$B^0 \to D^\star l\nu$ analysis

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Analysis meeting
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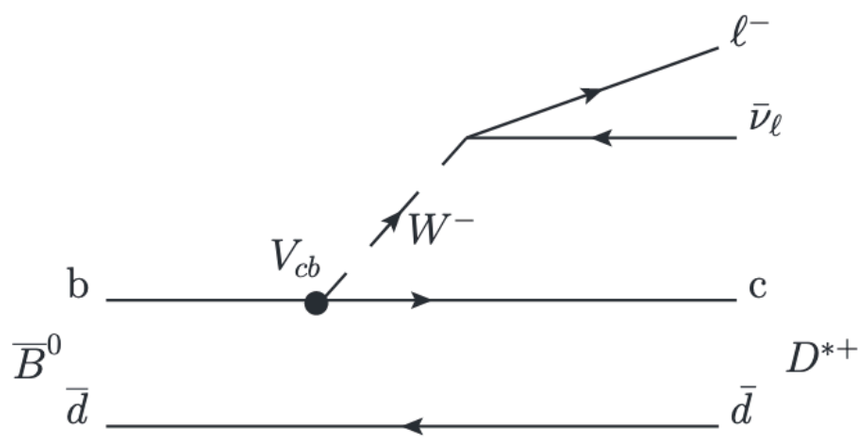
Motivation

$B^0 \to D^\star l\nu$ decays are useful to extract the magnitude Cabibbo-Kobayashi-Maskawa (CKM) matrix element $|V_{cb}|$, which gives the magnitude of the weak coupling between *b* and c quarks.

Two different $|V_{cb}|$ measurements:

$|V_{cb}| = (42.2 \pm 0.8) \times 10^{-3}$ (inclusive)
$|V_{cb}| = (39.5 \pm 0.9) \times 10^{-3}$ (exclusive)



The discrepancy underlines that precise measurements of $|V_{cb}|$ is still extremely important. In fact, the $|V_{cb}|$ measurement provides a strong constrain to unitarity of CKM matrix.

The determination of $|V_{cb}|$ from these decays relies on the description of strong-interaction effects for the *b* and c quarks bound in mesons (called “form factors”).

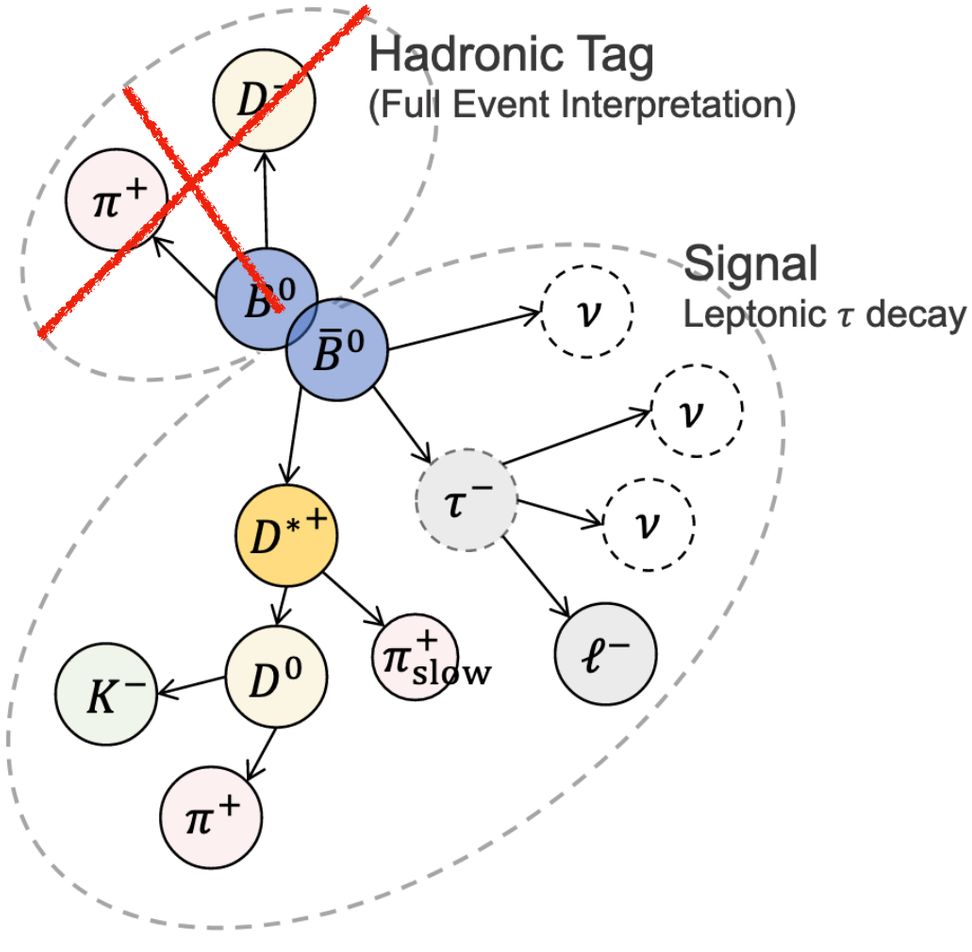
Goal: provide the first model-independent measurement of the form factors to yield a better determination of $|V_{cb}|$.

Untagged analysis

The form factors are functions of kinematic variables evaluated in the B rest frame. One of these kinematic variables is:

$$w = \frac{p_B \cdot p_{D^*}}{m_B m_{D^*}}$$

To measure w, we need to Know the B momentum. In the $B^0 \to D^\star l\nu$ the neutrino is not reconstructed → cannot reconstruct the B momentum.



Two different approach:

- Reconstruct the other B in the $e^+e^- \to Y(4s) \to B\bar{B}$ decay. From momentum conservation in the CM, the B signal momentum can be extracted: low efficiency, high resolution.

- Don't reconstruct the other B, approximate kinematics: high efficiency, low resolution(<1%).

I expect my measurement to be statistically limited: I use the second approach.

