

# Particle Physics on a Raspberry Pi: Machine Learning in Action

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# Outline

- Introduction to particle colliders
- Jets at colliders
- Machine learning & neural networks
- Raspberry Pi & HailoHat
- Coordinate System
- Workflow
- Demonstration
- Conclusions

# High-Energy Particle Colliders

Particle colliders smash particles together at extremely high energies!

**The goal:** to study the fundamental constituents of matter and energy!

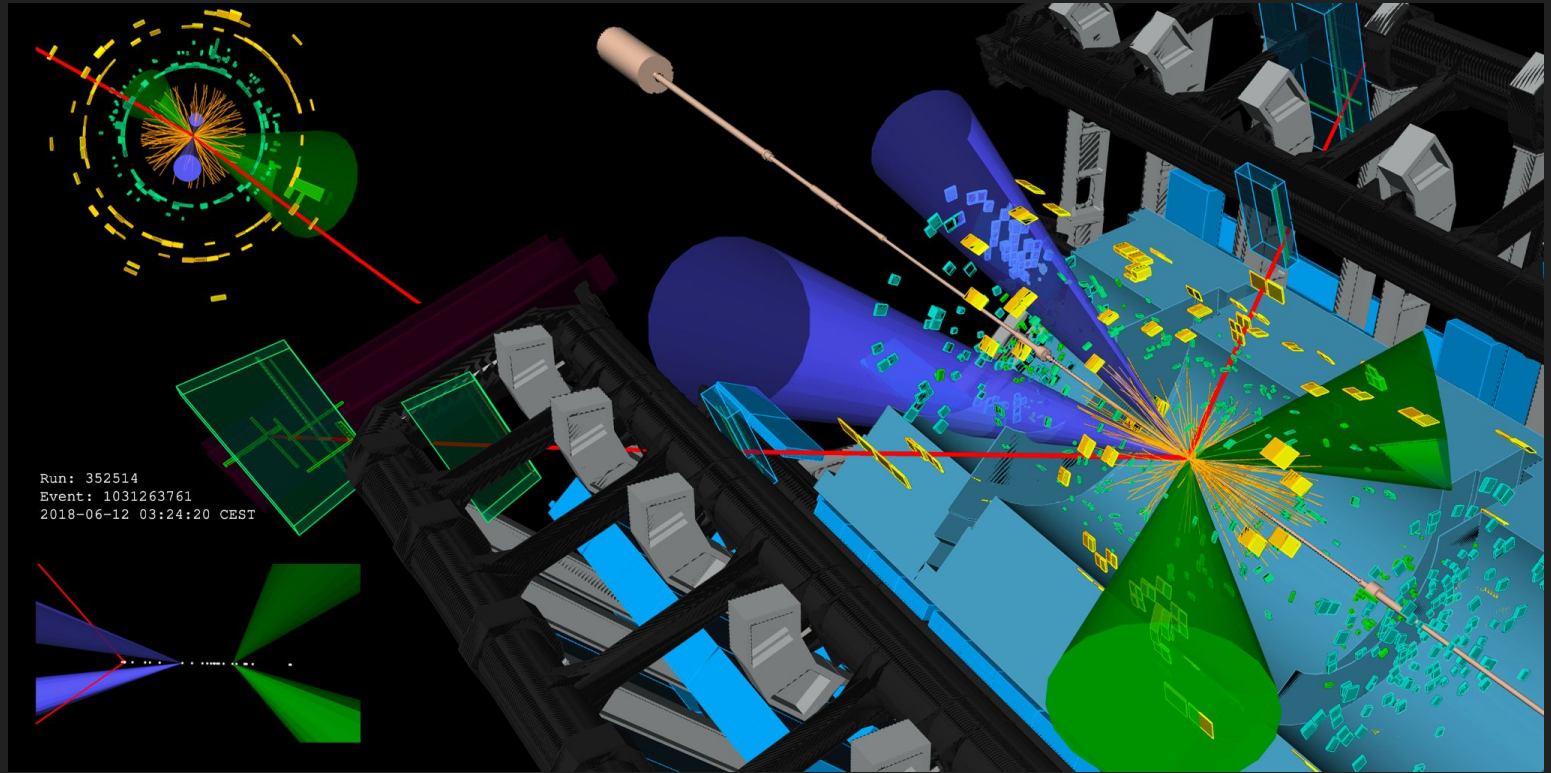


An aerial view of the Large Hadron Collider (LHC) at CERN (Geneva, Switzerland).



The LHC tunnel, where particles are accelerated.

