

# **COMPLETE PREDICTIONS FOR HIGH-ENERGY NEUTRINO PROPAGATION IN MATTER**

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The interpretation of the **cosmic neutrino flux** depends on the knowledge of the **high-energy** neutrinos cross section. Interactions with Earth matter modify the incoming neutrinos flux observed by large-volume detectors. We present a complete and reliable calculation of this effect.

If your neutrino experiment is affected by Earth absorption try this framework!\*

## **NEUTRINO ATTENUATION RATES ARE PROVIDED BY A NEW SOFTWARE PACKAGE**



**GENIE-based** application with the structure of a general-purpose Monte Carlo event generator. It allows following the path and interactions (fully differential) of individual neutrinos as they travel through Earth on an event-by-event basis.



STATE-OF-THE-ART CROSS SECTIONS FOR HIGH-ENERGY NEUTRINO

- All relevant processes are included:
- Absorption due to  $v_{\mu,e}$  DIS CC interactions.
- Energy degradation from  $v_x$  DIS NC scattering.
- $v_{\tau}$  regeneration accounting for  $\tau$  energy losses.
- Secondary v flux from  $\tau$  decays and sub-leading interactions.

#### **INTERACTIONS IMPLEMENTED IN THE HEDIS MODULE OF GENIE** 10<sup>7</sup> Glashow Res. NLO Glashow Res. LO $\sigma/A[10^{-38}cm^2]$ S-Resonant $0^{6}$ Coherent [<sup>16</sup>0] 10<sup>5</sup> .0<sup>4</sup> 10<sup>3</sup> 8 6 7 9 $\log_{10}(E_{\nu}[GeV])$

Deep inelastic scattering off guarks and gluons. Scattering on atomic electrons via the Glashow resonance (In)elastic scattering off the photon field of nucleons. Coherent scattering off the photon field of nuclei.

#### WE QUANTIFY THE DEPENDENCE OF THE TRANSMISSION COEFFICIENT T ON:

#### THE NEUTRINO FLAVOR

- Large deviations from full **absorption** approximation due to NC degradation and tau regeneration.
- Consistent evaluation of nucleon PDF uncertainties. Few percent level nucleon PDF errors for most of the relevant energy range.

### THE CROSS SECTION MODEL

Two models compared:

- BGR18 JHEP 01 (2019) 217 - CMS11 JHEP 08 (2011) 042
- 10-20% disagreement due to different scheme to account for heavy quark mass effects.
- Different prescription to compute PDF uncertainties have a **small** impact on errors.

#### -THE NUCLEAR CORRECTIONS

Thorough calculation to study the impact of nuclear effects (as shadowing) using nNNPDF1.0 as input.

- Nuclear PDF effects have a significant impact in the predictions for the attenuation rates.
- Large uncertainties due to the lack of constraints on nPDFs in the small-x regime.



\* NuPropEarth code: https://github.com/pochoarus/NuPropEarth