Methods

In the $B^0 \to D^\star l\nu$ we know the magnitude of B momentum in the CMS but not its direction. We can exploit these two informations:

A. B meson should lie on a cone around the D^*l system;

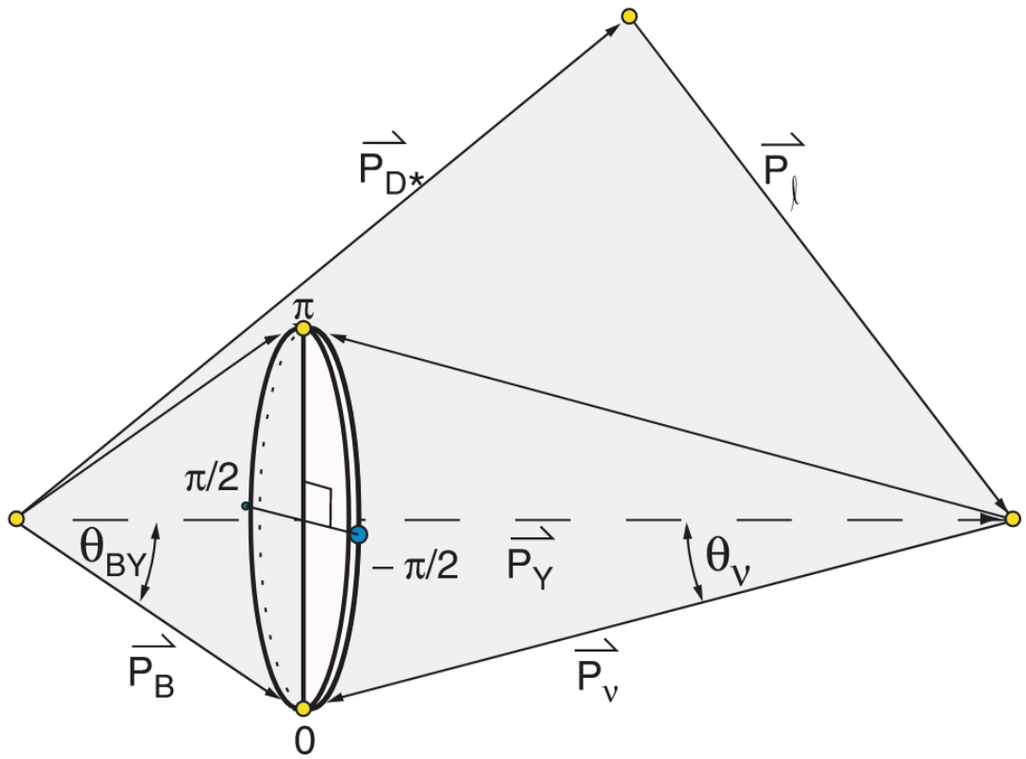
B. B meson is more likely to be perpendicular to the beams.

Three different methods to estimate the B's momentum direction:

1. Mediate 10 random directions by weighting them with B) probability;

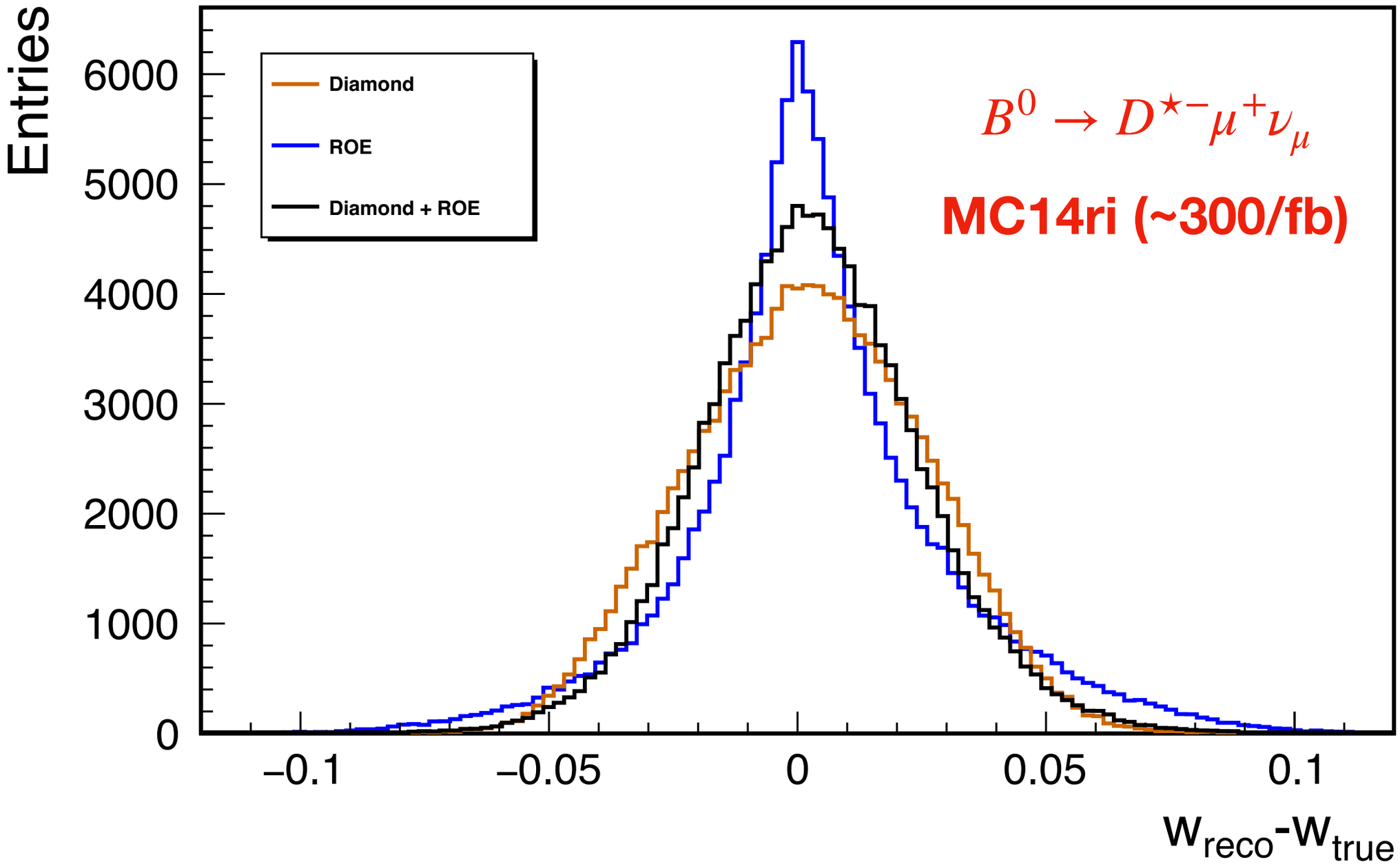
2. Reconstruct the other B inclusive and look for the direction on the cone closest to the opposite direction of the other B.

