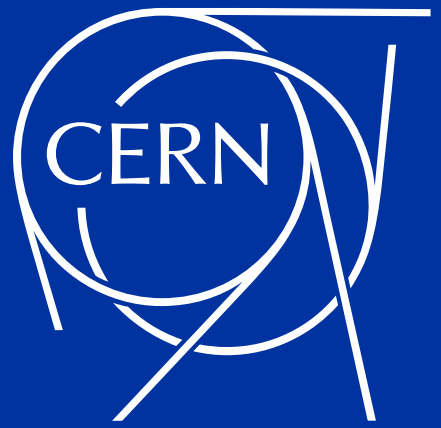


Computing Challenges at CERN

Enrica Porcari

10 September 2024

#1: Data deluge

CERN Science is Data Intensive Science

- Currently on **tape**: 702 PB unique datasets, 832 PB counting double copies.
- Currently on **disk**: 382 PB of physics data.
- LHC experiments
  - Run 1 (2009-2013) we stored 65 PB
  - Run 2 (2015-2018) we stored 209 PB
  - Run 3 (2022-2026) we expect to store more than 600 PB

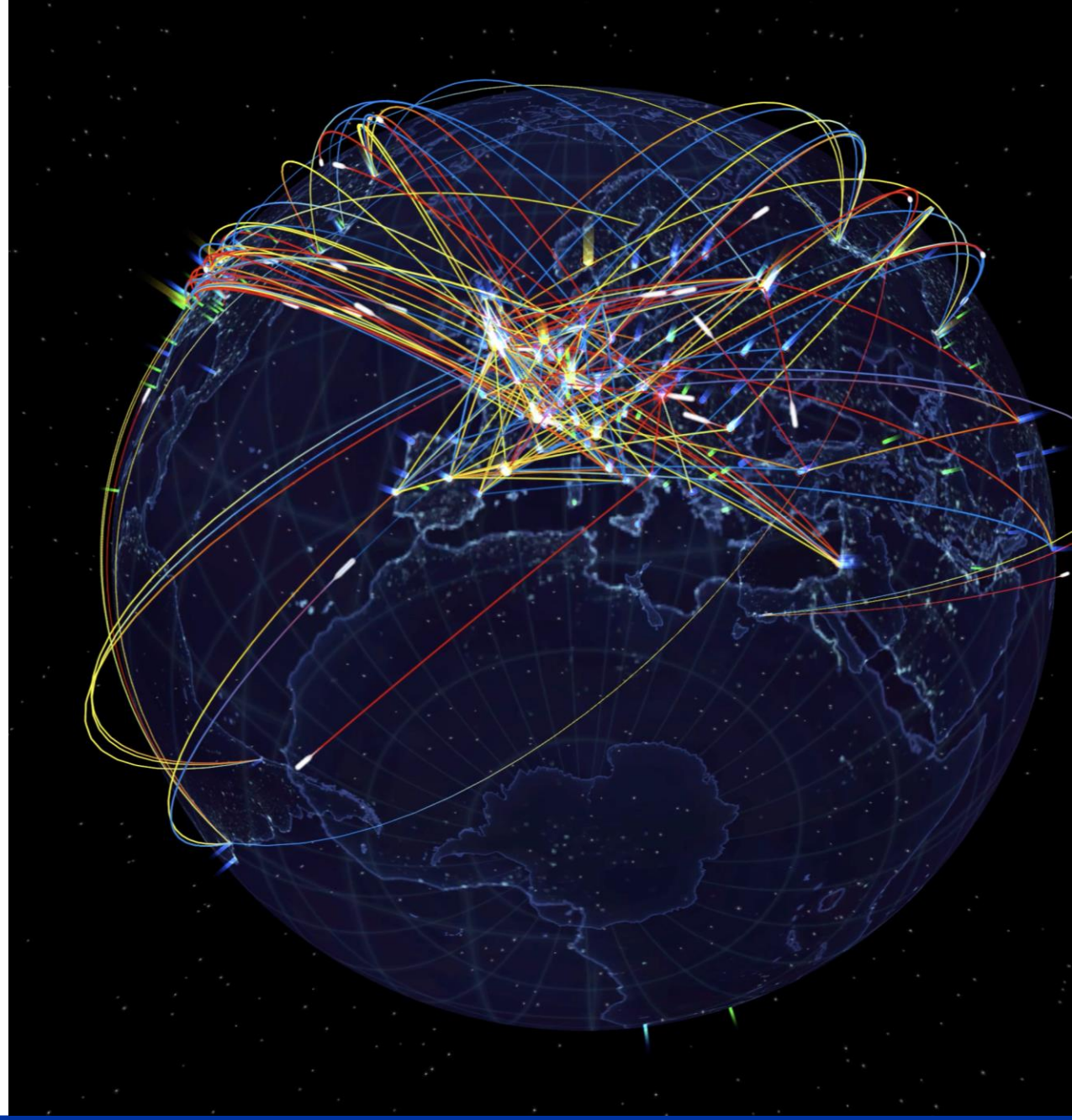
In total: about 360k CPU cores (mainly in PDC). MDC hosts now ~1104 PB of disks (RAW storage) that is used for both physics (872PB on EOS) and IT infrastructure.

