Updates on D0 Measurements at SPD

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Using KFParticle Package

- KFParticleBase class uses *Construct(*input*)* to add daugher KFParticleBase objects sequentially to calculate the point of closest approach / vertex
- KFParticle created with pos, mom, cov, chi2, charge, PID information of the particle (for daughters, info obtained for FirstState of the MCTrack object)
- *GetDistanceFrom***()* give DCA of KFParticle from vertices or other particles in cm
- *GetDeviationFrom***()* give χ^2/NDF form vertices or other particles

Comparison of Existing Wrapper and Inline SV Reconstructions

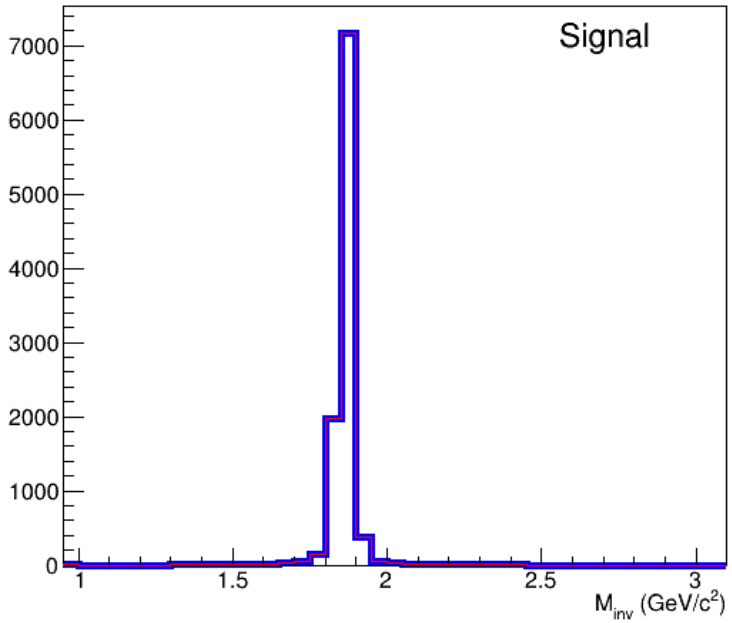

Figure 1: PYTHIA OpenCharm π^+K^- invariant mass : blue : wrapper reco output, Red inline reco output

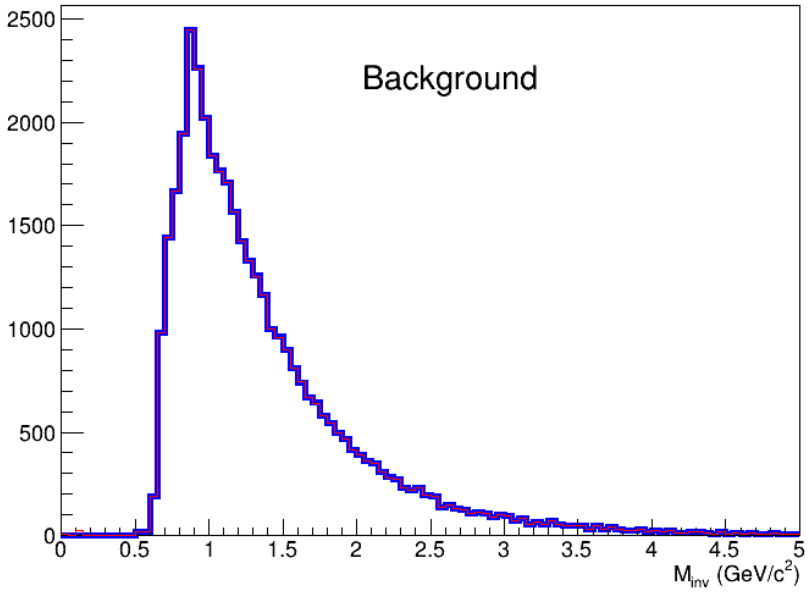

Figure 2: PYTHIA MinBias π^+K^- invariant mass : blue : wrapper reco output, Red inline reco output

Comment on Comparison

- In Physics and MC meeting mentioned mismatch
- After magnetic field was set properly (Vladimir Andreev fixed my problem), the match is now perfect
- Now we can look at other variables

