

Charged D Meson Reconstruction at SPD

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Strategy

- For neutral D, I did not try to suppress based on cuts of kinematic variables to not introduce bias + to not lose very forward/backward candidates
- Only applied cuts based on secondary vertex reconstruction i.e. decay length, χ^2 , DCA, opening angle of daughter tracks, collinearity angle of V0 etc.
- Same strategy for charged D mesons
- Some relevant numbers :
 - ① $\sim 49\%$ of open-charm events have at least 1 D^0
 - ② $\sim 26\%$ of open-charm events have at least 1 D^+
 - ③ $D^0 \rightarrow \pi^+ K^-$ BR : 3.89%
 - ④ $D^+ \rightarrow \pi^+ \pi^+ K^-$ BR : 9.22%
- $\sim 25\%$ more D^+ may be detected

Updated Vertex Tracker

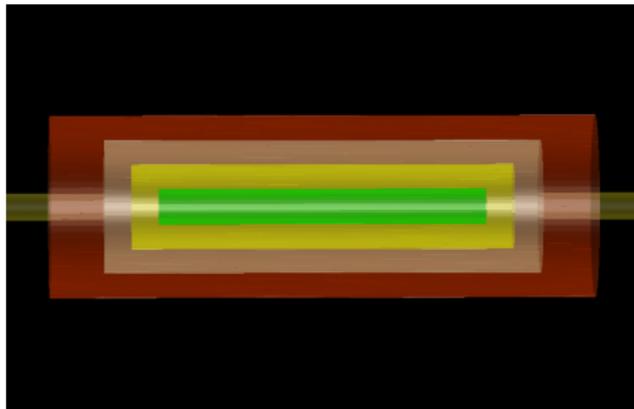


Figure 1: Previous configuration :
MAPS barrel only

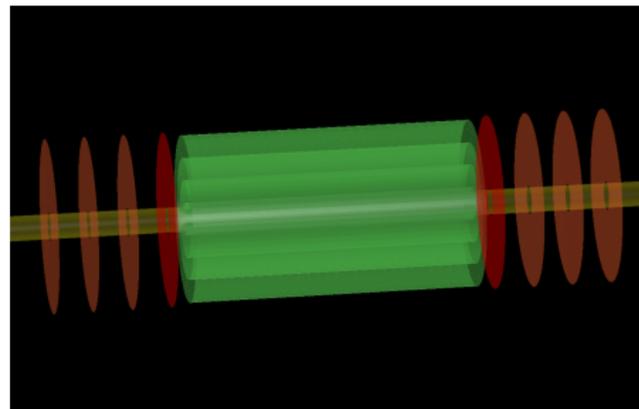


Figure 2: New configuration : MAPS
barrel + endcaps

Gain in Far Forward/Backward Statistics

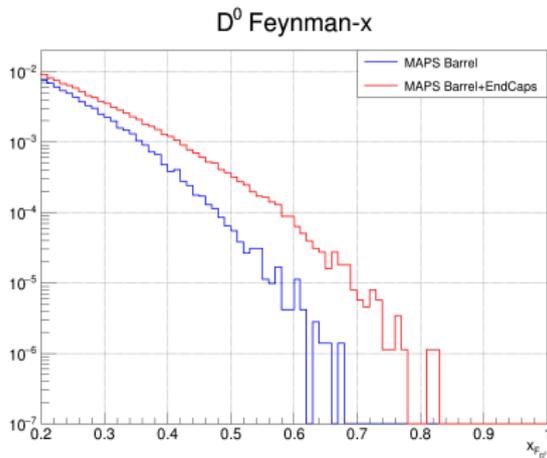


Figure 3: Reconstructed D^0 x -Feynman above 0.2

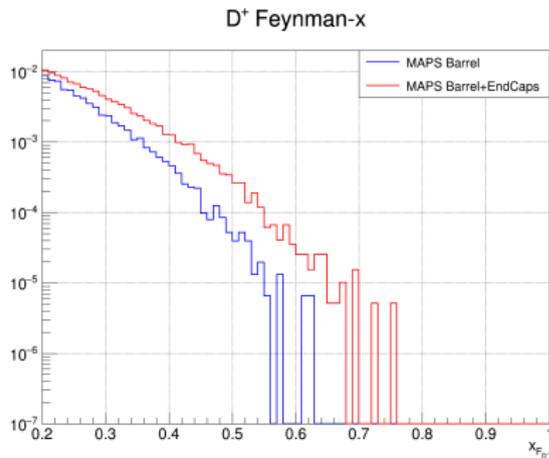


Figure 4: Reconstructed D^+ x -Feynman above 0.2

MC Simulation

- We'll look at comparisons of normalized distributions of our variables of interest of **signal** ($D^+ \rightarrow \pi^+\pi^+K^-$) and **background** (random combinations from MinBias data)
- This time, we'll ALSO look at the statistical significance $S/\sqrt{S+B}$ of the variables
- First look with ideal conditions : no vertex smearing + perfect PID
- **4M Open-Charm events + decay channel enforced**, **30M MinBias events** (elastic process not included)

