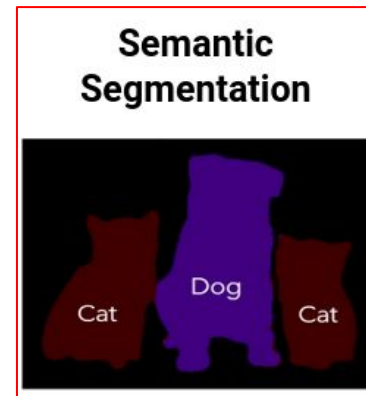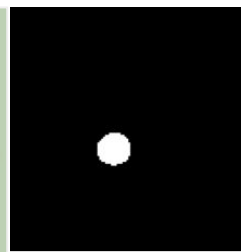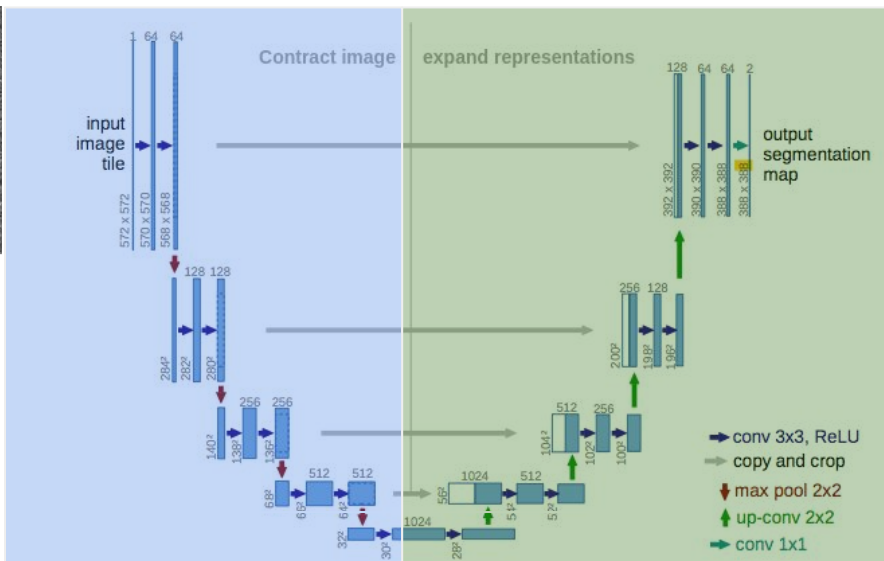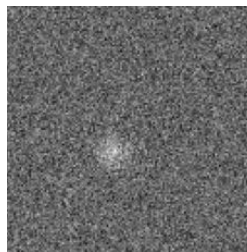# U-Net's performance for low energy events → *reconstruction algorithm*

Preliminary Results

Guilherme Lopes with Rafael Nóbrega

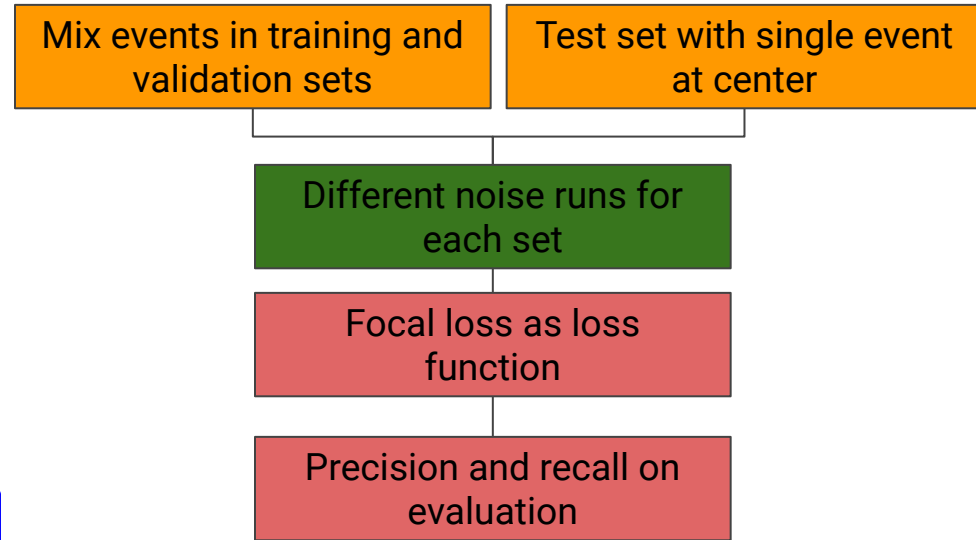# *Recap* U-Net *for pixel classification*

