

Extraction of Single and Double Differential Cross-Sections on Argon for CC1 μ 2p0 π Event Topologies in the SBND

Emilio Peláez Cisneros

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Abstract

The precise measurement of cross-sections for a variety of interactions is critical to the success of upcoming flagship neutrino experiments. Of special interest are neutrino interactions that leave the nucleus in a 2-particle 2-hole state (2p2h). This note will present cross-section measurements for the production of 2p2h states on Argon. Using SBND data collected from the **period** of operation, we select events corresponding to a charged-current ν_μ interaction that left the Argon nucleus in a 2p2h state. These interactions produce a topology with one muon and two protons in the final state (CC1 μ 2p0 π). This analysis targets both single differential and double differential cross-section measurements for CC1 μ 2p0 π event topologies in a variety of kinematic variables. Comparisons are made to a set of theoretical models that explore different cross-section modeling configurations. Code for this analysis is available on [GitHub](#).

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1 Introduction and motivation

2 Since many current and next generation neutrino oscillation experiments will utilize dense nuclear targets,
3 such as liquid argon (LAr), it is critical to characterize the impact of nuclear effects on neutrino cross-sections.
4 One area of interest are neutrino events that eject 2 nucleons from the nucleus, leaving it with 2 holes: known
5 as 2-particle 2-hole states (2p2h). The general picture is that the neutrino has a charged-current interaction
6 with a neutron in the nucleus, producing a proton with significant momentum; this proton interacts with
7 another proton, producing the 2p2h state. While the majority of 2p2h states are caused by Meson Exchange
8 Currents (MEC) [15], some nuclear effects, such as Short-Range Nucleon-Nucleon correlations (SRC) [10],
9 can also produce these states. In an accelerator-based liquid argon time projection chamber (LArTPC)
10 experiment, such as SBND, a charged-current (CC) muon neutrino (ν_μ) interaction that results in a 2p2h
11 state would have a final state topology of 1 muon, 2 protons, and no charged or neutral pions. While
12 there are existing measurements of CC1 μ 2p0 π events on argon, the analyses were statistically limited and
13 no cross-sections were extracted [1, 19]. There was a previous report with single differential cross-section
14 measurements from the MicroBooNE detector [20], but this document presents the first double differential
15 cross-section measurements of CC1 μ 2p0 π topologies on argon, using data collected from the period of SBND
16 operations.

17 2 Generator analysis

18 2.1 Signal definition

19 We choose charged-current muon neutrino interactions that result in one muon, two protons, no charged pions
20 with $P_\pi > 70$ MeV/c, no neutral pions or heavier mesons, and any number of neutrons. These interactions
21 are denoted as CC1 μ 2p0 π . We require the momentum of the muon and protons to be in the following ranges
22 (in MeV/c):

$$100 < P_P < 1200 \quad 300 < P_\mu < 1000 \quad (1)$$

23 2.2 Generators

24 The following generators are used to create events, which are then discriminated using the signal definition
25 above: NuWro, GiBUU, NEUT, GENIE G18, GENIE AR23. Information about these generators is
26 summarized in Table 1.

Name	Generator/Configuration
G18	GENIE v3.0.6 G18_10a_02_11a
AR23	G18 with SuSAv2 MEC model
NuWro	NuWro 19.02.1
NEUT	NEUT v5.4.0
GiBUU	GiBUU 2021

Table 1: Generator and configuration data.

27 The GENIE configurations we used are:

- 28 (i) GENIE G18 [2, 3]: This modern model configuration uses the local Fermi gas (LFG) model [9],
29 the Nieves CCQE scattering prescription [23], which includes Coulomb corrections for the outgoing
30 muon [11], and random phase approximation (RPA) corrections [22]. Additionally, it uses the
31 Nieves MEC model [25], the KuzminLyubushkin-Naumov Berger-Sehgal RES [6, 28, 16], Berger-Sehgal
32 COH [7] and Bodek-Yang DIS [29] scattering models with the PYTHIA [26] hadronization part, and
33 the hA2018 FSI model [4].
- 34 (ii) GENIE AR23: Same as the G18 model configuration but using the SuSAv2 MEC model.

35 The alternative event generators are:

- 36 (i) NuWro [12]: Includes the LFG model [9], the Llewellyn Smith model for QE events [18], the Nieves
37 model for MEC events [24], the AdlerRarita-Schwinger formalism to calculate the Δ resonance explicitly [13],
38 the Berger-Sehgal (BS) COH [7] scattering model, an intranuclear cascade model for FSI [24],
39 and a coupling to PYTHIA [26] for hadronization.
- 40 (ii) NEUT [14]: Corresponds to the combination of the LFG model [8, 9], the Nieves CCQE scattering
41 prescription [23], the Nieves MEC model using a lookup table [25], the Berger Sehgal RES [6, 13, 5]
42 and BS COH [7] scattering models, FSI with medium corrections for pions [2, 3], and PYTHIA [26]
43 purposes.
- 44 (iii) GiBUU [21]: Uses similar models to GENIE, but they are implemented in a coherent way by solving
45 the Boltzmann-Uehling-Uhlenbeck transport equation [21]. The modeling includes the LFG model [9],
46 a standard CCQE expression [17], an empirical MEC model, and a dedicated spin dependent resonance
47 amplitude calculation following the MAID analysis [21]. The DIS model is from PYTHIA [26]. GiBUU's
48 FSI treatment propagates the hadrons through the residual nucleus in a nuclear potential consistent
49 with the initial state.

50 2.3 Variables definition

51 Given the momentum vectors for the leading proton \vec{p}_L , recoil proton \vec{p}_R , and muon \vec{p}_μ , we define several
52 variables. First, we define the momenta and opening angle of each variable, denoted as $|\vec{p}|$ and $\cos(\theta_{\vec{p}})$, with
53 the appropriate index for each momentum vector. These variables are plotted in Figure 1.

54 We also define variables relating the multiple momentum vectors. First, the opening angle between the
55 protons in the lab frame, given by

$$\cos(\theta_{\vec{p}_L, \vec{p}_R}) = \frac{\vec{p}_L \cdot \vec{p}_R}{|\vec{p}_L| |\vec{p}_R|}. \quad (2)$$

56 Then, the opening angle between the total proton momentum ($\vec{p}_{\text{sum}} = \vec{p}_L + \vec{p}_R$) and the muon, given by

$$\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}}) = \frac{\vec{p}_\mu \cdot \vec{p}_{\text{sum}}}{|\vec{p}_\mu| |\vec{p}_{\text{sum}}|}. \quad (3)$$

57 The momentum transverse to the direction of the neutrino beam, which we denote $\delta\vec{P}_T$ and is given by

$$\delta\vec{P}_T = \vec{p}_T^\mu + \vec{p}_T^L + \vec{p}_T^R. \quad (4)$$

58 For the transverse momentum, we will be interested in its magnitude $|\delta\vec{P}_T|$. Finally, the angular orientation
59 of the transverse momentum with respect to the transverse muon is defined as

$$\delta\alpha_T = \cos^{-1} \left(\frac{-\vec{p}_T^\mu \cdot \delta\vec{P}_T}{|\vec{p}_T^\mu| |\delta\vec{P}_T|} \right). \quad (5)$$

60 We plot the differential cross sections of these variables for the given generators in Figure 2. We can also
61 see the cross section by event type for all variables and all generators in Figures 3 to 12.

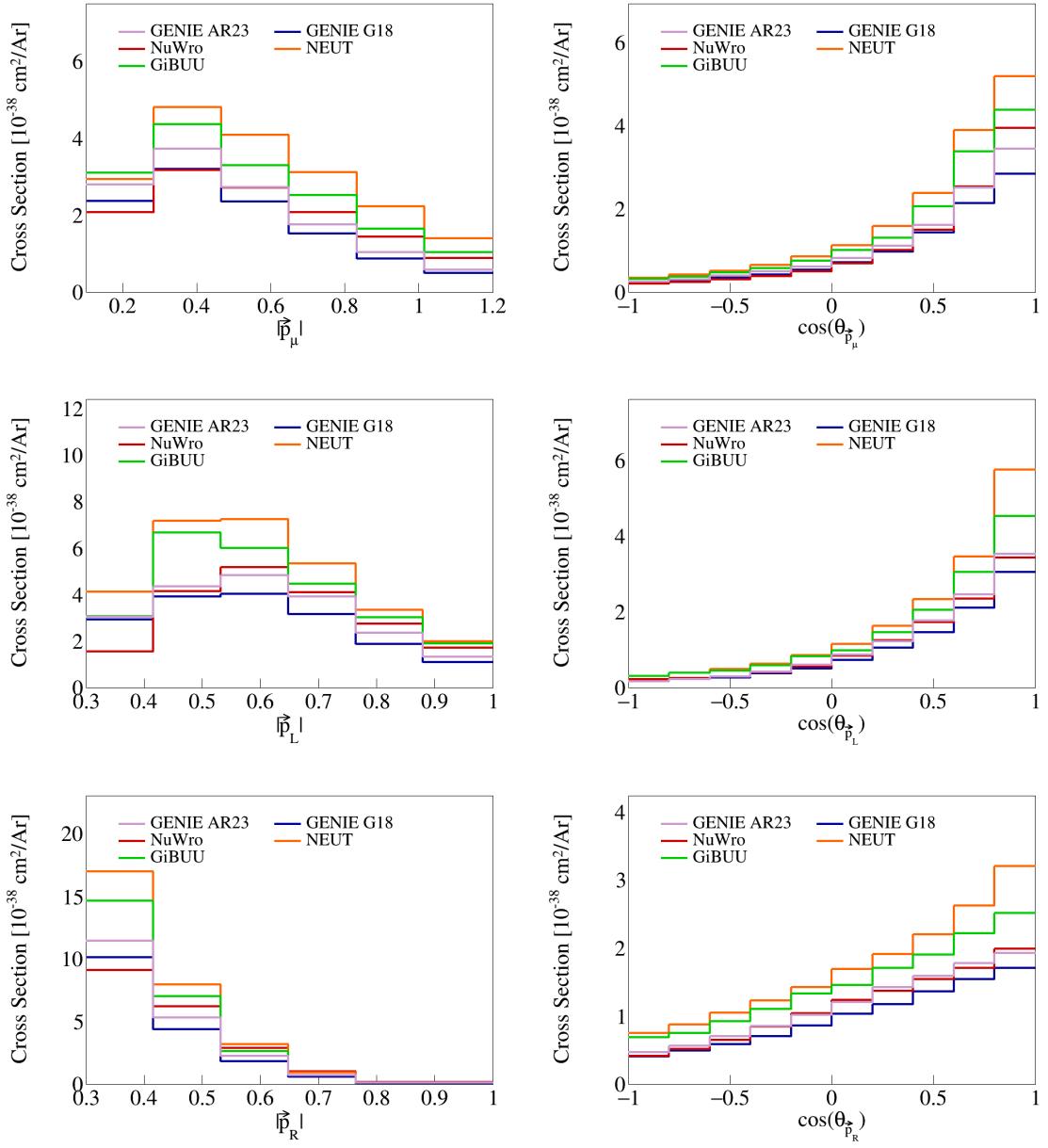


Figure 1: Cross sections for momentum and opening angles of individual particles.

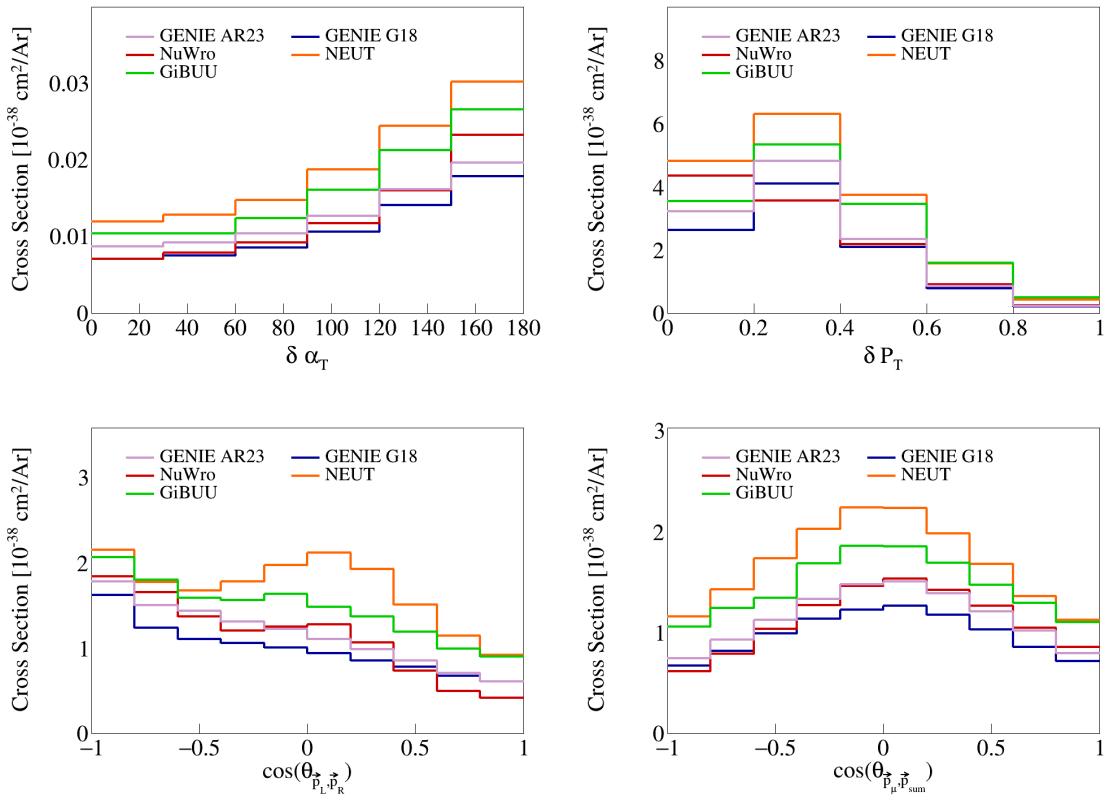


Figure 2: Cross sections for opening angles and transverse momentum.

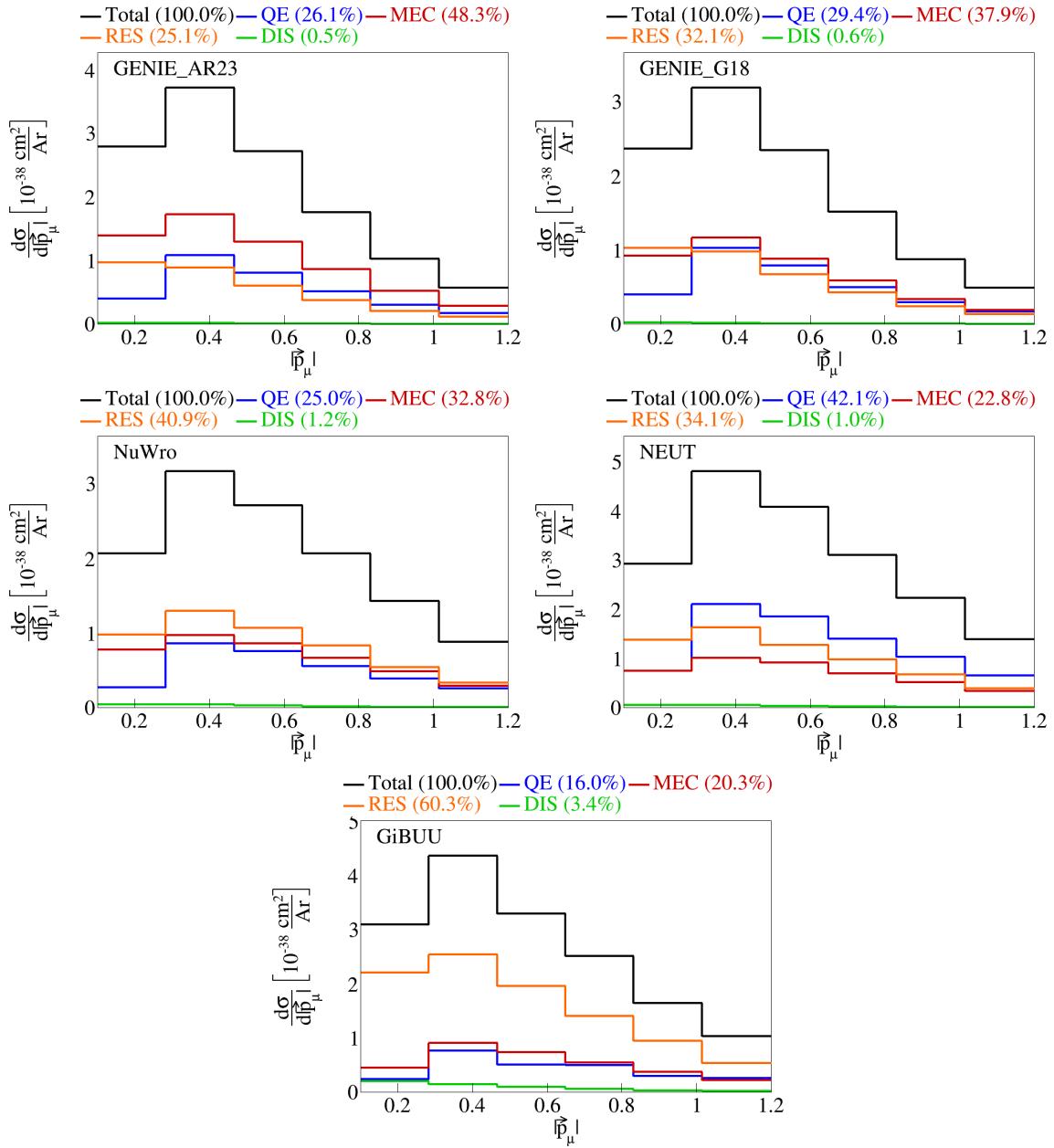


Figure 3: Event interaction breakdown for $|\vec{p}_\mu|$.

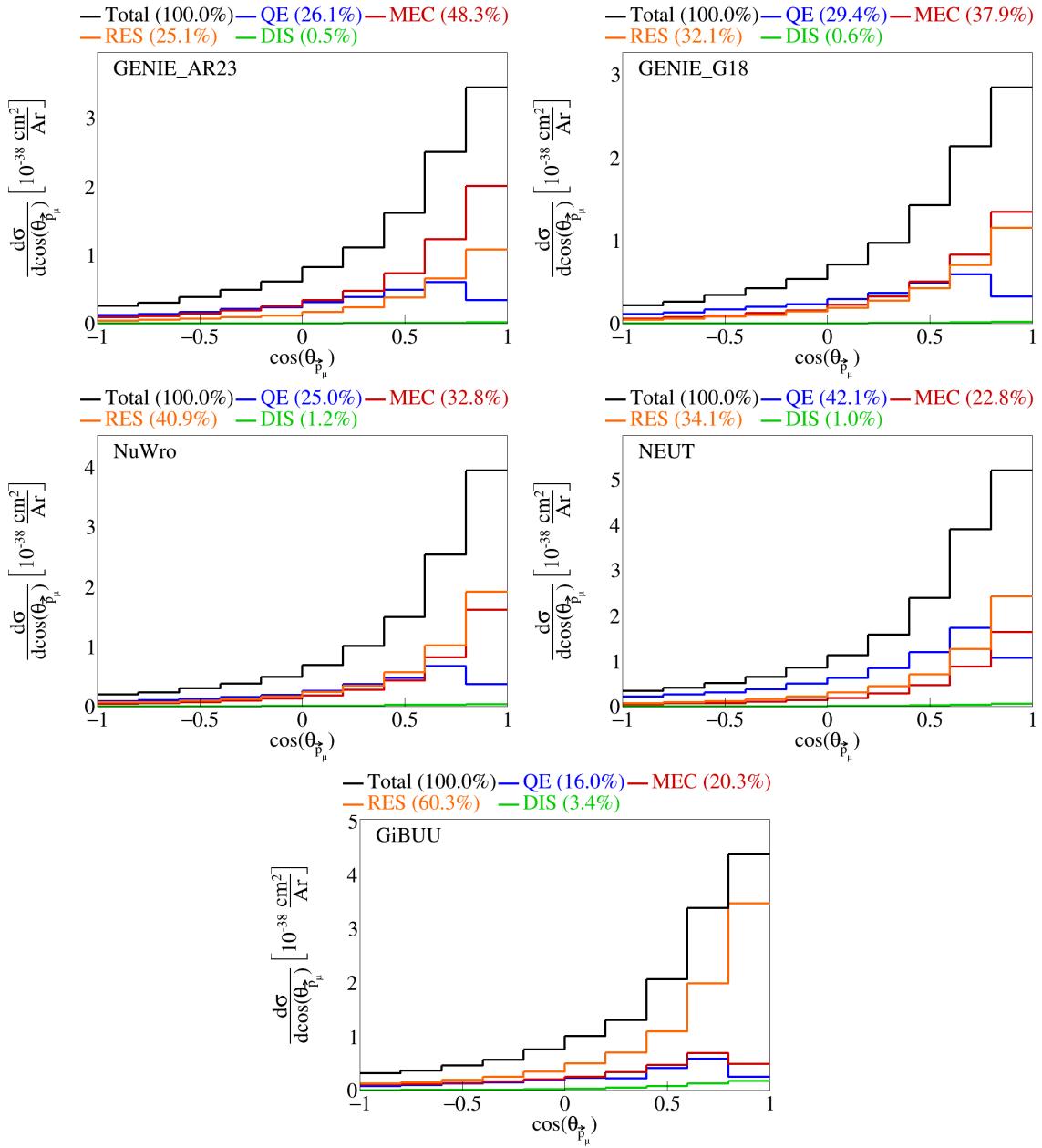


Figure 4: Event interaction breakdown for $\cos(\theta_{\vec{p}_\mu})$.

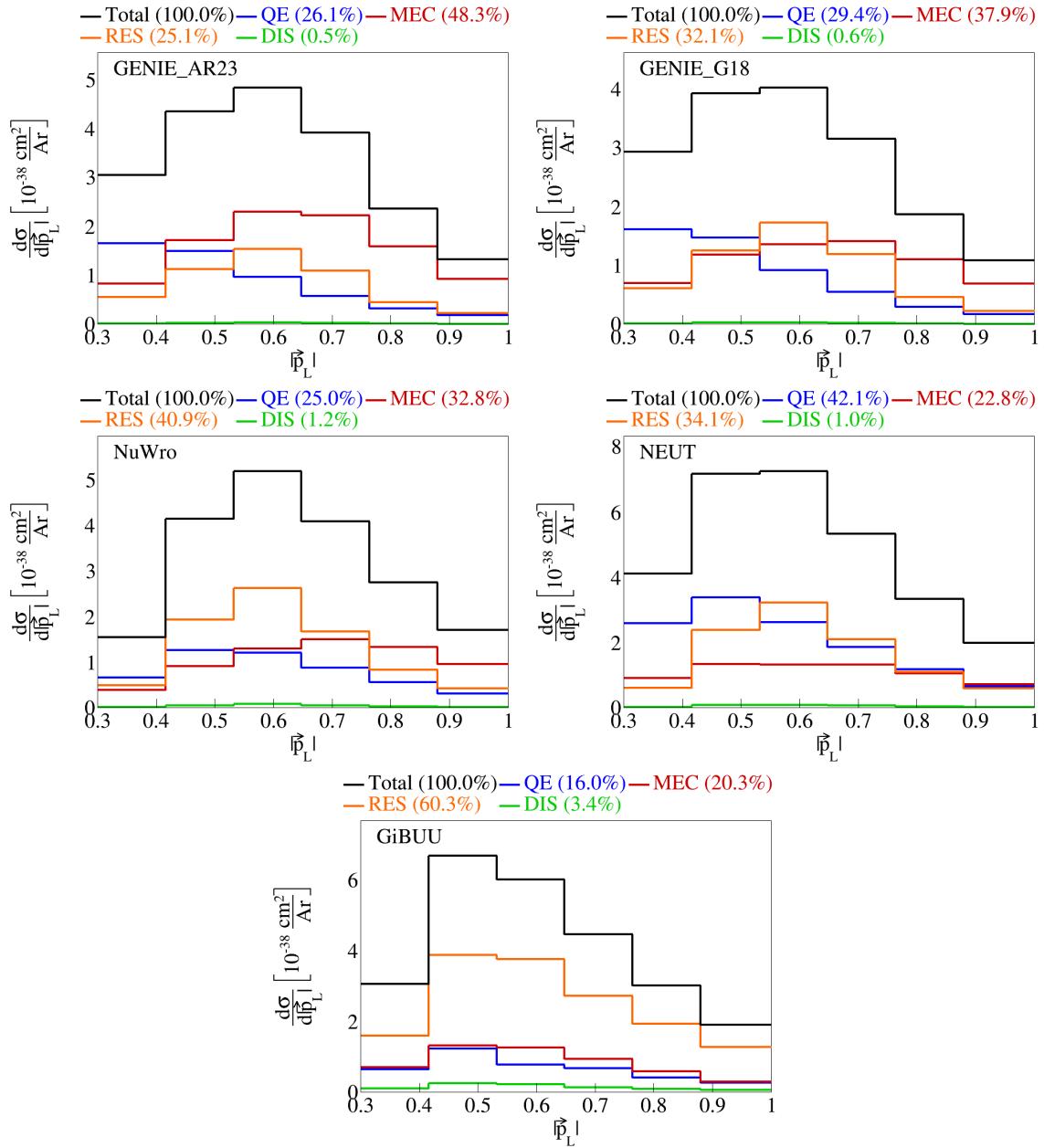


Figure 5: Event interaction breakdown for $|\vec{p}_L|$.

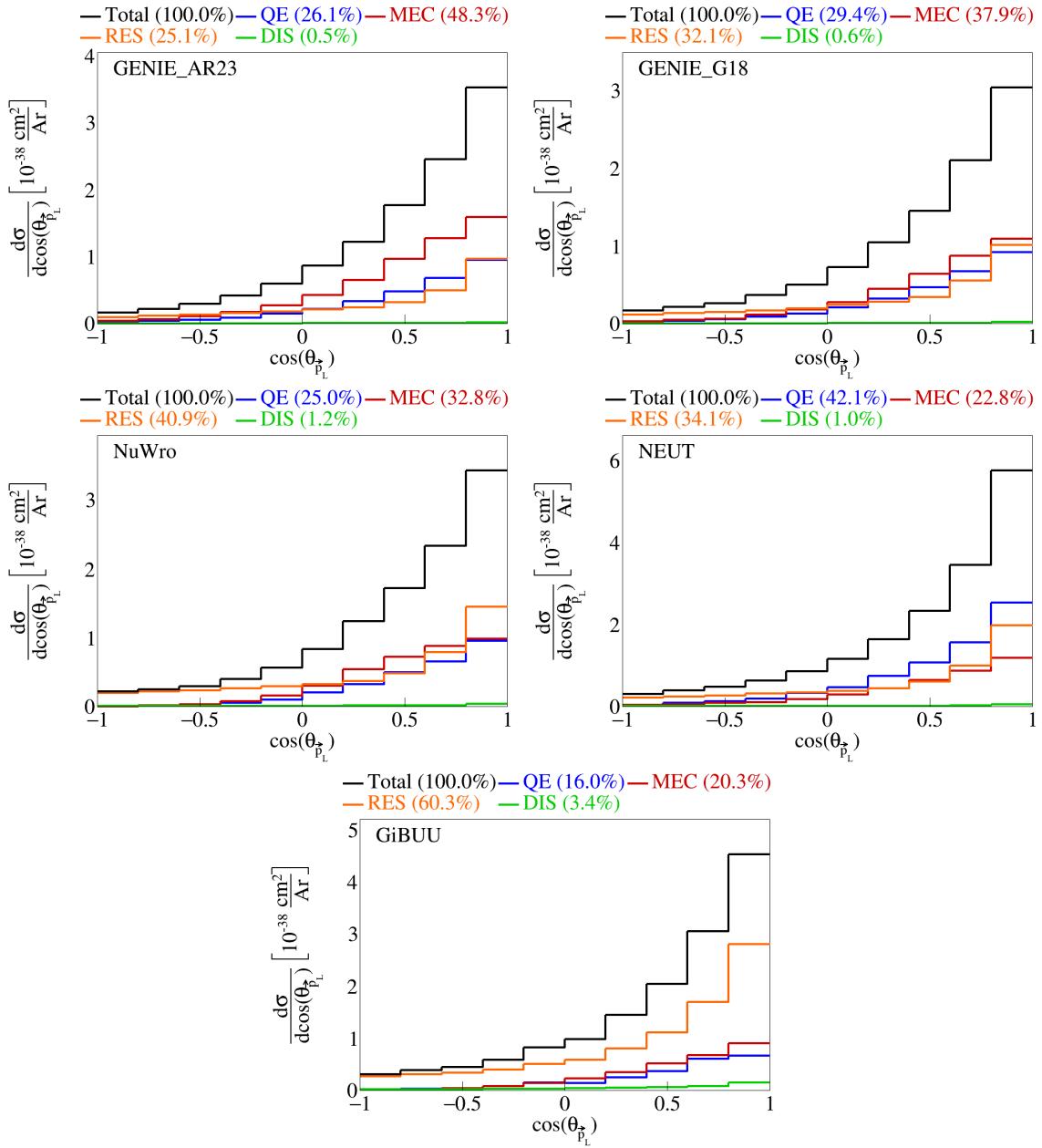


Figure 6: Event interaction breakdown for $\cos(\theta_{\vec{p}_L})$.

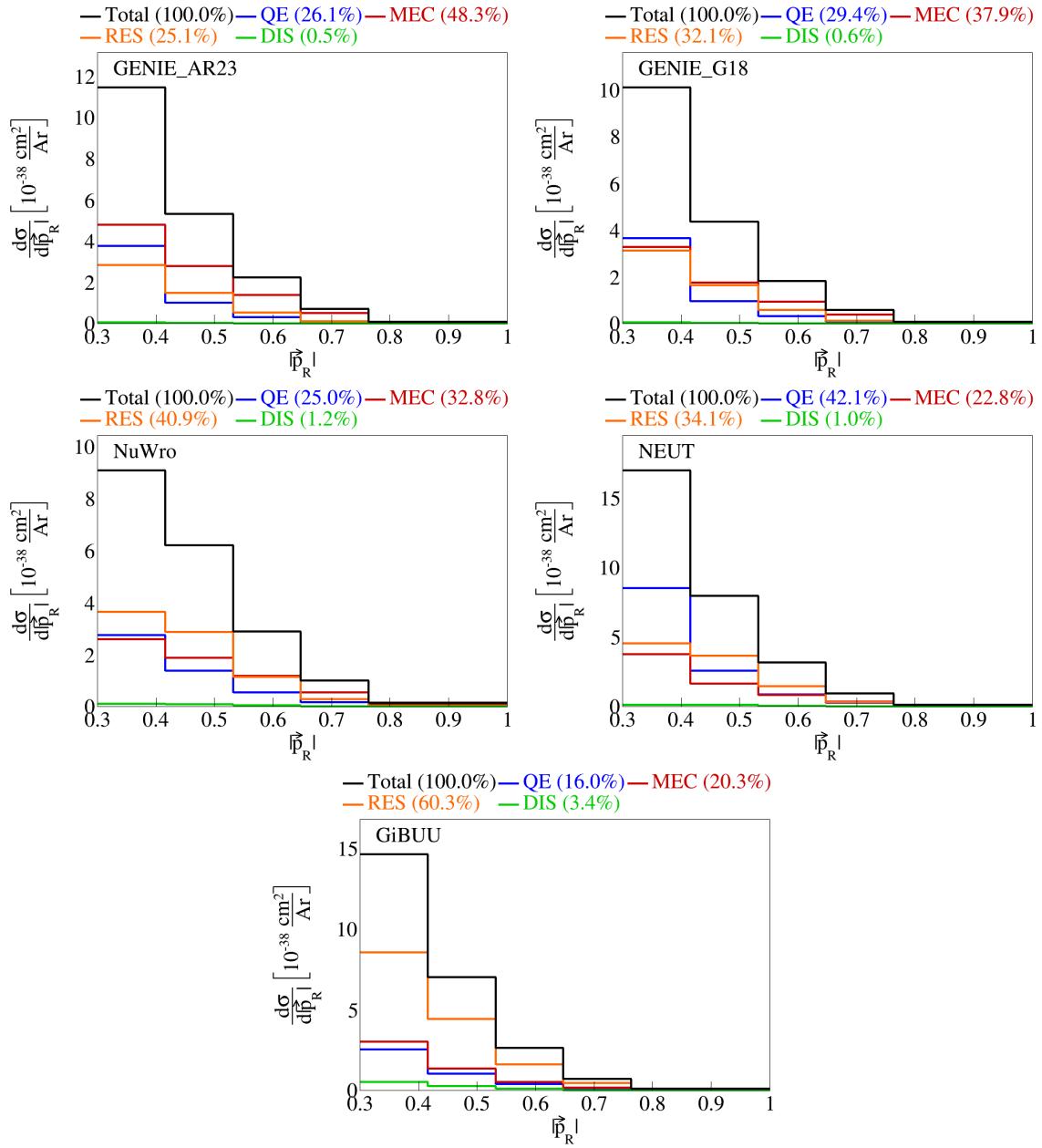


Figure 7: Event interaction breakdown for $|\vec{p}_R|$.

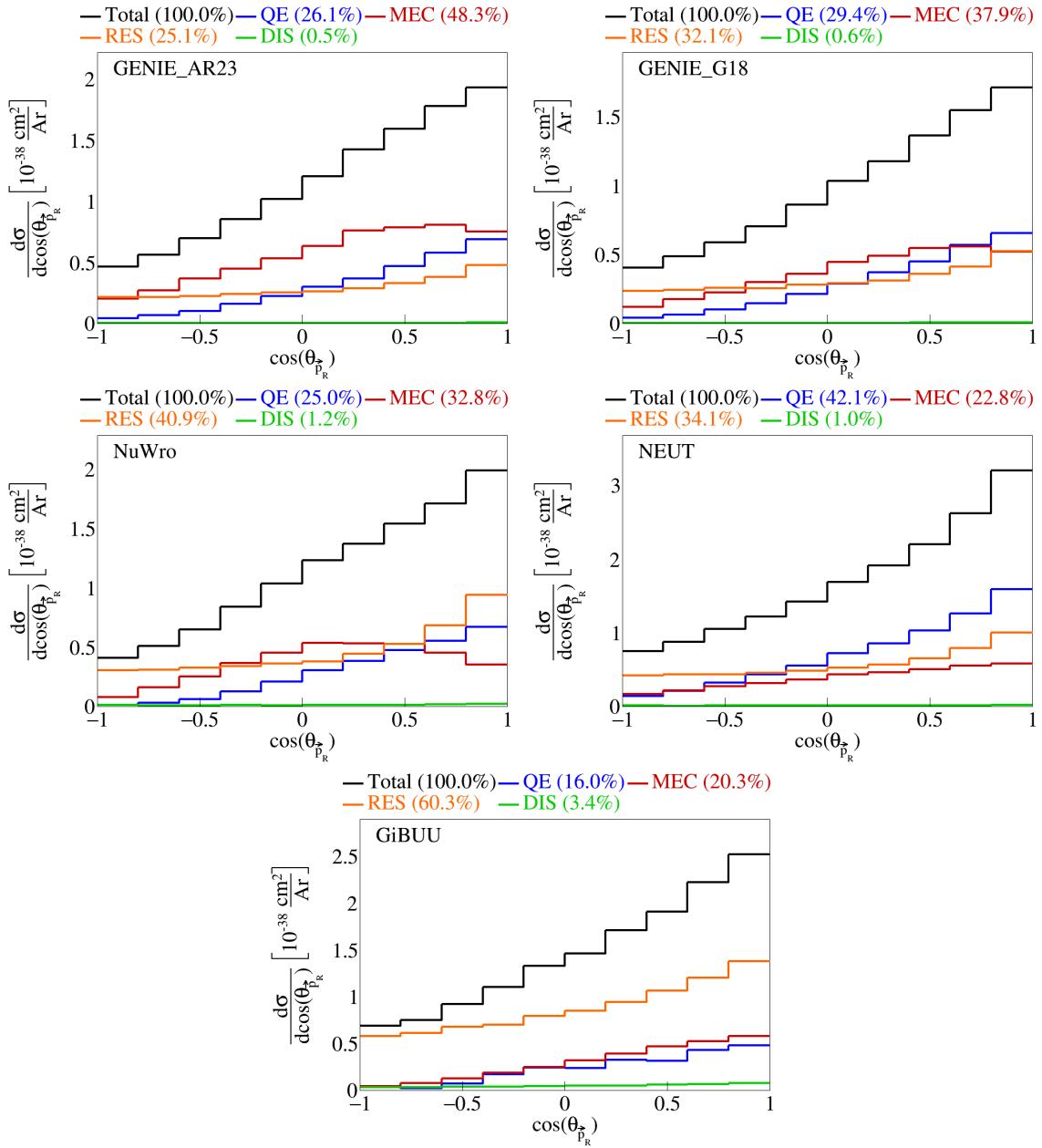


Figure 8: Event interaction breakdown for $\cos(\theta_{\vec{p}_R})$.

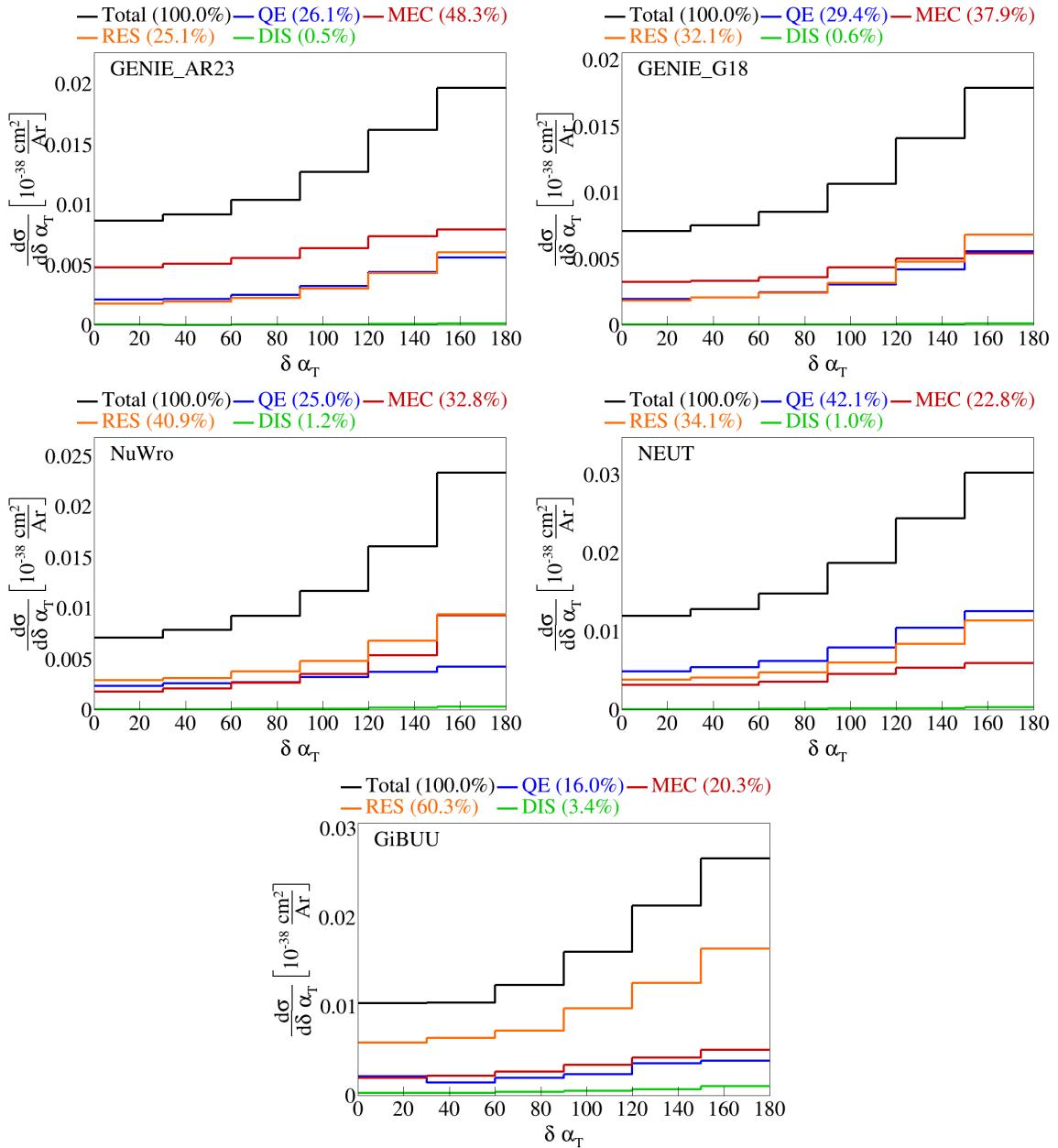


Figure 9: Event interaction breakdown for $\delta\alpha_T$.

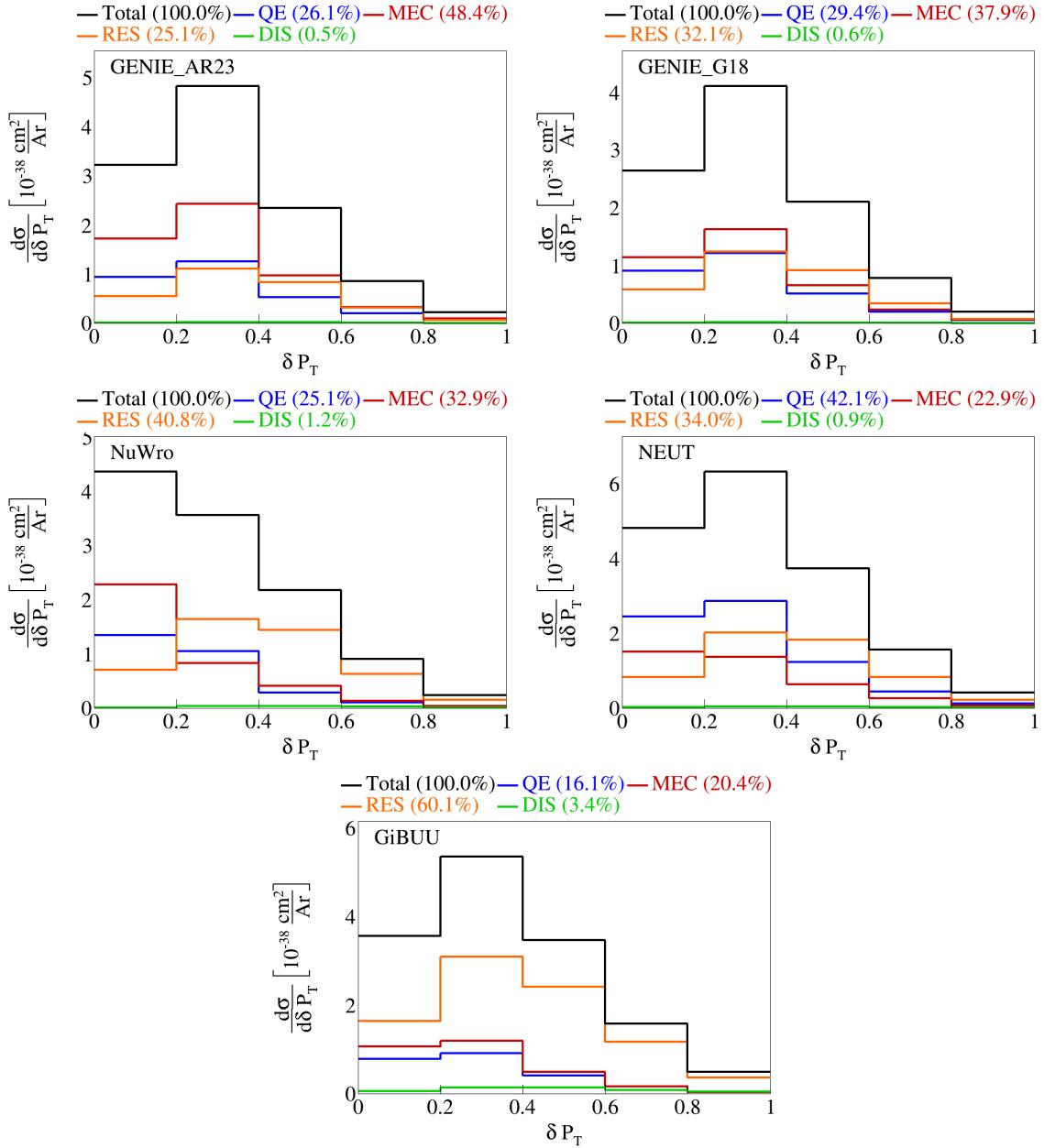


Figure 10: Event interaction breakdown for $|\delta \vec{P}_T|$.

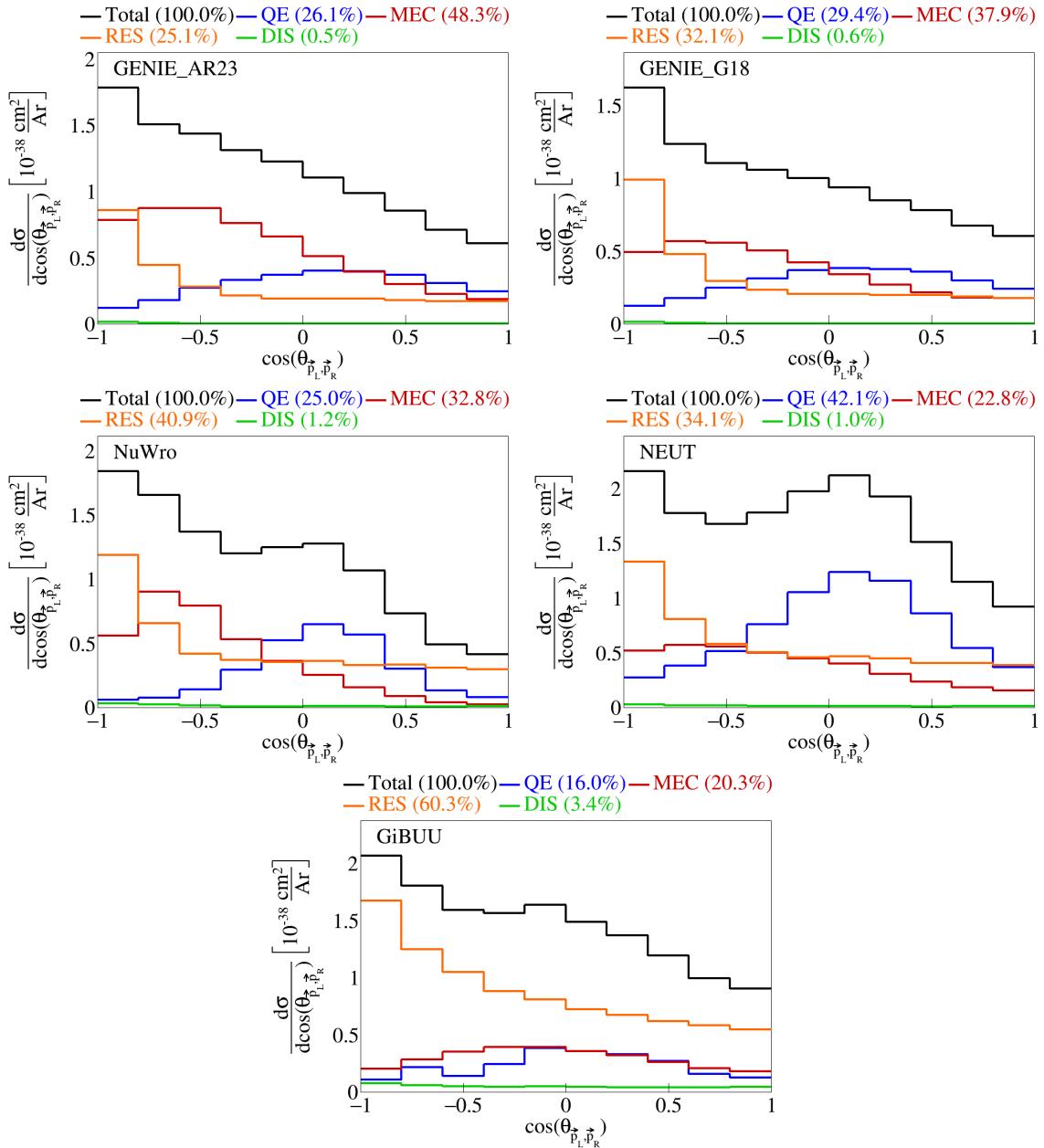


Figure 11: Event interaction breakdown for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

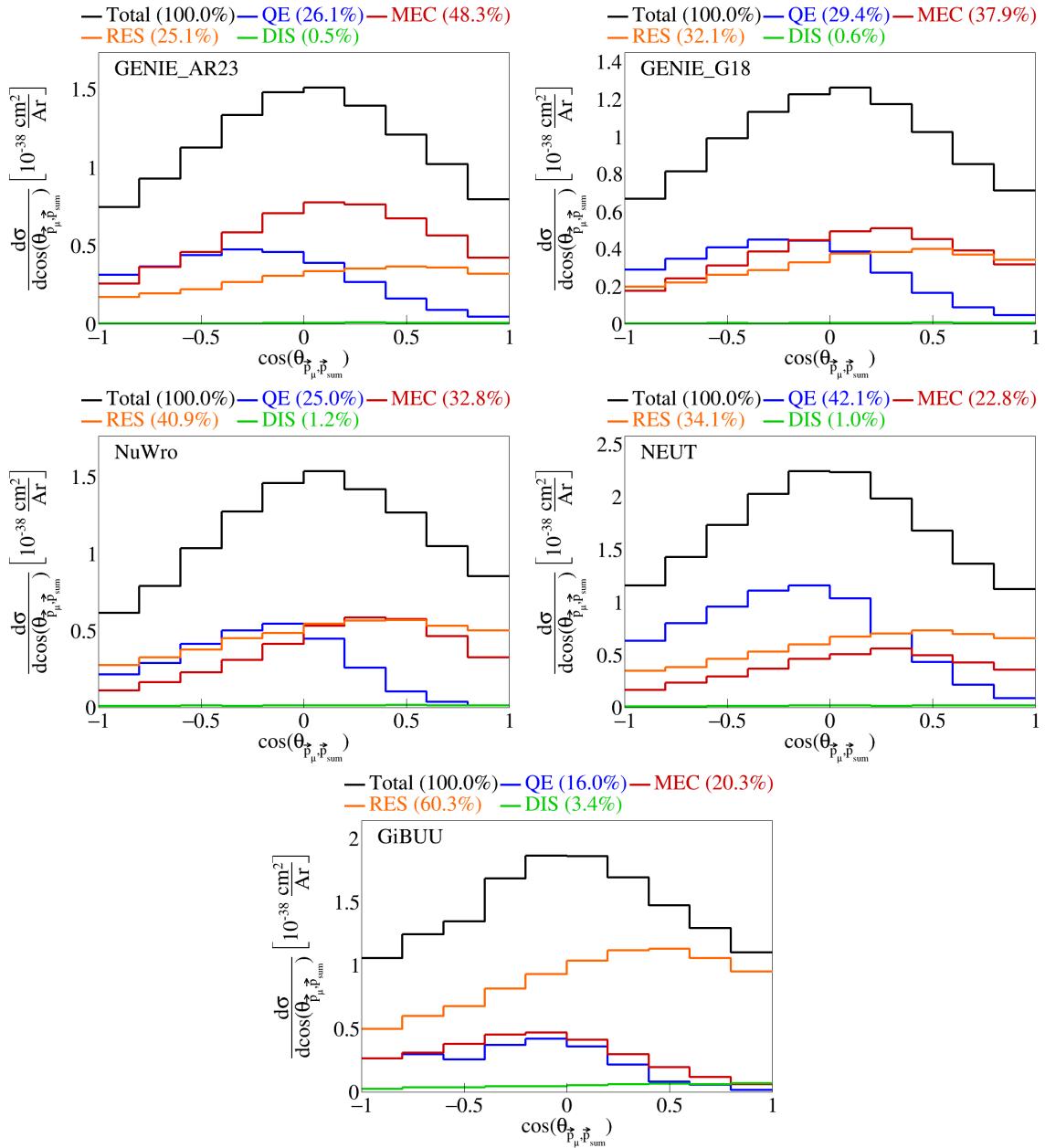


Figure 12: Event interaction breakdown for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

62 **2.4 Pre-FSI events**

63 To investigate why the percentage of MEC events for some generators is low, we performed event selection
64 before any final state interactions took place and plotted the interaction breakdown. For both GENIE tunes,
65 NEUT, and NuWro, we got 100% MEC events pre-FSI. For GiBUU, only 4.1% MEC versus 76.2% RES and
66 16% DIS events pre-FSI. The interaction breakdown for $|\vec{p}_\mu|$ for all the generators are shown in Figure 13.
67 Since GiBUU is the outlier, we checked the specific interaction mode for the resonance events. We got that
68 10 has 39.3%, 11 has 34.7%, 12 has 0.0136%, 13 has 26 %, and 27, 22, and 23 all have zero percent of the
69 resonance events. We also checked the event interaction breakdown for GiBUU samples generated without
70 final state interactions, in which we found that 100% of the events are MEC, shown in Figure 14.

71 Note that the difference between these two GiBUU samples is that in the former, the samples were
72 generated with final state interactions, and then we look at the state before the final state interactions
73 reportedly took place, and in the latter the event generation was done without any final state interactions.

74 **2.5 Double differential plots**

75 For our double differential variables, we look at δP_T , $\delta \alpha_T$, $\cos(\theta_{\vec{p}_L, \vec{p}_R})$, and $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$. We
76 have two bins for $\cos(\theta_{\vec{p}_\mu})$, the first one going from -1 to 0.5 and the second from 0.5 to 1. Therefore, these
77 are irregular bins, with the first holding a larger range than the first. These plots are shown in Figure 15.
78 Note that, in these plots, the horizontal axis is defined by bin number of the double differential measurement,
79 not the value of the variable. This is because we are representing two variables in a single axis, but we can
80 slice the plots to get our usual horizontal axis.

81 We slice the double differential plots into two plots each, so that we have the variable of interest in the
82 horizontal axis instead of bin numbers, and each slice corresponds to one bin of $\cos(\theta_{\vec{p}_\mu})$. These plots are
83 shown in Figure 16, and the plots broke down by interaction are in Figures 17 to 20. In these plots, the
84 bins contents have been reweighted appropriately, by dividing the content of each bin by the width of the
85 bin for the variable in the axis multiplied by the width of the $\cos(\theta_{\vec{p}_\mu})$ slice. Note that the plots for the
86 $0.5 < \cos(\theta_{\vec{p}_\mu}) < 1$ slice have more events in general, although they span a smaller phase space of $\cos(\theta_{\vec{p}_\mu})$,
87 as it can be seen by the scale of the vertical axis. We performed the same double differential analysis for
88 the events before final state interactions. These are shown in Figure 21, and the corresponding interaction
89 breakdown plots are in Figures 22 to 25.

90 **2.6 Pure MEC events**

91 We also generated pure meson exchange current events using different configurations to get the MEC splines.
92 These were all generated using different tunes of GENIE: AR23, G18 with Empirical MEC model, and G18
93 with Nieves MEC model. The plots for the transverse kinematic variables are shown in Figure 26. The sliced
94 double differential plots are shown in Figure 27.

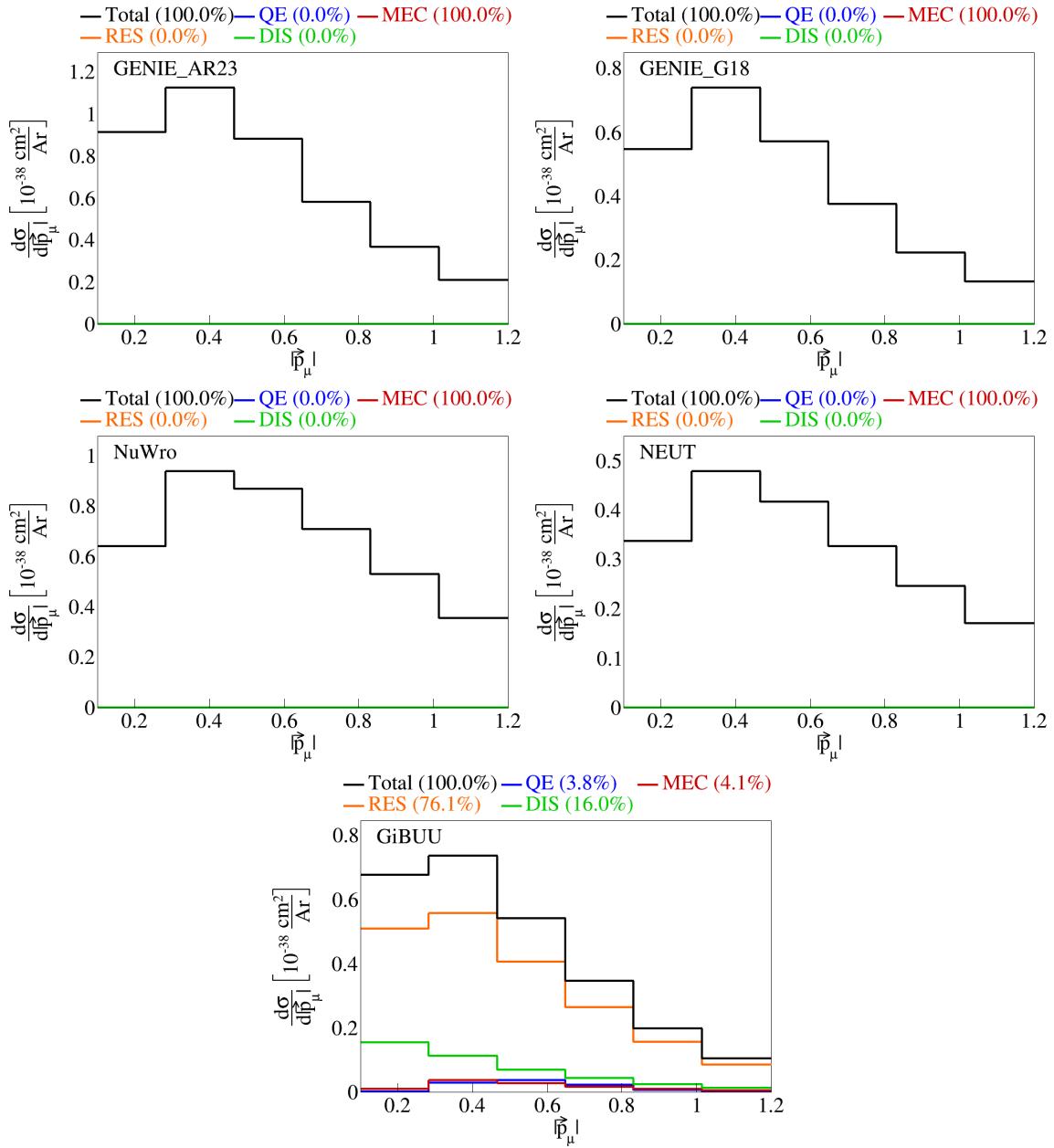


Figure 13: Event interaction breakdown of $|\vec{p}_\mu|$ before final state interactions.

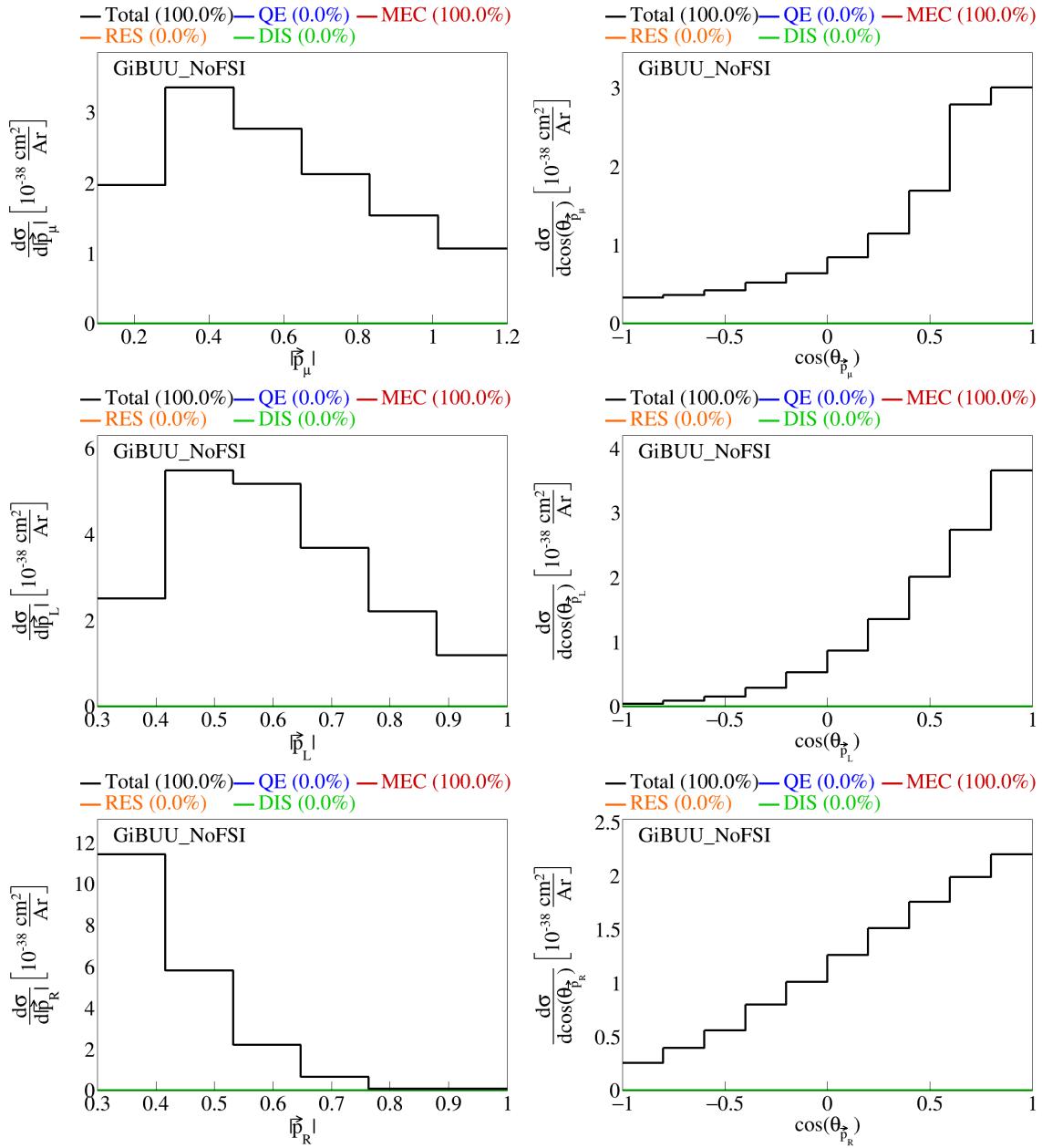


Figure 14: Event interaction breakdown for final events from GiBUU events with no FSI.

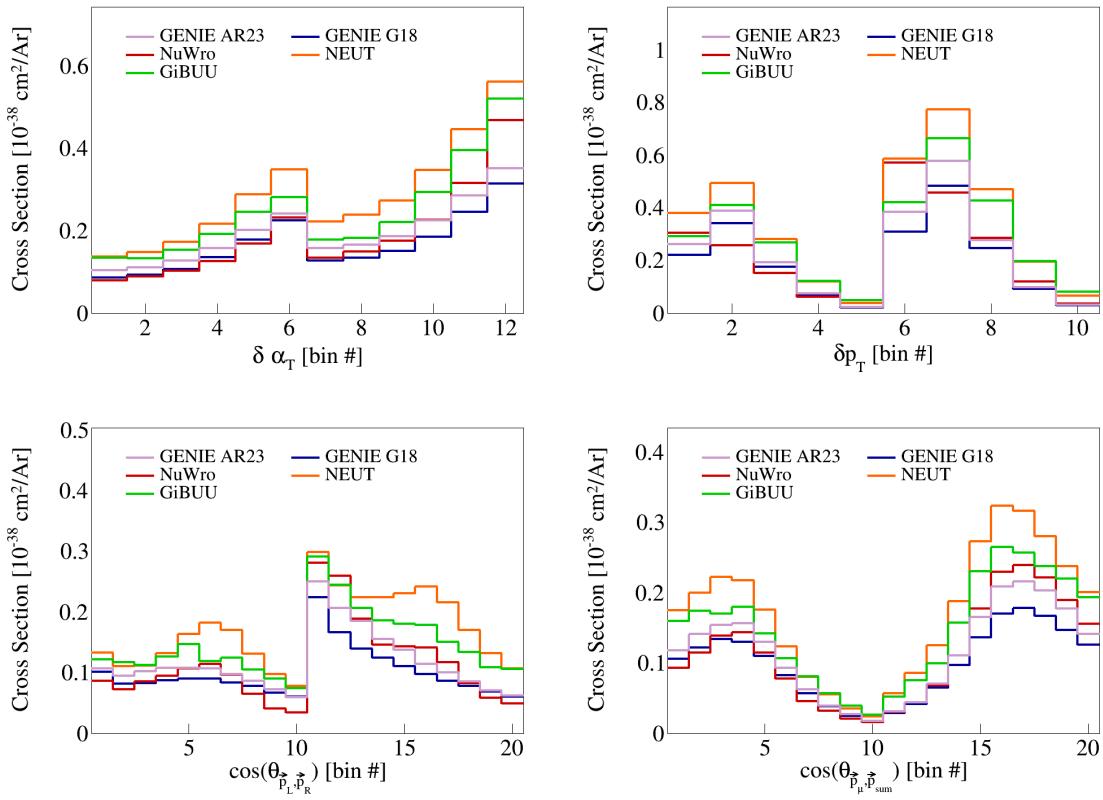


Figure 15: Double differential serial plots, all in $\cos(\theta_{\vec{p}_\mu})$.

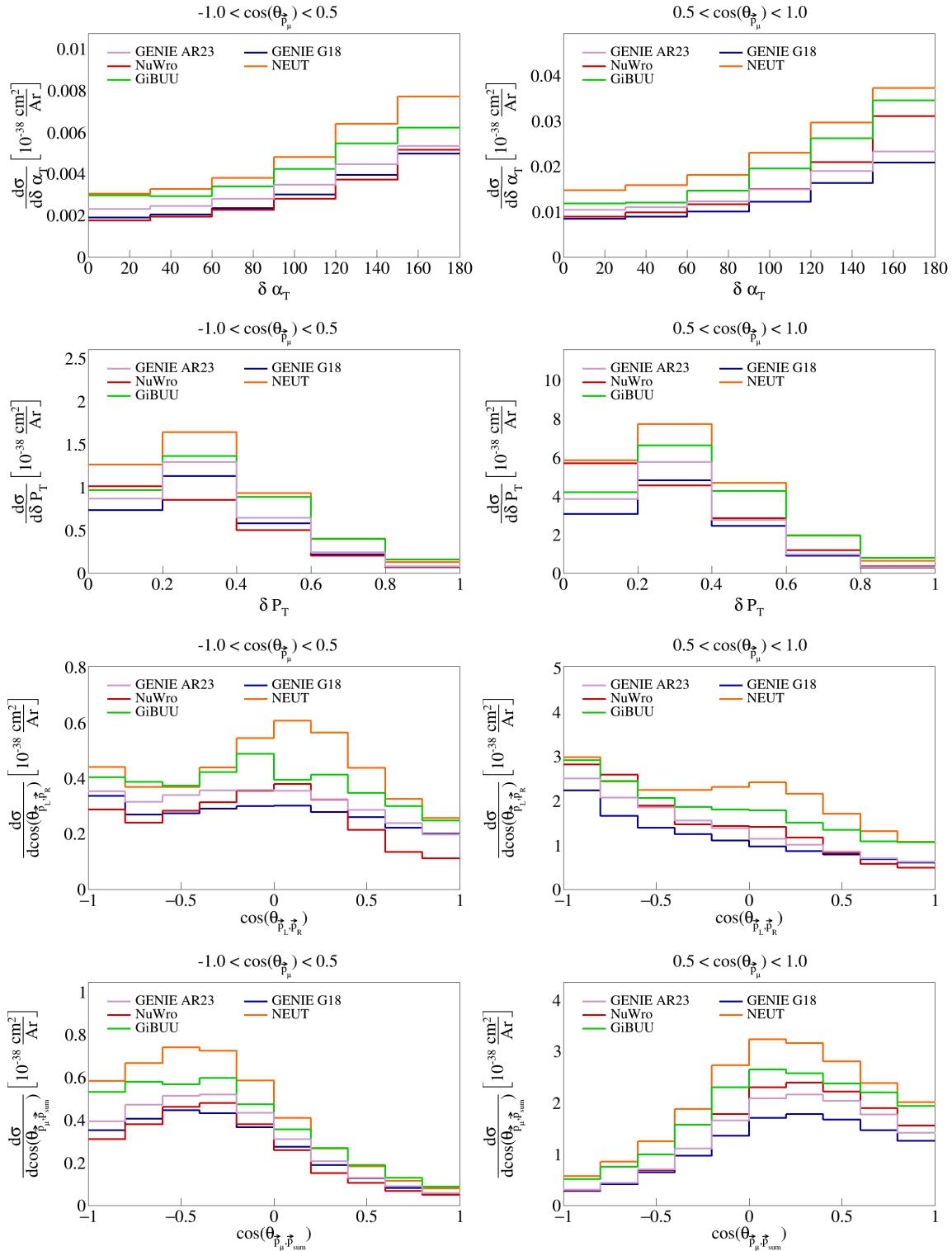


Figure 16: Sliced double differential plots.

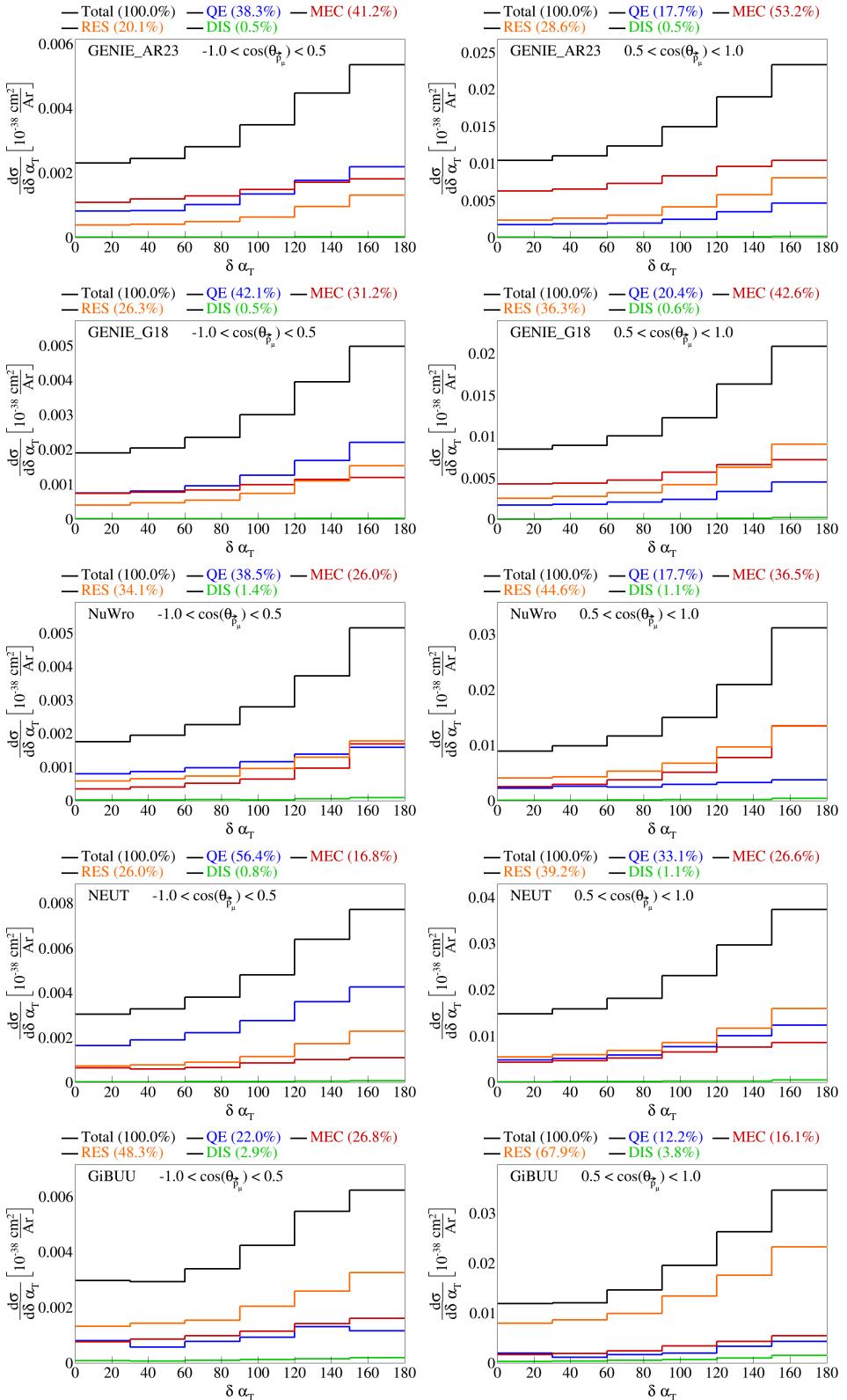


Figure 17: Interaction breakdown for sliced double differential plots for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

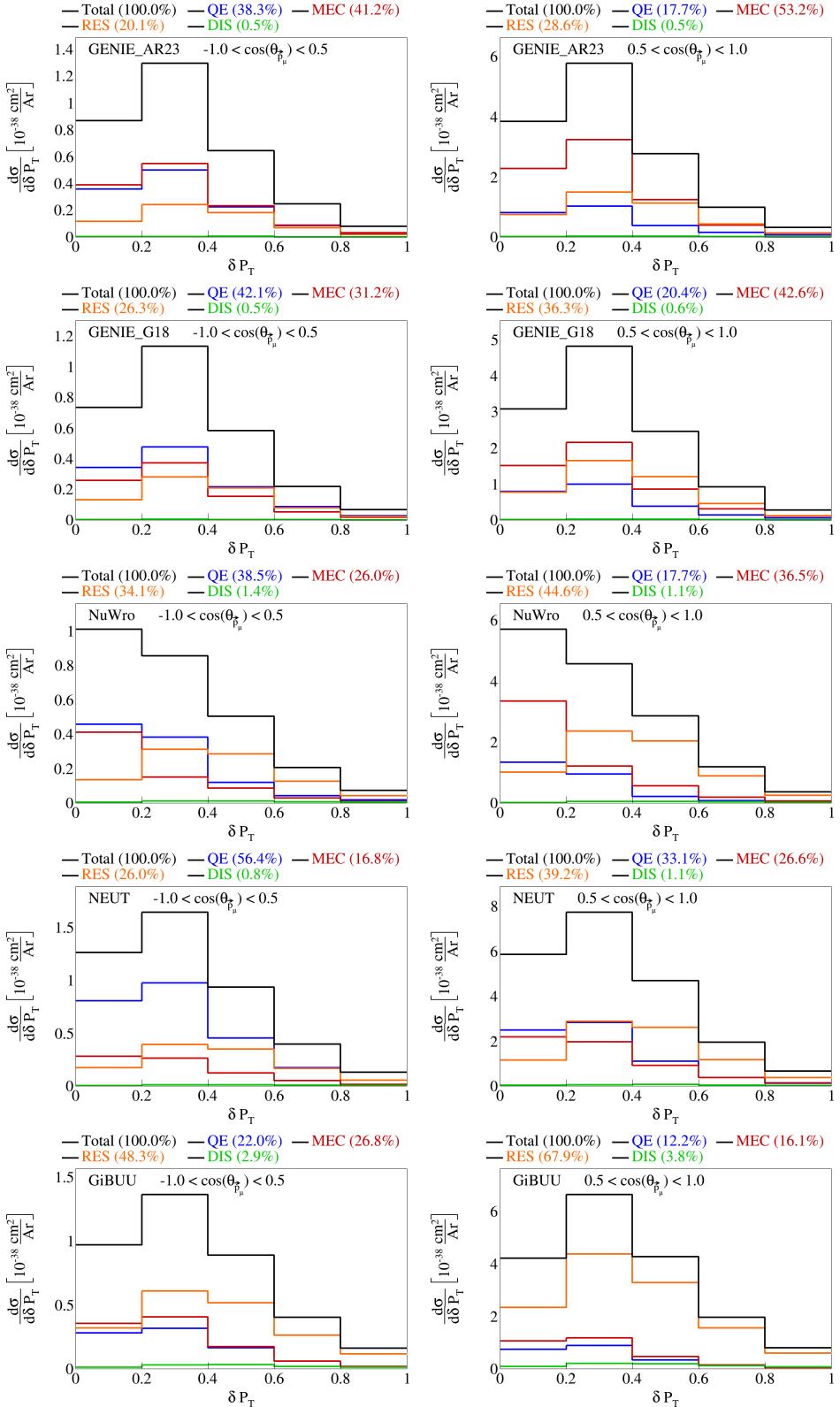


Figure 18: Interaction breakdown for sliced double differential plots for $|\delta \vec{P}_T|$ in $\cos(\theta_{\vec{p}_\mu})$.

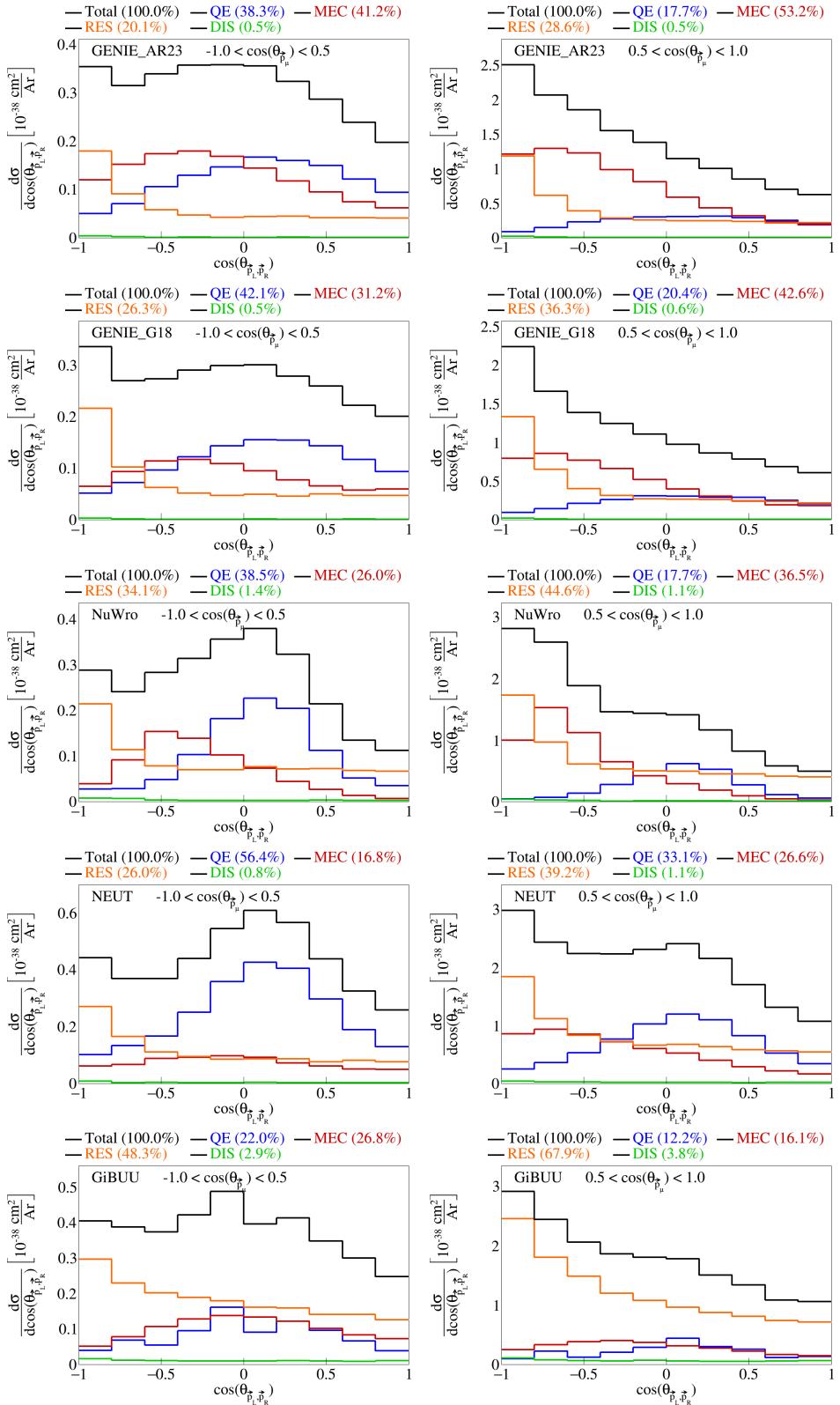


Figure 19: Interaction breakdown for sliced double differential plots for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

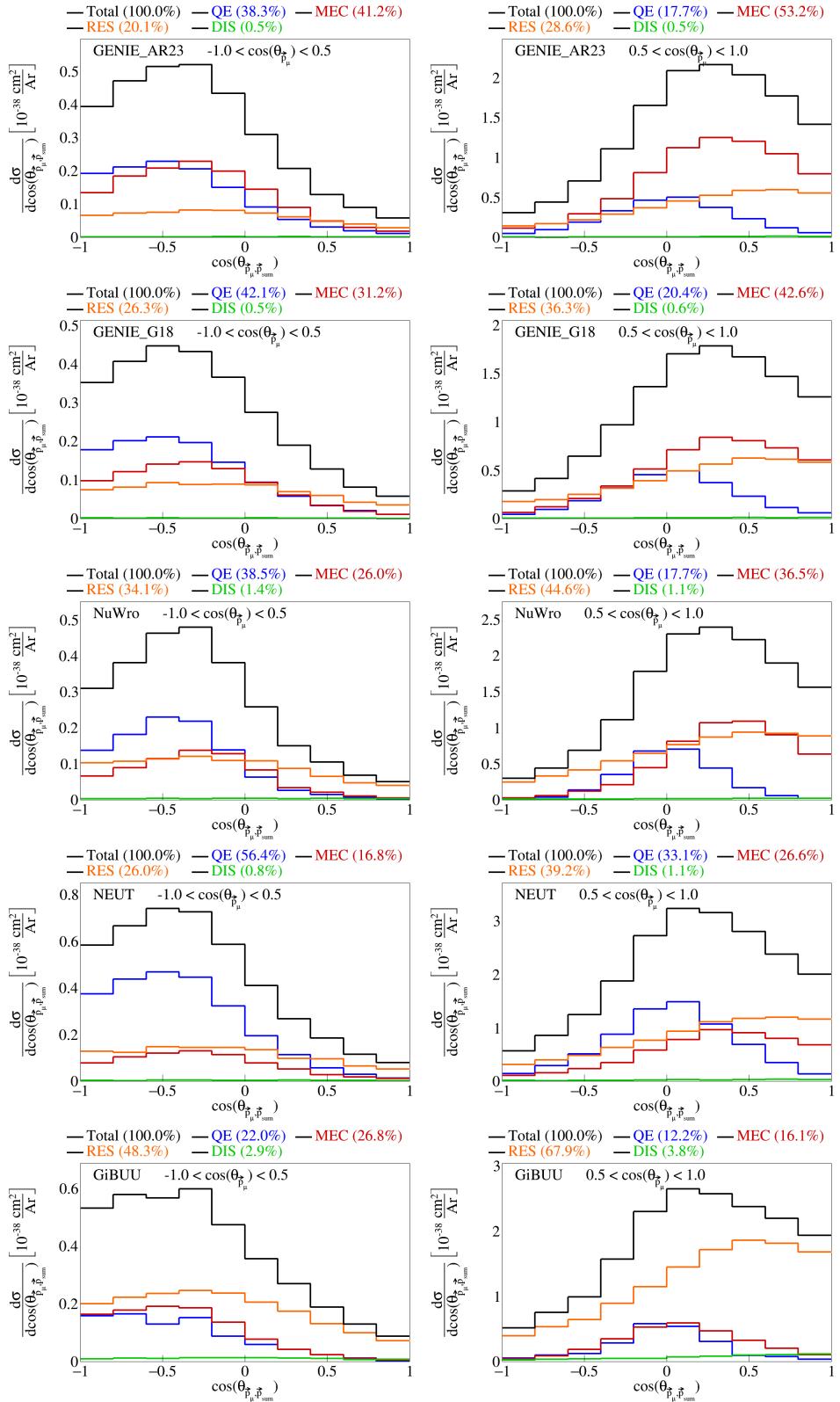


Figure 20: Interaction breakdown for sliced double differential plots for $\cos(\theta_{\vec{p}_\mu}^* \vec{p}_{\text{sum}}^*)$ in $\cos(\theta_{\vec{p}_\mu})$.

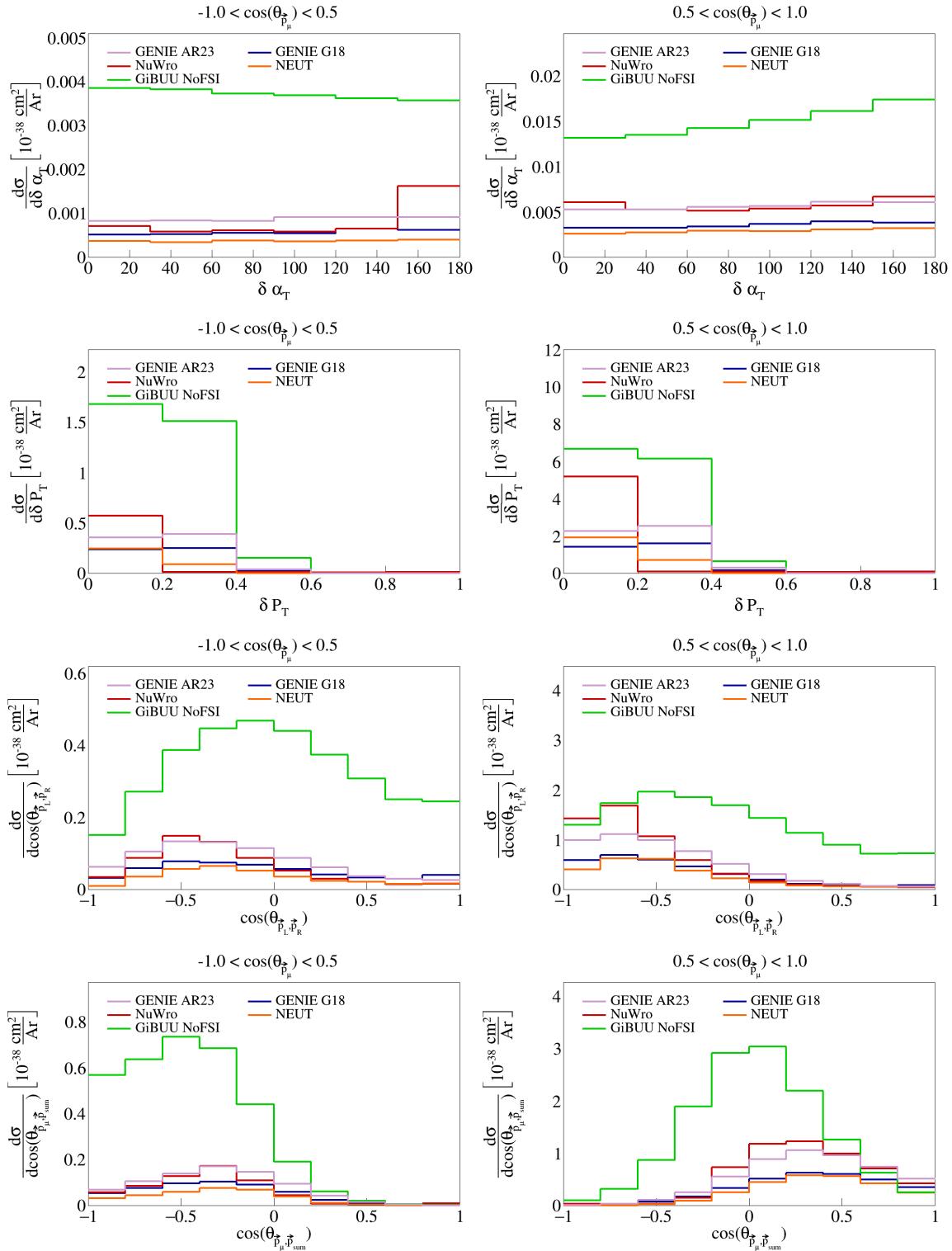


Figure 21: Sliced double differential plots for pre-FSI events.

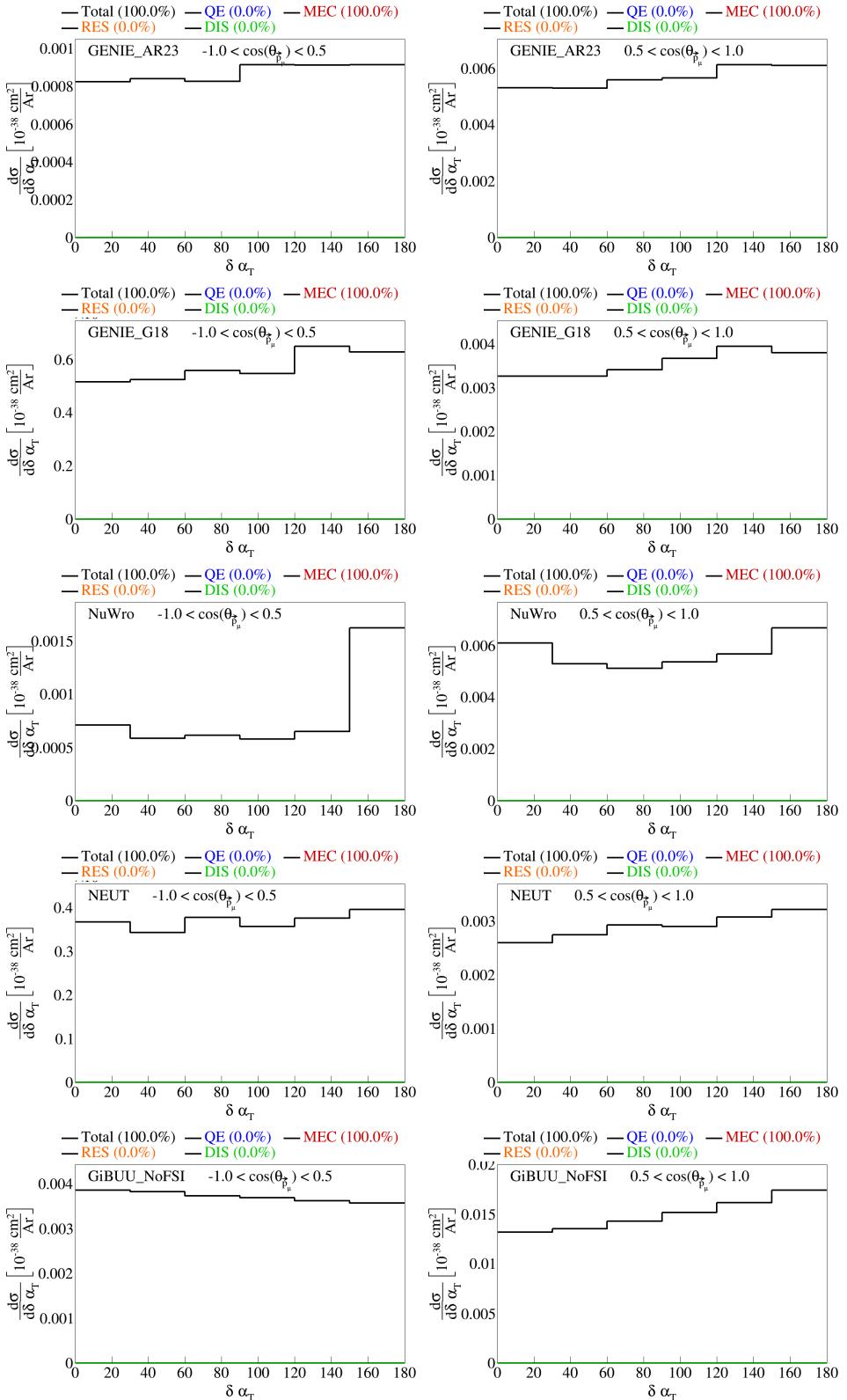


Figure 22: Interaction breakdown for sliced double differential plots for pre-FSI $\delta\alpha_T$ in $\cos(\theta_{\bar{p}_\mu})$.

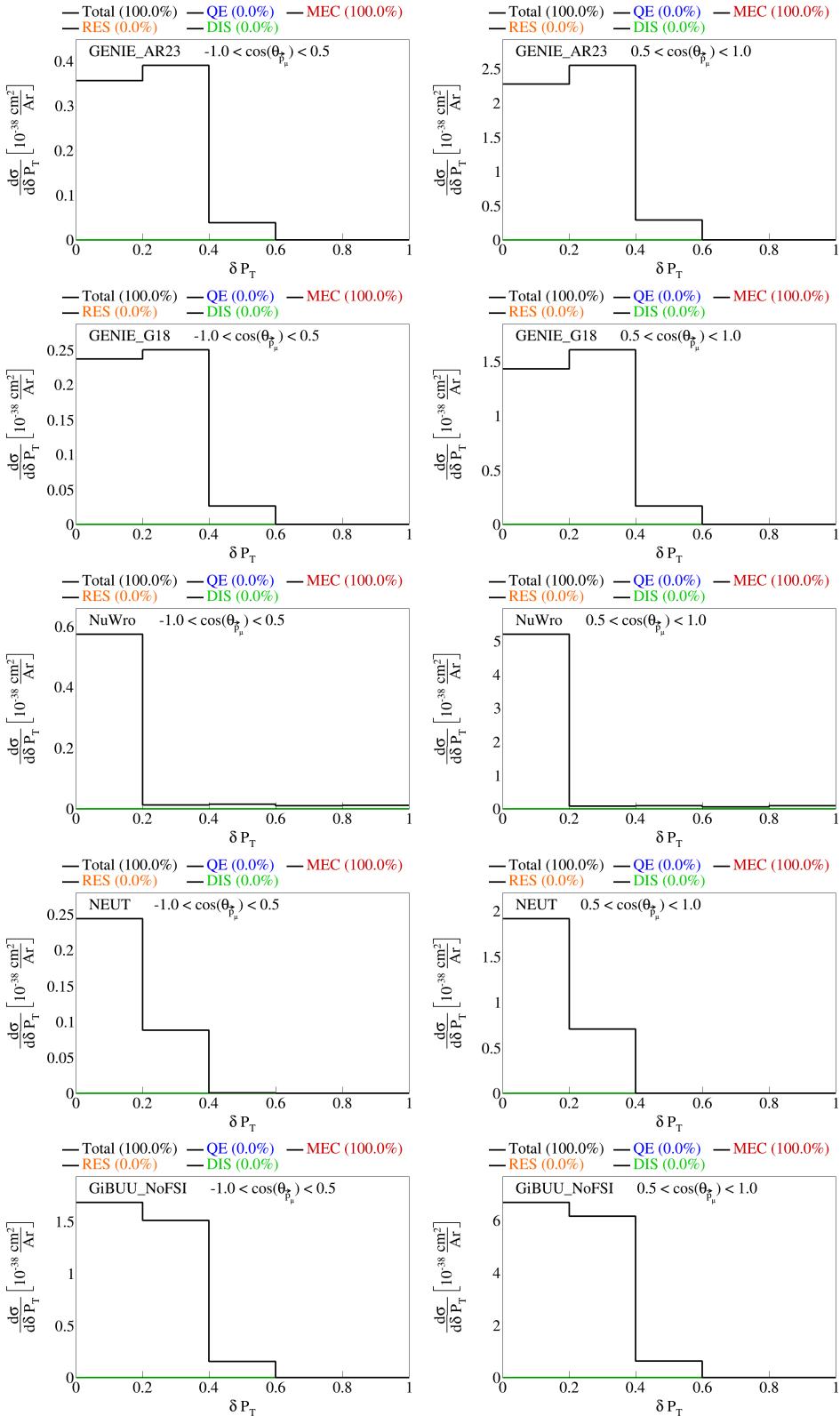


Figure 23: Interaction breakdown for sliced double differential plots for pre-FSI $|\delta \vec{P}_T|$ in $\cos(\theta_{\vec{p}_\mu})$.

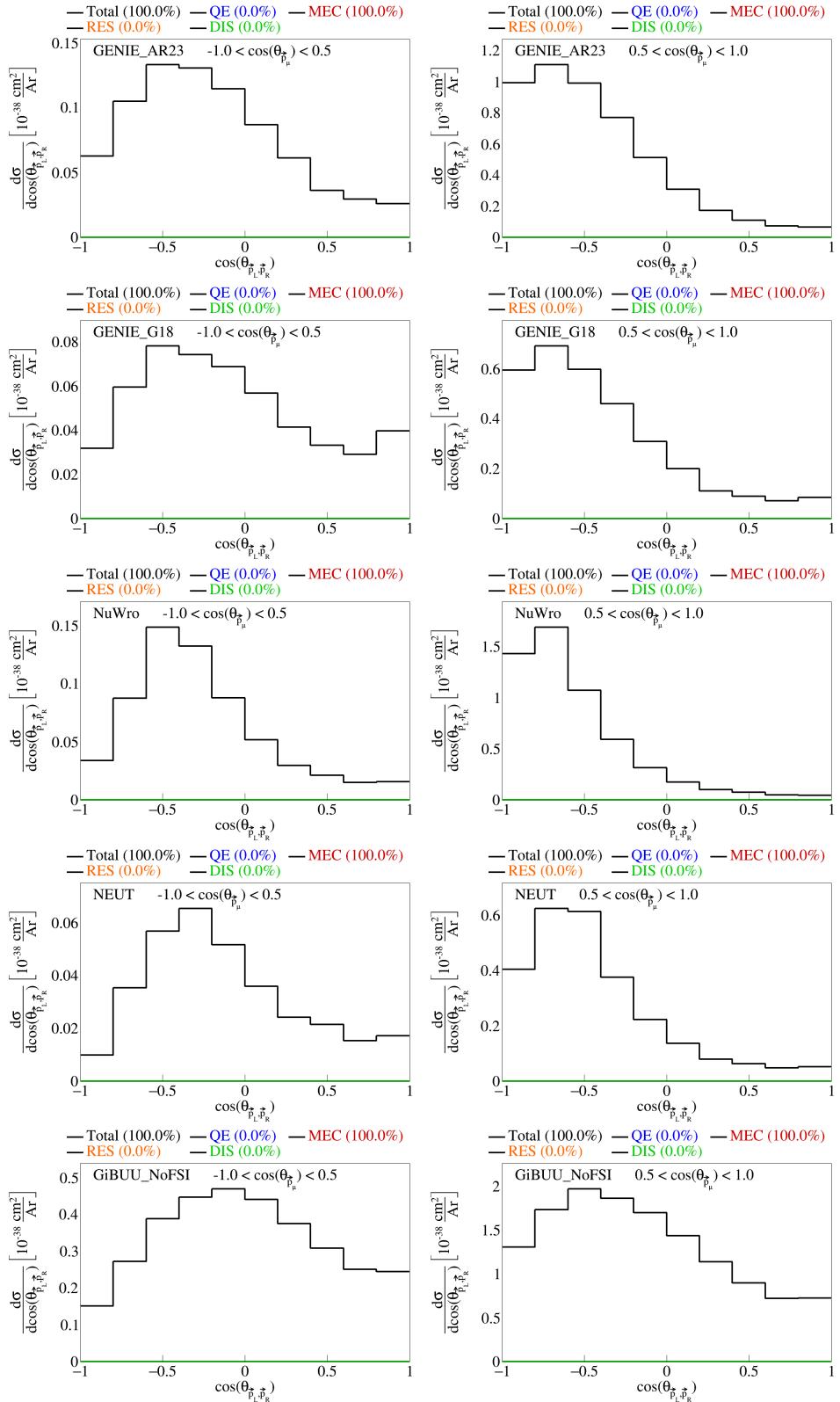


Figure 24: Interaction breakdown for sliced double differential plots for pre-FSI $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

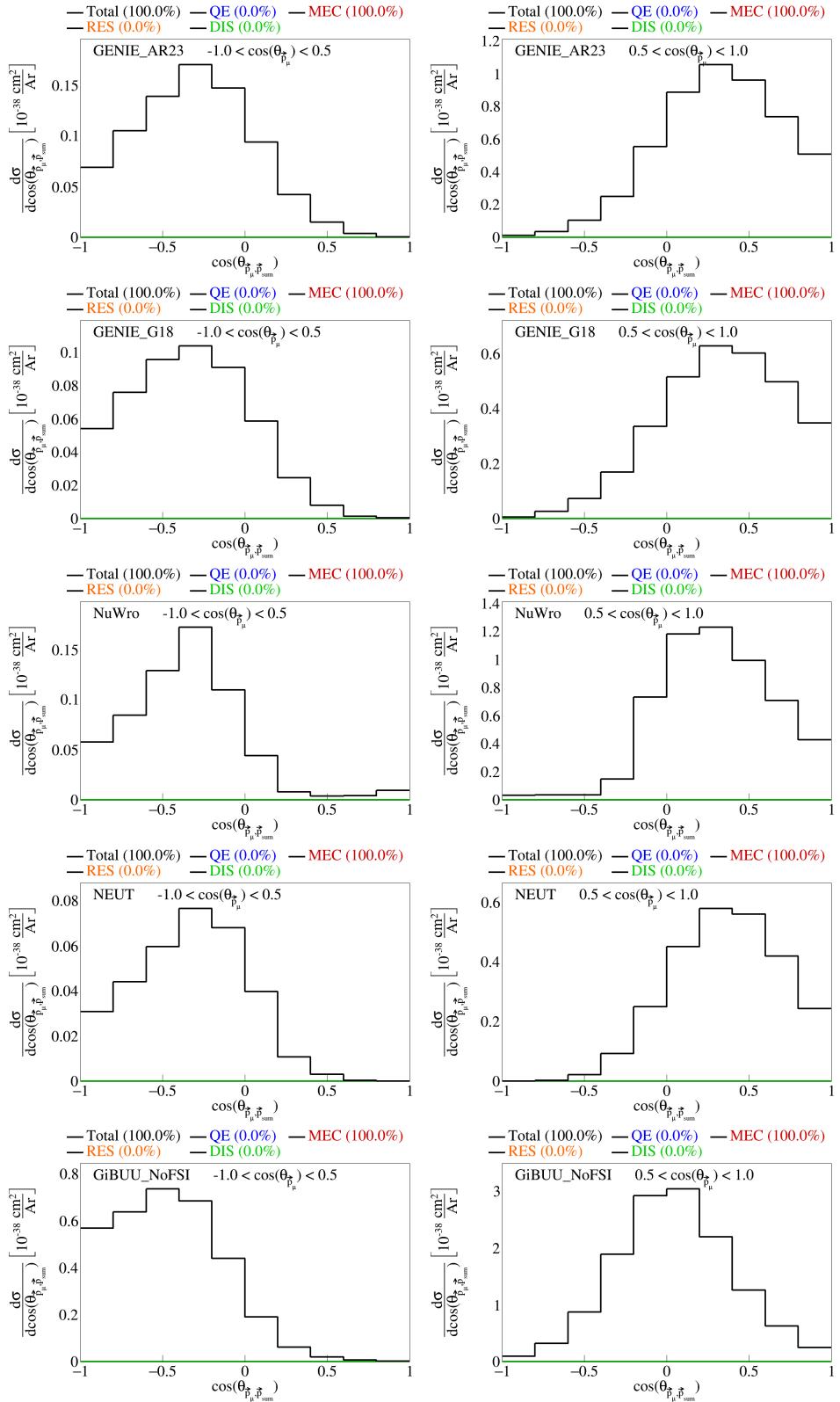


Figure 25: Interaction breakdown for sliced double differential plots for pre-FSI $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

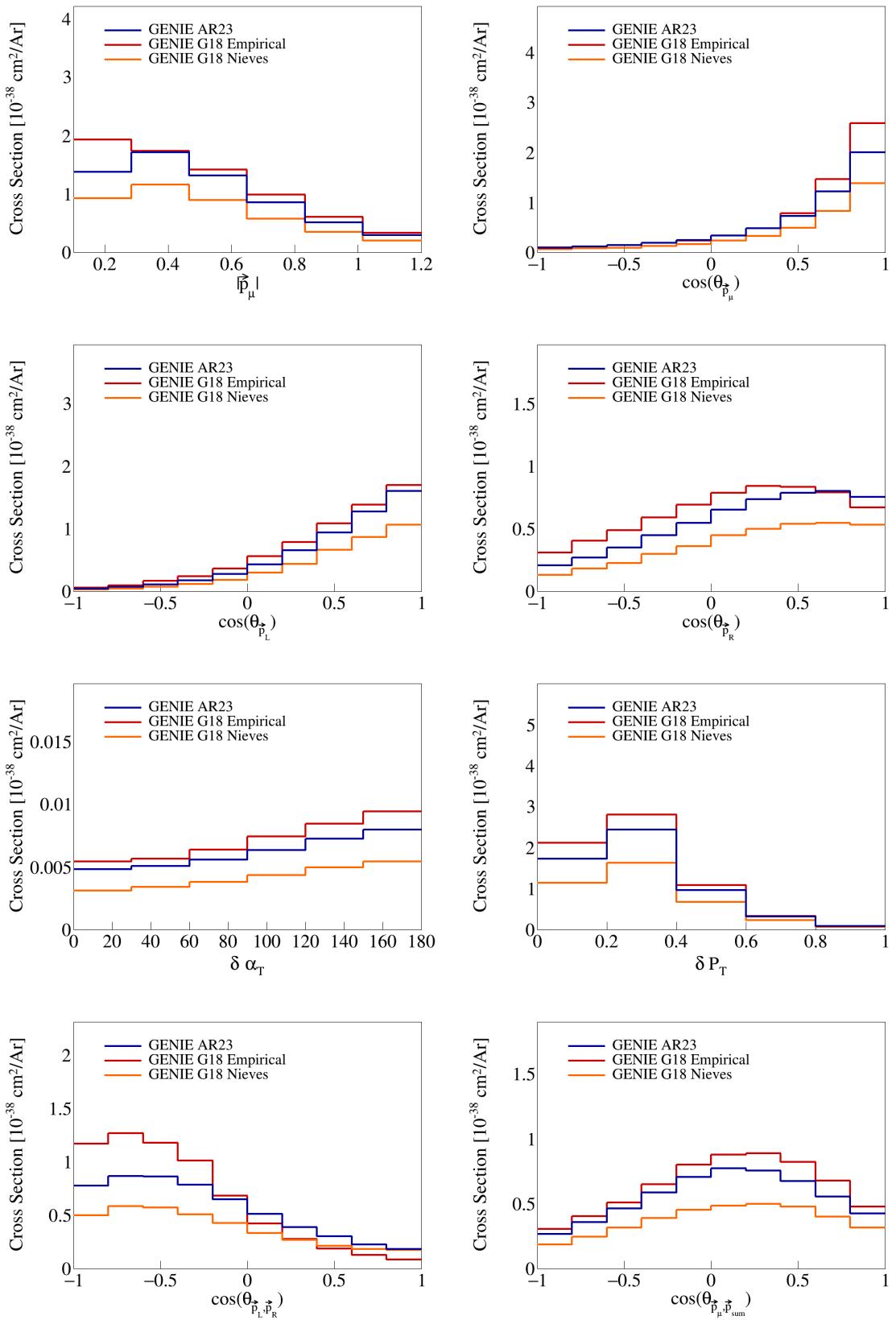


Figure 26: Variable plots for pure MEC events.

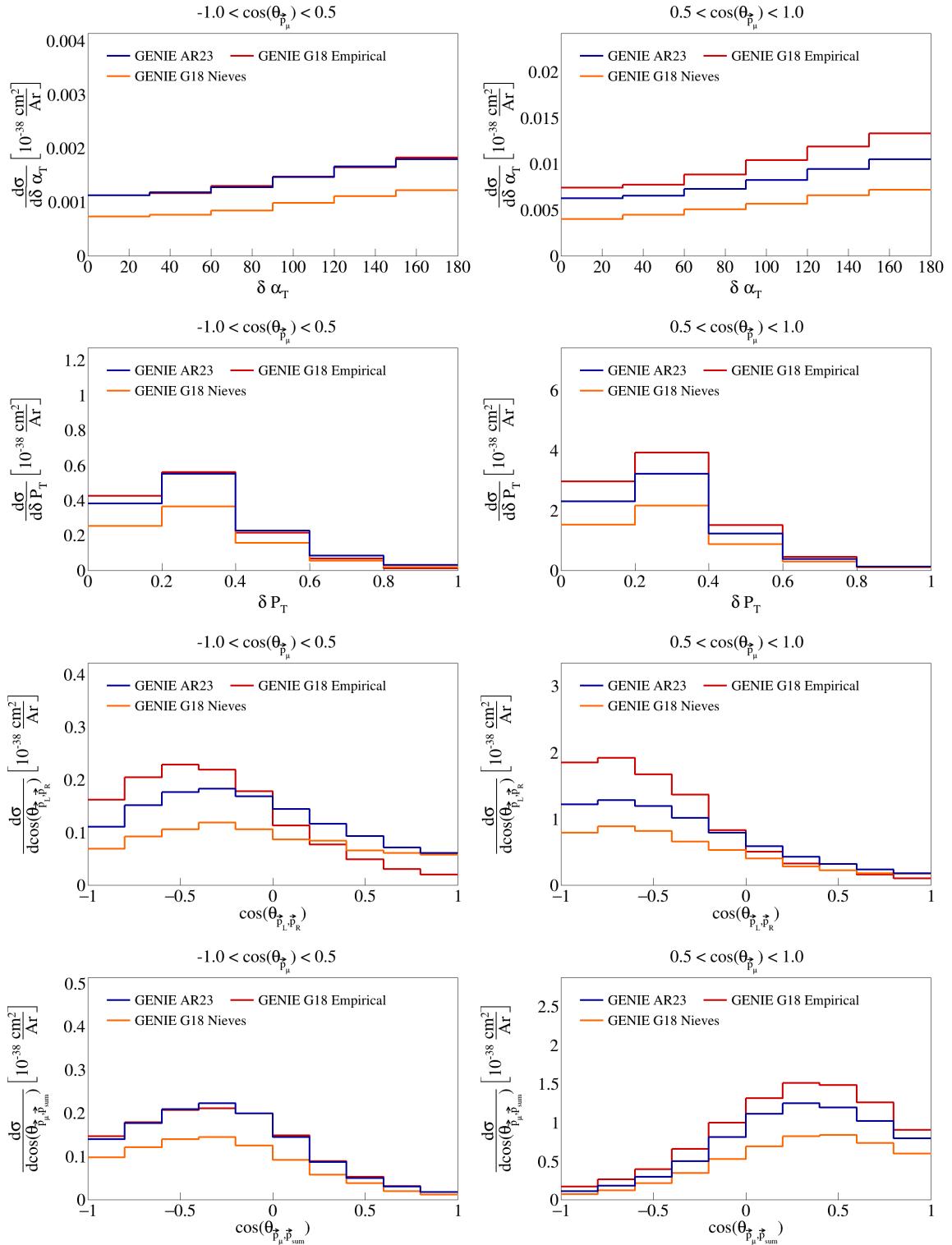


Figure 27: Sliced double differential plots for pure MEC events.

95 3 SBND analysis

96 The CAF files used for this analysis are available in the Fermilab gpvms at the path

97 `/pnfs/sbnd/persistent/users/twester/sbnd/v09_78_04/cv/*.flat.caf.root`

98 where the asterisk means that all the files in the directory with the extension `.flat.caf.root` will be used.

99 3.1 Fiducial volume

100 To perform the analysis of SBND data, we have to define the fiducial volume of the detector, which represents
101 a central part of the detector in which we will accept signals. The fiducial volume is given by the following
102 ranges:

$$5 < |x| < 180 \quad |y| < 180 \quad 10 < z < 450 \quad (6)$$

103 where x , y , and z are the coordinates in the detector frame, all in centimeters.

104 3.2 Signal definition

105 To perform analysis on experiment data, we will be using the CAFAna framework. This allows us to perform
106 cuts based on the reconstructed and Monte Carlo data (if available, i.e., only in the case of dealing with
107 simulated events), to discriminate events. To discriminate events based on their Monte Carlo data, we
108 perform a simple `TruthCut` that checks the following:

- 109 (i) That the neutrino interaction takes place in the fiducial volume.
- 110 (ii) That the neutrino is a muon neutrino.
- 111 (iii) That the interaction is a charged current interaction.
- 112 (iv) That there is only one muon in our allowed momentum range.
- 113 (v) That there are only two protons in our allowed momentum range.
- 114 (vi) That there are no charged/neutral pions in our defined momenta ranges.

115 Using the reconstructed event data, the cut we have to use is not as simple as in the Monte Carlo data
116 case. We now have to use a `Cut` that looks at different variables of the reconstructed event to determine if
117 it is a signal event. We perform the following cuts:

- 118 (i) Cosmic: that the event is not a cosmic event by Pandora's criteria, i.e., requiring `nu_score > 0.4` to
119 check how neutrino-like the event is, and `fmatch.score < 7` with $0 < fmatch.time < 1.8$ to check the
120 event comes from the beam.
- 121 (ii) Vertex in FV: that the reconstructed vertex for the neutrino interaction takes place in the fiducial
122 volume defined above.
- 123 (iii) One muon: that there is one muon track with $L_{\text{track}} > 50$ cm, starting point in the fiducial volume,
124 $\chi^2_\mu < 30$, $\chi^2_p > 60$, with momentum in our allowed range; if there are multiple candidate tracks, the
125 one with the longest track length is chosen.
- 126 (iv) Two protons: that there are two proton tracks with $\chi^2_p < 100$, full track in the fiducial volume, and
127 that these have momentum in our allowed range.
- 128 (v) No charged pions: that there are no other reconstructed tracks with momentum in the allowed range
129 for charged pions inside the fiducial volume.
- 130 (vi) No neutral pions: that there are no reconstructed particles with a positive `trackScore` less than 0.5
131 indicating a shower, so we don't allow any neutral pions.

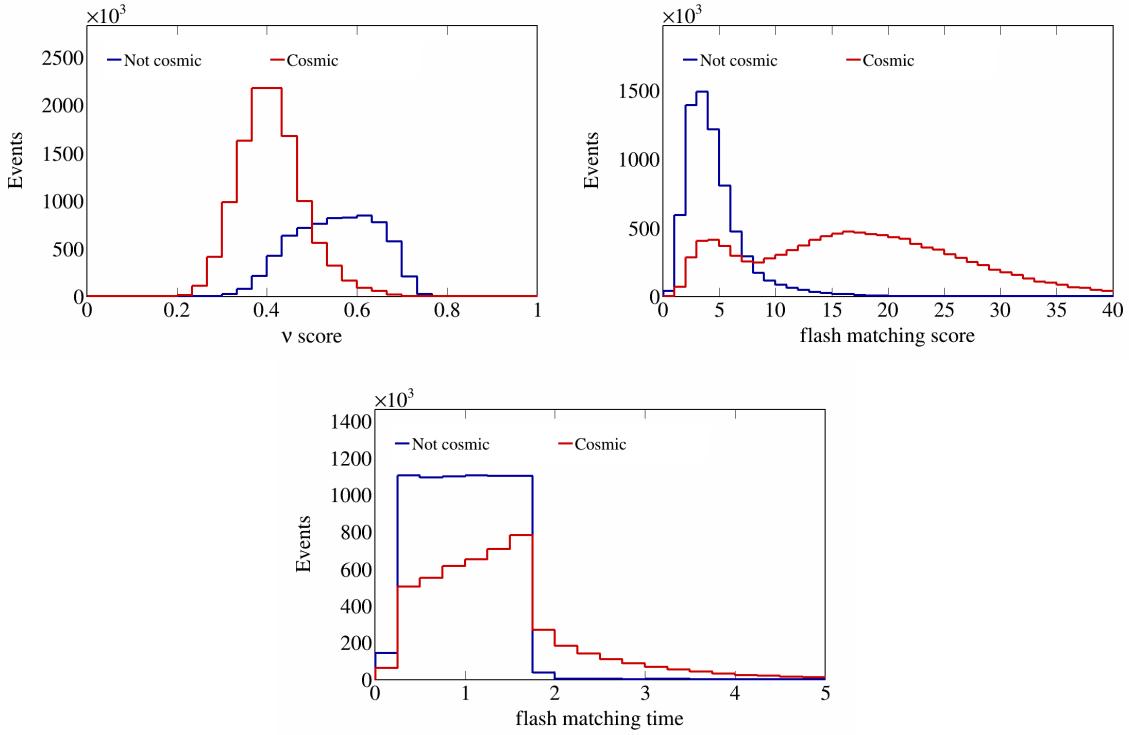


Figure 28: Cosmic cut variables before rejecting cosmic events.

Using these two discriminators on simulated events, the reconstructed events that satisfy the signal definition, and distinguish between true signal events and background events. To get a better sense of what values the variables chosen to do the cuts take on for each true particle, we plot the flash matching score, time, and ν score in Figures 28, and the χ^2 values for muons and protons in Figure 29.

We use a one-bin histogram with lower bound 0 and upper bound of 3 in the true energy variable to get total counts of generated events, true signal events, all reconstructed events, and efficiency and purity data after each of the cuts described above is applied to the reconstructed events. These results are shown in Table 2. Counts are obtained using ROOT’s command `Histo->Integral()`. Global efficiency is defined as the ratio between events that pass the cut and reconstructed events, signal efficiency as the ratio between true events that pass the cut and all true signal events, and purity as the ratio between true signal events that pass the cut and all events that pass the cut. The numbers reported in this table are POT normalized to 6.6×10^{20} .

3.3 Variable plots

Using all the variable definitions as we did when studying the event generators, and the signal definition based on the cuts described in the previous section, we can generate plots for SBND data. The reconstructed single differential variables corresponding to vector opening angles and magnitudes are shown in Figure 30. In these figures, three lines are shown, corresponding to: all reconstructed (all the reconstructed events that pass our signal definition), signal (reconstructed events that pass signal definition and are true signal events as determined by the `TruthCut` from our previous section), and background (reconstructed events that pass signal definition but are not true signal events) events. Similarly, the variables relating multiple vectors are shown in Figure 31, and double differential sliced variables are shown in Figure 32.

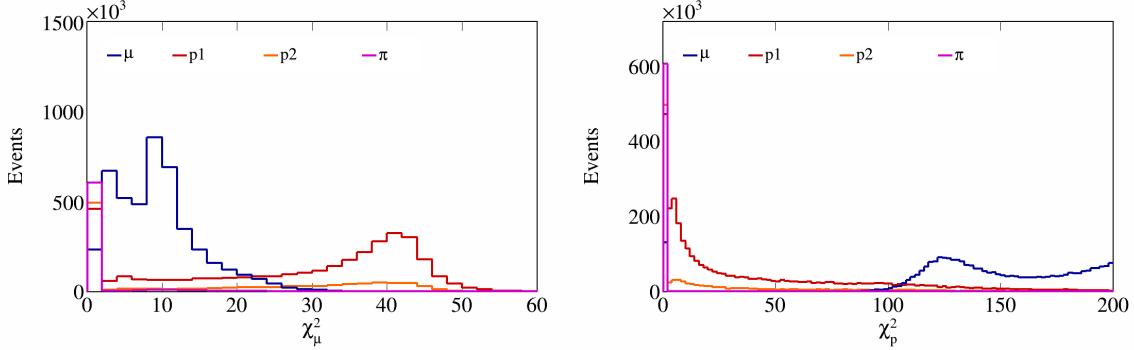


Figure 29: Muon and proton χ^2 values for all particles.

Cut	Number of events	Global efficiency	Signal efficiency	Purity
All	$1.3938 \cdot 10^7$	-	-	-
True signal events	272161	-	-	-
All reco events	$6.82359 \cdot 10^6$	100%	-	-
Cosmic cut	$5.88624 \cdot 10^6$	86.2632%	89.6205%	4.14377%
Vertex in FV cut	$3.29309 \cdot 10^6$	48.2603%	88.2885%	7.29671%
One muon cut	$2.23536e \cdot 10^6$	32.7593%	70.5202%	8.58603%
Two protons cut	146922	2.15315%	17.517%	32.4488%
No charged pions cut	67852.2	0.994377%	12.6665%	50.8065%
No neutral pions cut	54719.5	0.801917%	11.3094%	56.25%

Table 2: Global efficiency, selection efficiency, and purity for cuts made in signal definition.

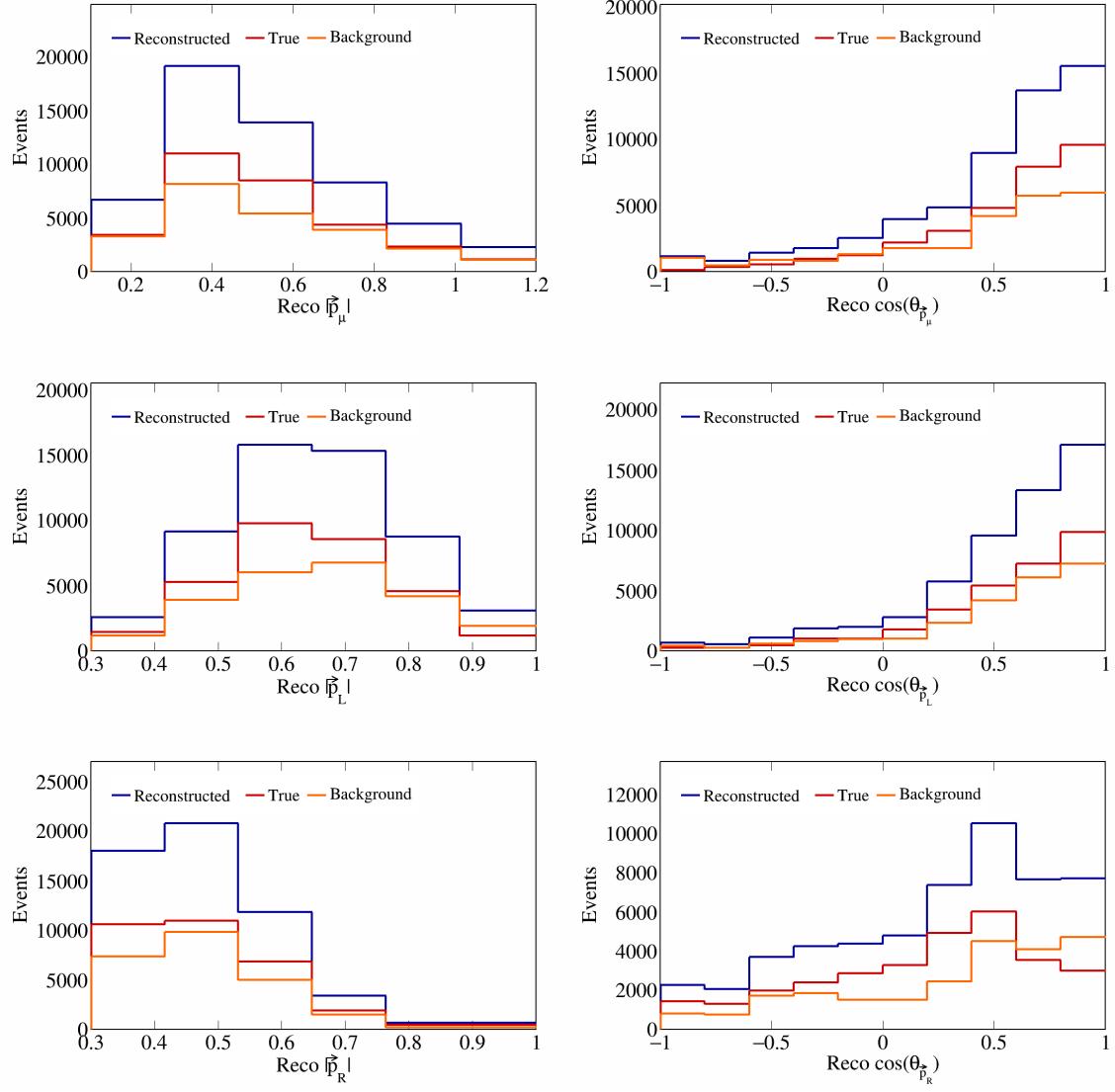


Figure 30: Vector directions and magnitudes for SBND data.

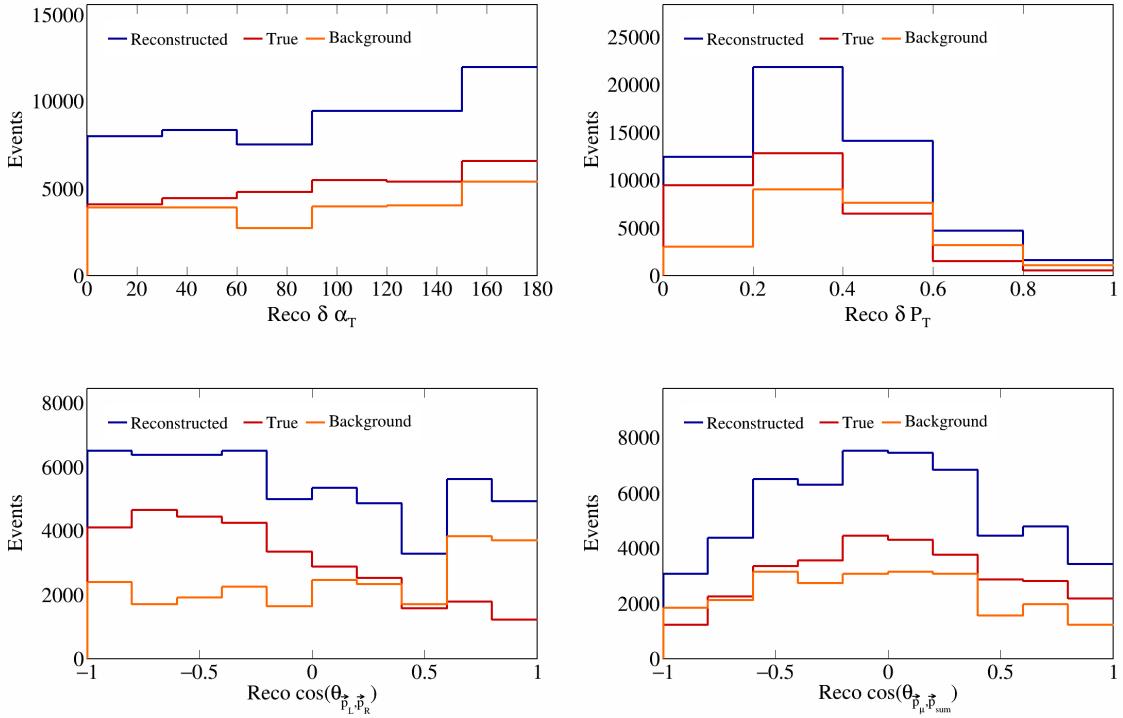


Figure 31: Vector opening angles and transverse momentum for SBND data.

153 3.4 Interaction and topology breakdown

154 We perform an interaction and topology breakdown for the SBND data. For these breakdowns, we look at
 155 the reconstructed events that pass our signal definitions cuts and see what percentage of these are generated
 156 from different interaction modes and topologies. This helps us get a better idea of what our background
 157 signal is composed of. For the interaction breakdown, we look at quasielastic (QE), MEC (meson-exchange
 158 current), RES (resonance), and DIS (deep inelastic scattering) events. For the topology breakdown, we look
 159 at the number of protons, pions, and muons in the final state. The topologies we label are CC2p0pi (our
 160 signal definition), CC1p0pi, CC($N > 2$)p0pi, CC($N \geq 0$)p1pi, and CC0p0pi. Any other topology is labeled
 161 as “Other”. These breakdowns are shown in Figures 33 to 36.

162 3.5 Signal efficiency

163 Using the truth information about reconstructed events, we can also compute signal efficiency on a bin-by-
 164 bin basis. To be precise, signal definition on a bin i is defined as the ratio between the number of events
 165 generated in bin i and reconstructed in any bin over the number of events generated in bin i . These plots
 166 are shown in Figure 37 and Figure 38 for single-differential variables and Figure 39 for double differential
 167 variables.

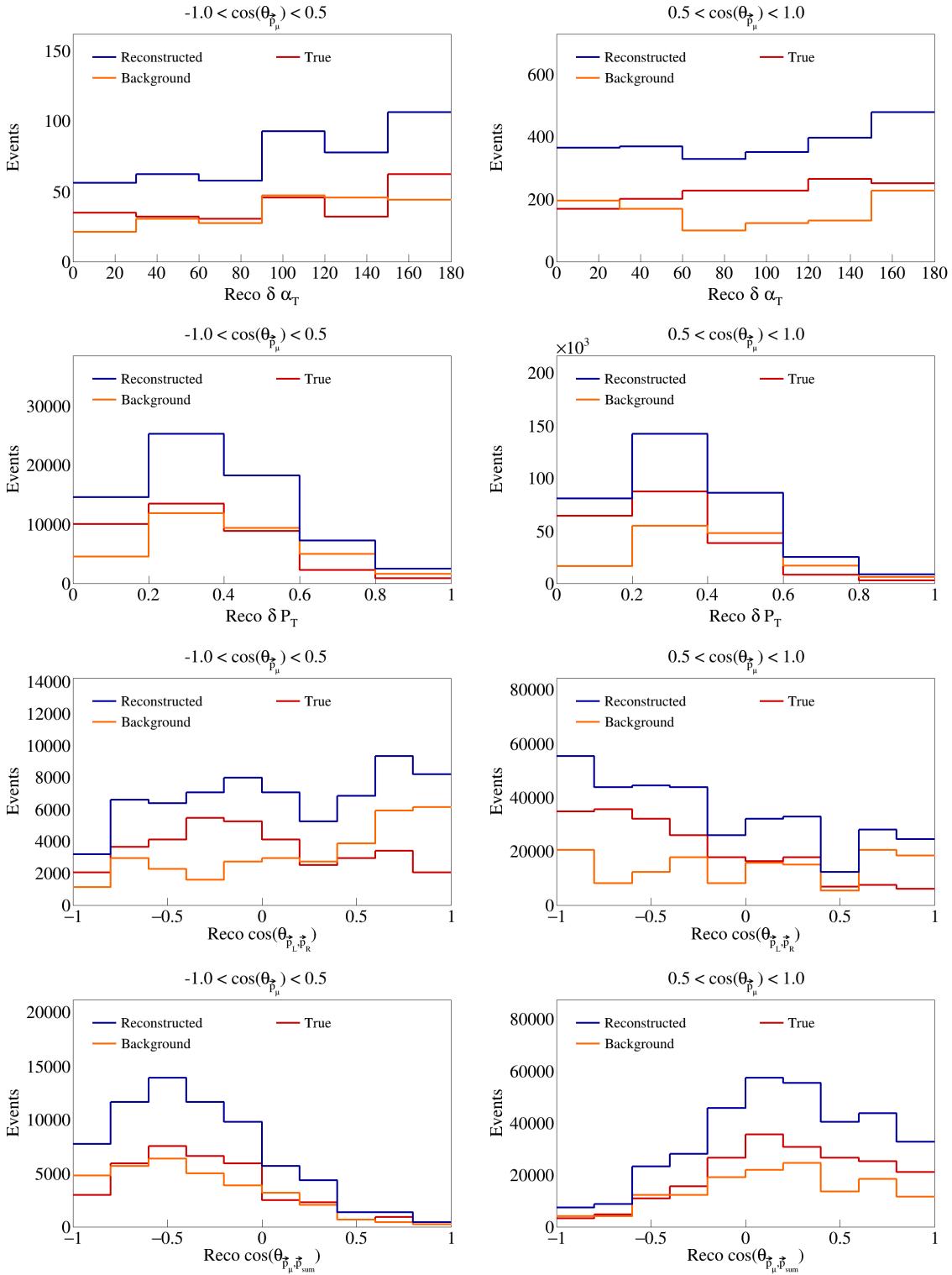


Figure 32: Sliced double differential plots for SBND events.

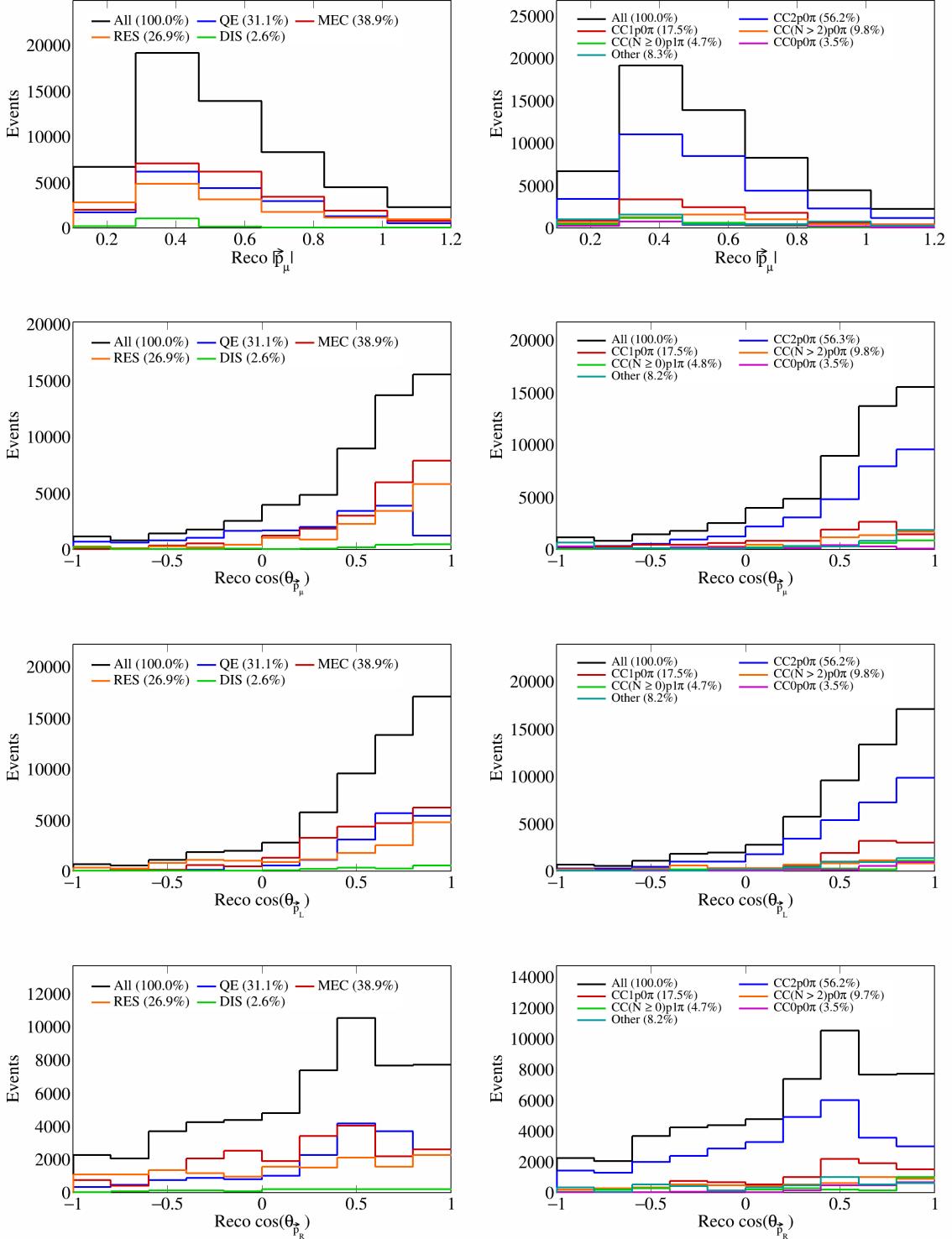


Figure 33: Interaction and topology breakdown for vector directions and magnitudes.

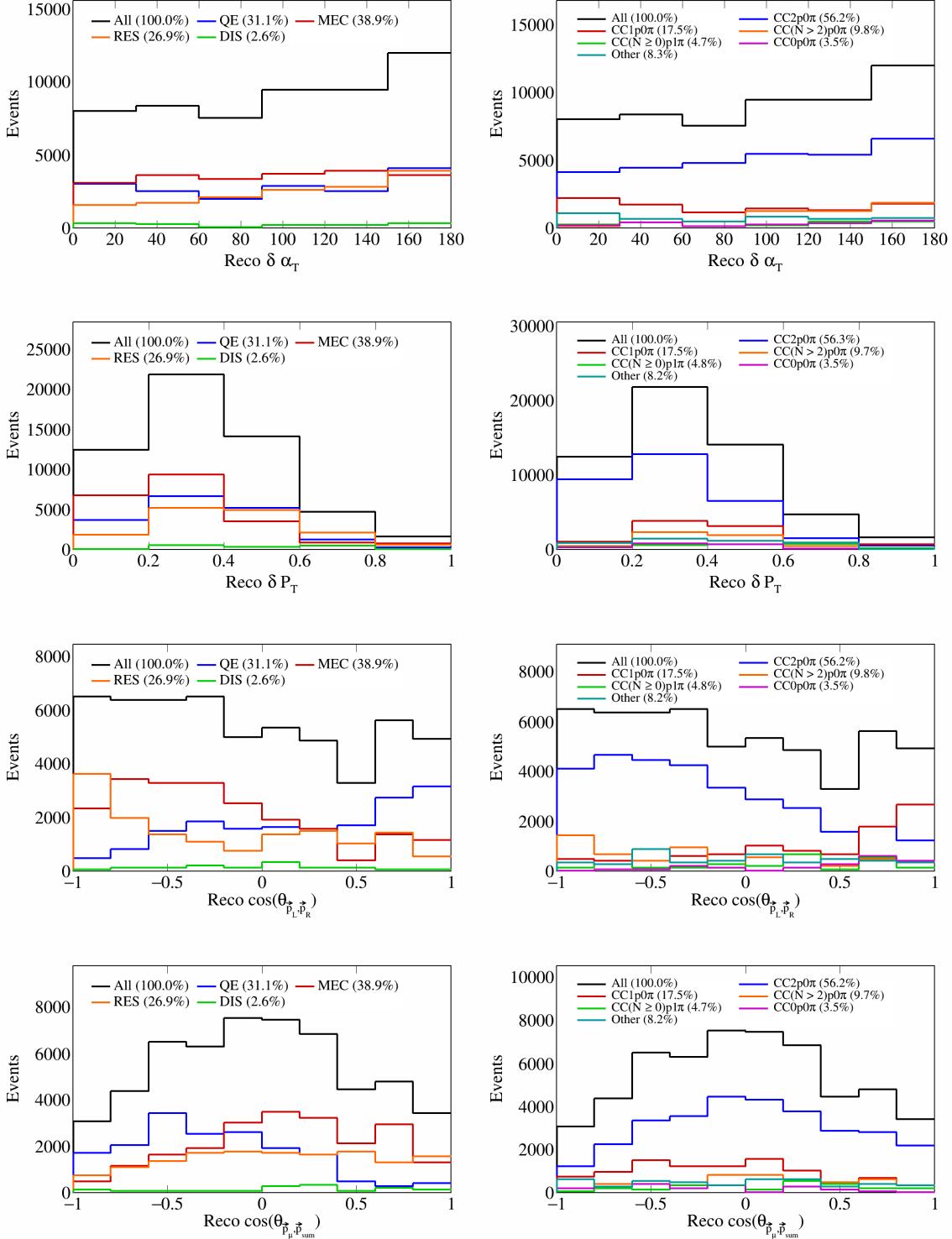


Figure 34: Interaction and topology breakdown for opening angles and transverse variables.

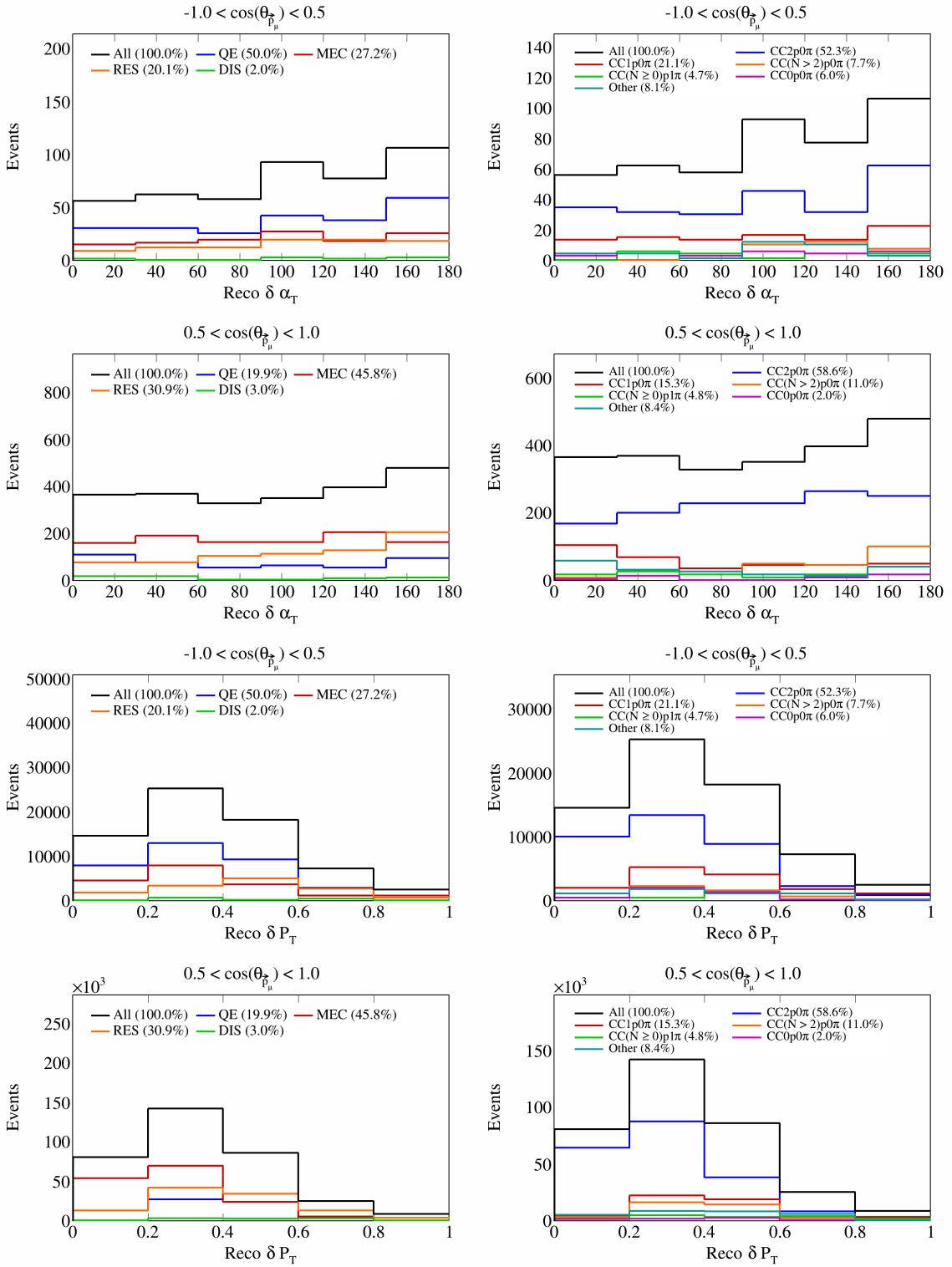


Figure 35: Interaction and topology breakdown for double differential transverse variables.

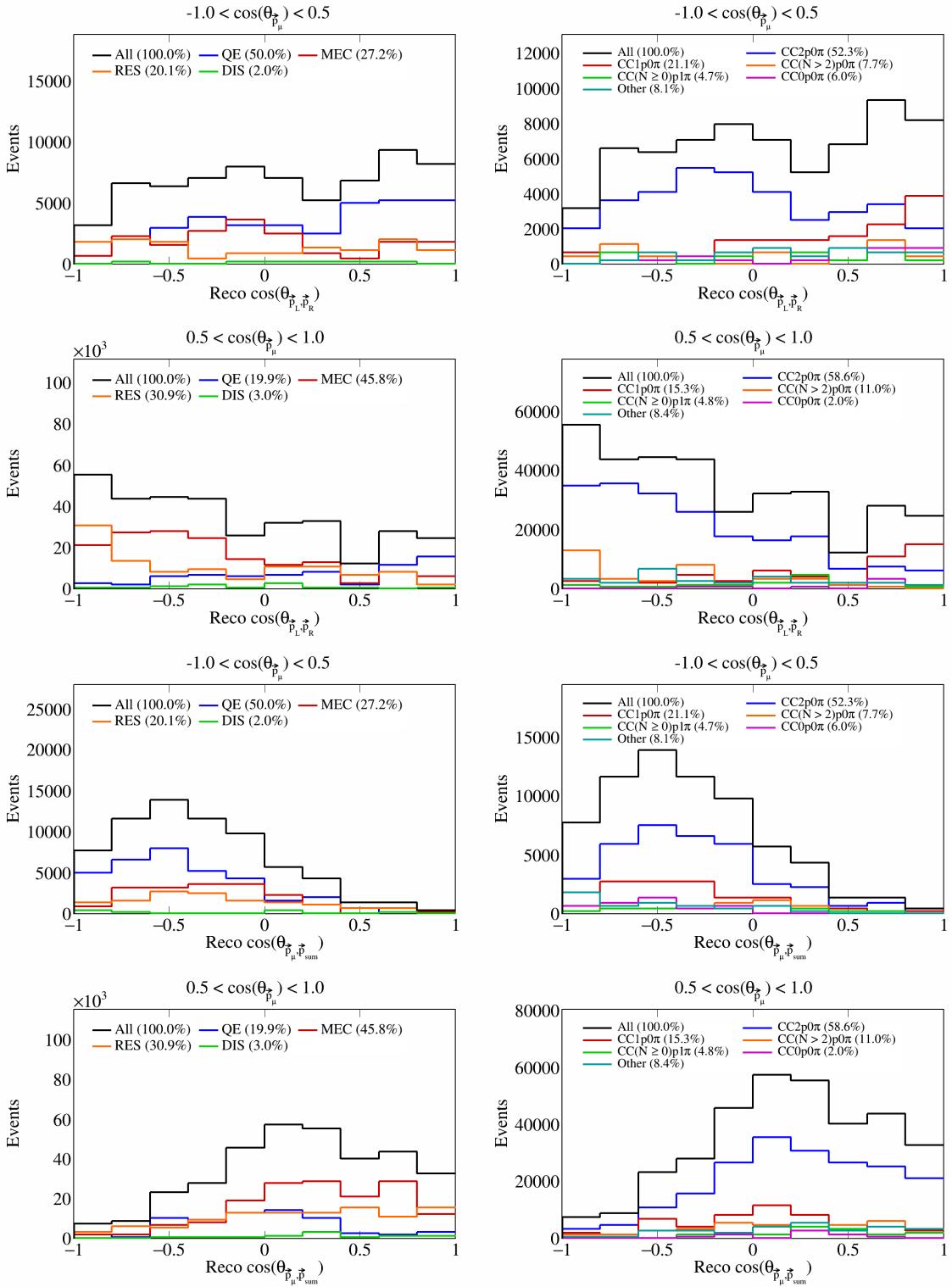


Figure 36: Interaction and topology breakdown for double differential opening angles.

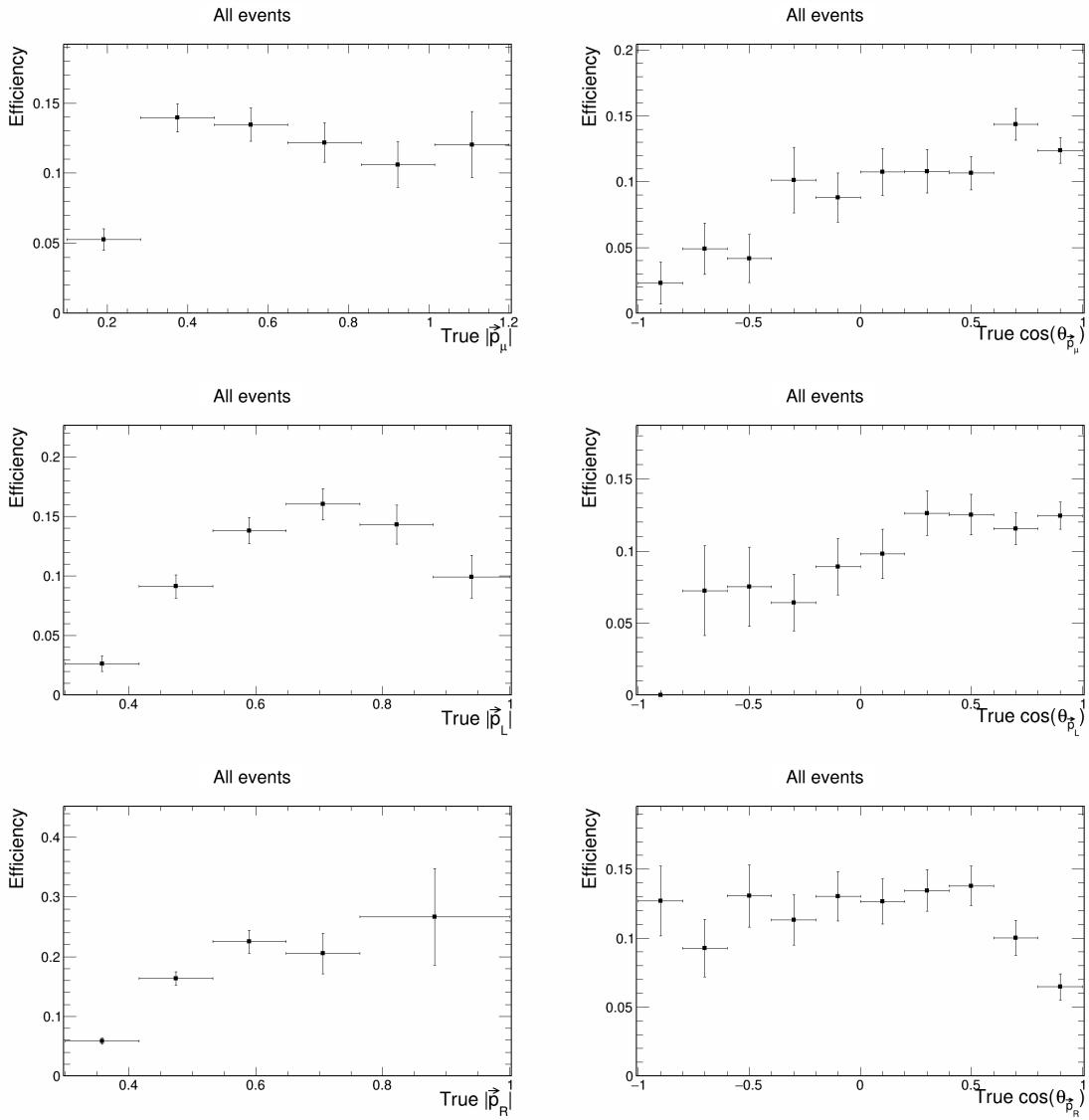


Figure 37: Signal efficiency plots for single differential vector directions and magnitudes.

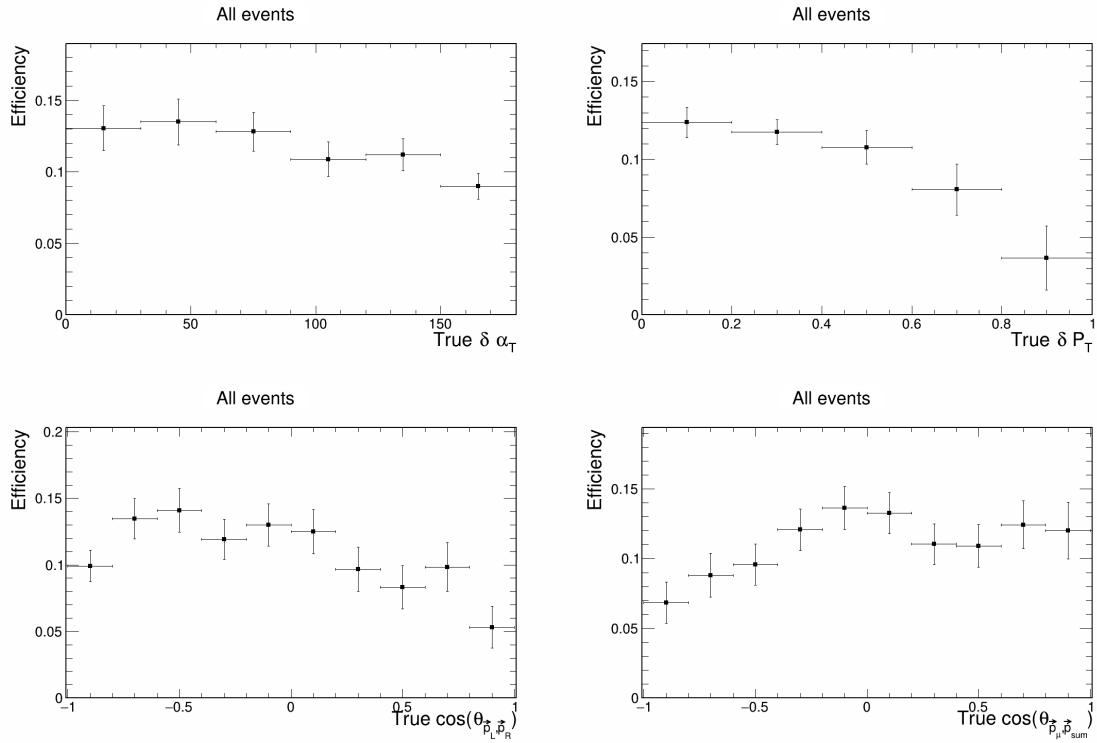


Figure 38: Signal efficiency plots for single differential vector opening angles and transverse momentum.

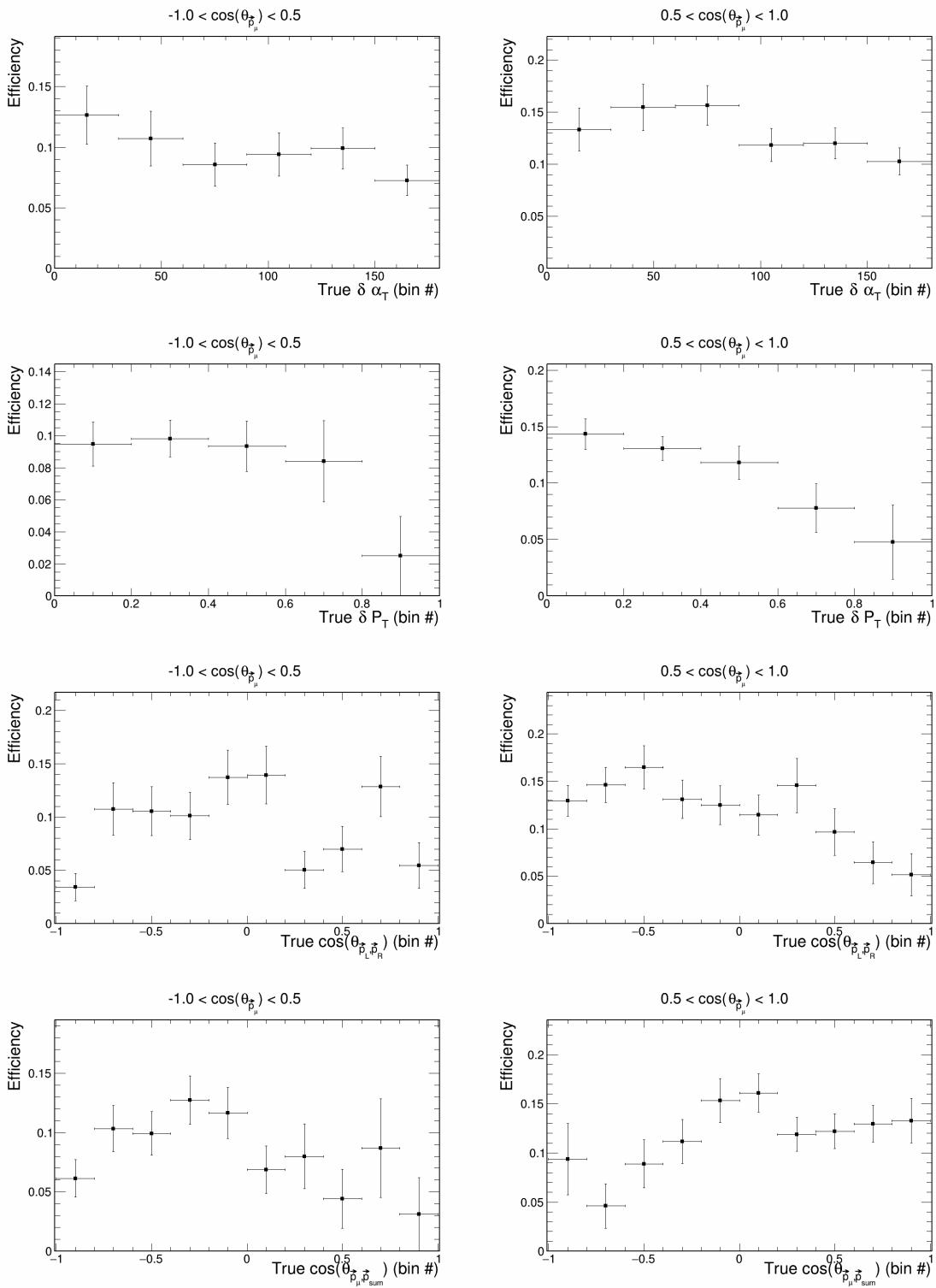


Figure 39: Signal efficiency plots for double differential variables.

168 **3.6 Migration and response matrices**

169 Further, we compute migration matrices which give us a measure of how reliable our reconstructed variables
170 are. A given column in this matrix represents a bin of the truth variable, i.e., the value with which the
171 event was generated. Then, each row corresponds to a reconstructed bin of the same variable, and each cell
172 corresponds to the probability that an event generated with the truth value corresponding to the column gets
173 reconstructed with the value corresponding to the row. For the migration matrix, we consider true signal
174 events that were reconstructed and satisfy our signal definition in the denominator. Therefore, the values in
175 each column must add up to 1. The migration matrices for the single differential variables are presented in
176 Figure 40 and Figure 41. The migration matrices for the double differential variables (given in terms of the
177 bin number) are presented in Figure 42.

178 Response matrices are computed in a similar manner, but using the total number of generated events in the
179 denominator when computing the ratios, i.e., without requiring the events to be successfully reconstructed.
180 Therefore, for these matrices, the columns of the response matrices do not have to add up to 1. The response
181 matrices for single differential variables are presented in Figure 43 and Figure 44, and the double differential
182 response matrices are given in Figure 45.

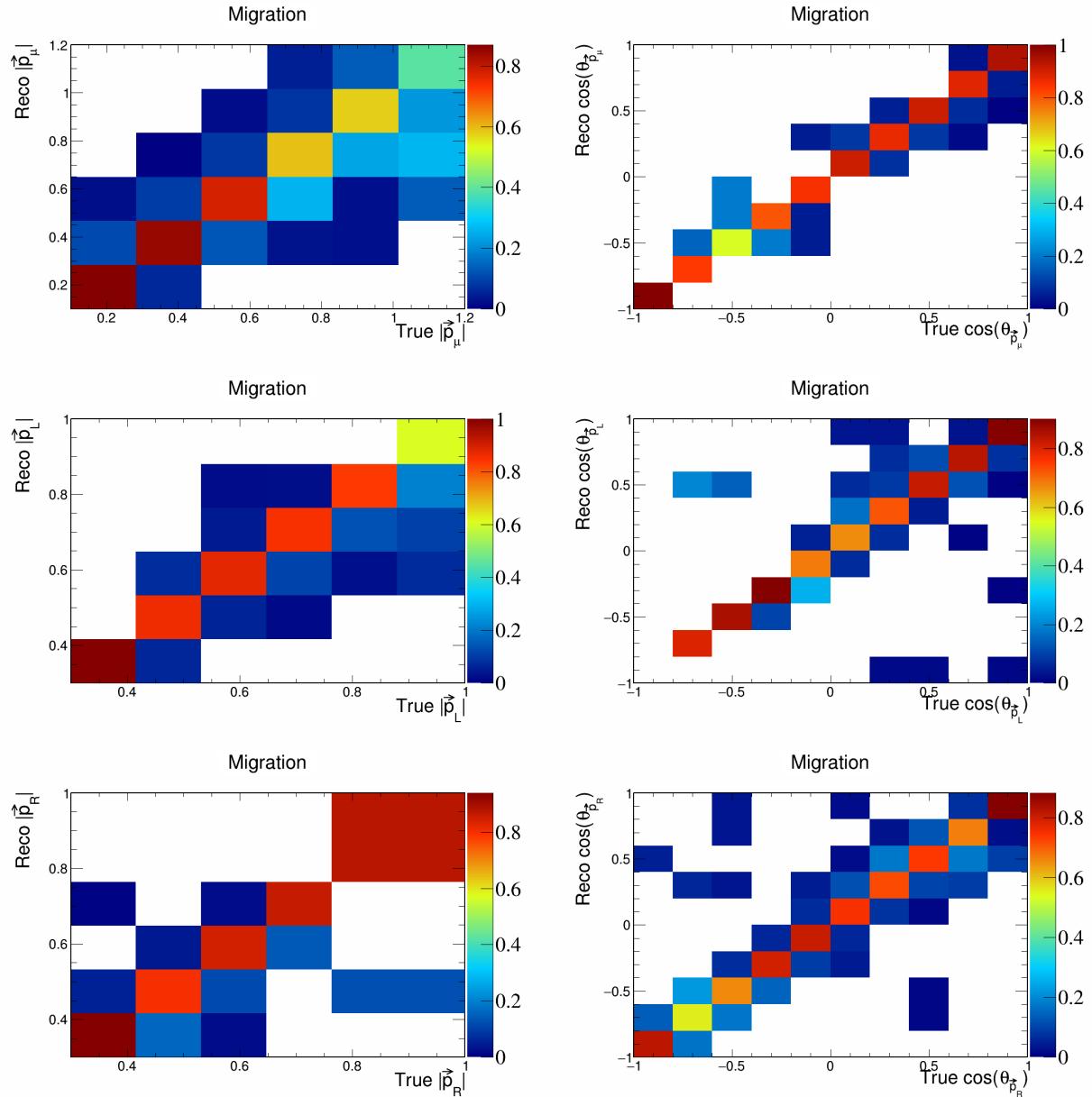


Figure 40: Migration matrices for signal differential vector directions and magnitudes.

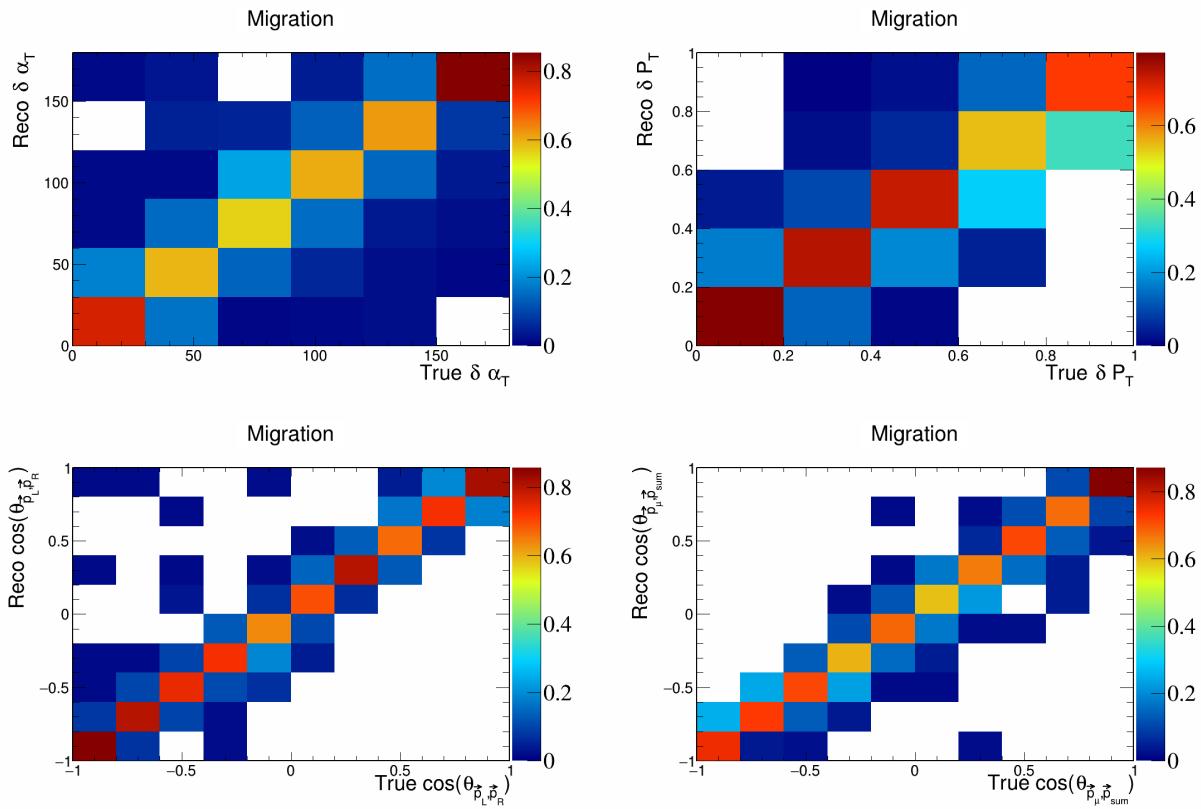


Figure 41: Migration matrices for signal differential vector opening angles and transverse momentum.

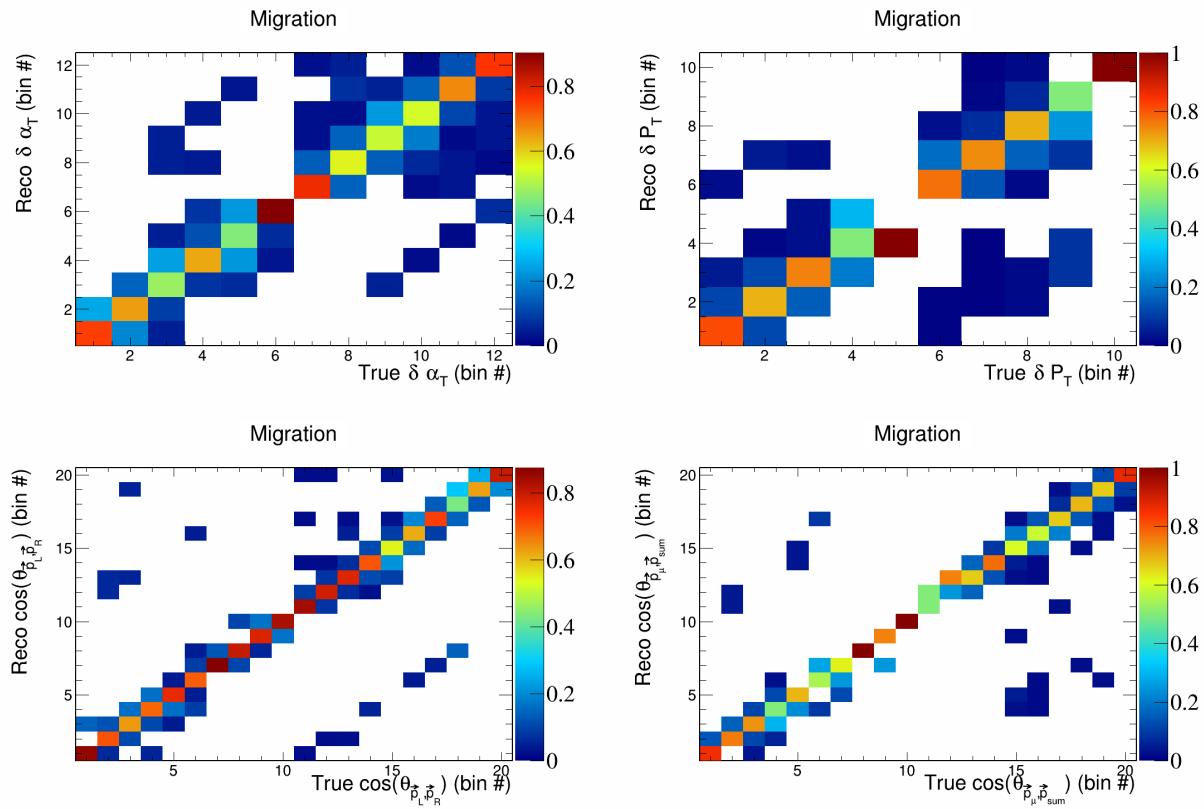


Figure 42: Migration matrices for double differential variables.

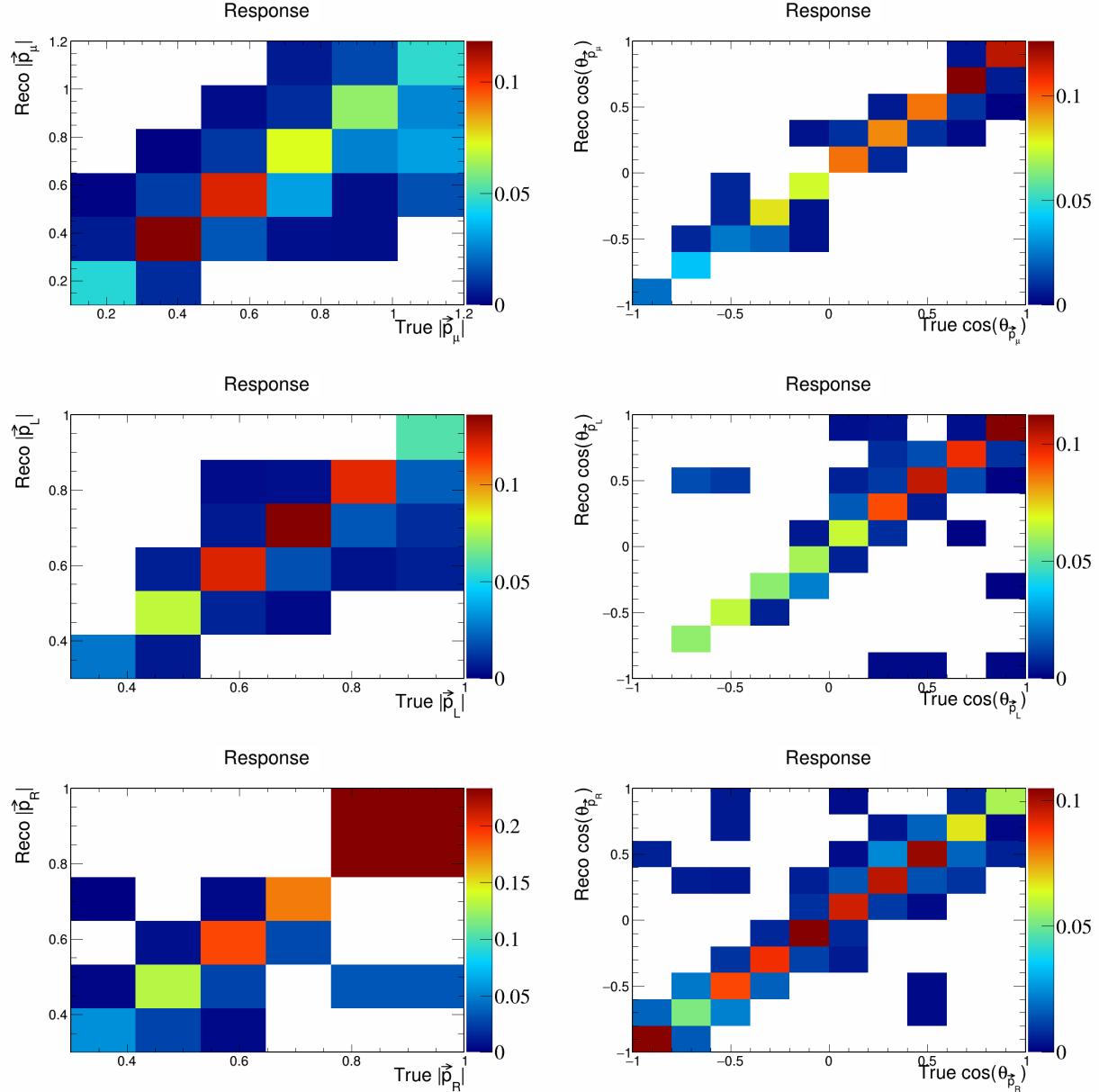


Figure 43: Response matrices for signal differential vector directions and magnitudes.

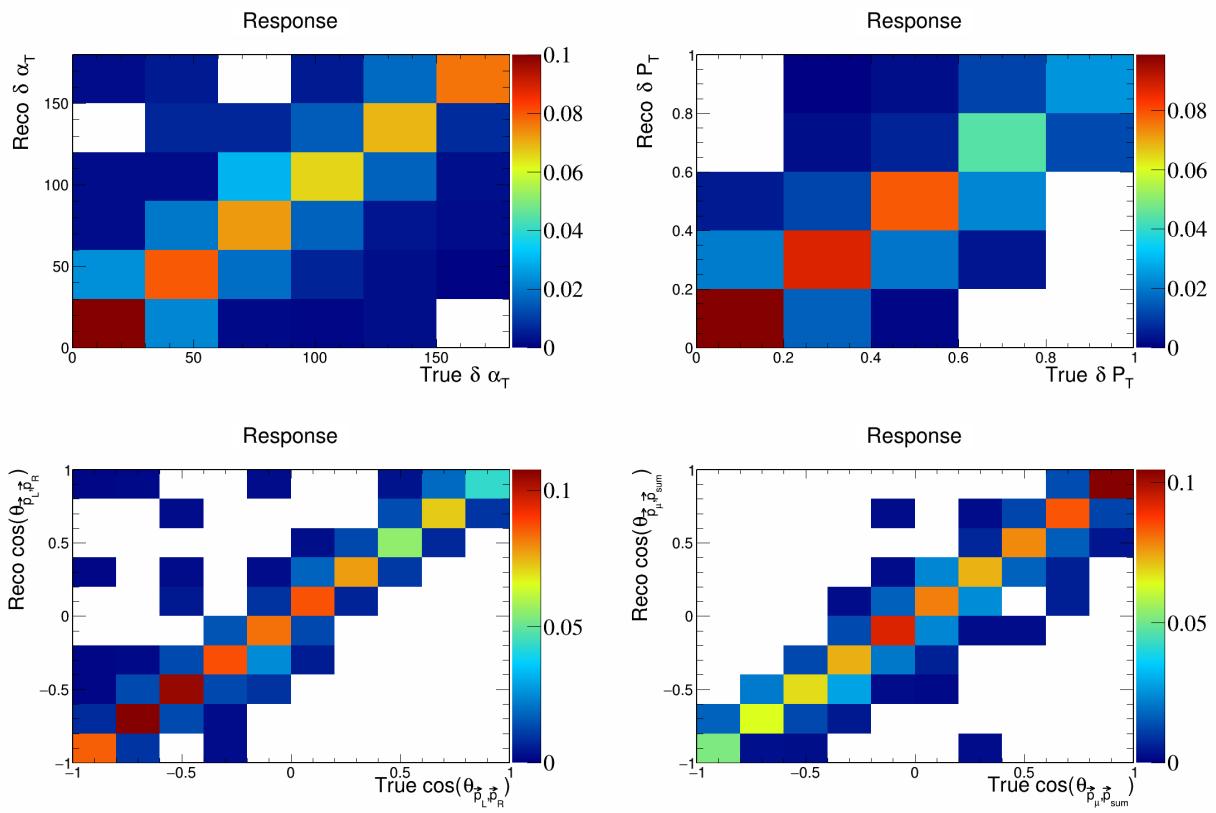


Figure 44: Response matrices for signal differential vector opening angles and transverse momentum.

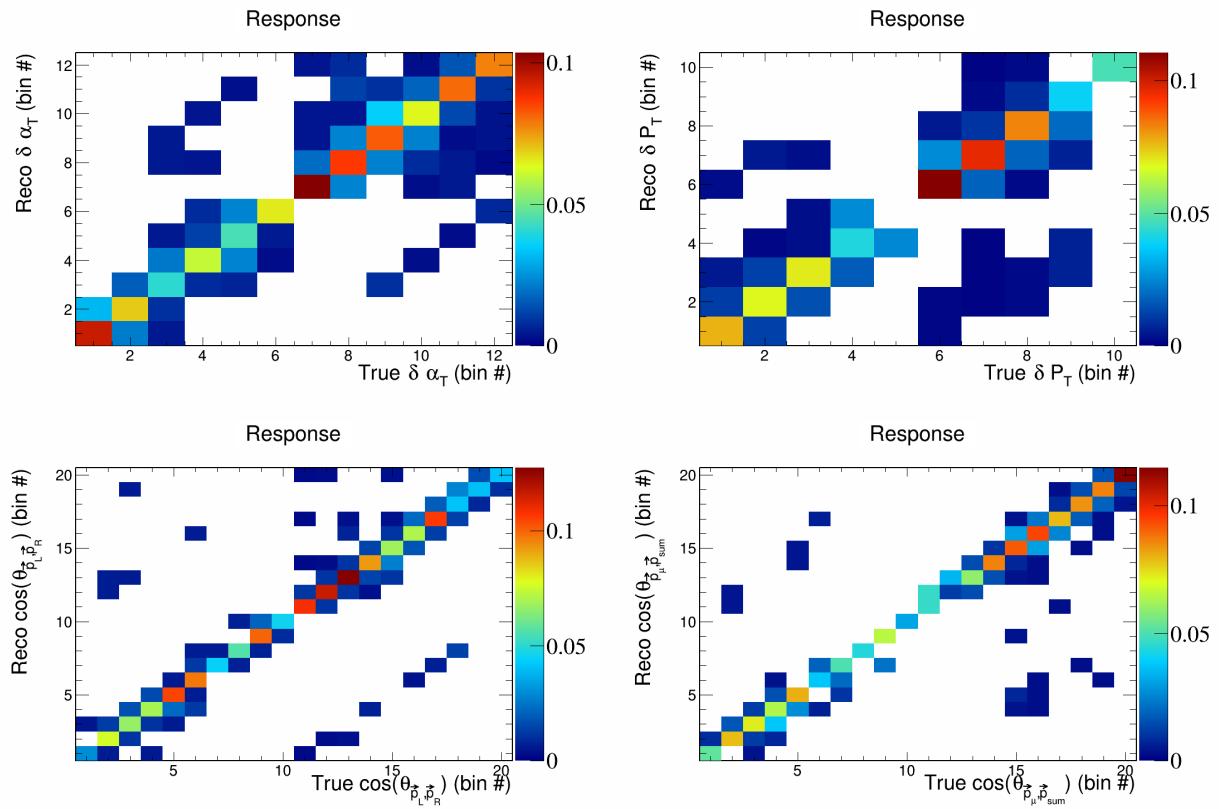


Figure 45: Response matrices for double differential variables.

183 **3.7 Systematics**

184 To include systematic uncertainties in our study, we first consider cross sectional systematics. These are
 185 variations in the cross section models used to generate the events. They can be of two types: multisigma
 186 and multisim. For the former, we consider a 1σ variation of the affected parameters, and in the latter we
 187 consider one hundred universes, each with a random variation picked from a Gaussian distribution between
 188 0σ and 1σ . From these variations, we compute the covariance matrix as

$$E_{i,j} = \frac{1}{N_{\text{Univ}}} \sum_{s=1}^{N_{\text{Univ}}} (\tilde{\sigma}_i^{\text{Var},s} - \tilde{\sigma}_i^{\text{CV}})(\tilde{\sigma}_j^{\text{Var},s} - \tilde{\sigma}_j^{\text{CV}}) \quad (7)$$

189 where $\tilde{\sigma}_i^{\text{Var},s}$ represents the variation cross section of the variable in the i -th bin in the s -th universe, and
 190 $\tilde{\sigma}_i^{\text{CV}}$ is the central value (without any variation) of the cross section in the i -th bin. Then, the fractional
 191 covariance matrix is defined as

$$F_{i,j} = \frac{E_{i,j}}{\tilde{\sigma}_i^{\text{CV}} \tilde{\sigma}_j^{\text{CV}}}. \quad (8)$$

192 And the correlation matrix is defined as

$$\rho_{i,j} = \frac{E_{i,j}}{\sqrt{E_{i,i} E_{j,j}}}. \quad (9)$$

193 In the case of a multisigma systematic, $N_{\text{Univ}} = 1$, and for a multisim systematic, $N_{\text{Univ}} = 100$. The plots
 194 for all the individual cross sectional systematics are shown in Appendix 5.2. Flux systematics are computed
 195 in the same way, but each universe varies a flux parameter. The corresponding plots for the individual
 196 flux systematics are shown in Appendix 5.3. Finally, we also consider statistical systematics. This are
 197 straightforward to compute, as the covariance matrix is given by the square root of the number of elements
 198 in the corresponding bin in the histogram. These statistical covariance matrices are shown in Appendix 5.4.
 199 The total covariance matrices for each variable are shown in Figures 46 and 47.

200 **3.8 Closure test**

201 We use the total covariance matrices obtained from all the systematics and shown in the previous section
 202 to unfold our data. We perform this unfolding following the Wiener-SVD method [27], which for a given
 203 variable takes as input a response matrix, true signal histogram, a reconstructed signal histogram, and the
 204 covariance matrix. The output is the unfolded spectrum and a smearing matrix that can be used to smear
 205 true signal histograms.

206 To ensure that the unfolding techniques that we will implement work correctly, we perform a closure test,
 207 meaning that we will perform the unfolding on simulated true signal events and check that the unfolded
 208 data matches the true signal data with added smearing. We can see that the plots that perform this test
 209 in Figure 48 and Figure 49. We also note that the overall shape and magnitude of our histograms match
 210 previously reported MicroBooNE analyses.

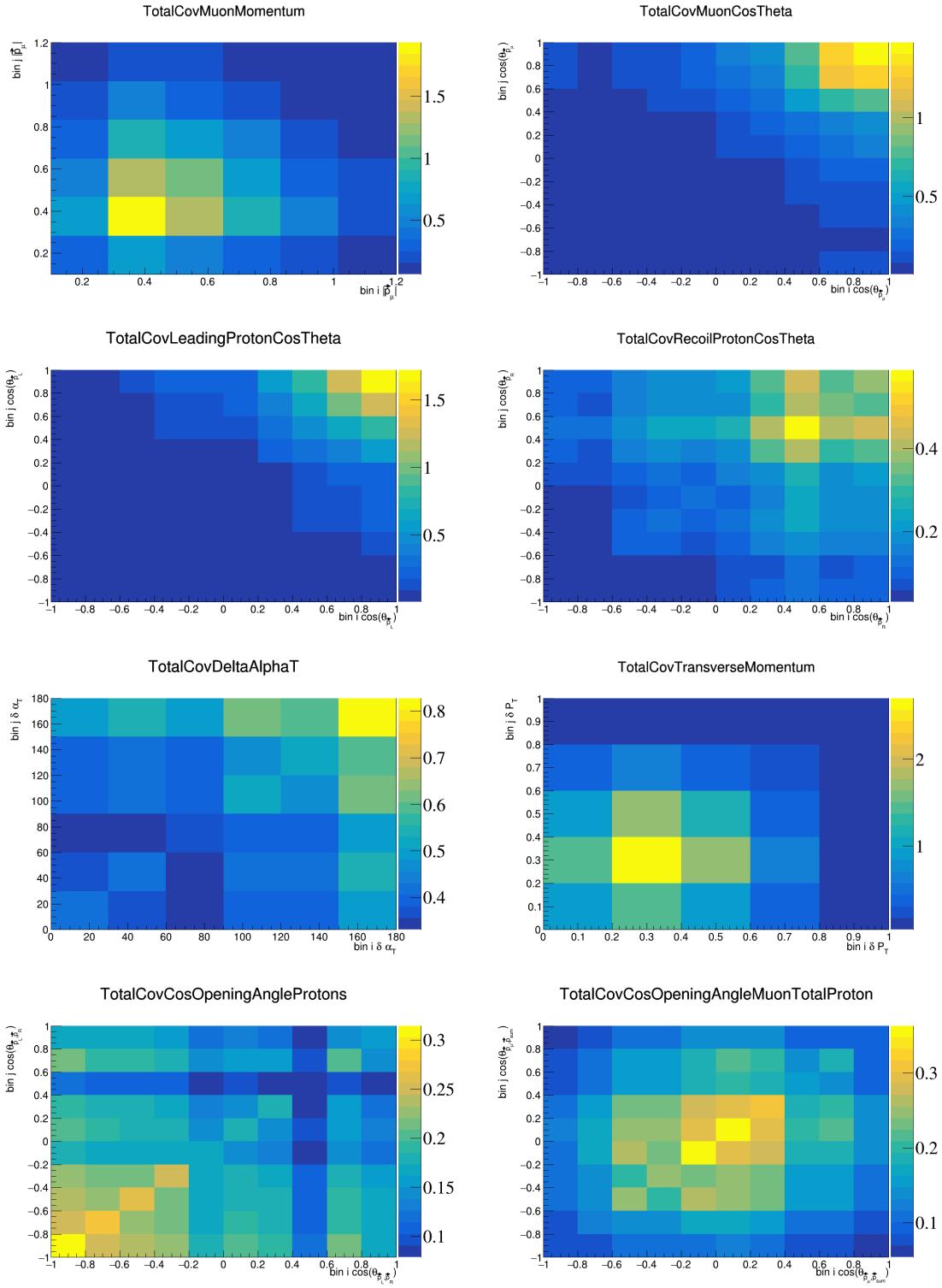


Figure 46: Total covariance matrices for single differential variables.

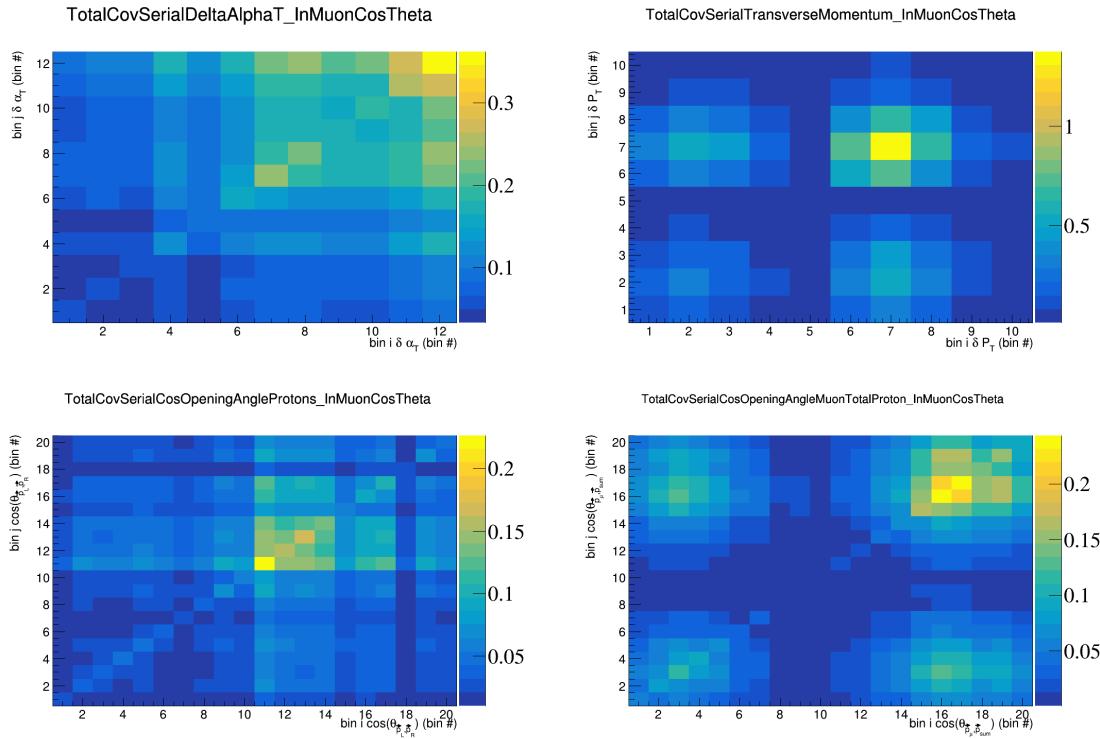


Figure 47: Total covariance matrices for double differential variables.

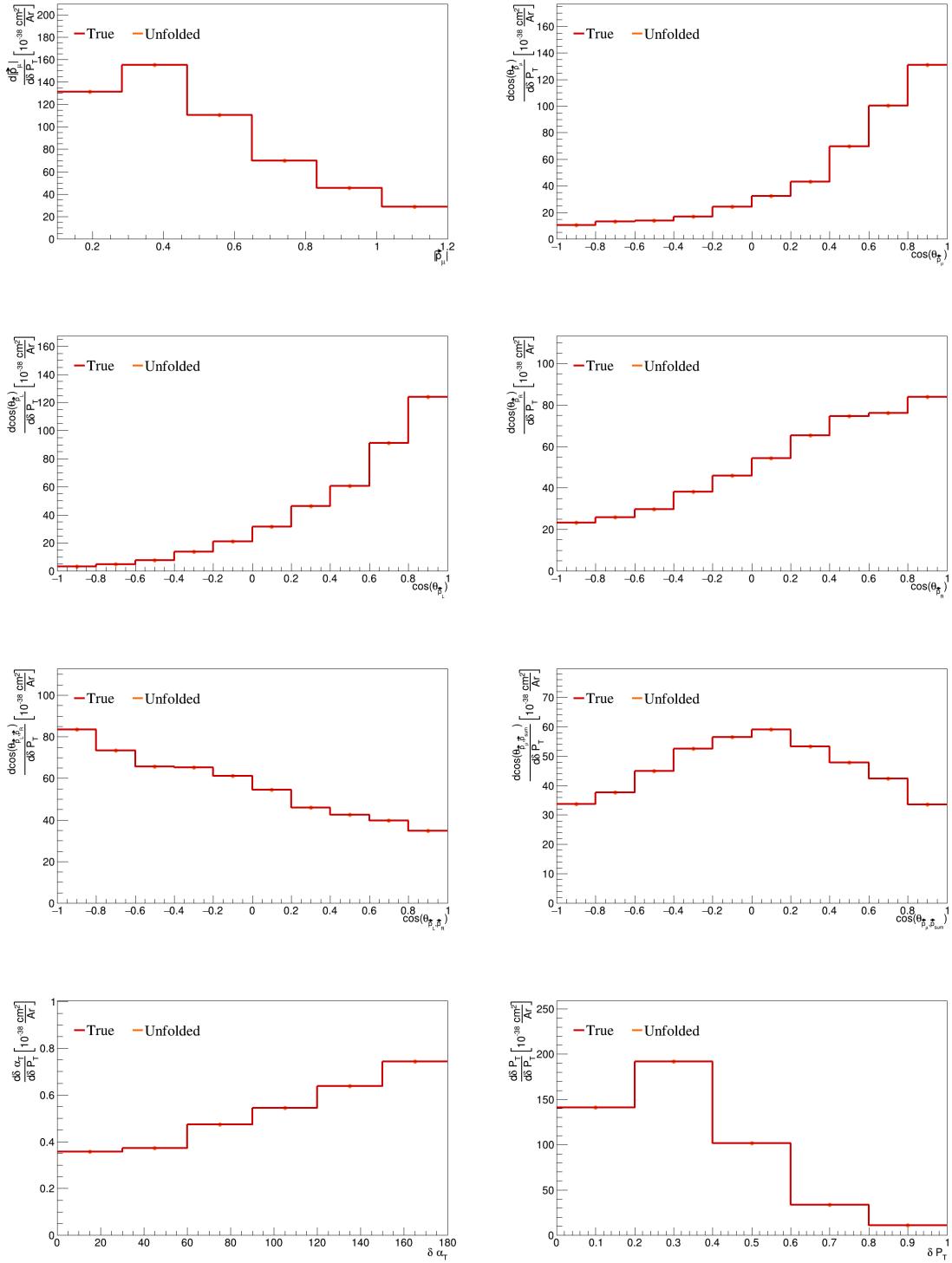


Figure 48: Closure test single differential plots.

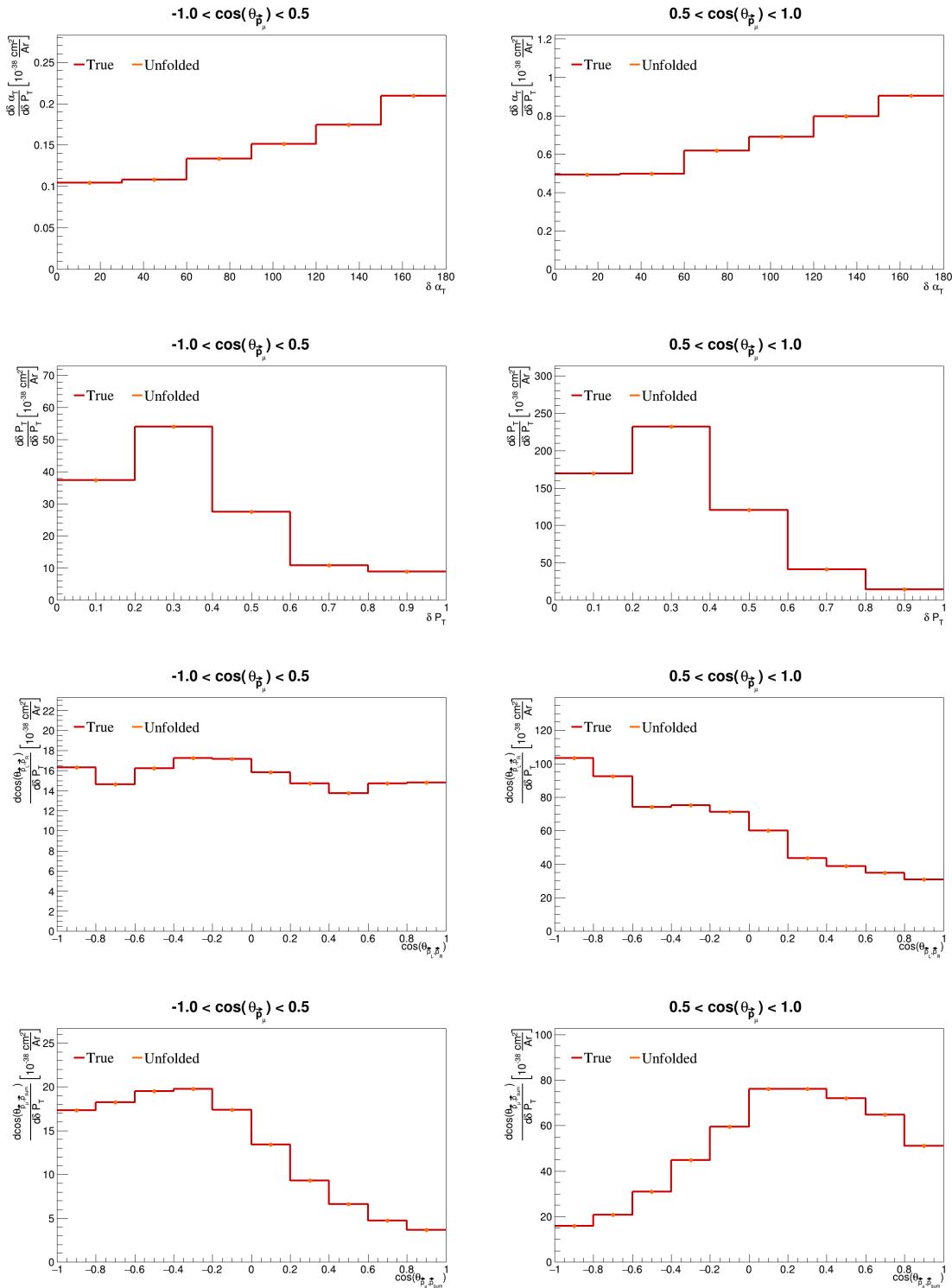


Figure 49: Closure test double differential plots.

211 3.9 Bin by bin uncertainties

212 Figure 50 shows the single bin uncertainty breakdown using the event rates. We used the square root of the
 213 relevant fractional covariance matrix for each of the outlined sources of uncertainty to obtain the figure.

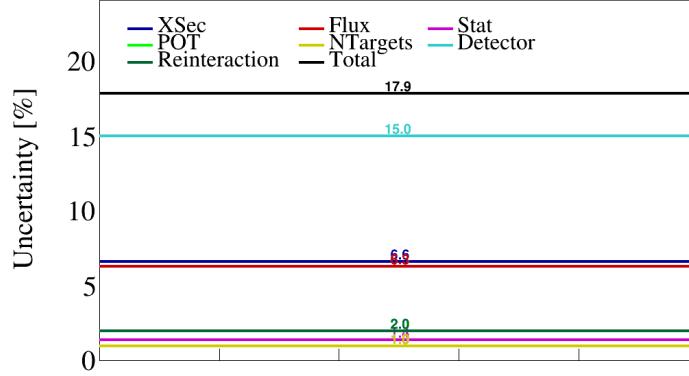


Figure 50: Fractional contribution for the sources of uncertainty using the event rates.

214 Figure 51 shows the single bin uncertainty breakdown using the cross sections. We used the unfolded
 215 covariances obtained with the Wiener-SVD filter for each of the sources of uncertainty. The square root of the
 216 corresponding fractional covariance matrix is normalized to the CV cross-section value for the uncertainties
 217 to be obtained.

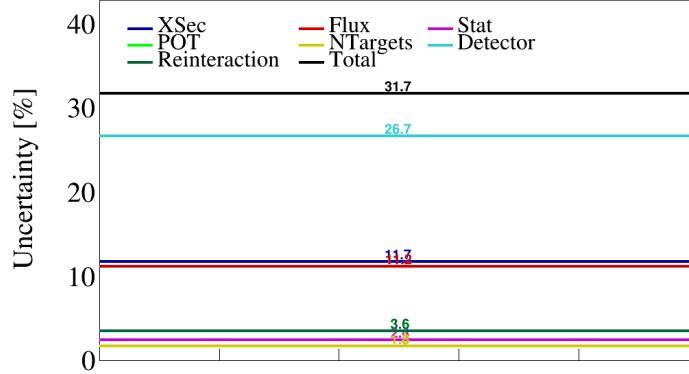


Figure 51: Fractional contribution for the sources of uncertainty using the cross sections.

218 The bin by bin event rate uncertainties for all our variables are shown in Figures 52 to 54. The bin by
 219 bin cross section uncertainties for all our variables are shown in Figures 55 to 57.

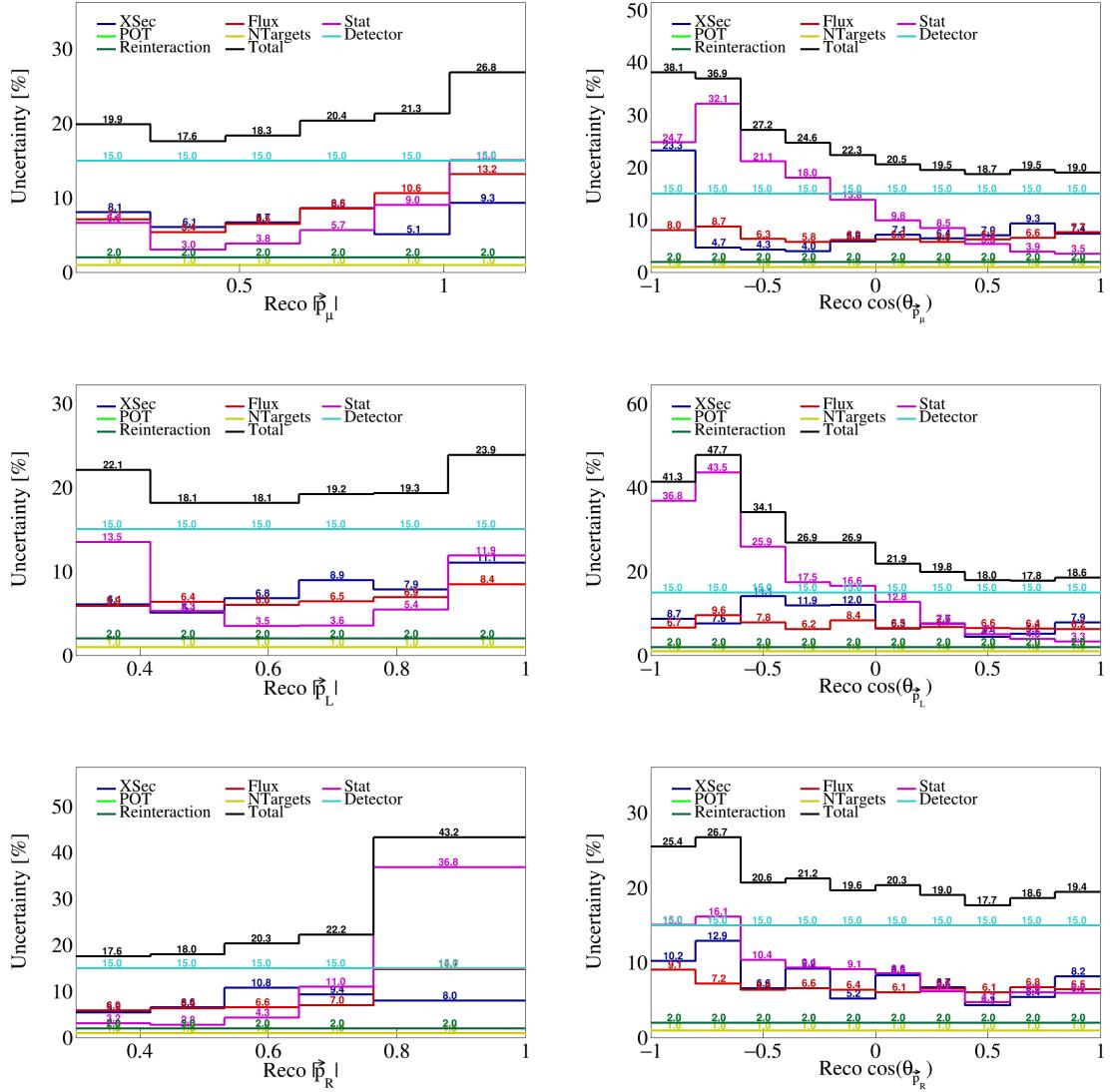


Figure 52: Bin by bin event rate uncertainties for single differential vector directions and magnitudes.

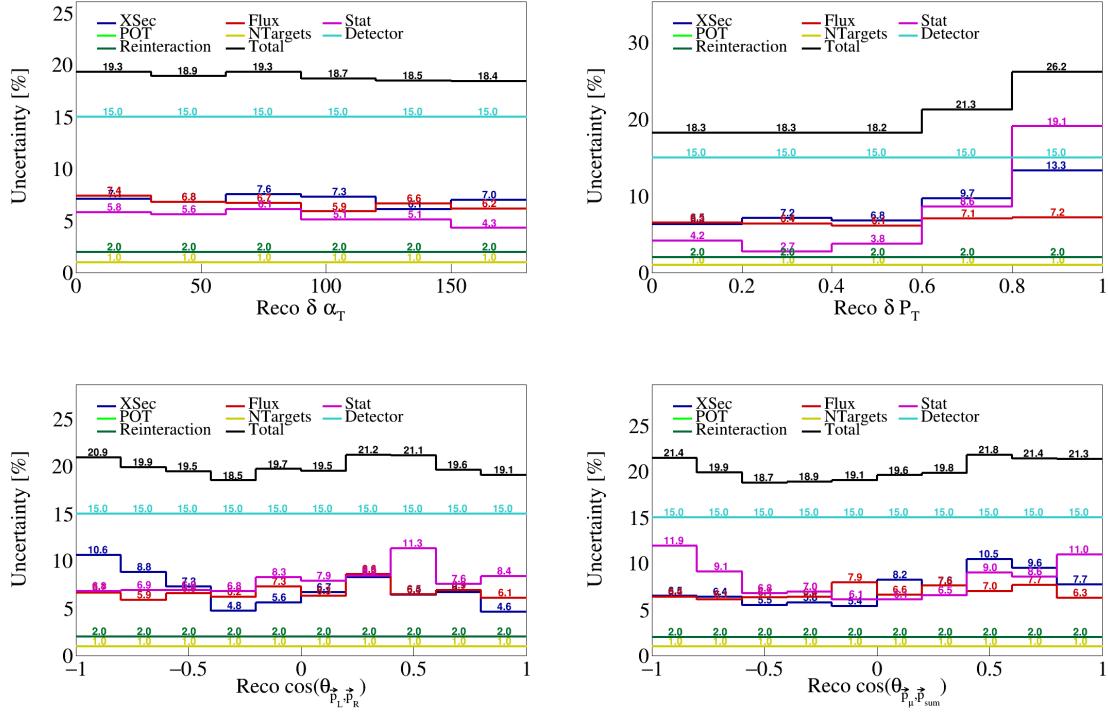


Figure 53: Bin by bin event rate uncertainties for single differential vector opening angles and transverse momentum.

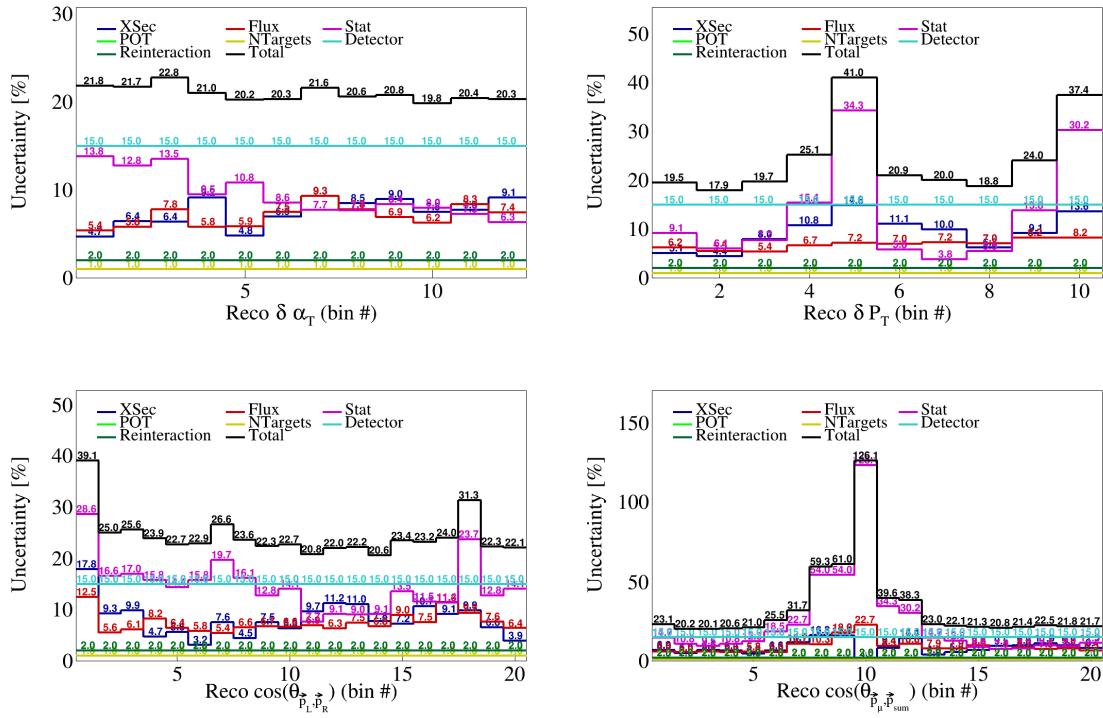


Figure 54: Bin by bin event rate uncertainties for double differential variables.

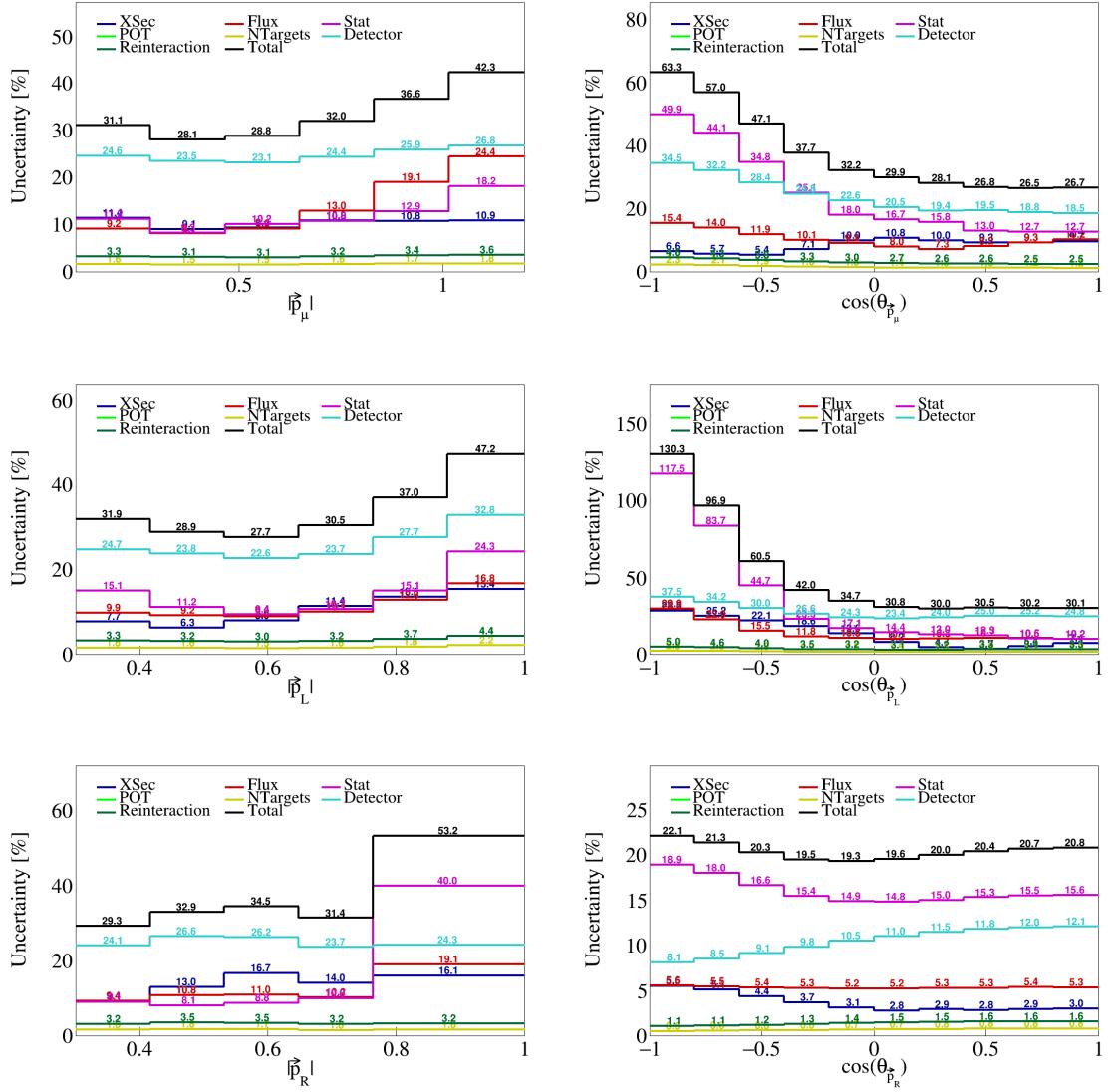


Figure 55: Bin by bin event cross-section uncertainties for single differential vector directions and magnitudes.

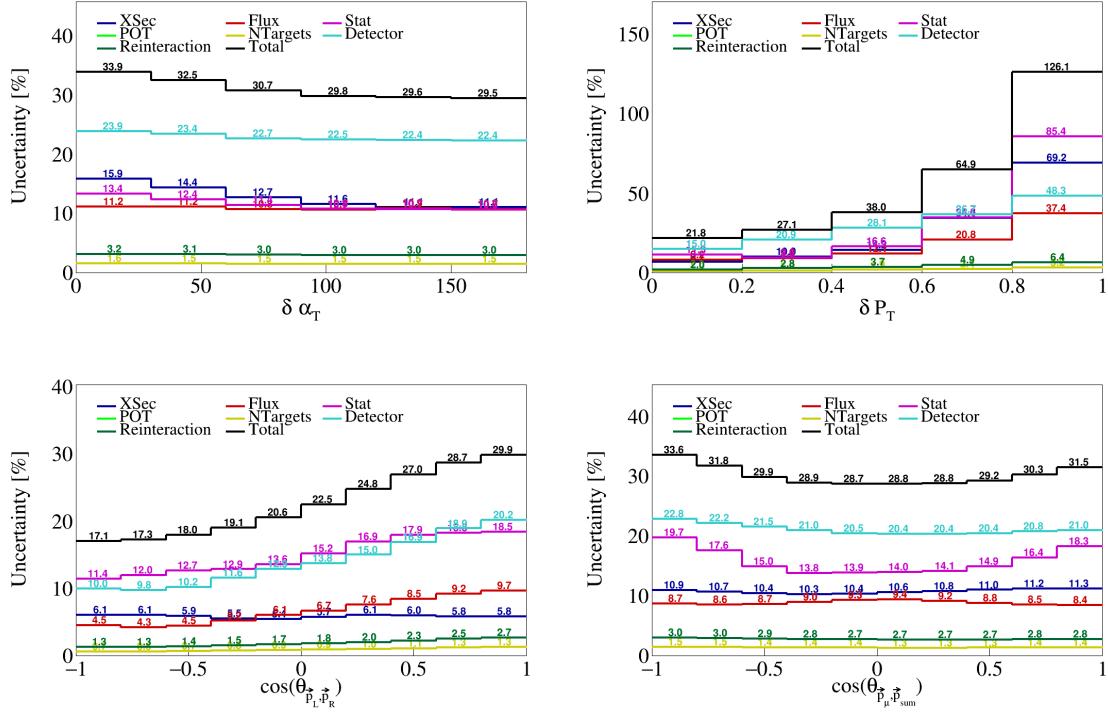


Figure 56: Bin by bin cross-section uncertainties for single differential vector opening angles and transverse momentum.

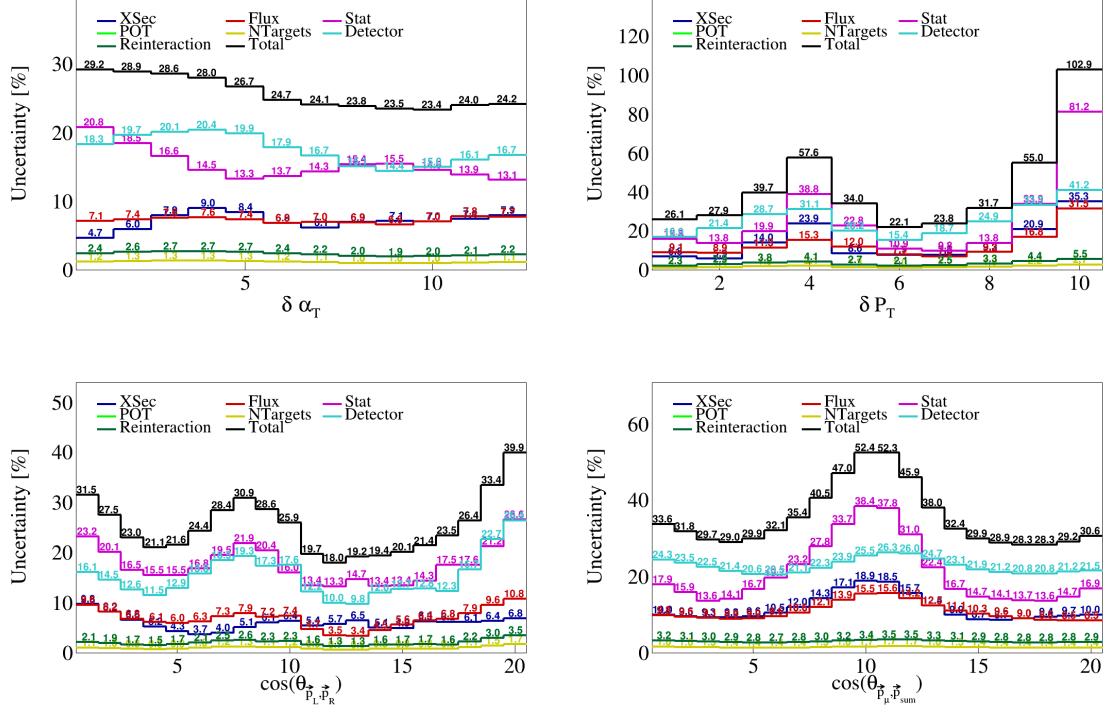


Figure 57: Bin by bin cross-section uncertainties for double differential variables.

220 **4 Cross-section results**

221 Placeholder.

222 5 Appendices

223 5.1 Wiener-SVD additional smearing matrices

224 The additional smearing matrices obtained from the Wiener-SVD unfolding are shown in this section.

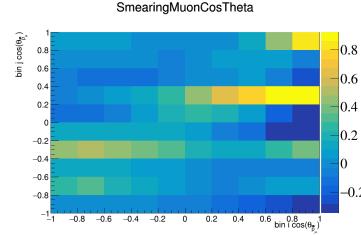


Figure 58: Additional smearing matrix for $\cos(\theta_{\vec{p}_\mu})$.

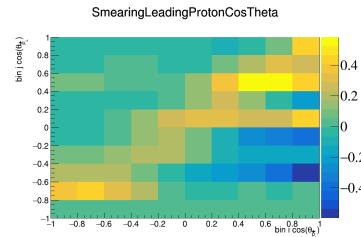


Figure 59: Additional smearing matrix for $\cos(\theta_{\vec{p}_L})$.

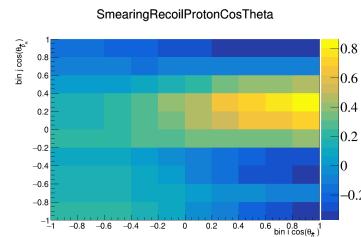


Figure 60: Additional smearing matrix for $\cos(\theta_{\vec{p}_R})$.

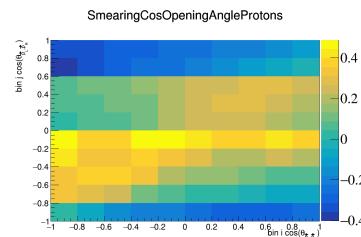


Figure 61: Additional smearing matrix for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

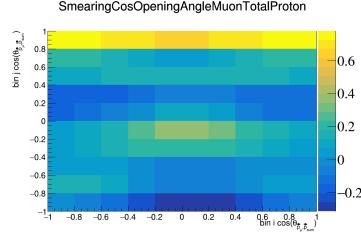


Figure 62: Additional smearing matrix for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

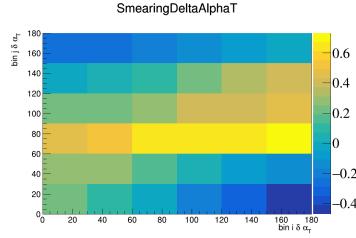


Figure 63: Additional smearing matrix for $\delta\alpha_T$.

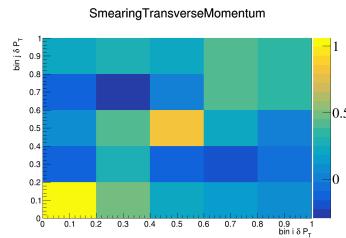


Figure 64: Additional smearing matrix for δP_T .

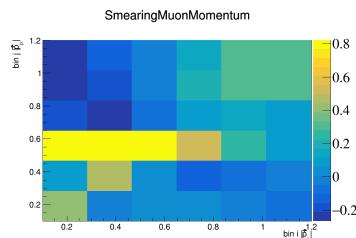


Figure 65: Additional smearing matrix for $|\vec{p}_\mu|$.

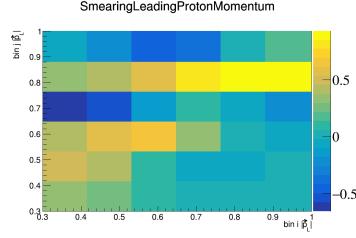


Figure 66: Additional smearing matrix for $|\vec{p}_L|$.

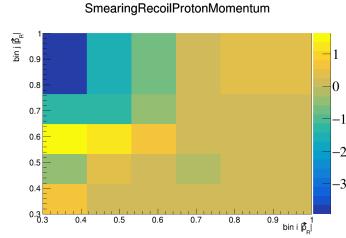


Figure 67: Additional smearing matrix for $|\vec{p}_R|$.

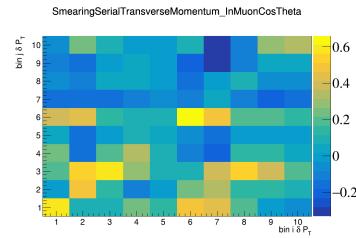


Figure 68: Additional smearing matrix for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

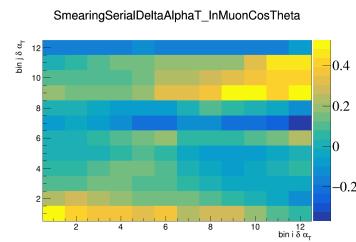


Figure 69: Additional smearing matrix for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

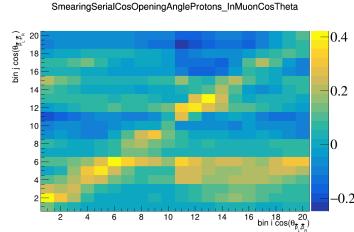


Figure 70: Additional smearing matrix for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

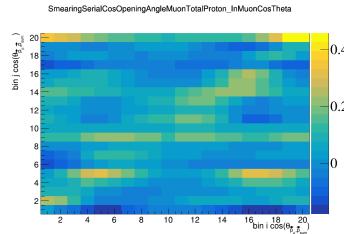


Figure 71: Additional smearing matrix for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

225 5.2 Cross section systematics

226 In this appendix, the variations, covariance matrices, fractional covariance matrices, and correlation matrices
 227 are plotted for all of the cross section systematics and variables.

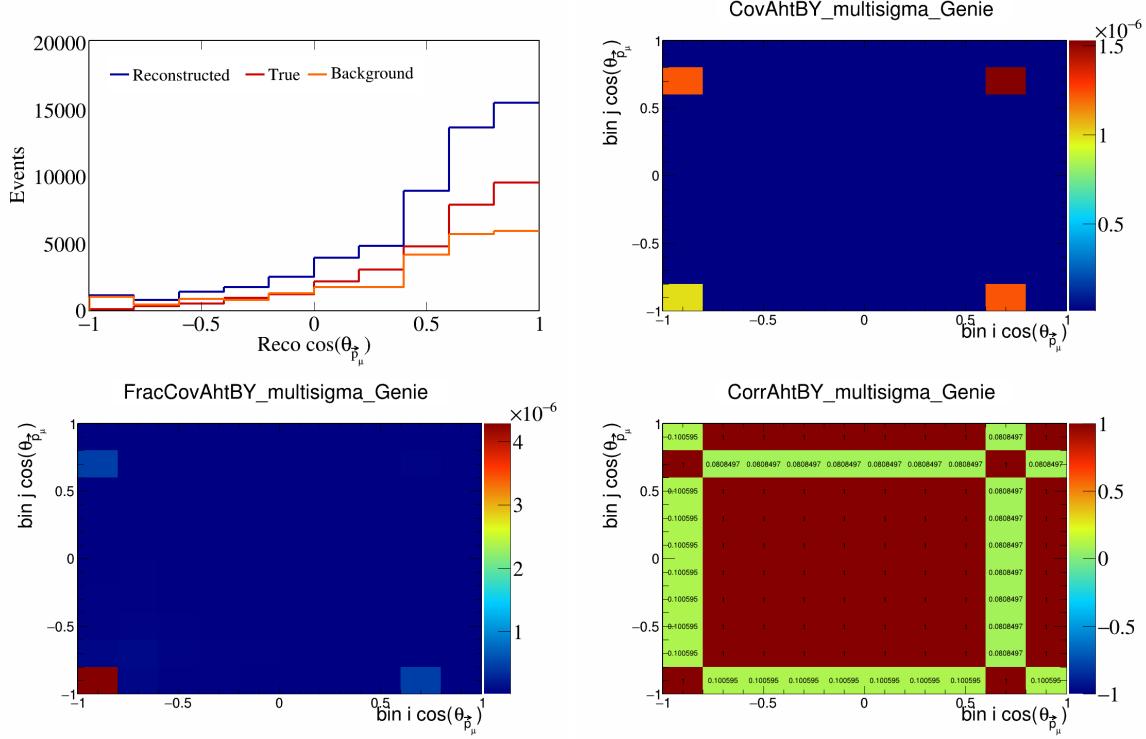


Figure 72: AhtBY variations for $\cos(\theta_{\vec{p}_\mu})$.

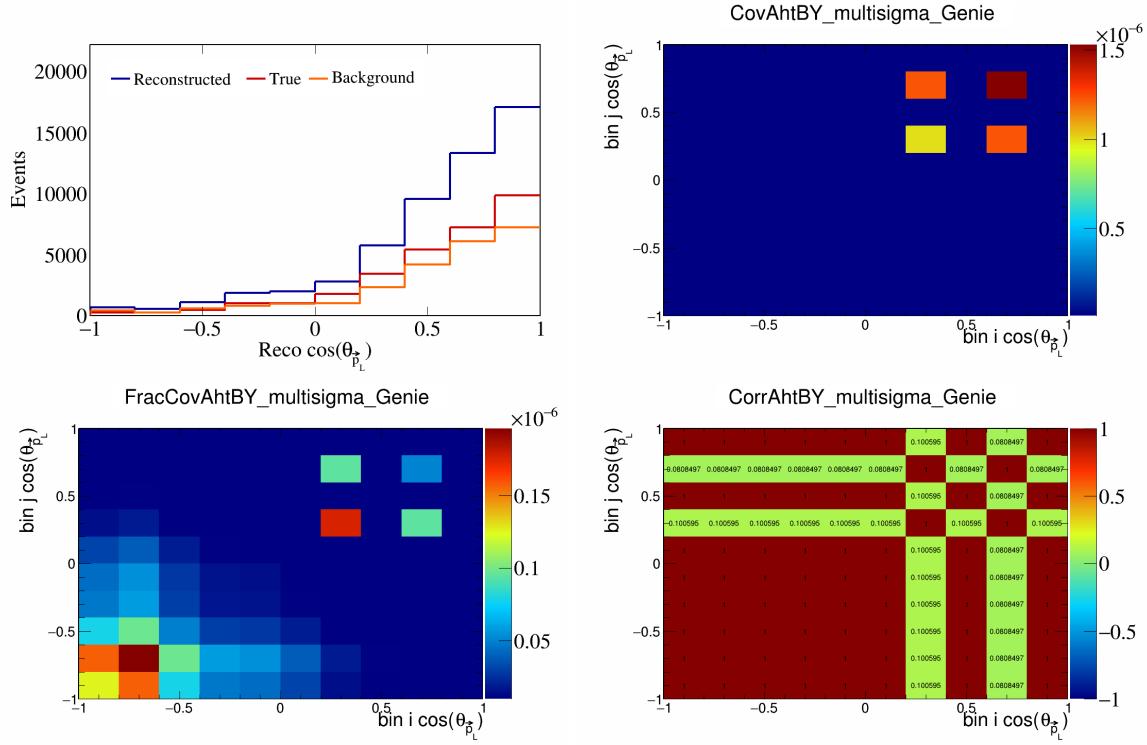


Figure 73: AhtBY variations for $\cos(\theta_{\vec{p}_L})$.

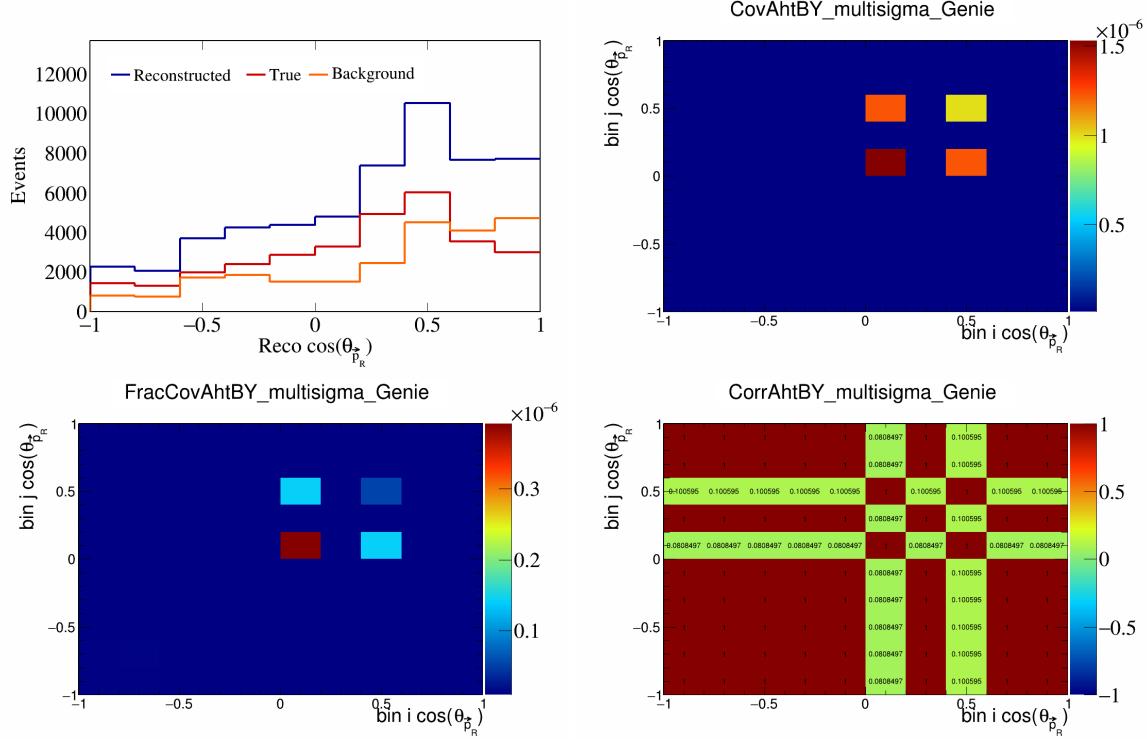


Figure 74: AhtBY variations for $\cos(\theta_{\vec{p}_R})$.

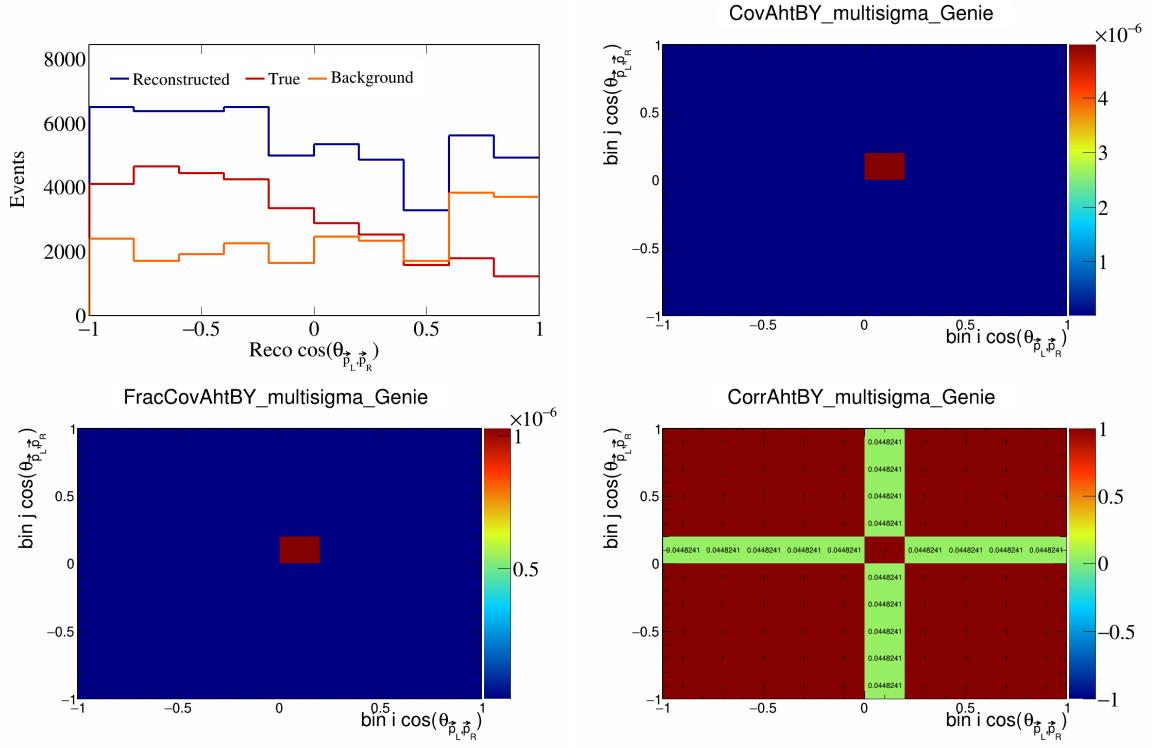


Figure 75: AhtBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

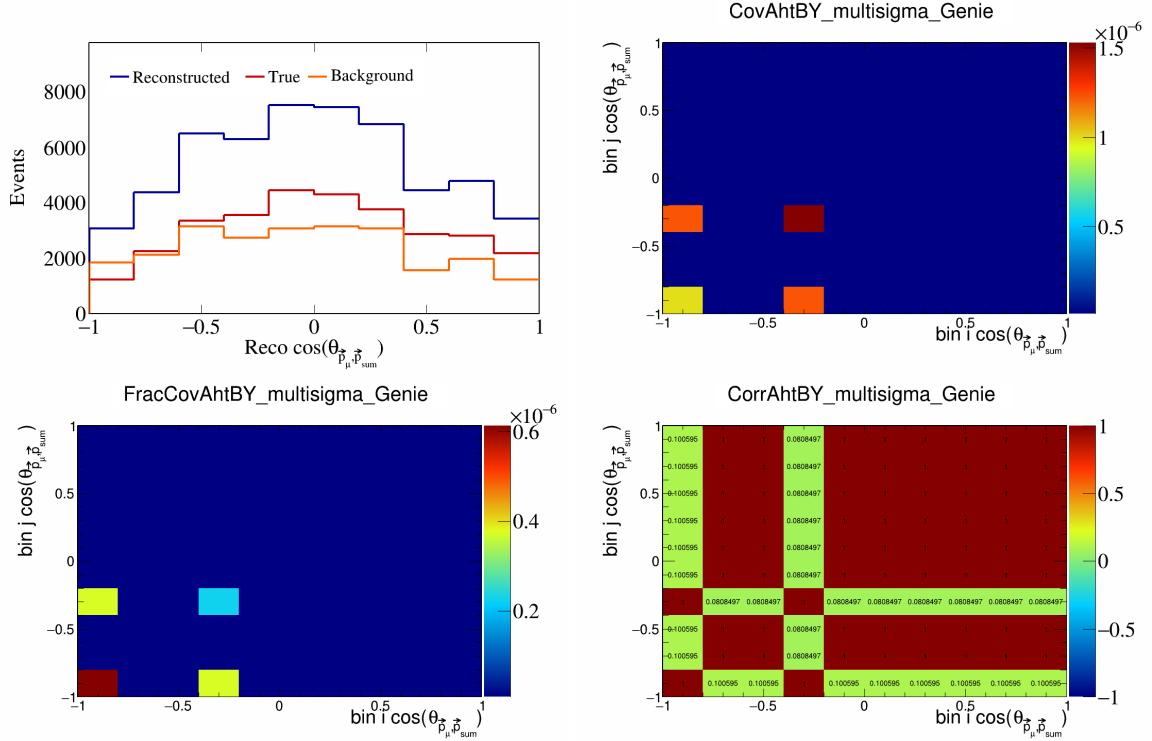


Figure 76: AhtBY variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

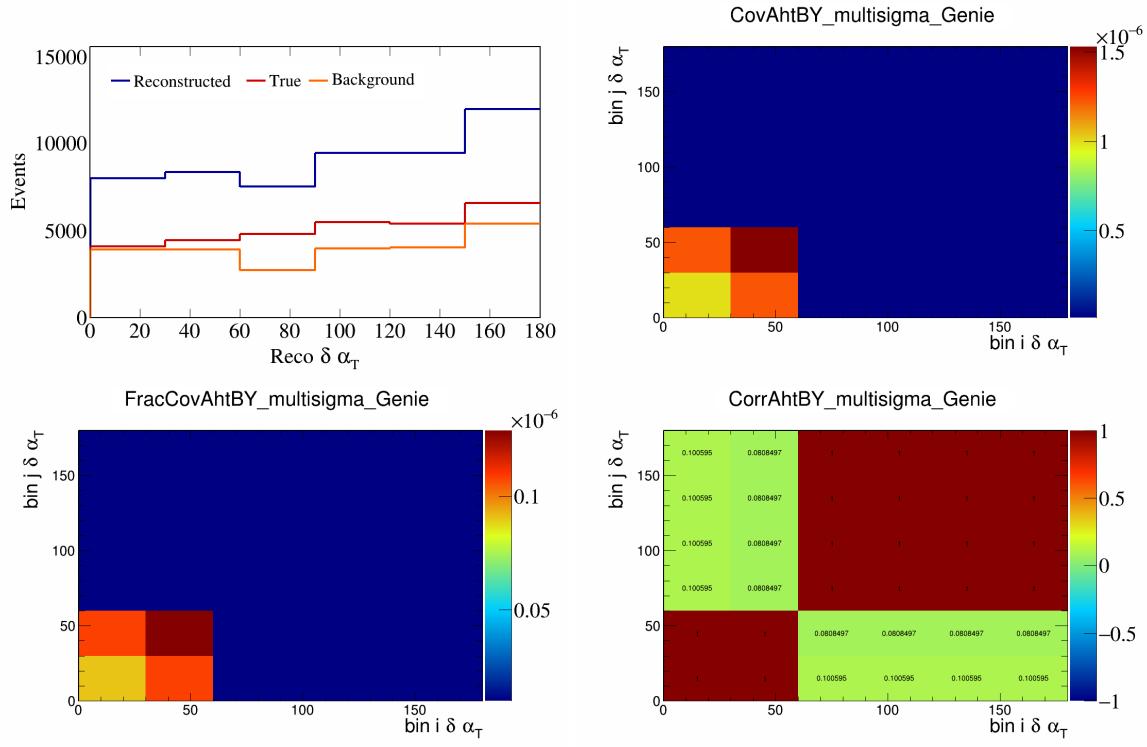


Figure 77: AhtBY variations for $\delta\alpha_T$.

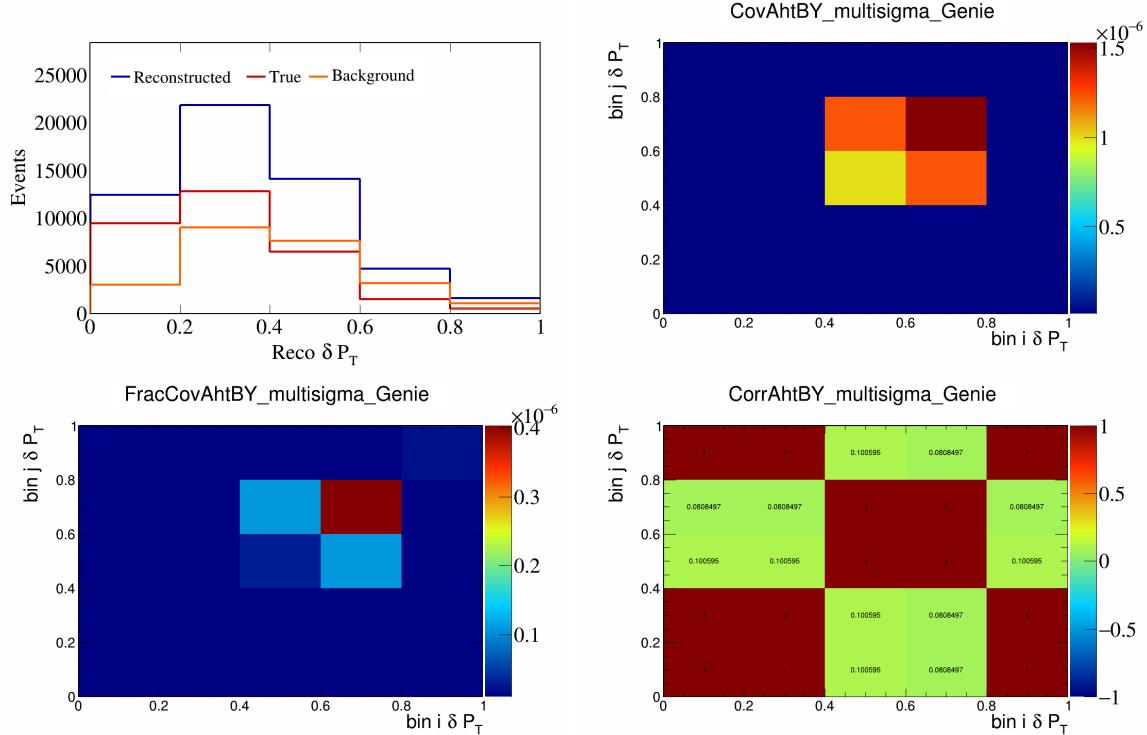


Figure 78: AhtBY variations for δP_T .

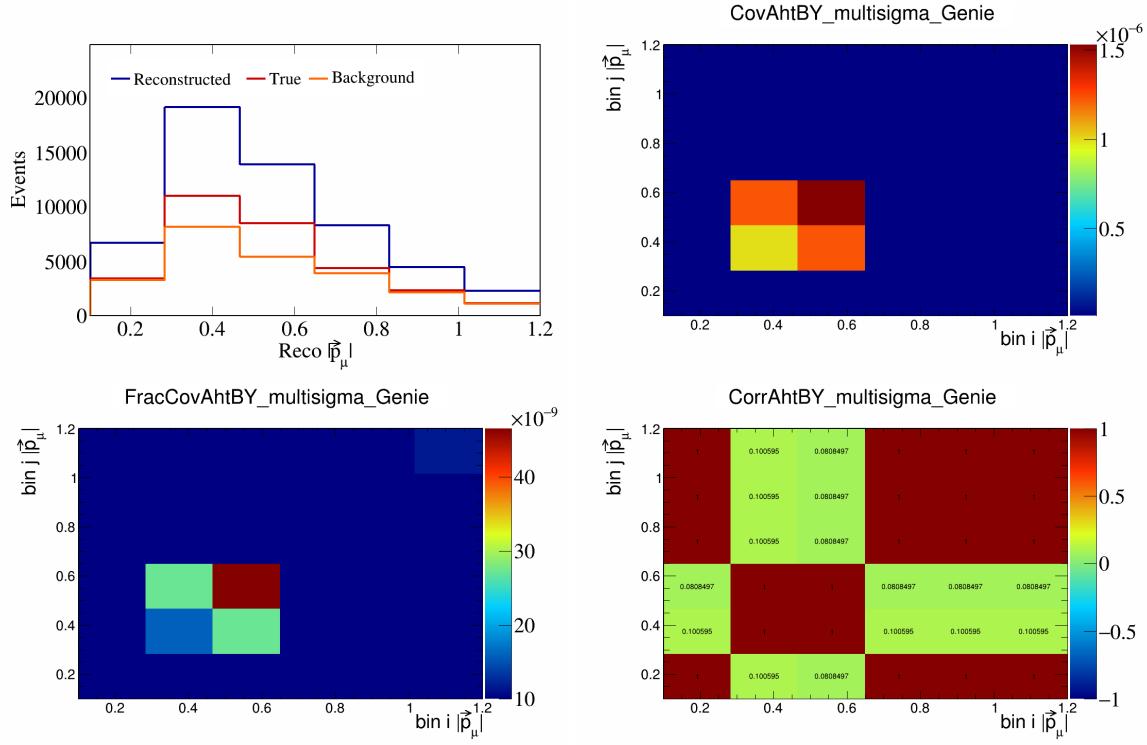


Figure 79: AhtBY variations for $|\vec{p}_\mu|$.

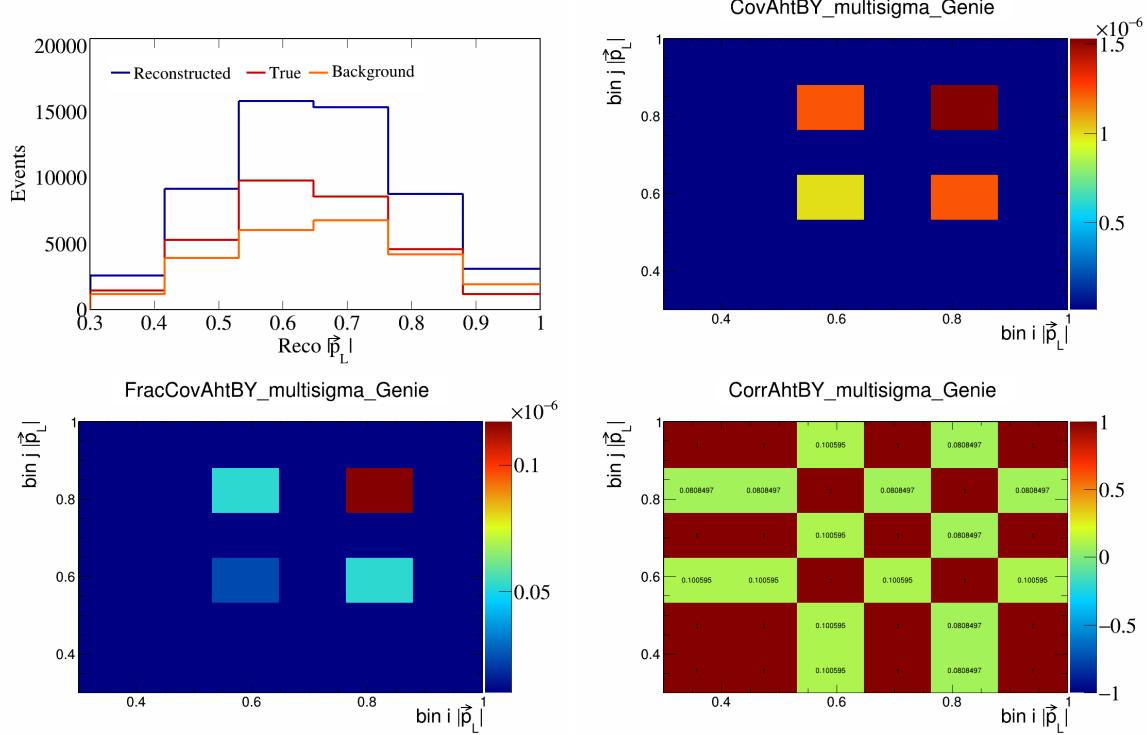


Figure 80: AhtBY variations for $|\vec{p}_L|$.

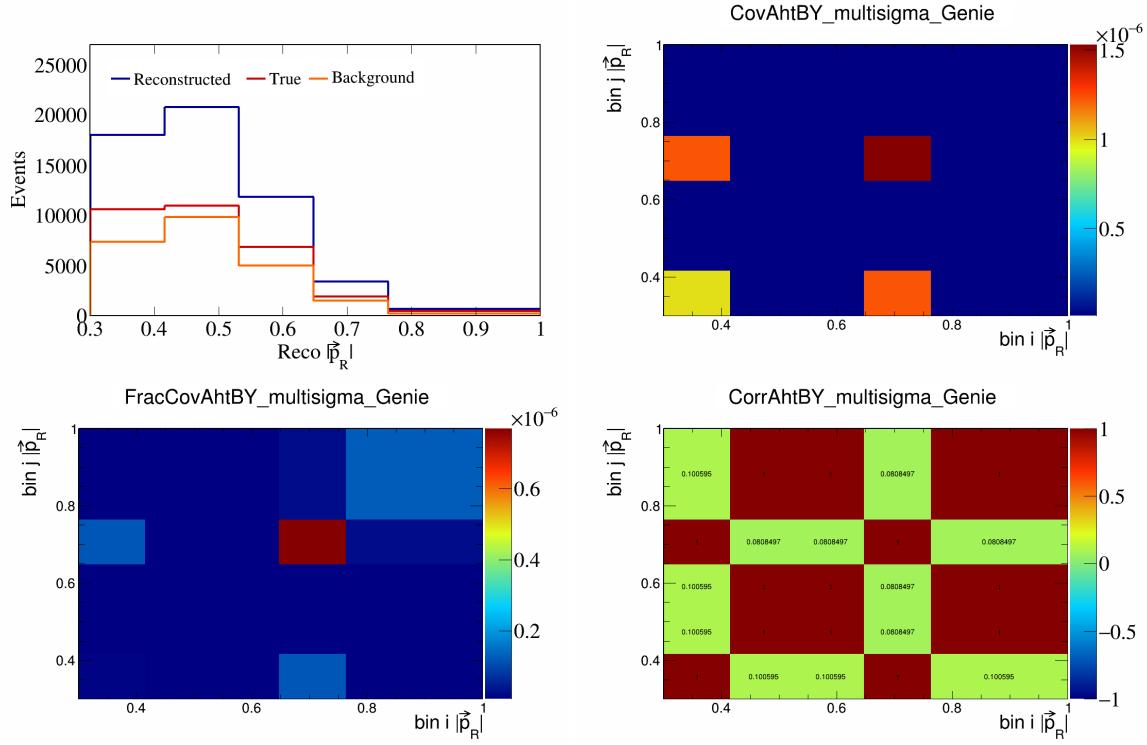


Figure 81: AhtBY variations for $|\vec{p}_R|$.

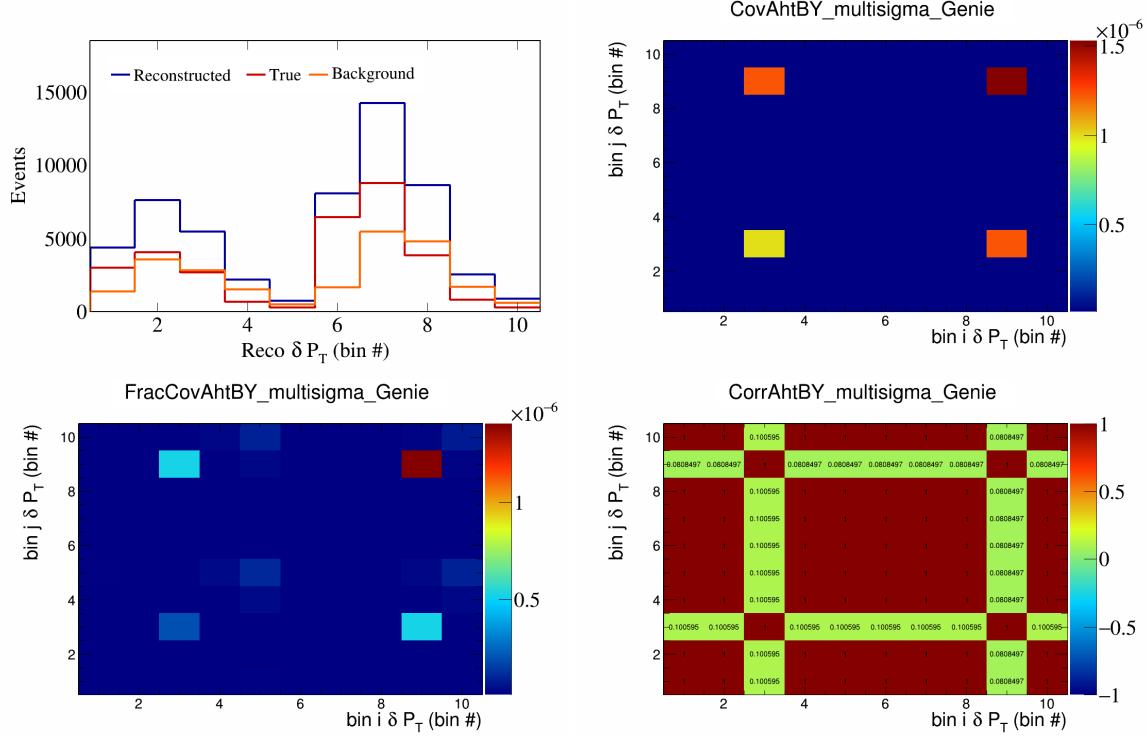


Figure 82: AhtBY variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

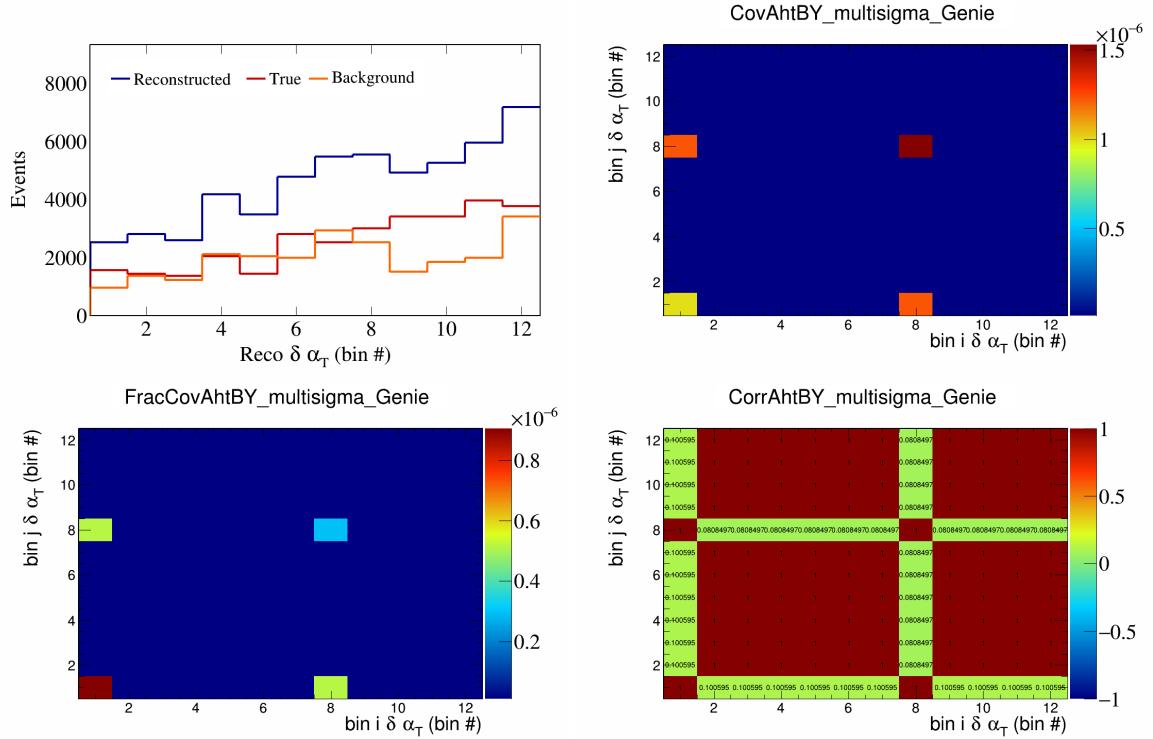


Figure 83: AhtBY variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

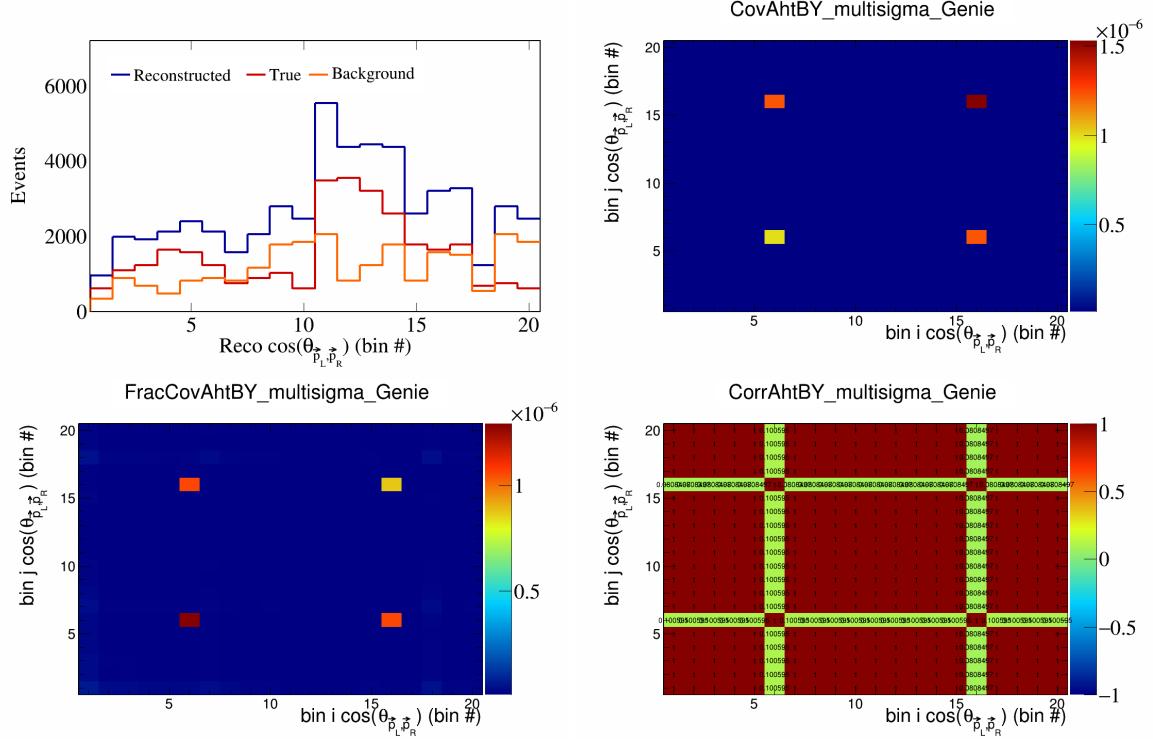


Figure 84: AhtBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

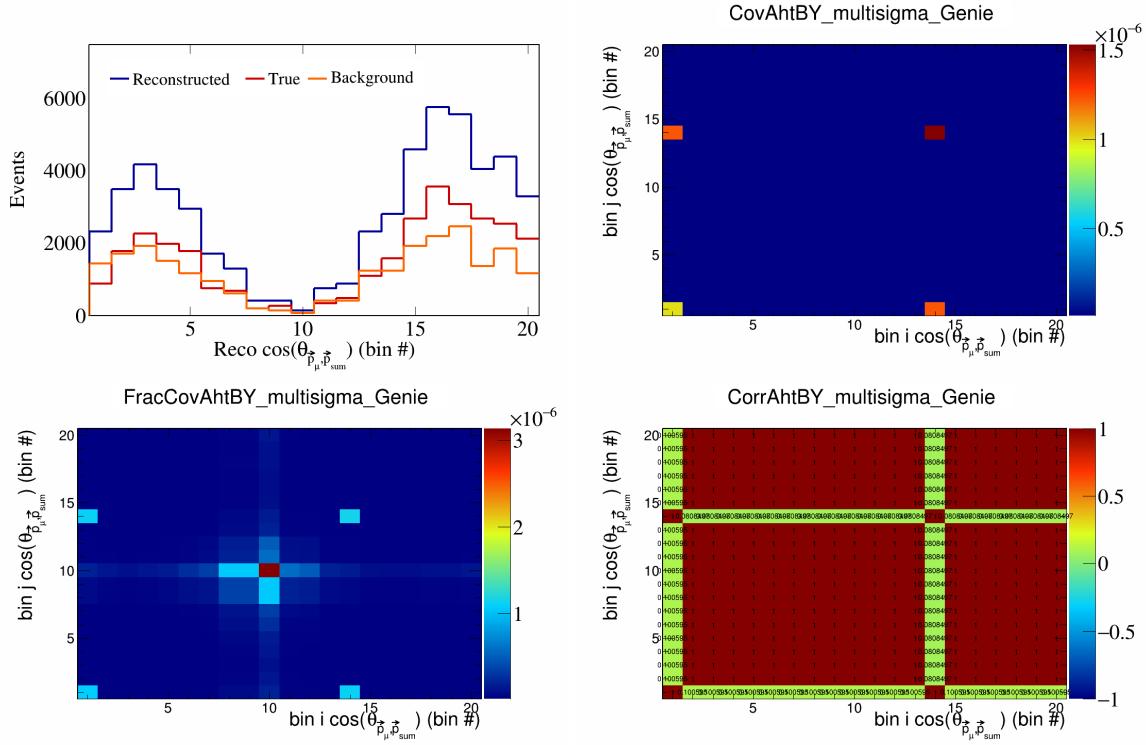


Figure 85: AhtBY variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

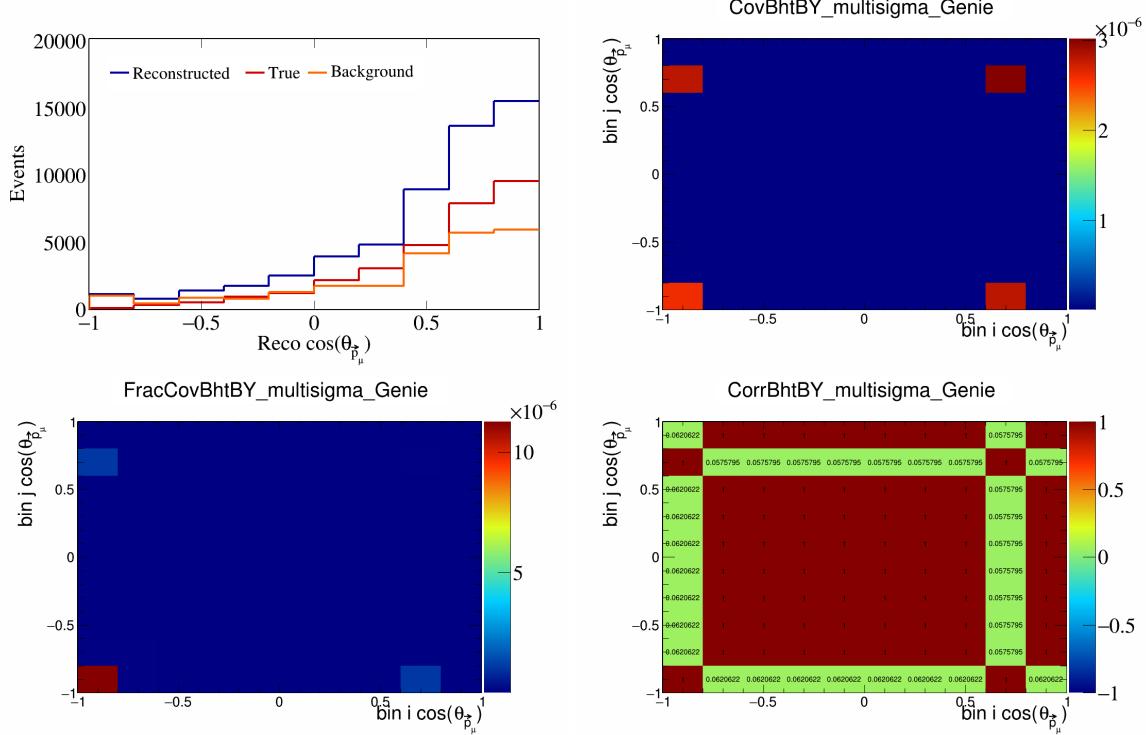


Figure 86: BhtBY variations for $\cos(\theta_{\vec{p}_\mu}^2)$ in $\cos(\theta_{\vec{p}_\mu})$.

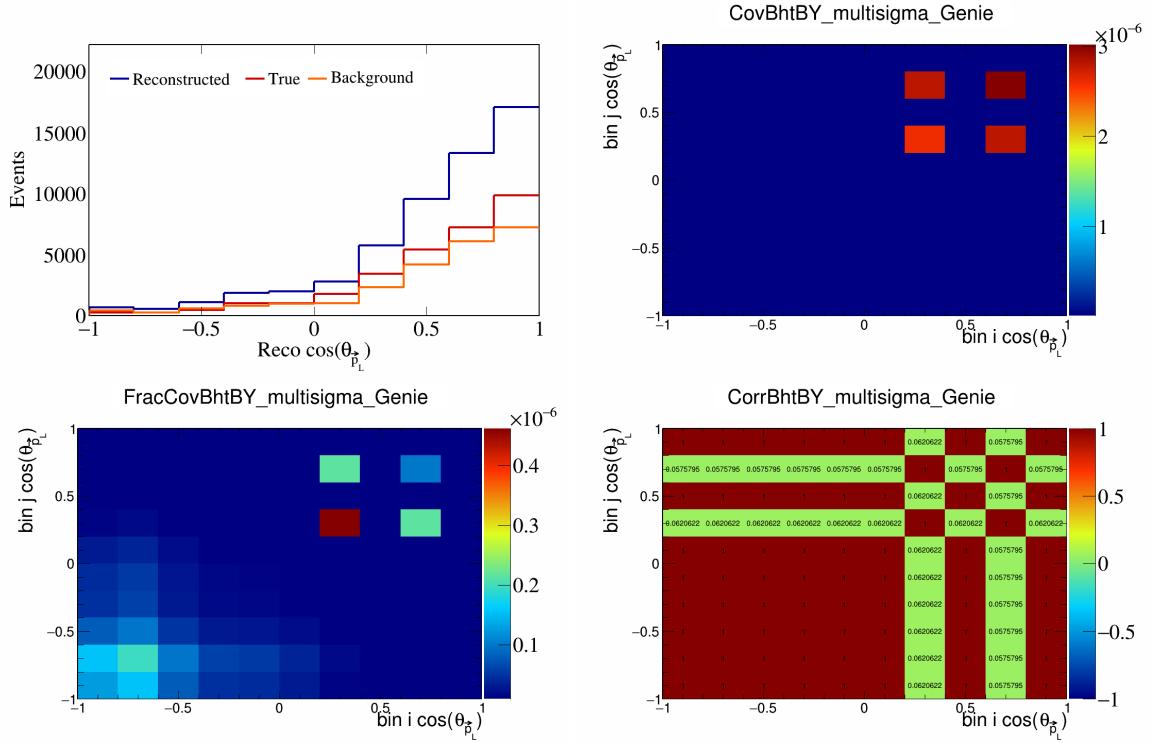


Figure 87: BhtBY variations for $\cos(\theta_{\vec{p}_L})$.

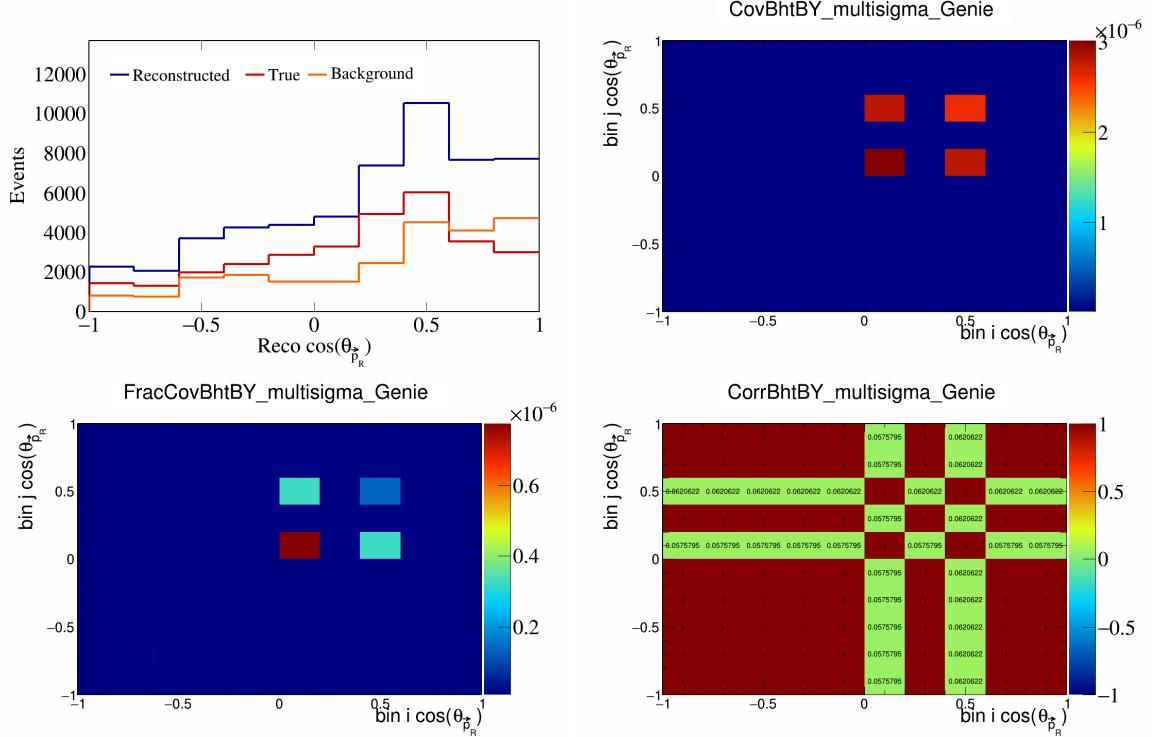


Figure 88: BhtBY variations for $\cos(\theta_{\vec{p}_R})$.

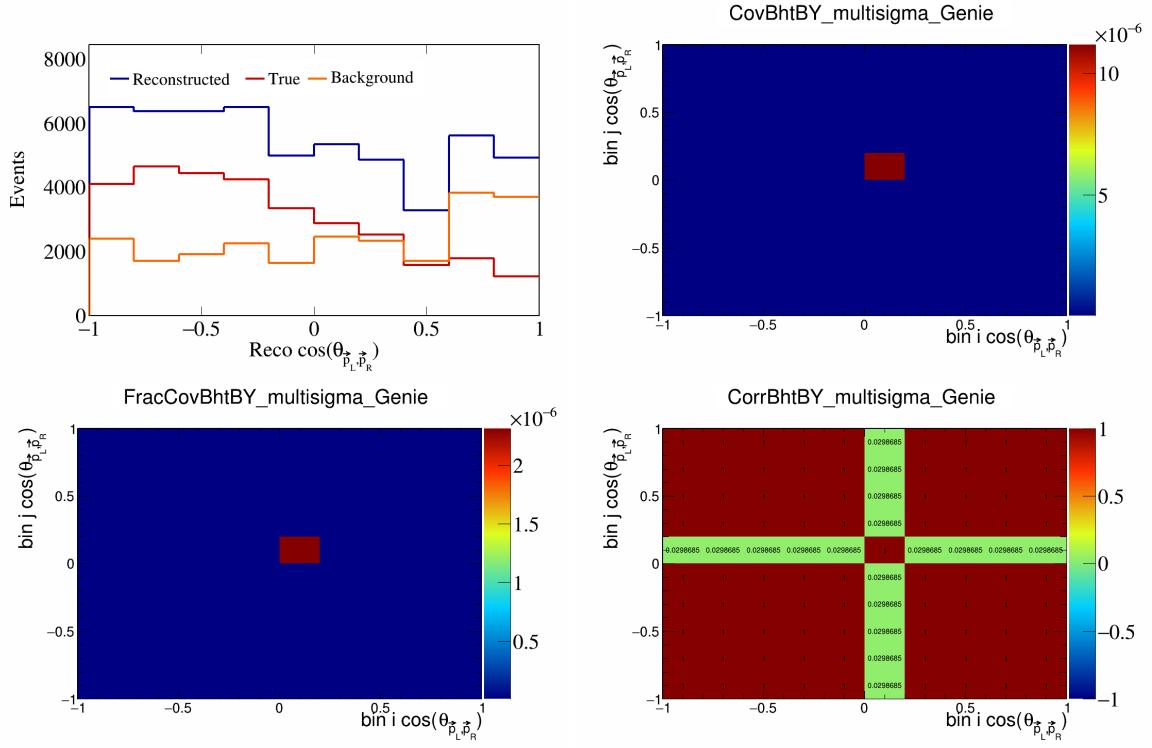


Figure 89: BhtBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

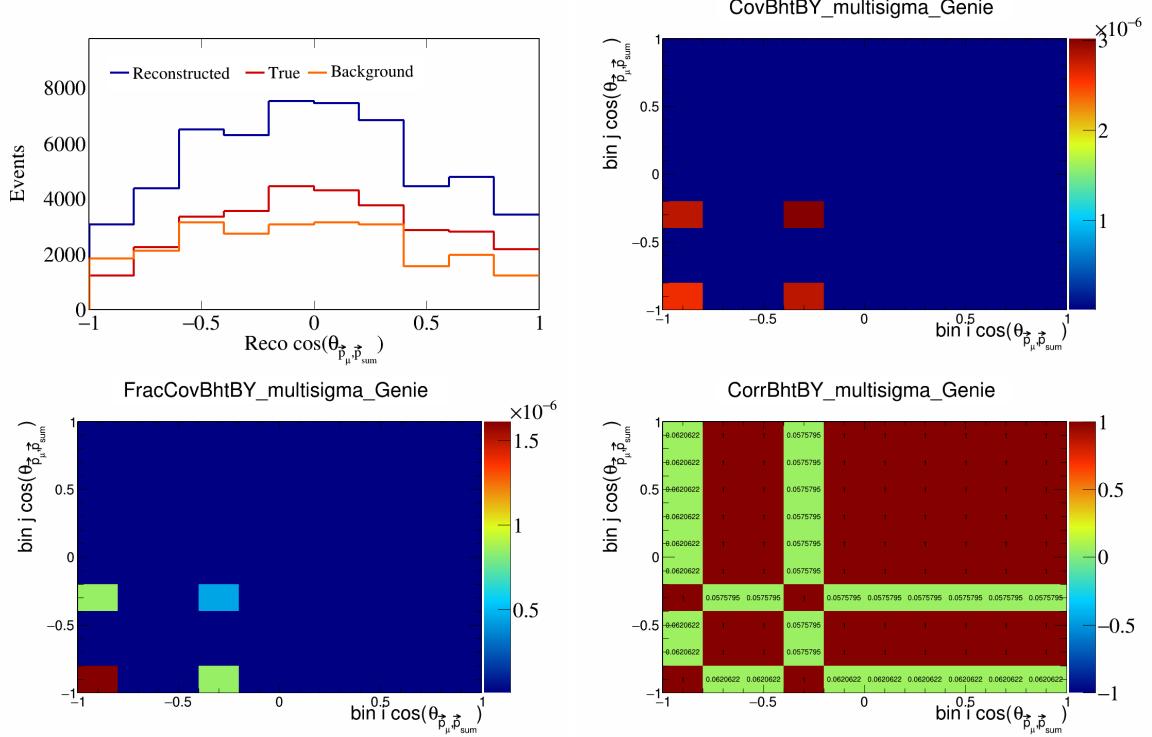


Figure 90: BhtBY variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

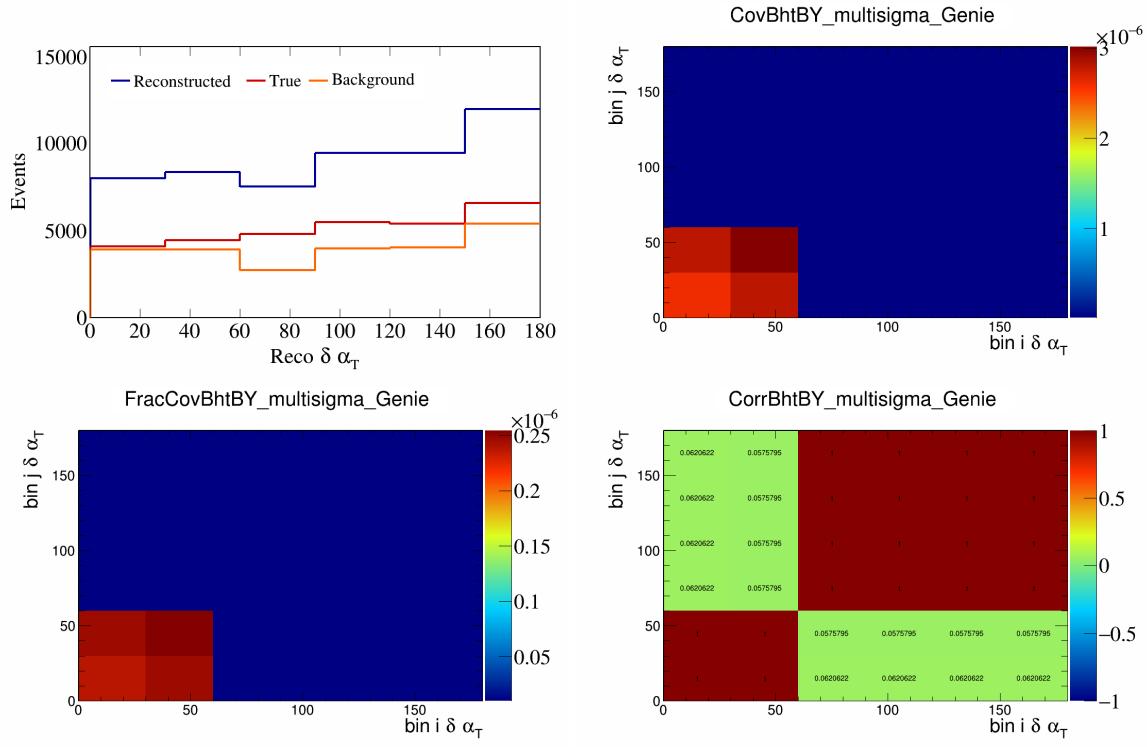


Figure 91: BhtBY variations for $\delta\alpha_T$.

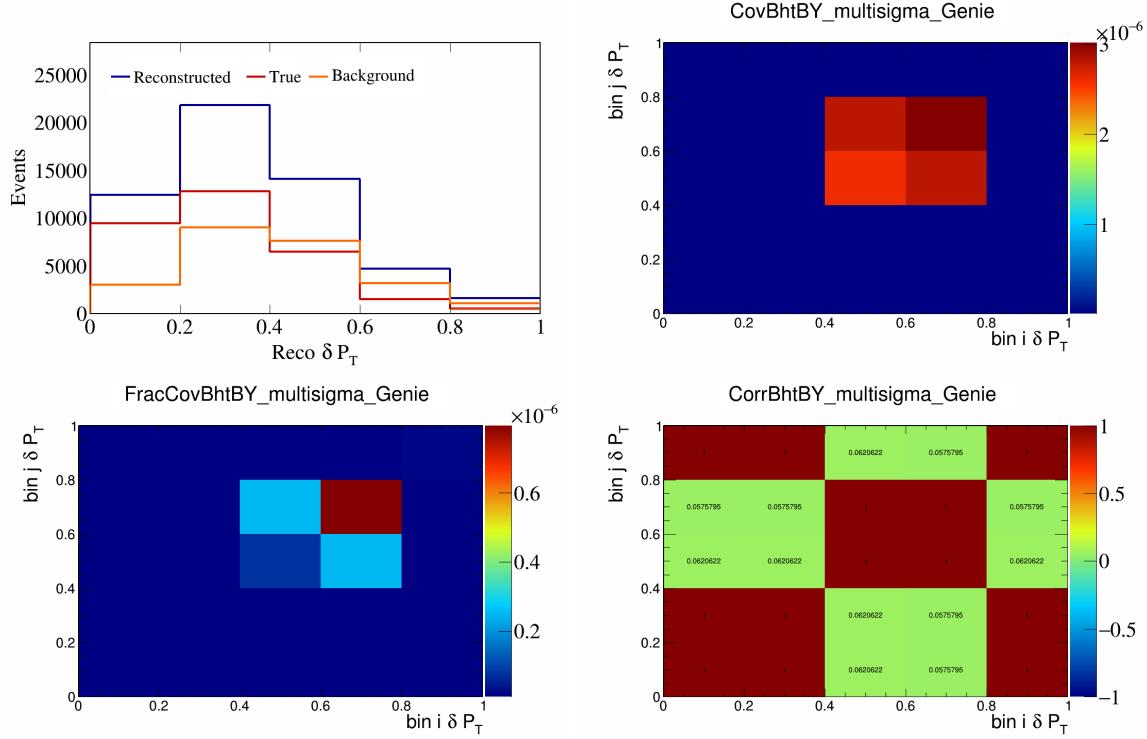


Figure 92: BhtBY variations for δP_T .

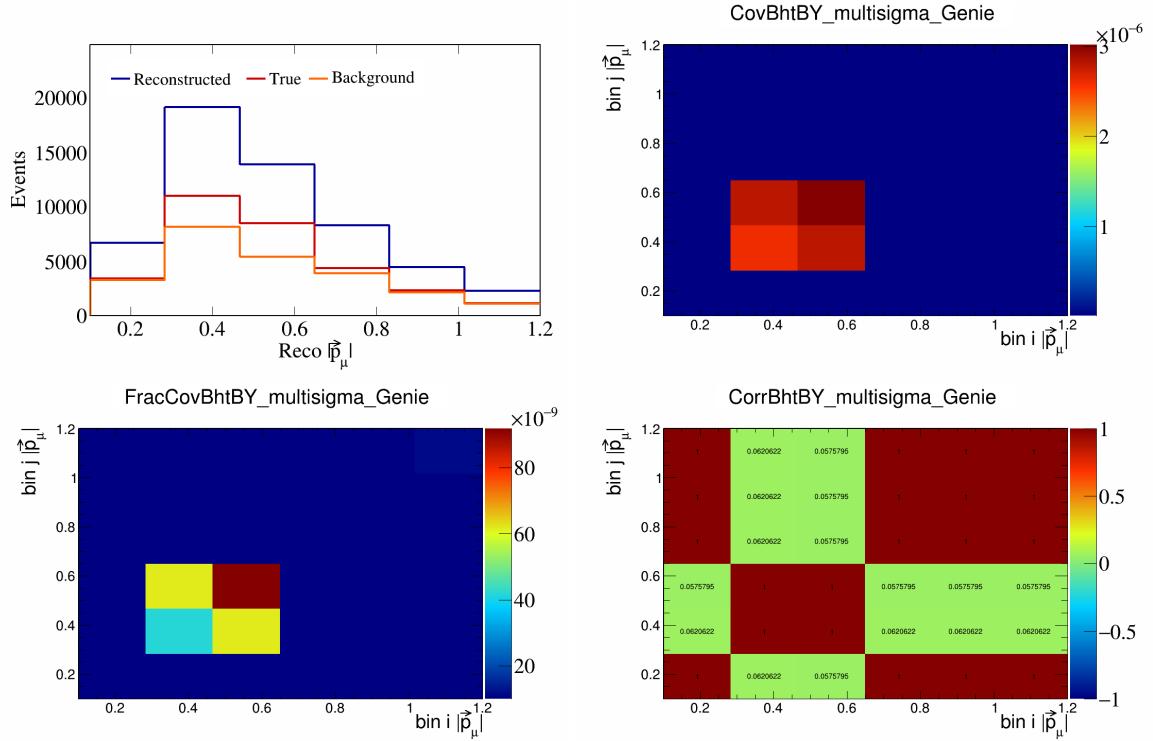


Figure 93: BhtBY variations for $|\vec{p}_\mu|$.