The WLCG in action

The combined power of the WLCG computing centres:

- T1s, T2s: 170 data centres in 40 countries
- Data transfer capability of 60 GB/s (2024 average)
- Highest standards in security protocols

In total: 1.4M CPU cores, 4 Exabytes of storage (disks+tapes)

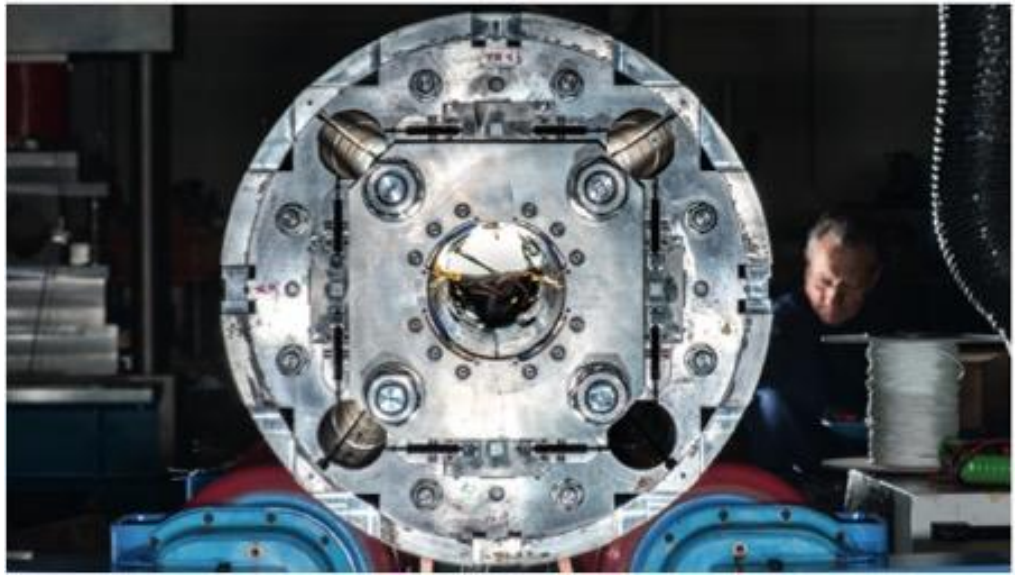


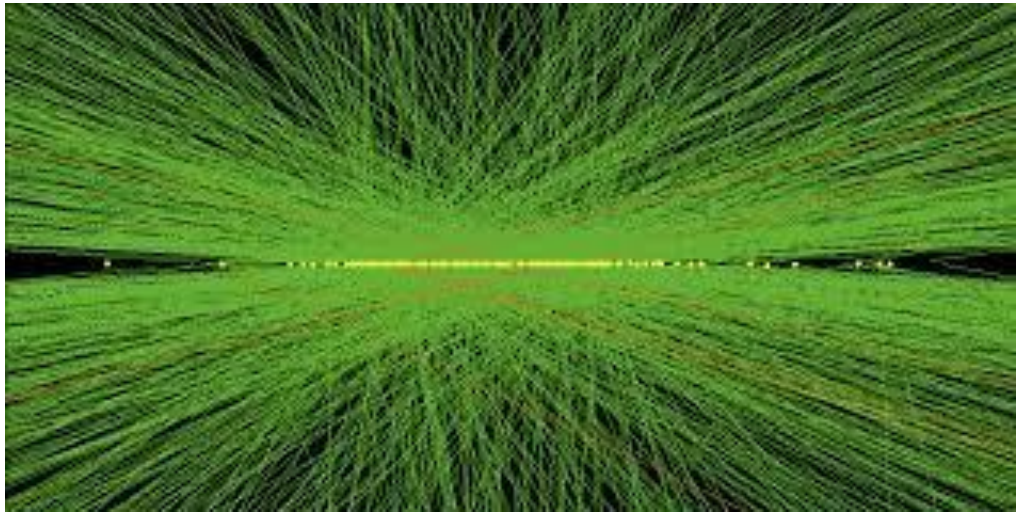
#2: HL-LHC

Higher luminosity equates to more data for the experiments, giving them greater precision and more potential for new discoveries

