Reconstruction of $\Lambda\overline{\Lambda}$ pairs in $\bar{p} + A$ reactions

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Introduction

- Studied reaction $\bar{p} + A \rightarrow \Lambda\bar{\Lambda}$
- Close to production threshold:
  - Beam momentum 1.646 GeV/c

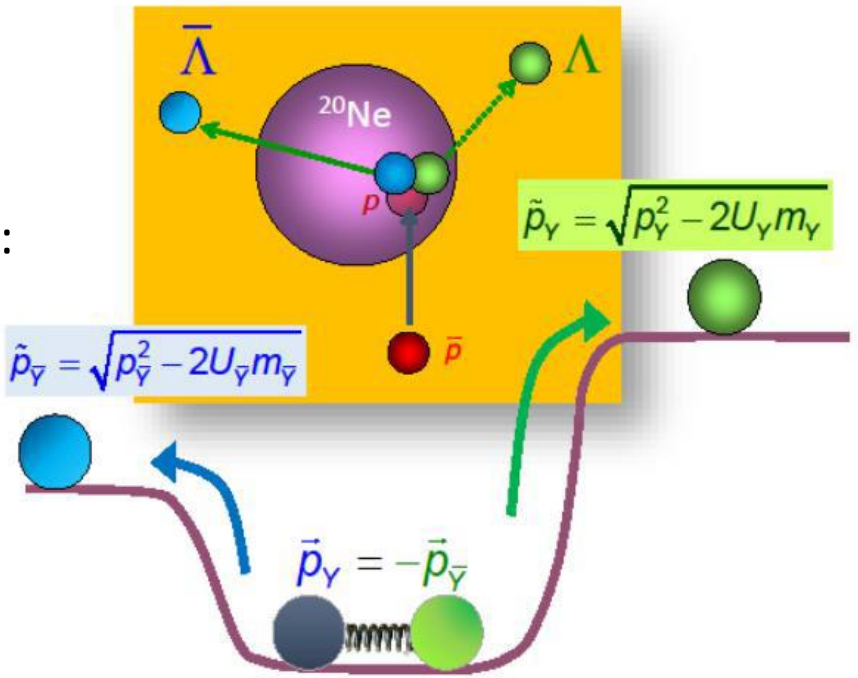
- $\Lambda\bar{\Lambda}$ momentum distributions modified by:
  - Fermi motion of nucleons
  - Nuclear (anti-)hyperon potential

- Define momentum asymmetry α:

$$\alpha = \frac{p_\Lambda - p_{\bar{\Lambda}}}{p_\Lambda + p_{\bar{\Lambda}}}$$

- If $m_{\bar{\Lambda}} \approx m_\Lambda \approx m$ and $U_{\bar{\Lambda}} \approx U_\Lambda \approx U$:

$$\Rightarrow \alpha \approx \frac{U_{\bar{\Lambda}} - U_\Lambda}{4E_{\mathrm{kin}}}$$



