CERN Day @ UPB

ATLAS EXPERIMENT @ Large Hadron Collider

Călin Alexa

Particle Physics Department, IFIN-HH
Doctoral School of Physics, University of Bucharest

Calin.Alexa@cern.ch

Purpose of this meeting:

- 10% giving hints about possibilities
- 90% listen to what you are interested into

Romania - 70 active members

National Contact Physicist:

[Romania] - Calin Alexa (calin.alexa@cern.ch)

Upgrade Advisory Board Representative:

[Romania] - Calin Alexa (calin.alexa@cern.ch)

short name	name	active members	physicist	PhD std	master	ugraduate	eng PhD	eng	eng std	tech	admin
Brasov TU	Transilvania University of Brasov	3	0	0	0	0	2	1	0	0	0
Bucharest IFIN-HH	Horia Hulubei National Institute of Physics and Nuclear Engineering	22	14	5	0	0	2	1	0	0	0
ITIM, Cluj Napoca	National Institute for Research and Development of Isotopic and Molecular Technologies	16	1	0	0	0	4	6	0	5	0
Iasi UAIC	Alexandru Ioan Cuza University of Iasi	8	6	0	0	0	0	2	0	0	0
Politehnica Bucharest	University Politehnica Bucharest	16	0	0	0	0	6	3	7	0	0
Timisoara WU	West University in Timisoara	1	1	0	0	0	0	0	0	0	0
University of Bucharest	Faculty of Physics, University of Bucharest	4	2	1	0	1	0	0	0	0	0
	total:	70	24	6	0	1	14	13	7	5	0

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Betaboltz: A Monte-Carlo simulation tool for gas scattering processes

M. Renda [a,*], D.A. Ciubotaru [a,b], C.I. Banu [c]

[a] IFIN-HH, Particles Physics Department, Măgurele, Romania
[b] Faculty of Physics, University of Bucharest, Bucharest - Măgurele, Romania
[c] Faculty of Electronics, Telecommunications and Information Technology, University Politehnica of Bucharest, Romania

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Gaseous detectors

ABSTRACT

We present an open-source code for the simulation of electron and ion transport for user-defined gas mixtures with static uniform electric and magnetic fields. The program provides microscopic interaction simulation and is interfaced with cross-section tables published by LXCat[1]. The framework was validated against drift velocity tables available in literature obtaining an acceptable match for atomic and non-polar molecular gases with spherical symmetry. The code is written in `C++17` and is available as a shared library for easy integration into other simulation applications.

Program summary
Program Title: Betaboltz
CPC Library link to program files: https://doi.org/10.17632/hjhx8bj45c.1
Licensing provisions: LGPL v3
Programming language: C++17
Nature of problem: Simulations of electron and ion transport in arbitrary gas mixture under static uniform electric and magnetic fields.
Solution method: Particle motion using classical and relativistic equation via interaction sampling using Monte-Carlo techniques.
Additional comments including restrictions and unusual features: At the time of writing only static uniform electromagnetic fields are supported. However, the implementation of arbitrary fields can be added given an analytical solution is available. A custom XML format for cross-section was developed, because full compatibility with LXCat [1] XML format was not possible. Cross-section databases in the new format are available in the download section of the LXCat site [2].
References:

[1] https://www.lxcat.net/
[2] https://lxcat.net/data/download.php

5. GPU acceleration

One of the most time-critical operations, during a simulation, is the solution of eq. (2). Solving this equation is computationally simple, requiring only basic arithmetic operations. However, if we analyze the real case usage of this equation, we realize it could become a critical bottle-neck, at least in some situations.

First, we have to sum all the components of the gas mixture (e.g. in common air, ≈10 components, to get a high precision simulation), when for each component, we have to sum all cross-section processes (between 10 to 100 tables) and then, for each table, we have to perform a linear interpolation. This operation must be repeated for each collision, including the null ones: we can realize how this operation can become very demanding when simulating complex gas mixtures.

However, due to the specific nature of this problem, we can take advantage of GPU computing to perform all the sum and interpolations using concurrent processing cores. Calin Banu implemented this feature as an optional external library [23], which can be compiled and linked to the main Betaboltz framework. It uses the CUDA library to offload the calculation of the real frequency on the GPU.

This implementation should be considered a proof of concept about the feasibility and the ability to provide results with the same accuracy of the non-GPU implementation. Additional work is required to improve the efficiency of the available solution and to make it competitive against the CPU only implementation.