Decay Length and Its Accuracy : Comparison

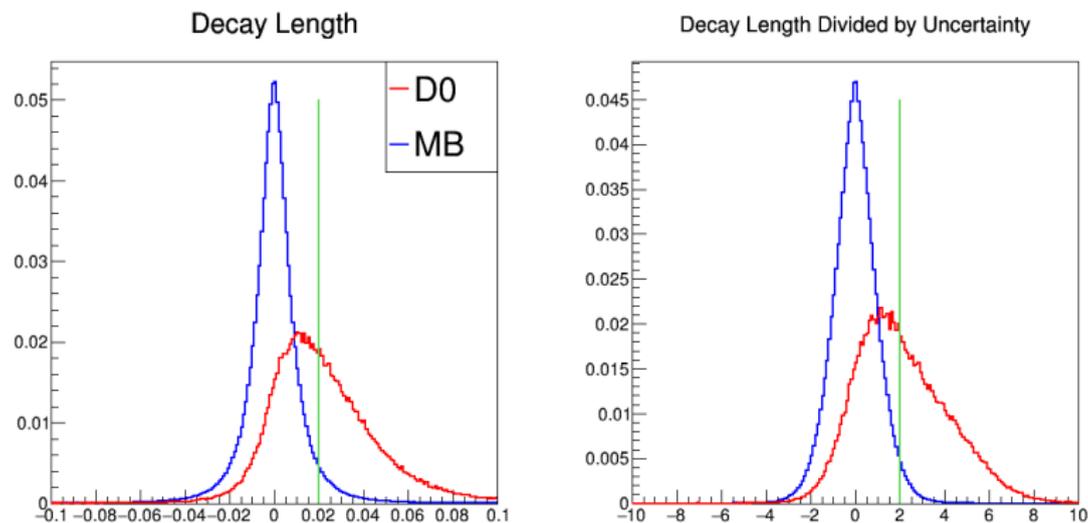


Figure 5: Decay length and decay length divided by uncertainty. Green lines denote cuts.

Decay Length and Its Accuracy : Significance

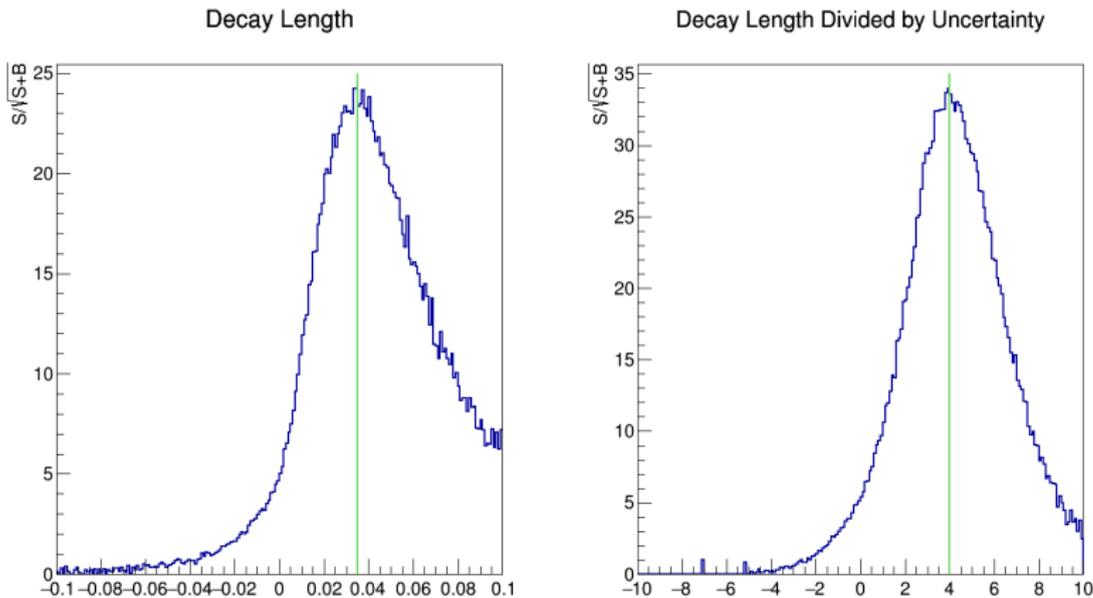


Figure 6: Decay length and decay length divided by uncertainty. Green lines denote $\max S/\sqrt{Signal + Background}$.