Daughter Candidate DCA To Secondary Vertex

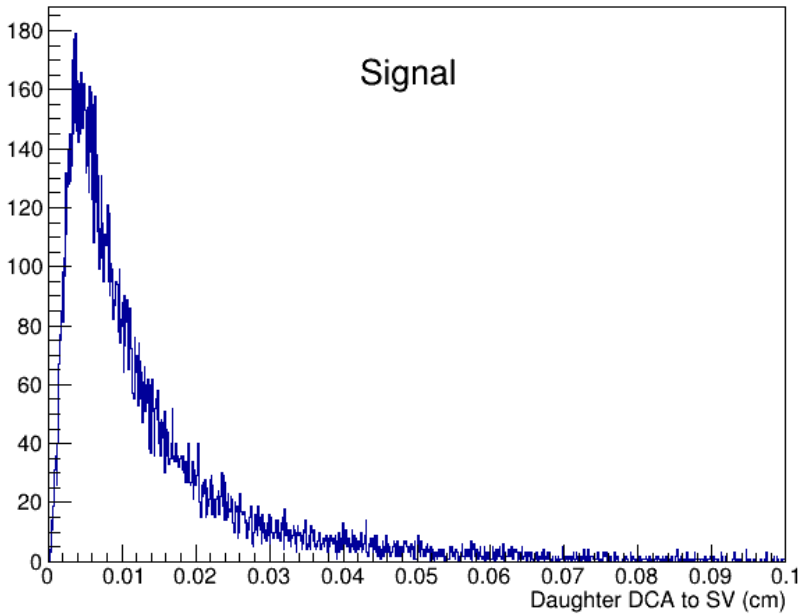

Figure 3: Signal : distance of daughter from secondary vertex

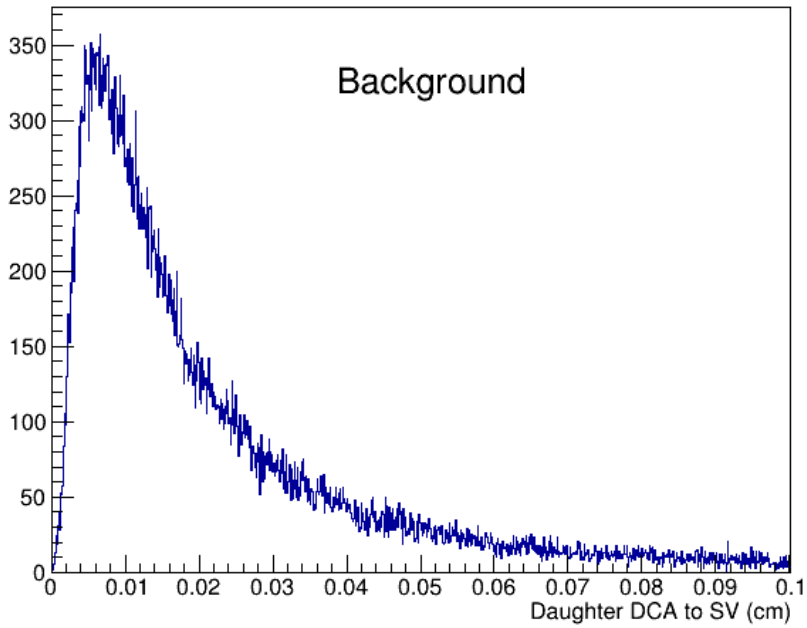

Figure 4: Background : distance of daughter from secondary vertex

Require daughter close to decay vertex, cut ≤ 0.01 cm

DCA Between Daughter Candidates

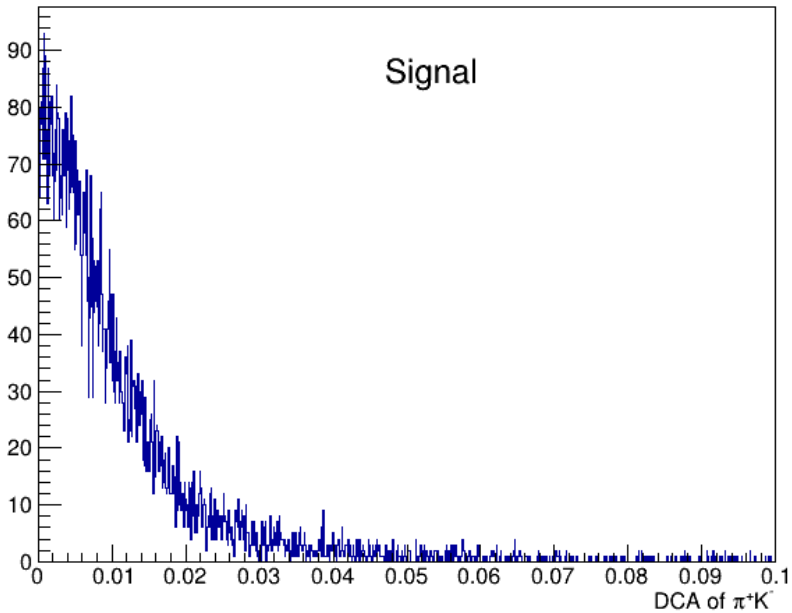

Figure 5: Signal : distance between daughters

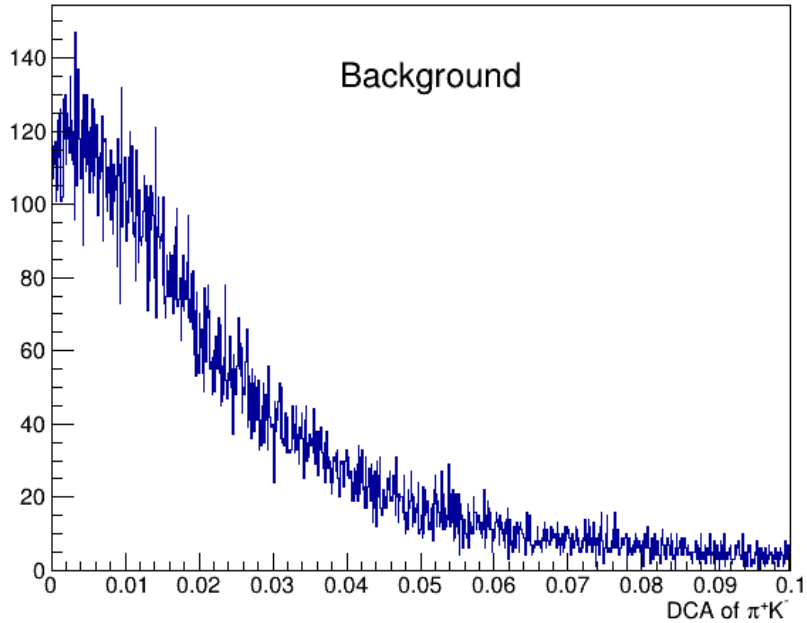

