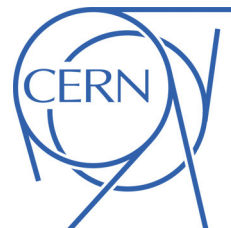




# ATLAS NOTE

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## FAQ for ATLAS guides

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### Abstract

This FAQ provides a list of typical questions asked by the public during ATLAS visits. It focuses on numerical answers that are not important for our everyday work but interesting for the layman. Comparisons to everyday life are provided. Rigorousness is not required.

# 1 CERN/LHC

## **How long lasts the hydrogen bottle used for the colliding protons?**

To empty the hydrogen bottle with its 140 g of hydrogen, it would take about 150 million years. Nonetheless, to ensure stable pressure, it is replaced twice a year.

## **How many work hours were spent to build the LHC?**

I don't know.

## **At what proton energies do the different accelerator systems operate?**

Linac2 accelerates the protons to 50 MeV, the PS booster to 1.4 GeV, the PS to 25 GeV and the SPS to 450 GeV.

## **What's the timeline of the LHC?**

Early 1980's while LEP was built, first plans about a possible successor circulated. In December 1994 the LHC was approved by the CERN council. Building started shortly thereafter. First collisions happened at 23<sup>rd</sup> November 2009. The four large experiments were approved between 1996 and 1998.

## **How long does it take to get a stable beam?**

It takes 4'20" to fill one LHC ring, the acceleration of the protons to 7 GeV takes 20 minutes, the stable beam is used for collisions for several hours before it is dumped. Before a proton is dumped, it has travelled the distance to Neptun and back. After a beam is dumped, it takes roughly 2 hours to get stable beams again.

## **How deep under ground is the LHC, ATLAS?**

The mean depth is ~ 100 m, the depth varies between 175 m (under the Jura) and 50 m (towards Lake Geneva). ATLAS is 92 m under ground.

## **What about LEP?**

LEP operated from 1989 to 2000. It's still the most powerful lepton collider ever built. Highest energy achieved was 209 GeV.

## **It is often said, that the LHC probes the early phase of the Universe. But at what time after the big bang was the typical energy density comparable to the energies reached at the LHC?**

$10^{-12}$  s

## **How much did the LHC cost?**

The construction costs of the LHC - including machine R & D and injectors, tests and pre-operation - was about 5 billion CHF. About a quarter was spent on personnels, the rest for materials. Additionally CERN shares some of the expenses of the detectors and computing facilities. In total 6.51 billion CHF was spent.

## **How much money does CERN contribute to the material budget of the different experiments?**

The experiments are individual entities, but CERN is a member of each experiment. It contributes 20 % to the material budget of CMS and LHCb, 16 % for ALICE, 14 % for ATLAS and 30 % for TOTEM.

## **What's the length of the tunnel?**

26.659 km

## **What are collision energies for ion runs?**

2.76 TeV per ion, this gives a total of 1150 TeV.

## **What's the temperature in a collision?**

I don't know.

**What's the temperature of the superconducting electromagnets?**

The LHC magnets use superfluid helium at 1.9 K. This is even less than the temperature at outer space (2.7 K).

**How many magnets are used in the LHC?**

The LHC has a large variety of different magnets, in total about 9593 are used. The biggest ones are the 1232 dipoles. Each dipole is 15 m long and weighs around 35 t.

**How many protons are circulating in the LHC at the same time?**

A complete fill has 2808 proton bunches, each having  $1.1 \cdot 10^{11}$  protons.

**How strong is the magnetic field of the superconducting dipoles?**

The peak magnetic dipole field is at 8.33 T.

**What is the distance between bunches?**

The minimal distance is 25 ns or about 7 m.

**What is the luminosity?**

The design luminosity is  $10^{34} \text{ cm}^{-2}\text{s}^{-1}$ , the peak luminosity reached is ???

**How many turns and collisions happen per second?**

The revolution frequency of a proton bunch is 11.245 kHz. The number of collisions per second obviously depends on bunch crossing and luminosity (pile-up), at designated values, there would be 600 million collisions per second.

**Do Tides influence the LHC?**

Yes. By new moon and full moon, the crust in the Geneva region rises by some 25 cm. This movement causes a variation of 1 mm in the circumference of the LHC and this produces changes in beam energy. The effect is not crucial, though, since the collision energy of the partons is not known (as opposed to the situation at LEP).

**What are the dimensions of a bunch?**

Usually, it's a few cm's long and about 1 mm wide, at collision point it is squeezed to  $16 \mu\text{m}$  to allow for a greater chance of collision.