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GiBUU simulations

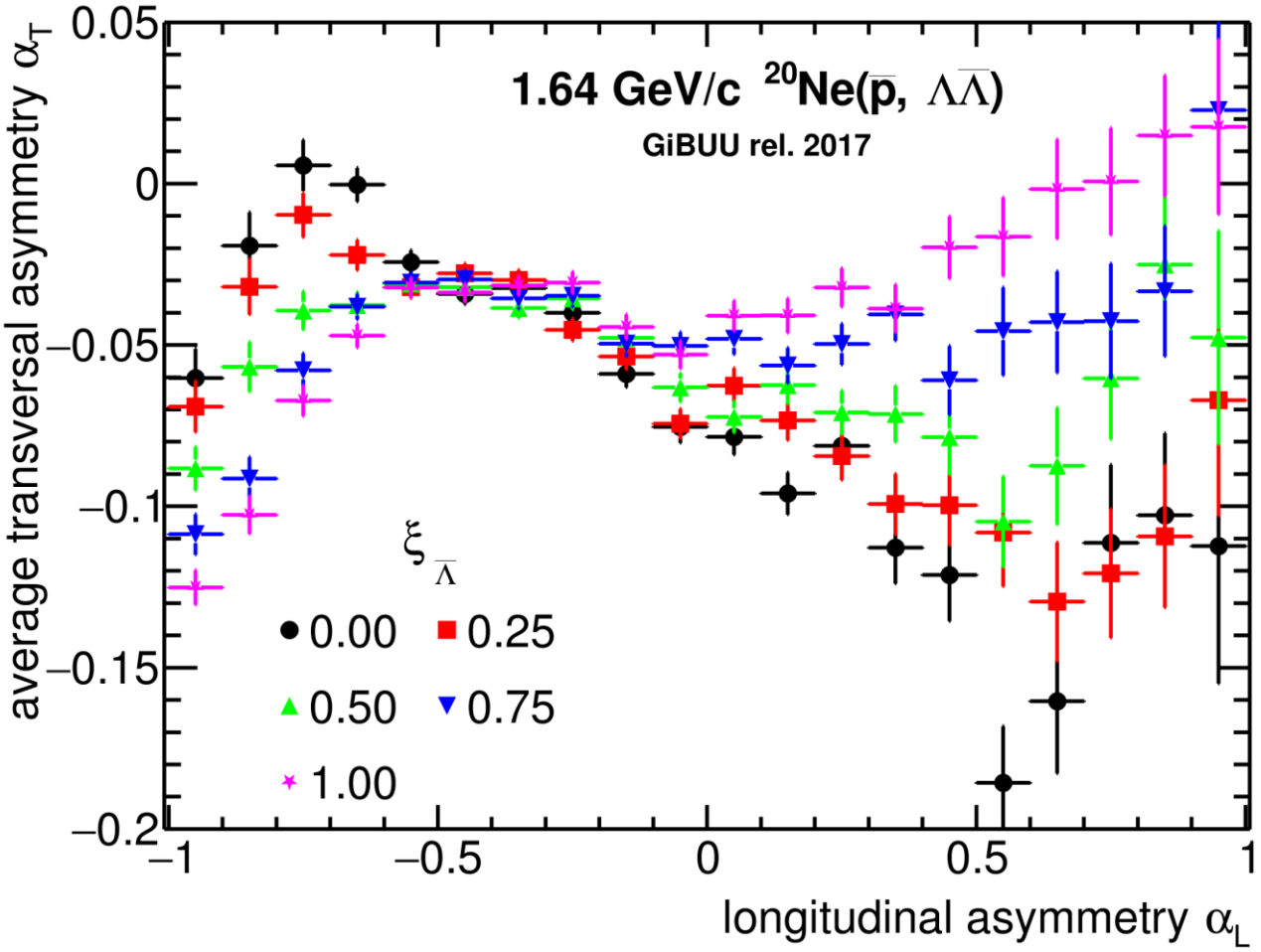
- Reaction simulated by GiBUU
  - Antihyperon potential modified by scaling factor $\xi_{\overline{\Lambda}}$
  - Several month of computation on Himster2 cluster

- Up to 10^9 events simulated for each potential

Momentum [GeV/c]	$\xi_{\overline{\Lambda}/\overline{\Xi}}$	# simulated events	#$\Lambda\overline{\Lambda}$ pairs	Effective PANDA time
1.64	0.0, 0.5, 0.75	$1.63 \cdot 10^8$	$\approx 70k$	11.2h
1.64	0.25, 1.0	$1.08 \cdot 10^9$	$\approx 500k$	74.6h
1.52	0.0, 0.25, 0.5, 0.75, 1.0	$1.35 \cdot 10^8$	$\approx 35k$	9.3h