- **More luminosity = more resources needed!**
  - *x10* increase
  - More than Moore's law and we have flat budget

- **More pile-up = more complex events**
  - 40 per bunch-crossing at Run 2
  - 200 expected at Run 4





Strategies to face the HL-LHC Challenge

Addressing conventionally:

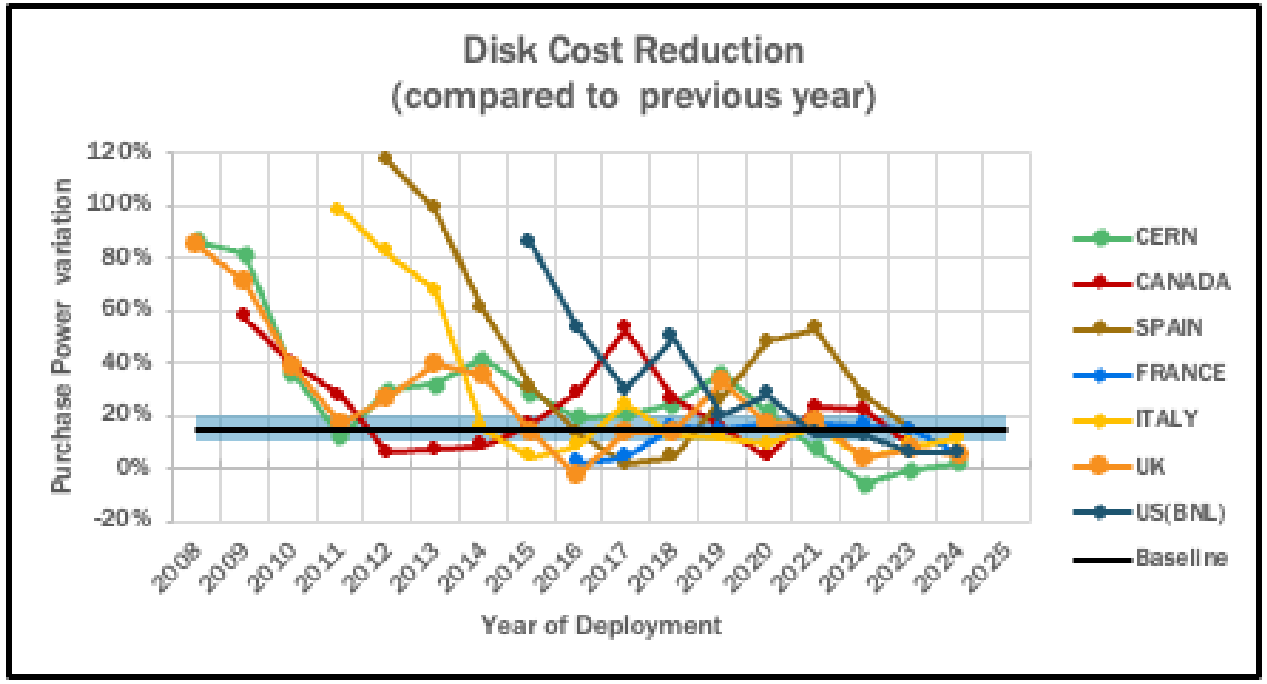
- Hardware efficiency and cost optimisation
- Refactoring, modernising, optimising code
- Operating the PDC at its full potential