Opening Angles : Comparison

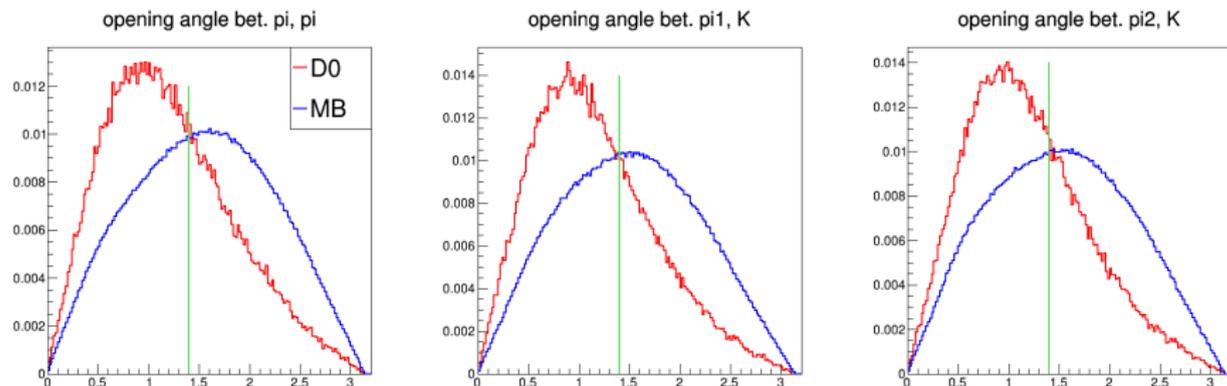


Figure 7: Opening Angles Between Pairs of Daughter Tracks

Opening Angles : Significance

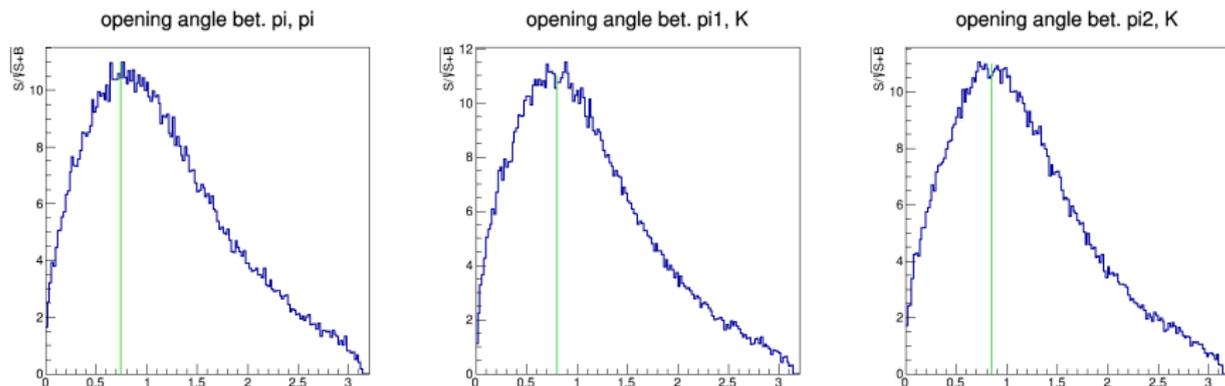


Figure 8: Opening Angles Between Pairs of Daughter Tracks

Reconstruction Variables 1 : Comparison

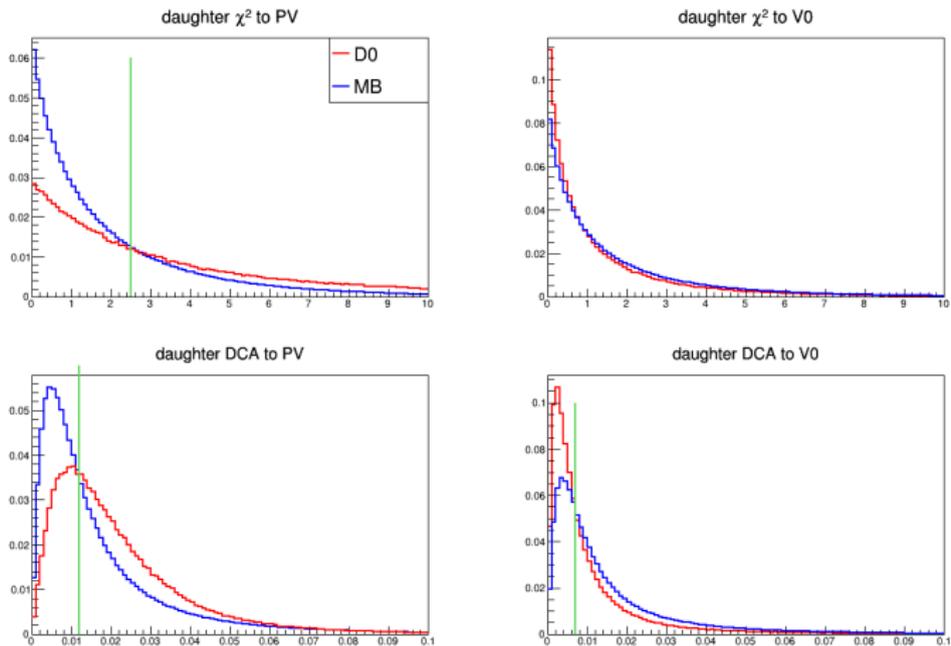


Figure 9: χ^2 and DCA of daughter tracks to PV and SV

