



# CERN – for UiA students

- What is CERN?
  - *General overview of CERN*
- What is LHC?
  - *The LHC accelerator and LHC challenges*
- Student projects at CERN
  - *Range of subjects, examples of NTNU Master's thesis at CERN*
- Working at CERN
  - *Professional environment, life in the Geneva region*

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Nils HØIMYR CERN / IT



# What is CERN?

CERN is the **world's largest particle physics centre**

- Particle physics is about:
  - **elementary particles** which all matter in the Universe is made of
  - **fundamental forces** which hold matter together
- Particle physics requires:
  - **special tools** to create and study new particles

**CERN is:**

- ~ **2300 staff scientists** (physicists, engineers, ...)
- 2000 Sub-contractors**
- **Some 10500 visiting scientists** (half of the world's particle physicists)

**They come from**

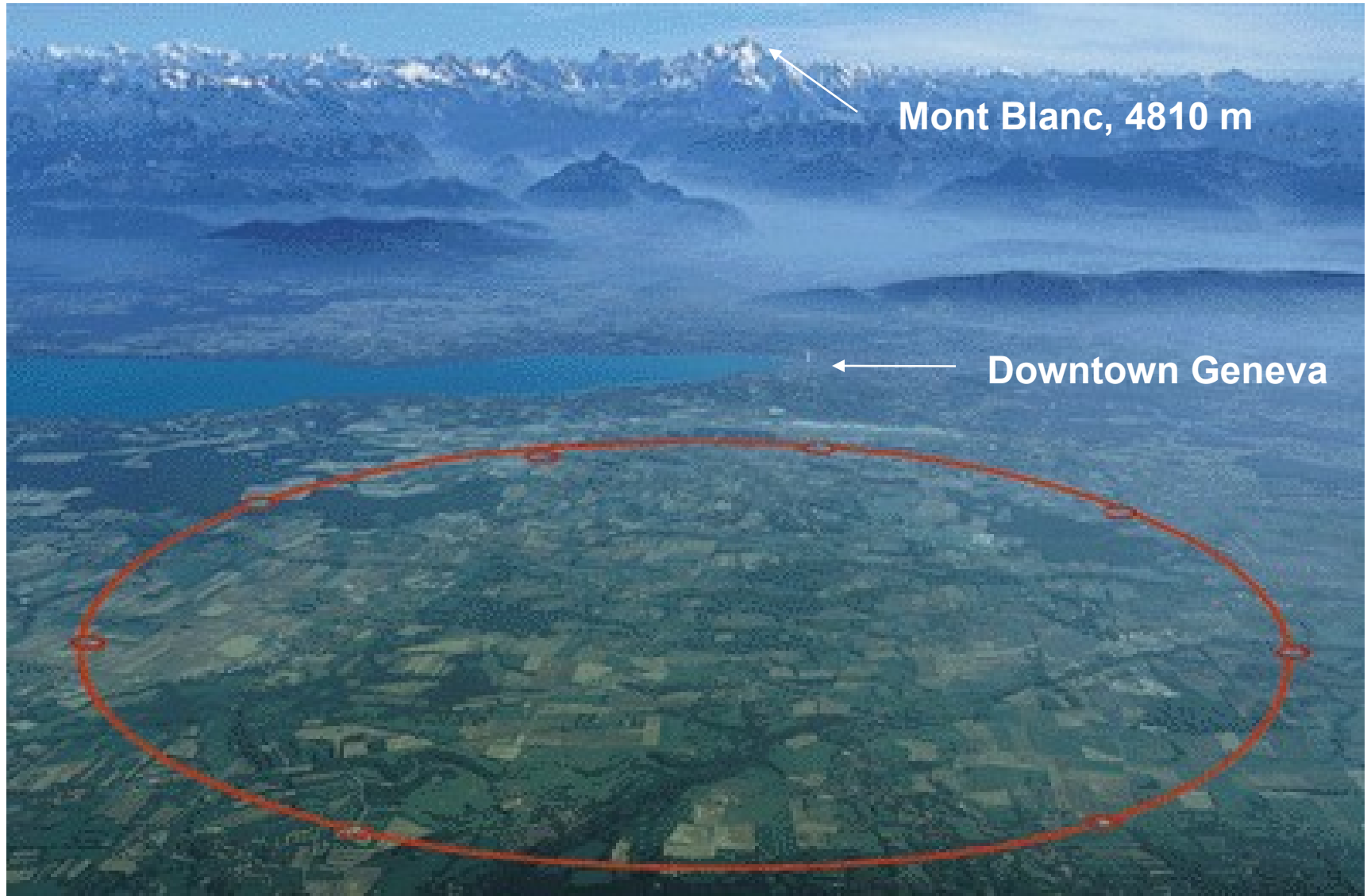
**600 universities**

**Representing more than 80 nationalities.**





# CERN Site





# What is CERN?

The special tools for particle physics are:

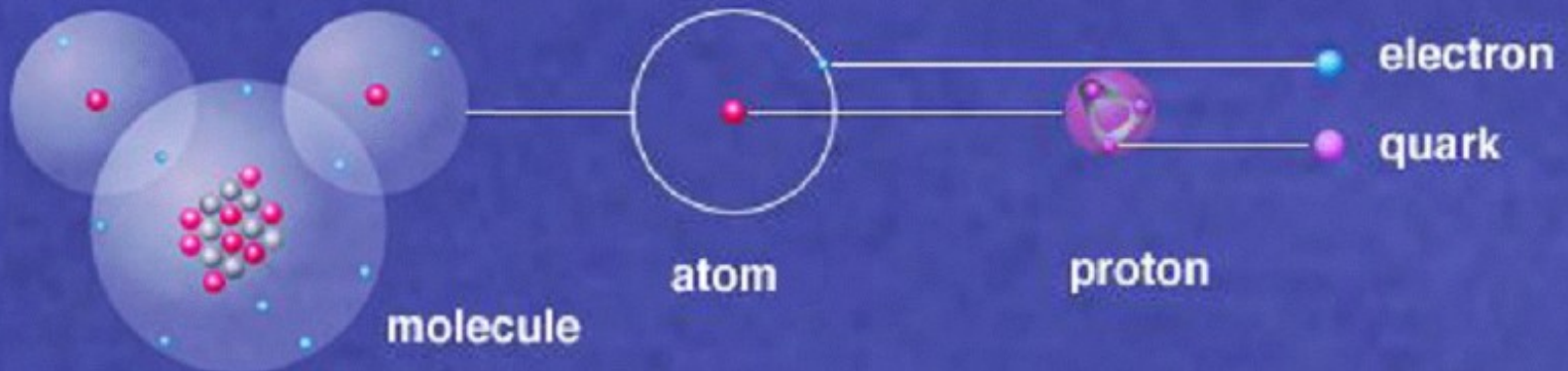
- **ACCELERATORS**, huge machines able to speed up particles to very high energies before colliding them into other particles
- **DETECTORS**, massive instruments which register the particles produced when the accelerated particles collide





# What is CERN?

- Physicists smash particles into each other to:
  - identify their **components**
  - **create** new particles
  - reveal the nature of the **interactions** between them
  - create an environment similar to the one present at the origin of our Universe
- **What for?** To answer fundamental questions like:  
*how did the Universe begin? What is the origin of mass?  
What is the nature of antimatter?*





# What is CERN?

*The [World Wide Web](#) was invented here, to improve and speed-up the information sharing between physicists working all over the world!*





# What is LHC?

- LHC collide beams of protons at an energy up 7 TeV (later 14 TeV)
- Using the latest super-conducting technologies, it operates at 1.9K (about  $-271\text{ }^{\circ}\text{C}$ ), just above absolute zero of temperature.
- With its 27 km circumference, the accelerator is the largest superconducting installation in the world.

*LHC collisions from November 2009  
Four experiments,  
with detectors as  
'big as cathedrals':*

