Study of the MPD Performance in the Fixed Target Mode for Λ Hyperon Selection (req.35 Xe+W@2.5GeV)

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Outline

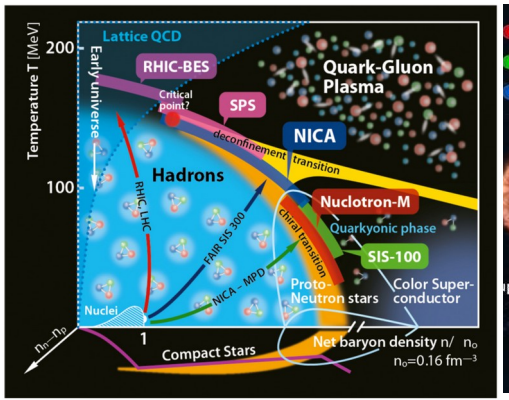
- ***Motivation for the Study of Hyperons***
- ***Overview of Multi - Purpose Detector (MPD) – FXT***
- ***Methods: Topological Cuts (TC)***
- ***Λ Hyperon Resonstruction: $\Lambda \rightarrow p + \pi^-$***
- ***Efficiency and p_T – spectra of Λ Hyperons***
- ***Summary***

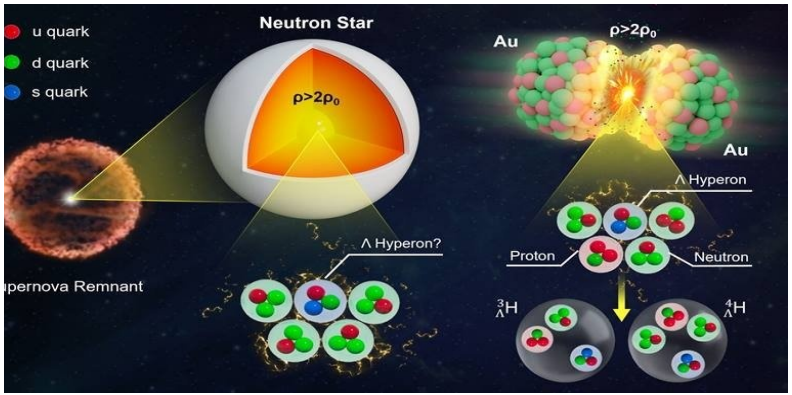
Physics Motivation

- ✓ **Significance of Hyperons:**
  - ◦ They have attractive experimental features, making them valuable tools for monitoring detector performance
- ✓ **Astrophysical Relevance:**
  - ◦ Hyperons provide essential signatures of excited and compressed baryonic matter
  - ◦ Help us to understand how matter behaves in extreme conditions in neutron stars
- ✓ **Quantum Chromodynamics (QCD):**
  - ◦ Study of hyperons helps to understand strong interactions and QGP
- ✓ **Experimental Techniques:**
  - ◦ Research on hyperons improves experimental methods and data analysis techniques in high-energy physics

The Goal of This Study

- ✓ **Λ hyperon reconstruction using the MPD in fixed-target mode:**
  - ◦ signal extraction
  - ◦ efficiency estimation
  - ◦ p_T-spectra analysis across centrality intervals





Data Set

- ✓ **Generator:** UrQMD, Geant -4, Min.bias (b = 0-15 fm), Xe+W @ 2.5 GeV, 15M events
- ✓ **Detectors:** MPD with fixed target

Analysis: Hyperon Wagon in the Analysis Train

- ✓ **Track reconstruction:** two-pass Kalman filter with track seeding using outer hits (1st pass) or leftover inner hits (2nd pass)
- ✓ **Track acceptance criterion:** $|\eta| < 1.3$, NTPC_hits ≥ 10
- ✓ **Particle Identification:** dE/dx in TPC & m^2 in TOF (A. Mudrokh)
- ✓ **Methods:** Topological Cuts (TC)

Multi – Purpose Detector General View

Fixed-Target Mode (FXT)

The wire-target is installed at z = -85 cm, wire diameter is 50 um, wire is shifted by 1.4 cm upwards in Y.

Time-Projection Chamber (TPC): Main tracking detector

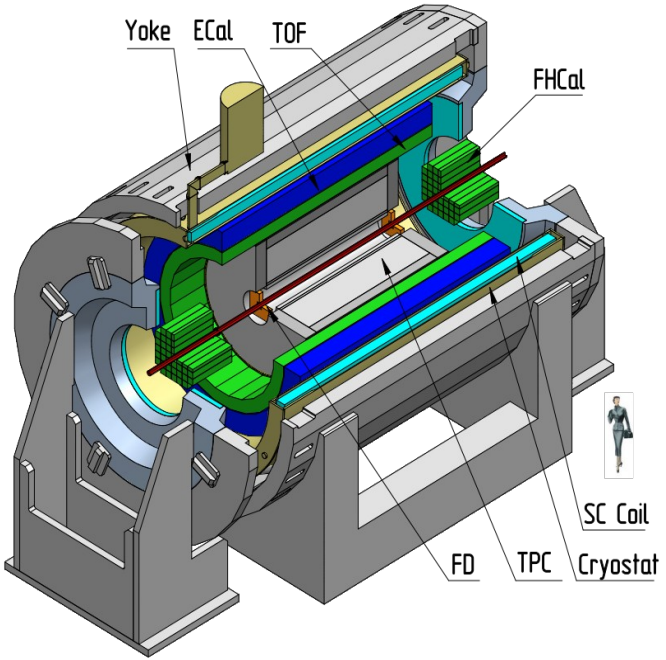
Time-Of-Flight (TOF): Particle identification via time-of-flight

Electromagnetic Calorimeter (Ecal): Measurements of photons and electrons

Forward Hadron Calorimeter (FHCal): Measures centrality and event plane

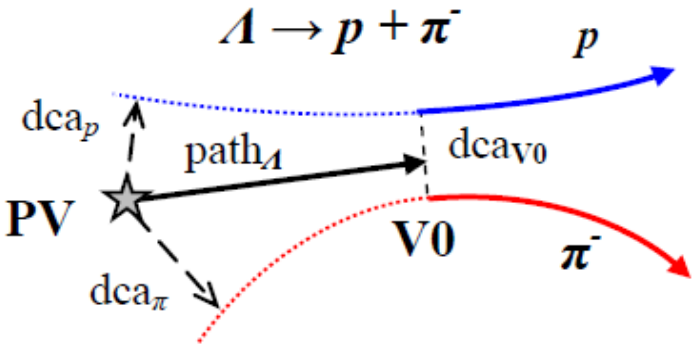
Forward Detector: Provides fast trigger for **TOF**

