Prospects of D^0 TSSA Measurements Without SVD

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Possible Inner Tracker Configurations

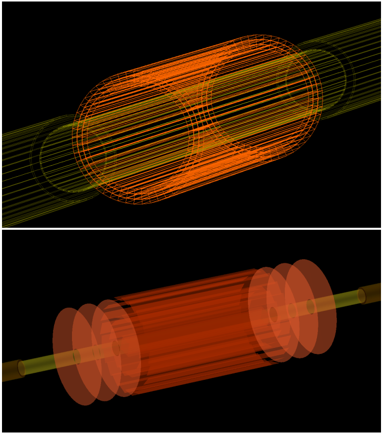

Figure 1: MicroMegas (above) and DSSD (below) TDR configurations

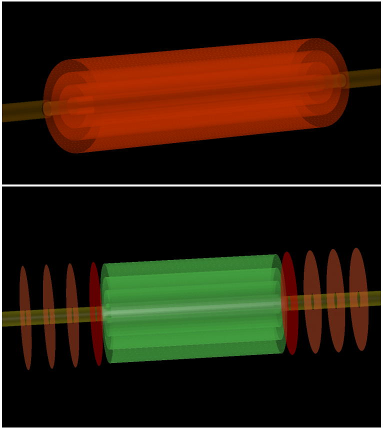

Figure 2: MAPS : TDR (above) and 'wishlist' (below) configurations

Role of SVD in Charm Meson Decay Measurements

- D^0 decay length 123 μm, $D^\pm$ decay length 312 μm
- With secondary vertex position resolution $\sim 50 - 80$ μm, SVD provides precise determination of decay vertex position, providing quantities like various distances of closest approach and chi-squares
- Distinctive distributions of these quantities for signal (decay of D^0) and background (random combination of daughter-like particles i.e. pions, kaons) allow us to put cuts and suppress (*more numerous by 4 orders of mangitude*) background efficiently
- Both DSSD and MAPS SVD are expensive ($\sim$ \$10 M)
- An important question :
  Can we do a decent D^0 TSSA measurement without SVD?

Simulation Details

- Pythia8 + SpdRoot
- Open-charm process : $D^0 \to \pi^+ K^-$ forced
- MinBias background : elastic not included
- Event vertex Z : Gaussian profile with $\sigma_z = 30$ cm
- KFParticle to reconstruct secondary vertex (D^0) from daughter particle candidate pairs
- Resolution obtained from the distribution of (Reconstructed - MC True) positions

