

# $\nu_\mu$ EVENT SELECTION AT THE DUNE NEAR DETECTOR

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## 1. DUNE AND THE NEAR DETECTOR

**DUNE** is a wide-band beam long-baseline neutrino oscillation experiment.

- Determine **neutrino mass ordering** and observe **CP violation** in the leptonic sector
- Precisely measure neutrino oscillation parameters
- Detect supernova neutrinos and BSM searches, including nucleon decay and sterile neutrinos

- Two-phase strategy to accomplish its scientific goals. Phase I ND: **ND-LAr + TMS + SAND**

- **PRISM**: off-axis movement samples different energy spectra, constraining systematic uncertainties

- **High-statistics**:  $\mathcal{O}(10^8)$  neutrino interactions per year

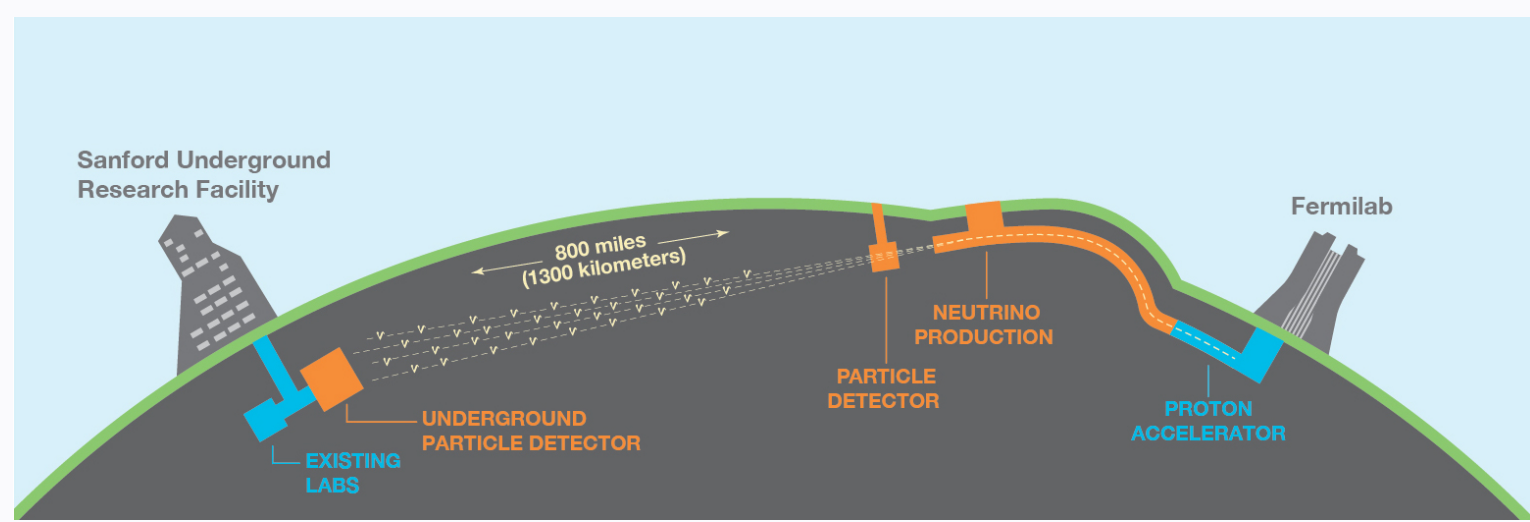


Figure 1: Schematic of DUNE and the LBNF neutrino beamline. [1].