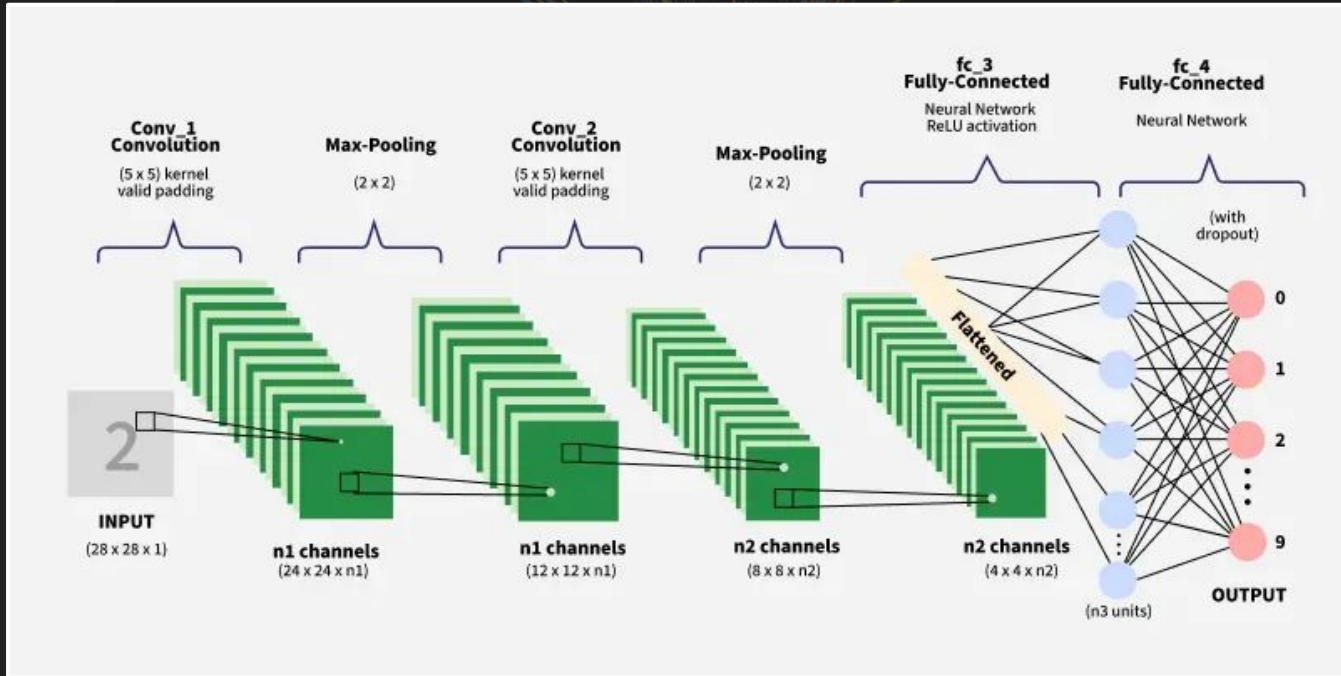
# Jets at Colliders & Fundamental Particles



Quarks vs. Gluons | How can we distinguish them?

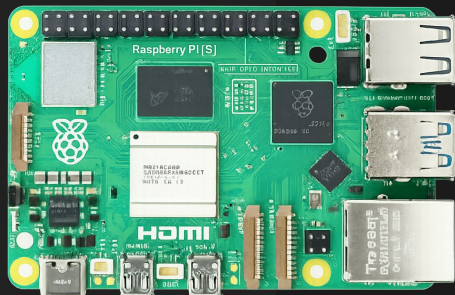
# Machine Learning

- Deep Learning
- Image Recognition Technology
- One type of deep learning - Convolutional Neural Network (CNN)

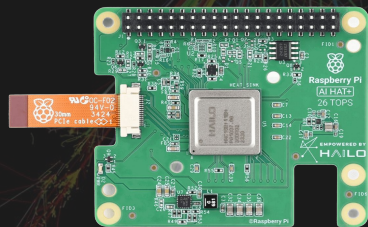


# HailoHat & Raspberry Pi

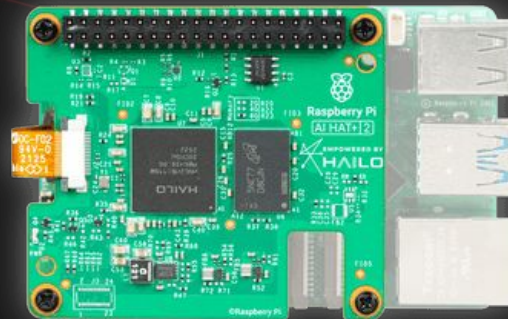
- **Raspberry Pi**: a tiny, affordable (~\$100), single-board computer.
- **AIHat+**: a high-performance expansion board for the Raspberry Pi 5 designed to run local AI inference.
- Helps relieve load on CPU!
- **Quantization**: 32-bit float  $\rightarrow$  8-bit integer