- „Effective PANDA time“ = time required to achieve same statistics in PANDA

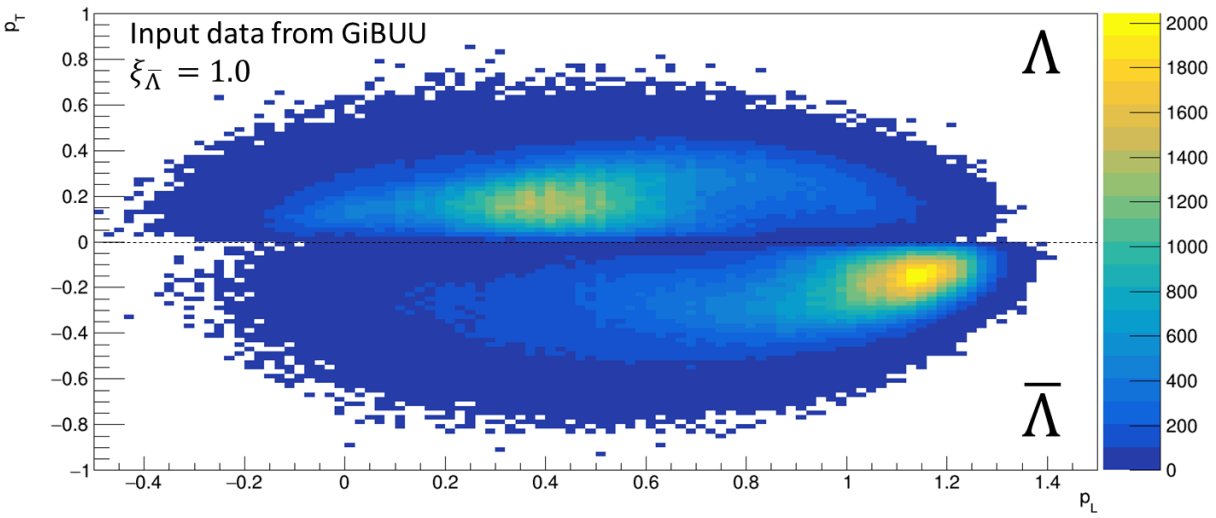
GiBUU results



- $\alpha = \frac{\tilde{p}_Y - \tilde{p}_Y}{\tilde{p}_Y + \tilde{p}_Y}$

- Same number of events used for each potential

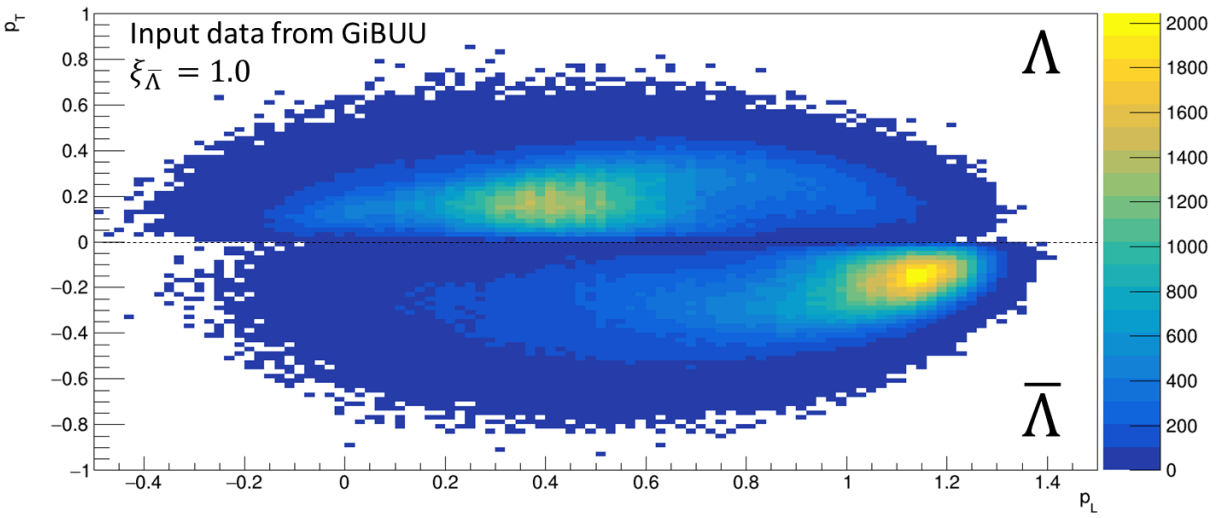
PandaRoot study

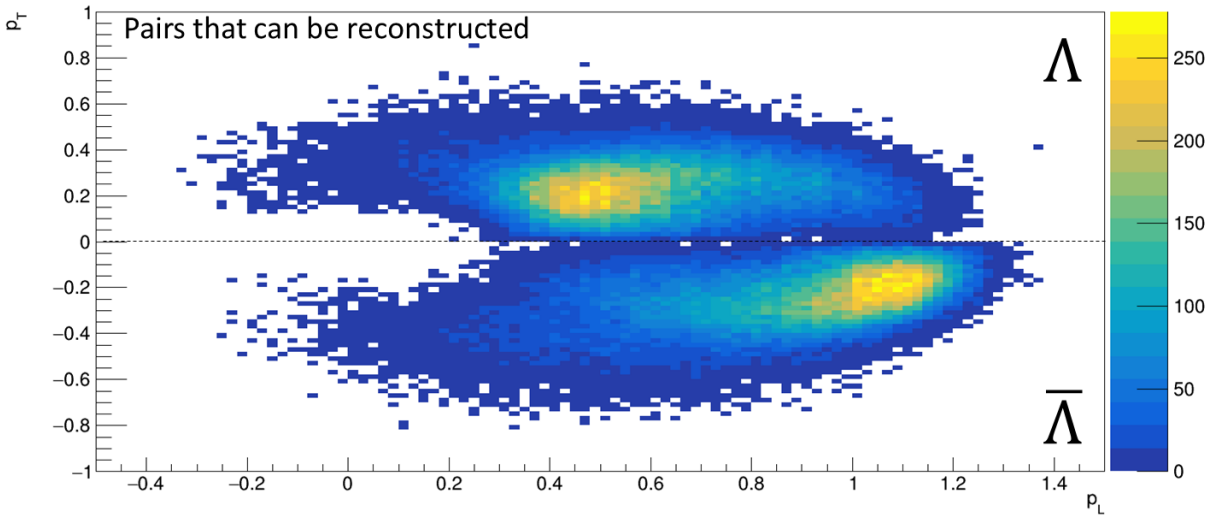


- Currently studying the reconstruction of GiBUU events in PANDA
  - Using PandaRoot v12.03 / FairSoft apr21p2 / FairRoot v18.6.7