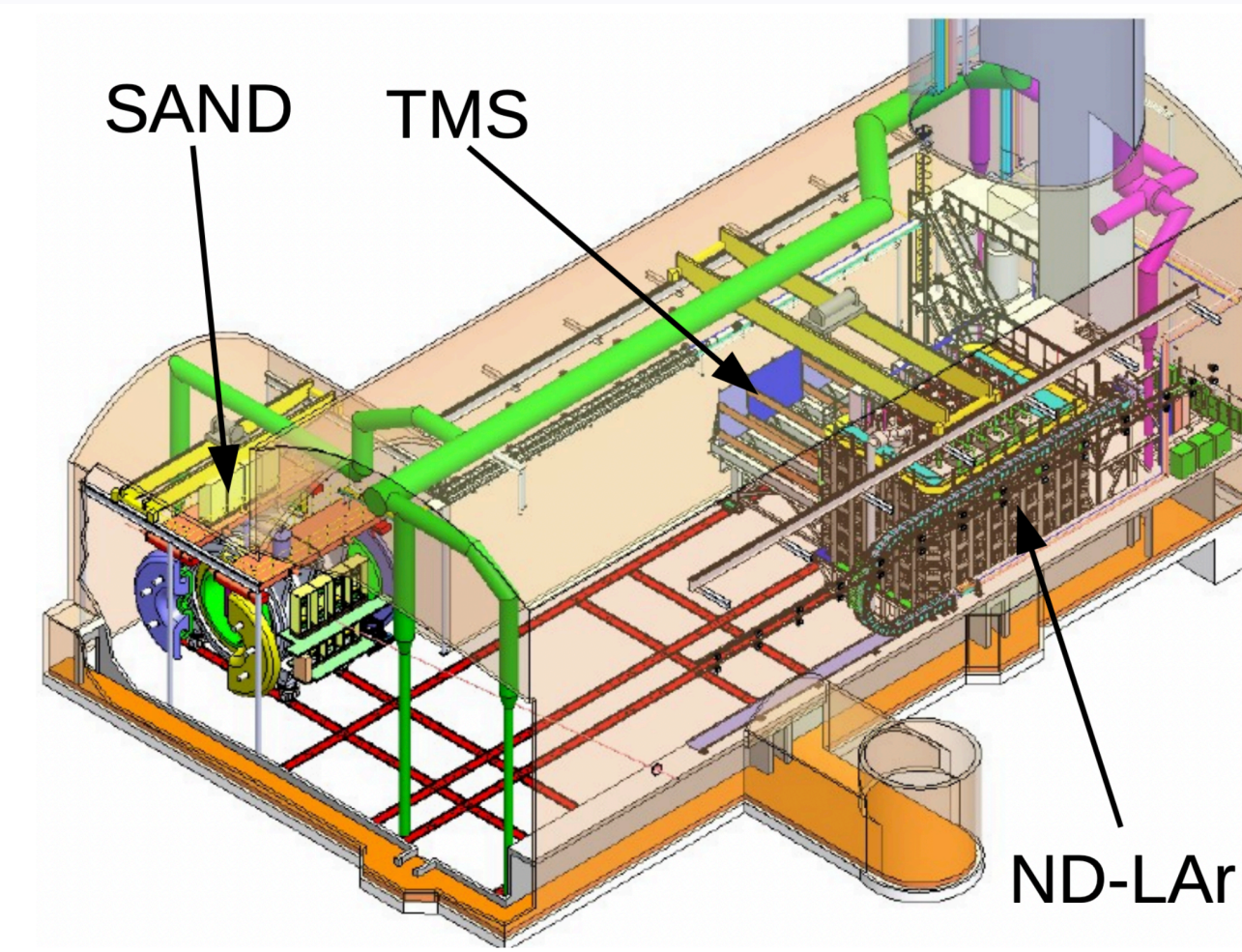
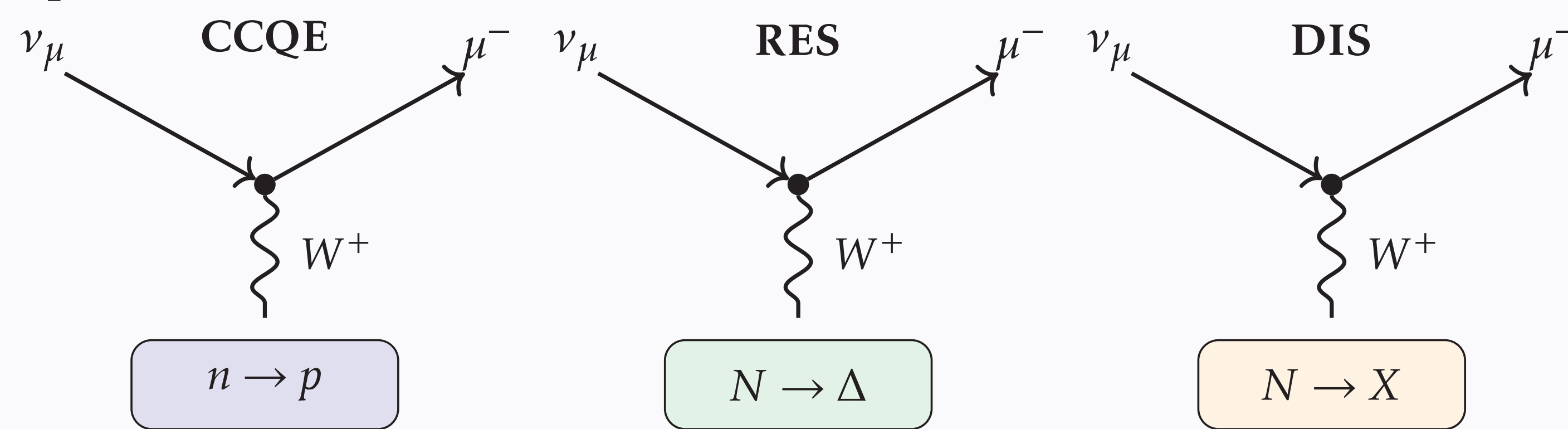


