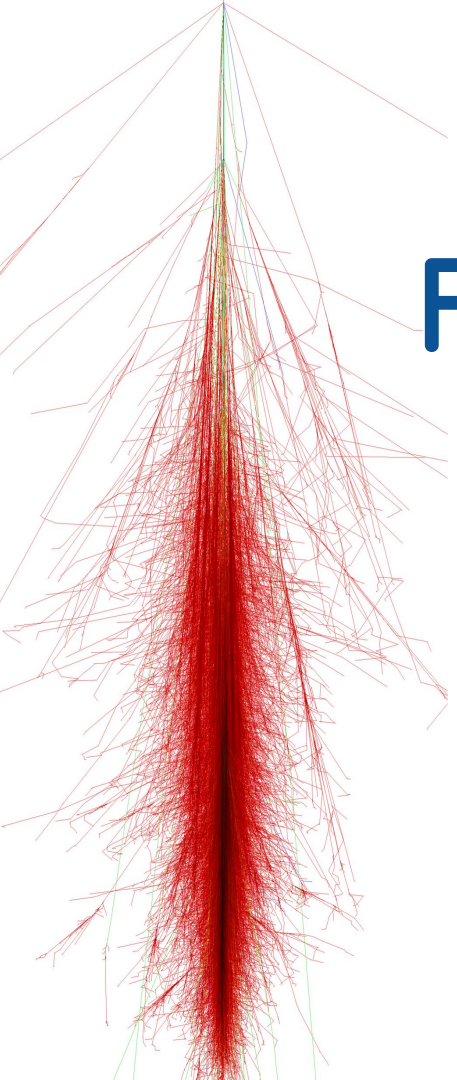


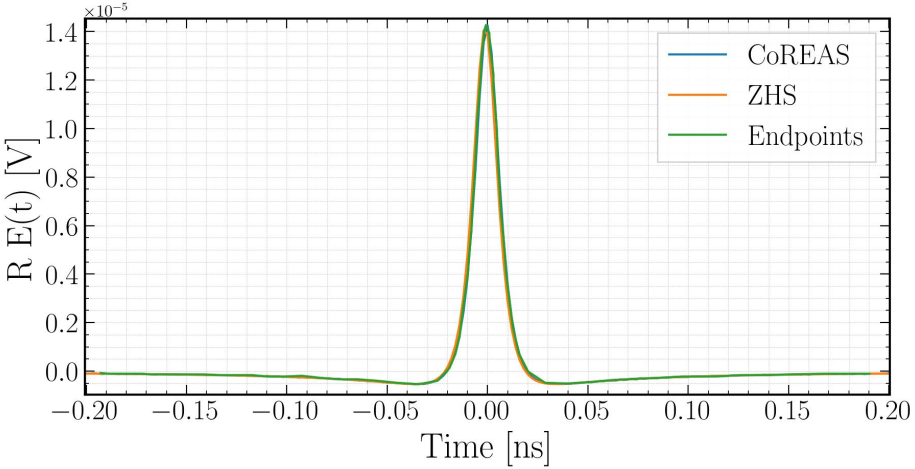
Future of Radio in CORSIKA 8

Nikos Karastathis

What do we have so far?

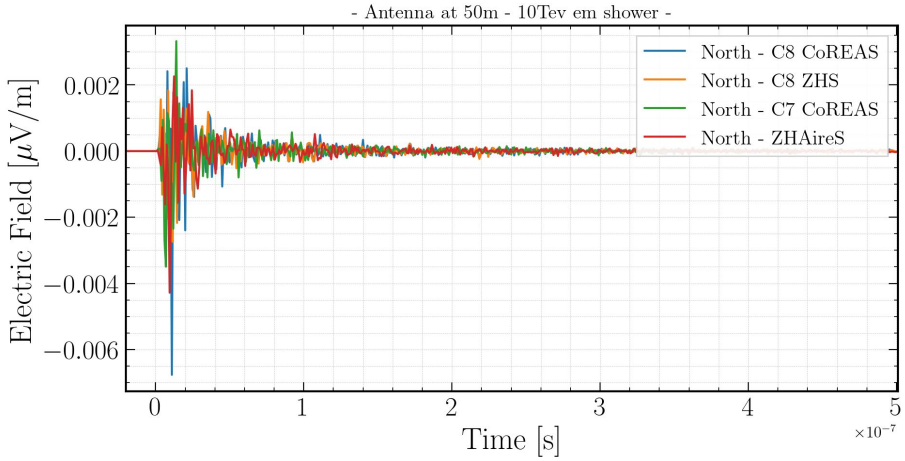
- Stable radio branch within C8, soon to be merged into master.
- All key aspects of the radio emission mechanism are developed.
- We can produce reasonable pulses using 2 algorithms.
- We can use radio as a testing mechanism for physics and relevant modules of C8, like tracking algorithms, timing issues etc. There are 2 versions of “Cyclotron Radiation” examples that serve us as “physics” tests.
- Straight ray propagation (analytic and numerical approach).
- Uniform & Exponential refractive index model.
- 3 examples are fully functional: 1) a full vertical (or not ;)) shower 2) an electromagnetic shower (the one we base most of our validation tests) & 3) the “Cyclotron Radiation” test.

