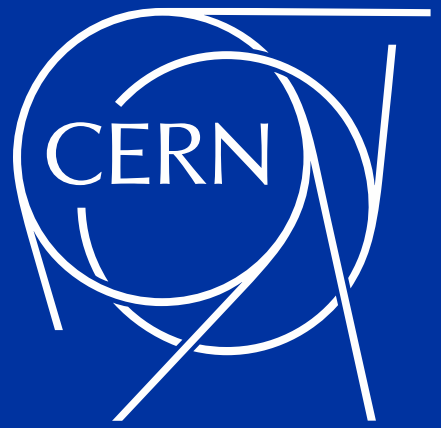
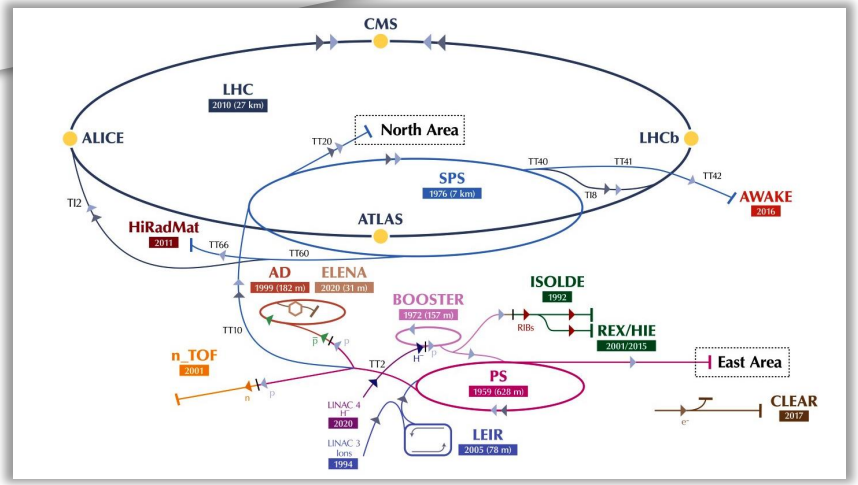
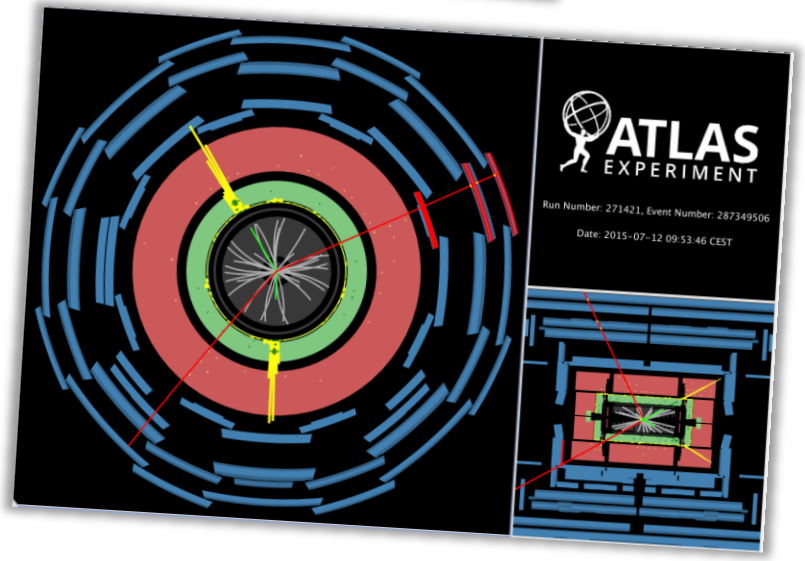


A hands-on introduction to particle detectors

Julia Woithe | DeTP | 10 Oktober 2023

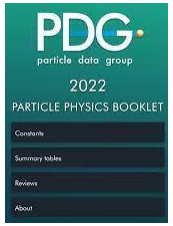
PARTICLE IDENTITIES

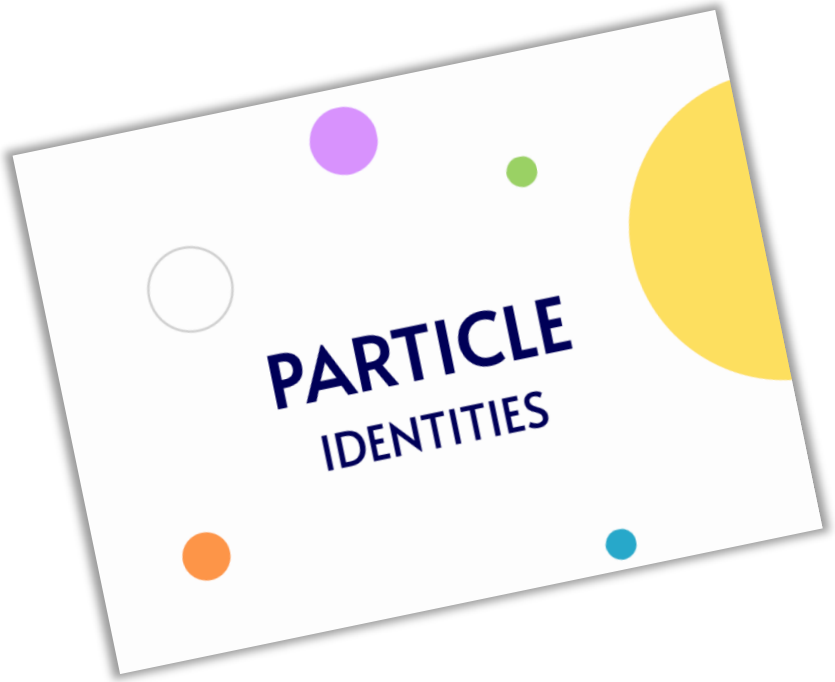




Welche Teilchen lassen sich detektieren?

cern.ch/identities

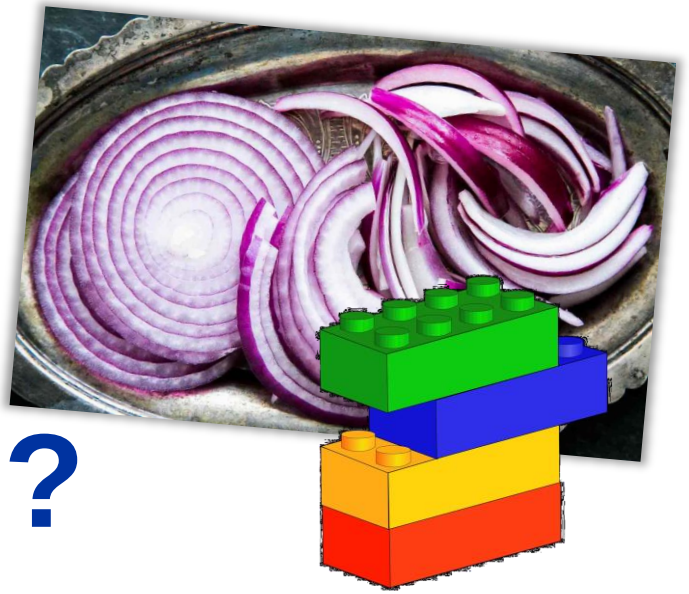




https://pdg.lbl.gov

Welche Komponenten braucht man für einen Vielzweck-Detektor am LHC?

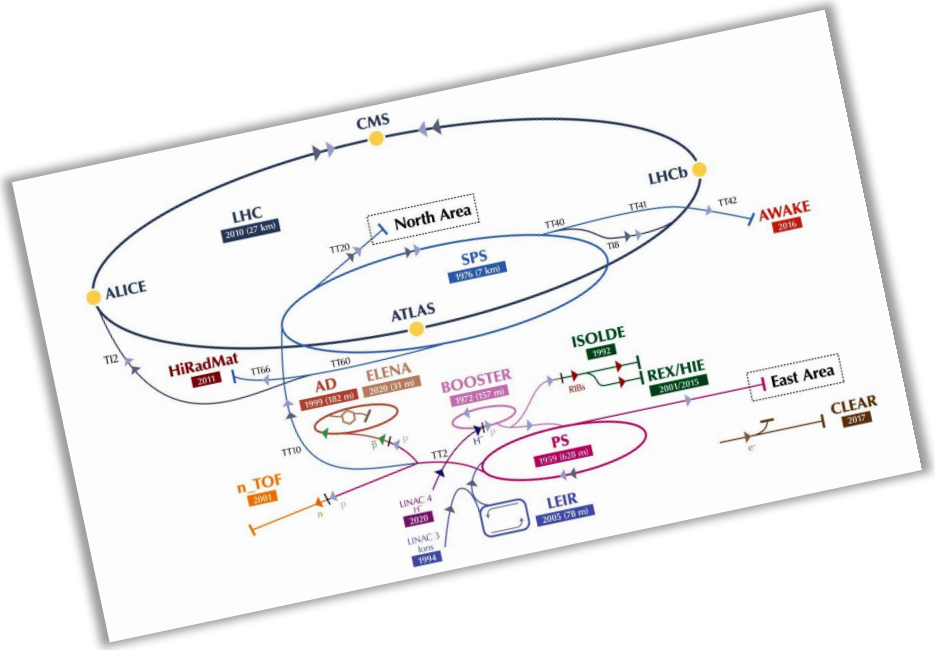
Test mit LEGO



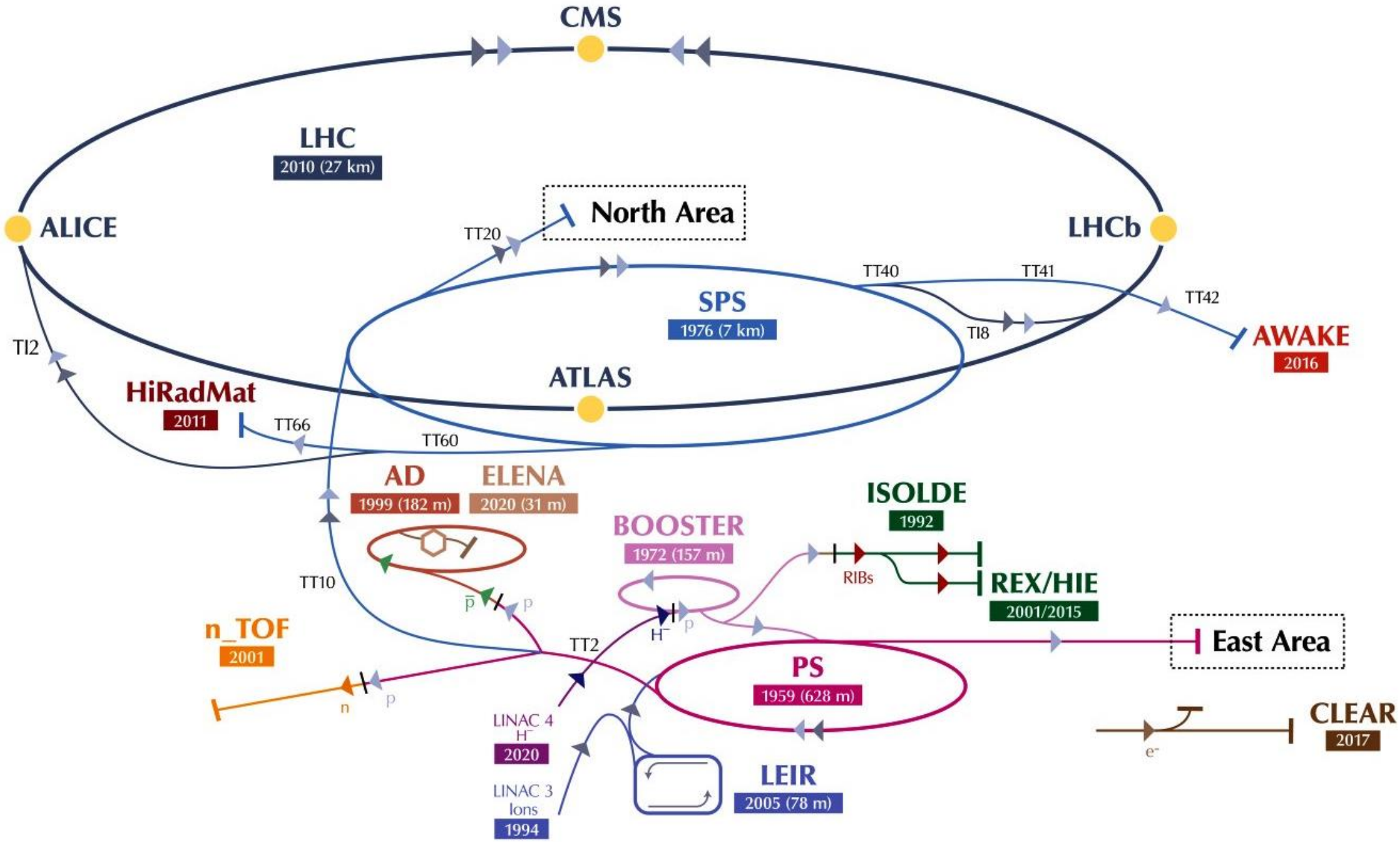
Time for a quiz! Which detector system is doing what?

