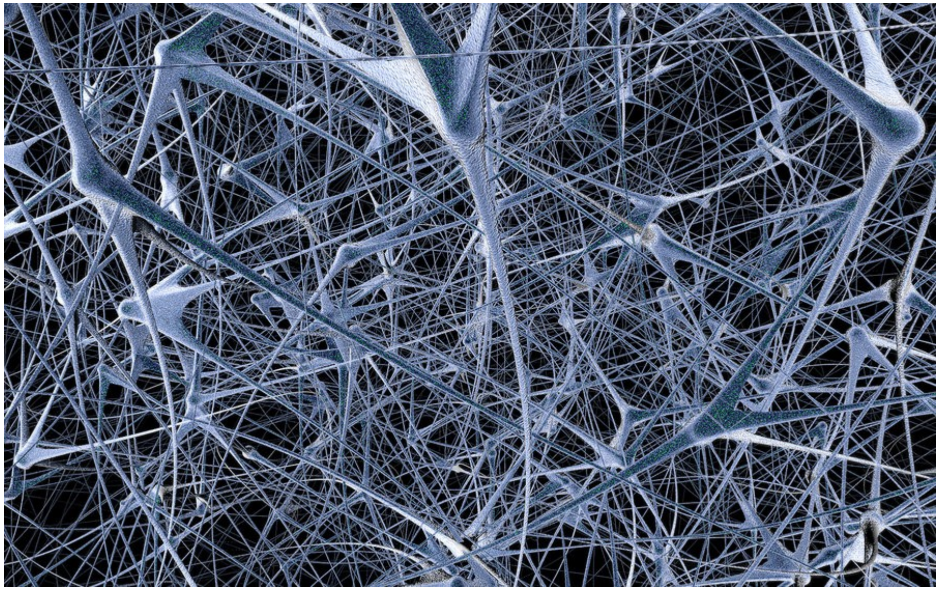
Using neural networks for gamma/neutron discrimination on NEDA data

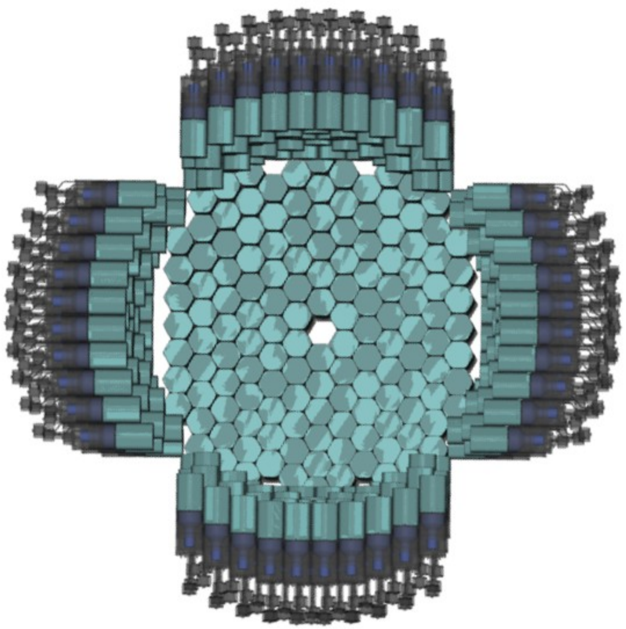


1. Context : NEutron Detector Array
2. Neural Networks
3. Results

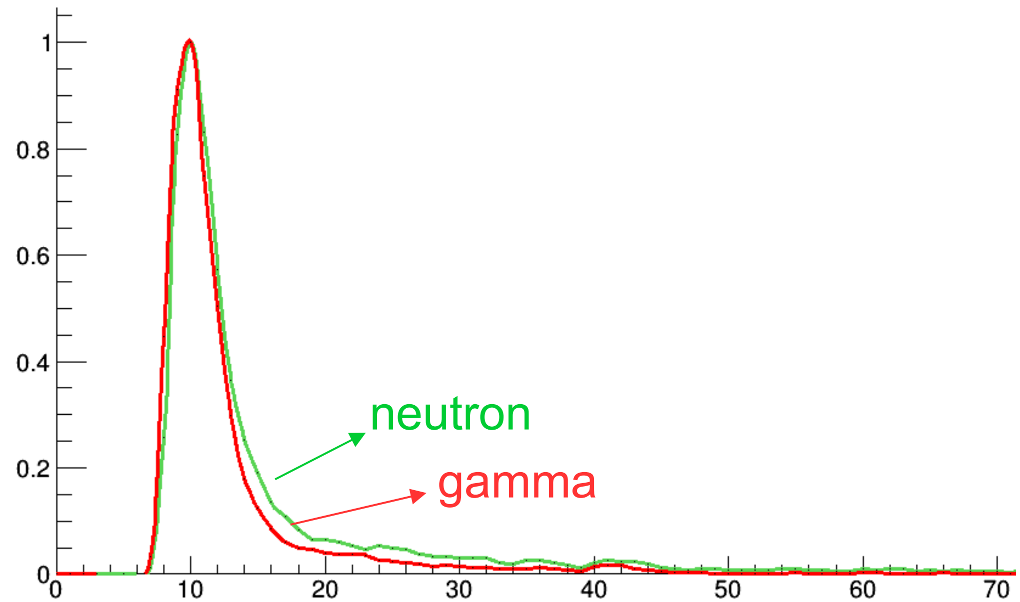
G. Baulieu, L. Ducroux, J. Dudouet, X. Fabian, O. Stezowski

IPN Lyon

→ **The NEutron Detector Array (NEDA)**

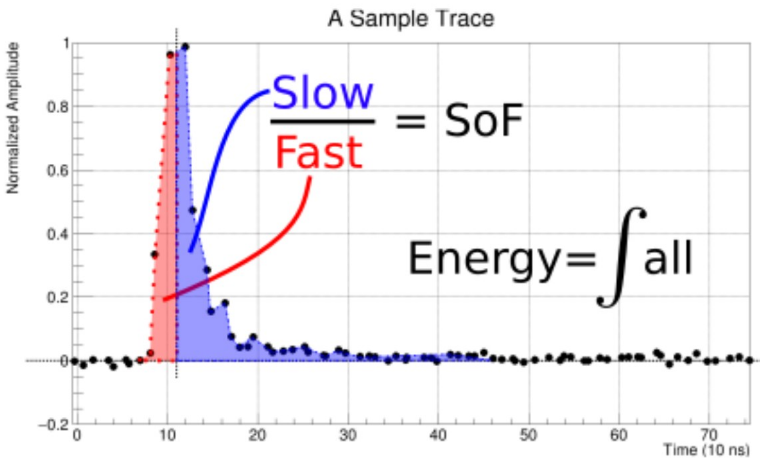


- **Neutron detector**
- First campaign in 2018 at GANIL :
  - **ancillary of AGATA** along with DIAMANT (charged particles)
    → selection of events according to neutrons, protons and alpha rays
- Made of liquid organic **scintillators**
- Reacts to neutrons and gamma rays



Target : to be able to distinguish neutrons and gammas by Pulse Shape Analysis

→ **NEDA PSA**



- Comparison of fast and slow components

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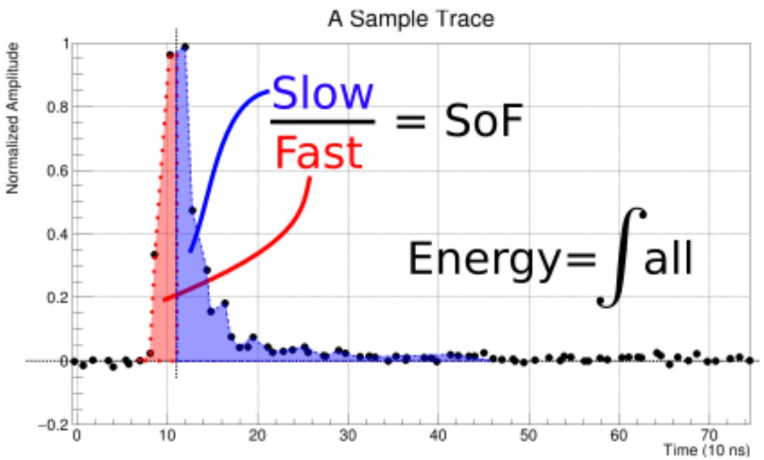