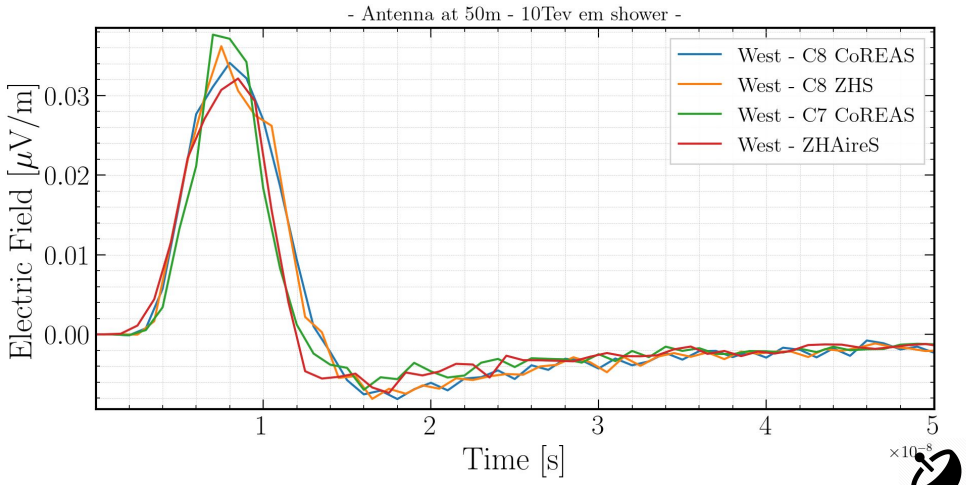
Some cherry picked results

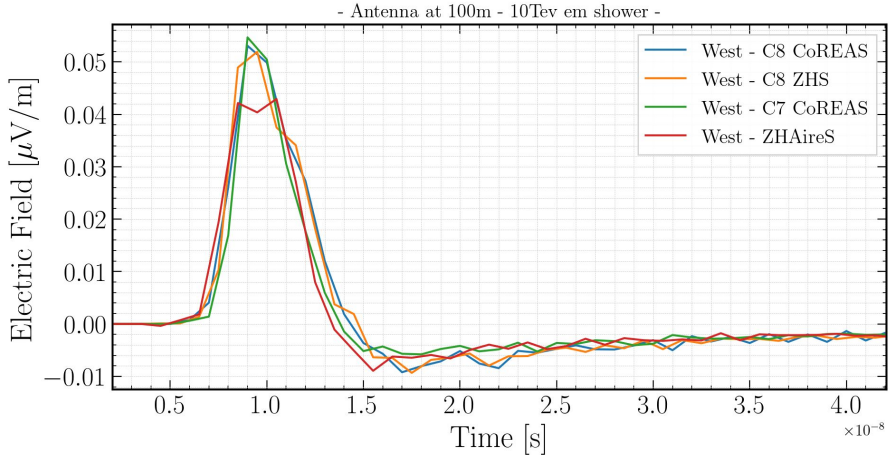


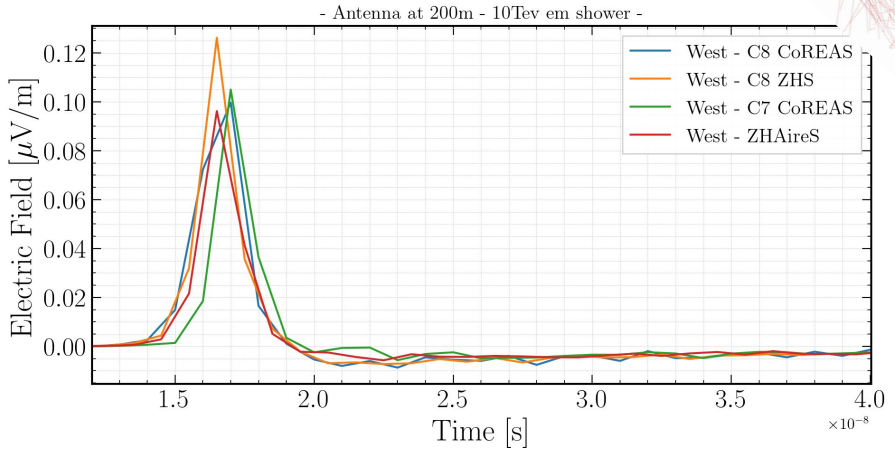
Electron in a uniform magnetic field

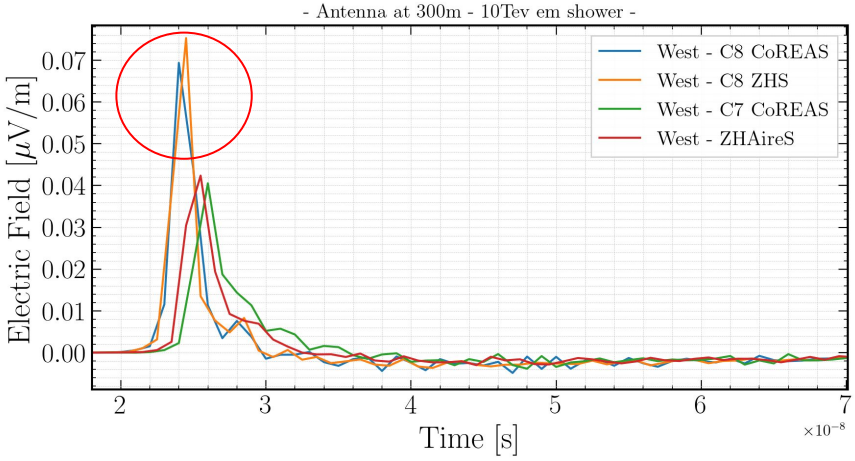
10 TeV em shower

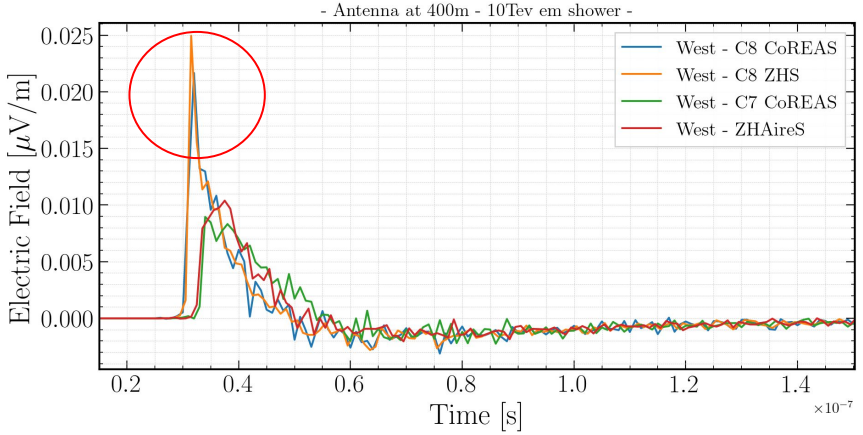


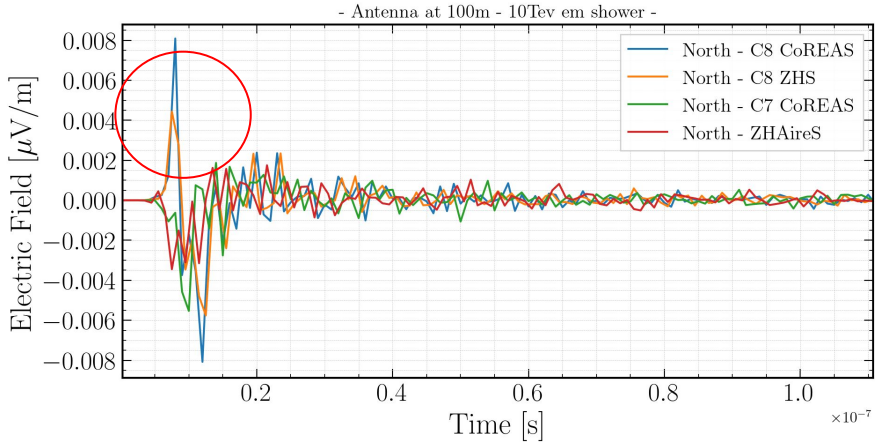


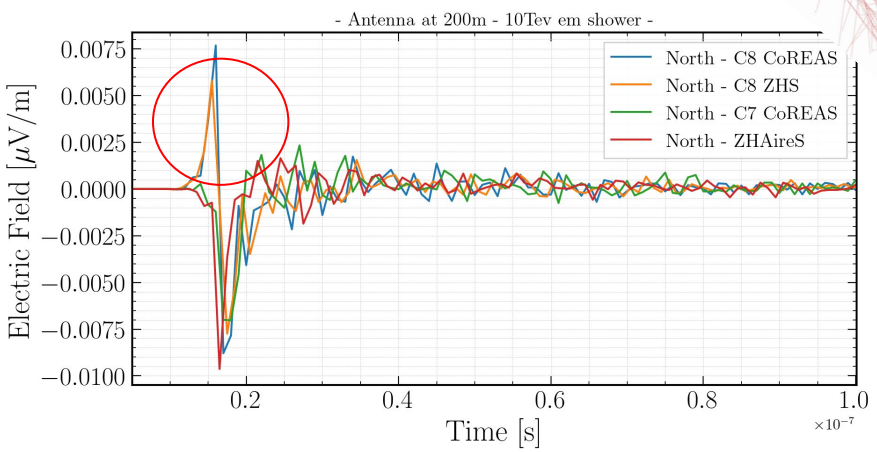

- Antenna at 100m - 10Tev em shower -
