

GENIE–Geant4 Progress Report

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MAIA Neutrino Working Group
October 1, 2026

Work Package 2

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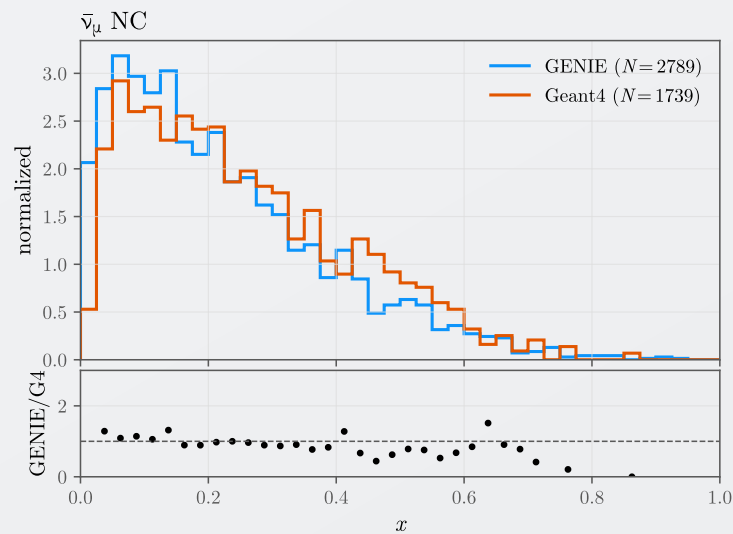
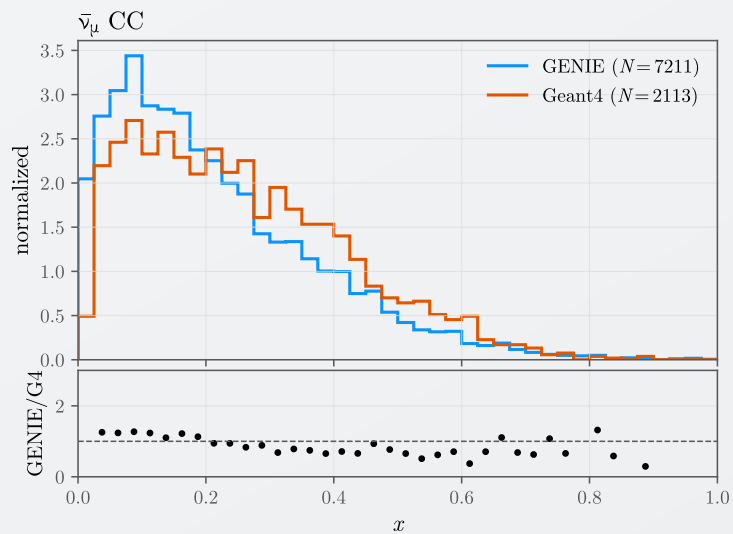
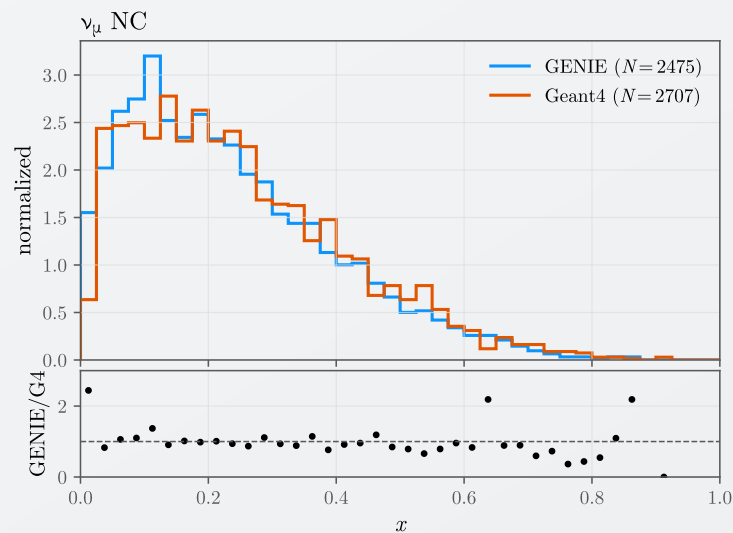
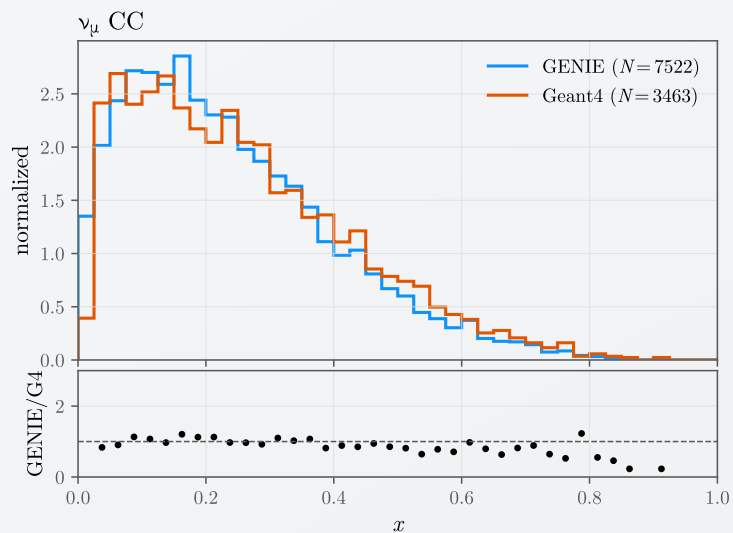
Production grid

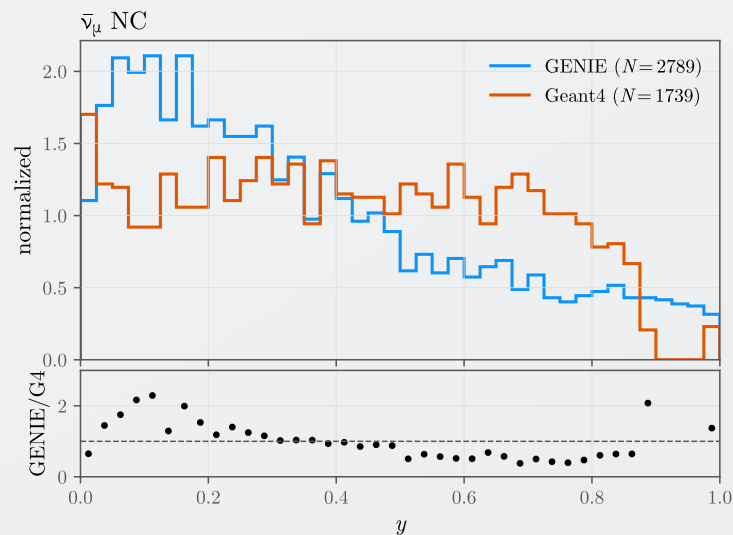
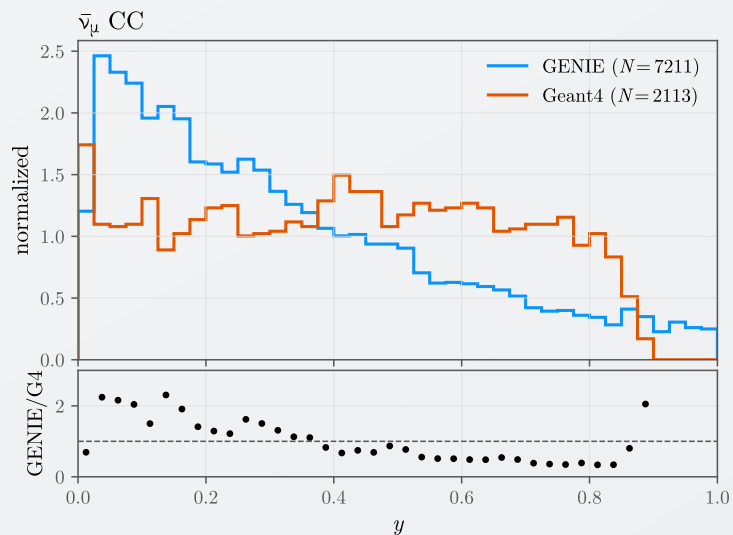
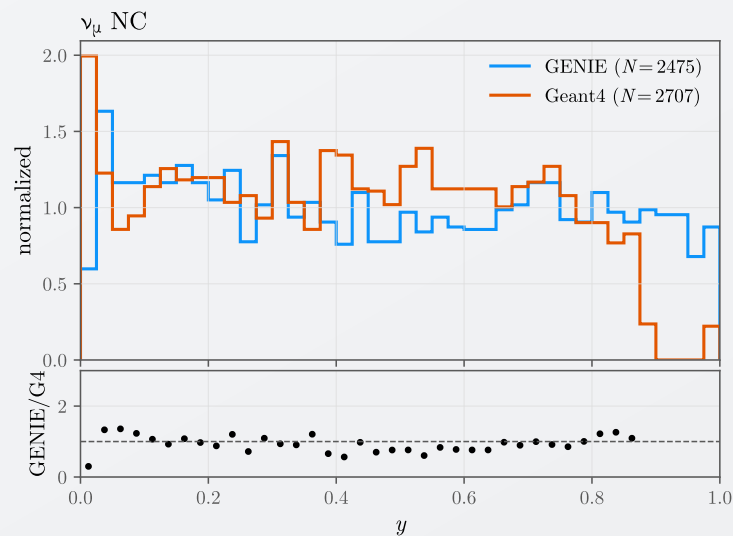
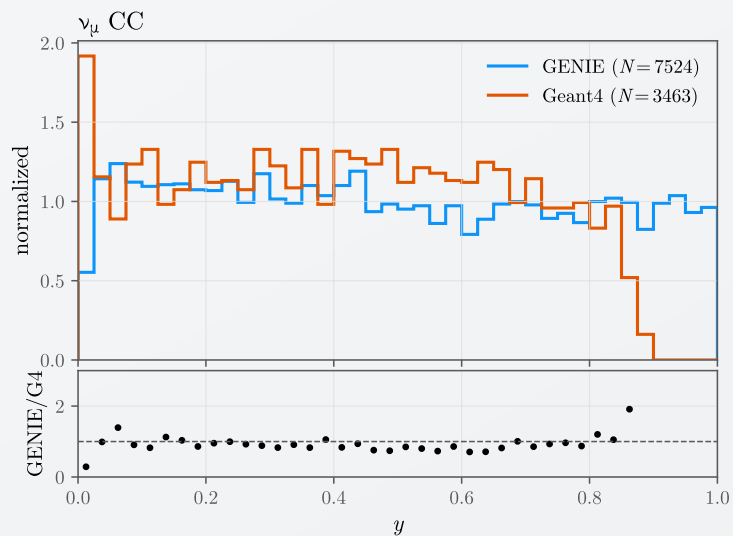
$$E_\nu = 0.1, 0.3, 0.5, 1, 2, 3, 5 \text{ TeV.} \quad (\text{A1})$$