*ALICE  
ATLAS  
CMS  
LHCb*



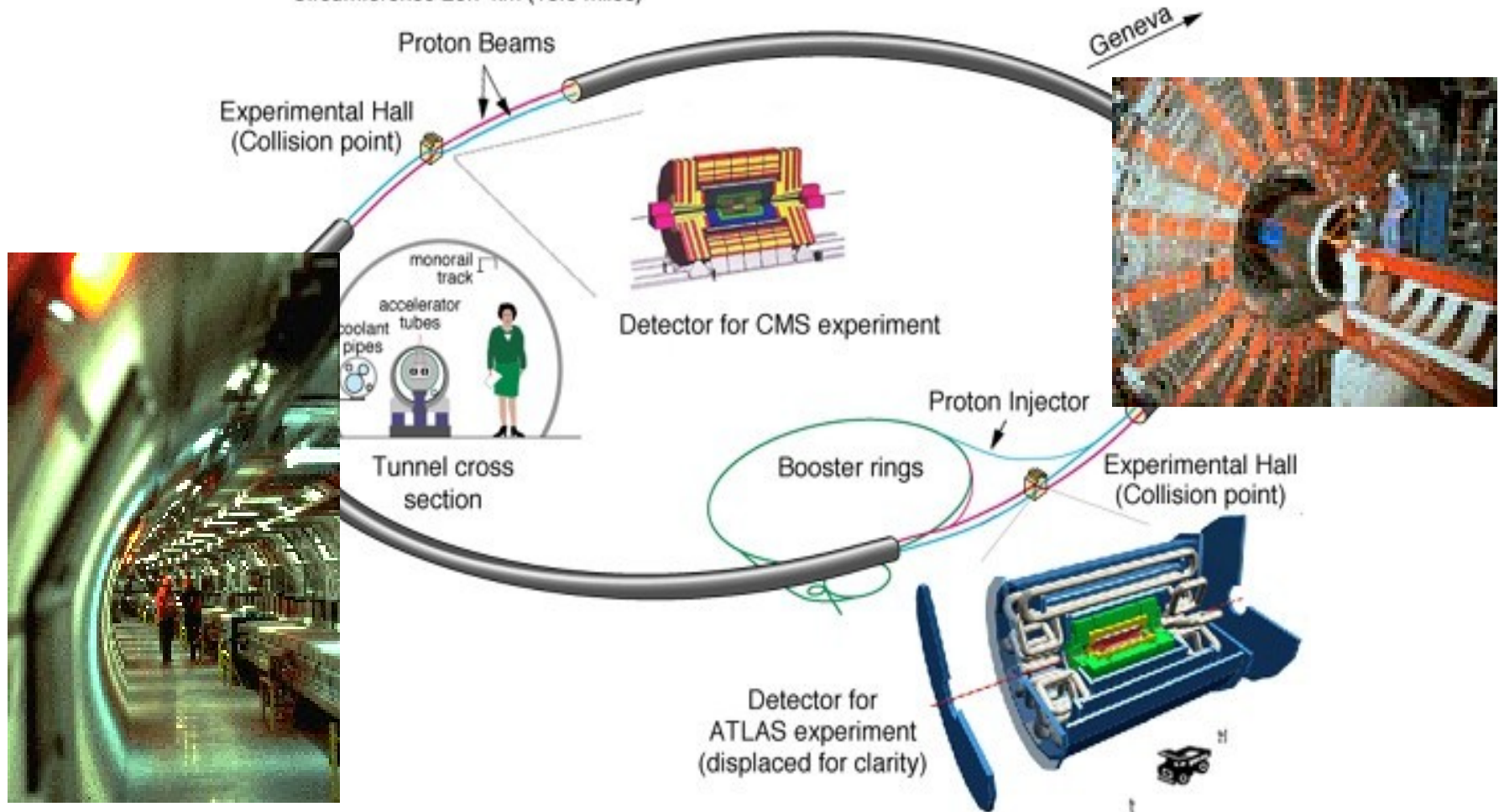




# LHC – Large scale engineering project

