Issues with KFParticle Package for Secondary Vertex Reconstruction

Amaresh Datta
(amaresh@jinr.ru)

DLNP
Dubna, Russia

Sep 07, 2022

Missing Quantities in SpdRCKFpartV0Finder

- DCA (distance of closest approach) between daughters or of daughters from reconstructed secondary vertex is one of the best cuts to distinguinsh decay signal from random combinatorial background
- We aim to do that for the challenging D meson measurements at SPD
- SpdRCKFpartV0Finder is SPD wrapper script that uses KFParticle package to reconstruct sec. vertex
- It does not store DCAs or even reco. sec. vertex coordinates
- Attempted to extract the quantities

Using KFParticle Package

- KFParticleBase class uses the method Construct(**daugher KFParticle info**) to add daugher KFParticleBase objects sequentially to calculate the point of closest approach / vertex
- KFParticle object created with pos, mom, cov, chi2, charge, pid information of the particle (for daughters, info obtained for FirstState of the MCTrack object)
- Attempted to reproduce the process to obtain secondary vertex and then calculate DCAs
- GetDistanceFromVertex(**vtx**) and GetDistanceFromParticle(**particle**) in KFParticleBase class should give DCA of daughter from primary or secondary vertices or between daughters in cm

Comparison of Wrapper and Inline SV Reconstructions

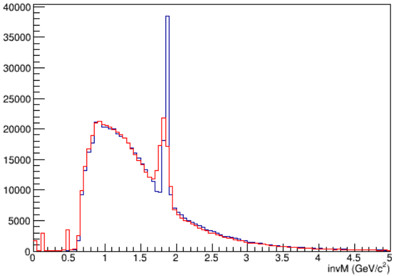

Figure 1: PYTHIA OpenCharm $\pi^+ K^-$ invariant mass : Black : wrapper reco output, Red inline reco output

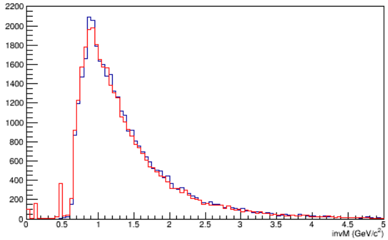

Figure 2: PYTHIA MinBias $\pi^+ K^-$ invariant mass : Black : wrapper reco output, Red inline reco output

Comment on Comparison

- We see some shape mismatch of D0 signal mass peak but overall I think we are looking at the same thing
- Signal peak mismatch could be because of problem of setting the Mag Field properly for swimming the tracks back
- Now we access secondary vertex position from KFParticle object of reco. vertex and look at DCA of daughter from Primary Vertex, Secondary Vertex and between daughters (π^+, K^-)

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]*"

How The Code Looks

- *KFParticle kfSV; kfSV.Construct(vdaughts, 2, &pvertex, -1);*
- vdaughts is vector of daughter KFParticele objects, pvertex is primary vertex KFParticle objects
- *dist1PV = d1.GetDistanceFromVertex(pvertex);*
- *dist1SV = d1.GetDistanceFromVertex(svpos);*
- *disttrk1trk2 = d1.GetDistanceFromParticle(d2);*
- d1,d2 are two daughter KFParticle objects, svpos is array[3] of secondary vertex position obtained from kfSV (KFParticle object of reoconstructed secondary vertex)

DCA To Primary Vertex

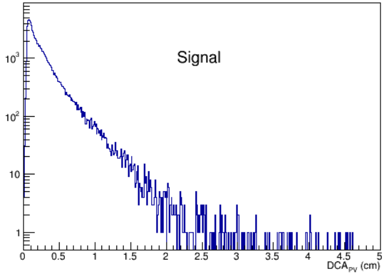

Figure 3: Signal : distance of daughter from primary vertex

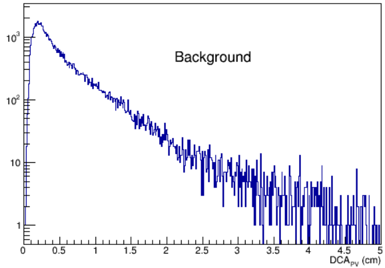

Figure 4: Background : distance of daughter from primary vertex

Too similar

DCA To Secondary Vertex

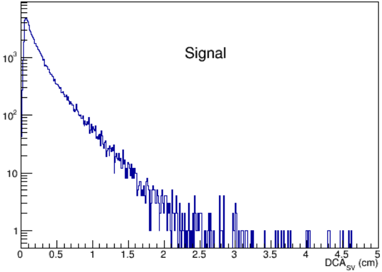

Figure 5: Signal : distance of daughter from secondary vertex

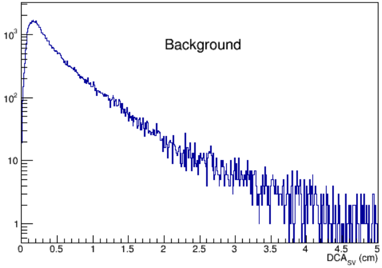

Figure 6: Background : distance of daughter from secondary vertex

Too similar and too large (for signal)

