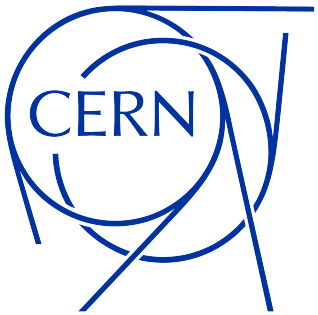


European Organization for Nuclear Research(CERN)

Stagiaires CPPM

Virtual Visit

June 21, 2024

Etienne FORTIN, Docteur-Ingenieur en physique et sciences de la matiere

Instrumentation pour la physique des hautes energies

Mon parcours

- **2011-2014: CPGE PTSI-PT Lycee Raoul Follereau Belfort**
  - TIPE 3/2: Détecteur de muons cosmiques, Lycée Follereau
  - TIPE 5/2: Régénérateurs de moteur de stirling, Laboratoire Femto-ST
- **2014-2017: Ecole des Mines de St Etienne, cursus ISMIN**
  - Stage 1A: Modélisation d'un aéroglisseur simulant le vol d'une mouche, Laboratoire des sciences du mouvement, équipe bio-robotique
  - Projet 2A: Création d'un module pour la communication entre les machines et les robots de transport de wafer, ST Microelectronics
  - Stage 3A: Création de l'étage de synchronisation du firmware de la carte back-end de l'upgrade phase-I du calorimètre LAr d'ATLAS, CPPM/CERN
- **2017-2018: Maître auxiliaire, Académie de Lyon**
  - remplaçant en menuiserie, technologie, maintenance industriel
- **2018-2022: Doctorat en physique et sciences de la matiere, spécialité instrumentation**
  - Mise en œuvre et performance du système de lecture et de déclenchement du calorimètre à argon liquide de l'expérience ATLAS
- **2022-maintenant: Applied fellowship au CERN**