Accelerating the ATLAS Trigger System with Graphical Processing Units

ATLAS Week

Early Career Scientists Session

11/10/2022

Nuno dos Santos Fernandes

REPÚBLICA PORTUGUESA | FCT Fundação para a Ciência e a Tecnologia | TÉCNICO LISBOA | LIP | LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS | ATLAS EXPERIMENT

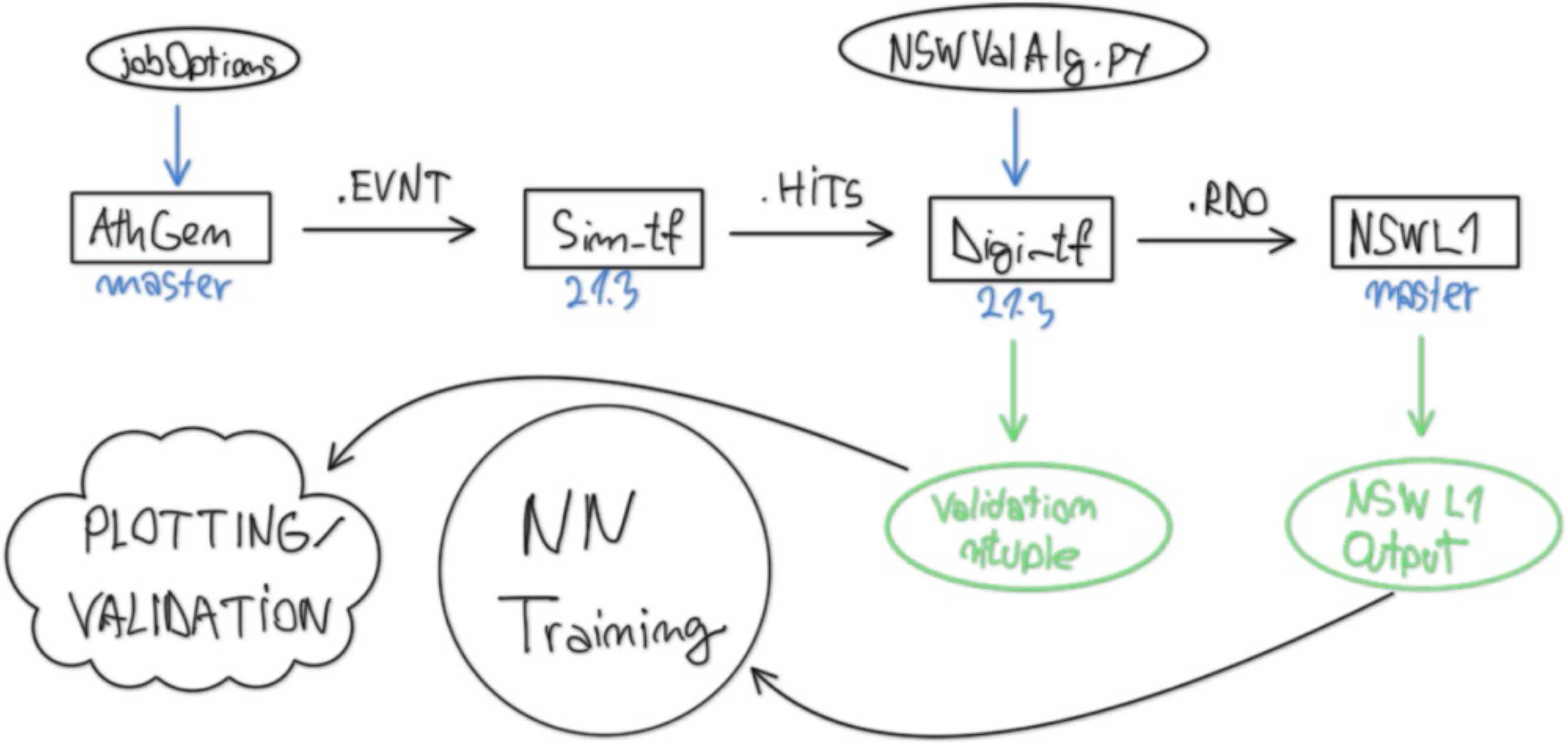
Conclusions and Future Work

- Goal: explore the possibility of GPU acceleration of Topological Cluster Growing
- Topological Cluster Growing was successfully ported to GPUs through Topo-Automaton Clustering
  - GPU algorithm speed-up: ~1.8 for di-jet events, ~2.8 for $t\bar{t}$ events
  - Data conversions and transfers represent a significant portion of the run time (65%~85%)
- CPU and GPU clusters have mostly the same cells and similar physical properties
- Future performance improvements can come from doing more steps of calorimeter reconstruction in the GPU
  - Cluster splitting (the second step of Topological Clustering) is already underway
    - ➢ GPU cluster splitting using the CPU approach (Cosmin Samoila, University Politehnica Bucharest)
    - ➢ I am experimenting with a Topo-Automaton Splitting for better GPU utilisation
- Data conversions might also be optimizable