→ Signal/Noise classification on the pixels basis

Semantic Segmentation

Cat   Dog   Cat

Contract image | expand representations

input image tile

output segmentation map

conv 3x3, ReLU
copy and crop
max pool 2x2
up-conv 2x2
conv 1x1

- Expand step will upsample these features,using deconvolution, to allow pixel wise relationship between input and output;

- Contract step is used to build feature maps using convolution;

Training U-Net *with Cygno images*

Simulation Image (0.25 to 60 keV)

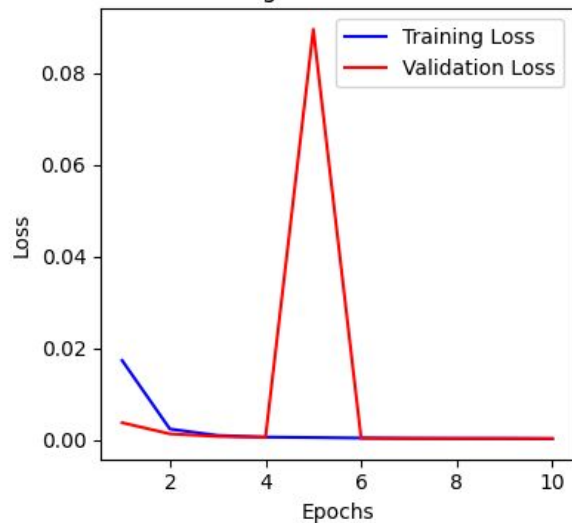