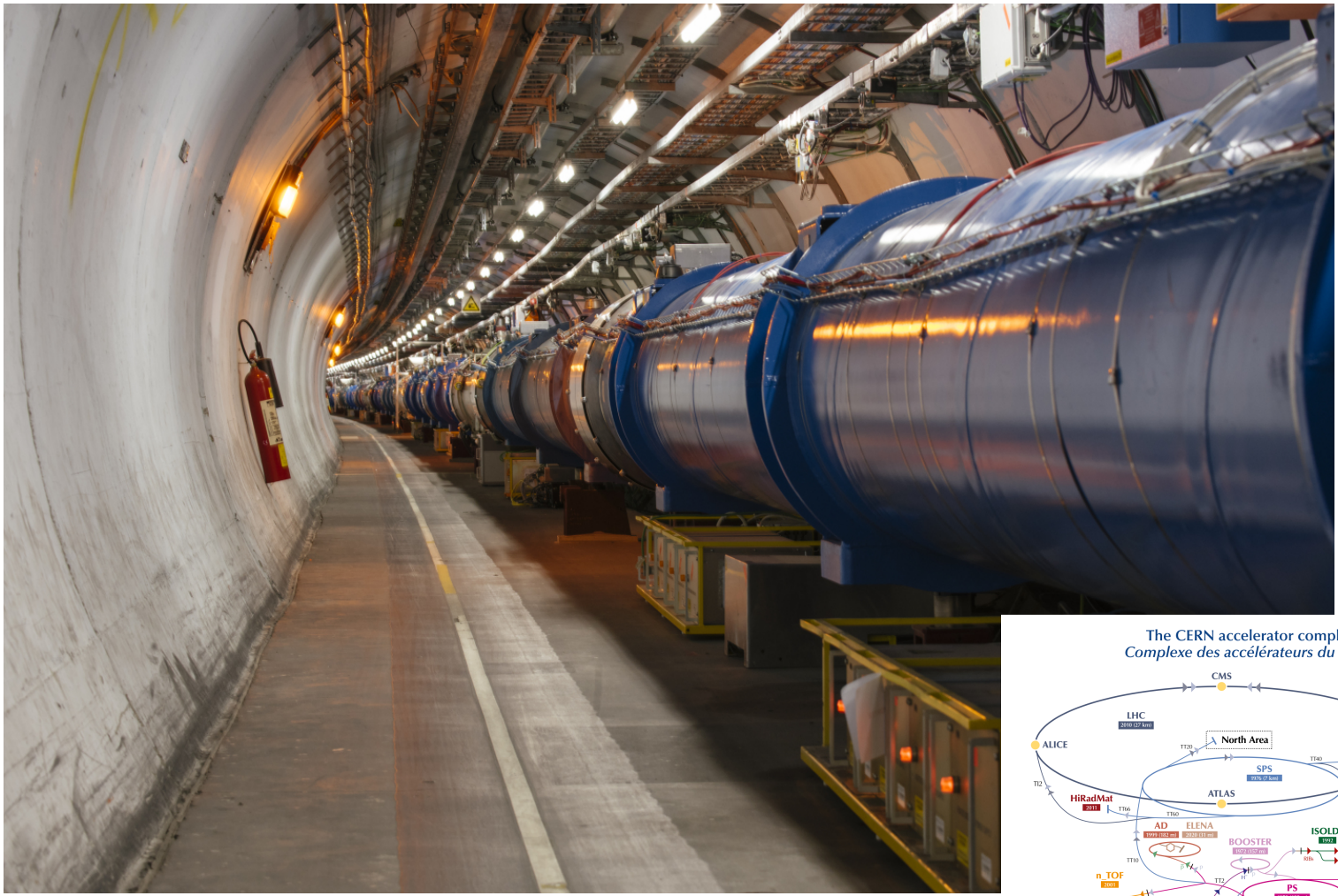
Ecole des mines de St Etienne, ISMIN

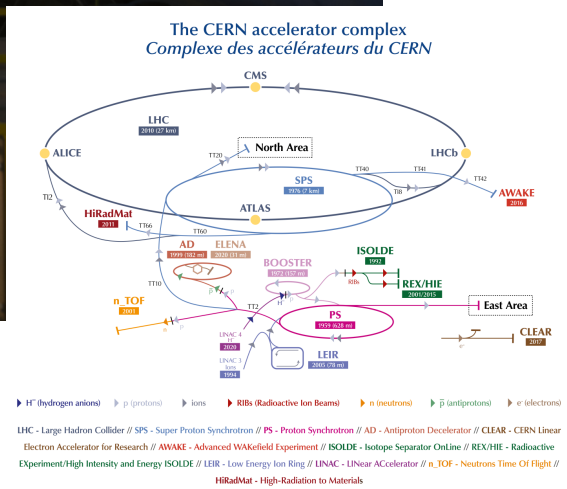
- Ingénieur Spécialité Microélectronique et Informatique
- Sur le campus Georges Charpak, Provence

- Informatique
- Electronique
- Management
- Projet/stages
  - 1A : Découverte de l'entreprise
  - 1A/2A: Projet Robot
  - 2A : Projet industriel
  - 3A : Stage de fin d'études

- **Majeur 3A:** Informatique, Systèmes Embarqués, Conception microélectronique
- **Mineur 3A:** Supply-chain, Mobilité et Sécurité, Electronique et énergie ,Systèmes biomédicaux

