

Accelerating Science through ART

Science & Art Research & Creation

Michael Hoch
CERN / art@CMS

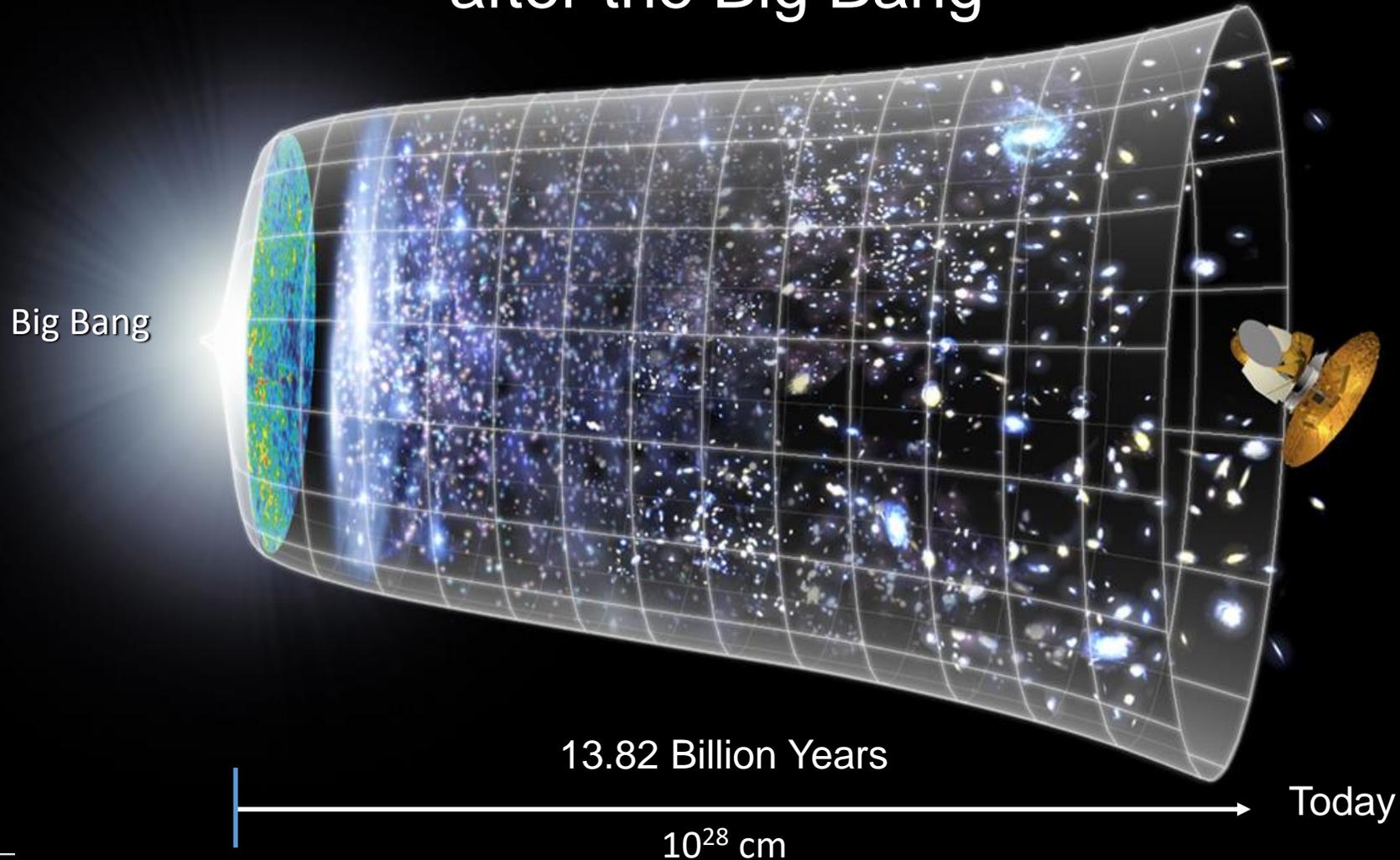
University of Montenegro 12/12/2017

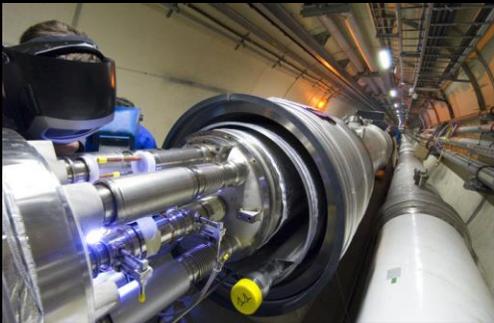
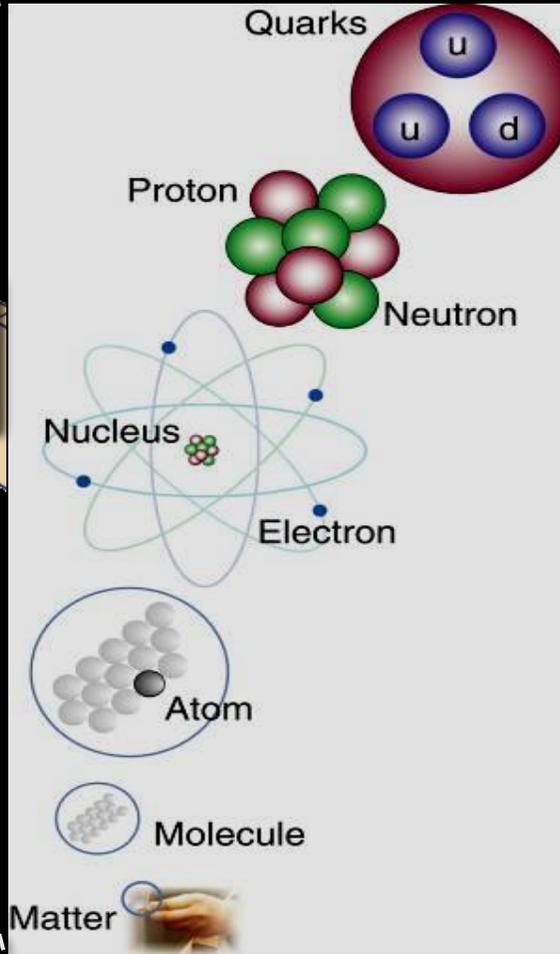
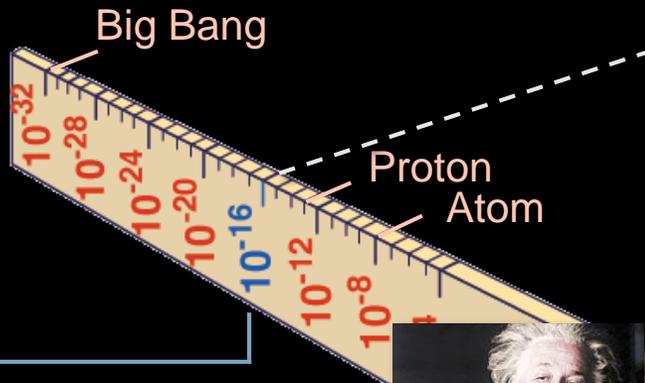


LHC 27 km



Next Scientific Challenge: to understand the very first moments of our Universe after the Big Bang





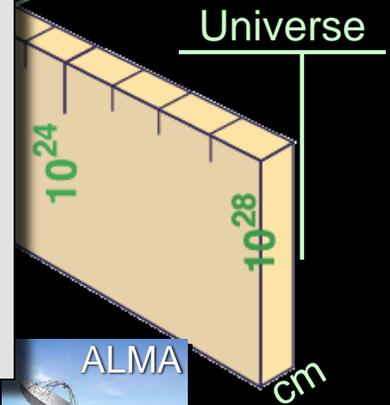
LHC

Super-Microscope



By studying physics laws of fundamental particles – the smallest construction elements of Nature - we can understand the rules of Astrophysics and Cosmology

Radius of Galaxies



Forces & Interactions

Electromagnetic force - photons
- electric and magnetic phenomes

Weak nuclear force - W & Z Bosons
- beta decay

Strong nuclear force – Gluon
burning in the Sun, nuclei

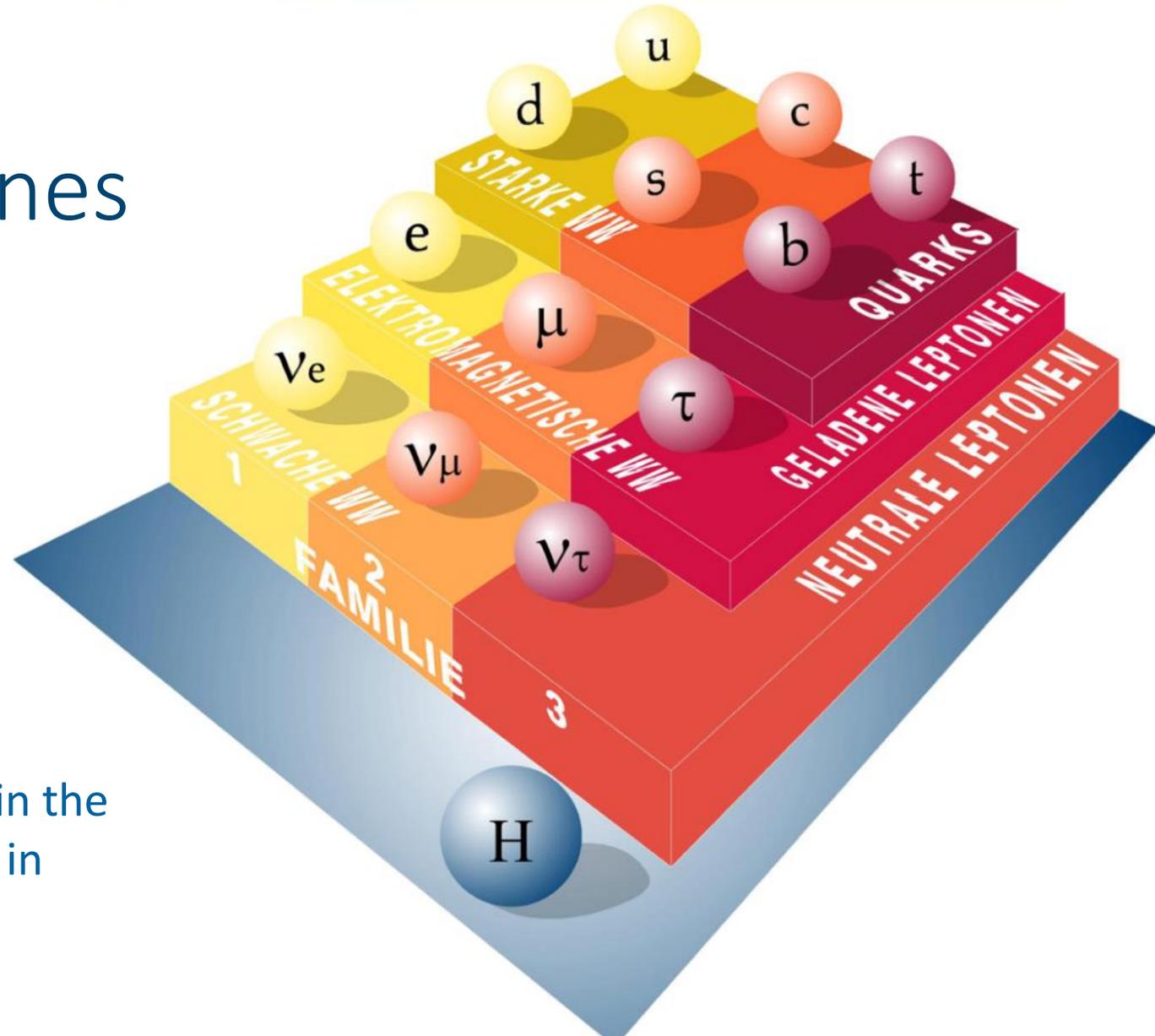
Gravitation – Graviton ?

Standard Model

Matter particles : Quarks & Leptones

6 Quarks and 6 Leptons .

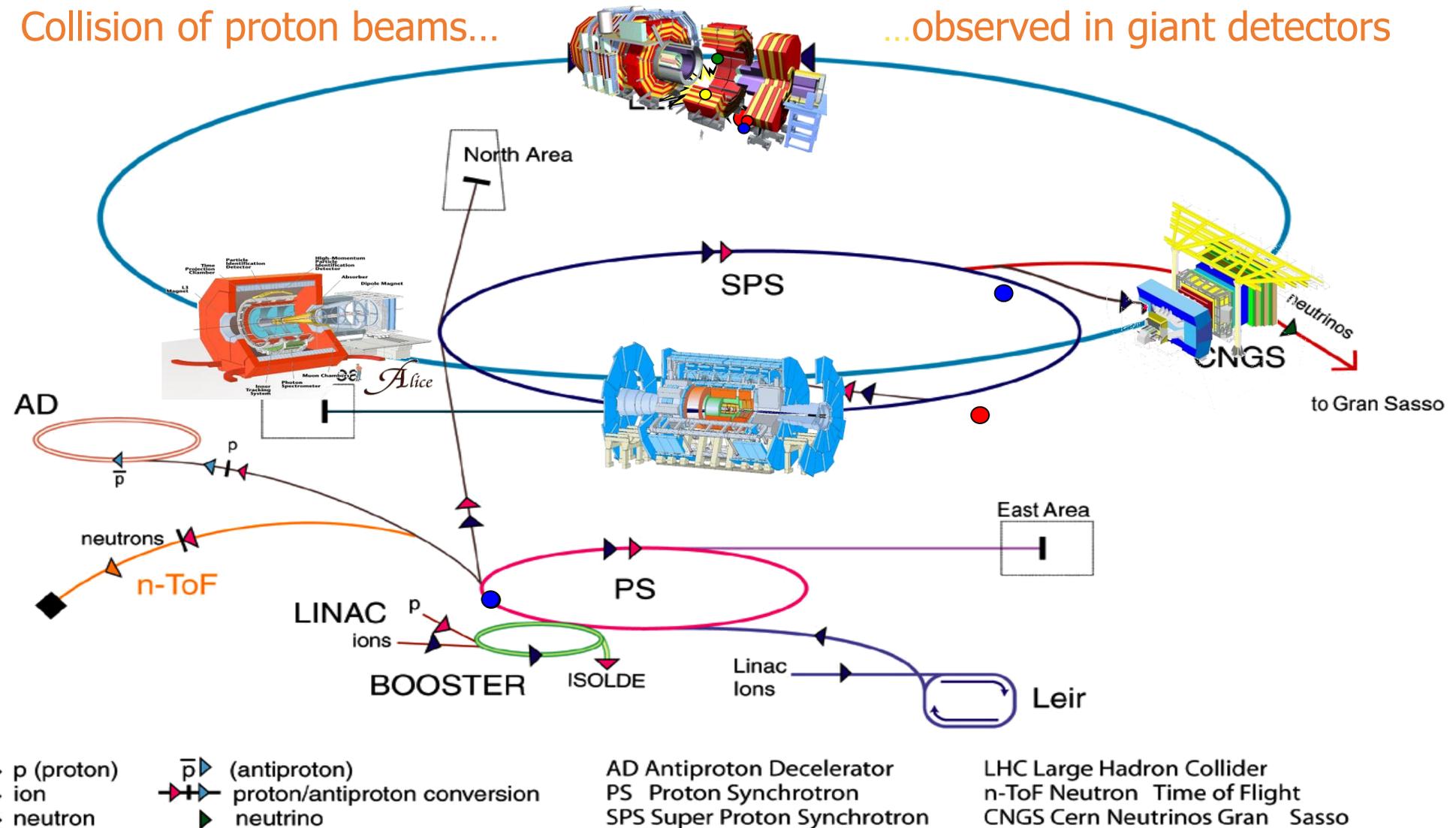
- 3 Families, with increasing mass
- Heavy particles decay to lighter ones
- Particles in Family 2 & 3 were existing in the eary Universe. Today they existing just in Cosmic Ray and particle accelerator.

