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Multi-wavelength observation of cosmic-ray air-showers with CODALEMA/EXTASIS

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Over the years, significant efforts have been devoted to the understanding of the radio emission of extensive air shower (EAS) in the range [20-80] MHz but, despite some studies led until the nineties, the [1-10] MHz band has remained unused for nearly 30 years. At that time it has been measured by some pioneering experiments but also suggested by theoretical calculations that EAS could produce a strong electric field in this band, and that there is possibly a large increase in the amplitude of the radio pulse with lower frequencies. The EXTASIS experiment, located within the radio astronomy observatory of Nançay and supported by the CODALEMA instrument, aims to reinvestigate the [1-10] MHz band, and to study the so-called "Sudden Death" contribution, the expected radiation electric field created by the particles that are stopped upon arrival to the ground. Currently, EXTASIS has confirmed some results obtained by the pioneering experiments, and tends to bring explanations to the other ones, for instance the role of the underlying atmospheric electric field.

Moreover, CODALEMA has demonstrated that in the most commonly used frequency band ([20-80] MHz) the electric field profile of EAS can be well sampled, and contains all the information needed for the reconstruction of EAS: an automatic comparison between the SELFAS3 simulations and data has been developed, allowing us to reconstruct in (quasi-)real time the latter ones. At last, the unique capability of the antennas and acquisition system used in CODALEMA widen the observation window up to 250 MHz. The high-frequency electric field (120-250 MHz) at ground level is expected to be distributed following a ring of amplified emission due to Cherenkov-like effects. We see such patterns in the CODALEMA data which, associated to EXTASIS, allows one to study EAS over a very wide band, from 1 to 250 MHz.

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