West - C8 CoREAS
West - C8 ZHS
West - C7 CoREAS
West - ZHAireS
Electric Field [μV/m]
Time [s]
×10⁻⁸


- Antenna at 200m - 10Tev em shower -
West - C8 CoREAS
West - C8 ZHS
West - C7 CoREAS
West - ZHAireS
Electric Field [μV/m]
Time [s]
×10⁻⁸

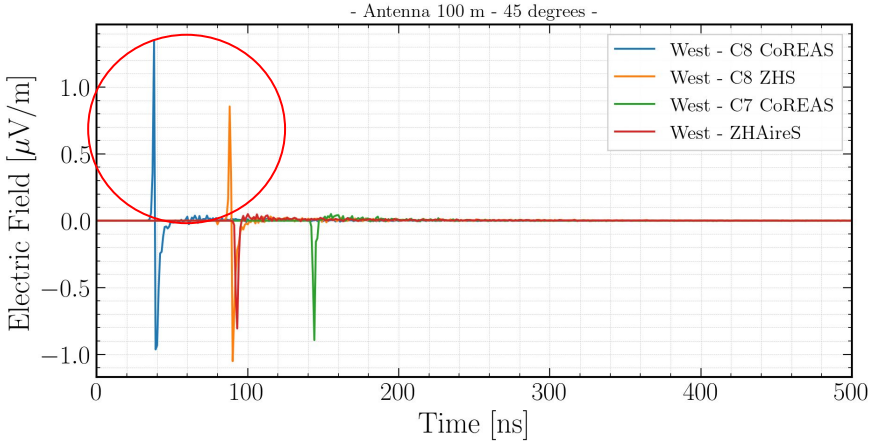

- Antenna at 300m - 10Tev em shower -
West - C8 CoREAS
West - C8 ZHS
West - C7 CoREAS
West - ZHAireS
Electric Field [μV/m]
Time [s]
×10⁻⁸

