SPD meeting,
28 October 2020

Reconstruction of short-lived particles in SPD experiment (update)

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Ideal V^0 finder (selection)

Selection criterion in KF Particle package:

1. select tracks (primary and secondary) on the base of chi2 of track and primary vertex (rec and sim)

$$\chi^2_{prim} = \Delta\mathbf{r}^T (C_{track} + C_{PV})^{-1} \Delta\mathbf{r},$$

where Δr – distance between track and the primary vertex position, C_{track} is covariance matrix of a track and C_{PV} is a covariance matrix of primary vertex

2. consider only combination of 2 particles with different charge (q1*q2 < 0) for 2 particles decay case

3. check the distance between 2 daughter particles

4. check L / dL - decay length normalized on the error

5. check χ^2_{topo} - of mother particle to primary vertex

6. check some kinematic variables (θ of mother particle, P_T mother or daughter particles)

Vertex detector (option)

1. different configuration of silicon vertex detector in SPDroot simulation

2. DSSD (c.t. = 300 mkm, 5 layers) => option = 0;

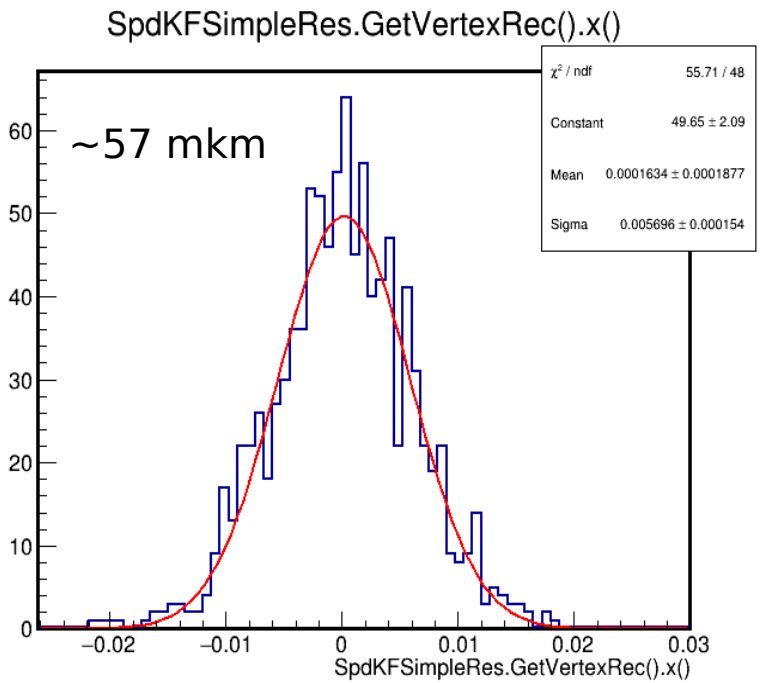
3. DSSD (c.t. = 50 mkm, 5 layers) => option = 1;

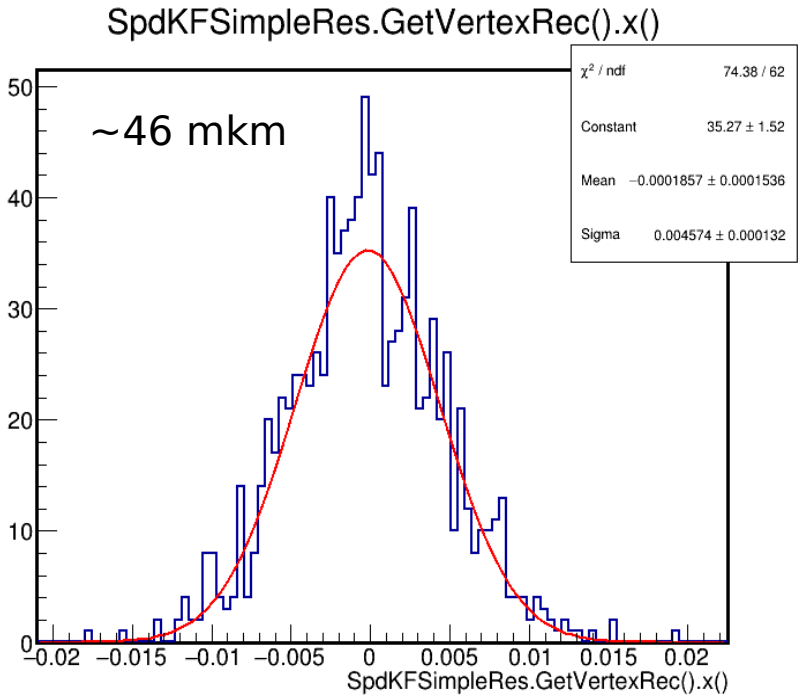
4. MAPS (c.t. = 50 mkm, 5 layers) => option = 2;

