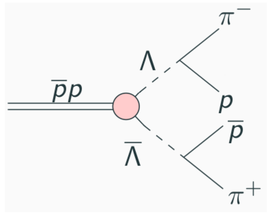
UPPSALA UNIVERSITET

Project in Computational Science 2017

Pattern Recognition Using Neural Networks in the PANDA Experiment

Introduction

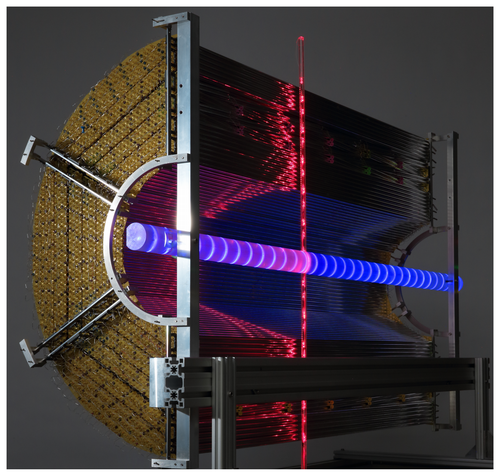
In the PANDA experiment, anti-protons are accelerated onto a stationary proton target and they annihilate. We have studied the specific decay reaction to the right where four charged particles are created. These are detected by the straw tube tracker (STT) where 4542 tubes are arranged cylindrically.



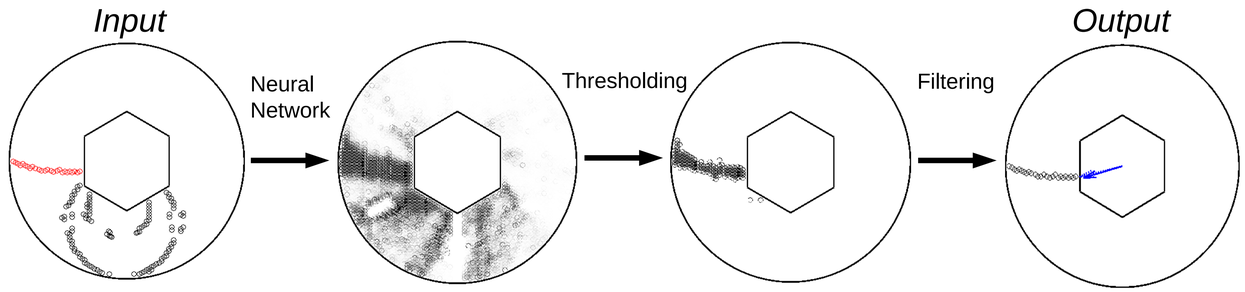
Decay reaction

Problem description

- Identify specific particle tracks
- Extract physical observables
- Are neural networks viable?



The Straw Tube Tracker



A visual representation of the reconstruction process for a specific event. The blue arrows represent the predicted (solid arrow) and true (dashed arrow) momentum vector.

Method

Two neural networks were implemented to solve different sub-problems and trained on simulated data. The networks can be connected together to directly extract physical observables of the particles from the raw detector signals.

First network (pattern recognizer):

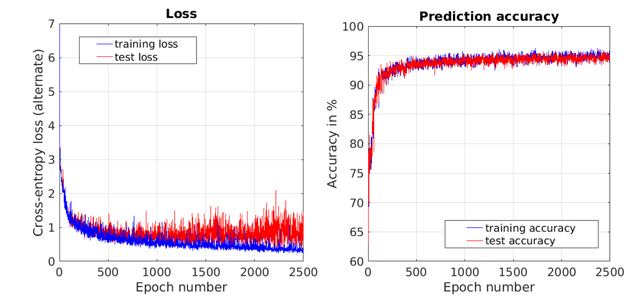
- Input: Raw STT signals (tube hits)
- Output: Specific particle track

Second network (momentum regressor):

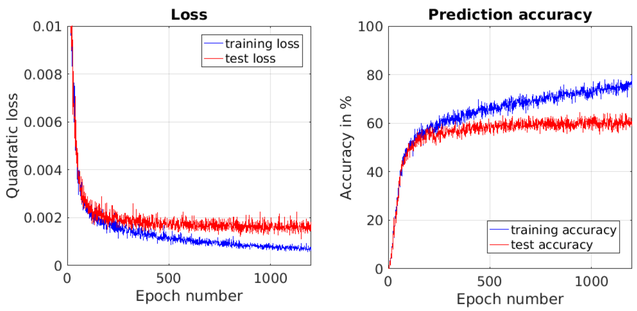
- Input: Specific particle track
- Output: 2D momentum vector

Results

The accuracy of the pattern recognizer is based on correctly predicted hits and misses. A correct prediction for the regression network is when the momentum vector is within 5° and 10 % of the magnitude.



Results for the pattern recognition network.



Results for the momentum regression network.

Discussion

With a 95 % prediction accuracy for the pattern recognizer it can be a great tool for particle identification. When the networks have been trained they can easily be implemented into a realistic setting.

Outlook

- Study more realistic decay reactions
- Explore different network structures
- Explore other loss functions
- Possible to extract other observables

Project members:
Adam Hedkvist
Arvi Jonnarth

Supervisors:
Michael Papenbrock
Karin Schönning

Course coordinator:
Maya Neytcheva