Reconstruction Variables 1 : Significance

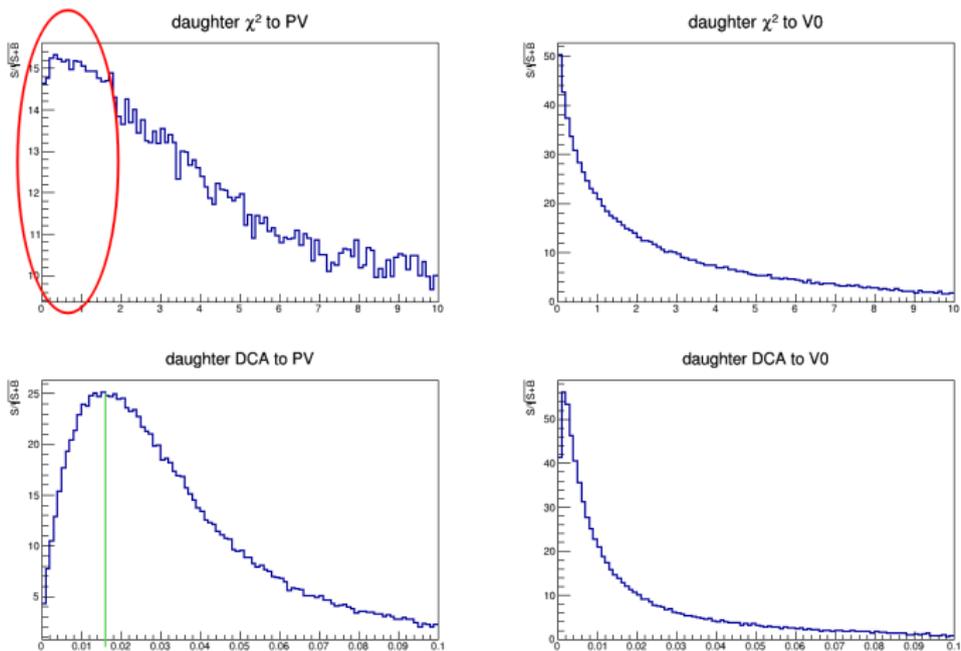


Figure 10: χ^2 and DCA of daughter tracks to PV and SV

Reconstruction Variables 2 : Comparison

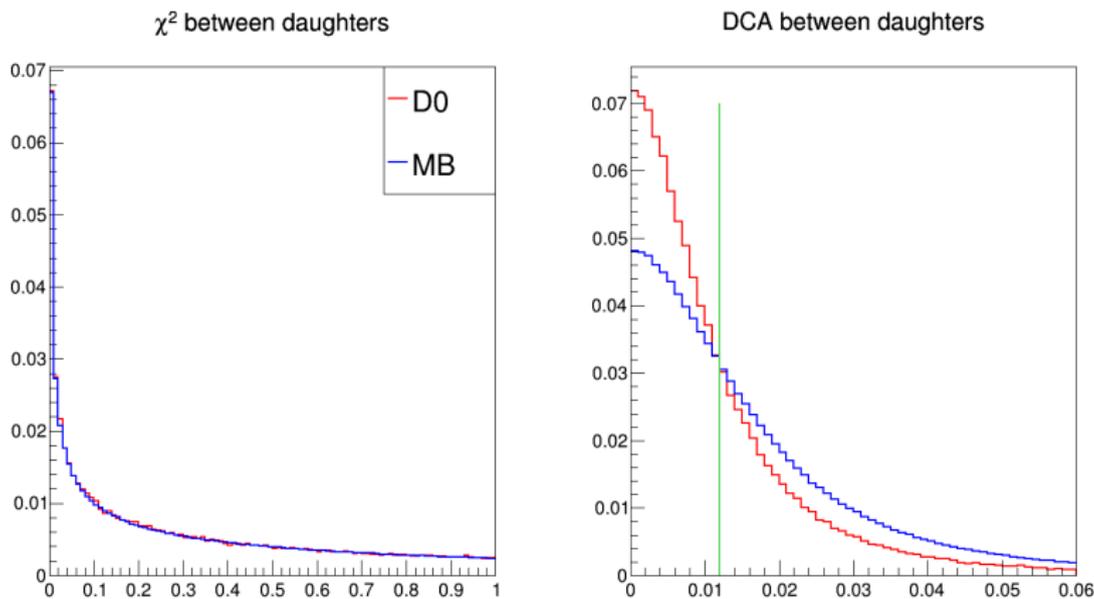


Figure 11: χ^2 and DCA between daughter tracks

Reconstruction Variables 2 : Significance

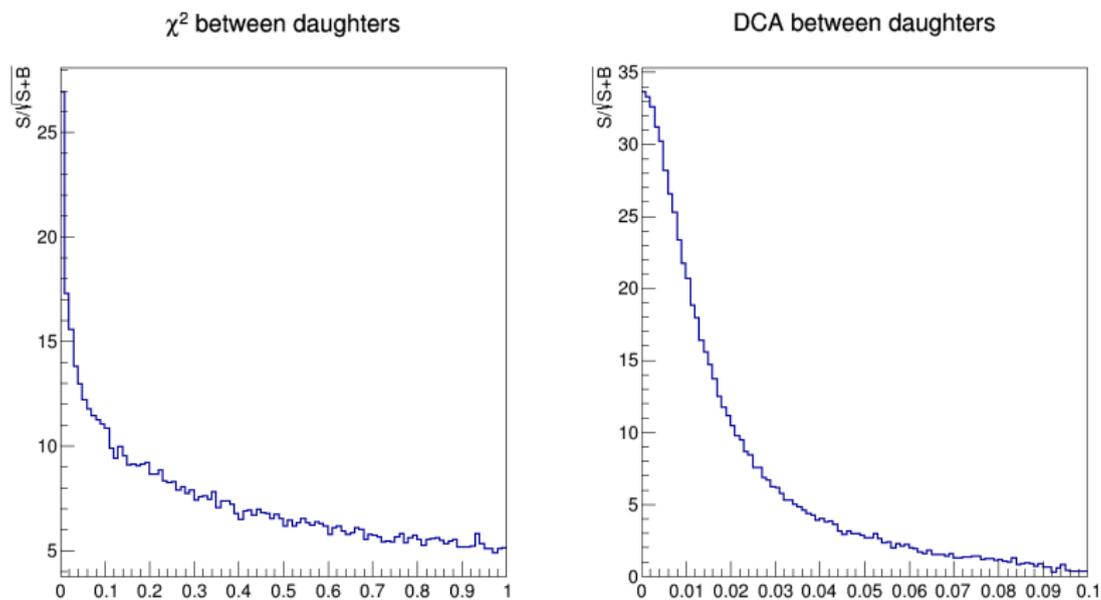


Figure 12: χ^2 and DCA between daughter tracks

