



Radiation Detector

SPA6309

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Lecture 19 – Detector system 1





Topic (collider physics)	Grade
ATLAS	B, D
ATLAS calorimeter	A+, A, C
ATLAS silicon detector	A+, A, A, B, B, B
CMS calorimeter	B, C
LHCb RICH detector	A+, A, B, E
CDF II	A+
BaBar drift chamber	A

Topic (others)	Grade
CCD	A+, A, B
muon tomography	B, C, C
CMOS	A
Semi-conductor	B
Organic semi-conductor	A
Dosimeter	A+
CosmicWatch	A+

Topic (dark matter)	Grade
DMLce	A, A, B, C, C, F
DAMIC	C, D
XENON IT	A, A, B, B, C
XENON 100T	B
LUX	A

Topic (neutrino)	Grade
T2K	C
T2K P0D detector	B
NOvA scintillator	A
Super-Kamiokande	B, C
Hyper-Kamiokande	A
SNO+	A, B, D

Topic (astrophysics)	Grade
NICER X-ray	A
DAMIC	A+, B
Vela-5B satellite	B
JEDI satellite	C



Magnificent 4
- ATLAS (Queen Mary)
- CMS
- LHCb
- ALICE

Non-LHC experiments

- SPS based experiments
 - COMPASS : spin physics <http://wwwcompass.cern.ch/>
 - NA61/SHINE : hadron production measurement <http://shine.web.cern.ch/>
 - NA62 : rare kaon decay <http://na62.web.cern.ch/na62/>
- Antiproton decelerator (AD) based experiments
 - ALPHA : <http://alpha.web.cern.ch/>
- Others
 - CAST : <https://home.cern/about/experiments/cast>
 - protoDUNE : https://dune.bnl.gov/wiki/CERN_Prototype (internal wiki)
 - MoEDAL : <http://moedal.web.cern.ch/>

etc

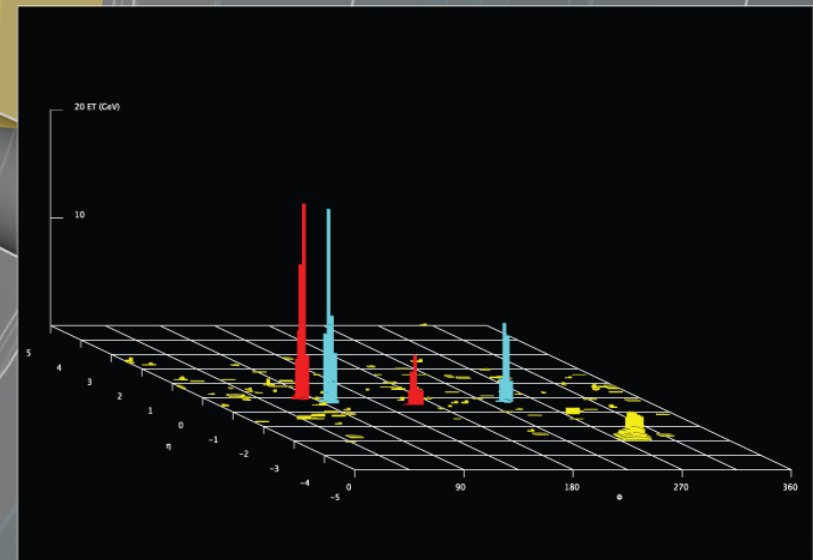
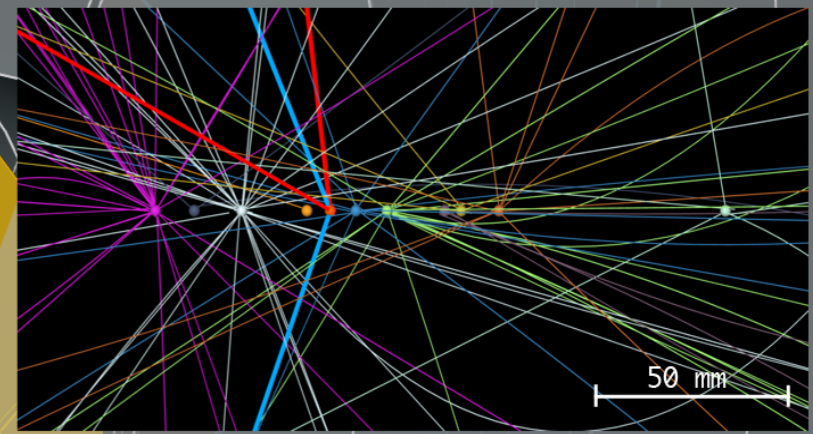
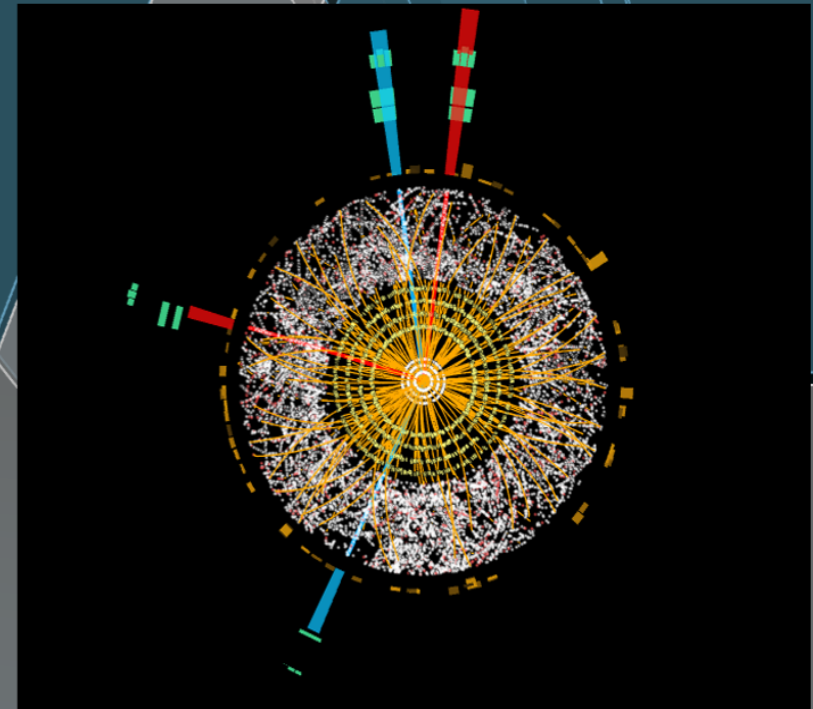
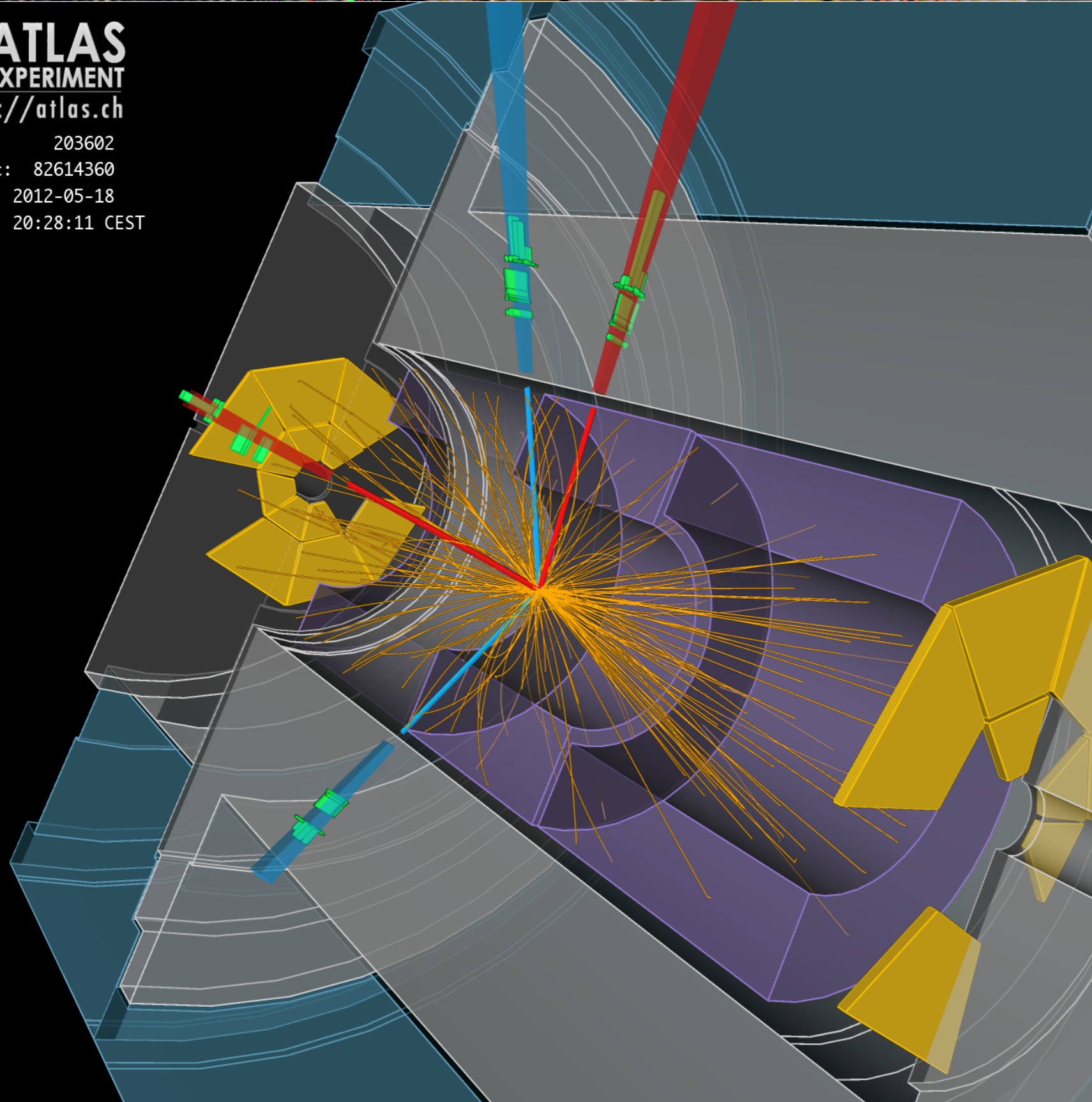
All CERN experiments
<http://home.cern/about/experiments>