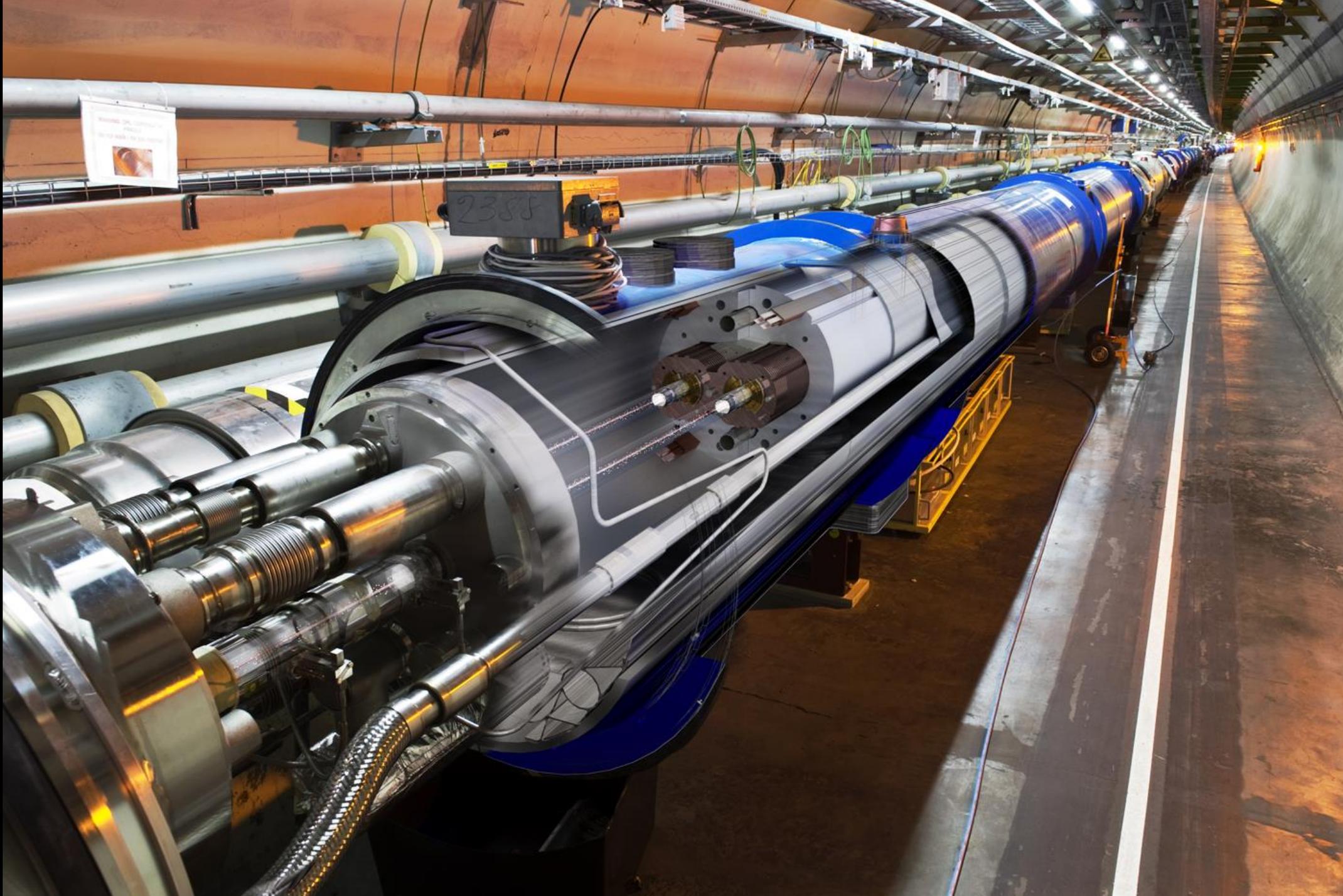


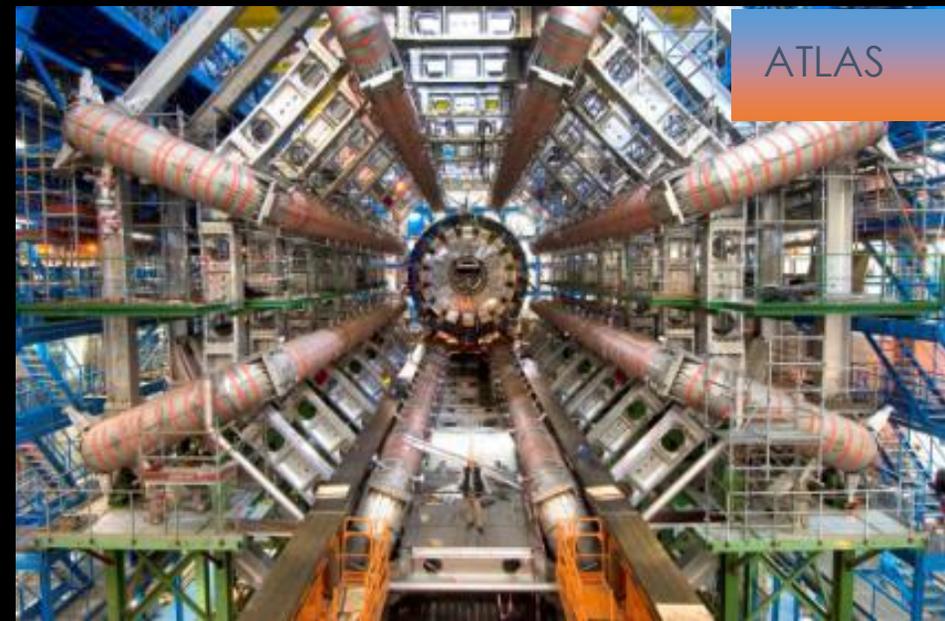
The Large Hadron Collider LHC and experiments @CERN - worlds most powerful microscope -

Collision of proton beams...

...observed in giant detectors







The
4
Large
Scale

LHC

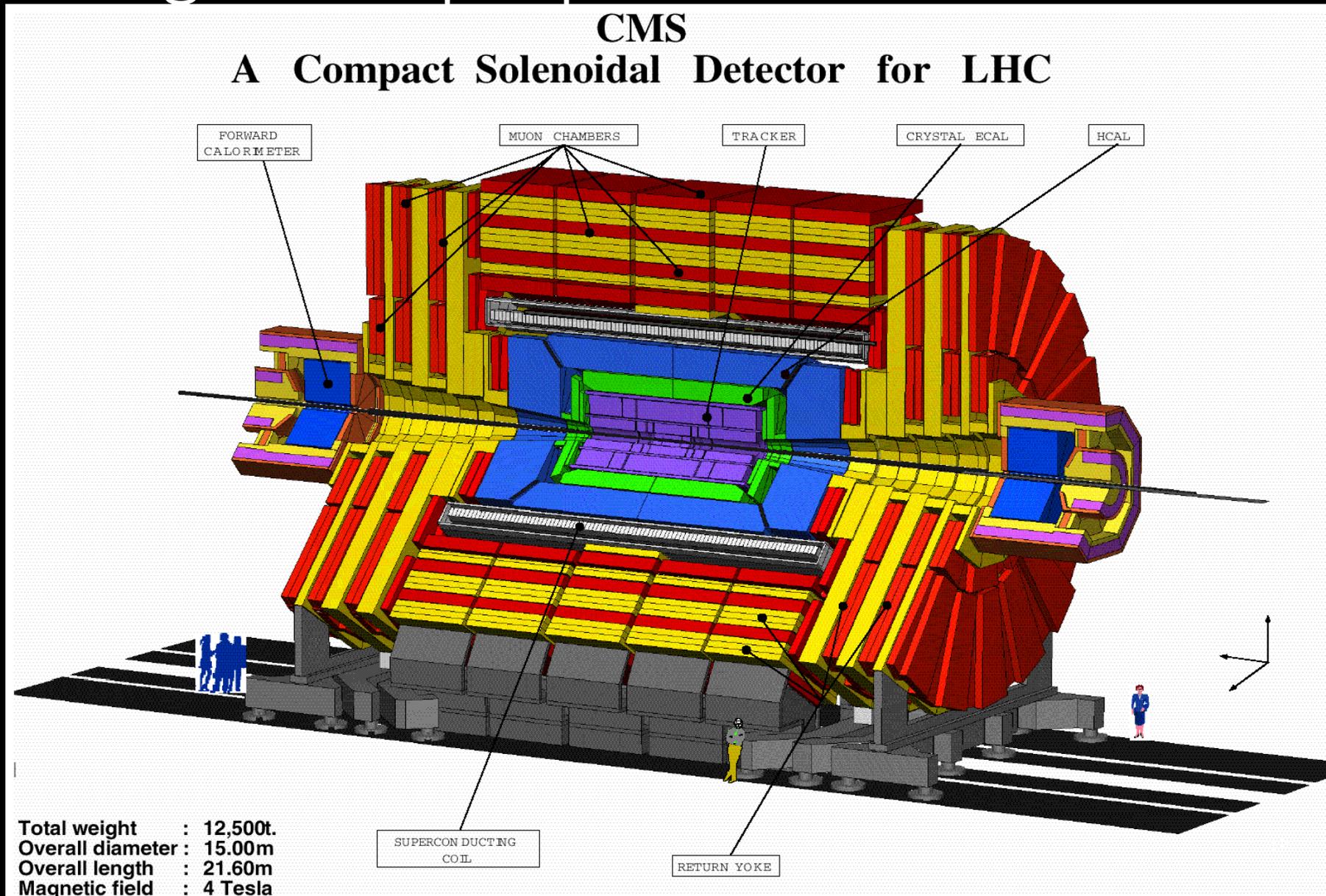


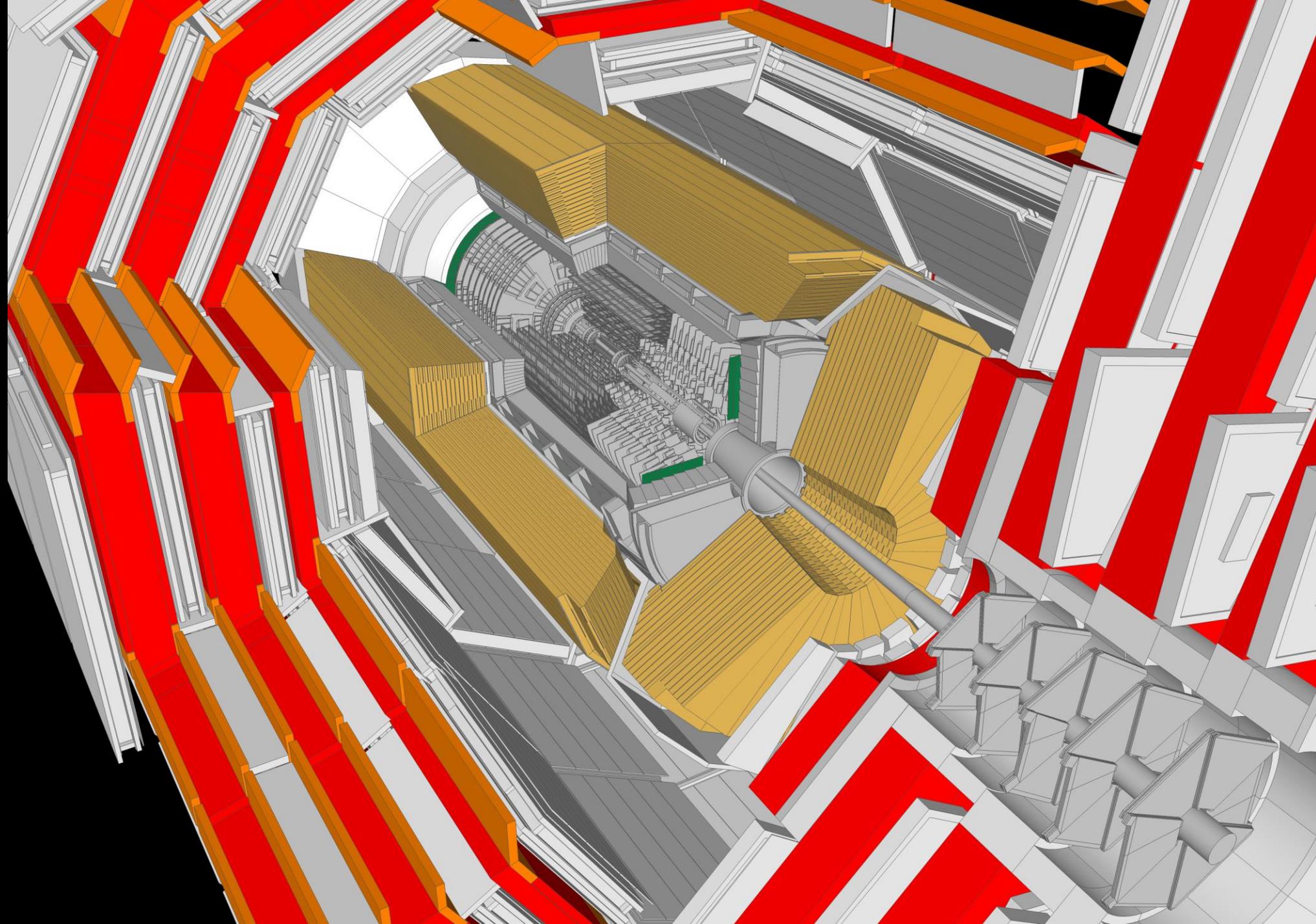
Experiments

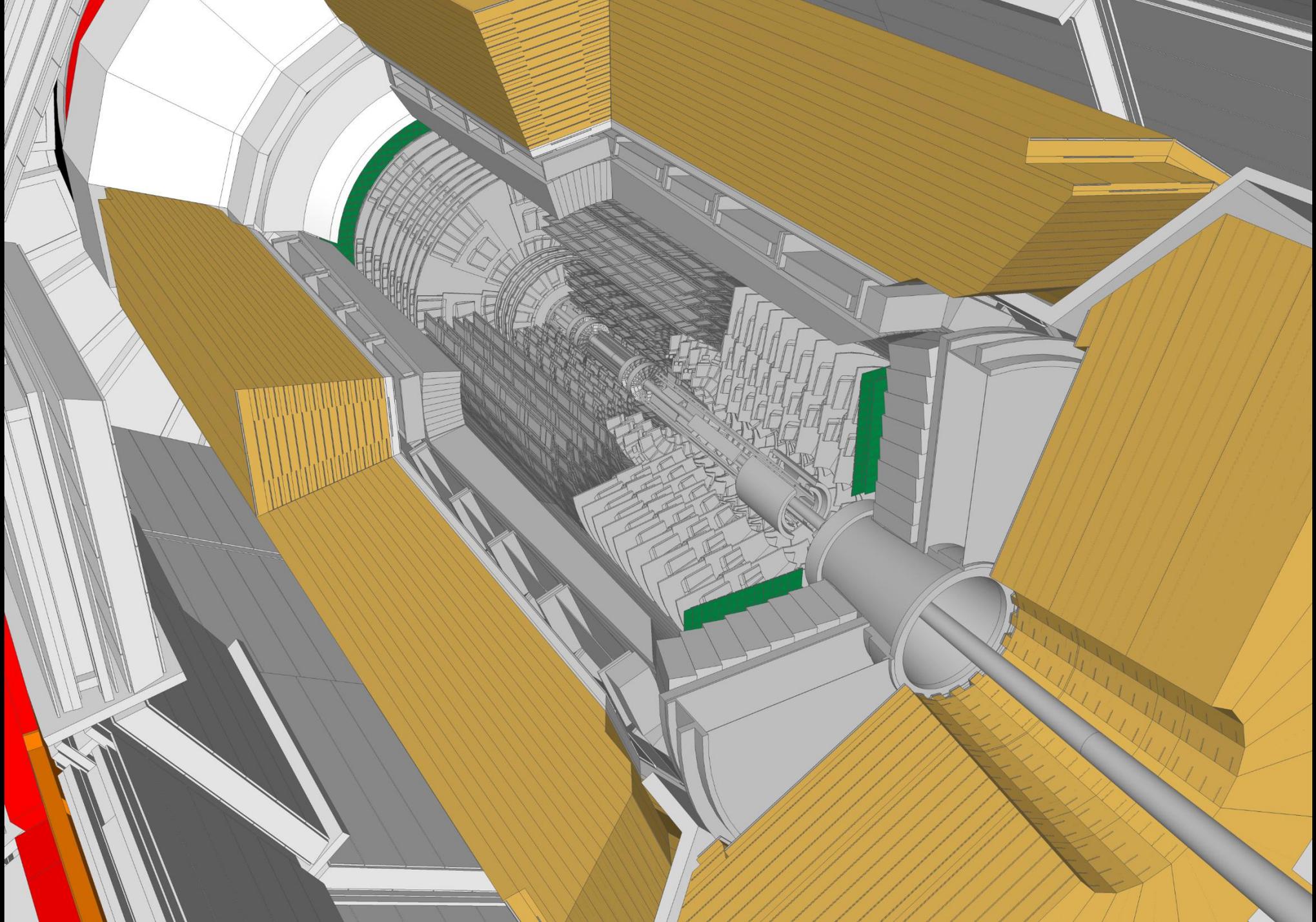
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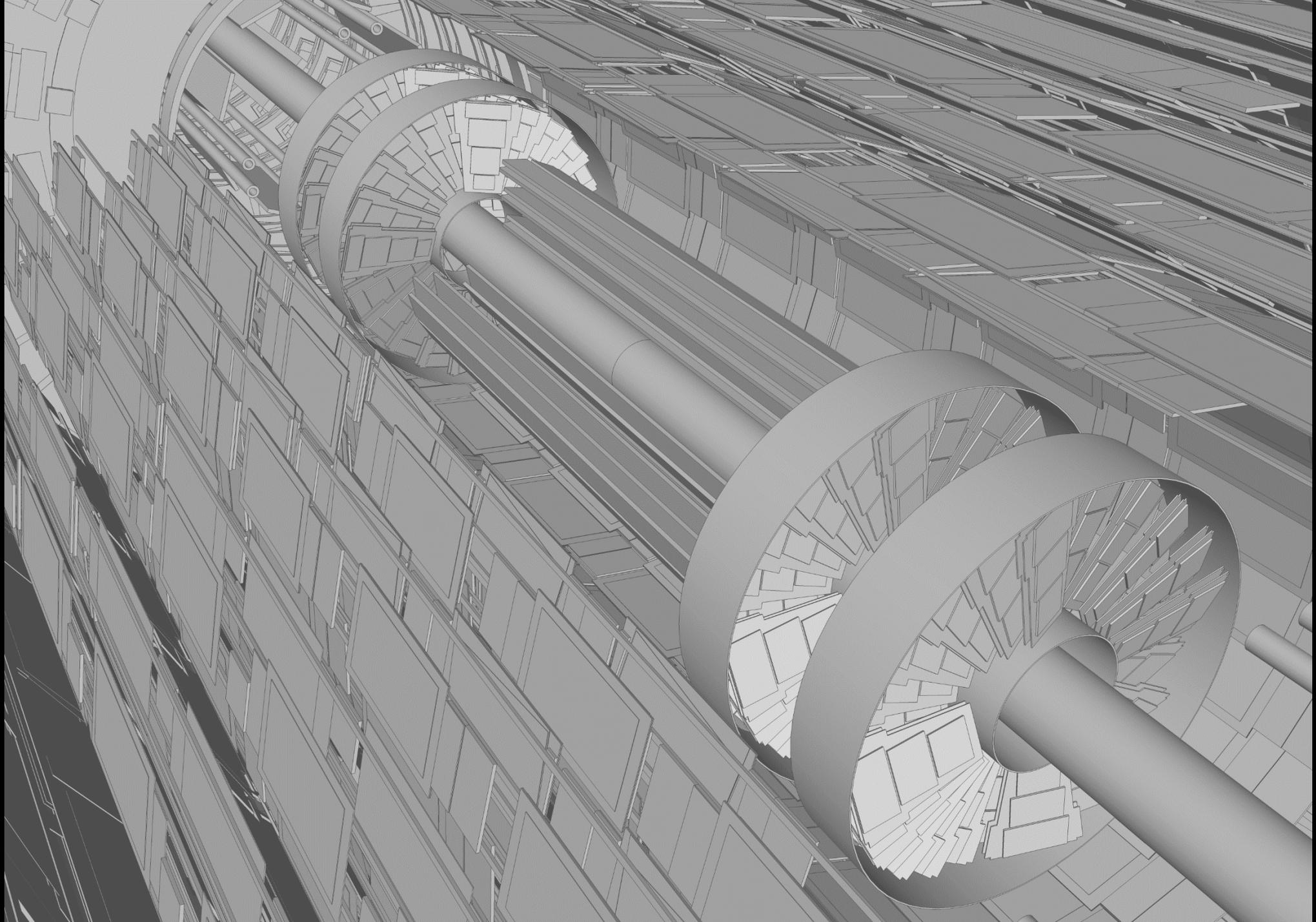
CERN