Secondary Vertex Position Resolutions

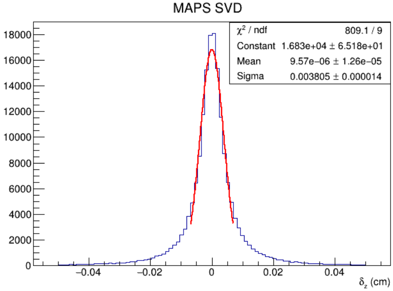

Figure 3: MAPS SVD : z-direction, $\sigma_z \sim 40\ \mu$m

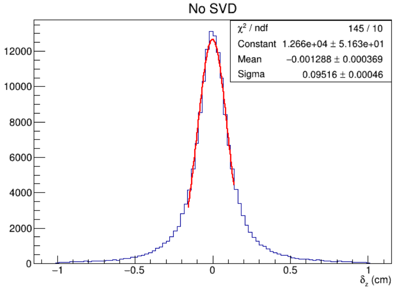

Figure 4: No SVD : z-direction, $\sigma_z \sim 1$ mm, way beyond decay length

Reconstructed D^0 Properties : 1

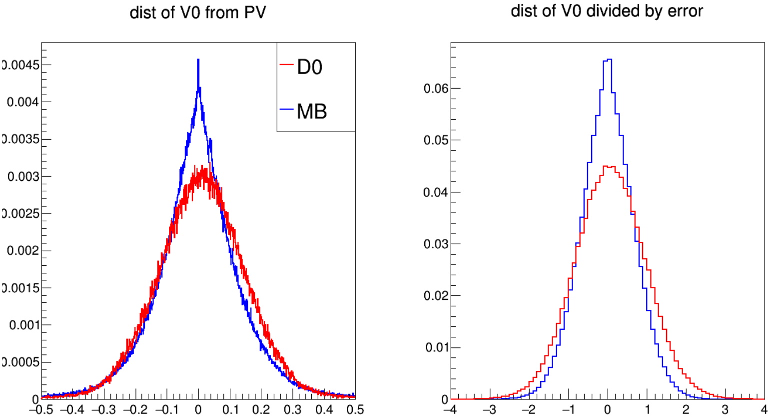

Figure 5: Differences in decay length washed out

Reconstructed D^0 Properties : 2

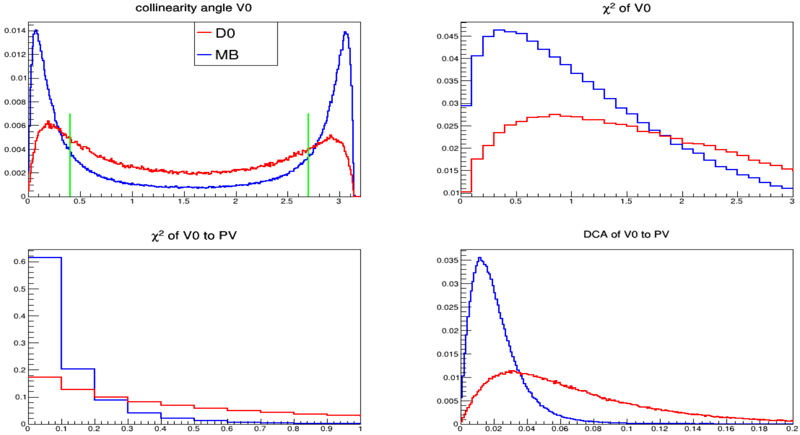

Figure 6: Unphysical cut on collinearity angle - just to beat down background. DCA of D^0 to PV (panel 4)?

Daughter Track Properties : 1

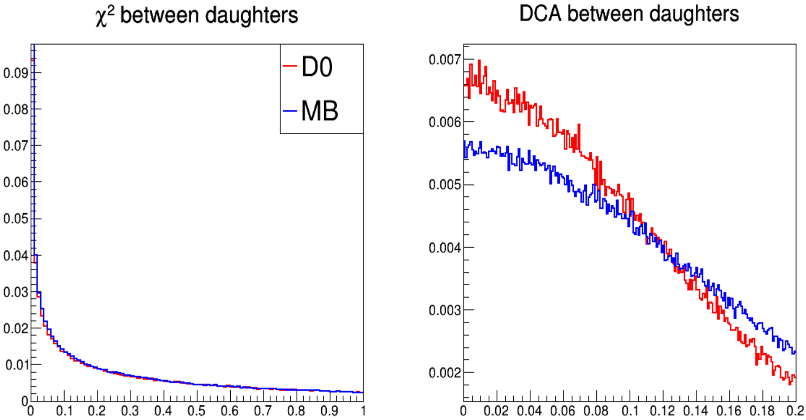

Figure 7: Not useful.

Daughter Track Properties : 2

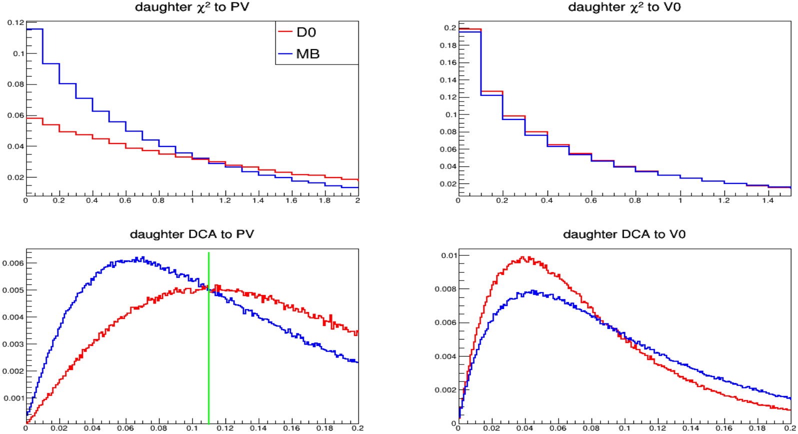

Figure 8: Most χ^2 and DCA are useless. DCA of π/K to PV somewhat useful.