Energy reduction
Only for 1keV

Noise addition and ped sub

* From runs 12163, 12166, 12168, 12175

Threshold = 0

Get truth

Train

Mix events in training and validation sets

Test set with single event at center

Different noise runs for each set

Focal loss as loss function
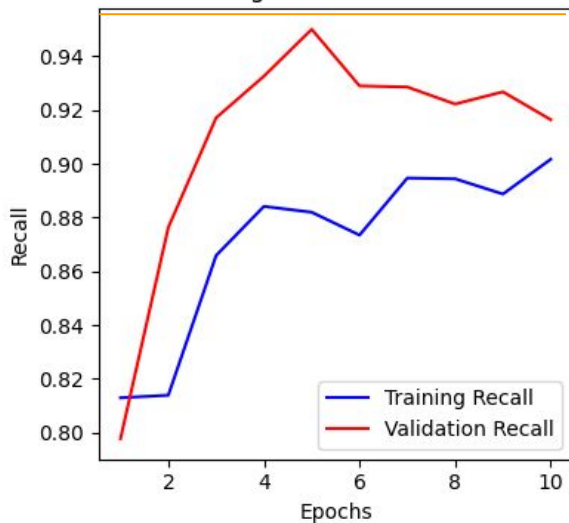
Precision and recall on evaluation
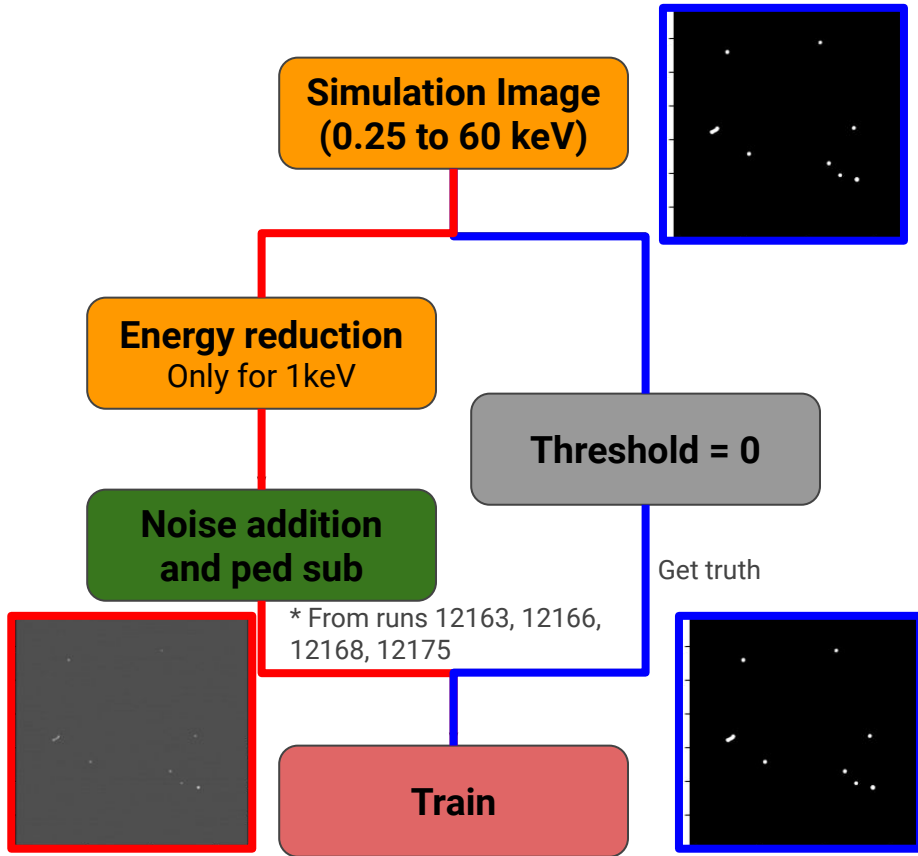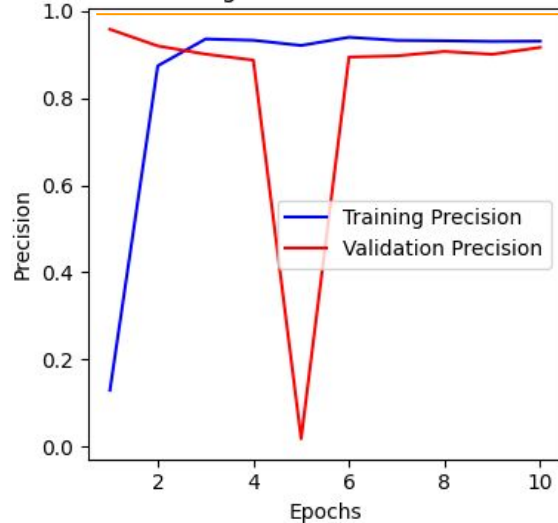
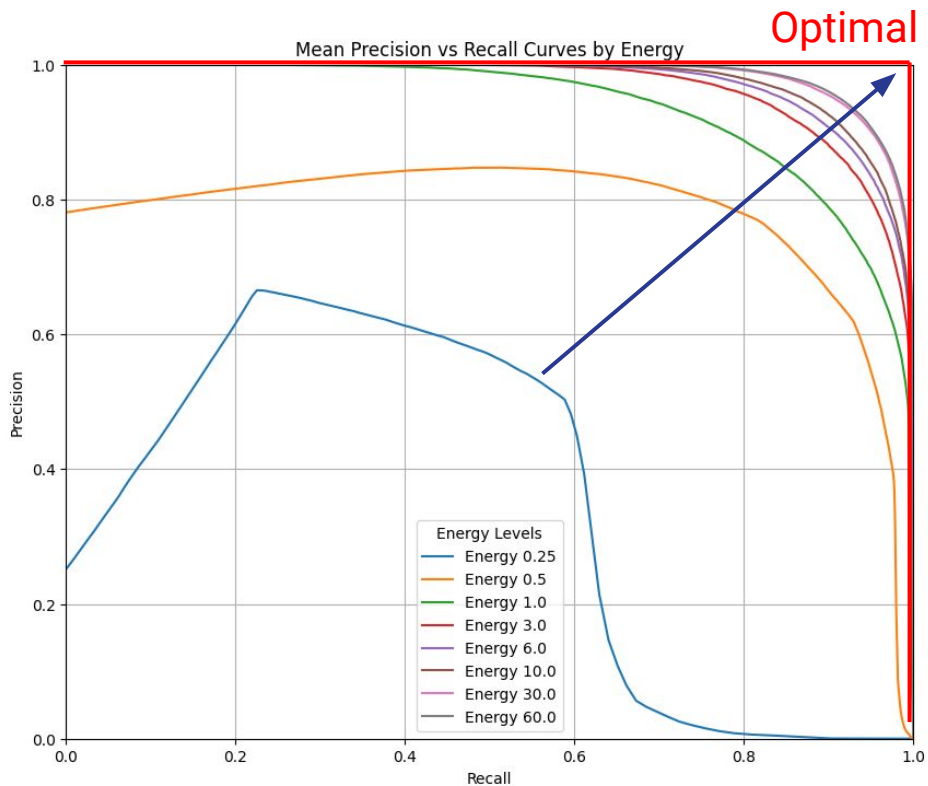# *Results* learning curves