+



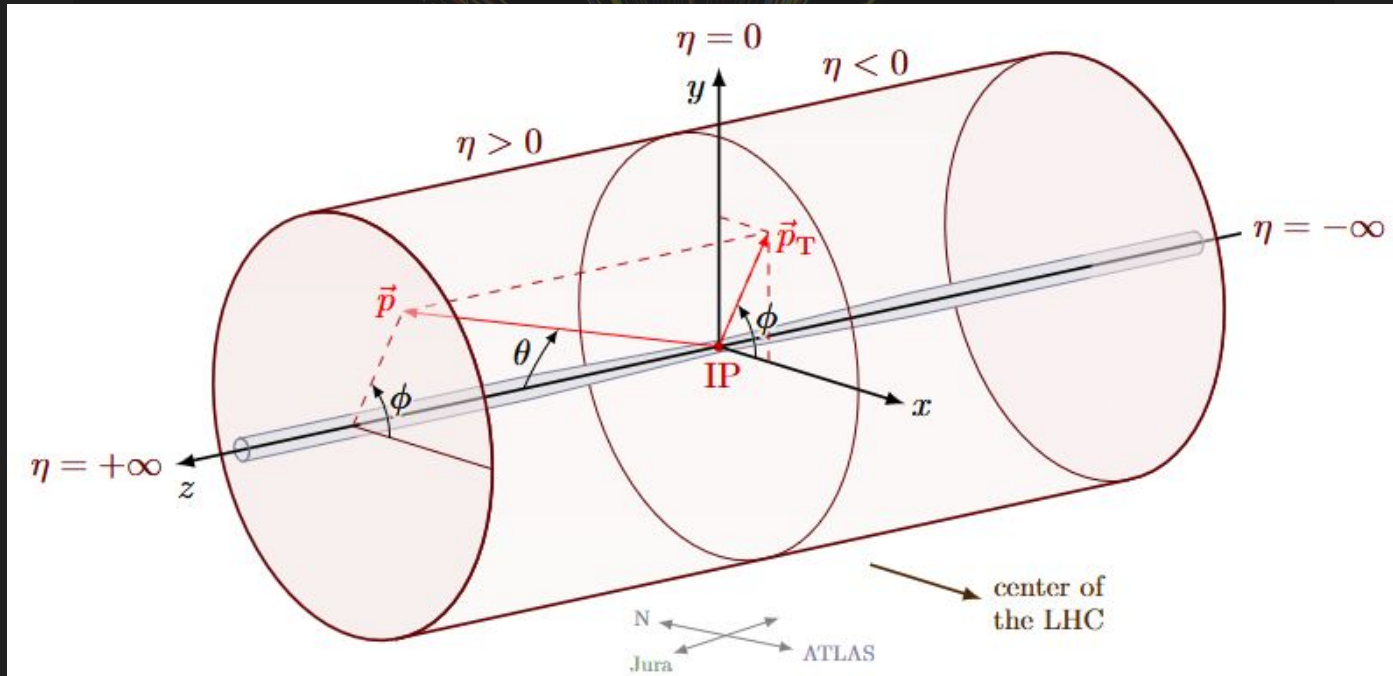
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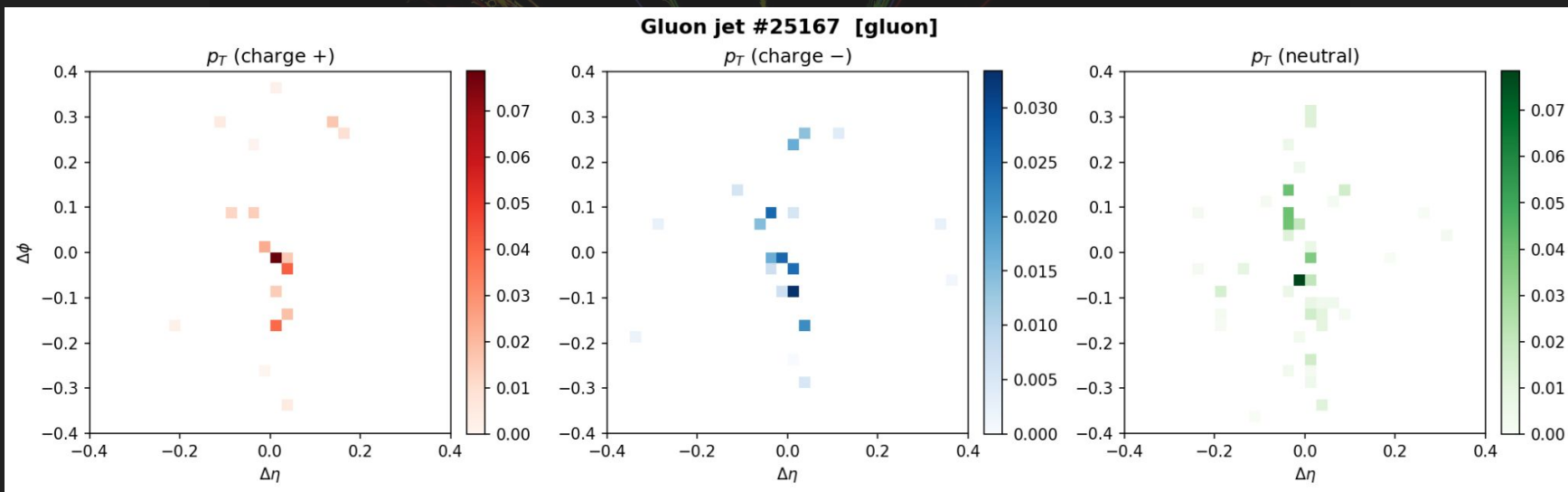
# Coordinate System