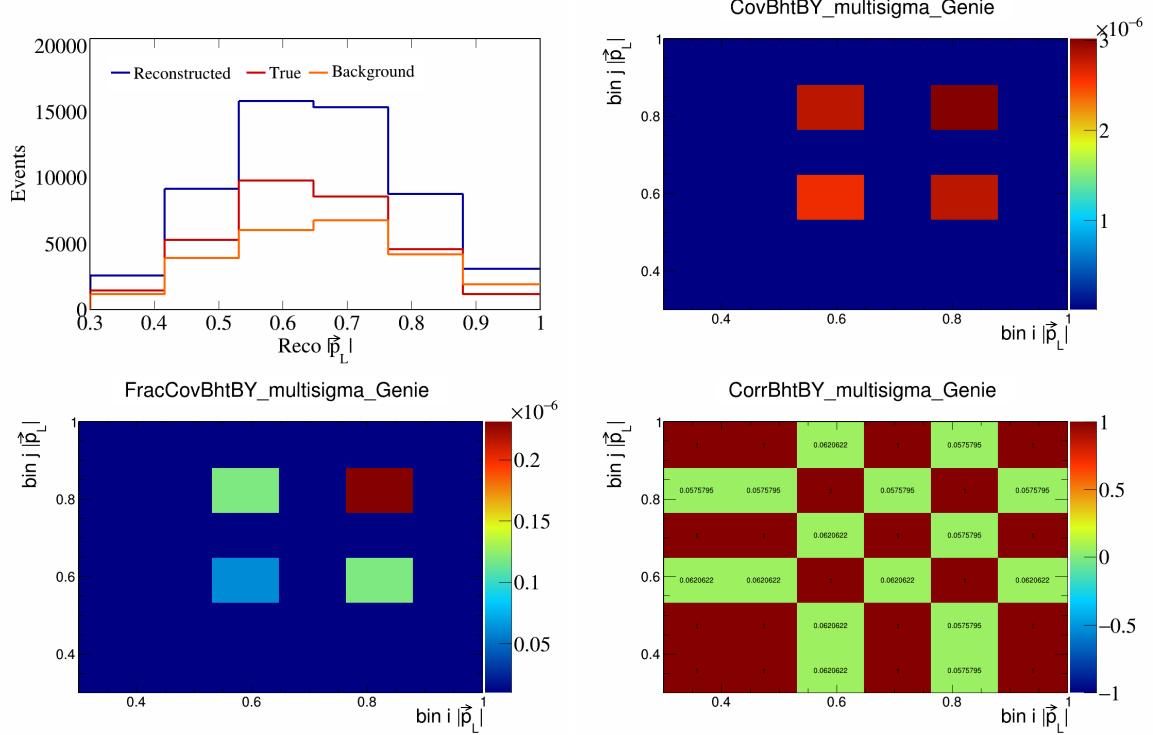


Figure 94: BhtBY variations for $|\vec{p}_L|$.

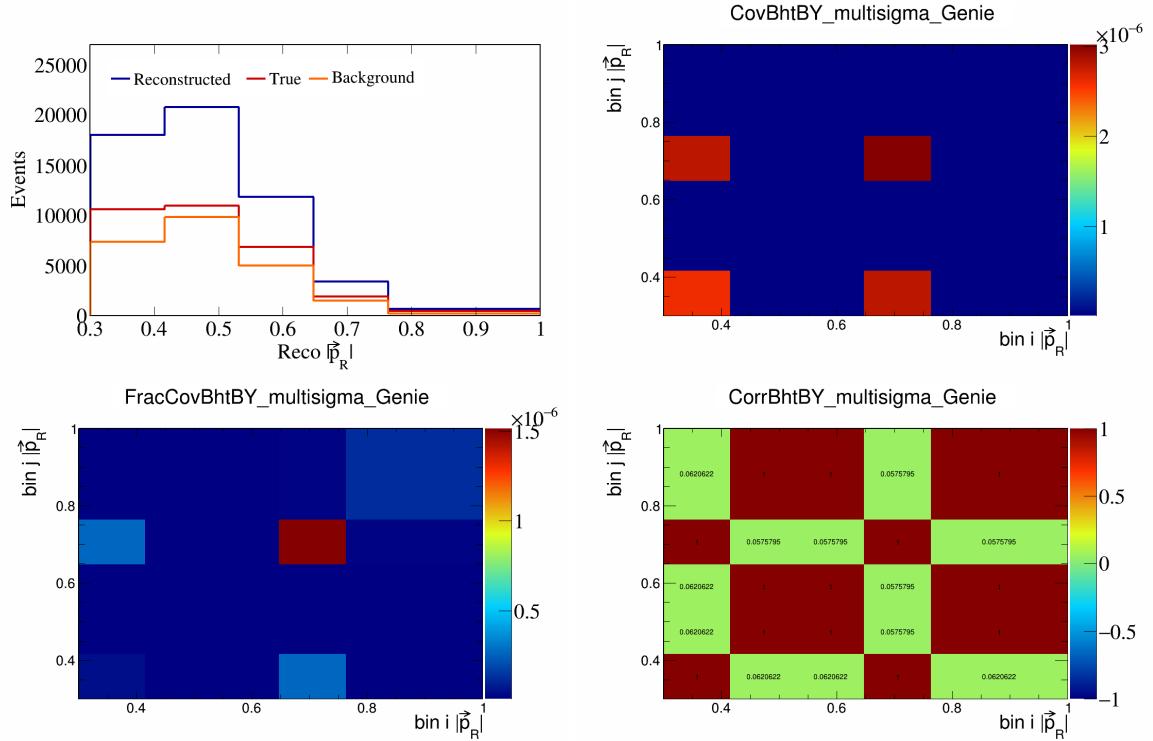


Figure 95: BhtBY variations for $|\vec{p}_R|$.

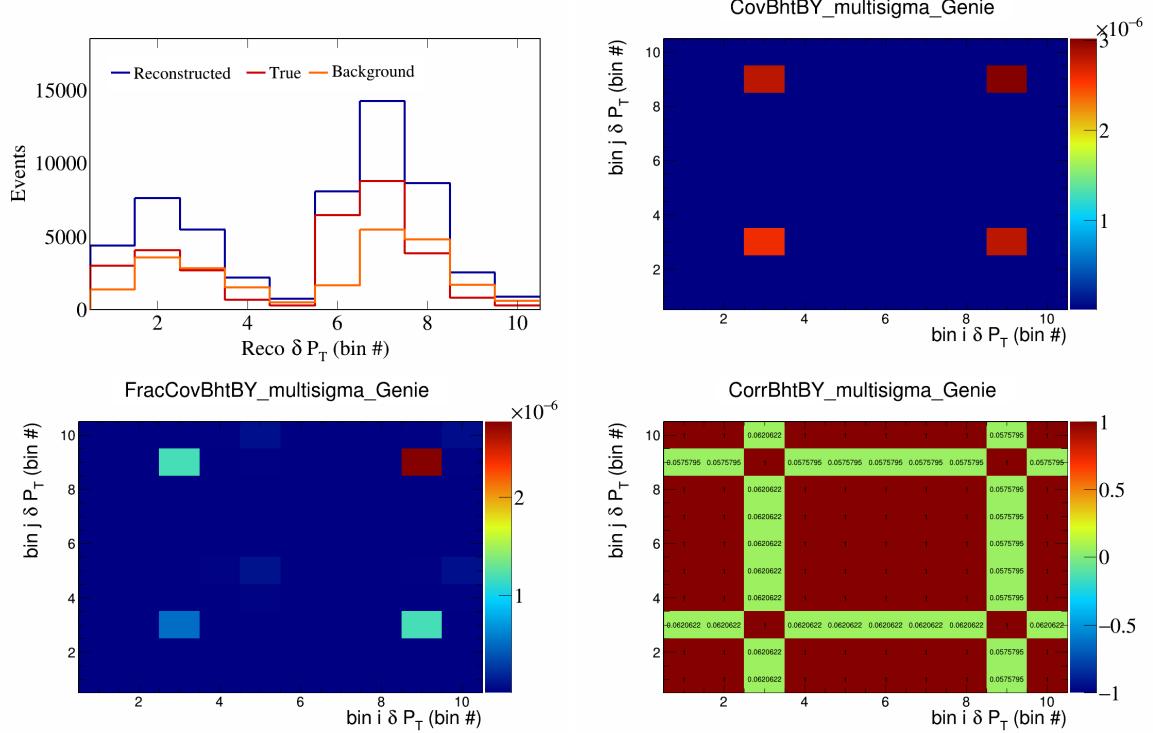


Figure 96: BhtBY variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

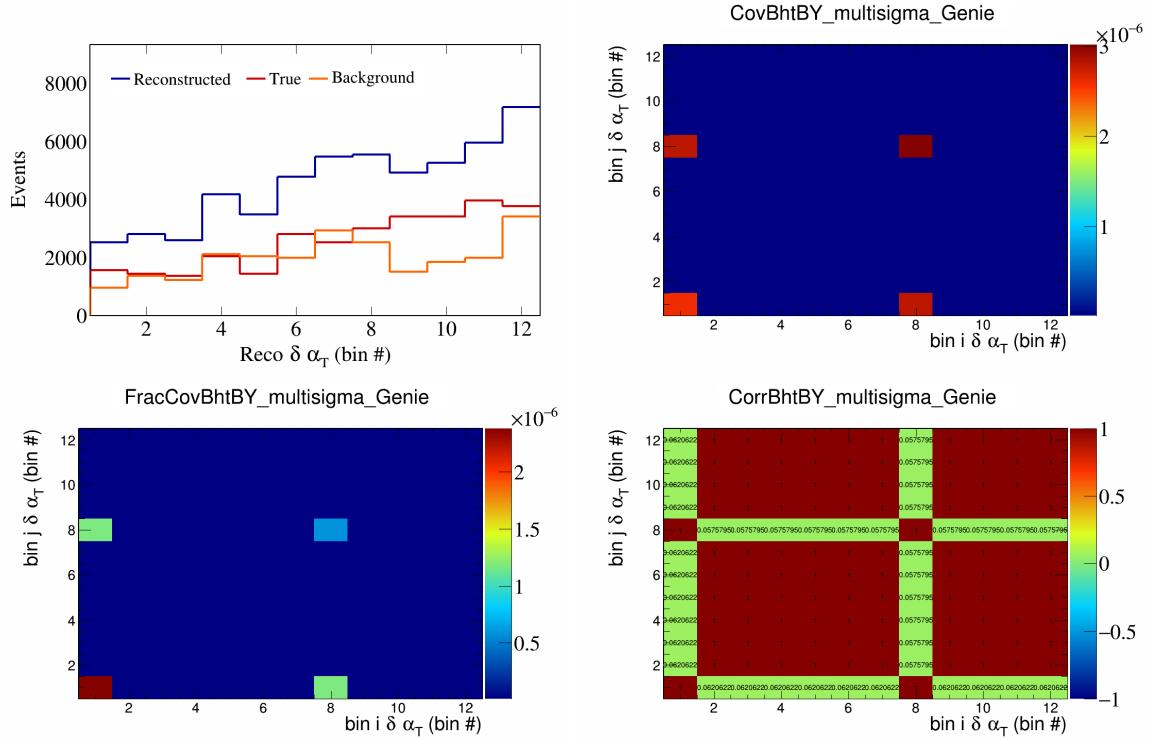


Figure 97: BhtBY variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

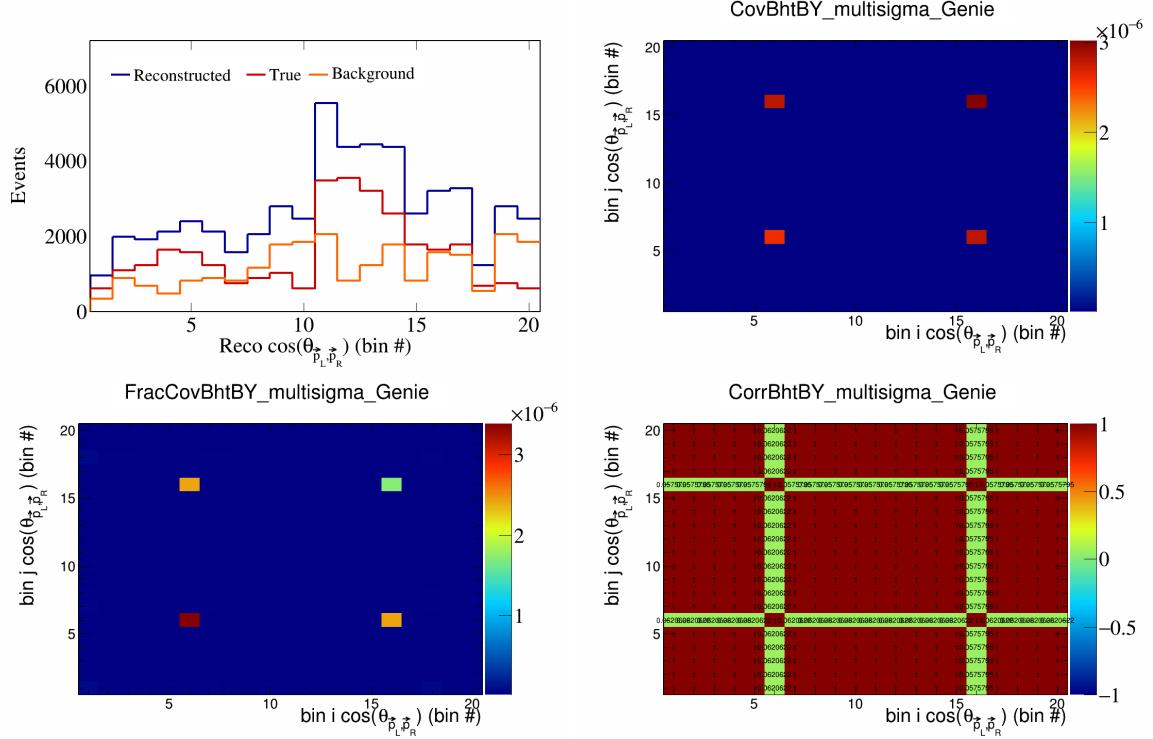


Figure 98: BhtBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

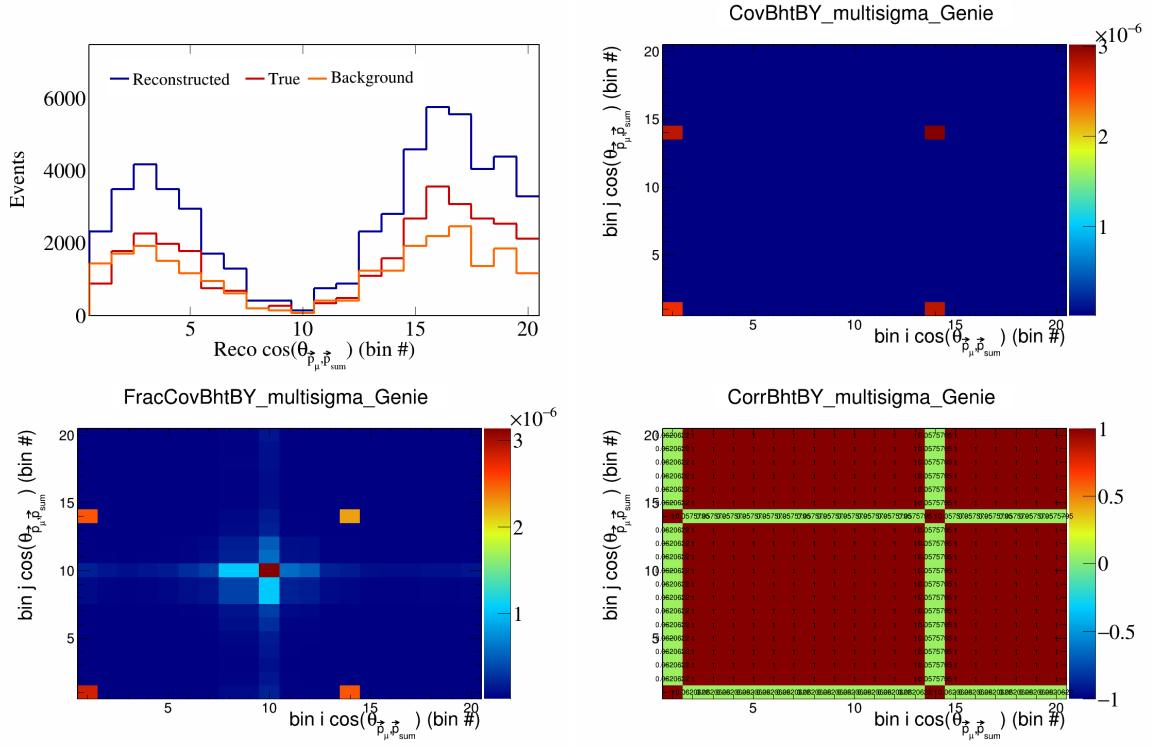


Figure 99: BhtBY variations for $\cos(\theta_{\vec{p}_\mu}^j)$ in $\cos(\theta_{\vec{p}_\mu})$.

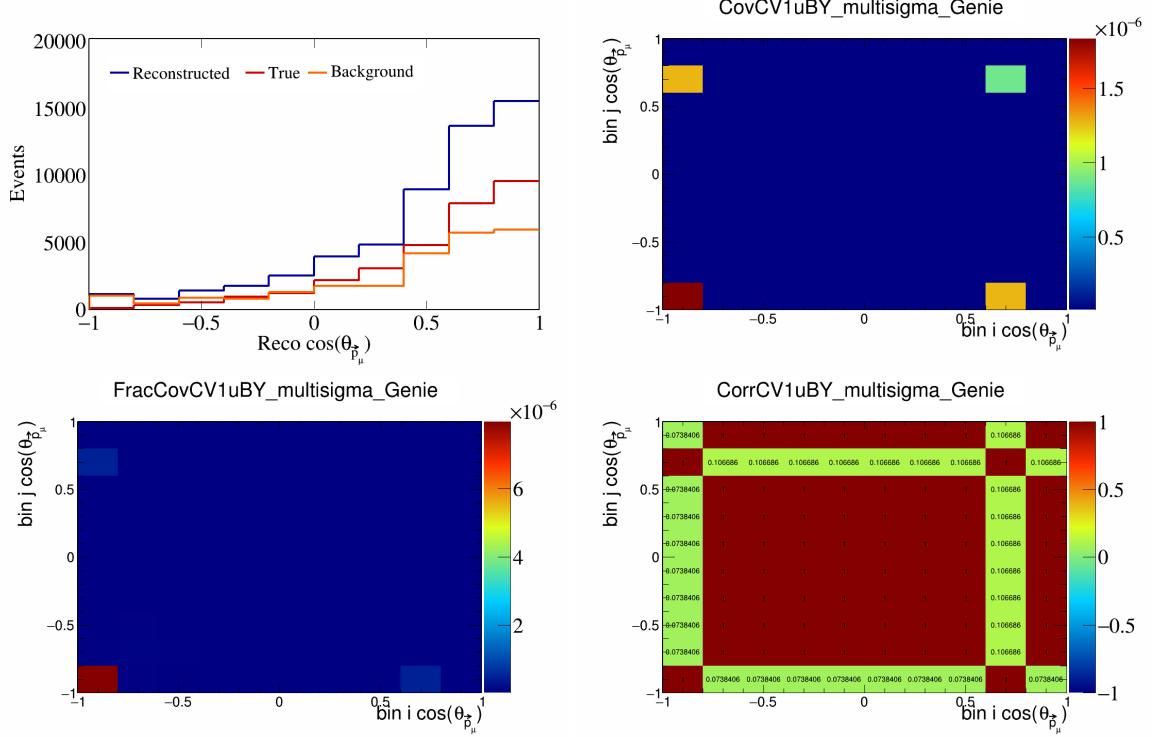


Figure 100: CV1uBY variations for $\cos(\theta_{\vec{p}_\mu})$.

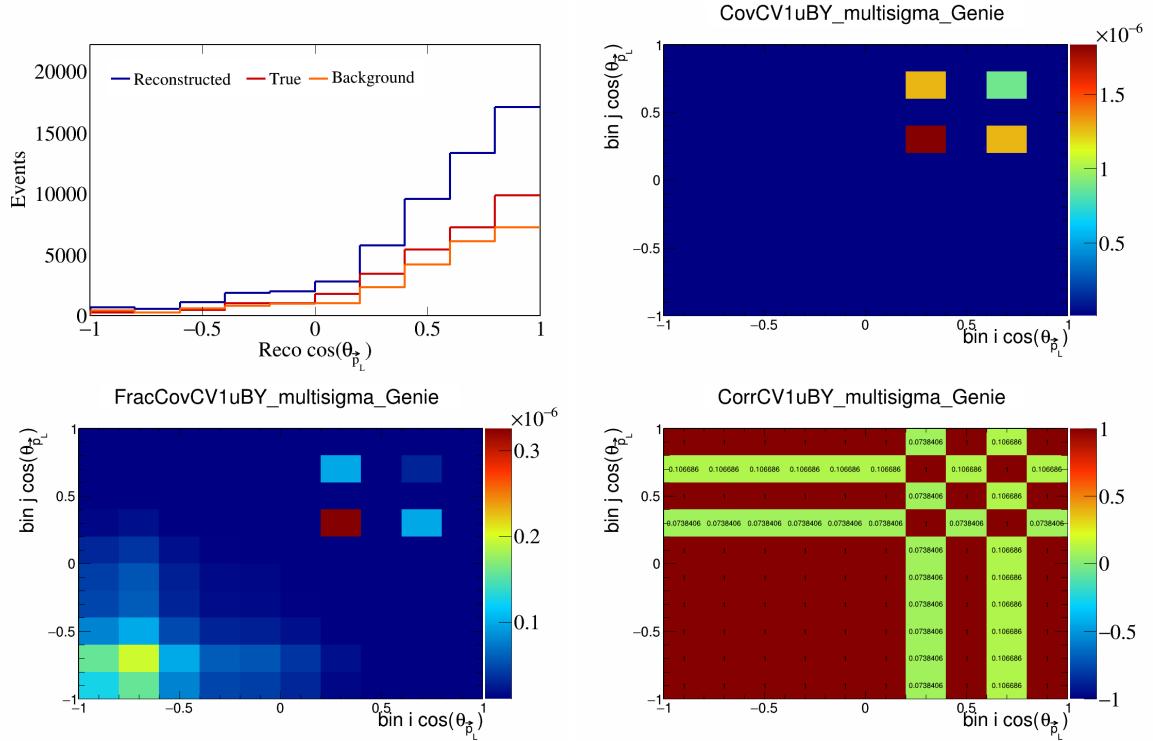


Figure 101: CV1uBY variations for $\cos(\theta_{\vec{p}_L})$.

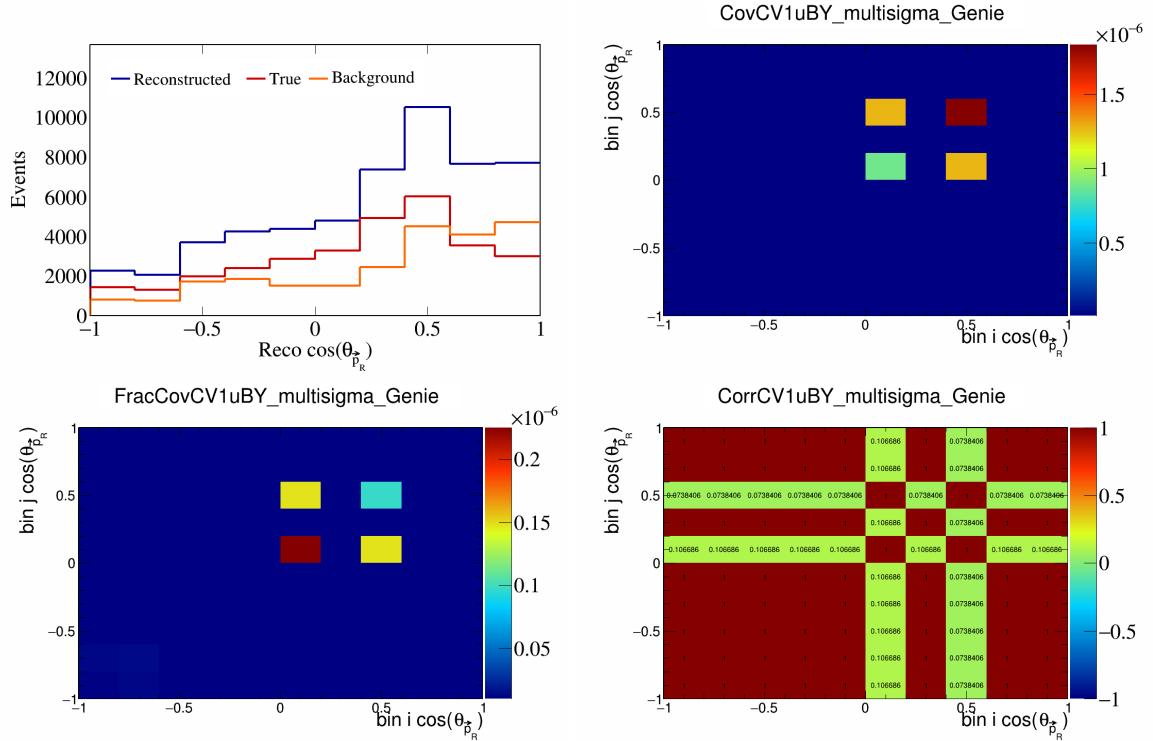


Figure 102: CV1uBY variations for $\cos(\theta_{\vec{p}_R})$.

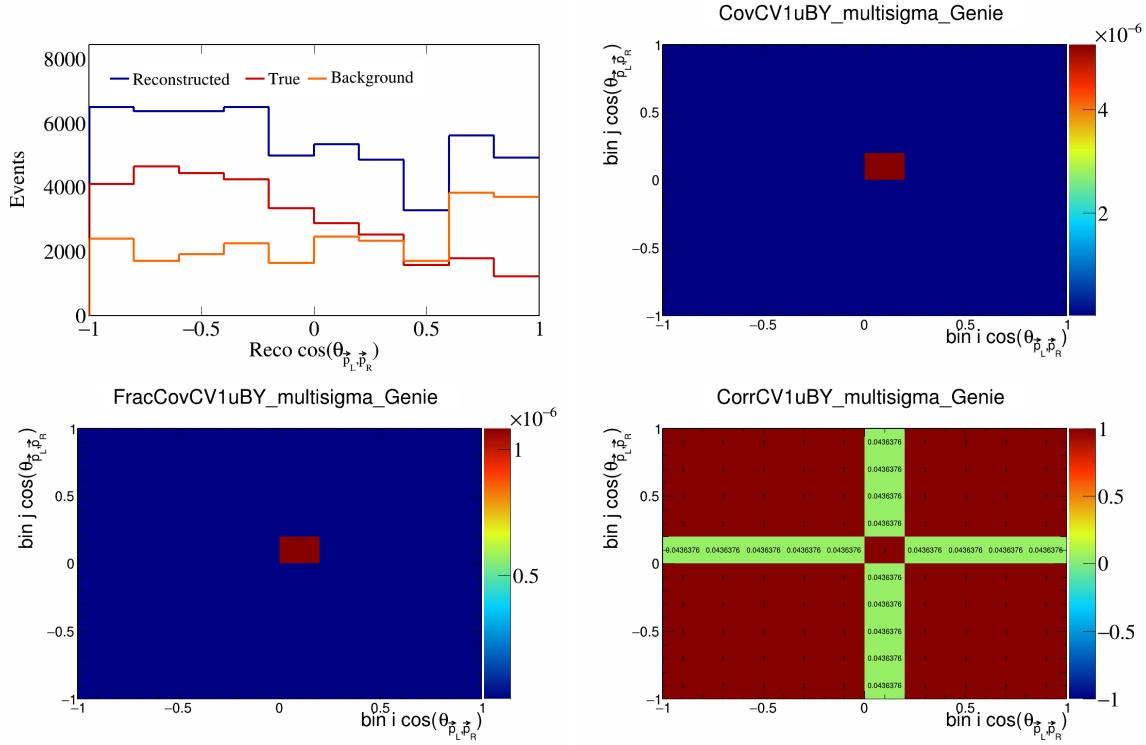


Figure 103: CV1uBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

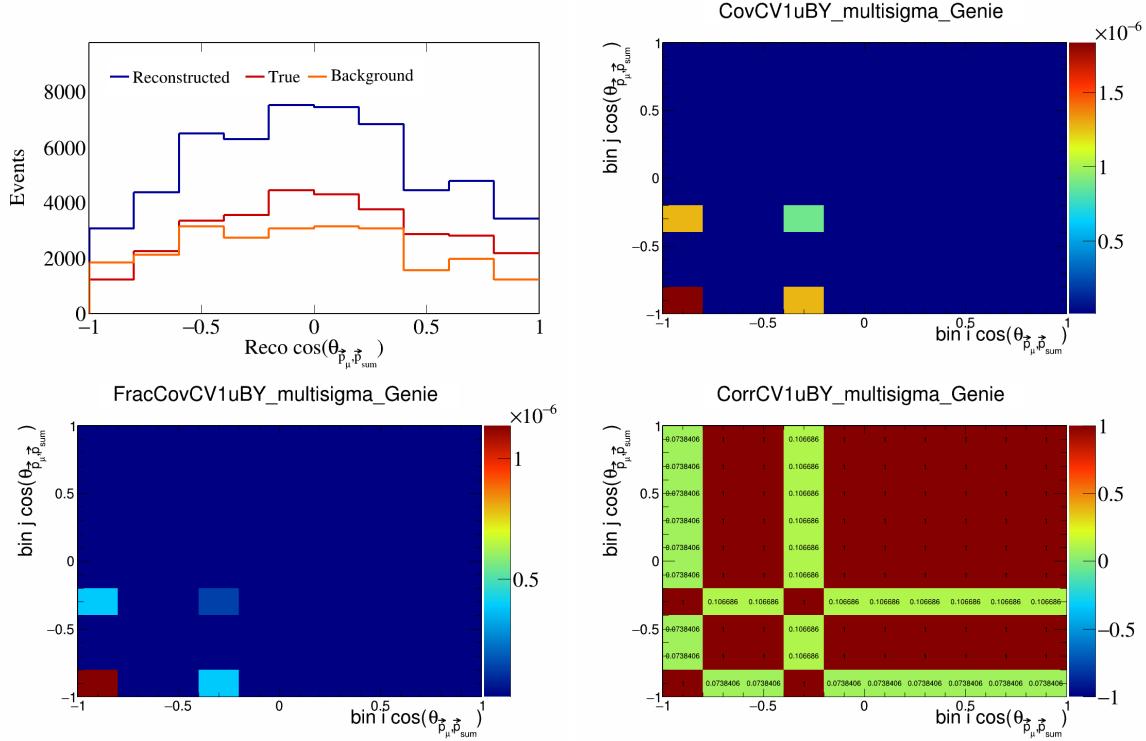


Figure 104: CV1uBY variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

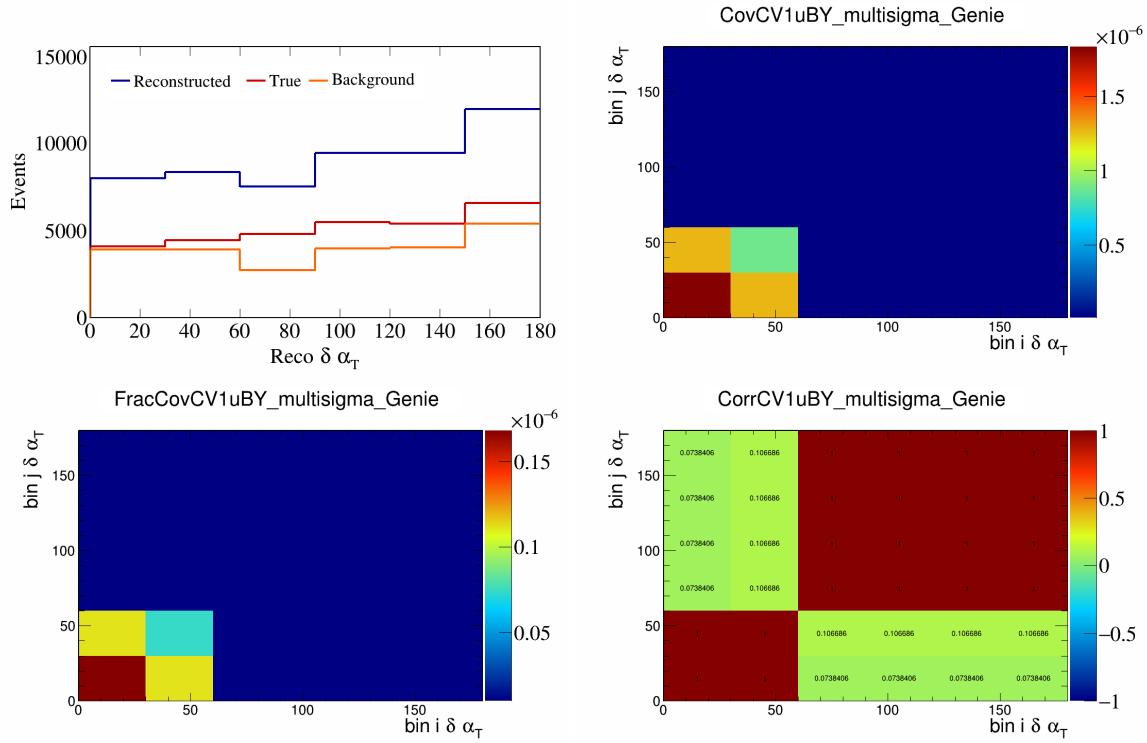


Figure 105: CV1uBY variations for $\delta\alpha_T$.

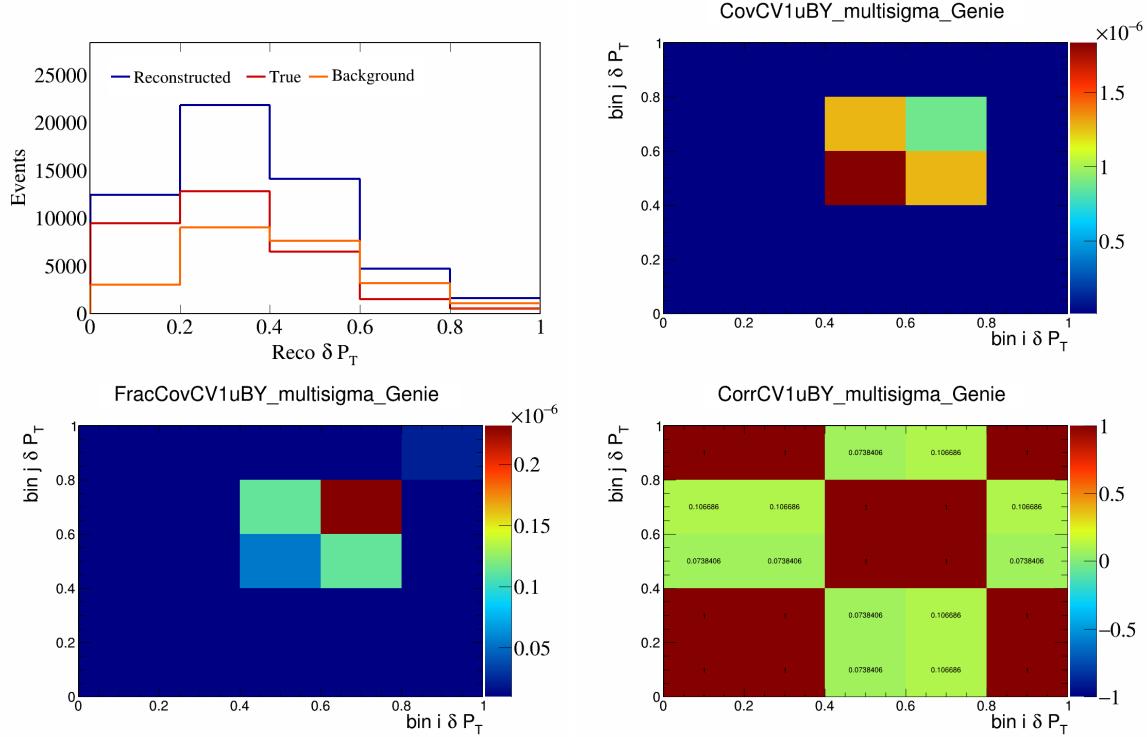


Figure 106: CV1uBY variations for δP_T .

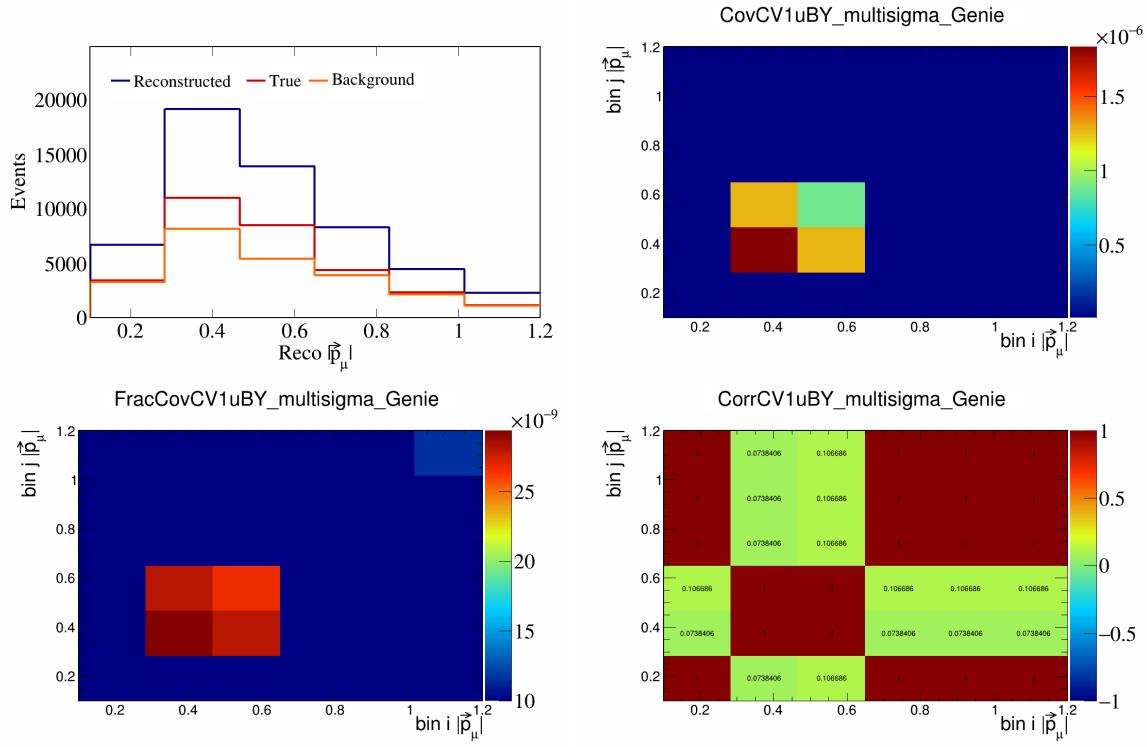


Figure 107: CV1uBY variations for $|\vec{p}_\mu|$.

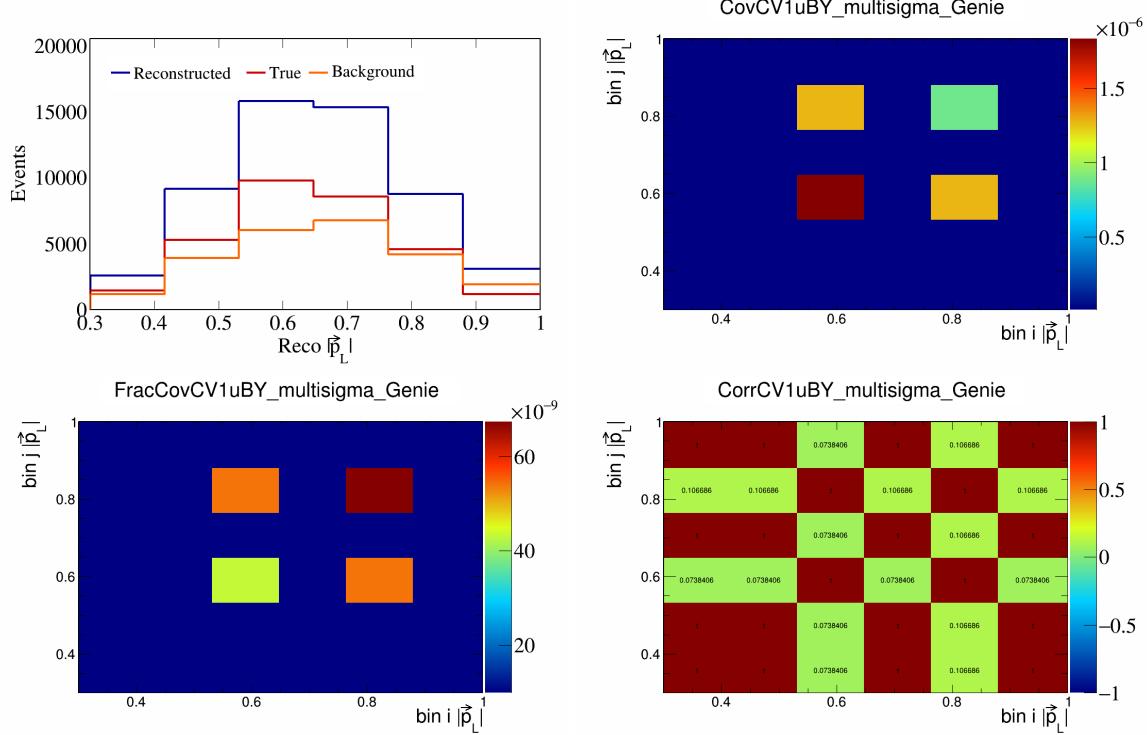


Figure 108: CV1uBY variations for $|\vec{p}_L|$.

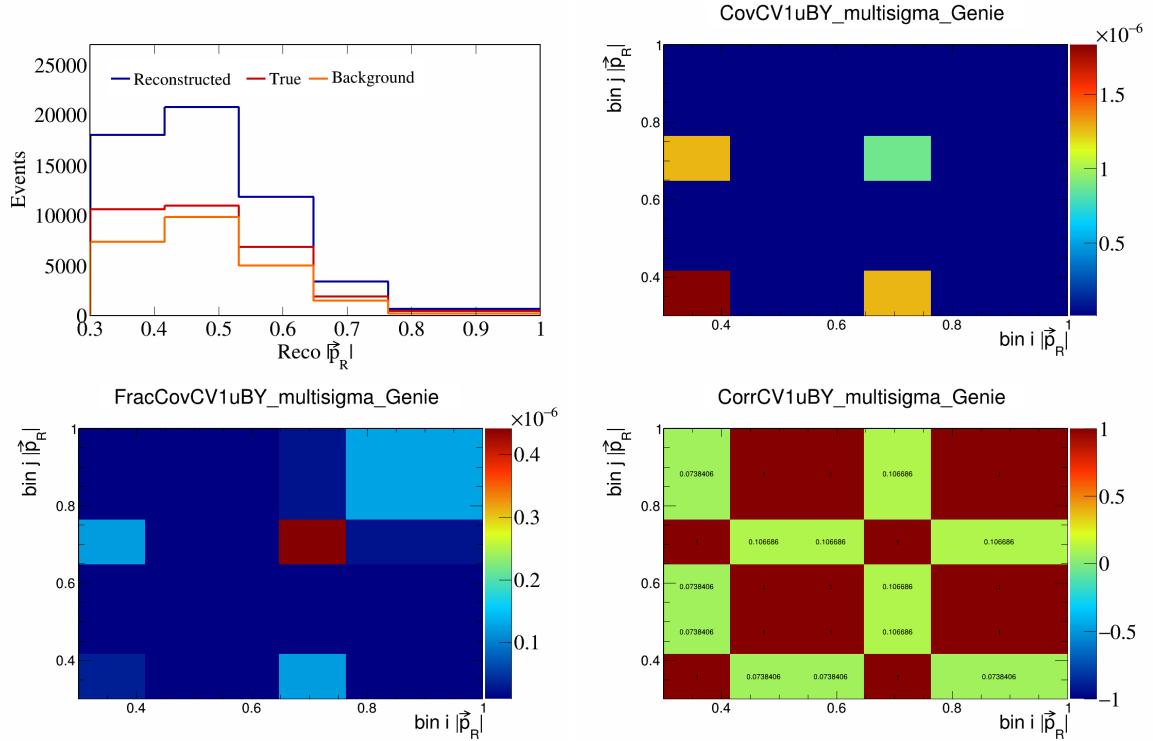


Figure 109: CV1uBY variations for $|\vec{p}_R|$.

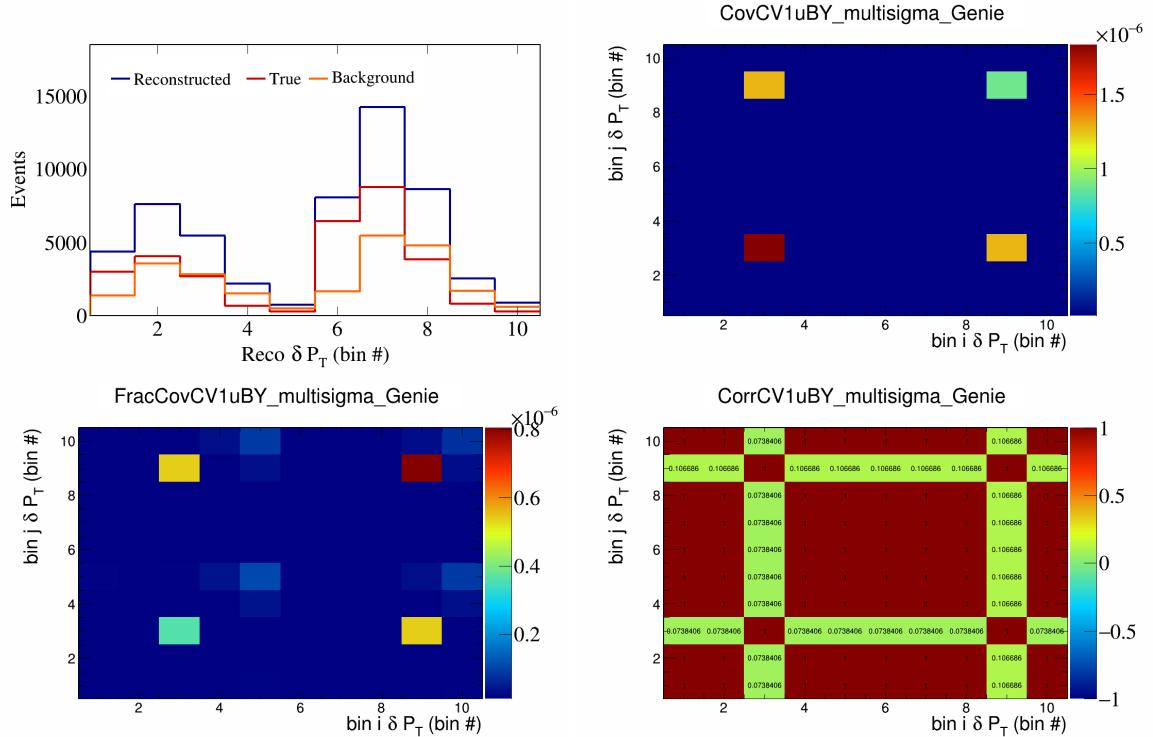


Figure 110: CV1uBY variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

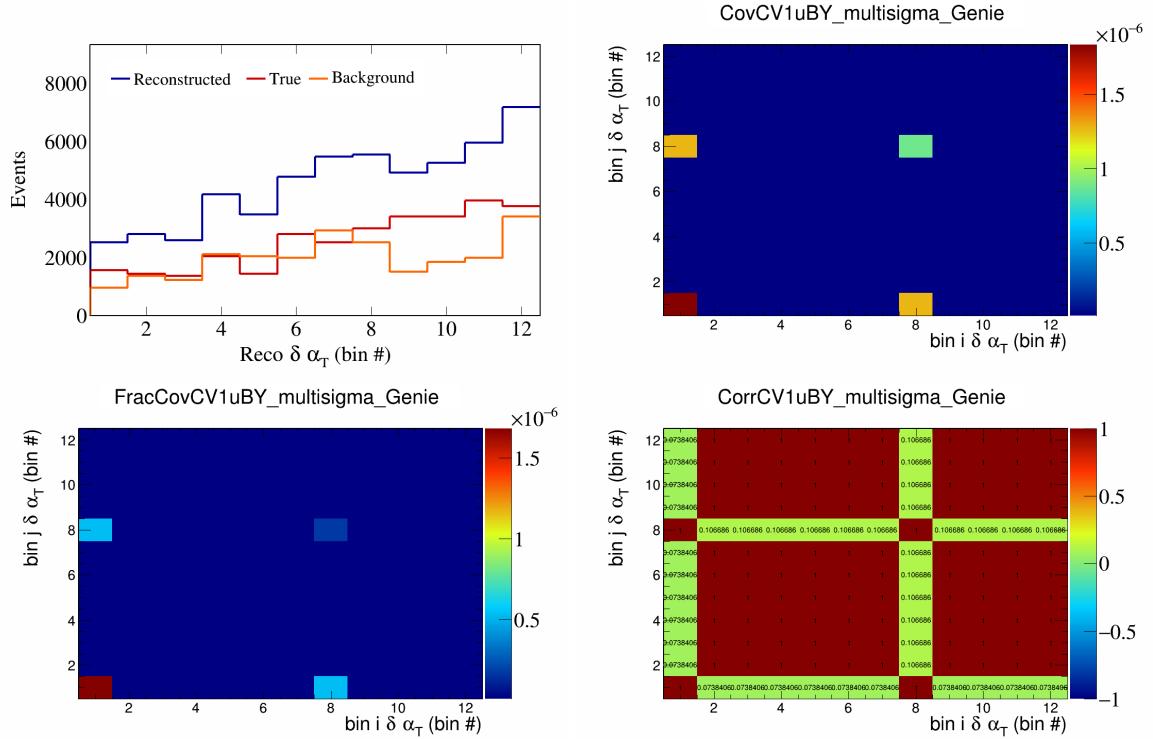


Figure 111: CV1uBY variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

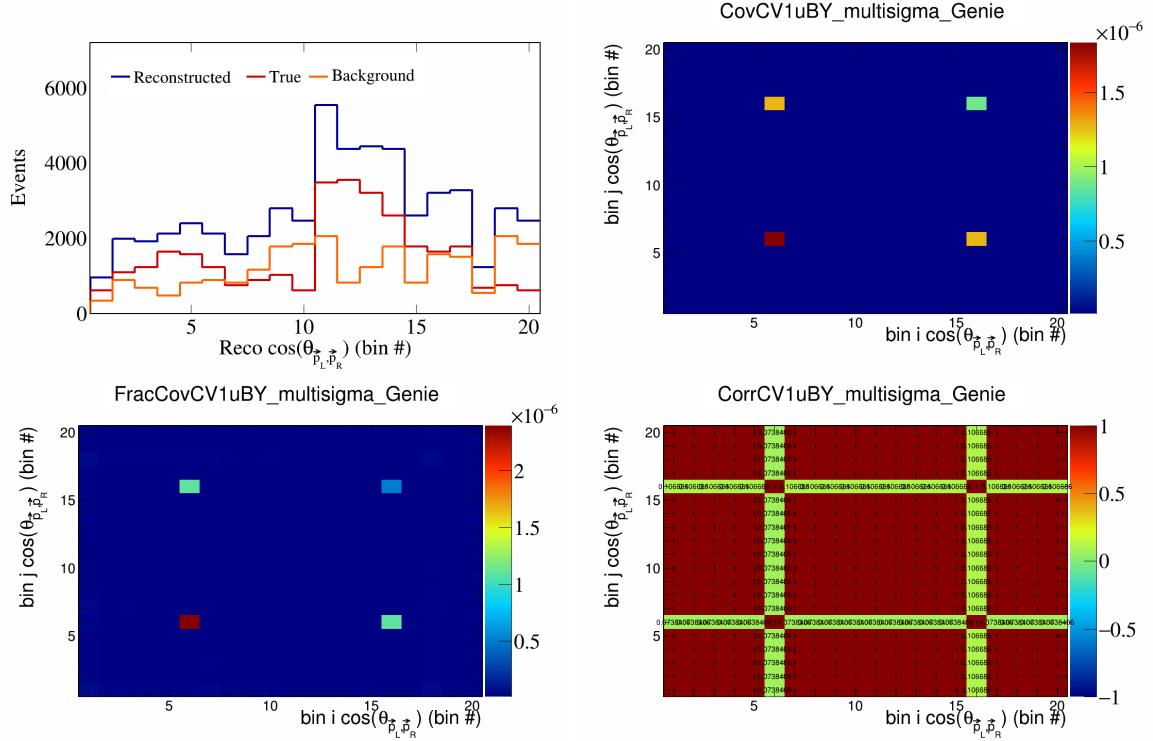


Figure 112: CV1uBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

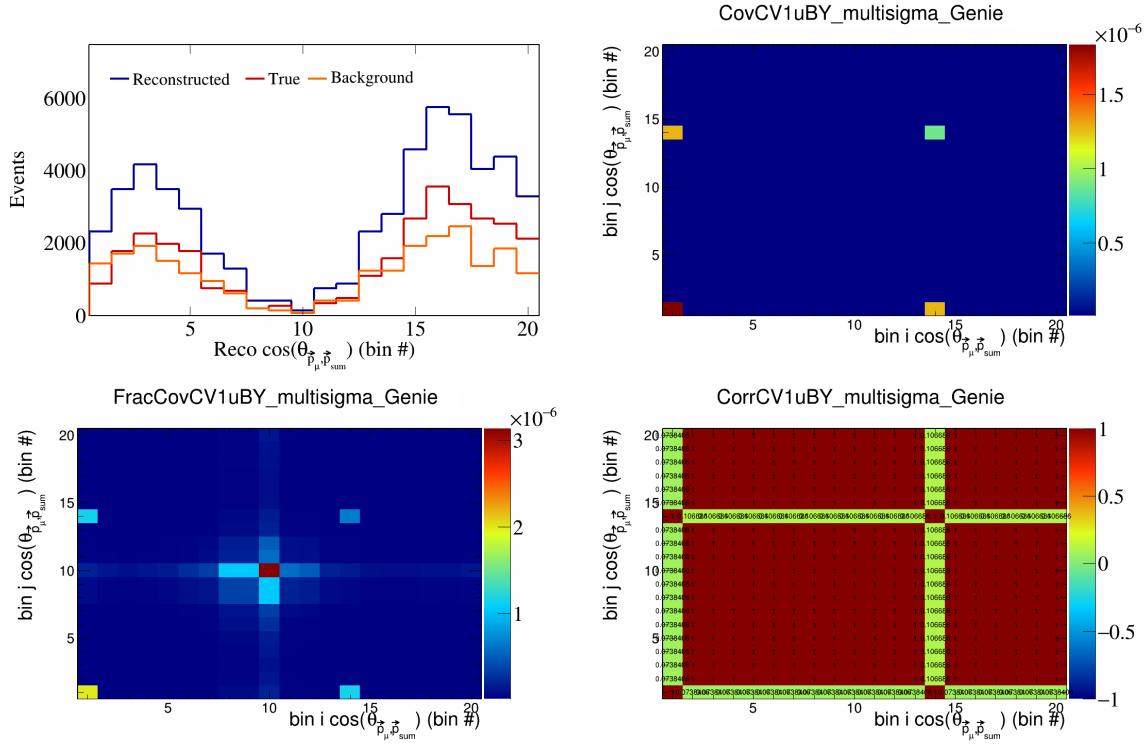


Figure 113: CV1uBY variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

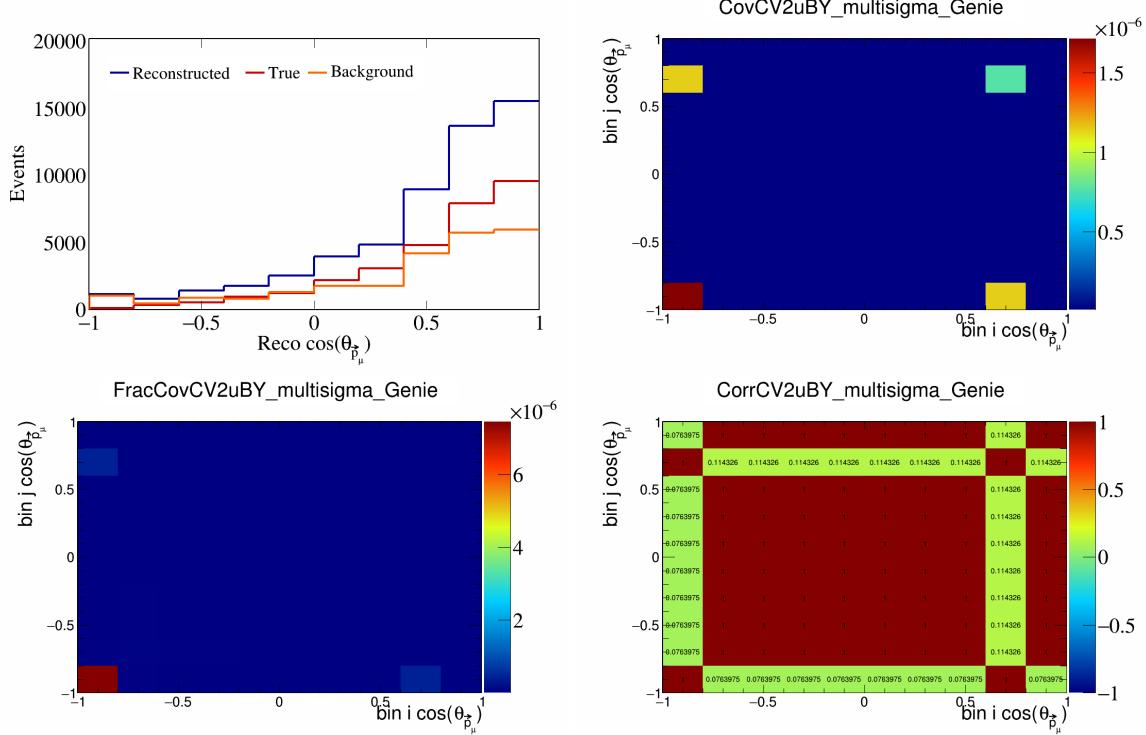


Figure 114: CV2uBY variations for $\cos(\theta_{\vec{p}_\mu})$.

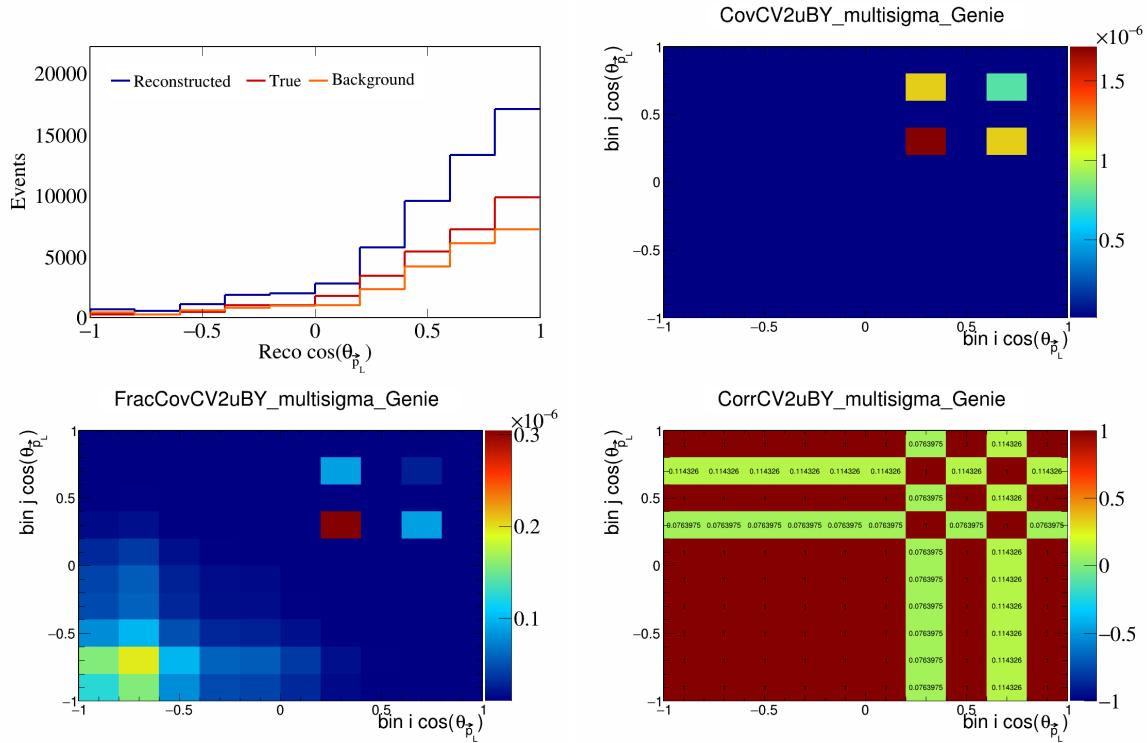


Figure 115: CV2uBY variations for $\cos(\theta_{\vec{p}_L})$.

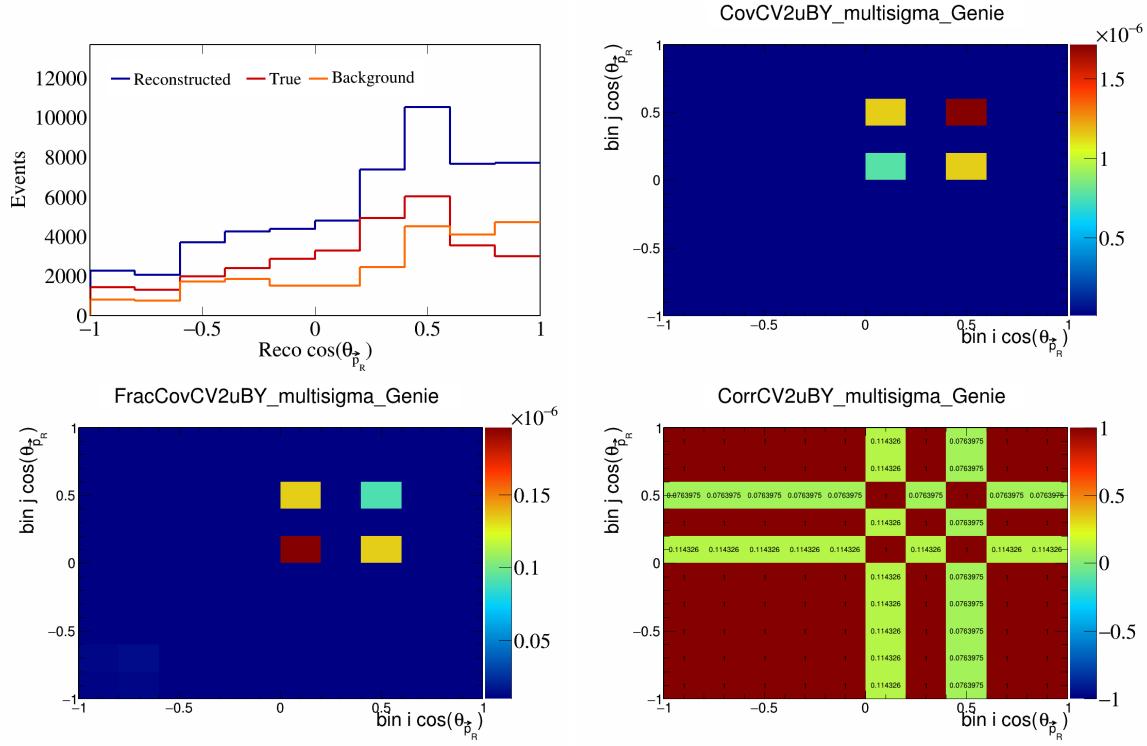


Figure 116: CV2uBY variations for $\cos(\theta_{\vec{p}_R})$.

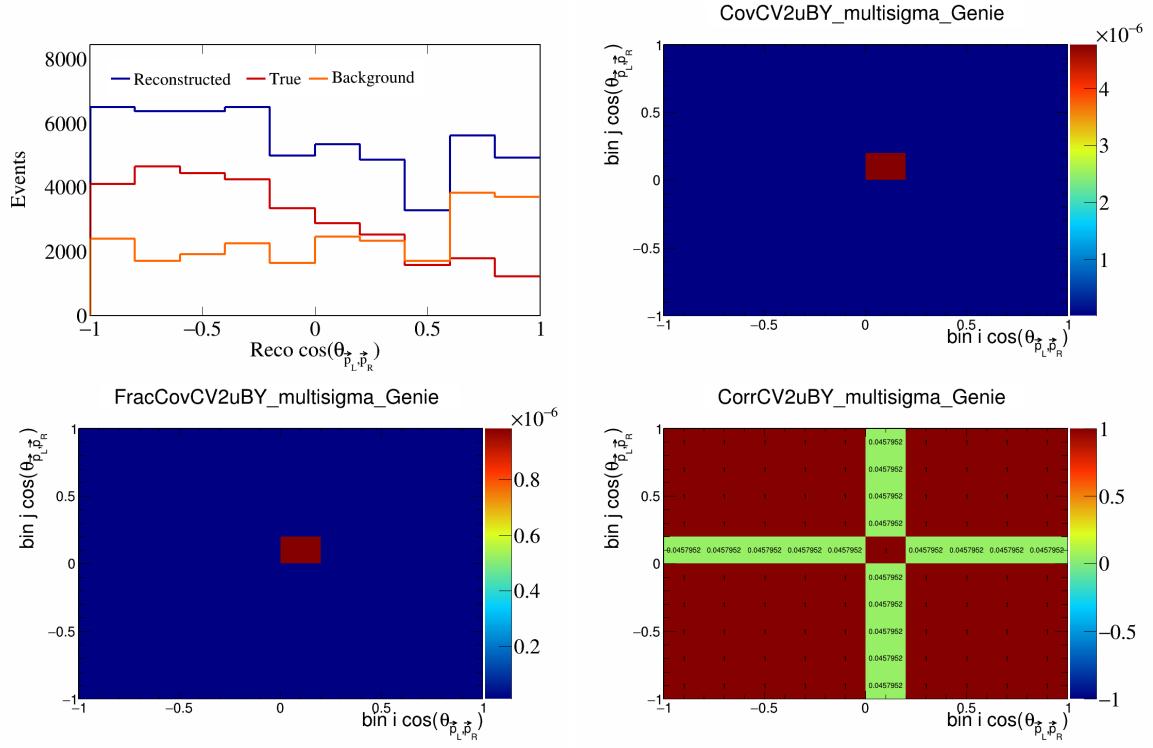


Figure 117: CV2uBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

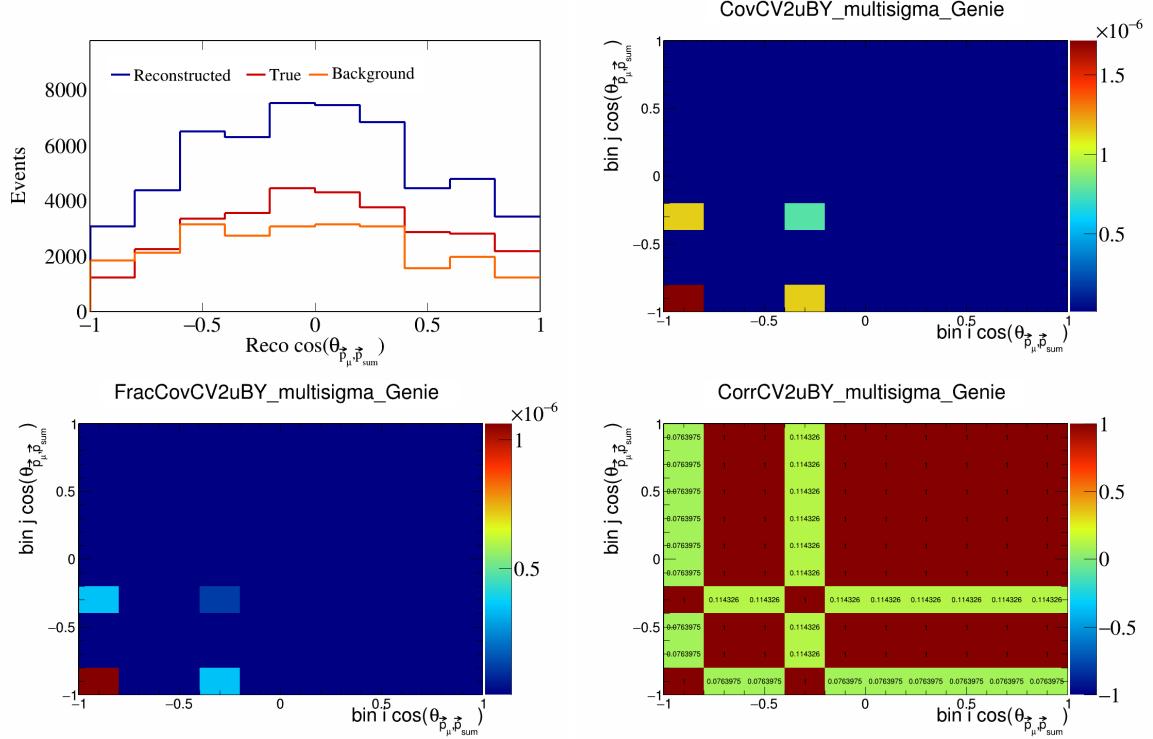


Figure 118: CV2uBY variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

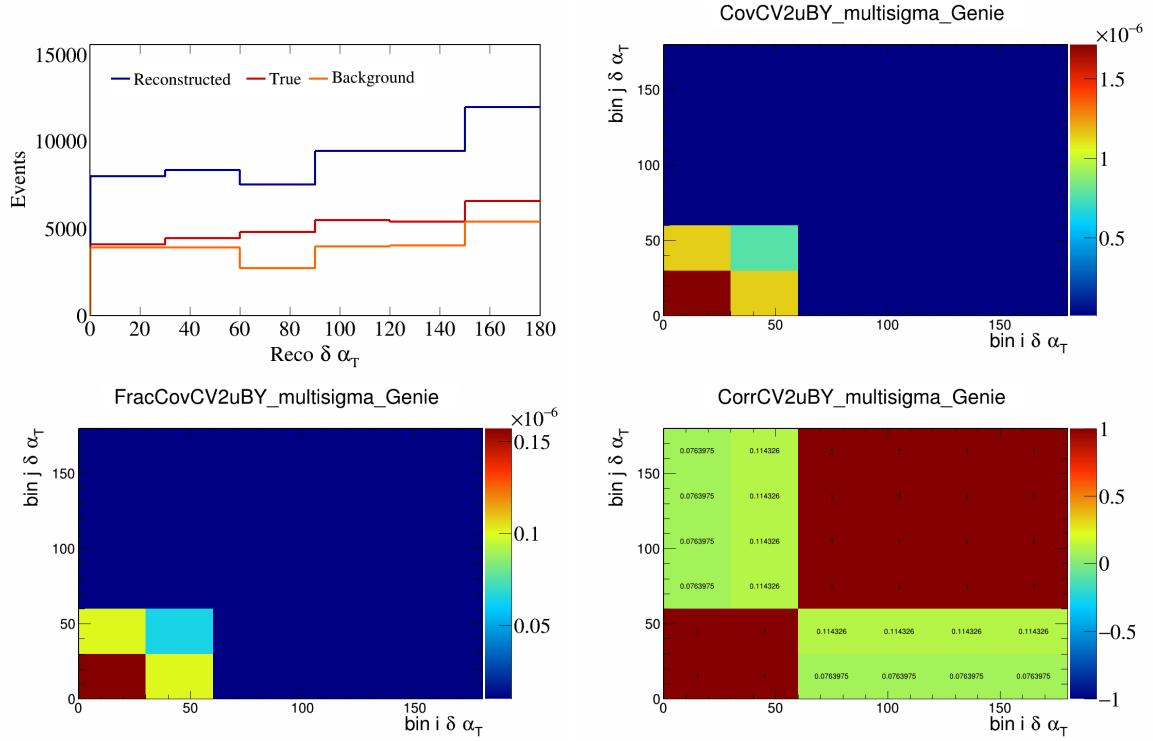


Figure 119: CV2uBY variations for $\delta\alpha_T$.

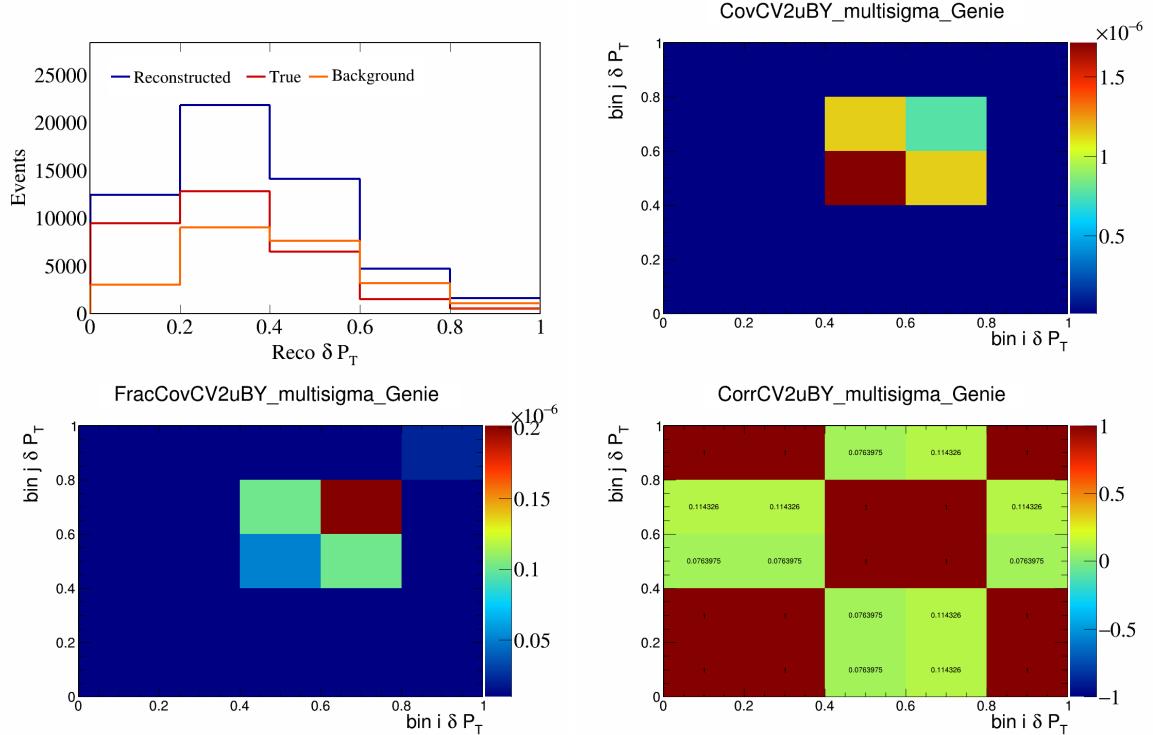


Figure 120: CV2uBY variations for δP_T .

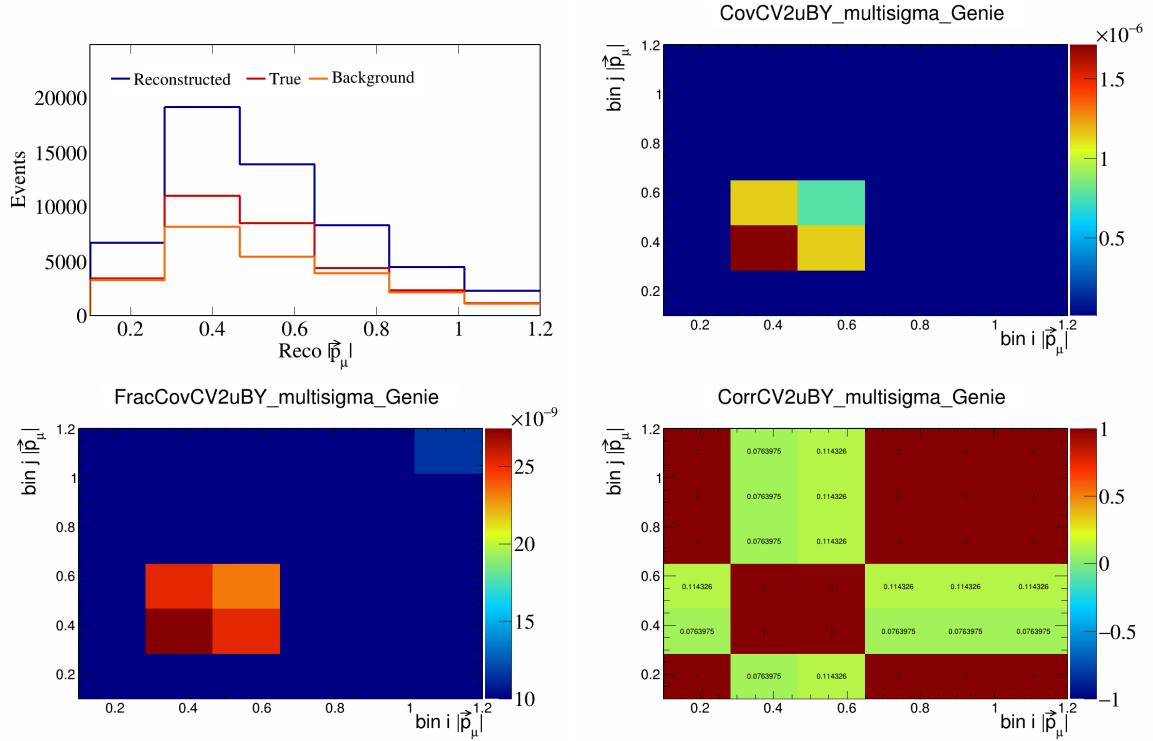


Figure 121: CV2uBY variations for $|\vec{p}_\mu|$.

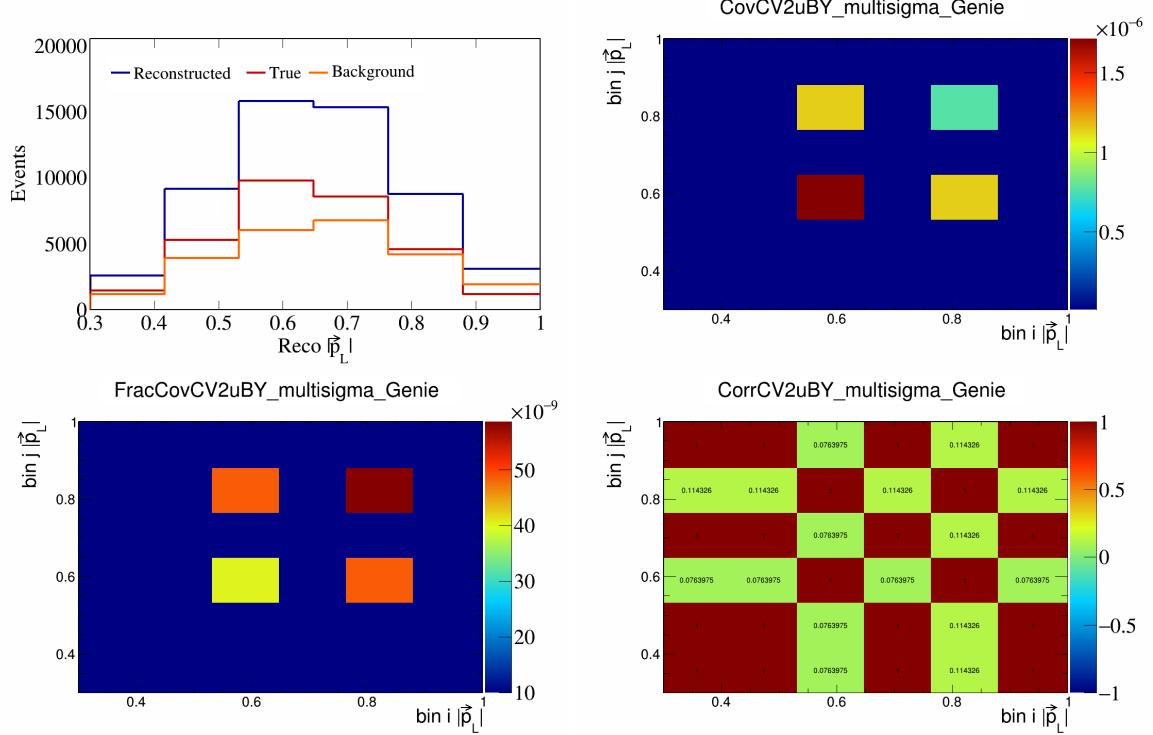


Figure 122: CV2uBY variations for $|\vec{p}_L|$.

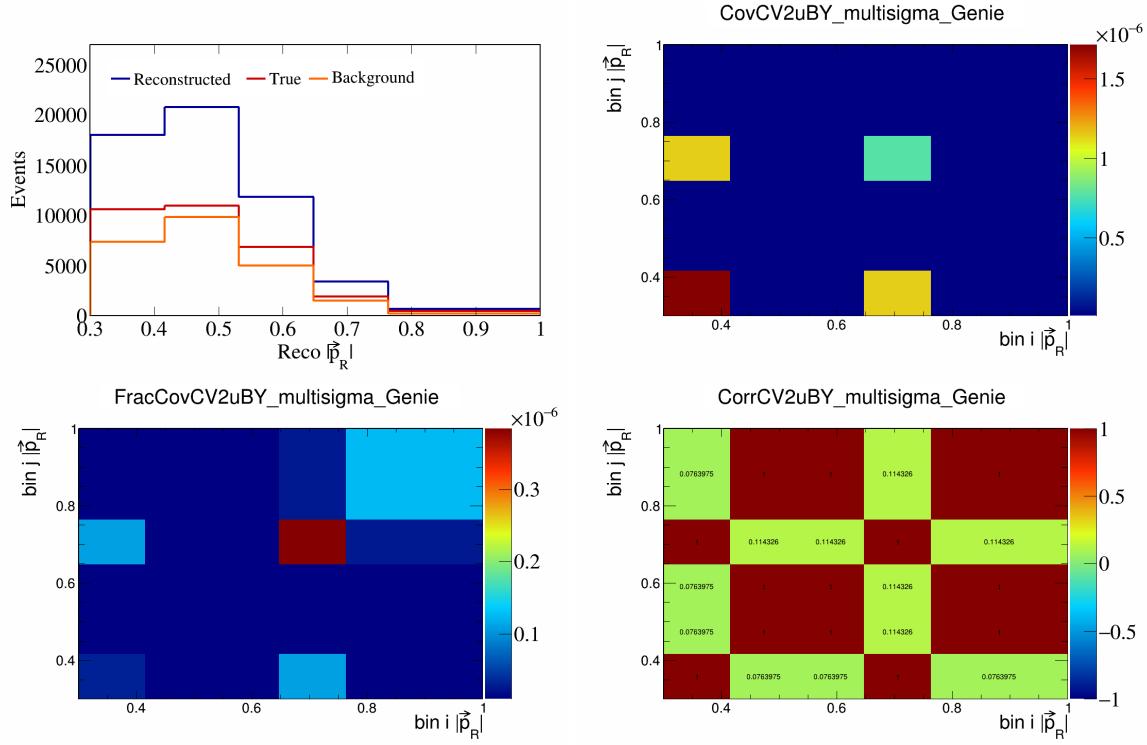


Figure 123: CV2uBY variations for $|\vec{p}_R|$.

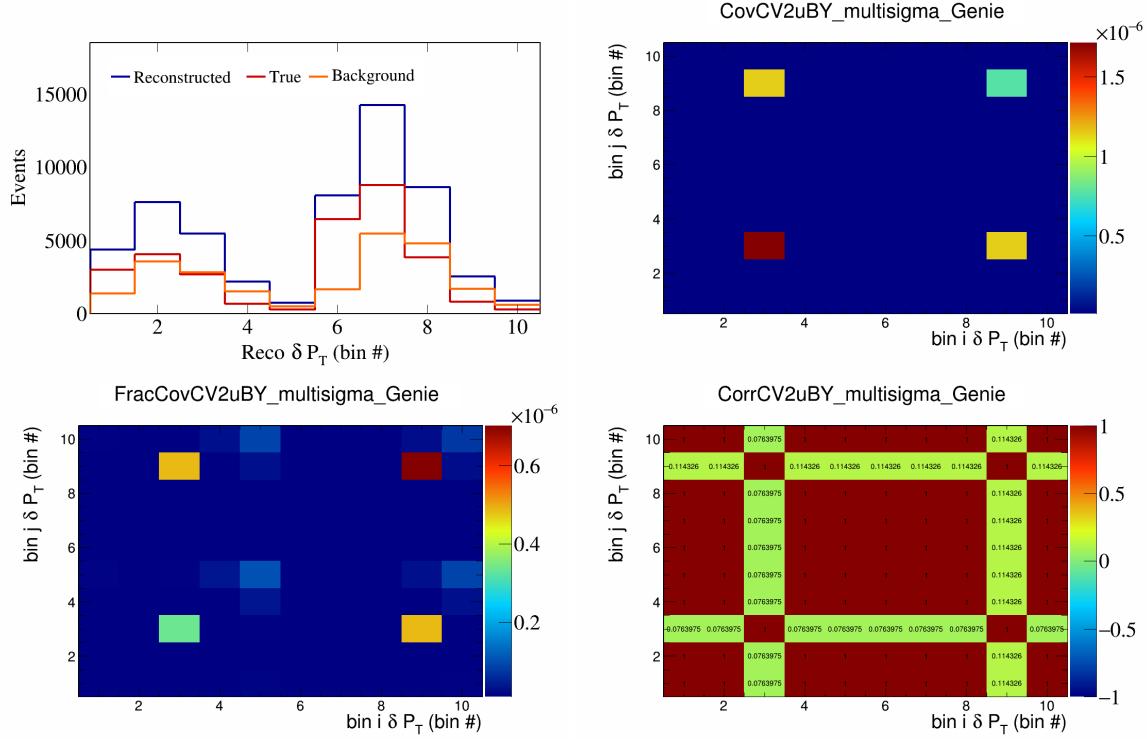


Figure 124: CV2uBY variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

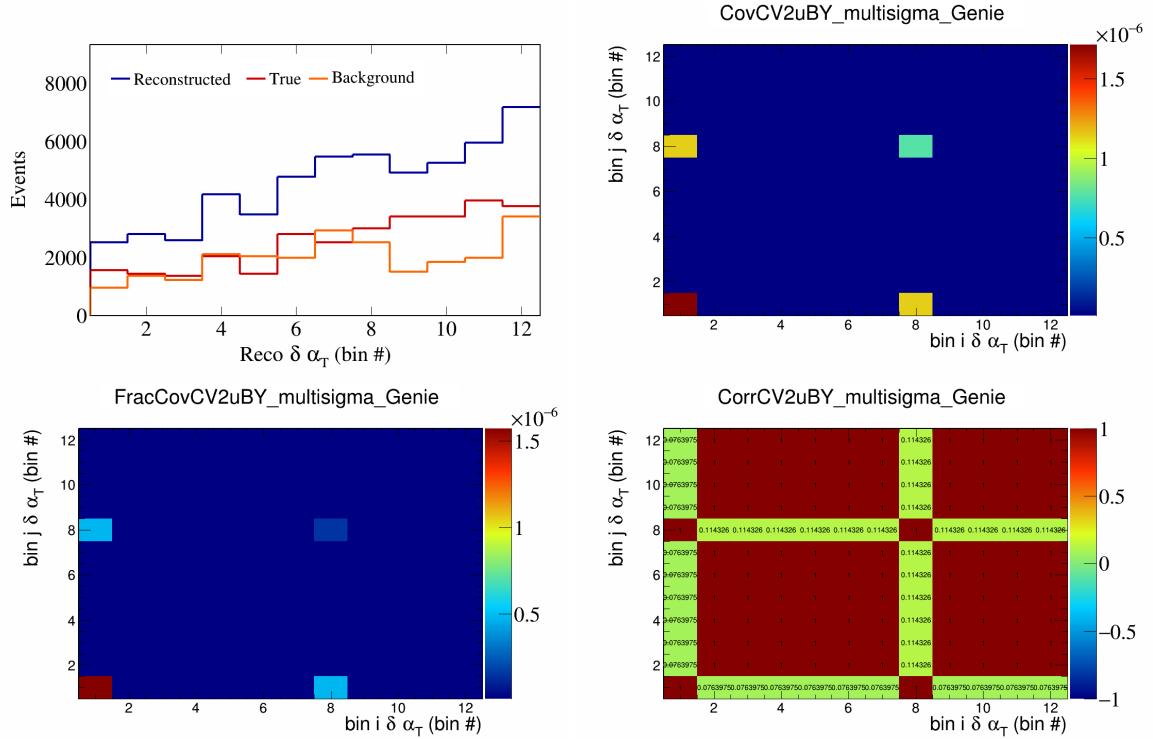


Figure 125: CV2uBY variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

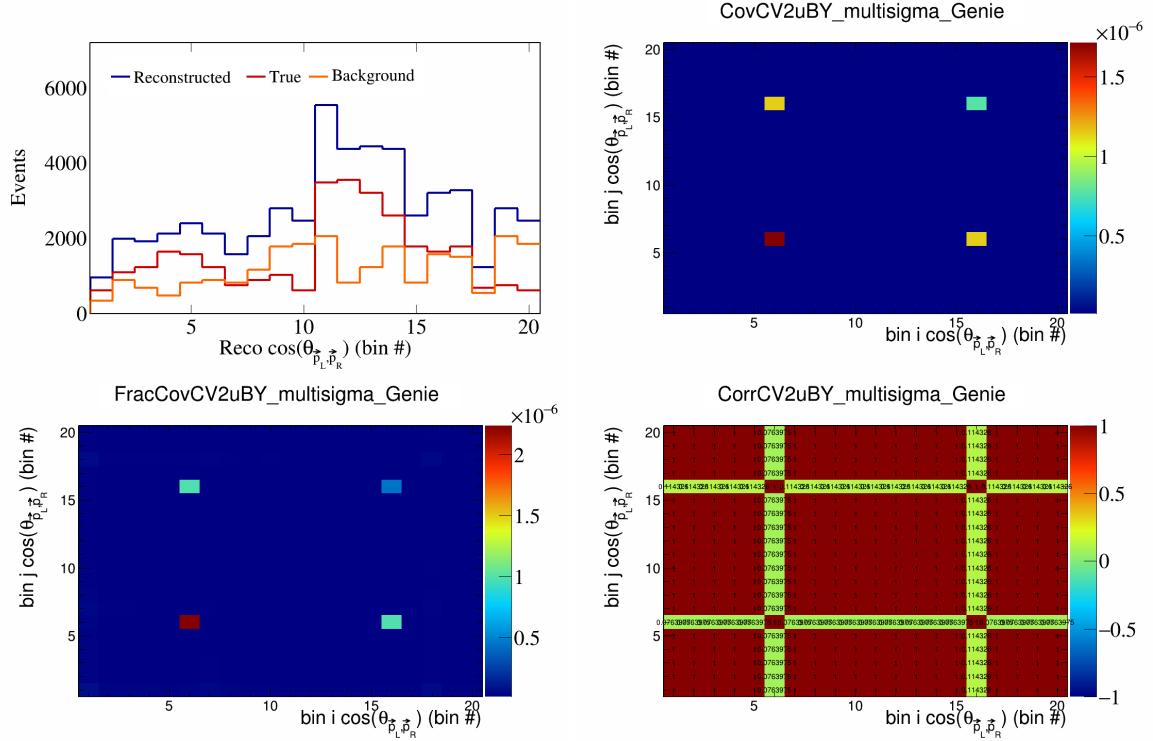


Figure 126: CV2uBY variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

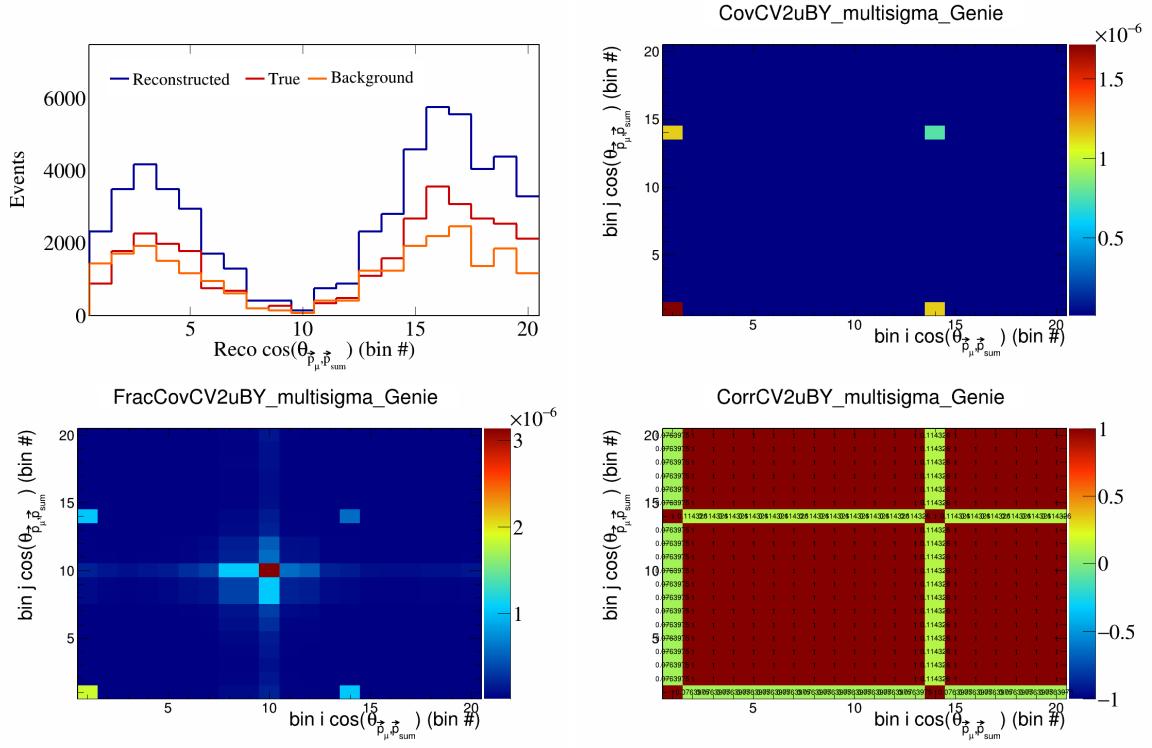


Figure 127: CV2uBY variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

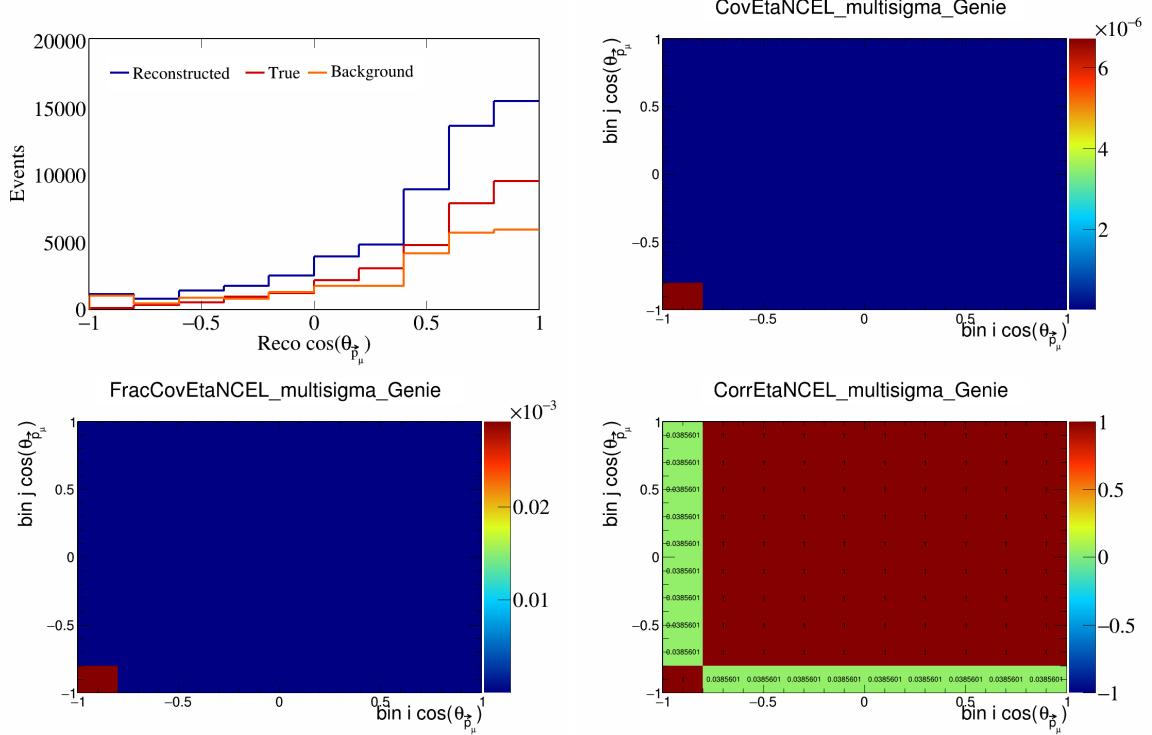


Figure 128: EtaNCEL variations for $\cos(\theta_{\vec{p}_\mu})$.

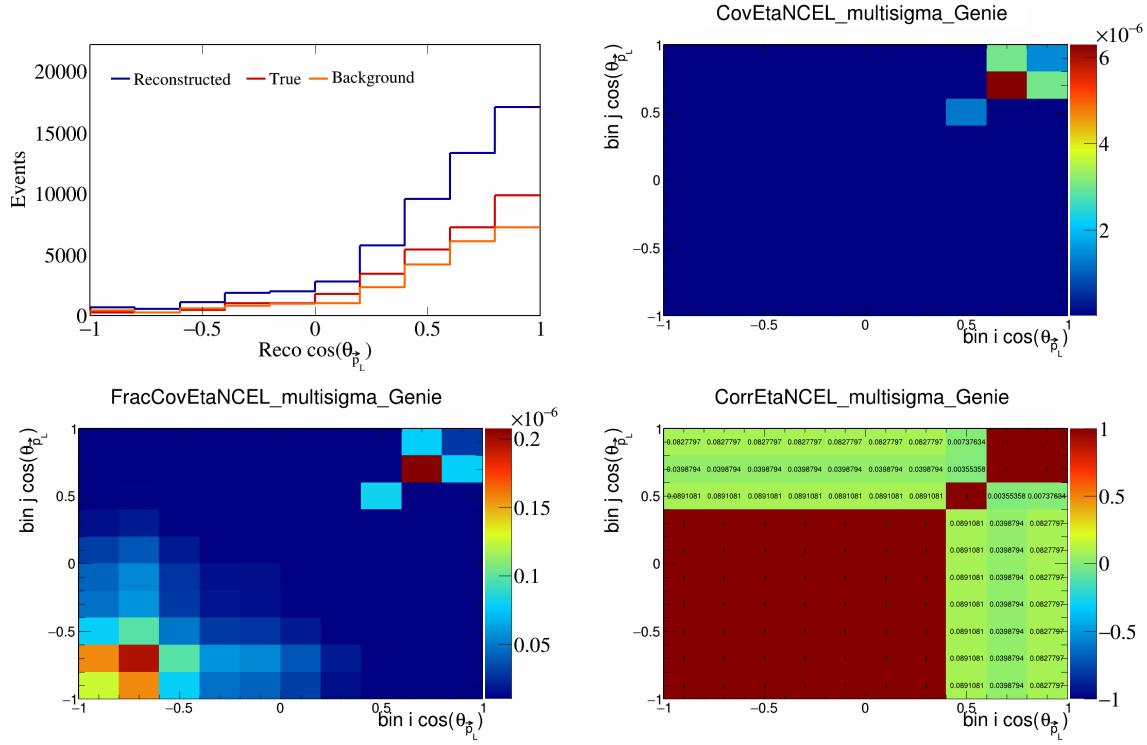


Figure 129: EtaNCEL variations for $\cos(\theta_{\vec{p}_L})$.

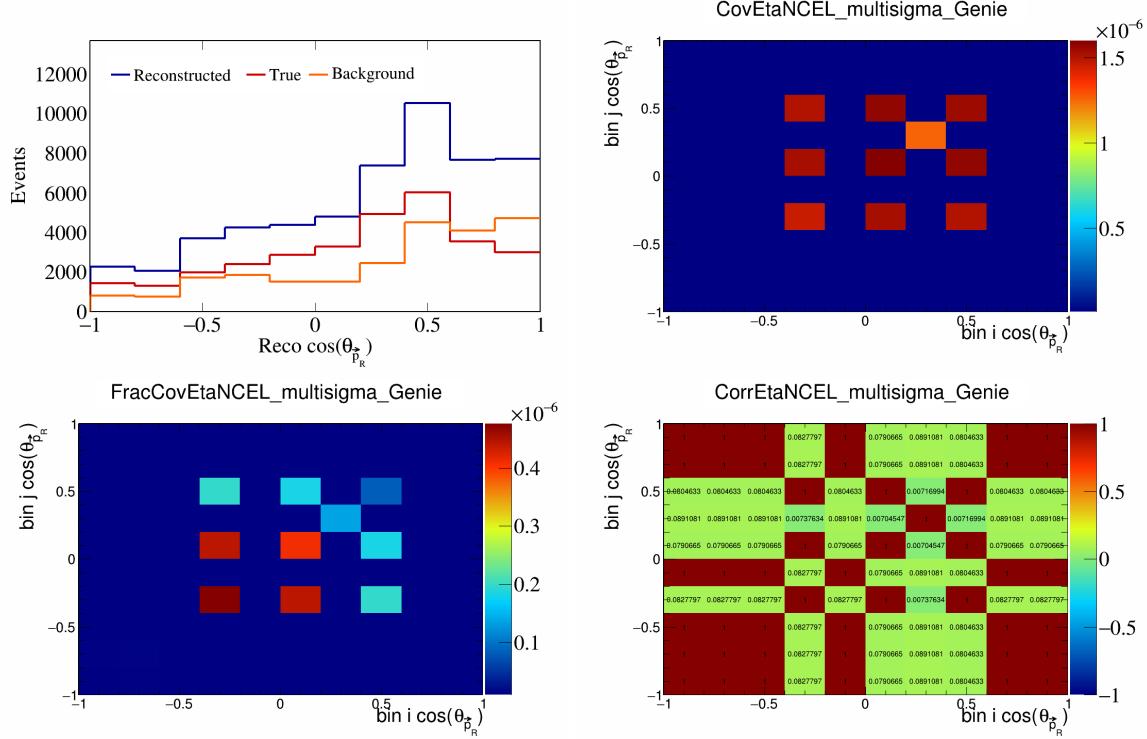


Figure 130: EtaNCEL variations for $\cos(\theta_{\vec{p}_R})$.

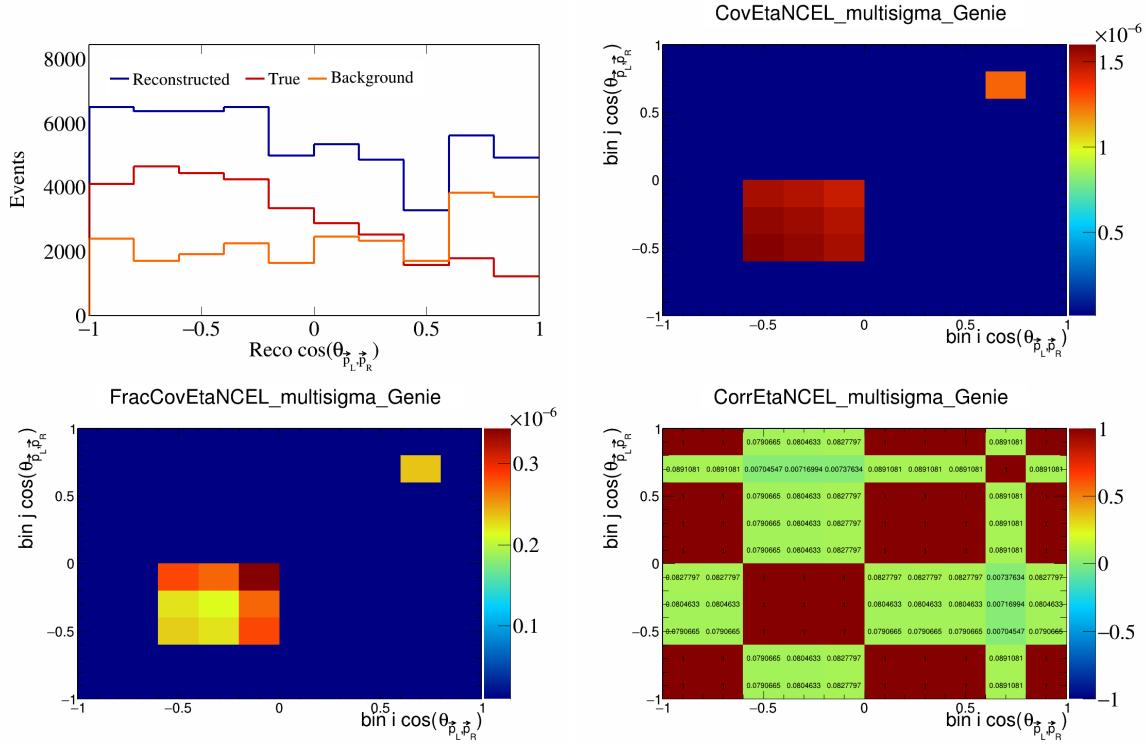


Figure 131: EtaNCEL variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

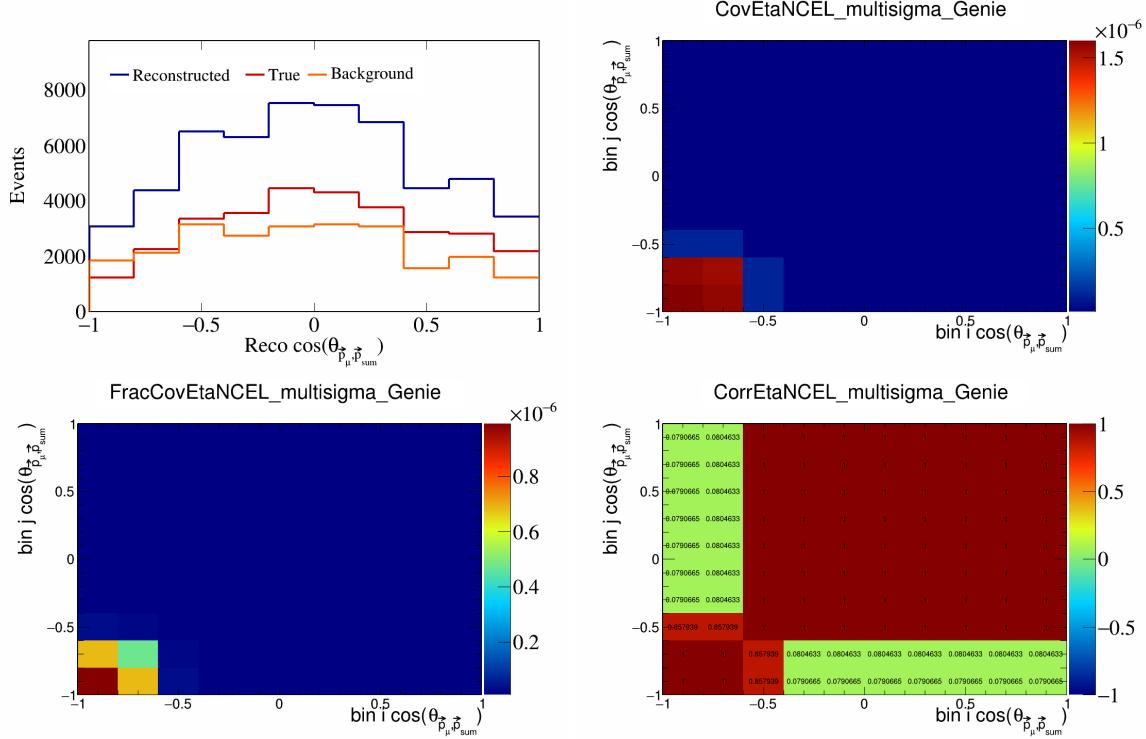


Figure 132: EtaNCEL variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

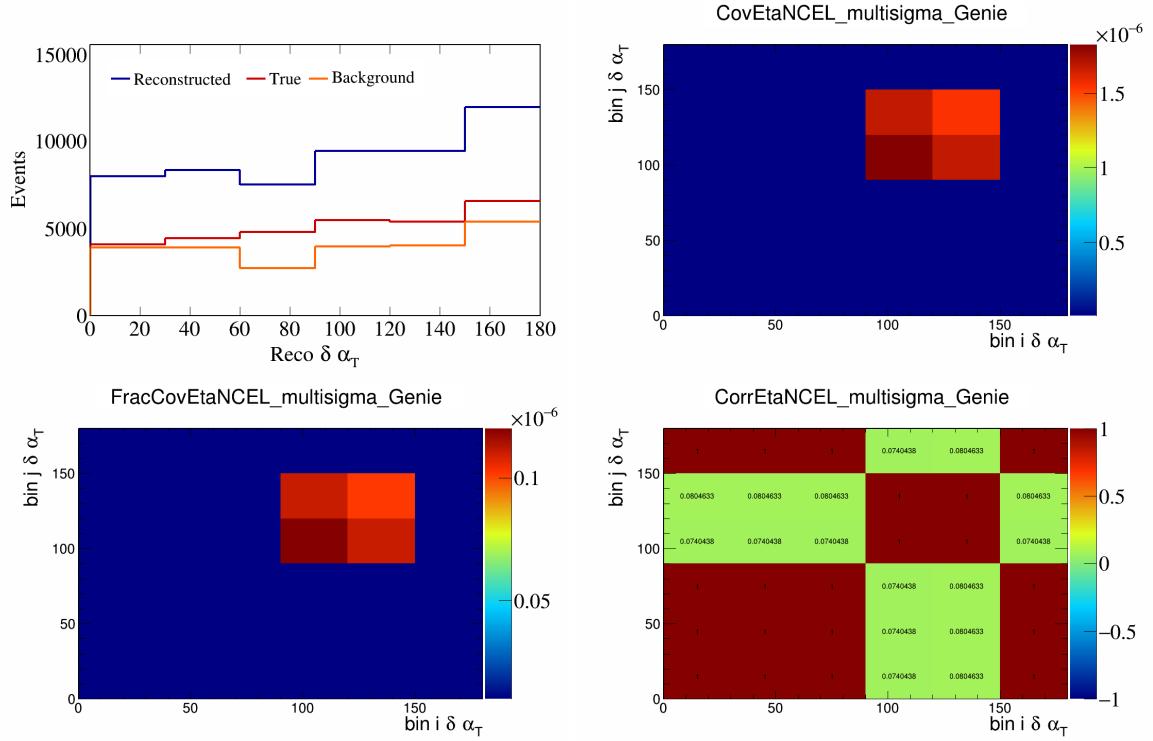


Figure 133: EtaNCEL variations for $\delta\alpha_T$.

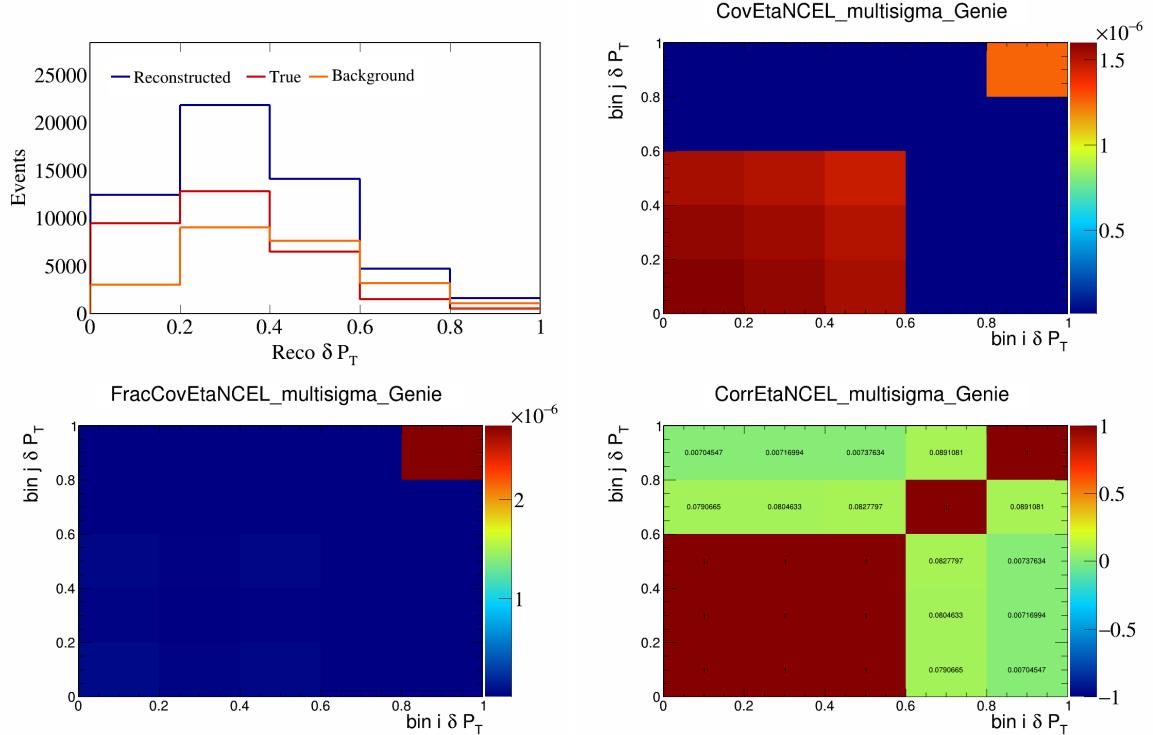


Figure 134: EtaNCEL variations for δP_T .

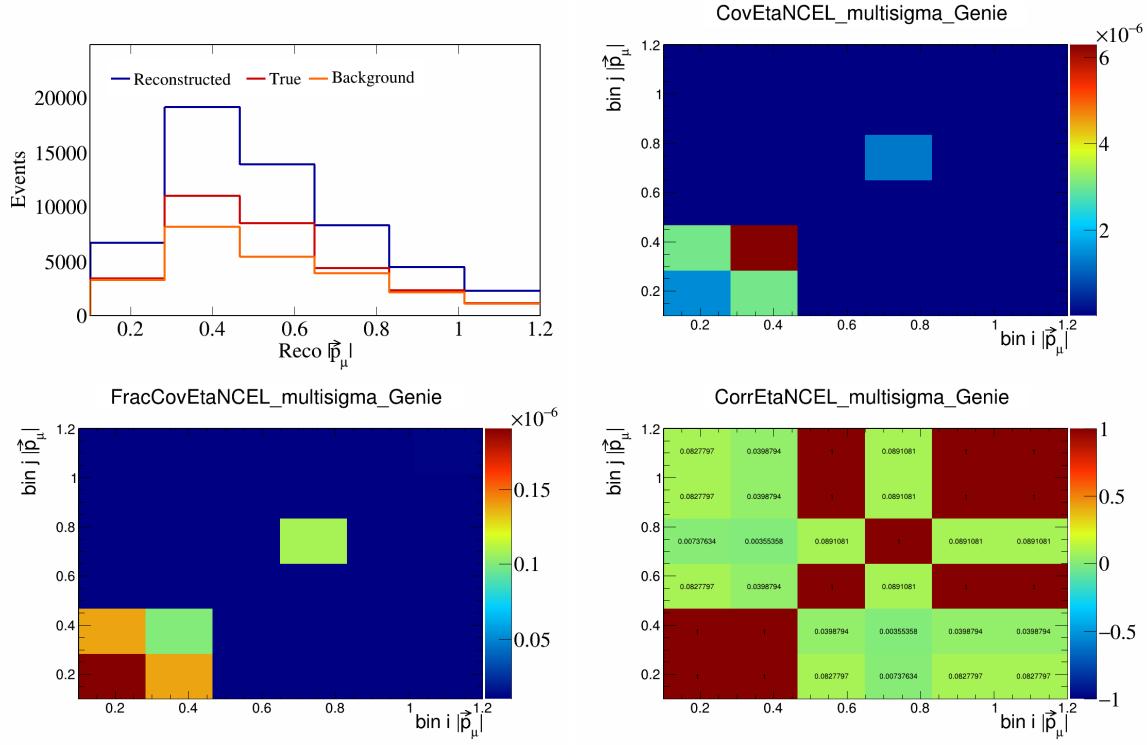


Figure 135: EtaNCEL variations for $|\vec{p}_\mu|$.

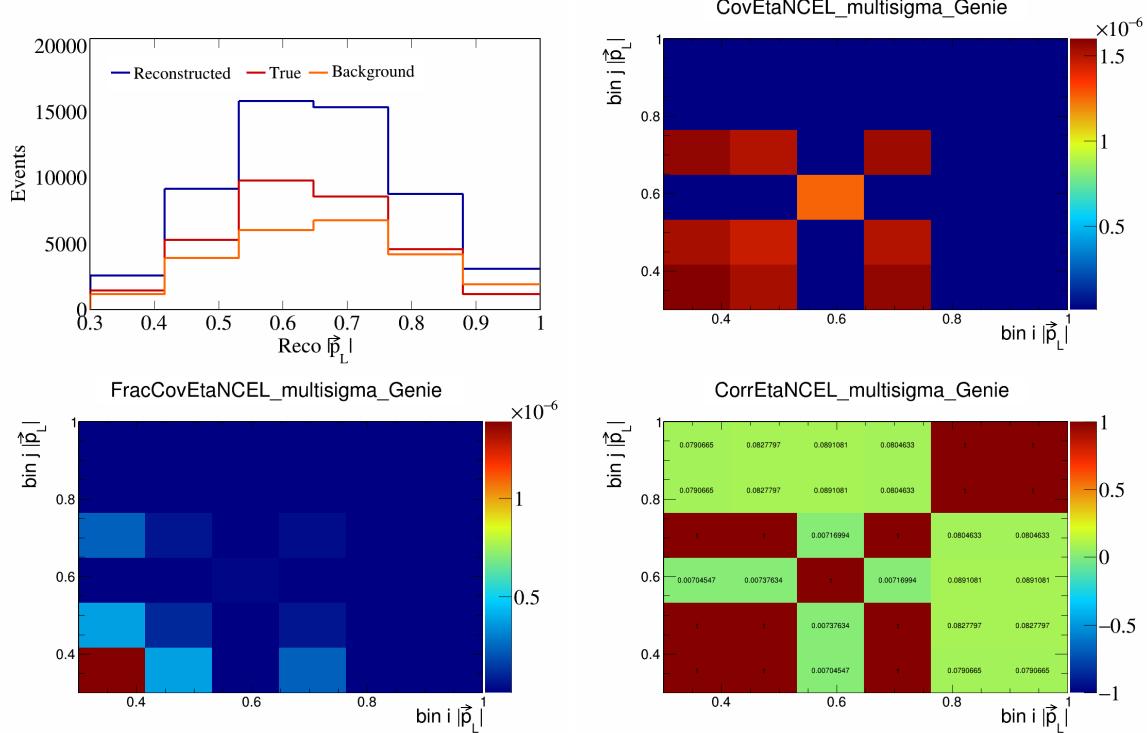


Figure 136: EtaNCEL variations for $|\vec{p}_L|$.

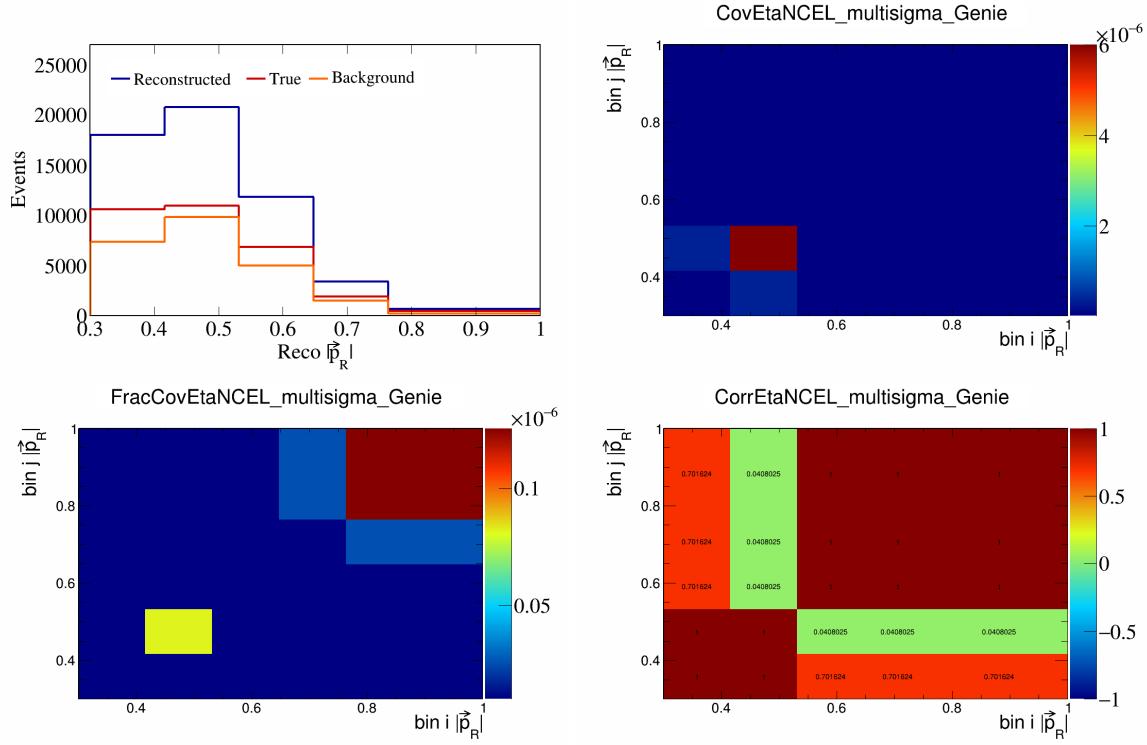


Figure 137: EtaNCEL variations for $|\vec{p}_R|$.

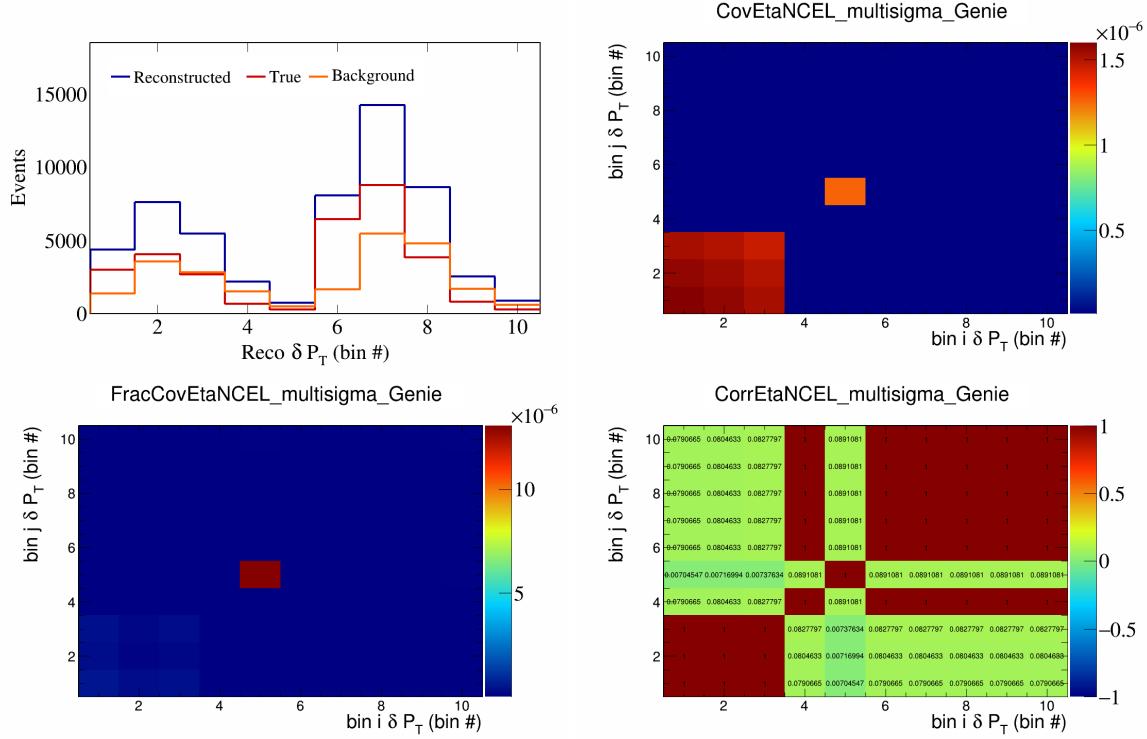


Figure 138: EtaNCEL variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

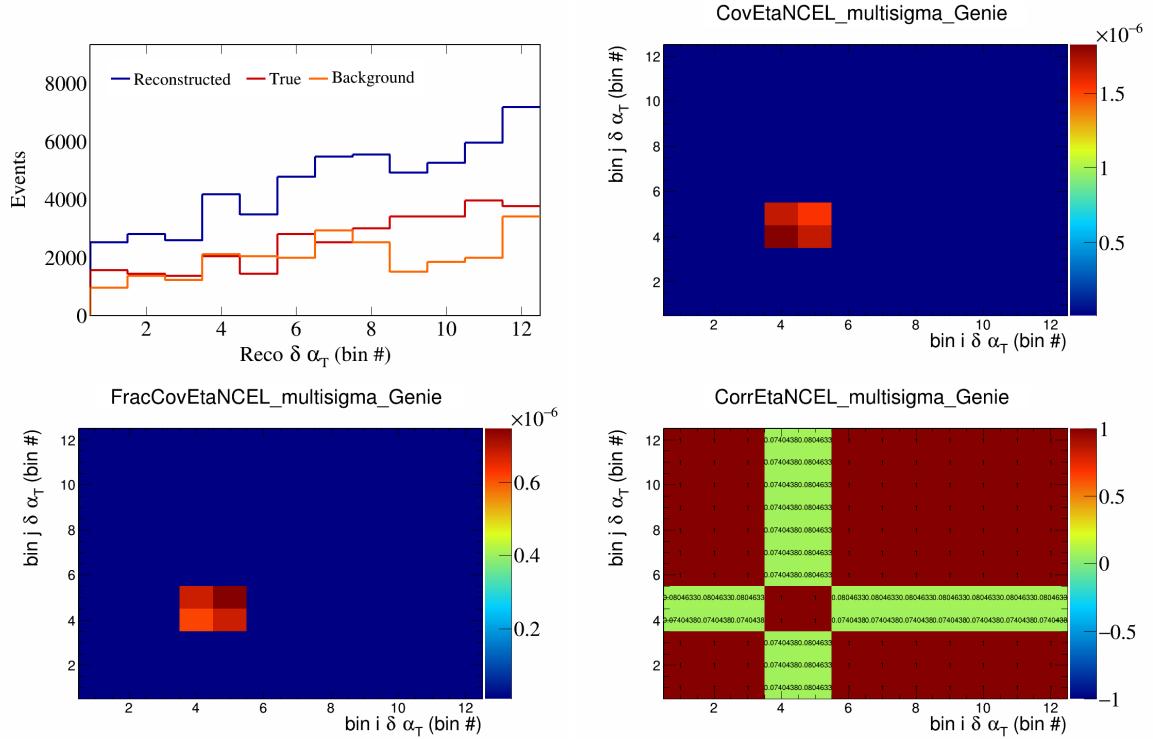


Figure 139: EtaNCEL variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

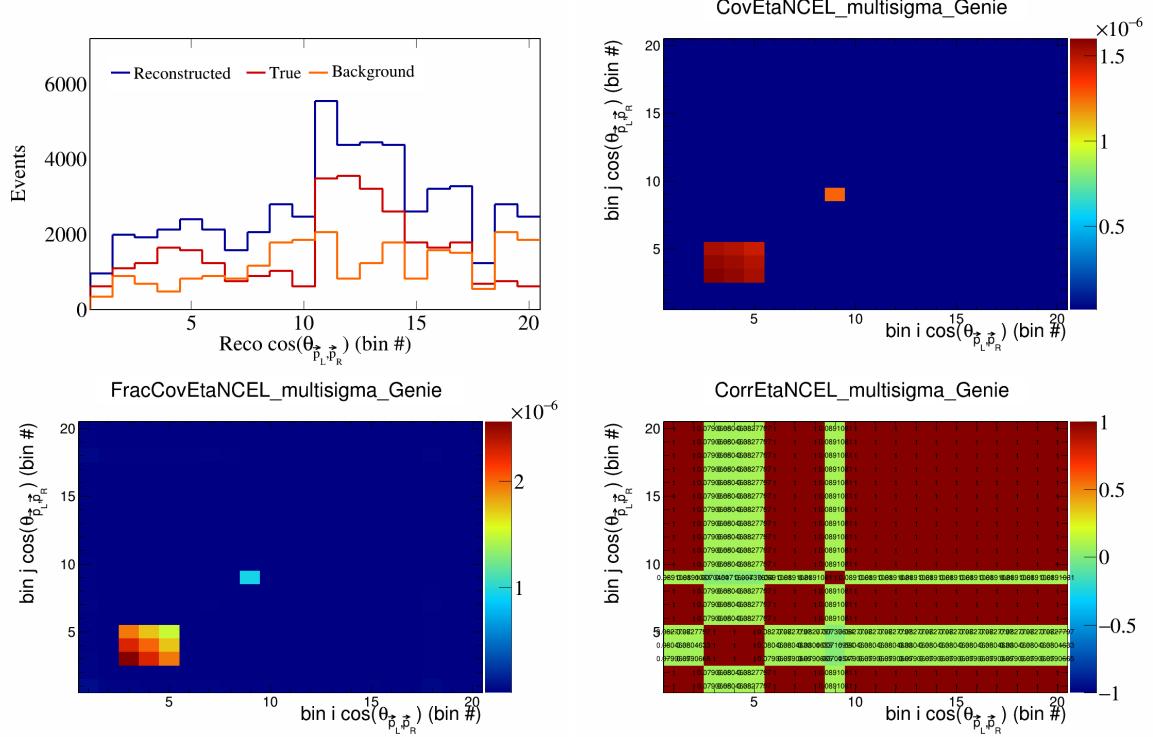


Figure 140: EtaNCEL variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

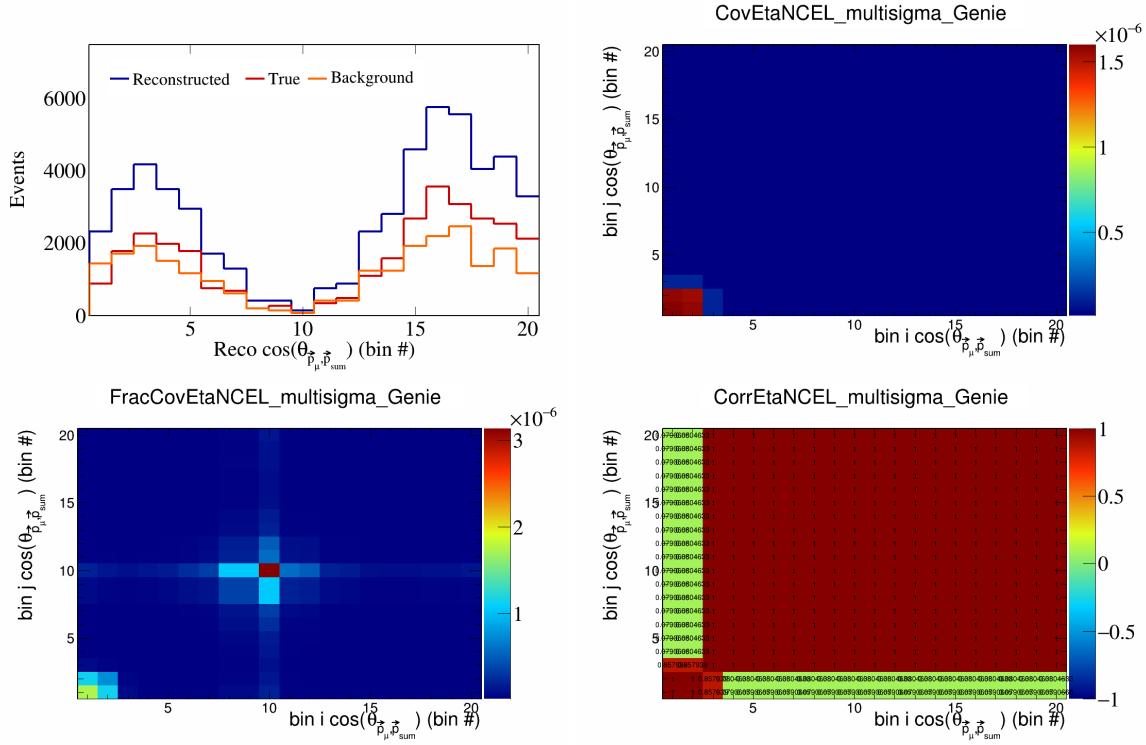


Figure 141: EtaNCEL variations for $\cos(\theta_{\vec{p}_\mu} \cdot \vec{p}_{\text{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

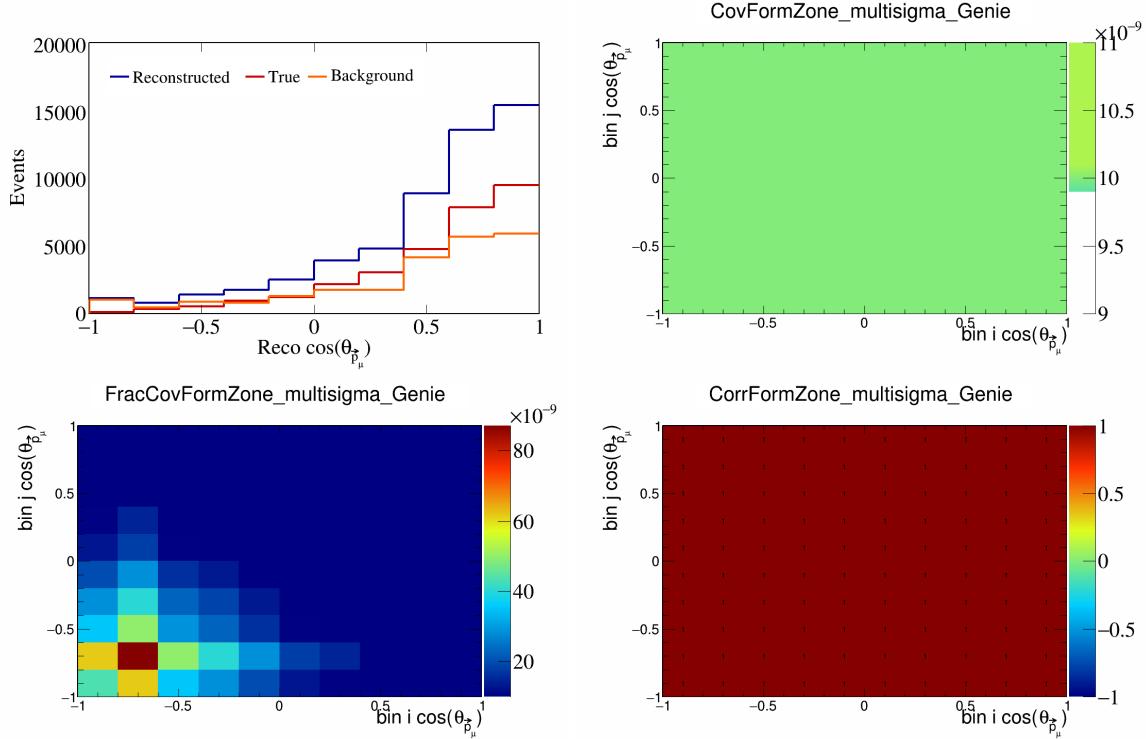


Figure 142: FormZone variations for $\cos(\theta_{\vec{p}_\mu})$.

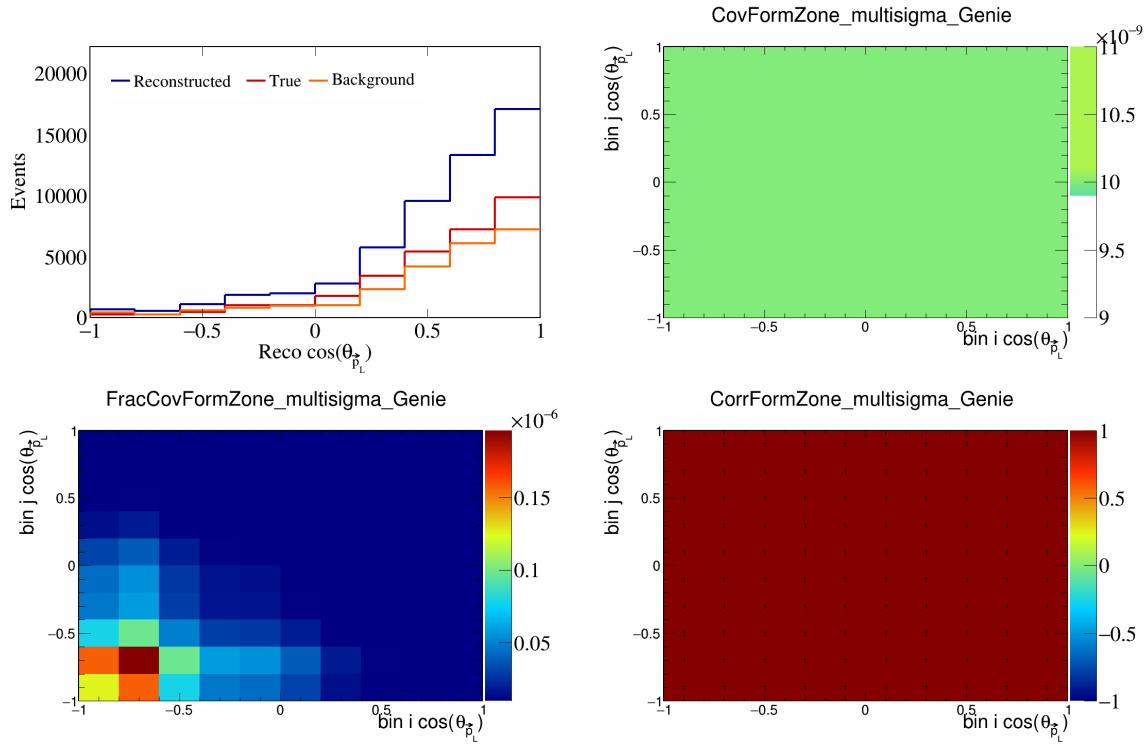


Figure 143: FormZone variations for $\cos(\theta_{\vec{p}_L})$.

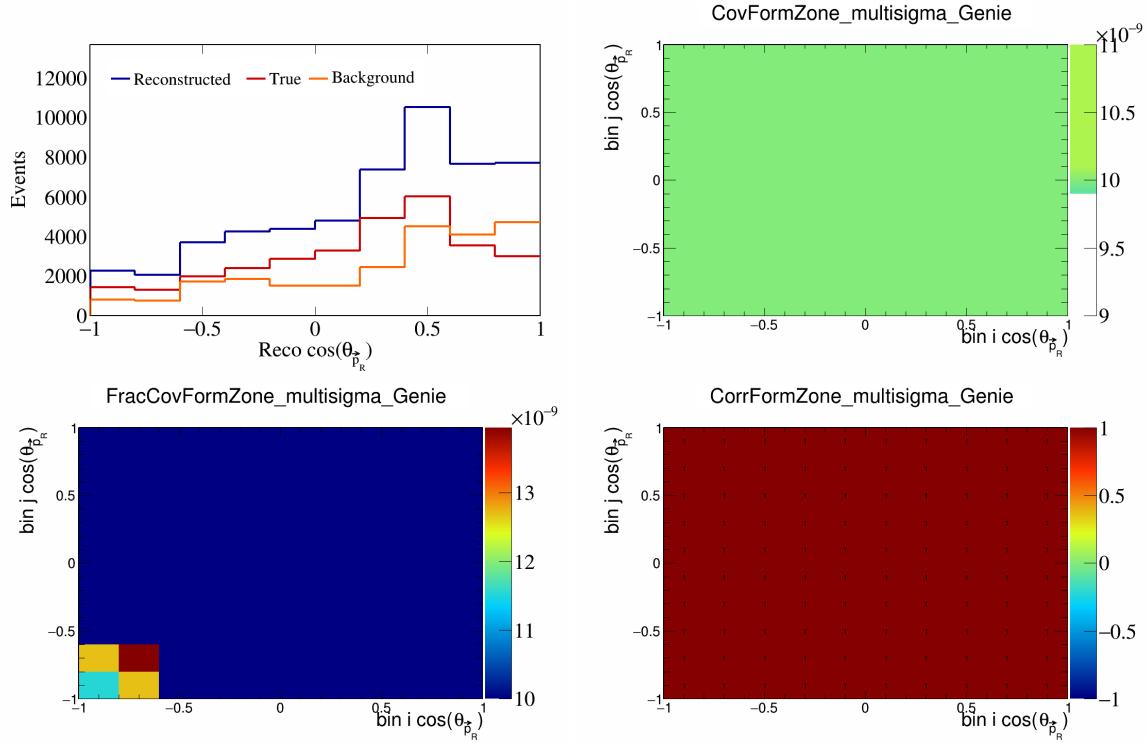


Figure 144: FormZone variations for $\cos(\theta_{\vec{p}_R})$.

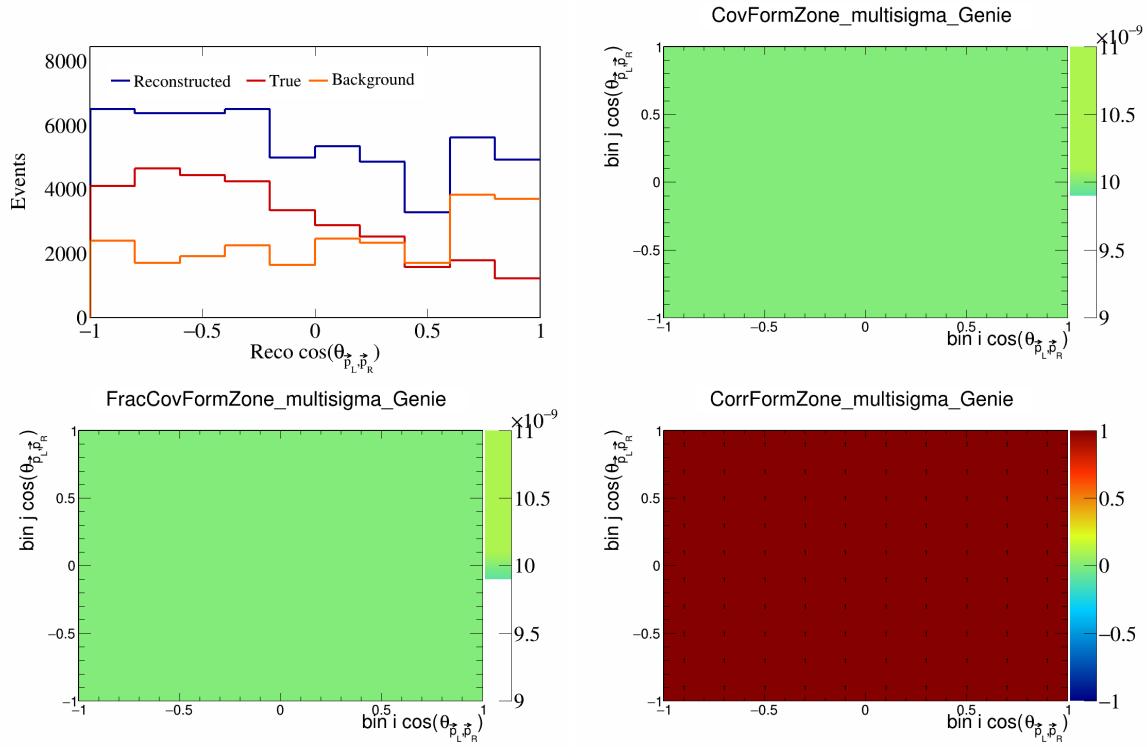


Figure 145: FormZone variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

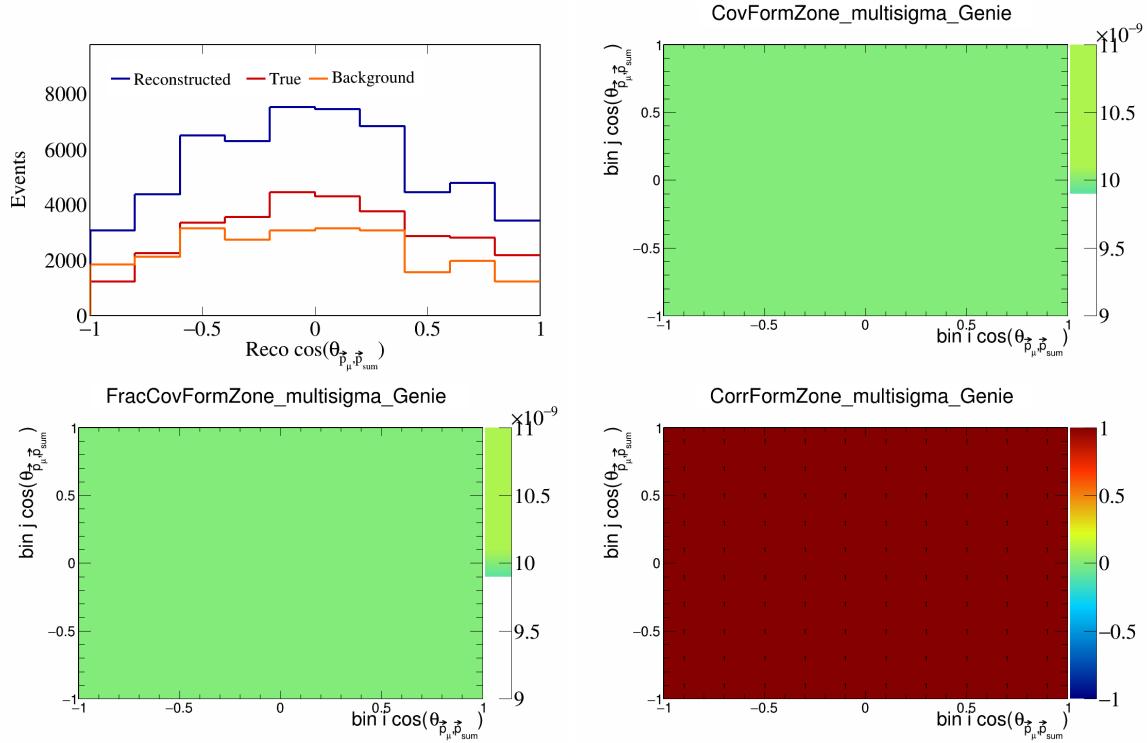


Figure 146: FormZone variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

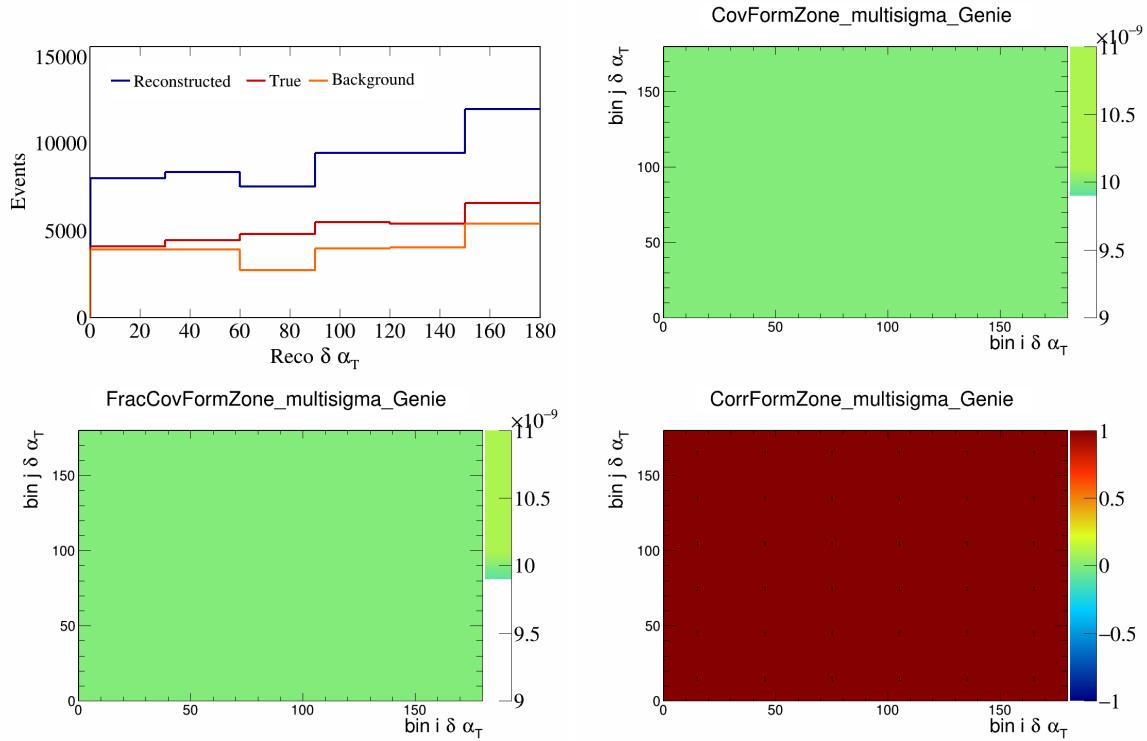


Figure 147: FormZone variations for $\delta\alpha_T$.

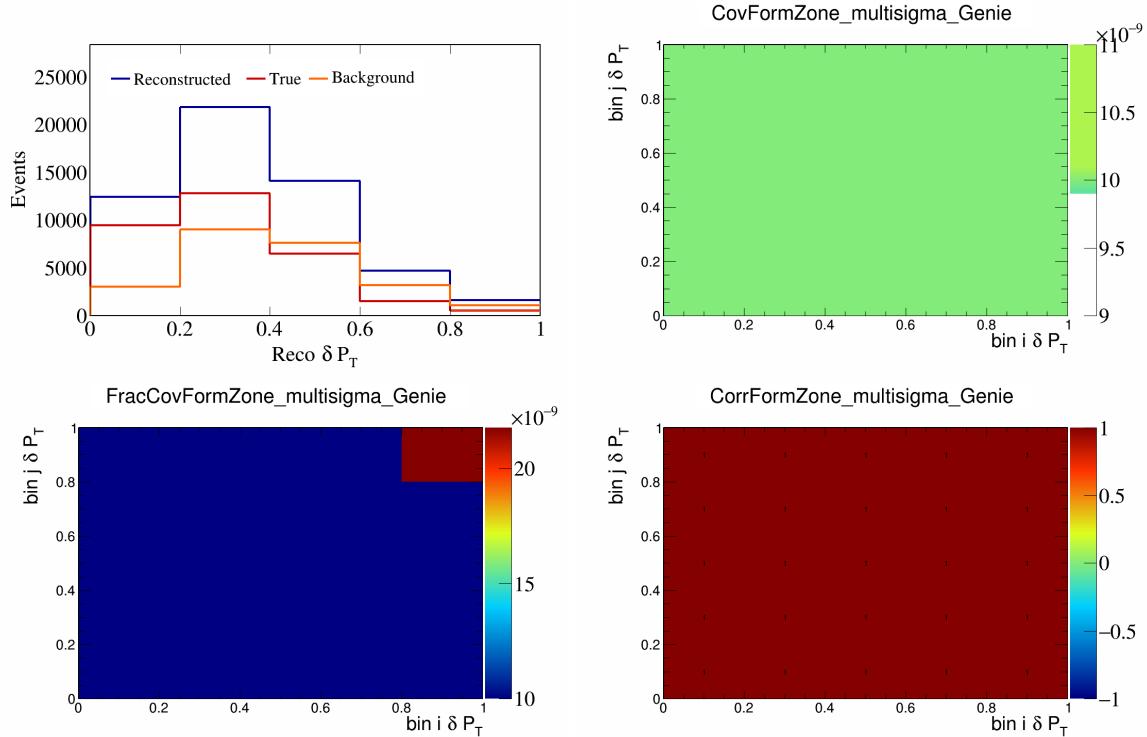


Figure 148: FormZone variations for δP_T .

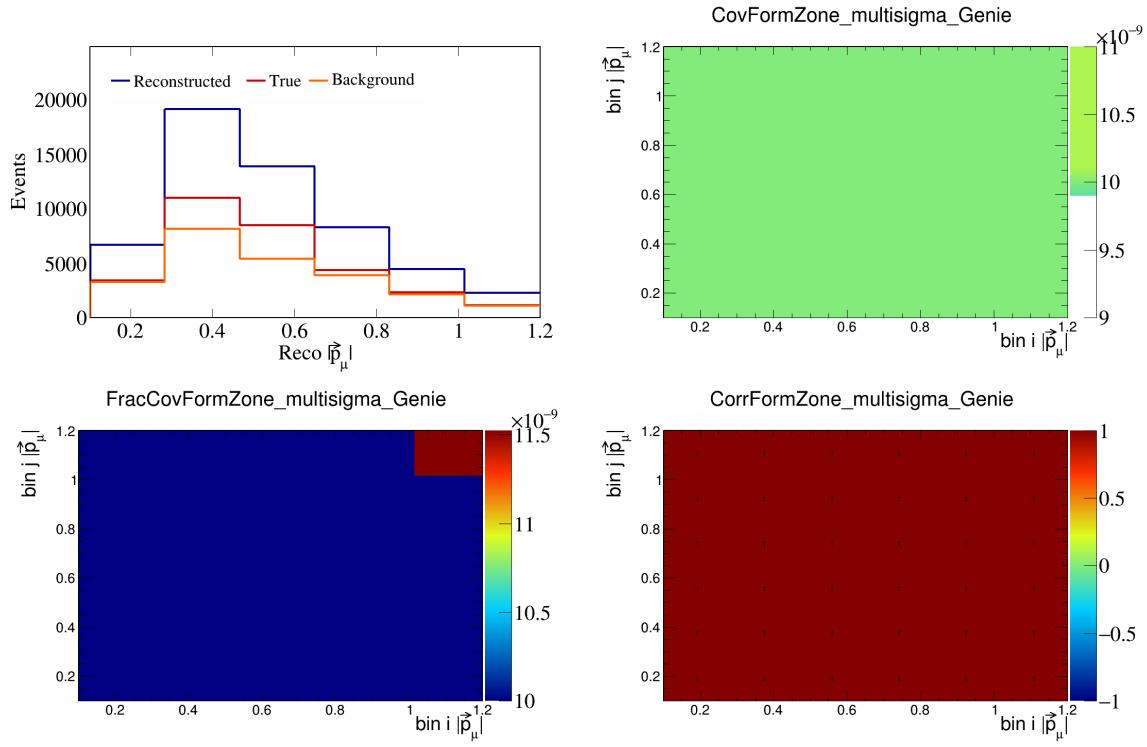


Figure 149: FormZone variations for $|\vec{p}_\mu|$.

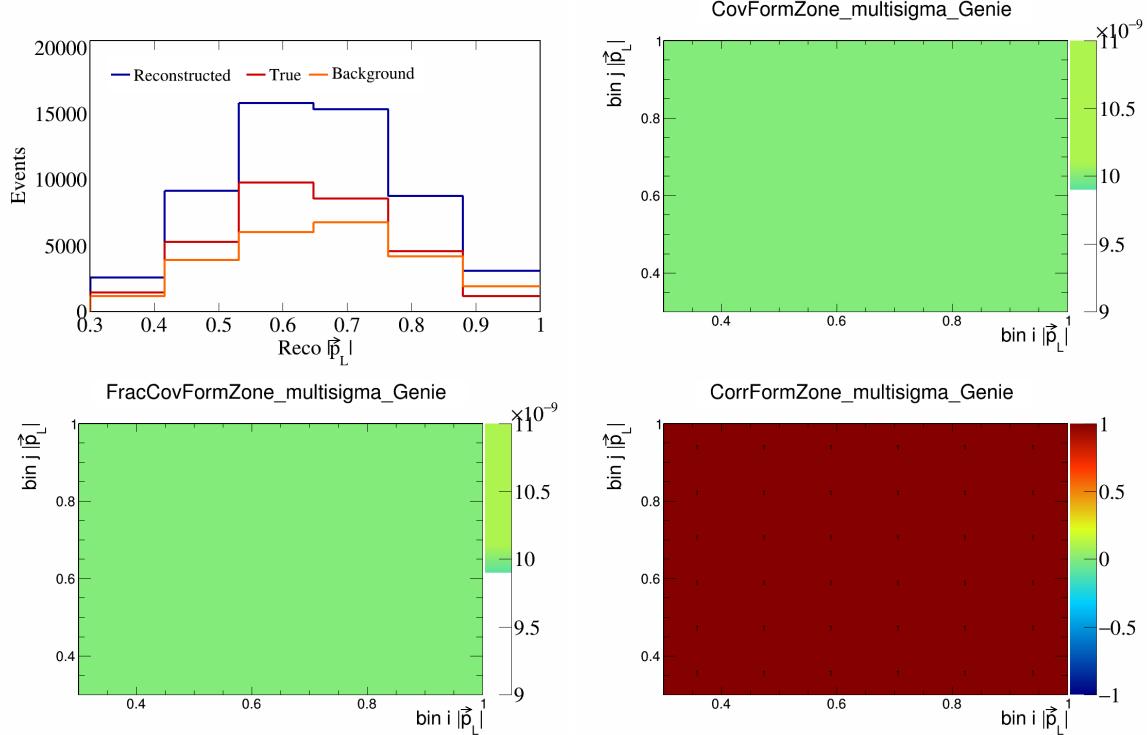


Figure 150: FormZone variations for $|\vec{p}_L|$.

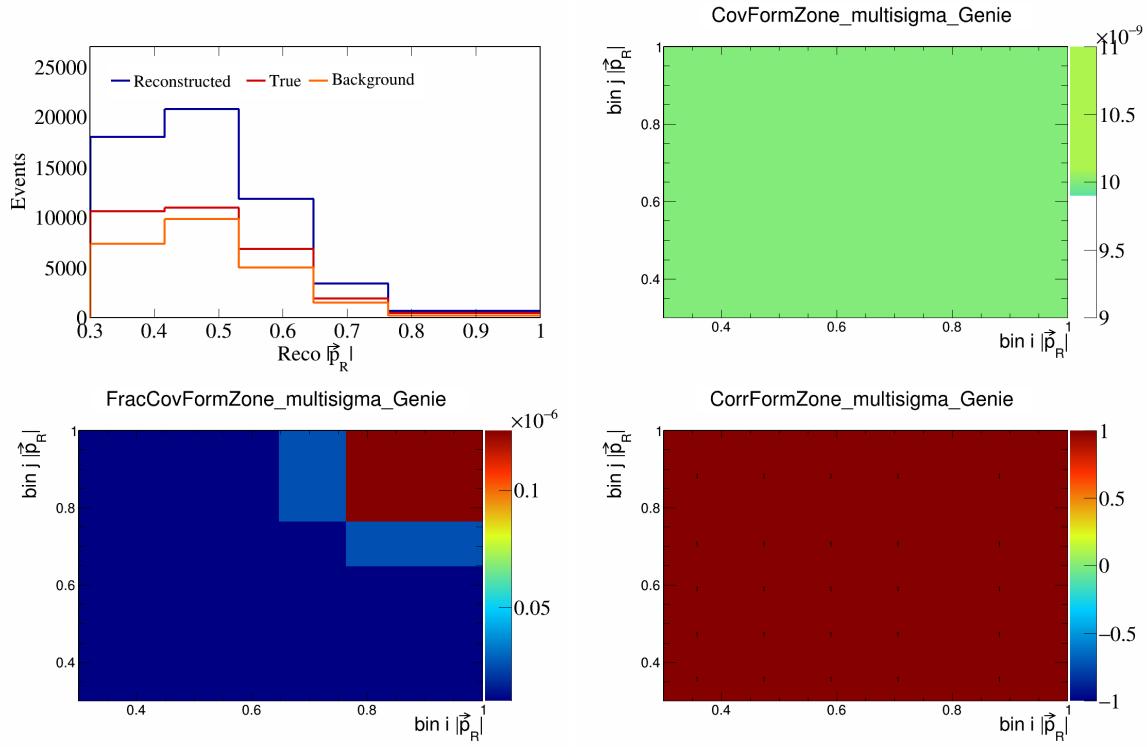


Figure 151: FormZone variations for $|\vec{p}_R|$.

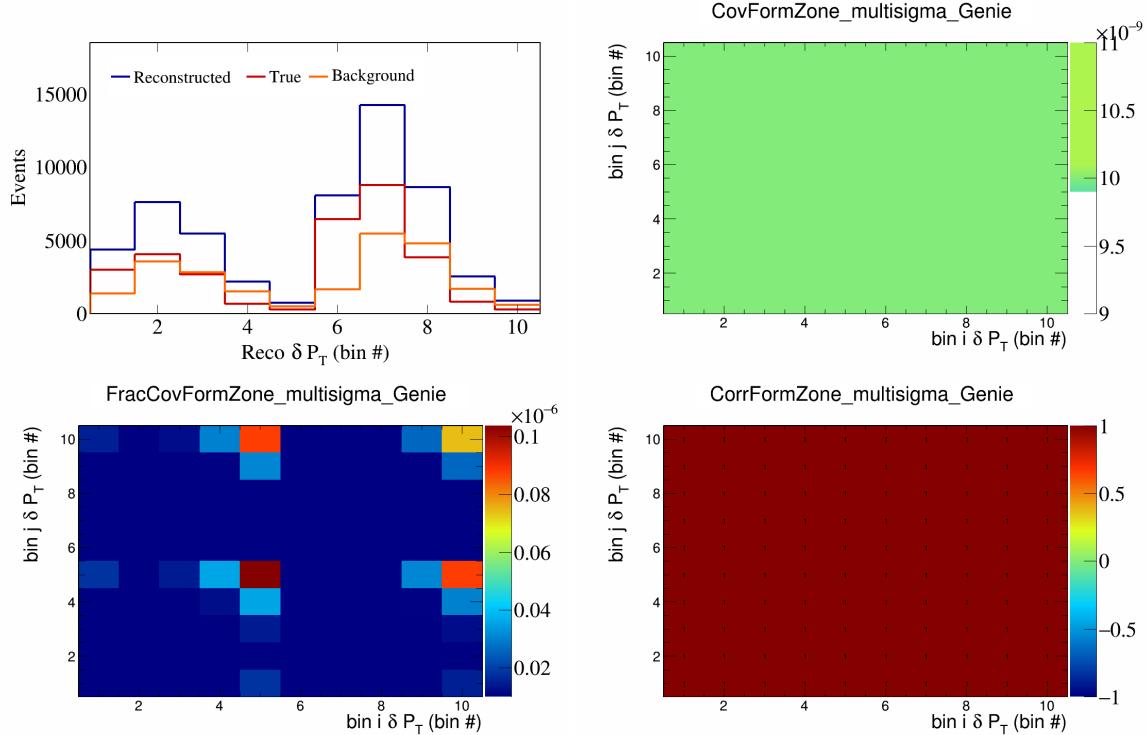


Figure 152: FormZone variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

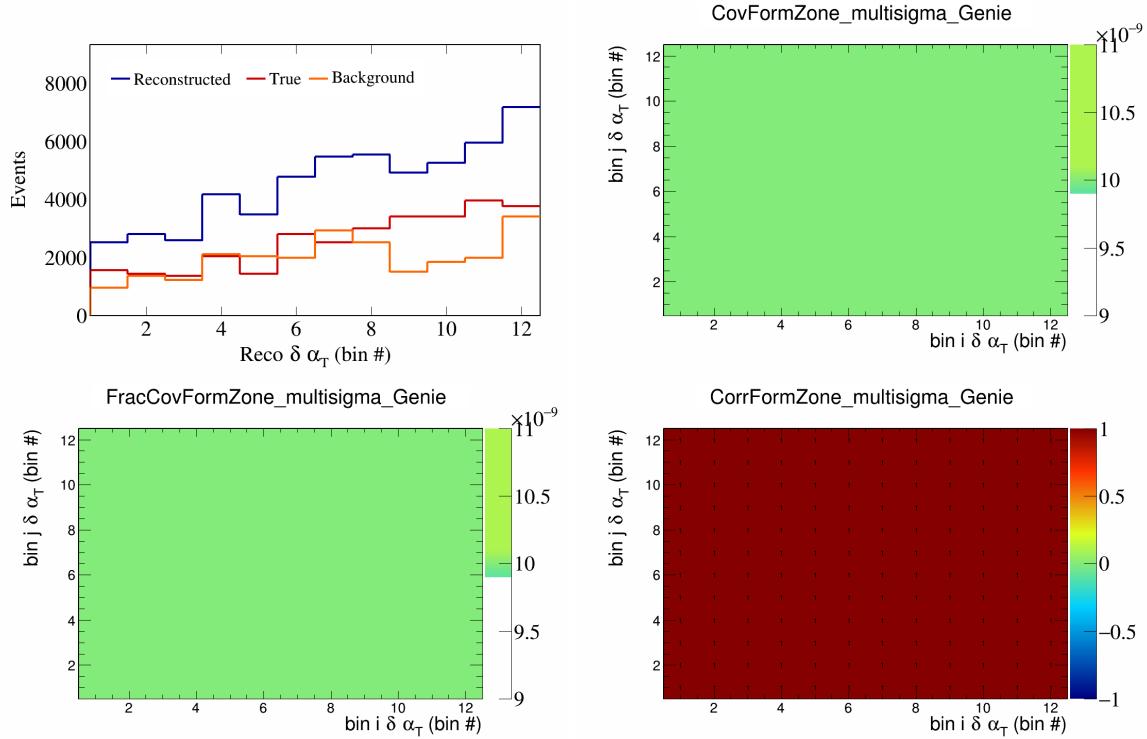


Figure 153: FormZone variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

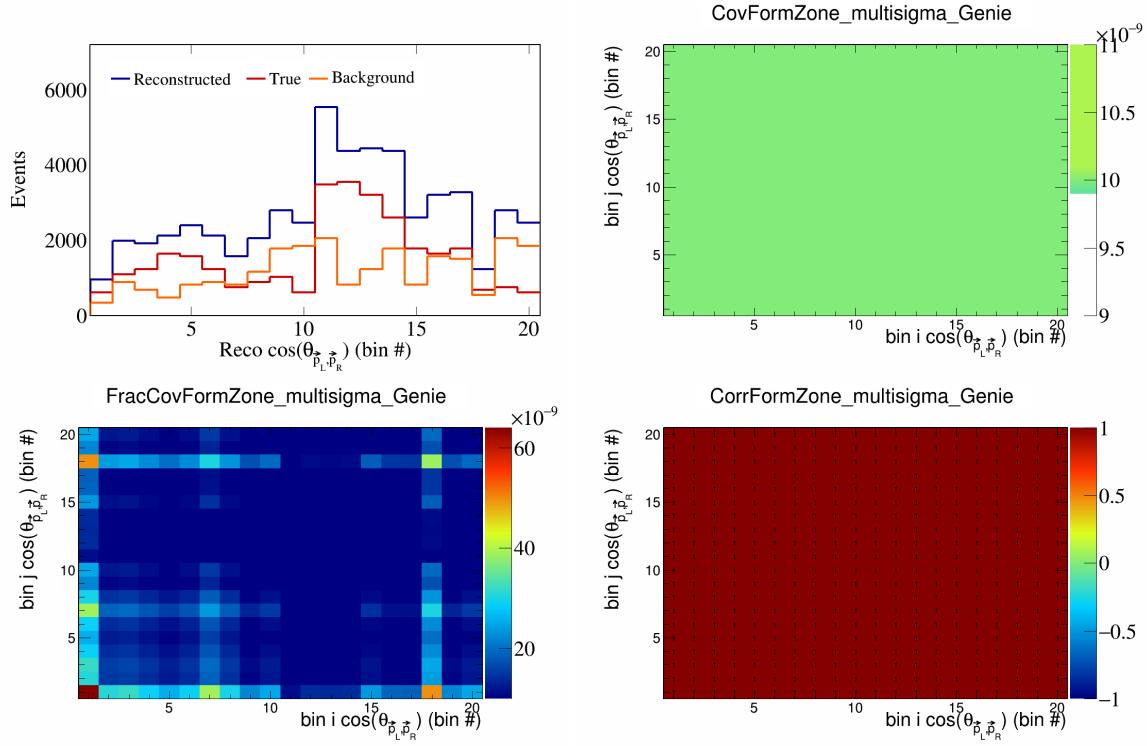


Figure 154: FormZone variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

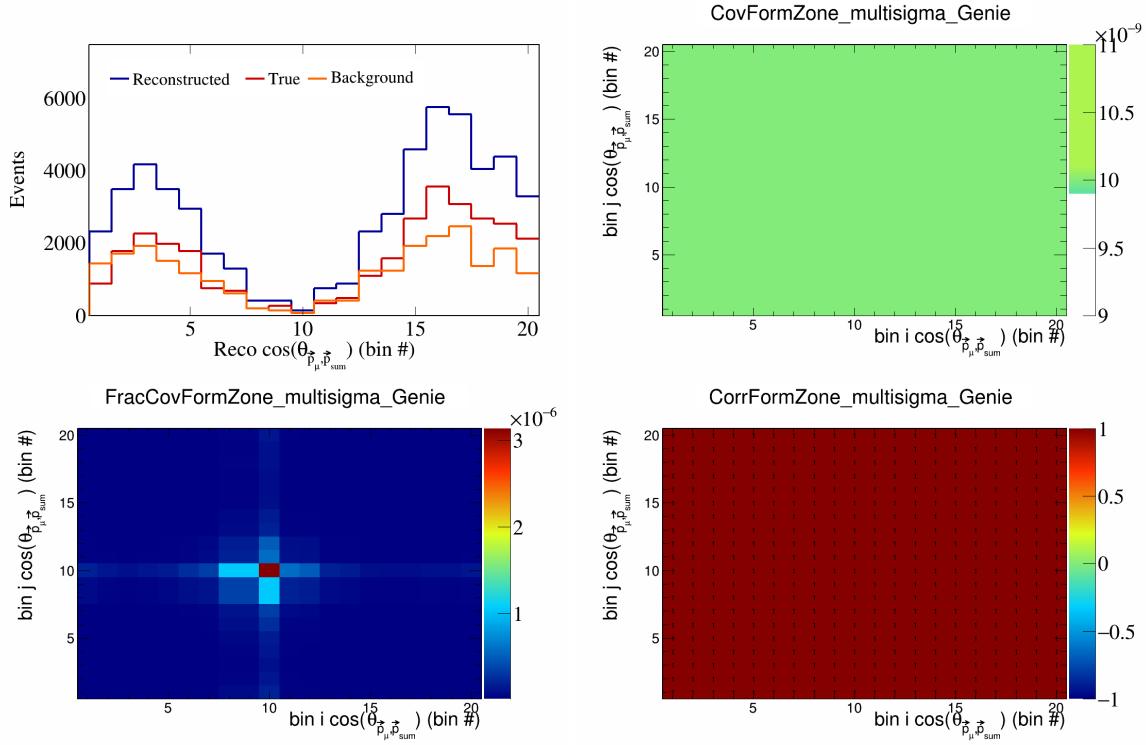


Figure 155: FormZone variations for $\cos(\theta_{\vec{p}_\mu} \cdot \vec{p}_{\text{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

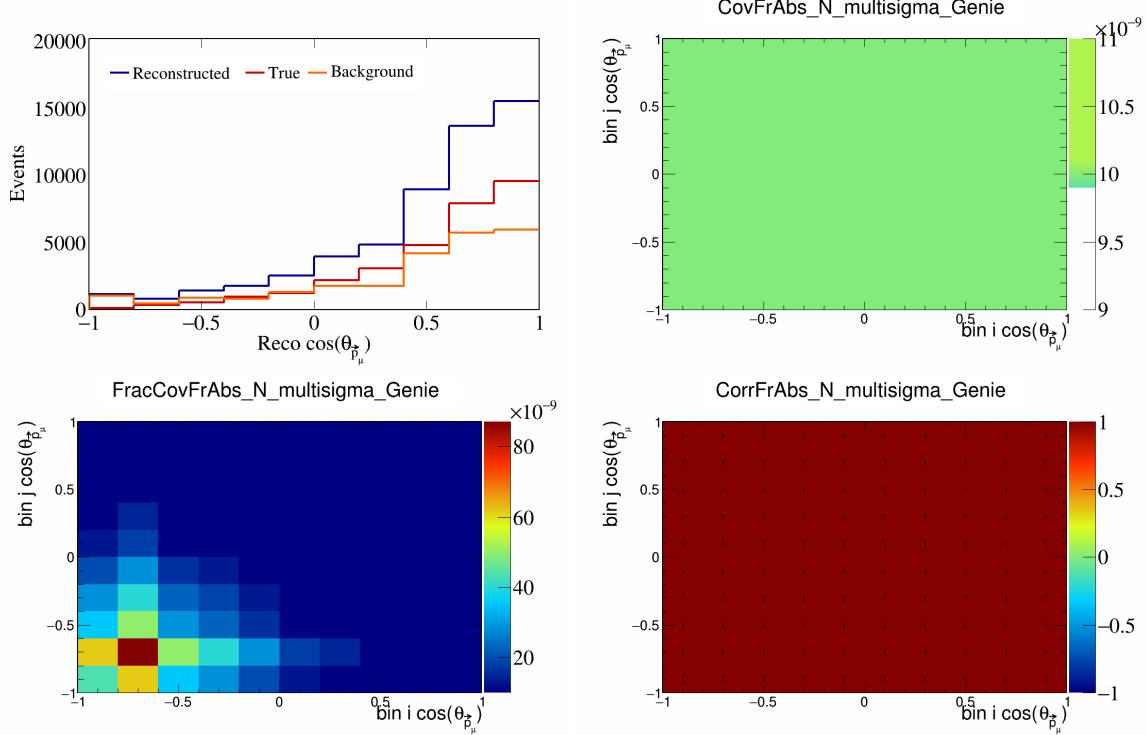


Figure 156: FrAbsN variations for $\cos(\theta_{\vec{p}_\mu})$.

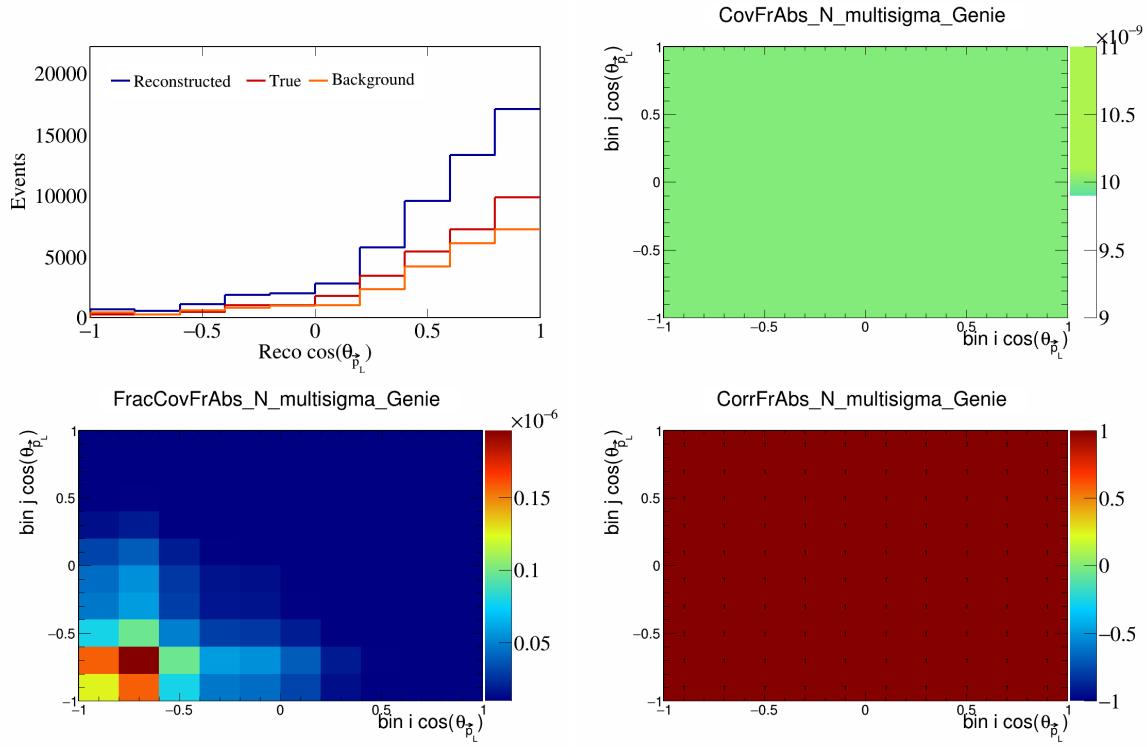


Figure 157: FrAbsN variations for $\cos(\theta_{\vec{p}_L})$.

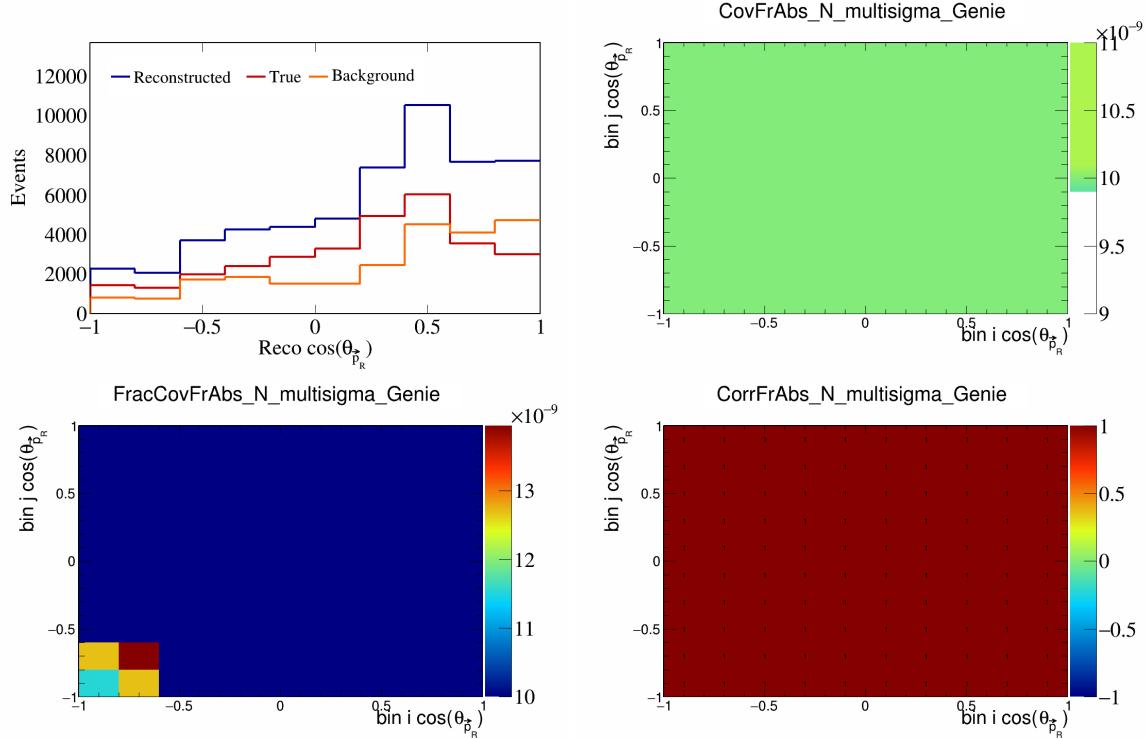


Figure 158: FrAbsN variations for $\cos(\theta_{\vec{p}_R})$.

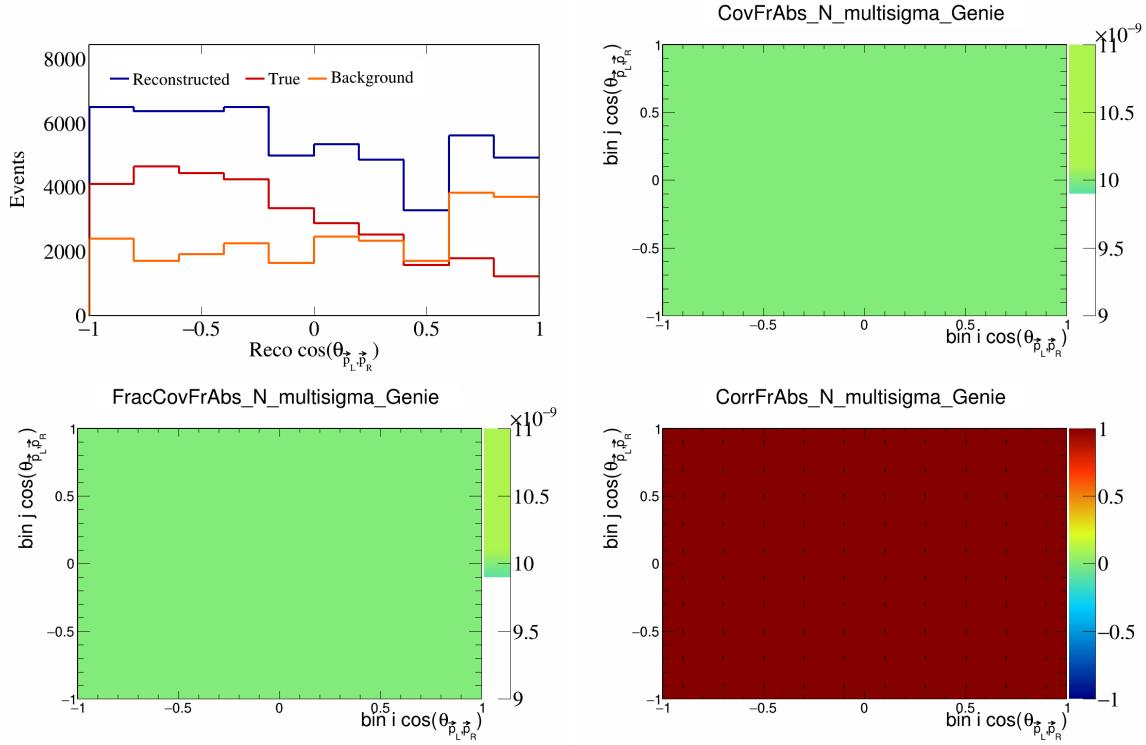


Figure 159: FrAbsN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

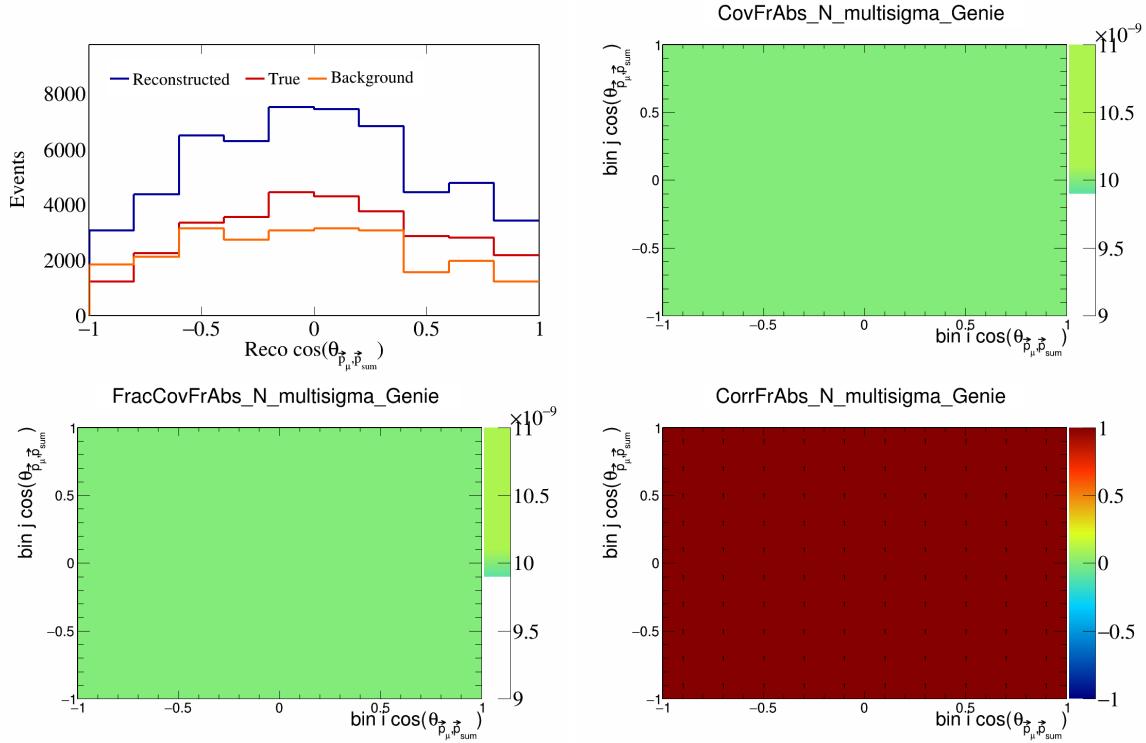


Figure 160: FrAbsN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

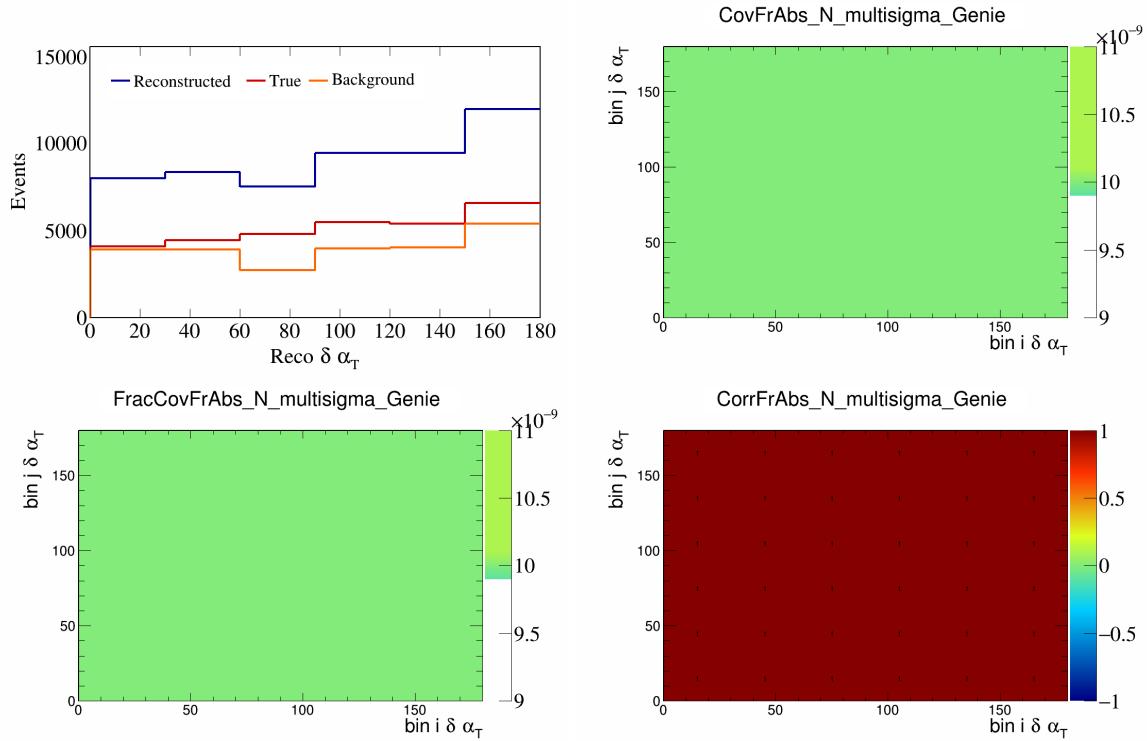


Figure 161: FrAbsN variations for $\delta\alpha_T$.

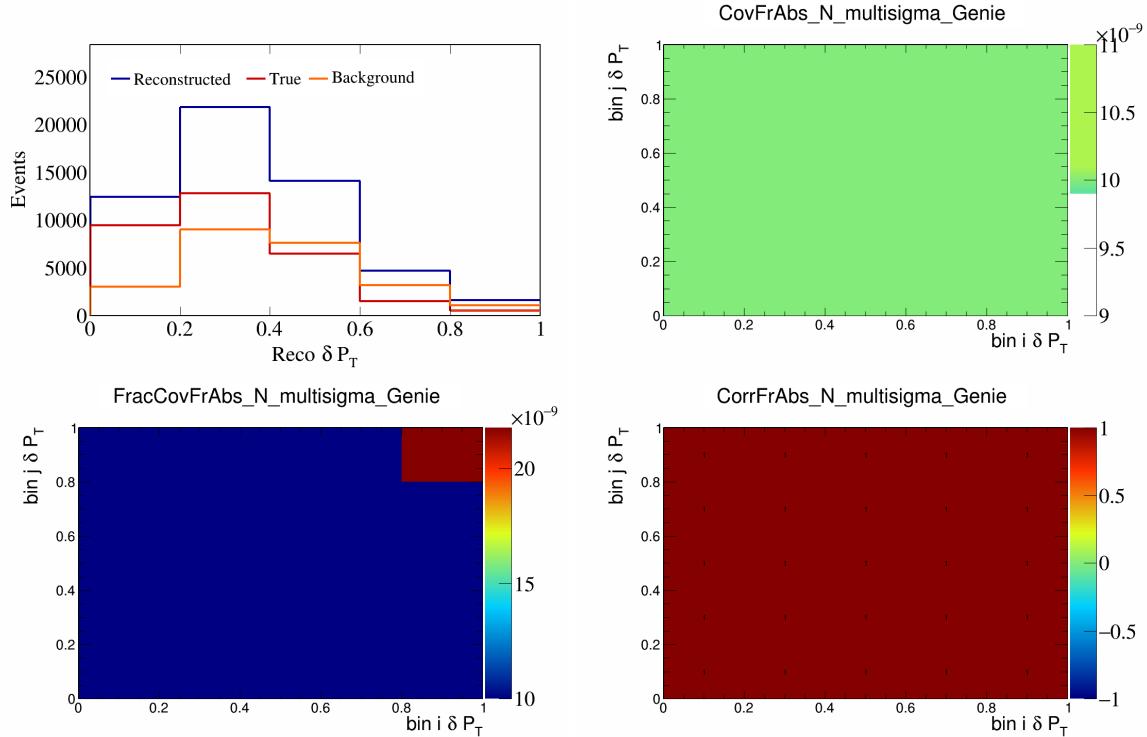


Figure 162: FrAbsN variations for δP_T .

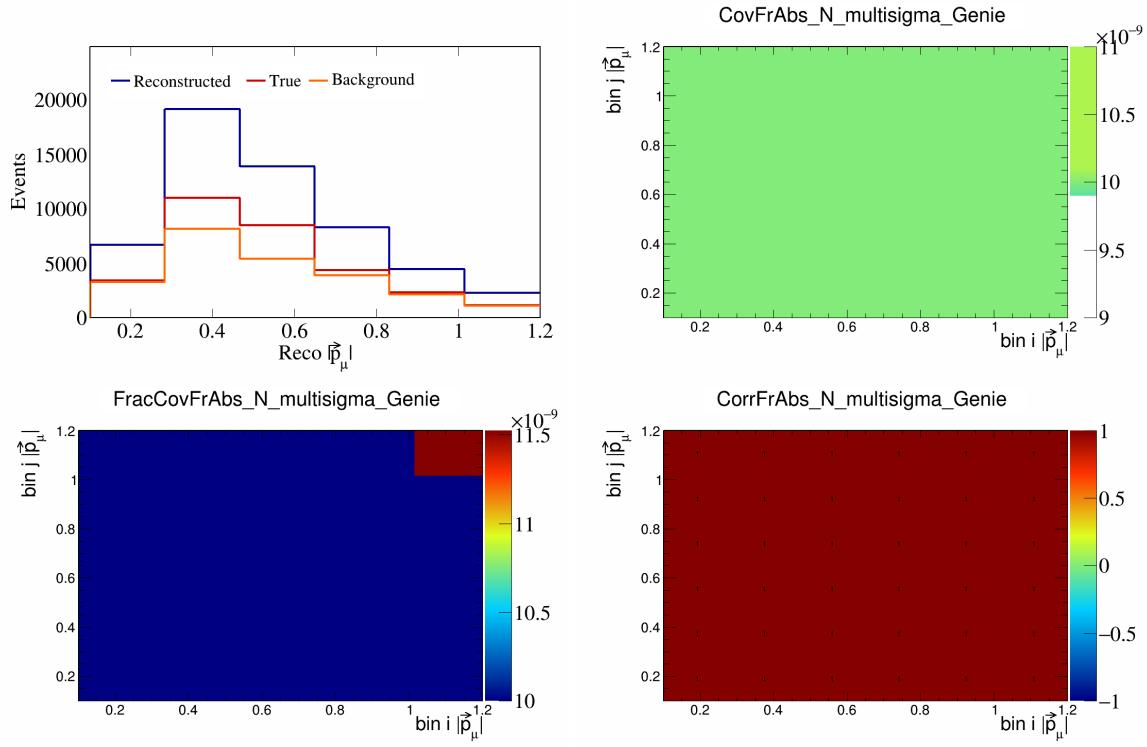


Figure 163: FrAbsN variations for $|\vec{p}_\mu|$.

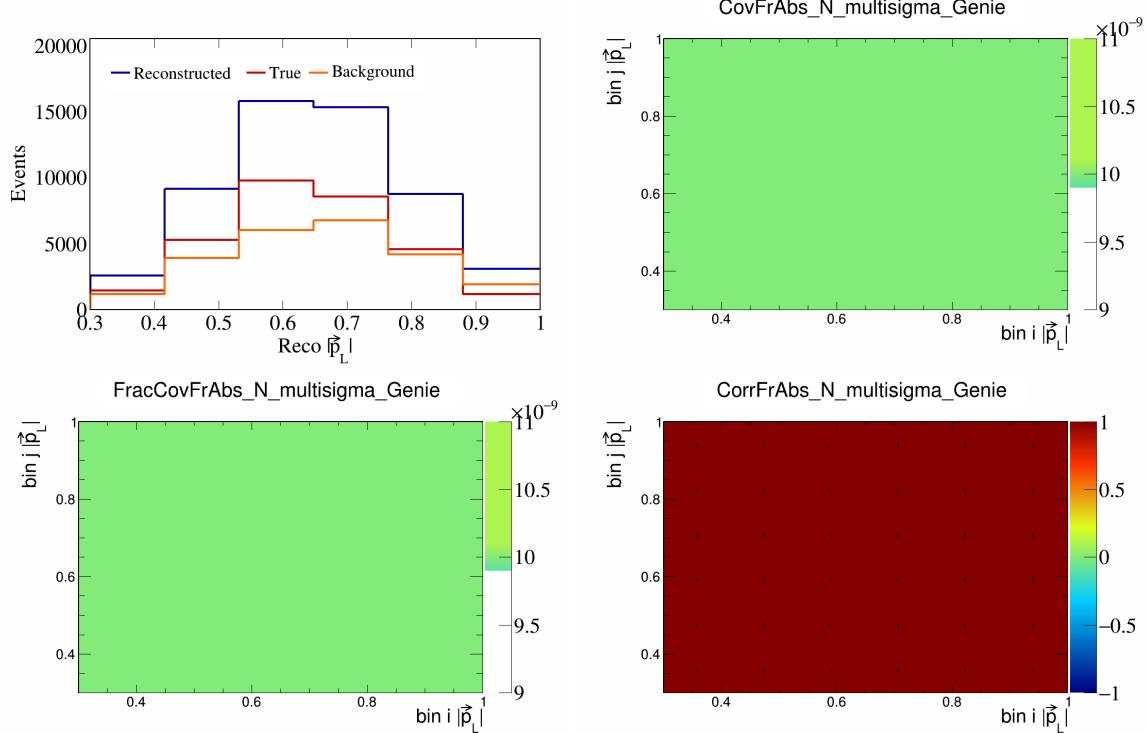


Figure 164: FrAbsN variations for $|\vec{p}_L|$.

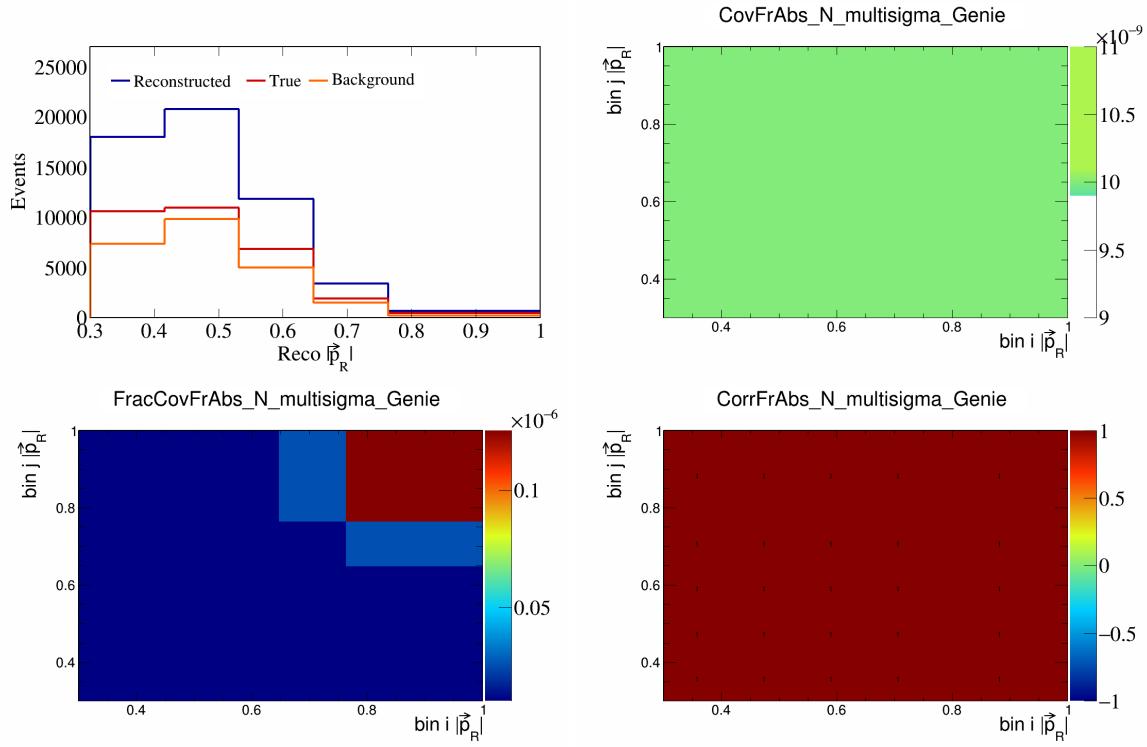


Figure 165: FrAbsN variations for $|\vec{p}_R|$.

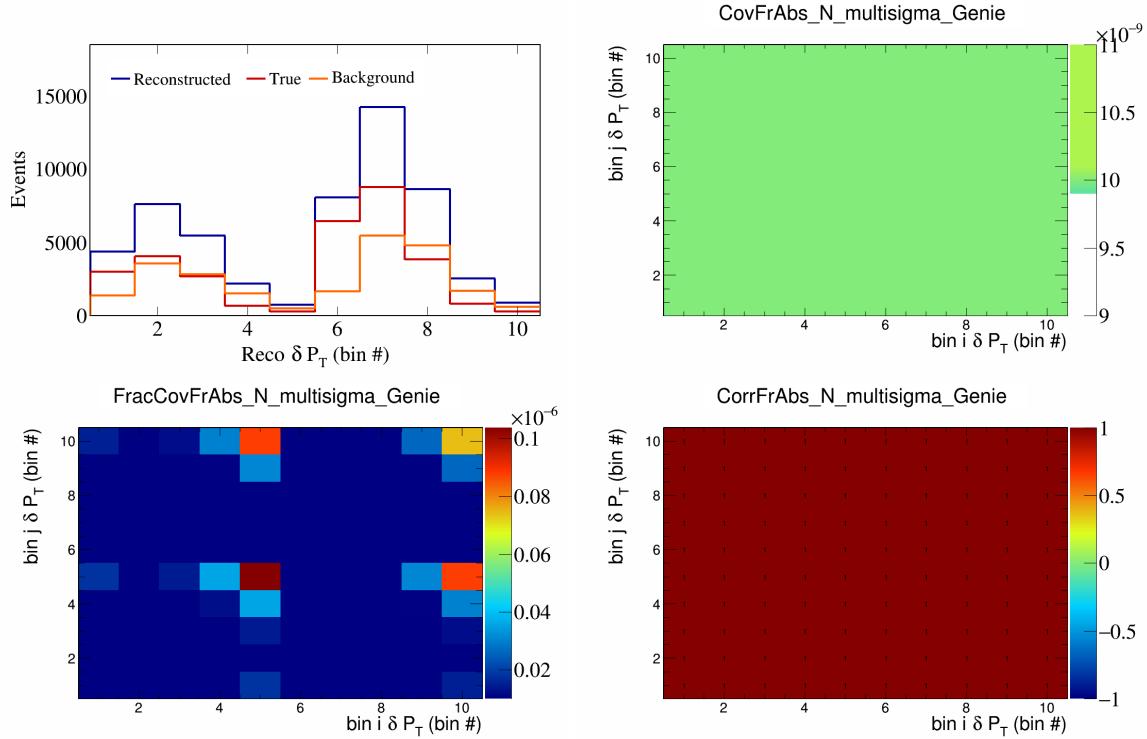


Figure 166: FrAbsN variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

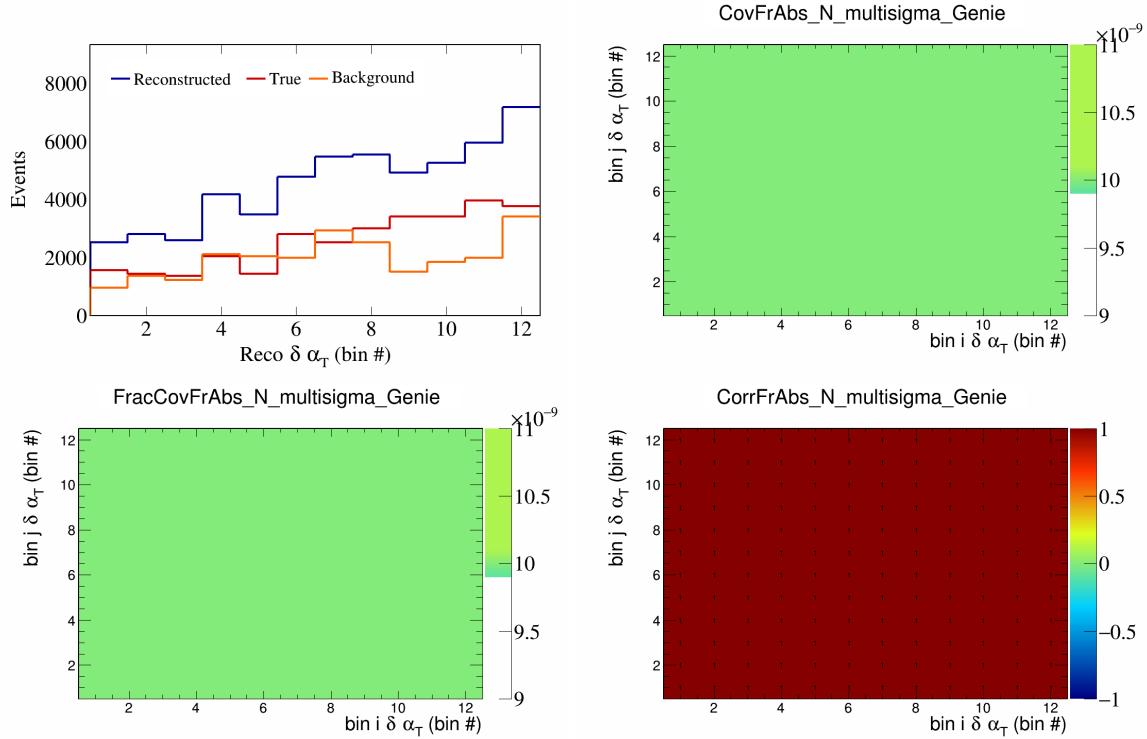


Figure 167: FrAbsN variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

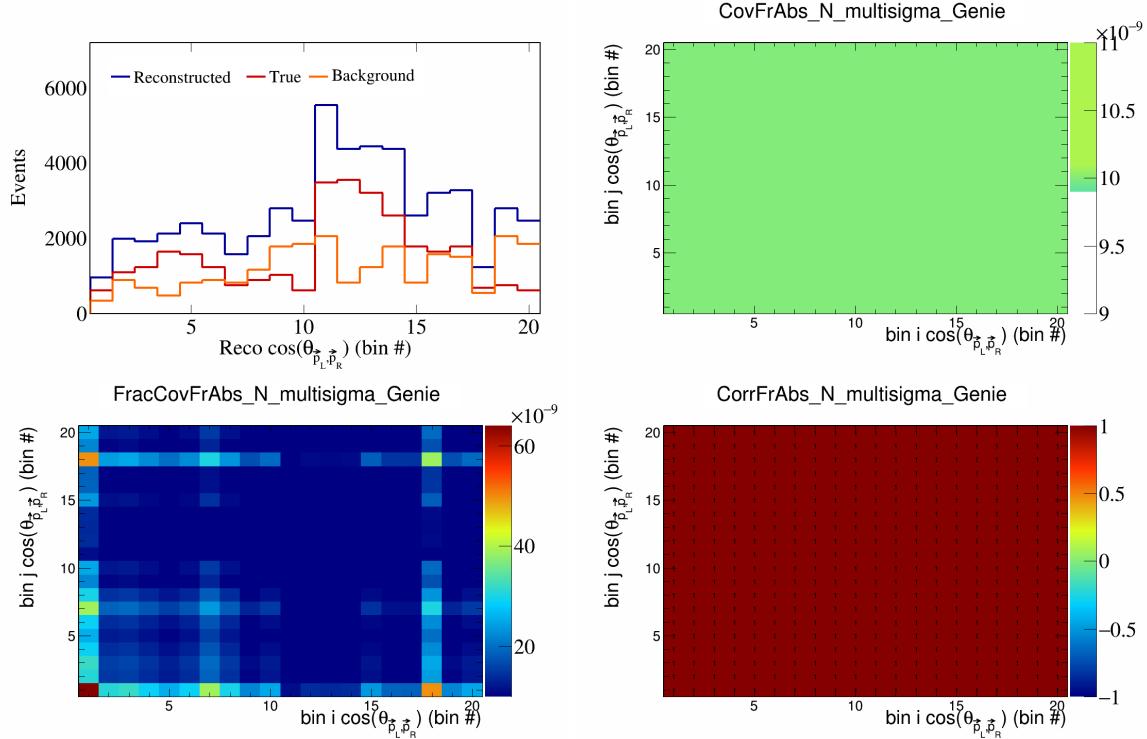


Figure 168: FrAbsN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

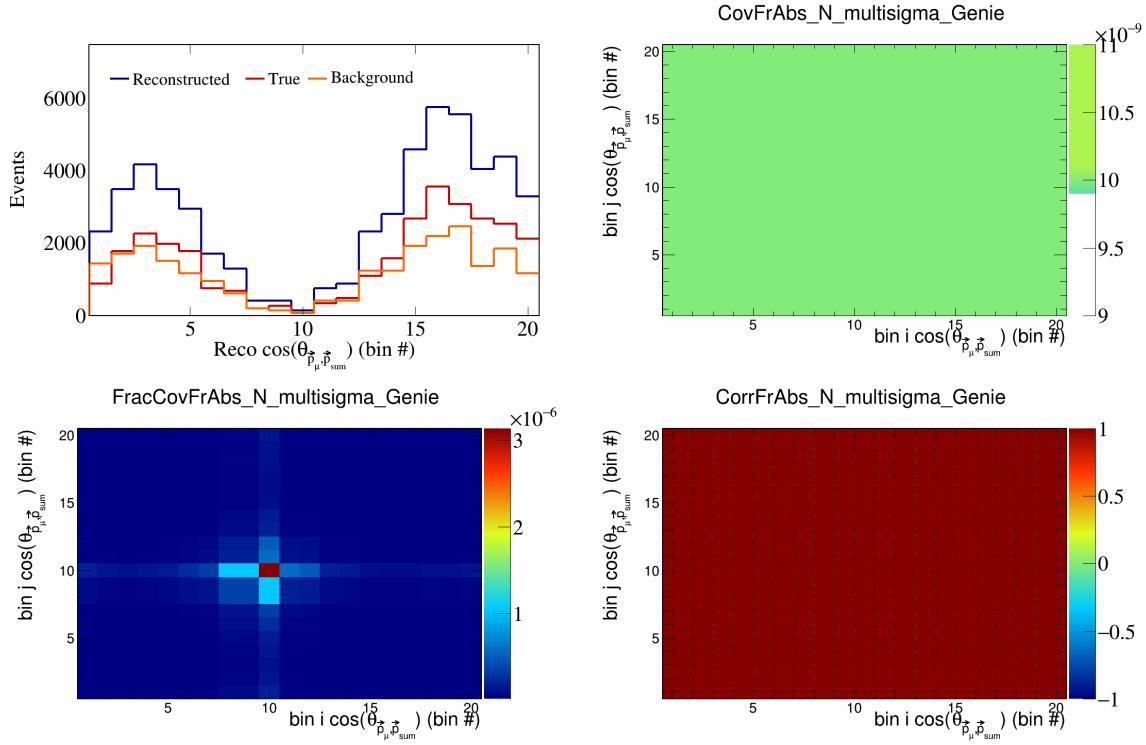


Figure 169: FrAbsN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

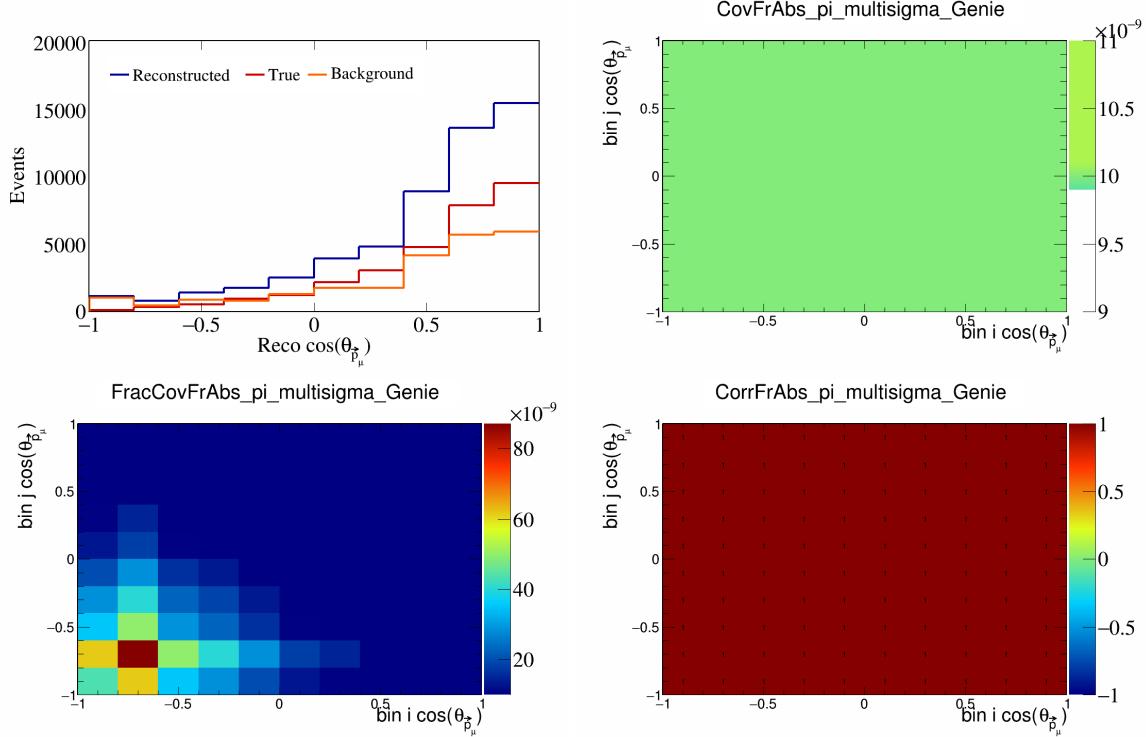


Figure 170: FrAbspi variations for $\cos(\theta_{\vec{p}_\mu})$.

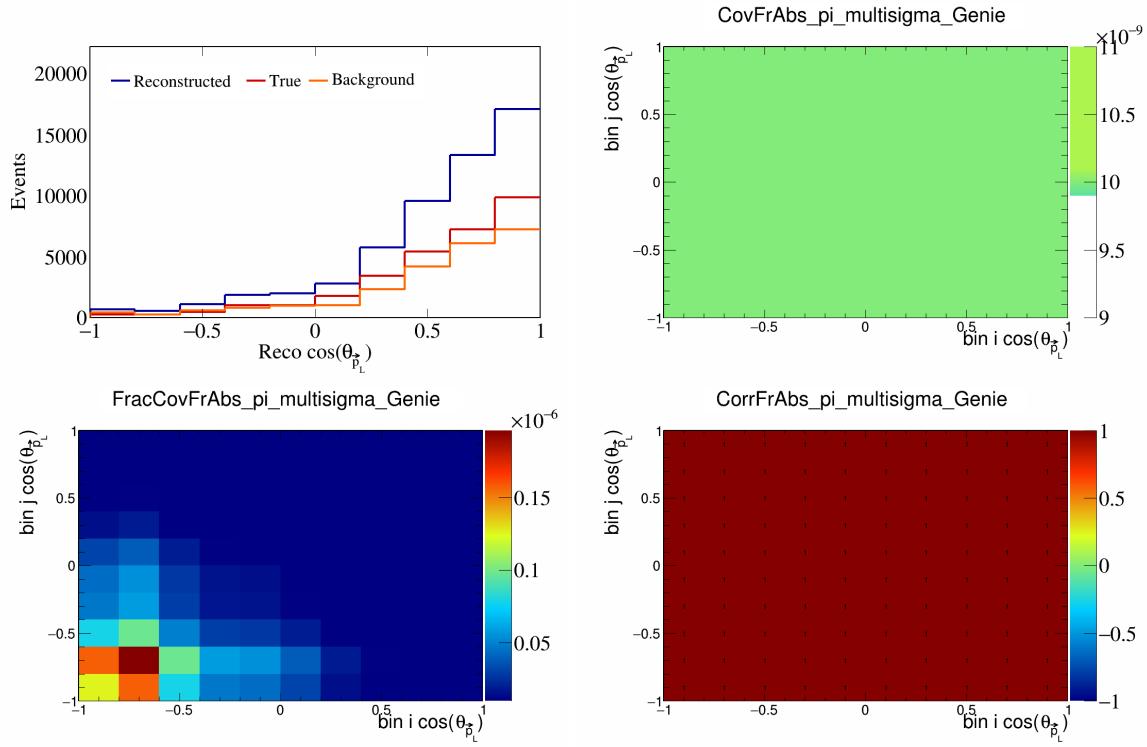


Figure 171: FrAbspi variations for $\cos(\theta_{\vec{p}_L})$.

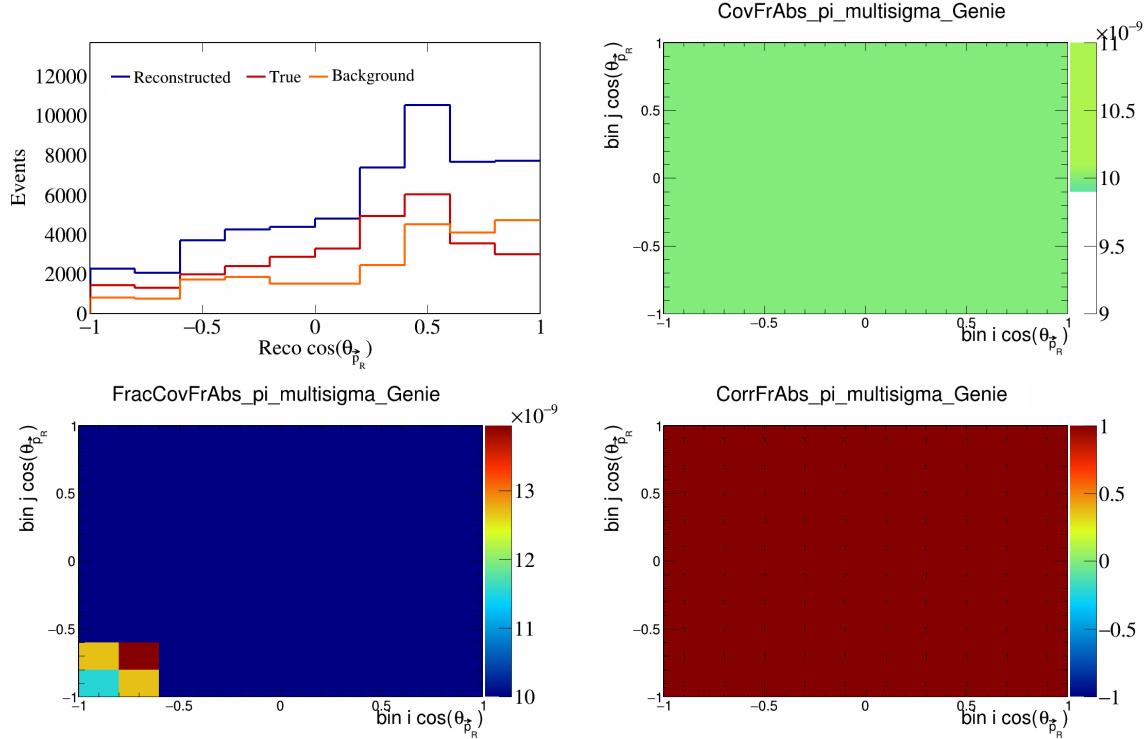


Figure 172: FrAbspi variations for $\cos(\theta_{\vec{p}_R})$.

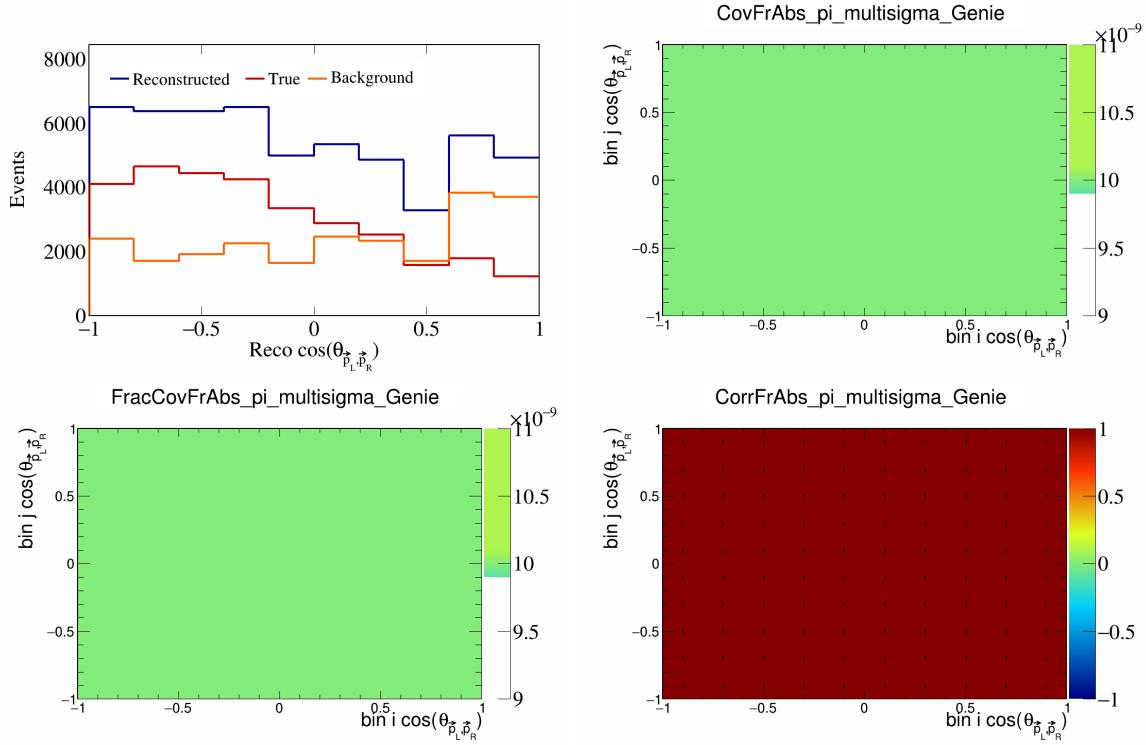


Figure 173: FrAbspi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

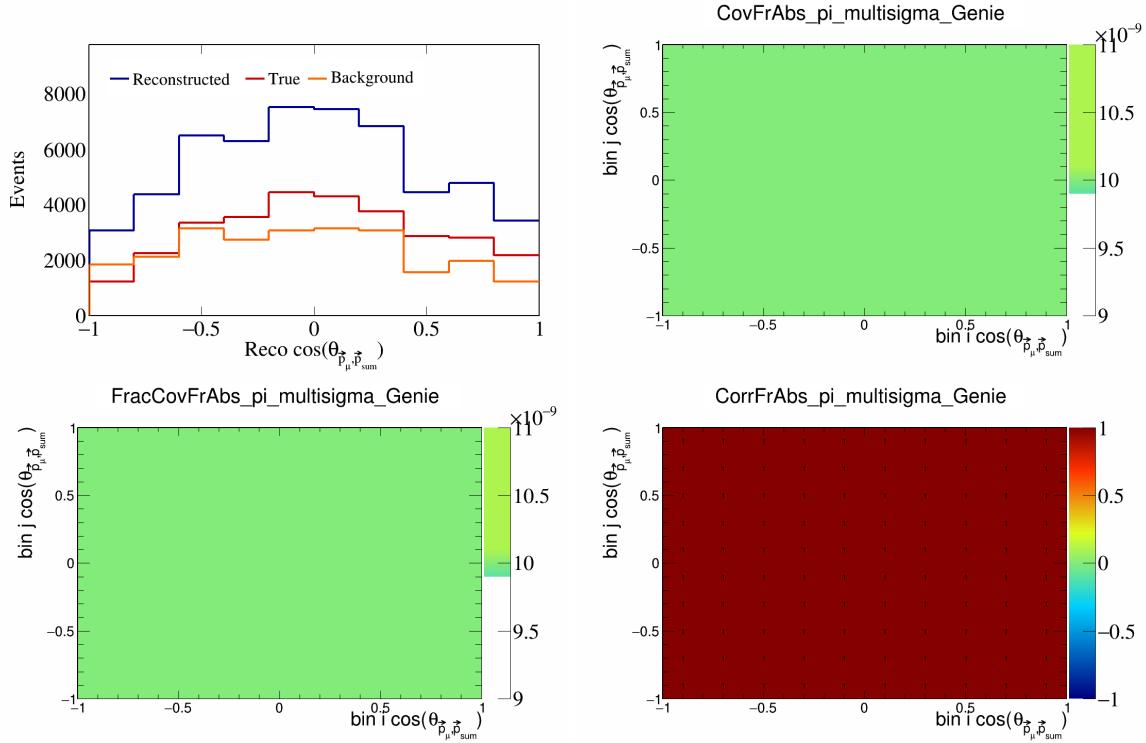


Figure 174: FrAbspi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

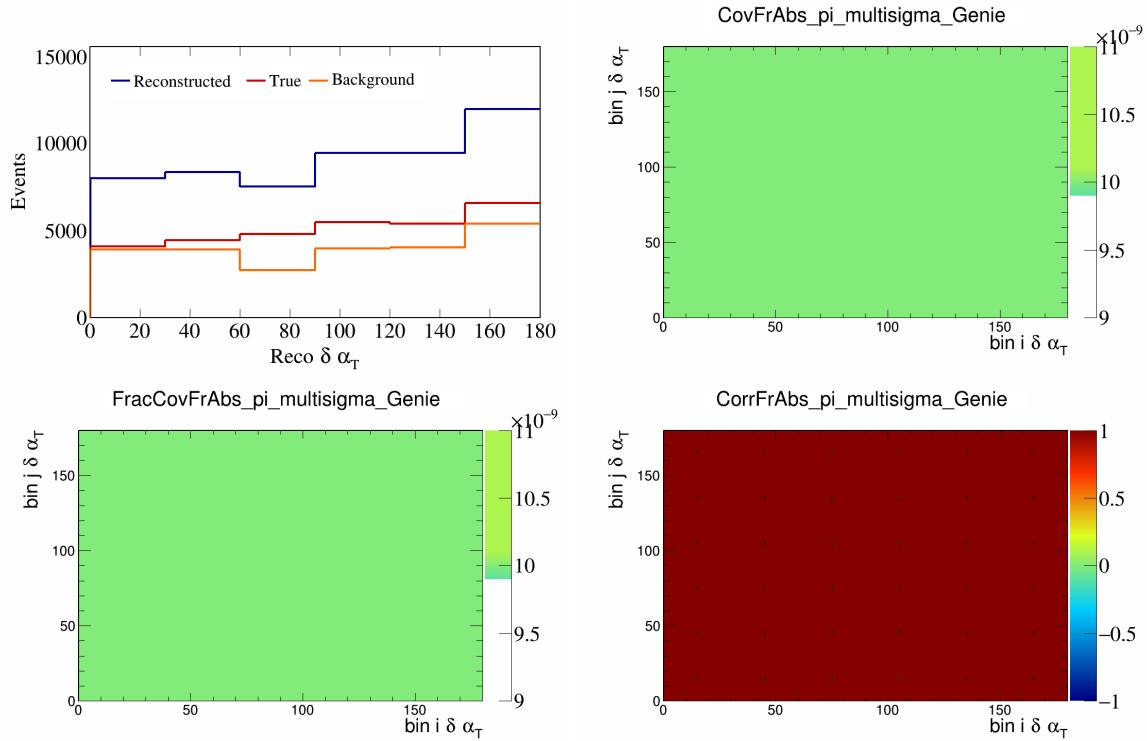


Figure 175: FrAbspi variations for $\delta\alpha_T$.

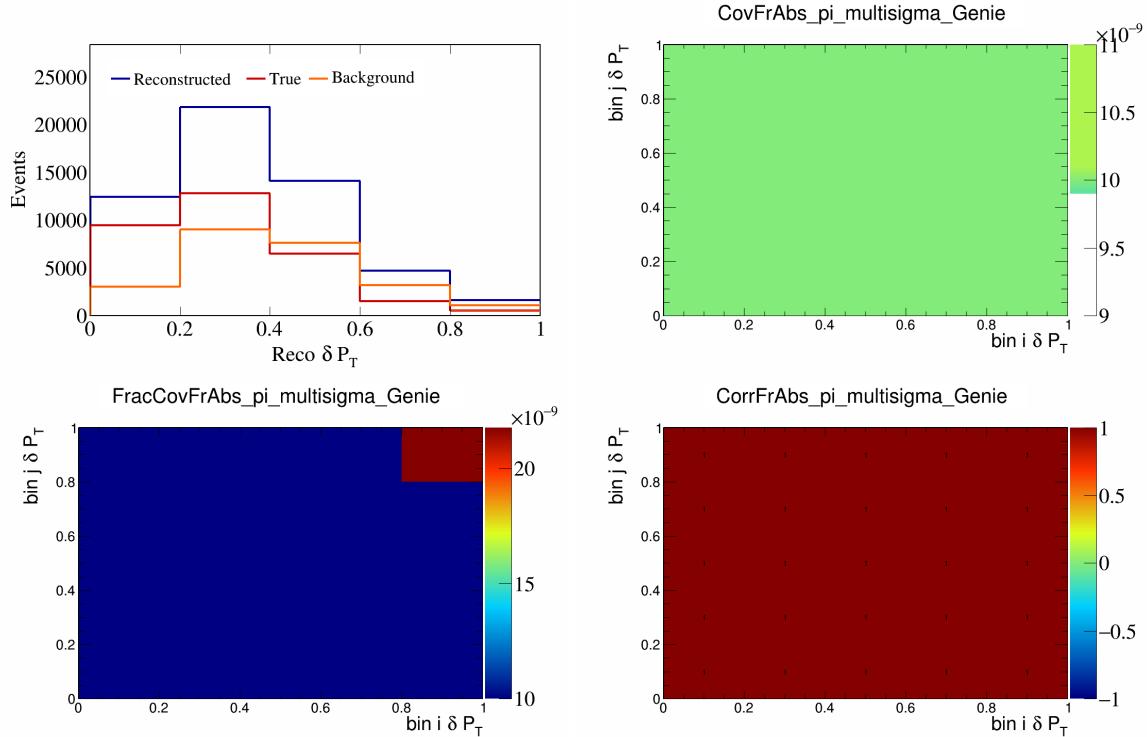


Figure 176: FrAbspi variations for δP_T .

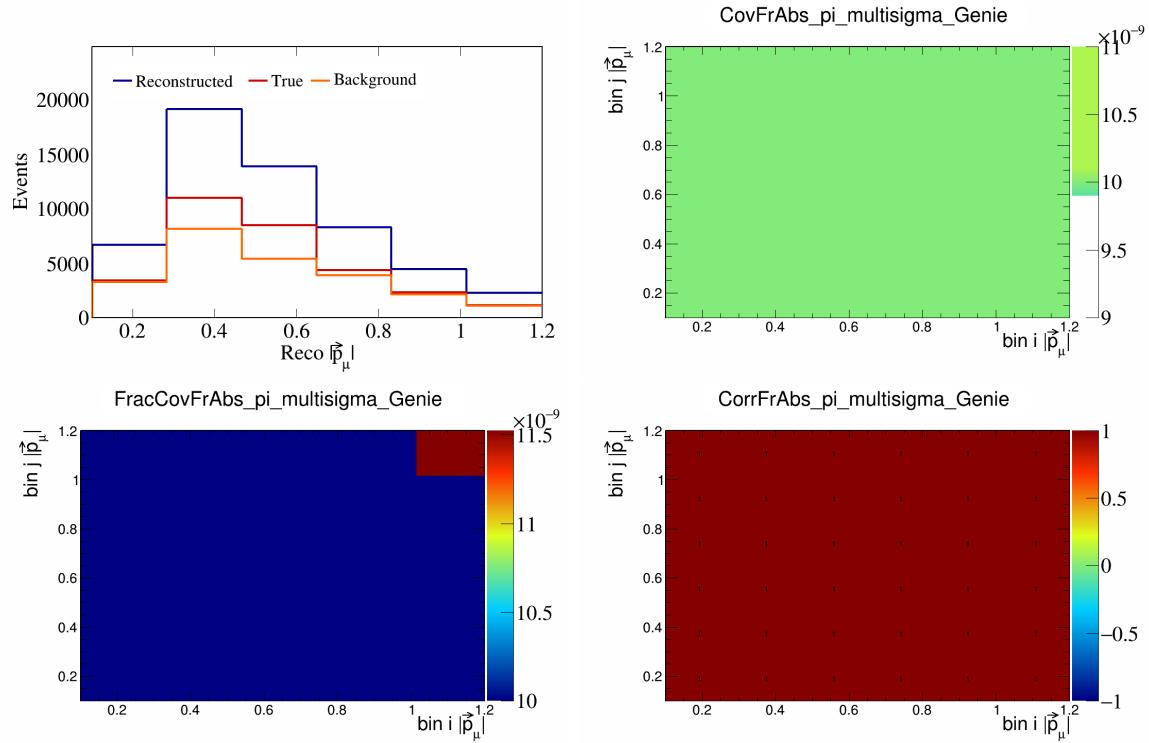


Figure 177: FrAbspi variations for $|\vec{p}_\mu|$.

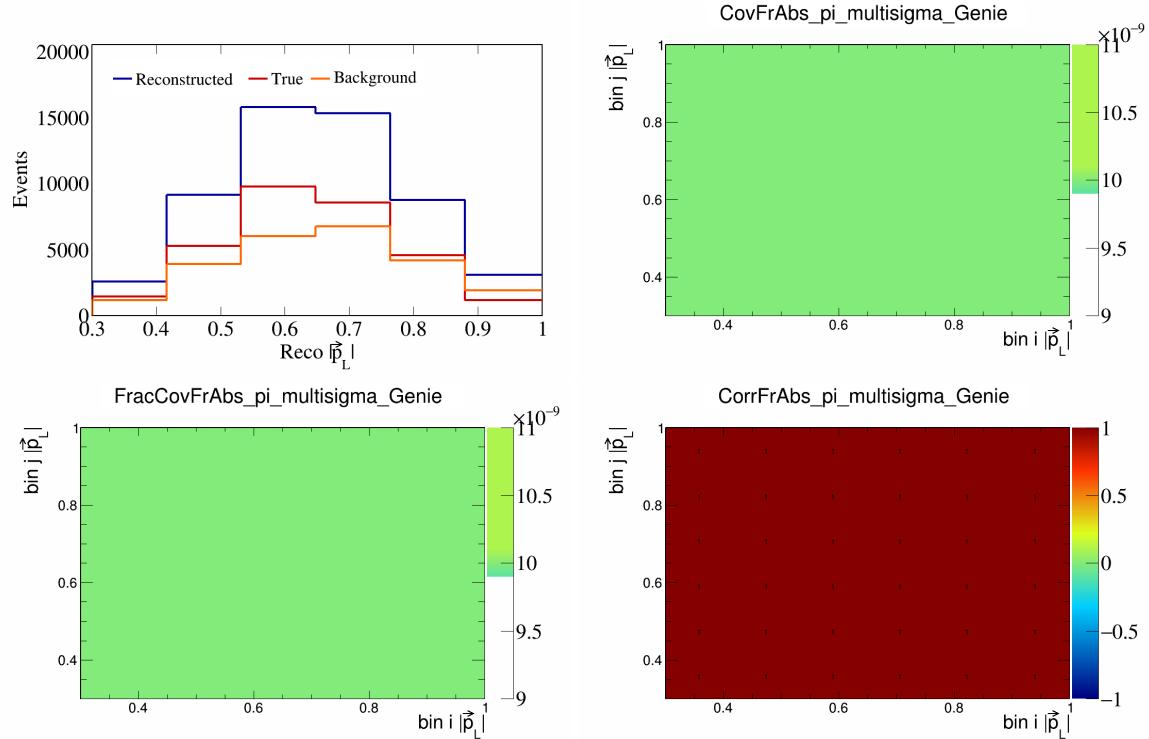


Figure 178: FrAbspi variations for $|\vec{p}_L|$.

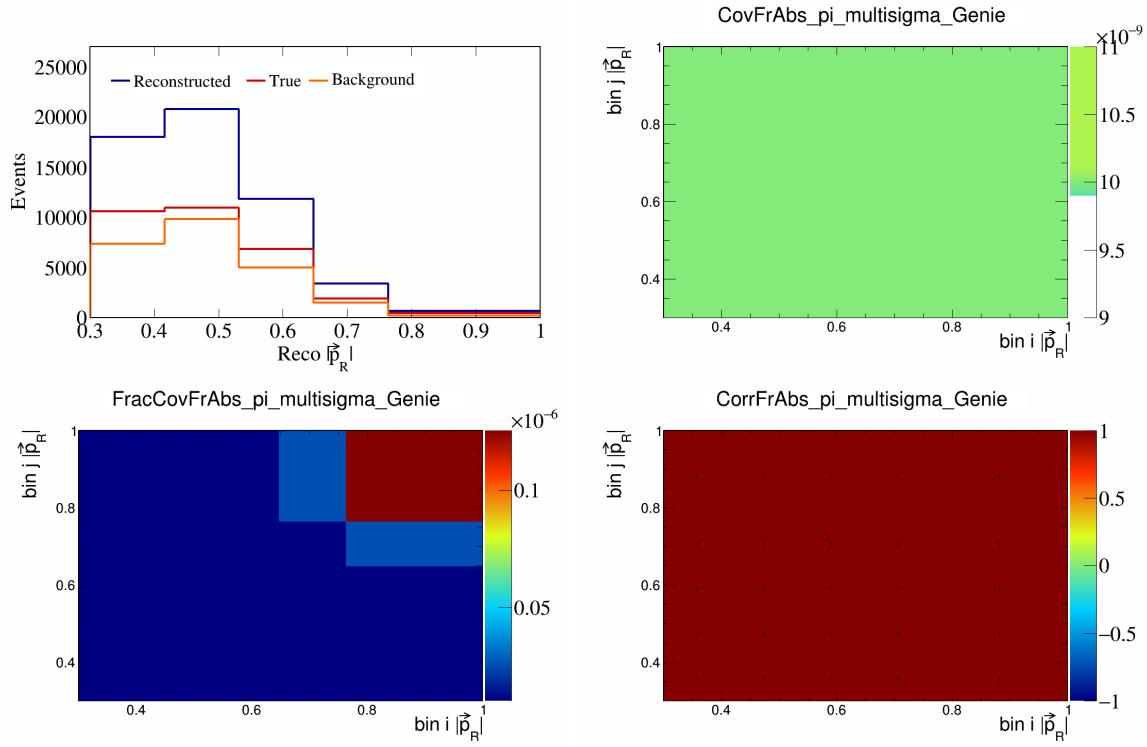


Figure 179: FrAbspi variations for $|\vec{p}_R|$.

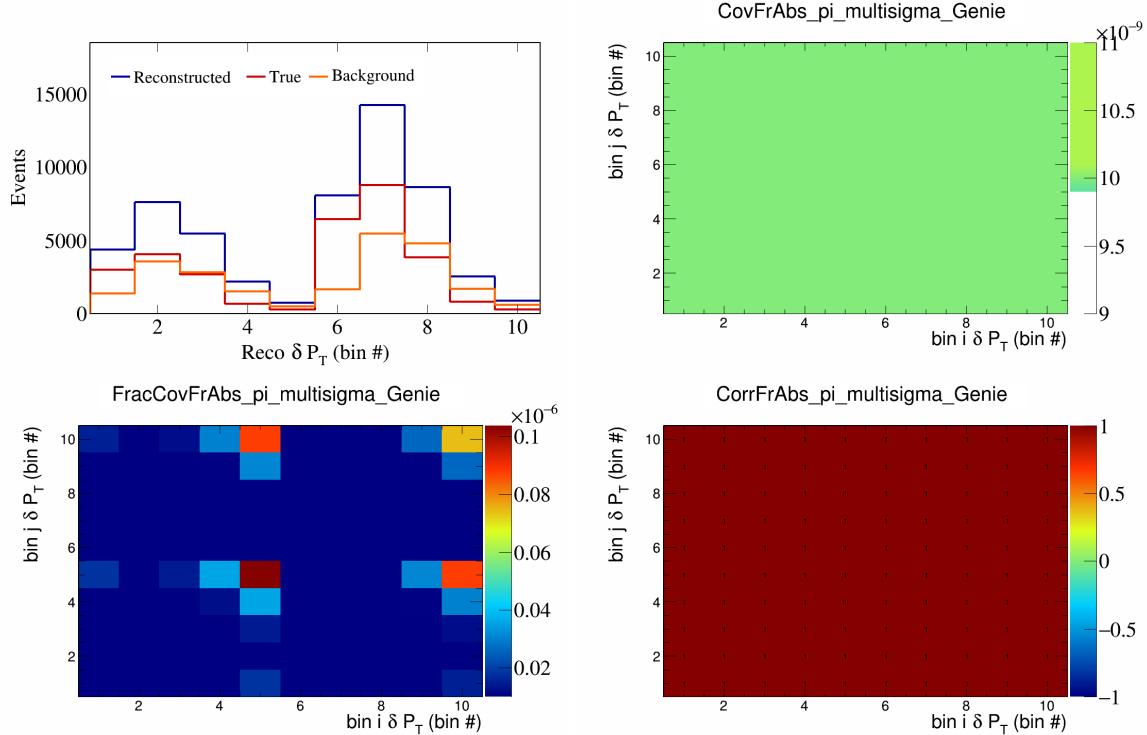


Figure 180: FrAbspi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

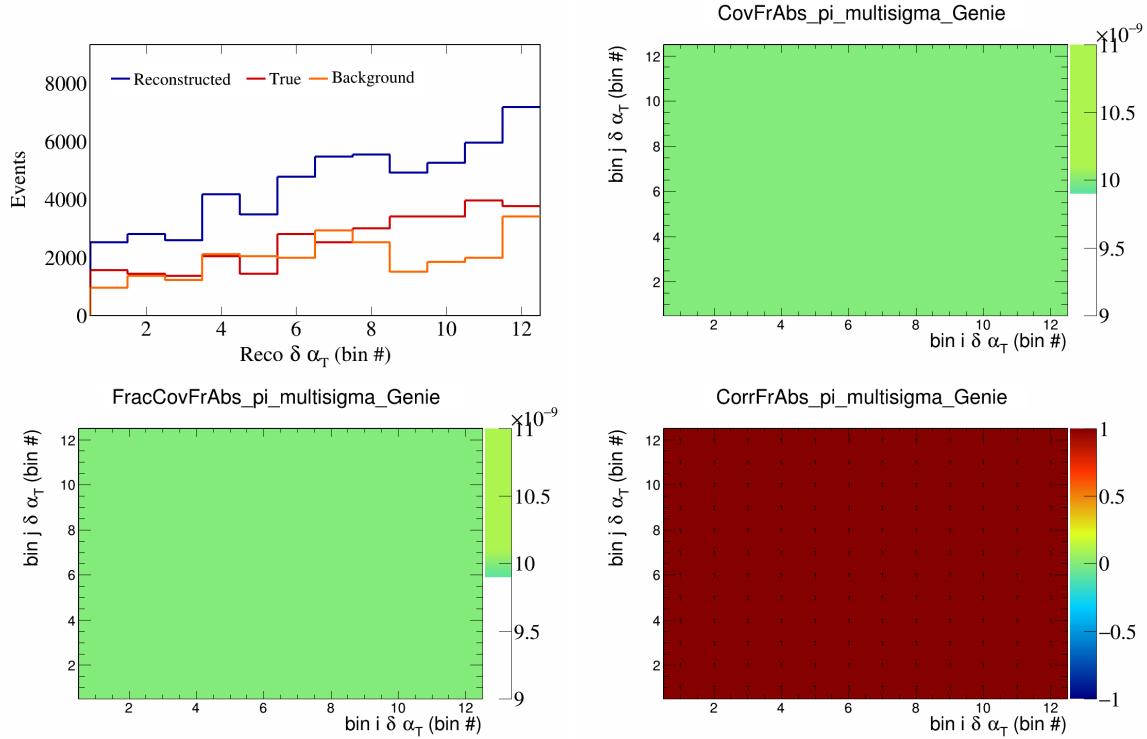


Figure 181: FrAbspi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

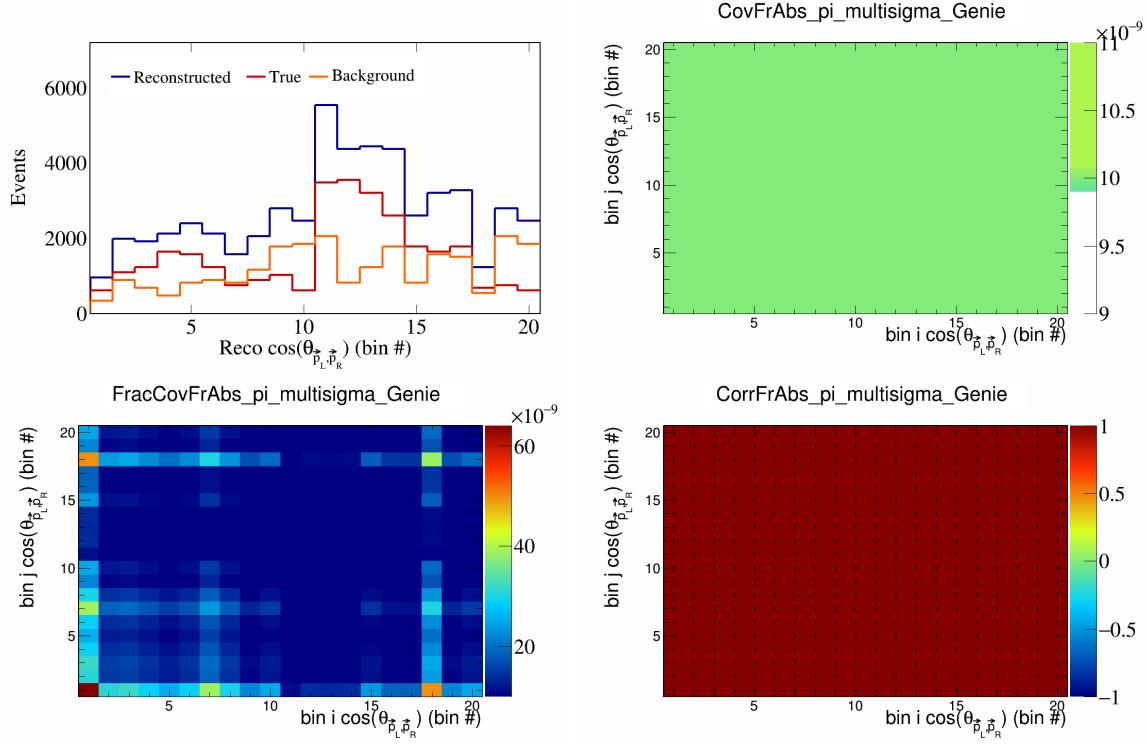


Figure 182: FrAbspi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

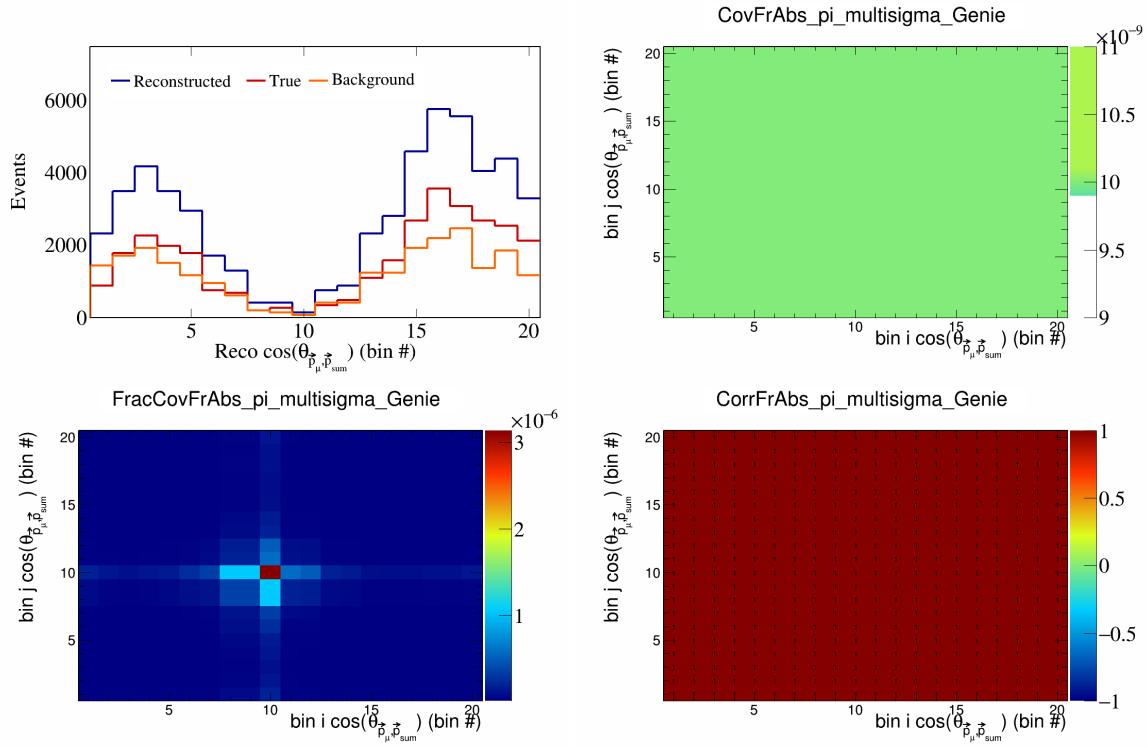


Figure 183: FrAbspi variations for $\cos(\theta_{\vec{p}_\mu})$ in $\cos(\theta_{\vec{p}_\mu})$.

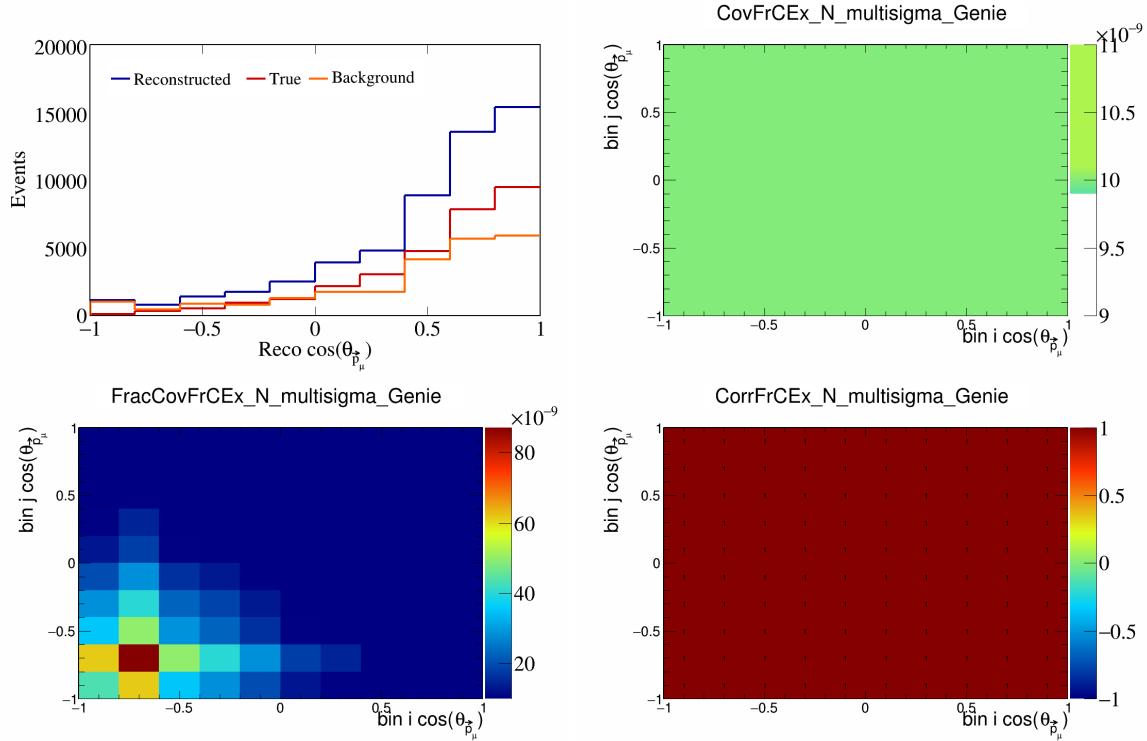


Figure 184: FrCExN variations for $\cos(\theta_{\vec{p}_\mu})$.

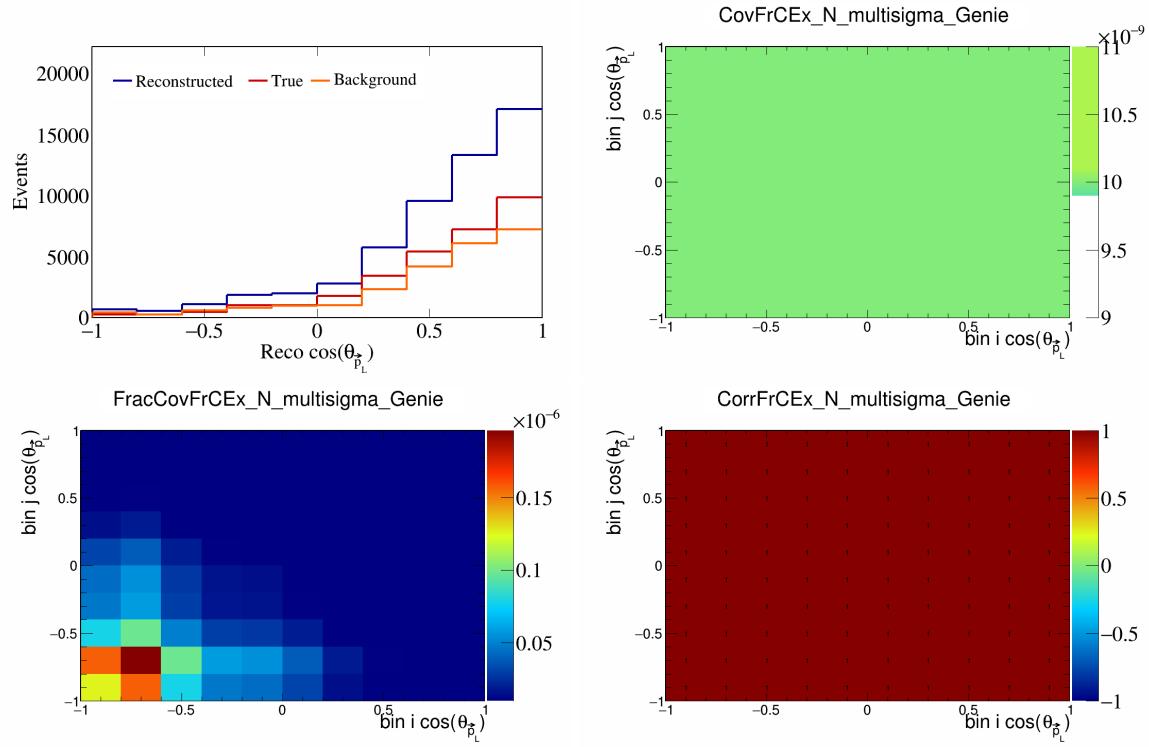


Figure 185: FrCExN variations for $\cos(\theta_{\vec{p}_L})$.

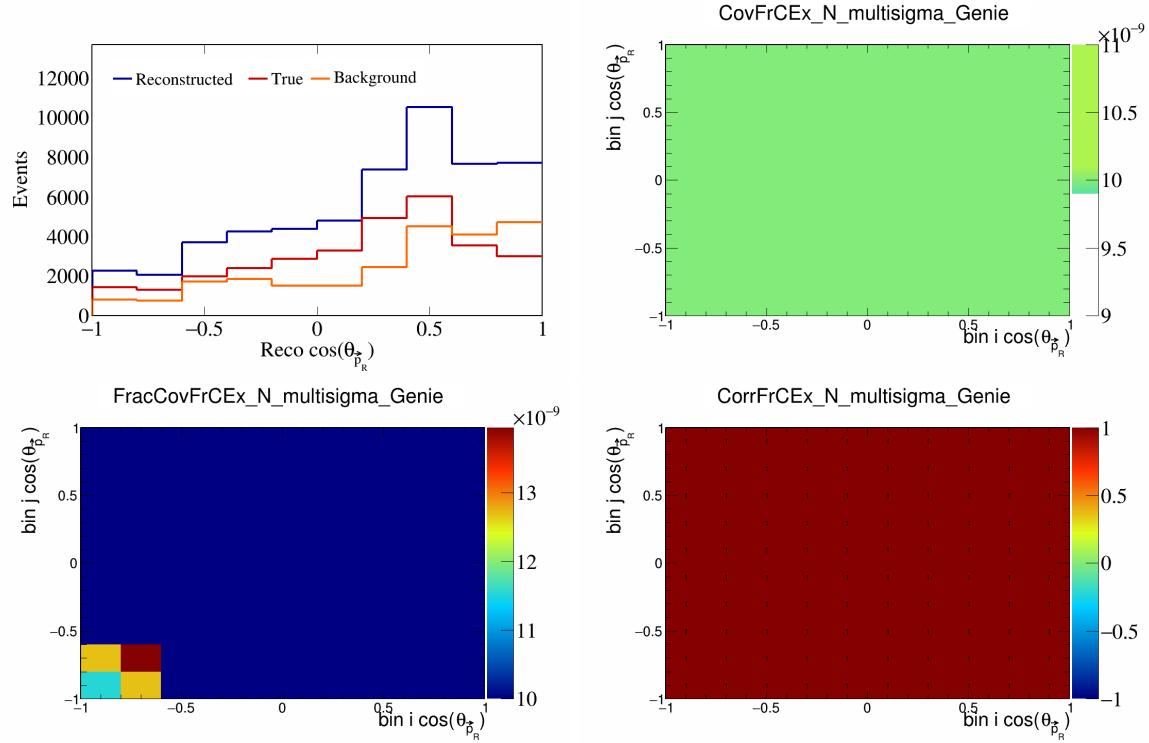


Figure 186: FrCExN variations for $\cos(\theta_{\vec{p}_R})$.

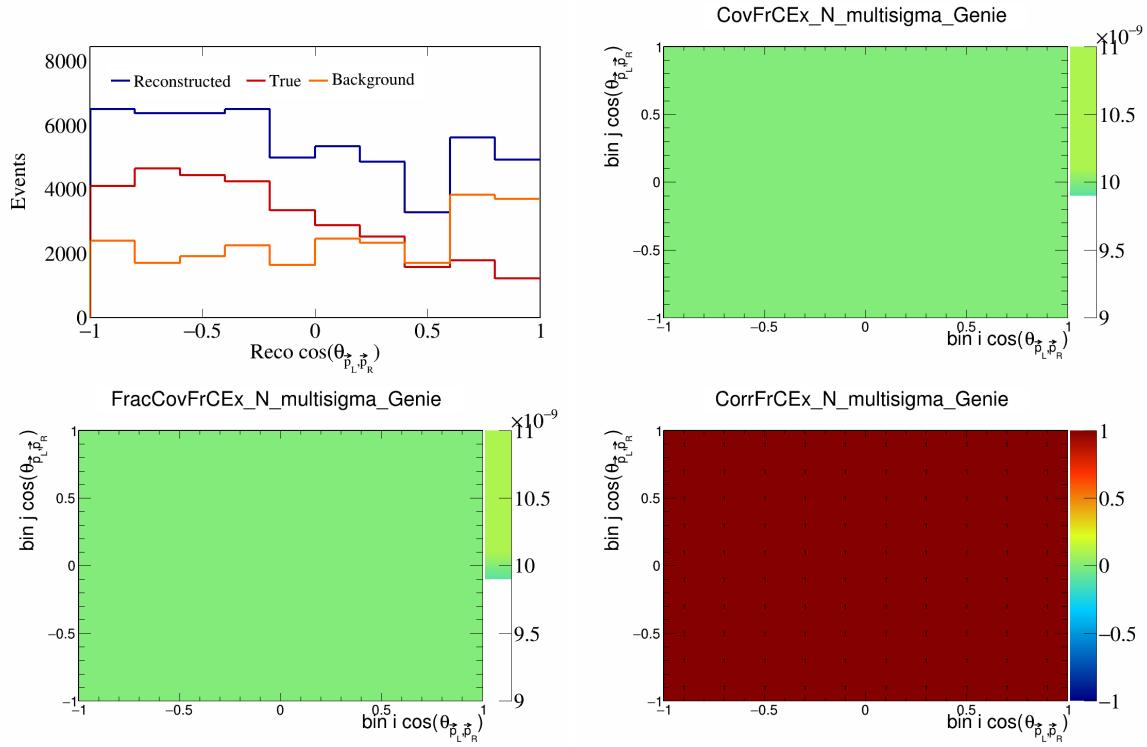


Figure 187: FrCEExN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

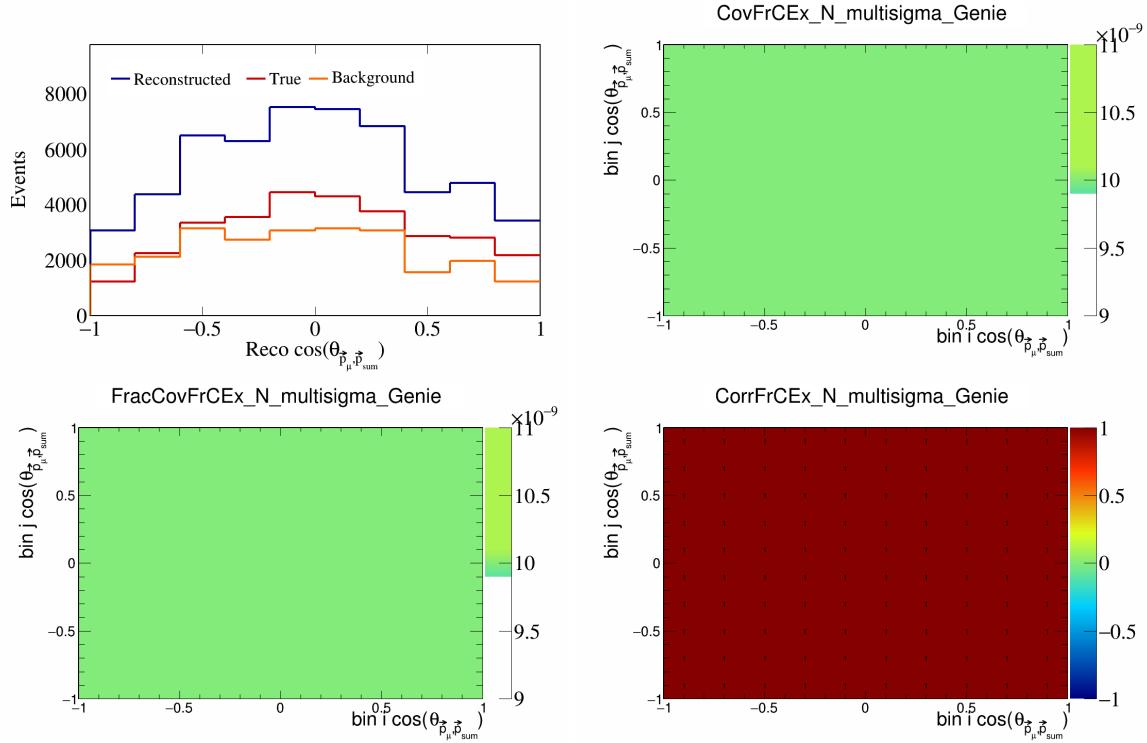


Figure 188: FrCEExN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

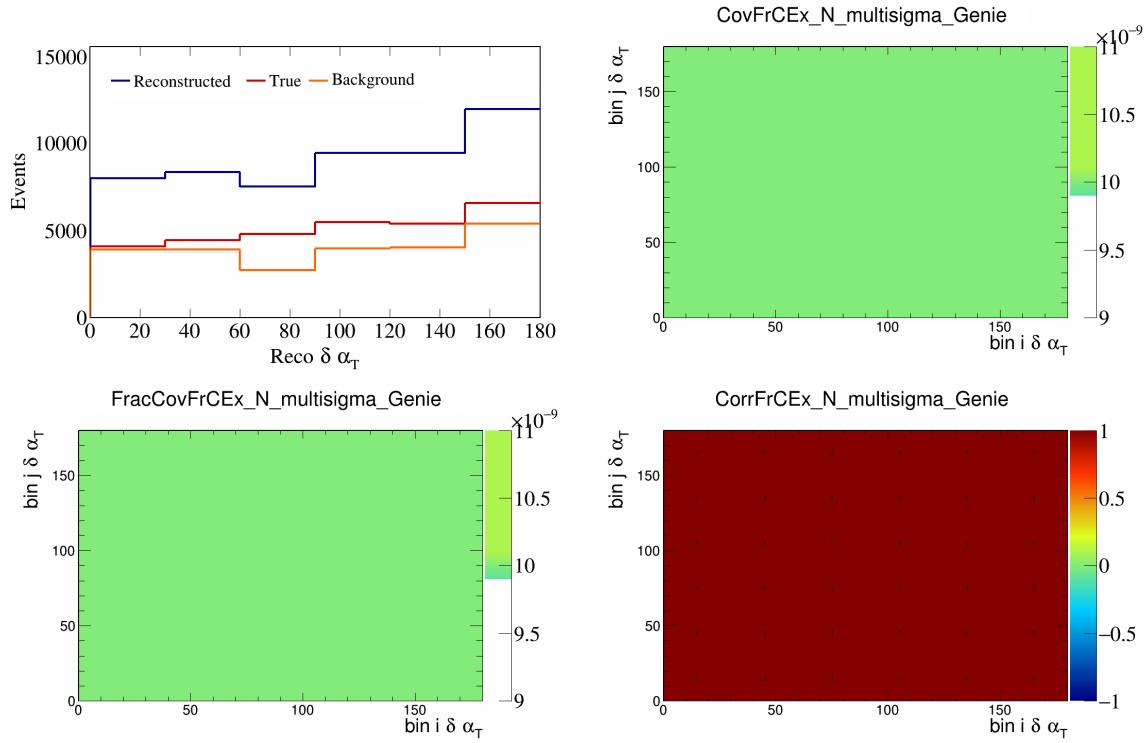


Figure 189: FrCEExN variations for $\delta\alpha_T$.

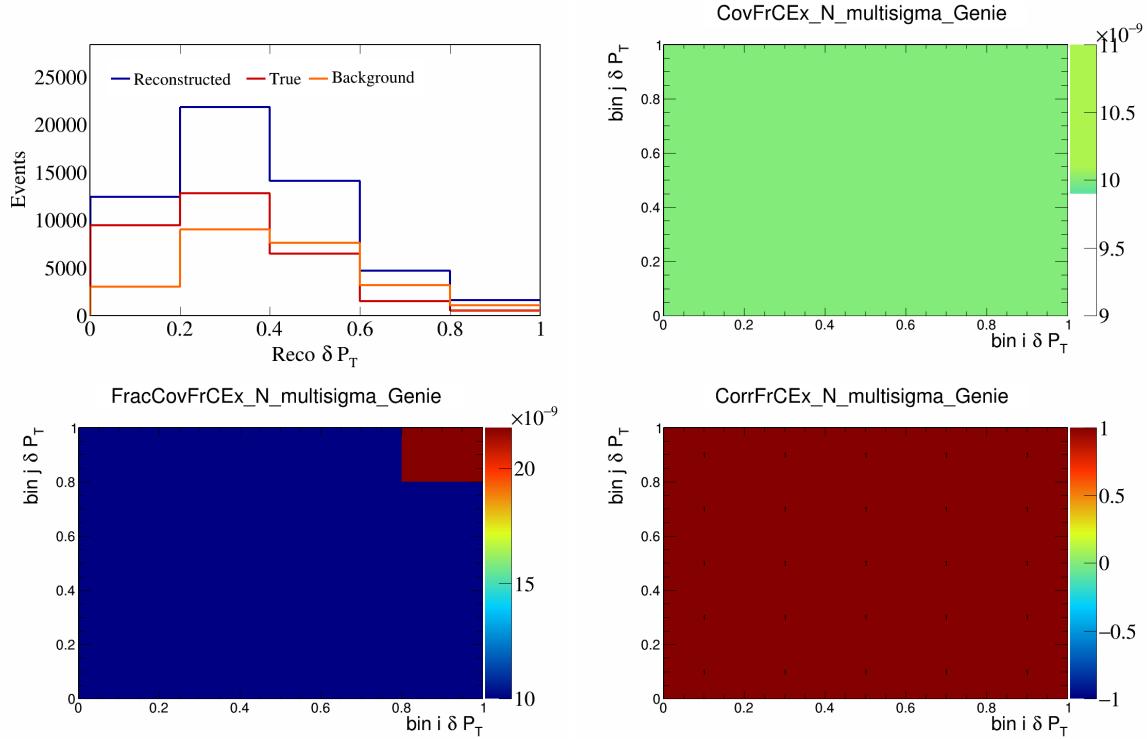


Figure 190: FrCEExN variations for δP_T .

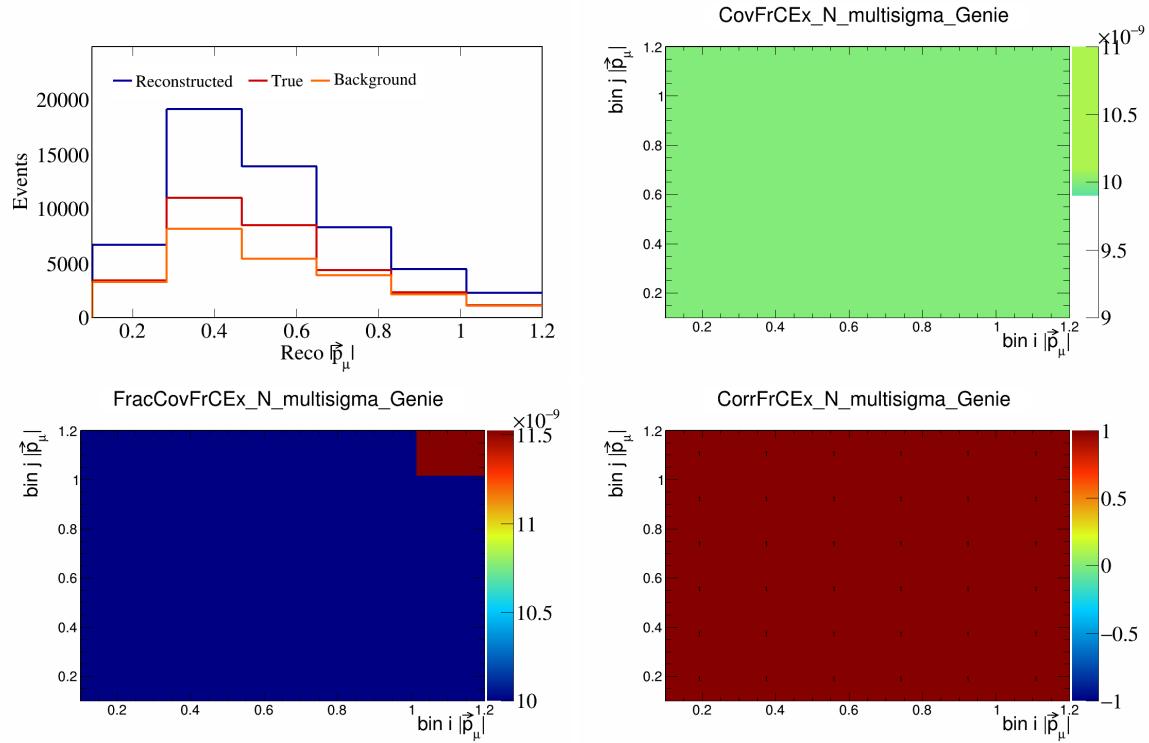


Figure 191: FrCEExN variations for $|\vec{p}_\mu|$.

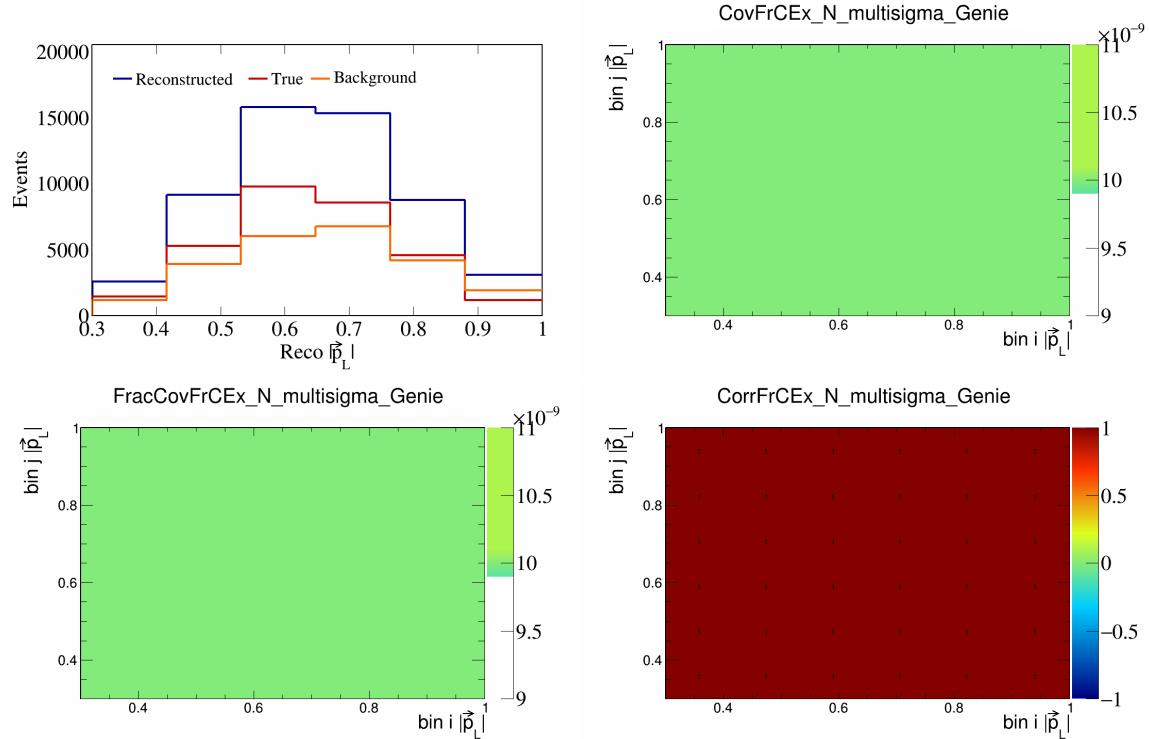


Figure 192: FrCEExN variations for $|\vec{p}_L|$.

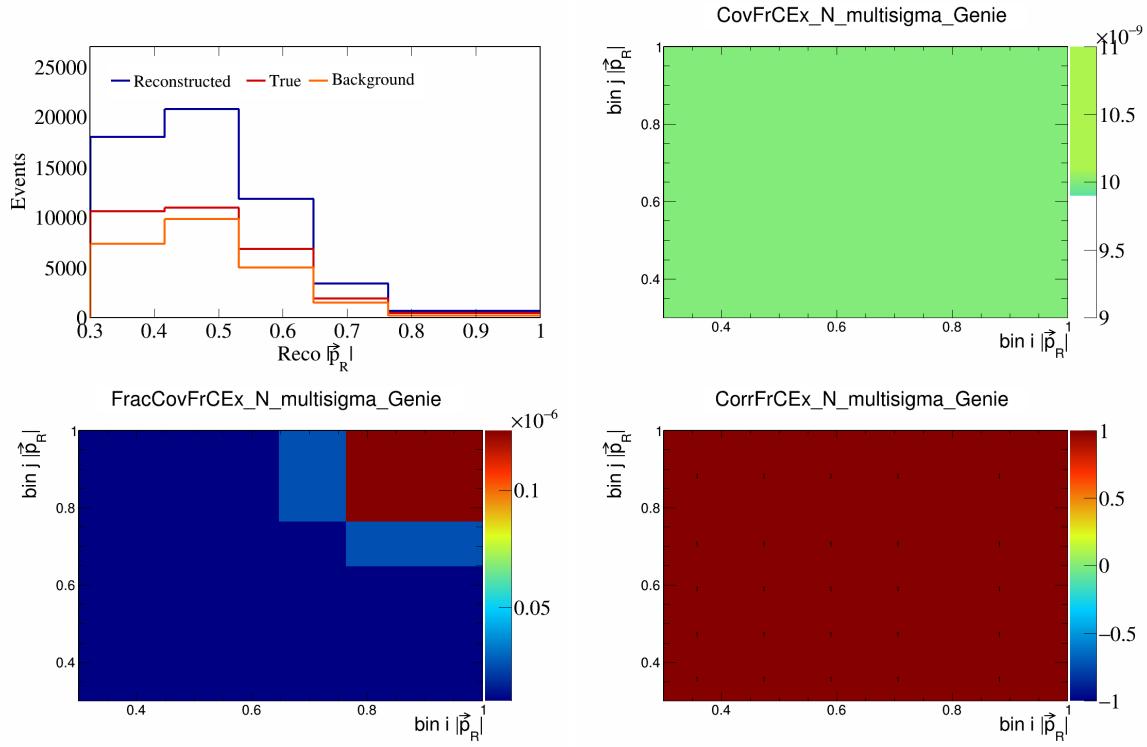


Figure 193: FrCEExN variations for $|\vec{p}_R|$.

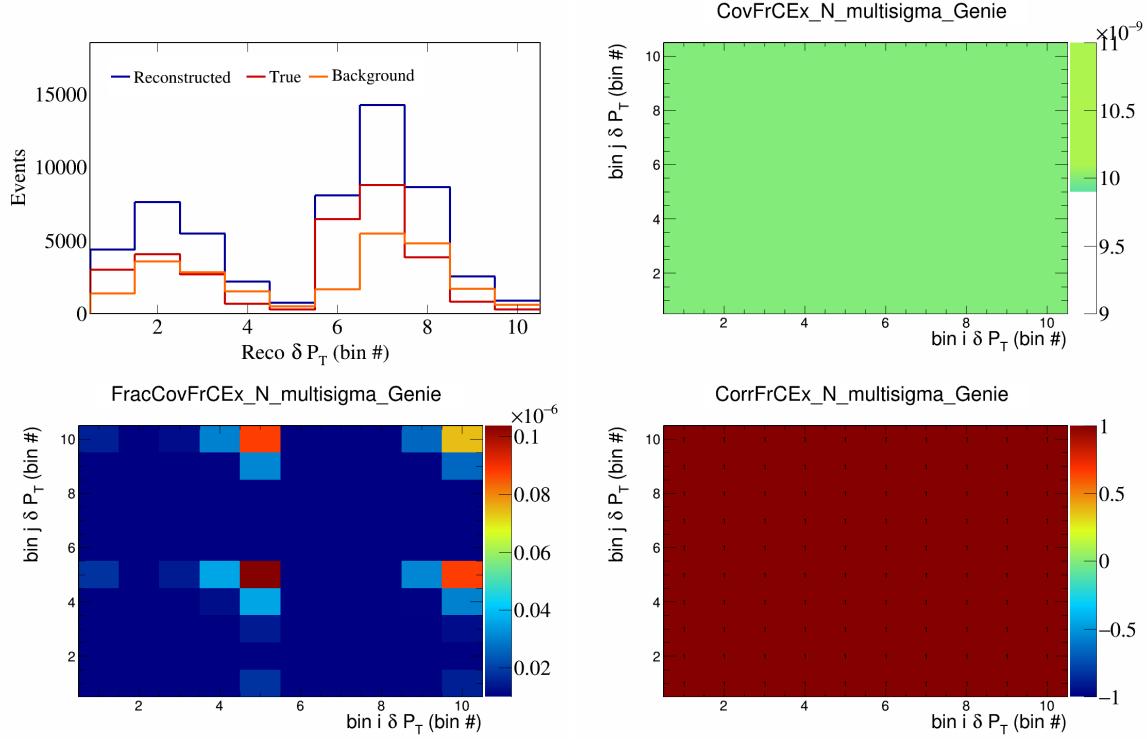


Figure 194: FrCEExN variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

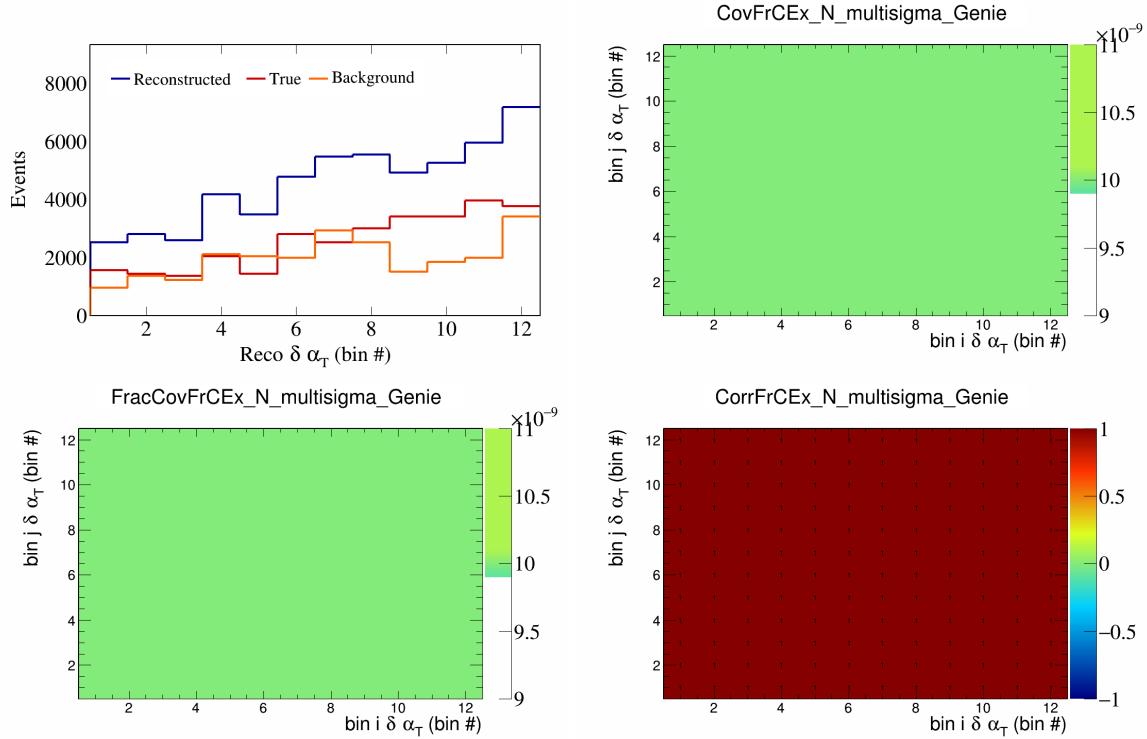


Figure 195: FrCEExN variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

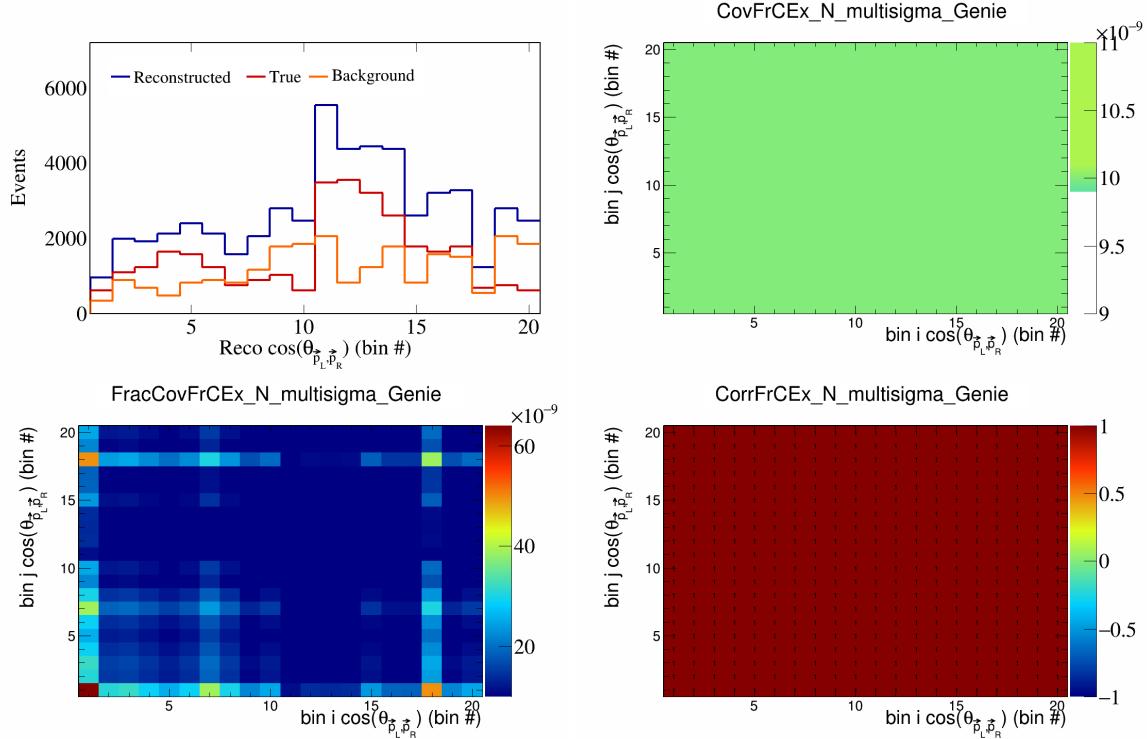


Figure 196: FrCEExN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

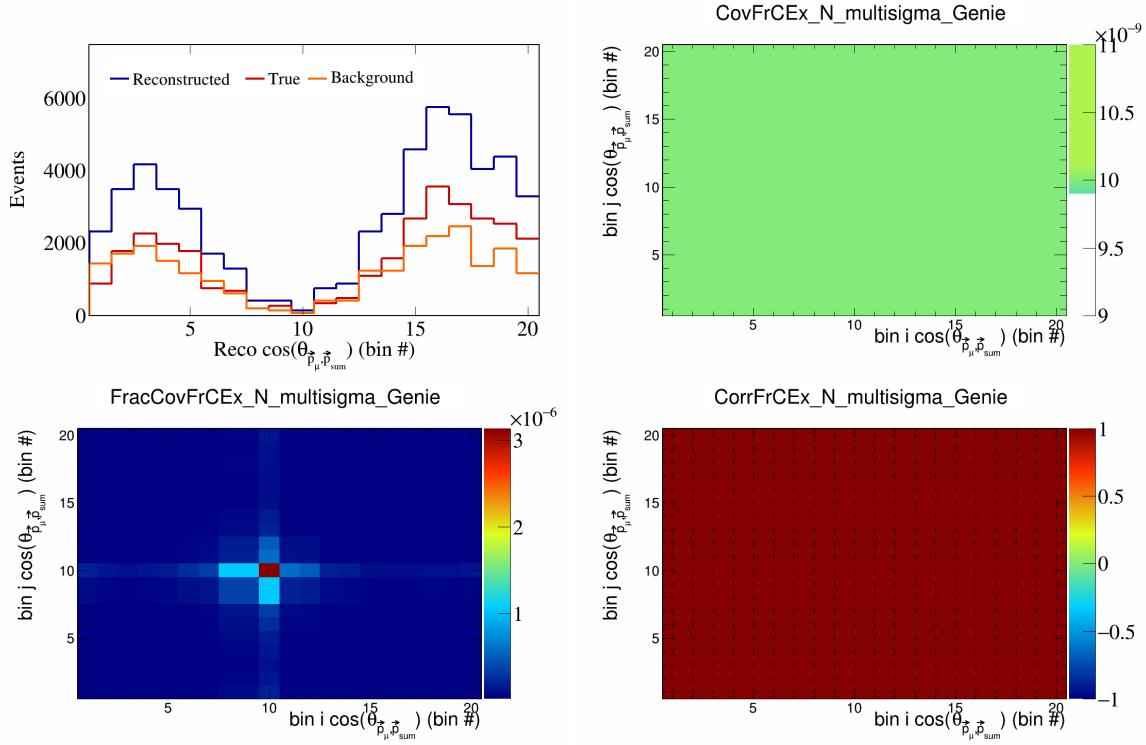


Figure 197: FrCEExN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

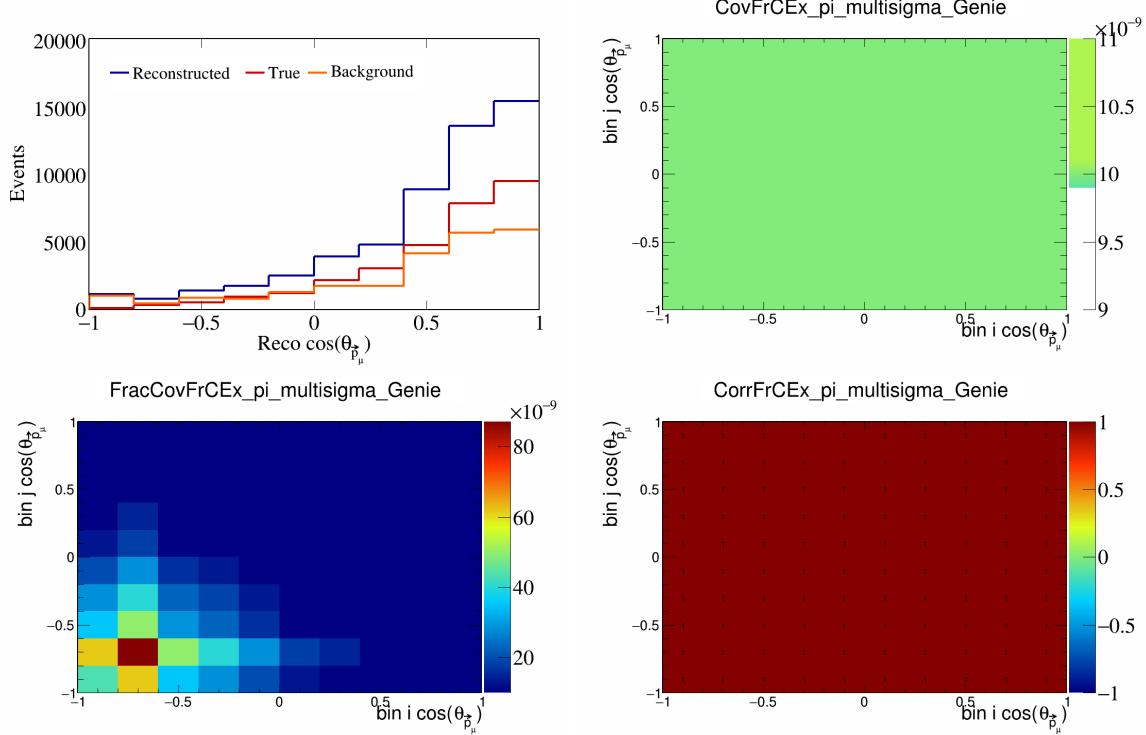


Figure 198: FrCEExpi variations for $\cos(\theta_{\vec{p}_\mu})$.

