Improved ML selection on sensor-on events

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Idea

Classify tracks based on topology

- From cut based analysis: create a dataset of tracks
- Train the model on those tracks
- Ideally it will learn to generalise outside the cut region

- Sensor-on: easy to identify (cut on rho)
- Identify low-energy sensor-on events

$$\rho \equiv \frac{\text{sc\_rms}}{\text{sc\_nhits}} < 0.15$$

The Dataset

- From cut on rho + visual inspection: select relevant events
- Cut a 100x100 patch around the coordinates of the sensor on event in the original image
- Data Augmentation: Position + Flips + 20° Rotations

Event Classes:

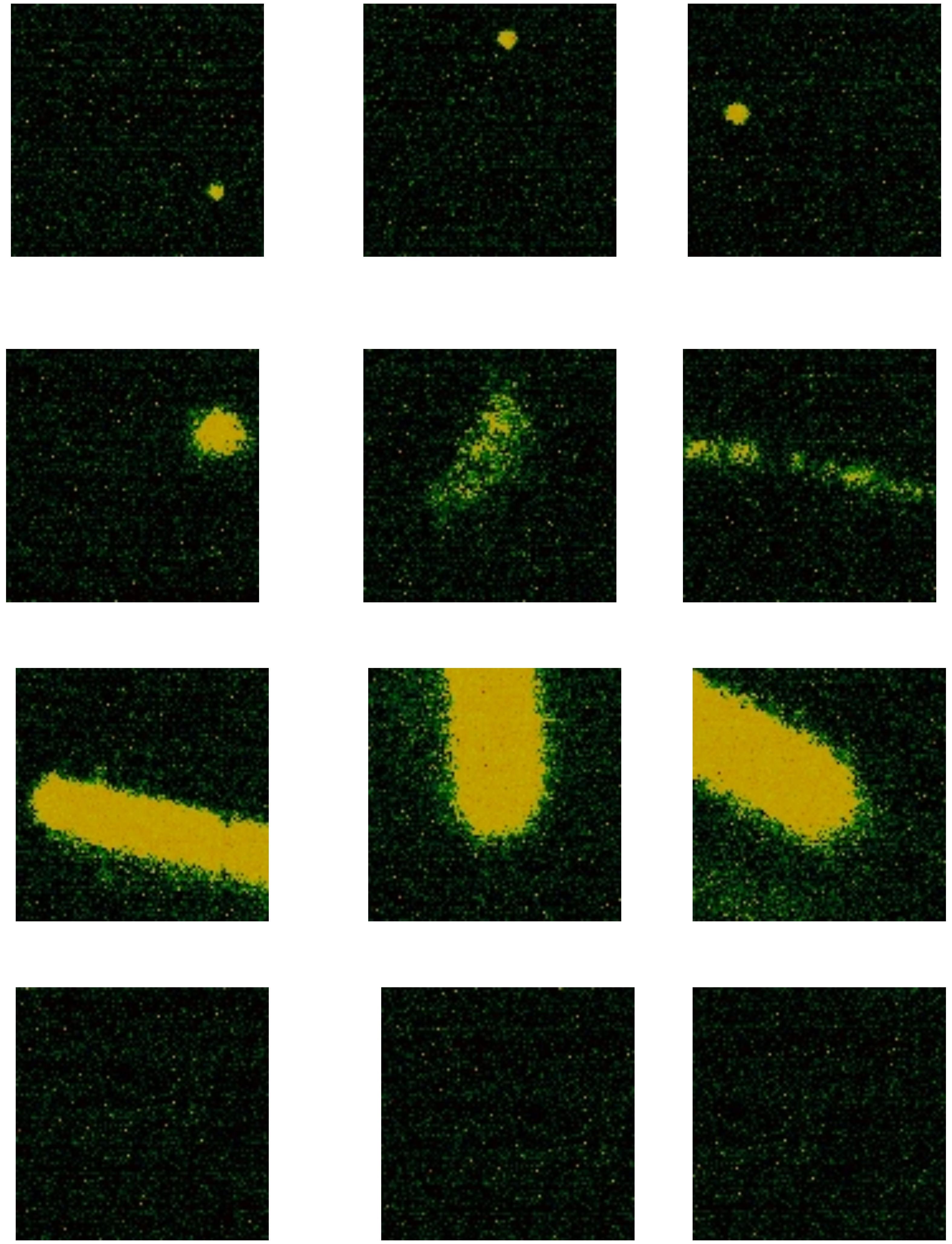
- Noise, Sensor_on, Alfa, Other

Sensor_on

