SMARTHEP

REAL-TIME ANALYSIS FOR SCIENCE AND INDUSTRY

Mid-term Check

ESR1: Machine learning and Real-Time Analysis for Higgs boson measurements and fleet safety

CERN, 9 January 2023

Patin Inkaew

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About me

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Why Higgs?

- Higgs boson was one of the initial goal of LHC

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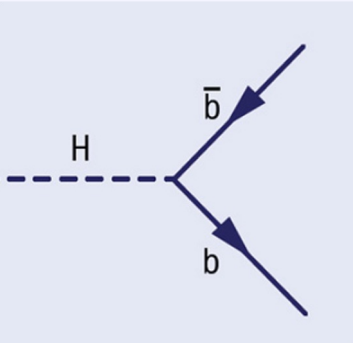

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  - H → γγ / H → ZZ* → 4l are rare, but have low background
  - H → bb has higher branching ratio, but suffers larger background

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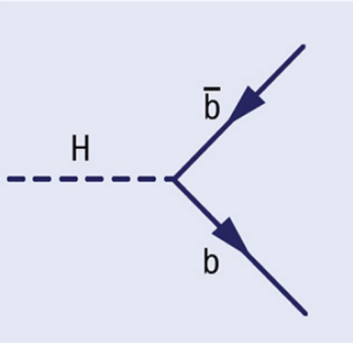

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- Improve Higgs boson measurement
  - H → γγ / H → ZZ* → 4l are rare, but have low background
  - H → bb has higher branching ratio, but suffers larger background
  - Real-time analysis can improve data acquisition rate in trigger system
  - Validated with frequent and well-studied Z → bb

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PhD:
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Supervisors:
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Henning Kirschenmann

Secondment:
CERN, Switzerland

Collaborator:
Maurizio Pierini

Secondment:
Verizon Connect, Italy

Collaborators:
Leonardo Taccari,
Francesco Sambo

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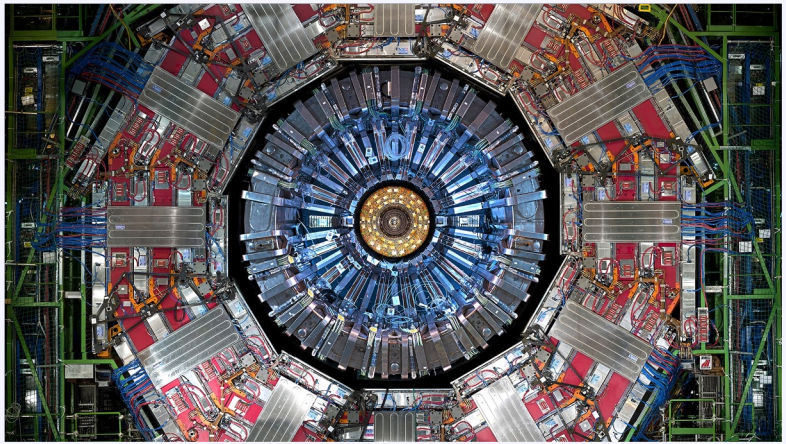
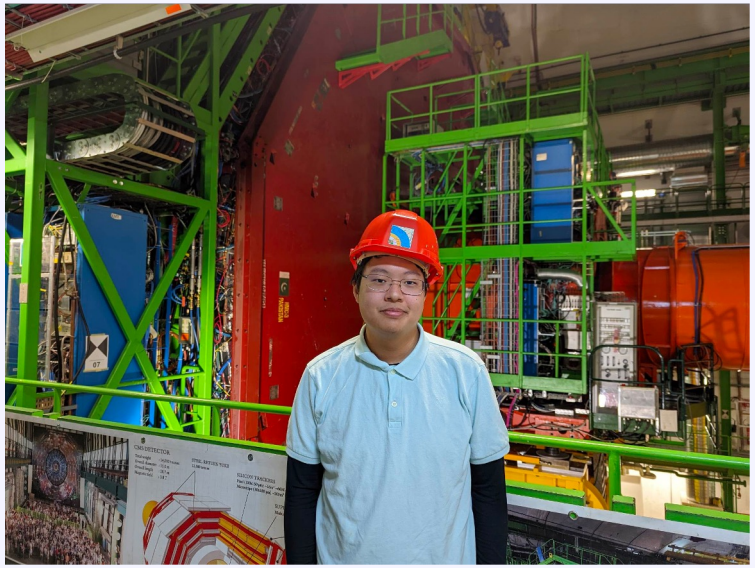
The Compact Muon Solenoid Experiment (CMS)





CMS is a general-purpose detector,

one of the four large experiments at LHC.

Focus: rare event search, precise measurement

CMS Experimental Cavern during current technical stop!

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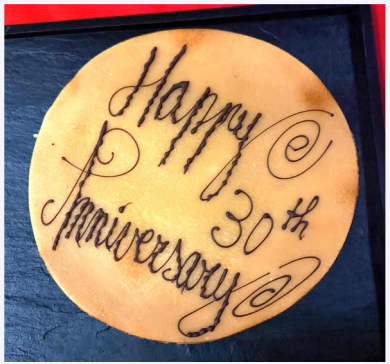
CMS 30th anniversary!