3. Arithmetic average of 1. and 2. solutions.



Resolution plots

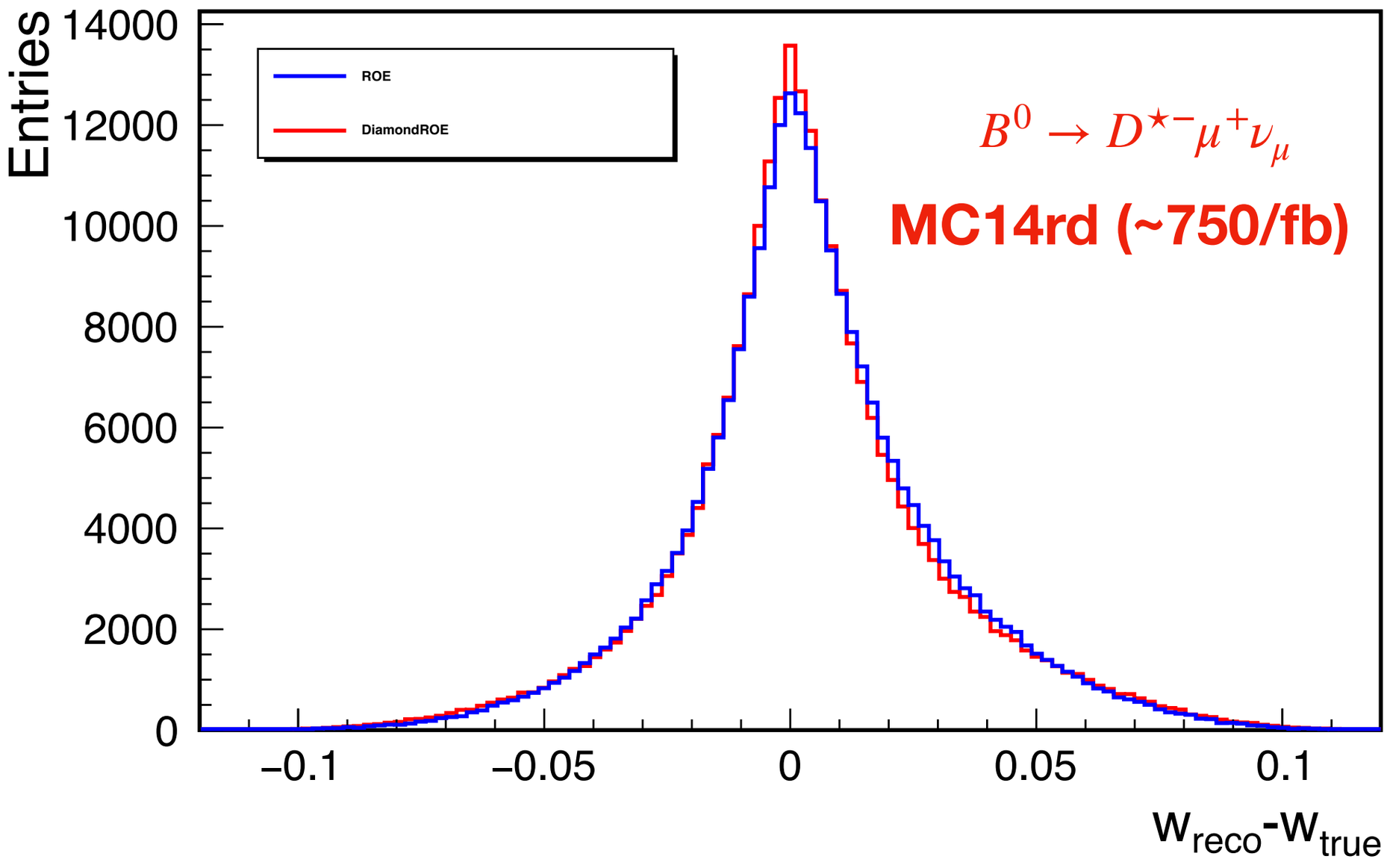
The first step of this study is to determine the resolution of the kinematic variables for each method.



ROE method reproduces the better results.

Resolution plots: ROE vs new Diamond+ROE

I modified the classical Diamond+ROE method and I took for each event the ϕ_i of B that has the highest weight. After that I compared the new resolution plots with the resolution plots using the ROE method.



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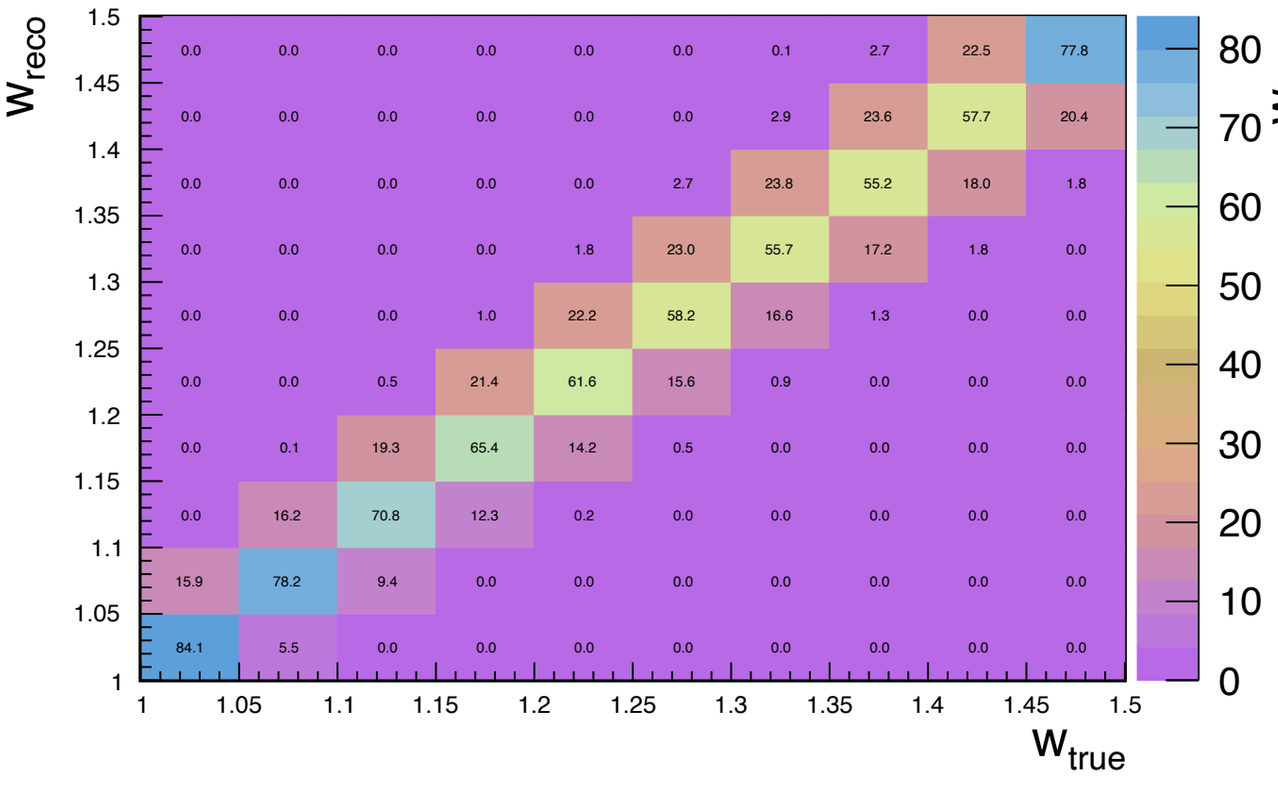
Migration matrix: ROE vs new Diamond+ROE