Figure 6: Background : distance between daughters

Require $\pi^+ K^-$ to be close, cut ≤ 0.01 cm

Daughter Candidate DCA To Primary Vertex

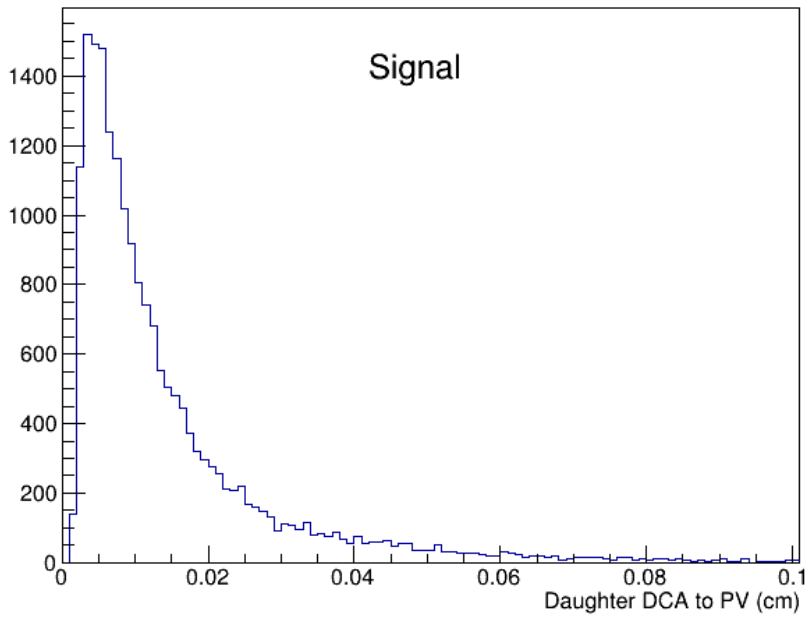

Figure 7: Signal : distance of daughter from primary vertex

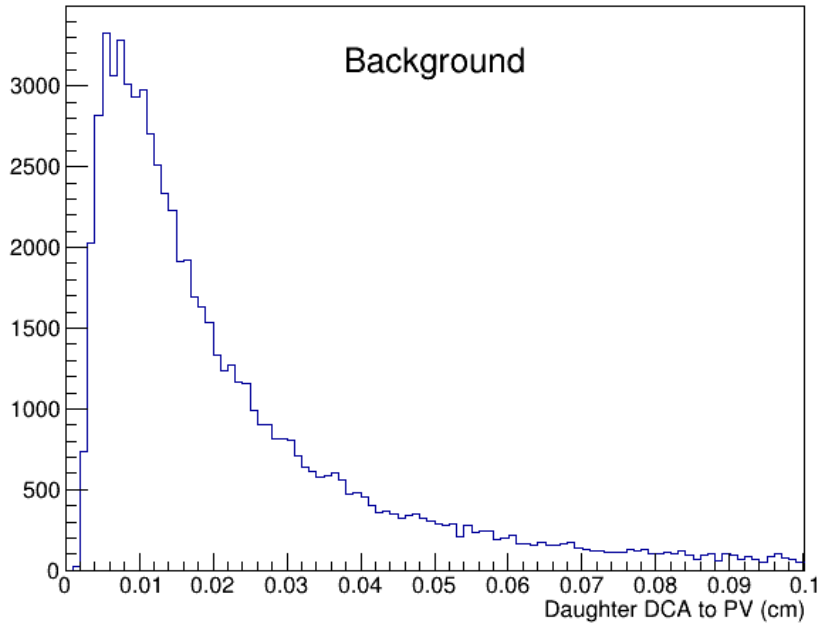

Figure 8: Background : distance of daughter from primary vertex

Still something that does not make sense to me, Bkg should have had narrower and closer to zero

