

Displaced Vertex

Bishoy H. Dongwi
CFNS Edward Bouchet Fellow

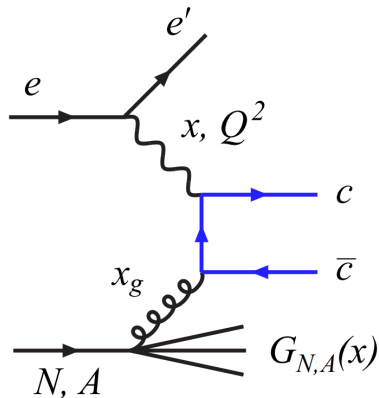
Stony Brook University, Stony Brook NY 11794

July 11, 2025



Introduction: Overture

E. C. Aschenauer, et. al., PRD 96 (2017) 114005

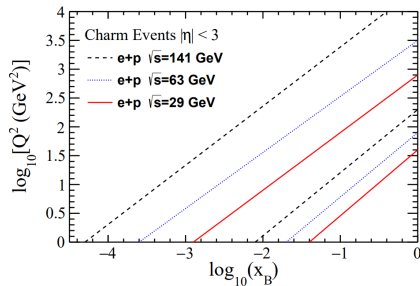
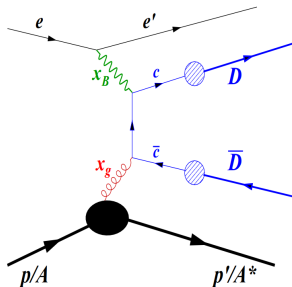


- LO: photon-gluon fusion

- Clean environment to precisely determine nPDFs in wide region of $x - Q^2$
- Access to nPDFs at poorly constrained high x_B
- Quark and gluon fragmentation
- Constrains parton energy loss in cold nuclear matter
- Insights into charm fragmentation

Introduction: Kinematic Reach

M. Kelsey, et. al., PRD 104 (2021) 054002

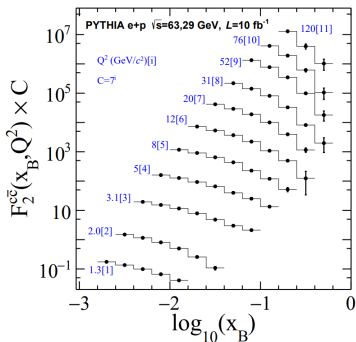


- Unique and direct access to gluons, especially at high x
- Broad kinematic coverage:
 - Probe intrinsic charm

Introduction: Charm Structure Functions

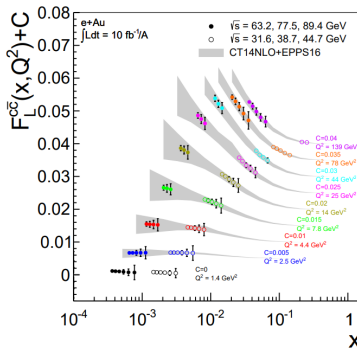
M. Kelsey, et. al., PRD 104 (2021) 054002

$e+p$, $\sqrt{s} = 63$, $\mathcal{L} = 10 \text{ fb}^{-1}$



E. C. Aschenauer, et. al., PRD 96 (2017) 114005

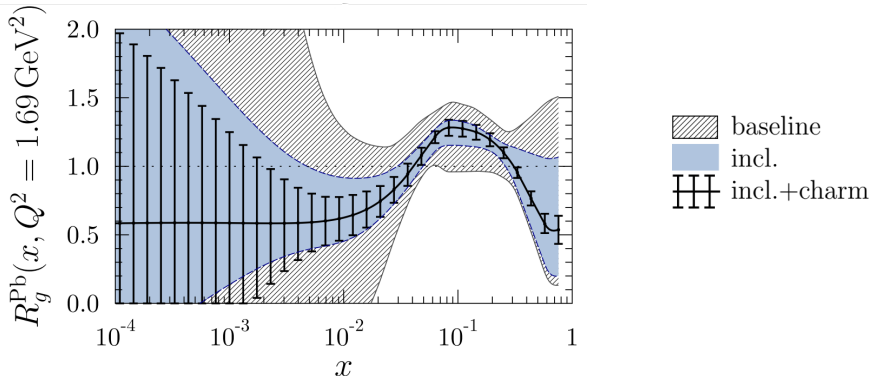
$e+A$, $\mathcal{L} = 10 \text{ fb}^{-1}$