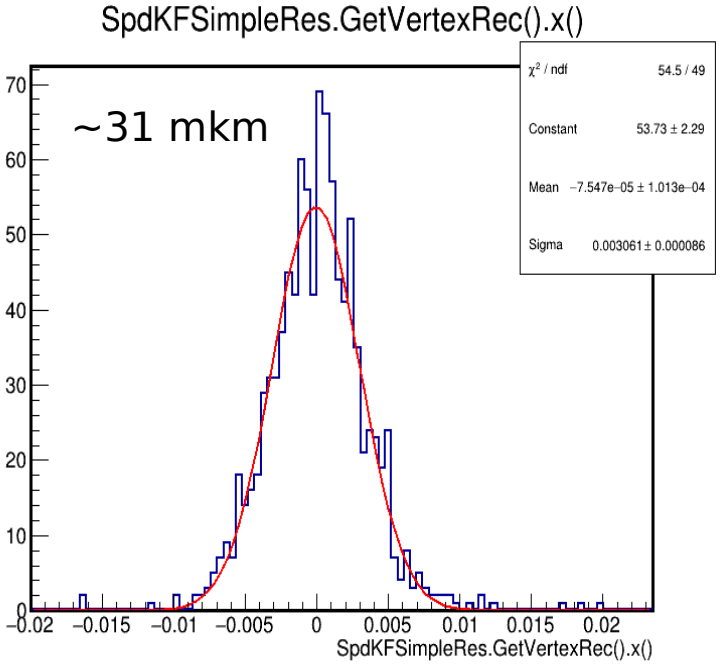
5. MAPS (c.t. = 5 mkm, 1,2,3 layers) + DSSD (c.t. = 300 mkm, 4,5 – layers) => option=3;

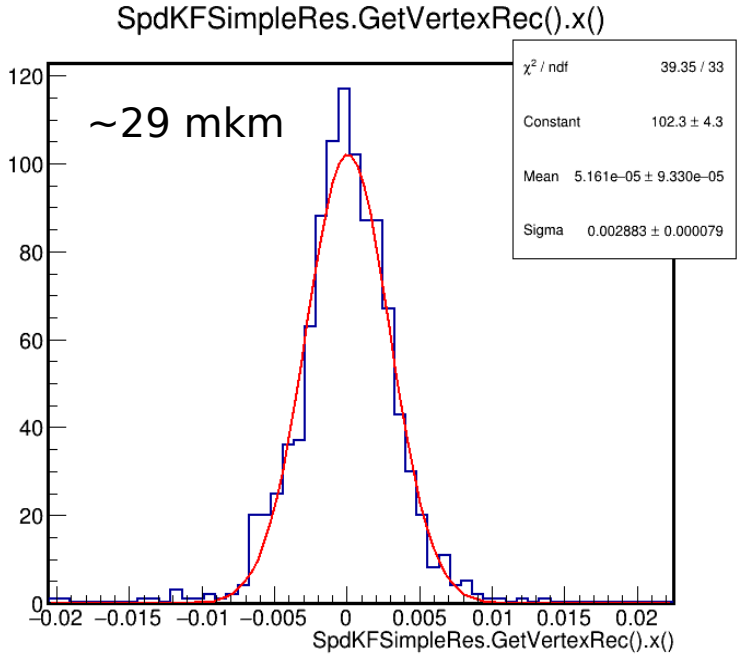
6. Errors
   MAPS: u = v = 4 mkm
   DSSD: u(z) = 23 mkm, v(x) = 11 mkm

Vertex detector (x)