Decay Length

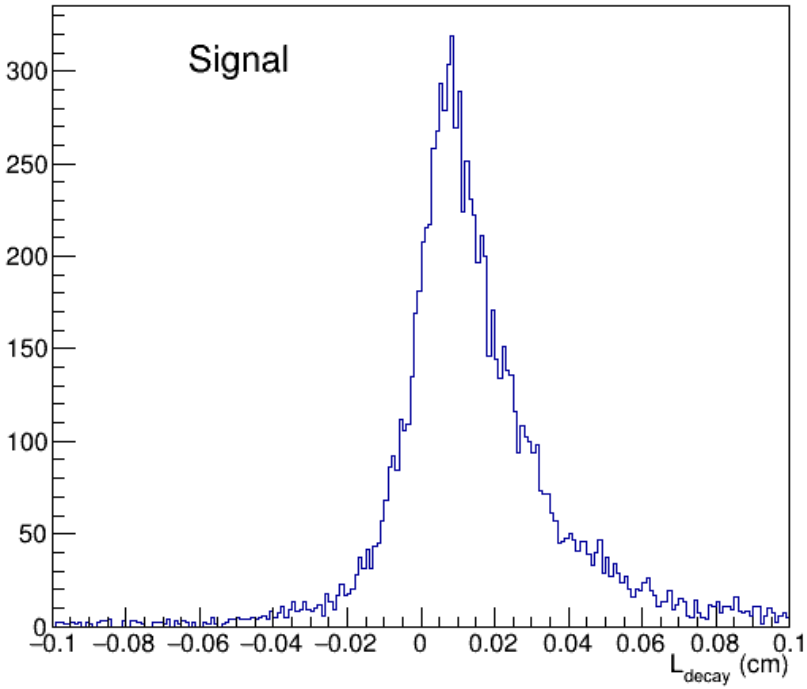

Figure 9: Signal : decay length

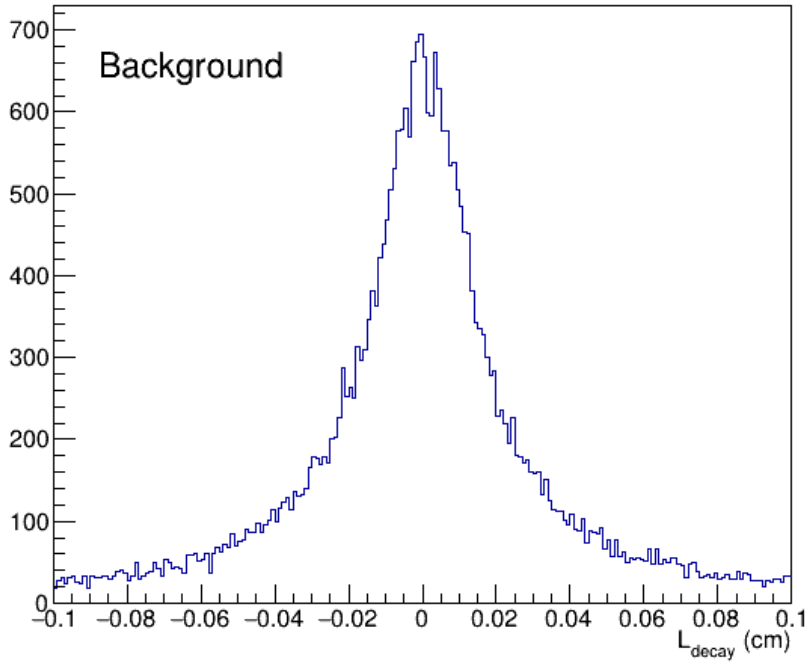

Figure 10: Background : decay length

Signal peak is clealy shifted to about expected lifetime $\sim 100\ \mu$, although it does not cut random background by much. Cut : $L > 0.01$ cm