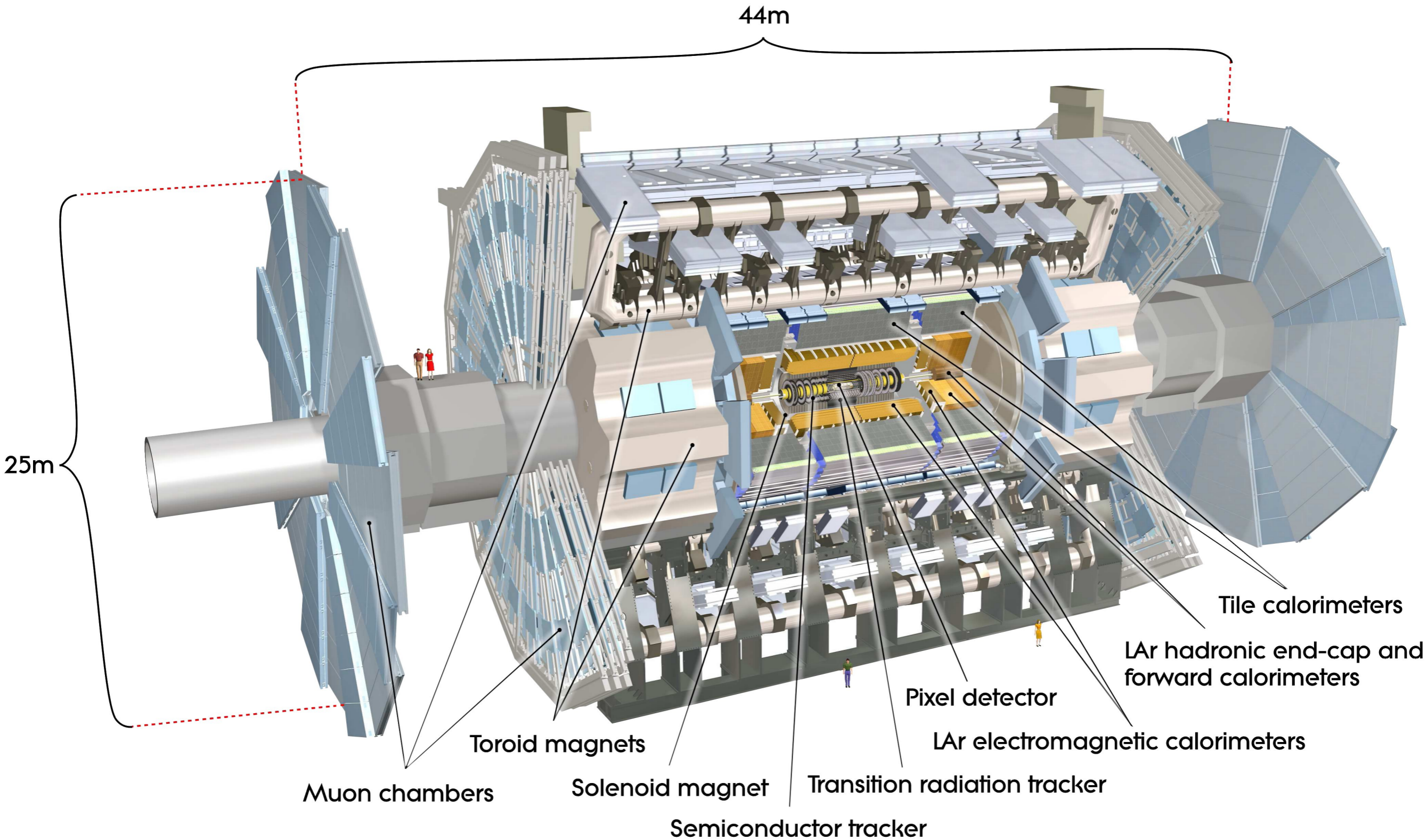
ATLAS detector system

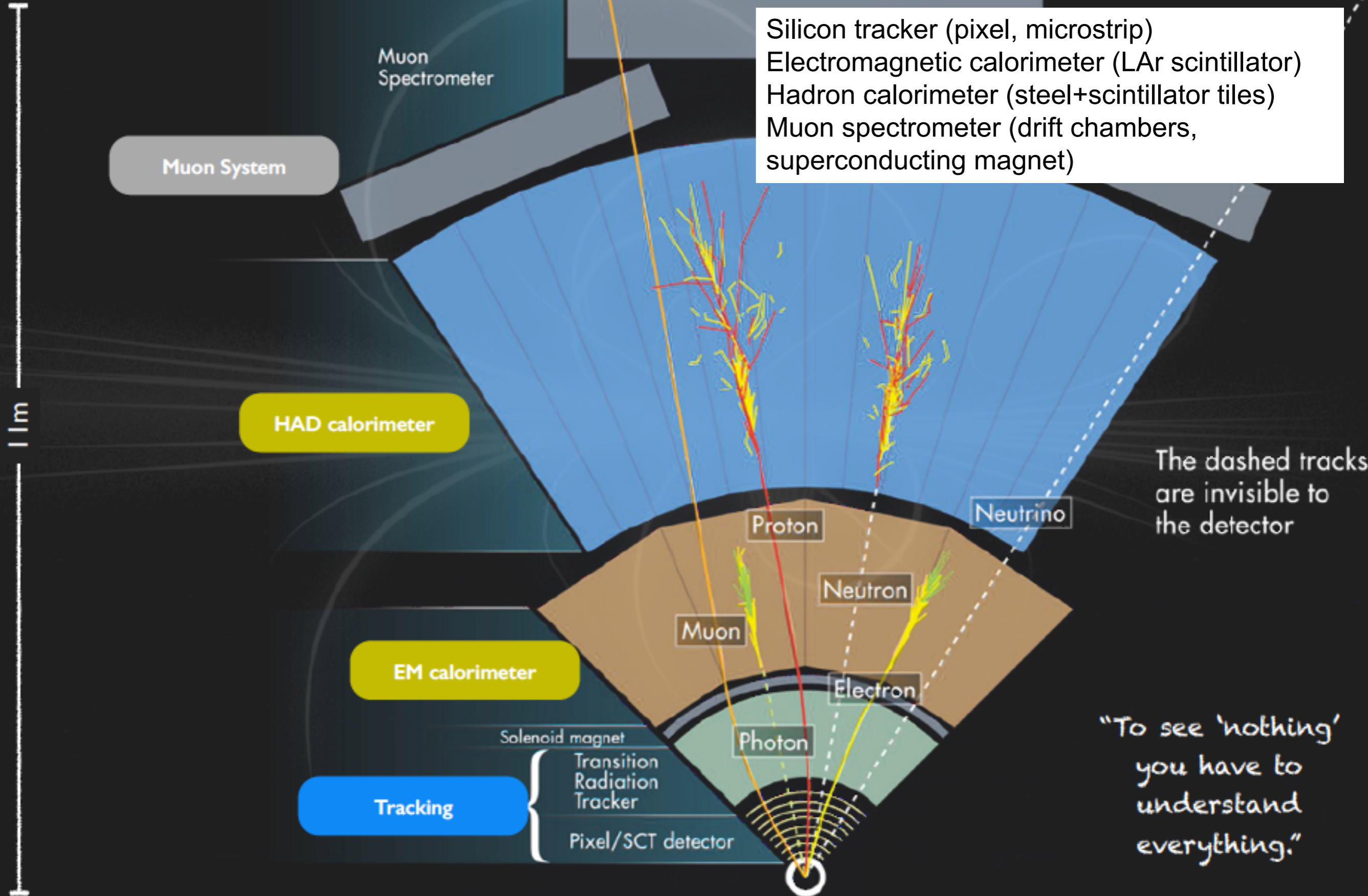


ATLAS
EXPERIMENT
<http://atlas.ch>

Run: 203602
Event: 82614360
Date: 2012-05-18
Time: 20:28:11 CEST







Silicon tracker (pixel, microstrip)
Electromagnetic calorimeter (LAr scintillator)
Hadron calorimeter (steel+scintillator tiles)
Muon spectrometer (drift chambers, superconducting magnet)

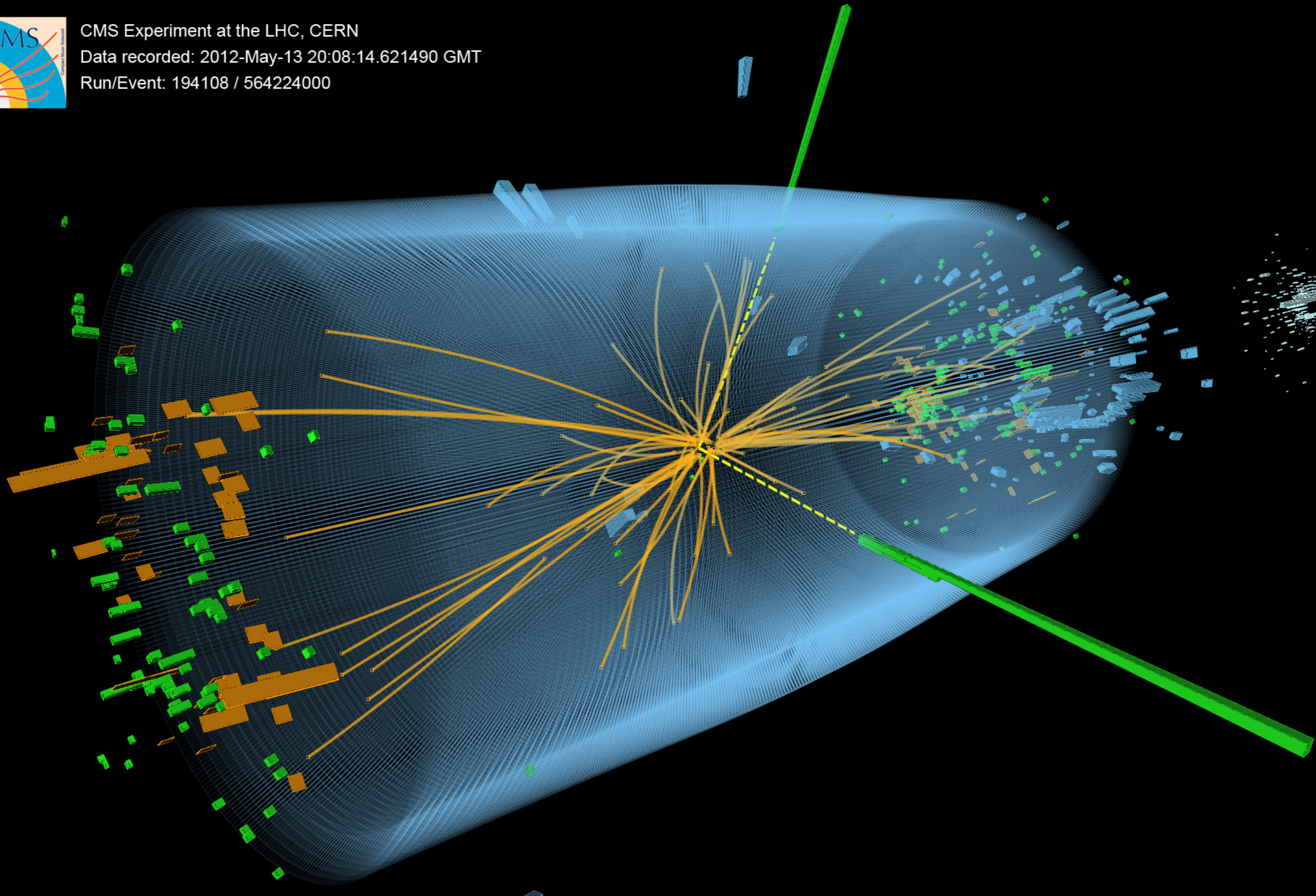
The dashed tracks are invisible to the detector

"To see 'nothing' you have to understand everything."