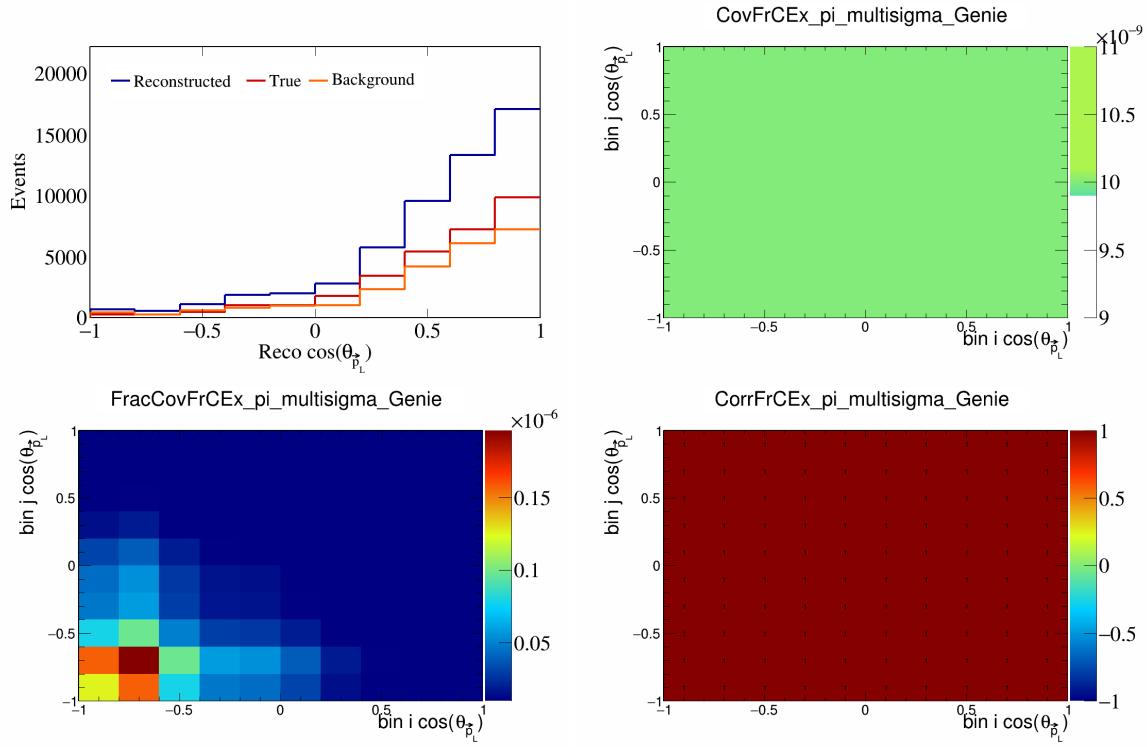


Figure 199: FrCExpi variations for $\cos(\theta_{\vec{p}_L})$.

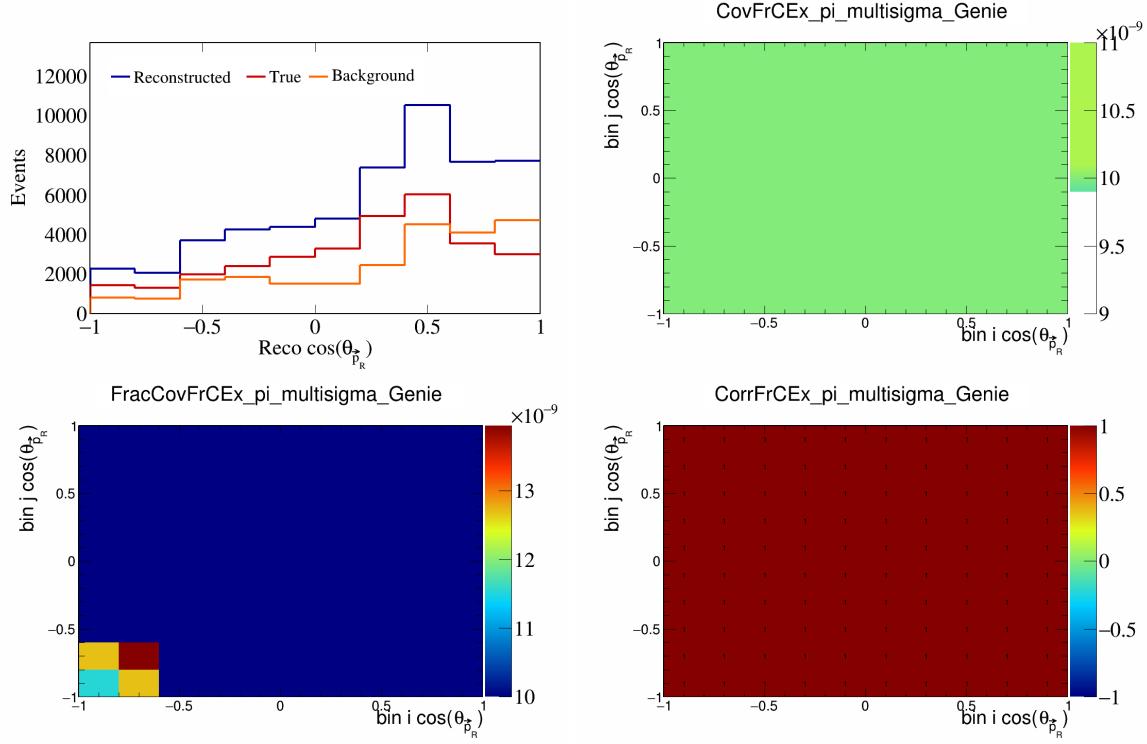


Figure 200: FrCExpi variations for $\cos(\theta_{\vec{p}_R})$.

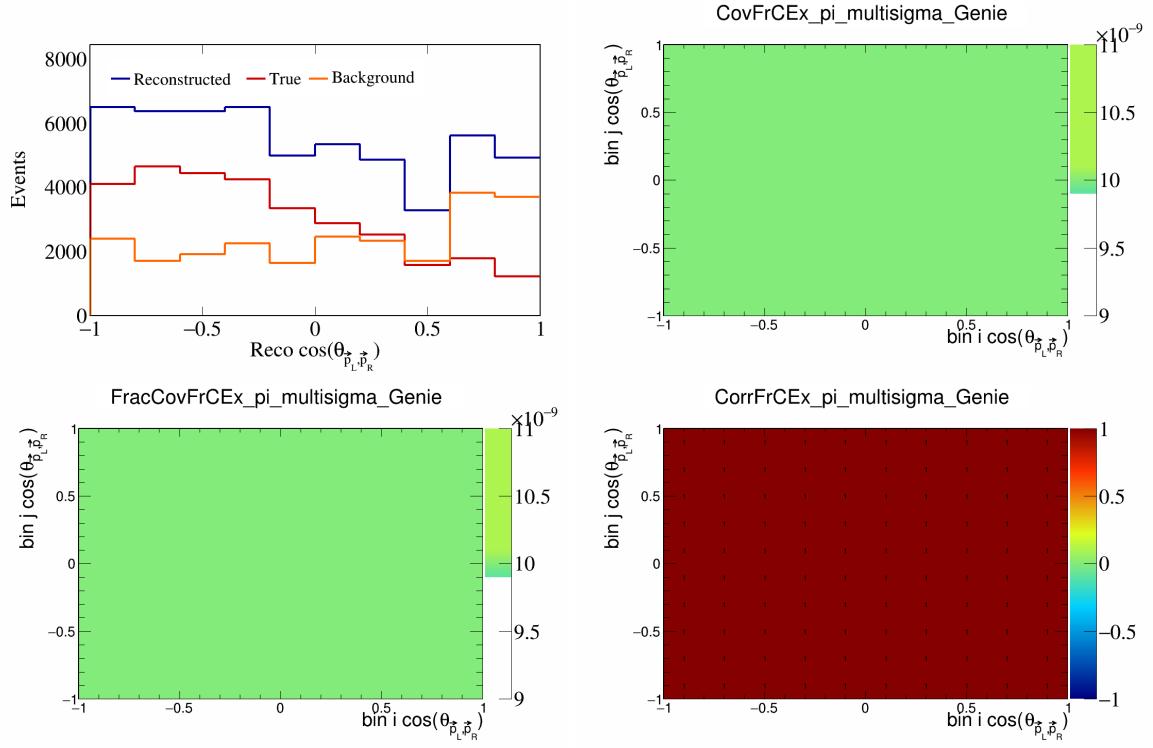


Figure 201: FrCEpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

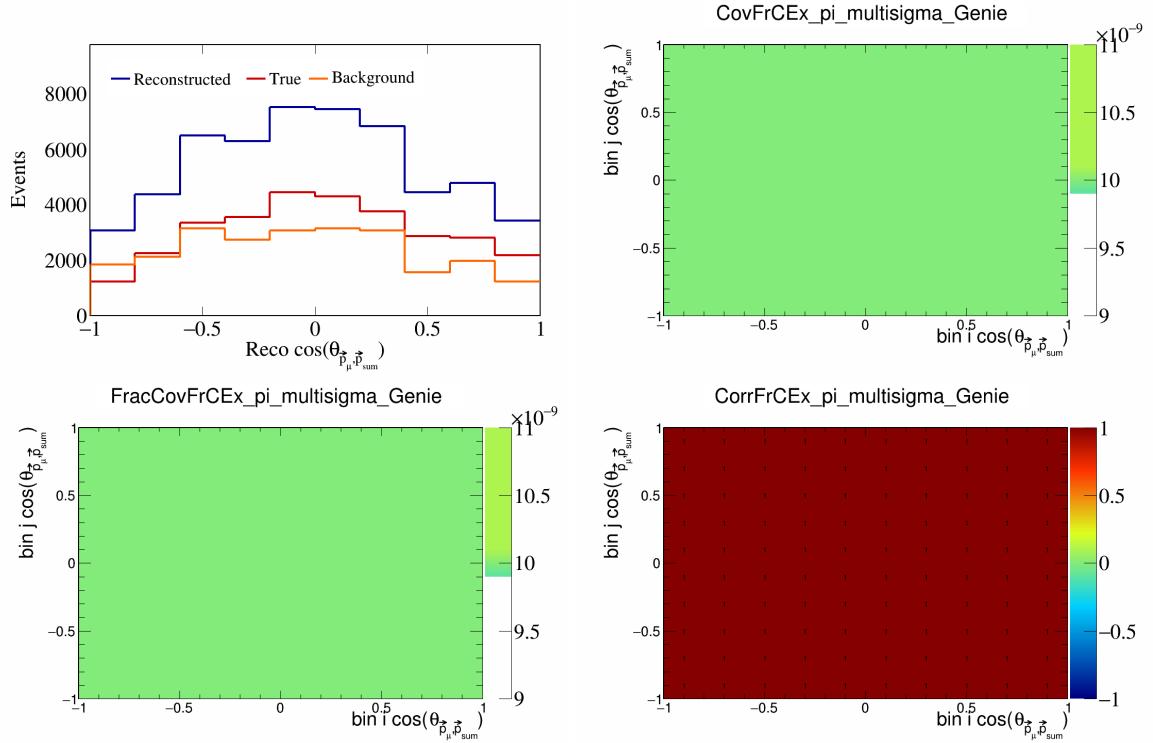


Figure 202: FrCEpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

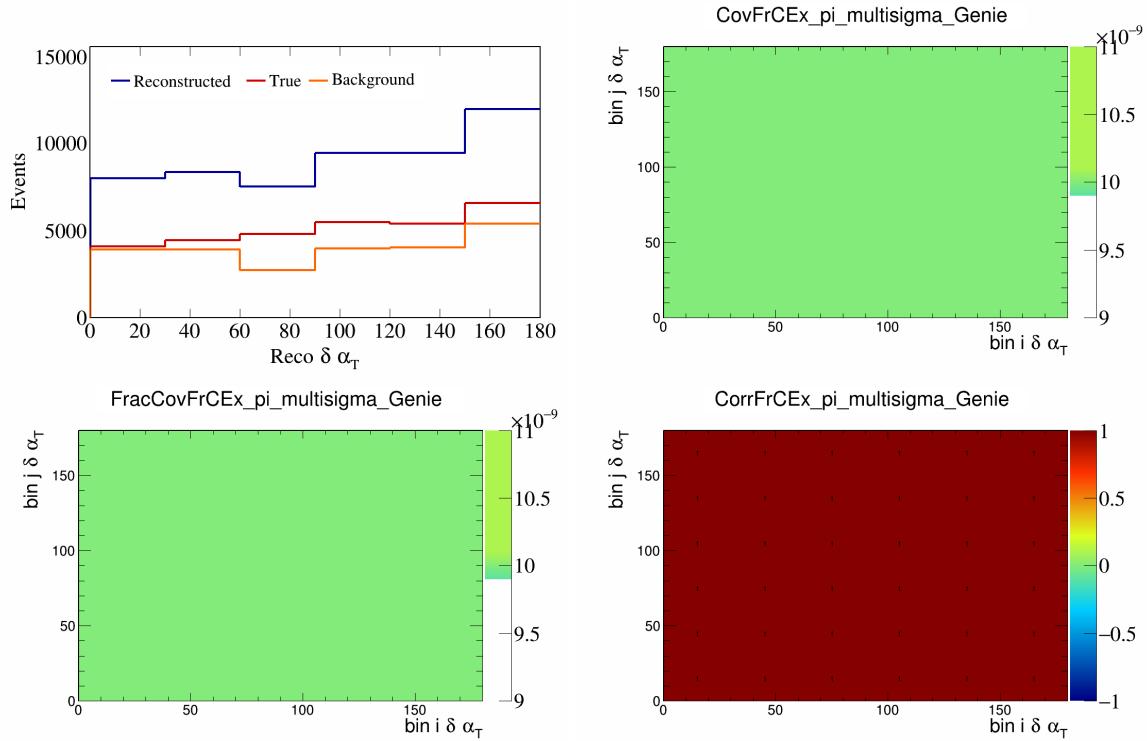


Figure 203: FrCEExpi variations for $\delta \alpha_T$.

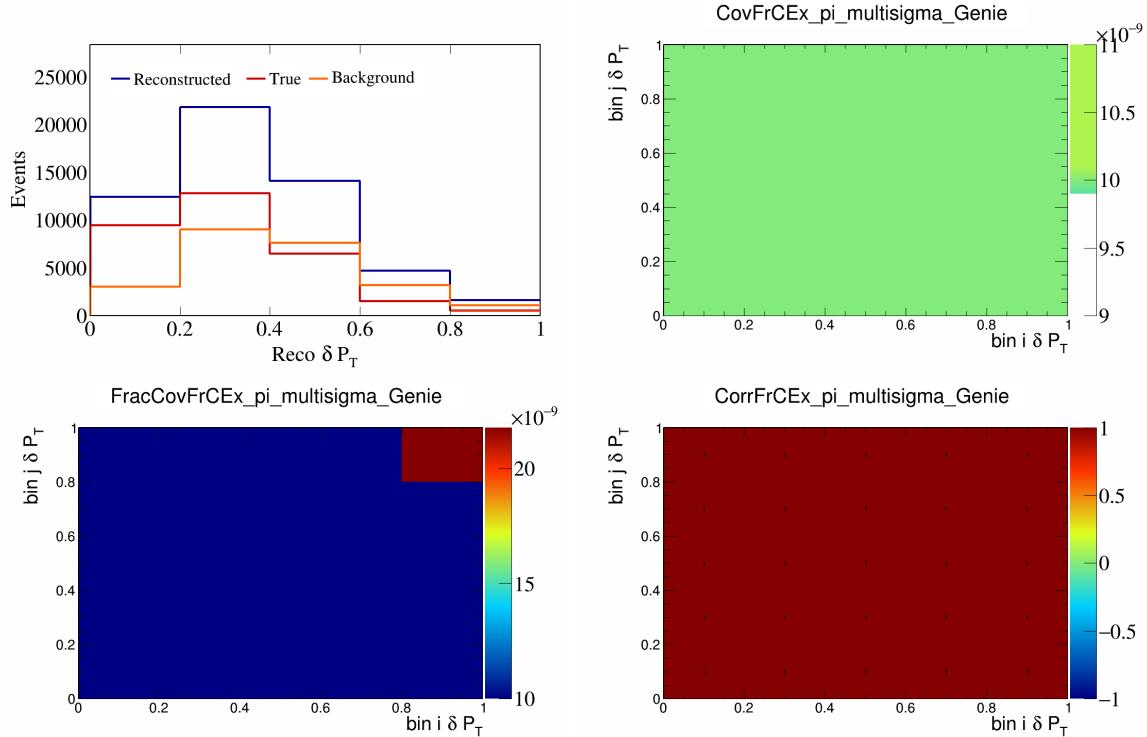


Figure 204: FrCEExpi variations for δP_T .

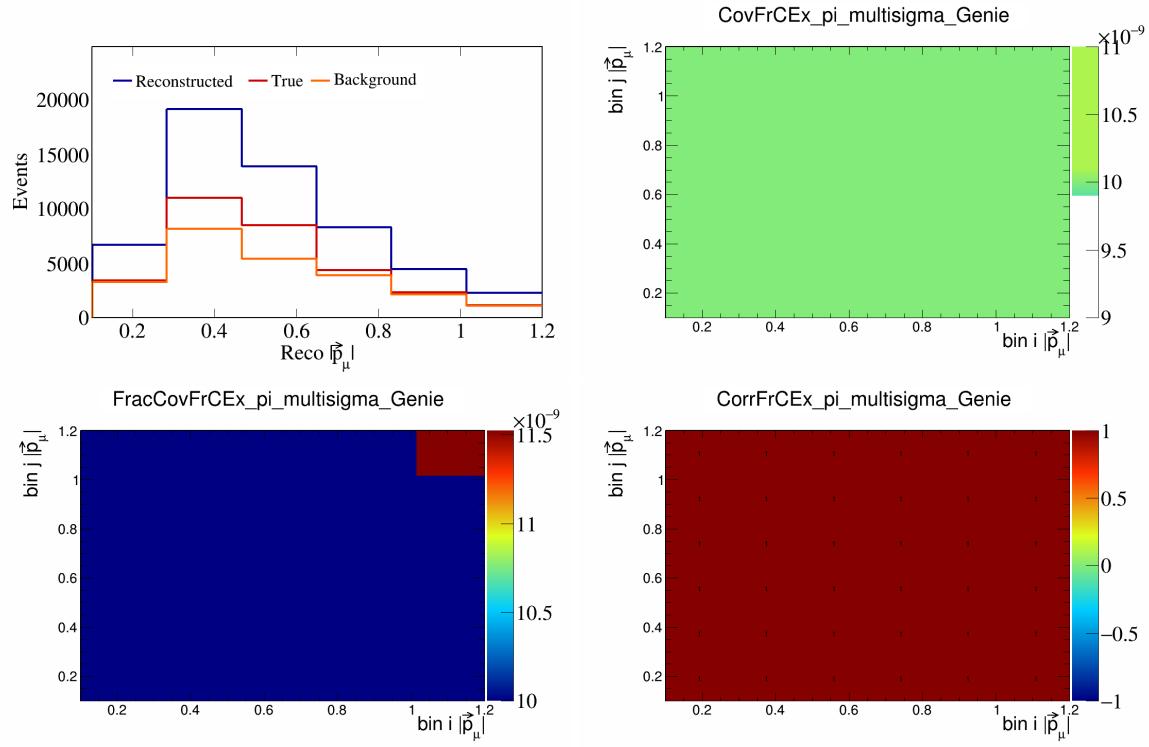


Figure 205: FrCEExpi variations for $|\vec{p}_\mu|$.

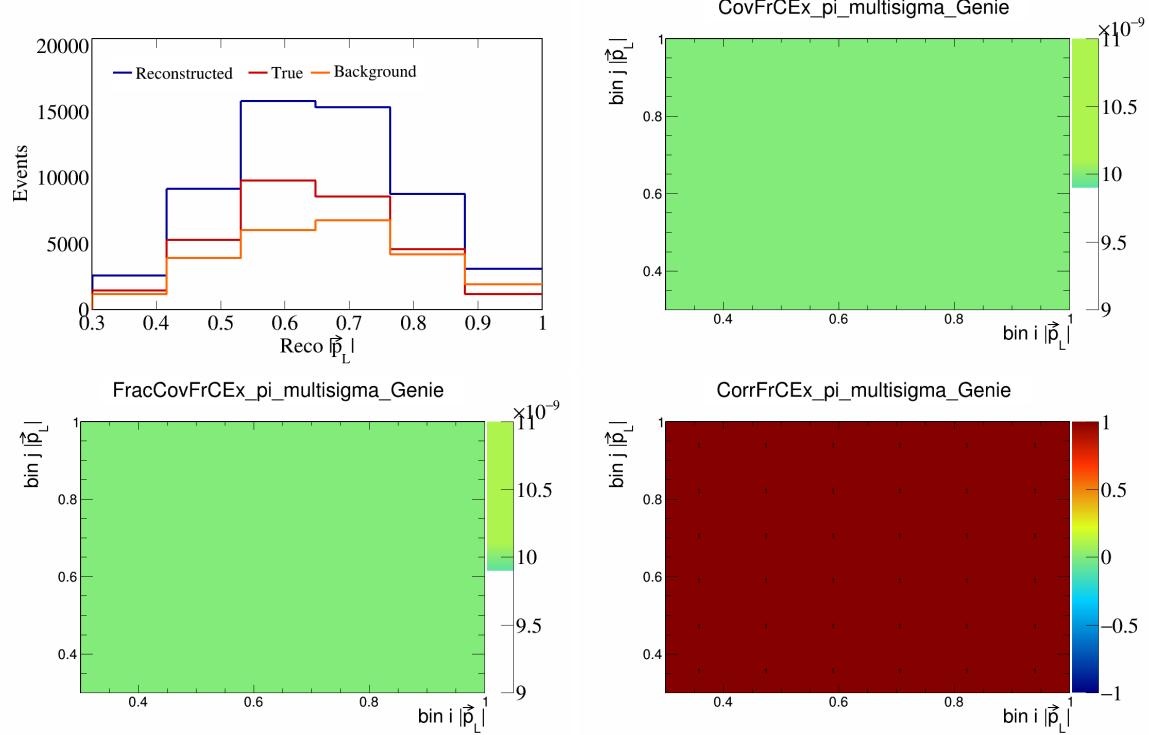


Figure 206: FrCEExpi variations for $|\vec{p}_L|$.

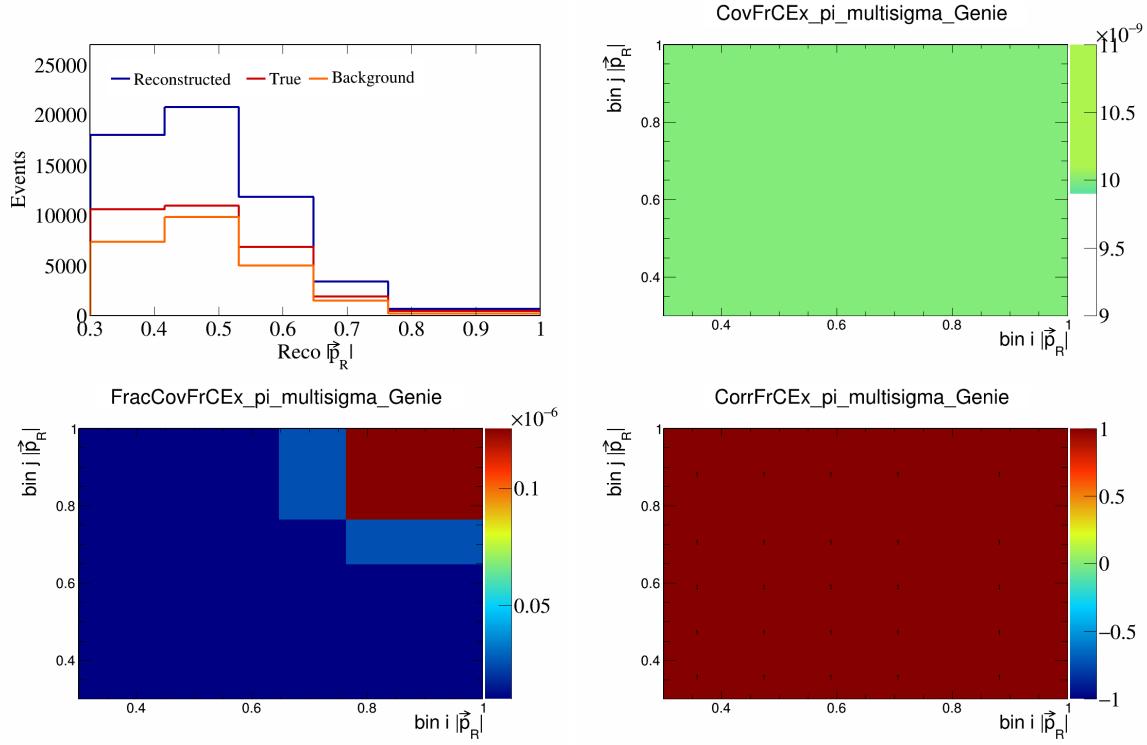


Figure 207: FrCEExpi variations for $|\vec{p}_R|$.

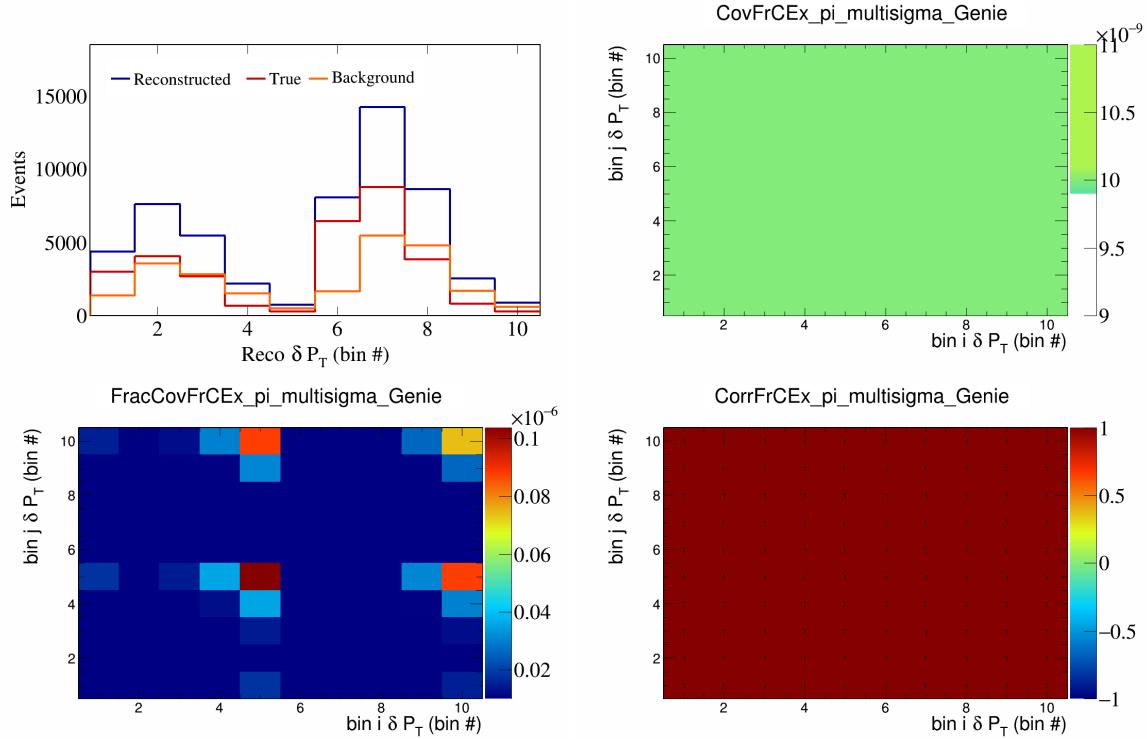


Figure 208: FrCEExpi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

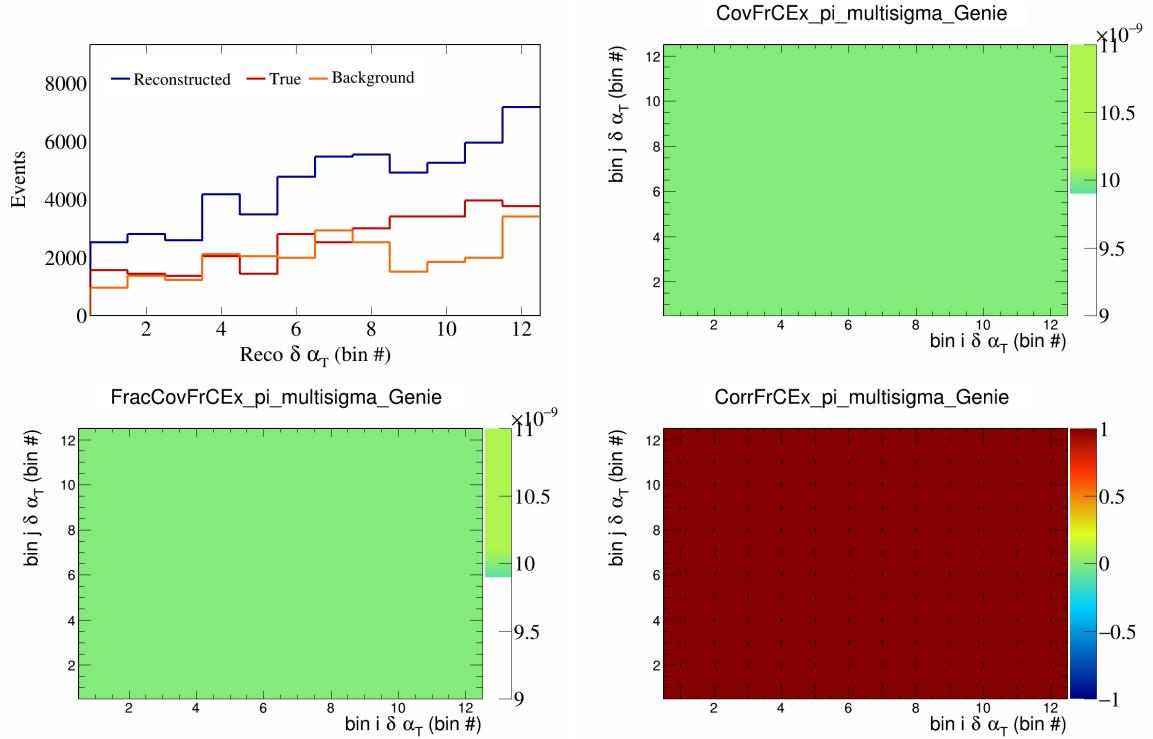


Figure 209: FrCEExpi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

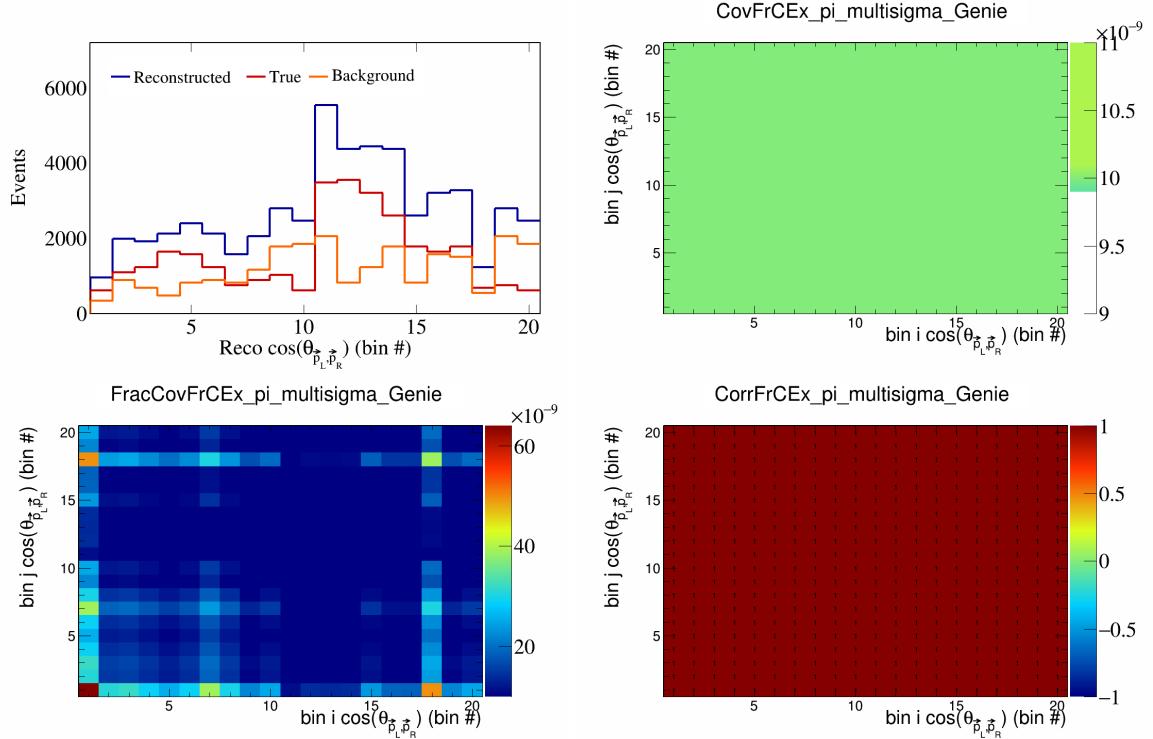


Figure 210: FrCEExpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

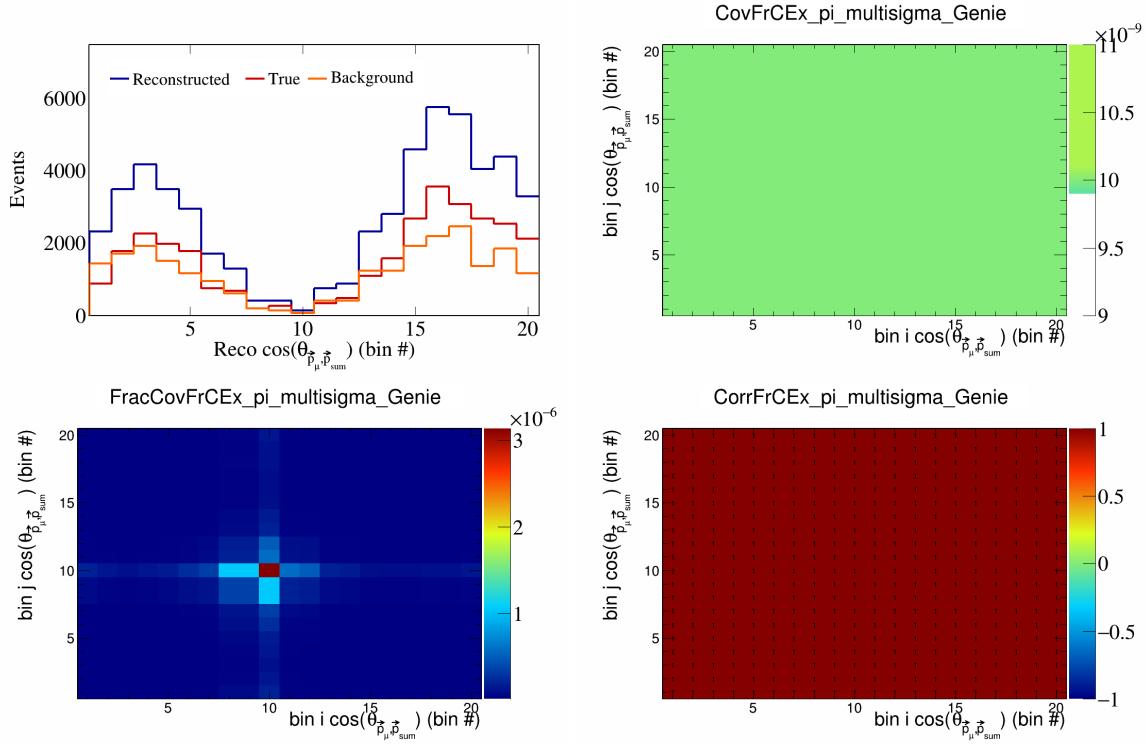


Figure 211: FrCEExpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

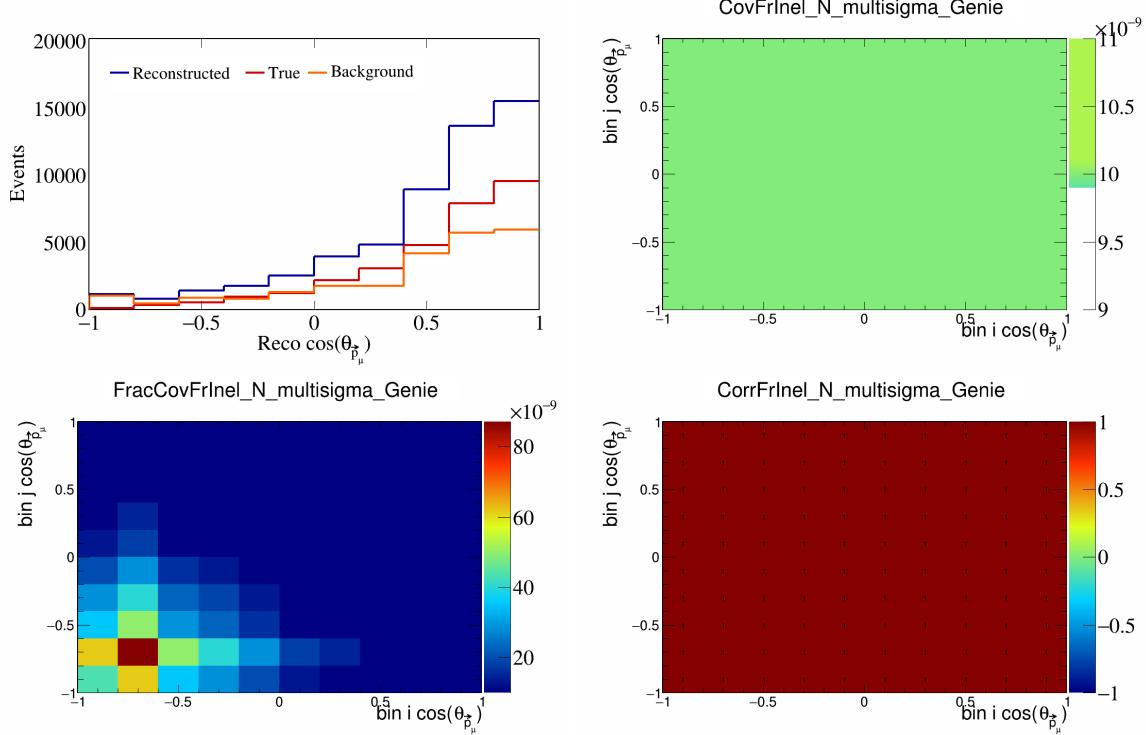


Figure 212: FrInelN variations for $\cos(\theta_{\vec{p}_\mu})$.

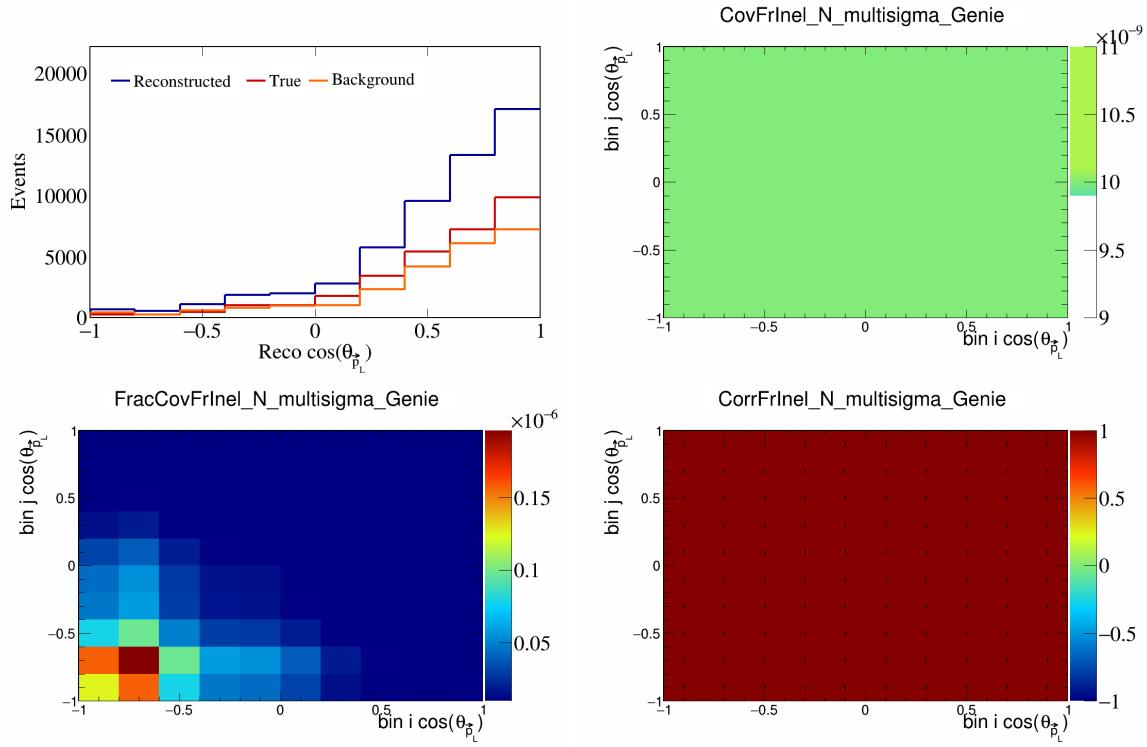


Figure 213: FrInelN variations for $\cos(\theta_{\vec{p}_L})$.

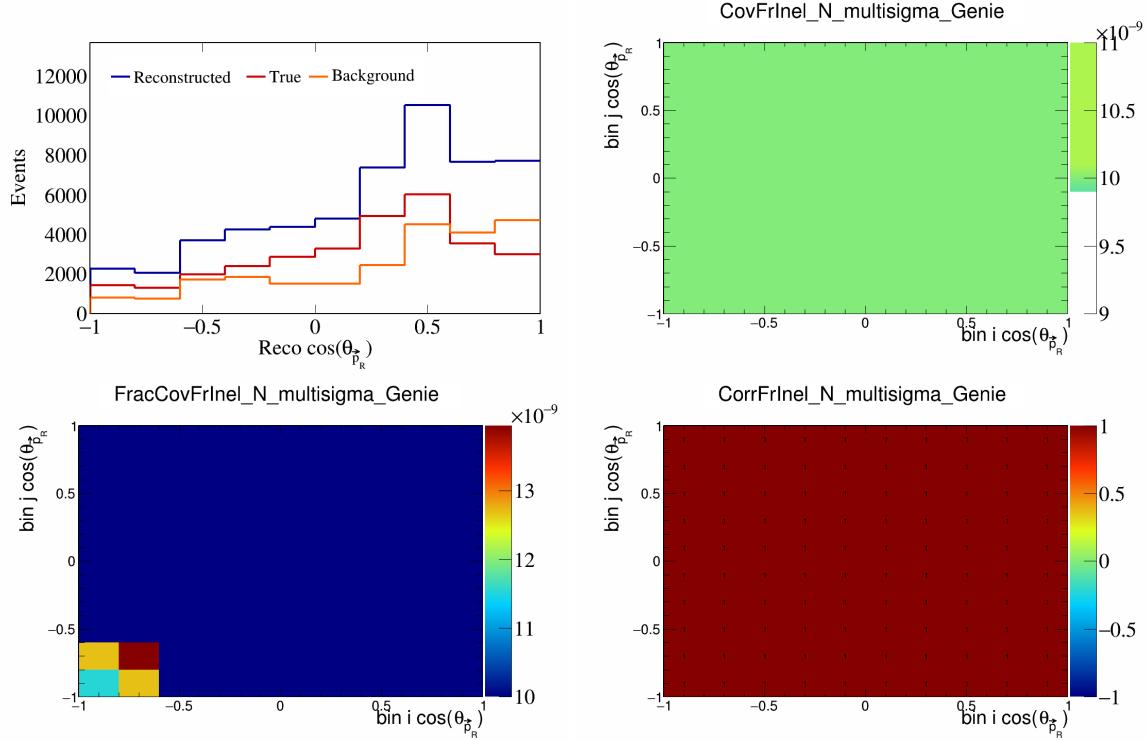


Figure 214: FrInelN variations for $\cos(\theta_{\vec{p}_R})$.

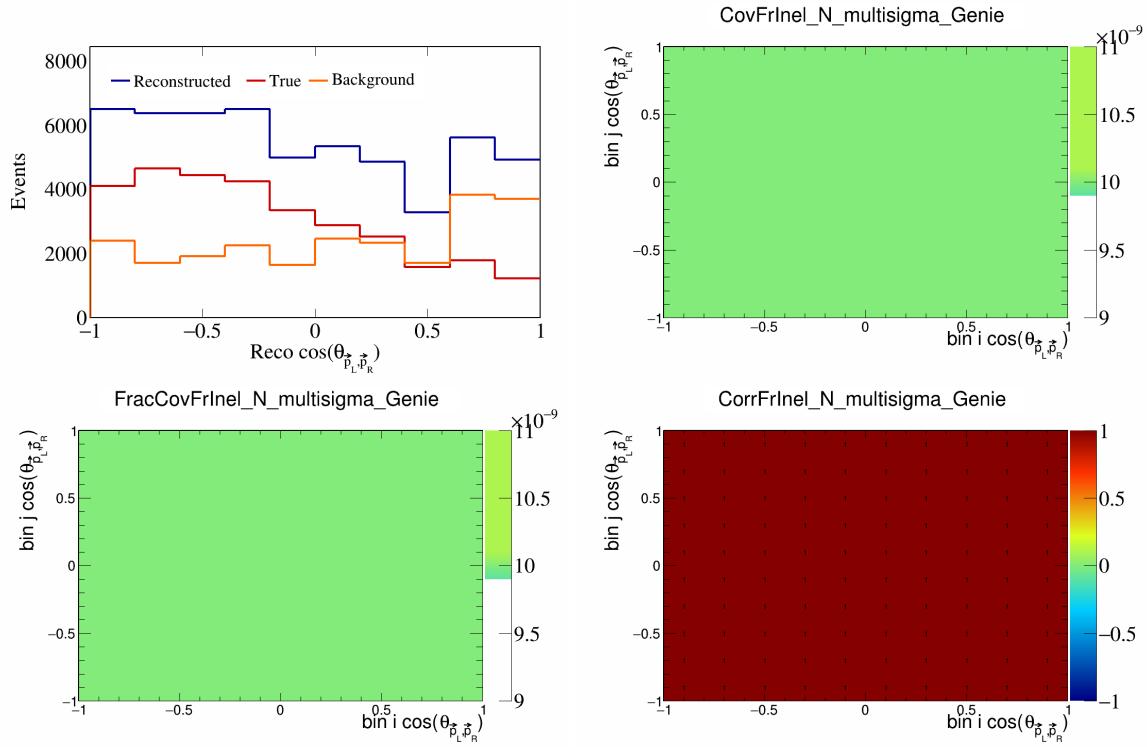


Figure 215: FrInelN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

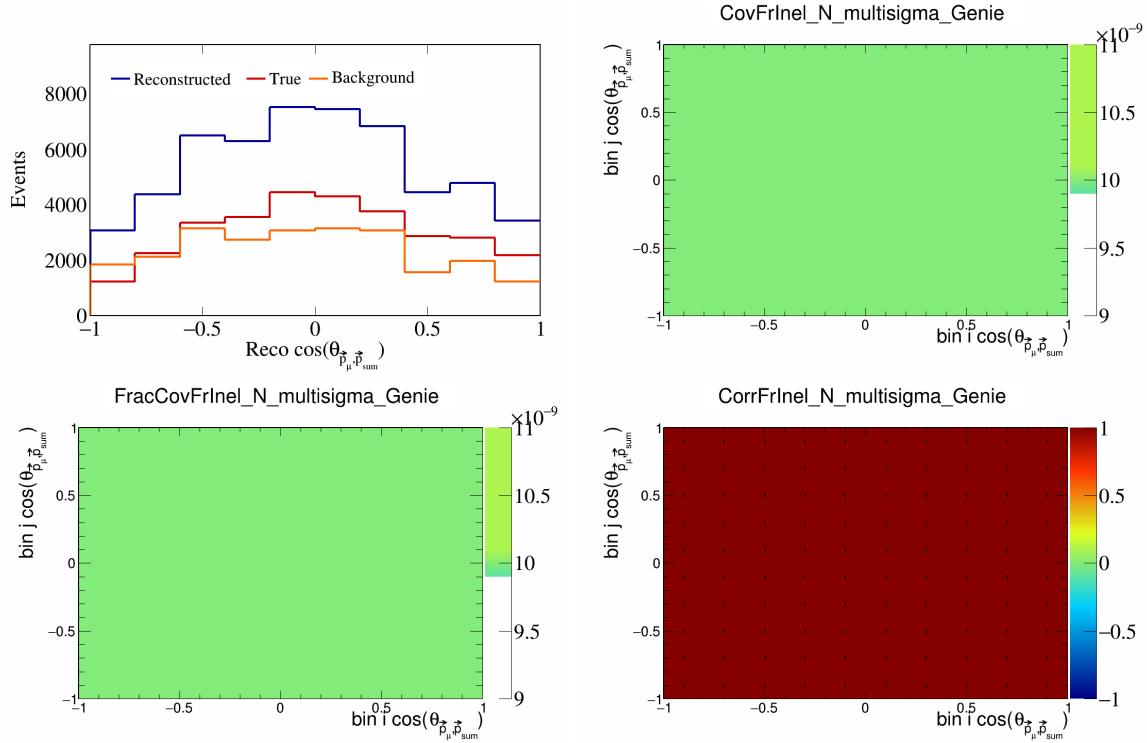


Figure 216: FrInelN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

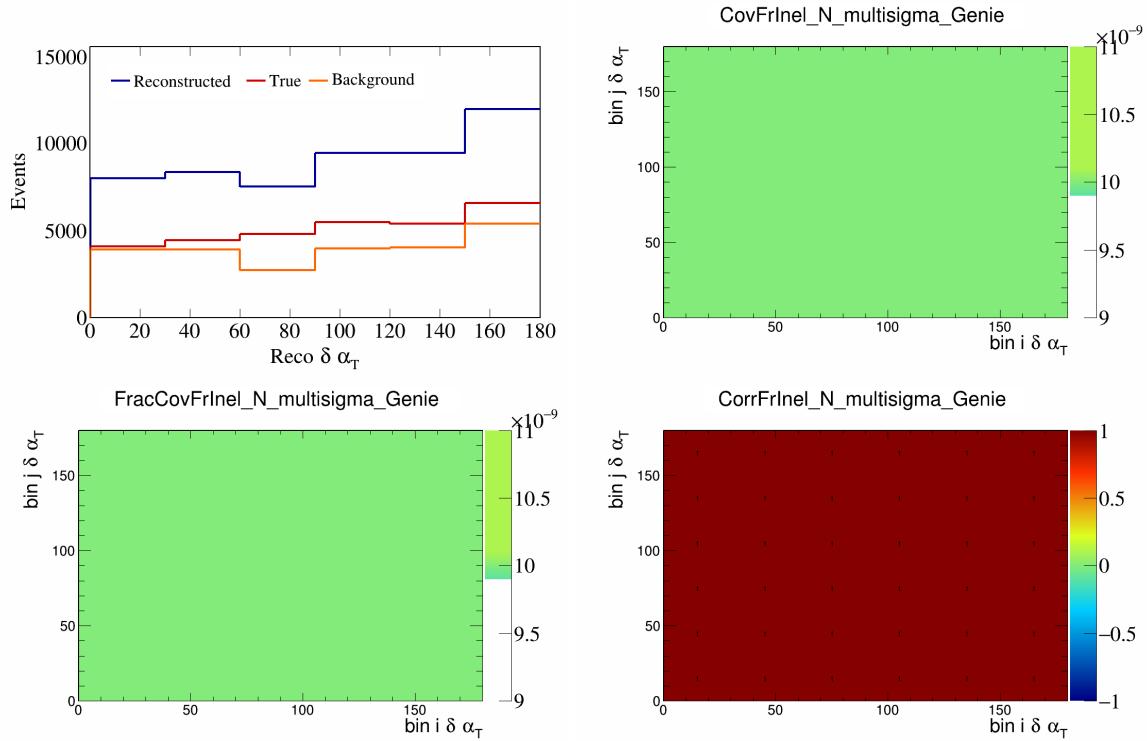


Figure 217: FrInelN variations for $\delta\alpha_T$.

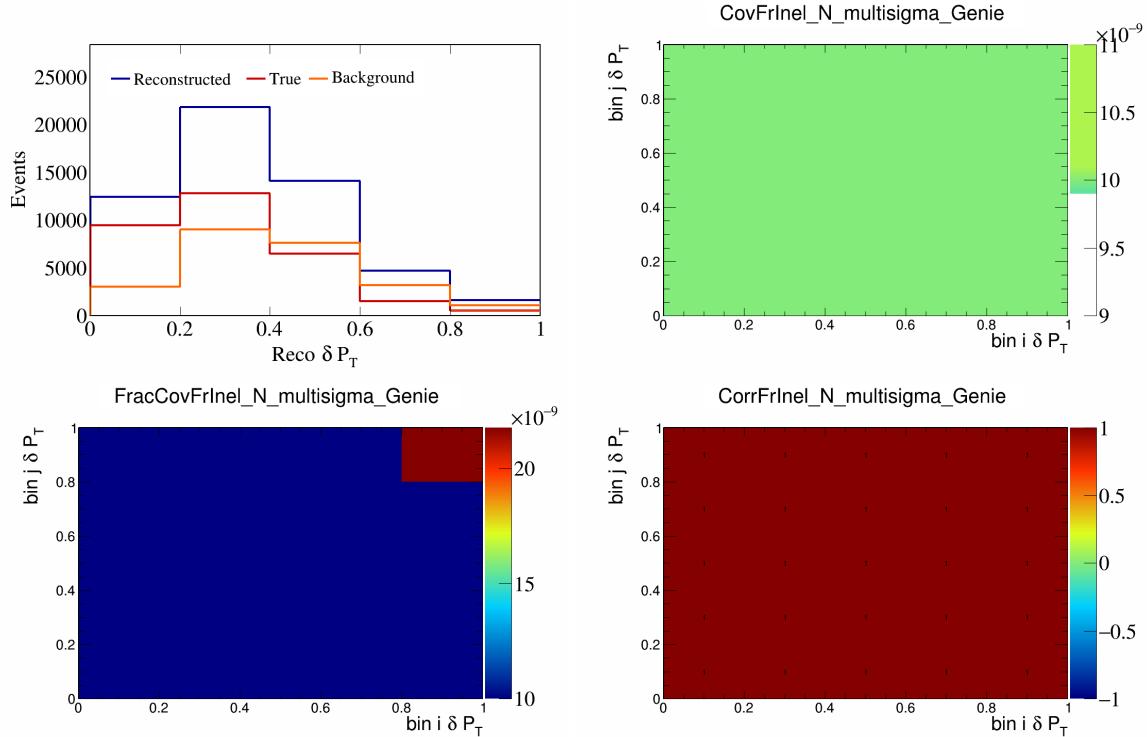


Figure 218: FrInelN variations for δP_T .

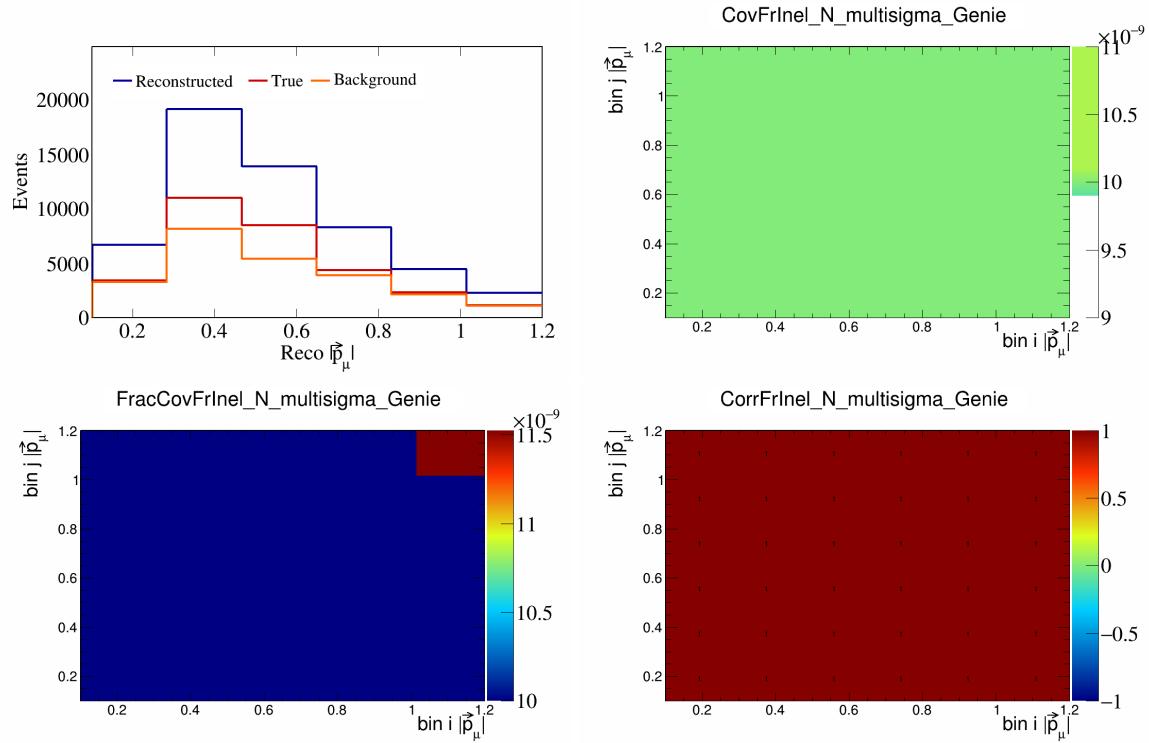


Figure 219: FrInelN variations for $|\vec{p}_\mu|$.

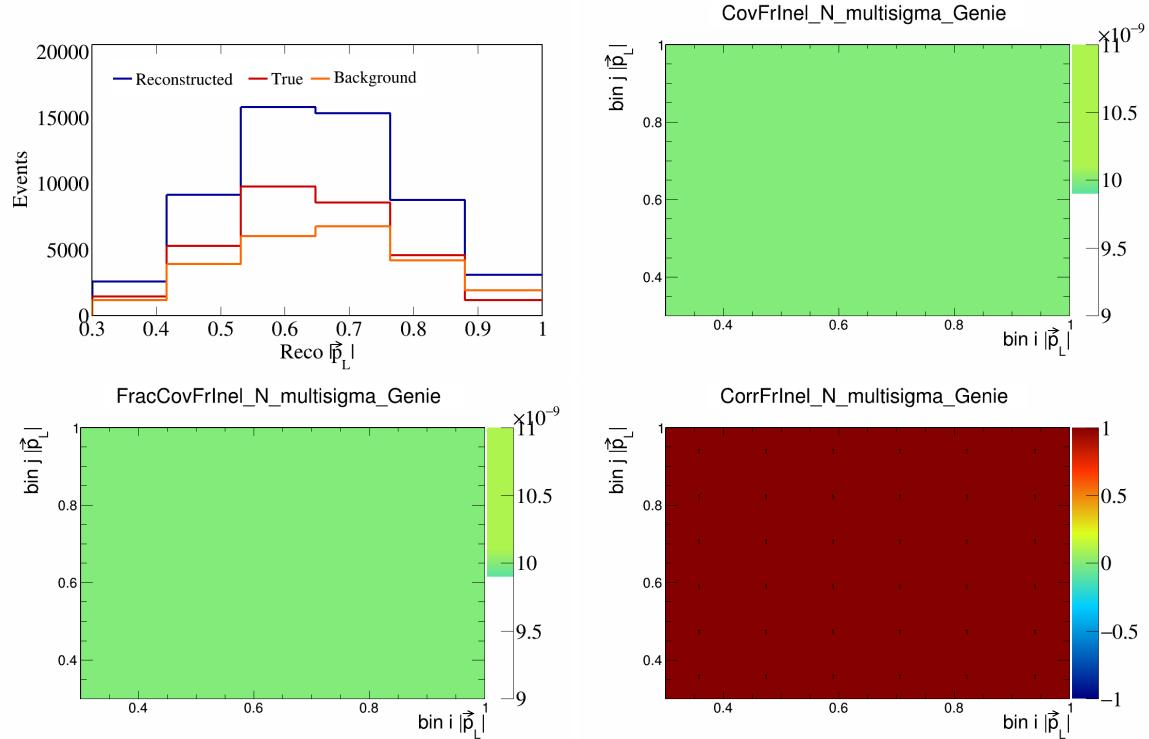


Figure 220: FrInelN variations for $|\vec{p}_L|$.

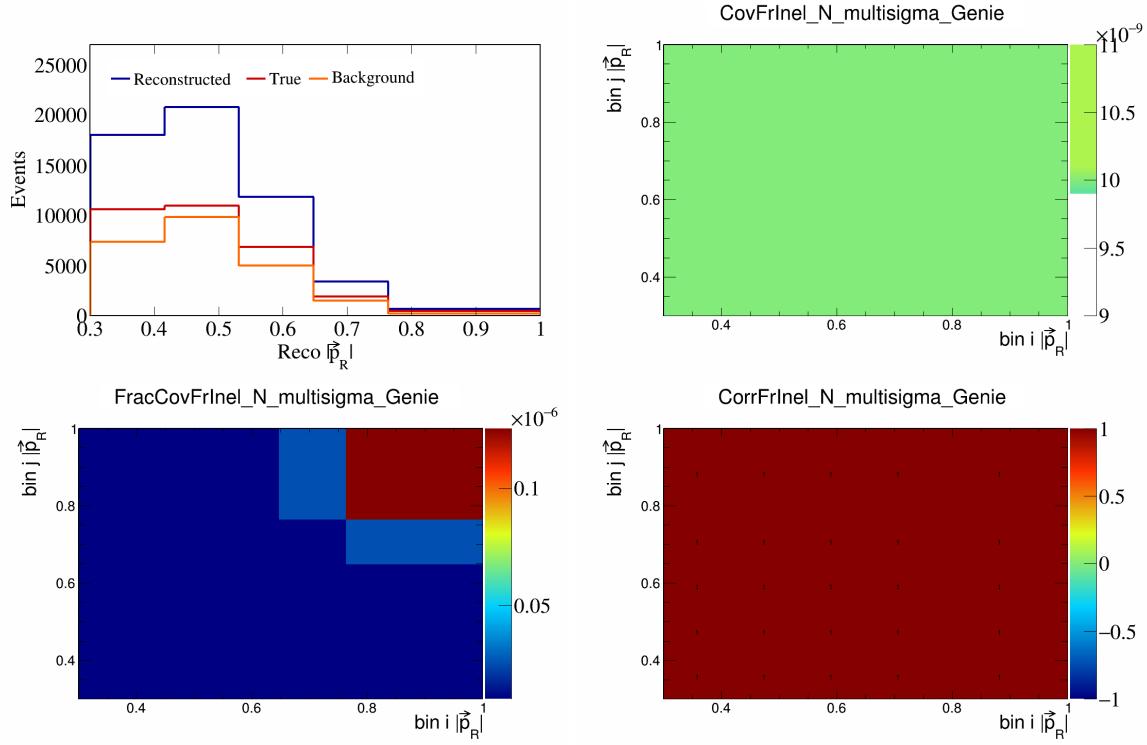


Figure 221: FrInelN variations for $|\vec{p}_R|$.

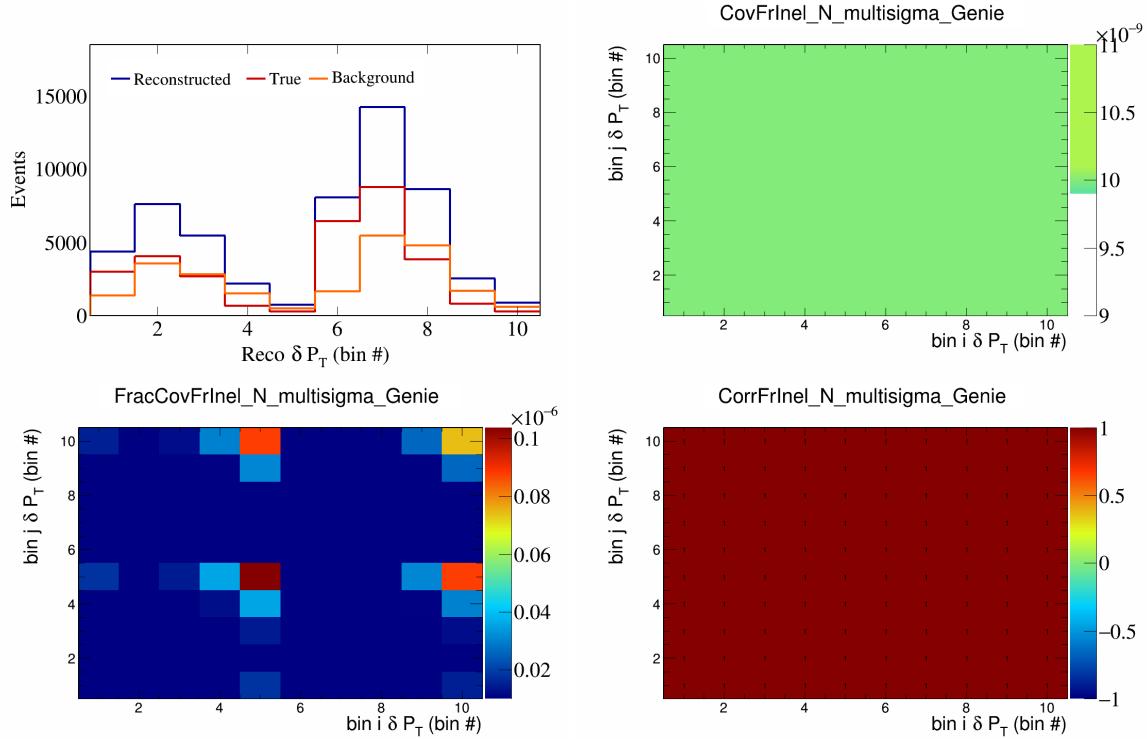


Figure 222: FrInelN variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

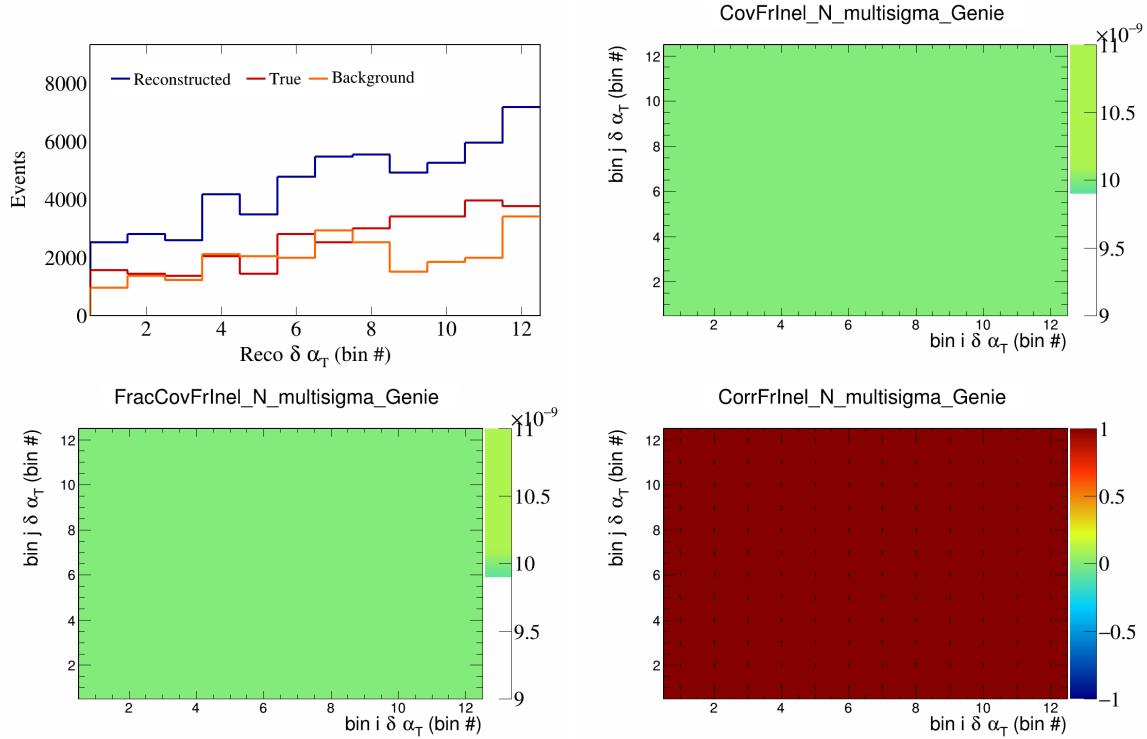


Figure 223: FrInelN variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

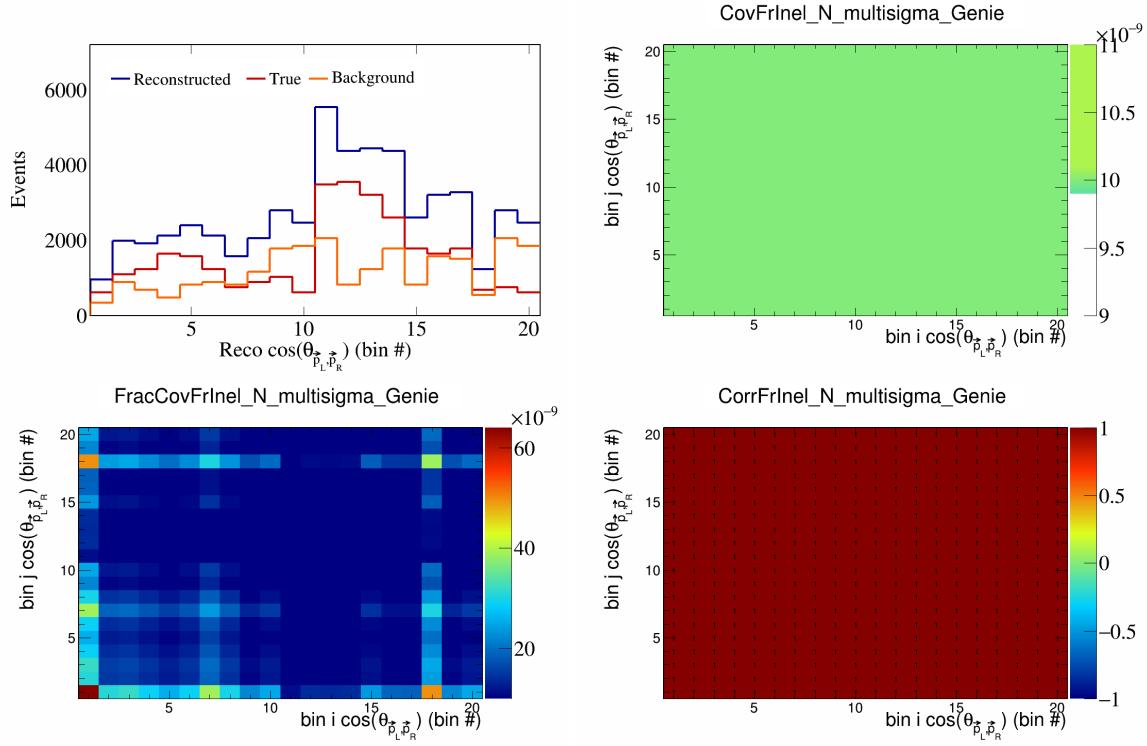


Figure 224: FrInelN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

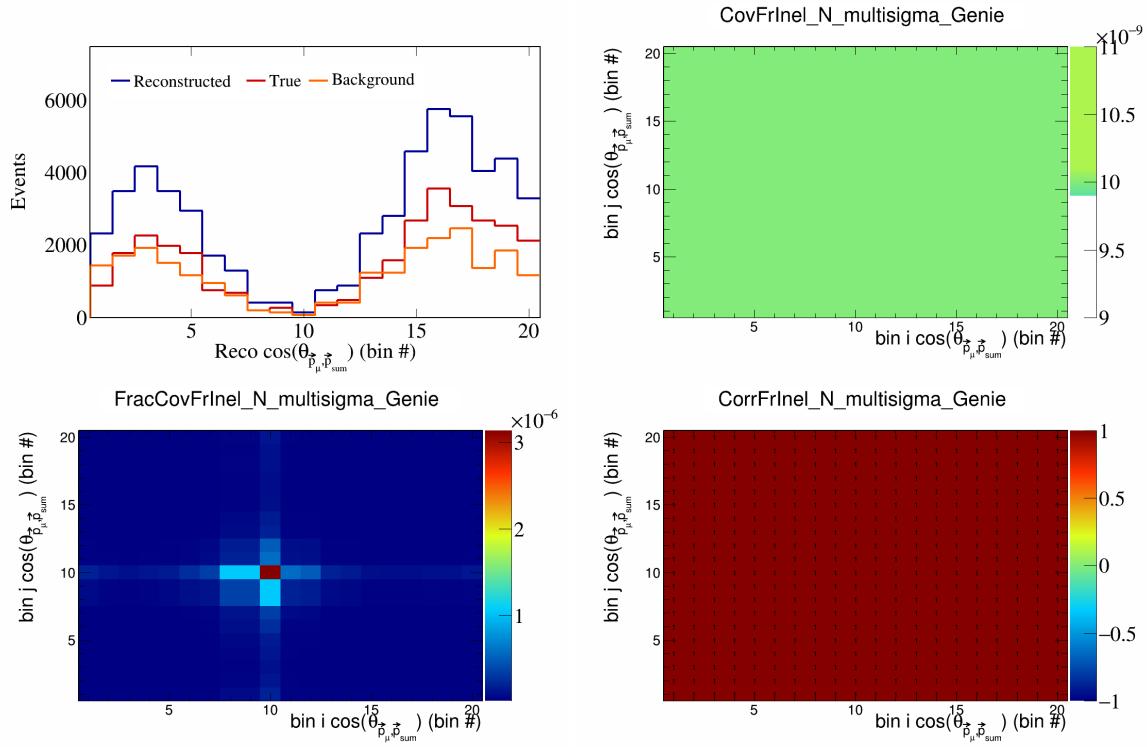


Figure 225: FrInelN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

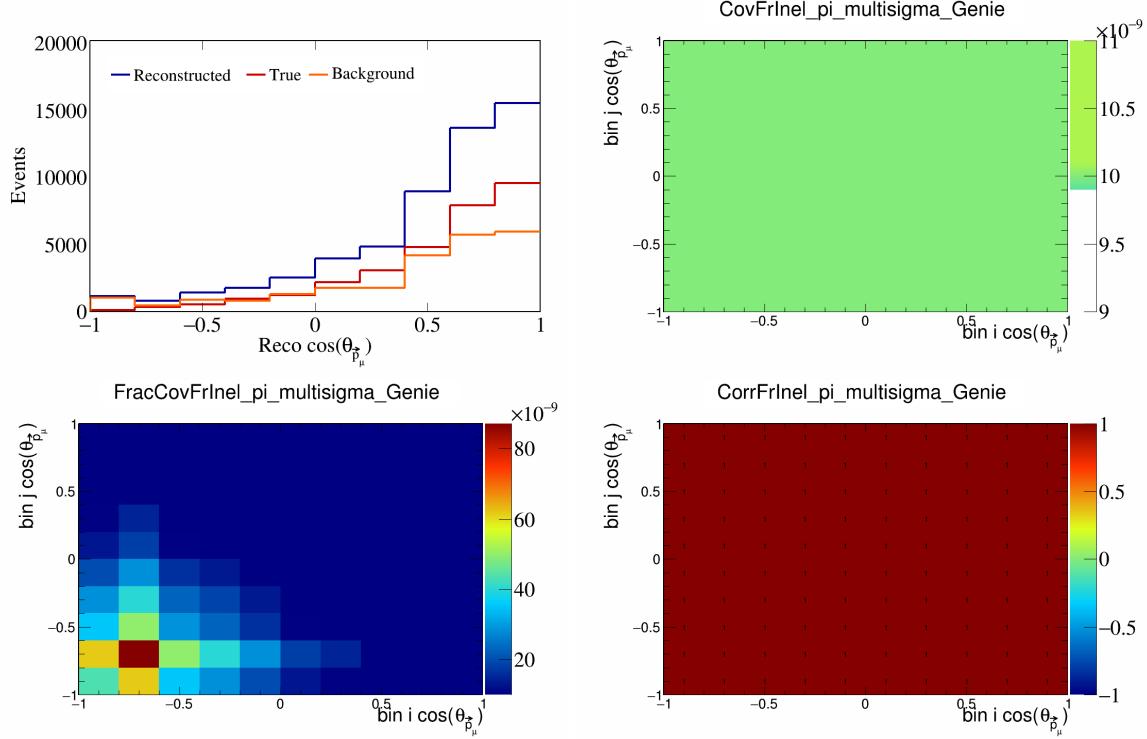


Figure 226: FrInelpi variations for $\cos(\theta_{\vec{p}_\mu})$.

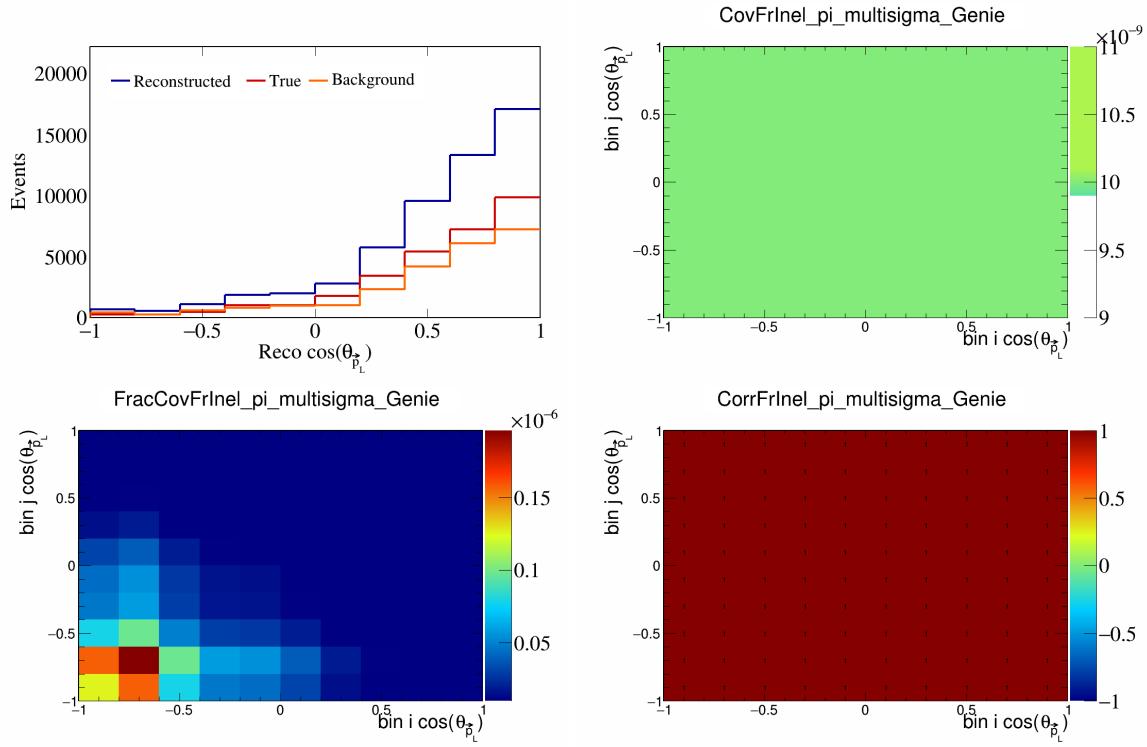


Figure 227: FrInelpi variations for $\cos(\theta_{\vec{p}_L})$.

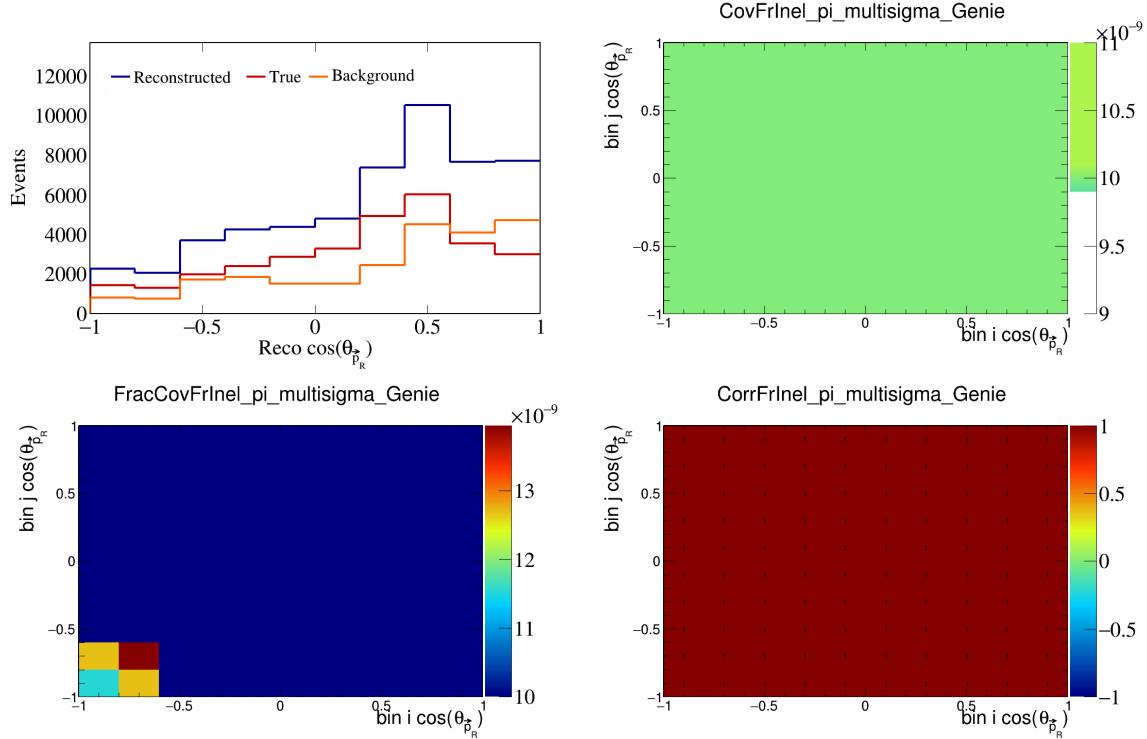


Figure 228: FrInelpi variations for $\cos(\theta_{\vec{p}_R})$.

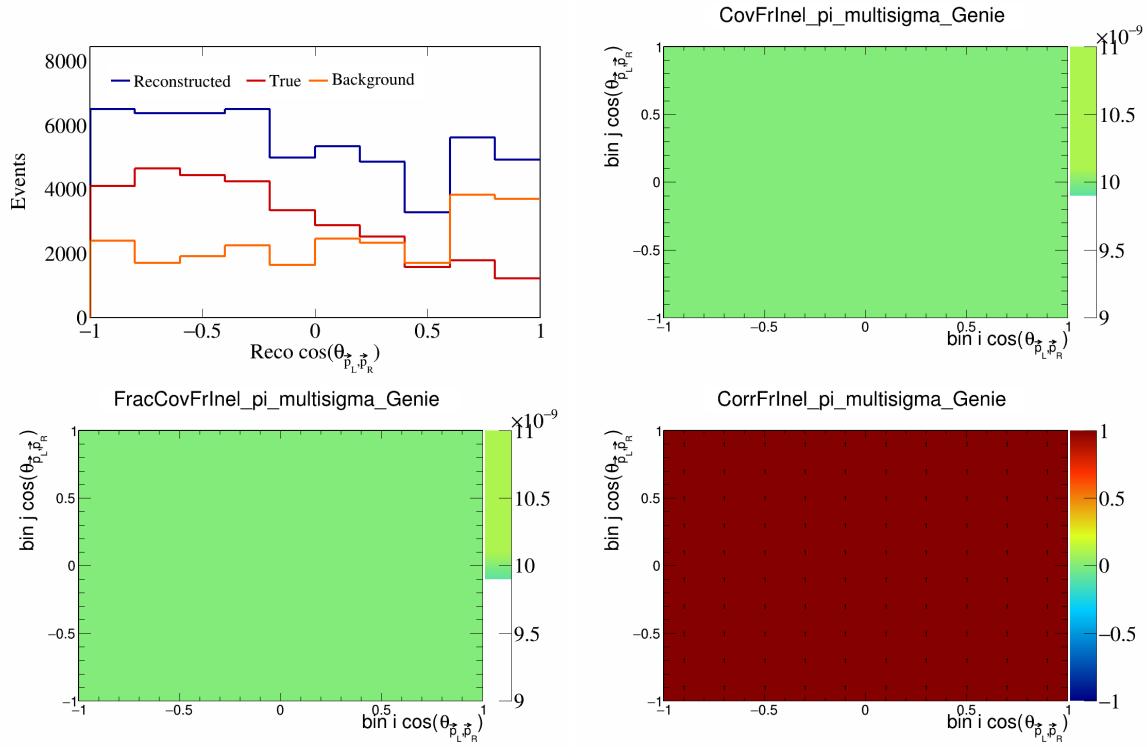


Figure 229: FrInelpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

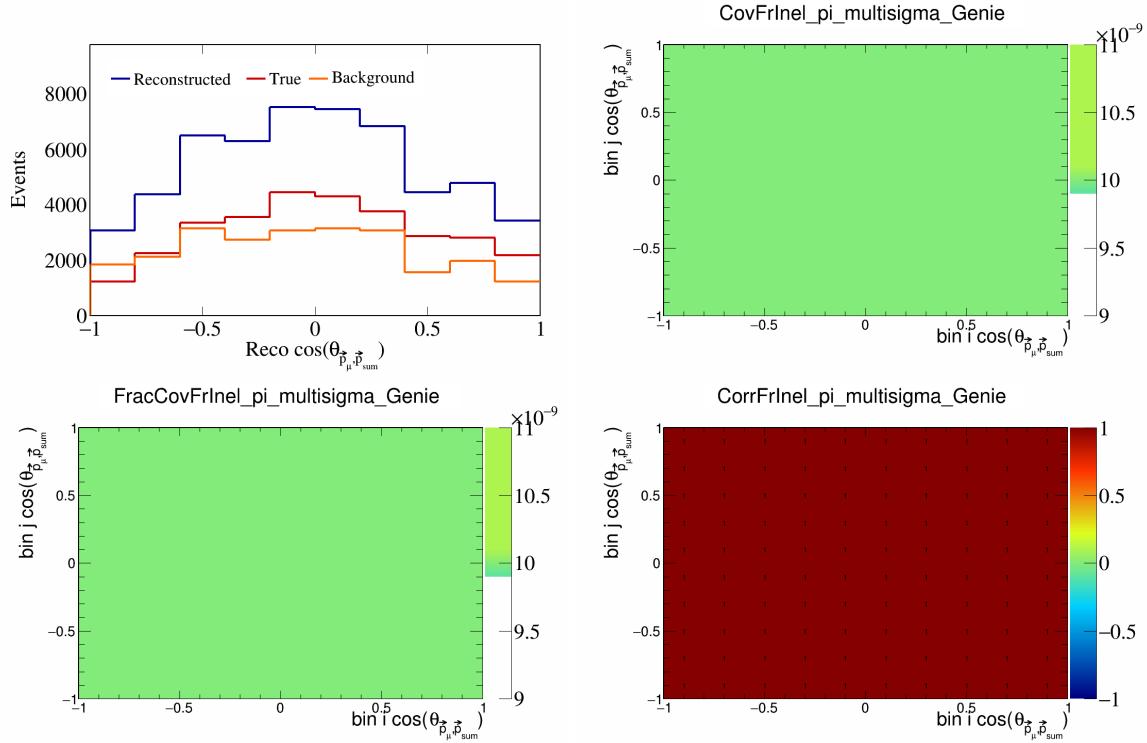


Figure 230: FrInelpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

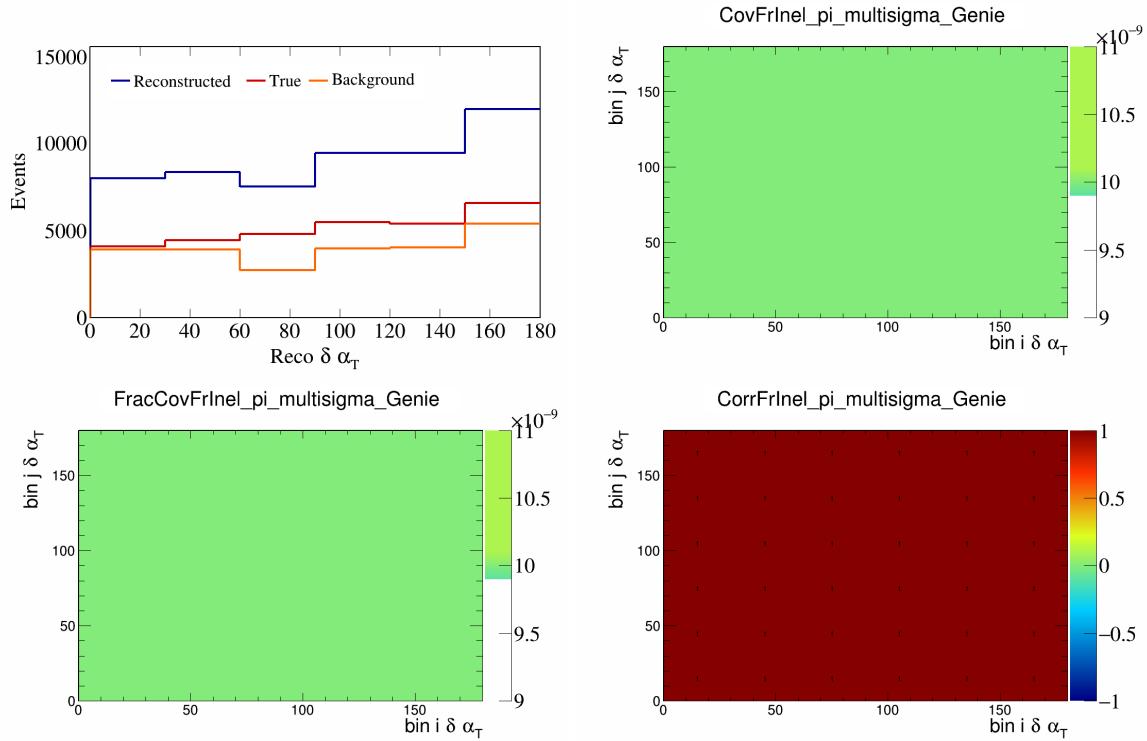


Figure 231: FrInelpi variations for $\delta\alpha_T$.

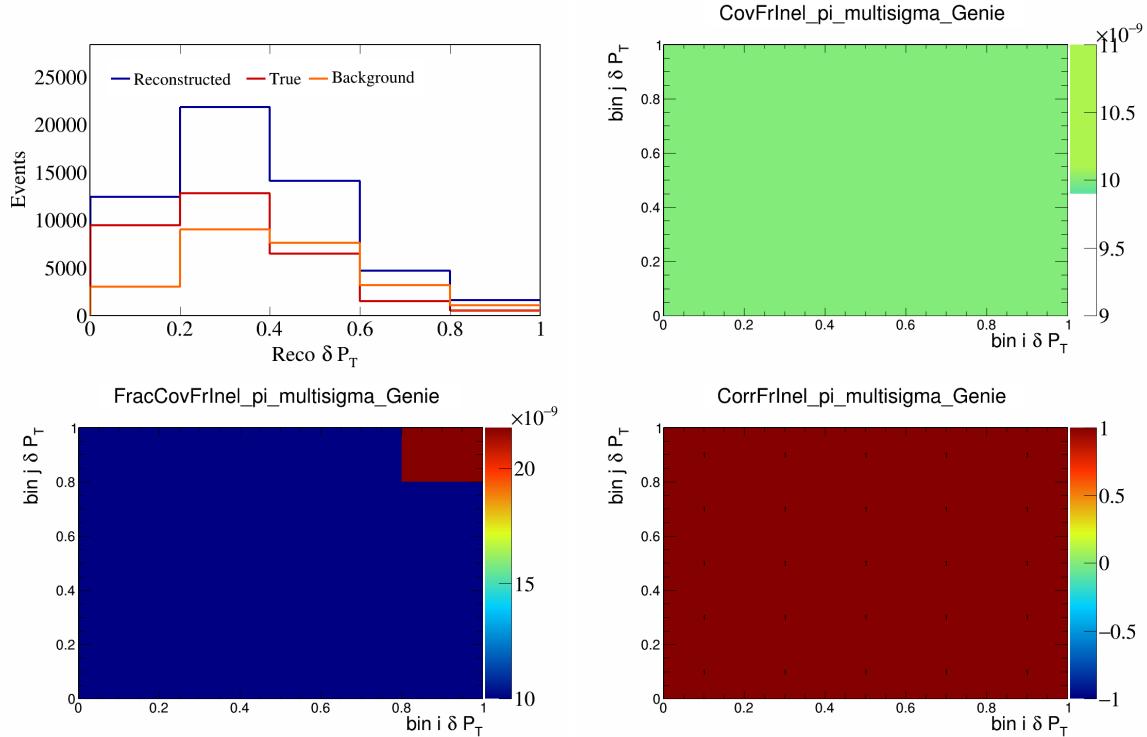


Figure 232: FrInelpi variations for δP_T .

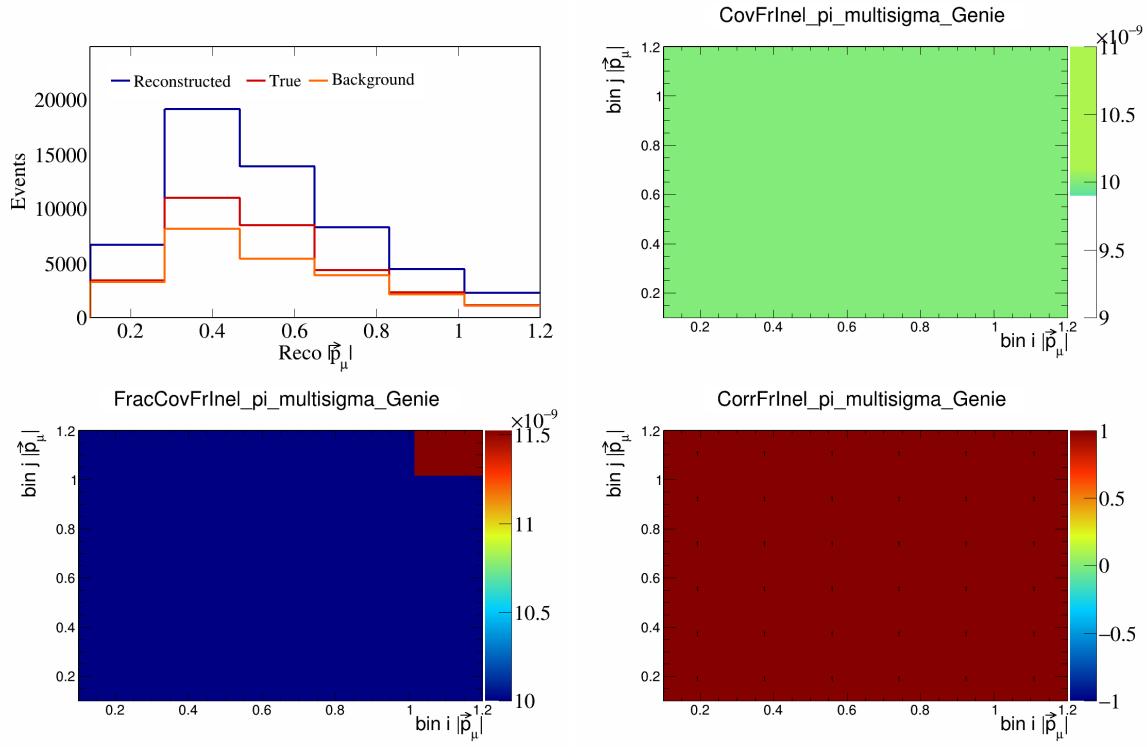


Figure 233: FrInelpi variations for $|\vec{p}_\mu|$.

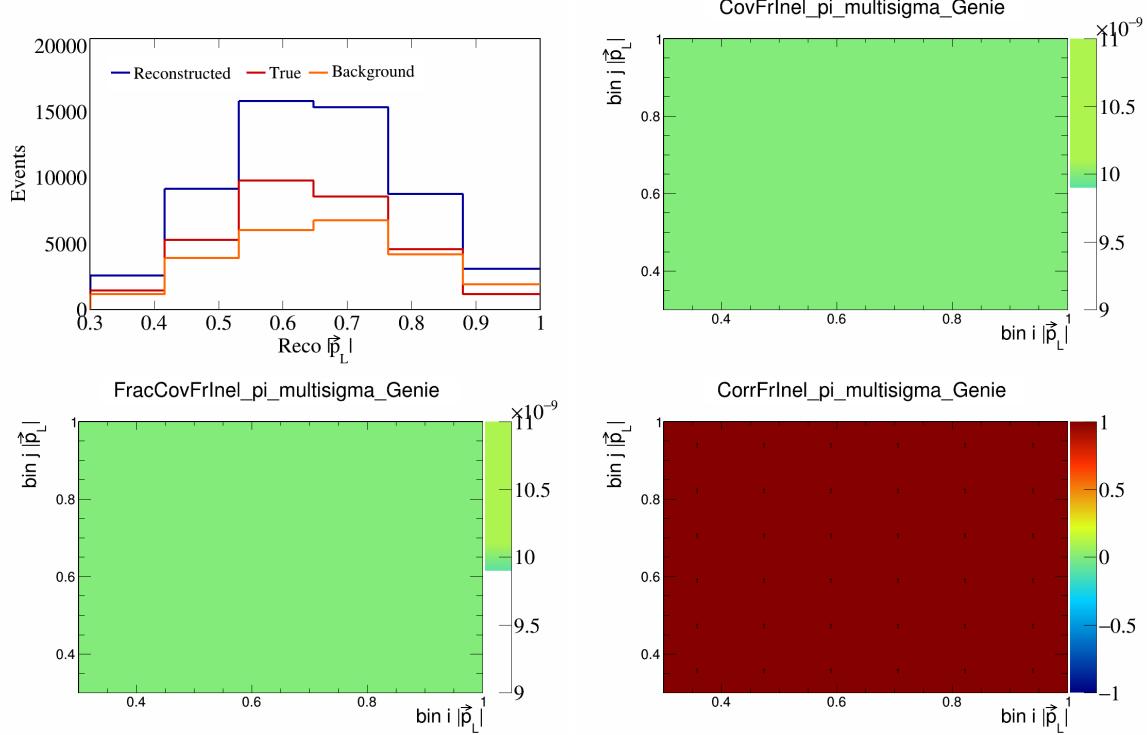


Figure 234: FrInelpi variations for $|\vec{p}_L|$.

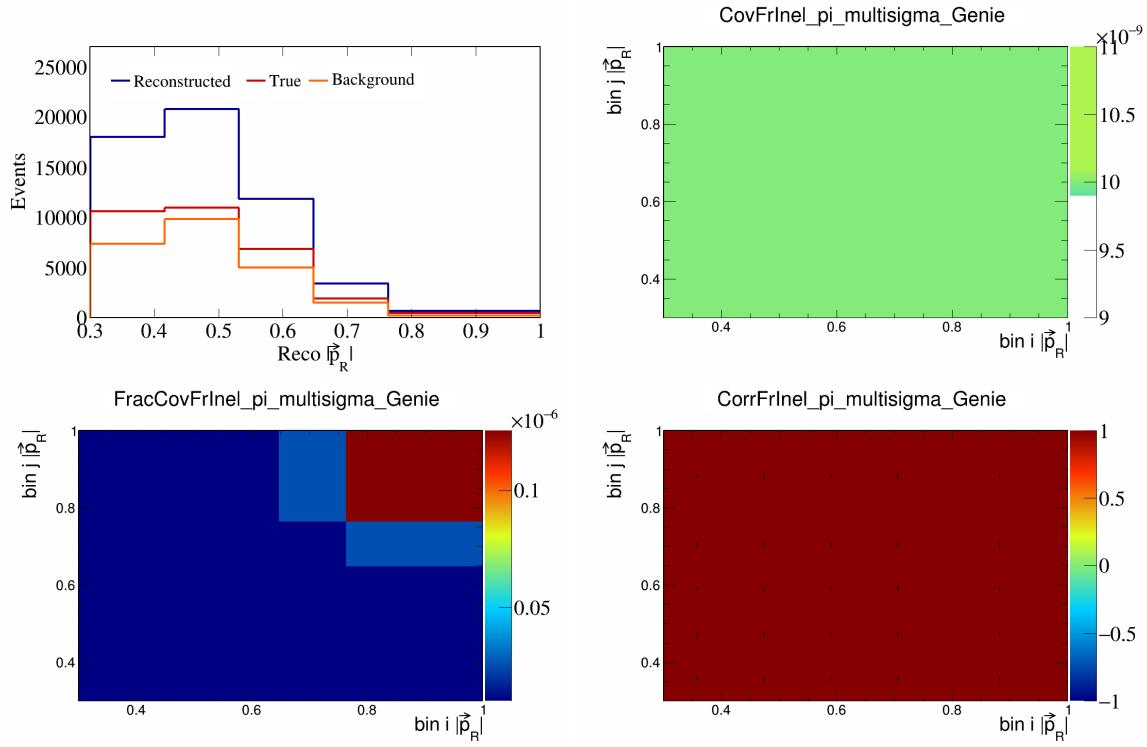


Figure 235: FrInelpi variations for $|\vec{p}_R|$.

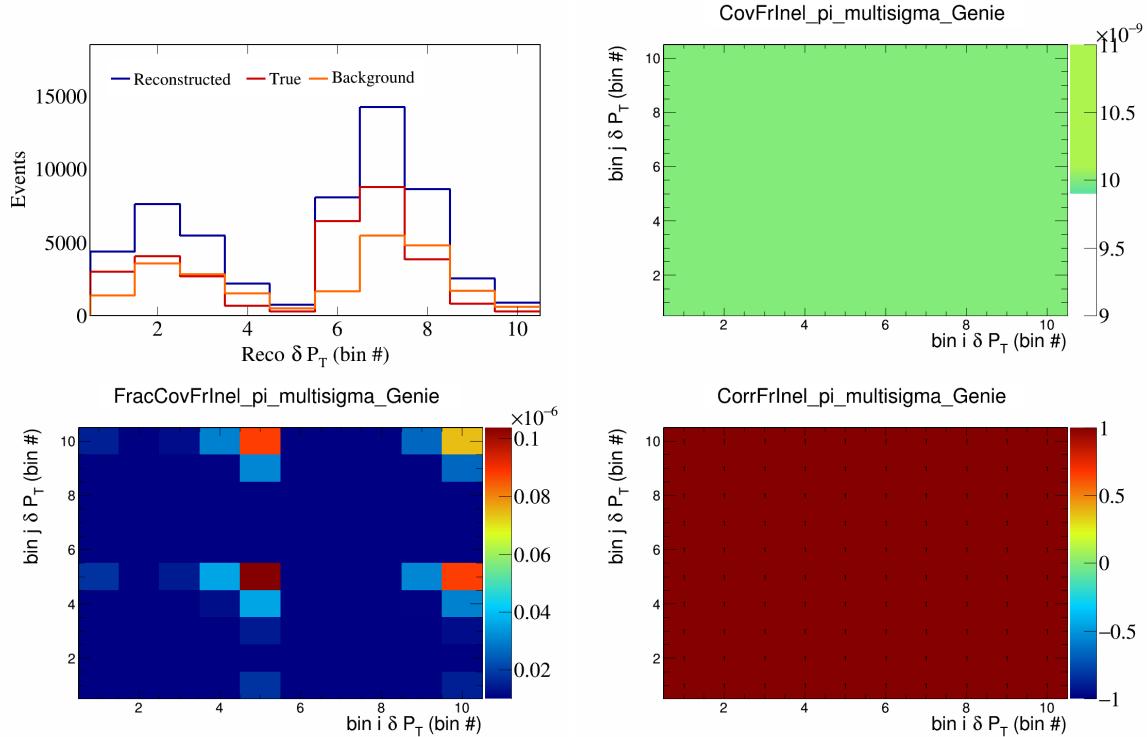


Figure 236: FrInelpi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

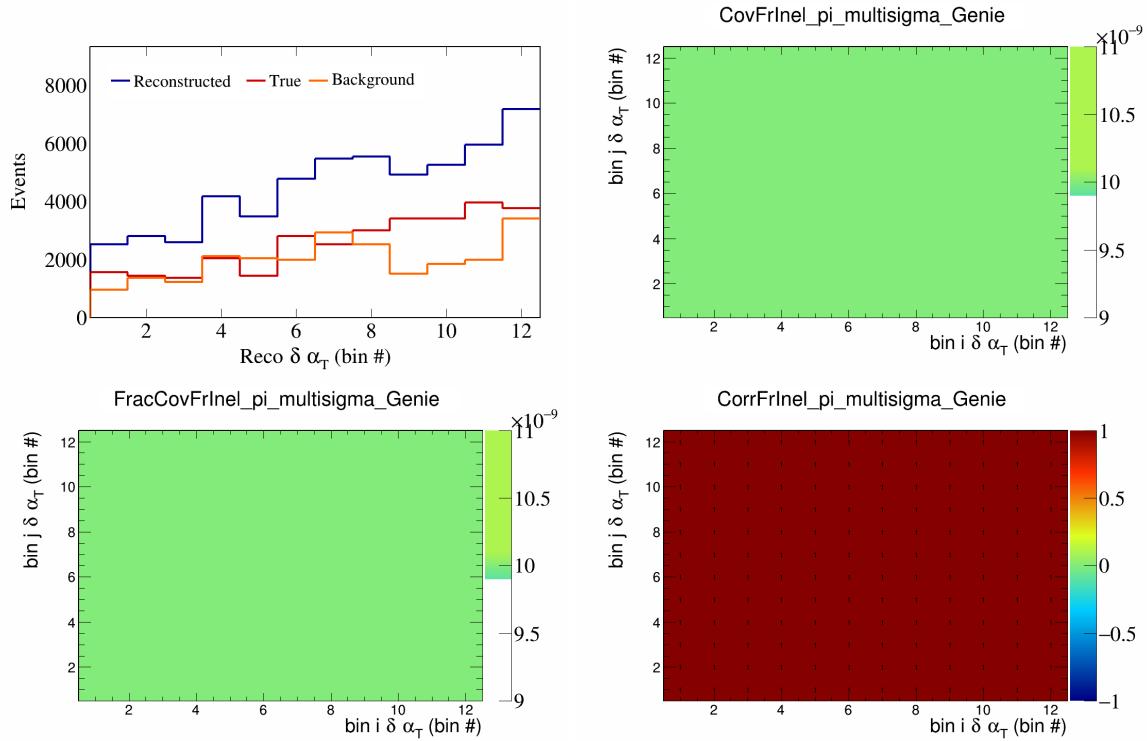


Figure 237: FrInelpi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

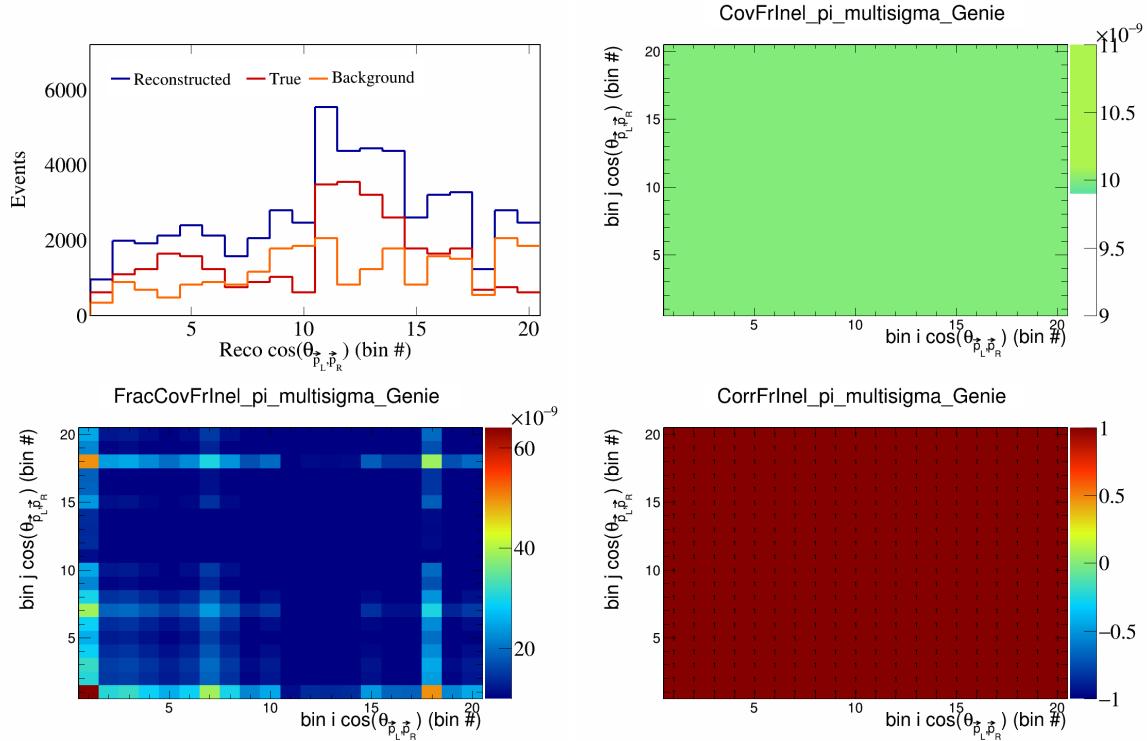


Figure 238: FrInelpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

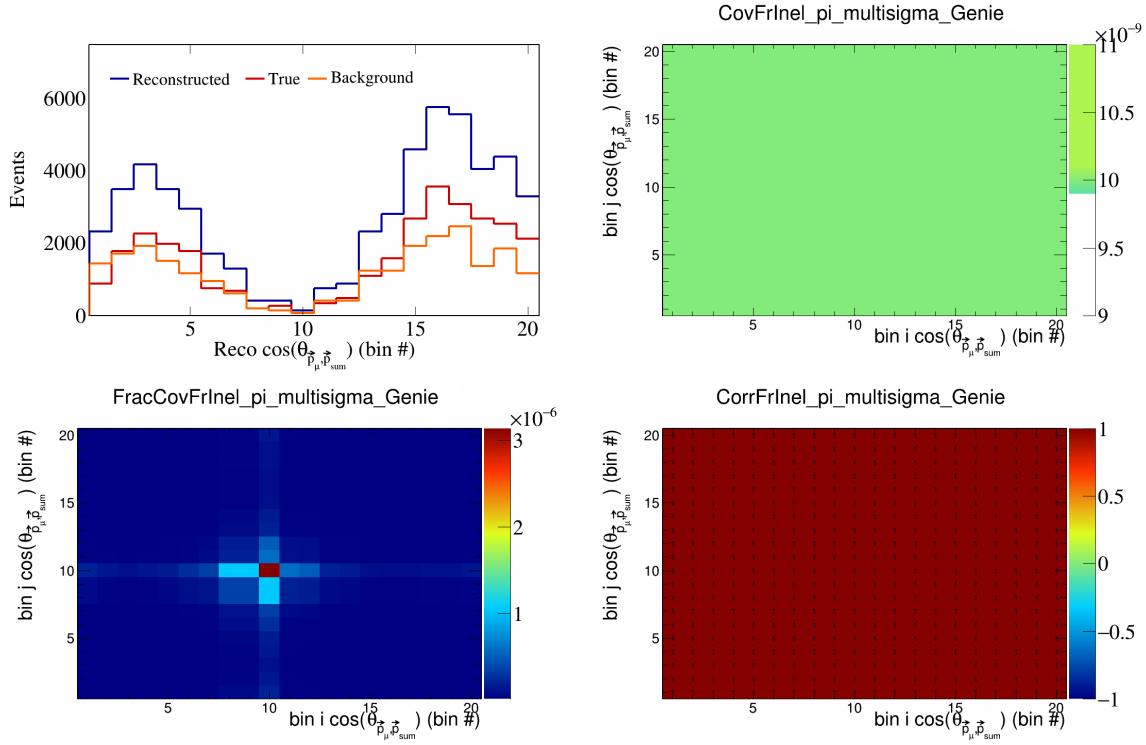


Figure 239: FrInelpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

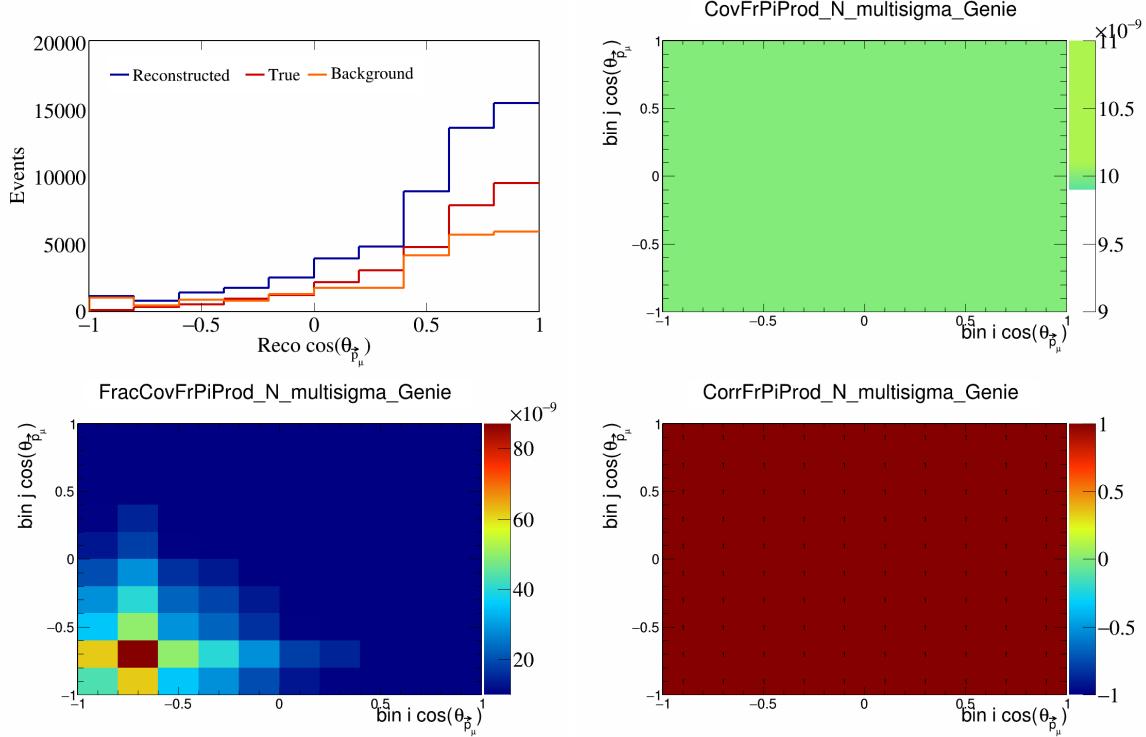


Figure 240: FrPiProdN variations for $\cos(\theta_{\vec{p}_\mu})$.

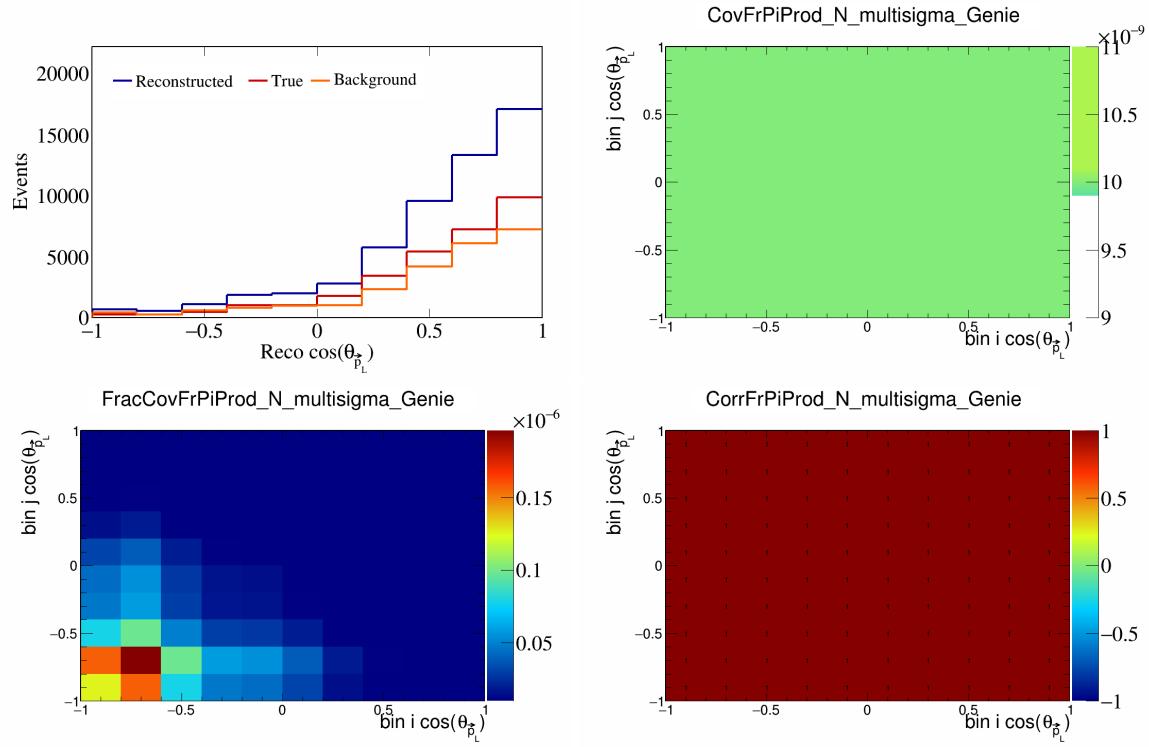


Figure 241: FrPiProdN variations for $\cos(\theta_{\vec{p}_L})$.

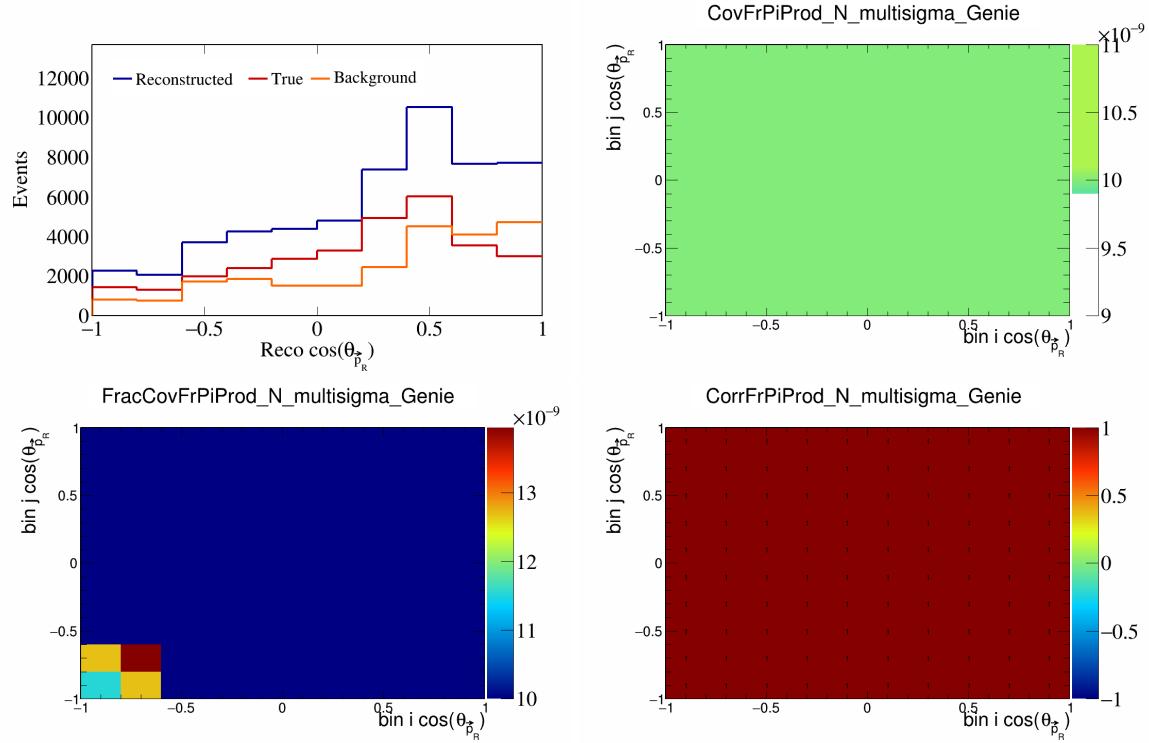


Figure 242: FrPiProdN variations for $\cos(\theta_{\vec{p}_R})$.

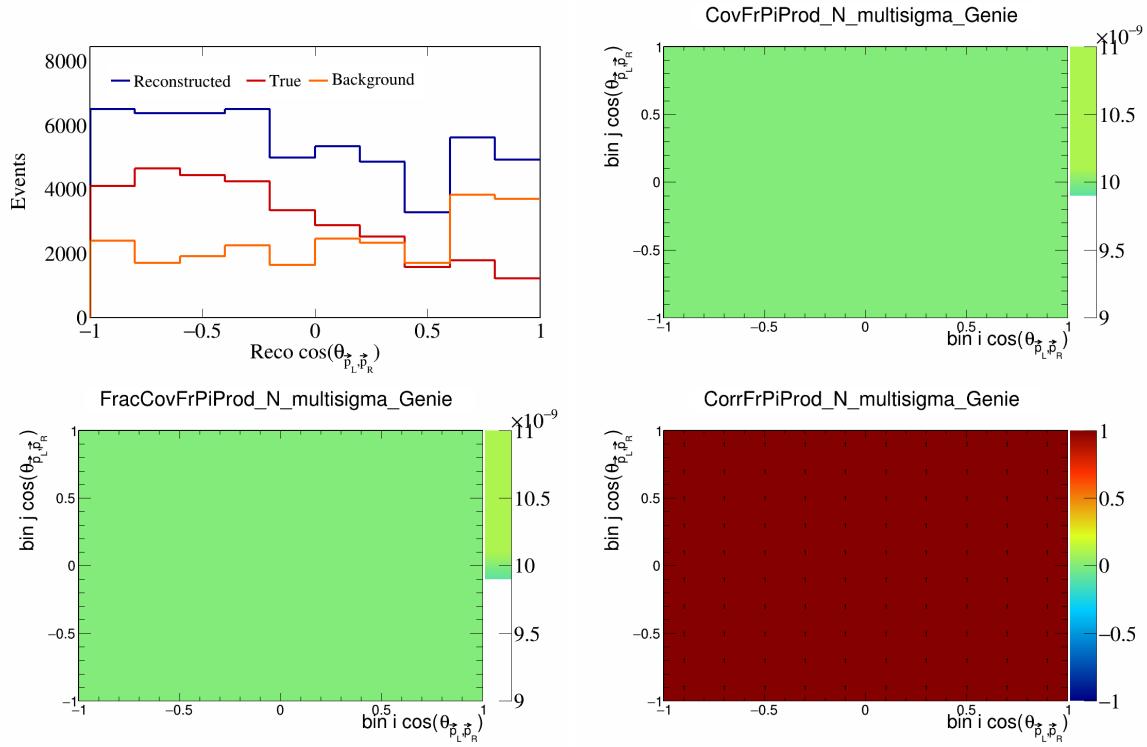


Figure 243: FrPiProdN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

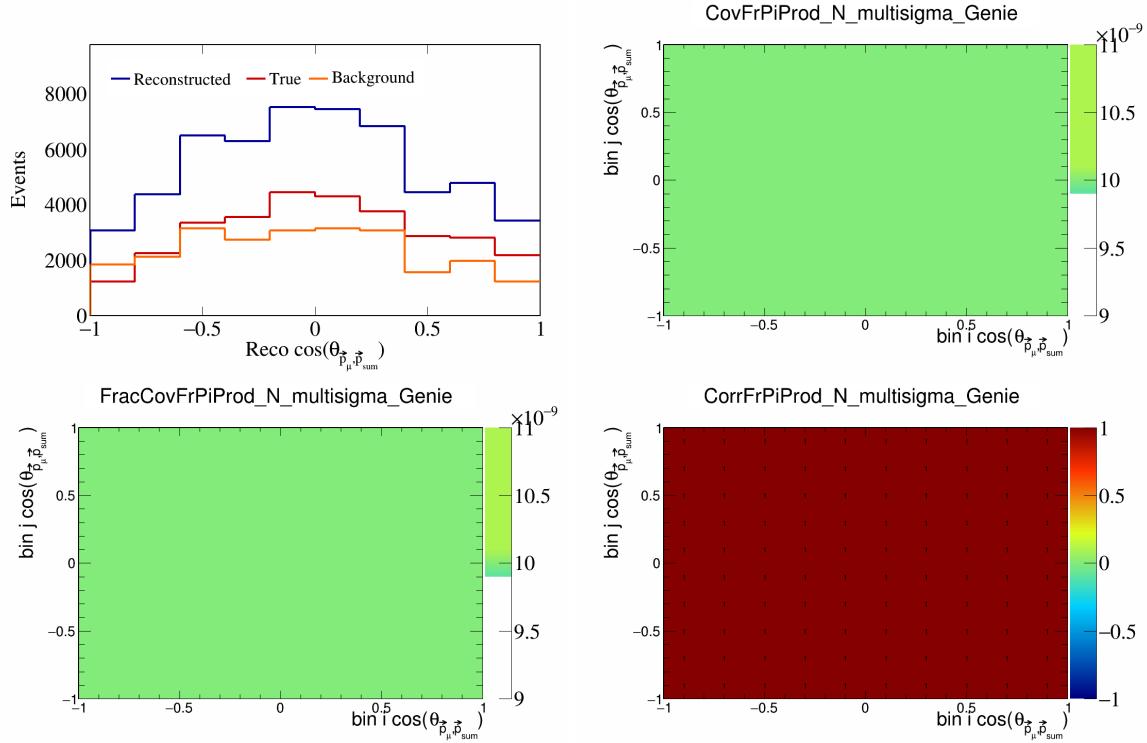


Figure 244: FrPiProdN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

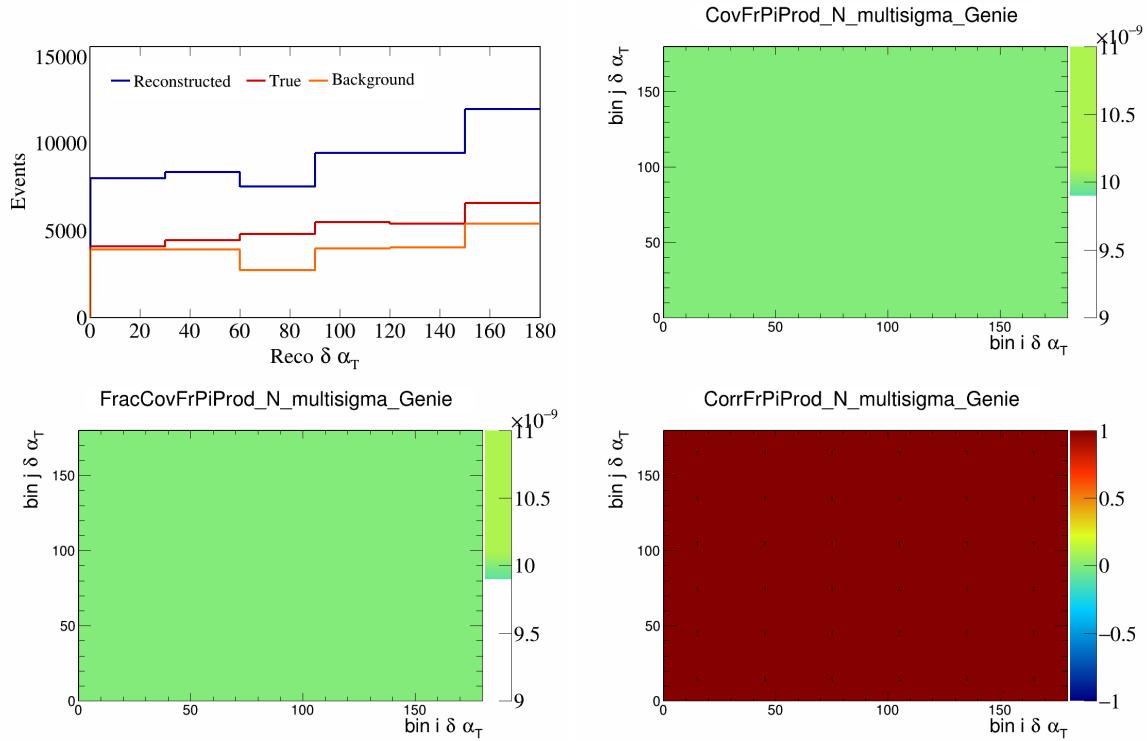


Figure 245: FrPiProdN variations for $\delta\alpha_T$.

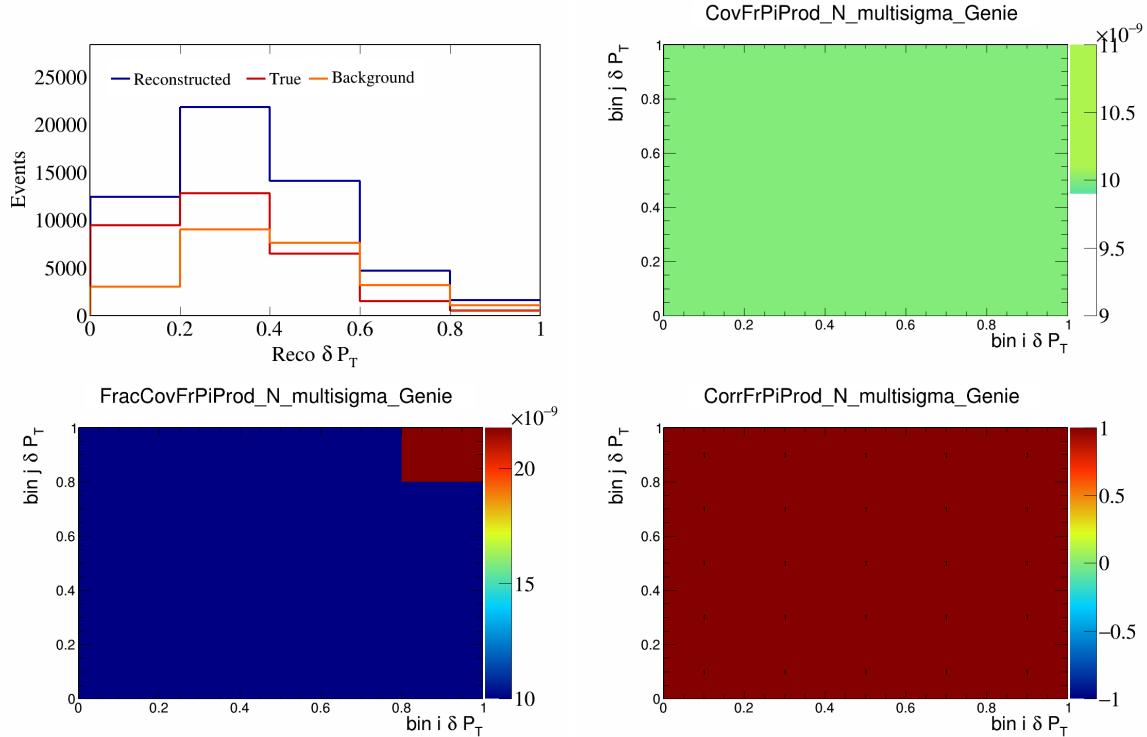


Figure 246: FrPiProdN variations for δP_T .

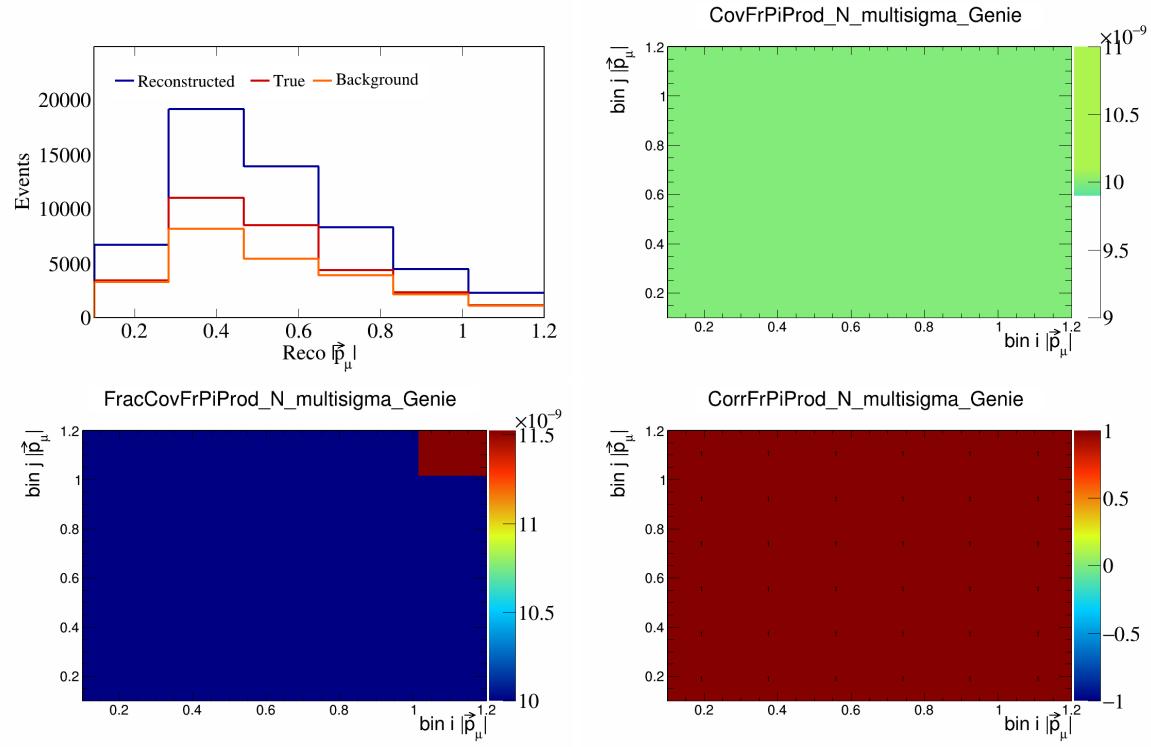


Figure 247: FrPiProdN variations for $|\vec{p}_\mu|$.

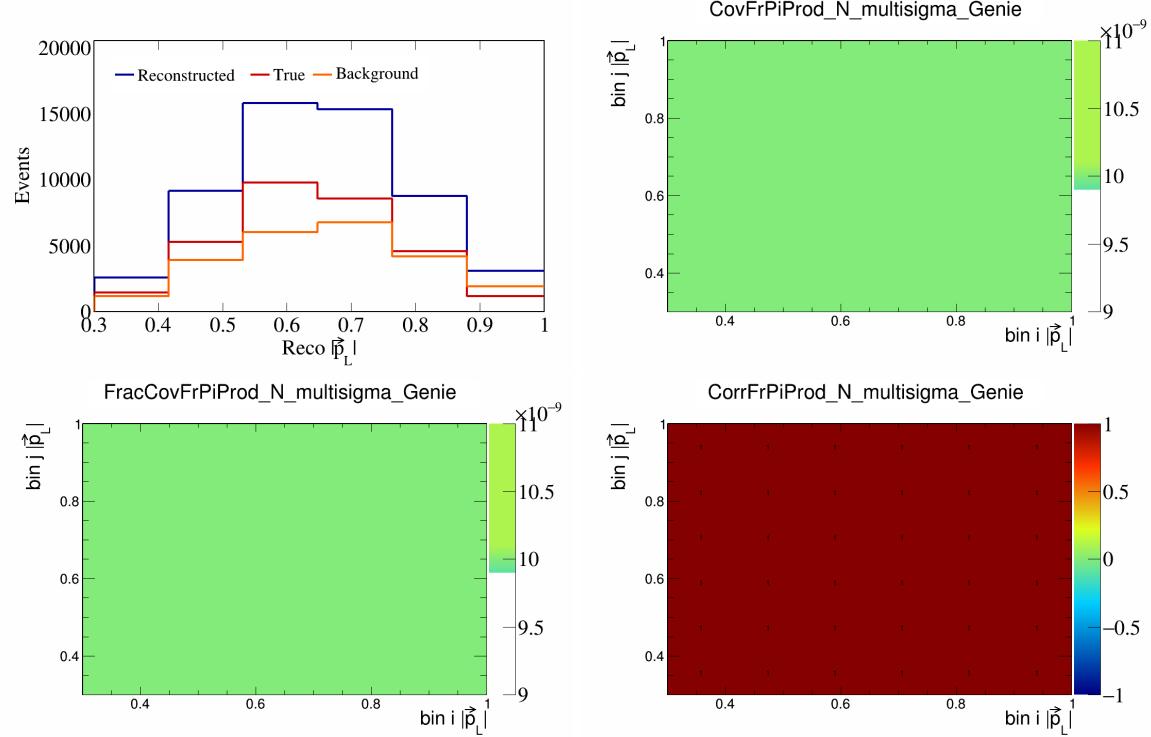


Figure 248: FrPiProdN variations for $|\vec{p}_L|$.

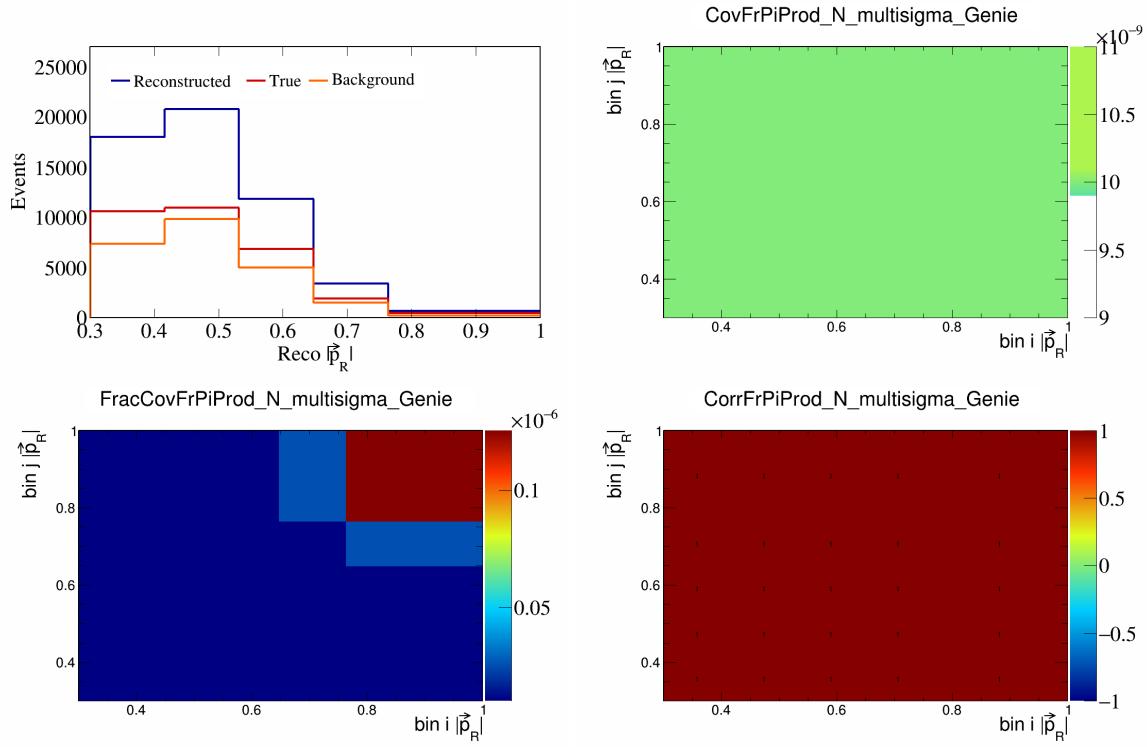


Figure 249: FrPiProdN variations for $|\vec{p}_R|$.

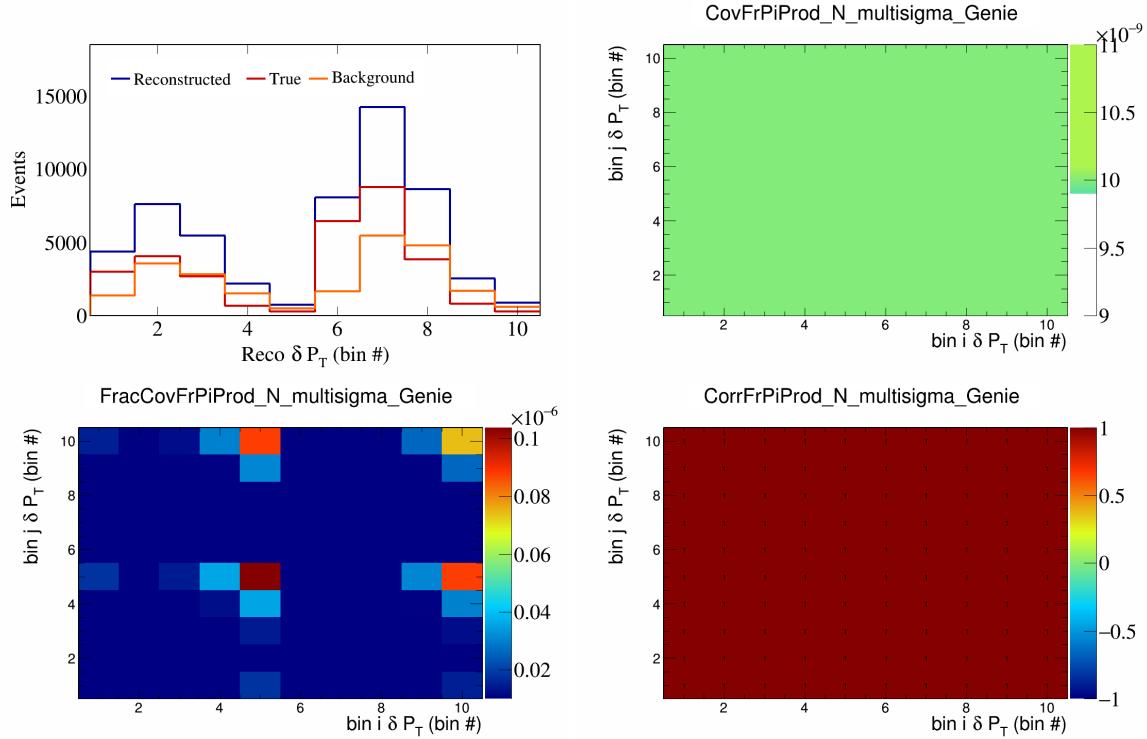


Figure 250: FrPiProdN variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

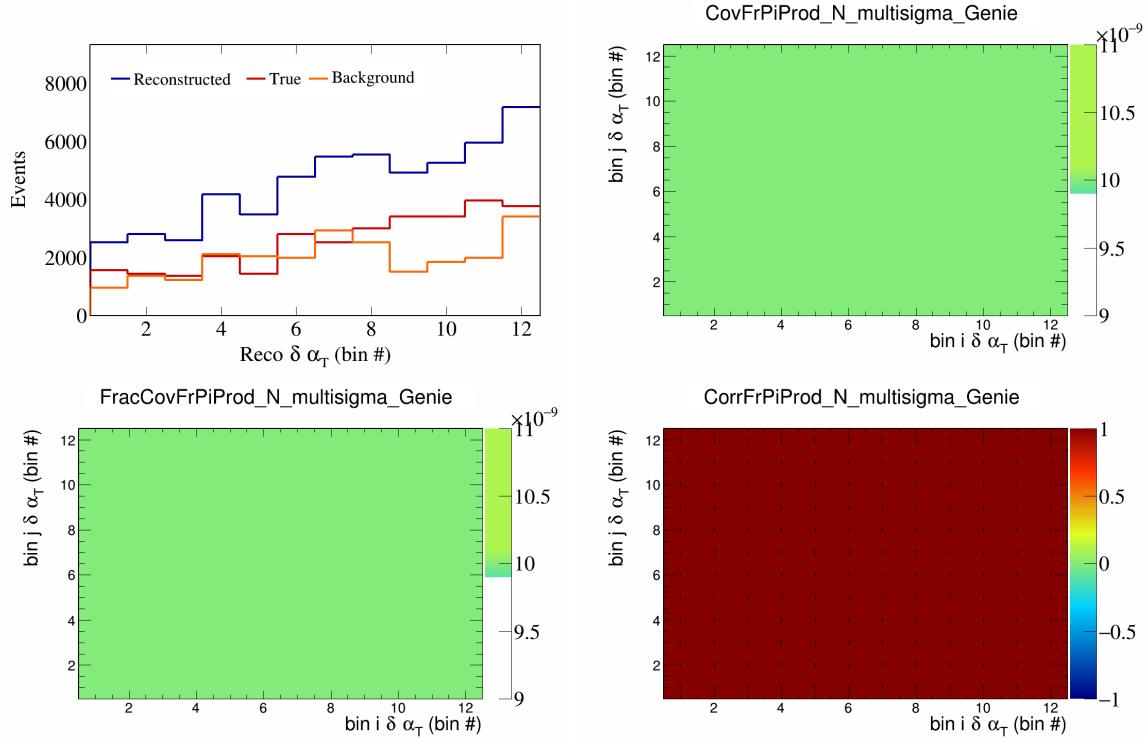


Figure 251: FrPiProdN variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

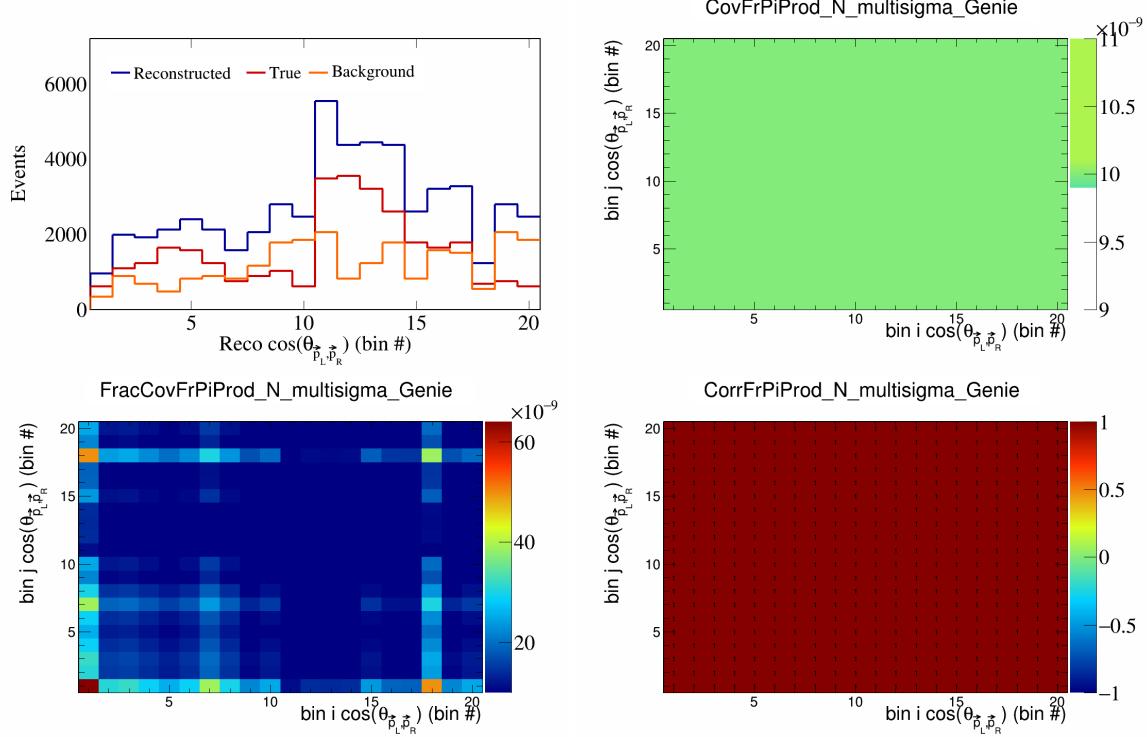


Figure 252: FrPiProdN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

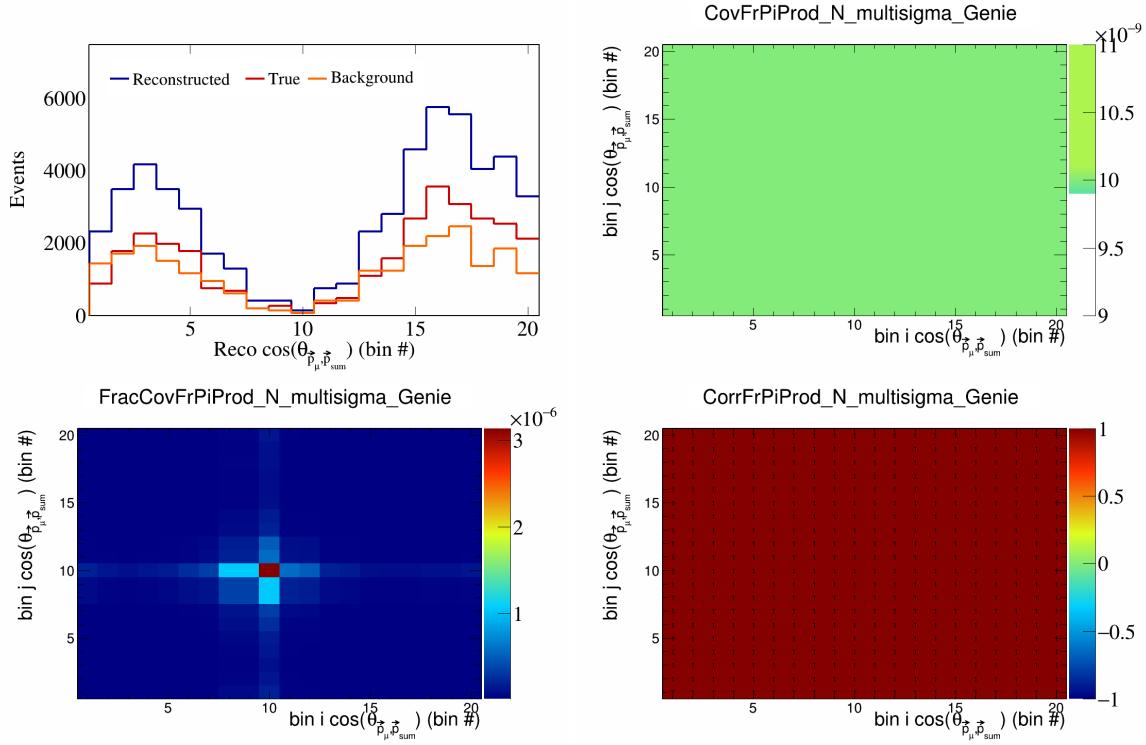


Figure 253: FrPiProdN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

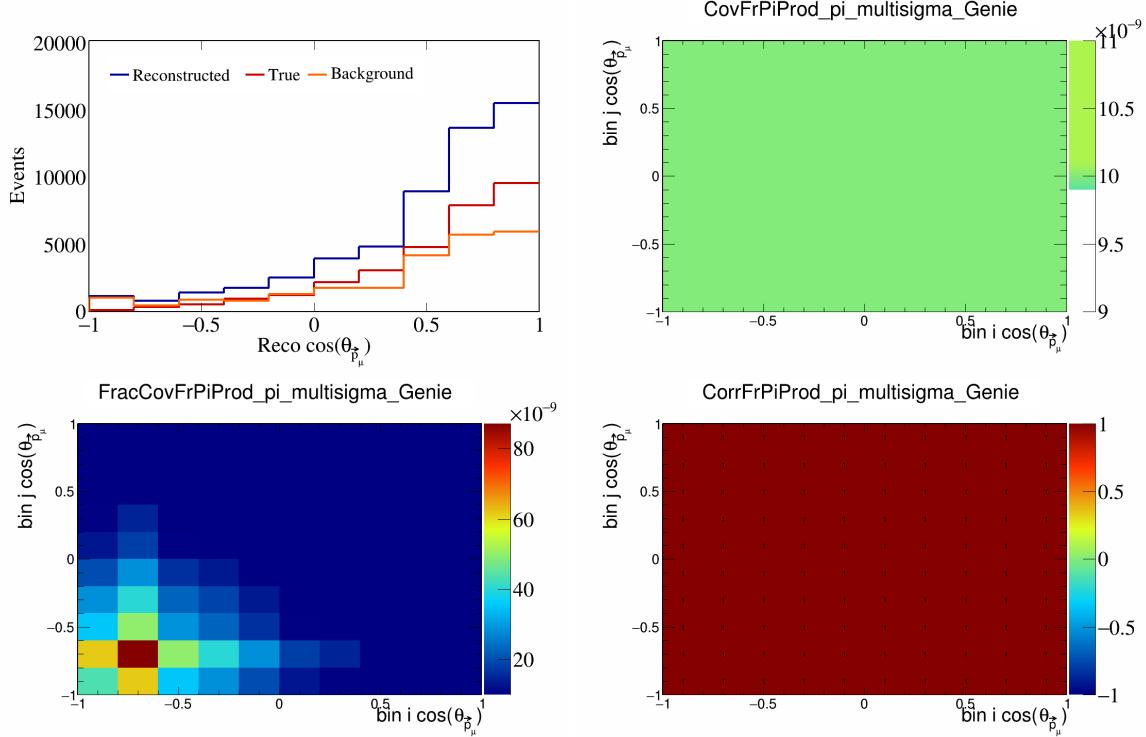


Figure 254: FrPiProdpi variations for $\cos(\theta_{\vec{p}_\mu})$.

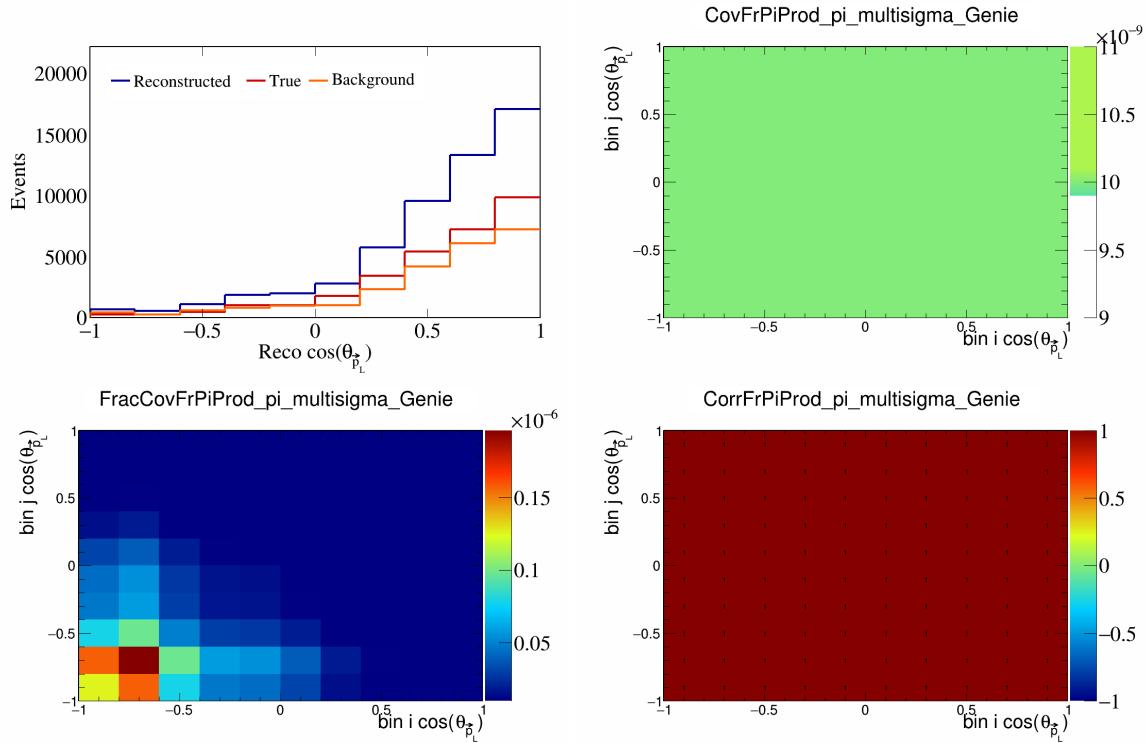


Figure 255: FrPiProdpi variations for $\cos(\theta_{\vec{p}_L})$.

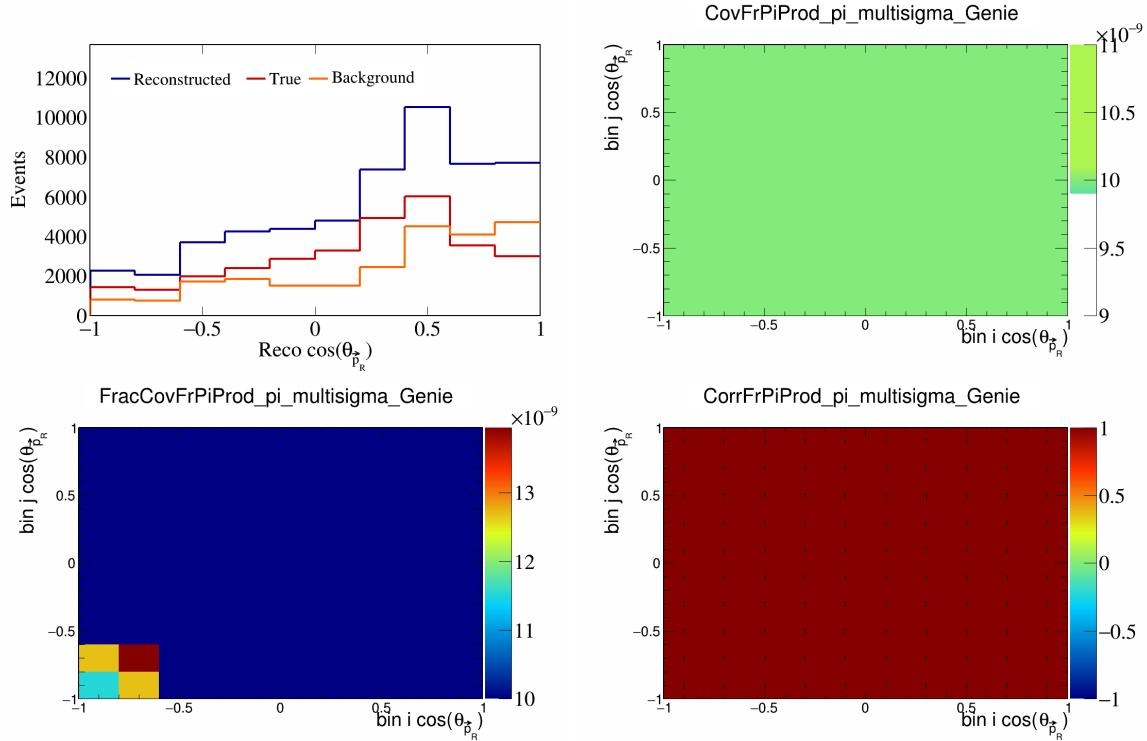


Figure 256: FrPiProdpi variations for $\cos(\theta_{\vec{p}_R})$.

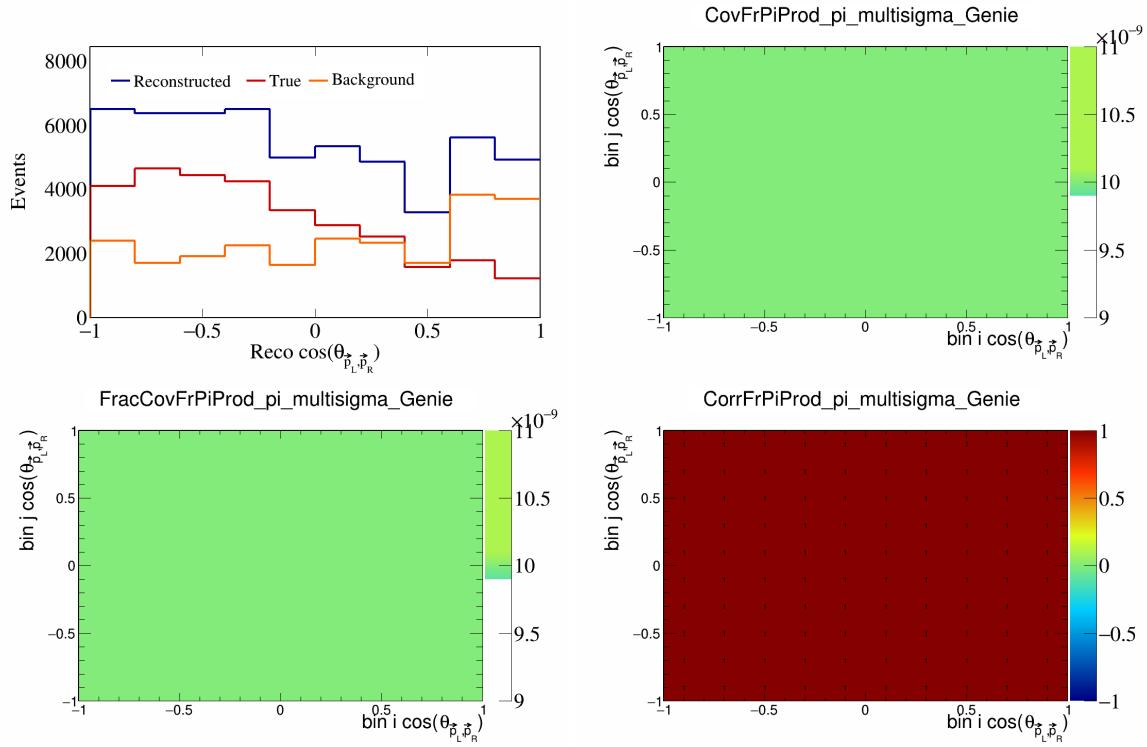


Figure 257: FrPiProdpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

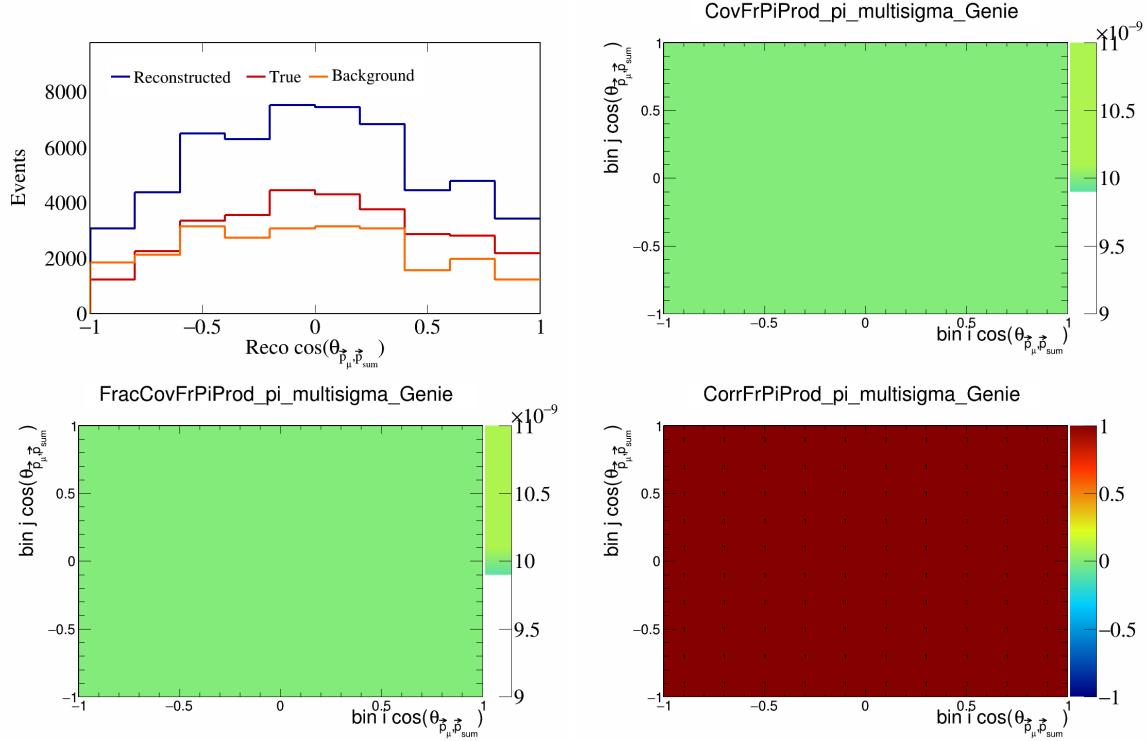


Figure 258: FrPiProdpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

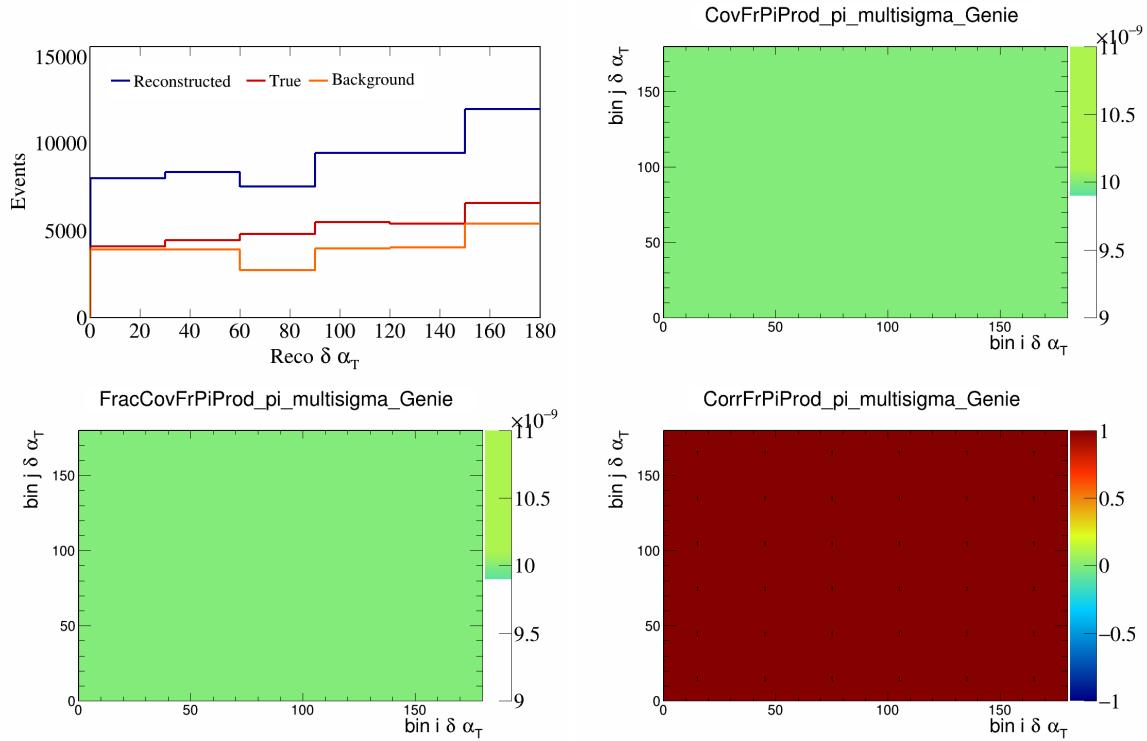


Figure 259: FrPiProdpi variations for $\delta\alpha_T$.

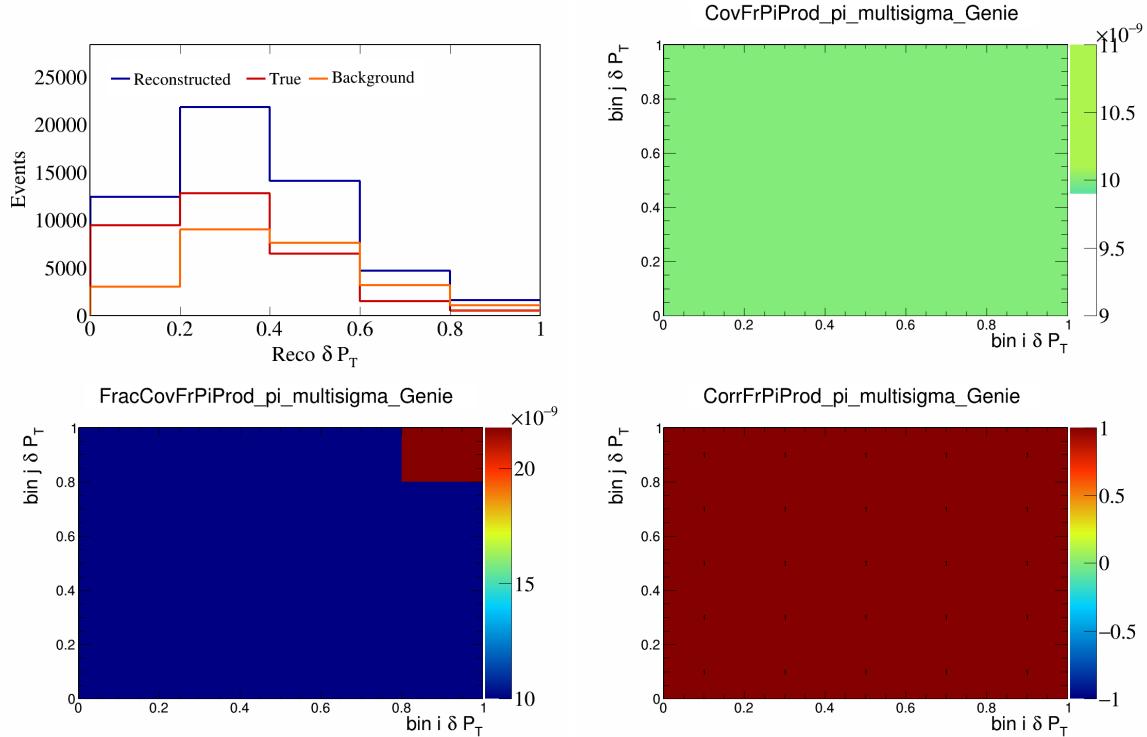


Figure 260: FrPiProdpi variations for δP_T .

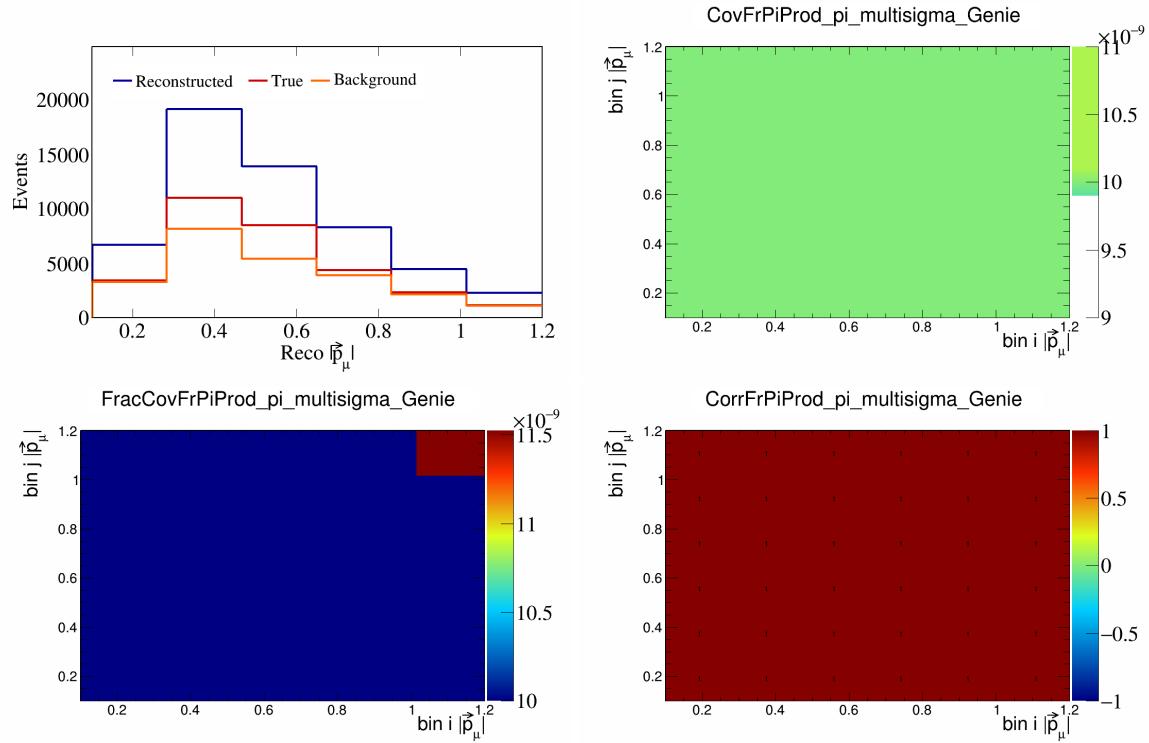


Figure 261: FrPiProdpi variations for $|\vec{p}_\mu|$.

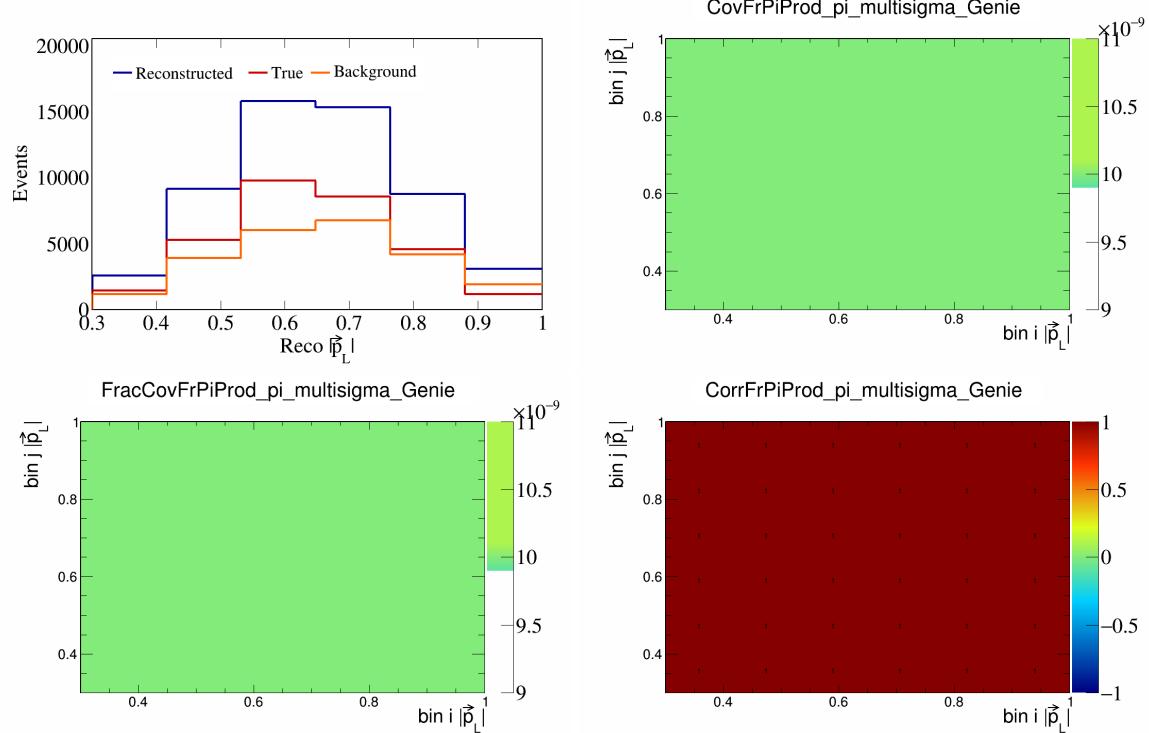


Figure 262: FrPiProdpi variations for $|\vec{p}_L|$.

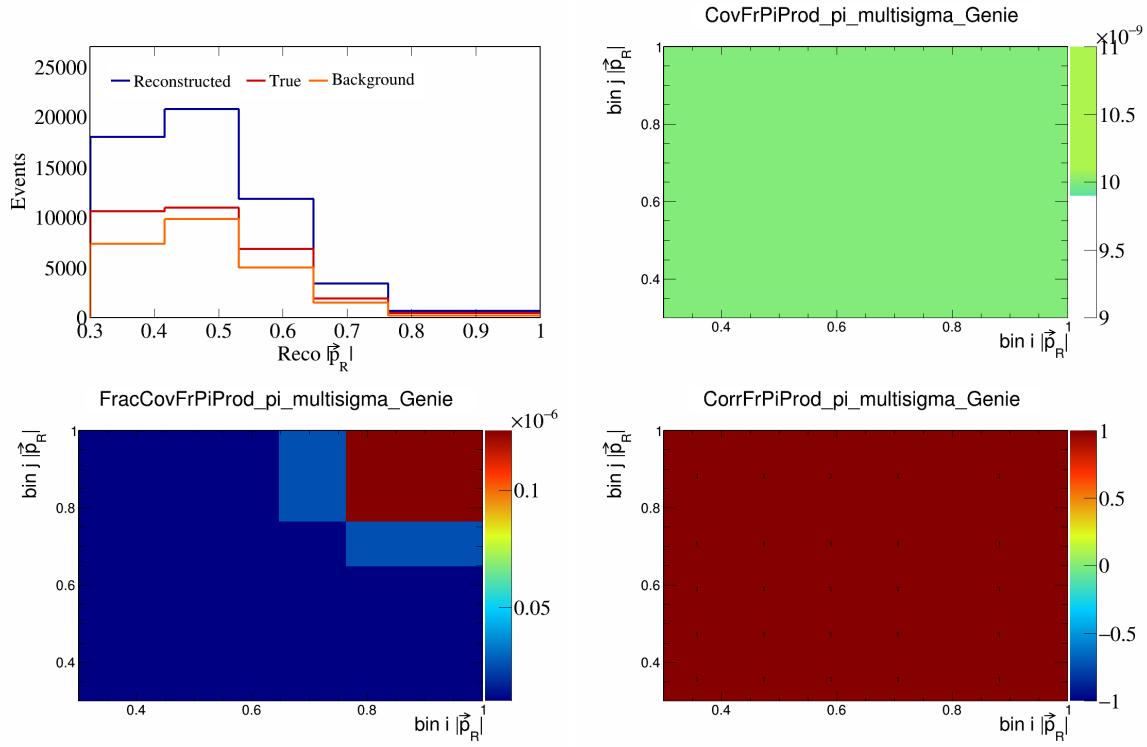


Figure 263: FrPiProdpi variations for $|\vec{p}_R|$.

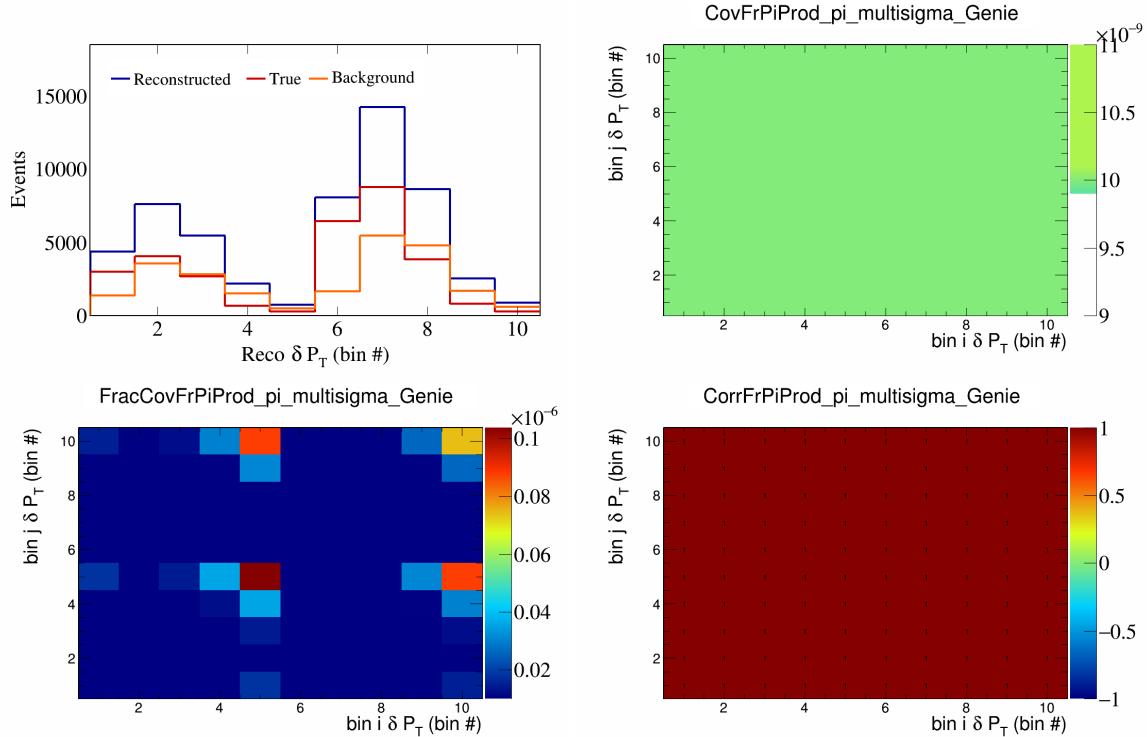


Figure 264: FrPiProdpi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

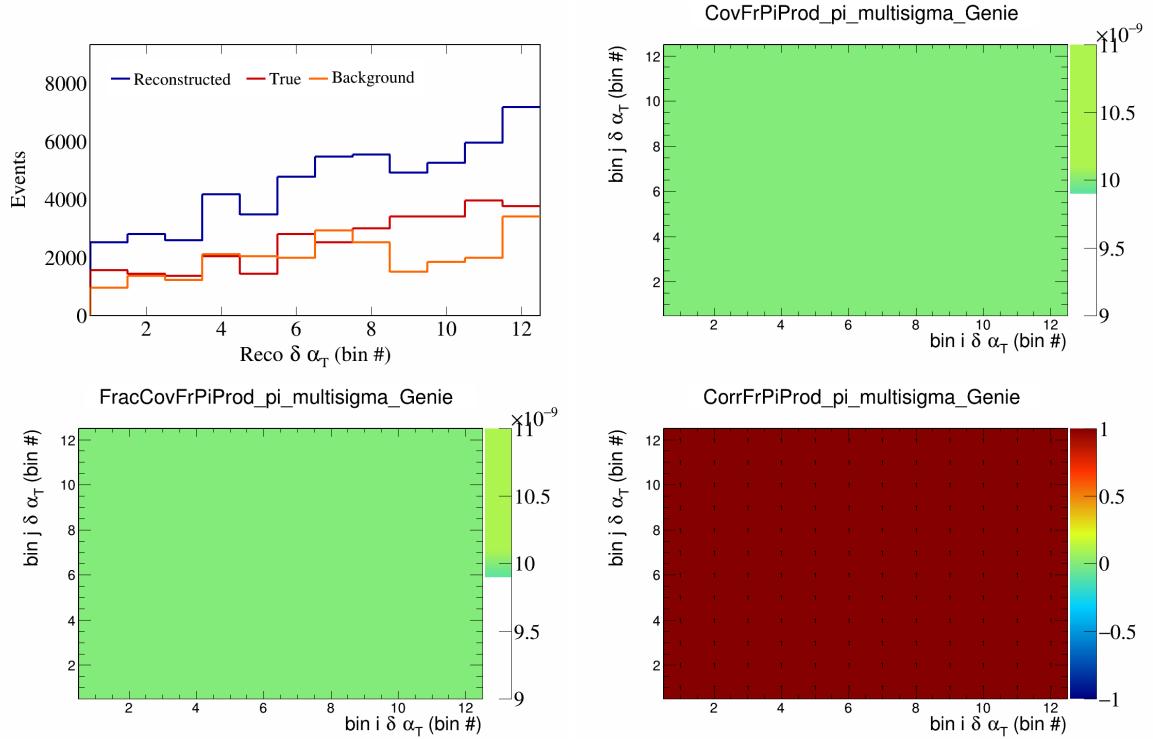


Figure 265: FrPiProdpi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

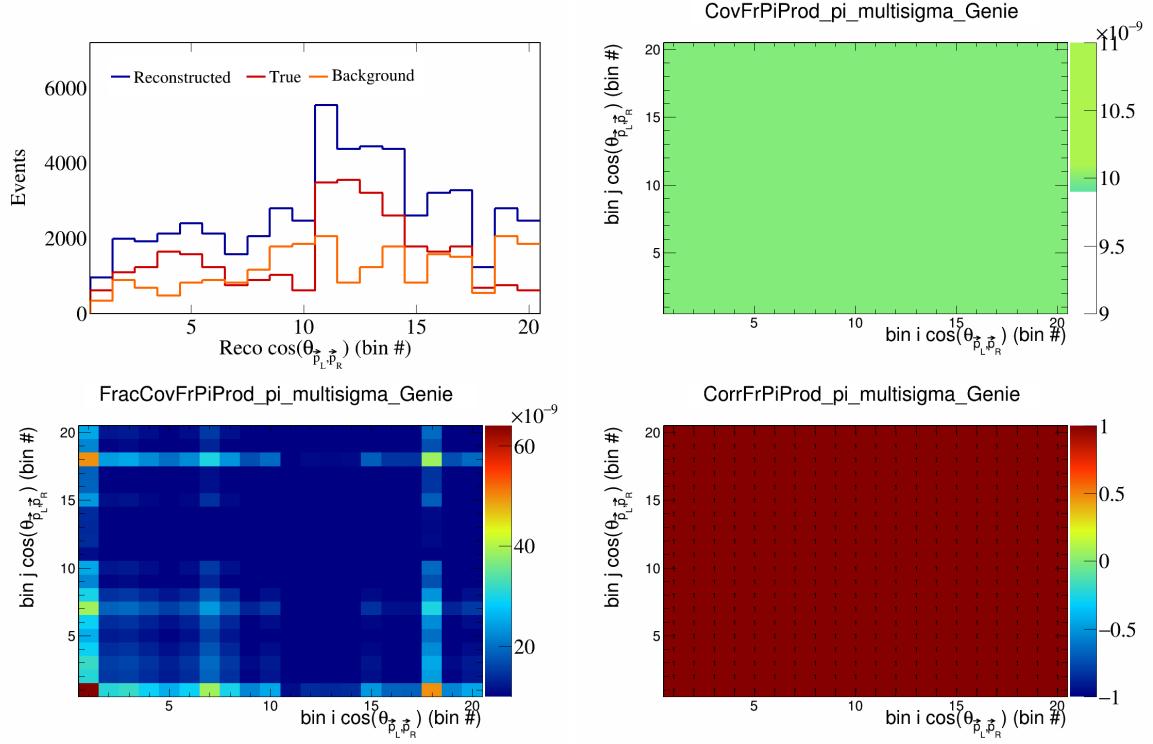


Figure 266: FrPiProdpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

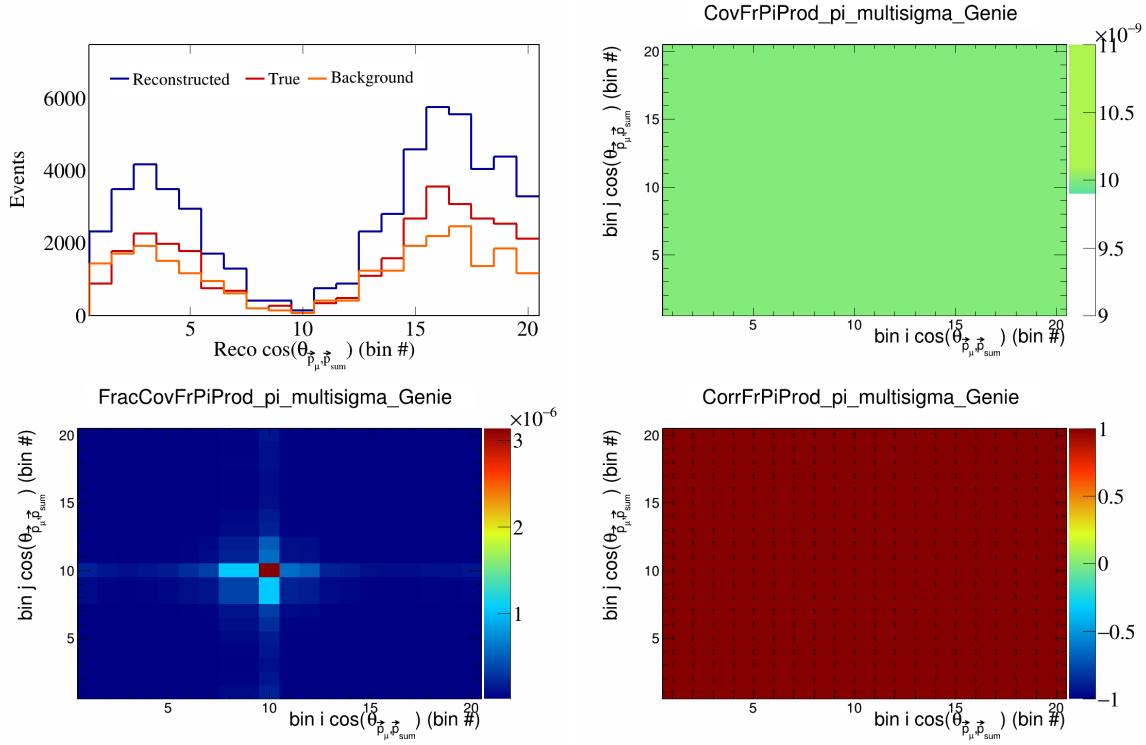


Figure 267: FrPiProdpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

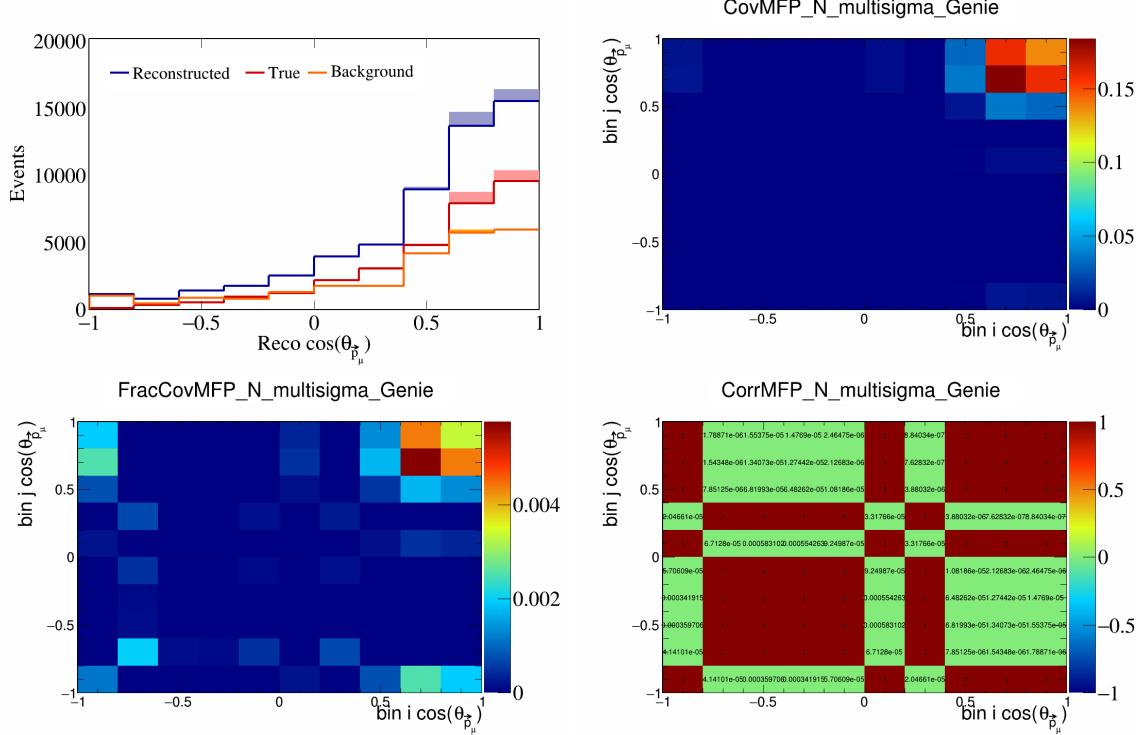


Figure 268: MFPN variations for $\cos(\theta_{\vec{p}_\mu})$.

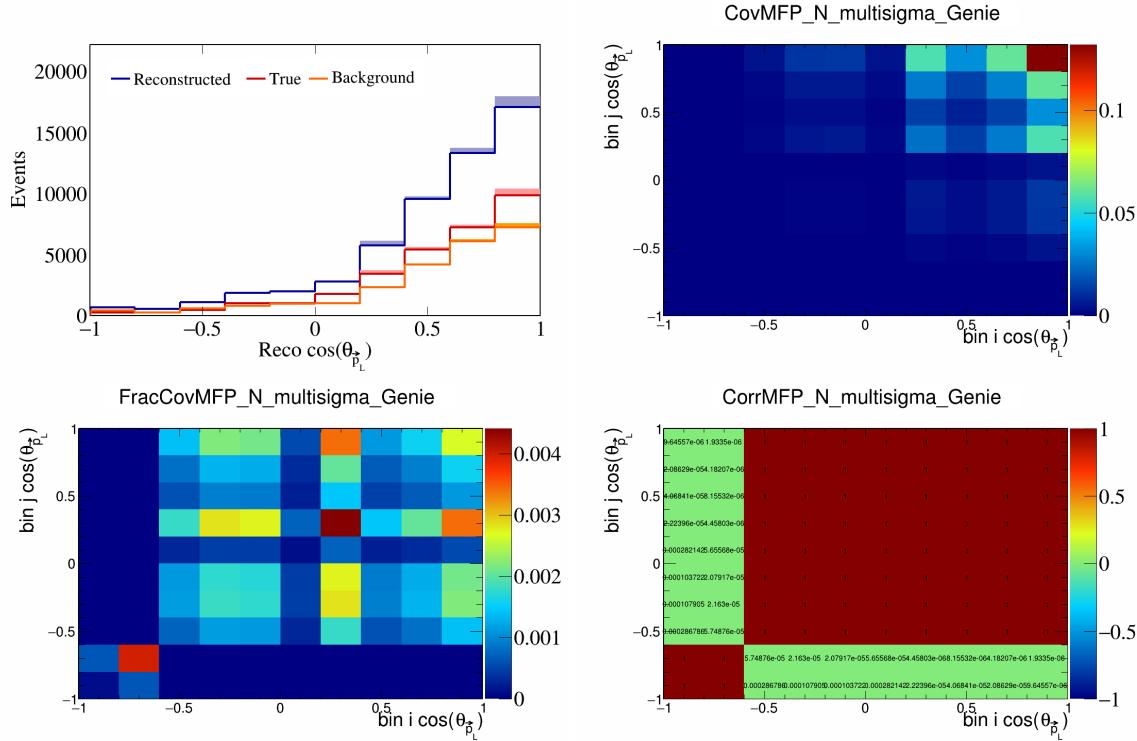


Figure 269: MFPN variations for $\cos(\theta_{\vec{p}_L})$.

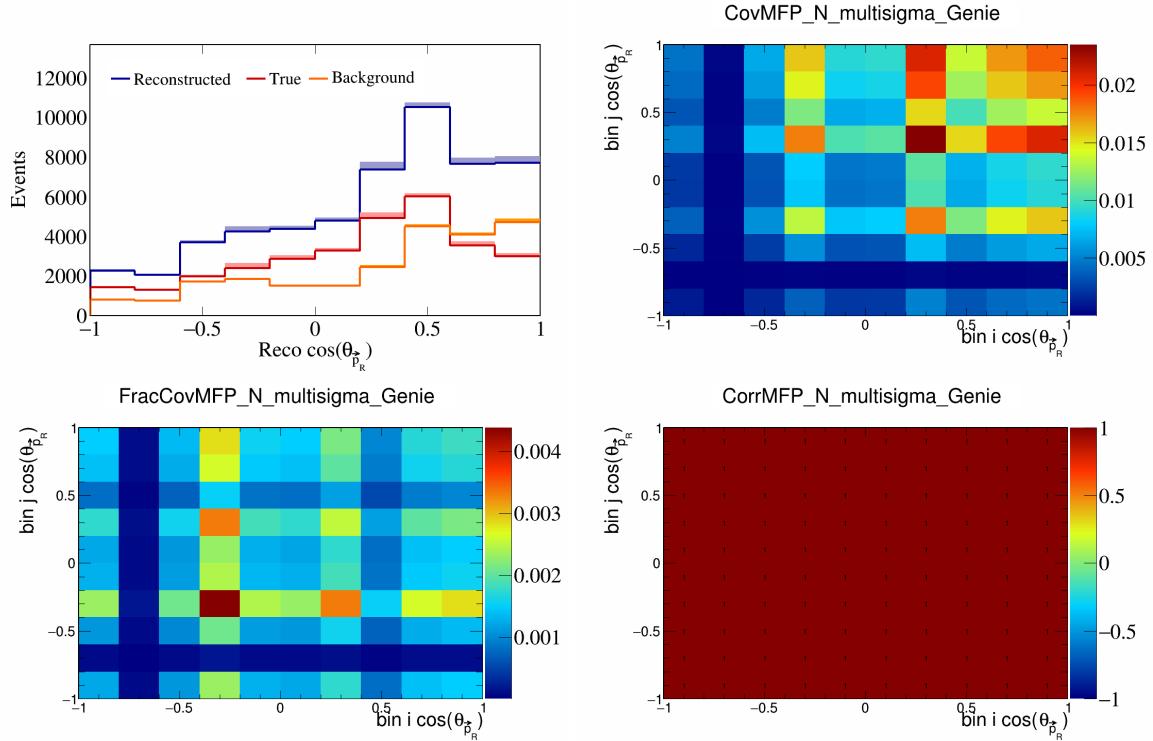


Figure 270: MFPN variations for $\cos(\theta_{\vec{p}_R})$.

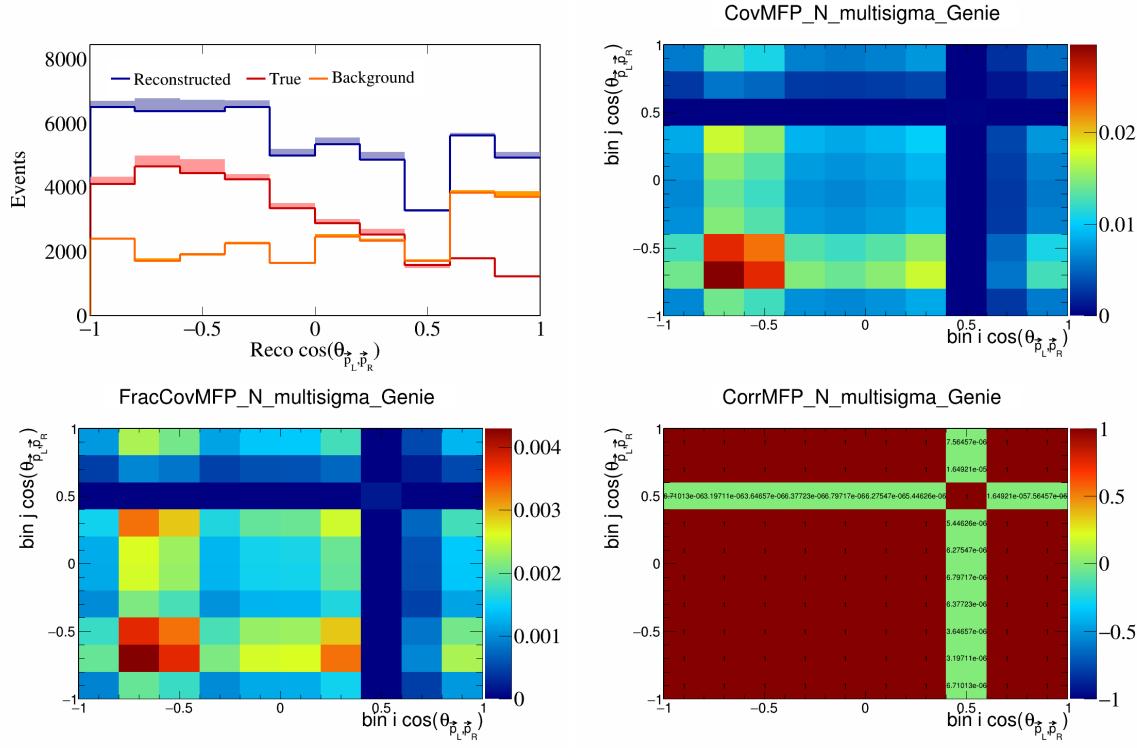


Figure 271: MFPN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

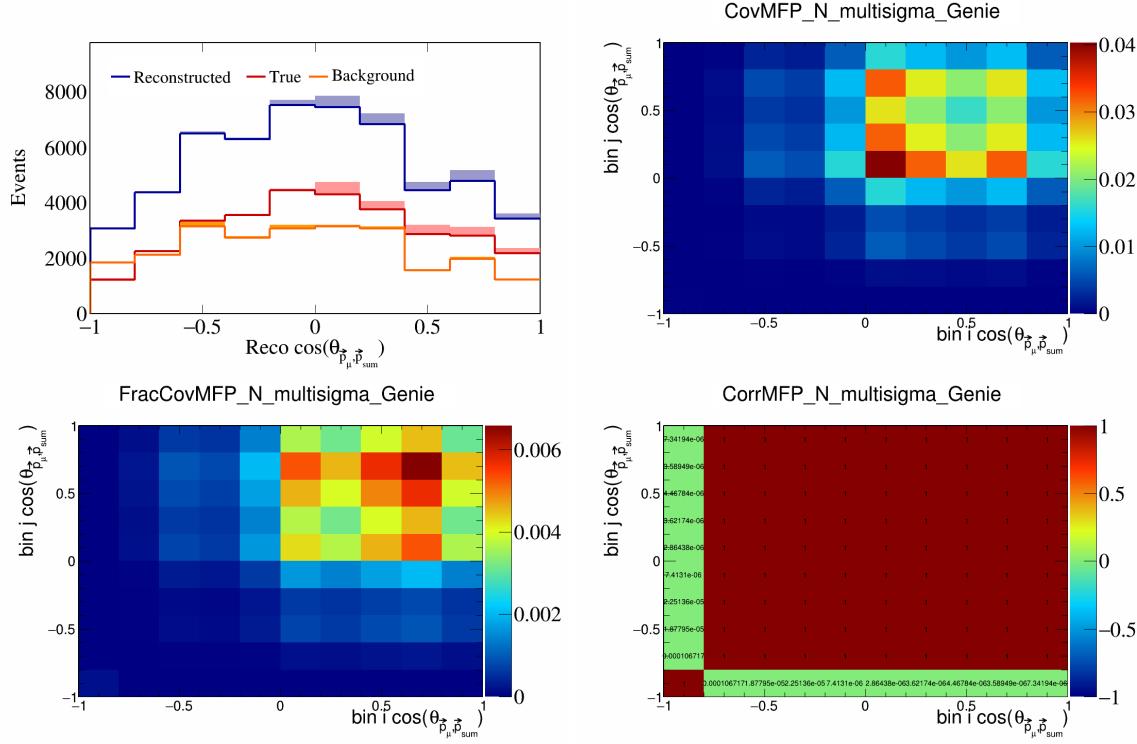


Figure 272: MFPN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

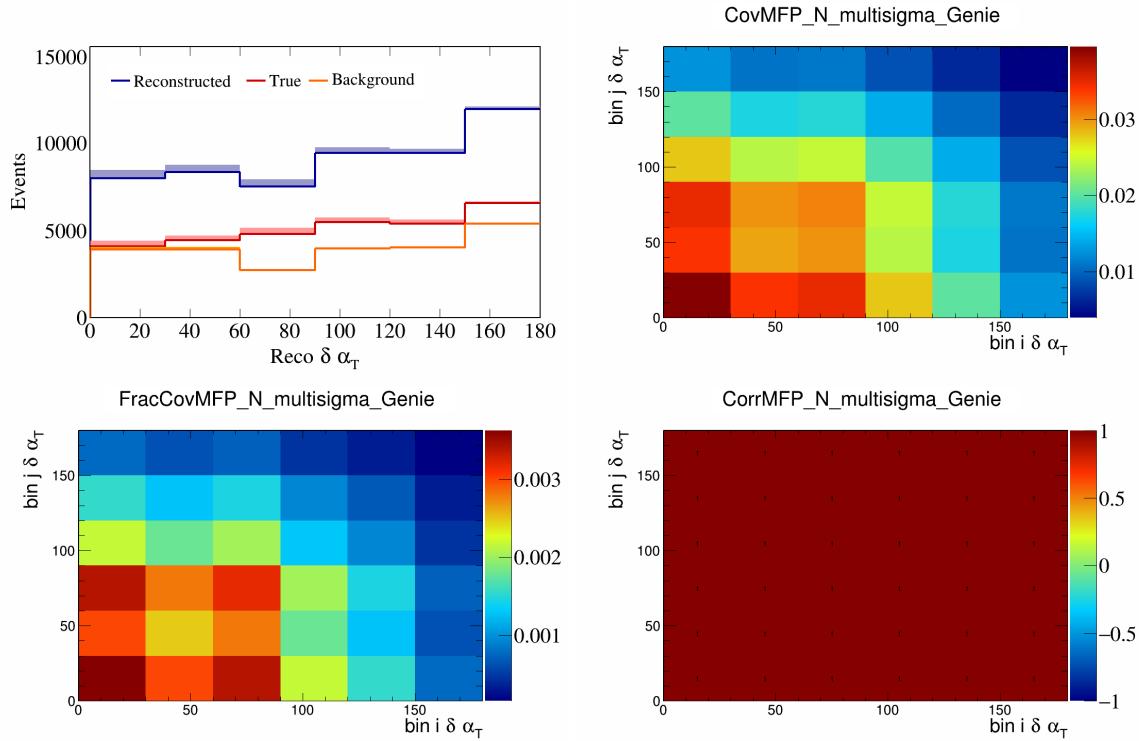


Figure 273: MFPN variations for $\delta\alpha_T$.

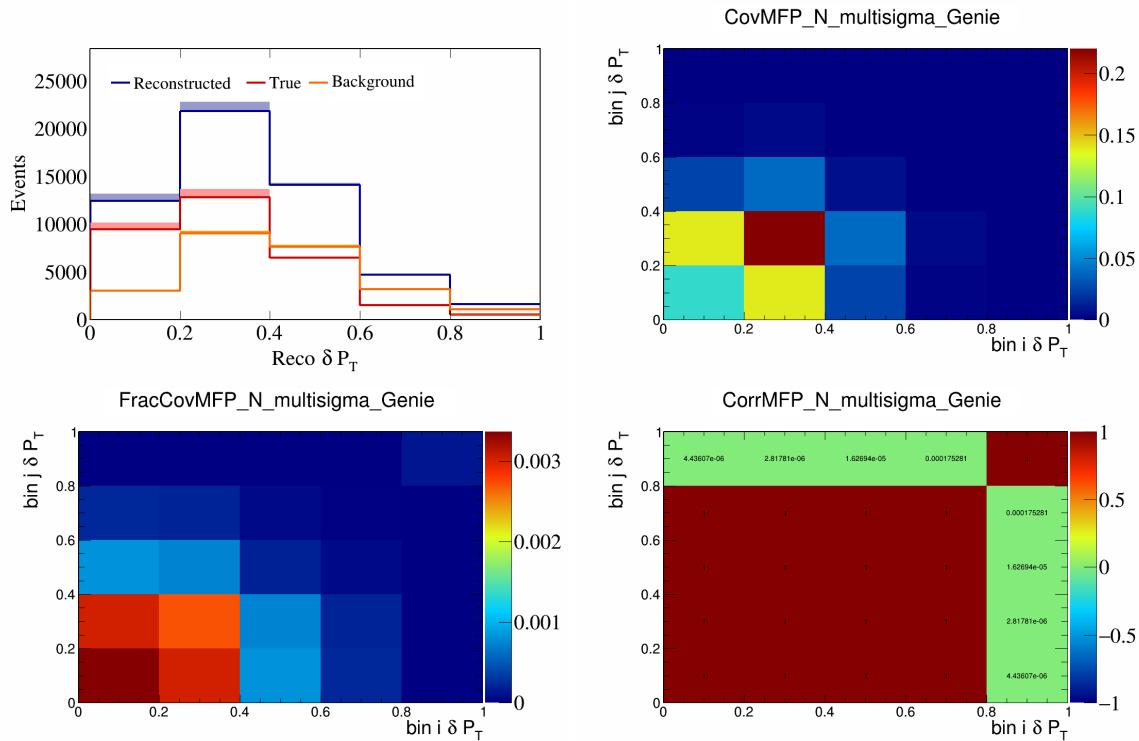


Figure 274: MFPN variations for δP_T .

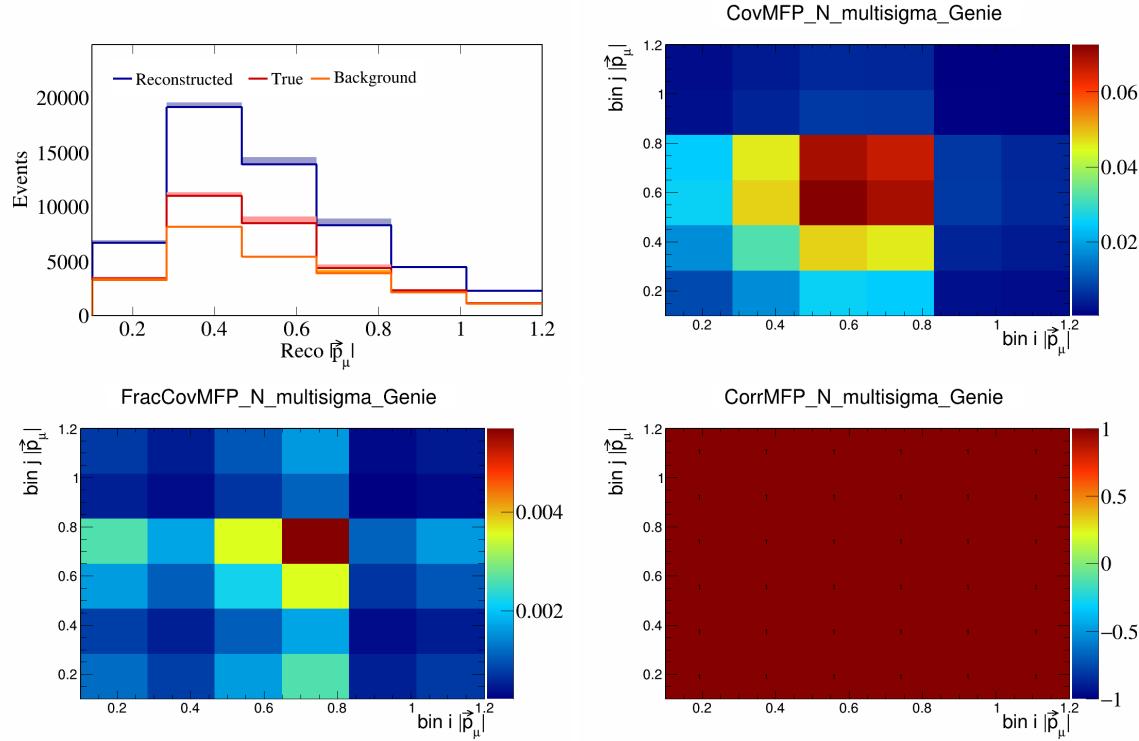


Figure 275: MFPN variations for $|\vec{p}_\mu|$.

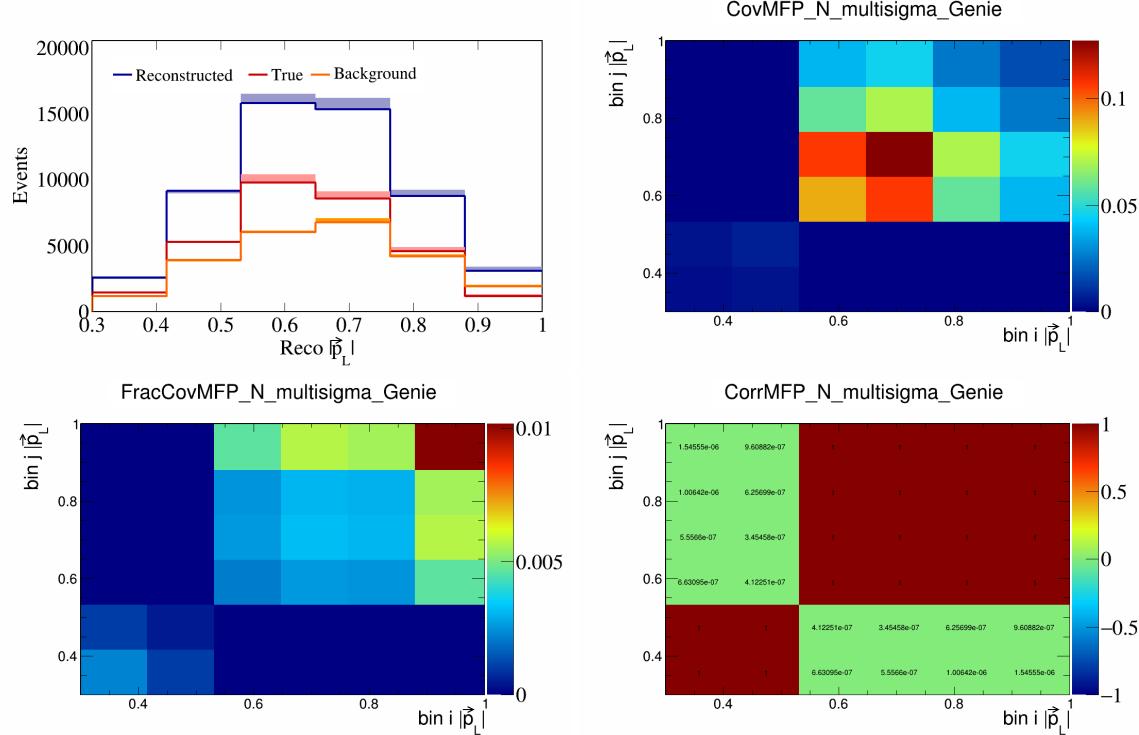


Figure 276: MFPN variations for $|\vec{p}_L|$.

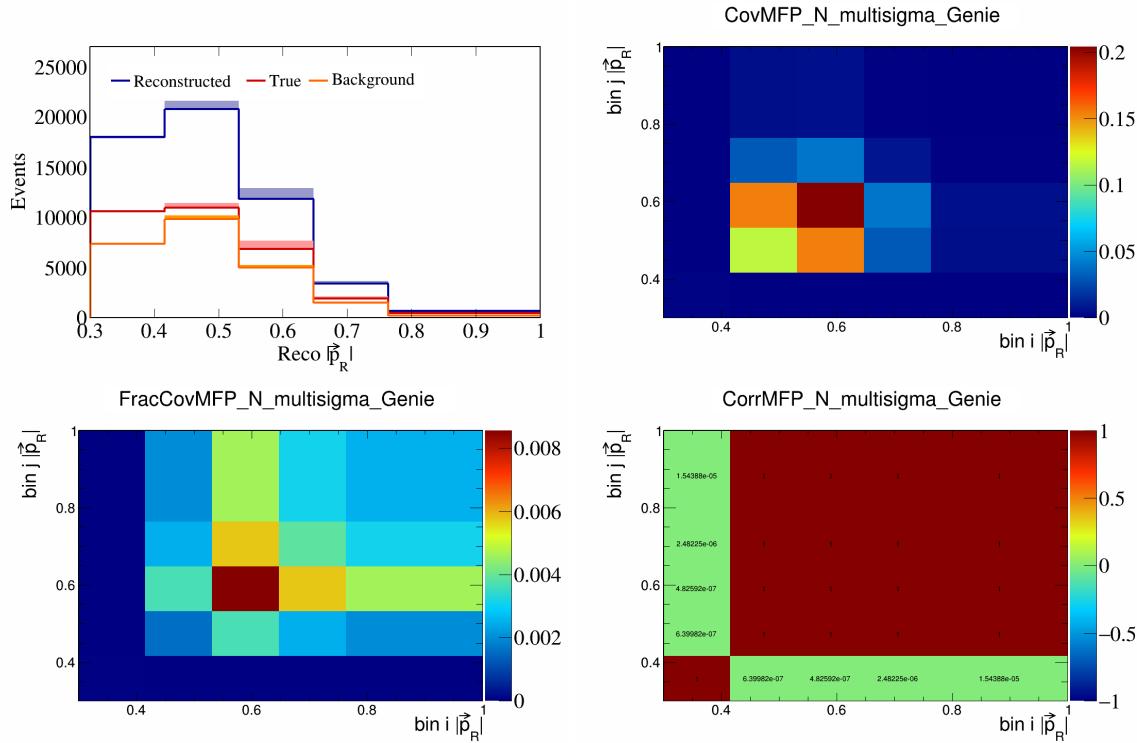


Figure 277: MFPN variations for $|\vec{p}_R|$.

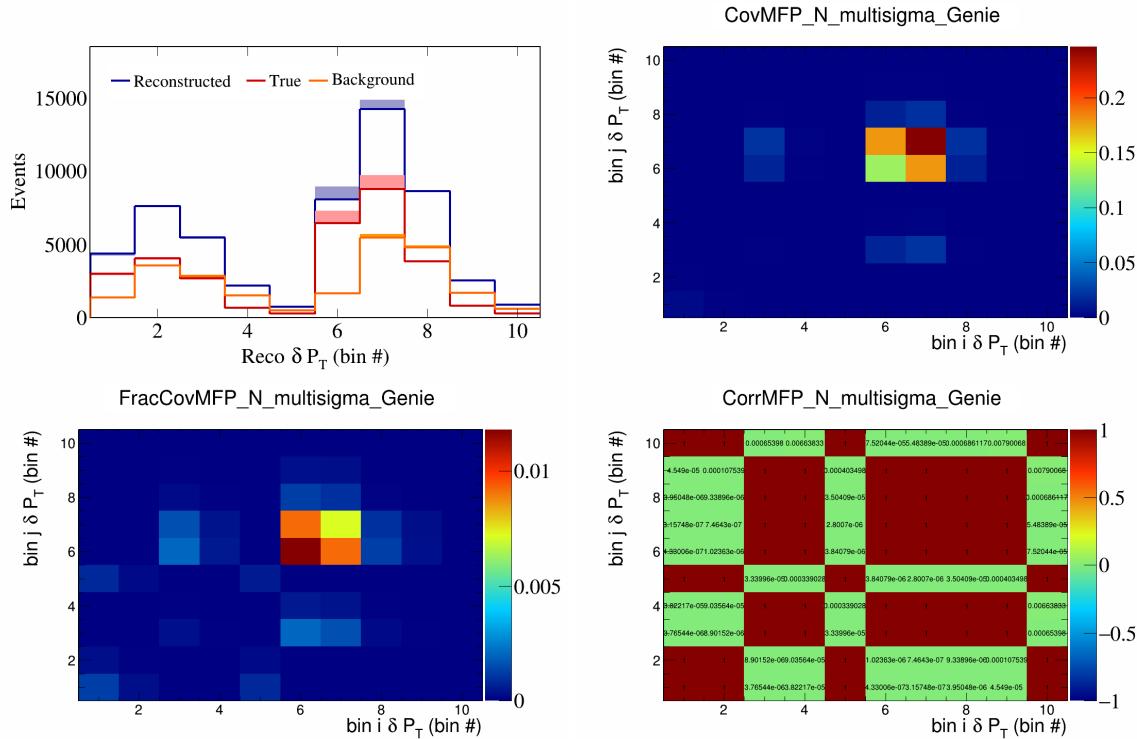


Figure 278: MFPN variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

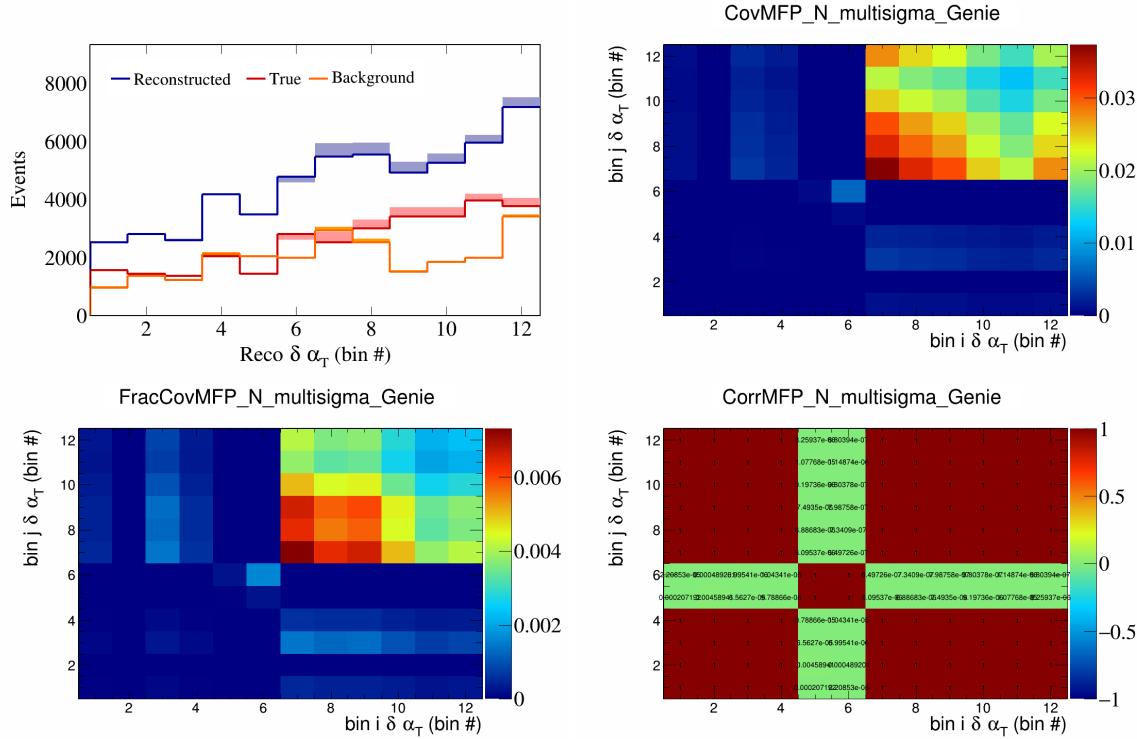


Figure 279: MFPN variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

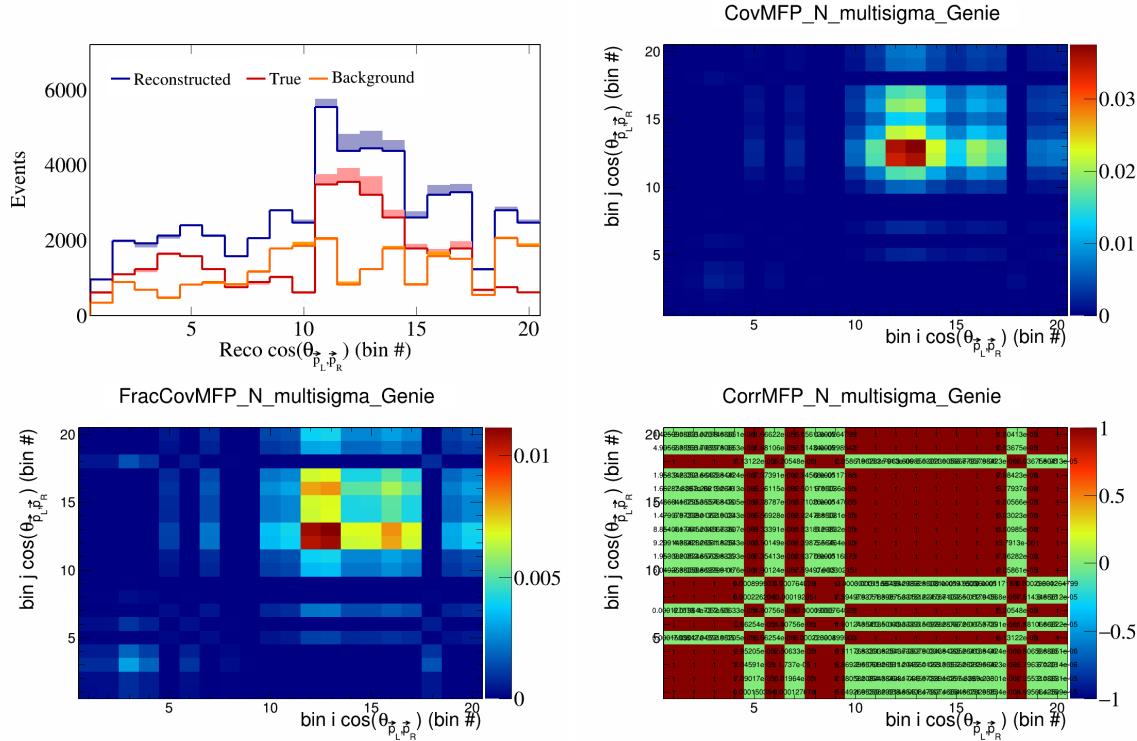


Figure 280: MFPN variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

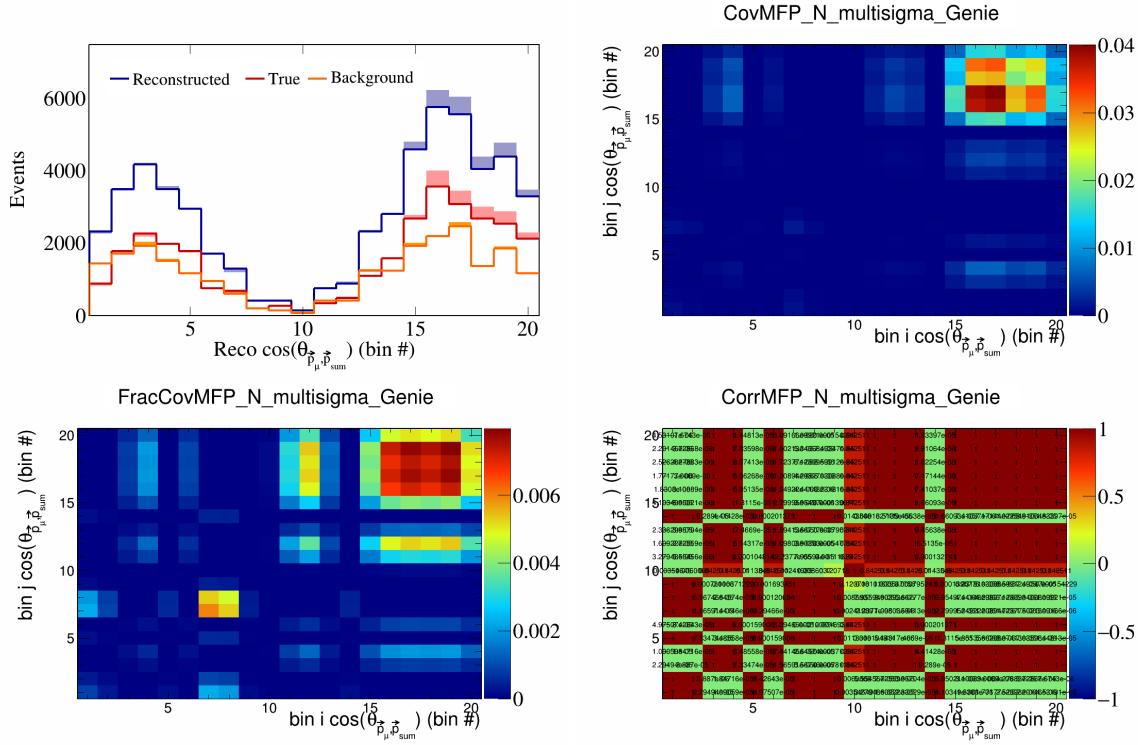


Figure 281: MFPN variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

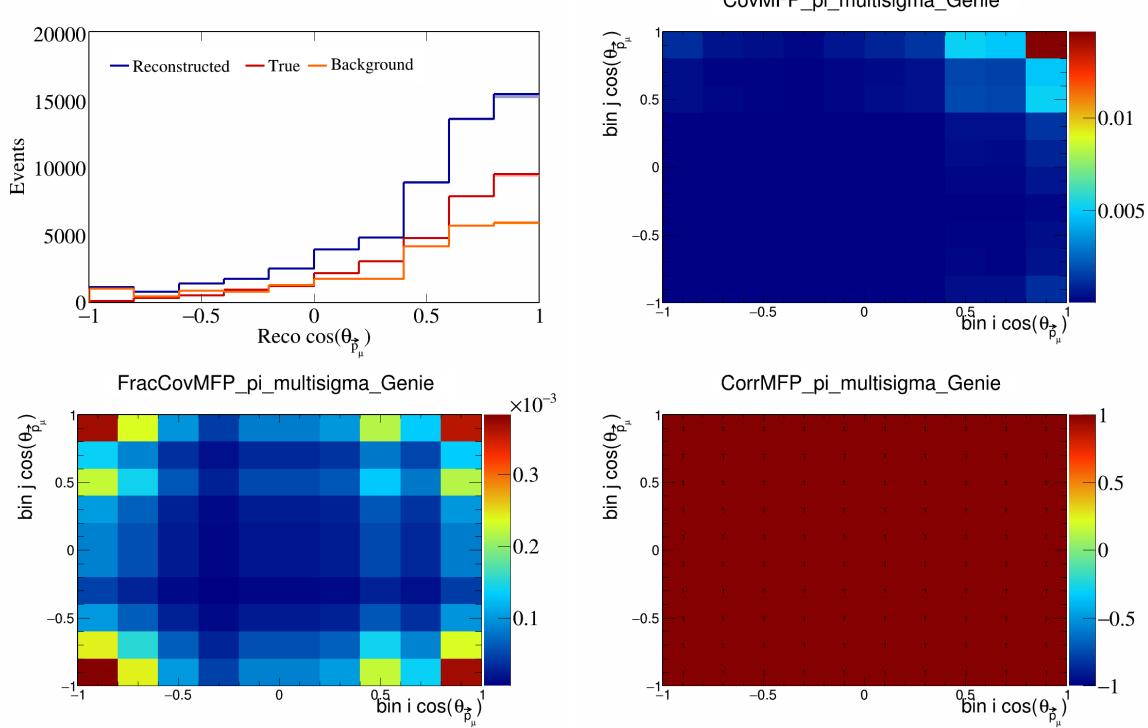


Figure 282: MFPPi variations for $\cos(\theta_{\vec{p}_\mu})$.

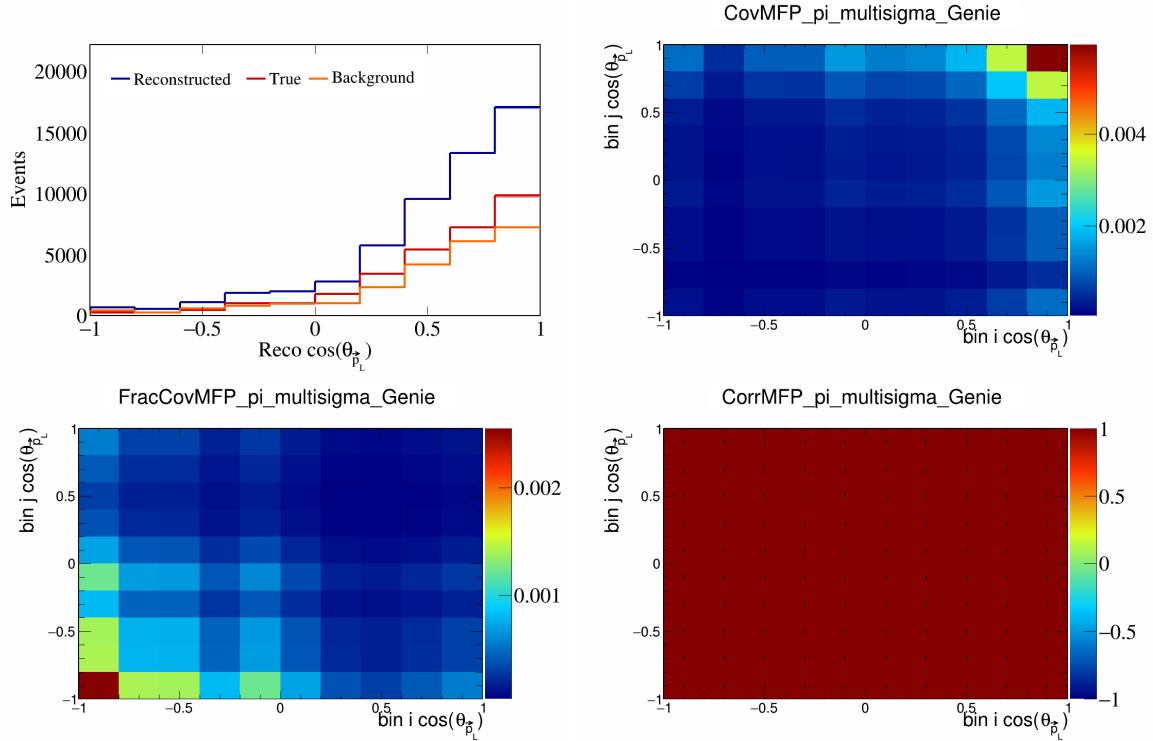


Figure 283: MFPpi variations for $\cos(\theta_{\vec{p}_L})$.

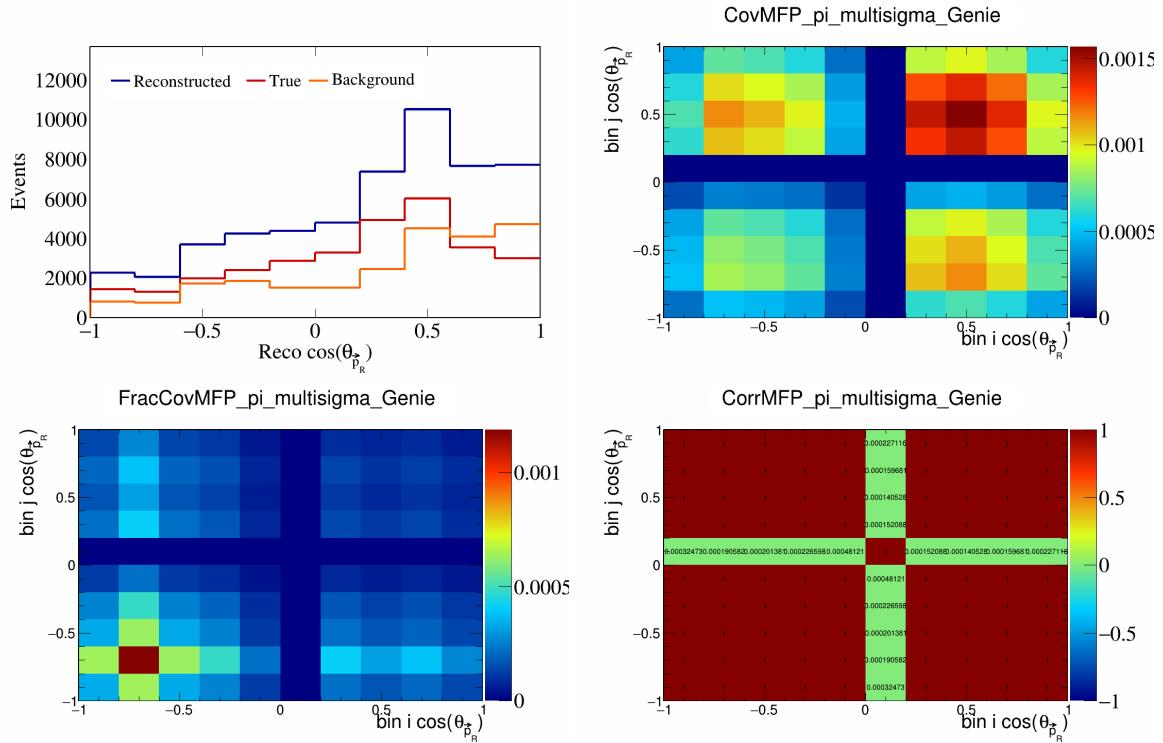


Figure 284: MFPpi variations for $\cos(\theta_{\vec{p}_R})$.

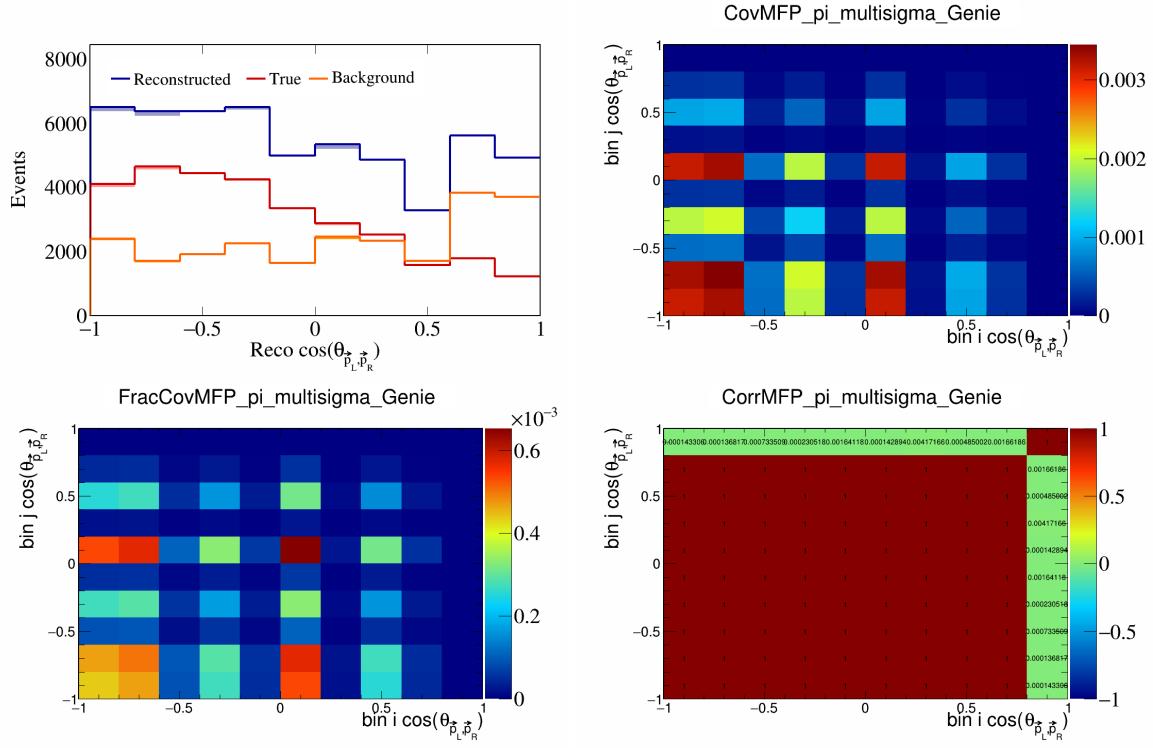


Figure 285: MFPpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

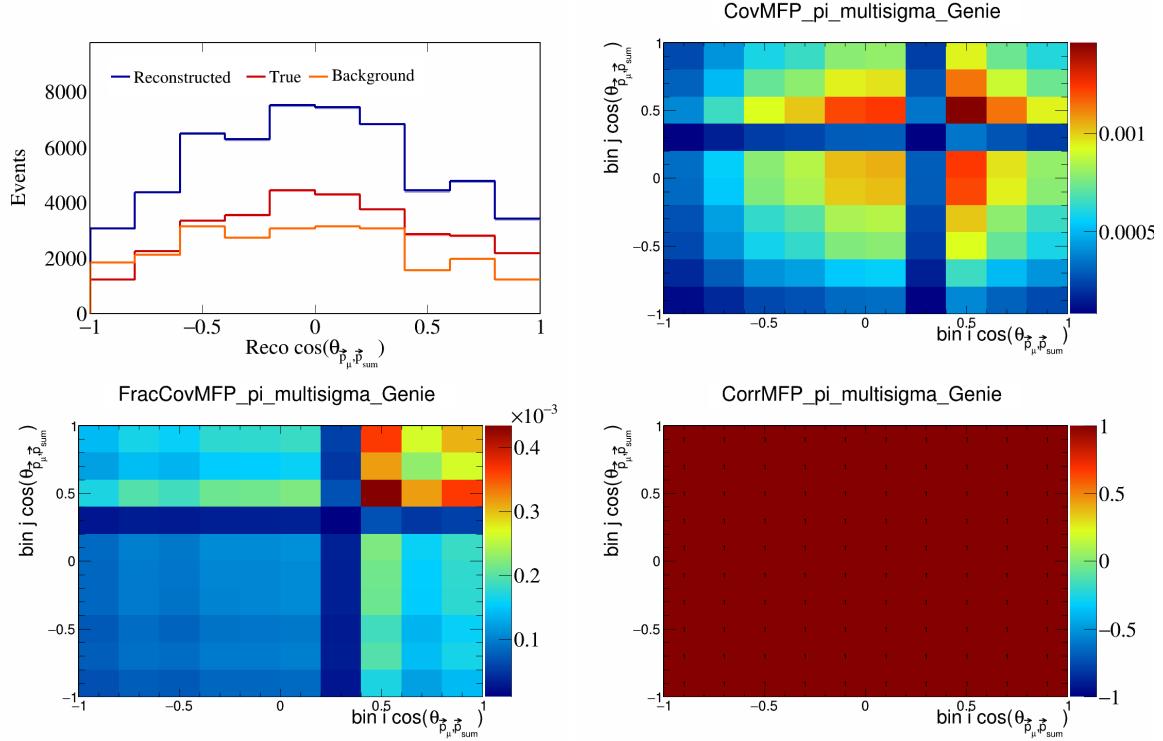


Figure 286: MFPpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

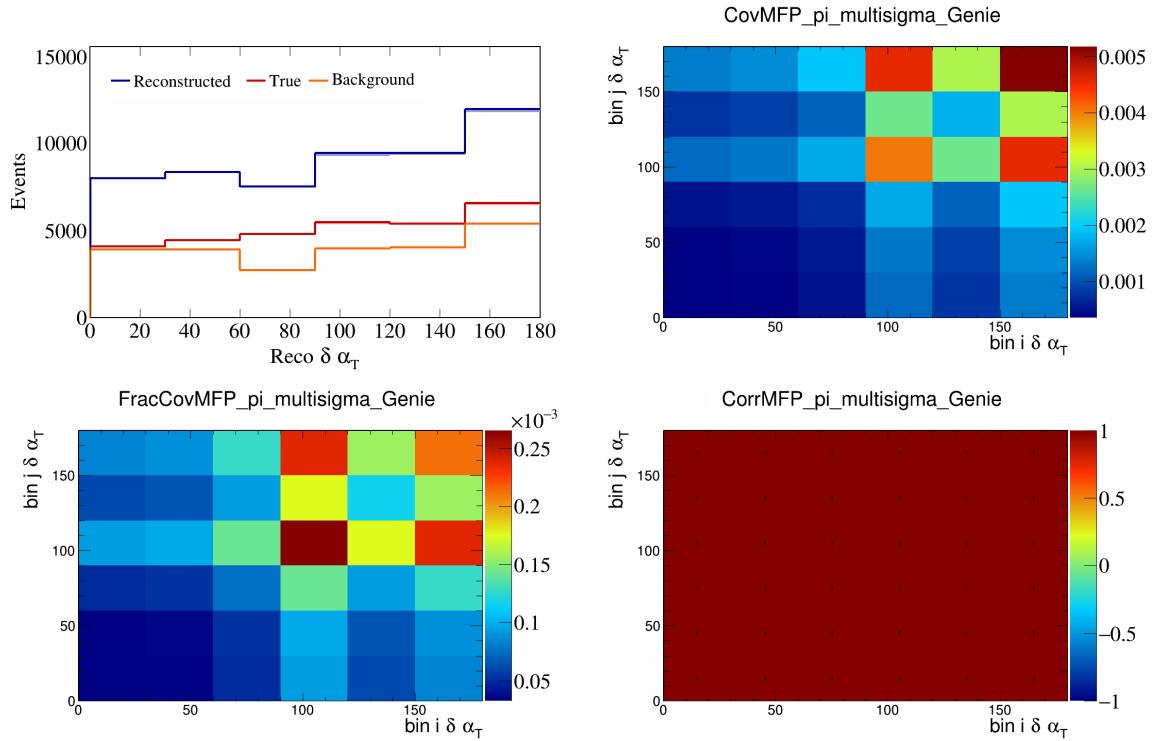


Figure 287: MFPPi variations for $\delta\alpha_T$.

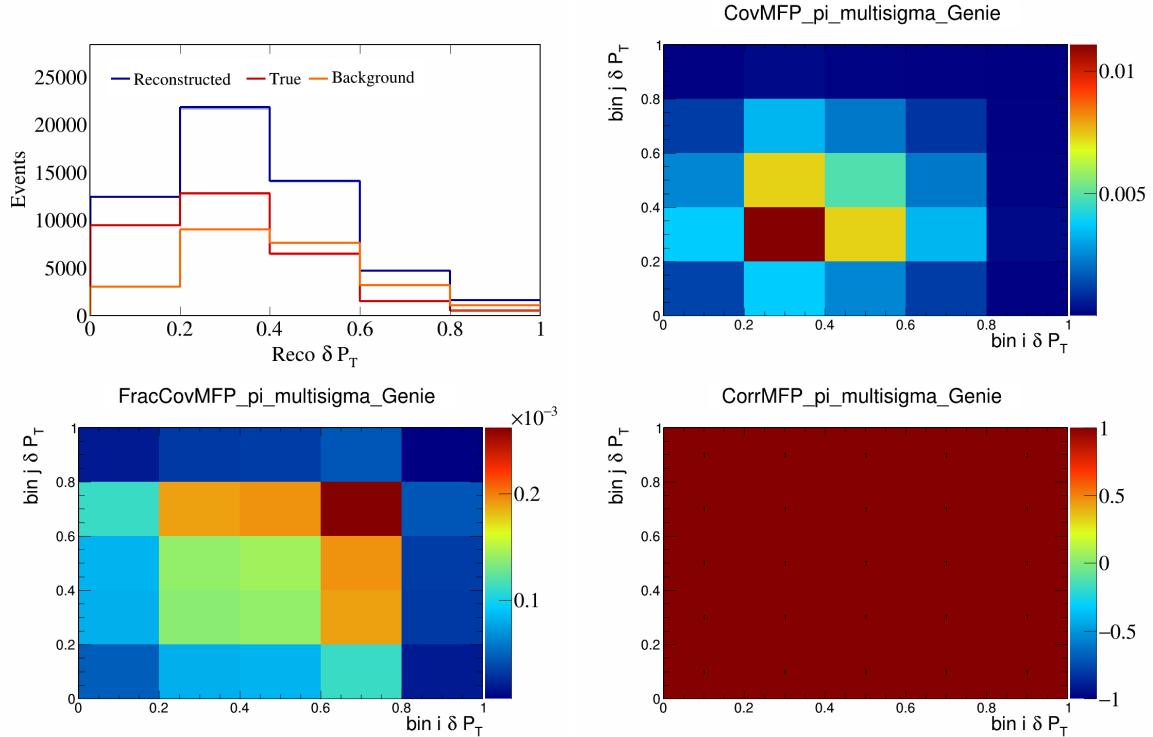


Figure 288: MFPPi variations for δP_T .

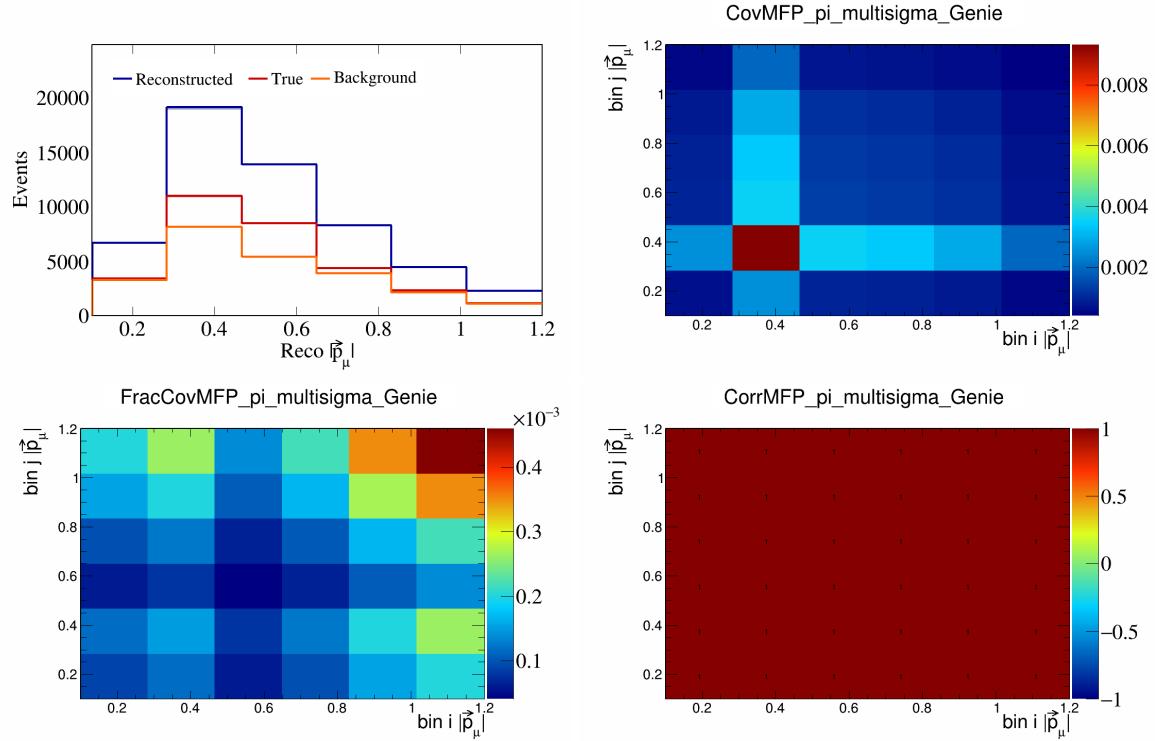


Figure 289: MFPpi variations for $|\vec{p}_\mu|$.

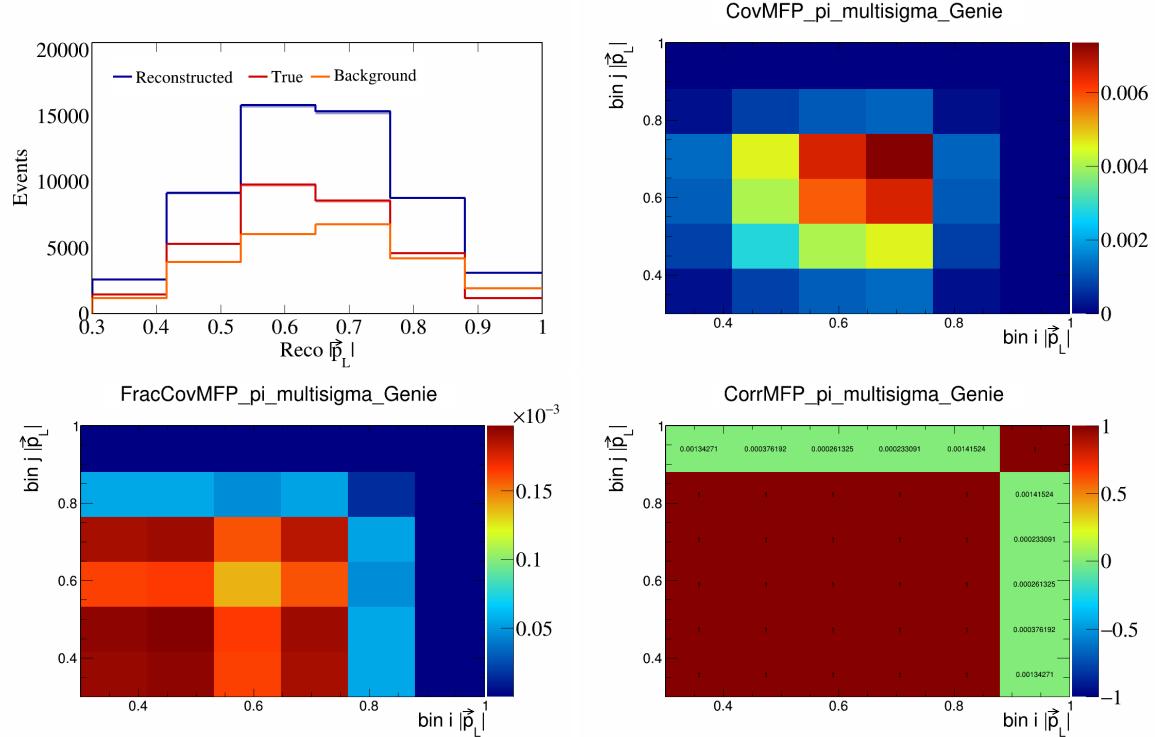


Figure 290: MFPpi variations for $|\vec{p}_L|$.

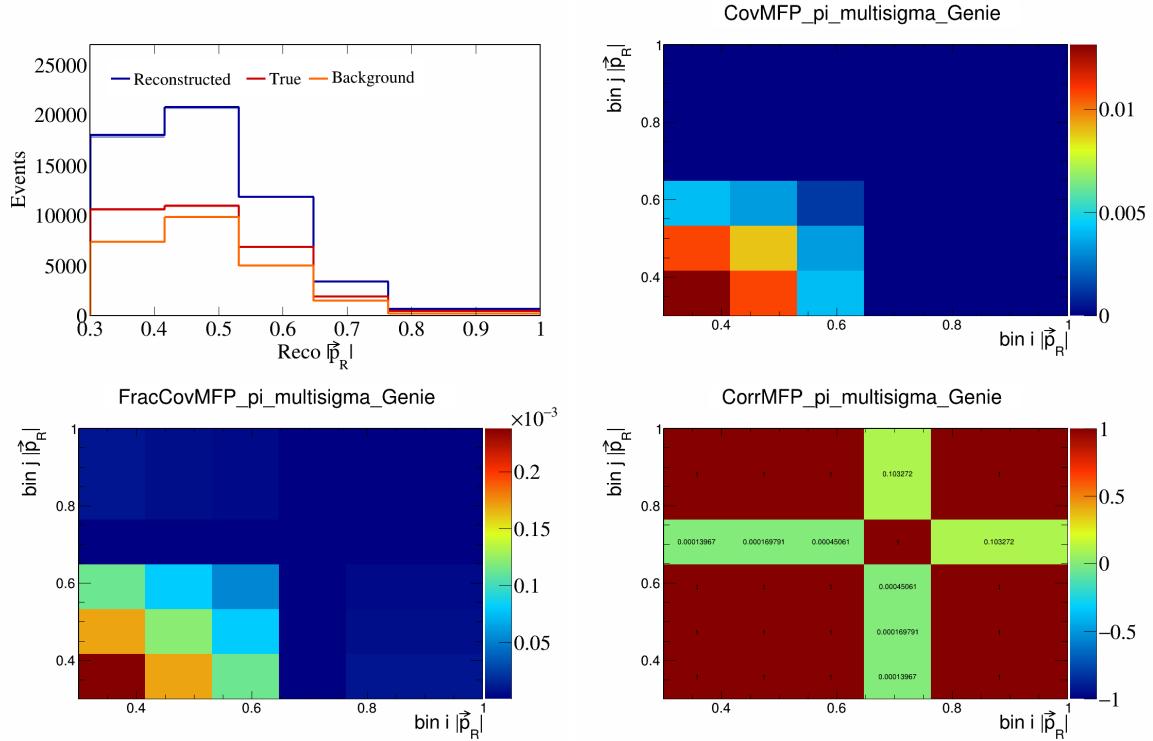


Figure 291: MFPPi variations for $|\vec{p}_R|$.

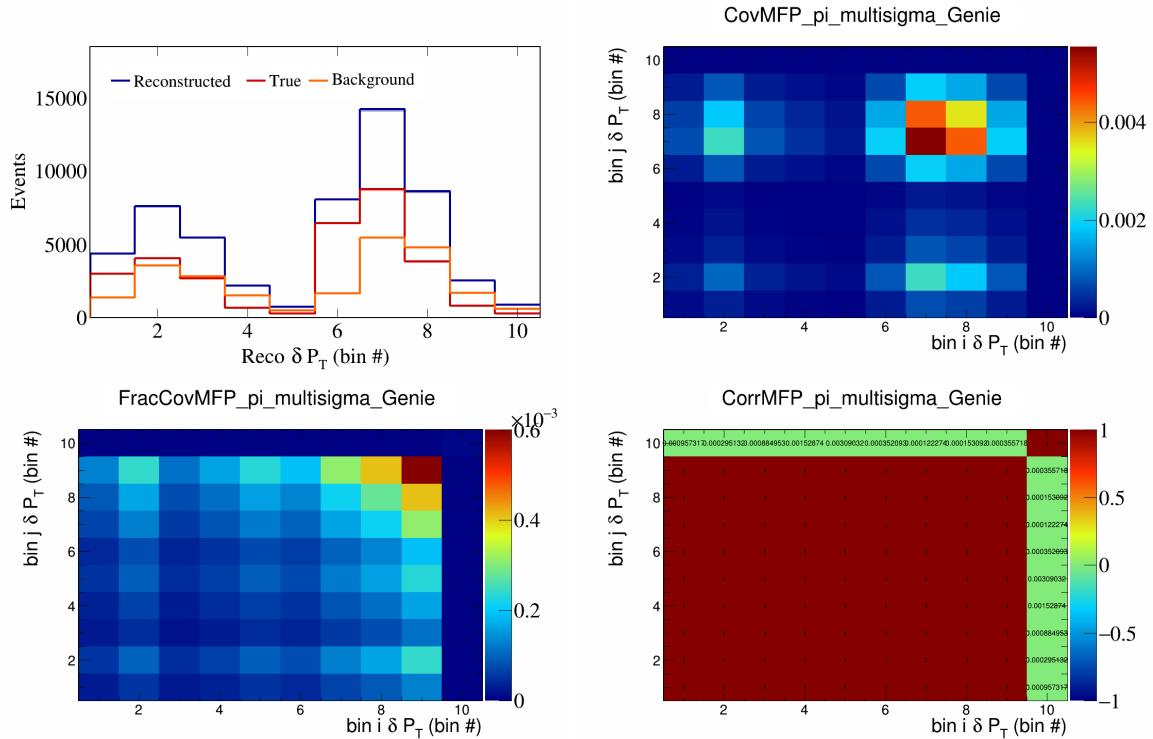


Figure 292: MFPPi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

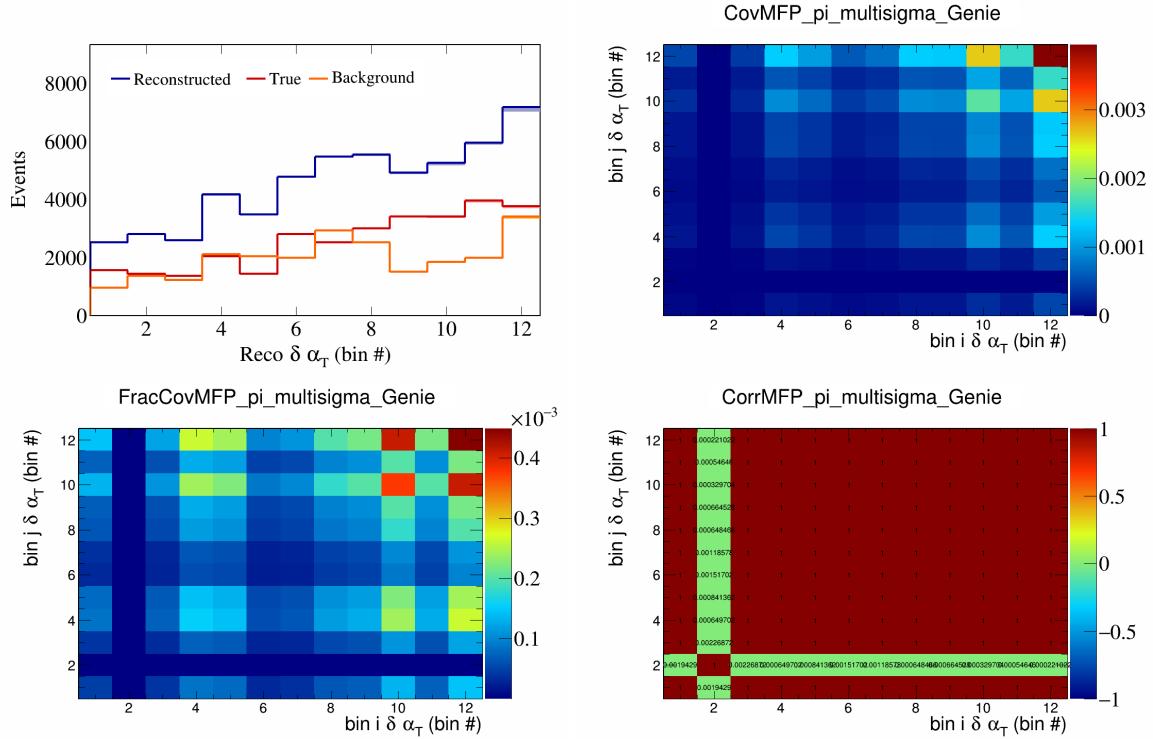


Figure 293: MFPpi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

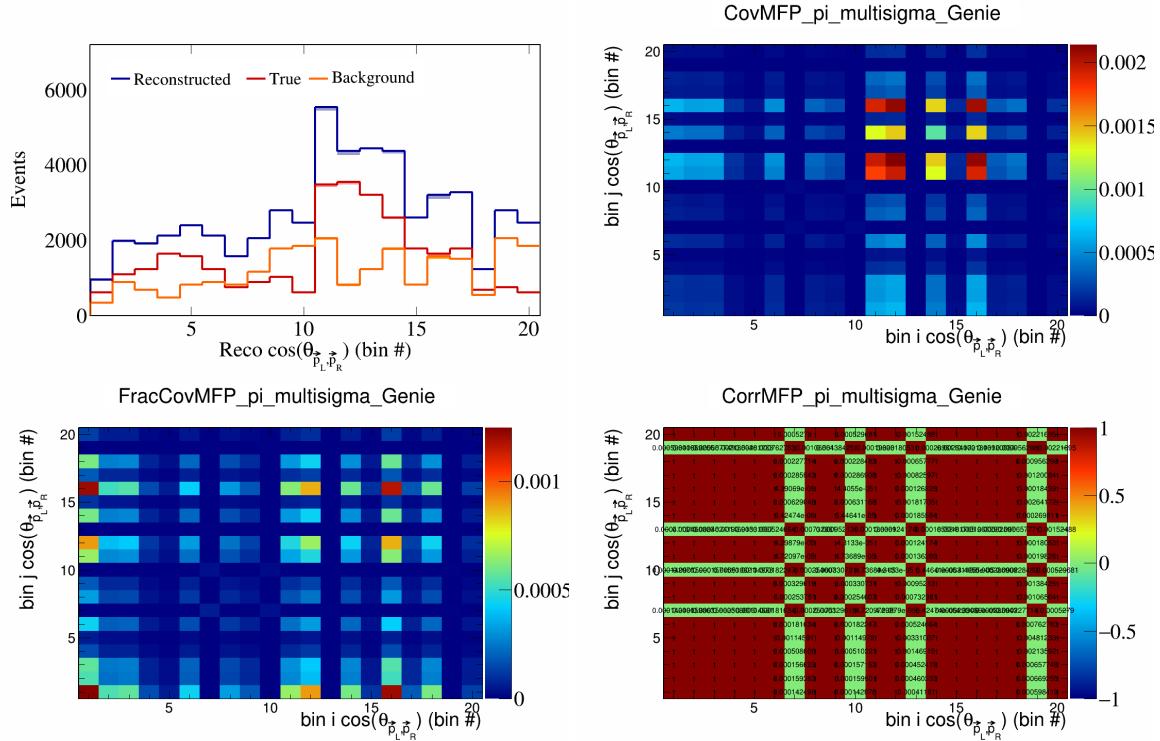


Figure 294: MFPpi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

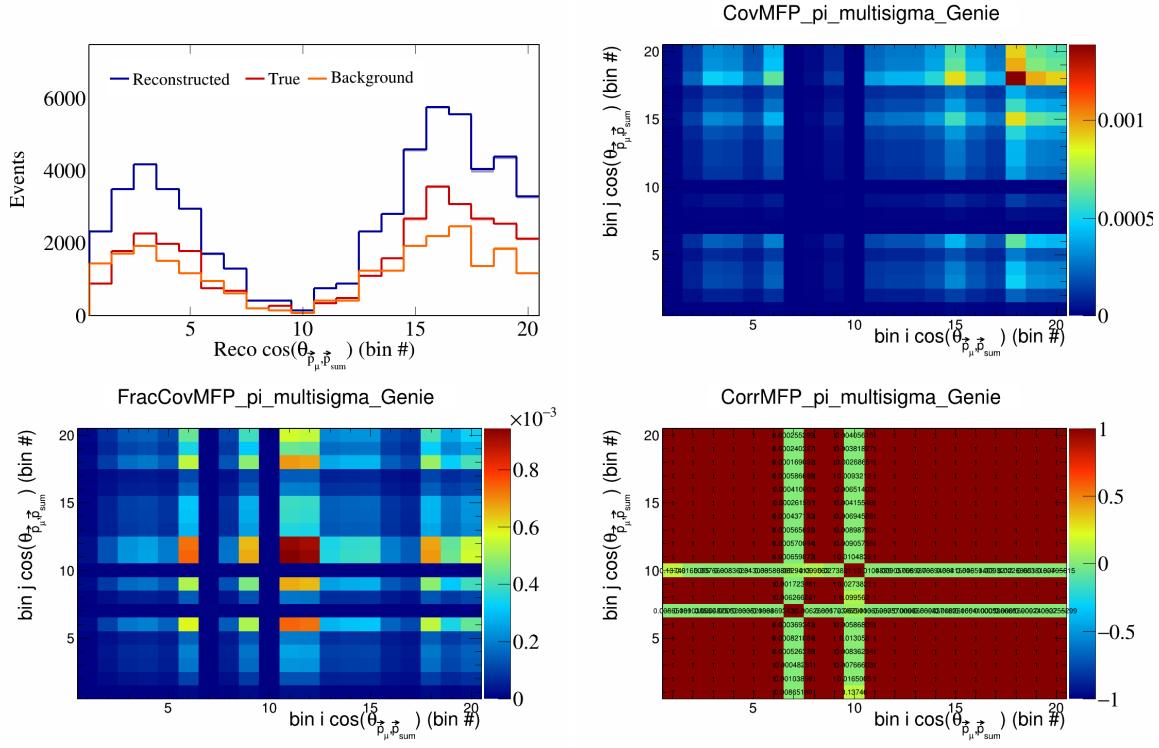


Figure 295: MFPpi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

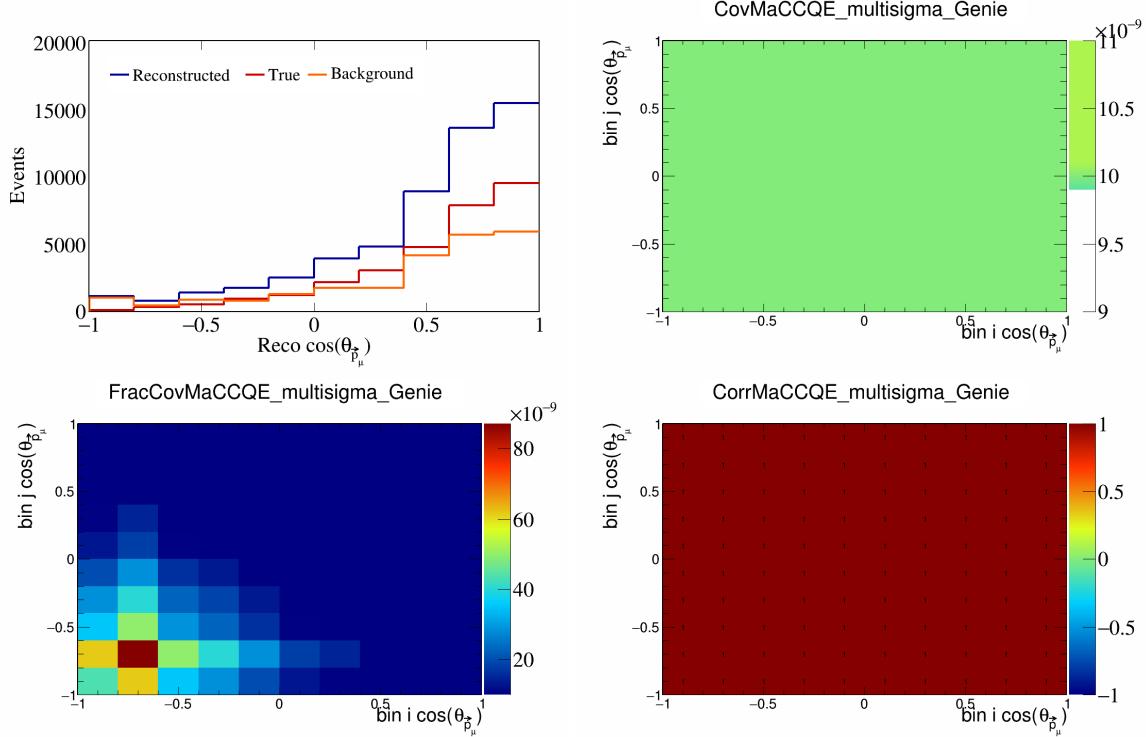


Figure 296: MaCCQE variations for $\cos(\theta_{\vec{p}_\mu})$.

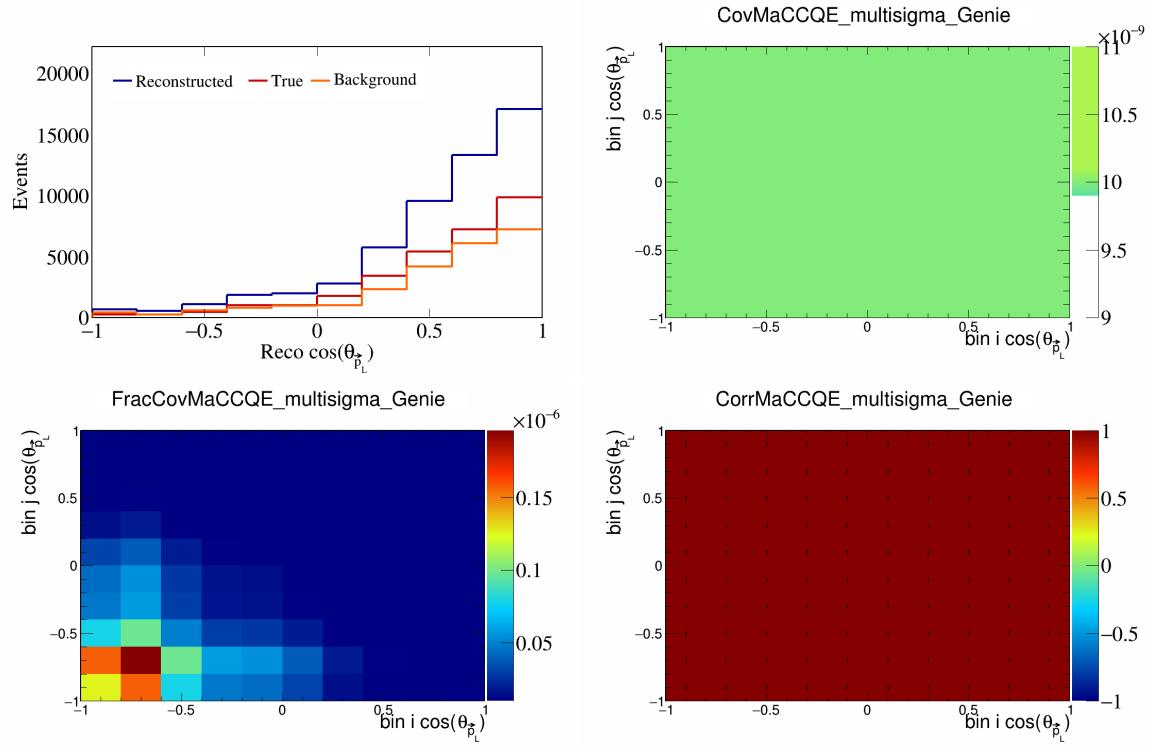


Figure 297: MaCCQE variations for $\cos(\theta_{\vec{p}_L})$.

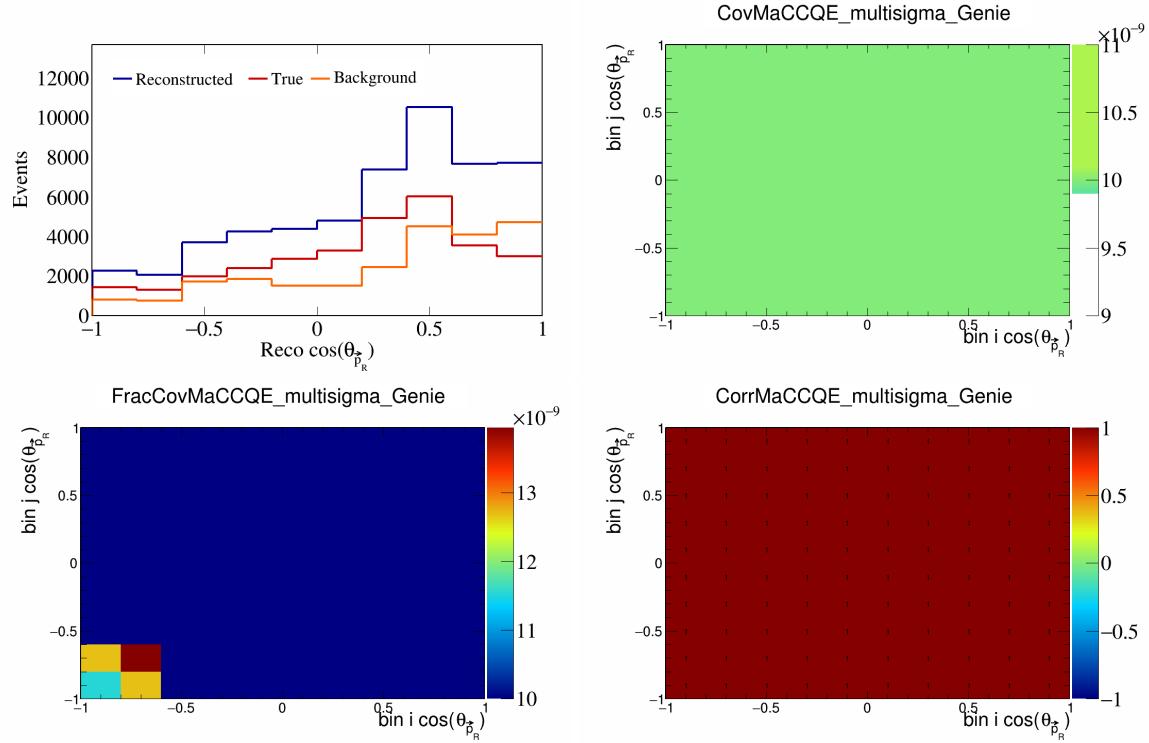


Figure 298: MaCCQE variations for $\cos(\theta_{\vec{p}_R})$.

