Contribution ID: **159** Type: **oral**

RDSim, a fast and comprehensive simulation of radio detection of air showers

Thursday, 28 July 2022 15:15 (15 minutes)

We present RDSim, a fast and comprehensive framework for the simulation of the radio detection of downgoing air showers. It can handle any downgoing shower that can be simulated with ZHAireS, including those induced by CC and NC neutrino interactions and τ decays. RDSim is based on a superposition toymodel that disentangles the Askaryan and geomagnetic components of the shower emission. By using full ZHAireS simulations as input, it is able to estimate the radio footprint anywhere on the ground. A single input simulation at a given energy and arrival direction can be scaled in energy and rotated in azimuth by taking into account all relevant effects. This makes it possible to simulate a huge number of geometries and energies using just a few ZHAireS input simulations.

The framework takes into account the main characteristics of the detector, such as trigger setups, thresholds and antenna patterns. To accommodate arrays that use particle detectors for triggering, such as the Auger RD extension, it also features a second toymodel to estimate the muon density at ground level, which is used to perform simple particle trigger simulations.

It's speed makes it possible to investigate in detail events with a very low trigger probability, as well as many geometrical effects, such as those due to asymmetric arrays, infills and other border effects. In case more detailed studies of the radio detection are needed, RDSim can also be used to sweep the phase-space for the efficient creation of dedicated full simulation sets. This is particularly important in the case of neutrino events, that have extra variables that greatly impact shower characteristics, such as interaction or τ decay depth as well as the type of interaction and it's fluctuations.

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Session Classification: Parallel 1

Track Classification: EAS