CMS detector system



CMS Experiment at the LHC, CERN
Data recorded: 2012-May-13 20:08:14.621490 GMT
Run/Event: 194108 / 564224000





CMS DETECTOR

Total weight : 14,000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T

STEEL RETURN YOKE
12,500 tonnes

SILICON TRACKERS
Pixel ($100 \times 150 \mu\text{m}$) $\sim 16\text{m}^2 \sim 66\text{M}$ channels
Microstrips ($80 \times 180 \mu\text{m}$) $\sim 200\text{m}^2 \sim 9.6\text{M}$ channels

SUPERCONDUCTING SOLENOID
Niobium titanium coil carrying $\sim 18,000\text{A}$

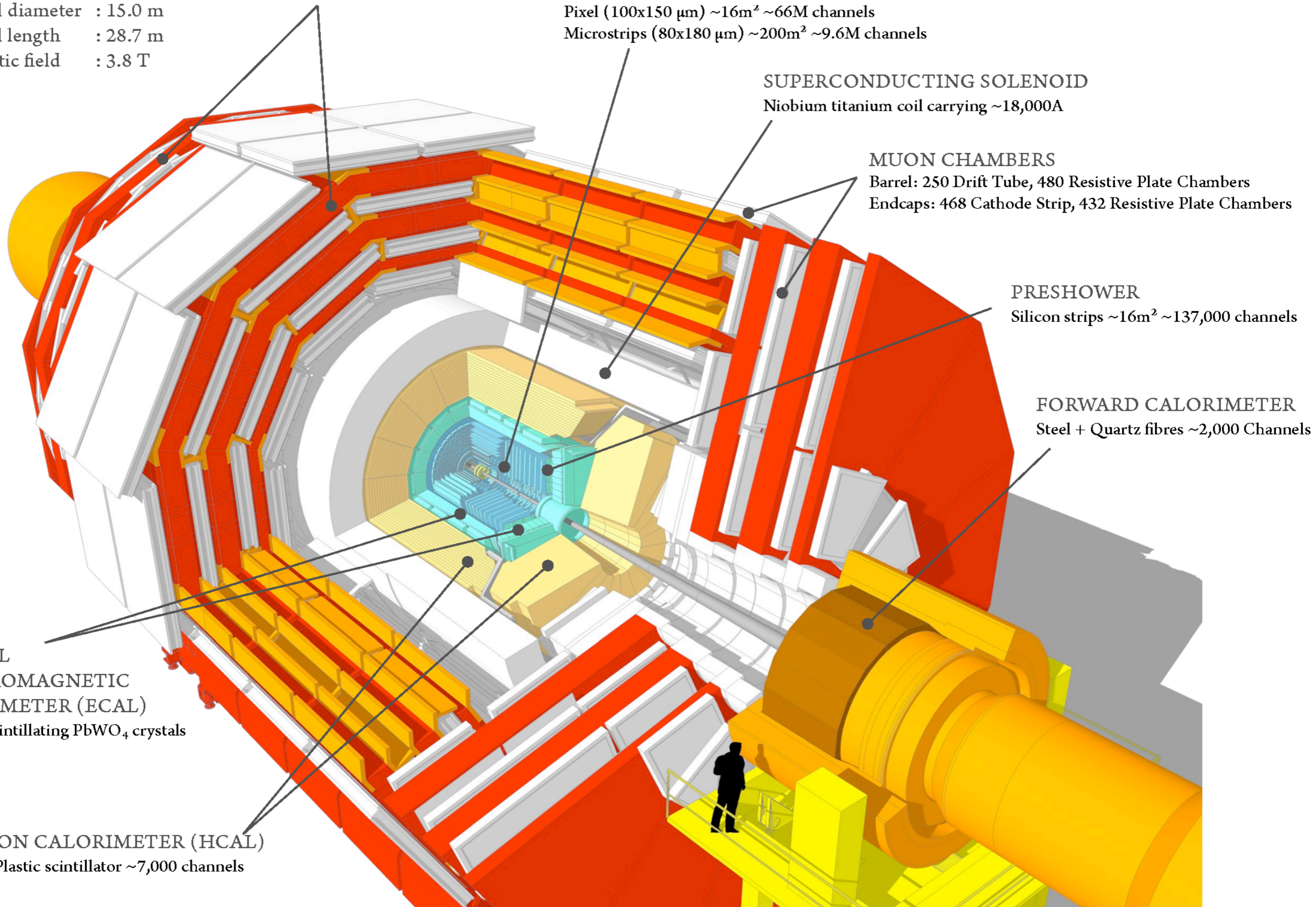
MUON CHAMBERS
Barrel: 250 Drift Tube, 480 Resistive Plate Chambers
Endcaps: 468 Cathode Strip, 432 Resistive Plate Chambers

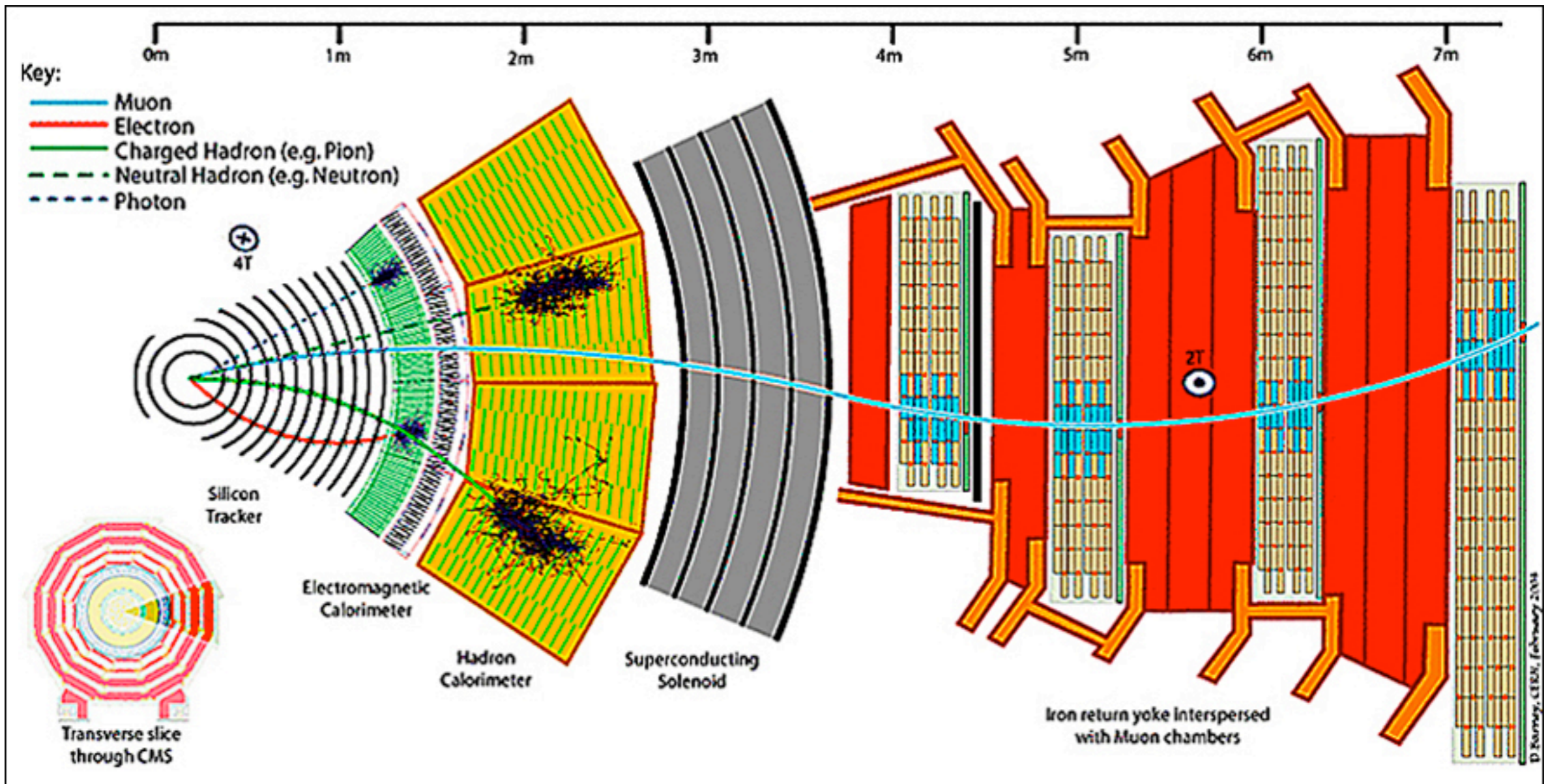
PRESHOWER
Silicon strips $\sim 16\text{m}^2 \sim 137,000$ channels

FORWARD CALORIMETER
Steel + Quartz fibres $\sim 2,000$ Channels

CRYSTAL
ELECTROMAGNETIC
CALORIMETER (ECAL)
 $\sim 76,000$ scintillating PbWO_4 crystals

HADRON CALORIMETER (HCAL)
Brass + Plastic scintillator $\sim 7,000$ channels





Silicon tracker (pixel, microstrip)

Electromagnetic calorimeter (crystal)