Figure 2: ND cavern for Phase 1 [2].

## 2. WHY A $\nu_\mu$ CC SAMPLE

- **High statistics**  $\rightarrow \nu_\mu$  CC interactions are the **dominant interaction mode** in the ND and are easier to identify than NC interactions because of the distinctive outgoing muon. ND-LAr expects  $\mathcal{O}(30)$  neutrino interactions per spill.

- **Disappearance and appearance oscillation analyses**  $\rightarrow$  need the un-oscillated ND spectrum as baseline.



## 4. CONCLUSIONS

- $\nu_\mu$  CC event selection developed for ND-LAr.
- Selected events exhibit good muon reconstructed momentum and reconstructed angular resolutions.
- Provides the foundation for future disappearance and appearance oscillation analyses.

## ACKNOWLEDGEMENTS

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## 3. $\nu_\mu$ CC SAMPLE

### Selection cuts:

- **Quality cut**: interactions should have primary particles with tracks longer than 1 mm
- **Fiducial Volume (FV) cut**: reconstructed vertex in the FV (25 cm from all wall edges in ND-LAr)
- **Containment cut**: all particles contained, *except* the primary muon which may escape downstream to TMS
- Reconstructed interaction must have a **primary muon candidate**

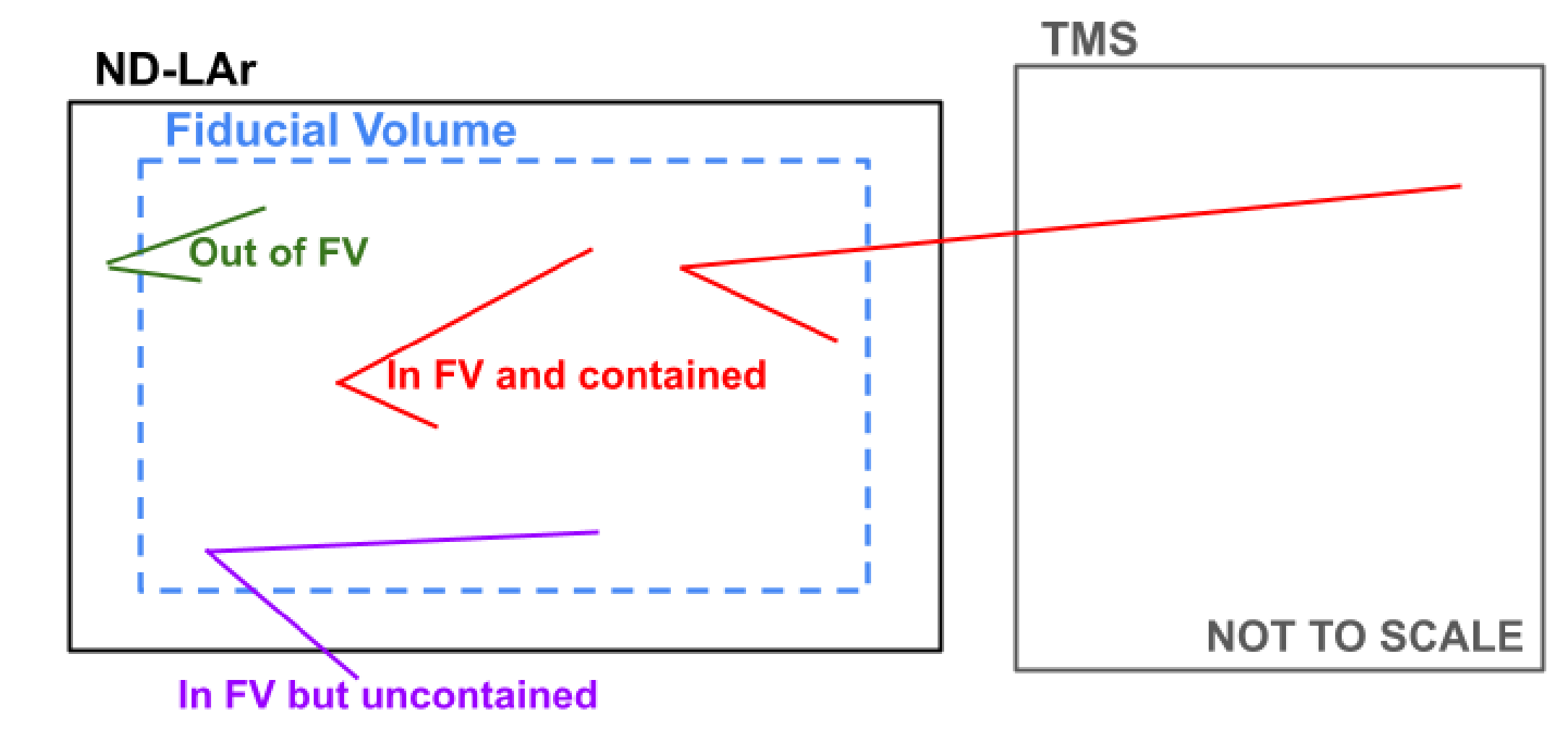


Figure 3: Diagram showing the FV and containment cuts.