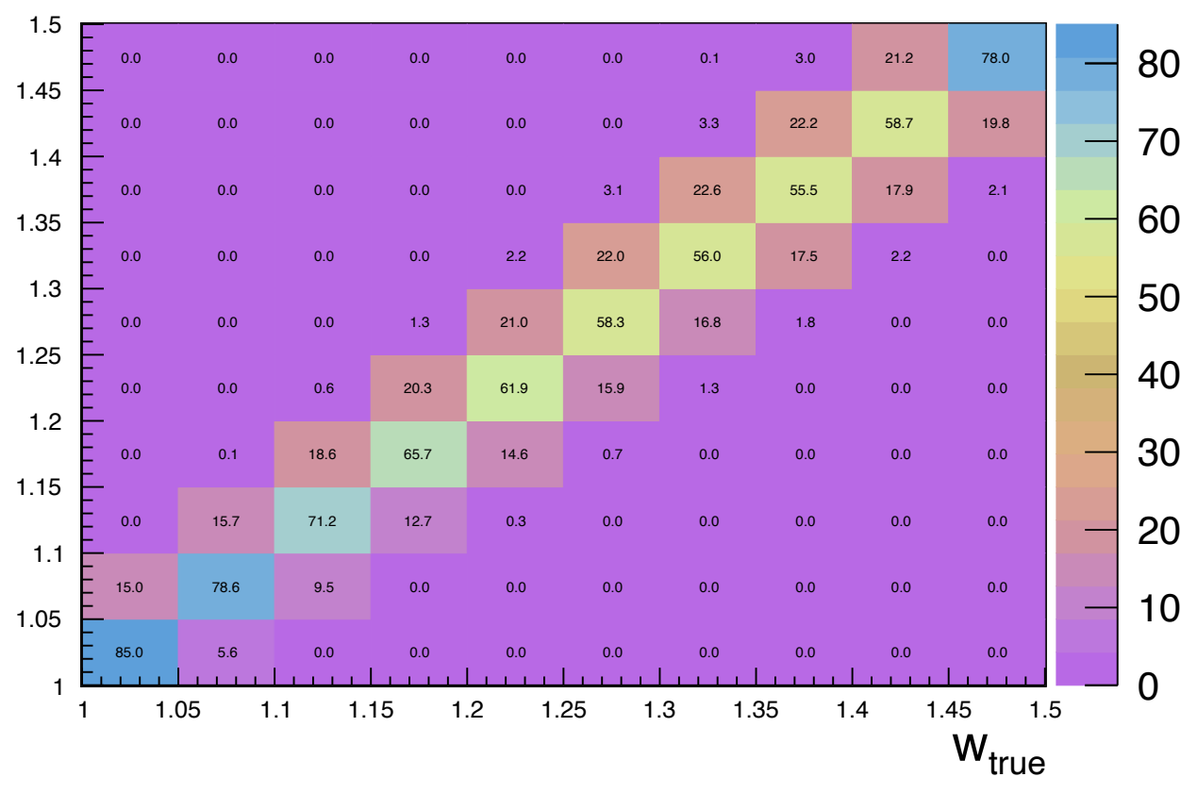
To evaluate the performance of the two methods we can see at the migration matrices of the kinematic variables. The migration matrix elements are defined as conditional probabilities:

$$\mathcal{M}_{ij} = \mathcal{P}(\text{measured value in bin } i | \text{ true value in bin } j)$$

ROE method



New diamond + ROE method



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Next step: try adding information of the other B and combining it into a MVA regression algorithm to see if we get something better.

Backup

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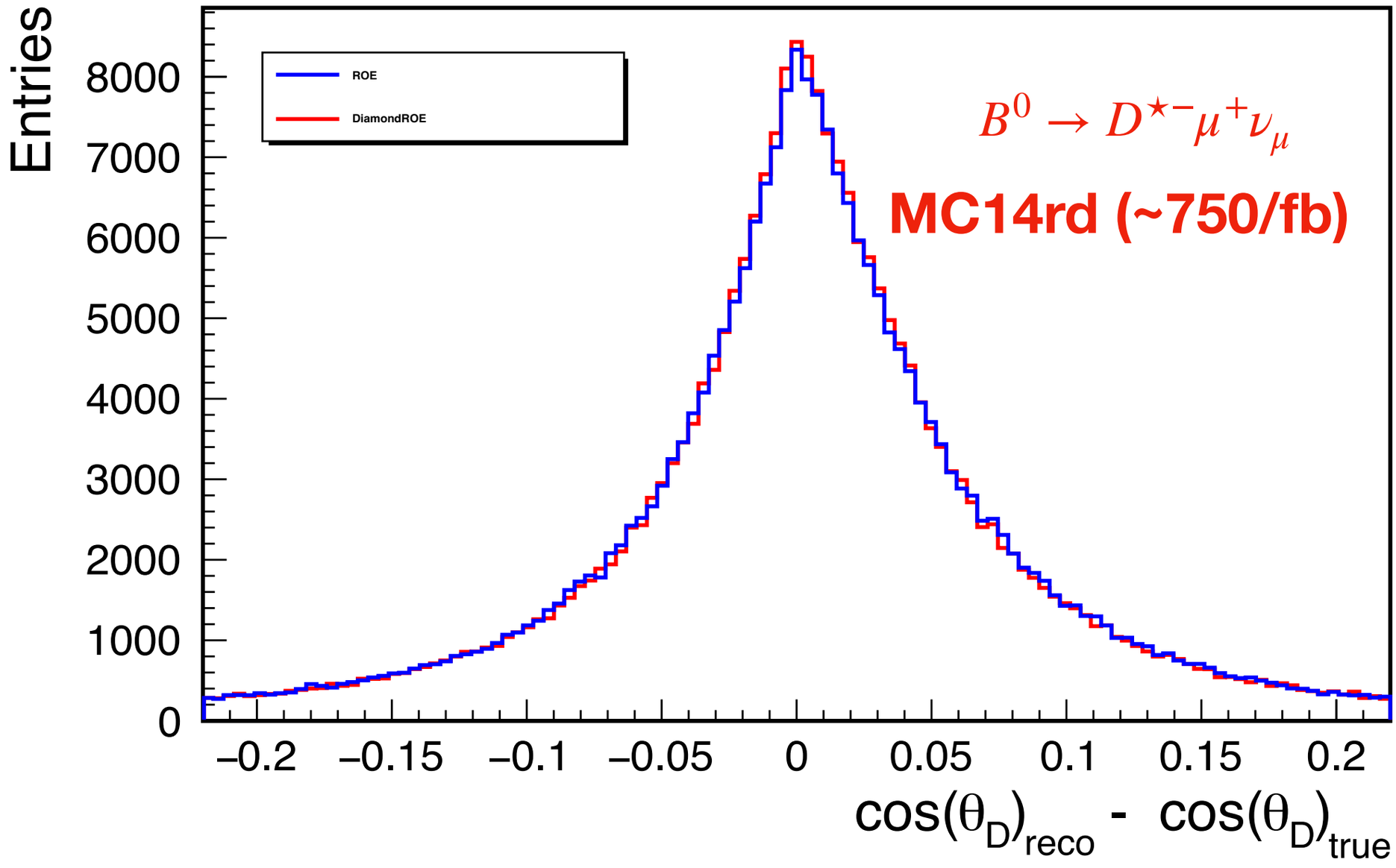

