Status on the first tests of Machine Learning applied to PSA for AGATA at Lyon

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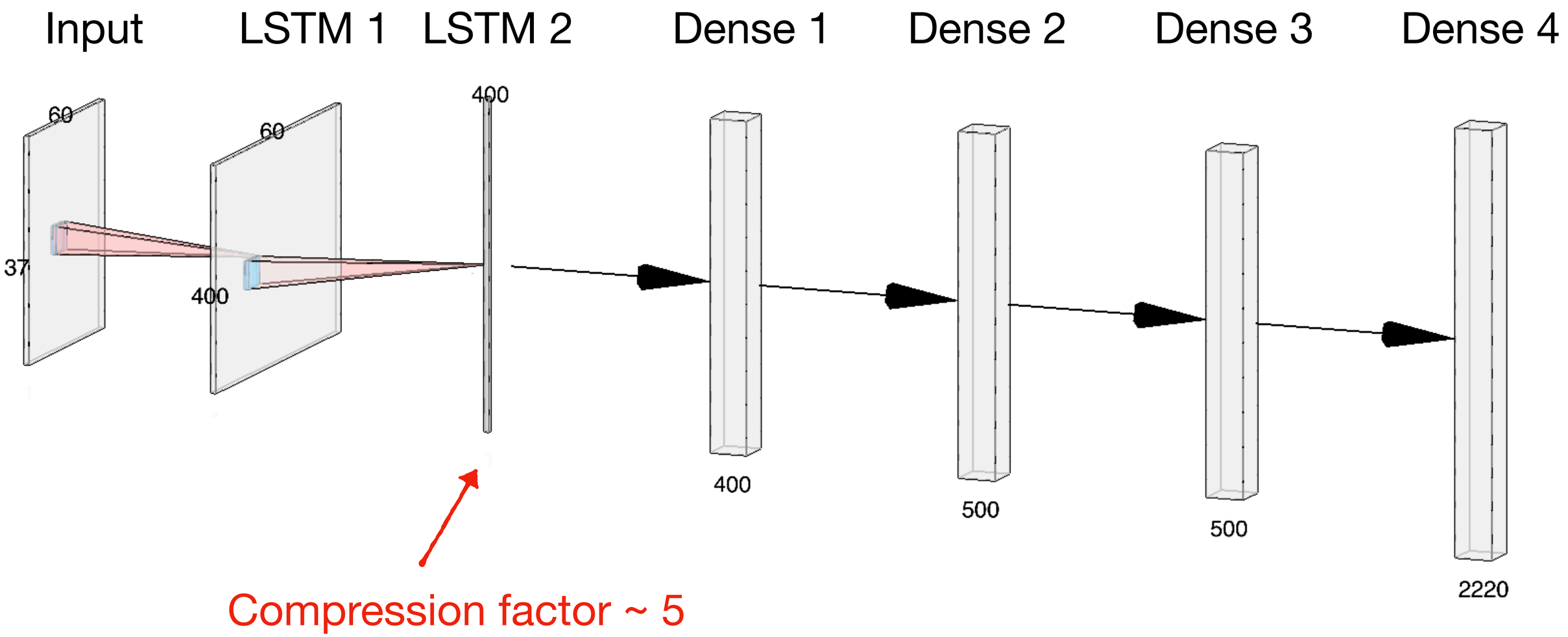
Goal: Apply auto-encoder on the traces to investigate:

- Data reduction
- Signal noise reduction
- Anomaly detection
- Increase PSA performances

Composition of the neural network:

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input (InputLayer)           (None, 60, 37)            0
_________________________________________________________________
lambda (Lambda)              (None, 60, 37)            0
_________________________________________________________________
lstm1 (LSTM)                 (None, 60, 400)           700800