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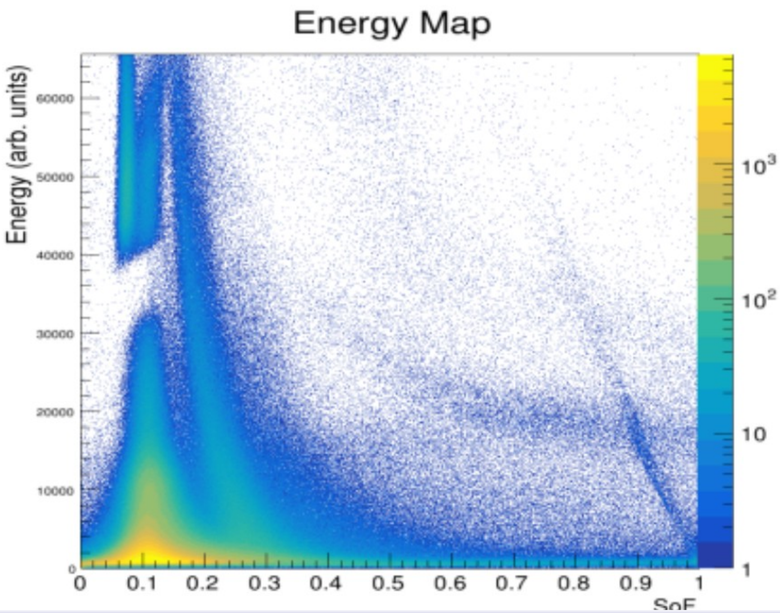

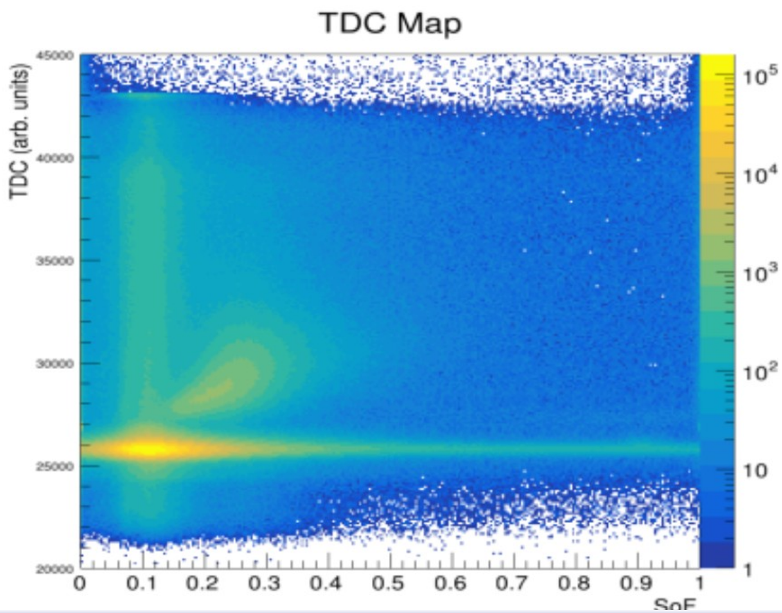

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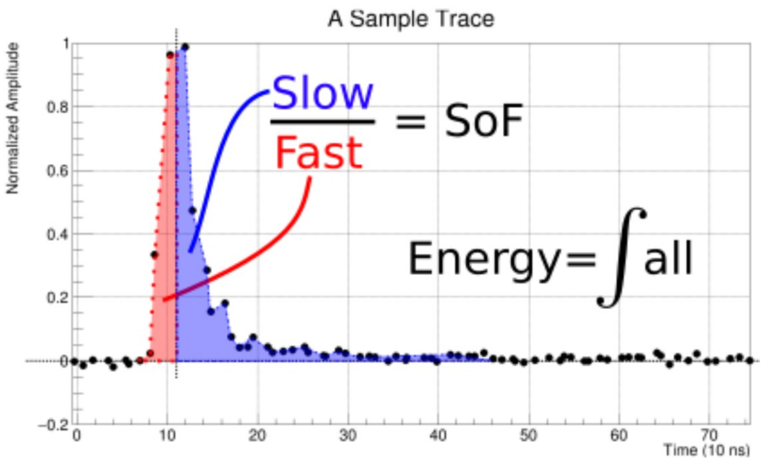
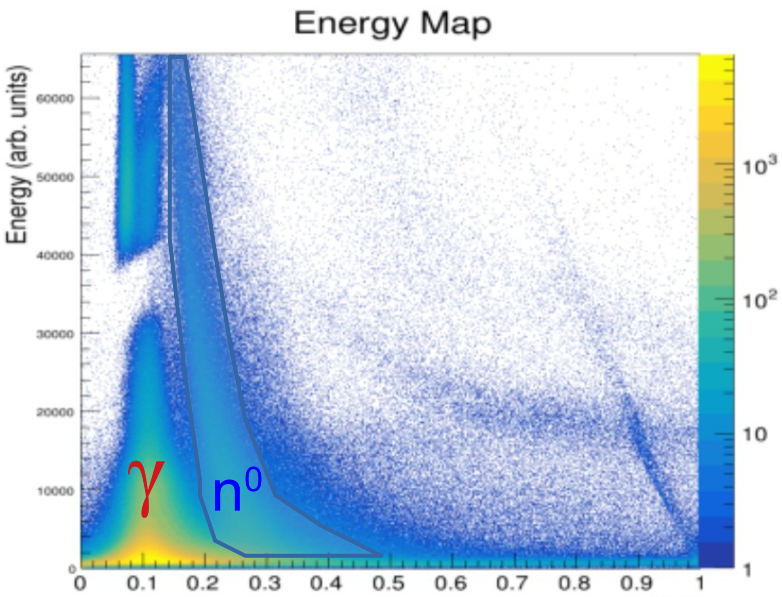
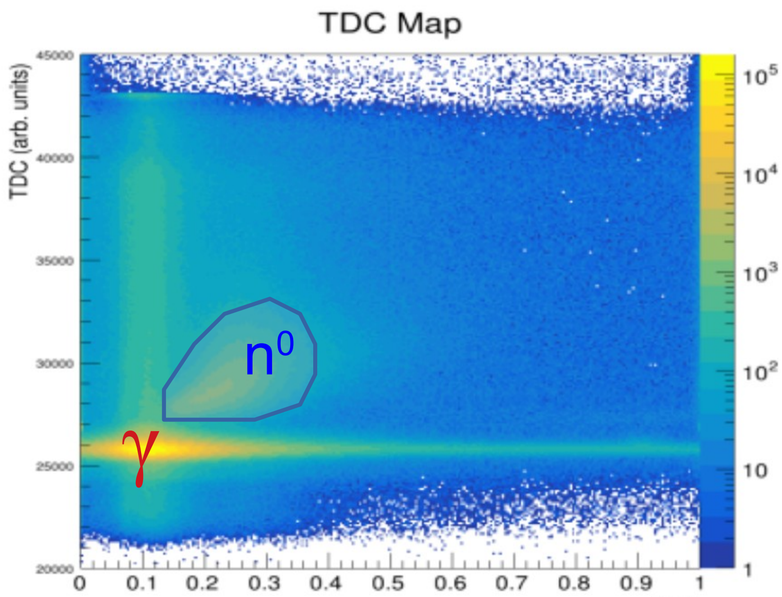


- Comparison of fast and slow components
- Cuts for final selection





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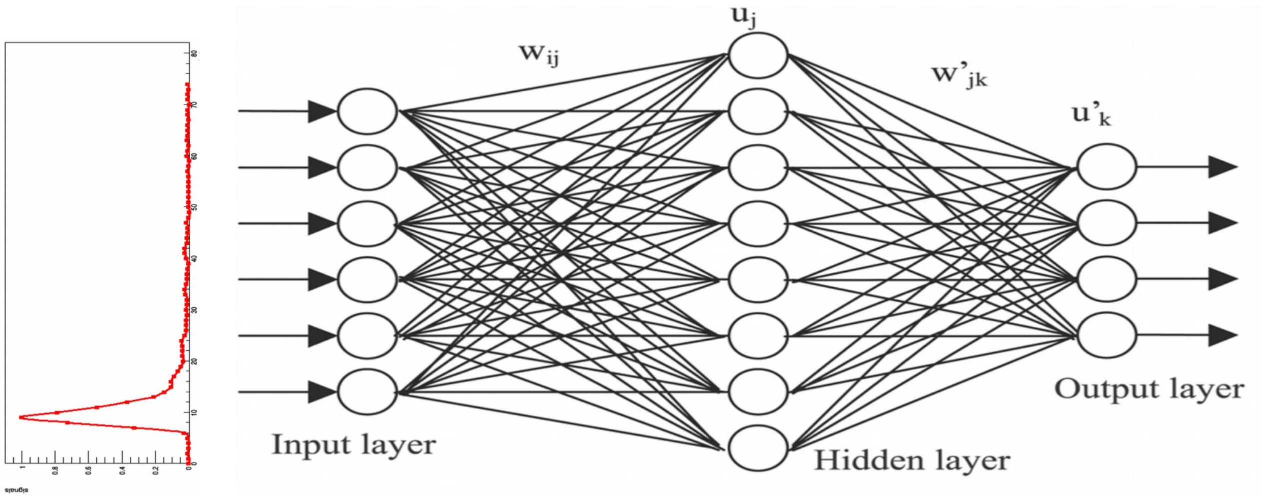
First studies by P-A Söderström et al using a Multi Layers Perceptron in Root