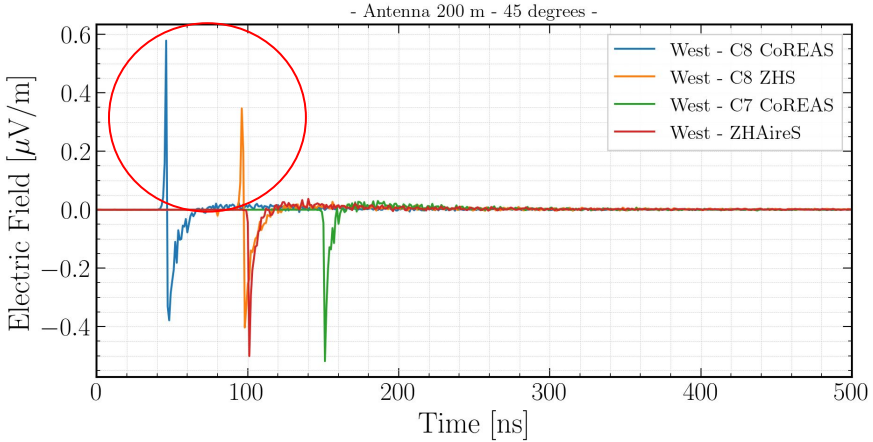

- Antenna at 400m - 10Tev em shower -
West - C8 CoREAS
West - C8 ZHS
West - C7 CoREAS
West - ZHAireS
Electric Field [μV/m]
Time [s]
×10⁻⁷



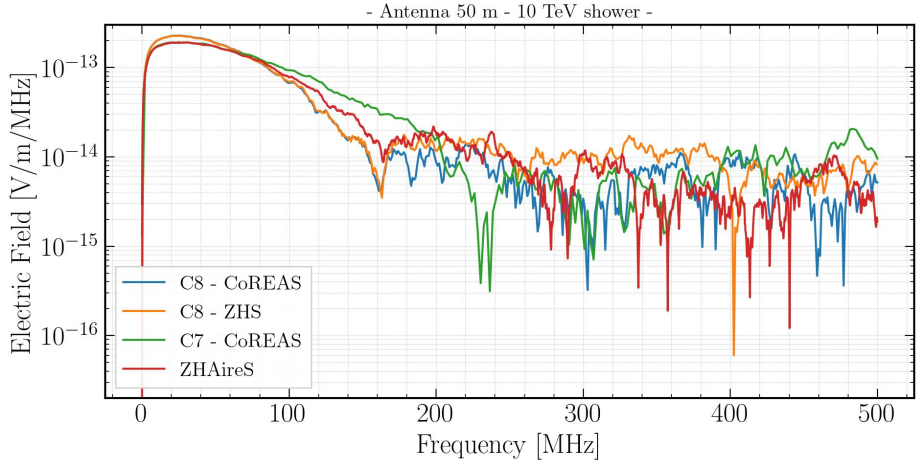


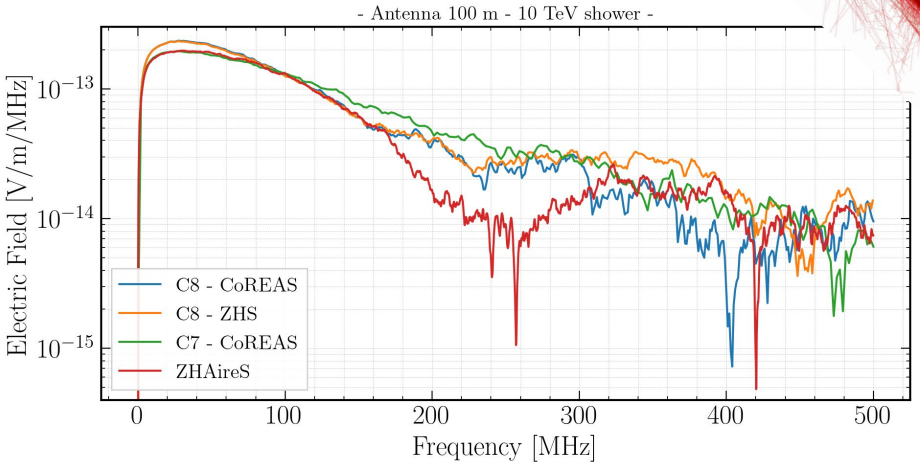
Askaryan emission for 1 PeV shower illustrates the issue