- Charm structure functions can be extracted in large $x - Q^2$ range
- Constrain nPDF**
 - Based on early projections with smearing and not on full ePIC reconstruction

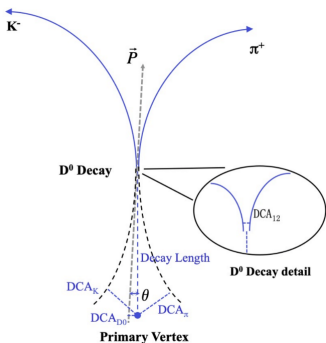
Introduction: Improvement on nPDF

E. C. Aschenauer, et. al., PRD 96 (2017) 114005



- Charm data can uniquely constrain gluon nPDF at high x
- Blue band are fits with no charm data and black error bands are full analyses include charm cross sections
- $\sqrt{s} = 20 \times 100 \text{ GeV}$

D^0 Topological Reconstruction



STAR, Phys. Rev. C 99, 034908 (2019)

- Topological variables
 - DCA_{π} , DCA_K , DCA_{12}
 - DCA_{D^0} , decay length, $\cos(\theta)$
- Calculated based on helix swimming in a constant magnetic field
 - Adapted from STAR software
 - $B = -1.7$ T

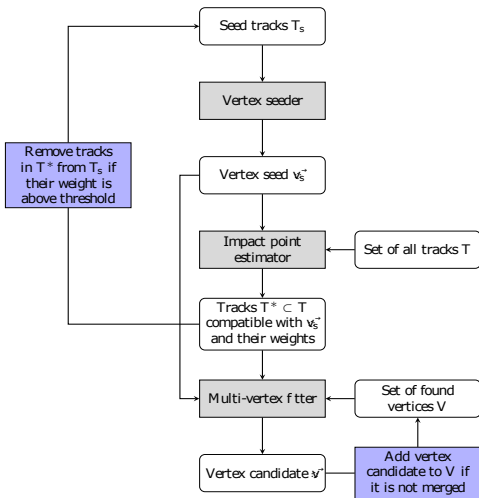
Rongrong

Secondary Vertex Finder

Nature of the Study

- The ACTS framework is broadly used in EICrecon for tracking and PV
- Implemented the `ACTS::AdaptiveMultiVertexFinder`
- Calculate both the primary and secondary vertices using AMVF
- Input file: `pythia8NCDIS_18x275_minQ2=10_beamEffects_xAngle=-0.025_hiDiv_vtxfix_1.hepmc3.MC.root`

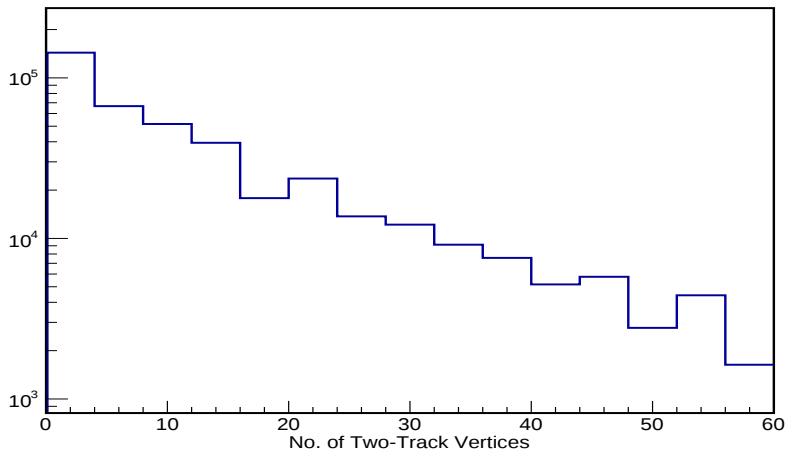
Adaptive Multi-VertexFinder (AMVF)