All subdetectors are located inside a superconducting solenoid



- ✓ http://mpd.jinr.ru/mpd/

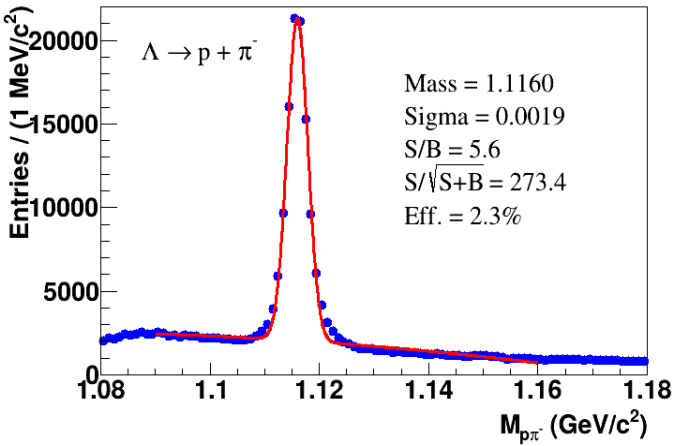
Method – Topological Cuts (TC)

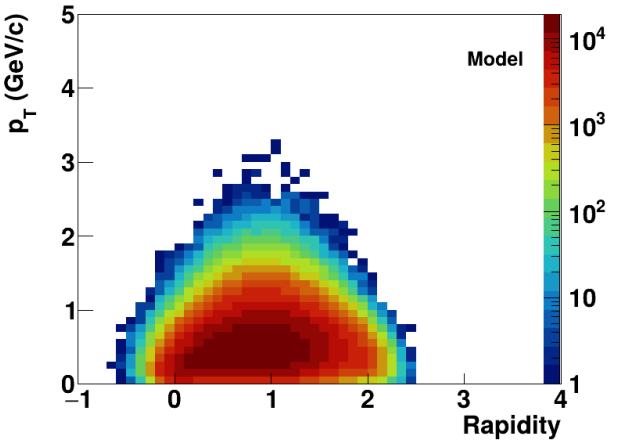


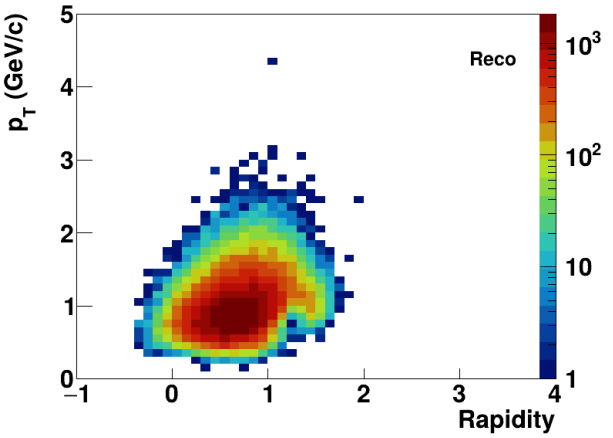
- **P**V – primary vertex
- **V_0** – vertex of Λ decay
- **dca** – distance of the closest approach
- **path –** decay length

Maximization of significance: Significance is defined as **S/√(S+B)**, where **S** and **B** are the total numbers of signal and background combinations inside ±2σ interval around the invariant mass peak position (σ is taken from Gaussian fit of the peak).