Other

Alfa

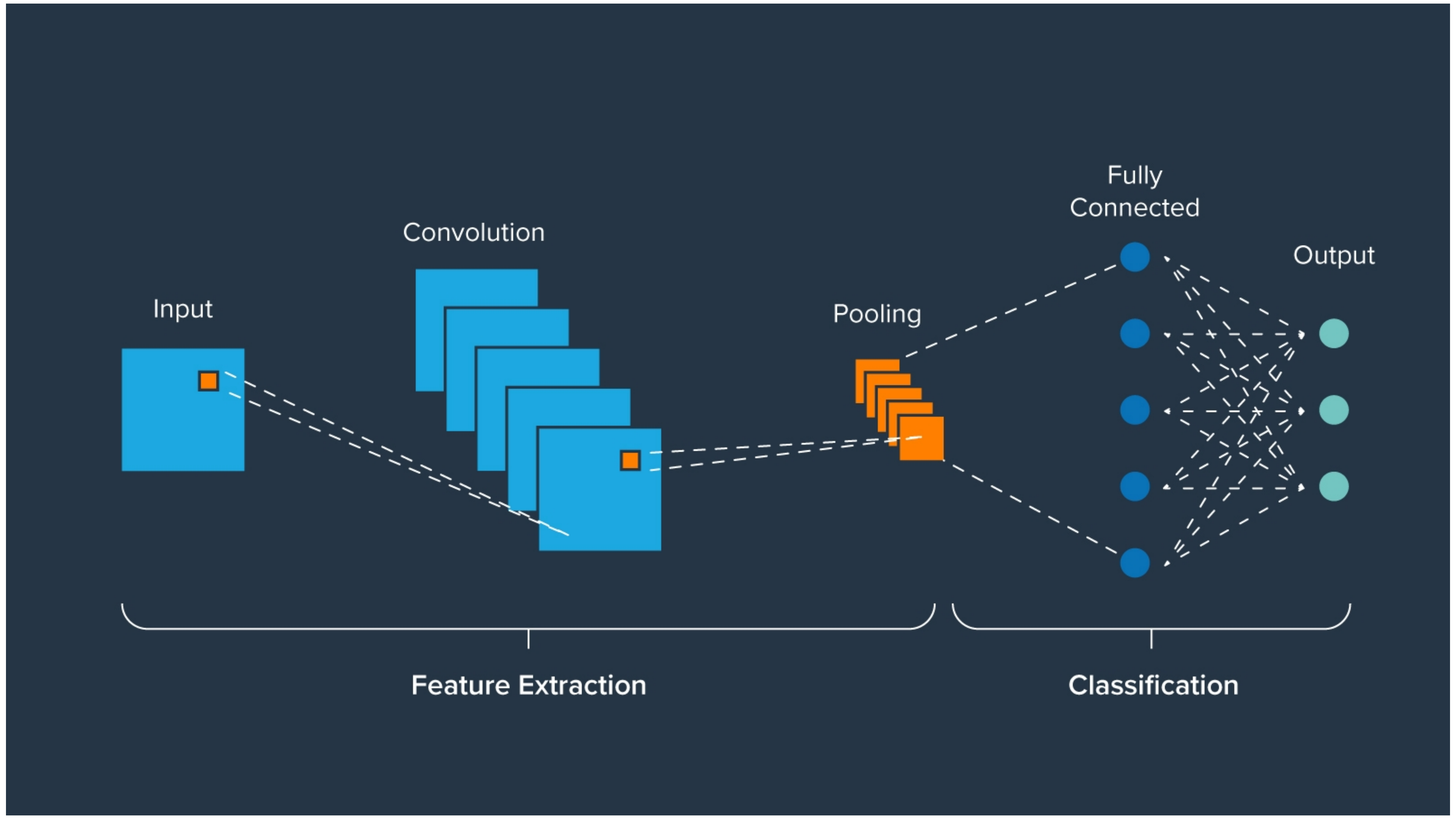
Noise

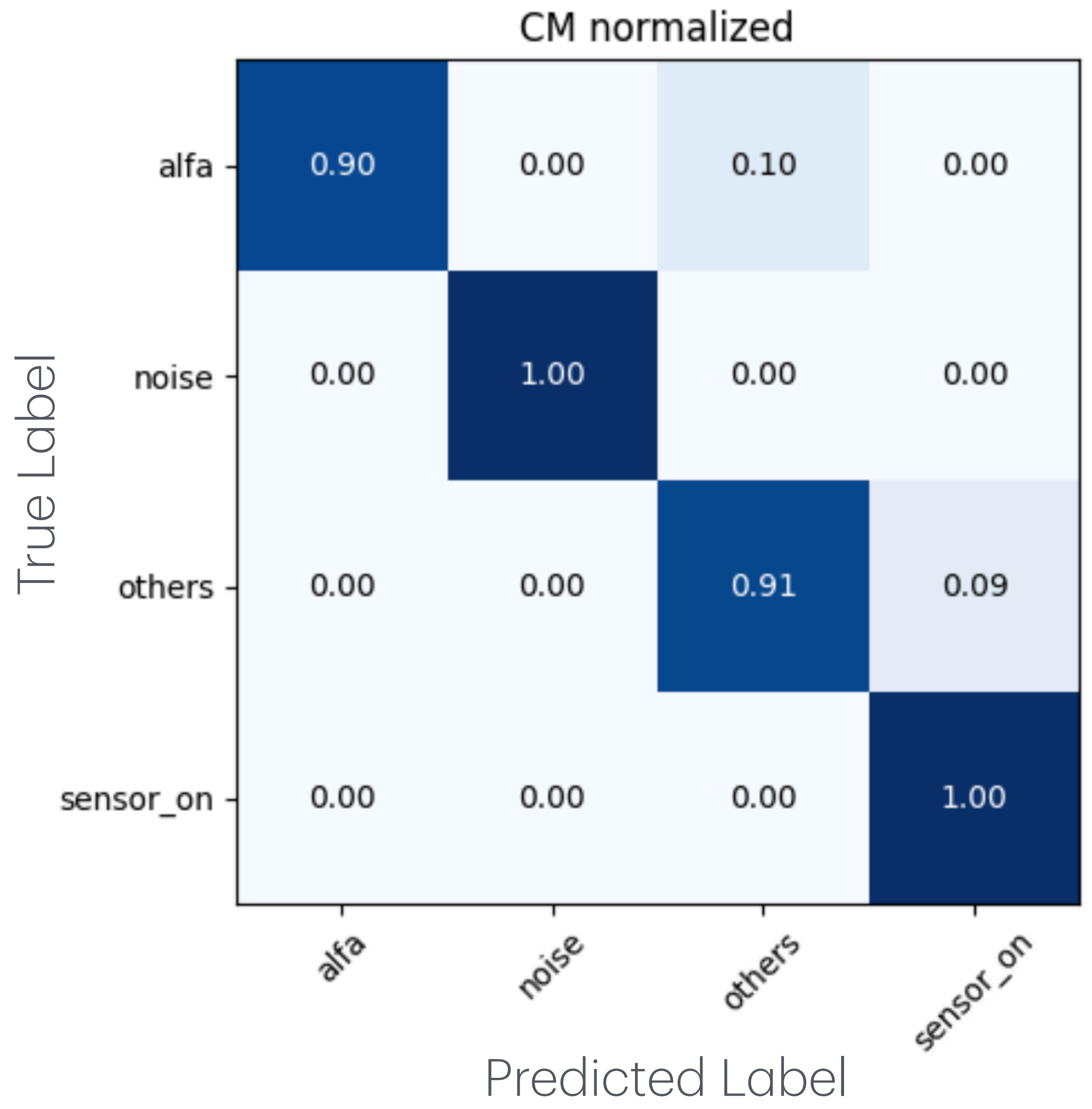


The Model

- For now: simple convolutional classifier (test the approach)
- Train on 100x100 image patches selected via the help of cut based analysis

Layer (type)	Output Shape	Param #
input_layer (InputLayer)	(None, 100, 100, 3)	0
conv2d (Conv2D)	(None, 100, 100, 16)	448
max_pooling2d (MaxPooling2D)	(None, 50, 50, 16)	0
conv2d_1 (Conv2D)	(None, 50, 50, 32)	4,640
max_pooling2d_1 (MaxPooling2D)	(None, 25, 25, 32)	0
conv2d_2 (Conv2D)	(None, 25, 25, 64)	18,496
max_pooling2d_2 (MaxPooling2D)	(None, 12, 12, 64)	0
flatten (Flatten)	(None, 9216)	0
dense (Dense)	(None, 64)	589,888
dropout (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 4)	260