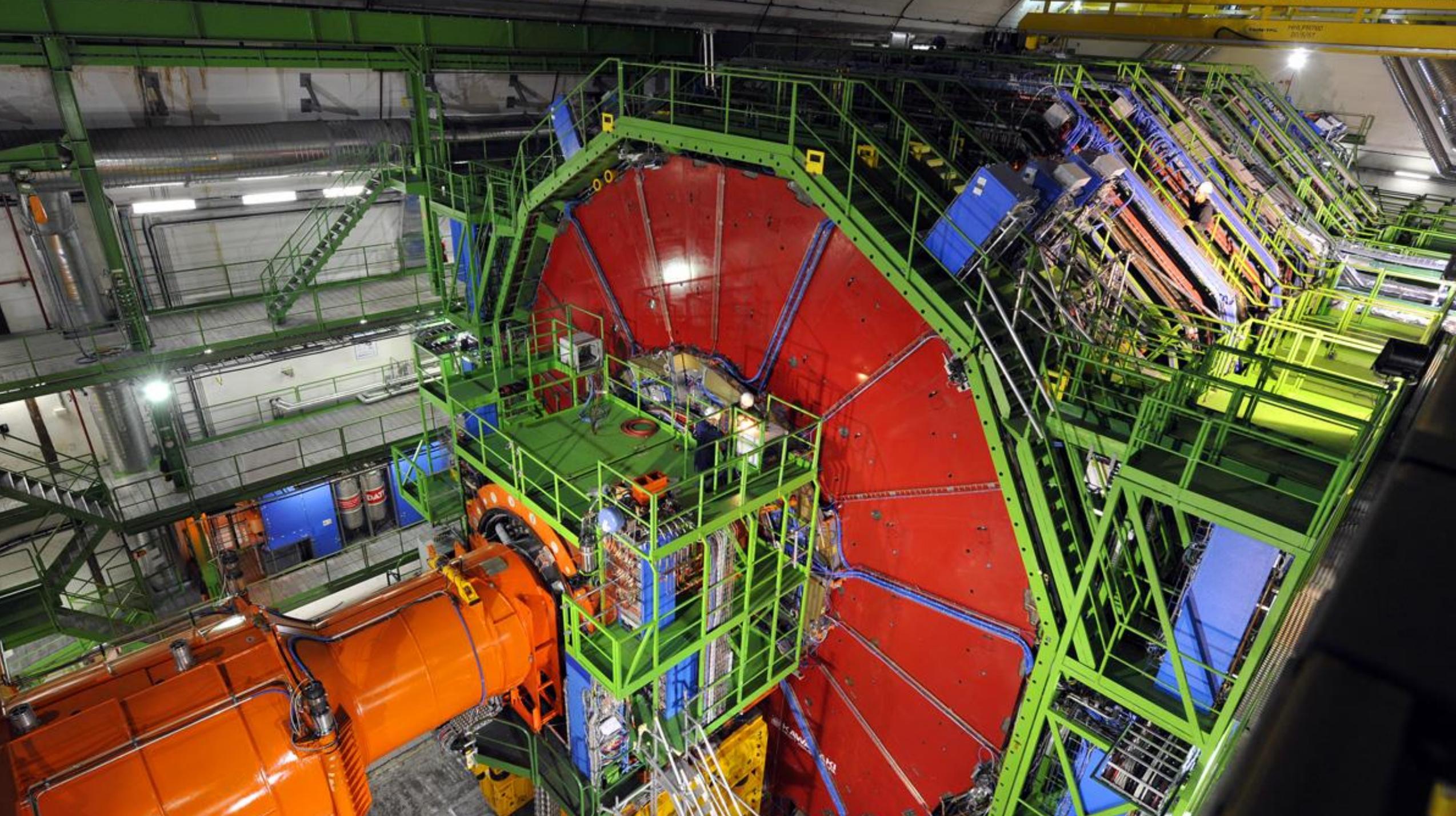
CMS - a general purpose LHC detector

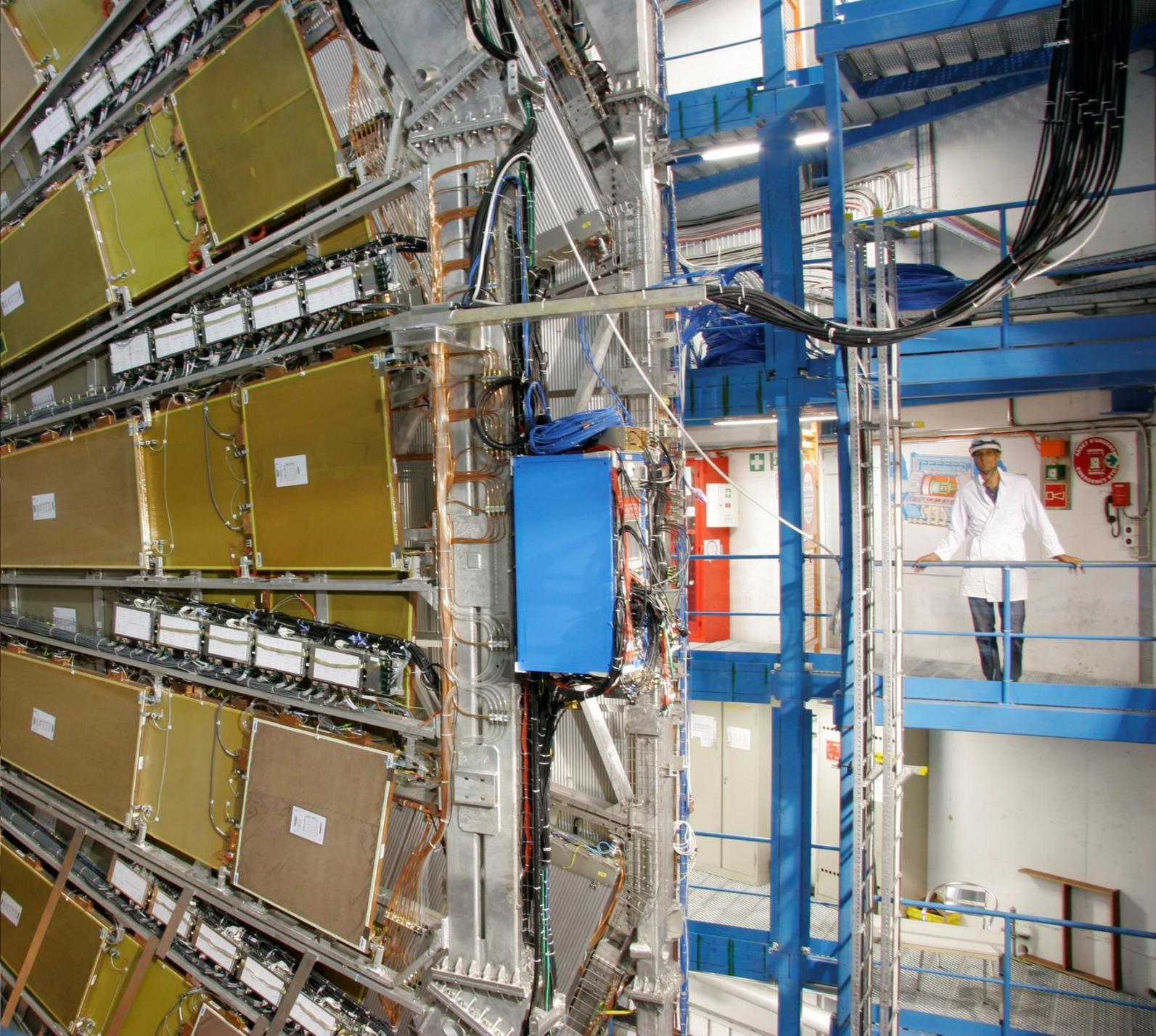




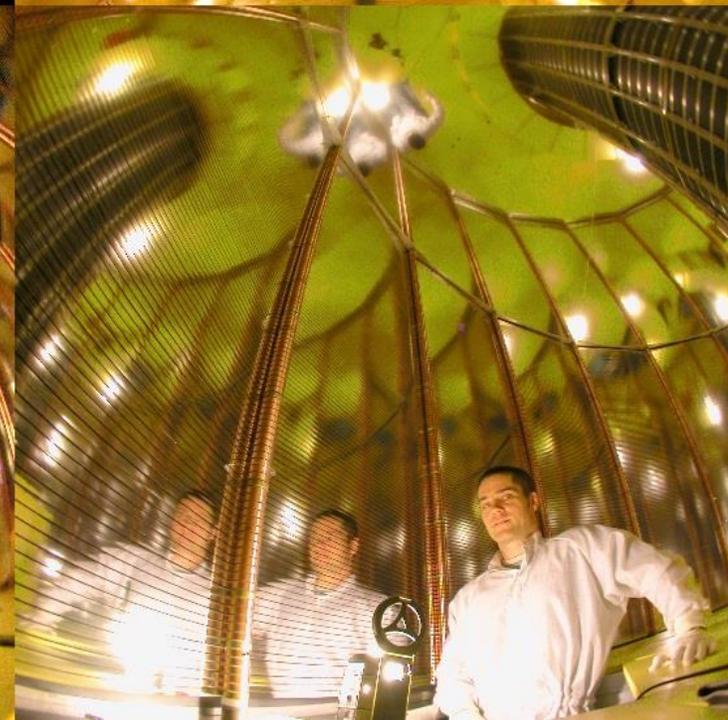
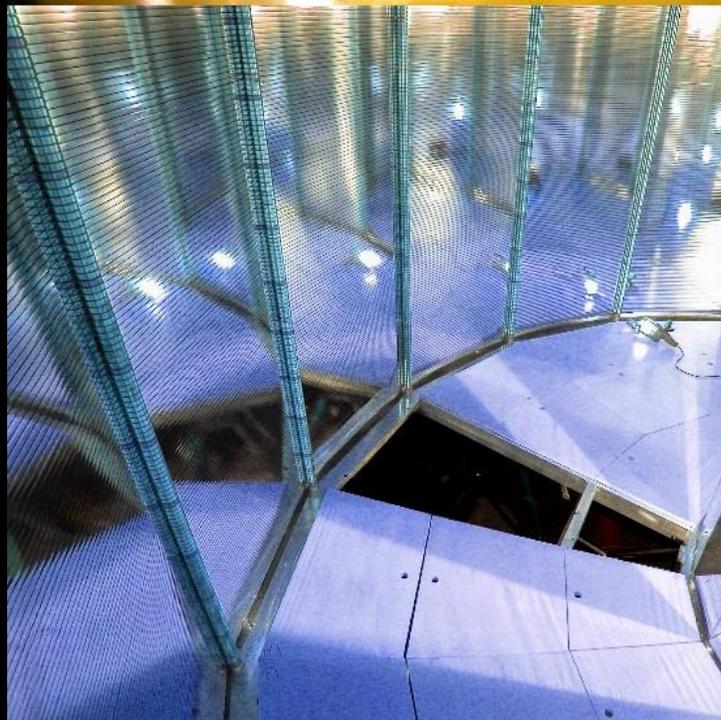
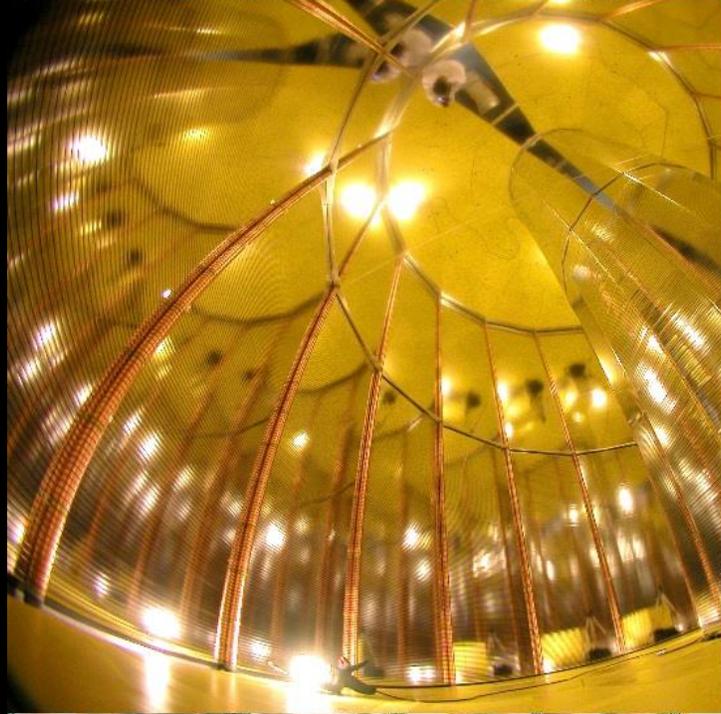