Invariant Mass Λ and Phase Space



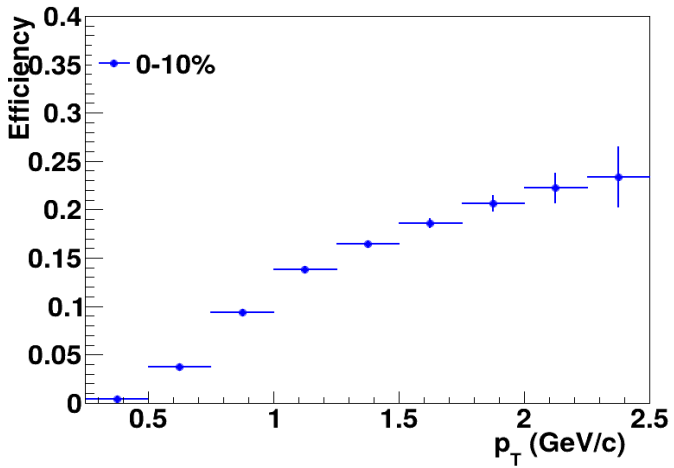


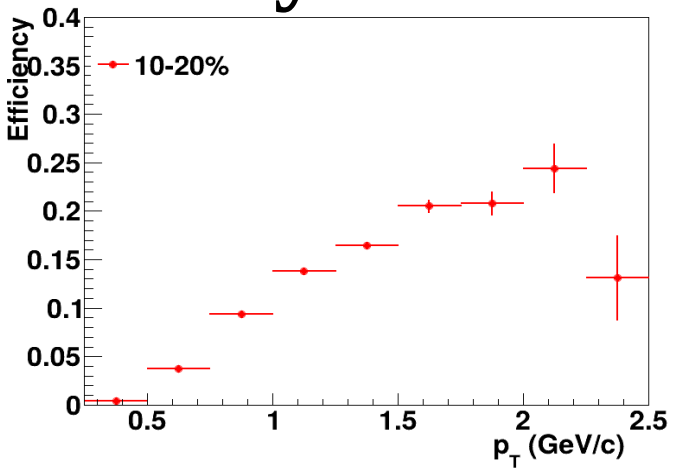


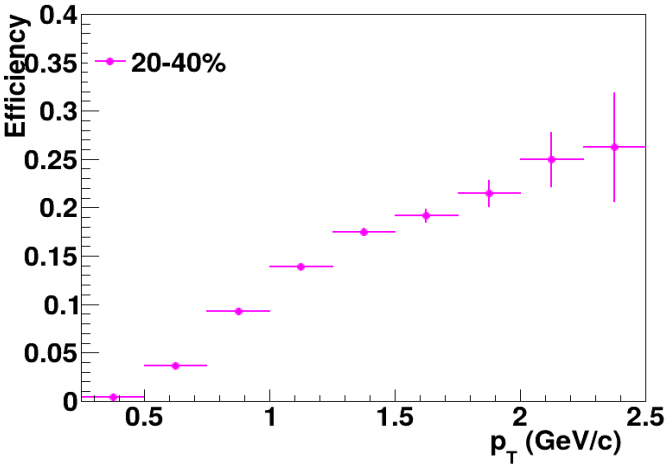
- ✓ l0.chi2s[][0] > 25.0 – normalized π⁻-to-primary vertex impact parameter
- ✓ l0.chi2s[][1] > 11. – normalized proton-to-primary vertex impact parameter
- ✓ l0.chi2h < 10. – chi2 of secondary vertex reconstruction
- ✓ l0.disth < 0.8 – distance of the closest approach
- ✓ l0.path > 3. – lambda decay path
- ✓ l0.angle < 0.04 – lambda momentum and primary-to-secondary vertex vector noncollinearity

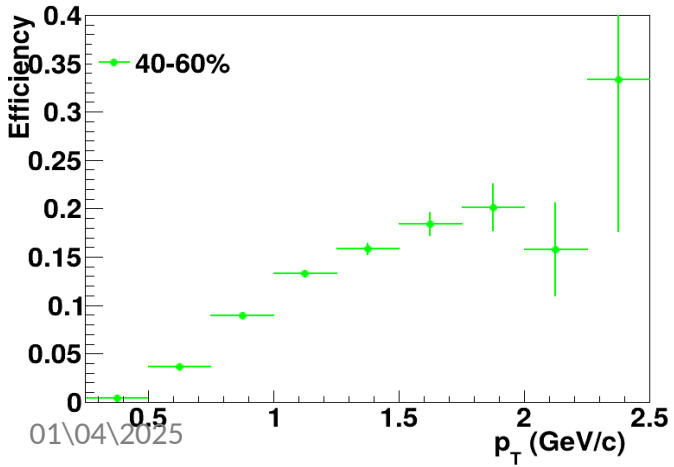
- ✓ **Selection:** $0. \leq y < 1.$
- ✓ **Centrality bins:** 0-10%, 10-20%, 20-40%, 40-60%, 60-80%, 80-100%

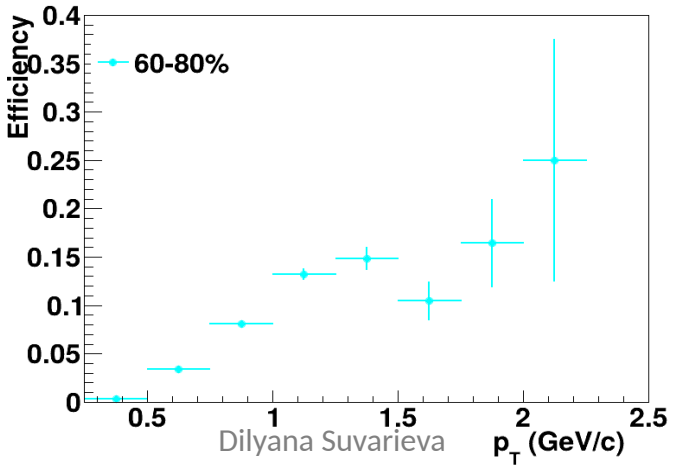
Efficiency of Λ Reconstruction versus Transverse Momentum in Centrality Intervals