_________________________________________________________________
lstm2 (LSTM)                 (None, 400)               1281600
_________________________________________________________________
dense (Dense)                (None, 400)               160400
_________________________________________________________________
dense_1 (Dense)              (None, 500)               200500
_________________________________________________________________
dense_2 (Dense)              (None, 500)               250500
_________________________________________________________________
dense_3 (Dense)              (None, 2220)              1112220
_________________________________________________________________
reshape (Reshape)            (None, 60, 37)            0
=================================================================
Total params: 3,706,020
Trainable params: 3,706,020
Non-trainable params: 0
_________________________________________________________________
```

Composition of the neural network:



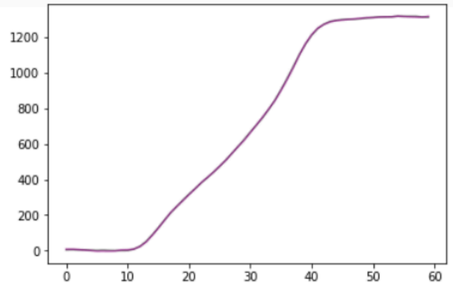
Data used:

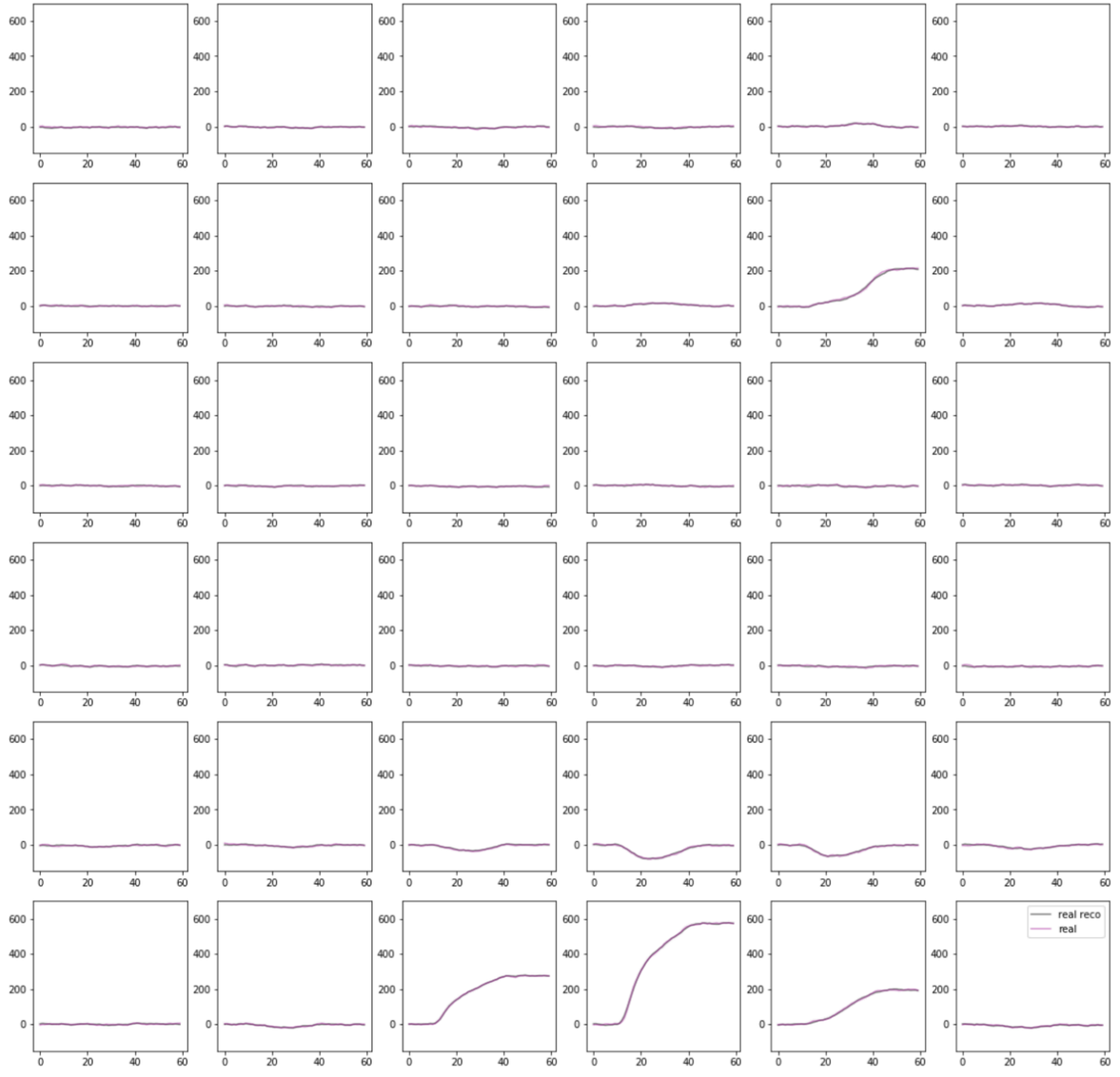
- ^{60}Co, run 3, from experiment e775s, Detector 14B

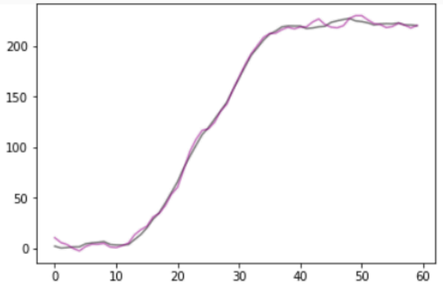
Exercice N°1:

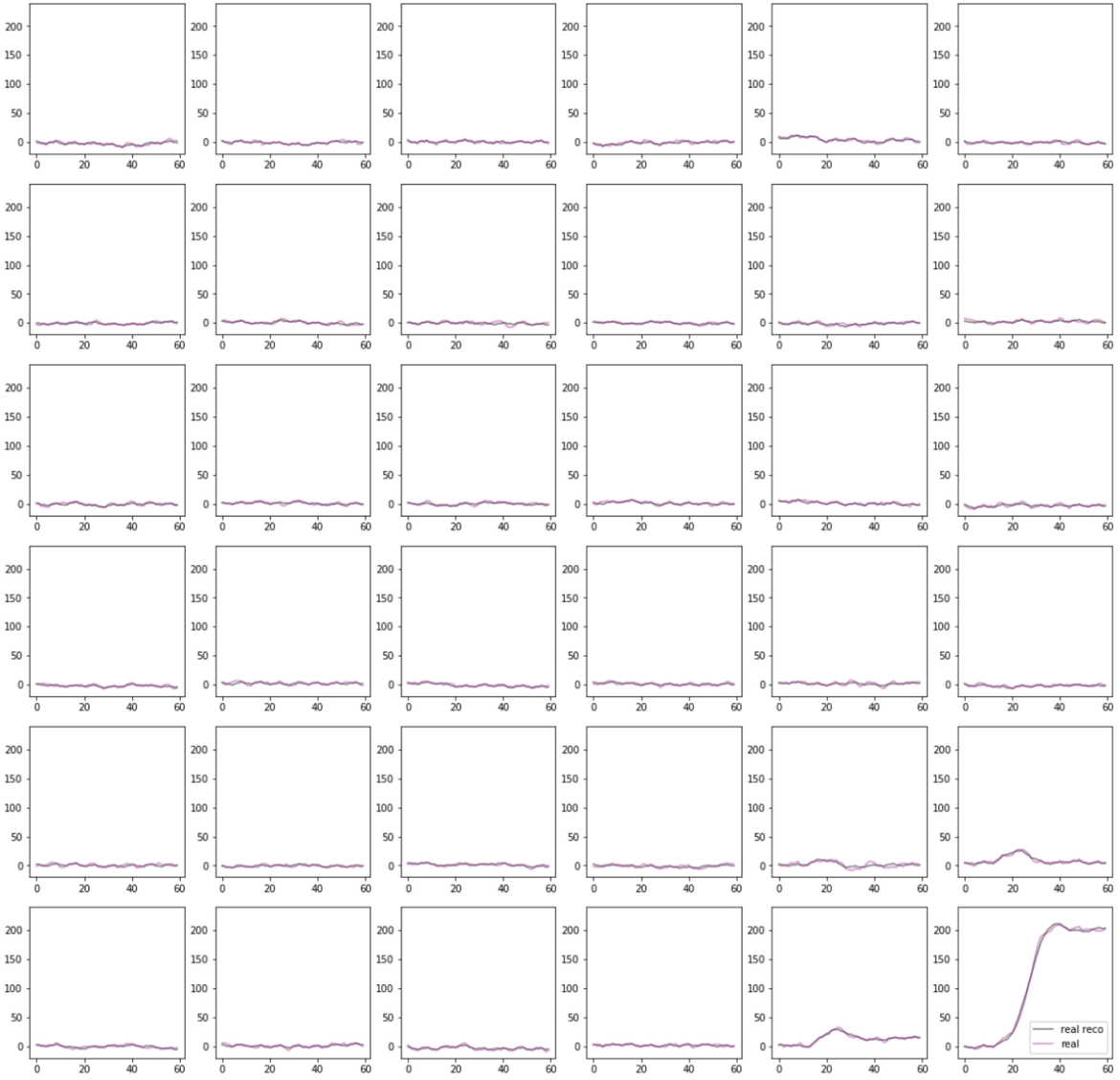
Can we improve the PSA performances by applying a « ADL » filter on the experimental traces.