  - Ideal pattern recognition
  - Ideal PID

Pair reconstruction





- Low momenta Λ and $\overline{\Lambda}$ difficult to reconstruct
- Pairs are missing where the Λ or $\overline{\Lambda}$ has low momentum
- Losing approximately 20% of pairs due to low momentum hyperon

Reconstruction efficiency

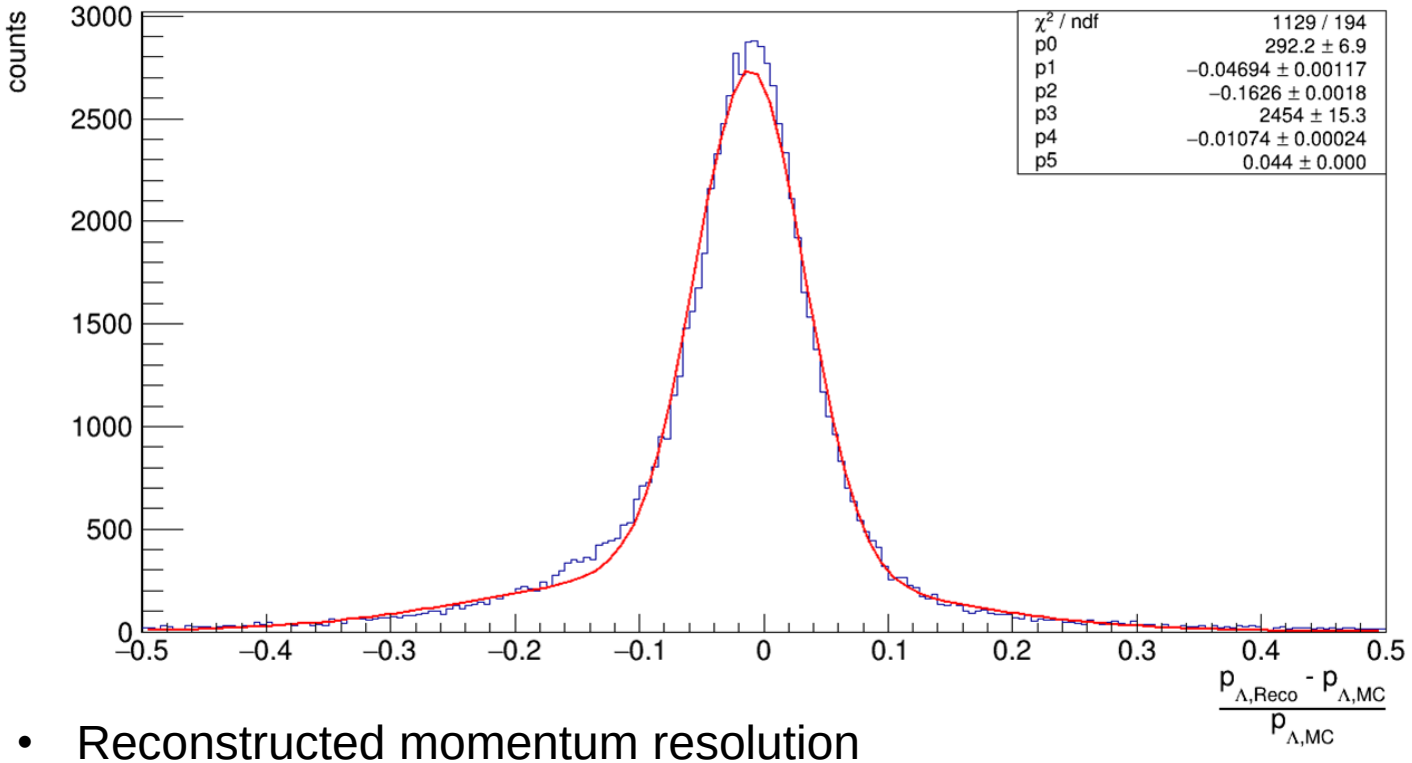
- Acceptance of final state particles
  - Monte-Carlo truth matching PDG code
  - Daughter of primary hyperon

