Deep learning based event reconstruction for Limadou HEPD

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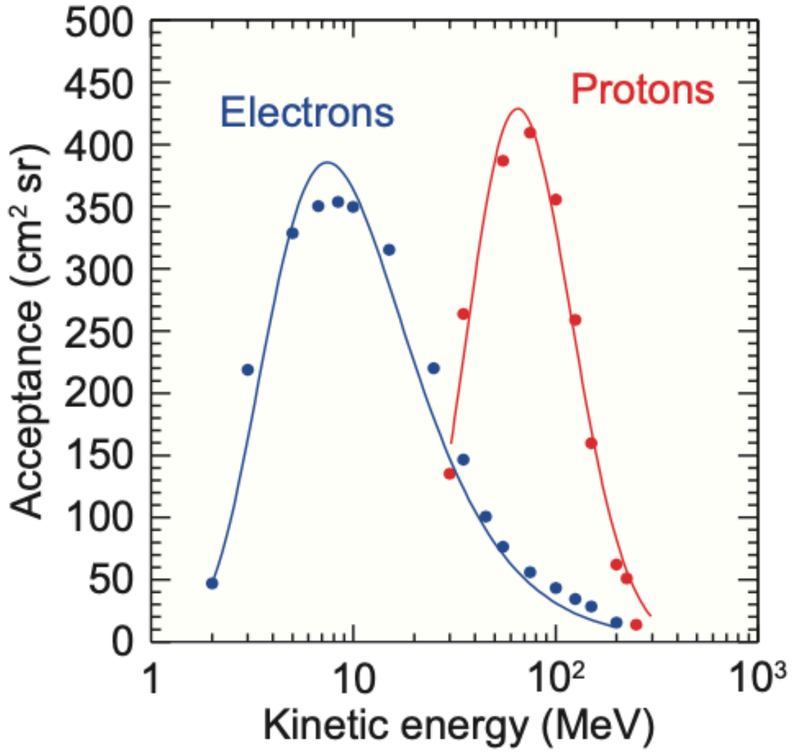
On behalf of the CSES-Limadou Collaboration

Detector and Simulation

Limadou HEPD [1,2] 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:

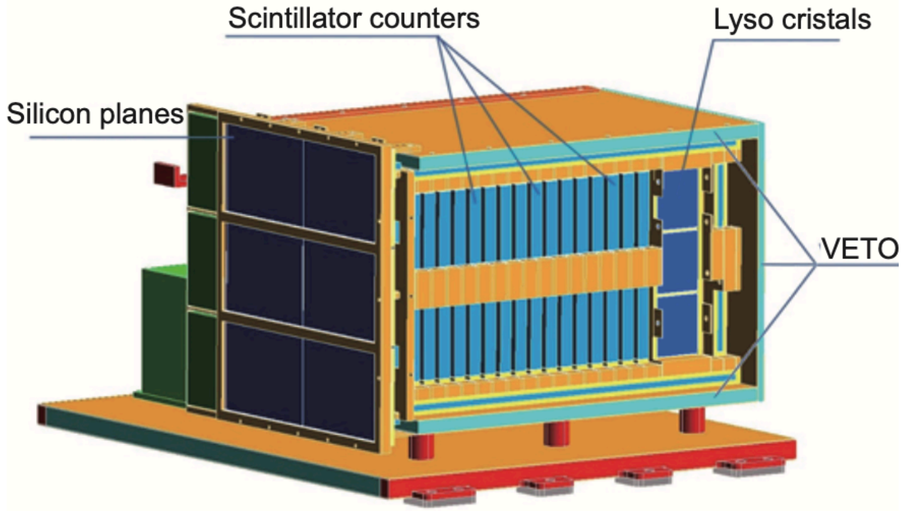


Electrons: [3-100] MeV

Protons: [30-200] MeV

Trigger: 6 bars EJ200 (read with PMTs)
Calo: 16 planes EJ200 + 9 LYSO cubes (read with PMTs)

Tracker: 2 planes double-sided microstrips



Veto: 5 EJ200 planes

A **GEANT4 simulation** has been realized. The digitized signals are used to **train and test the DL algorithms:**

- e- : isotropic flux and energy [0-100] MeV;
- protons : isotropic flux and energy [0-1000] MeV;