- NN trained on ADL bases
- Traces after preprocessing level are sent to the auto-encoder
- « Auto-encoded traces » are then sent to the PSA

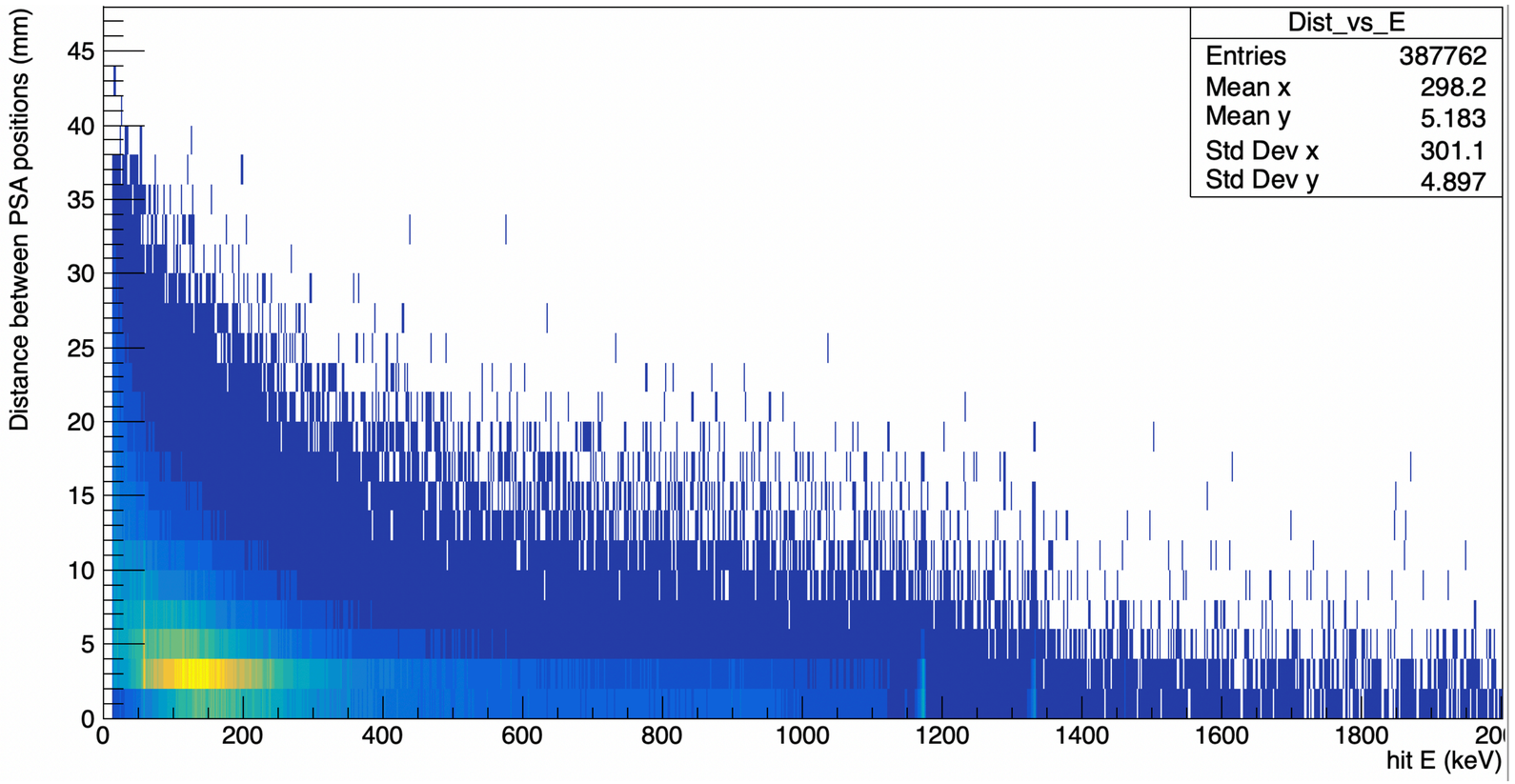

1200
1000
800
600
400
200
0
0
10
20
30
40
50
60


real reco
real




real reco
real

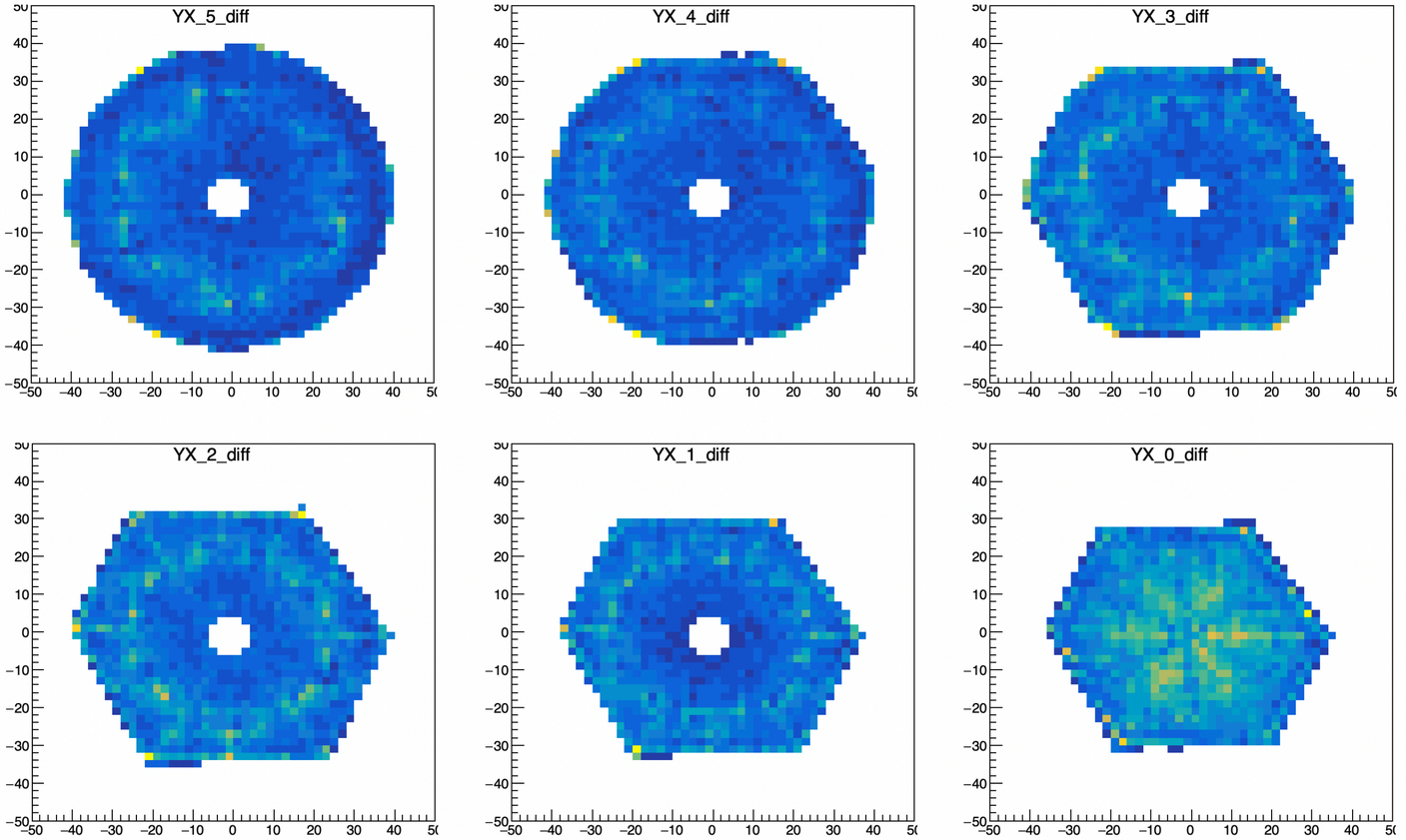
Results: PSA comparison