Electromagnet	☐	☐ Control the magnetic field & support the detector
Magnet Return Yoke	☐	☐ Bend the path of electrically charged particles
Inner Tracking System	☐	☐ Detect muons
Calorimeters	☐	☐ Track the paths of electrically charged particles
Muon system	☐	☐ Measure the energy of particles

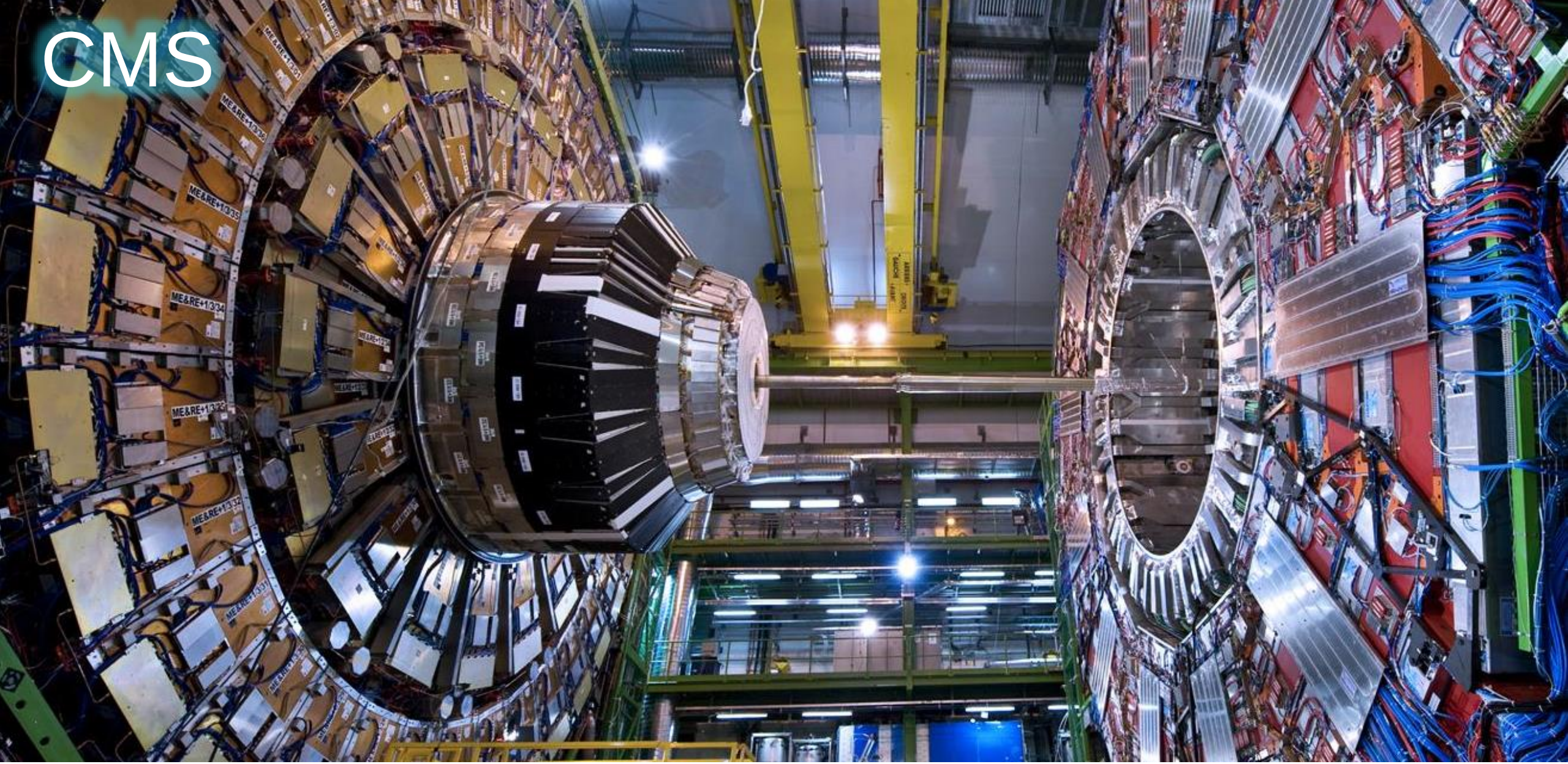
Teilchendetektoren am LHC

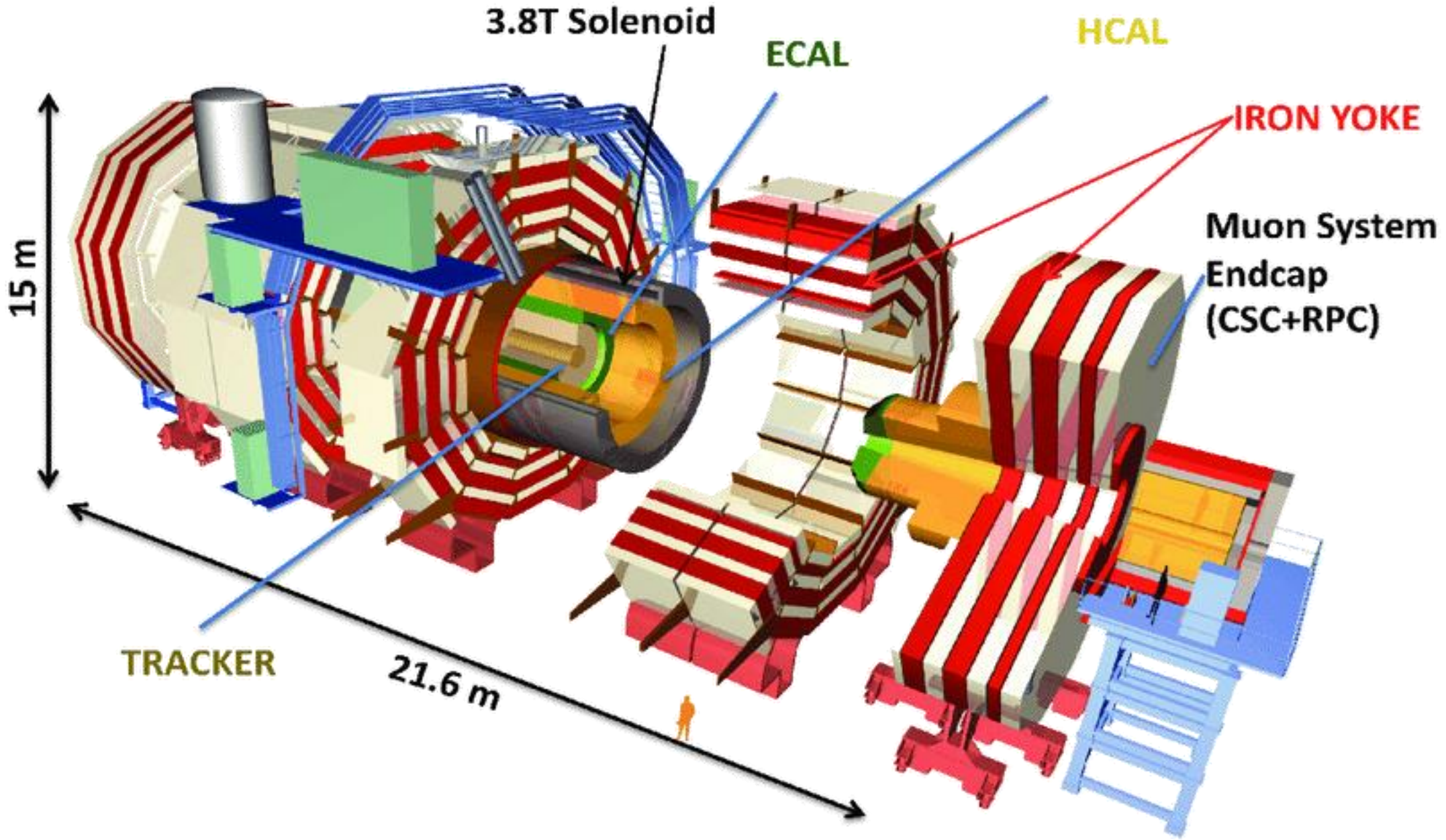


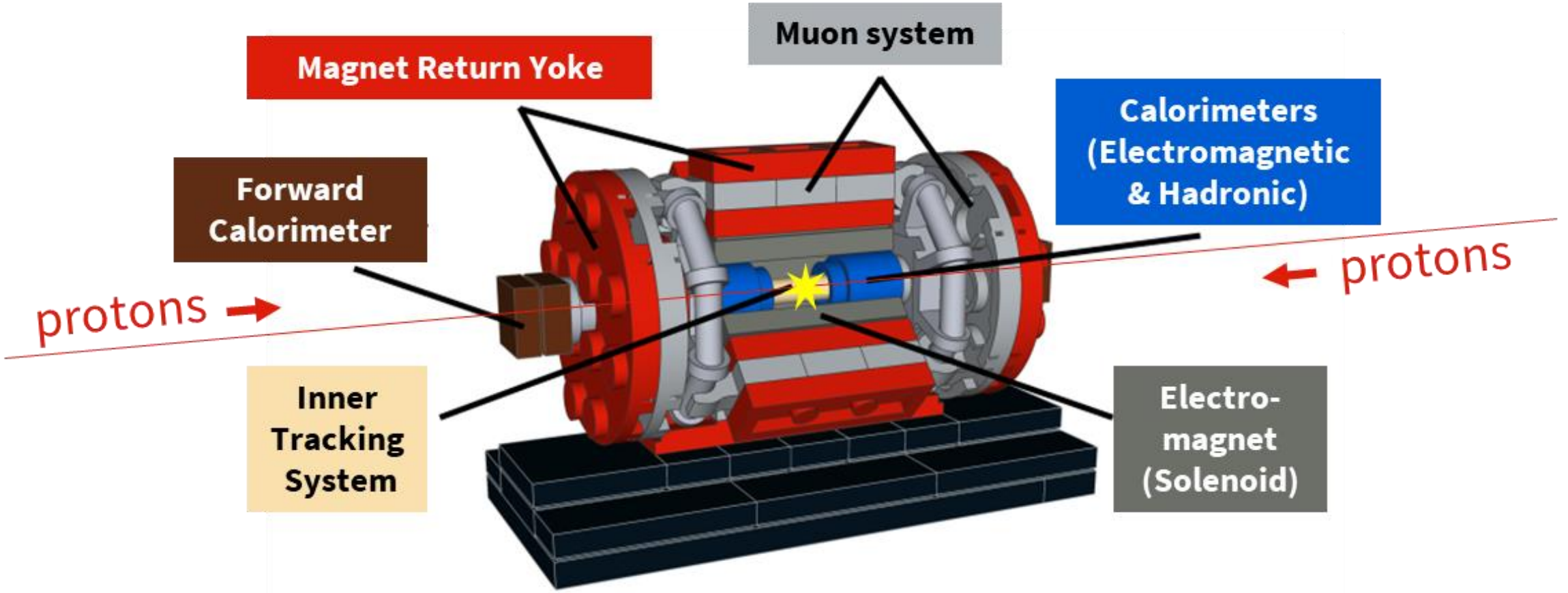

LHCb
ATLAS
CERN Meyrin
CERN Prévessin
PS 628 m
SPS 7 km
Suisse
France
ALICE
CMS
LHC 27 km


CMS
LHC
2010 (27 km)
ALICE
LHCb
North Area
TT20
TT40
TT41
TT42
SPS
1976 (7 km)
TI8
AWAKE
2016
TI2
ATLAS
HiRadMat
2011
TT66
TT60
AD
1999 (182 m)
ELENA
2020 (31 m)
ISOLDE
1992
BOOSTER
1972 (157 m)
RIBs
REX/HIE
2001/2015
TT10
n_TOF
2001
TT2
East Area
PS
1959 (628 m)
LINAC 4
H⁻
2020
CLEAR
2017
LINAC 3
Ions
1994
LEIR
2005 (78 m)