Machine Learning - Based New Small Wheel Trigger Processor

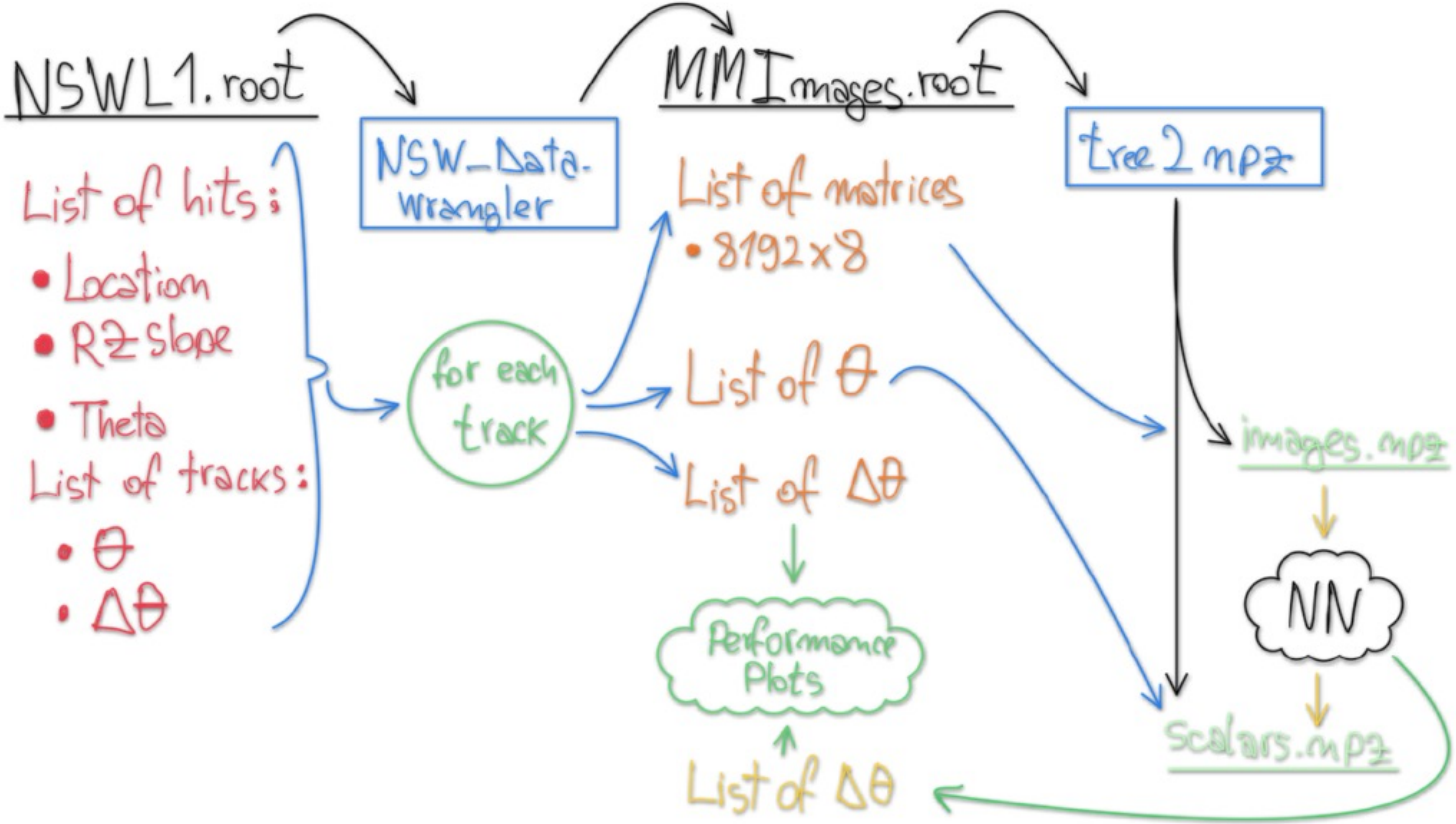
Athena Simulation

Full pipeline

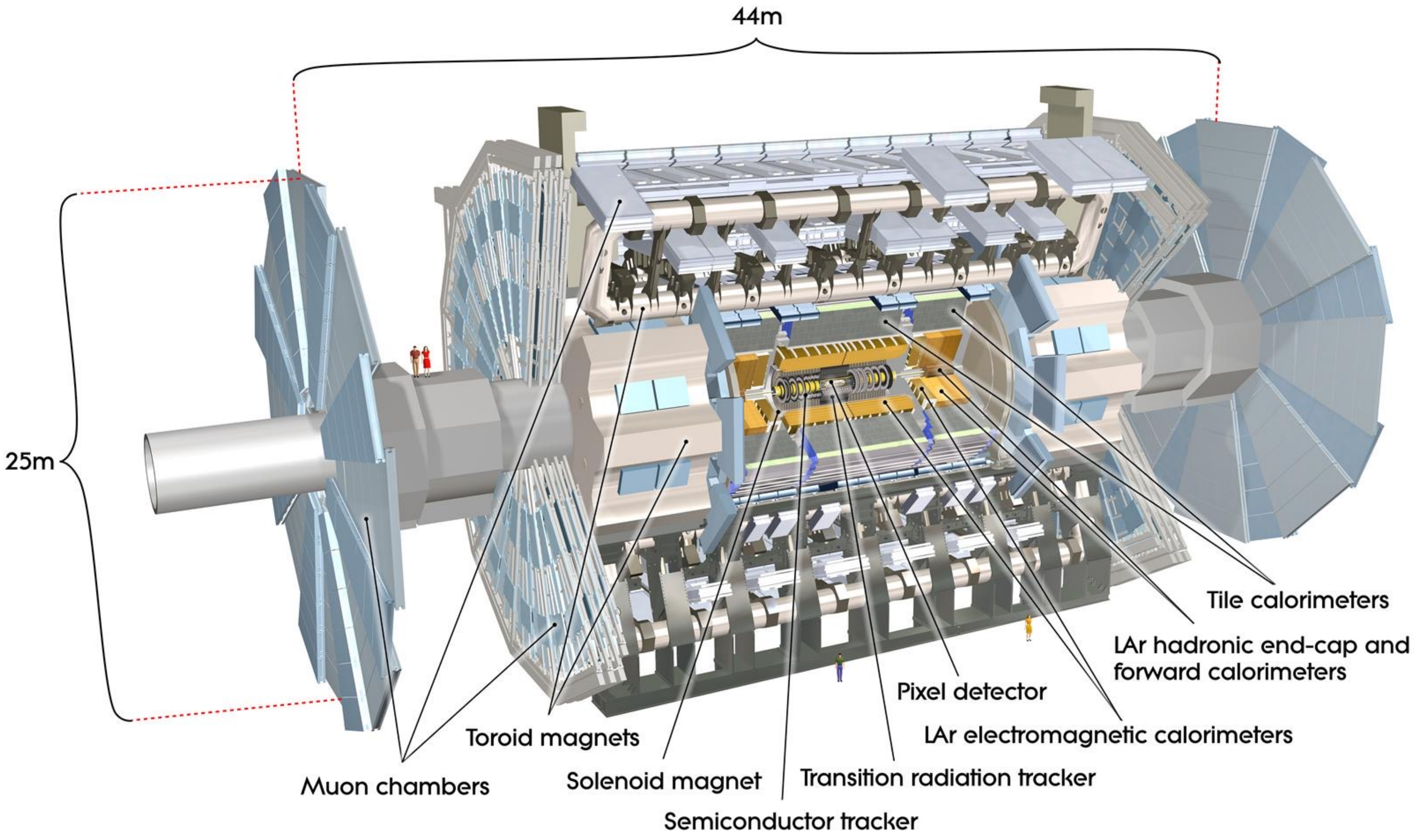


Data Wrangling Pipeline

ROOT -> Tensorflow



100.000.000 sensors sending data every 25 ns



https://inspirehep.net/literature/1845103

ATLAS HL-LHC Computing Conceptual Design Report

Contents

ATLAS Computing and Software

Administration of information and documentation

- Information Protection
- Data Preservation
- Technical Collaborations
- Computing Documents
- Documentation Tools and Management

