

Displaced Vertex

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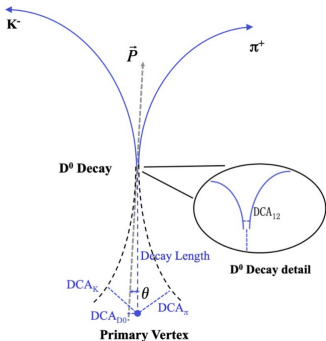


Secondary Vertex Finder

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
- Feed in `ReconstuctedParticleCollection`, `Trajectories`
- Preliminary results form Helix swimming
- Standalone dev repo of AMVF exists on the main repo
- PR has been submitted and currently work-in-progress
- Input file: `pythia8NCDIS_18x275_minQ2=10_beamEffects_xAngle=-0.025_hiDiv_vtxfix_1.hepmc3.MC.root`

D^0 Topological Reconstruction

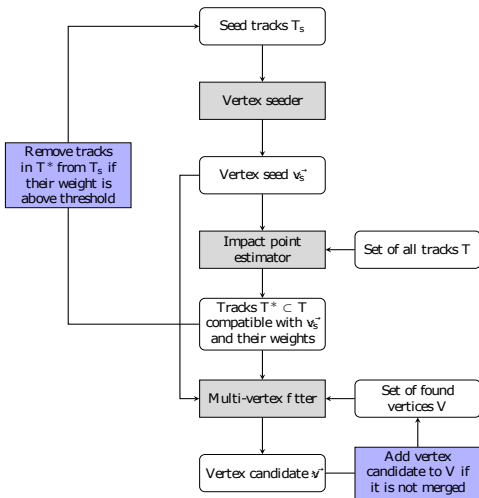


STAR, Phys. Rev. C 99, 034908 (2019)

- 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

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)

Secondary Track Vertex Factory

```
#include <vector>

#include "algorithms/tracking/SecondaryVertexFinderConfig.h"
#include "algorithms/tracking/SecondaryVertexFinder.h"
#include "extensions/jana/JOMniFactory.h"
#include <spdlog/logger.h>

namespace eicrecon {

class SecondaryVertexFinder_factory
    : public JOMniFactory<SecondaryVertexFinder_factory, SecondaryVertexFinderConfig> {
private:
    using AlgoT = eicrecon::SecondaryVertexFinder;
    std::unique_ptr<AlgoT> m_algo;

    PodioInput<edm4eic::ReconstructedParticle> m_reco_input(this);
    Input<ActsExamples::Trajectories> mActsTrajectories_input(this);
    PodioOutput<edm4eic::Vertex> m_sec_vertices_output(this);
    PodioOutput<edm4eic::Vertex> m_sec_vertices_output(this);

    ParameterRef<int> m_maxVertices(this, "maxVertices", config().maxVertices,
        "Maximum num vertices that can be found");
    ParameterRef<bool> m_reassignTracksAfterFirstFit(
        this, "reassignTracksAfterFirstFit", config().reassignTracksAfterFirstFit,
        "Whether or not to reassign tracks after first fit");
    ParameterRef<float> m_tracksMaxInterval(this, "tracksMaxInterval", config().tracksMaxInterval,
        "Max z interval for Acts:AdaptiveMultiVertexFinder");
    ParameterRef<float> m_maxIterations(this, "maxIterations", config().maxIterations,
        "Max iterations for Acts:AdaptiveMultiVertexFinder");
    ParameterRef<float> m_maxDistToLinPoint(
        this, "maxDistToLinPoint", config().maxDistToLinPoint,
        "Max distance to line point (pca) for Acts:AdaptiveMultiVertexFinder");

    Service<ACTSGeo_service> m_ACTSGeoSvc(this);

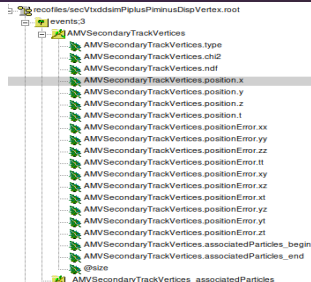
public:
    void Configure() {
        m_algo = std::make_unique<AlgoT>();
        m_algo->applyConfig(config());
        m_algo->init(m_ACTSGeoSvc(), logger());
    }

    void ChangeRun(int32_t /*run_number*/) {}

    void Process(int32_t /*run_number*/, uint64_t /*event_number*/) {
        std::tie(m_sec_vertices_output(), mActsTrajectories_input()) =
            m_algo->produce(m_reco_input(), mActsTrajectories_input());
    }
};

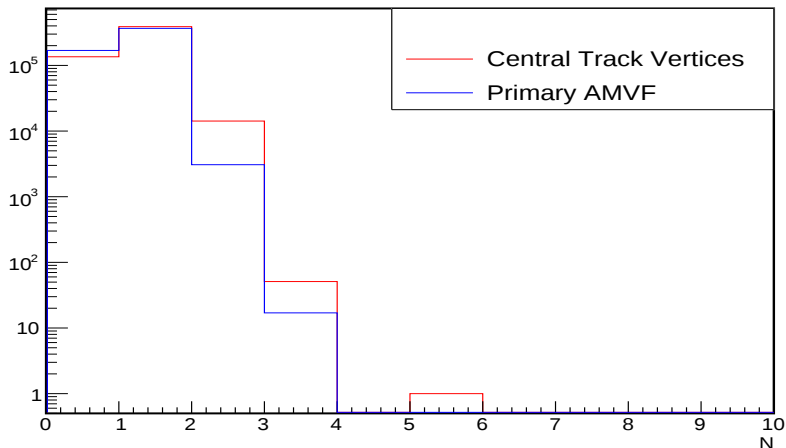
} // namespace eicrecon
```

```
app->Add(new JOMniFactoryGenerator<SecondaryVertexFinder_factory>{
    "SecondaryTrackVerticesAMVF", {"ReconstructedParticles", "CentralCKActsTrajectories"},
    {
        "PrimaryTrackVerticesAMVF",
        "SecondaryTrackVerticesAMVF",
    },
    {}, app);
```



