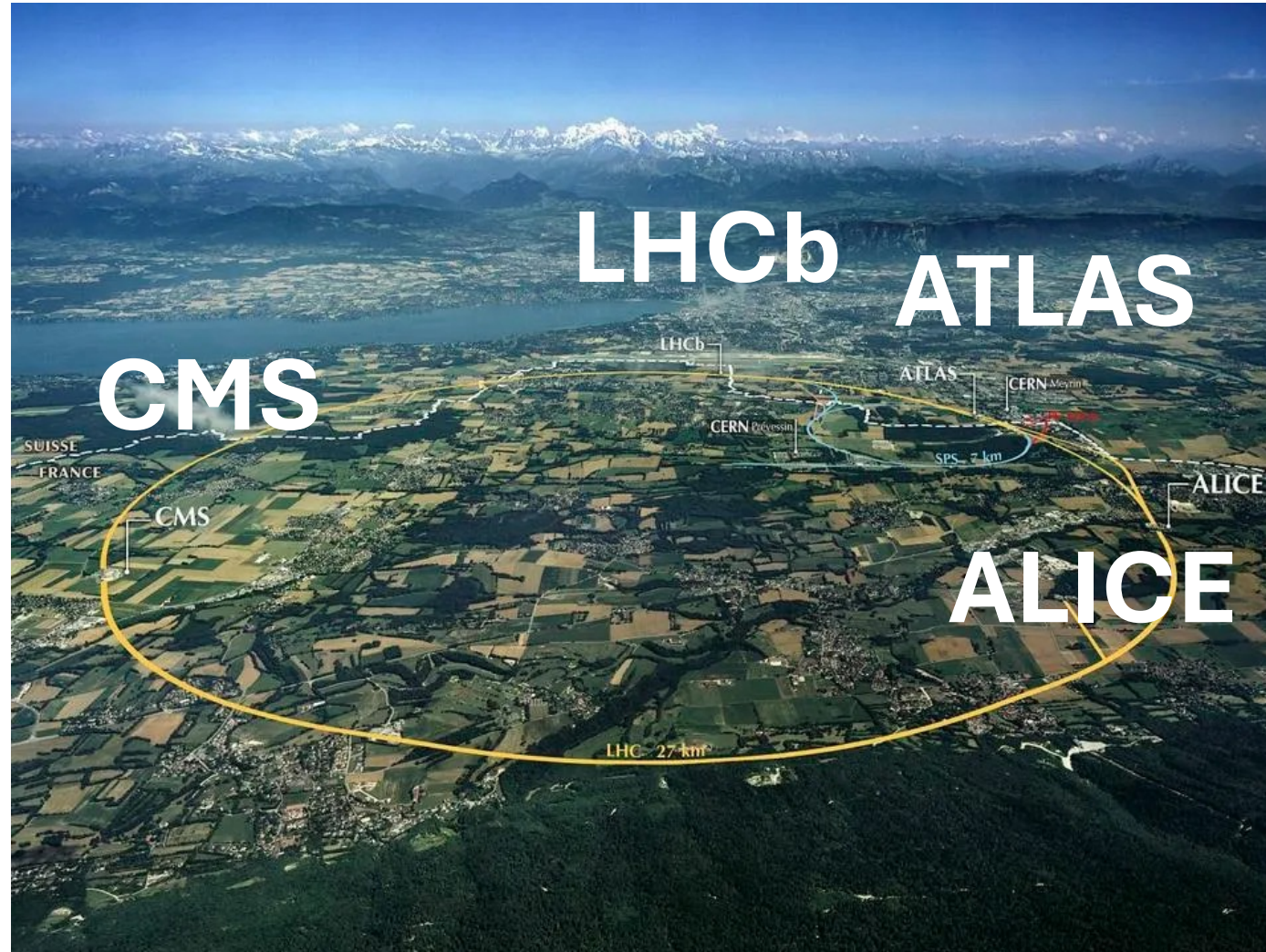


# Particle Images Challenge

DeepLearn Hackathon Summer 2024

The Large Hadron Collider is the world's largest man-made particle collider



# The CMS detector is one of largest experiments at the large hadron collider, specialized in studying heavy particles and their decay products

