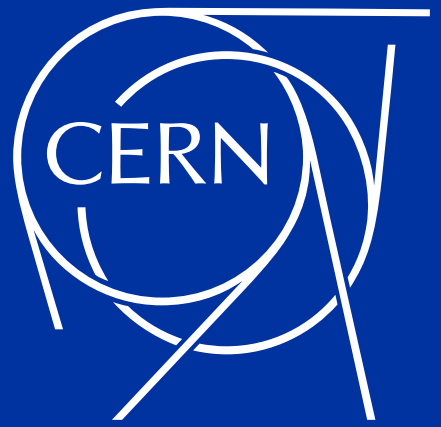


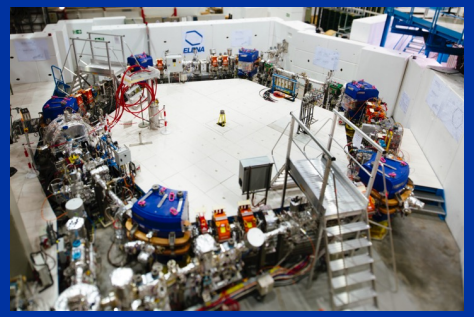
AXEL – 2023

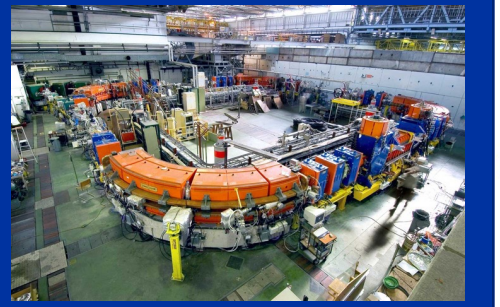
Introduction to the CERN Accelerator Complex