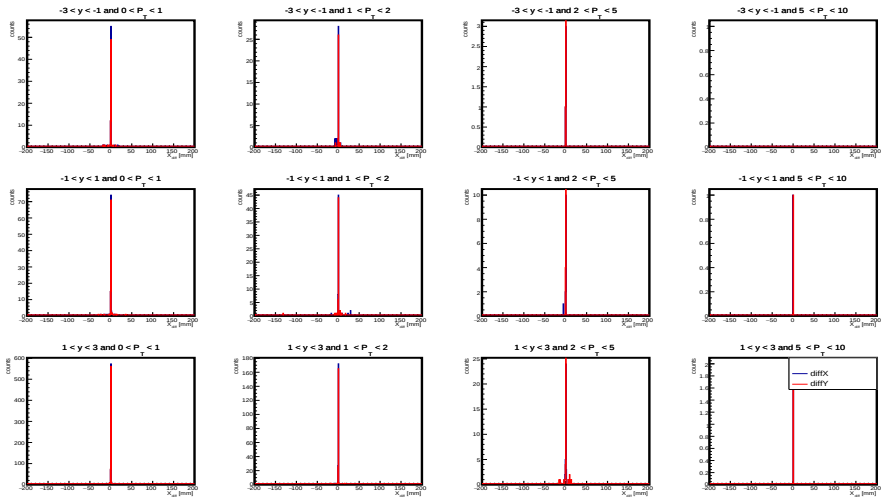
- Secondary vertex Factory
- Might need to create a custom Collection for our Secondary Vertices to play with removal of overlapping vertices

Primary Vertex Multiplicity



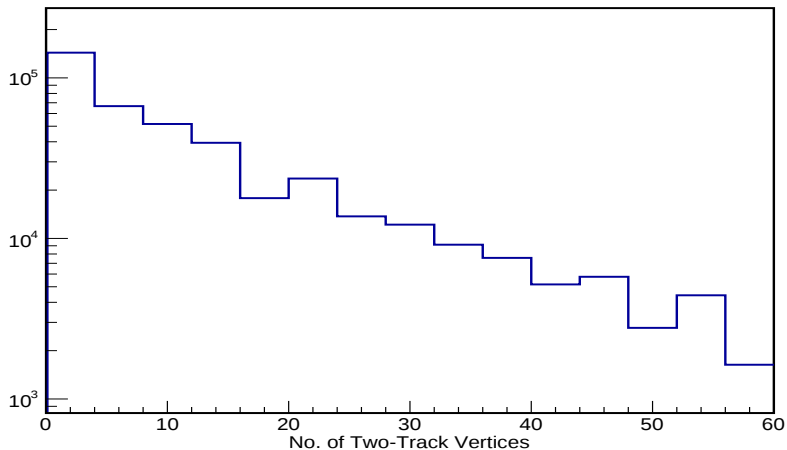
- Good agreement in Multiplicity between both primary vertex finder