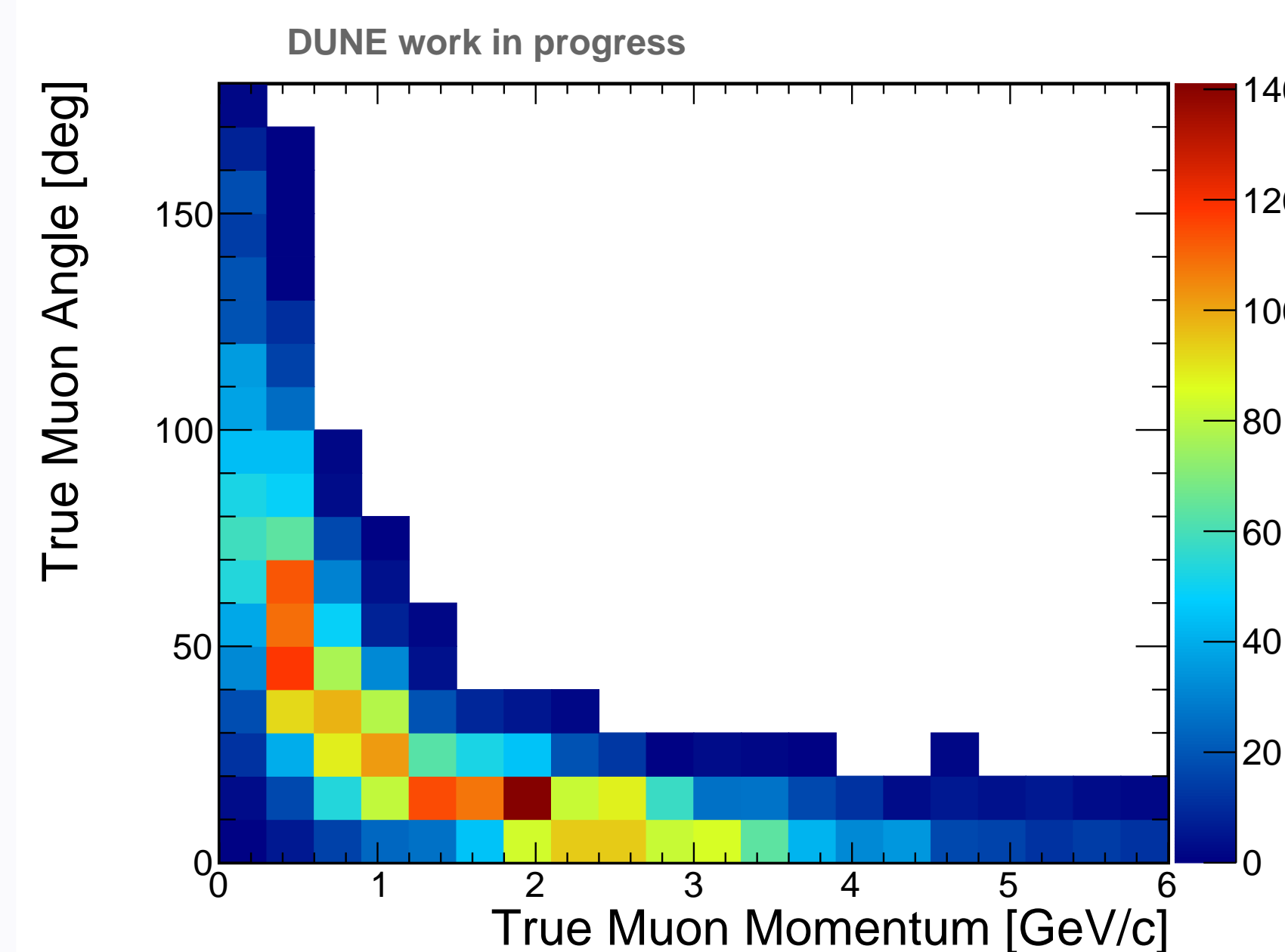


Figure 4: True muon angle vs. momentum for signal  $\nu_\mu$  CC interactions passing the full selection.