Reconstruction Variables 3 : Comparison

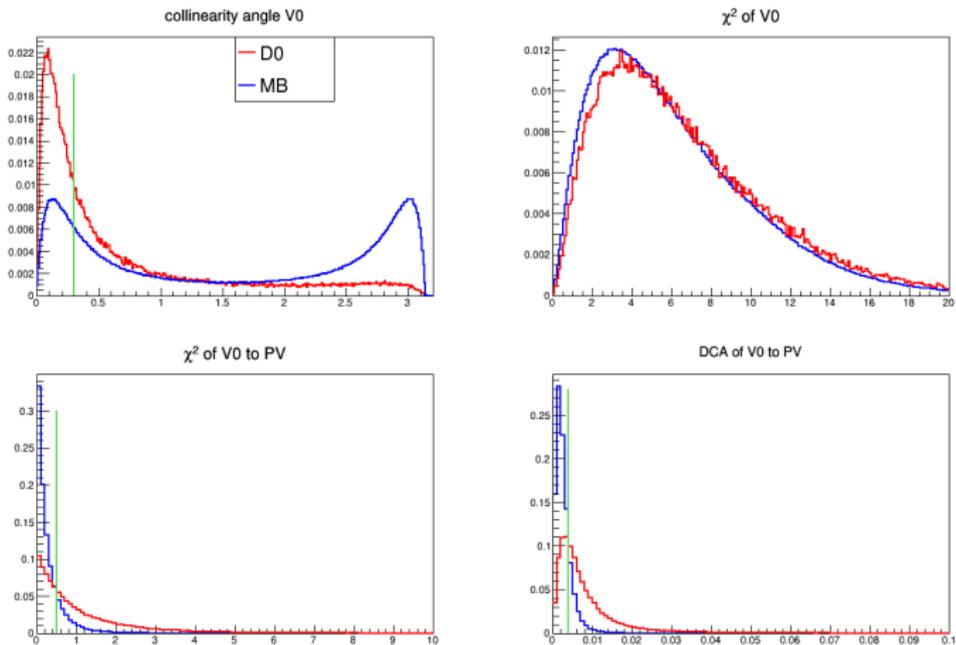


Figure 13: Properties of V0 candidates

Reconstruction Variables 3 : Significance

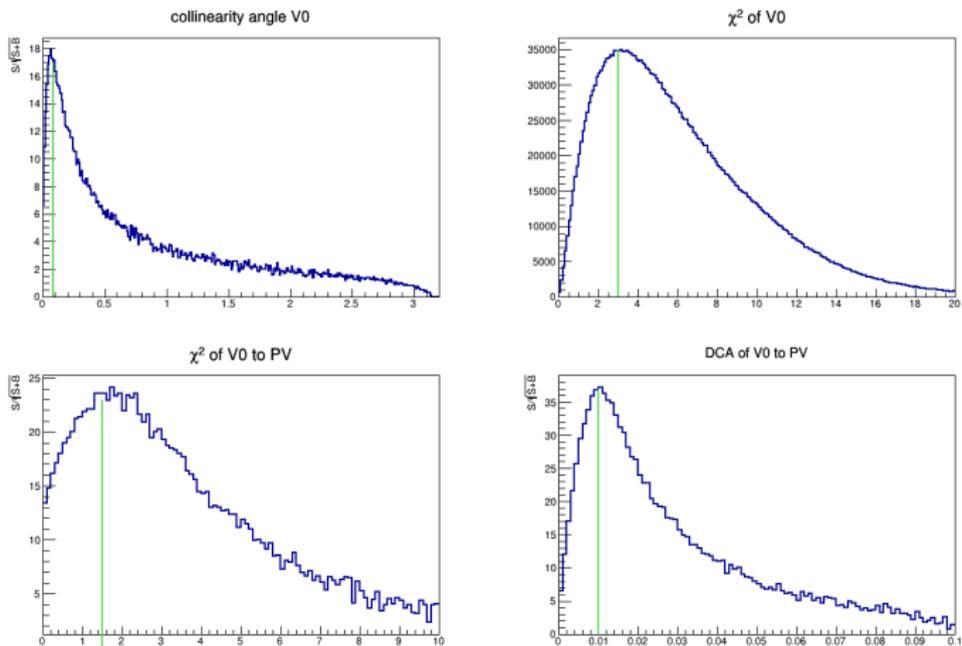
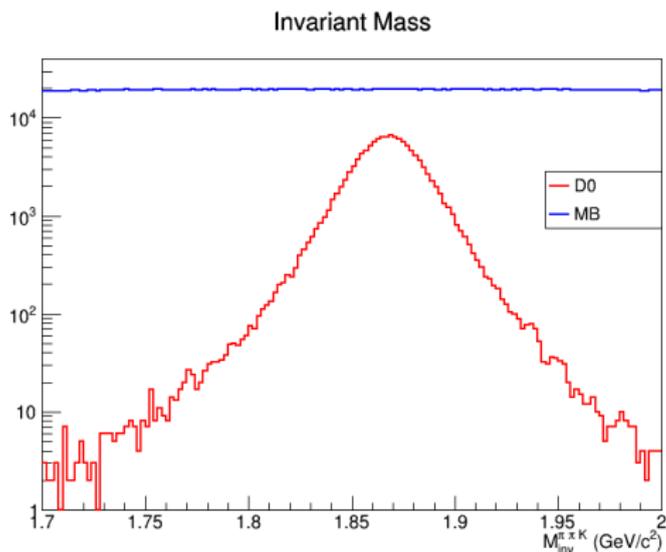


Figure 14: Properties of V0 candidates

Cuts to Suppress MB Background

- Decay length : $L > 0.02$ cm, $L/\delta L > 2$.
- Collinearity angle : $\theta_{col} < 0.3$ rad
- V0 properties : $\chi^2_{V0-PV} > 0.5$, $DCA_{V0-PV} > 0.004$ cm
- Daughter track properties :
- $DCA < 0.012$ cm, opening angle $\theta_{OA} < 1.5$ rad, for all pairs of daughter tracks
- Daughter to PV : $\chi^2 > 2.5$, $DCA > 0.012$ cm for each daughter
- Daughter to V0 : $DCA < 0.007$ cm for each daughter
- Invariant mass window 1.7-2.0 GeV/ c^2
- $|x_F| > 0.2$ for asymmetry measurements