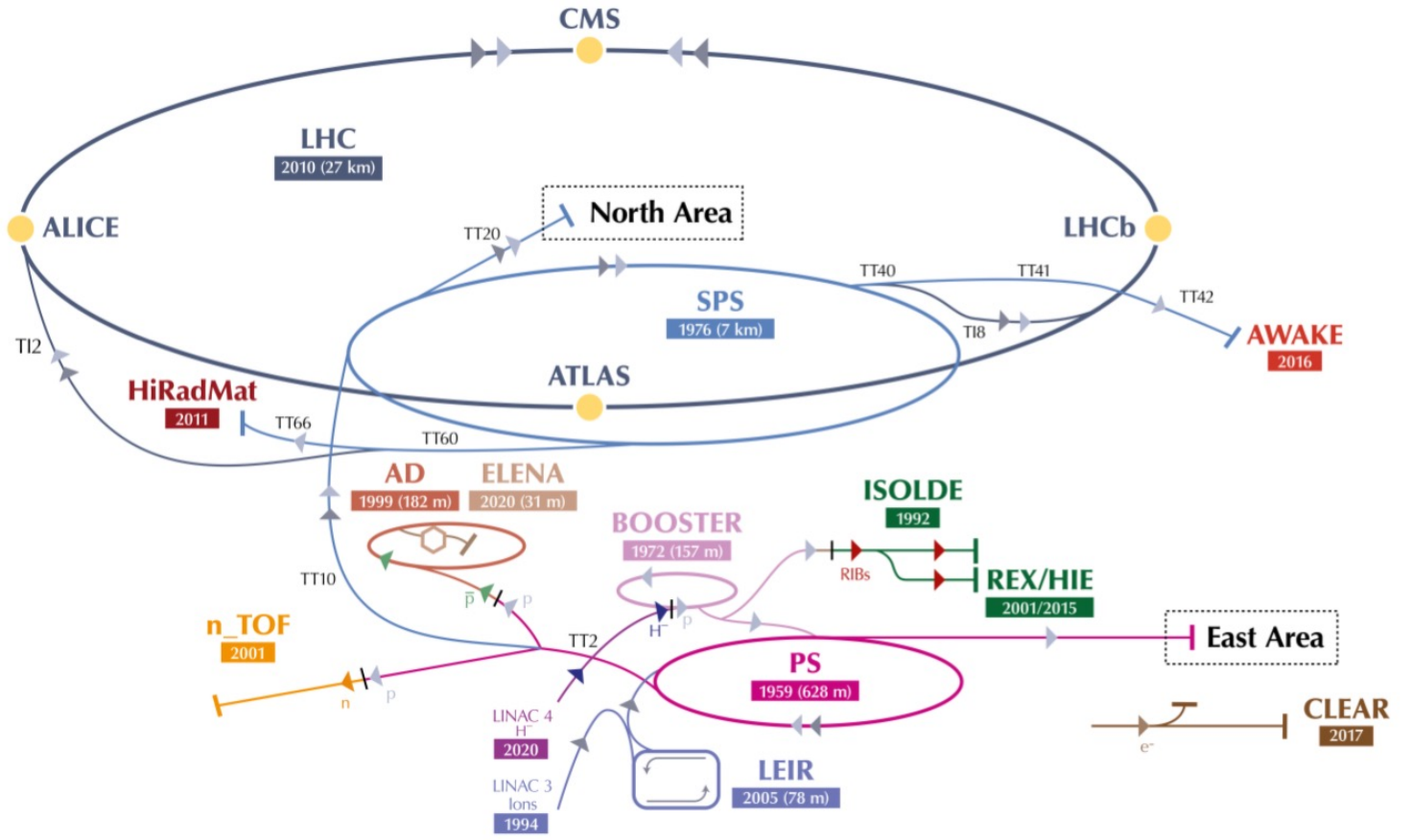
Rende Steerenberg, BE-OP

27 February 2022

The CERN Accelerator Complex





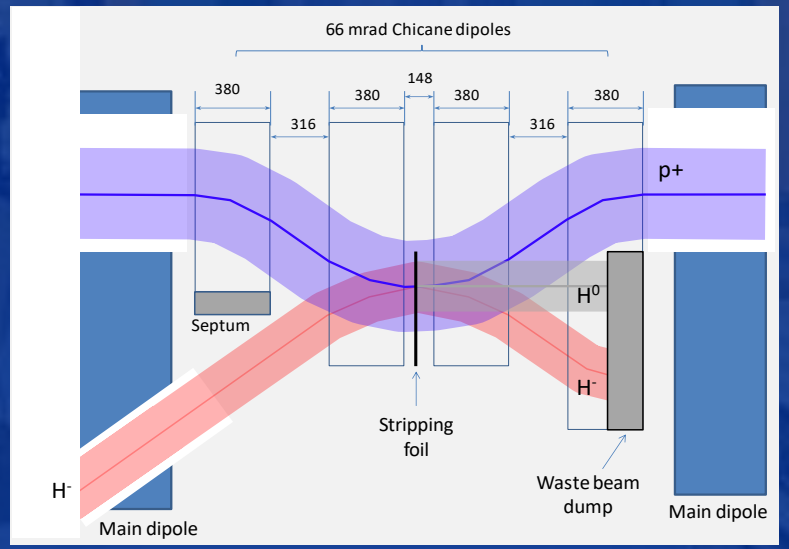


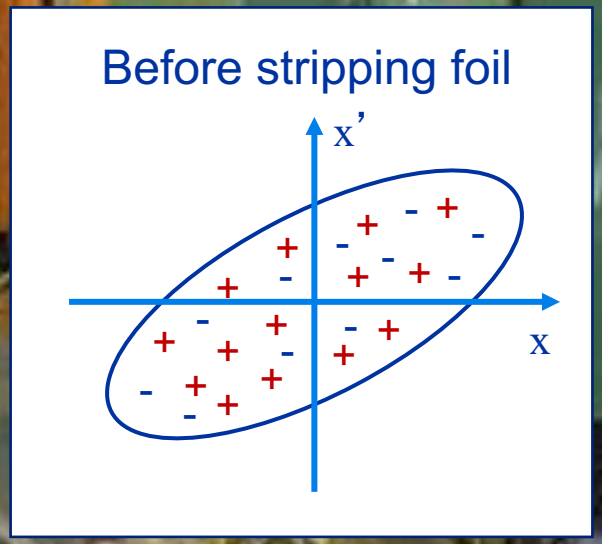
Linac 4

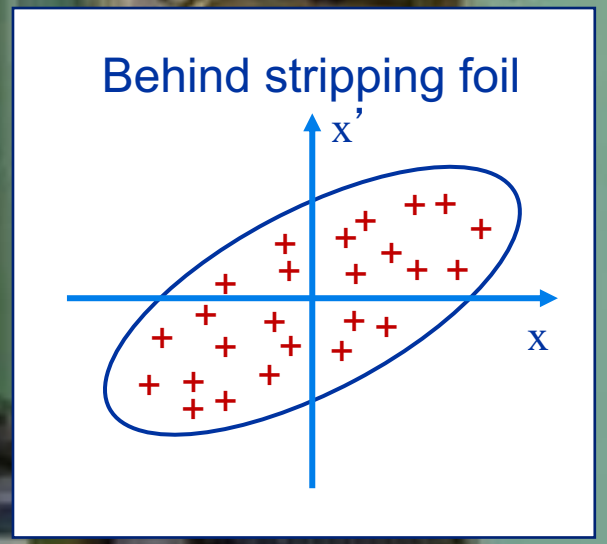
- H^- ion source at 45 keV
- Accelerates beam up to 160 MeV
- The chopping scheme allows removing some of the Linac bunches to make the beam fit into the PS Booster RF buckets
- Pulse rate 1.2 s

PS Booster

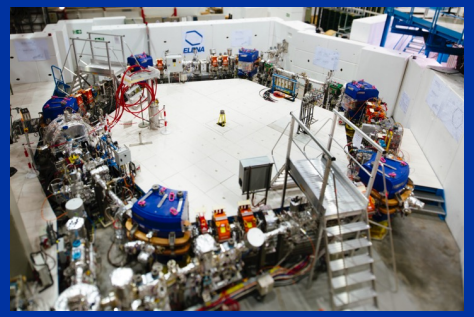
- 1st Synchrotron with 4 superposed rings
- Circumference of 157 m
- Proton energy from 160 MeV to 2 GeV
- Can cycle every 1.2 s
- Each ring will inject over multi-turns, using charge exchange injection