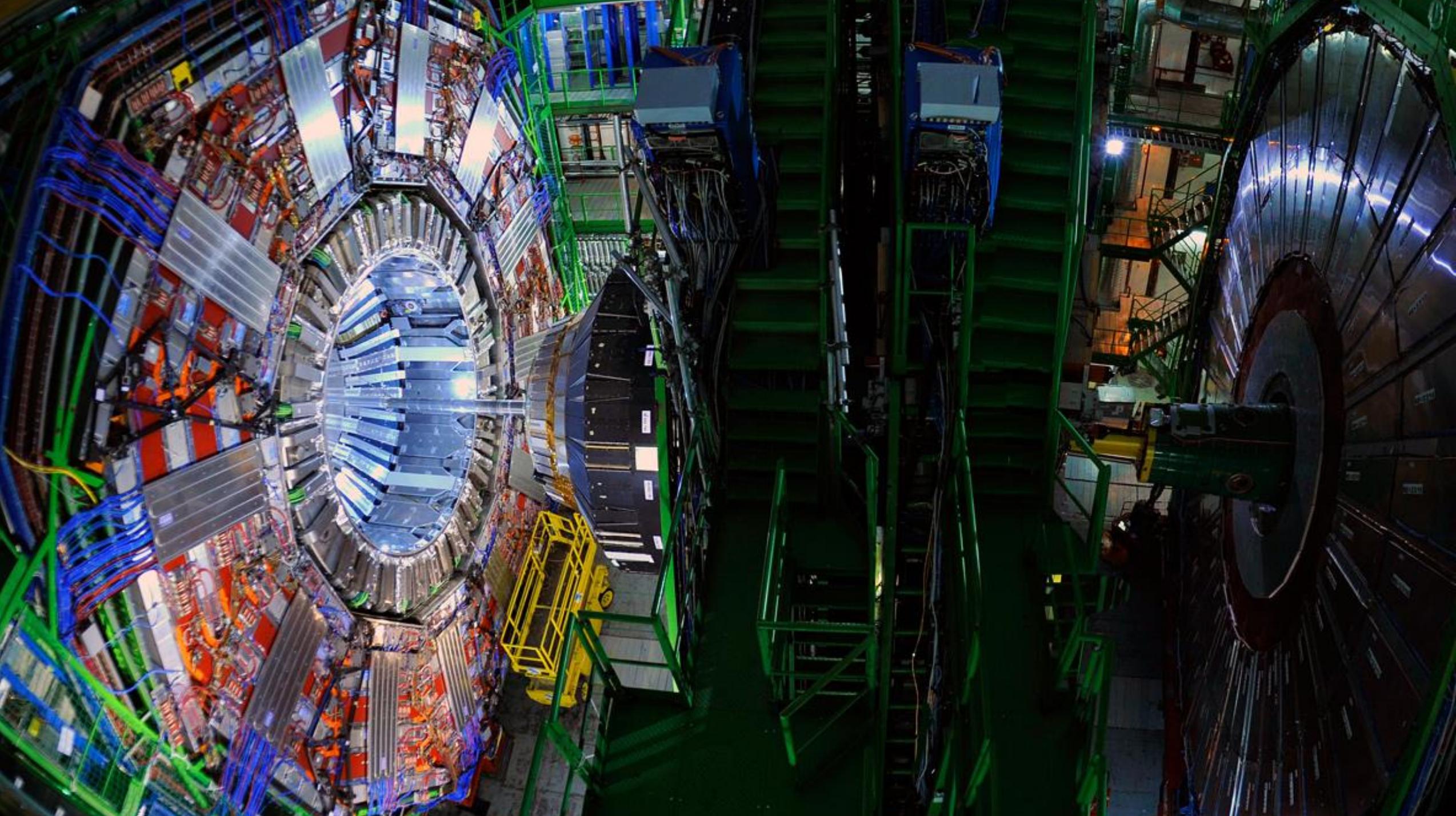


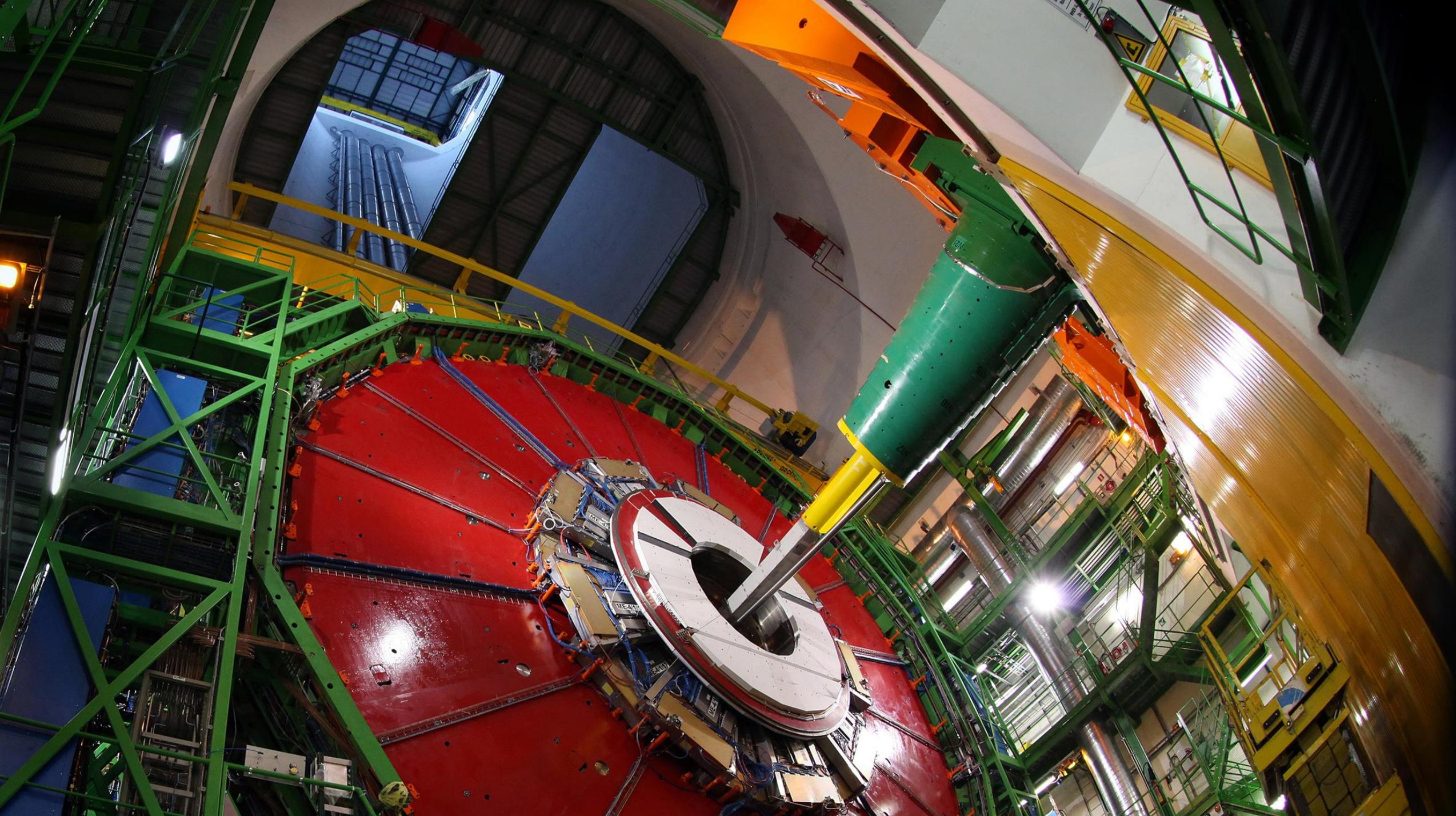


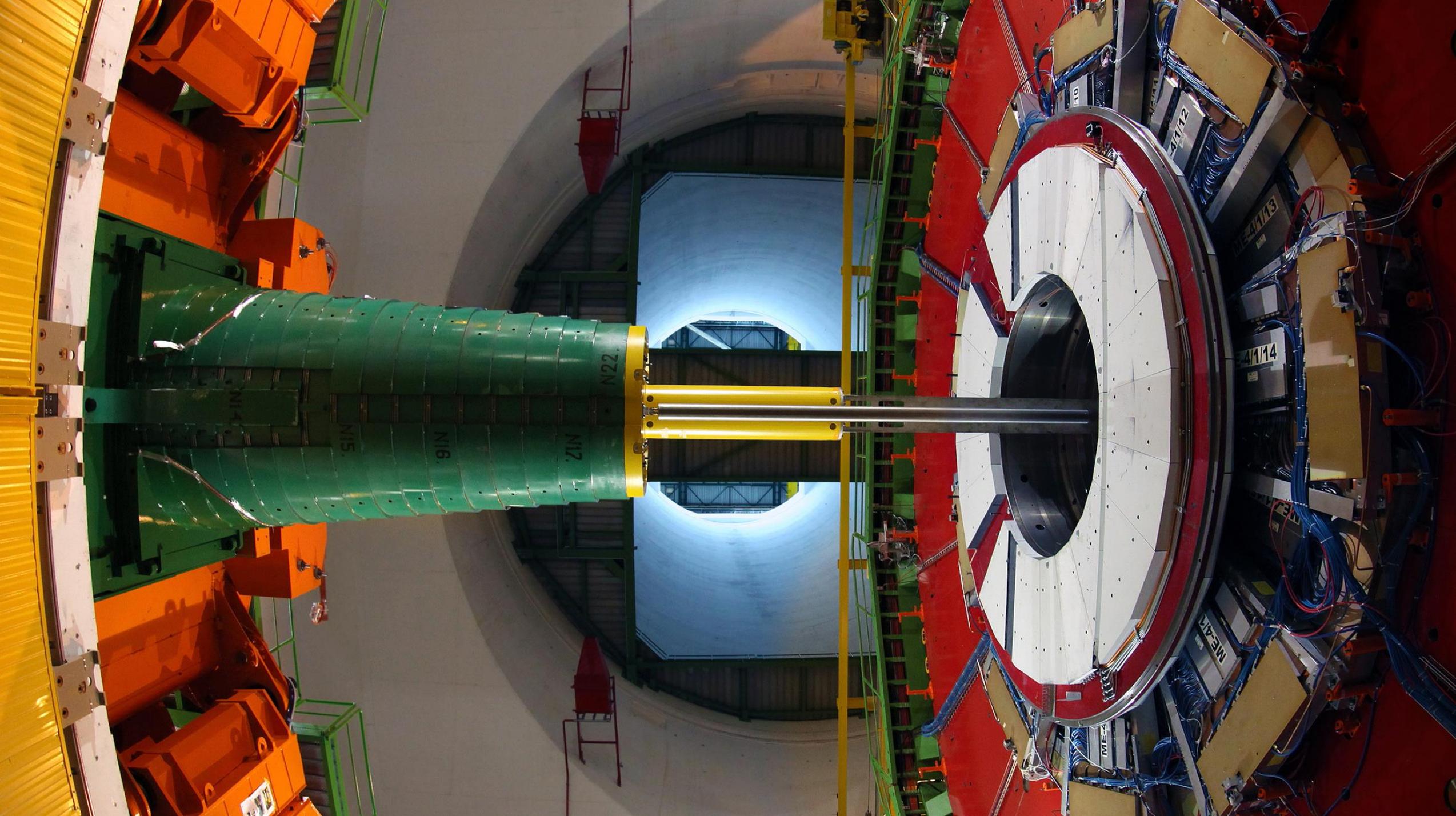


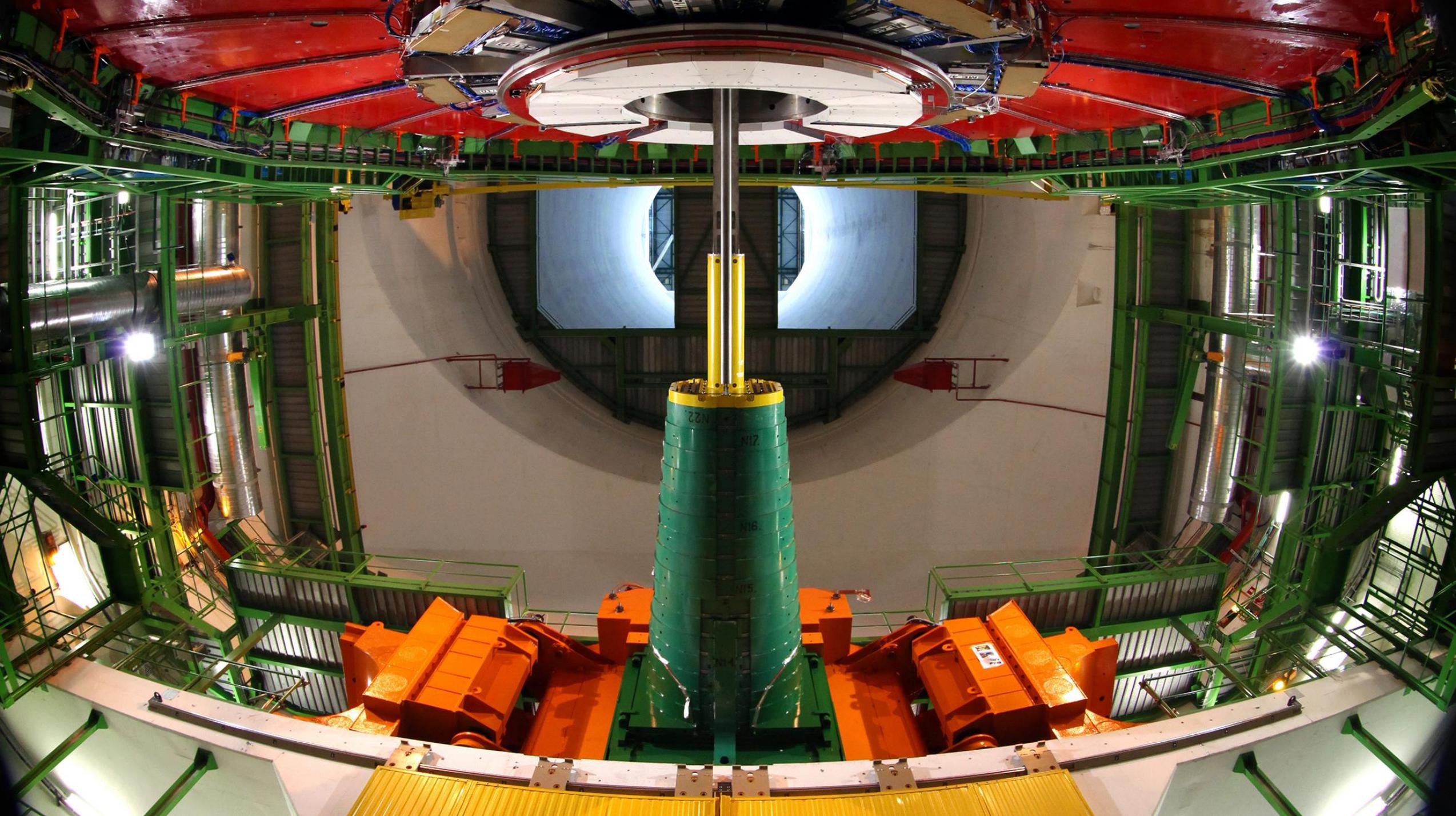


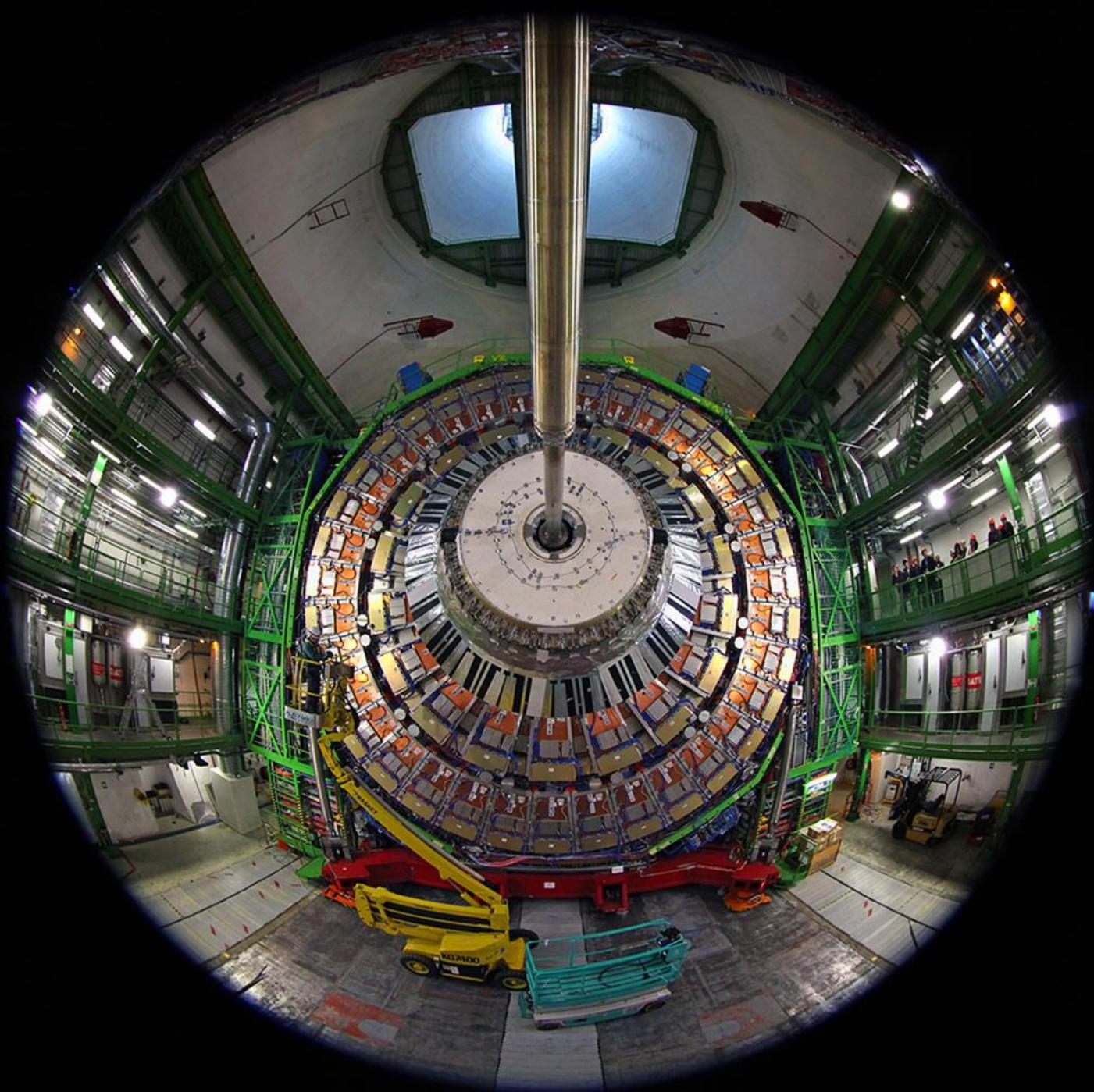


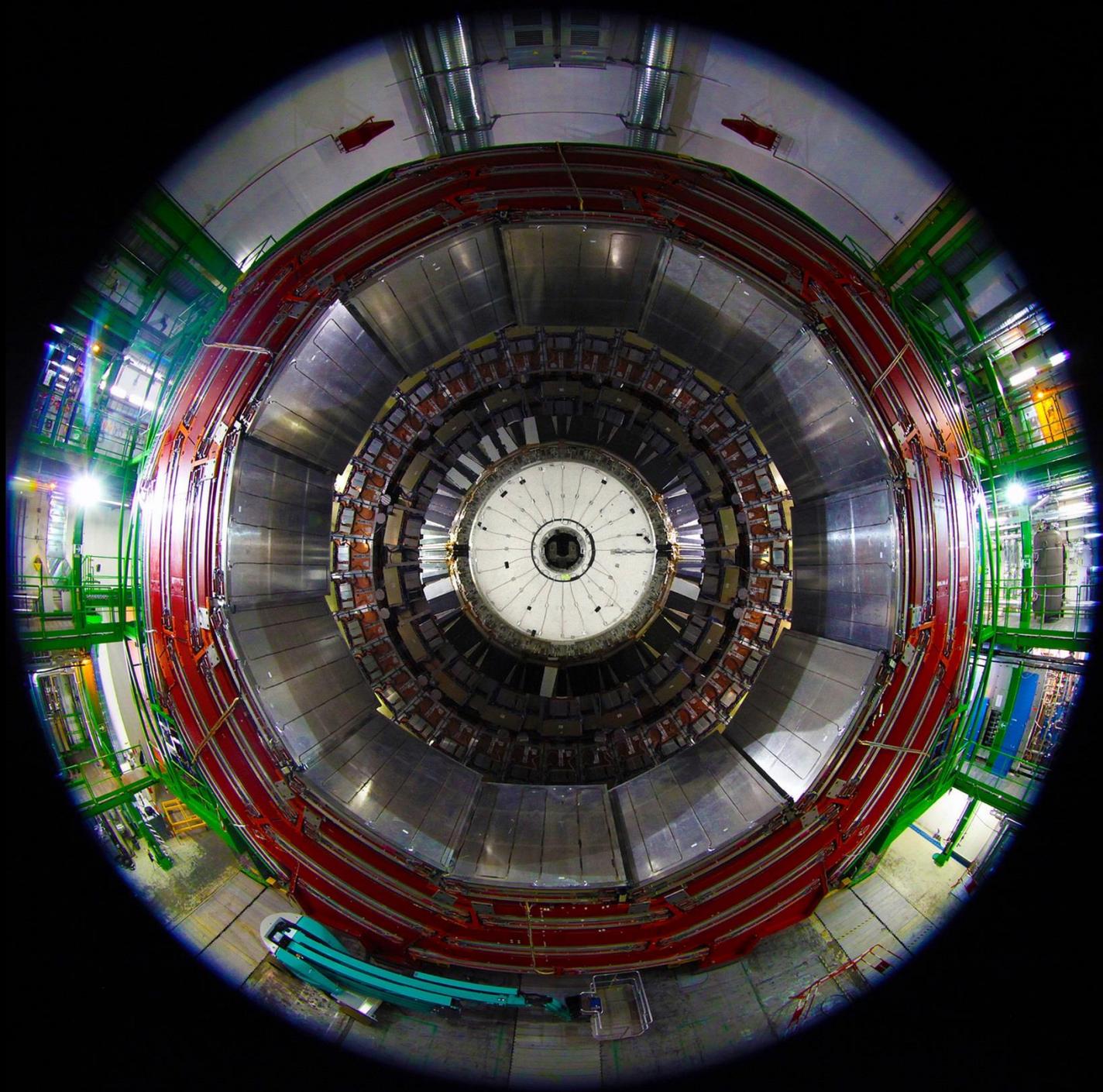


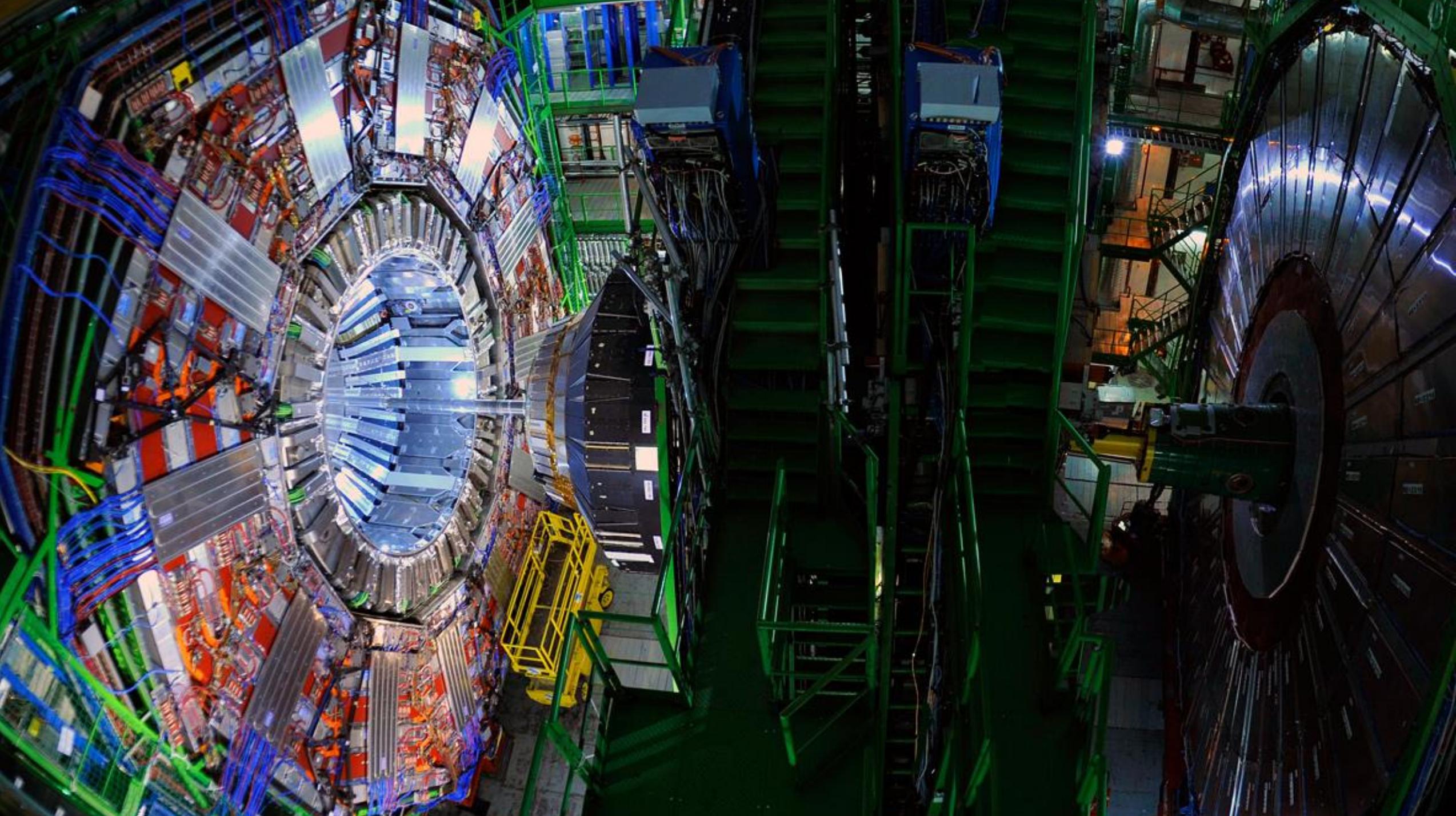