DCA Between Daughter Tracks

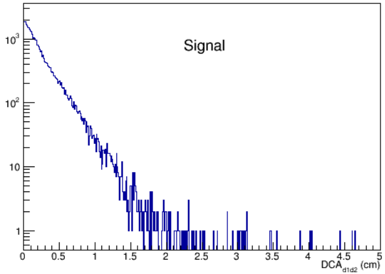

Figure 7: Signal : distance between daughters

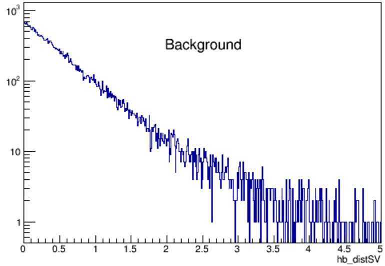

Figure 8: Background : distance between daughters

Too similar and too large (for signal)

DCA To Vertices

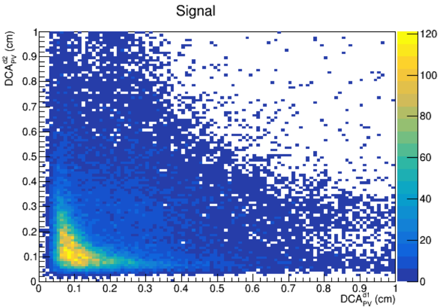

Figure 9: Signal : DCA 2D

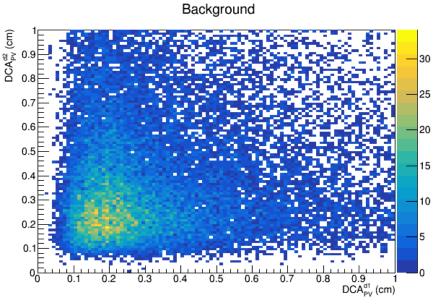

Figure 10: Background : DCA 2D

Given that the DCA are not dramatically different for Signal and Background, cuts based on 2D profile provide only a factor of ~ 10 background suppression

Correlated Daughter p_T

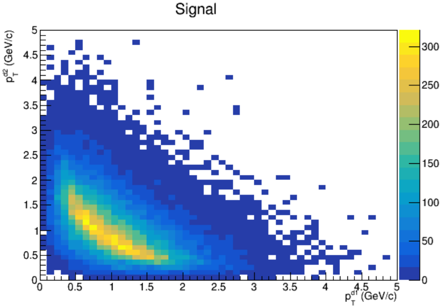

Figure 11: Signal : daughter p_T 2D

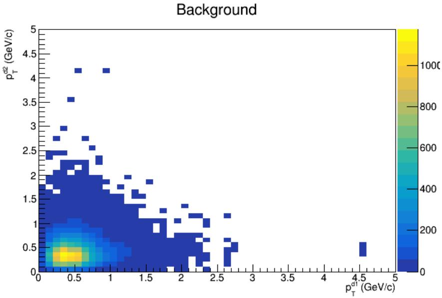

Figure 12: Background : daughter p_T 2D

Cuts based on 2D profile of correlated daughter particles provide a factor of $\sim$ 20 background suppression

DCA at MPD

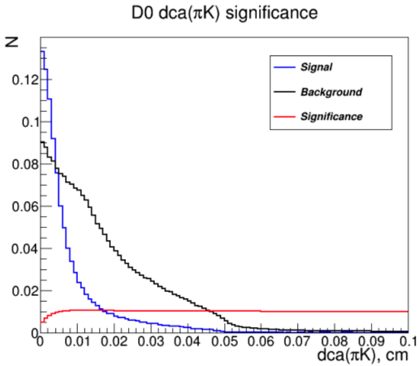

Figure 13: DCA at MPD for D0

- Plot on left from MPD TDR
- Notice the peak for signal is much smaller than 0.01 cm (100 microns) with width $\sim 50 - 60$ microns and significantly wider background
- Not too sure about the quantity, if it is dca between π^+ and K^-, this looks very different from what I get and this is something I expected

Summary and Outlook

- DCAs of Signal and Background events look ridiclously similar
- Would have expected DCA for signal to be in a few tens or hundred microns and for random combination of pions and kaons to be larger mm/cm
- DCA should have been the cleanest quantitiy to suppress background whereas these quantities look so similar that orders of magnitude background suppression seems imposisble
- ASSUMING they are ok, these info can be combined to suppress bkg by a factor of ~ 200
- An independent look or advice will be welcome

Thank You