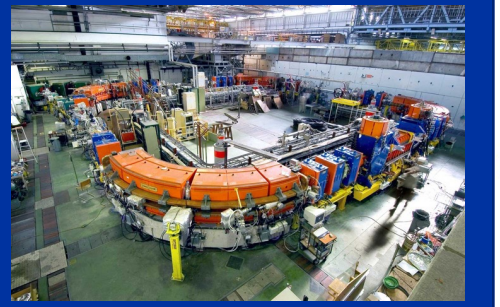


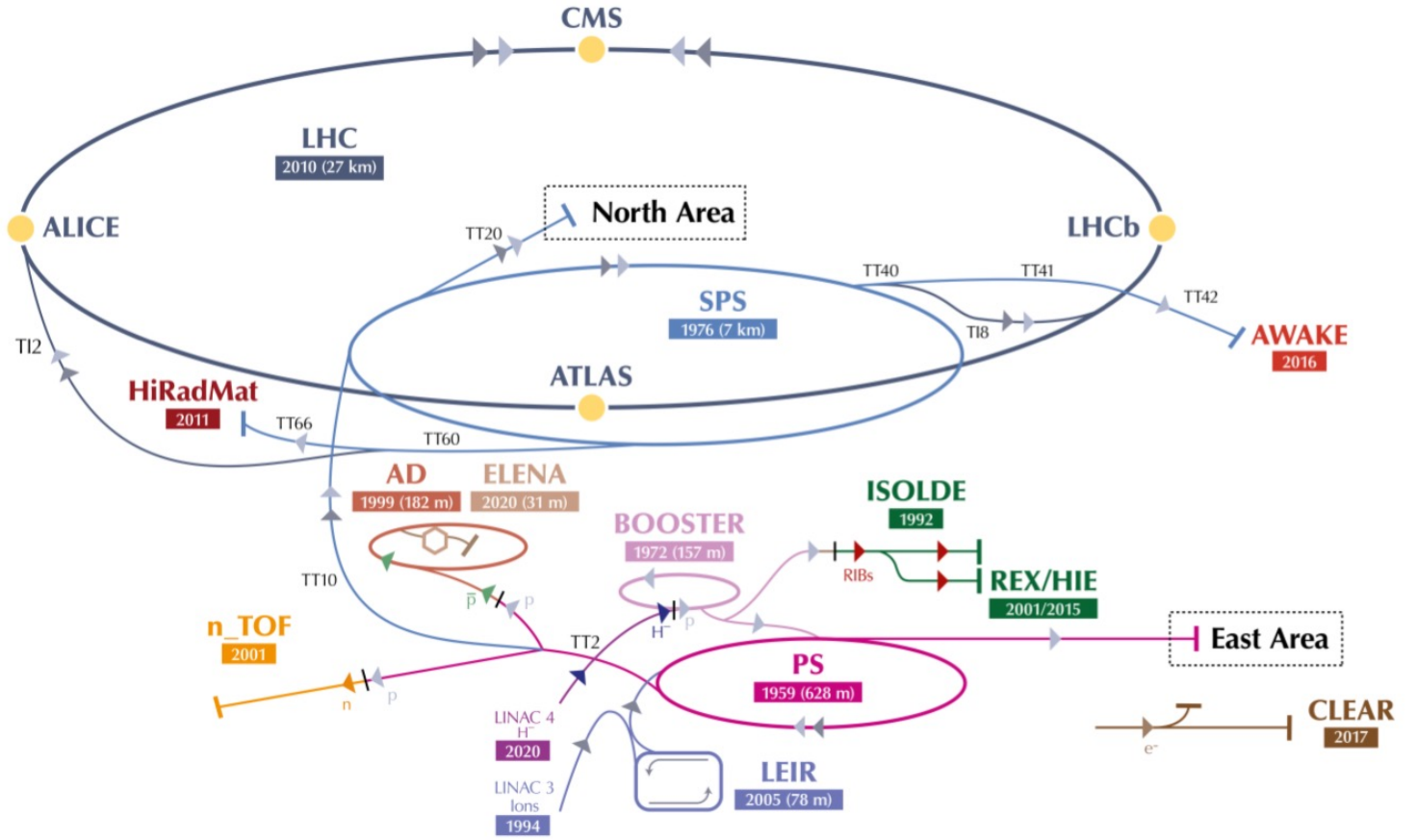




The CERN Accelerator Complex

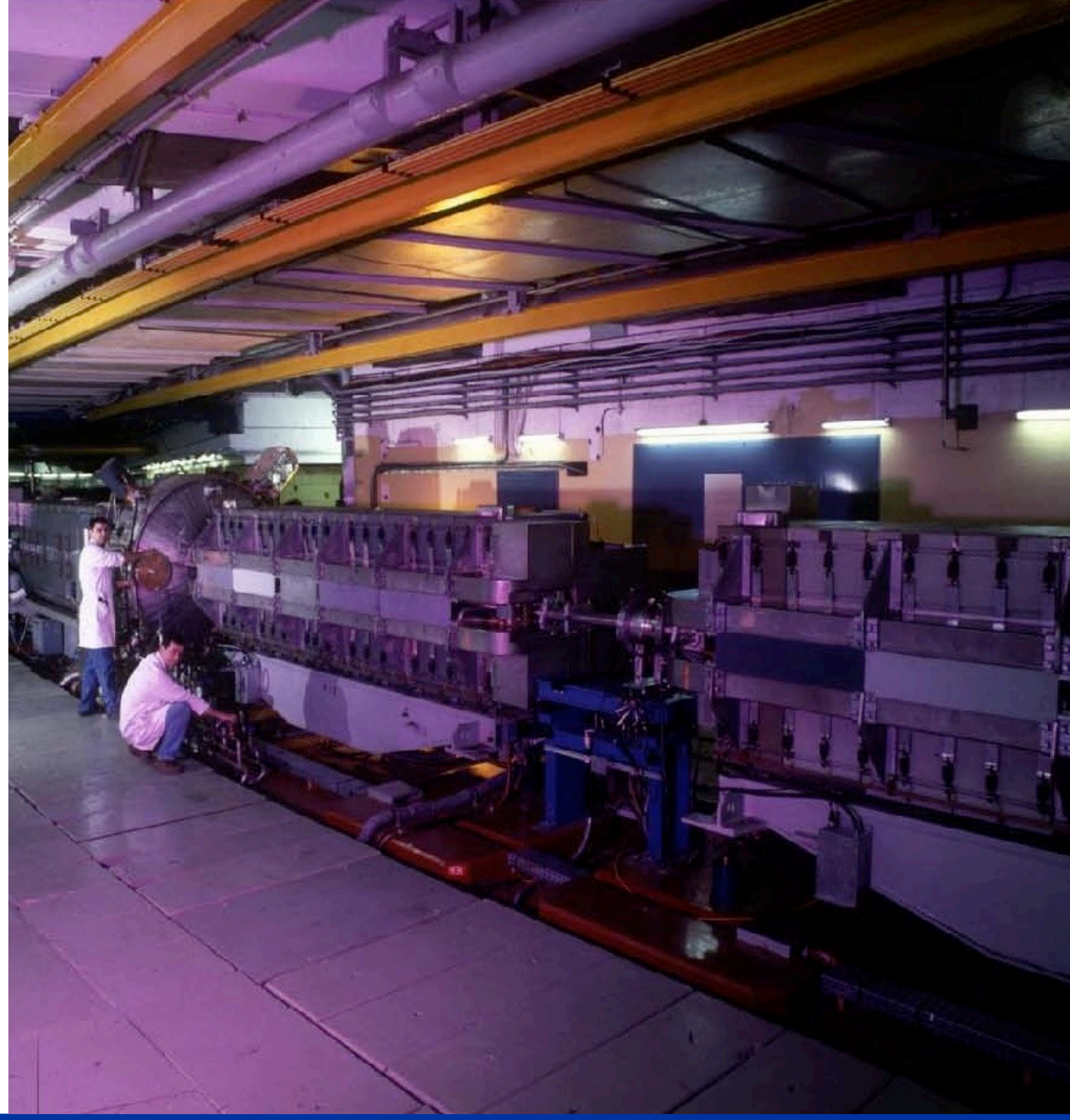






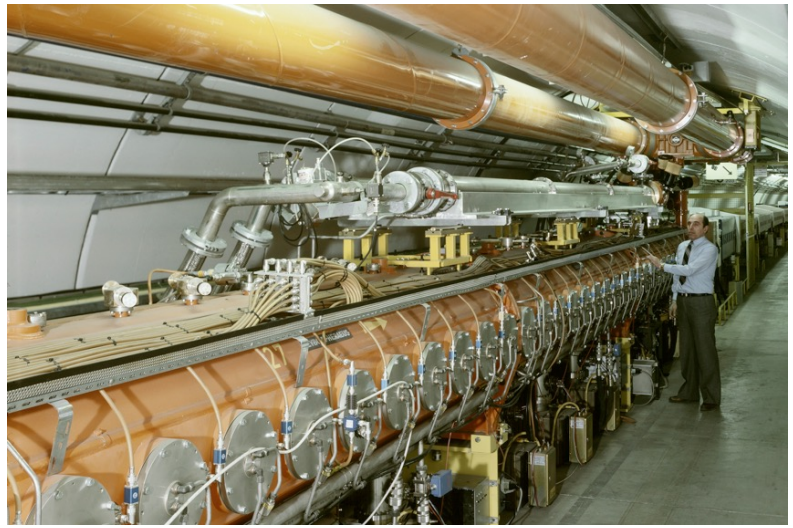
PS

- **The oldest operating synchrotron at CERN**
- **Circumference of 628m**
  - 4 x PSB circumference
- **Increases proton energy from 2 GeV to max. 26 GeV**
- **Cycle length ranges from 1.2s to 3.6s**
- **Many RF systems allow for complex RF gymnastics**
- **Various types of extractions:**
  - Fast extraction
  - Multi-turn extraction (MTE)
  - Slow extraction