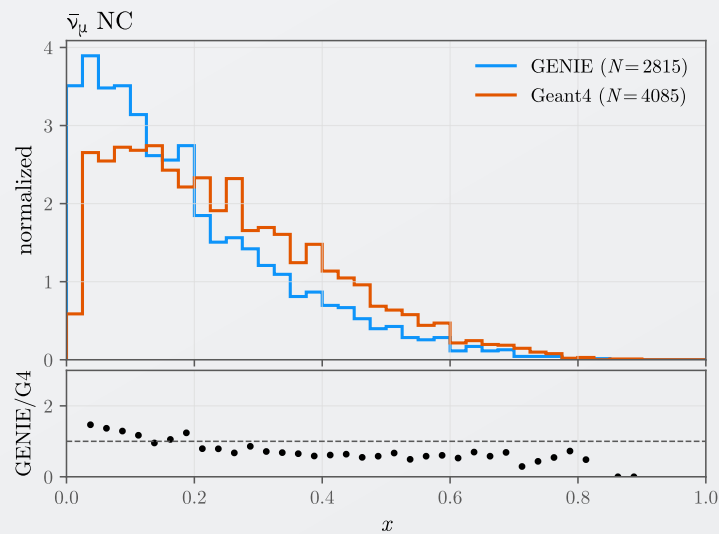
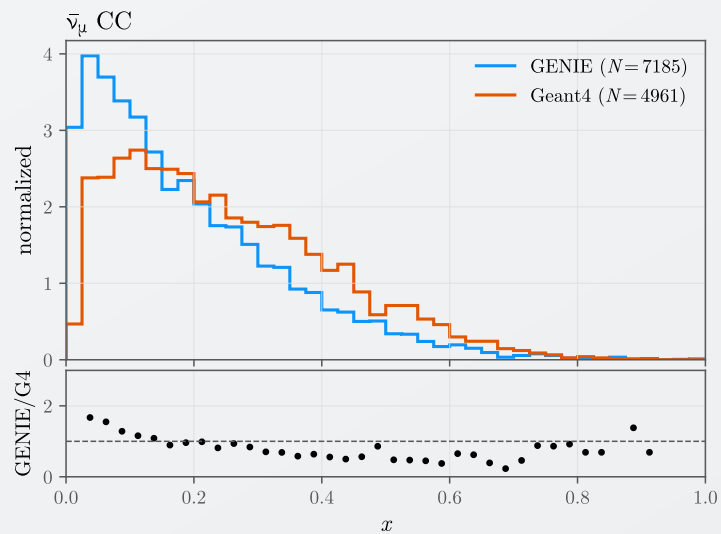
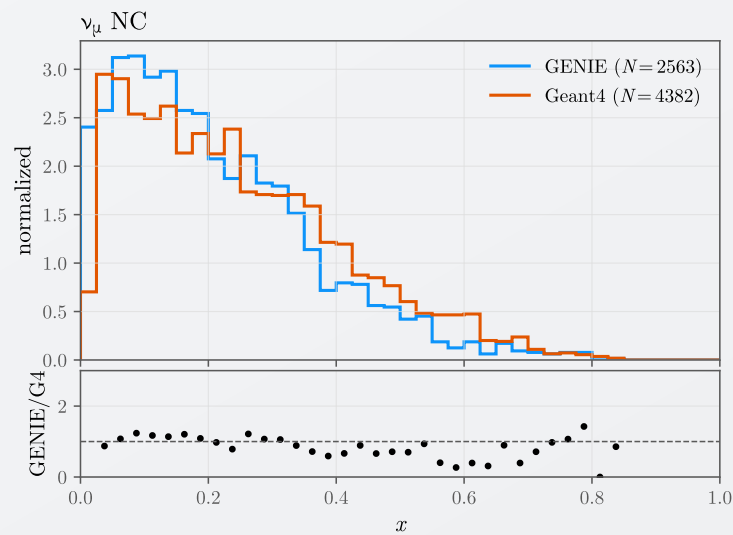
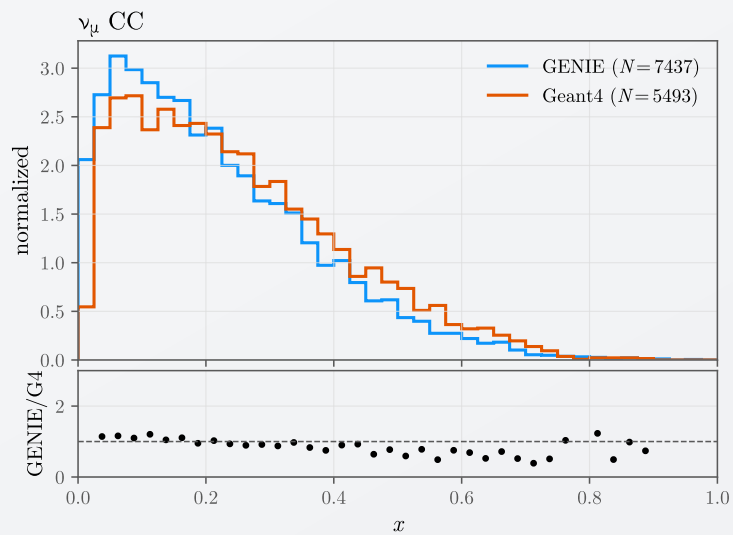
The same grid used for all cross-section and kinematic validation plots. Plots so far cover 0.1, 0.3, 0.5 TeV only; the ≥ 1 TeV points have not been done yet.

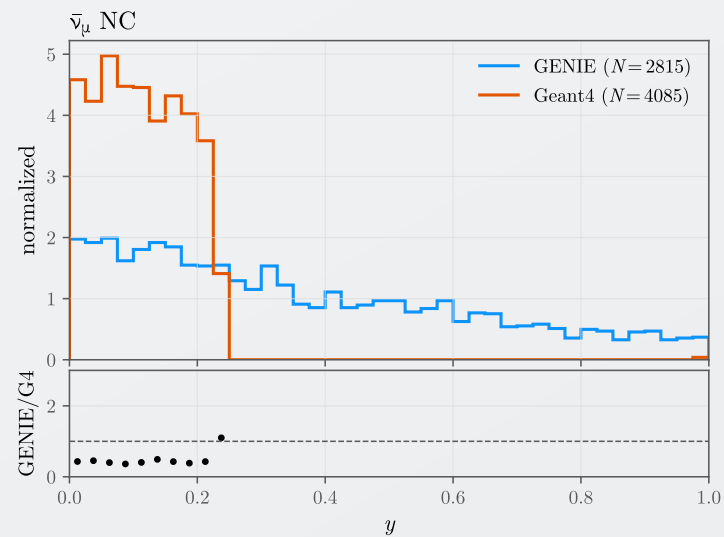
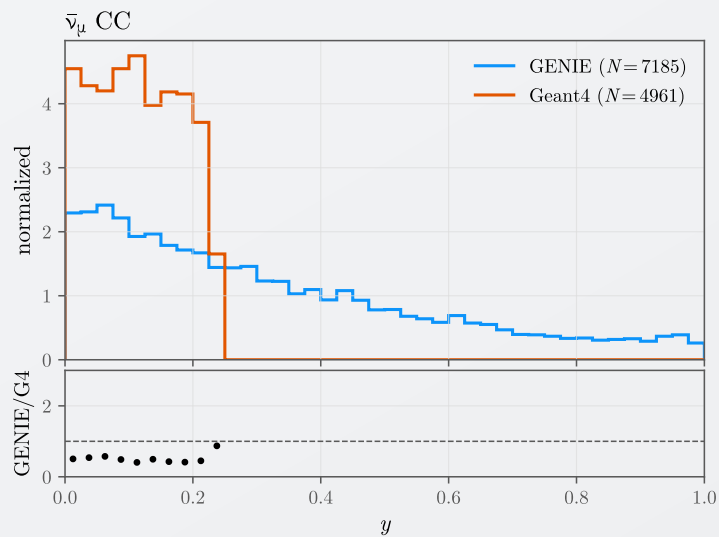
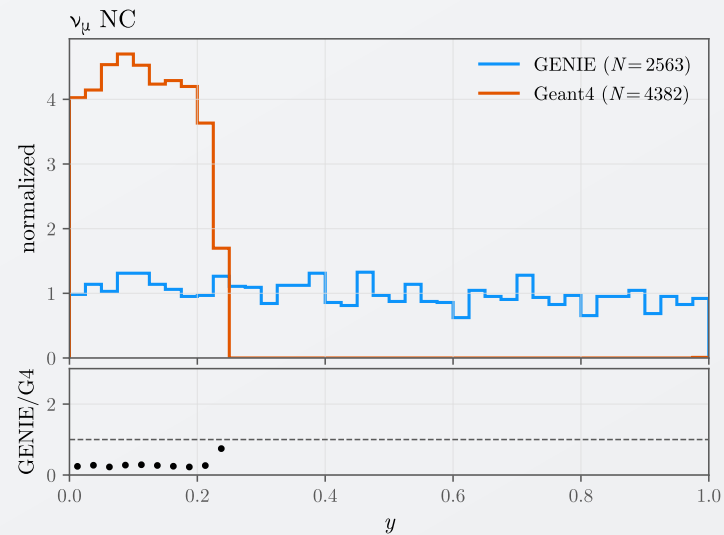
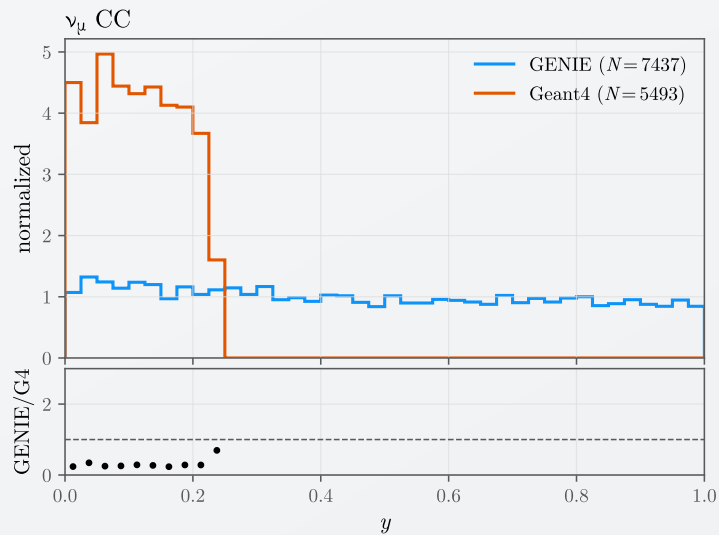
At every energy point, normalized one-dimensional distributions of x , y , Q^2 , W :

- ✎ GENIE and Geant4 overlaid and normalized to unit area.
- ✎ Ratio plots.
- ✎ Separate panels by: ν and $\bar{\nu}$, CC and NC.
- ✎ ~~Theory benchmark where available, e.g. average inelasticity $\langle y \rangle$ from Choi et al. (2026).~~