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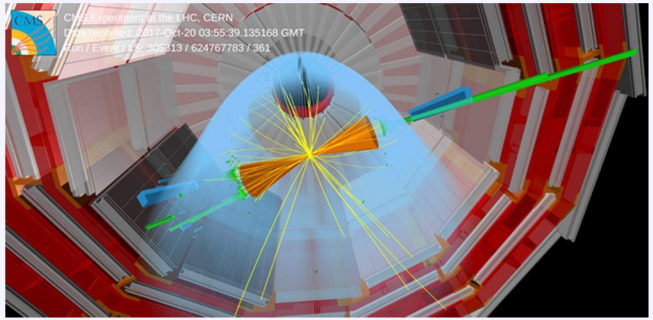
Project Goals

- Understand the resource cost of ML architectures and adapt them for real-time analysis and resource-constrained environments



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- Understand the resource cost of ML architectures and adapt them for real-time analysis and resource-constrained environments
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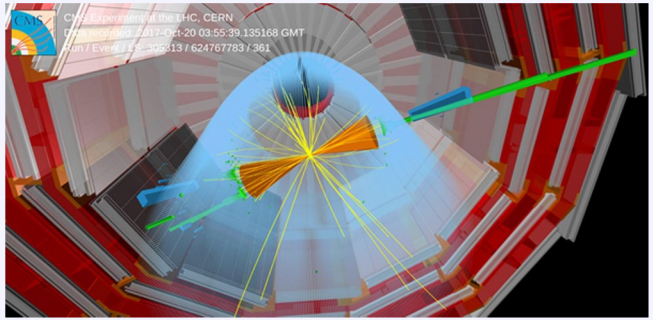

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Project Goals

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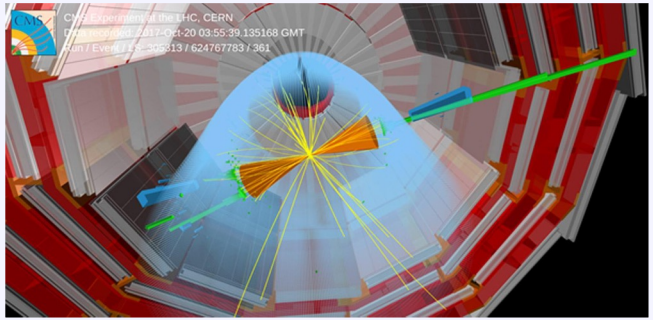
- Develop real-time image processing in resource-constrained environment from embedded devices on vehicle at VERIZON



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ESR1: Project Updates

Studies on online (HLT) vs. offline jet energy correction at the CMS

Background

- **Jets** are signatures of quarks (incl. b) and gluons, but generally, anything can become jets (incl. t, H) → want to study more interesting physics!

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  - CMS uses **factorized approach:** several step (or level), each takes care of different corrections

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- Jet reconstruction is still challenging task during triggering. Many upgrades are planned, e.g. tracking and pileup mitigation at trigger

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Motivation

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- How can we transfer knowledge / information between online (HLT) and offline jet reconstruction?

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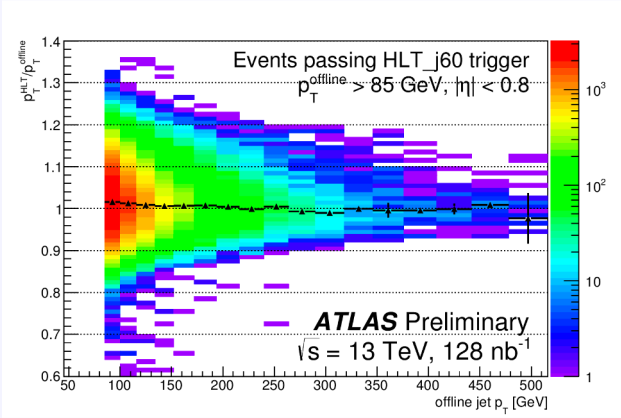
Methods and Results

- Starting project to get used to analysis environment
- Analysis code in python: sciket-hep (e.g. uproot, awkward) and coffea
- Study effects of
  - trigger cut
  - tag and probe
  - different levels of Jet Energy Correction (JEC)
- Run 3 data (currently private...)
- Example plot and fit:
  - HLT pt vs offline pt correlation
  - HLT/offline response vs offline pt



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Conferences

- CMS Week (5-9 Dec 2022)
- Spåtind 27th Nordic Conference on Particle Physics (3-8 Jan 2023): link
  - see my talk on the current project

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Workshops / Trainings

- LPC HATs: Hand-on Advanced Training, LHC Physics Center (FermiLab)
- CMS Data Analysis School (following last year)
- CMS Open Data Workshop → CMSSW
- Other CMS-related workshops: PPD workshop, HLT workshop
- CMS shift: Technical Shifter (plan to take shifts in summer 2023)

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Career expectation

Academia

- Particle physics + Computer science: develop computational tools for particle physics research
- Collaboration: CMS group in Finland and Thailand
- University Professor: love teaching
- Or scientist in scientific institutions, e.g. CERN

Industry

- Software engineer? Machine Learning? Computer Vision? Computer Graphics?
- Quant?

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