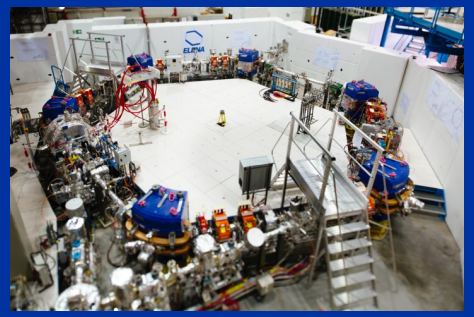


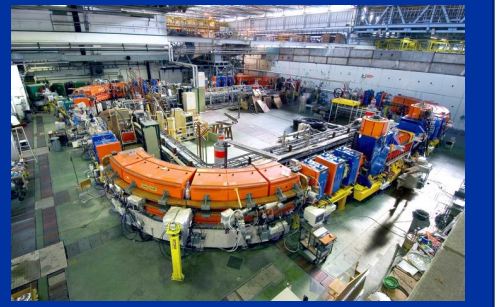
SPS

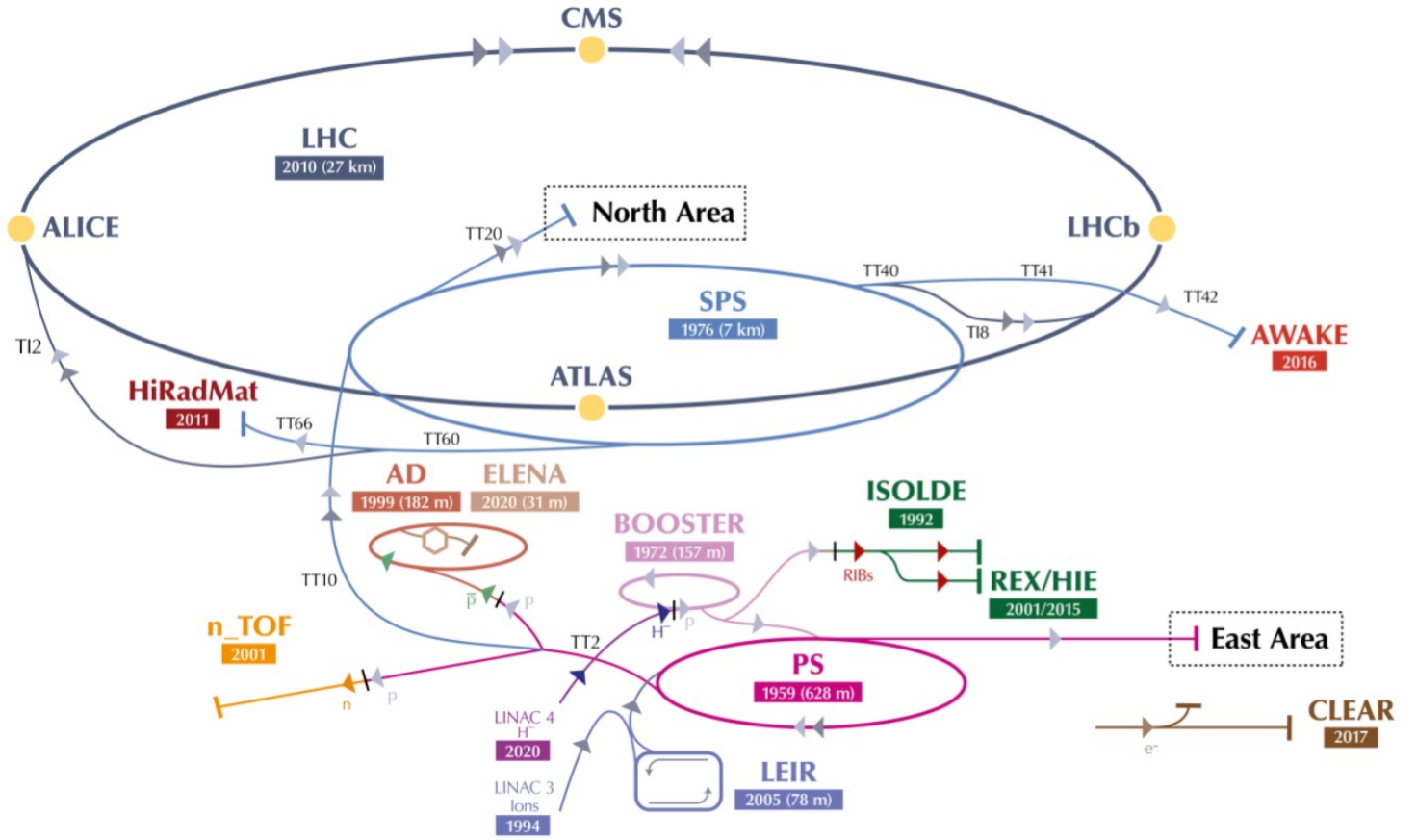
- **The first synchrotron in the chain at ~30m under ground**
- **Circumference of 6.9 km**
  - 11 x PS circumference
- **Increases proton beam energy up to 450 GeV with up to ~5x10^{13} protons per cycle**
- **Provides slow extracted beam to the North Area**
- **Provides fast extracted beam to LHC, AWAKE and HiRadMat**