	Acceptance
p	67,7%
π^-	69,1%
$\bar{p}$	82,5%
π^+	75,8%

	Efficiency	Purity
Λ	36,4%	89,2%
$\overline{\Lambda}$	46,5%	96,2%

- Hyperon reconstruction:
  - Combining proton and pion candidates
  - Simple mass cut
  - Use best candidate after vertex fit
  - Candidate must also pass mass fits

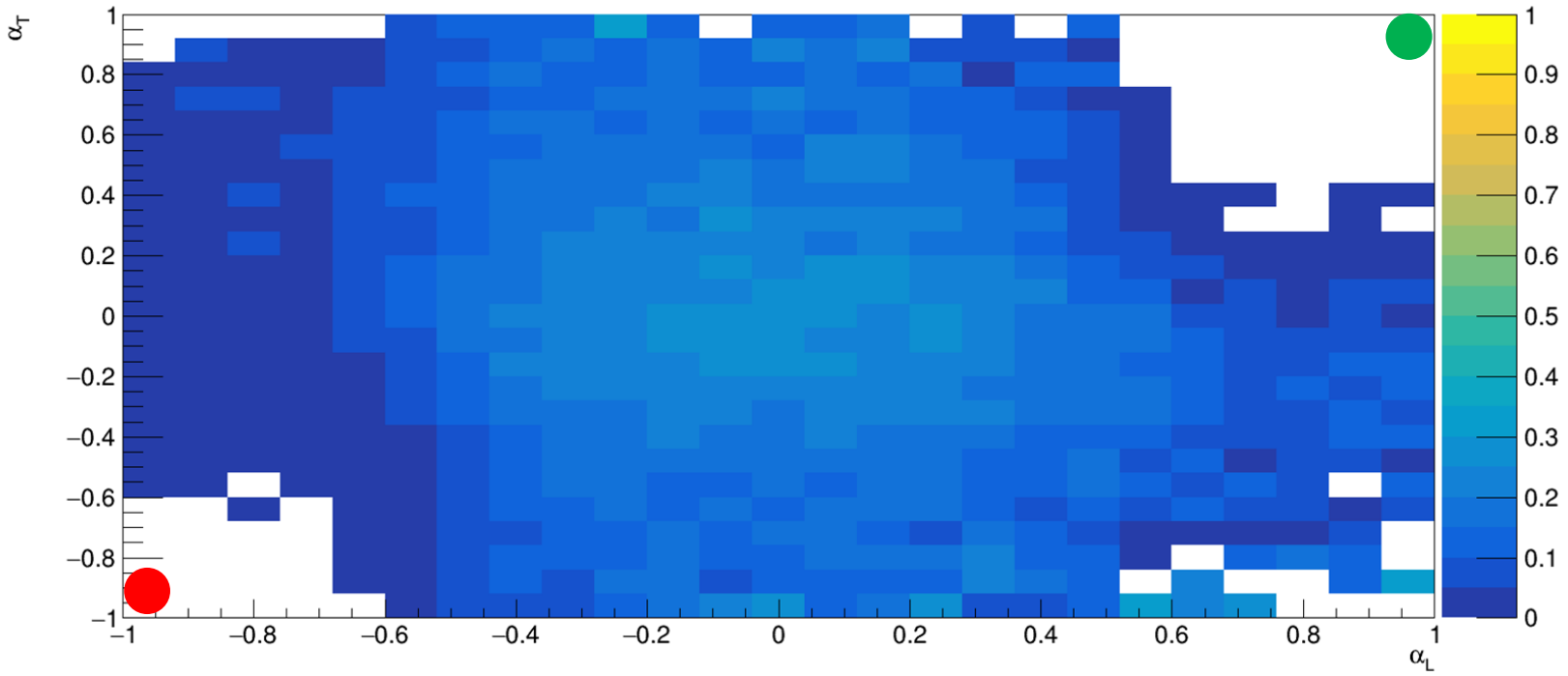