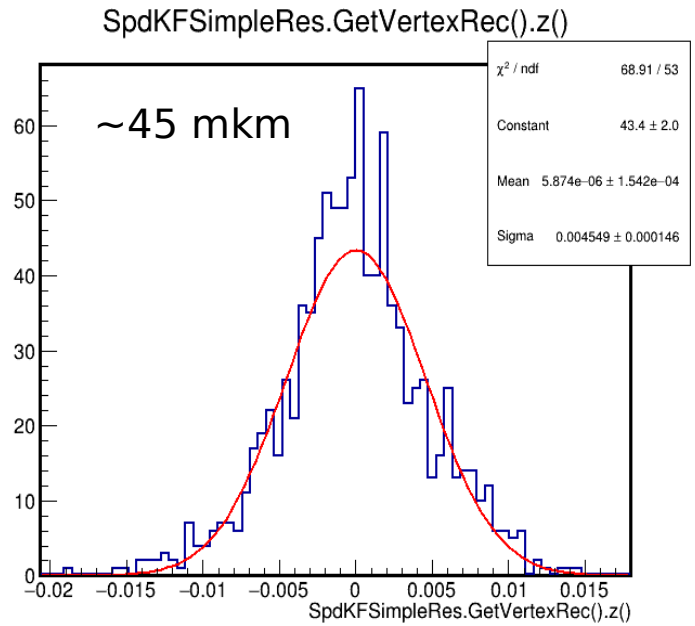


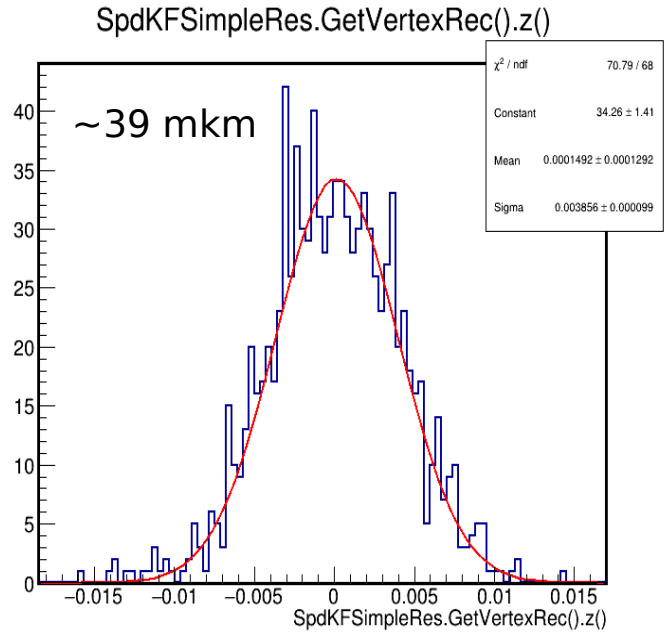


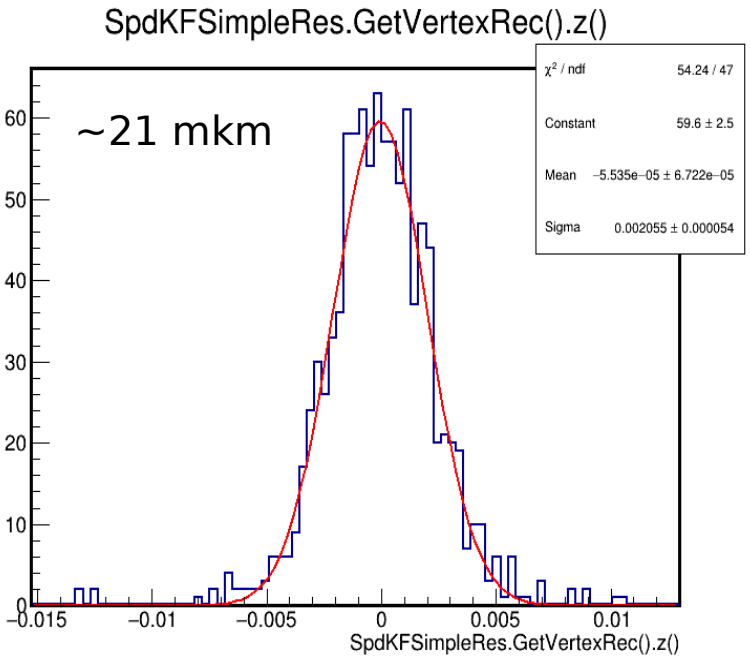


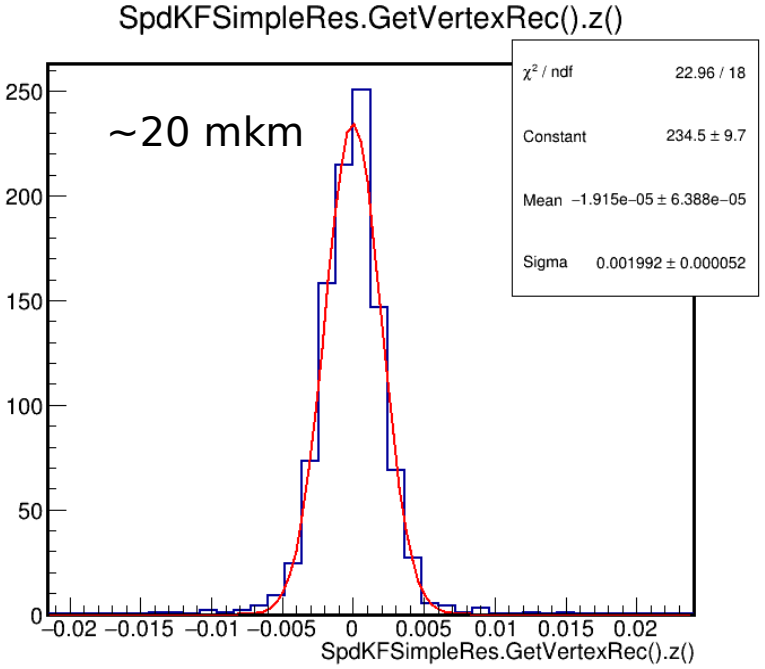


Vertex detector (z)