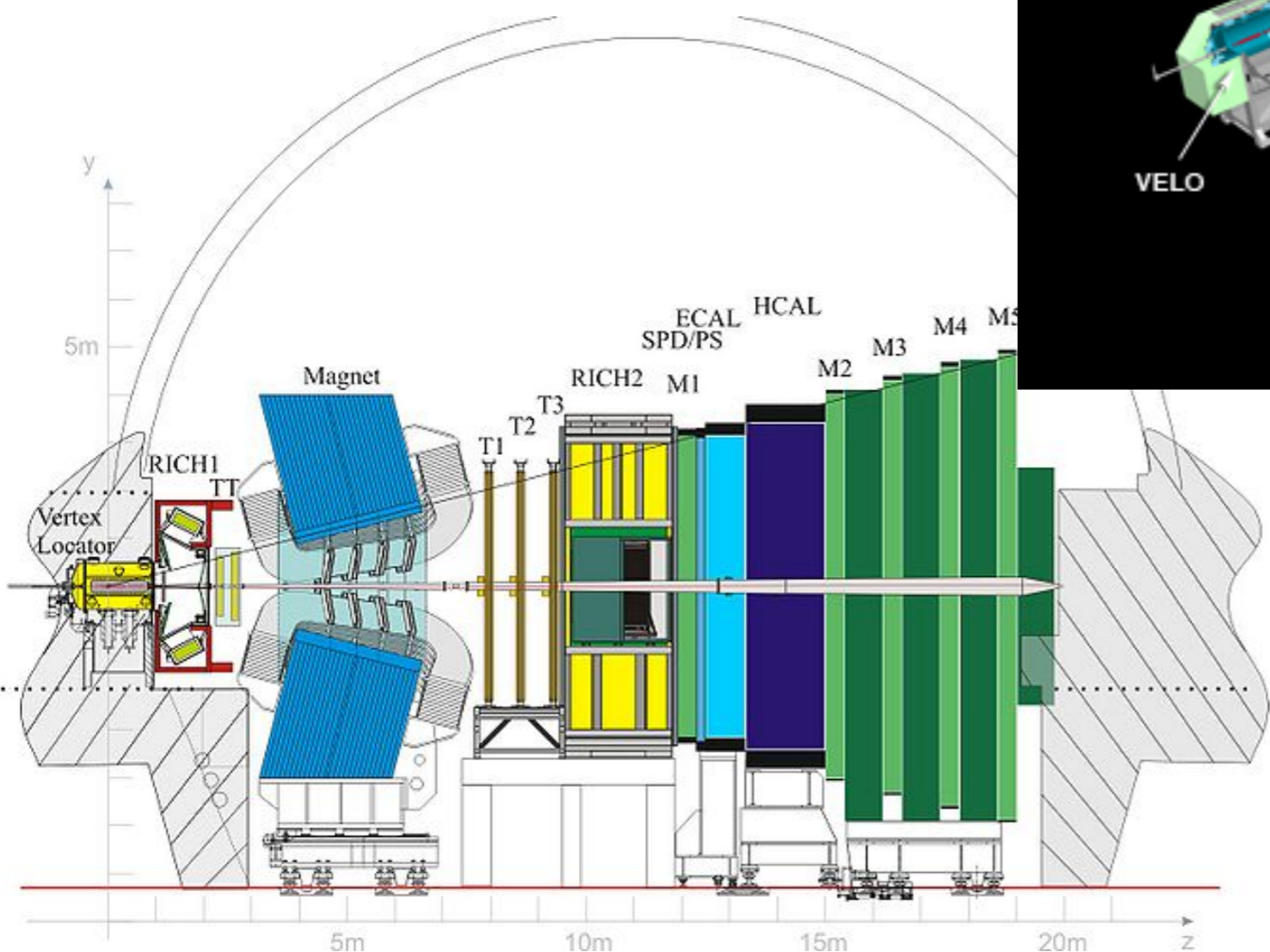
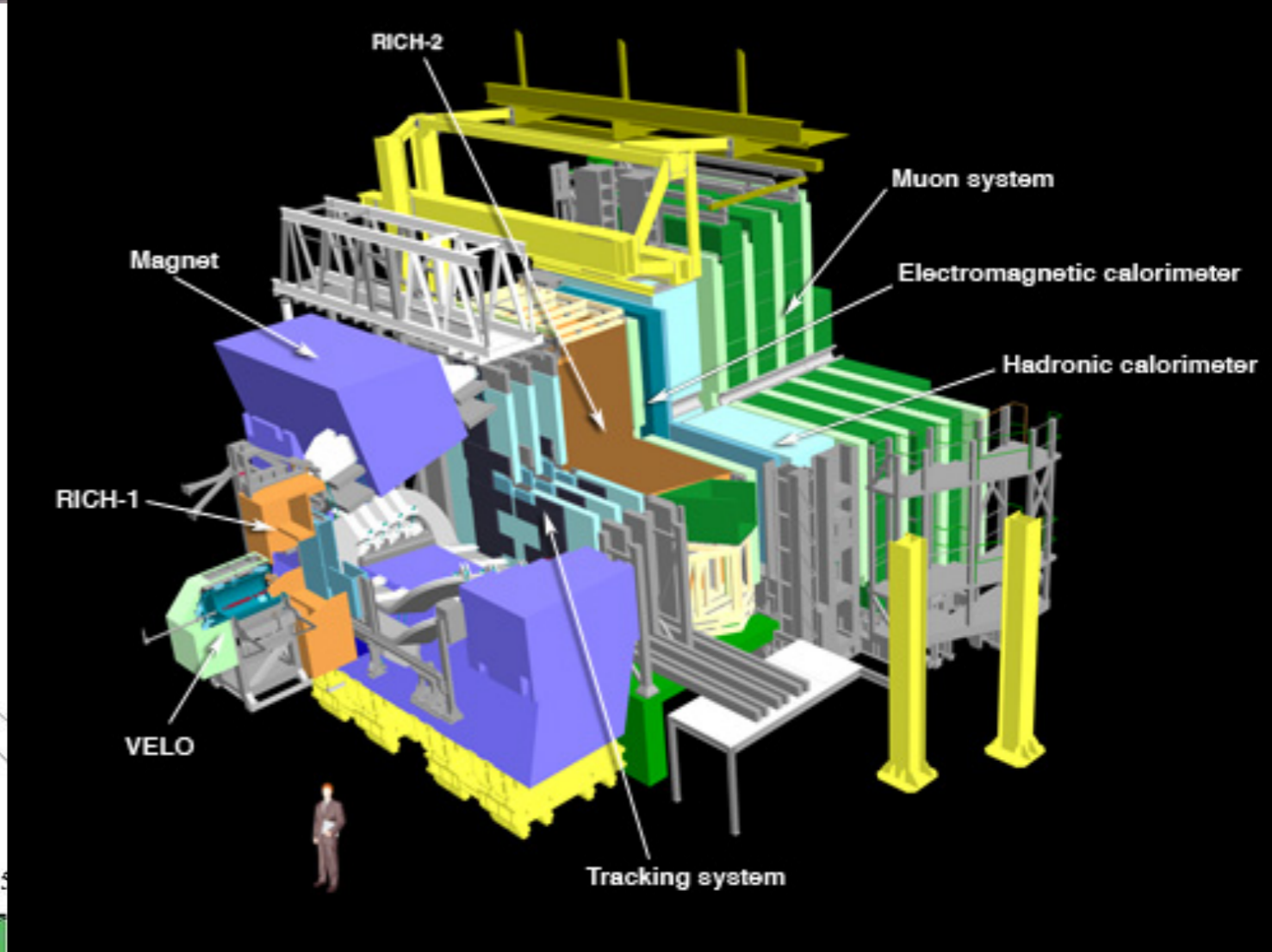
Hadron calorimeter (brass+scintillator)

Muon chambers (drift tubes, resistive plate chamber, superconducting magnet)

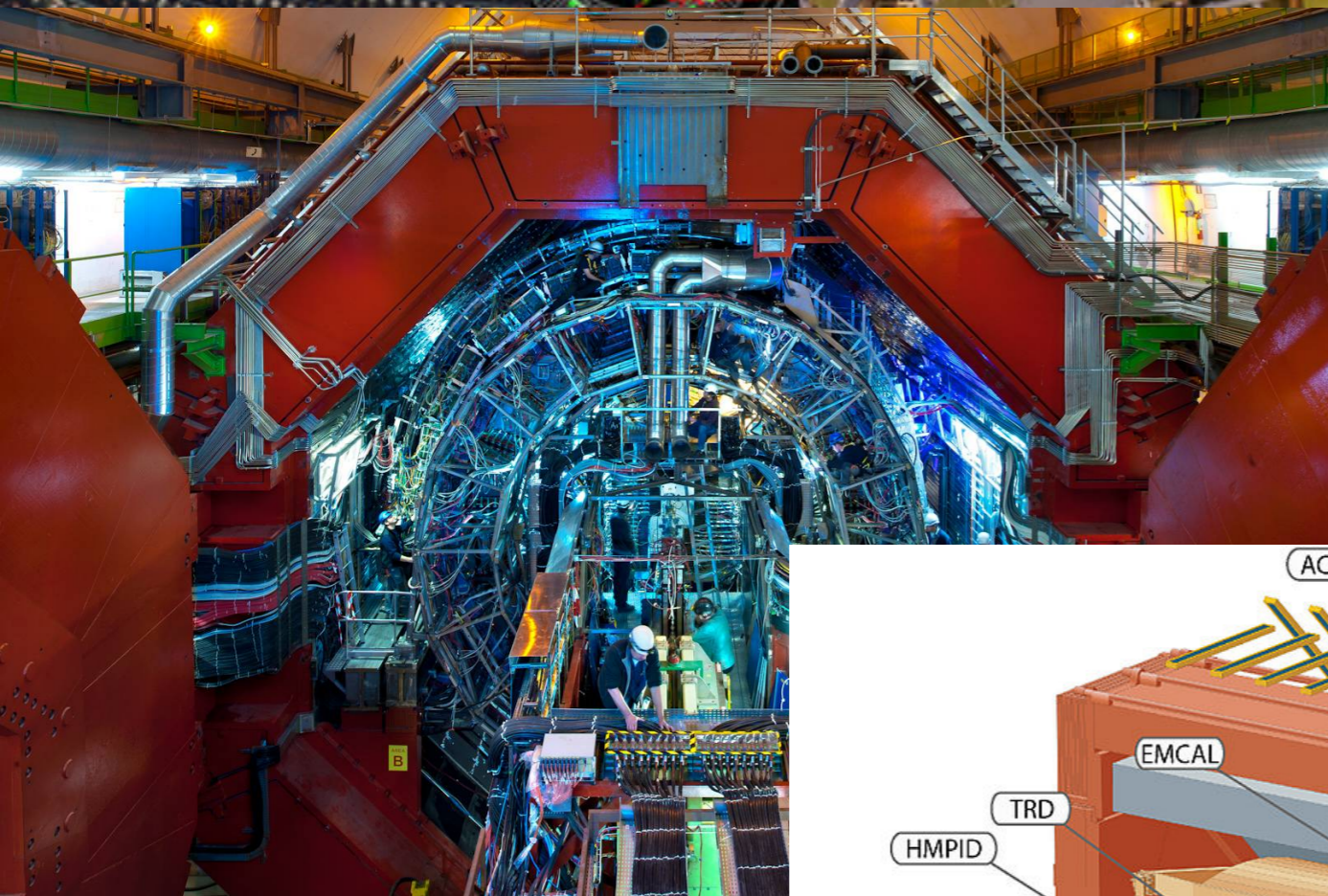
LHCb detector system – study b-quarks



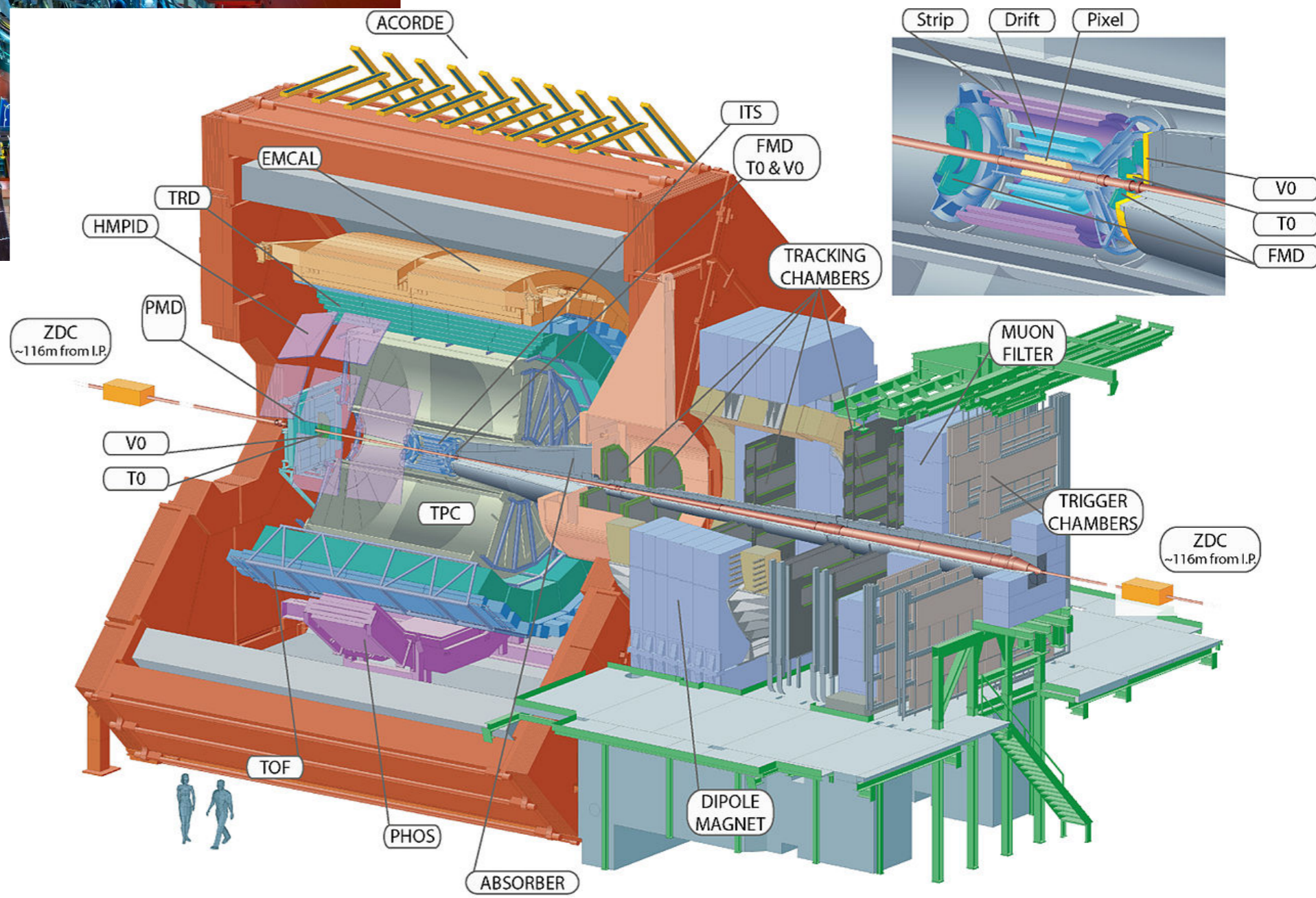
- VELO (vertex locator)
- RICH (ring image Cherenkov detector)
- ECal
- HCal
- Muon system



