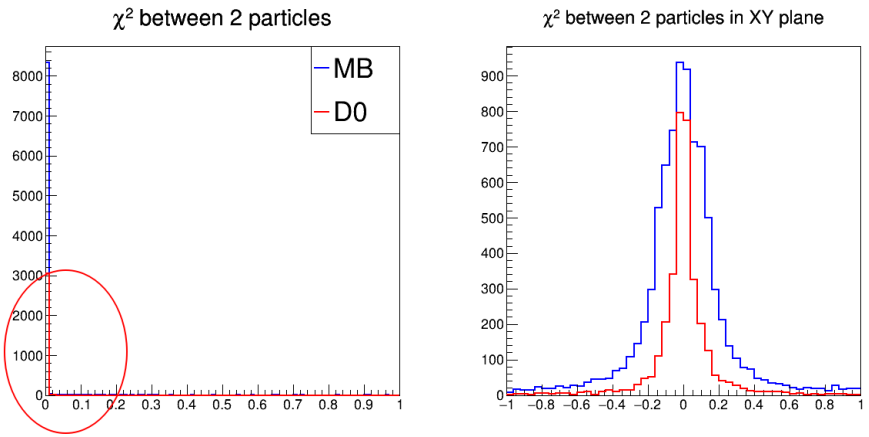
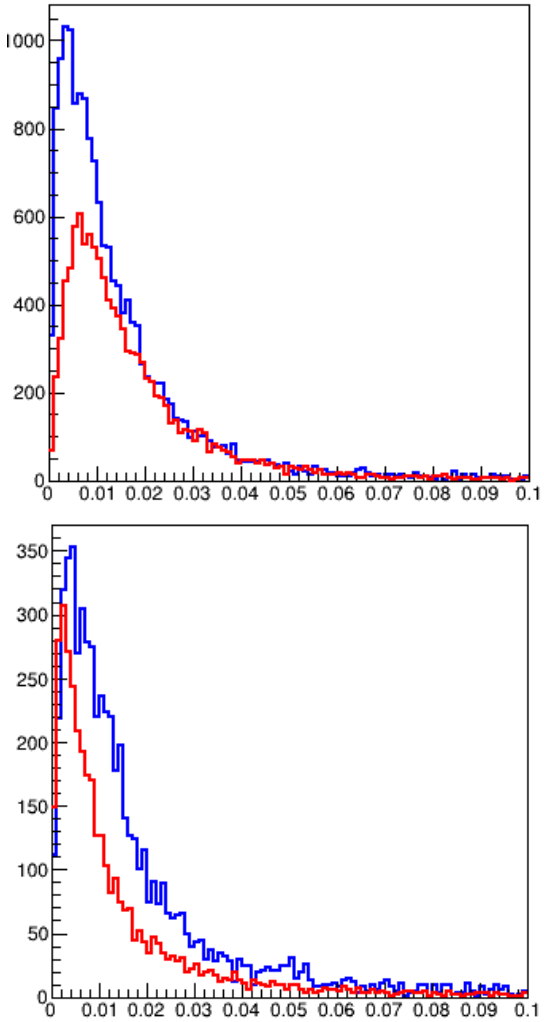


Figure 6: χ^2 between daughter tracks (left) and χ^2 between daughter tracks in XY plane

- One of the strange behaviours of KFParticle reconstruction shown on left. Vladimir Andreev and I will investigate this strange behaviour.
- Methods to access these variables :
- *float GetDeviationFromParticleXY(const KFParticle &p) const ;*
- *float GetDeviationFromParticle(const KFParticleBase &p) const;*

Open Issues : 2



- Red : D0 signal, Blue : minbias background
- Minbias background pions and kaons are produced essentially at the primary vertex. Would have expected blue bkg distribution to be peaked at zero and red signal to be wide at peak $\sim 100\mu m$
- Not as expected

Figure 7: DCA of daughter tracks to primary vertex

Next Steps

- To my understanding, KFParticle algorithm finds DCA point between successive tracks to reconstruct vertex. So, I am not sure why for smeared/realistic vertex distribution KFParticle reco of PV failed - need to understand
- Need to understand why a variable fails for two-particle decay reconstruction and why the distance/DCA different from what is expected
- Vladimir Andreev's and my parallel tests converged for now. Next step is to check the properties of D0 (sig and bkg) for more realistic resonstruction : a) smeared event vertex, b) use TOF for PID and not PDG code
- A simulation issue : jobs submitted to Slurm batch queue system are (mostly) not running as network can not establish kerberos authorization. Happening since last weekend. Problem still there.