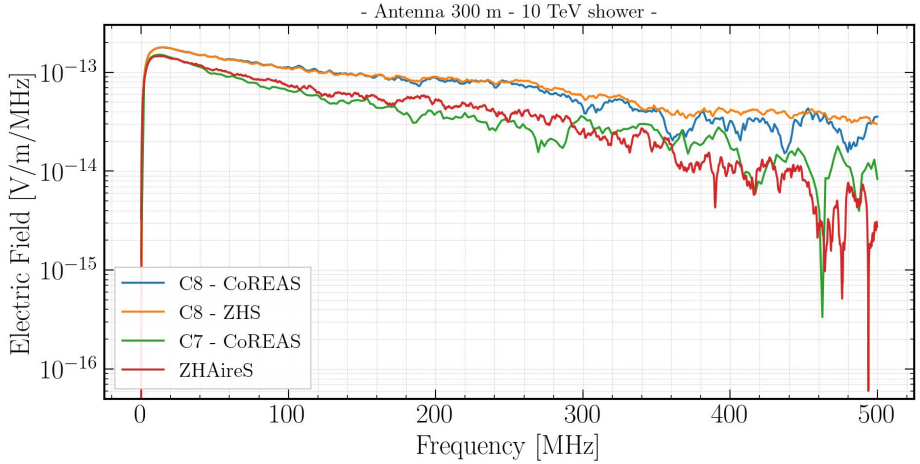


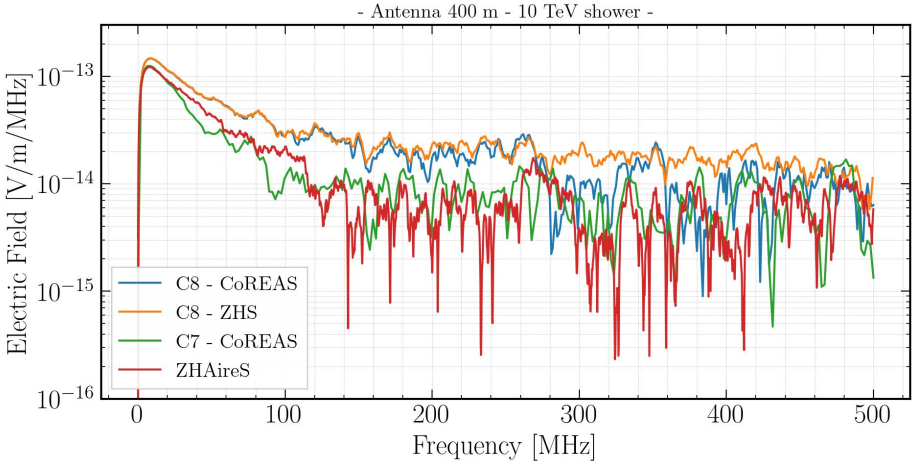


Frequency spectra

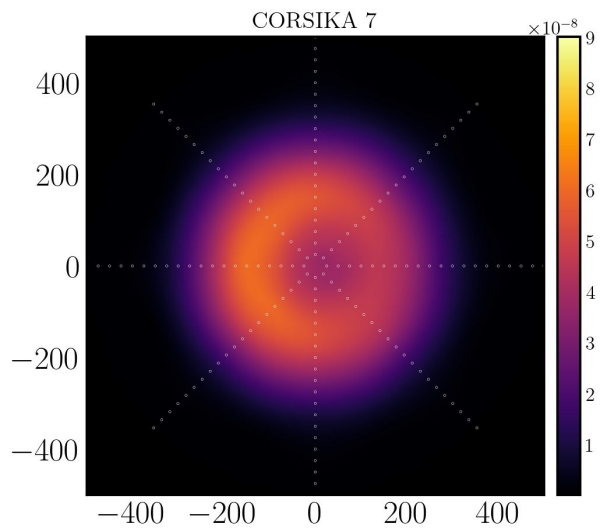




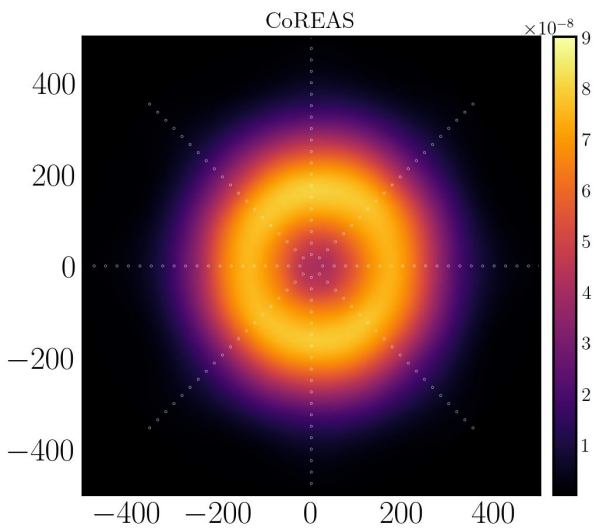




All Polarizations

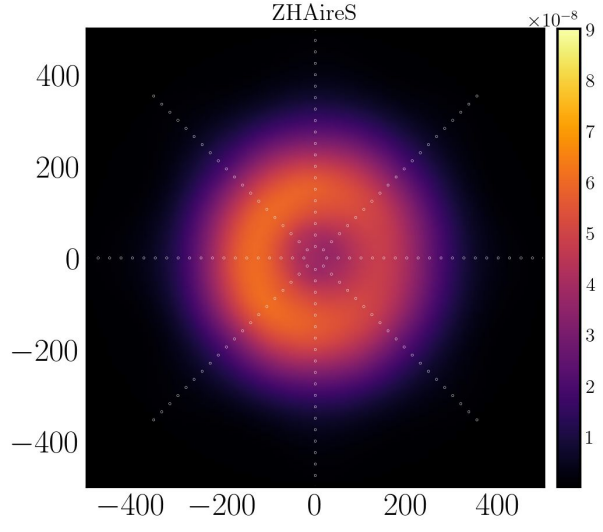


Corsika 7

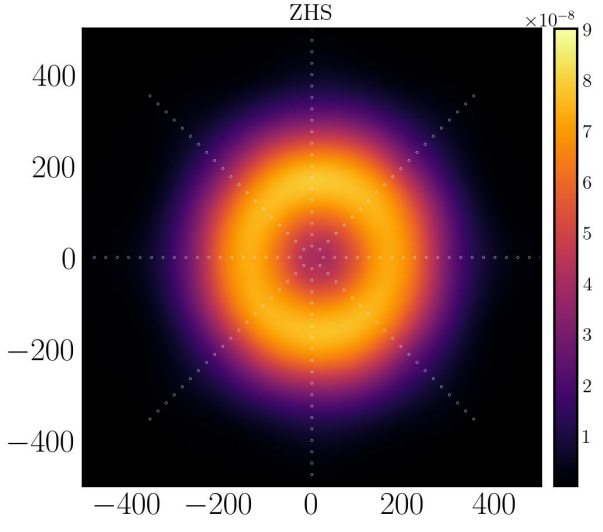