ALICE detector system – study heavy ion collisions



Combinations of many more detectors to allow particle identification (PID)





LHC (p-p)

- ATLAS, CMS, LHCb, ALICE (heavy-ion)

Tevatron (p-antip)

- CDF, Dzero

SLAC (e+e-)

- Babar

KEKB (KEK, e+e-)

- Belle II

HERA (DESY, e-p)

- ZEUS, HERMES

LEP (CERN, e+e-, old)

- ALPHA, DELPHI, OPAL, L3

RHIC (heavy-ion)

- PHENIX, STAR, PHOBOS, BRAHMAS

All these collider detector system use at least 3 layers of detectors

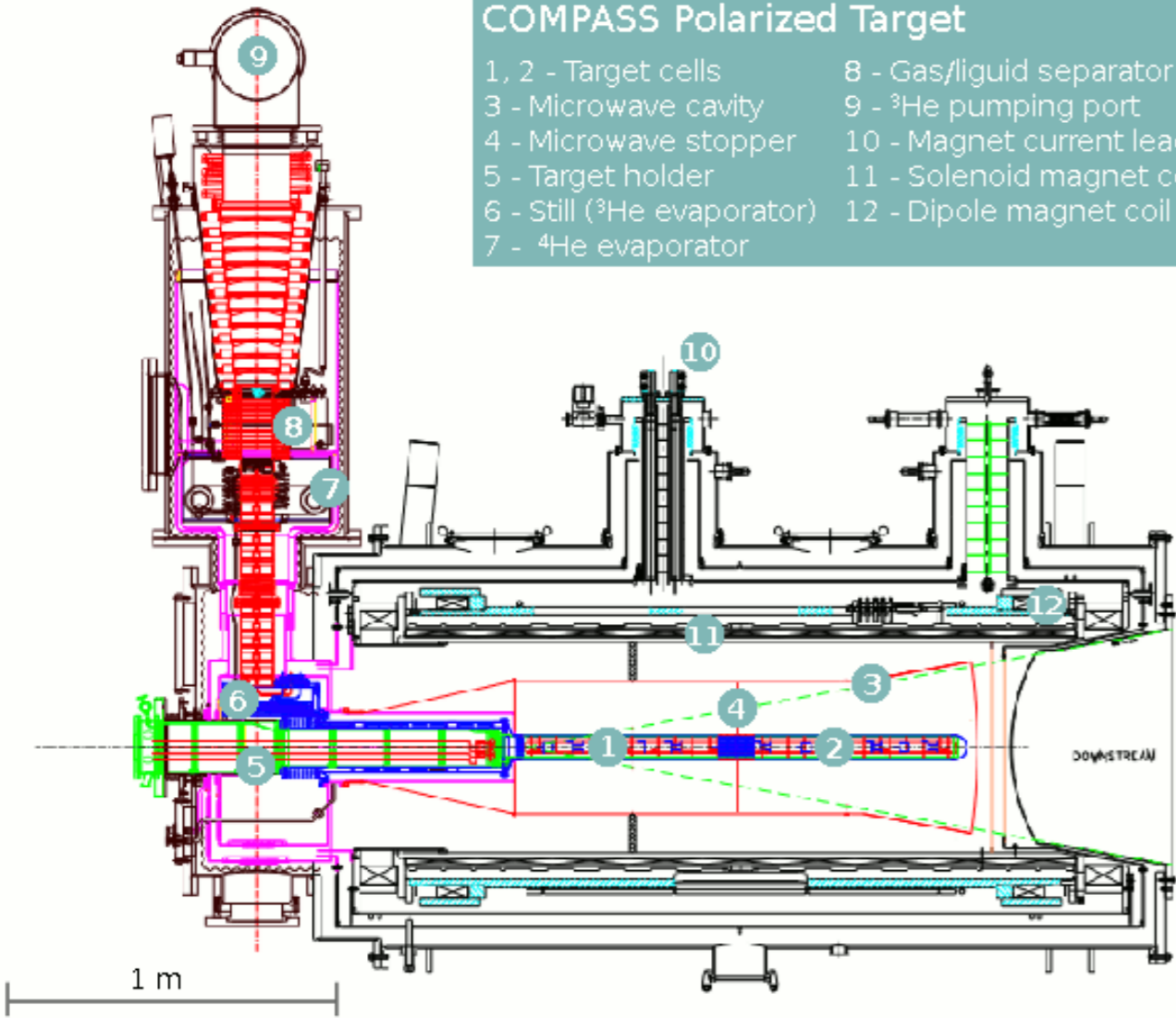
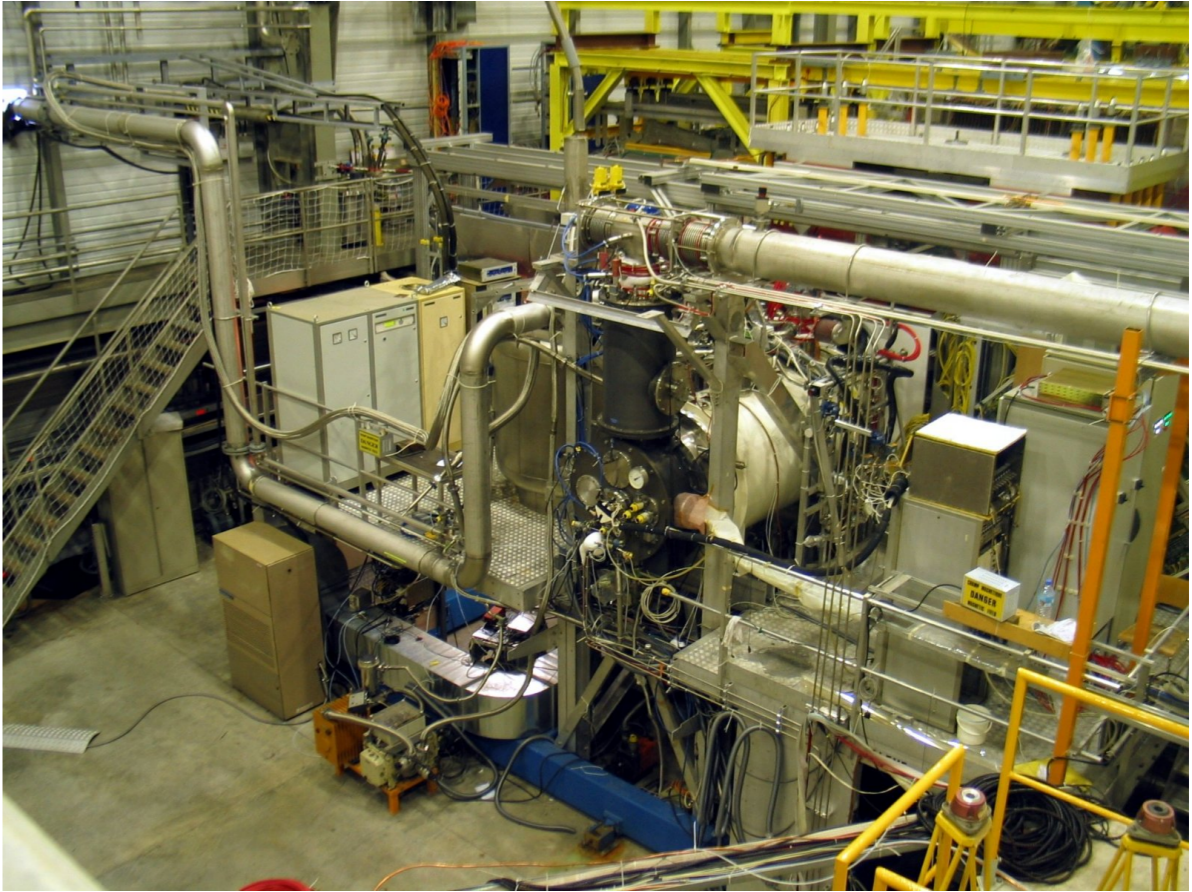
- inner tracker
- electromagnetic calorimeter
- hadronic calorimeter
- muon system