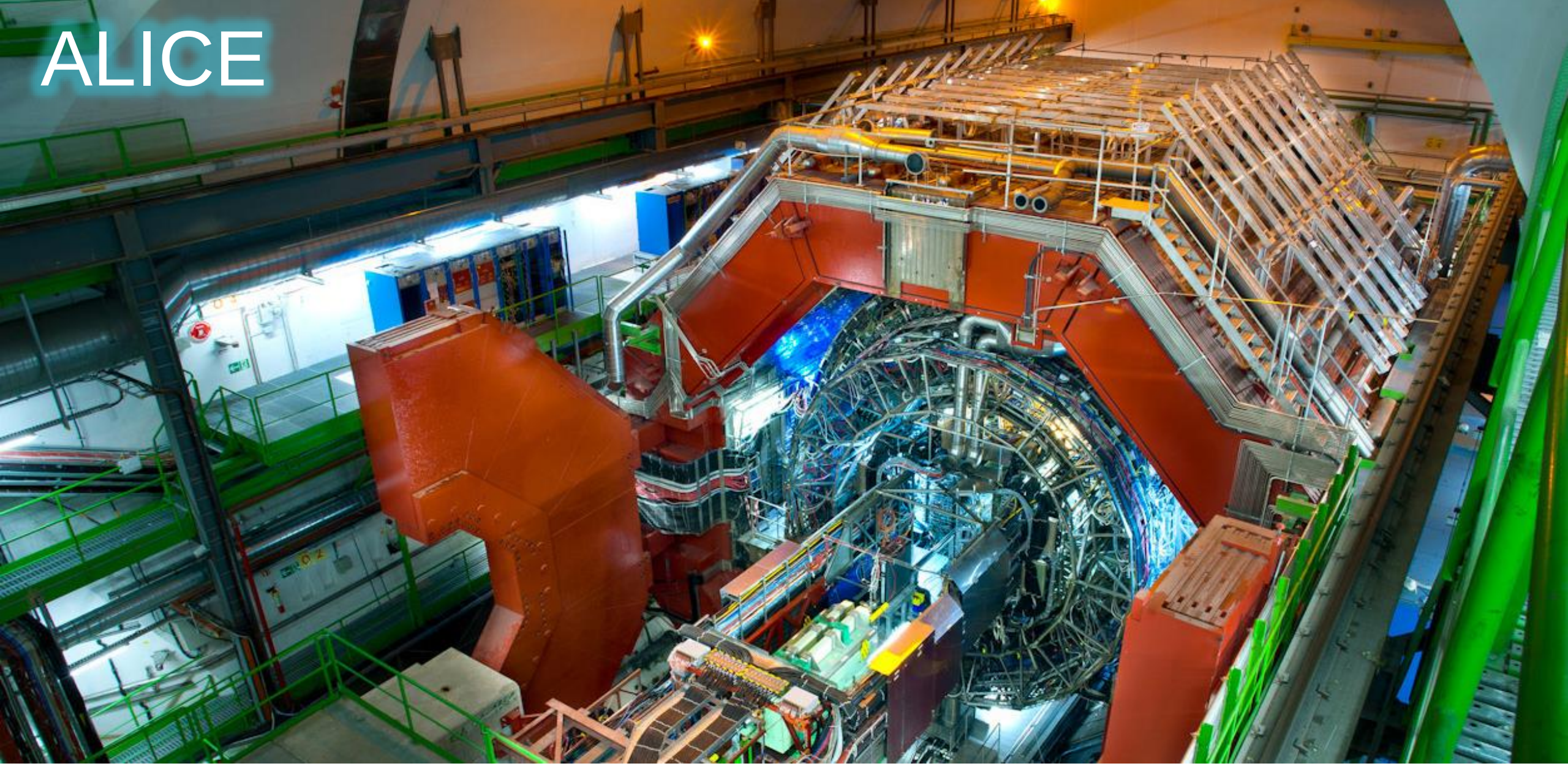
CMS

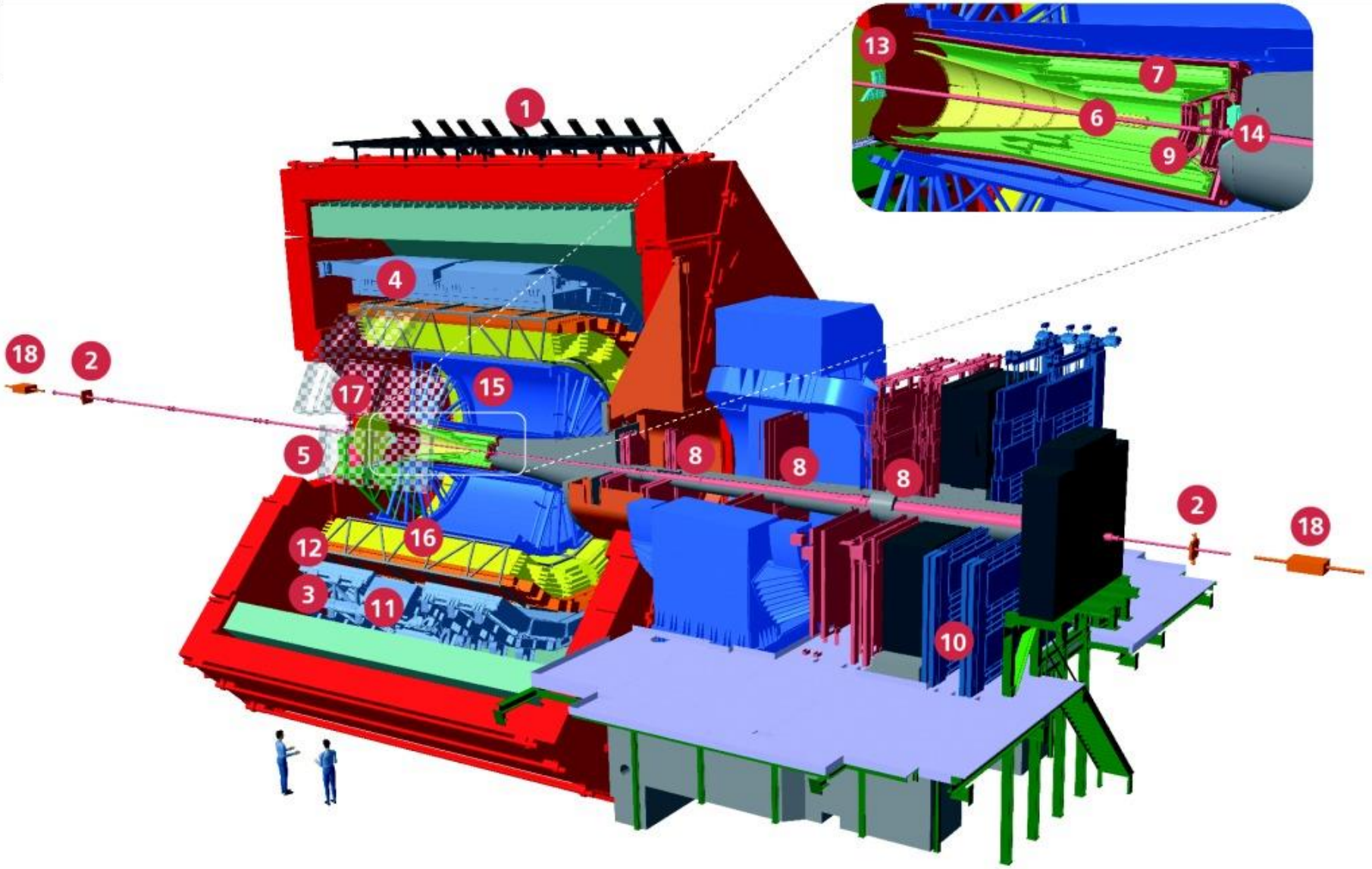



3.8T Solenoid
ECAL
HCAL
IRON YOKE
Muon System
Endcap
(CSC+RPC)
15 m
TRACKER
21.6 m


Magnet Return Yoke
Muon system
Calorimeters (Electromagnetic & Hadronic)
Forward Calorimeter
protons
protons
Inner Tracking System
Electro-magnet (Solenoid)

ALICE



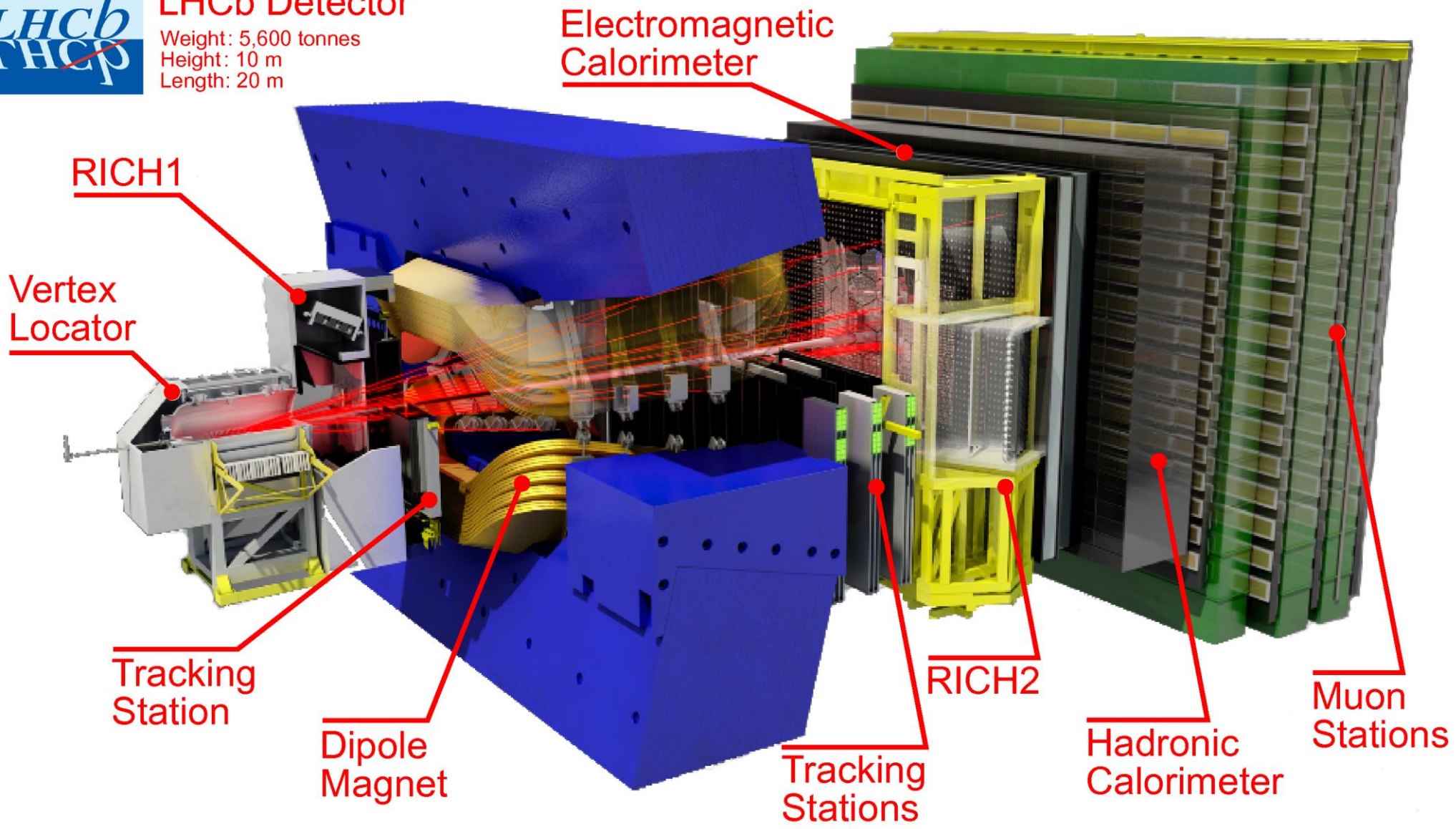


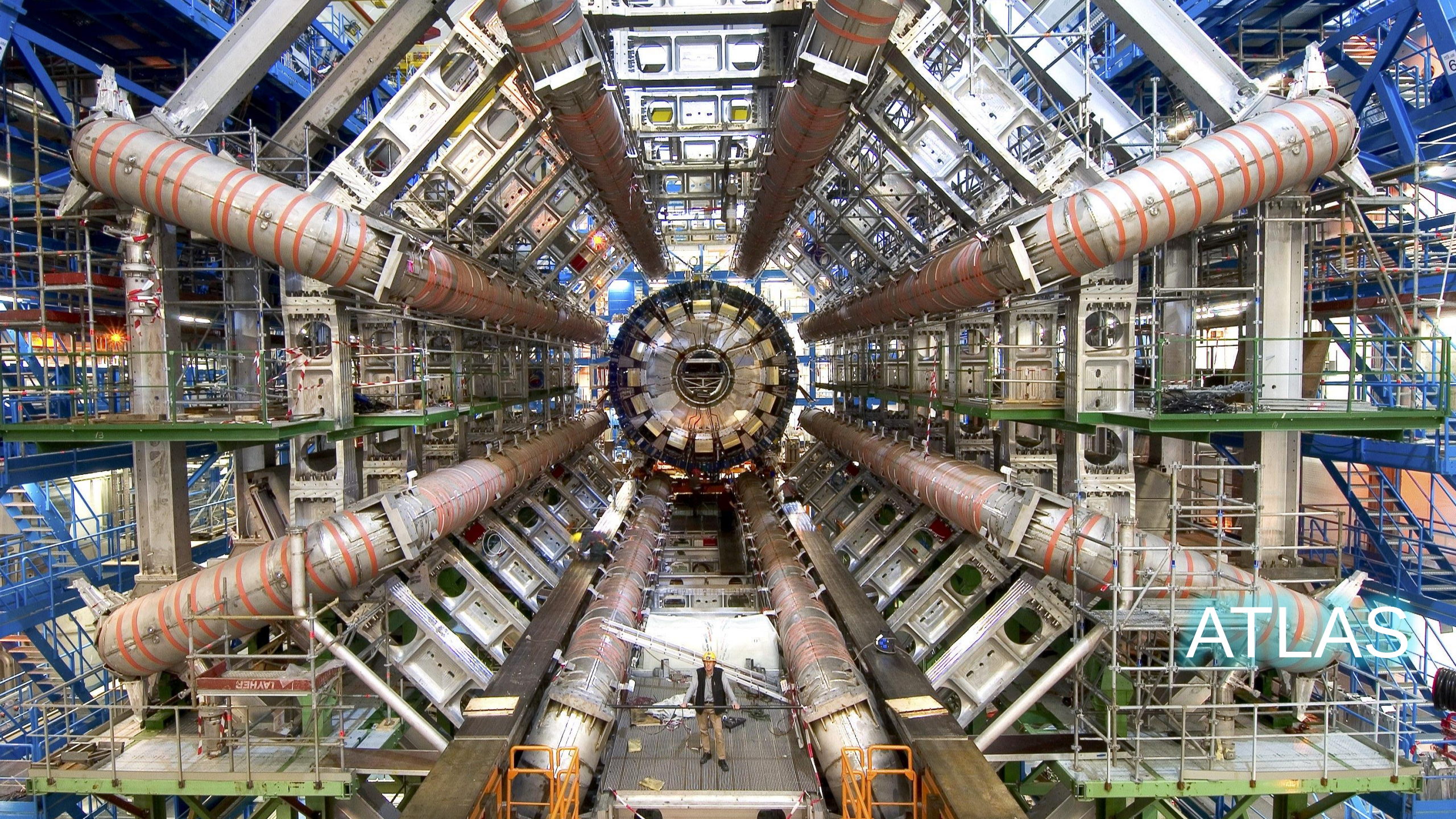
1. **ACORDE** | ALICE Cosmic Rays Detector
2. **AD** | ALICE Diffractive Detector
3. **DCal** | Di-jet Calorimeter
4. **EMCal** | Electromagnetic Calorimeter
5. **HMPID** | High Momentum Particle Identification Detector
6. **ITS-IB** | Inner Tracking System - Inner Barrel
7. **ITS-OB** | Inner Tracking System - Outer Barrel
8. **MCH** | Muon Tracking Chambers
9. **MFT** | Muon Forward Tracker
10. **MID** | Muon Identifier
11. **PHOS / CPV** | Photon Spectrometer
12. **TOF** | Time Of Flight
13. **T0+A** | Tzero + A
14. **T0+C** | Tzero + C
15. **TPC** | Time Projection Chamber
16. **TRD** | Transition Radiation Detector
17. **V0+** | Vzero + Detector
18. **ZDC** | Zero Degree Calorimeter