Decay Length and Uncertainty

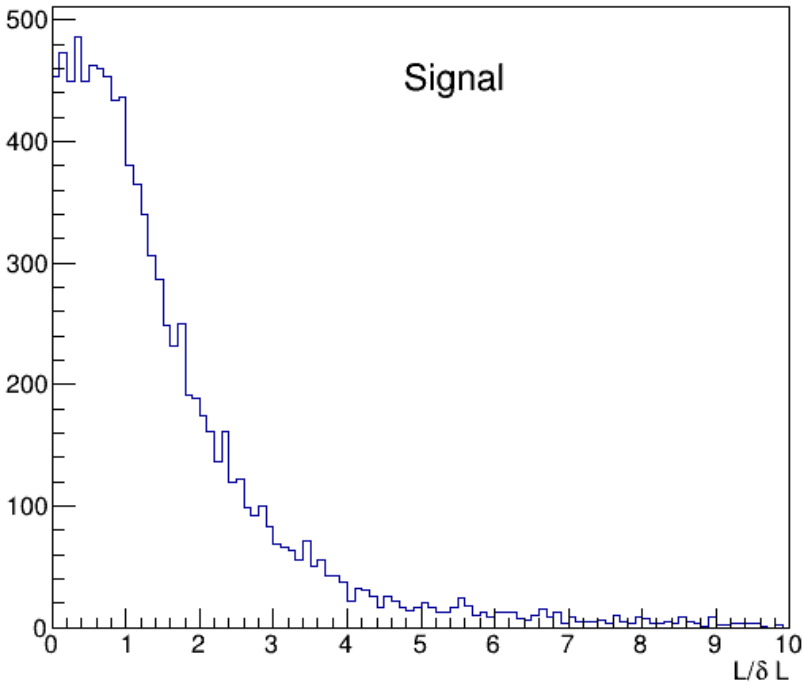

Figure 11: Signal : decay length / uncertainty

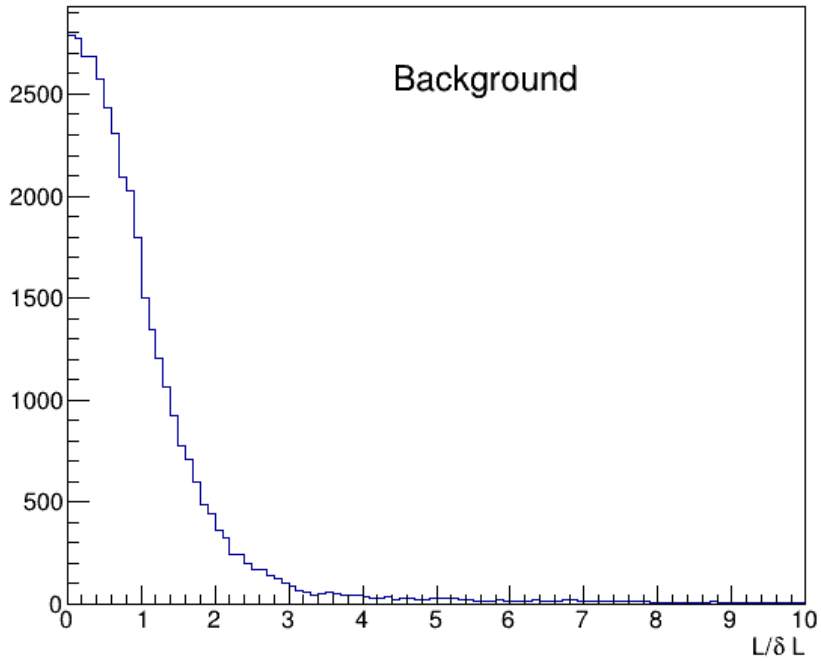

Figure 12: Background : decay length / uncertainty

I expected signal to have smaller uncertainties, but may be this is limitation due to inner tracker resolution. Cut : $L/\delta L \geq 3$ drastic cut