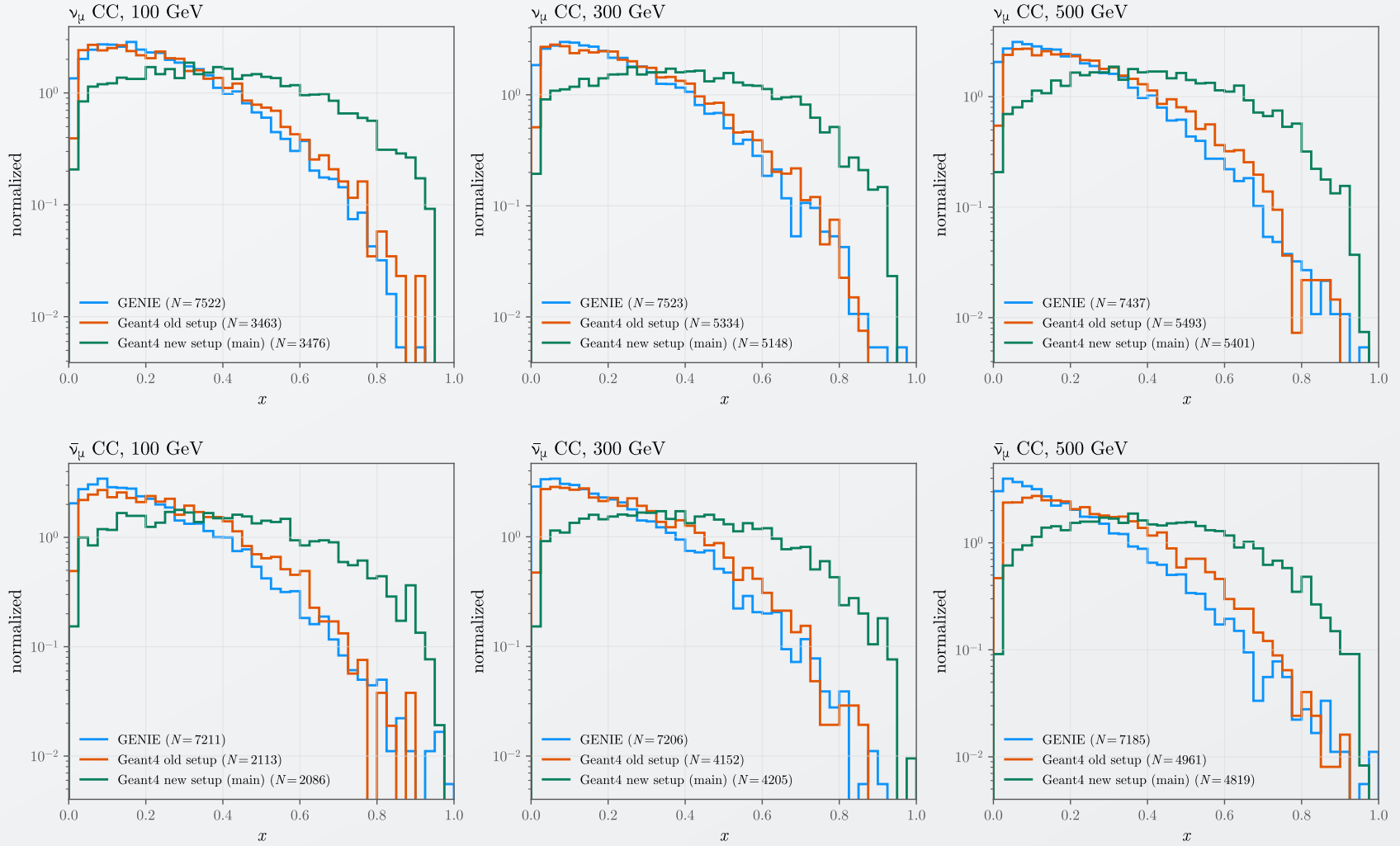


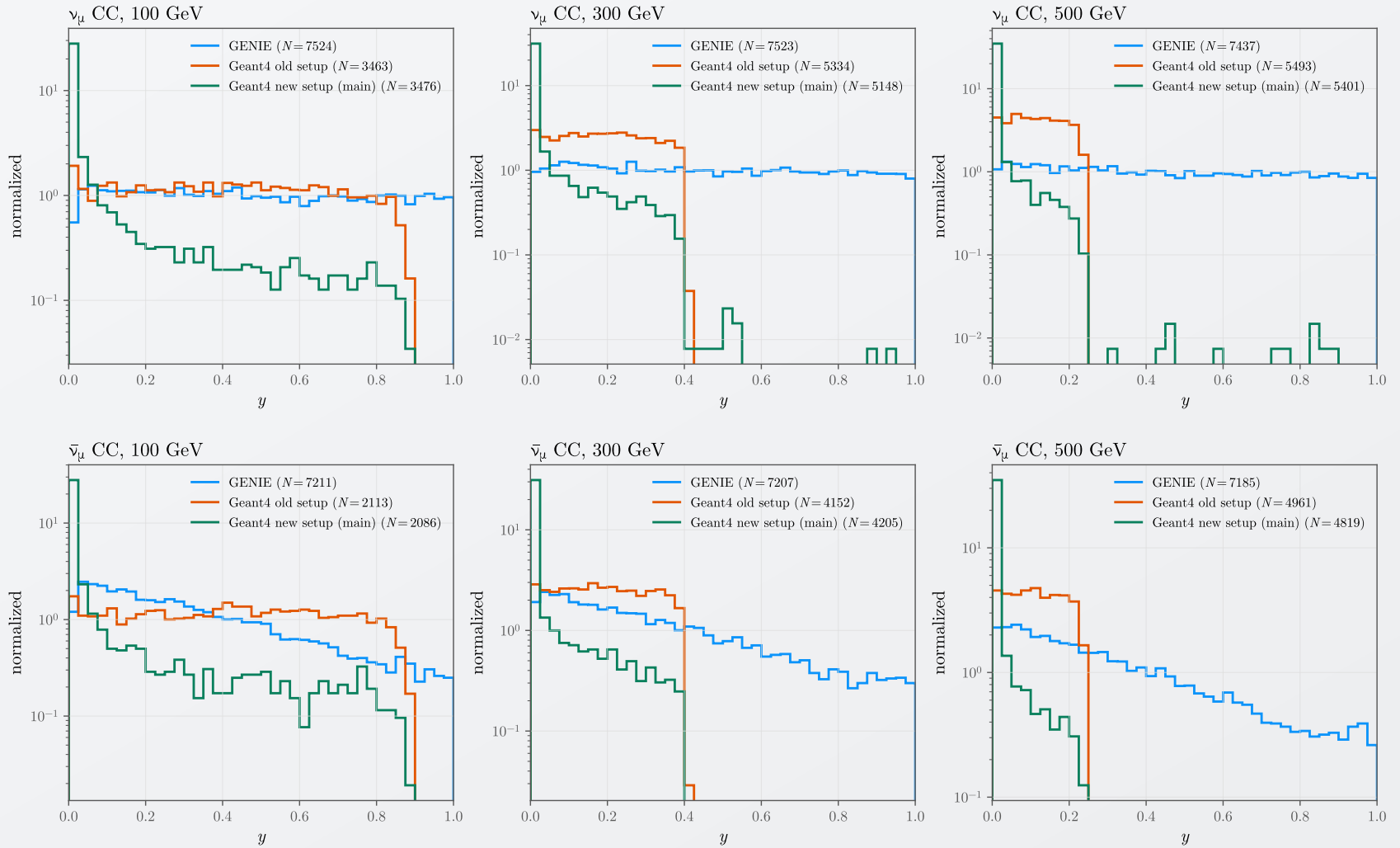
Wanted to move on to using HEDIS tunes and new splines for generating events at > 1 TeV. Previously using a pre-Jon-biasing (+other changes) version of GTP.

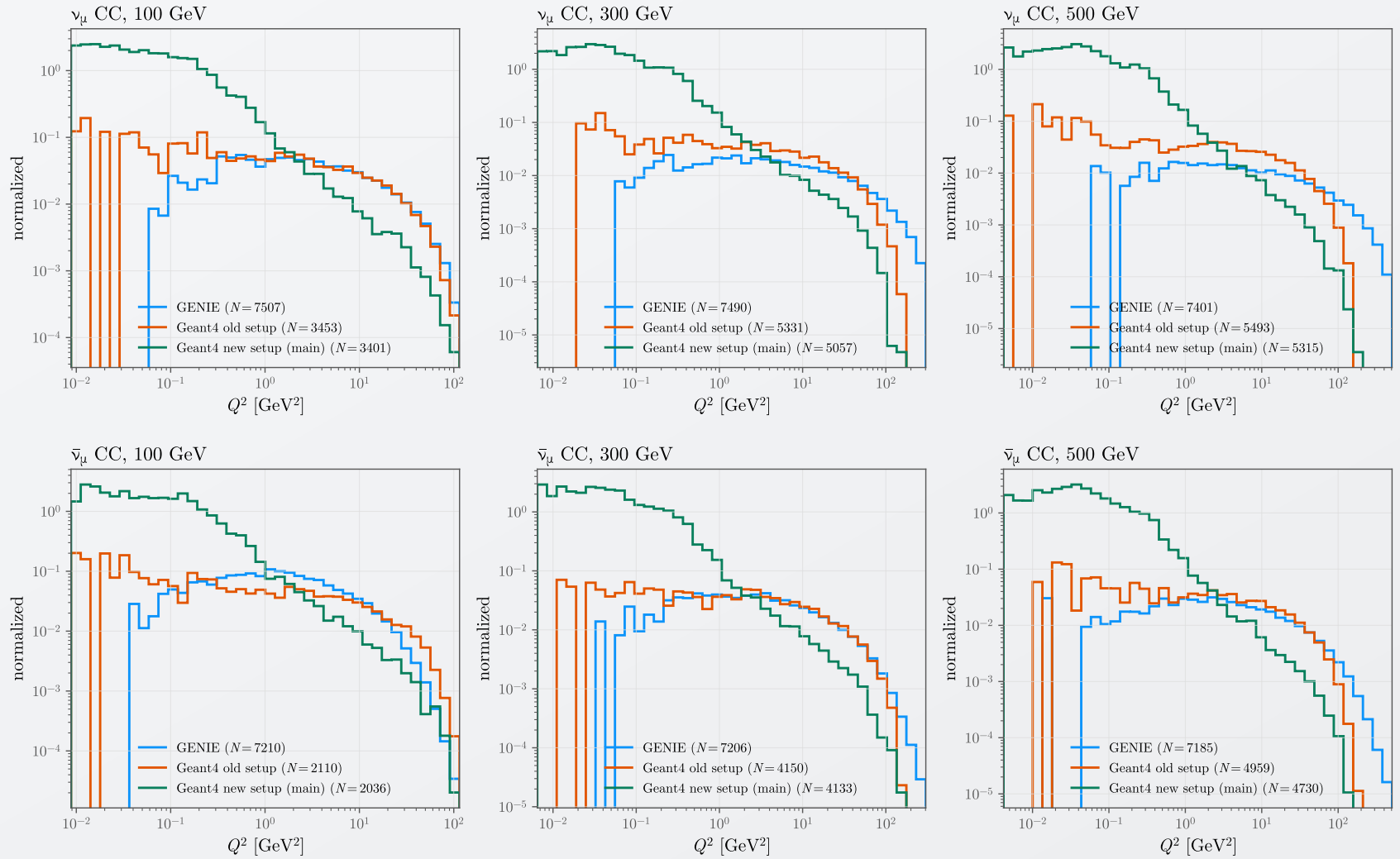
✦ Pulled new `main` and generated Geant4 kinematic plots in the same regime as before: very different behavior (watch for logarithmic axes):

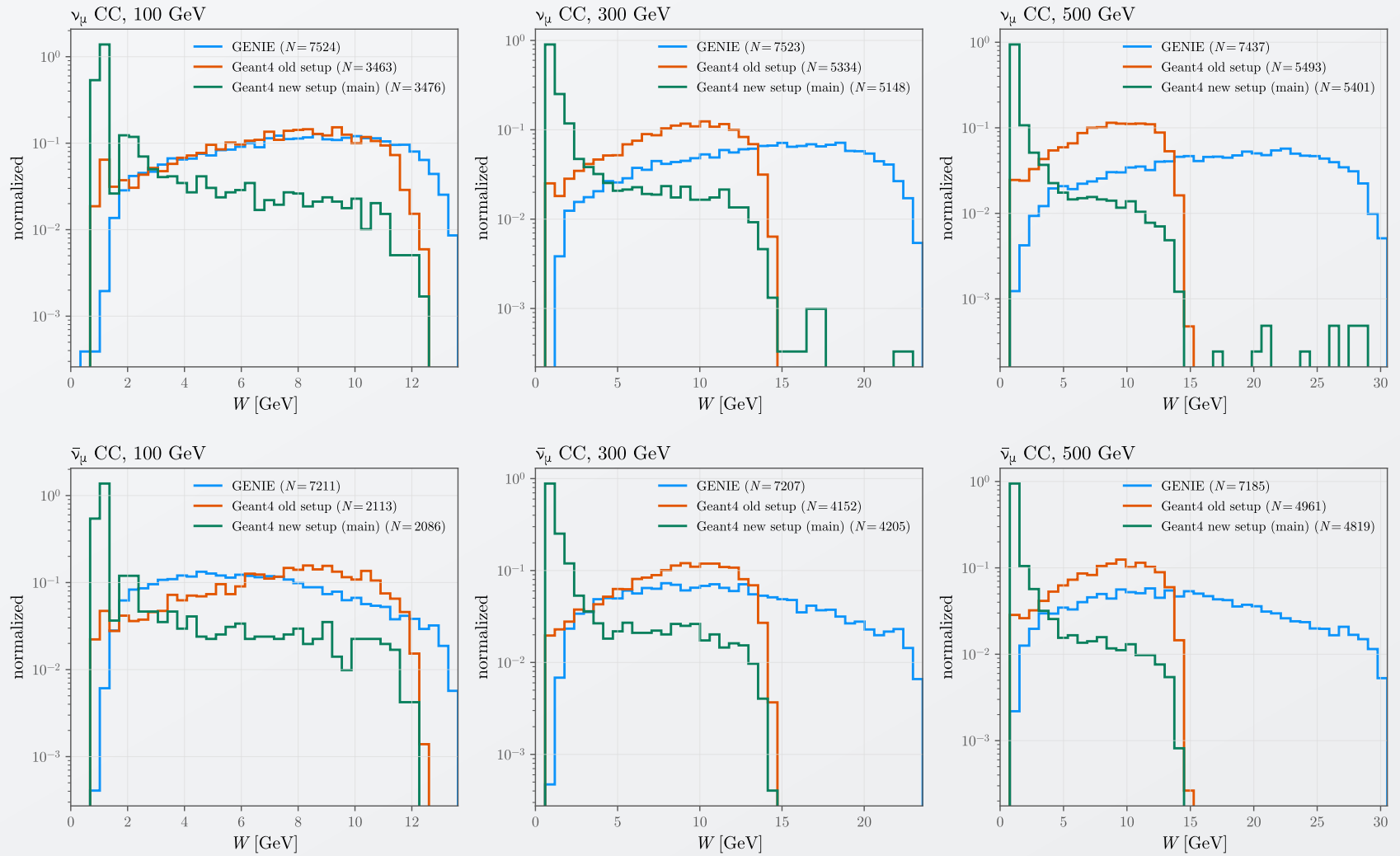
My Suspicion:

Could be related to energy conservation/resampling checks skewing the distribution. Related to the question of whether non-conservations in G4 are energy-dependent.

Bjorken x : GENIE and Geant4 (old vs new setup), graphite (C-12)

Inelasticity y : GENIE and Geant4 (old vs new setup), graphite (C-12)

Momentum transfer Q^2 : GENIE and Geant4 (old vs new setup), graphite (C-12)