C8 - CoREAS

10 TeV em shower

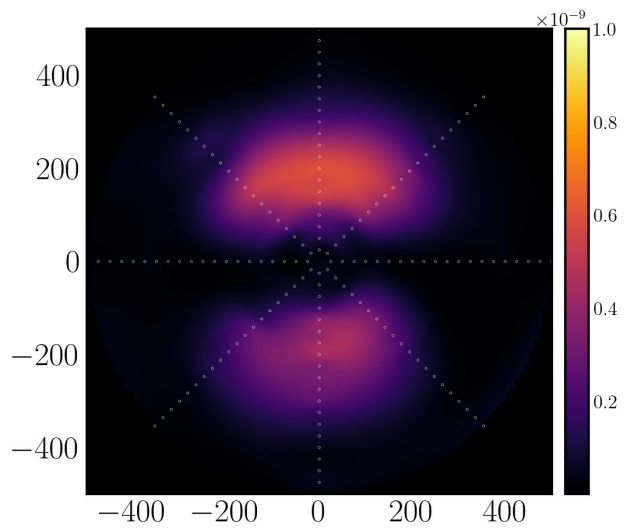


ZHAireS



C8 - ZHS

North Polarization



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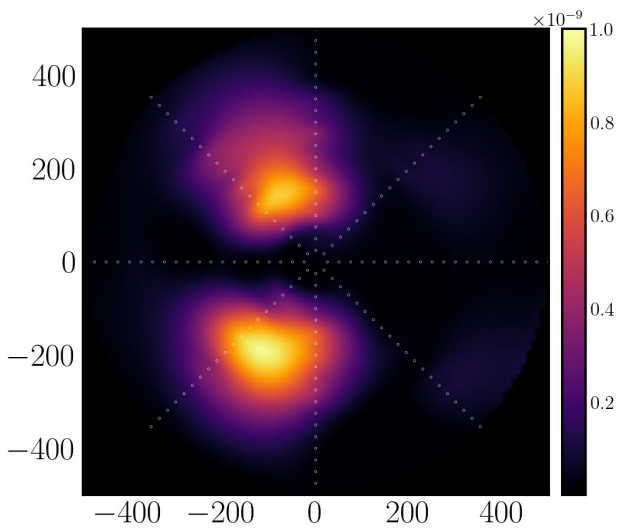
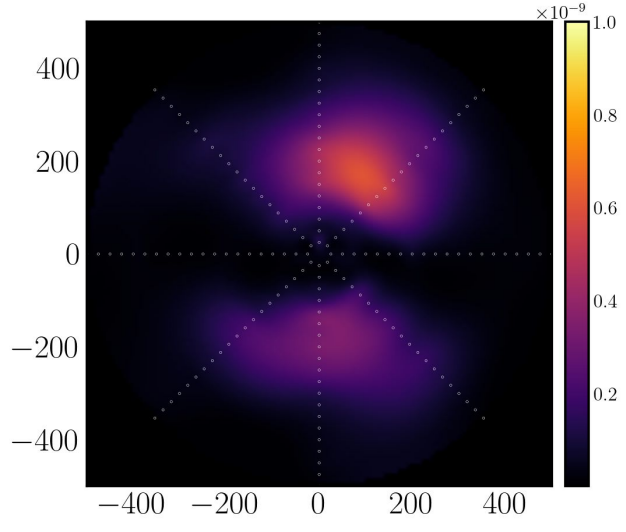
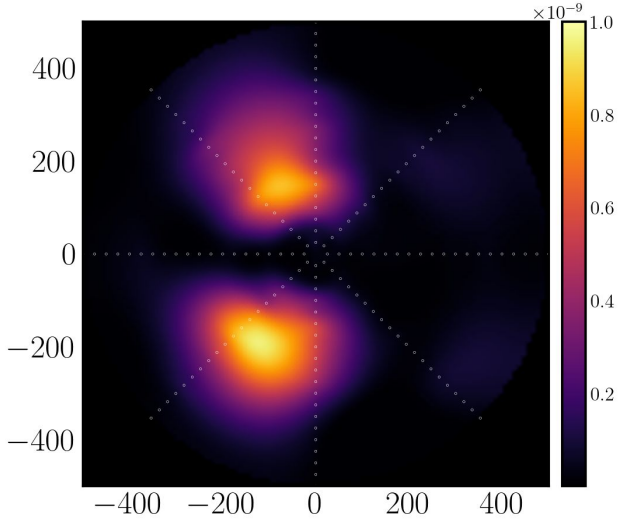