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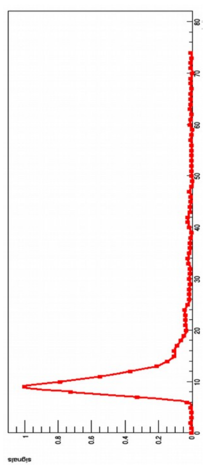

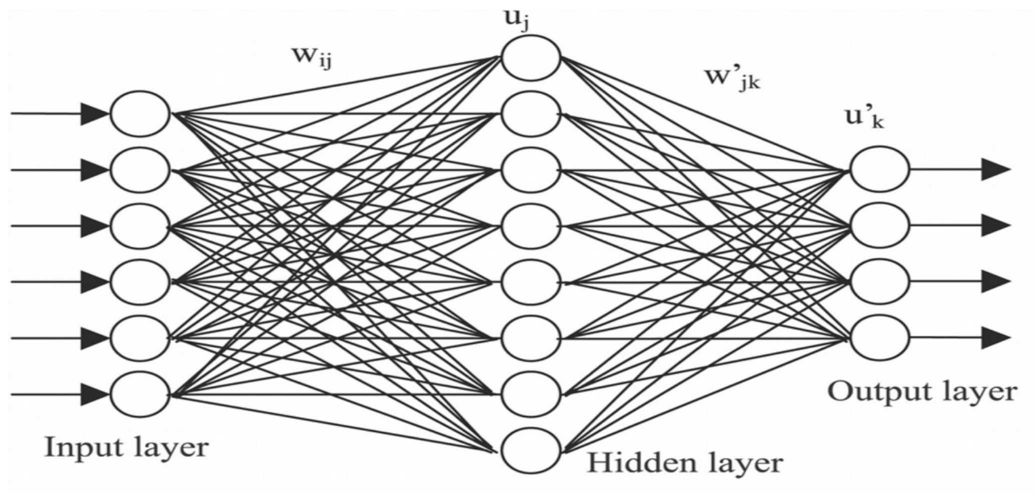

Interesting results but too slow → Migration to TensorFlow

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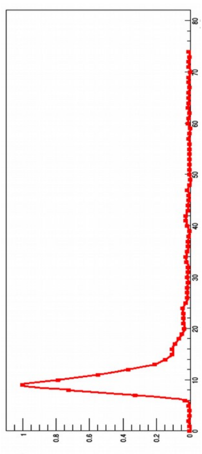

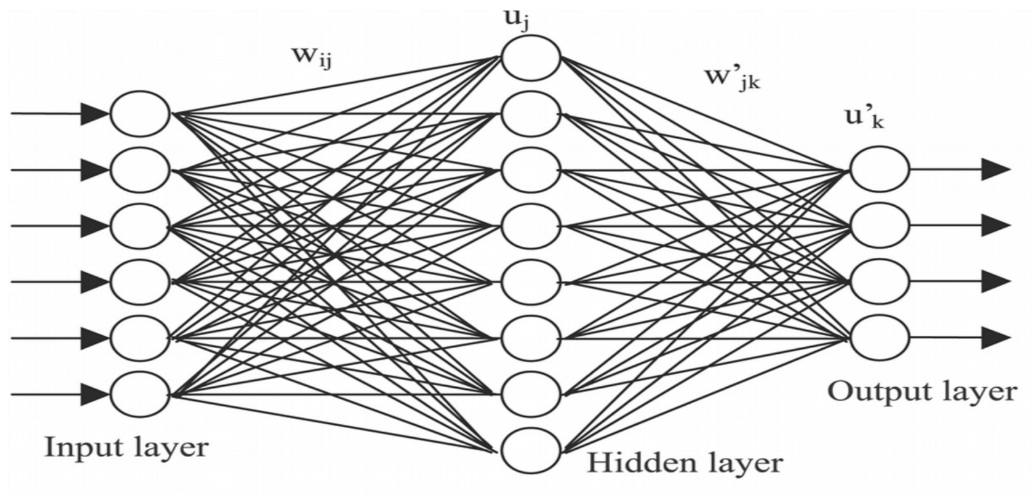

Interesting results but too slow → Migration to TensorFlow

Training in Python → Freeze the model → Load the model for inference in C++ (Ganpro)

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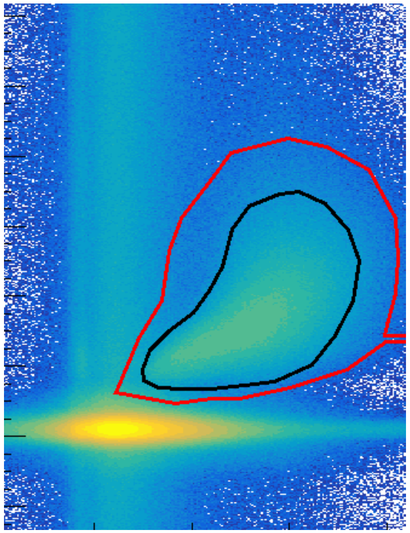

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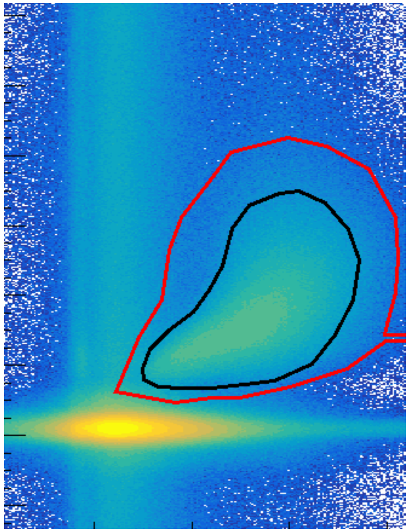

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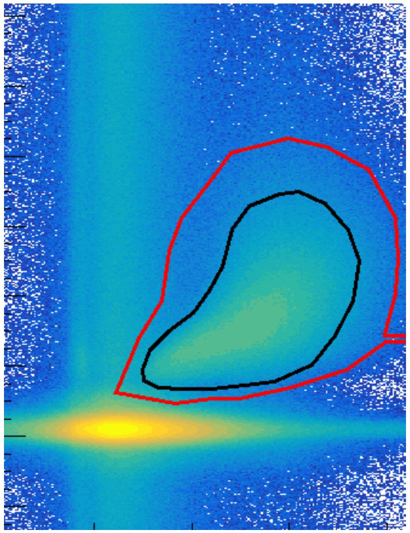

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- **Multi-Layers perceptron** : legacy, easy to setup and compute
- **Recursive Neural Network** (Long Short-Term Memory) : interesting to analyze time-series...

→ **Setup on GPU Farm**

- Existing Docker image used in Gitlab-CI (Ubuntu 16.04)
  → Conversion to **Singularity**
- Compilation of **TensorFlow-GPU** (v1.11) on the cluster with **Cuda 9.2**
- Each job starts a **singularity container** before launching the computing process
- NEDA data are naturally split in 6 (number of acquisition cards) : **6 analysis jobs** per run

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- Not efficient to send a single signal to the GPU → buffering of the signals

