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Radio universality and template-based pulse synthesis

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When discussing radio emission from cosmic ray air showers we commonly make a number of assumptions regarding the production and propagation physics. Incorporating all of these it should be possible to construct a forward model to predict the radio signal produced by an air shower from simple parameters, an application and generalisation of shower universality to radio emission.

In terms of particle detection shower universality focuses on the one-dimensional longitudinal profile, counting only the number of particles. This appears insufficient in the context of radio emission, the particle cascade develops on the scale of traversed atmospheric depth while electromagnetic radiation scales with the geometric trajectories of the sources. Further a real shower extends several radio wavelengths in the lateral direction while analyses often assume a point source on the shower axis. Thus we perform simulations to assess the validity of assumptions such as point-like emission, scaling of the radio output with particle number and mean free path length, spherical propagation and symmetries in the radio footprint as predicted by the analytical descriptions of geomagnetic and charge excess emission.

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