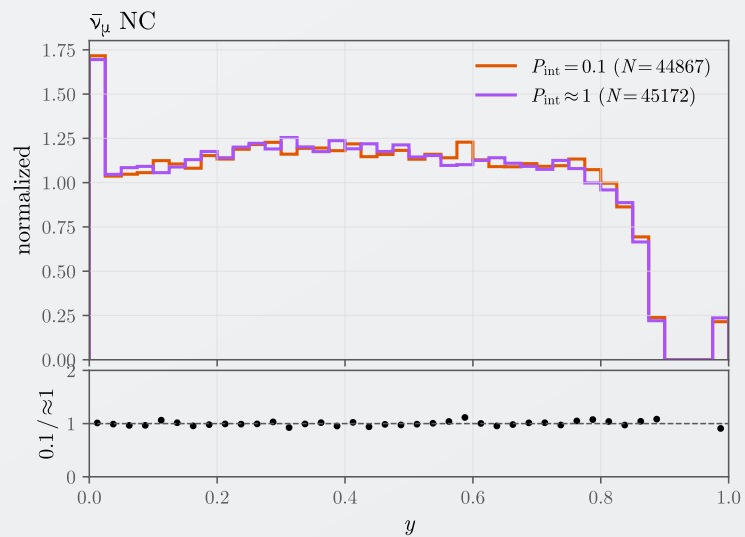
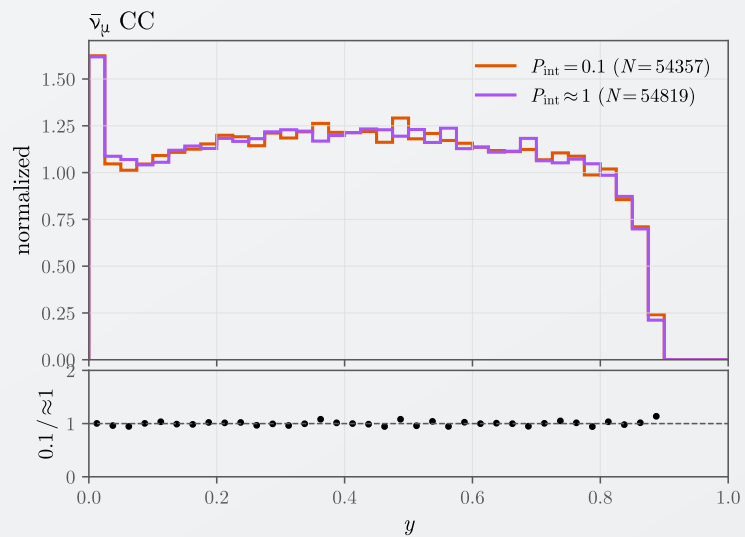
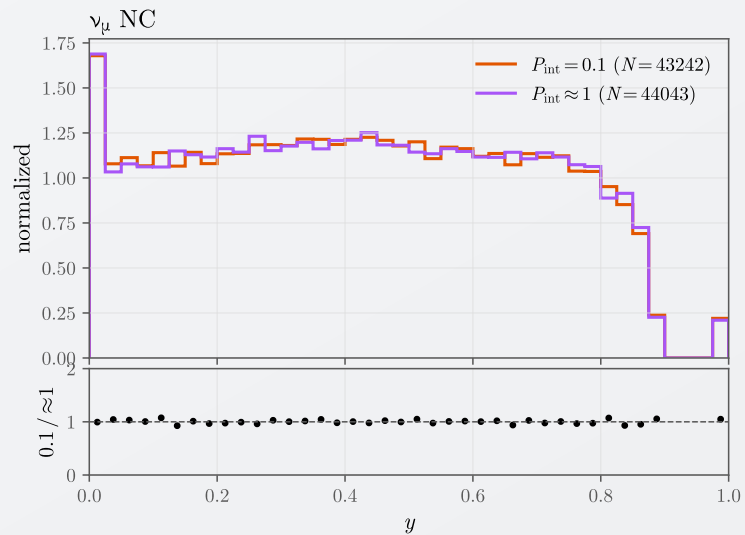
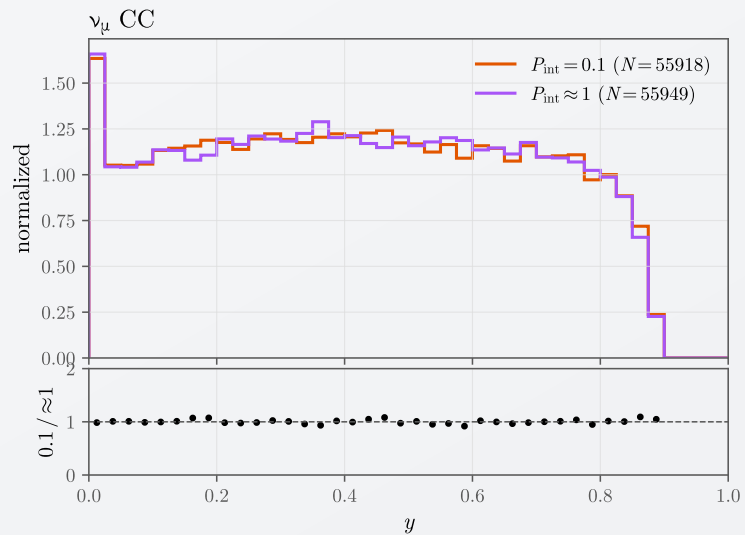
Hadronic mass W : GENIE and Geant4 (old vs new setup), graphite (C-12)

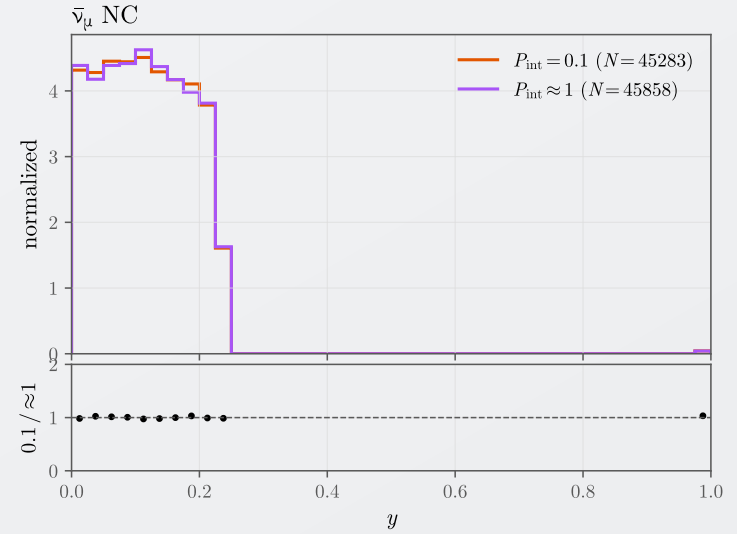
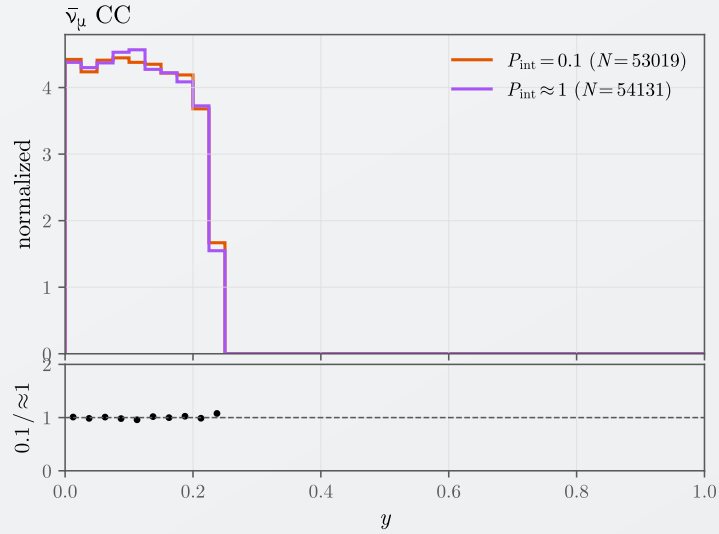
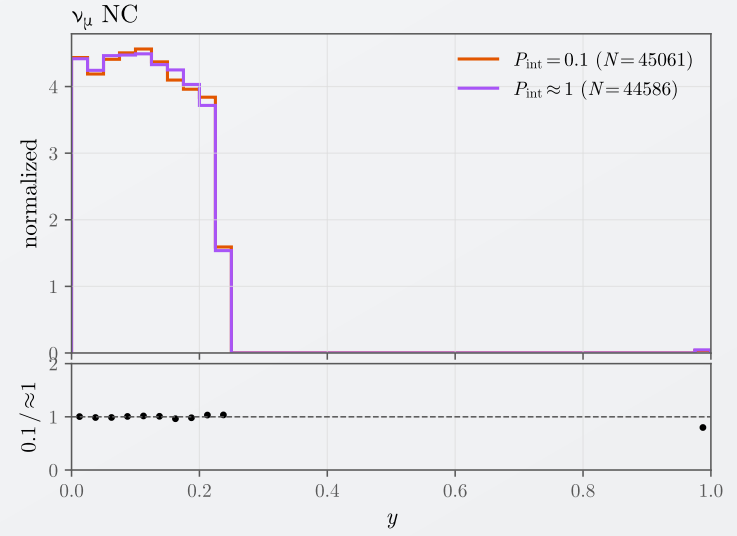
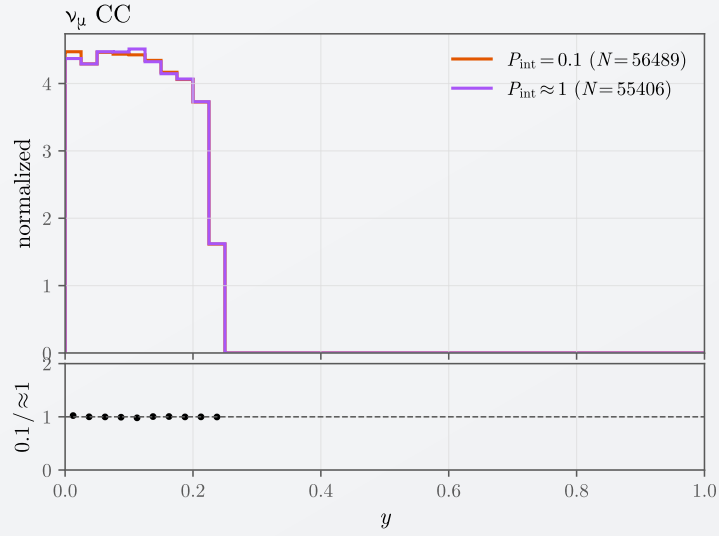
Are kinematics biasing-dependent

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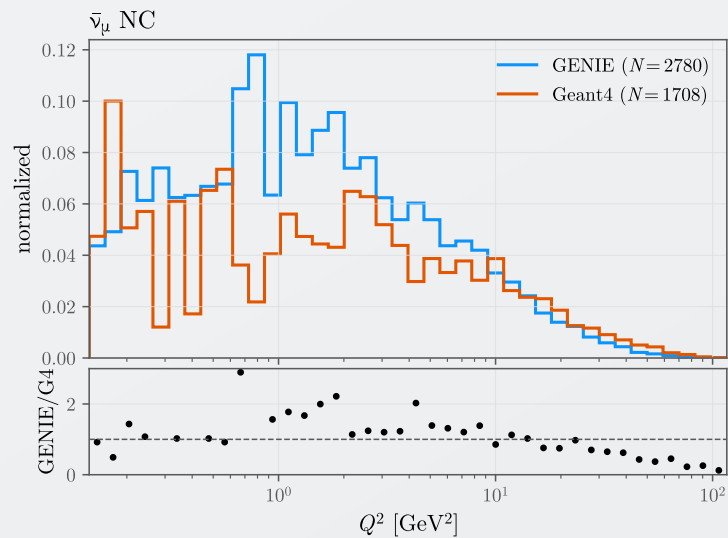
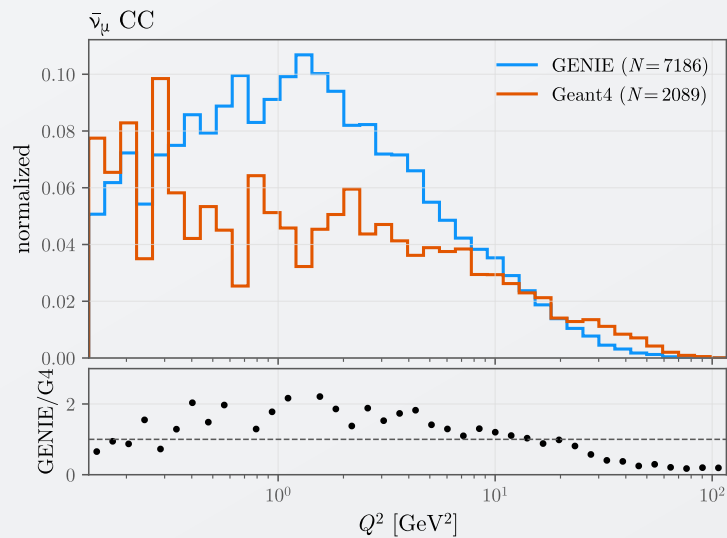
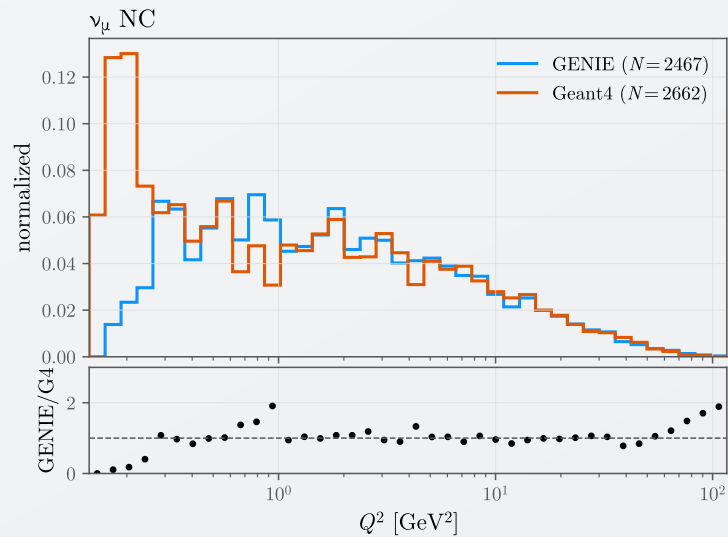
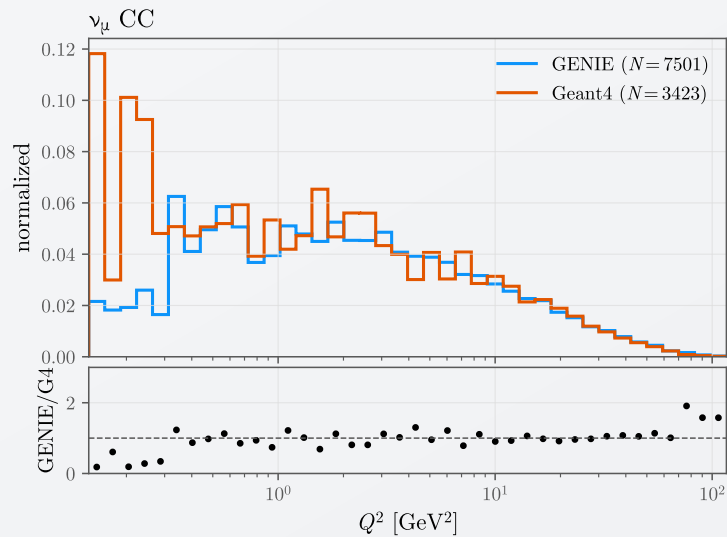
Daisy requested a check of this, the answer appears to be “no”.