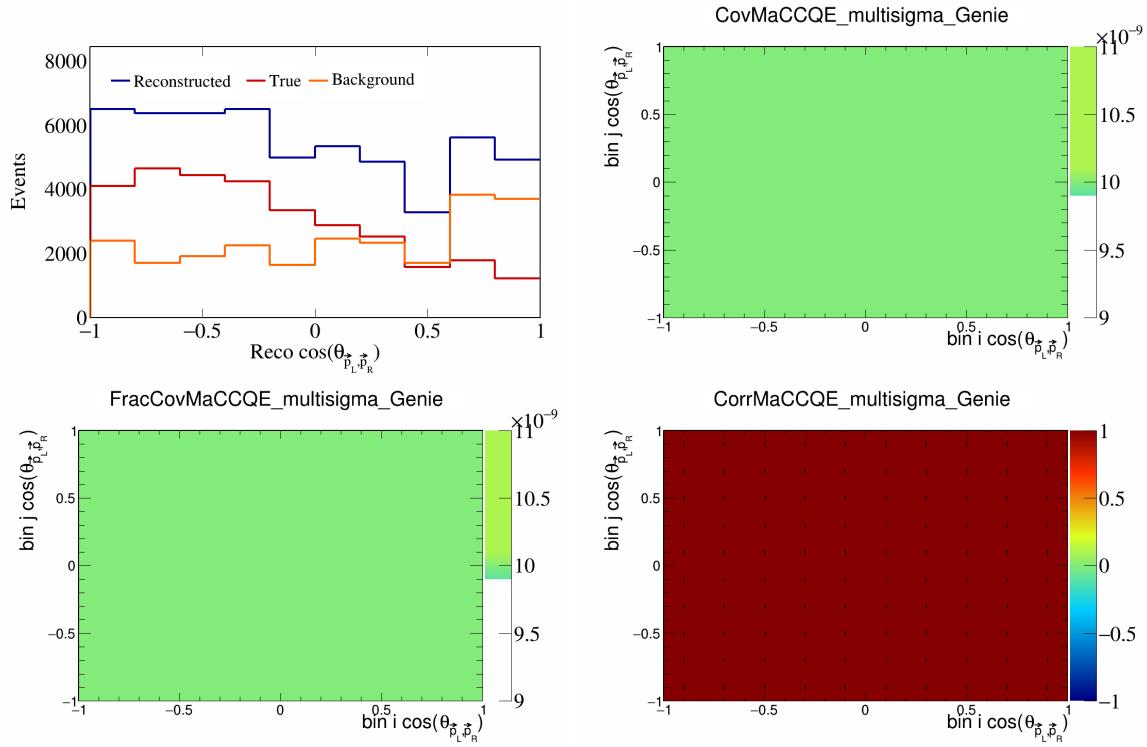


Figure 299: MaCCQE variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

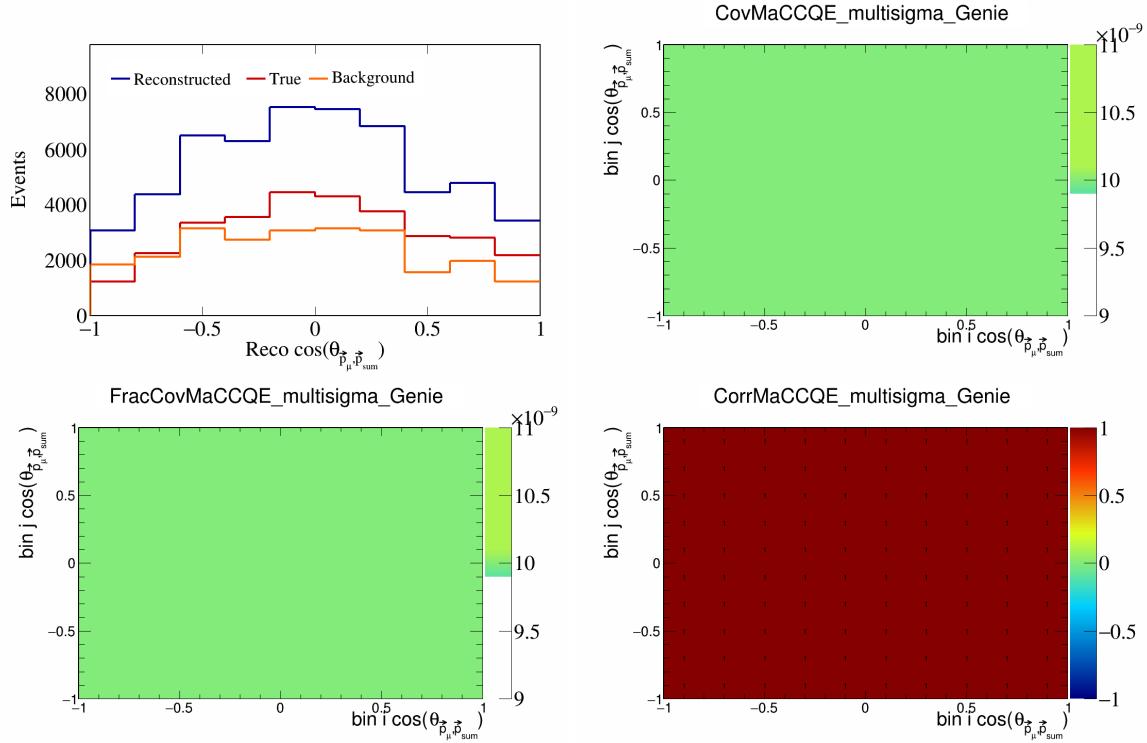


Figure 300: MaCCQE variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

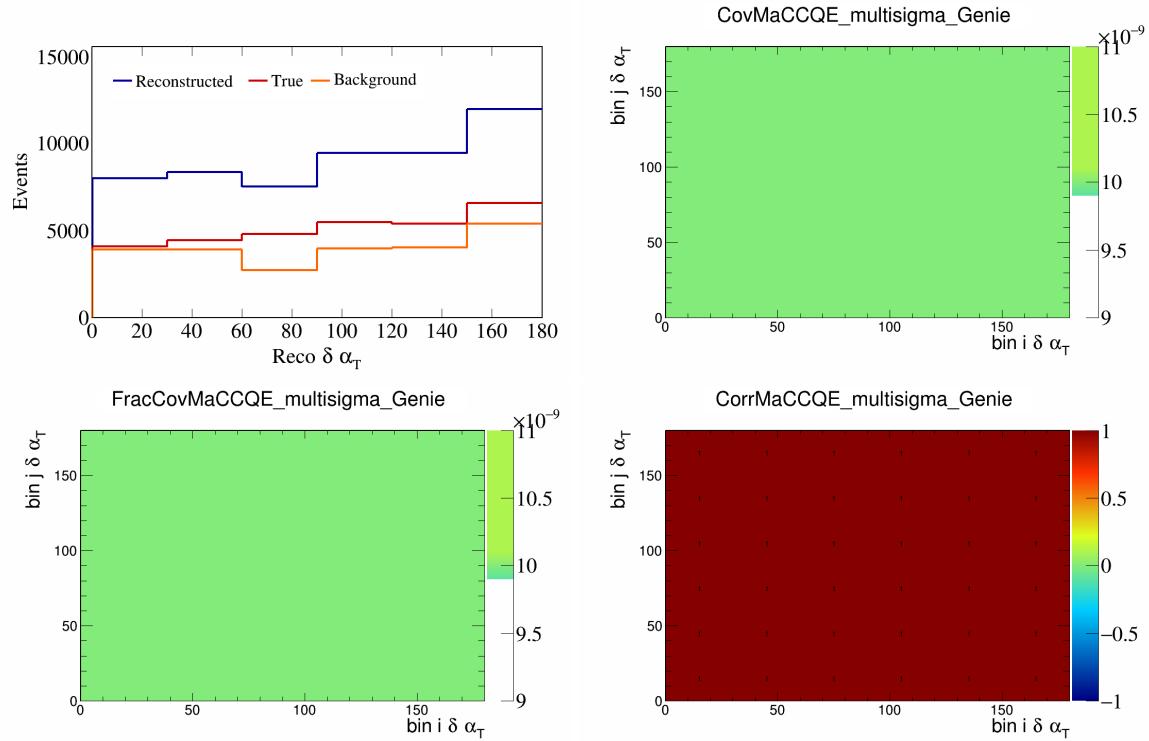


Figure 301: MaCCQE variations for $\delta\alpha_T$.

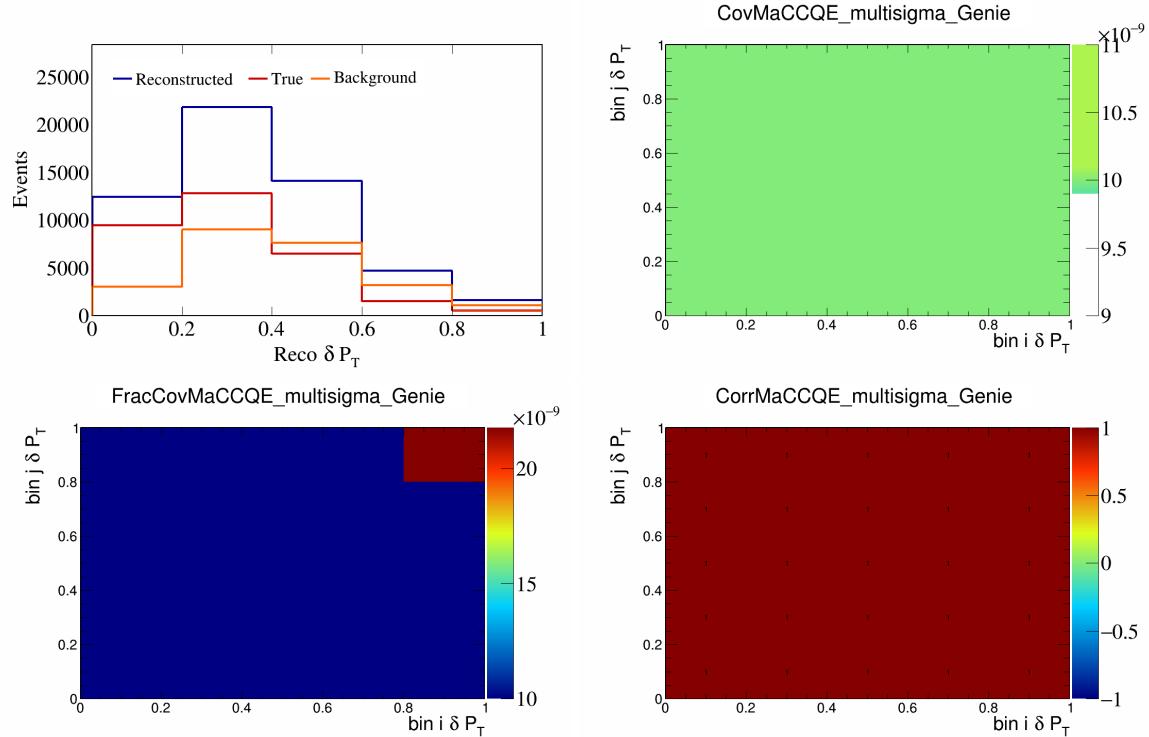


Figure 302: MaCCQE variations for δP_T .

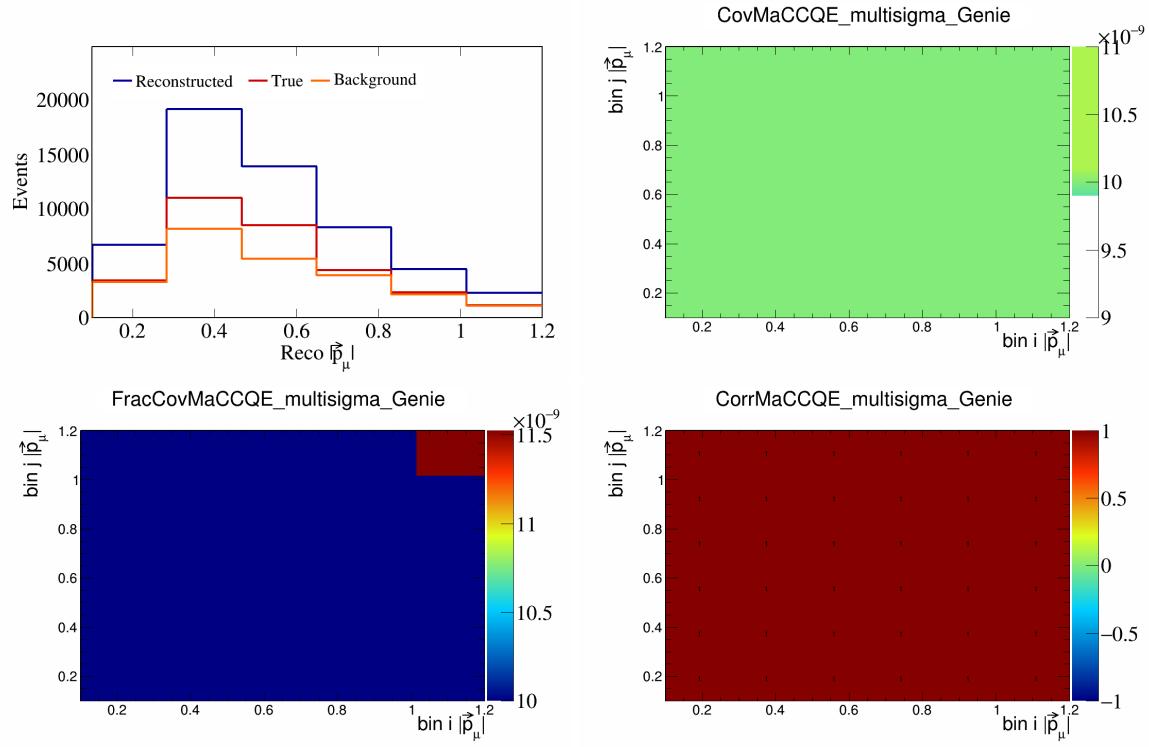


Figure 303: MaCCQE variations for $|\vec{p}_\mu|$.

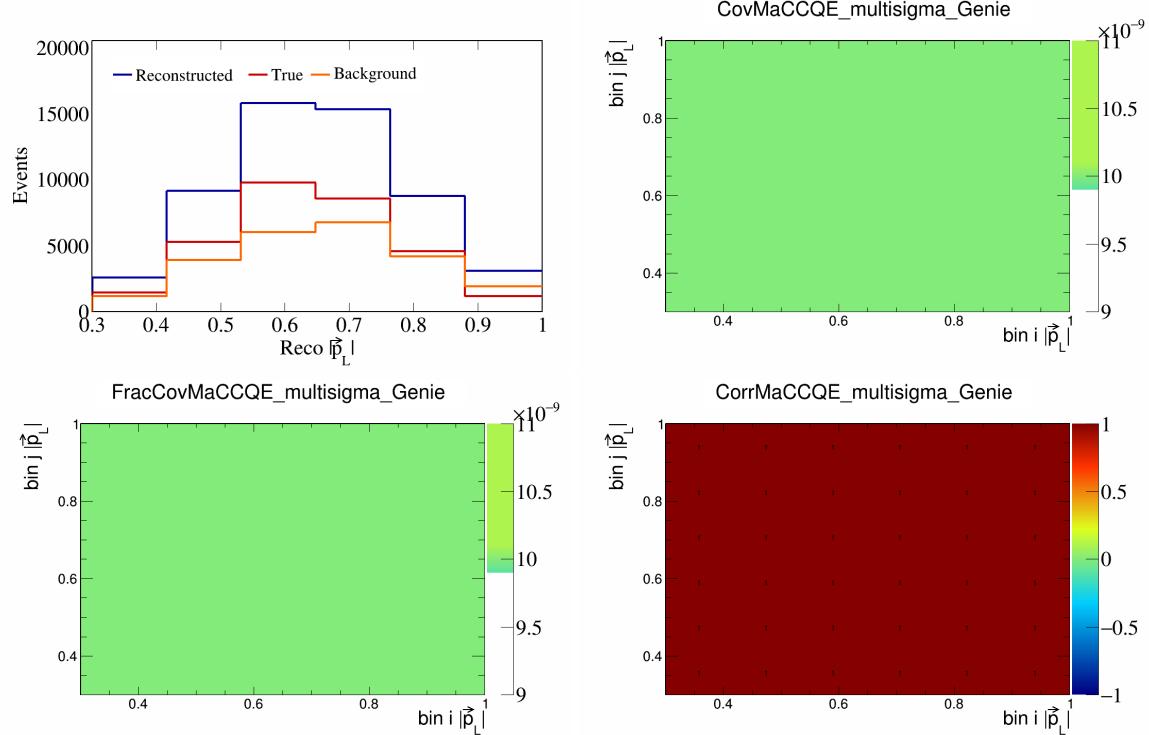


Figure 304: MaCCQE variations for $|\vec{p}_L|$.

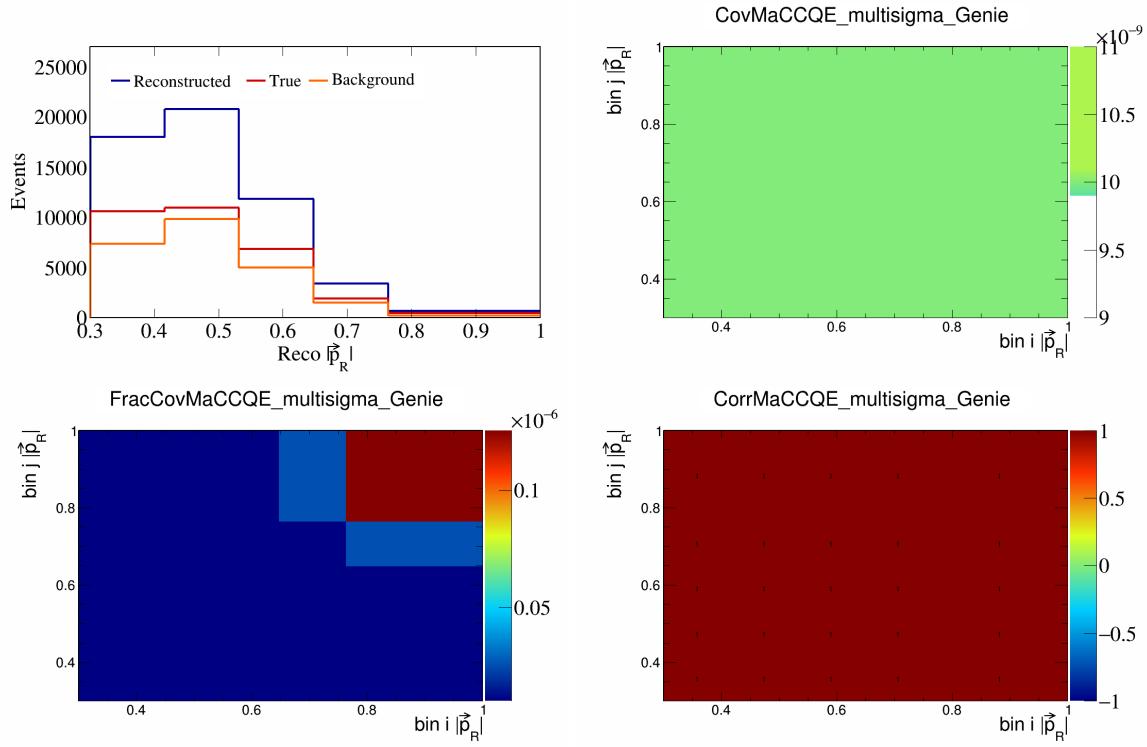


Figure 305: MaCCQE variations for $|\vec{p}_R|$.

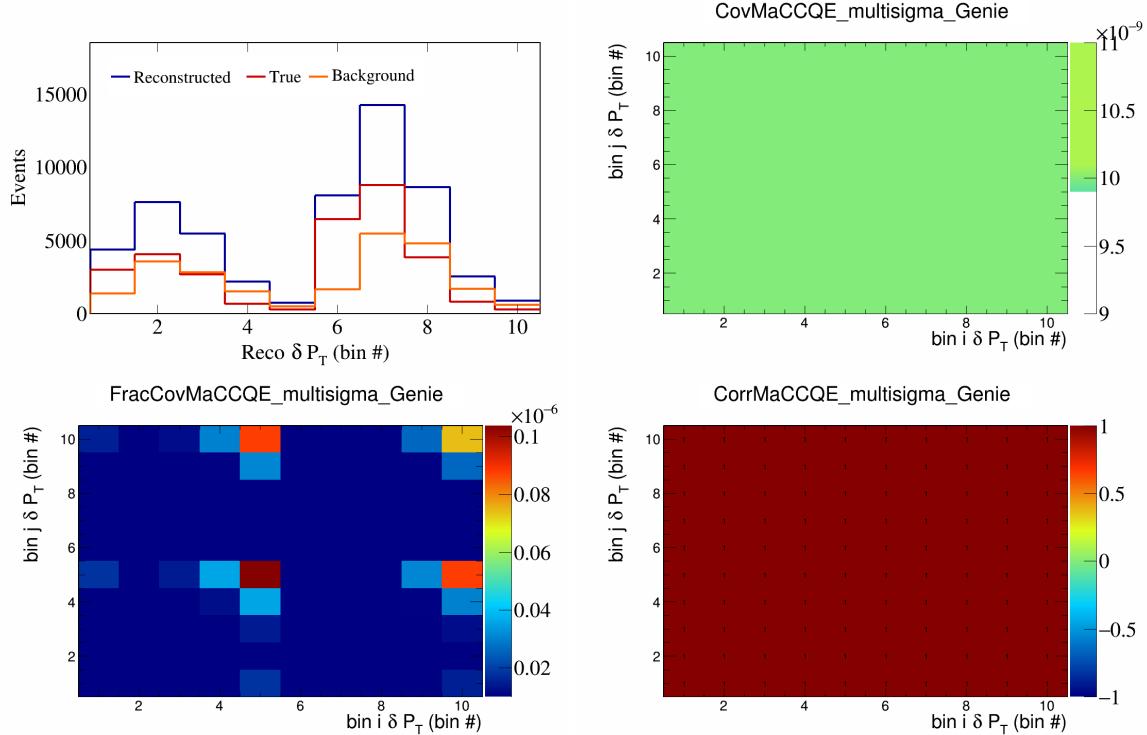


Figure 306: MaCCQE variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

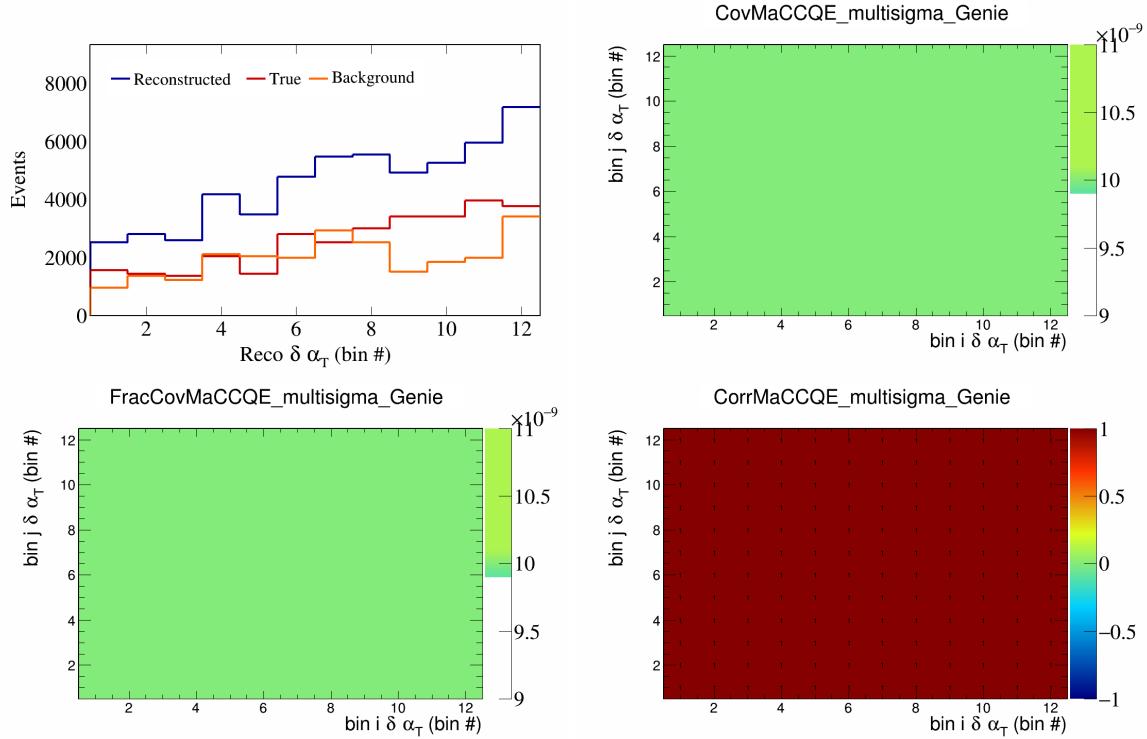


Figure 307: MaCCQE variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

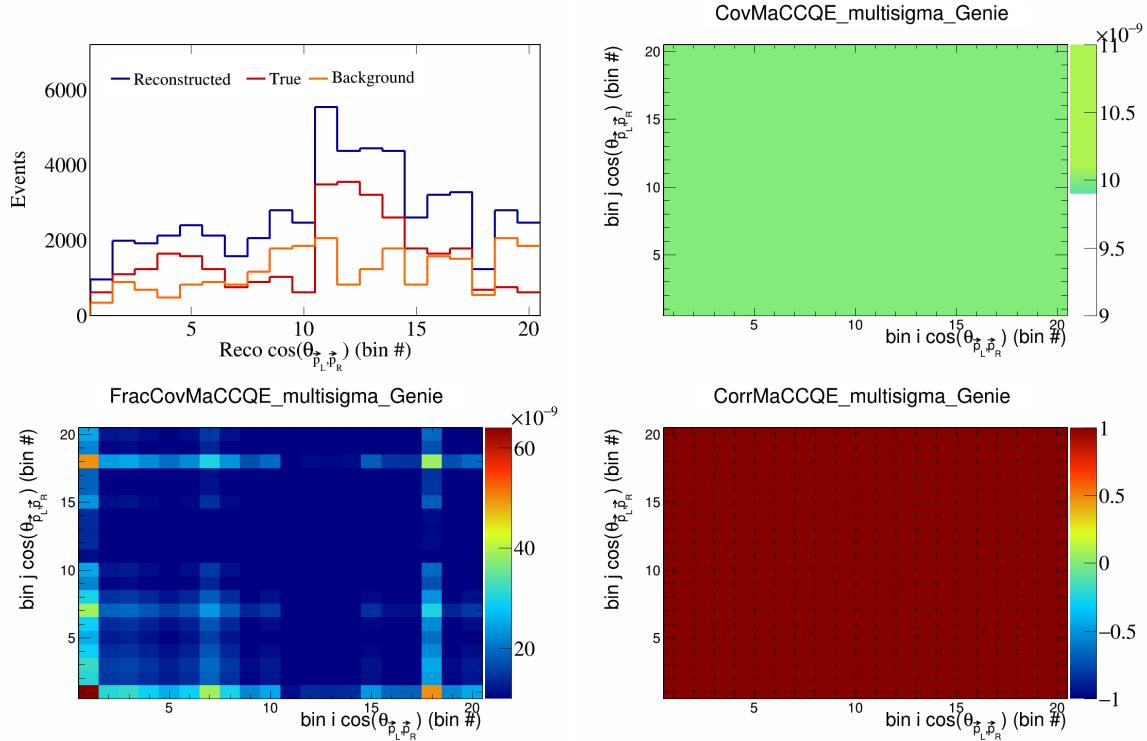


Figure 308: MaCCQE variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

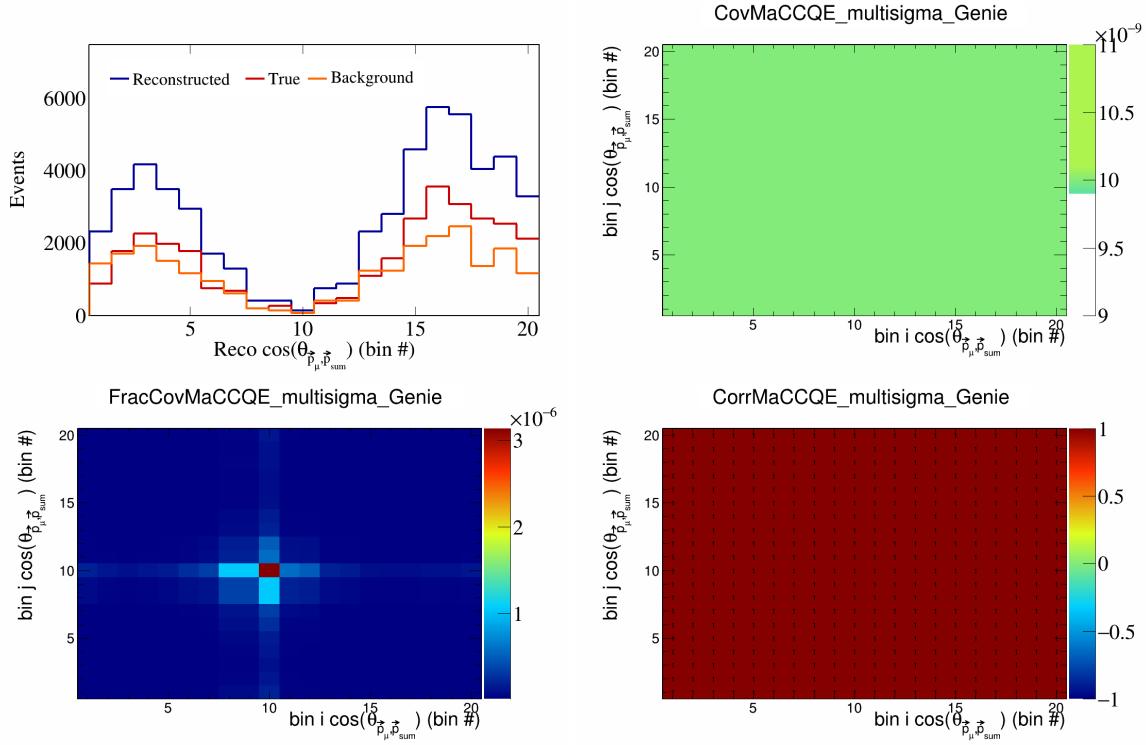


Figure 309: MaCCQE variations for $\cos(\theta_{\vec{p}_\mu \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

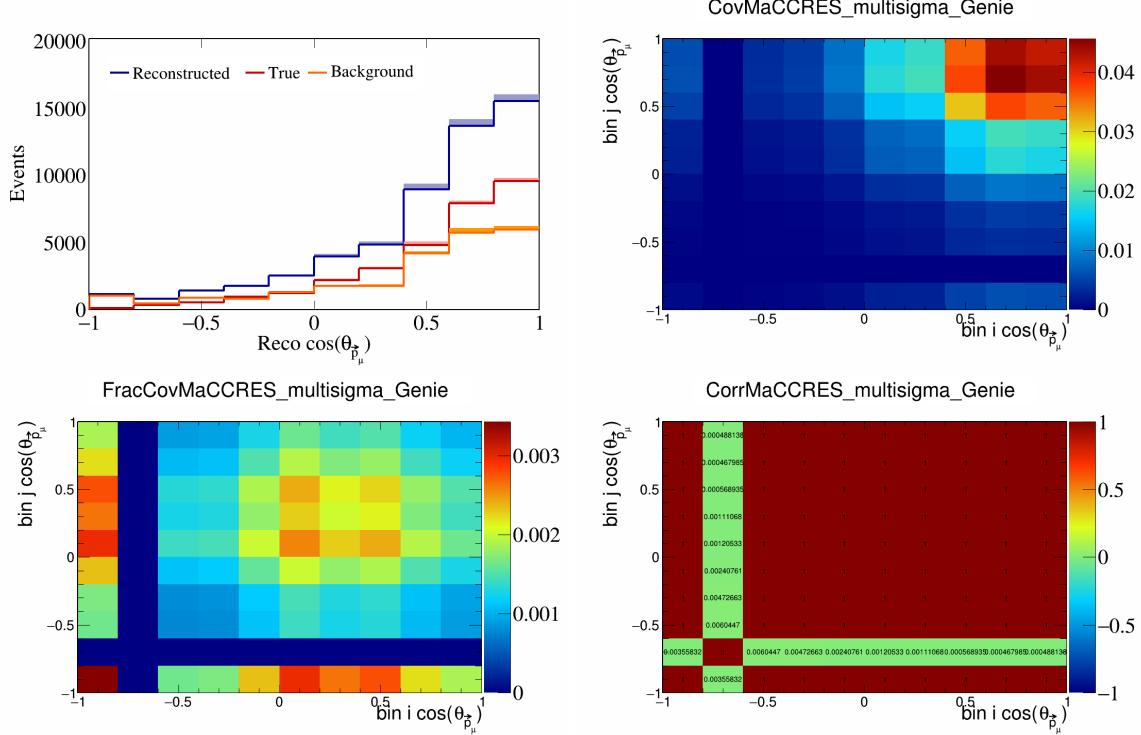


Figure 310: MaCCRES variations for $\cos(\theta_{\vec{p}_\mu})$.

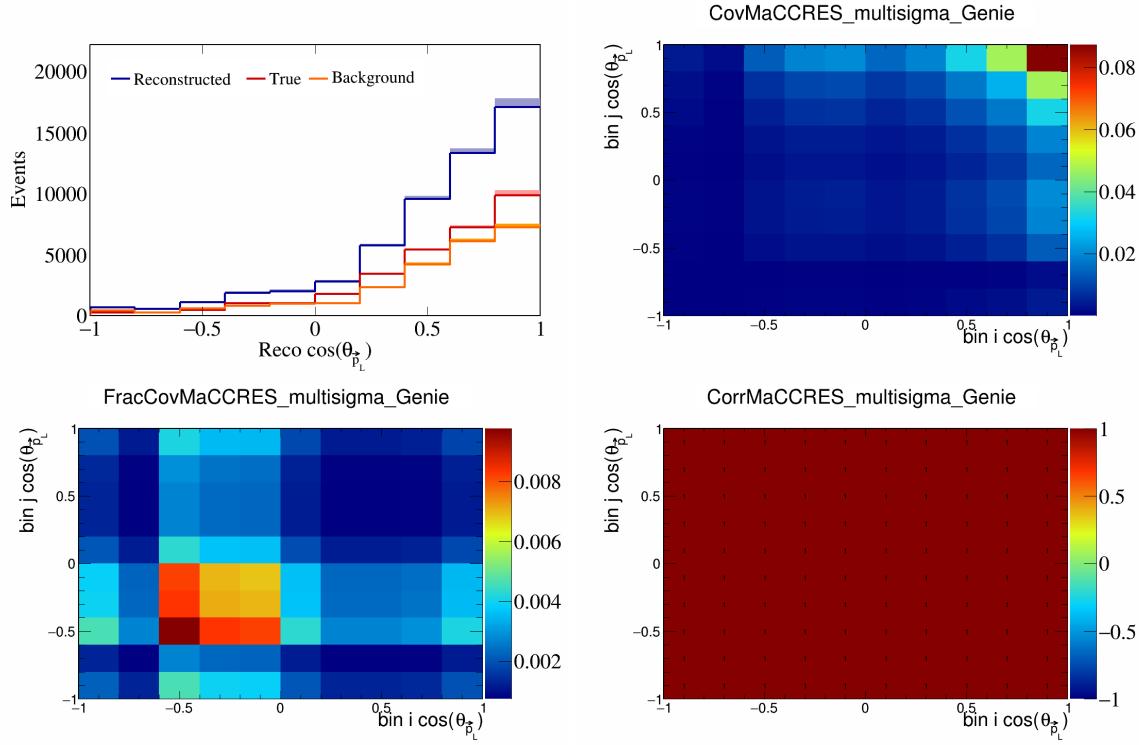


Figure 311: MaCCRES variations for $\cos(\theta_{\vec{p}_L})$.

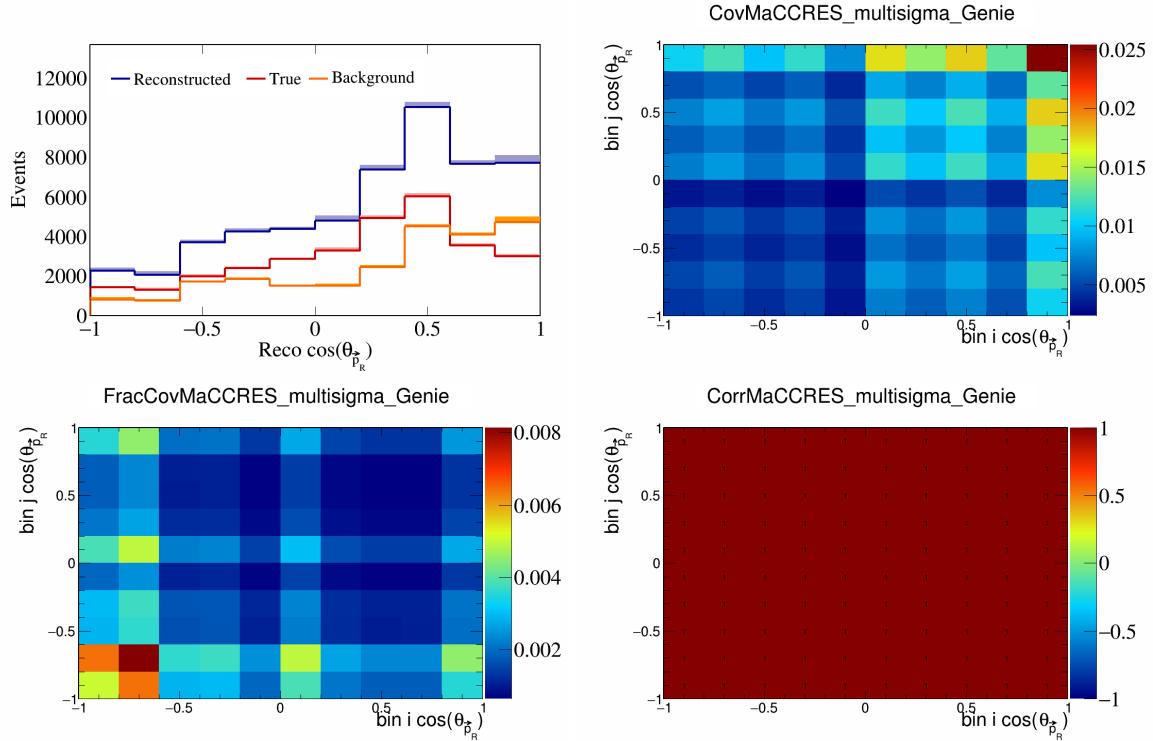


Figure 312: MaCCRES variations for $\cos(\theta_{\vec{p}_R})$.

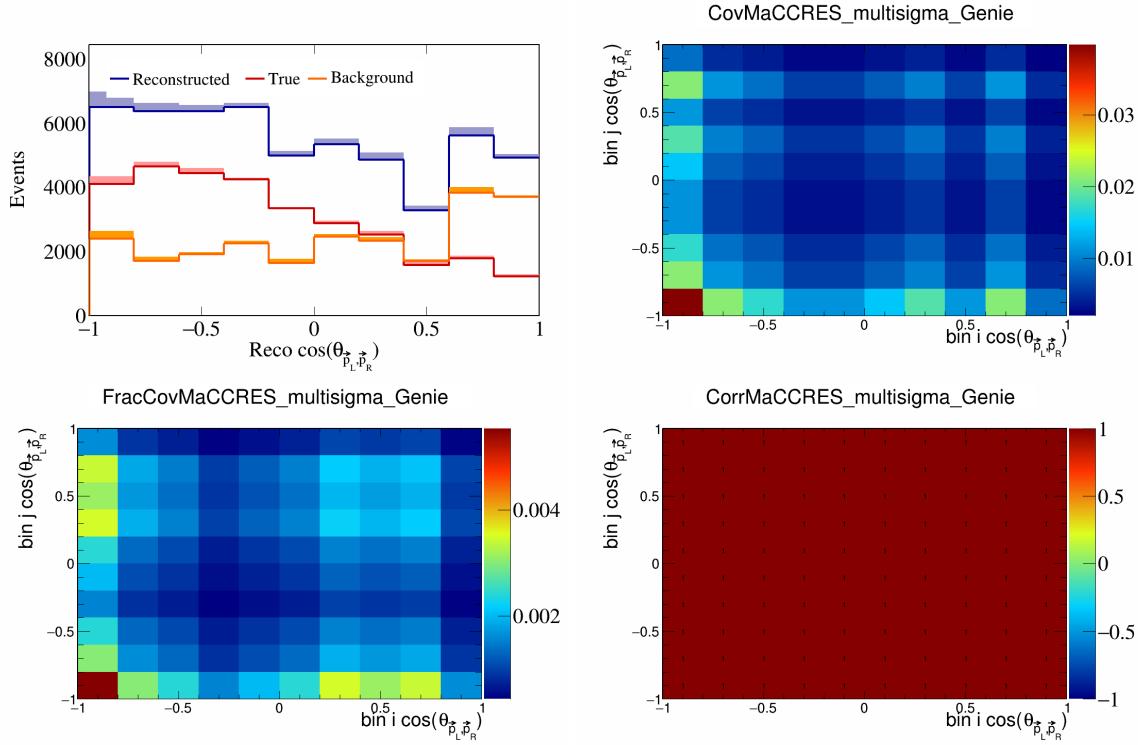


Figure 313: MaCCRES variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

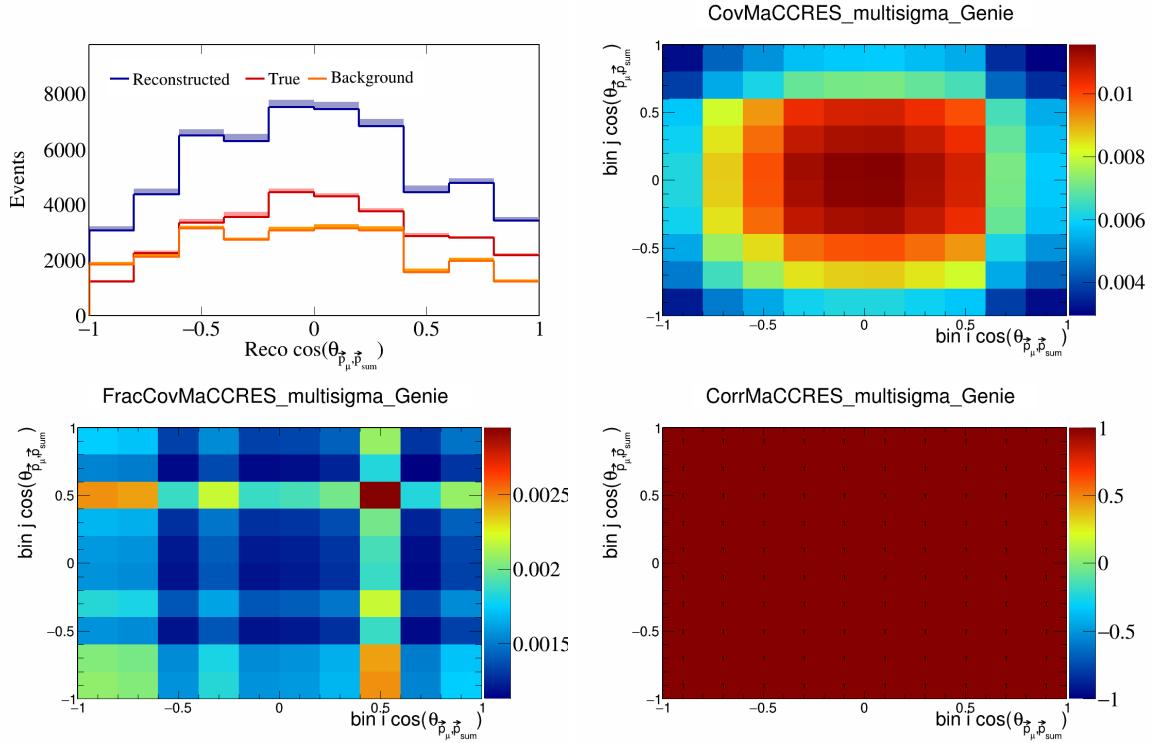


Figure 314: MaCCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

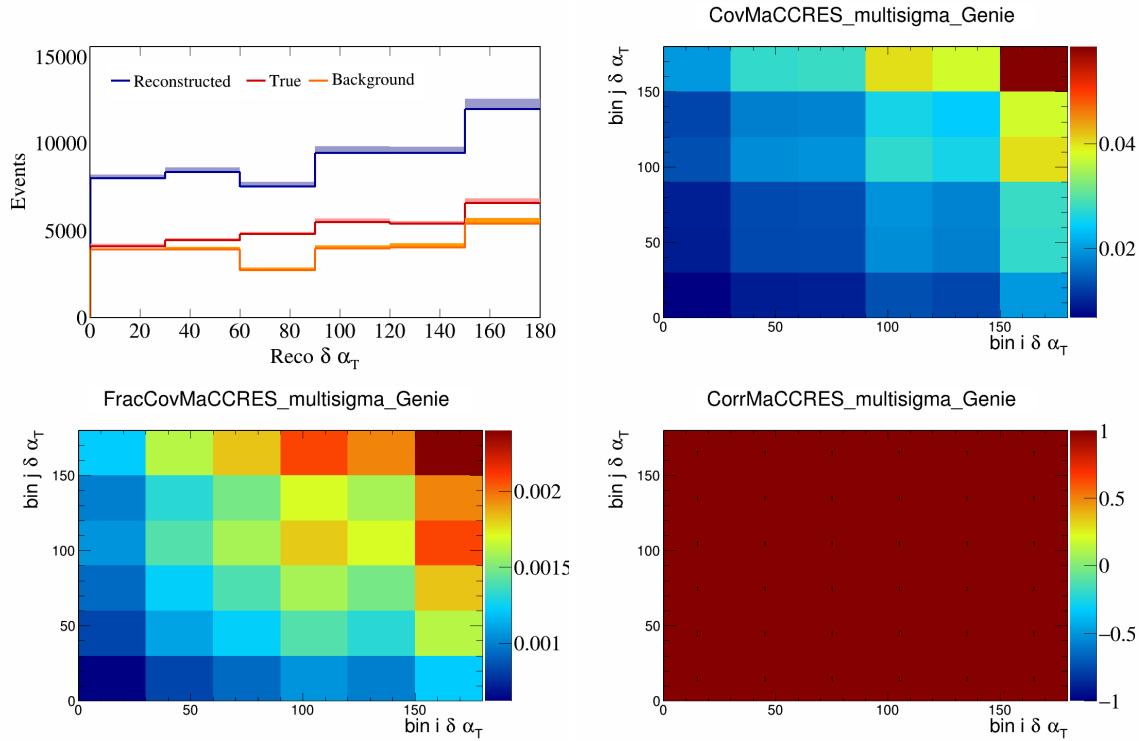


Figure 315: MaCCRES variations for $\delta\alpha_T$.

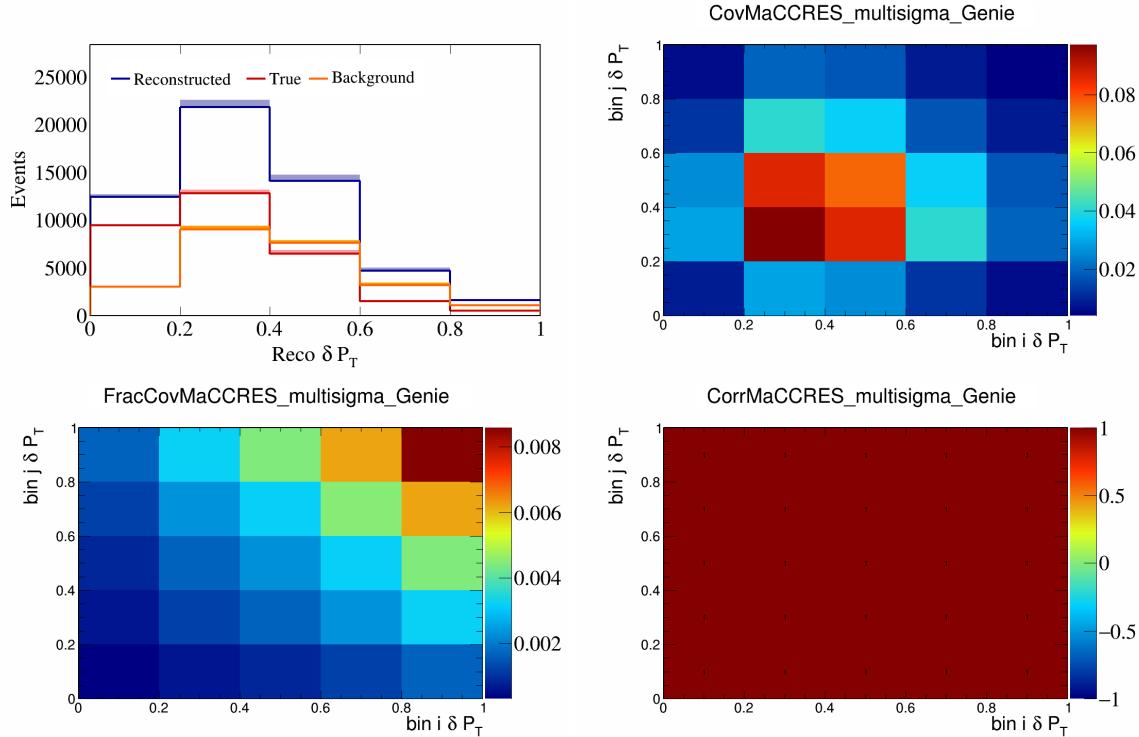


Figure 316: MaCCRES variations for δP_T .

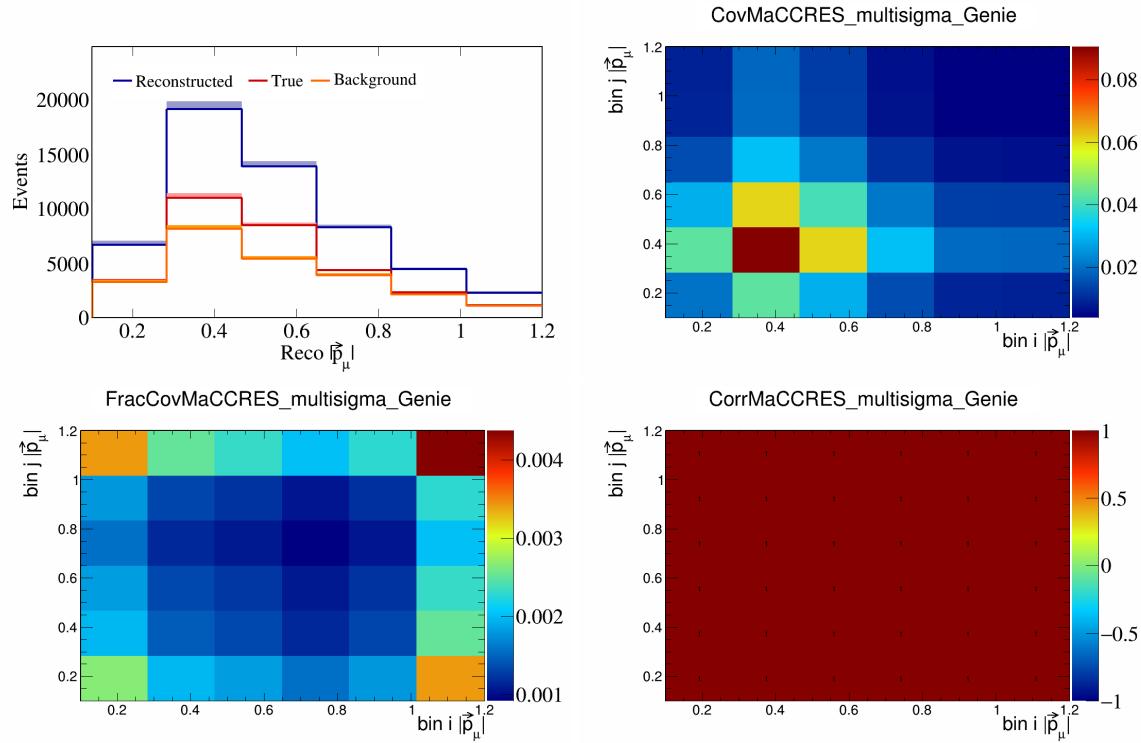


Figure 317: MaCCRES variations for $|\vec{p}_\mu|$.

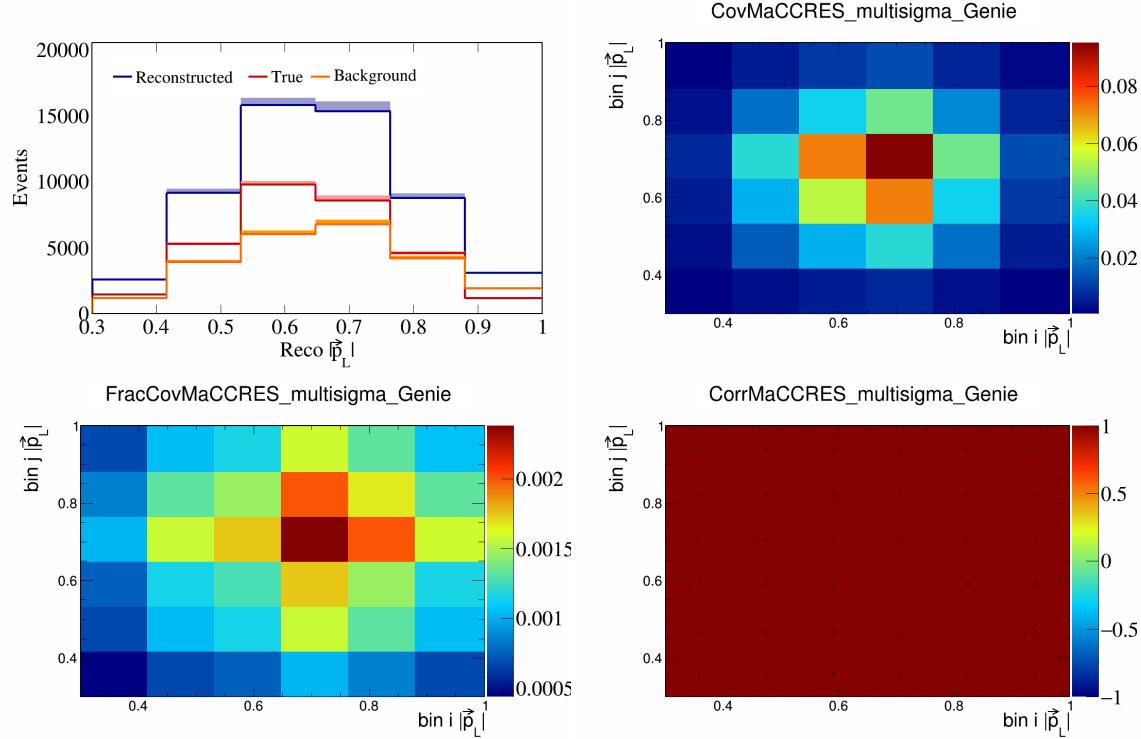


Figure 318: MaCCRES variations for $|\vec{p}_L|$.

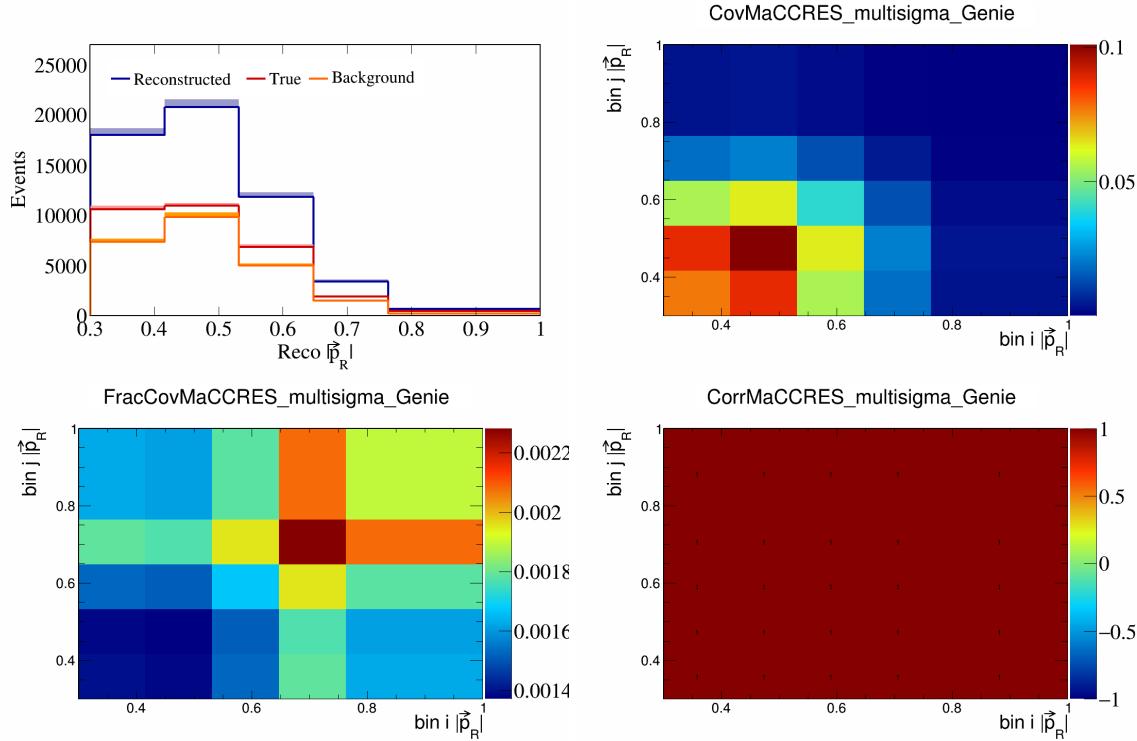


Figure 319: MaCCRES variations for $|\vec{p}_R|$.

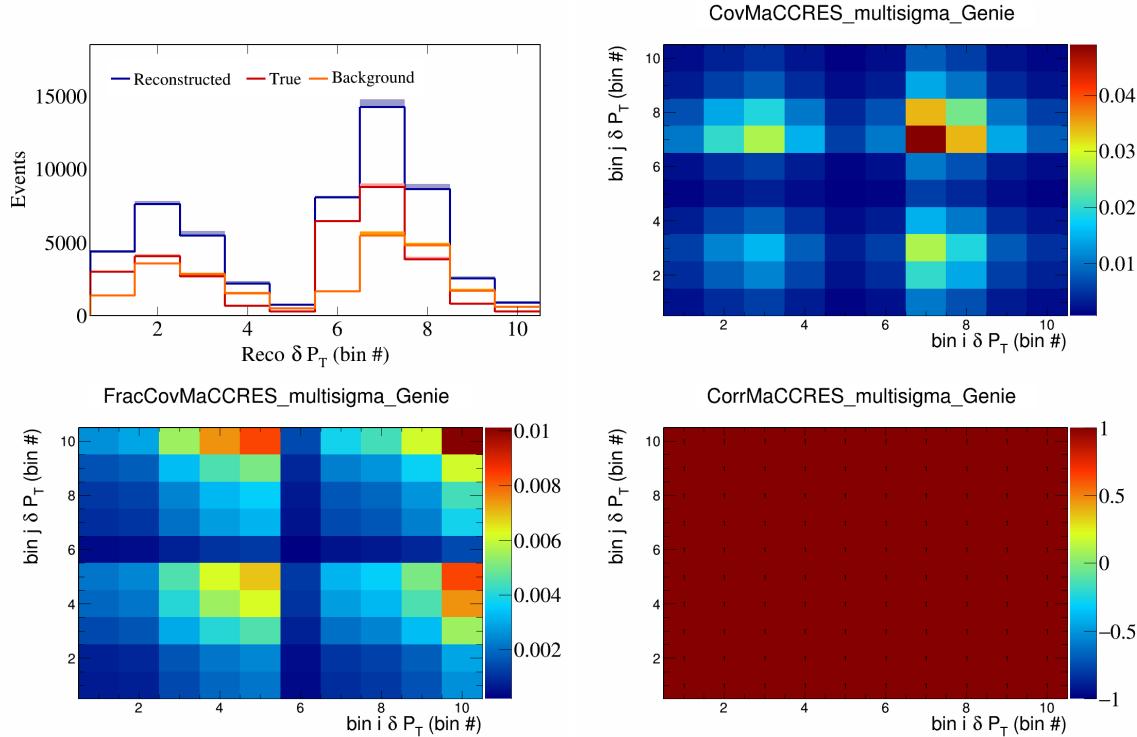


Figure 320: MaCCRES variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

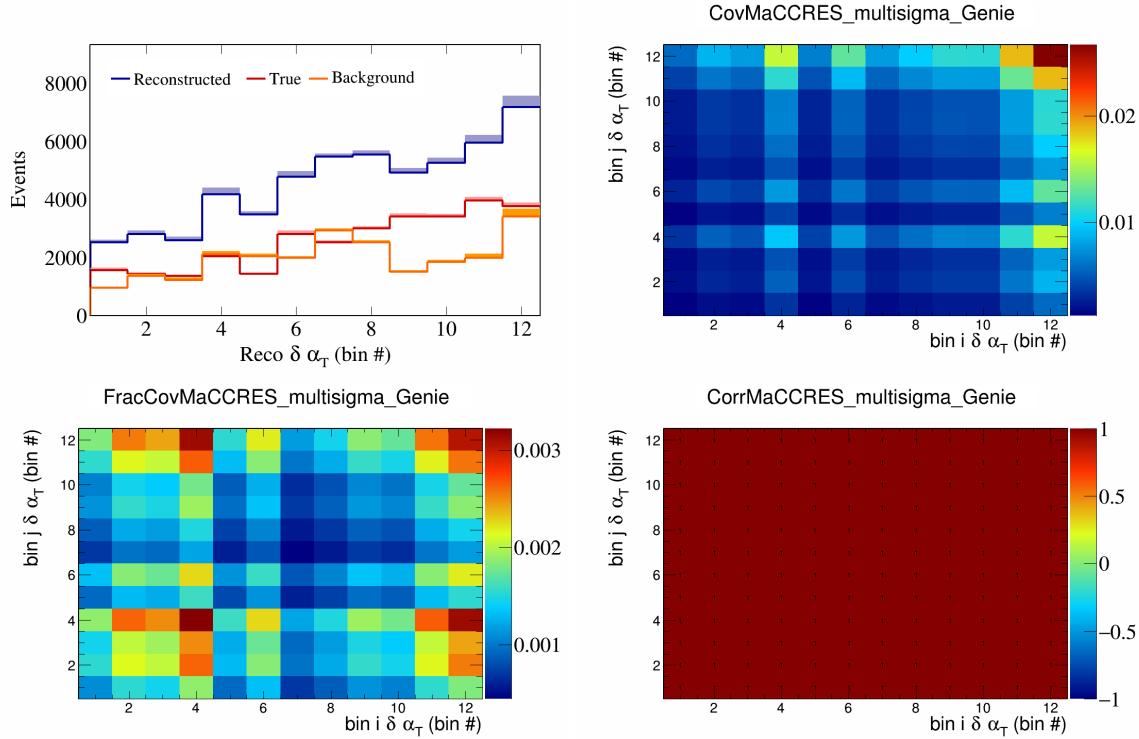


Figure 321: MaCCRES variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

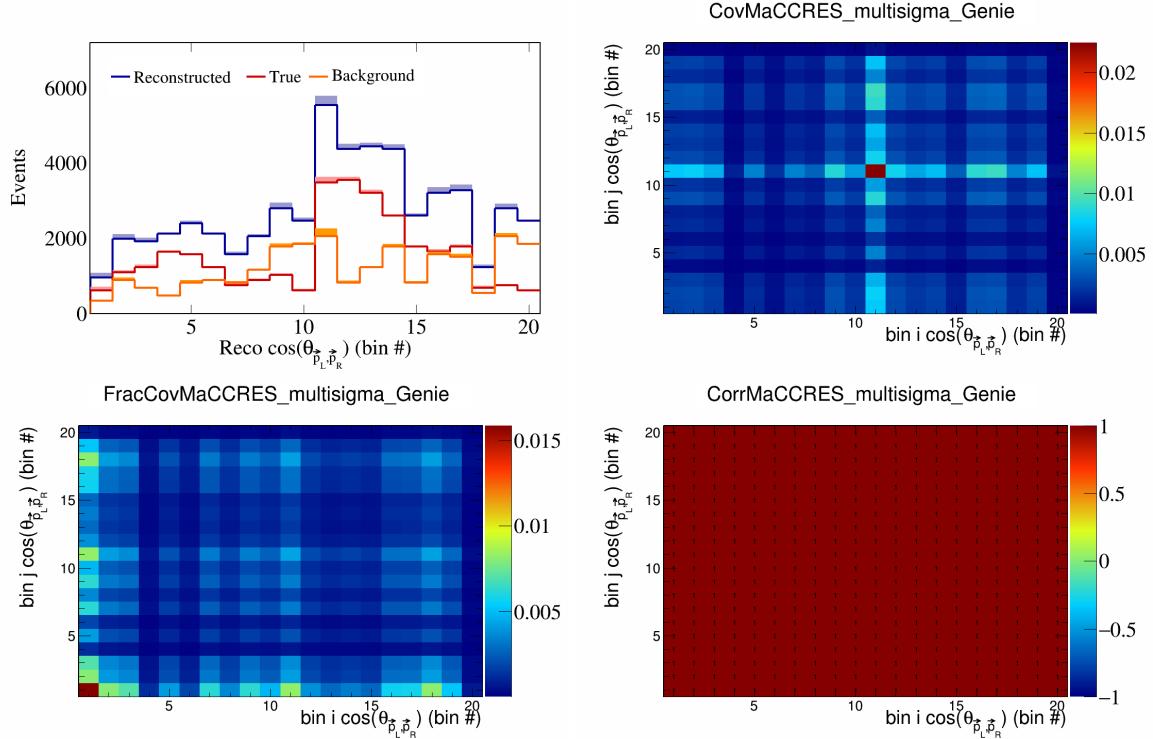


Figure 322: MaCCRES variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

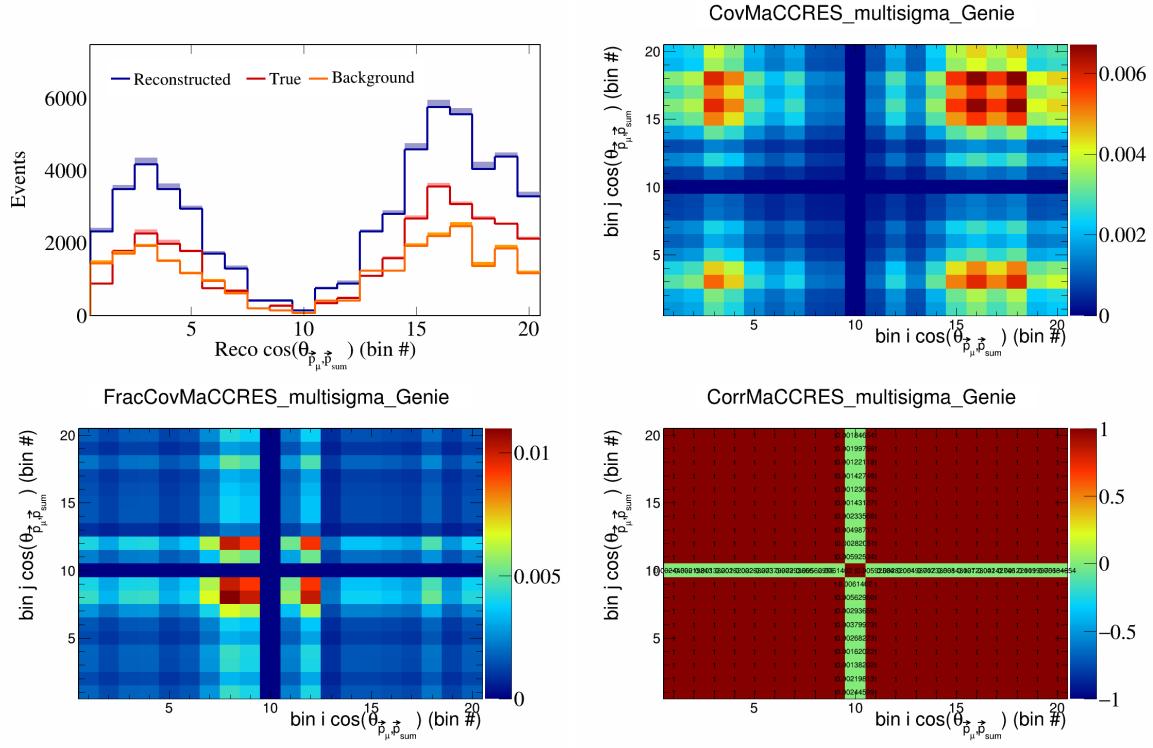


Figure 323: MaCCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

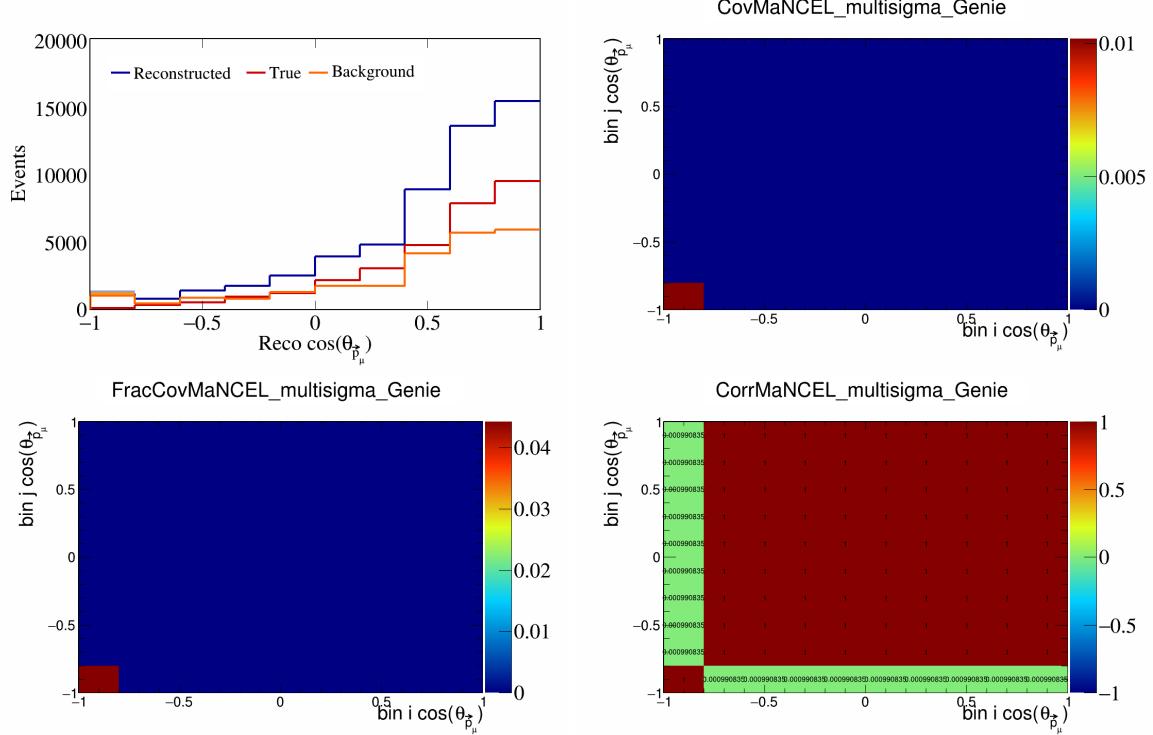


Figure 324: MaNCEL variations for $\cos(\theta_{\vec{p}_\mu})$.

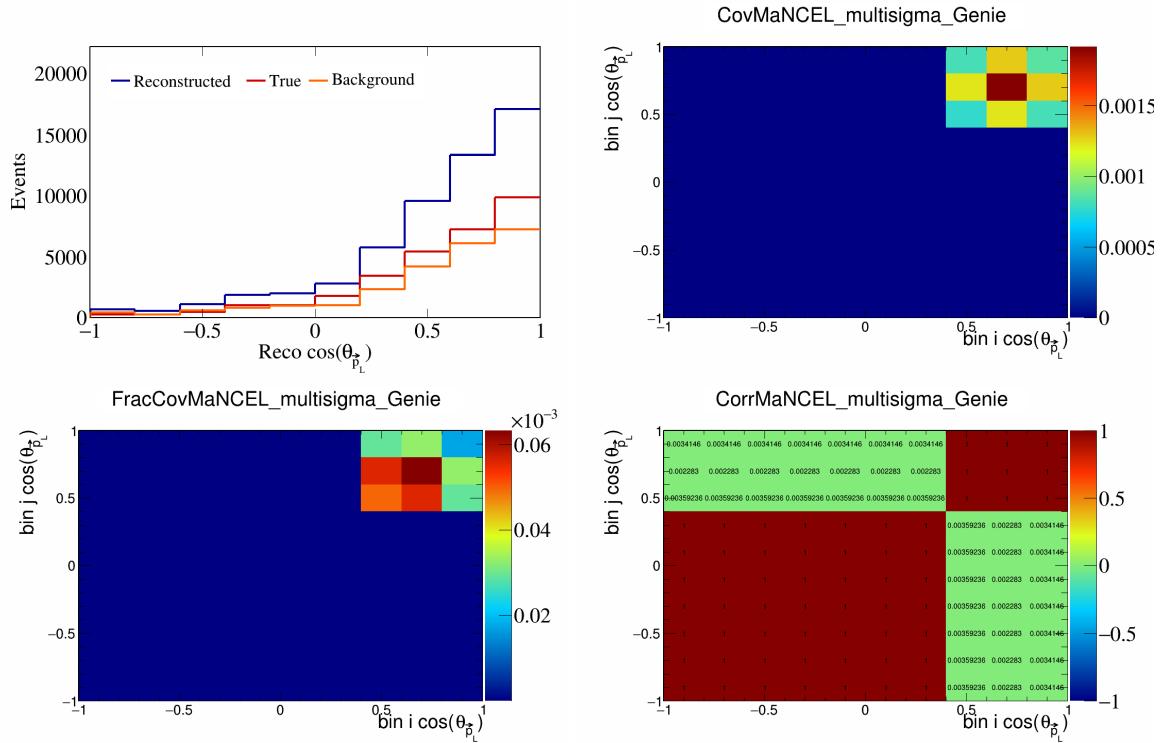


Figure 325: MaNCEL variations for $\cos(\theta_{\vec{p}_L})$.

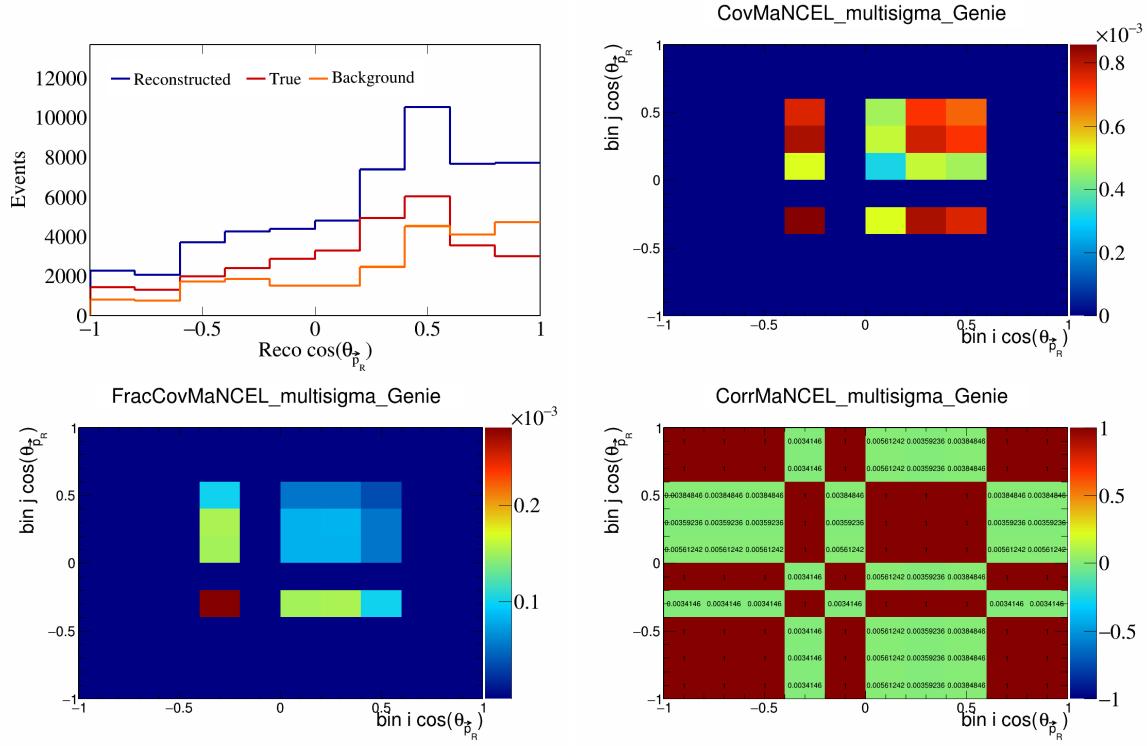


Figure 326: MaNCEL variations for $\cos(\theta_{\vec{p}_R})$.

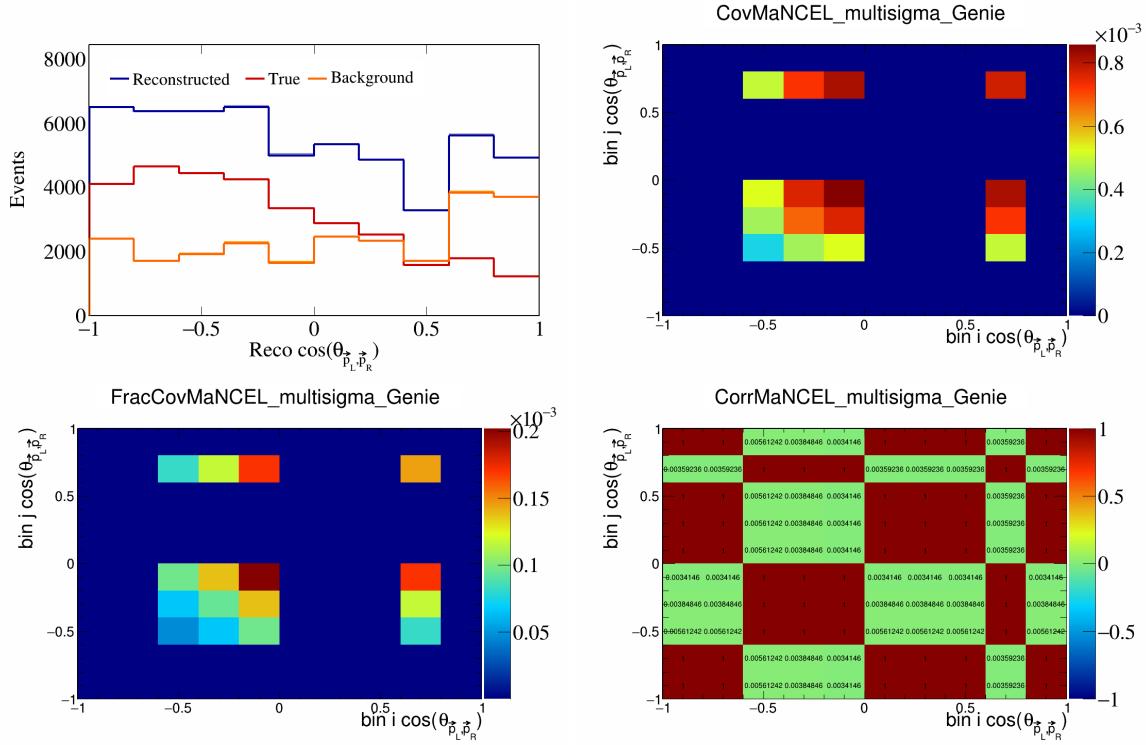


Figure 327: MaNCEL variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

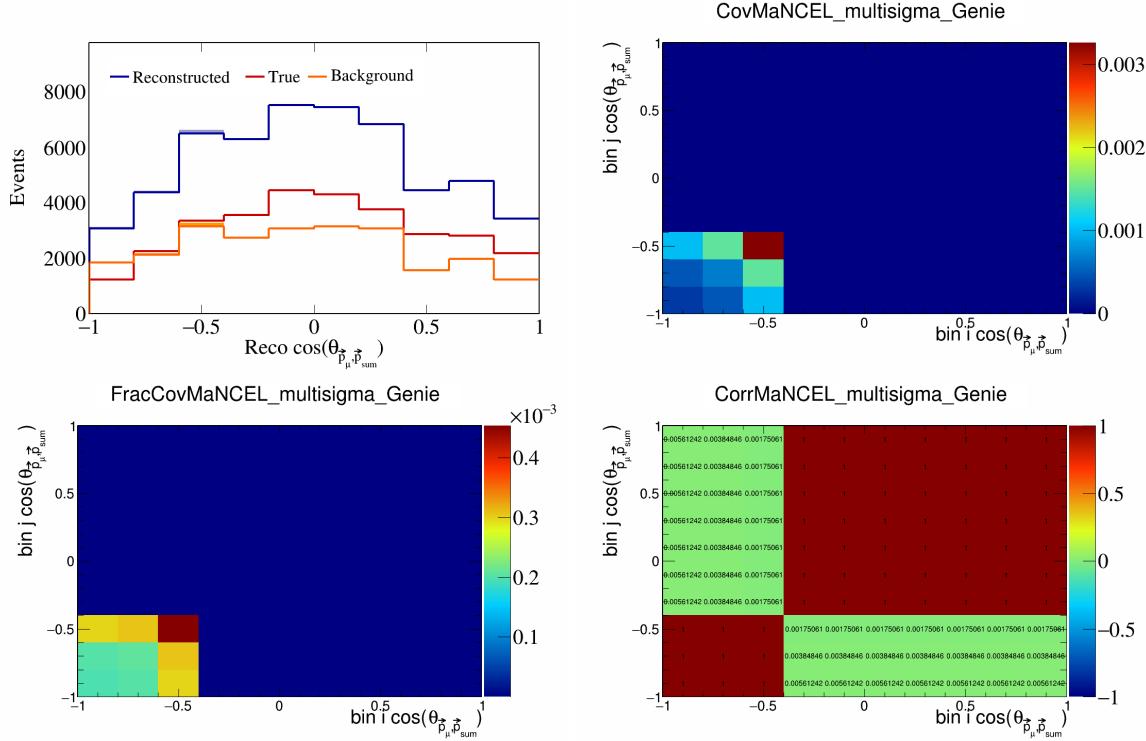


Figure 328: MaNCEL variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

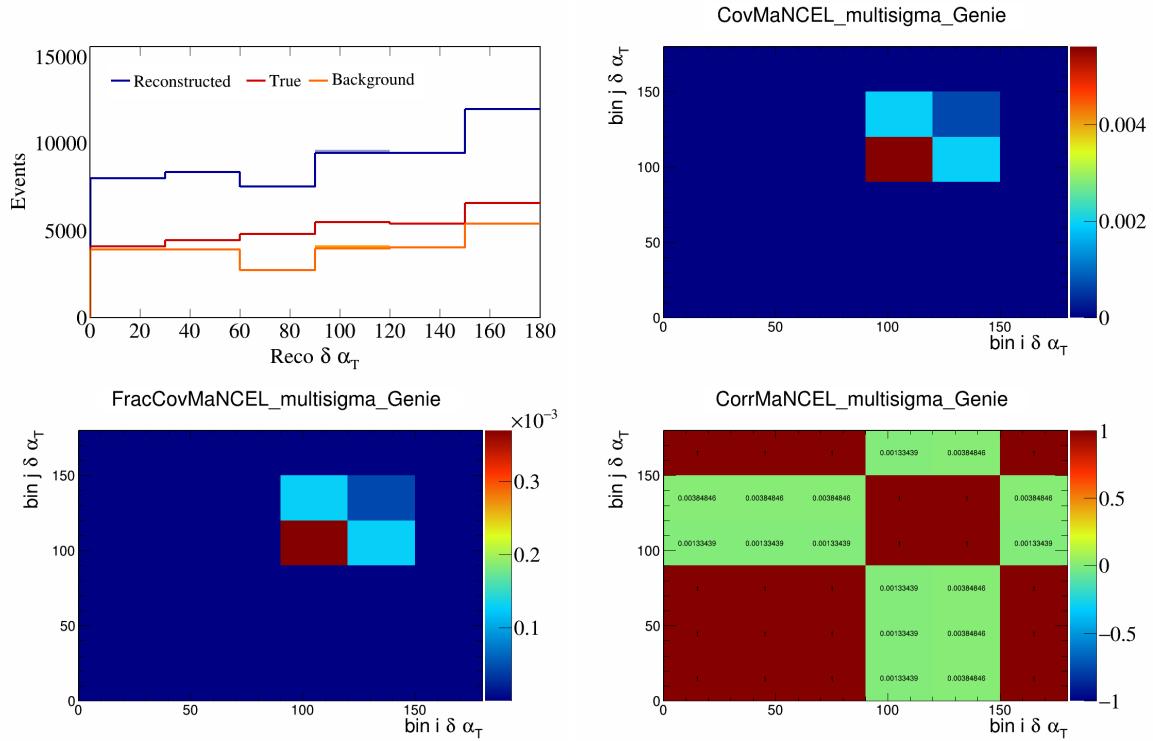


Figure 329: MaNCEL variations for $\delta\alpha_T$.

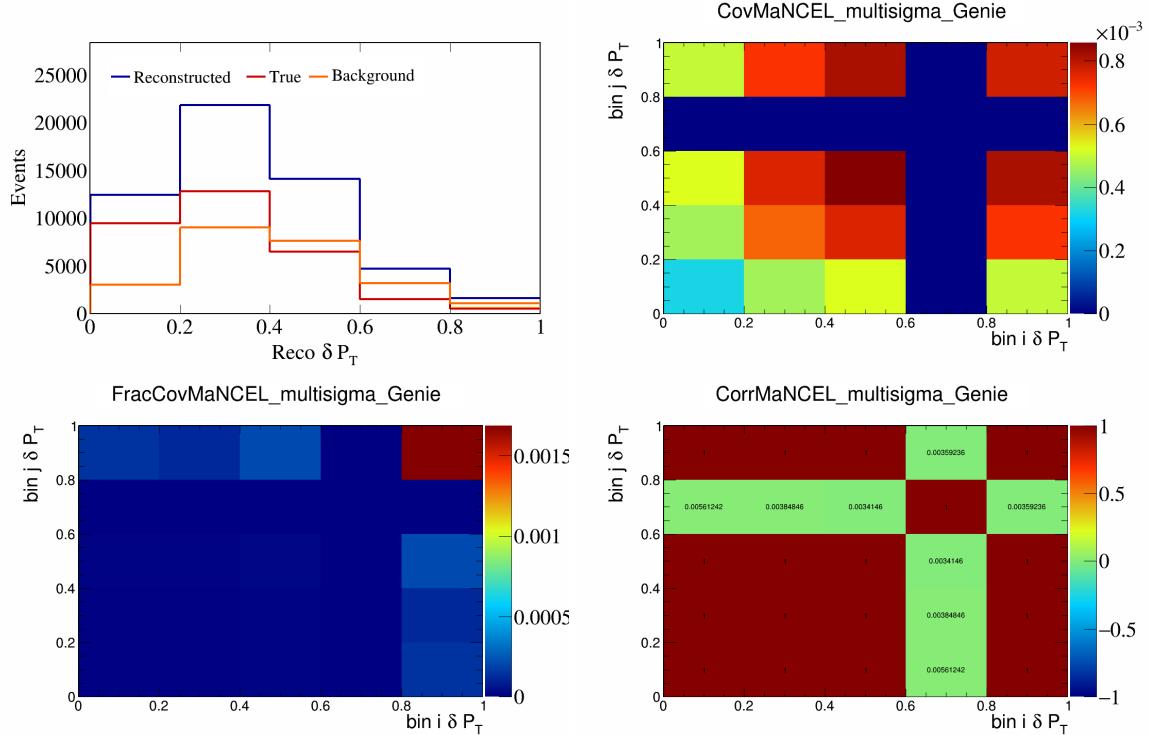


Figure 330: MaNCEL variations for δP_T .

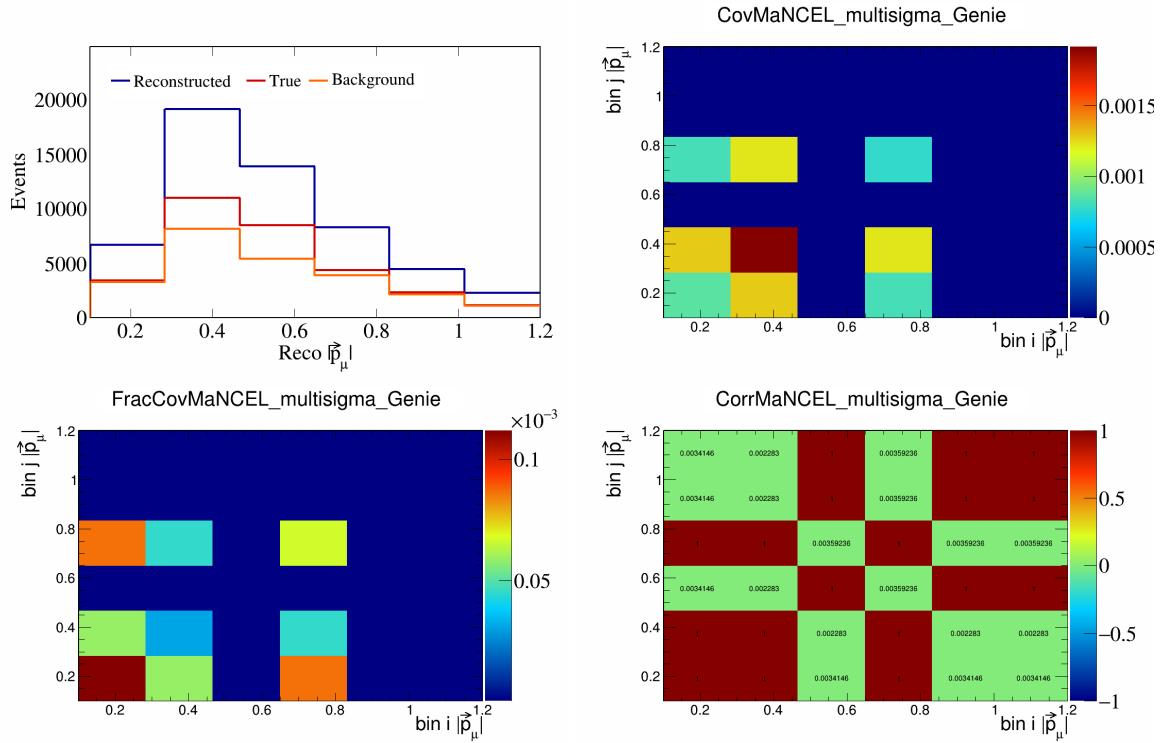


Figure 331: MaNCEL variations for $|\vec{p}_\mu|$.

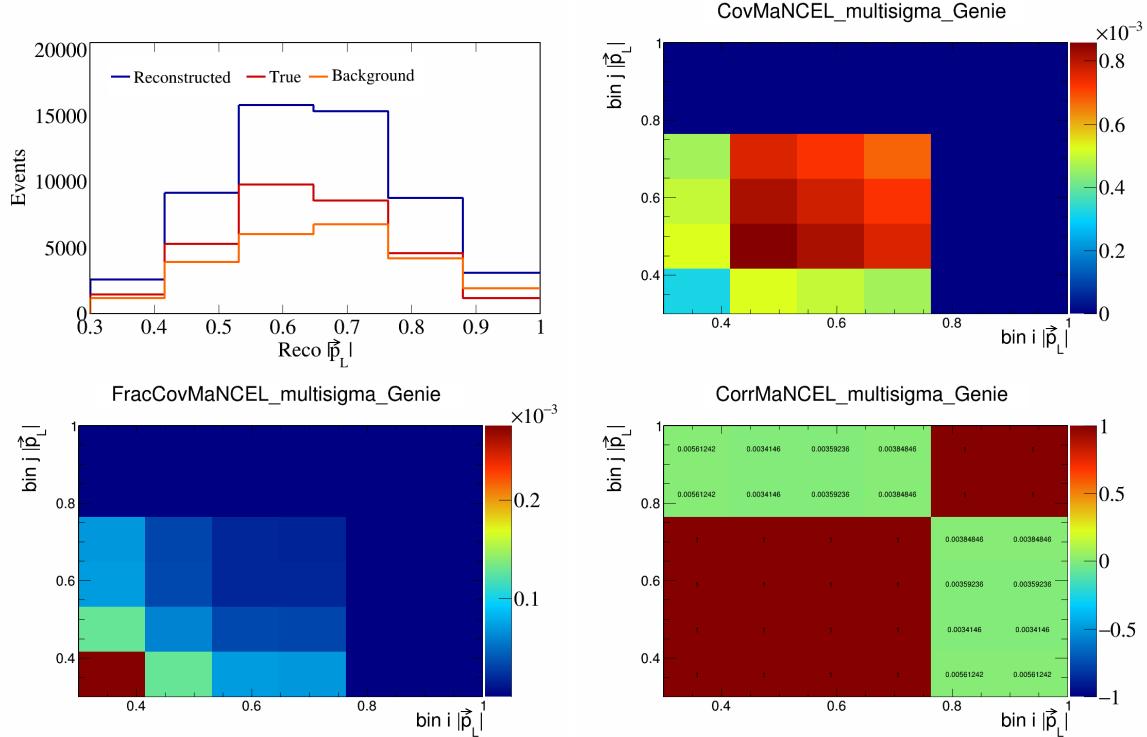


Figure 332: MaNCEL variations for $|\vec{p}_L|$.

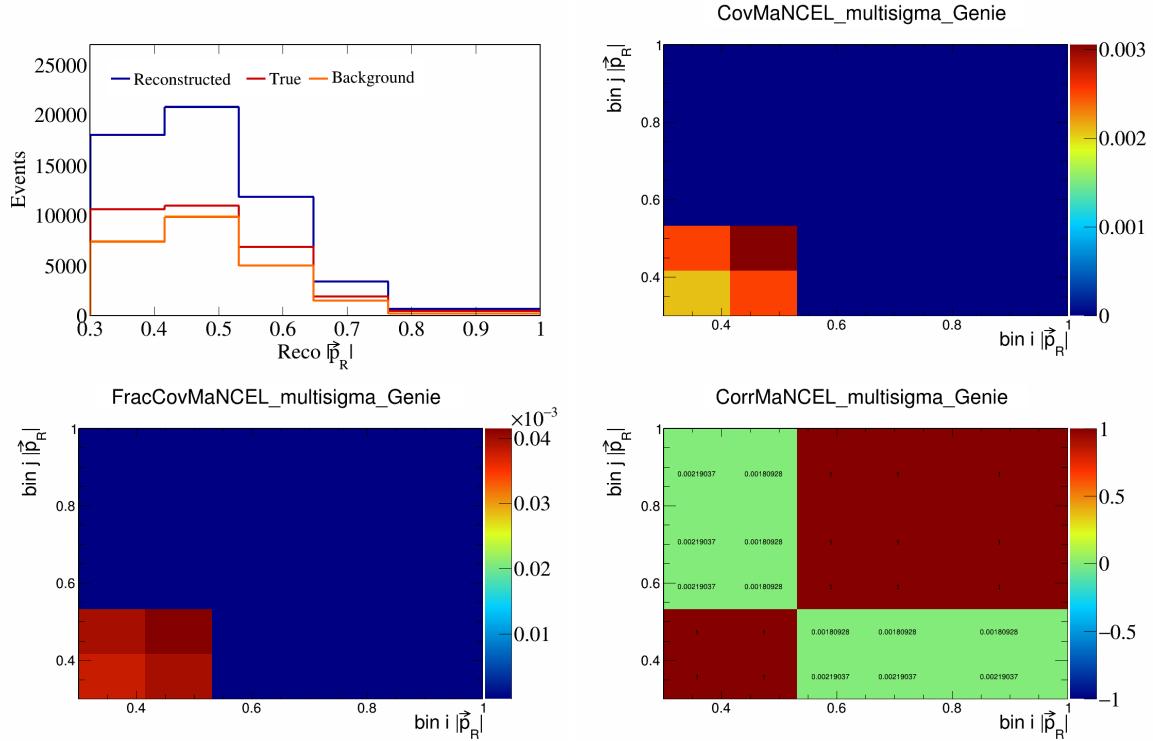


Figure 333: MaNCEL variations for $|\vec{p}_R|$.

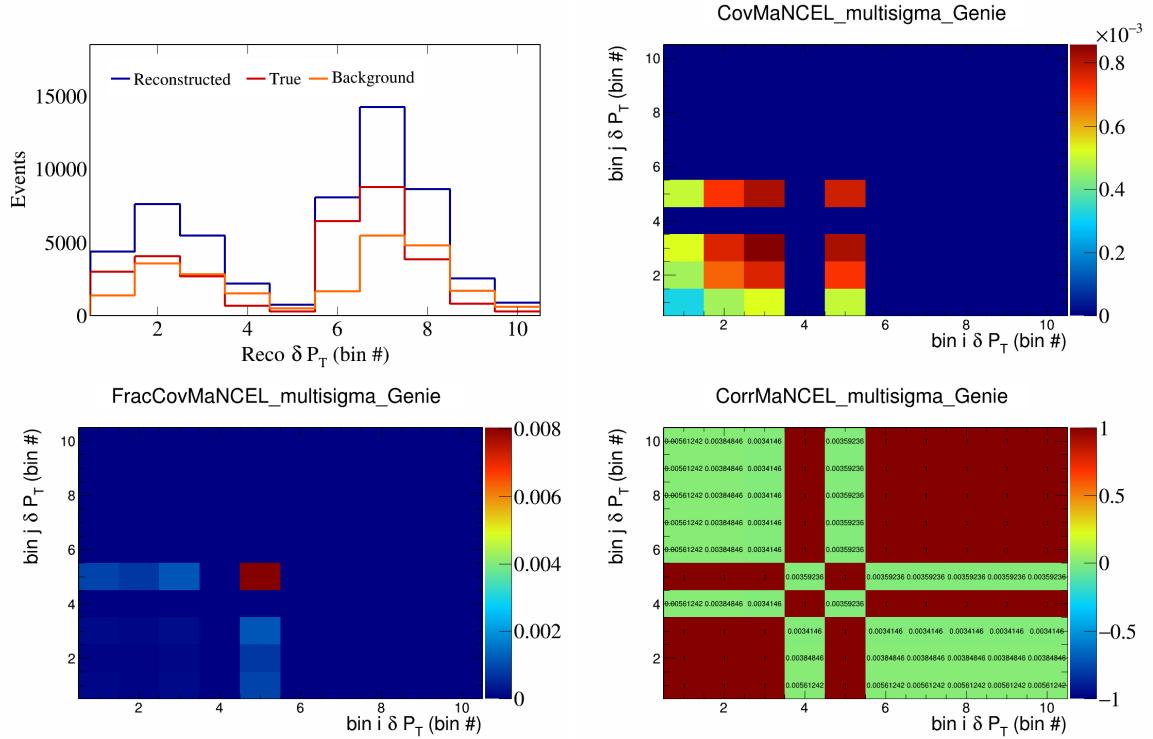


Figure 334: MaNCEL variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

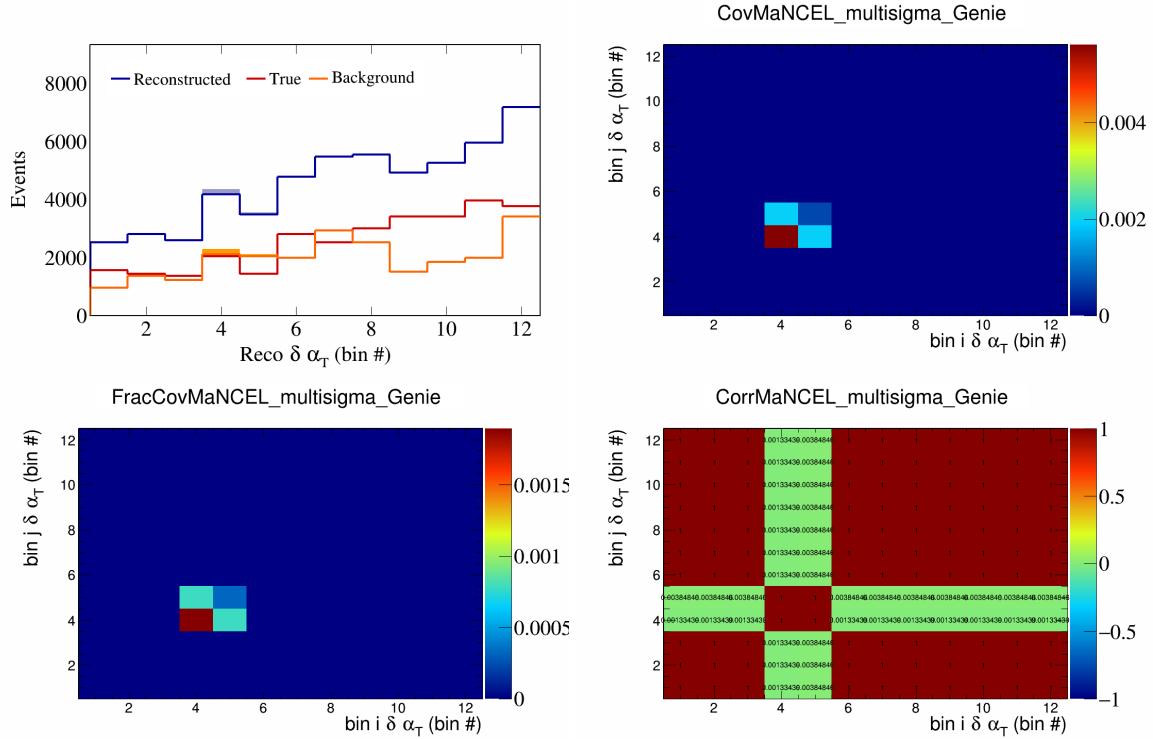


Figure 335: MaNCEL variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

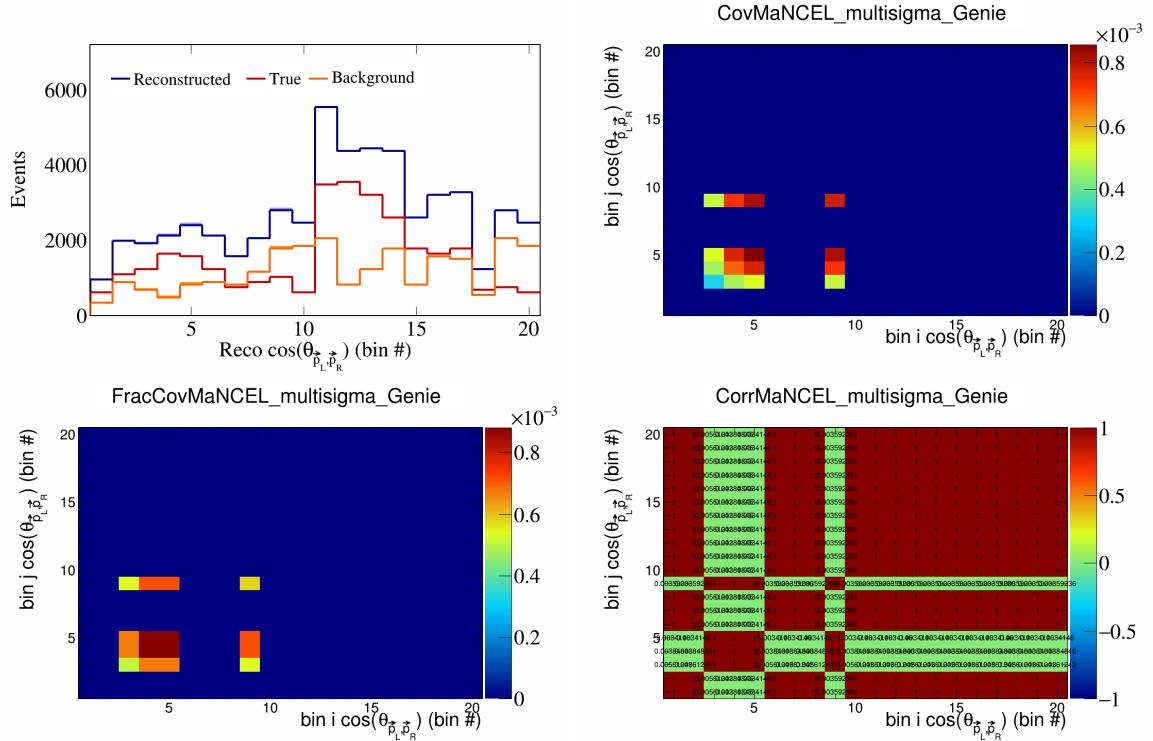


Figure 336: MaNCEL variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

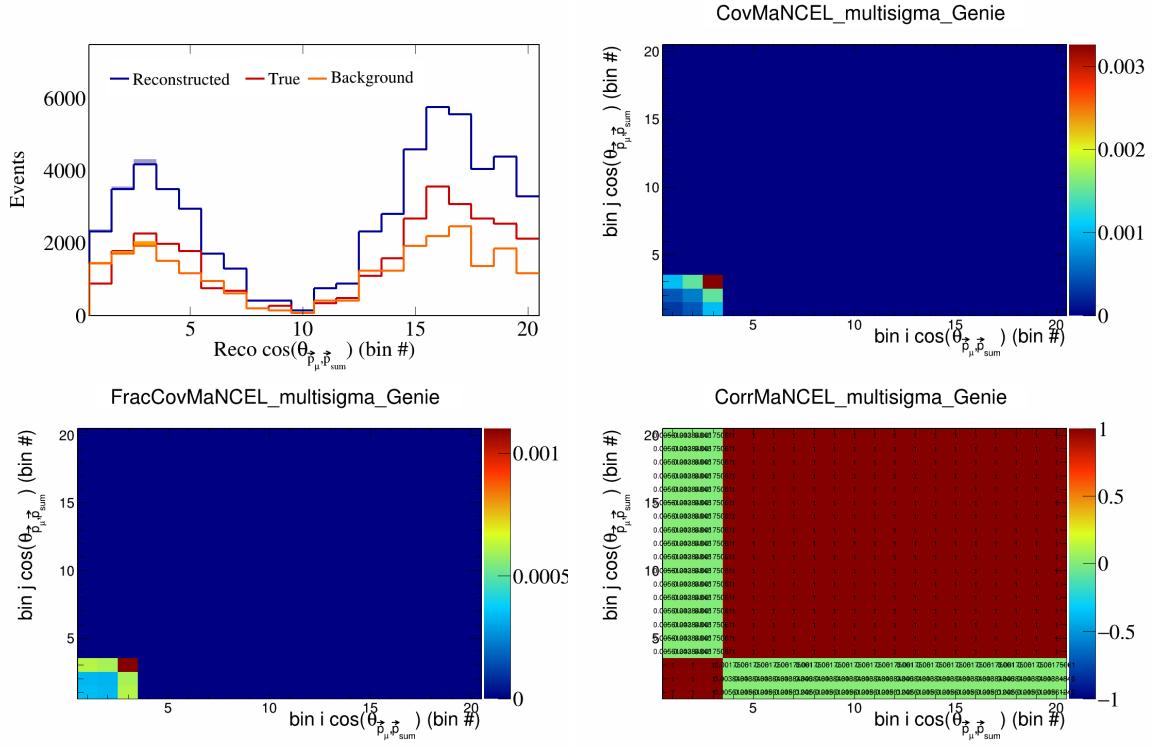


Figure 337: MaNCEL variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

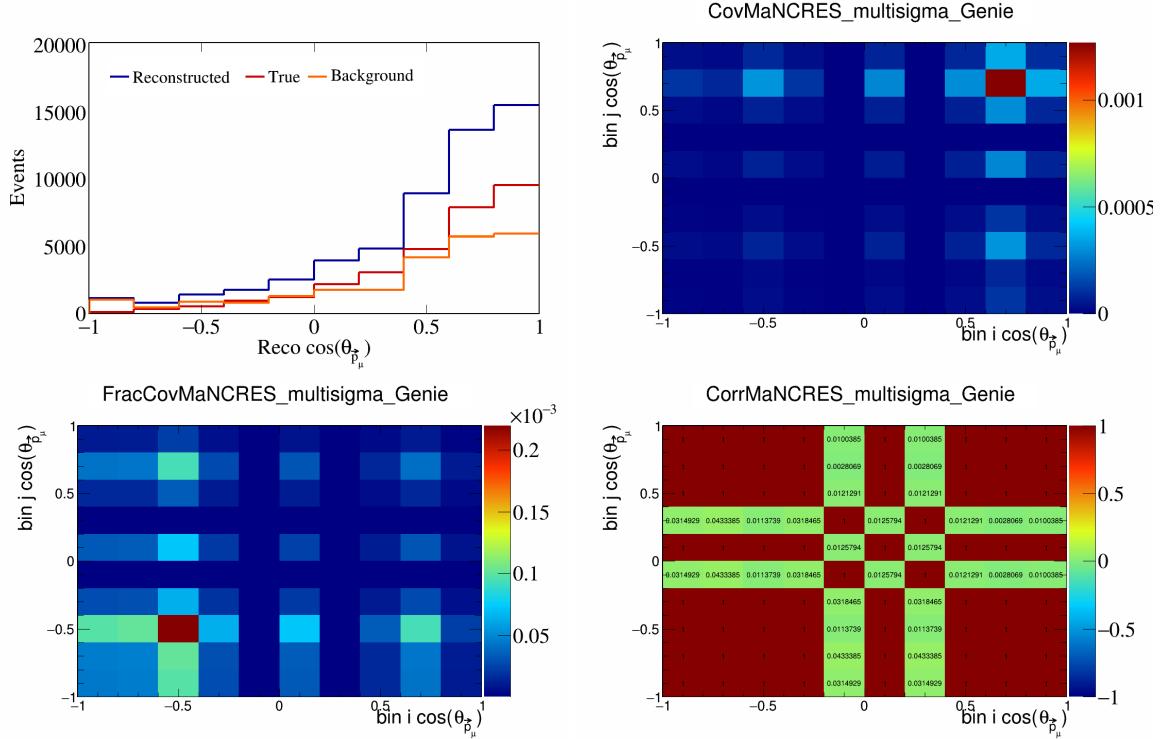


Figure 338: MaNCRES variations for $\cos(\theta_{\vec{p}_\mu})$.

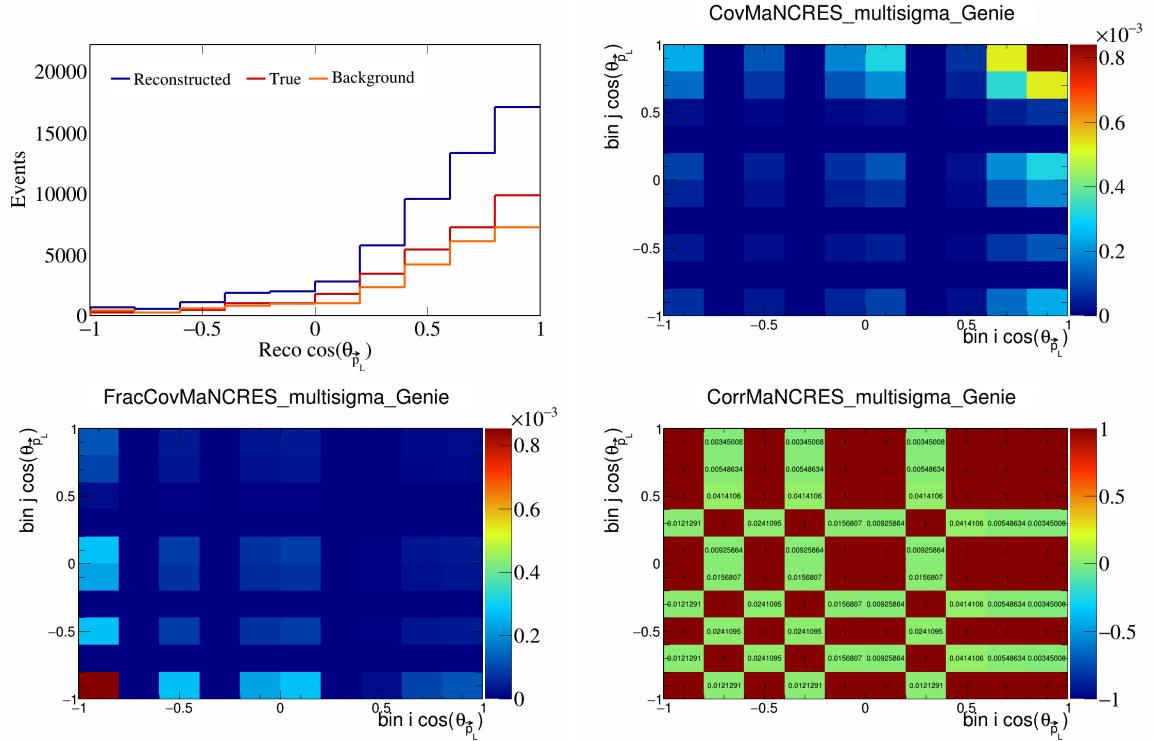


Figure 339: MaNCRES variations for $\cos(\theta_{\vec{p}_L})$.

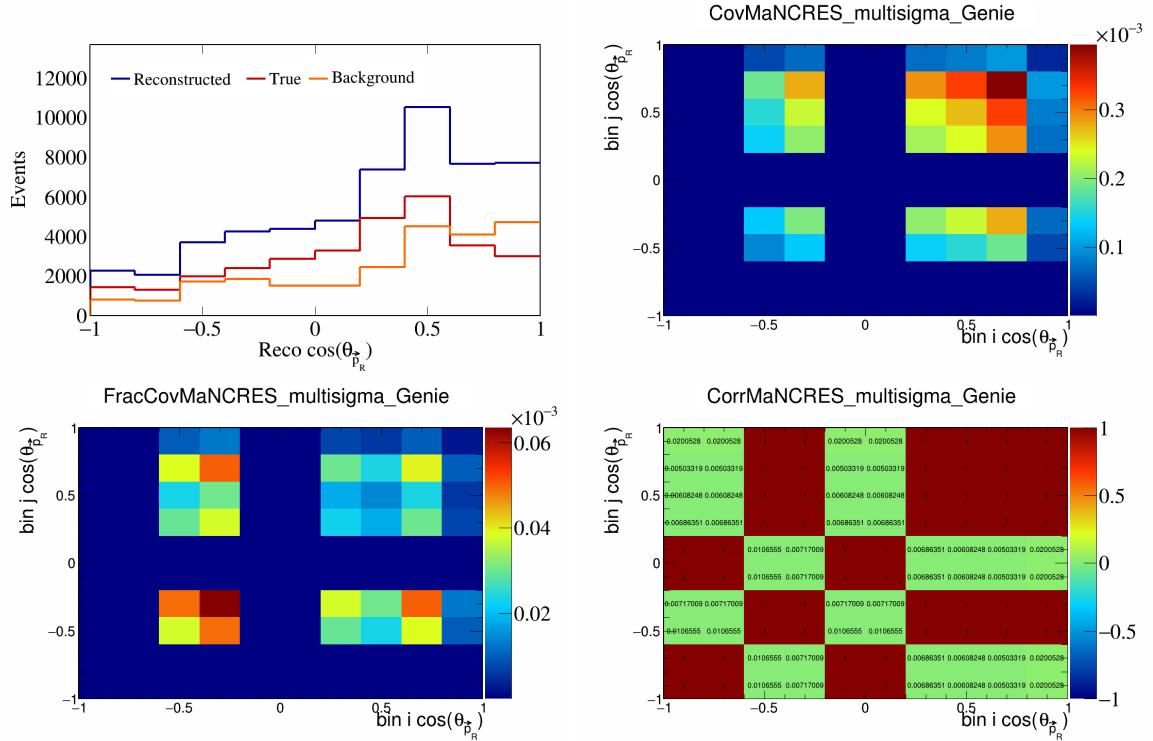


Figure 340: MaNCRES variations for $\cos(\theta_{\vec{p}_R})$.

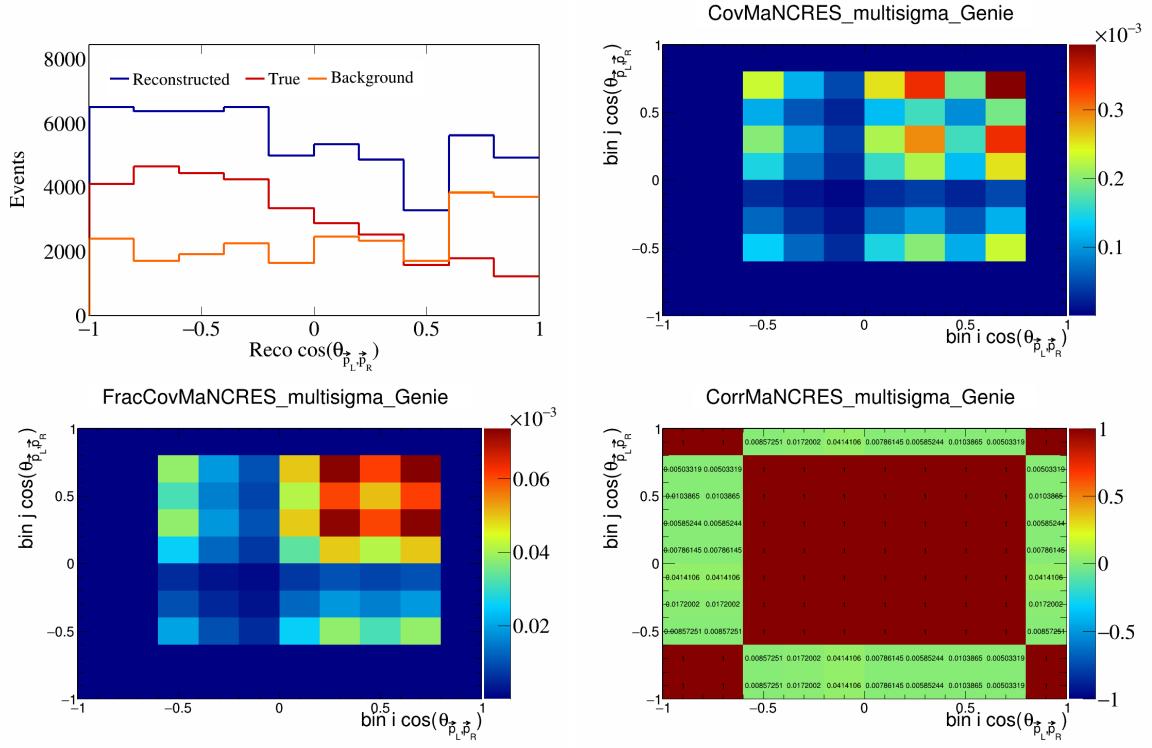


Figure 341: MaNCRES variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

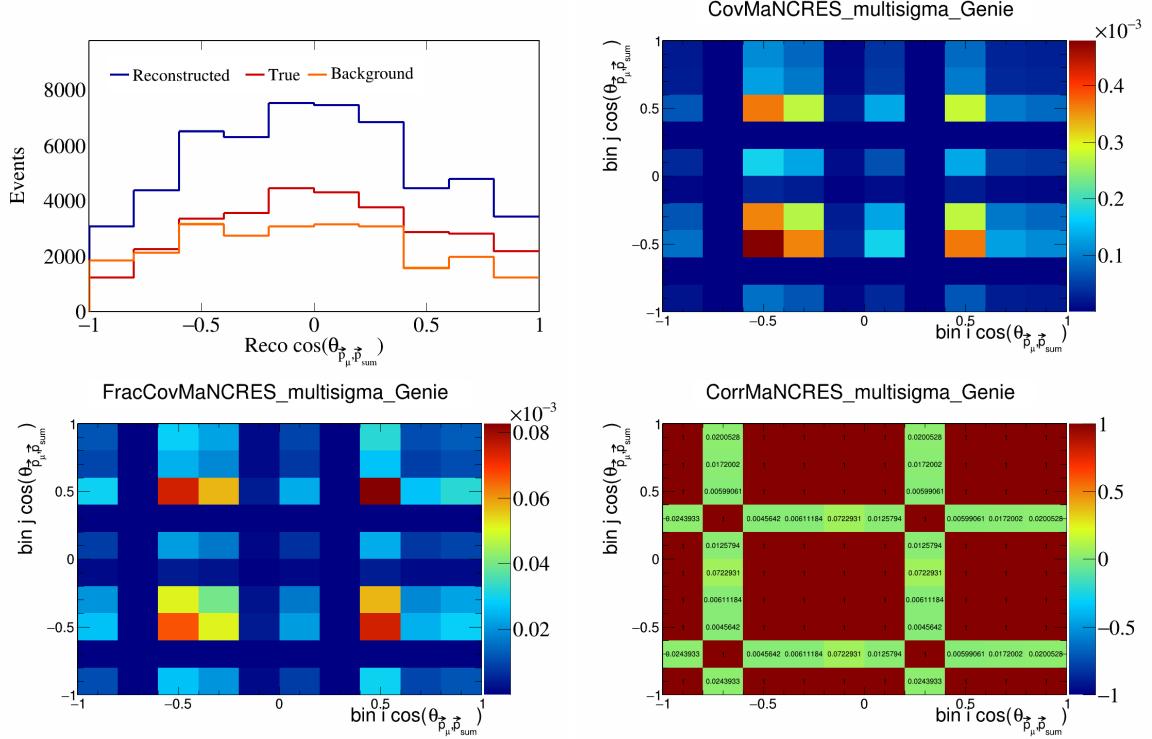


Figure 342: MaNCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

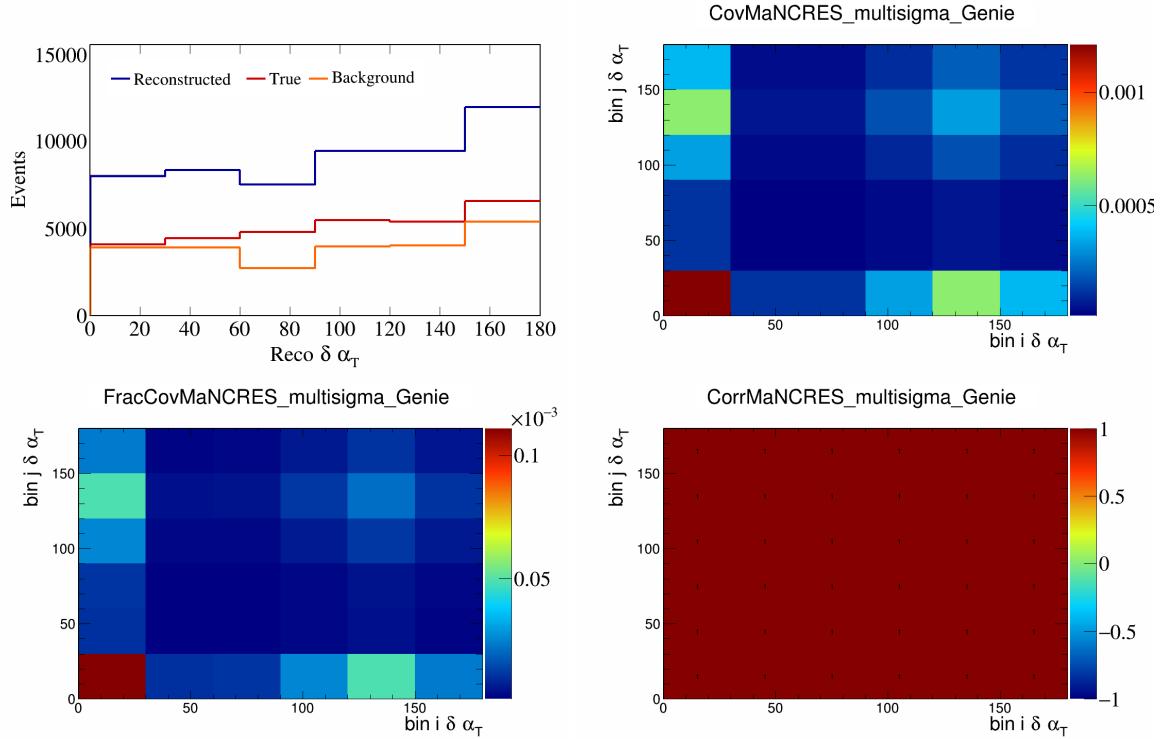


Figure 343: MaNCRES variations for $\delta\alpha_T$.

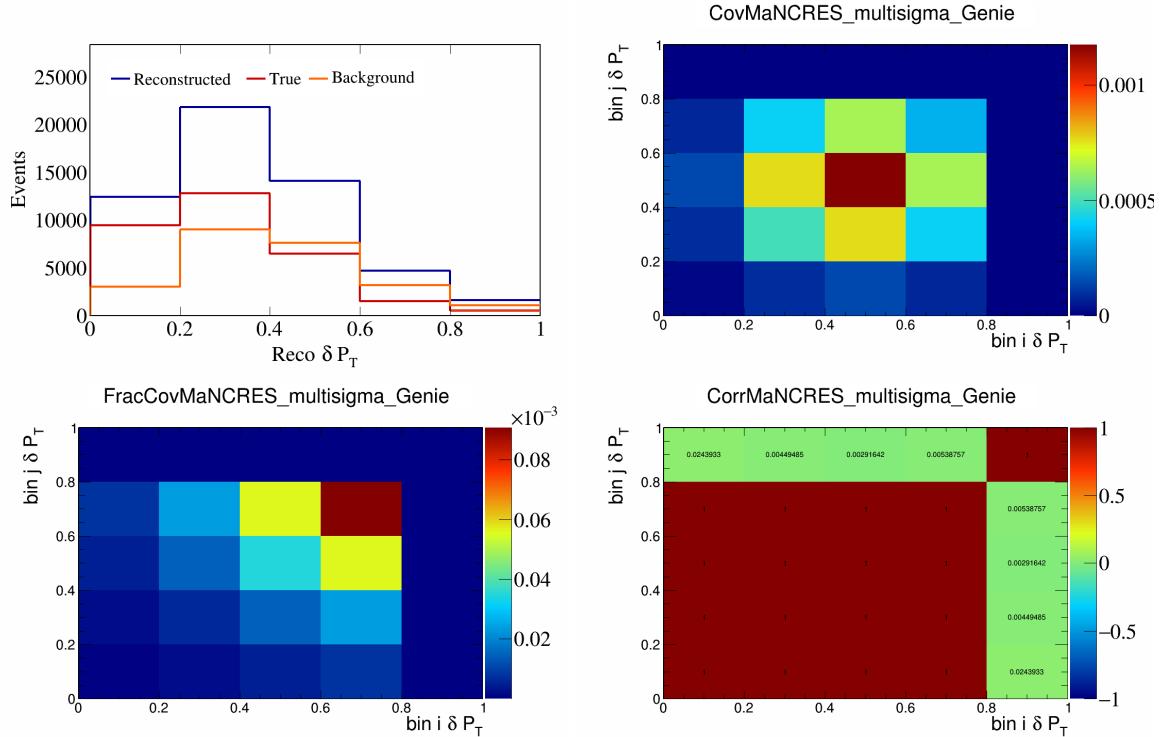


Figure 344: MaNCRES variations for δP_T .

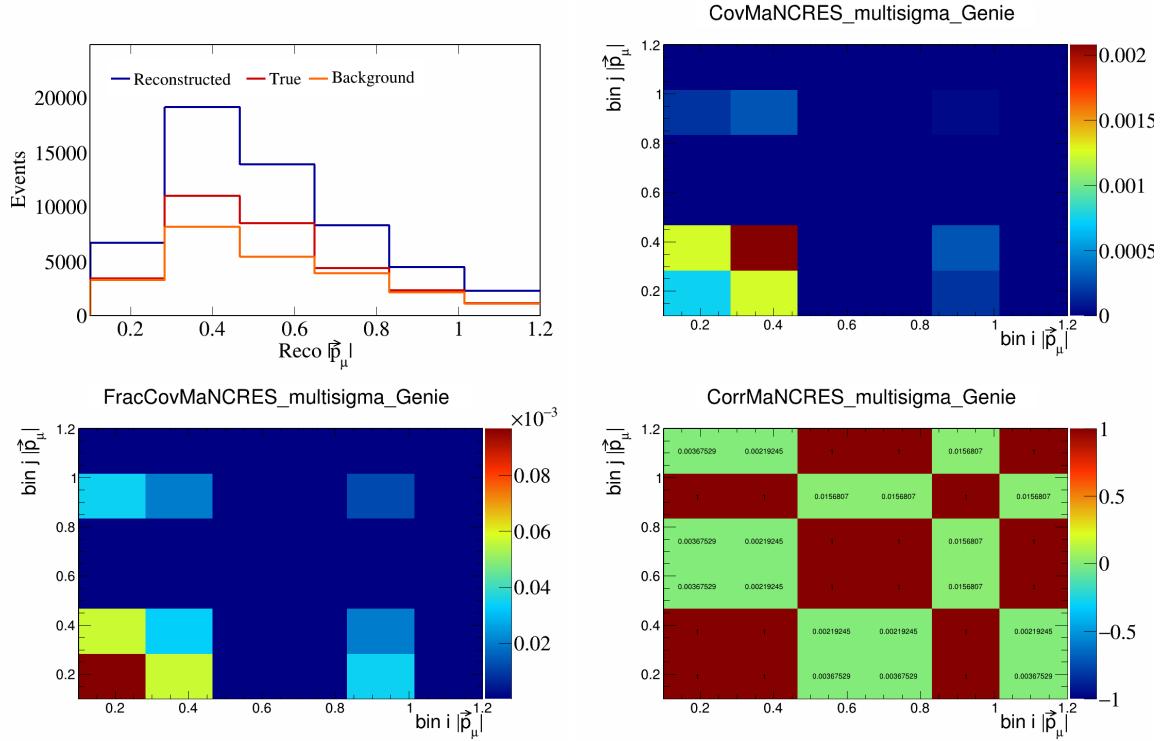


Figure 345: MaNCRES variations for $|\vec{p}_\mu|$.

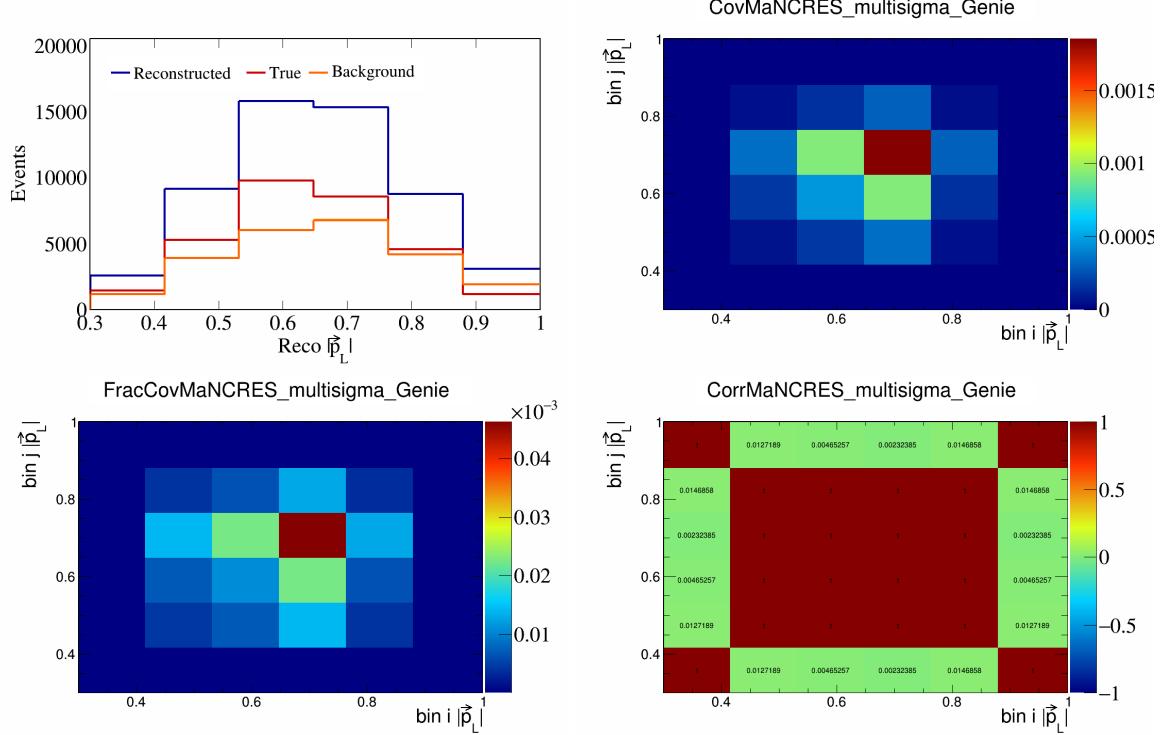


Figure 346: MaNCRES variations for $|\vec{p}_L|$.

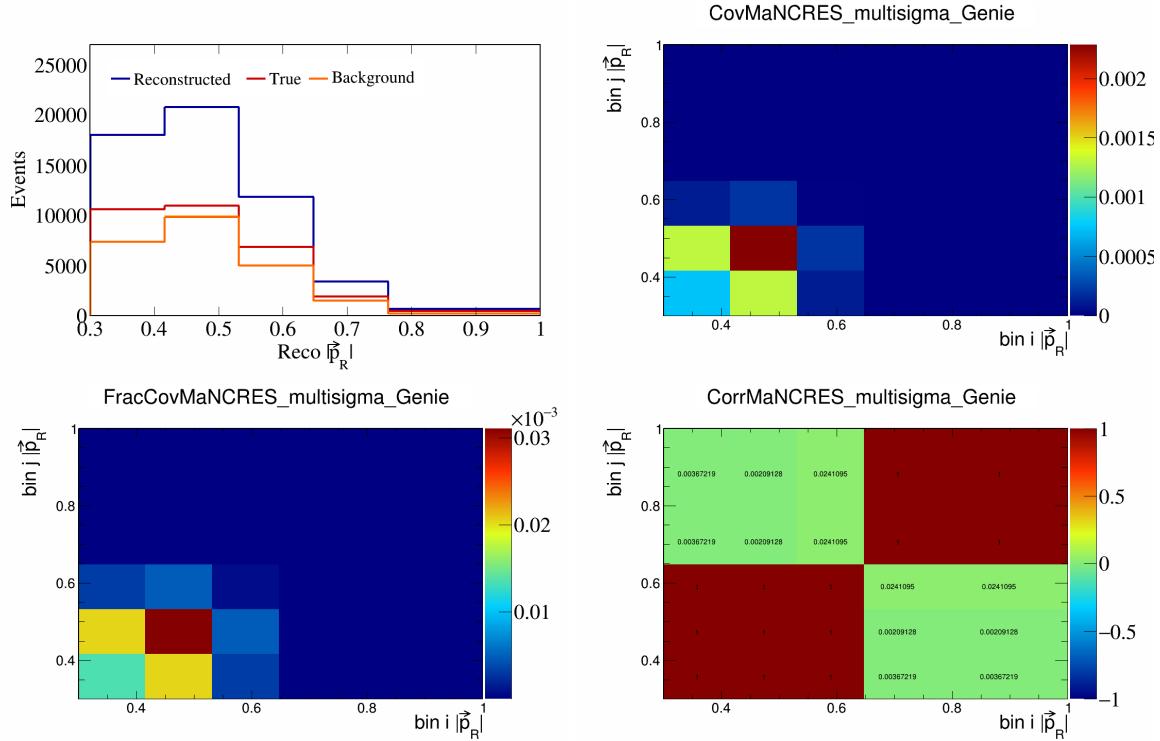


Figure 347: MaNCRES variations for $|\vec{p}_R|$.

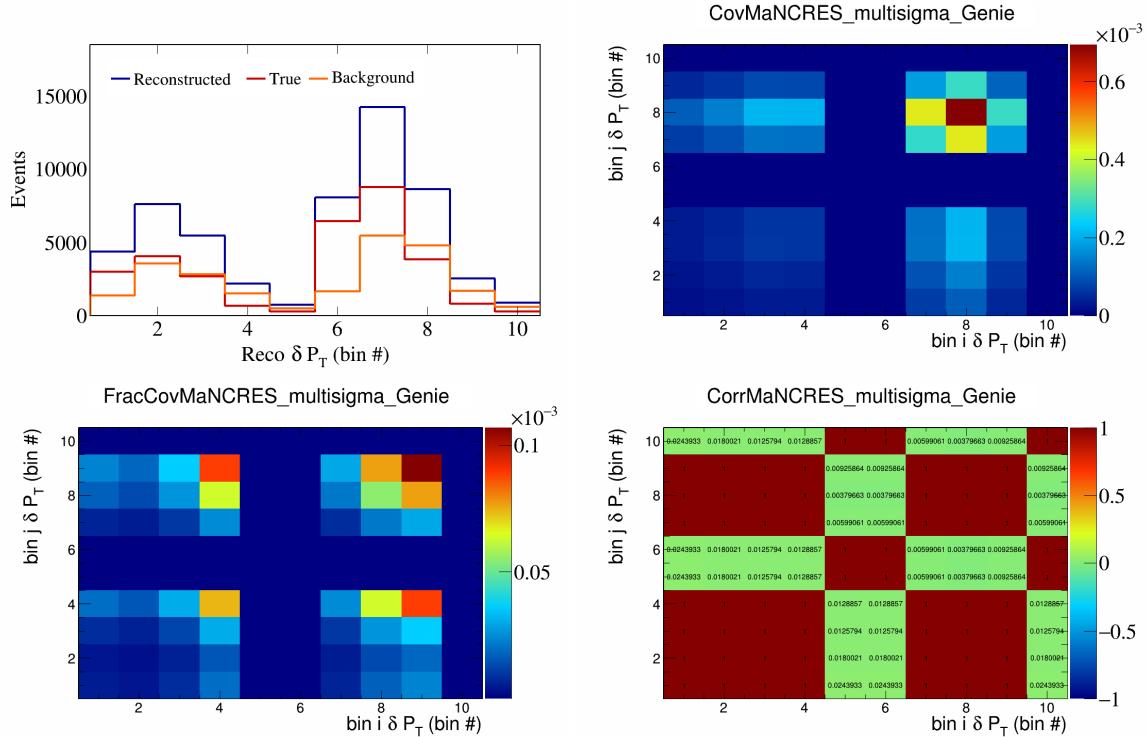


Figure 348: MaNCRES variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

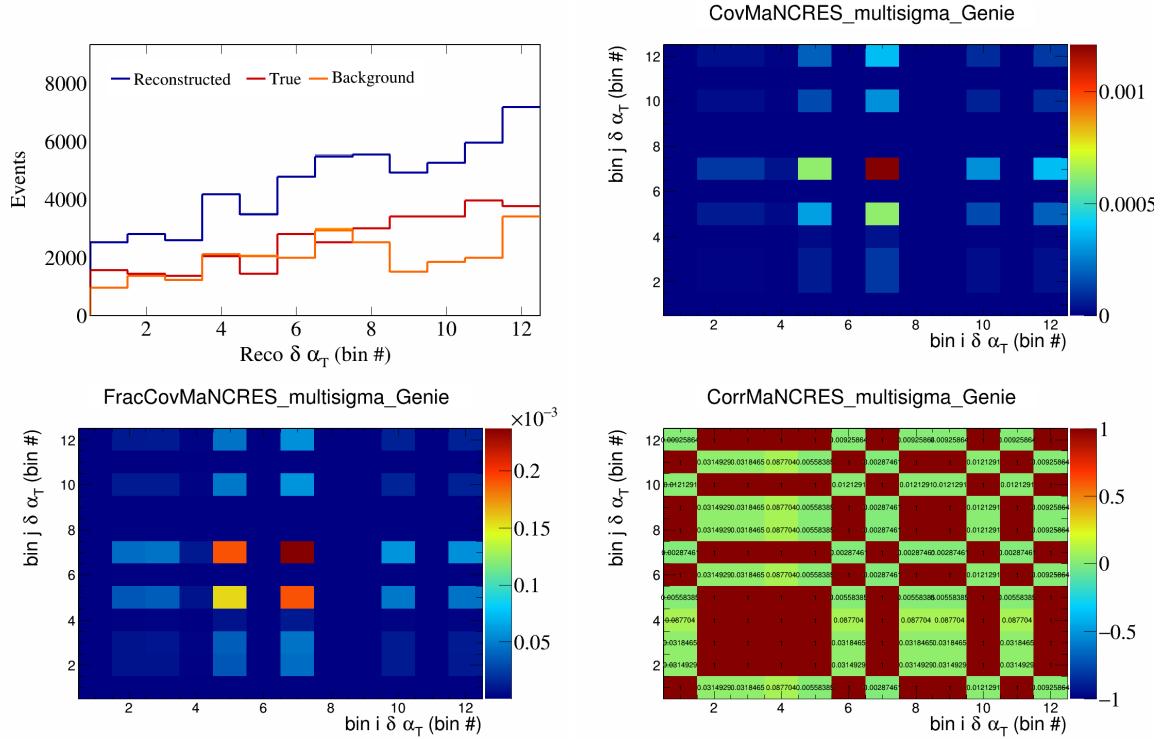


Figure 349: MaNCRES variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

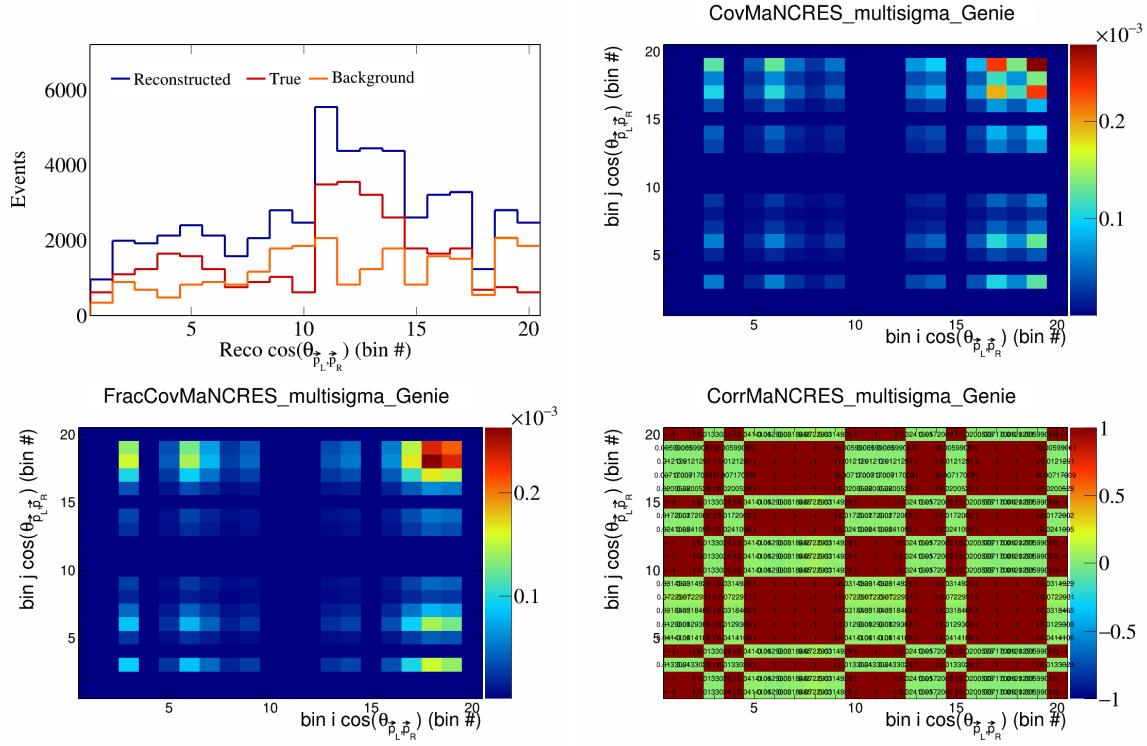


Figure 350: MaNCRES variations for $\cos(\theta_{p_L, p_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

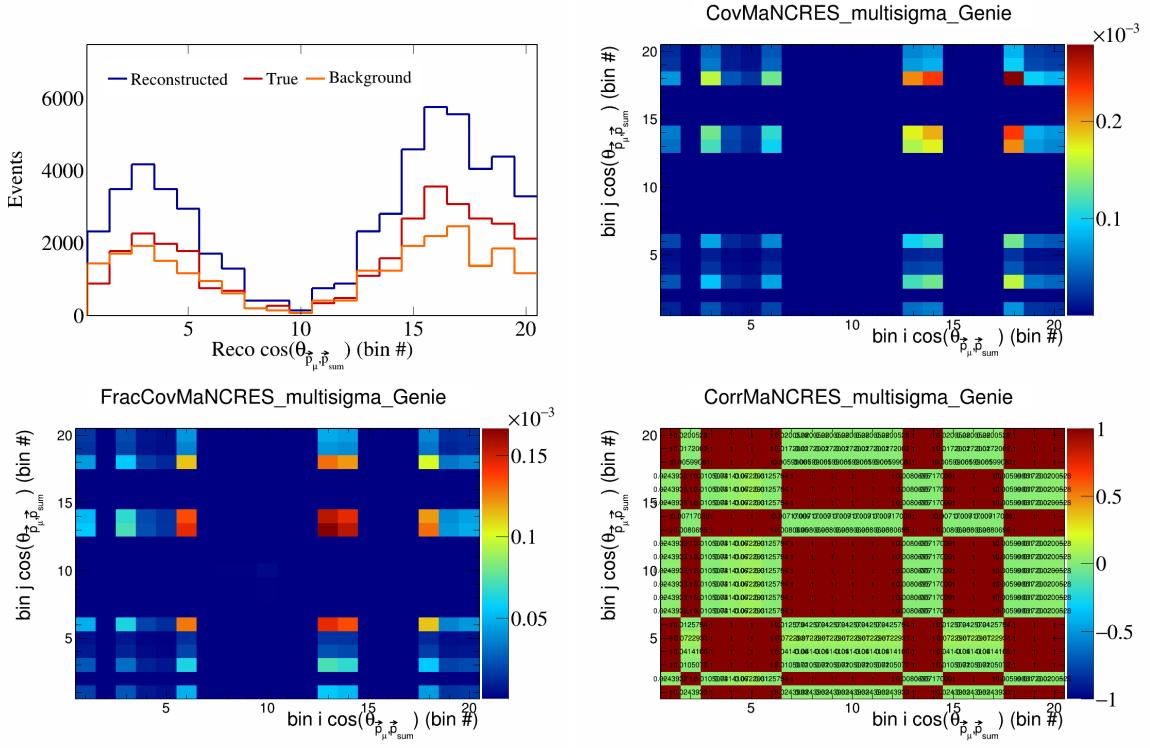


Figure 351: MaNCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

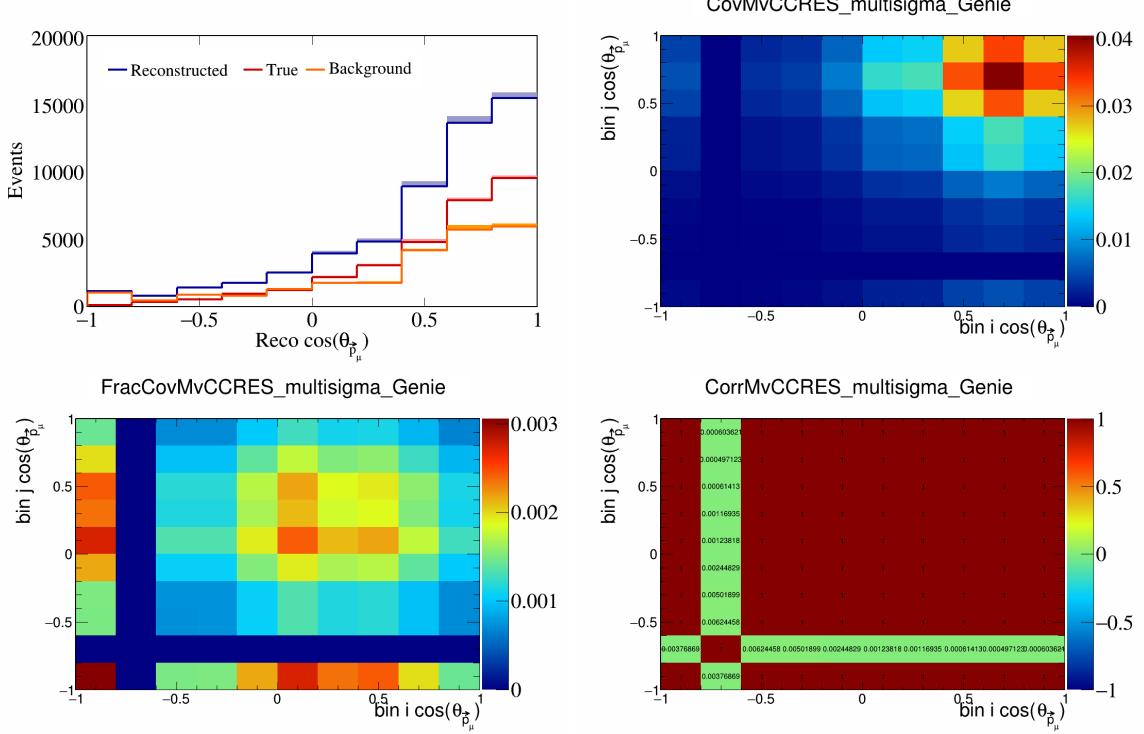


Figure 352: MvCCRES variations for $\cos(\theta_{\vec{p}_\mu})$.

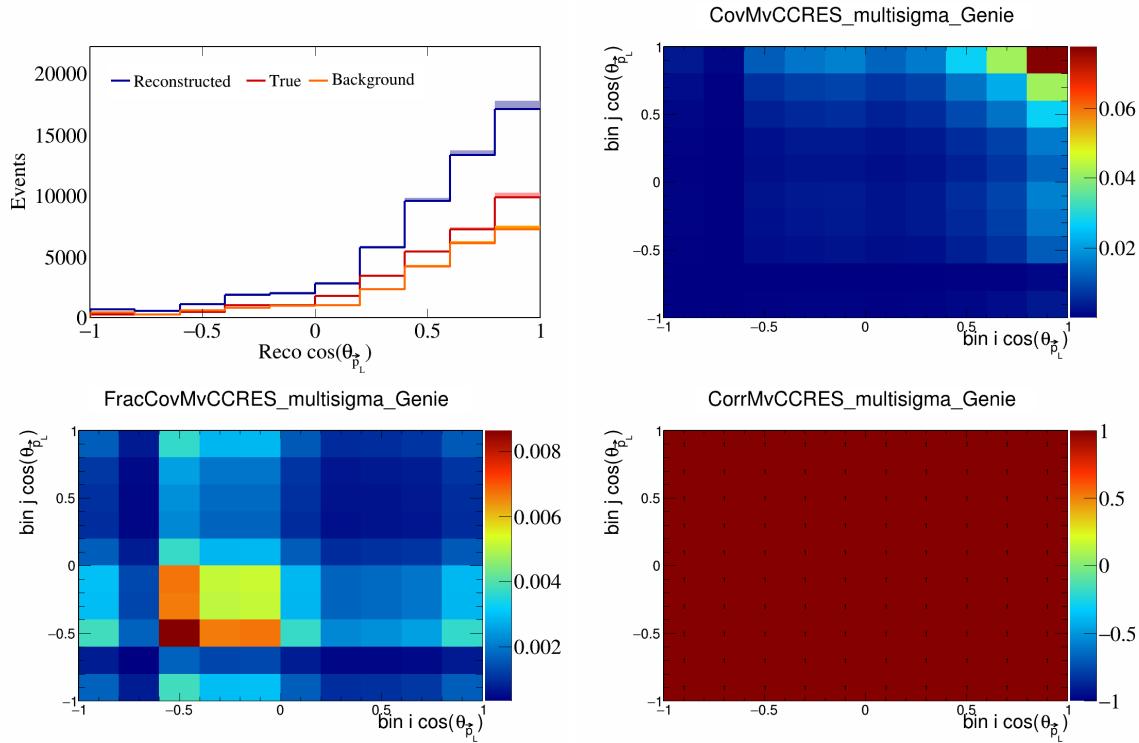


Figure 353: MvCCRES variations for $\cos(\theta_{\vec{p}_L})$.

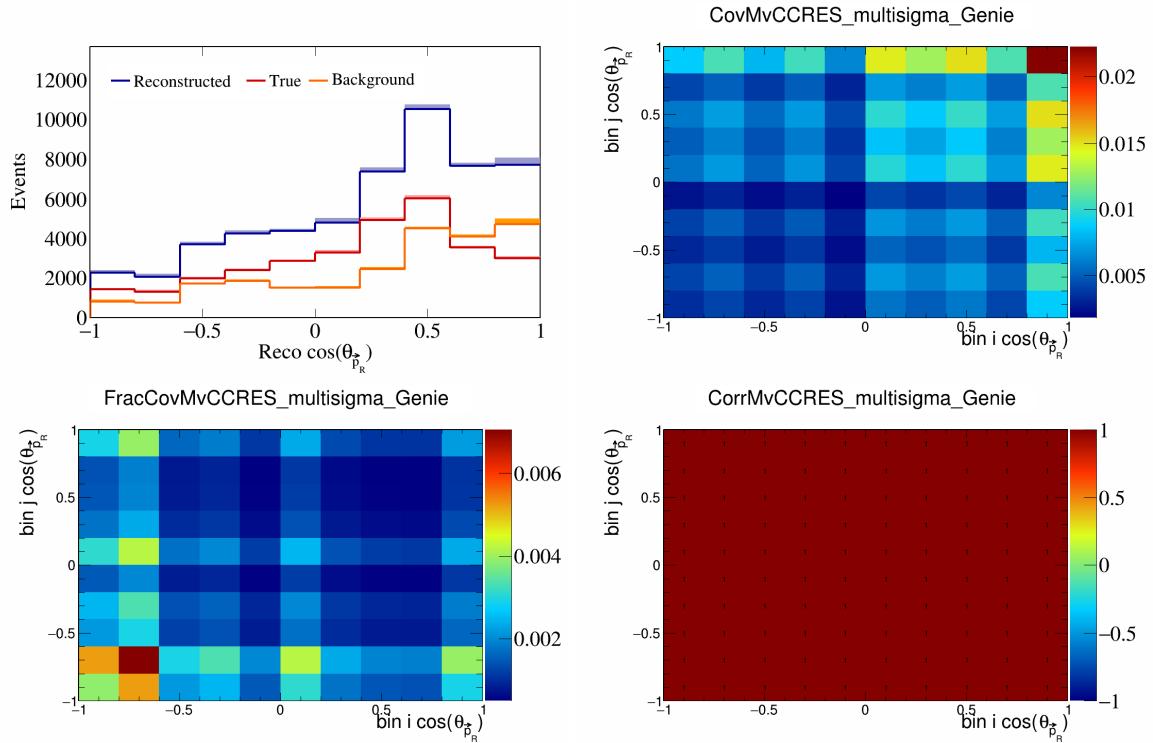


Figure 354: MvCCRES variations for $\cos(\theta_{\vec{p}_R})$.

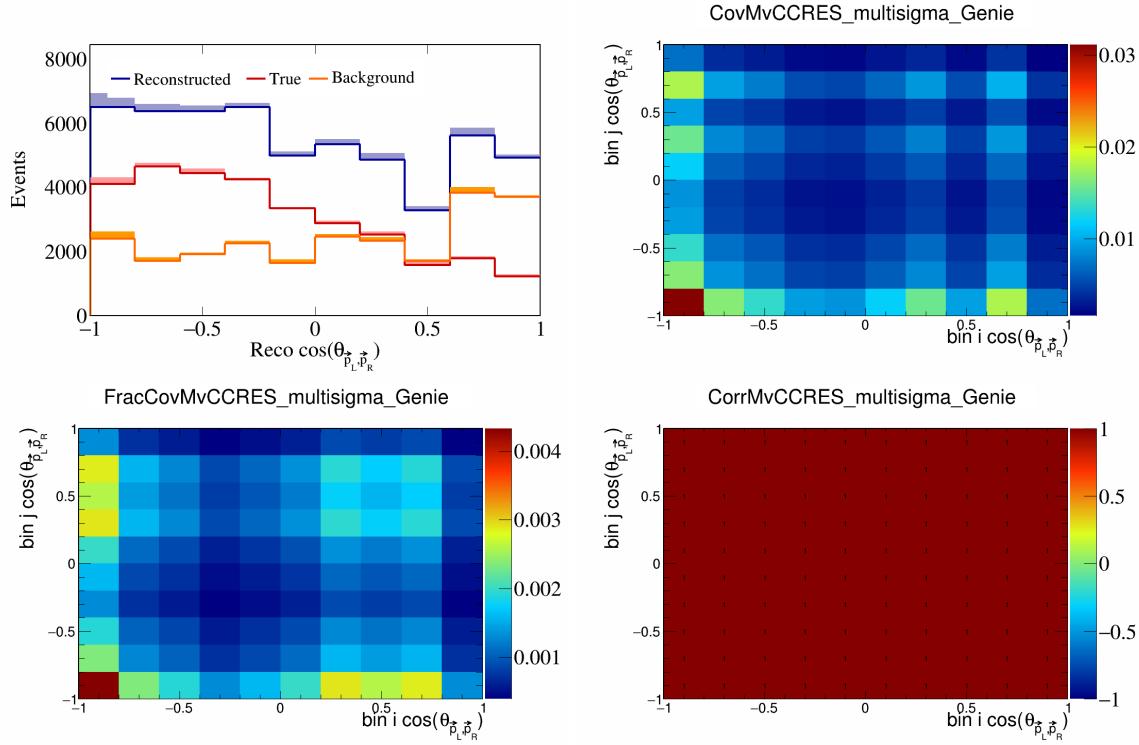


Figure 355: MvCCRES variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

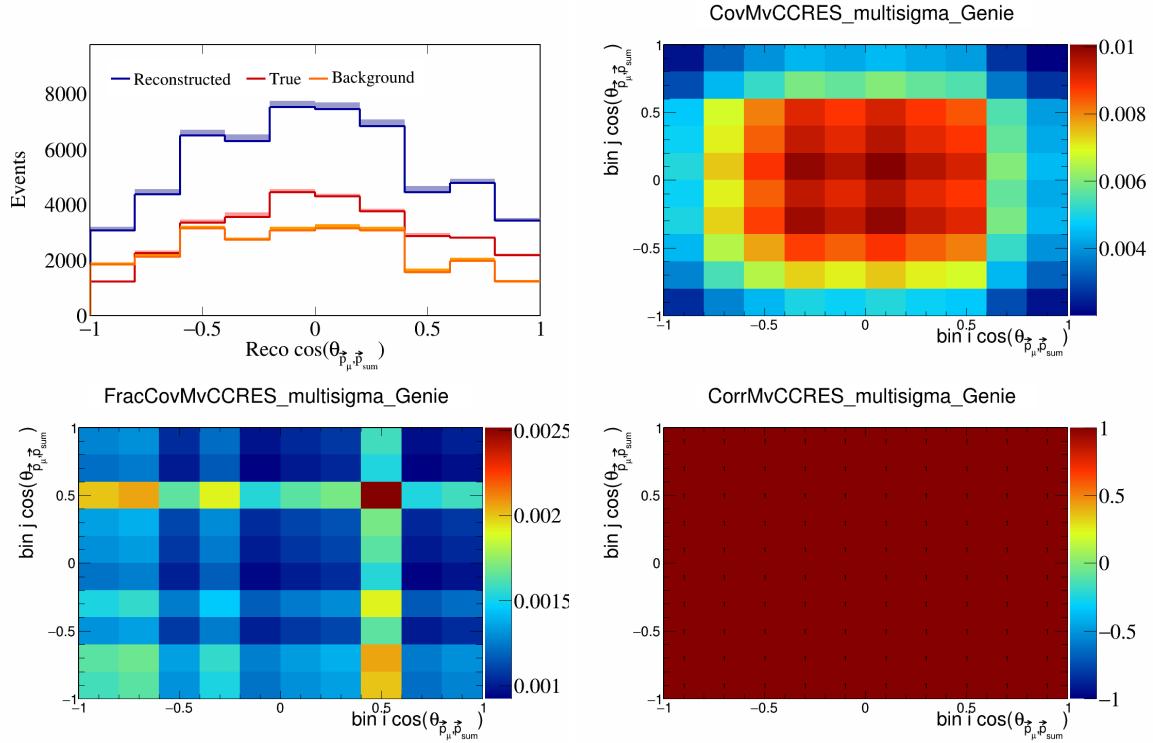


Figure 356: MvCCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

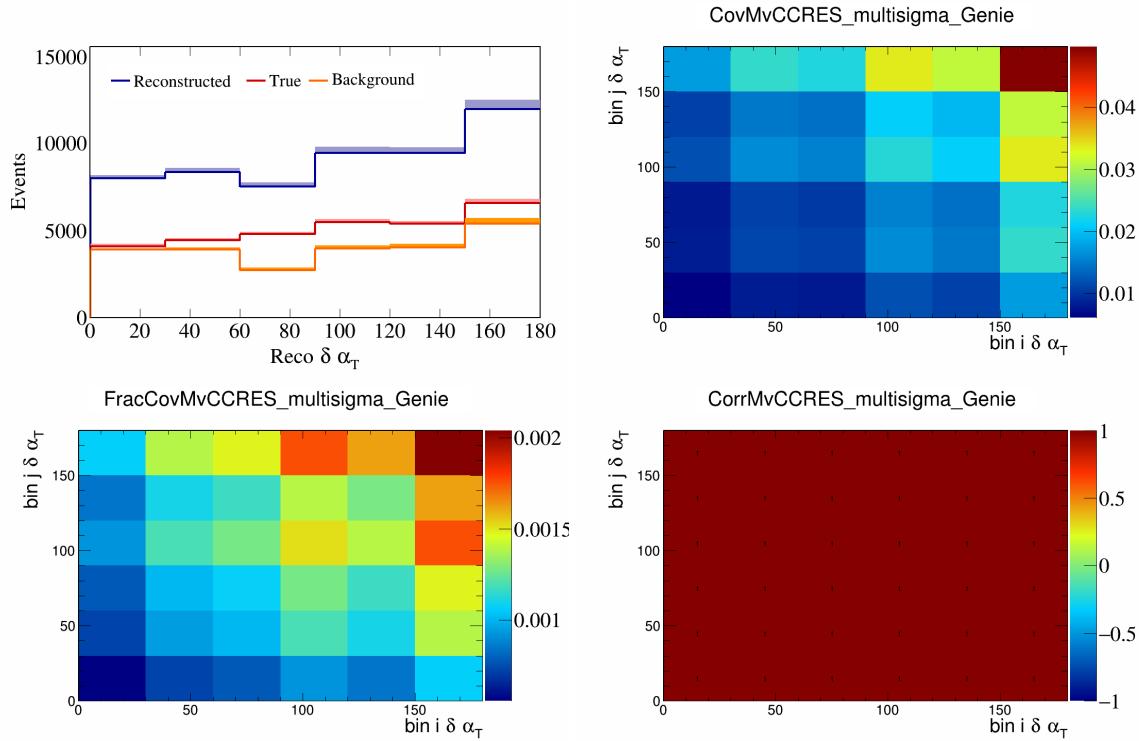


Figure 357: MvCCRES variations for $\delta\alpha_T$.

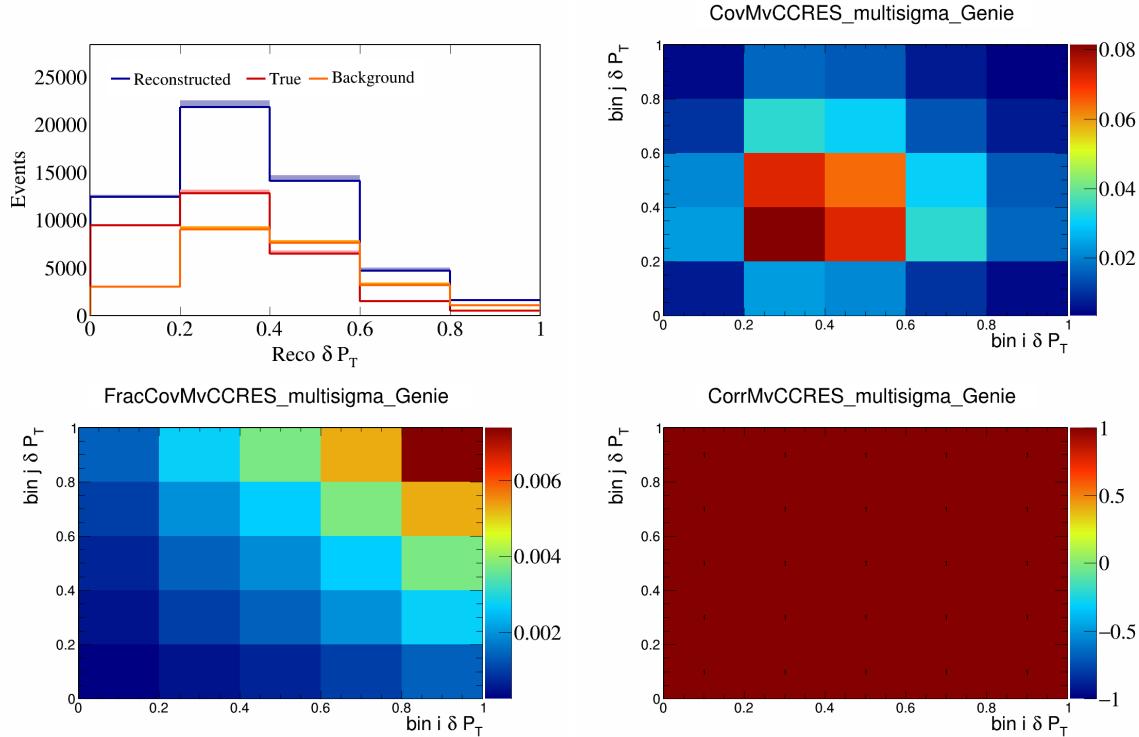


Figure 358: MvCCRES variations for δP_T .

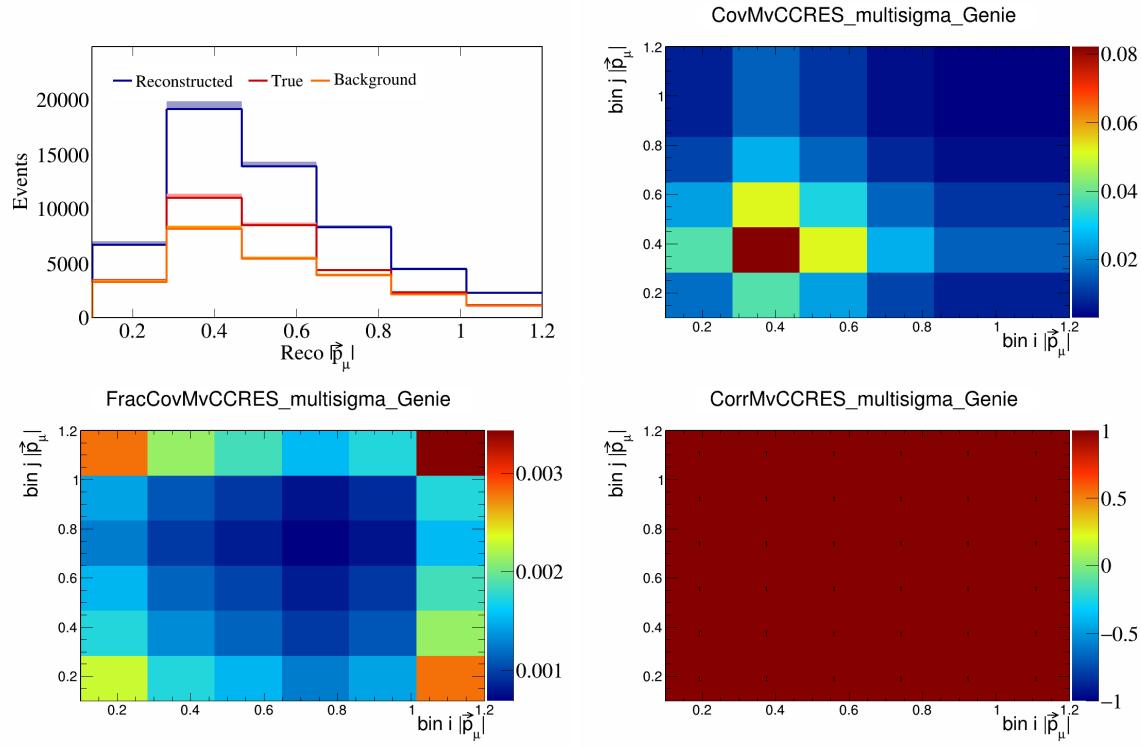


Figure 359: MvCCRES variations for $|\vec{p}_\mu|$.

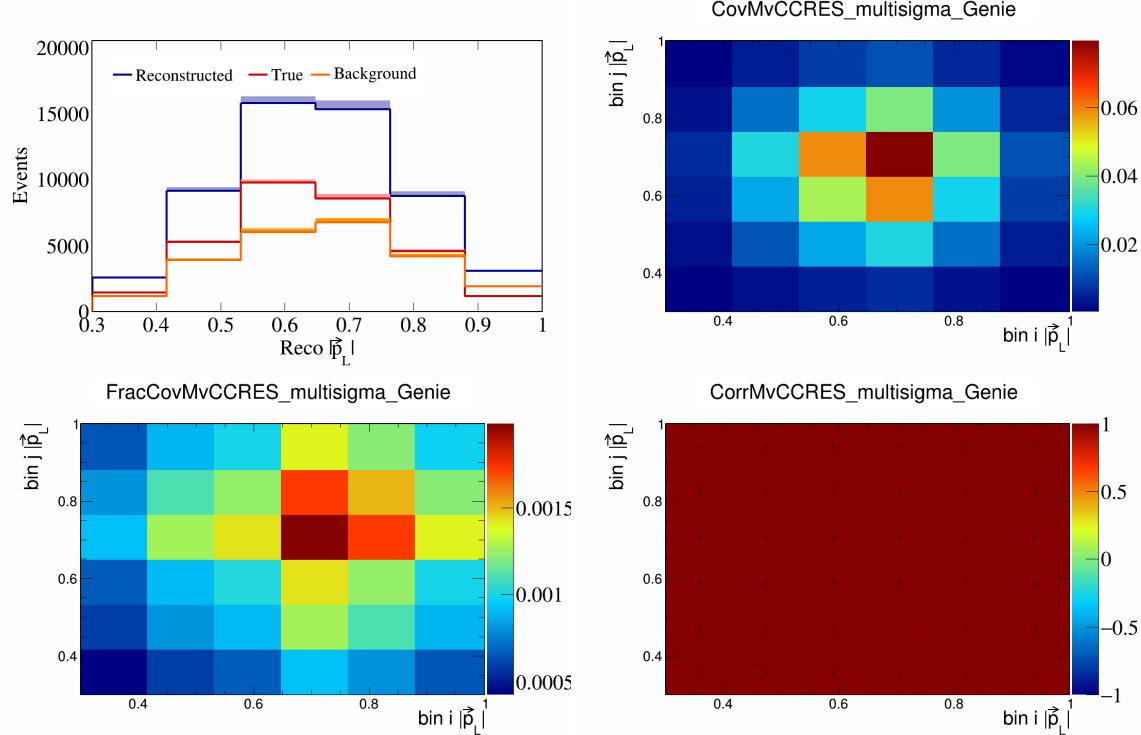


Figure 360: MvCCRES variations for $|\vec{p}_L|$.

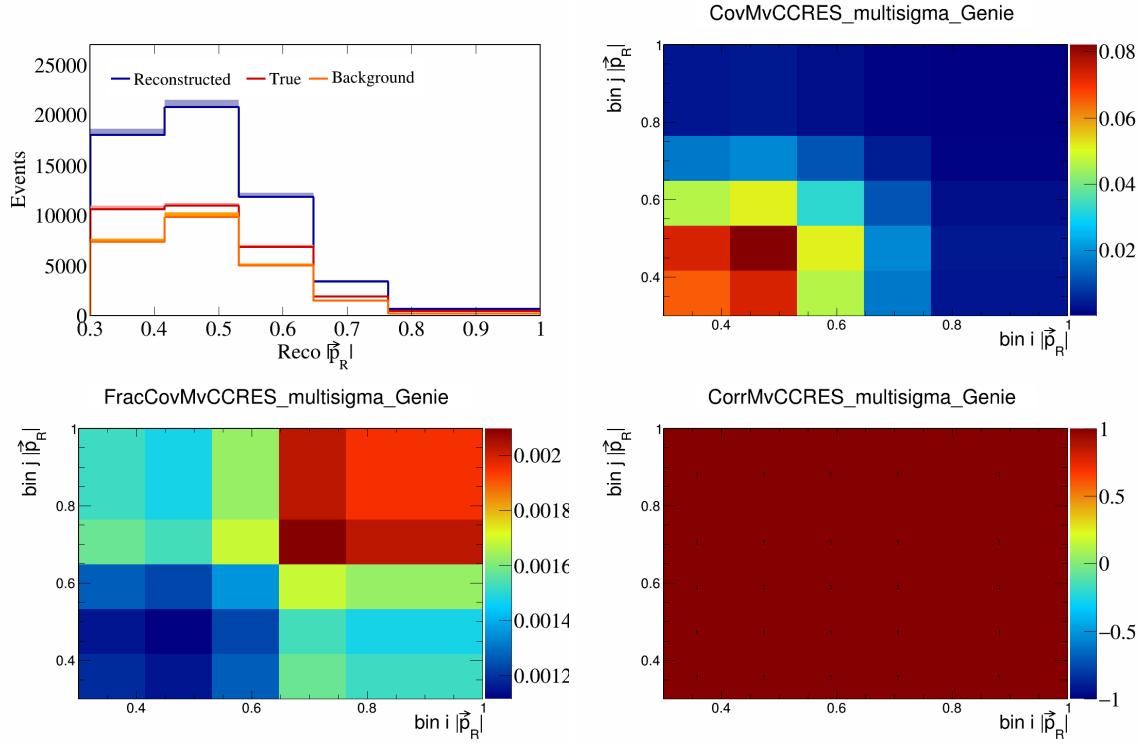


Figure 361: MvCCRES variations for $|\vec{p}_R|$.

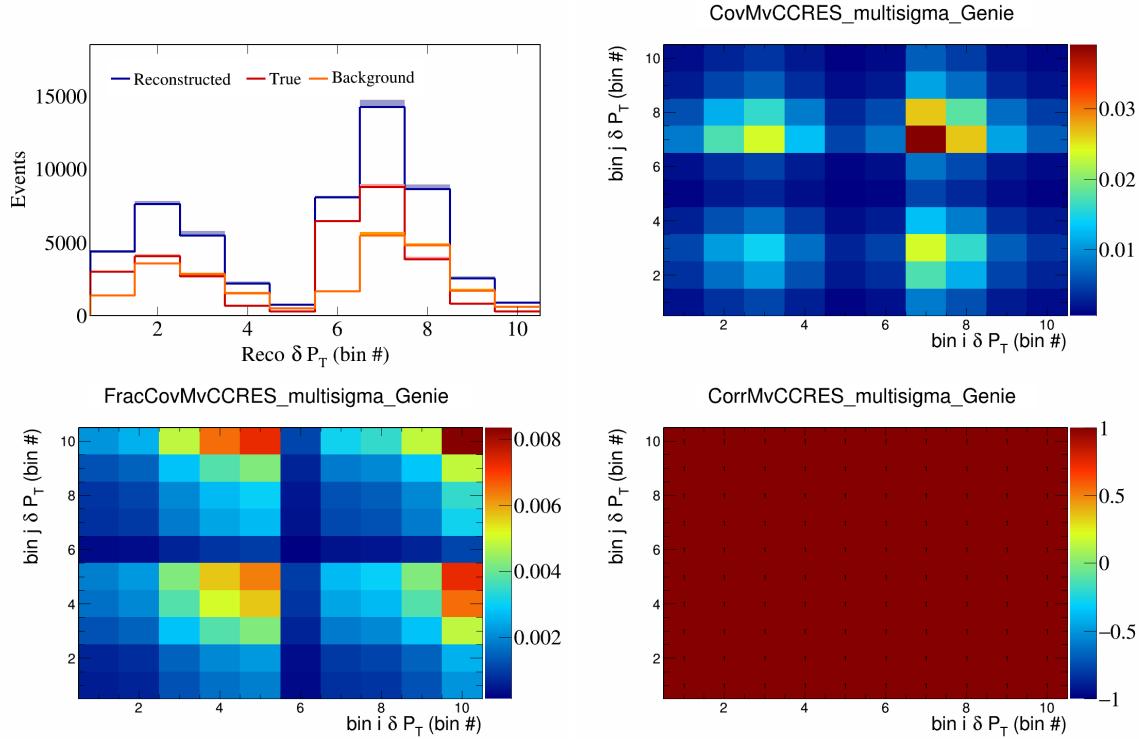


Figure 362: MvCCRES variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

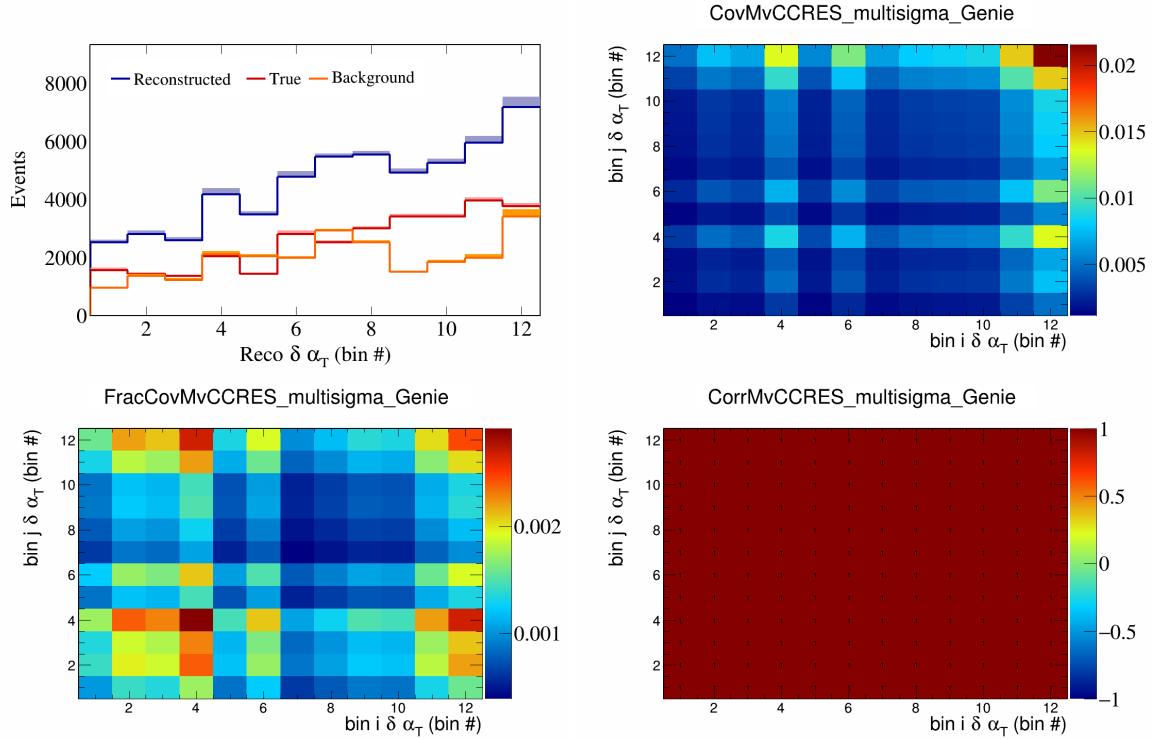


Figure 363: MvCCRES variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

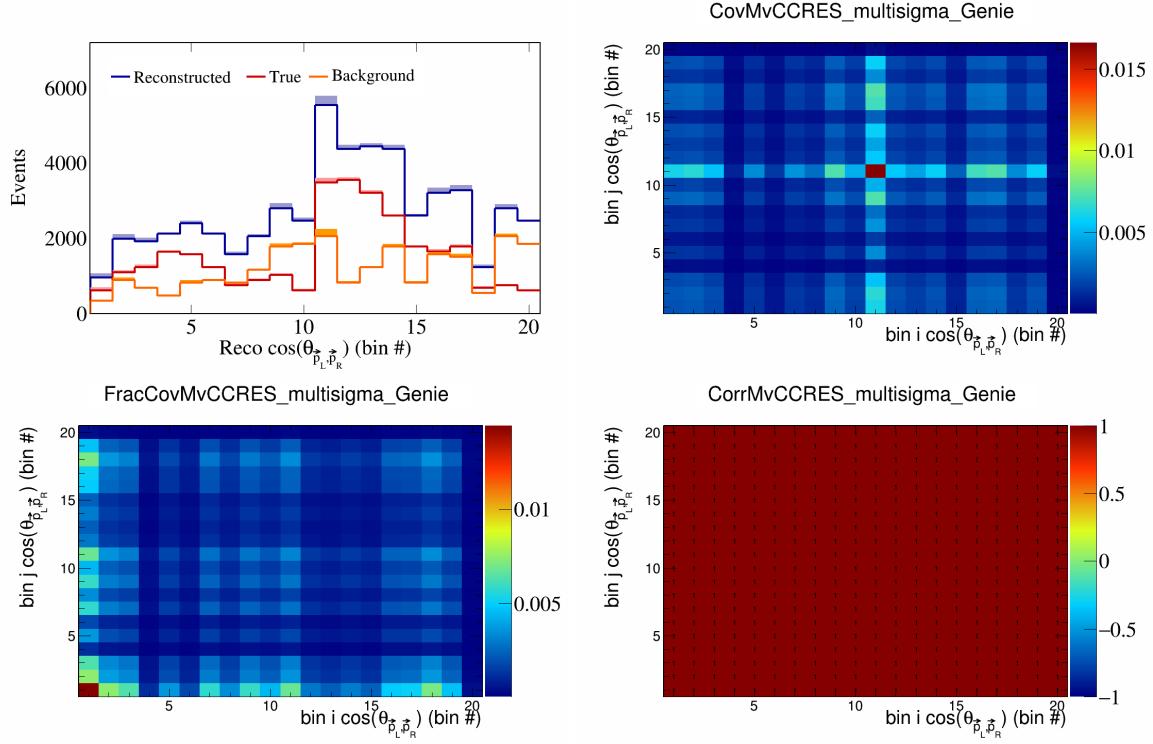


Figure 364: MvCCRES variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

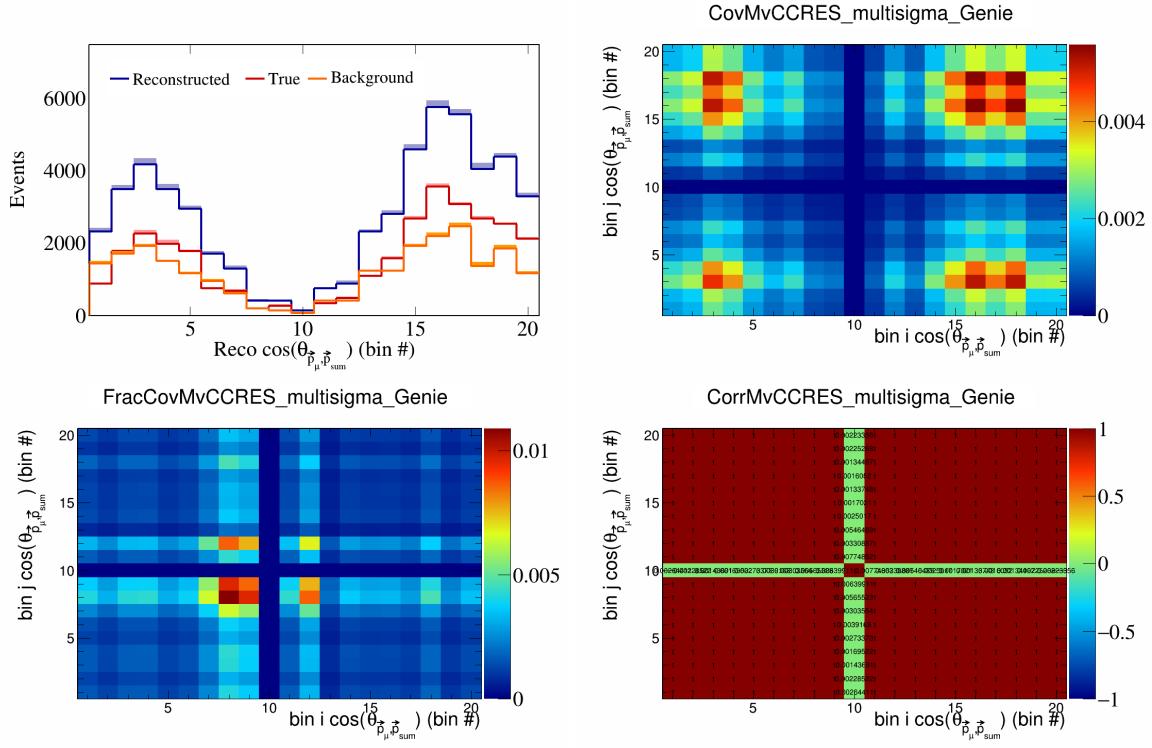


Figure 365: MvCCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

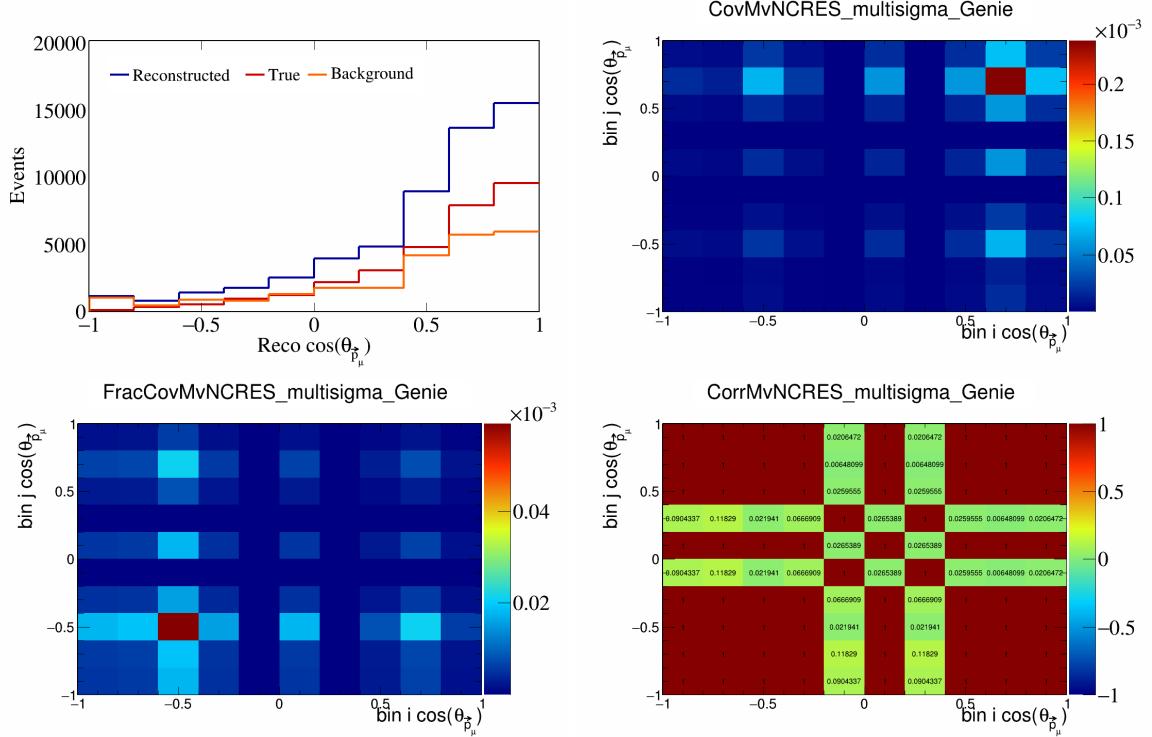


Figure 366: MvNCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

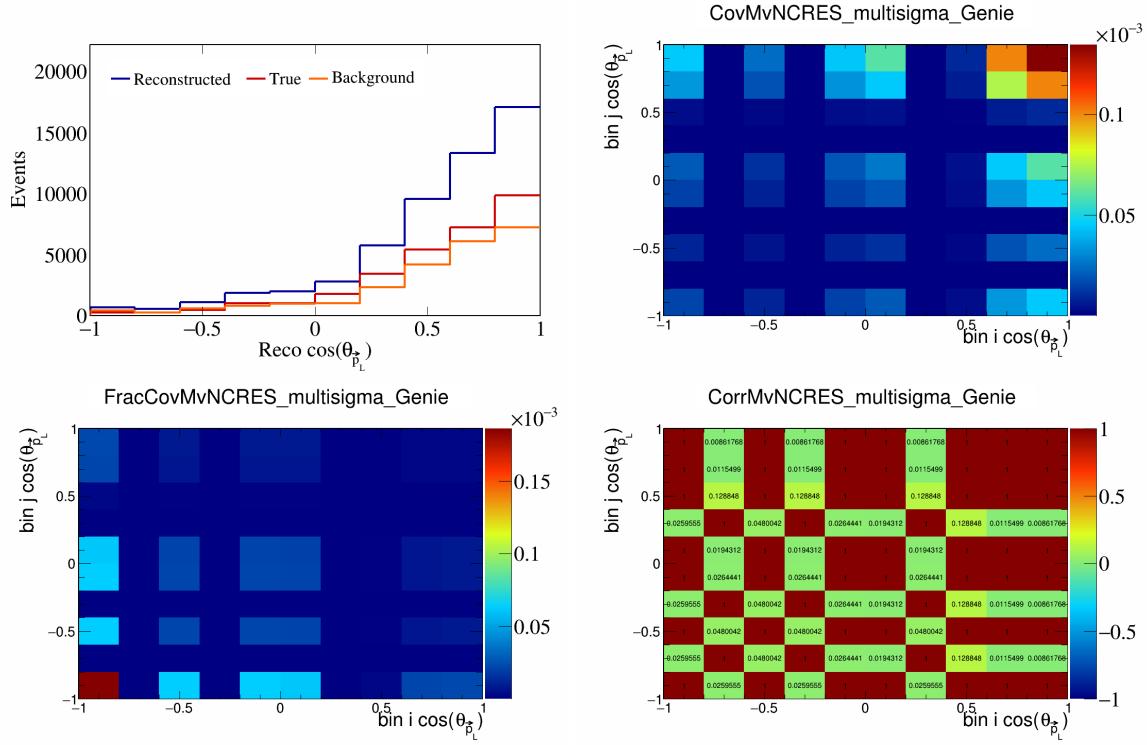


Figure 367: MvNCRES variations for $\cos(\theta_{\vec{p}_L})$.

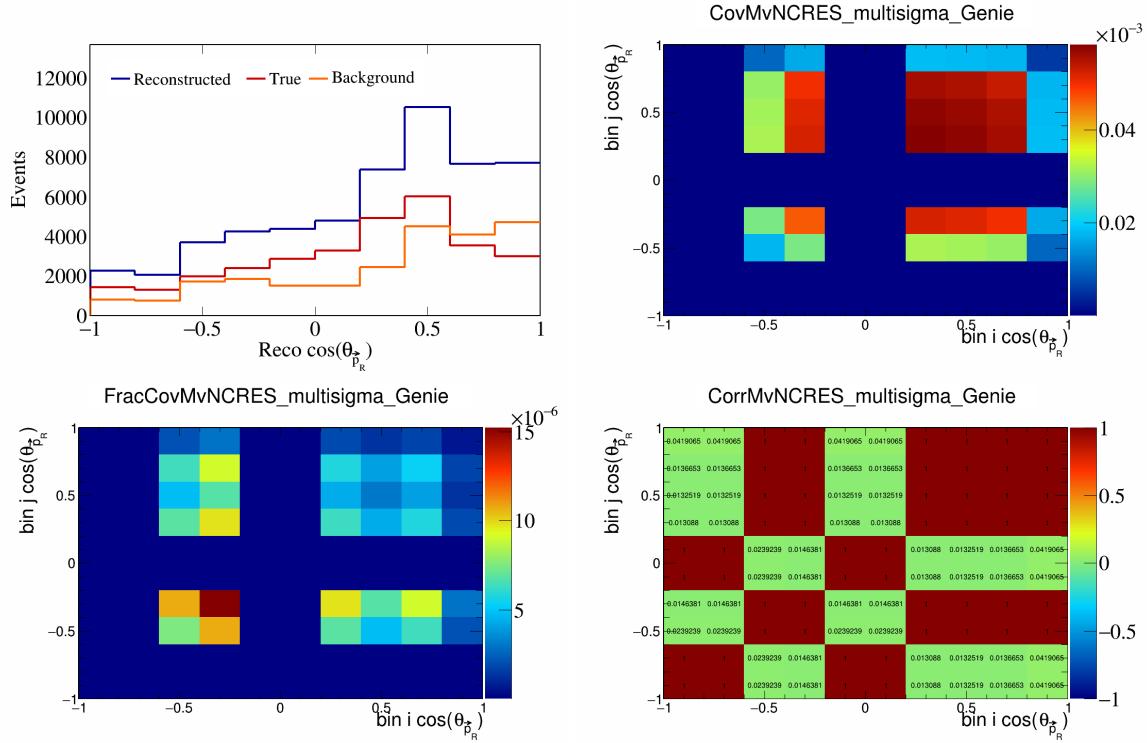


Figure 368: MvNCRES variations for $\cos(\theta_{\vec{p}_R})$.

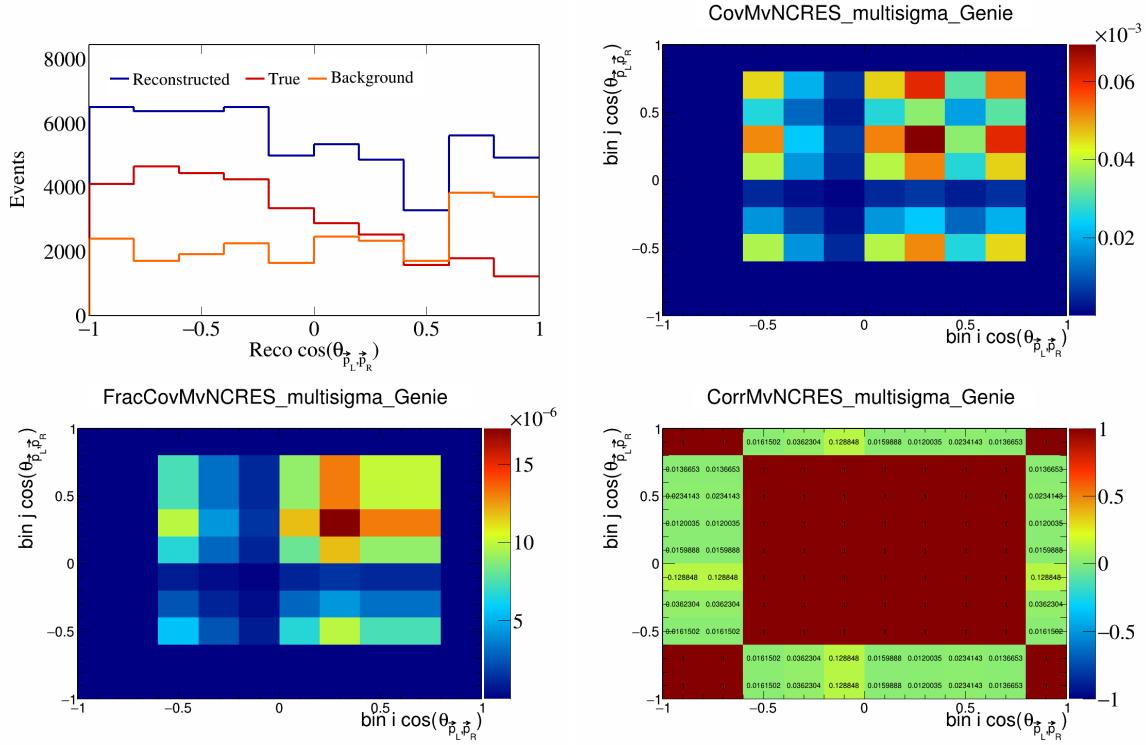


Figure 369: MvNCRES variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

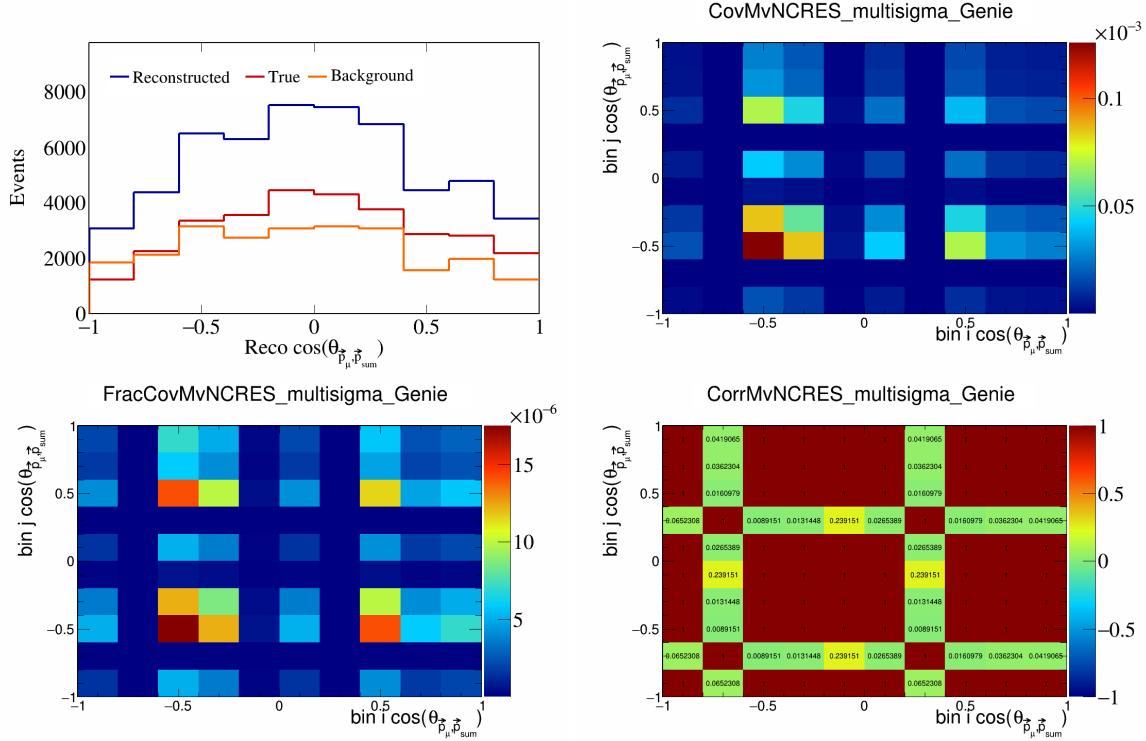


Figure 370: MvNCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

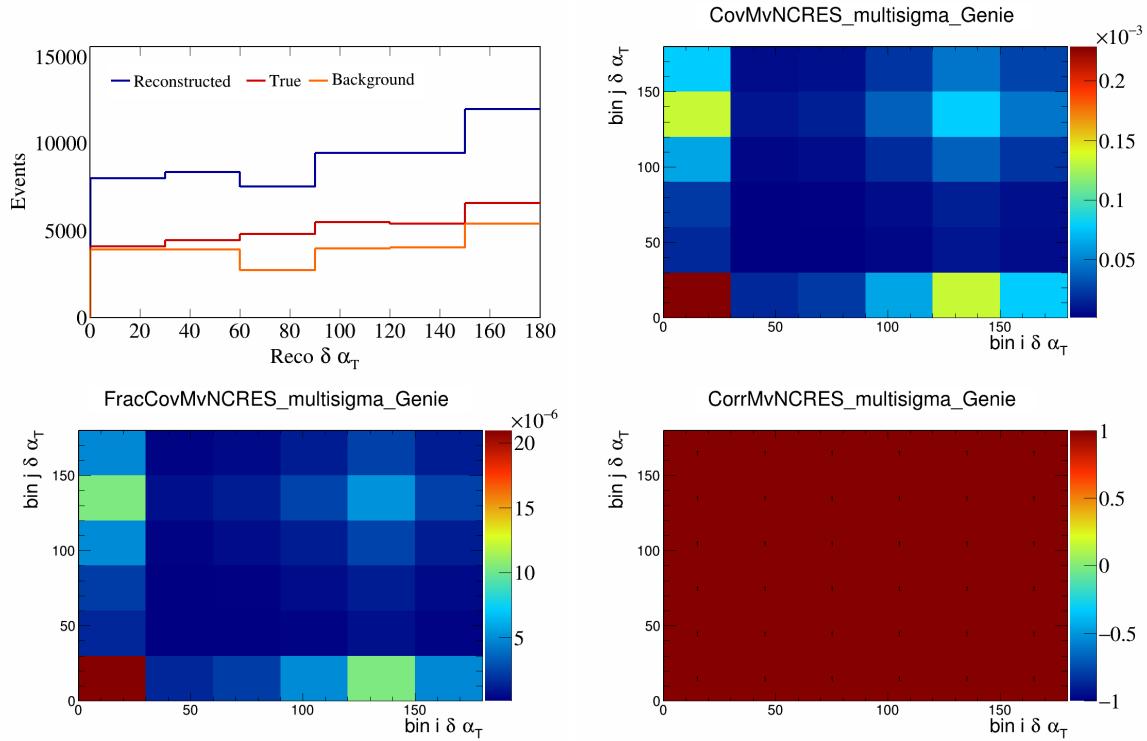


Figure 371: MvNCRES variations for $\delta\alpha_T$.

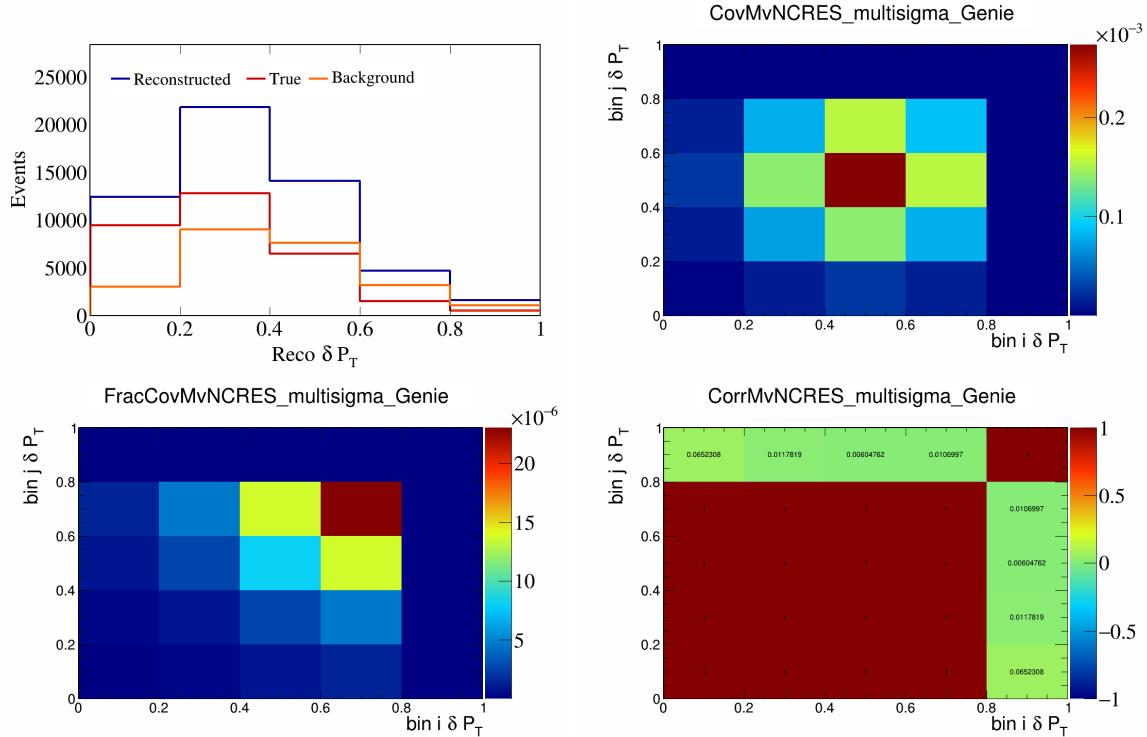


Figure 372: MvNCRES variations for δP_T .

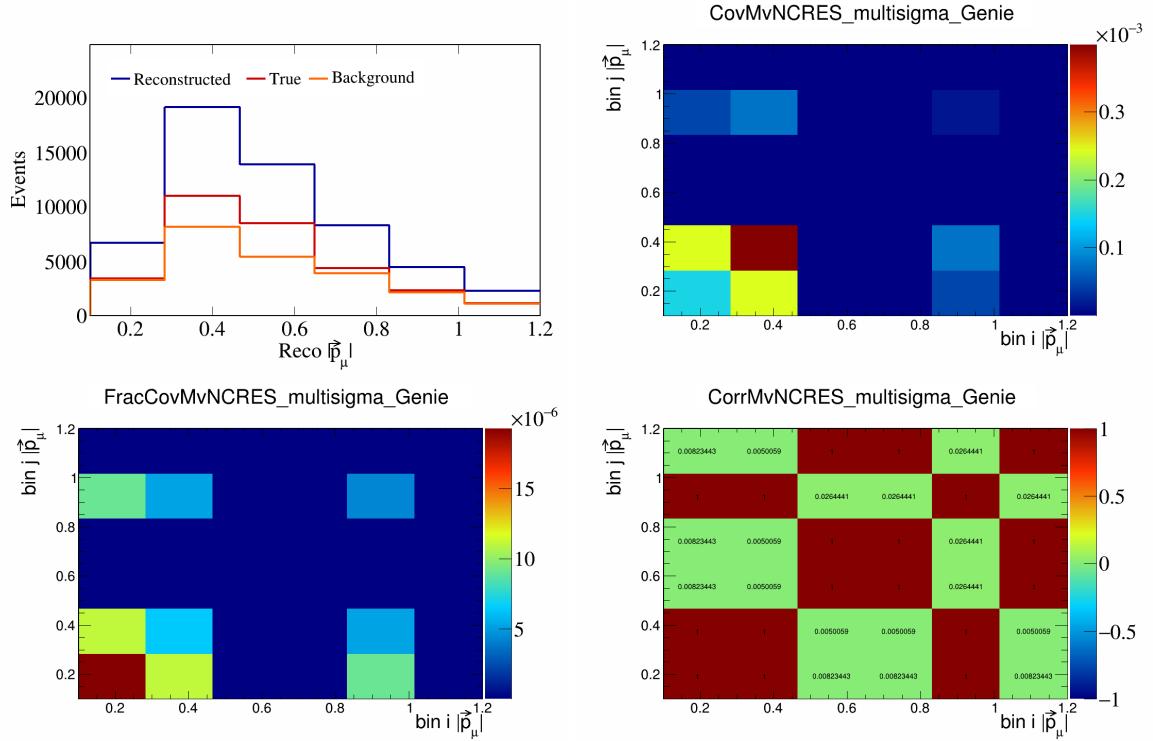


Figure 373: MvNCRES variations for $|\vec{p}_\mu|$.

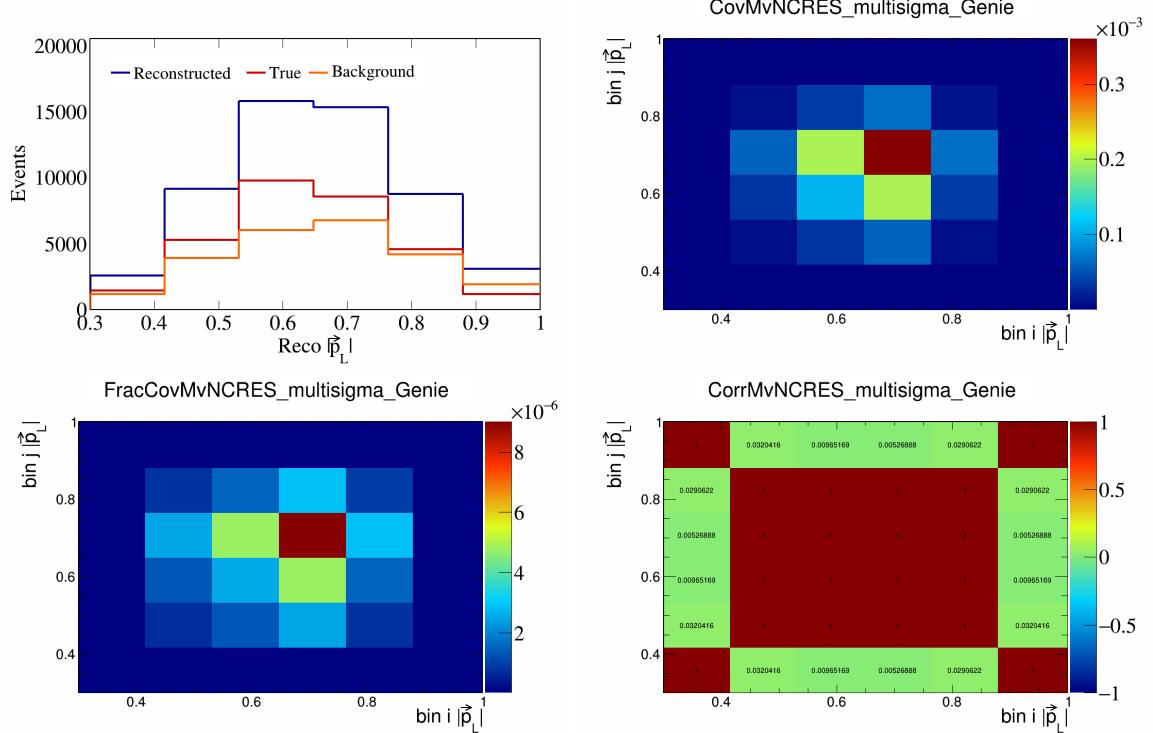


Figure 374: MvNCRES variations for $|\vec{p}_L|$.

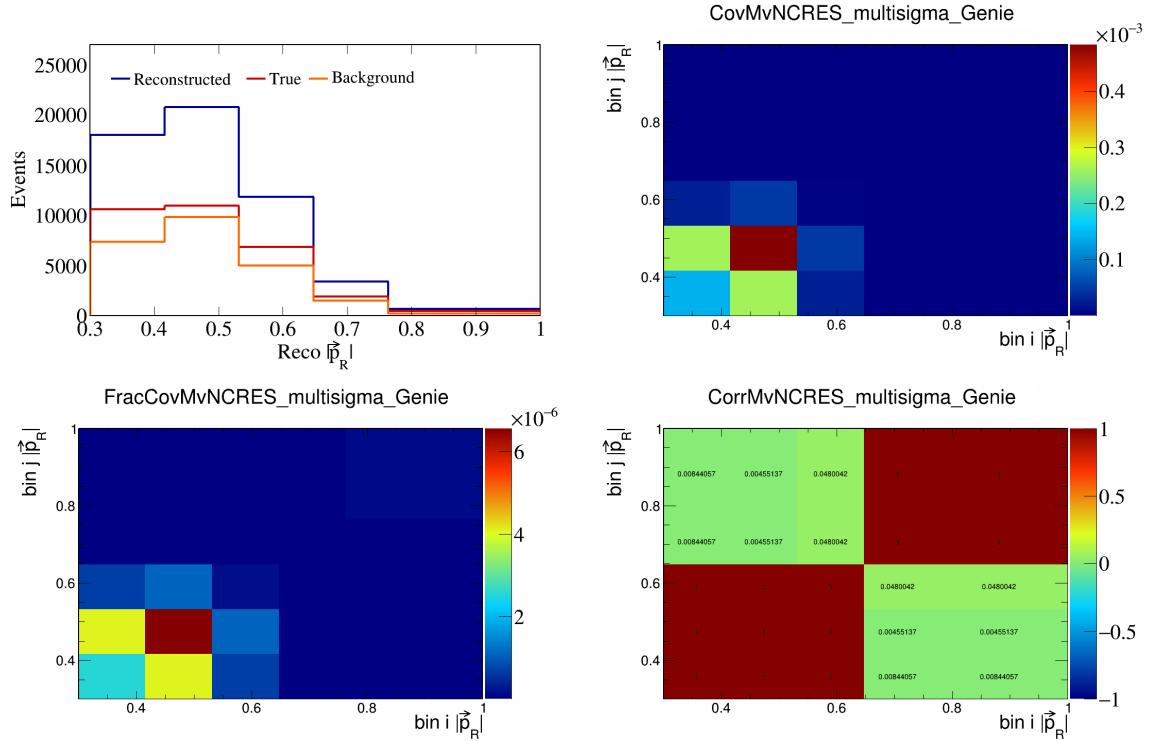


Figure 375: MvNCRES variations for $|\vec{p}_R|$.

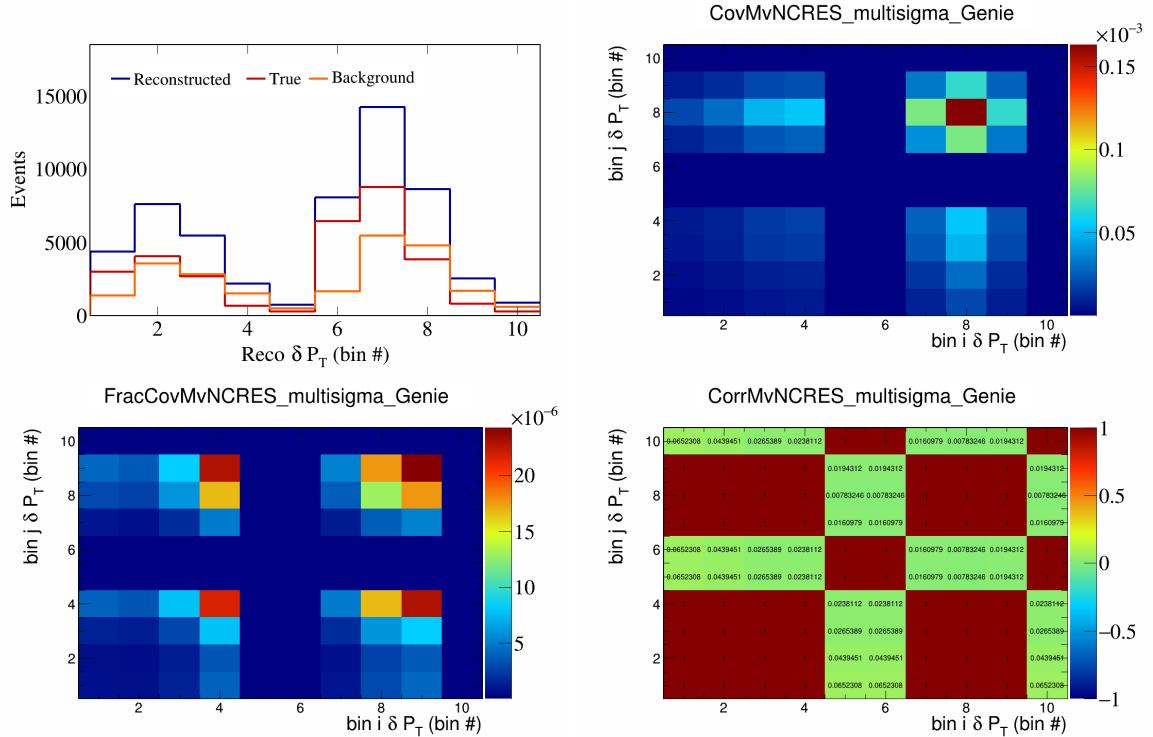


Figure 376: MvNCRES variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

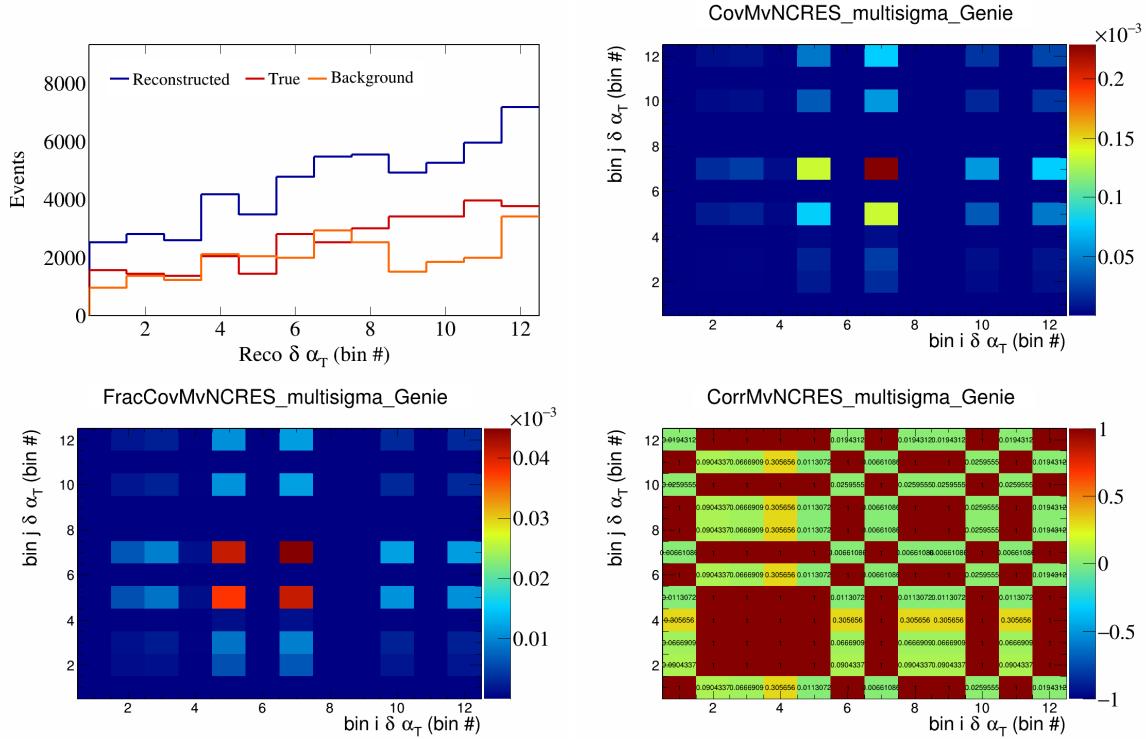


Figure 377: MvNCRES variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

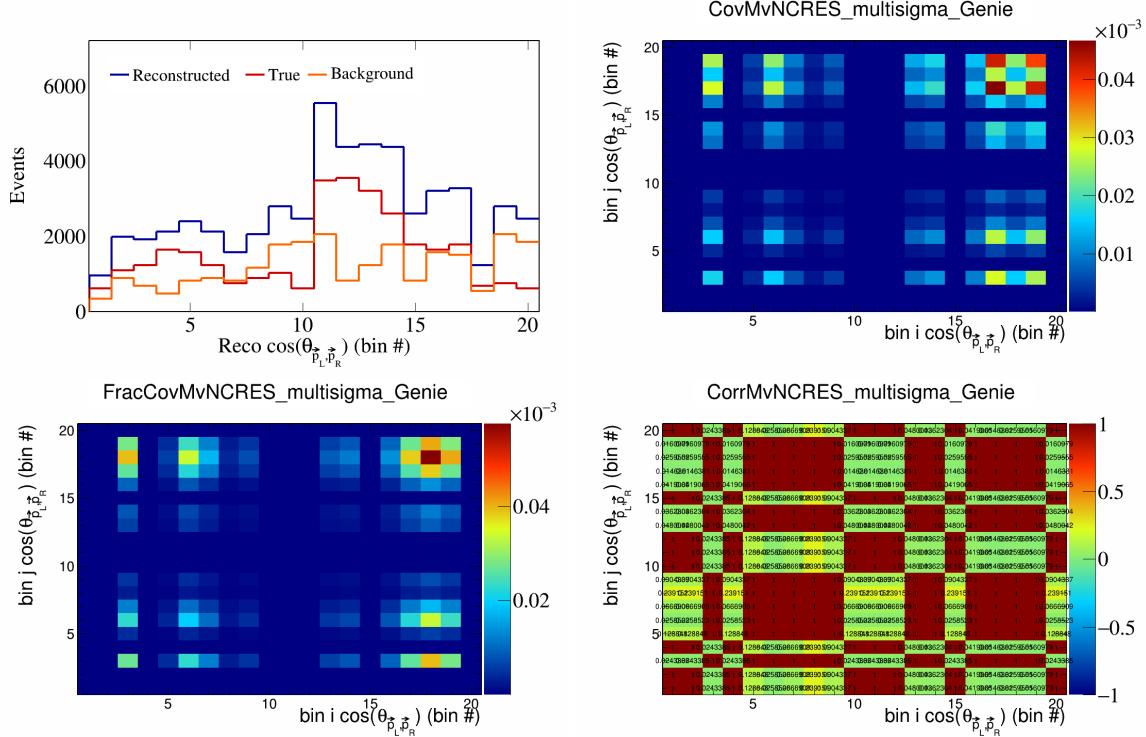


Figure 378: MvNCRES variations for $\cos(\theta_{p_L, p_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

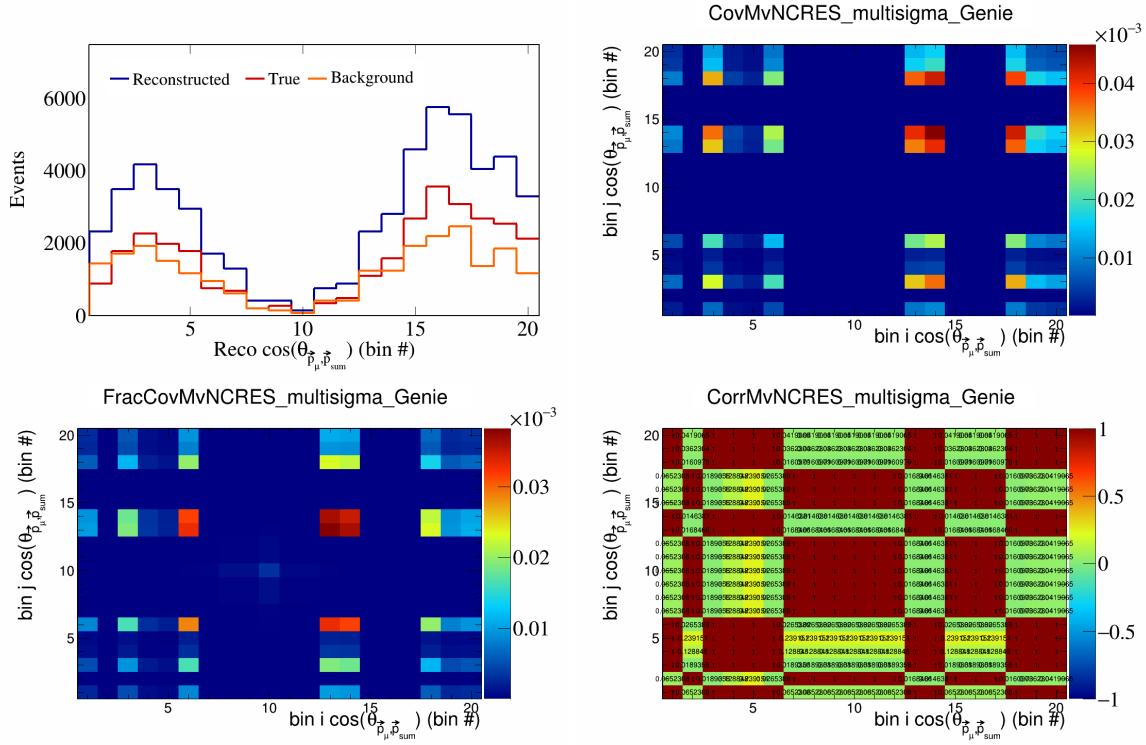


Figure 379: MyNCRES variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

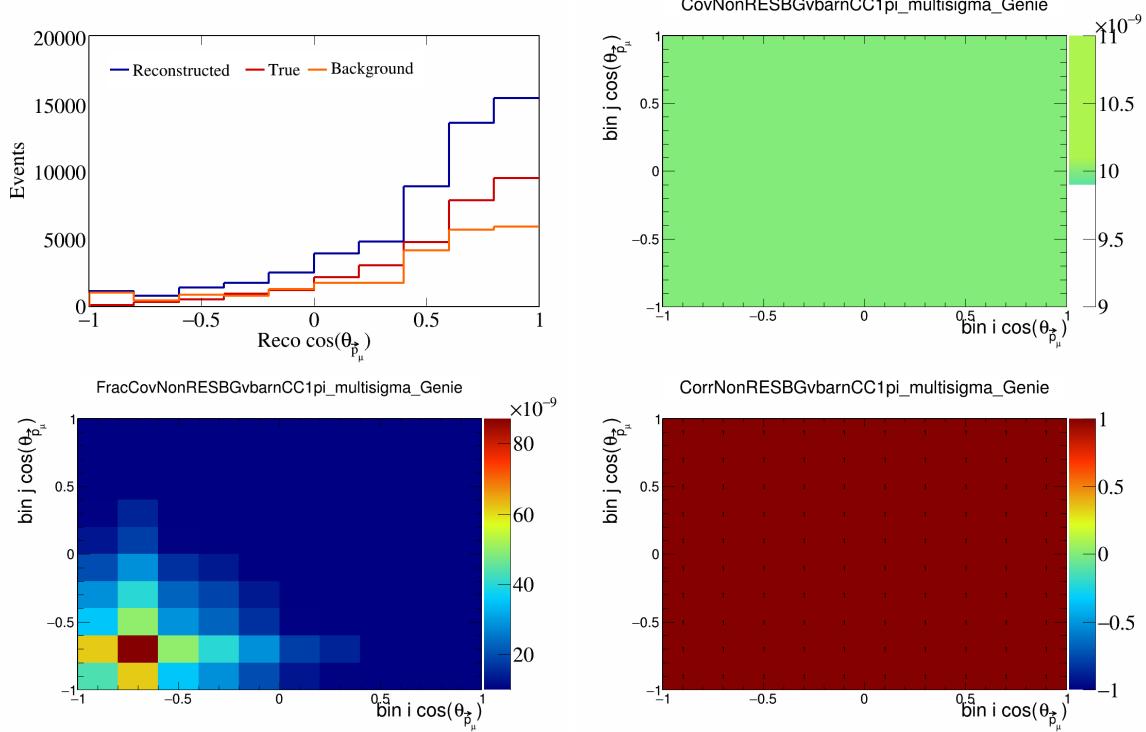


Figure 380: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

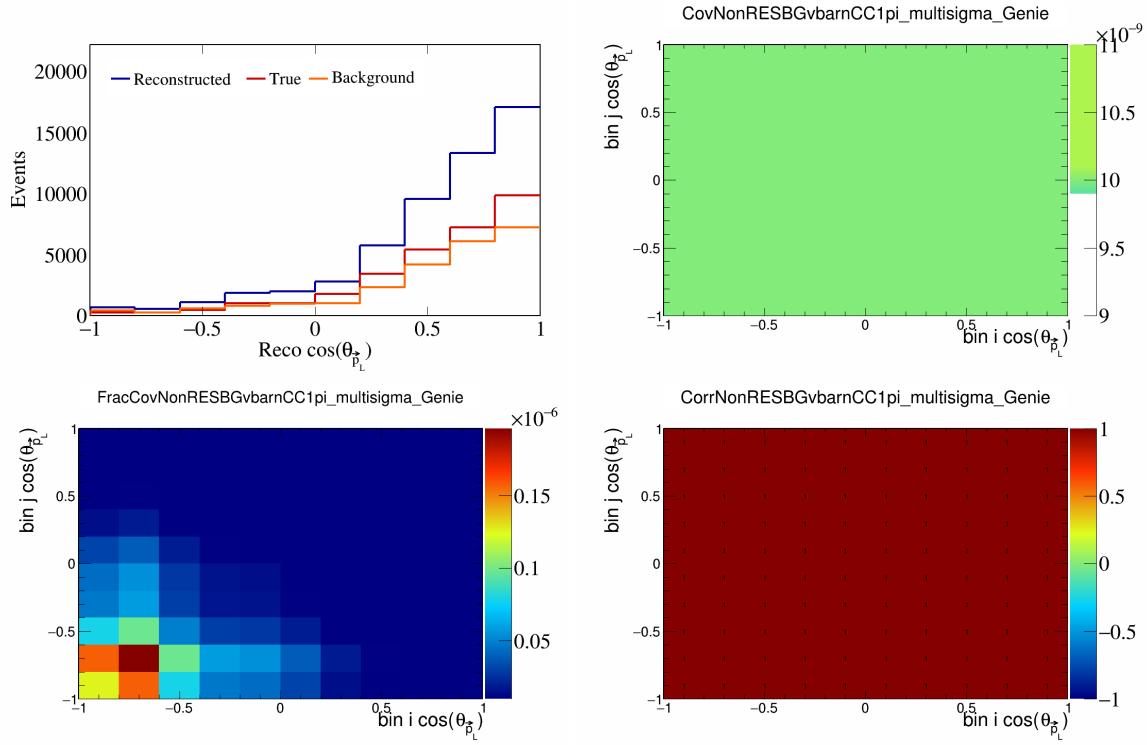


Figure 381: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_L})$.

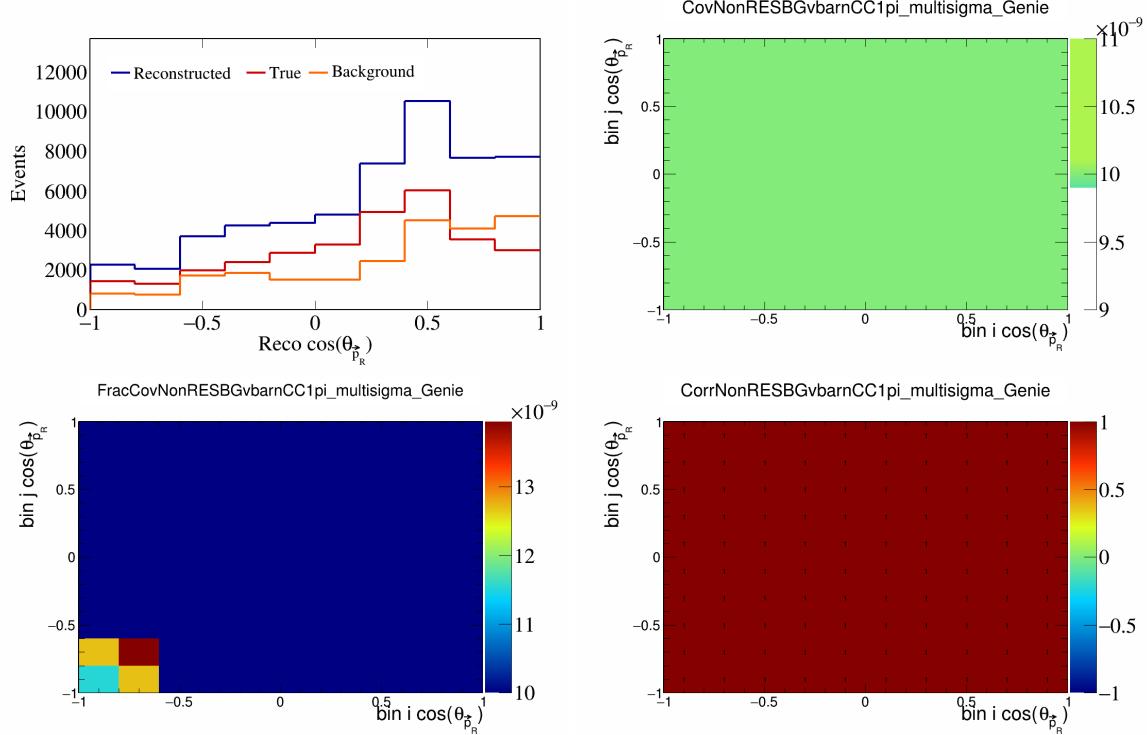


Figure 382: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_R})$.

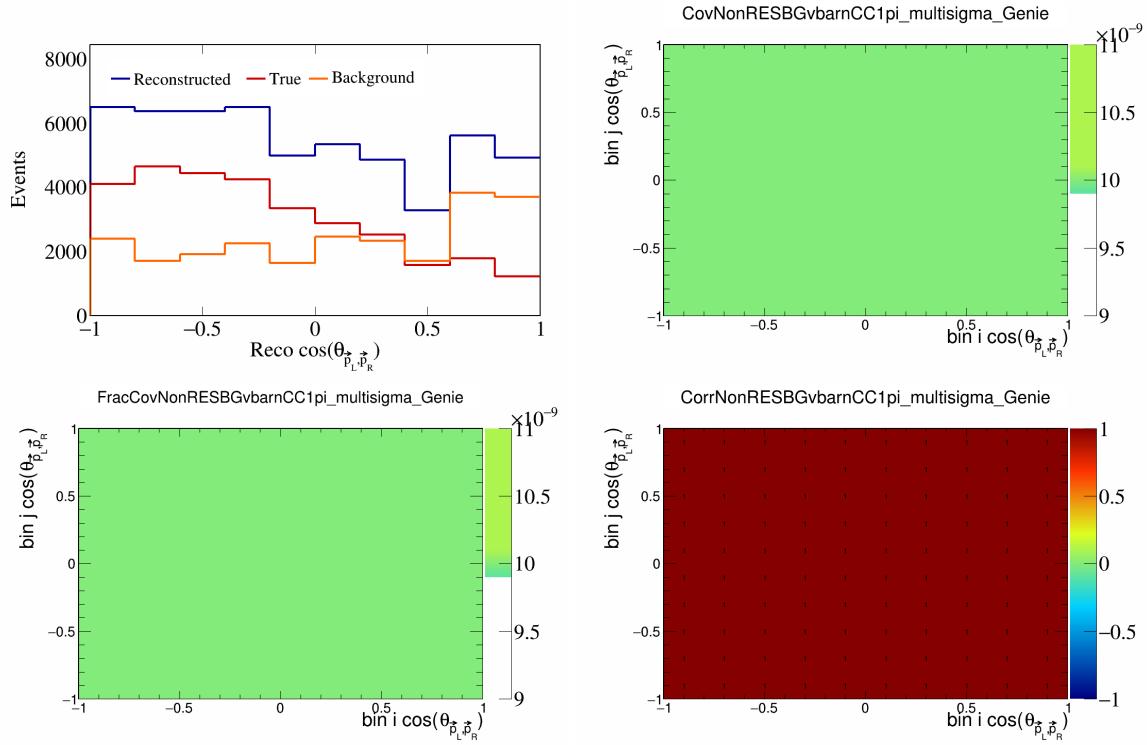


Figure 383: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

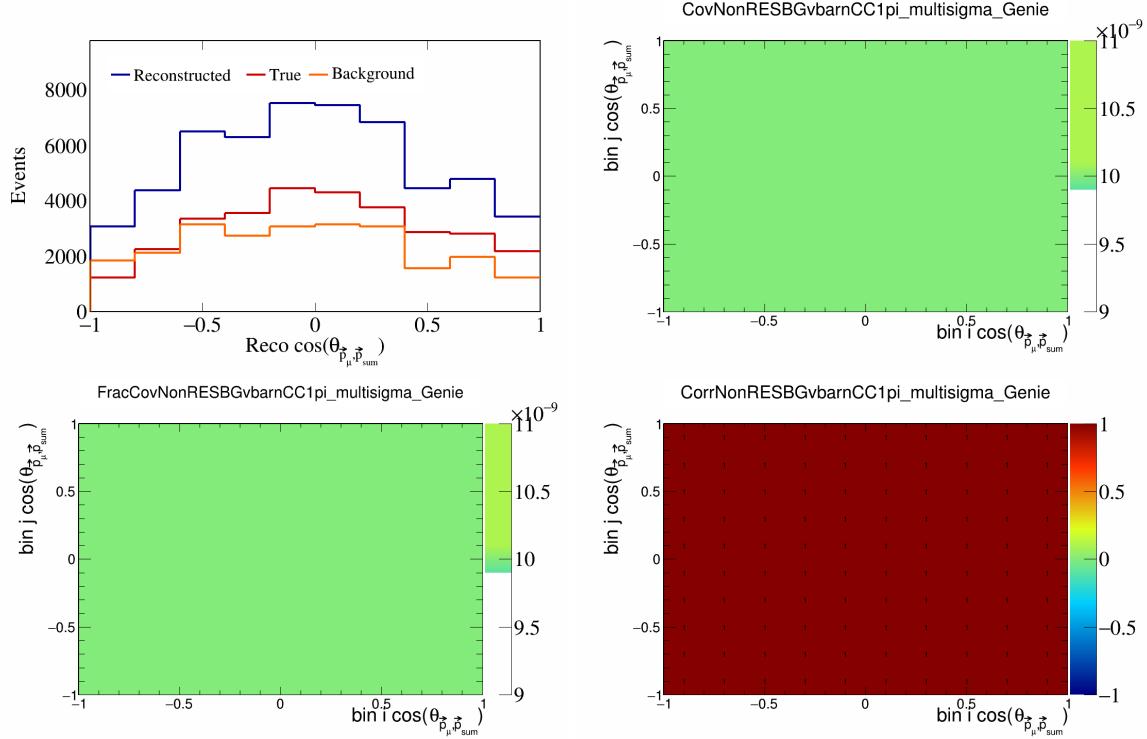


Figure 384: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

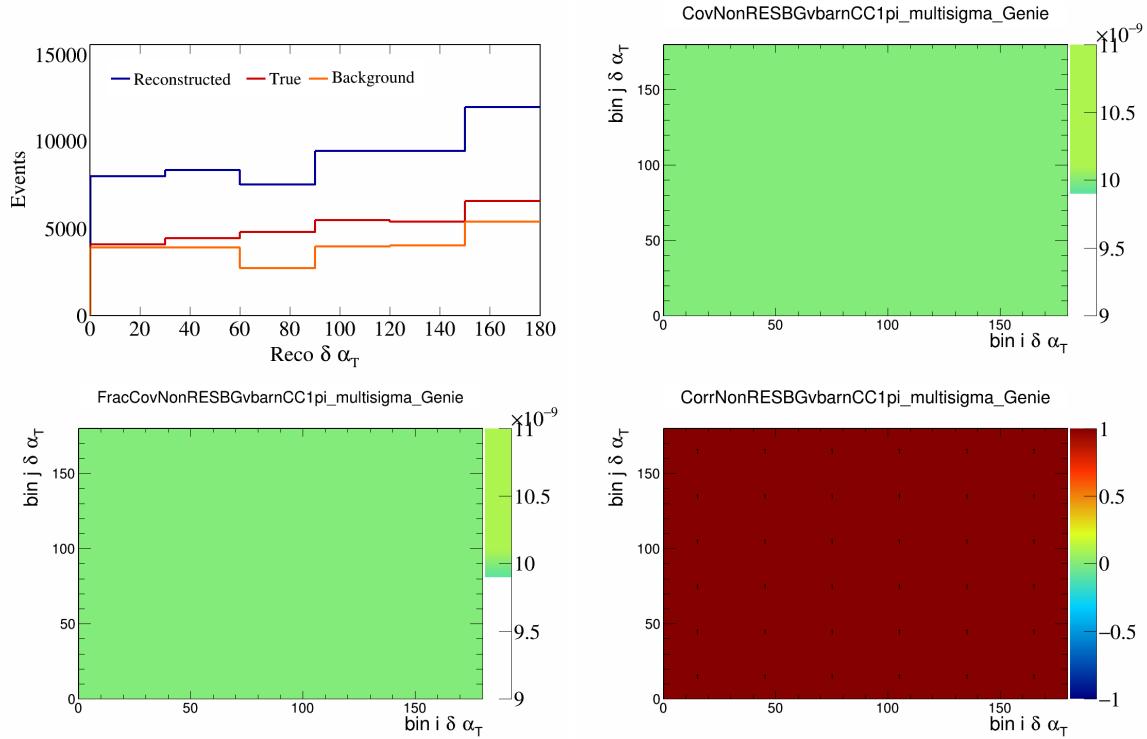


Figure 385: NonRESBGvbarCC1pi variations for $\delta\alpha_T$.

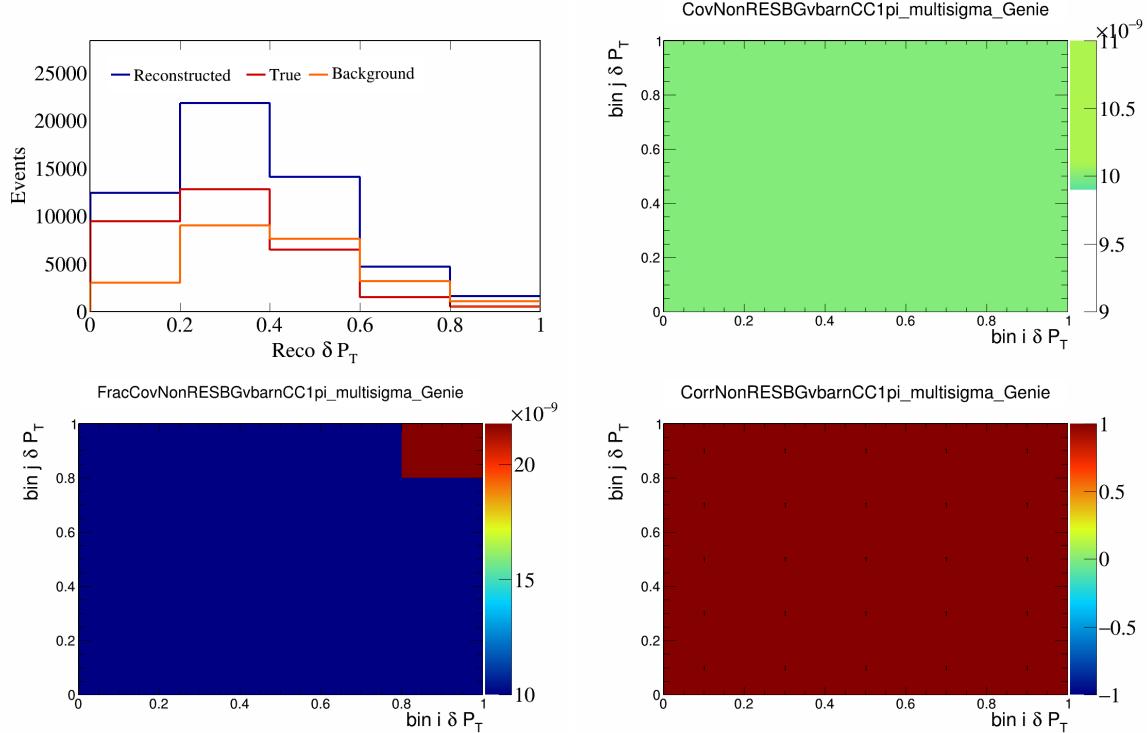


Figure 386: NonRESBGvbarCC1pi variations for δP_T .

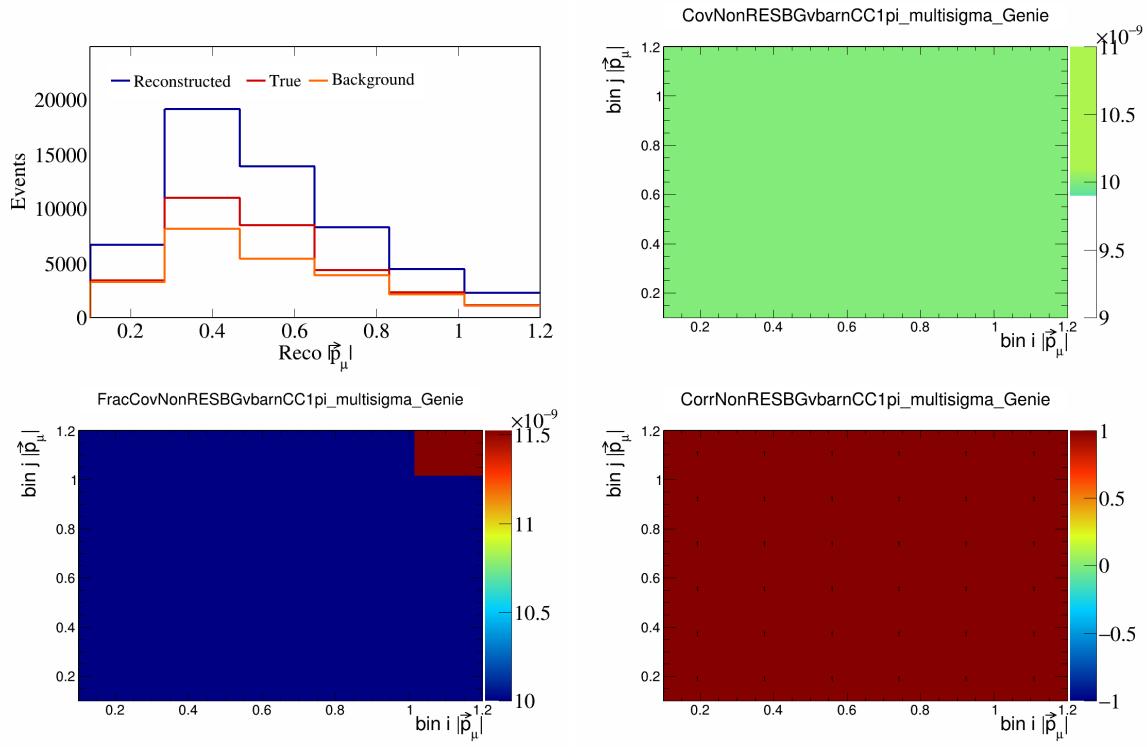


Figure 387: NonRESBGvbarCC1pi variations for $|\vec{p}_\mu|$.

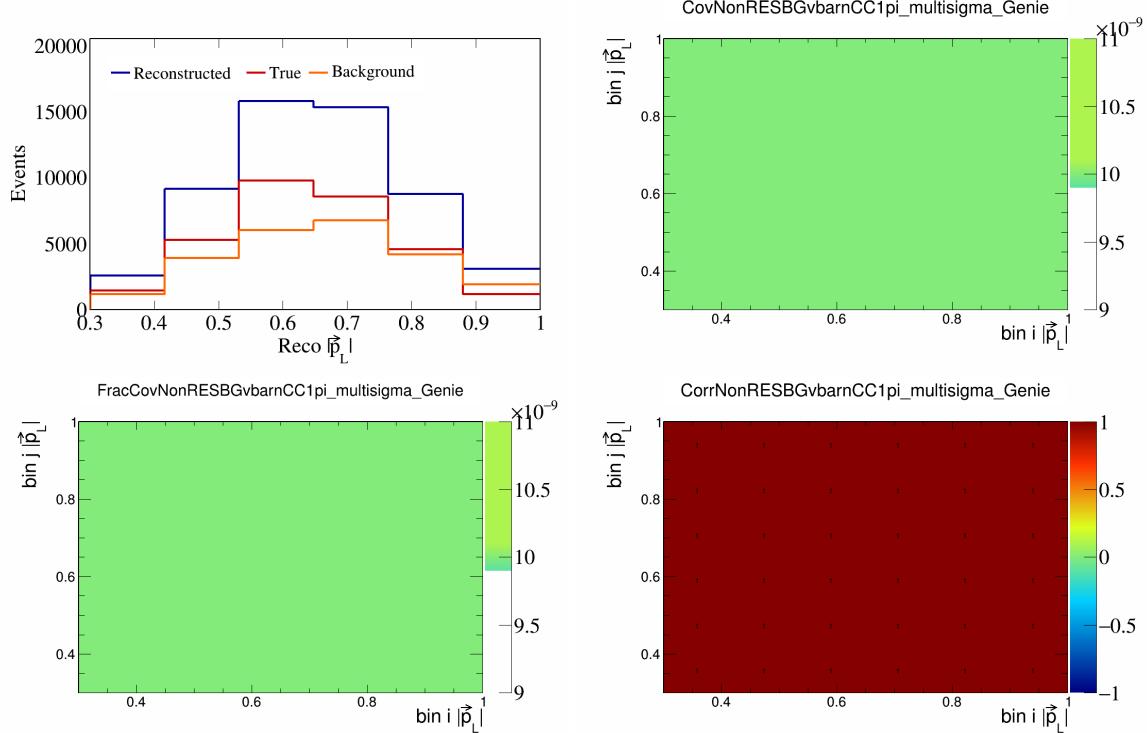


Figure 388: NonRESBGvbarCC1pi variations for $|\vec{p}_L|$.

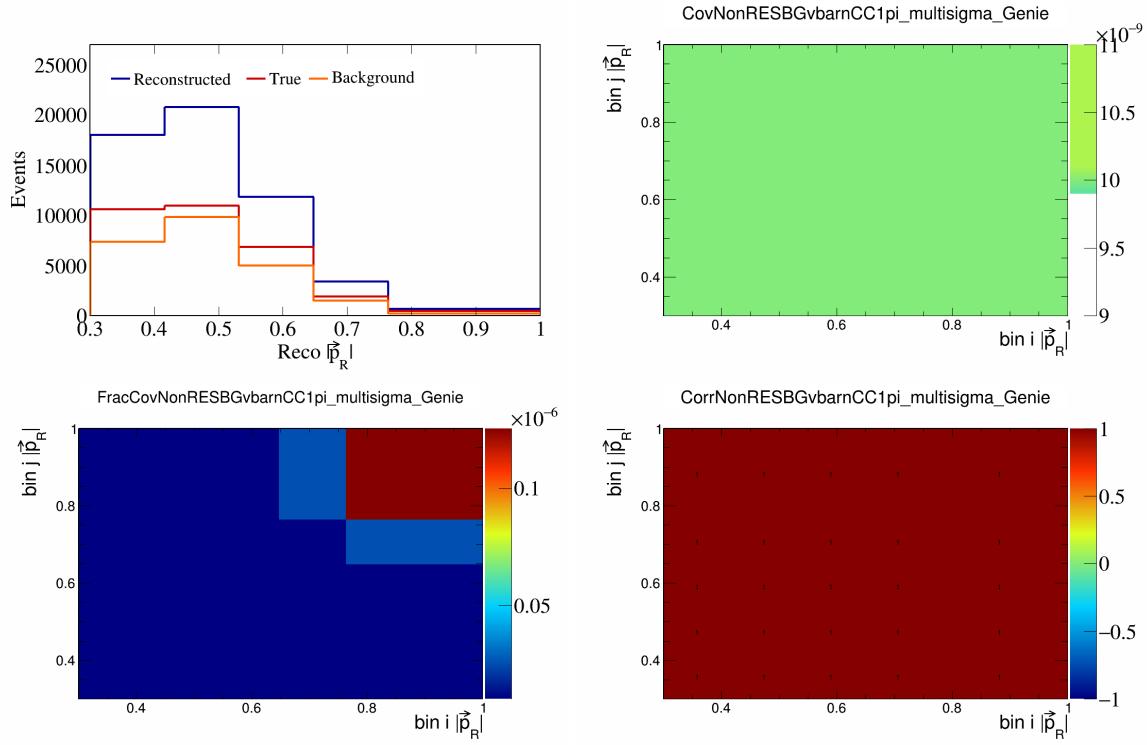


Figure 389: NonRESBGvbarCC1pi variations for $|\vec{p}_R|$.

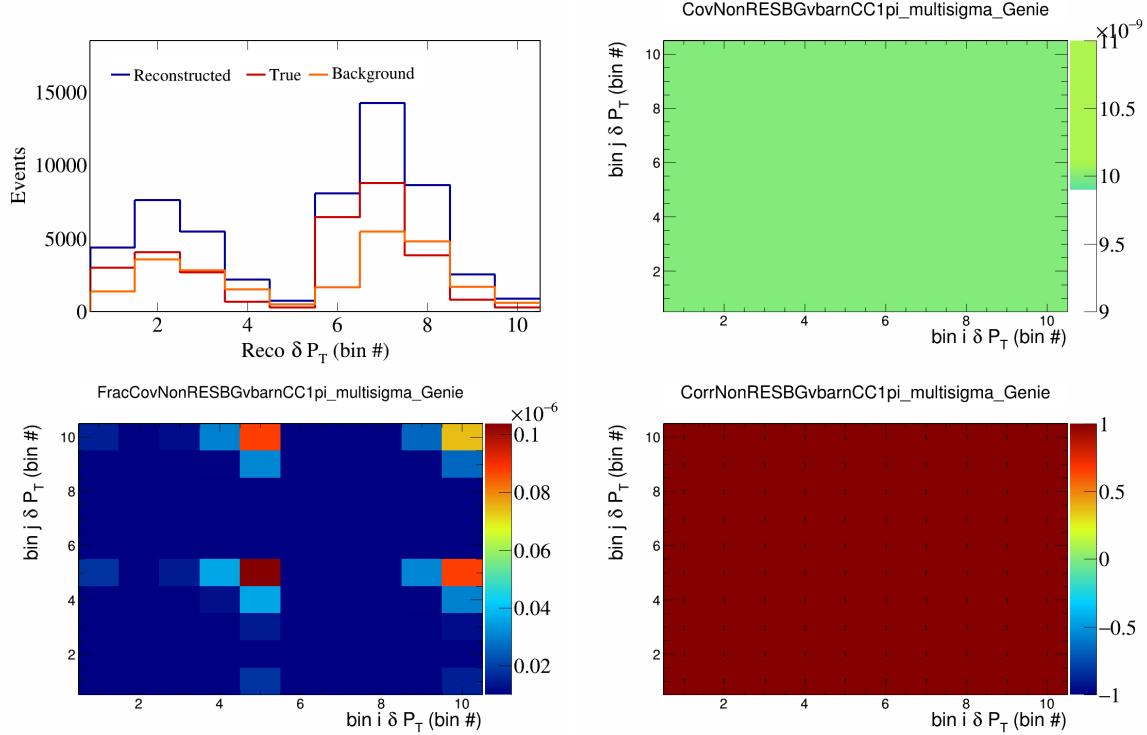


Figure 390: NonRESBGvbarCC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

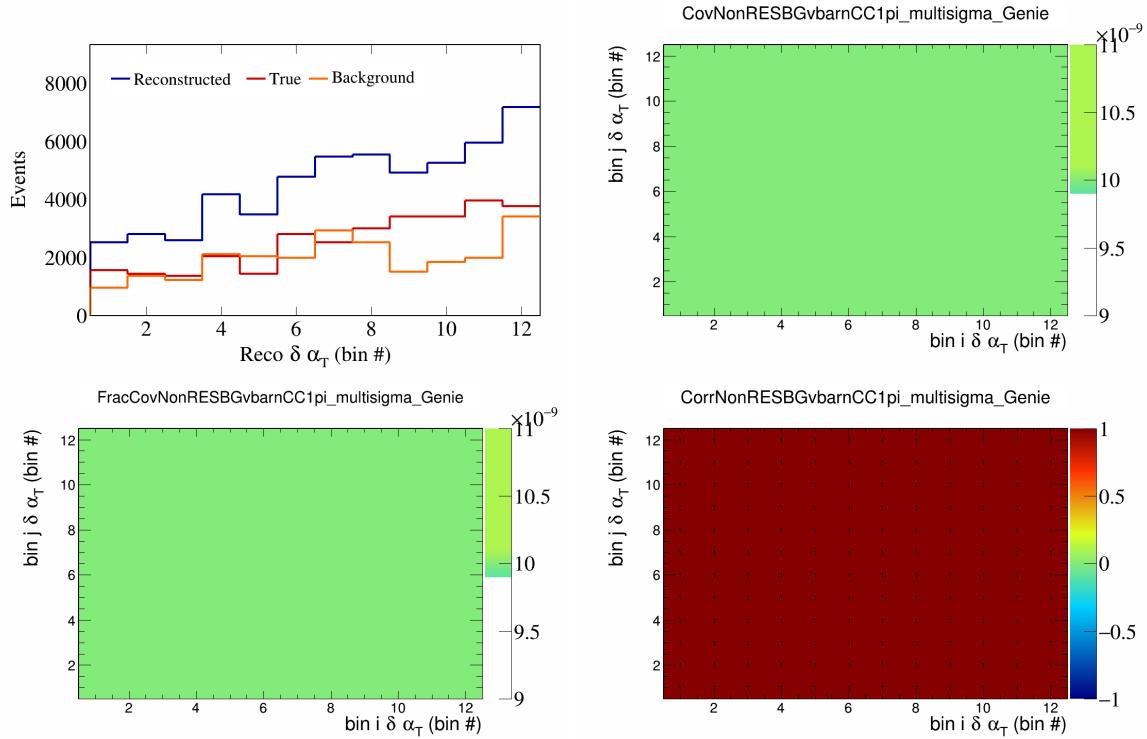


Figure 391: NonRESBGvbarCC1pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

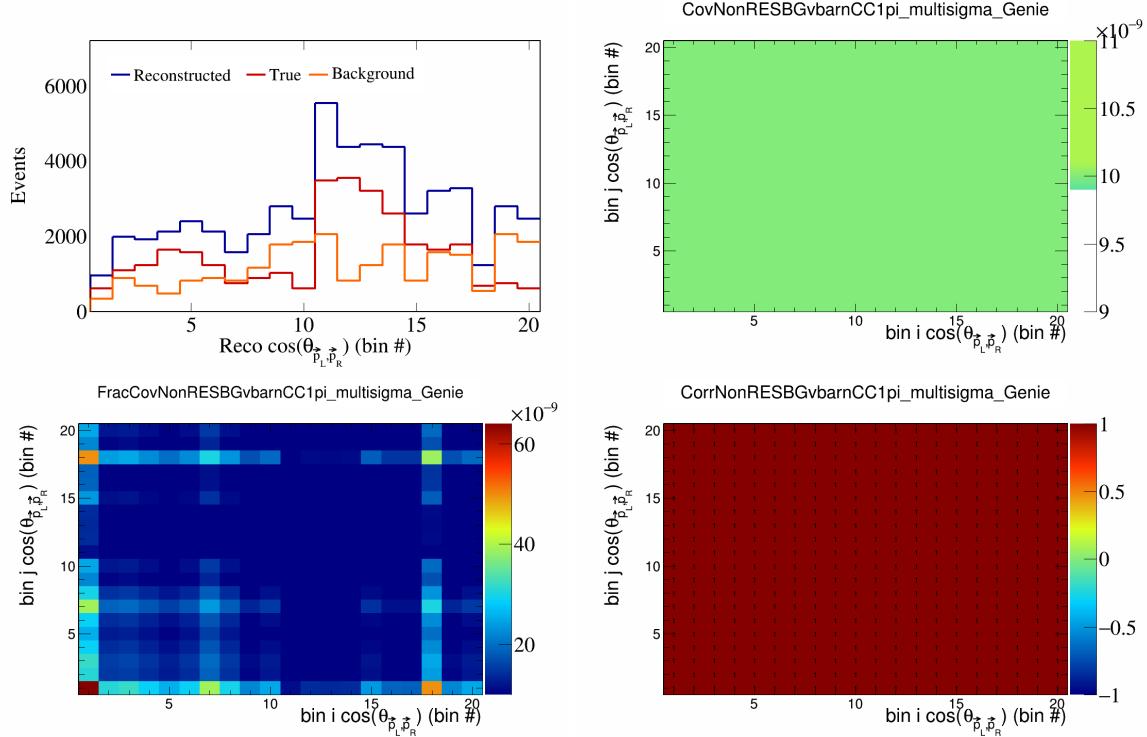


Figure 392: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

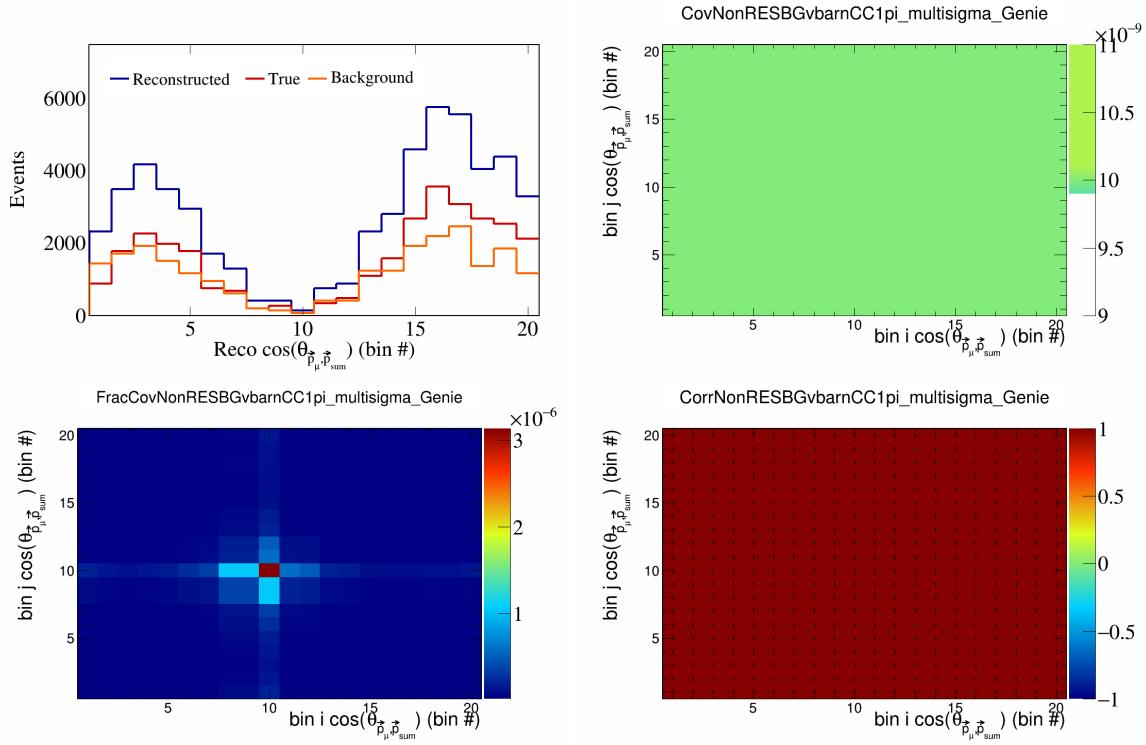


Figure 393: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

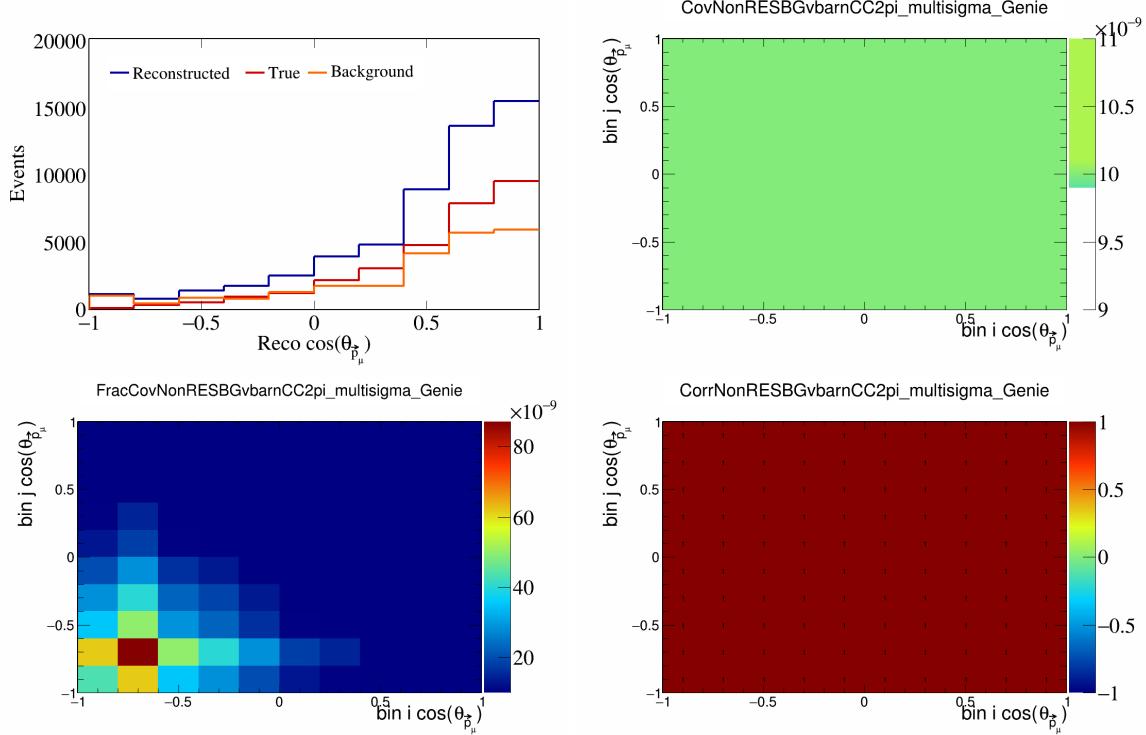


Figure 394: NonRESBGvbarCC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

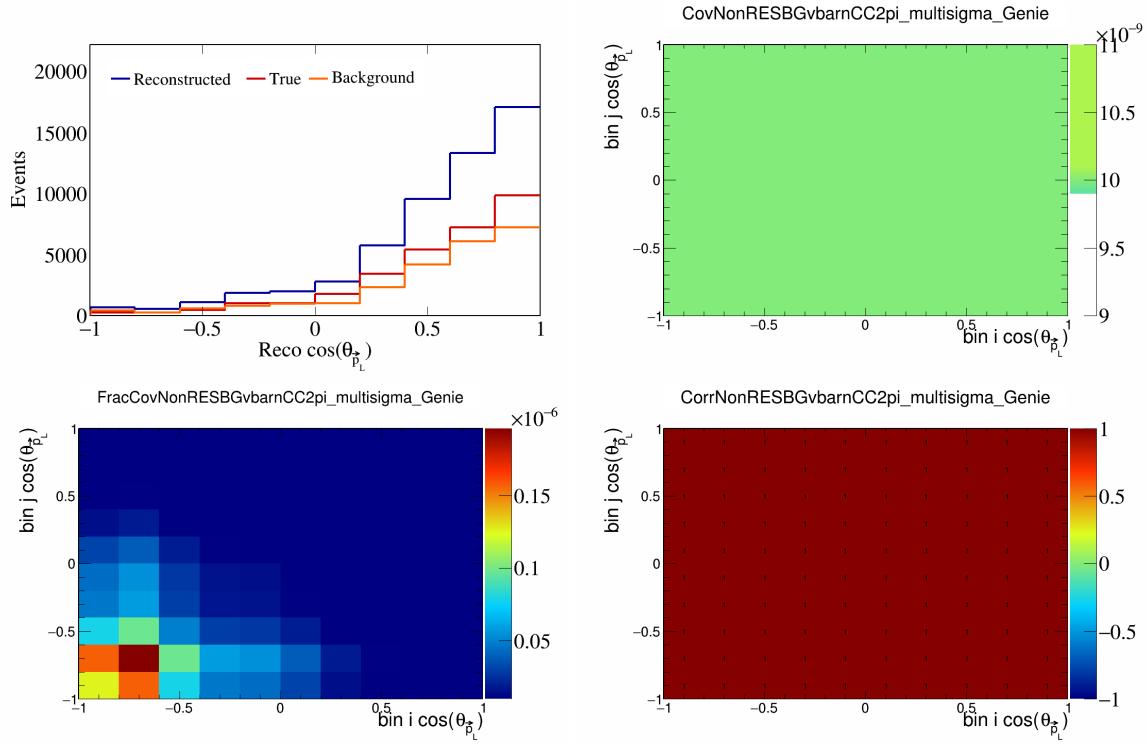


Figure 395: NonRESBGvbarCC2pi variations for $\cos(\theta_{\vec{p}_L})$.

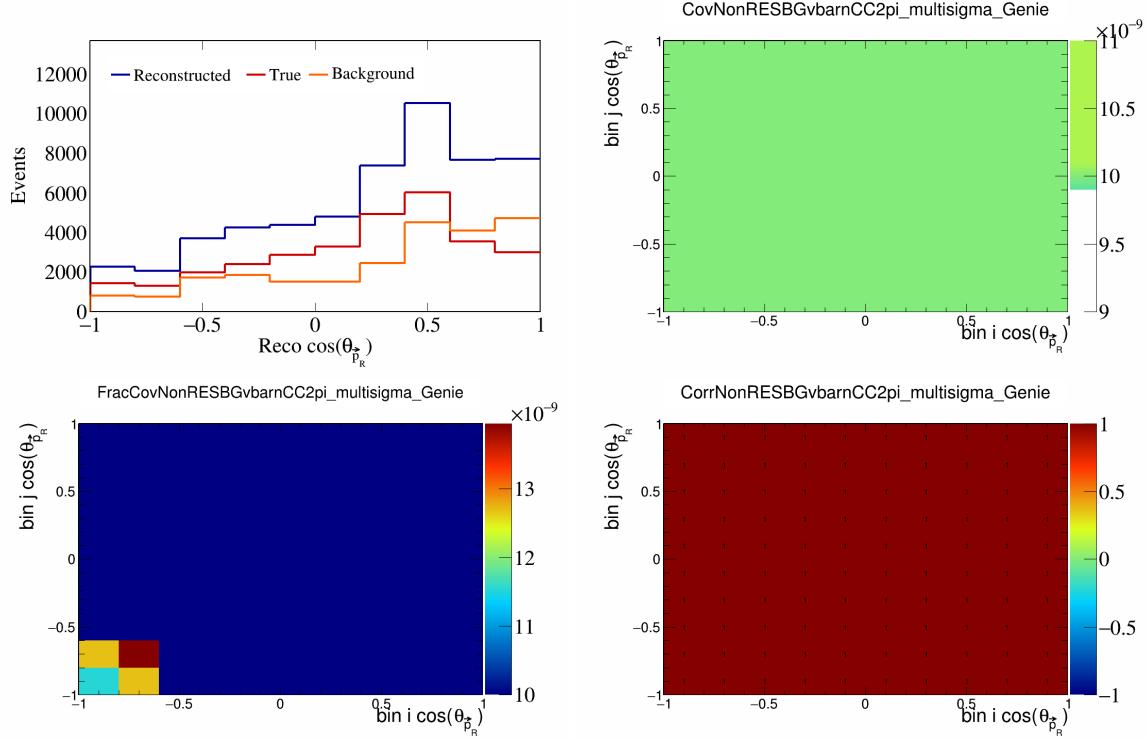


Figure 396: NonRESBGvbarCC2pi variations for $\cos(\theta_{\vec{p}_R})$.

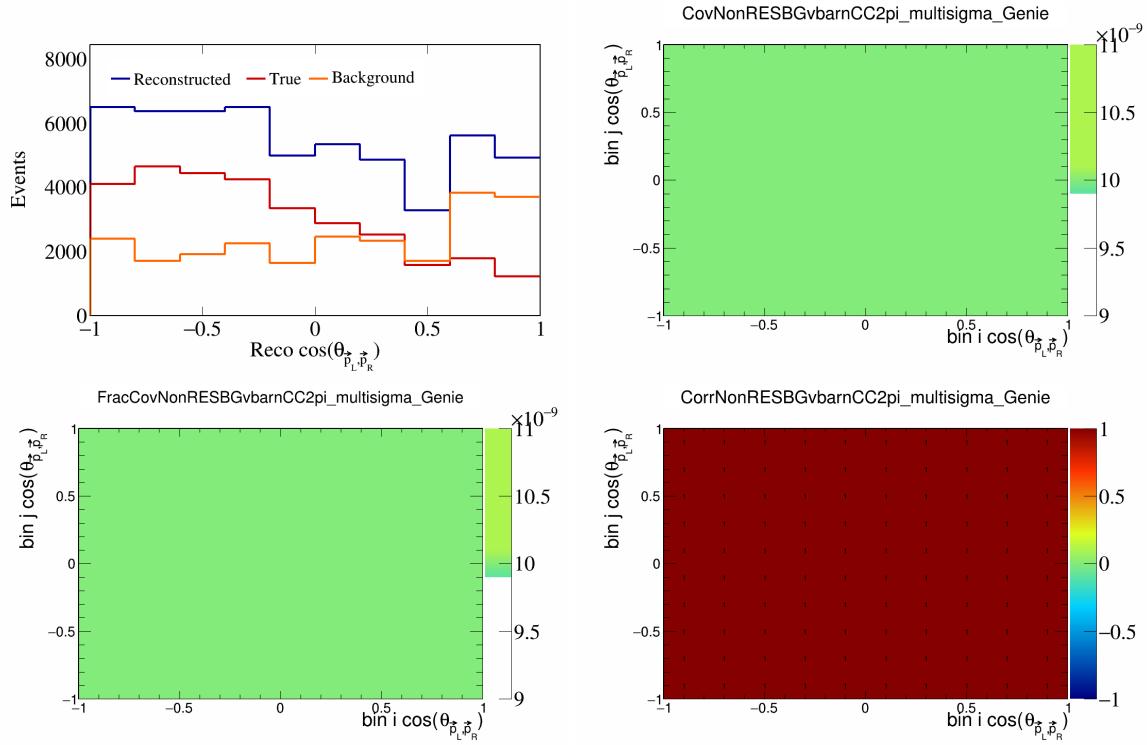


Figure 397: NonRESBGvbarCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

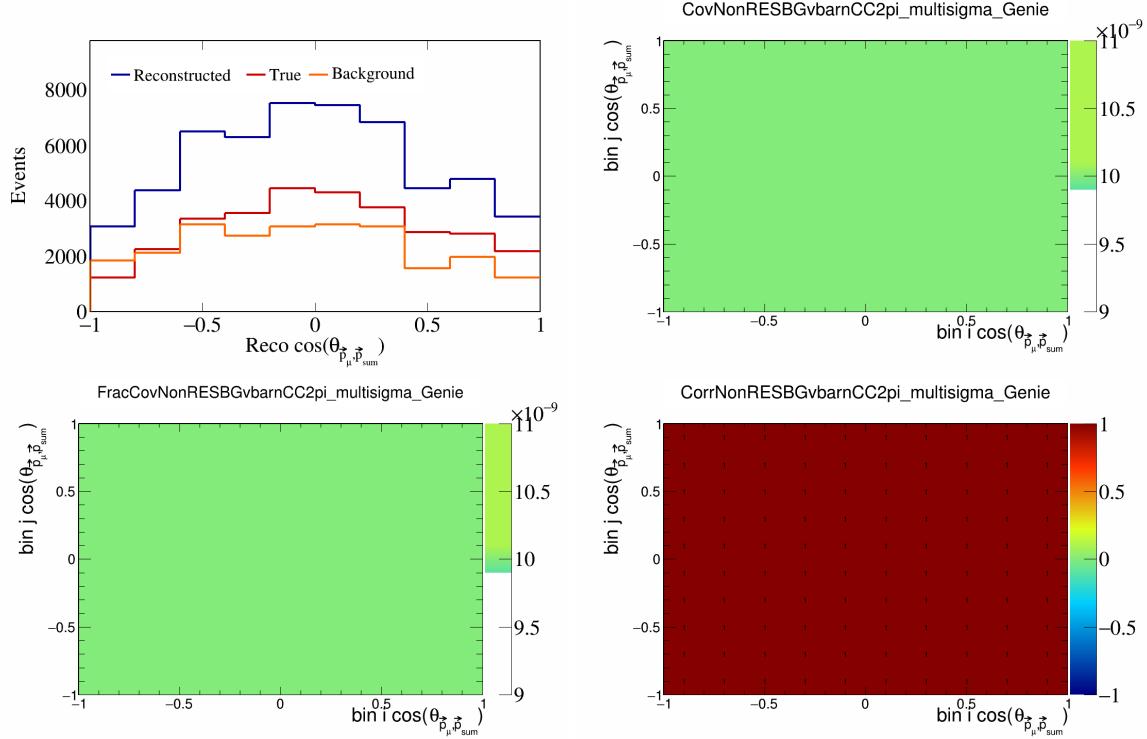


Figure 398: NonRESBGvbarCC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

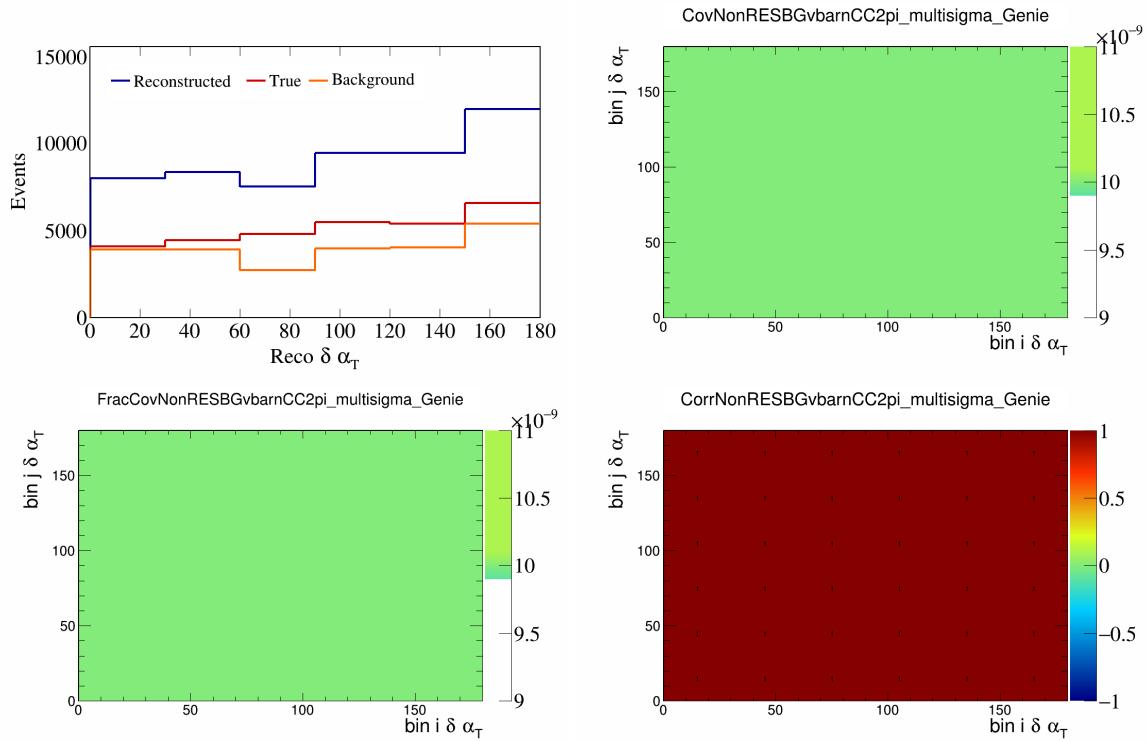


Figure 399: NonRESBGvbarCC2pi variations for $\delta\alpha_T$.

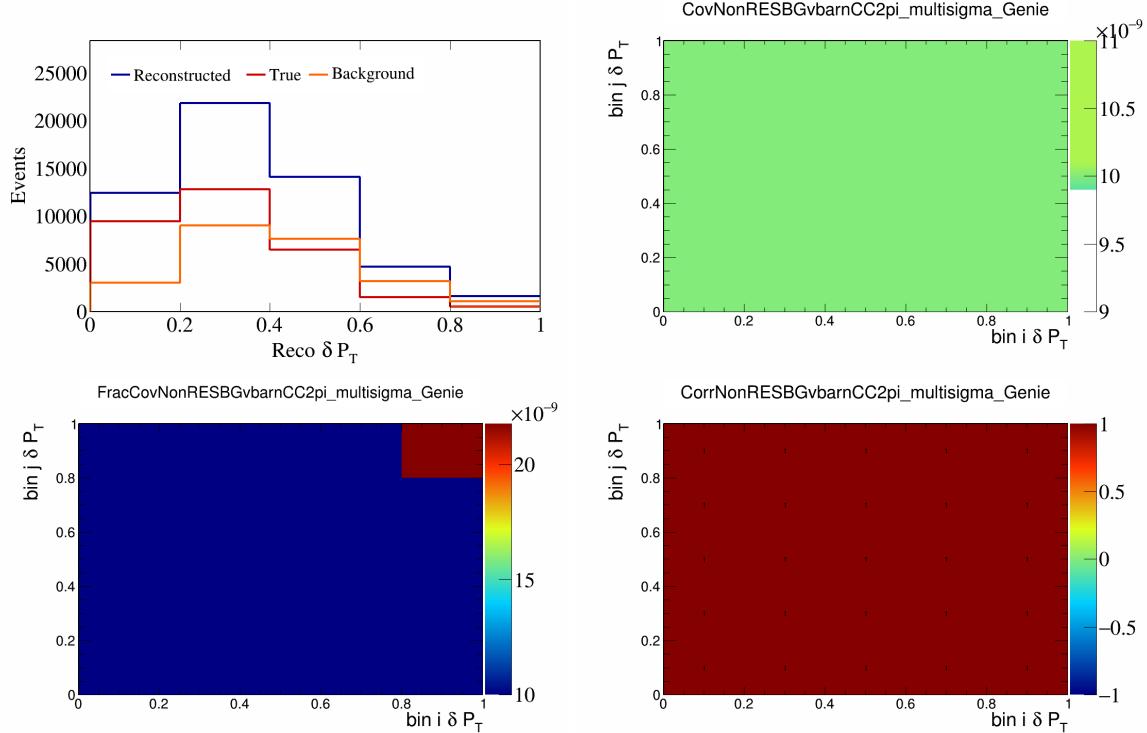


Figure 400: NonRESBGvbarCC2pi variations for δP_T .

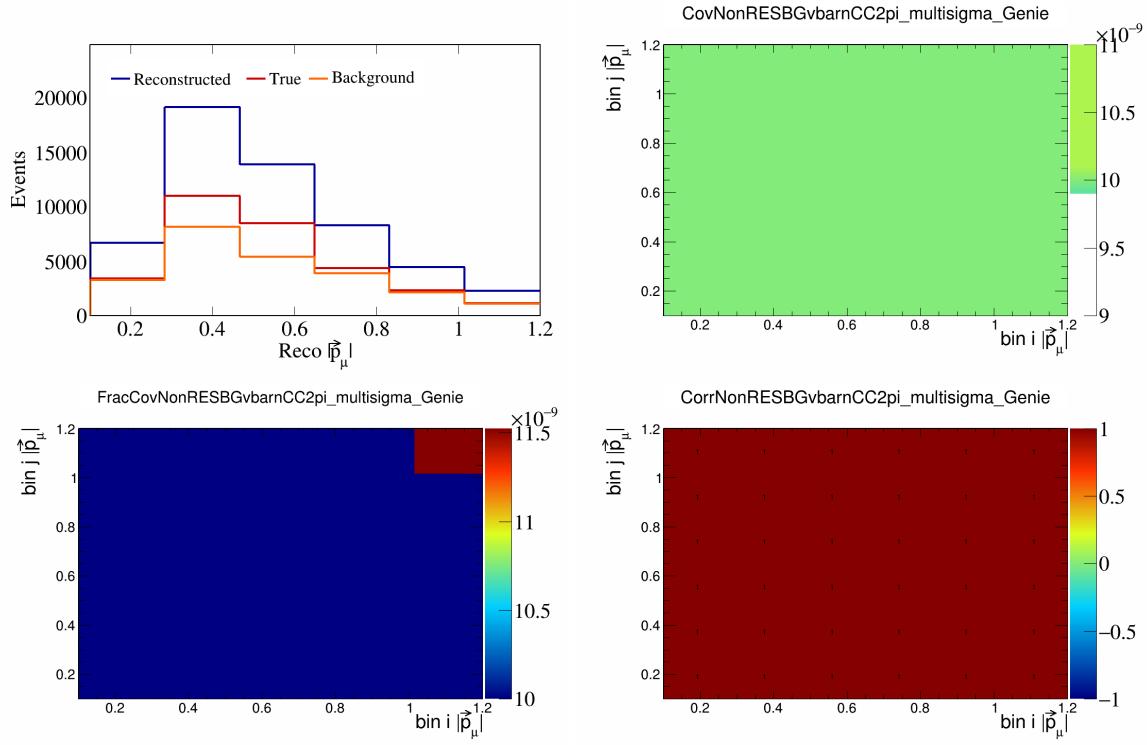


Figure 401: NonRESBGvbarCC2pi variations for $|\vec{p}_\mu|$.