Don't discuss too many, **choose few detectors (ideally one) to discuss**

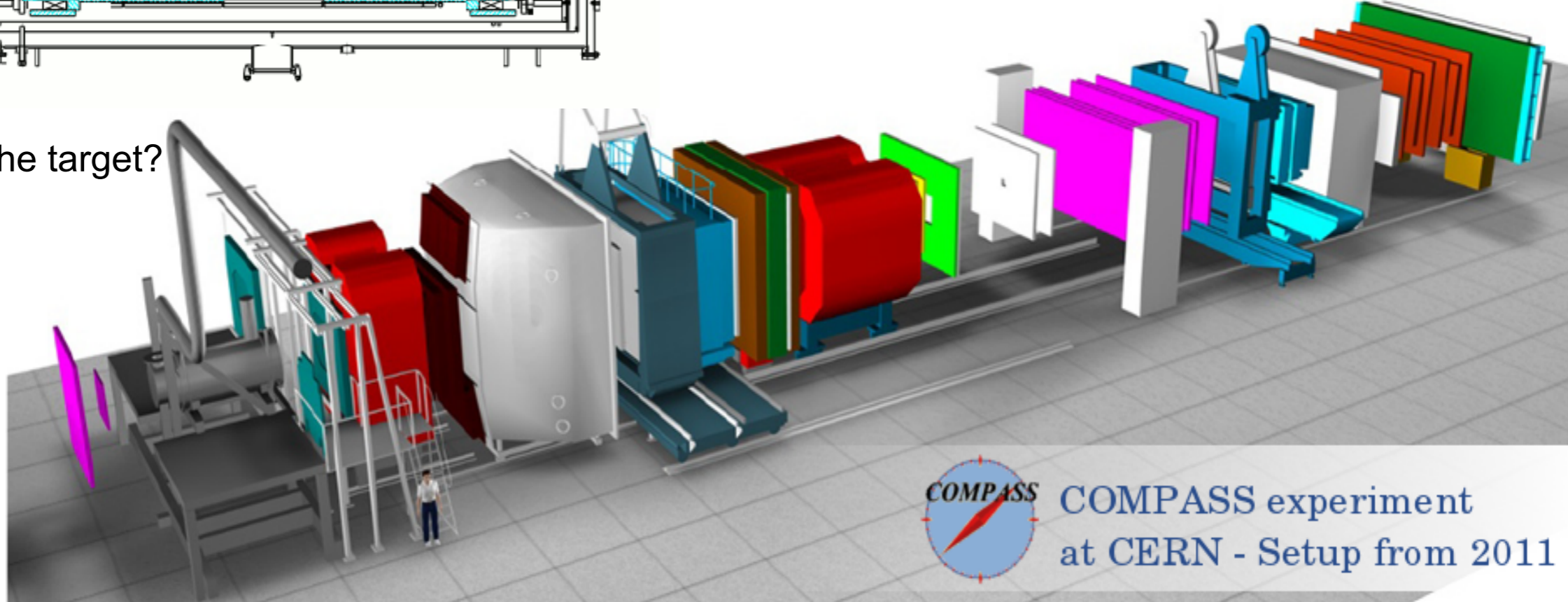


COMPASS Polarized Target

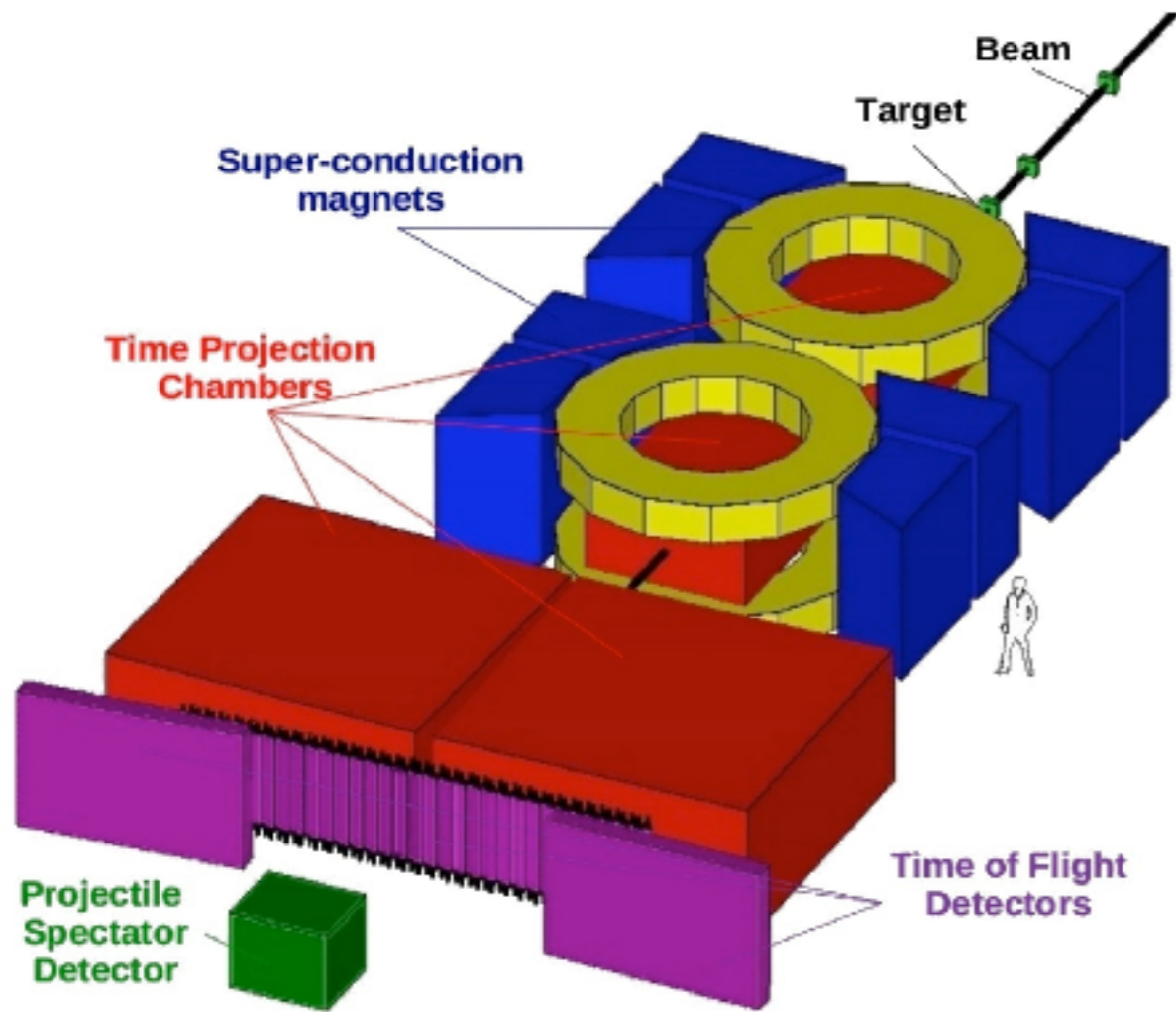
1, 2 - Target cells	8 - Gas/liquid separator
3 - Microwave cavity	9 - ^3He pumping port
4 - Microwave stopper	10 - Magnet current leads
5 - Target holder	11 - Solenoid magnet coil
6 - Still (^3He evaporator)	12 - Dipole magnet coil
7 - ^4He evaporator	



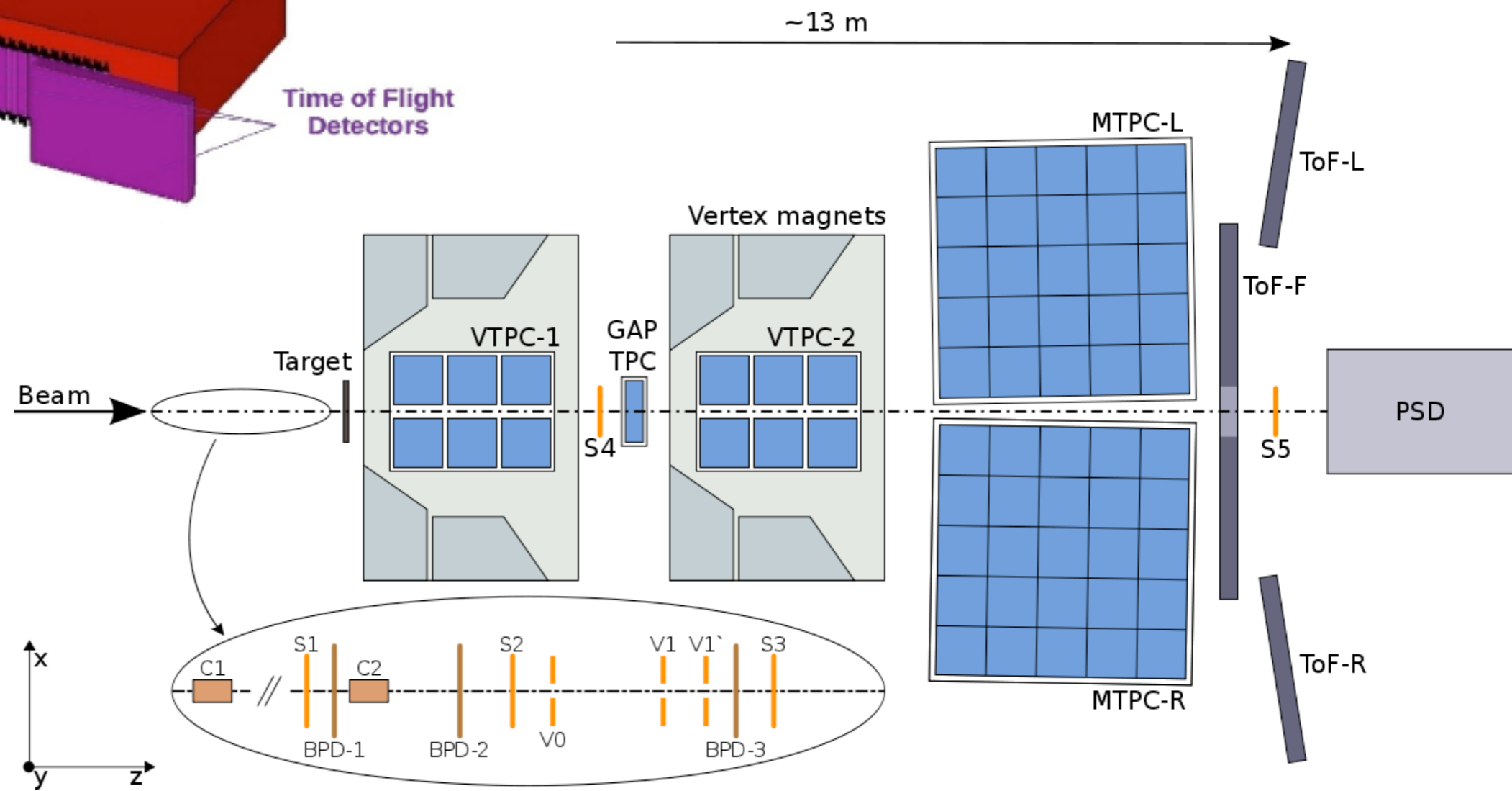
How to polarize the target?



COMPASS experiment at CERN - Setup from 2011

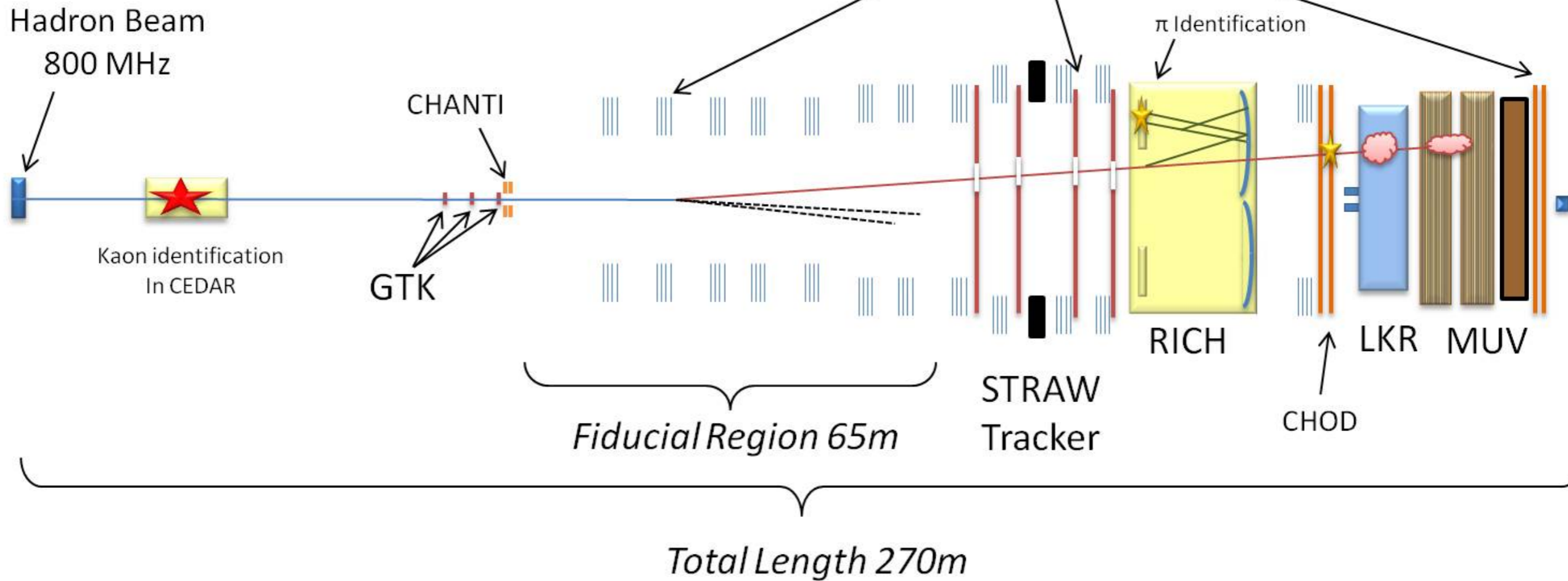


How to measure hadron multiplicity?