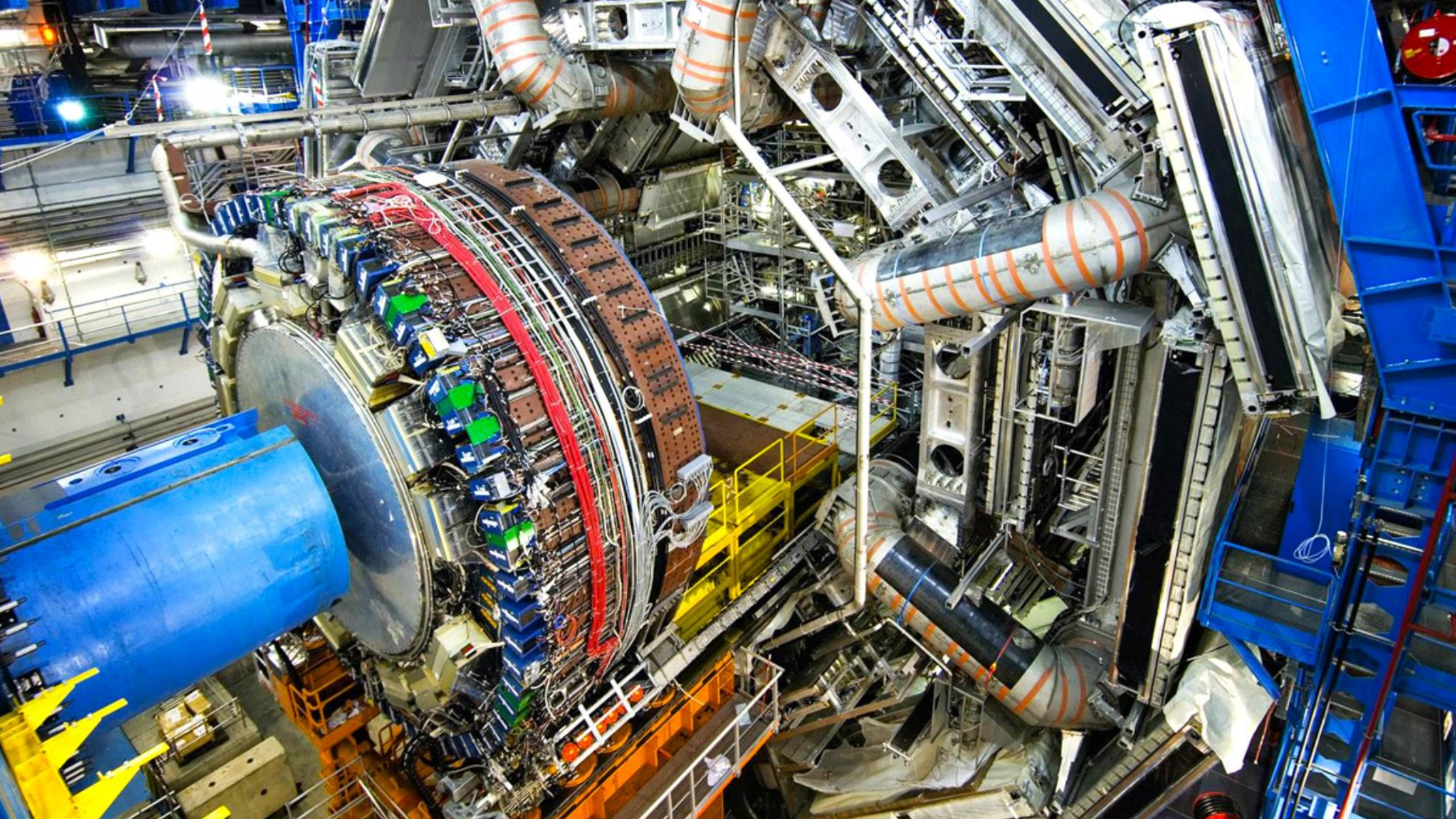

LHCb

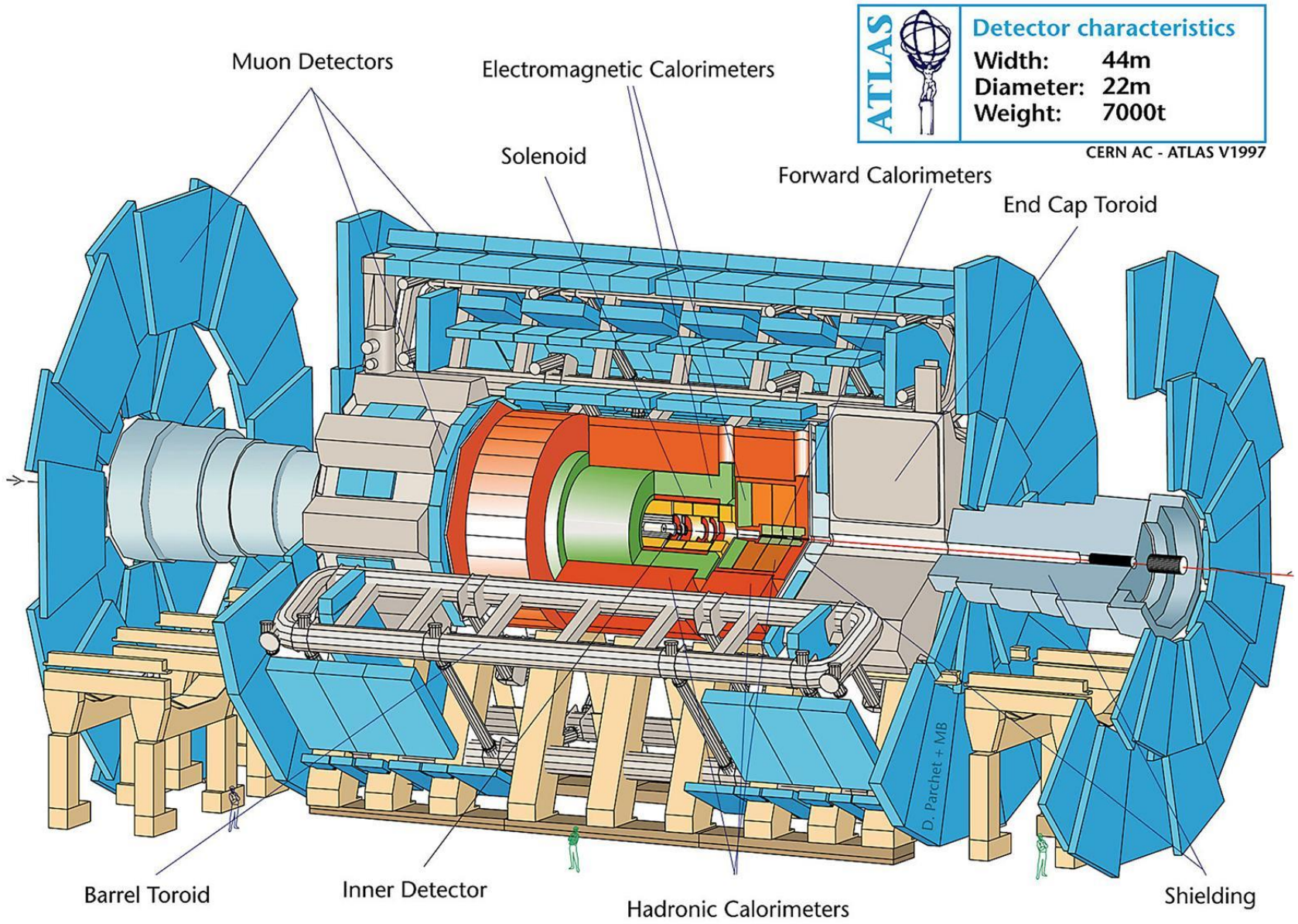
LHCb Detector

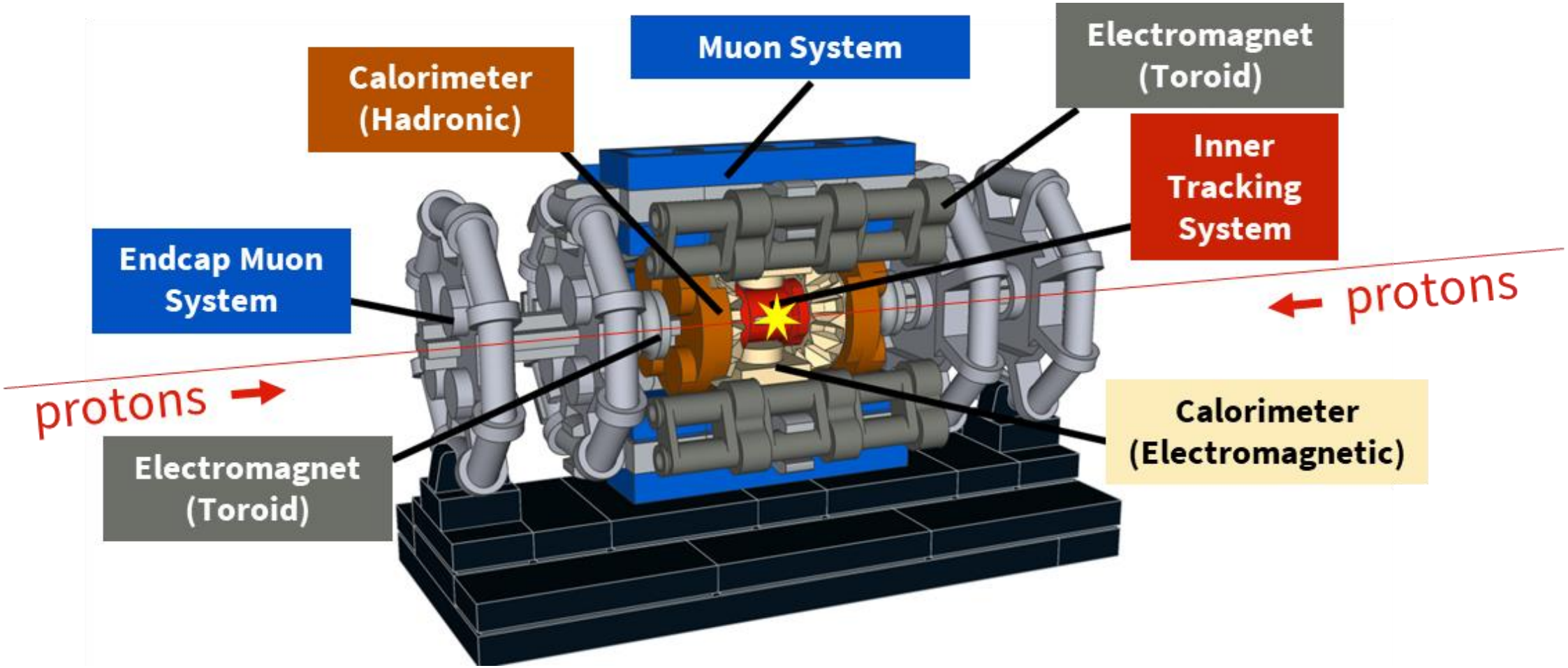
Weight: 5,600 tonnes
Height: 10 m
Length: 20 m