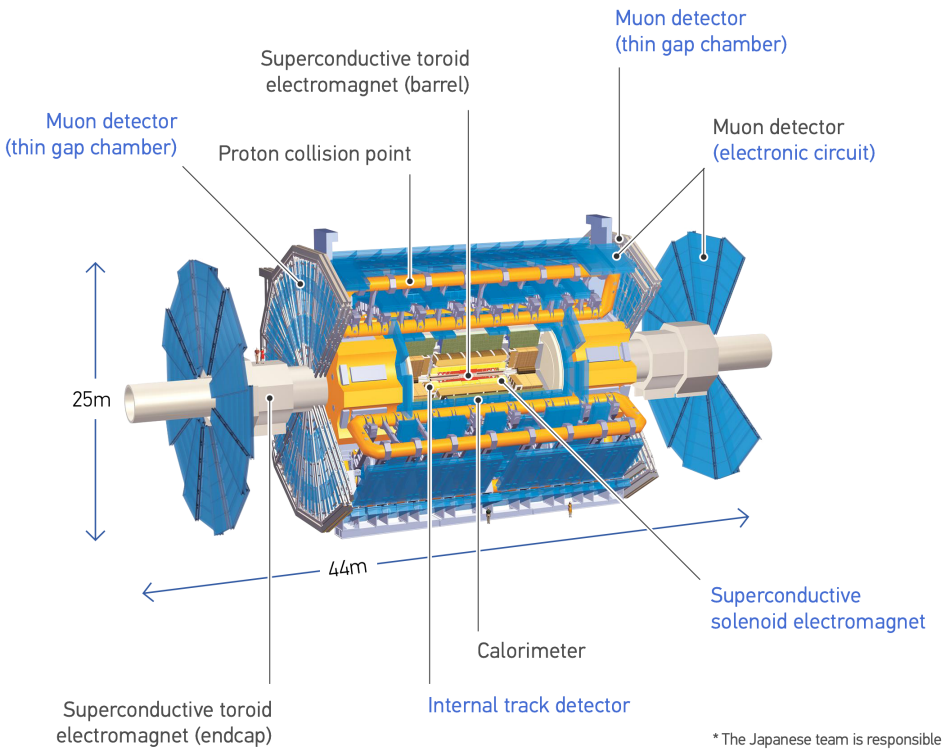
Mon metier actuel: LHC



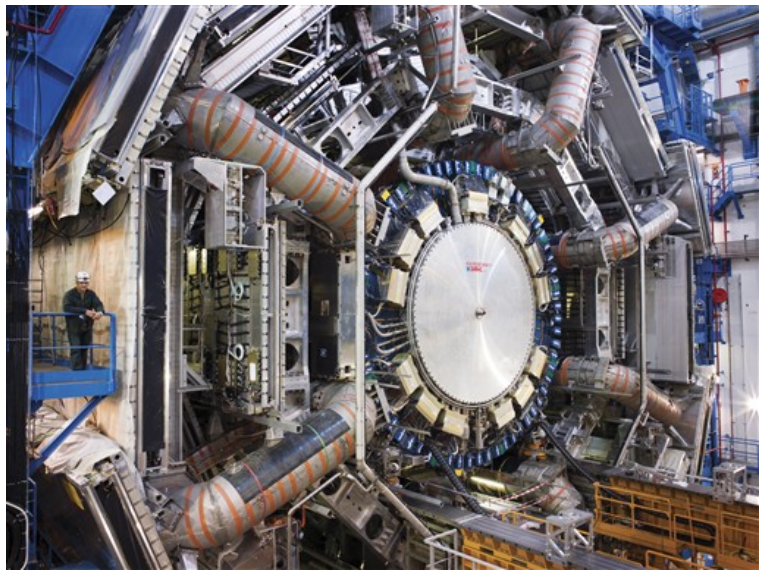


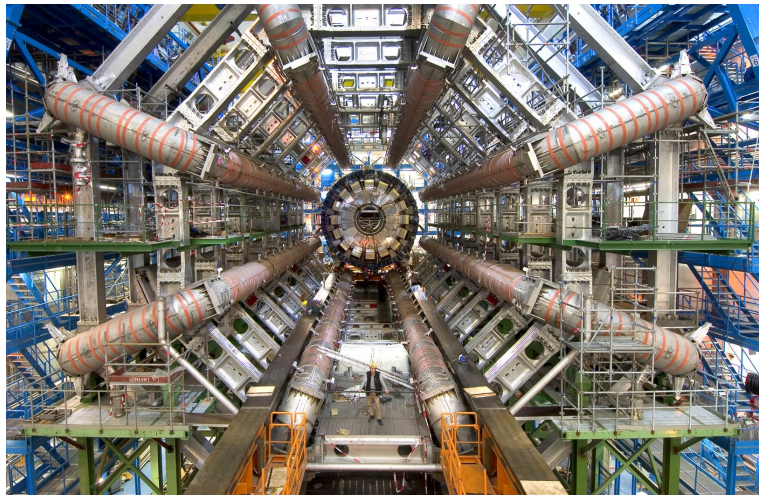
Mon metier actuel:ATLAS