## *Large Hadron Collider* at CERN

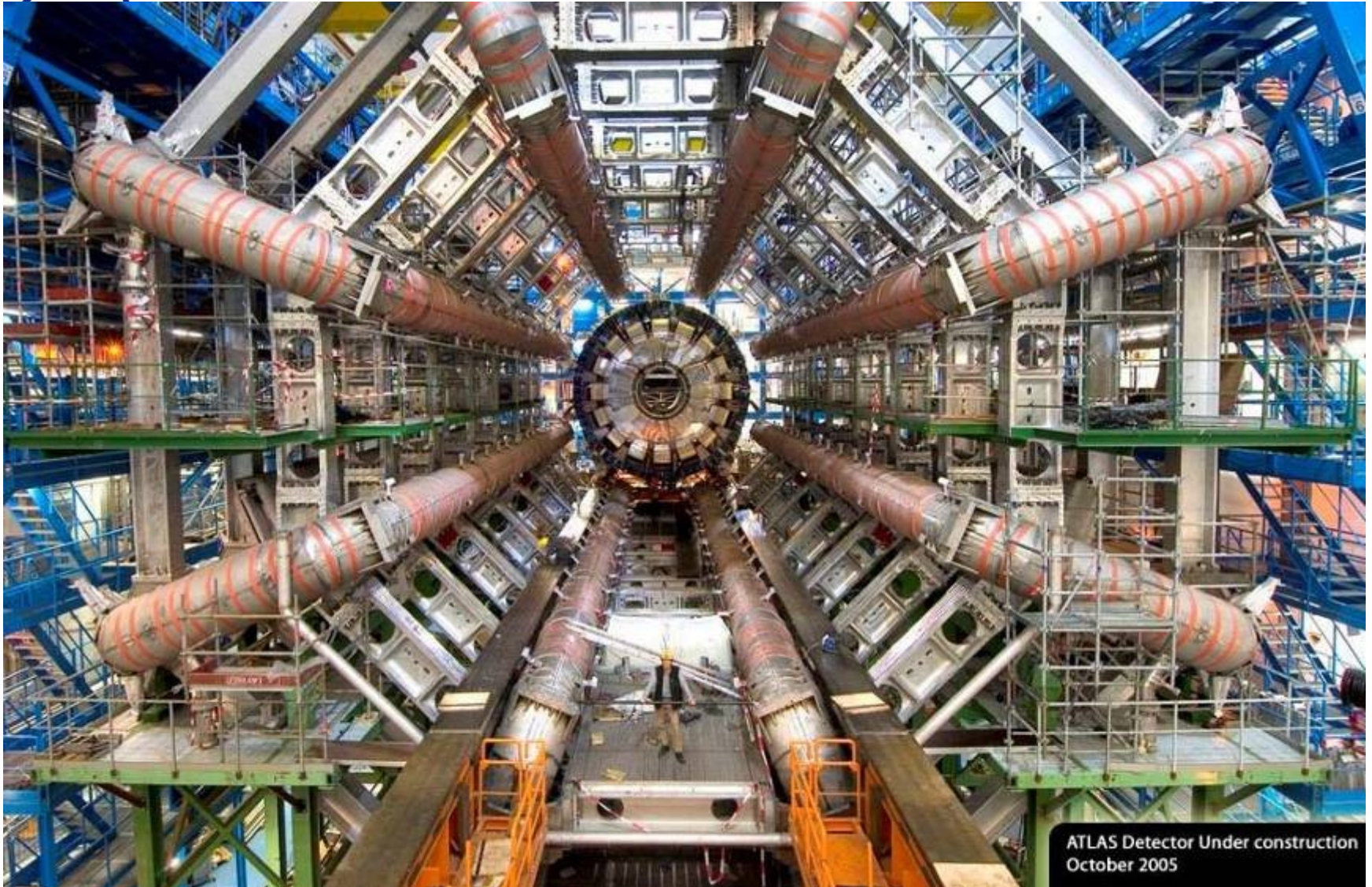
Circumference 26.7 km (16.6 miles)