Momentum resolution



- Reconstructed momentum resolution
- No four-momentum constraint possible

$$\left[\frac{\Delta p}{p}\right]_{\Lambda} = \left[\frac{\Delta p}{p}\right]_{\bar{\Lambda}} = 4.4\%$$

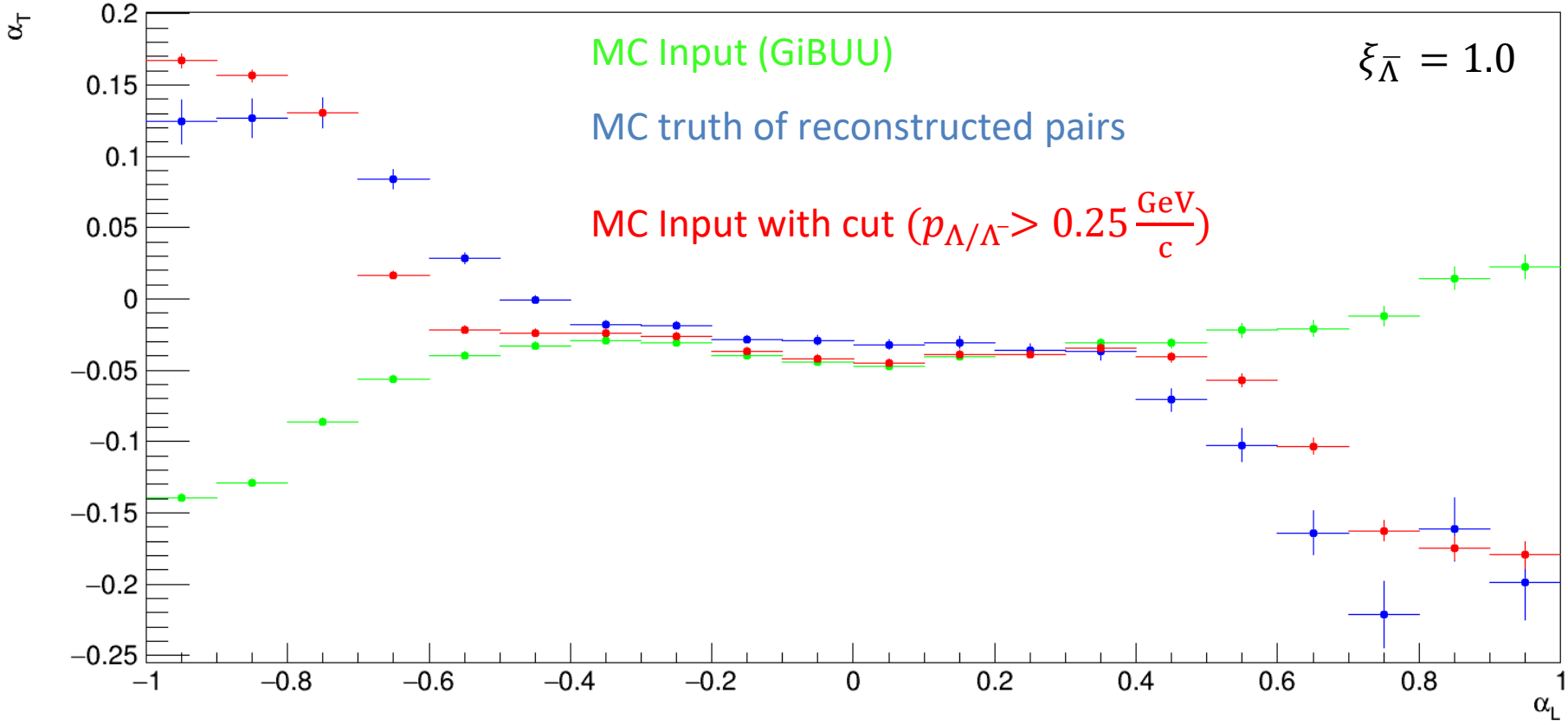
(compared to J. Pütz: $\sim 1.6\%$ but $\bar{p}A$ vs $\bar{p}p$)