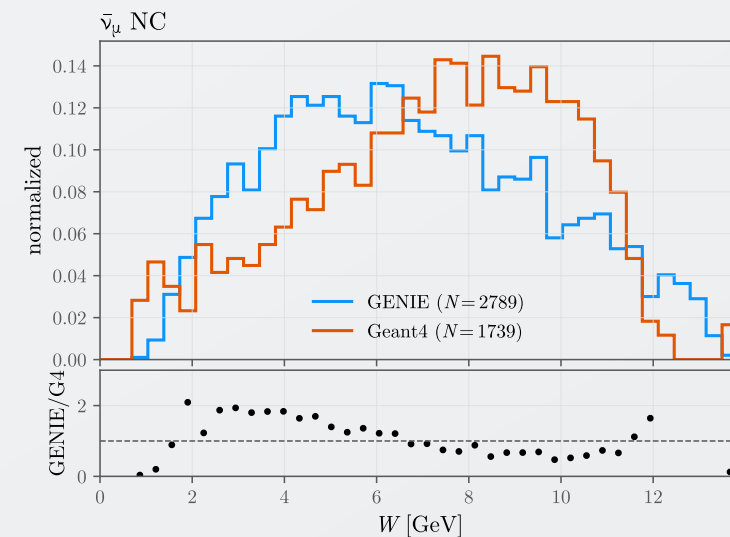
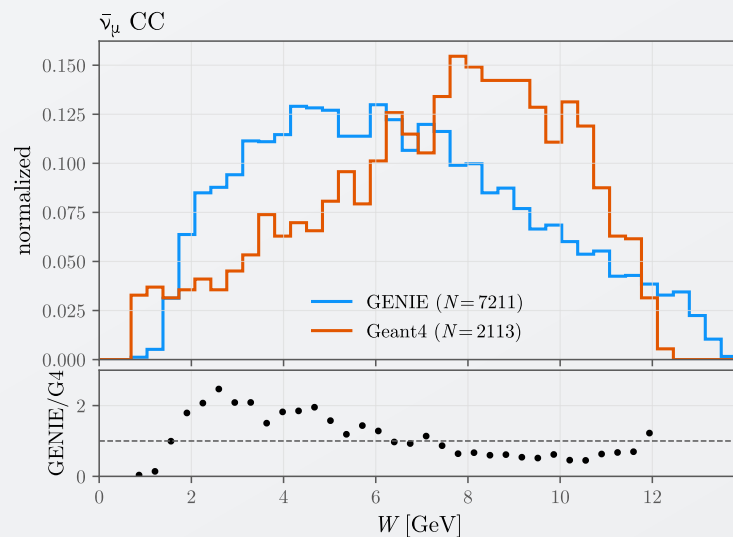
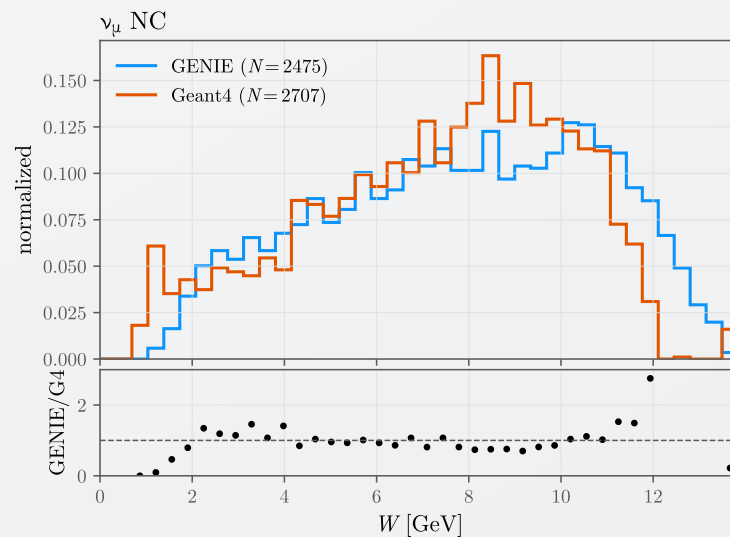
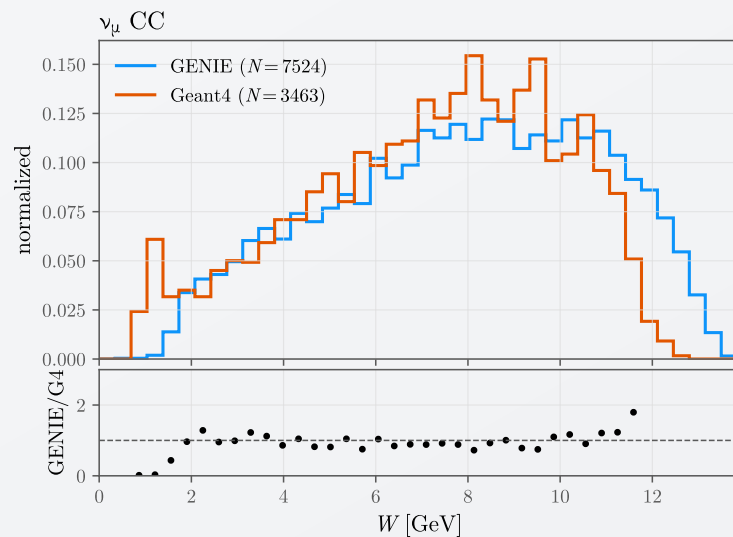
Generated two sets of data in graphite block. One with high biasing factor such that interaction probability was close to 1 and one tuned to 0.1. Virtually identical results.

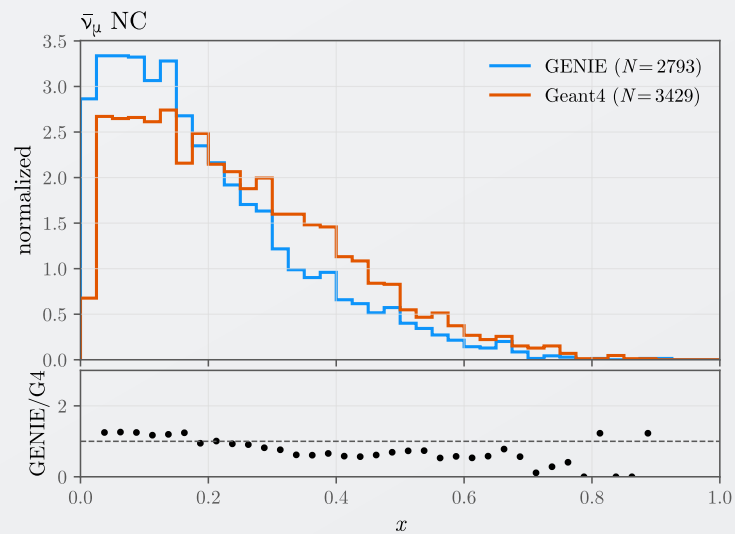
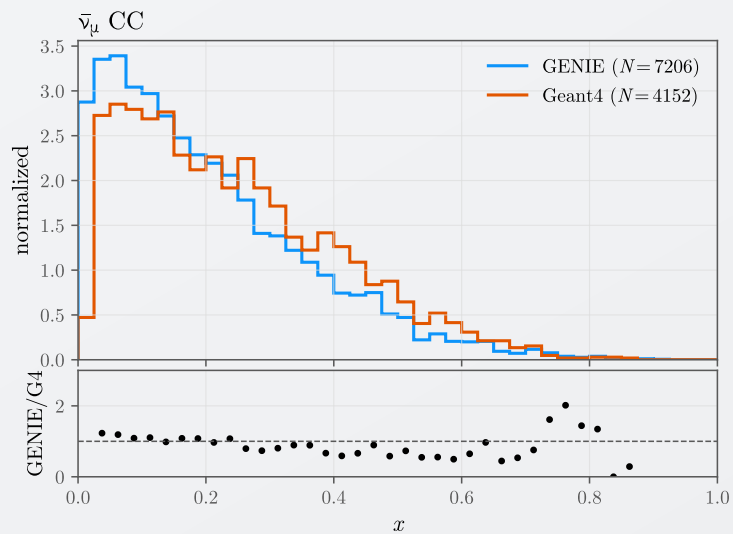
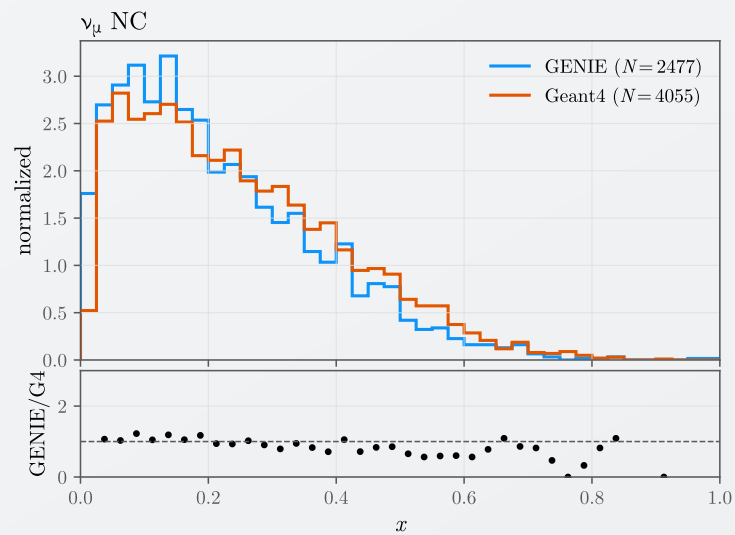
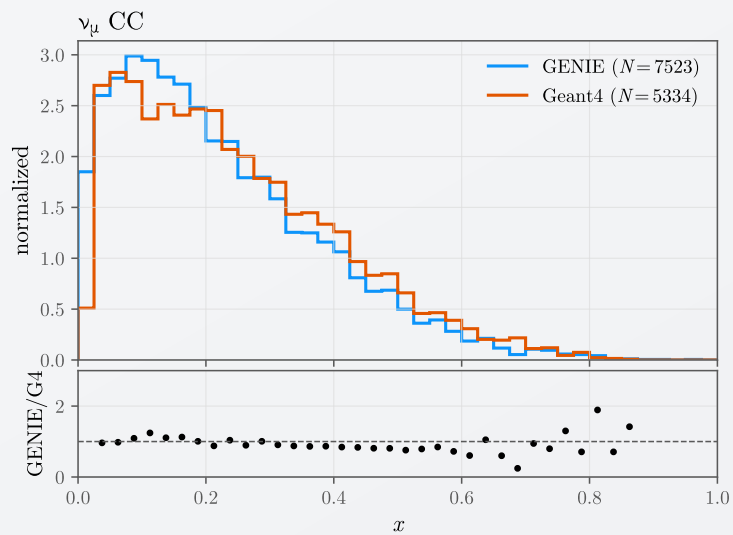


