Contribution ID: **1347** Type: **Poster**

Event-by-event primary composition discrimination method using supervised machine learning

We have developed a radio detection mass discrimination method for cosmic ray events. This method uses supervised machine learning (ML) algorithms, namely random forests, to discriminate between light (p) and heavy (Fe) primary compositions on an event-by-event basis. It bypasses any X_{max} reconstructions and instead tries to infer the primary composition directly. To perform the discrimination, the method also needs an estimate of the primary or electromagnetic (EM) energy of the shower along with its uncertainty, which is also taken into account. As features of the random forest we initially only used, for each triggered antenna, its distance to the shower axis and the peak amplitude of the electric field. Using this initial 2-feature approach we were able to obtain discrimination accuracies of up to 82% for the primary composition, even with large primary energy uncertainties of up to 30%. An analysis of the random forest feature importances uncovered that such good accuracies were possible due to a large electric field amplitude dependence on the position of the shower maximum (X_{max}). We describe this X_{max} amplitude dependence and explain it in detail on our other contribution to this conference. We have also investigated the impact of adding other X_{max} sensitive features, such as the spectral slope of the radio signal, on the discrimination efficiency of the method. This work is Monte Carlo based and uses ZHAireS simulations along with RDSim to generate separate sets of events for training and testing the random forest algorithm.

Collaboration(s)

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Session Classification: PO-1

Track Classification: Cosmic-Ray Indirect