Contribution ID: **834** Type: **Poster**

# Boosting the performance of the neural network using symmetry properties for the prediction of the shower maximum using the water Cherenkov Detectors of the Pierre Auger Observatory as an example

*Friday 16 July 2021 19:18 (12 minutes)*

To probe physics beyond the scales of human-made accelerators with cosmic rays demands an accurate knowledge of their primary mass composition. Using fluorescence detectors, one is able to estimate this by measuring the depth of the shower maximum $X_{\mathrm{max}}$. These, however, exhibit a very low duty cycle of typically below 15 %.

Inferring $X_{\mathrm{max}}$ from a surface detector array (SD) such as the water-Cherenkov array of the Pierre Auger Observatory is highly non-trivial due to the inherent complexity and fluctuations of the shower footprint. Moreover, the sheer amount of data makes it non-trivial to find hidden patterns in the spatial and temporal distributions of detector signals. Neural networks provide a straightforward way of tackling such a problem doing a data-driven analysis.

Relying solely on geometrical quantities, timing, and the signal-time information of the SD stations, we show that by exploiting the symmetries due to their triangular arrangement, we are able to boost a standard analysis network significantly without modifying its architecture or training process. Furthermore, these considerations yield a standardization procedure which also enables us to encode the footprint's information in a memory-efficient way. The presented procedure can also be generalized and extended to systems whose setup has an underlying hexagonal geometry.

## Keywords

pierre auger observatory; mass estimation of primary; neural network analysis

## Collaboration

## other Collaboration

## Subcategory

Experimental Methods & Instrumentation

**Primary authors:** HAHN, Steffen (KIT - IAP); Dr ROTH, Markus (KIT); SCHMIDT, David (Karlsruhe Institute of Technology); Dr VEBERIC, Darko (Karlsruhe Institute of Technology (KIT))

**Presenter:** HAHN, Steffen (KIT - IAP)

**Session Classification:** Discussion

**Track Classification:** Scientific Field: CRI | Cosmic Ray Indirect