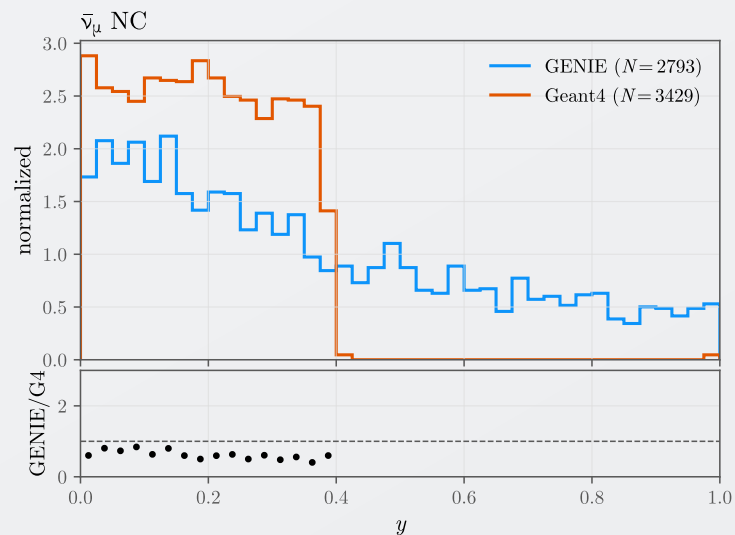
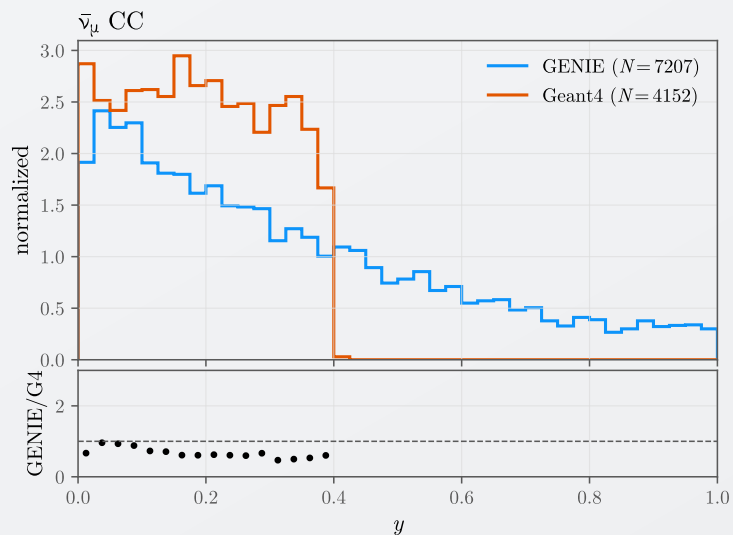
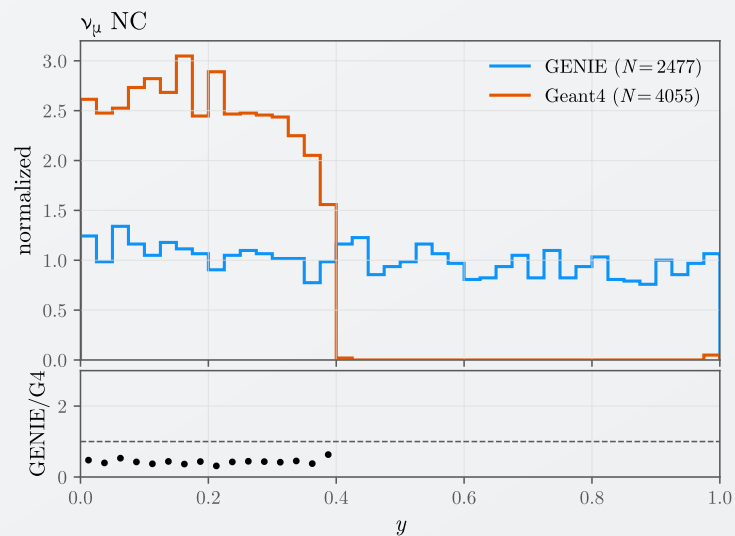
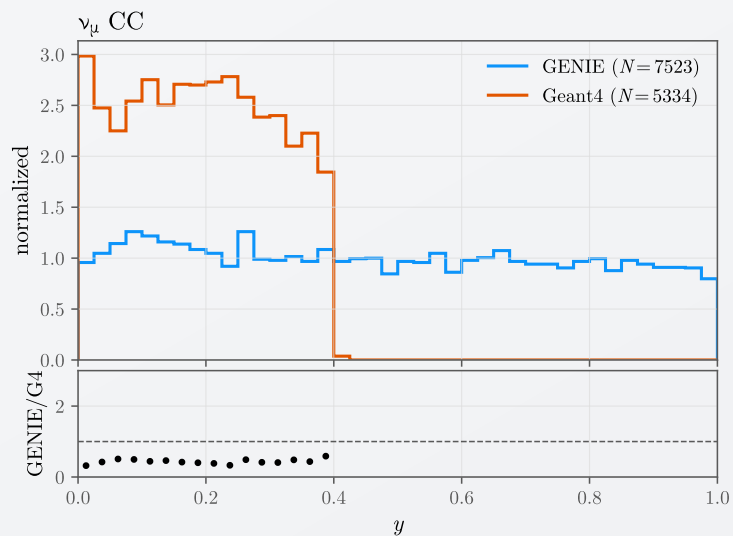


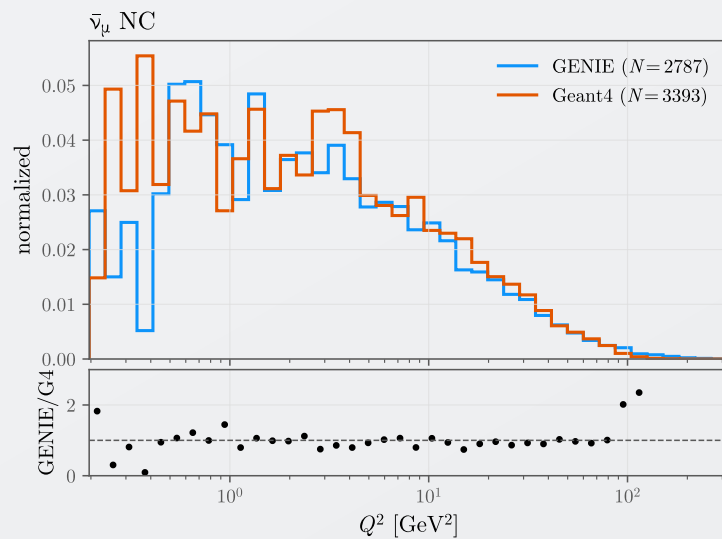
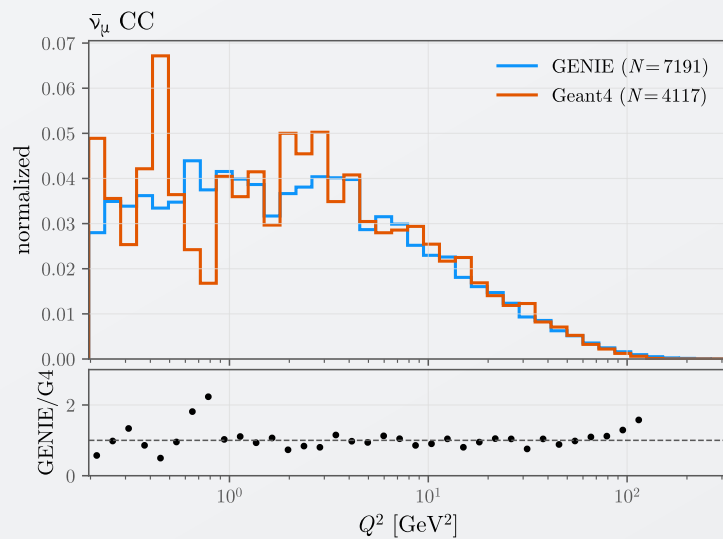
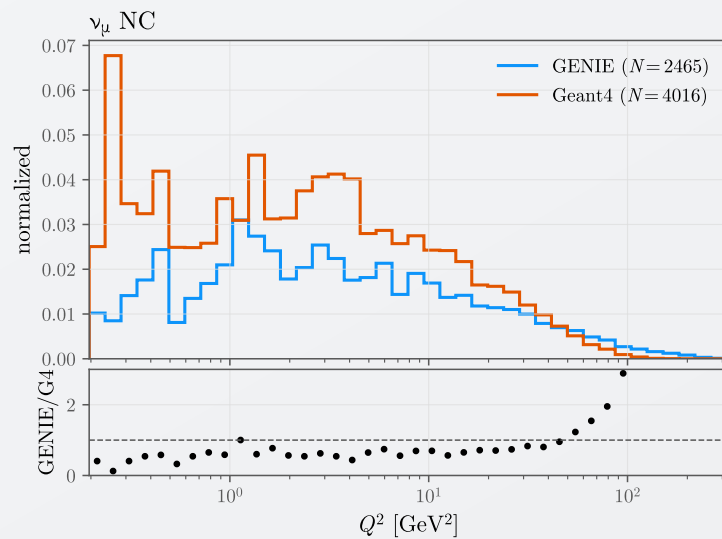
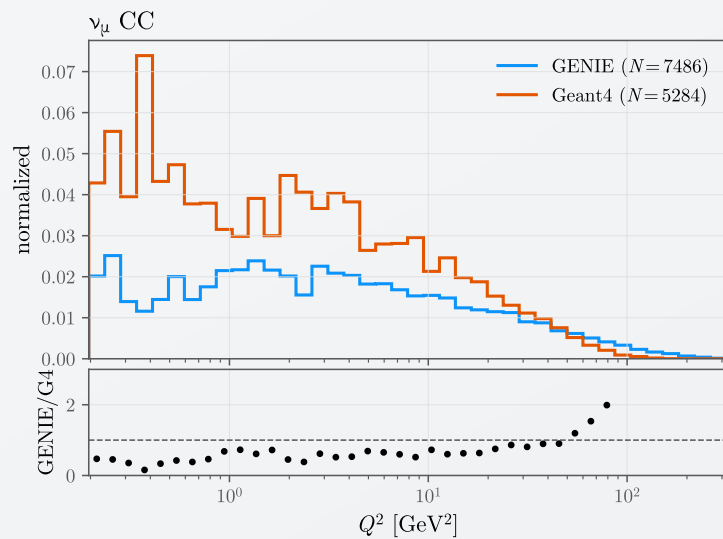
Backup

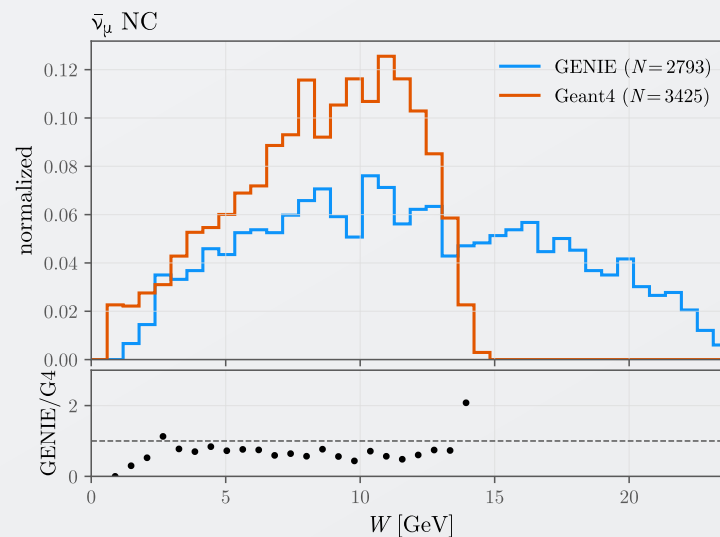
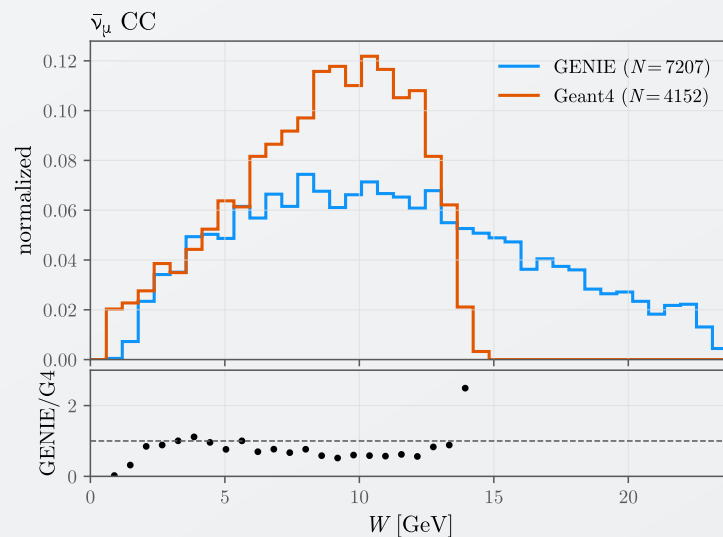
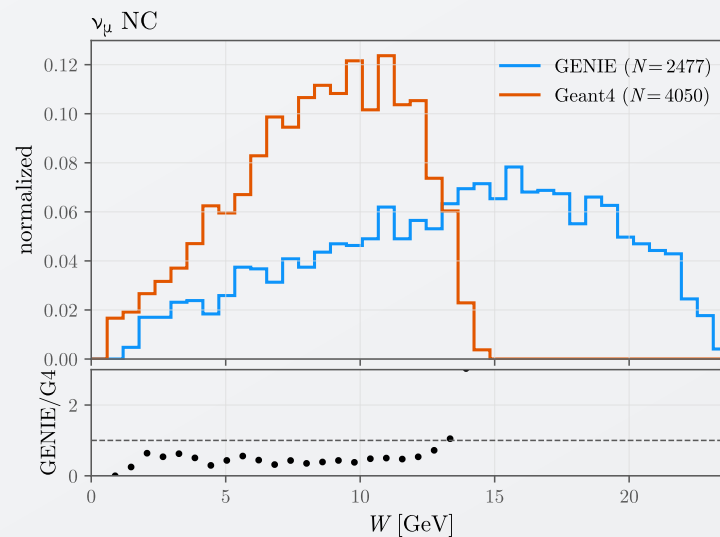
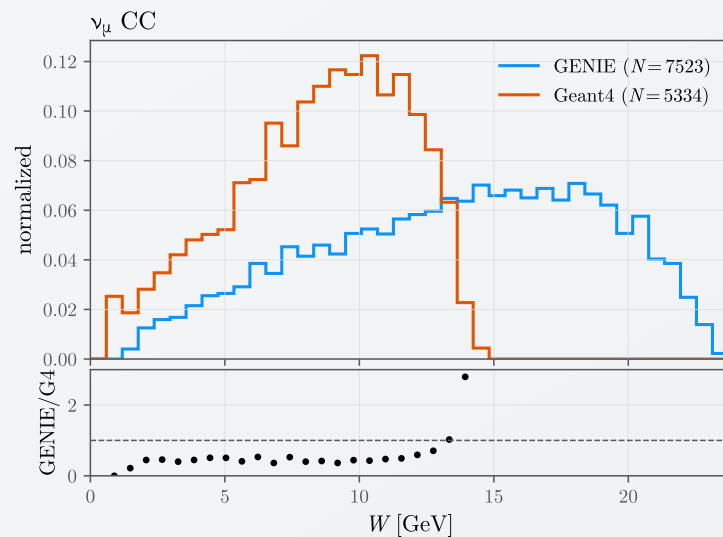


