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Refinement of antenna response and ice properties at radio wavelengths

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The now decommissioned ARIANNA experiment, which operated in Antarctica between 2014 and 2021, demonstrated that low cost, near surface, directional radio antennas can reject thermal and anthropogenic backgrounds as sufficient levels required by future arrays of similarly constructed near surface stations of 500 stations or more, while the neutrino efficiency remains above 90%. Each ARIANNA station is self contained and operated reliably at a power consumption of only 10 watts, which is low enough to permit year round eco-friendly operation in polar climates such as solar panels, and because up to half the year is without sun, wind turbines. The neutrino sensitivity was indirectly assessed by observing cosmic ray events, which produce similar radio pulse emission by their collisions in atmosphere, by identical in-situ antennas facing the upward direction. The collaboration also published a study of energy resolution, which utilizes field data and simulation of the double pulse technique known as DNR, to determined the distance to neutrino interaction. One commonly discussed method to obtain the direction of the neutrino requires the measurement of the incoming direction of the emitted radio pulse and its polarization.The ARIANNA collaboration has reported good agreement between measured and calculated polarization from a radio pulse generated lowered in a previously cored hole near the South Pole, Antarctica, between depths of 1000 m and 1700 m. The angular range of the arrival directions of the radio pulses covered in this study overlaps with most of the expected signal arrival directions from neutrino events within detectors located on the Ross Ice Shelf.

In this paper, we describe work to assess the polarization reconstruction from pulser emission at shallower depths, where upward traveling signals arrive within 30 deg of the local horizontal direction. The shallower pulser depths corresponds to arrival directions that cover a majority of neutrino interactions within detectors at high elevation polar locations. Two issues are studied: (1) the simulated in situ antenna response for large arrivals angles relative are not proven to be reliable, and must be calibrated or empirically assessed; (2) radio signals will reflect off the snow-air surface an enter the antenna through the back lobe, and the antenna response is also poorly known. The predicted polarization is compared to the measured value using archival pulser data collected in a follow up study.

Collaboration(s)

ARIANNA

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