# Example of complexity: ATLAS



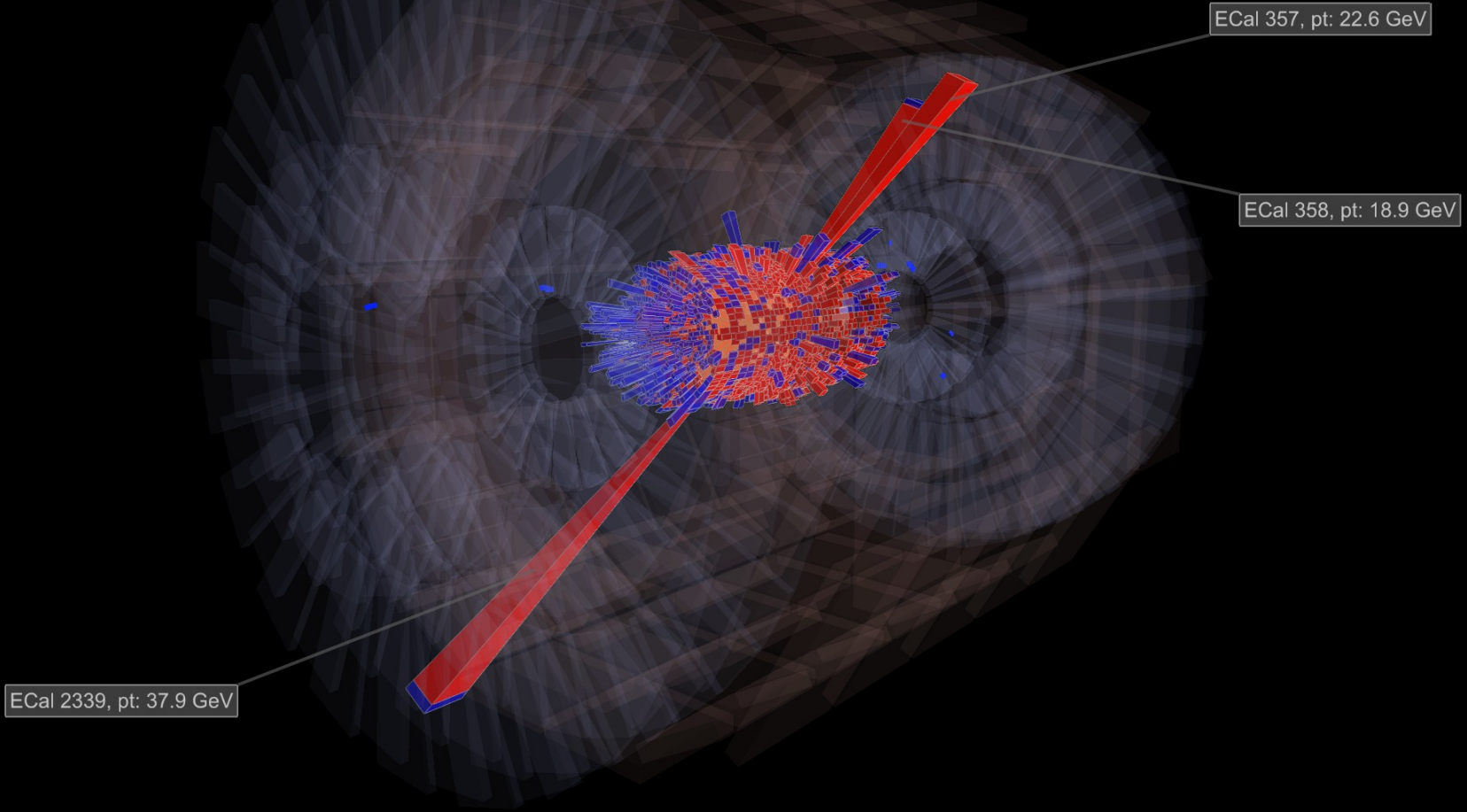
ATLAS Detector Under construction  
October 2005