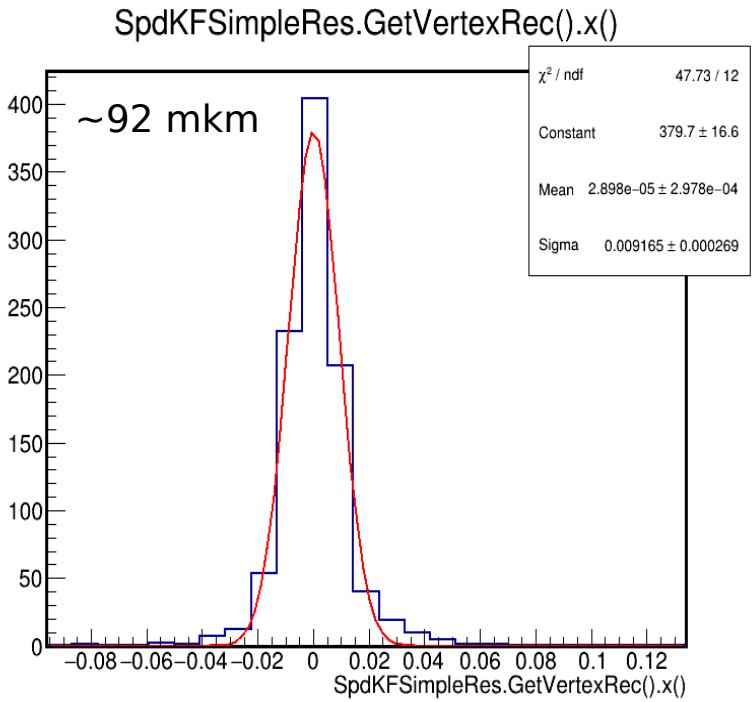


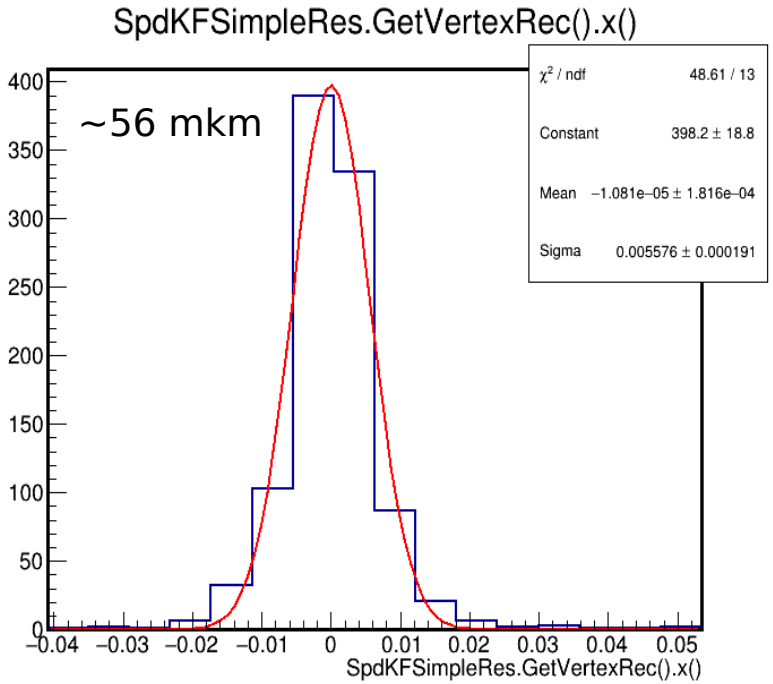


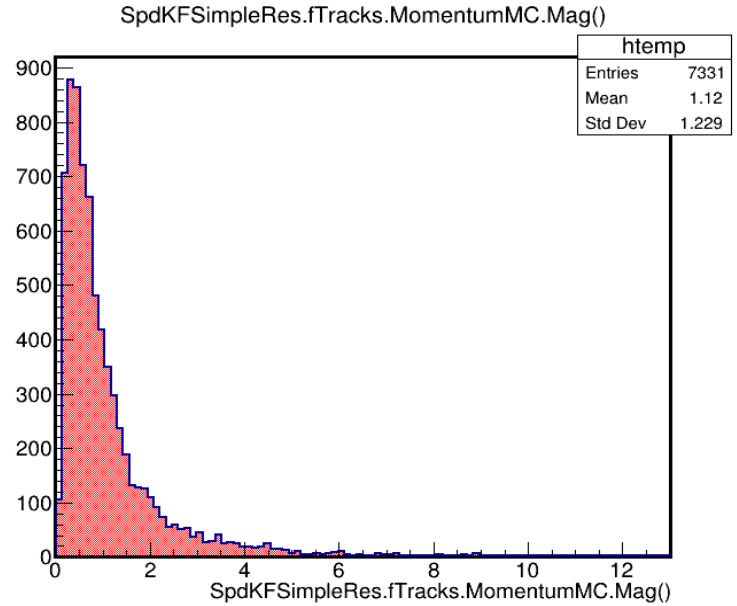




Vertex detector (MB)







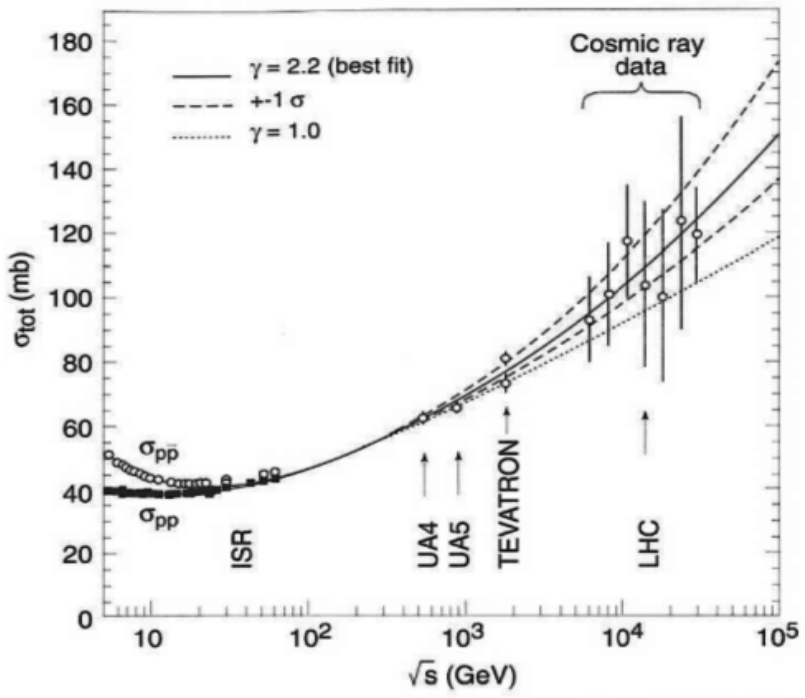