Coordinate Plane → Convert to 32x32 pixel images,

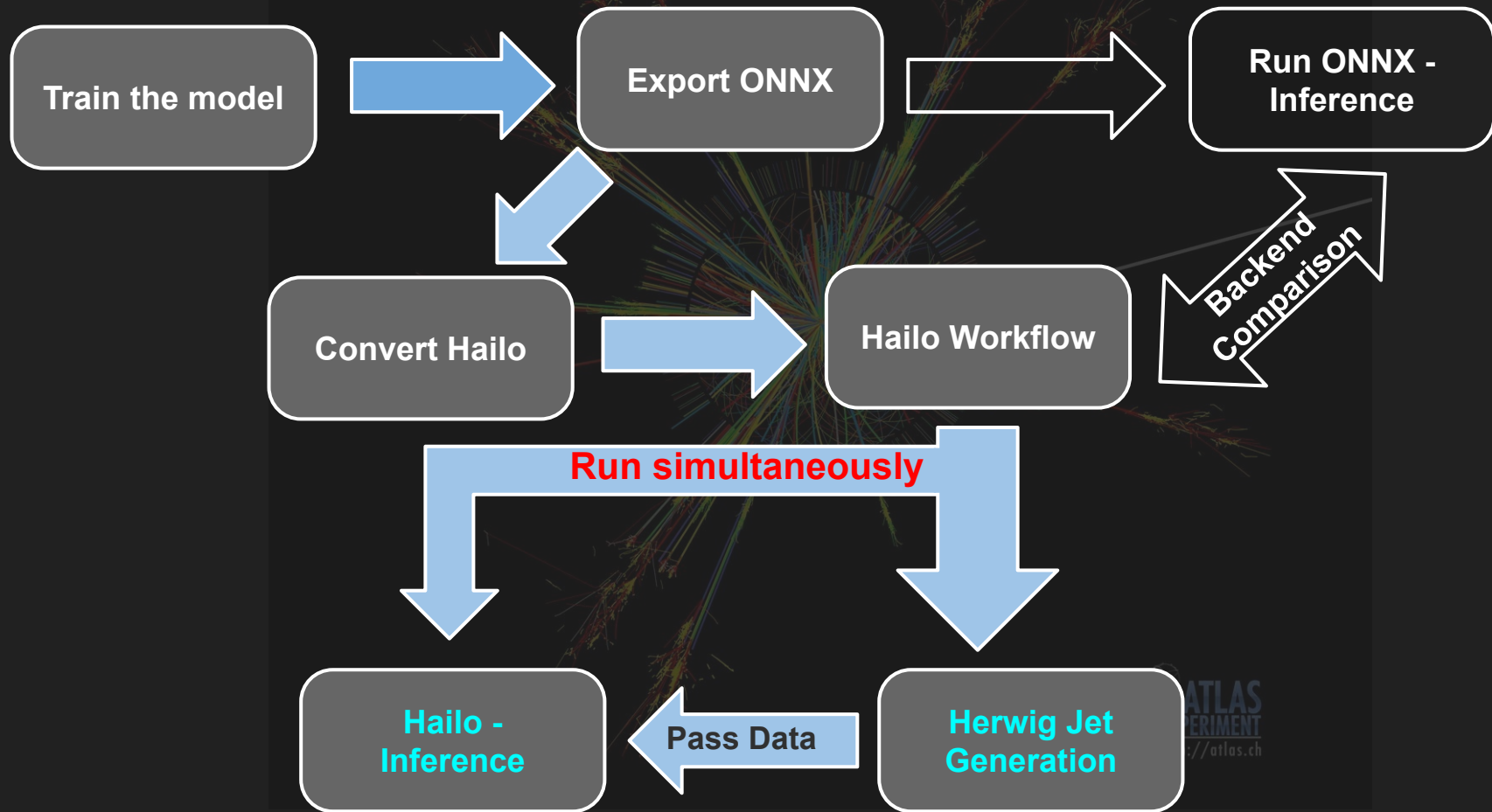
& Use to train neural network to distinguish progenitors (quarks versus gluons).



