End-to-End Object Reconstruction in a Sampling Calorimeter using YOLO

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Motivation

Constantly improving object detection frameworks, e.g., YOLO

Increasing granularity of sampling calorimeters using silicon, e.g., CMS high granularity calorimeter

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Novel idea of interpreting the layers in sampling calorimeter as colours of image

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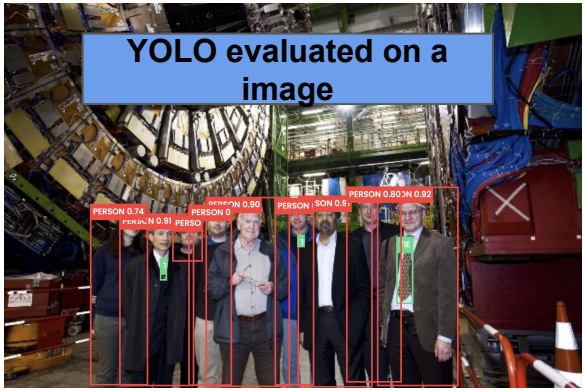
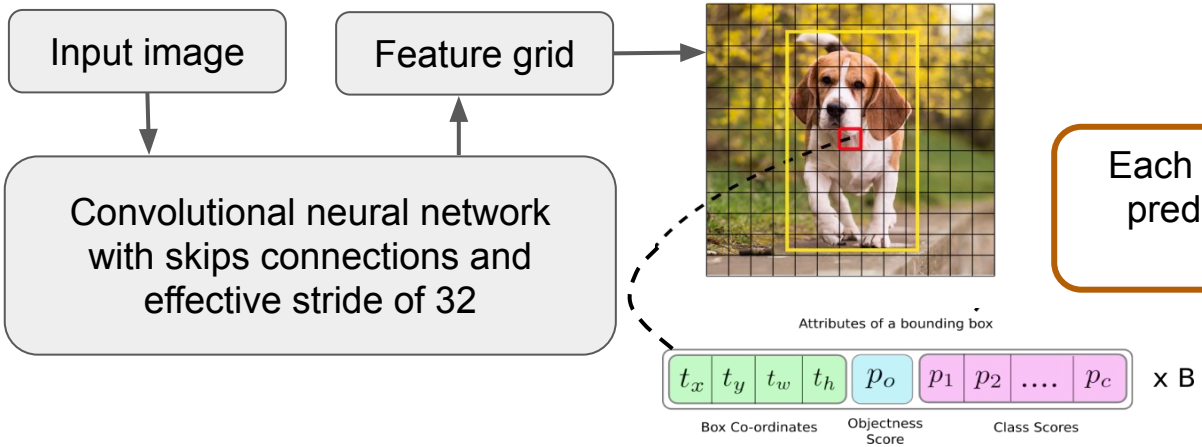
Efficient way to reconstruct physics objects, e.g., electrons, muons, etc.

YOLO working

You Only Look Once (YOLO) is a highly popular object detection framework extensively used in computer vision to identify objects of different types such as animals, person, automobile, etc.



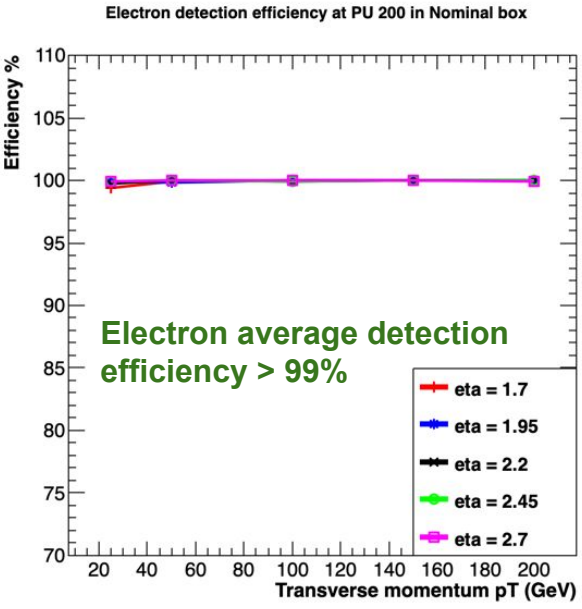


Each element in feature grid is trained to predict the bounding-box and class for objects of interest

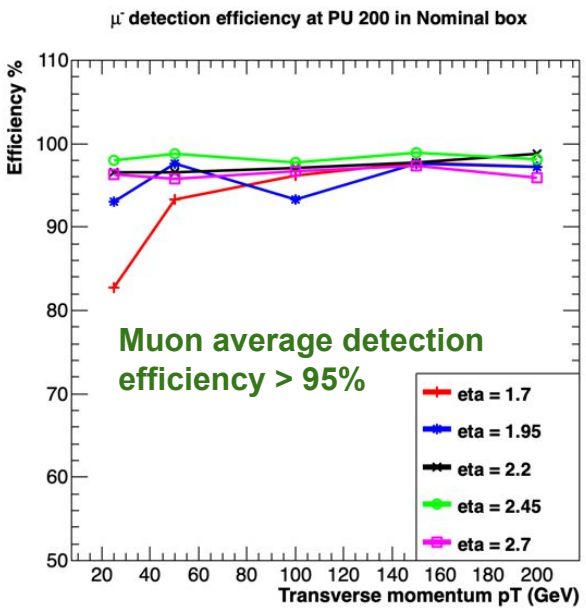
Calorimeter design

- Dummy calorimeter with 47 layers of 200 μm Silicon segmented into 3.5 * 3.5 mm^2 cells as active material, with lead + copper-tungsten (stainless steel) as absorbers for electromagnetic (hadronic) sections.
- 10,000 electrons and muons with transverse-momentum pT$\in$ [20, 200] GeV and pseudo -rapidity $\eta \in$ [1.6, 2.9] are simulated at three different average PU interactions (0, 50, 200) are used for training
- Every three consecutive layers are combined to create 736*736 image in eta-phi plane, creating a total of 16 coloured channels

Results



Electron average detection efficiency > 99%



Muon average detection efficiency > 95%

Fast evaluation independent of complexity (PU senario)

GPU NVIDIA RTX 3090 (RTX 4090) Batch size = 4				
Input Particle	PU	Pre processing (ms)	Inference (ms)	NMS (ms)
Electron or Muon	0	1.1	1.1	0.3
	50	1.1	1.1	0.3
	200	1.1	1.1	0.3

Thank You

Please drop by the poster on Thursday at location 89