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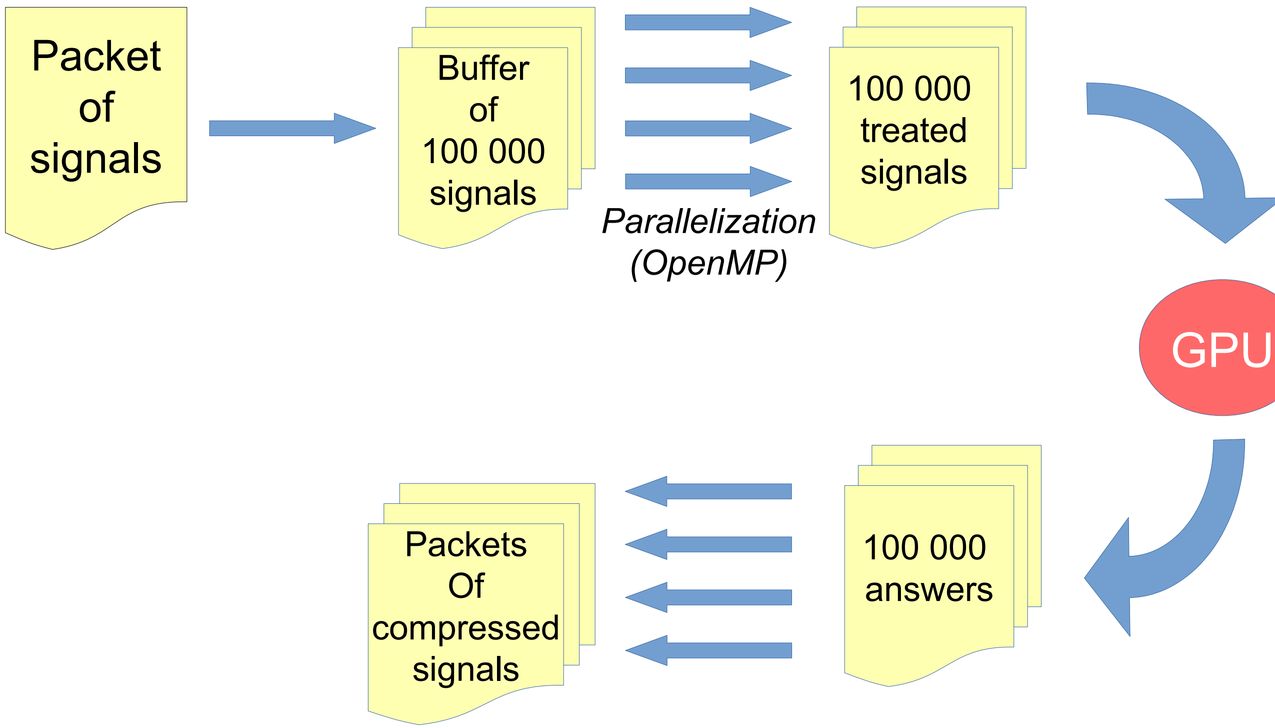

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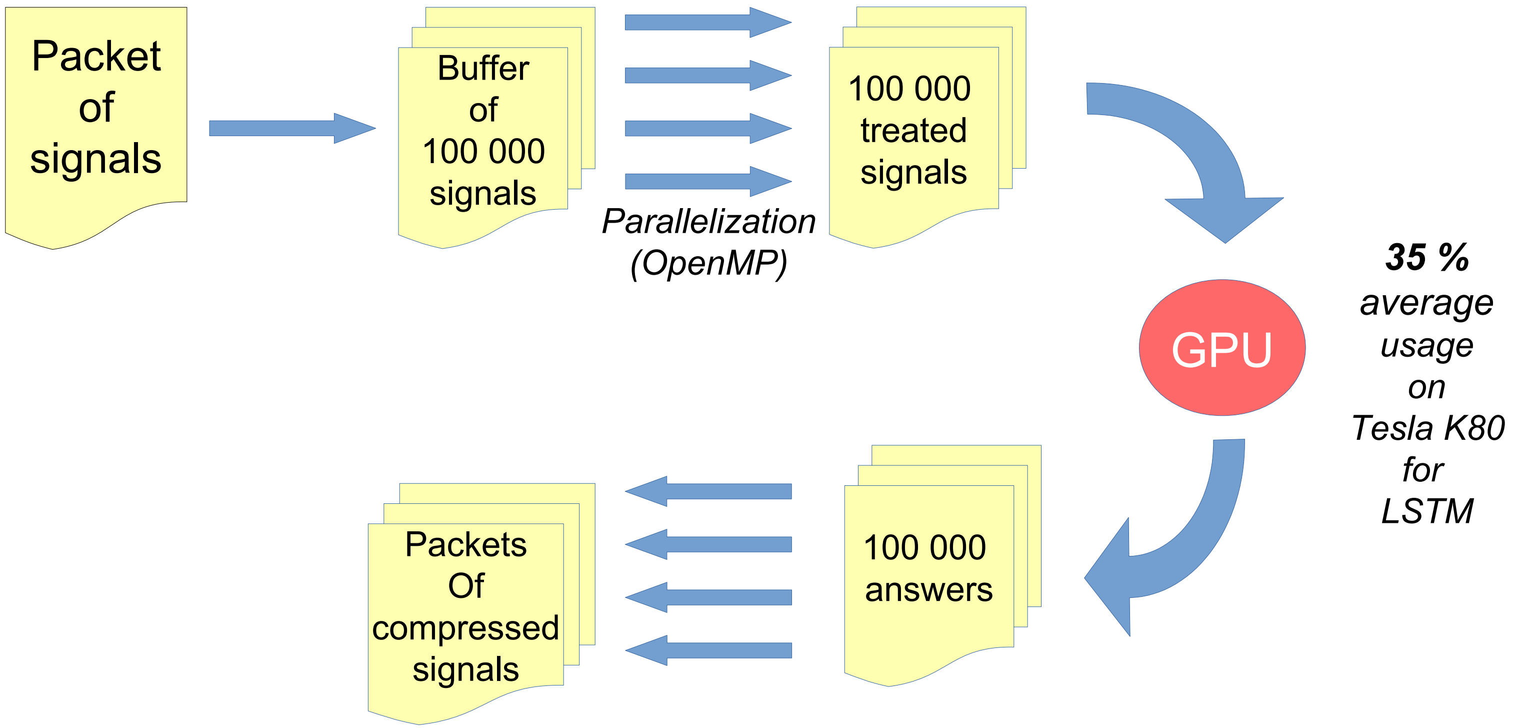
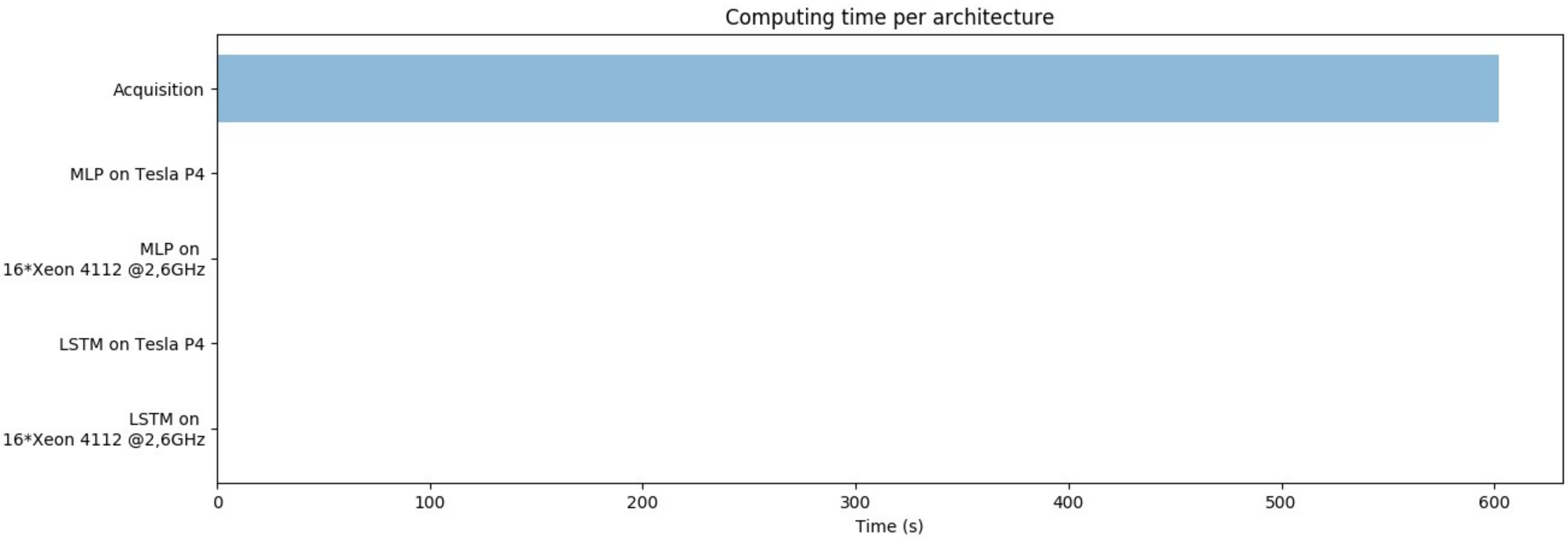