## CMS DETECTOR

Total weight : 14,000 tonnes  
Overall diameter : 15.0 m  
Overall length : 28.7 m  
Magnetic field : 3.8 T

STEEL RETURN YOKE  
12,500 tonnes

### SILICON TRACKERS

Pixel ( $100 \times 150 \mu\text{m}$ )  $\sim 16\text{m}^2 \sim 66\text{M}$  channels  
Microstrips ( $80 \times 180 \mu\text{m}$ )  $\sim 200\text{m}^2 \sim 9.6\text{M}$  channels

### SUPERCONDUCTING SOLENOID

Niobium titanium coil carrying  $\sim 18,000\text{A}$

### MUON CHAMBERS

Barrel: 250 Drift Tube, 480 Resistive Plate Chambers  
Endcaps: 468 Cathode Strip, 432 Resistive Plate Chambers

### PRESHOWER

Silicon strips  $\sim 16\text{m}^2 \sim 137,000$  channels

### FORWARD CALORIMETER

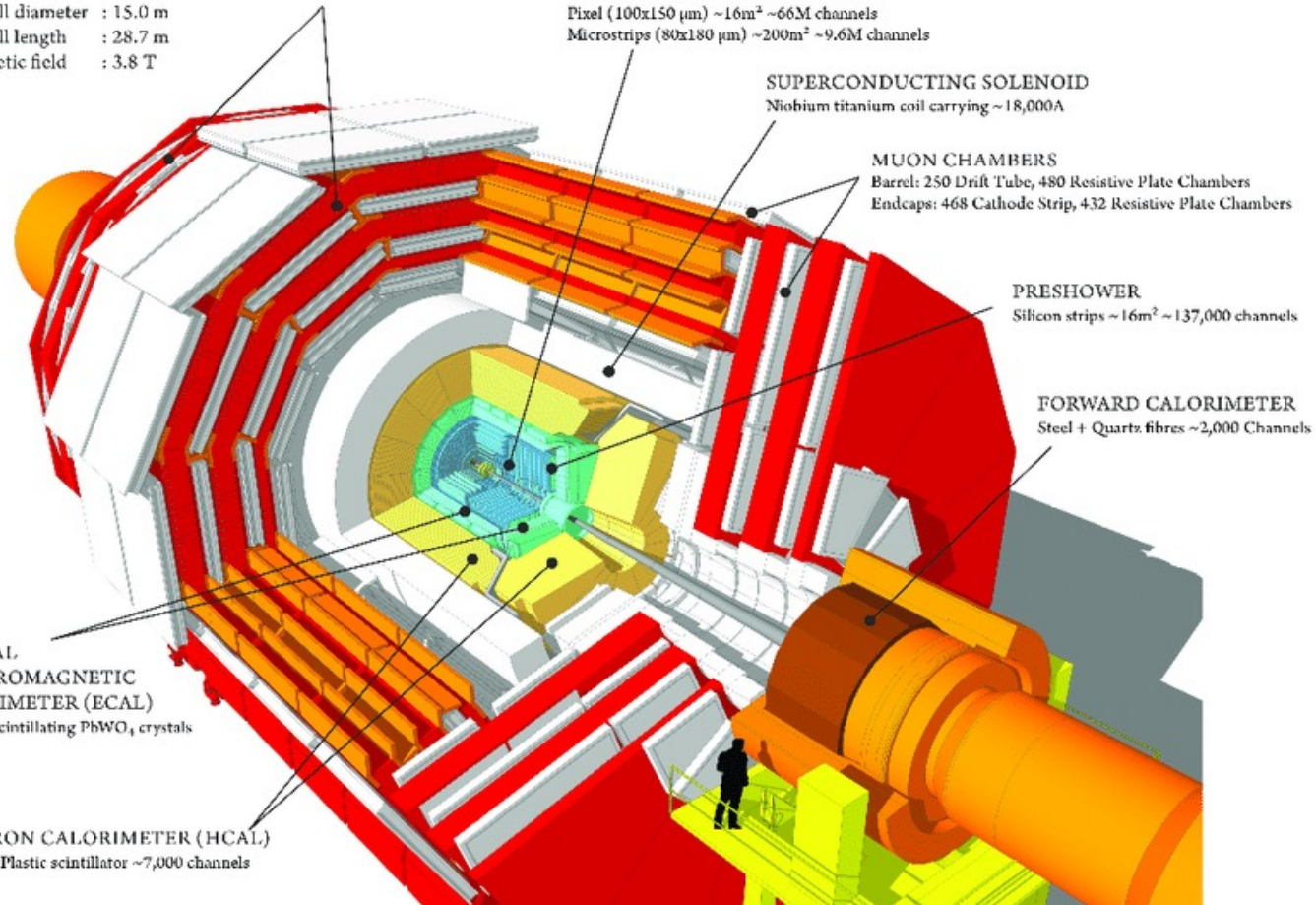
Steel + Quartz fibres  $\sim 2,000$  Channels