C8 - CoREAS

10 TeV em shower

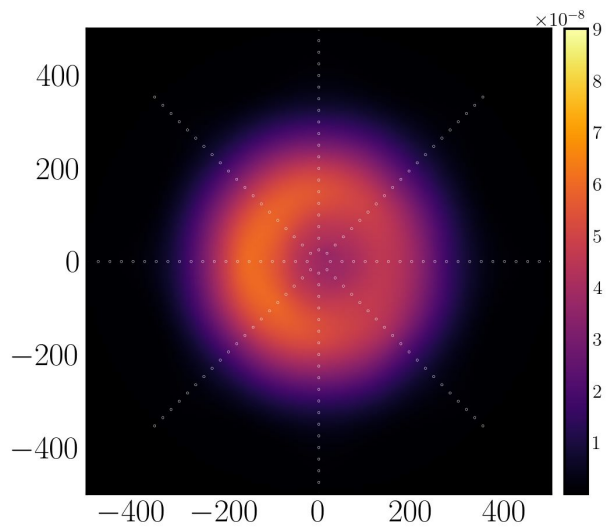


ZHAireS



C8 - ZHS

West Polarization



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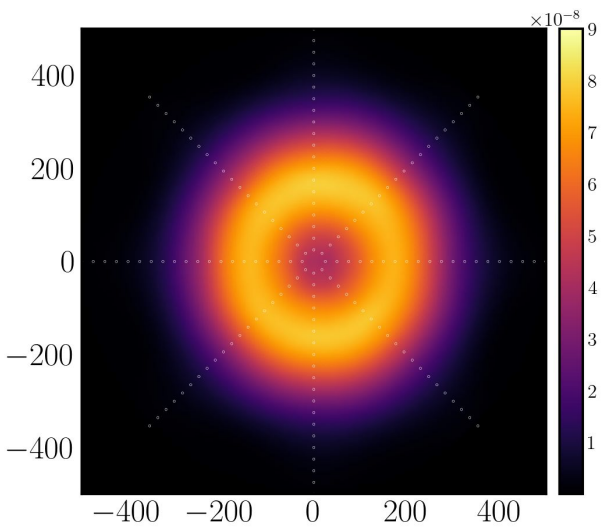
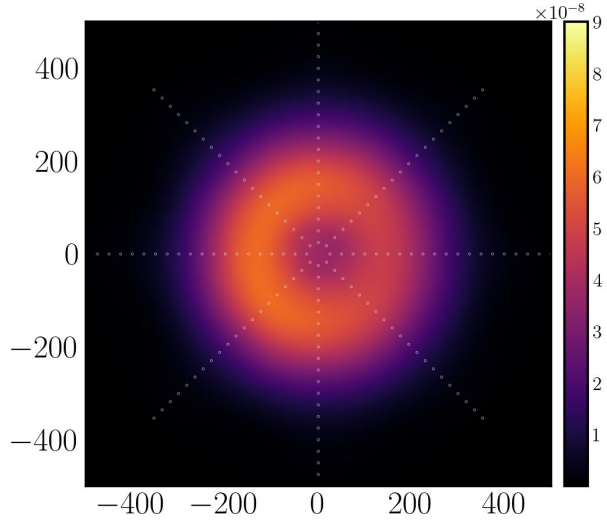
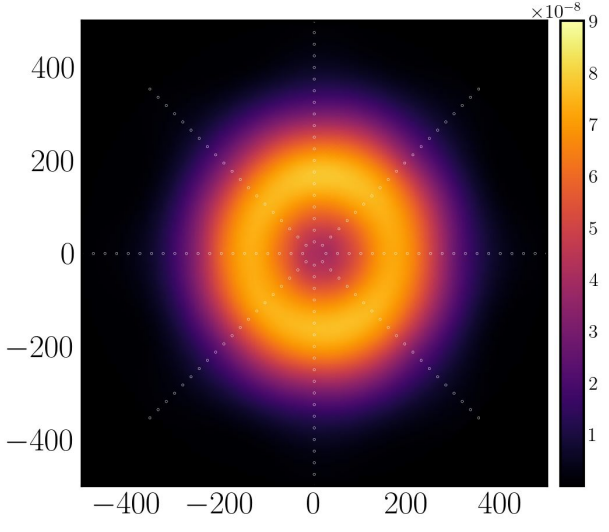


