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An analytic description of the radio emission of air showers based on its emission mechanisms

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The spatial signal distribution of the radio frequency radiation from extensive air showers on the ground contains information on crucial cosmic-ray properties, such as energy and mass. A long standing challenge to access this information experimentally with a sparse grid of antennas is an analytic modeling of the radio signal distribution, which will be addressed in this contribution. We present an analytic model based on the two physical processes generating radio emission in air showers: the geomagnetic and the charge-excess emission. Our study is based on full Monte Carlo simulations with the CoREAS code. Besides an improved theoretical understanding of radio emission, our model describes the radio signal distribution with unprecedented precision. Our model explicitly includes polarization information, which basically doubles the information that is used from a single radio station. Our model depends only on the definition of the shower axis and on the parameters energy and distance to the emission region, where the distance to the emission region has a direct relation to the cosmic-ray's mass. We show with the use of CoREAS Monte Carlo simulation that fitting the measurements with our model does not result in significant contributions in both systematic bias and in resolution for the extracted parameters energy and distance to emission region, when compared to the expected experimental measurement uncertainties.

Authors: GLASER, Christian (University of California, Irvine); ERDMANN, Martin (Rheinisch Westfaelische Tech. Hoch. (DE)); DE JONG, Sijbrand (Radboud University Nijmegen (NL)); HÖRANDEL, Jörg (Ru Nijmegen/Nikhef)

Presenter: GLASER, Christian (University of California, Irvine)

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