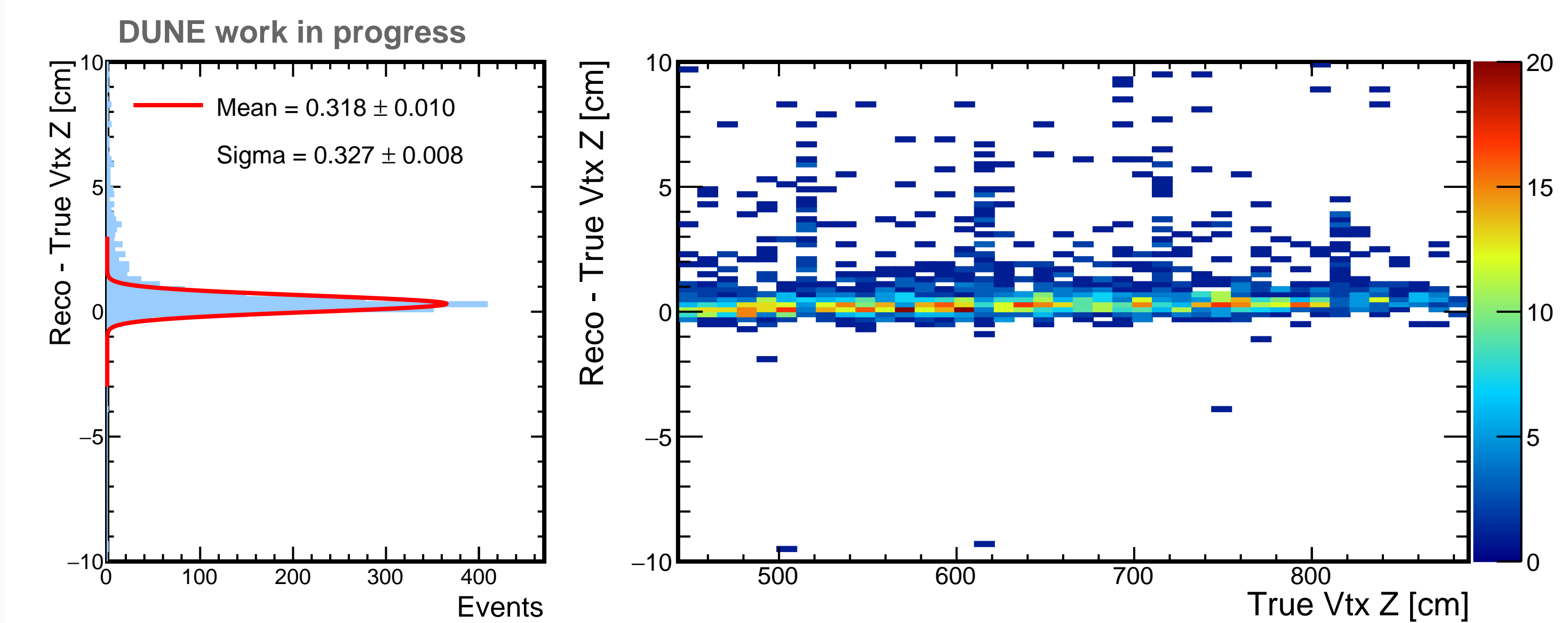


Figure 5: Reconstructed vertex resolution as a function of the true vertex position in the z axis. We have a resolution of 3.3 mm (the pixel pitch is 4 mm).