OVERVIEW OF THE ATLAS DETECTOR



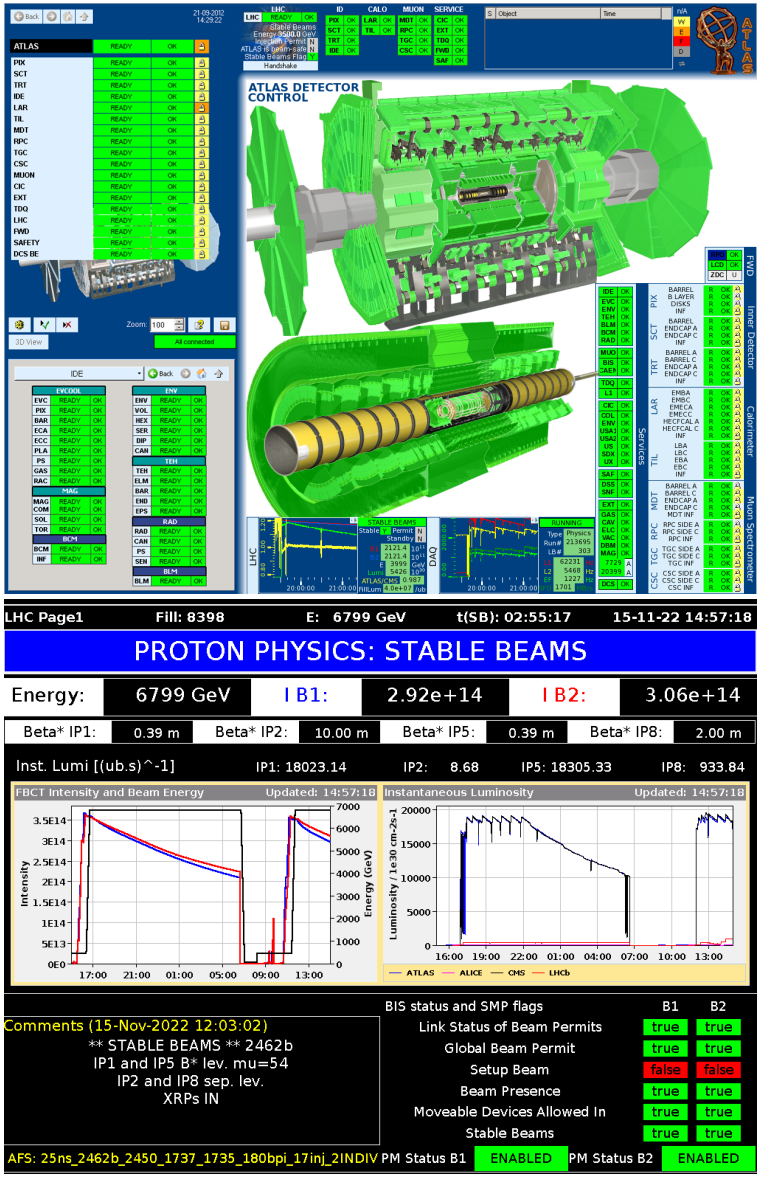
* The Japanese team is responsible for the sections with names indicated in blue