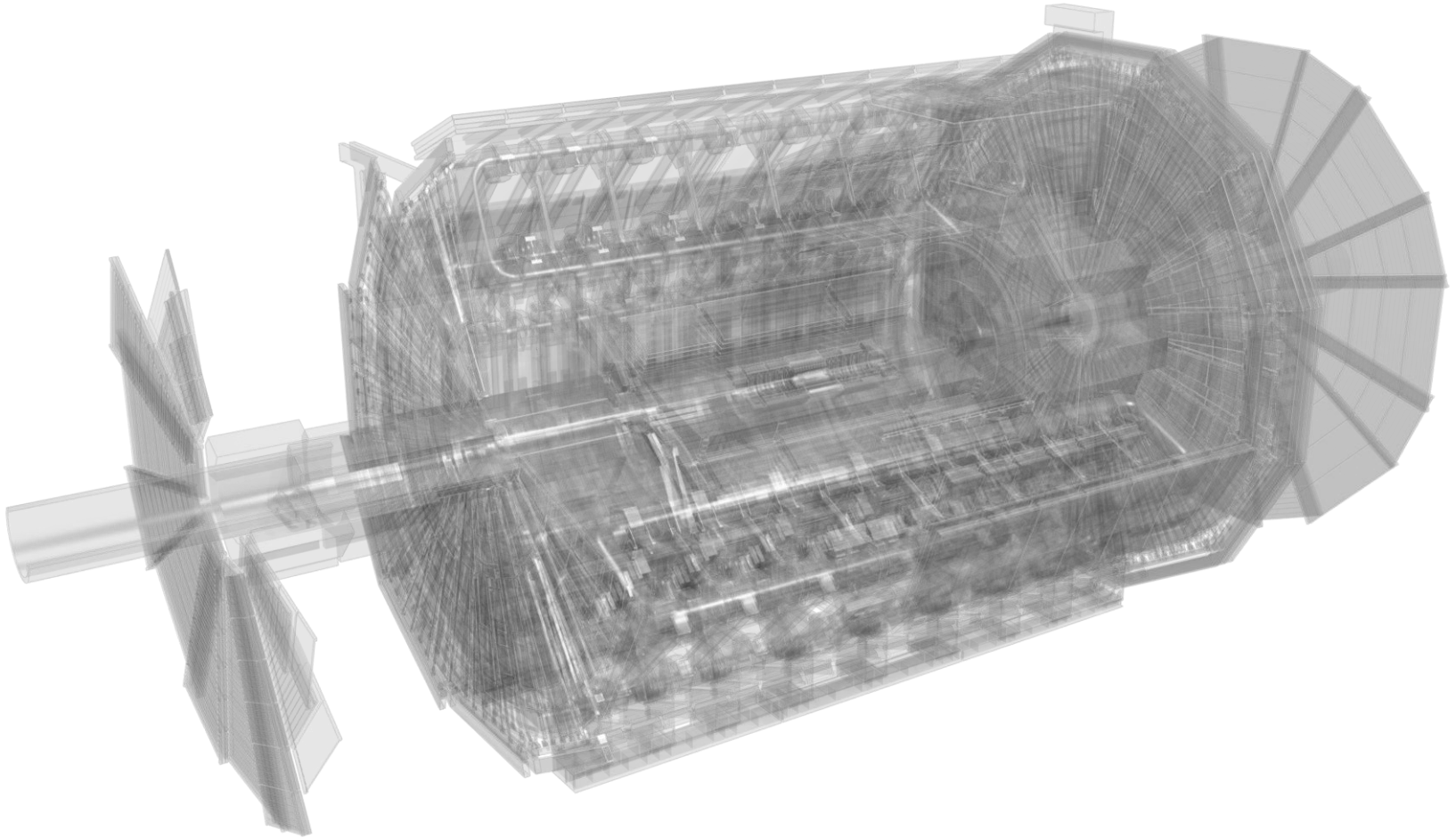



ATLAS

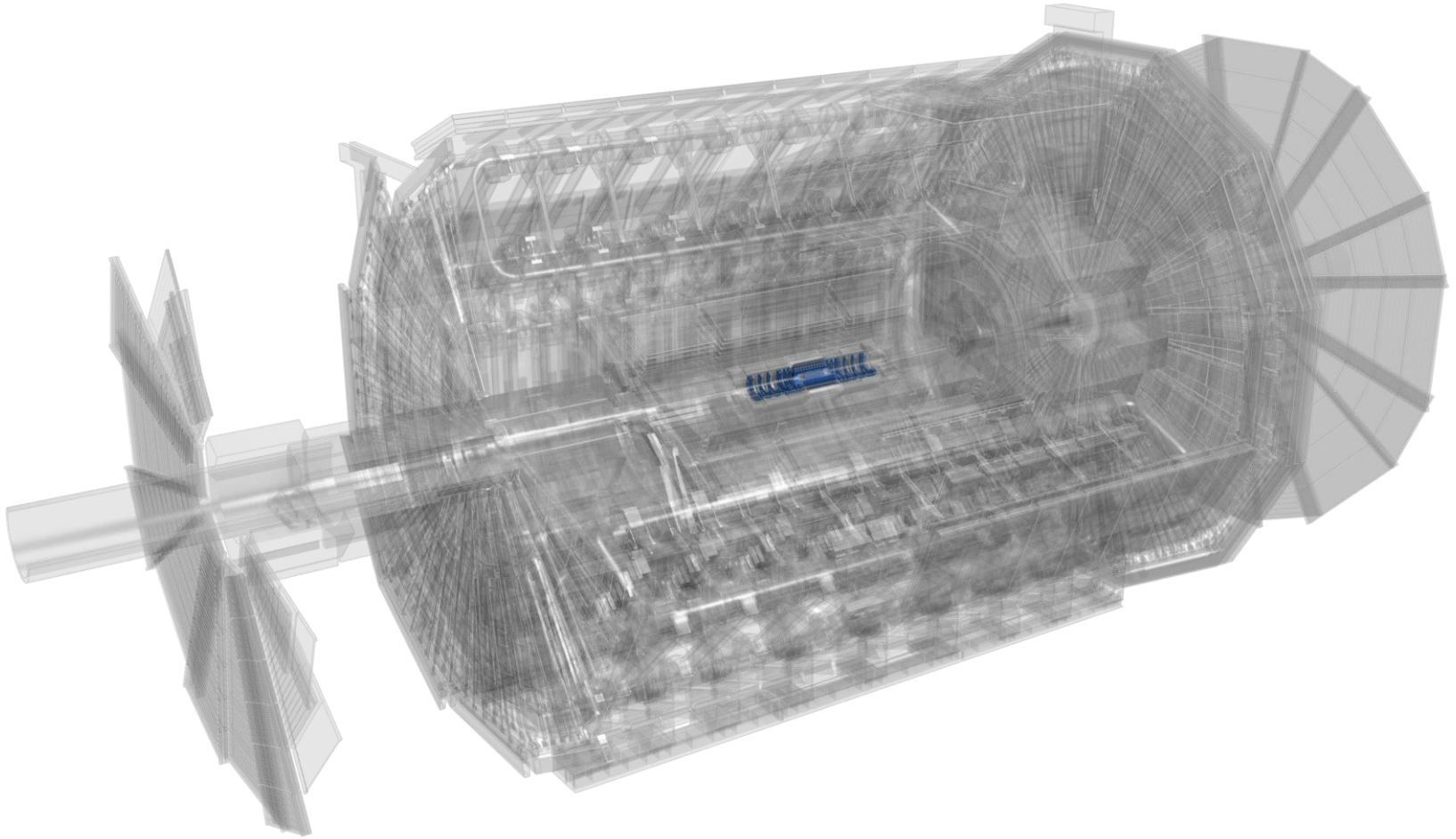



ATLAS
Detector characteristics
Width: 44m
Diameter: 22m
Weight: 7000t
CERN AC - ATLAS V1997
Muon Detectors
Electromagnetic Calorimeters
Solenoid
Forward Calorimeters
End Cap Toroid
Barrel Toroid
Inner Detector
Hadronic Calorimeters
Shielding
D. Parchet + MB

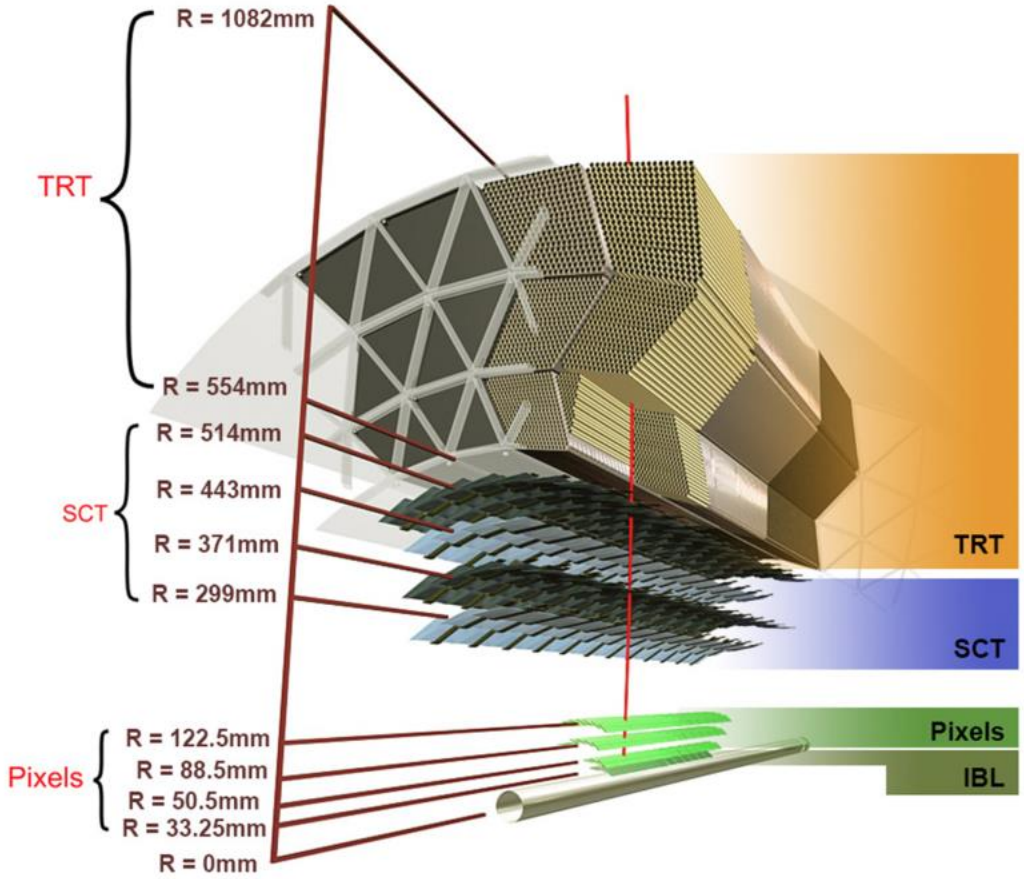

Muon System
Calorimeter (Hadronic)
Electromagnet (Toroid)
Inner Tracking System
Endcap Muon System
protons
protons
Calorimeter (Electromagnetic)
Electromagnet (Toroid)