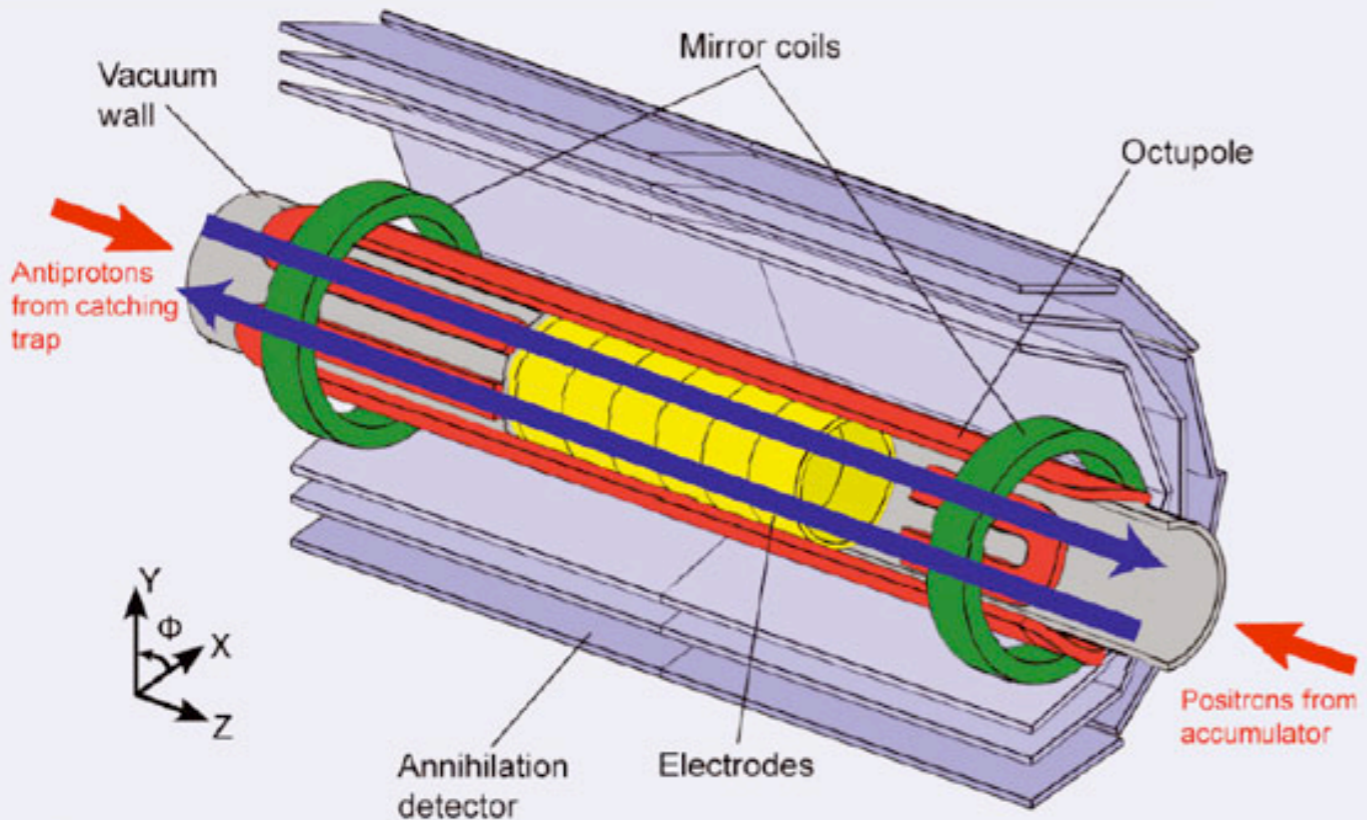




How to measure rare kaon decay?

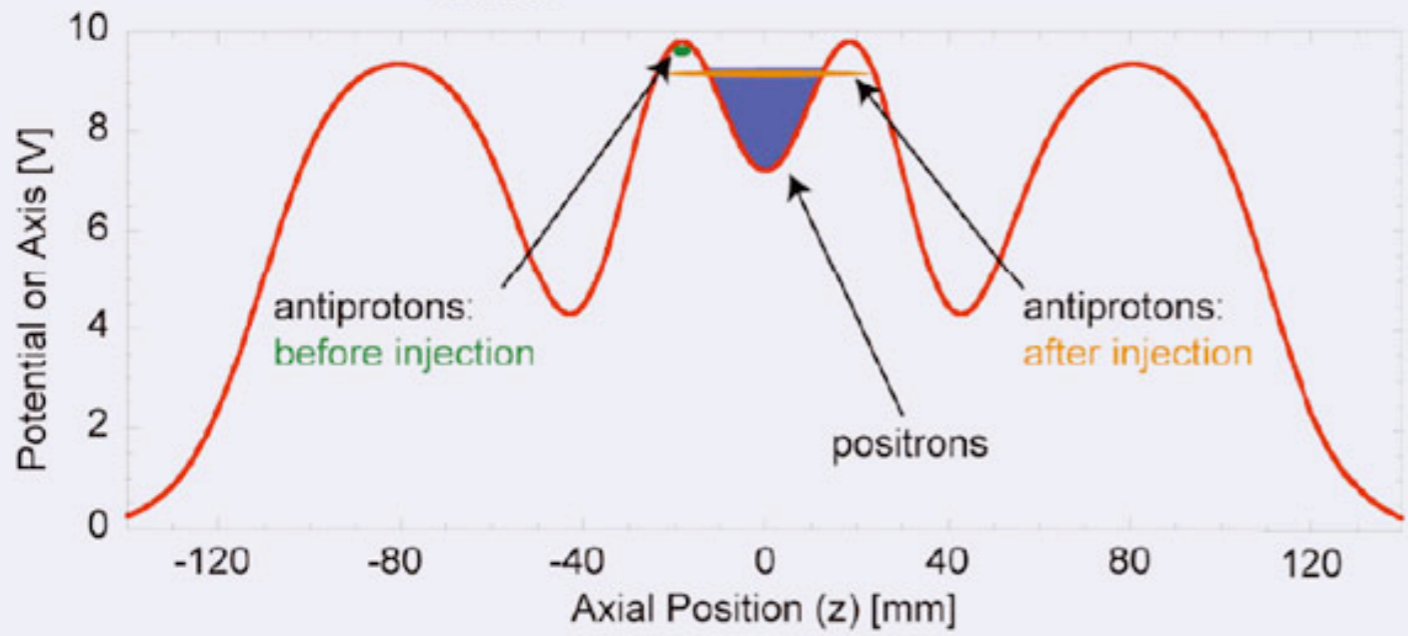


ALPHA – anti-hydrogen production



5 experiments with anti-proton decelerator (AD)

- ALPHA
- ACE
- AEGIS
- ATRAP
- ASACUSA



CERN



Spin physics

- COMPASS, HERMES, PHENIX

These experiments have technologies to produce polarized beam and/or polarized target

