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Prometheus: An Open-Source Neutrino Telescope Simulation

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The construction of a worldwide network of gigaton-scale neutrino telescopes aims to address multiple open questions in physics, such as the origin of astrophysical neutrinos and the acceleration mechanism of high-energy cosmic rays. Besides astrophysics, neutrino telescopes probe center-of-mass energies similar to colliders, offering an additional window into high-energy particle interactions.

Currently, there are no publicly available simulation tools for these detectors, leading to duplication in effort for each experiment and hindering the testing of theoretical models.

While these detectors are built in ice or water at different locations, they operate on the same detection principle: Using multiple optical modules to detect Cherenkov photons emitted by charged particles.

Using this, we developed Prometheus, an open-source simulation tool that offers a common simulation chain for all neutrino telescopes. It can inject neutrinos, propagate their interaction products, and model the amount of light reaching the optical modules of a user-defined detector in either ice or water. We will show its runtime performance, highlight successes in reproducing simulation results from multiple ice- and water-based observatories, and discuss simulation sets that we have made publicly available for various detectors.

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