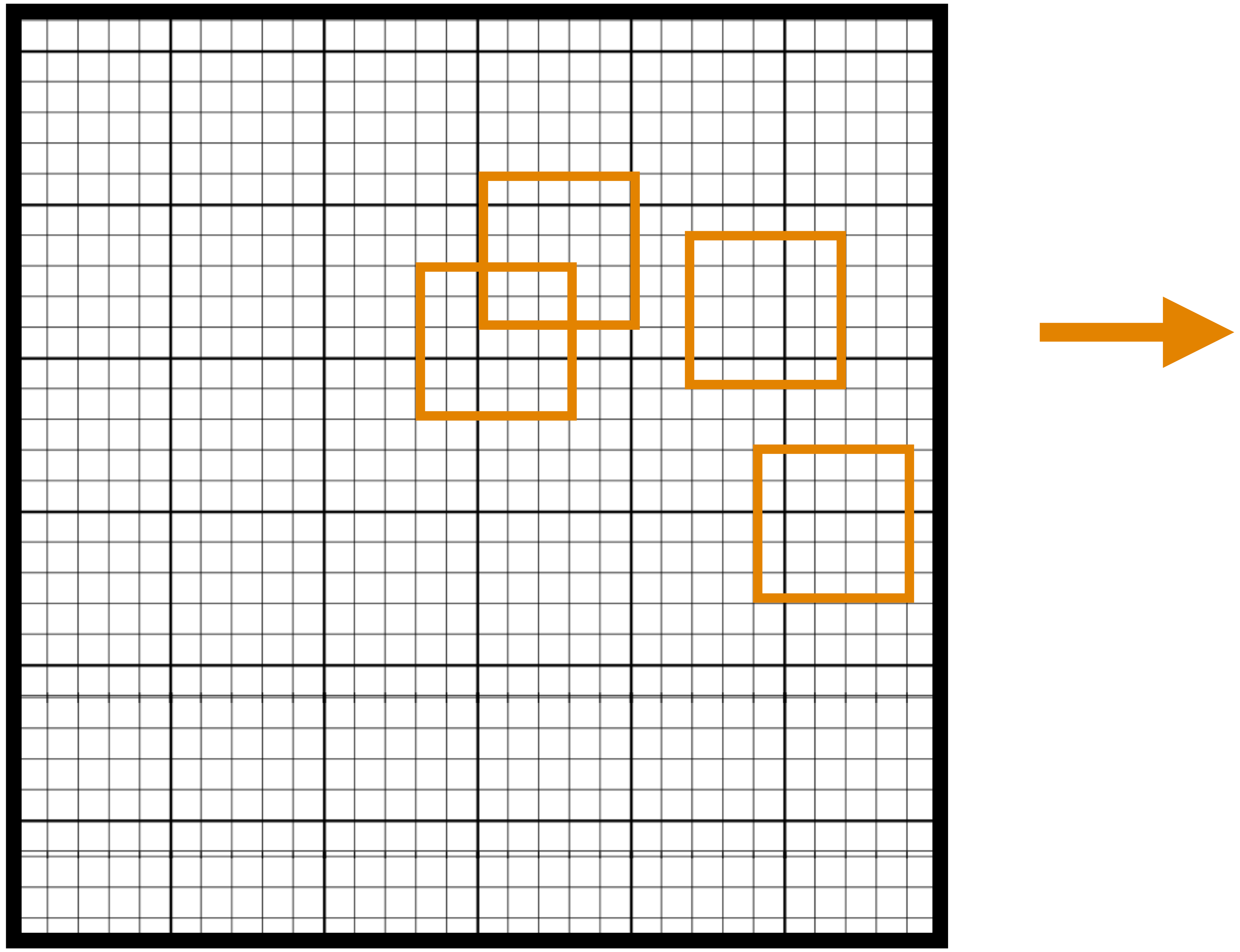




Using the model on real data

“Faking” Higher resolution

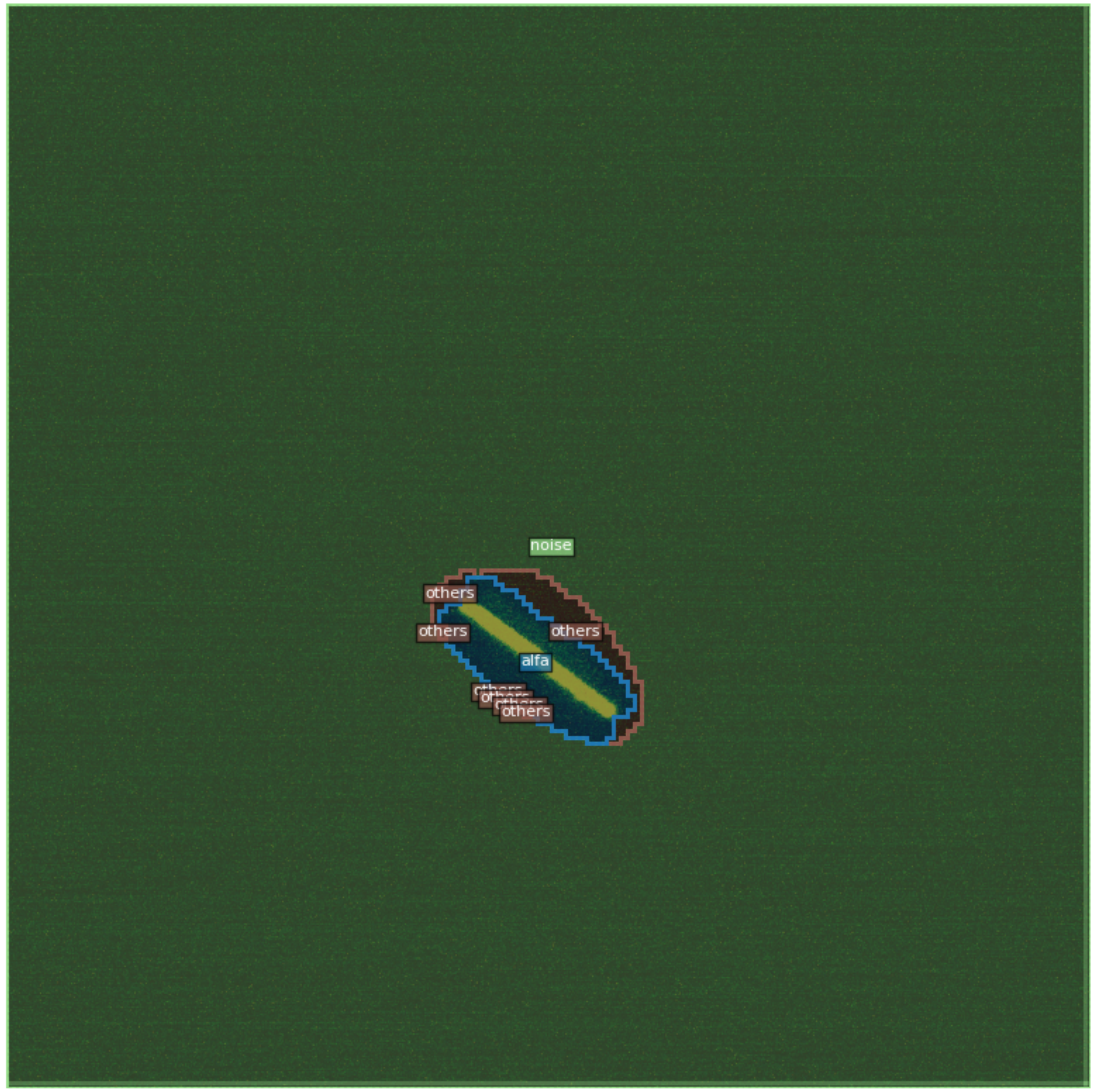
- Idea:

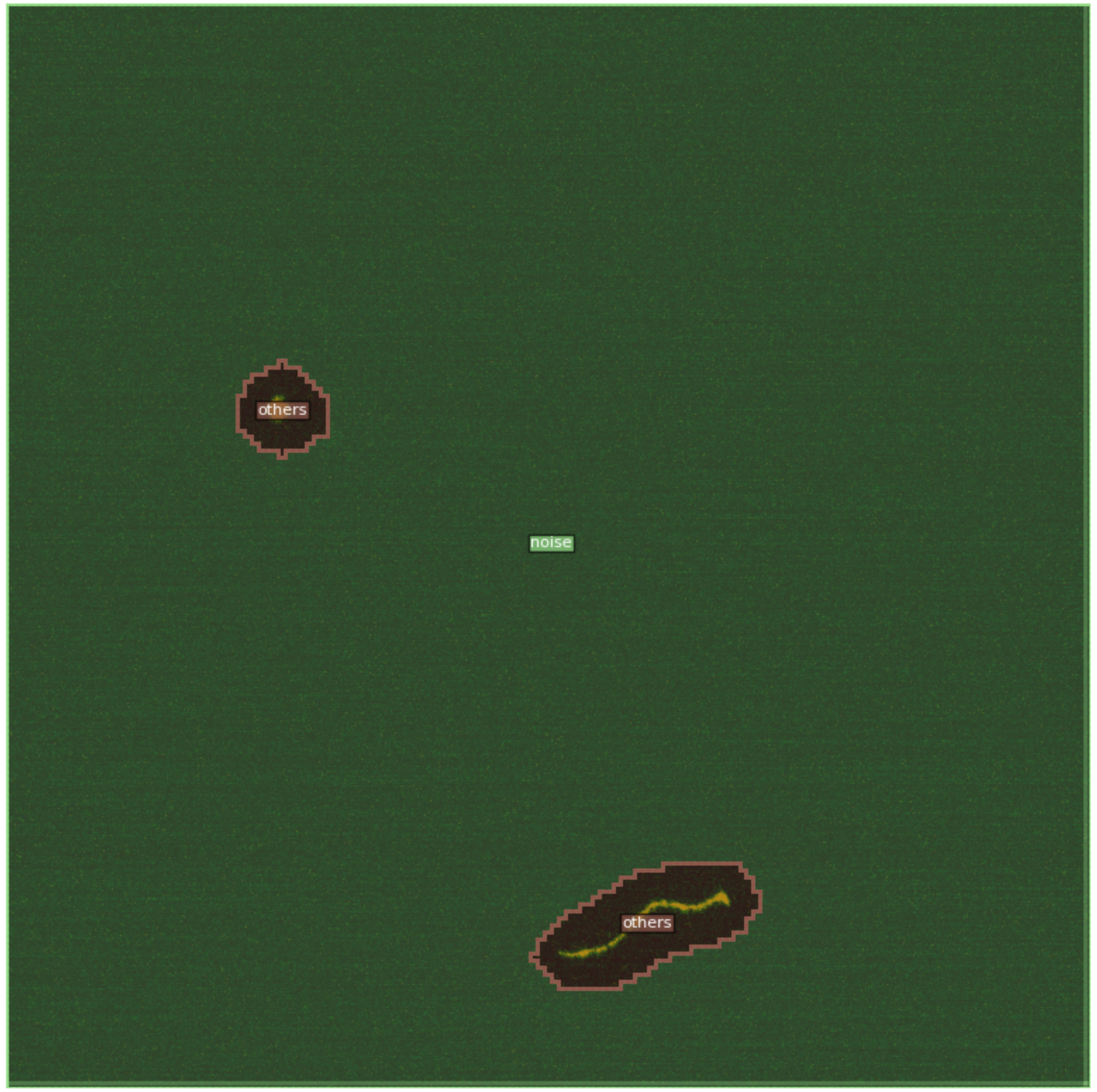


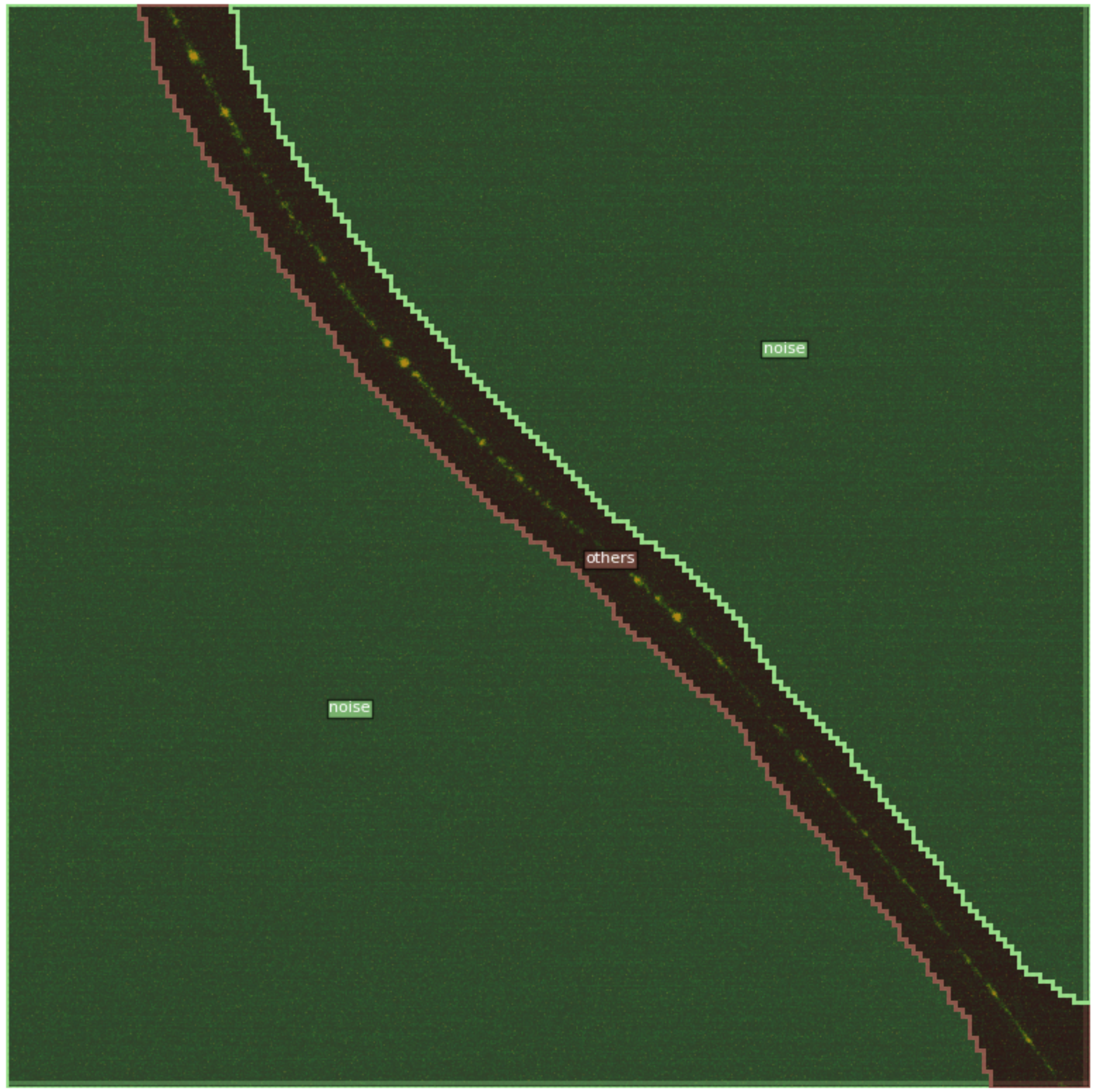
- Move the model across the image with stride 10
- Each 10x10 area will be classified multiple times
- Take the mean probability -> classify
- More resilient to errors
- Independent of the model, possibility to swap it out and use on other aspects