Fixed target experiments

- SHINE, MIPP, HARP

These experiments are relatively small, but high rate

Rare process experiments

- NA62, g-2, mu2e

These experiments are specialized to see one process

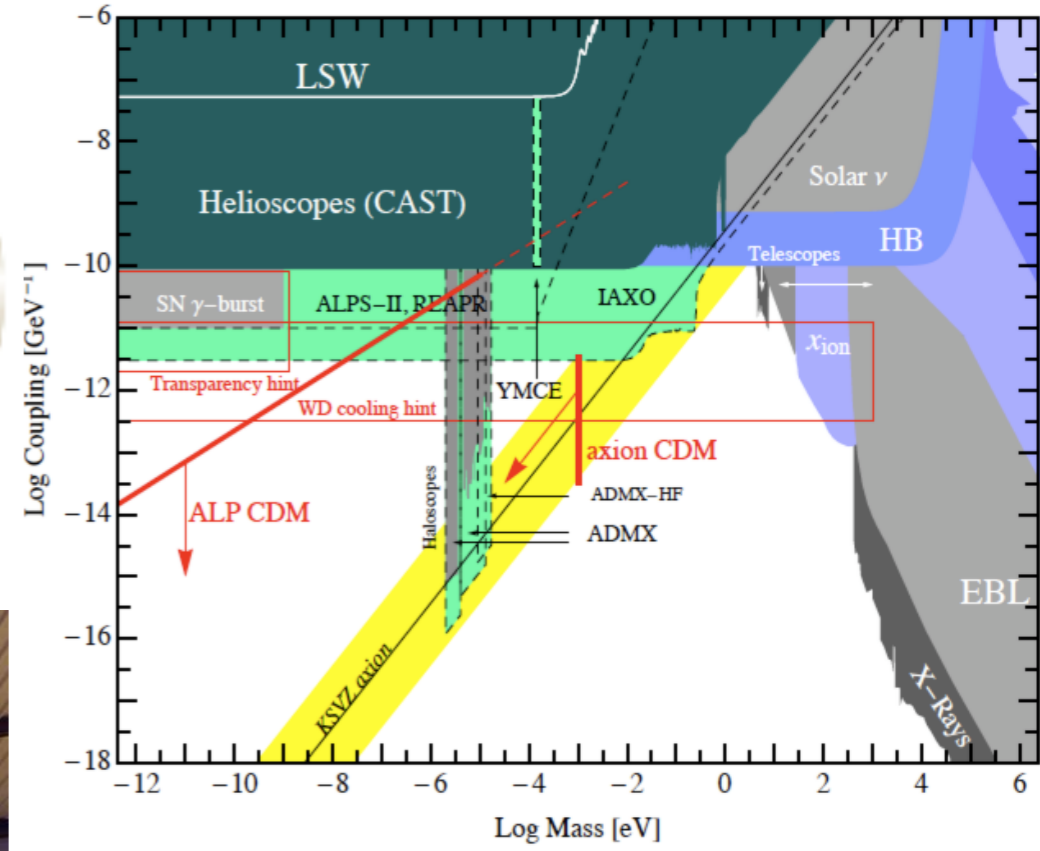
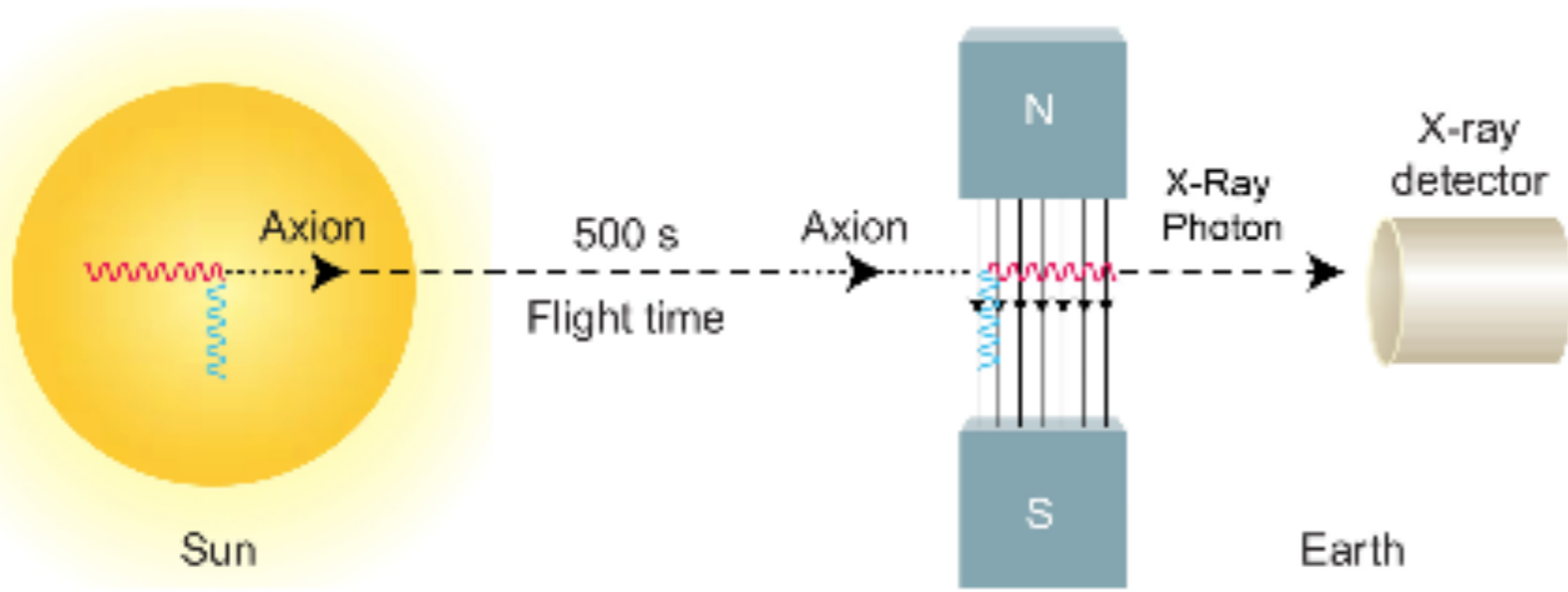
Anti-hydrogen experiments

- ALPHA, ACE, AEGIS, ATRAP, ASACUSA

These experiments try to trap anti-hydrogens as much as possible.

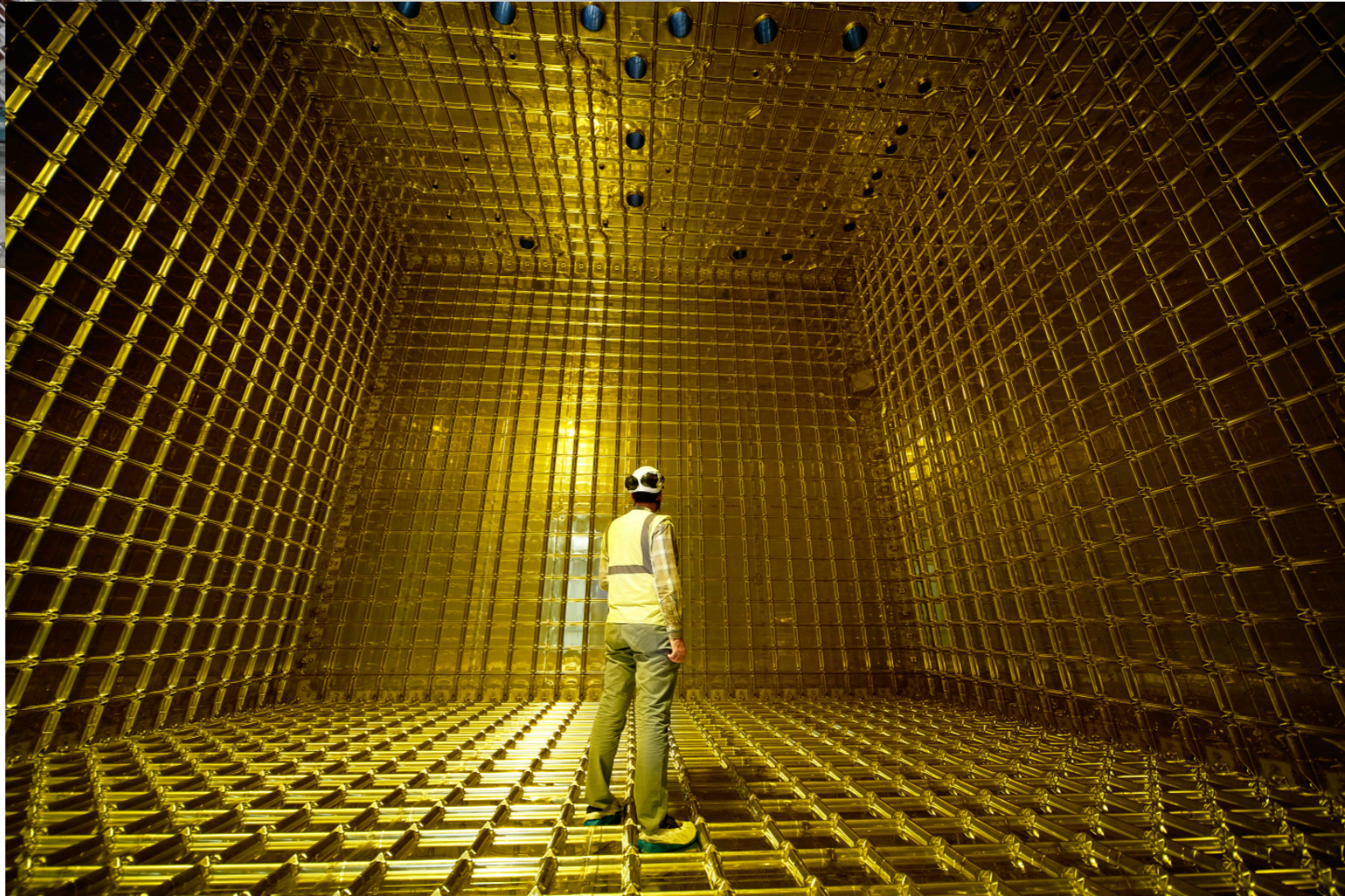
You are welcome to choose **your favorite device** as a report topic. For example, these experiments have special devices for special purposes (target polarization, beam polarization, positron-antiproton trap, etc)

CAST, CERN Axion Solar Telescope

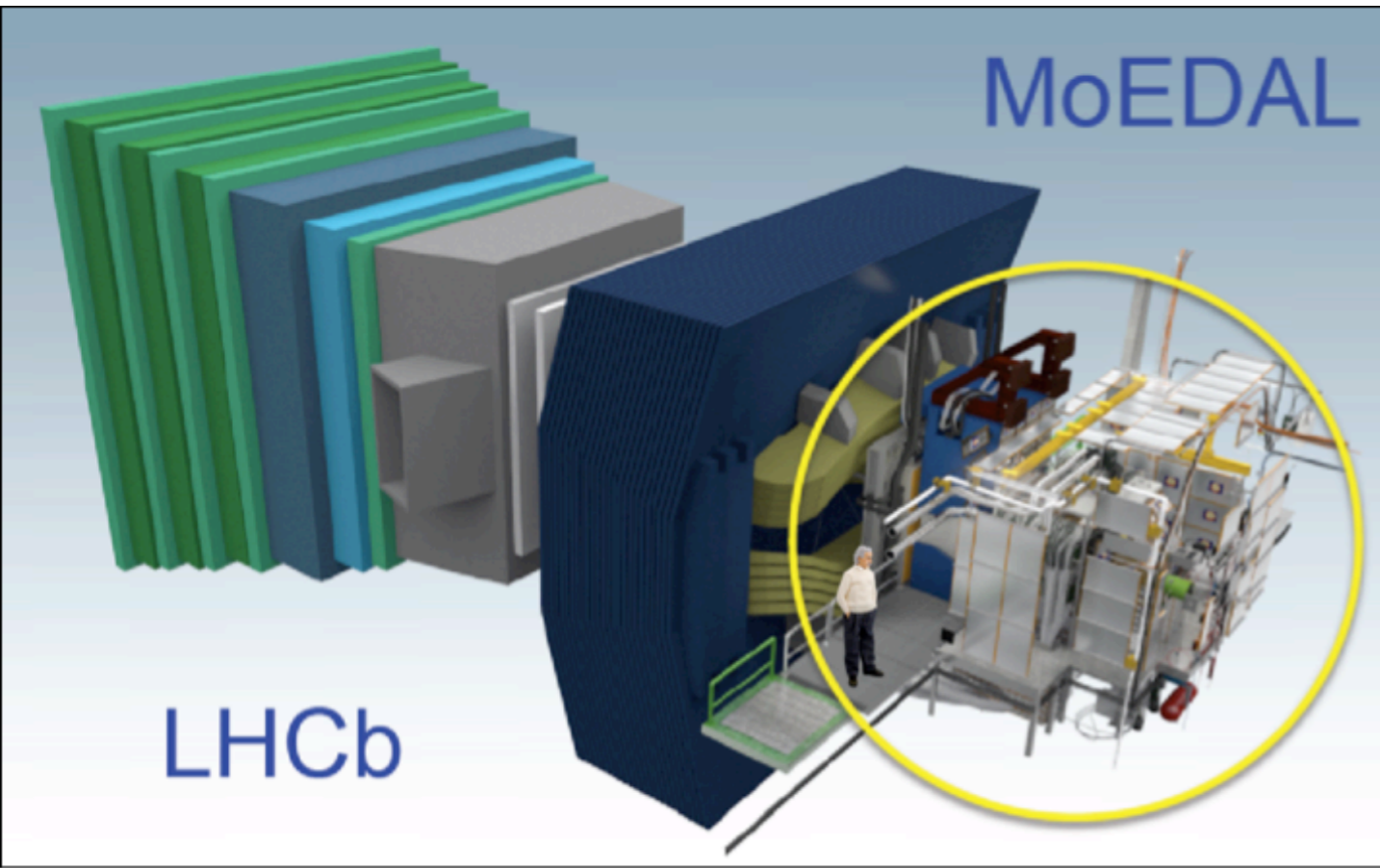


This is one of few dark matter experiment at CERN (next week).

protoDUNE, LArTPC prototype detector of DUNE



This is a proto type neutrino detector at CERN (next week).



This is a type of non-conventional detector at CERN.



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etc

All CERN experiments
<http://home.cern/about/experiments>