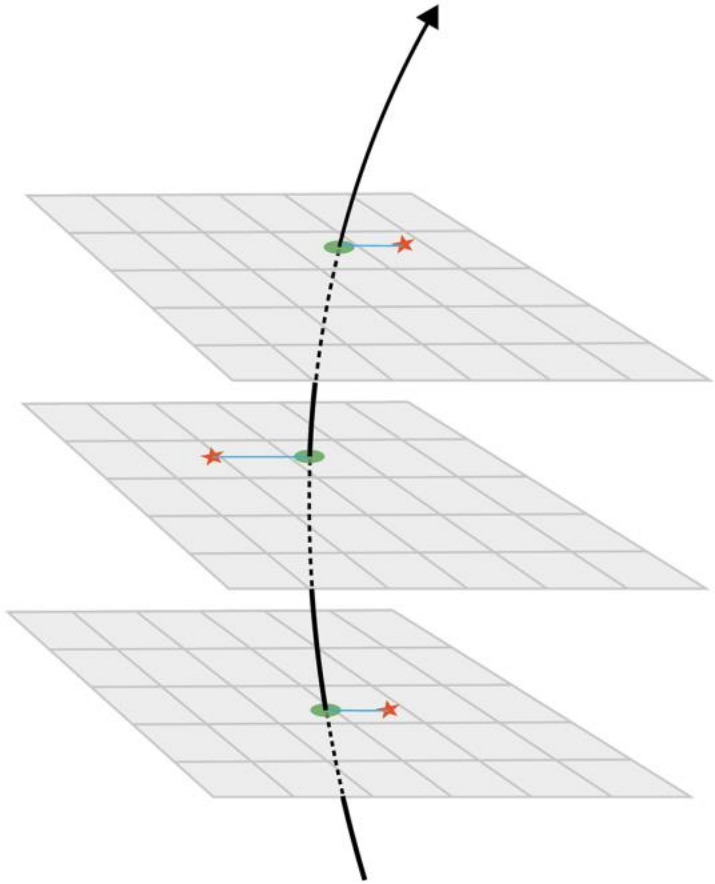


Innerer Spurdetektor

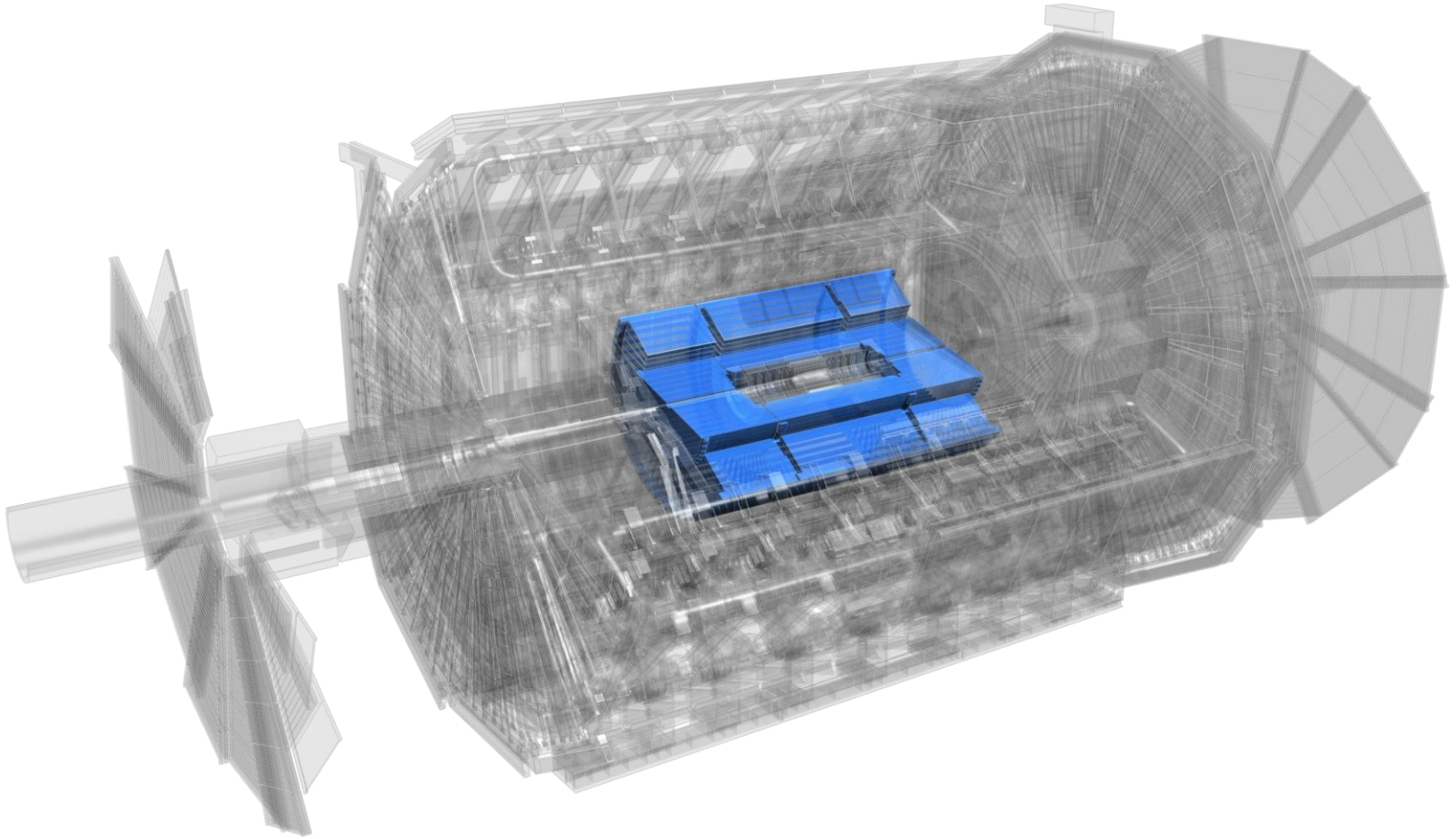


Innerer Spurdetektor

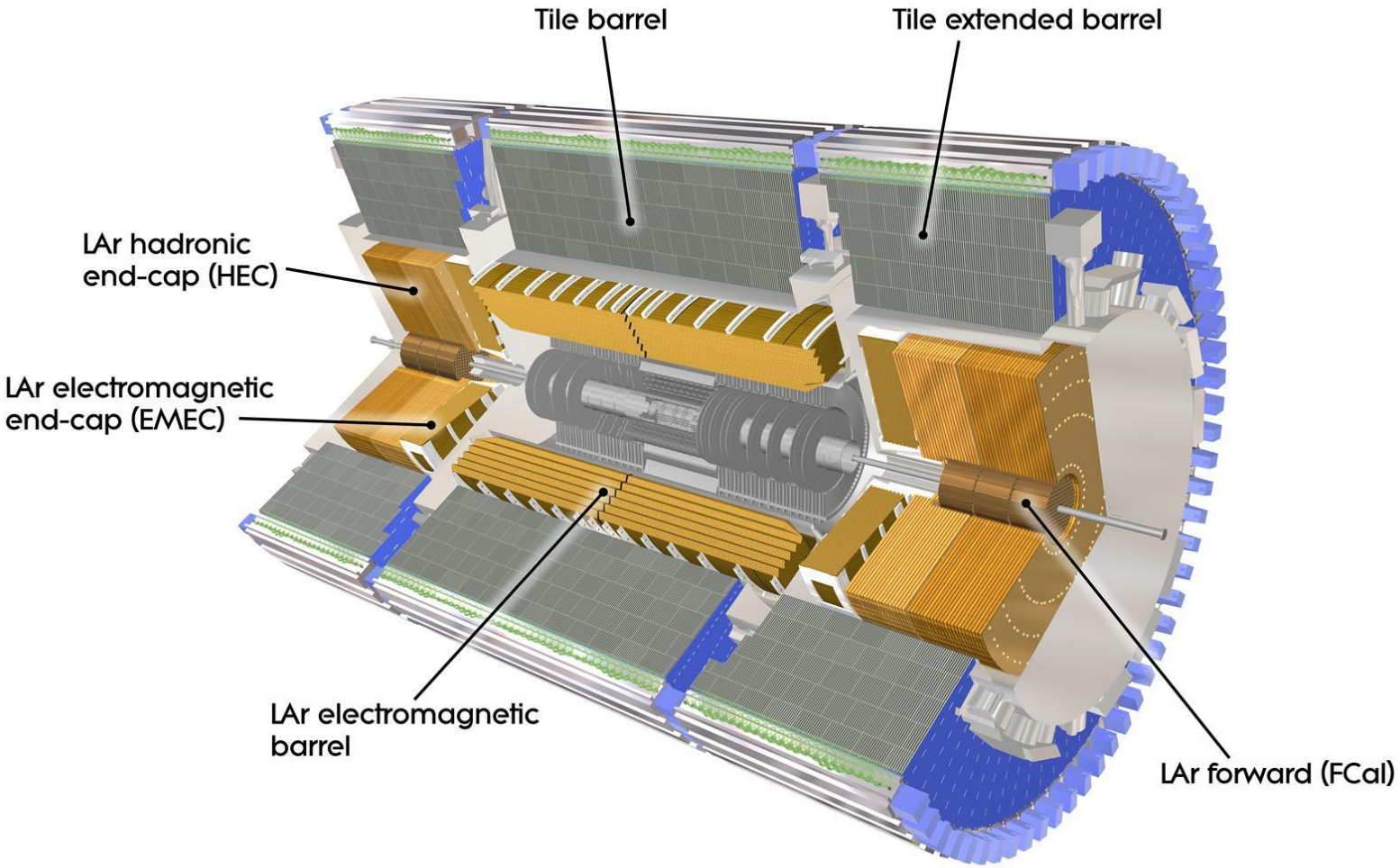




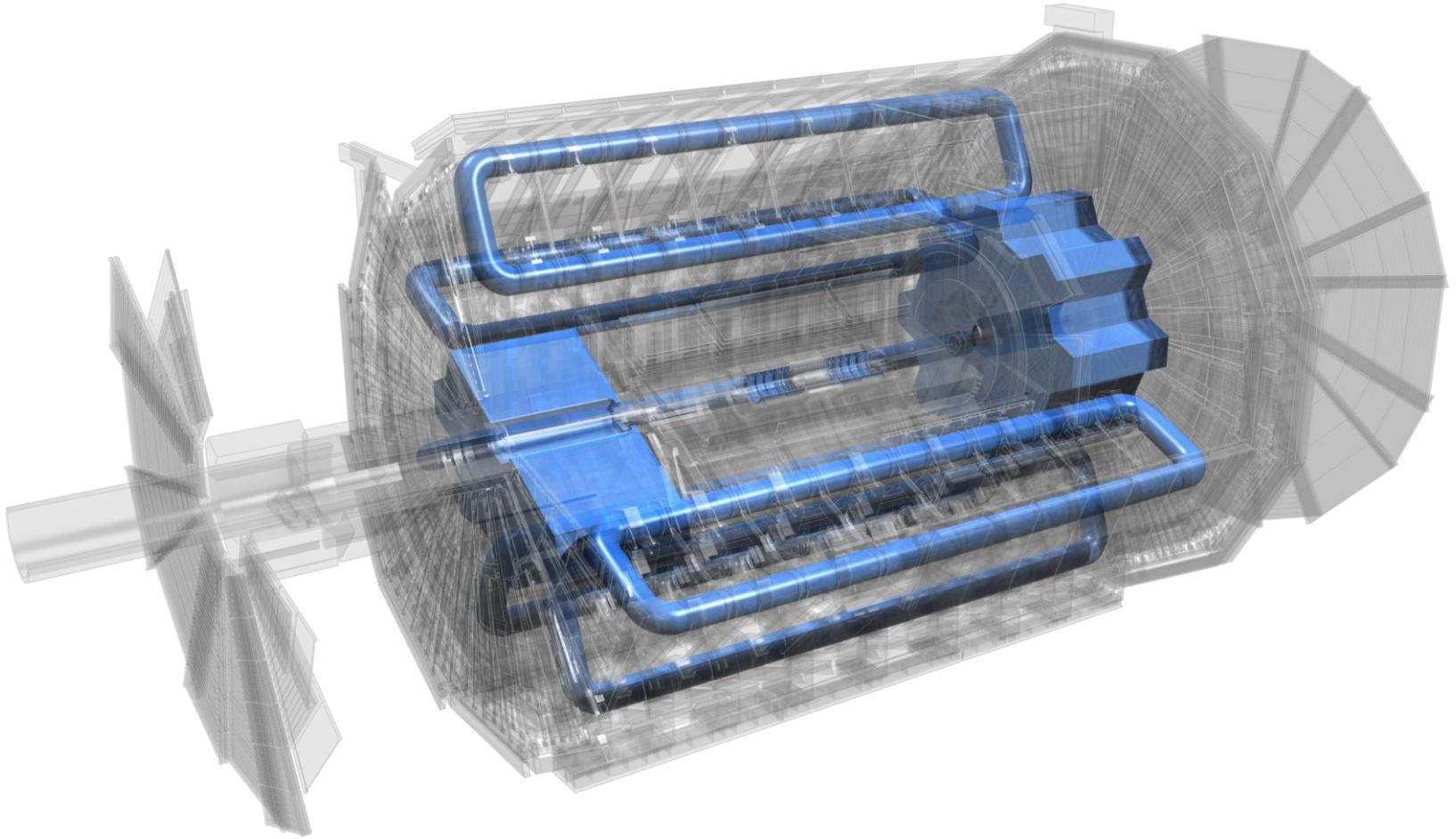
Kalorimeter



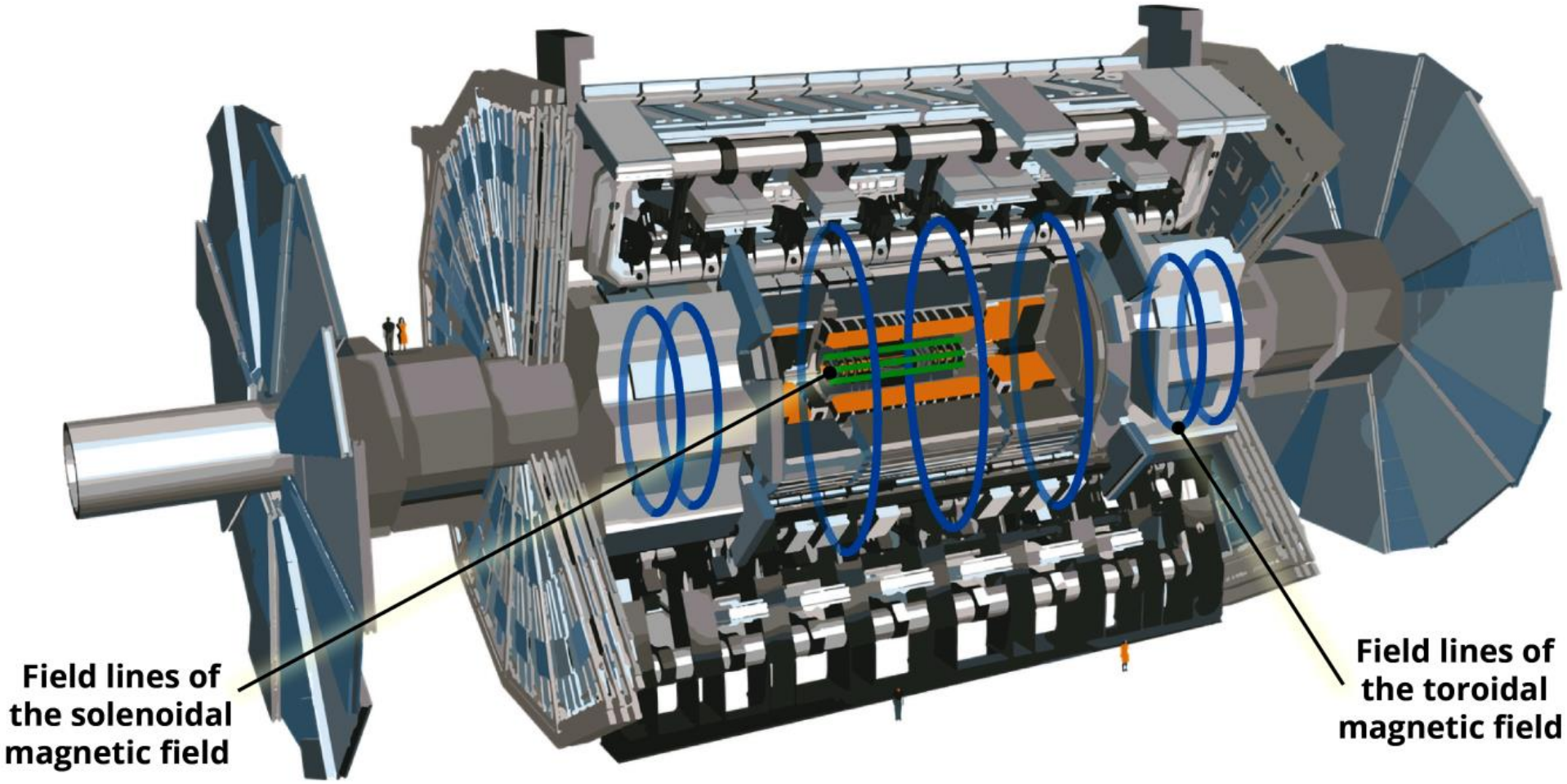
Kalorimeter



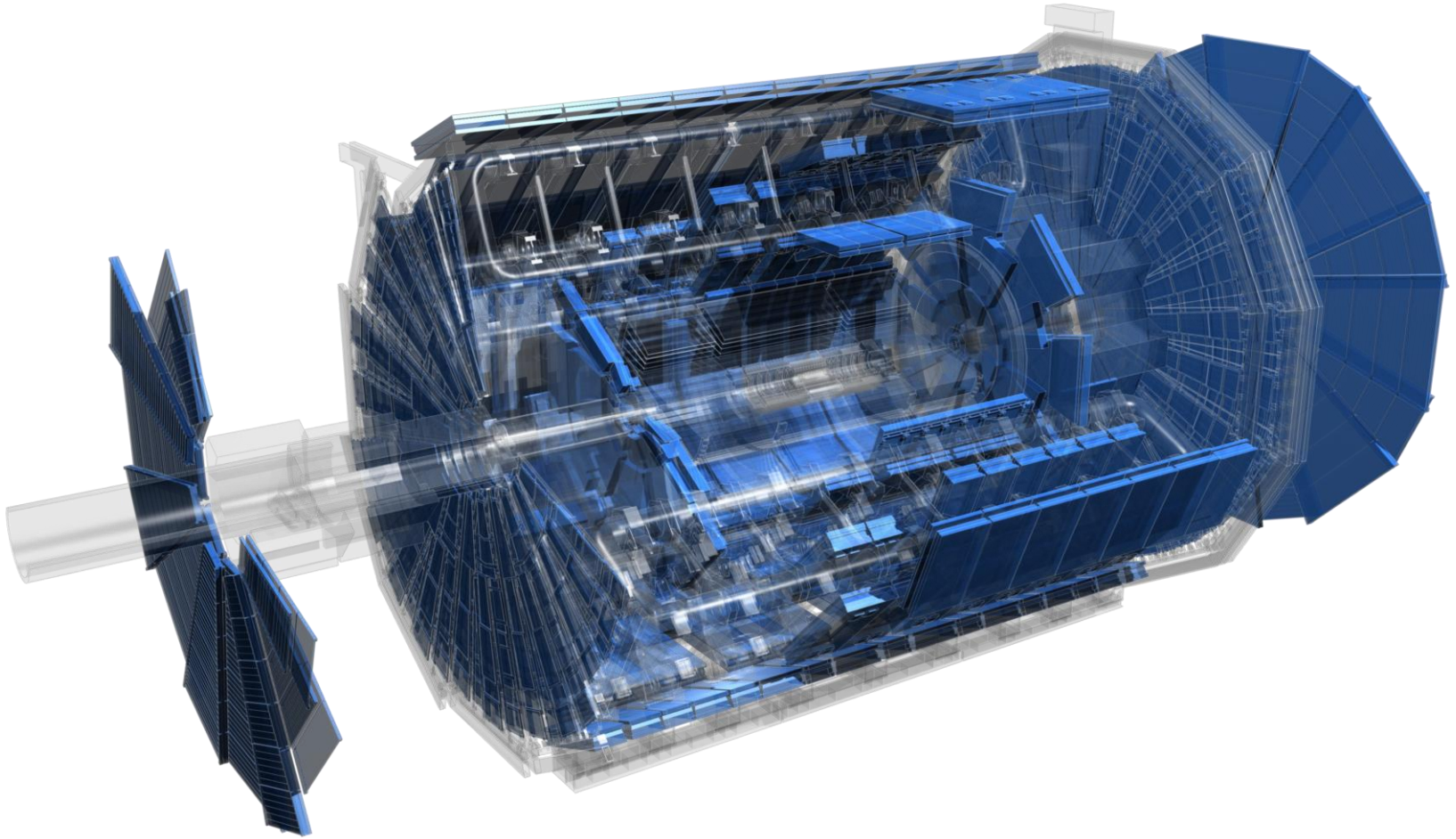
Magnetsystem



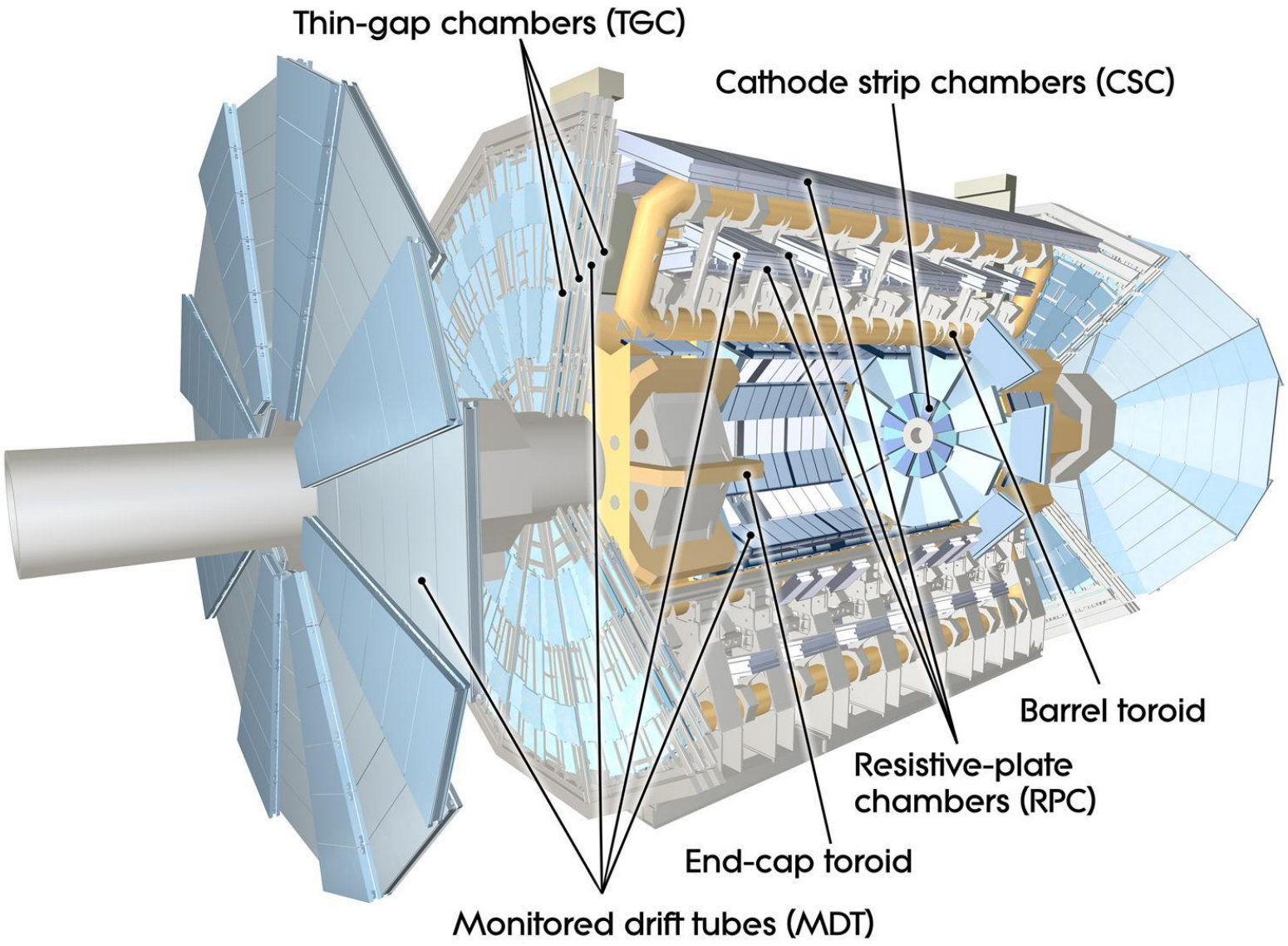
Magnetsystem