Ideal D^0 finder (M=1864,84 MeV/c²)

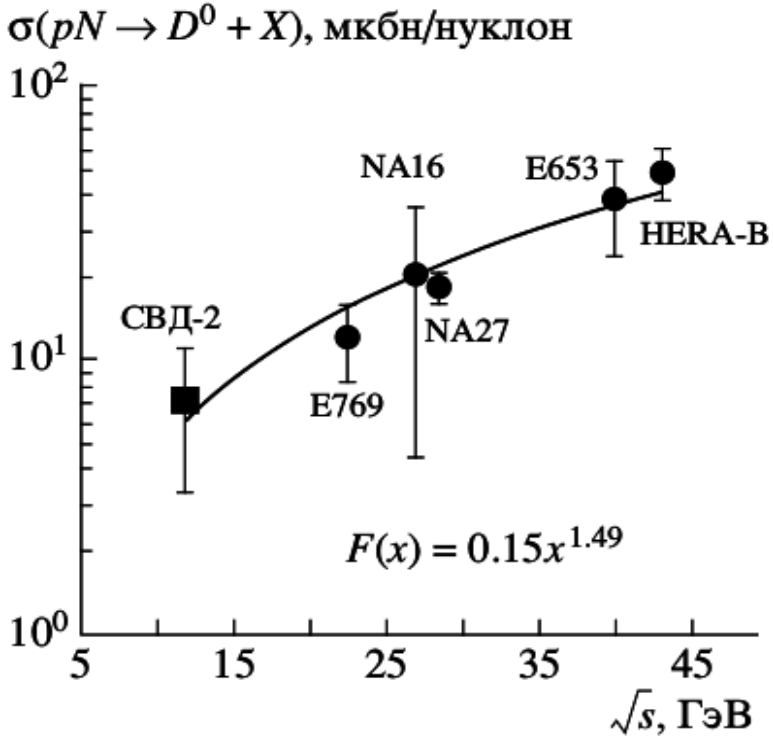
1. consider $D^0 \to K^- \pi^+$ decay (BR 3.9 %) => cτ = 122.9 μm, M=1864,84 MeV/c²