Starting Point

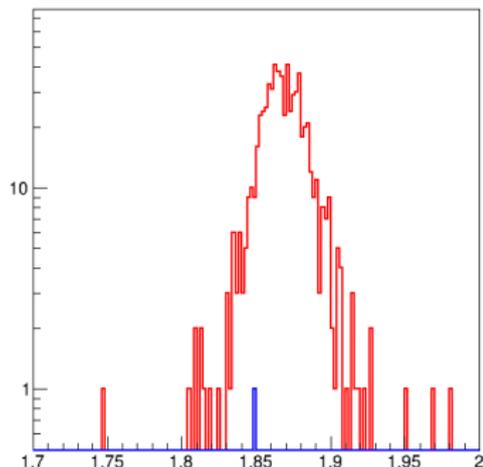


Generated : 4 M open-charm events, 30 M MinBias events

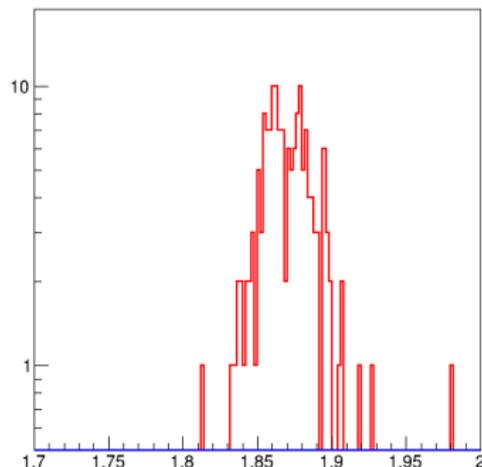
Detected : 127785 D^+ , 2.9054×10^6 MB

After Background Suppression

Invariant Mass After Cuts



Invariant Mass After (Cuts + x_F -range)



Generated : 4 M open-charm events, 30 M MinBias events

Detected ($-1 \leq x_F \leq 1$) : 657 D^+ , 1 MB

Suppression Efficiency

- $S/B = 657$ (from *generated* MC event ratio $N_S/N_B = 2/15$)
- Accounting for proper D^+ BR (9.22%), $S/B = 60.57$
- Assuming 32.8 mb for MB (sans elastic) and $9.4 \mu b$ for open-charm, *produced* real data event ratio $N_S/N_B = \sigma_S/\sigma_B = 1/3489$
- Finally, expected S/B in real data : $\sim 1/7.7$
- for D^0 , $S/B \sim 1/8$
- Background counts after cut statistically not reliable yet. Requires a much larger sample

Projection for One Year : D^+

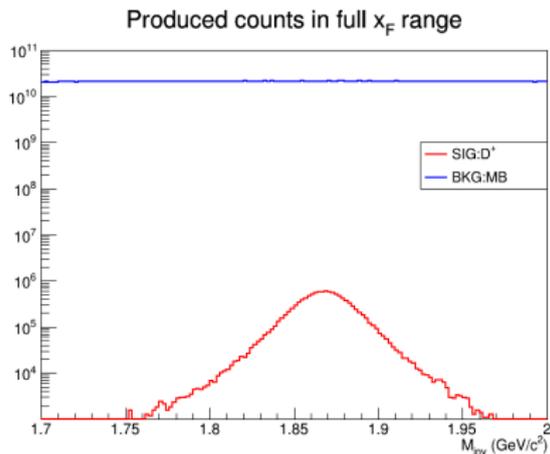


Figure 15: Projected invariant mass plot for *produced* counts in 1 year of data.

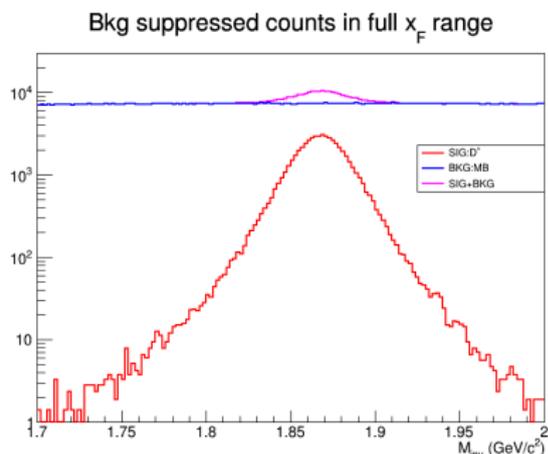


Figure 16: Projected invariant mass plot for *detected* counts (after background suppression cuts) in 1 year of data.

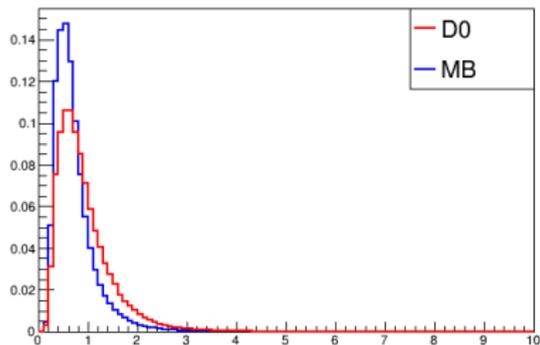
Outlook

- CDR gives 520 Million $D^+ \rightarrow \pi^+\pi^+K^-$ counts, my estimate gives 225 Million (I discussed similar over-estimate in CDR for the D^0 case)
- So far, results for charged D mesons are very similar to the case of neutral D mesons
- Need large MinBias data sample (some steps are being taken for the mass production) for statistically reliable background counts after cuts
- Had a conversation with Danila and Artem, gave sample scripts for event generations and reconstruction. Hope large scale production starts soon
- Next steps : refine cuts, use realistic PID and vertex smearing