Opening Angle Between Daughters

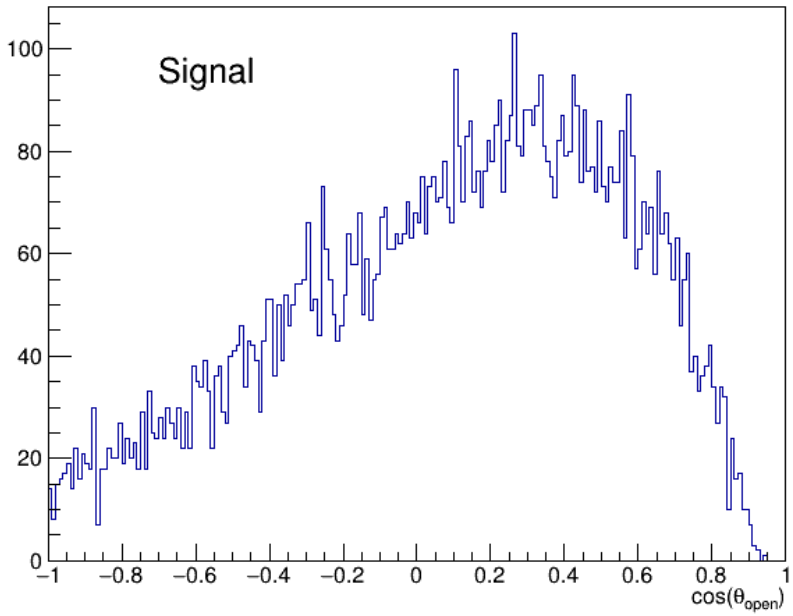

Figure 13: Signal : cosine of angle between daughters

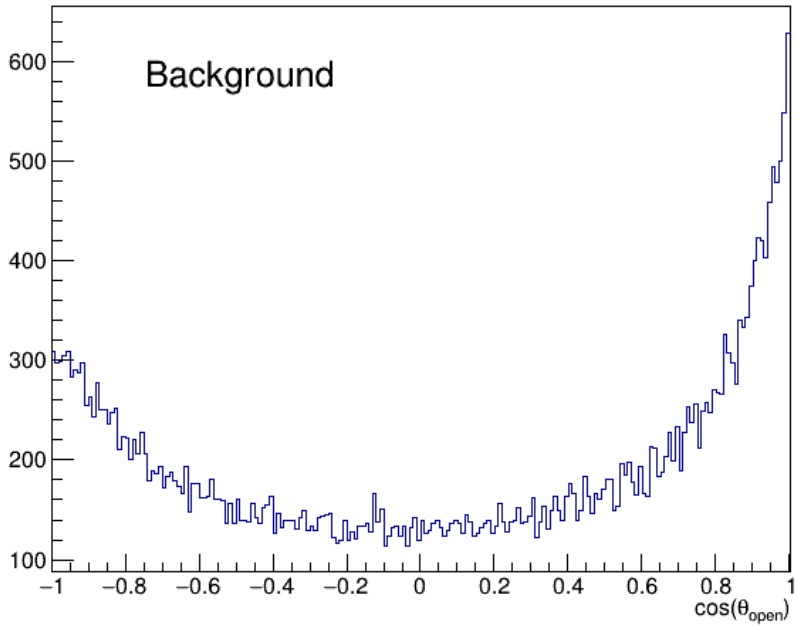

Figure 14: Background : cosine of angle between daughters

Cut : $-0.4 \leq cos(\theta_{open}) \leq 0.7$

Correlated Daughter p_T

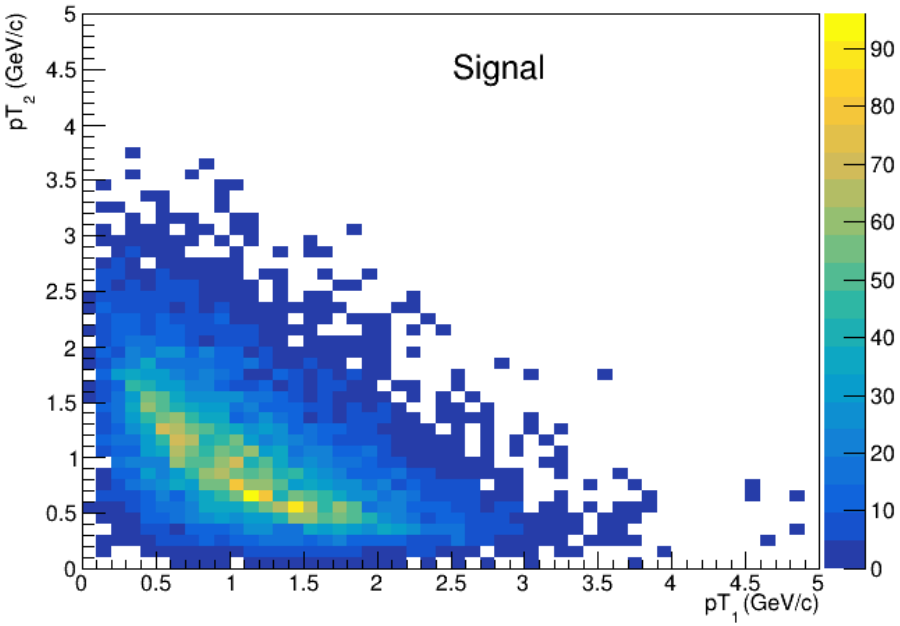

Figure 15: Signal : daughter p_T 2D

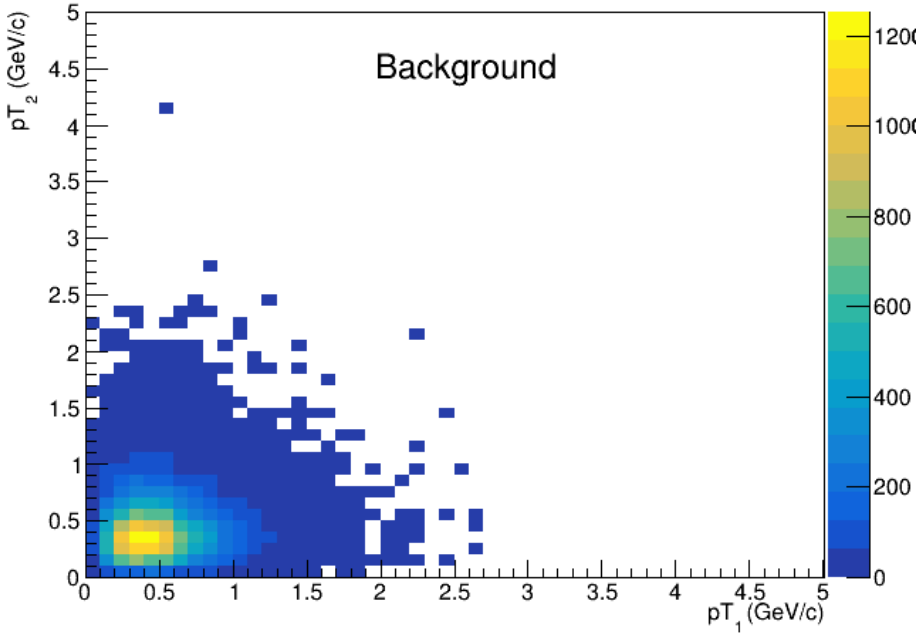

Figure 16: Background : daughter p_T 2D

Probably the best separator so far. Cut : $(p_{T1} + p_{T2}) \geq 1.5$

Cumulative Set of Cuts

- decay $L \geq 0.01$ cm and $(p_{T1} + p_{T2}) \geq 1.5$ blue
- DCA of daughter track to SV ≤ 0.01 cm green
- DCA between daughter tracks ≤ 0.01 cm red
- $-0.4 \leq cos(\theta_{open}) \leq 0.7$ purple
- $|cos(\theta_{pol})| > 0.8$: *Ignore this one*
- Requiring even $\frac{L}{\delta L} \geq 3$ on top of other cuts removes signal entirely