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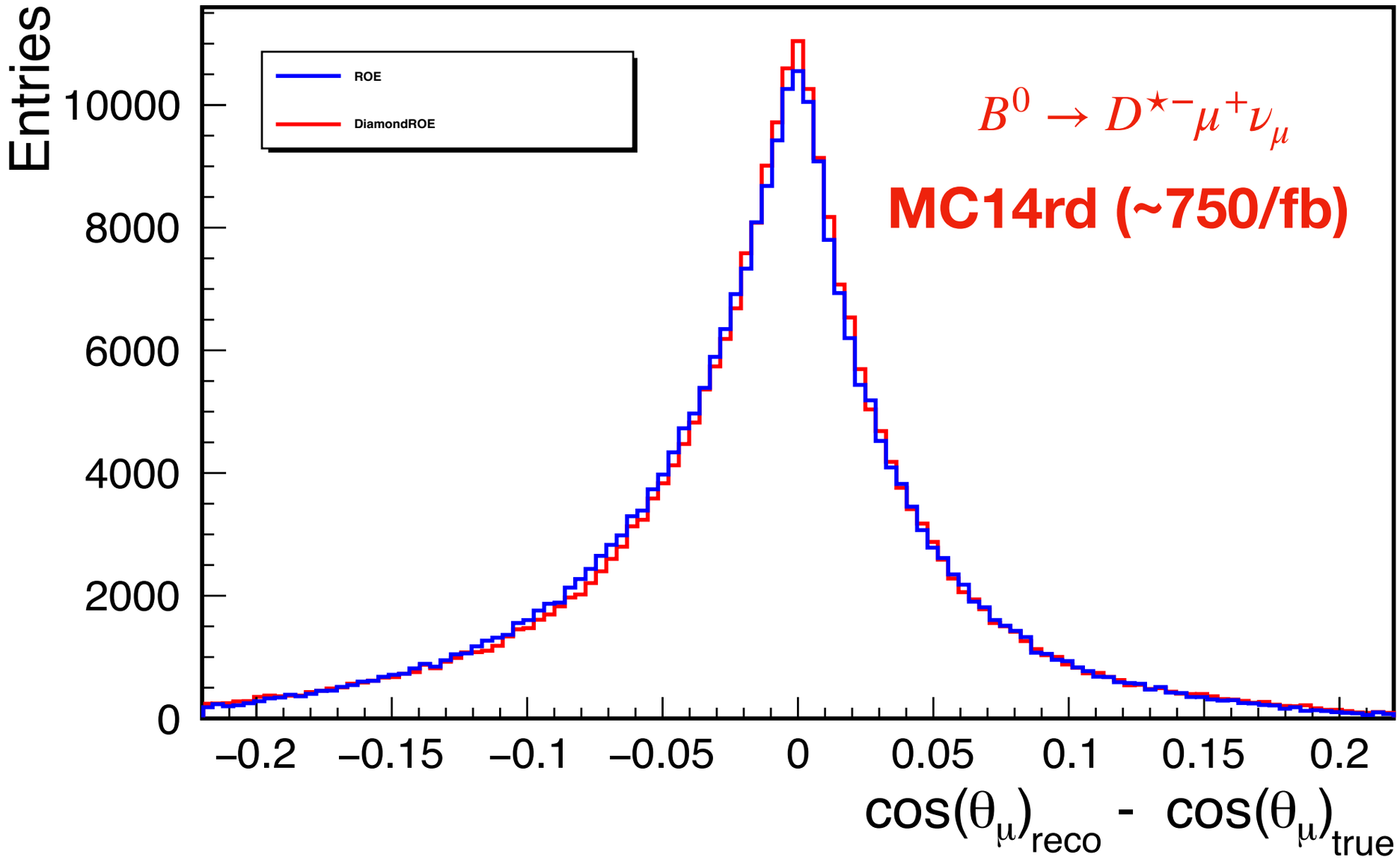

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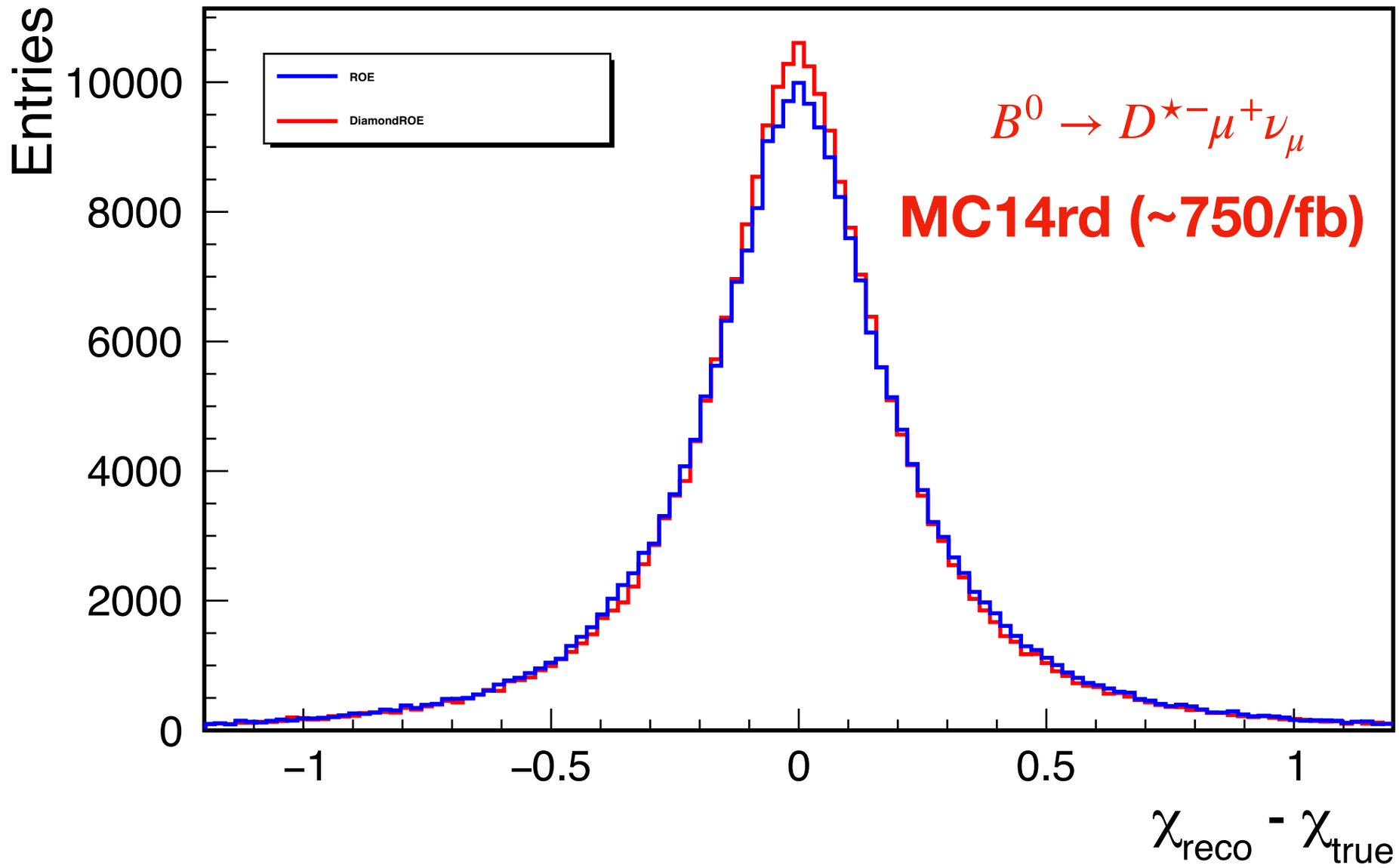