→ **Computing Time**



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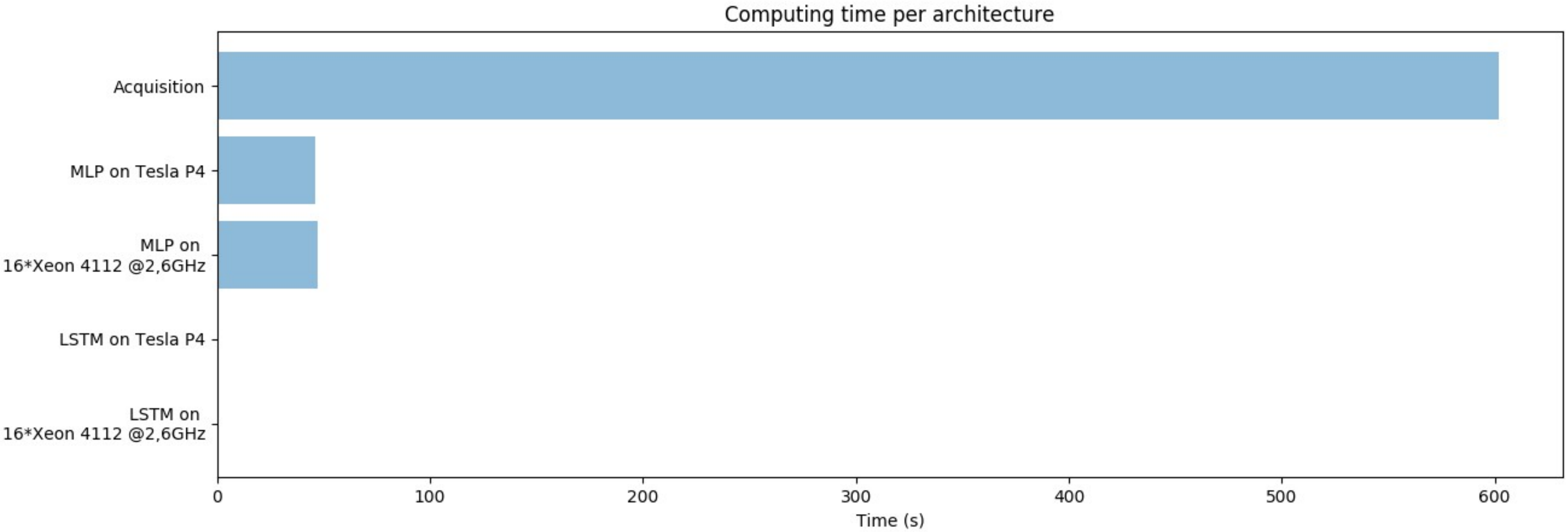

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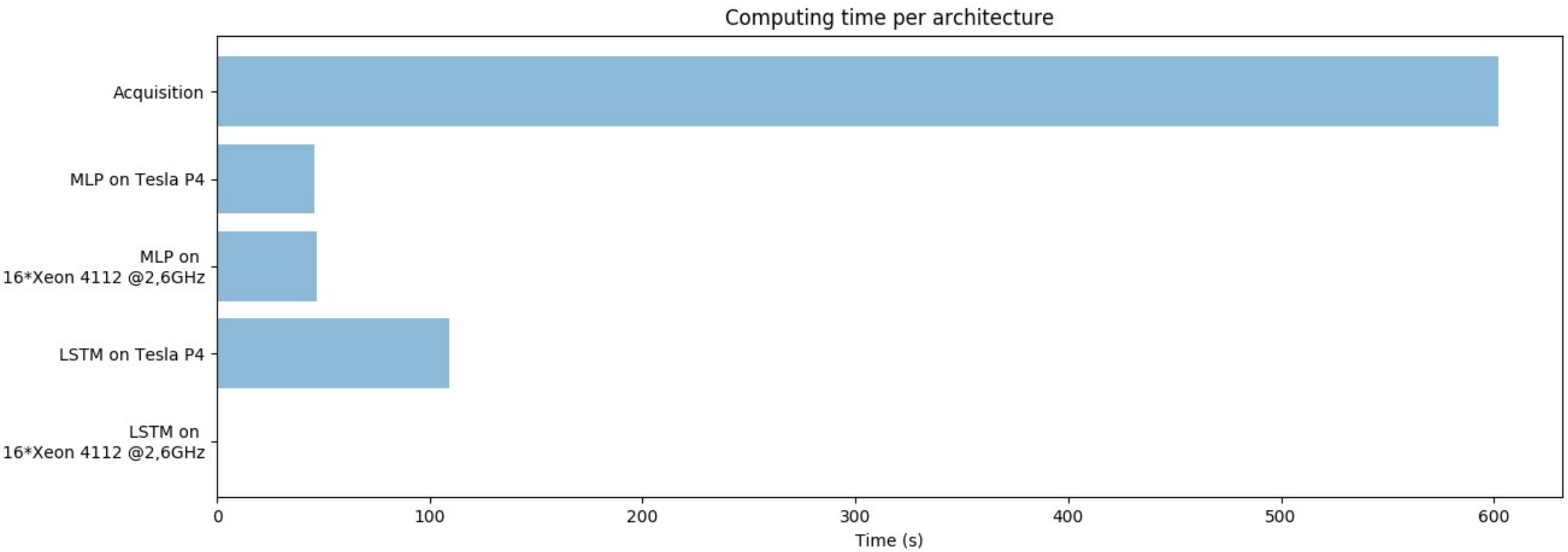

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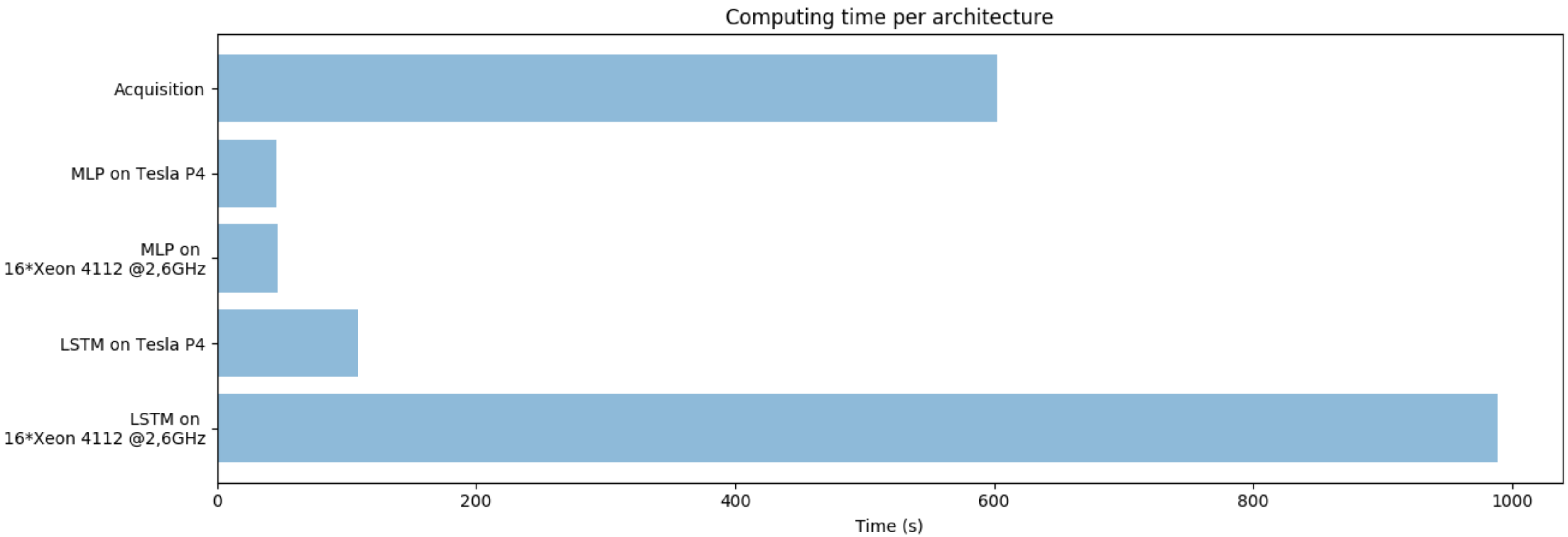