Effect of Cuts

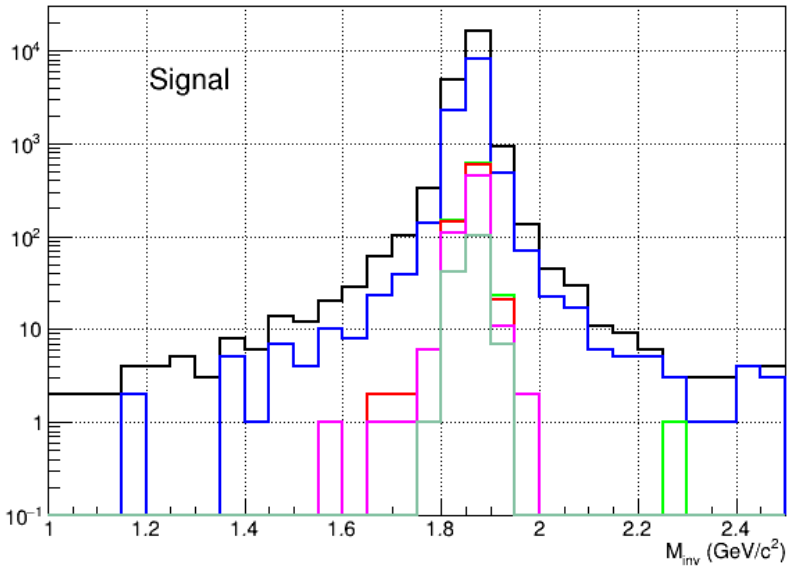

Figure 17: Signal : cumulative cuts

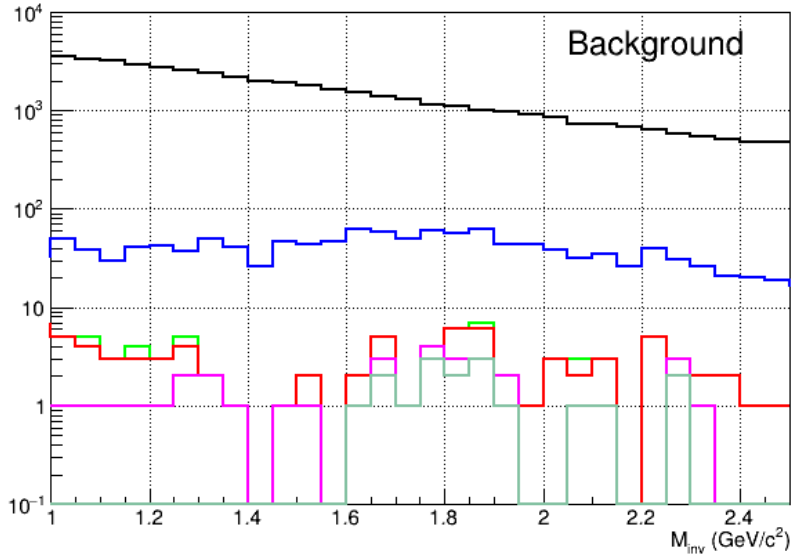

Figure 18: Background : cumulative cuts

Ignore the faint green, consider up to the purple line

Outlook

- About two and half orders of magnitude reduction in background
- A little more than one order of magnitude reduction in signal
- Still not enough background suppression for a fit
- DCA or chi2 of decay products (π^+, K^-) to primary vertex are unhelpful when similar analyses depended heavily on this cut. Is it limited by our inner tracker resolution?
- Some recent changes in the inner tracker config (Igor's suggestions) : DSSD 3 layers : 1st layer at 4 cm, 2nd at 14cm, 3rd at 24 cm
- 1st layer now closer than in default config (7 cm)
- Looking at only forward D0 ($|x_F| > 0.2$) next to see if it's easier to separate background and signal (Alexey Guskov's suggestions)

Thank You

Backup

From KFParticle Package

- All methods are part of **KFParticleBase** class (spdroot/external/KFParticle/KFParticle/KFParticleBase.cxx)
- "*void KFParticleBase::Construct(const KFParticleBase* vDaughters[],Int_t nDaughters,const KFParticleBase *Parent,float Mass)*"
- "*Constructs a short-lived particle from a set of daughter particles*"
- "*float KFParticleBase::GetDistanceFromVertex(const float vtx[]) const*"
- "*Returns the DCA distance from vertex in 3D.*"
- "*float KFParticleBase::GetDistanceFromParticle(const KFParticleBase &p) const*"
- "*Returns the DCA distance from another particle p.*"
- "*Calculate distance from another object [cm]*"