Some Examples

Applying this technique on random independent pictures

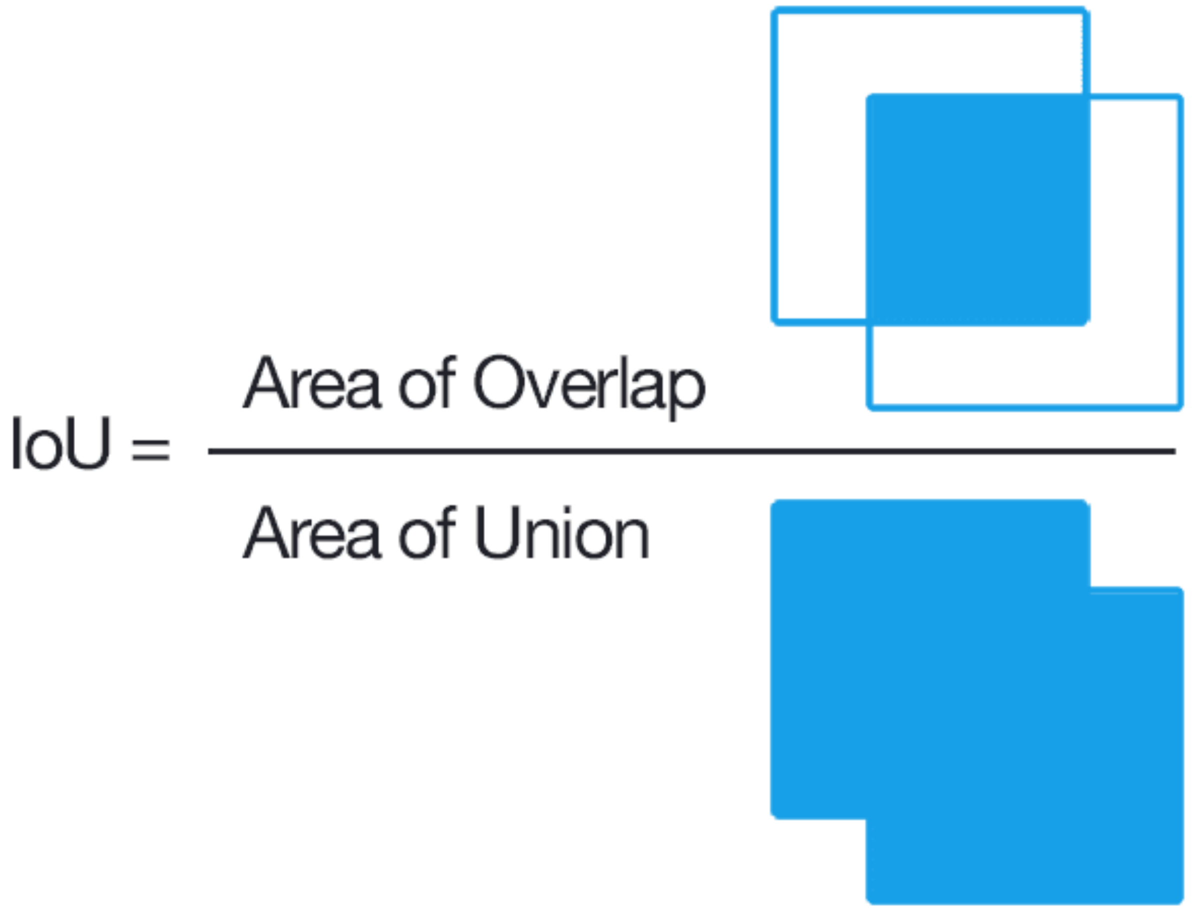


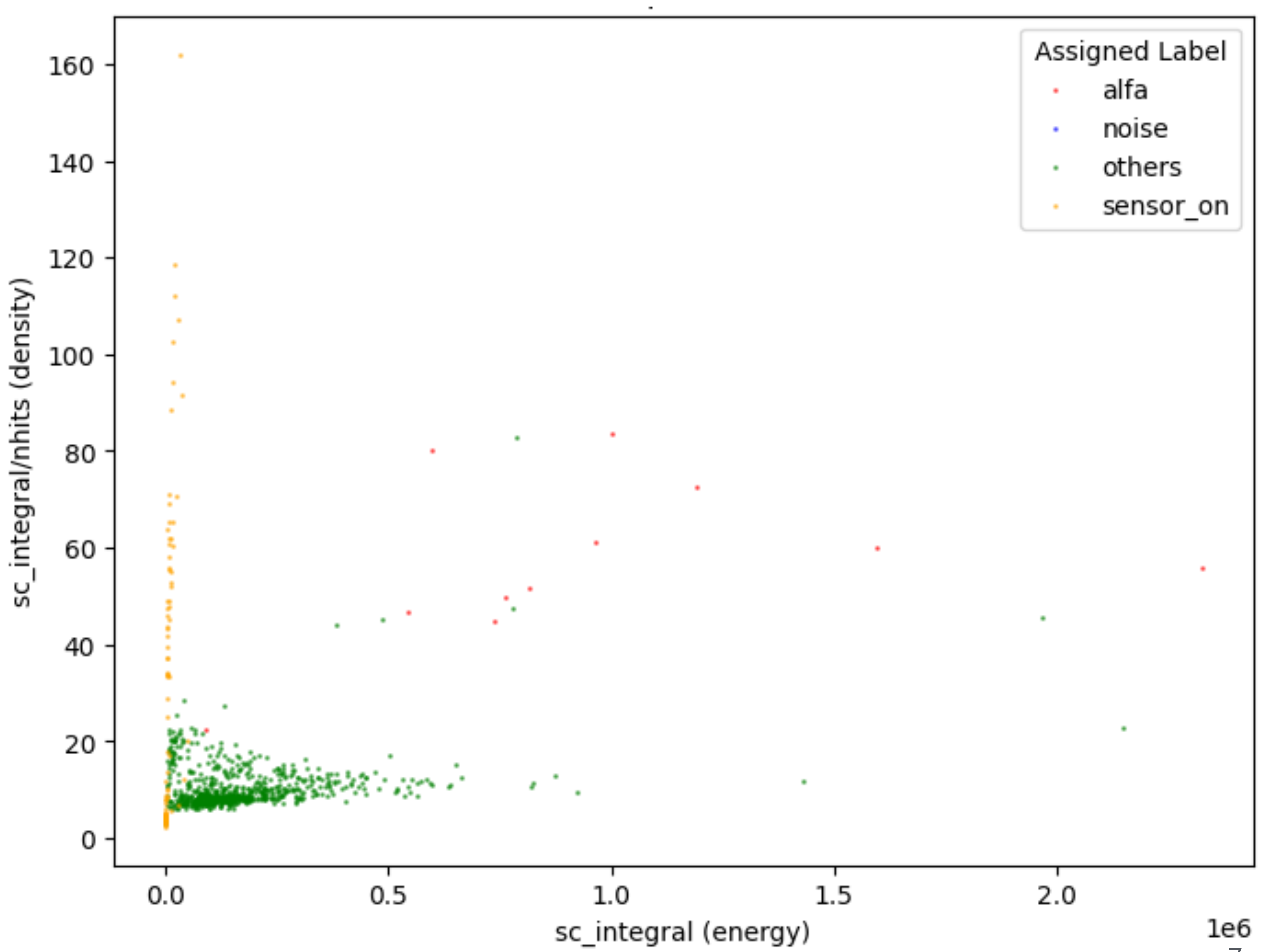




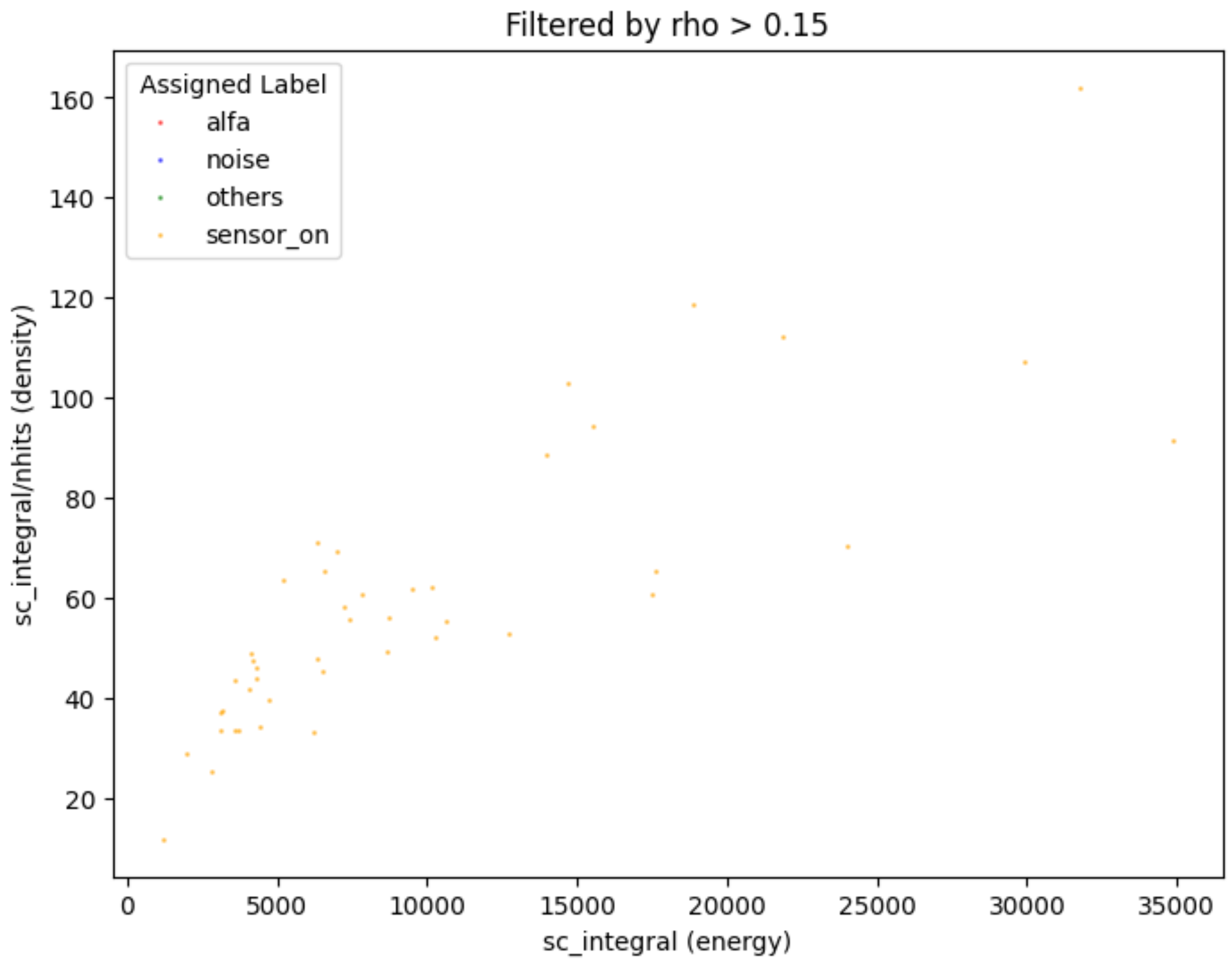