Conference talks and publications

- Publishing papers on ATLAS computing and software
- Conference talks and proceedings
- Public plots and documents

Liaison

- Physics Modelling Group
- Upgrade simulation
- Trigger Software
- Physics Validation
- ATLAS Machine Learning Forum

External links

- High Energy Physics Software Foundation (HSF)
- World-wide LHC Computing Grid (WLCG)
- Open Science Grid (OSG)

Superseded and obsolete pages

- Common Tracking
- Software Development Workbook
- Technology Forum (FSTF)
- Offline Release Coordination
- CERN Analysis Facility
- Software education review group
- Event Store

Pages requiring updates

- Writing Code
- Detector Description
- Software Validation

Software Project

Domains:

- Event generation
- Simulation (Geometries)
- Reconstruction
- Derivation production and software
- Analysis model and software
- Core Software

Activities:

- ATLAS AFS Phaseout
- Databases
- Job Transforms
- Common tracking software
- Data Quality
- Event Display
- Data Characterization & Curation
- Software Performance Optimisation Team (SPOT)
- Heterogeneous Computing and Accelerators Forum (HCAF)

Code

- Viewing Code
- Installing Software
- Software Quality
- Using Docker to run ATLAS software
- Glossary

Software Releases

- Run-3 Release planning
- Offline Release Numbering Scheme
- Code Management
- Offline Releases (RPMs, old CMT builds)
- Code Distribution
- Nightly builds (ATN Testing, CI Testing)
- ATLAS Release Tester ART documentation

Detector Software

- Calorimeter
- Inner Detector
- Muon Spectrometer

Distributed Computing

- ADC: Distributed Computing
  - ADC Monitoring
  - AMI Metadata Interface
  - DDM Distributed Data Management
  - PanDA
  - Distributed Analysis
  - ADC shifts
  - Resources for physics/CP groups
- Databases
  - ConditionsDatabase
  - Database Operations
- Tier0 Homepage
  - Tier0 Monitoring

Computing and Software Shifts

- ADC shifts
- Git merge request review shifts

- A relatively complex organisation is needed to
    - Collect data from the many parts of the ATLAS detector
    - Calibrate the various sub-detectors
    - Align the sub-detectors internally and relative to each other
    - Reconstruct the low-level physics objects (tracks, calorimeter clusters etc.) and determine their properties
    - Reconstruct the high-level physics objects (particles)
    - Store the original ("raw") data and the reconstructed data and make them available for physics analysis
    - Generate simulated events to estimate geometrical and trigger acceptances, reconstruction efficiencies and resolutions, and compare real data to theoretical models
- Developments for the software framework and the algorithmic code started in 1999, in preparation for Run 1, and continued all along
- The design and development of the Distributed Computing system, i.e. the environment and tools to process and store the data using all available computing facilities, was also started in the early 2000s

- As for all software projects, development never stops:
  - Technology evolves (platforms, compilers, processor architecture…)
  - New data processing models become available (multiprocessor and multithreaded programming)
  - More open-source tools can be used for large data storage and access
  - Commercial cloud computing can be a future possibility to replace in-house computer centres
    - Projects with Google and Amazon
  - Machine Learning can be used efficiently in reconstruction and analysis
  - More and more accumulated data need more efficient storage and processing
- A number of substantial improvements were made to all parts of ATLAS Software & Computing tools in preparation of Run 3, and more are underway for Run 4

HSF
HEP Software Foundation

The HEP Software Foundation facilitates cooperation and common efforts in High Energy Physics software and computing internationally.

Meetings

The HSF holds regular meetings in its activity areas and has bi-weekly coordination meetings as well. All of our meetings are open for everyone to join.

- HSF Coordination Meeting #237, 13 October 2022
- HSF Coordination Meeting #236, 29 September 2022
- HSF Coordination Meeting #235, 15 September 2022

Upcoming HSF and community events »

Full list of past meetings »

Hacktoberfest

The Hacktoberfest is now running again. Contribute to selected repositories from HSF Training and Scikit-HEP and earn a T-shirt or plant a tree. Click here to find all eligible issues!

HACKTOBERFEST

Activities

We organise many activities, from our working groups, to organising events, to supporting projects as HSF projects, and helping communication within the community through c

and technical notes.