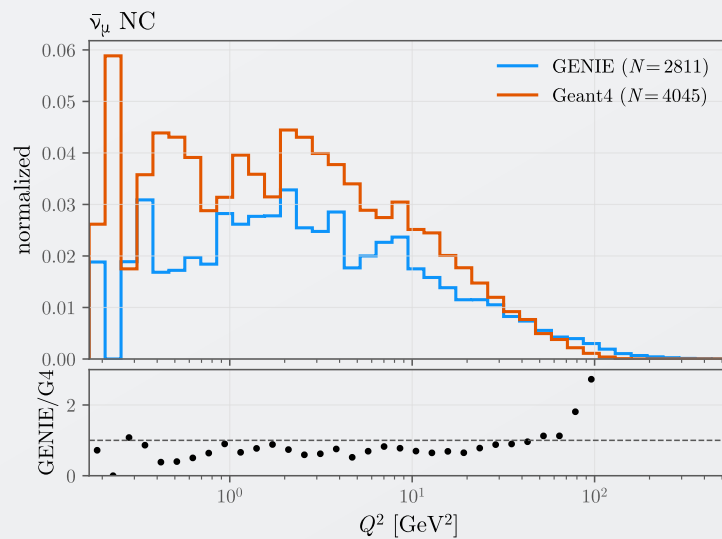
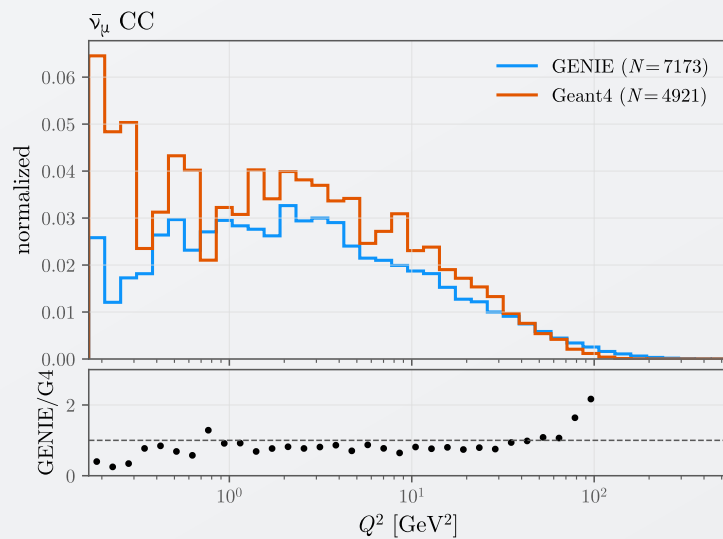
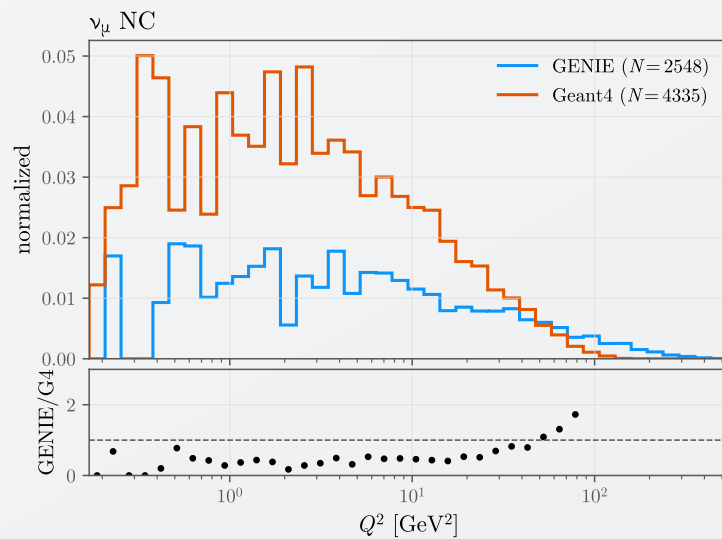
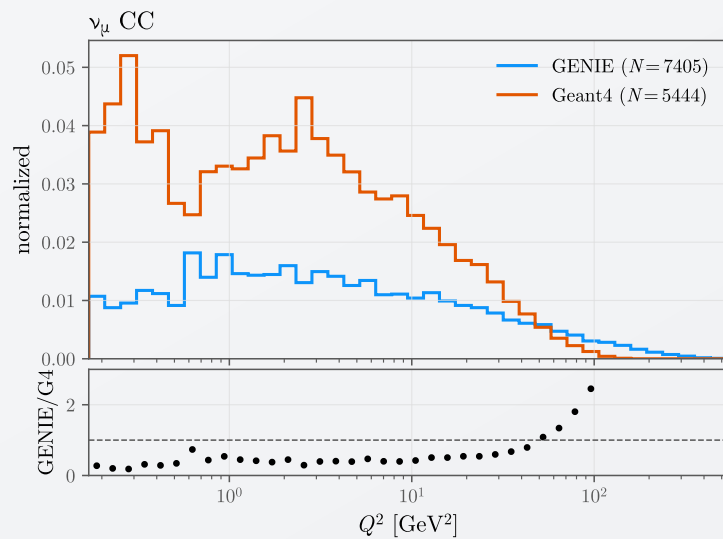


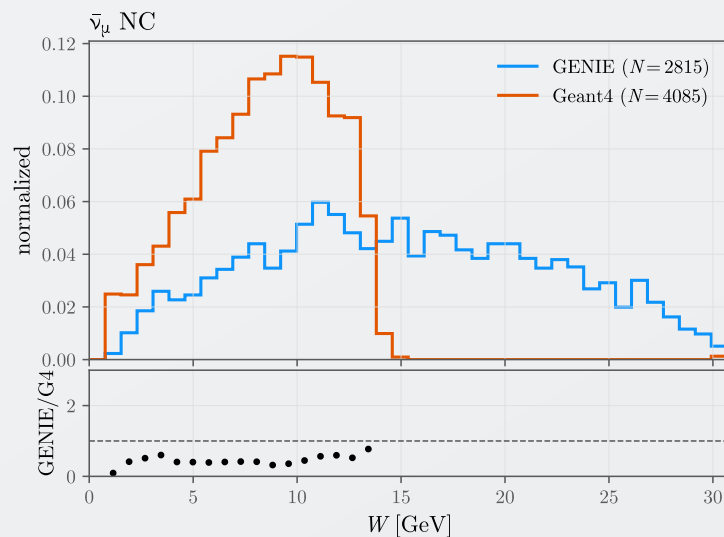
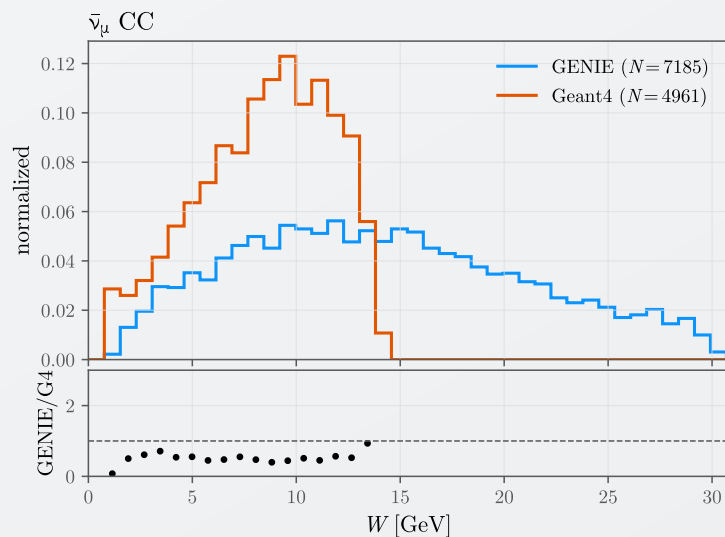
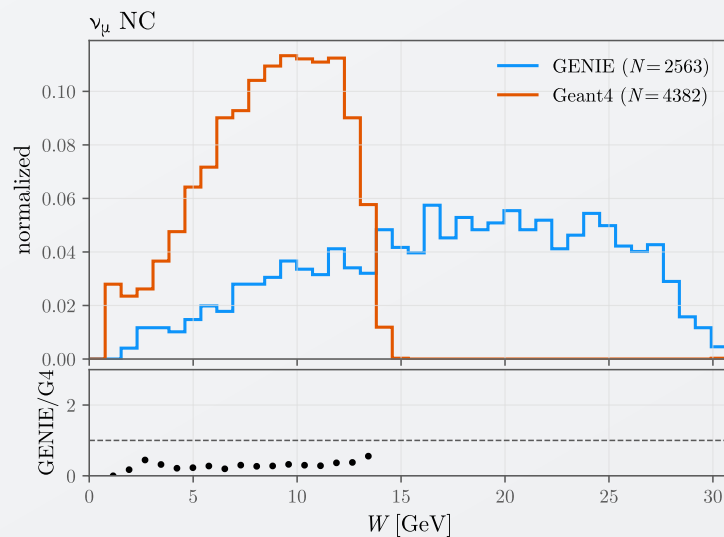
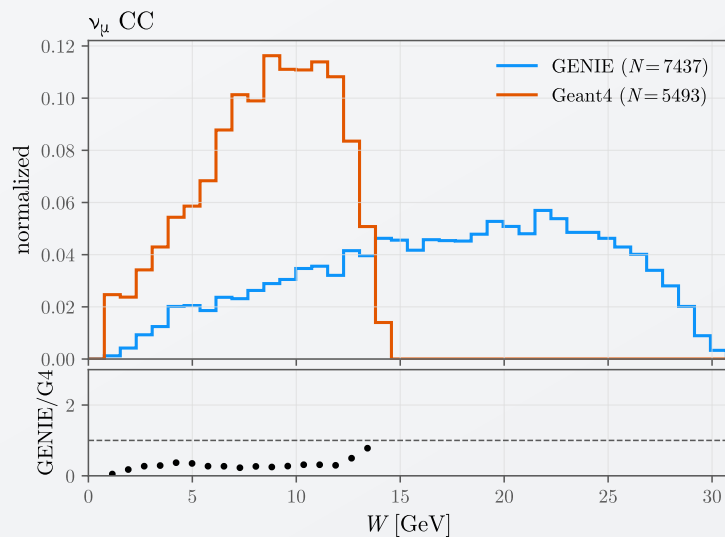