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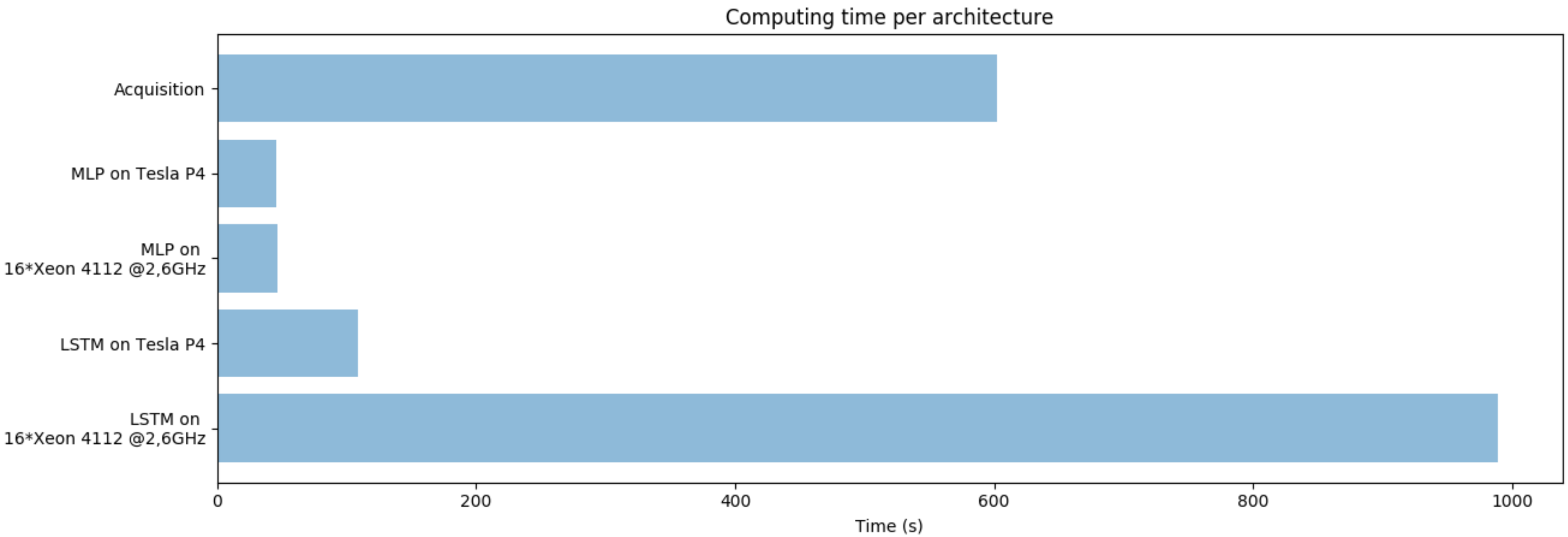
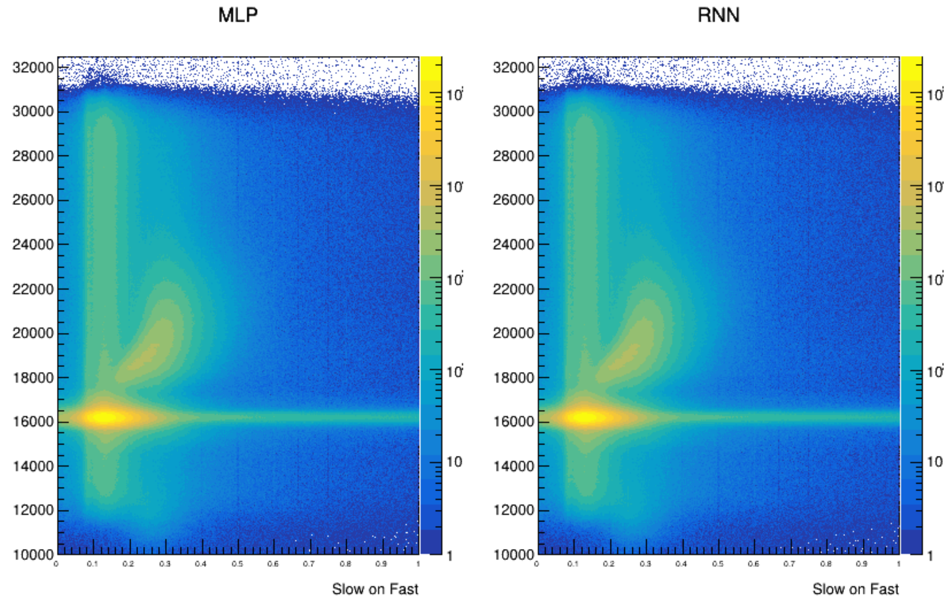


