

Machine Learning Inference in FPGA

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About me



Robiah Oktiavi (Avi)

Master's student

- Department of Physics, Universitas Indonesia
- HEP Experiment group, Research Center for Quantum Physics, National Research and Innovation Agency (BRIN), Indonesia

Current research: muon tomography simulation

Research interest: HEP experiment, particle detector, dark matter

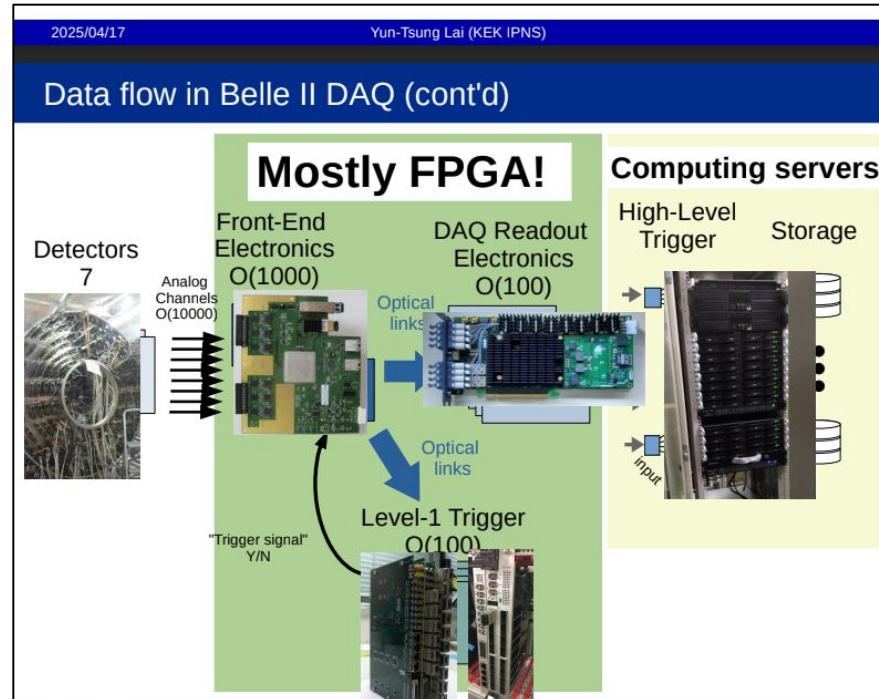
Hobbies: reading, cooking, walking, singing, crocheting

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In this Summer Student Program, I learn about....

FPGA

- Field Programmable Gate Array → a configurable integrated circuit.
- Programmable based on the user's design using hardware description language (HDL).
- High energy physics application: Front-End Electronics to readout the analog signals from detectors and record the digitized signal.