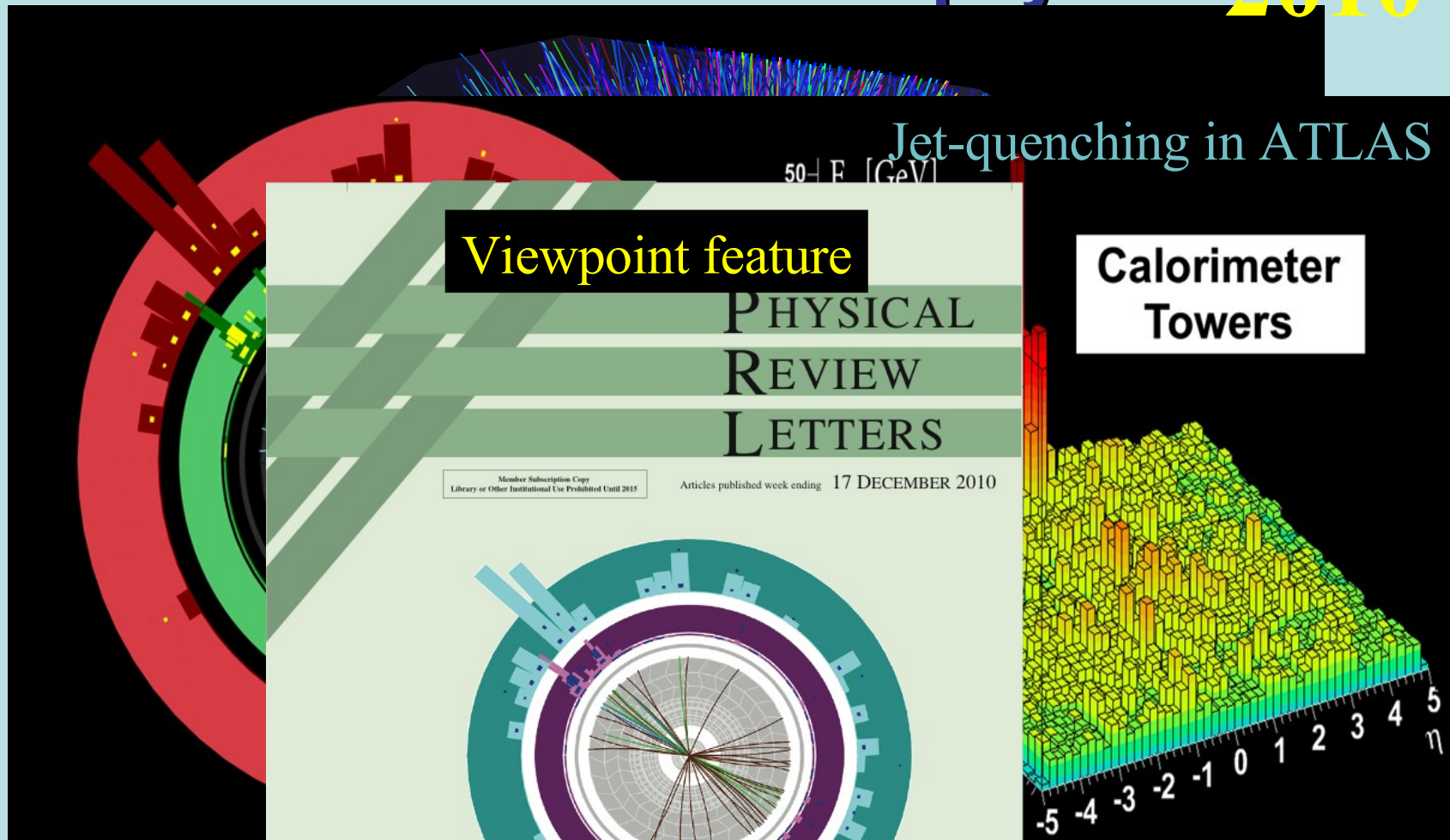
# Spectacular collisions ... 2010



CMS Experiment at LHC, CERN  
Data recorded: Sun Nov 14 04:29:43 2010 CEST  
Run/Event: 151058 / 4096951  
Lumi section: 747

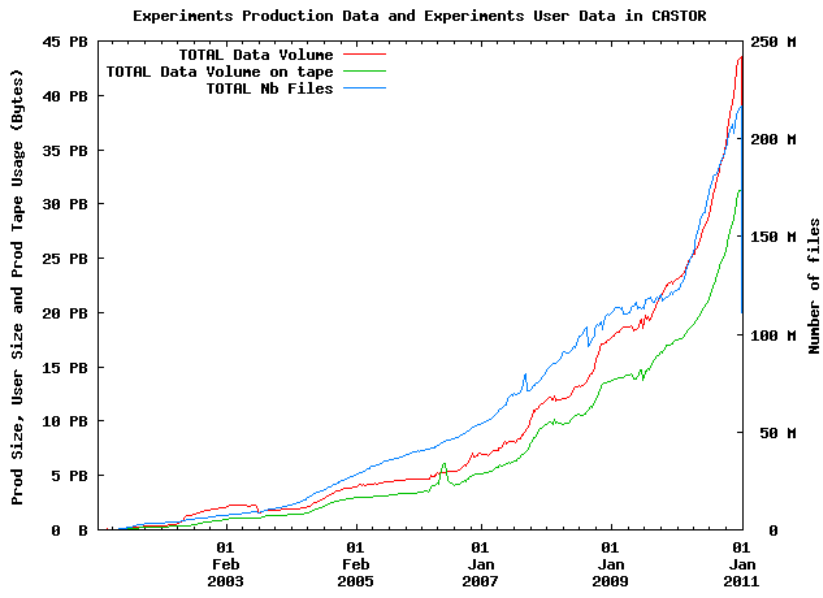


# Spectacular collisions ... and physics 2010

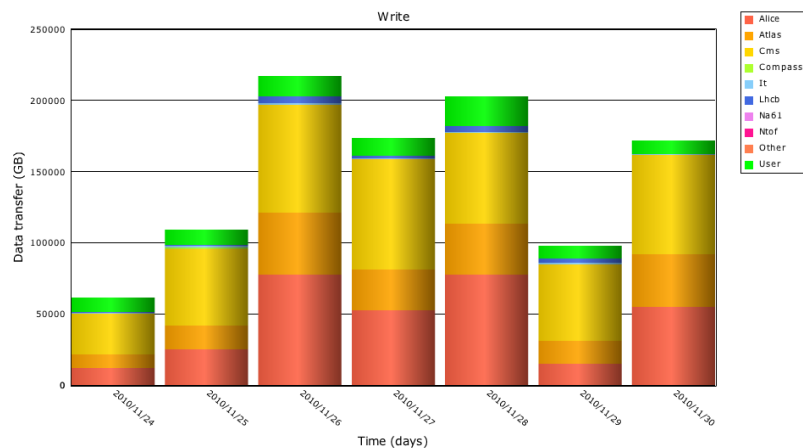


After just three weeks of the LHC run with heavy ions, we are witnessing a very exciting start of this new era. *Edward Shuryak*