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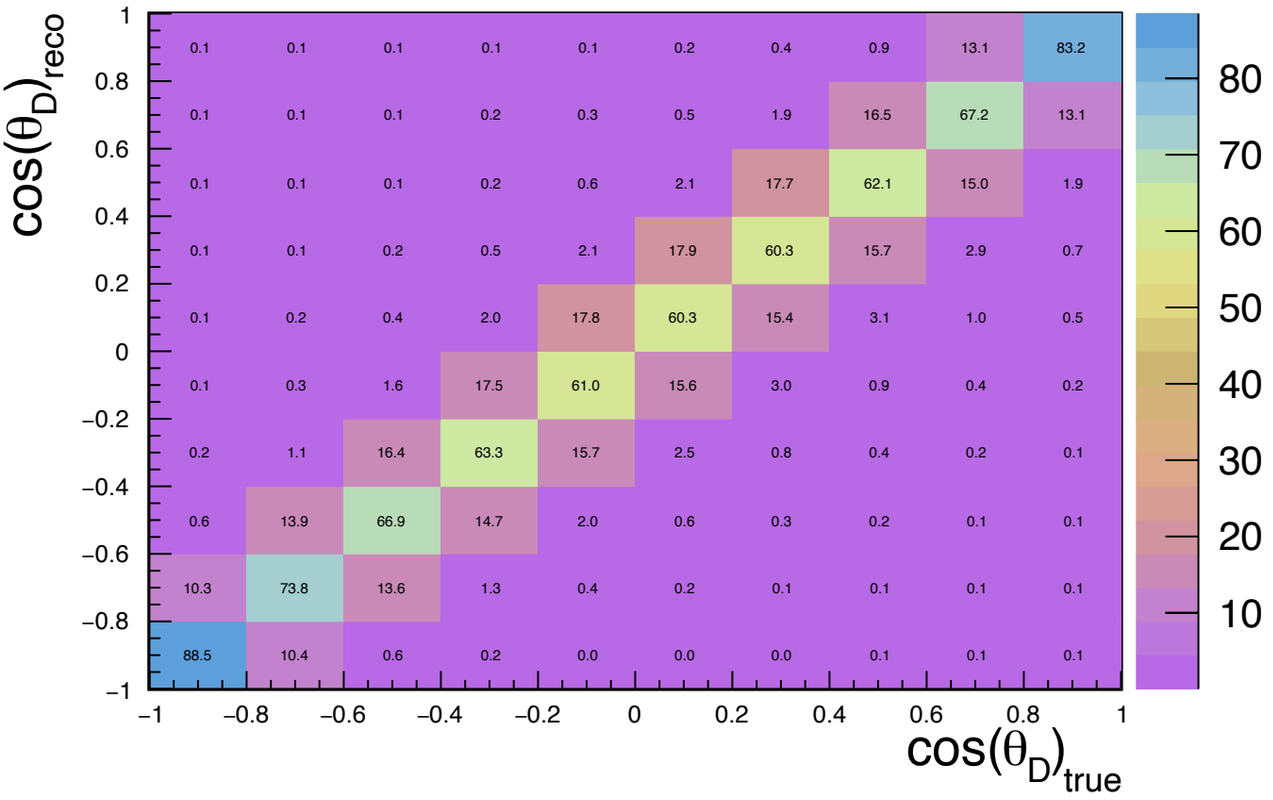

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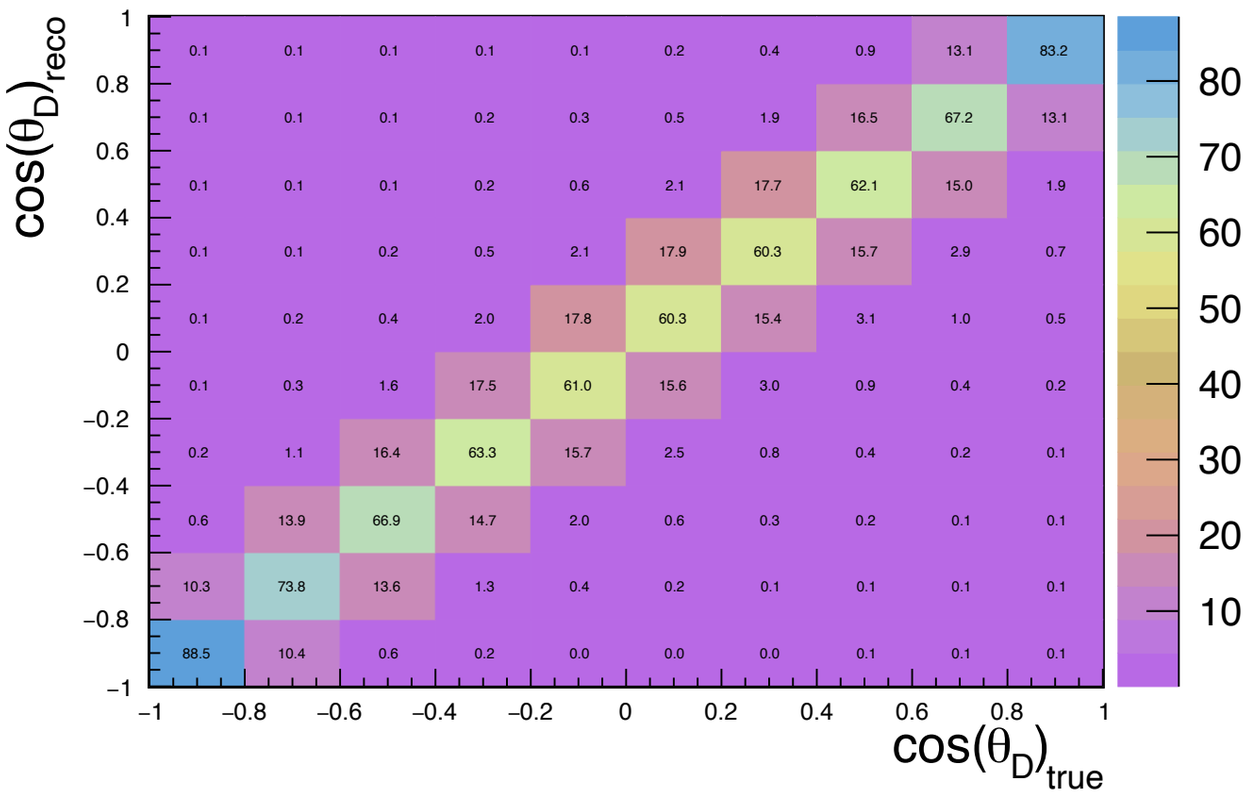