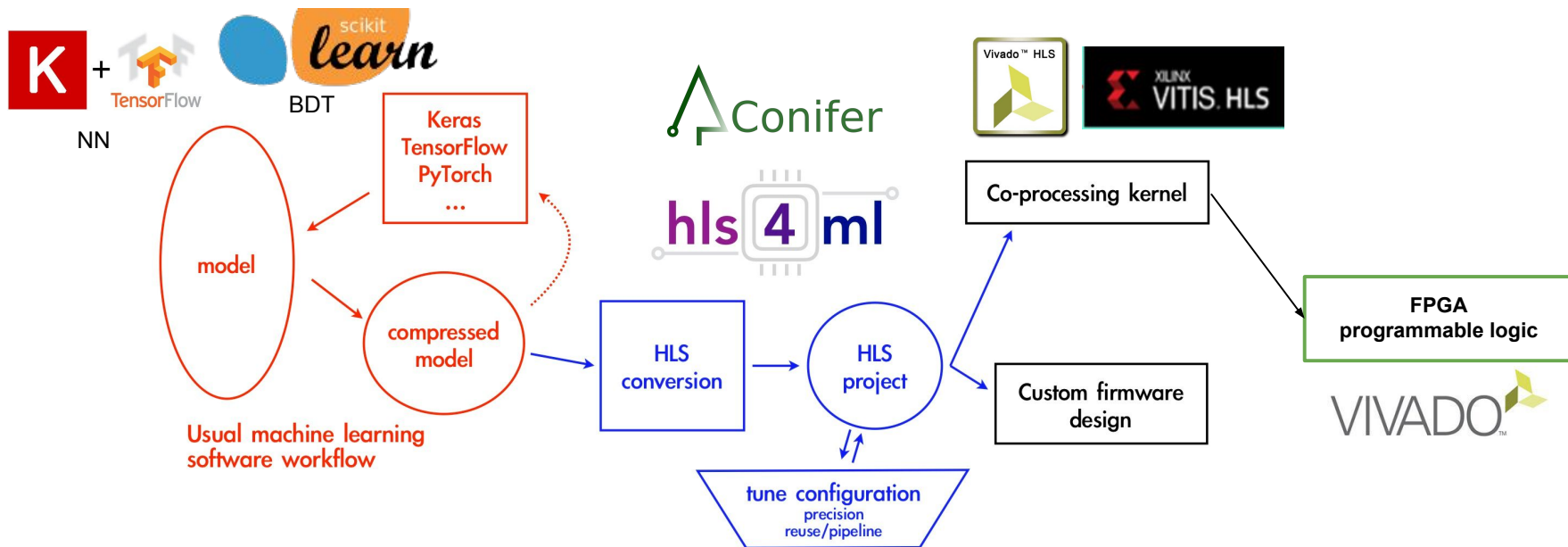


Why FPGA?

- Programmable → better flexibility on the processing design
- Fast processing on large amount of data in real time.
- Limited latency.
- Possible to inference machine learning for complex algorithm!

High-Level-Synthesis (HLS)

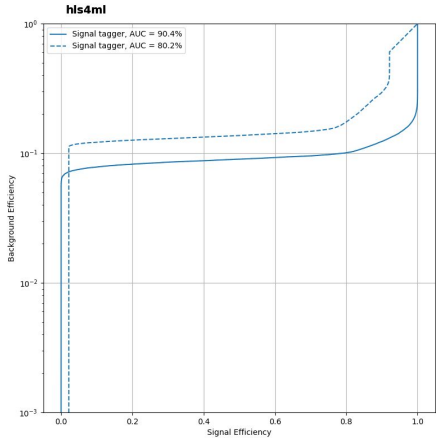
Machine learning inference in FPGA



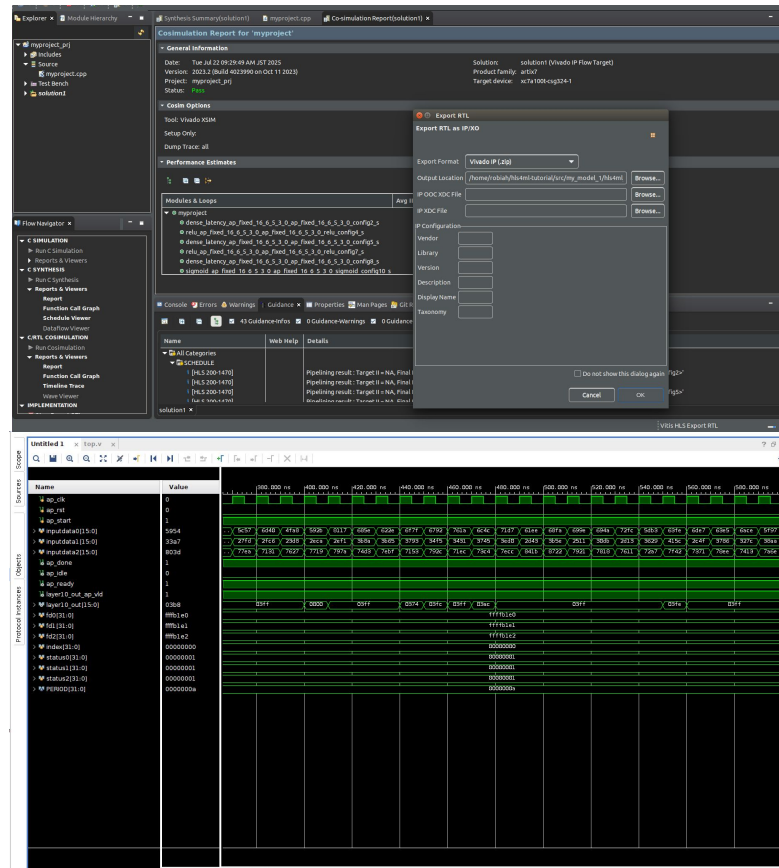
source: <https://fastmachinelearning.org/hls4ml/intro/introduction.html>