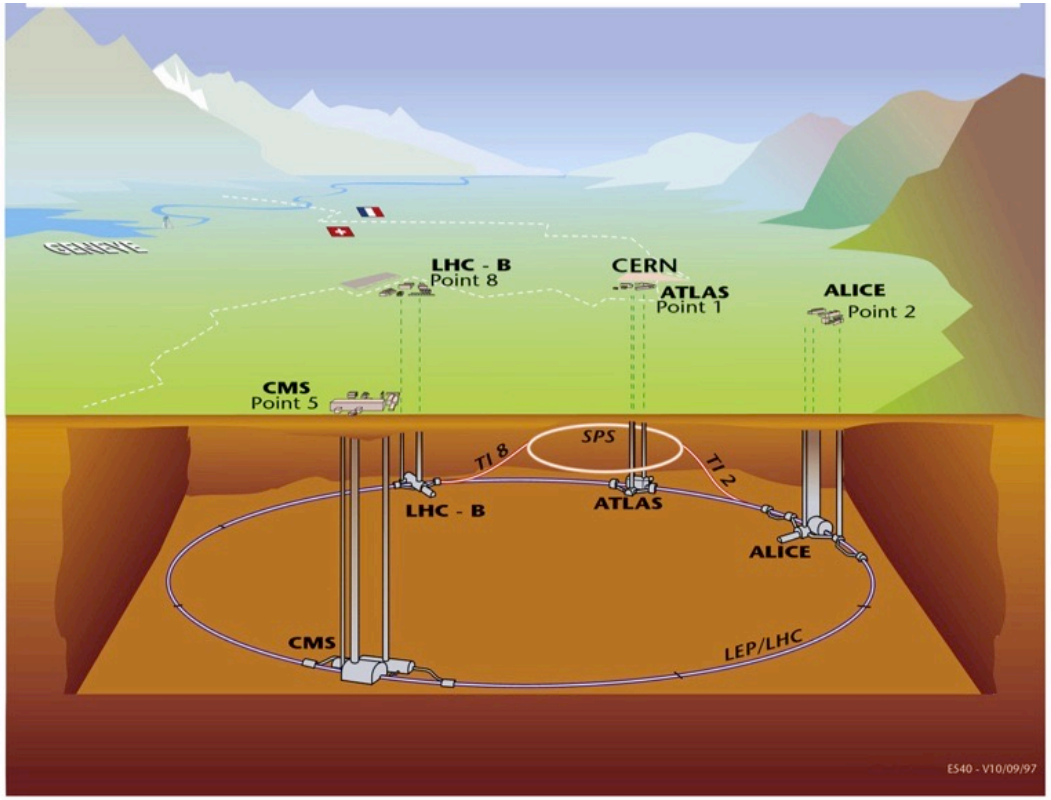
The CERN Accelerator Complex

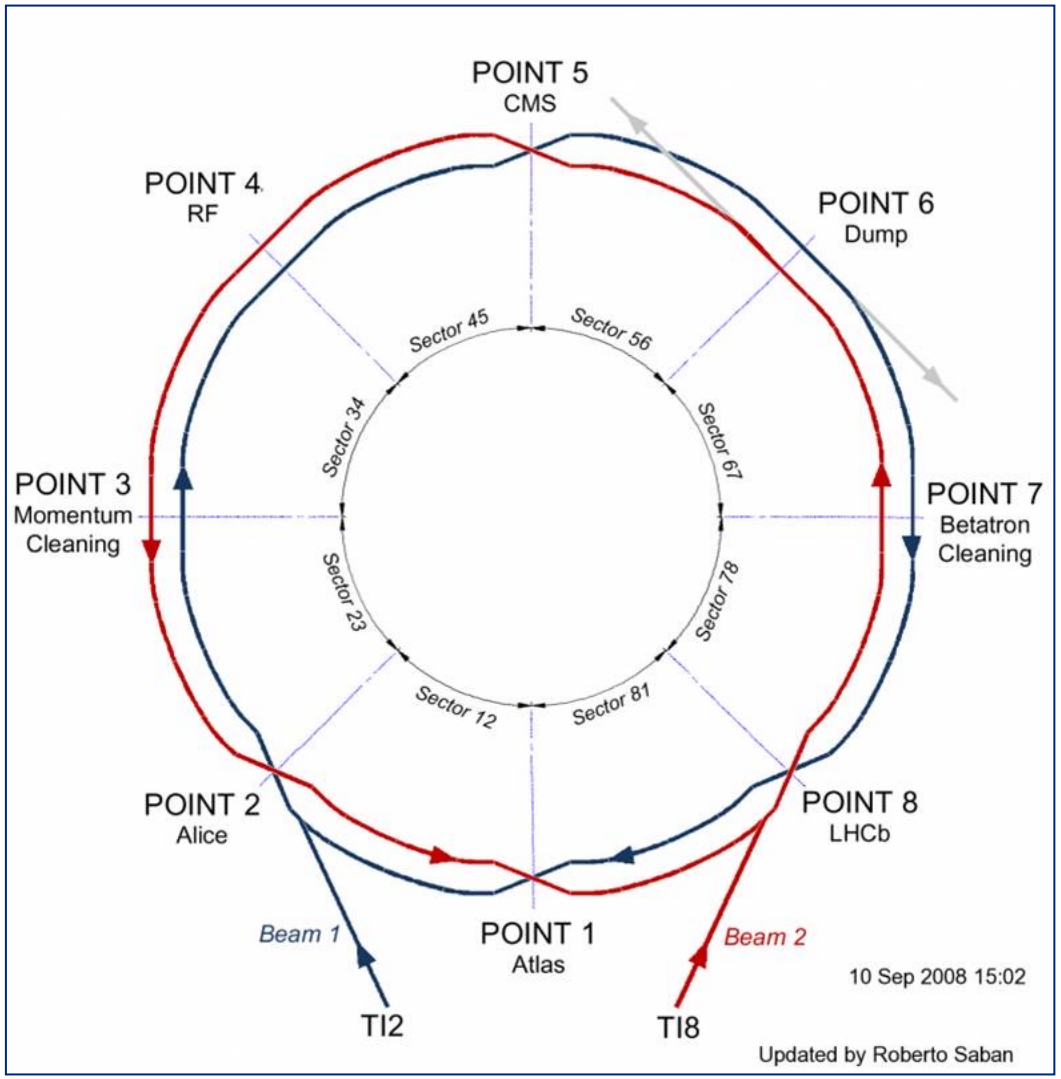




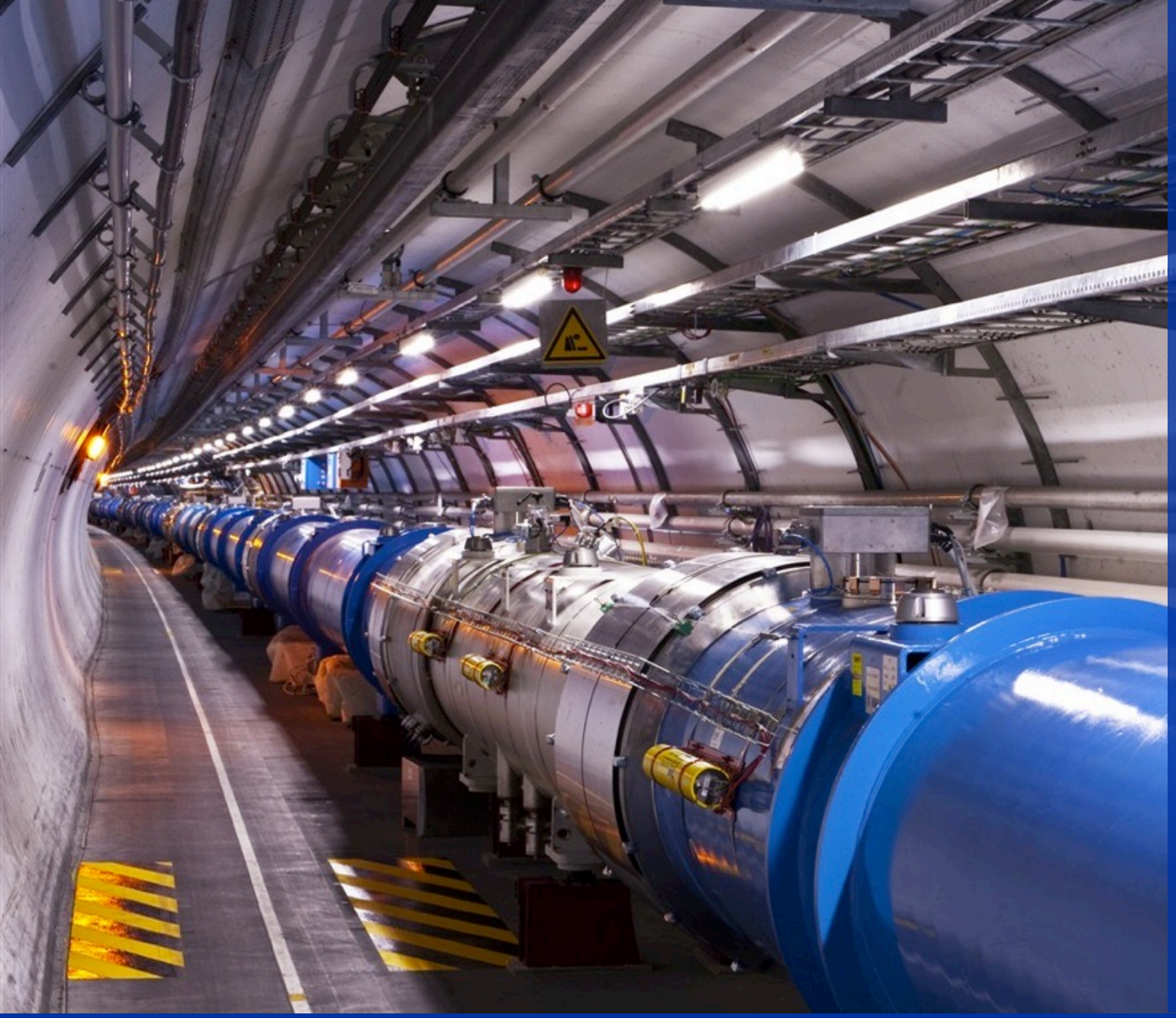


LHC





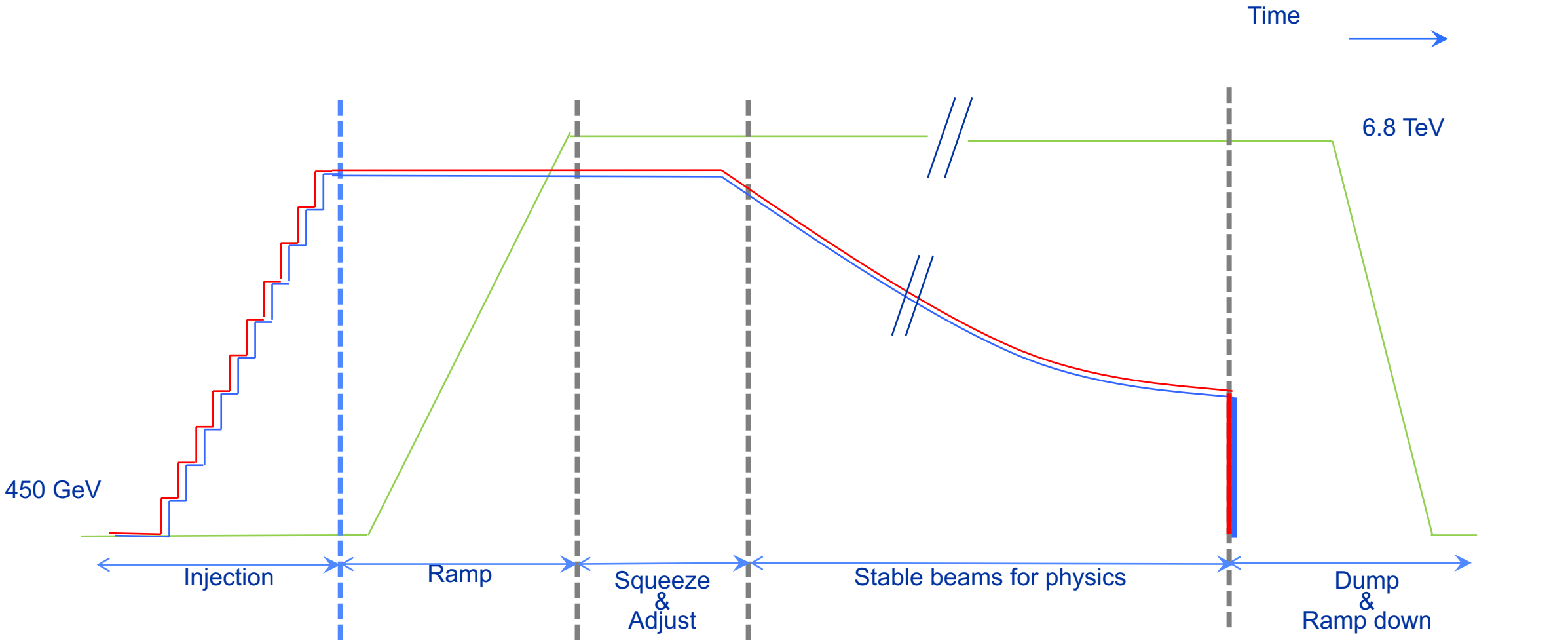
- Situated on average ~100 m under ground
- Four major experiments
- Circumference 26.7 km
- Two separate beam pipes going through the same cold mass 19.4 cm apart
- 150 tons of liquid helium to keep the magnets cold and superconducting



LHC

- 1232 main dipoles of 15 m each that deviate the beams around the 27 km circumference
- 858 main quadrupoles that keep the beam focused
- 6000 corrector magnets to preserve the beam quality
- Main magnets use superconducting cables (Cu-clad Nb-Ti)
- 12’000 A provides a nominal field of 8.33 Tesla
- Operating in superfluid helium at 1.9K

The LHC Cycle



Filling the LHC & Satisfying Fixed Target users