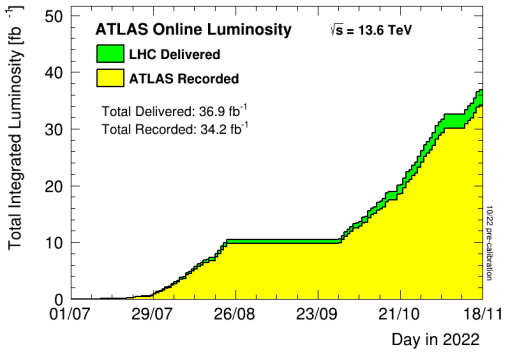


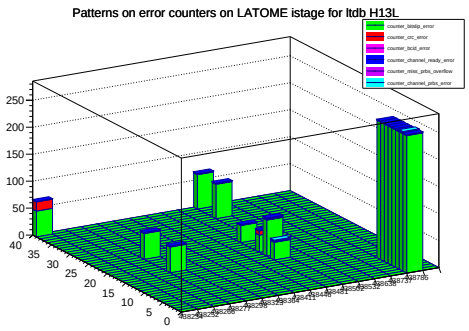


Operation

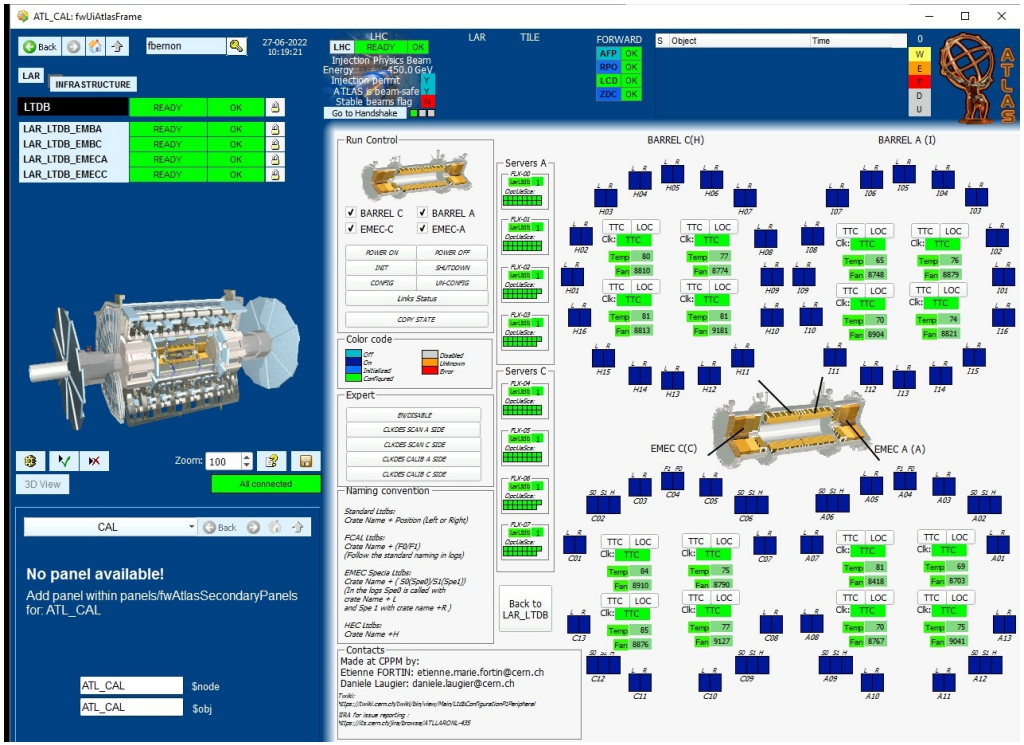

ATLAS
ATLAS Control Room

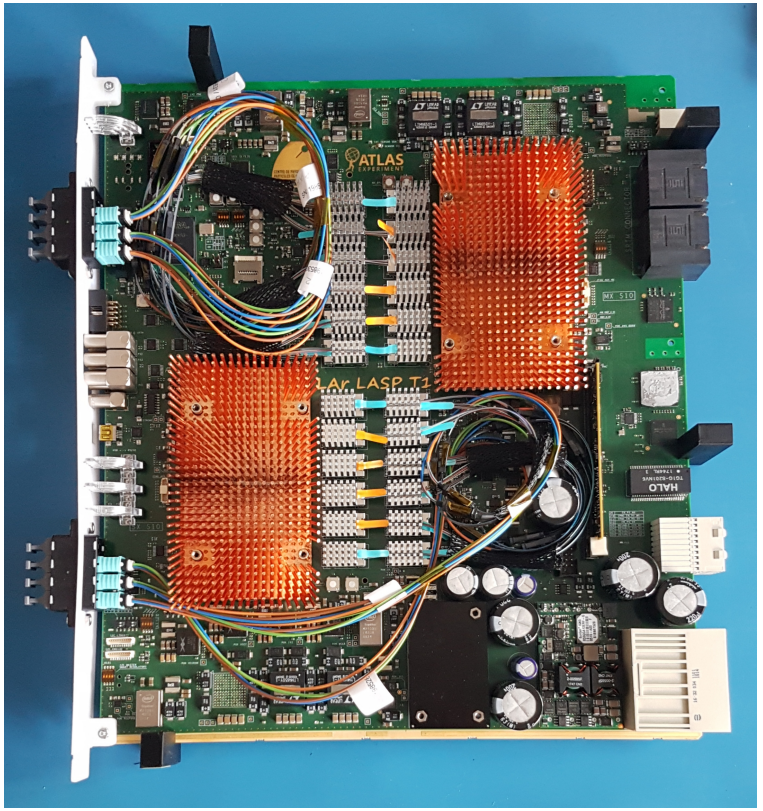

ATLAS DETECTOR CONTROL
LHC Page1
Fill: 8398
E: 6799 GeV
t(SB): 02:55:17
15-11-22 14:57:18
PROTON PHYSICS: STABLE BEAMS
Energy: 6799 GeV
I B1: 2.92e+14
I B2: 3.06e+14
Beta* IP1: 0.39 m
Beta* IP2: 10.00 m
Beta* IP5: 0.39 m
Beta* IP8: 2.00 m
Inst. Lumi [(ub.s)^-1]
IP1: 18023.14
IP2: 8.68
IP5: 18305.33
IP8: 933.84
FBCT Intensity and Beam Energy
Updated: 14:57:18
Instantaneous Luminosity
Updated: 14:57:18
Comments (15-Nov-2022 12:03:02)
** STABLE BEAMS ** 2462b
IP1 and IP5 B* lev. mu=54
IP2 and IP8 sep. lev.
XRPs IN
BIS status and SMP flags
B1
B2
Link Status of Beam Permits