### CRYSTAL ELECTROMAGNETIC CALORIMETER (ECAL)

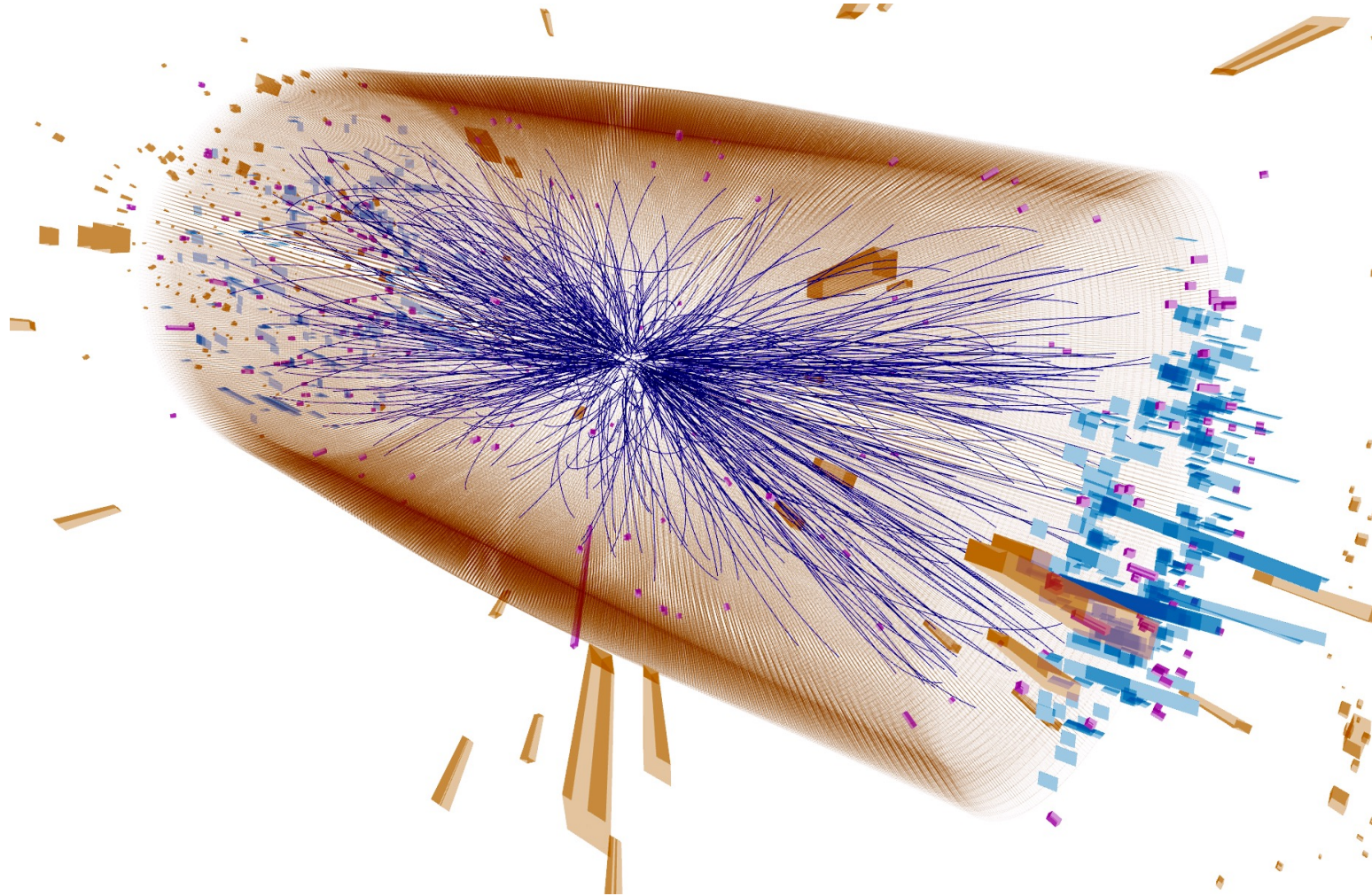
$\sim 76,000$  scintillating  $\text{PbWO}_4$  crystals