Label Matching to Data

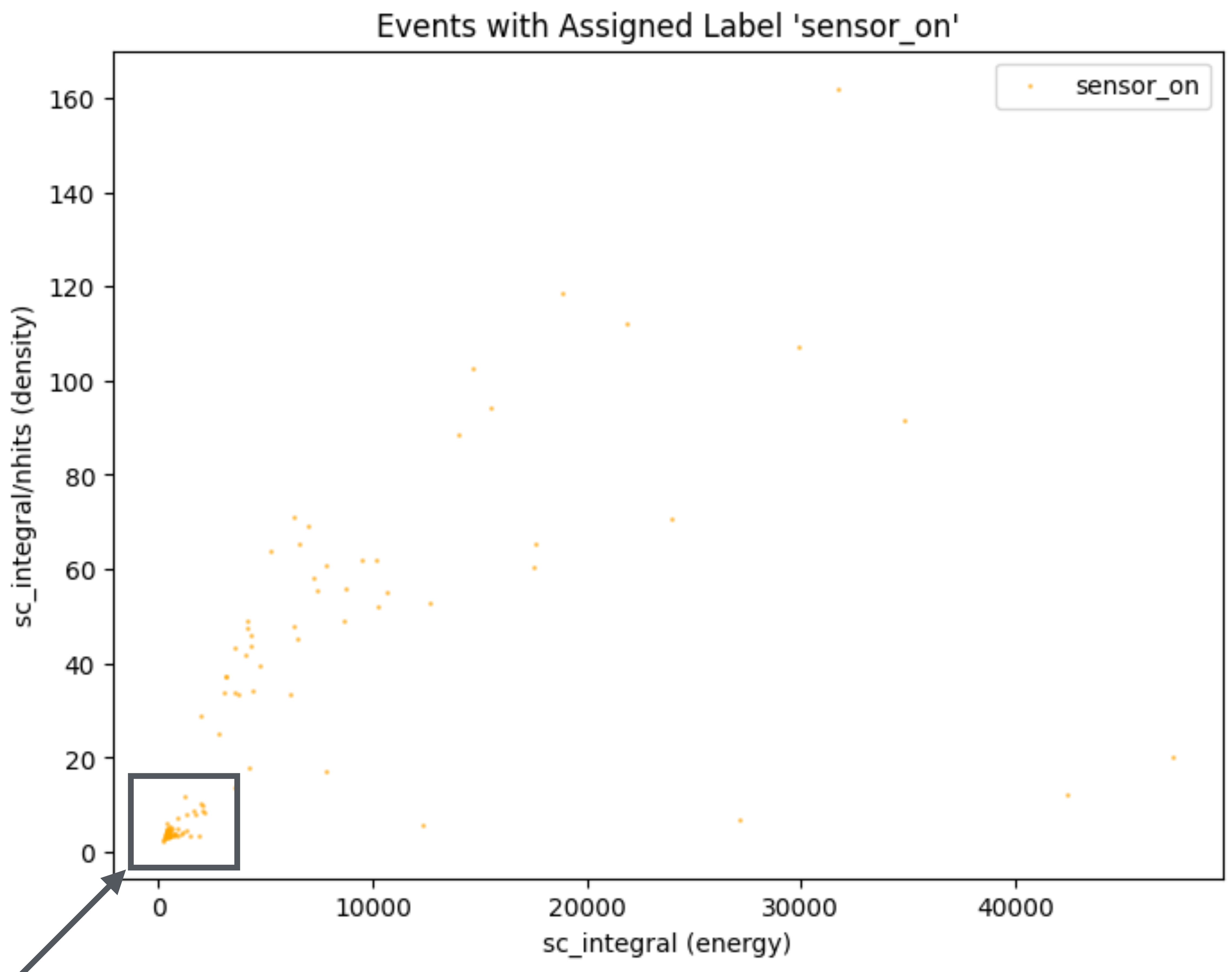
- Evaluate IoU between model prediction and Reco “boxes” (via sc_xmin, sc_ymin, ...)
- Assign label to dataframe based on IoU