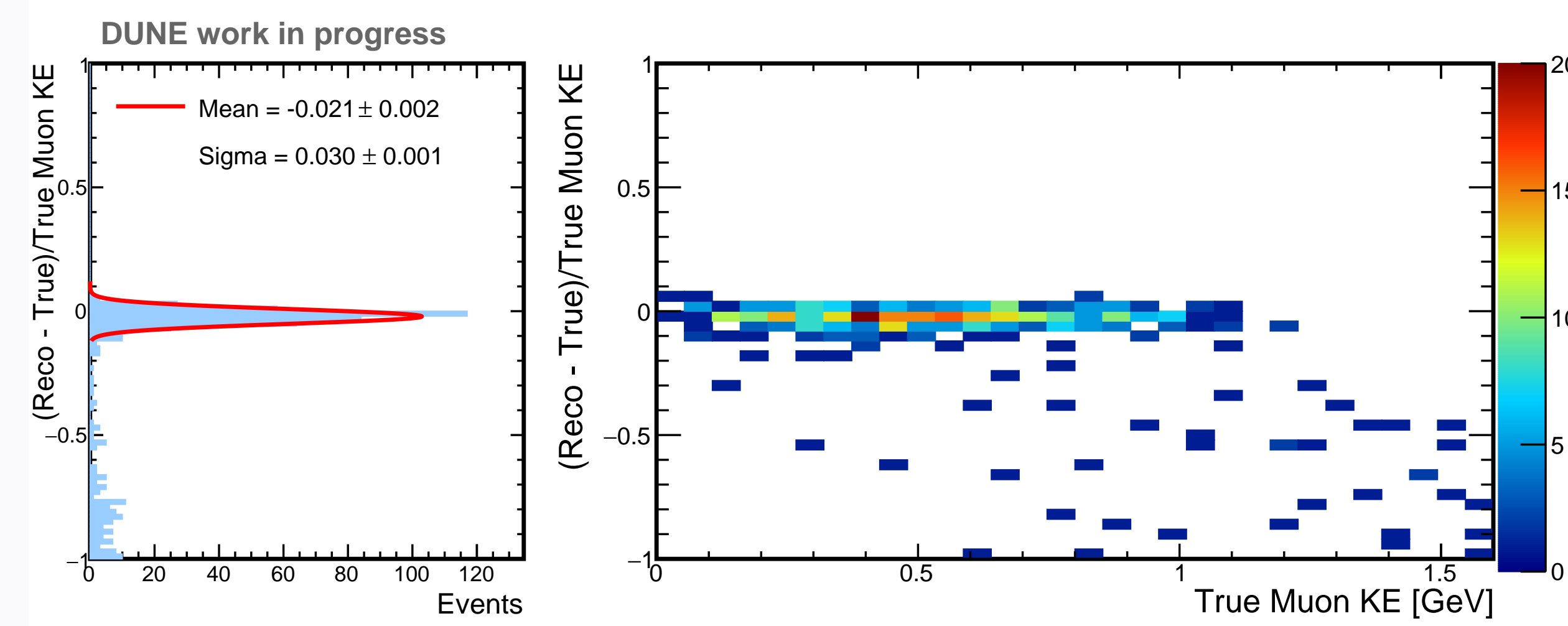


Figure 6: Reconstructed muon energy resolution as a function of true muon energy, for muons contained in ND-LAr. The energy resolution is  $3.0 \pm 0.1\%$  with a small negative bias.