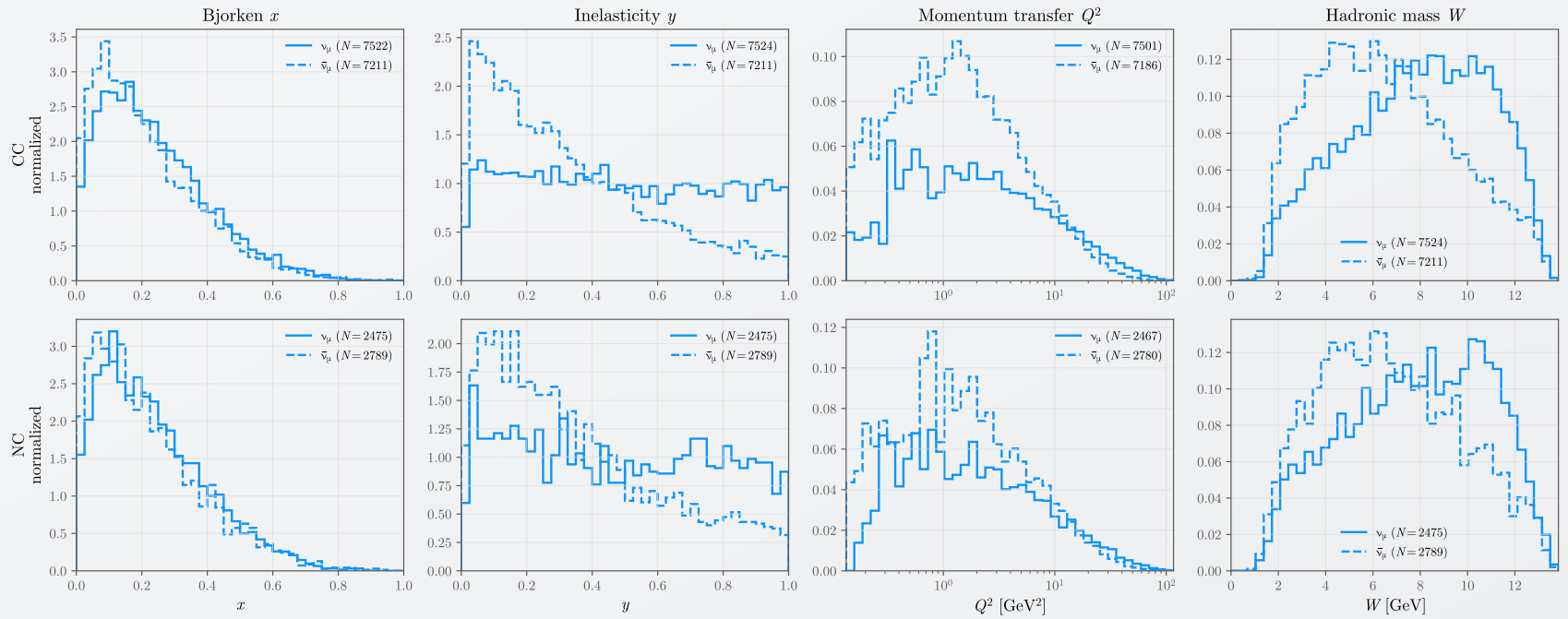


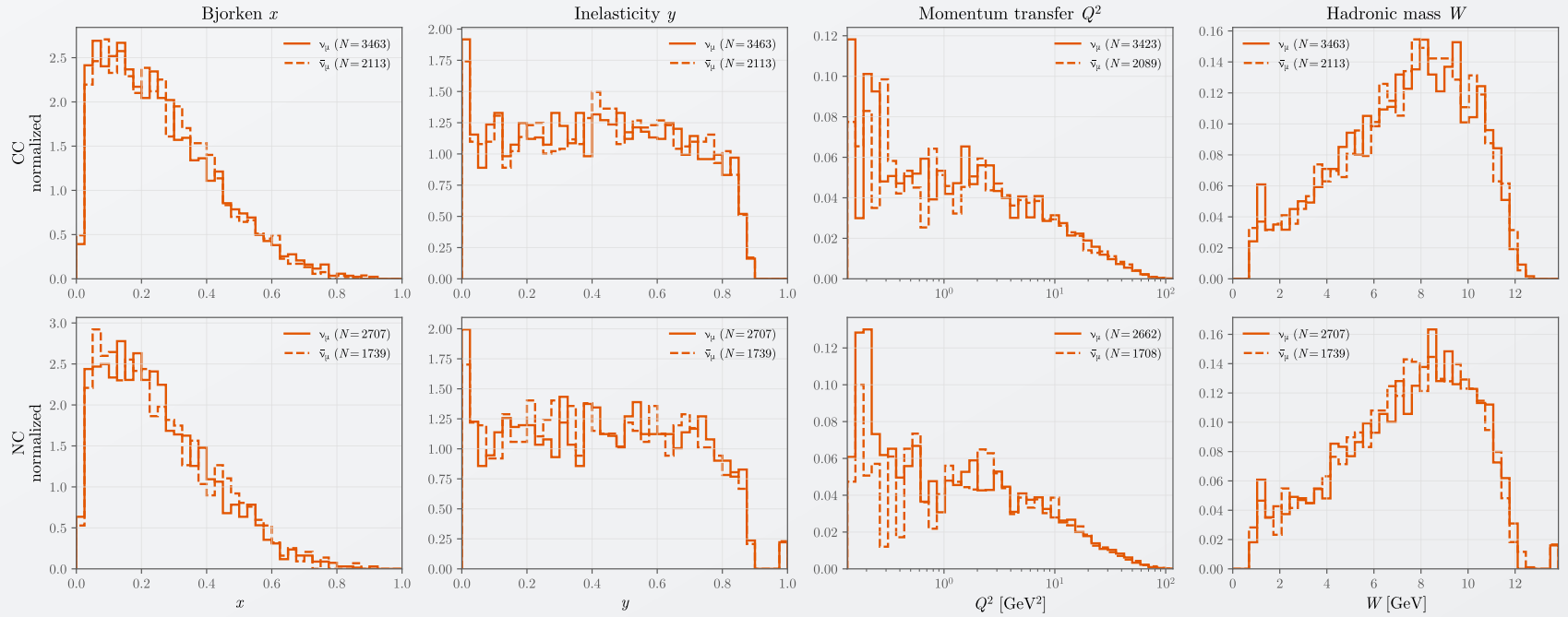


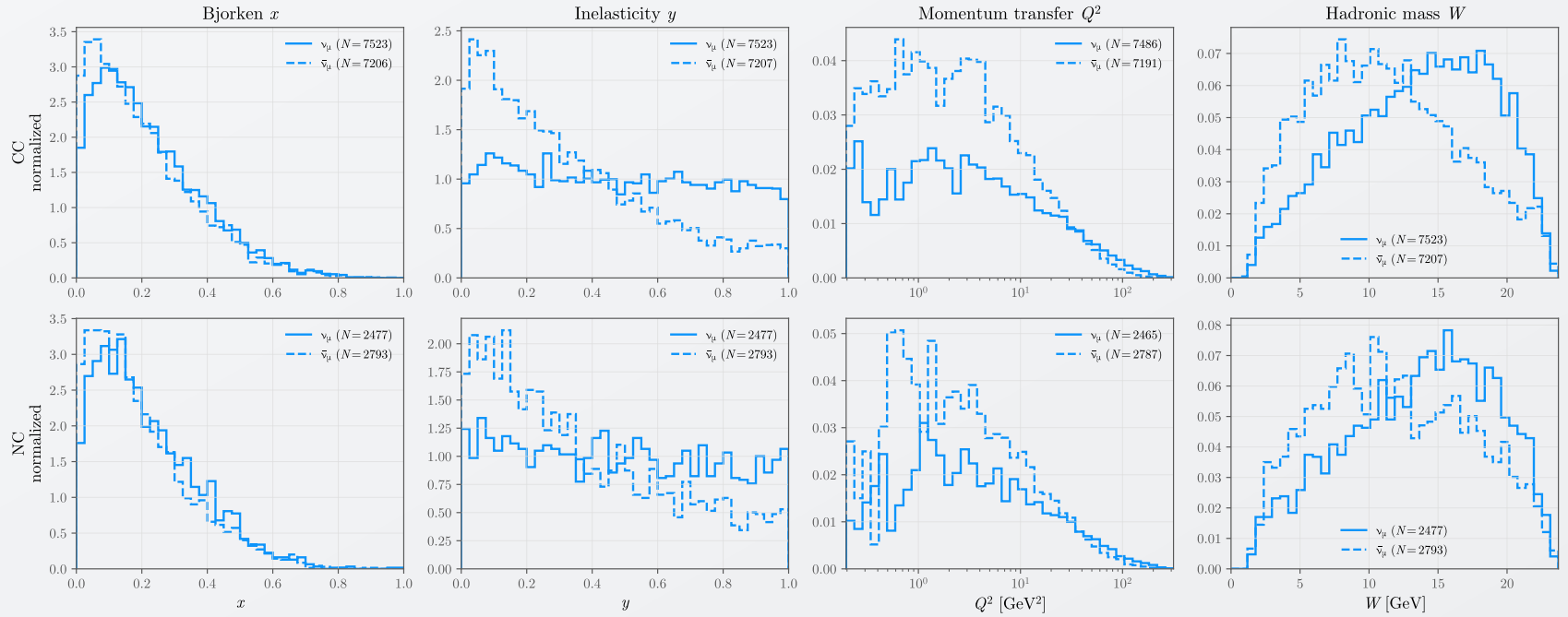


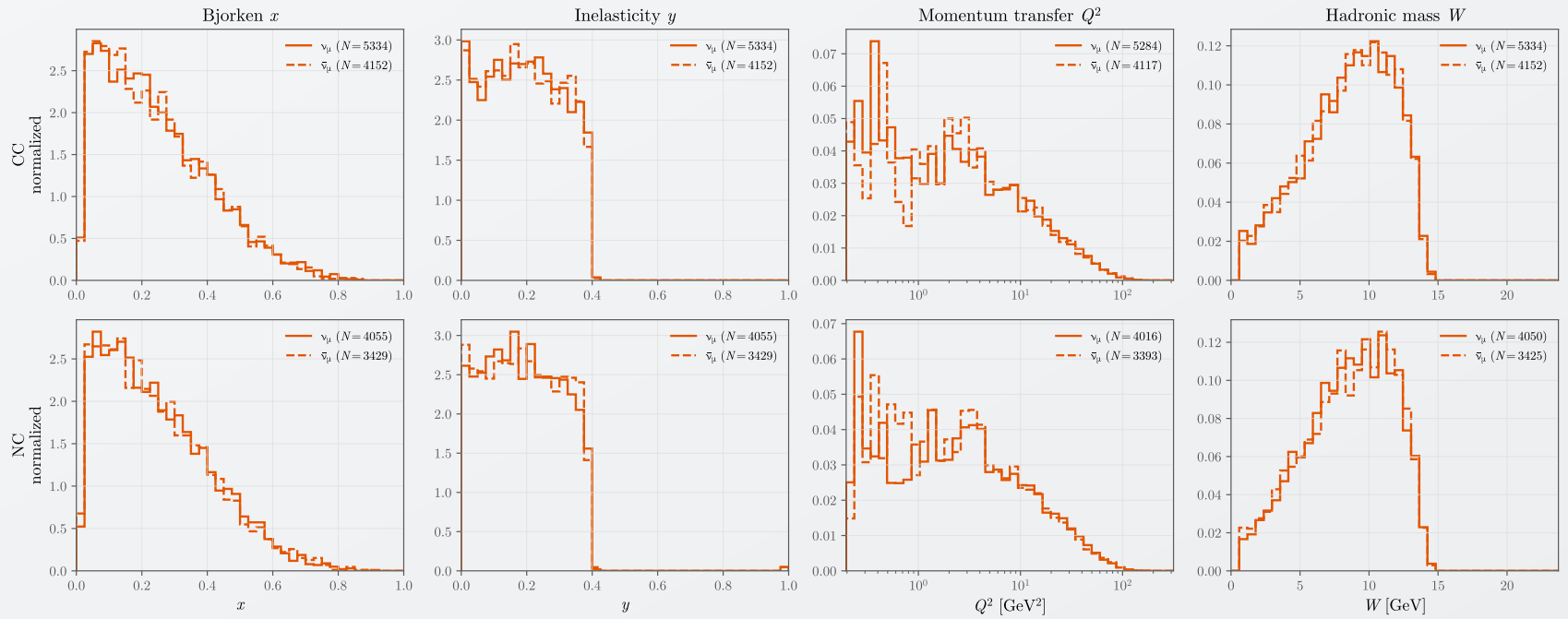


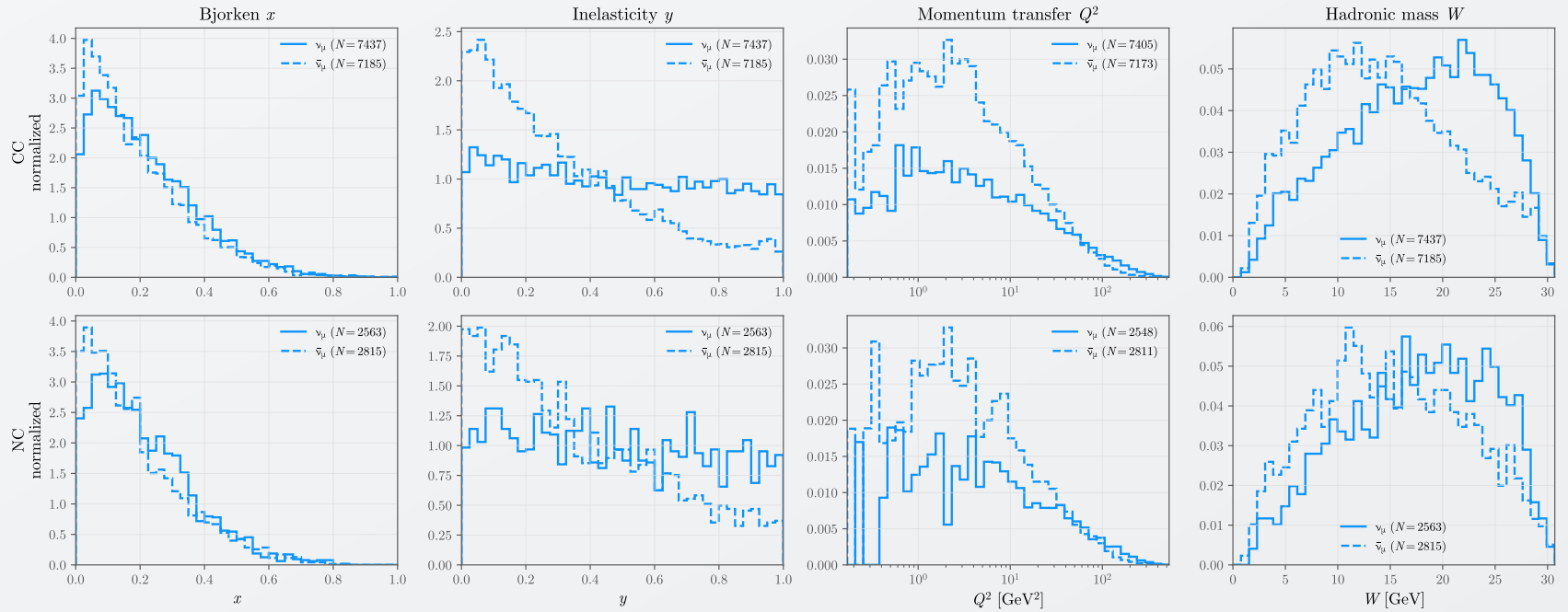


GENIE: ν_μ vs $\bar{\nu}_\mu$, 100 GeV, graphite (C-12)

Geant4: ν_μ vs $\bar{\nu}_\mu$, 100 GeV, graphite (C-12)

GENIE: ν_μ vs $\bar{\nu}_\mu$, 300 GeV, graphite (C-12)

Geant4: ν_μ vs $\bar{\nu}_\mu$, 300 GeV, graphite (C-12)

GENIE: ν_μ vs $\bar{\nu}_\mu$, 500 GeV, graphite (C-12)

Geant4: ν_μ vs $\bar{\nu}_\mu$, 500 GeV, graphite (C-12)