### HADRON CALORIMETER (HCAL)

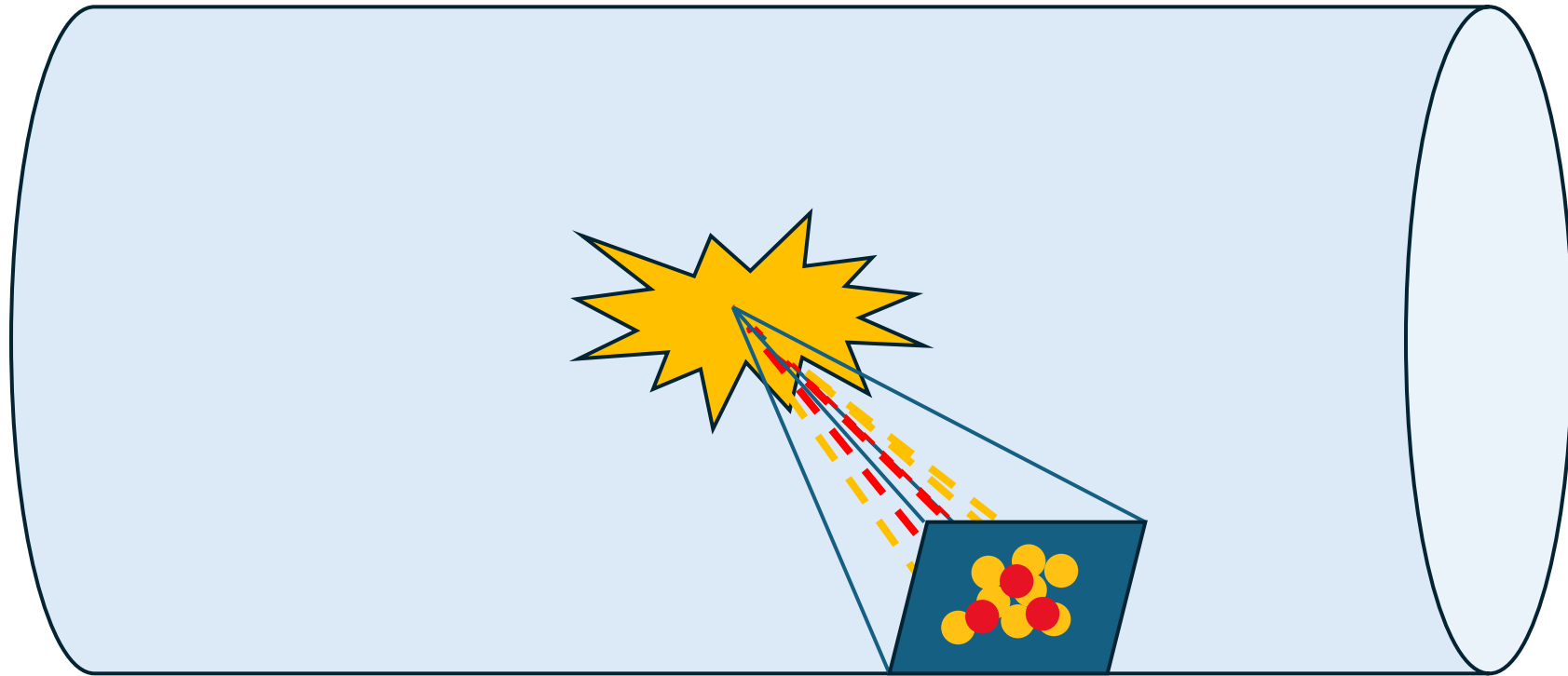
Brass + Plastic scintillator  $\sim 7,000$  channels