The HSF can also writ

collaboration and coo

proposals.

How to get involve

Working Groups are added to the website of the HSF,

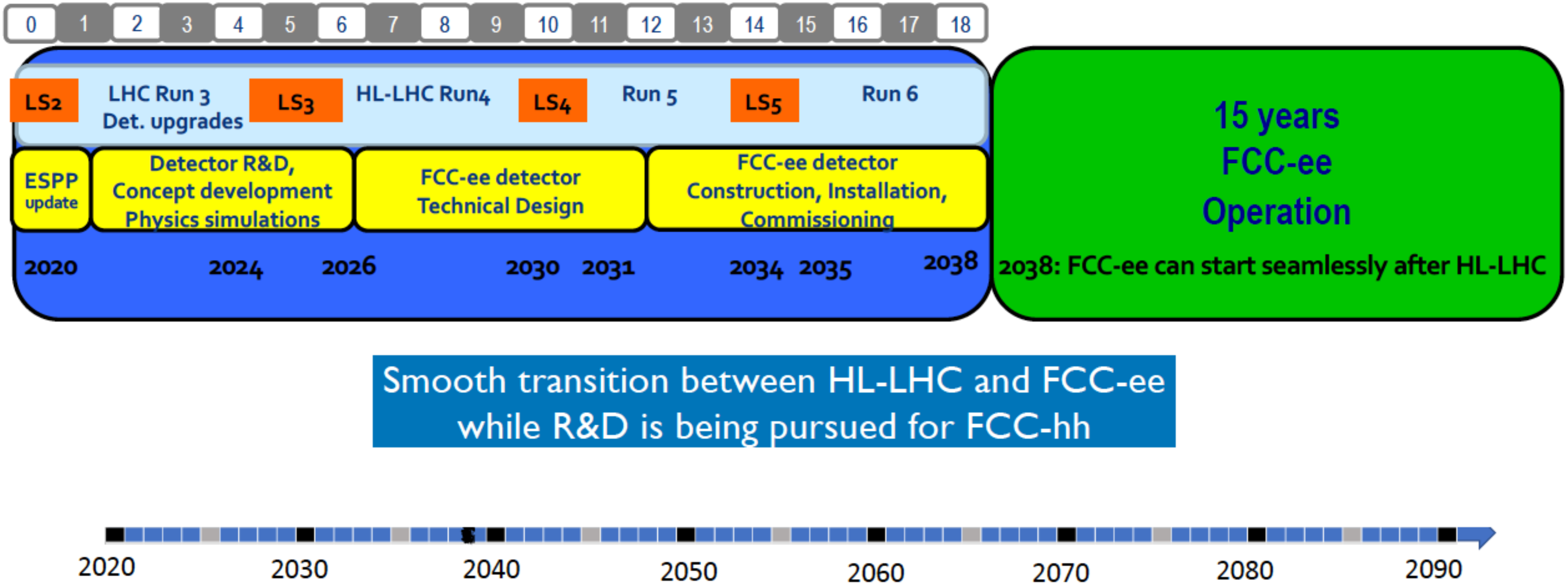
- Data Analysis
- Detector Simulation
- Frameworks
- Physics Generators
- PyHEP - Python in HEP
- Reconstruction and Software Triggers
- Software Developer Tools and Packaging
- HSF Training

Future of HEP: Flagship Projects

Possible scenarios of future colliders

don't wait LHC to finish

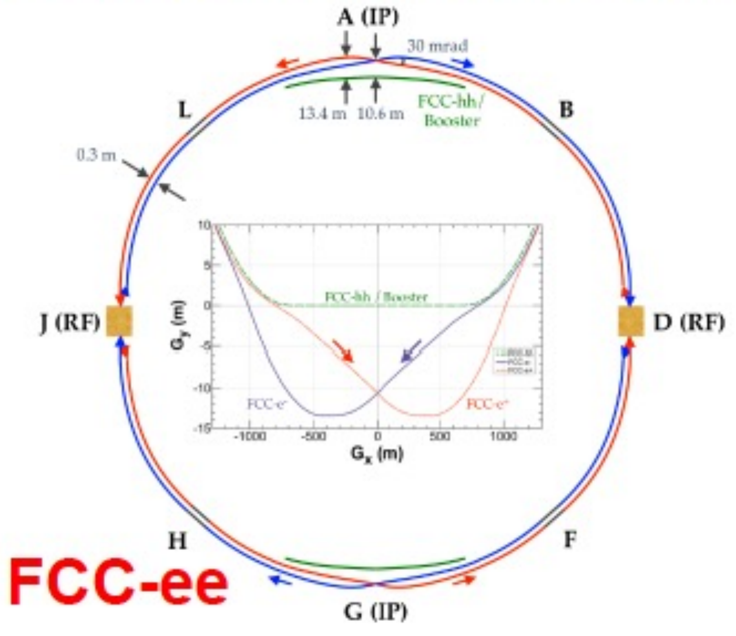
- Proton collider
- Electron collider
- Electron-Proton collider
- Construction/Transformation