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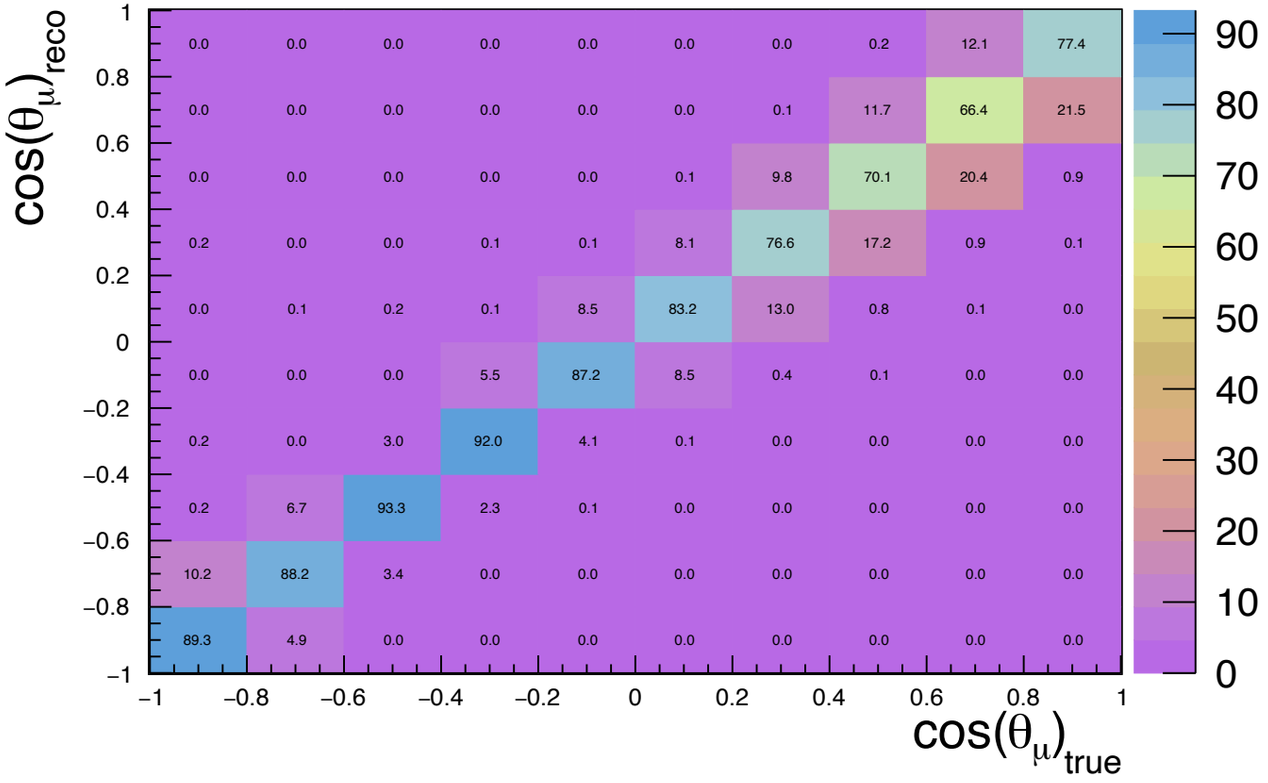

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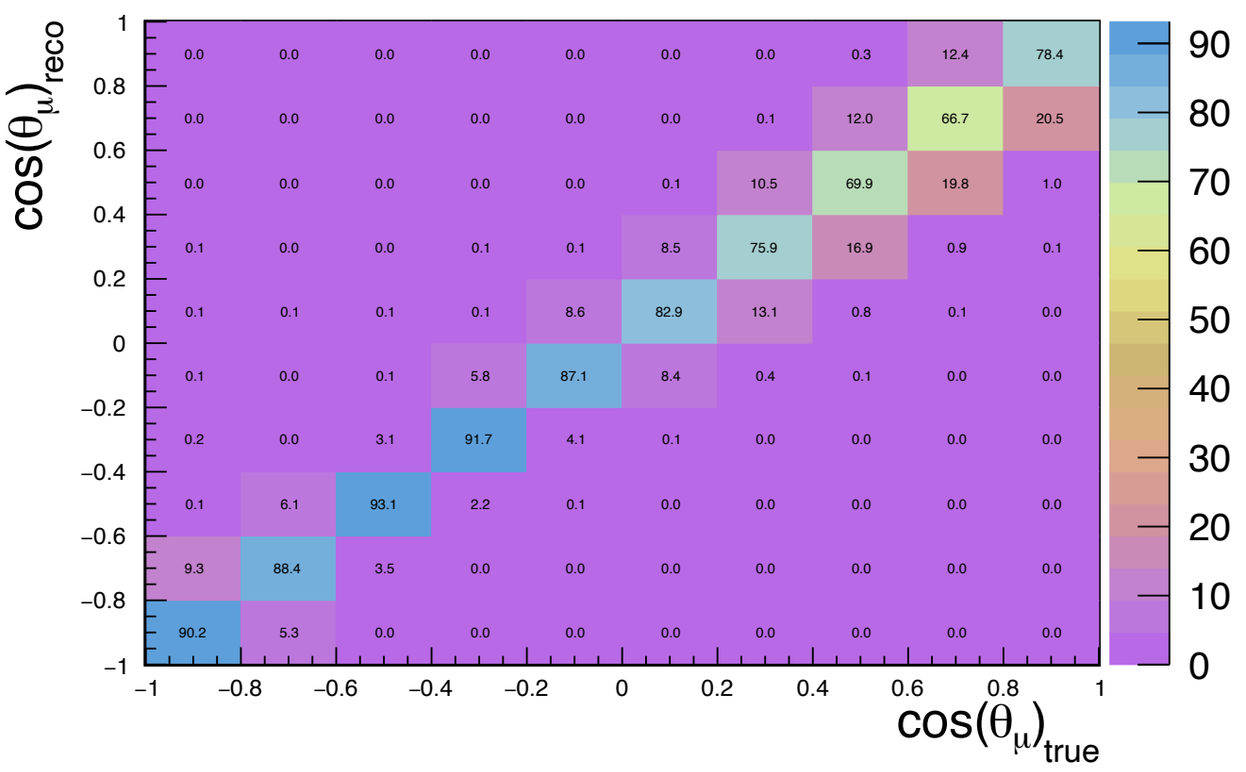