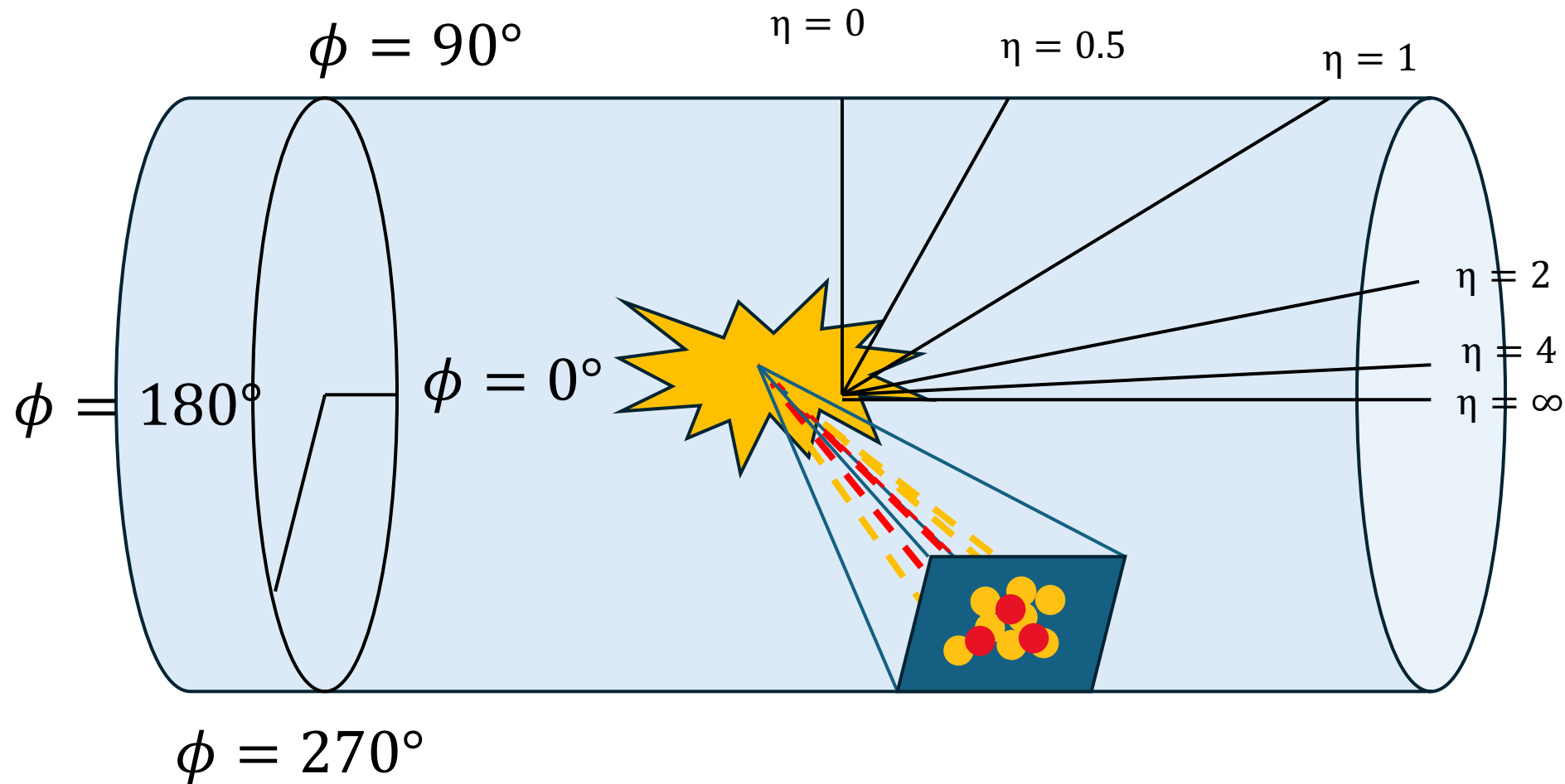
Task: Determine whether a signal in simulated particle collision data is from electrons or photons