Difference between Primary Vertices

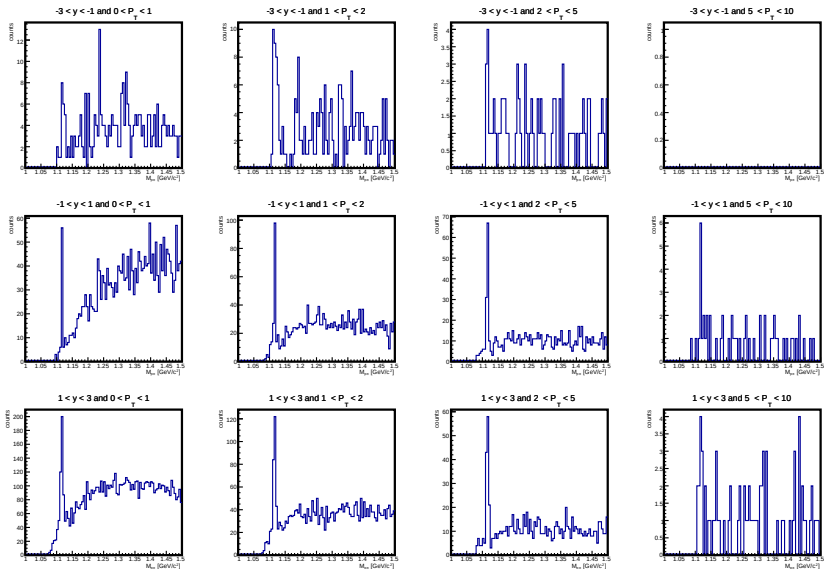


- Distributions of $PV_{AMVF} - PV_{CTV}$ in XY
- Distributions at p_T and y cuts

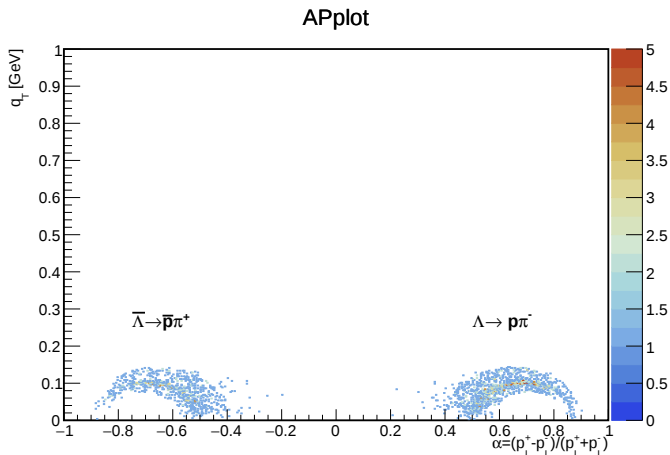
SV Multiplicity



M_Λ Distribution in p_T and y bins

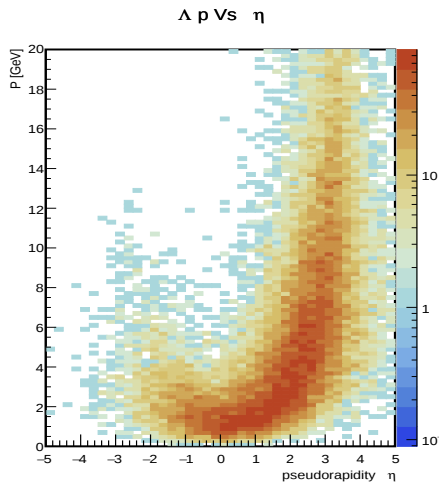
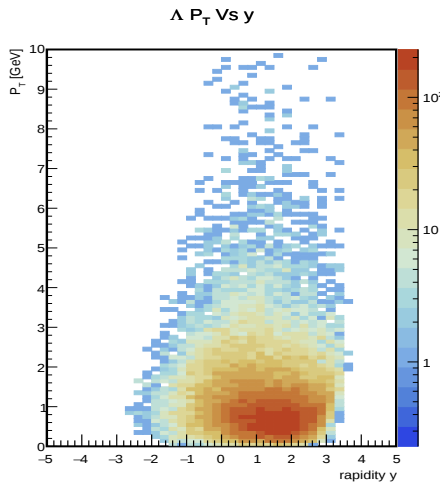