- Major effect on low energies
- But we don’t know if it’s better or worse…

Results: PSA comparison

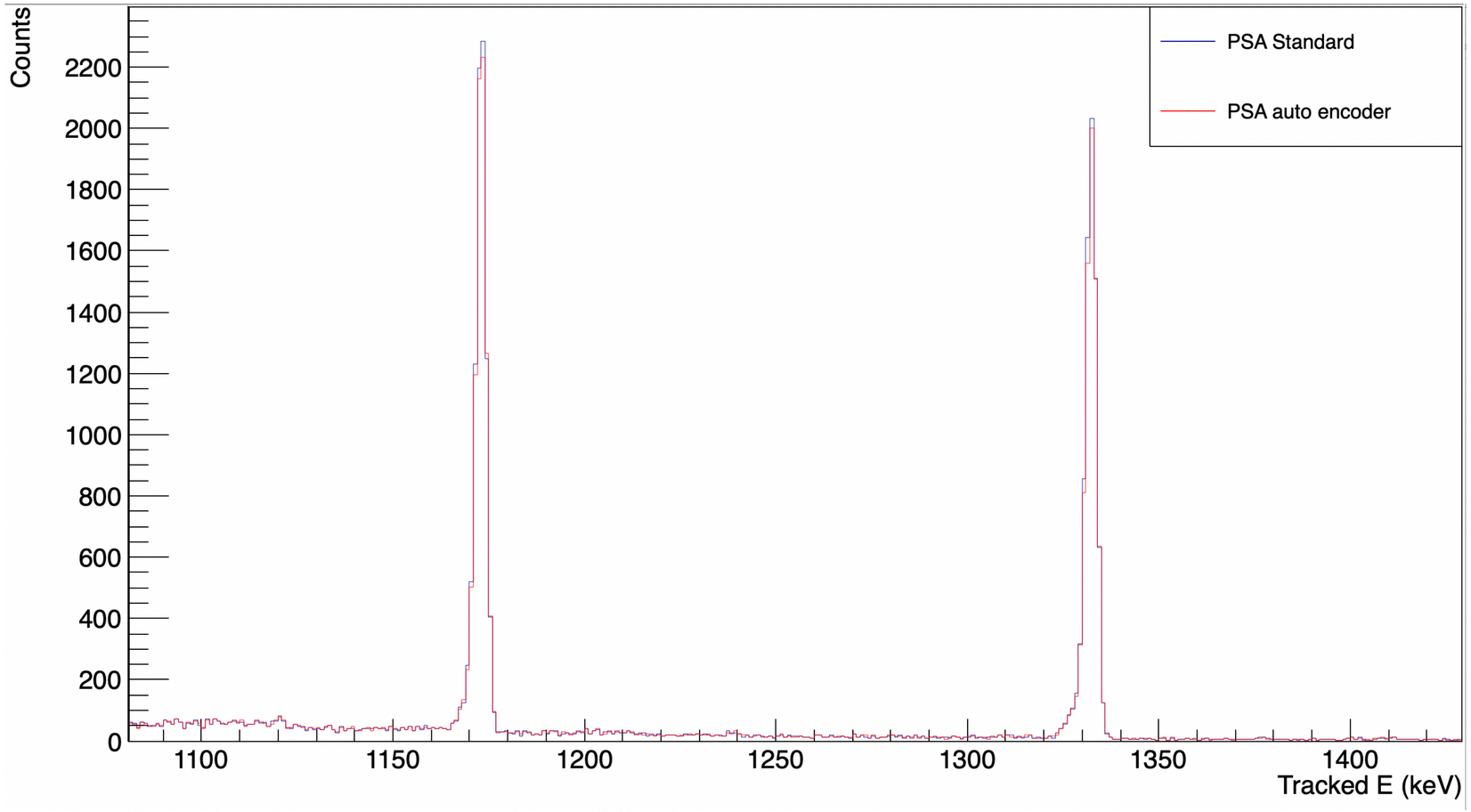
Distance between new and standard PSA



- We probably pack hits toward the segment centers
- Need to adapt the positions taken for training to not favor centers

Results: Tracking comparison