Consequences

- Most of the distinctions between signal and combinatorial background are washed out due to secondary vertex positions resolutions being much larger than decay lengths
- Need to look for other kinematic properties of daughter tracks and reconstructed D^0 to reduce background
- Be mindful not to restrict D^0 x_F distribution as that's where we wish to do the measurements

Daughter Track Properties : 3

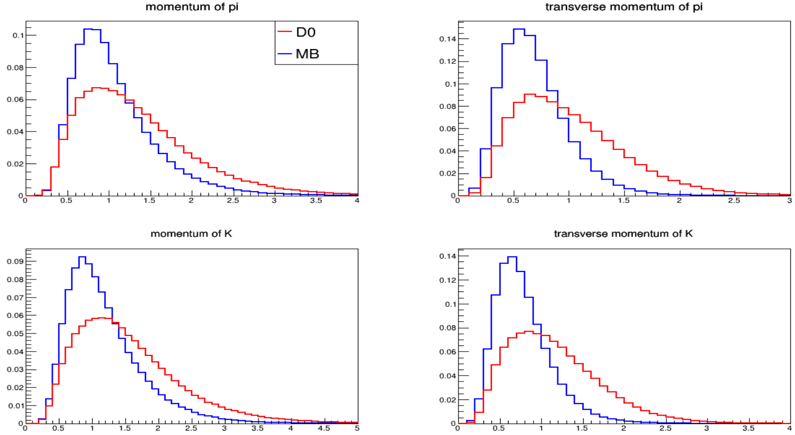

Figure 9: Possible cuts : pion/kaon transverse momentum

Daughter Track Properties : 4

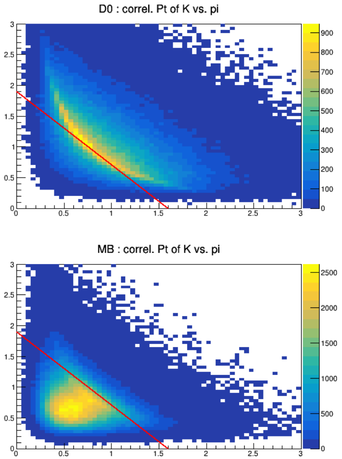

Figure 10: For all x_F

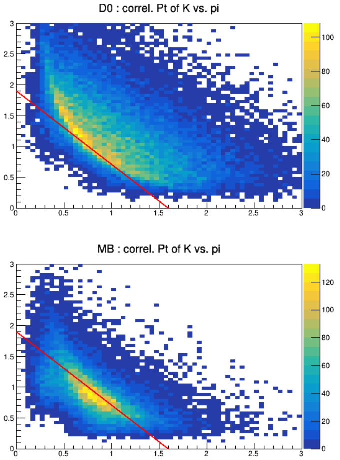

Figure 11: For $|x_F| \geq 0.2$

Daughter Track Properties : 5

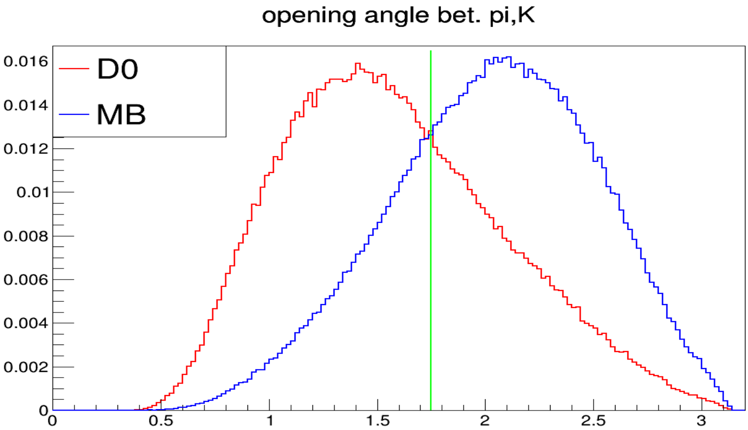

Figure 12: Opening angle. Still useful.

Reconstructed D^0 Properties : 3

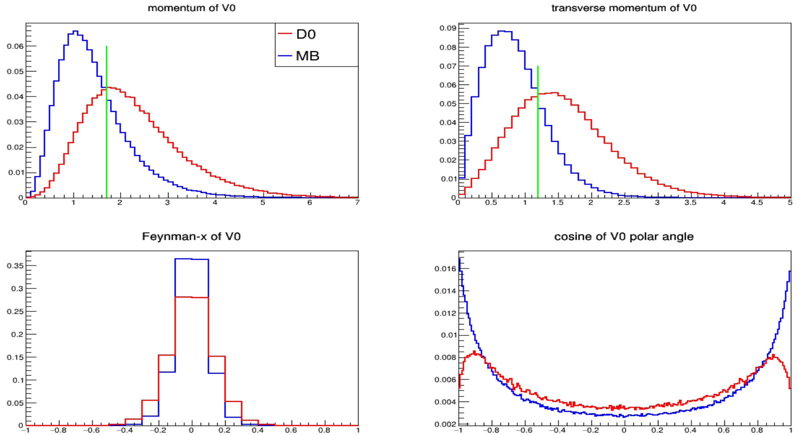

Figure 13: Focus on high x_F : can not restrict polar angle and transverse momentum of D^0