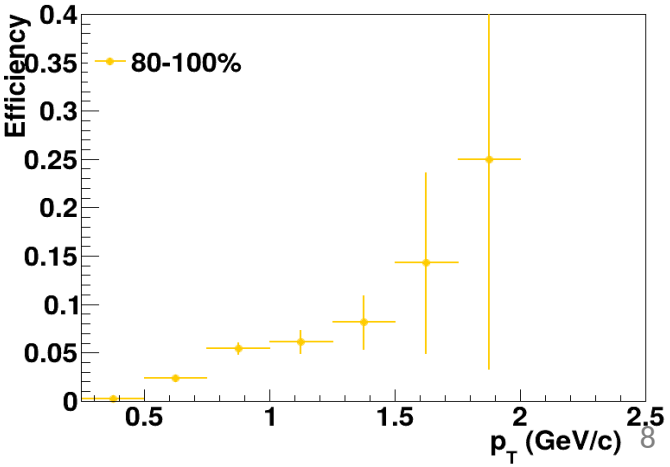




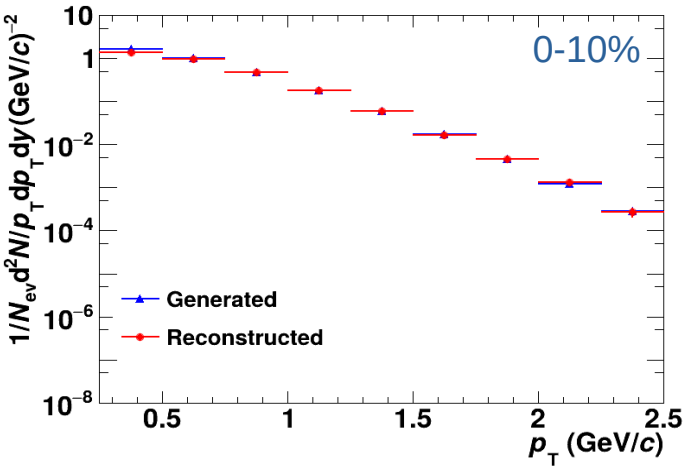


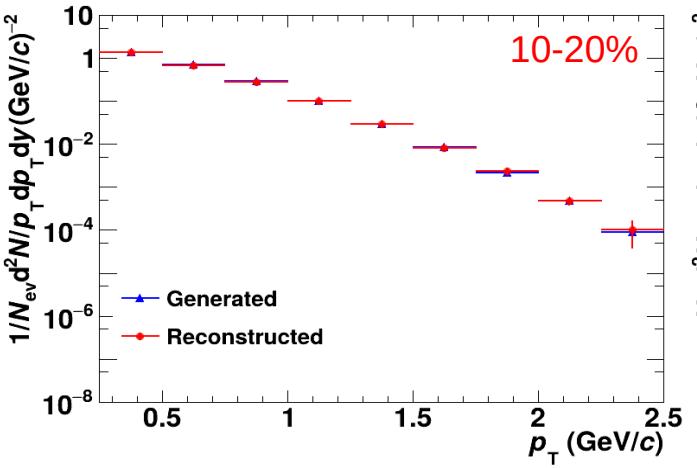


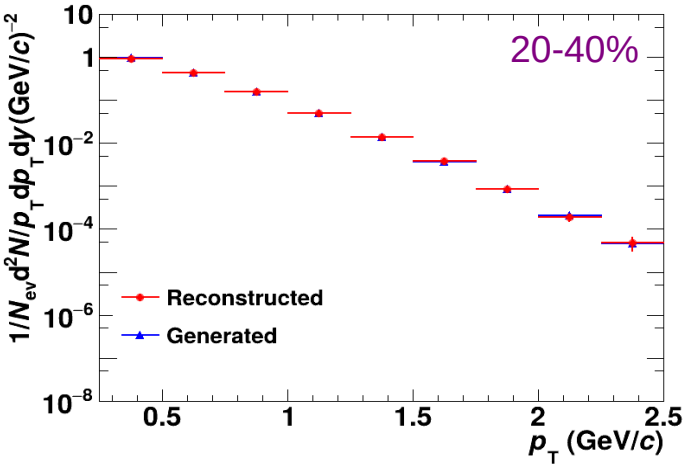


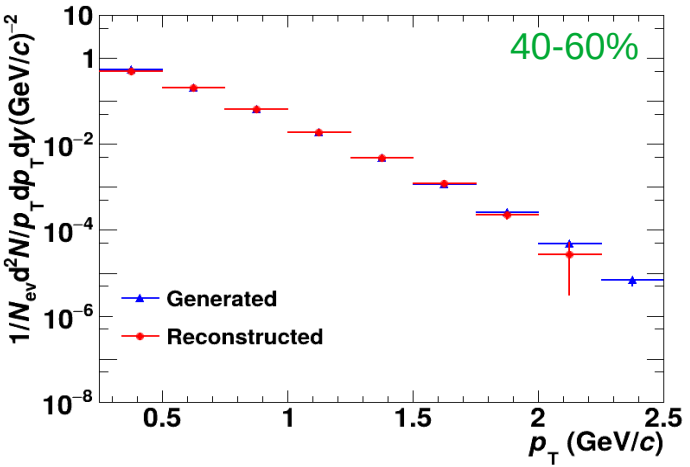


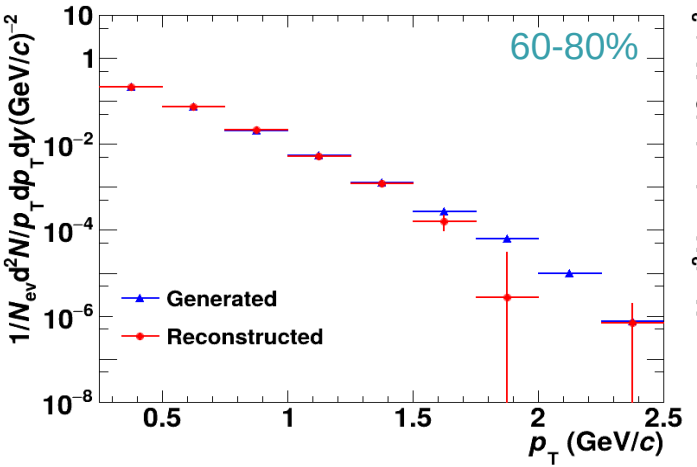
Invariant p_T -spectrum of Λ in Centrality Bins

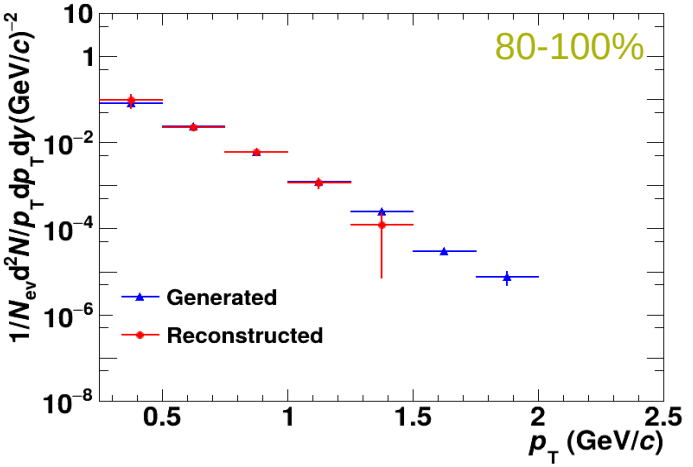




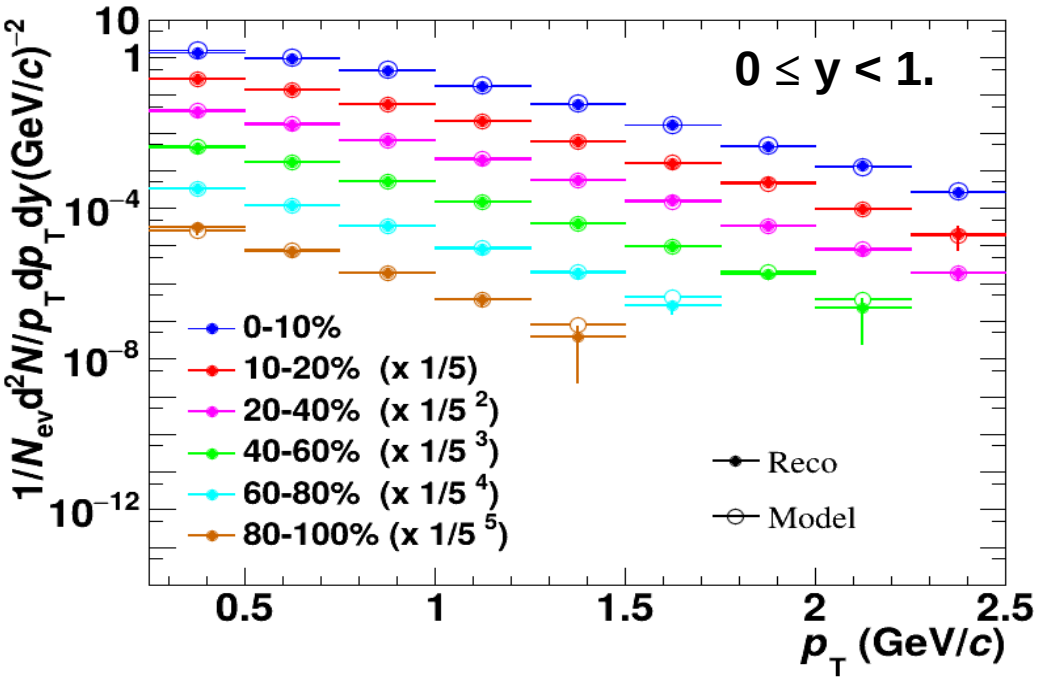








Invariant p_T -spectrum of Λ in all Centrality Bins



- Λ spectra comparison in 0 ≤ y < 1.
- Good agreement in central events
- Analysis in high p_T at peripheral events is limited for this data set