Training & Validation Loss

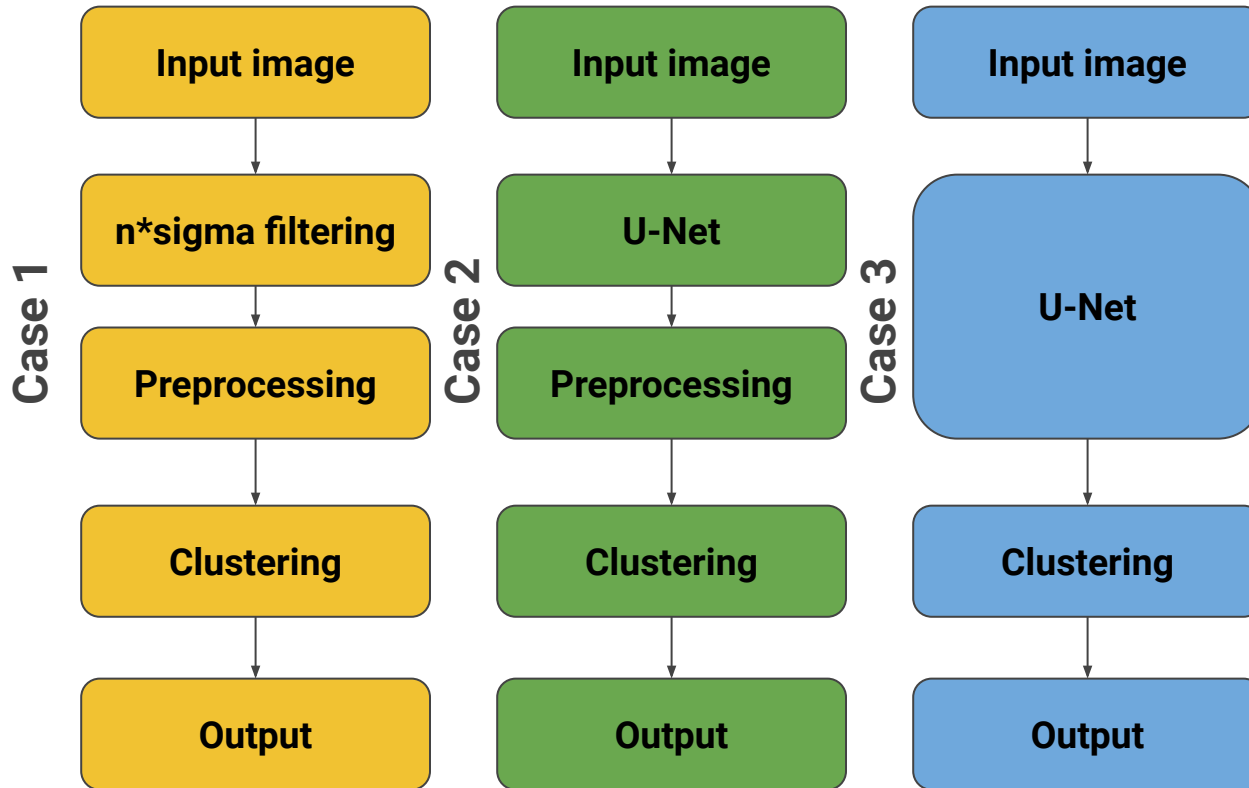Training & Validation Recall

Training & Validation Precision

Pixel classification Results on test set

As expected, the precision-recall curves is poor for lower energies (0.25 keV)

When energy increases, the precision recall approaches to the optimal

Put it on reconstruction

Case 1

Input image → n*sigma filtering → Preprocessing → Clustering → Output

Case 2

Input image → U-Net → Preprocessing → Clustering → Output

Case 3

Input image → U-Net → Clustering → Output

Cluster detection preliminary results *(Lower energies on test set)*

Method	Case 1 (Reco)	Case 2 (Unet+Reco)	Case 3 (Unet + Reco)
Detected events (%)	68	86	86

Energy	0.25	0.5
Detected (%)	3,5	89,36

Energy	0.25	0.5
Detected (%)	53.6	97.87

U-net makes reconstruction see events that would not be detected.