Before Cuts

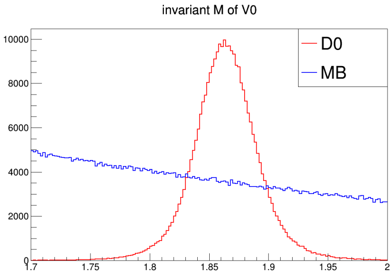

Figure 14: Reconstructed from simulations

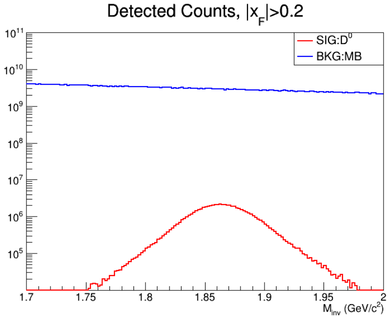

Figure 15: Projected for 1 year of data

After Cuts : No SVD

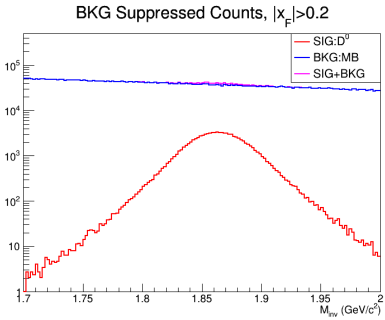

Figure 16: Projected for 1 year

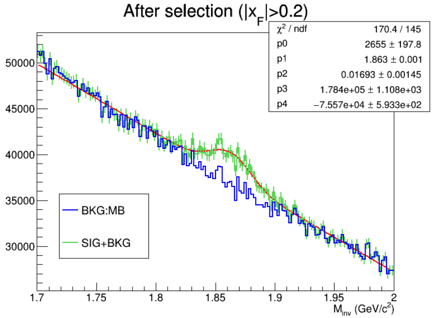

Figure 17: Projected for 1 year : signal from fit

After Cuts : MAPS SVD

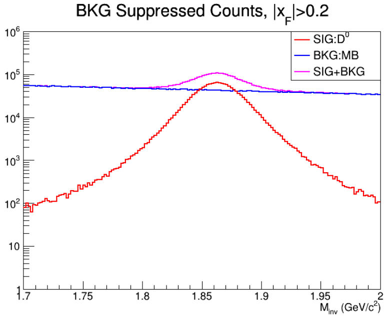

Figure 18: Projected for 1 year

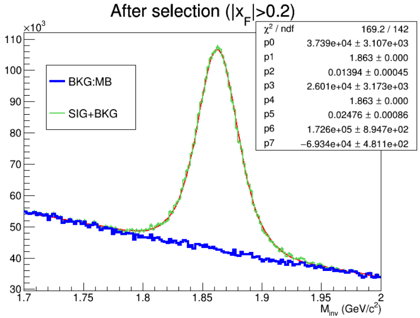

Figure 19: Projected for 1 year : signal from fit

Statistical Uncertainties : No SVD and MAPS

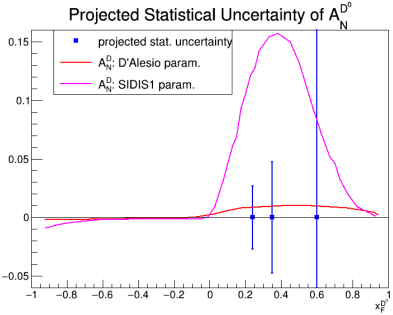

Figure 20: No SVD

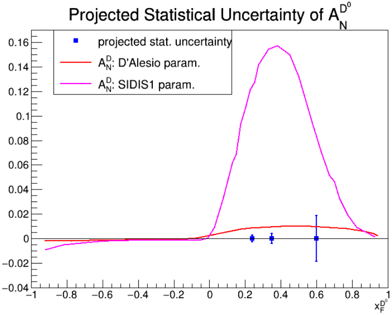

Figure 21: MAPS SVD

Highest x_F bin has no count after cuts

Summary

- Without SVD the chances of a 'meaningful' TSSA measurements look bleak
- Even though expected uncertainties are calculated here, it's a shakey analysis, some cuts (collinearity angle, DCA) are unphysical - used only because the distributions are different for signal and background
- Chances are the backgrounds can not be reduced enough to extract signal form a fit
- Next step : find out what to expect from the DSSD TDR configurations
- Good news : large scale production of Monte Carlo MinBias data is about to begin with DSSD as the default SVD