Analysis time for a 1 To run (6x15h) on GPU Farm (Tesla K80) : ~ 5 hours

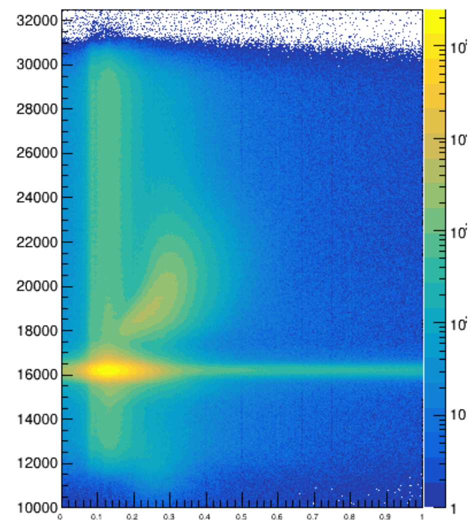
Results

→ Results on discrimination

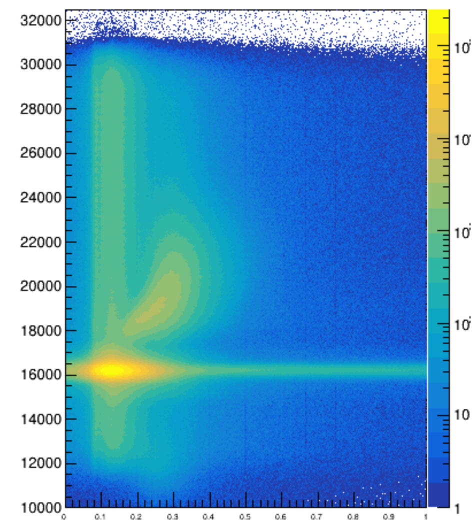


→ Results on discrimination

MLP

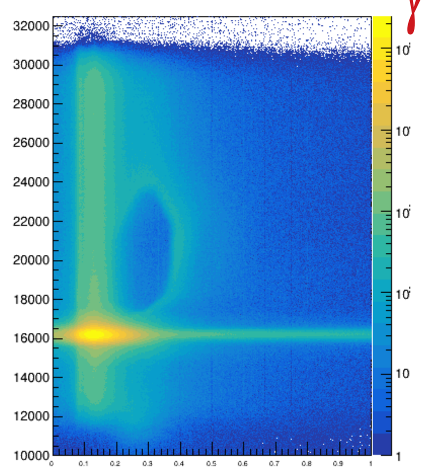


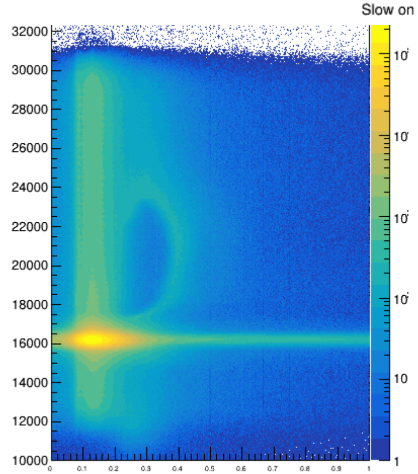
RNN



MLP

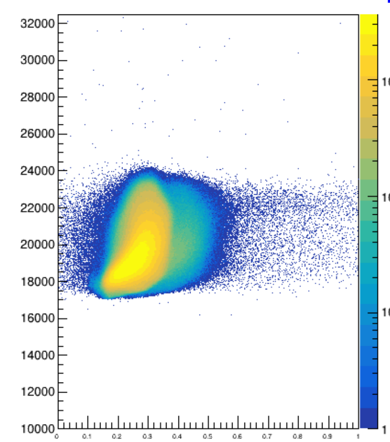
γ

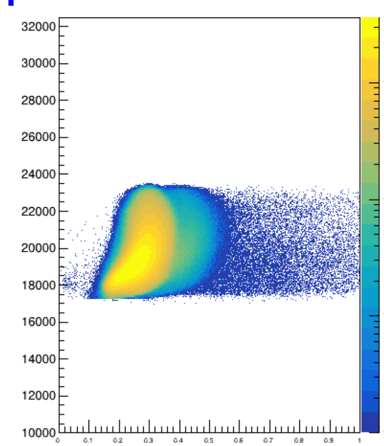




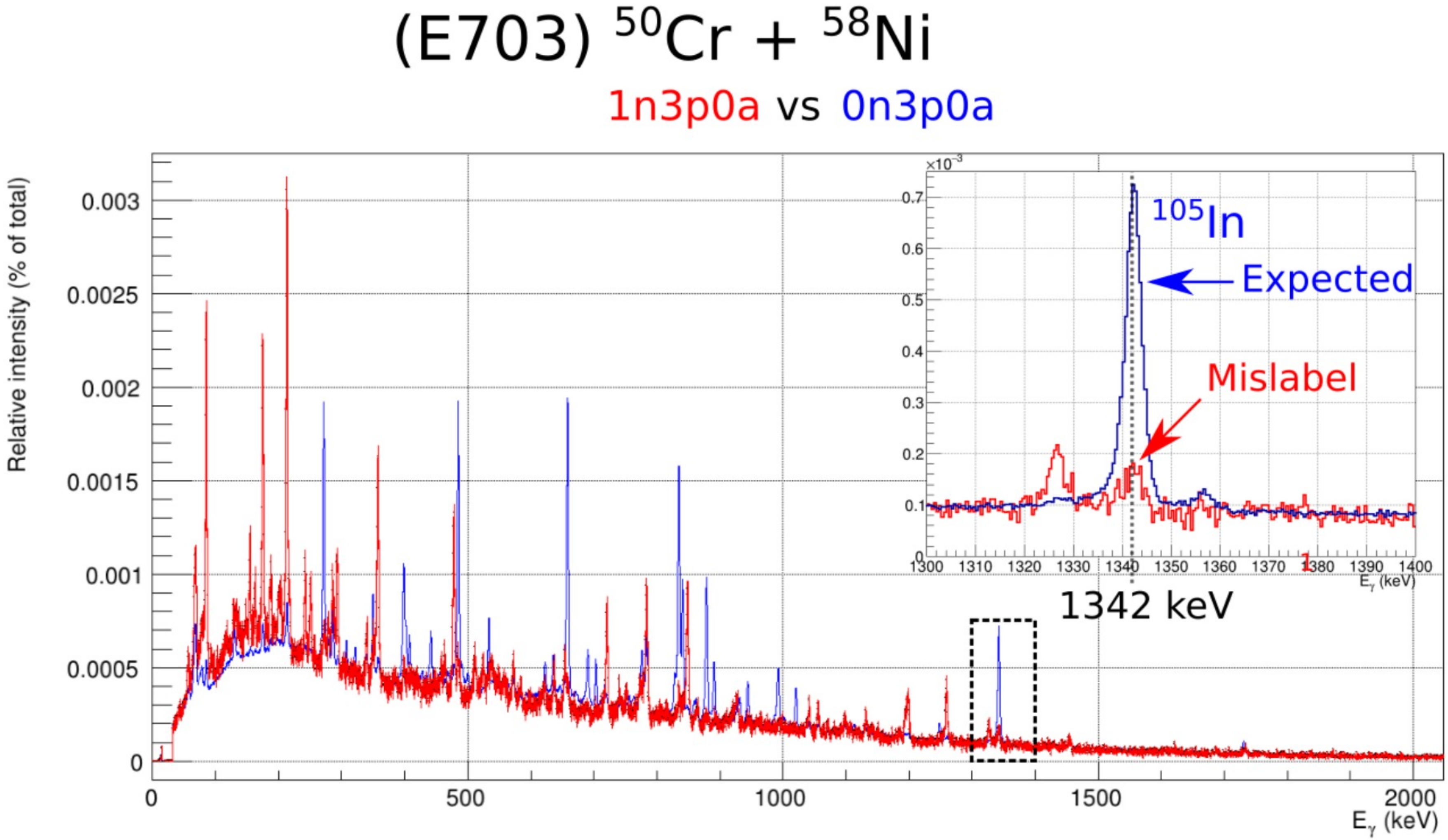
n^0

RNN





→ **Quantification of results using AGATA (1/2)**



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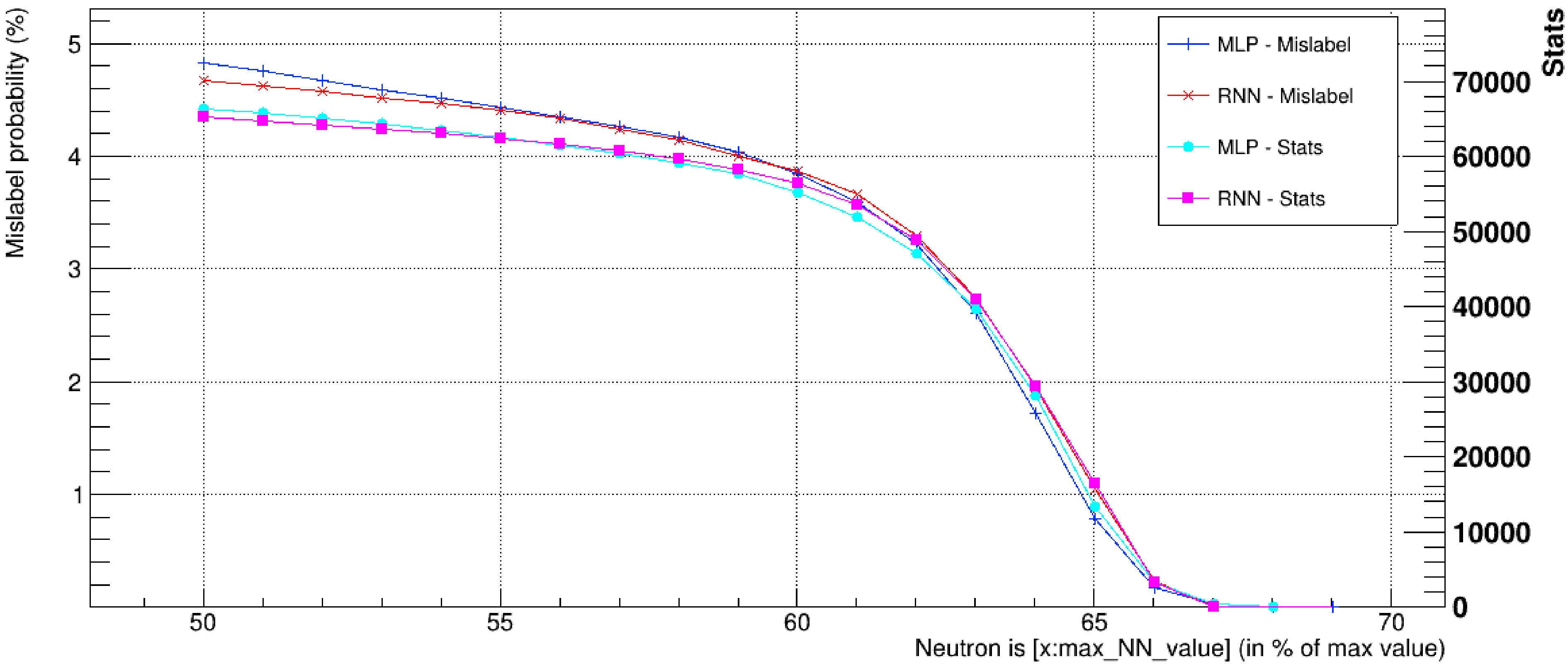

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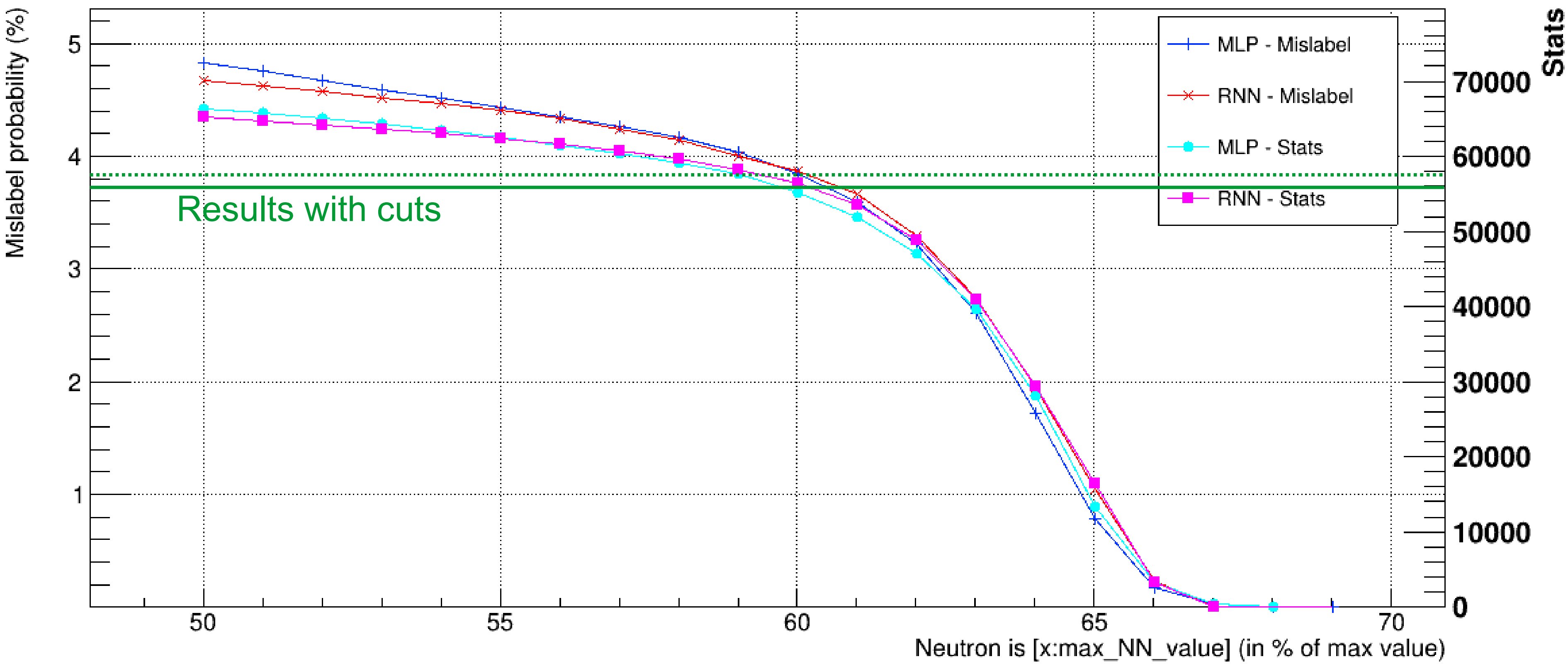
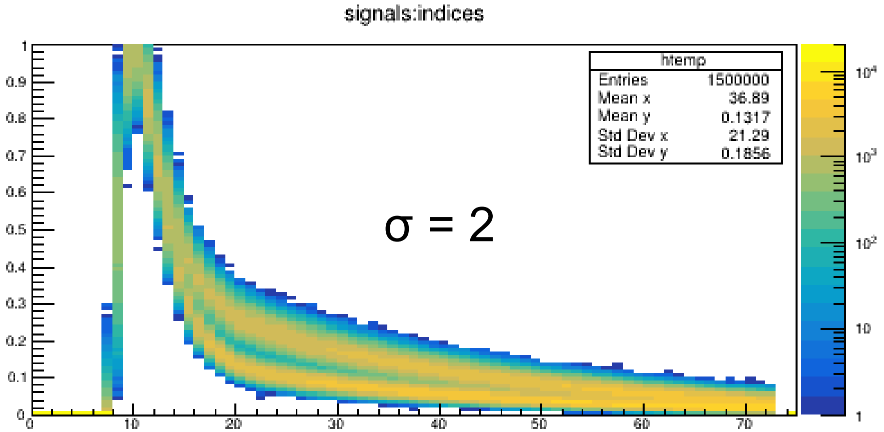