Armenteros-Podolansky Plot



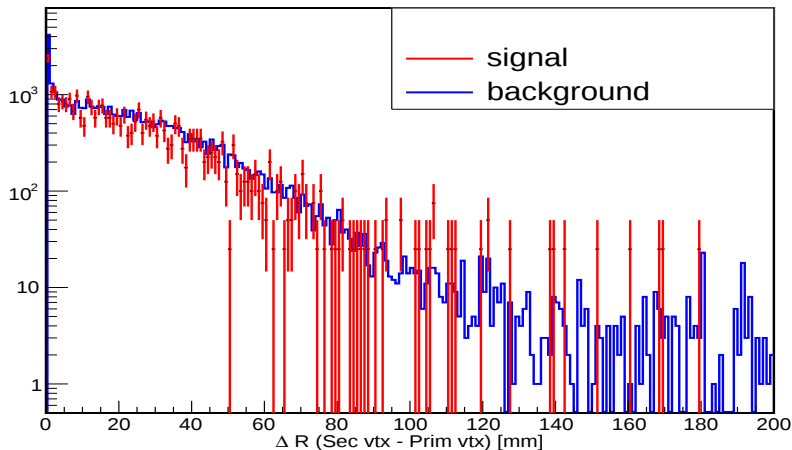
- PID plot of daughters p_L asymmetry relative to the parent particle

Kinematic Plots



- Λ kinematic plots

Decay Length: SV-PV



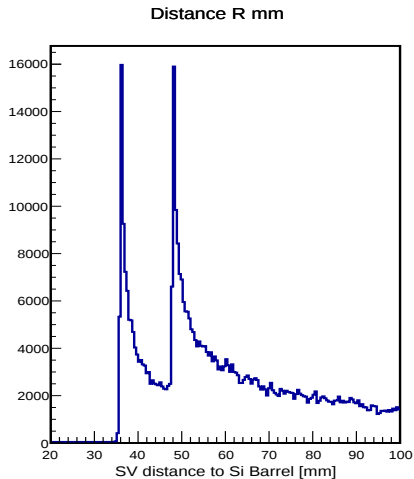
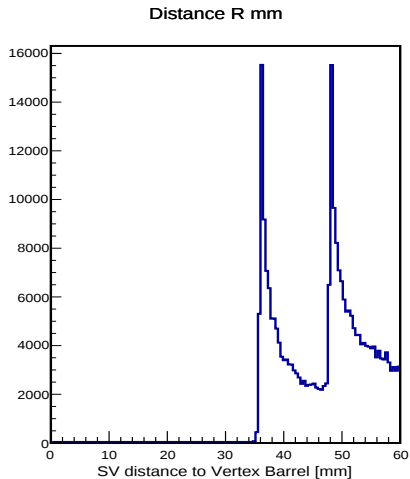
- Signal here refers to narrow cuts around M_Λ
- Need more stats

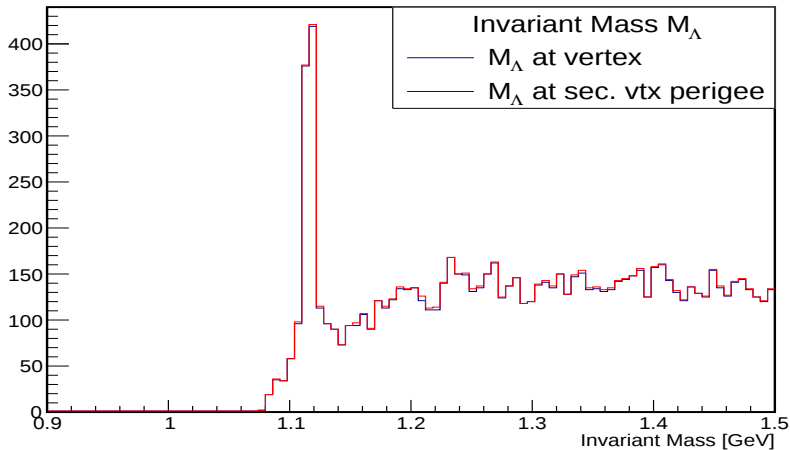
Summary and Beyond

- 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 $\rightarrow$ Use enriched D^0 samples
- Directly use **Secondary vertex** to find $\Lambda \rightarrow p\pi^-$

Back Up

SV Distance to Material





Using Secondary