Leveraging innovations:

- Accelerators like GPUs and TPUs (and FPGAs) in readout chain
- ML and DL (deep learning) applied to all stages of readout/analysis
- Data Lakes (Pooled research centres; with streaming and caches)
- Utilise HPC centres

Helping to drive paradigm shifts

- Quantum Technology Initiative
- Next Generation Triggers



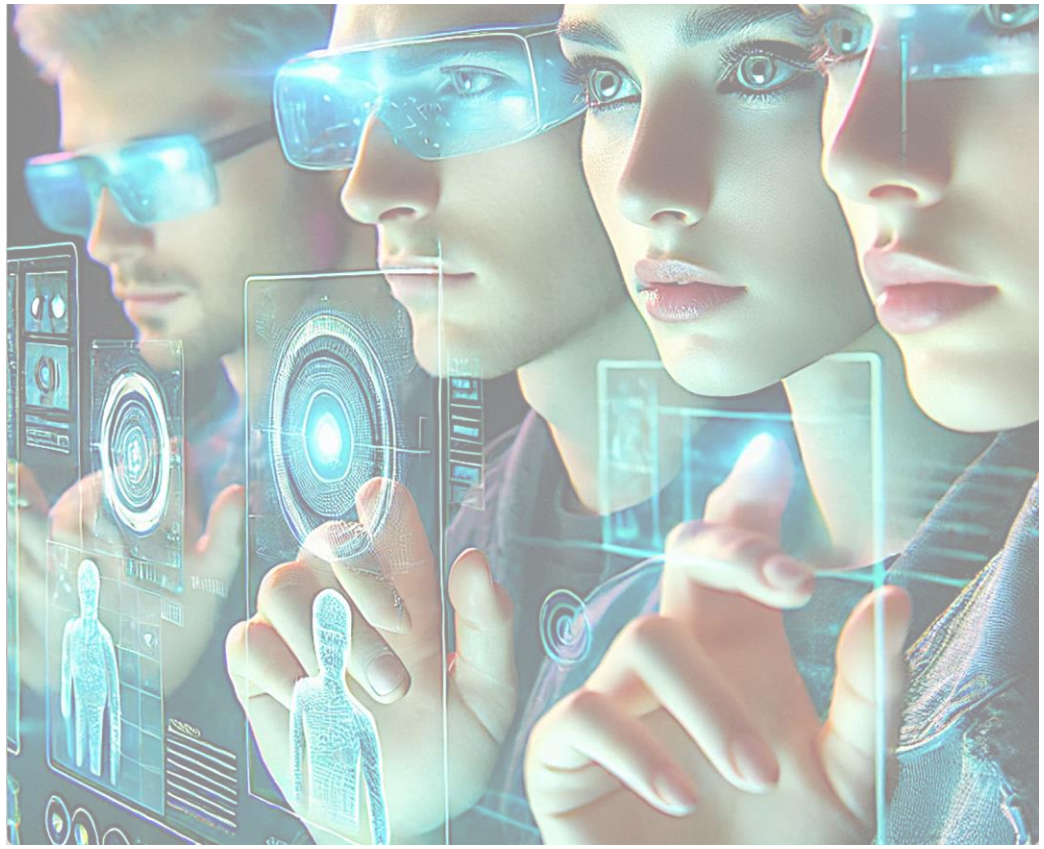
#3: Future

Creating today the basis for a **fair and sustainable future** where access to information technologies will be fully democratised and regulated by public bodies and where the needs of the scientific community will continue to be addressed with excellence.

At CERN:

- **QTI:** it aims to assess the potential impact of quantum technologies on future research programmes and to prepare skills and resources required for future generations of researchers to further investigate and better understand how to apply quantum technologies to their specific research fields, be it computational chemistry or materials science, high-energy-physics or space applications.

- **OQI:** it is a multilateral governance initiative that promotes global and inclusive access to quantum computing and the development of applications for the benefit of humanity. It brings together academia, diplomacy, private sector and philanthropy stakeholders.



AI produced image

Empowering the future generations

- **This school helps work on challenges together!**
  - Data Science, data management, data visualisation, data technologies, security, software design, machine learning

….and shape the future

Welcome and enjoy the two weeks with the great CSC team!