Energy	0.25	0.5
Detected (%)	57.14	97.87

Cluster detection preliminary results *(Lower energies on test set)*

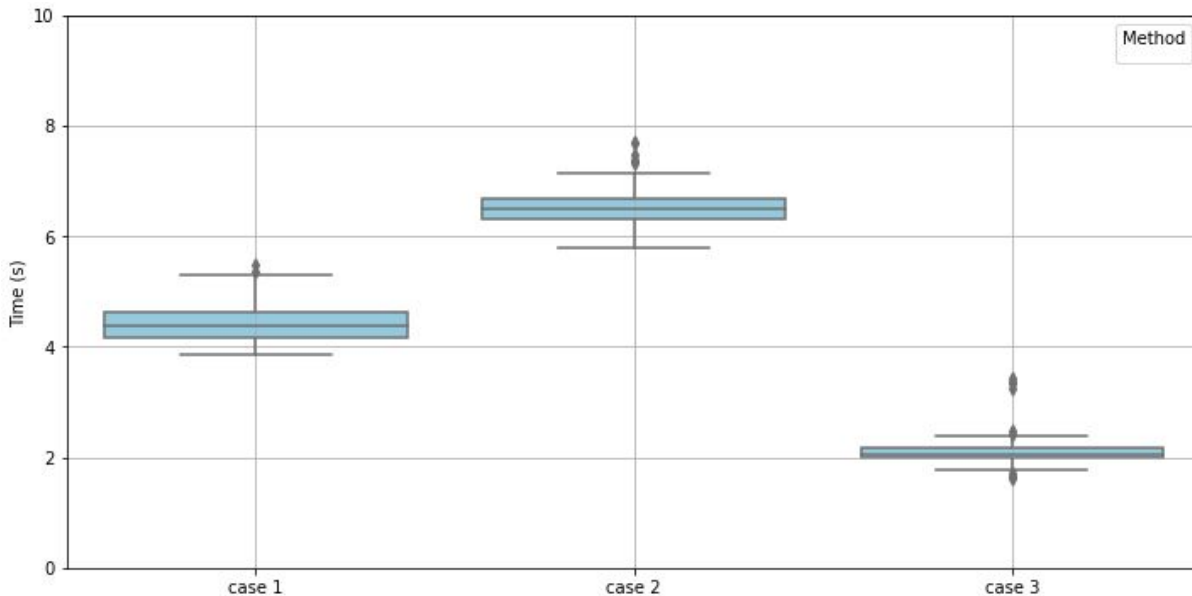**(%) Truth pixels into xmin,ymin,xmax,ymax region**
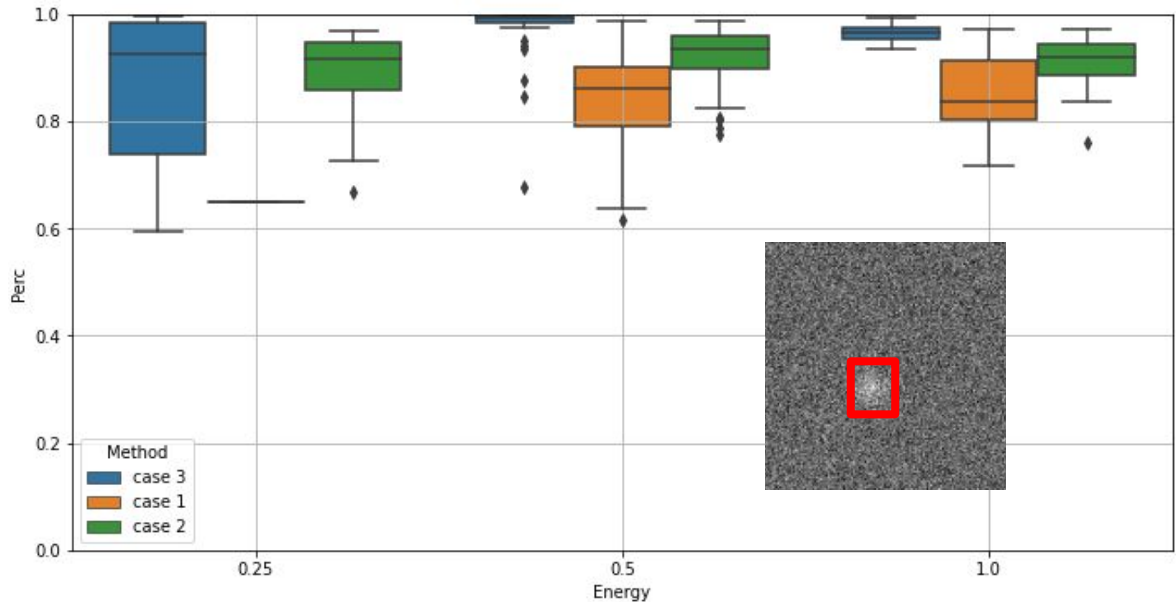
Percentage of truth pixels on detected region

U-net shows an improvement.

Cluster detection preliminary results *(Lower energies)*

Processing Time

Case 2 spends more time as expected

When only U-Net is used as preprocessing, the processing time is reduced by half.

Next steps

Hyperparameter tuning U-Net

Reconstructed energy Analysis

Test it using real data