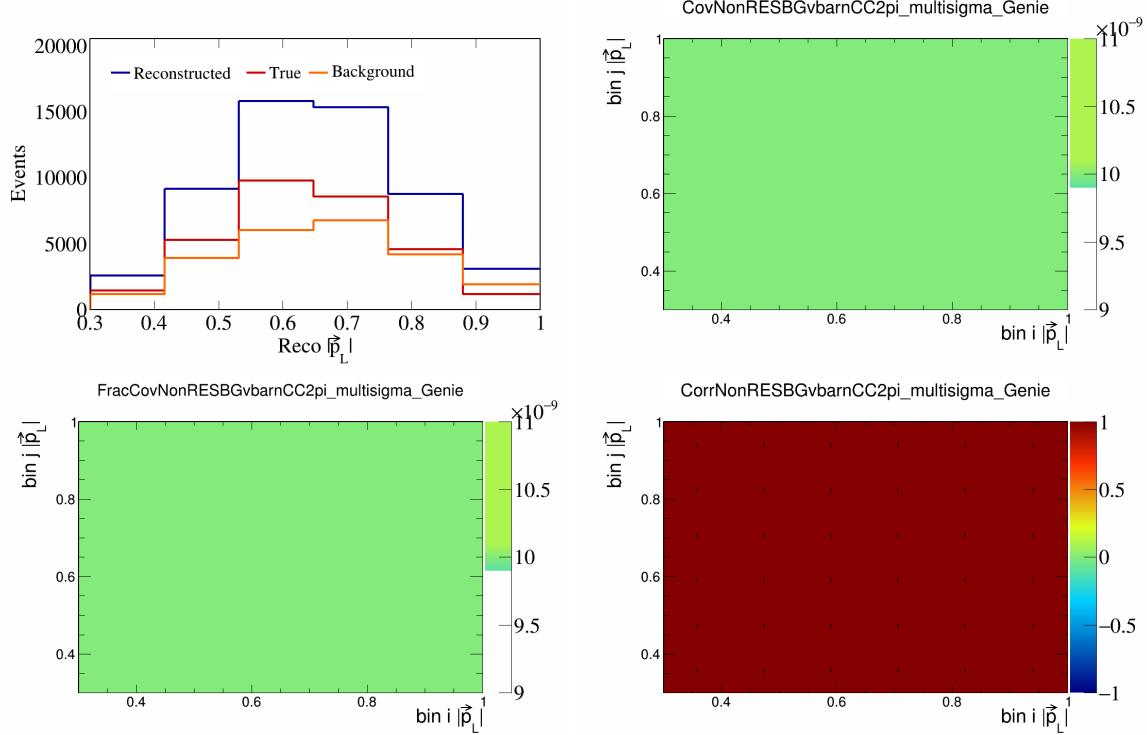


Figure 402: NonRESBGvbarCC2pi variations for $|\vec{p}_L|$.

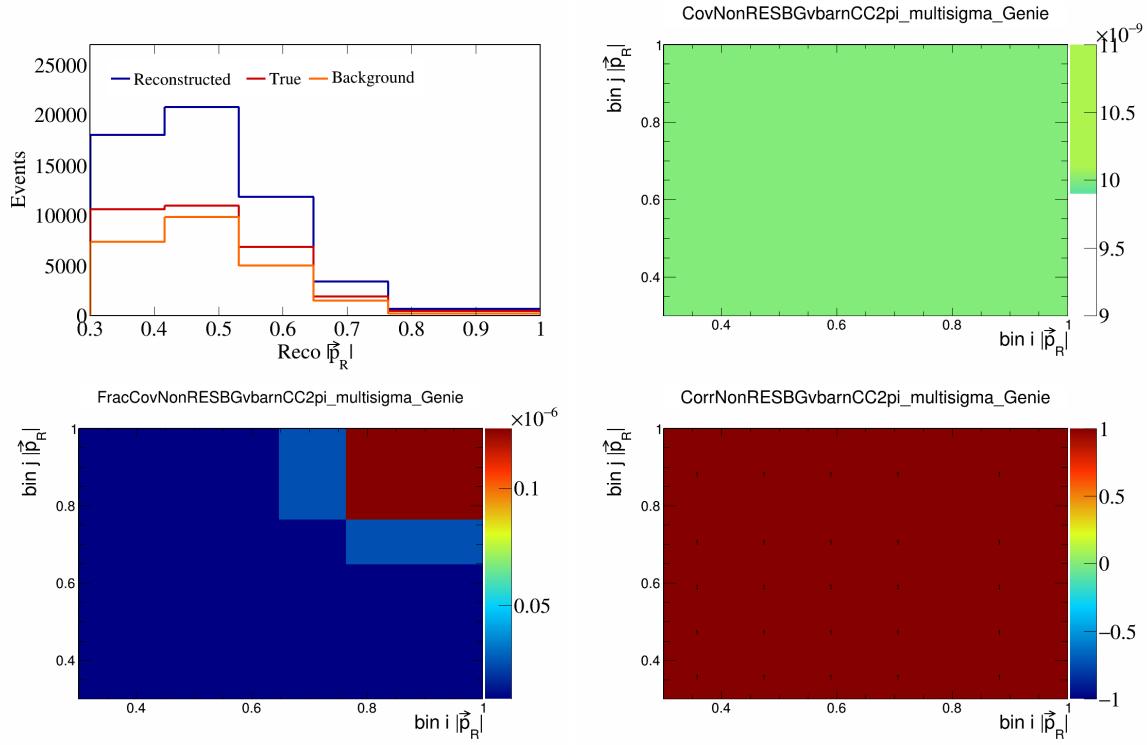


Figure 403: NonRESBGvbarCC2pi variations for $|\vec{p}_R|$.

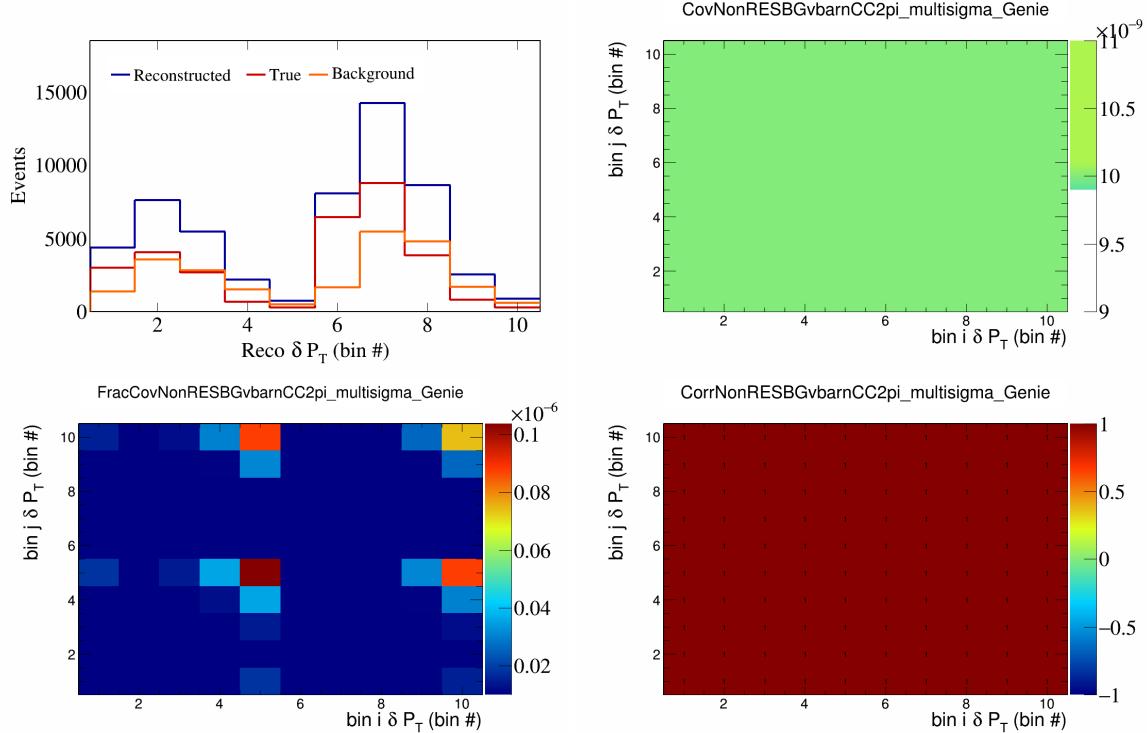


Figure 404: NonRESBGvbarCC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

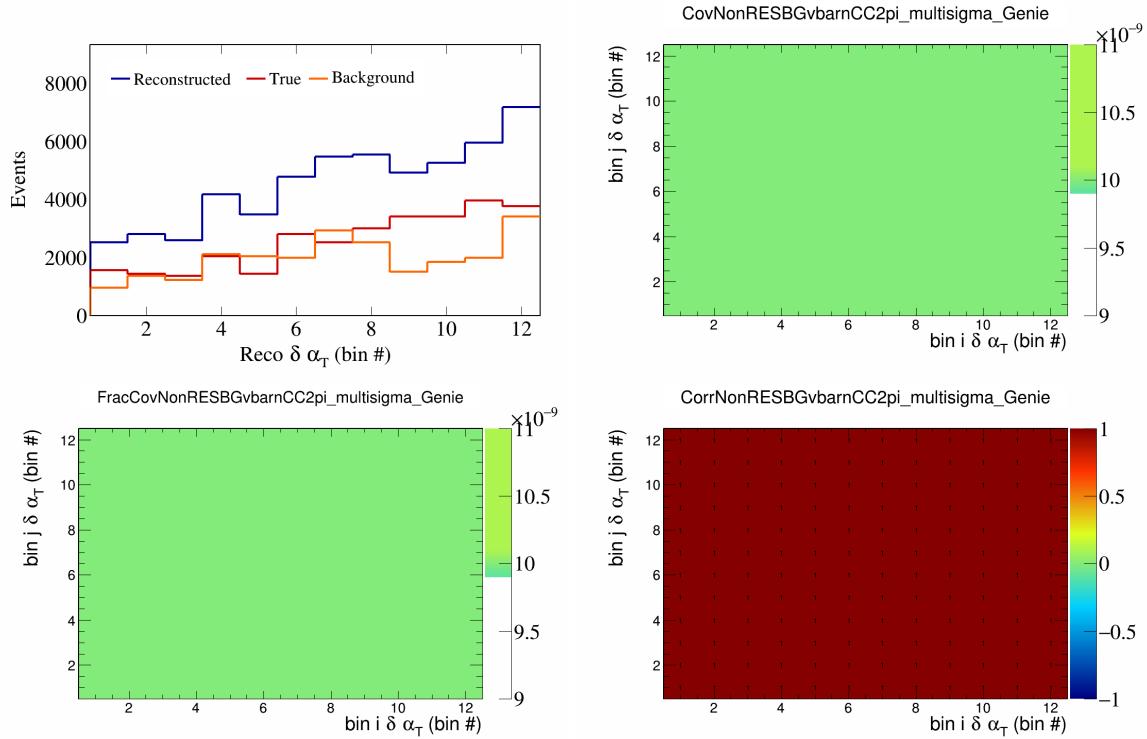


Figure 405: NonRESBGvbarCC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

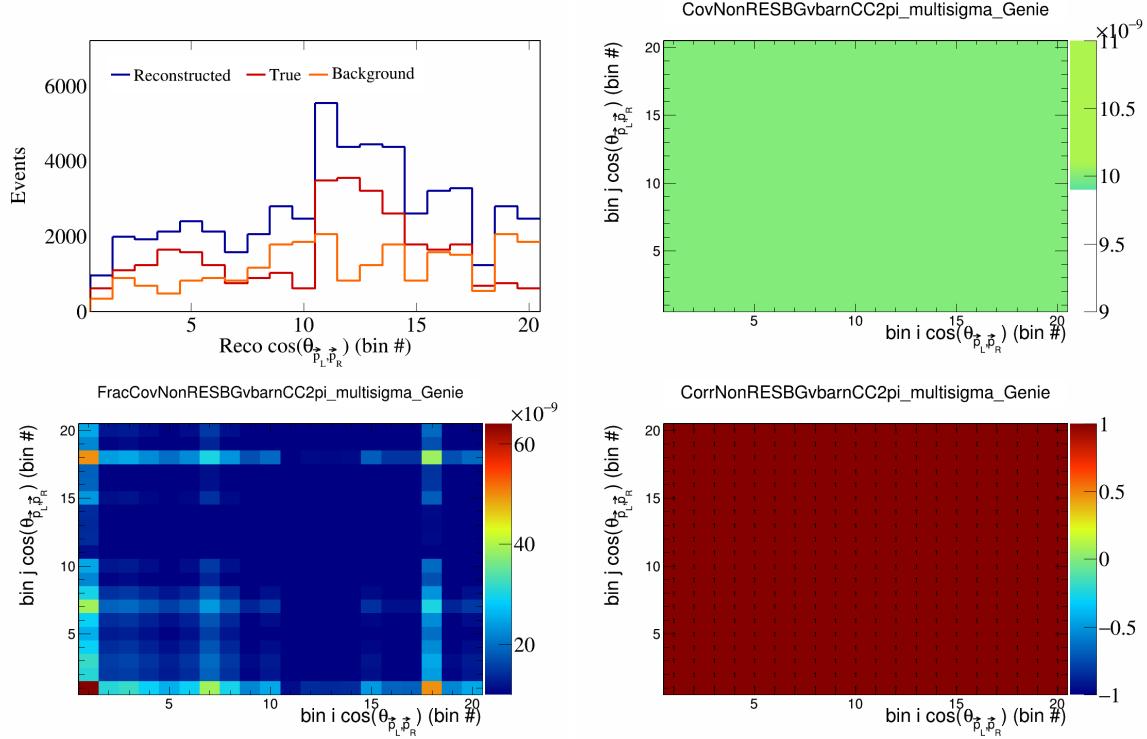


Figure 406: NonRESBGvbarCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

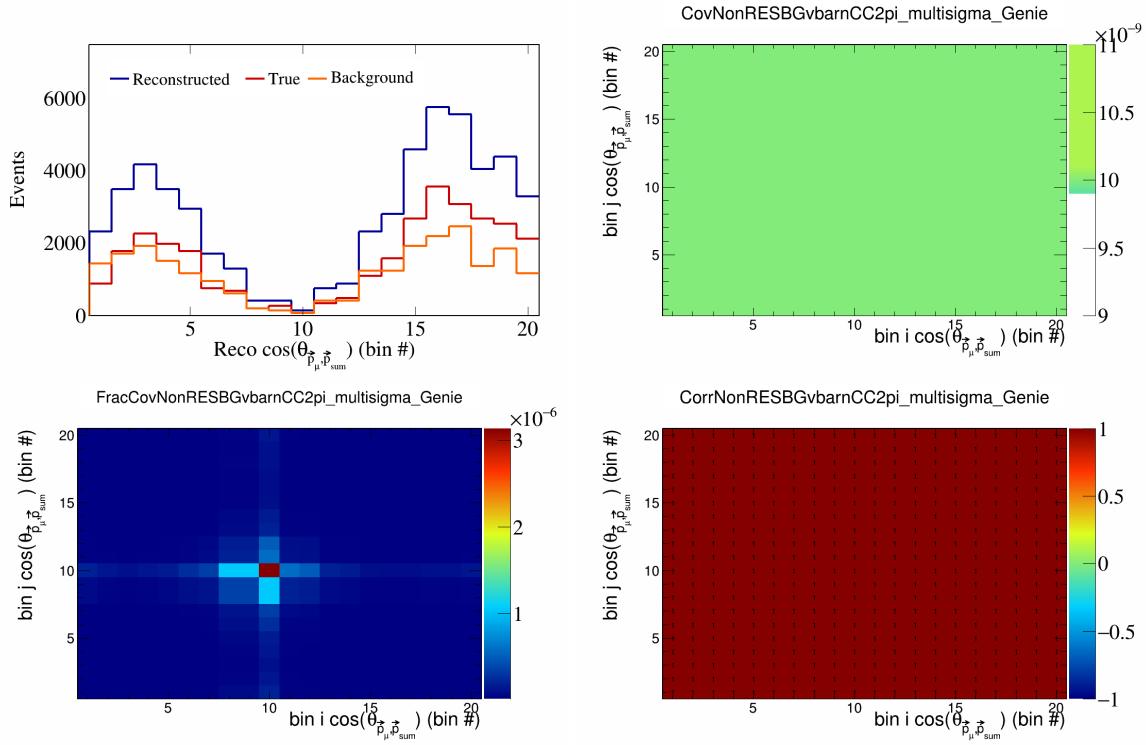


Figure 407: NonRESBGvbarCC2pi variations for $\cos(\theta_{\vec{p}_\mu})$ in $\cos(\theta_{\vec{p}_\mu})$.

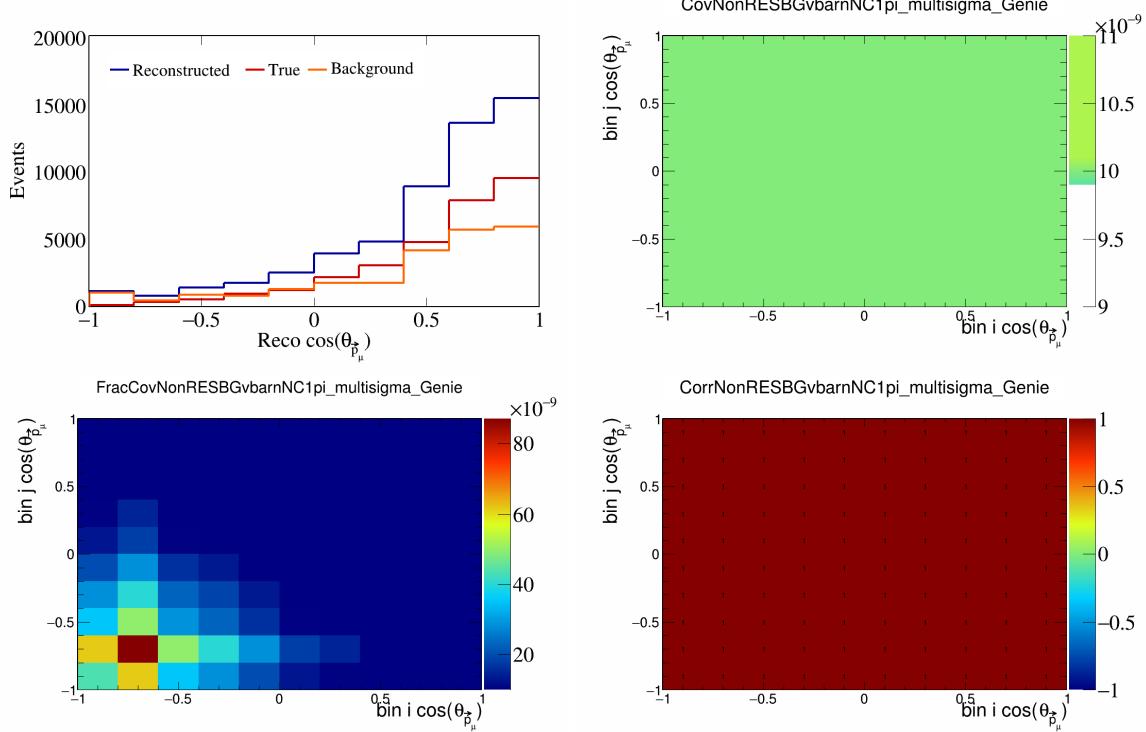


Figure 408: NonRESBGvbarNC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

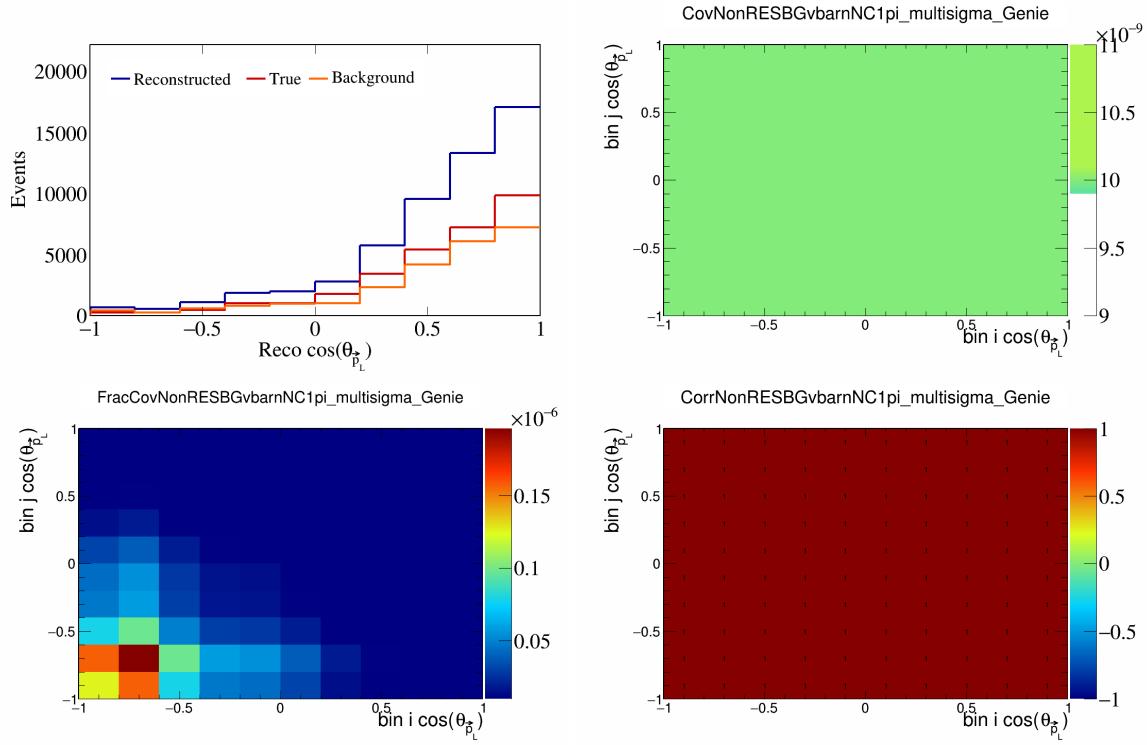


Figure 409: NonRESBGvbarNC1pi variations for $\cos(\theta_{\vec{p}_L})$.

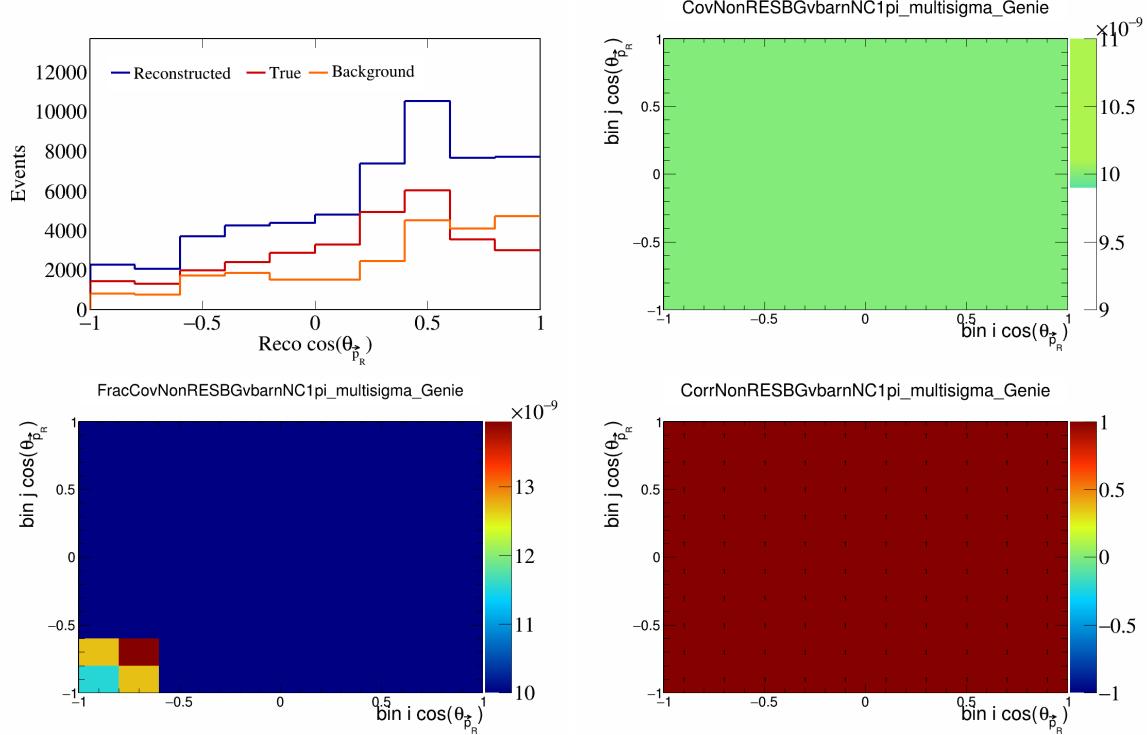


Figure 410: NonRESBGvbarNC1pi variations for $\cos(\theta_{\vec{p}_R})$.

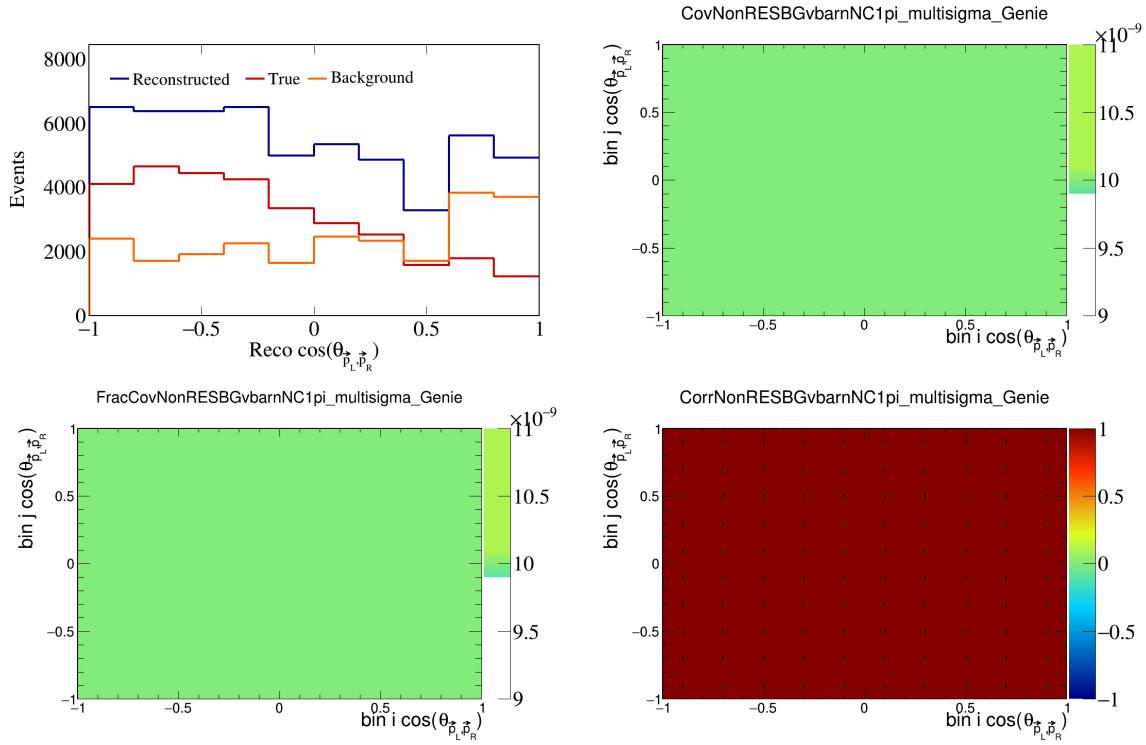


Figure 411: NonRESBGvbarNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

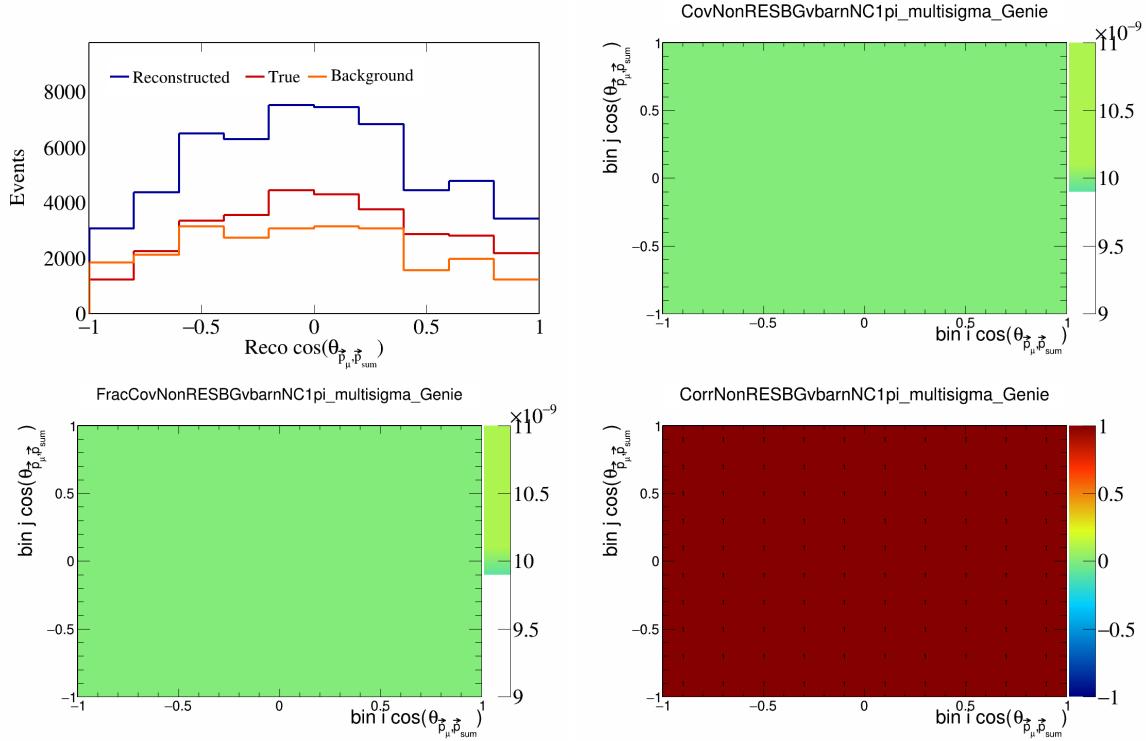


Figure 412: NonRESBGvbarNC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

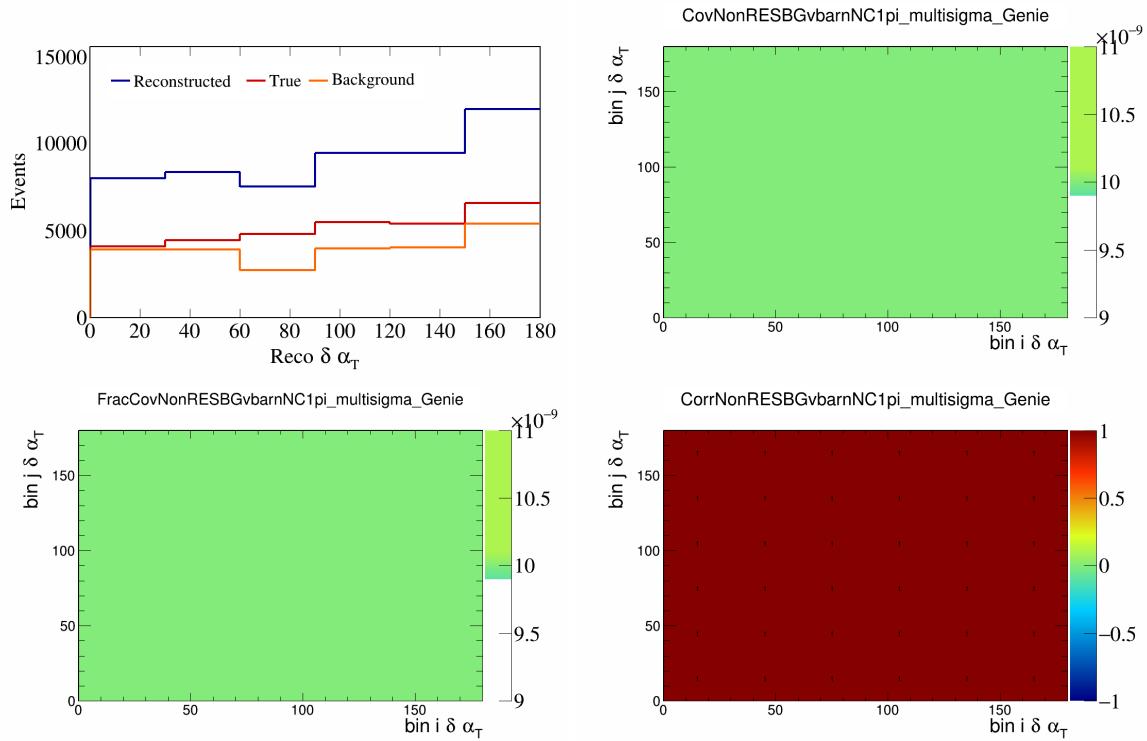


Figure 413: NonRESBGvbarNC1pi variations for $\delta\alpha_T$.

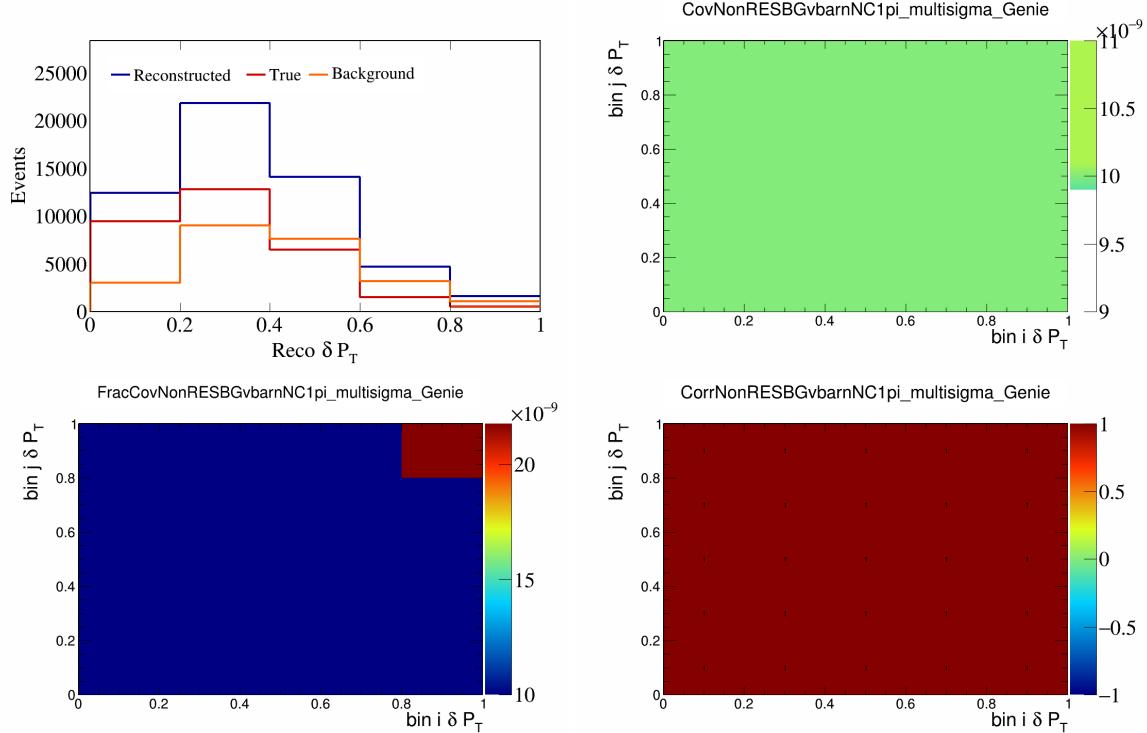


Figure 414: NonRESBGvbarNC1pi variations for δP_T .

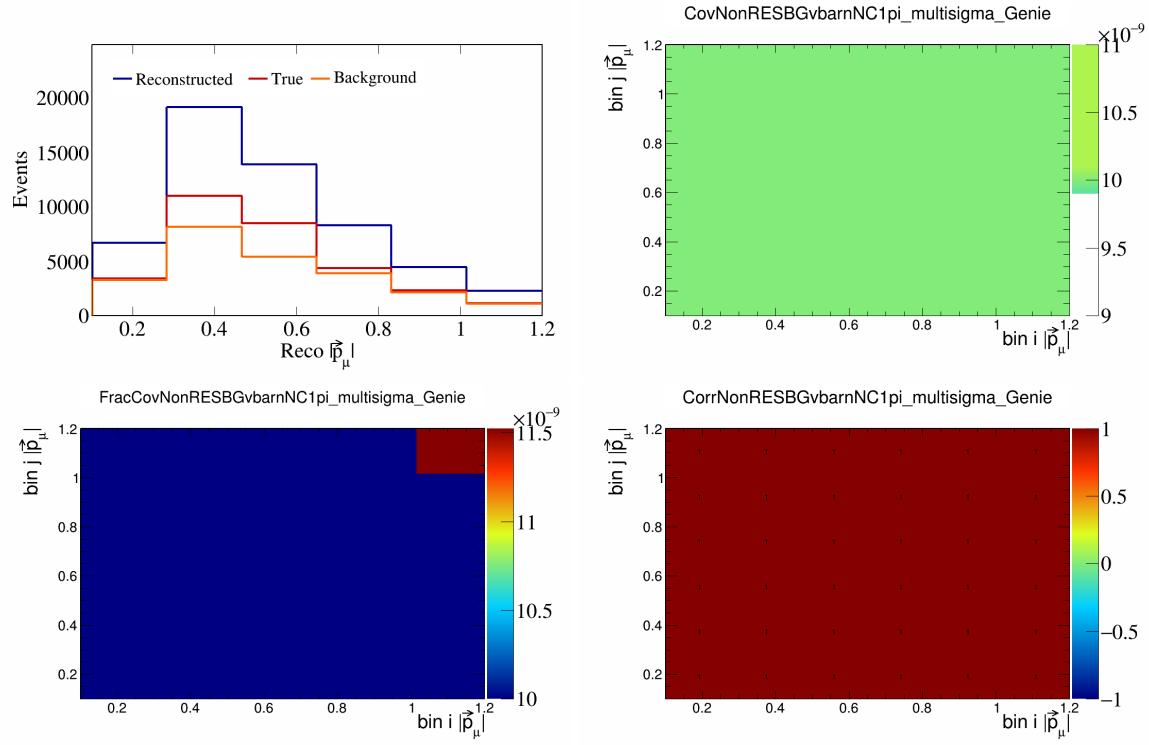


Figure 415: NonRESBGvbarNC1pi variations for $|\vec{p}_\mu|$.

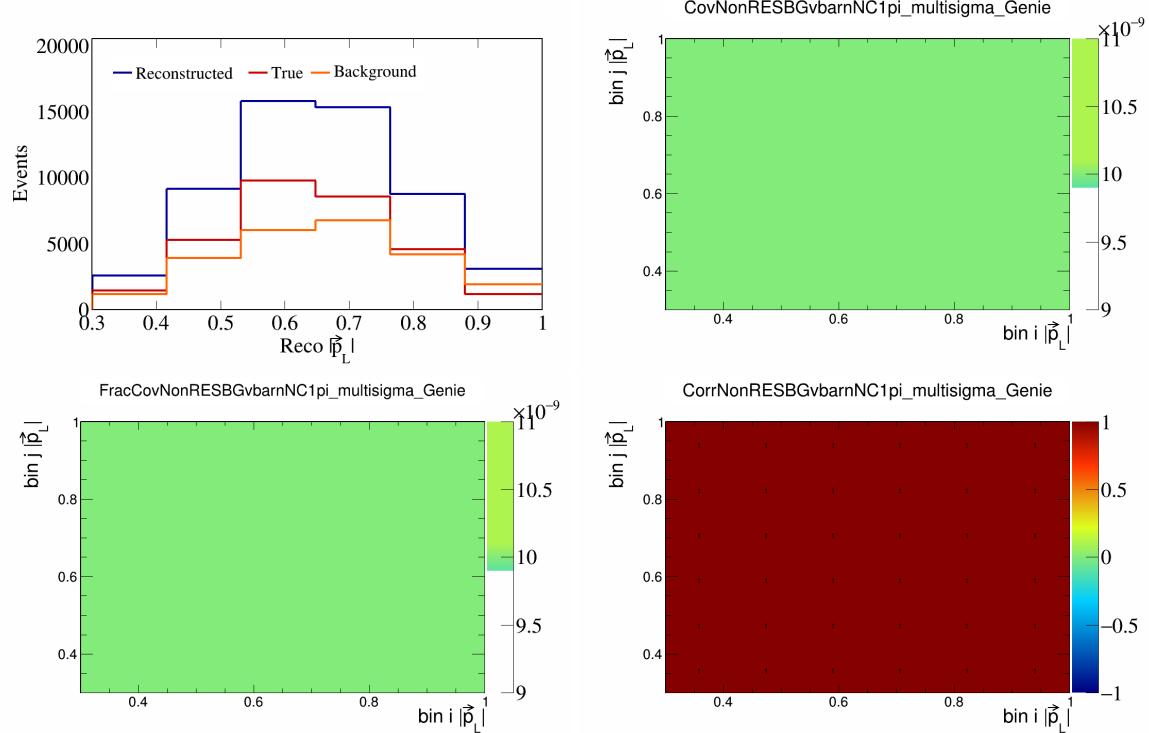


Figure 416: NonRESBGvbarNC1pi variations for $|\vec{p}_L|$.

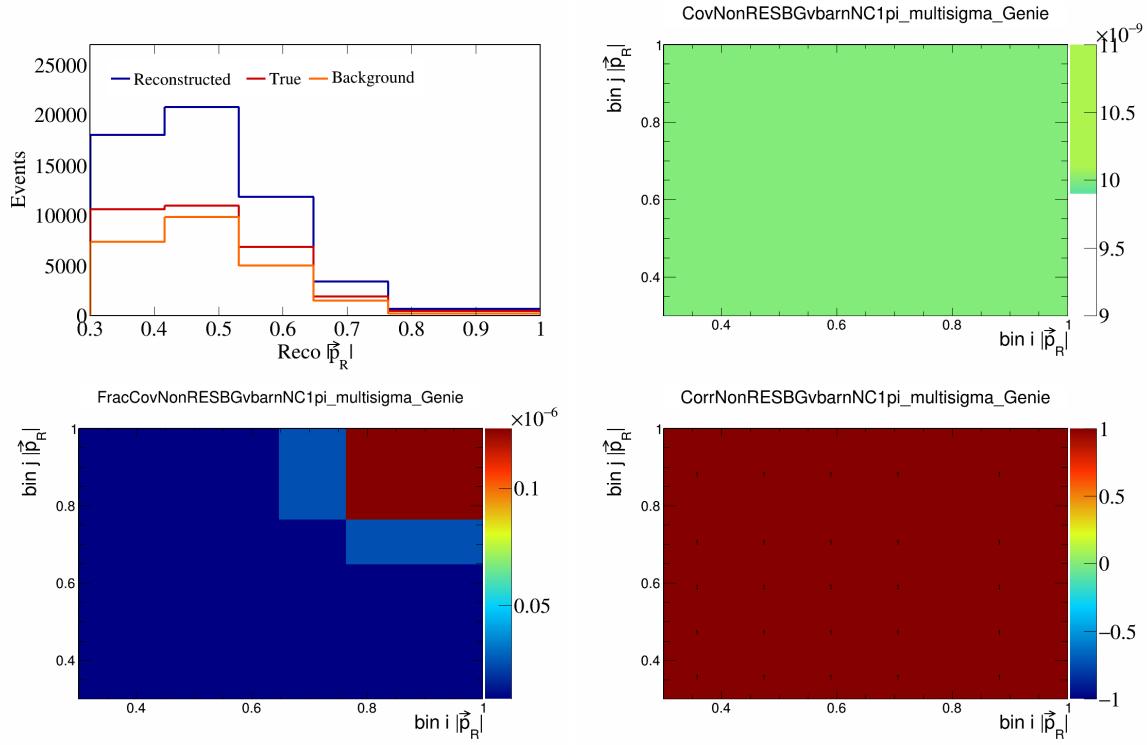


Figure 417: NonRESBGvbarNC1pi variations for $|\vec{p}_R|$.

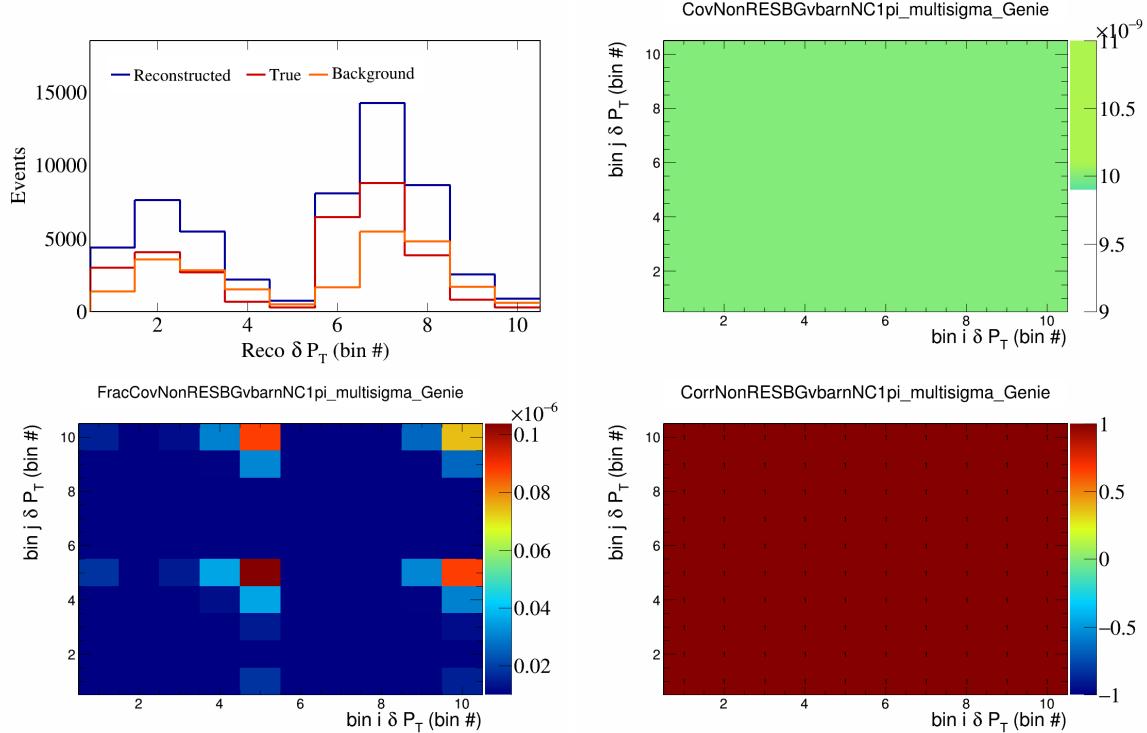


Figure 418: NonRESBGvbarNC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

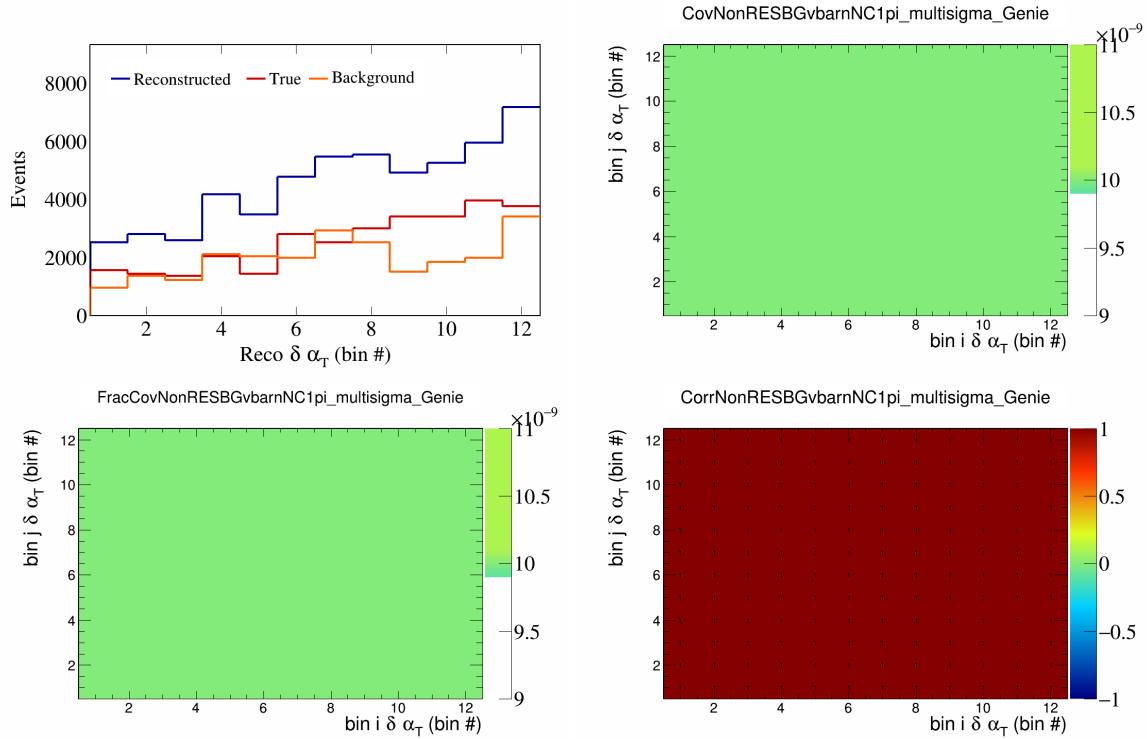


Figure 419: NonRESBGvbarNC1pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

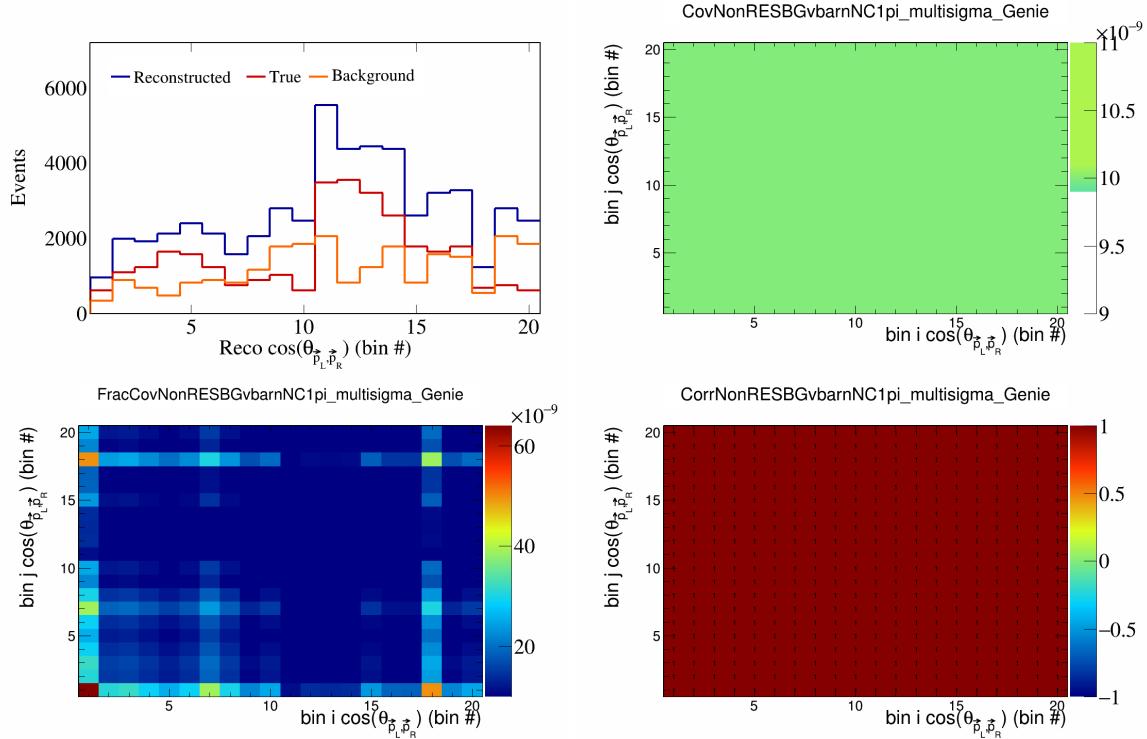


Figure 420: NonRESBGvbarNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

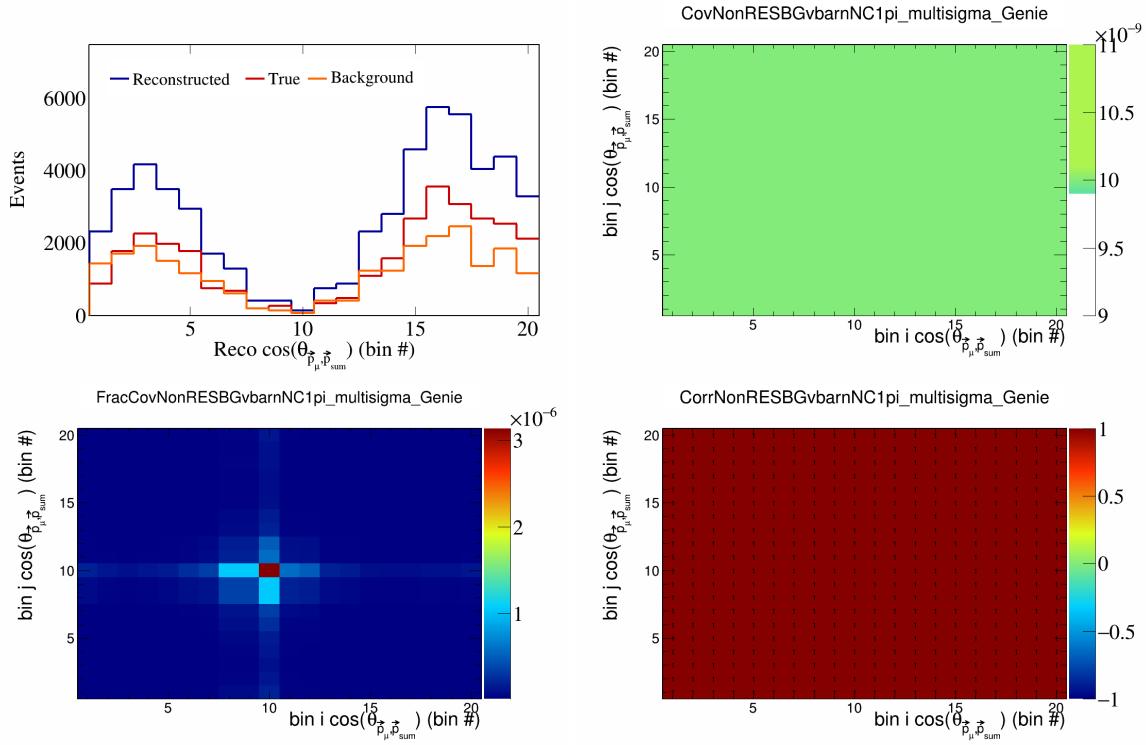


Figure 421: NonRESBGvbarNC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

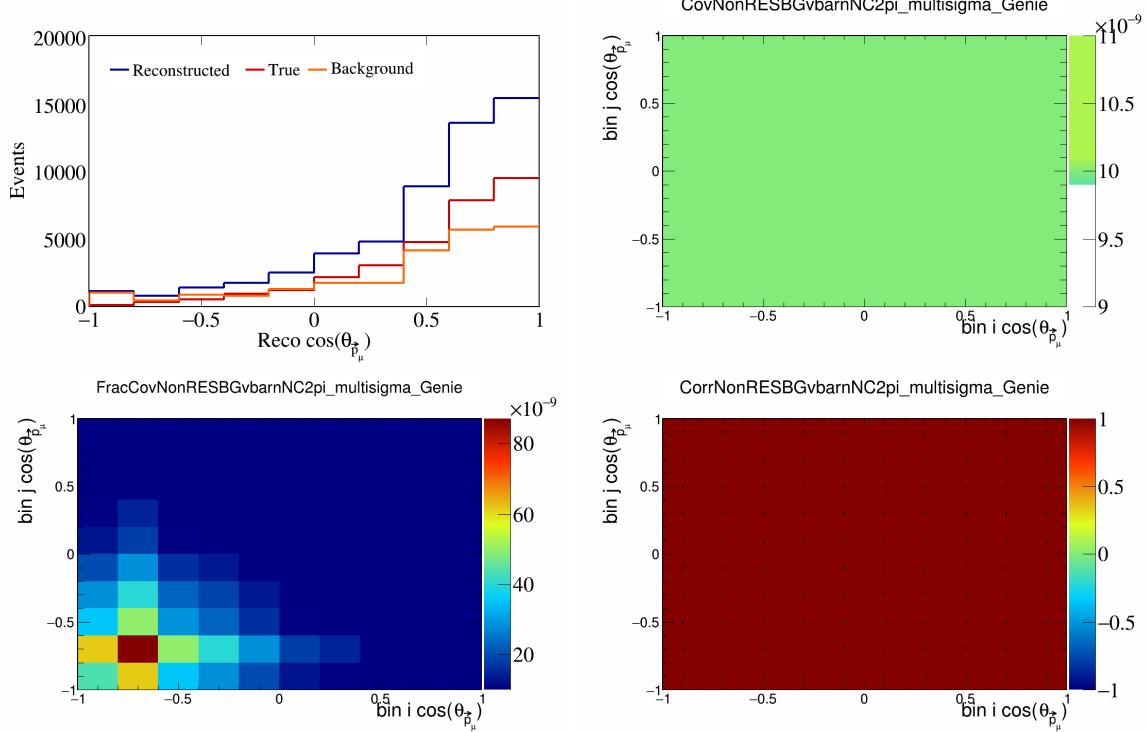


Figure 422: NonRESBGvbarNC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

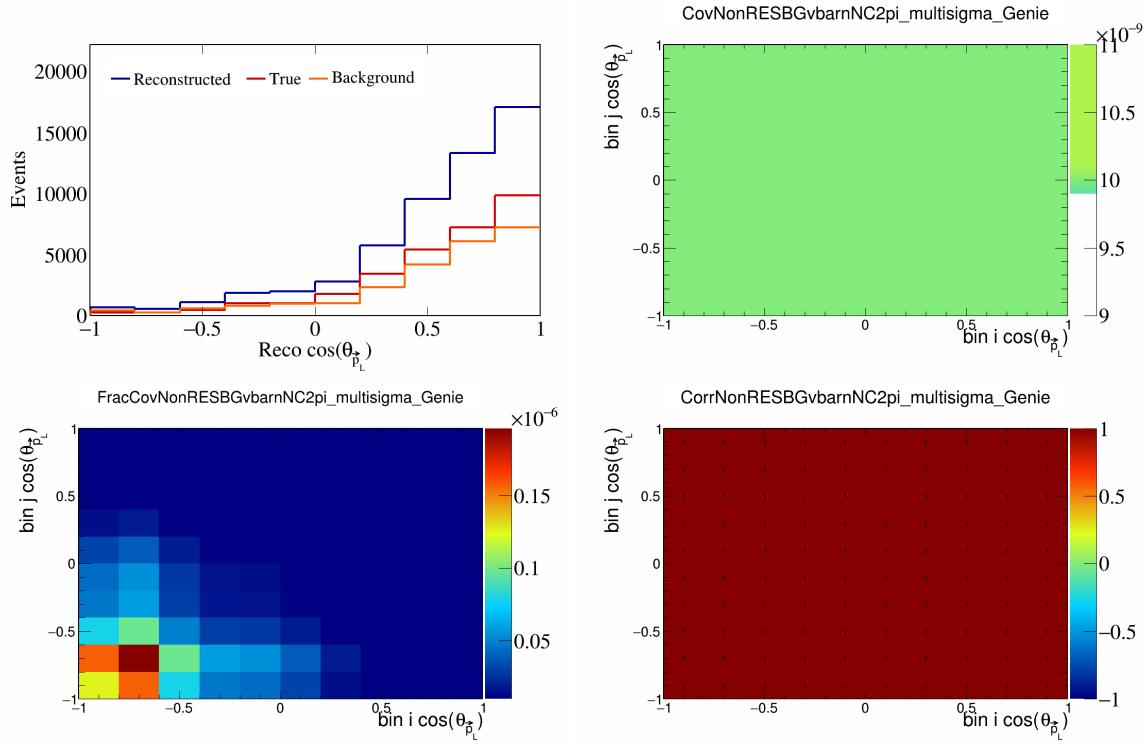


Figure 423: NonRESBGvbarNC2pi variations for $\cos(\theta_{\vec{p}_L})$.

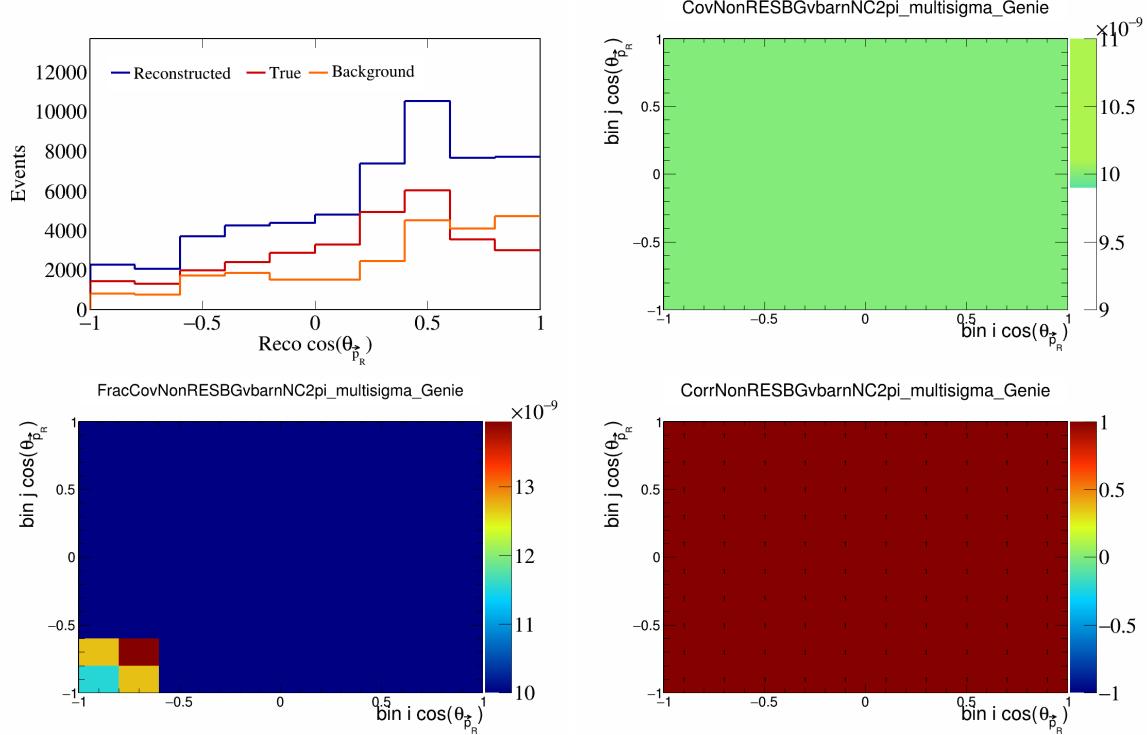


Figure 424: NonRESBGvbarNC2pi variations for $\cos(\theta_{\vec{p}_R})$.

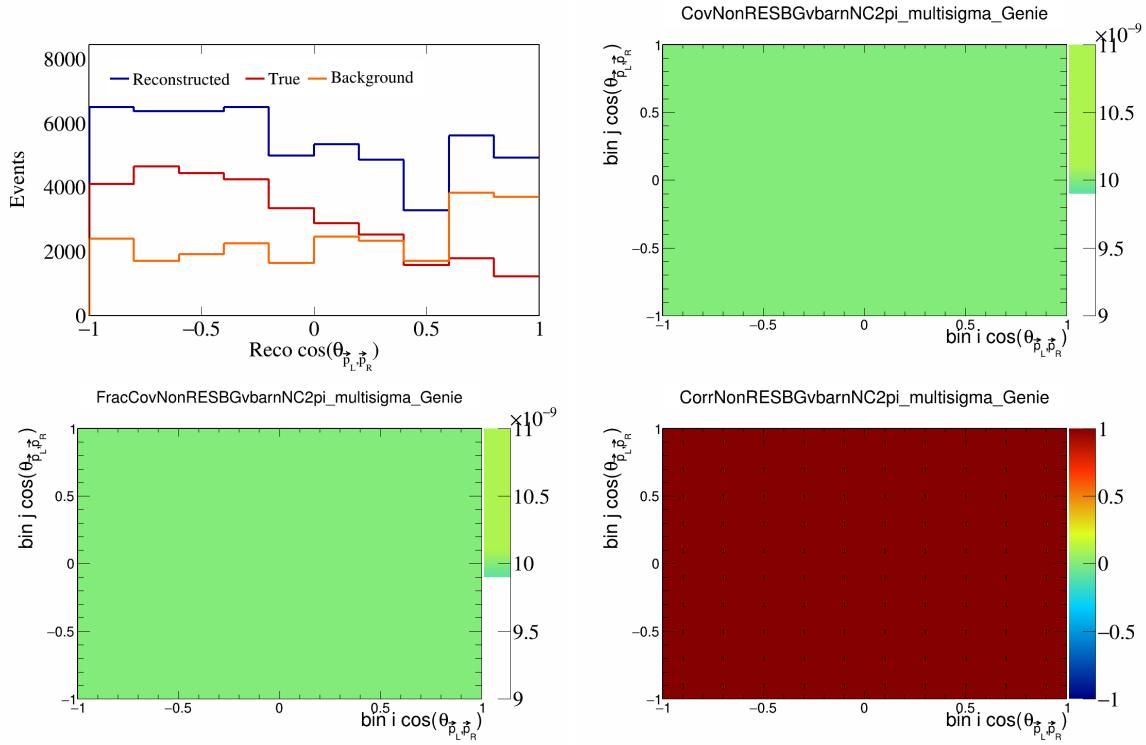


Figure 425: NonRESBGvbarNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

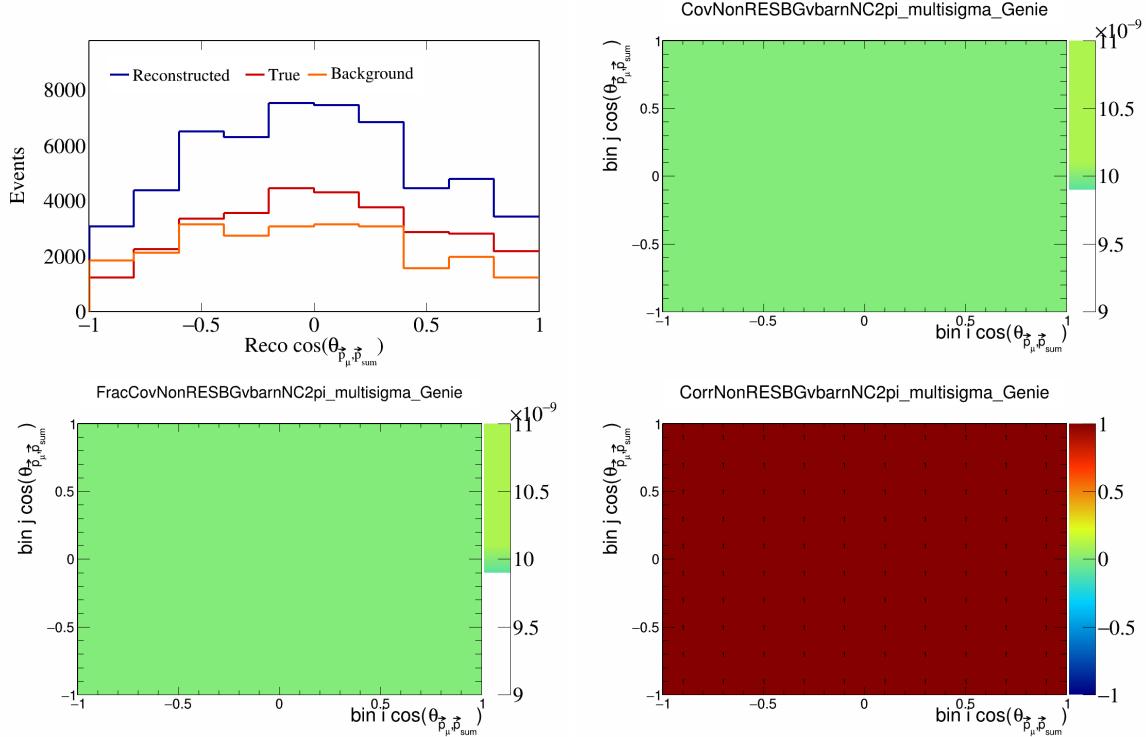


Figure 426: NonRESBGvbarNC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

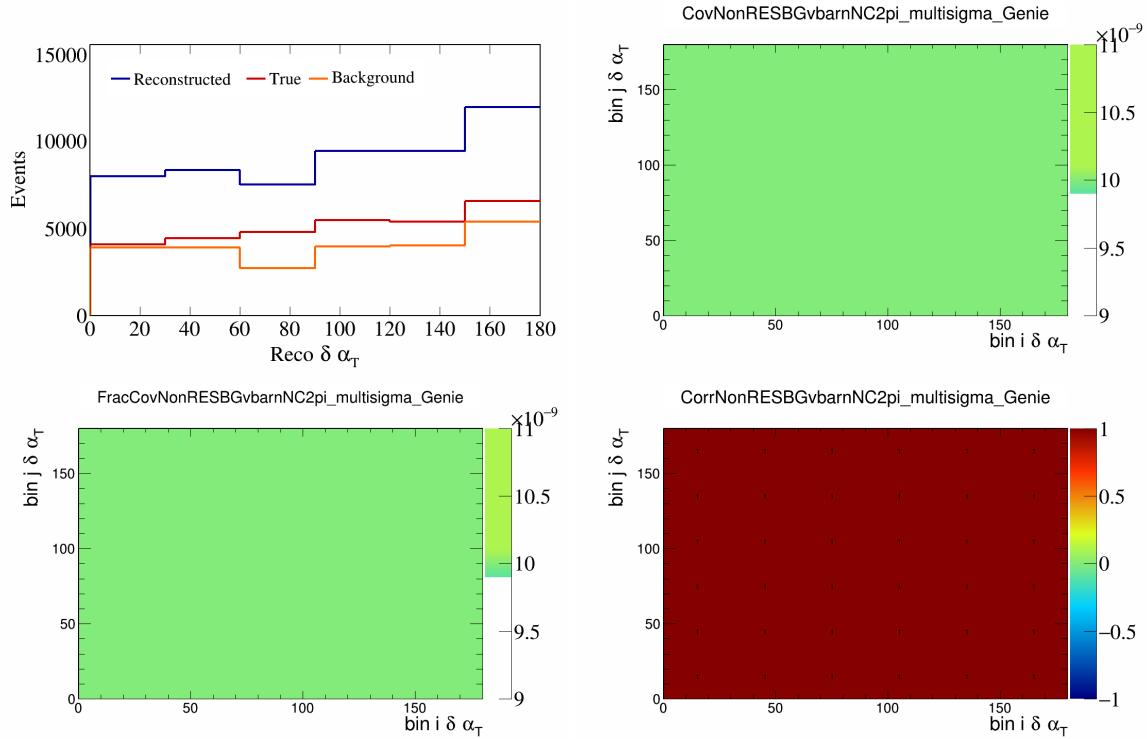


Figure 427: NonRESBGvbarNC2pi variations for $\delta\alpha_T$.

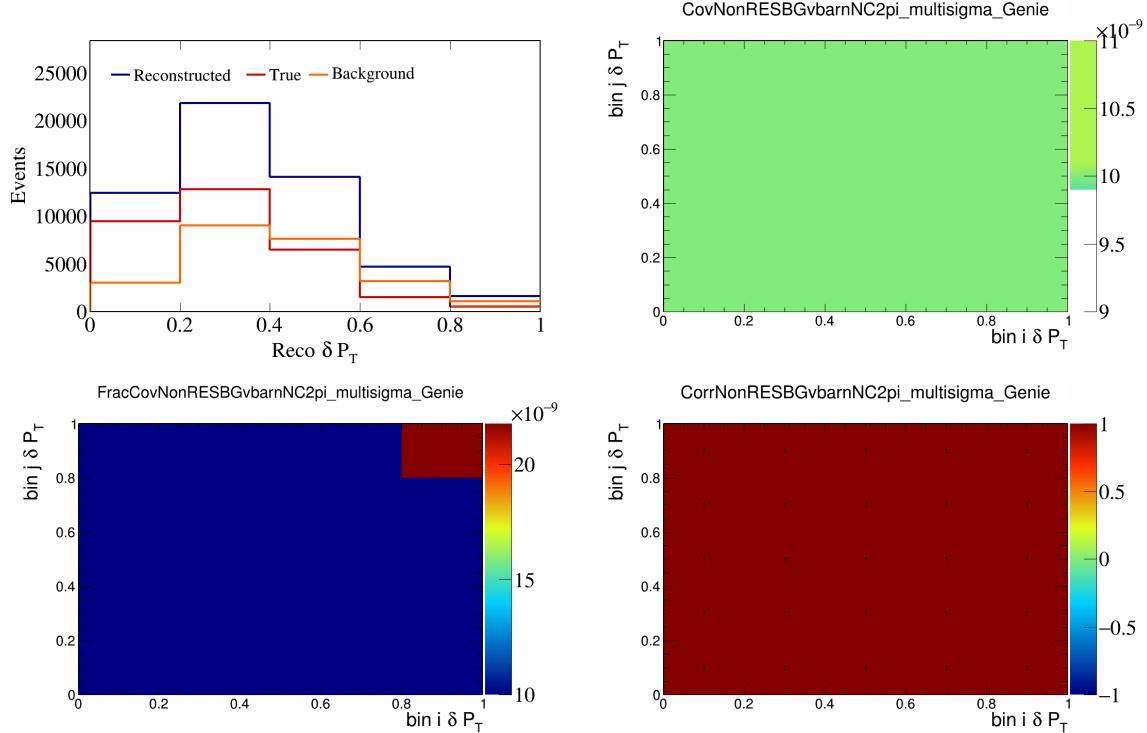


Figure 428: NonRESBGvbarNC2pi variations for δP_T .

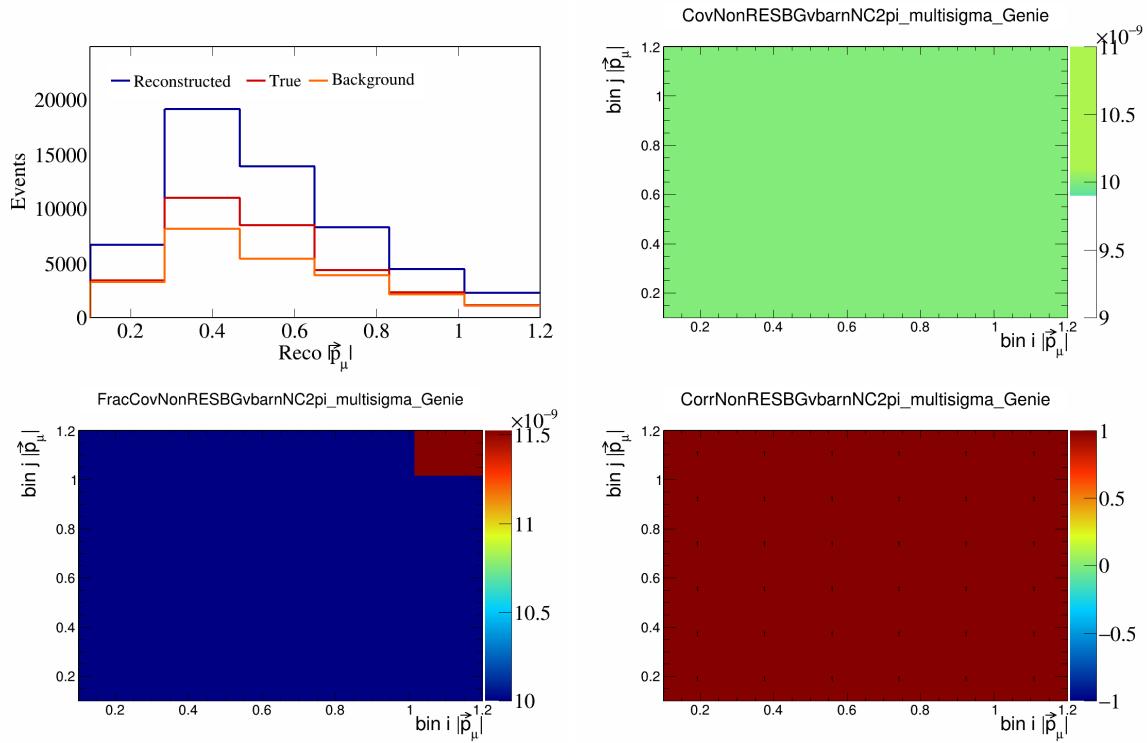


Figure 429: NonRESBGvbarNC2pi variations for $|\vec{p}_\mu|$.

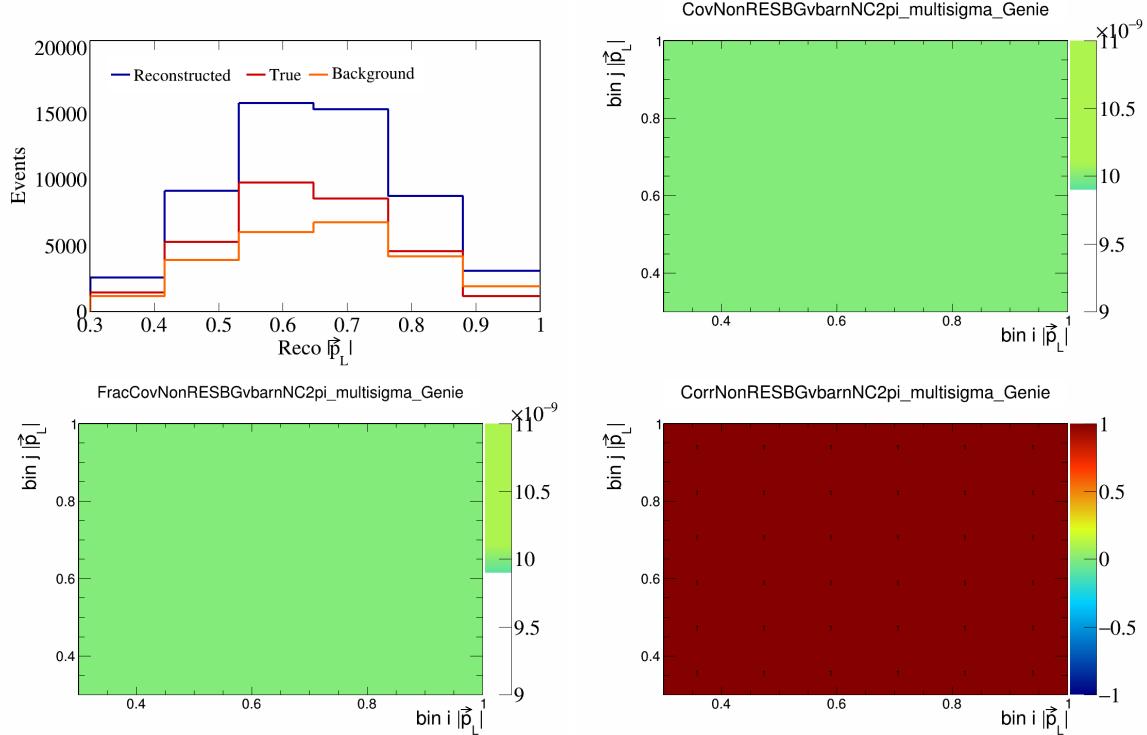


Figure 430: NonRESBGvbarNC2pi variations for $|\vec{p}_L|$.

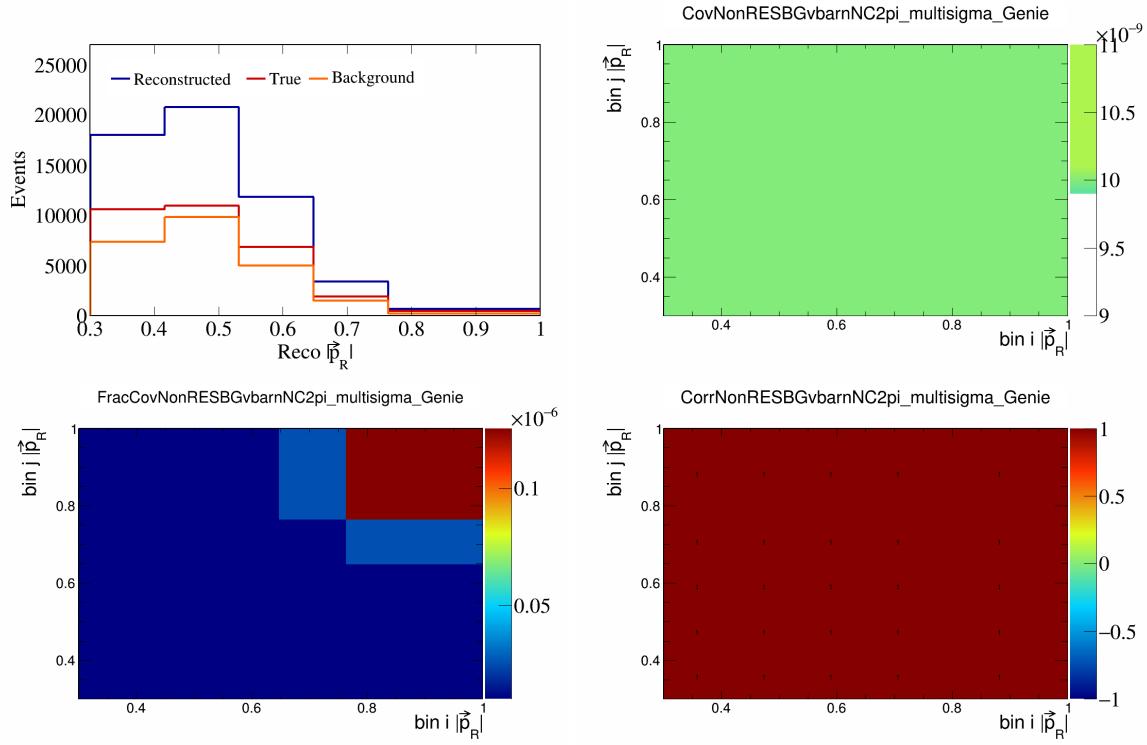


Figure 431: NonRESBGvbarNC2pi variations for $|\vec{p}_R|$.

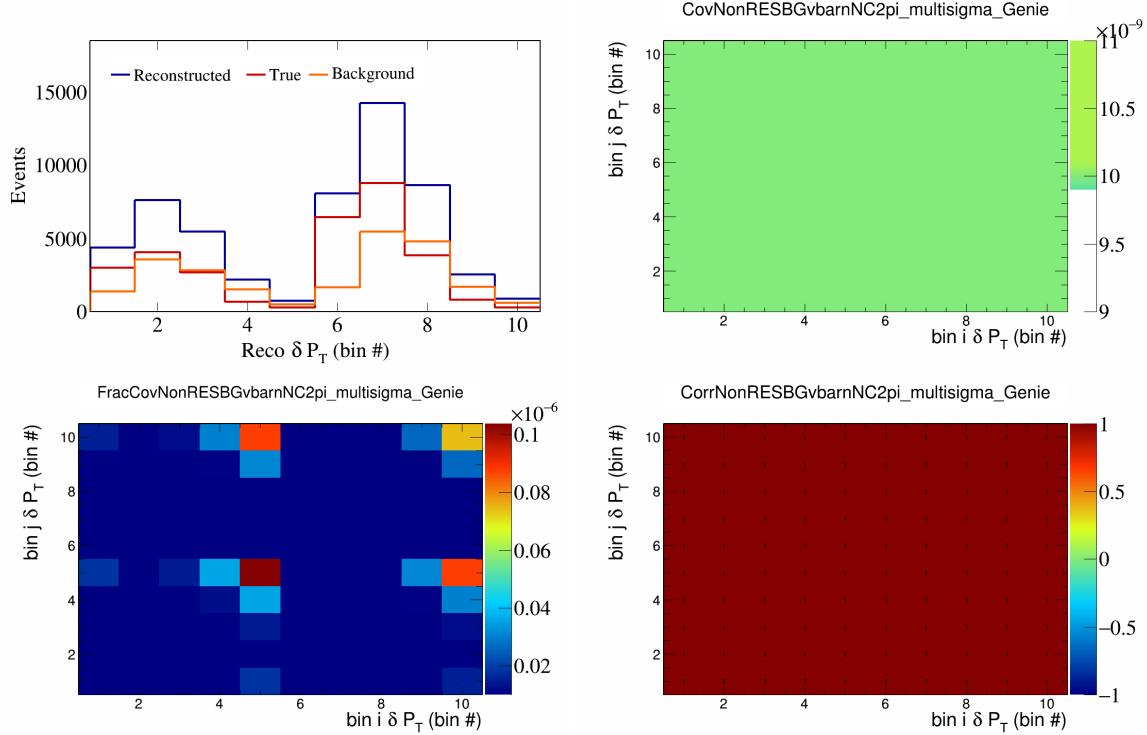


Figure 432: NonRESBGvbarNC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

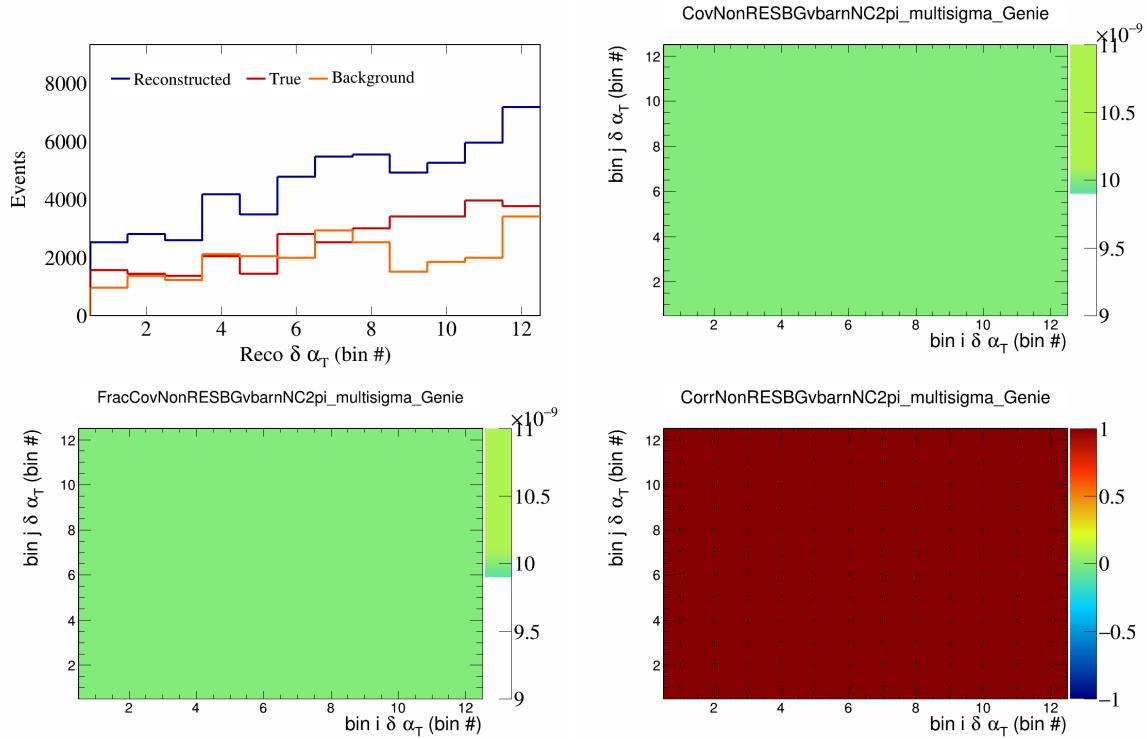


Figure 433: NonRESBGvbarNC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

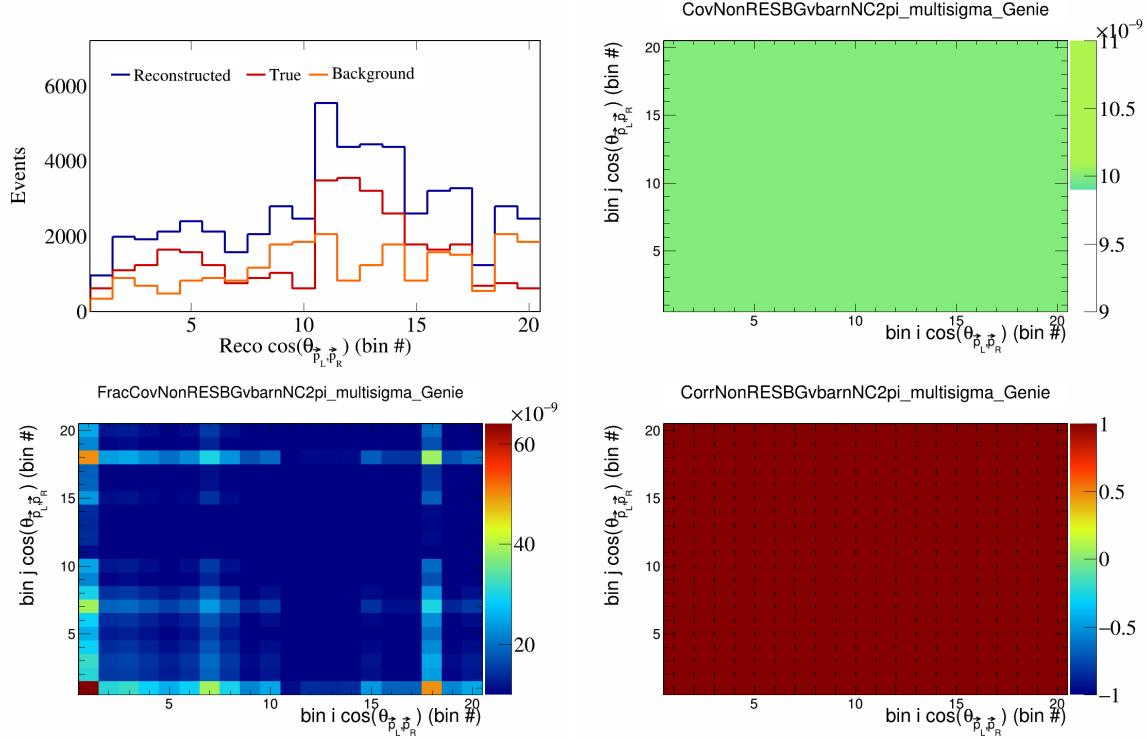


Figure 434: NonRESBGvbarNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

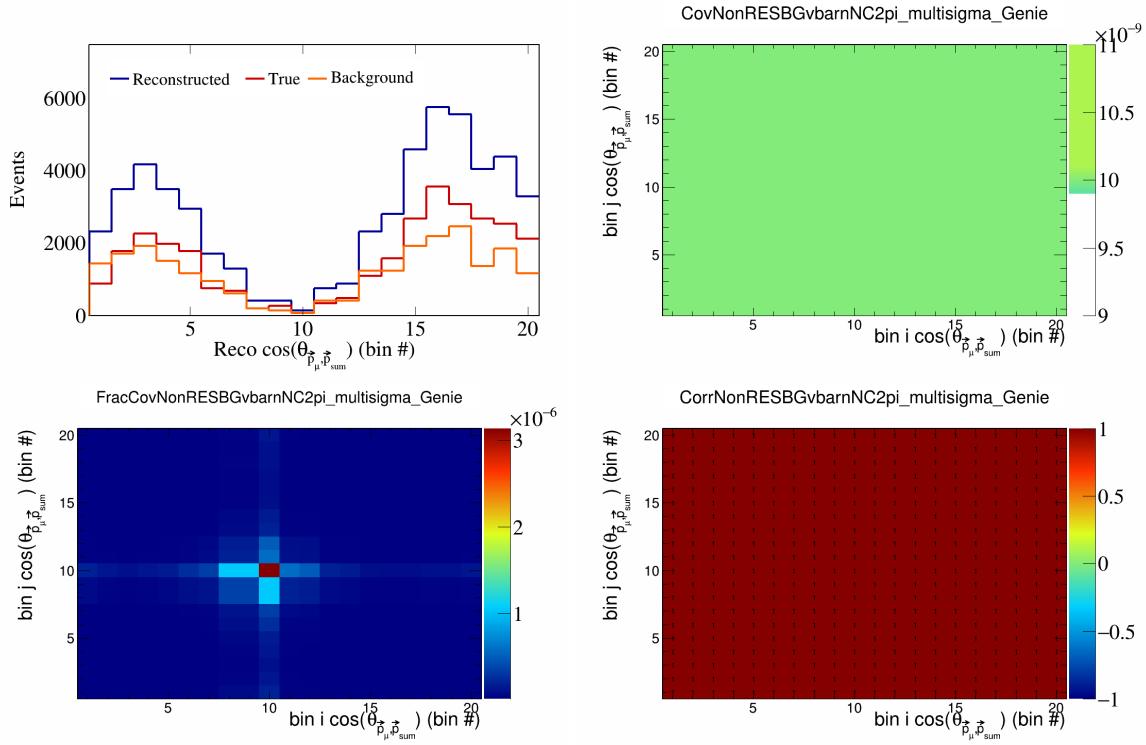


Figure 435: NonRESBGvbarNC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

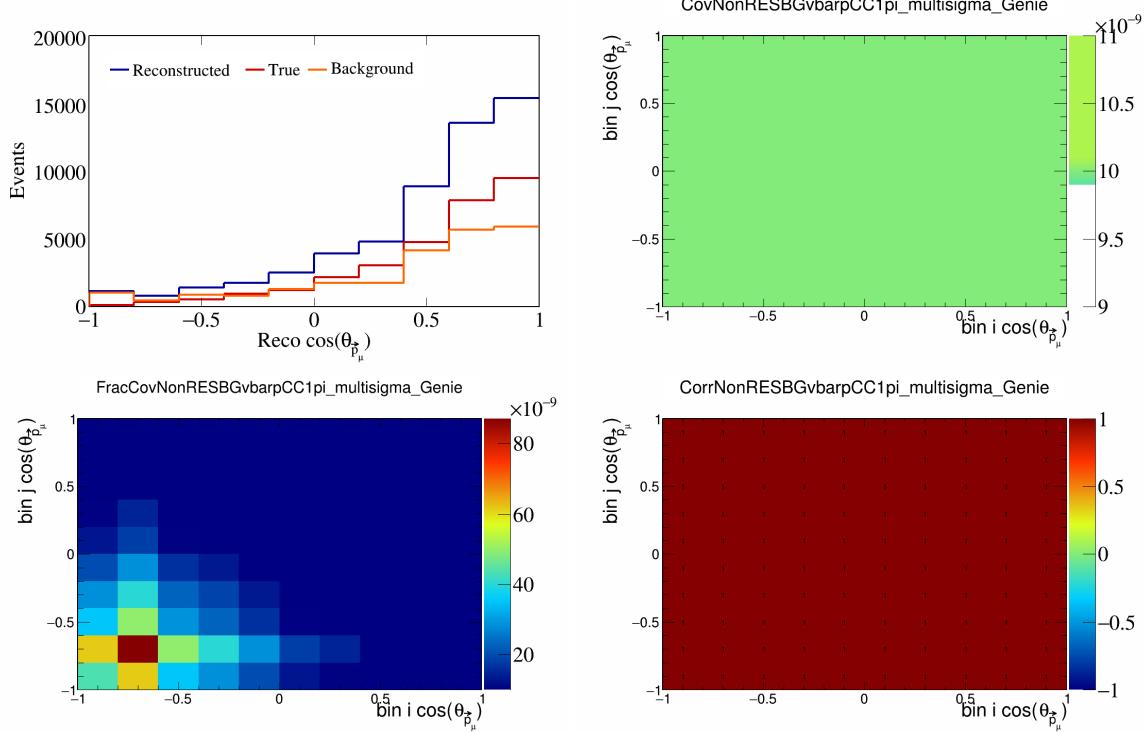


Figure 436: NonRESBGvbarCC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

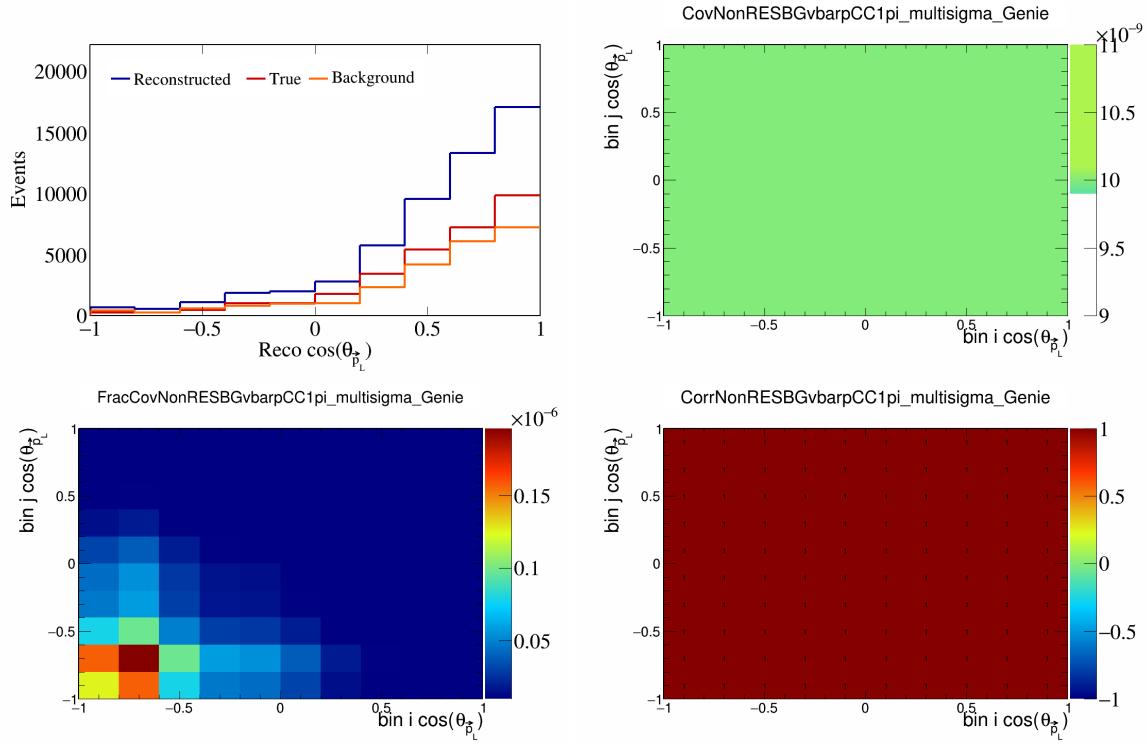


Figure 437: NonRESBGvbarpCC1pi variations for $\cos(\theta_{\vec{p}_L})$.

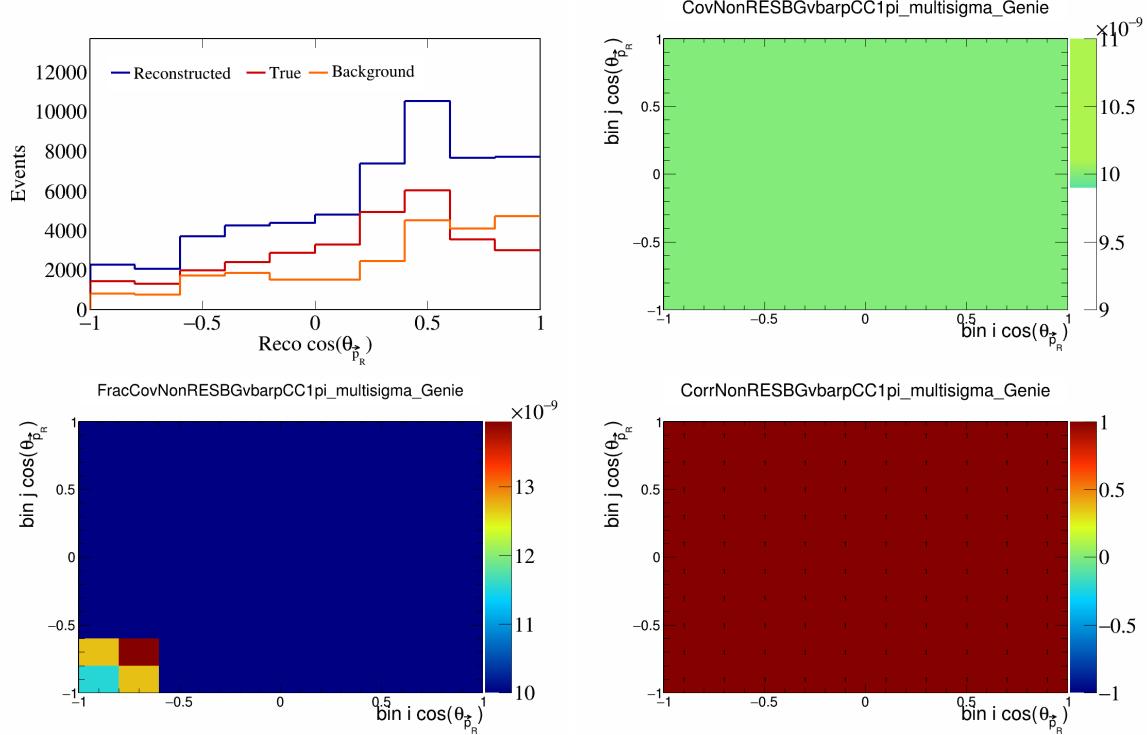


Figure 438: NonRESBGvbarpCC1pi variations for $\cos(\theta_{\vec{p}_R})$.

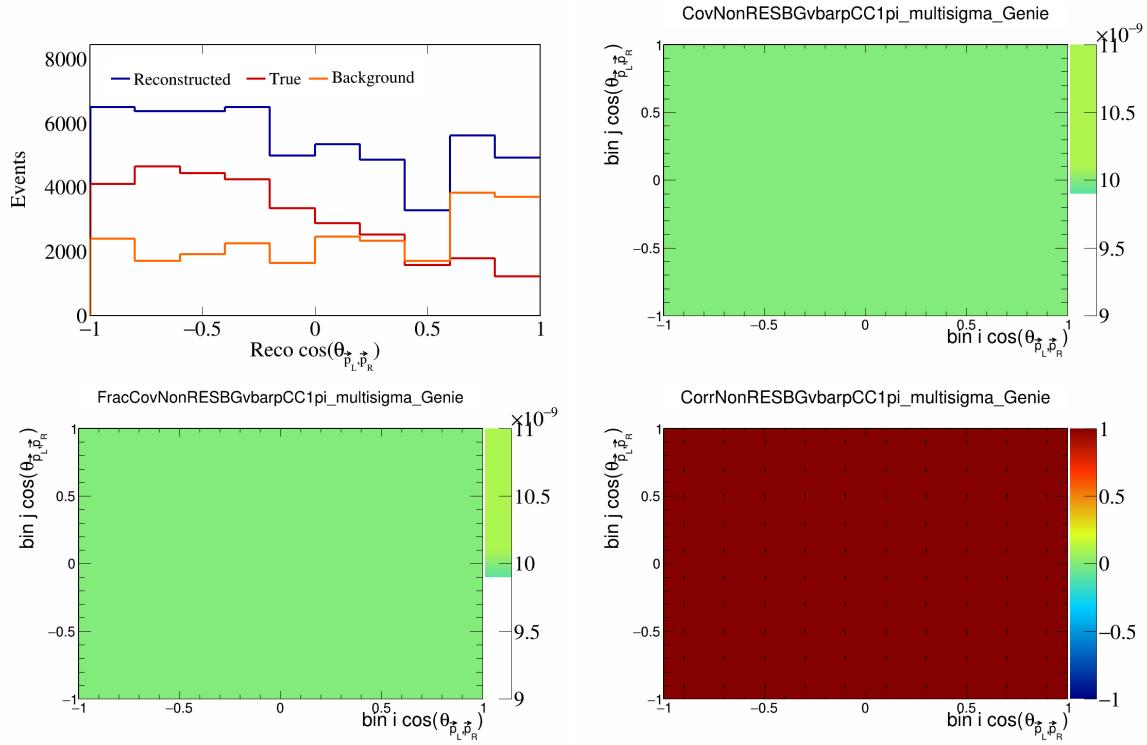


Figure 439: NonRESBGvbarpCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

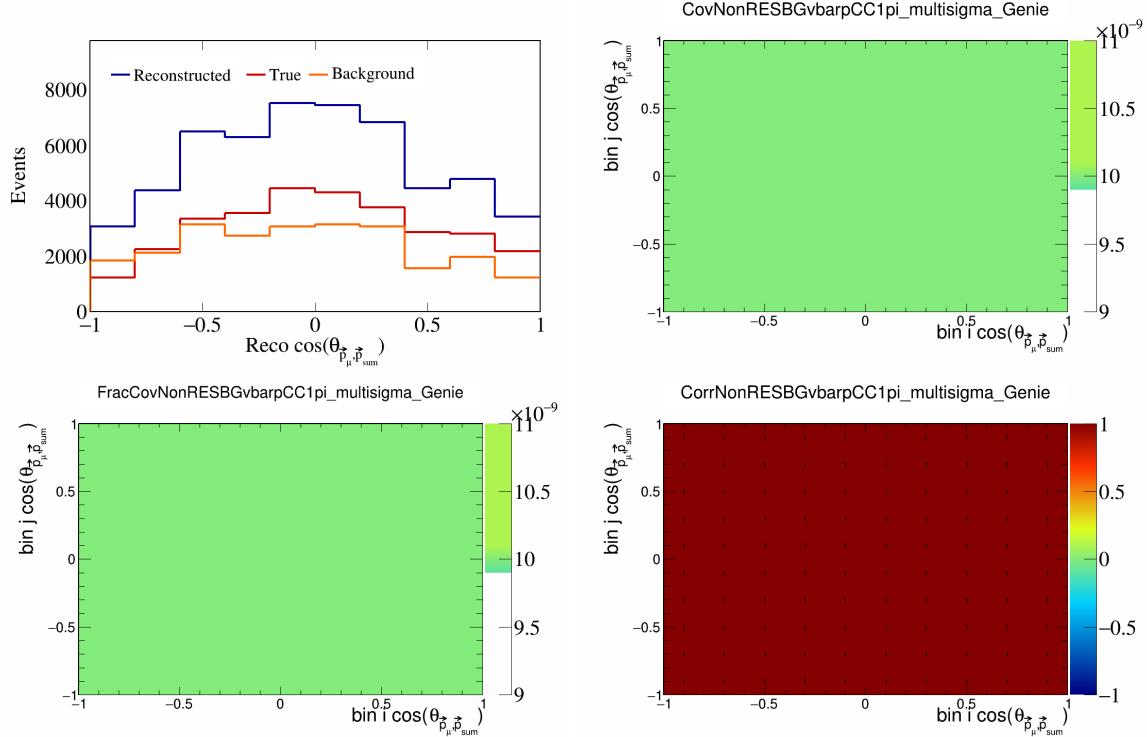


Figure 440: NonRESBGvbarpCC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

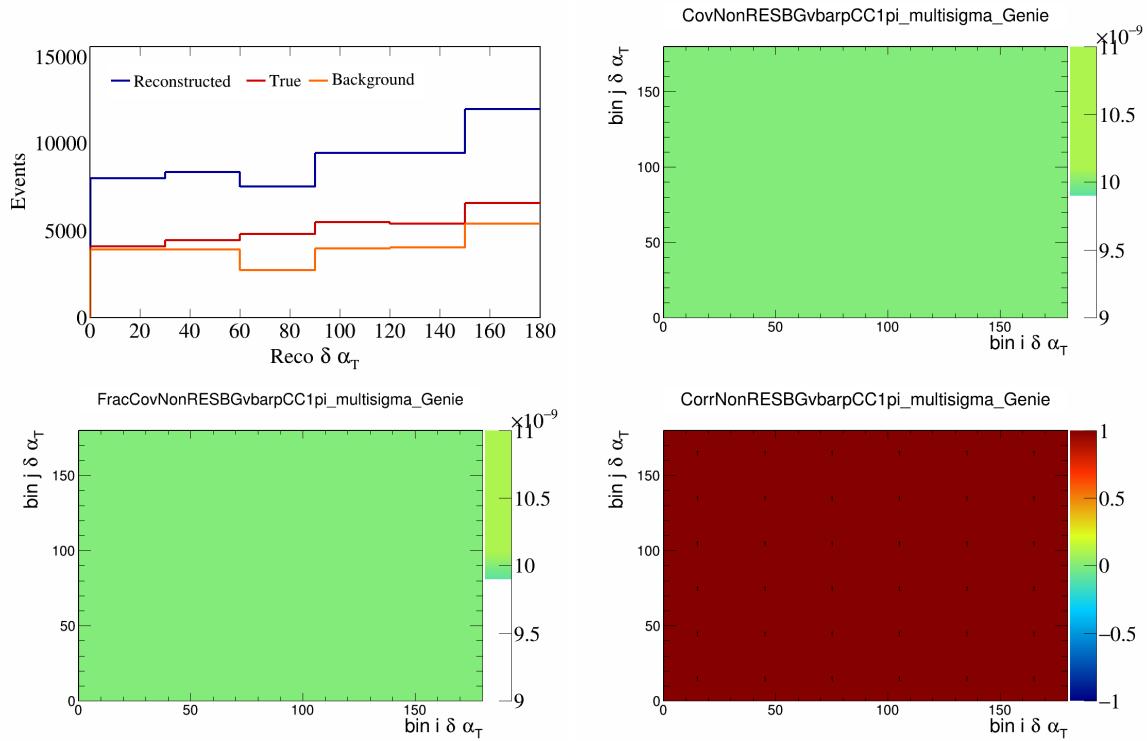


Figure 441: NonRESBGvbarpCC1pi variations for $\delta\alpha_T$.

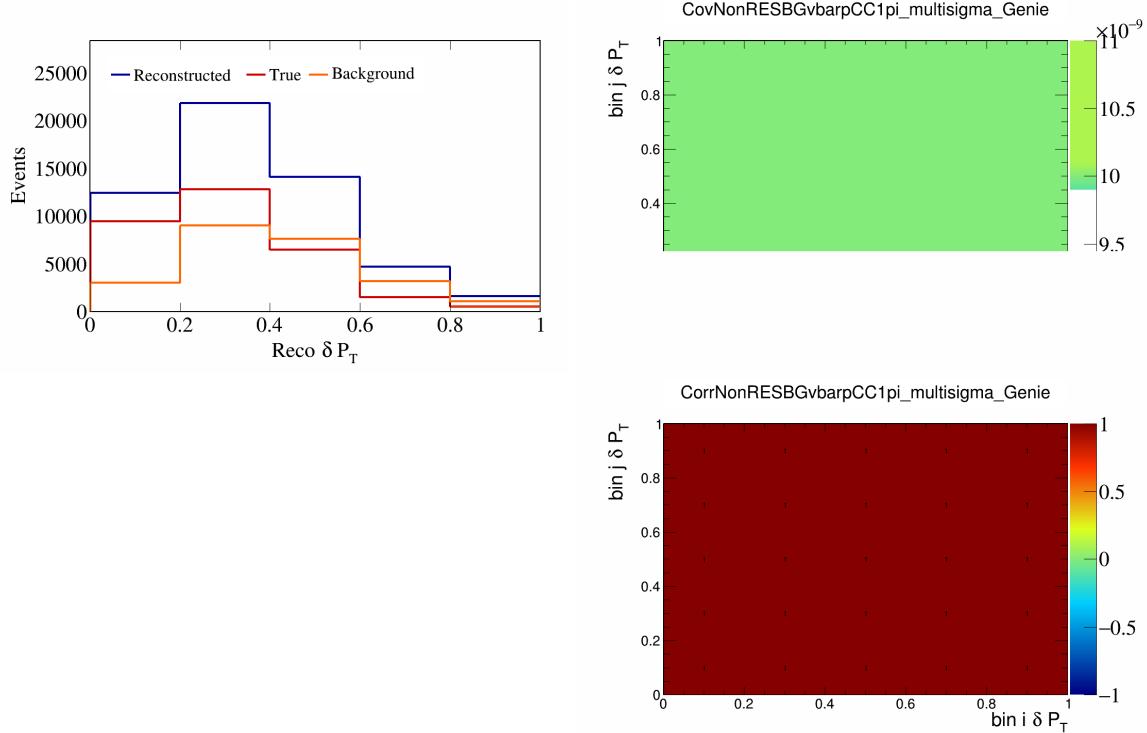


Figure 442: NonRESBGvbarpCC1pi variations for δP_T .

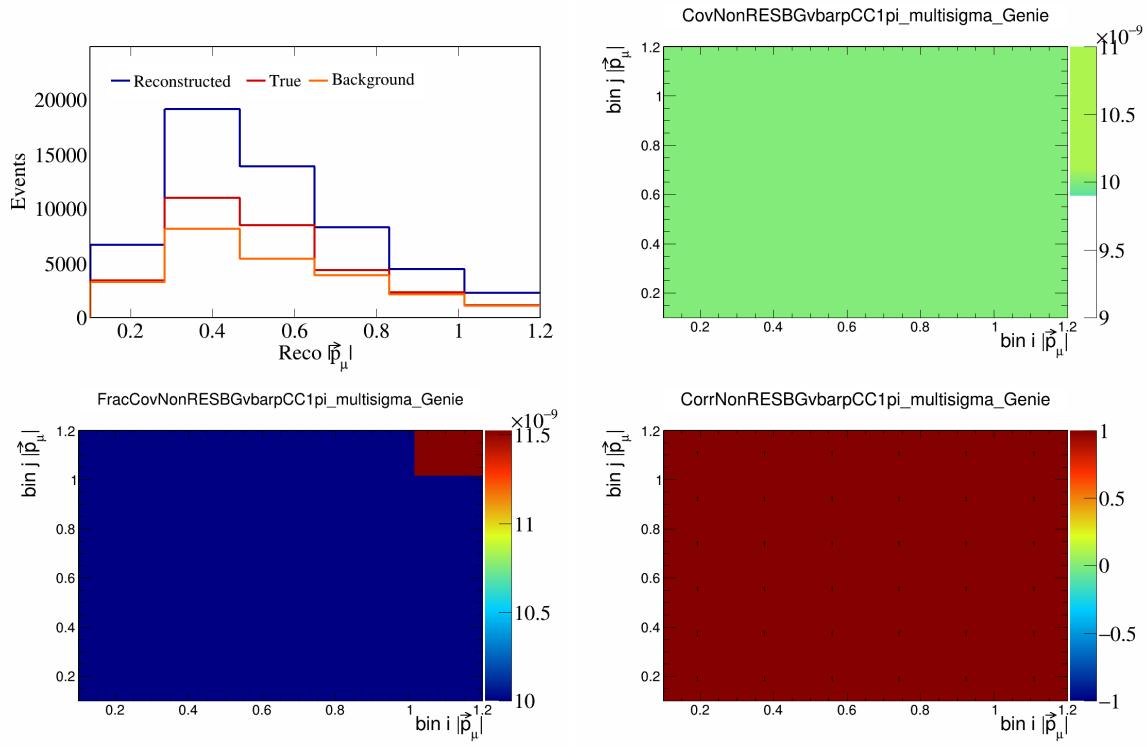


Figure 443: NonRESBGvbarpCC1pi variations for $|\vec{p}_\mu|$.

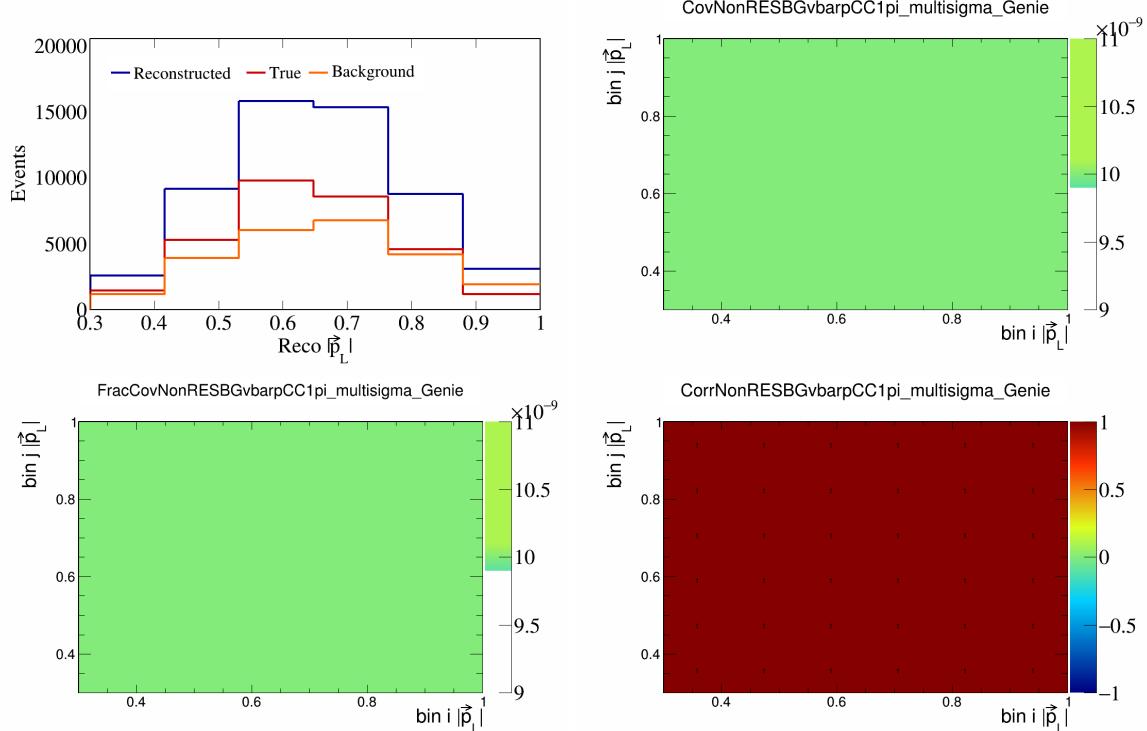


Figure 444: NonRESBGvbarpCC1pi variations for $|\vec{p}_L|$.

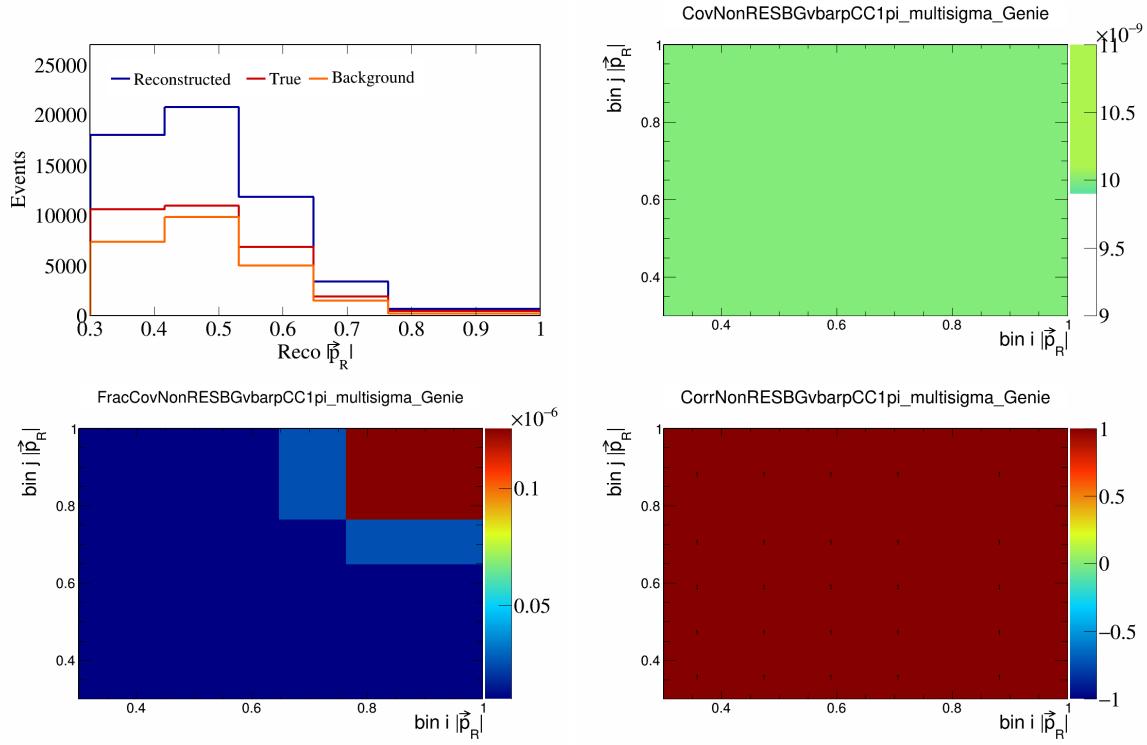


Figure 445: NonRESBGvbarpCC1pi variations for $|\vec{p}_R|$.

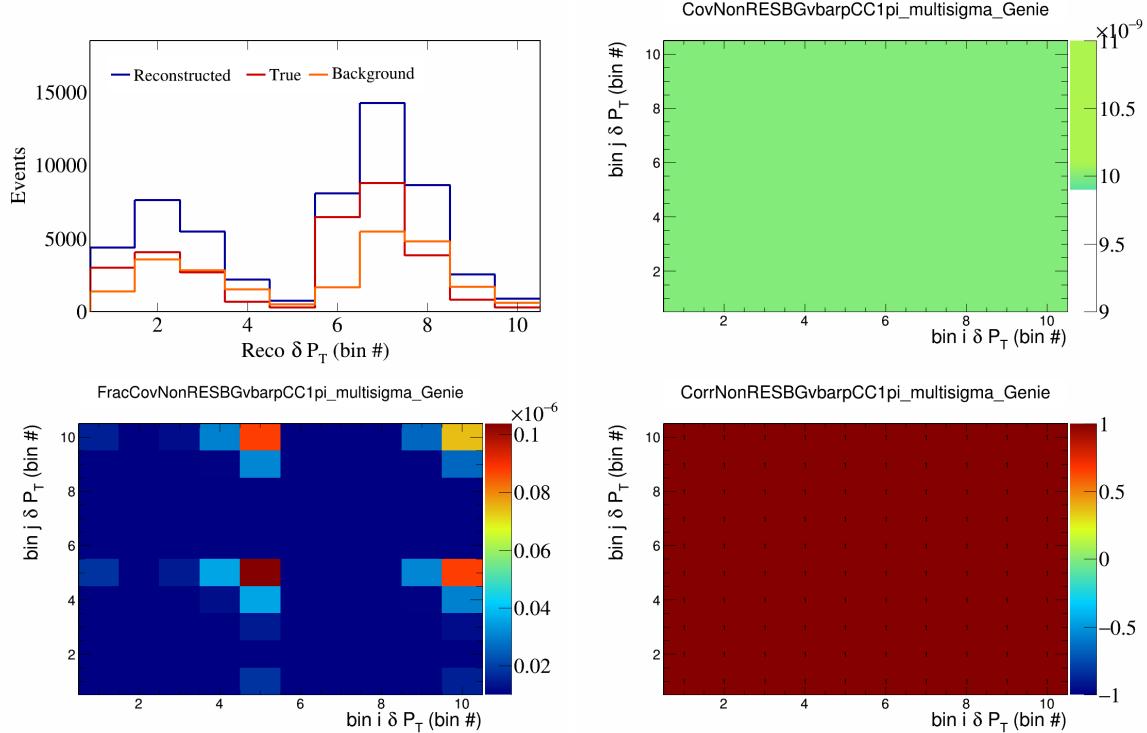


Figure 446: NonRESBGvbarpCC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

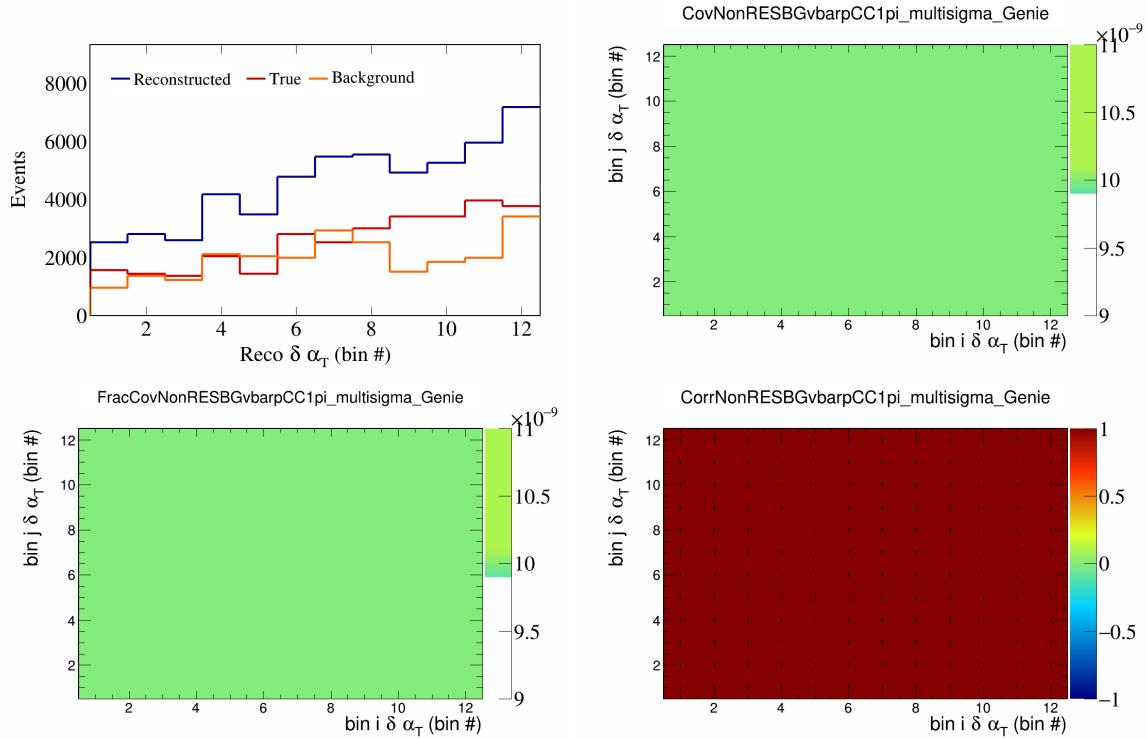


Figure 447: NonRESBGvbarpCC1pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

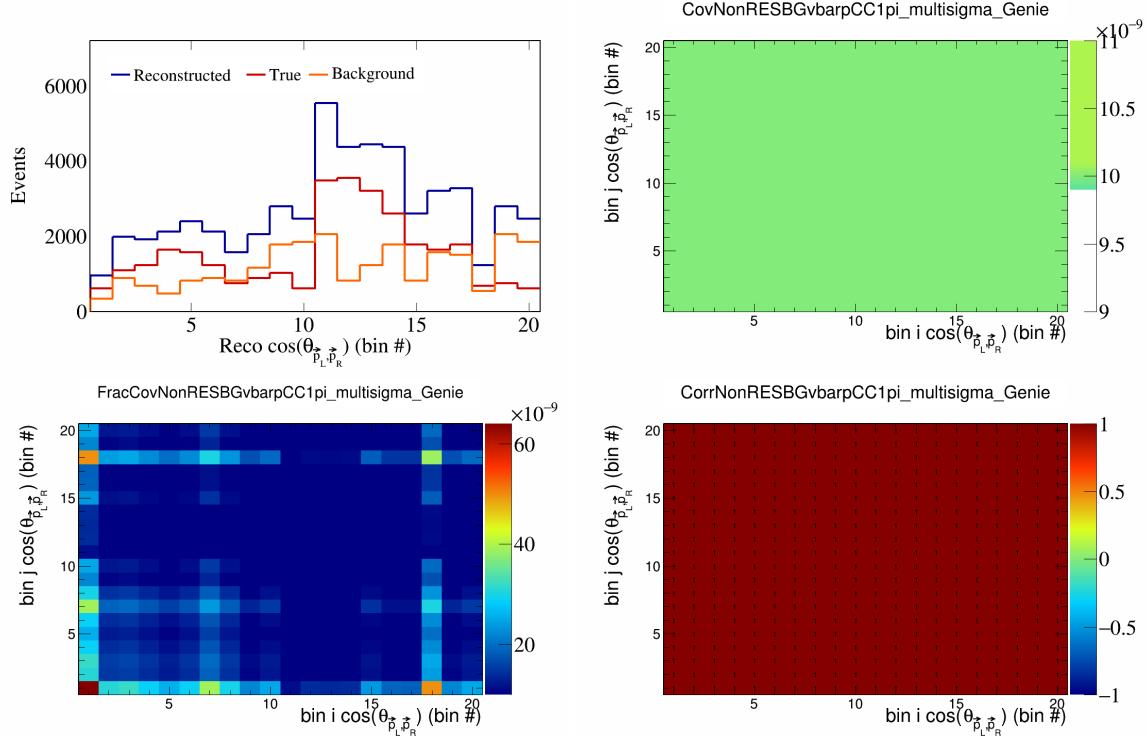


Figure 448: NonRESBGvbarpCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

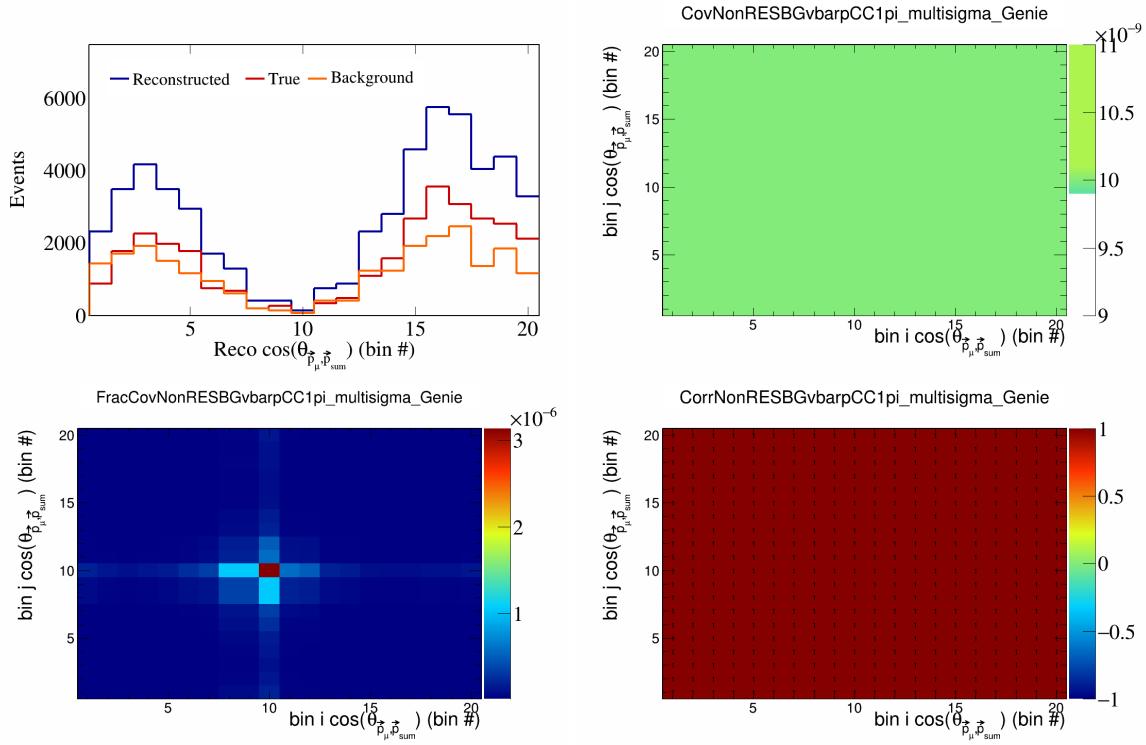


Figure 449: NonRESBGvbarpCC1pi variations for $\cos(\theta_{\vec{p}_\mu})$ in $\cos(\theta_{\vec{p}_\mu})$.

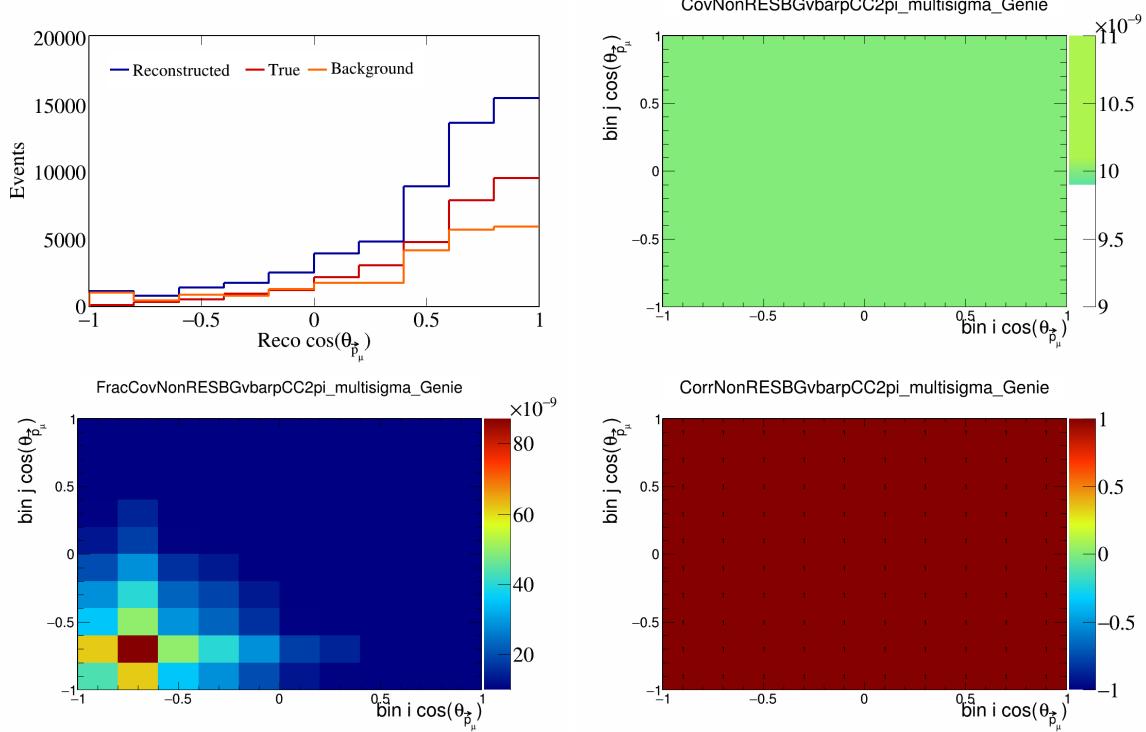


Figure 450: NonRESBGvbarpCC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

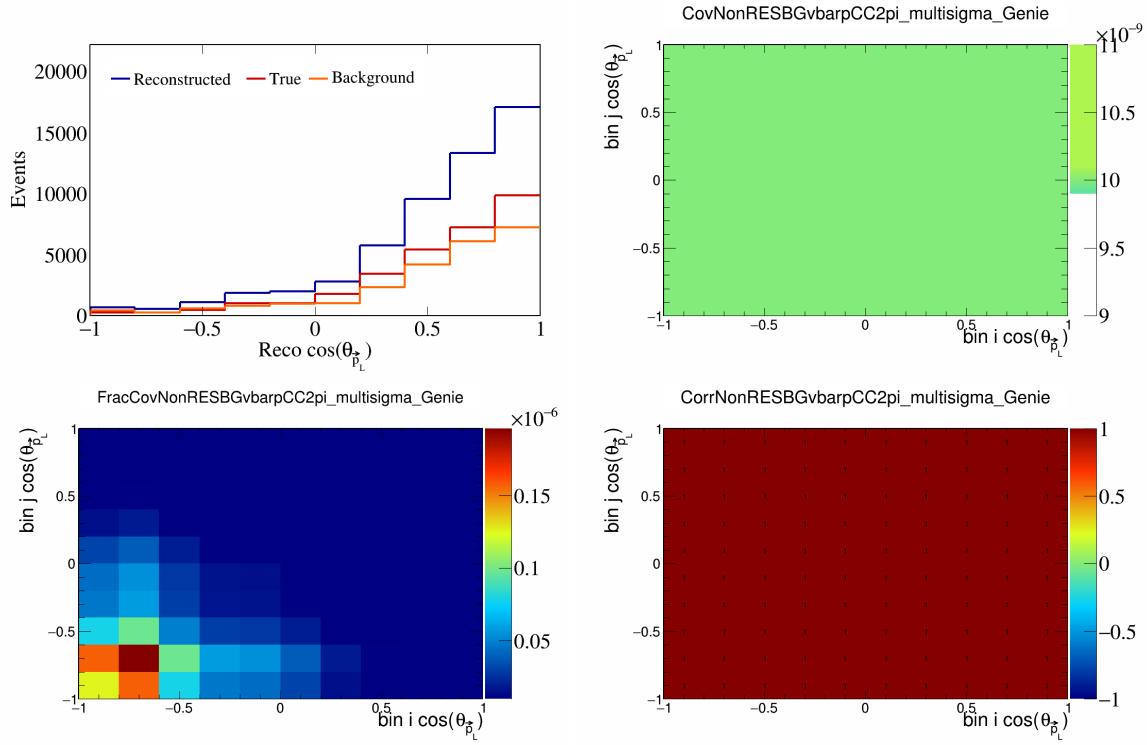


Figure 451: NonRESBGvbarpCC2pi variations for $\cos(\theta_{\vec{p}_L})$.

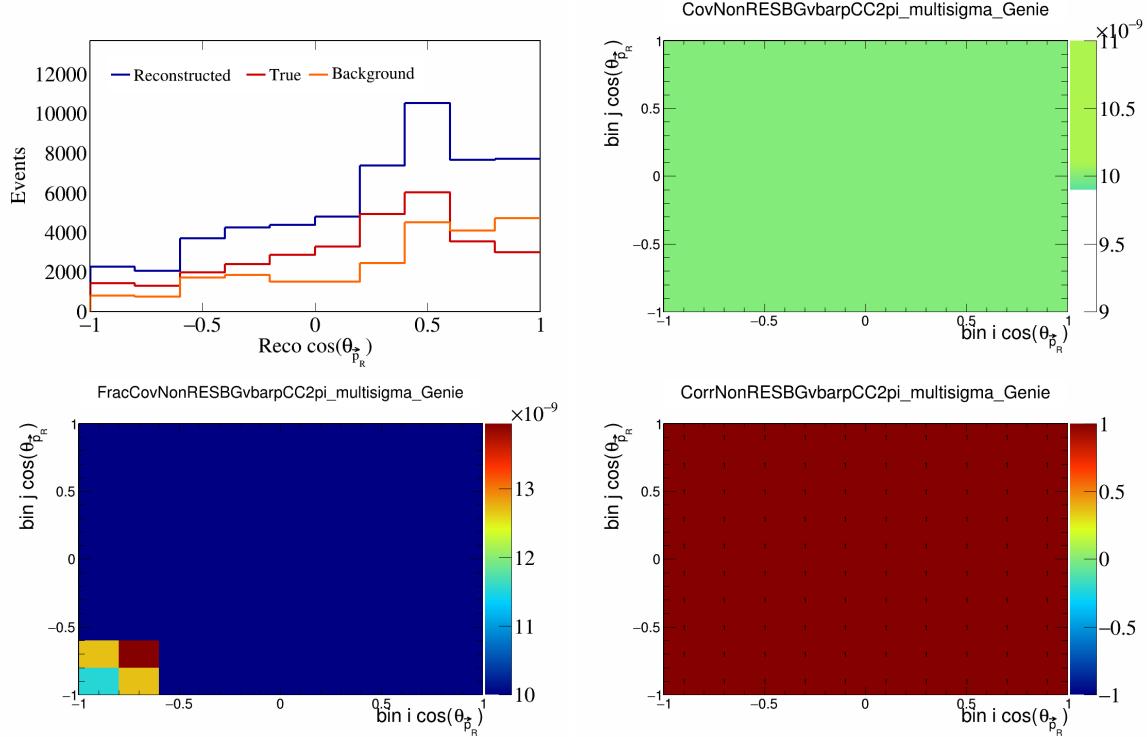


Figure 452: NonRESBGvbarpCC2pi variations for $\cos(\theta_{\vec{p}_R})$.

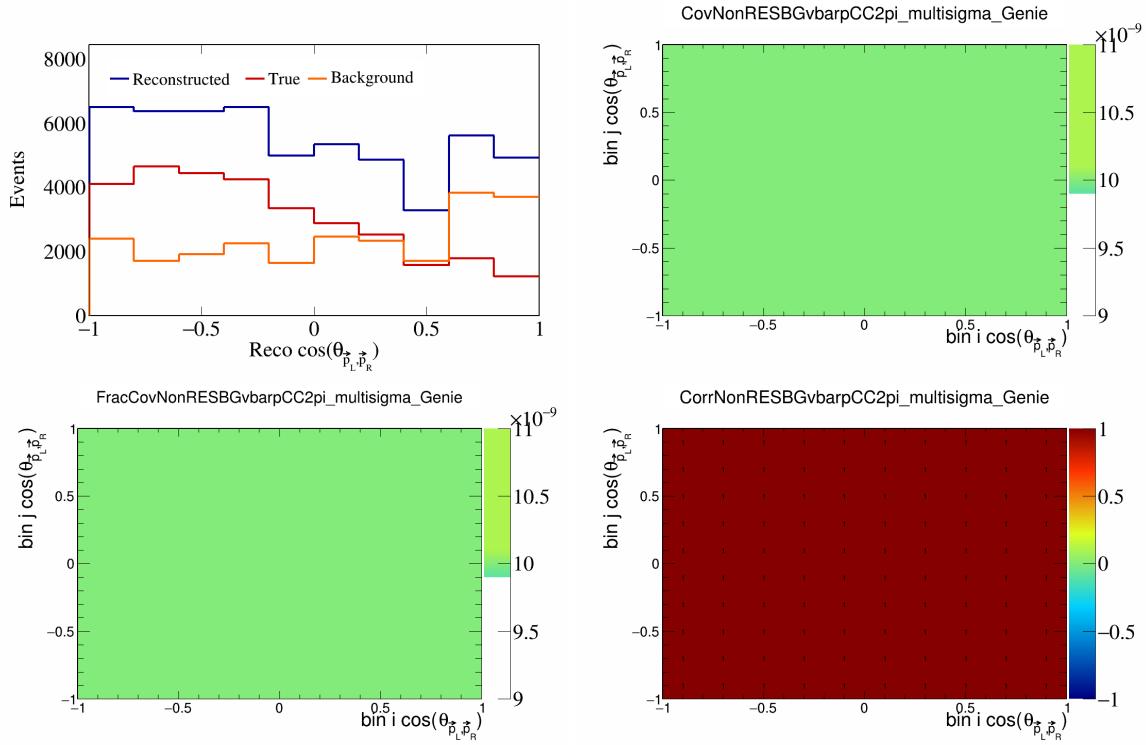


Figure 453: NonRESBGvbarpCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

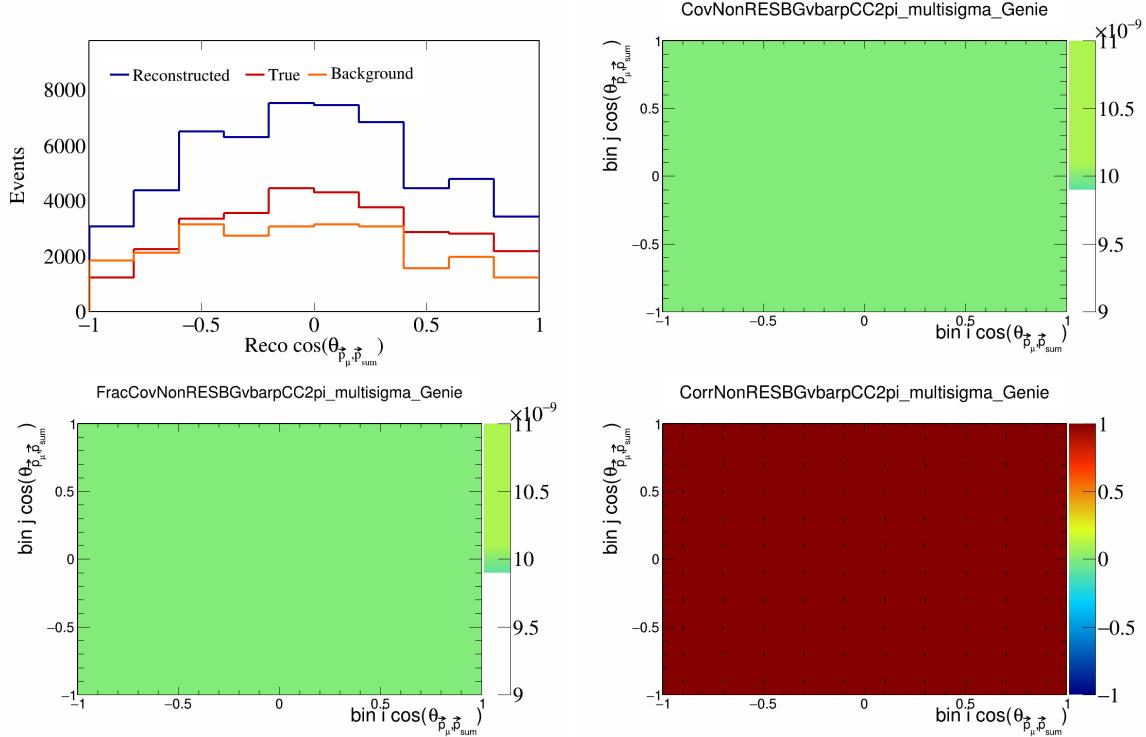


Figure 454: NonRESBGvbarpCC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

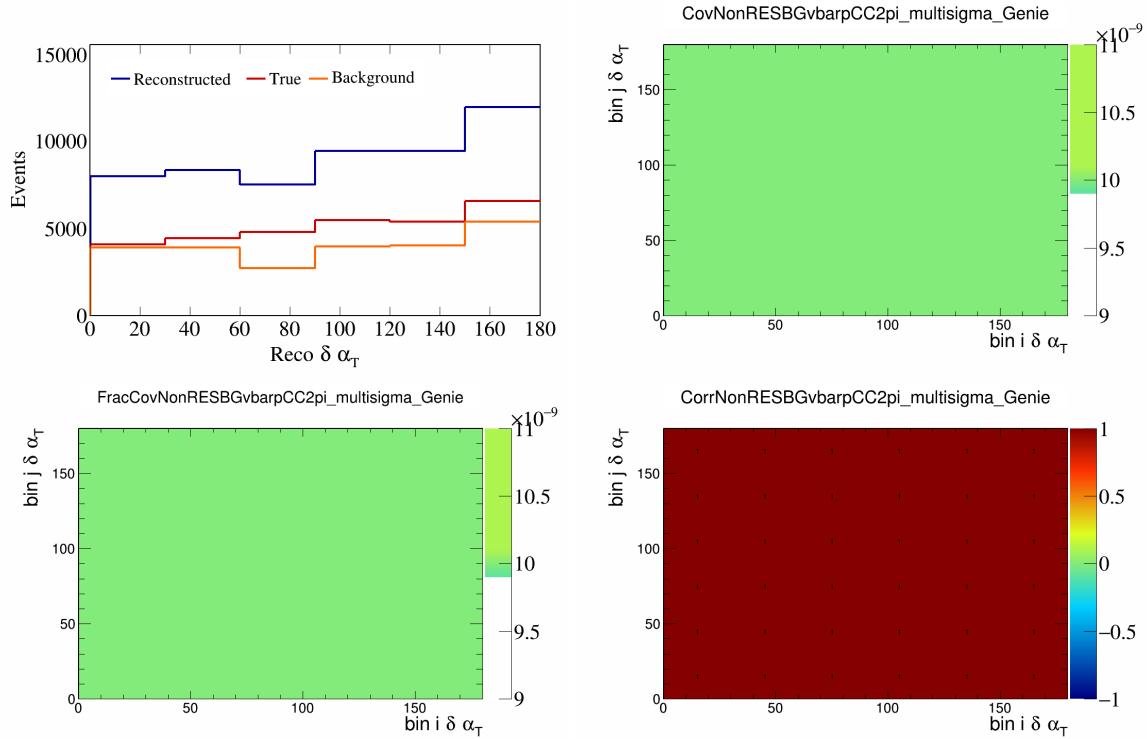


Figure 455: NonRESBGvbarpCC2pi variations for $\delta\alpha_T$.

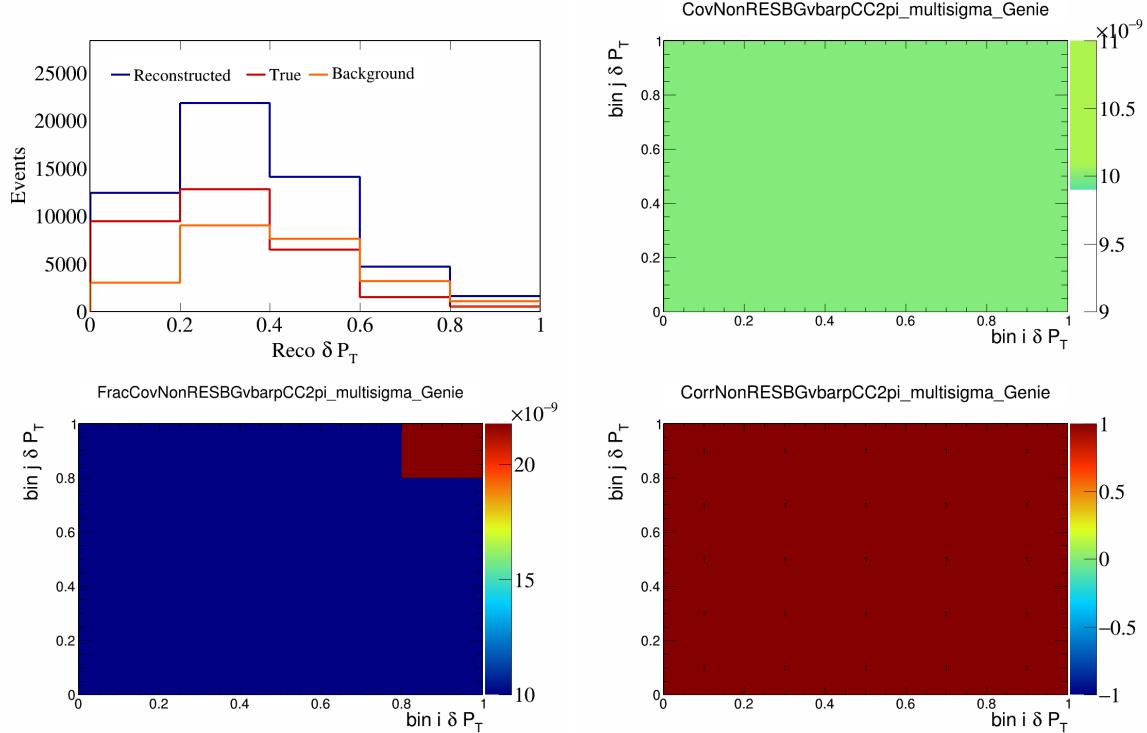


Figure 456: NonRESBGvbarpCC2pi variations for δP_T .

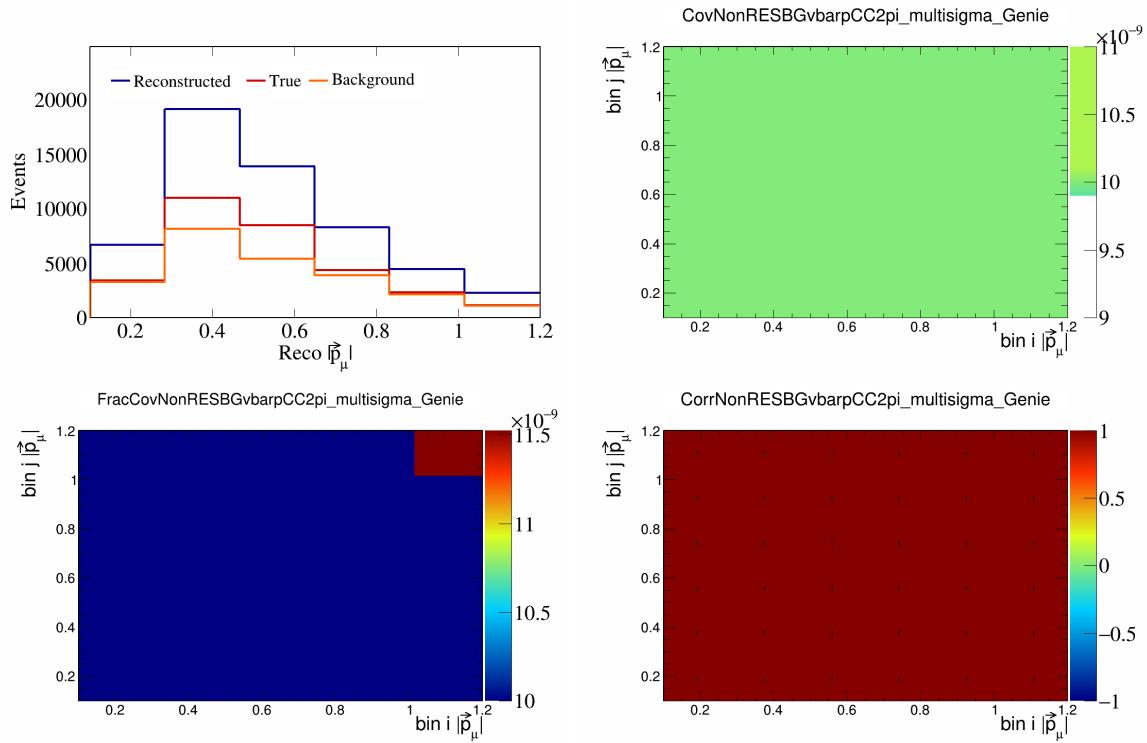


Figure 457: NonRESBGvbarpCC2pi variations for $|\vec{p}_\mu|$.

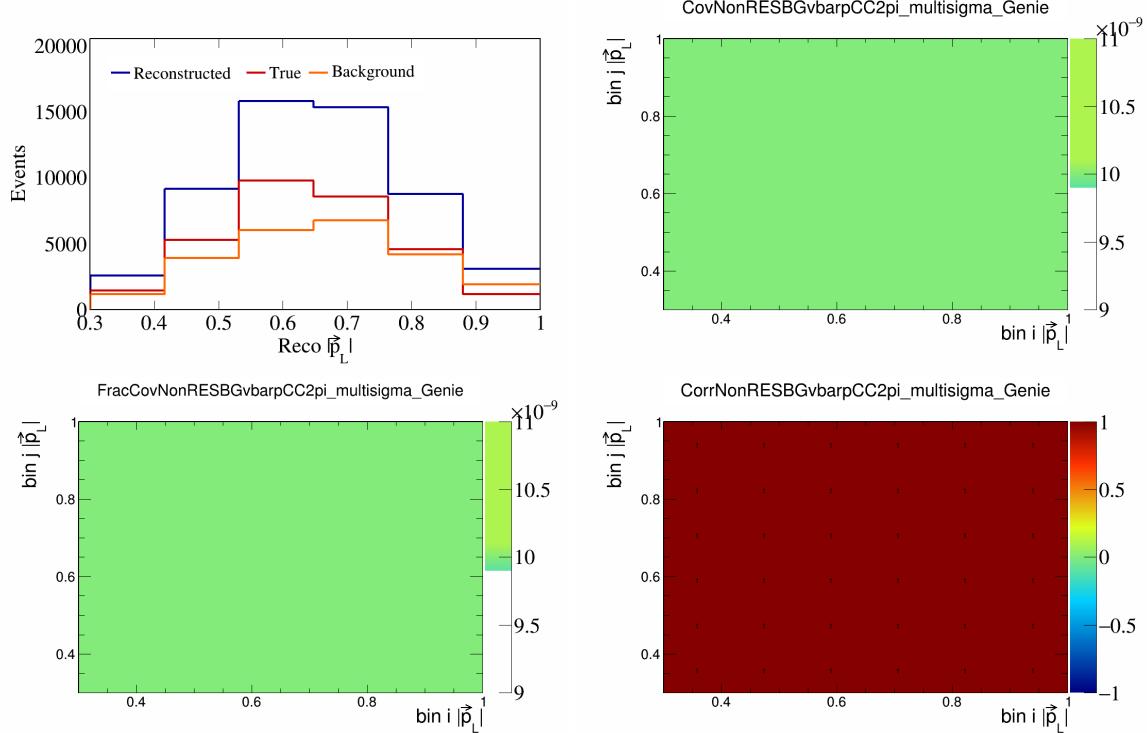


Figure 458: NonRESBGvbarpCC2pi variations for $|\vec{p}_L|$.

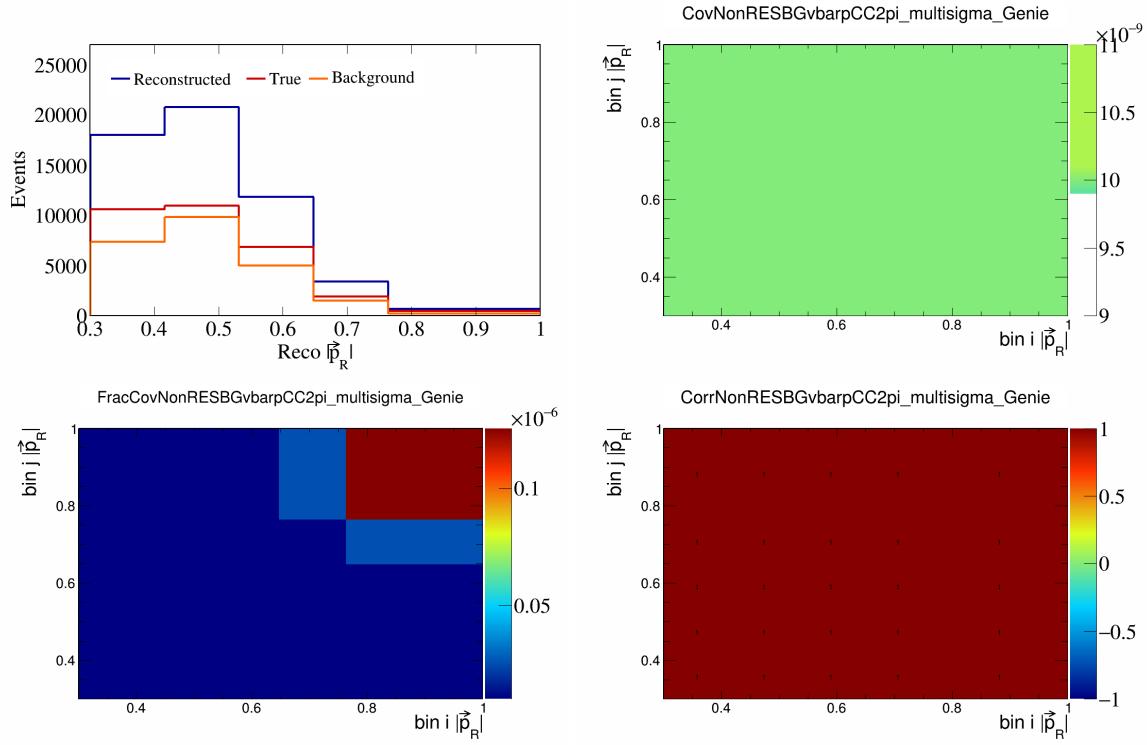


Figure 459: NonRESBGvbarpCC2pi variations for $|\vec{p}_R|$.

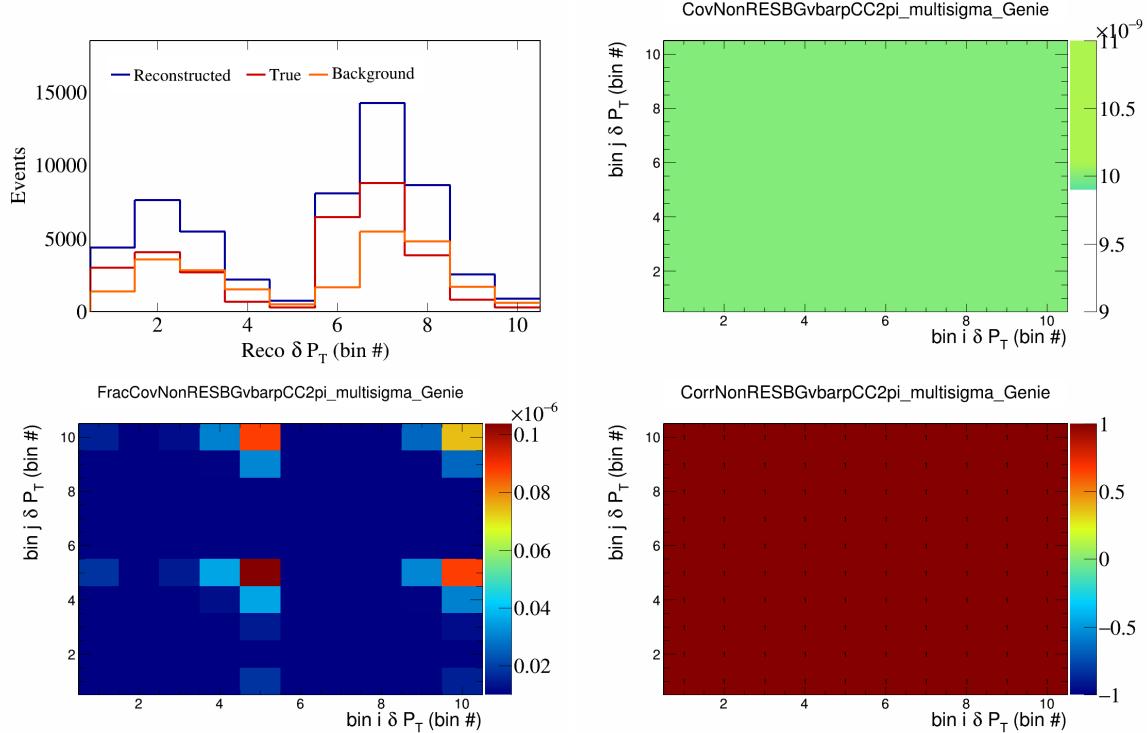


Figure 460: NonRESBGvbarpCC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

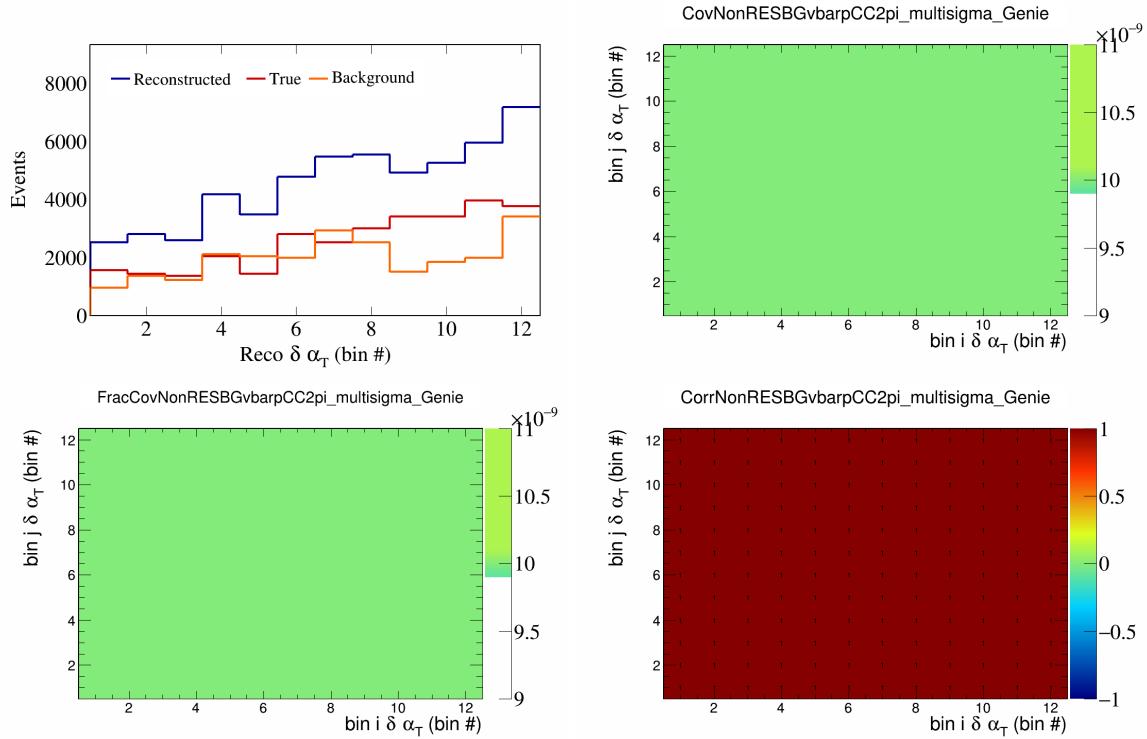


Figure 461: NonRESBGvbarpCC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

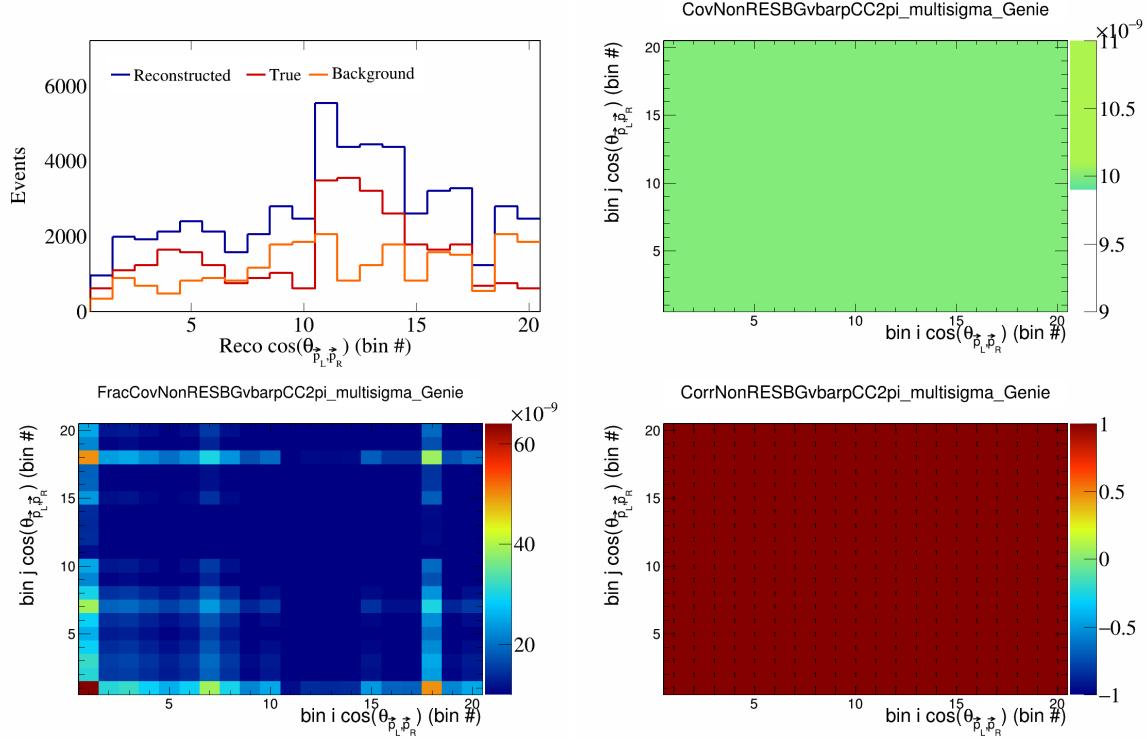


Figure 462: NonRESBGvbarpCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

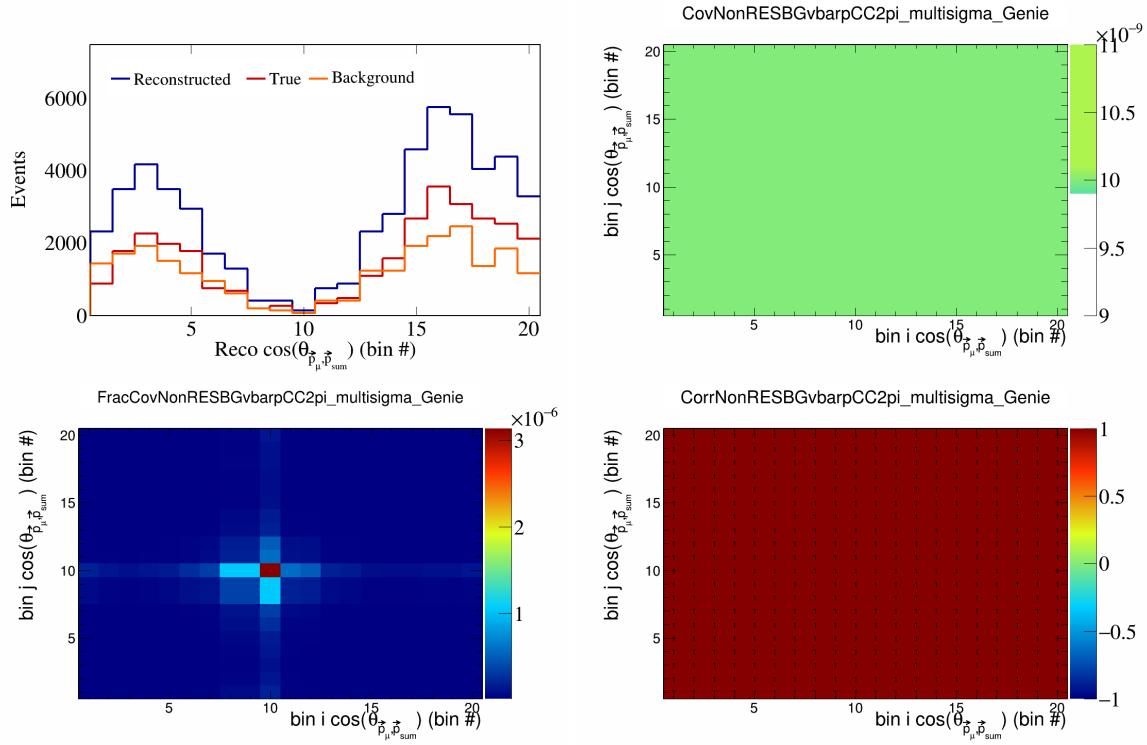


Figure 463: NonRESBGvbarpCC2pi variations for $\cos(\theta_{\vec{p}_\mu})$ in $\cos(\theta_{\vec{p}_\mu})$.

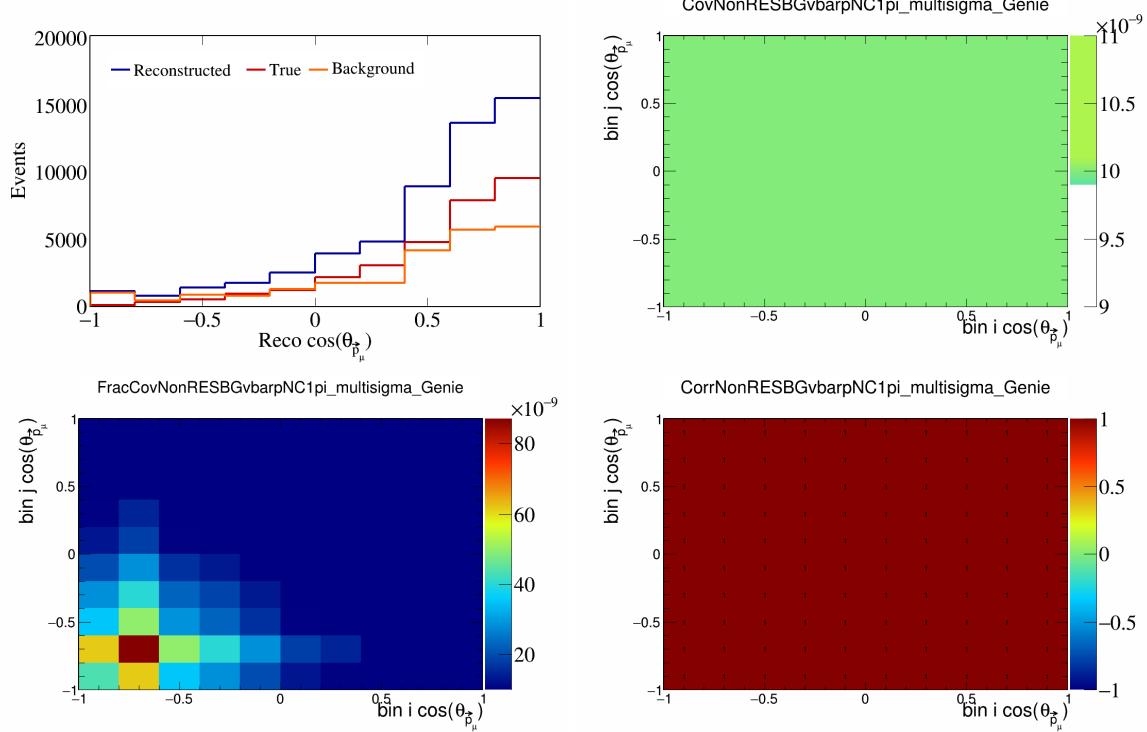


Figure 464: NonRESBGvbarpNC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

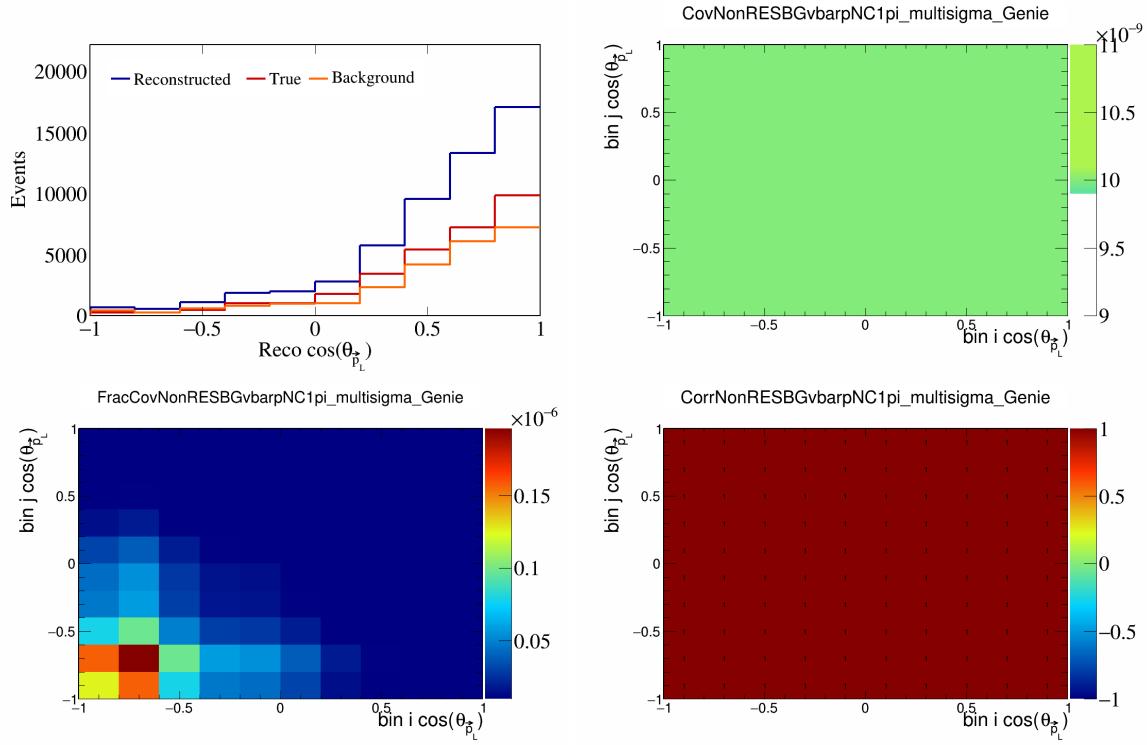


Figure 465: NonRESBGvbarpi variations for $\cos(\theta_{\vec{p}_L})$.

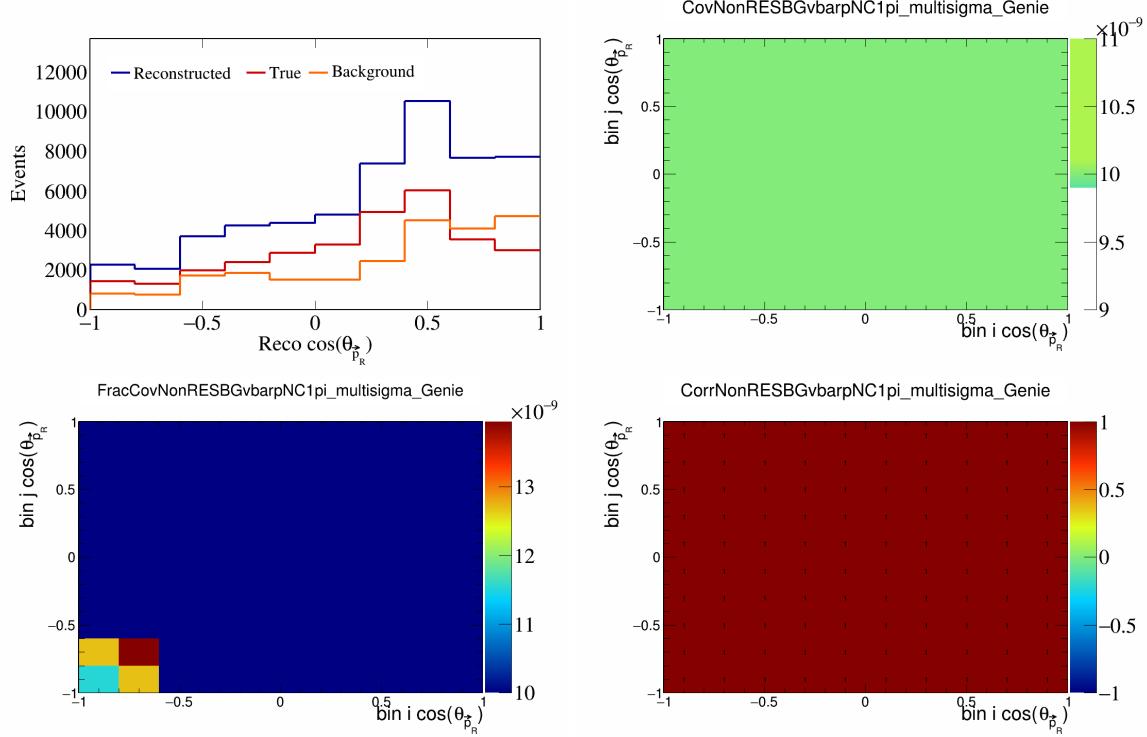


Figure 466: NonRESBGvbarpi variations for $\cos(\theta_{\vec{p}_R})$.

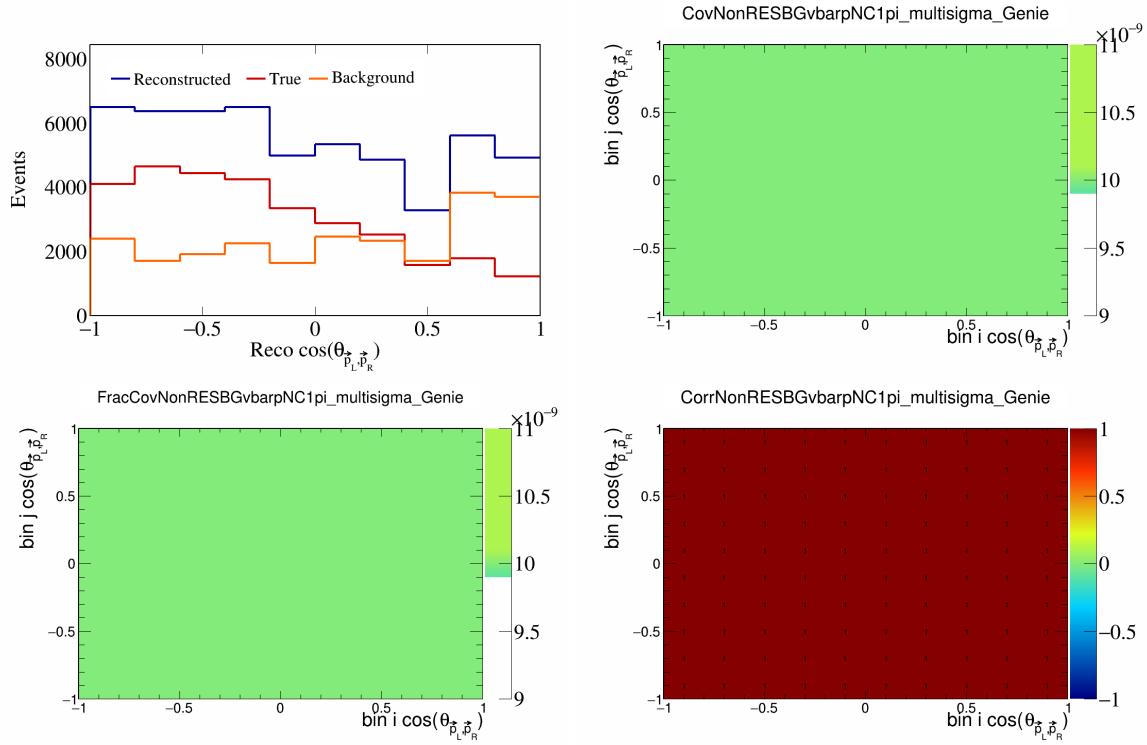


Figure 467: NonRESBGvbarpNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

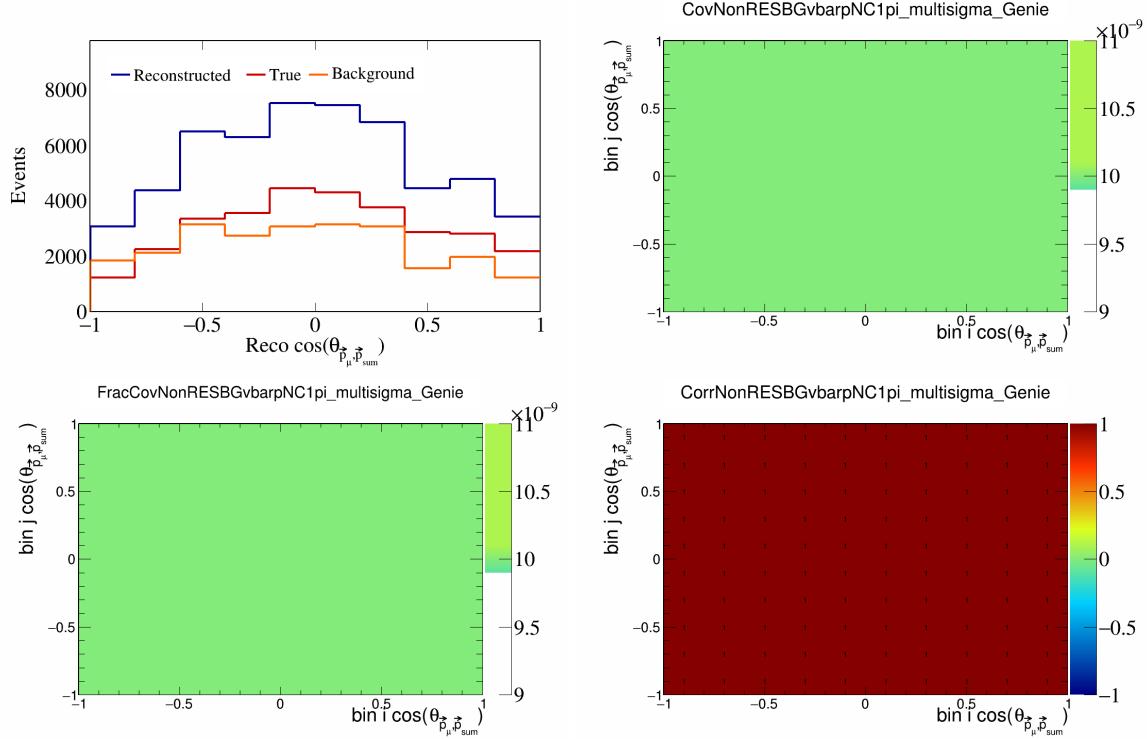


Figure 468: NonRESBGvbarpNC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

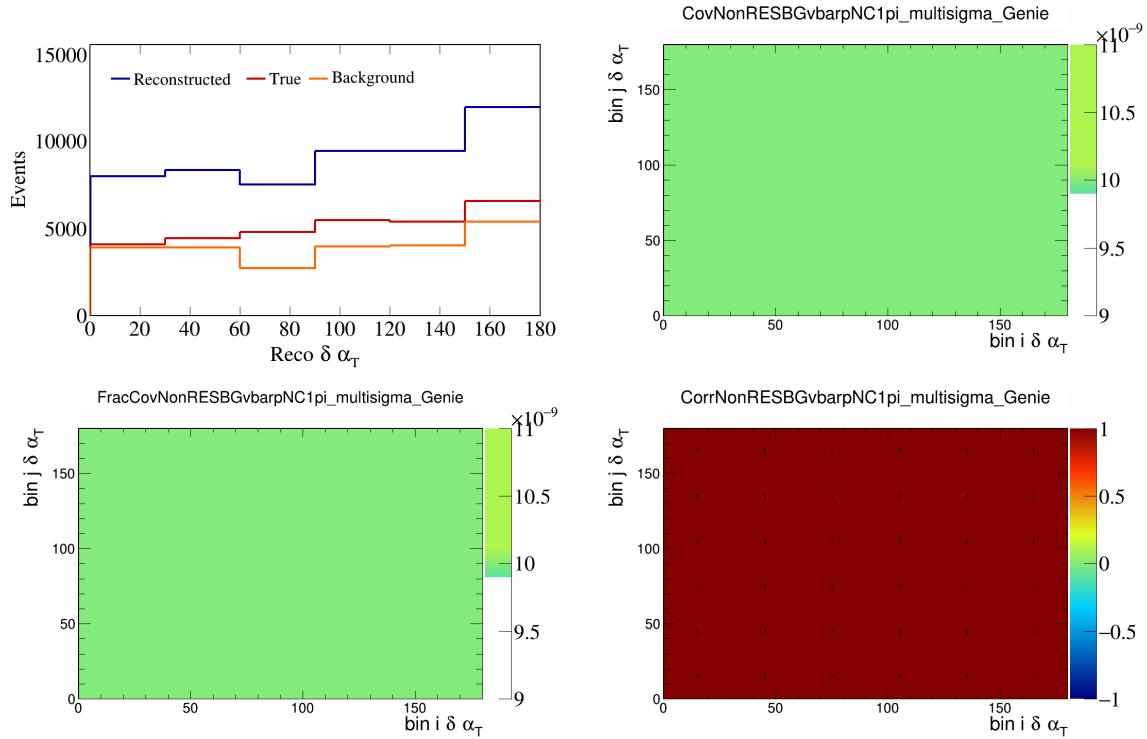


Figure 469: NonRESBGvbarpNC1pi variations for $\delta\alpha_T$.

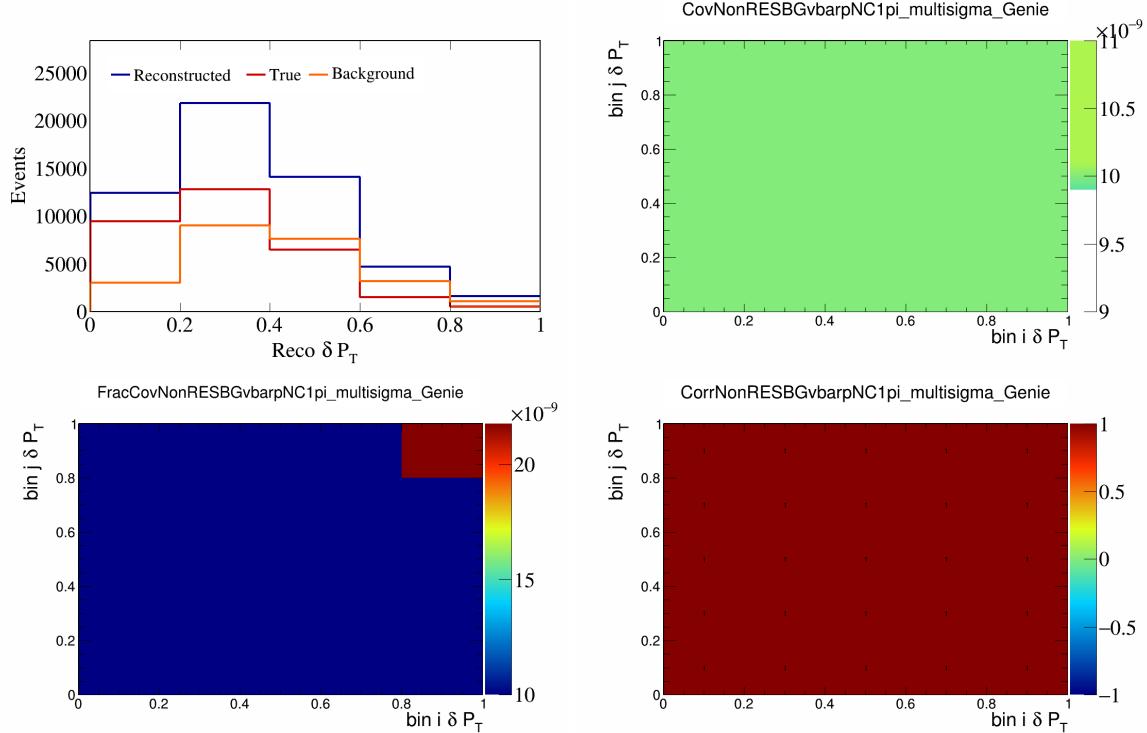


Figure 470: NonRESBGvbarpNC1pi variations for δP_T .

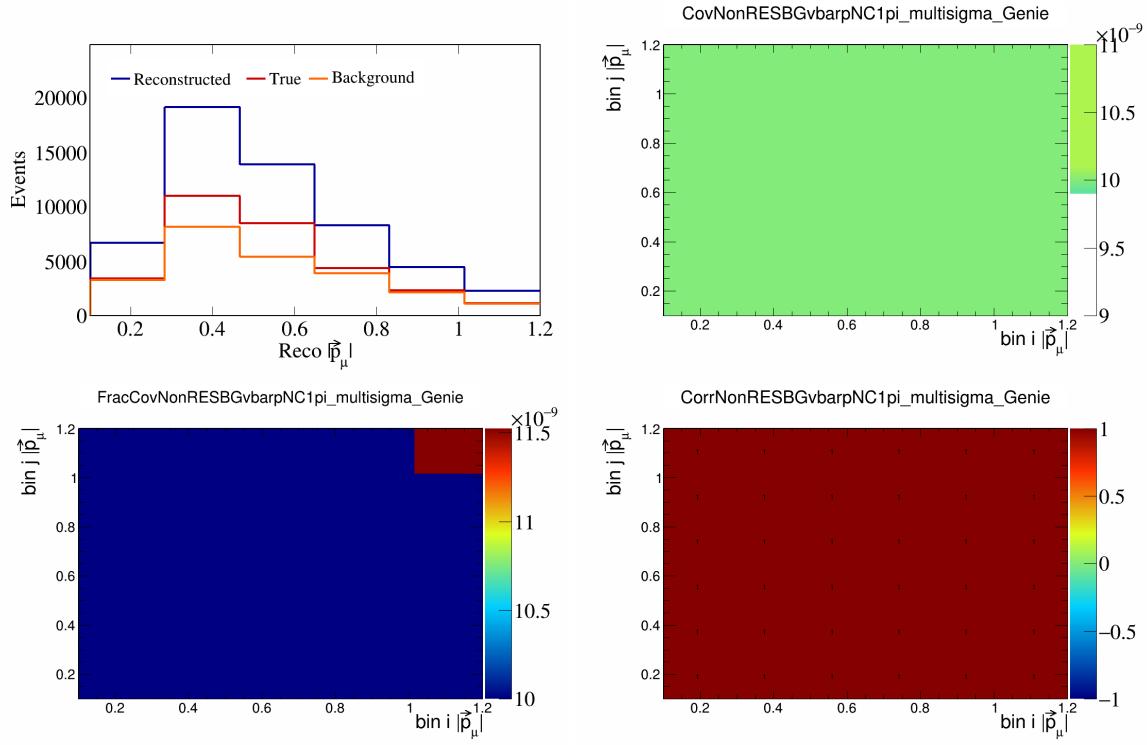


Figure 471: NonRESBGvbarpNC1pi variations for $|\vec{p}_\mu|$.

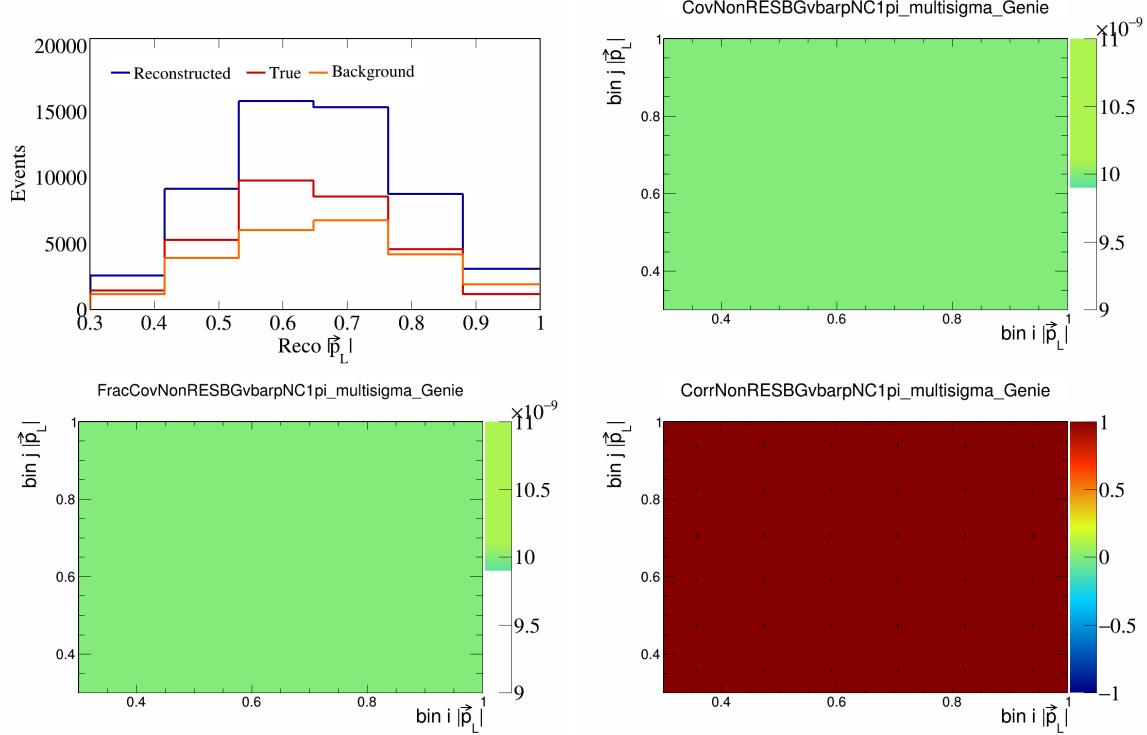


Figure 472: NonRESBGvbarpNC1pi variations for $|\vec{p}_L|$.

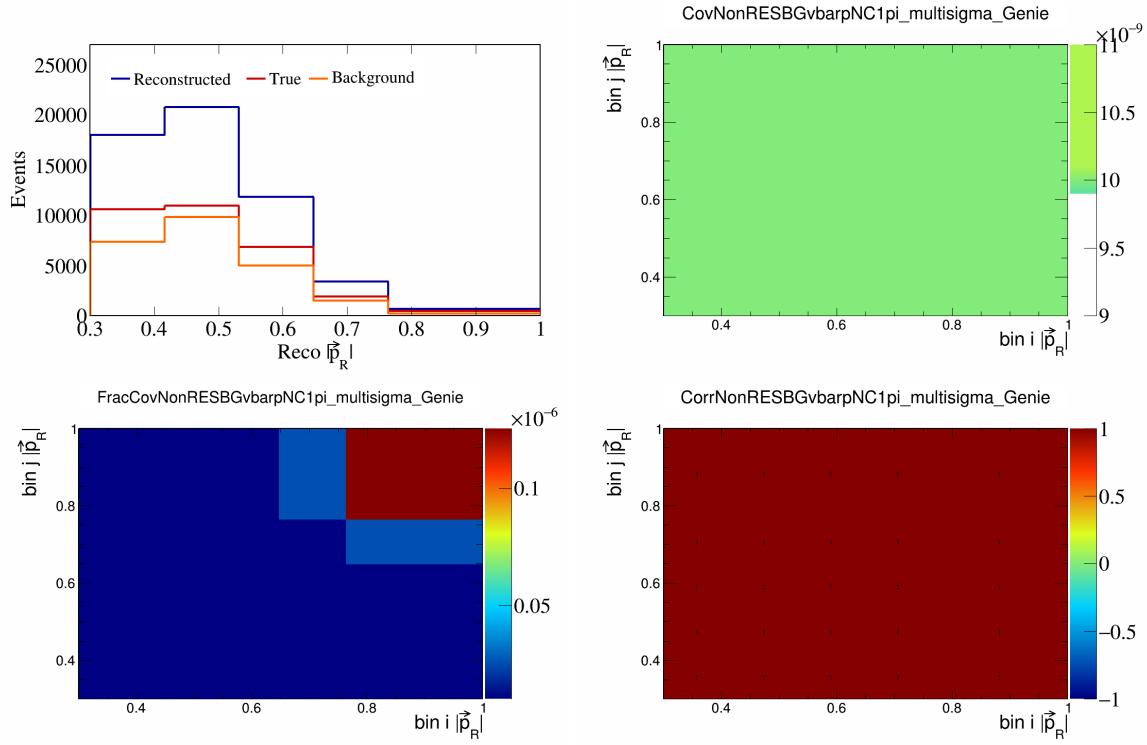


Figure 473: NonRESBGvbarpNC1pi variations for $|\vec{p}_R|$.

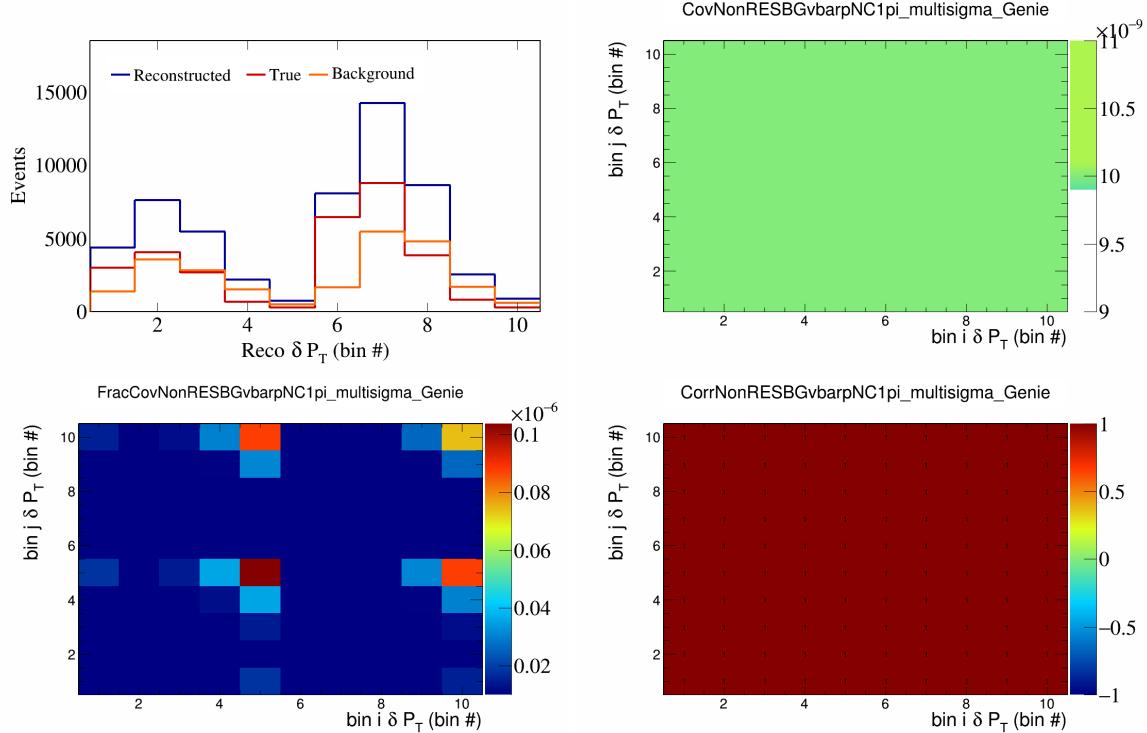


Figure 474: NonRESBGvbarpNC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

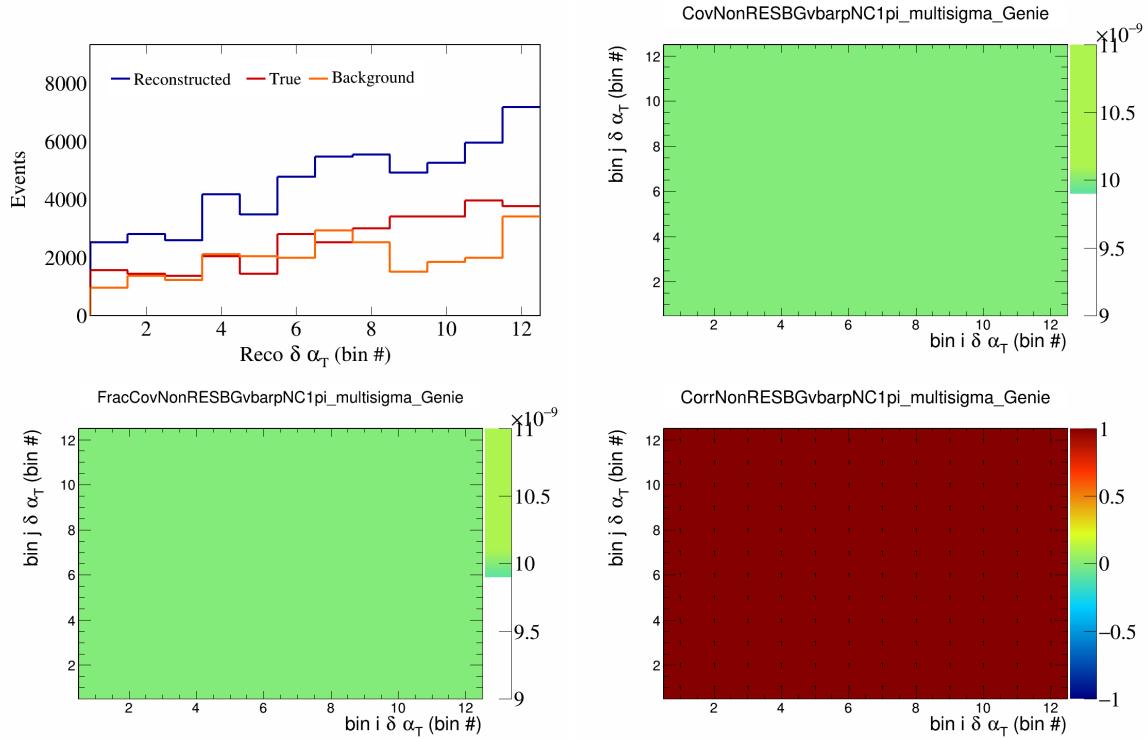


Figure 475: NonRESBGvbarpNC1pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

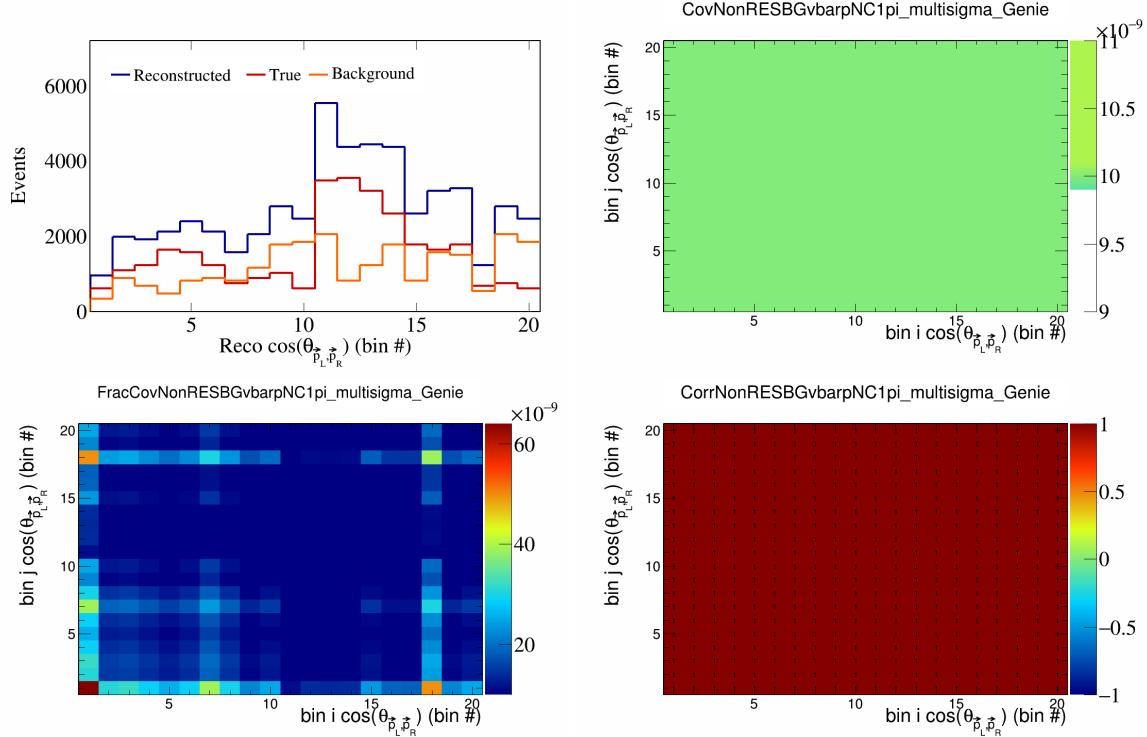


Figure 476: NonRESBGvbarpNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

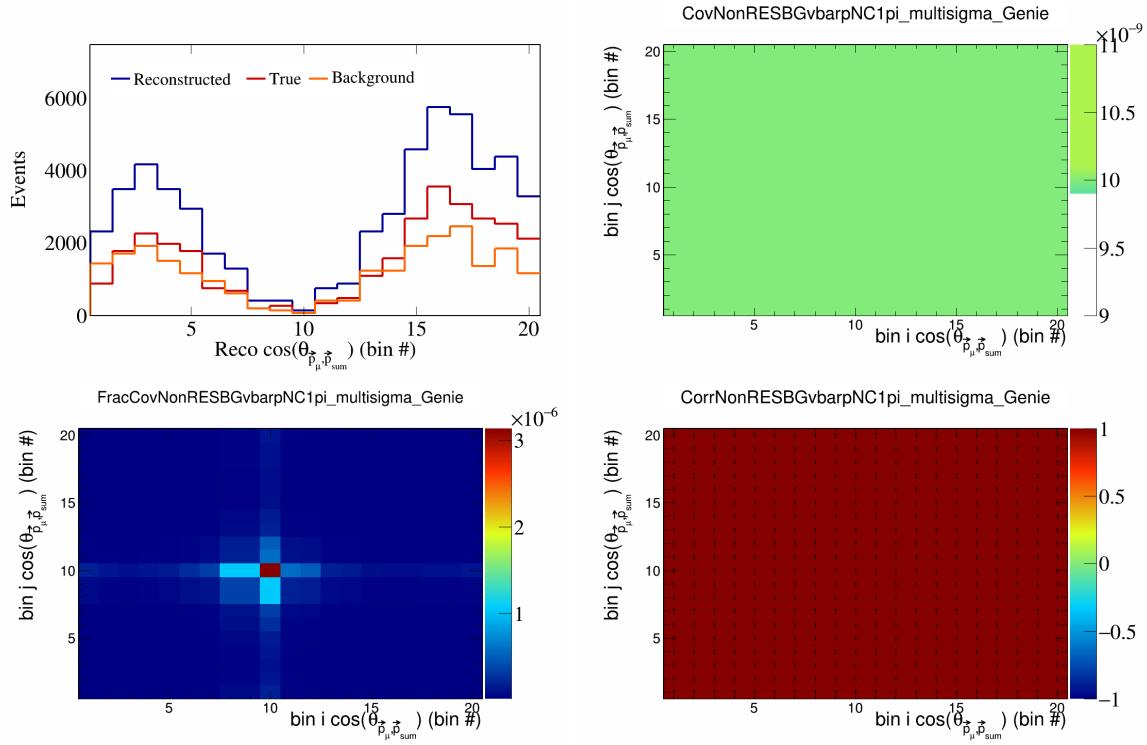


Figure 477: NonRESBGvbarpNC1pi variations for $\cos(\theta_{\vec{p}_\mu})$ in $\cos(\theta_{\vec{p}_\mu})$.

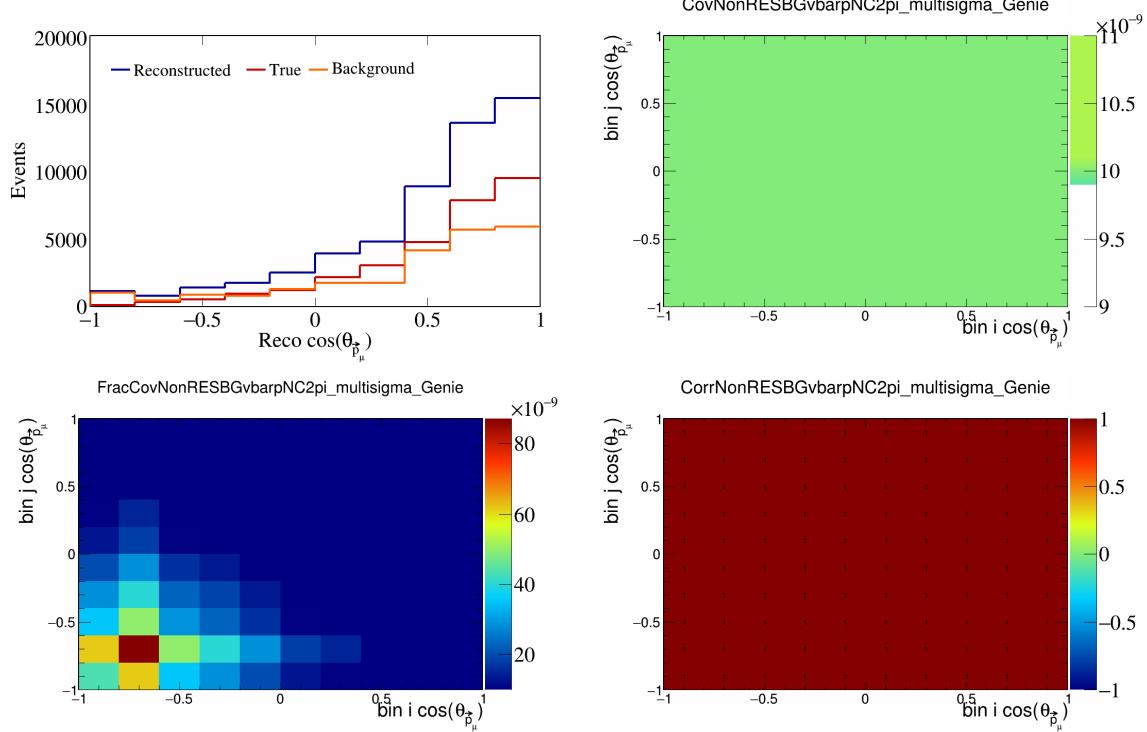


Figure 478: NonRESBGvbarpNC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

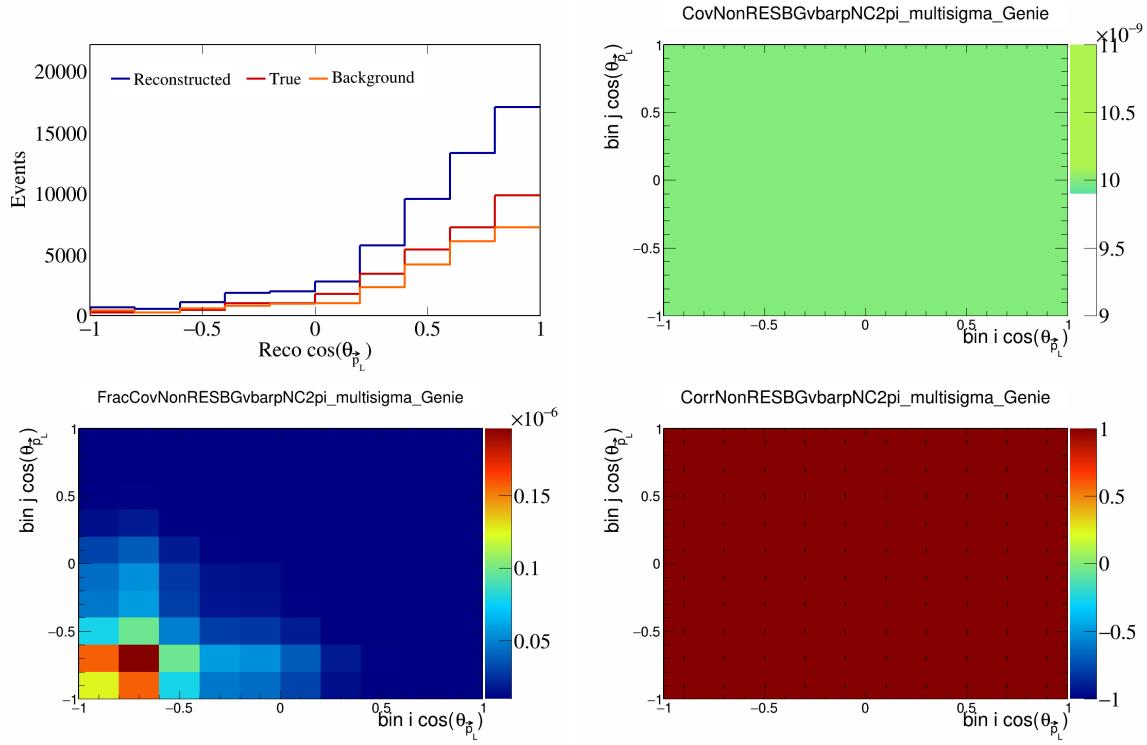


Figure 479: NonRESBGvbarpiNC2pi variations for $\cos(\theta_{\vec{p}_L})$.

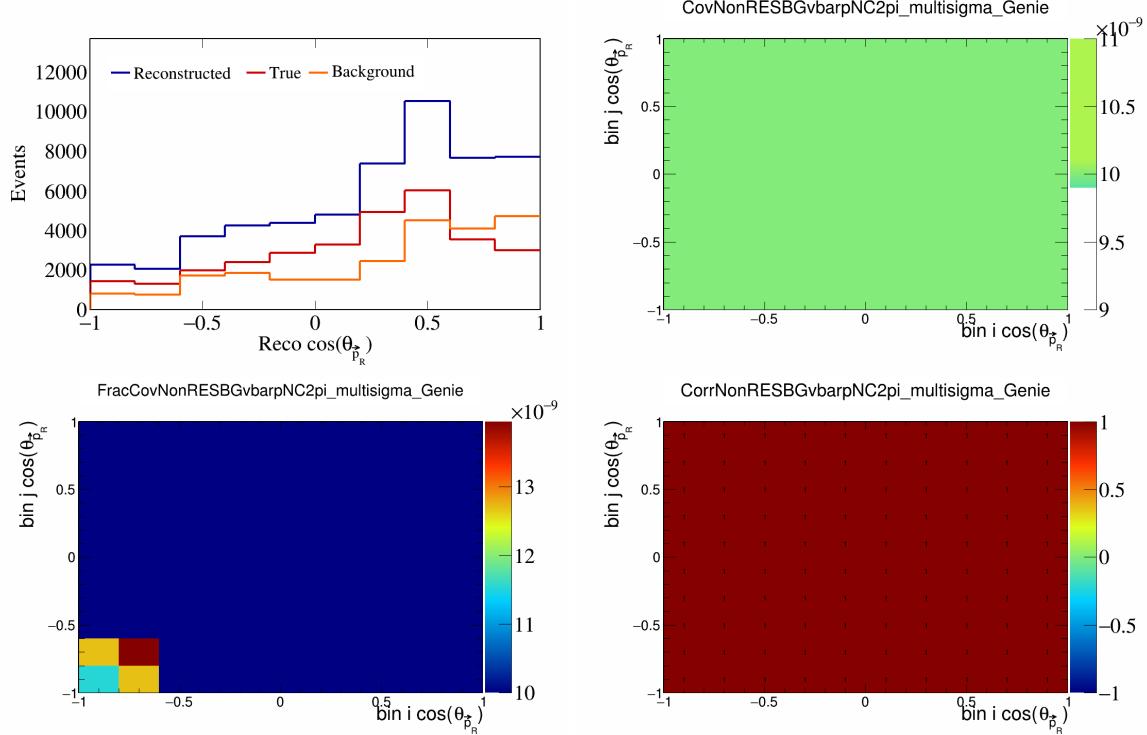


Figure 480: NonRESBGvbarpiNC2pi variations for $\cos(\theta_{\vec{p}_R})$.

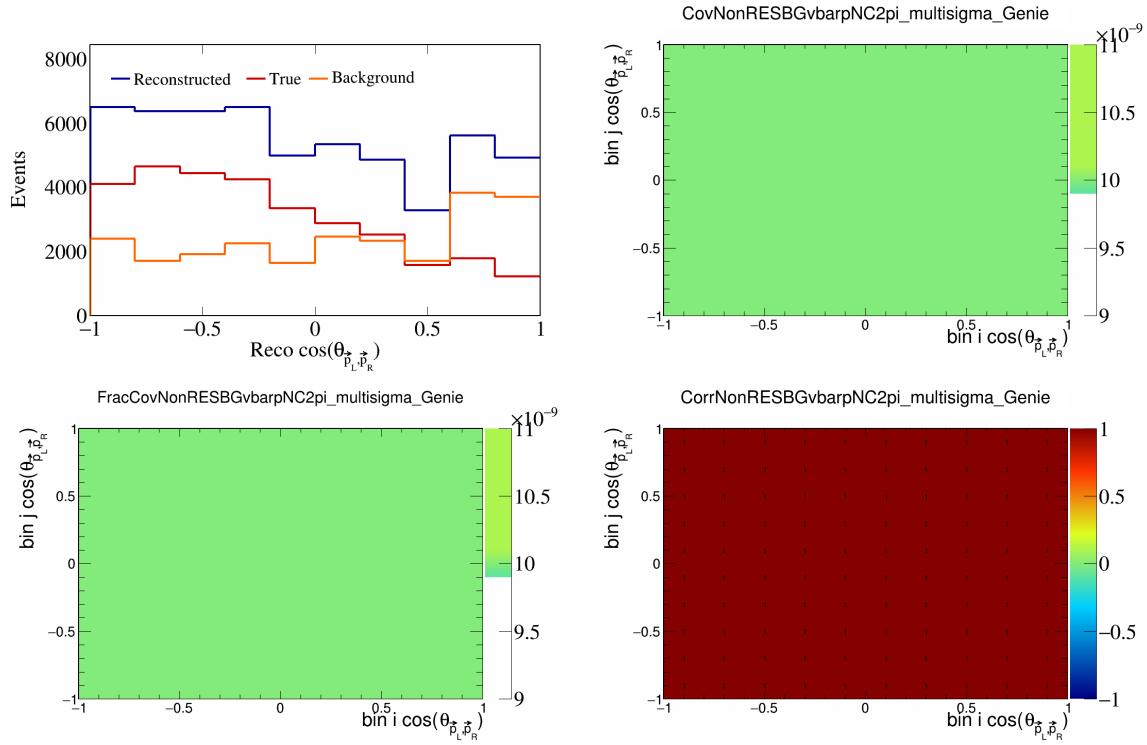


Figure 481: NonRESBGvbarpNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

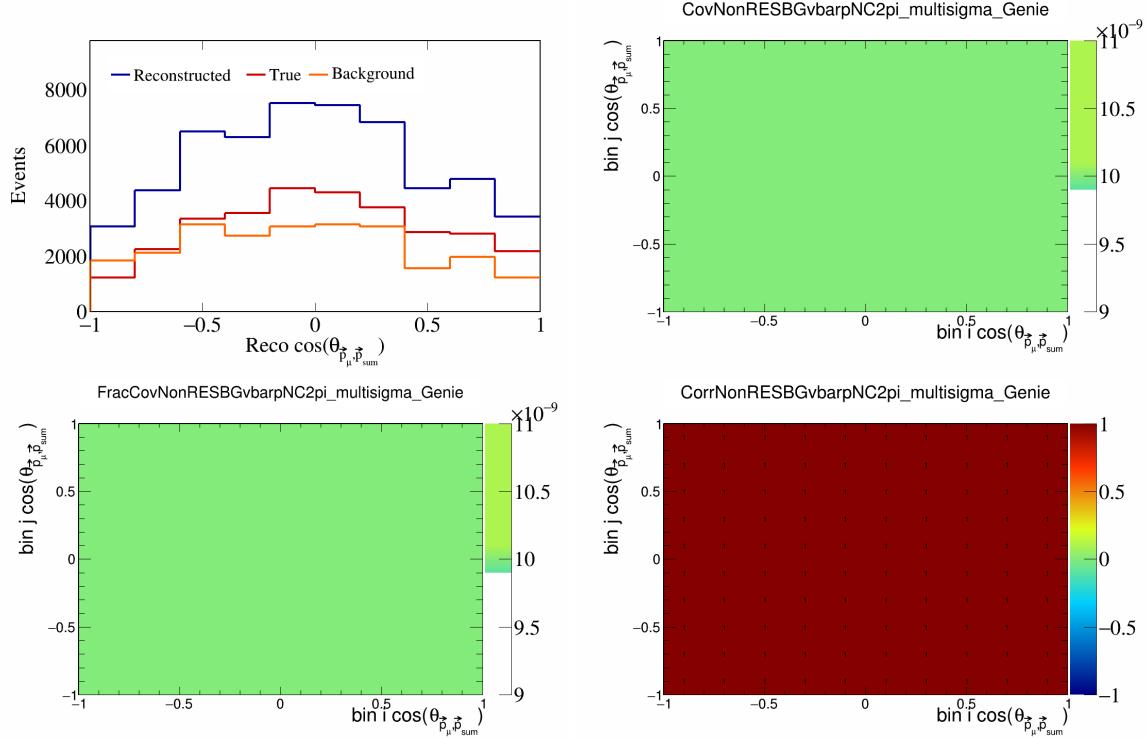


Figure 482: NonRESBGvbarpNC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

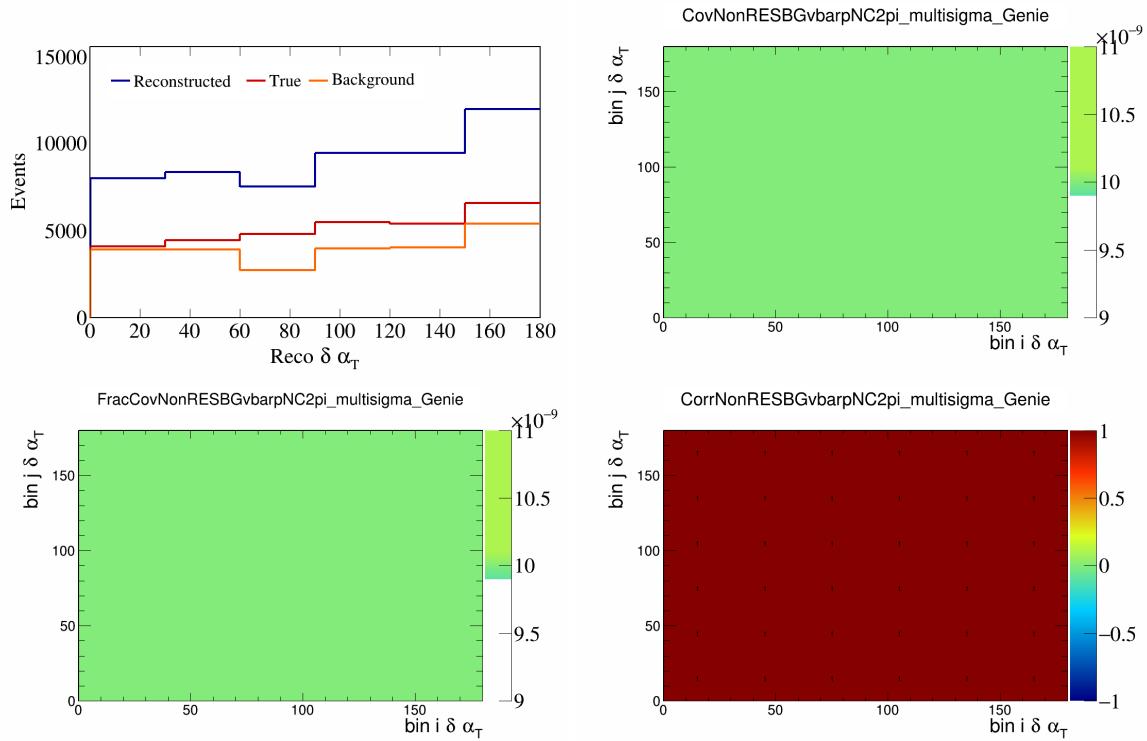


Figure 483: NonRESBGvbarpNC2pi variations for $\delta\alpha_T$.

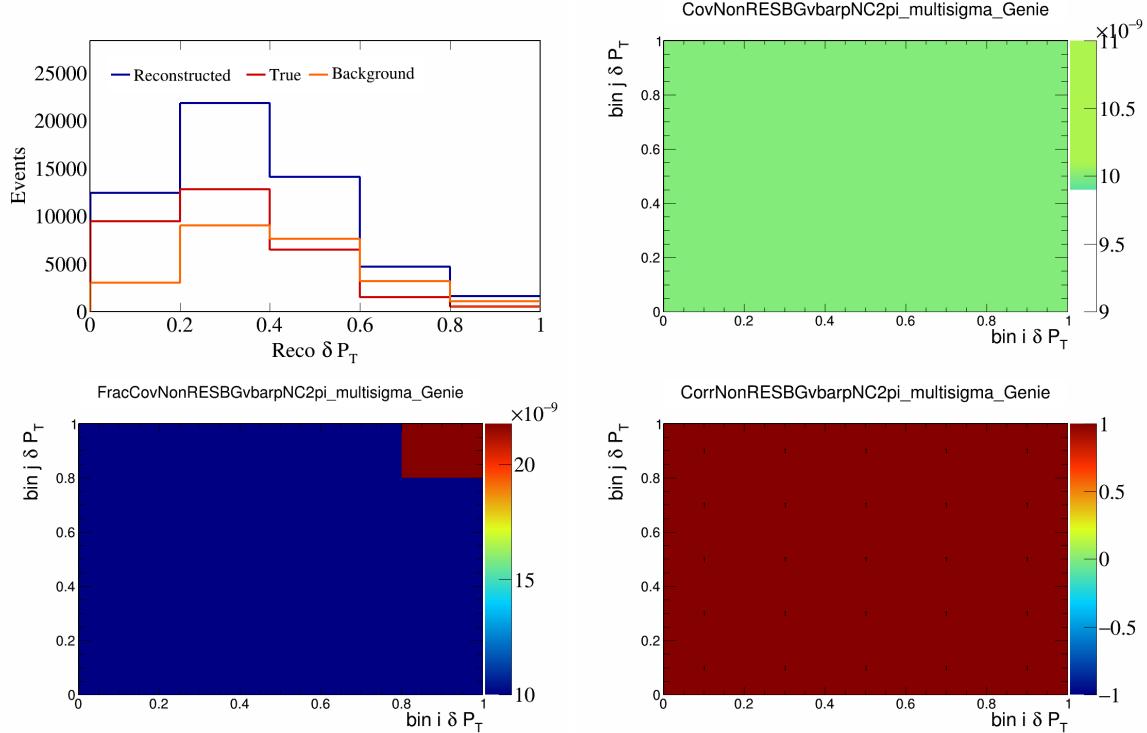


Figure 484: NonRESBGvbarpNC2pi variations for δP_T .

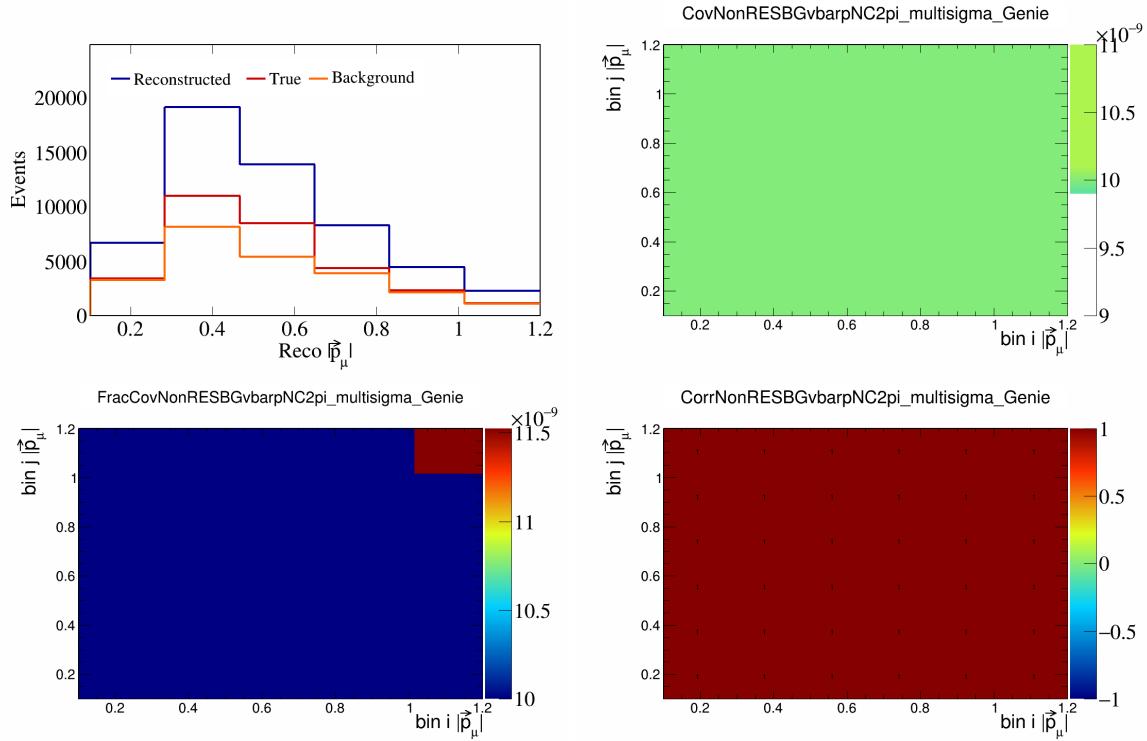


Figure 485: NonRESBGvbarpNC2pi variations for $|\vec{p}_\mu|$.

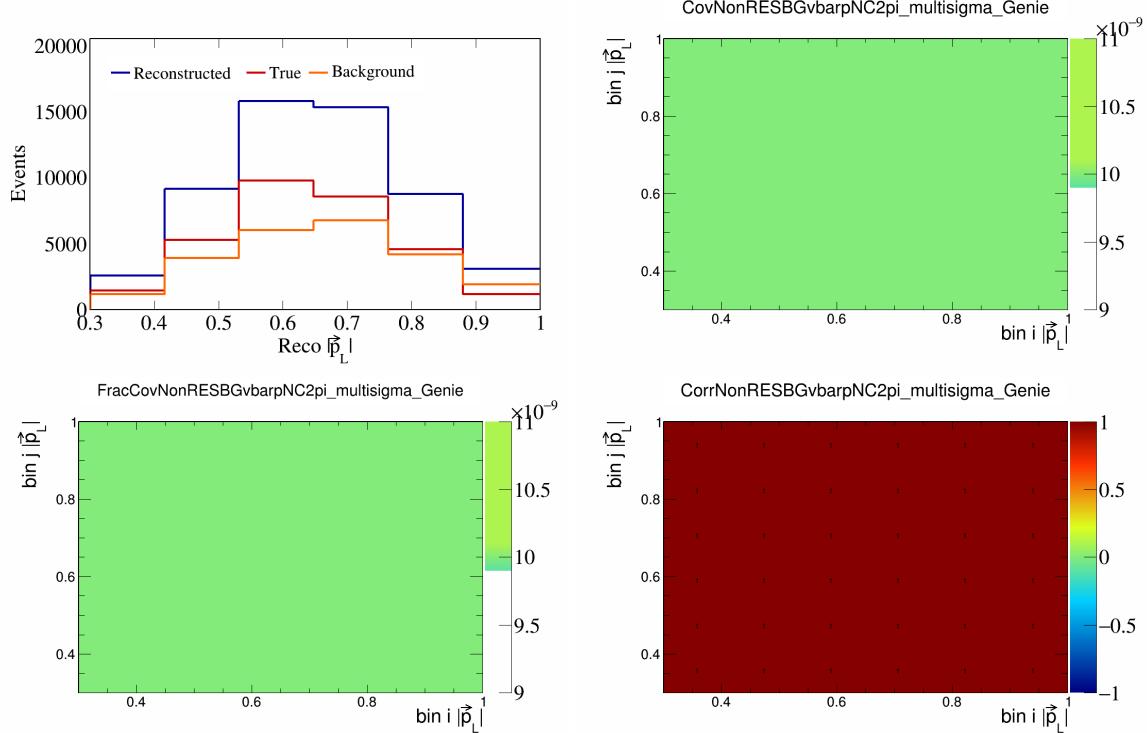


Figure 486: NonRESBGvbarpNC2pi variations for $|\vec{p}_L|$.

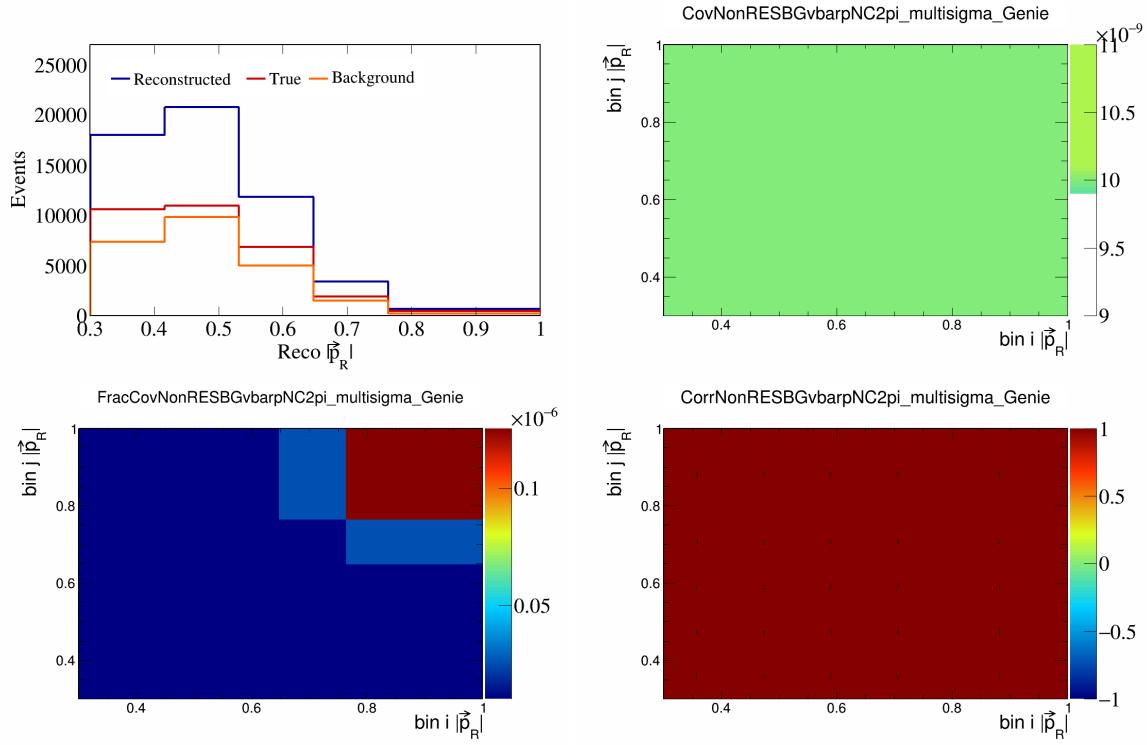


Figure 487: NonRESBGvbarpNC2pi variations for $|\vec{p}_R|$.

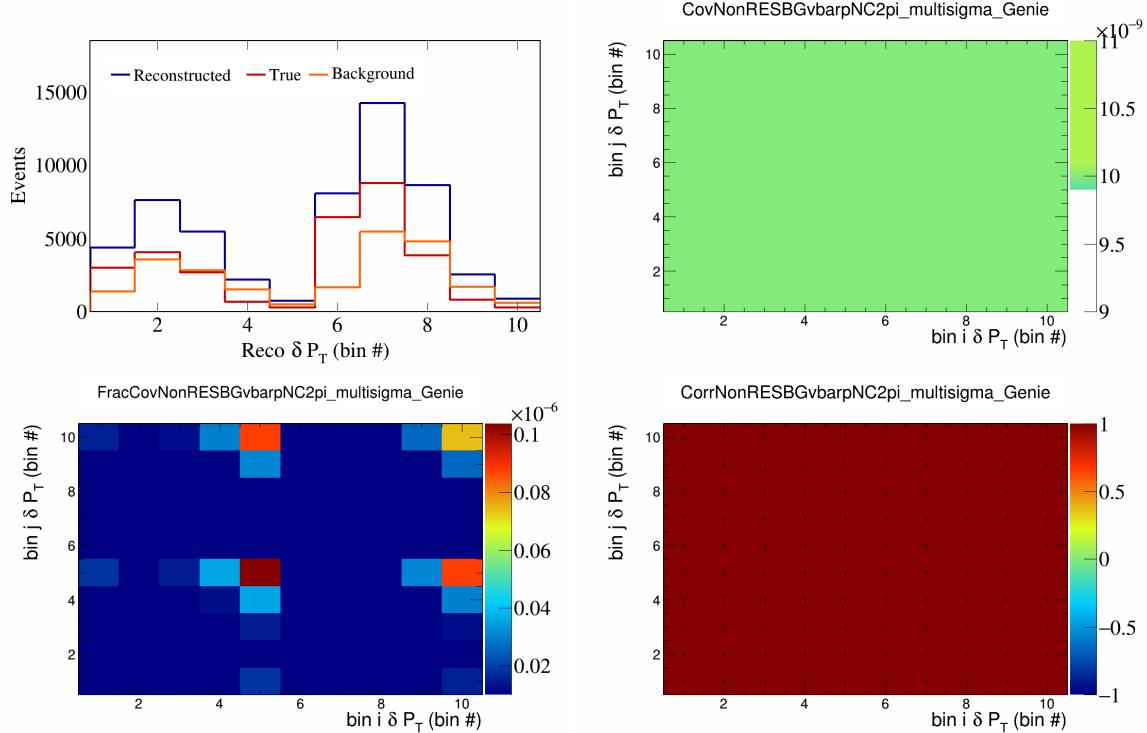


Figure 488: NonRESBGvbarpNC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

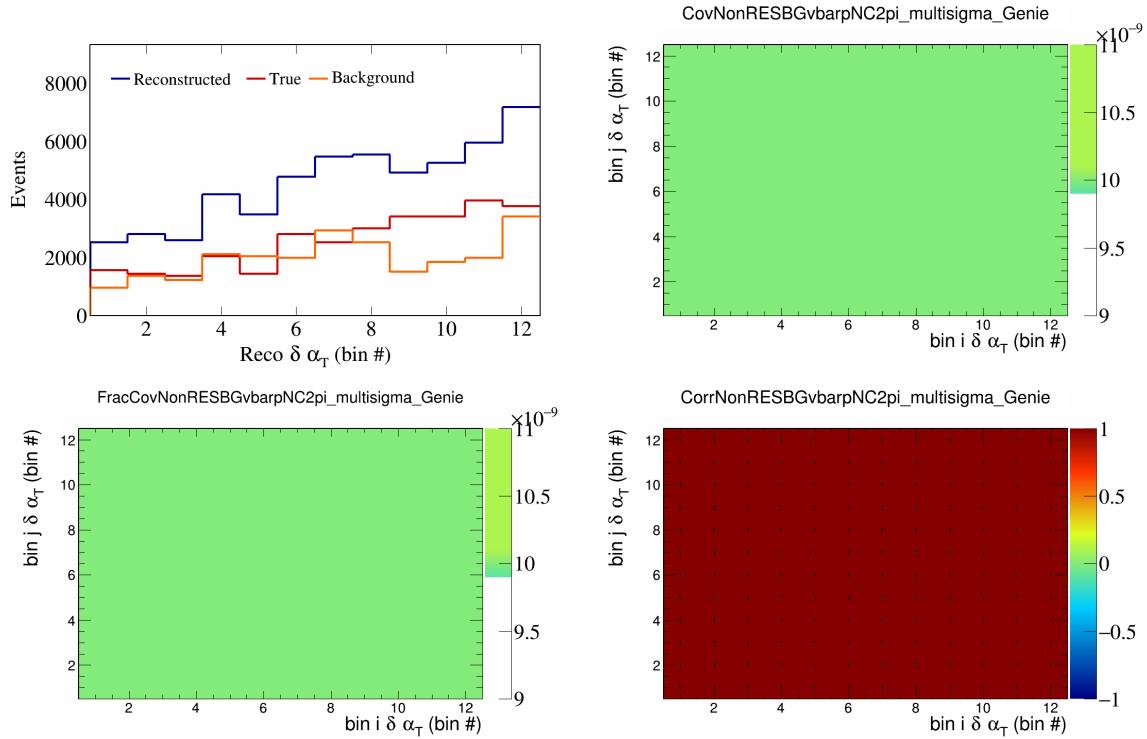


Figure 489: NonRESBGvbarpNC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

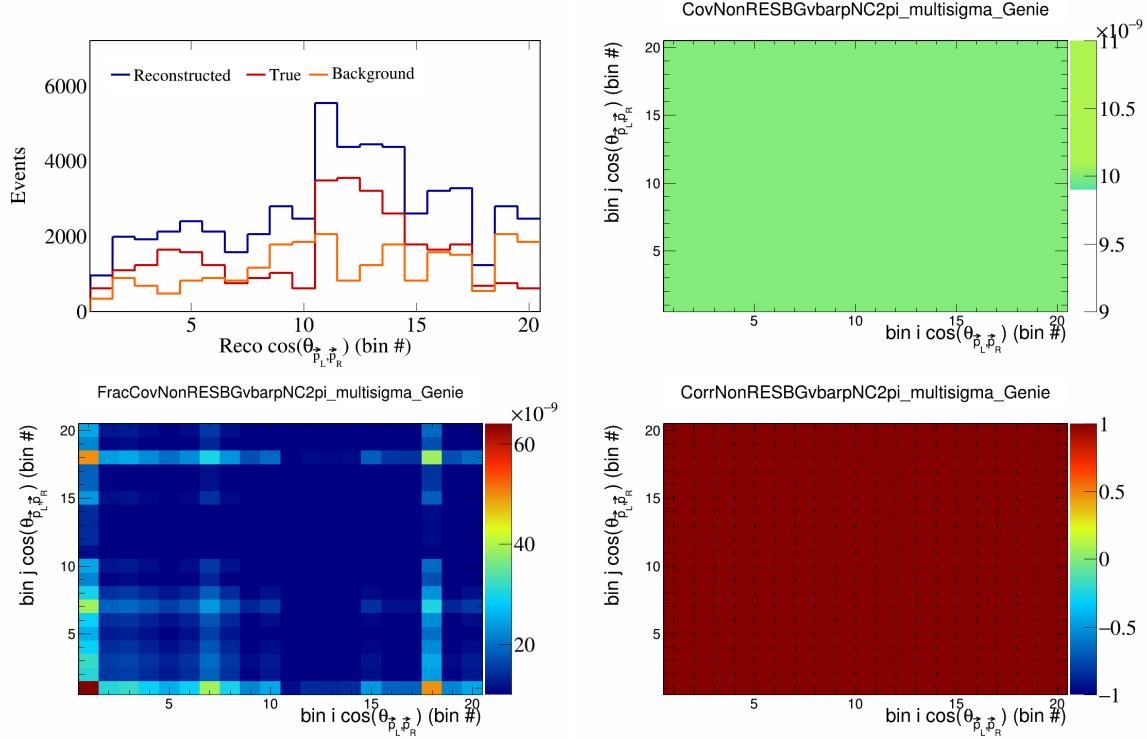


Figure 490: NonRESBGvbarpNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

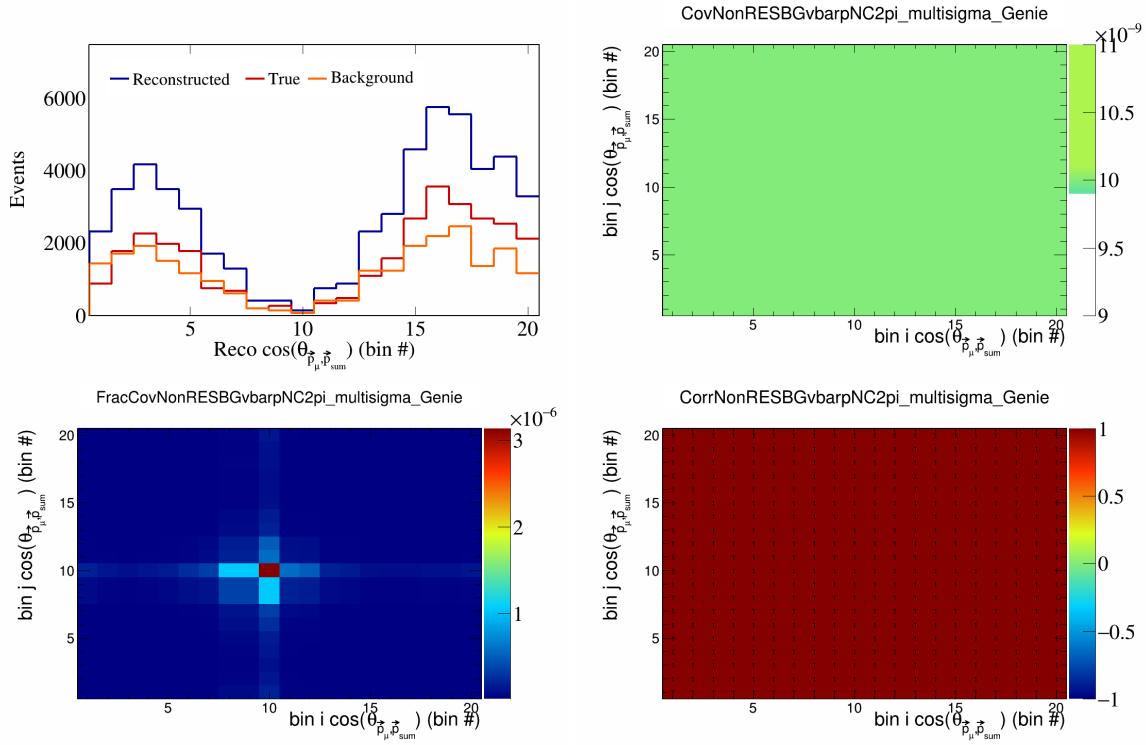


Figure 491: NonRESBGvbarpNC2pi variations for $\cos(\theta_{\vec{p}_\mu} \cdot \vec{p}_{\text{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

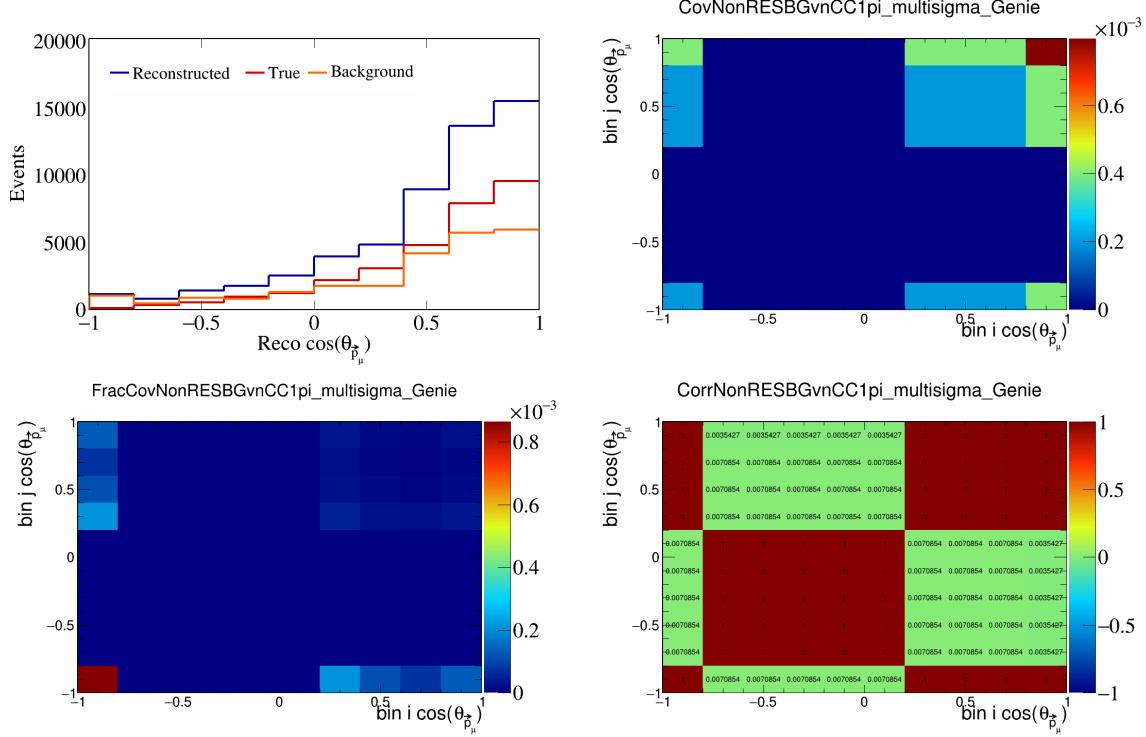


Figure 492: NonRESBGvnCC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

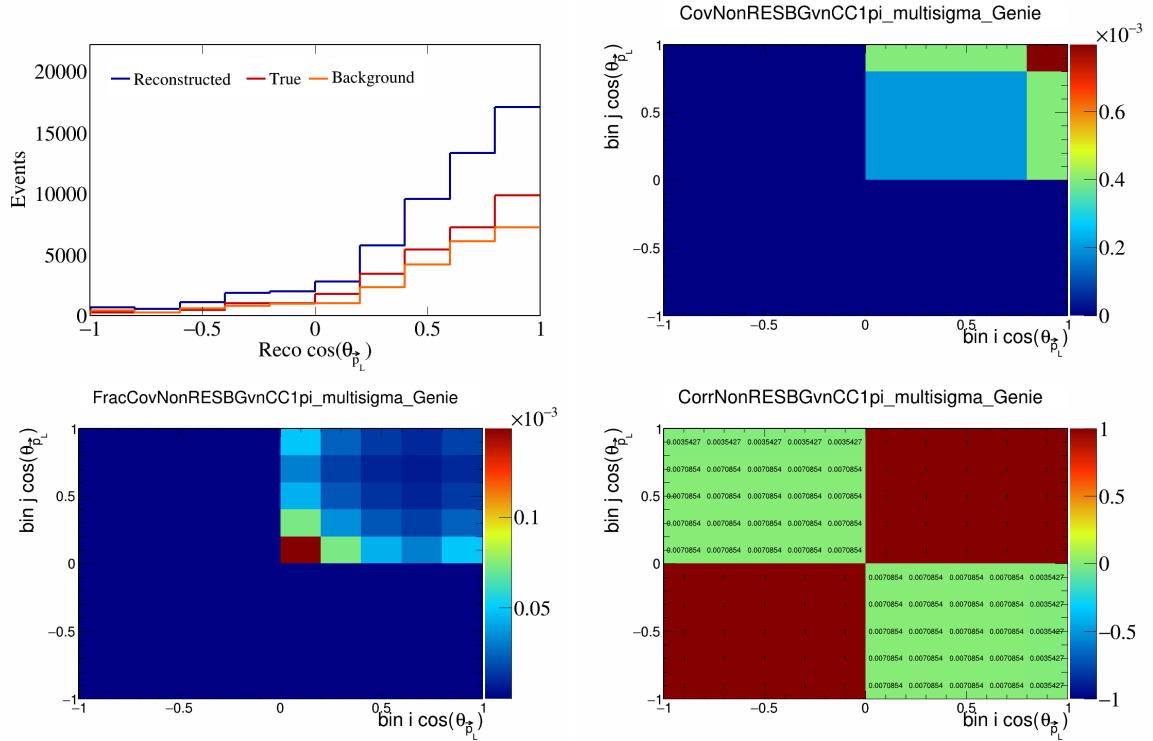


Figure 493: NonRESBGvnCC1pi variations for $\cos(\theta_{\vec{p}_L})$.

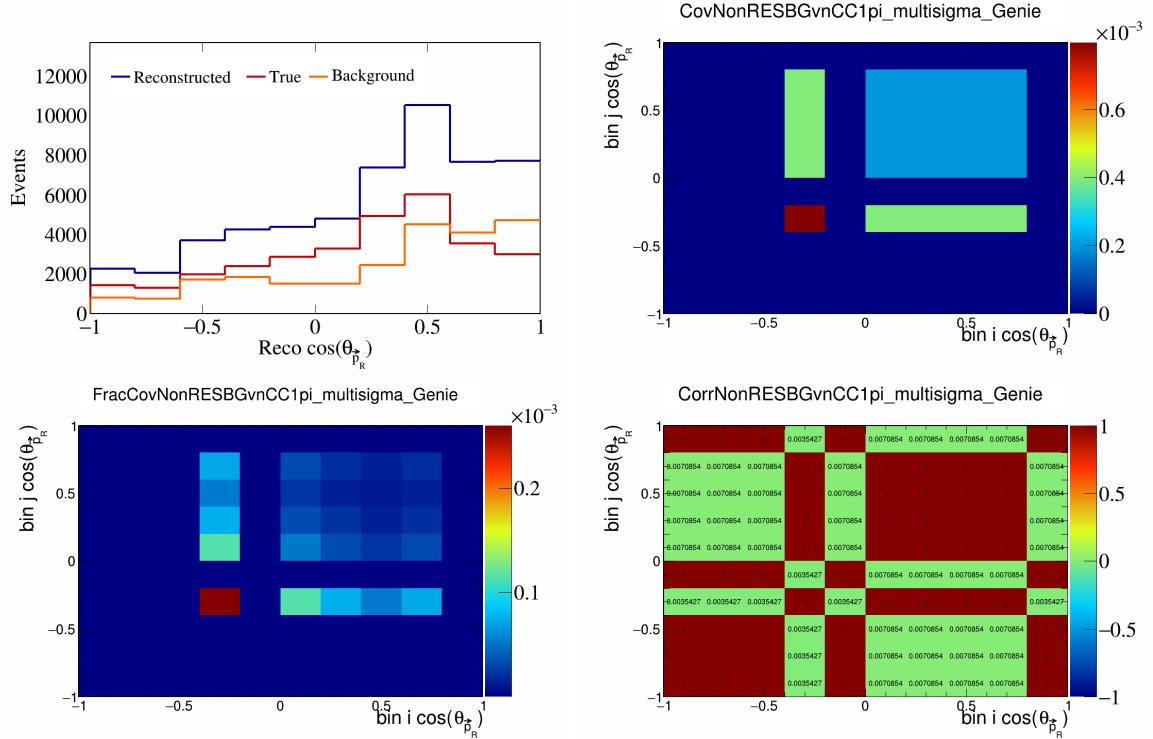


Figure 494: NonRESBGvnCC1pi variations for $\cos(\theta_{\vec{p}_R})$.

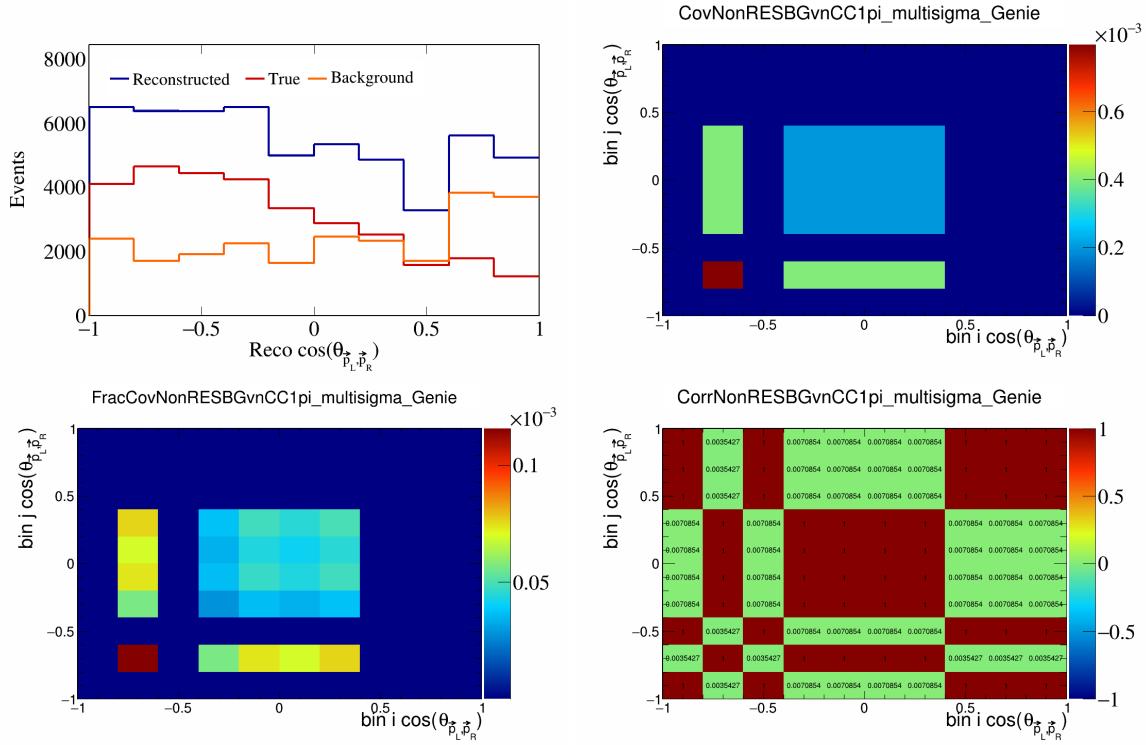


Figure 495: NonRESBGvnCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

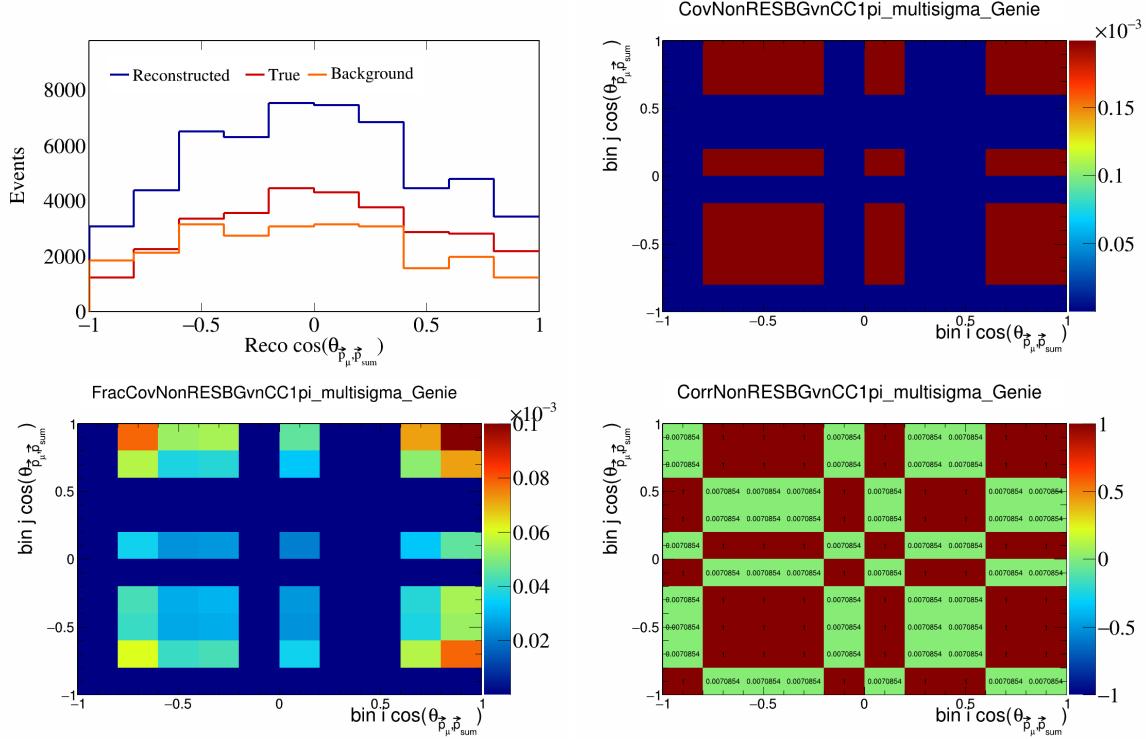


Figure 496: NonRESBGvnCC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

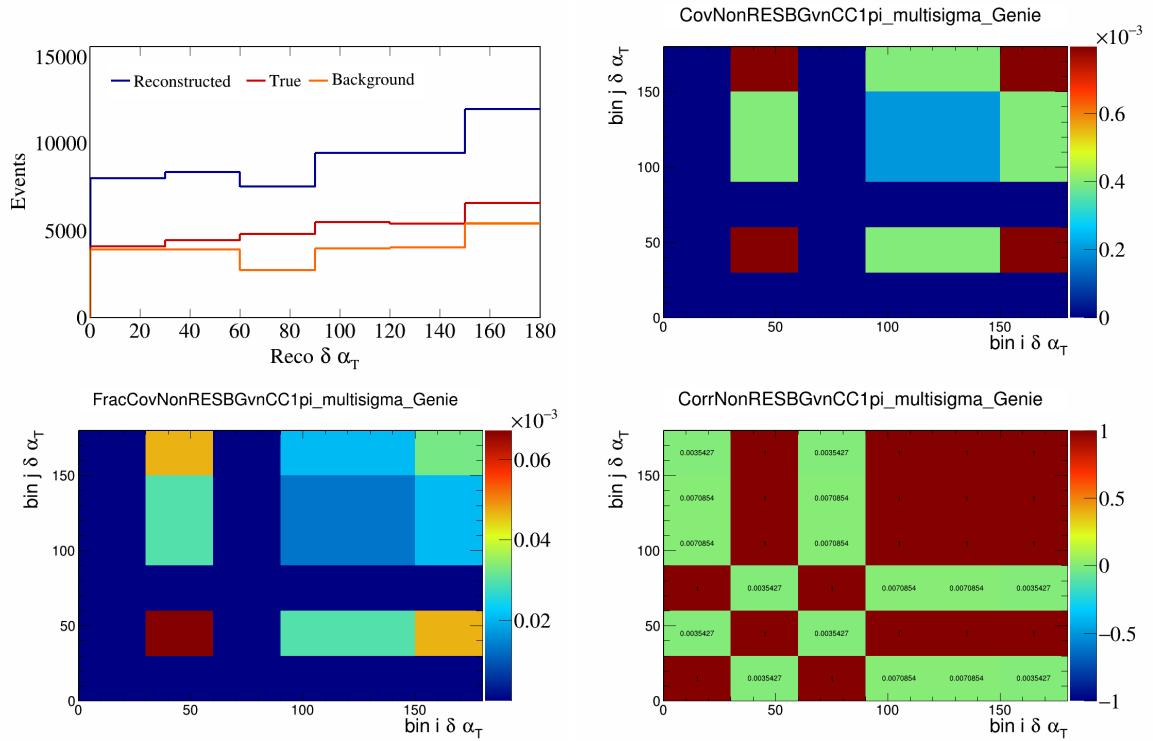


Figure 497: NonRESBGvnCC1pi variations for $\delta \alpha_T$.

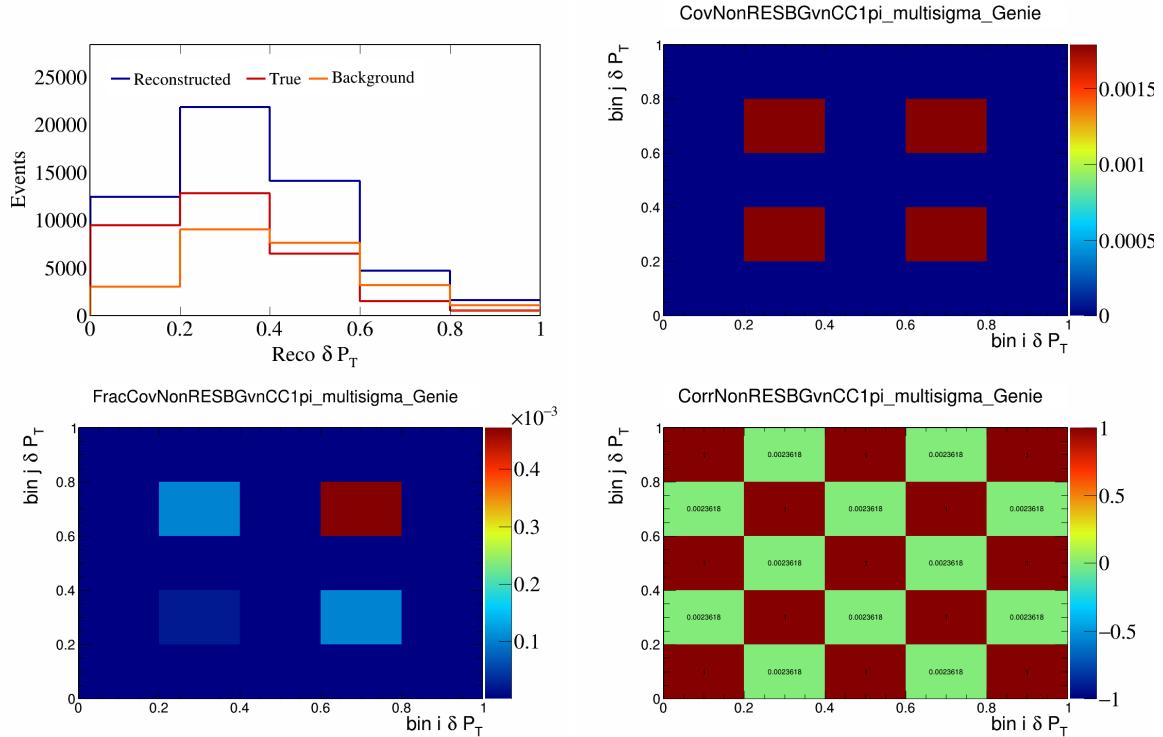


Figure 498: NonRESBGvnCC1pi variations for δP_T .

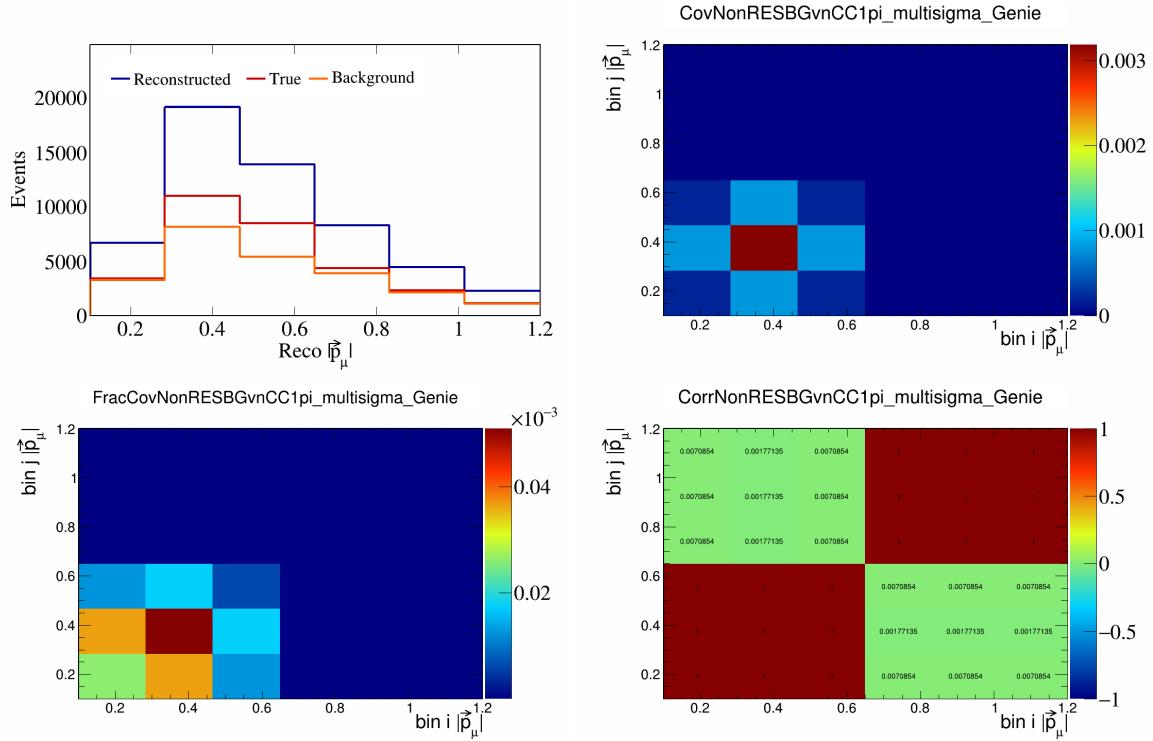
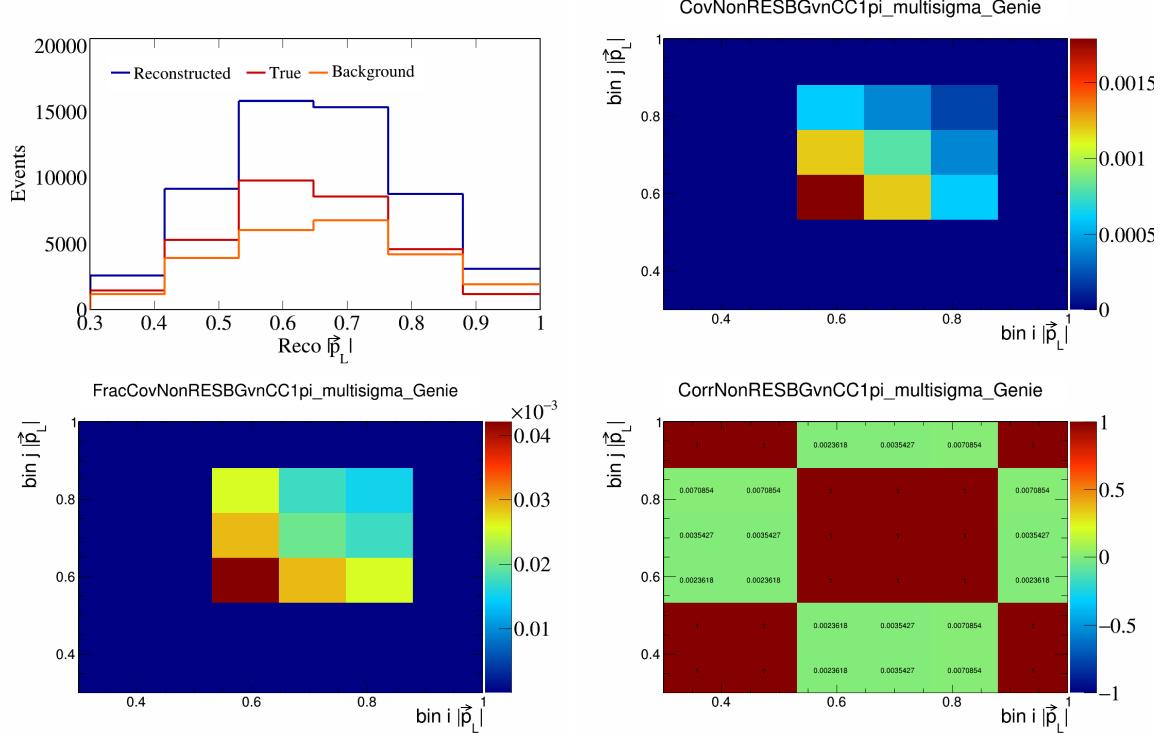


Figure 499: NonRESBGvnCC1pi variations for $|\vec{p}_\mu|$.



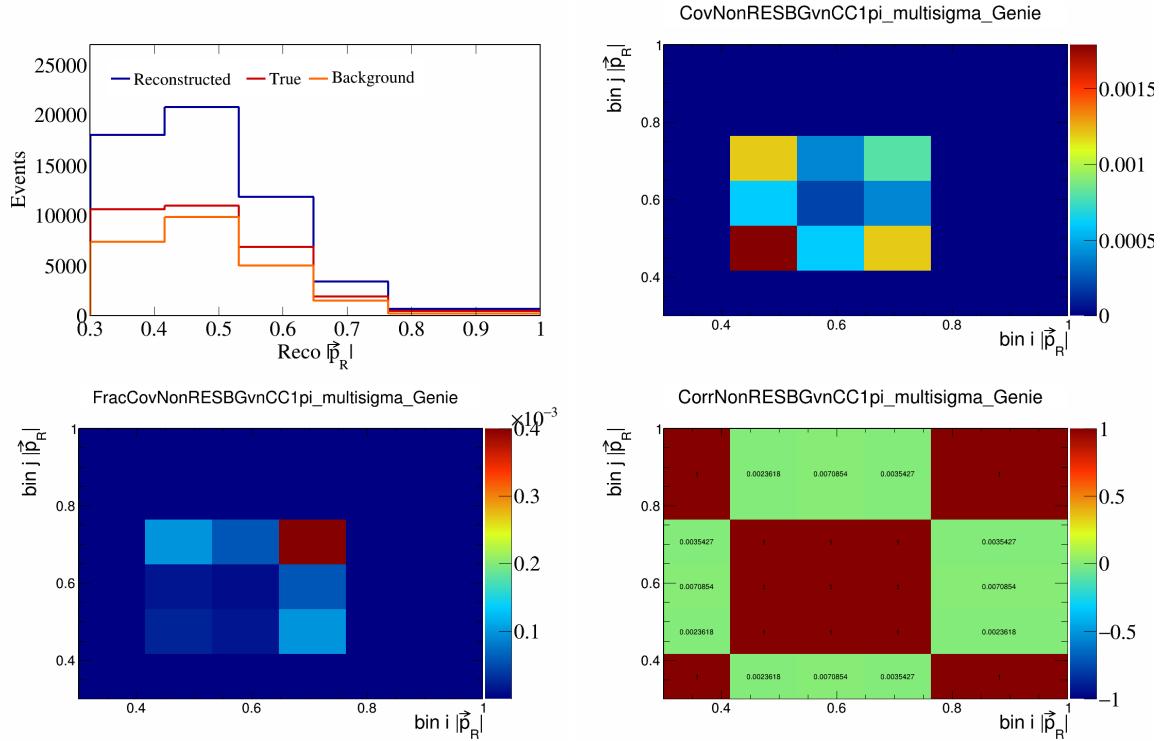


Figure 501: NonRESBGvnCC1pi variations for $|\vec{p}_R|$.

