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Probing the Earth Core Composition with Neutrino Oscillation Tomography

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Atmospheric neutrinos open the way to alternative probing methods to study the structure and composition of the inner Earth, complementary to geophysical methods. At GeV energies, the flavour oscillations of neutrinos crossing the Earth are distorted due to coherent forward scattering on electrons along their path. The signature of these matter effects in the neutrino angular, energy
and flavour distributions may provide sensitivity to the electron density, and thus the composition, in the different layers traversed. The combination of this neutrino-based measurement with a reference mass density profile constrains the effective proton-to-nucleon ratio of the medium (Z/A), providing new insights into the chemical composition of the inner Earth, and in particular its core, whose content in light elements is still controversial.

Such a measurement requires large-sized neutrino detectors with good efficiency in the relevant energy range and precise determination of the neutrino energy, arrival direction, and flavour. Considering a generic but realistic model of detector response, we discuss the influence of various detector performance indicators on the sensitivity to the average Z/A in the core. Starting from
specific examples of the next-generation detectors (ORCA, DUNE), we also identify the main improvements required to reach a measurement of the H content of the core at the 1 wt% level.

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