- Reconstruction efficiency strongly depends on asymmetry

- Poor reconstruction efficiency for high or low longitudinal asymmetries
  - Asymmetries (+1,+1) and (−1,−1)

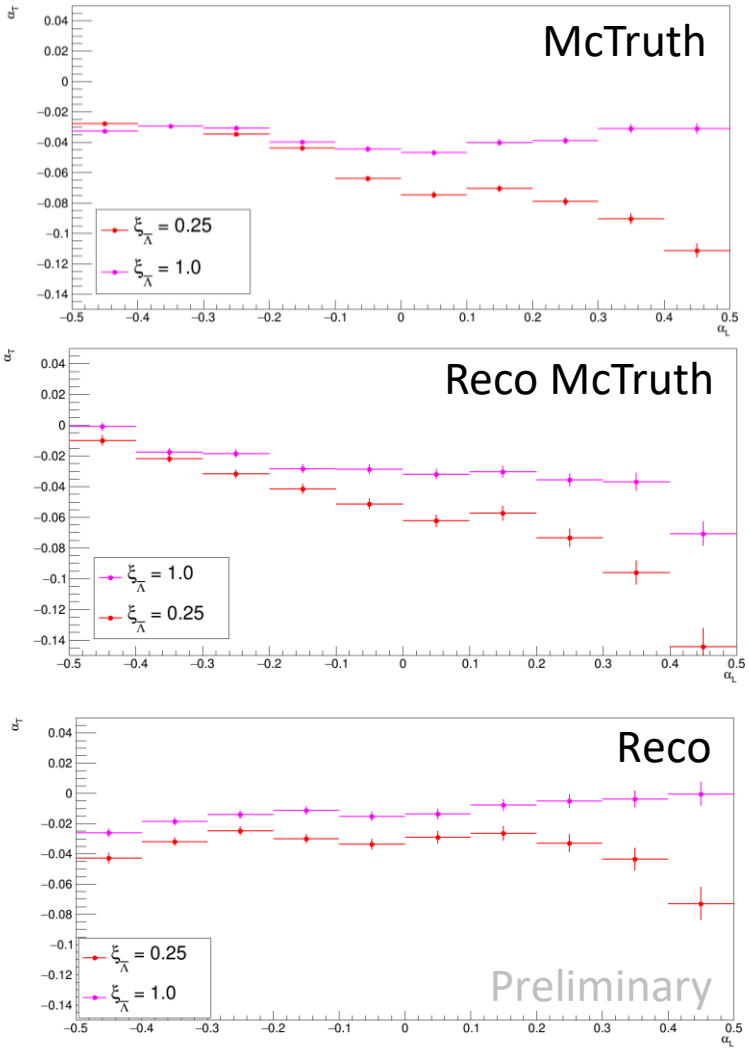
$$\Rightarrow p_\Lambda = 0 \text{ or } p_{\bar{\Lambda}} = 0$$



- Different behavior of GiBUU data (green) and reconstructed pairs (blue) observed
- Can be understood by simple momentum cut on the GiBUU data (p>0.25 GeV/c) (red)

- In the region of $\alpha_L = [-0.2; 0.4]$
  - Best reconstruction efficiency
  - Different potentials can be distinguished

- High sensitivity remains



Summary and Outlook

- Major effort was made to simulate sufficient statistics with GiBUU
- Event reconstruction in PANDA looks promising
  - Asymmetry remains sensitive to antihyperon potential
  - Understood asymmetry profile distortion due to efficiencies
- Recently started with background study
  - Using GiBUU background events
  - 10 million events simulated so far waiting for analysis
- Since the asymmetry is strongly affected by efficiencies, maybe better observables are available
  - Work in progress

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