What happens during collisions of elementary particles ?



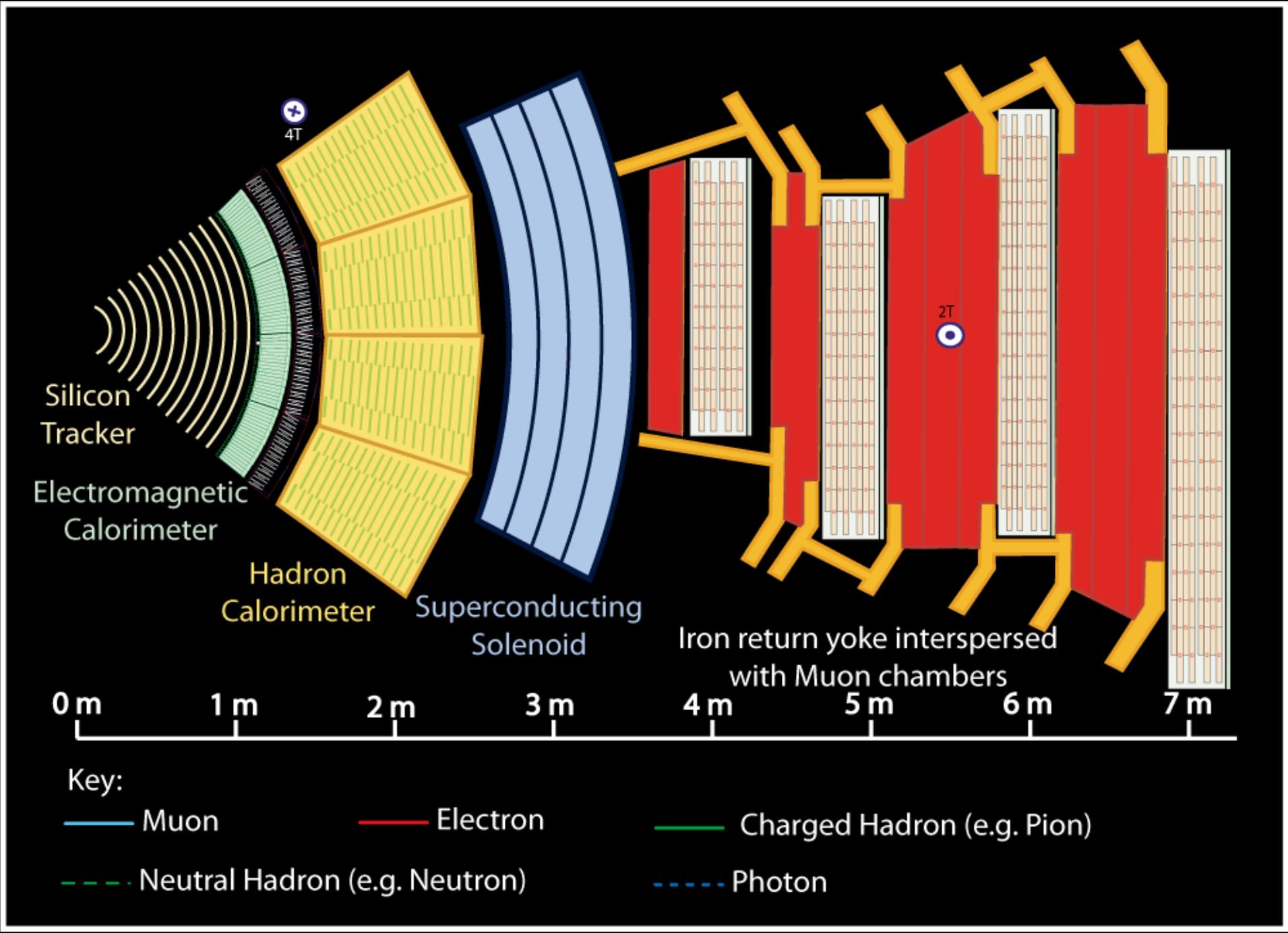


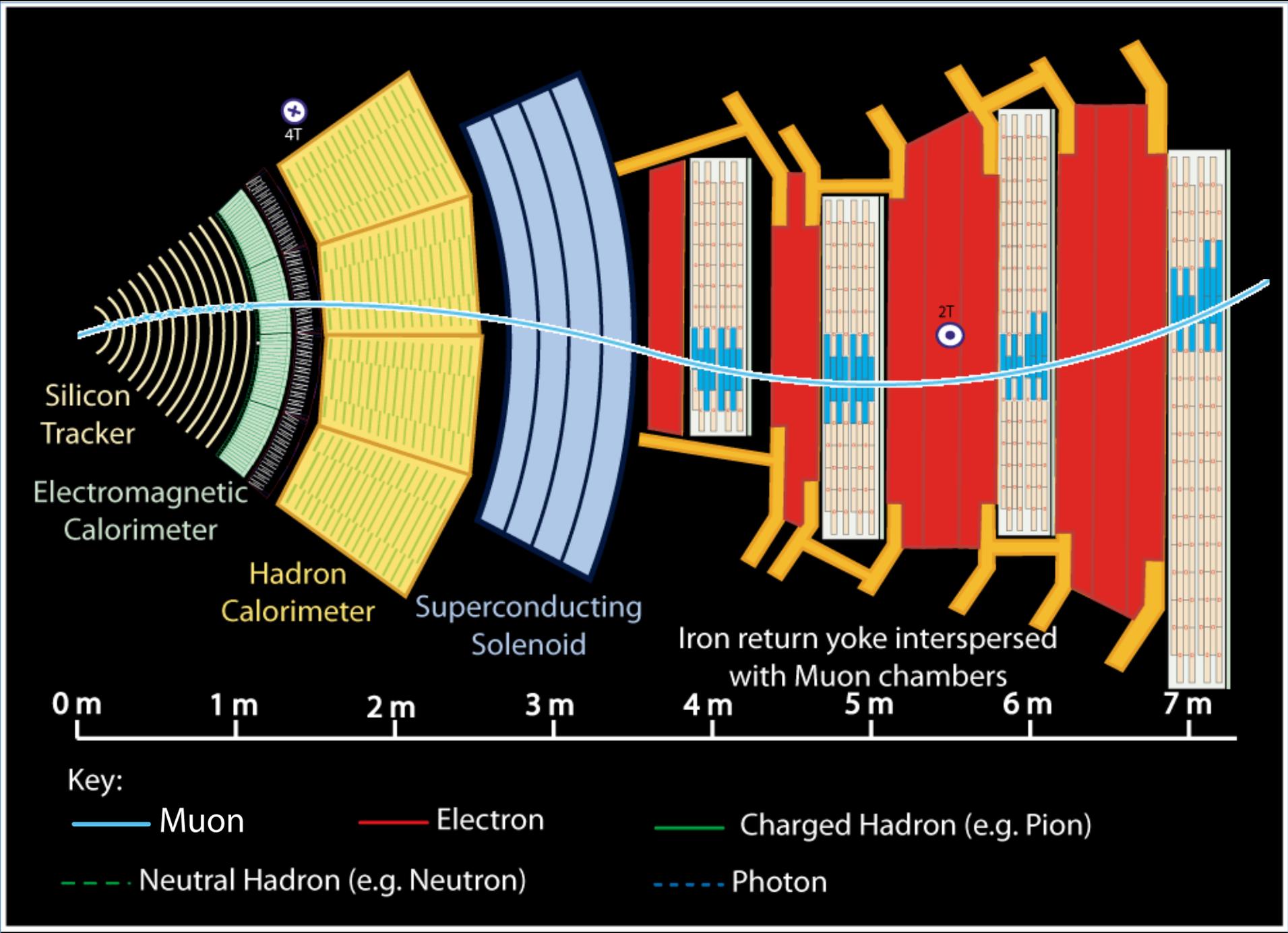
CMS Experiment at the LHC, CERN

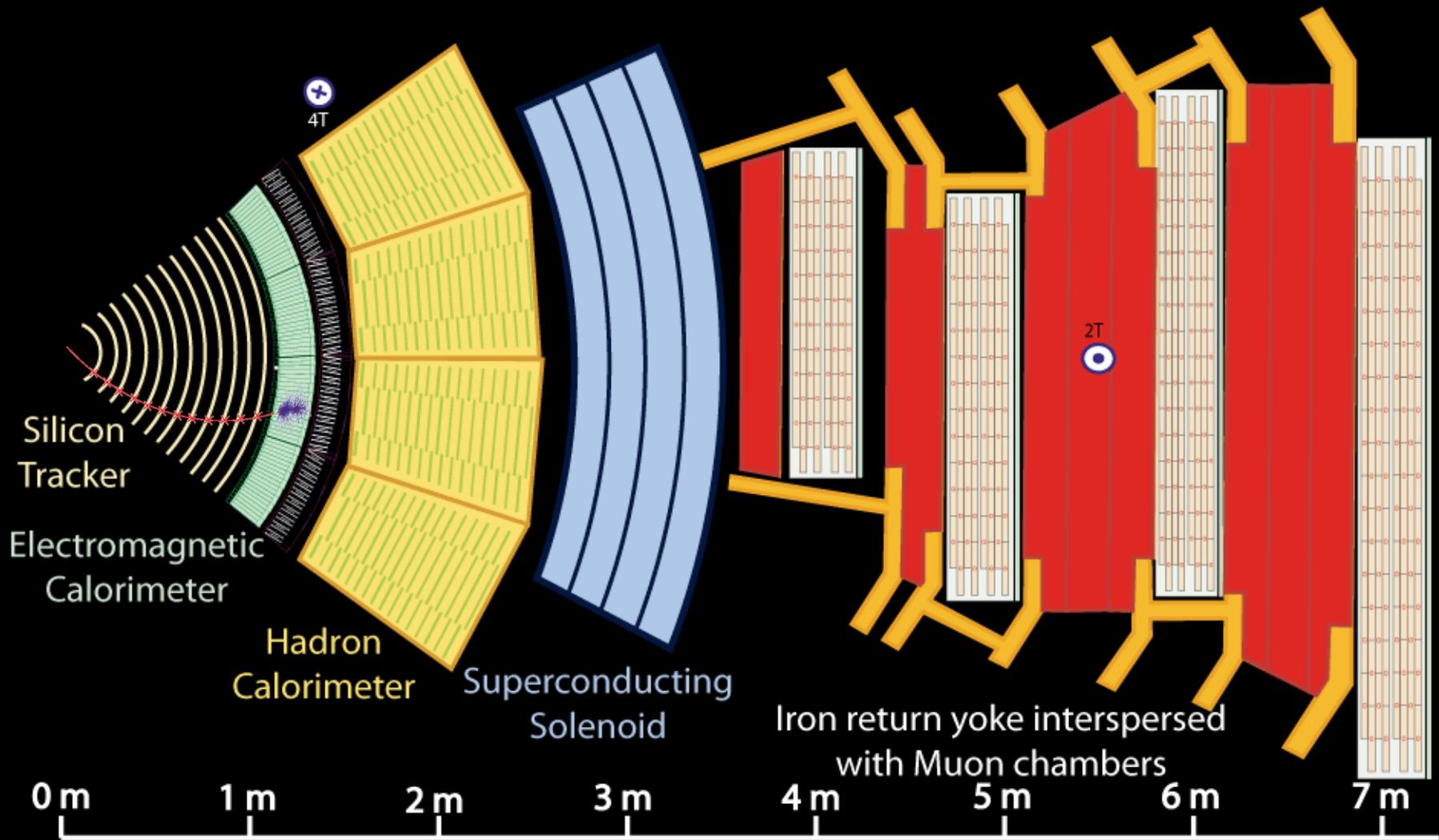
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Run / Event: 139779 / 4994190

2







Key:

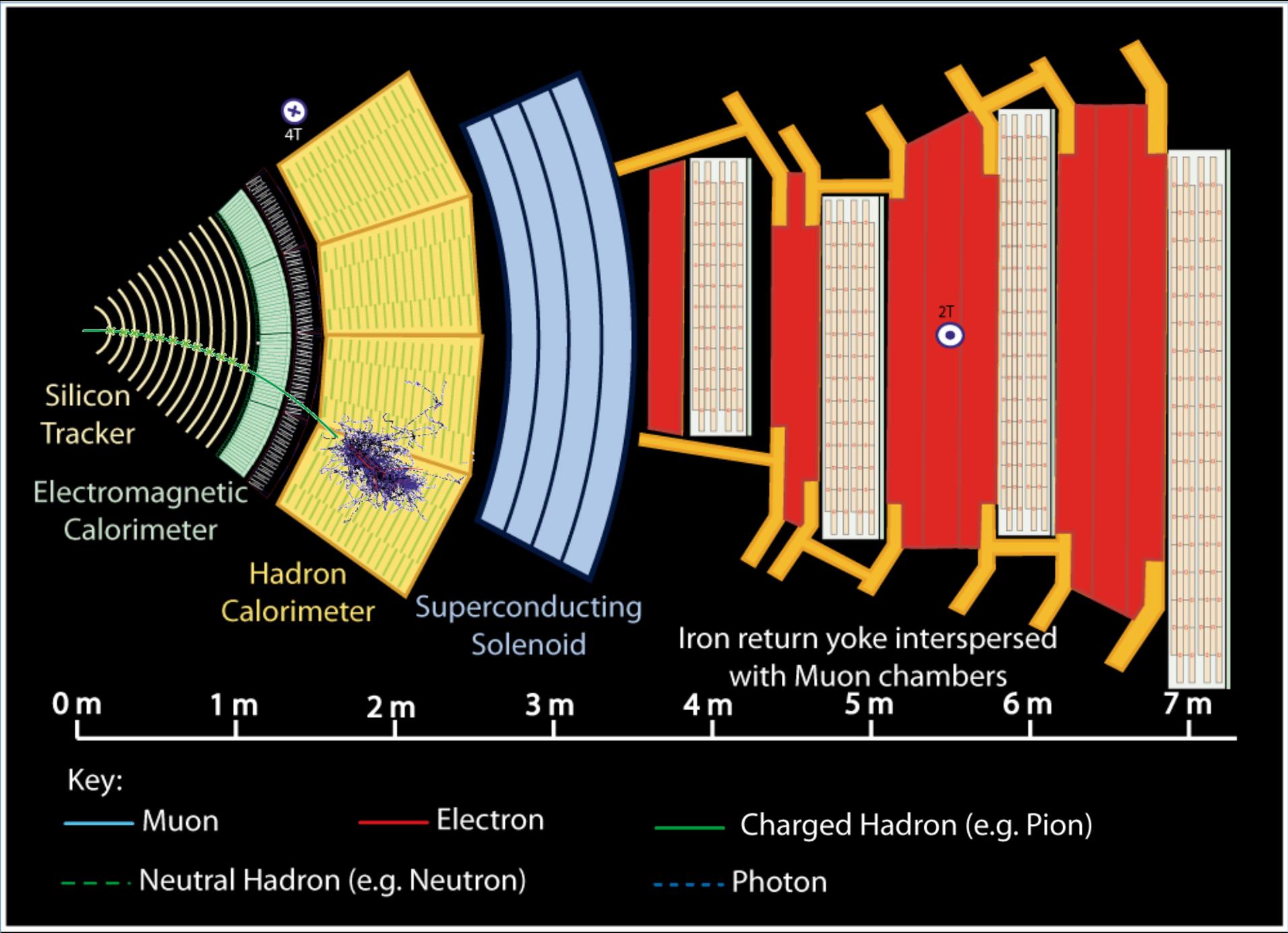
— Muon

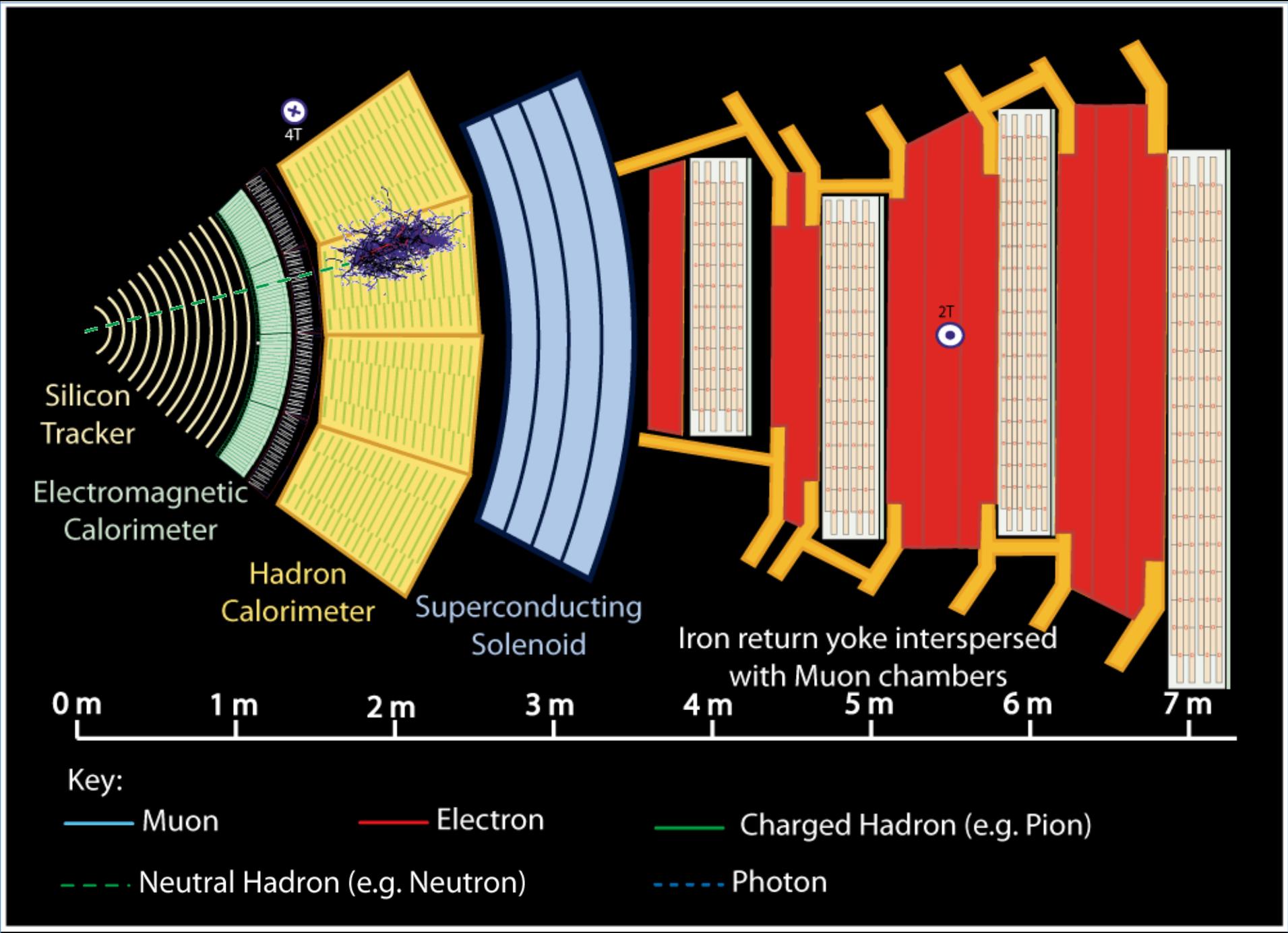
— Electron

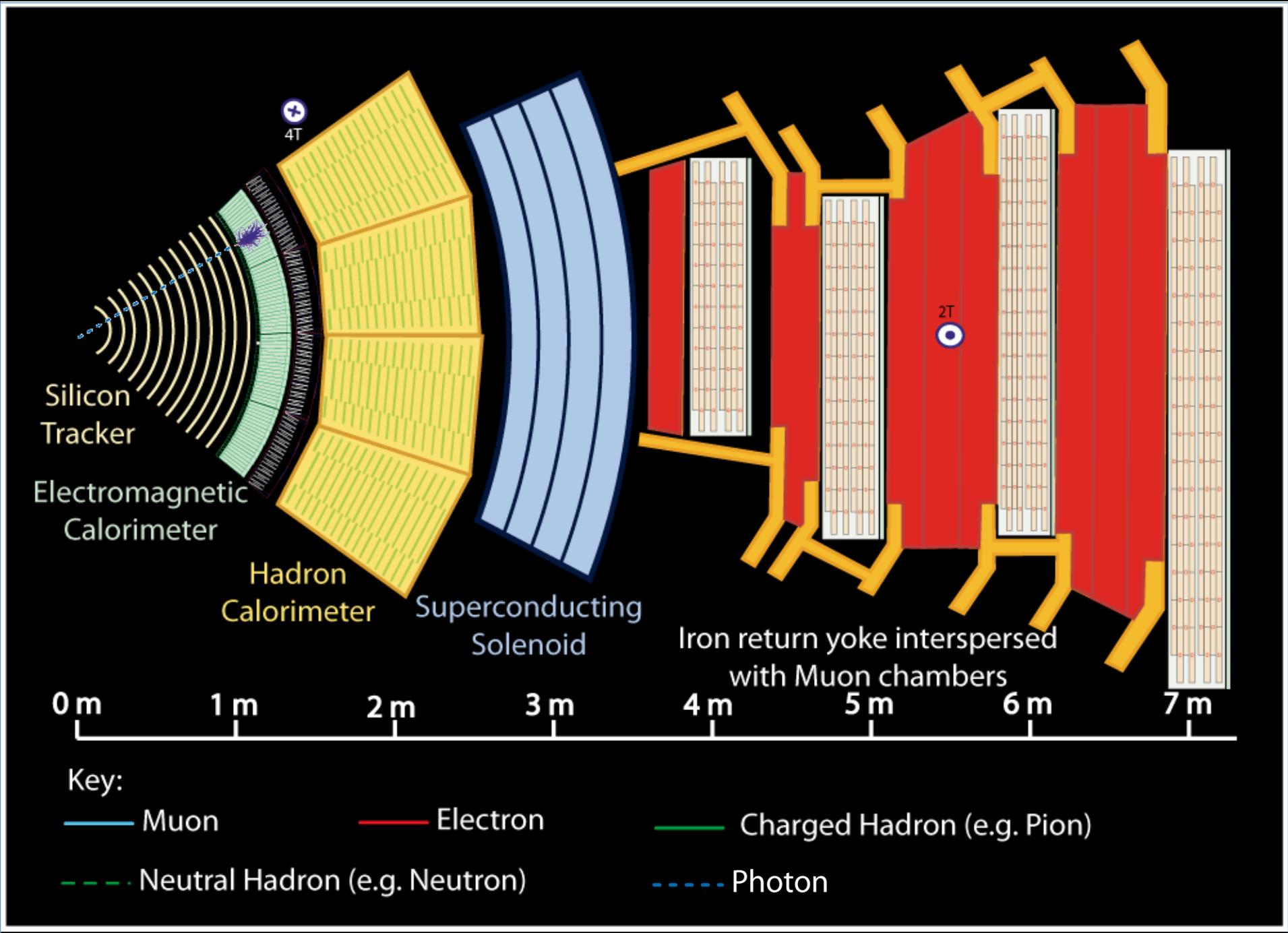
— Charged Hadron (e.g. Pion)

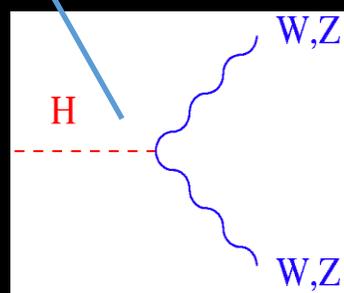
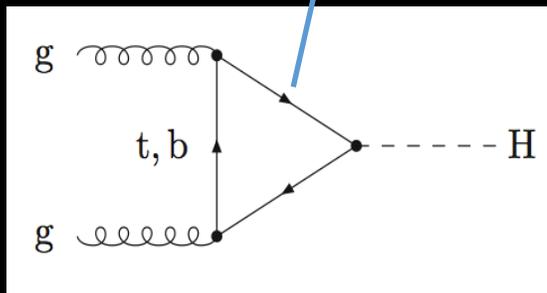
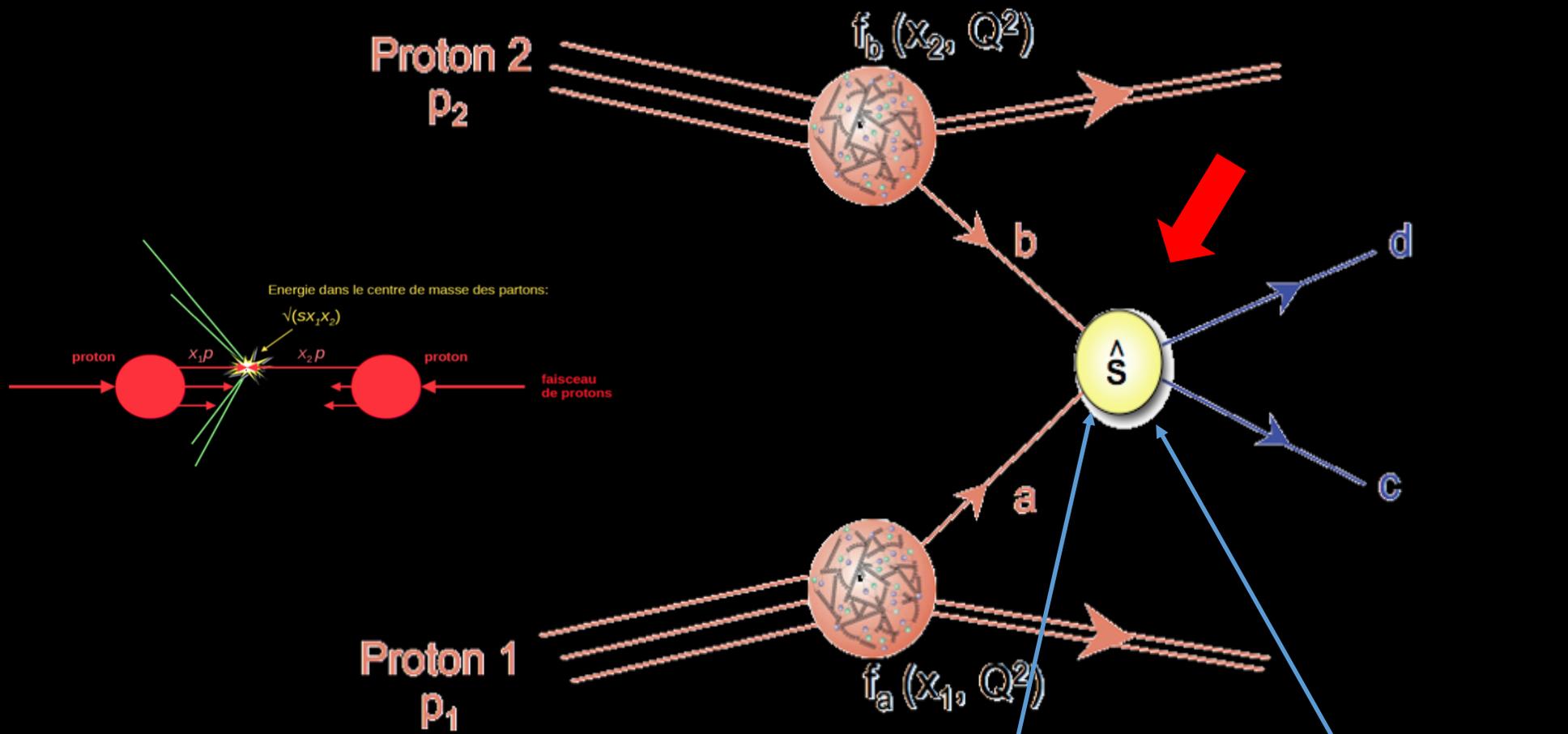
- - - Neutral Hadron (e.g. Neutron)