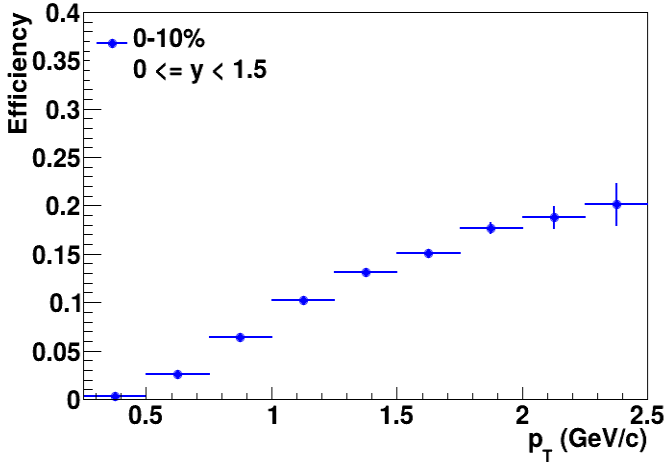
Summary

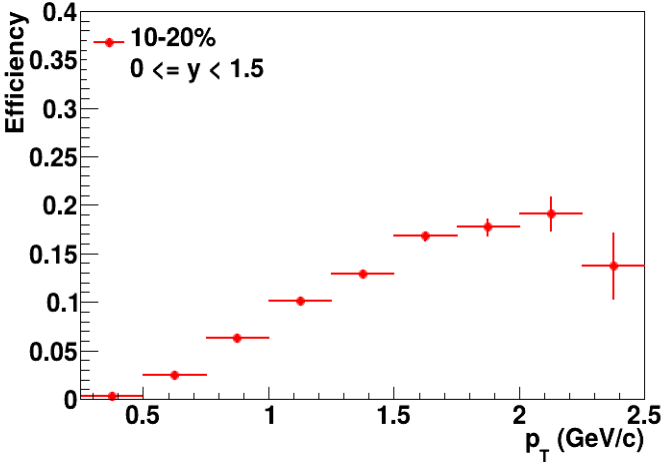
- **The MPD detector shows good performance in FXT mode for reconstructing Λ hyperons**
- **Invariant mass and p_T spectra are reliably reconstructed, showing agreement with generated distributions**
- **These results confirm the feasibility of hyperon studies in MPD/FXT**

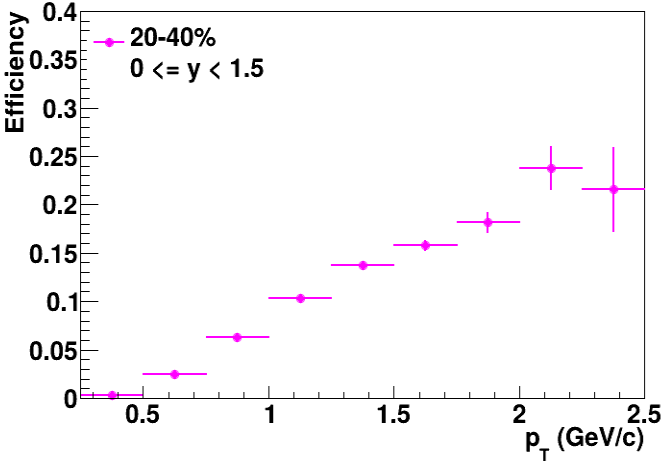
Thank you for your atetion!

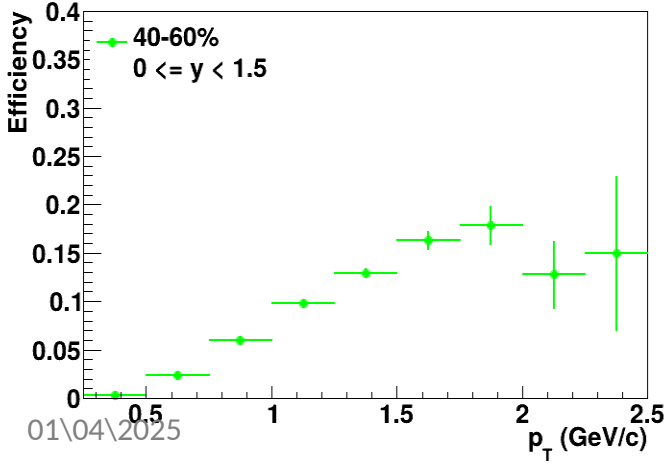
Some BackUp ….

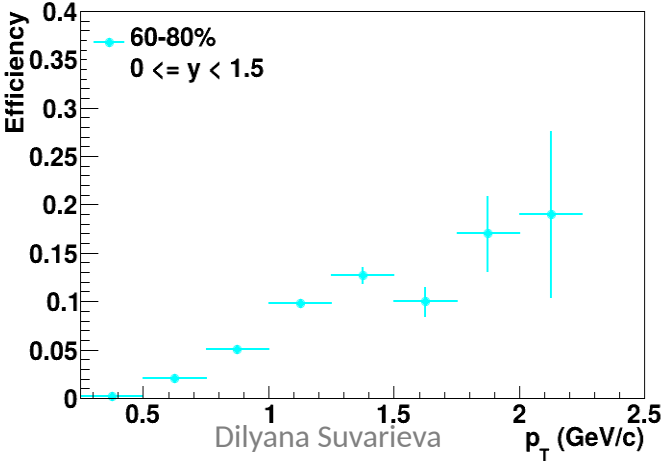
Efficiency of Λ Reconstruction versus Transverse Momentum in Centrality Intervals