2. simulate 100000 Minimum Bias (MB) events with Pythia6, √s = 27 GeV

3. additionally simulate 20000 D^0 events, uniform θ and φ (~15240 reconstructed, ~76%)

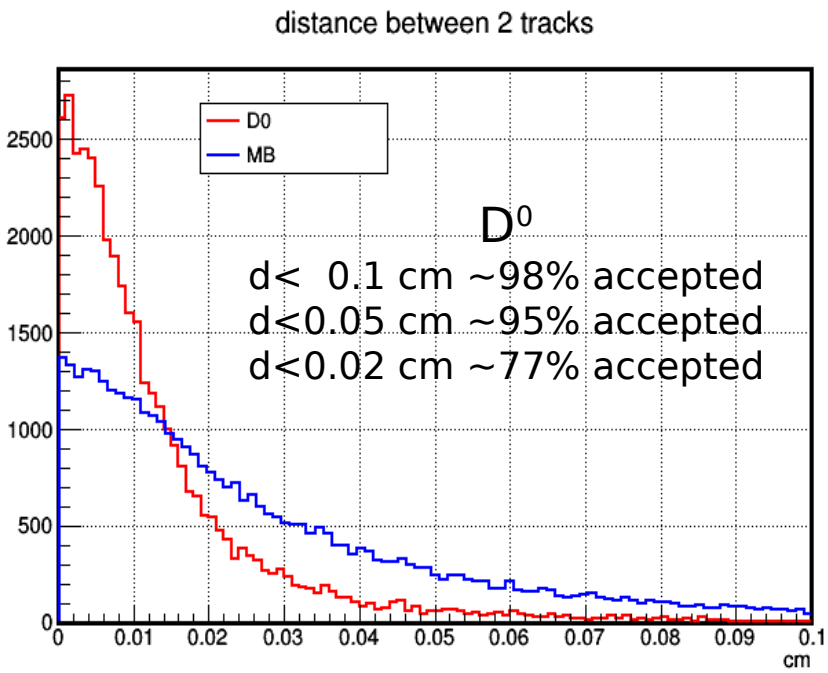
4. consider $K^- \pi^+$ ombination with different charge (q1*q2 < 0) in each event

