Deep learning based event reconstruction for Limadou HEPD

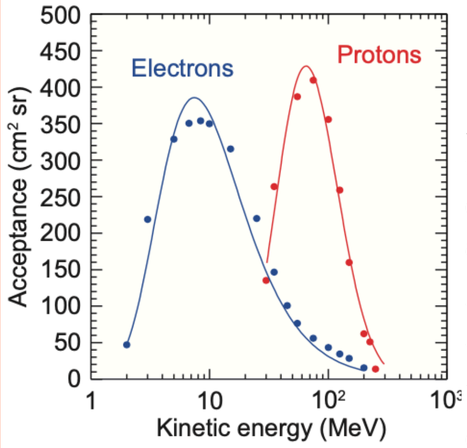
ICRC 2021, 12-23 July, Berlin

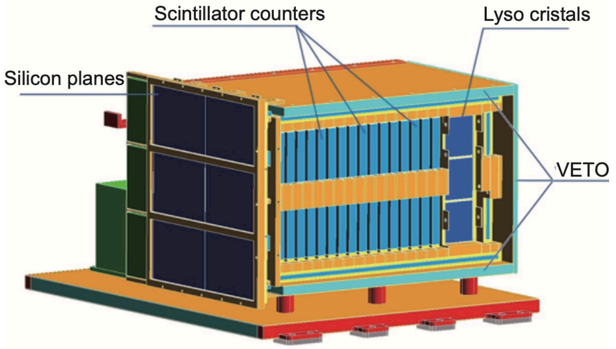
Motivation

The goal of this work is to develop and **apply Deep Learning algorithms to the event reconstruction of the High Energy Particle Detector** (Limadou HEPD) of the CSES Mission [1]. This reconstruction chain is designed to estimate with high accuracy the kinetic energy, the nature and the arrival direction of an incoming particle starting from the full collection of detector digitized signals.

Detector and Simulation

Limadou HEPD [2] is the Italian contribution to the CSES mission. It was **launched on board of the CSES satellite in February 2018** and collects mainly fluxes of protons and electrons:





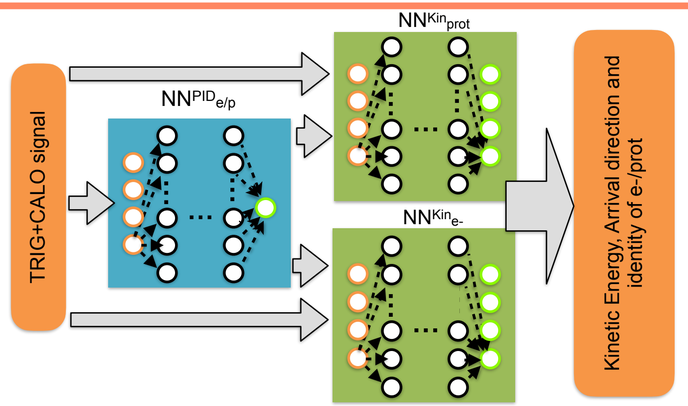
An accurate **GEANT4 simulation** has been realized to **characterize the detector** response to charged particles and to **train and test the DL algorithms** of our reconstruction chain:

- e- : isotropic flux and kin. energy [0-100] MeV;
- p: isotropic flux and kin. energy [0-1000] MeV;

This energy deposited by e-/protons in the detector material is **converted to electric signal**.

DL Event Reconstruction

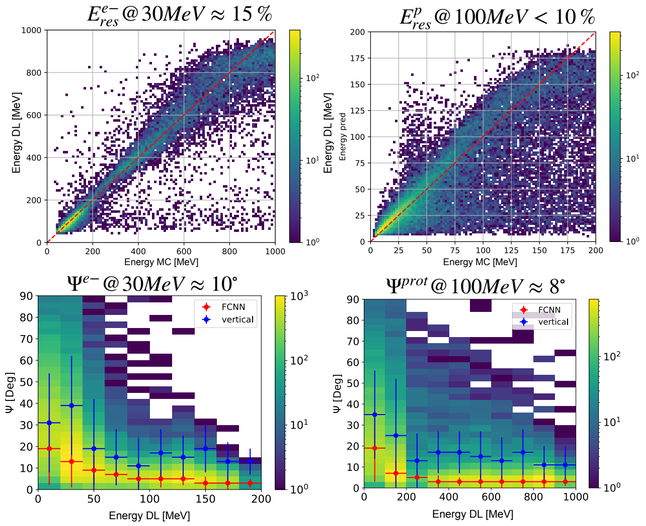
The signals produced by the particle interaction with the detector is used to train **2 sets of Fully Connected Neural Networks** [3]. The first one **separates between e-/protons** (classification task), while the second ones reconstruct the kinetic energy and the arrival direction of the incoming particle (regression task).



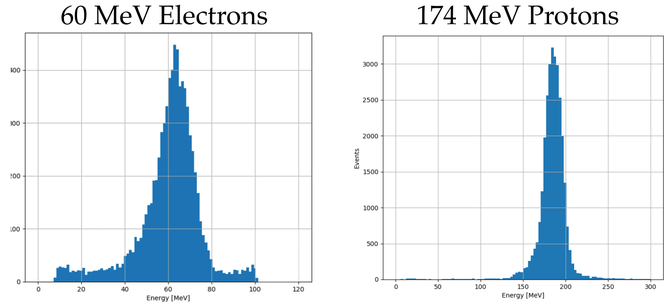
Performance and results

Performance on MC

Prot/e- are identified with of 97% accuracy



Performance on Test Beam Data



References

[1] https://doi.org/10.1007/s11431-018-9234-9
[2] https://doi.org/10.1016/j.nima.2020.164170
[3] https://doi.org/10.1109/45.329294

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