Comparison with Rho cut



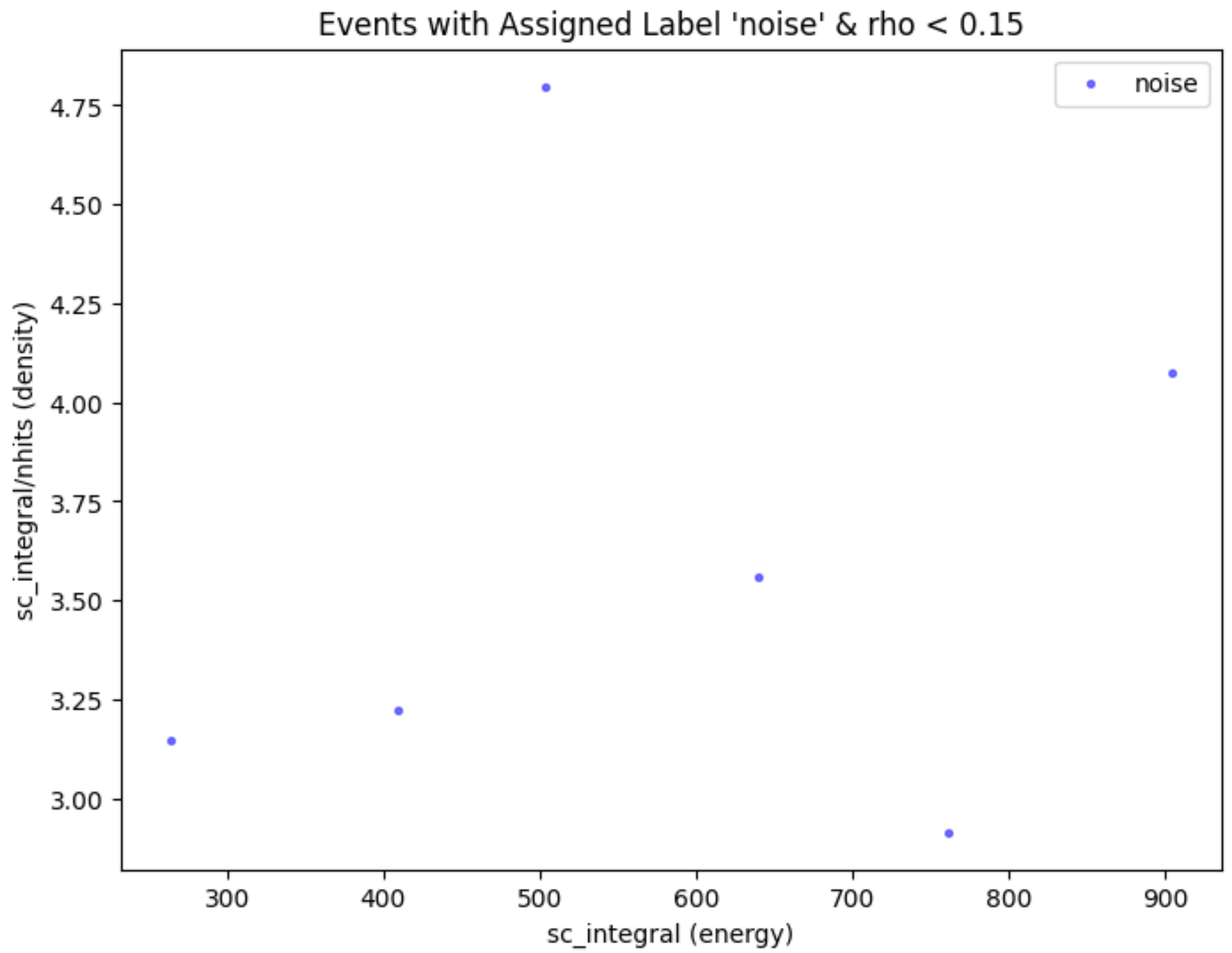


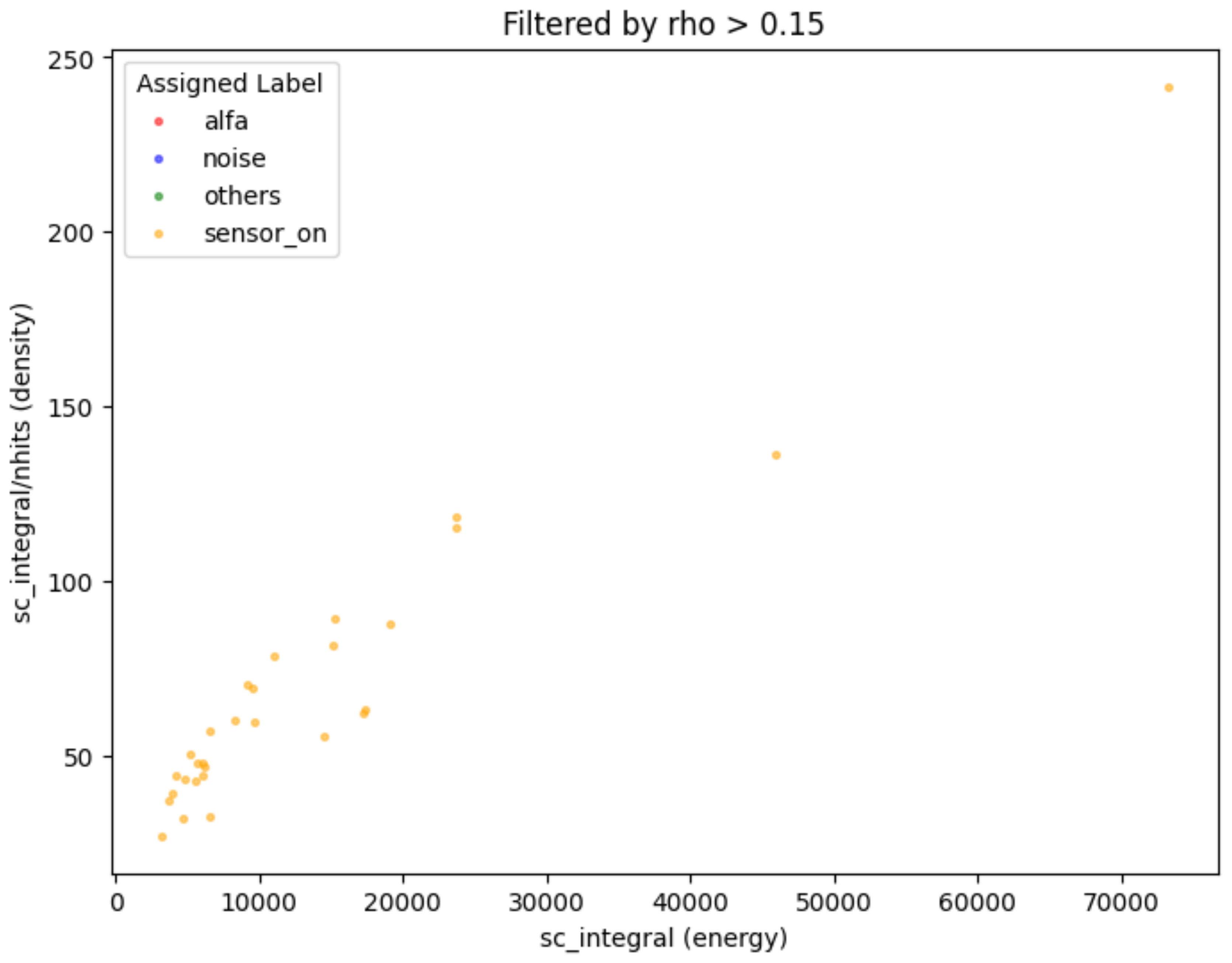
Model finds more Sensor on events at low energy than rho cut

How can we be sure they are real sensor-on?