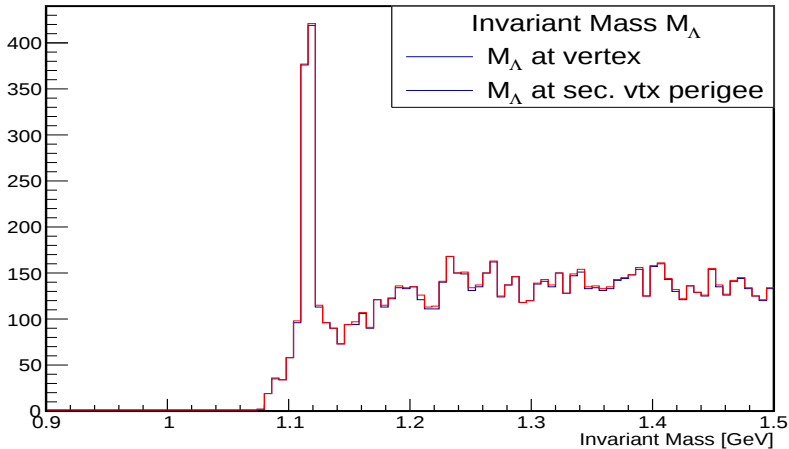


- Based on weighted adaptive Kalman filter with deterministic annealing
- Removeable beamspot constraint (useful for secondary vertices)
- Gaussian track density seed finder to estimate vertex position
- Check compatibility of tracks with seeder (**assign weight if compatible**)
- Simultaneous refit of all previously found vertices and vertex seed
- After convergence of fit, check whether the vertex candidate is merged with other vertices, **discard if merged**
- Remove seed tracks if their weights are above threshold

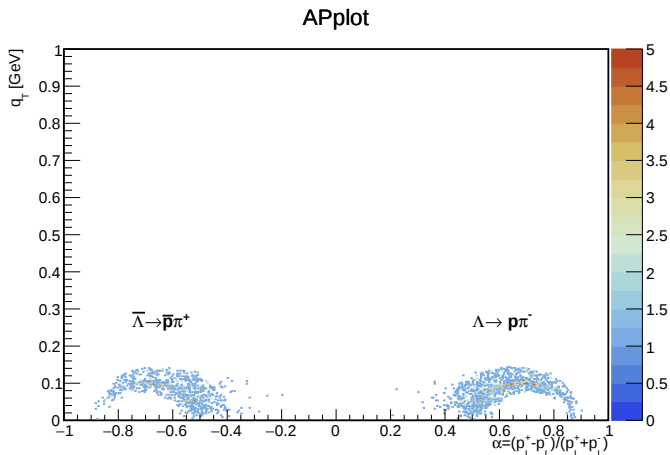
Identification of b-jets and investigation of the discovery potential of a Higgs boson in the $WH \rightarrow \ell \nu b\bar{b}$ channel with the ATLAS experiment
N. G. Piacquadio (2010)

SV Multiplicity



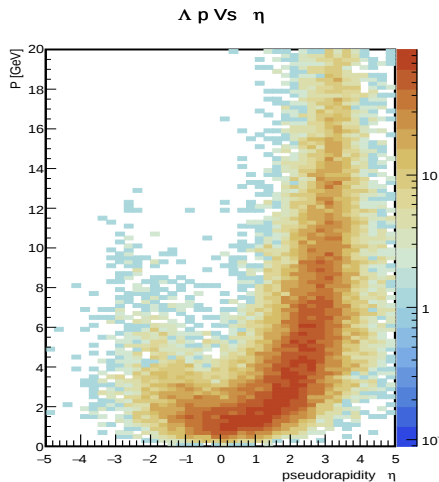
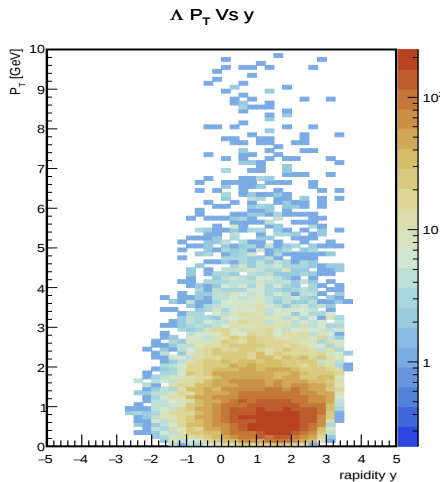