- - - Photon

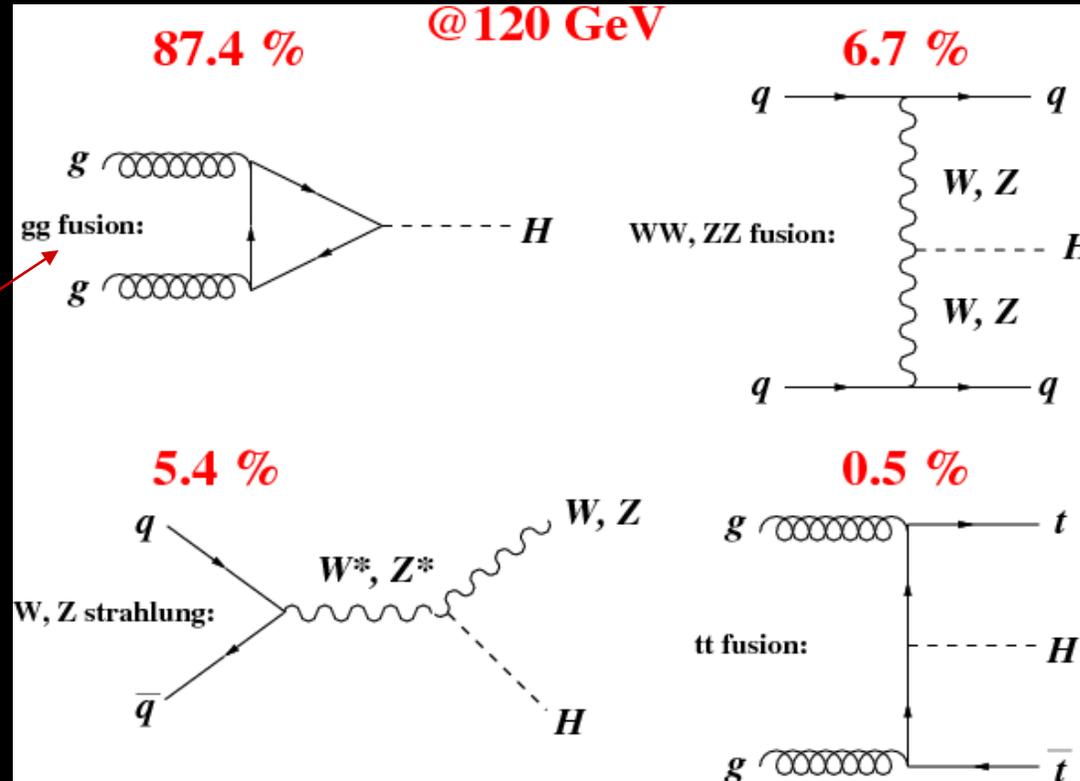




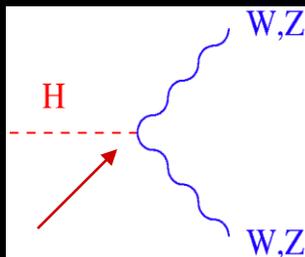




The various Higgs production mechanisms and decay modes

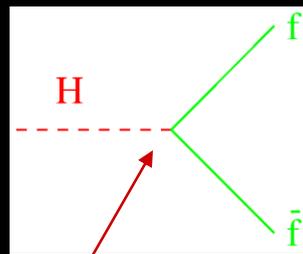


indirect coupling to gg , top in the loop

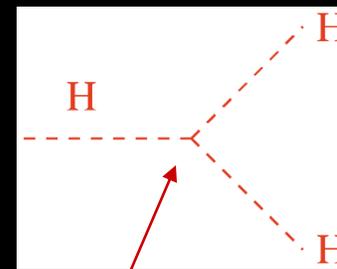


$$g_{HVV} = 2m_V^2/v$$

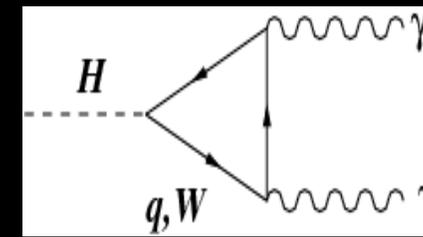
$$g_{HWW} = g m_W$$



$$g_{Hff} = m_f/v$$

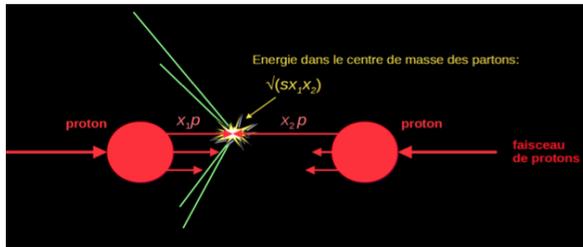


$$g_{HHH} = 3m_H^2/v$$

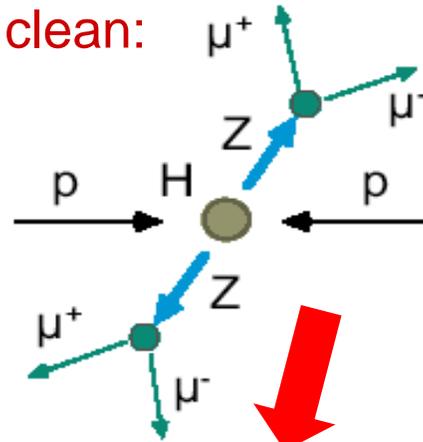


indirect coupling to $\gamma\gamma$

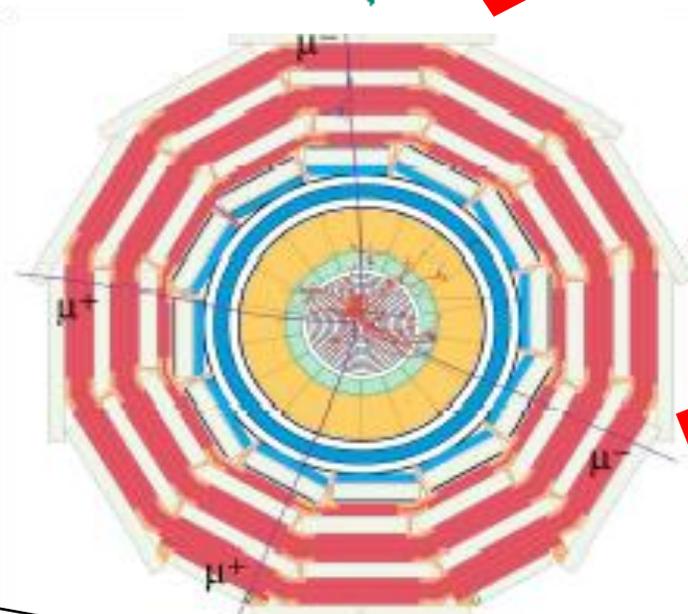
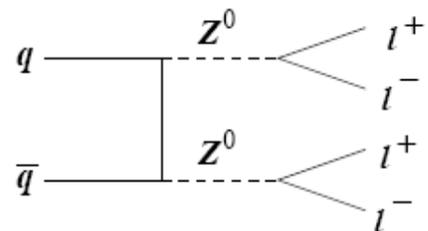
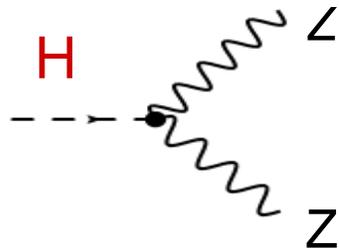
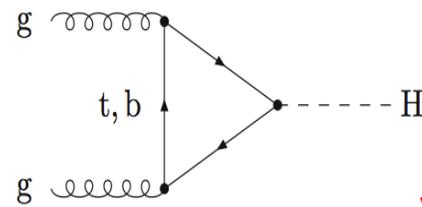
Production and detection of the Higgs in CMS



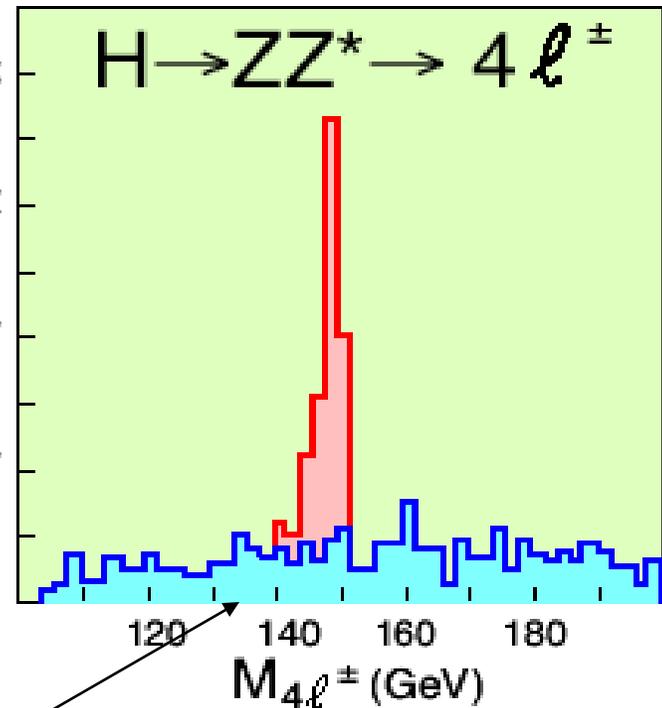
very rare collision 1 in 10^{15} ,
but clean:



Expectations for signal and background if the Higgs has a mass ~ 150 GeV



Events / 2 GeV



Electroweak ZZ background

World Lagrangian -

$$\begin{aligned}\mathcal{L} = & -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} \\ & + i\bar{\psi} \not{D} \psi + \text{h.c.} \\ & + \bar{\psi}_i Y_{ij} \psi_j \phi + \text{h.c.} \\ & + |D_\mu \phi|^2 - V(\phi)\end{aligned}$$

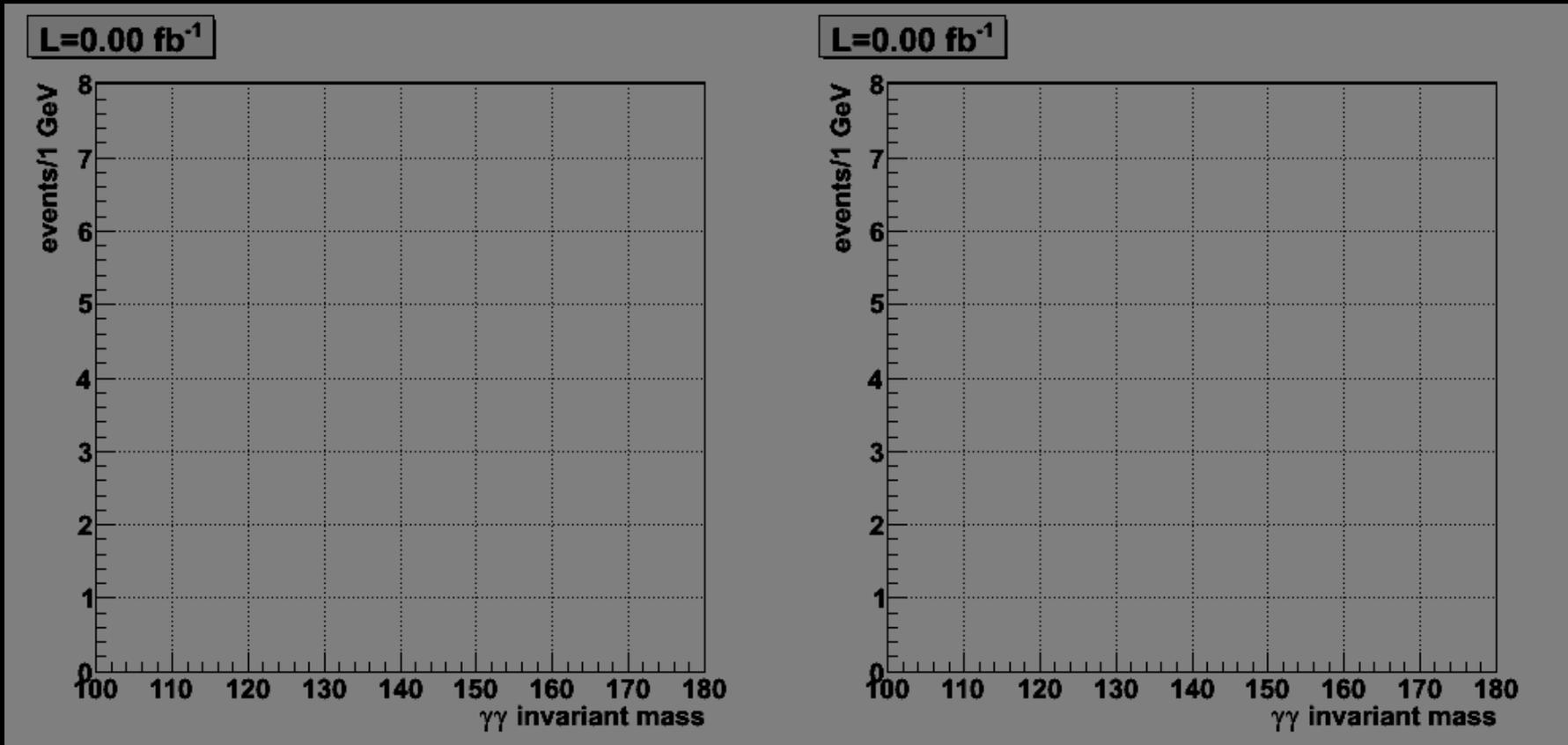
1. describes the forces: electricity, magnetism and the strong and weak nuclear forces
2. how these forces act on the fundamental particles of matter, namely quarks & leptons
3. how these particles obtain their masses from the Higgs boson
4. enables the Higgs boson to do the job

World Lagrangian - all the couplings are here!

$$\begin{aligned}
 \mathcal{L}_{\text{SM}} = & -\frac{1}{2}\partial_\nu g_\mu^a \partial_\nu g_\mu^a - g_s f^{abc} \partial_\mu g_\nu^a g_\mu^b g_\nu^c - \frac{1}{4}g_s^2 f^{abc} f^{adc} g_\mu^b g_\nu^c g_\mu^d g_\nu^e + \frac{1}{2}ig_s^2 (\bar{q}_i^\sigma \gamma^\mu q_j^\sigma) g_\mu^a + \bar{G}^a \partial^2 G^a + g_s f^{abc} \partial_\mu \bar{G}^a G^b g_\mu^c \\
 & -\partial_\nu W_\mu^+ \partial_\nu W_\mu^- - M^2 W_\mu^+ W_\mu^- - \frac{1}{2}\partial_\nu Z_\mu^0 \partial_\nu Z_\mu^0 - \frac{1}{2c_w^2} M^2 Z_\mu^0 Z_\mu^0 - \frac{1}{2}\partial_\mu \Lambda_\nu \partial_\mu \Lambda_\nu - \frac{1}{2}\partial_\mu H \partial_\mu H - \frac{1}{2}m_h^2 H^2 - \partial_\mu \phi^+ \partial_\mu \phi^- \\
 & -M^2 \phi^+ \phi^- - \frac{1}{2}\partial_\mu \phi^0 \partial_\mu \phi^0 - \frac{1}{2c_w^2} M \phi^0 \phi^0 - \beta_h \left[\frac{2M^2}{g^2} + \frac{2M}{g} H + \frac{1}{2}(H^2 + \phi^0 \phi^0 + 2\phi^+ \phi^-) \right] + \frac{2M^4}{g^2} \alpha_h \\
 & -igc_w \left[\partial_\nu Z_\mu^0 (W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - Z_\nu^0 (W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + Z_\mu^0 (W_\nu^+ \partial_\nu W_\mu^- - W_\nu^- \partial_\nu W_\mu^+) \right] \\
 & -igs_w \left[\partial_\nu \Lambda_\mu (W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - \Lambda_\nu (W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + \Lambda_\mu (W_\nu^+ \partial_\nu W_\mu^- - W_\nu^- \partial_\nu W_\mu^+) \right] \\
 & -\frac{1}{2}g^2 W_\mu^+ W_\mu^- W_\nu^+ W_\nu^- + \frac{1}{2}g^2 W_\mu^+ W_\nu^- W_\mu^+ W_\nu^- + g^2 c_w^2 (Z_\mu^0 W_\mu^+ Z_\nu^0 W_\nu^- - Z_\mu^0 Z_\nu^0 W_\mu^+ W_\nu^-) + g^2 s_w^2 (\Lambda_\mu W_\mu^+ \Lambda_\nu W_\nu^- - \Lambda_\mu \Lambda_\nu W_\mu^+ W_\nu^-) \\
 & +g^2 s_w c_w \left[\Lambda_\mu Z_\nu^0 (W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - 2\Lambda_\mu Z_\mu^0 W_\nu^+ W_\nu^- \right] - g\alpha \left[H^3 + H\phi^0 \phi^0 + 2H\phi^+ \phi^- \right] \\
 & -\frac{1}{8}g^2 \alpha_h \left[H^4 + (\phi^0)^4 + 4(\phi^+ \phi^-)^2 + 4(\phi^0)^2 \phi^+ \phi^- + 4H^2 \phi^+ \phi^- + 2(\phi^0)^2 H^2 \right] - gM W_\mu^+ W_\mu^- H - \frac{1}{2}g \frac{M}{c_w^2} Z_\mu^0 Z_\mu^0 H \\
 & -\frac{1}{2}ig \left[W_\mu^+ (\phi^0 \partial_\mu \phi^- - \phi^- \partial_\mu \phi^0) - W_\mu^- (\phi^0 \partial_\mu \phi^+ - \phi^+ \partial_\mu \phi^0) \right] + \frac{1}{2}g \left[W_\mu^+ (H \partial_\mu \phi^- - \phi^- \partial_\mu H) - W_\mu^- (H \partial_\mu \phi^+ - \phi^+ \partial_\mu H) \right] \\
 & +\frac{1}{2}g \frac{1}{c_w} Z_\mu^0 (H \partial_\mu \phi^0 - \phi^0 \partial_\mu H) - ig \frac{s_w^2}{c_w} M Z_\mu^0 (W_\mu^+ \phi^- - W_\mu^- \phi^+) + igs_w M \Lambda_\mu (W_\mu^+ \phi^- - W_\mu^- \phi^+) - ig \frac{1-2c_w^2}{2c_w} Z_\mu^0 (\phi^+ \partial_\mu \phi^- \\
 & -\phi^- \partial_\mu \phi^+) + igs_w \Lambda_\mu (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) - \frac{1}{4}g^2 W_\mu^+ W_\mu^- \left[H^2 + (\phi^0)^2 + 2\phi^+ \phi^- \right] - \frac{1}{4}g^2 \frac{1}{c_w^2} Z_\mu^0 Z_\mu^0 \left[H^2 + (\phi^0)^2 \right. \\
 & \left. + 2(2s_w^2 - 1)^2 \phi^+ \phi^- \right] - \frac{1}{2}g^2 \frac{s_w^2}{c_w} Z_\mu^0 \phi^0 (W_\mu^+ \phi^- + W_\mu^- \phi^+) - \frac{1}{2}ig^2 \frac{s_w^2}{c_w} Z_\mu^0 H (W_\mu^+ \phi^- - W_\mu^- \phi^+) + \frac{1}{2}g^2 s_w \Lambda_\mu \phi^0 (W_\mu^+ \phi^- + W_\mu^- \phi^+) \\
 & +\frac{1}{2}ig^2 s_w \Lambda_\mu H (W_\mu^+ \phi^- - W_\mu^- \phi^+) - g^2 \frac{s_w}{c_w} (2c_w^2 - 1) Z_\mu^0 \Lambda_\mu \phi^+ \phi^- - g^1 s_w^2 \Lambda_\mu \Lambda_\mu \phi^+ \phi^- - e^\lambda (\gamma \partial + m_c^\lambda) e^\lambda - \bar{\nu}^\lambda \gamma \partial \nu^\lambda \\
 & -\bar{u}_i^\lambda (\gamma \partial + m_u^\lambda) u_i^\lambda - \bar{d}_i^\lambda (\gamma \partial + m_d^\lambda) d_i^\lambda + igs_w \Lambda_\mu [-(e^\lambda \gamma^\mu e^\lambda) + \frac{2}{3}(\bar{u}_i^\lambda \gamma^\mu u_i^\lambda) - \frac{1}{3}(\bar{d}_i^\lambda \gamma^\mu d_i^\lambda)] \\
 & +\frac{ig}{4c_w} Z_\mu^0 \left[(\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (e^\lambda \gamma^\mu (4s_w^2 - 1 - \gamma^5) e^\lambda) + (\bar{u}_i^\lambda \gamma^\mu (\frac{4}{3}s_w^2 - 1 - \gamma^5) u_i^\lambda) + (\bar{d}_i^\lambda \gamma^\mu (1 - \frac{8}{3}s_w^2 - \gamma^5) d_i^\lambda) \right] \\
 & +\frac{ig}{2\sqrt{2}} W_\mu^+ \left[(\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) e^\lambda) + (\bar{u}_i^\lambda \gamma^\mu (1 + \gamma^5) C_{\lambda\kappa} d_i^\kappa) \right] + \frac{ig}{2\sqrt{2}} W_\mu^- \left[(e^\lambda \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{d}_i^\kappa C_{\lambda\kappa}^\dagger \gamma^\mu (1 + \gamma^5) u_i^\lambda) \right] \\
 & +\frac{ig}{2\sqrt{2}} \frac{m_e^\lambda}{M} \left[-\phi^+ (\bar{\nu}^\lambda (1 - \gamma^5) e^\lambda) + \phi^- (e^\lambda (1 + \gamma^5) \nu^\lambda) \right] - \frac{g}{2} \frac{m_e^\lambda}{M} \left[H(e^\lambda e^\lambda) + i\phi^0 (e^\lambda \gamma^5 e^\lambda) \right] \\
 & +\frac{ig}{2M\sqrt{2}} \phi^+ \left[-m_d^\lambda (\bar{u}_i^\lambda C_{\lambda\kappa} (1 - \gamma^5) d_i^\kappa) + m_u^\lambda (\bar{u}_i^\lambda C_{\lambda\kappa} (1 + \gamma^5) d_i^\kappa) \right] + \frac{ig}{2M\sqrt{2}} \phi^- \left[m_d^\lambda (\bar{d}_i^\kappa C_{\lambda\kappa}^\dagger (1 + \gamma^5) u_i^\lambda) - m_u^\lambda (\bar{d}_i^\kappa C_{\lambda\kappa}^\dagger (1 - \gamma^5) u_i^\lambda) \right] \\
 & -\frac{g}{2} \frac{m_u^\lambda}{M} H(\bar{u}_i^\lambda u_i^\lambda) - \frac{g}{2} \frac{m_d^\lambda}{M} H(\bar{d}_i^\lambda d_i^\lambda) + \frac{ig}{2} \frac{m_u^\lambda}{M} \phi^0 (\bar{u}_i^\lambda \gamma^5 u_i^\lambda) - \frac{ig}{2} \frac{m_d^\lambda}{M} \phi^0 (\bar{d}_i^\lambda \gamma^5 d_i^\lambda) + X^+ (\partial^2 - M^2) X^+ + X^- (\partial^2 - M^2) X^-
 \end{aligned}$$