Mother χ^2 to Primary Vertex

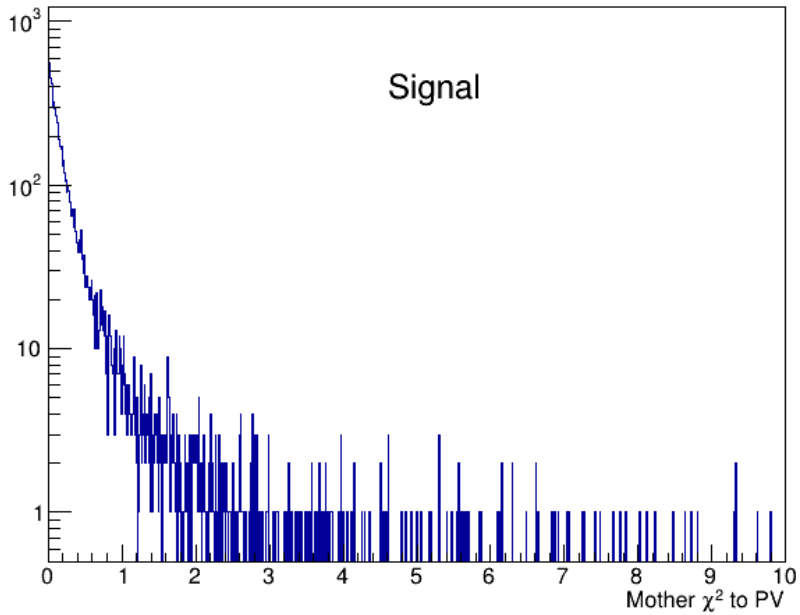

Figure 19: Signal : Reconstructed KFParticle χ^2 to Primary Vertex

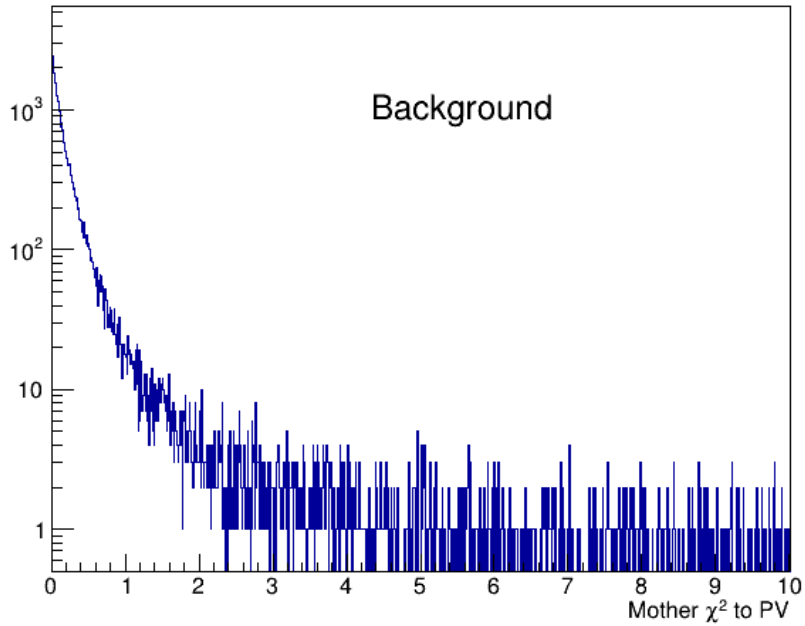

Figure 20: Background : Reconstructed KFParticle χ^2 to Primary Vertex

χ^2 of Secondary Vertex Fit

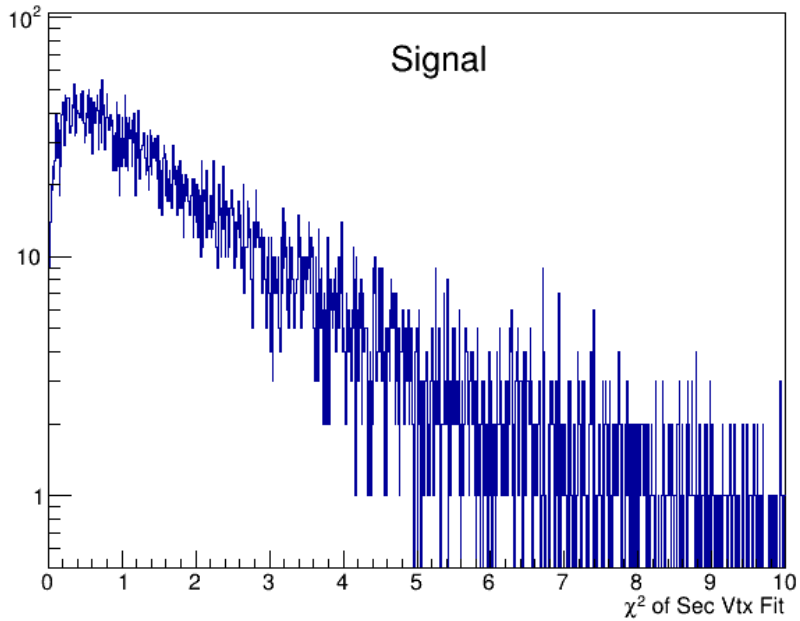

Figure 21: Signal : Reconstructed KFParticle χ^2

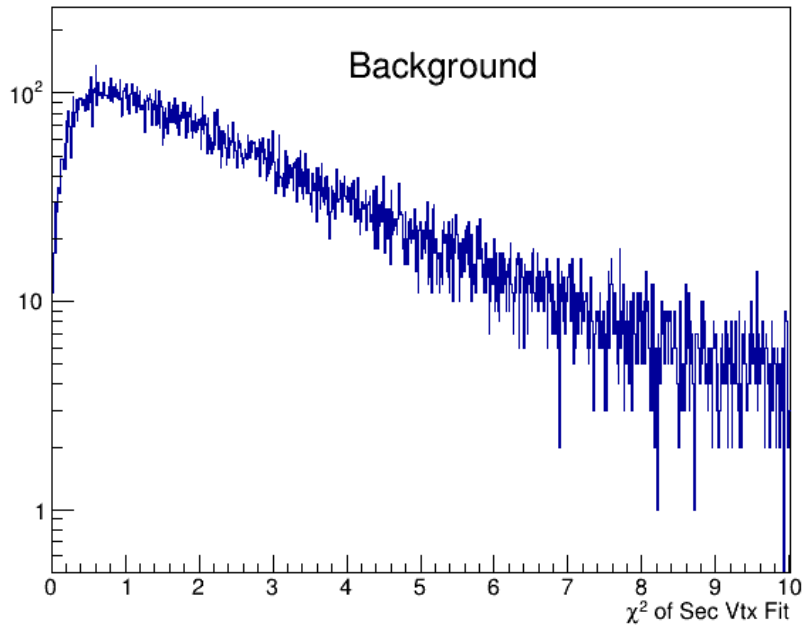

Figure 22: Background : Reconstructed KFParticle χ^2