Global Beam Permit
Setup Beam
Beam Presence
Moveable Devices Allowed In
Stable Beams
AFS: 25ns_2462b_2450_1737_1735_180bpi_17inj_2INDIV
PM Status B1
ENABLED
PM Status B2
ENABLED

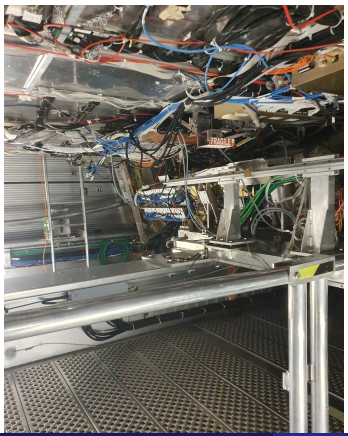

ATLAS Online Luminosity
√s = 13.6 TeV
LHC Delivered
ATLAS Recorded
Total Delivered: 36.9 fb-1
Total Recorded: 34.2 fb-1
Total Integrated Luminosity [fb-1]
Day in 2022
01/07
29/07
26/08
23/09
21/10
18/11

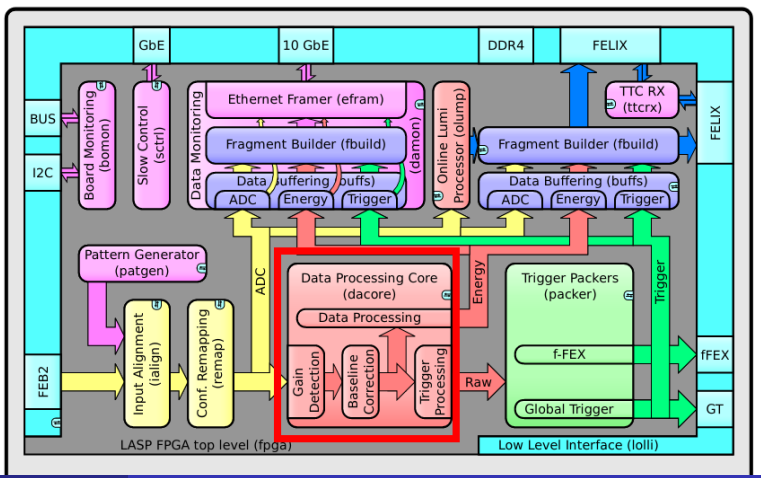

Patterns on error counters on LATOME istage for ltdb H13L

Développement/Test/Installation









Recherche

Computing and Software for Big Science (2021) 5:19
https://doi.org/10.1007/s41781-021-00066-y

ORIGINAL ARTICLE

Artificial Neural Networks on FPGAs for Real-Time Energy Reconstruction of the ATLAS LAr Calorimeters