# 2010 Tier-0 Data Taking



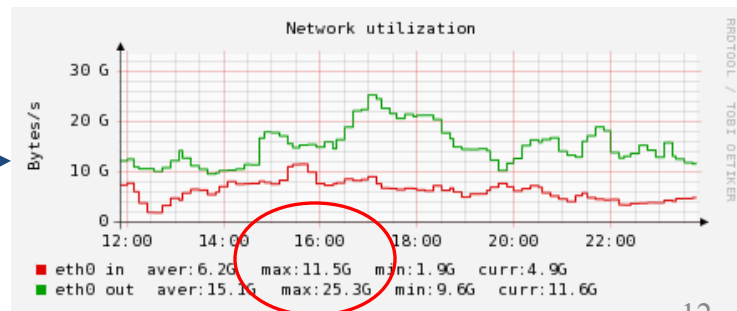
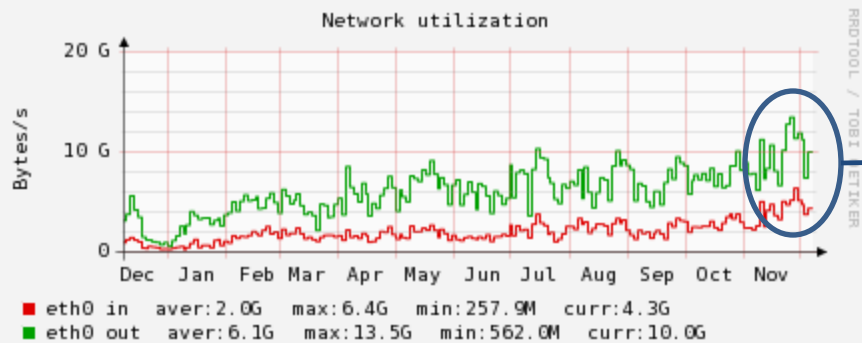
**Stored ~ 15 PB in 2010 with peaks at 220 TB/day during Pb+Pb**



## Tier-0 Bandwidth

**Average in: 2 GB/s with peaks at 11.5 GB/s**

**Average out: 6 GB/s with peaks at 25 GB/s**





# Future projects

- Future LHC upgrade: sLHC
- Linear collider: ILC or CLIC?
  - Accelerator and detector development
- Linac4 – new injector complex for LHC
  - Civil engineering started, installation by 2013
  - SPS and PS accelerator upgrades proposed
- Consolidation of CERN facilities
  - Maintenance, upgrades, buildings, renovation...



# Teknologijobber ved CERN

- Ingeniørvitenskap og teknologi
  - Kuldeteknikk, prosessteknikk, vakuumteknologi
  - Elektronikk, elkraft
  - Prosjektadministrasjon
  - Tekniske drift og vedlikeholdsaktiviteter
  - Bygg og anlegg, VVS
- **IT**
  - Tungregning, GRID, Cloud computing
  - Nettverk, Kommunikasjon, Datasikkerhet
  - Kontrollsystemer (kybernetikk)
  - Systemutvikling, databaser
  - Informasjonssystemer, etc
- Fysikk og forskning
  - Partikkelfysikk (mange om beinet!)
  - Detektorutvikling, signalbehandling, elektronikk
  - Materialfysikk



# Eksempler på diplomer ved CERN

- **Prosess og kuldeteknikk**
  - L'air liquide 6kW cryoplant for covering ATLAS detector cooling needs
  - Heat exchangers in the ATLAS liquid argon calorimeter
  - Contribution to the dynamic analysis and optimal control of the superfluid helium cooling loop for the LHC magnet string
  - Cryoplant process simulation program
- **Ingeniørvitenskap og teknologi**
  - Computerized process planning for Mechanical workshops
  - FEM Structural Analysis of vacuum chamber for the CERN JetSET experiment
  - Optimized project coordination of distributed projects via the mile-stone method (Case from ATLAS)
  - Quality Assurance Procedures in a Large Engineering project with help of PDM (Case from LHC coordination)
  - Technology Transfer at CERN - a study on inter-organizational knowledge transfer within multinational R&D collaborations
- **IT**
  - Software Distribution Techniques for Large Scale Computer Systems Using SmartFrog
  - Compiler Comparisons using Performance Counters
  - Linking CAD/CAM with Physics Simulation tools using the ISO STEP standard