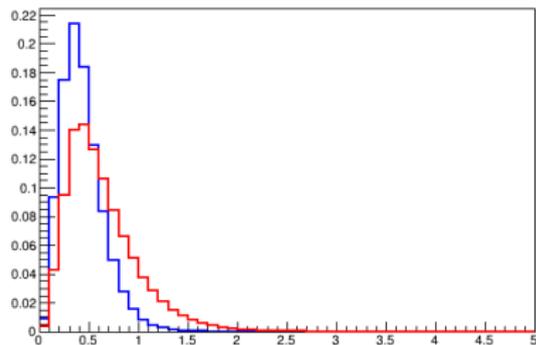
Backup

Kinematic Variables : 1

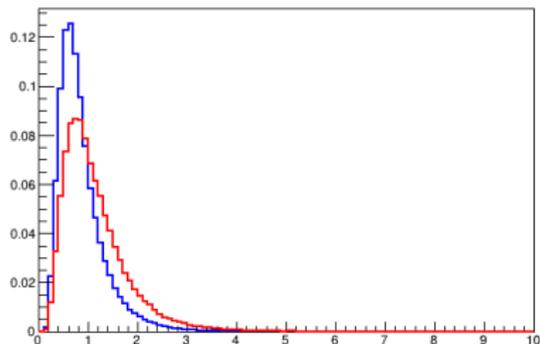
momentum of pi



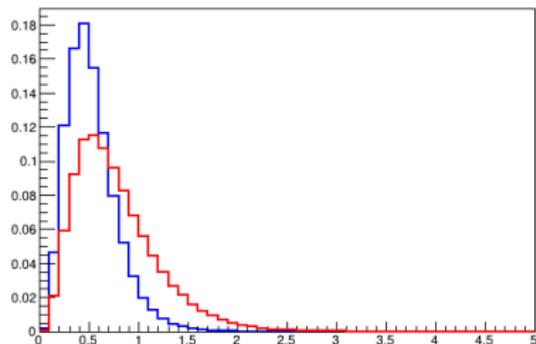
transverse momentum of pi



momentum of K

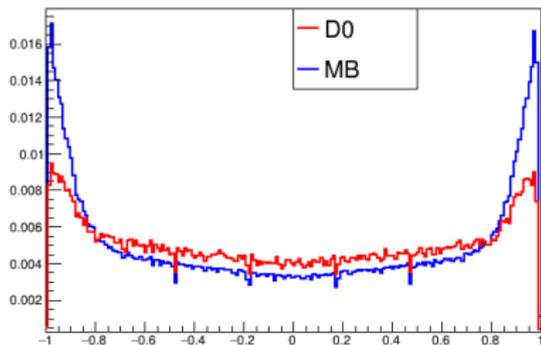


transverse momentum of K

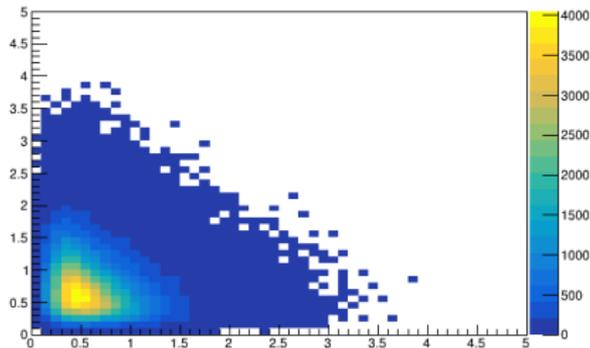


Kinematic Variables : 2

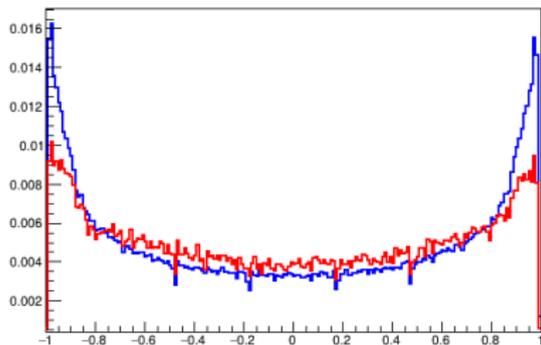
cosine of polar angle of pi



D^0 : correl. Pt of K vs. pi



cosine of polar angle of K



MB : correl. Pt of K vs. pi

