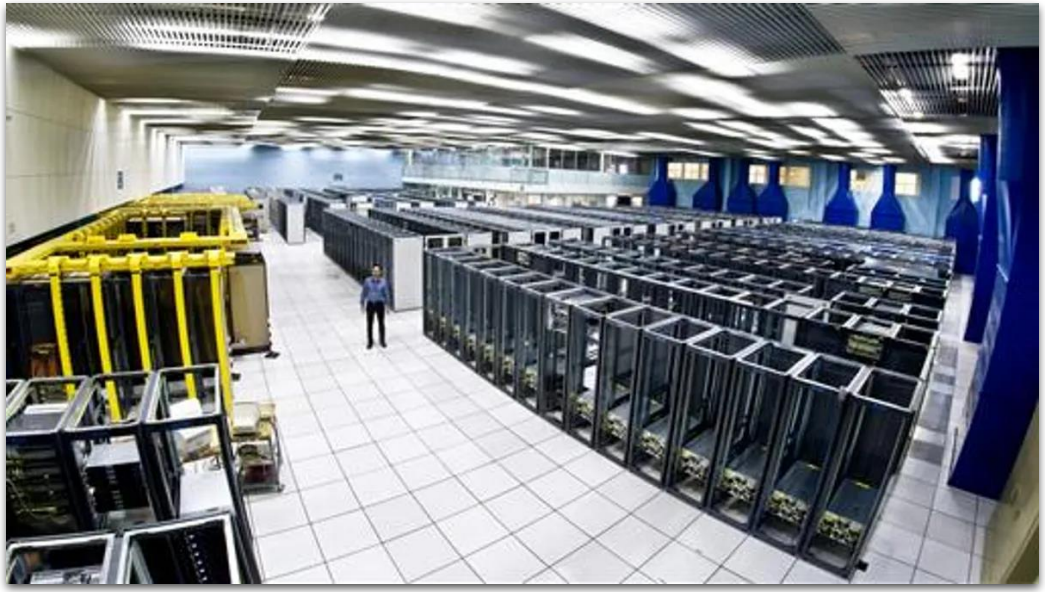
COMPUTING AT CERN

HST2026 Study Group 3



Picture taken from: At CERN, computers to tackle the Big Bang - CNET

Key Ideas

First Data Acquisition and Processing Systems @CERN:

Human Calculators -> Computer Processing

Current Data Flow at CERN (from Peta -> Giga)

Sensors -> L1 triggers (machine learning algorithms programed into FPGAs) -> High Level Trigger -> CERN Data Center -> Worldwide LHC Computing Grid

CERN pioneered in multiple aspects of computing writing its own software in many cases:

- Drivers for long-term data storage, Distributed systems (first farms to grid around the world), Networking (Internet) Information sharing (WWW)

CERN operates from an Open Source perspective (OpenScience)

- Scientific collaboration across borders (Internet and scientific resources repositories)
- Not driven by profit (WWW)

Specifically for Physics:

- classify particle collisions, recognize patterns, analyse detector images, identify different particle jets,
- and reduce the huge amount of data produced by experiments.

Misinformation was the word of the year in 2018 and I think students should know how to follow evidence chains to verify facts and search for real data.

Curriculum & Classroom Connections

- Encouraging students to do some STEM projects
- Discussion about misinformation and following evidence chains to fact check.
- Connections to *Computer Science* and *Technology and Engineering* subjects in Spain:
  - Simulate intelligent sensors by using Arduino programming or digital circuits: i.e. creating a ADC that saves/transmits data only if a condition is matched.
- Physics Sensors Laboratories (Pasco, Vernier, PocketLab, PhyPhox)
- QuarkNet Particle Physics Data Processing Projects
- Machine Learning Projects
  - Keras TensorFlow (Python) to create a compressor

Potential Students' Conceptions & Challenges

- Commercial vs. open science operation: what is the point if you get no money?
- Scientific collaboration across borders
- Machine Learning is a complex subject when you look into the black box, and seems magic when you look from the outside: need to find a midpoint.
- Statistics and probability conceptual limitations
- Computer architecture and scalable computing system architecture high-school materials are limited and materials are often inaccessible

Useful Material & Resources

Artificial Intelligence videos by IBM

- Video: Machine Learning vs. Deep Learning vs. Foundation Models
- Playlist Humans vs. AI: Who should make the decision?

Digital Literacy:

- Common Sense (English and Spanish) https://www.commonsense.org/education/digital-citizenship?topic=115541&grades=9%2C10%2C11%2C12
- Is4k from INCIBE (Spanish) https://www.incibe.es/menores/tematicas/fake-news-y-bulos

QuarkNet Data Projects:

- https://quarknet.org/data-portfolio/activity/mass-us-pennies
- https://quarknet.org/data-portfolio/activity/signal-and-noise-basics
- https://quarknet.org/data-portfolio/activity/plotting-consensus

Online Machine Learning Courses:

- https://www.coursera.org/learn/machine-learning?specialization=machine-learning-introduction

Kaggle Machine Learning Projects

- https://www.kaggle.com/competitions/higgs-boson-detection-2025

Pasco Sensors Motion Data Analysis Lab:

- https://www.pasco.com/resources/lab-experiments/976?srsltid=AfmBOoru02xa59_n7RRBhJ2slwTQeFd4qotvpU9W3PPUwDHuU5IOK19v

Best Practice Example

Students are split in groups of 4: (S1, S2, S3, S4)

S1 reads a piece of information of a paragraph (1 min).

S1 has 1 min to communicate as much as he can to S2.

S2 has 45 sec to communicate as much as he can to S3.

S3 has 30 secs to communicate as much as he can to S4.

S4 comes up with one sentence and compare input paragraph to final sentence.

If students are able to summarize data then this is great! However, if data is getting misinterpreted along the way, then we may not be getting the correct data in the end. This can show students the importance of fact checking and help them think about how they summarize and present information that they come across. This may help them see the value in citing sources.

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One way in which our thinking has changed…

- We see the importance of connecting our curriculum to industry, research and hands on activities.
- We understand the process and purpose of the research that is happening at CERN and we can now connect it to concepts being taught in our classroom.

Highlights, snapshots, farewell messages…

- Field trips, hands on experiences and incredible guest speakers.
- International collaboration among teachers both during the event and in the future through the group chat.