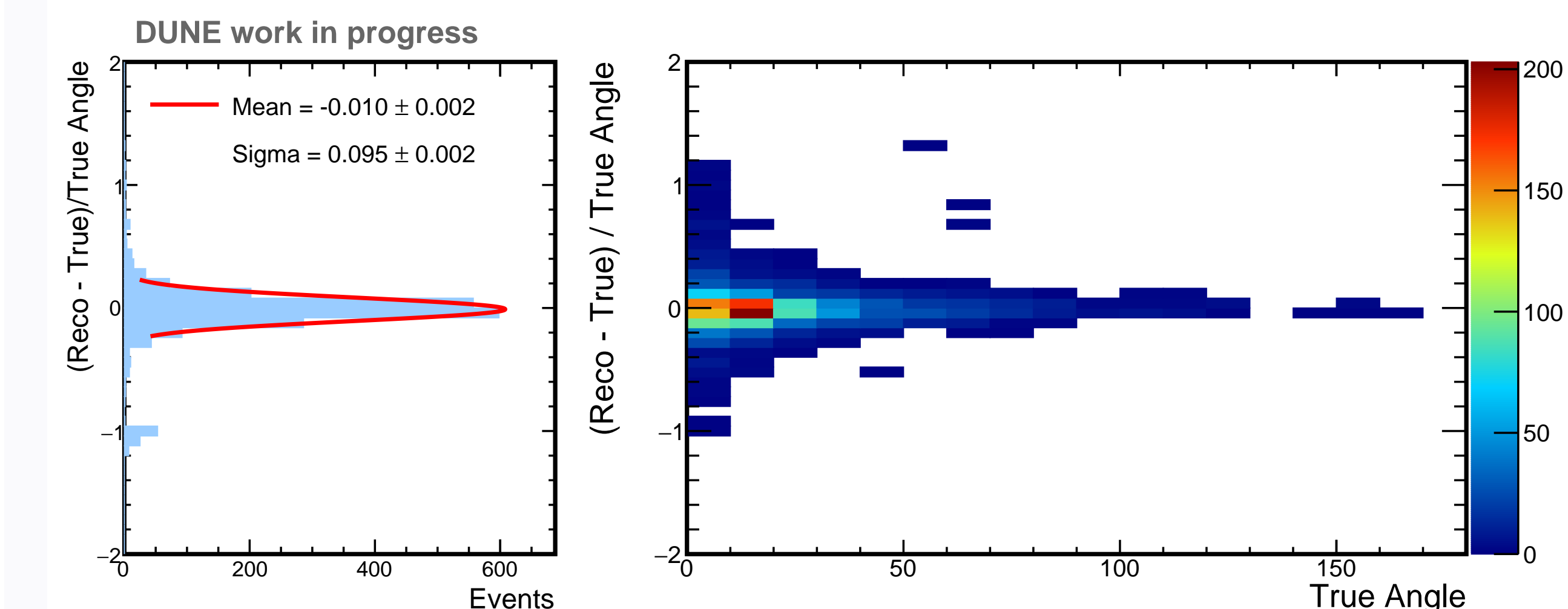


Figure 7: Reconstructed muon angle resolution as a function of true muon angle. The fractional muon angular resolution is  $9.5 \pm 0.2\%$ , with a bias of  $-1.0 \pm 0.2\%$ .

[1] Abi B, Acciarri R, Acero MA, Adamov G, Adams D, Adinolfi M, et al.. Deep Underground Neutrino Experiment (DUNE), Far Detector Technical Design Report, Volume II: DUNE Physics; 2020.

[2] Abud AA, Abi B, Acciarri R, Acero MA, Adamov G, Adams D, et al.. Deep Underground Neutrino Experiment (DUNE) Near Detector Conceptual Design Report; 2021.