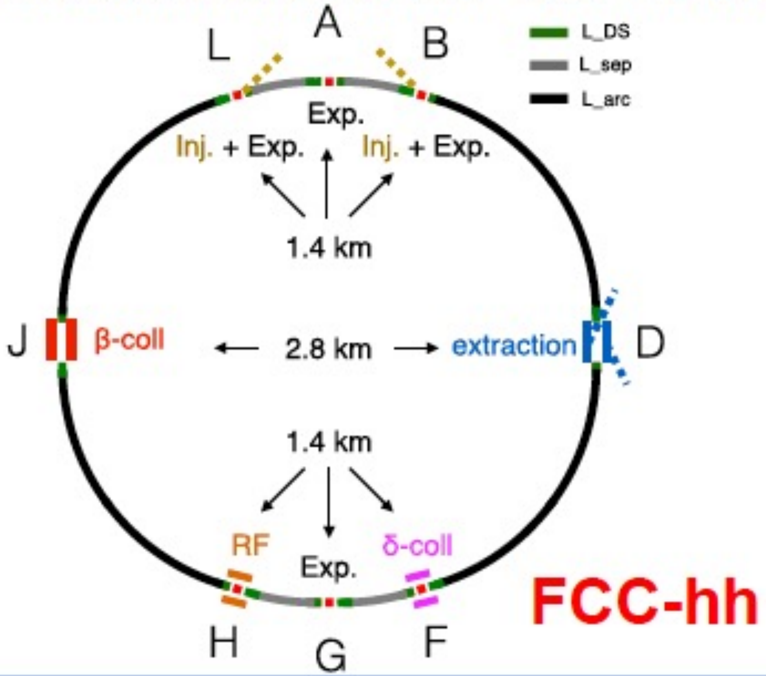


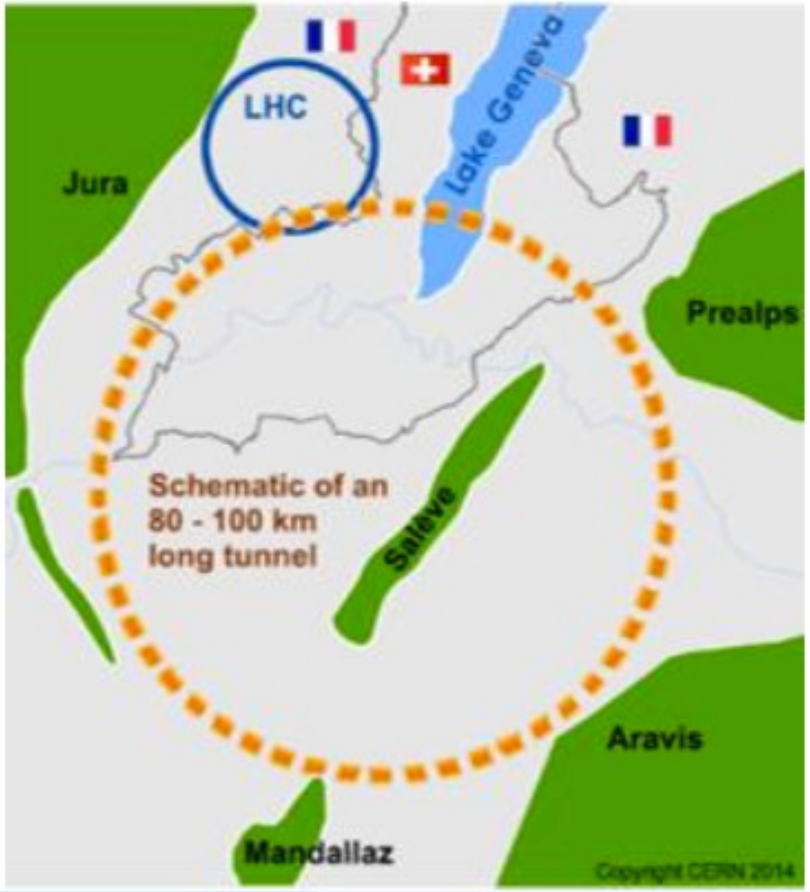
The FCC integrated program inspired by successful LEP – LHC programs at CERN