Georges Aad[1] · Anne-Sophie Berthold[2] · Thomas Calvet[1] · Nemer Chiedde[1] · Etienne Marie Fortin[1] · Nick Fritzsche[2] · Rainer Hentges[2] · Lauri Antti Olavi Laatu[1] · Emmanuel Monnier[2] · Arno Straessner[2] · Johann Christoph Voigt[2]

Received: 5 July 2021 / Accepted: 14 September 2021 / Published online: 2 October 2021

Abstract
The ATLAS experiment at the Large Hadron Collider (LHC) is operated at CERN and measures proton–proton collisions at multi-TeV energies with a repetition frequency of 40 MHz. Within the phase-II upgrade of the LHC, the readout electronics of the liquid-argon (LAr) calorimeters of ATLAS are being prepared for high luminosity operation expecting a pileup of up to 200 simultaneous proton–proton interactions. Moreover, the calorimeter signals of up to 25 subsequent collisions are overlapping, which increases the difficulty of energy reconstruction by the calorimeter detector. Real-time processing of digitized pulses sampled at 40 MHz is performed using field-programmable gate arrays (FPGAs). To cope with the signal pileup, new machine learning approaches are explored: convolutional and recurrent neural networks outperform the optimal signal filter currently used, both in assignment of the reconstructed energy to the correct proton bunch crossing and in energy resolution. The improvements concern in particular energies derived from overlapping pulses. Since the implementation of the neural networks targets an FPGA, the number of parameters and the mathematical operations need to be well controlled. The trained neural network structures are converted into FPGA firmware using automated implementations in hardware description language and high-level synthesis tools. Very good agreement between neural network implementations in FPGA and software based calculations is observed. The prototype implementations on an Intel Stratix-10 FPGA reach maximum operation frequencies of 344–640 MHz. Applying time-division multiplexing allows the processing of 390–576 calorimeter channels by one FPGA for the most resource-efficient networks. Moreover, the latency achieved is about 200 ns. These performance parameters show that a neural-network based energy reconstruction can be considered for the processing of the ATLAS LAr calorimeter signals during the high-luminosity phase of the LHC.

Keywords Machine learning · Convolutional neural network · Recurrent neural network · FPGA · Real-time processing · High-energy physics

Introduction

The ATLAS detector [1] is installed at the Large Hadron Collider [2] (LHC) to detect the particles produced in high-energy proton–proton collisions, and measure their properties. The proton bunches collide every 25 ns corresponding to a frequency of 40 MHz. During the future high-luminosity phase of LHC (HL-LHC) the machine is expected to produce instantaneous luminosities of $5-7\times10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ starting with Run-4 in 2027. This corresponds to 140–200 simultaneous proton–proton interactions. The liquid-argon (LAr) calorimeters of ATLAS mainly measure the energy of electromagnetic showers of photons, electrons and positrons using their ionisation signal. The LAr calorimeters are challenged by the large in-time pileup and because up to 25 signal pulses created in subsequent LHC bunch crossings (BCs) can overlap leading to out-of-time pileup. Moreover, a new trigger scheme is foreseen [3] which allows the selection of collision events in subsequent BCs. Thus, an assignment of the reconstructed energy to the correct BC with best possible energy resolution is necessary for each of the 182,000 calorimeter cells. The digital processing of the LAr calorimeter signals must be capable to treat continuous data

✉ Arno Straessner
Arno.Straessner@cern.ch

[1] CPPM, Aix-Marseille Université, CNRS/IN2P3, Marseille, France

[2] Institut für Kern- und Teilchenphysik, Technische Universität Dresden, Dresden, Germany

- Reseau de neuronnes(IA)
- Sur FPGA
- 1 Tb par s

Formation/Transmettre

Scientifique

- Conferences:
  Russie/Grece/USA/Afrique du sud
- Ecoles : Espagne,Paris
- Workshop: Italie/Canada

Grand public

- Fete de la science
- Visites
  laboratoire/CERN
- Stagiaires

Conclusion

Ce que j'aime dans mon travail

- Contexte international ++
- Au contact d'experts mondiaux
- Une certaine liberté
- J'apprend tout les jours