**How much data is produced by the LHC?**

From the 600 million events per second only a few 100's are stored. Thus, more than 99.9999 % of the collision data is thrown away immediately. The recorded events generate about 700 MB/s or 15 PB/year of data. If all data would be recorded, it would be more than 3 PB/s or about 7.5 million PB/year (= 7.5 zettabyte/year).

**What is the LHC power consumption?**

It is around 120 MW (230 MW for all CERN), which corresponds more or less to the power consumption for households in the Canton of Geneva. The estimated yearly energy consumption is about  $8 \cdot 10^5$  MWh, including site based load and experiments. The total yearly cost is therefore about 25 million CHF.

**How large is the radiation generated at CERN?**

The radioactivity released by the LHC is less than  $10 \mu\text{Sv/year}$ . As a comparison, the natural radioactivity is about  $2400 \mu\text{Sv/year}$  in Switzerland, a flight from Europe to Los Angeles accounts for about  $100 \mu\text{Sv}$ . Despite its low levels, the LHC's radioactivity is closely monitored by CERN, which conducts a rigorous control programme that includes over 200 monitoring stations, in agreement with the Swiss and French authorities.

**What's the amount of helium needed to cool down the LHC?**

Around 120 t.

**What is the total energy of the beam?**

The total energy in each beam at maximum energy is about 350 MJ, which is about as energetic as the TGV travelling at 150 km/h. This is enough energy to melt around 500 kg of copper. The total energy stored in the LHC magnets is about 11 GJ.

**How much filament is used in the LHC magnet coils?**

If all the filaments in the magnet coils were unravelled, they would stretch to the Sun and back five times with enough left over for 150 trips to the Moon and back.

**When was the tunnel excavated?**

It was excavated at 1988. The two ends met up to within 1 cm.

**What's the pressure inside the beam pipe?**

$10^{-13}$  bar, about ten times lower than on the Moon.

**How many member states does CERN have?**

21, the last to join being Israel in 2013. CERN has also associate members and states with observer status.

**What computing power is used at CERN?**

The CERN computer centre consists of 25000 computers. The grid adds more than 100000 computers. The grid runs more than 1 million jobs per day.

**How many people are working at CERN?**

CERN employs just over 2400 people. Some 10000 scientists from over 113 countries come to CERN for their research.

**When was CERN established?**

29<sup>th</sup> September 1954.

**What are the biggest scientific achievements at CERN?**

- 1973: The discovery of neutral currents in the Gargamelle bubble chamber
- 1983: The discovery of W and Z bosons in the UA1 and UA2 experiments
- 1989: The determination of the number of light neutrino families at the Large Electron-Positron Collider (LEP) operating on the Z boson peak
- 1989: The World Wide Web began as a CERN project called ENQUIRE, initiated by Tim Berners-Lee and Robert Cailliau
- 1995: The first creation of antihydrogen atoms in the PS210 experiment
- 1999: The discovery of direct CP violation in the NA48 experiment
- 2010: The isolation of 38 atoms of antihydrogen
- 2011: Maintaining antihydrogen for over 15 minutes
- 2012: A boson with mass around 125 GeV consistent with long-sought Higgs boson

## **2 ATLAS**

**How many people work at ATLAS?**

The ATLAS collaboration consists of about 3000 scientists, working in 177 institutions from 38 countries.

**What are the key figures of ATLAS?**

ATLAS is 46 m long, 25 m high and 25 m wide. It weighs 7000 tons and its material cost was 540 million CHF. ATLAS is the biggest of the CERN detectors (CMS the heaviest, with about 12000 tons).

**How many cables are used in ATLAS?**

ATLAS uses about 100 million electronic channels and about 3000 km of cables.

**What are the key figures of the superconducting magnet coils?**

They are 25 m long and weigh over 100 t. They work at a temperature of 4 K, with a magnetic field of 4 T, storing more than 1 GJ of energy.

**What are the figures of the surface hall (SX1)?**

SX1 is 84 m long, 24 m wide, 18 m high. Two cranes, each can carry 140 t, can lower down pieces through the two access shafts. The heaviest piece to lower down were the liquid Argon endcaps (270 t each).

**References**

- [1] ATLAS Fact sheet [http://www.atlas.ch/fact\\_sheets.html](http://www.atlas.ch/fact_sheets.html)
- [2] LHC milestones <http://lhc-milestones.web.cern.ch/LHC-Milestones/>
- [3] Destination Universe: The Incredible Journey of a Proton in the Large Hadron Collider <http://cds.cern.ch/record/1259890>
- [4] LHC: The guide <http://cds.cern.ch/record/1165534/>