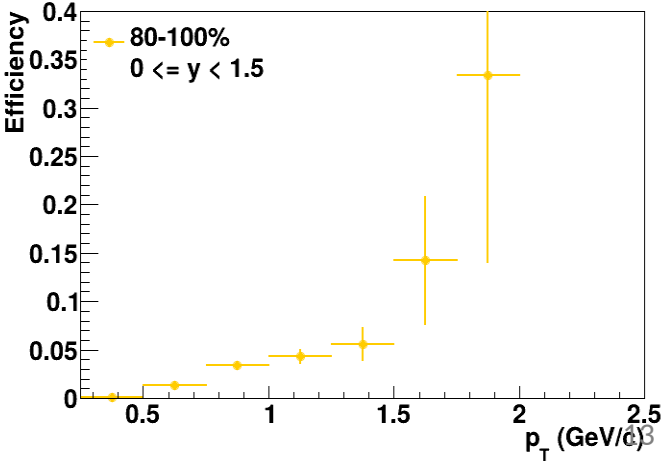




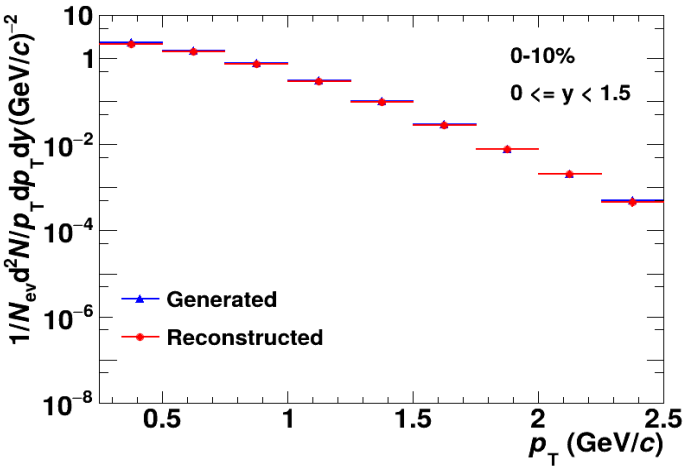


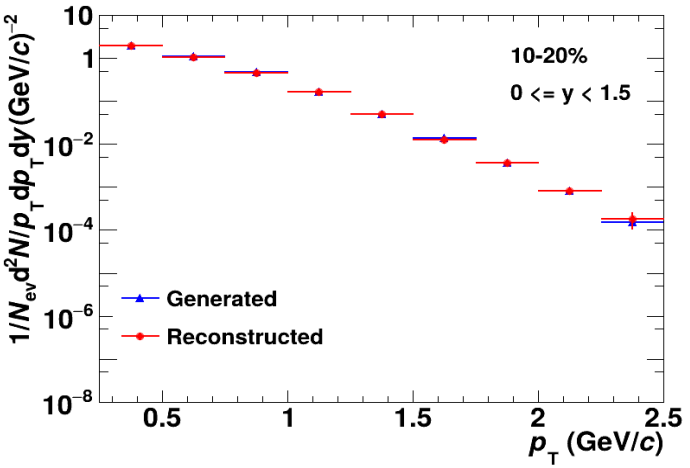


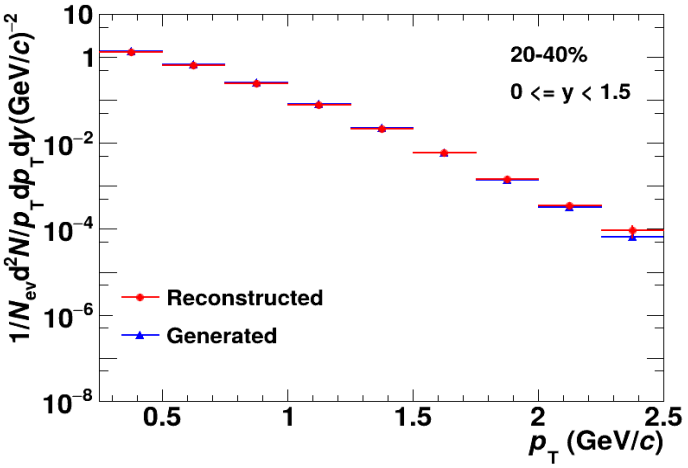


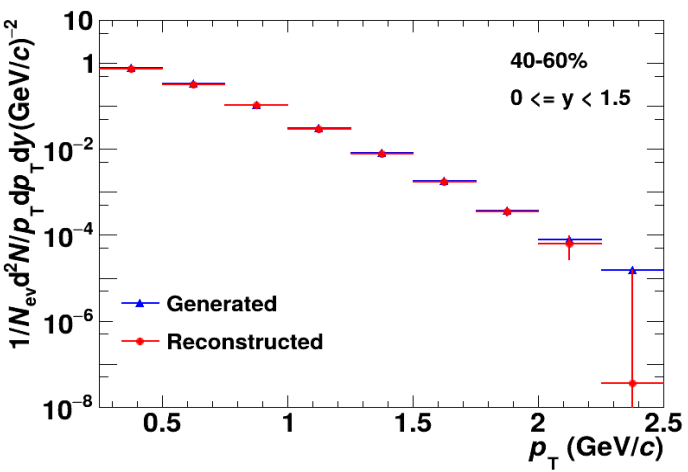


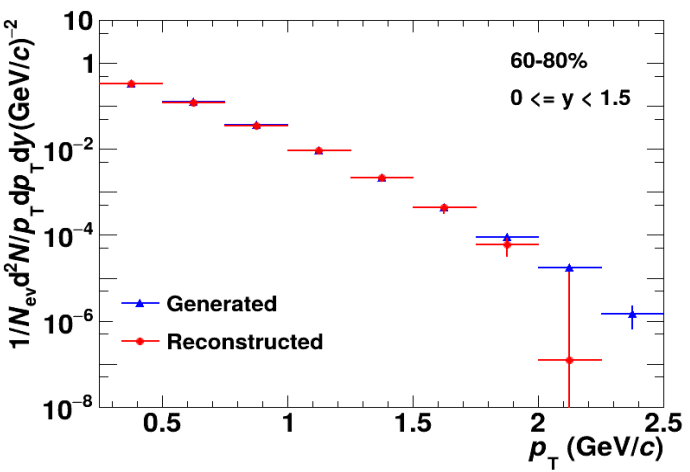
Invariant p_T -spectrum of Λ in Centrality Bins