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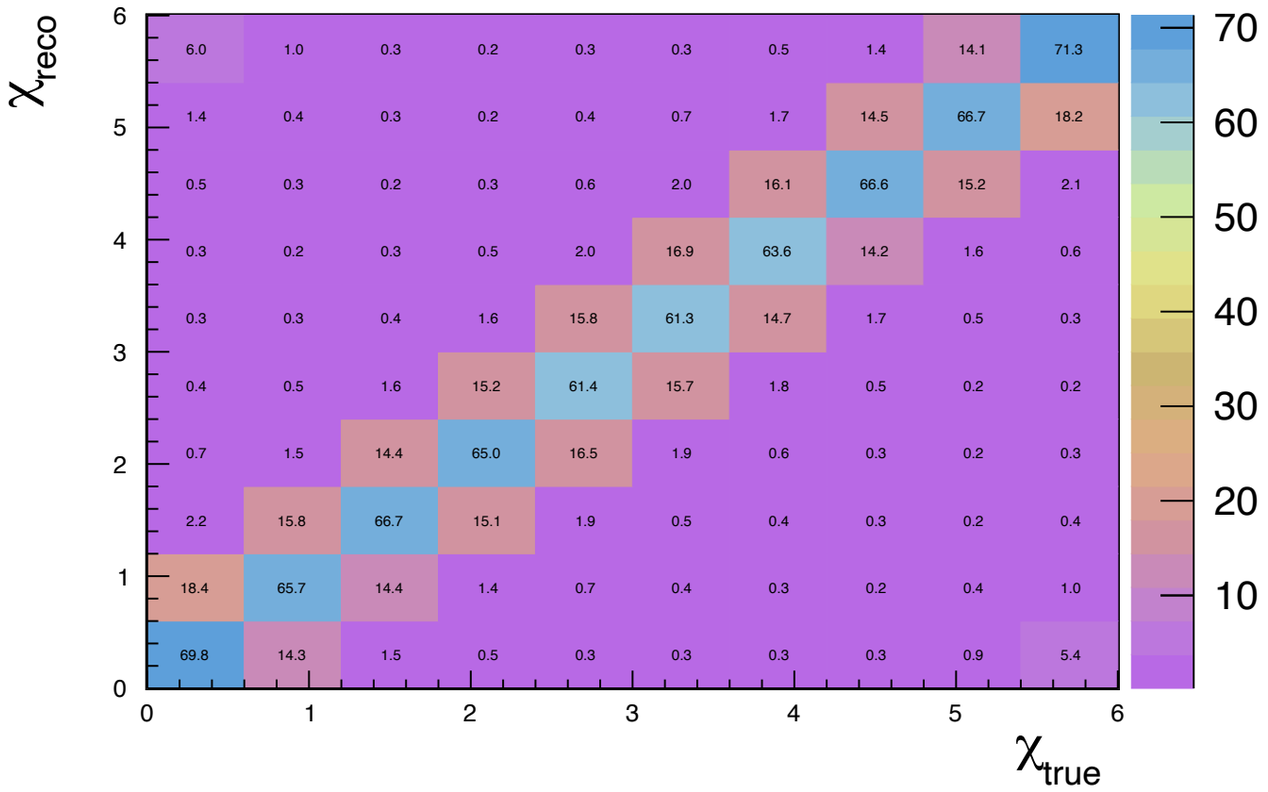

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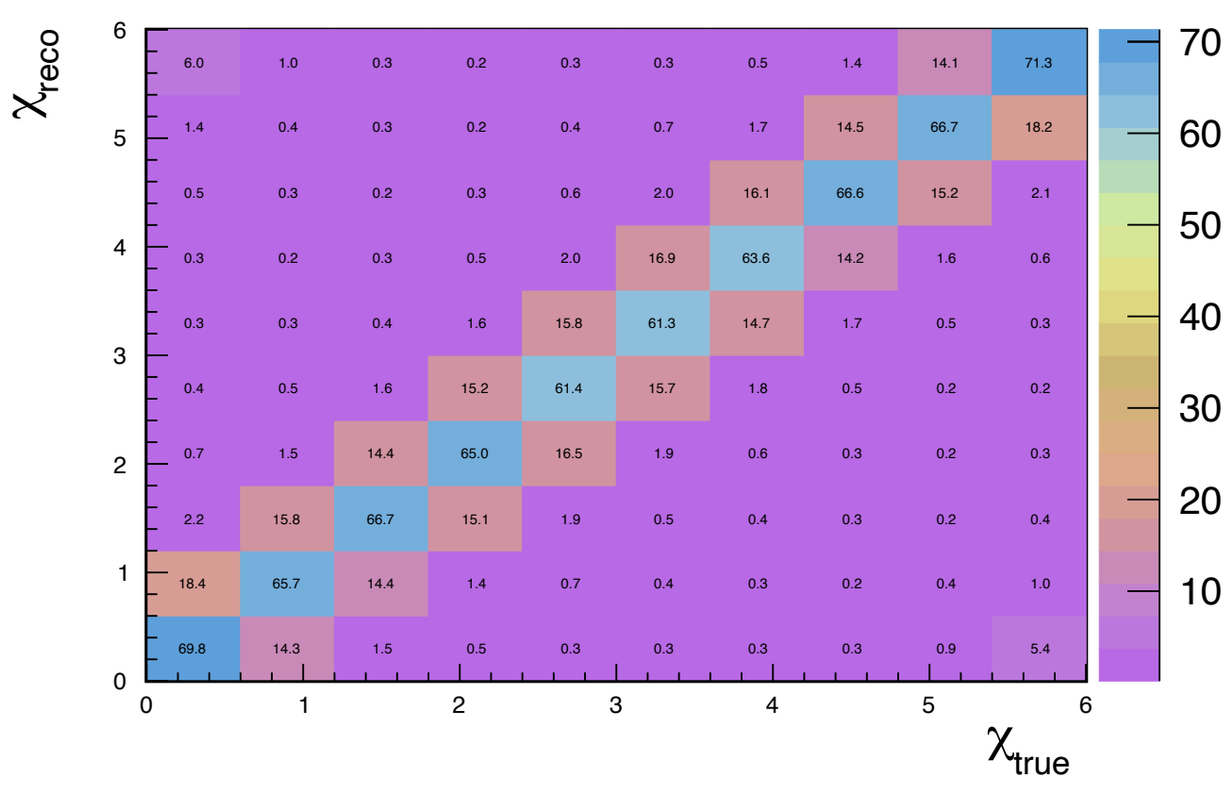

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