The particle images date you will use to make your predictions are cropped around the center of where conical jets of particles hit the detector

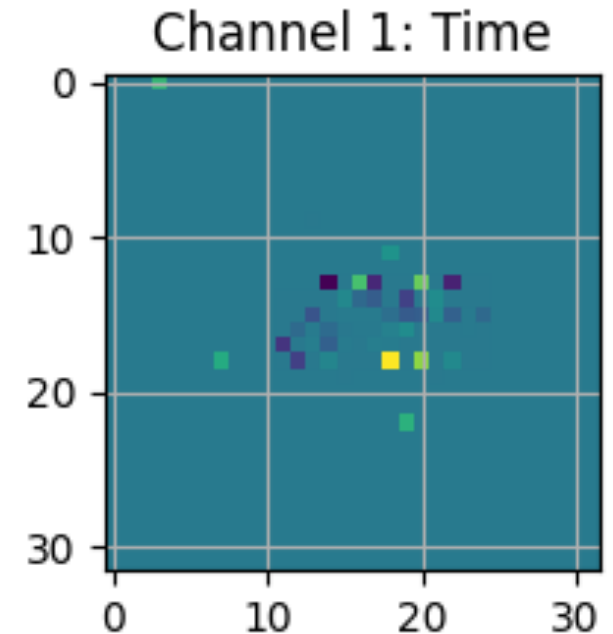
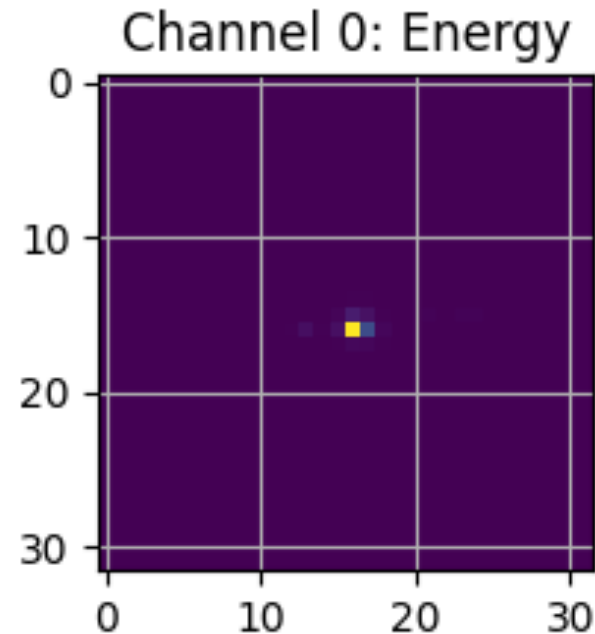


The coordinate system for the particle detector images is non-cartesian (not  $x, y, z$ ) so, keep that in mind if you choose to do any data augmentation



The data files contain the energy and timing information as two “channels” in a 32x32 window

- For the simplest models, using only energy will give the best results
- To best use the time information, you should consider the two channels as generally separate



# Optional Advanced Challenge (Vision Transformers)

- If you want to explore more advanced models, then try to get the best results you can using Vision Transformers