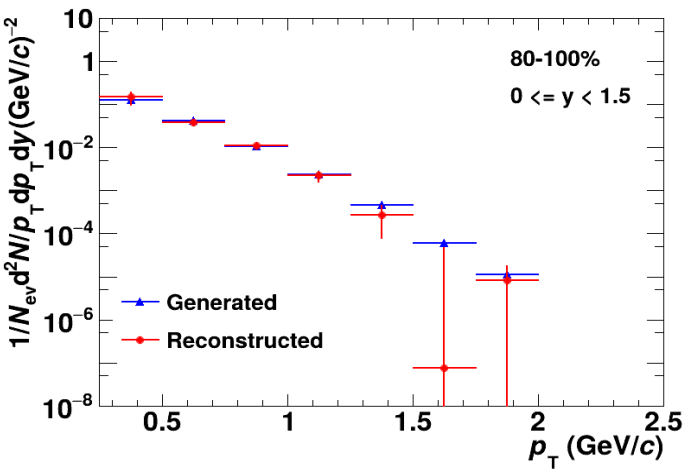




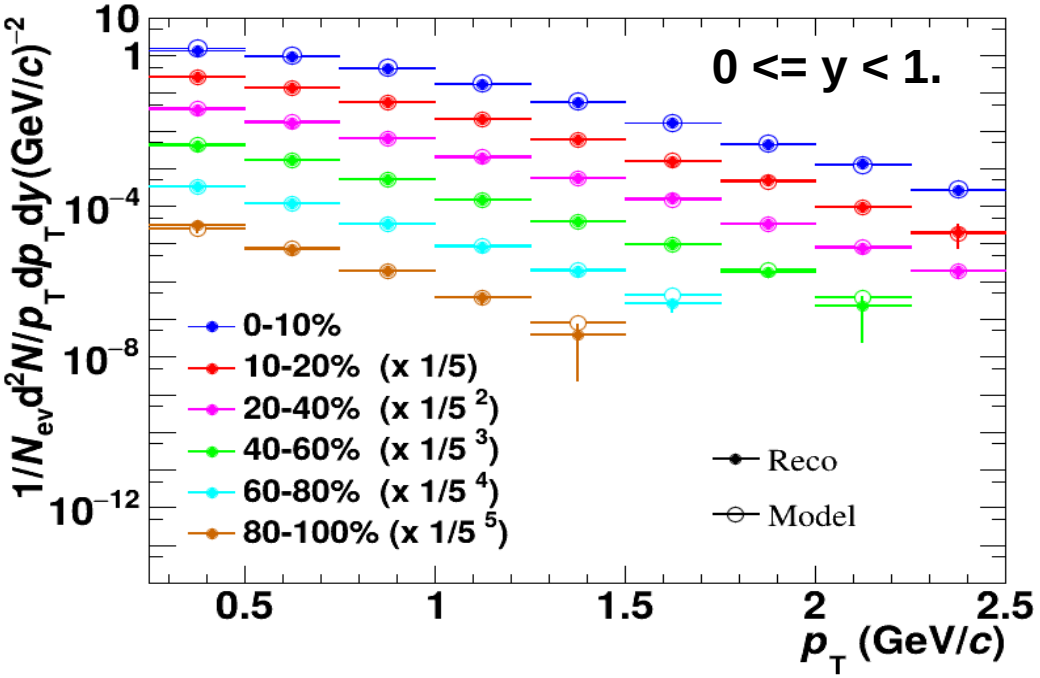


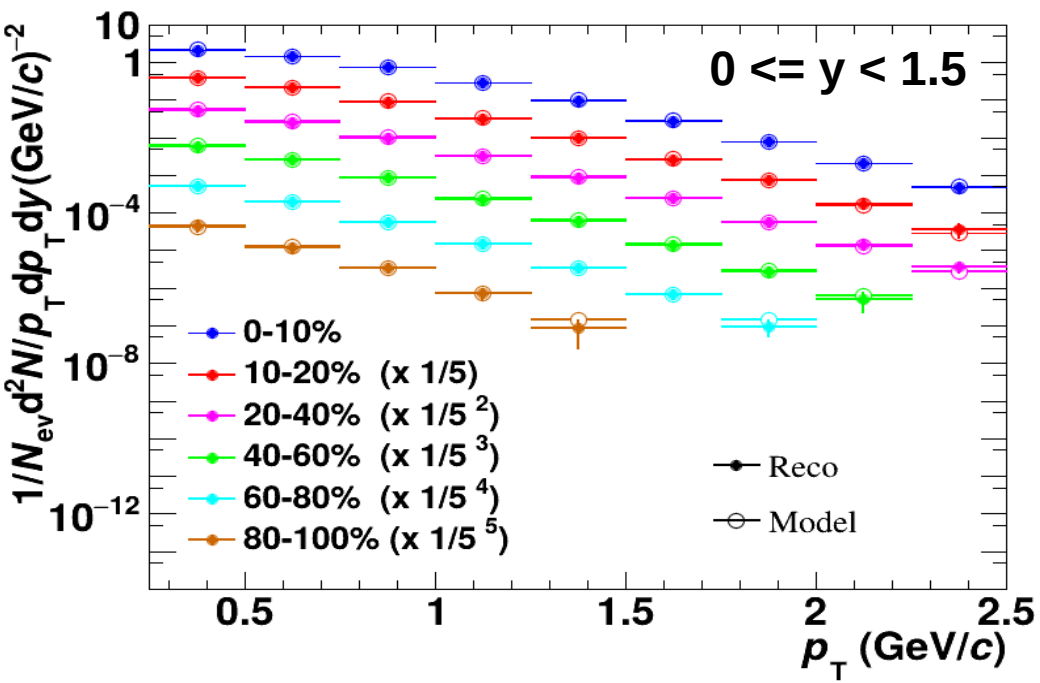




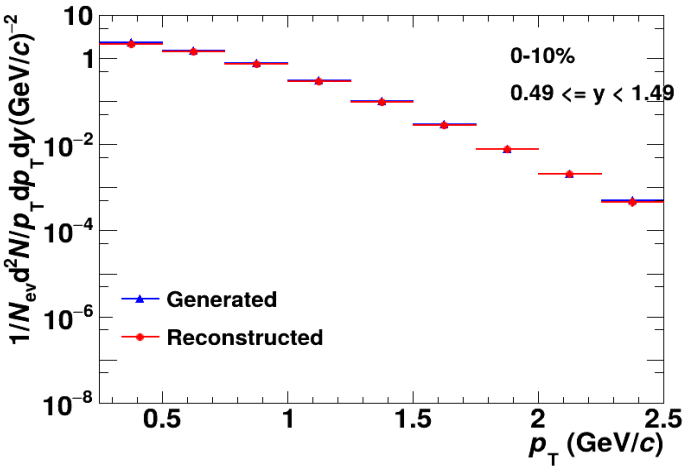


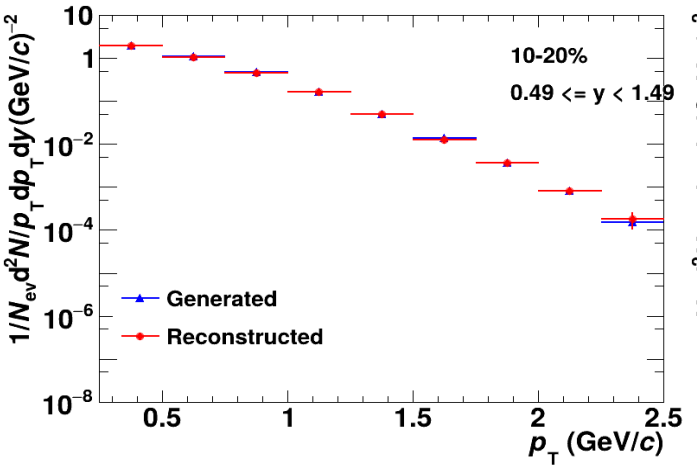
Invariant p_T -spectrum of Λ in all Centrality Bins