Machine learning inference in FPGA

Example: NN model using Keras



- Input shape: 3
- 3 hidden layers with number of neuron: 16, 32, 32
- 1 output

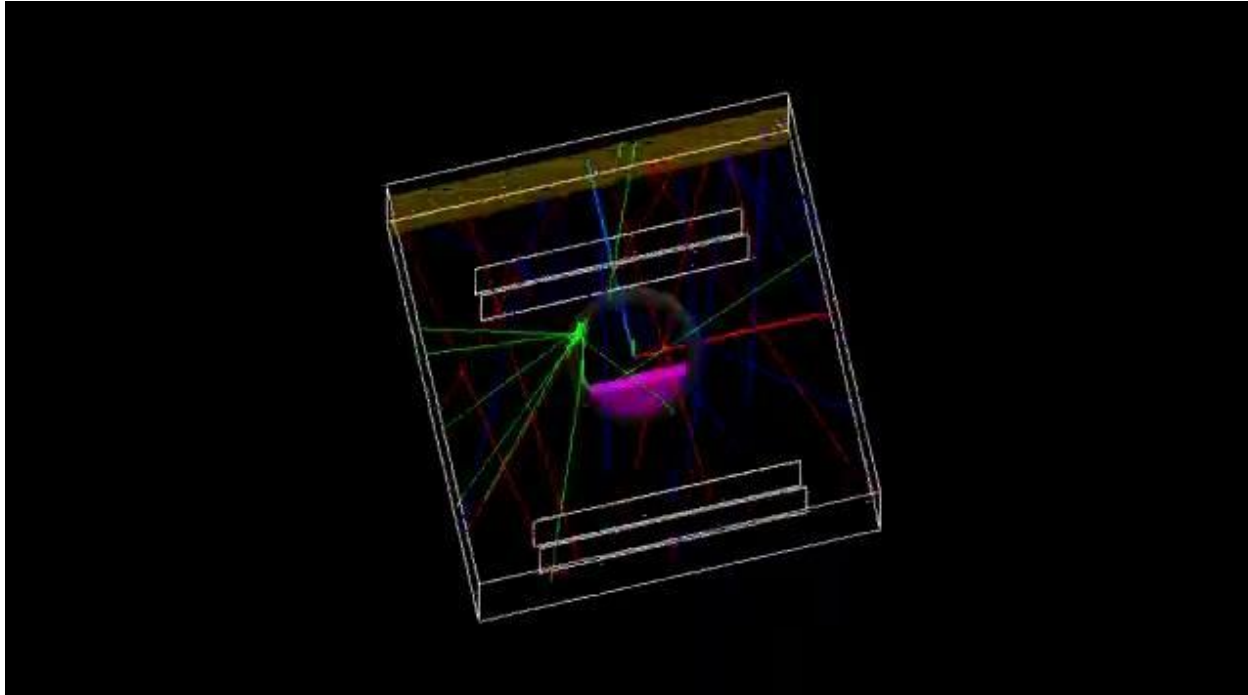


Vitis HLS to export the IP core

Vivado simulation

Final project

Particle tracking algorithm for simulated detectors

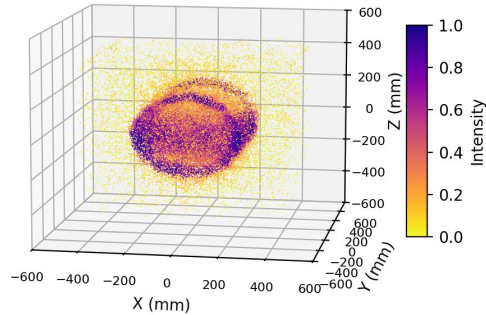


GEANT4 simulation setup

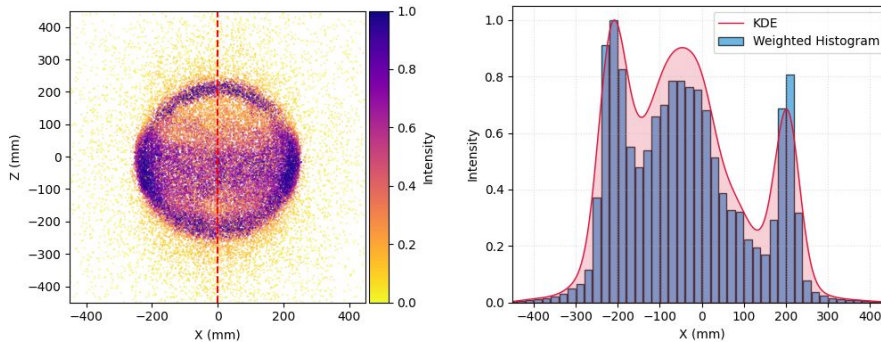
- Geothermal pipes with scaling inside.
- 2 sets of detectors record incoming and outgoing muon trajectories.

Final project

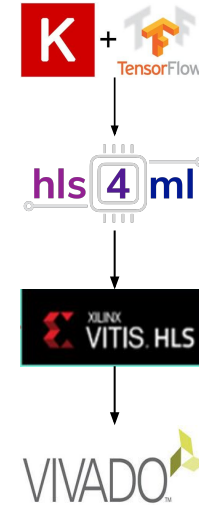
Particle tracking algorithm for simulated detectors



3D reconstruction using point of closest approach (PoCA)



2D projection and histogram



FPGA board to use

Thank you



Me with my uni friends



Universitas Indonesia



BRIN co-working space