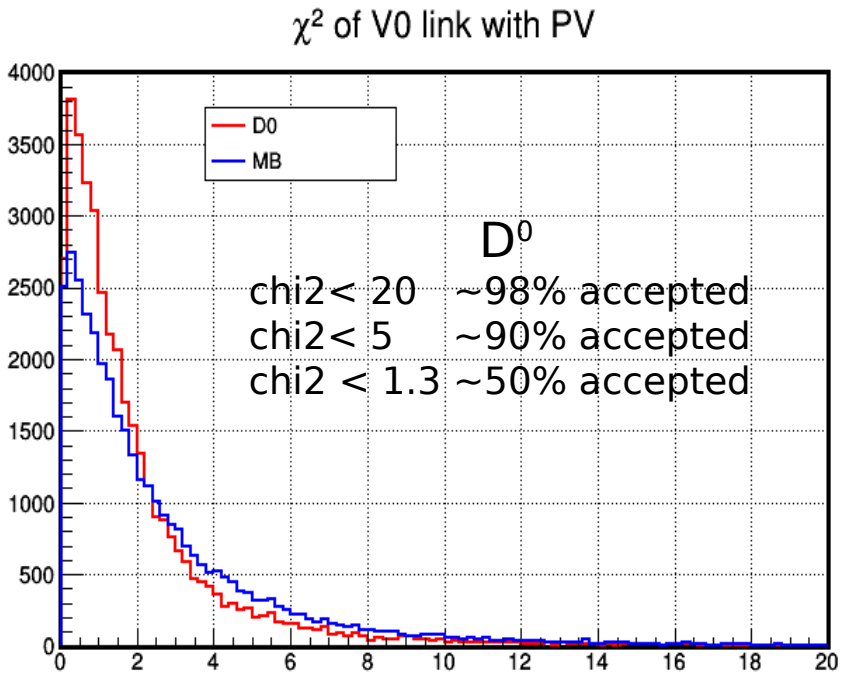


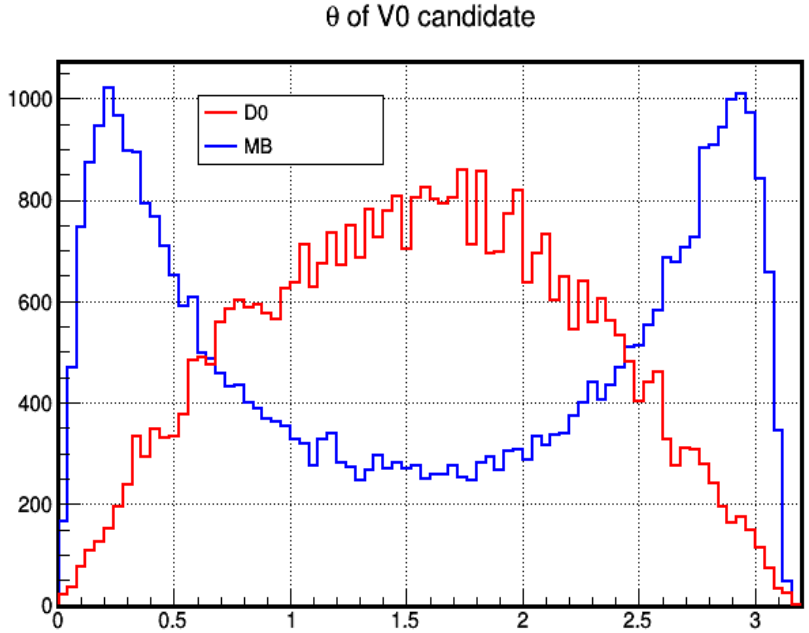


5. need to suppress MB background:
   a) S/B ~ 1 => ~10^{-5} times (with ~50% D^0 reconstruction and selection efficiency)
   b) S/B ~0.1 => ~10^{-4} times (with ~50% D^0 reconstruction and selection efficiency)