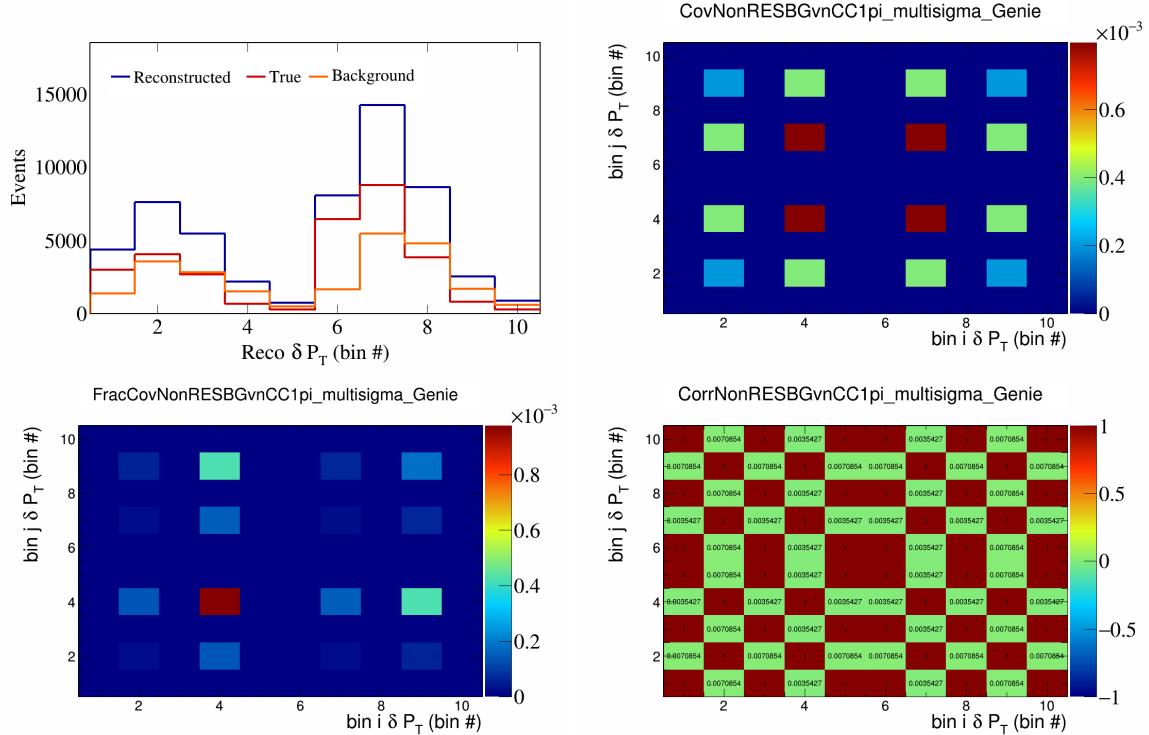


Figure 502: NonRESBGvnCC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

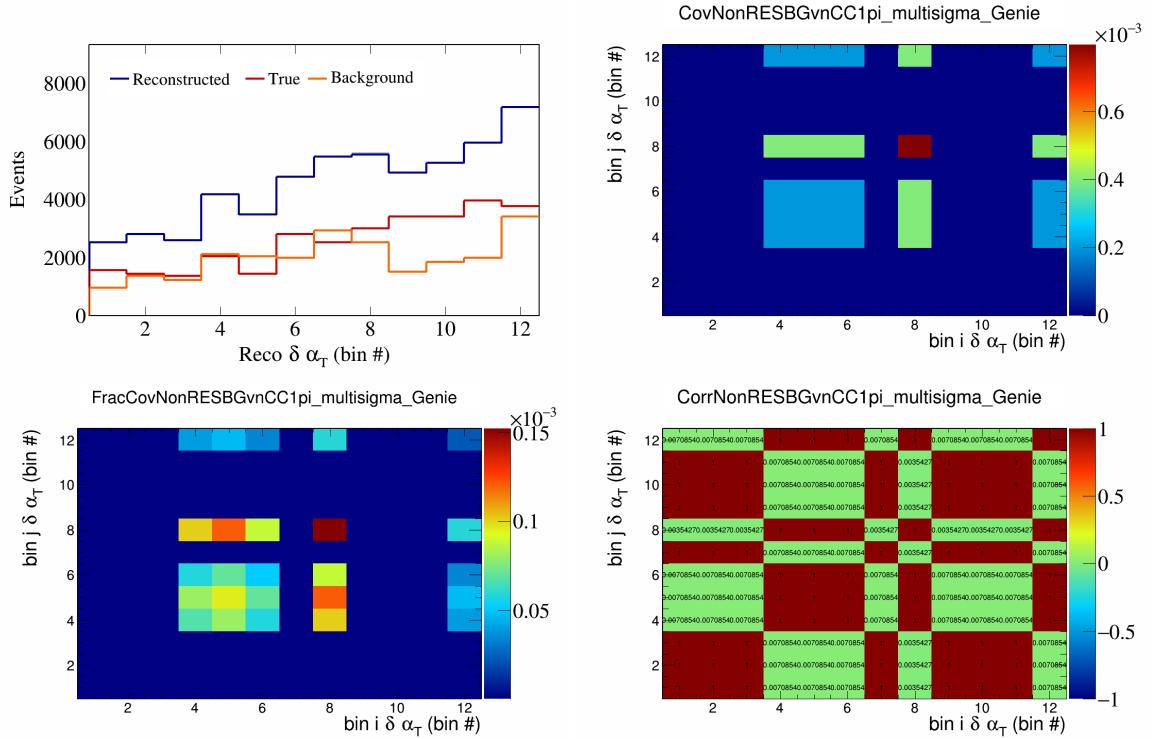


Figure 503: NonRESBGvnCC1pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

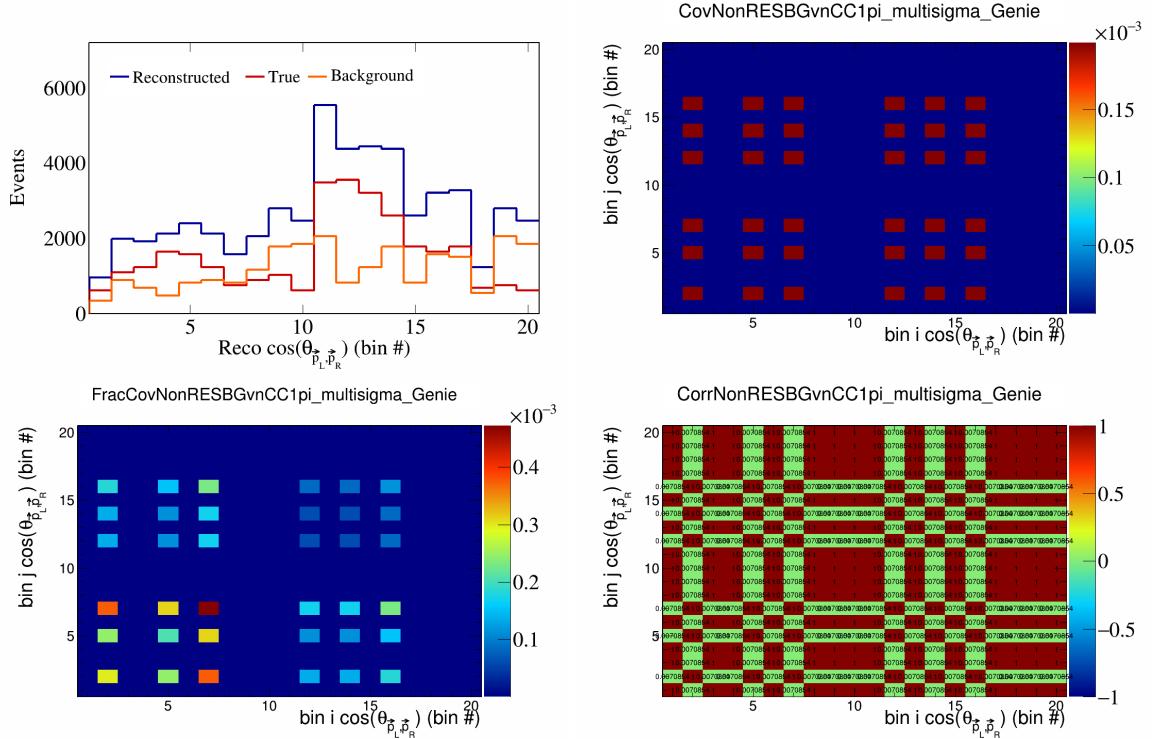


Figure 504: NonRESBGvnCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

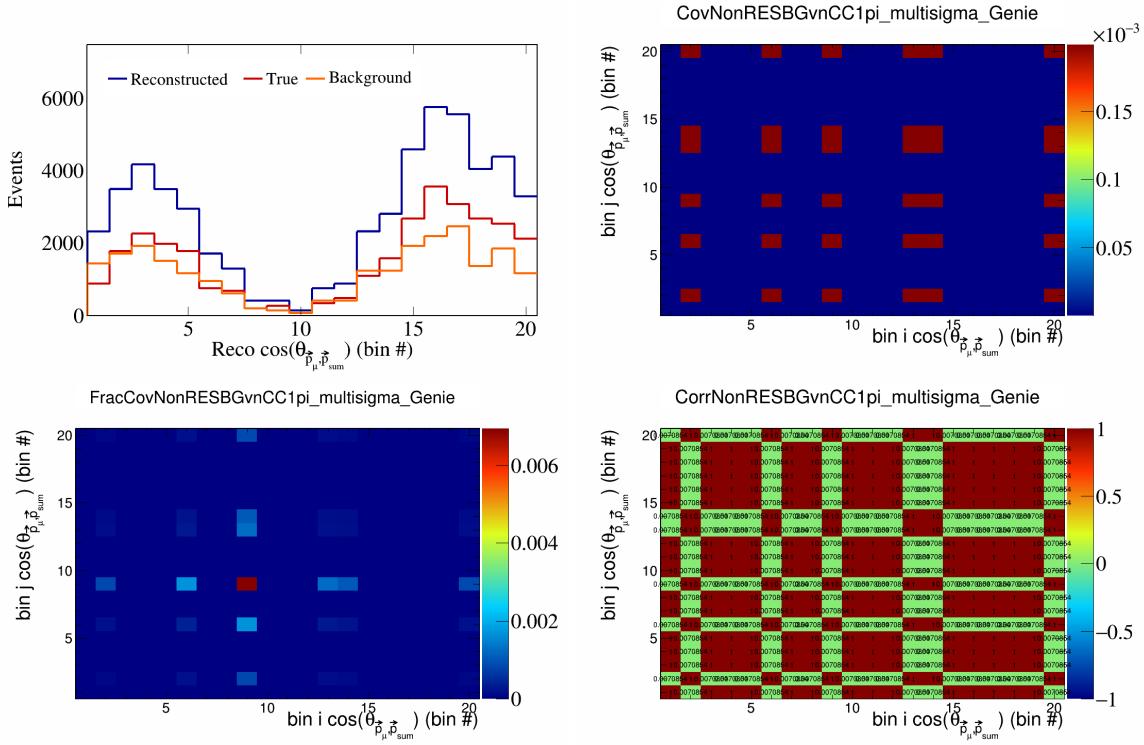


Figure 505: NonRESBGvnCC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

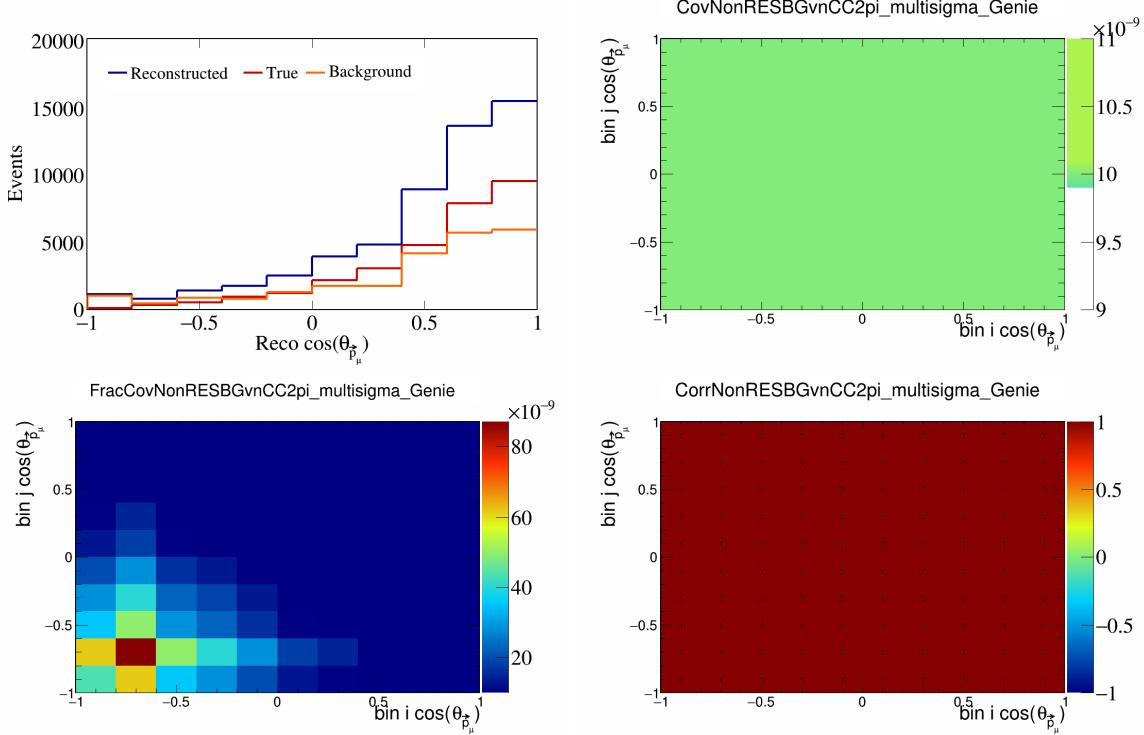


Figure 506: NonRESBGvnCC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

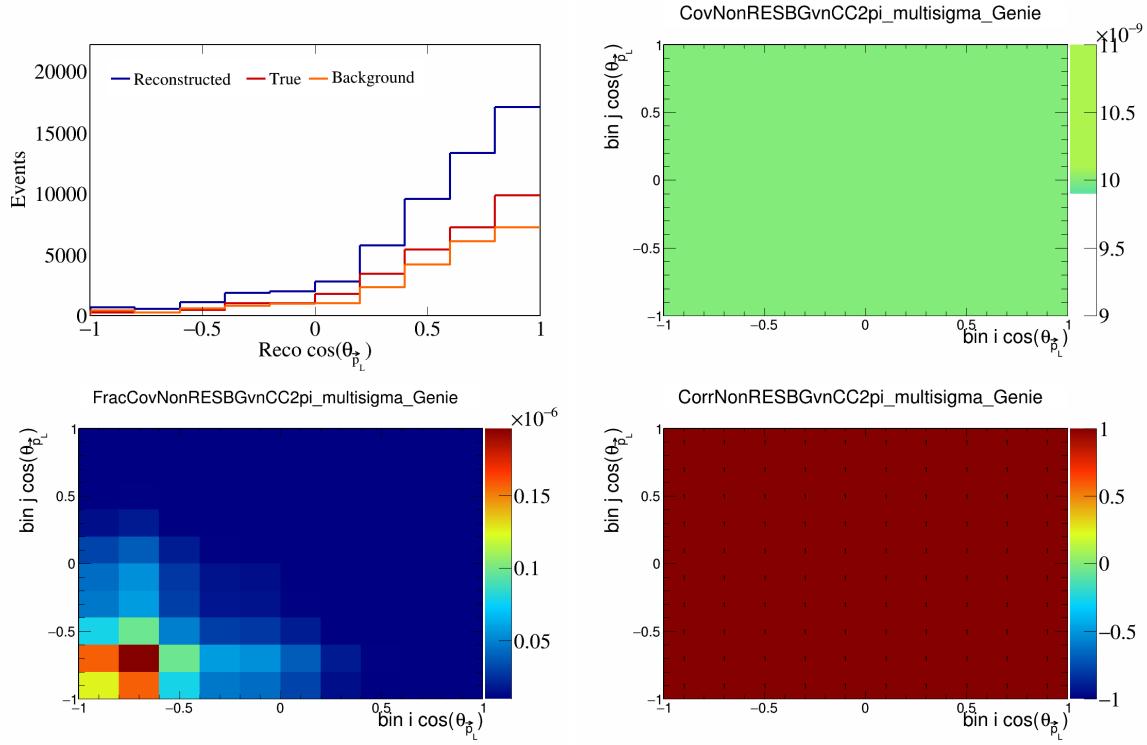


Figure 507: NonRESBGvnCC2pi variations for $\cos(\theta_{\vec{p}_L})$.

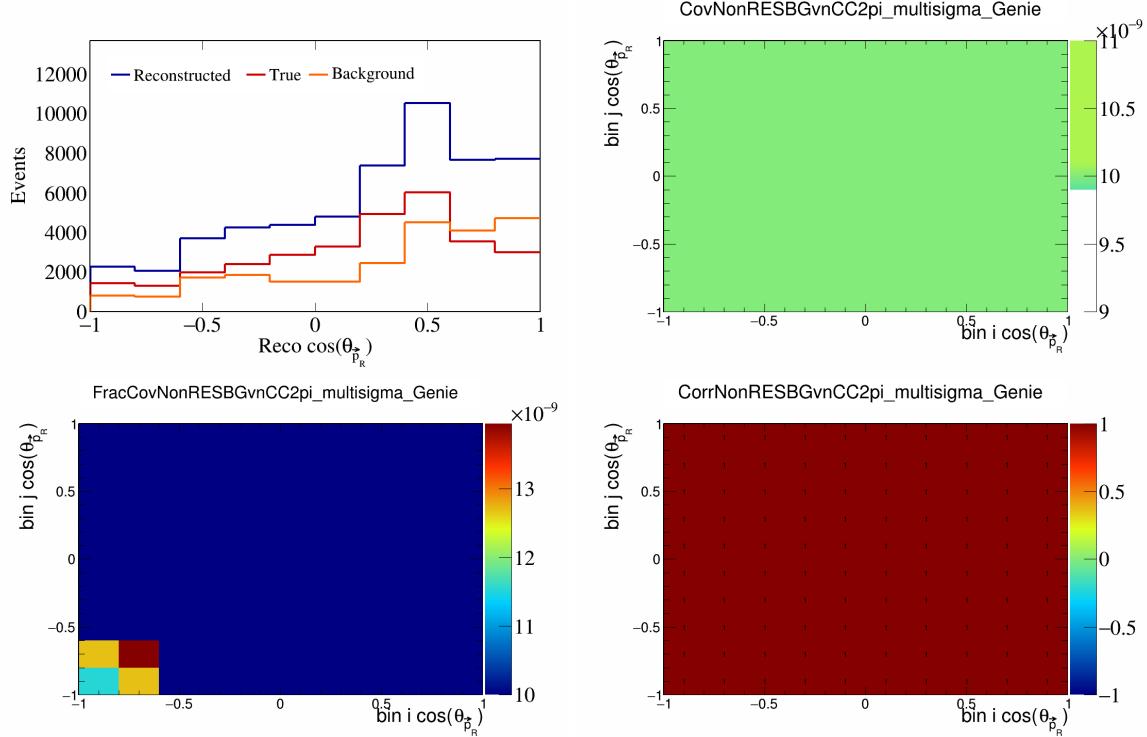


Figure 508: NonRESBGvnCC2pi variations for $\cos(\theta_{\vec{p}_R})$.

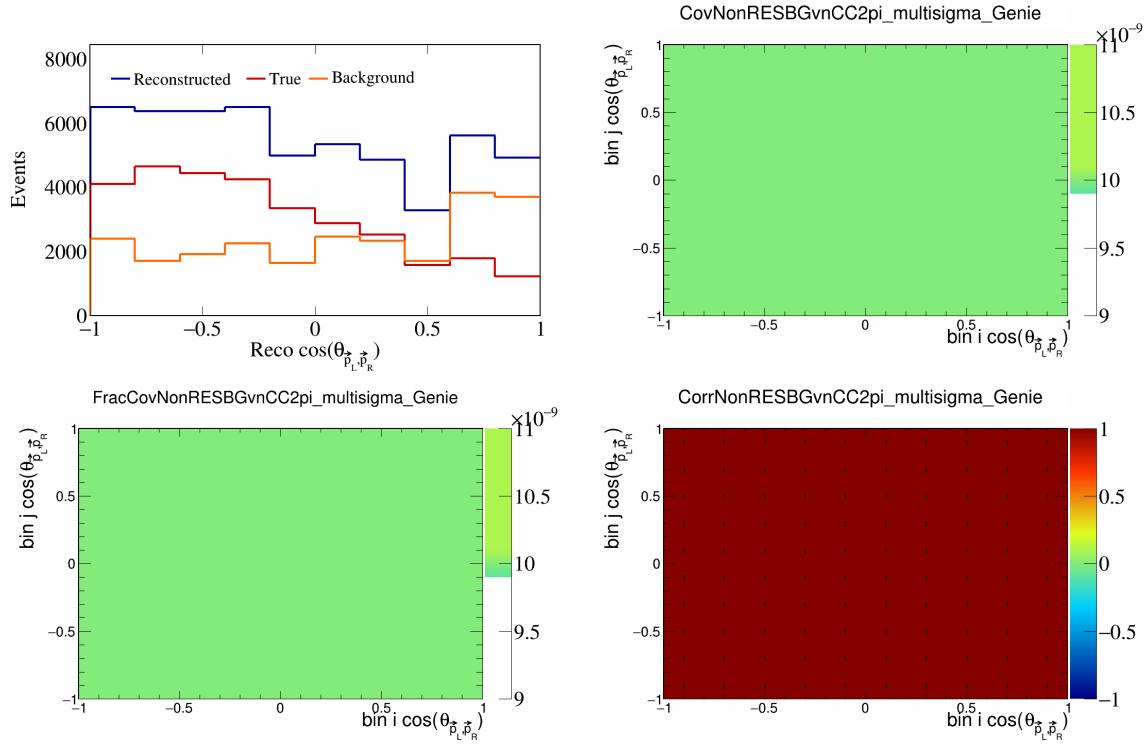


Figure 509: NonRESBGvnCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

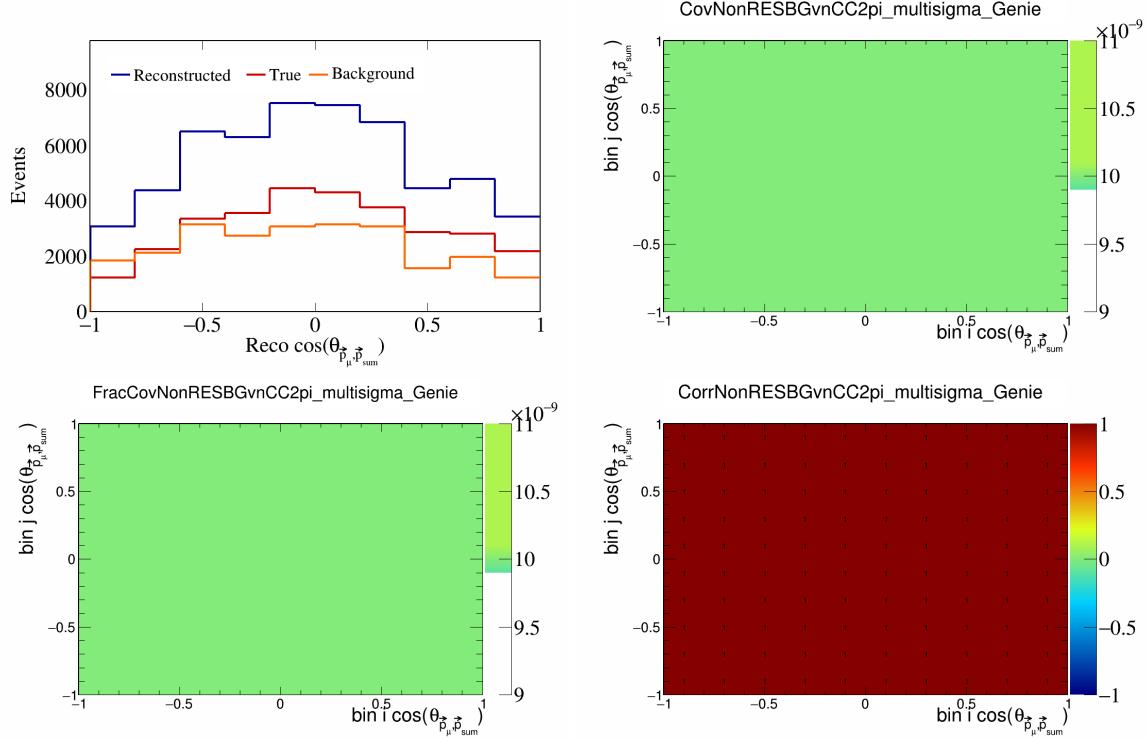


Figure 510: NonRESBGvnCC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

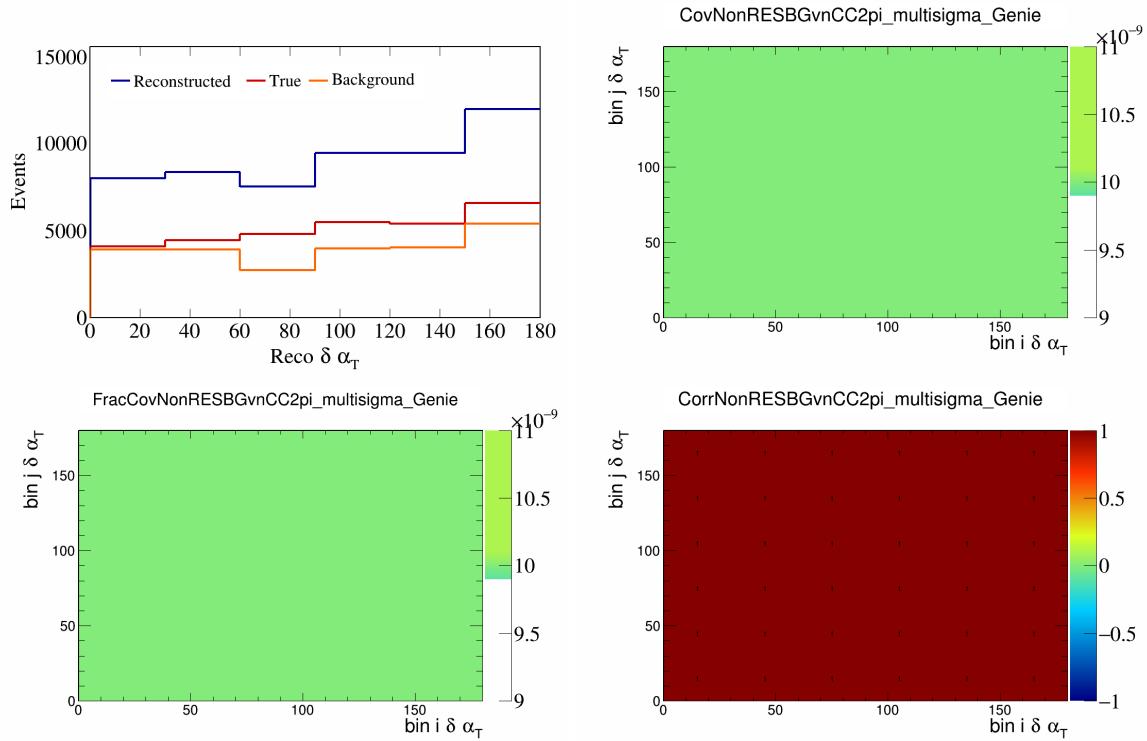


Figure 511: NonRESBGvnCC2pi variations for $\delta\alpha_T$.

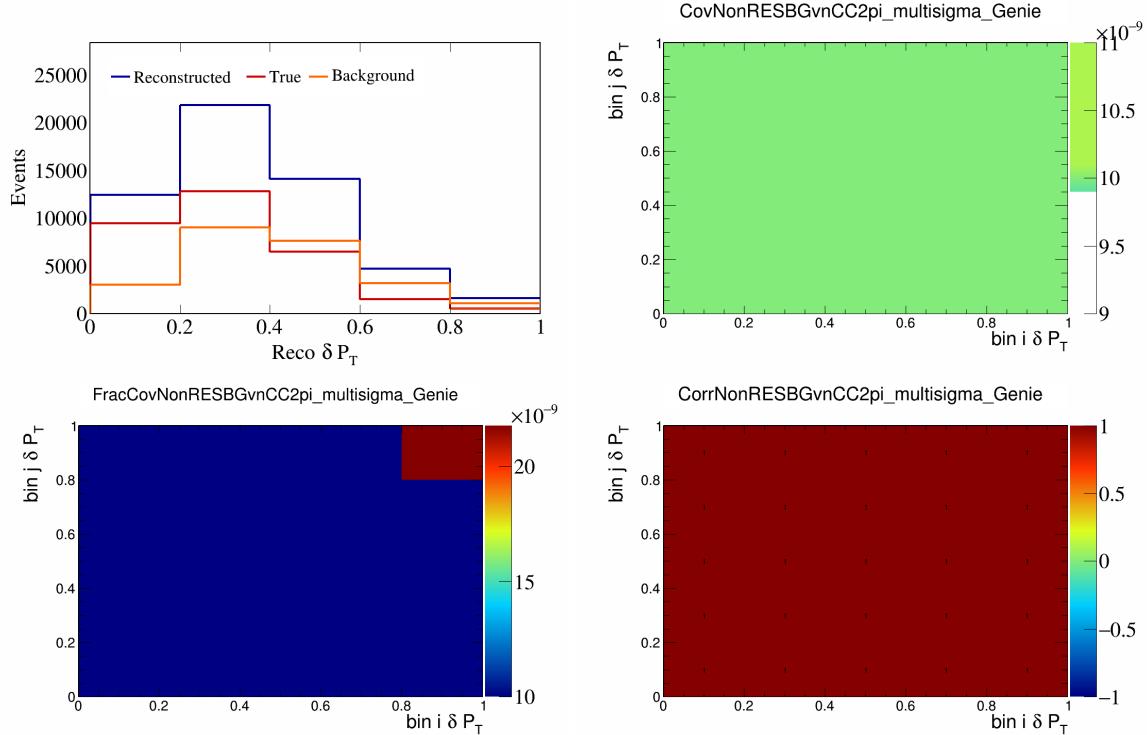


Figure 512: NonRESBGvnCC2pi variations for δP_T .

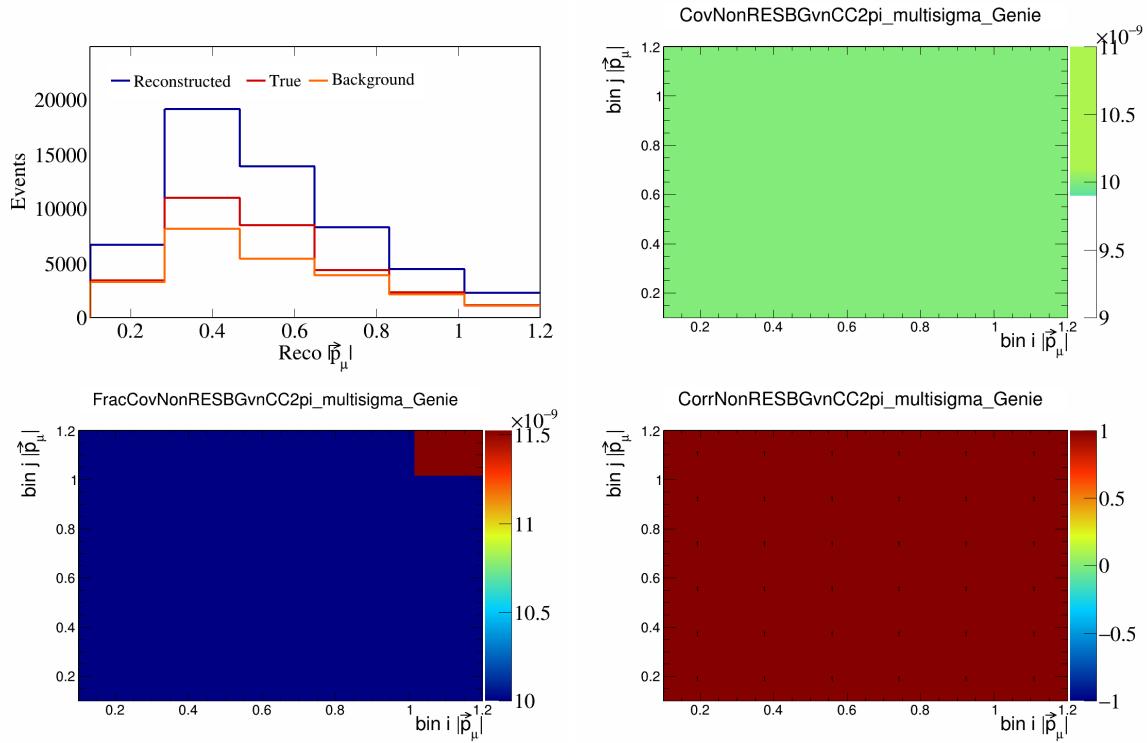


Figure 513: NonRESBGvnCC2pi variations for $|\vec{p}_\mu|$.

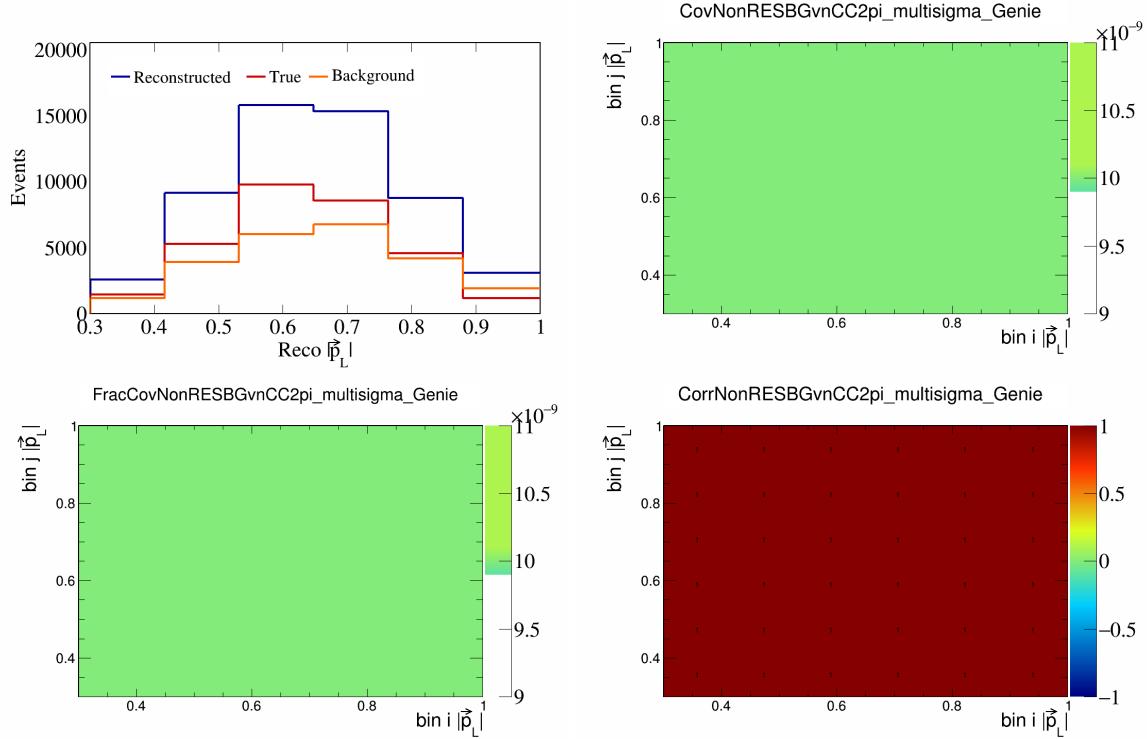


Figure 514: NonRESBGvnCC2pi variations for $|\vec{p}_L|$.

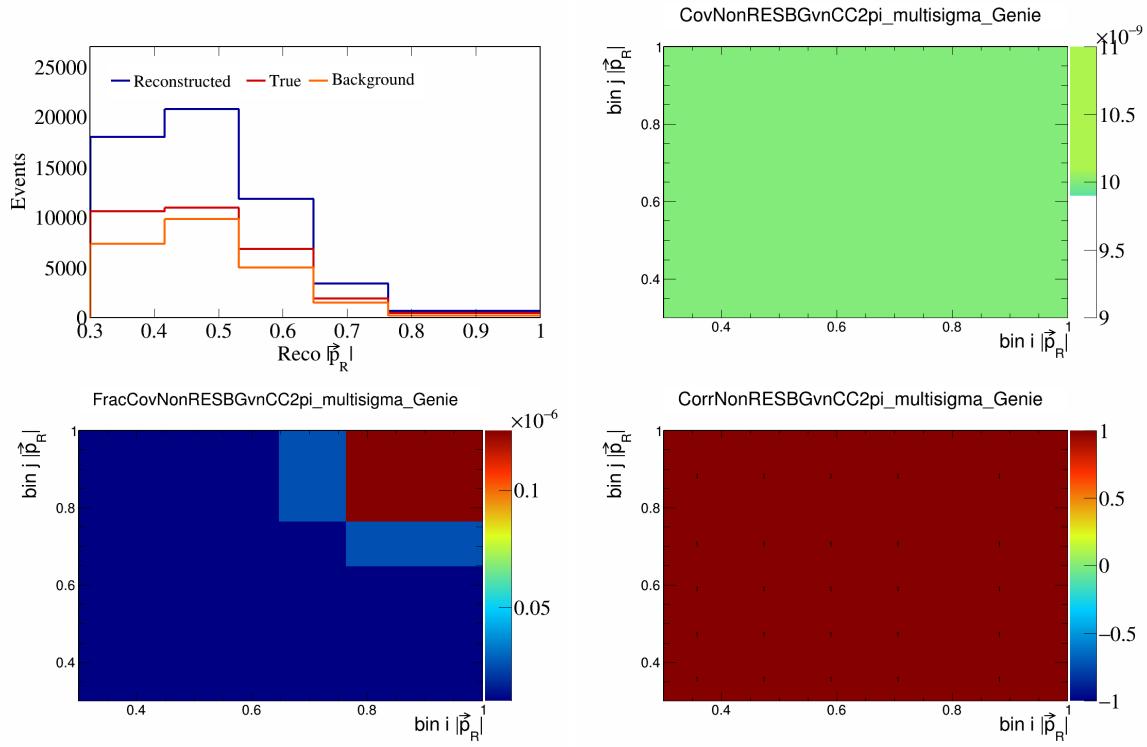


Figure 515: NonRESBGvnCC2pi variations for $|\vec{p}_R|$.

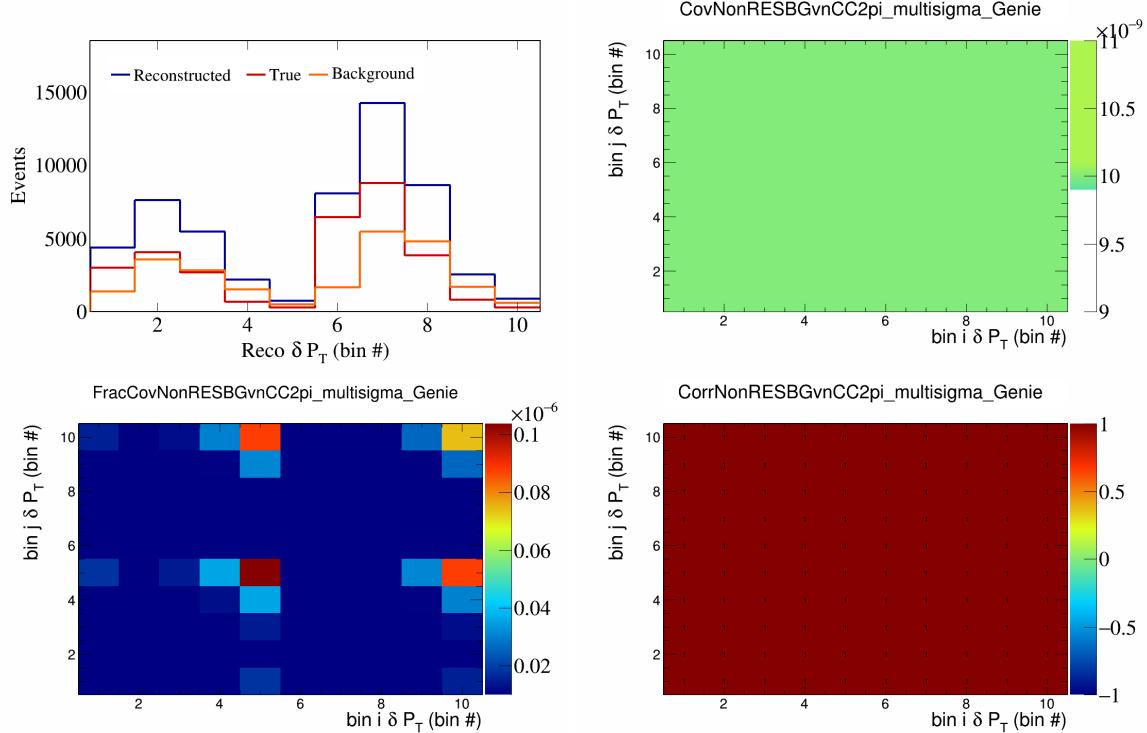


Figure 516: NonRESBGvnCC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

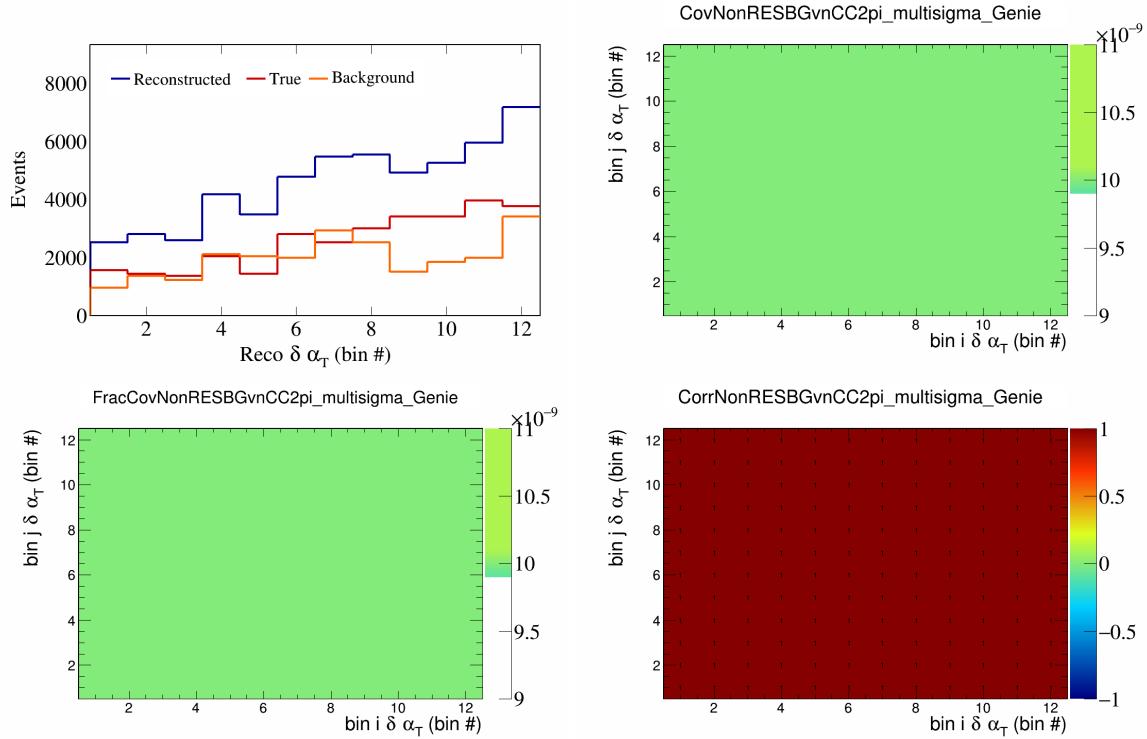


Figure 517: NonRESBGvnCC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

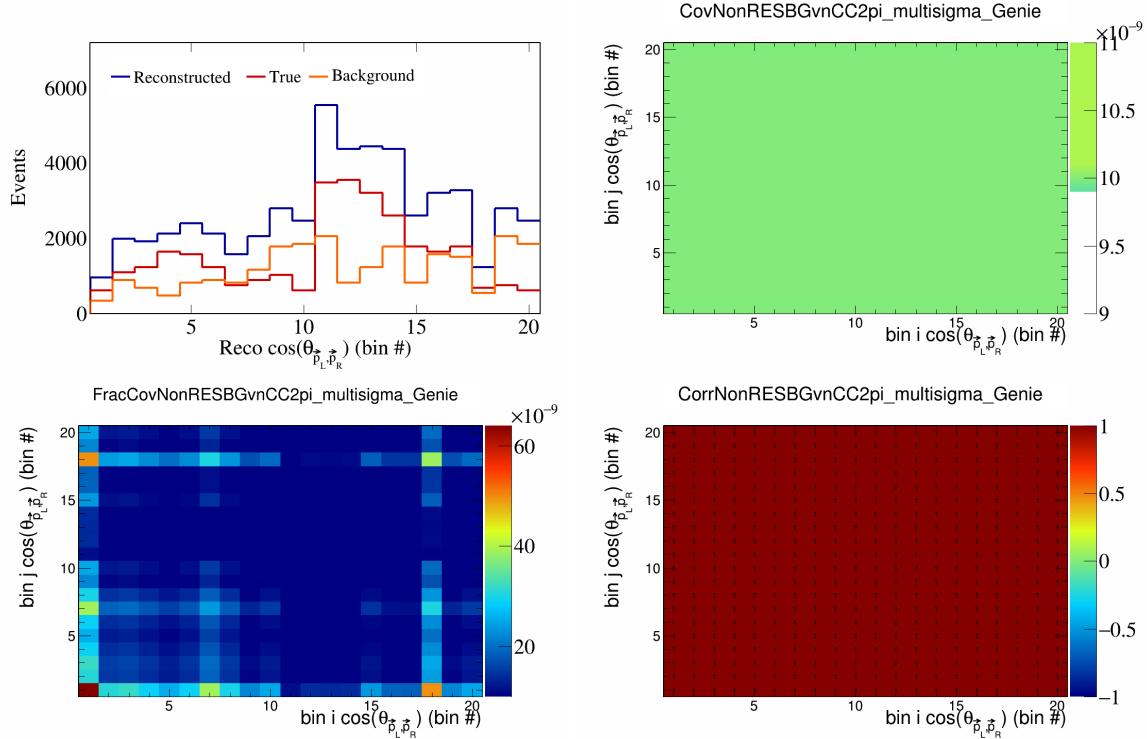


Figure 518: NonRESBGvnCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

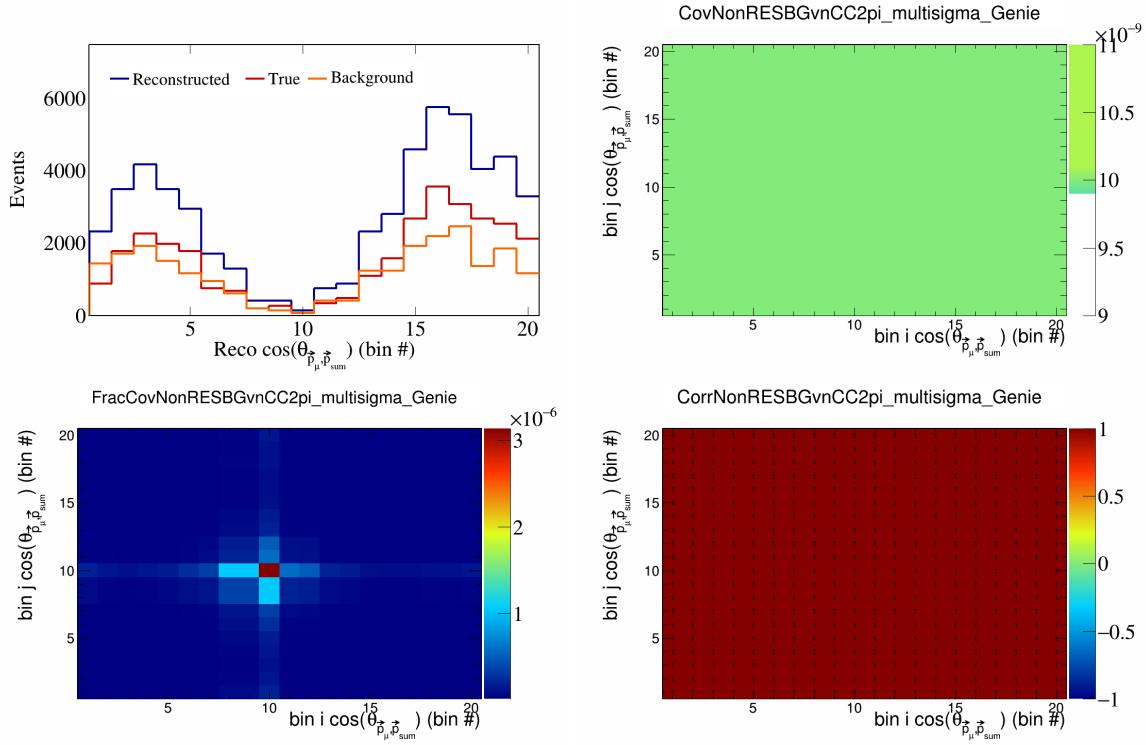


Figure 519: NonRESBGvnCC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

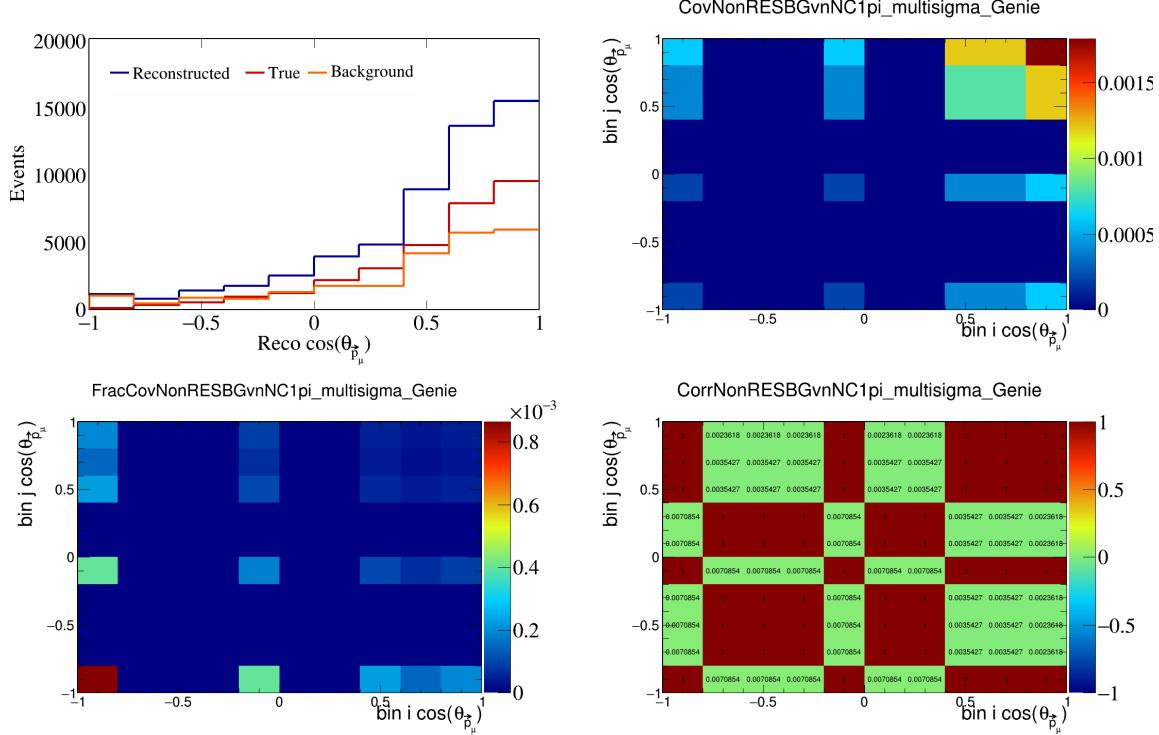


Figure 520: NonRESBGvnNC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

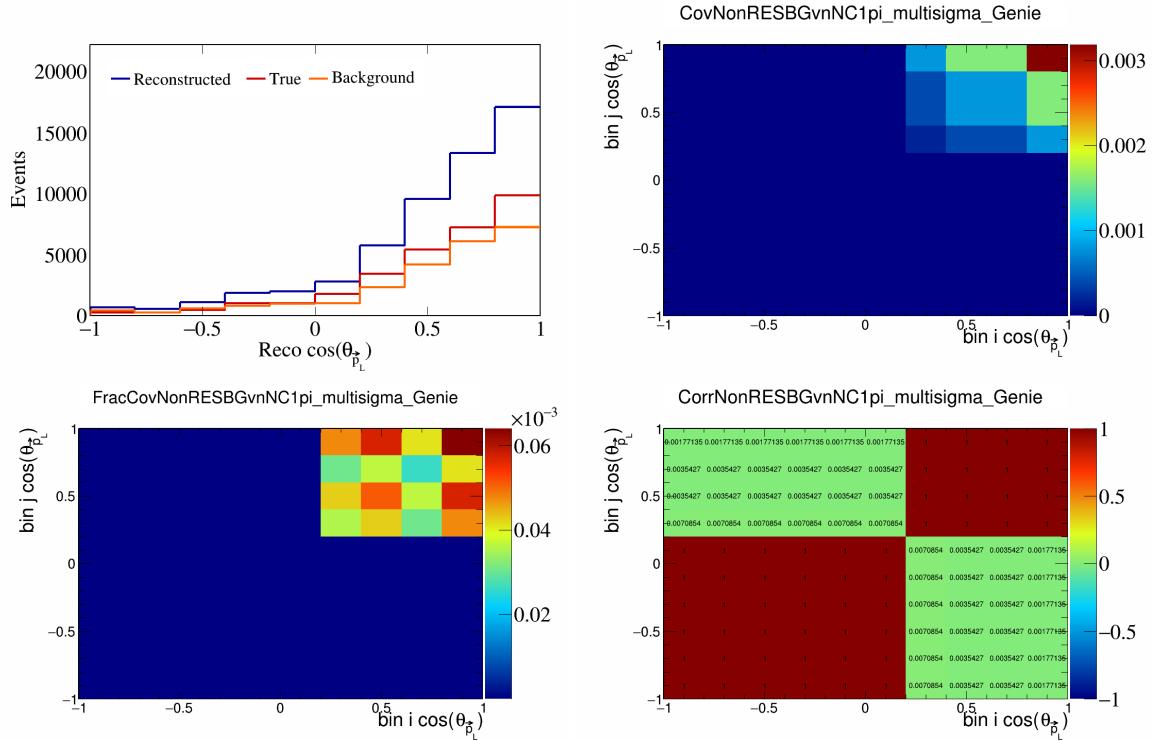


Figure 521: NonRESBGvnNC1pi variations for $\cos(\theta_{\vec{p}_L})$.

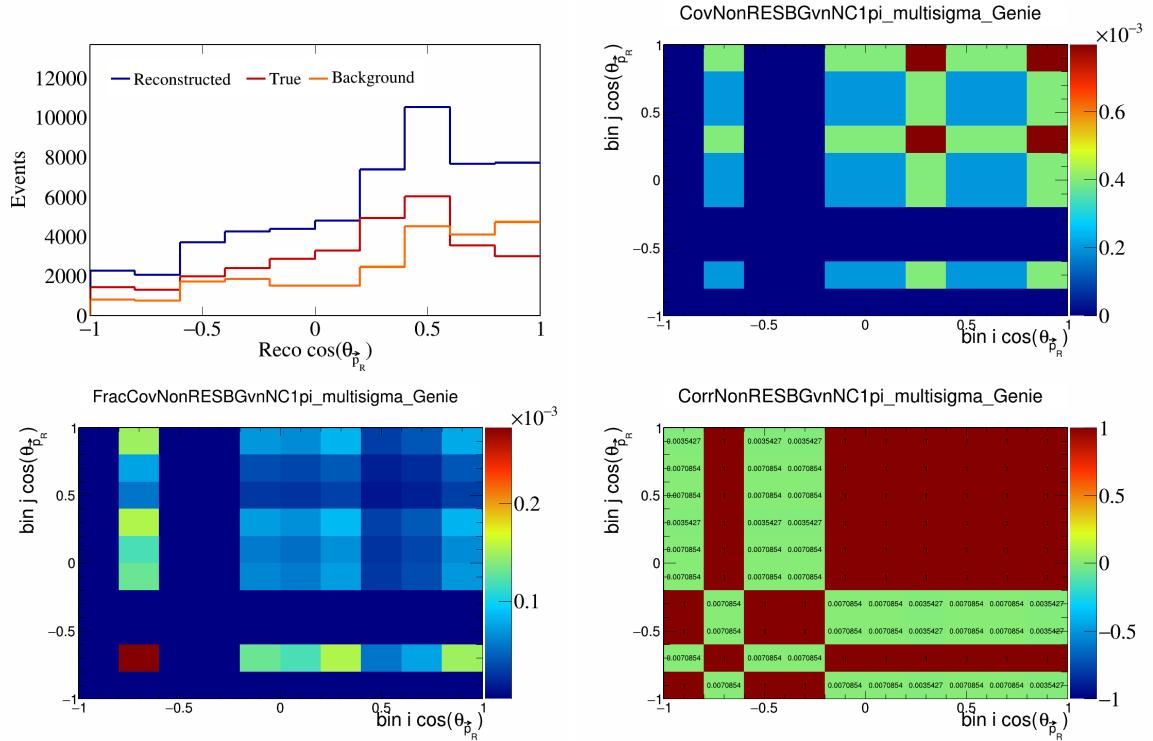


Figure 522: NonRESBGvnNC1pi variations for $\cos(\theta_{\vec{p}_R})$.

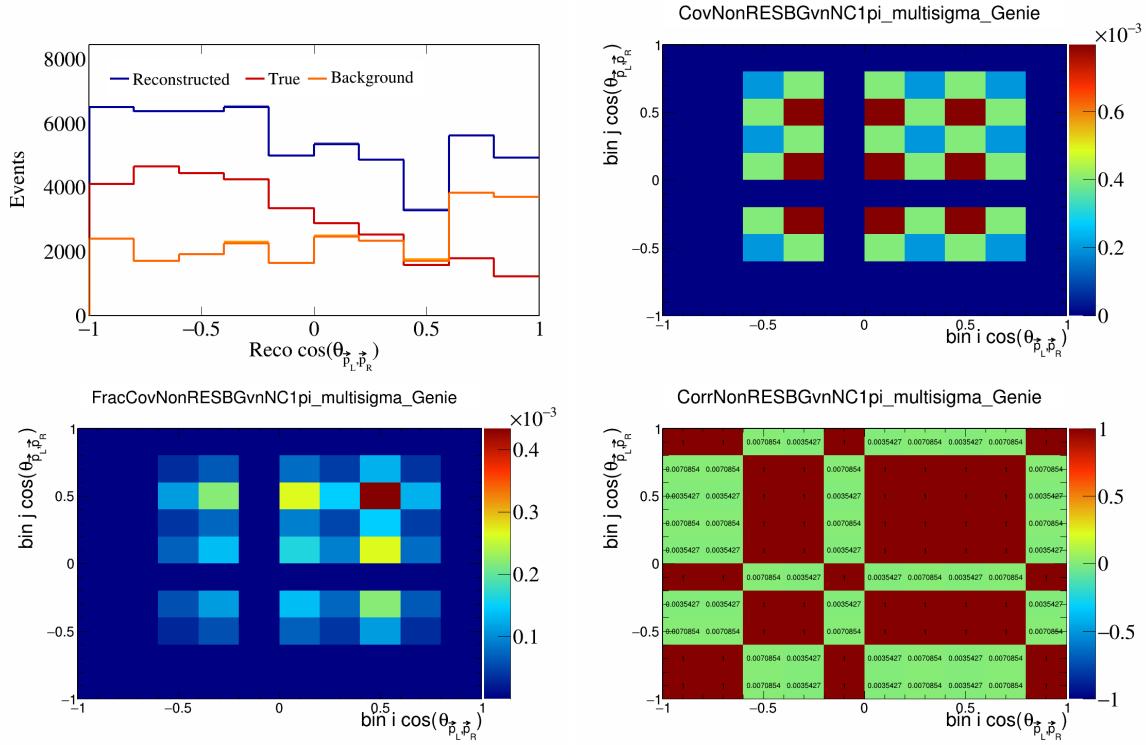


Figure 523: NonRESBGvnNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

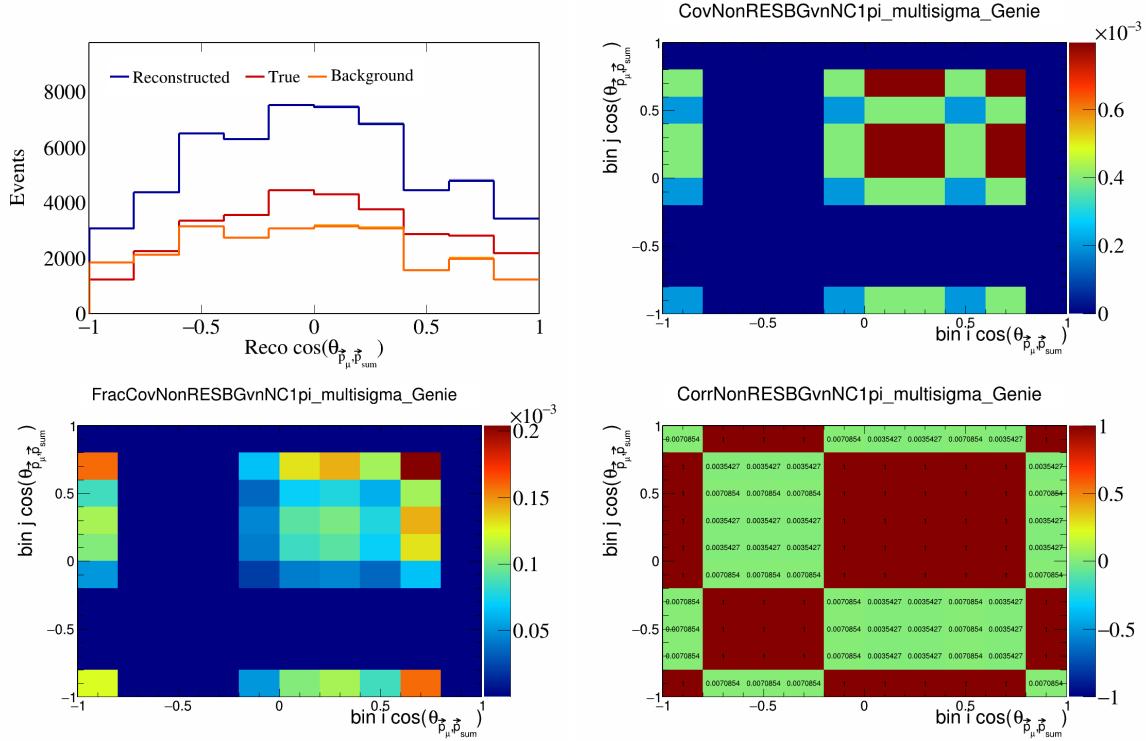


Figure 524: NonRESBGvnNC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

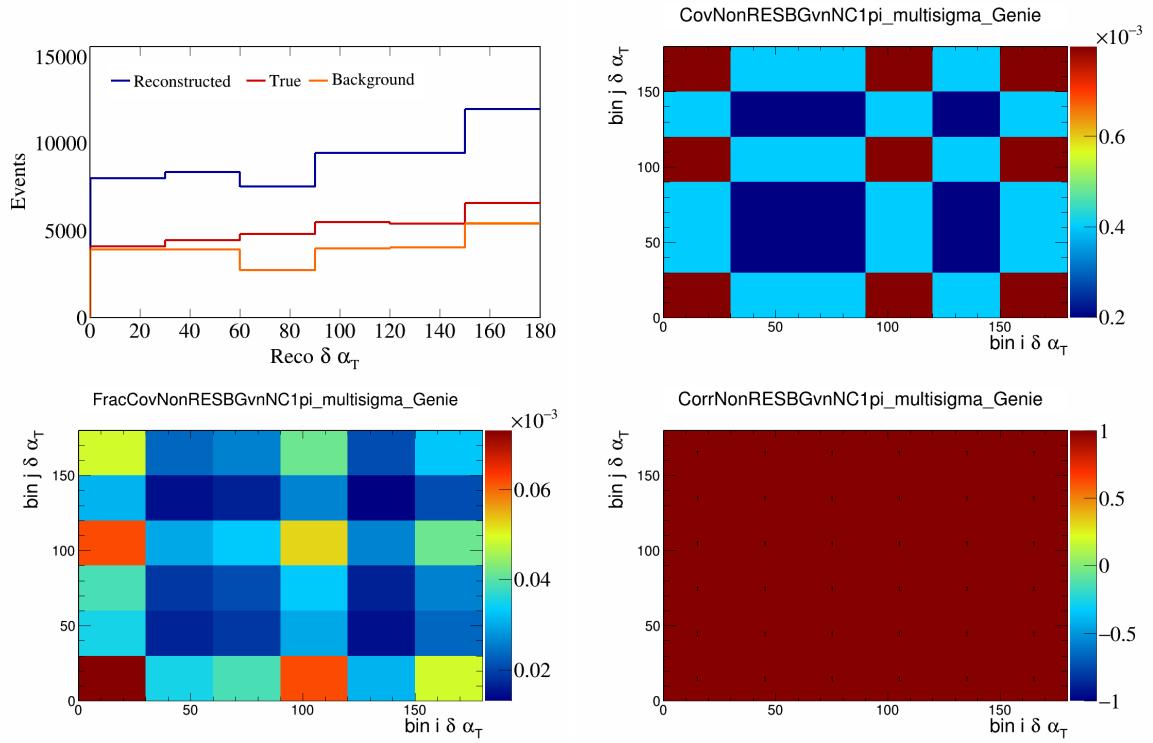


Figure 525: NonRESBGvnNC1pi variations for $\delta\alpha_T$.

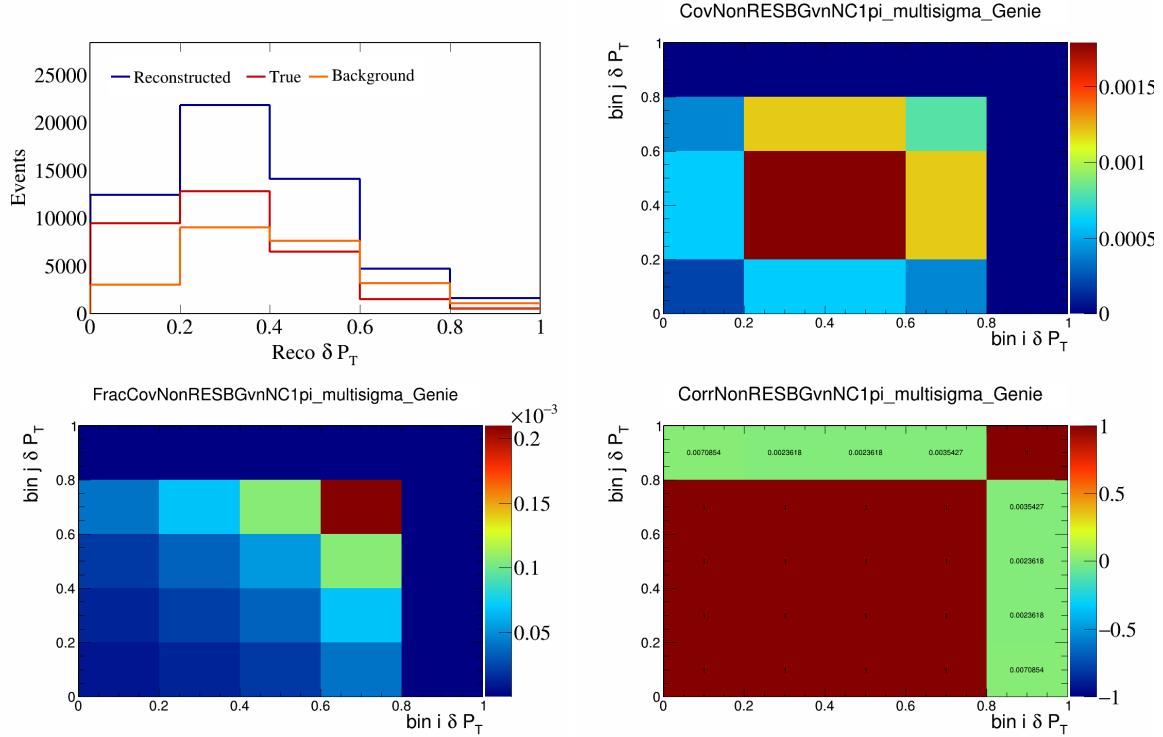


Figure 526: NonRESBGvnNC1pi variations for δP_T .

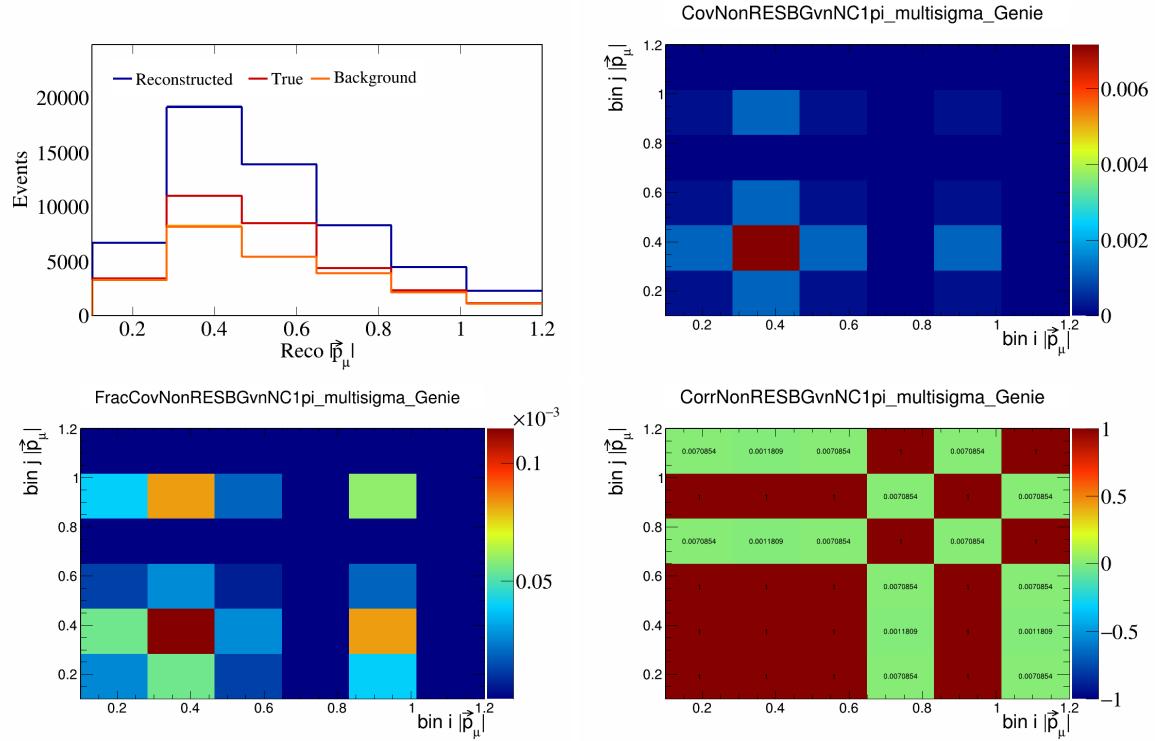


Figure 527: NonRESBGvnNC1pi variations for $|\vec{p}_\mu|$.

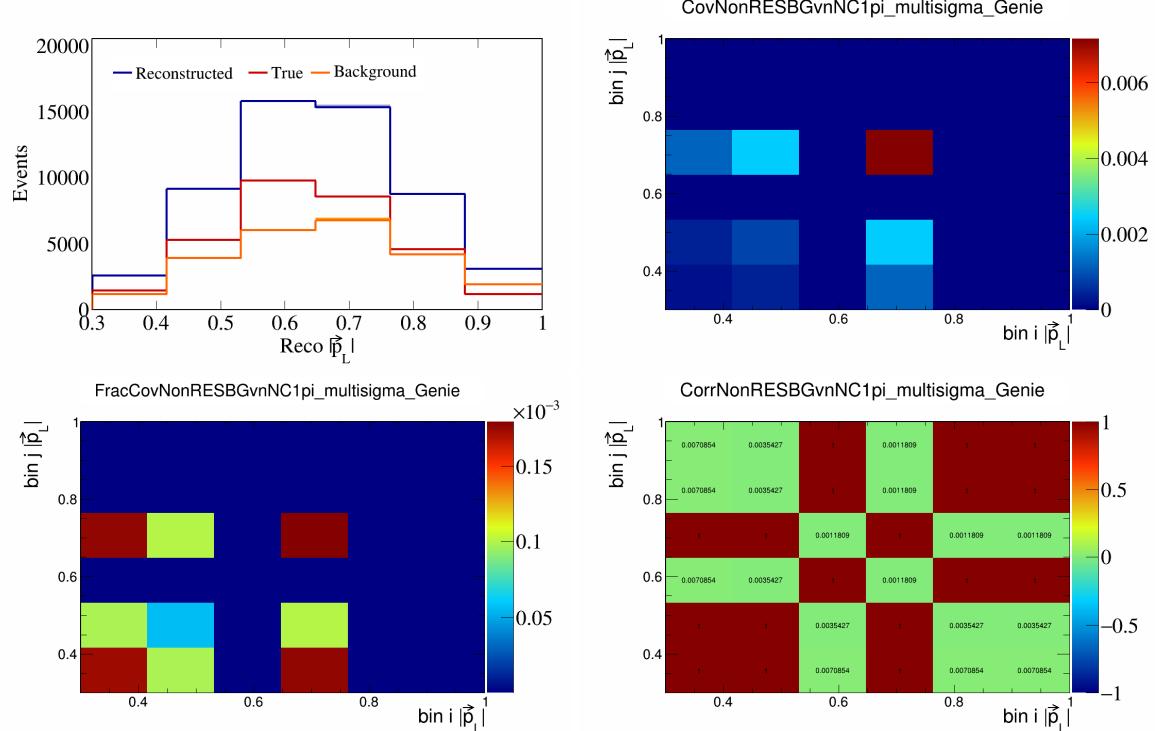


Figure 528: NonRESBGvnNC1pi variations for $|\vec{p}_L|$.

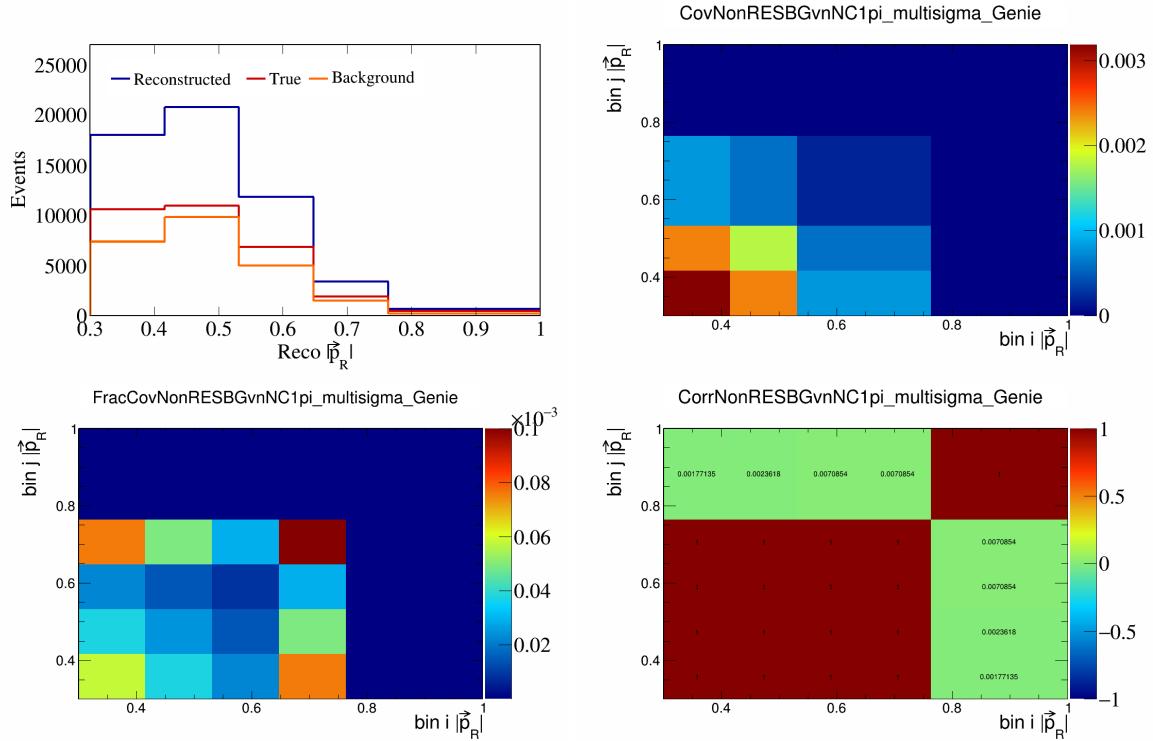


Figure 529: NonRESBGvnNC1pi variations for $|\vec{p}_R|$.

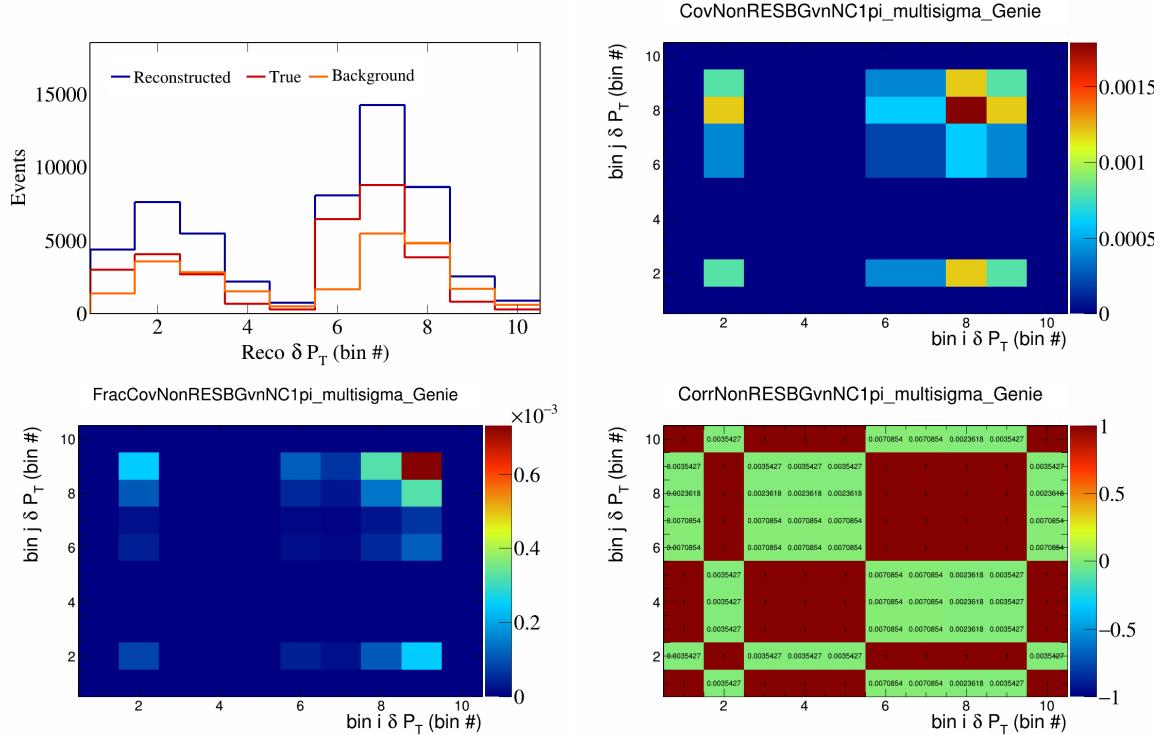


Figure 530: NonRESBGvnNC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

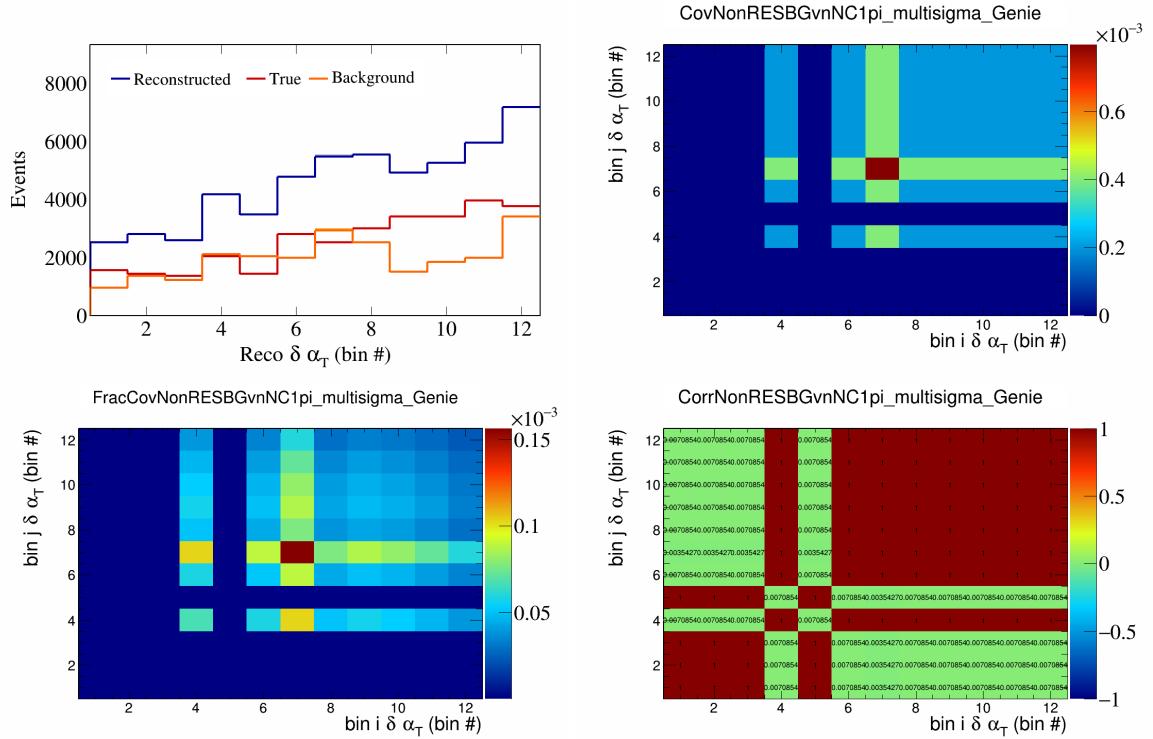


Figure 531: NonRESBGvnNC1pi variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

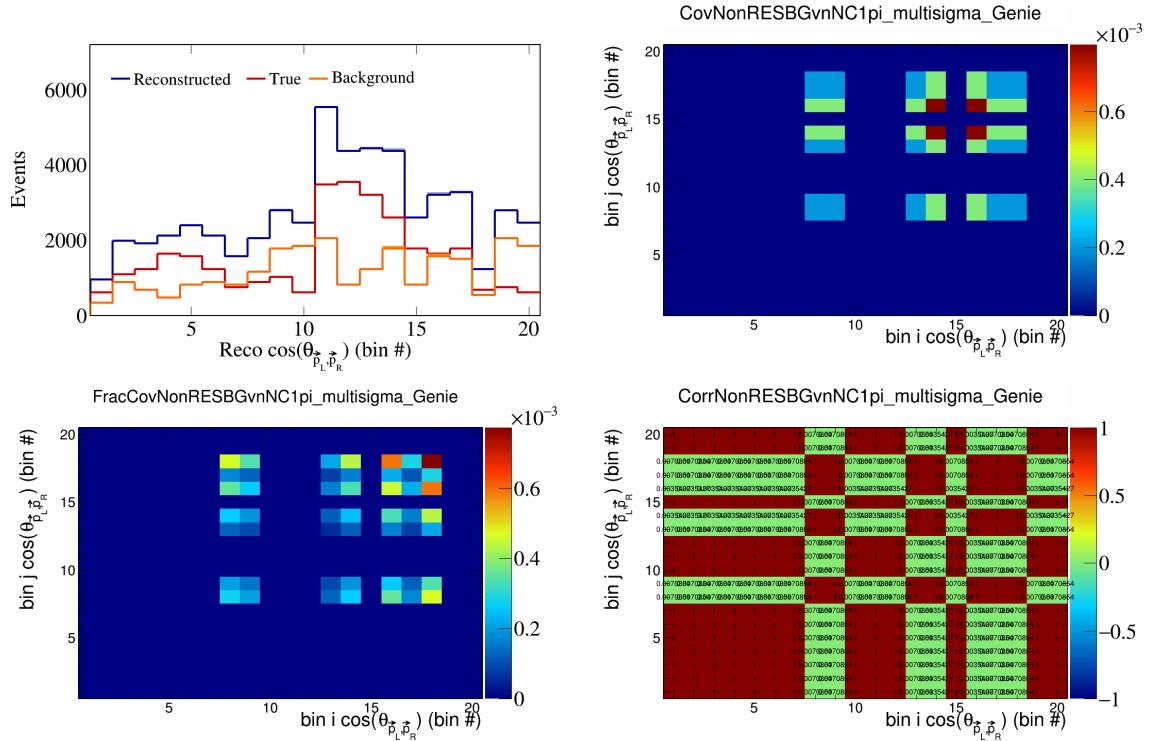


Figure 532: NonRESBGvnNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

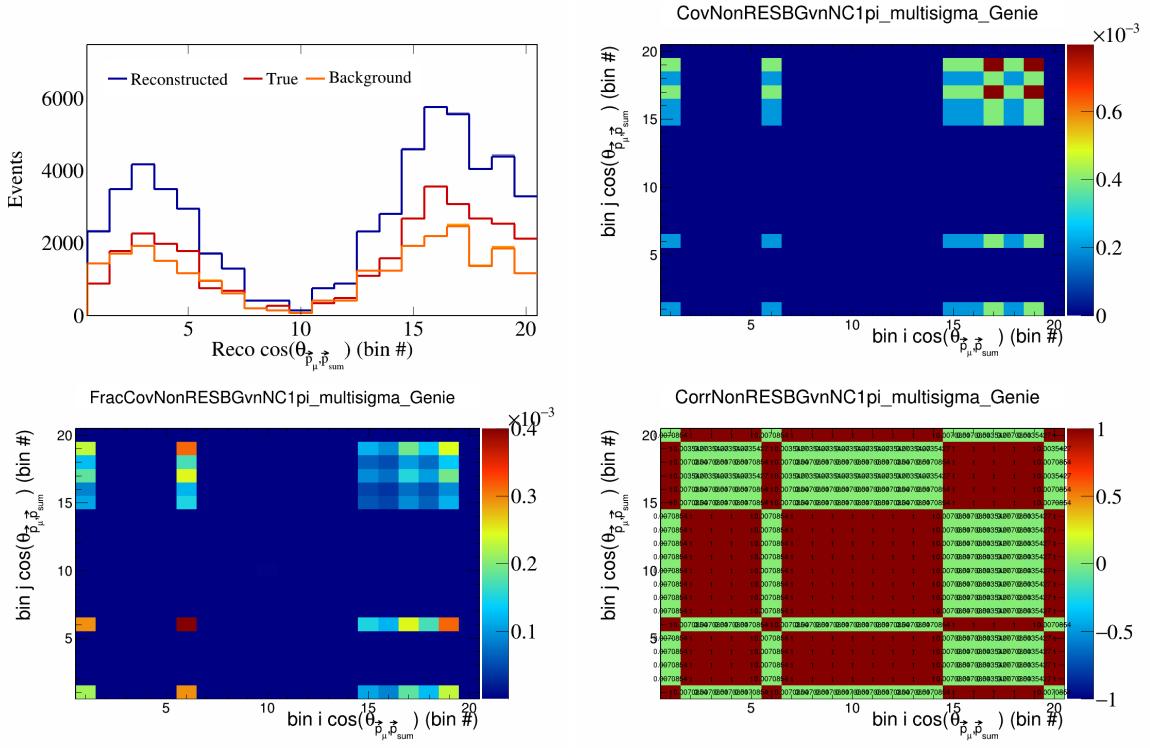


Figure 533: NonRESBGvnNC1pi variations for $\cos(\theta_{\vec{p}_\mu})$ in $\cos(\theta_{\vec{p}_\mu})$.

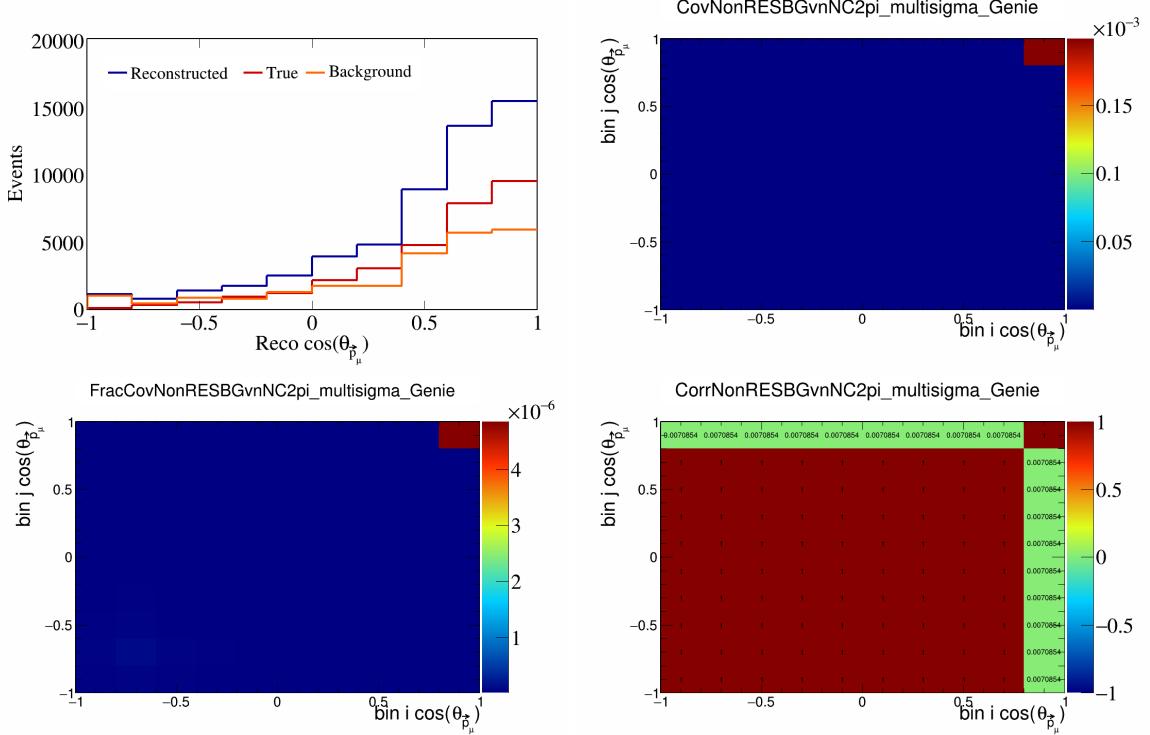


Figure 534: NonRESBGvnNC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

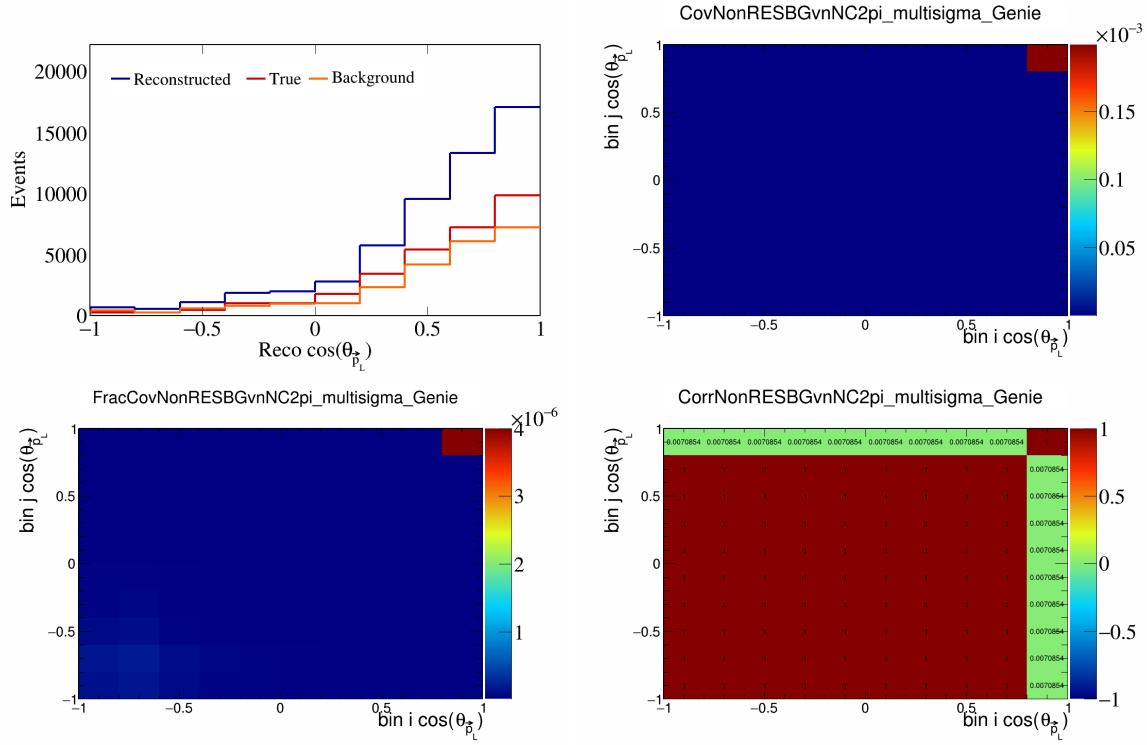


Figure 535: NonRESBGvnNC2pi variations for $\cos(\theta_{\vec{p}_L})$.

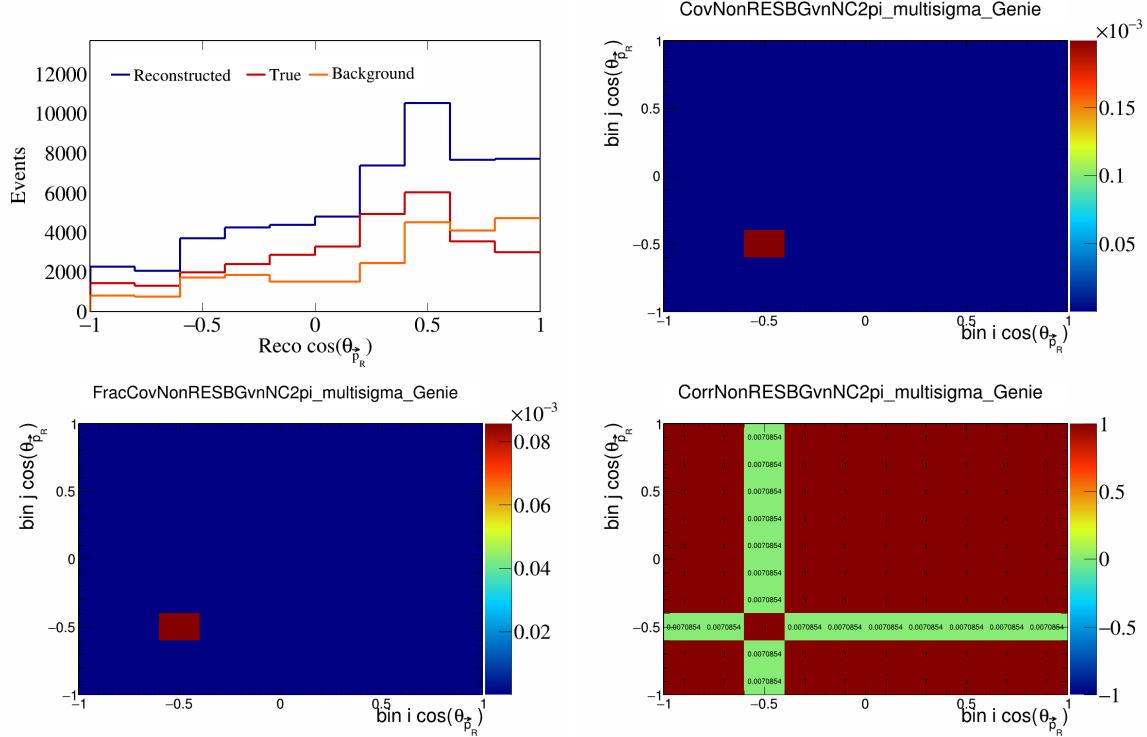


Figure 536: NonRESBGvnNC2pi variations for $\cos(\theta_{\vec{p}_R})$.

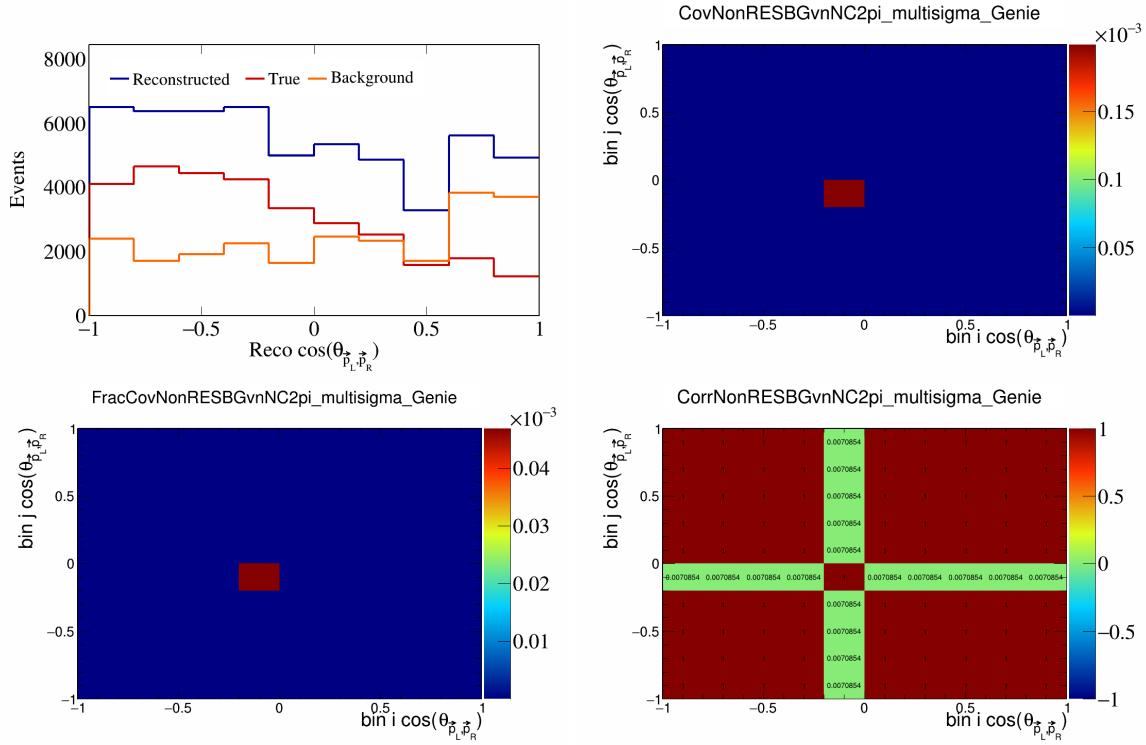


Figure 537: NonRESBGvnNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

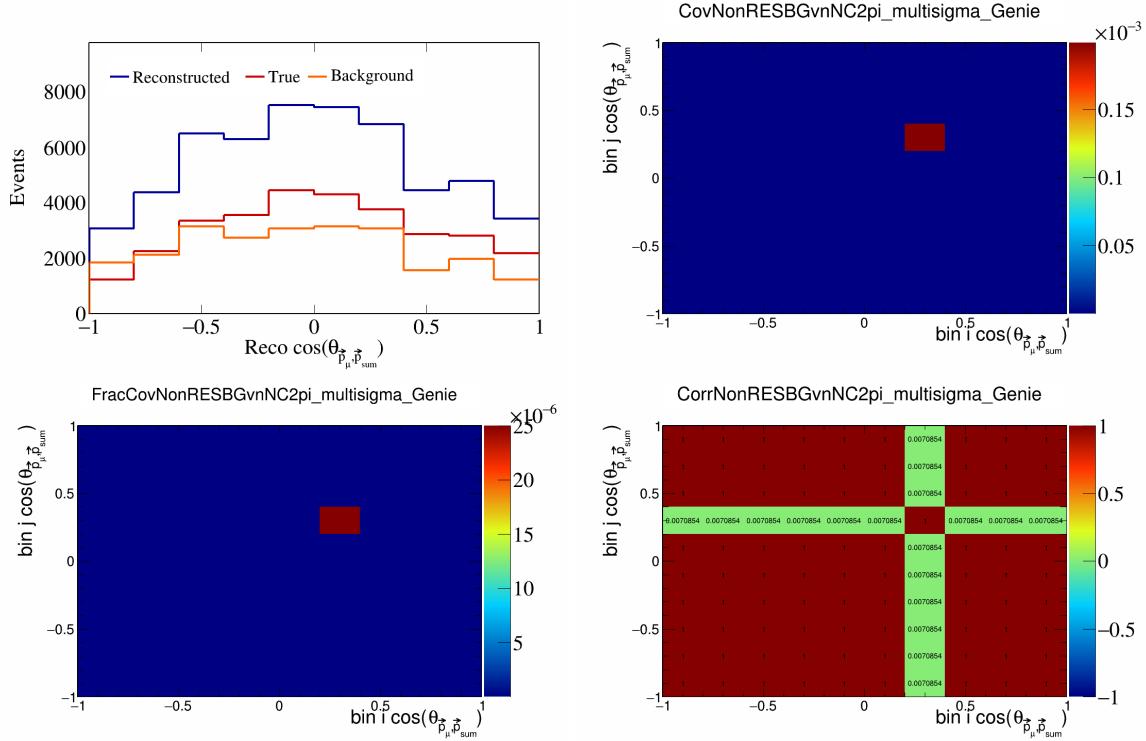


Figure 538: NonRESBGvnNC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

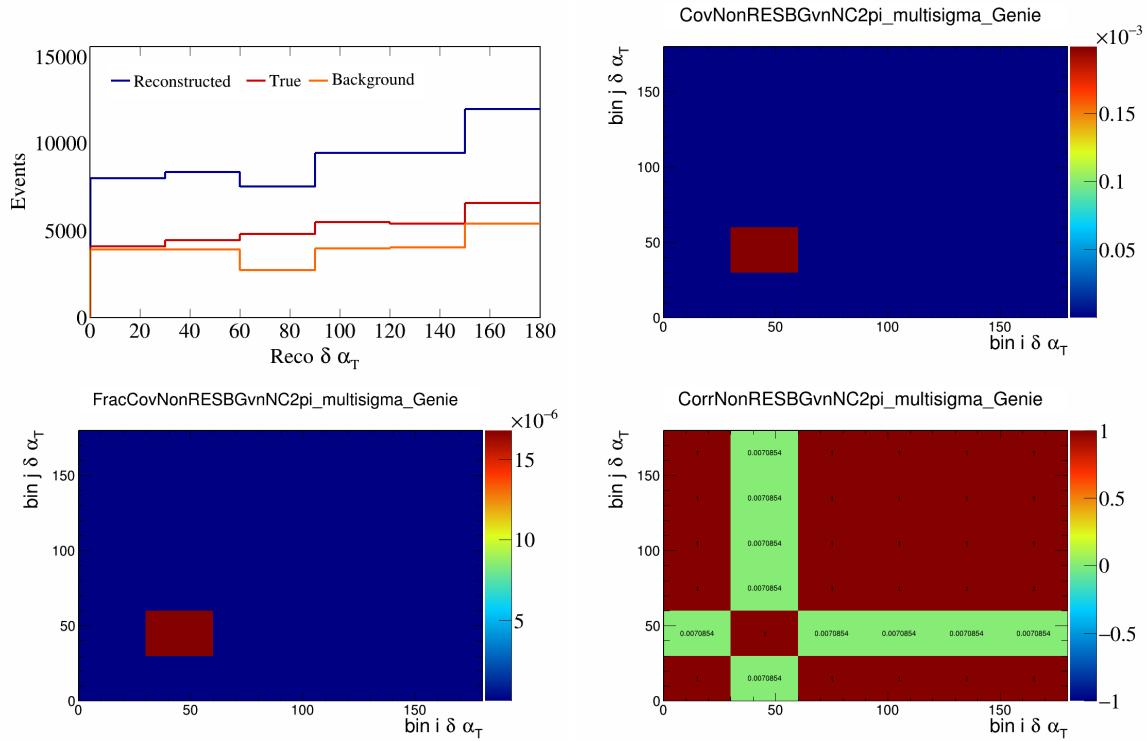


Figure 539: NonRESBGvnNC2pi variations for $\delta\alpha_T$.

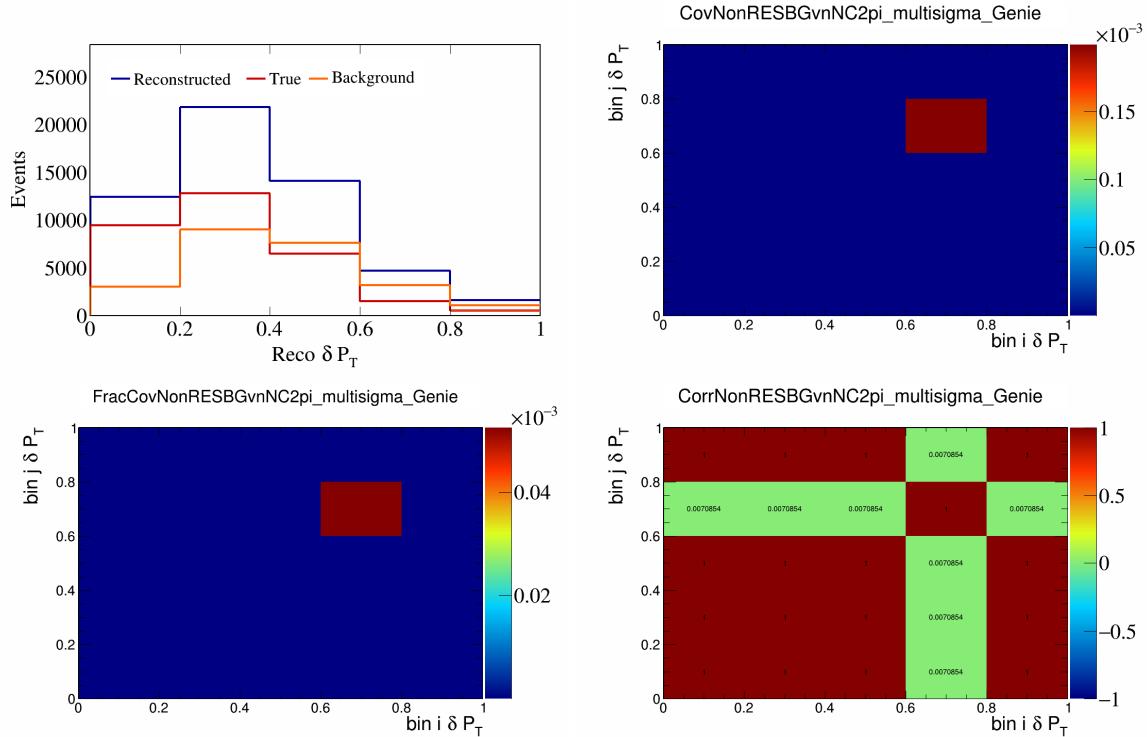


Figure 540: NonRESBGvnNC2pi variations for δP_T .

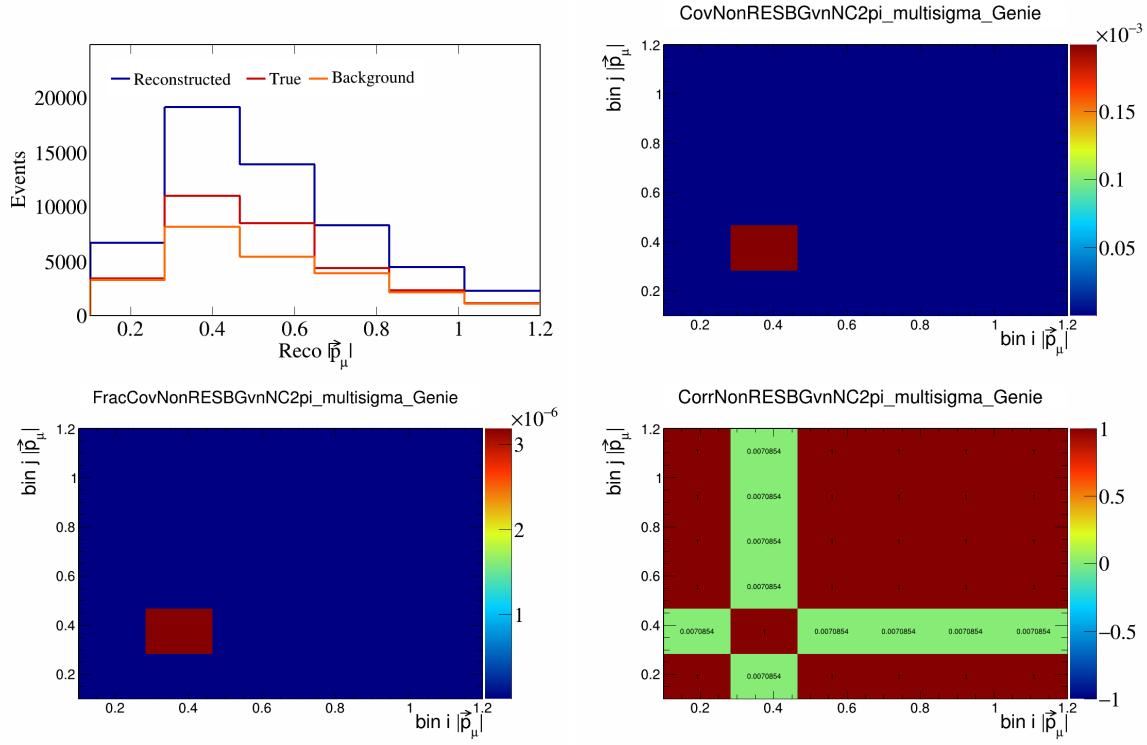


Figure 541: NonRESBGvnNC2pi variations for $|\vec{p}_\mu|$.

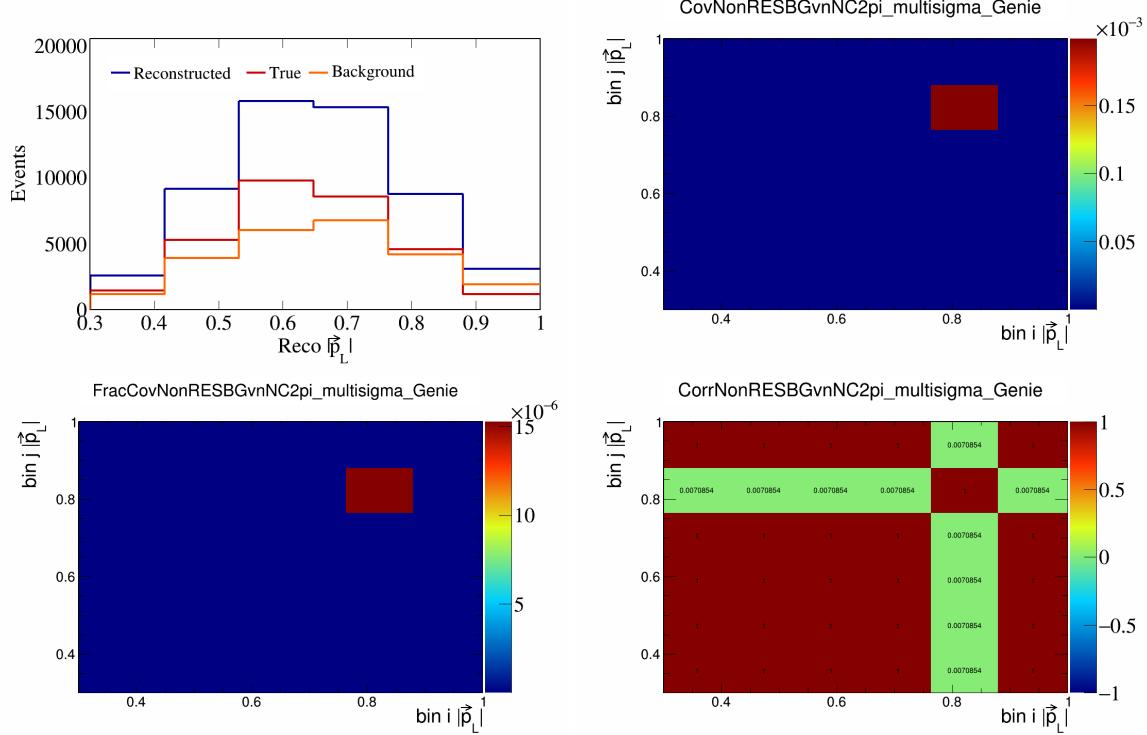


Figure 542: NonRESBGvnNC2pi variations for $|\vec{p}_L|$.

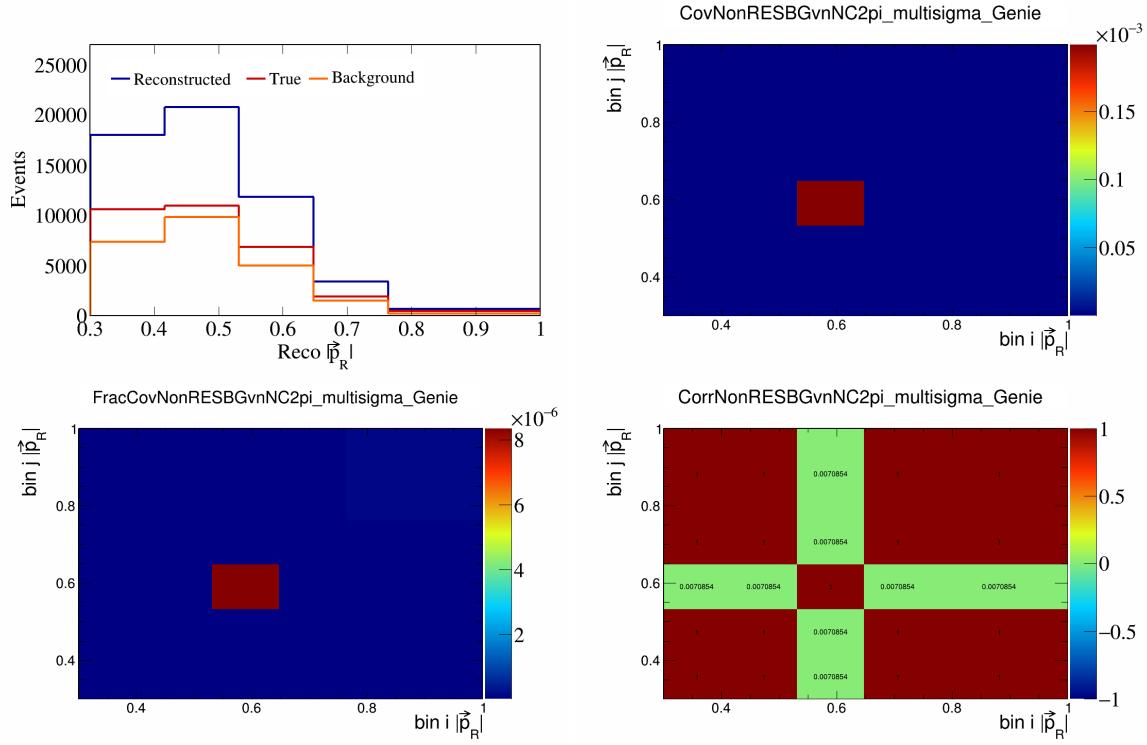


Figure 543: NonRESBGvnNC2pi variations for $|\vec{p}_R|$.

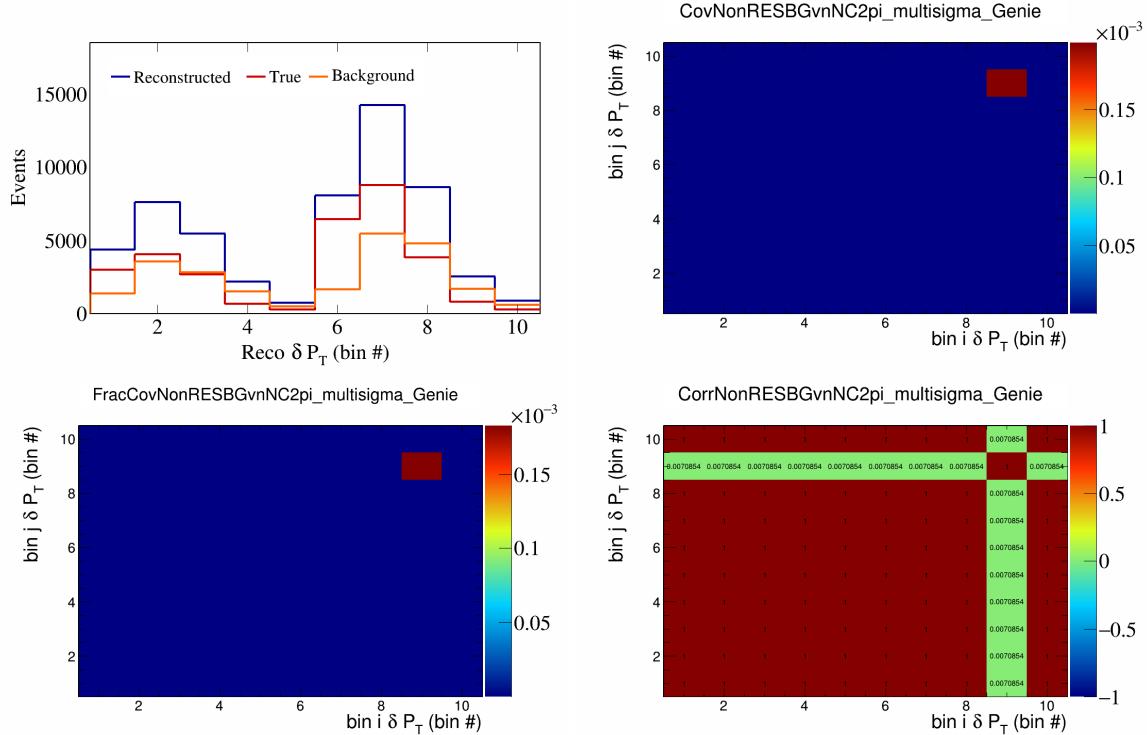


Figure 544: NonRESBGvnNC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

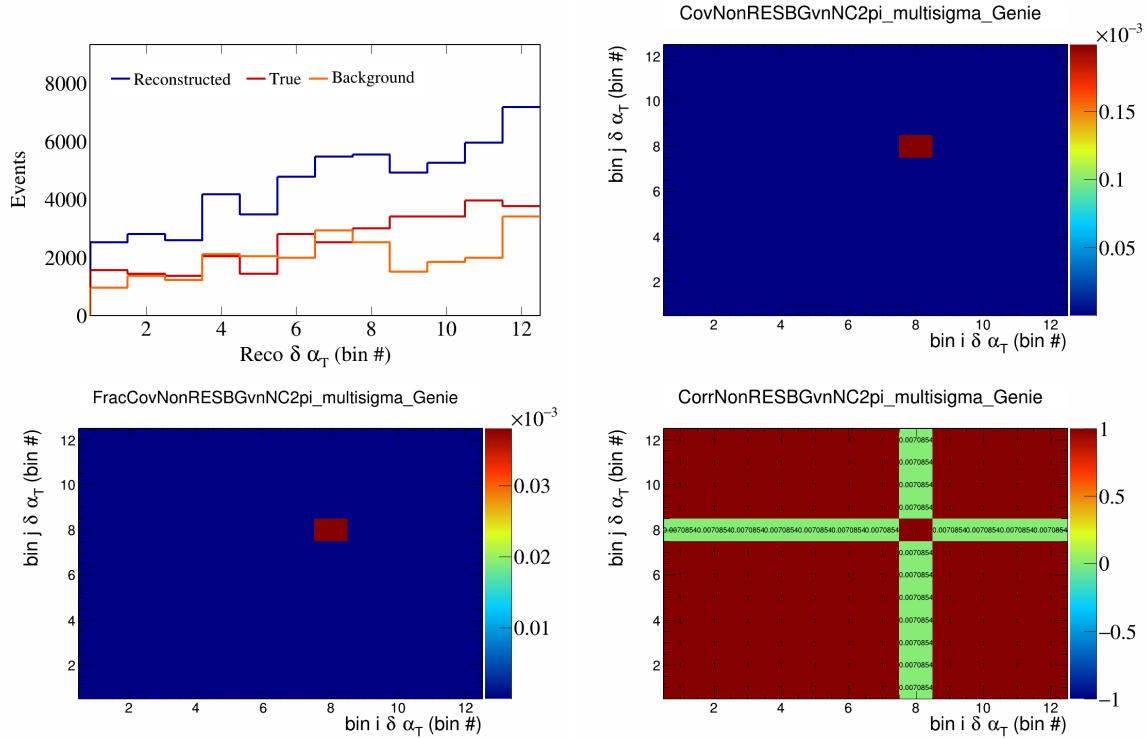


Figure 545: NonRESBGvnNC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

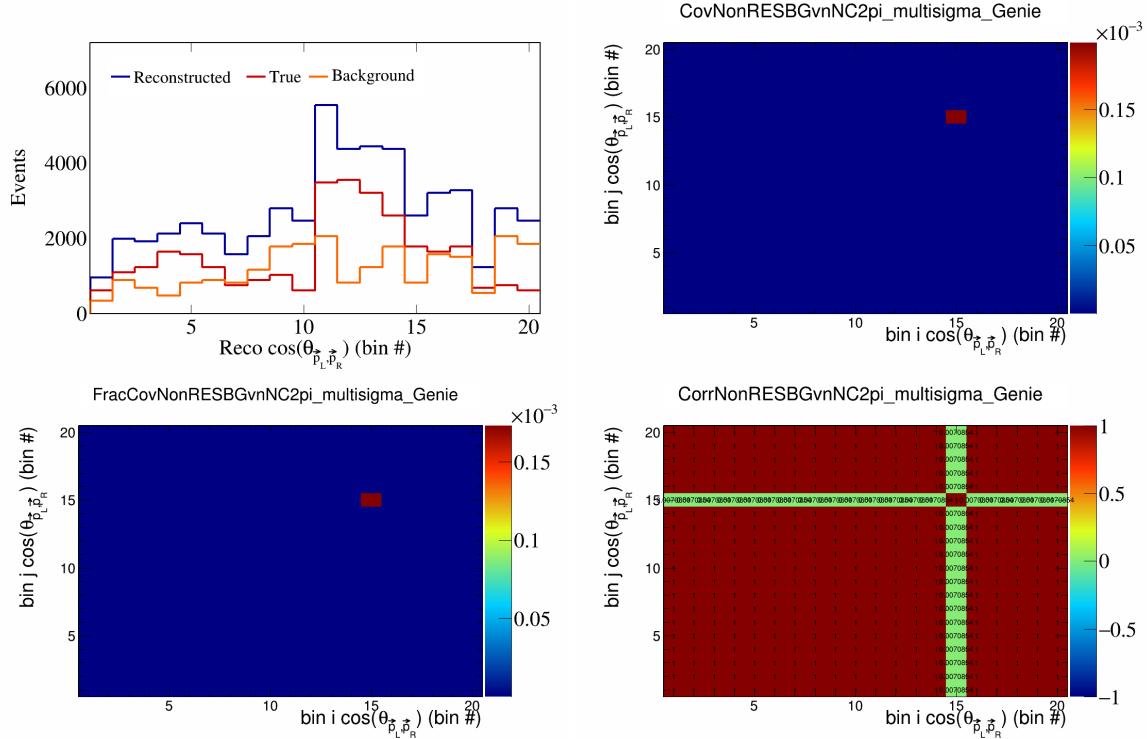


Figure 546: NonRESBGvnNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

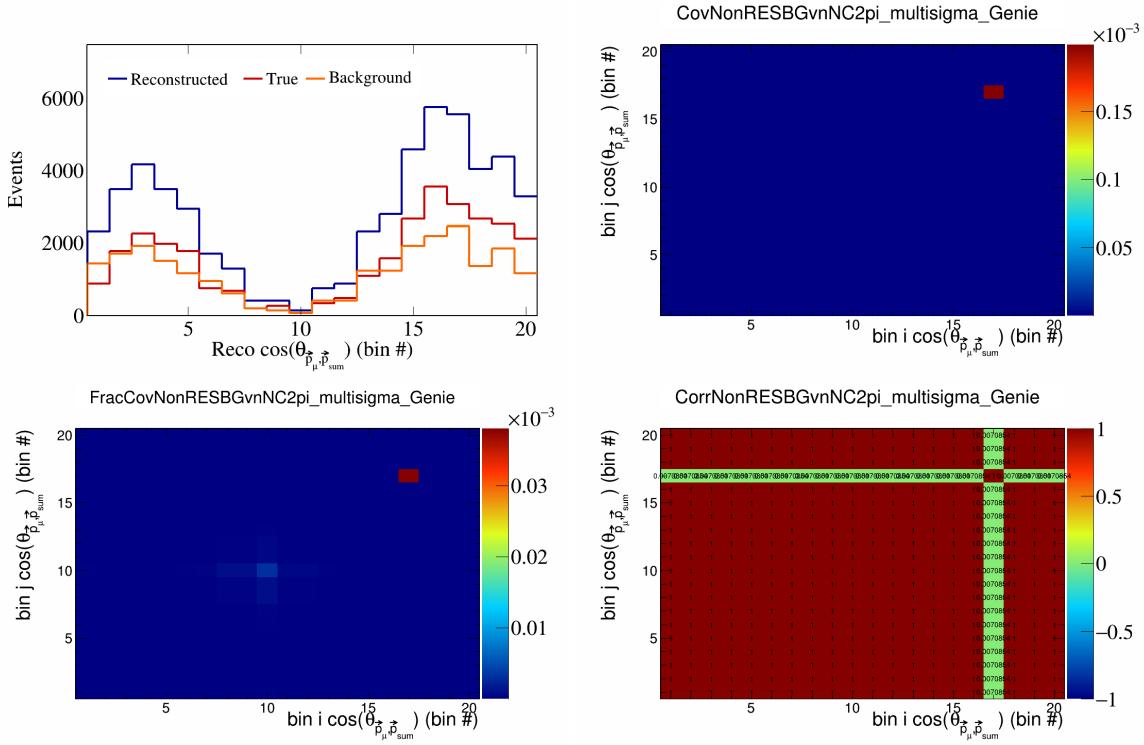


Figure 547: NonRESBGvnNC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

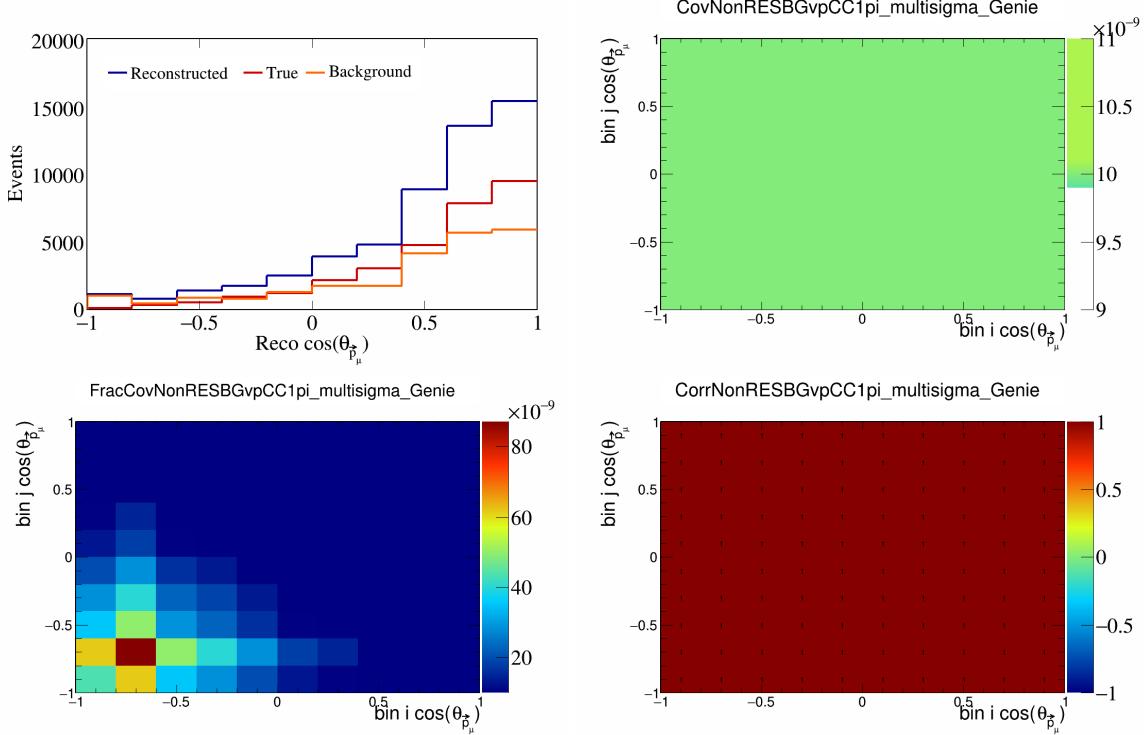


Figure 548: NonRESBGvpCC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

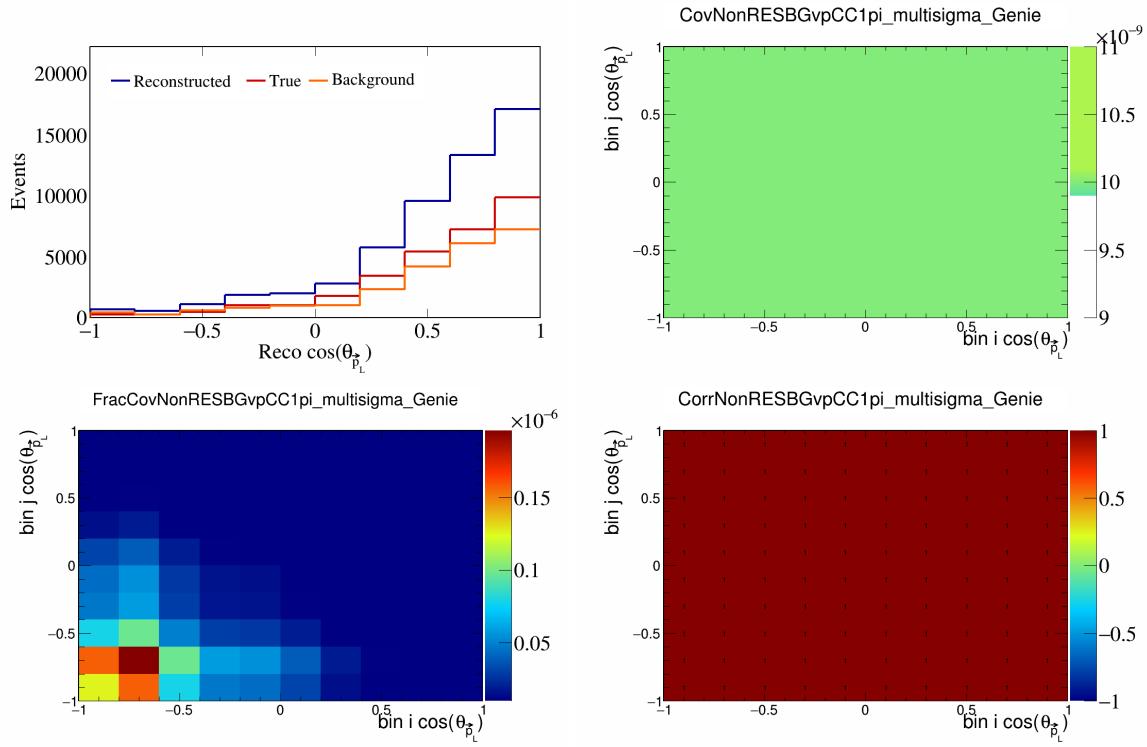


Figure 549: NonRESBGvpCC1pi variations for $\cos(\theta_{\vec{p}_L})$.

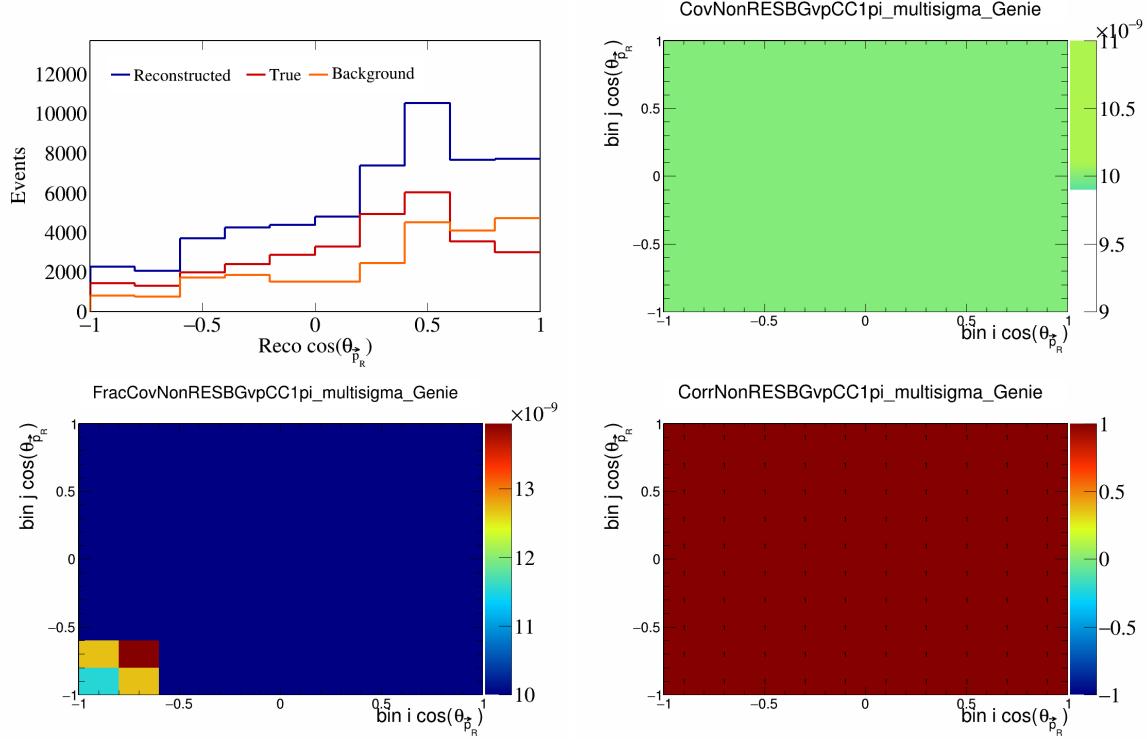


Figure 550: NonRESBGvpCC1pi variations for $\cos(\theta_{\vec{p}_R})$.

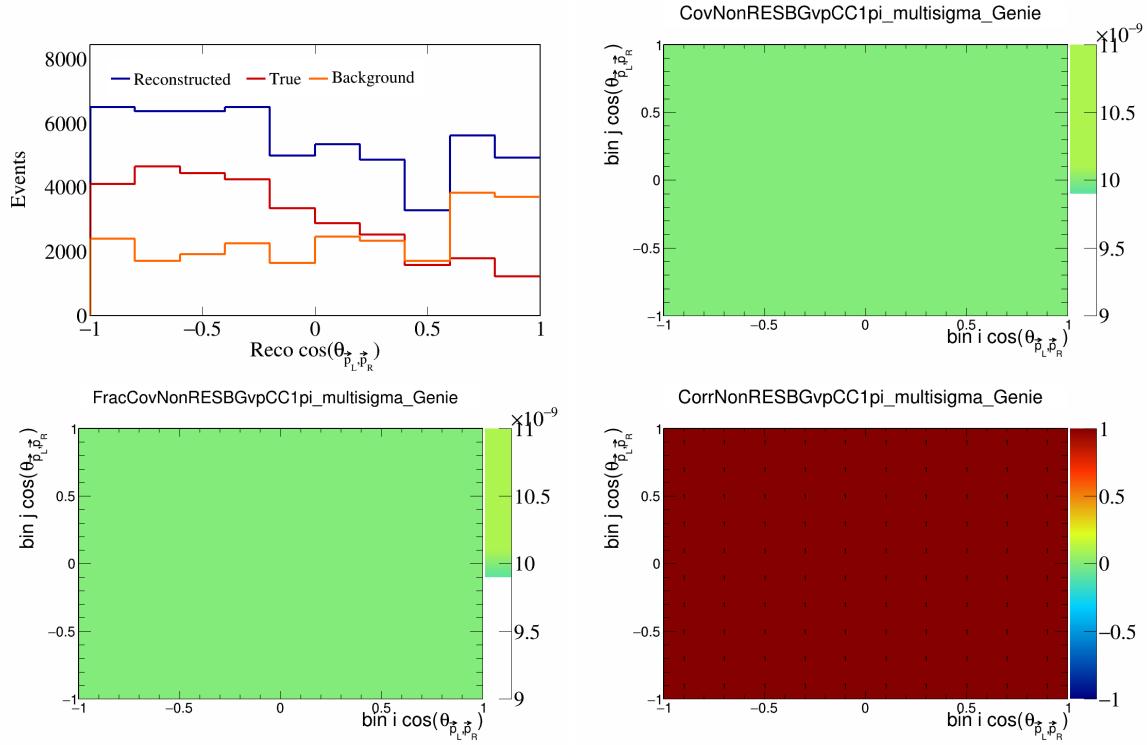


Figure 551: NonRESBGvpCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

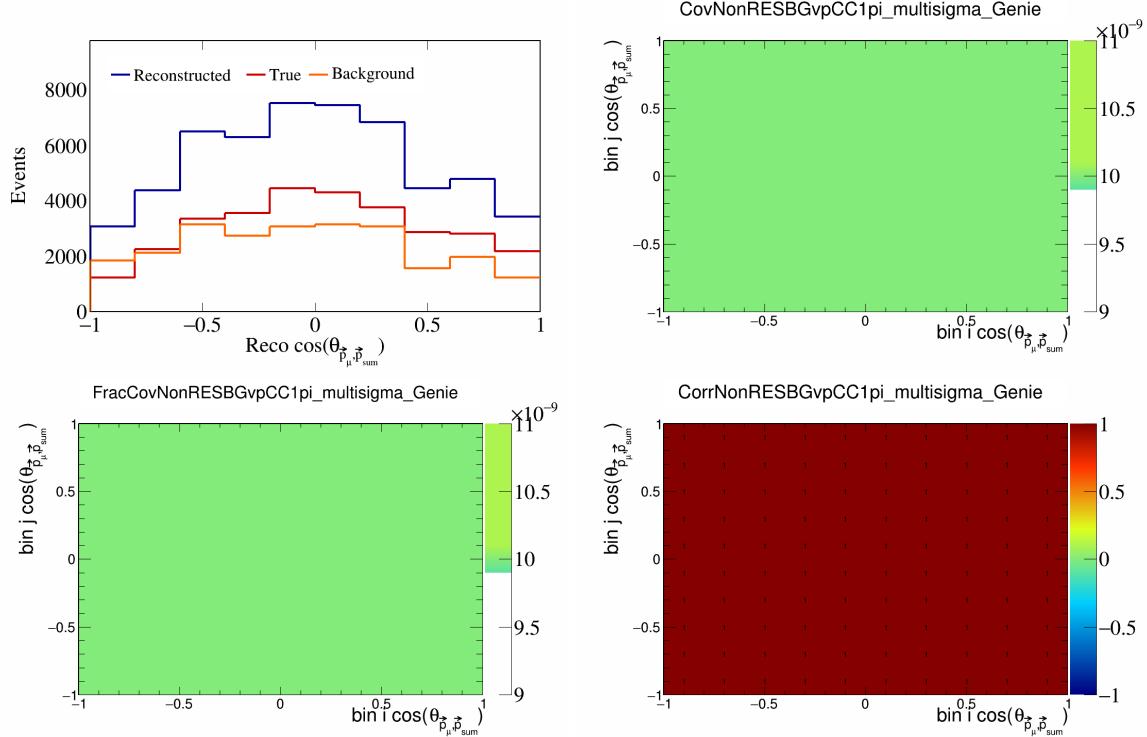


Figure 552: NonRESBGvpCC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

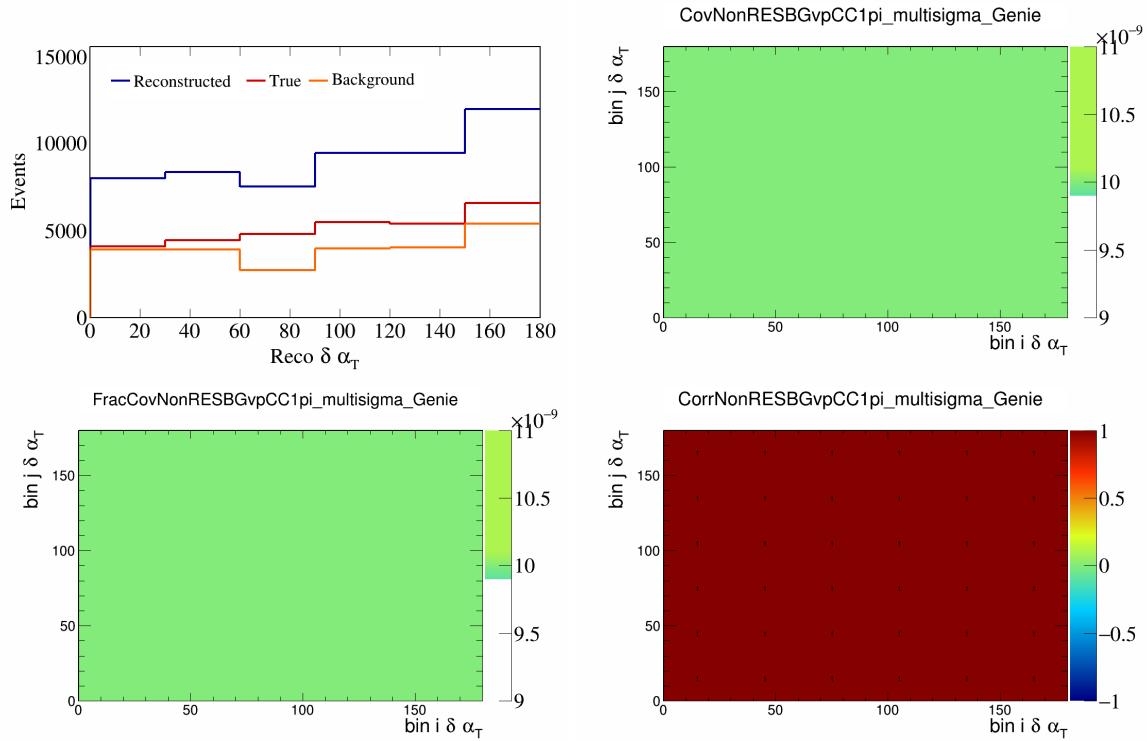


Figure 553: NonRESBGvpCC1pi variations for $\delta\alpha_T$.

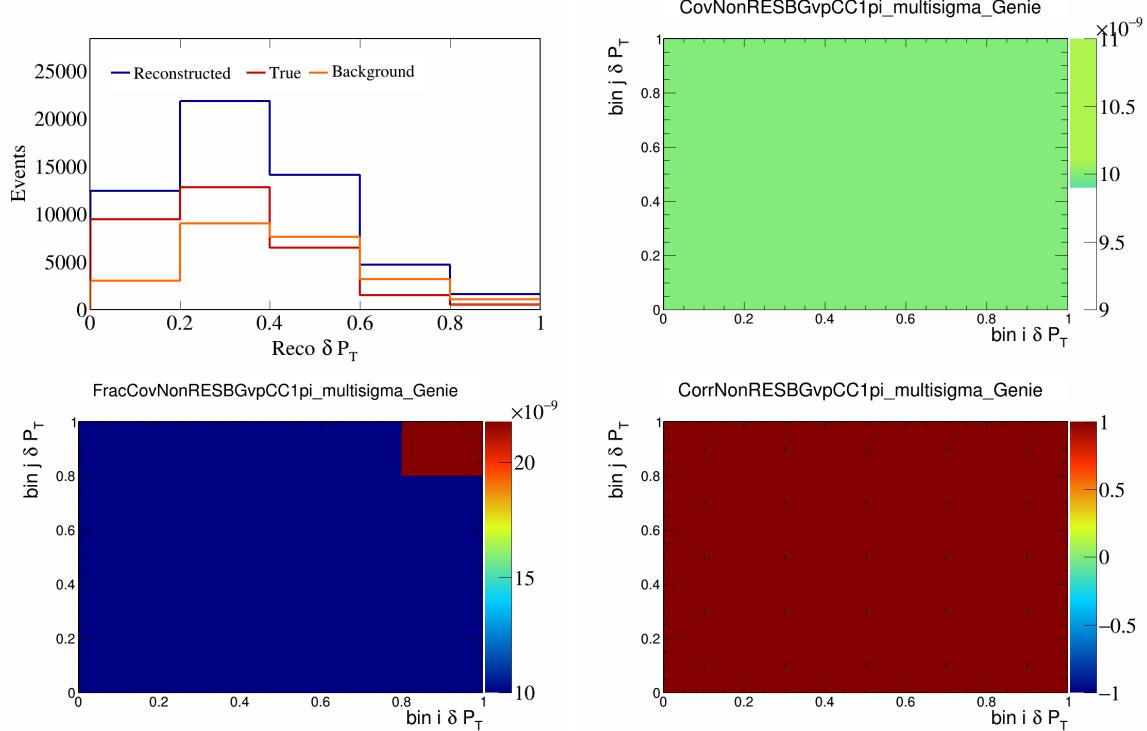


Figure 554: NonRESBGvpCC1pi variations for δP_T .

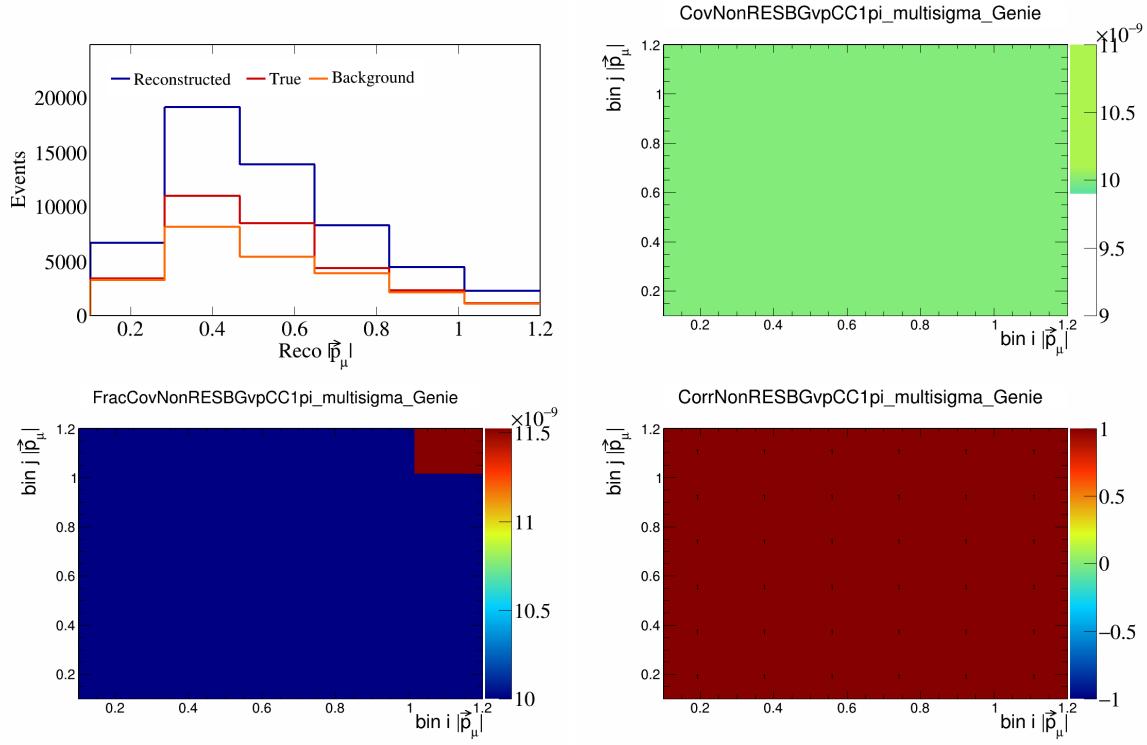


Figure 555: NonRESBGvpCC1pi variations for $|\vec{p}_\mu|$.

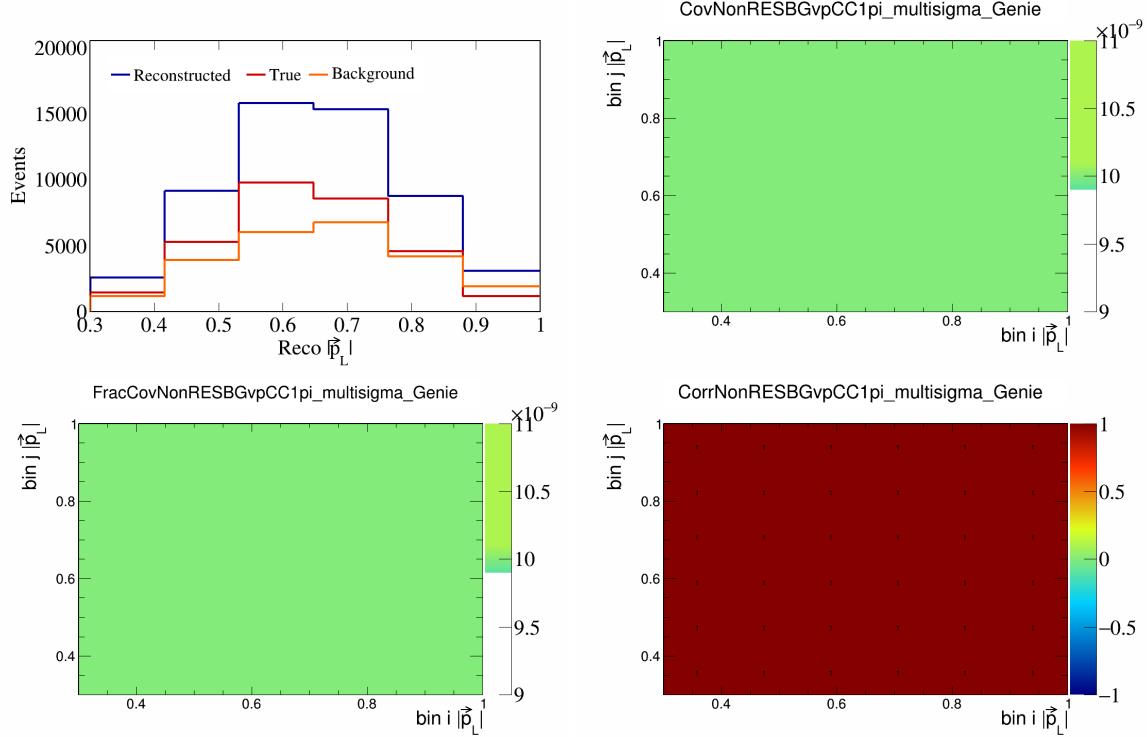


Figure 556: NonRESBGvpCC1pi variations for $|\vec{p}_L|$.

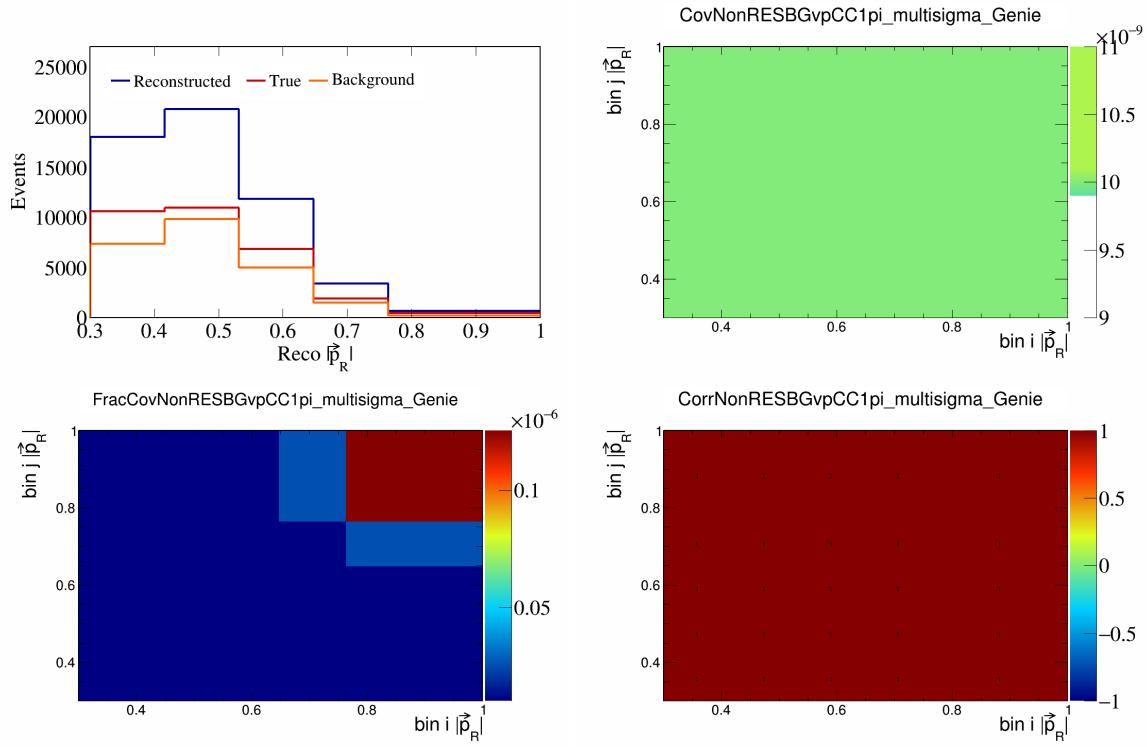


Figure 557: NonRESBGvpCC1pi variations for $|\vec{p}_R|$.

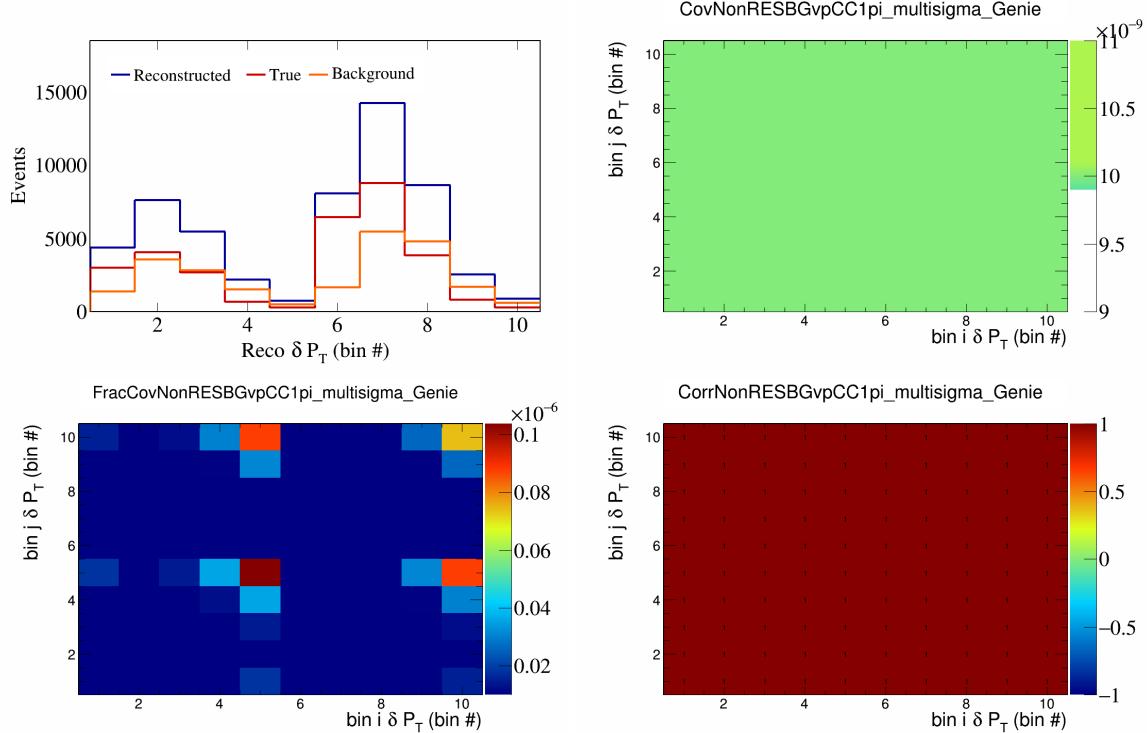


Figure 558: NonRESBGvpCC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

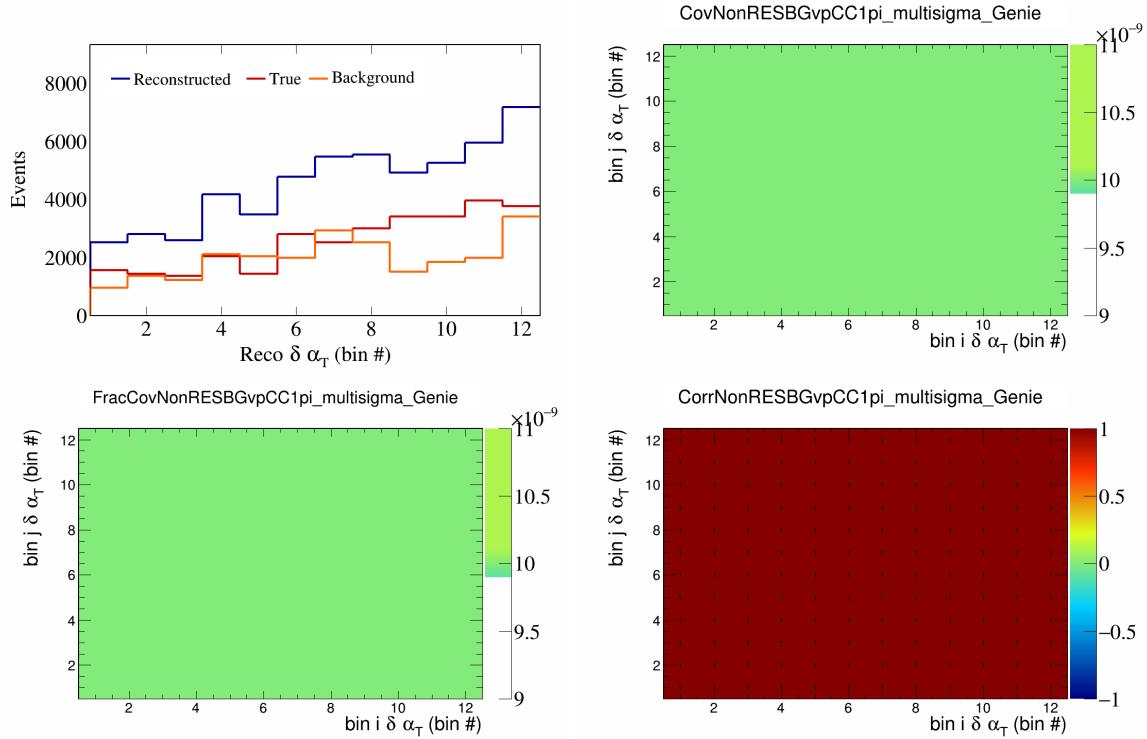


Figure 559: NonRESBGvpCC1pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

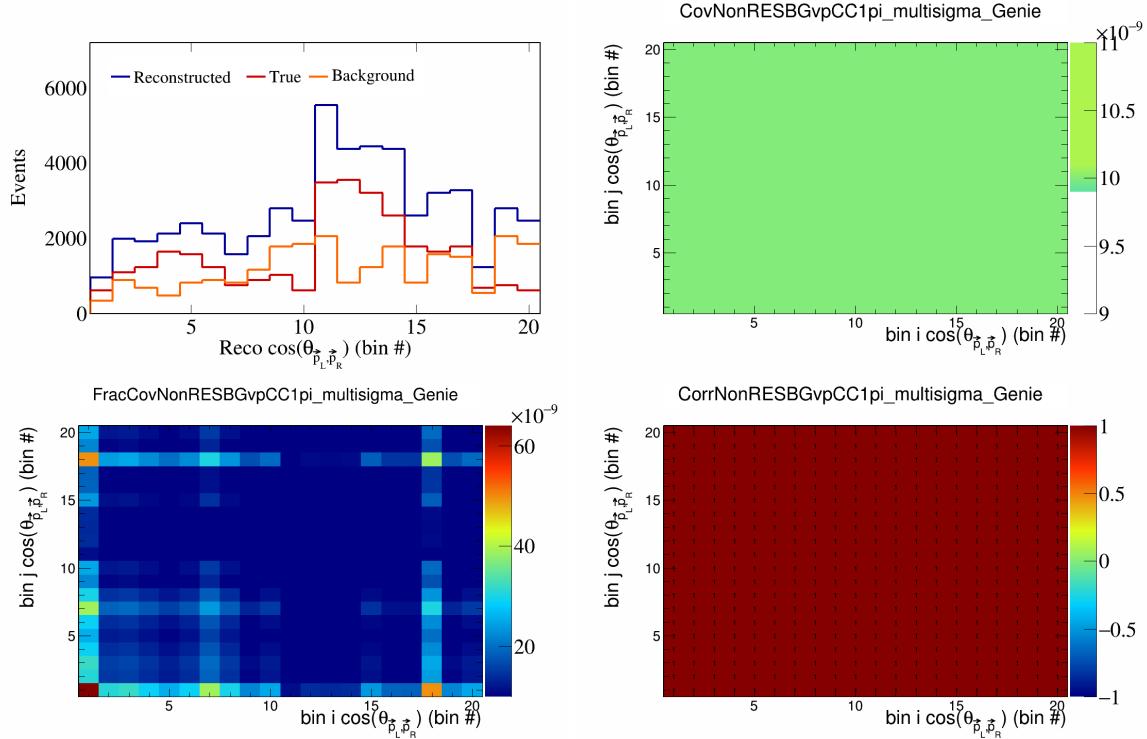


Figure 560: NonRESBGvpCC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

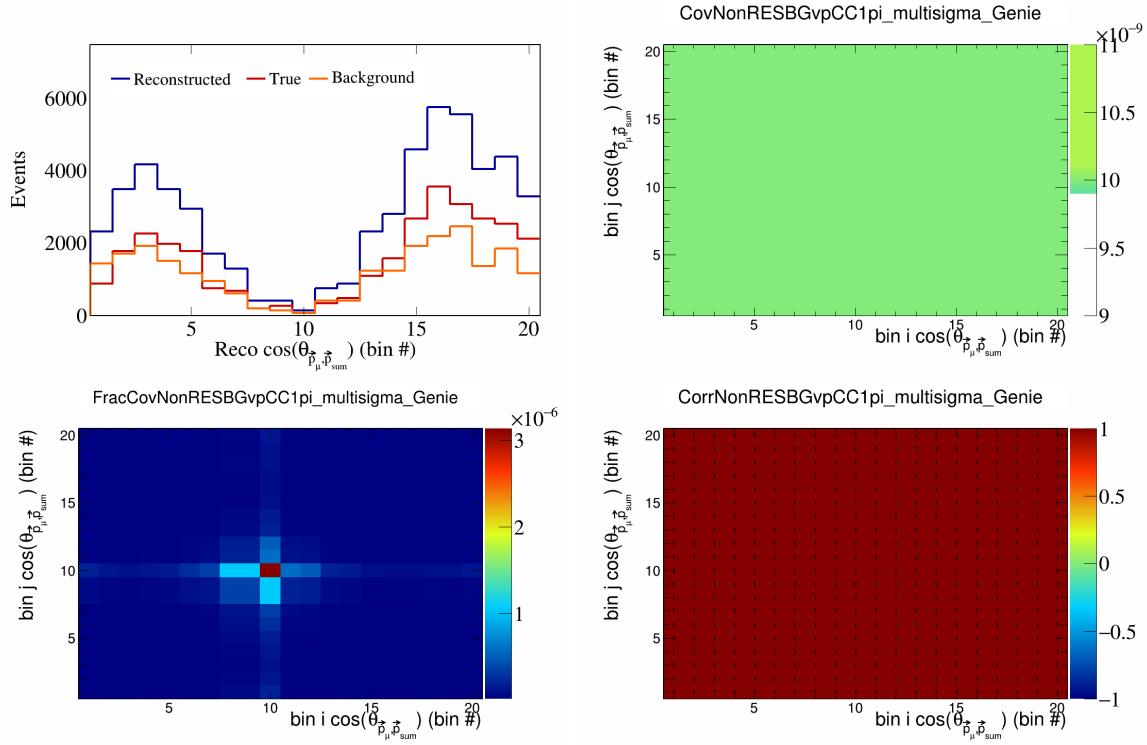


Figure 561: NonRESBGvpCC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

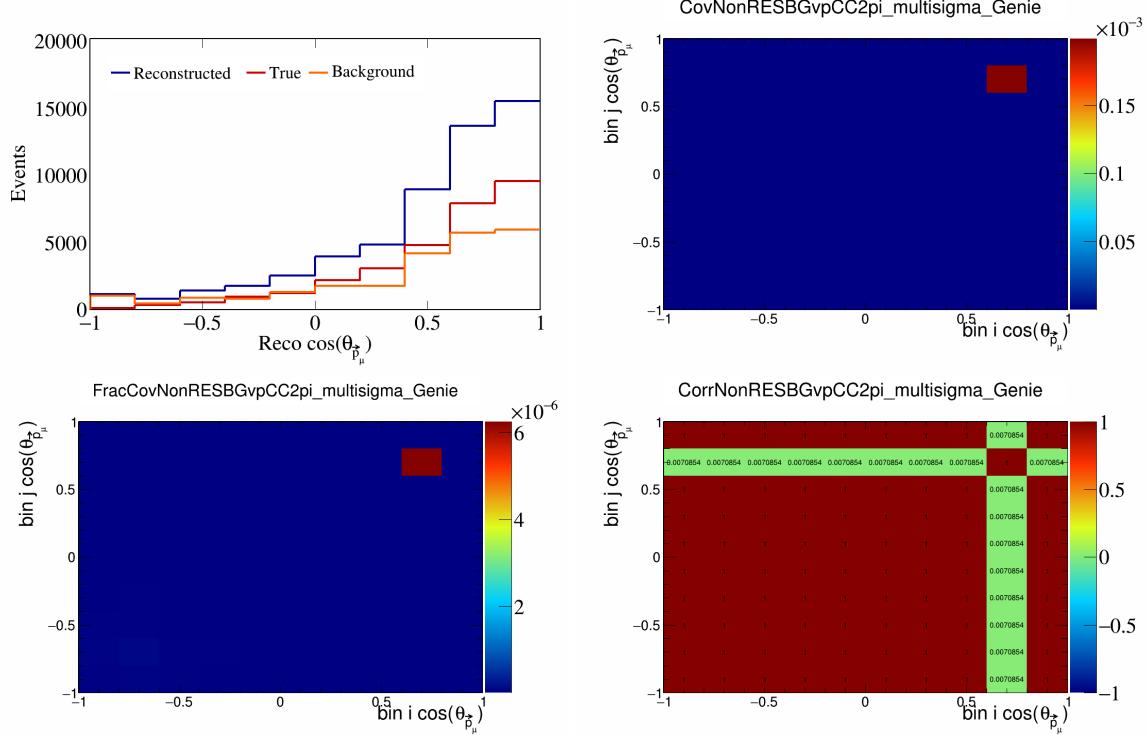


Figure 562: NonRESBGvpCC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

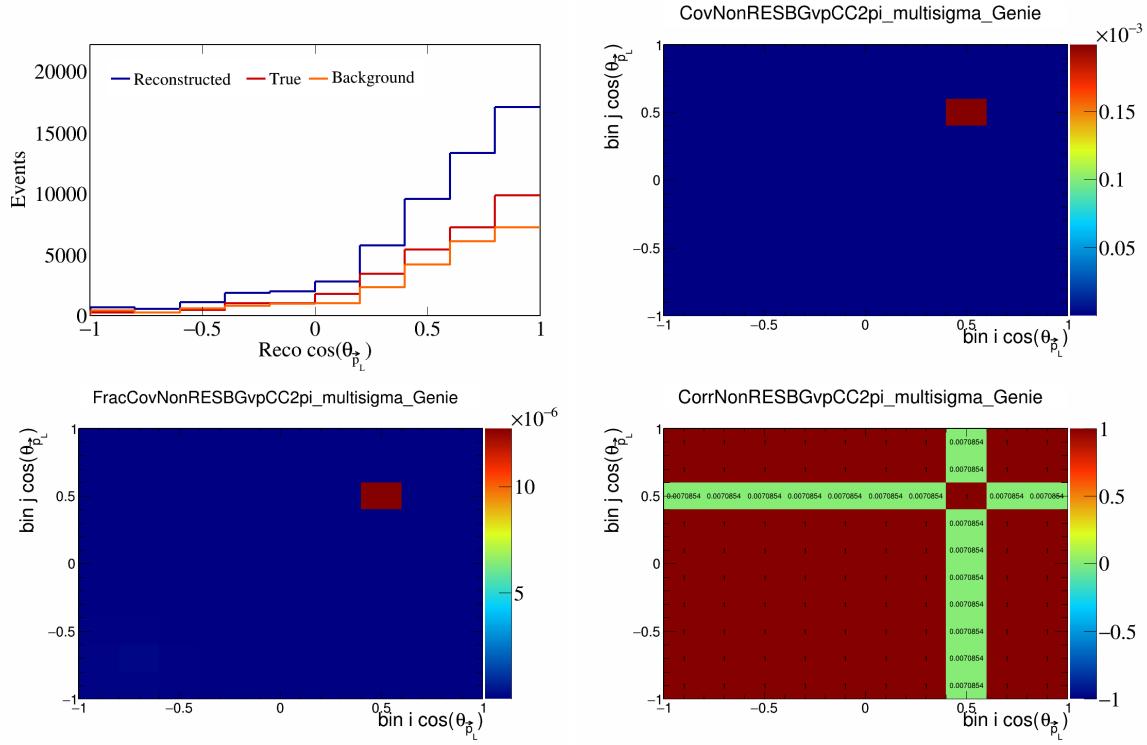


Figure 563: NonRESBGvpCC2pi variations for $\cos(\theta_{\vec{p}_L})$.

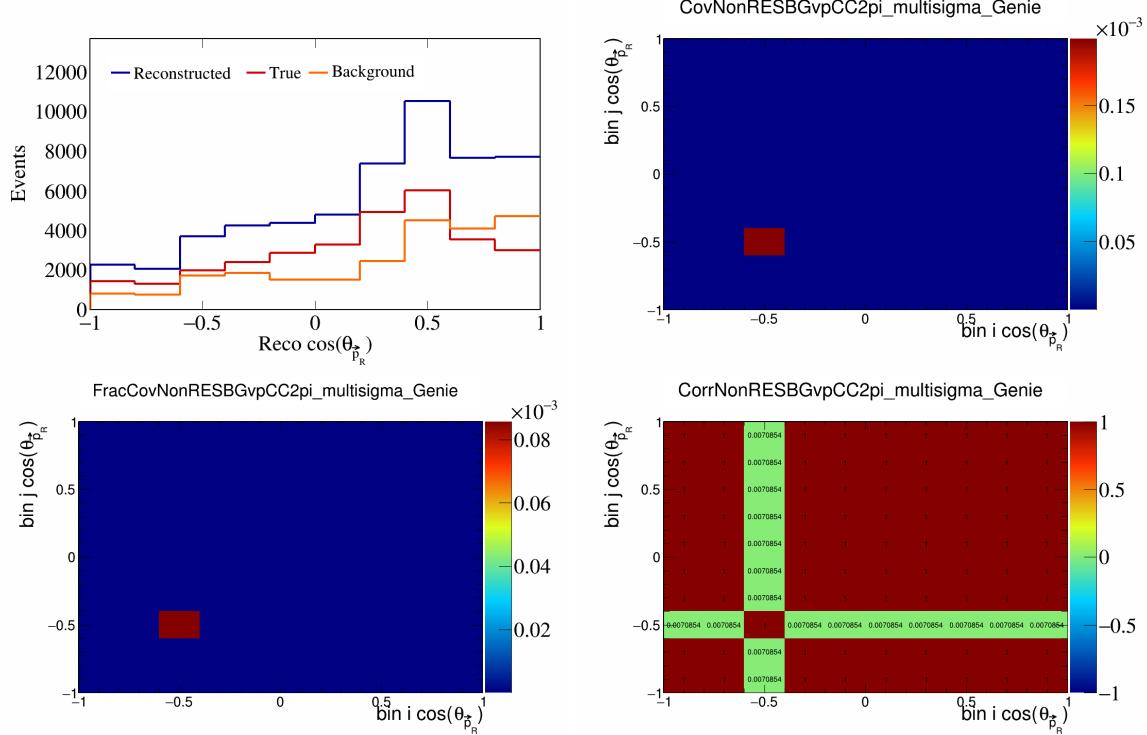


Figure 564: NonRESBGvpCC2pi variations for $\cos(\theta_{\vec{p}_R})$.

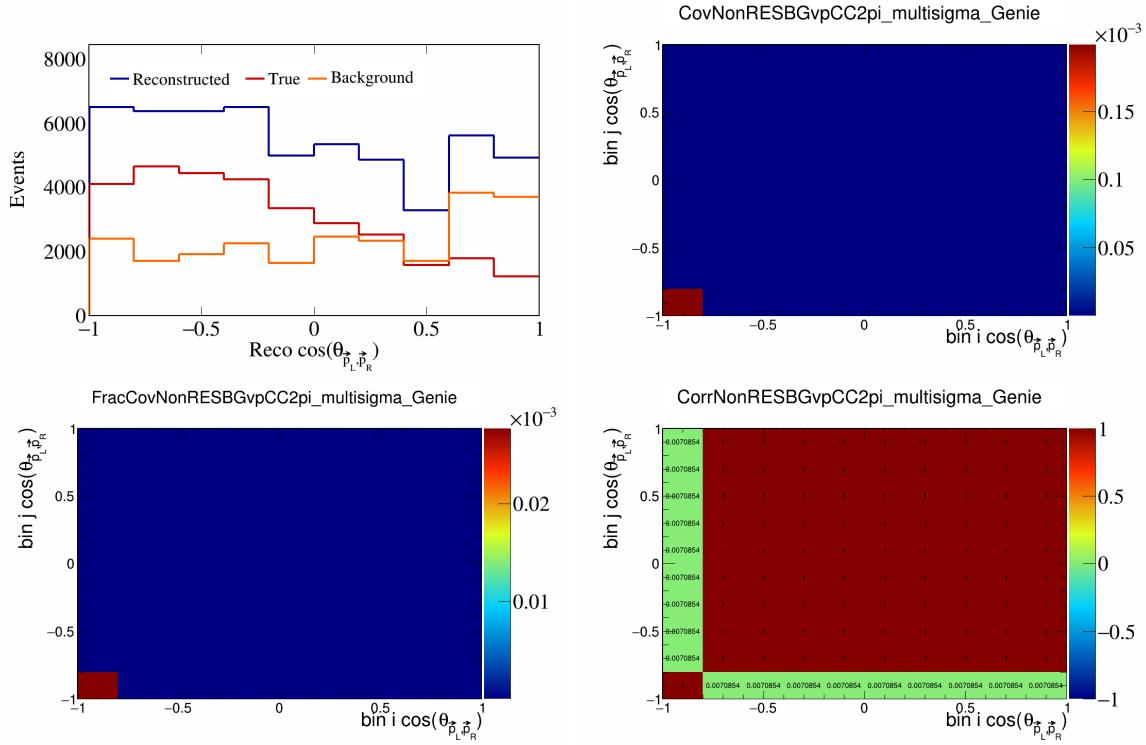


Figure 565: NonRESBGvpCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

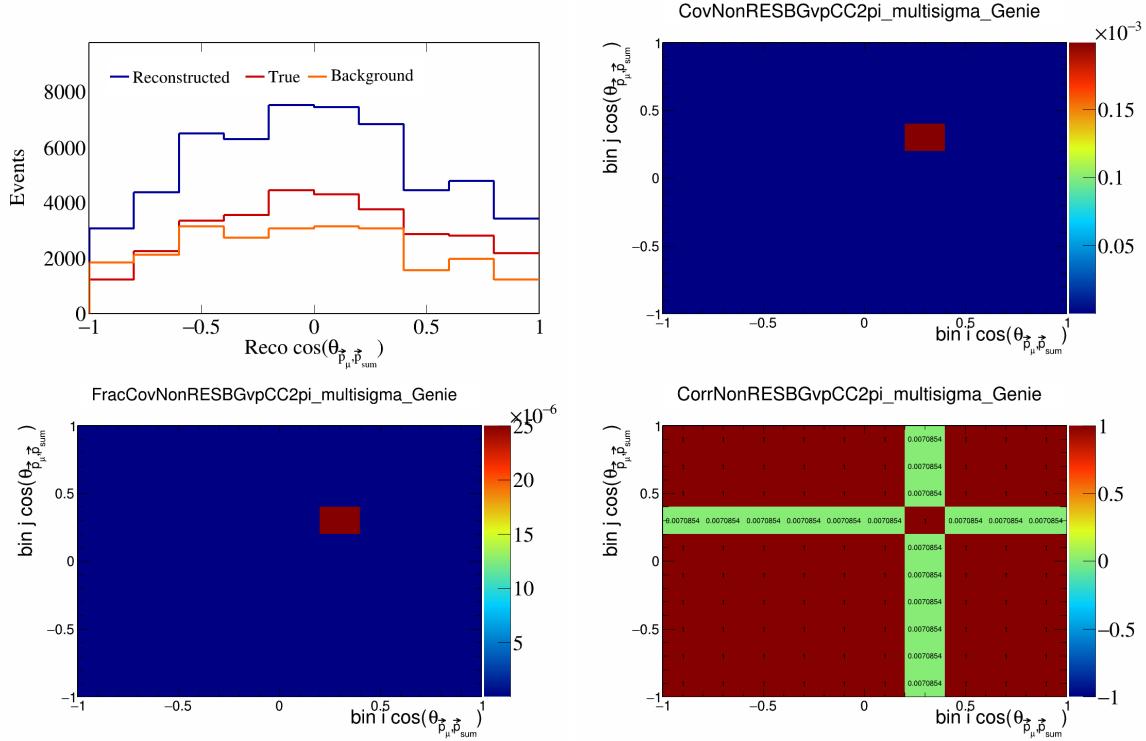


Figure 566: NonRESBGvpCC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{sum}})$.

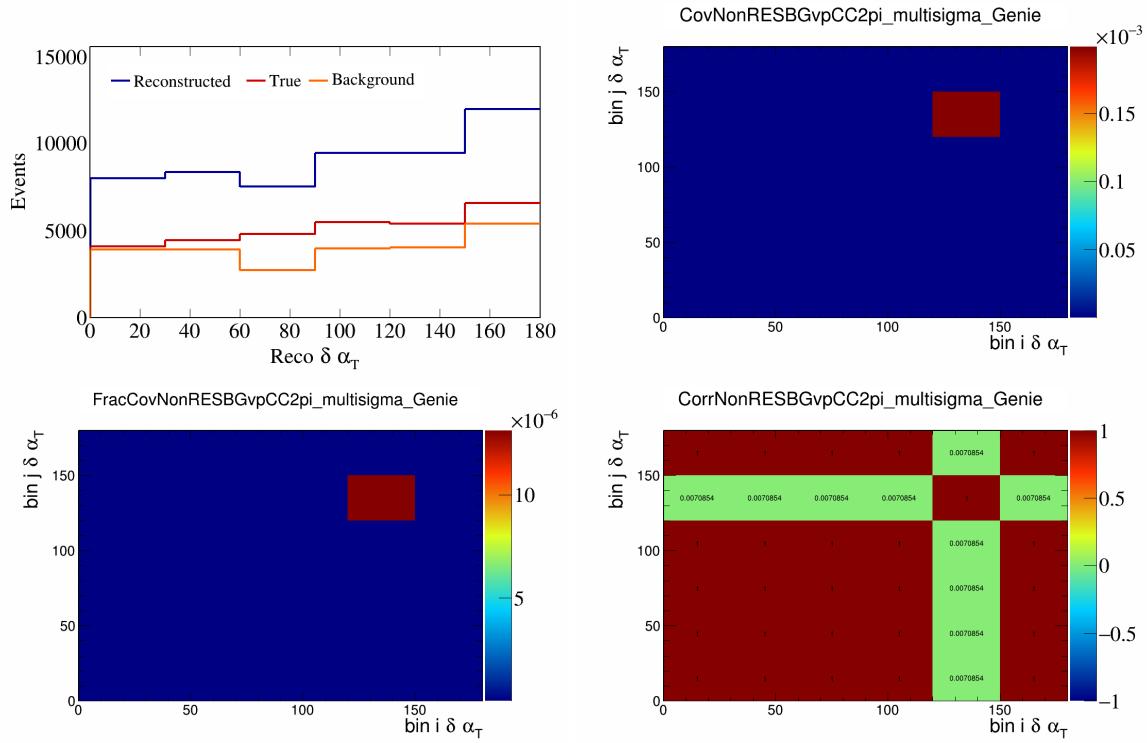


Figure 567: NonRESBGvpCC2pi variations for $\delta\alpha_T$.

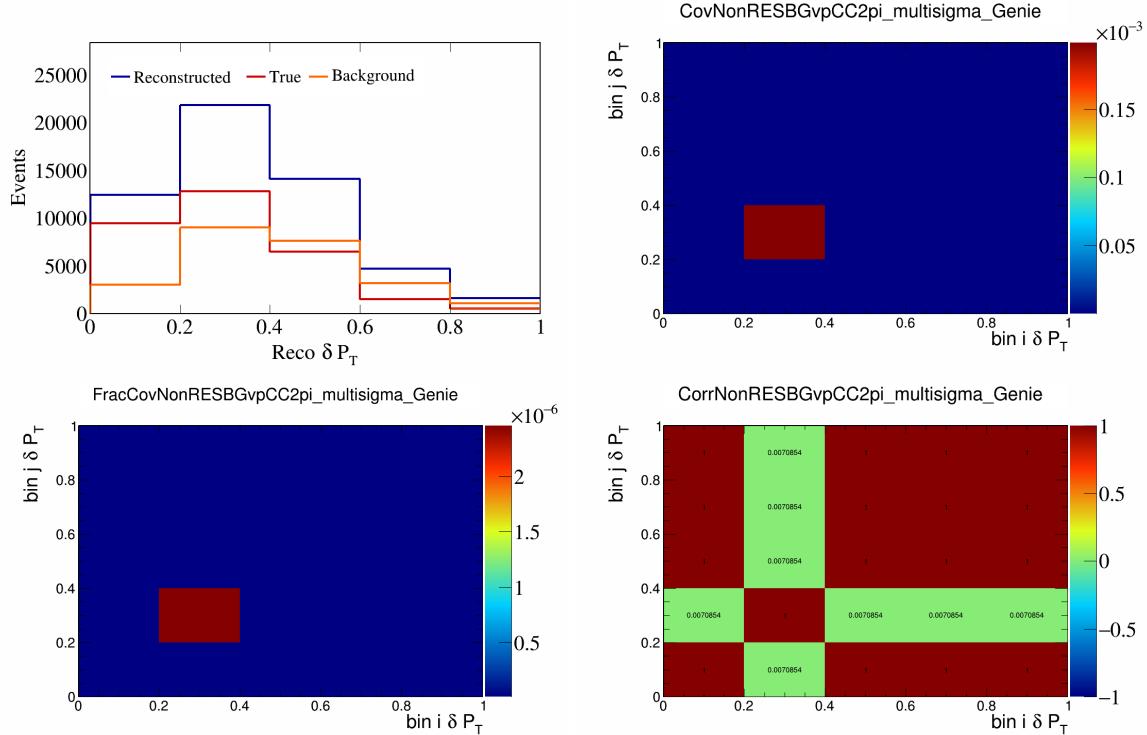


Figure 568: NonRESBGvpCC2pi variations for δP_T .

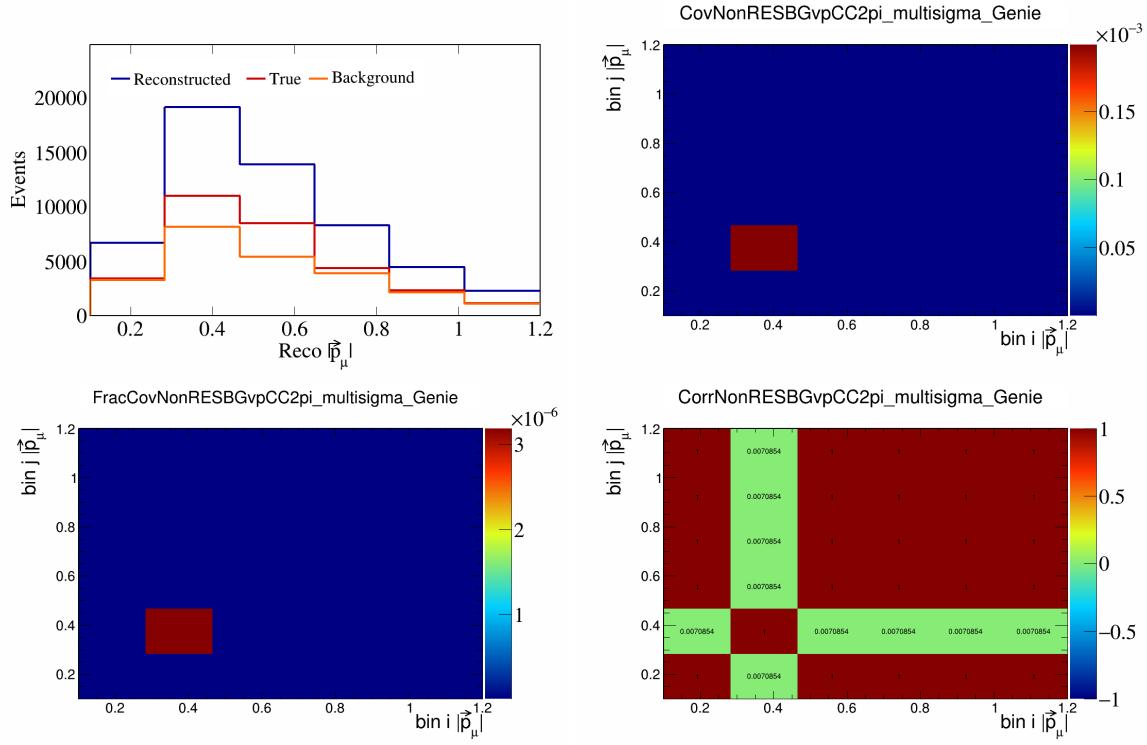


Figure 569: NonRESBGvpCC2pi variations for $|\vec{p}_\mu|$.

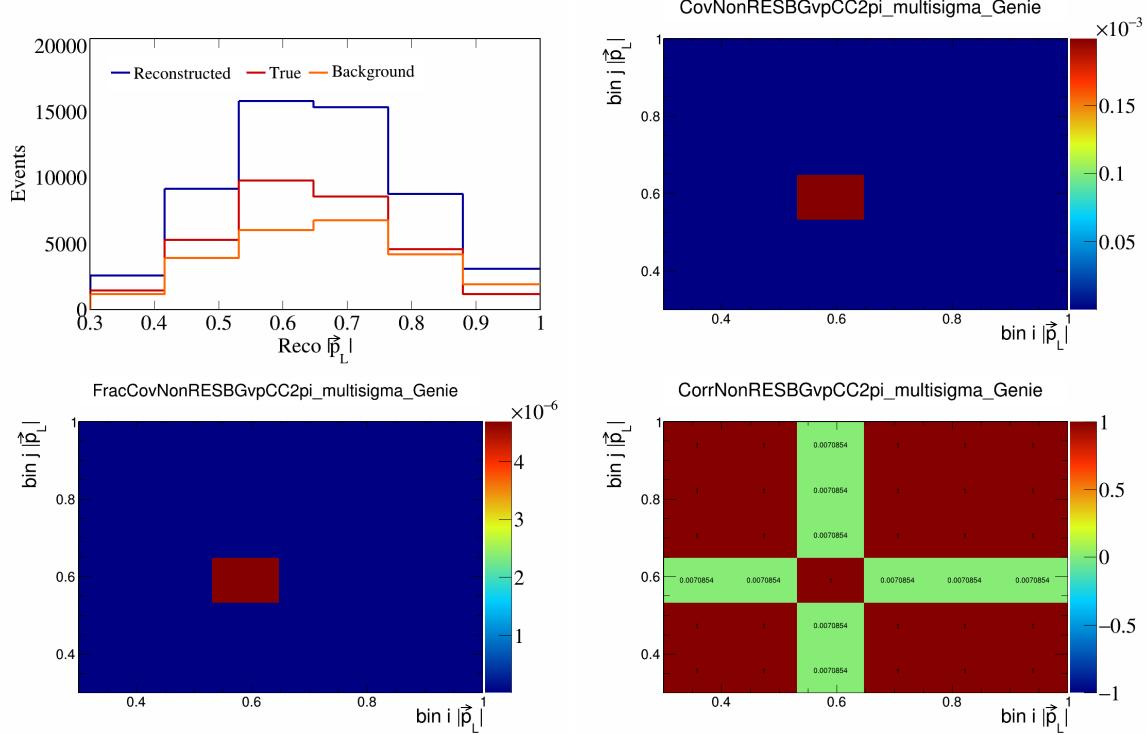


Figure 570: NonRESBGvpCC2pi variations for $|\vec{p}_L|$.

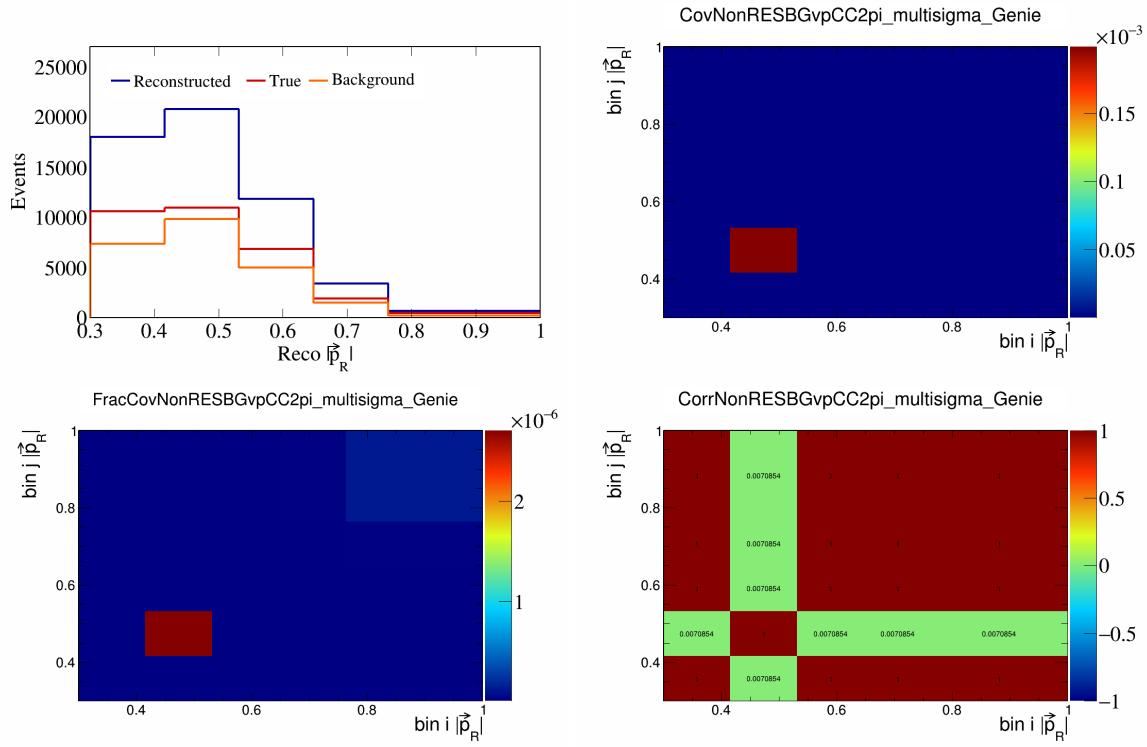


Figure 571: NonRESBGvpCC2pi variations for $|\vec{p}_R|$.

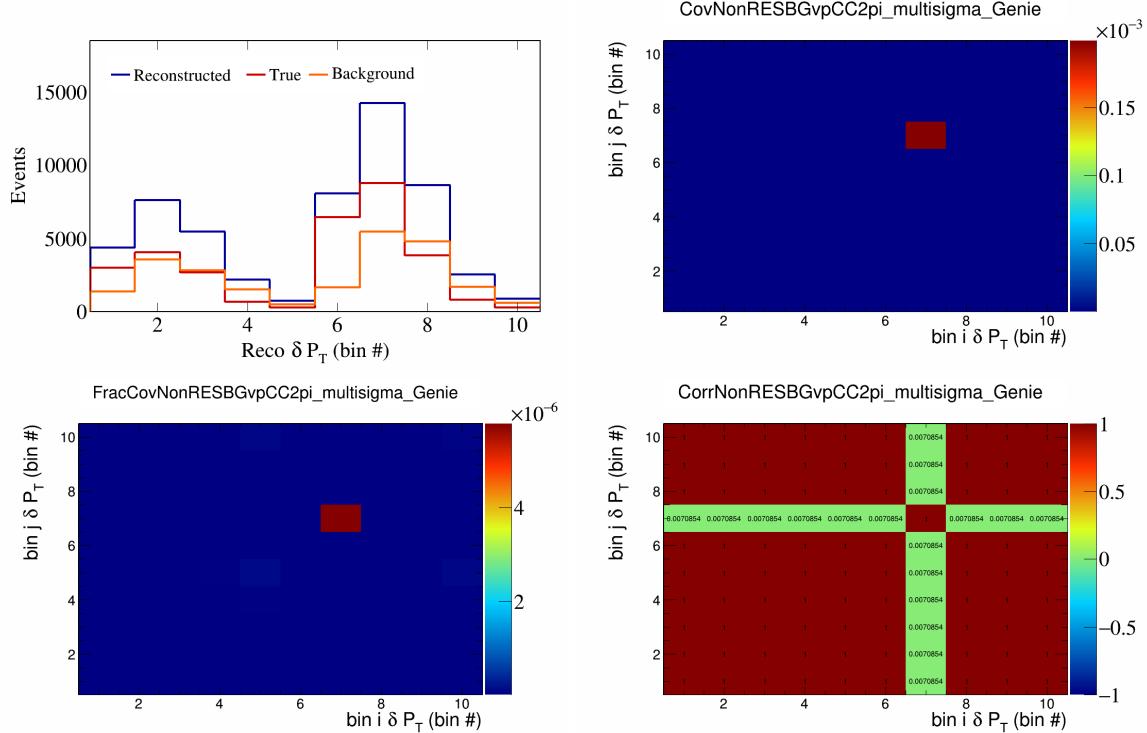


Figure 572: NonRESBGvpCC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

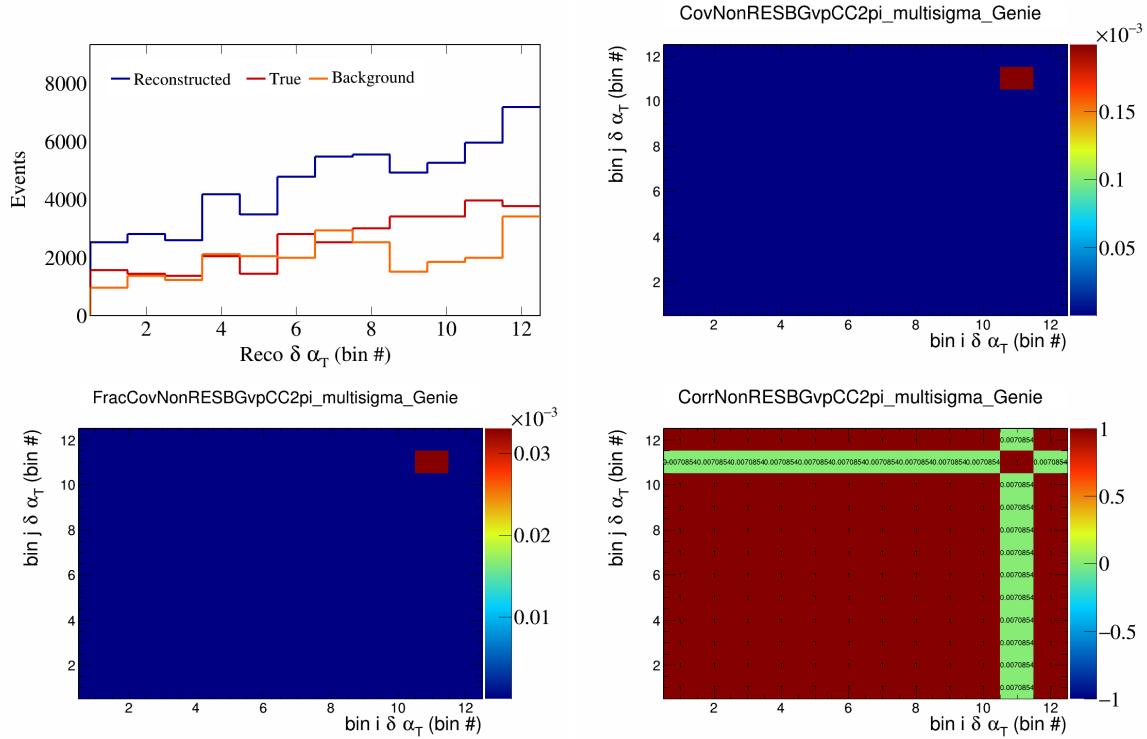


Figure 573: NonRESBGvpCC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

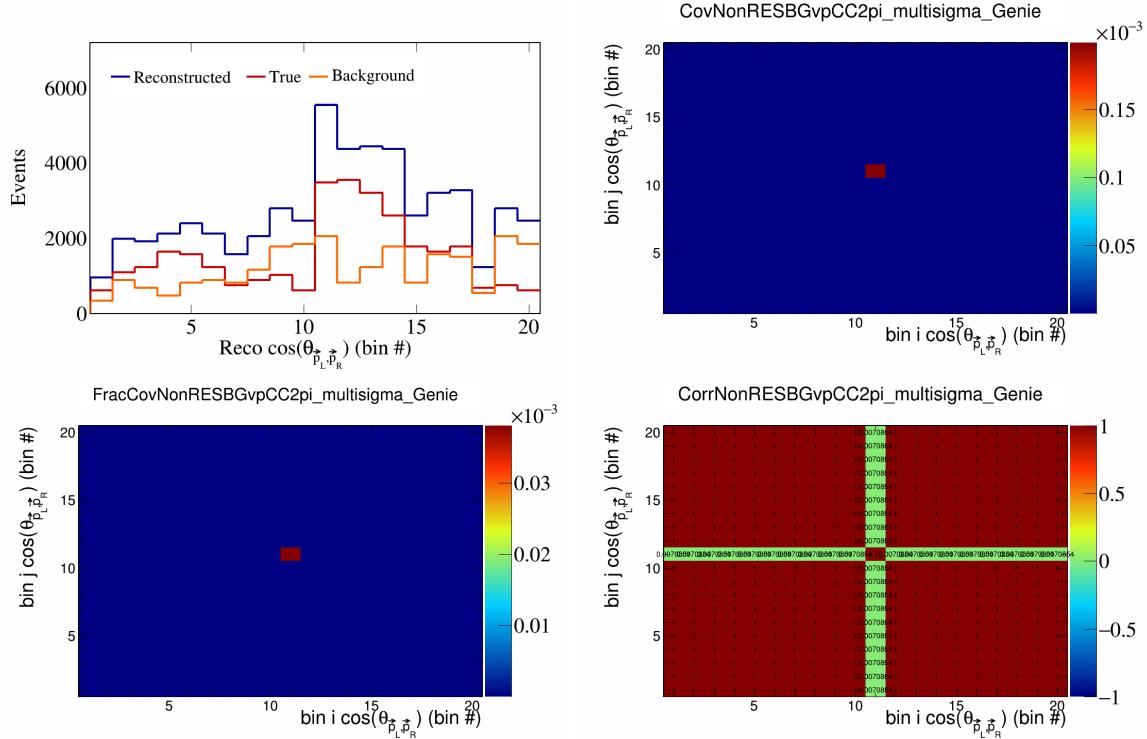


Figure 574: NonRESBGvpCC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

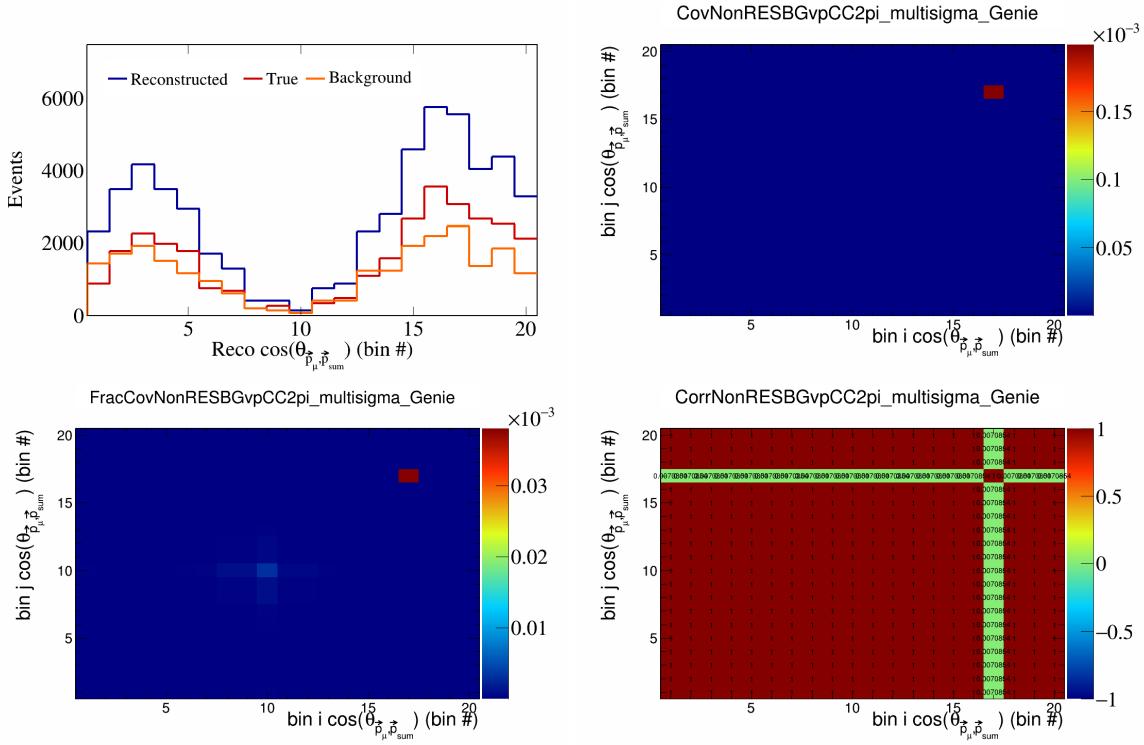


Figure 575: NonRESBGvpCC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

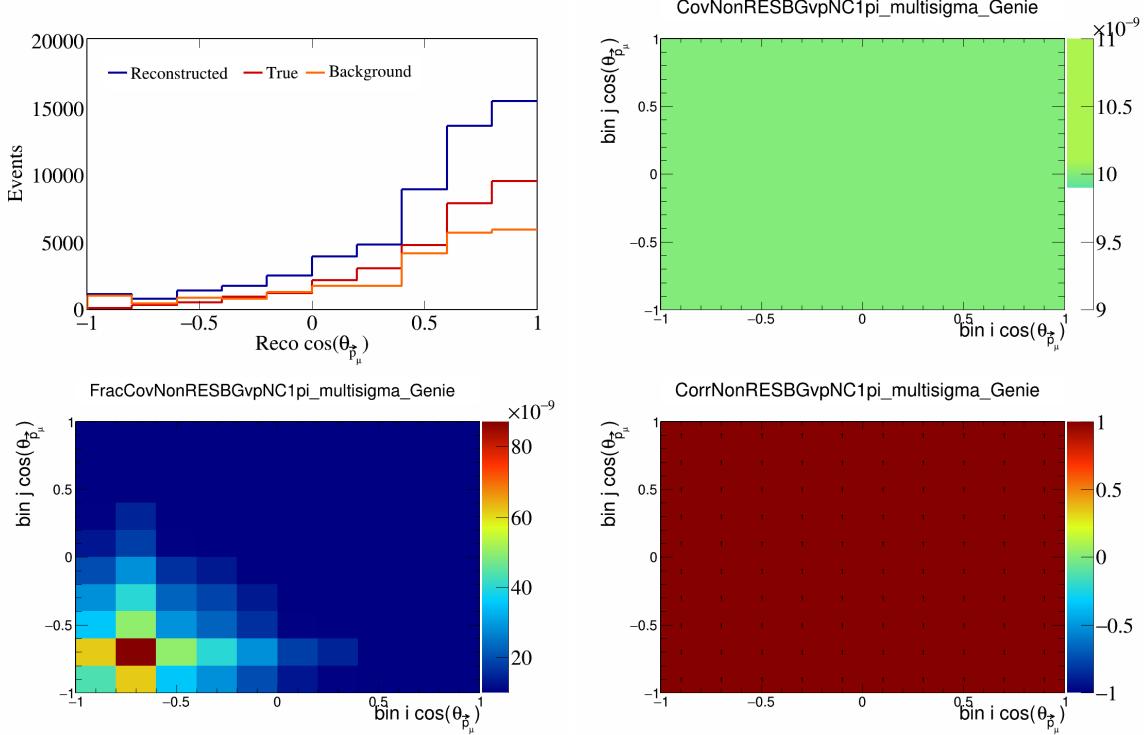


Figure 576: NonRESBGvpNC1pi variations for $\cos(\theta_{\vec{p}_\mu})$.

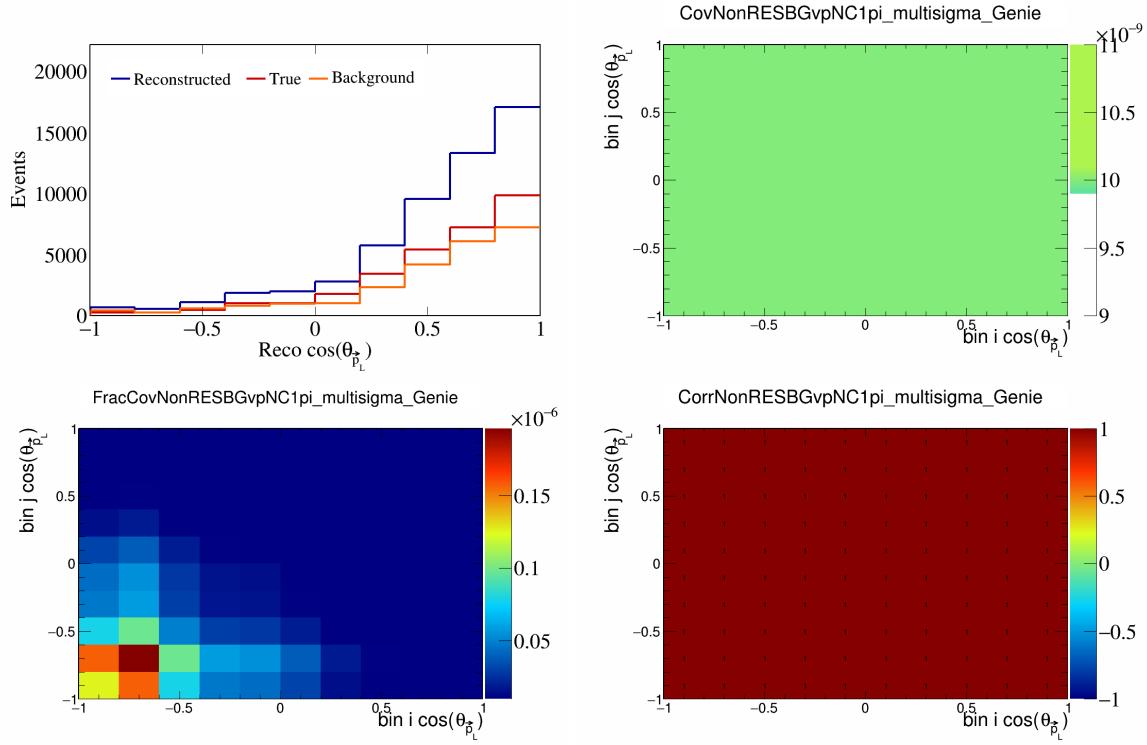


Figure 577: NonRESBGvpNC1pi variations for $\cos(\theta_{\vec{p}_L})$.

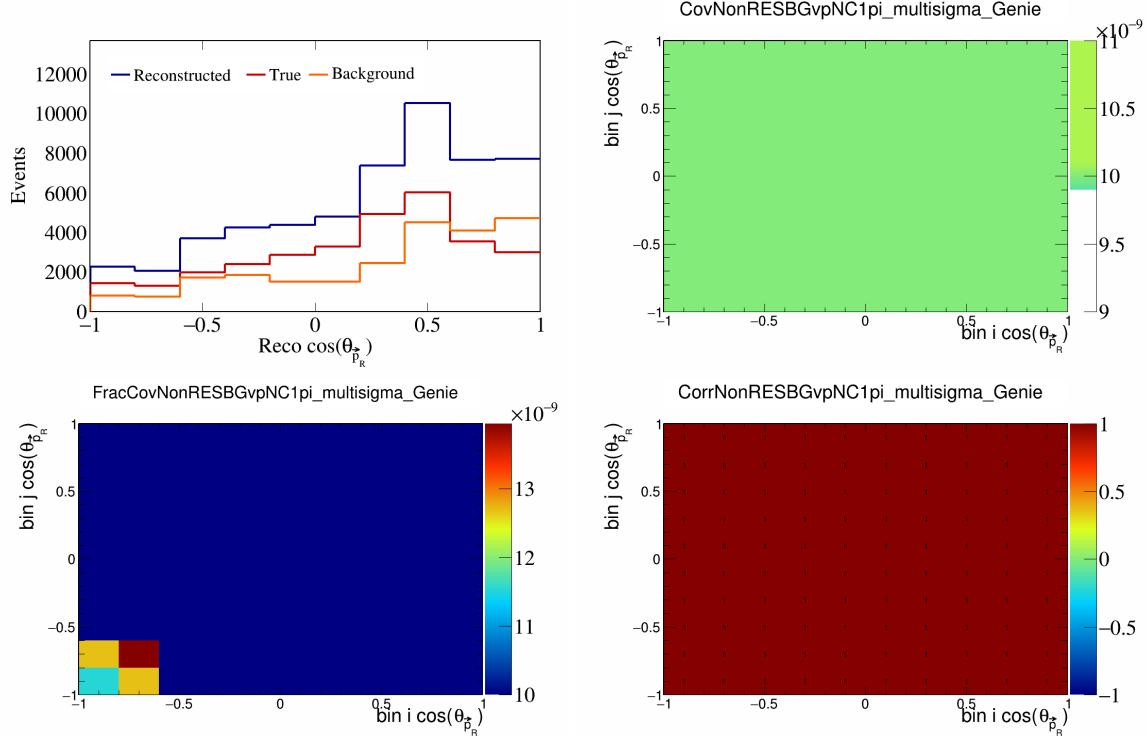


Figure 578: NonRESBGvpNC1pi variations for $\cos(\theta_{\vec{p}_R})$.

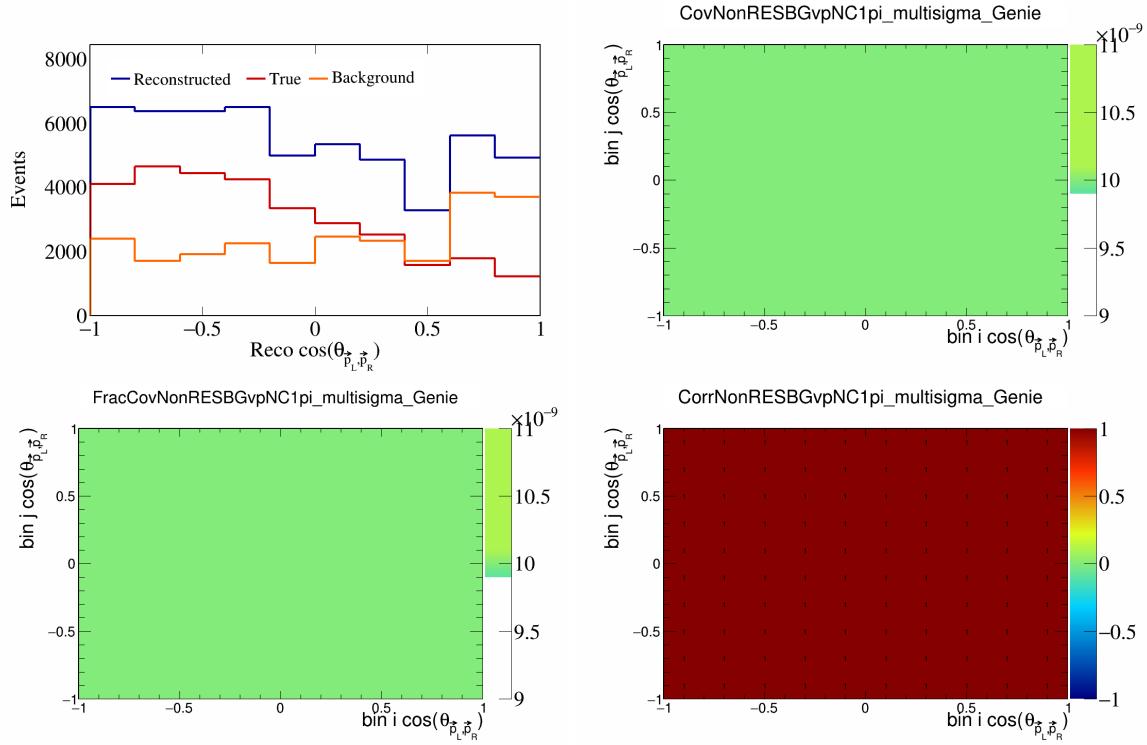


Figure 579: NonRESBGvpNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

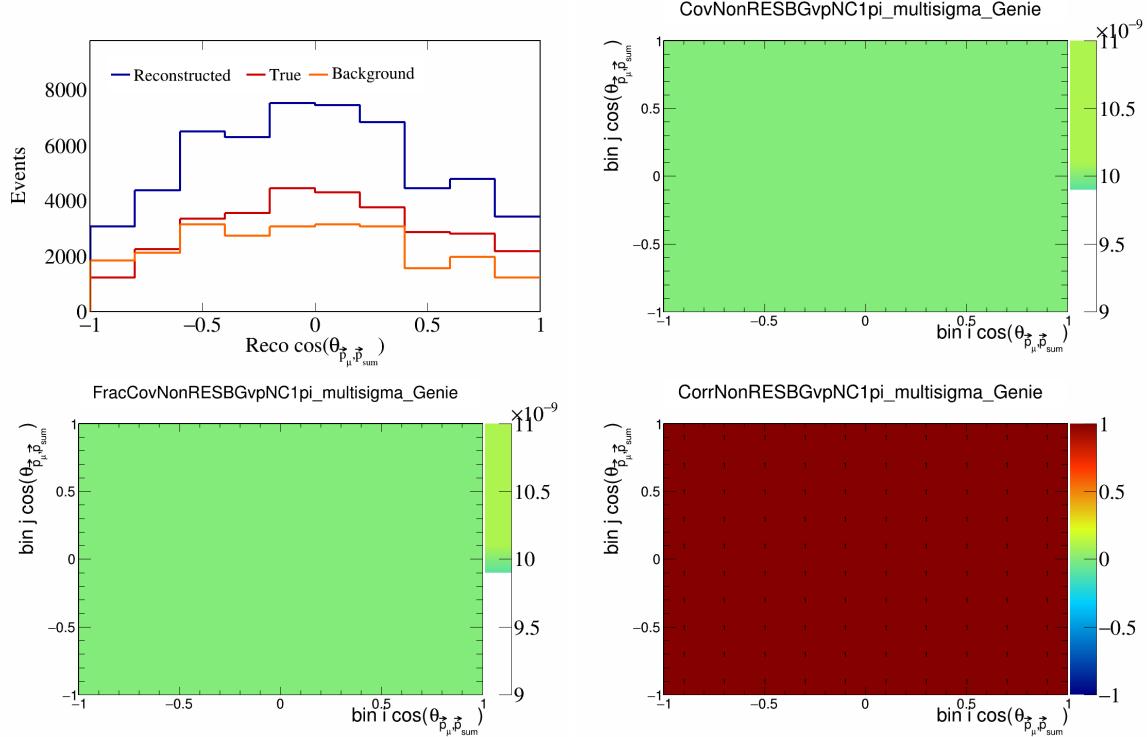


Figure 580: NonRESBGvpNC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

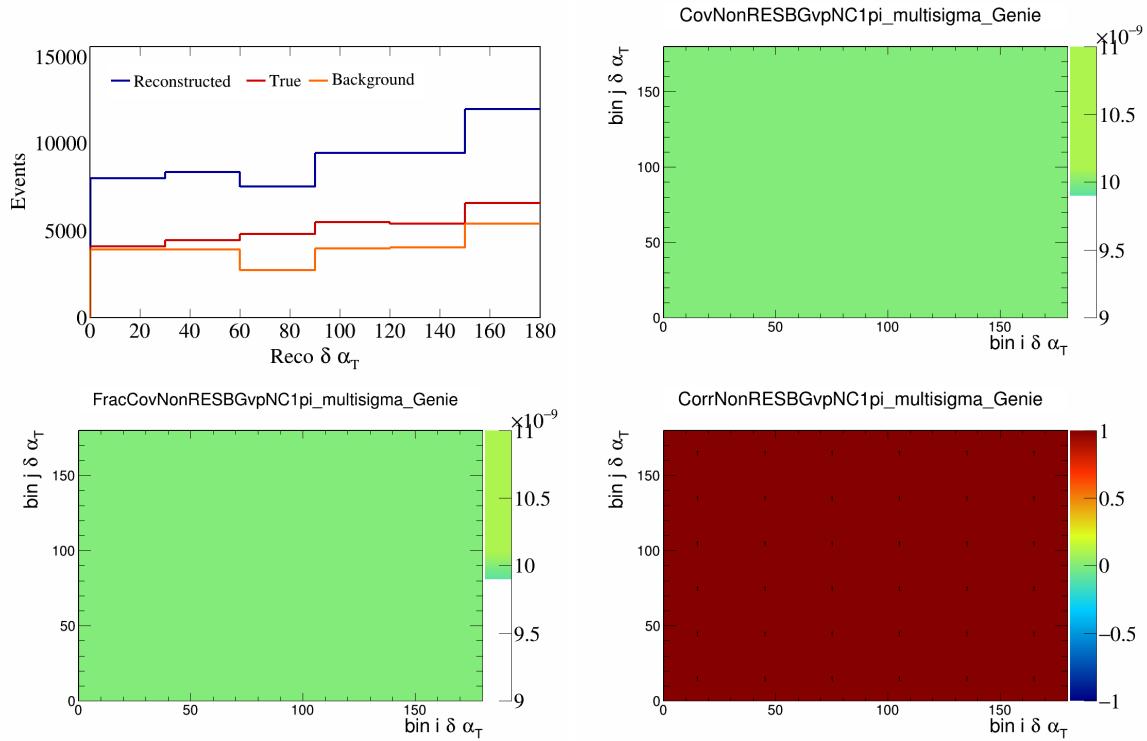


Figure 581: NonRESBGvpNC1pi variations for $\delta\alpha_T$.

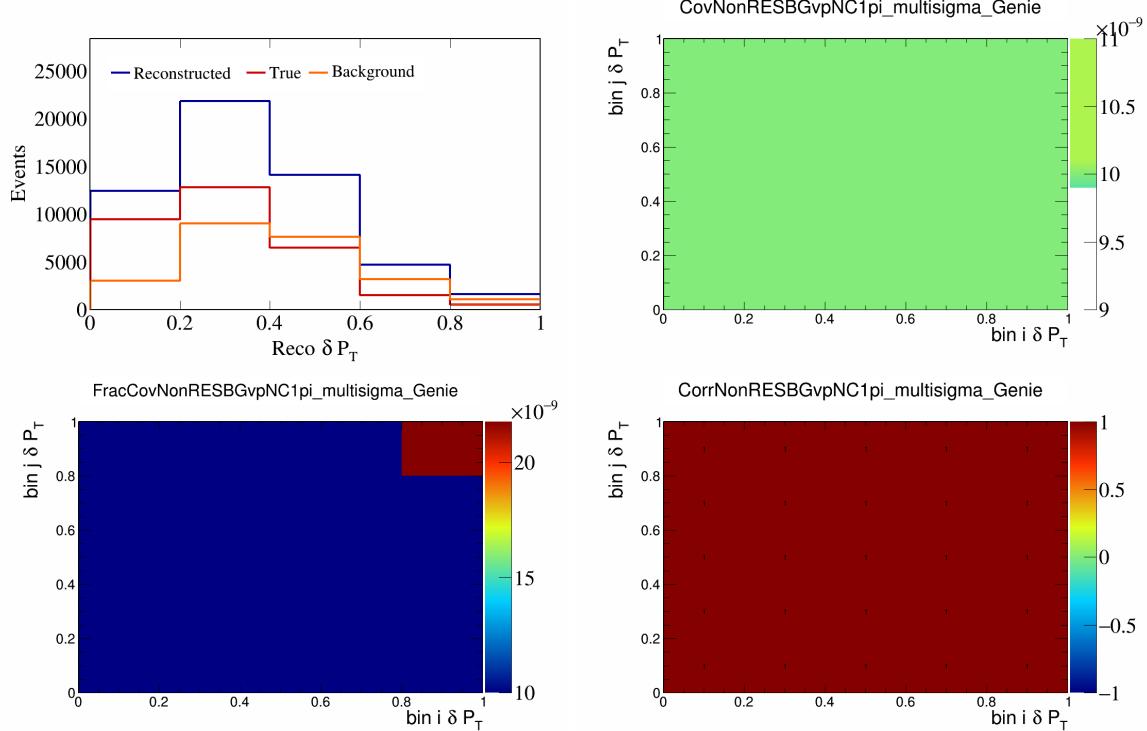


Figure 582: NonRESBGvpNC1pi variations for δP_T .

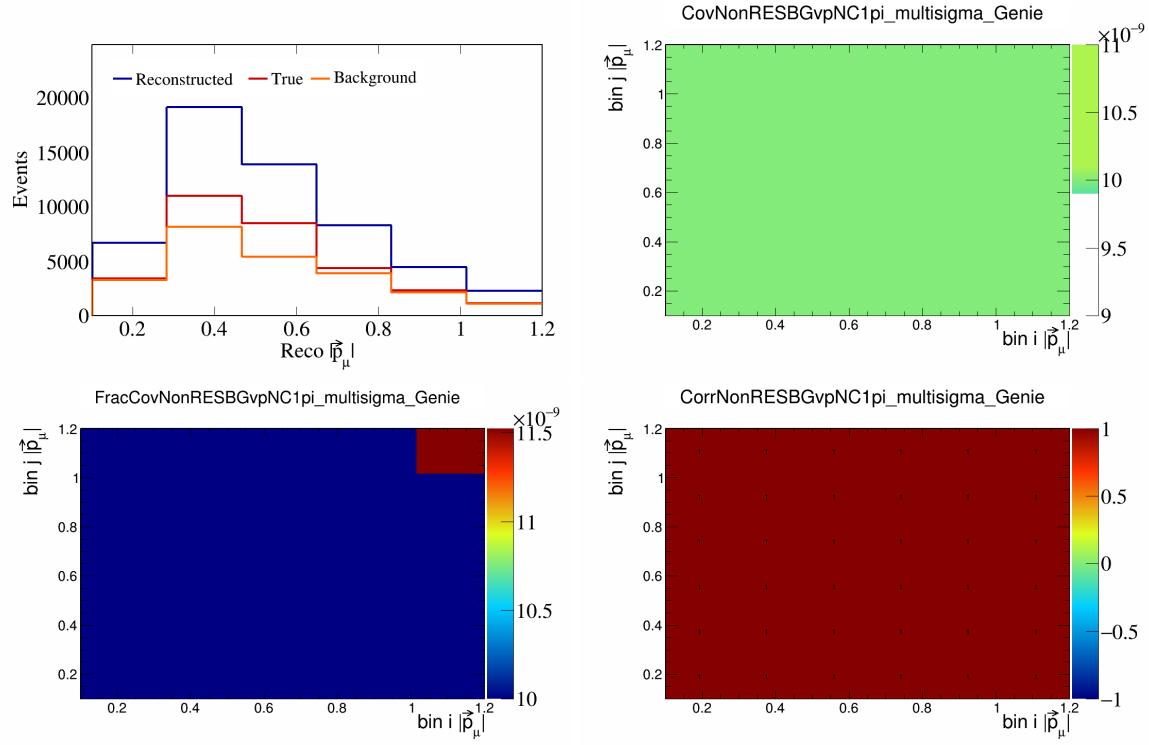


Figure 583: NonRESBGvpNC1pi variations for $|\vec{p}_\mu|$.

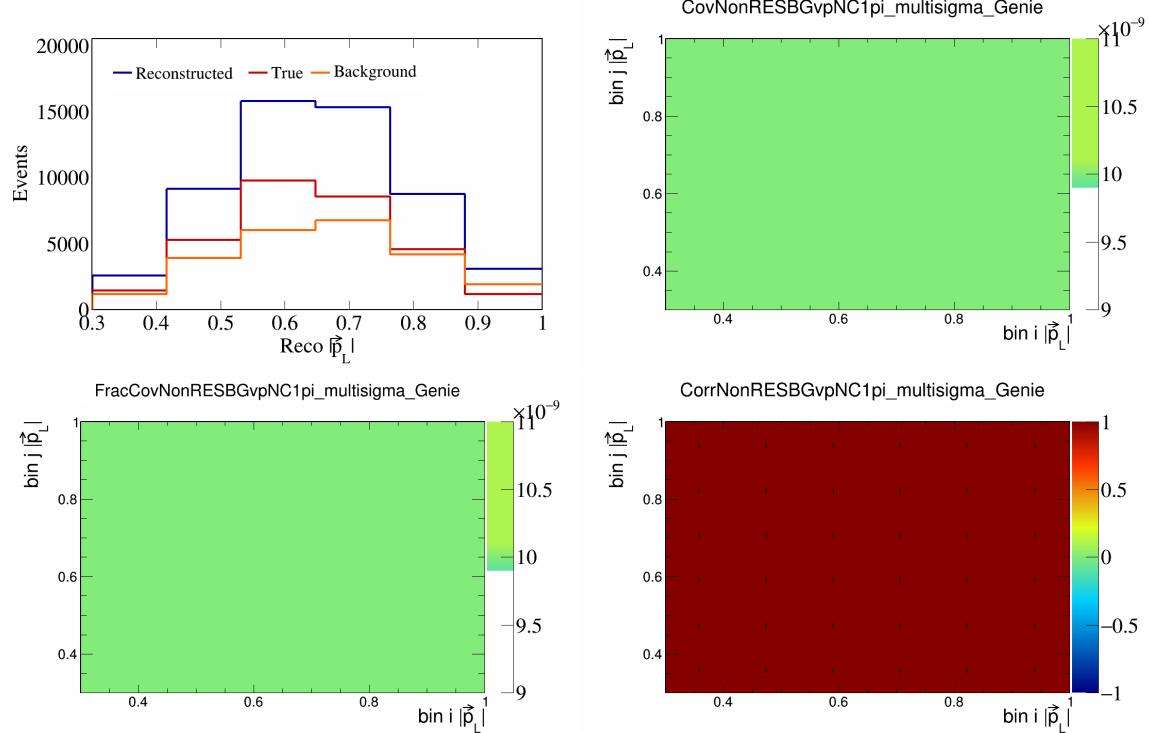


Figure 584: NonRESBGvpNC1pi variations for $|\vec{p}_L|$.

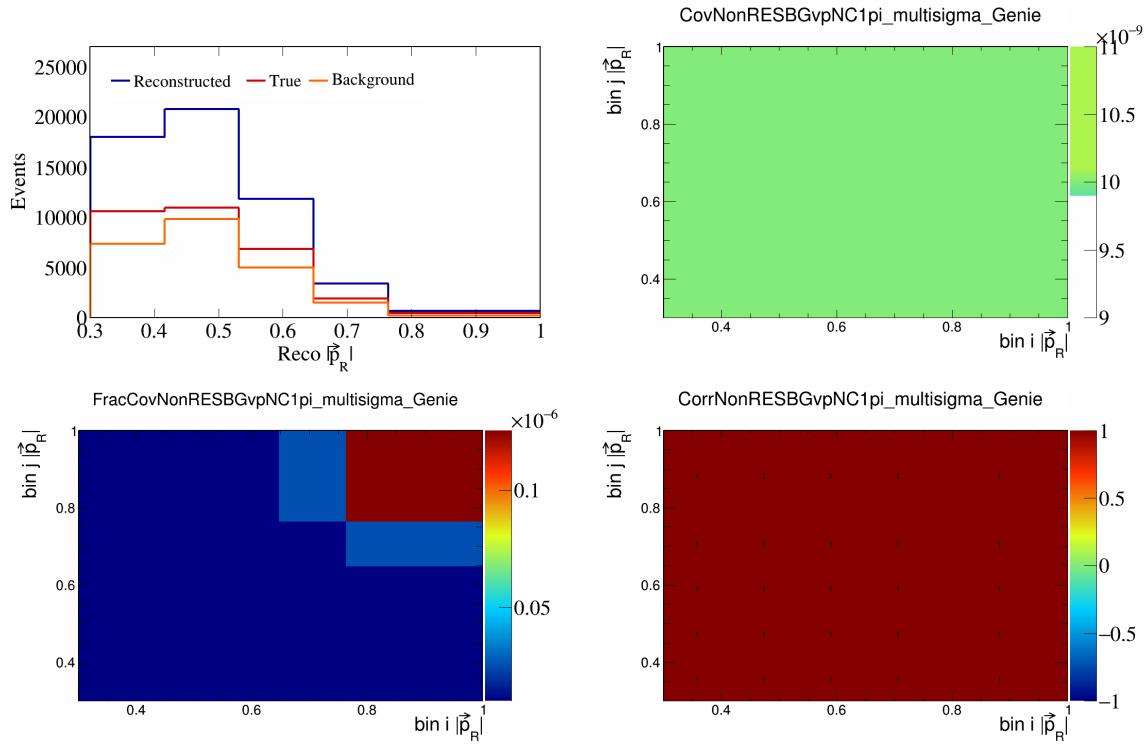


Figure 585: NonRESBGvpNC1pi variations for $|\vec{p}_R|$.

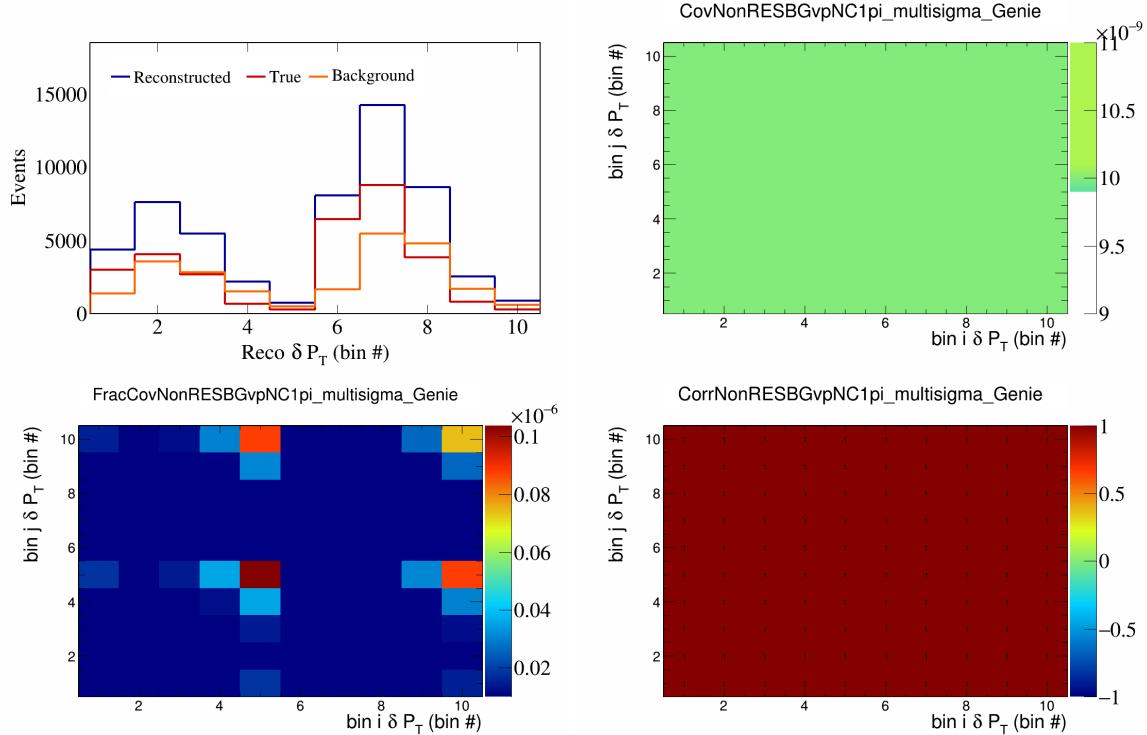


Figure 586: NonRESBGvpNC1pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

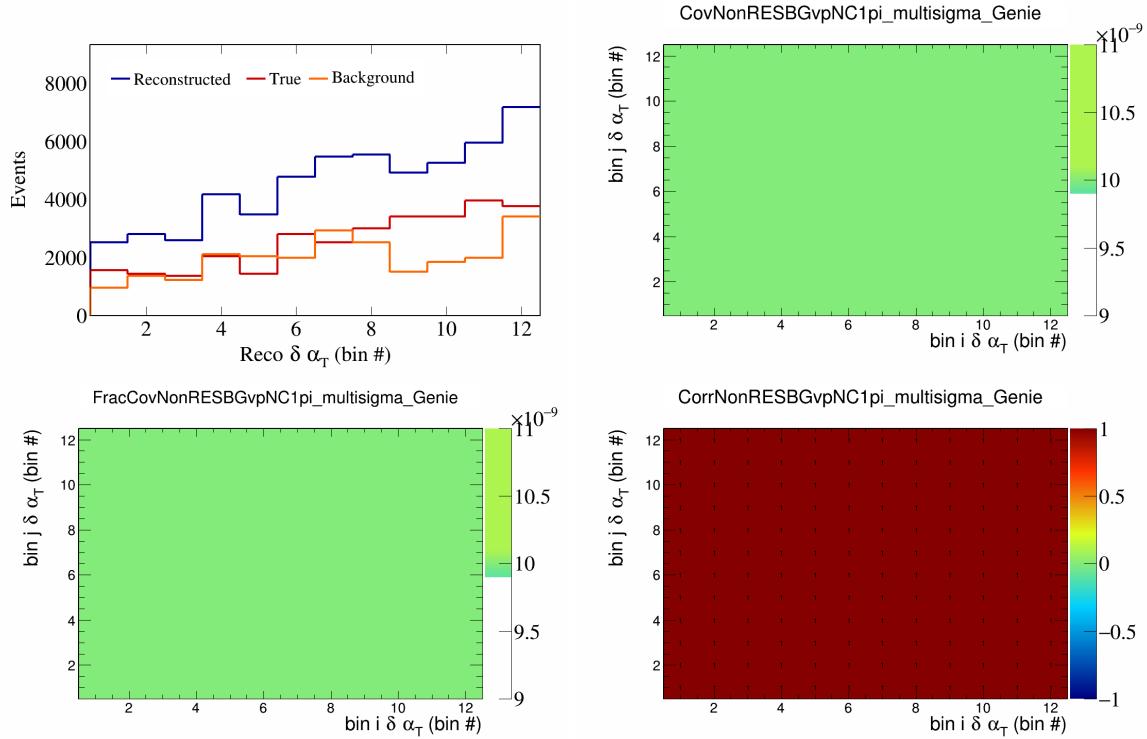


Figure 587: NonRESBGvpNC1pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

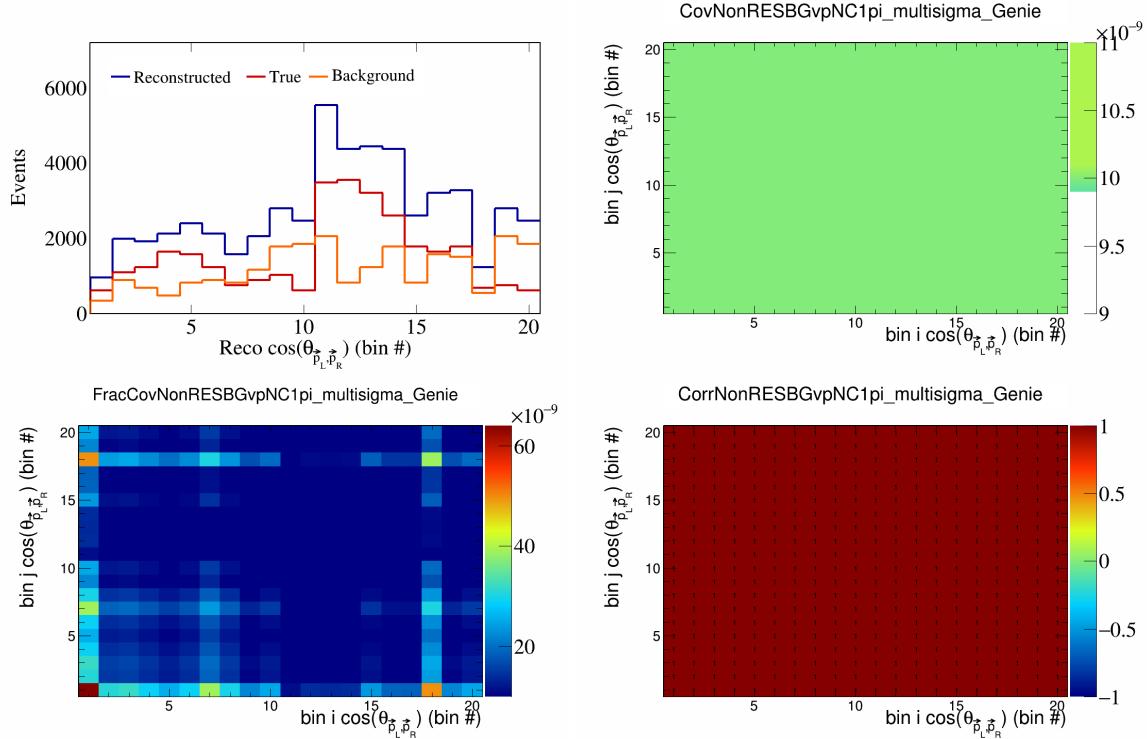


Figure 588: NonRESBGvpNC1pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

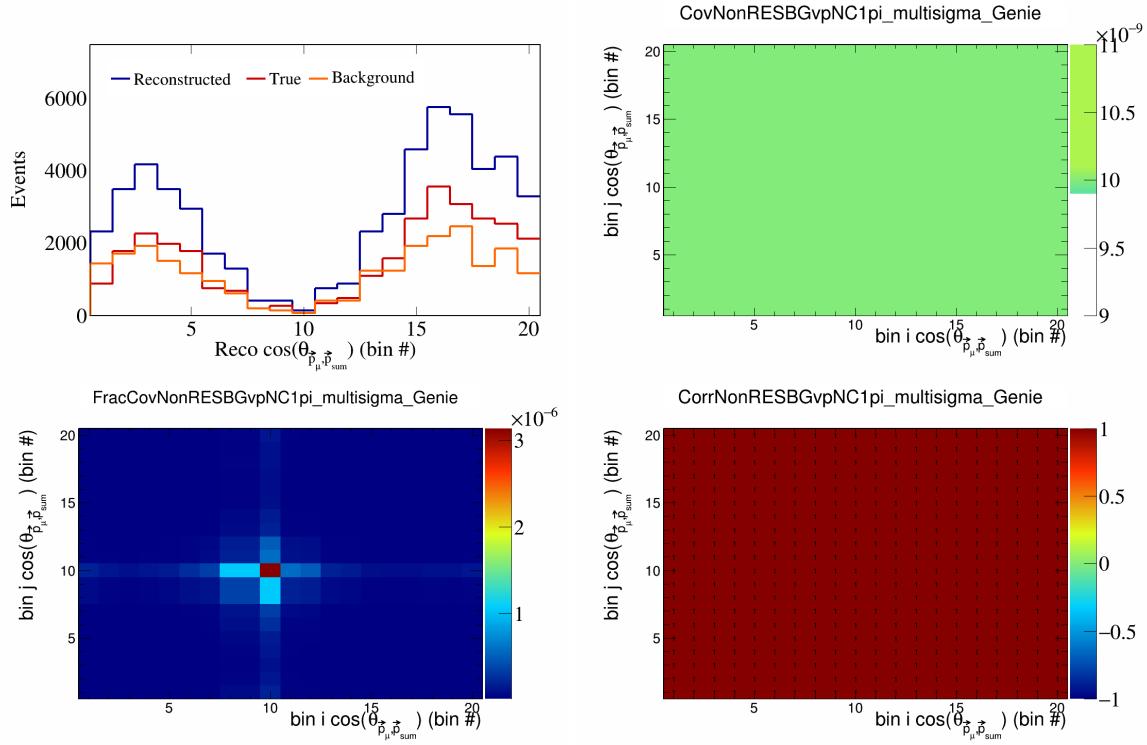


Figure 589: NonRESBGvpNC1pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

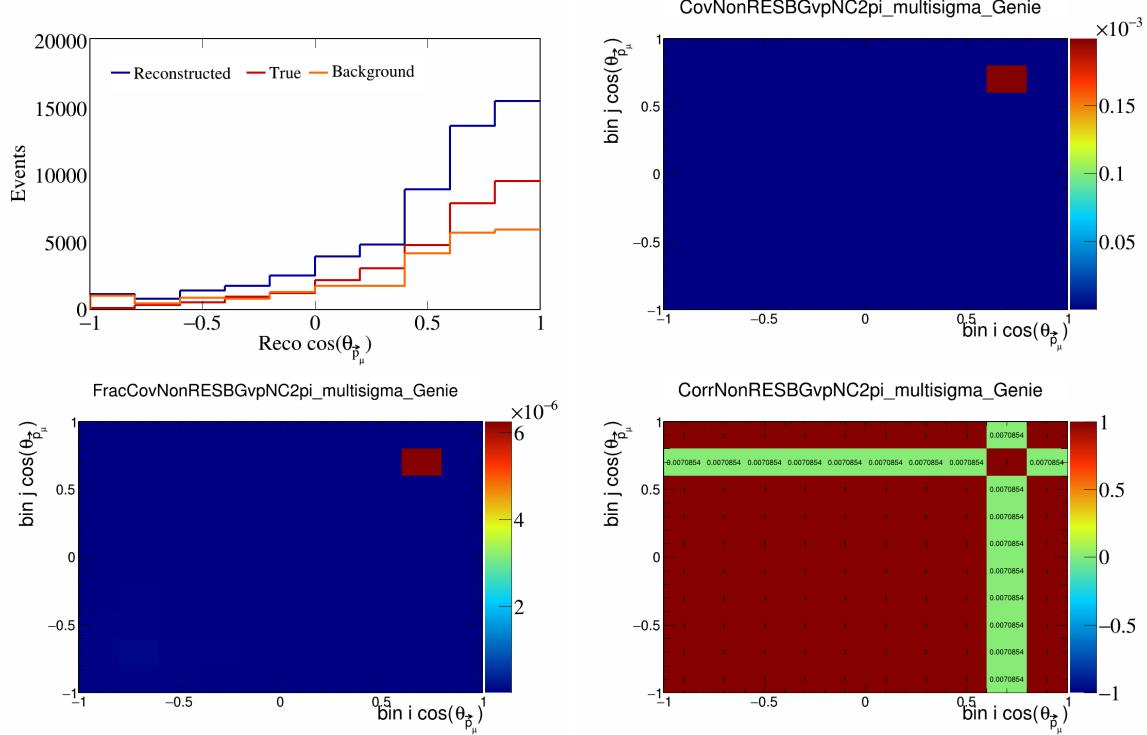


Figure 590: NonRESBGvpNC2pi variations for $\cos(\theta_{\vec{p}_\mu})$.

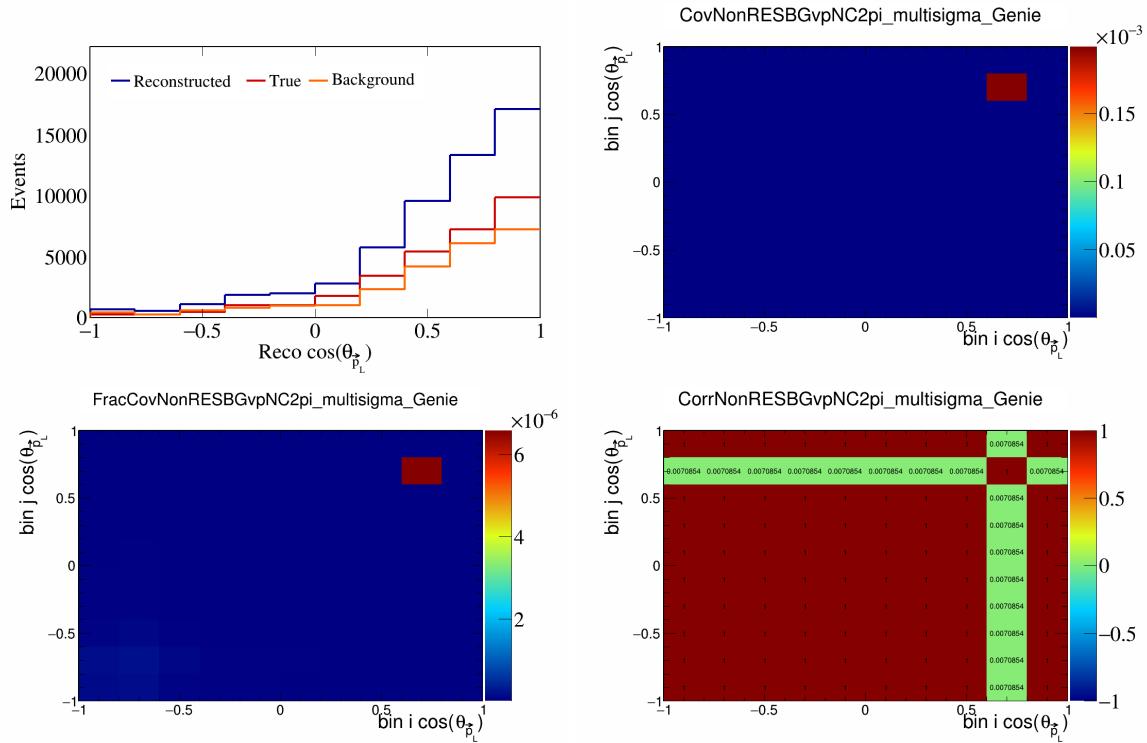


Figure 591: NonRESBGvpNC2pi variations for $\cos(\theta_{\vec{p}_L})$.

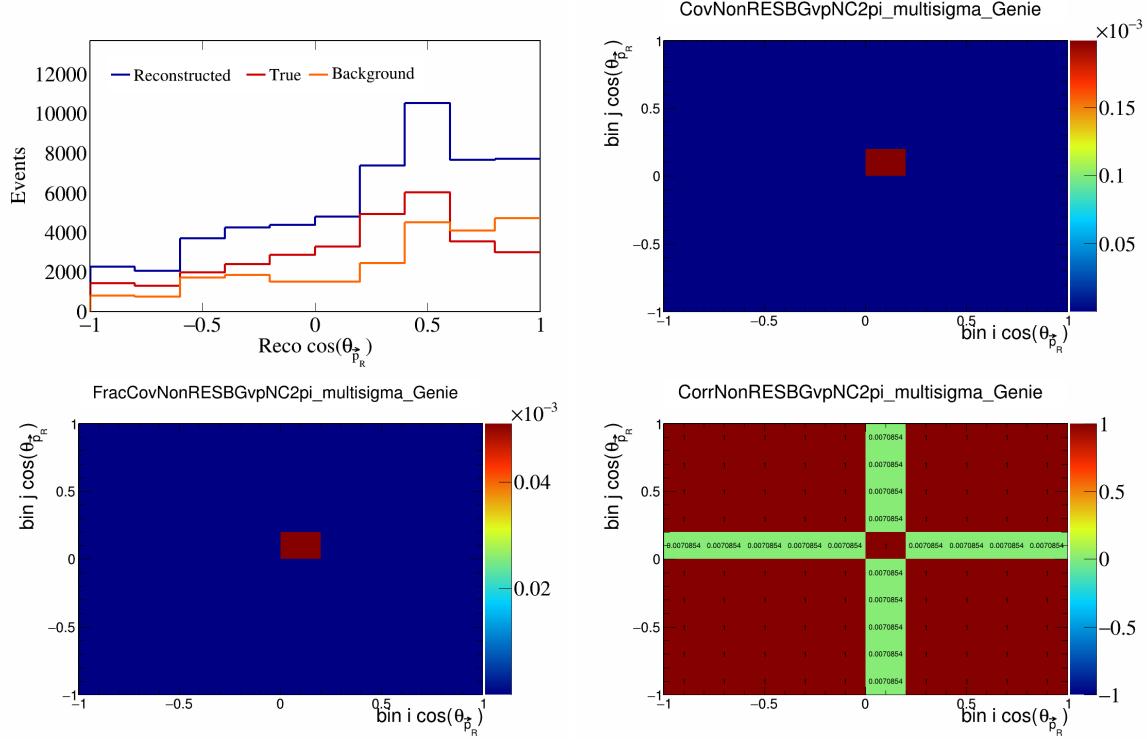


Figure 592: NonRESBGvpNC2pi variations for $\cos(\theta_{\vec{p}_R})$.

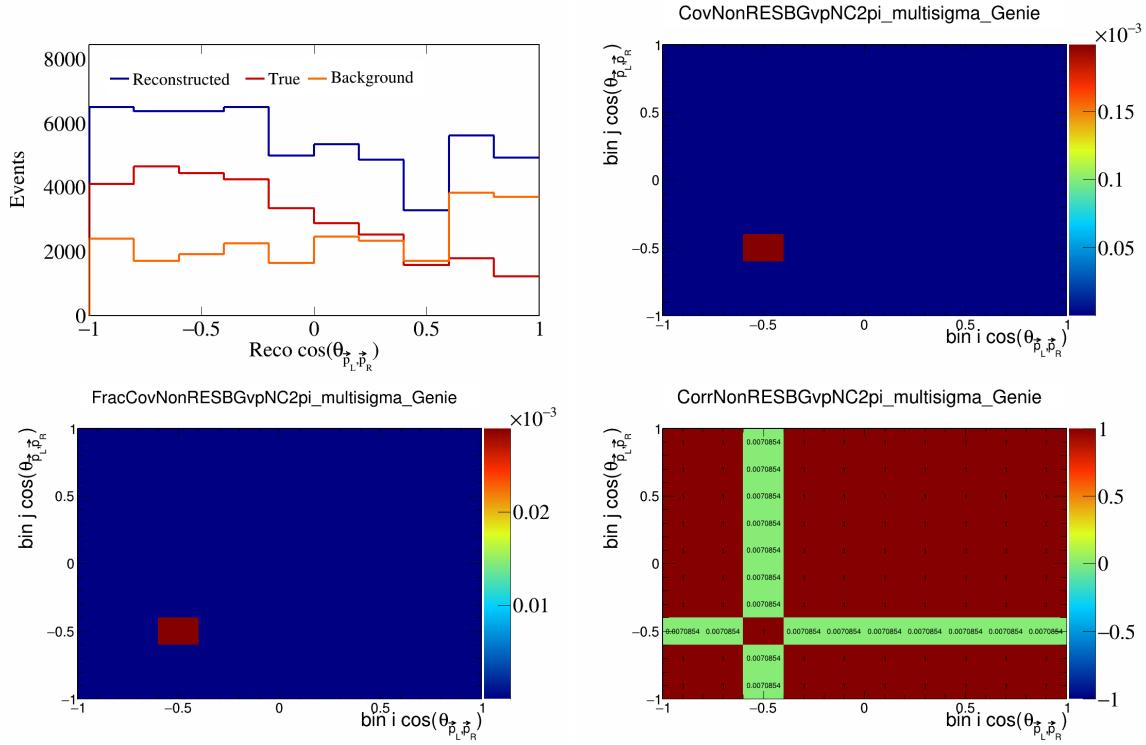


Figure 593: NonRESBGvpNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

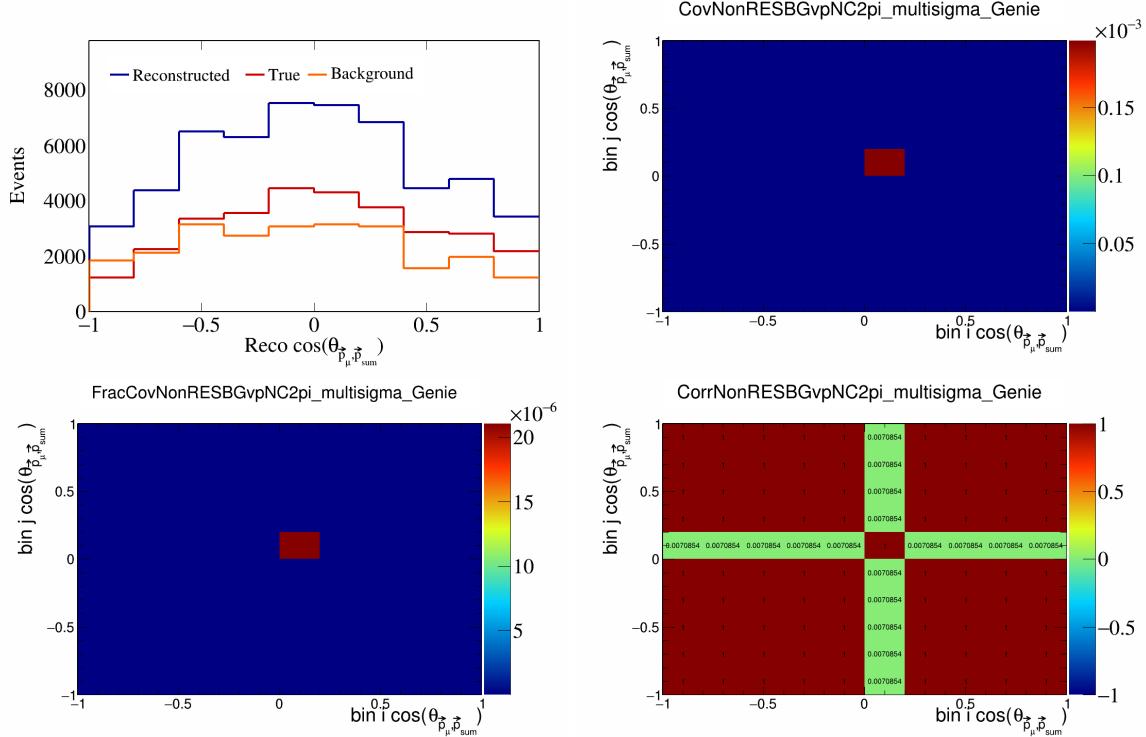


Figure 594: NonRESBGvpNC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

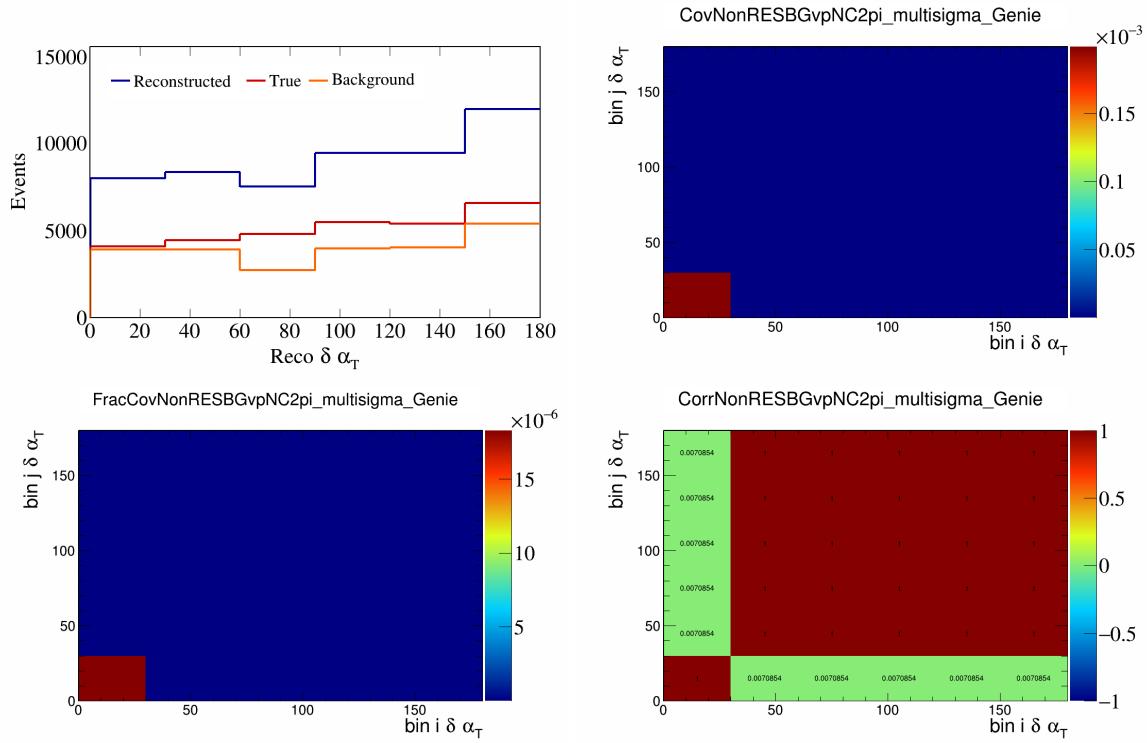


Figure 595: NonRESBGvpNC2pi variations for $\delta \alpha_T$.

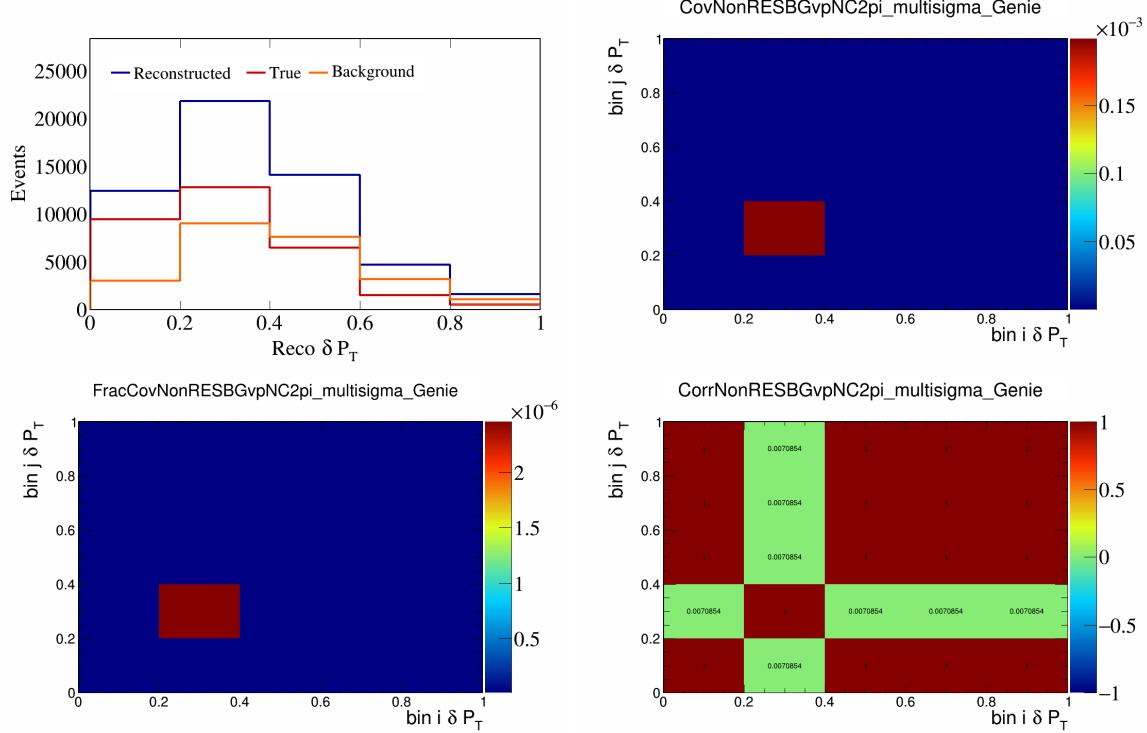


Figure 596: NonRESBGvpNC2pi variations for δP_T .

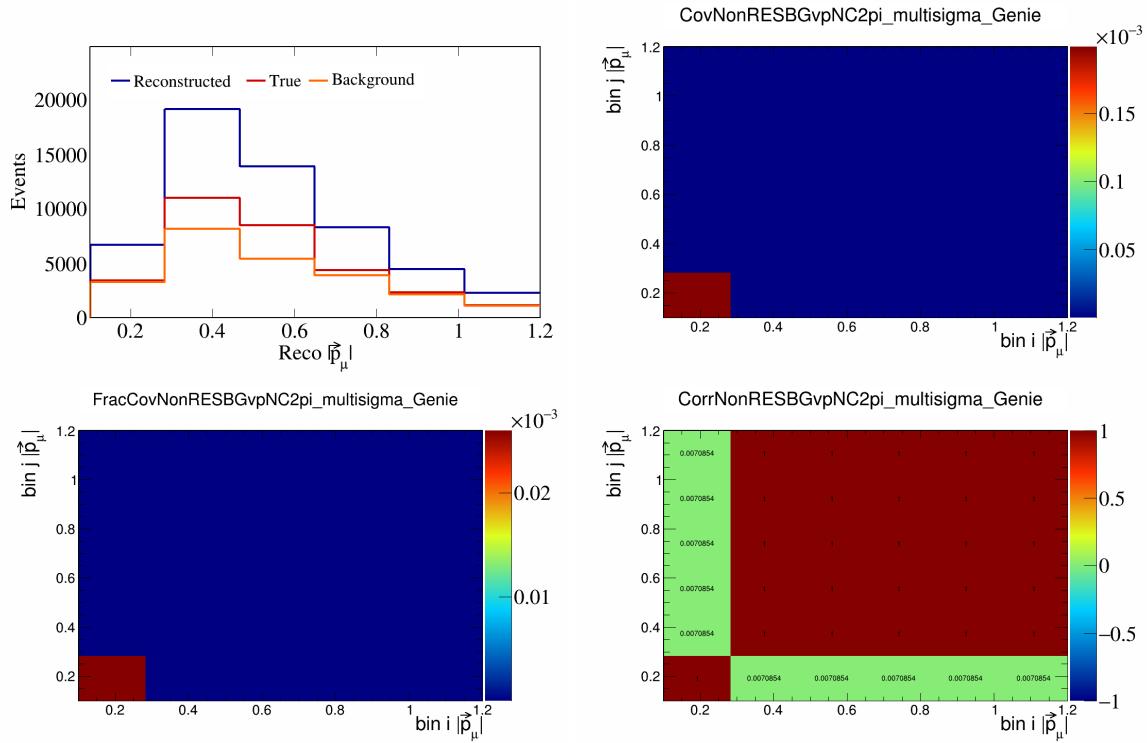


Figure 597: NonRESBGvpNC2pi variations for $|\vec{p}_\mu|$.

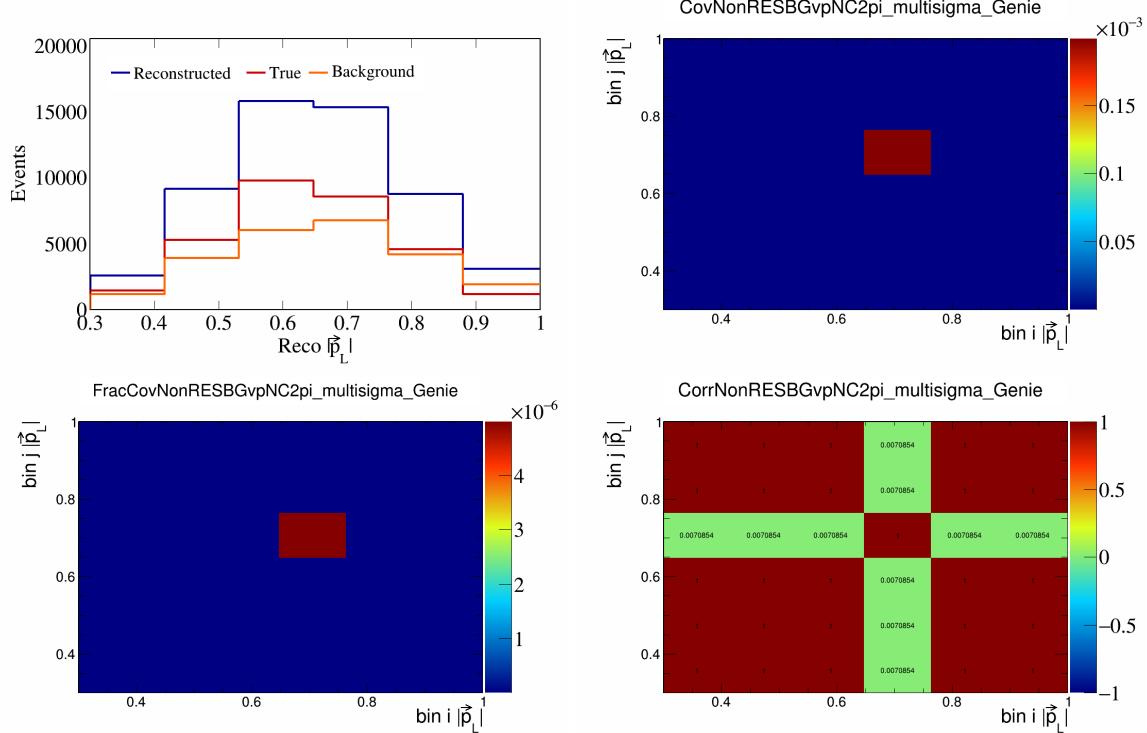


Figure 598: NonRESBGvpNC2pi variations for $|\vec{p}_L|$.

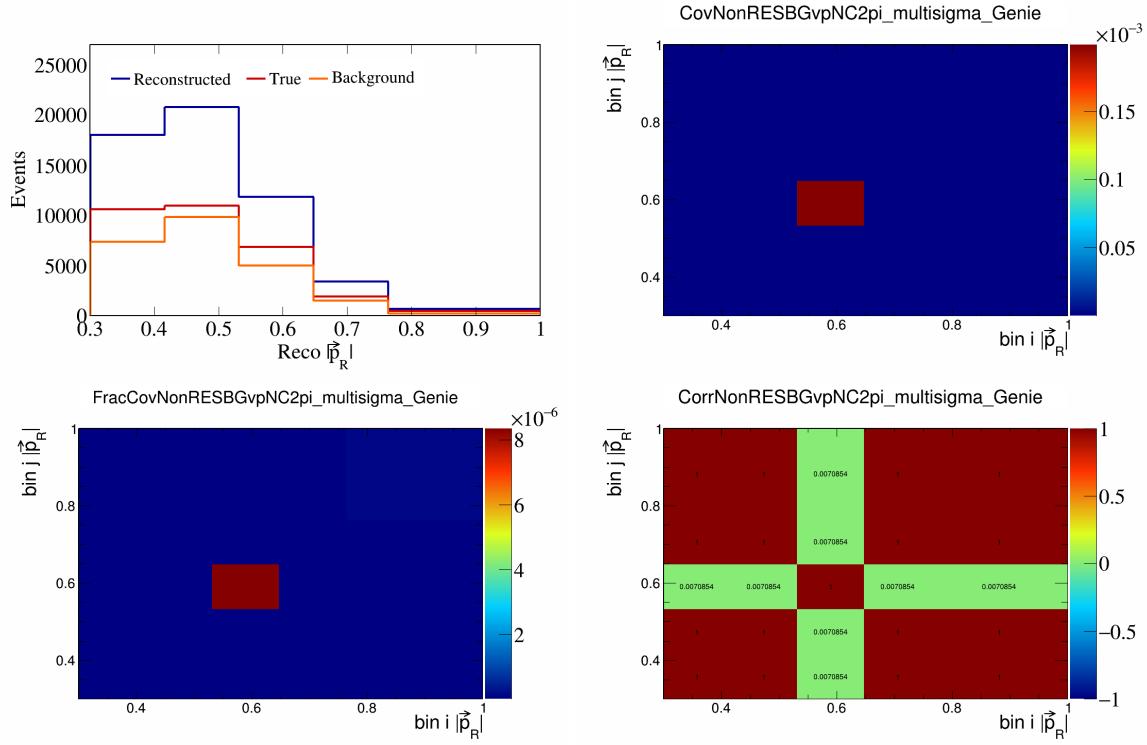


Figure 599: NonRESBGvpNC2pi variations for $|\vec{p}_R|$.

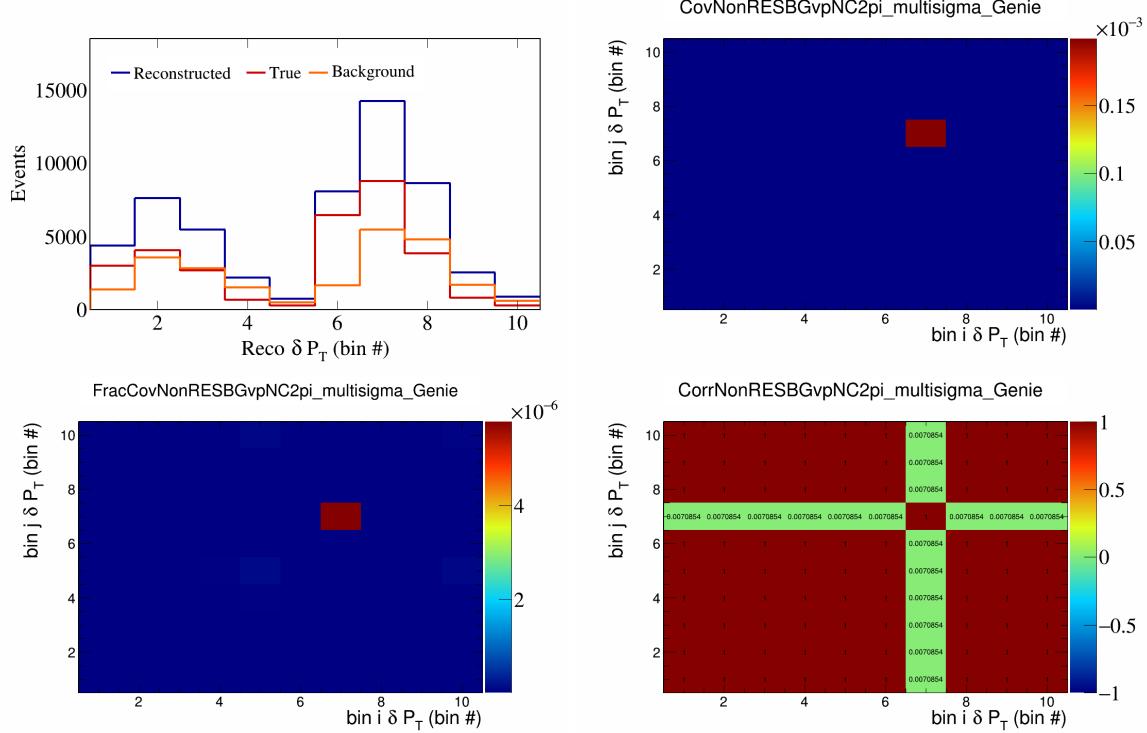


Figure 600: NonRESBGvpNC2pi variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

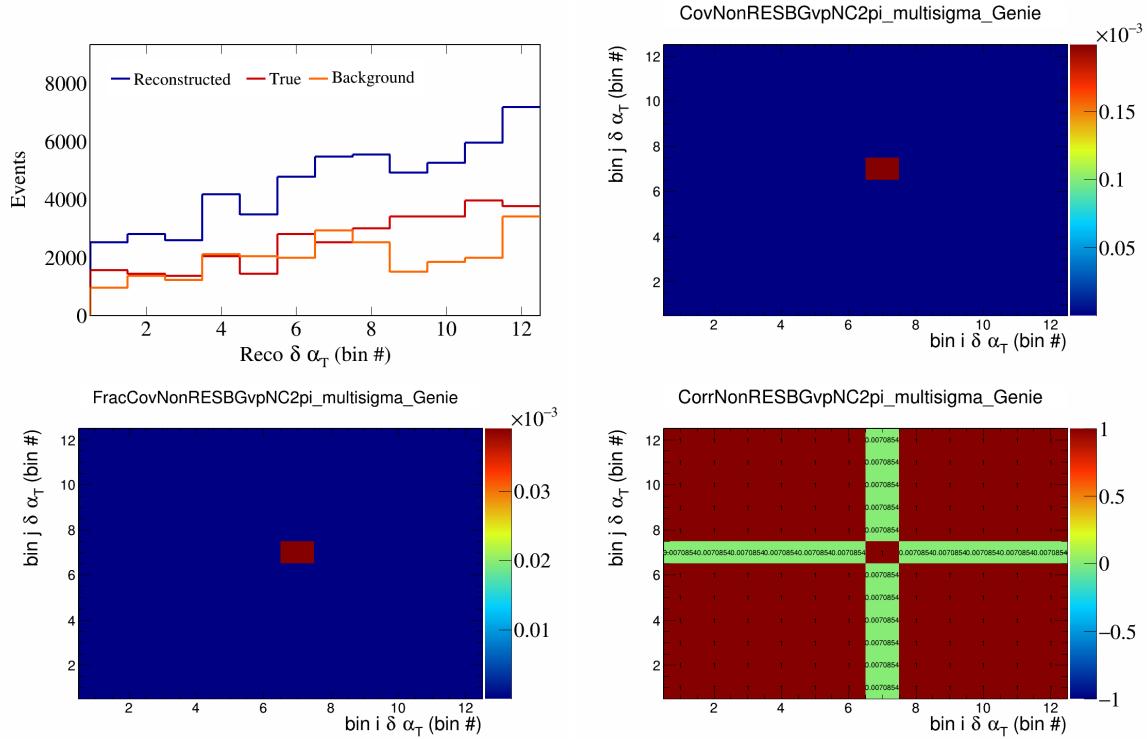


Figure 601: NonRESBGvpNC2pi variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

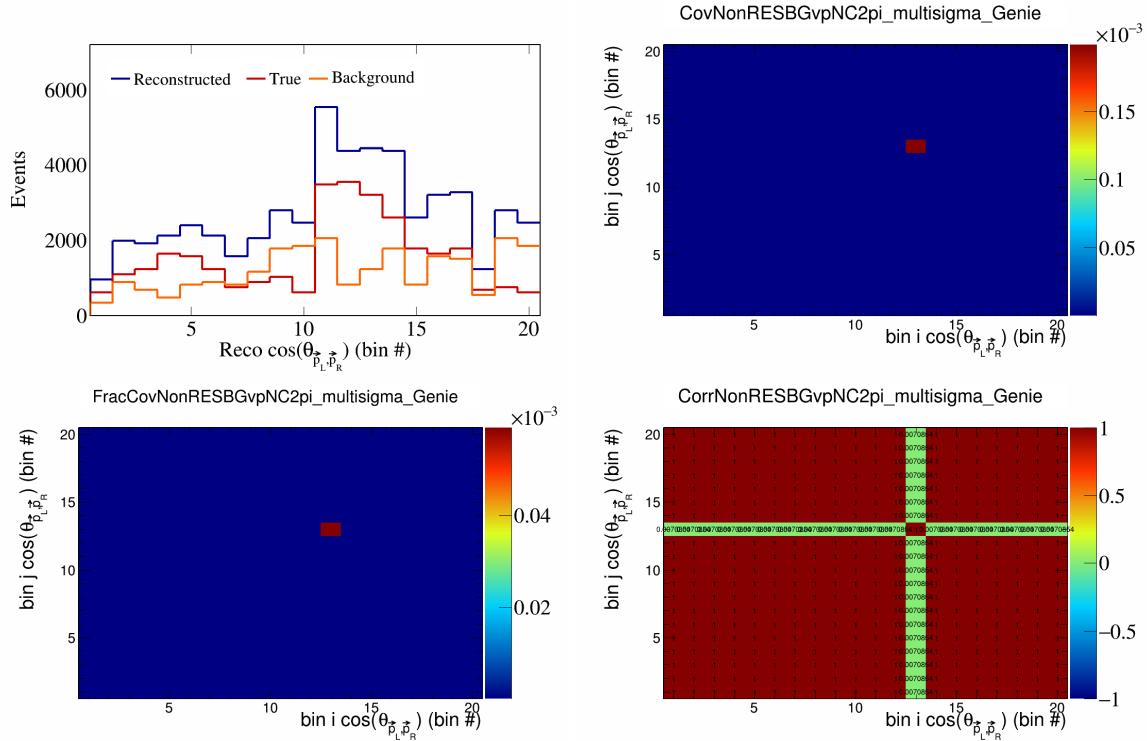


Figure 602: NonRESBGvpNC2pi variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

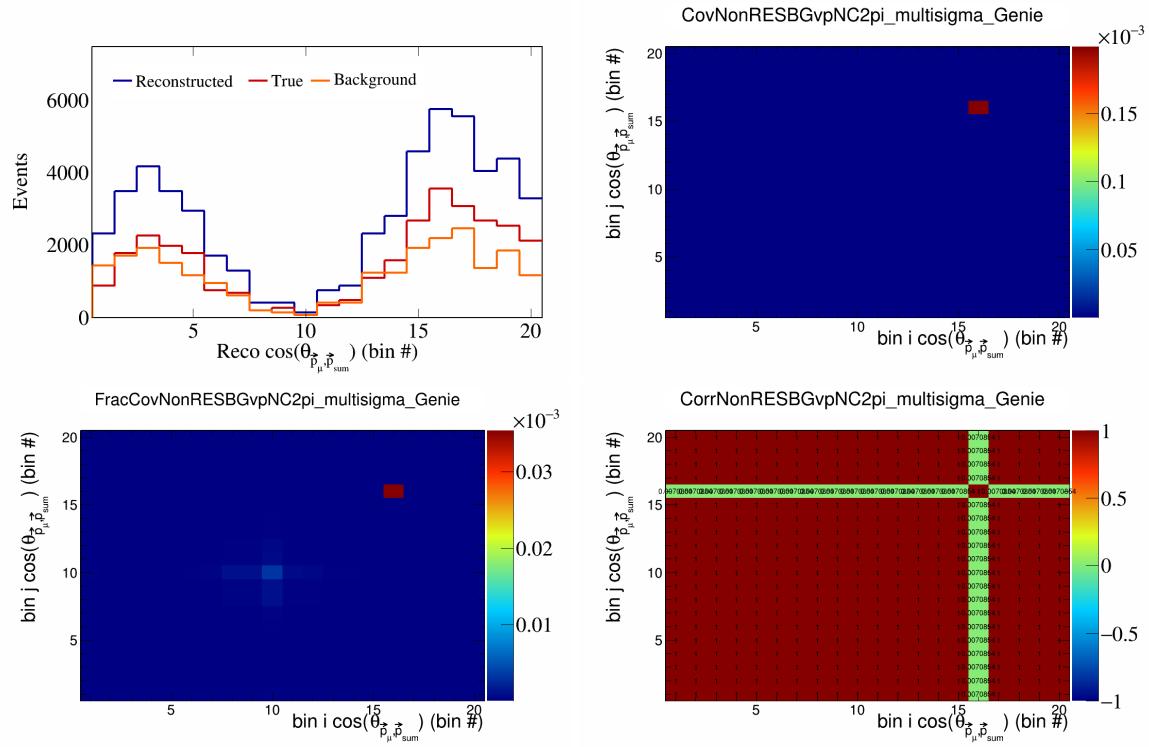


Figure 603: NonRESBGvpNC2pi variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

228 **5.3 Flux systematics**

229 In this appendix, the variations, covariance matrices, fractional covariance matrices, and correlation matrices
 230 are plotted for all of the flux systematics and variables.

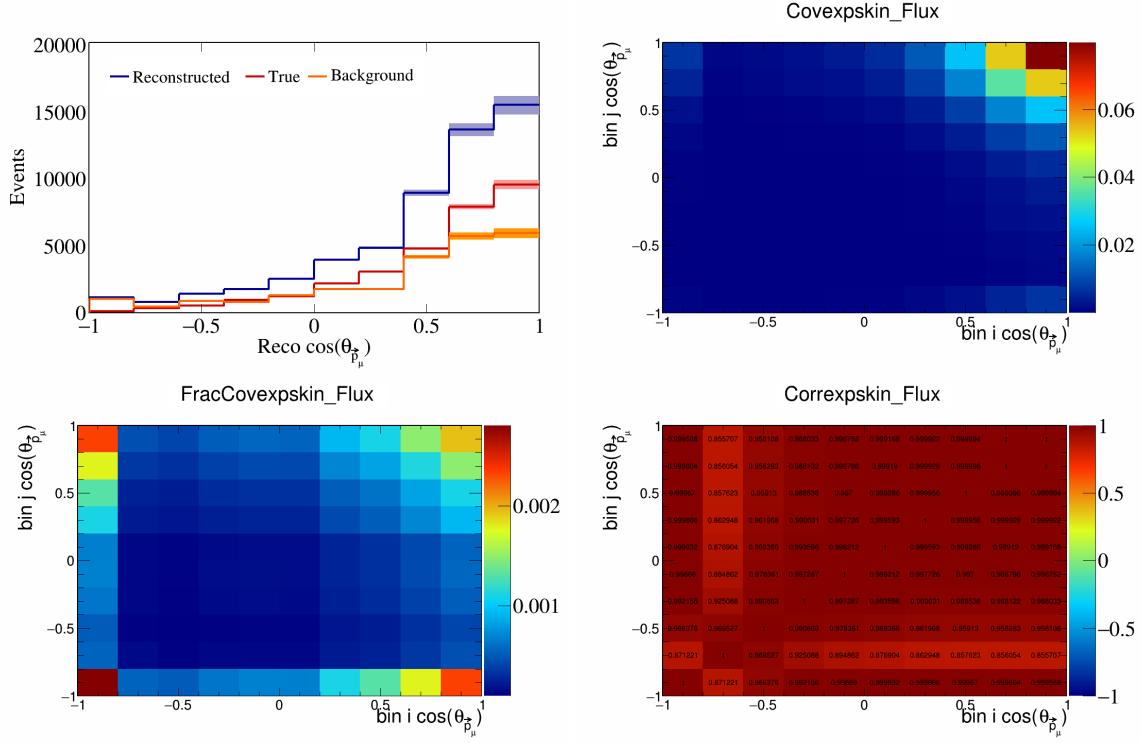


Figure 604: Epskin variations for $\cos(\theta_{\vec{p}_\mu})$.

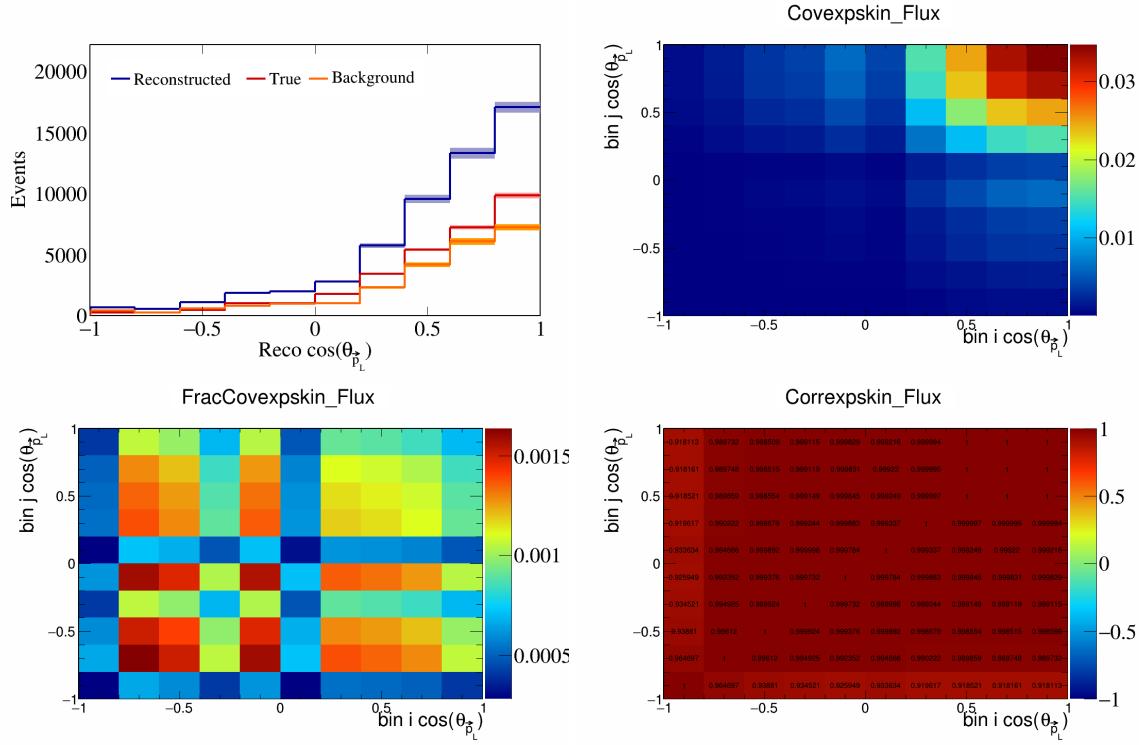


Figure 605: Expskin variations for $\cos(\theta_{\vec{p}_L})$.

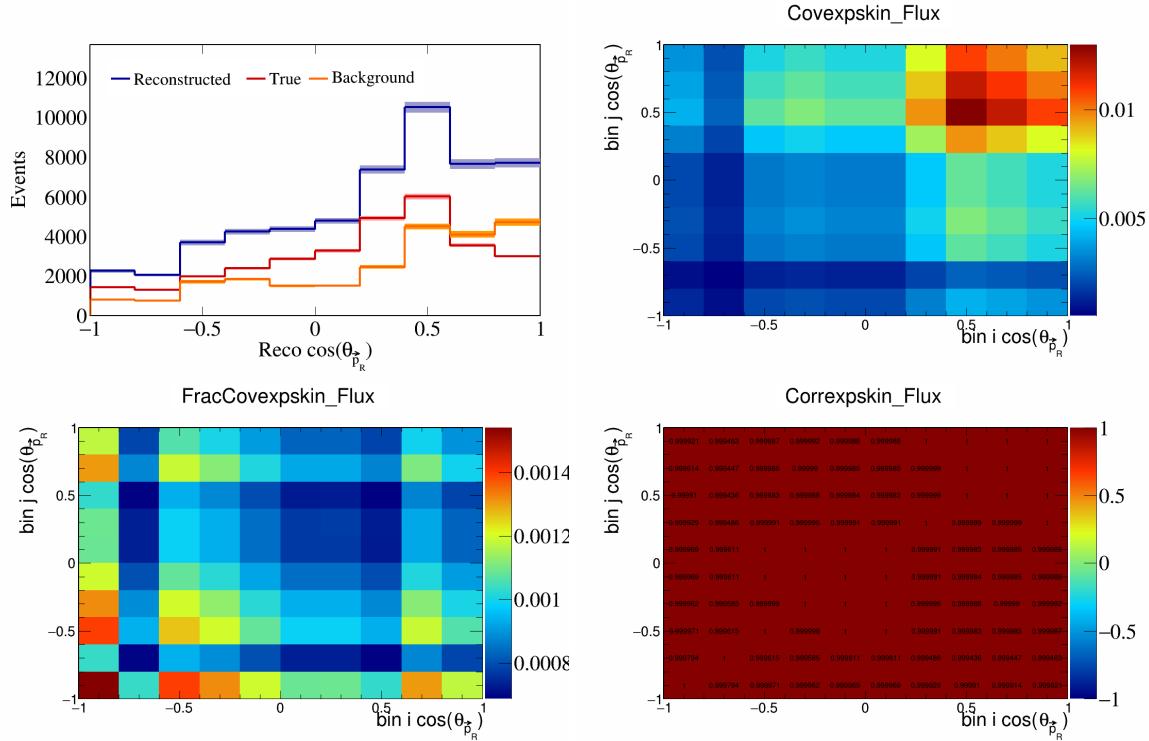


Figure 606: Expskin variations for $\cos(\theta_{\vec{p}_R})$.

