ICRC 2025 - The Astroparticle Physics Conference

Contribution ID: **1050** Type: **Talk**

Backtracking radio signals for the X_{max} measurement of extensive air showers: A new approach

Thursday 17 July 2025 14:05 (15 minutes)

Precise measurements of the composition of cosmic rays in the energy range of $10^{17} - 10^{18}$ eV could provide crucial insights into the long-standing questions about the origin and acceleration of these particles. Ground-based experiments typically rely on determining the position of the extensive air shower maximum (X_{max}) to identify the type of cosmic ray particle. One effective method for determining X_{max} is by analyzing the radio emission produced by these air showers. This approach offers several advantages, including continuous operation and a higher duty cycle compared to fluorescence telescopes, which are limited by weather conditions and lunar phases. However, conventional radio-based methods often involve computationally intensive Monte Carlo simulations, or rely on pre-calculated parameterizations derived from simulations. In this contribution, we present a new method which is highly efficient and has the potential to reconstruct X_{max} with very minimal input from simulations. This method reconstructs the radio emission profile of air showers by backtracking the radio signals recorded by a ground-based antenna array, considering that the signal received by each antenna travels perpendicular to the radio wavefront. By analyzing simulated proton and iron showers in the $10^{17} - 10^{18}$ eV range, this study reveals a strong correlation between the radio emission profiles in the 20–80 MHz frequency band, and the longitudinal profile of the air shower.

Collaboration(s)

Author: Dr VUTA, Jhansi (Department of Astroparticle Physics, Institute of Physics of the Czech Academy of Sciences, 18200 Prague, Czech Republic.)

Co-authors: Dr CORSTANJE, Arthur (Interuniversity Institute for High-Energy, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium); Prof. HÖRANDEL, Jörg (Department of Astrophysics / IMAPP, Radboud University Nijmegen, P. O. Box 9010, 6500 GL, Nijmegen, The Netherlands); Dr MULREY, Katharine (Department of Astrophysics / IMAPP, Radboud University Nijmegen, P. O. Box 9010, 6500 GL, Nijmegen, The Netherlands); Mr DESMET, Mitja (Astrophysical Institute, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium); Prof. SCHOLTEN, Olaf (University of Groningen, Kapteyn Astronomical Institute, Groningen, 9747 AD, Netherland); Dr THOUDAM, Satyendra (Department of Physics, Khalifa University of Science and Technology, P.O. Box 127788, Abu Dhabi, United Arab Emirates); Dr BUITINK, Stijn (Astrophysical Institute, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium); Prof. HUEGE, Tim (Institut f¨ur Astroteilchenphysik (IAP), Karlsruhe Institute of Technology (KIT), P. O. Box 3640, 76021, Karlsruhe, Germany)

Presenter: Dr VUTA, Jhansi (Department of Astroparticle Physics, Institute of Physics of the Czech Academy of Sciences, 18200 Prague, Czech Republic.)

Session Classification: CRI

Track Classification: Cosmic-Ray Indirect