# Example Jet

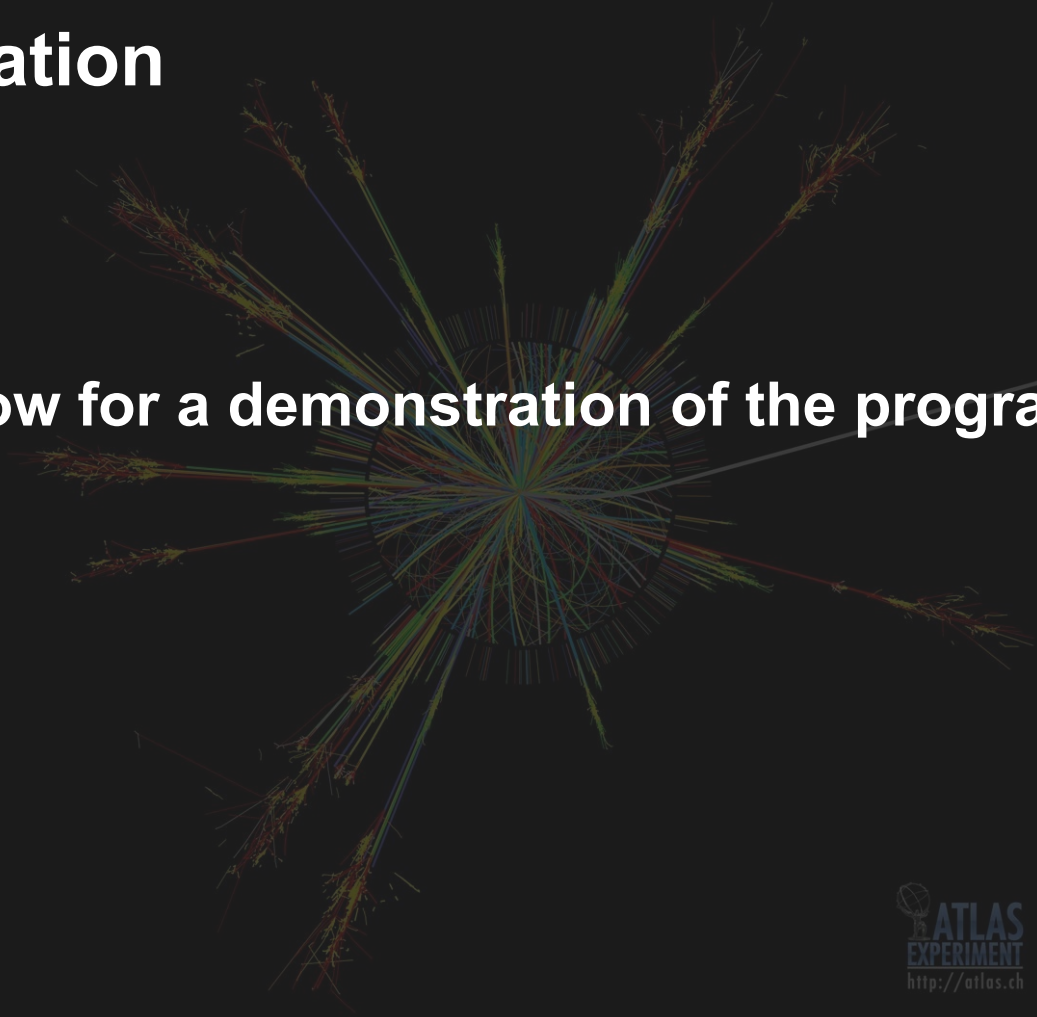


# Workflow



# Demonstration

**Now for a demonstration of the program!**



# Conclusions & Outlook

**CNNs are effective for distinguishing quark and gluon jets**

**Quantization holds overall accuracy well over data conversion**

**Real time high level particle physics is possible even on low level hardware**