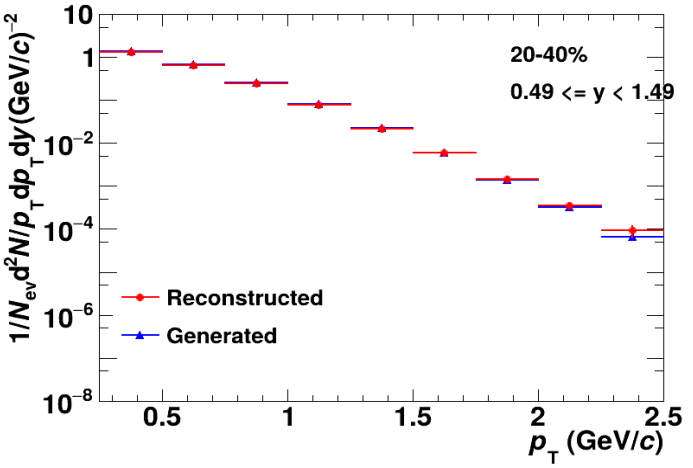


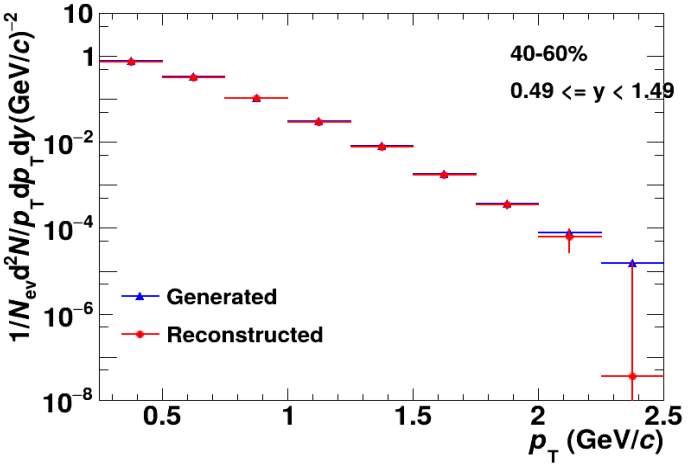


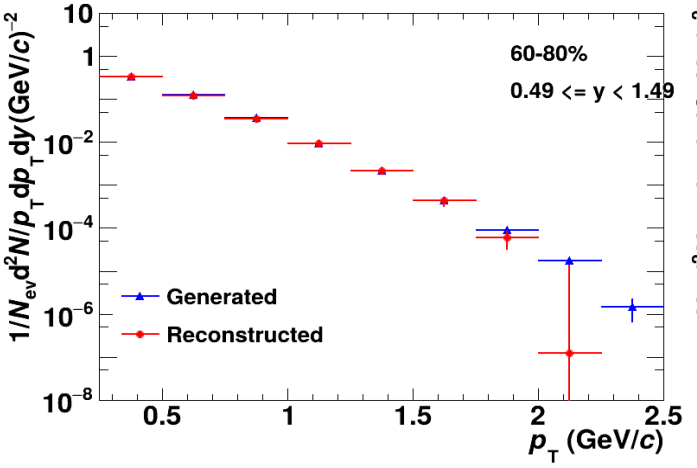
Invariant p_T -spectrum of Λ in Centrality Bins

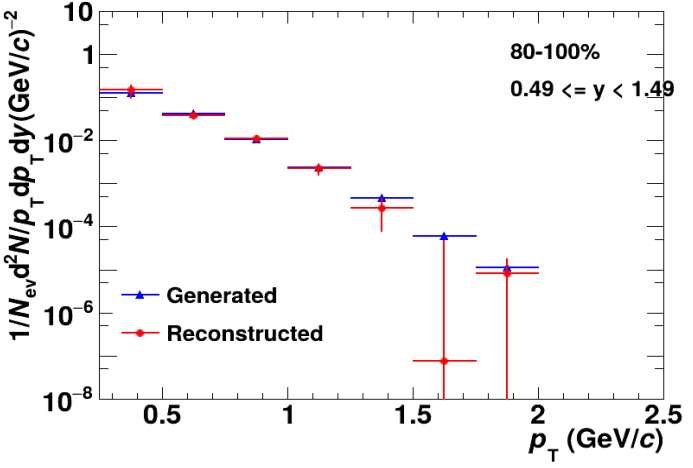












Invariant p_T -spectrum of Λ in all Centrality Bins