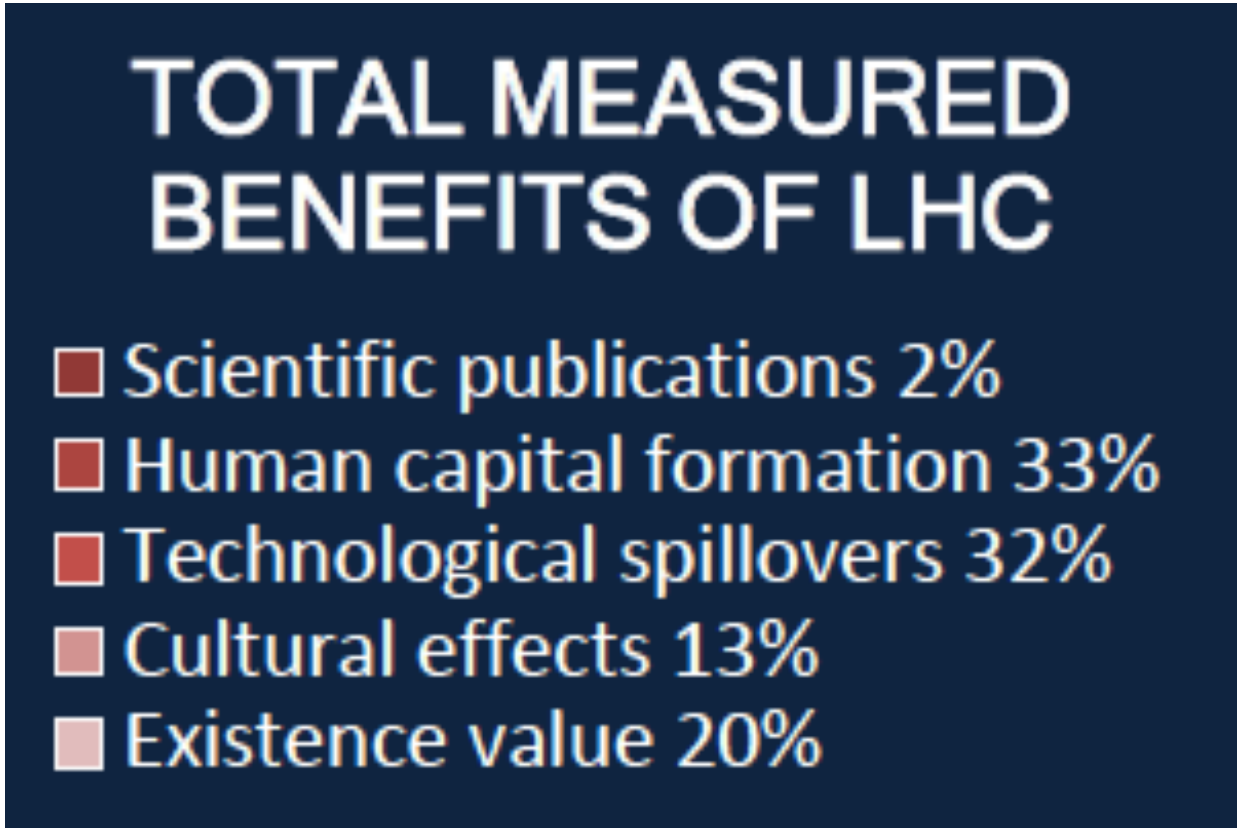
Comprehensive cost-effective program maximizing physics opportunities

- **Stage 1: FCC-ee (Z, W, H, $t\bar{t}$) as Higgs factory, electroweak & and top factory at highest luminosities**
- **Stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, with ion and eh options**
- Complementary physics
- Common civil engineering and technical infrastructures
- Building on and reusing CERN's existing infrastructure
- FCC integrated project allows seamless continuation of HEP after HL-LHC









https://cds.cern.ch/record/2025538?ln=en

Thanks !

Questions ?