Armenteros-Podolansky Plot



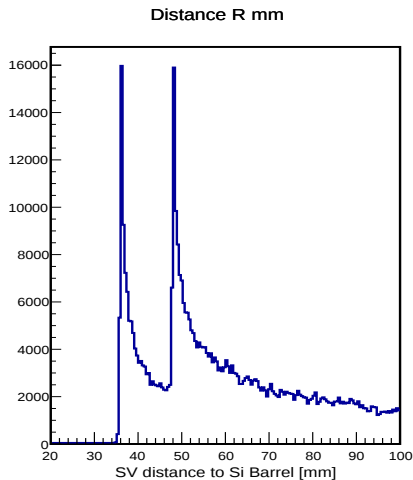
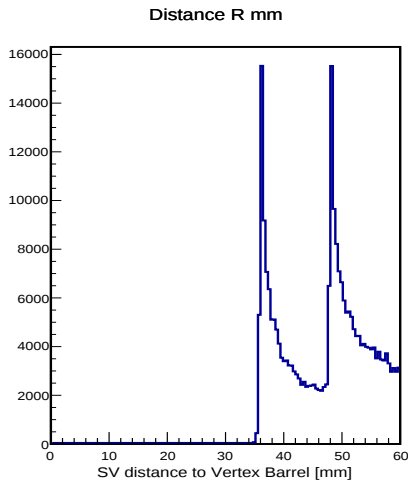
- PID plot of daughters p_L asymmetry relative to the parent particle