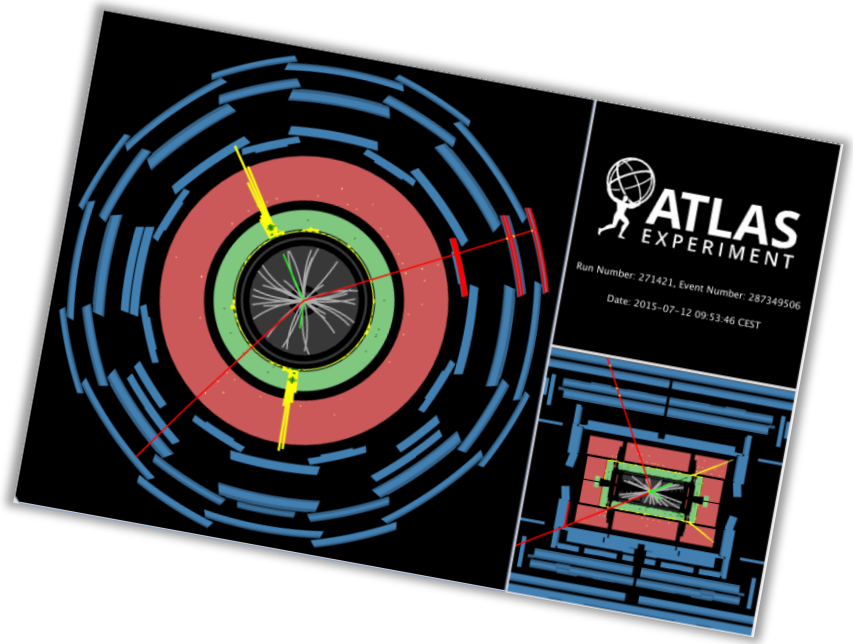
Muon-System



Muon-System


Thin-gap chambers (TGC)
Cathode strip chambers (CSC)
Barrel toroid
Resistive-plate chambers (RPC)
End-cap toroid
Monitored drift tubes (MDT)

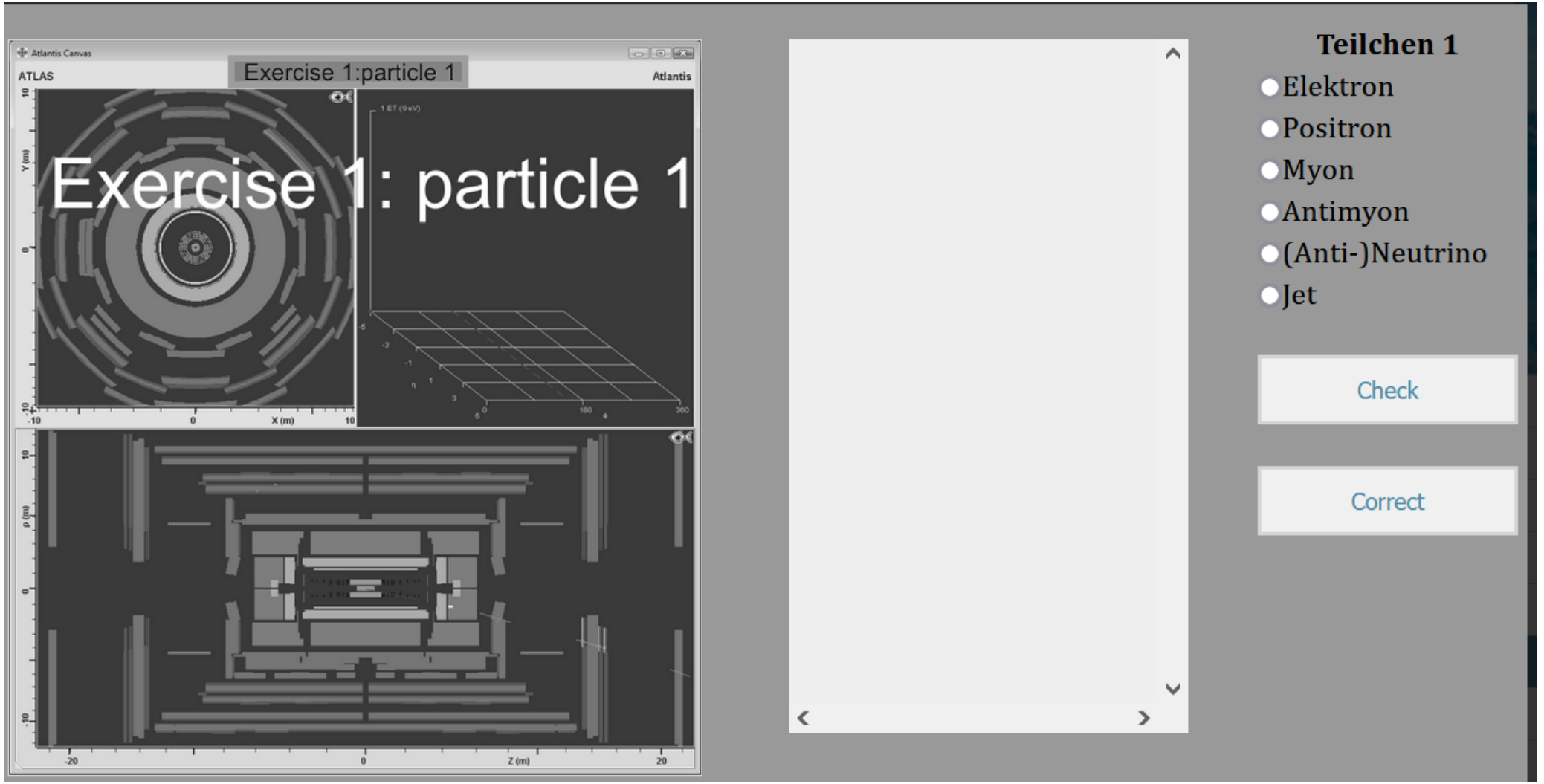
Teilchendetektoren am Beispiel ATLAS





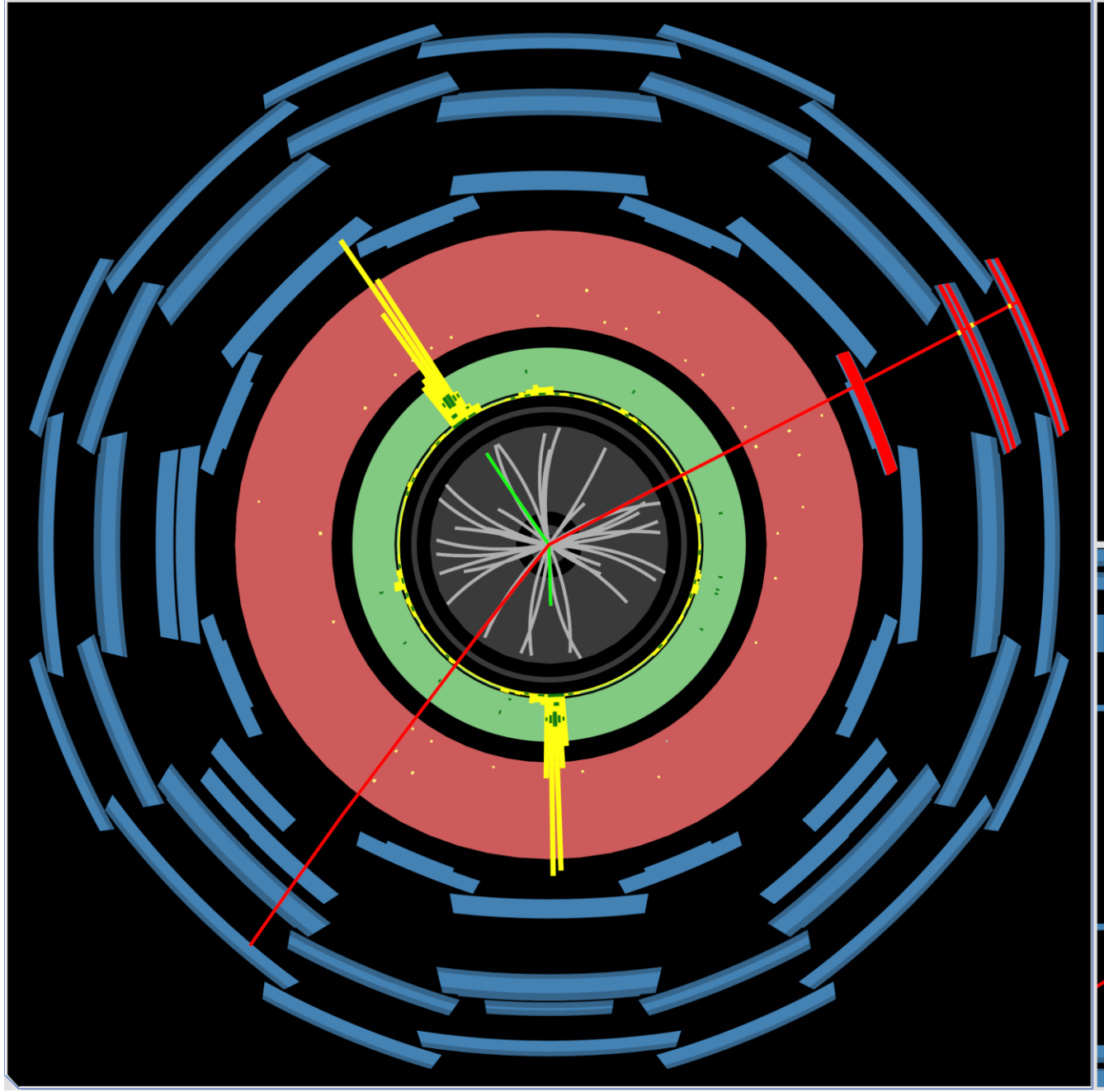
Electron
Photon
Proton
Neutron
Muon
Neutrino

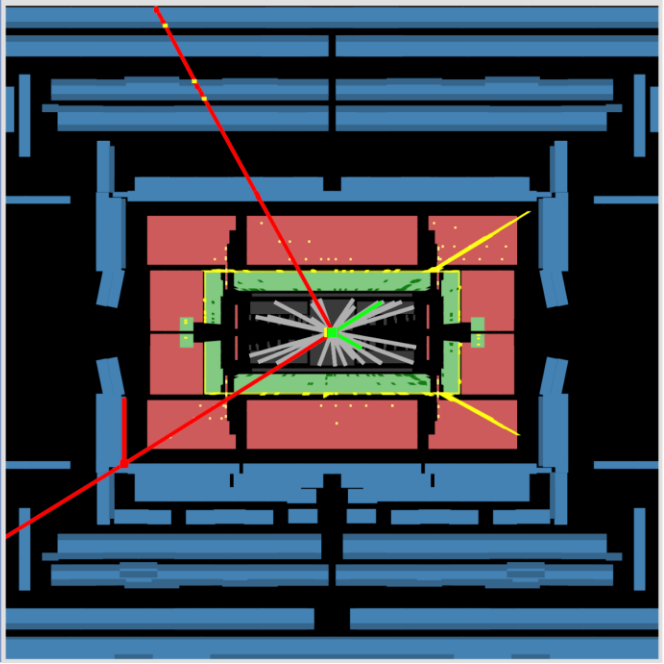
Und in 3D?