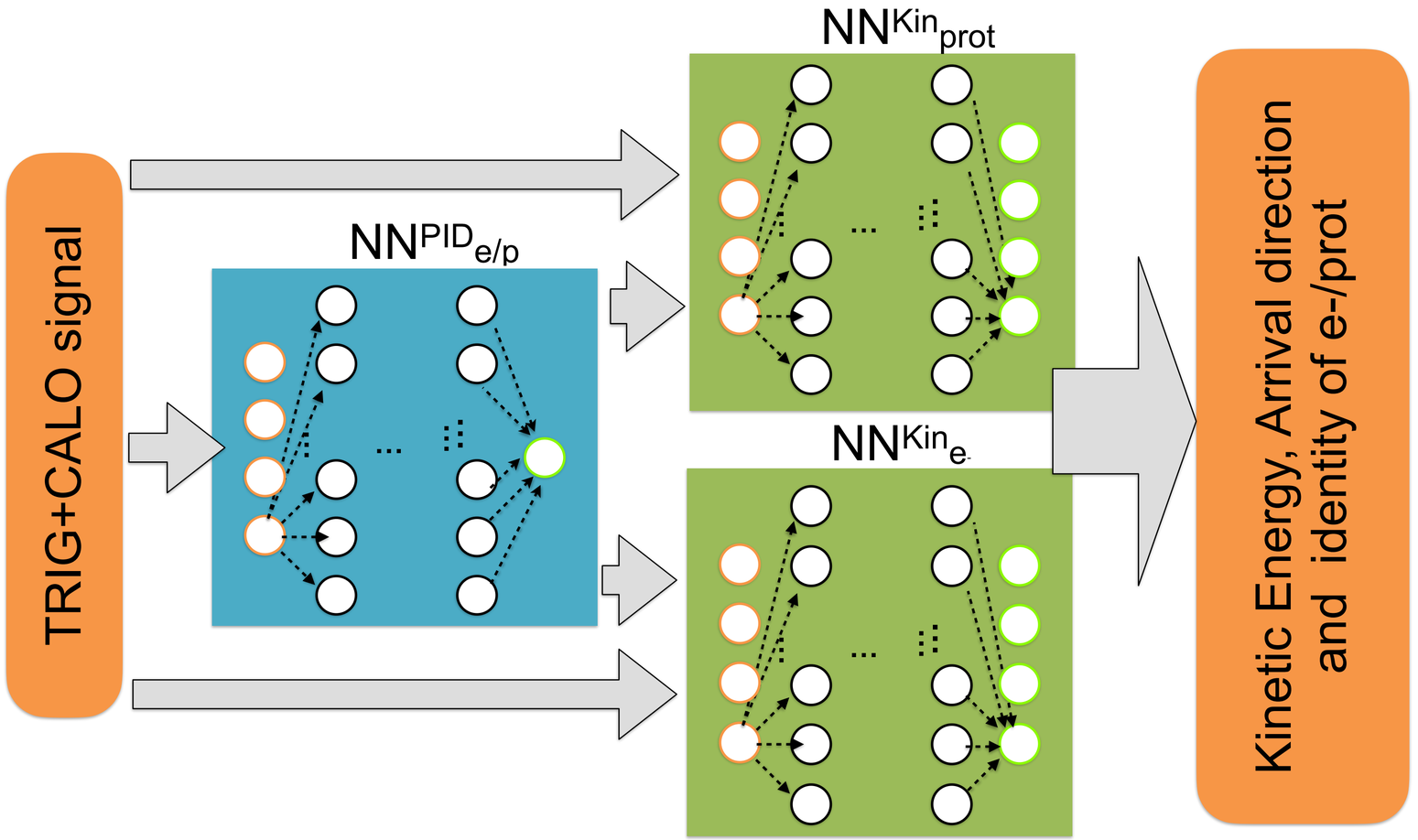
[1] “The HEPD particle detector of the CSES satellite mission…”, G. Ambrosi et al., https://doi.org/10.1007/s11431-018-9234-9
[2] “Beam test calibrations of the HEPD detector …”, G. Ambrosi et al., https://doi.org/10.1109/45.329294

DL Event Reconstruction Chain

The signals produced by the particle interaction with the detector is given to a **set of Fully Connected Neural Networks** [3]:

1. The first one **discriminates between electrons and protons** (classification - BCELoss);

2. the second ones reconstruct the kinetic energy and the arrival direction of the incoming particle (regression- L1Loss + AngDistance).