Ideal D^0 finder

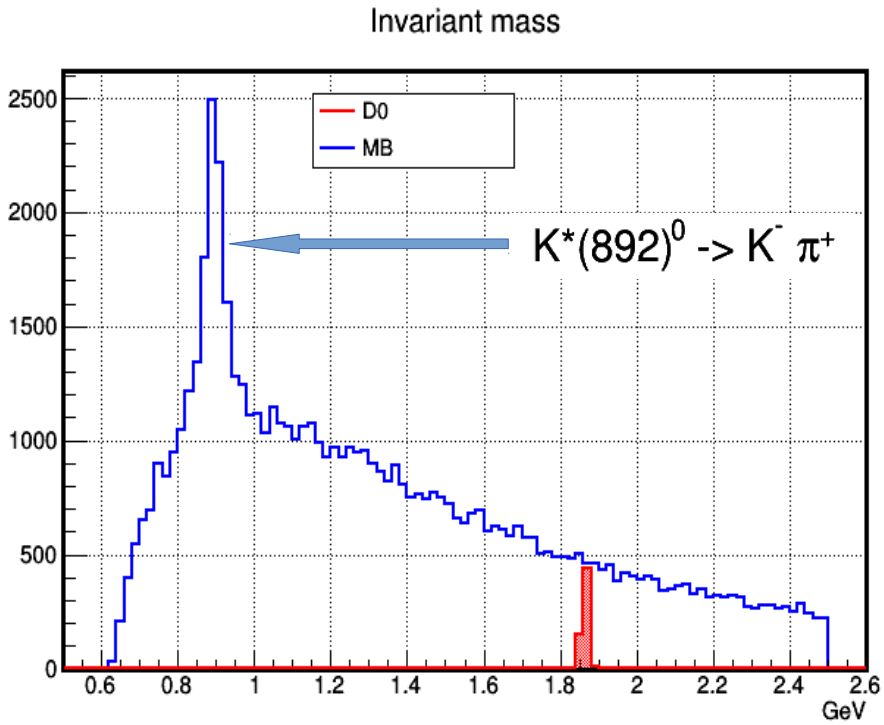






$0.57 < \theta < 2.57$ => ~85% of D^0 accepted

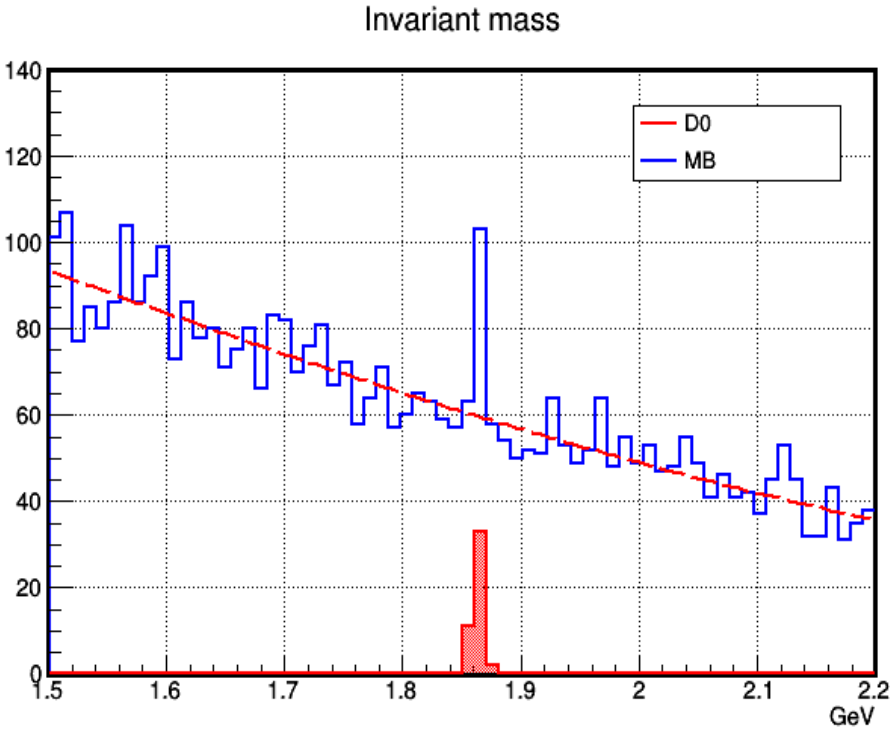
Ideal D^0 finder



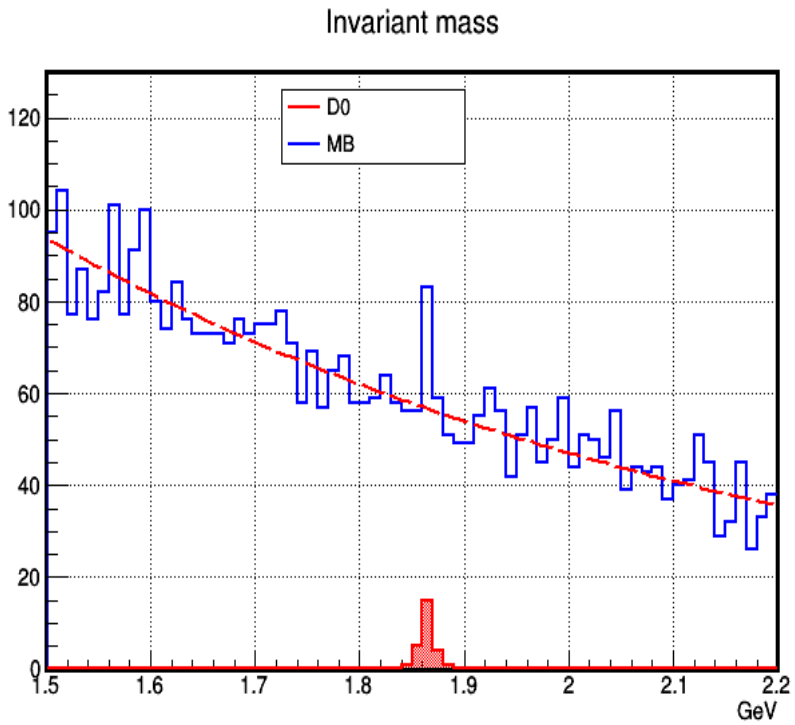
100000 MB events + 100 D^0 events
S/B ~10^{-3} - no selection
S/B ~$5*10^{-4}$ - with selection

Selection efficiency (~50%):
a) dist<0.02 cm
b) chi2 link D^0 to PV<5
c) $\Delta\theta < 1.0$

S/B ~0.19 inside 3*σ
around signal



Ideal D^0 finder



100000 MB events + 50 D^0 events
S/B ~$5*10^{-4}$ - no selection
S/B ~$2.5*10^{-4}$ - with selection

Selection efficiency (~50%):
a) dist<0.02 cm
b) chi2 link D^0 to PV<5
c) $\Delta\theta < 1.0$

S/B ~0.10 inside 3*σ around signal

100000 MB events + 20 D^0 events
S/B ~ $2*10^{-4}$ - no selection
S/B ~ 10^{-4} – with selection

Selection efficiency (~50%):
a) dist<0.02 cm
b) chi2 link D^0 to PV<5
c) $\Delta\theta < 1.0$

S/B ~0.05 inside 3*σ around signal