The only way to know if the positions are better or worse is to look at tracked spectra



- We loose ~2% of photo peak efficiency
- But we gain a factor 5 in data size

Data used:

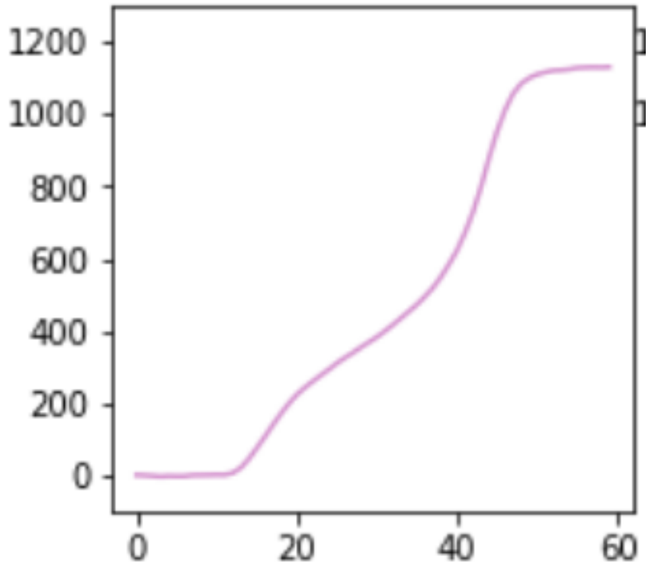
- ^{60}Co, run 3, from experiment e775s, Detector 14B

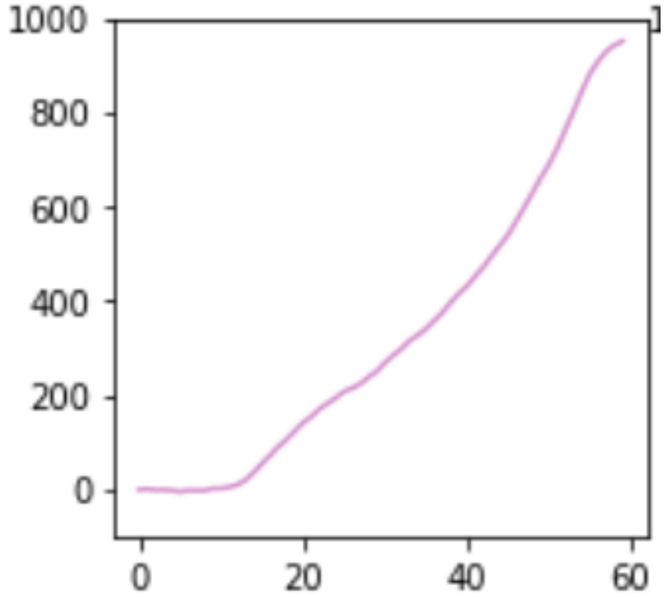
Exercice N°2:

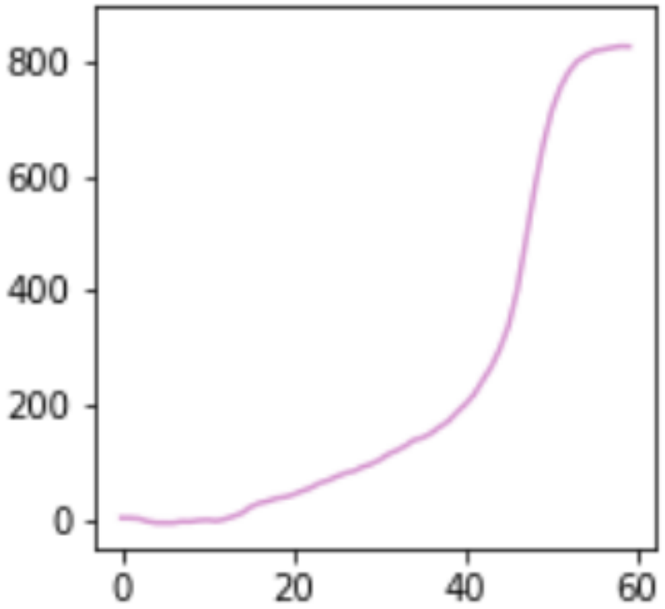
Can use auto-encoder to tag bad signals

- NN trained on ADL bases
- A chi2 gives the error on the signal reconstruction

Results: some bad reconstructions

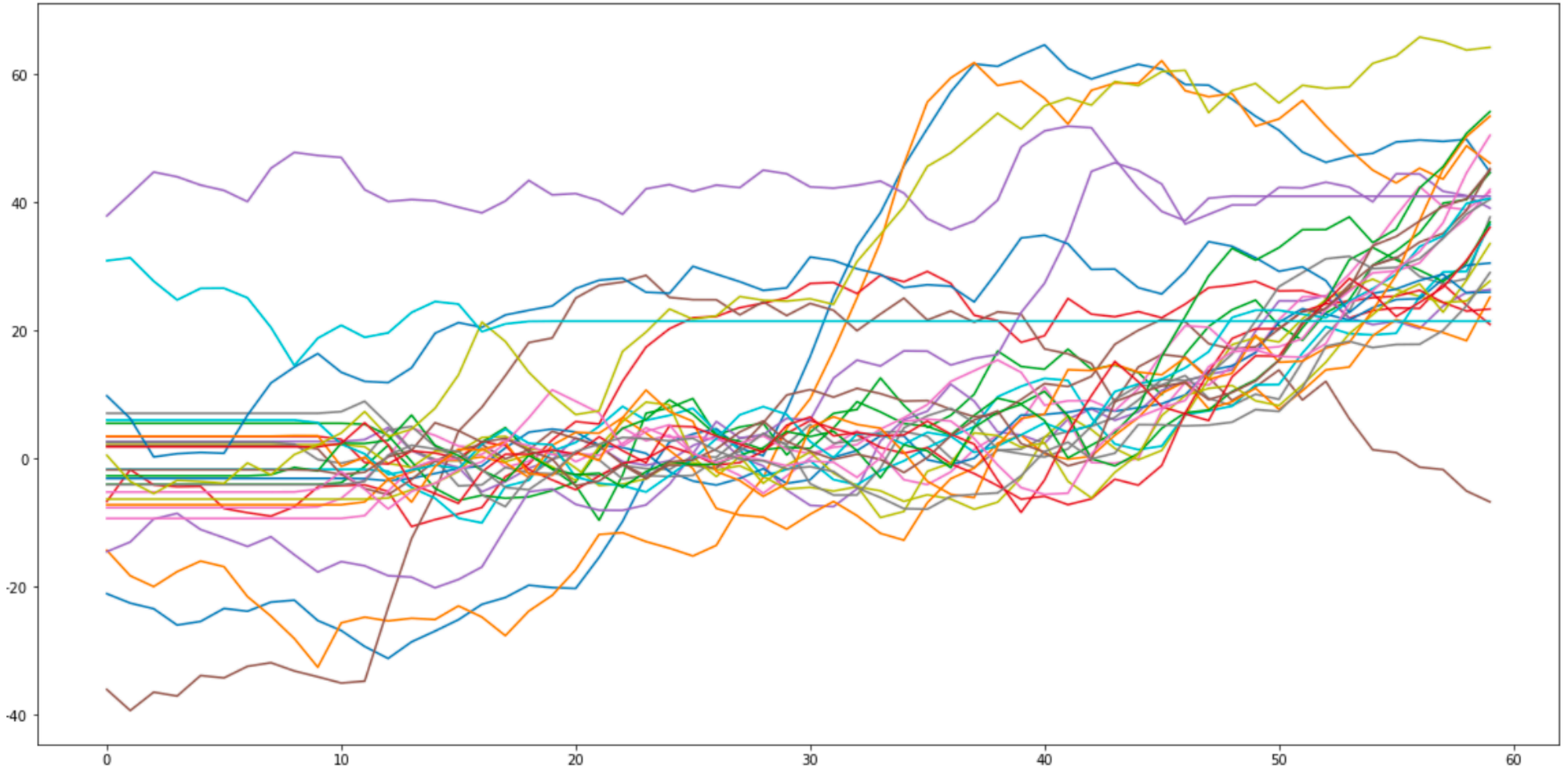






- Pile up detection ?

Results: the 30 worse Chi2 results



- To be investigate in more details…

Conclusions:

- This is the really beginning and nothing is optimized,
- but the full chain (NN + agapro and femul replay) is operational.
- The key point is to be able to work on 3D scanned data, for NN training, and to have be able to know if the results are better or worse. Tracking is not a precise way to do it.

- Work is ongoing…