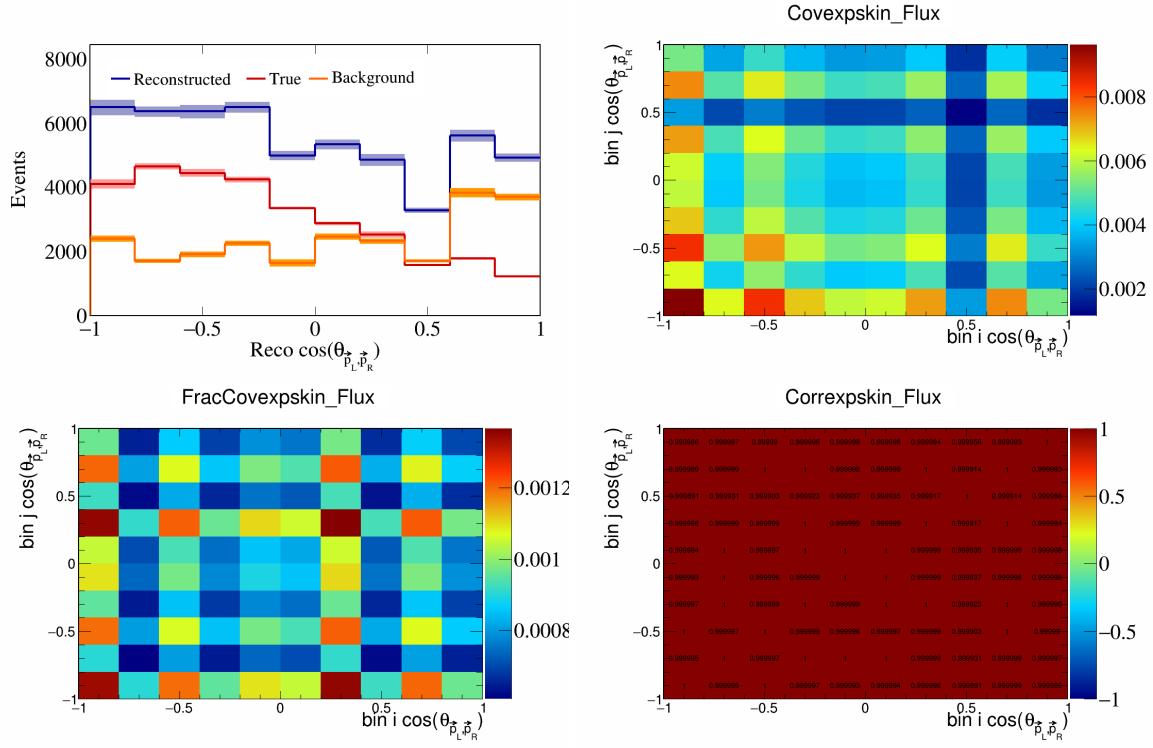


Figure 607: ExpSkin variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

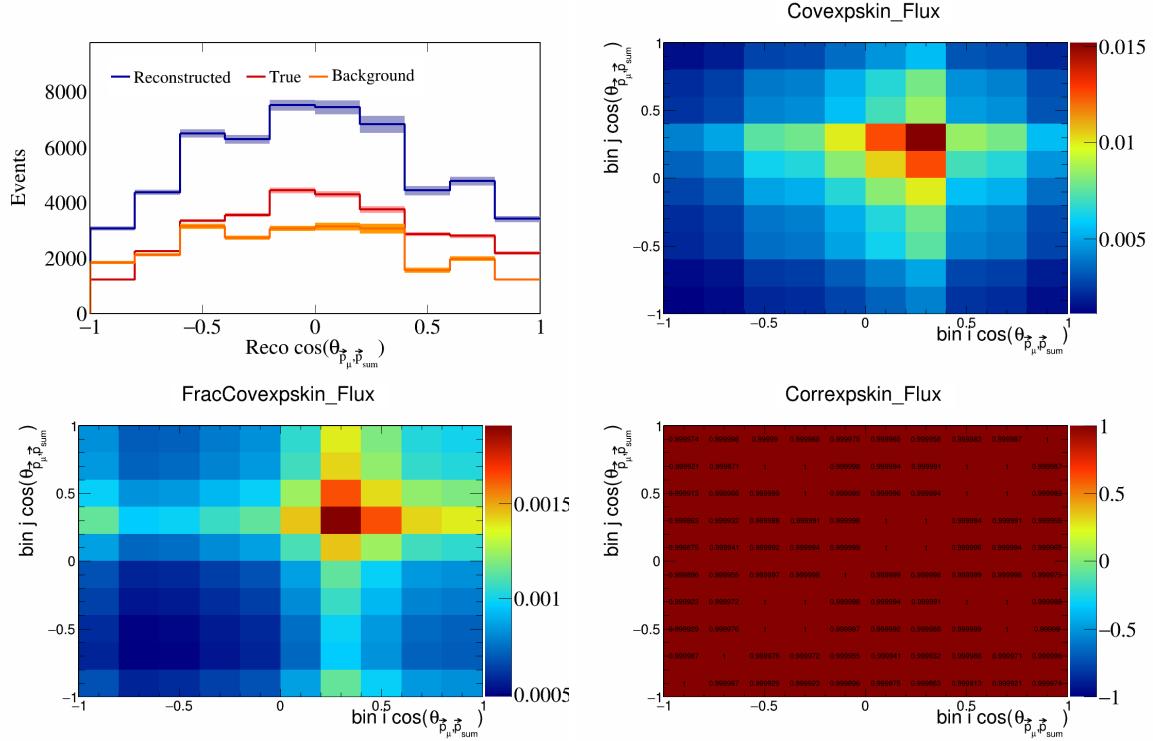


Figure 608: ExpSkin variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

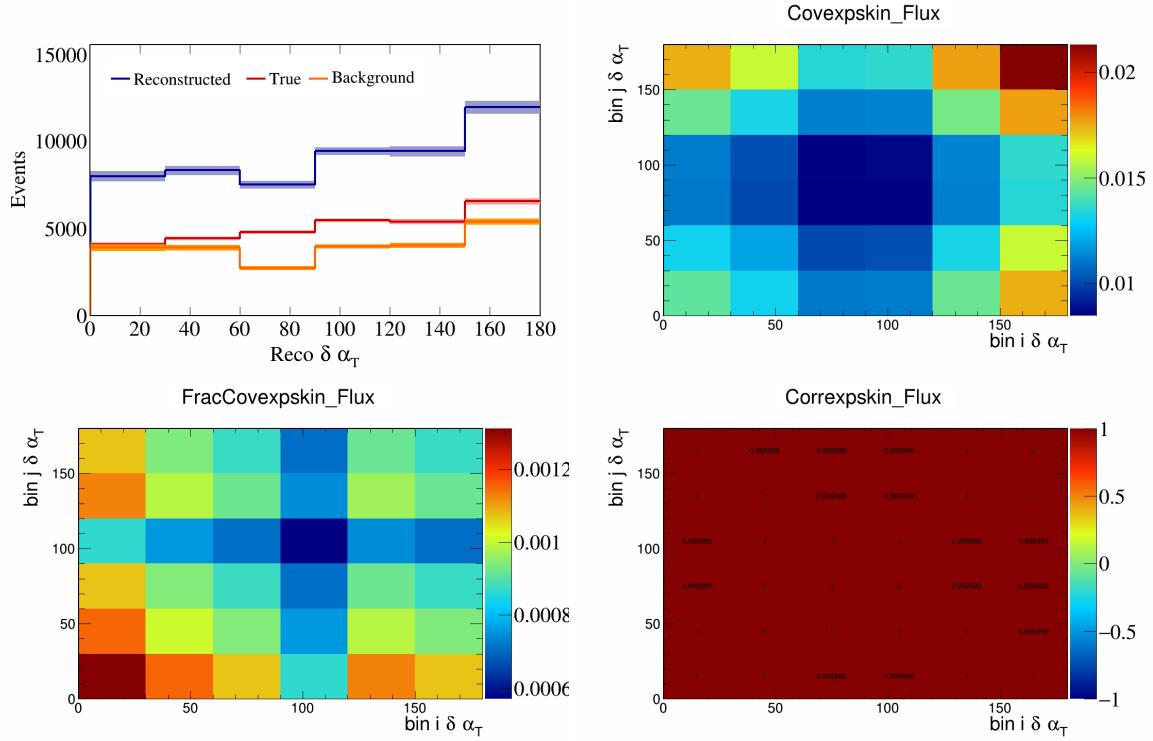


Figure 609: Expskin variations for $\delta \alpha_T$.

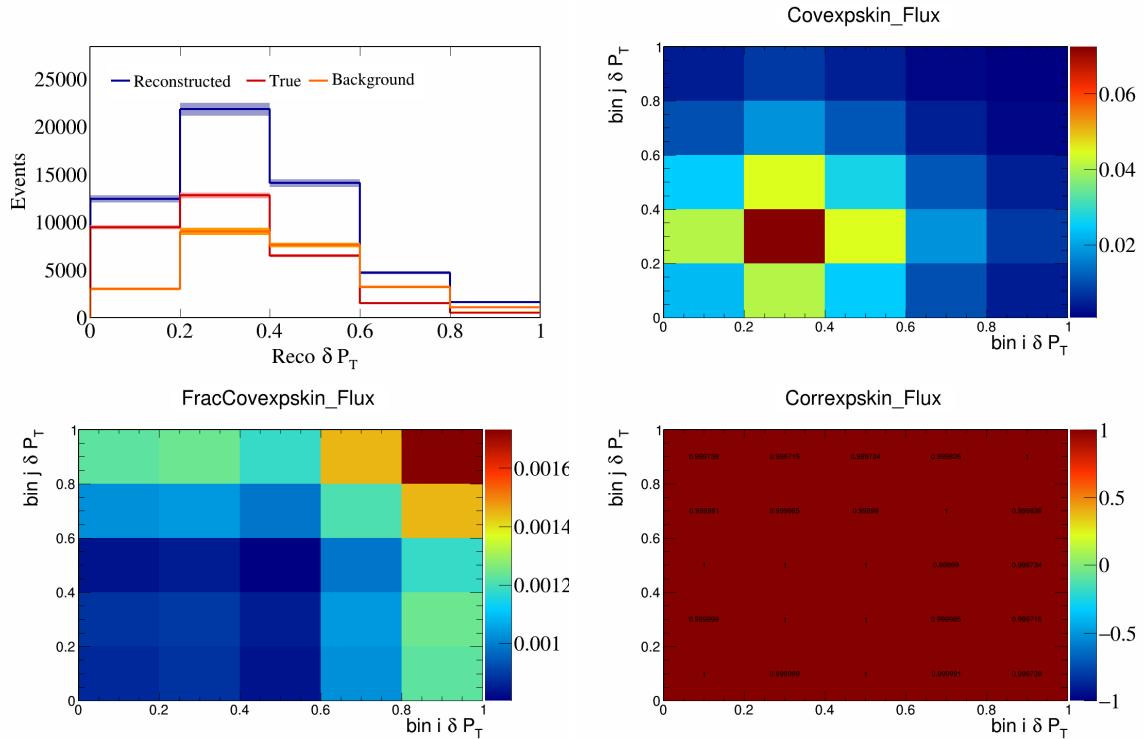


Figure 610: Expskin variations for δP_T .

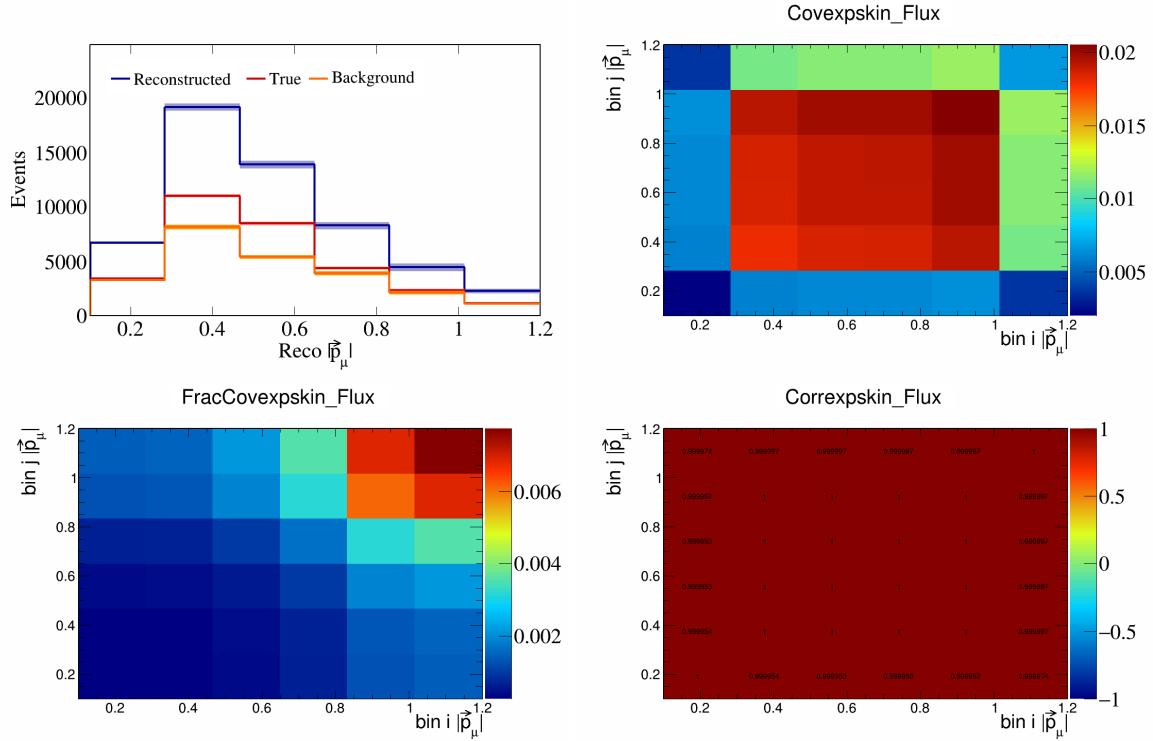


Figure 611: Expskin variations for $|\vec{p}_\mu|$.

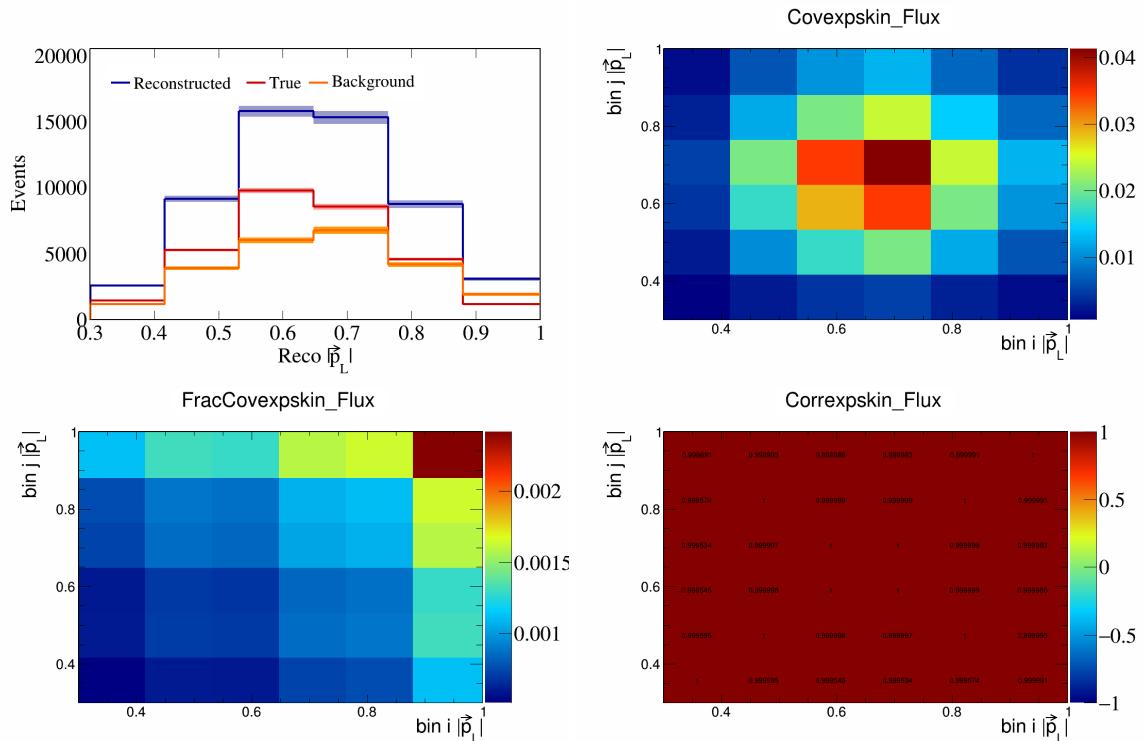


Figure 612: Expskin variations for $|\vec{p}_L|$.

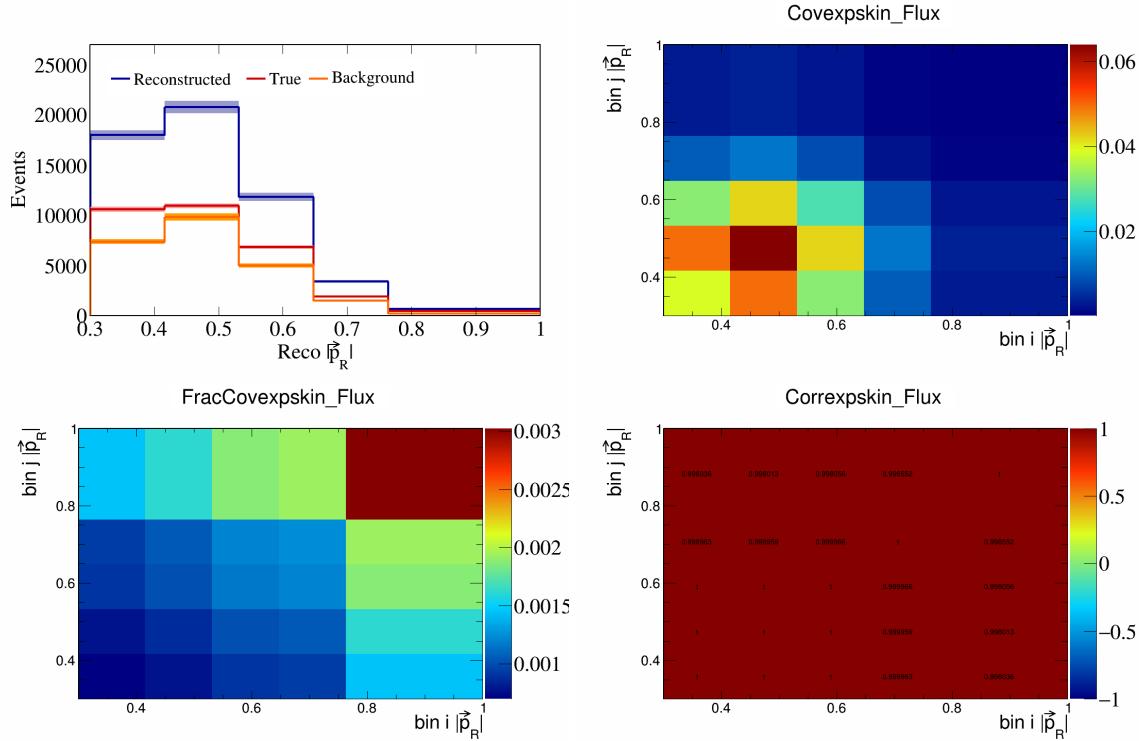


Figure 613: Expskin variations for $|\vec{p}_R|$.

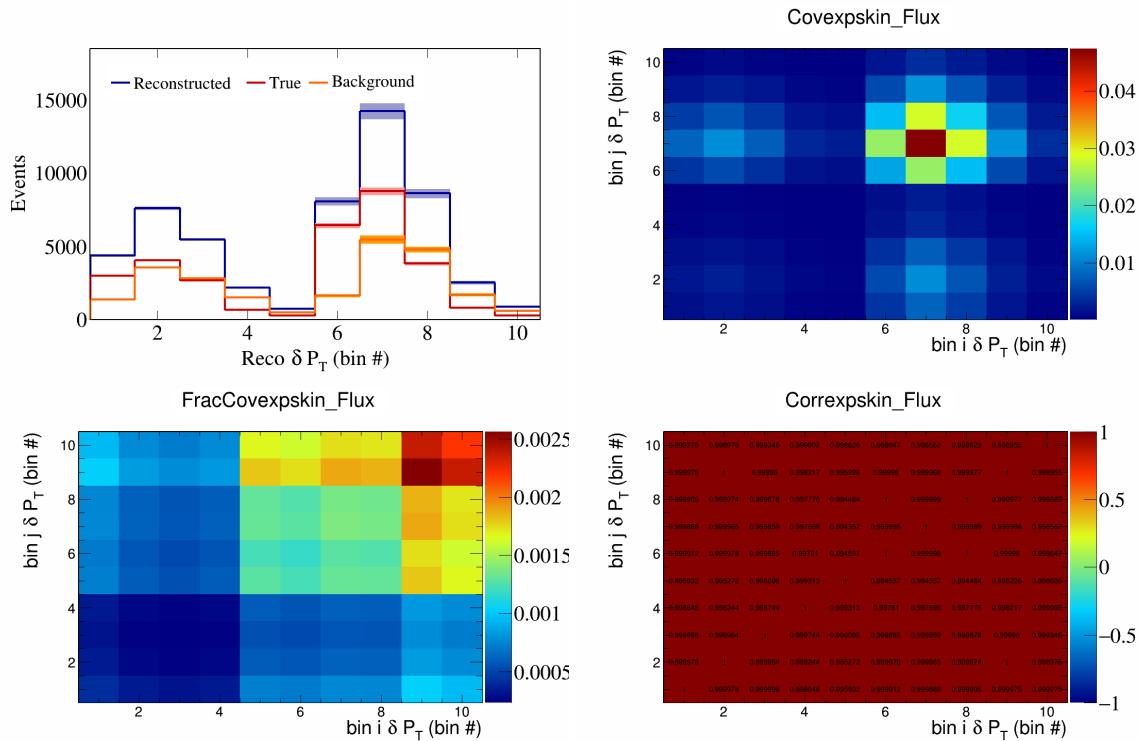


Figure 614: Expskin variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

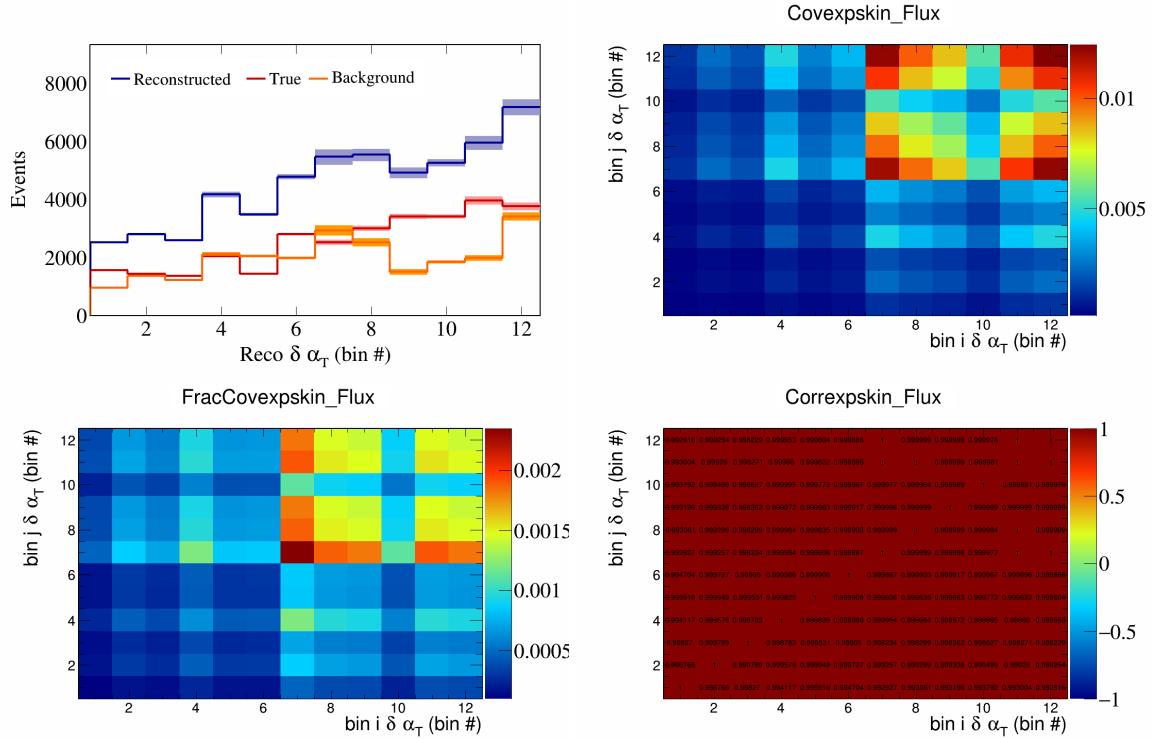


Figure 615: Expskin variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

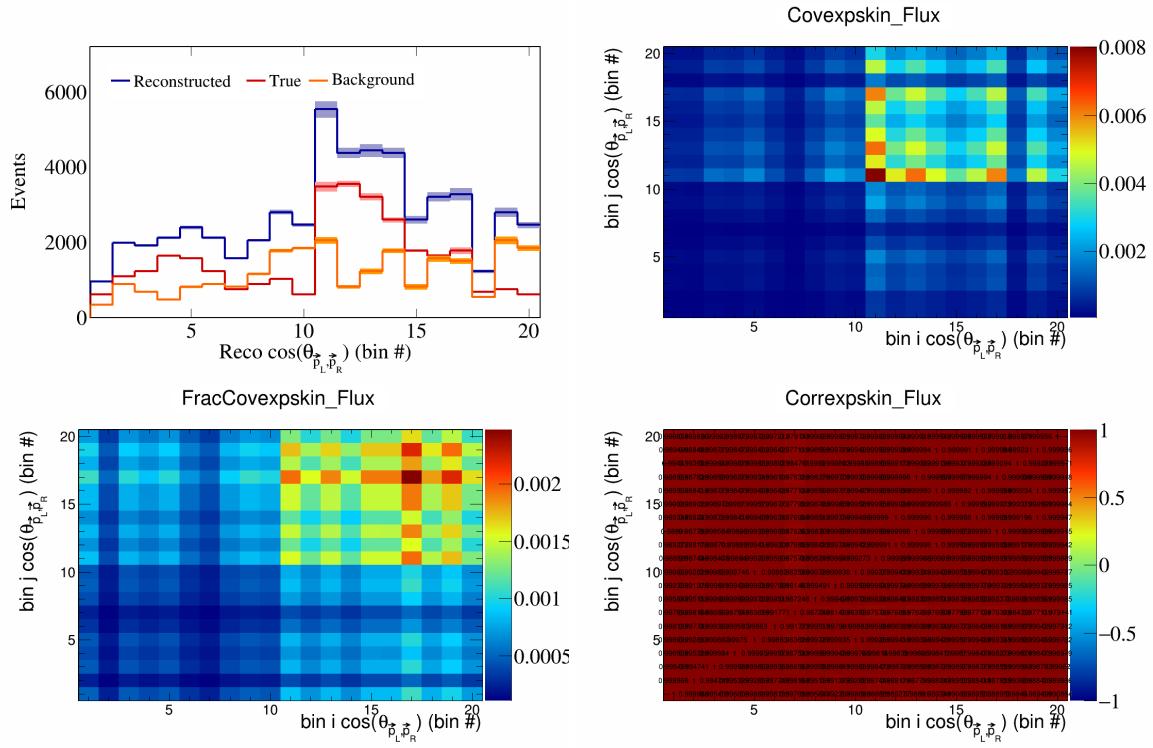


Figure 616: Expskin variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

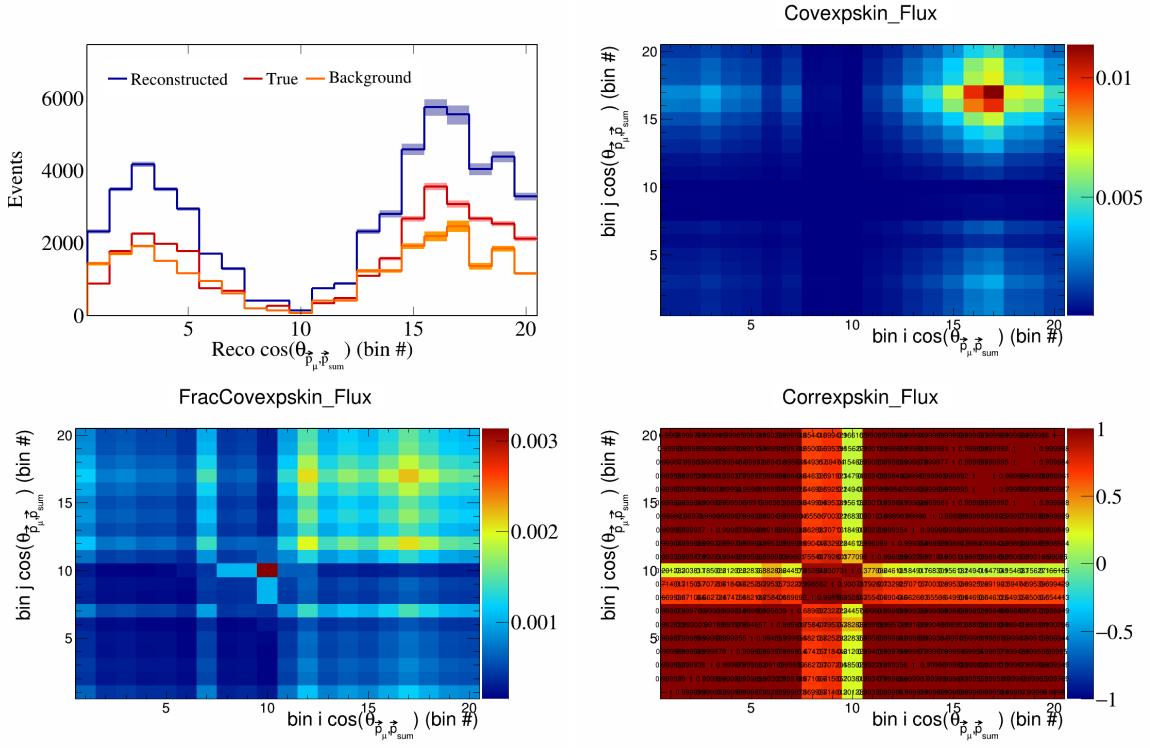


Figure 617: ExpSkin variations for $\cos(\theta_{\vec{p}_\mu}, \vec{p}_{\text{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

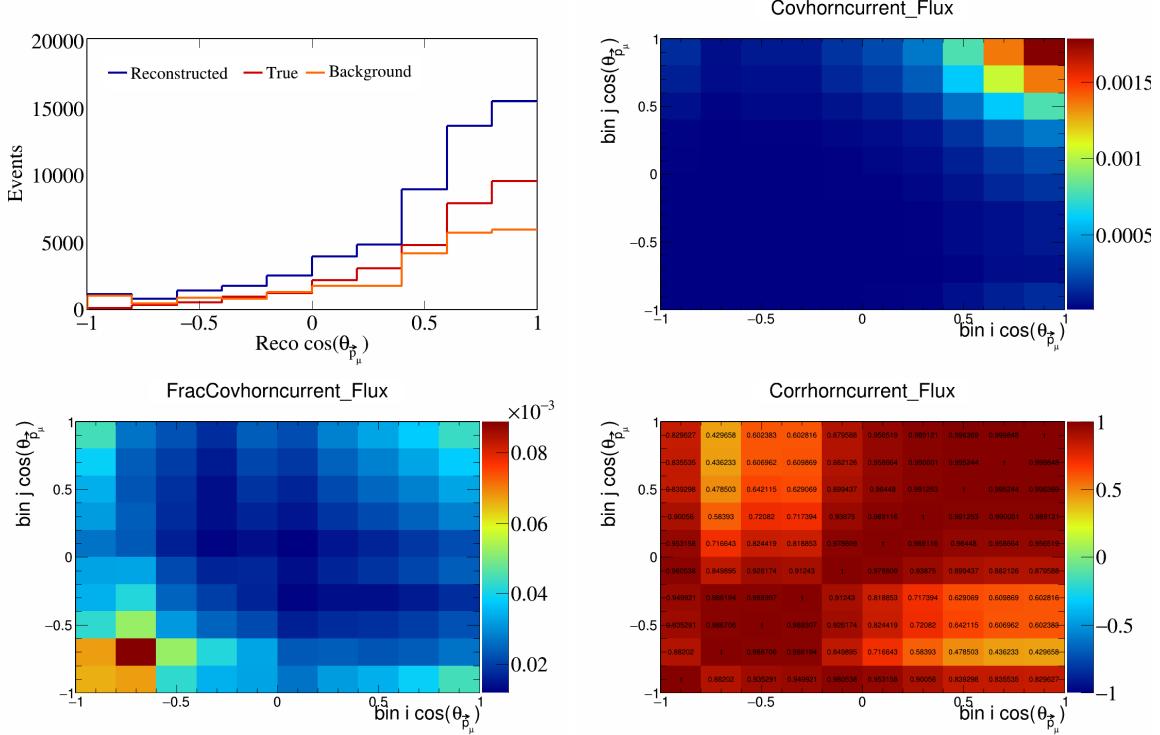


Figure 618: HornCurrent variations for $\cos(\theta_{\vec{p}_\mu})$.

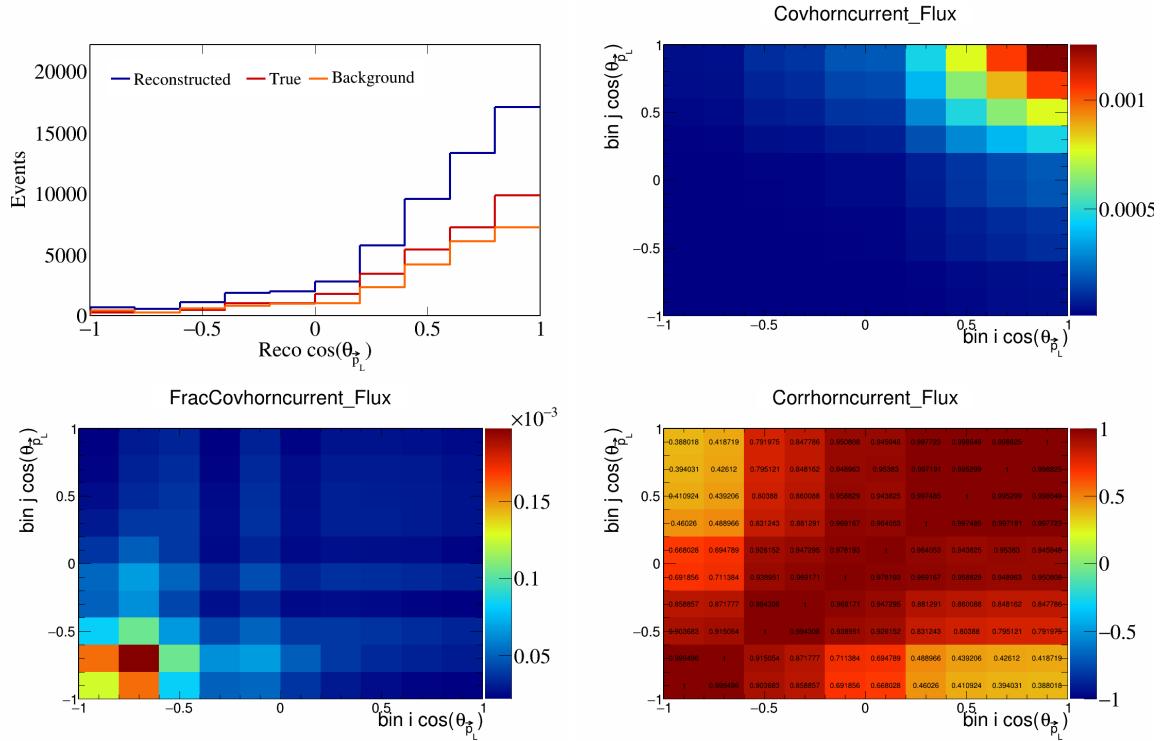


Figure 619: HornCurrent variations for $\cos(\theta_{\vec{p}_L})$.

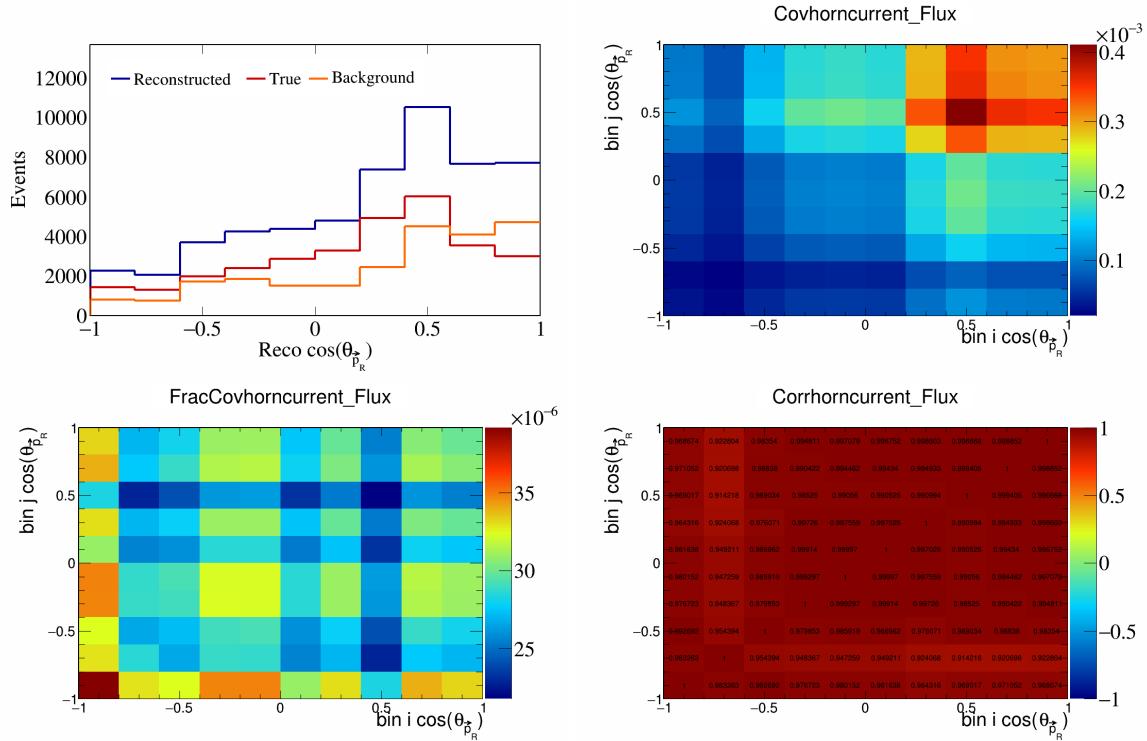


Figure 620: HornCurrent variations for $\cos(\theta_{\vec{p}_R})$.

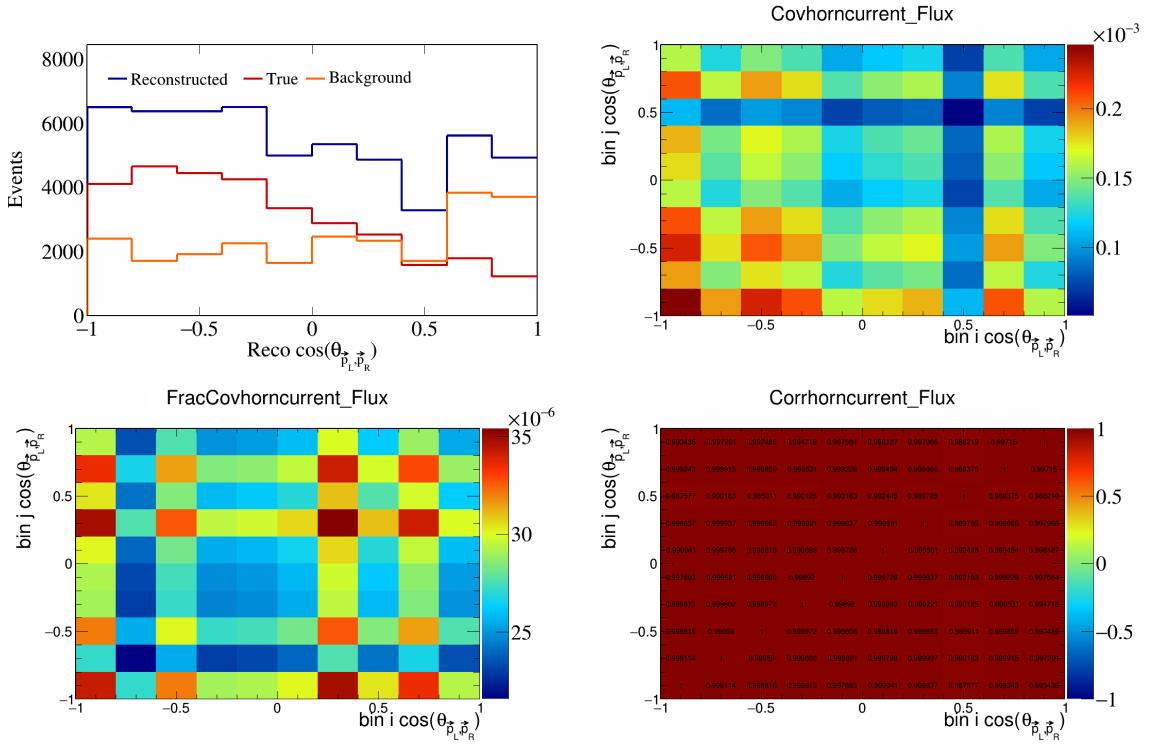


Figure 621: HornCurrent variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

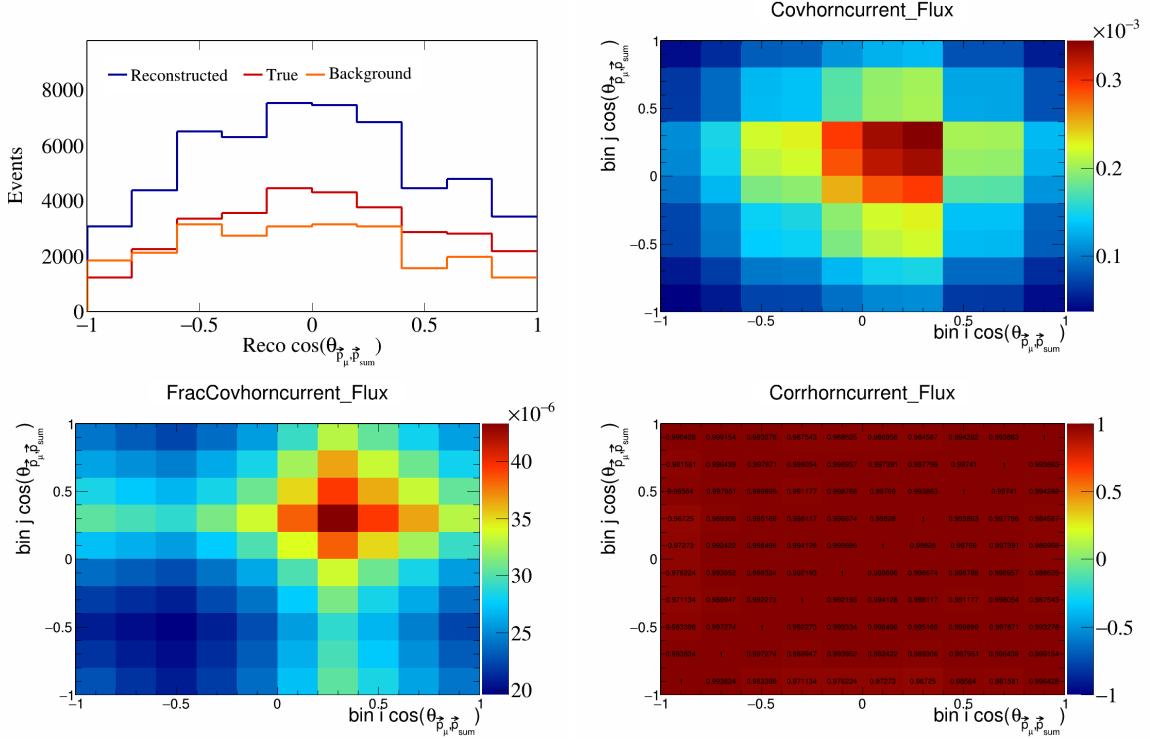


Figure 622: HornCurrent variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

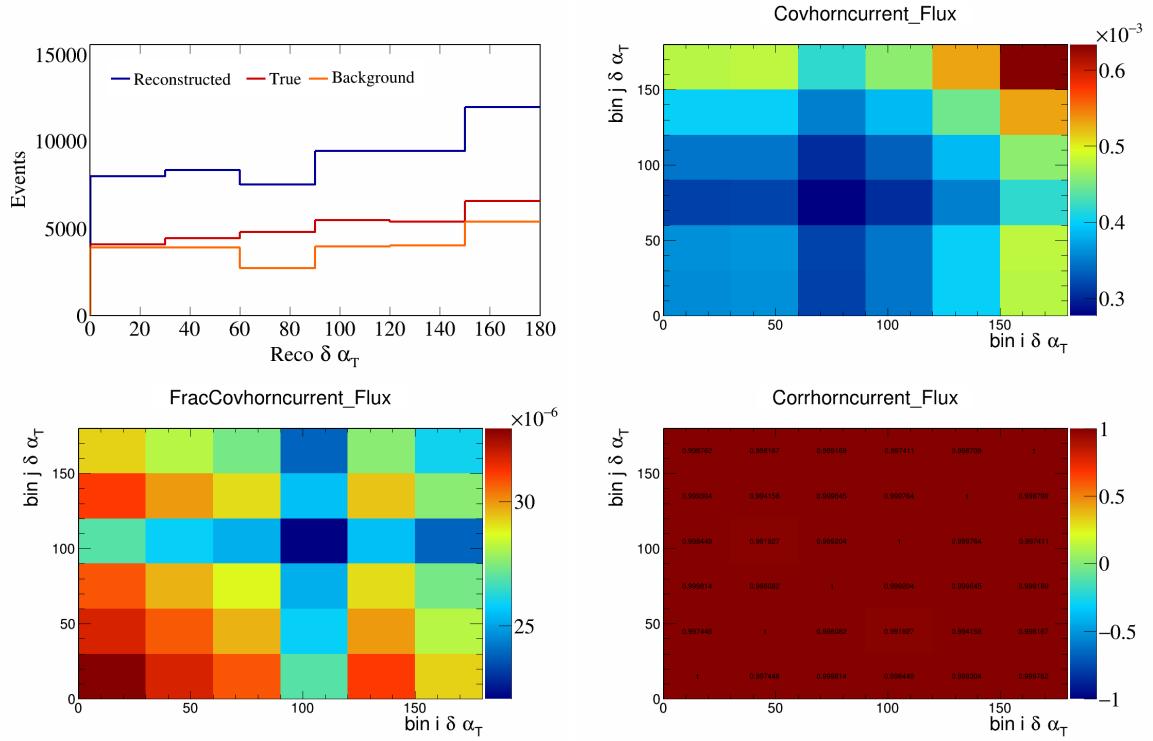


Figure 623: HornCurrent variations for $\delta\alpha_T$.

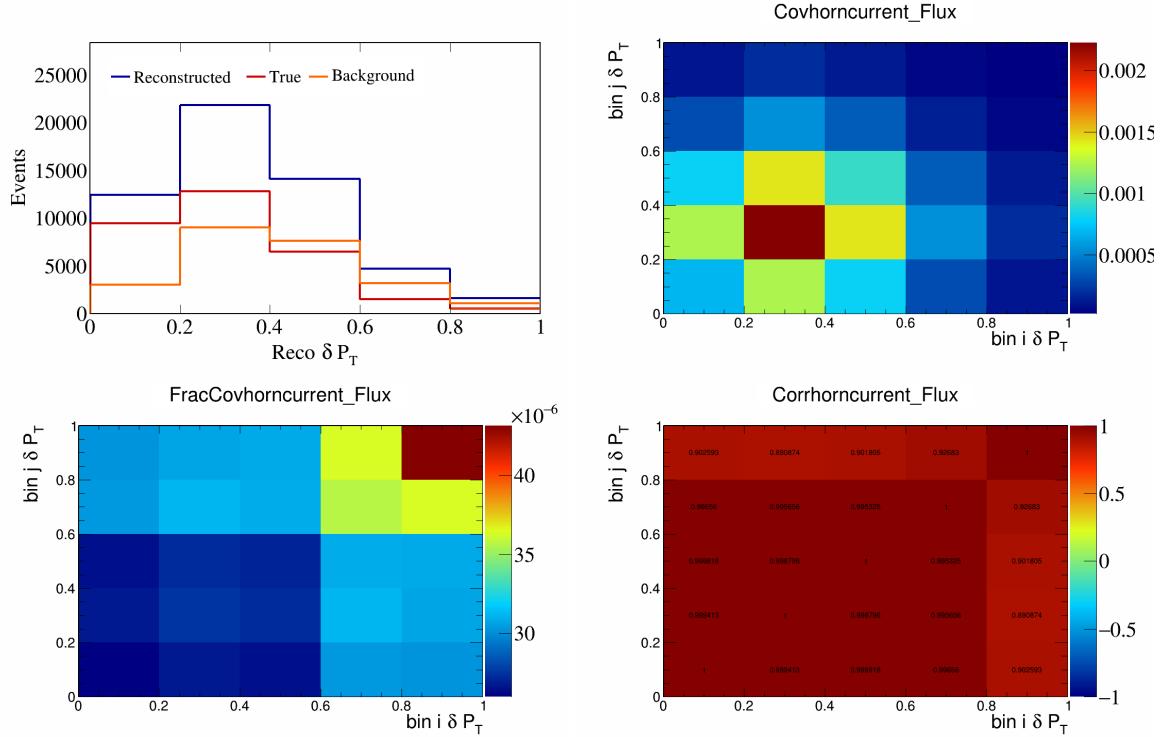


Figure 624: HornCurrent variations for δP_T .

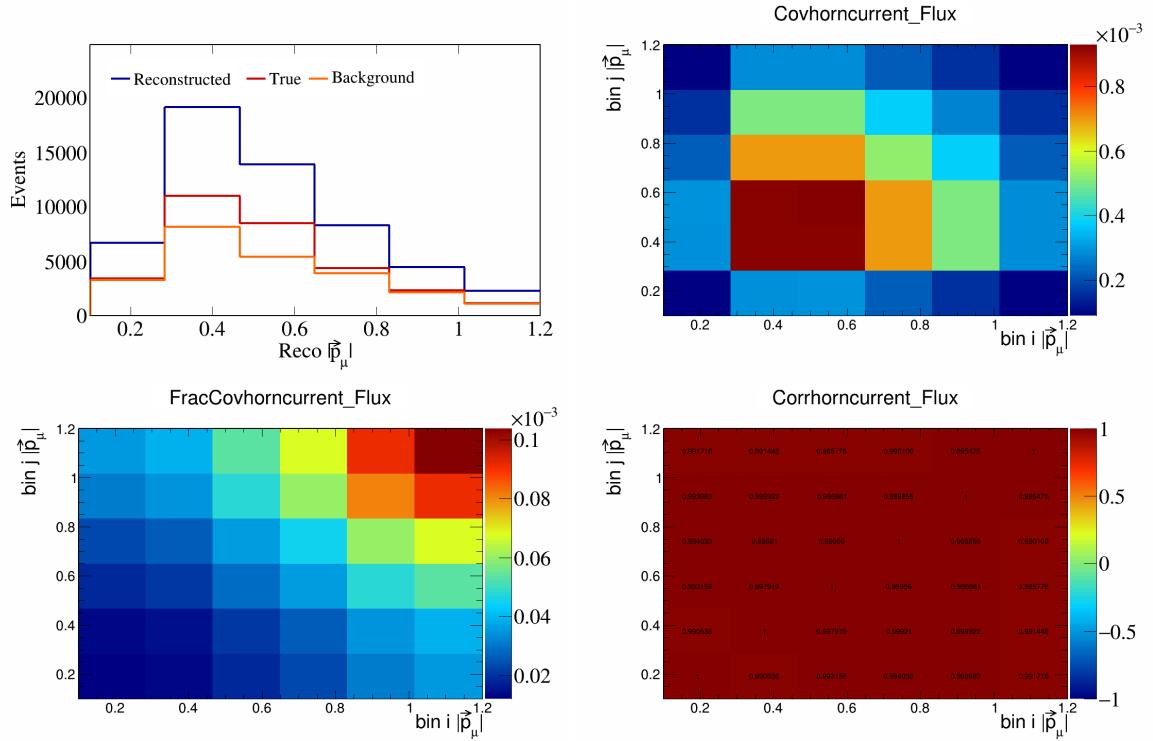


Figure 625: HornCurrent variations for $|\vec{p}_\mu|$.

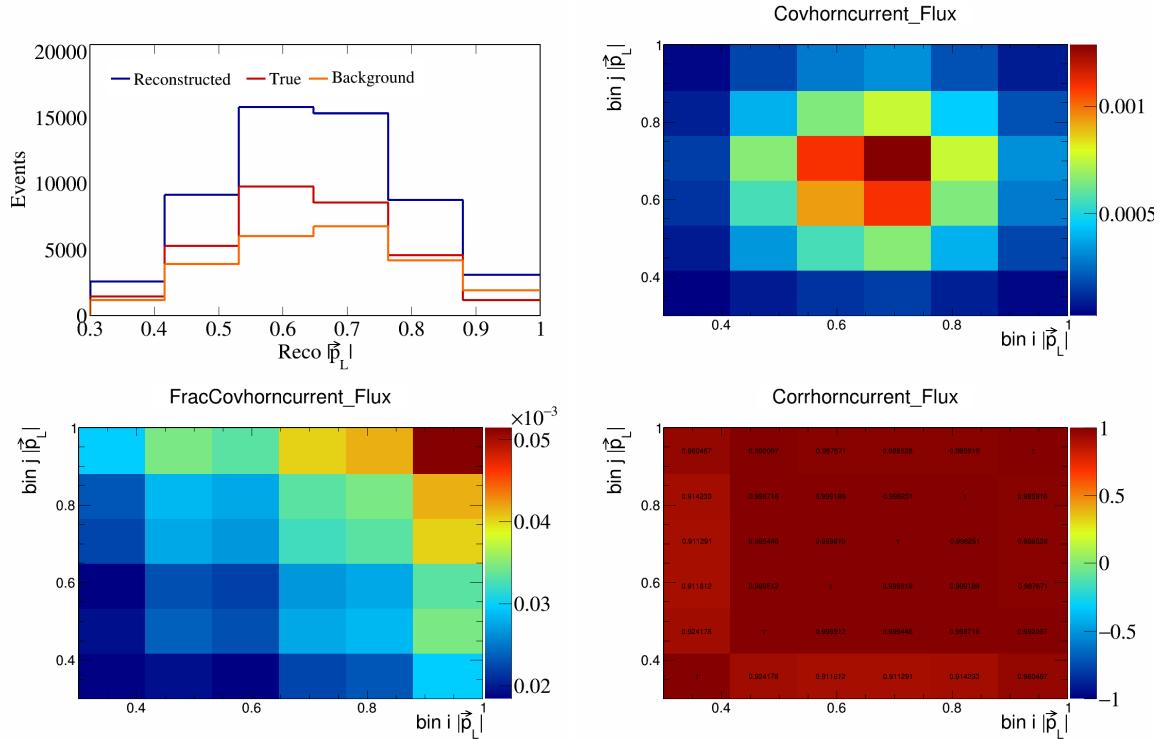


Figure 626: HornCurrent variations for $|\vec{p}_L|$.

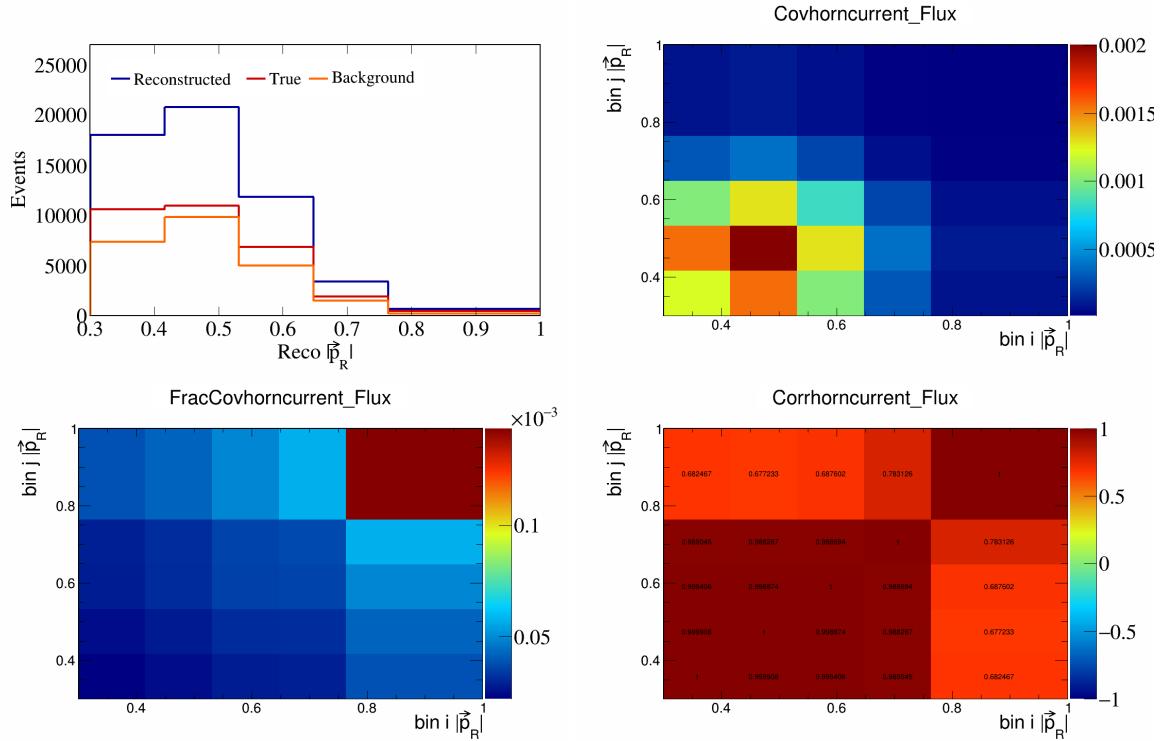


Figure 627: HornCurrent variations for $|\vec{p}_R|$.

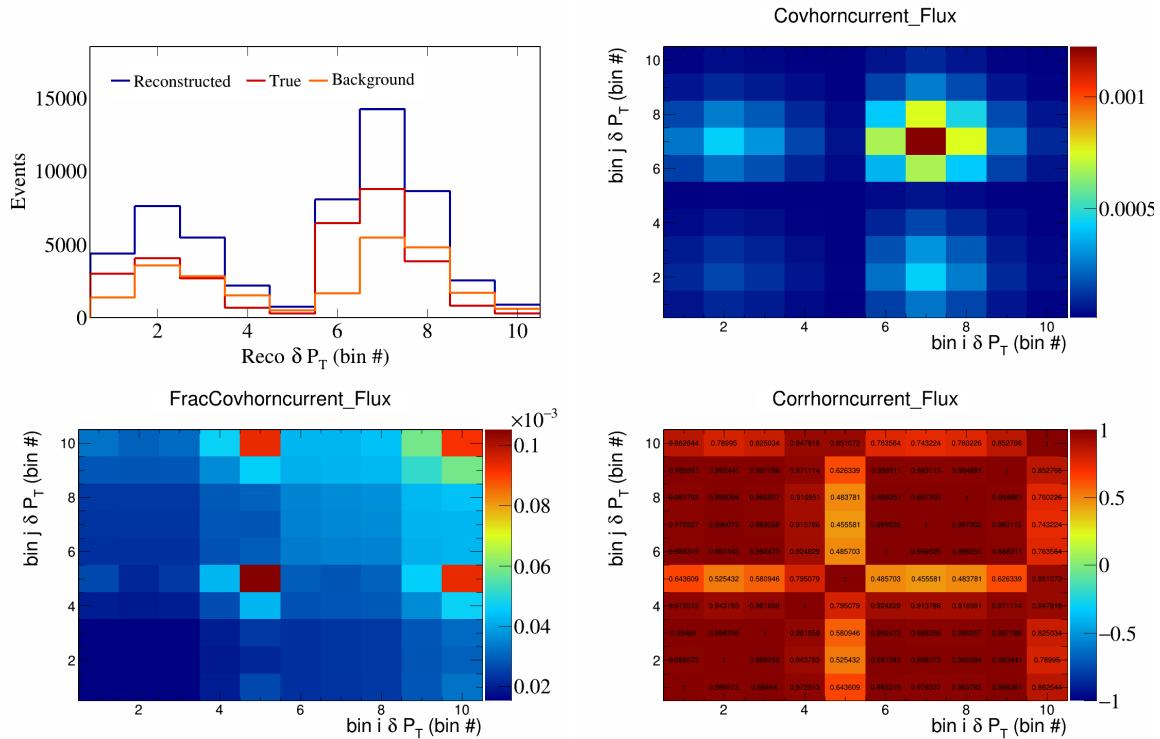


Figure 628: HornCurrent variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

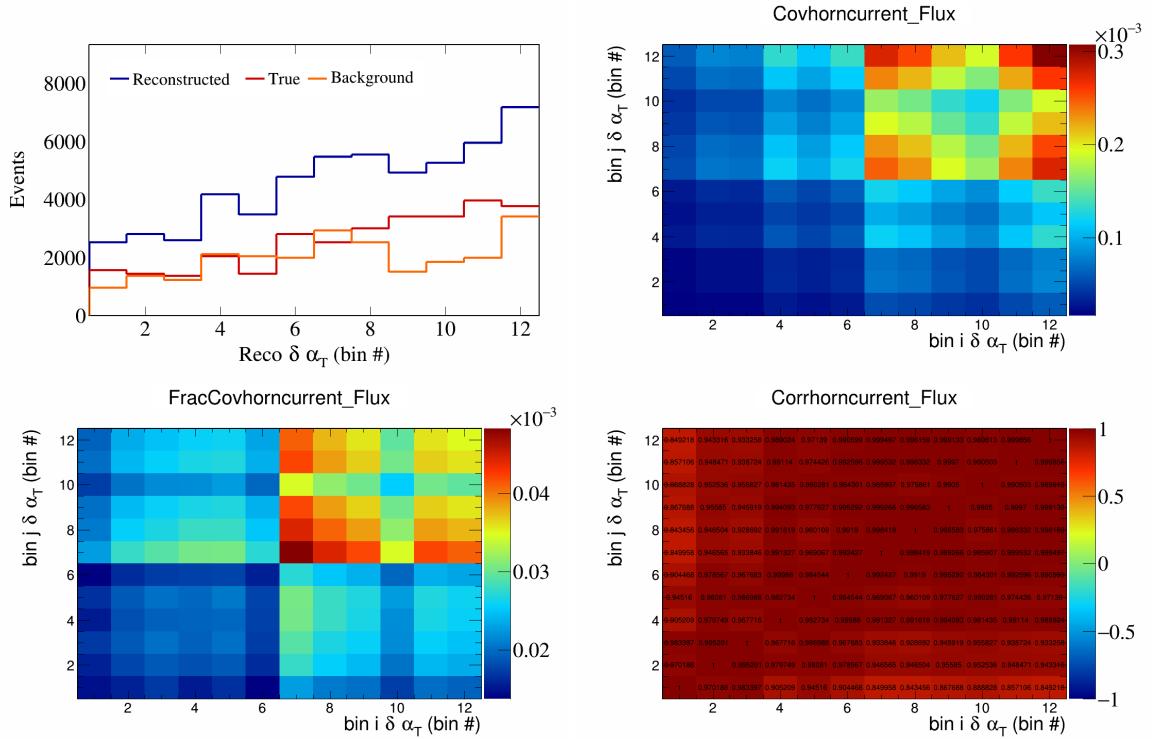


Figure 629: HornCurrent variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

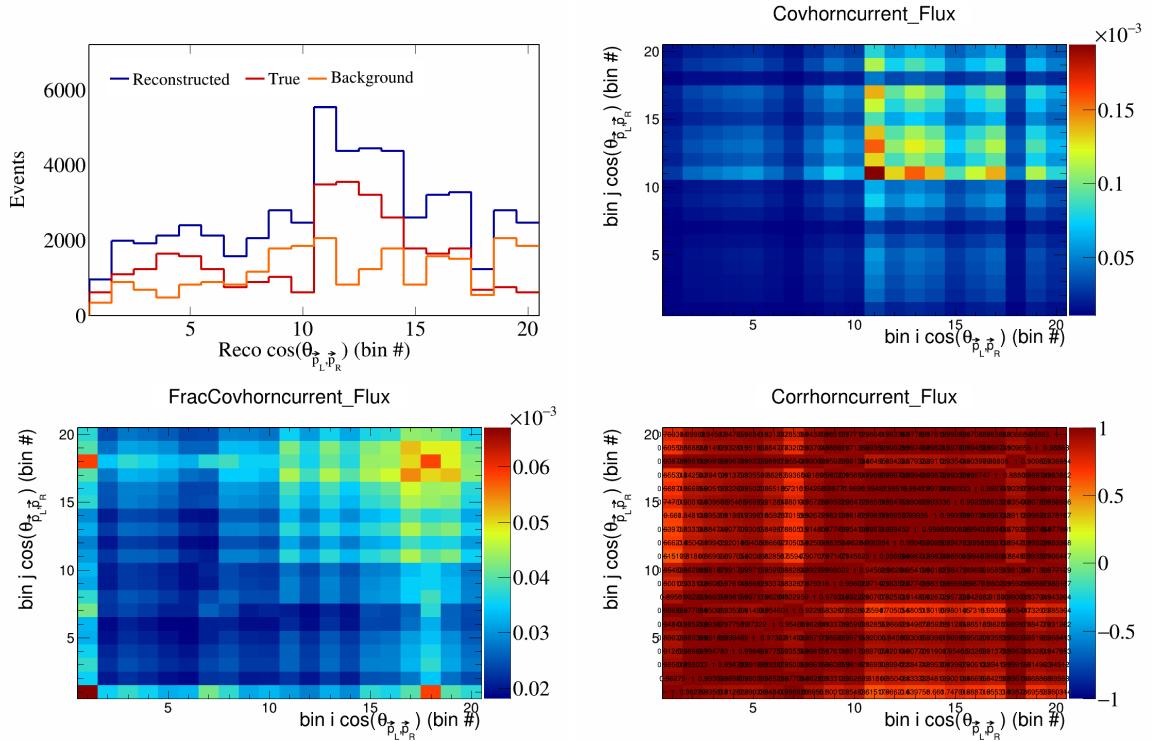


Figure 630: HornCurrent variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

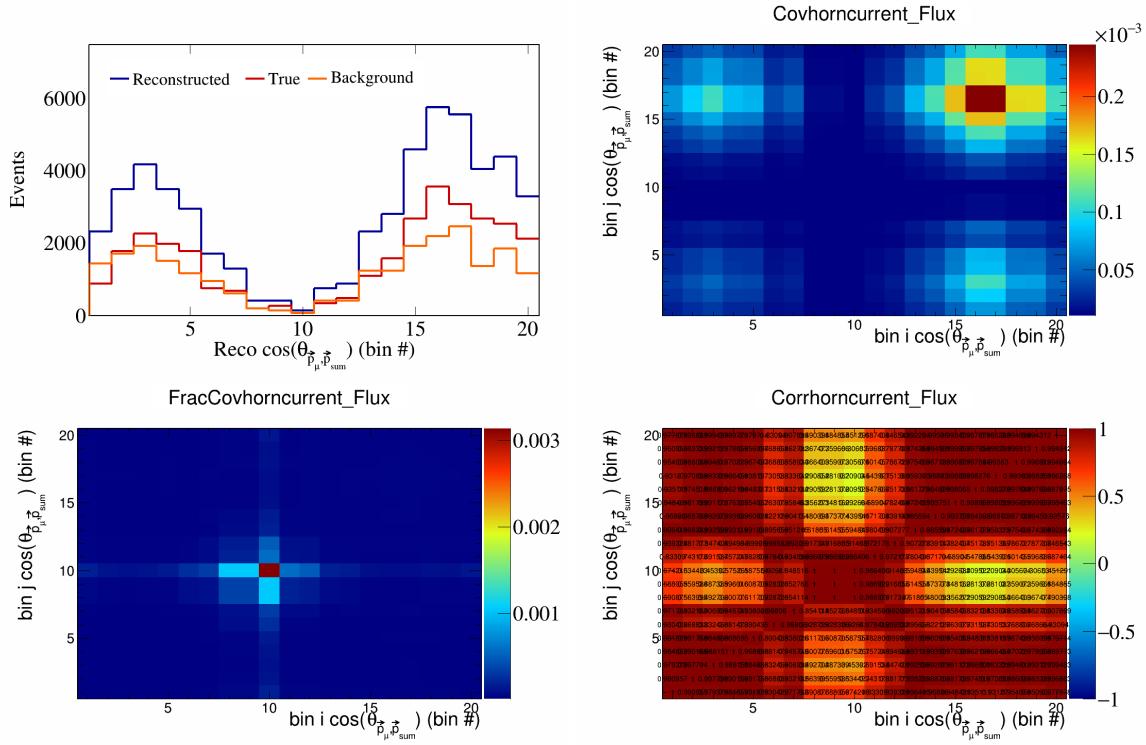


Figure 631: HornCurrent variations for $\cos(\theta_{\vec{p}_\mu} \vec{p}_{\text{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

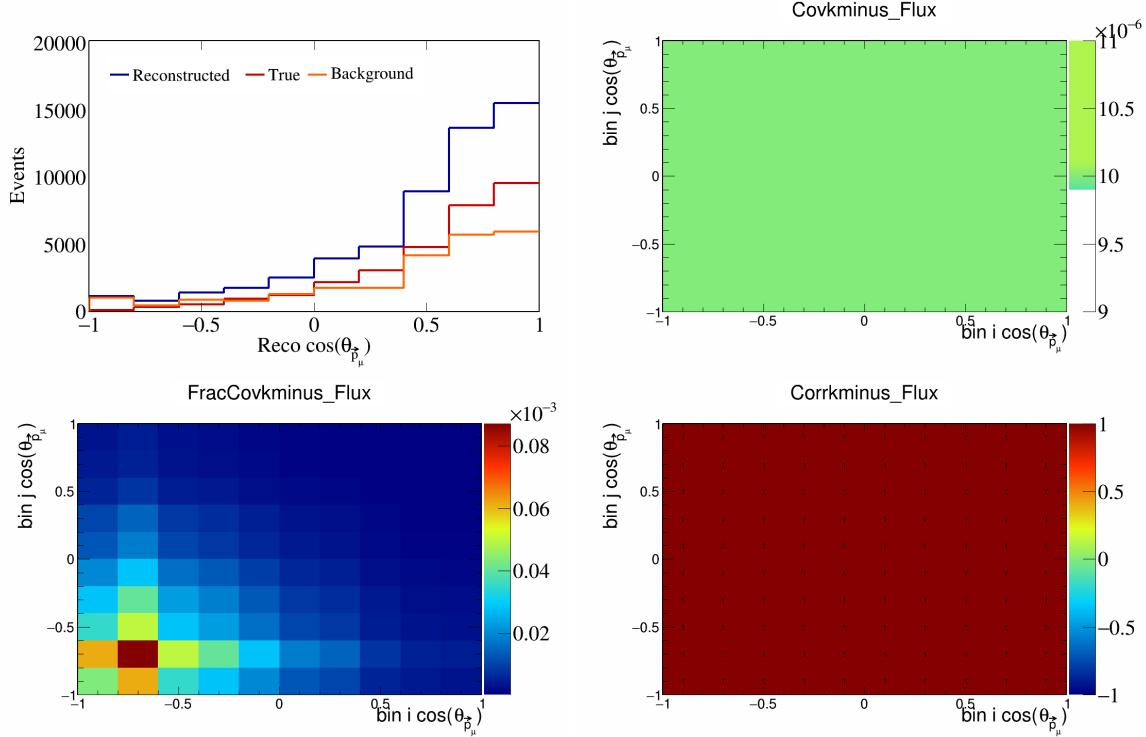


Figure 632: KMinus variations for $\cos(\theta_{\vec{p}_\mu})$.

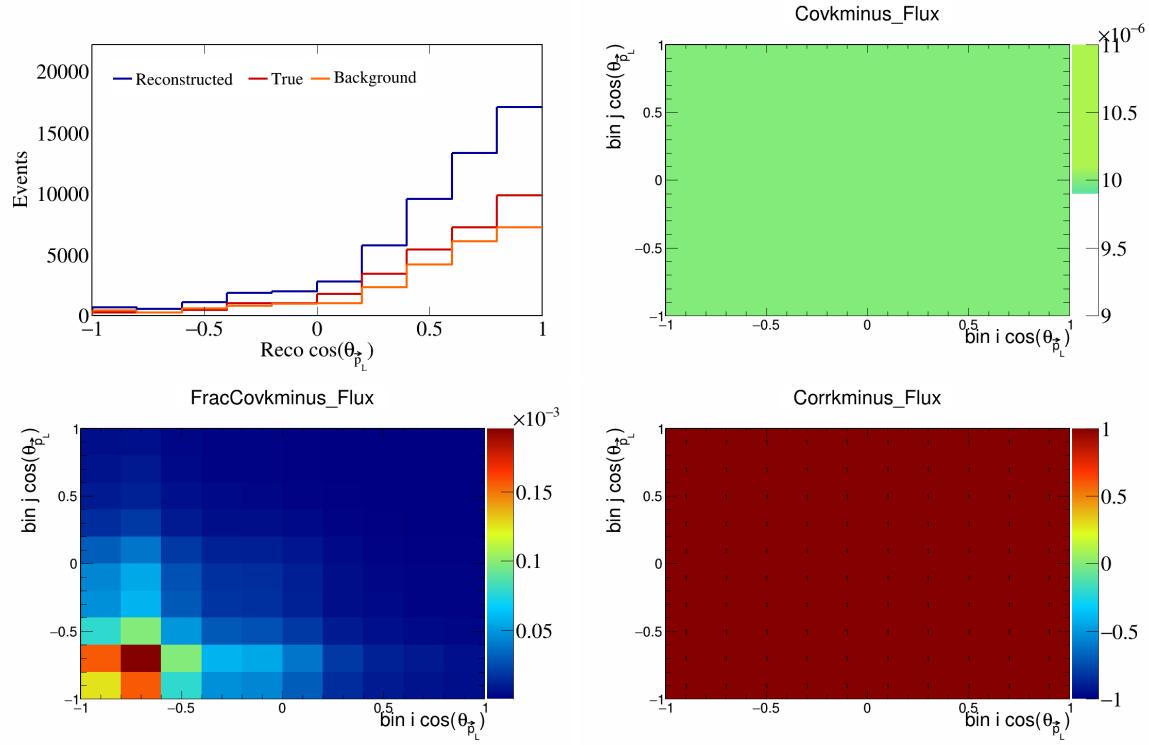


Figure 633: KMinus variations for $\cos(\theta_{\vec{p}_L})$.

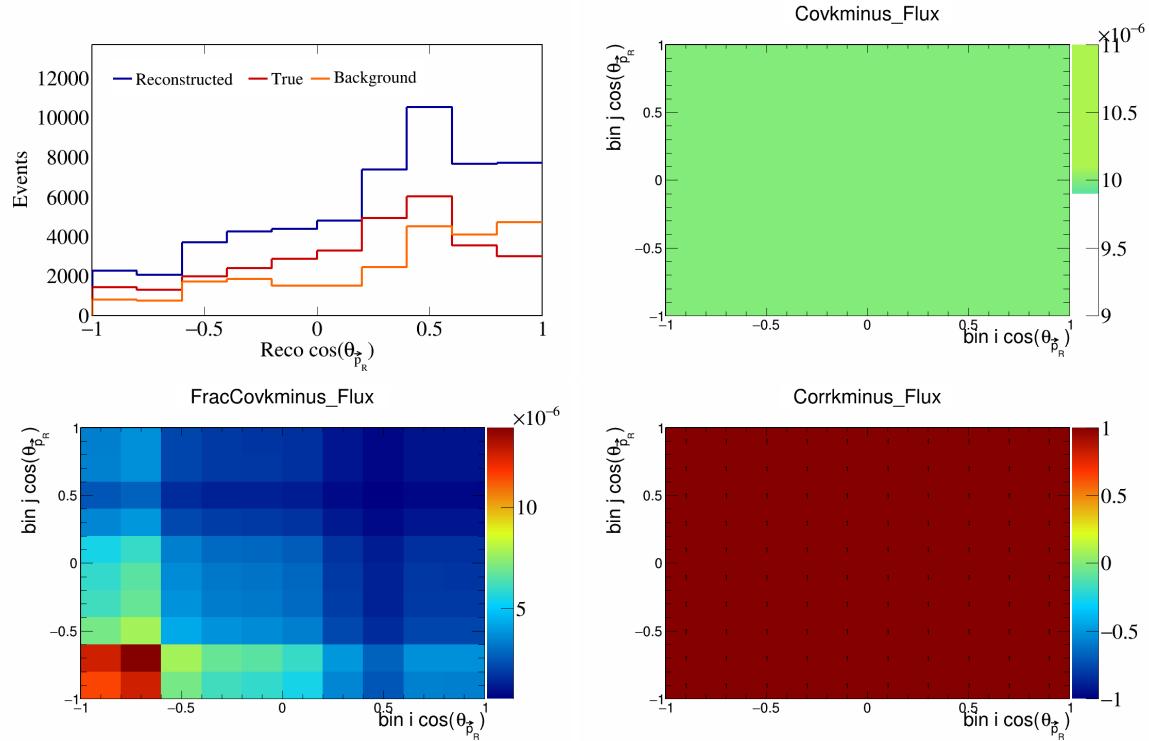


Figure 634: KMinus variations for $\cos(\theta_{\vec{p}_R})$.

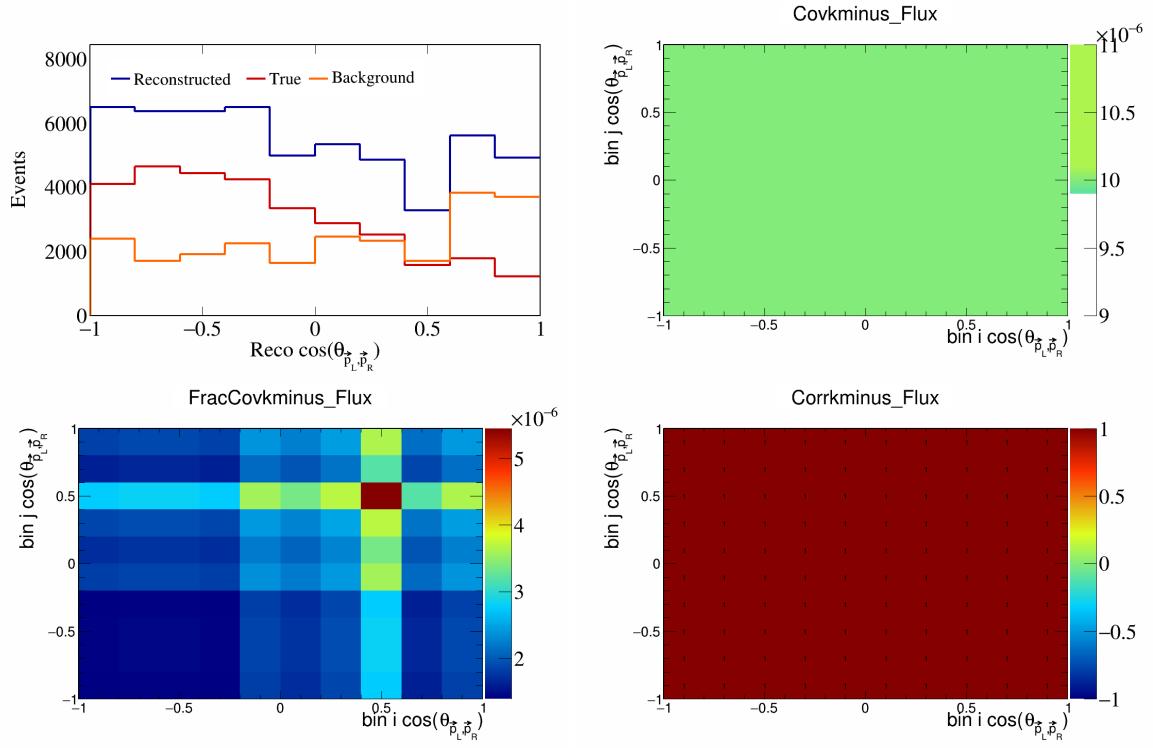


Figure 635: KMinus variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

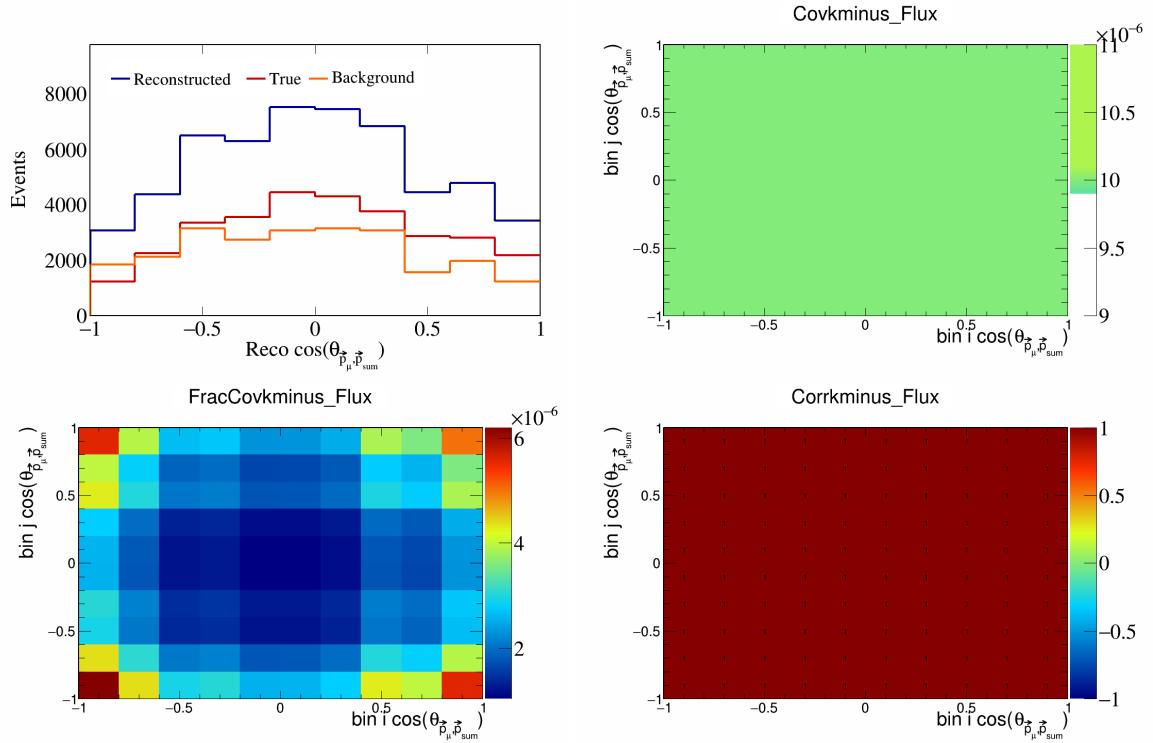


Figure 636: KMinus variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

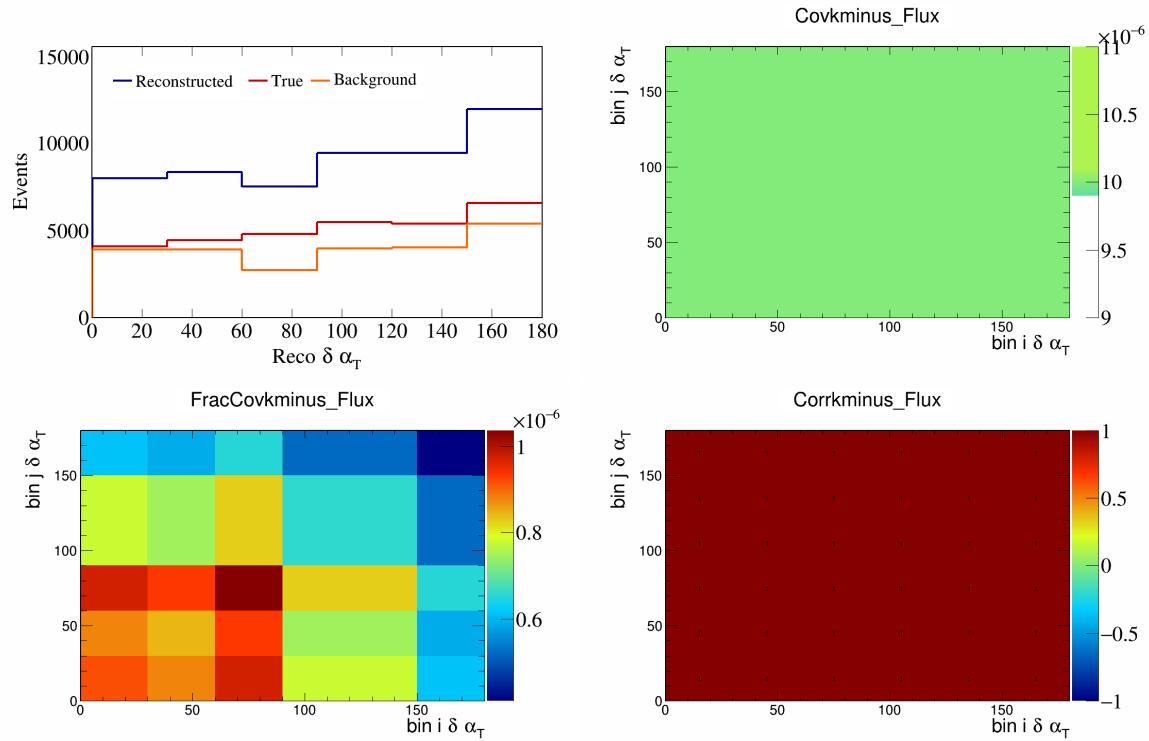


Figure 637: KMinus variations for $\delta\alpha_T$.

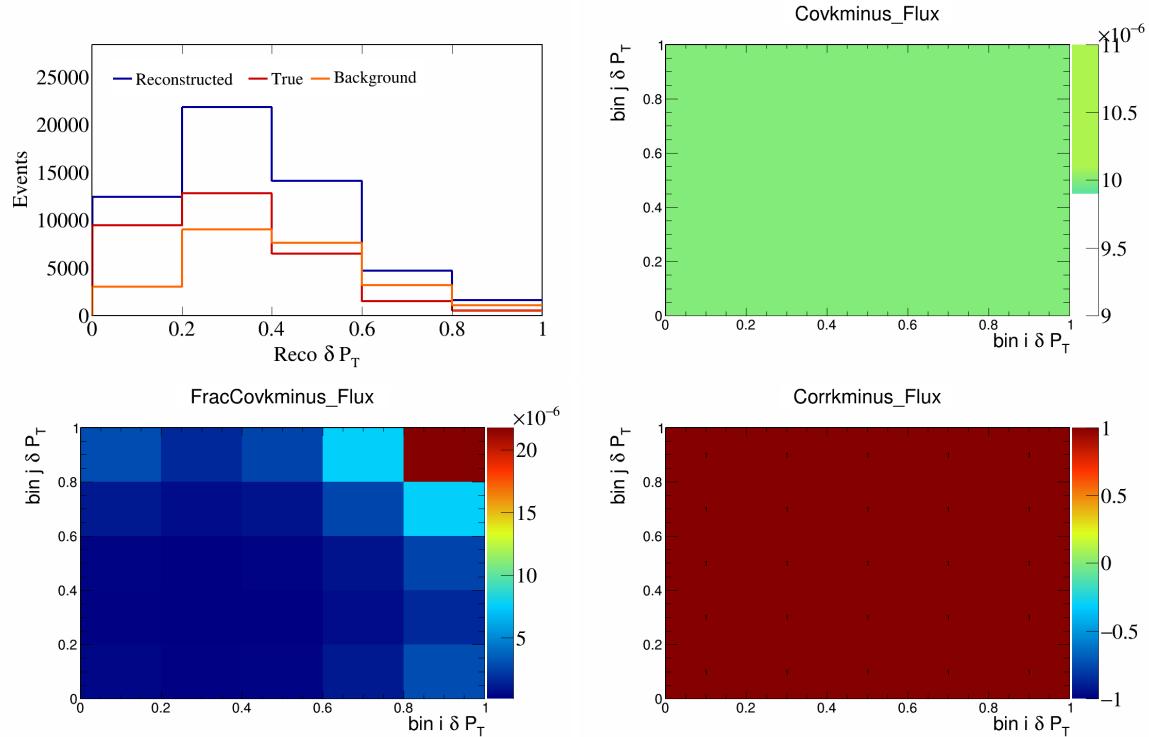


Figure 638: KMinus variations for δP_T .

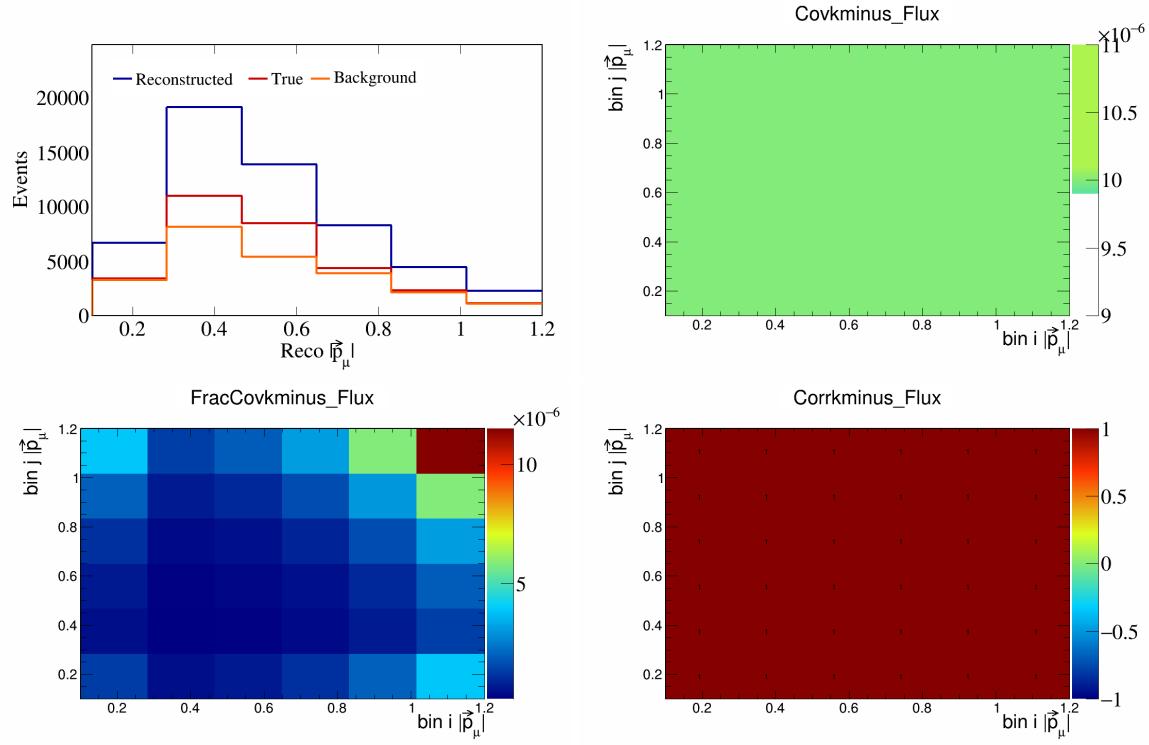


Figure 639: KMinus variations for $|\vec{p}_\mu|$.

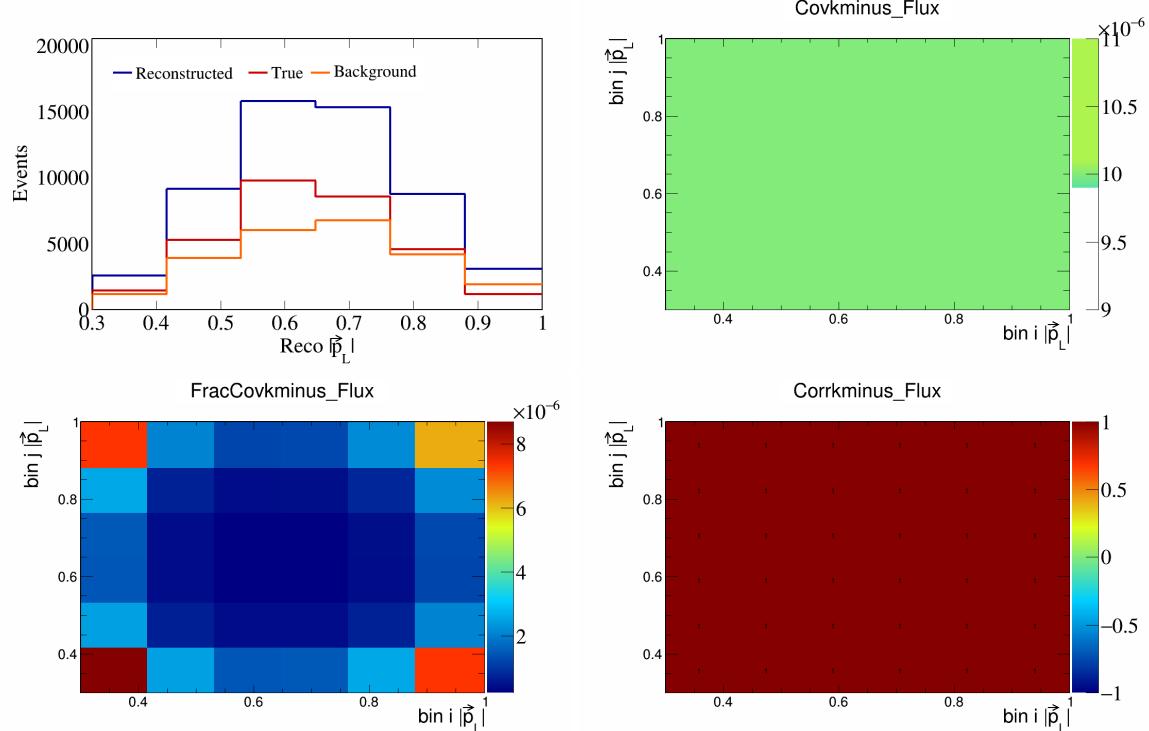


Figure 640: KMinus variations for $|\vec{p}_L|$.

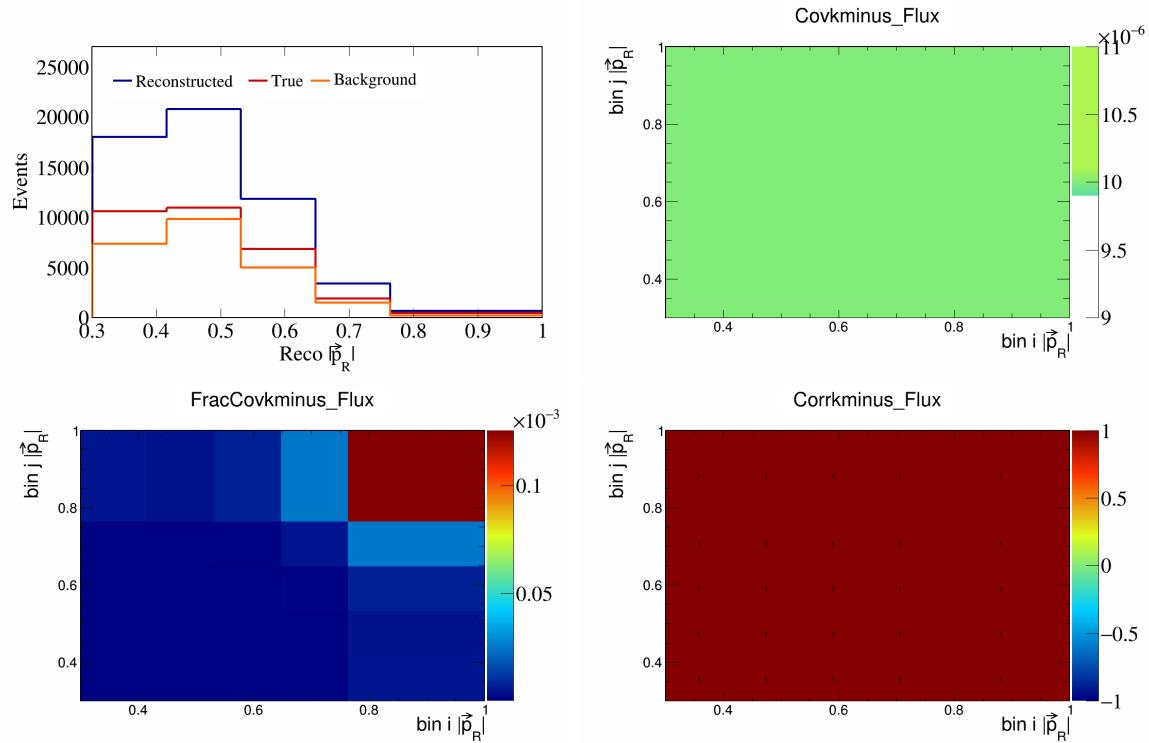


Figure 641: KMinus variations for $|\vec{p}_R|$.

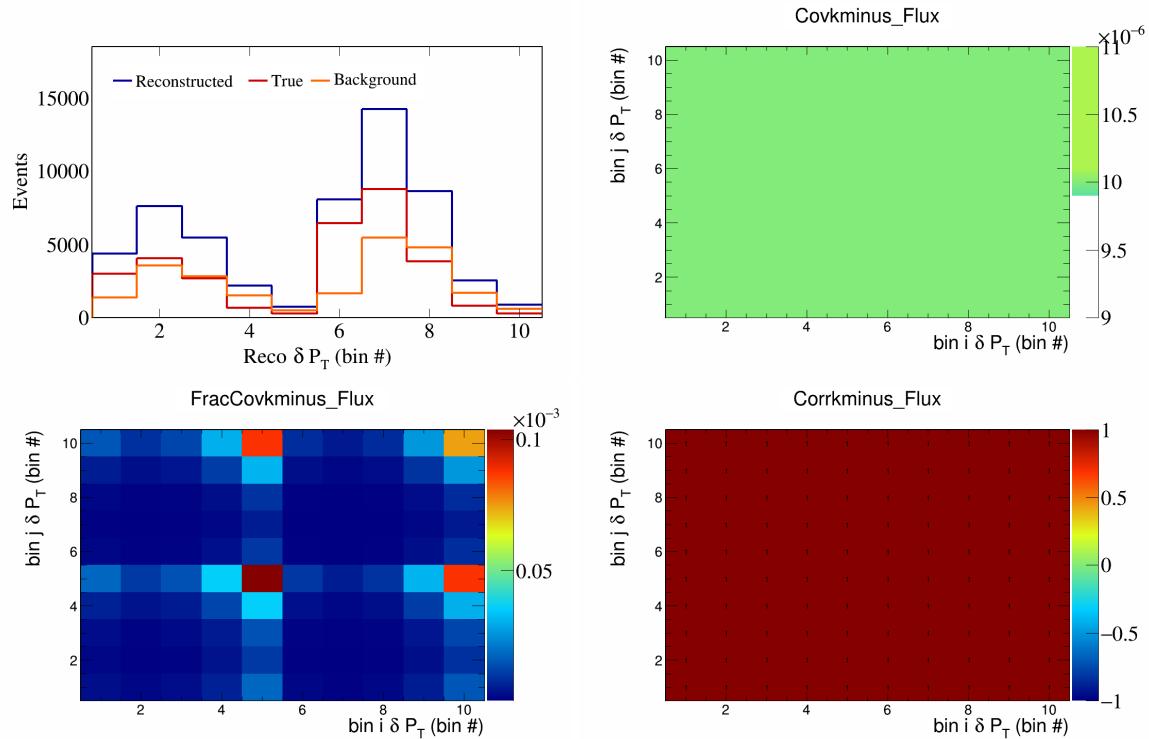


Figure 642: KMinus variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

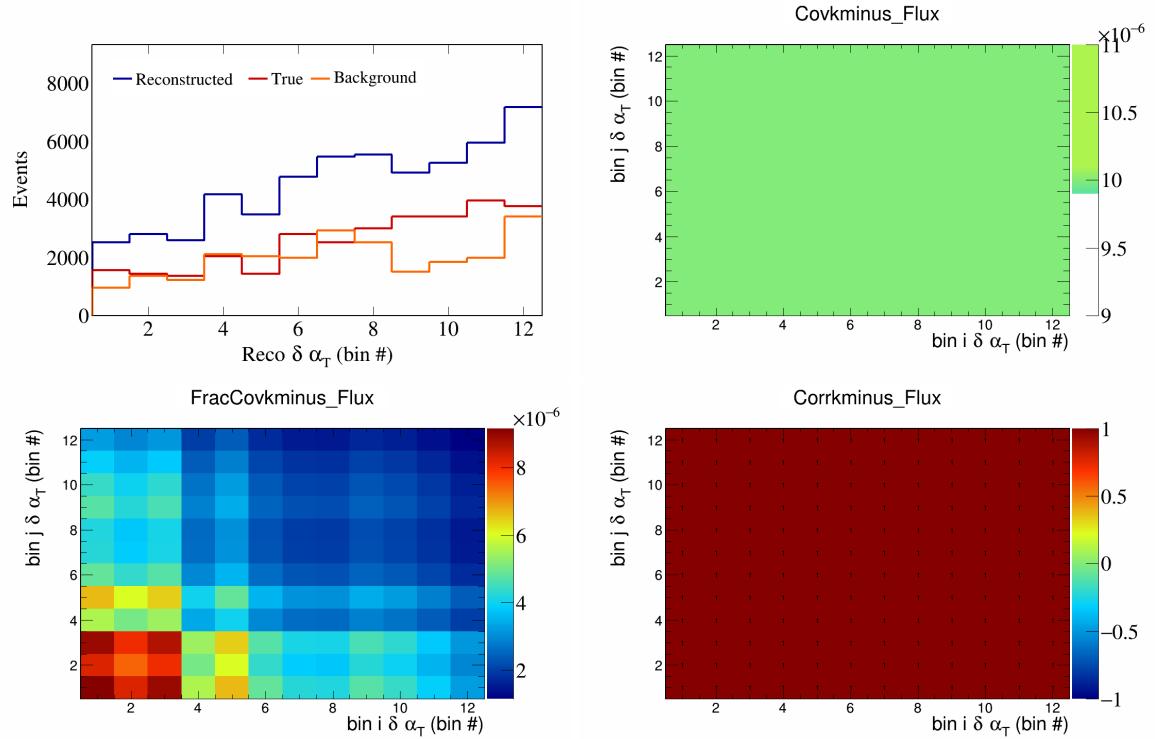


Figure 643: KMinus variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

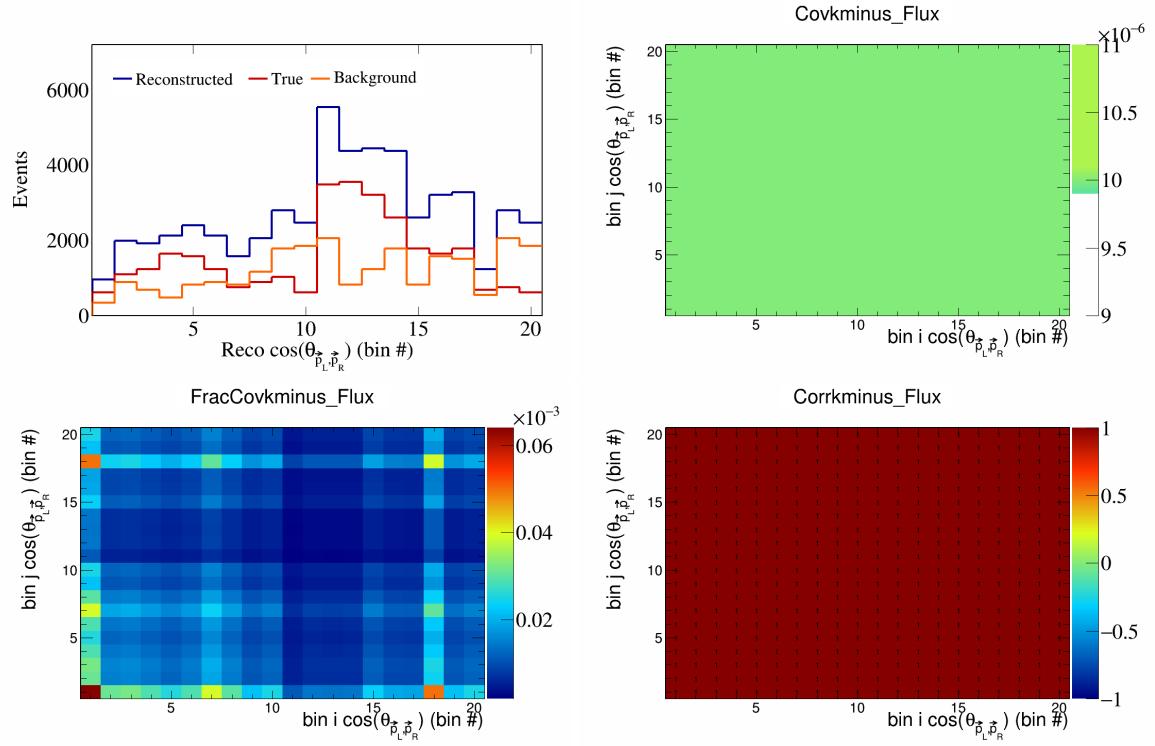


Figure 644: KMinus variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

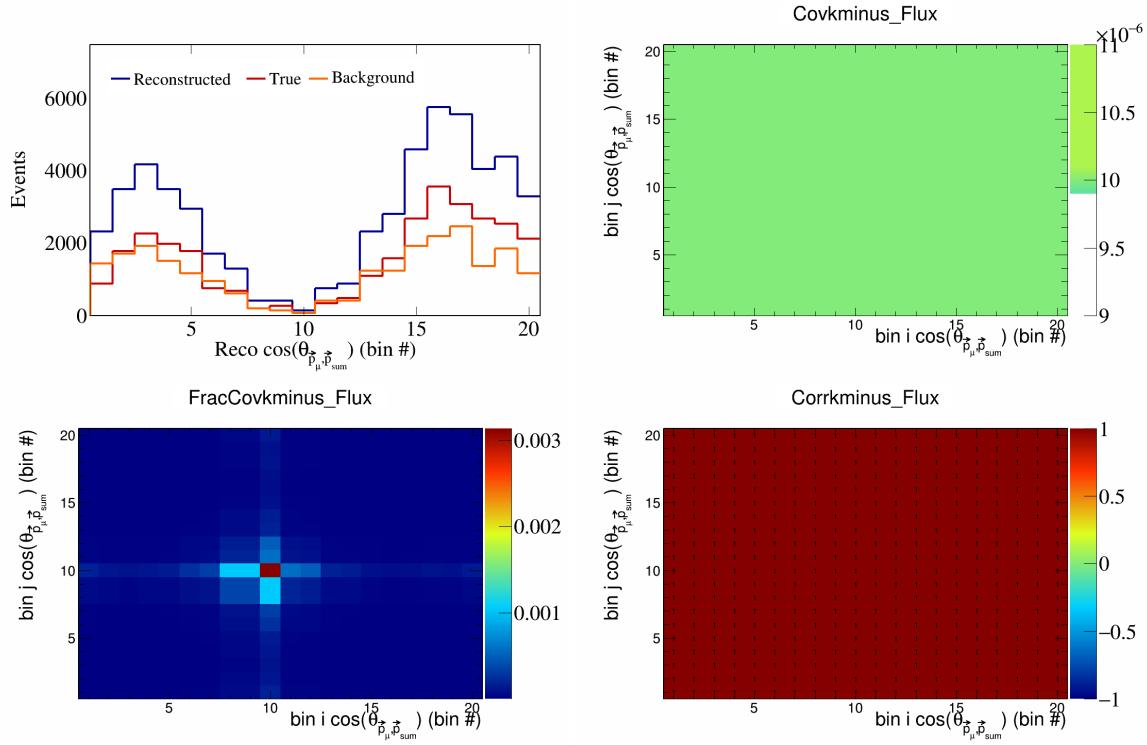


Figure 645: KMinus variations for $\cos(\theta_{\vec{p}_\mu}, \vec{p}_{\text{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

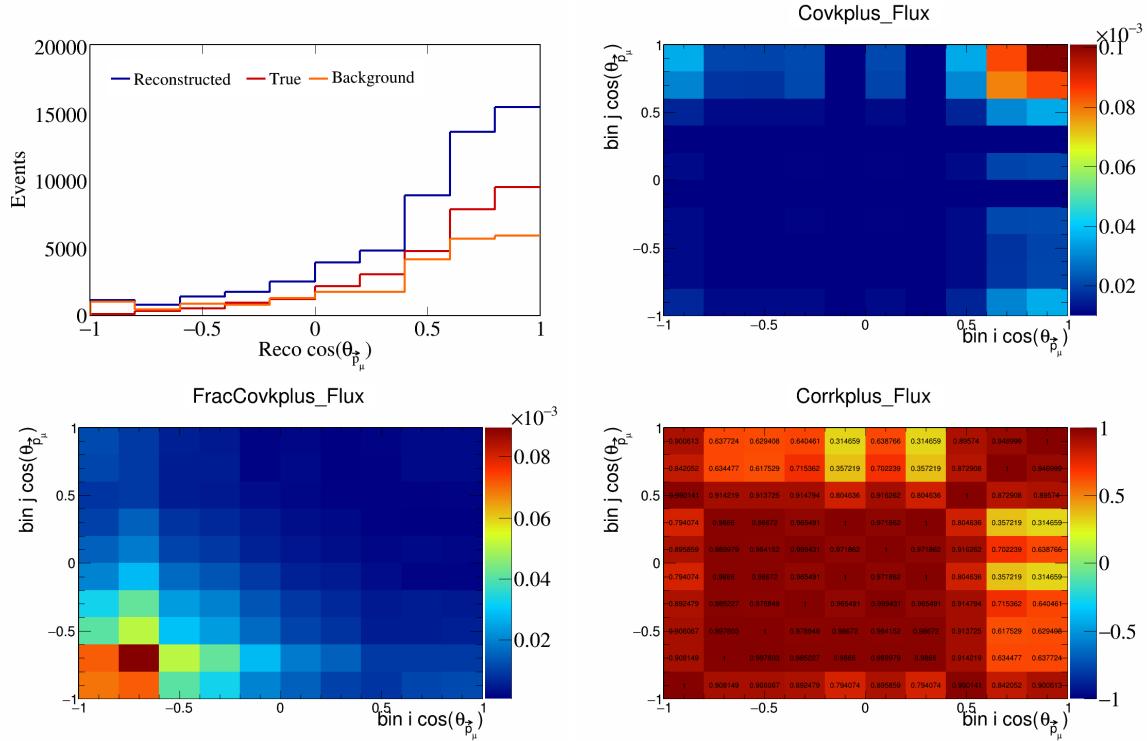


Figure 646: KPlus variations for $\cos(\theta_{\vec{p}_\mu})$.

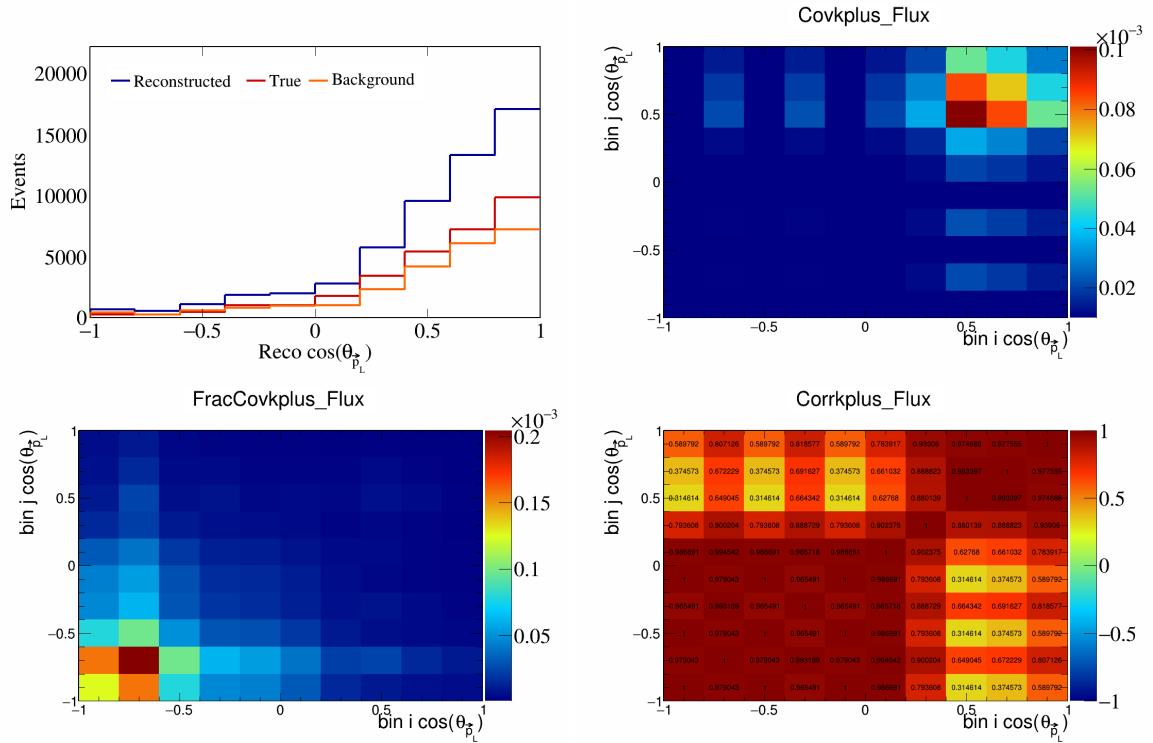


Figure 647: KPlus variations for $\cos(\theta_{\vec{p}_L})$.

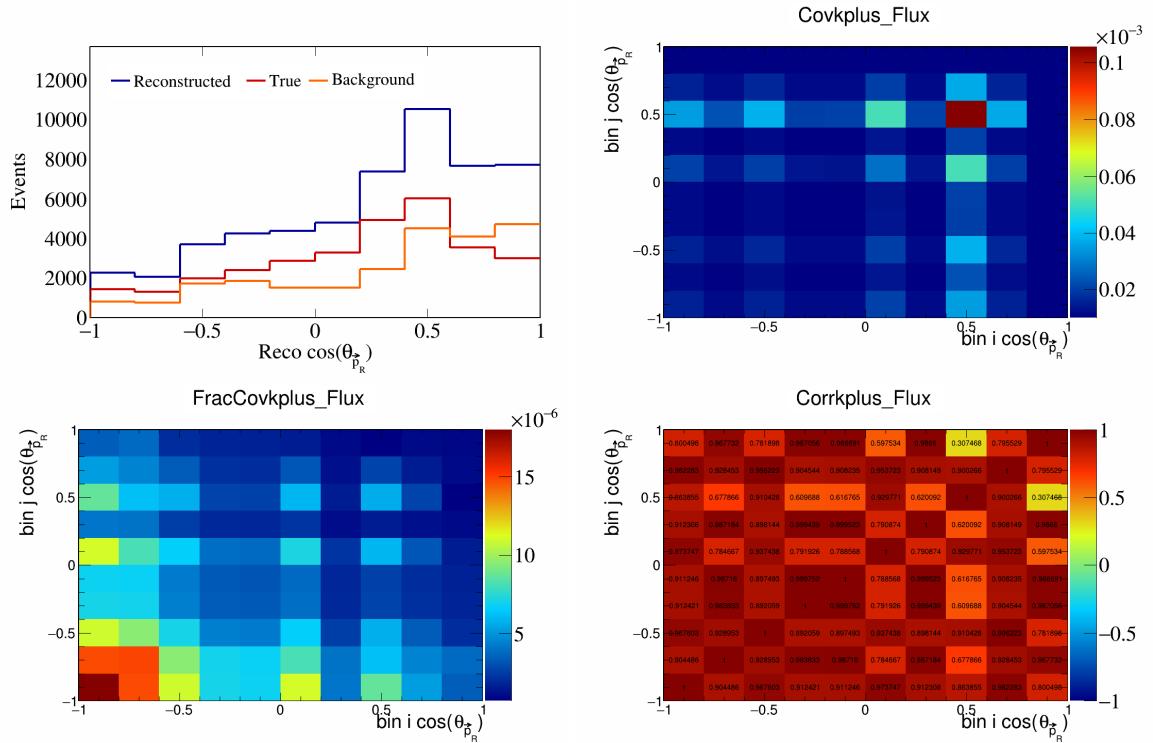


Figure 648: KPlus variations for $\cos(\theta_{\vec{p}_R})$.

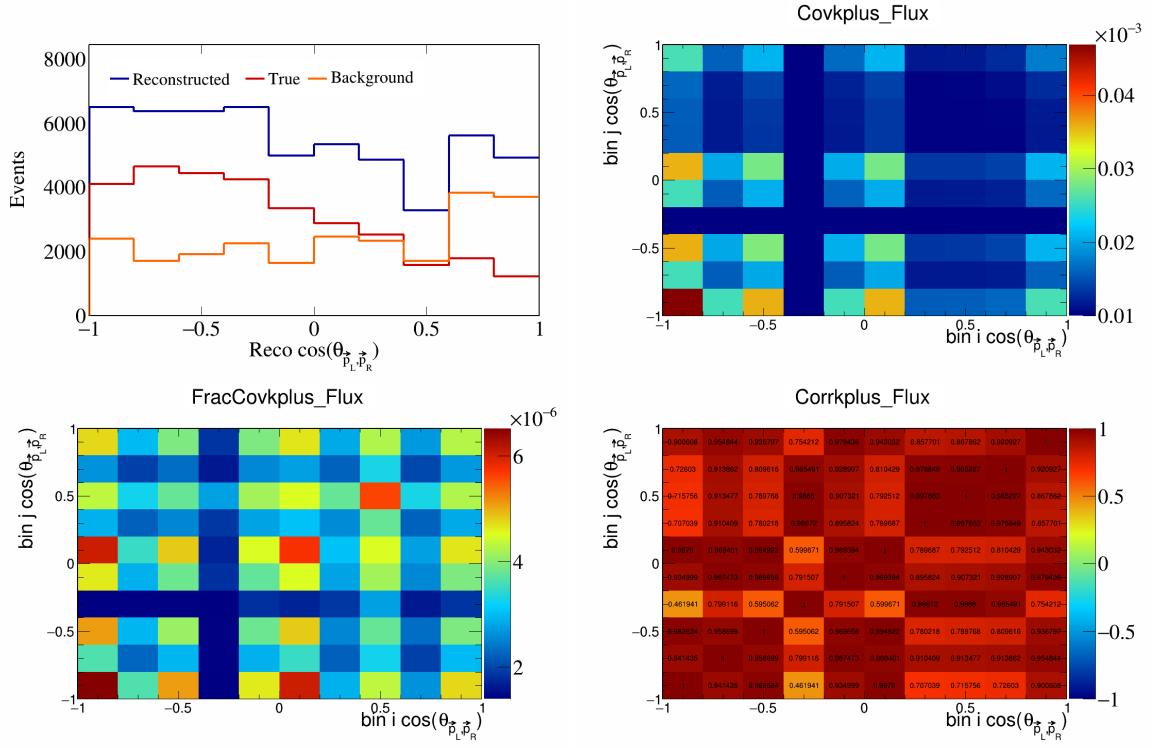


Figure 649: KPlus variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

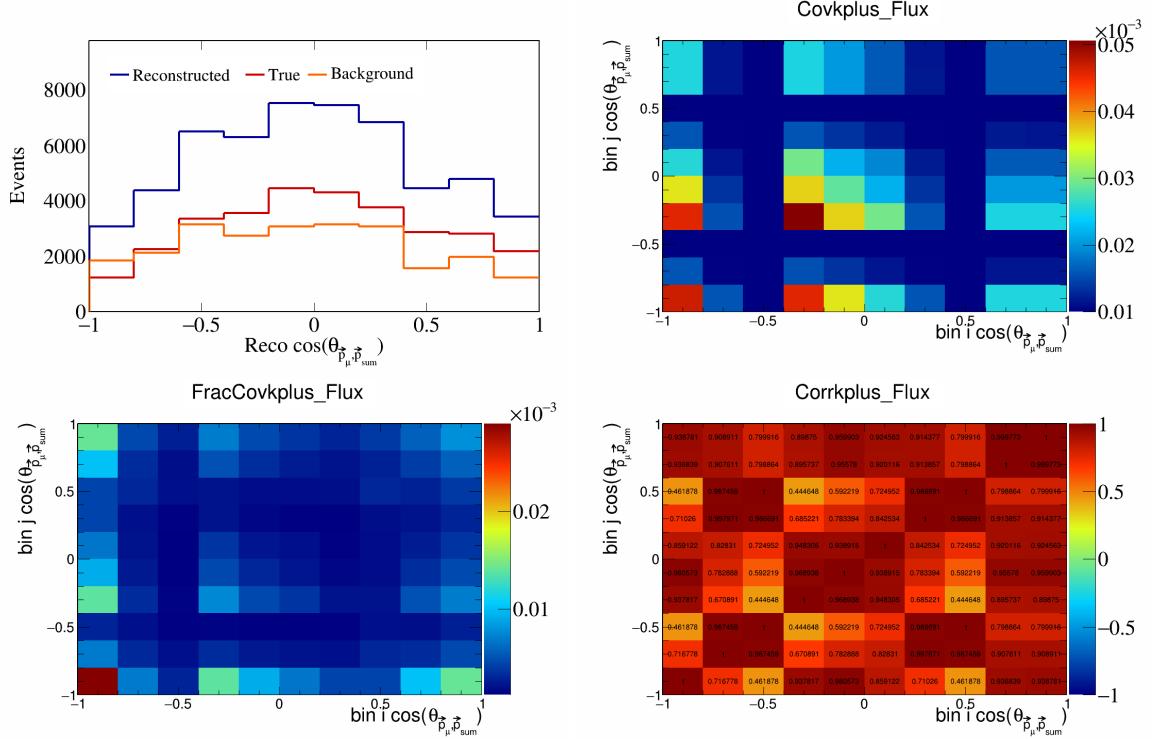


Figure 650: KPlus variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

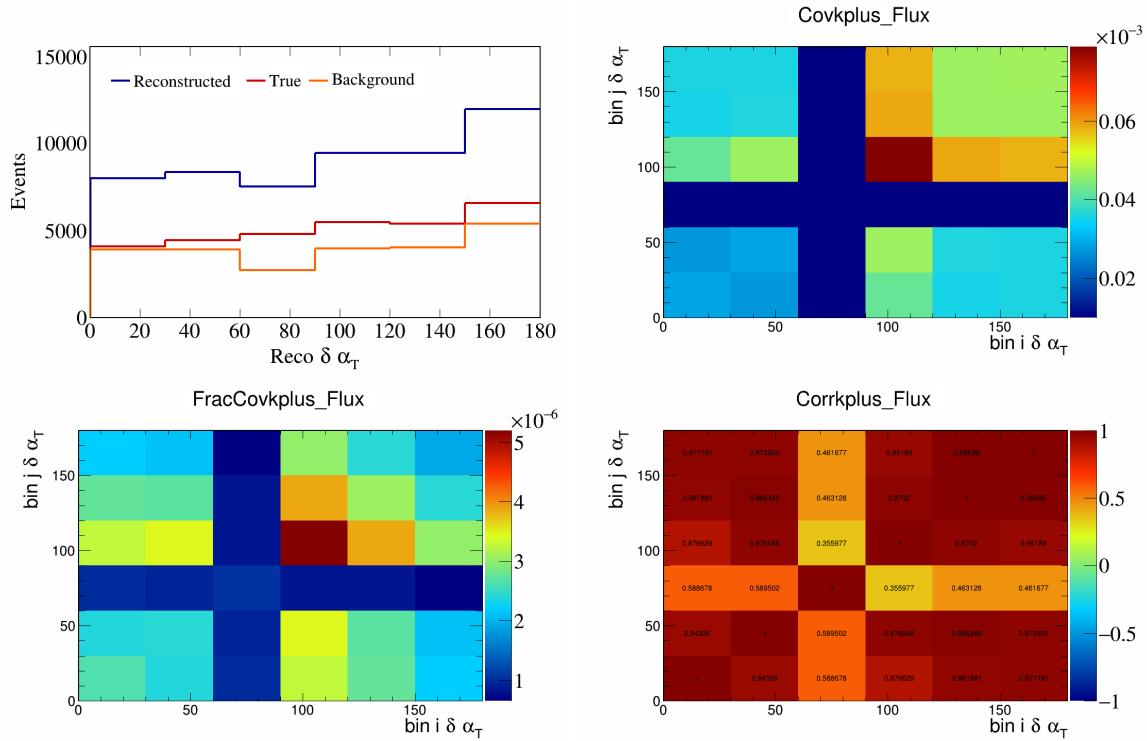


Figure 651: KPlus variations for $\delta\alpha_T$.

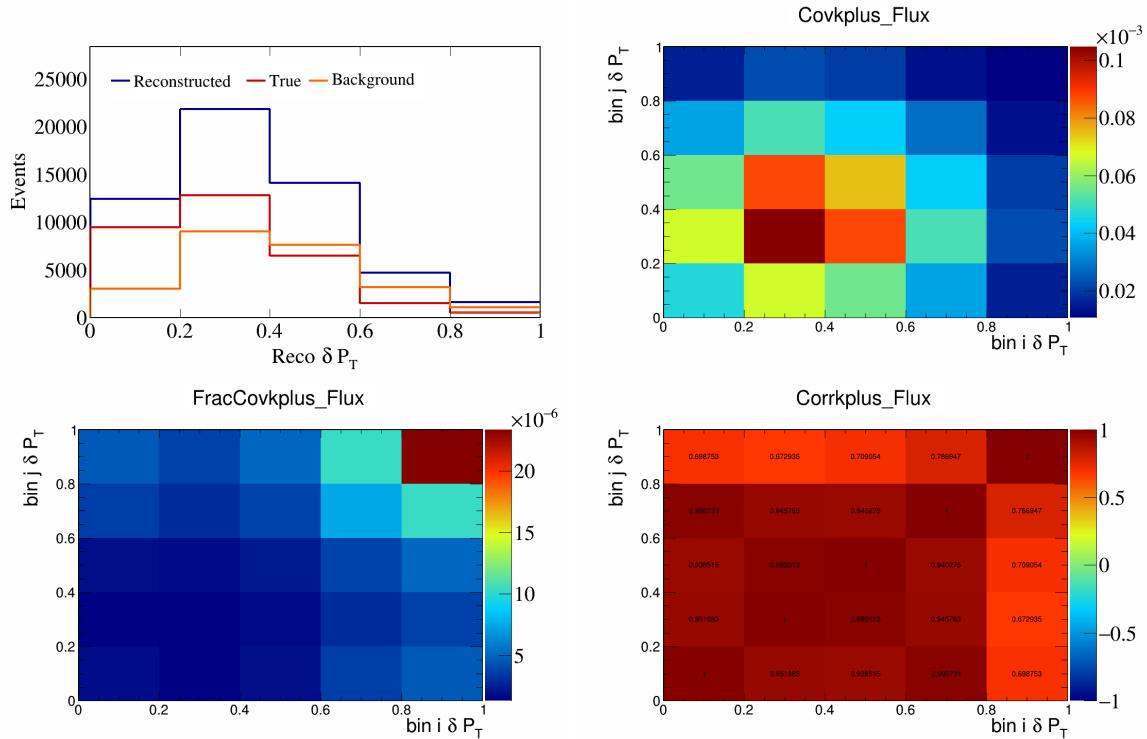


Figure 652: KPlus variations for δP_T .

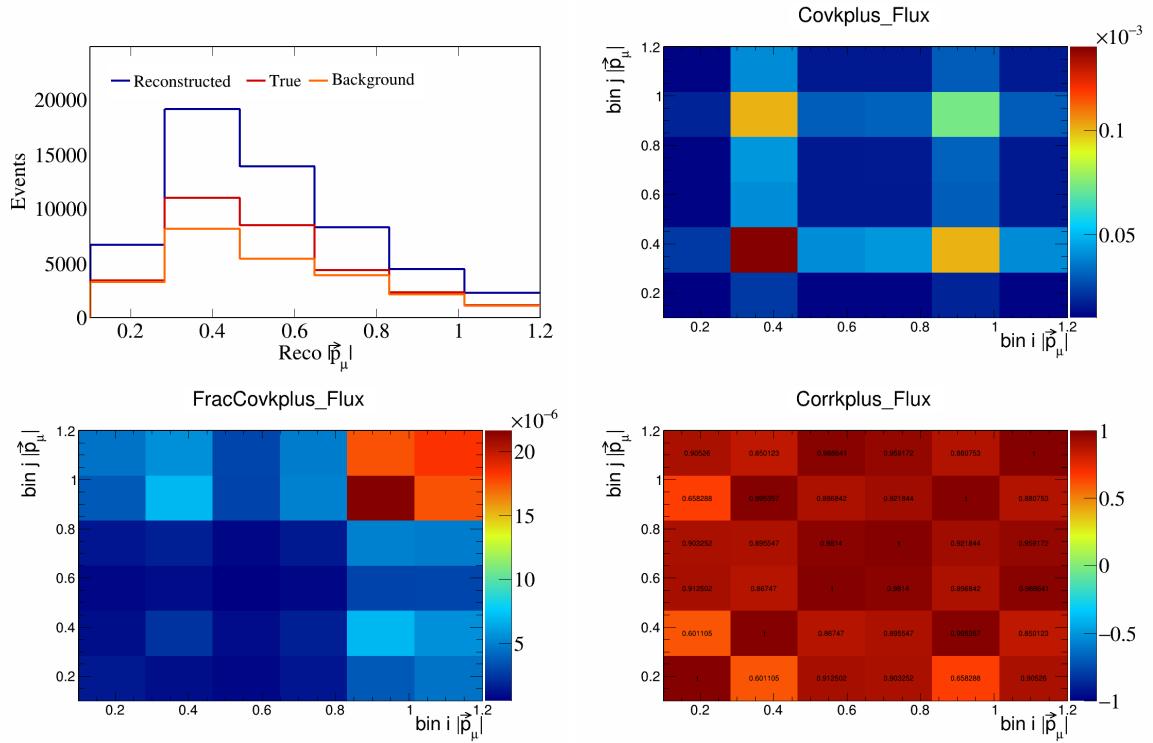


Figure 653: KPlus variations for $|\vec{p}_\mu|$.

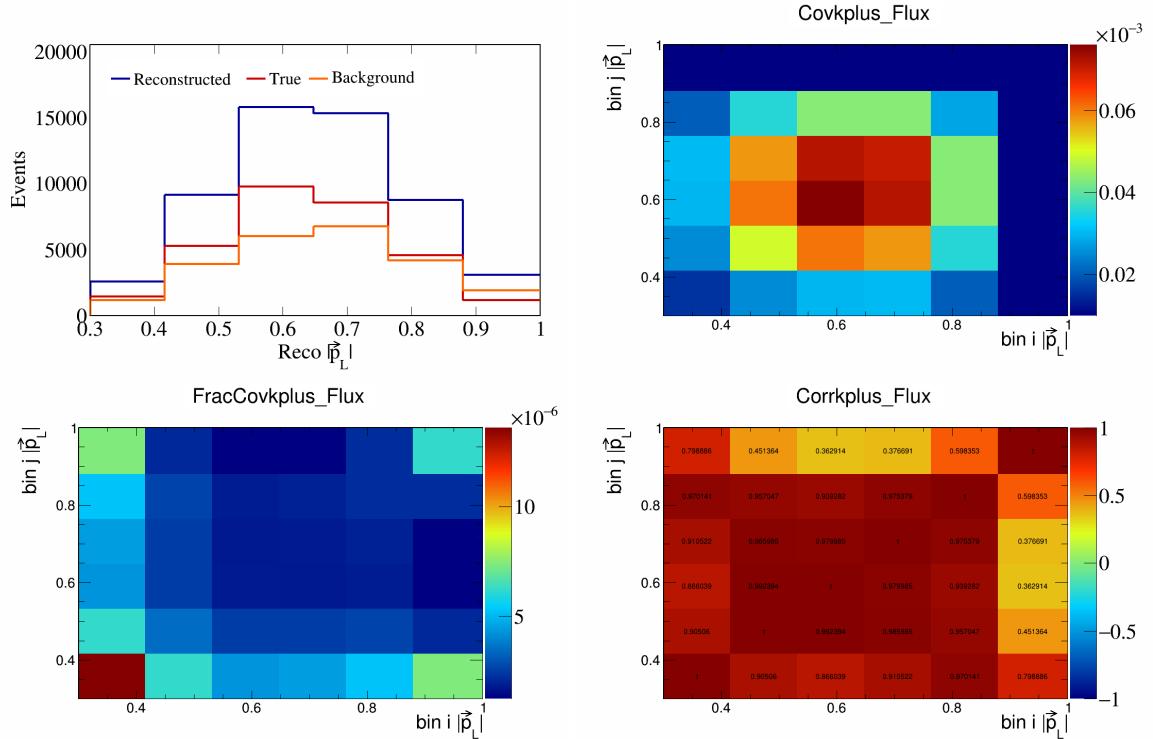


Figure 654: KPlus variations for $|\vec{p}_L|$.

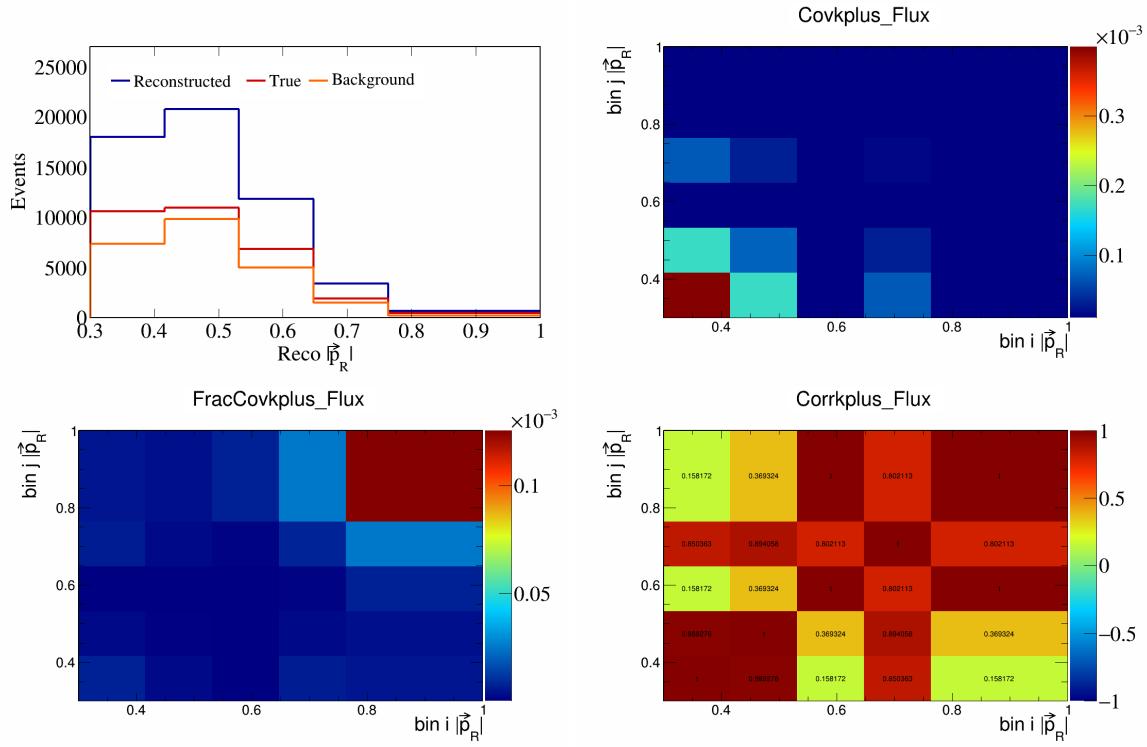


Figure 655: KPlus variations for $|\vec{p}_R|$.

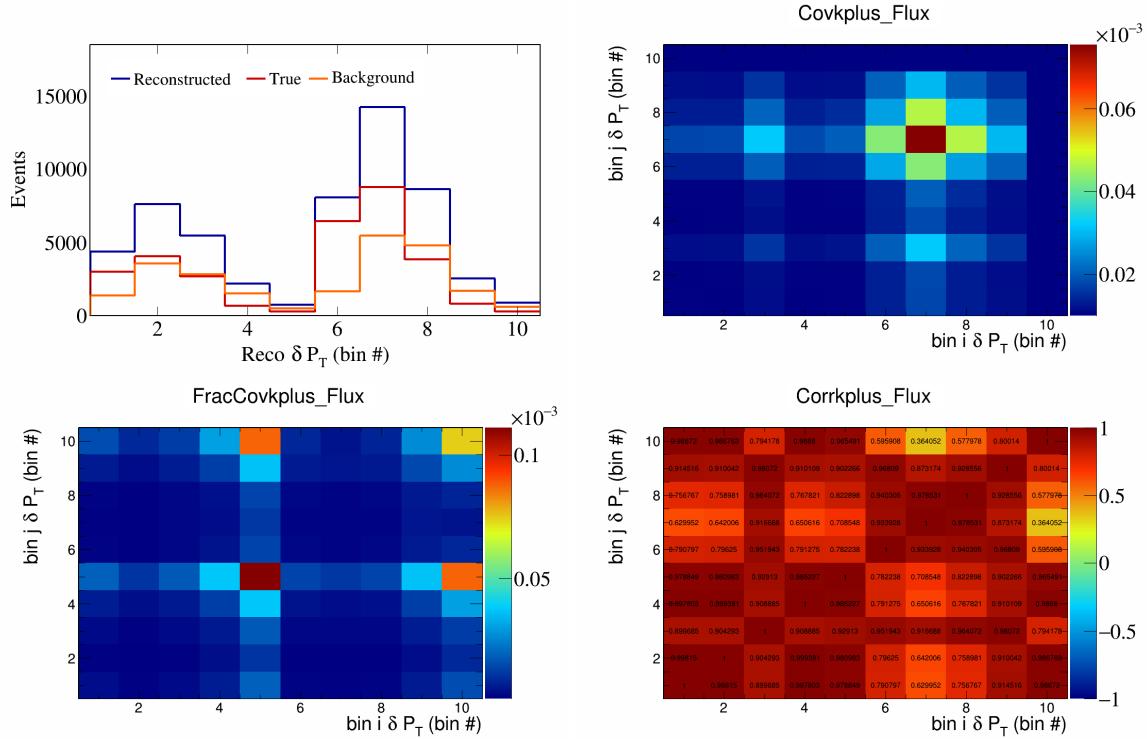


Figure 656: KPlus variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

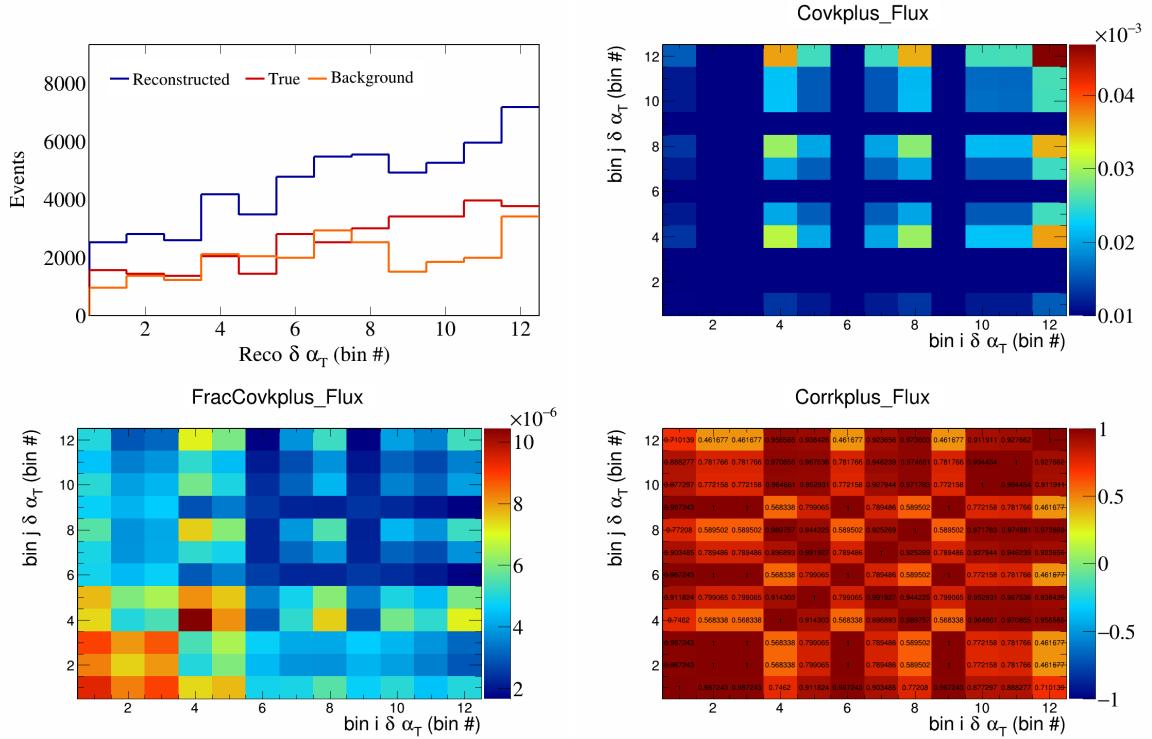


Figure 657: KPlus variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

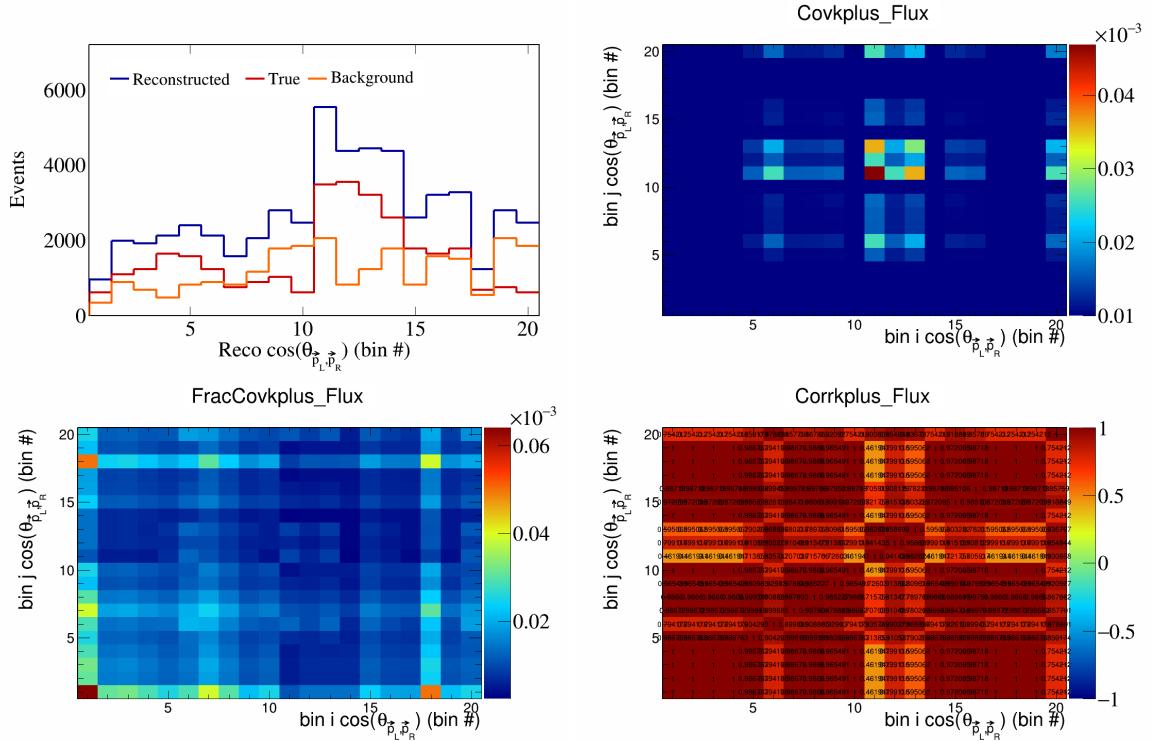


Figure 658: KPlus variations for $\cos(\theta_{p_L, p_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

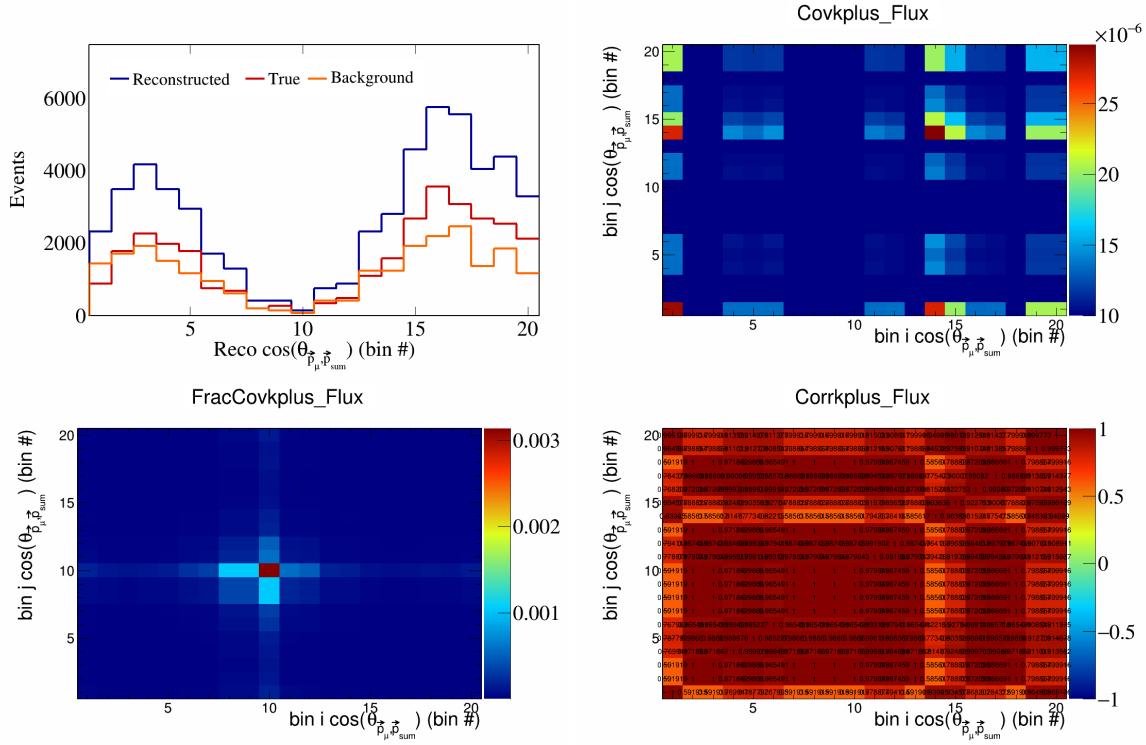


Figure 659: KPlus variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

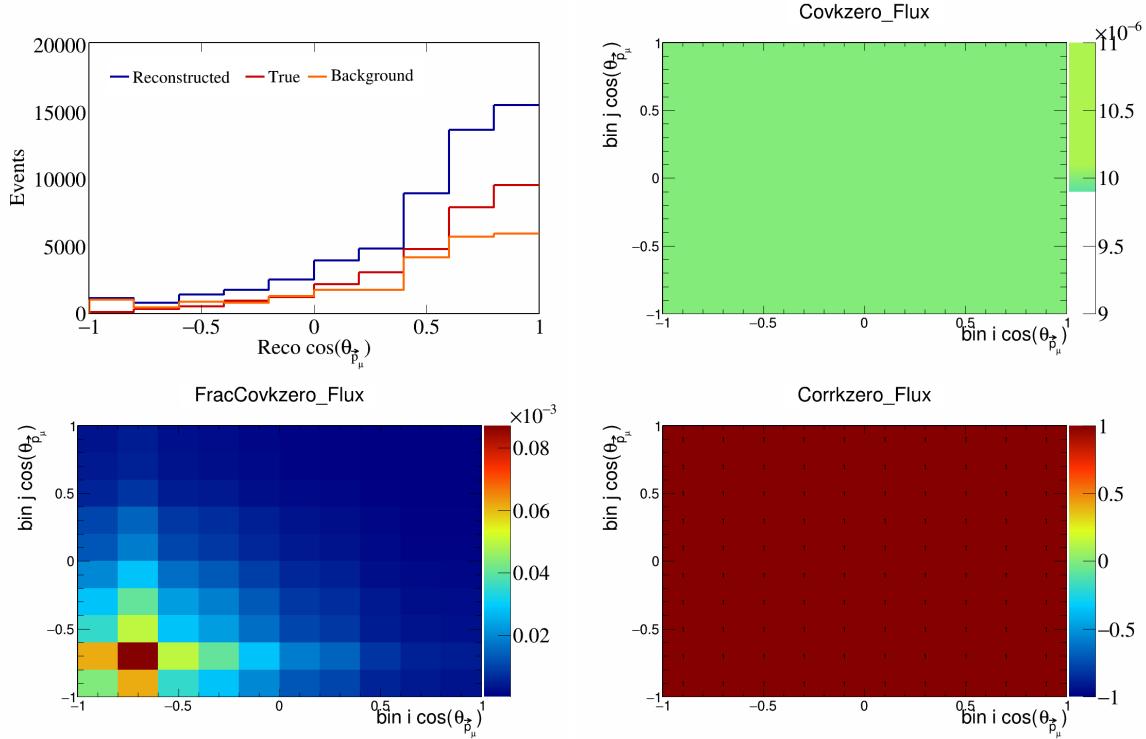


Figure 660: KZero variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

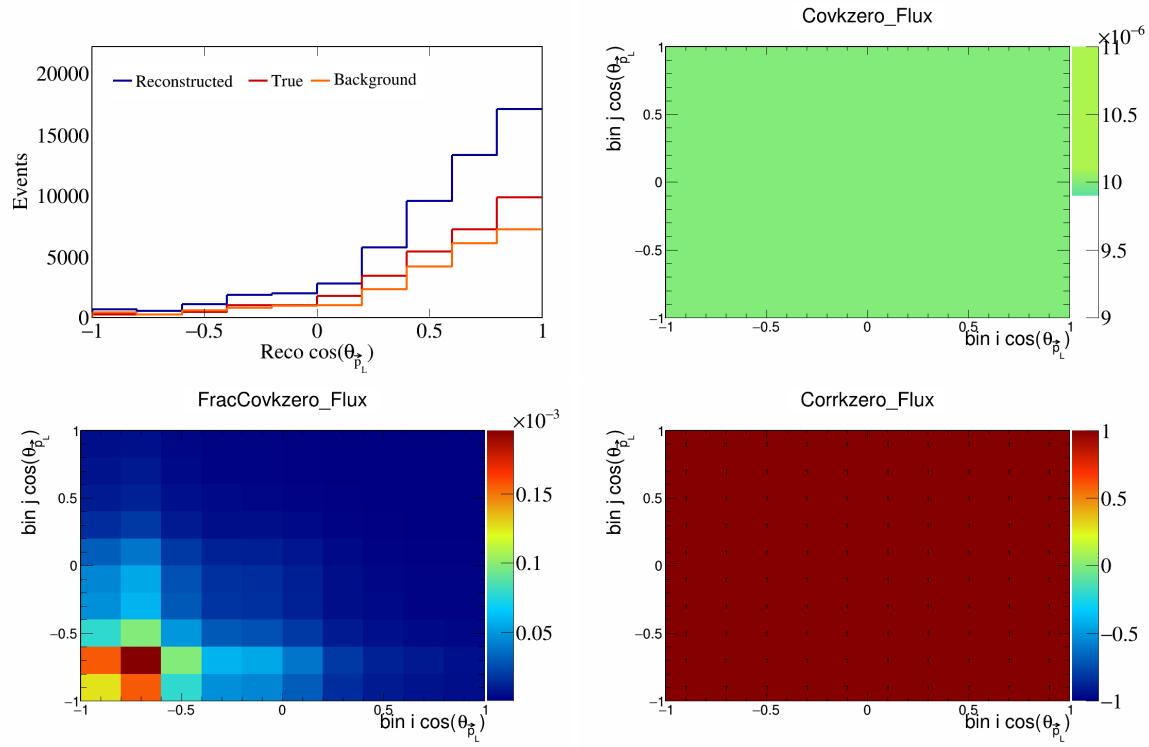


Figure 661: KZero variations for $\cos(\theta_{\vec{p}_L})$.

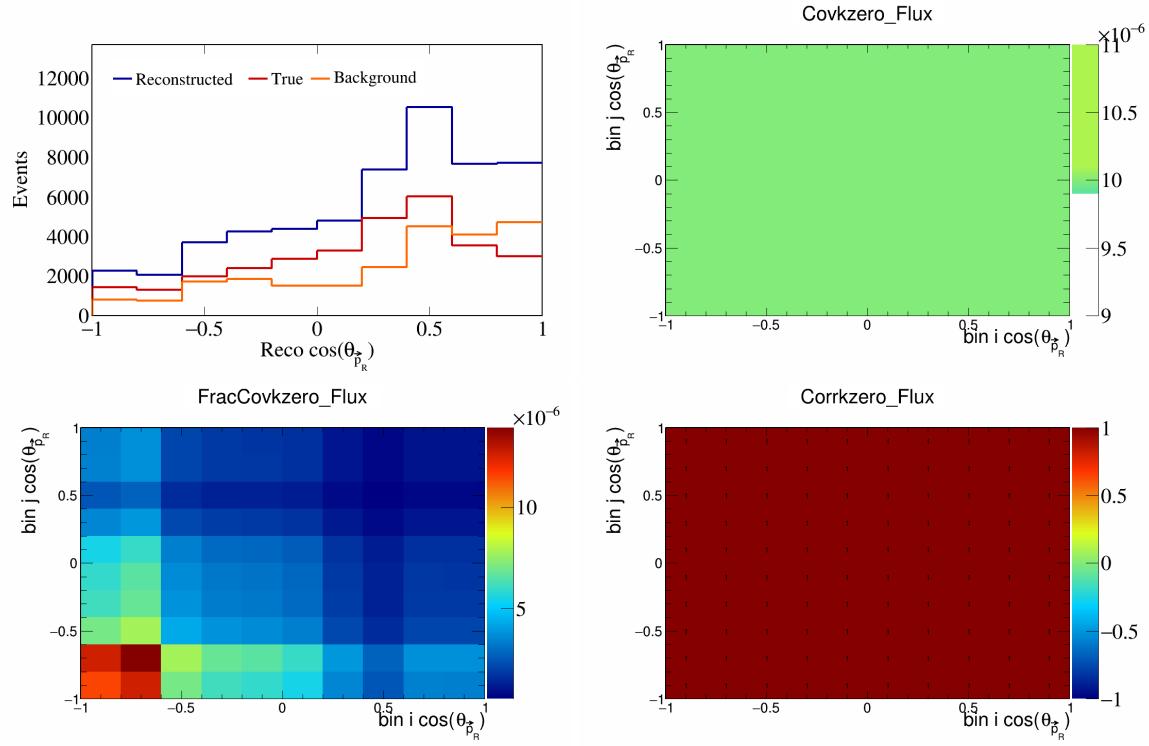


Figure 662: KZero variations for $\cos(\theta_{\vec{p}_R})$.

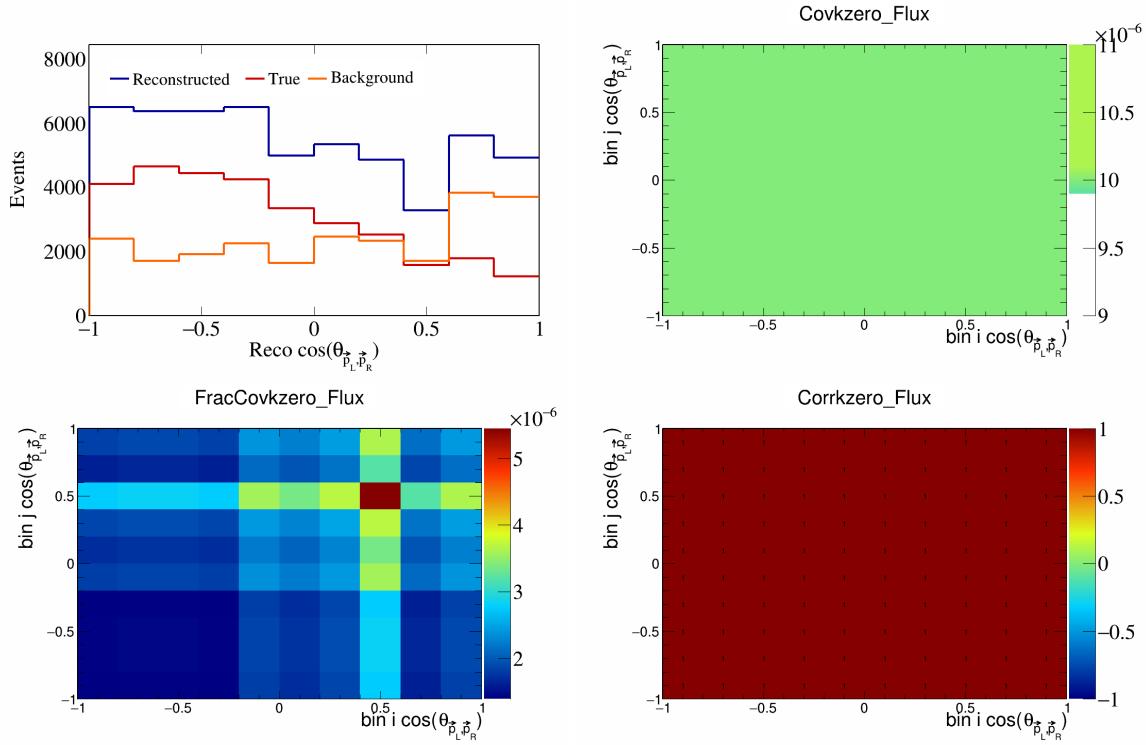


Figure 663: KZero variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

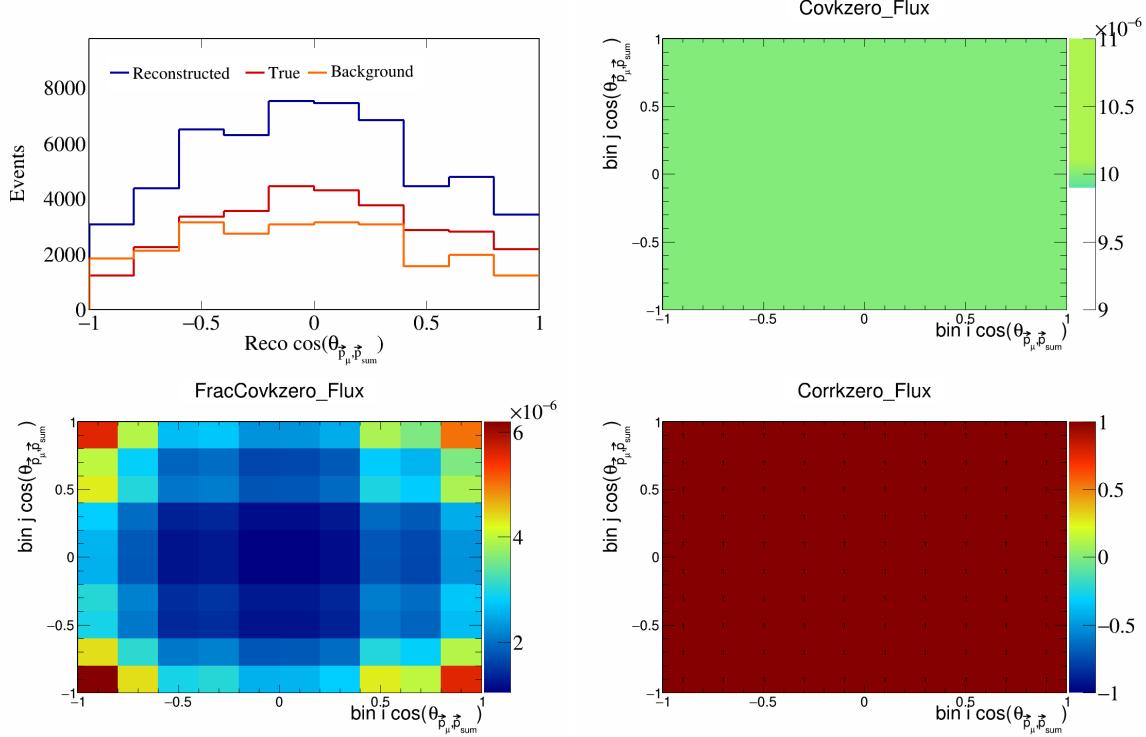


Figure 664: KZero variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

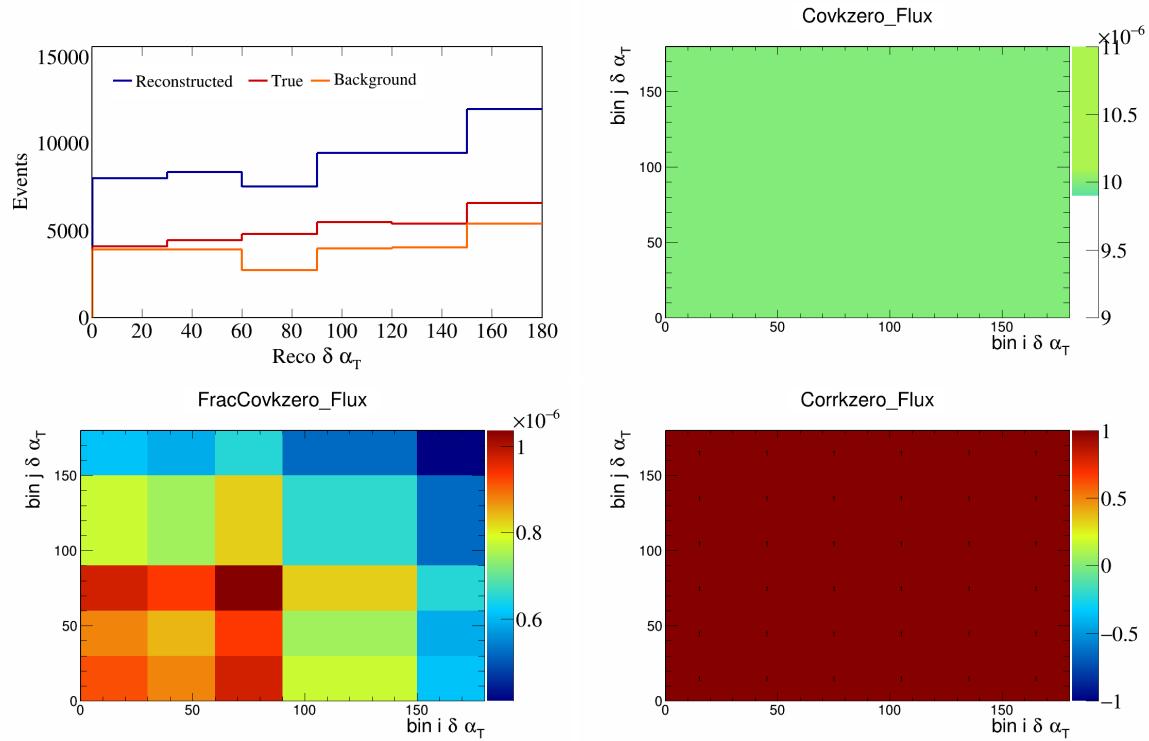


Figure 665: KZero variations for $\delta\alpha_T$.

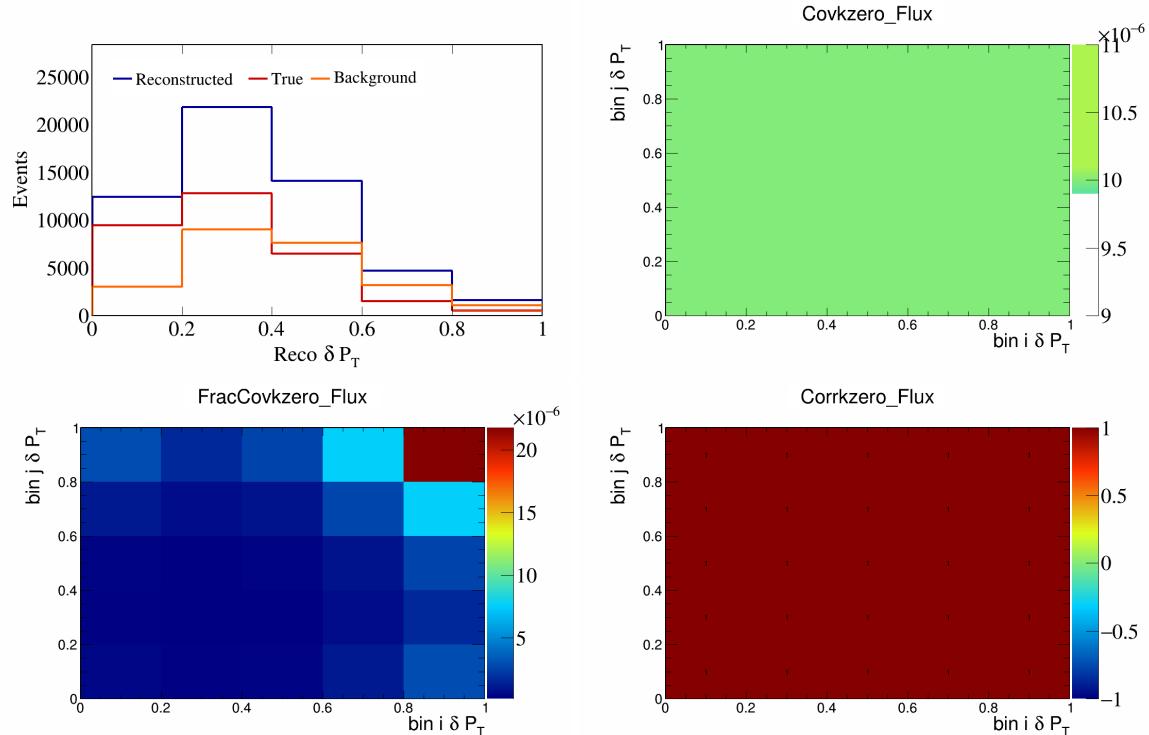


Figure 666: KZero variations for δP_T .

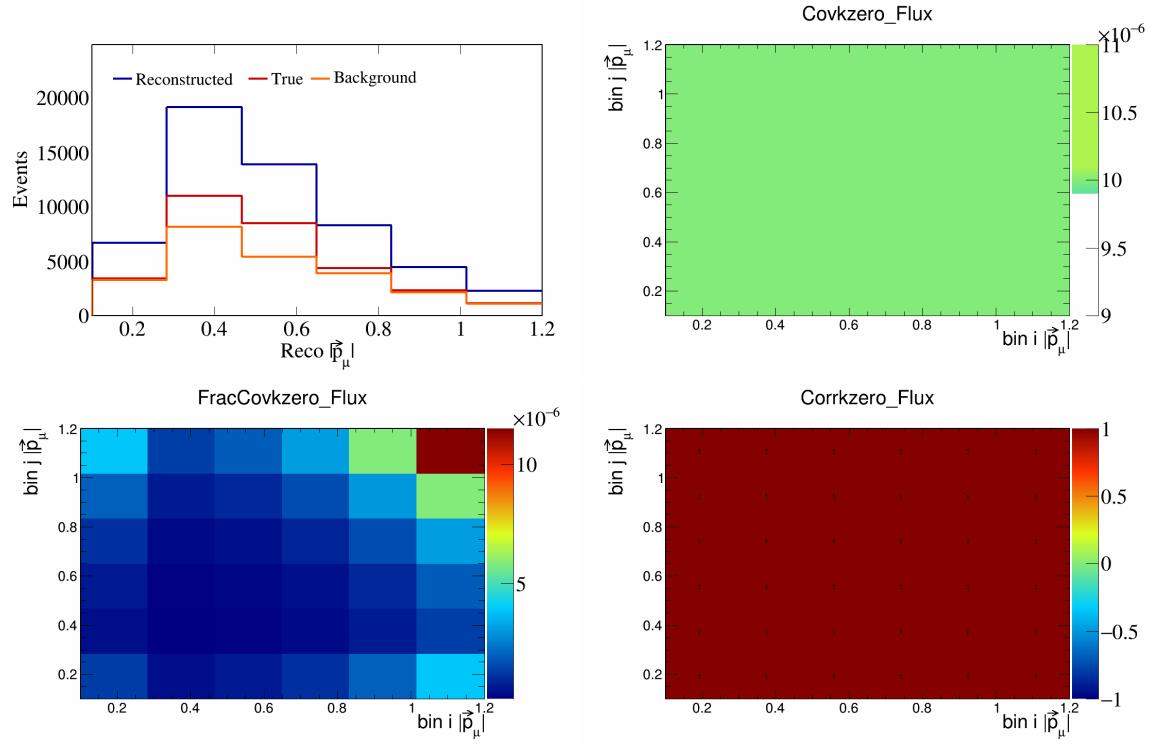


Figure 667: KZero variations for $|\vec{p}_\mu|$.

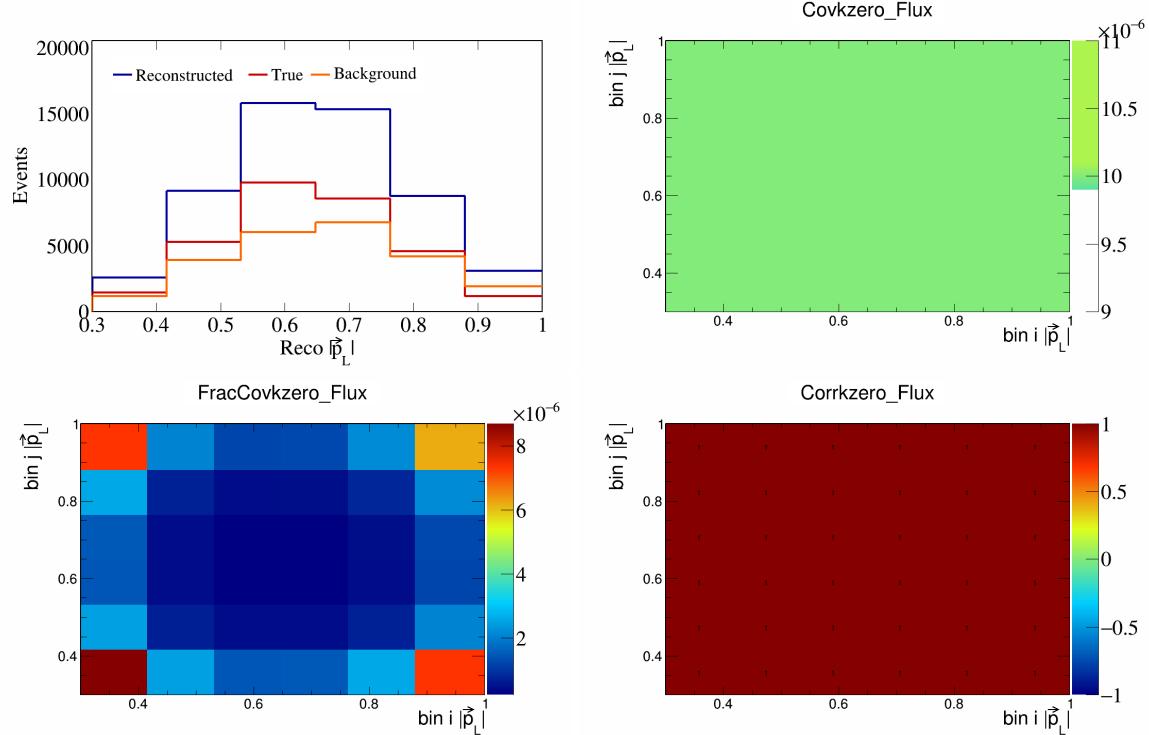


Figure 668: KZero variations for $|\vec{p}_L|$.

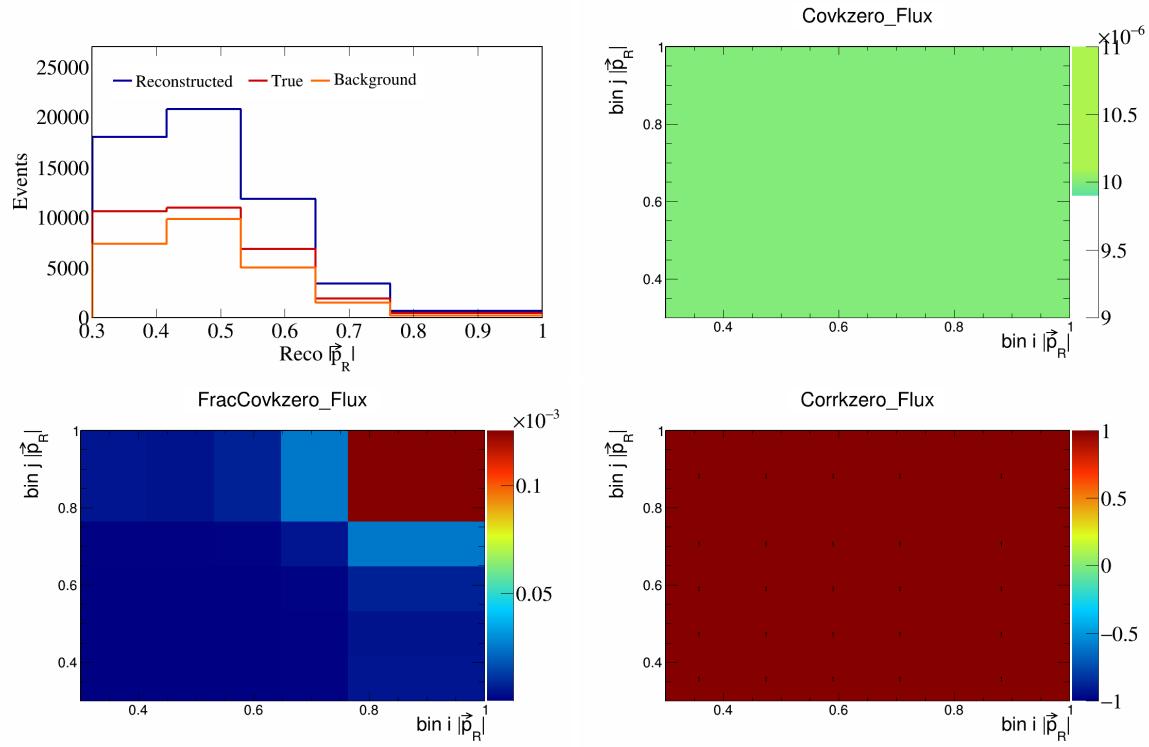


Figure 669: KZero variations for $|\vec{p}_R|$.

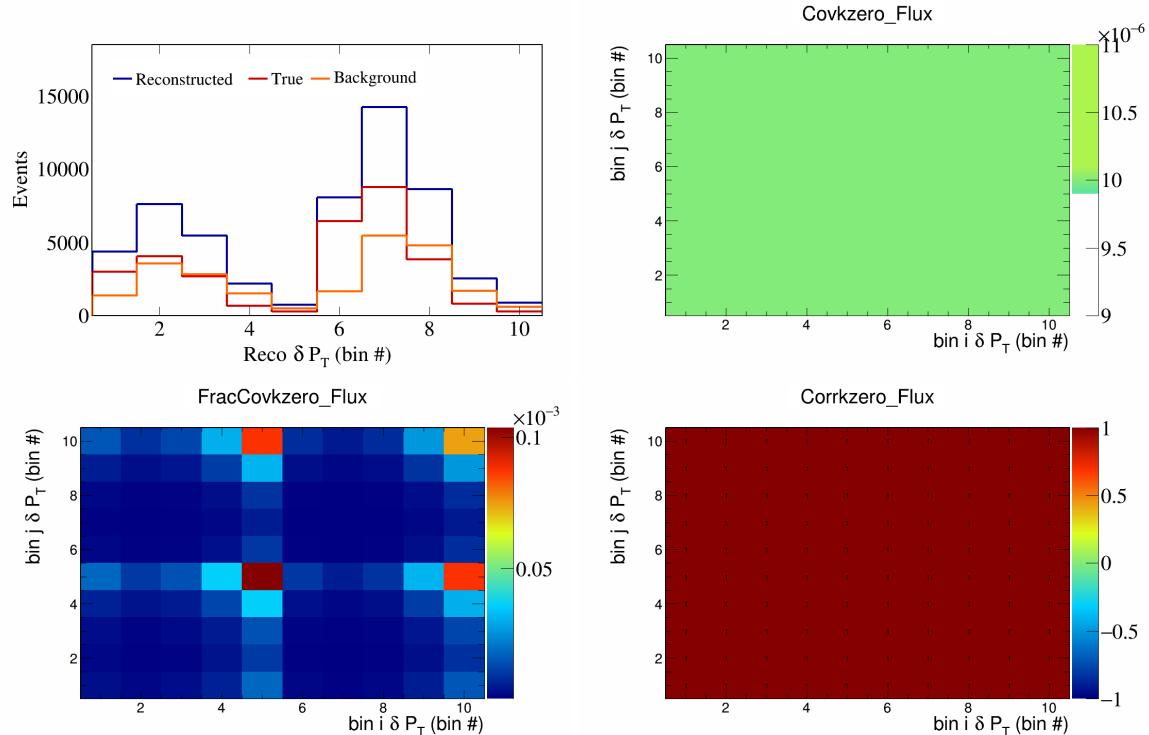


Figure 670: KZero variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

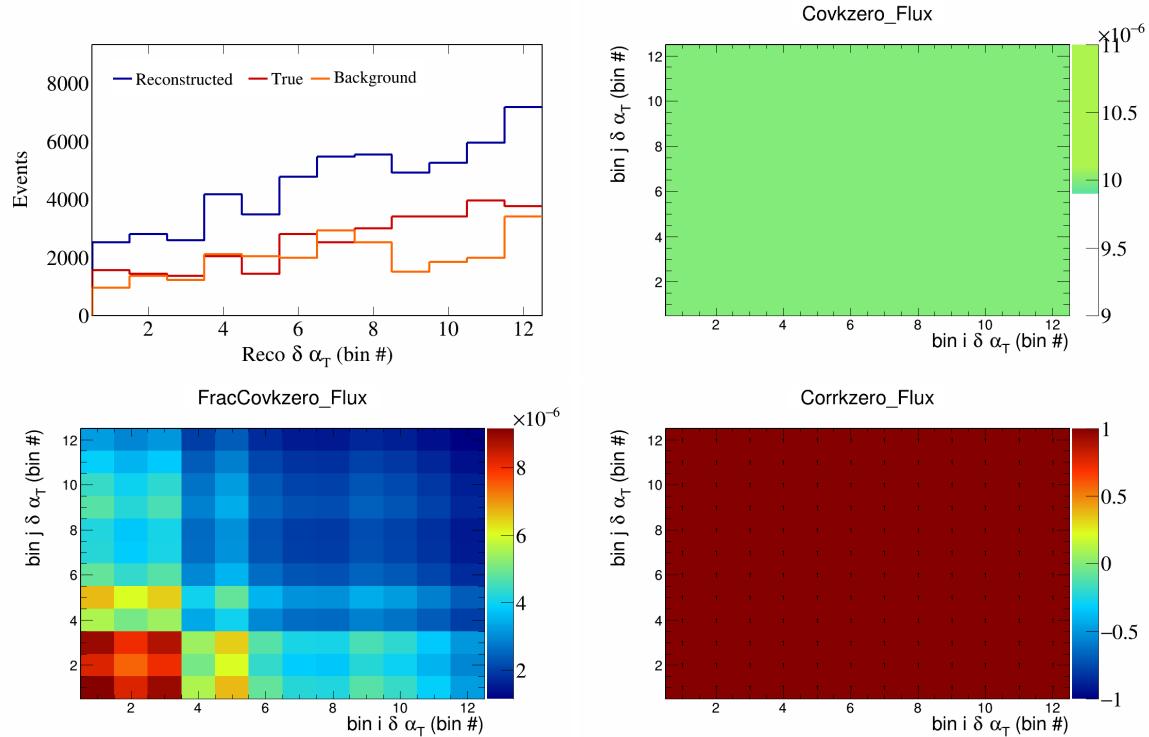


Figure 671: KZero variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

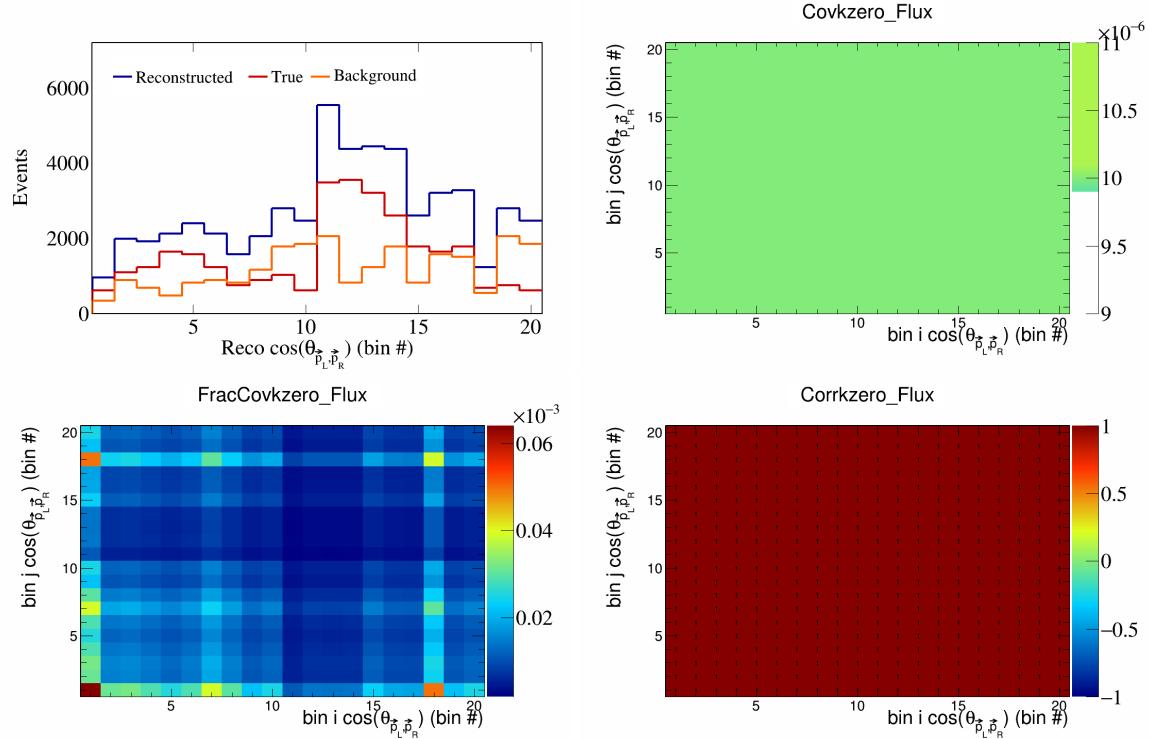


Figure 672: KZero variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

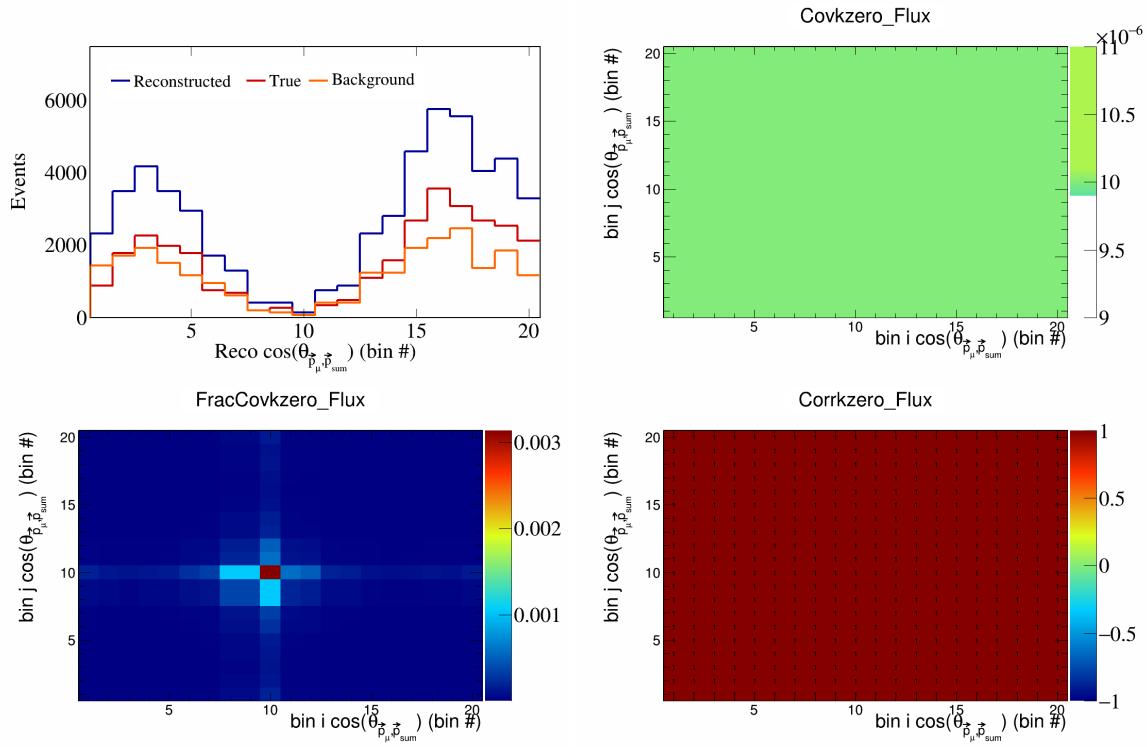


Figure 673: KZero variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

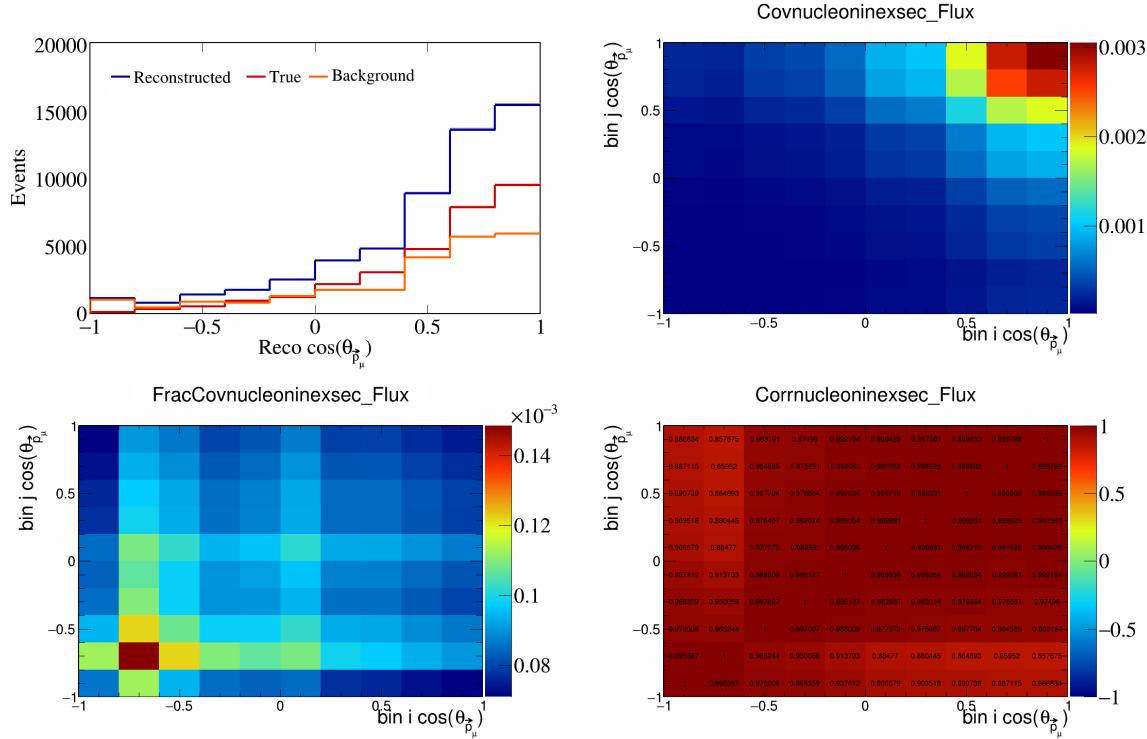


Figure 674: NucleonIneXSec variations for $\cos(\theta_{\vec{p}_\mu})$.

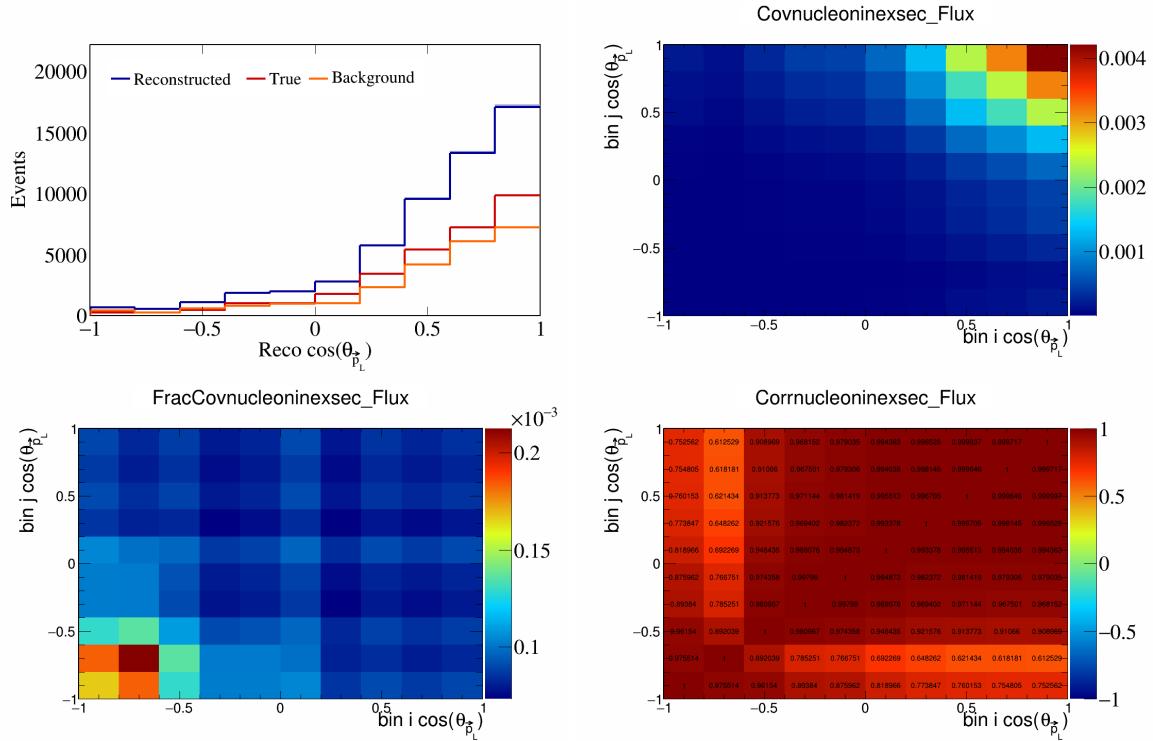


Figure 675: NucleonIneXSec variations for $\cos(\theta_{\vec{p}_L})$.

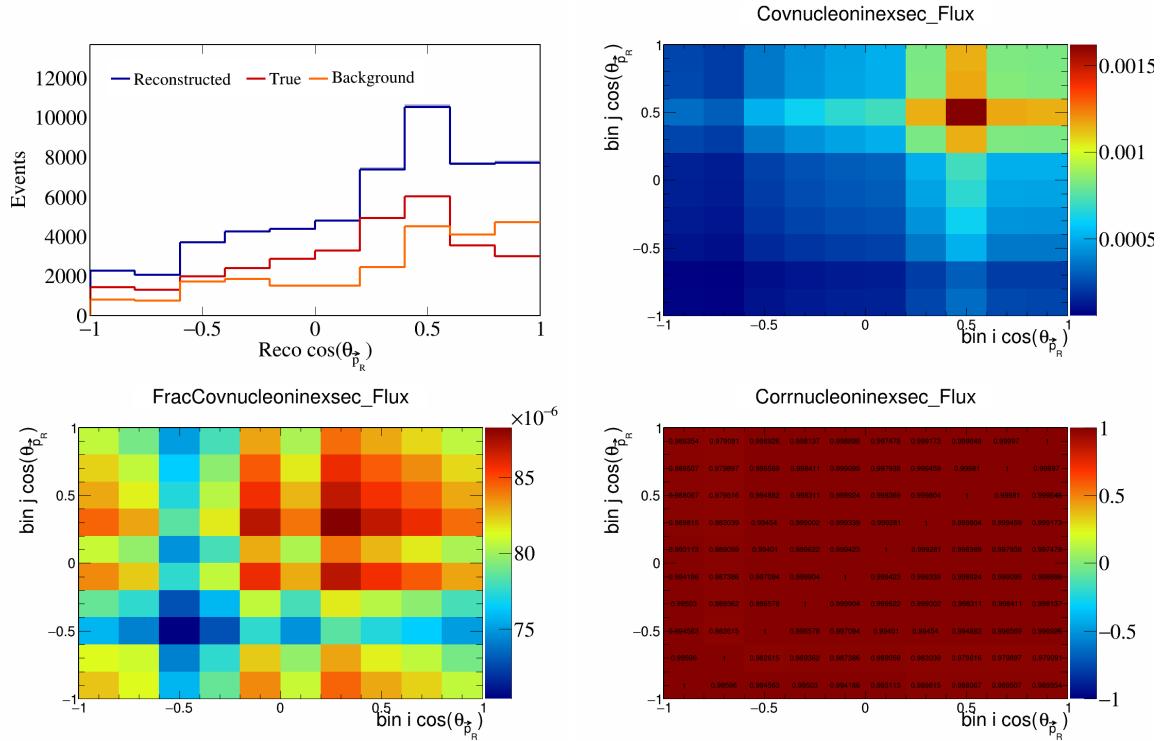


Figure 676: NucleonIneXSec variations for $\cos(\theta_{\vec{p}_R})$.

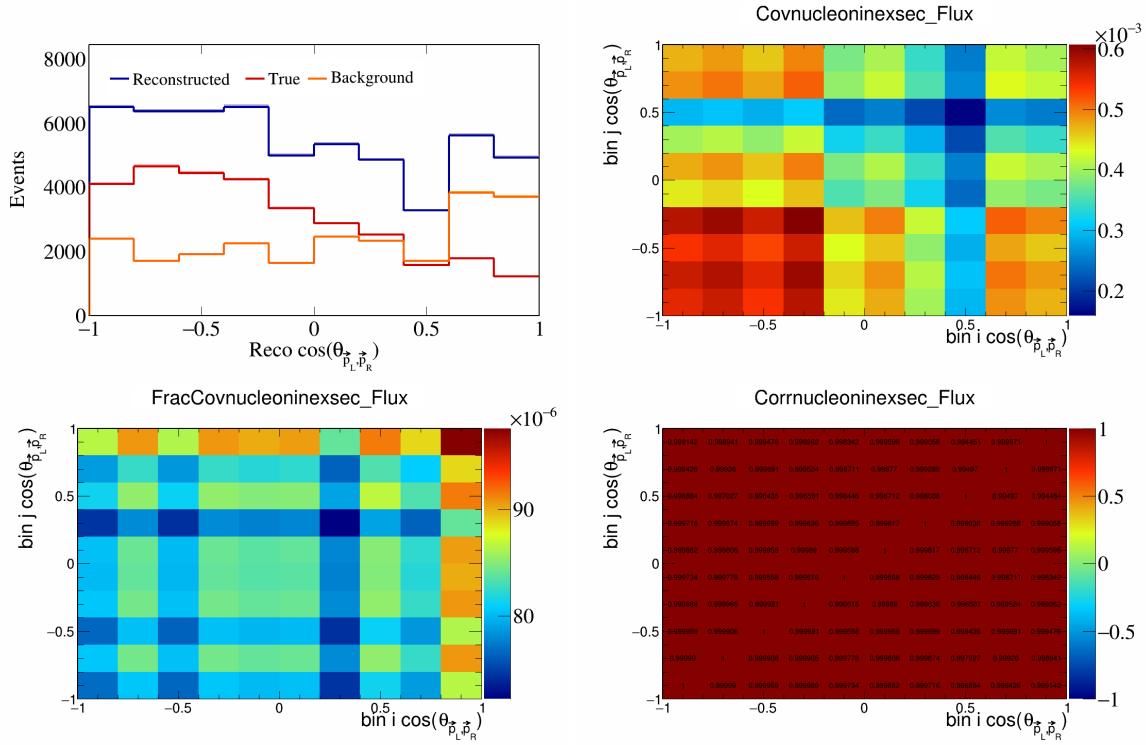


Figure 677: NucleonIneXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

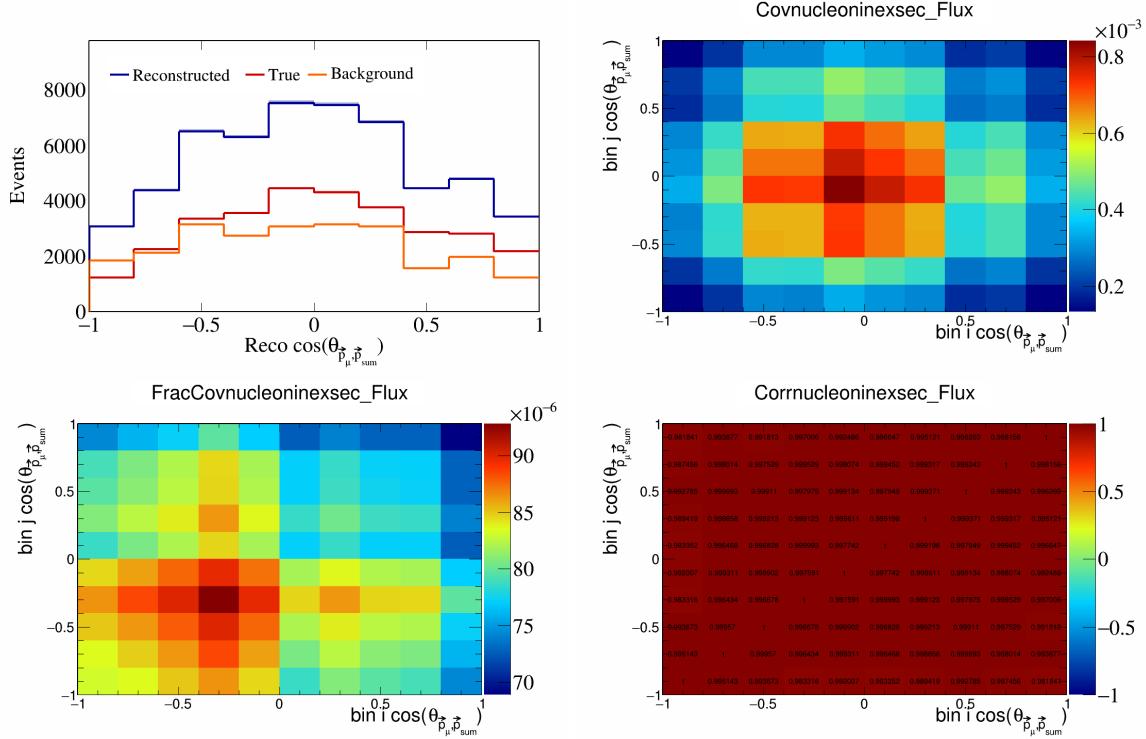


Figure 678: NucleonIneXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

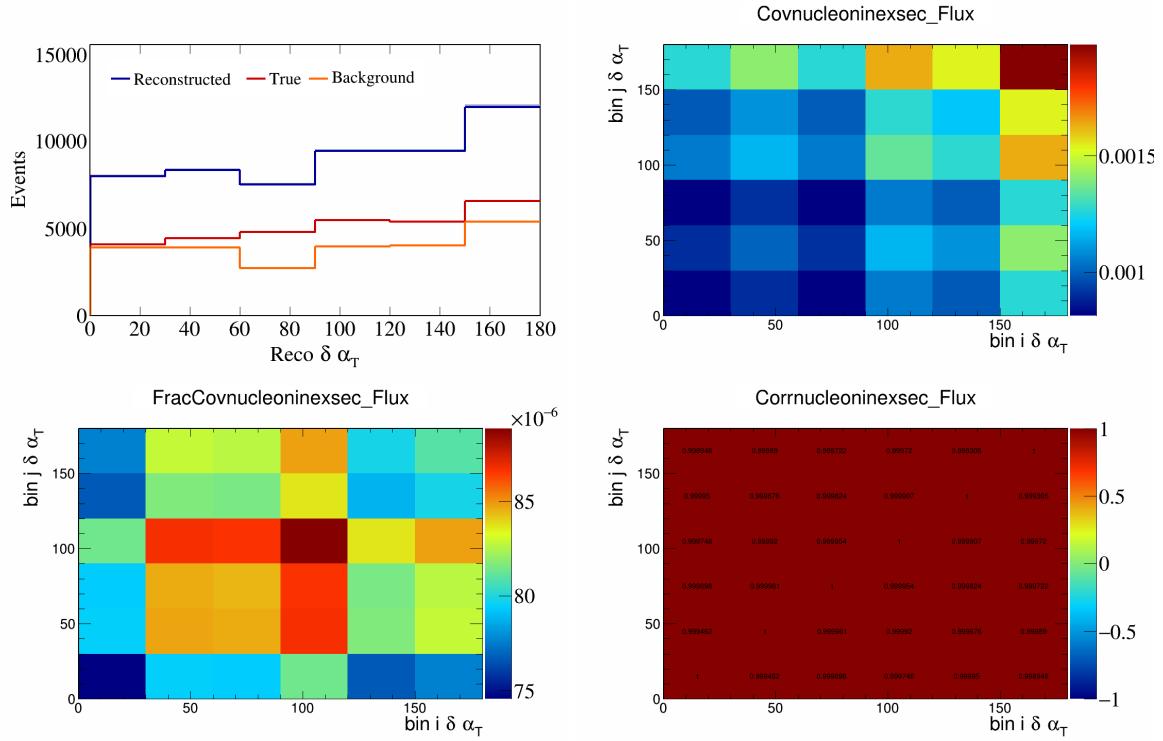


Figure 679: NucleonIneXSec variations for $\delta \alpha_T$.

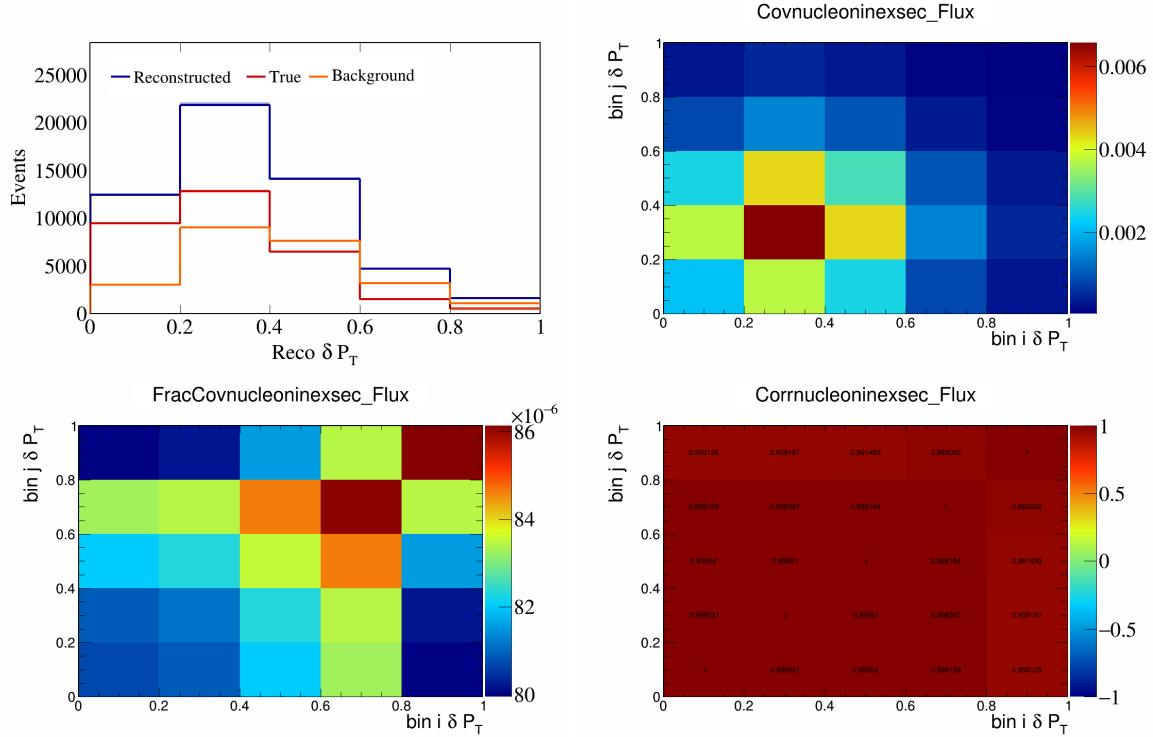


Figure 680: NucleonIneXSec variations for δP_T .

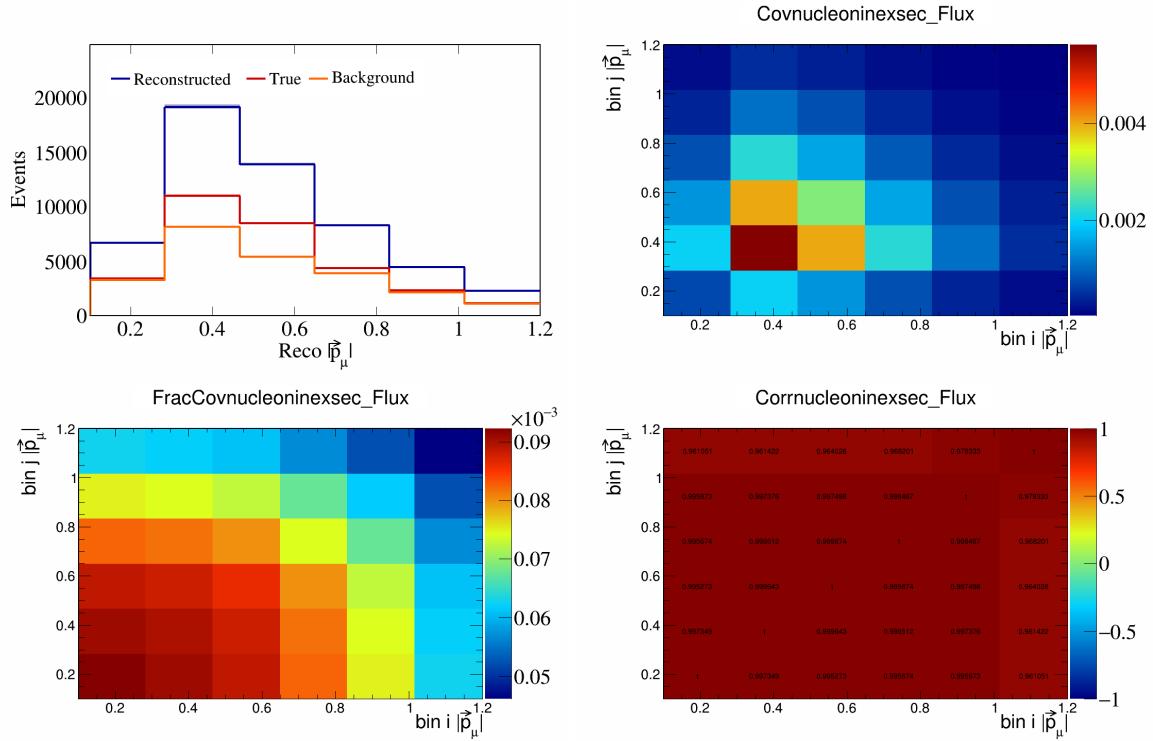


Figure 681: NucleonIneXSec variations for $|\vec{p}_\mu|$.

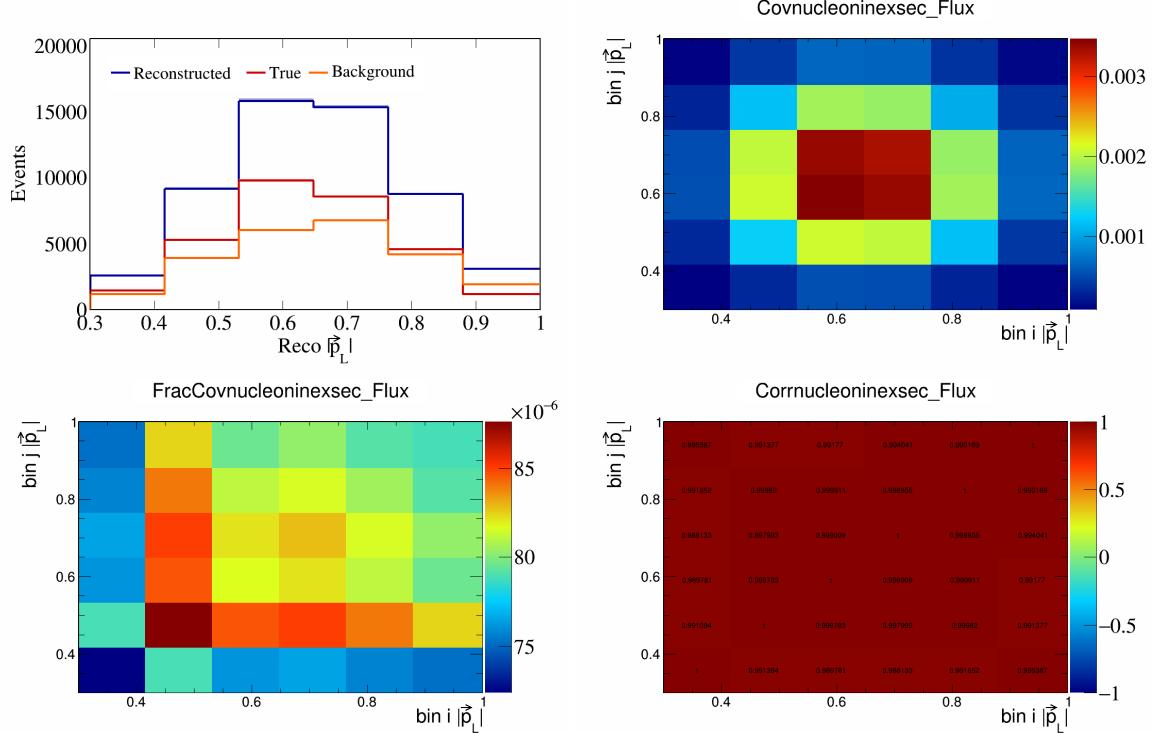


Figure 682: NucleonIneXSec variations for $|\vec{p}_L|$.

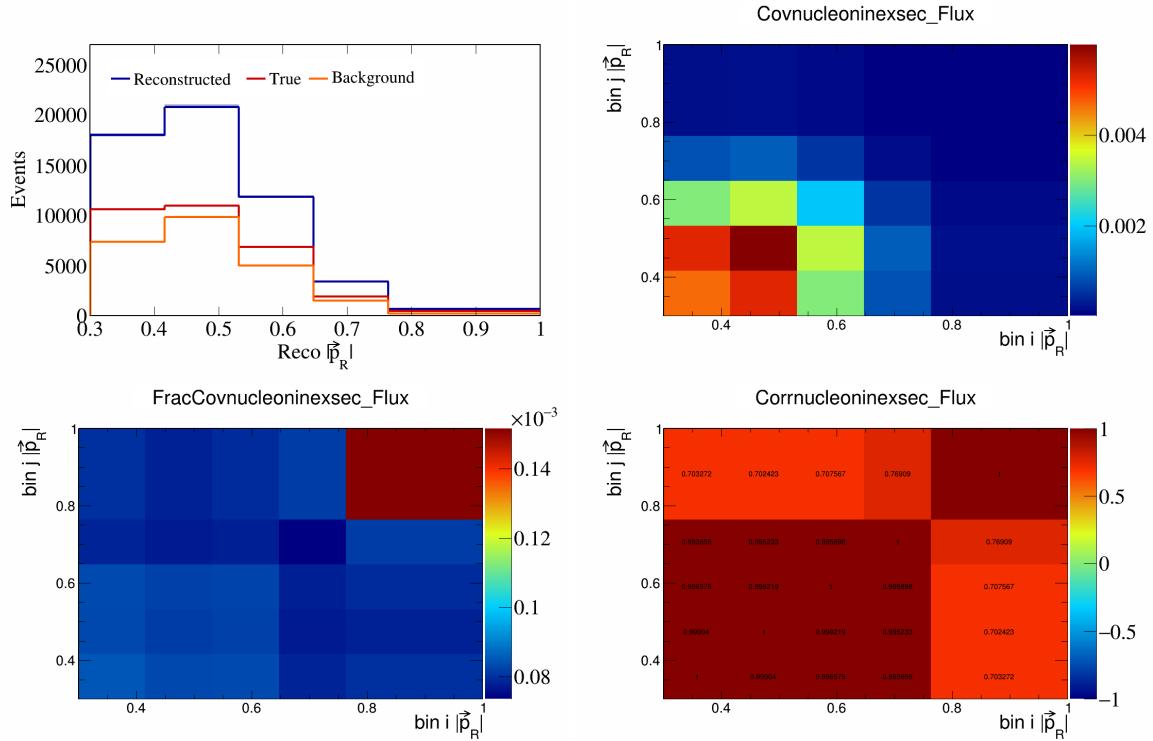


Figure 683: NucleonIneXSec variations for $|\vec{p}_R|$.

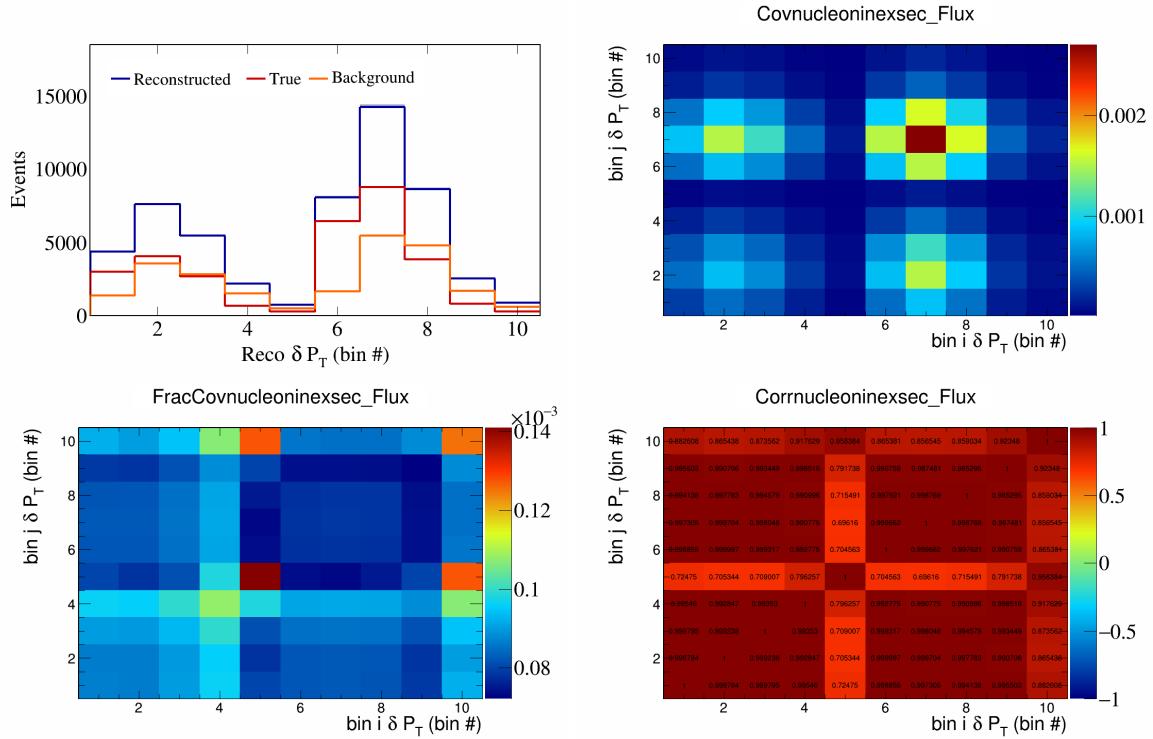


Figure 684: NucleonIneXSec variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

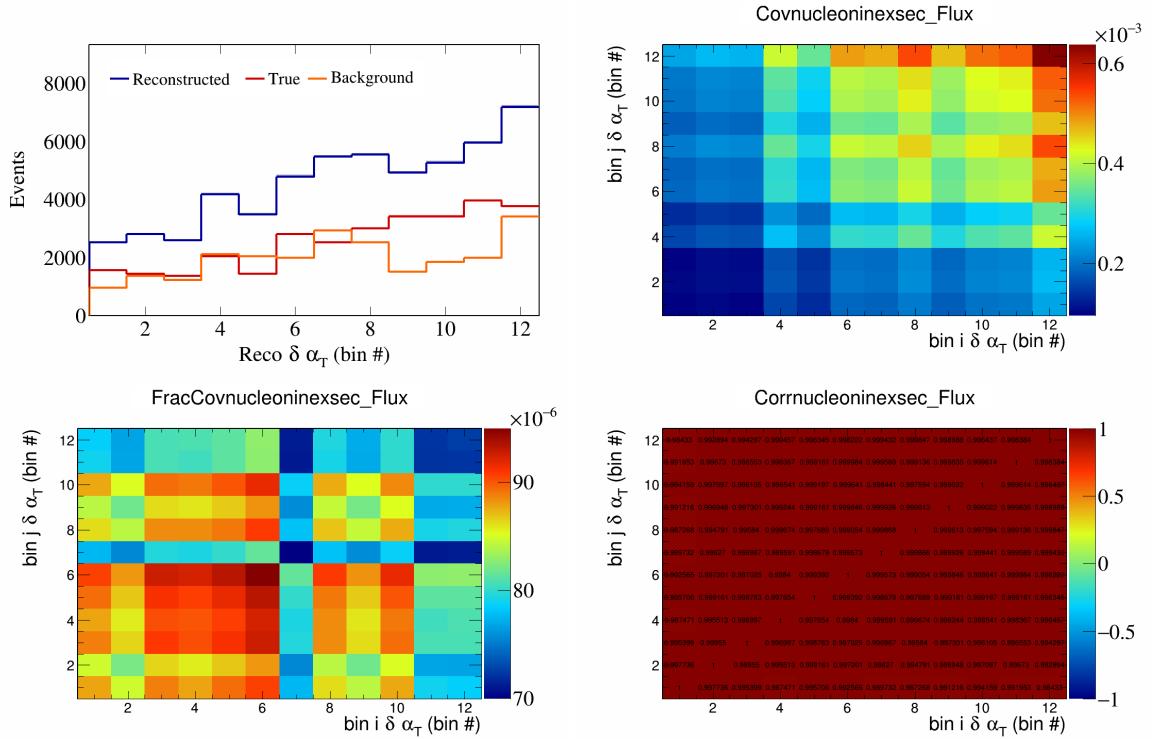


Figure 685: NucleonIneXSec variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

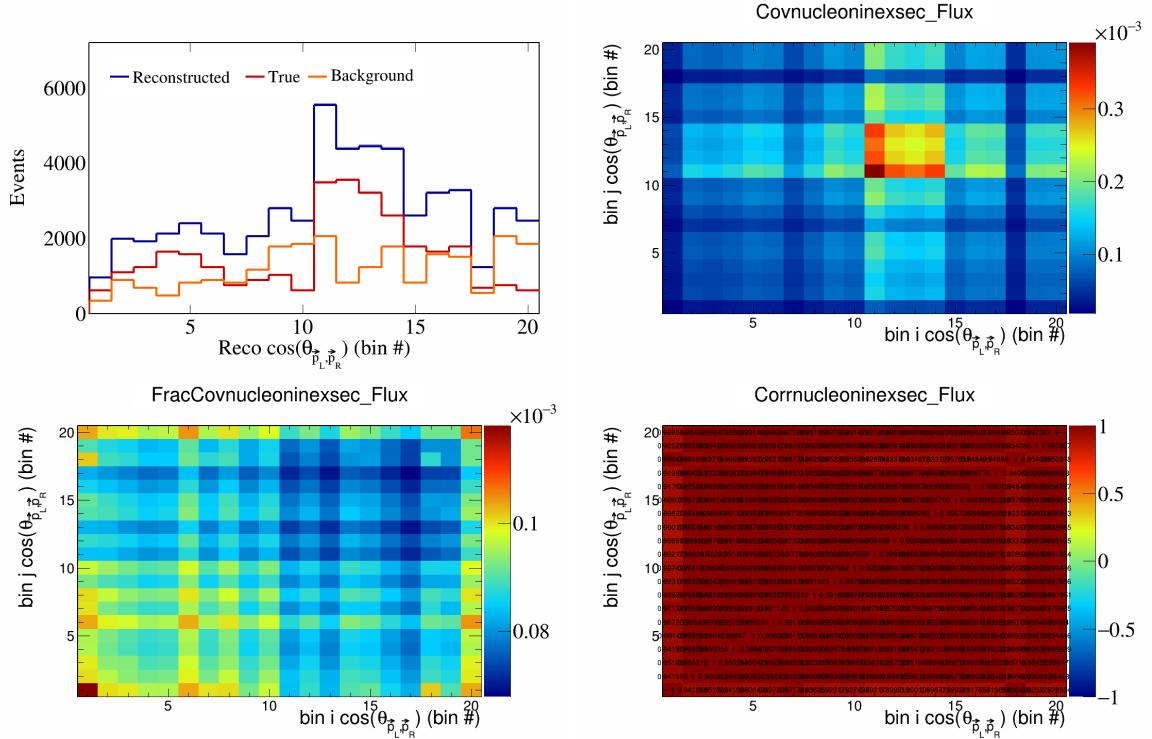


Figure 686: NucleonIneXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

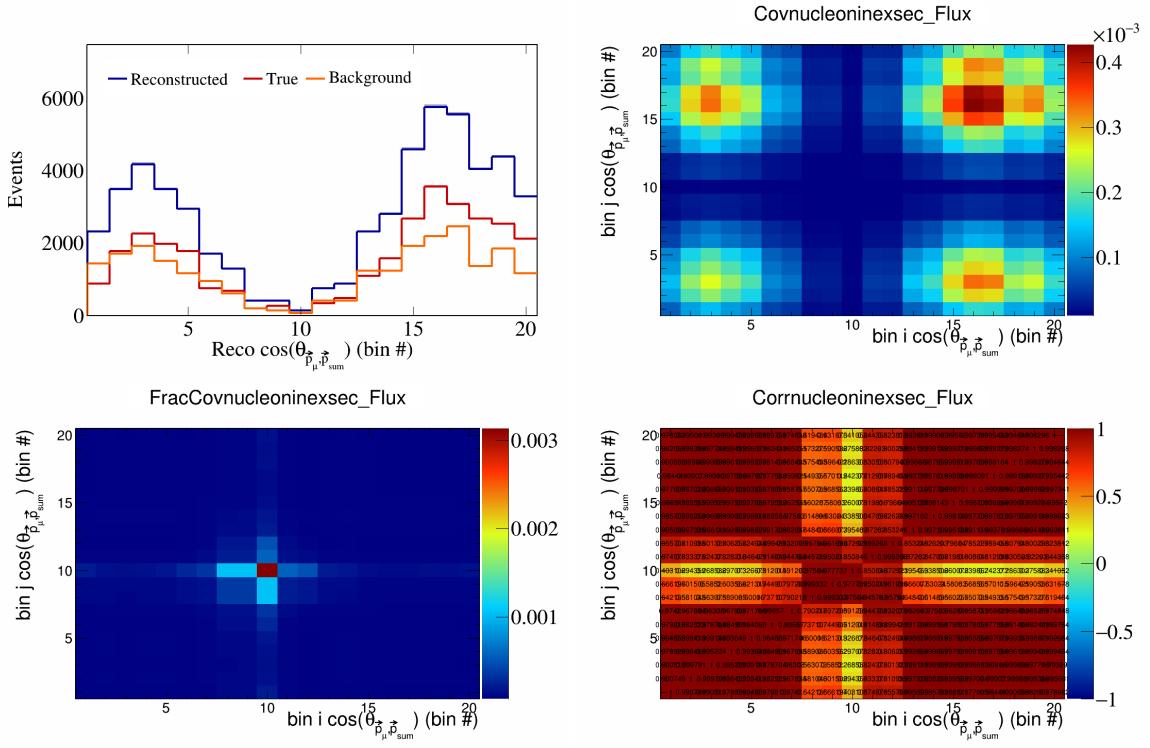


Figure 687: NucleonIneXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

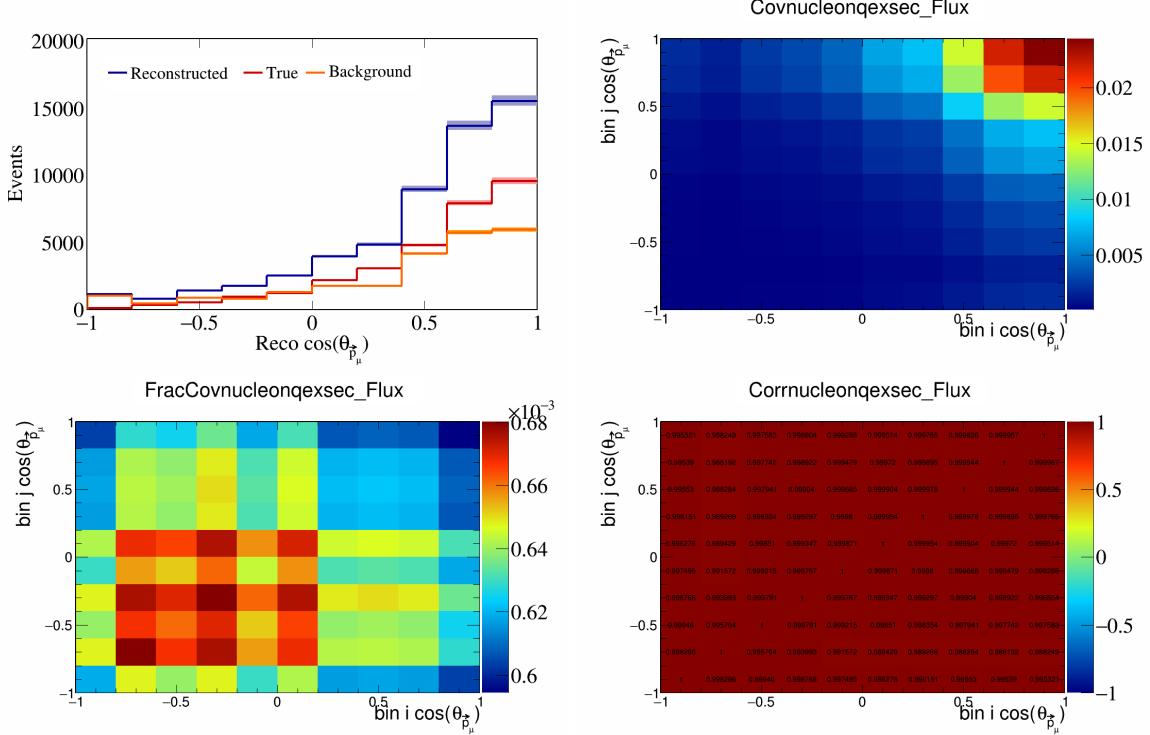


Figure 688: NucleonQeXSec variations for $\cos(\theta_{\vec{p}_\mu})$.

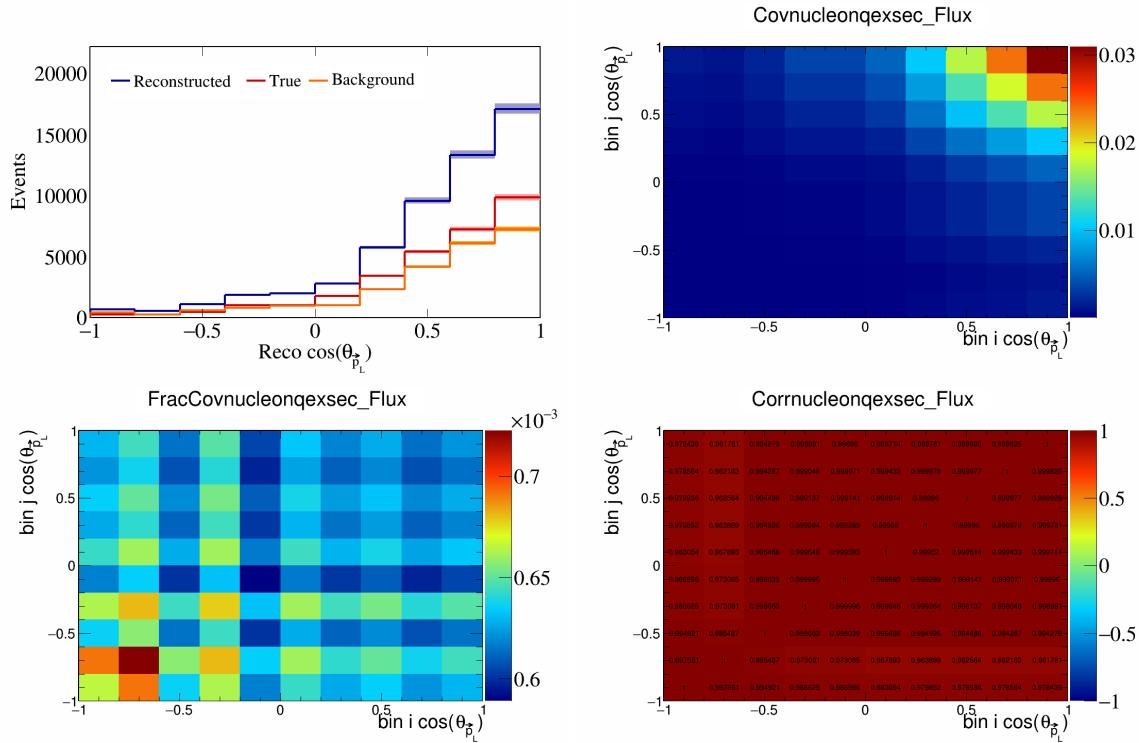


Figure 689: NucleonQeXSec variations for $\cos(\theta_{\vec{p}_L})$.

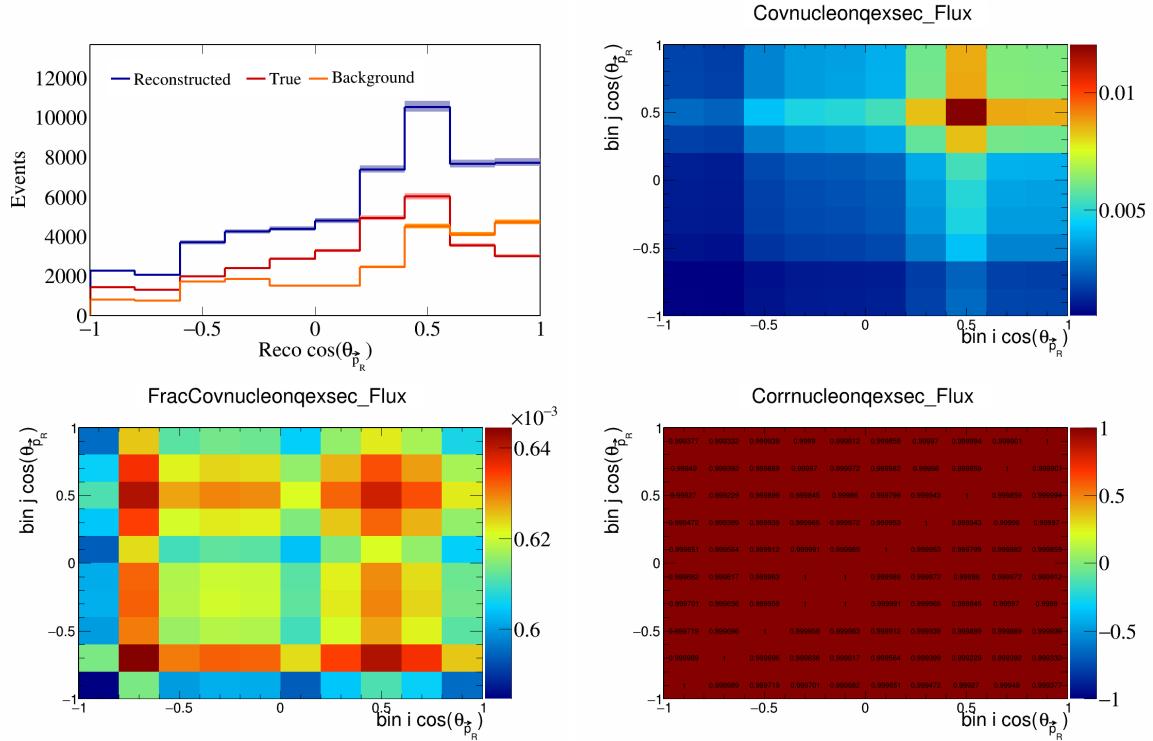


Figure 690: NucleonQeXSec variations for $\cos(\theta_{\vec{p}_R})$.

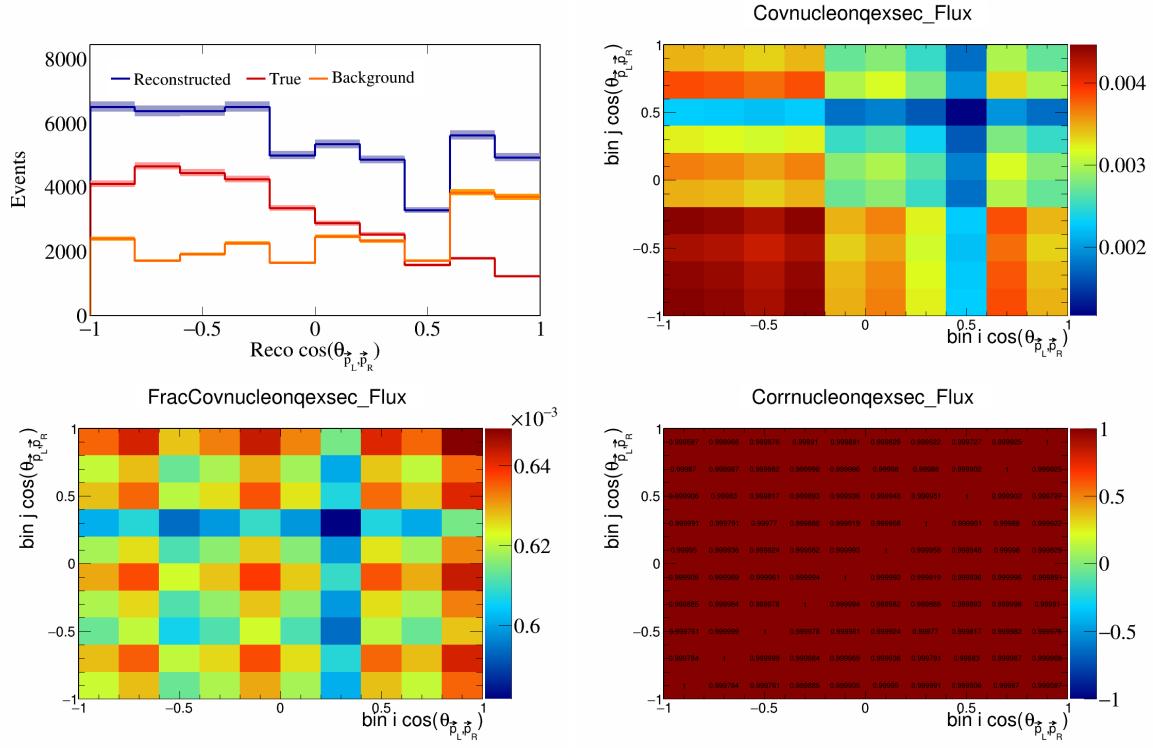


Figure 691: NucleonQeXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

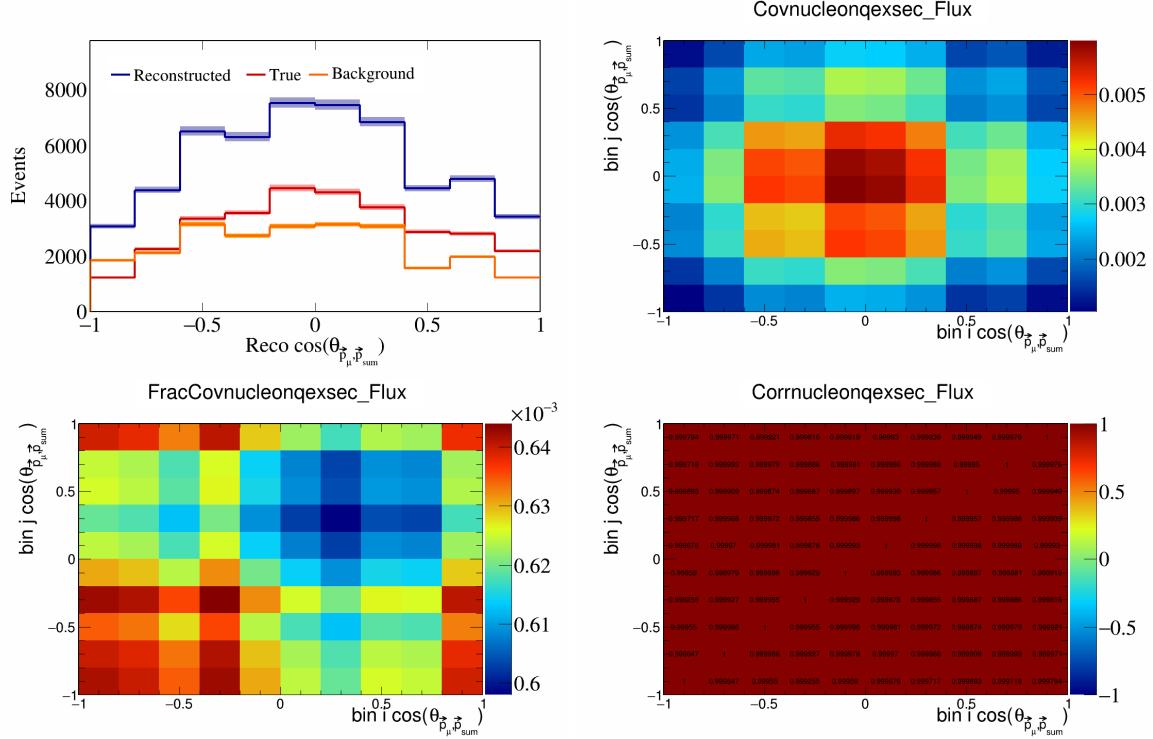


Figure 692: NucleonQeXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

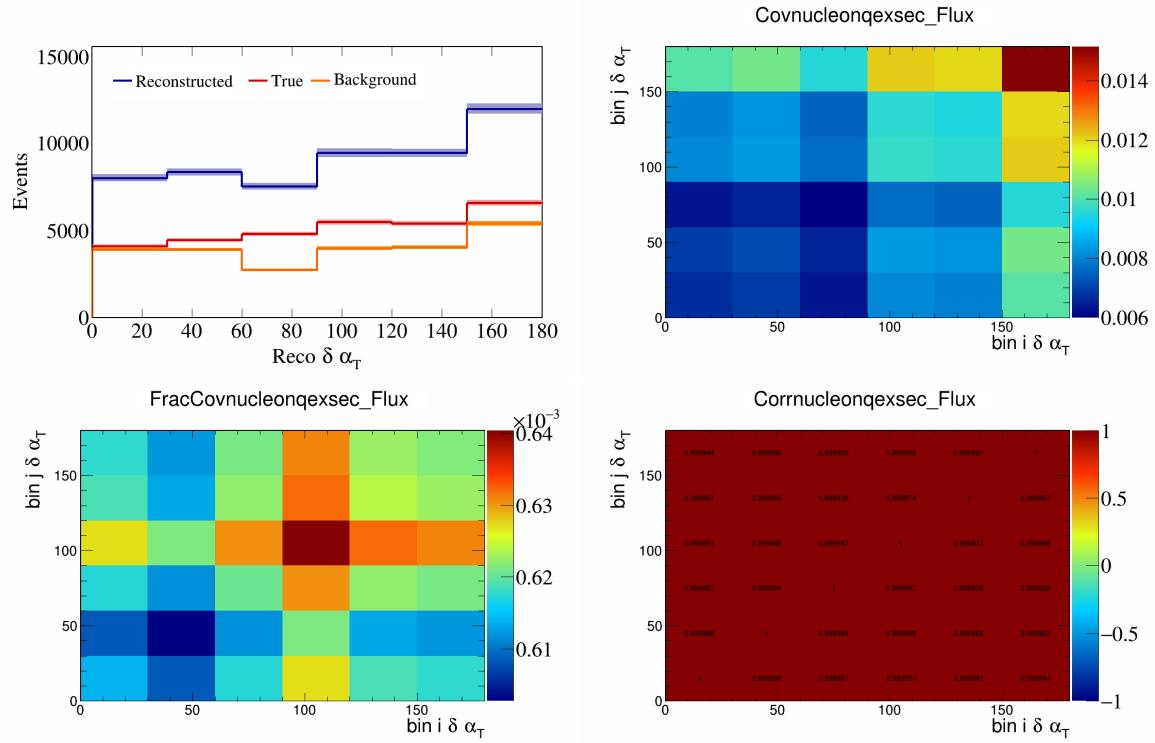


Figure 693: NucleonQeXSec variations for $\delta\alpha_T$.

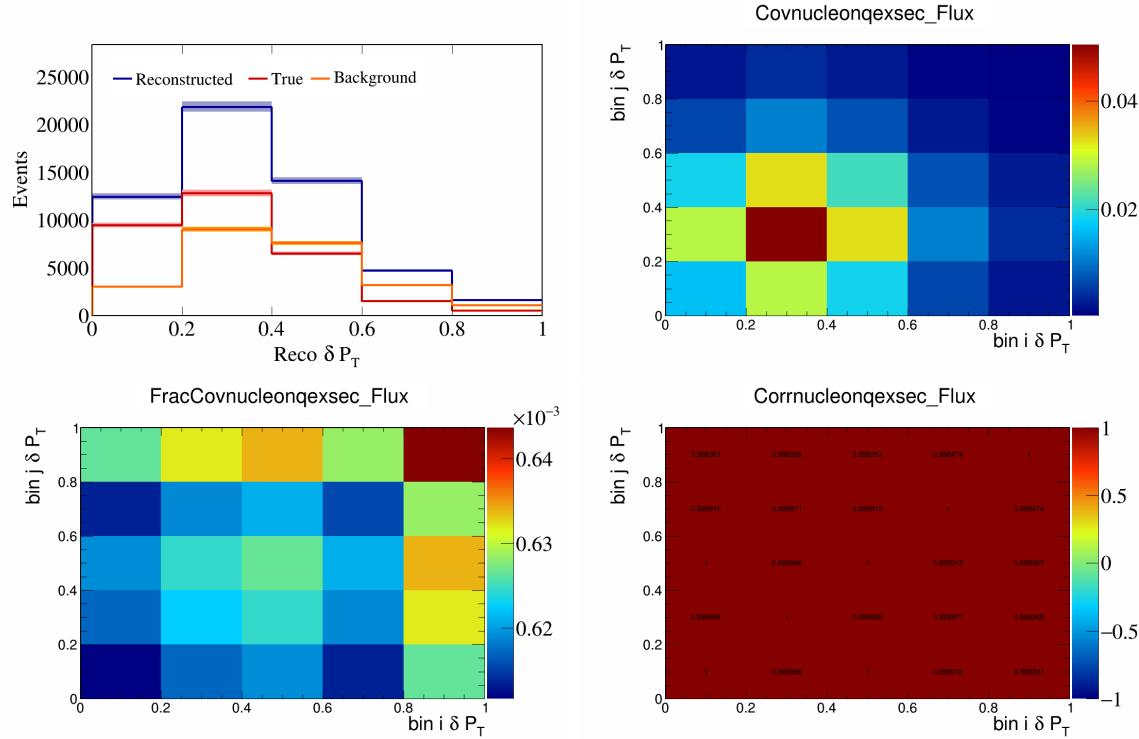


Figure 694: NucleonQeXSec variations for δP_T .

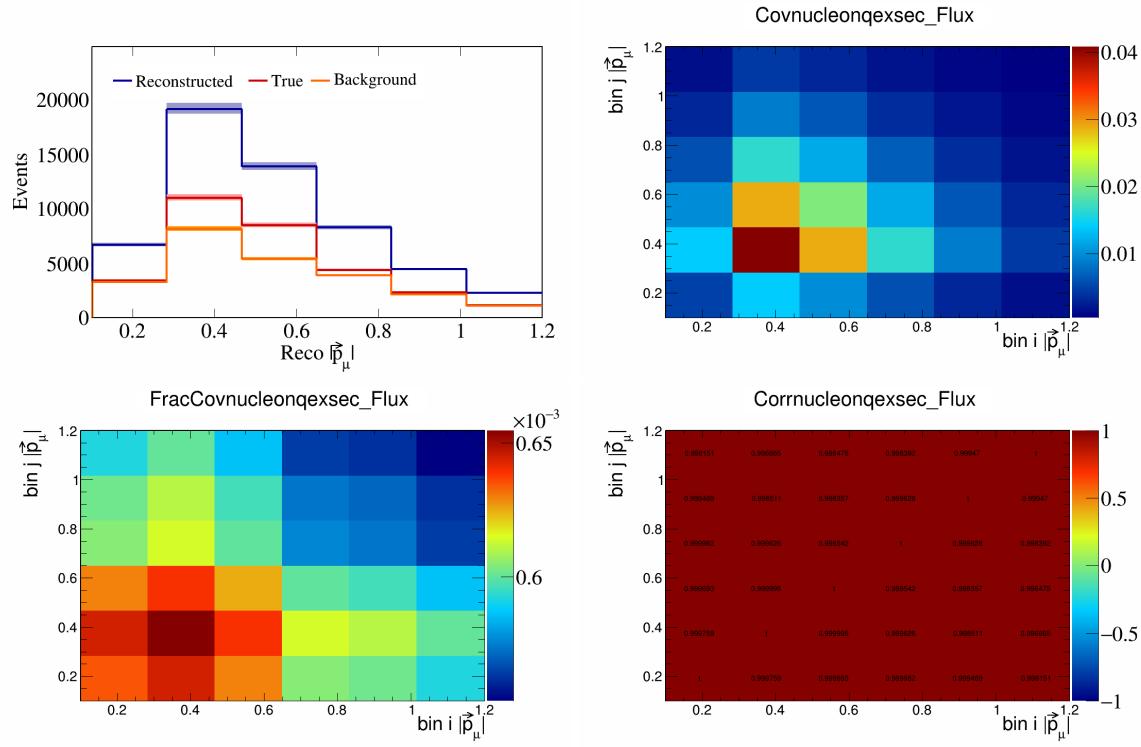


Figure 695: NucleonQeXSec variations for $|\vec{p}_\mu|$.

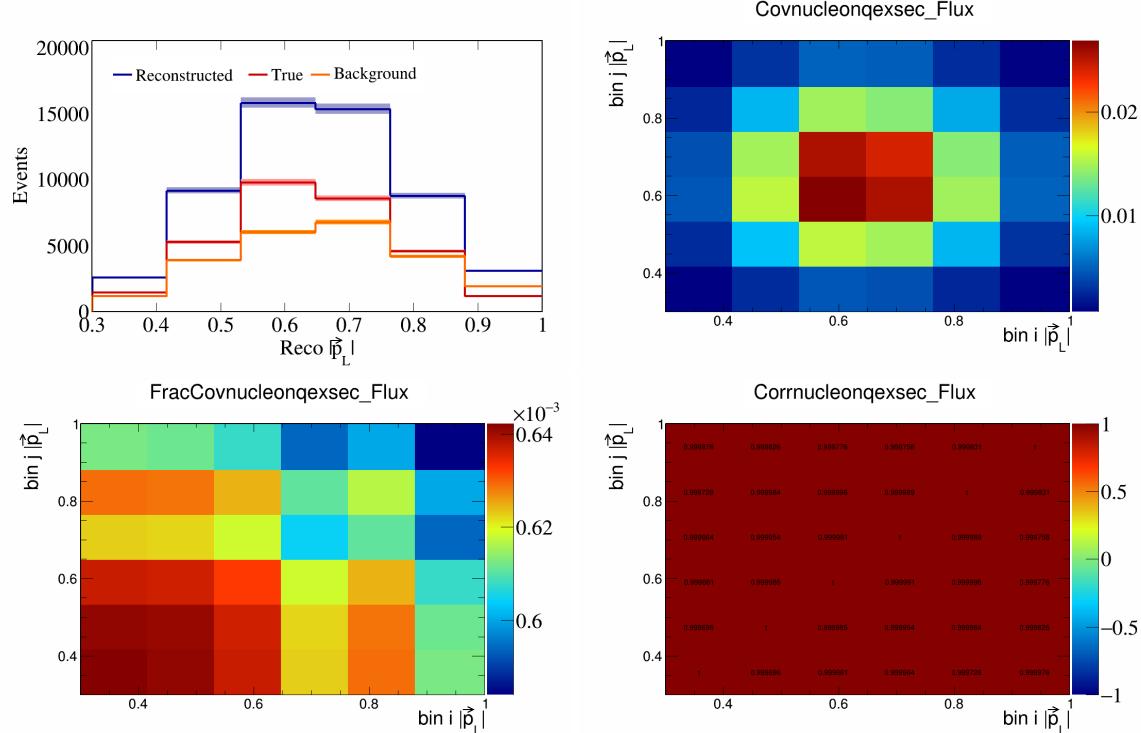


Figure 696: NucleonQeXSec variations for $|\vec{p}_L|$.

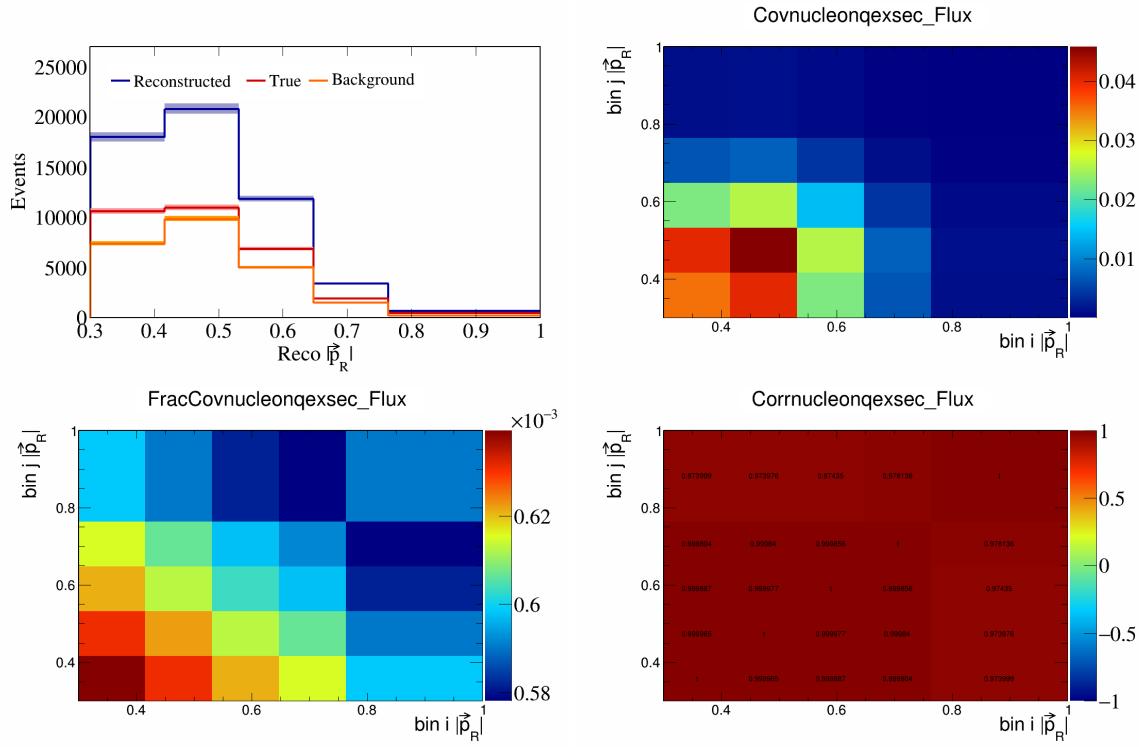


Figure 697: NucleonQeXSec variations for $|\vec{p}_R|$.

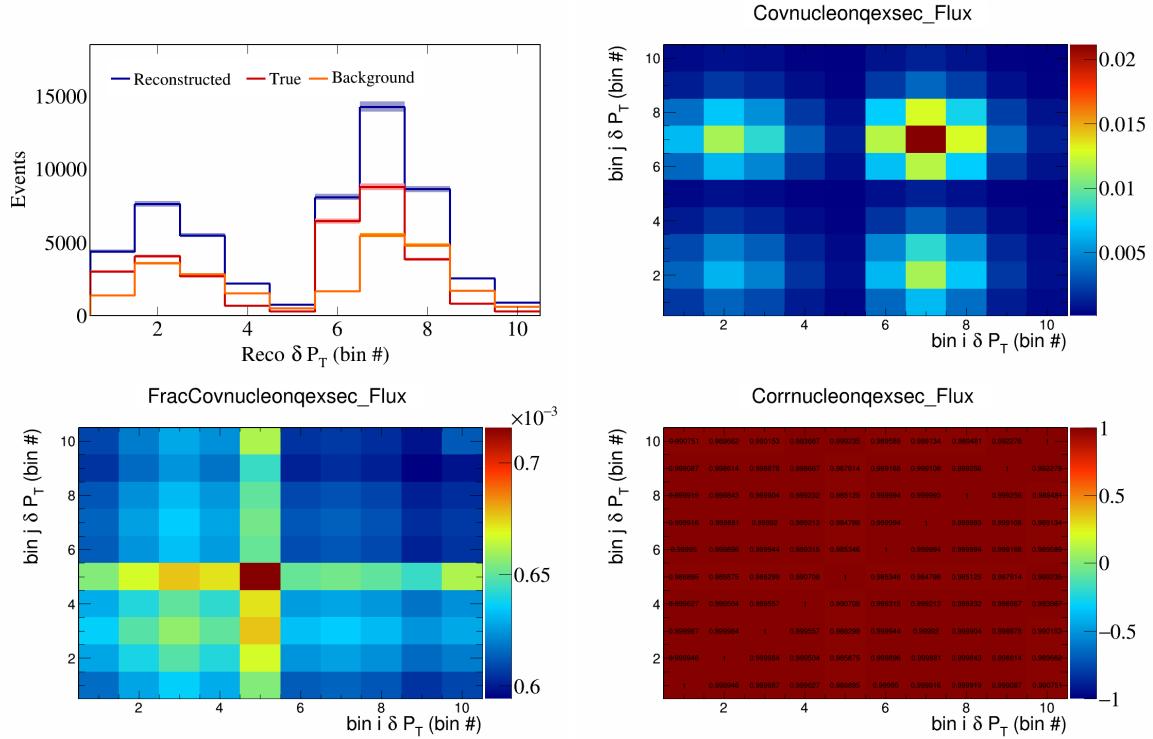


Figure 698: NucleonQeXSec variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

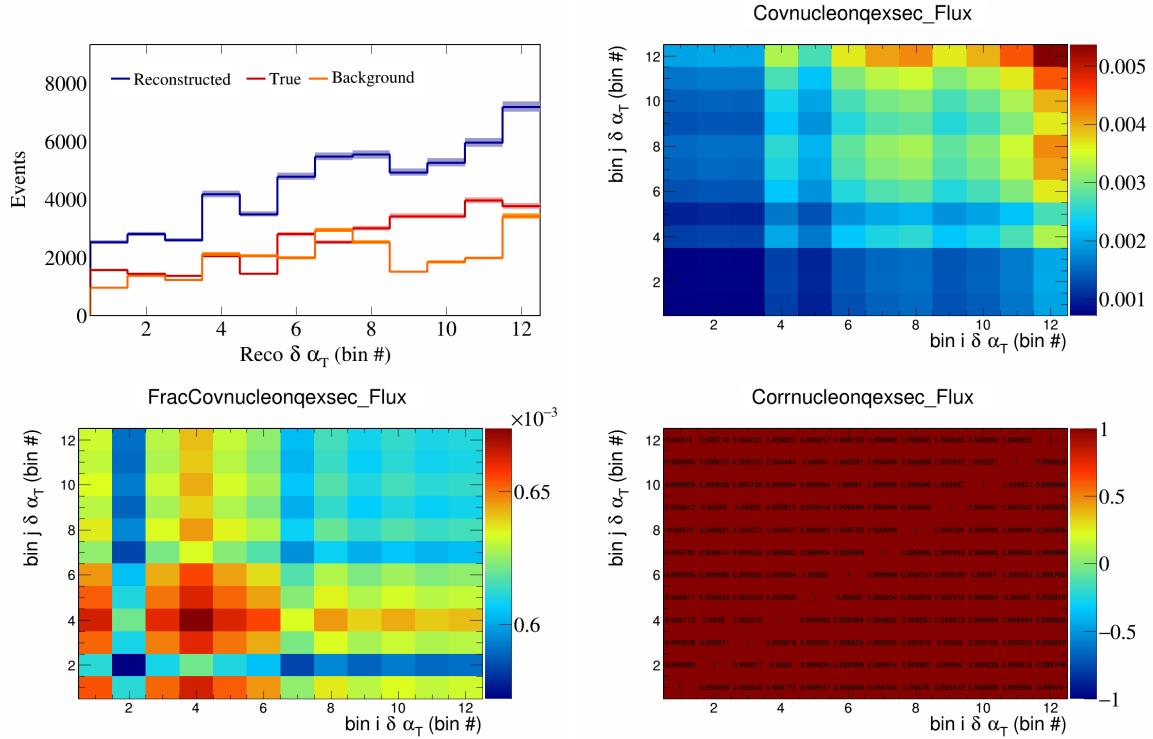


Figure 699: NucleonQeXSec variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

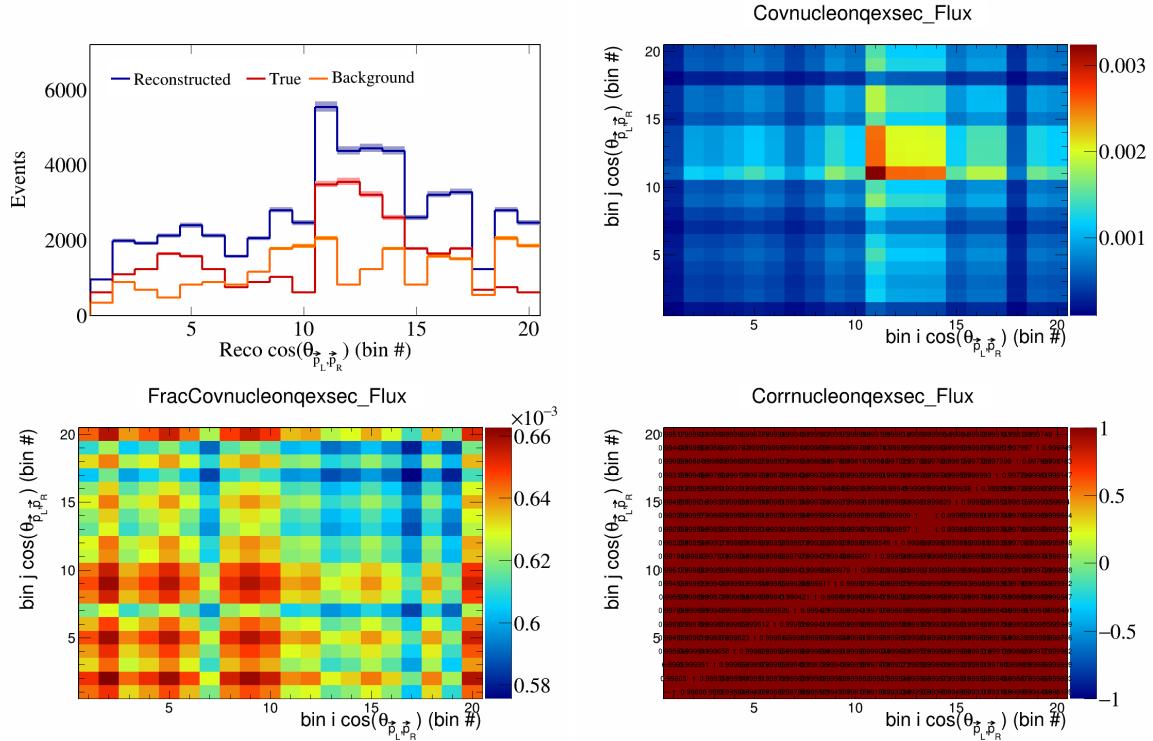


Figure 700: NucleonQeXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

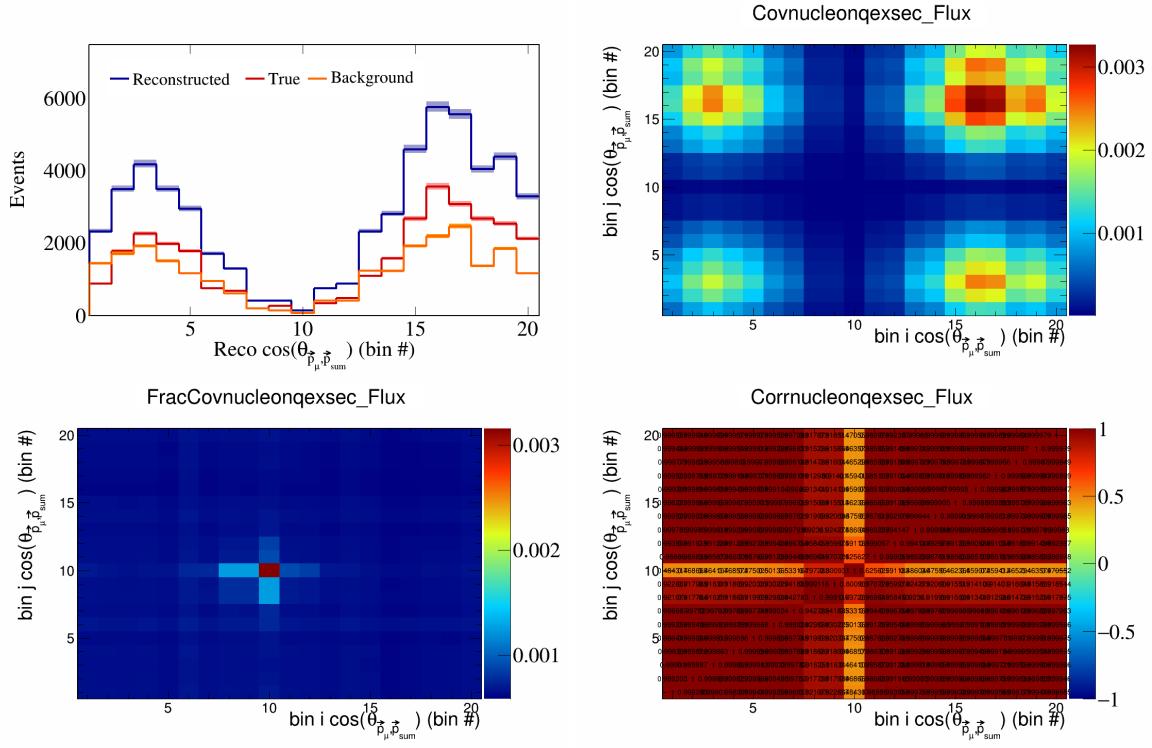


Figure 701: NucleonQeXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

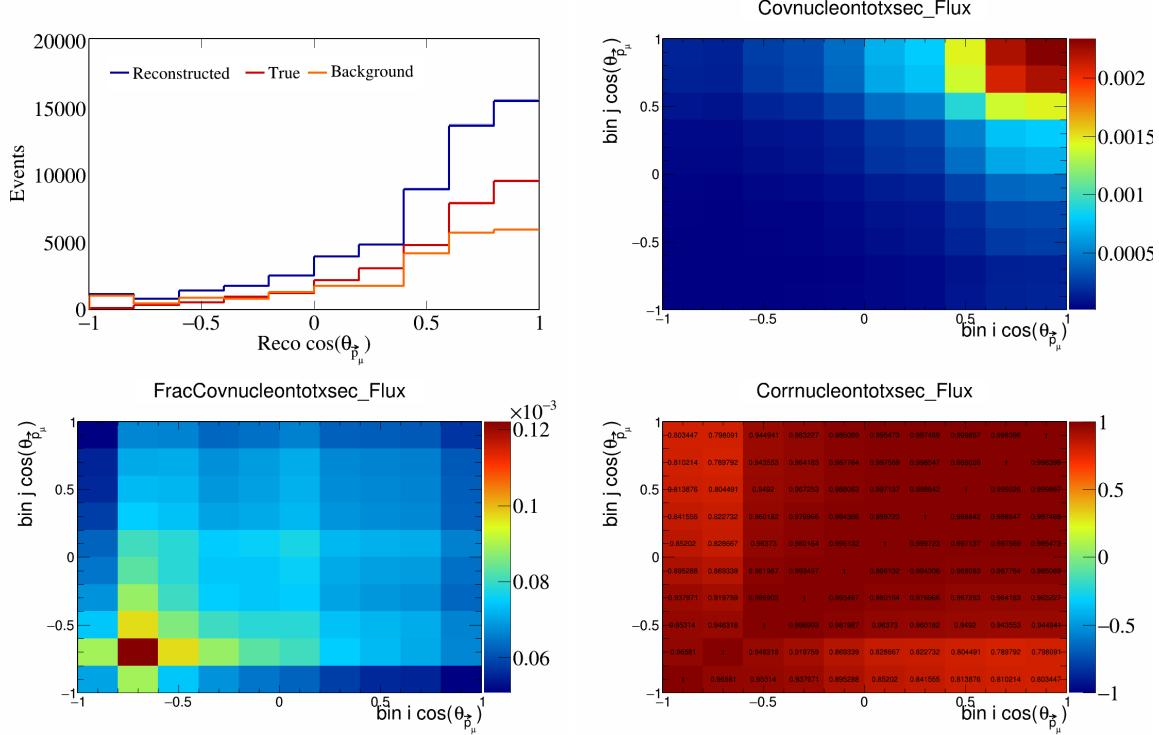


Figure 702: NucleonTotXSec variations for $\cos(\theta_{\vec{p}_\mu})$.

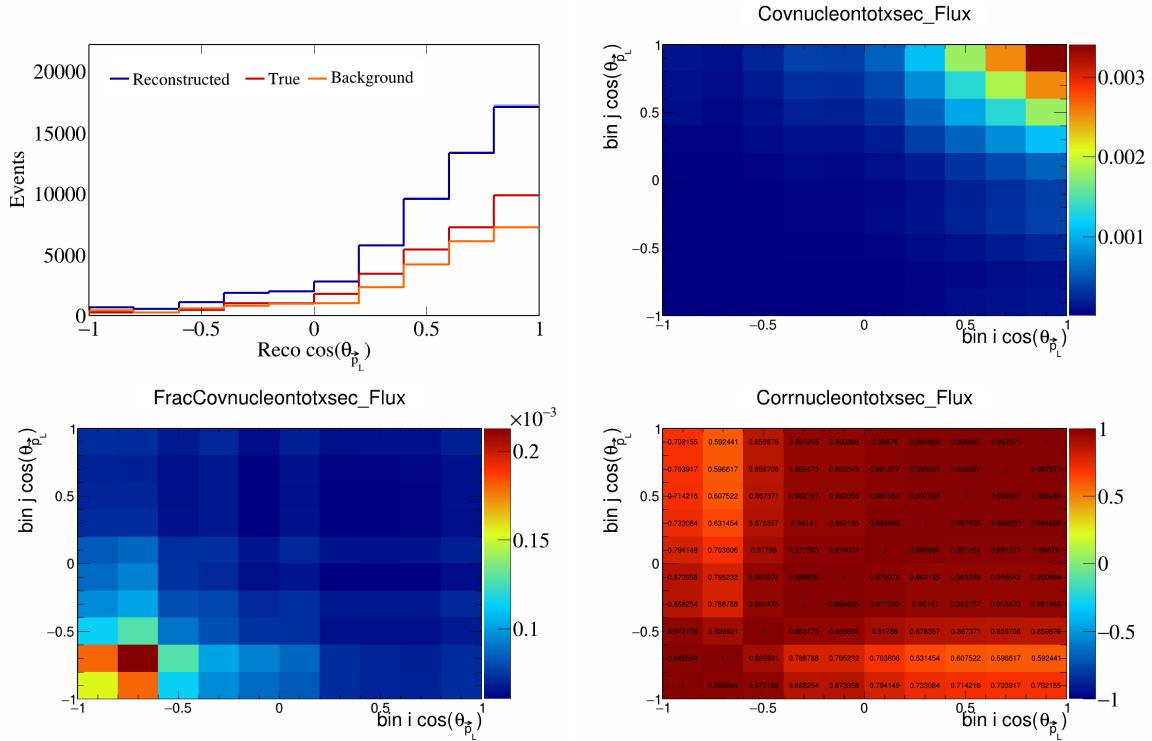


Figure 703: NucleonTotXSec variations for $\cos(\theta_{\vec{p}_L})$.

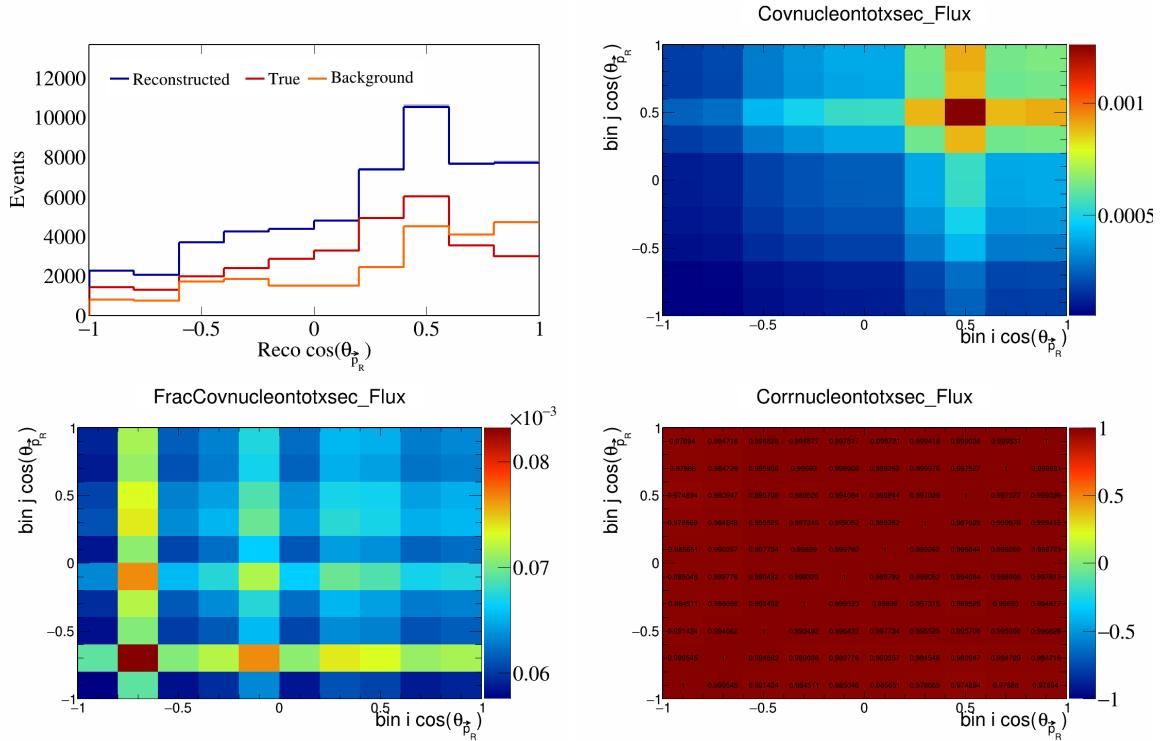


Figure 704: NucleonTotXSec variations for $\cos(\theta_{\vec{p}_R})$.

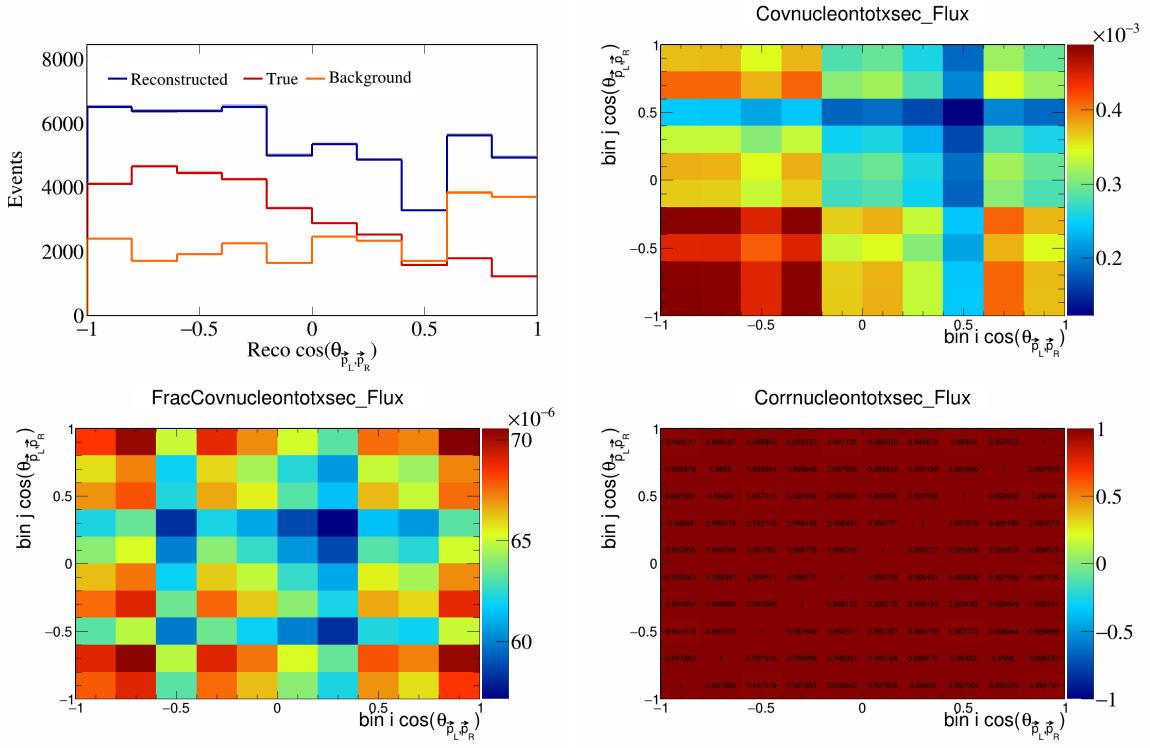


Figure 705: NucleonTotXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

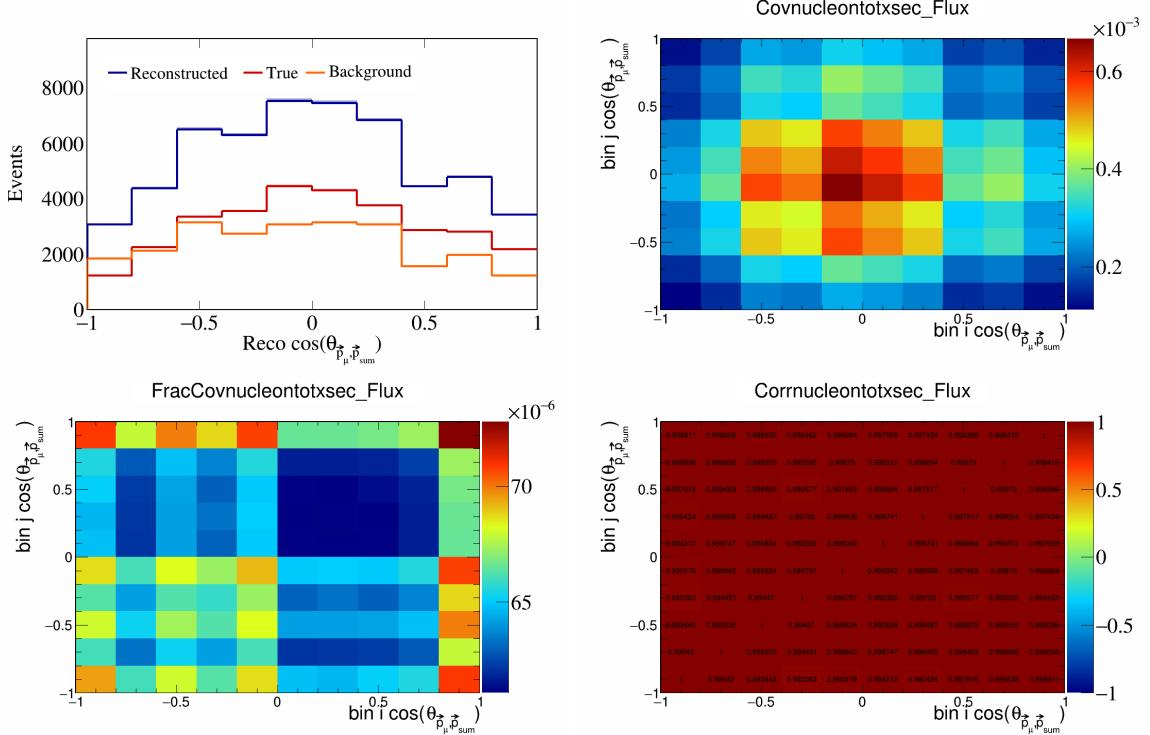


Figure 706: NucleonTotXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

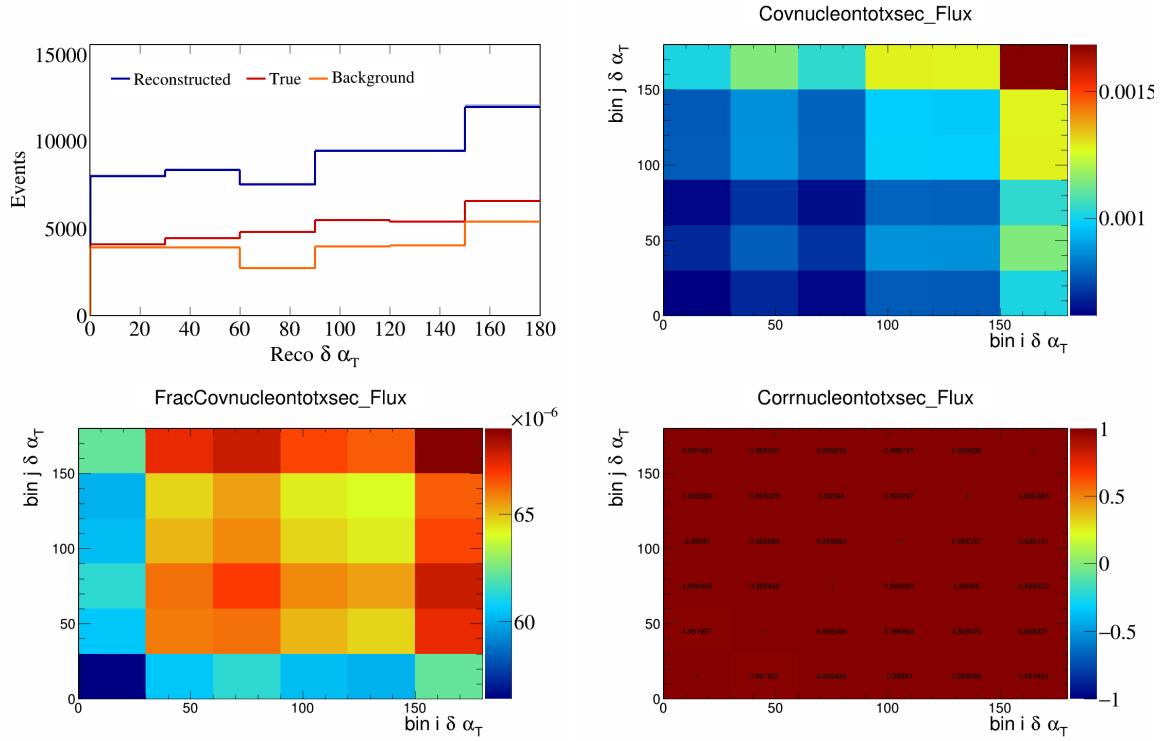


Figure 707: NucleonTotXSec variations for $\delta\alpha_T$.

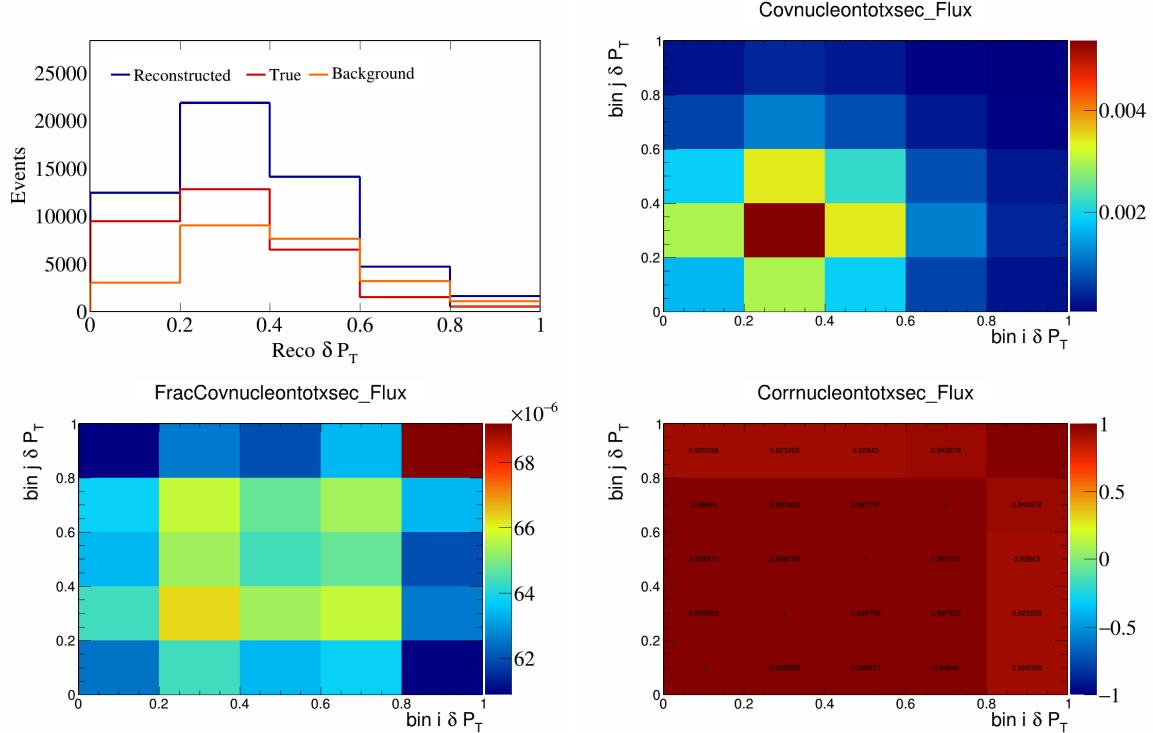


Figure 708: NucleonTotXSec variations for δP_T .