Test on other Pedestal Runs

- Tested on independent pedestals (small sample)
- For now model performed the same as rho cut
- Need more pedestal runs
- Isolated some noise events which made it past rho<0.15 (2% of total)





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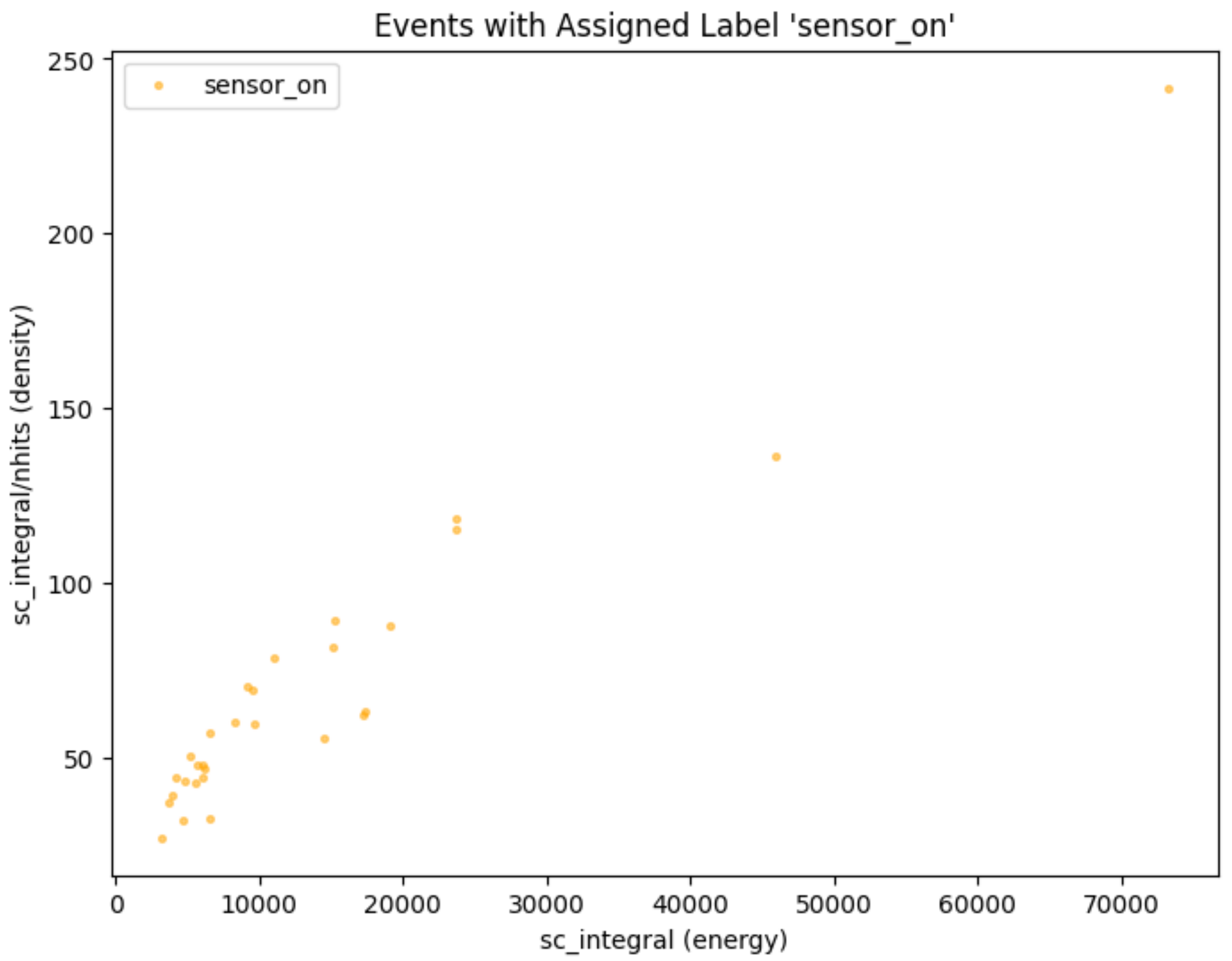


Conclusion

Going Forward

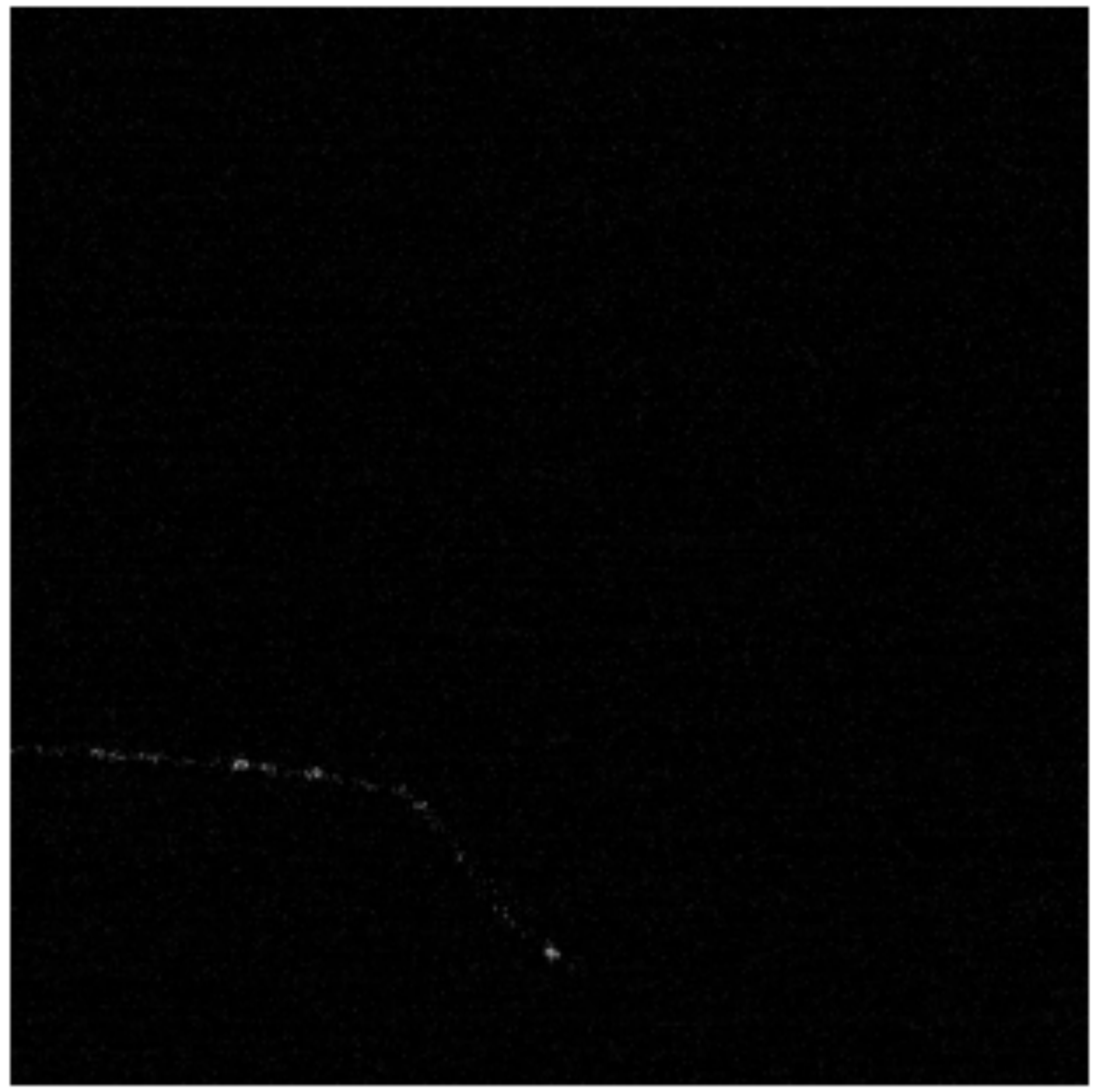
- The model works and has a lot of room for improvement:
- A bigger dataset is likely to vastly improve performance
- Model Architecture can be modified to increase resolution and performance

What's next ?

Image segmentation: in development

- From Redpixes: Truth Mask
- Train on real images, goal: reconstruct relevant pixels from reco
- Quality cuts on reco to create classes of events (automate the dataset creation process)
- Identify relevant pixels from images and classify them

Raw



Merged Mask