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Propagating Air Shower Radio Signals to In-ice Antennas

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Radio emissions from cosmic ray showers serve as an essential background signal for in-ice radio detectors in the polar regions. Furthermore, cosmic ray showers can also serve as calibration sources for in-ice radio detectors due to their relatively large flux. Thus, we have adapted CoREAS for simulating their radio signals in in-ice antennas. We present a novel way to upgrade CoREAS such that it takes into account curved ray paths caused by the exponential refractive index profiles of air and ice, which enables propagating signals from air to antennas located inside the ice sheets. Analytic raytracing expressions are used to calculate the relevant parameters for the curved ray paths between the air shower particles and the in-ice antennas. Although analytic raytracing takes around 0.05 to 0.1 ms per call, it is still too slow to do it for all the particles in the air shower. Therefore we have developed an interpolation scheme that calculates ray parameters using pre-tabulated raytraced values and takes around 200 ns per call. In this work, we will show some simulations of air-shower signals as observed by in-ice antennas.

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