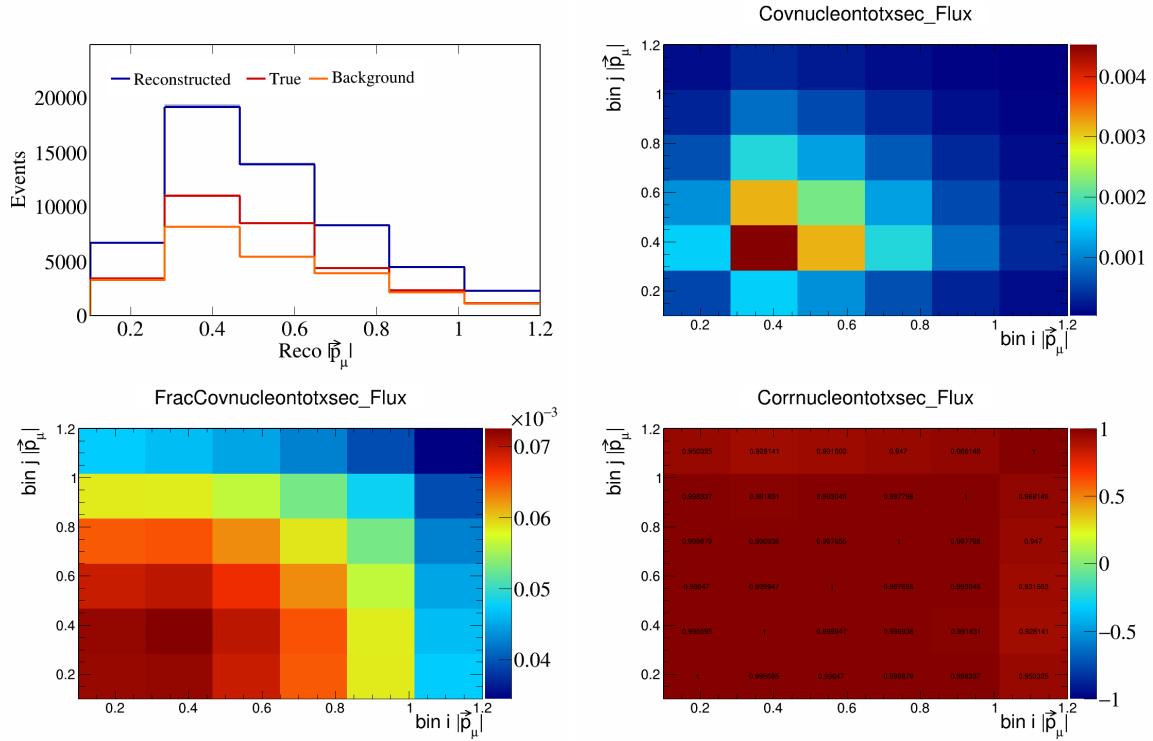


Figure 709: NucleonTotXSec variations for $|\vec{p}_\mu|$.

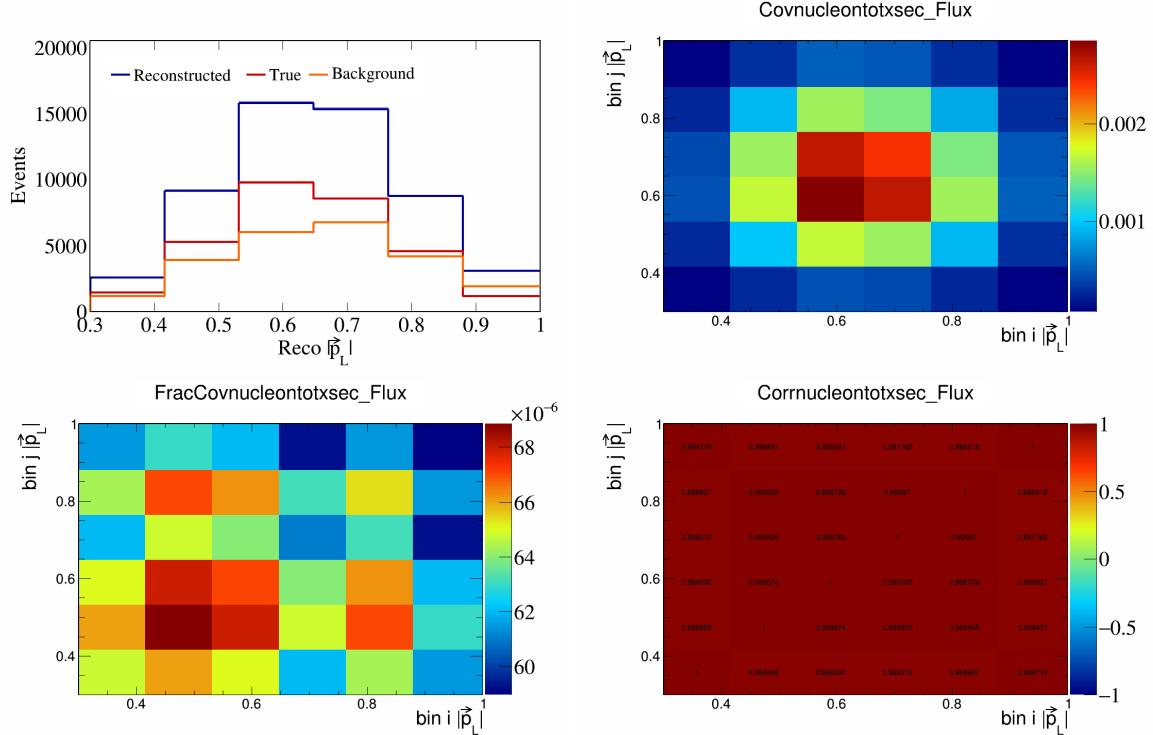


Figure 710: NucleonTotXSec variations for $|\vec{p}_L|$.

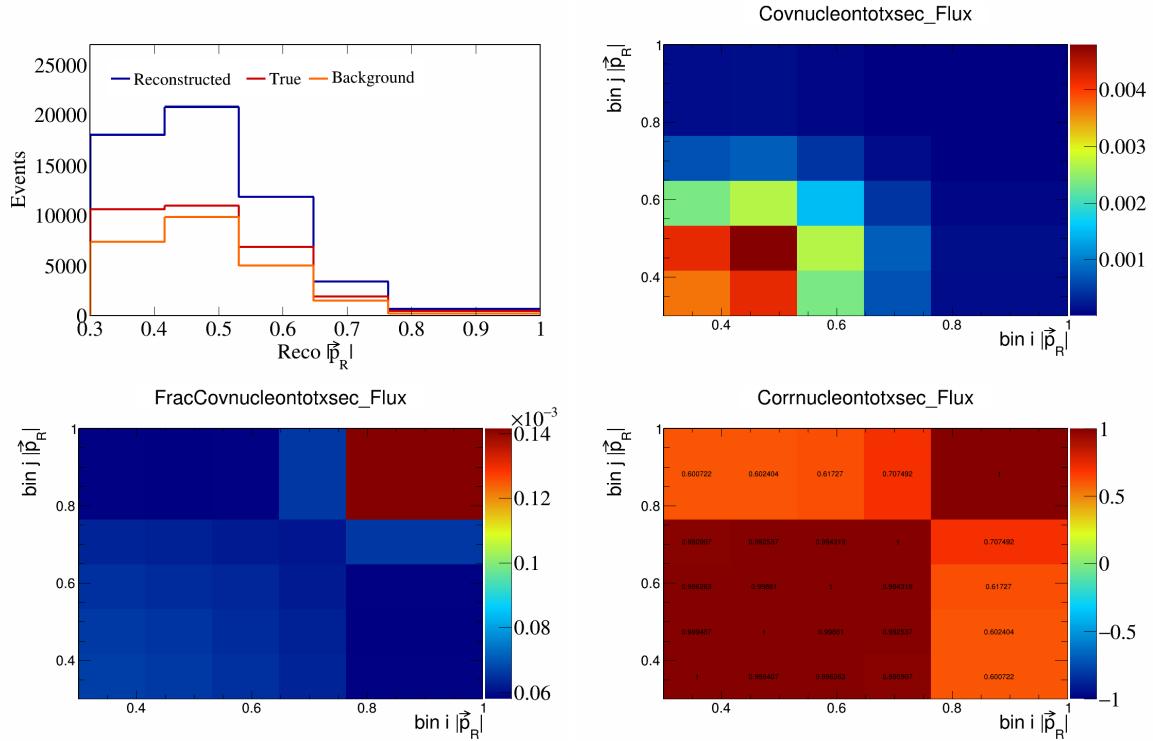


Figure 711: NucleonTotXSec variations for $|\vec{p}_R|$.

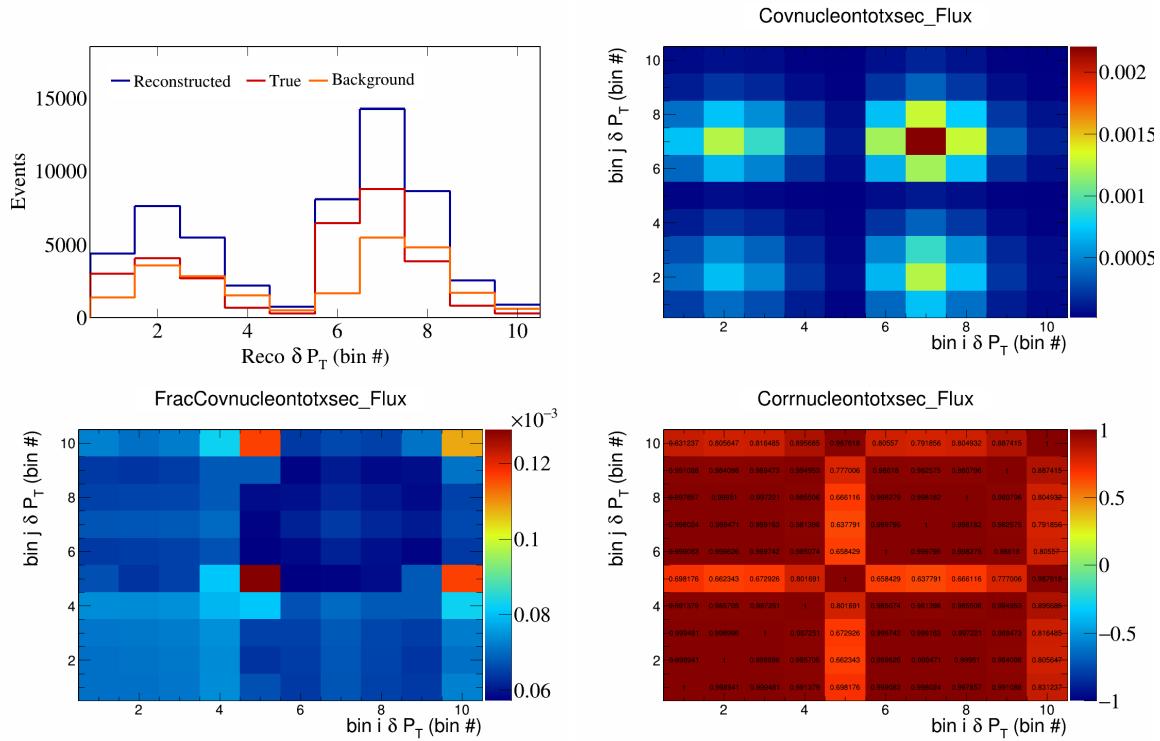


Figure 712: NucleonTotXSec variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

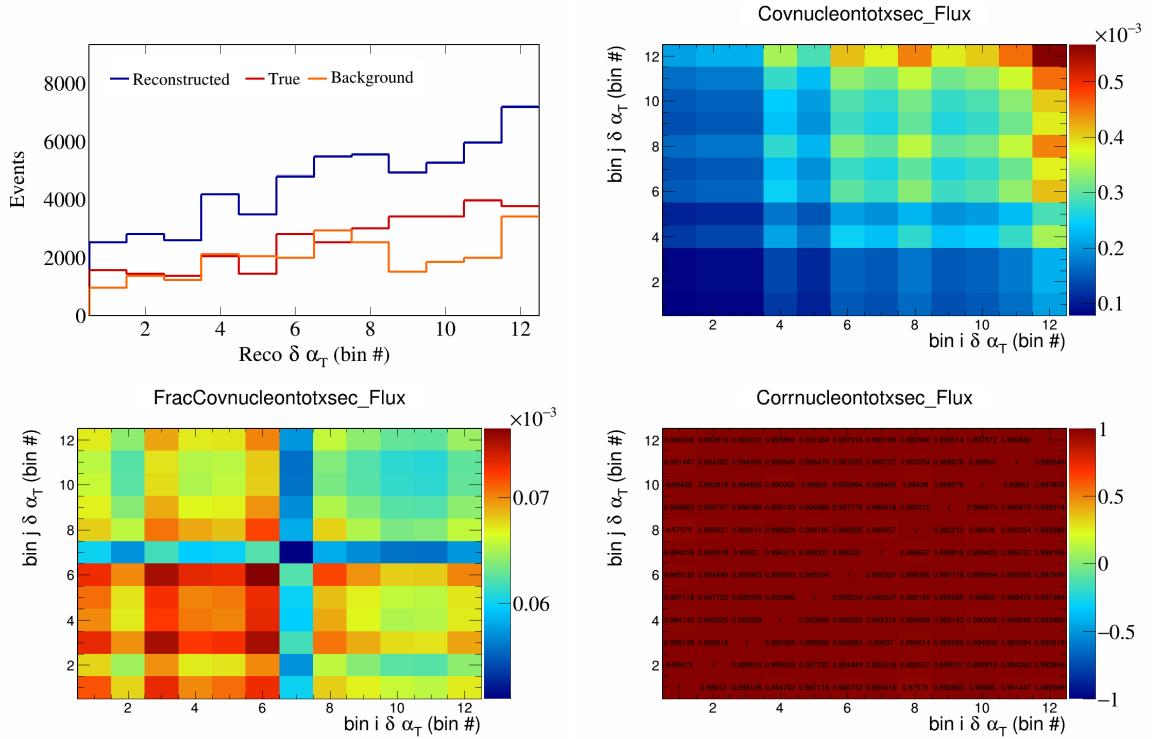


Figure 713: NucleonTotXSec variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

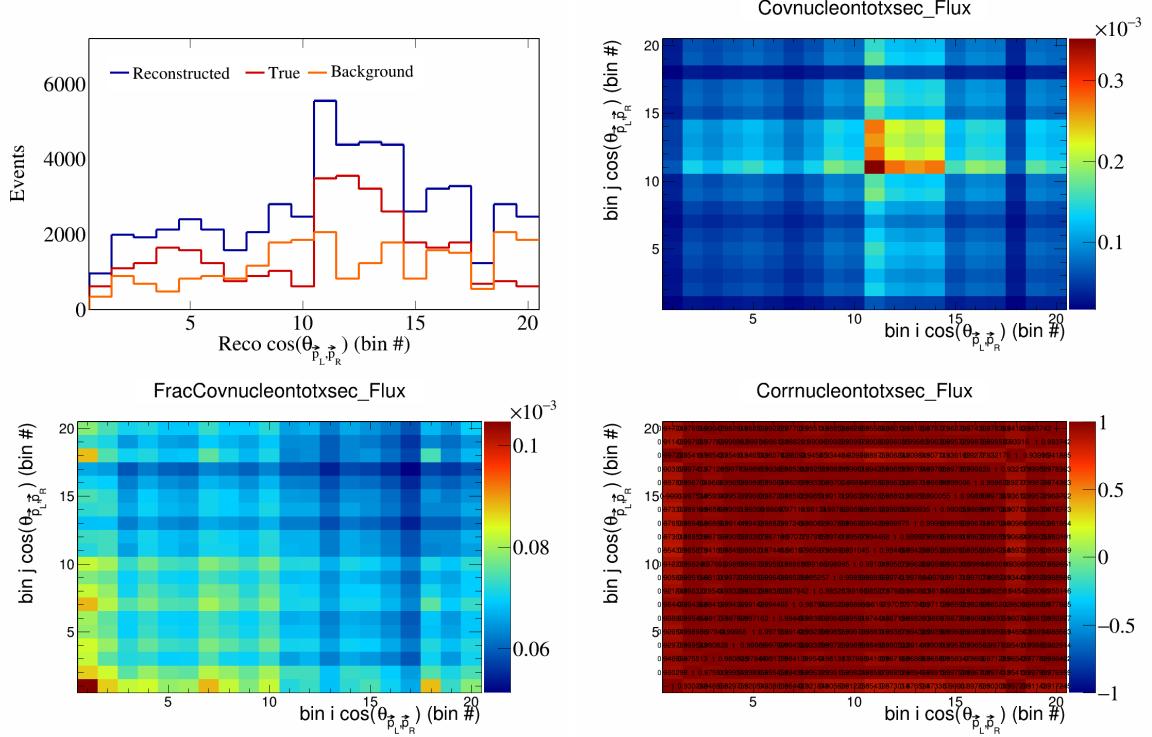


Figure 714: NucleonTotXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

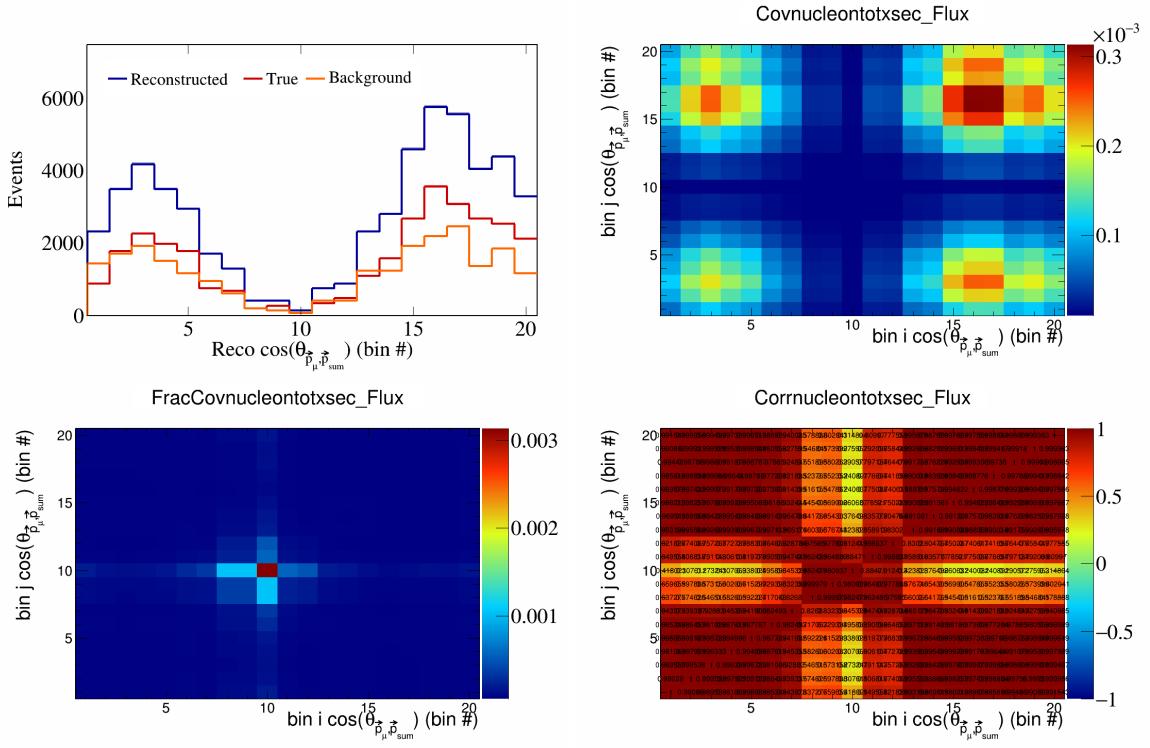


Figure 715: NucleonTotXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

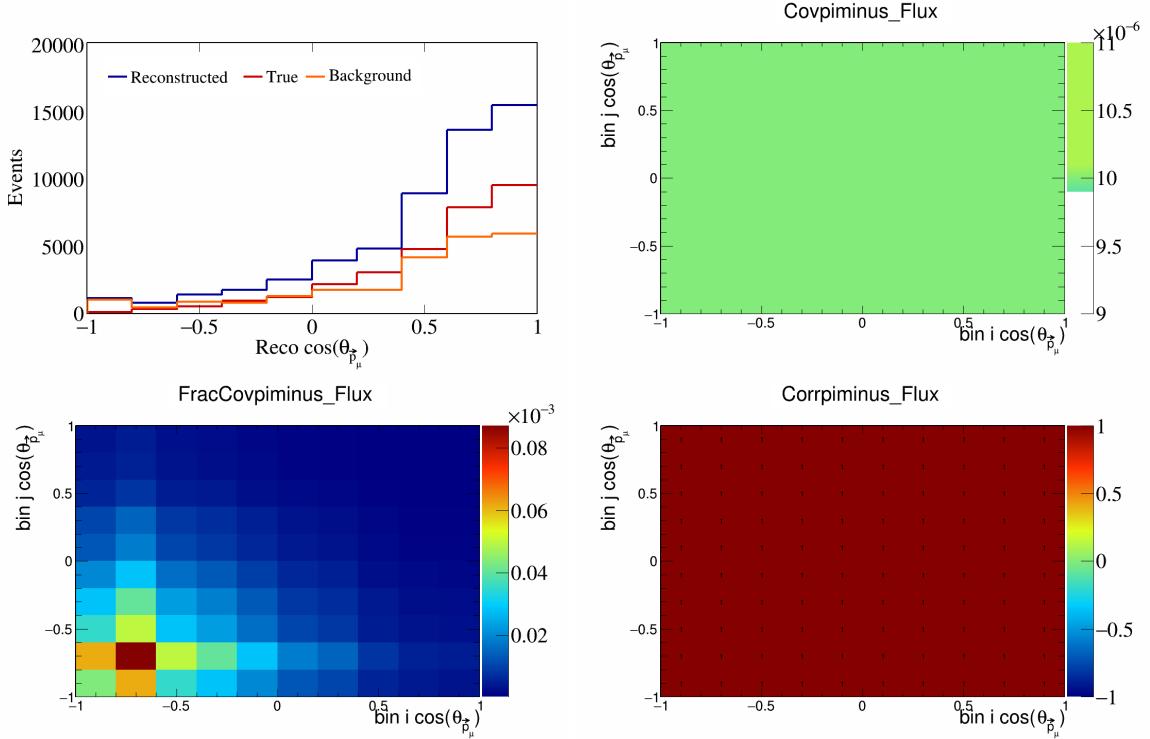


Figure 716: PiMinus variations for $\cos(\theta_{\vec{p}_\mu})$.

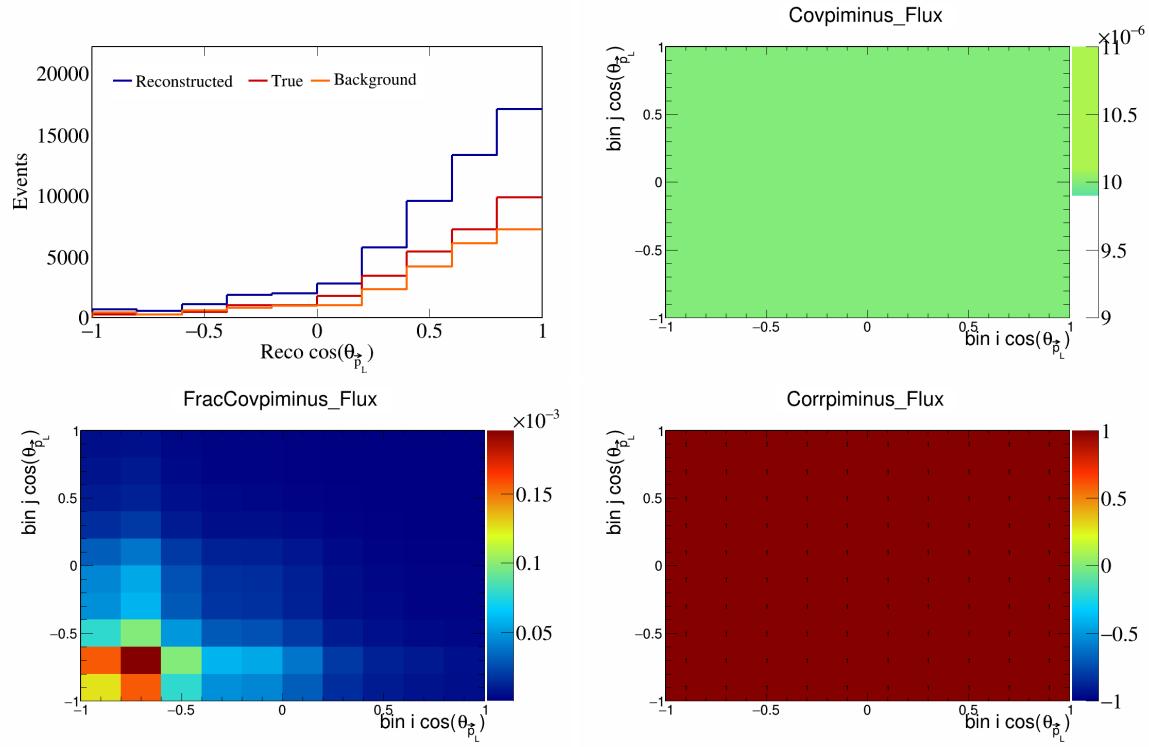


Figure 717: PiMinus variations for $\cos(\theta_{\vec{p}_L})$.

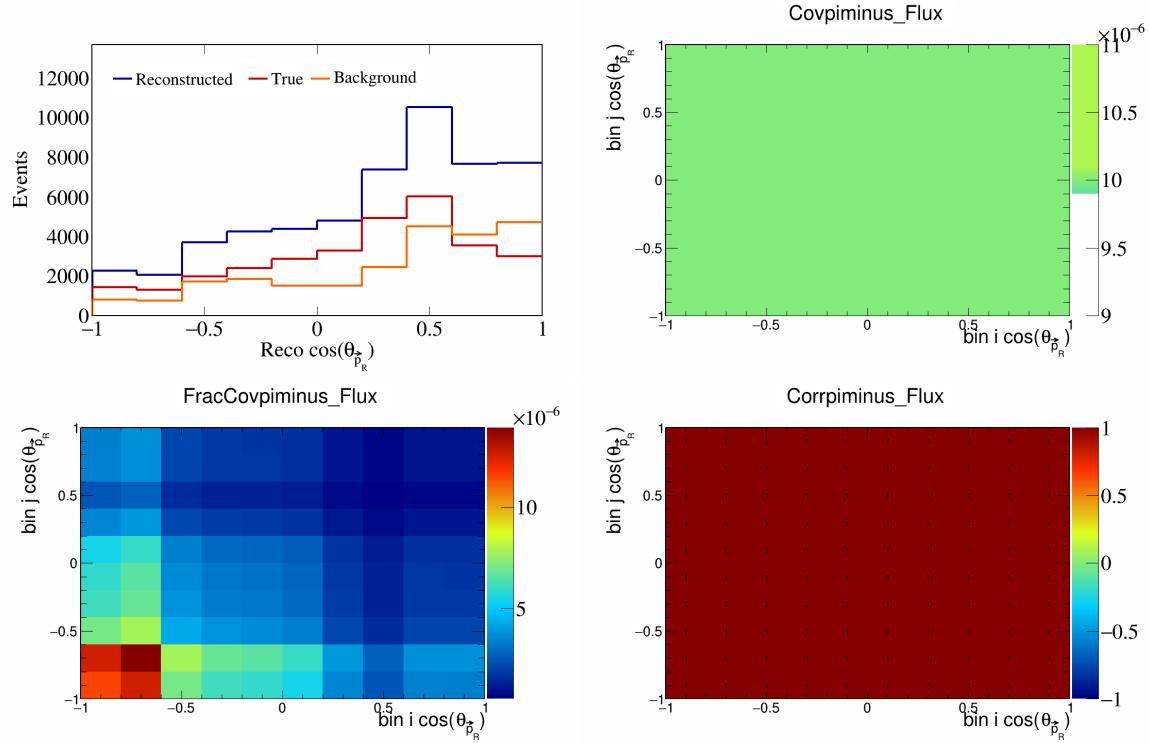


Figure 718: PiMinus variations for $\cos(\theta_{\vec{p}_R})$.

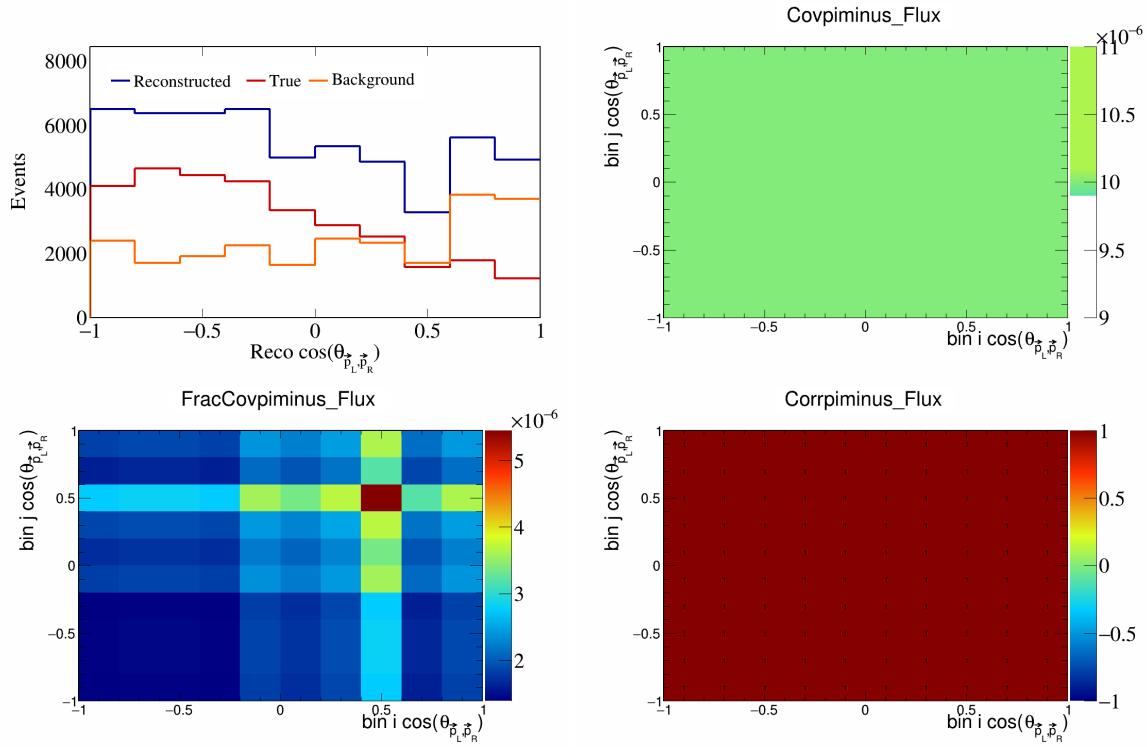


Figure 719: PiMinus variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

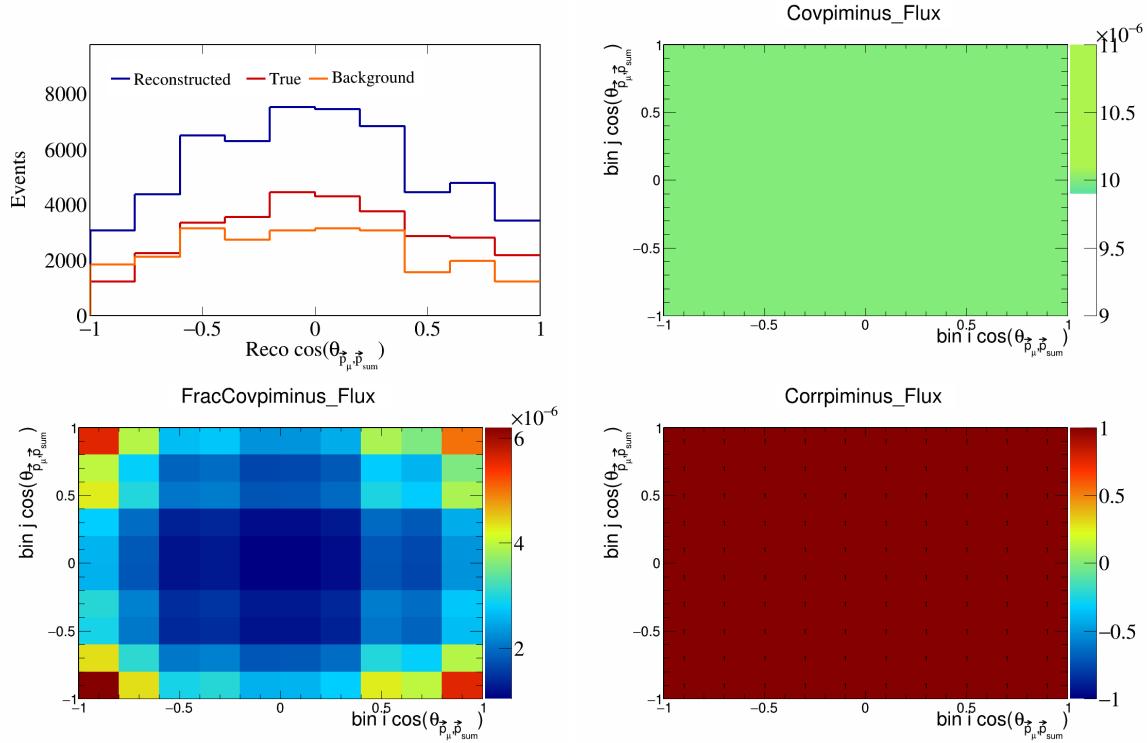


Figure 720: PiMinus variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

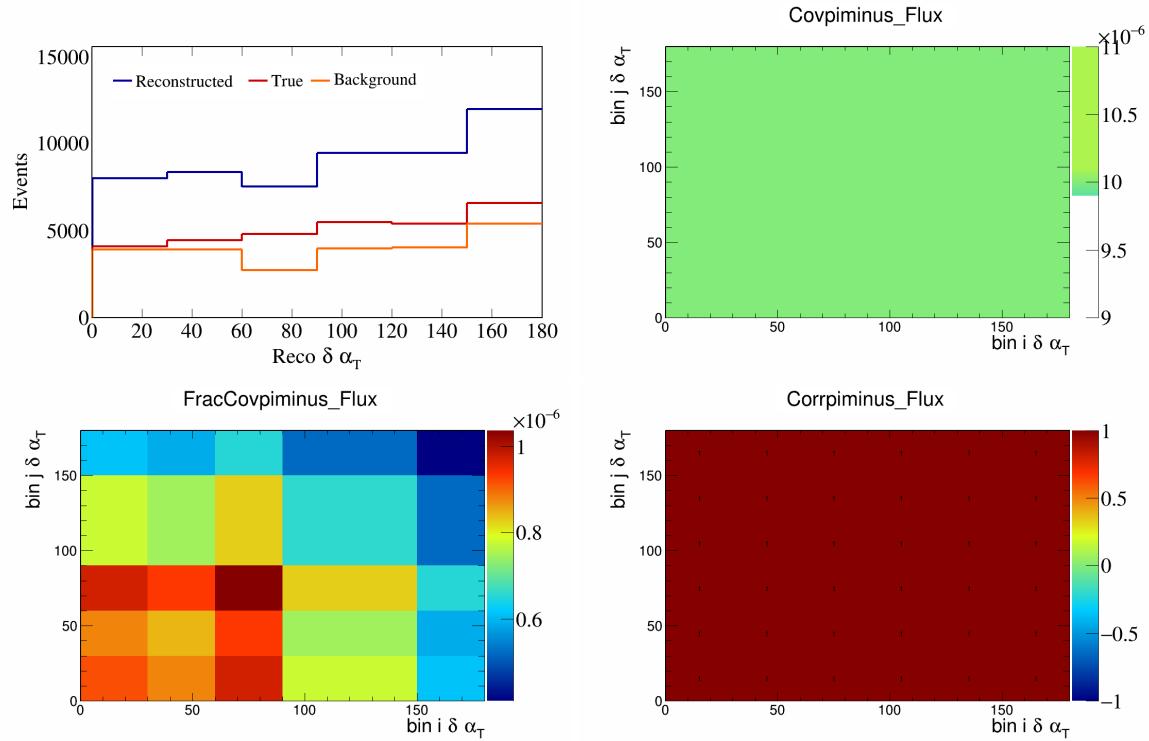


Figure 721: PiMinus variations for $\delta\alpha_T$.

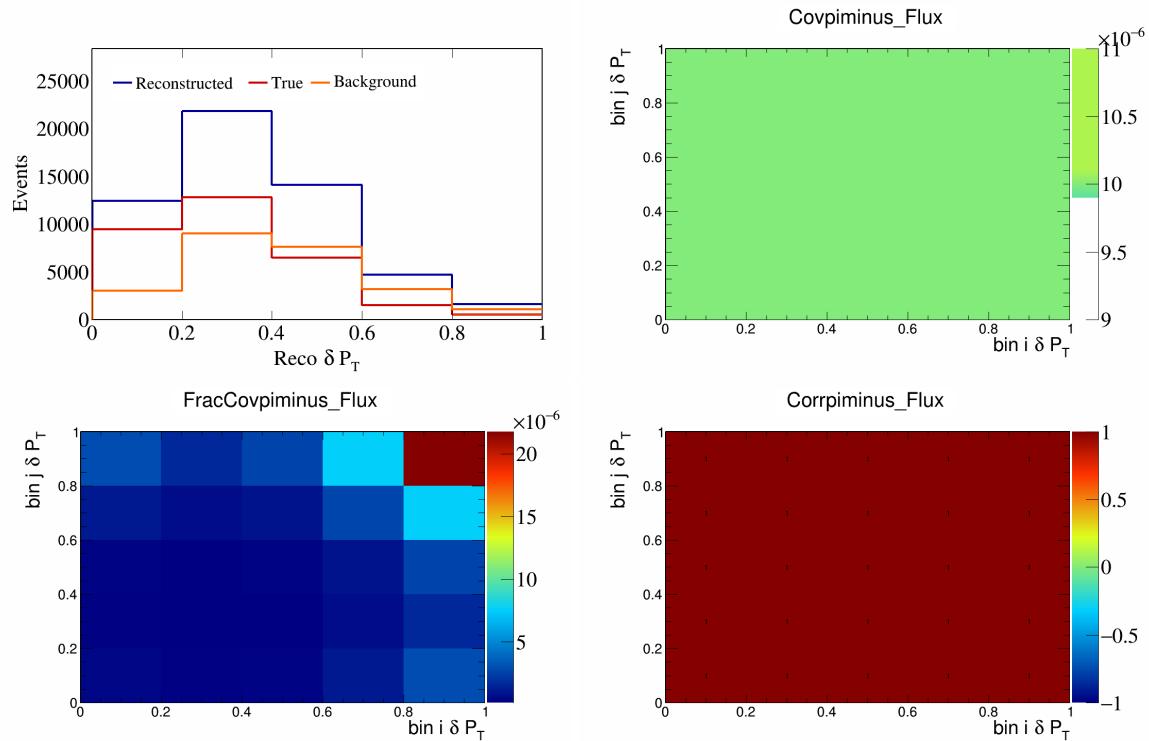


Figure 722: PiMinus variations for δP_T .

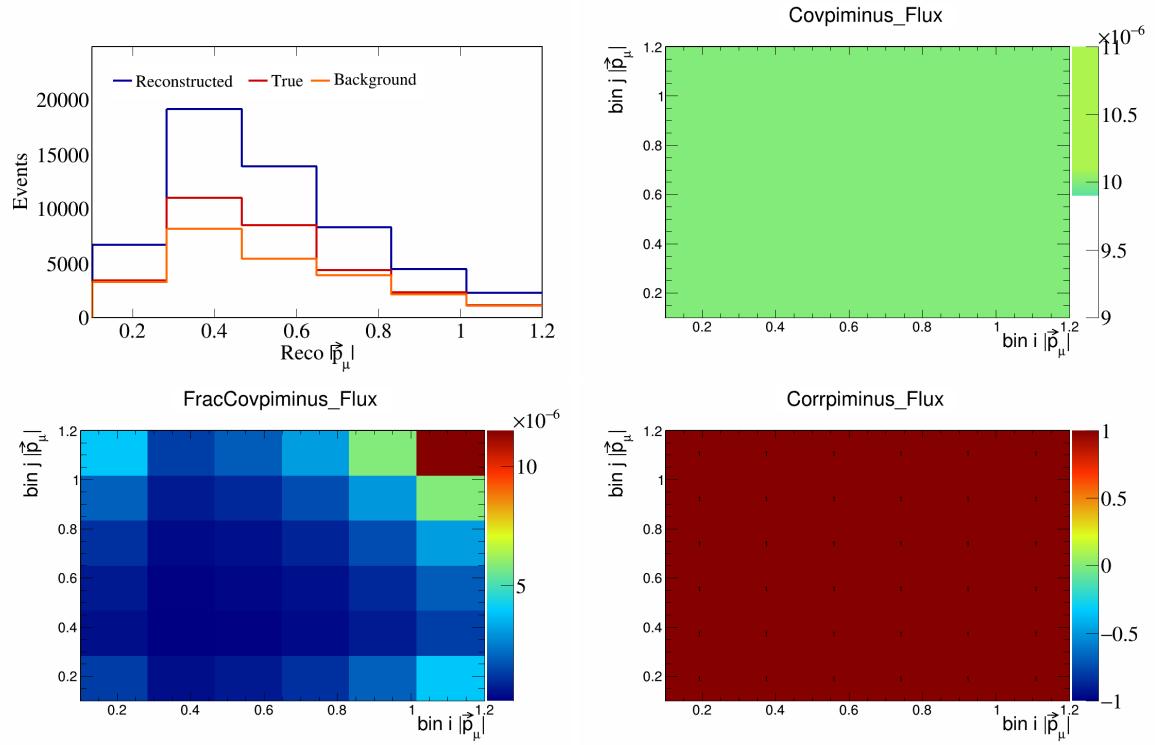


Figure 723: PiMinus variations for $|\vec{p}_\mu|$.

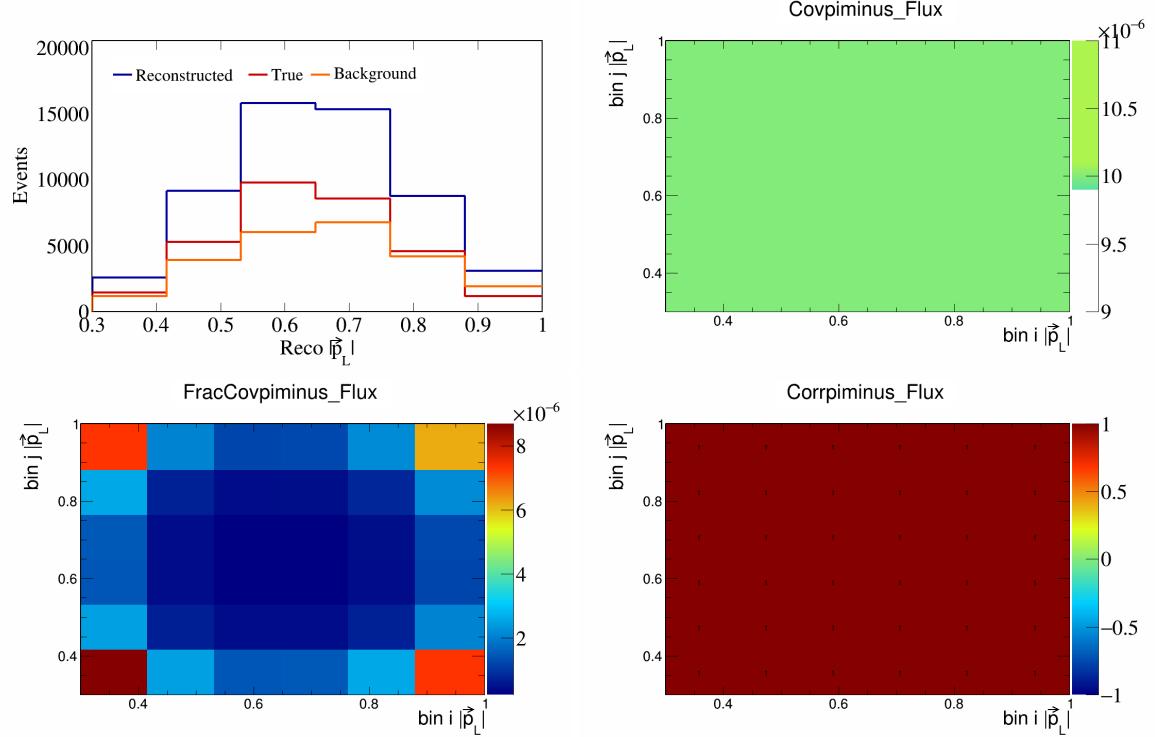


Figure 724: PiMinus variations for $|\vec{p}_L|$.

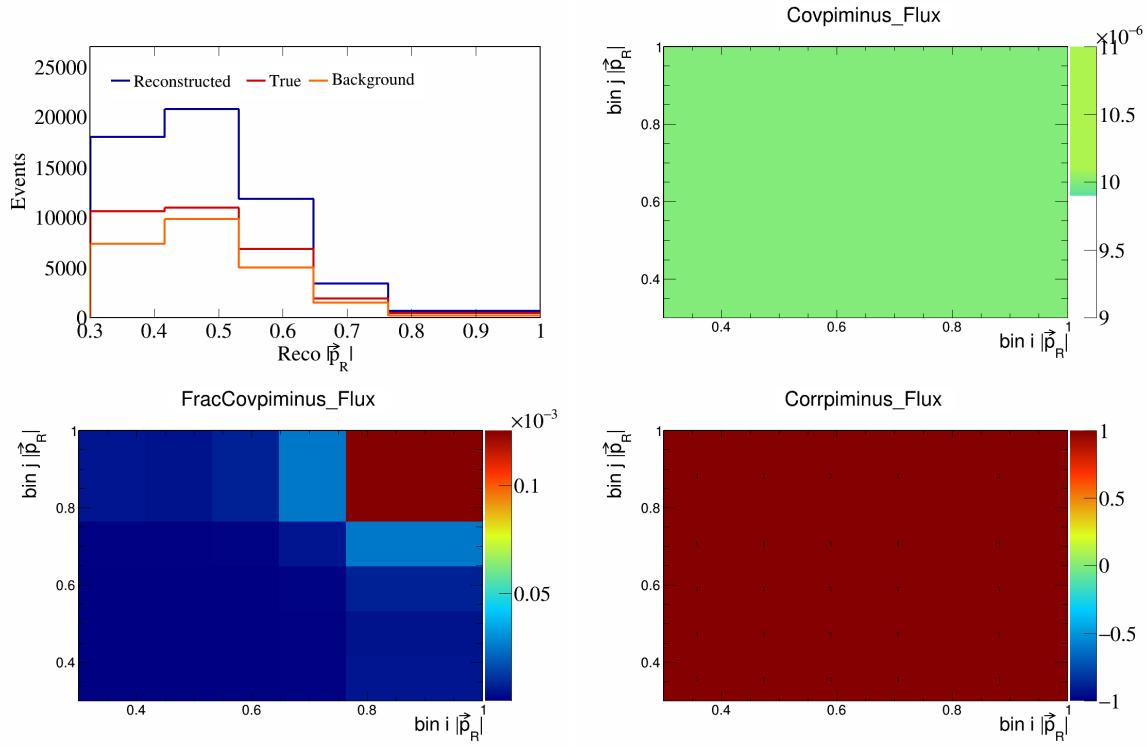


Figure 725: PiMinus variations for $|\vec{p}_R|$.

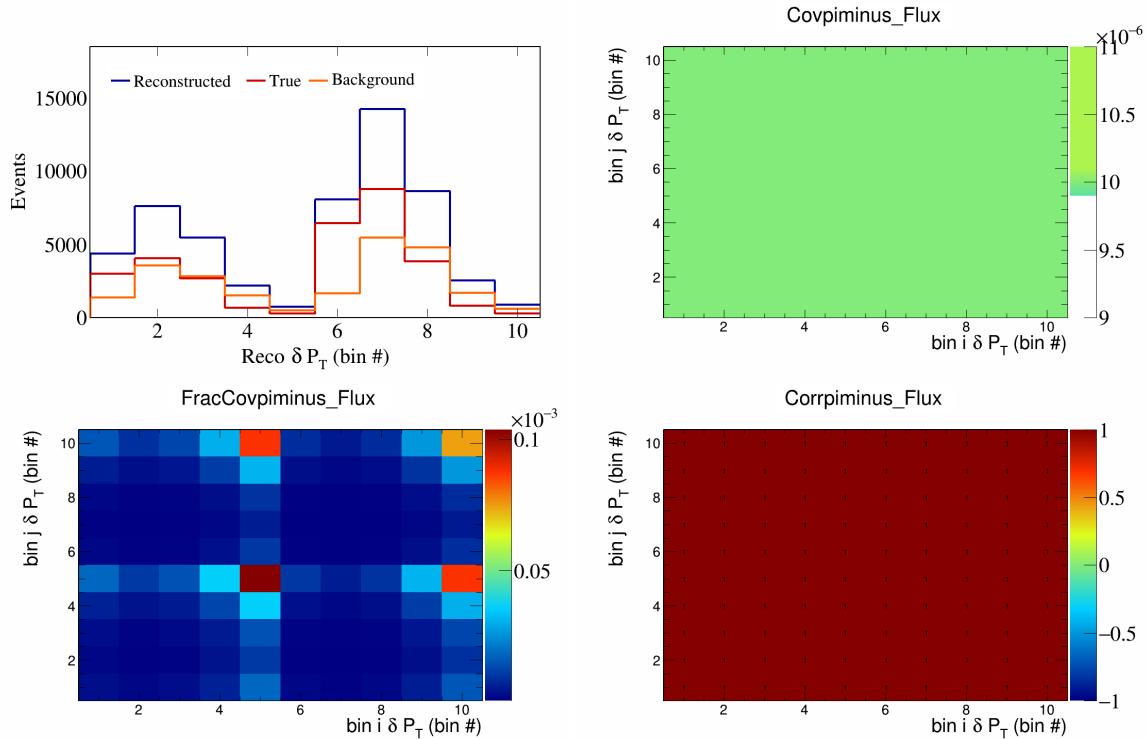


Figure 726: PiMinus variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

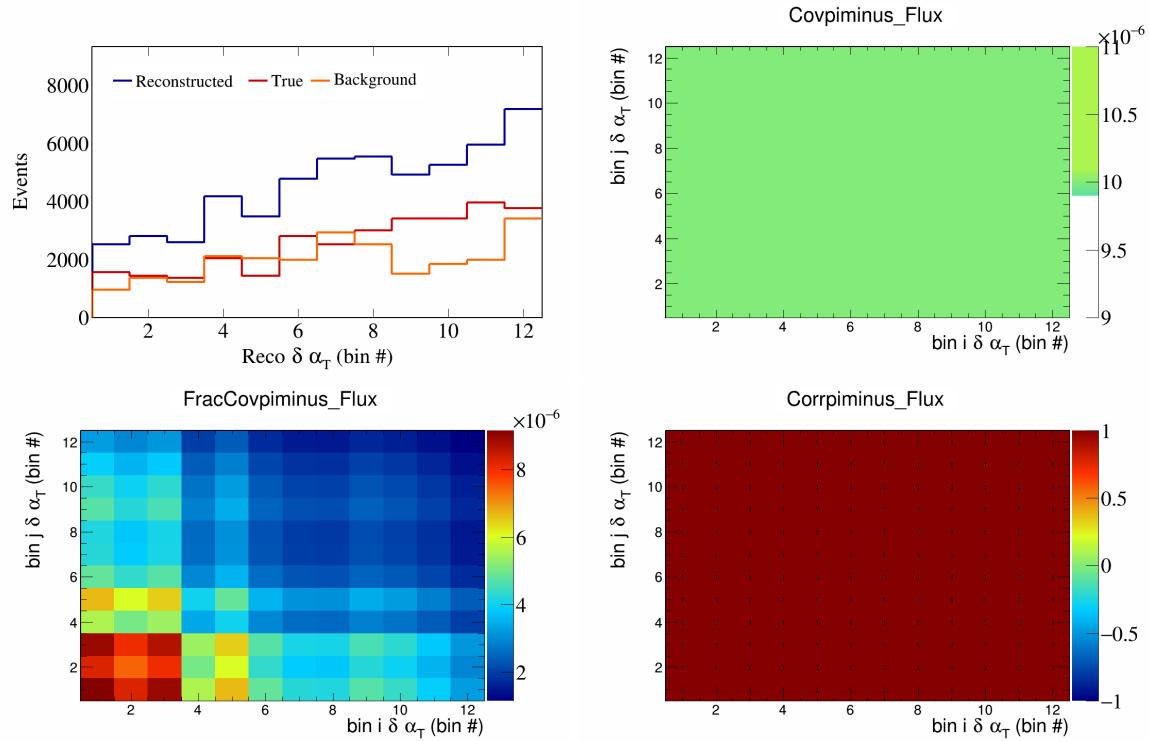


Figure 727: PiMinus variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

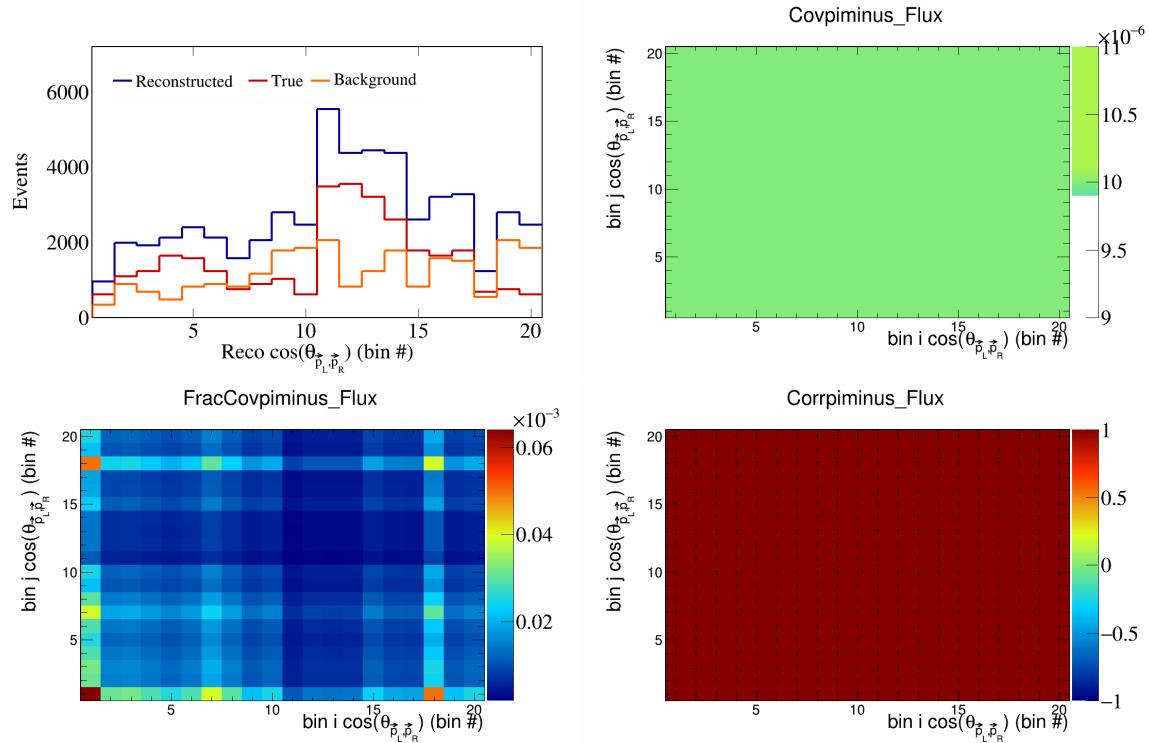


Figure 728: PiMinus variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

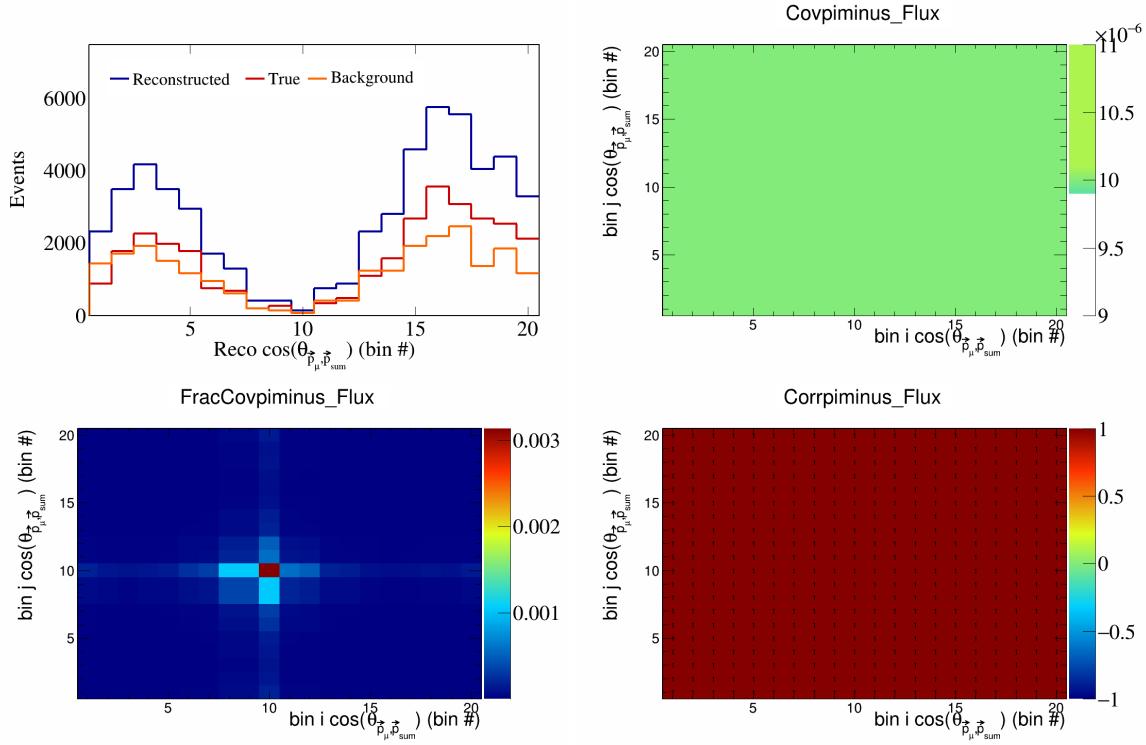


Figure 729: PiMinus variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

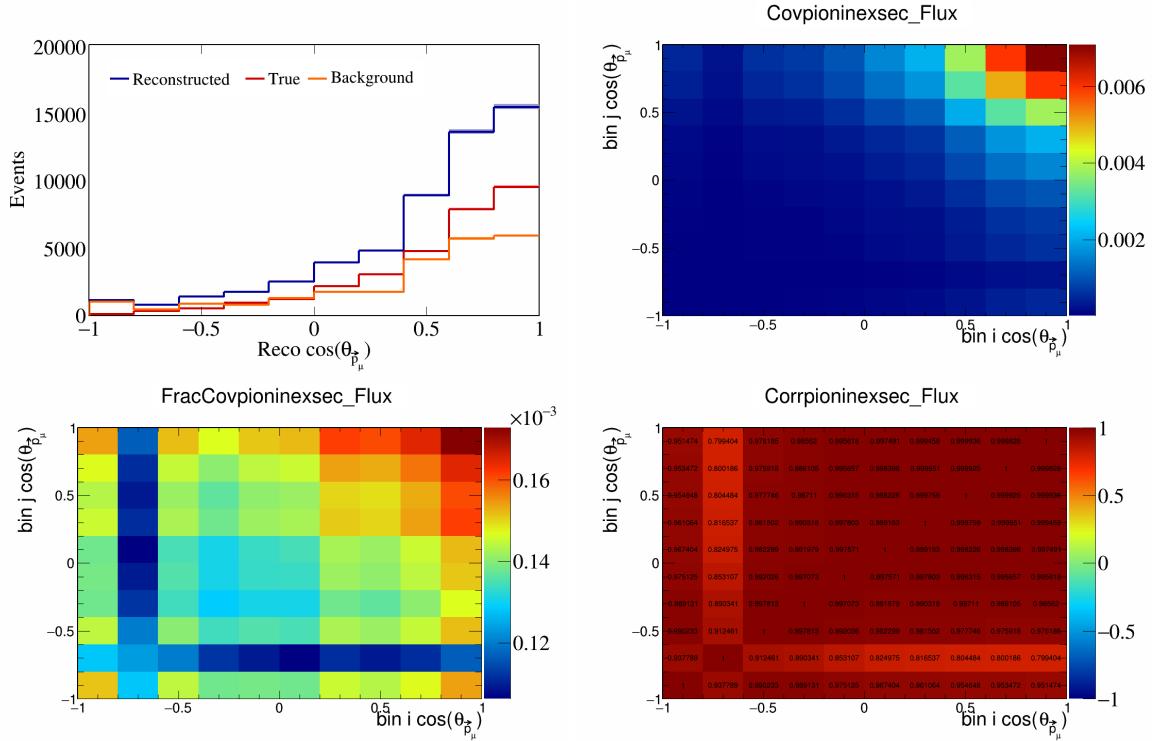


Figure 730: PionIneXSec variations for $\cos(\theta_{\vec{p}_\mu})$.

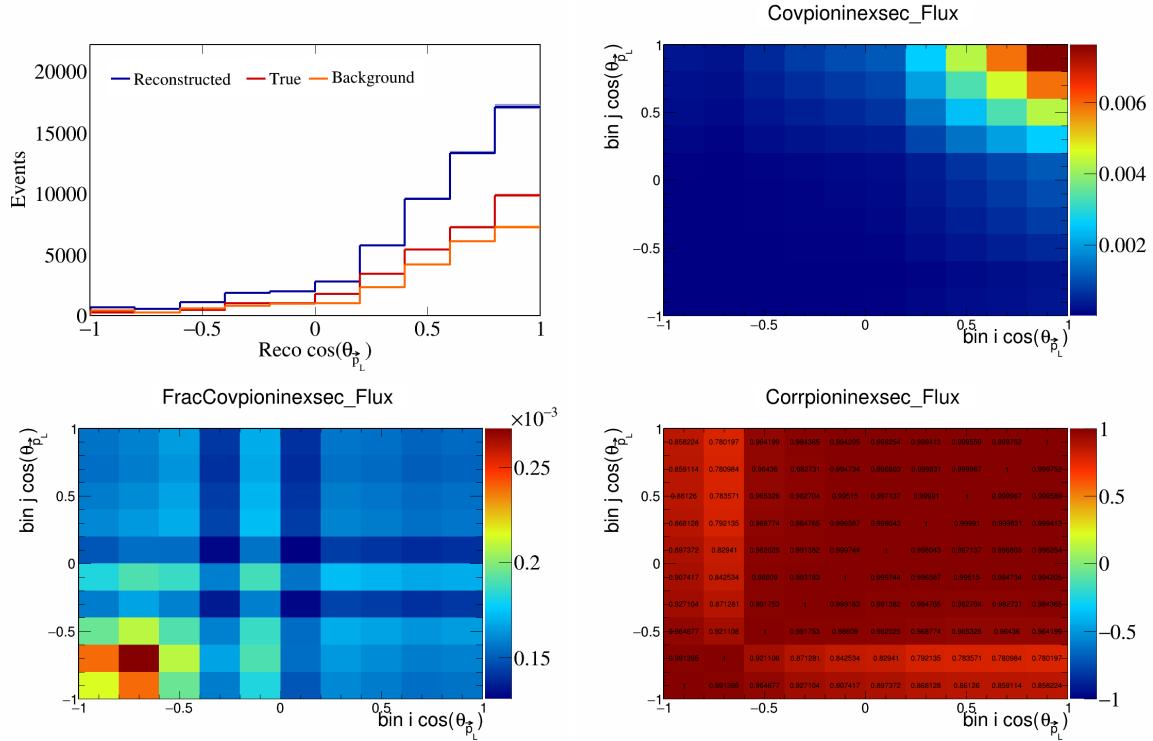


Figure 731: PionIneXSec variations for $\cos(\theta_{\vec{p}_L})$.

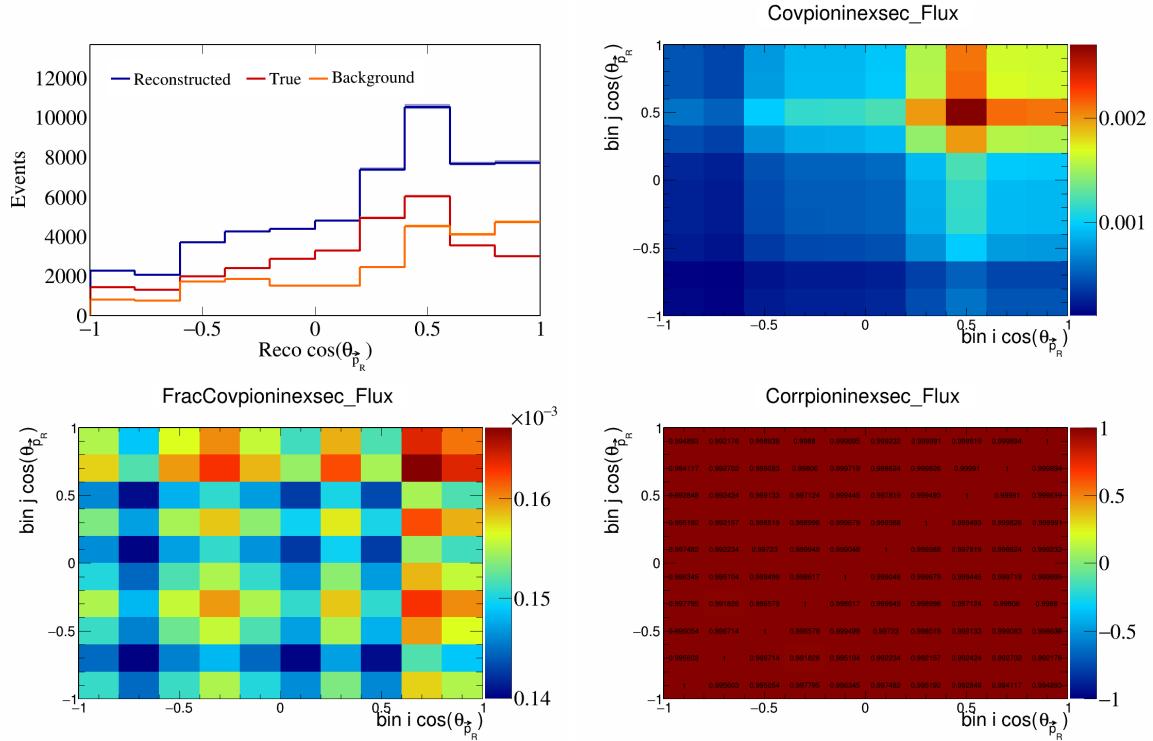


Figure 732: PionIneXSec variations for $\cos(\theta_{\vec{p}_R})$.

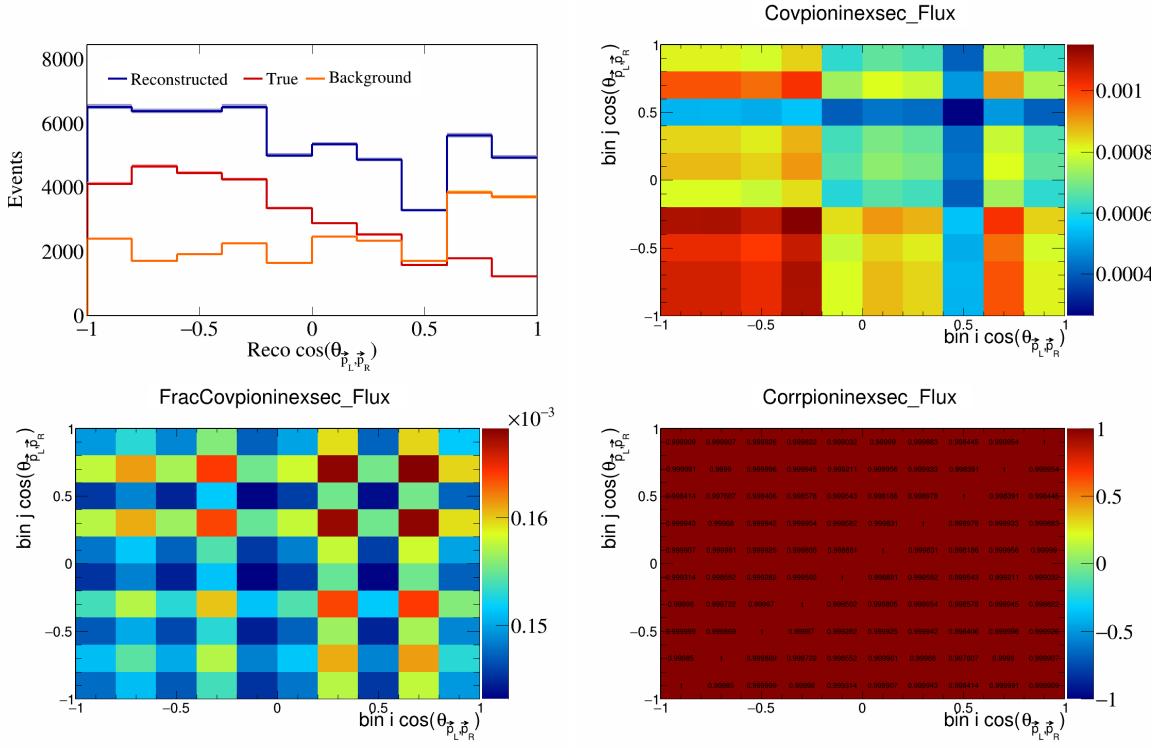


Figure 733: PionIneXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

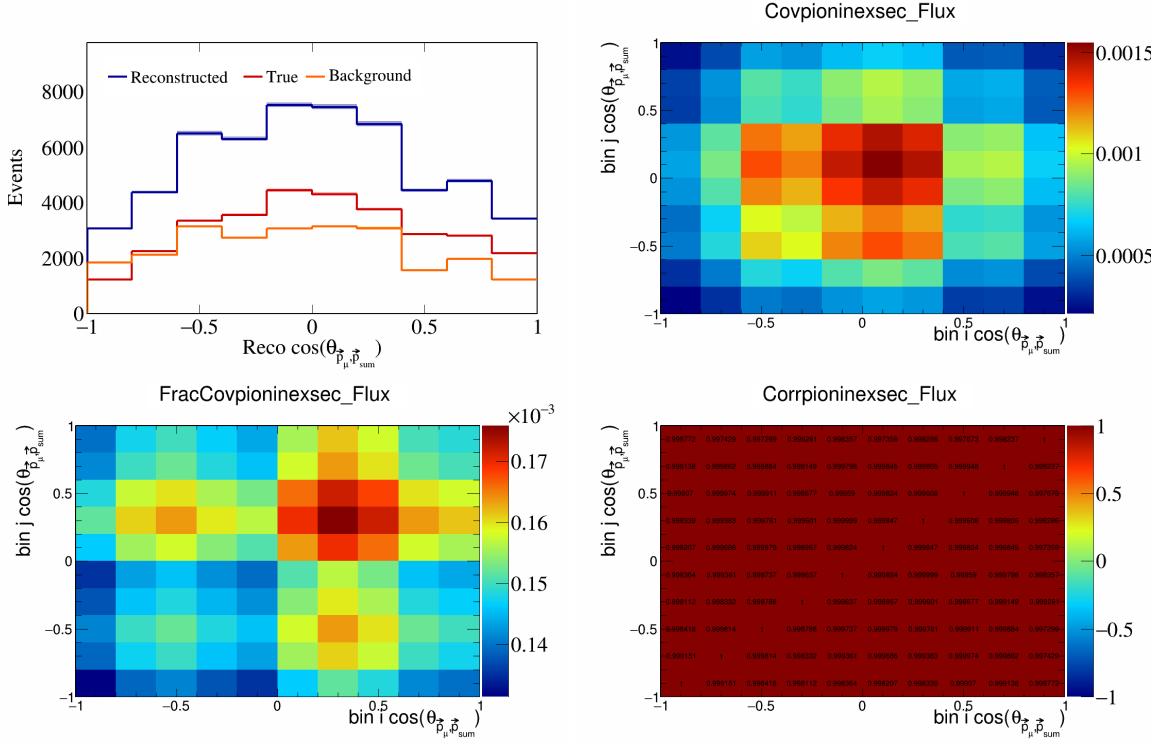


Figure 734: PionIneXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

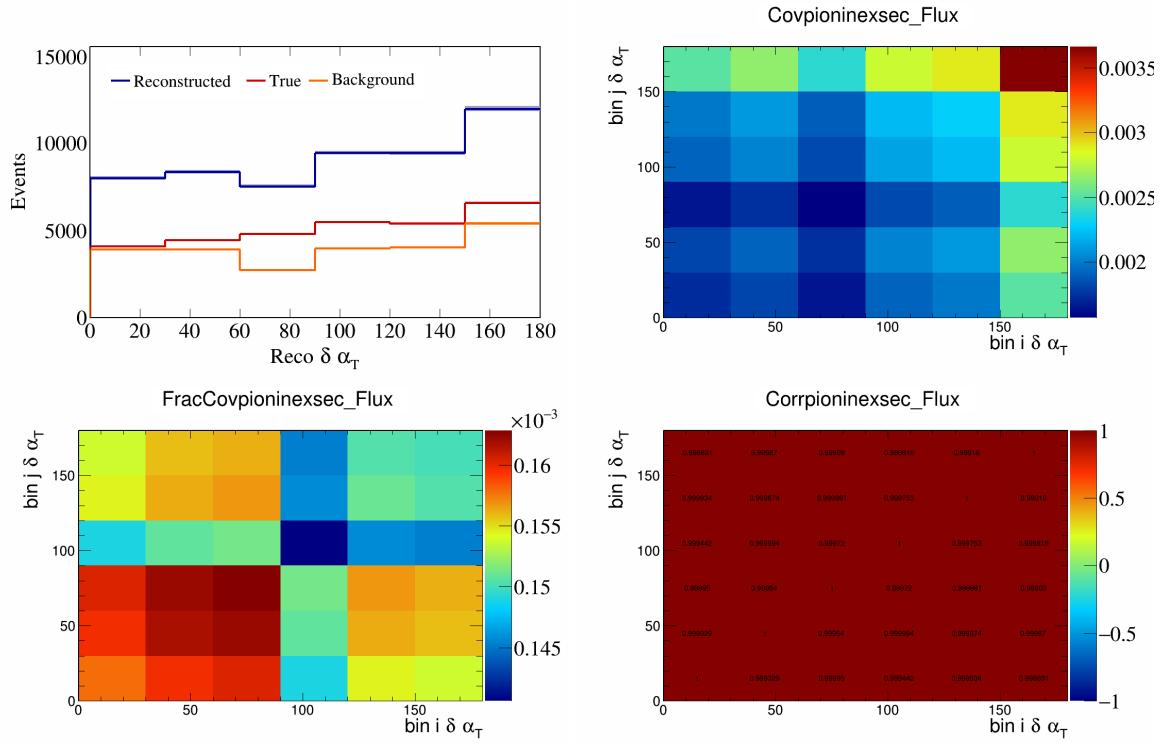


Figure 735: PionIneXSec variations for $\delta\alpha_T$.

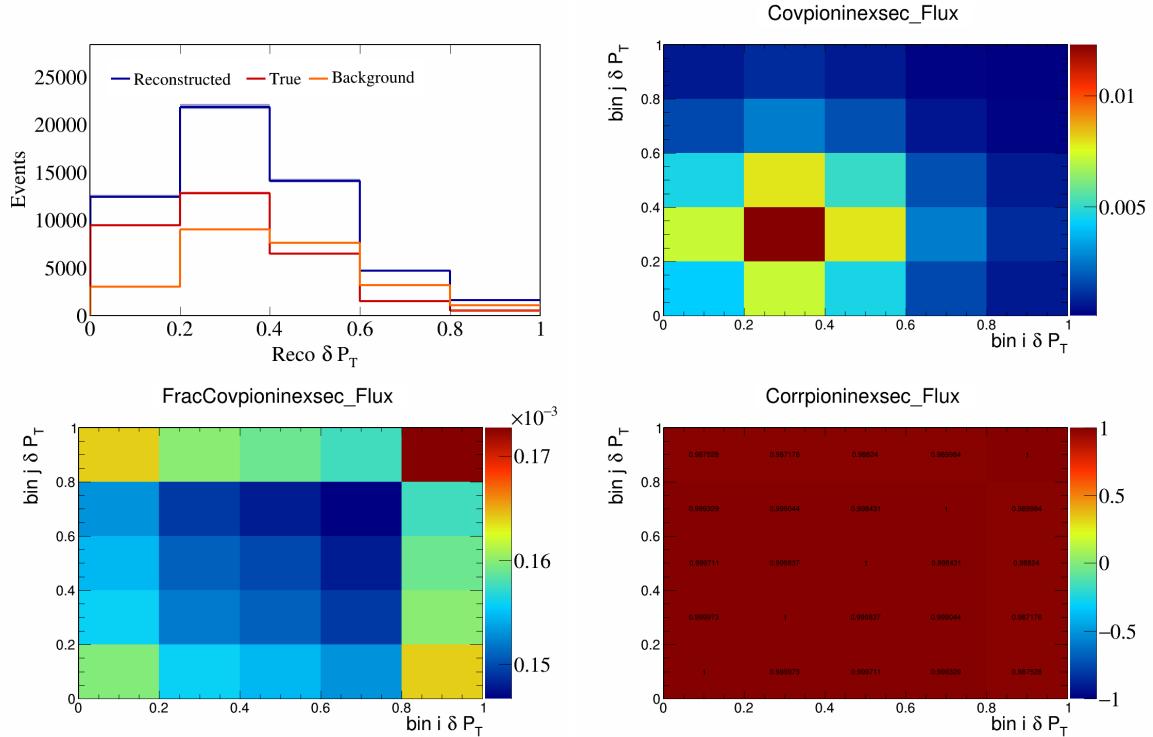


Figure 736: PionIneXSec variations for δP_T .

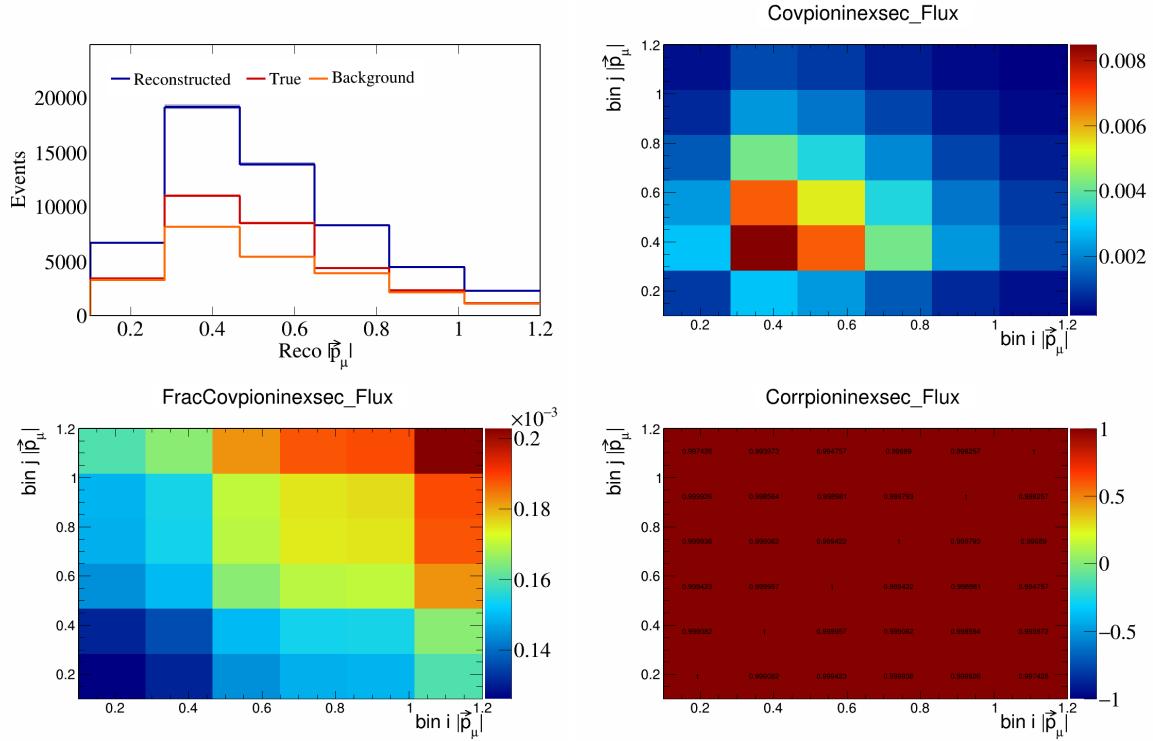


Figure 737: PionIneXSec variations for $|\vec{p}_\mu|$.

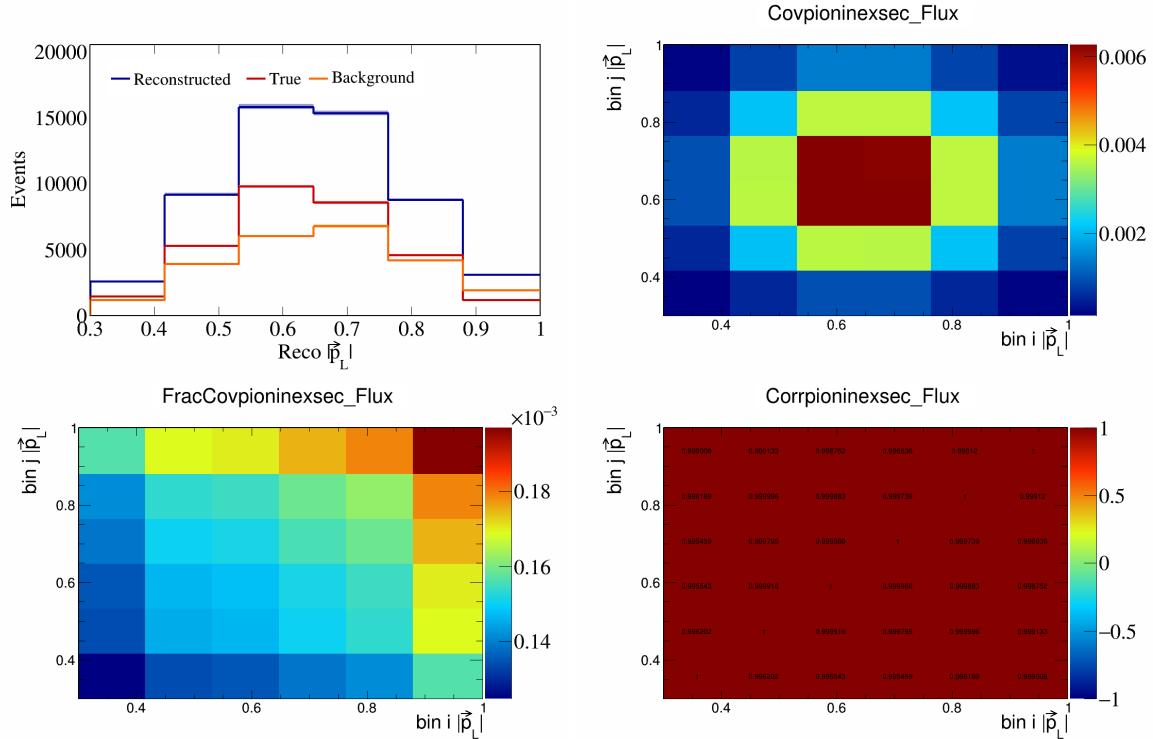


Figure 738: PionIneXSec variations for $|\vec{p}_L|$.

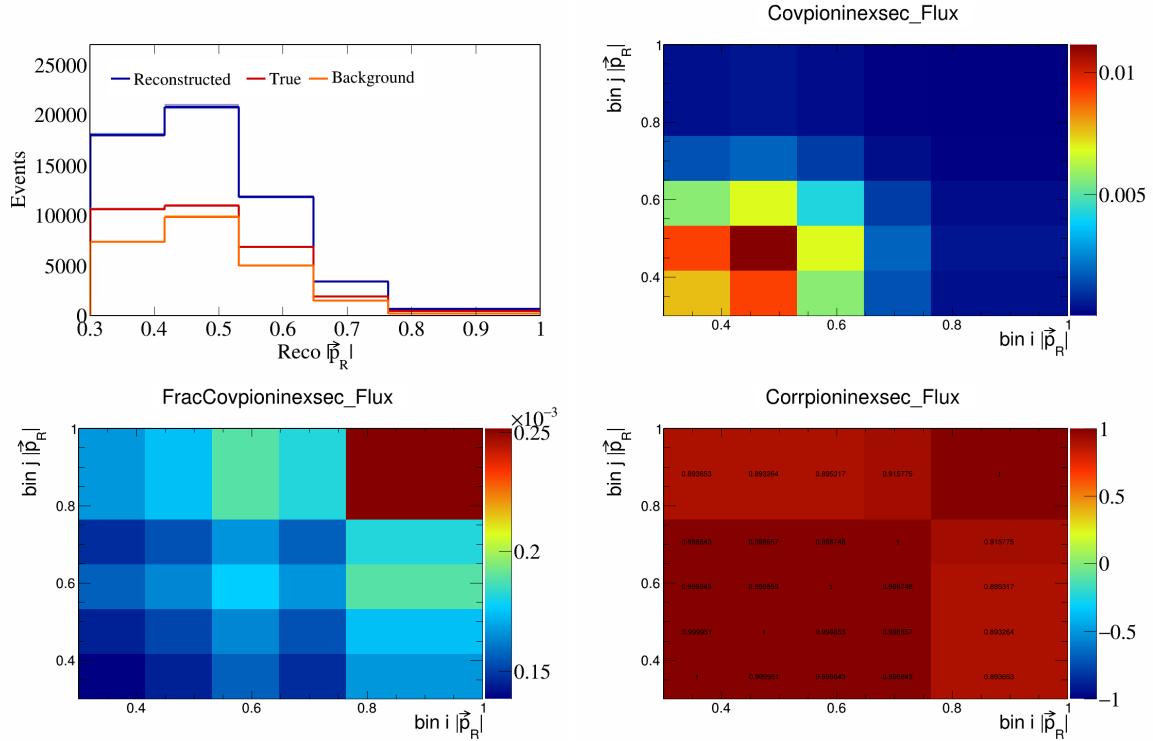


Figure 739: PionIneXSec variations for $|\vec{p}_R|$.

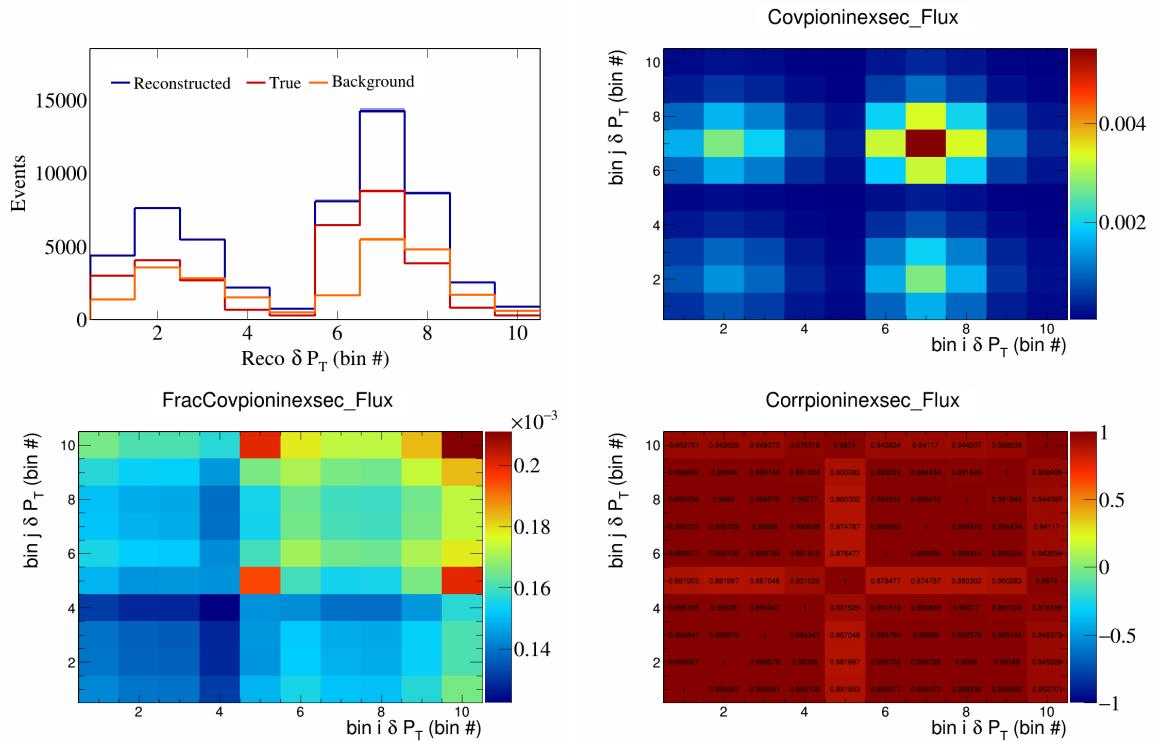


Figure 740: PionIneXSec variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

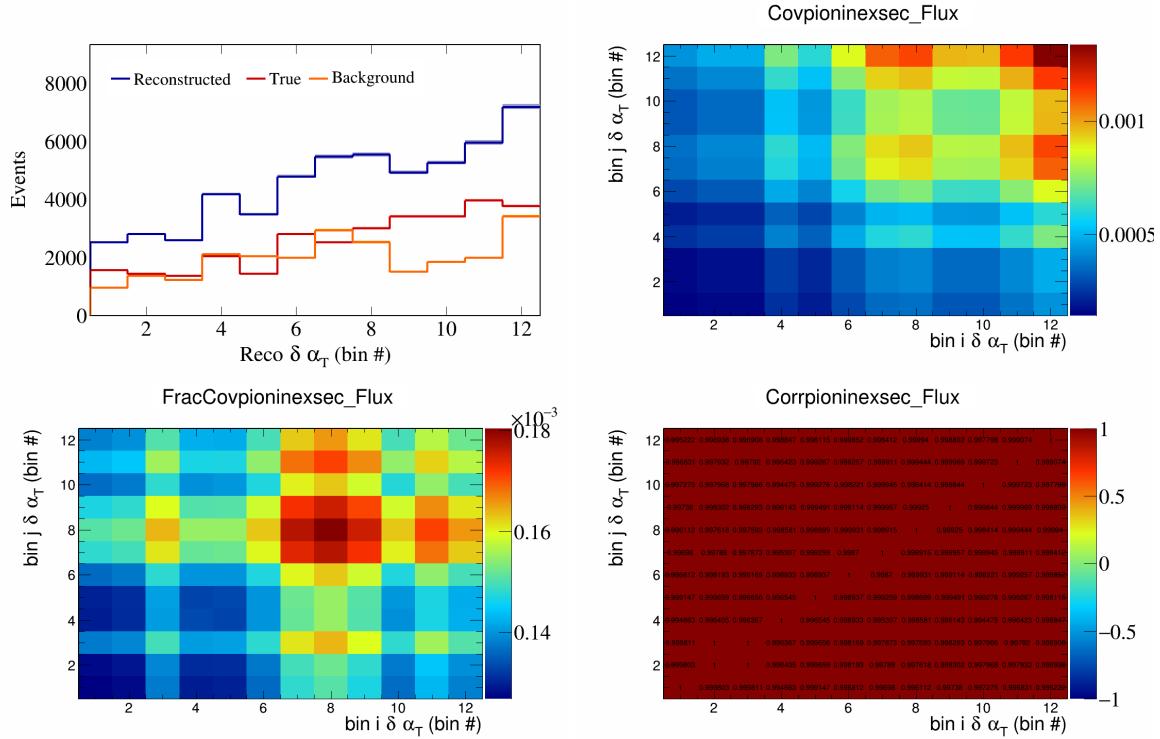


Figure 741: PionIneXSec variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

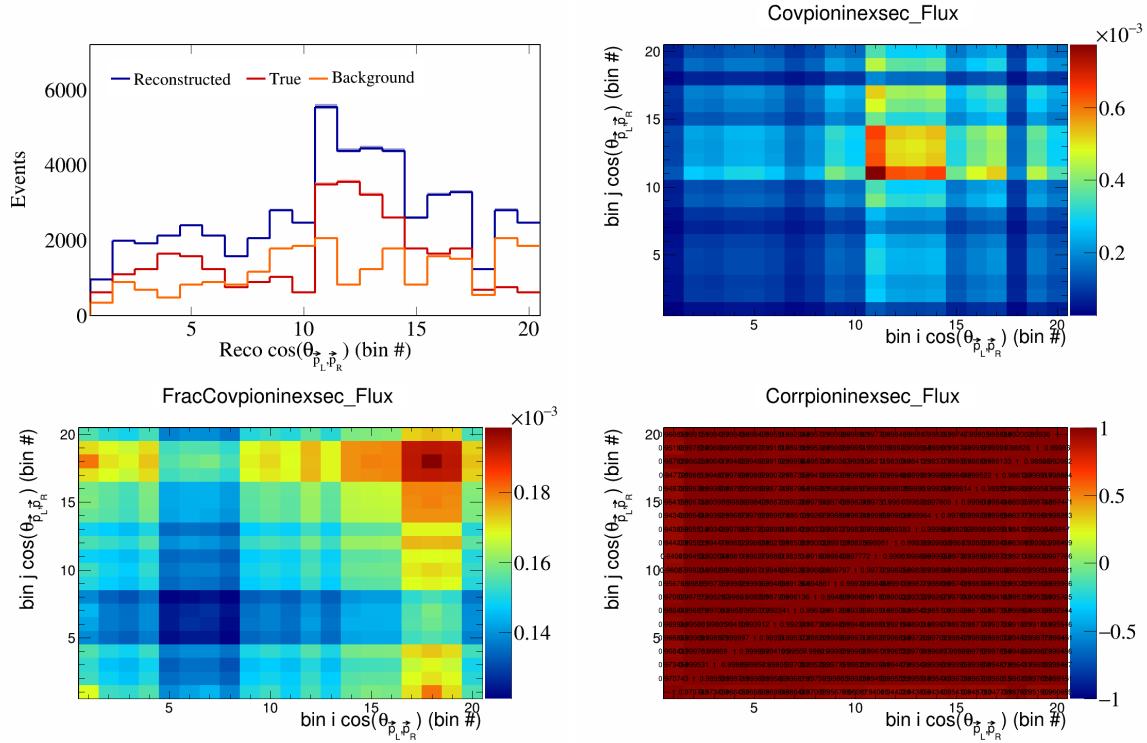


Figure 742: PionIneXSec variations for $\cos(\theta_{\vec{p}_L \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

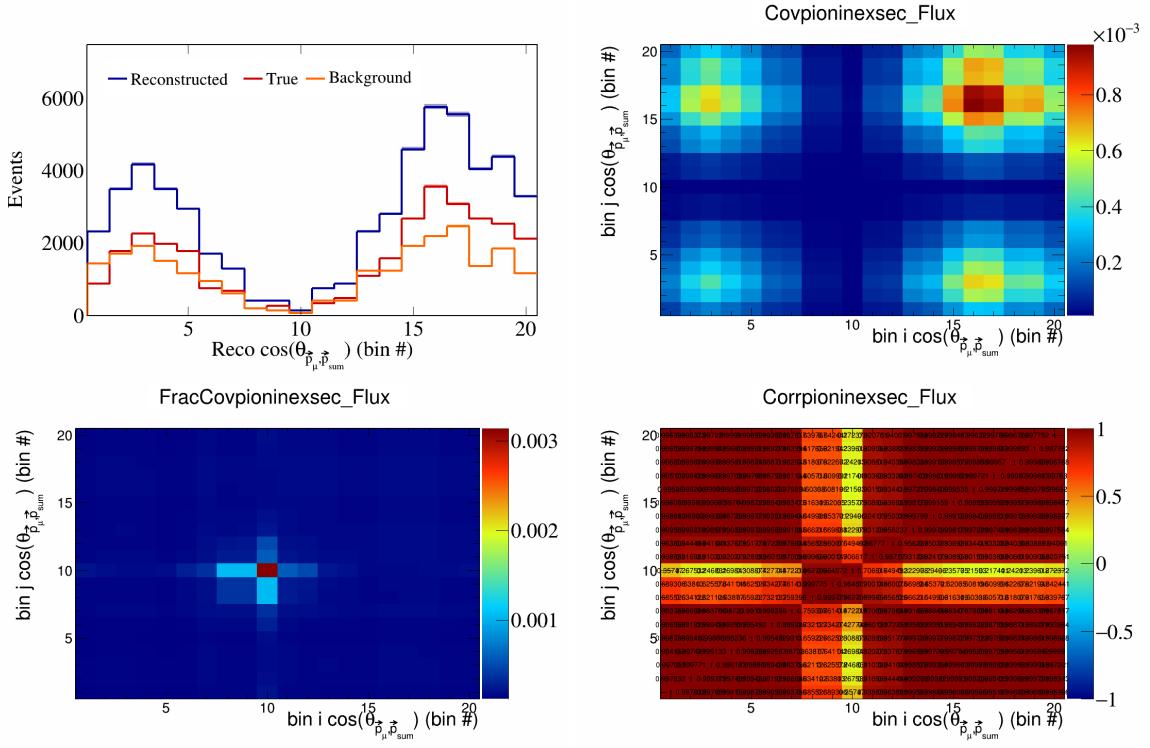


Figure 743: PionIneXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

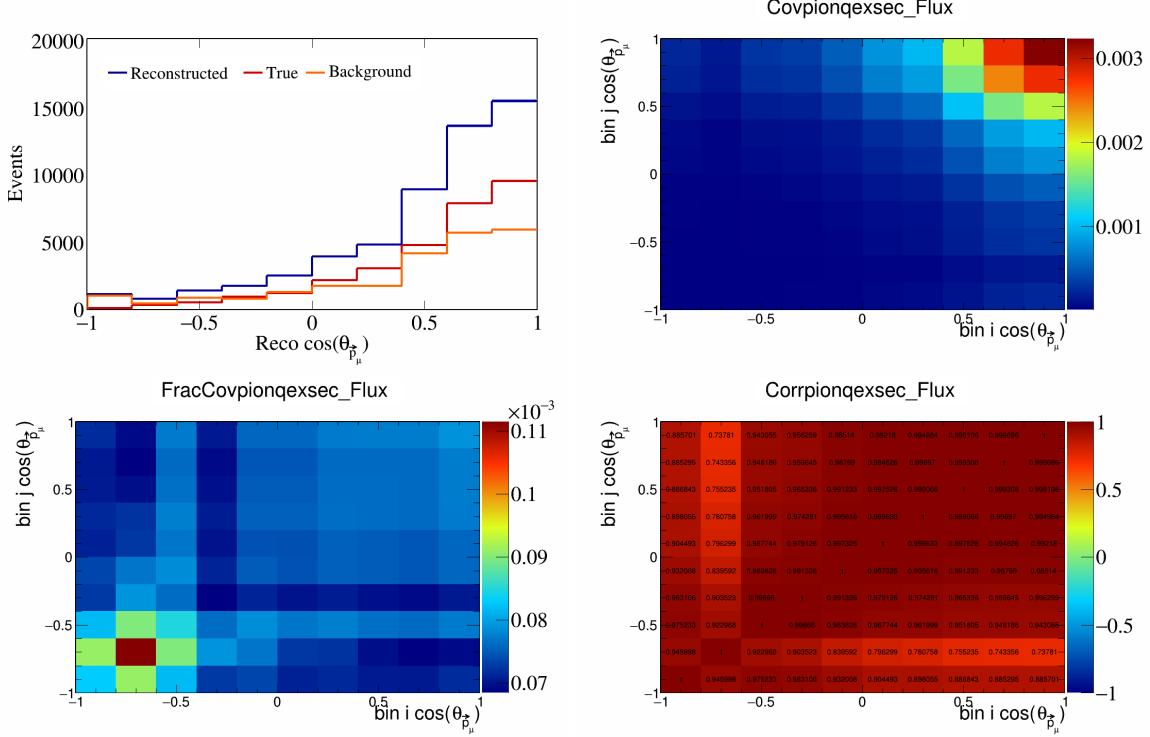


Figure 744: PionQeXSec variations for $\cos(\theta_{\vec{p}_\mu})$.

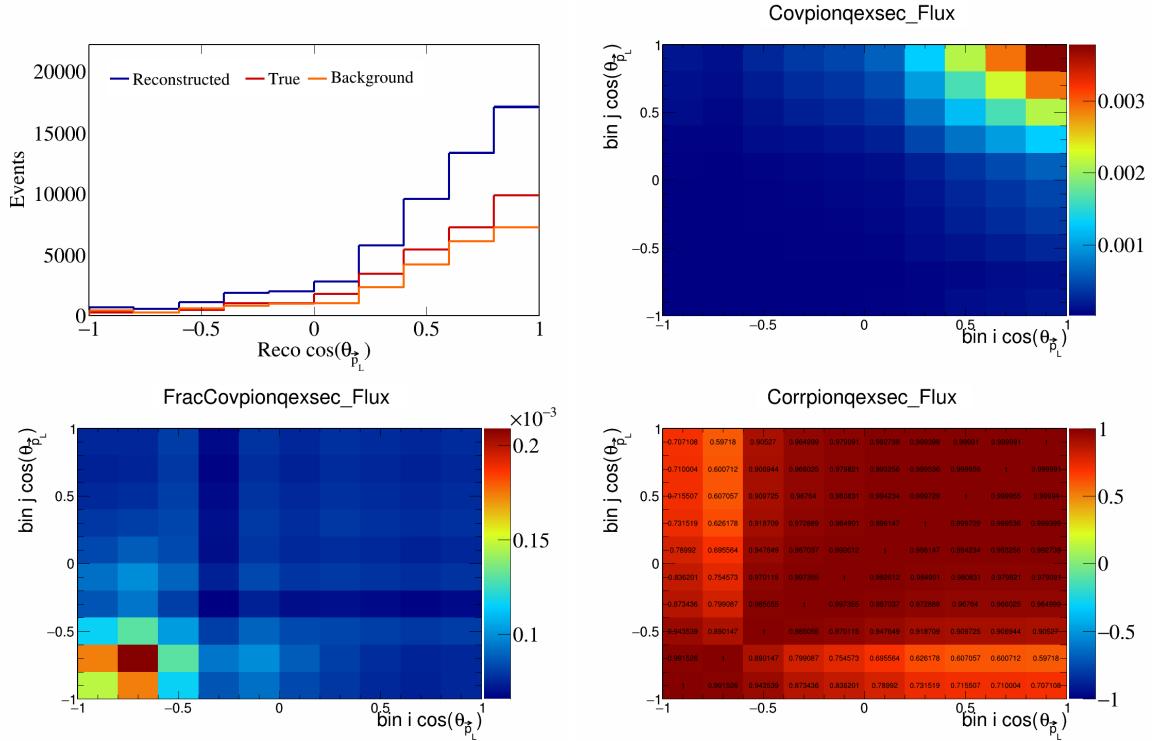


Figure 745: PionQeXSec variations for $\cos(\theta_{\vec{p}_L})$.

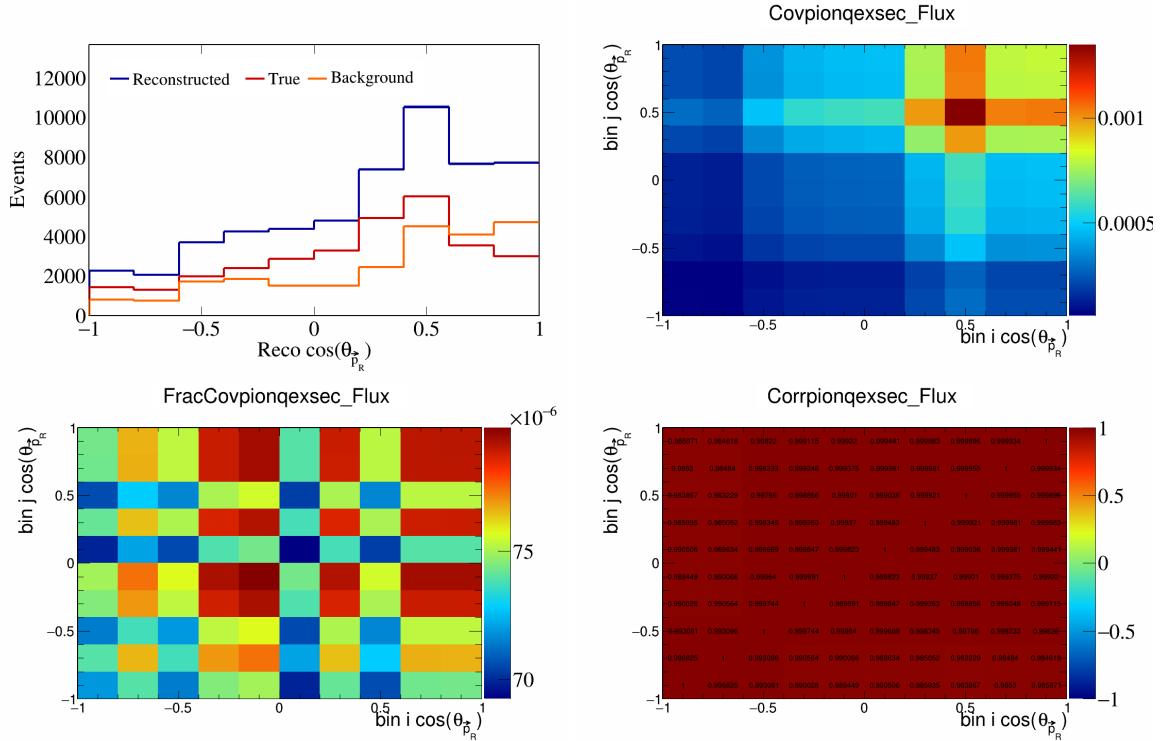


Figure 746: PionQeXSec variations for $\cos(\theta_{\vec{p}_R})$.

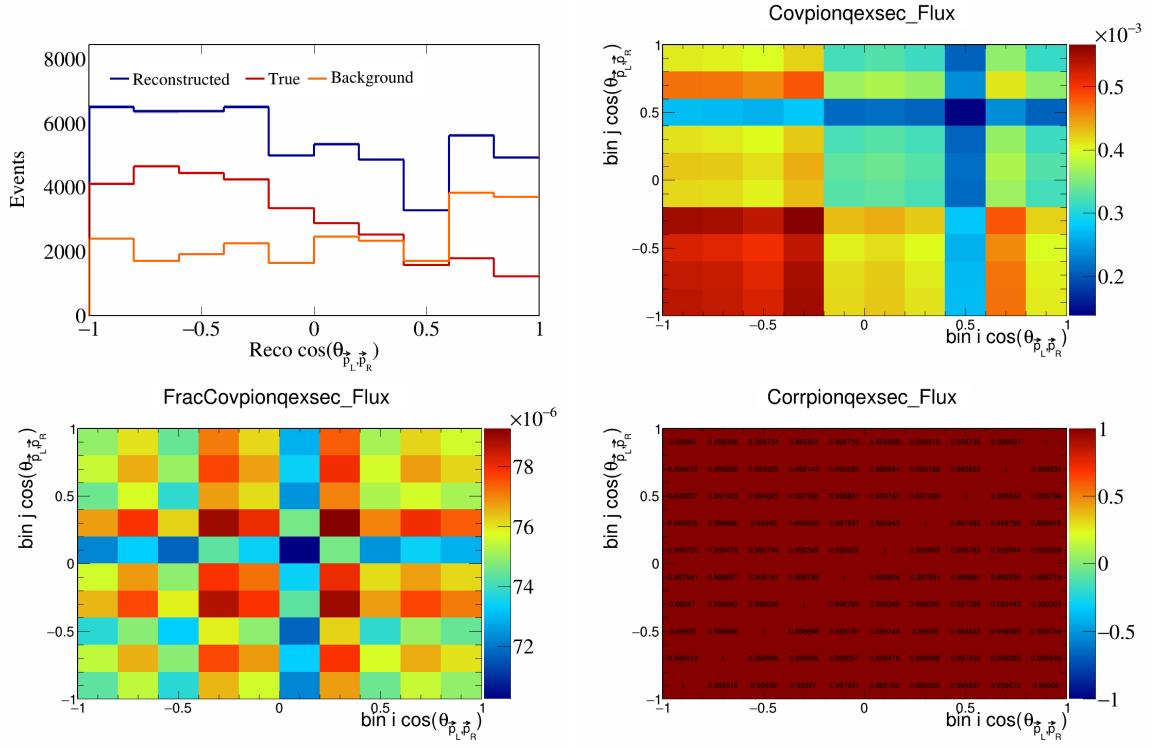


Figure 747: PionQeXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

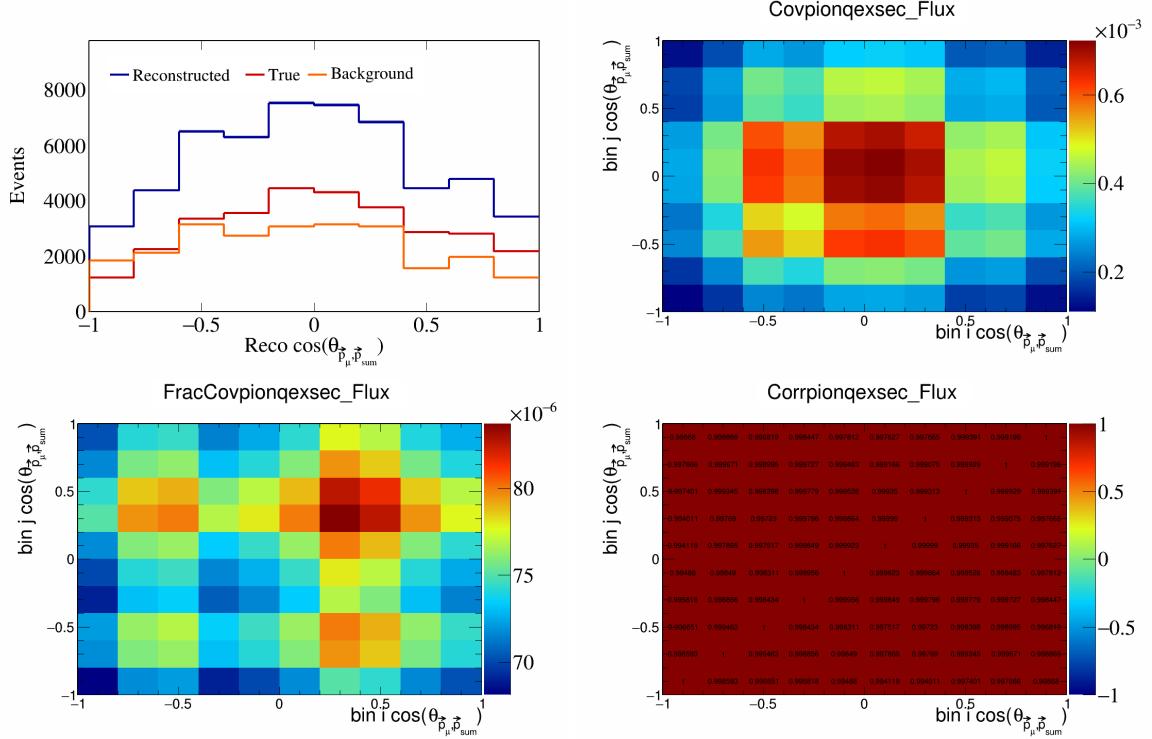


Figure 748: PionQeXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

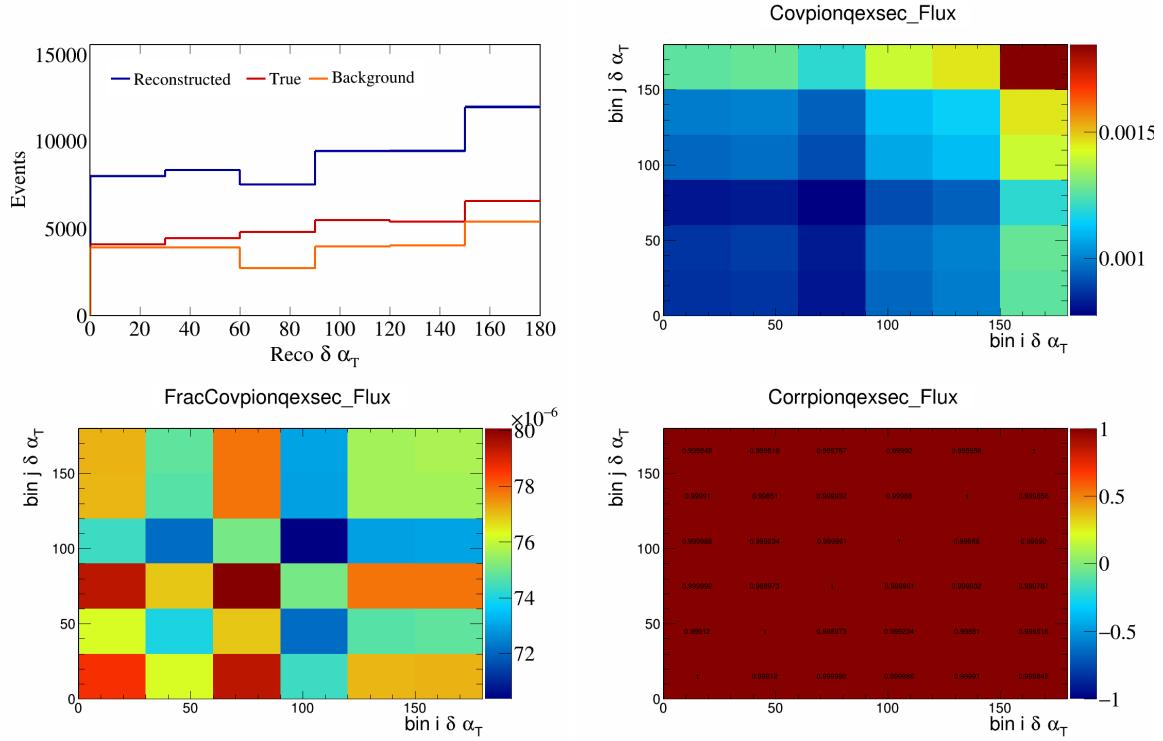


Figure 749: PionQeXSec variations for $\delta\alpha_T$.

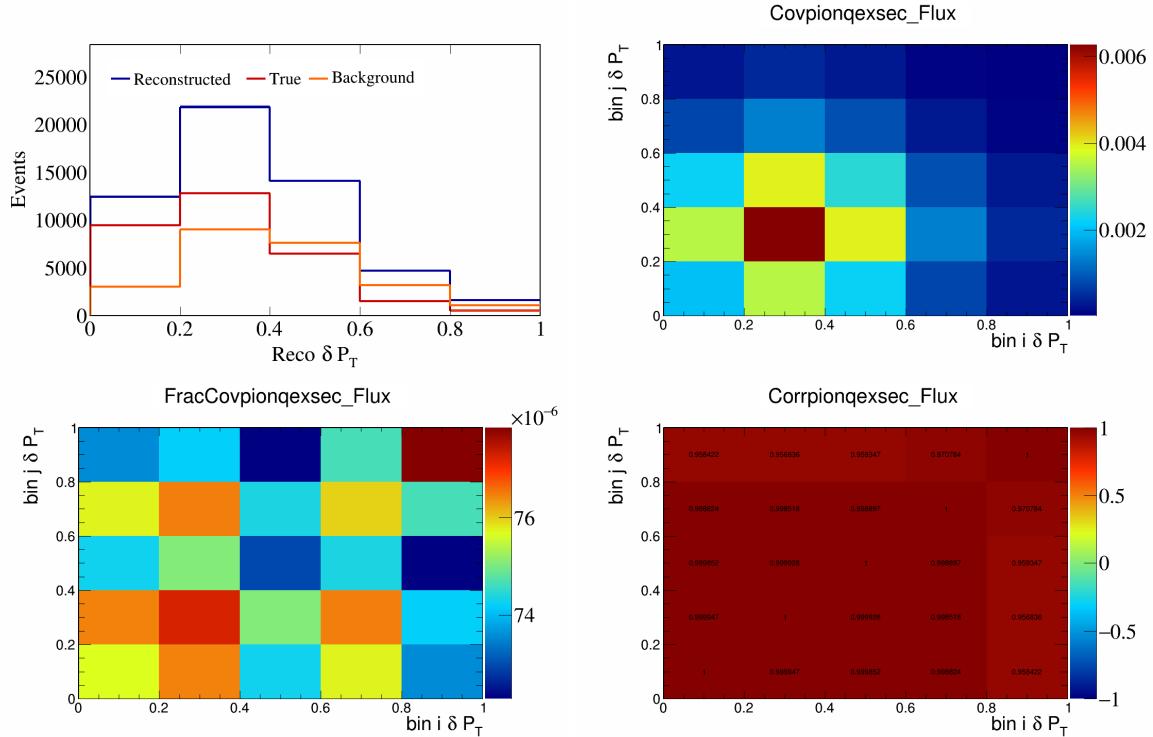


Figure 750: PionQeXSec variations for δP_T .

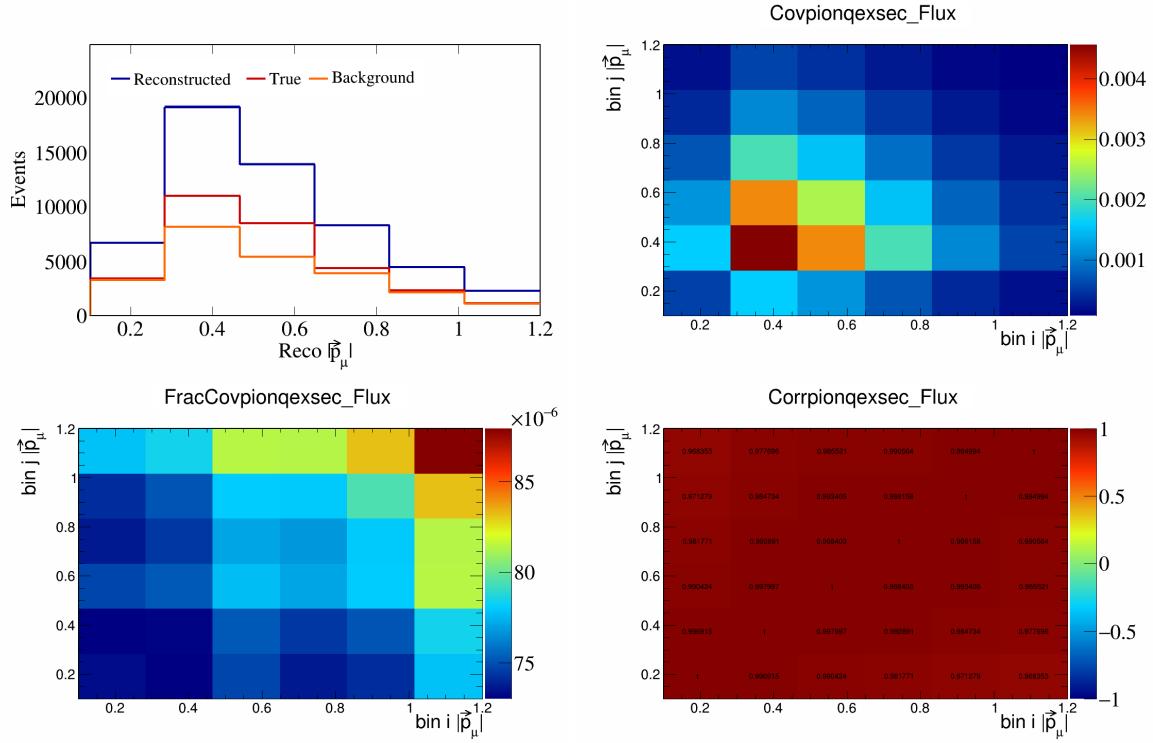
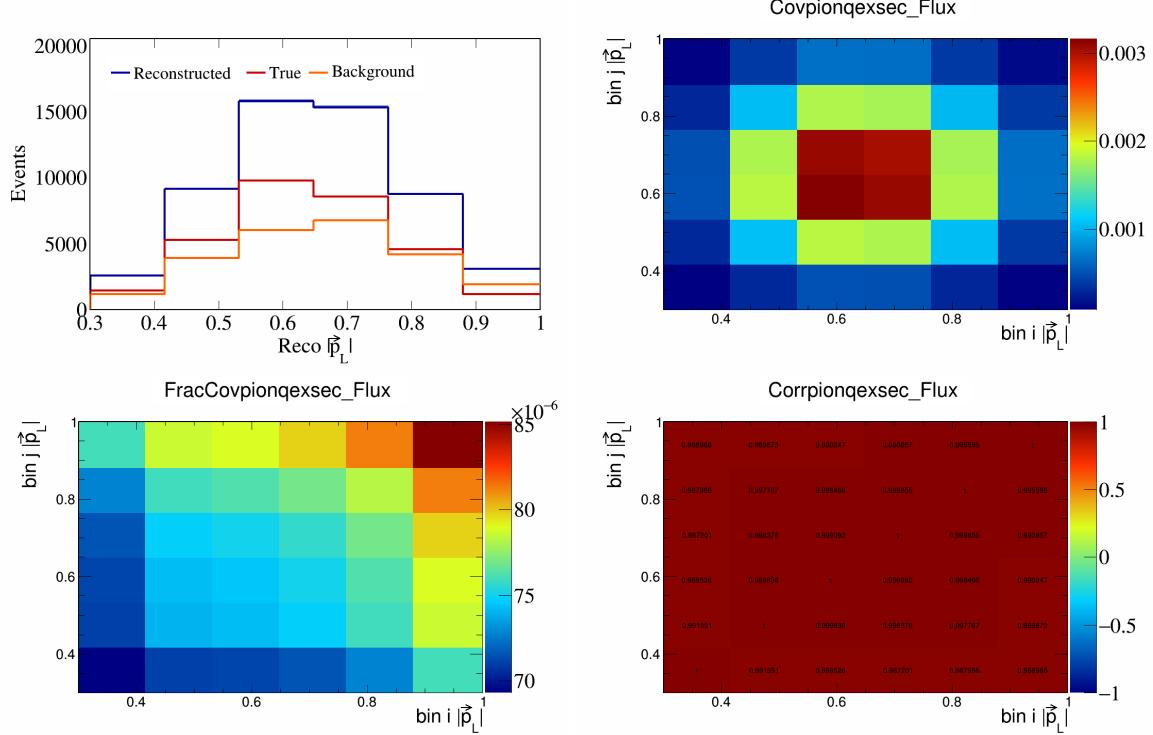


Figure 751: PionQeXSec variations for $|\vec{p}_\mu|$.



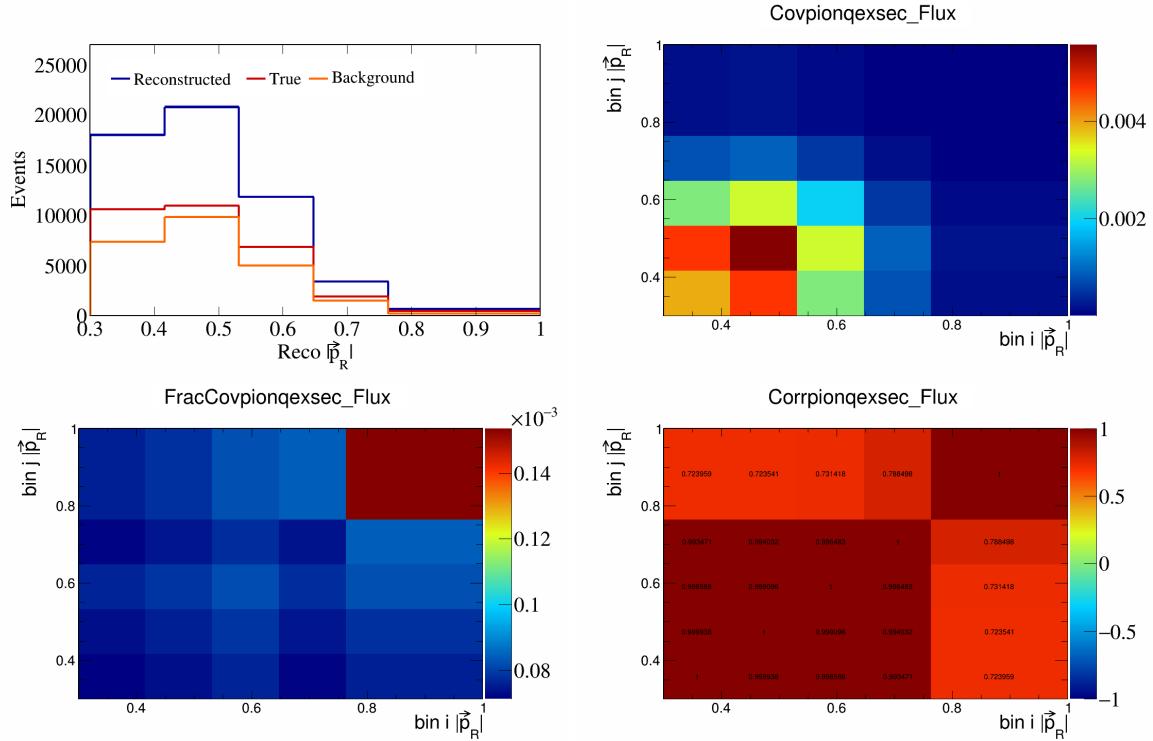


Figure 753: PionQeXSec variations for $|\vec{p}_R|$.

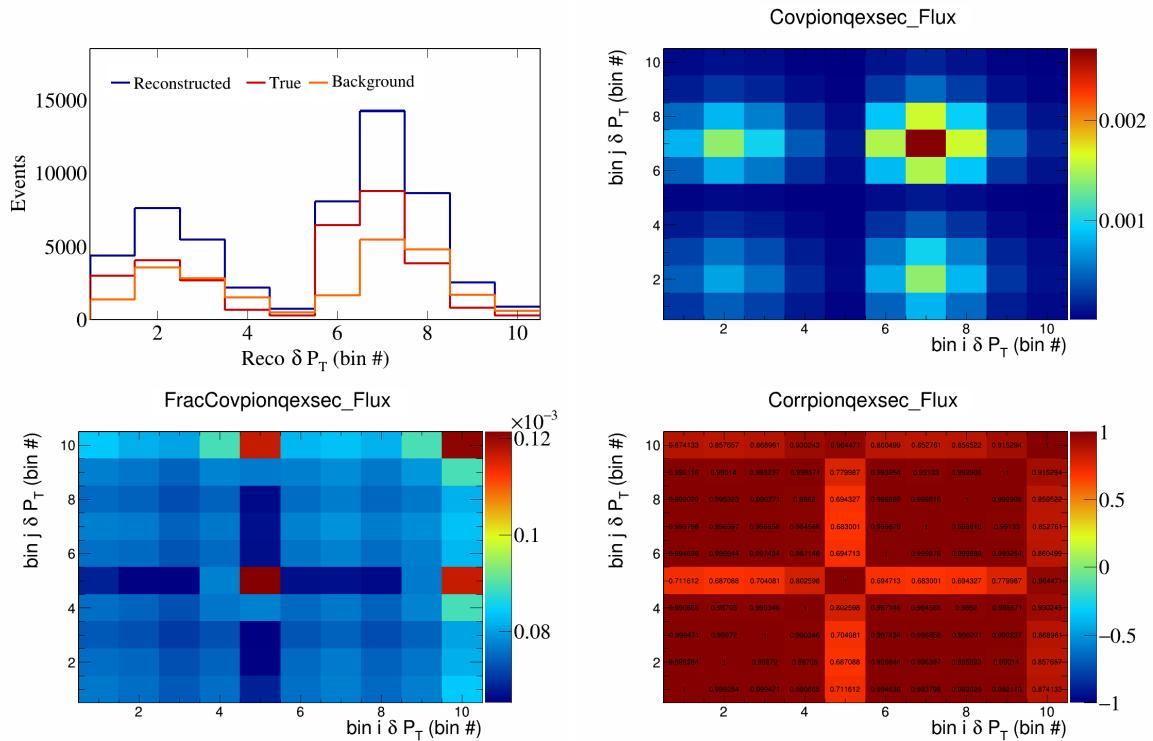


Figure 754: PionQeXSec variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

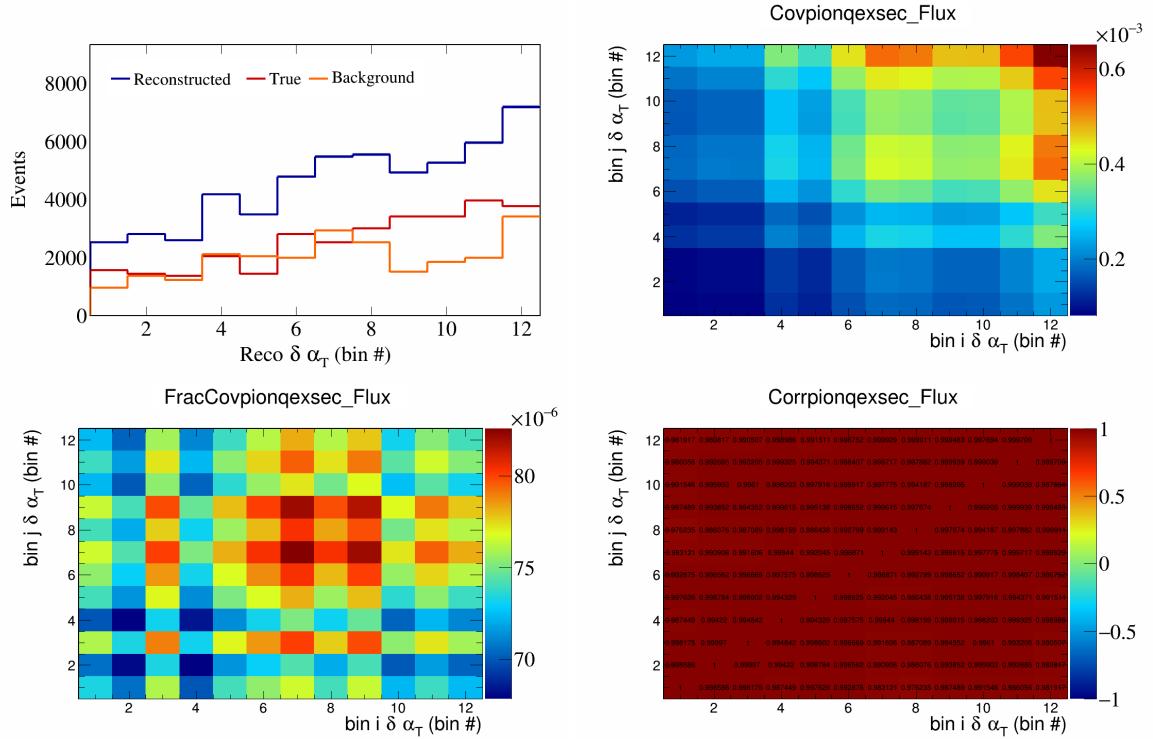


Figure 755: PionQeXSec variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

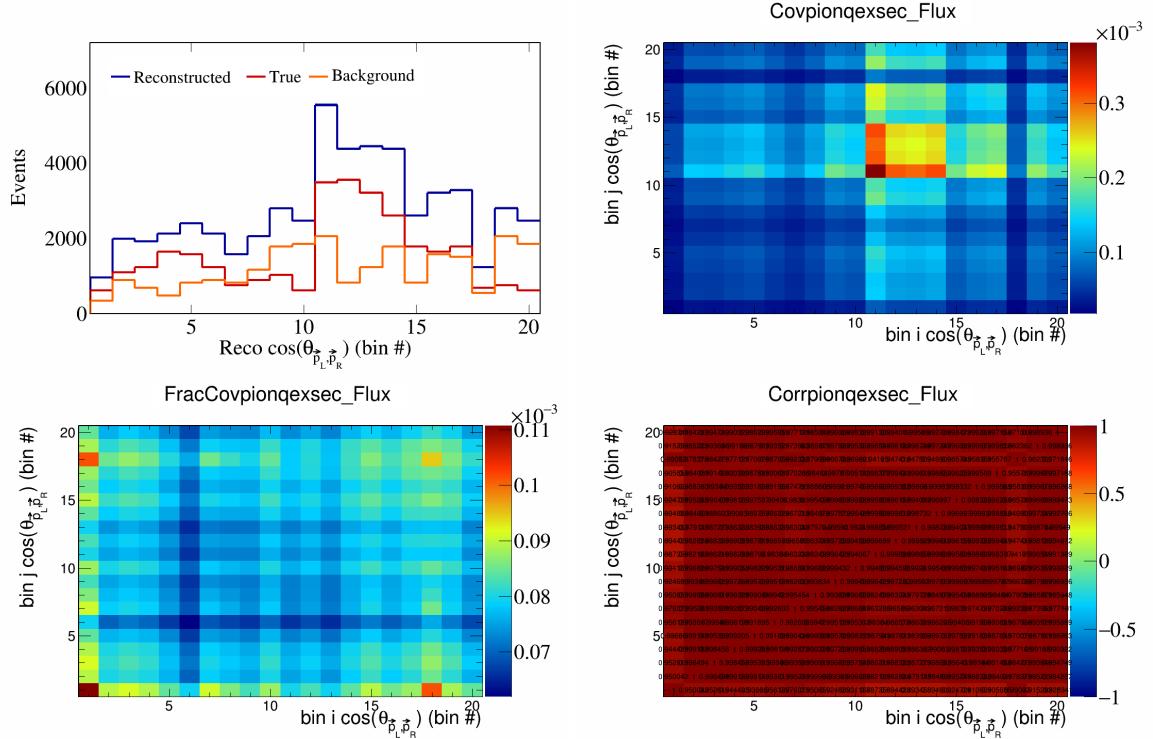


Figure 756: PionQeXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

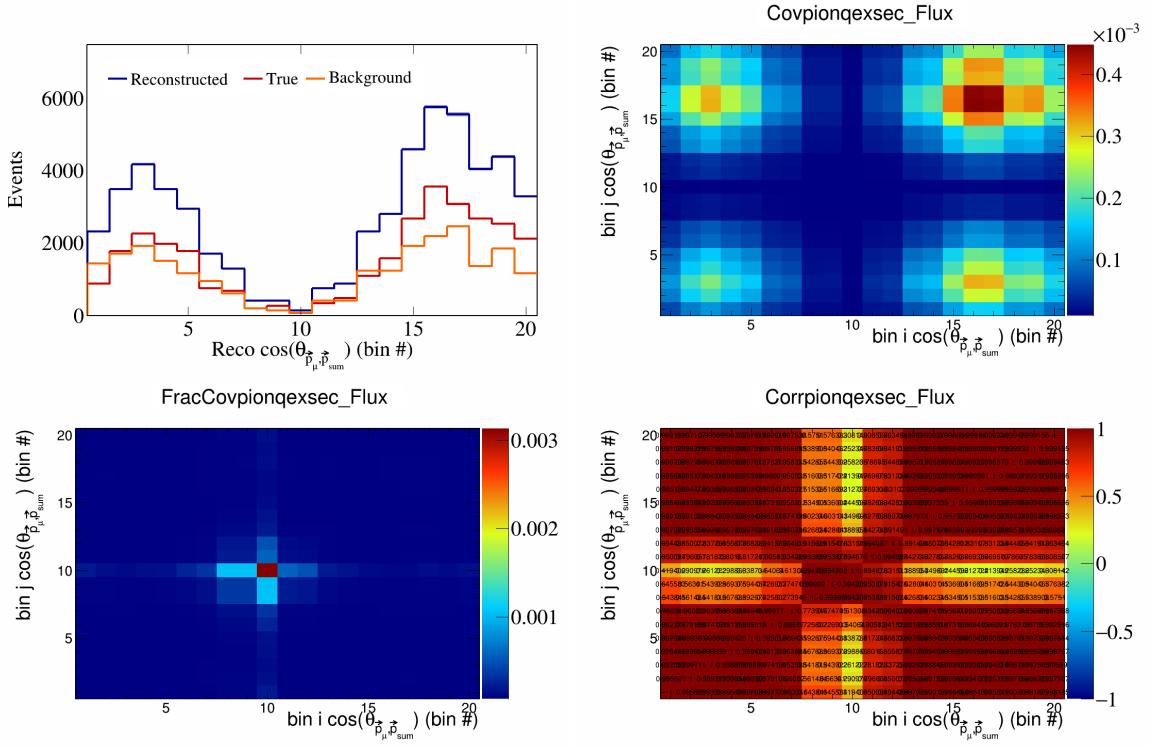


Figure 757: PionQeXSec variations for $\cos(\theta_{\vec{p}_\mu} \vec{p}_{\text{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

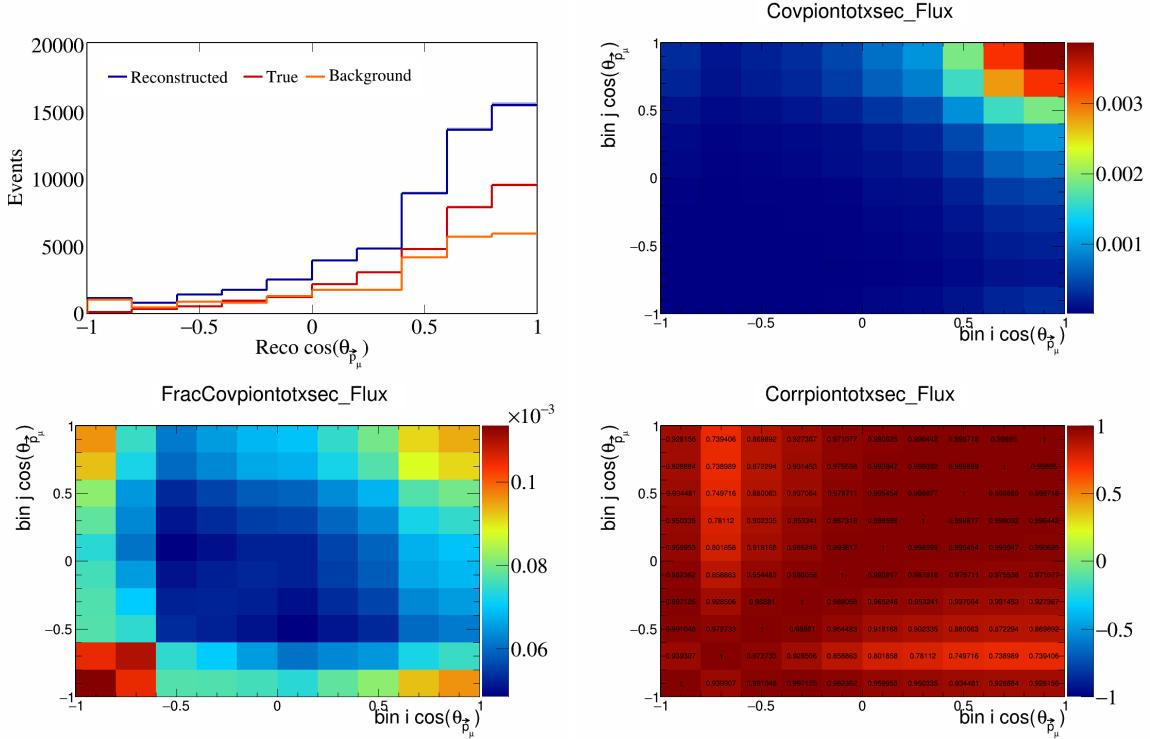


Figure 758: PionTotXSec variations for $\cos(\theta_{\vec{p}_\mu})$.

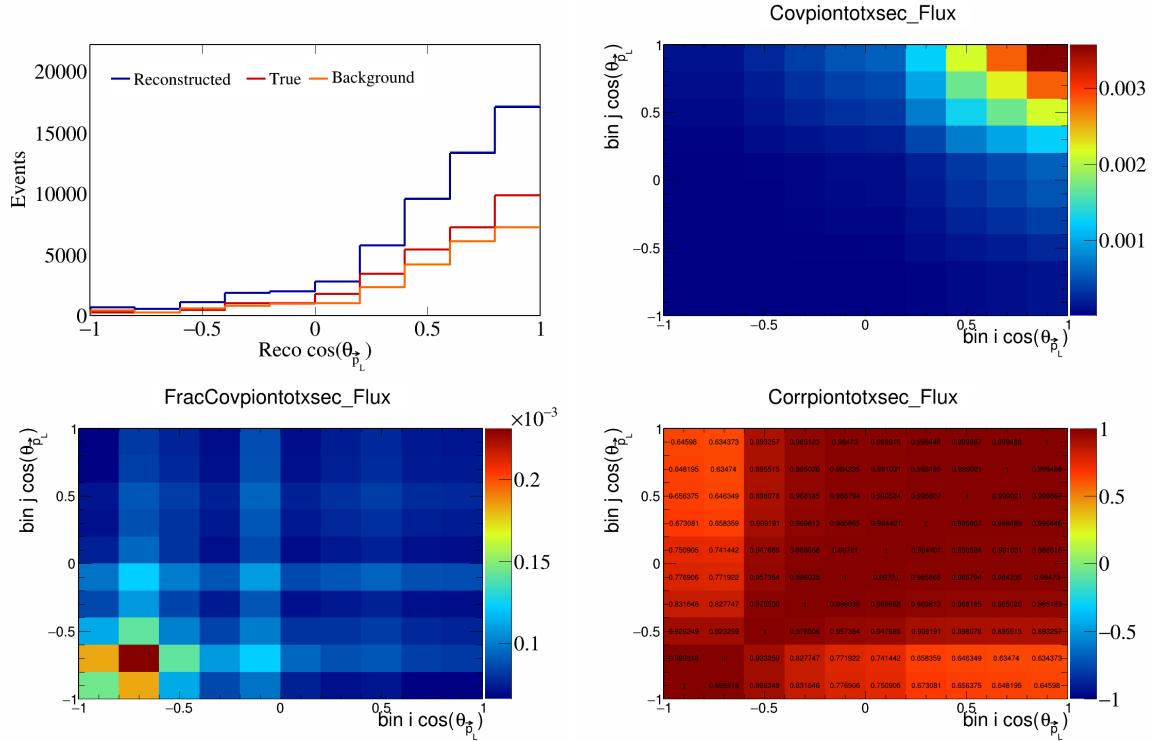


Figure 759: PionTotXSec variations for $\cos(\theta_{\vec{p}_L})$.

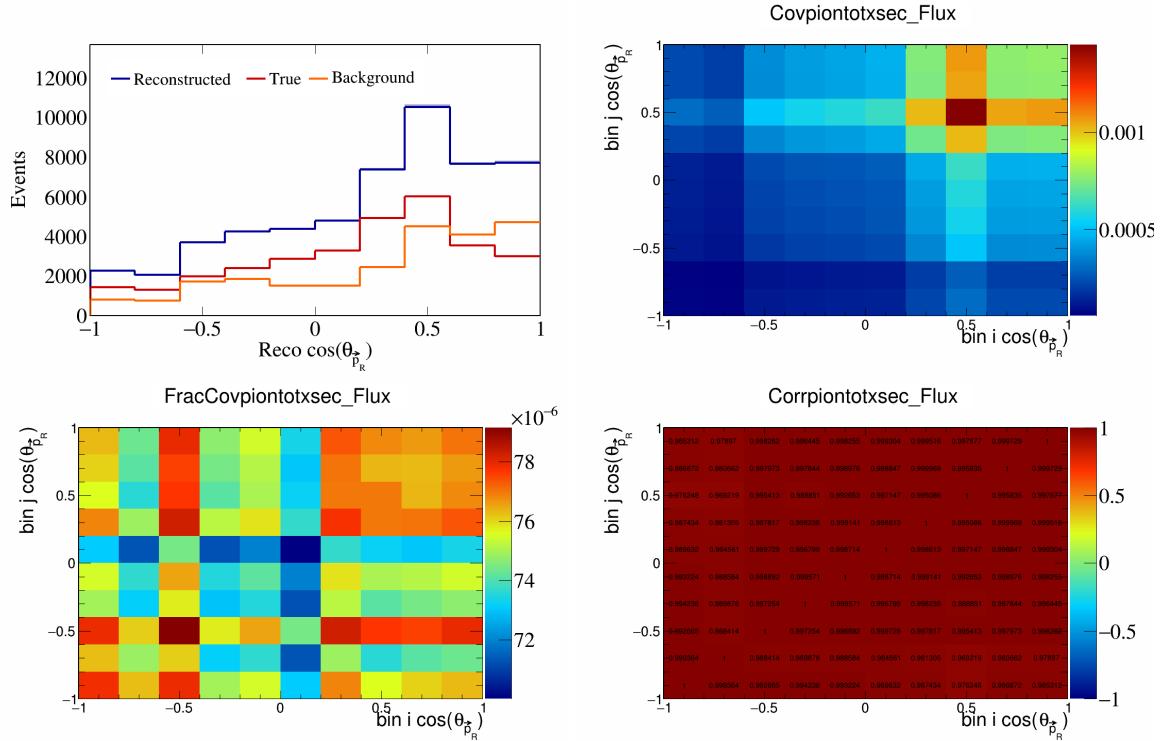


Figure 760: PionTotXSec variations for $\cos(\theta_{\vec{p}_R})$.

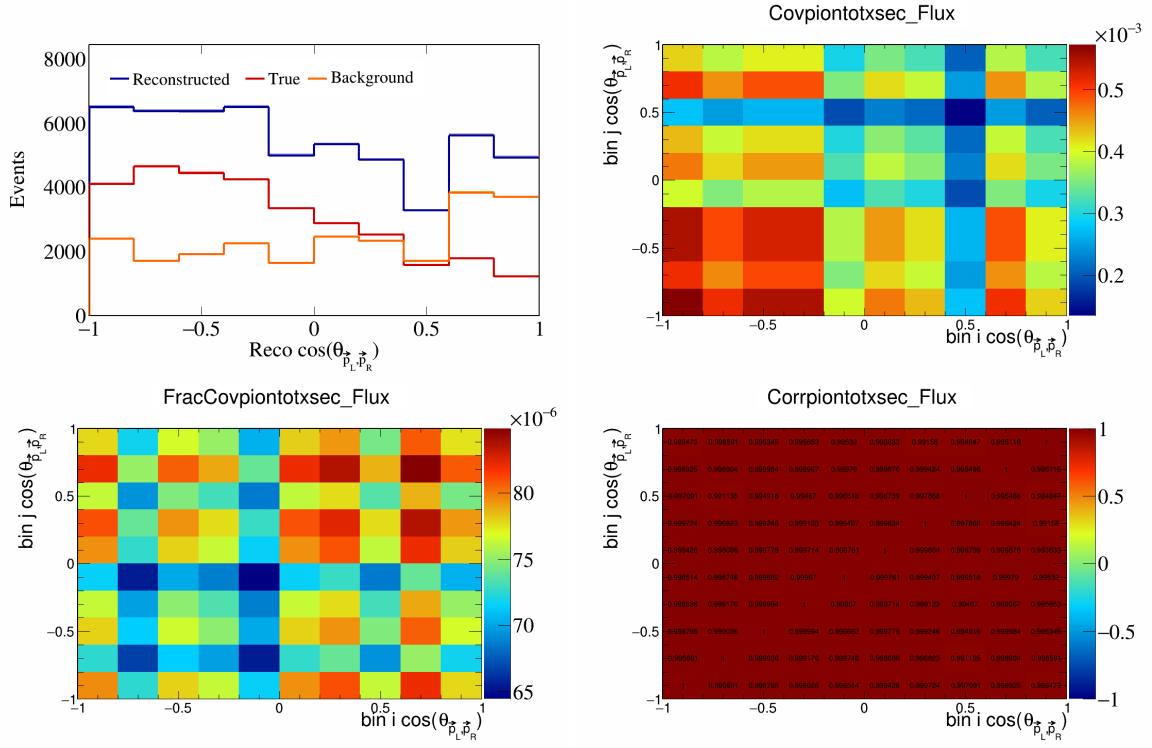


Figure 761: PionTotXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

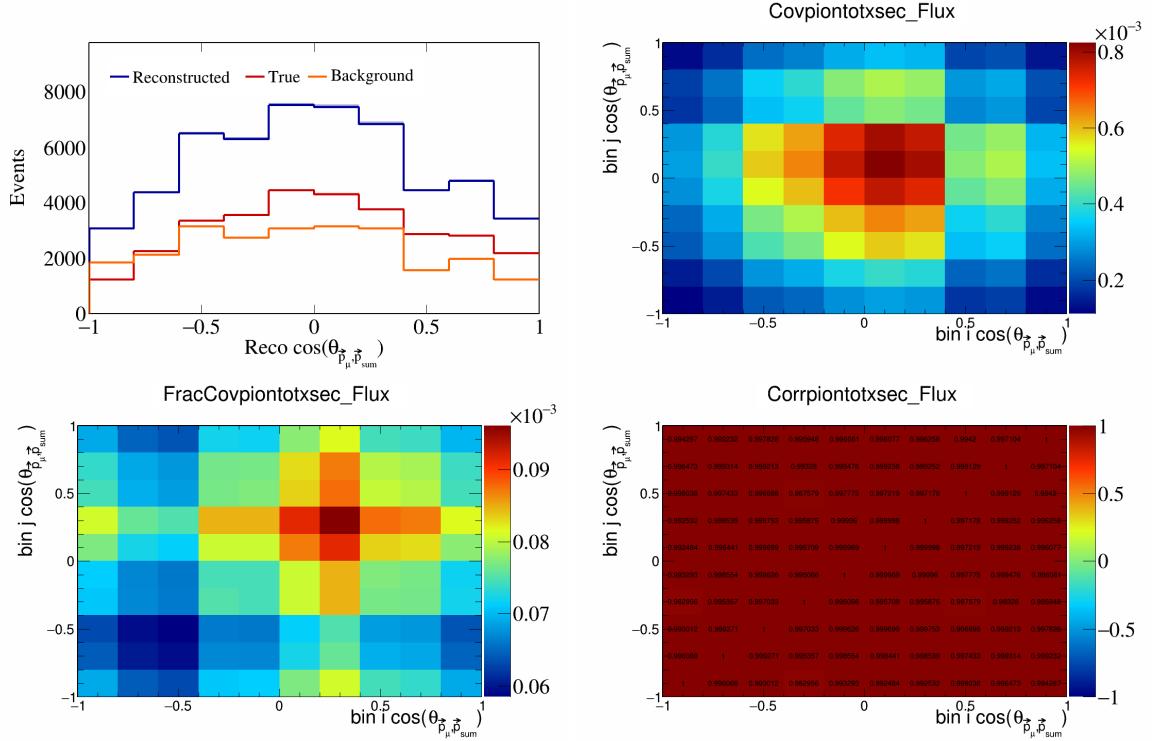


Figure 762: PionTotXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

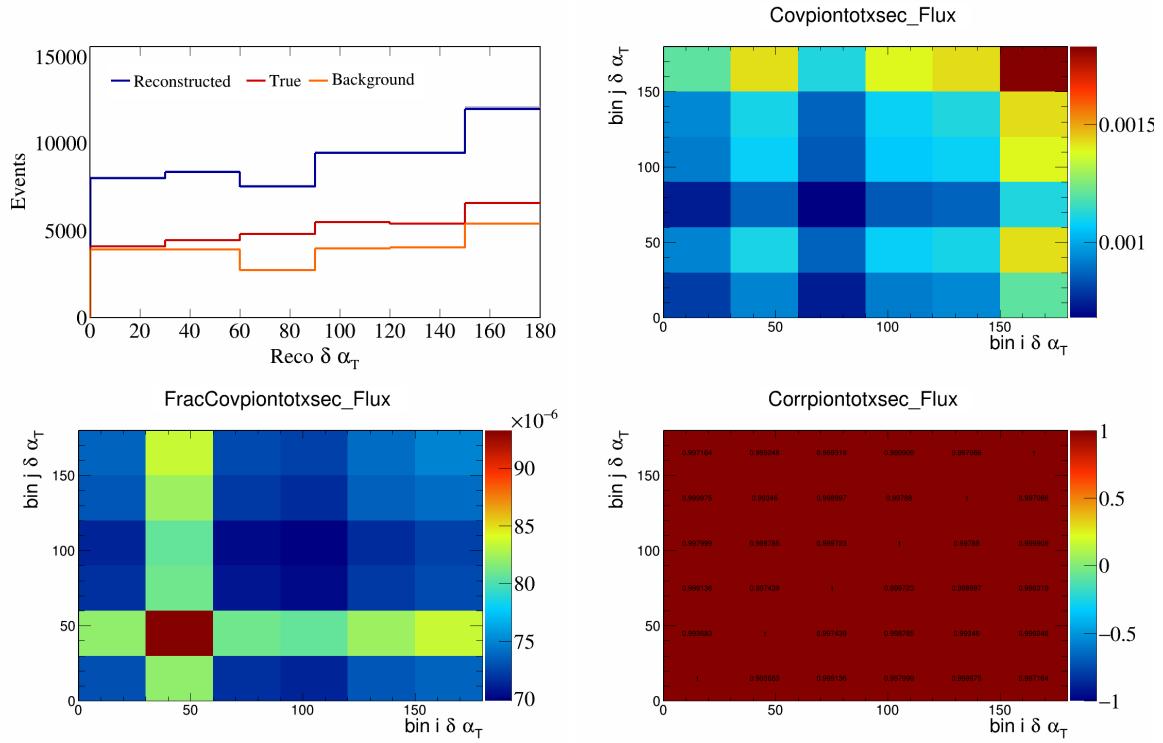


Figure 763: PionTotXSec variations for $\delta\alpha_T$.

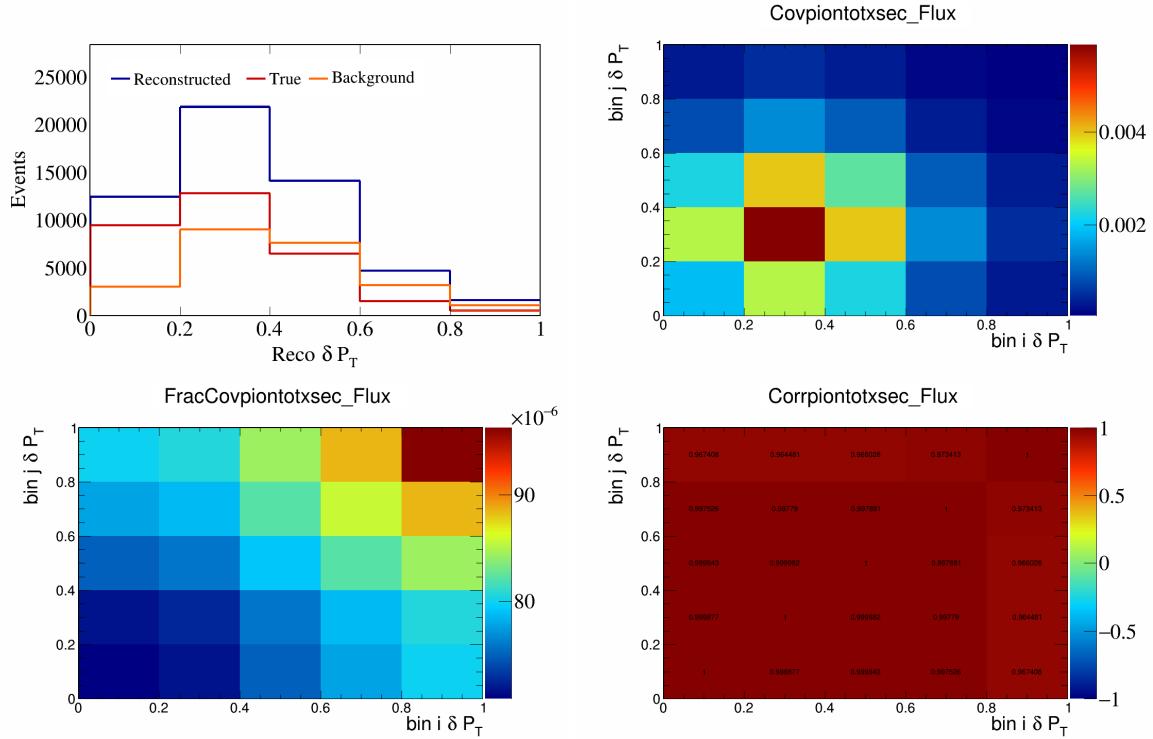


Figure 764: PionTotXSec variations for δP_T .

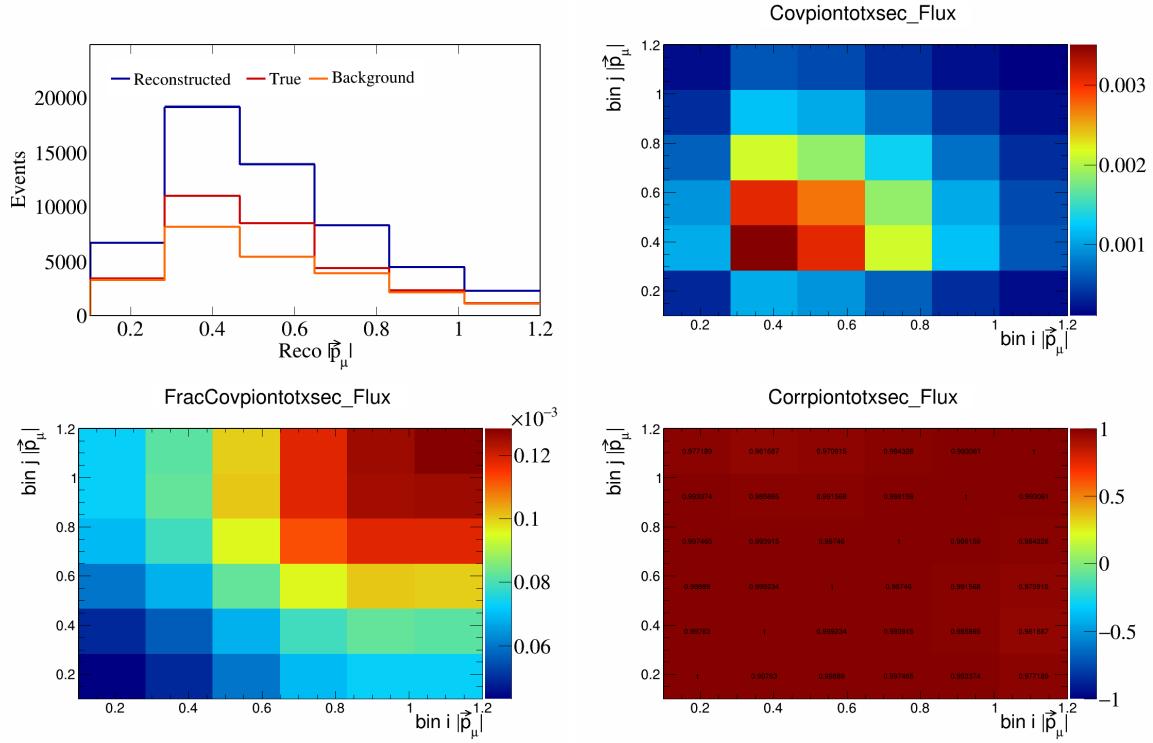


Figure 765: PionTotXSec variations for $|\vec{p}_\mu|$.

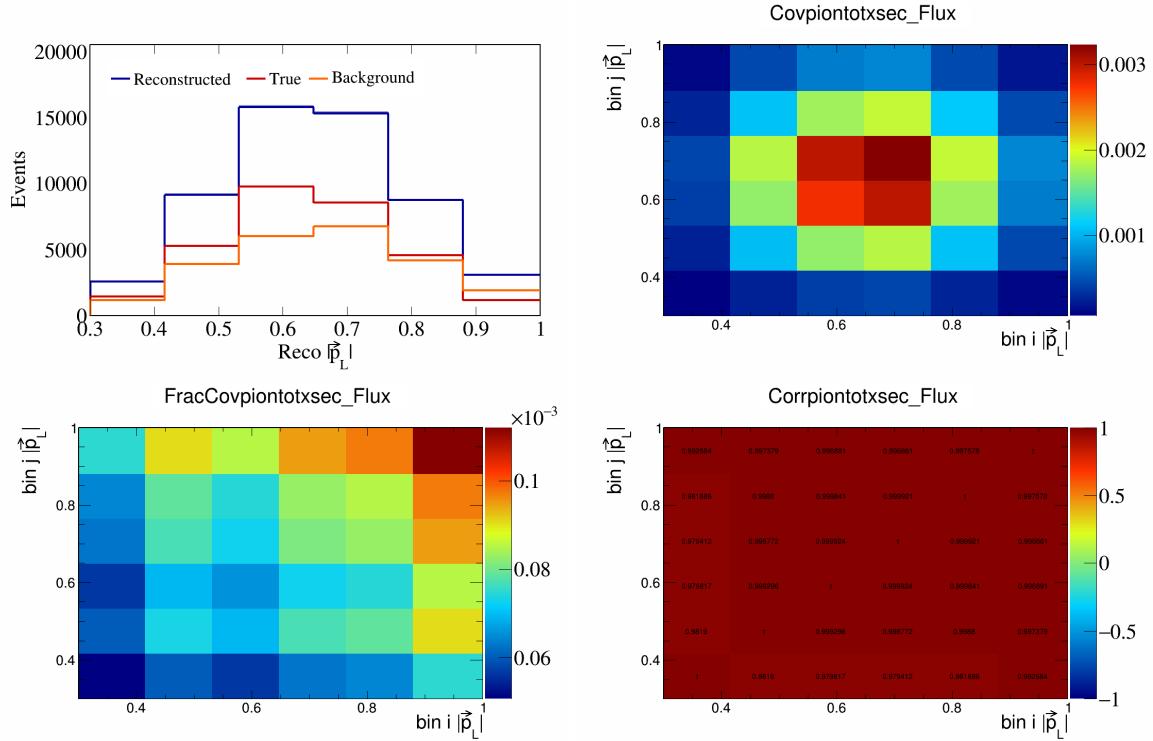


Figure 766: PionTotXSec variations for $|\vec{p}_L|$.

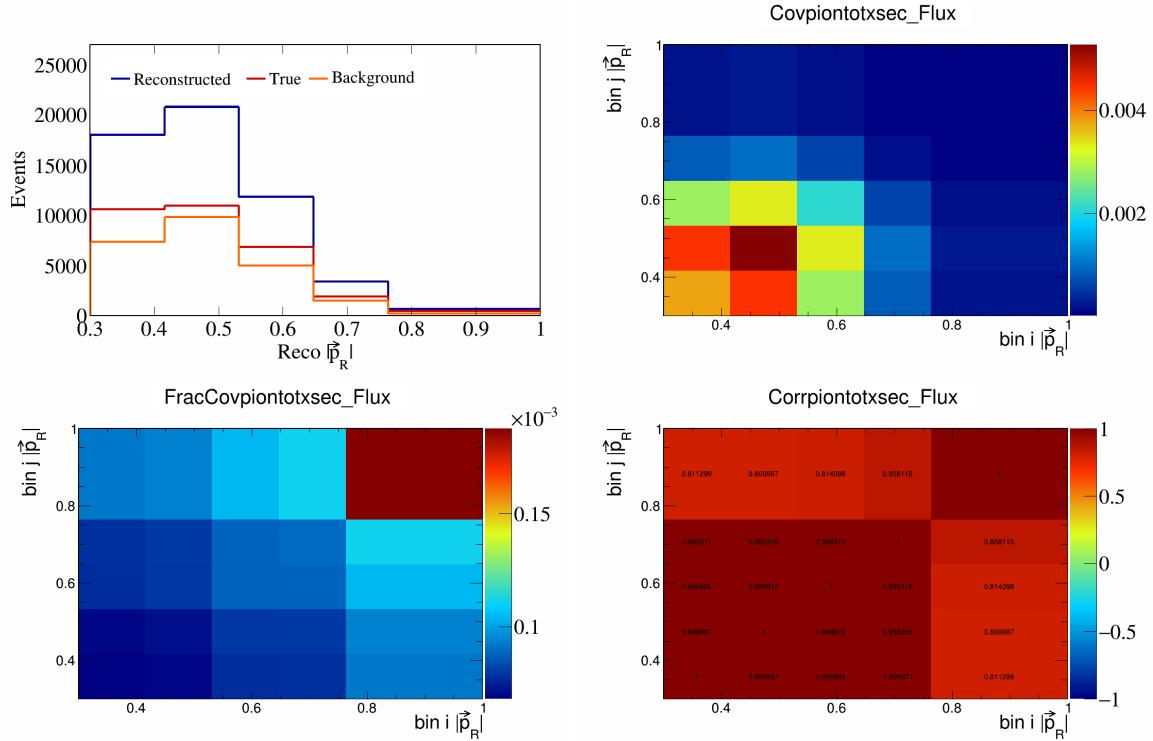


Figure 767: PionTotXSec variations for $|\vec{p}_R|$.

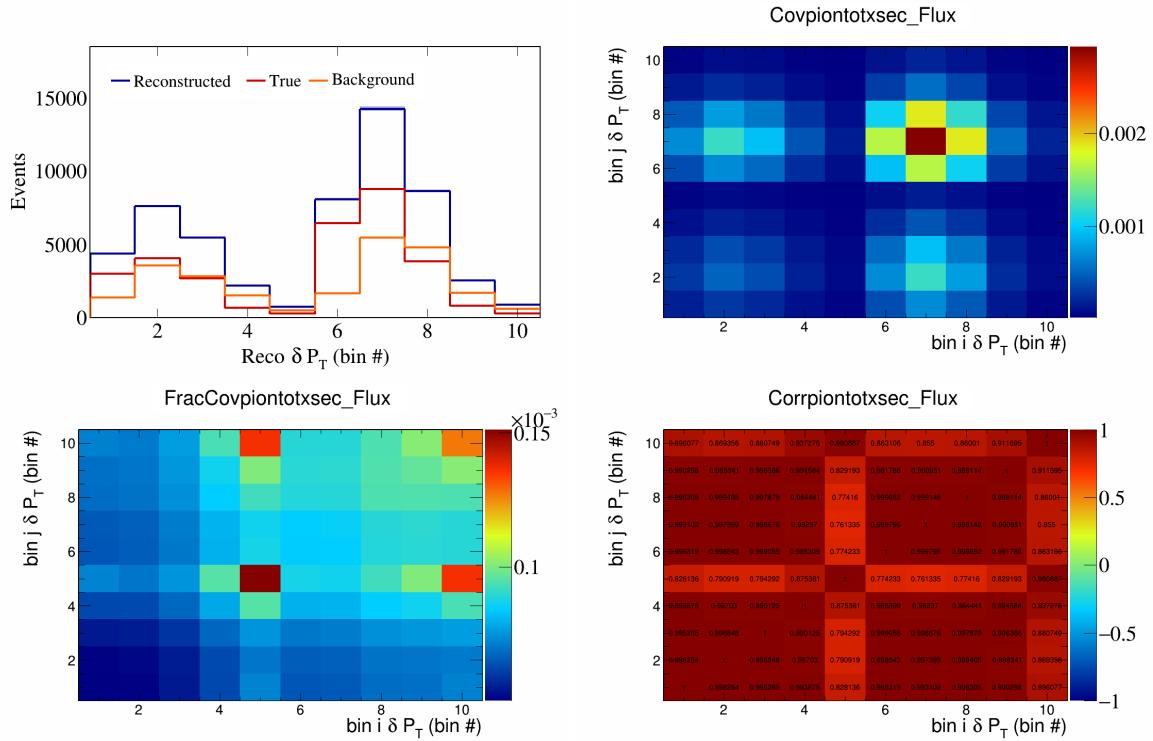


Figure 768: PionTotXSec variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

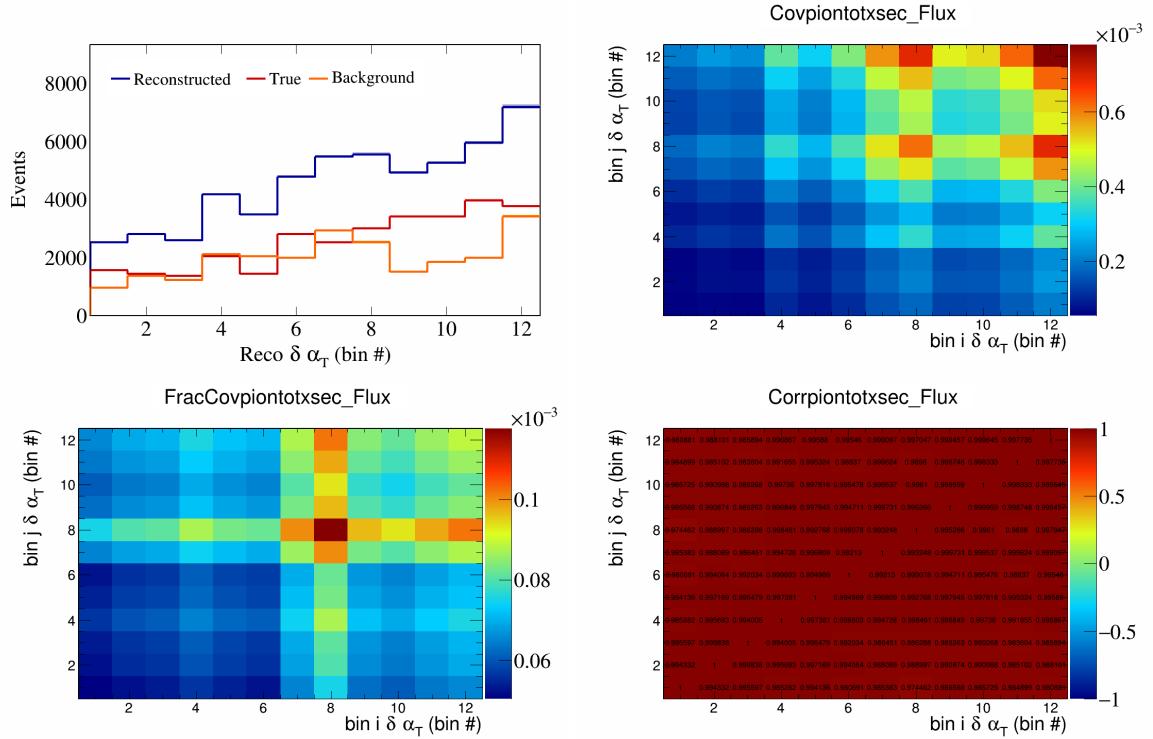


Figure 769: PionTotXSec variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

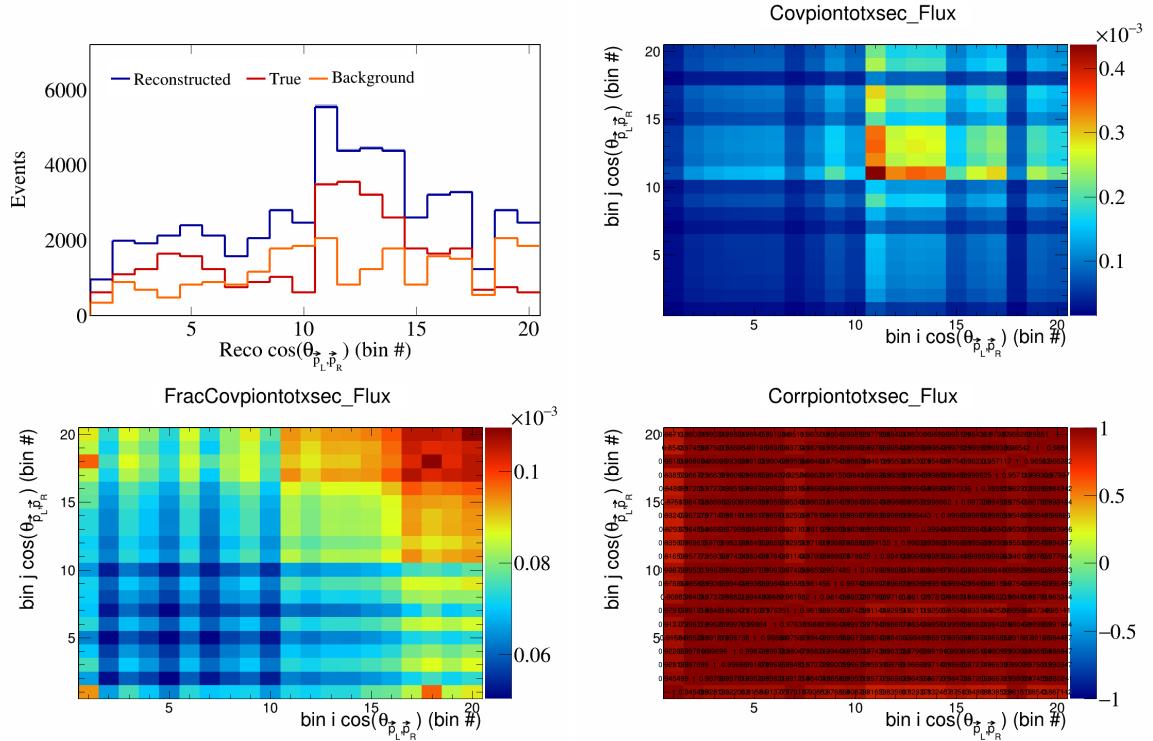


Figure 770: PionTotXSec variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

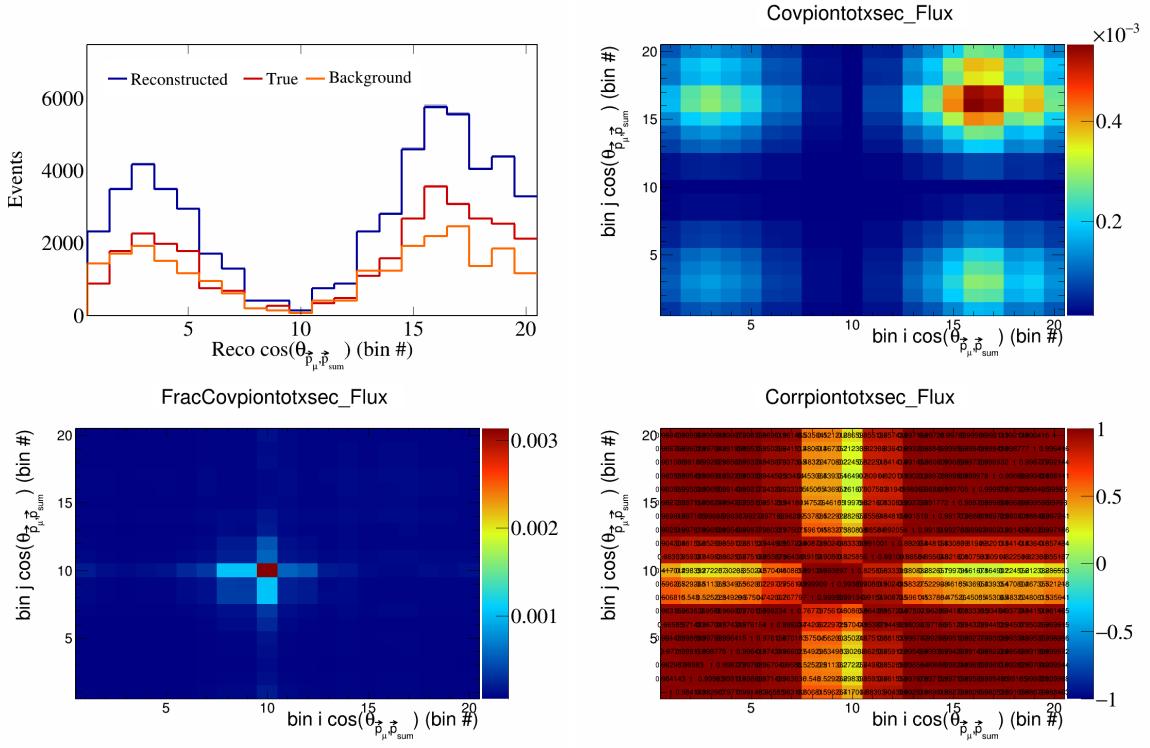


Figure 771: PionTotXSec variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

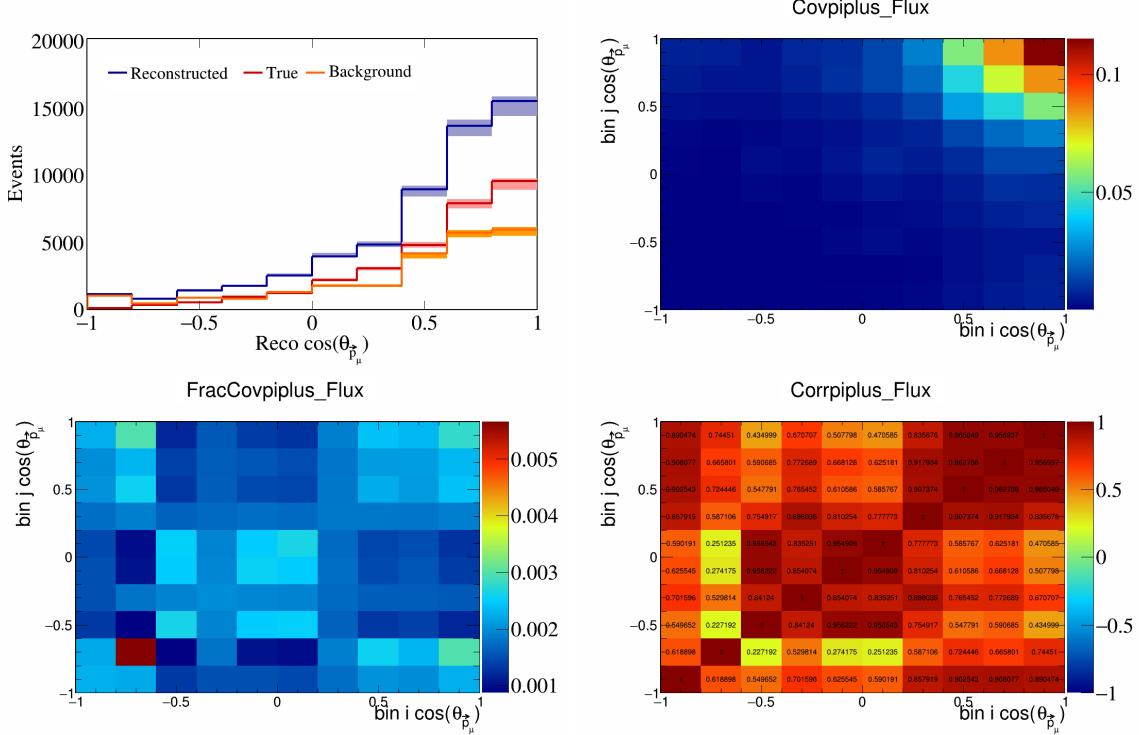


Figure 772: PiPlus variations for $\cos(\theta_{\vec{p}_\mu})$.

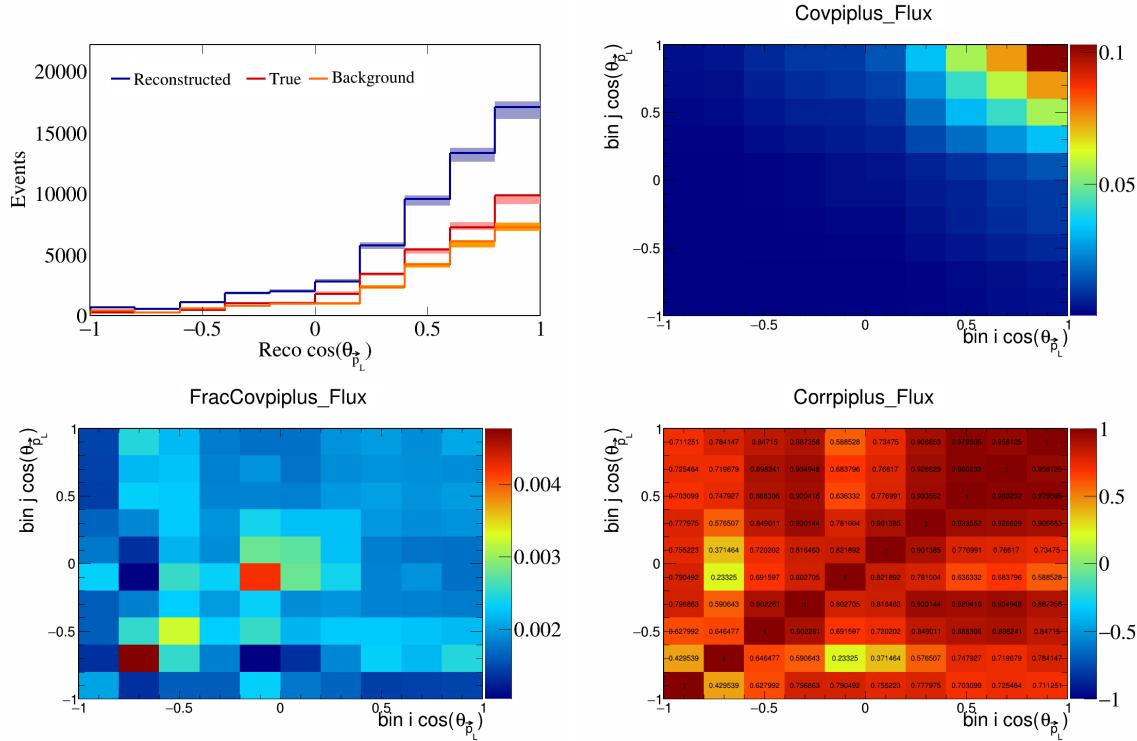


Figure 773: PiPlus variations for $\cos(\theta_{\vec{p}_L})$.

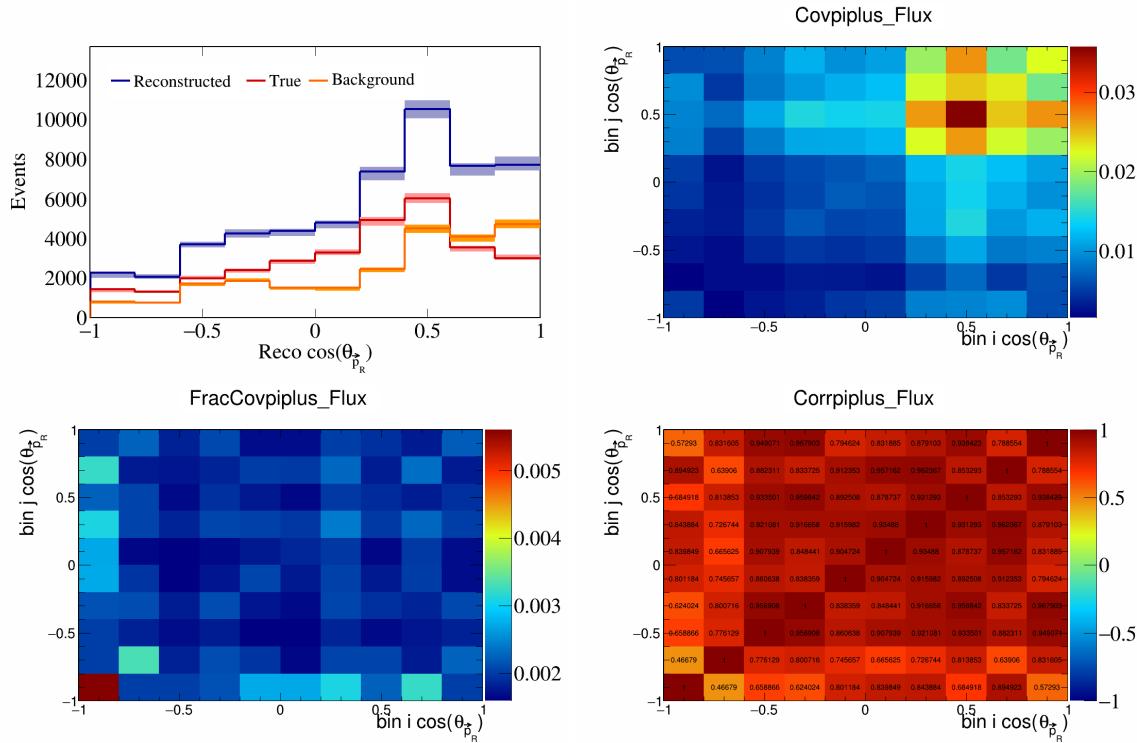


Figure 774: PiPlus variations for $\cos(\theta_{\vec{p}_R})$.

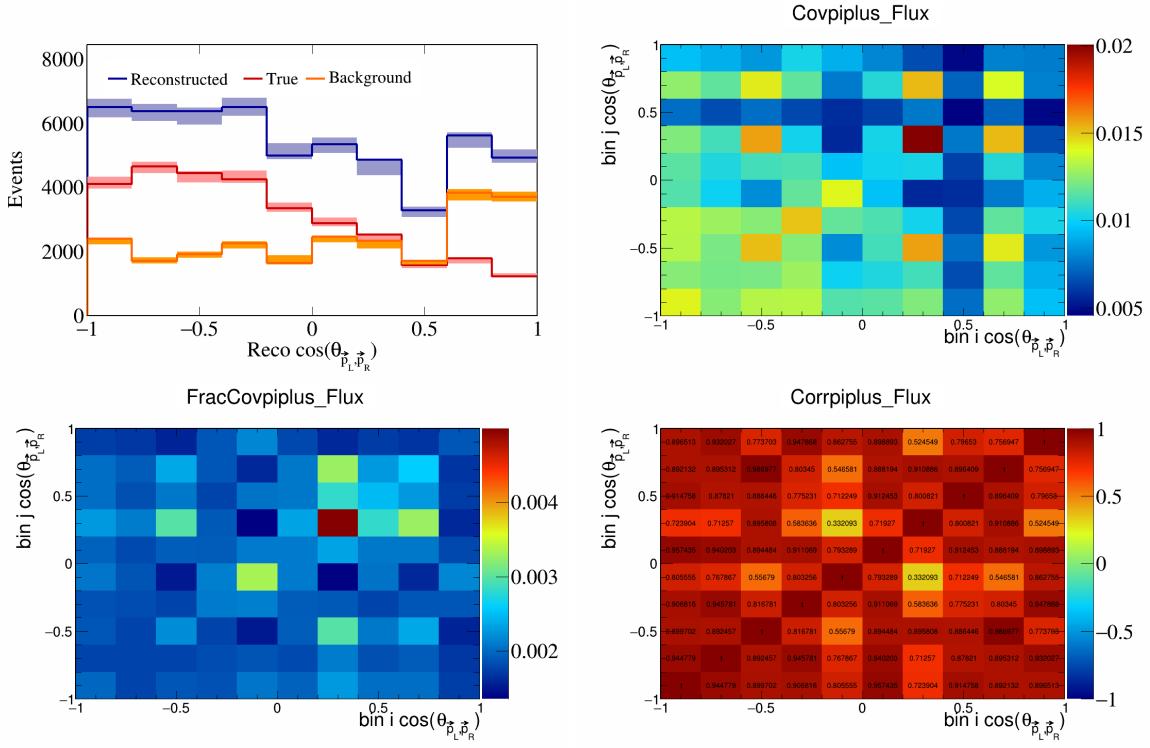


Figure 775: PiPlus variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

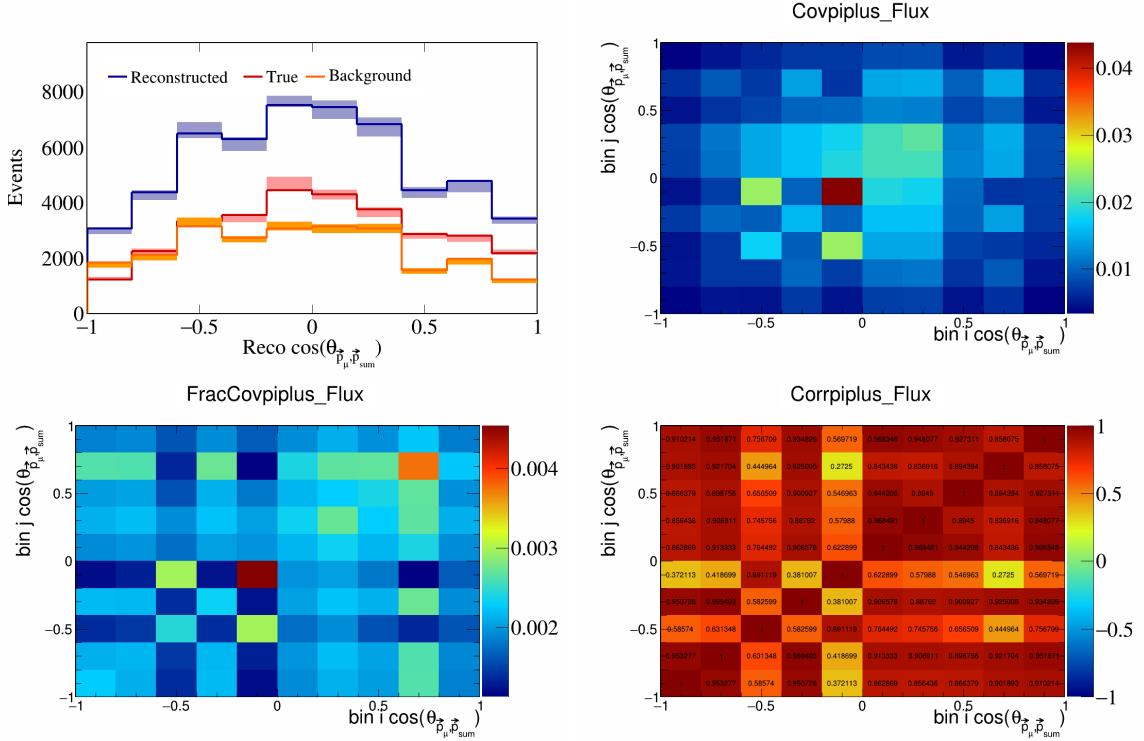


Figure 776: PiPlus variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

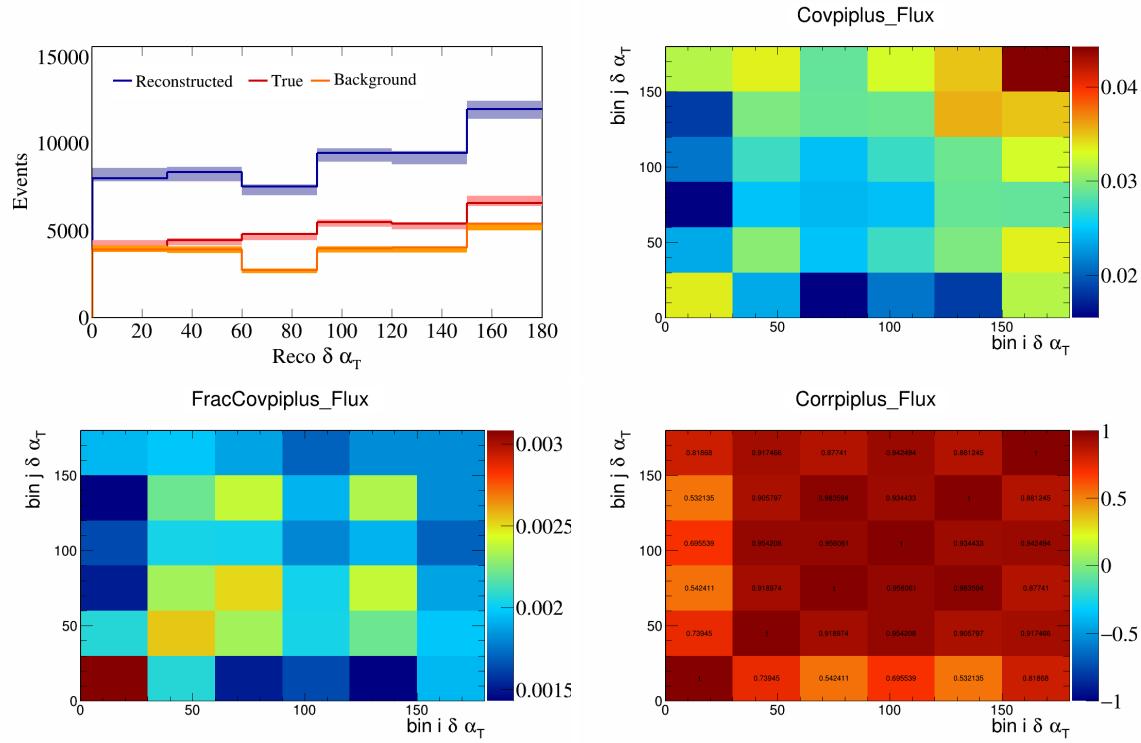


Figure 777: PiPlus variations for $\delta\alpha_T$.

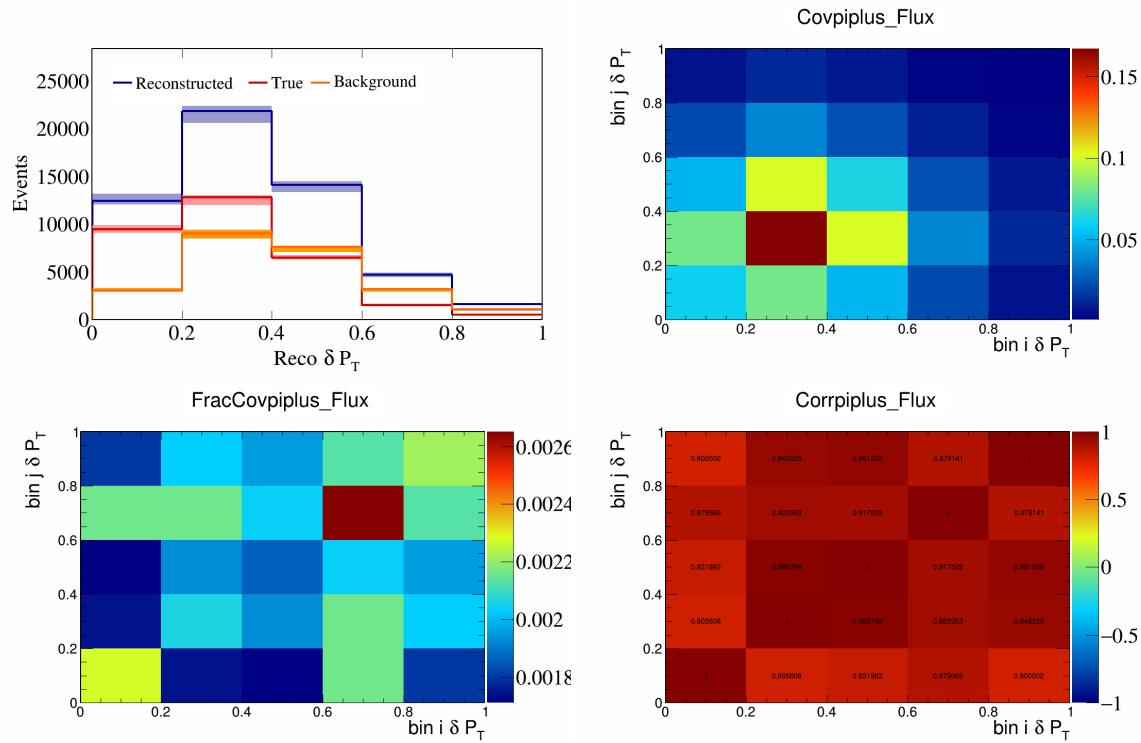


Figure 778: PiPlus variations for δP_T .

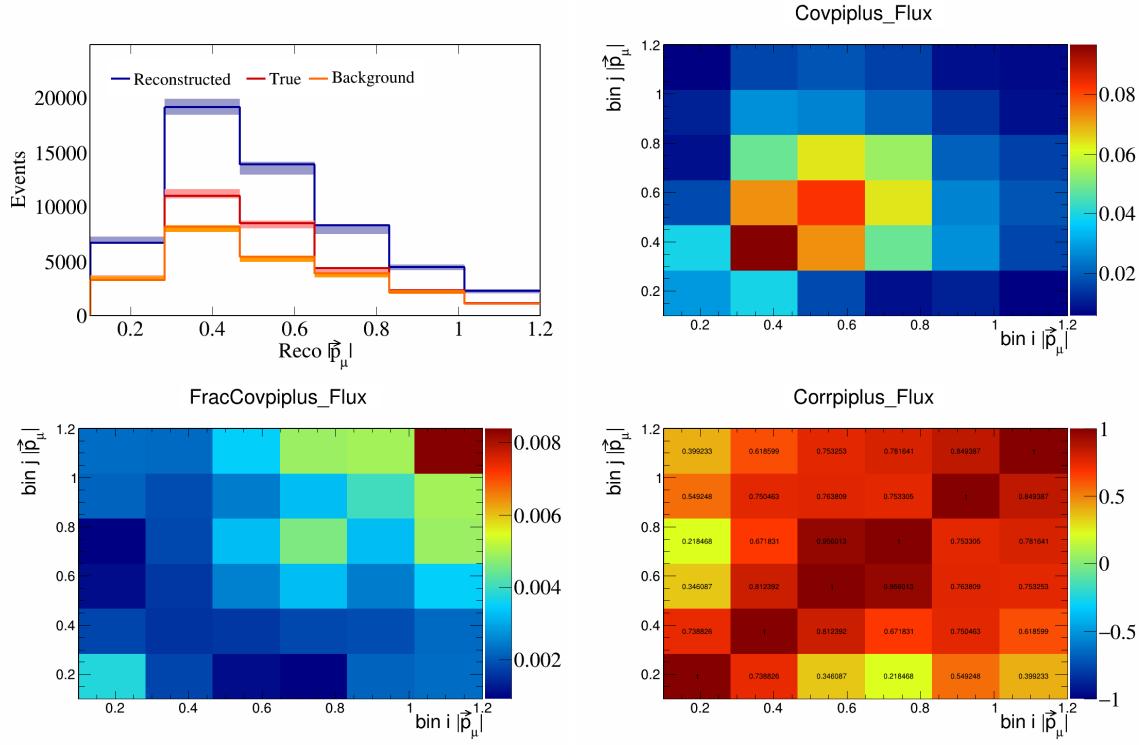


Figure 779: PiPlus variations for $|\vec{p}_\mu|$.

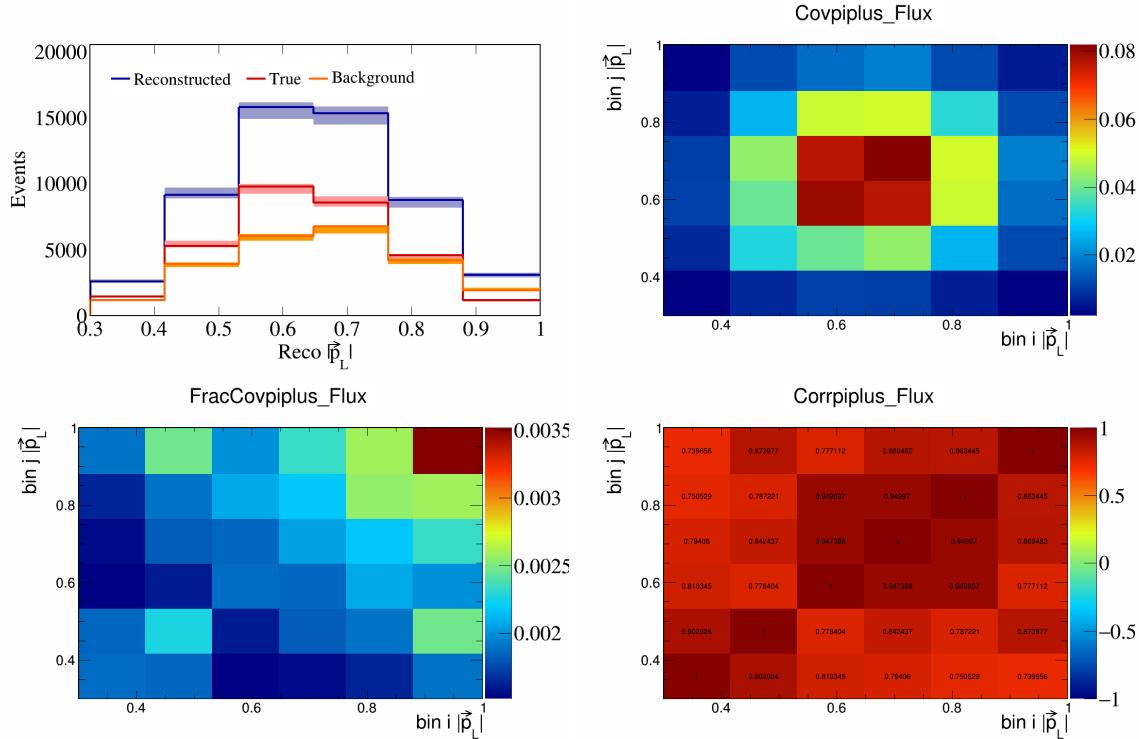


Figure 780: PiPlus variations for $|\vec{p}_L|$.

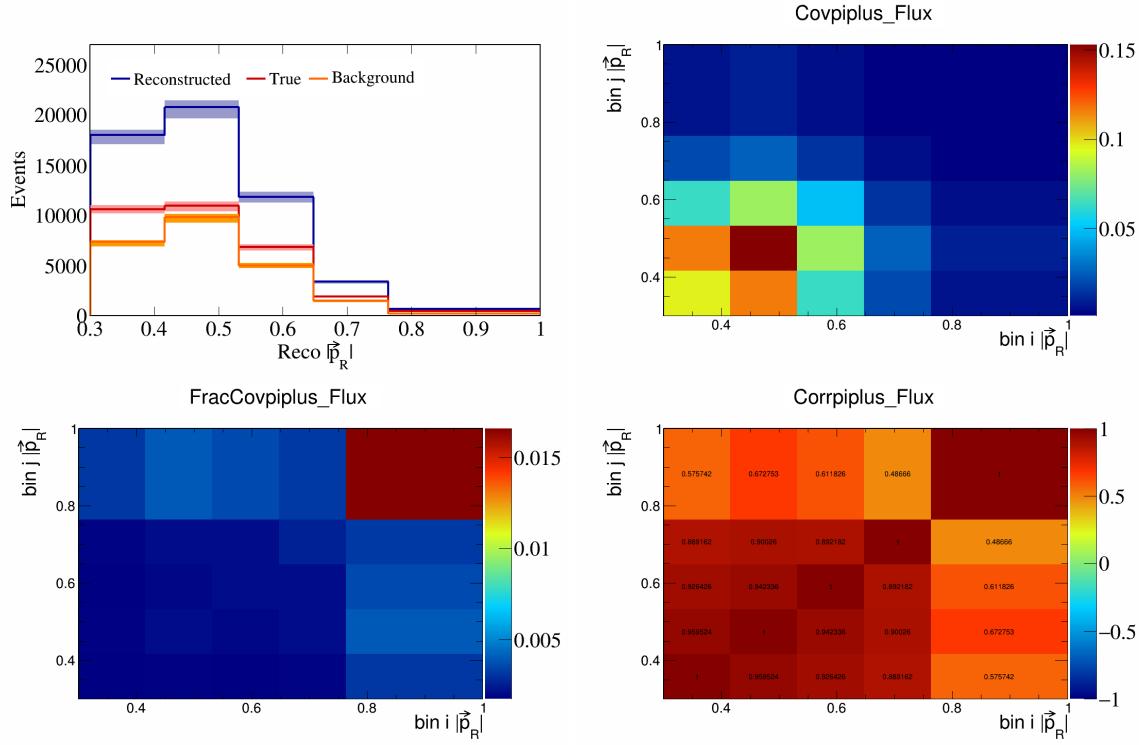


Figure 781: PiPlus variations for $|\vec{p}_R|$.

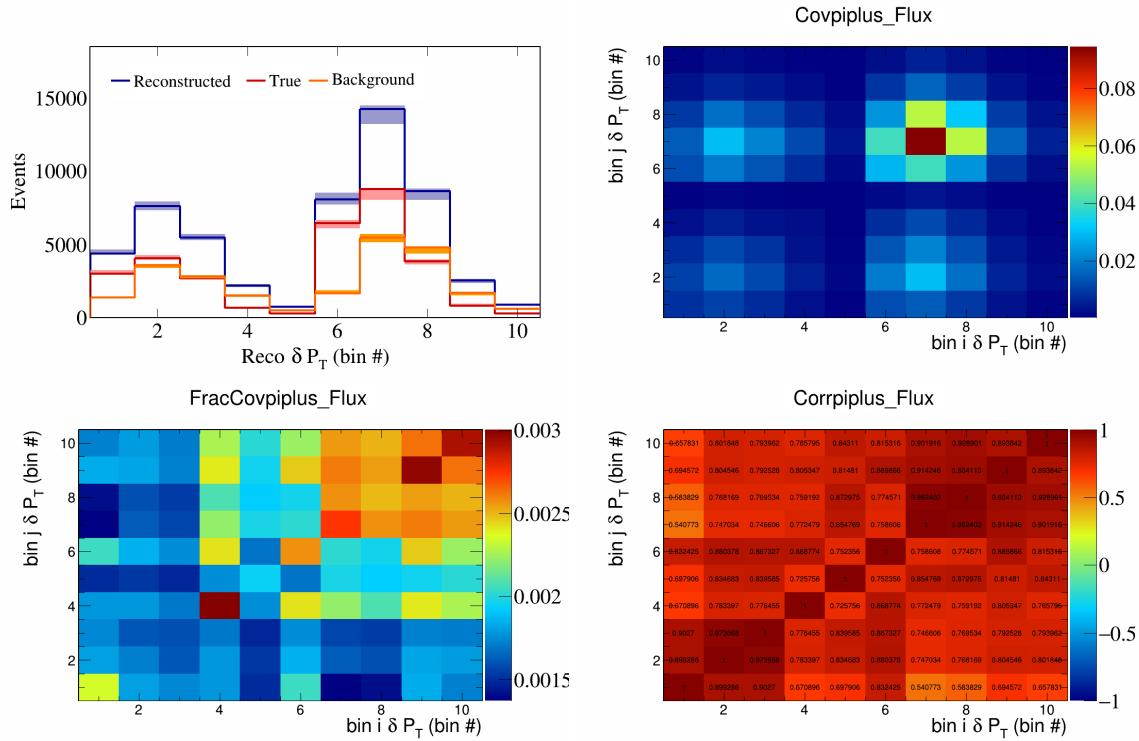


Figure 782: PiPlus variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

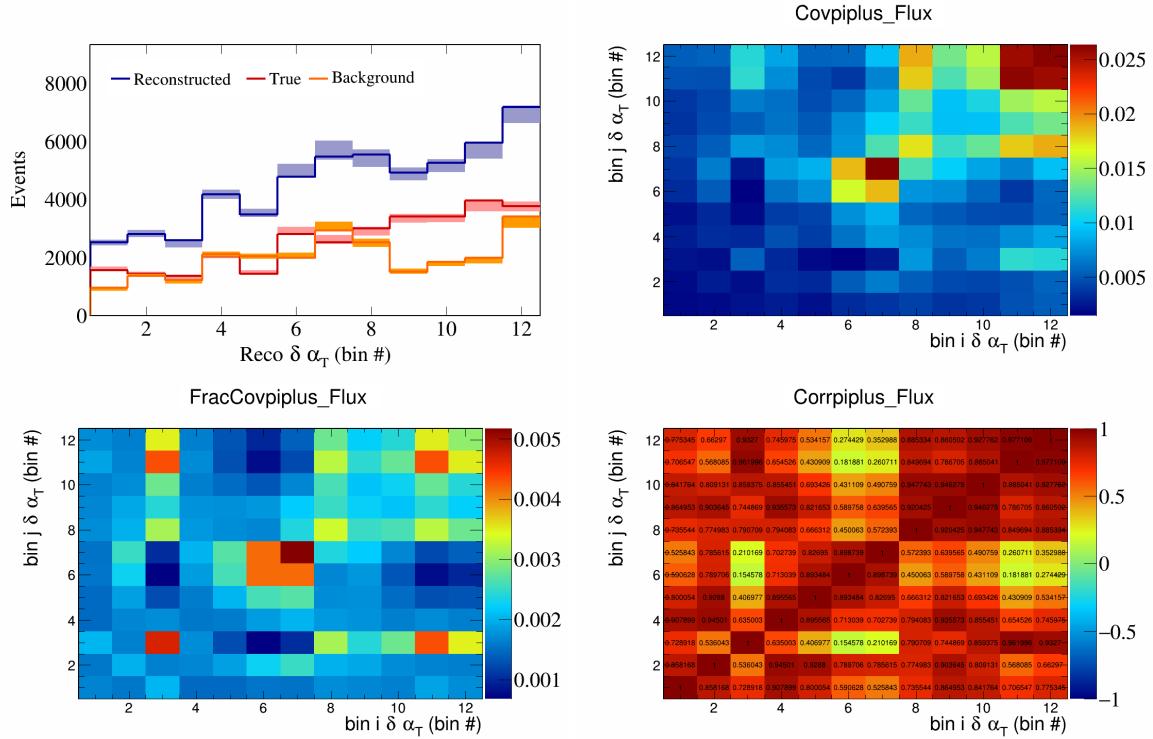


Figure 783: PiPlus variations for $\delta\alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

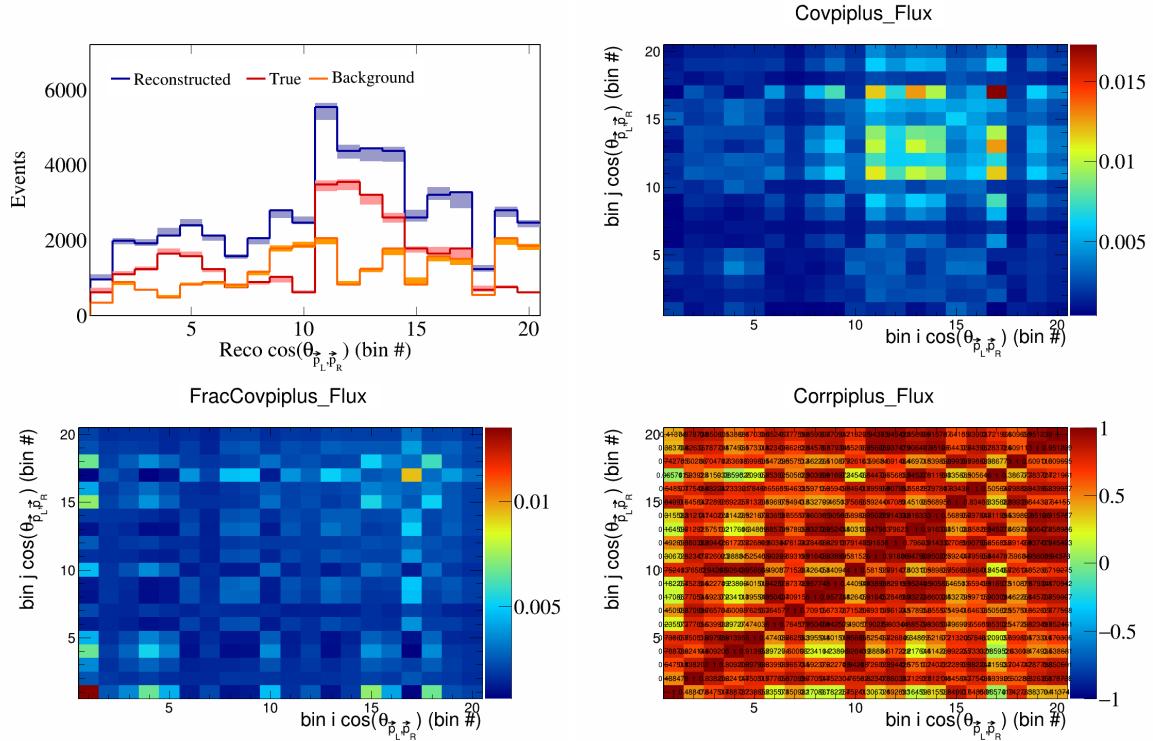


Figure 784: PiPlus variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

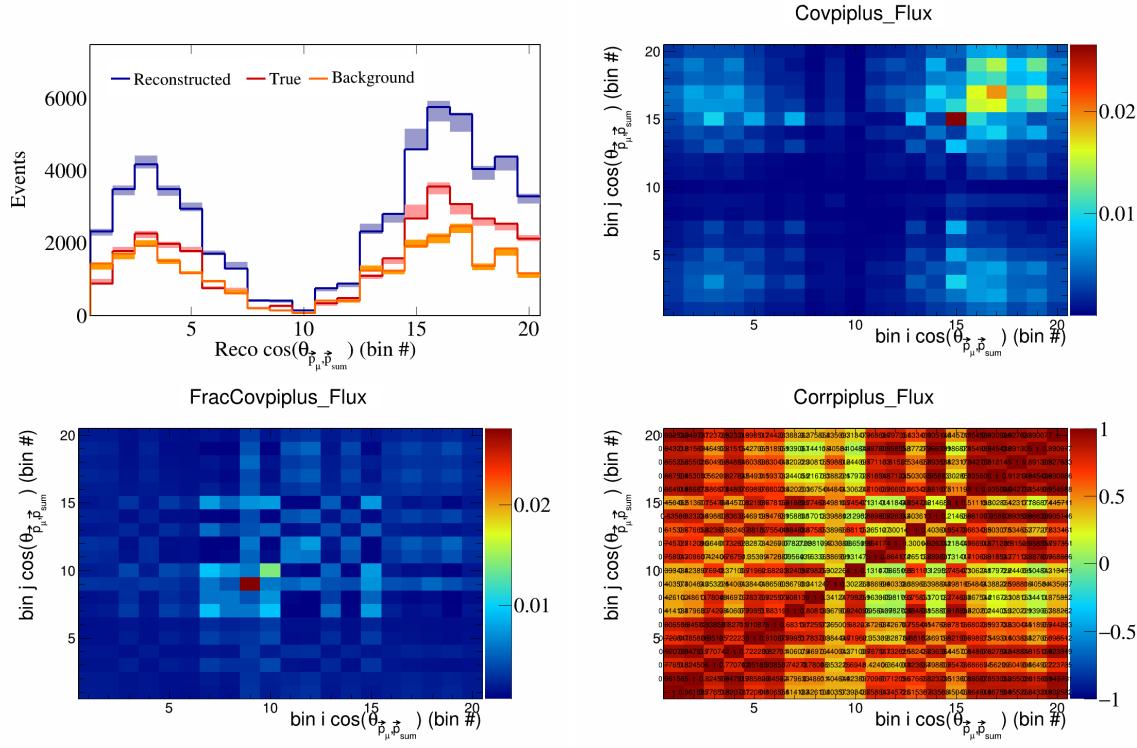


Figure 785: PiPlus variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

231 5.4 Statistical systematics

232 In this appendix, the covariance, fractional covariance, and correlation matrices for the statistical systematics
 233 are plotted.

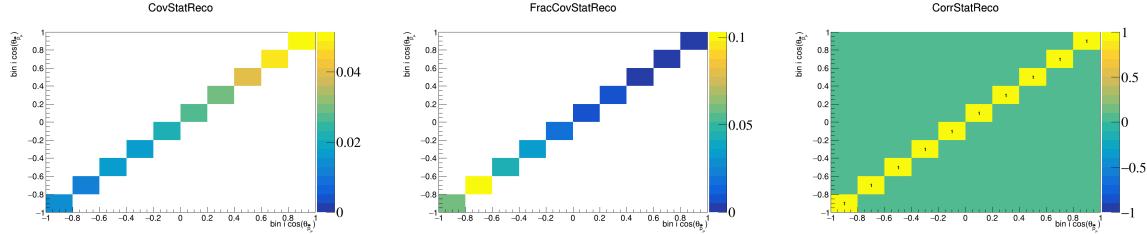


Figure 786: Statistical variations for $\cos(\theta_{\vec{p}_\mu})$.

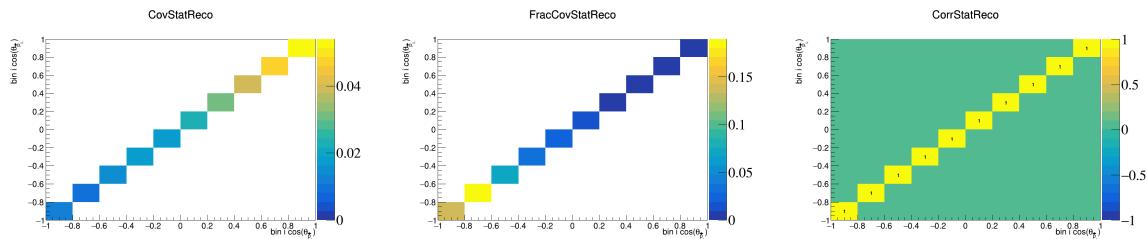


Figure 787: Statistical variations for $\cos(\theta_{\vec{p}_L})$.

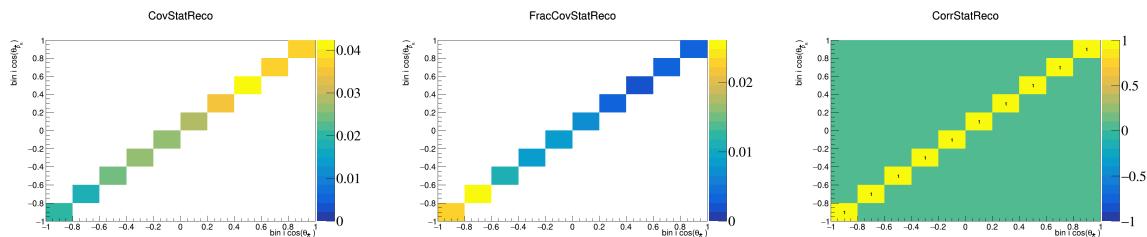


Figure 788: Statistical variations for $\cos(\theta_{\vec{p}_R})$.

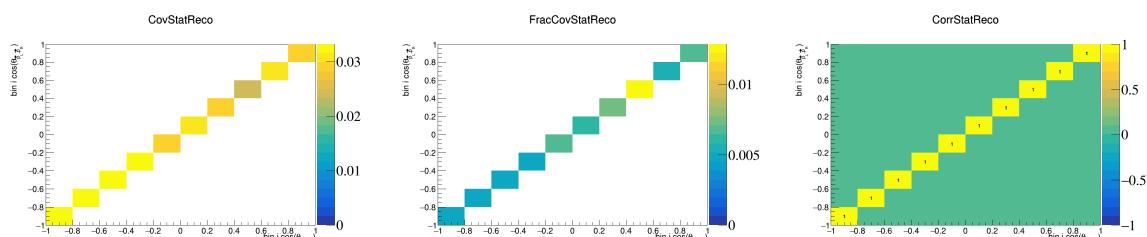


Figure 789: Statistical variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

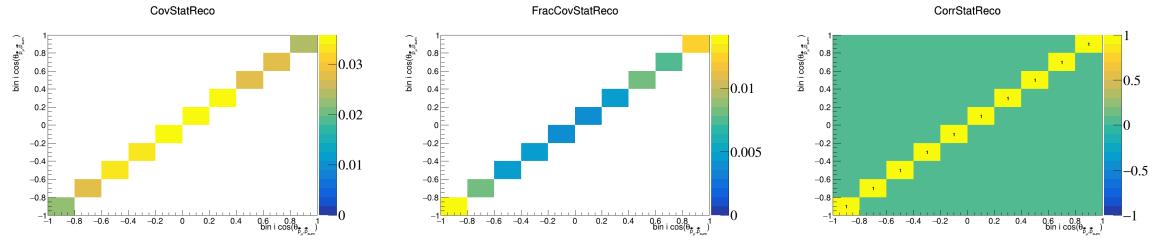


Figure 790: Statistical variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

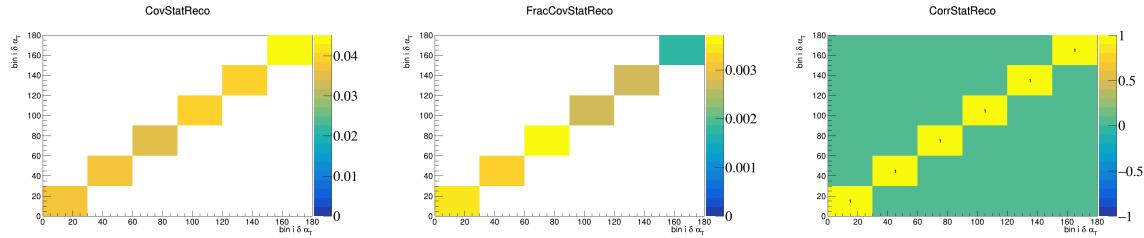


Figure 791: Statistical variations for $\delta\alpha_T$.

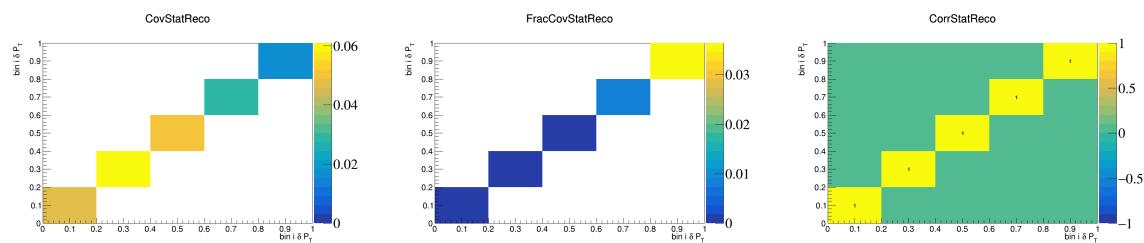


Figure 792: Statistical variations for δP_T .

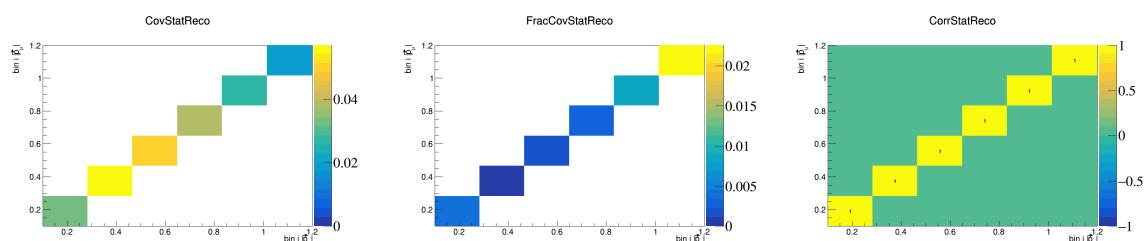


Figure 793: Statistical variations for $|\vec{p}_\mu|$.

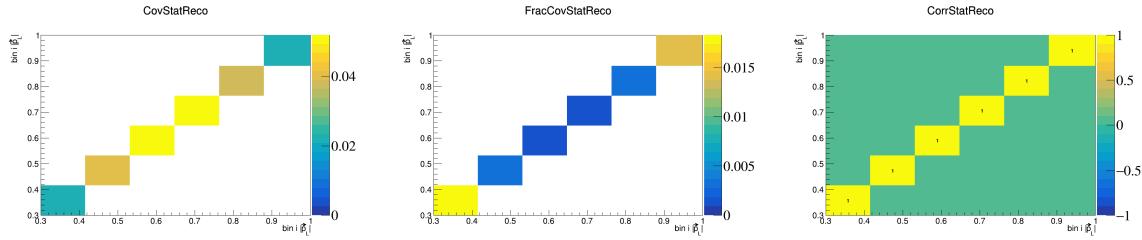


Figure 794: Statistical variations for $|\vec{p}_L|$.

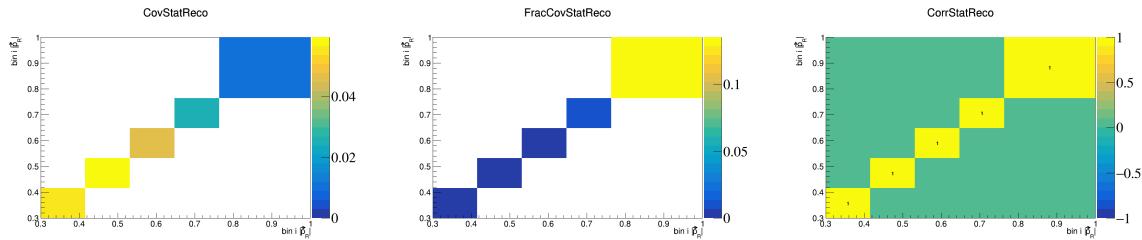


Figure 795: Statistical variations for $|\vec{p}_R|$.

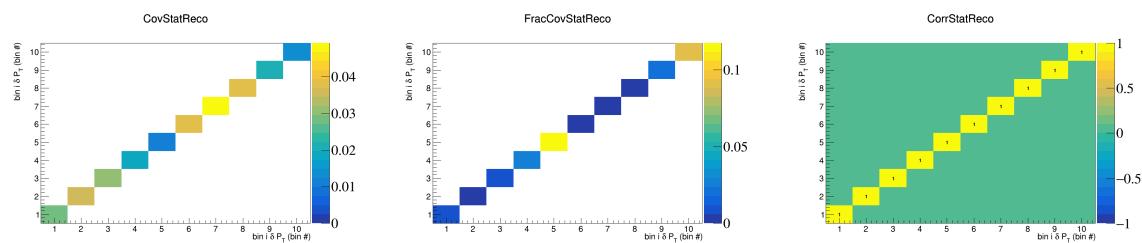


Figure 796: Statistical variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

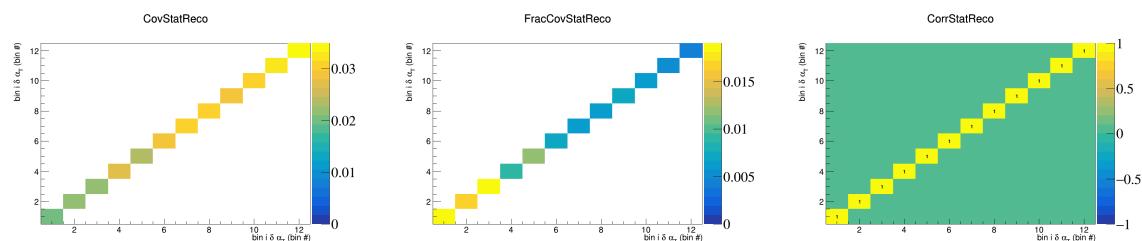


Figure 797: Statistical variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

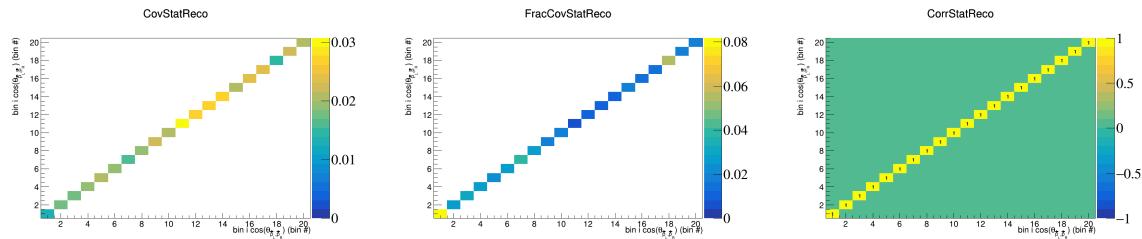


Figure 798: Statistical variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

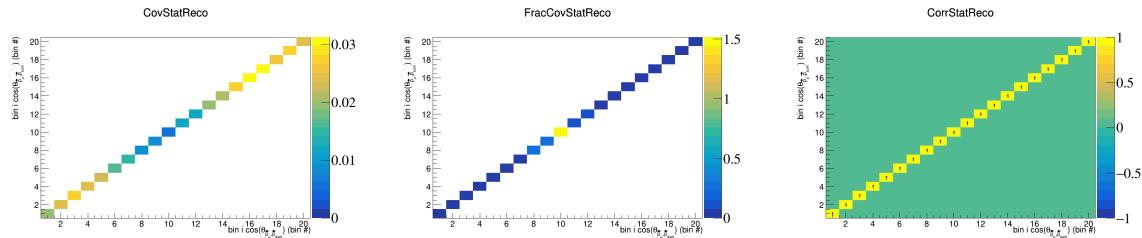


Figure 799: Statistical variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

234 **5.5 POT**

235 In this appendix, the covariance, fractional covariance, and correlation matrices for the POT systematics are
 236 plotted.

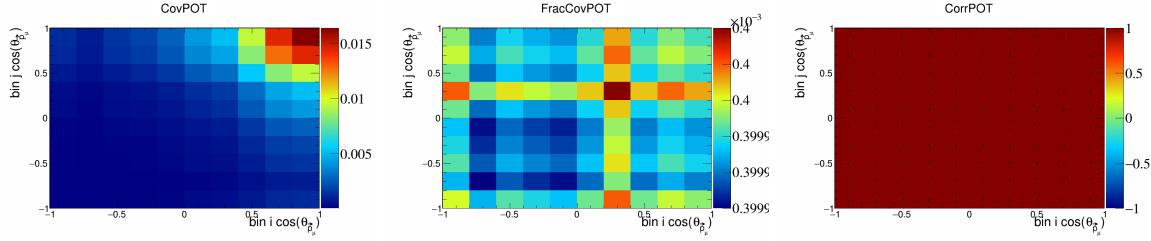


Figure 800: POT variations for $\cos(\theta_{\vec{p}_\mu})$.

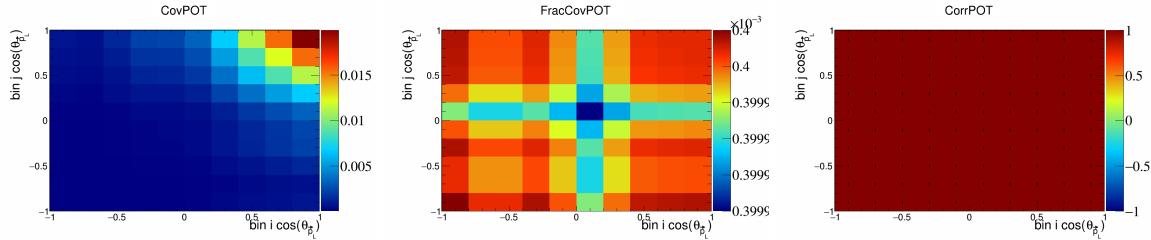


Figure 801: POT variations for $\cos(\theta_{\vec{p}_L})$.

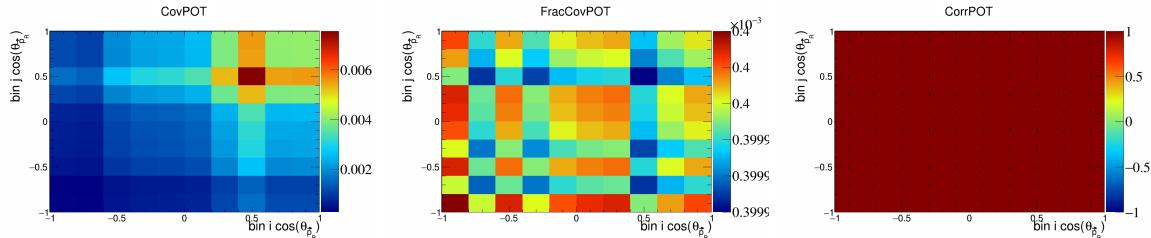


Figure 802: POT variations for $\cos(\theta_{\vec{p}_R})$.

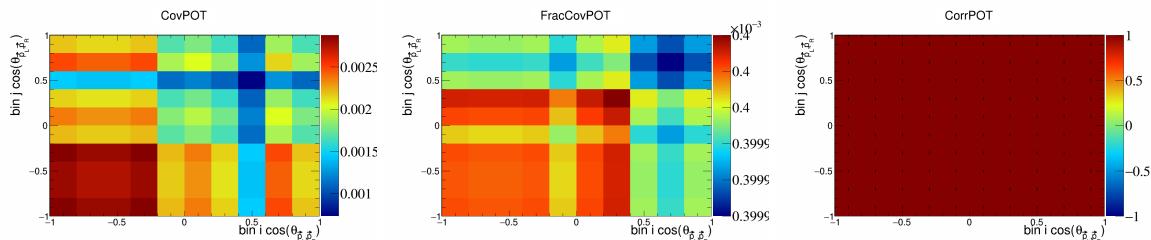


Figure 803: POT variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

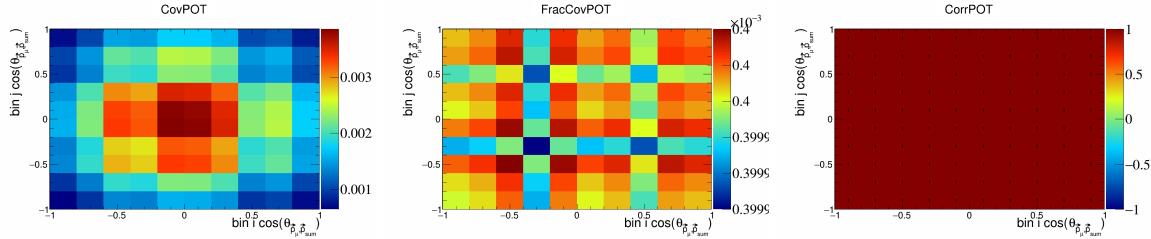


Figure 804: POT variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{sum}})$.

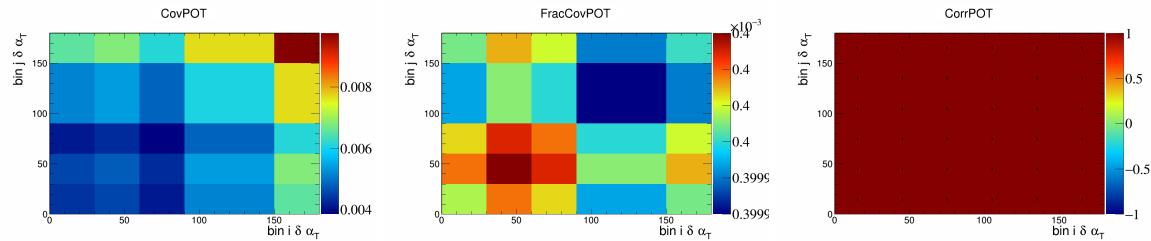


Figure 805: POT variations for $\delta \alpha_T$.

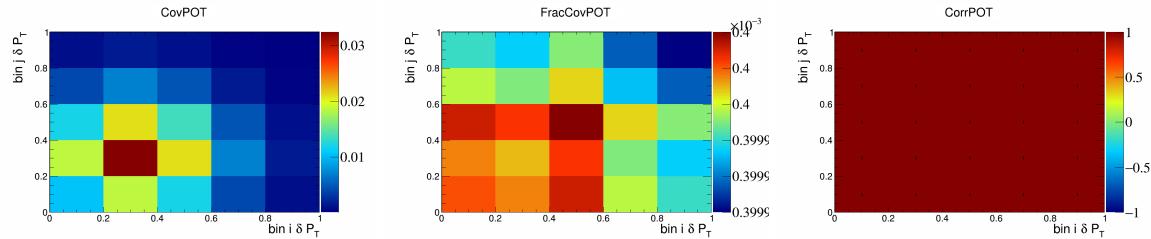


Figure 806: POT variations for δP_T .

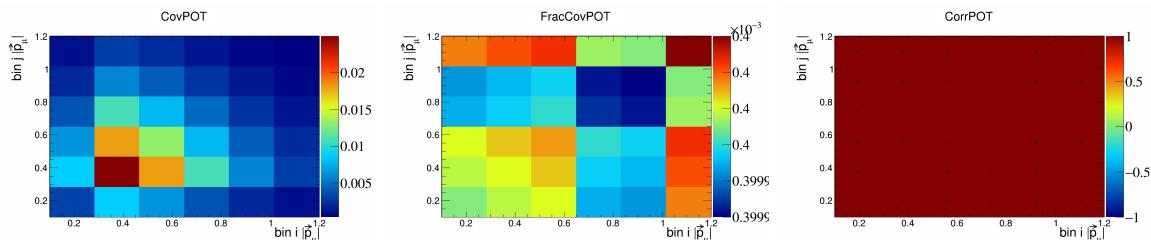


Figure 807: POT variations for $|\vec{p}_\mu|$.

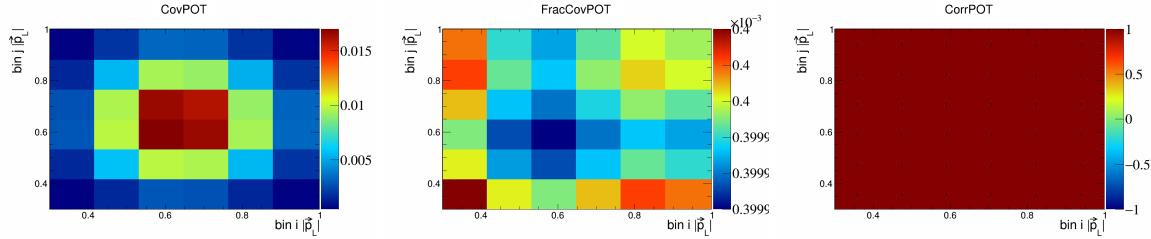


Figure 808: POT variations for $|\vec{p}_L|$.

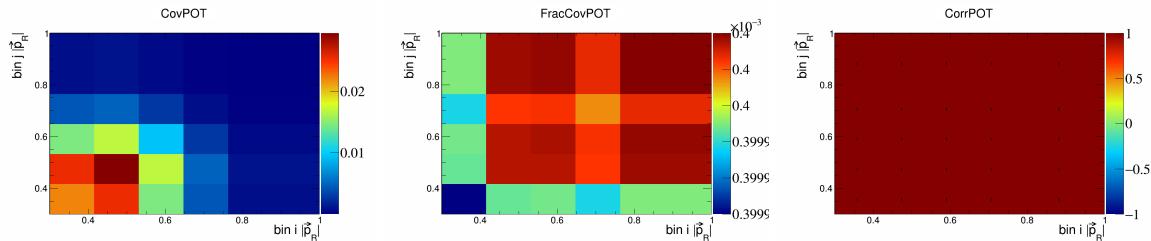


Figure 809: POT variations for $|\vec{p}_R|$.

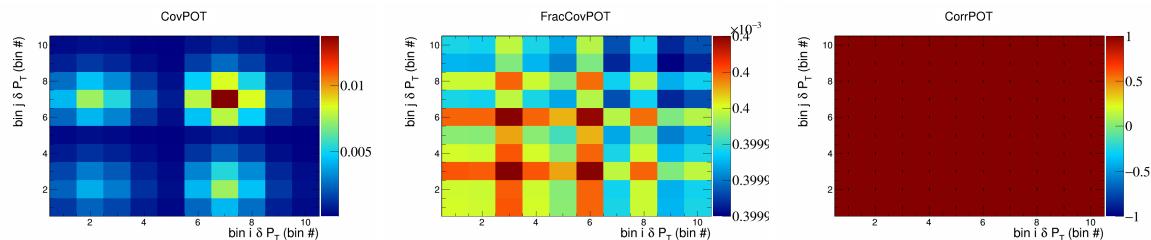


Figure 810: POT variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

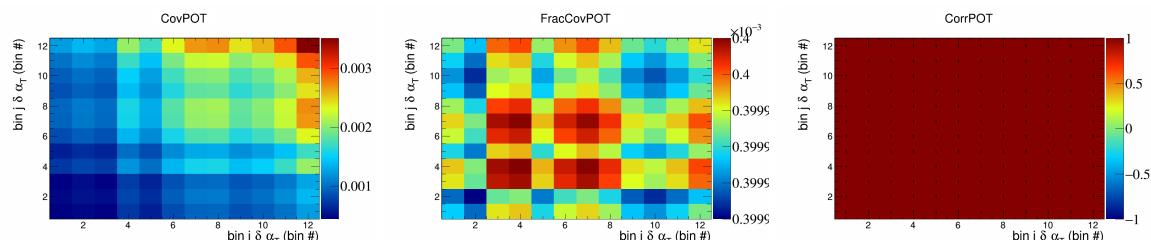


Figure 811: POT variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

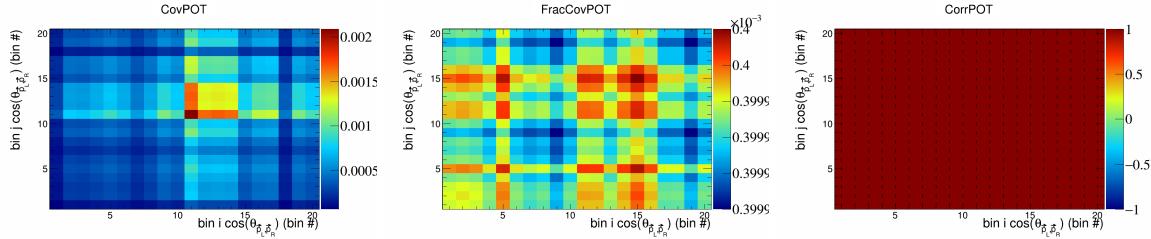


Figure 812: POT variations for $\cos(\theta_{\vec{p}_L,\vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

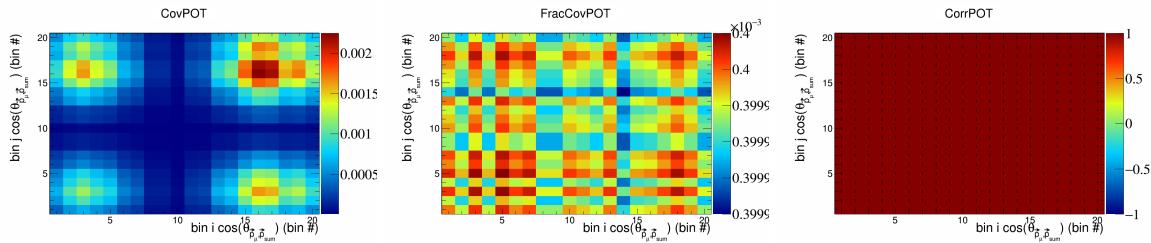


Figure 813: POT variations for $\cos(\theta_{\vec{p}_\mu,\vec{p}_{sum}})$ in $\cos(\theta_{\vec{p}_\mu})$.

237 5.6 Number of targets

238 In this appendix, the covariance, fractional covariance, and correlation matrices for the number of targets
 239 systematics are plotted.

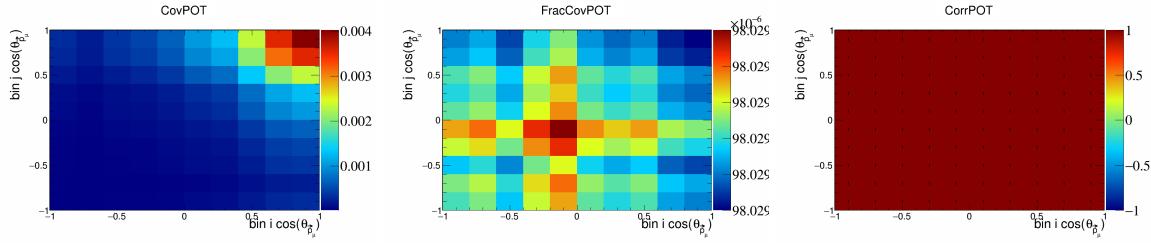


Figure 814: NTargets variations for $\cos(\theta_{\vec{p}_\mu})$.

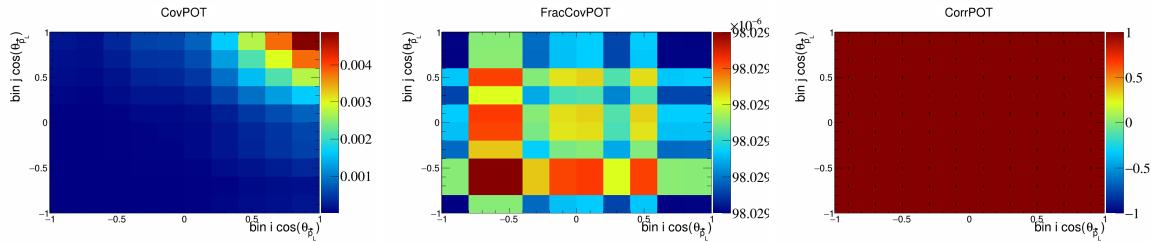


Figure 815: NTargets variations for $\cos(\theta_{\vec{p}_L})$.

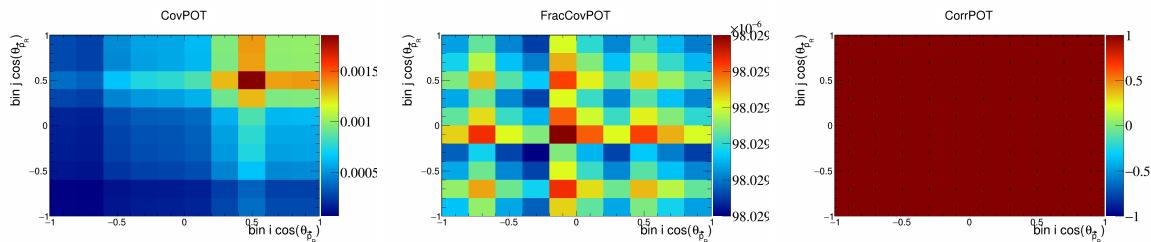


Figure 816: NTargets variations for $\cos(\theta_{\vec{p}_R})$.

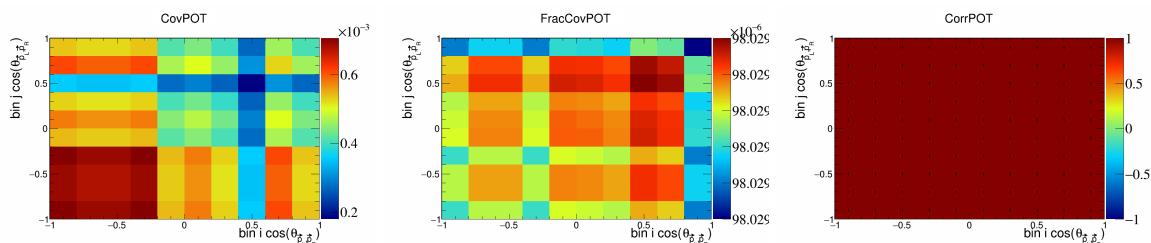


Figure 817: NTargets variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

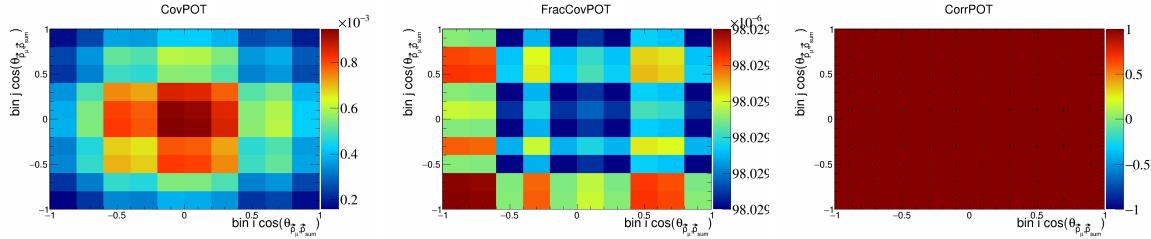


Figure 818: NTargets variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

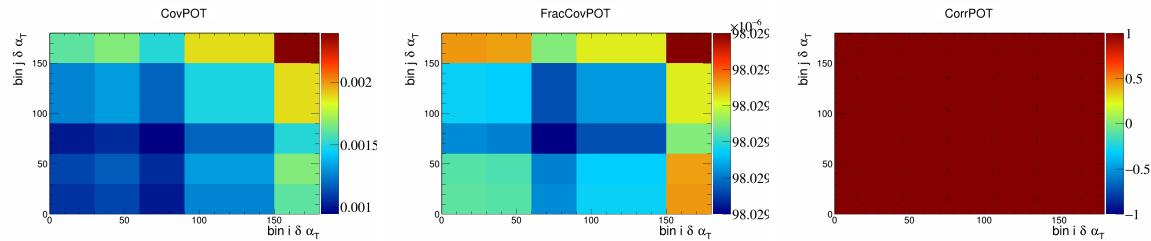


Figure 819: NTargets variations for $\delta \alpha_T$.

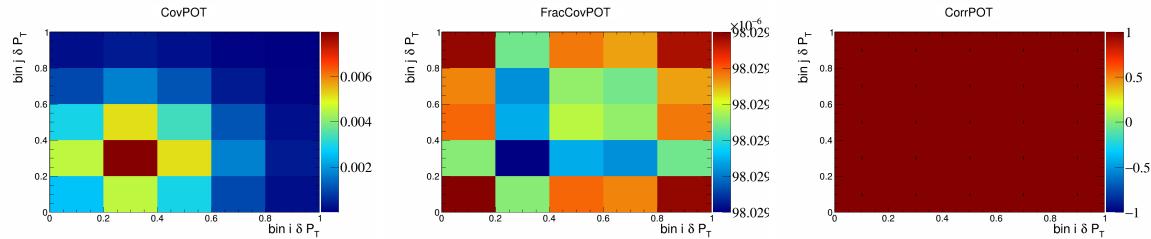


Figure 820: NTargets variations for δP_T .

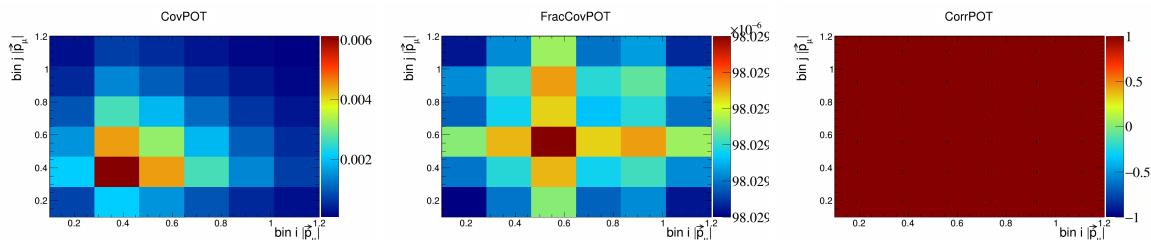


Figure 821: NTargets variations for $|\vec{p}_\mu|$.

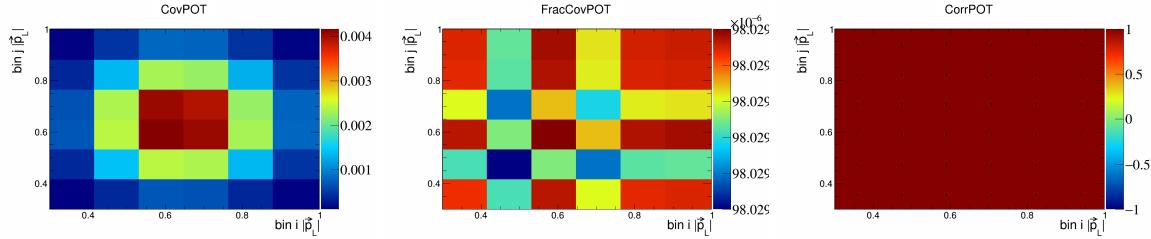


Figure 822: NTargets variations for $|\vec{p}_L|$.

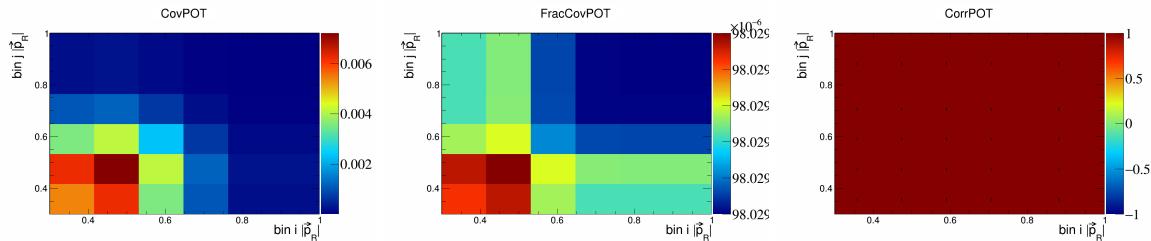


Figure 823: NTargets variations for $|\vec{p}_R|$.

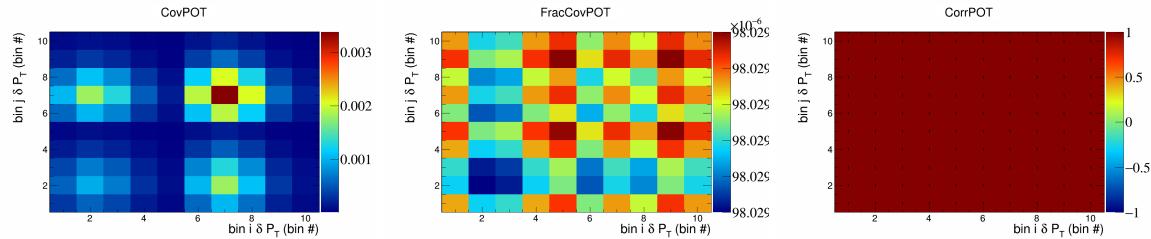


Figure 824: NTargets variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

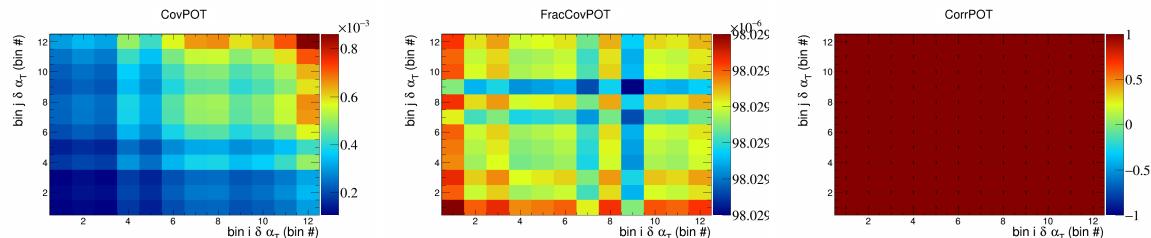


Figure 825: NTargets variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

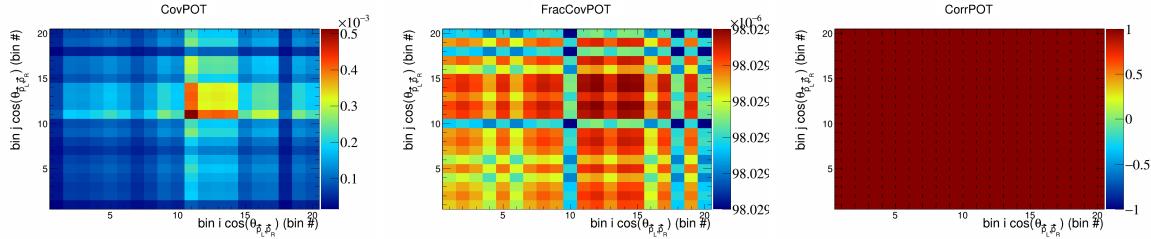


Figure 826: NTargets variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

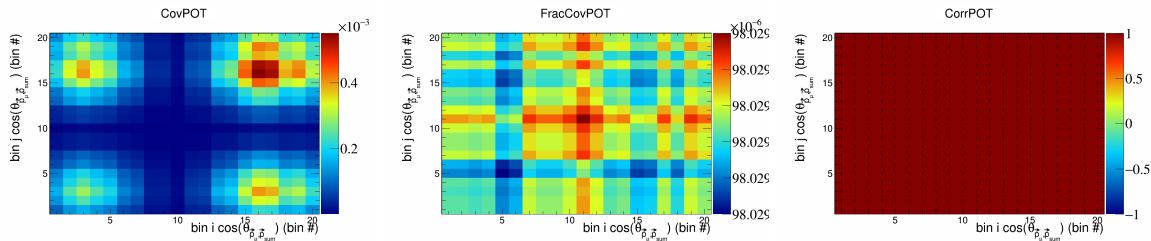


Figure 827: NTargets variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

240 5.7 Detector

241 In this appendix, the covariance, fractional covariance, and correlation matrices for the detector systematics
 242 are plotted.

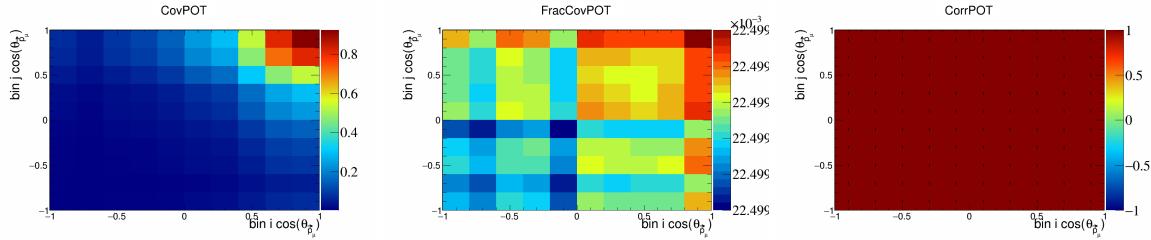


Figure 828: Detector variations for $\cos(\theta_{\vec{p}_\mu})$.

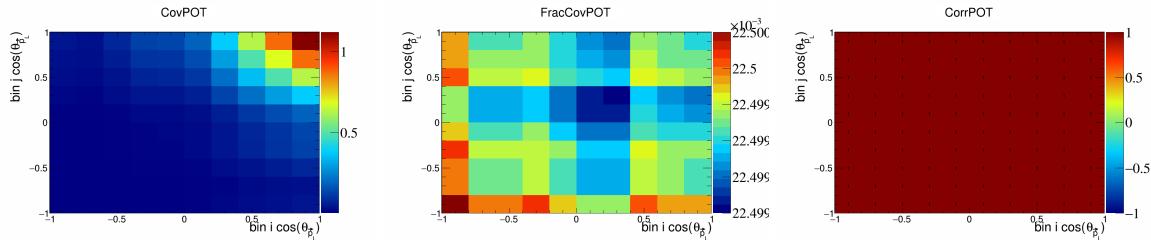


Figure 829: Detector variations for $\cos(\theta_{\vec{p}_L})$.

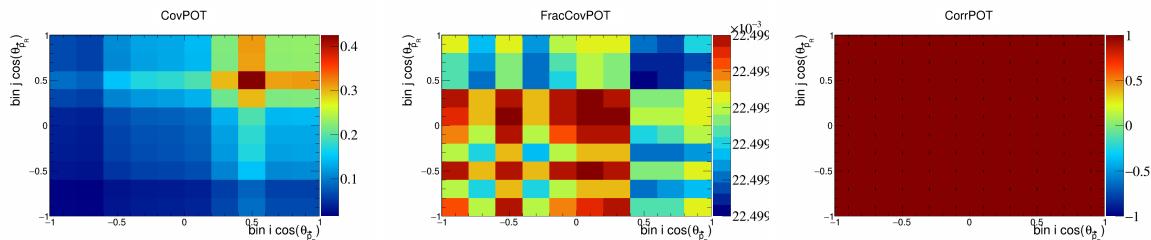


Figure 830: Detector variations for $\cos(\theta_{\vec{p}_R})$.

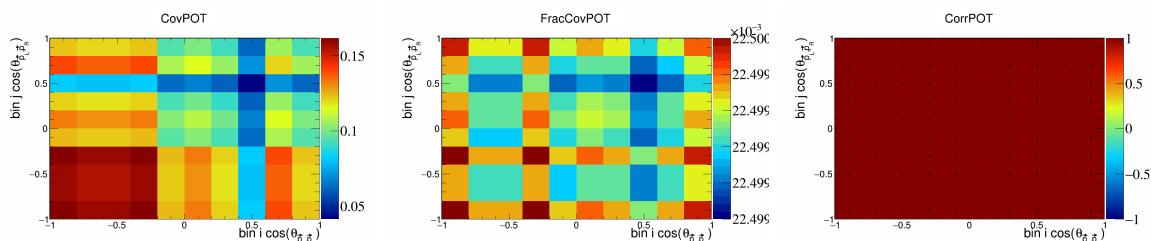


Figure 831: Detector variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

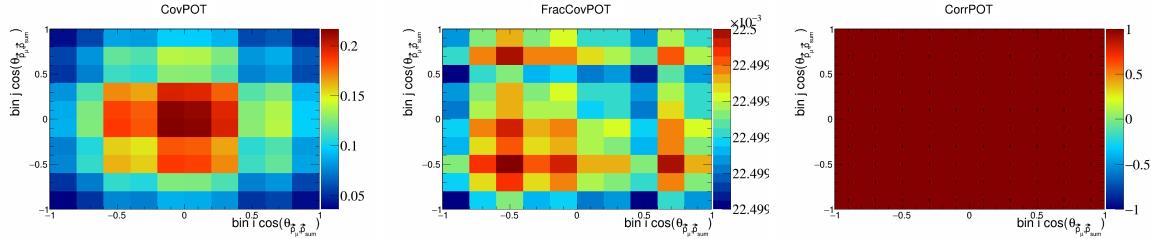


Figure 832: Detector variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{sum}})$.

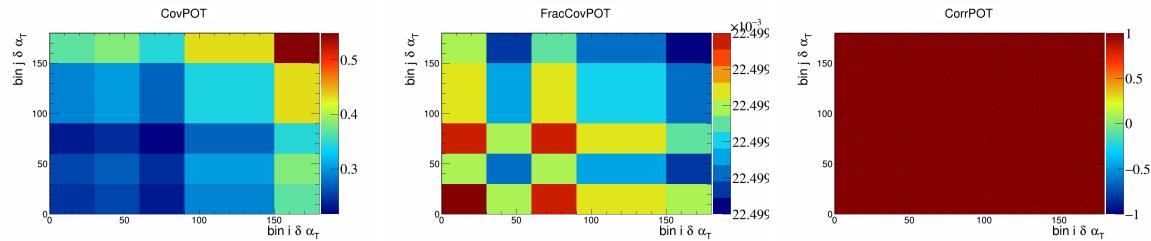


Figure 833: Detector variations for $\delta \alpha_T$.

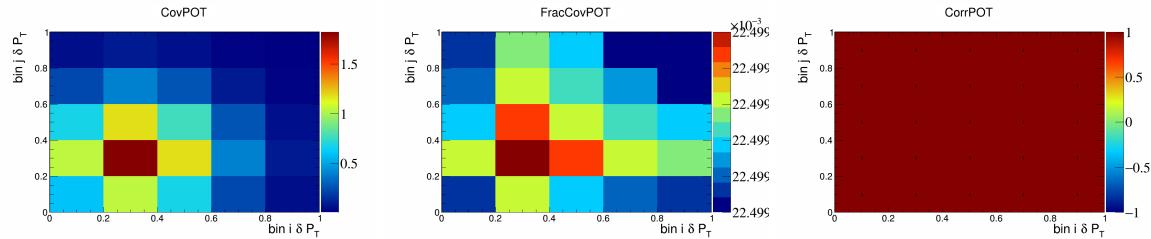


Figure 834: Detector variations for δP_T .

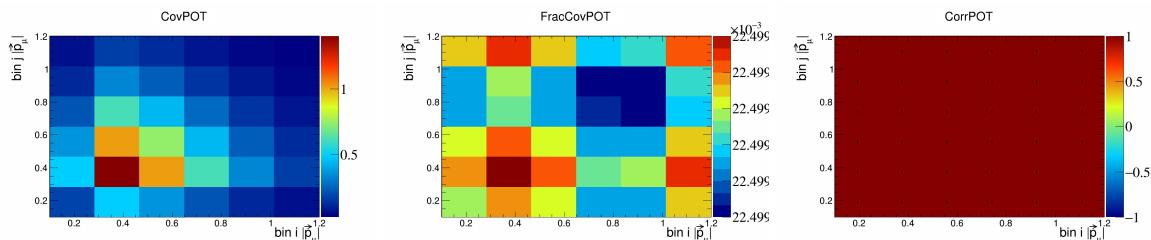


Figure 835: Detector variations for $|\vec{p}_\mu|$.

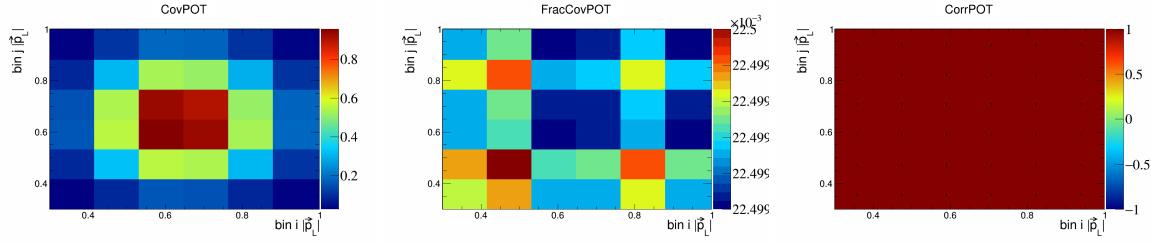


Figure 836: Detector variations for $|\vec{p}_L|$.

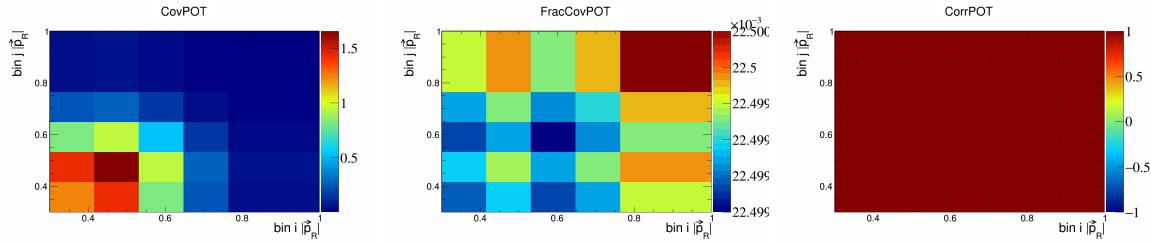


Figure 837: Detector variations for $|\vec{p}_R|$.

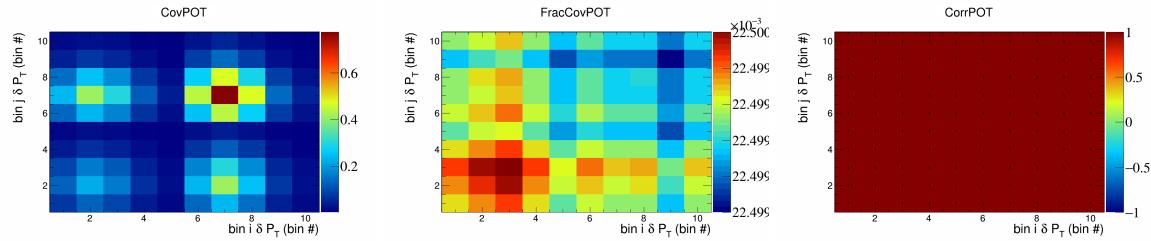


Figure 838: Detector variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

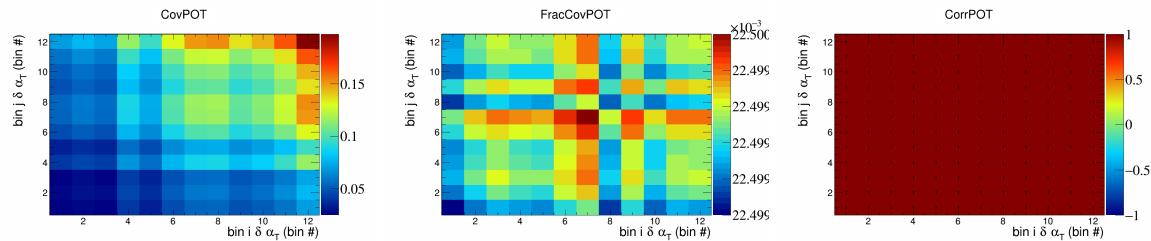


Figure 839: Detector variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

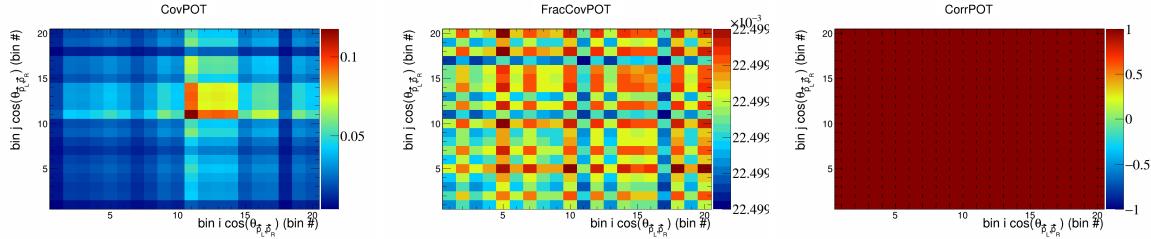


Figure 840: Detector variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

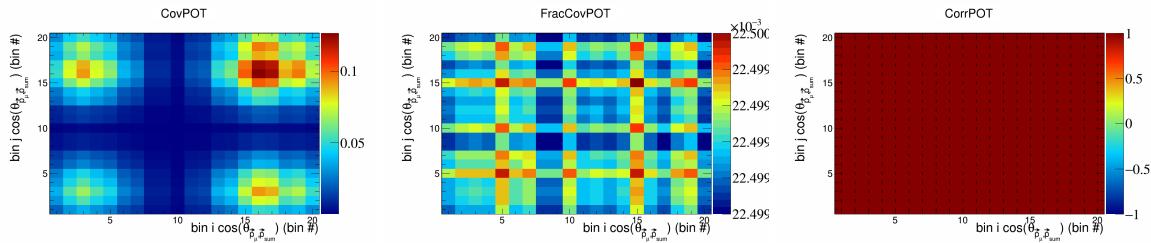


Figure 841: Detector variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

243 5.8 Reinteraction

244 In this appendix, the covariance, fractional covariance, and correlation matrices for the reinteraction sys-
245 tematics are plotted.

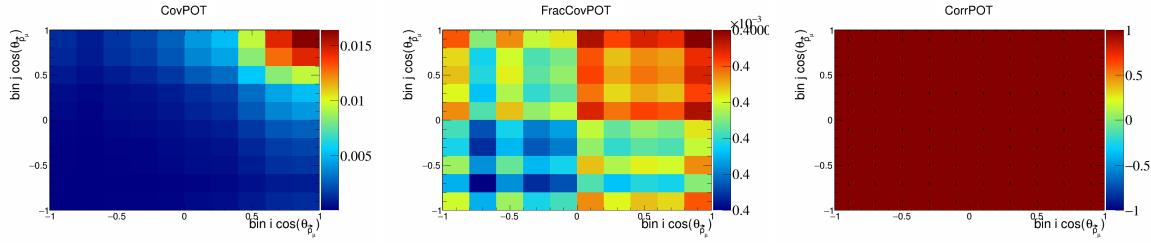


Figure 842: Reinteraction variations for $\cos(\theta_{\vec{p}_\mu})$.

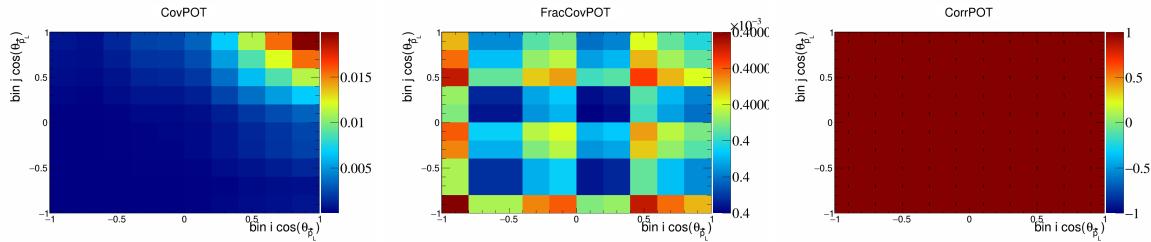


Figure 843: Reinteraction variations for $\cos(\theta_{\vec{p}_L})$.

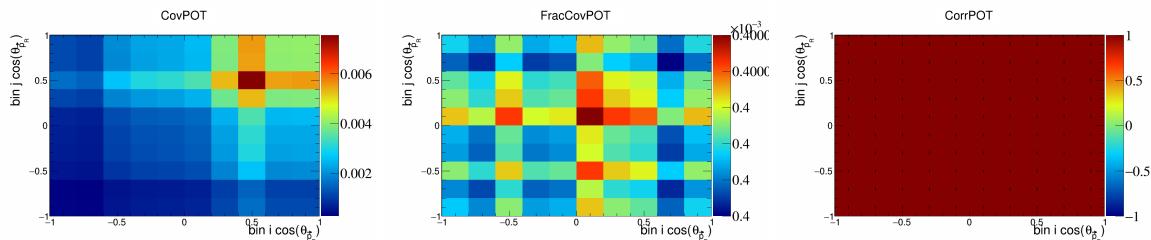


Figure 844: Reinteraction variations for $\cos(\theta_{\vec{p}_R})$.

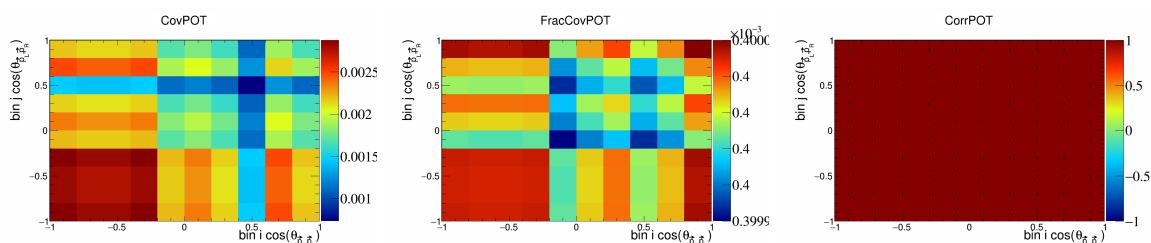


Figure 845: Reinteraction variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$.

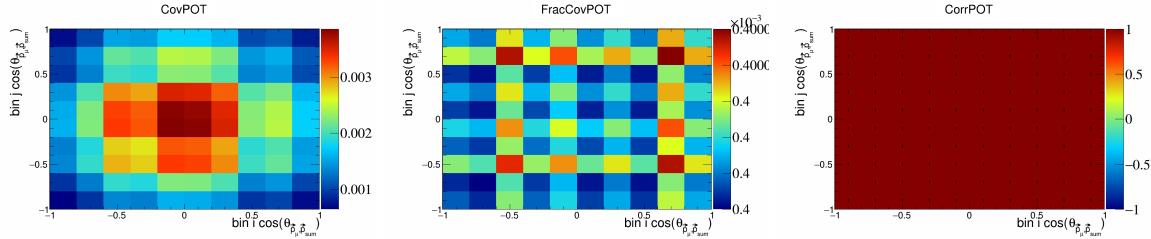


Figure 846: Reinteraction variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$.

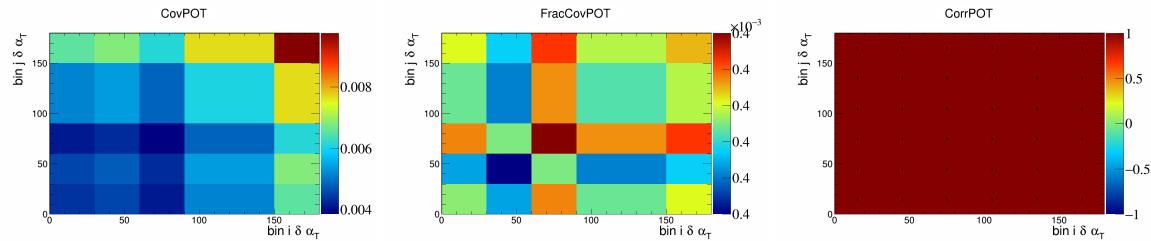


Figure 847: Reinteraction variations for $\delta \alpha_T$.

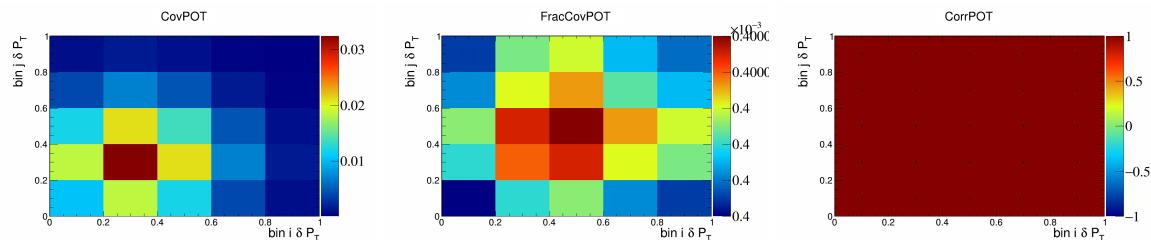


Figure 848: Reinteraction variations for δP_T .

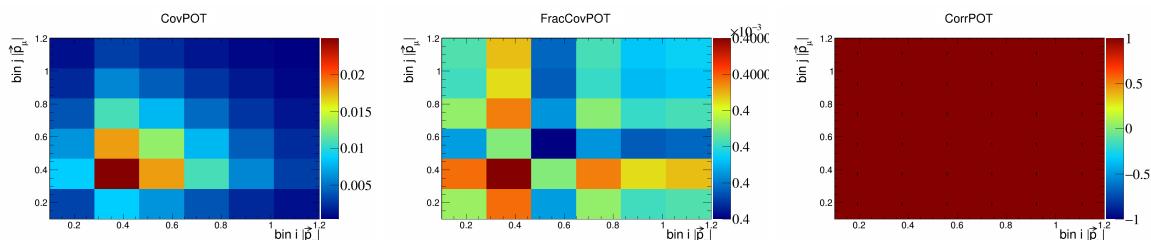


Figure 849: Reinteraction variations for $|\vec{p}_\mu|$.

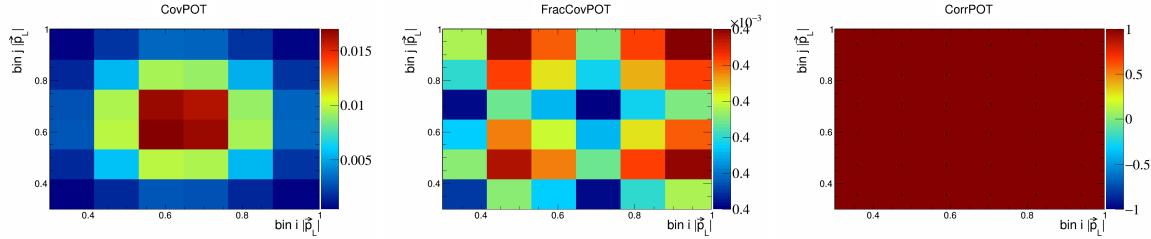


Figure 850: Reinteraction variations for $|\vec{p}_L|$.

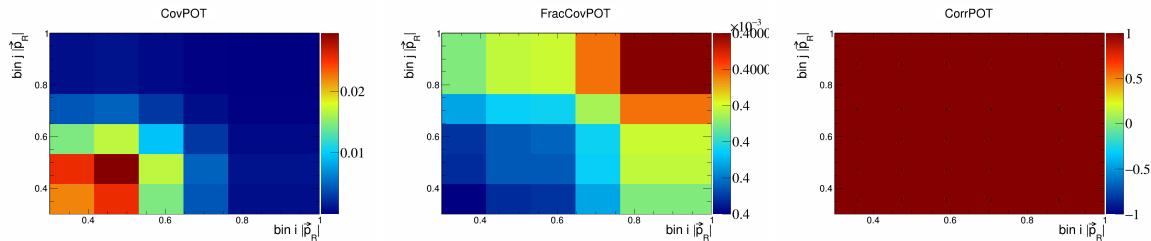


Figure 851: Reinteraction variations for $|\vec{p}_R|$.

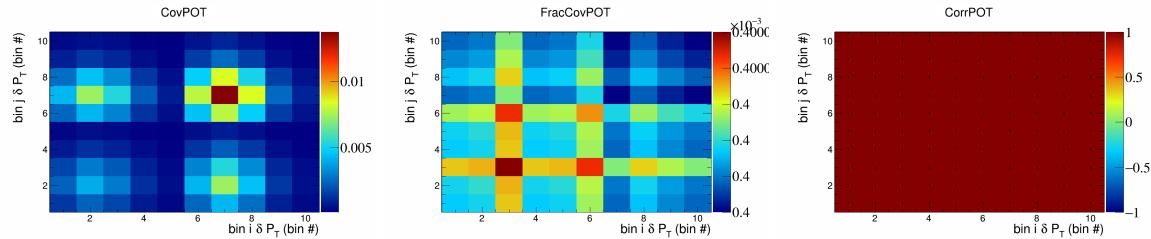


Figure 852: Reinteraction variations for δP_T in $\cos(\theta_{\vec{p}_\mu})$.

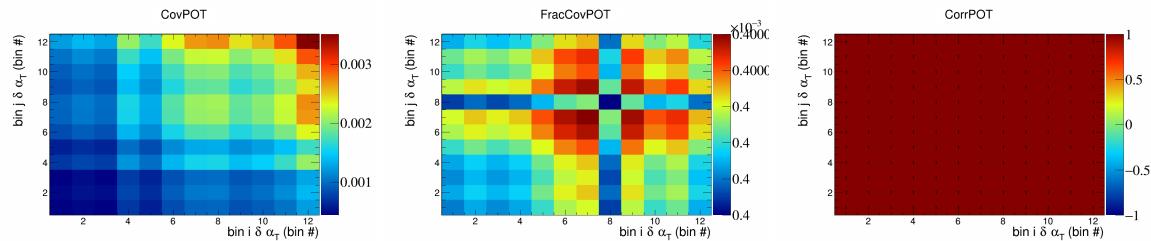


Figure 853: Reinteraction variations for $\delta \alpha_T$ in $\cos(\theta_{\vec{p}_\mu})$.

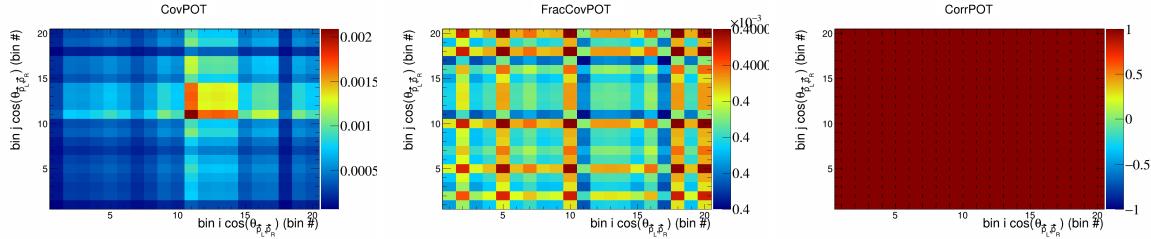


Figure 854: Reinteraction variations for $\cos(\theta_{\vec{p}_L, \vec{p}_R})$ in $\cos(\theta_{\vec{p}_\mu})$.

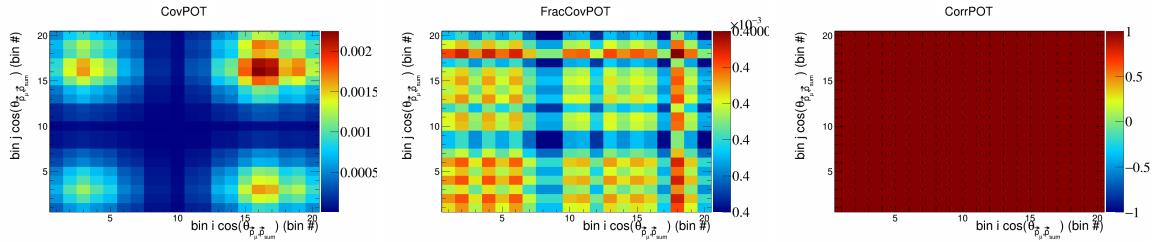


Figure 855: Reinteraction variations for $\cos(\theta_{\vec{p}_\mu, \vec{p}_{\text{sum}}})$ in $\cos(\theta_{\vec{p}_\mu})$.

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