C8 - CoREAS

10 TeV em shower

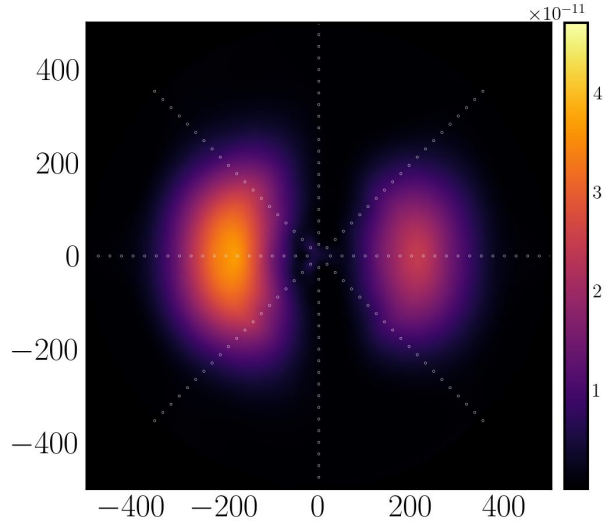


ZHAireS



C8 - ZHS

Vertical Polarization



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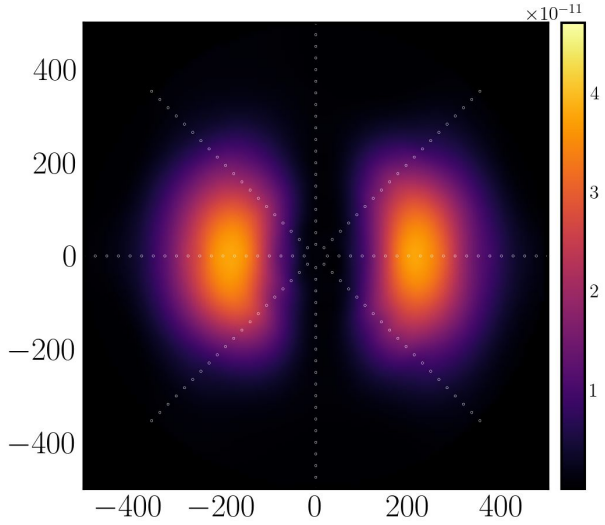
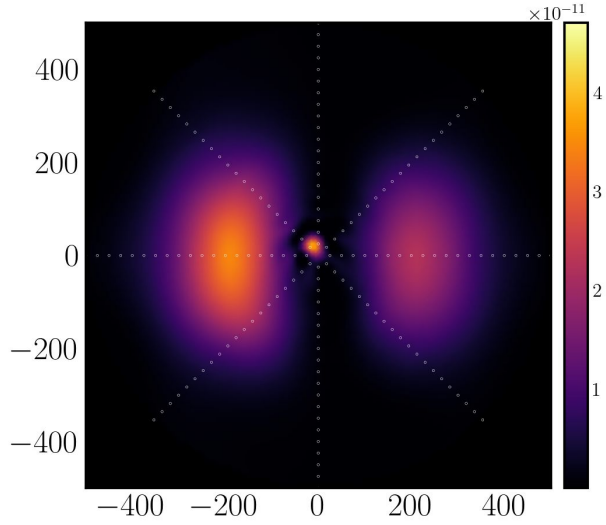
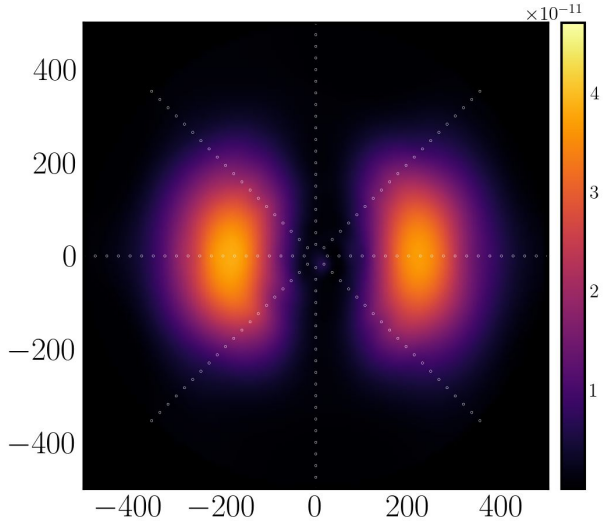


C8 - CoREAS

10 TeV em shower



ZHAireS



C8 - ZHS

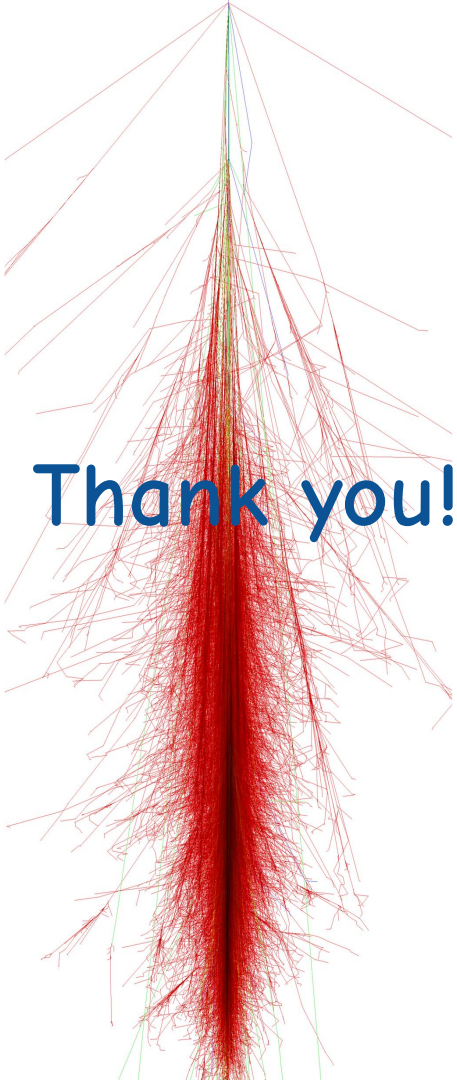
What is the current status of work?

- Validation and testing of PROPOSAL.
- There is an issue probably in charge excess.
- Pulses seem to disagree by 50% after the Cherenkov ring.
- Clean up the code and merge with CORSIKA 8 master.
- Document our results.

What is the future of Radio in C8?

- Help with validation of PROPOSAL hopefully soon, so we have nice pulses.
- Develop new propagators that include more physics and focus on performance. These can be propagators that allow ray tracing when crossing boundaries and come up with clever pre-tabulated propagators that save us calculation time.
- Work actively in the parallelization of the sequence mechanism of C8 and use radio as a benchmarking tool in terms of physics and performance.
- Write code that deploys GPUs so we can save time when simulating lots of antennas.
- The plan is to have the bullets above done by June approximately.
- Write specific examples that simulate the setup of experiment of interest. For instance, we have specific examples for Auger, LOFAR, IceTop etc. that use the correct propagator (i.e. if we propagate through ice we use the ray tracing propagator) and we simply change shower properties.

Focus on running simulations for LOFAR



Thank you!