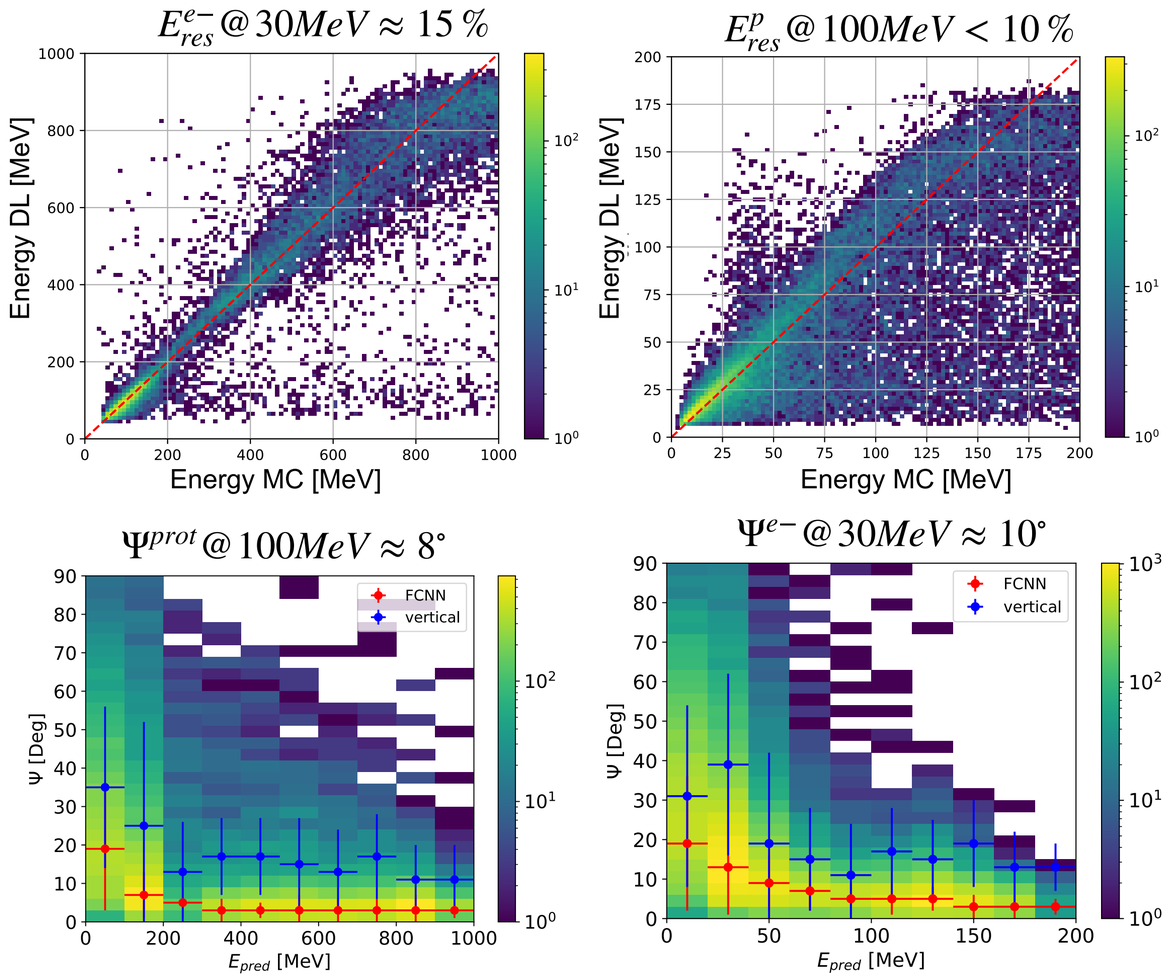


[3] “Feed-forward neural networks”, G. Bebis; M. Georgiopoulos, https://doi.org/10.1109/45.329294

Performance and results on TB data

Performance on MC

Prot/e- are identified with of 97,1% accuracy

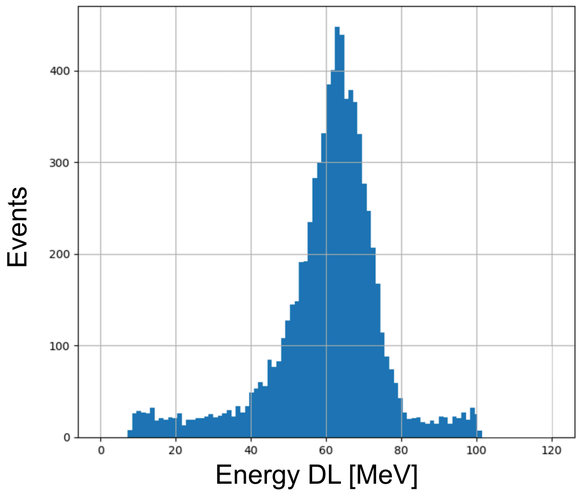


Performance on Test Beam Data

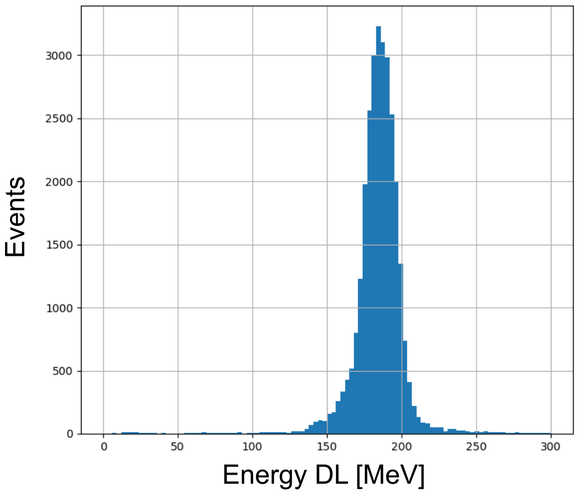
Electron tested at the Beam Test Facility (Frascati, Italy)

Proton tested at Proton Therapy APSS (Trento, Italy)

60 MeV Electrons



174 MeV Protons



This DL event reconstruction is now included in the official reconstruction software of the collaboration.

Working on the evaluation of DL EvRec on flight data!