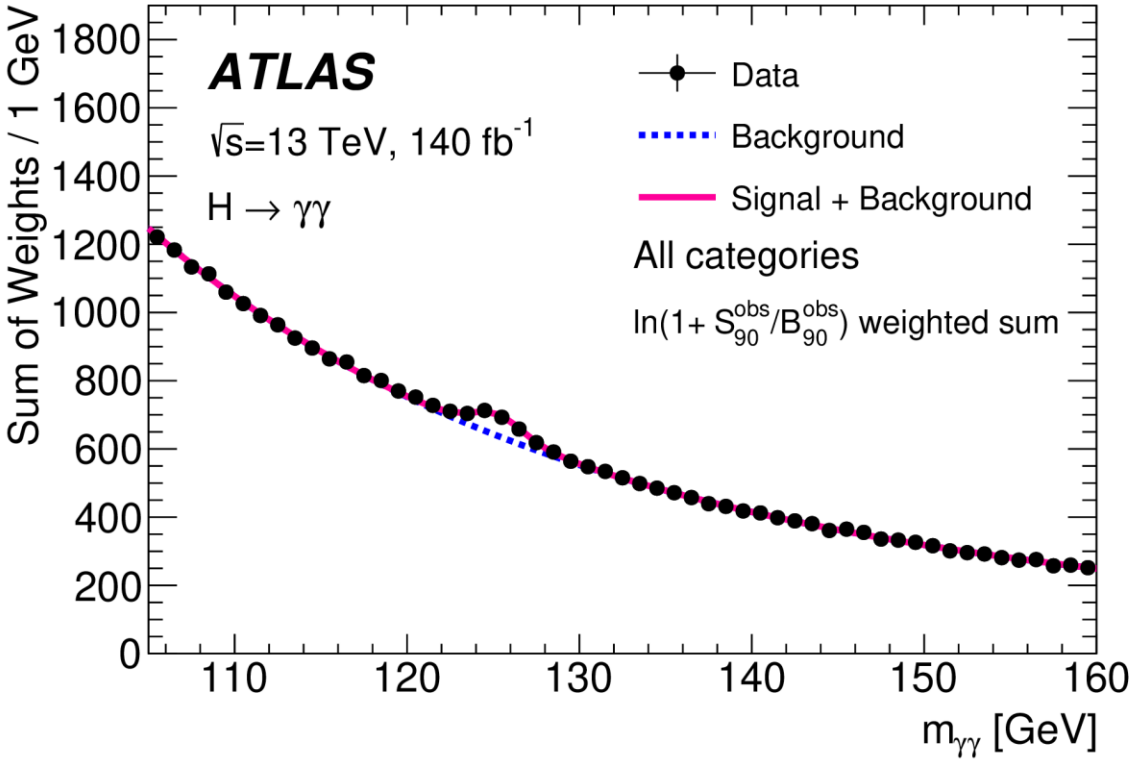
https://atlas.physicsmasterclasses.org/de/wpath_exercise1.htm#

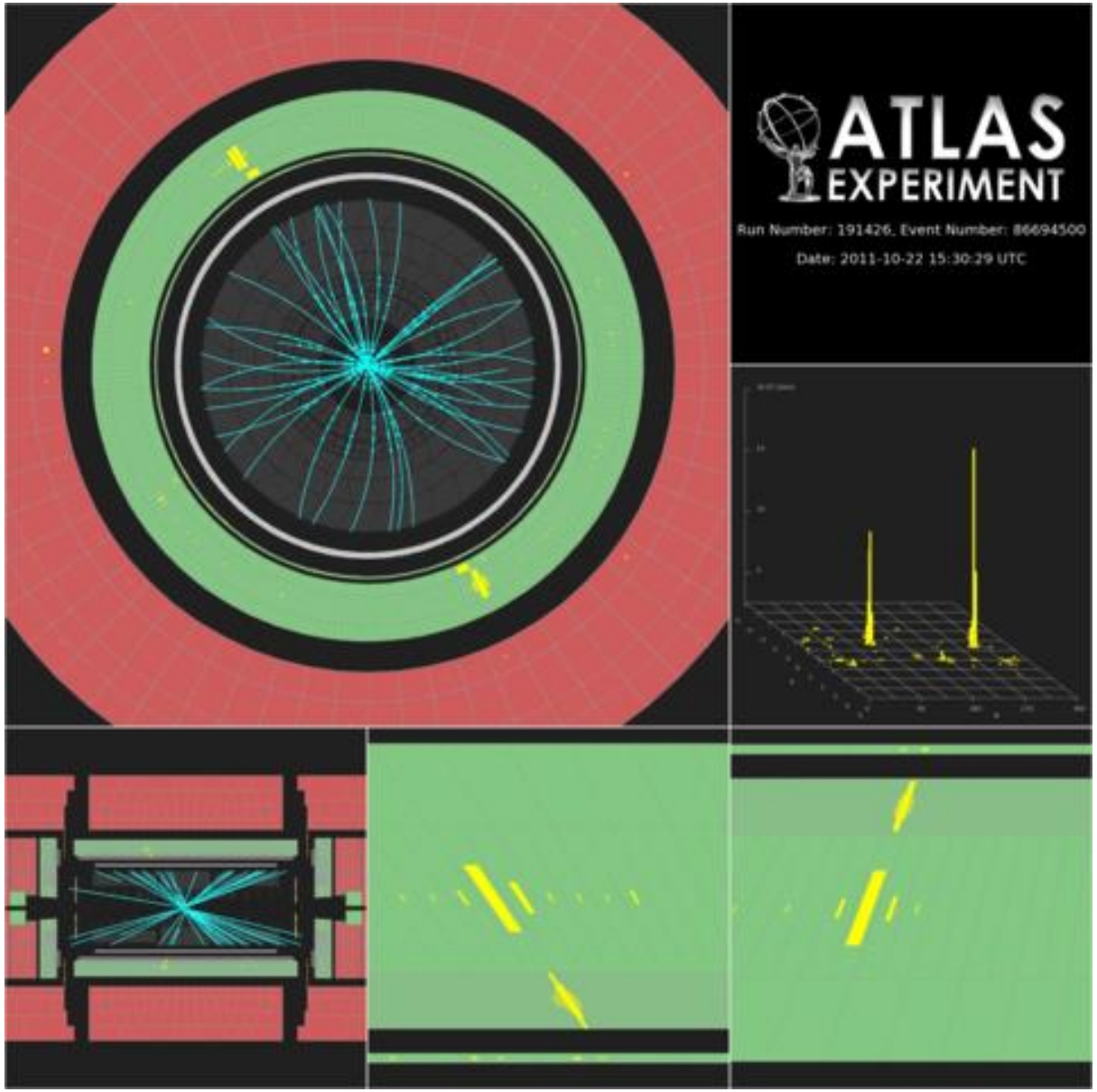
H → ZZ Kandidat





H → γγ Kandidat



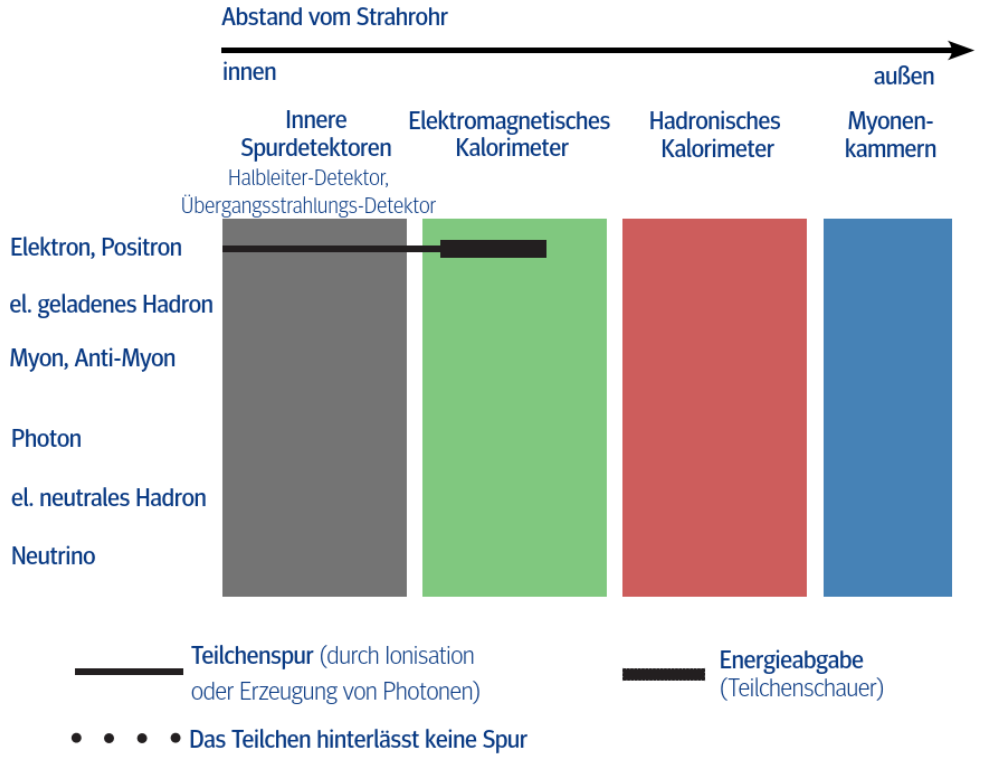


https://www.youtube.com/playlist?list=PLAk-9e5KQYEqvdBn_fSMsuVPt-qOBhEEv

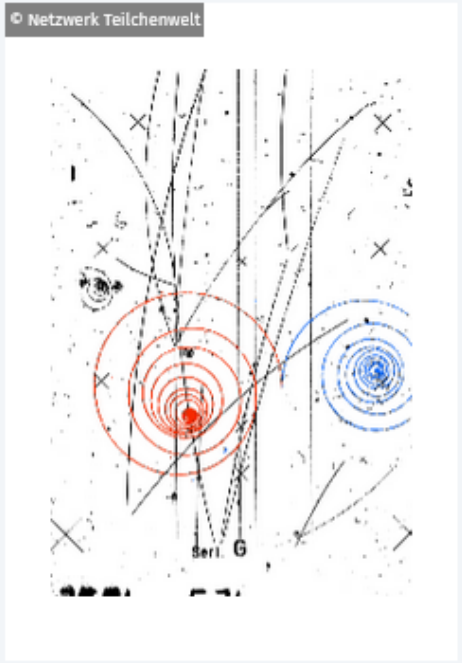
Weitere Resourcen

ATLAS Detektor mit Erklärvideo

https://www.teilchenwelt.de/materialien/begleitmaterial/



Blasenkammern



Blasenkammerbilder mit GeoGebra I

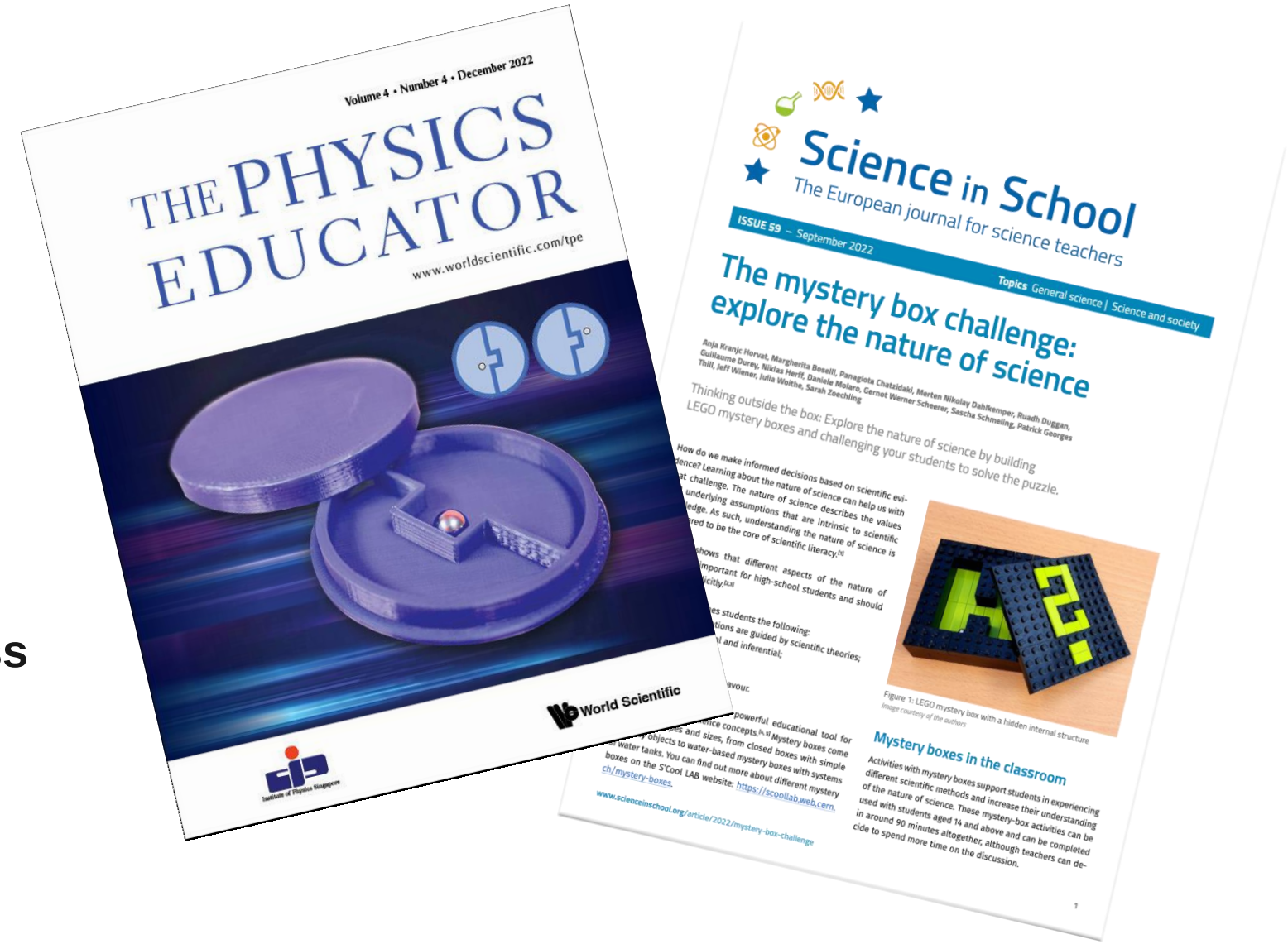
Mit diesem GeoGebra-Material kann die Auswertung von Blasenkammerbildern auf grundlegendem Anforderungsniveau erarbeitet werden. Die Arbeitsblätter entstanden im Rahmen einer Lehramt-Abschlussarbeit.

Download

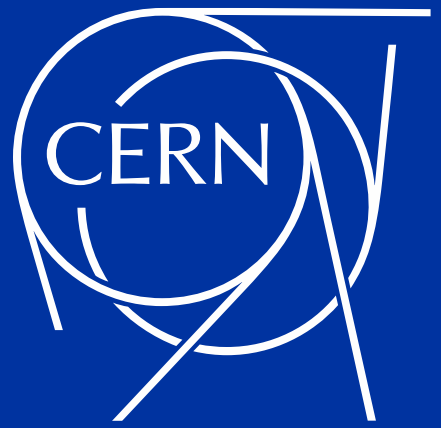
https://shenovafashion.com/products/particle-physics-dress
https://www.teilchenwelt.de/materialien/begleitmaterial/

Higgs in a Box

- **Theory-laden**
- **Empirical & inferential**
- **Creative**
- **Tentative**
- **Social & cultural embeddedness**



https://doi.org/10.1142/S2661339522500196
https://www.scienceinschool.org/article/2022/mystery-box-challenge/



Vielen Dank für Ihre Aufmerksamkeit!
Fragen?