→ Robustness to desynchronization

Simulation of signals with a gaussian T0 distribution



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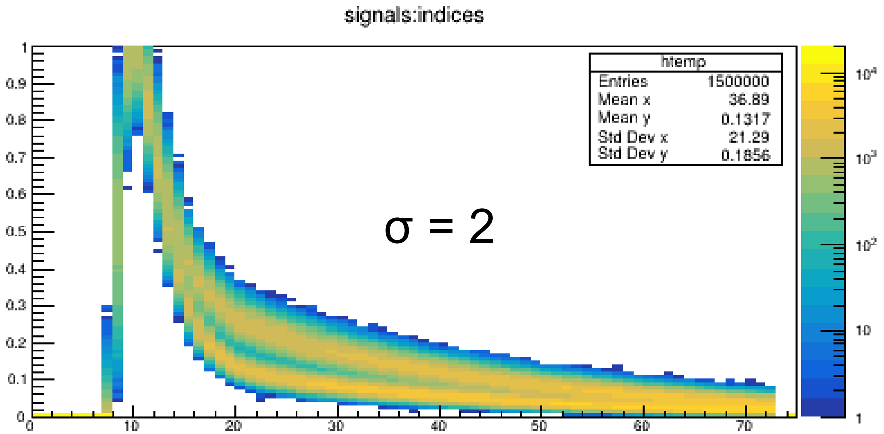

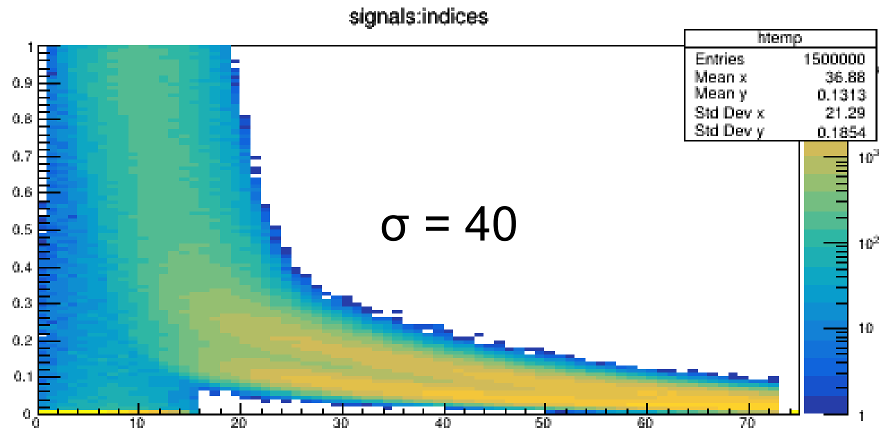

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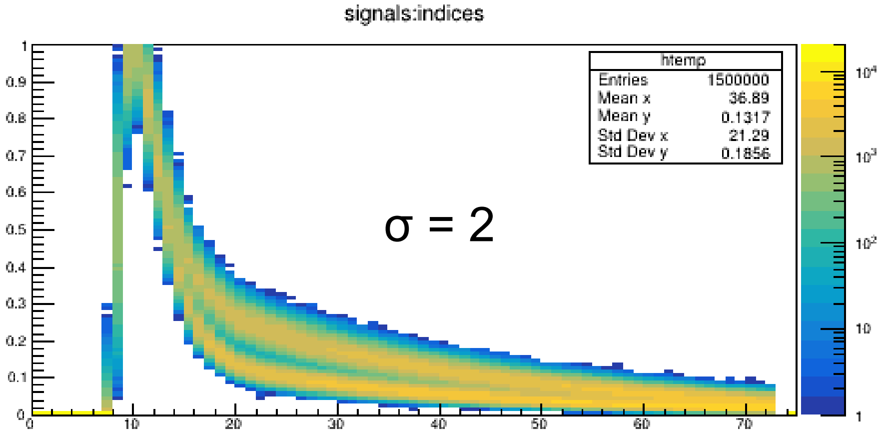

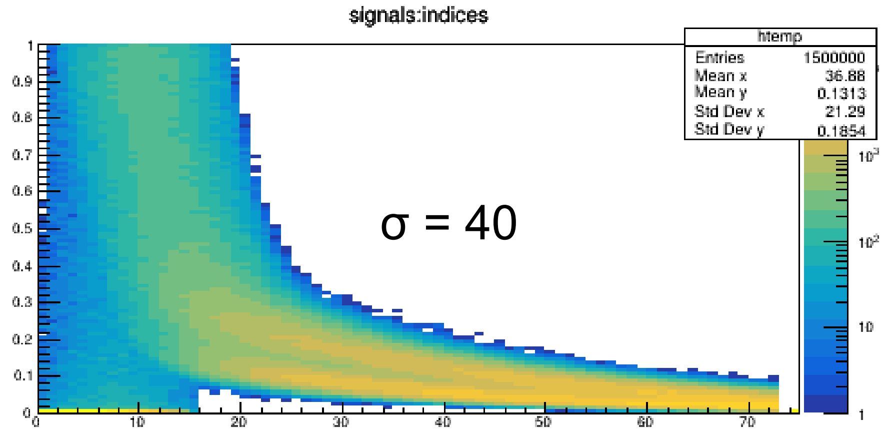

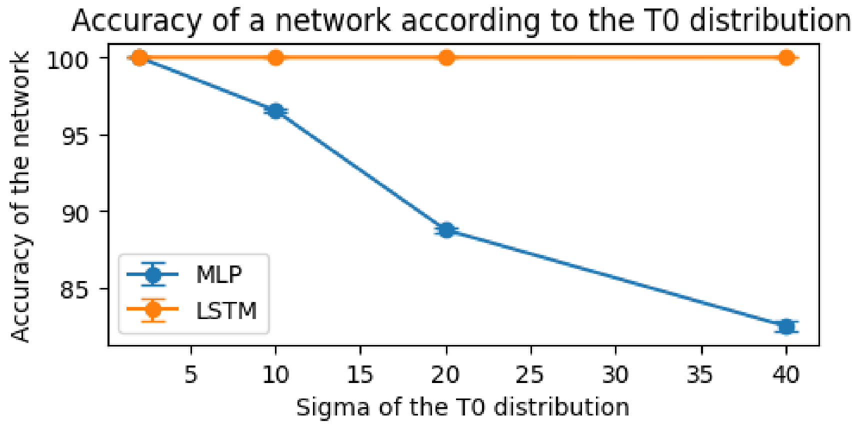

LSTM is very robust to T0 shifts!

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- Network's output values usable for fine tuning of neutrons selection (better quality or more statistic)