# Bra start på karrieren

- Opphold ved CERN gir internasjonal erfaring og nettverk som verdsettes senere
- De fleste studenter og fellows fra CERN har gått videre til gode jobber, selv i dårlige tider
- Eksempler på tidligere CERN studenter og ansatte:
  - Rolf Skår, gründer av Norsk Data
  - Håkon Lie, CTO Opera Software
  - Bjørn Erik Reinseth, Ferd venture, tidligere direktør av Bredbåndsfabrikken og Sense Communications



# Virke i et utfordrende miljø

- **Faglig**
  - På mange felt har CERN unike krav
- **Mellommenneskelig**
  - CERN yter tjenester til 80 forskjellige nasjonaliteter
- **Sosialt**
  - Utenfor CERNs gjerder snakker ikke alle engelsk ...



# En typisk arbeidsdag

- Hva kan du gjøre for CERN?
  - CERN-kulturen fordrer initiativ
- Hva gjør CERN for deg?
  - Kurs: språk, ledelse, kommunikasjon, teknikk osv.
  - Tid til egenutvikling
- "Kjernetid" 8.30-17.30
  - Dog svært fleksibelt med en god lunsjpause



# Et stimulerende miljø

- Banebrytende vitenskapsfolk
  - Nobelprisvinnere, primadonnaer, hippier ....
- WWW ble utviklet på CERN i 1990
  - "Interesting, but vague"
- Akademiske foredrag
  - Forelesninger



# Eminente besøk...







# CERN er ikke bare for nerder...

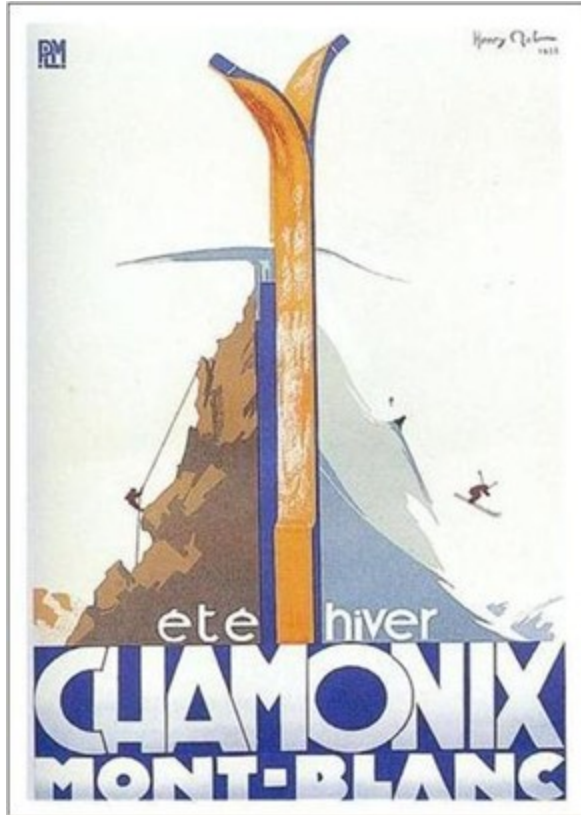
- Alpene er ikke langt unna...



- Internasjonalt miljø, fransk og engelsk offisielle språk
- Sentral beliggenhet, 3 timer med tog til Paris og Milano



# Aktiviteter i Genève og omegn



- Ski
- Fjellturer
- Klatring
- Seiling
- Luftsport
- Termalbad
- Generell turisme





# Norsk miljø i Genève

- **Ansatte ved CERN**
  - Spiser sammen, sosial omgang
- **Sjømannskirke med leseværelse**
  - Mor og barn treff, barnegruppe , gudstjenester osv.
- **Norsk kor i Genève**
  - (Evt. Internasjonalt norsk kor i Genève)
- **Nordisk klubb**
  - Tradisjonelle fester



# Ta hovedoppgaven på CERN!

- Gode stipendordninger
- Søknadsfrist: 10 oktober og 5 mars!
- Jobbmuligheter også for nyutdannede sivilingeniører
  - Fellowship (frist 7 september) og diverse andre stillingskategorier

*Mere info her:*

*<http://www.cern.ch/jobs> (følg "Students")*

*<http://cern.ch/norway>*