Kinematic Plots

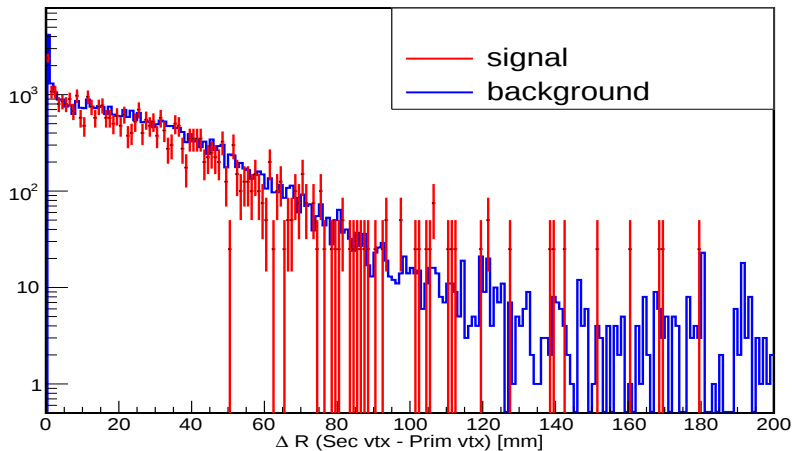


- Λ kinematic plots

SV Distance to Material



Decay Length: SV-PV



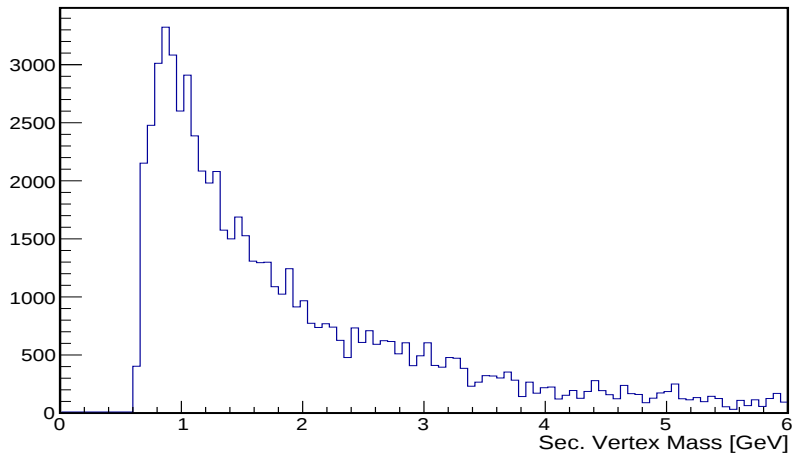
- Signal here refers to narrow cuts around M_Λ
- Need more stats

Summary and Beyond

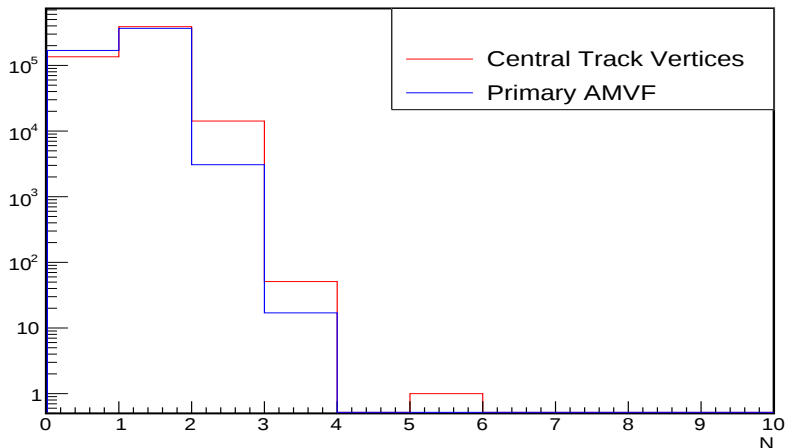
- Heavy flavor production at EIC provides unique access to gluon distributions, especially at large x
- $\Lambda \rightarrow p\pi$ two-track vertex
- Consistency check: PV evaluation with AMVF and compare to existing results
- D^0 studies with SV now underway and compare with Helix fitter results
- Directly use **Secondary vertex** to find $\Lambda \rightarrow p\pi^-$

Back Up

Using Secondary

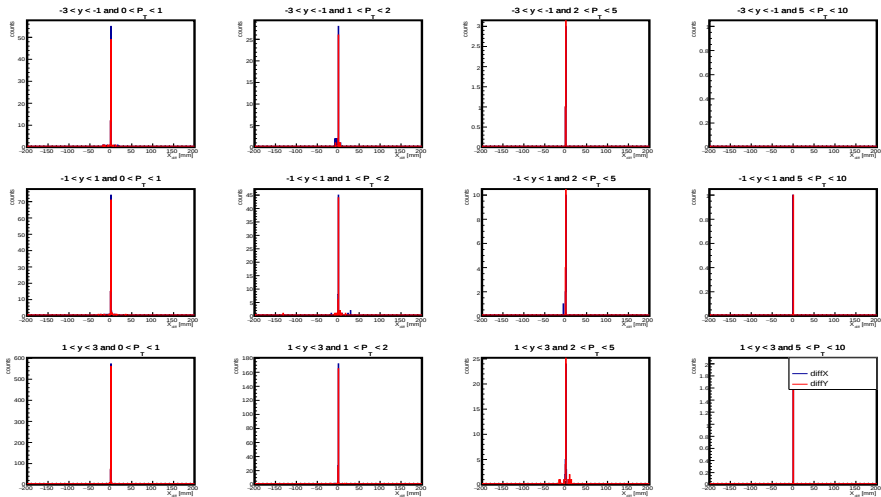


Primary Vertex Multiplicity



- Good agreement in Multiplicity between both primary vertex finder

Difference between Primary Vertices



- Distributions of $PV_{AMVF} - PV_{CTV}$ in XY
- Distributions at p_T and y cuts