It an statistical process

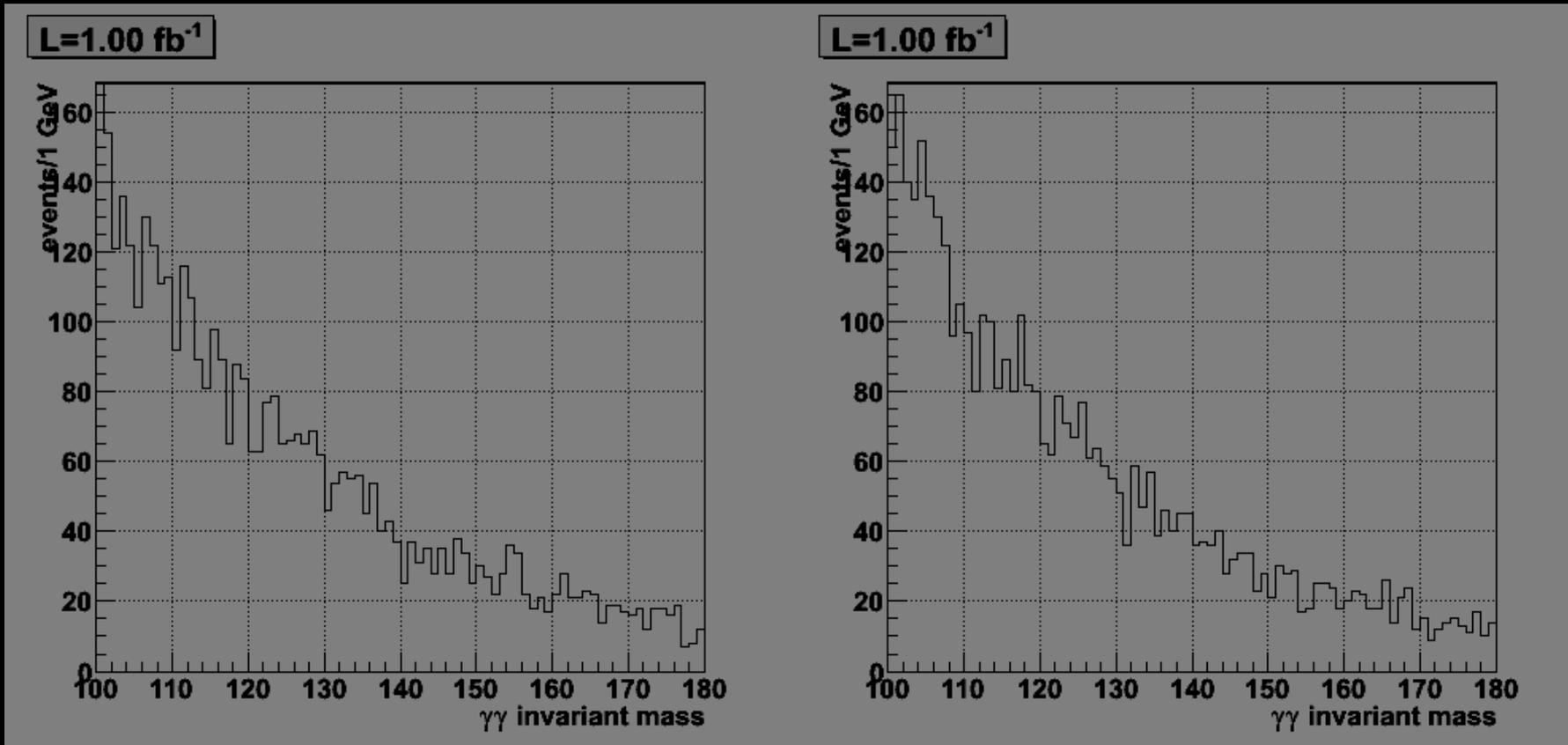
..... like play dice



One of these plots contains the (simulated) Higgs boson signal.

Can you spot it?

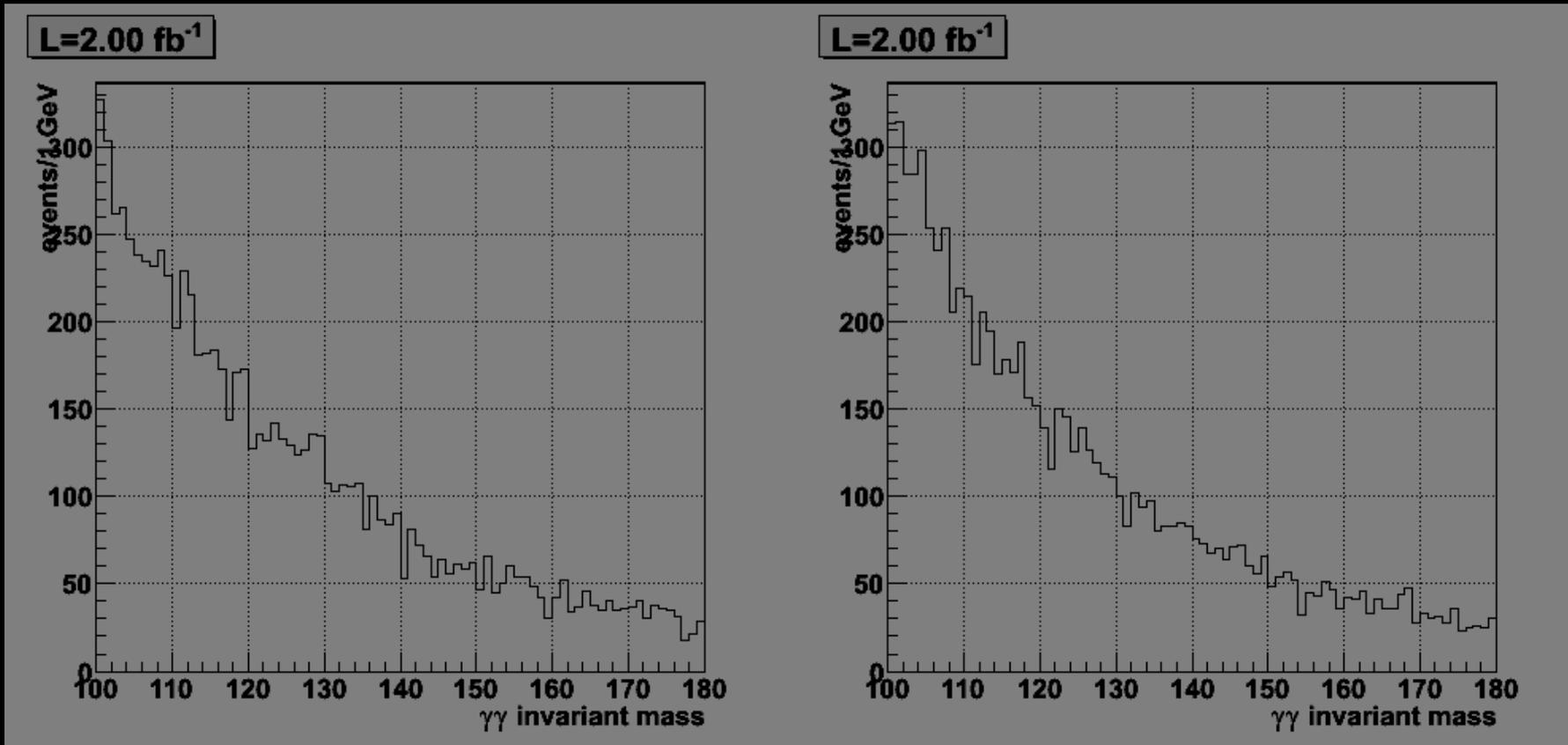
by Piotr Traczyk



One of these plots contains the (simulated) Higgs boson signal.

Can you spot it?

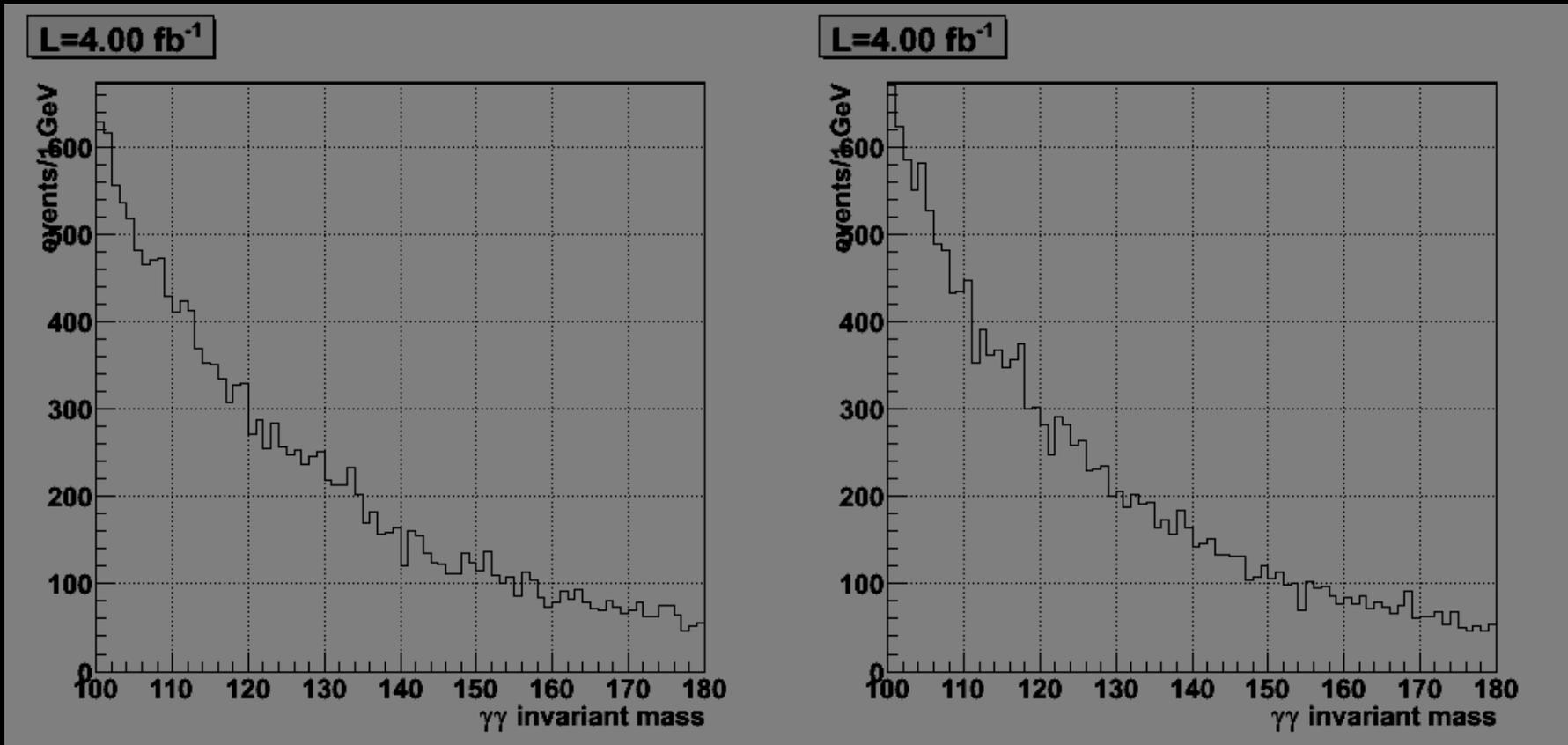
by Piotr Traczyk



One of these plots contains the (simulated) Higgs boson signal.

Can you spot it?

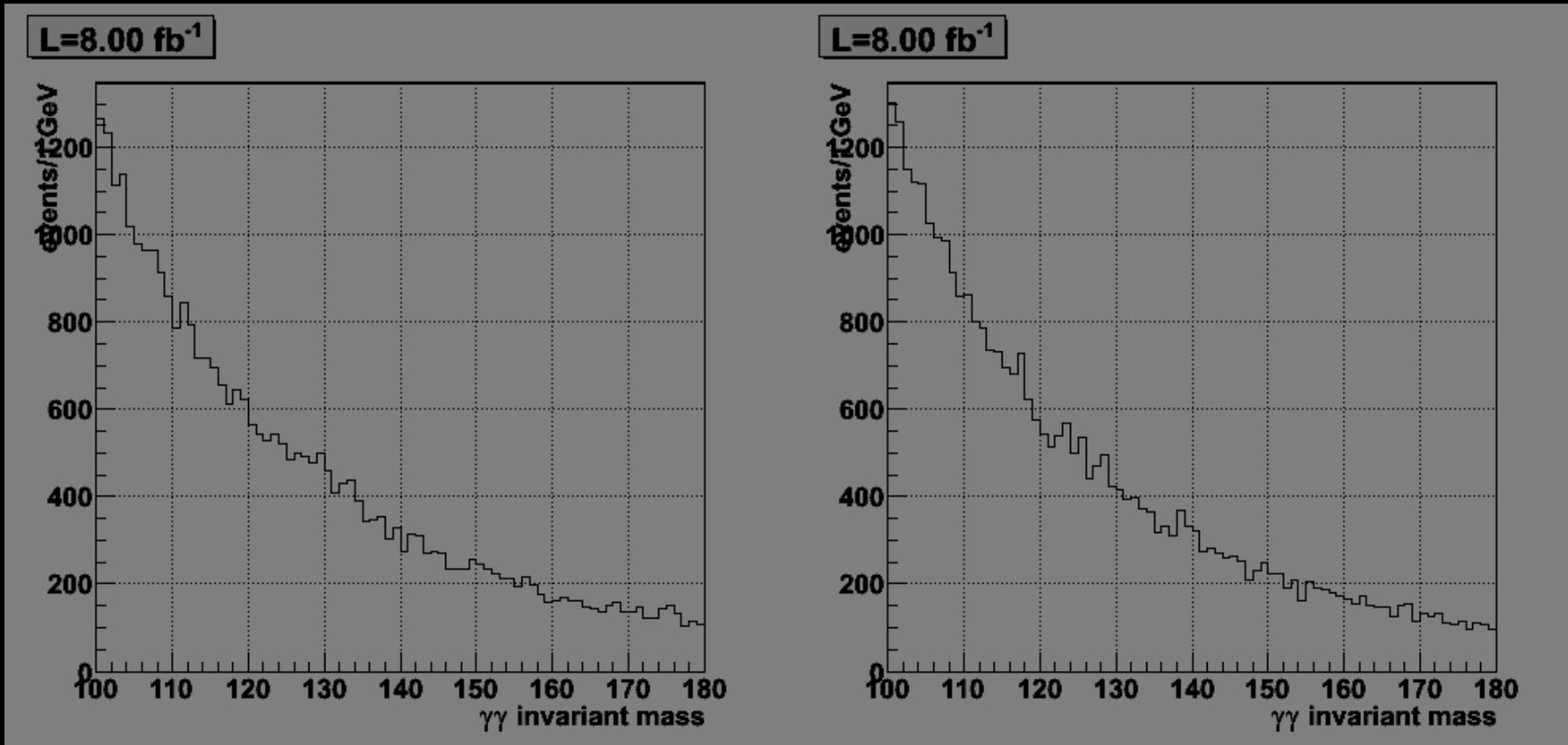
by Piotr Traczyk



One of these plots contains the (simulated) Higgs boson signal.

Can you spot it?

by Piotr Traczyk

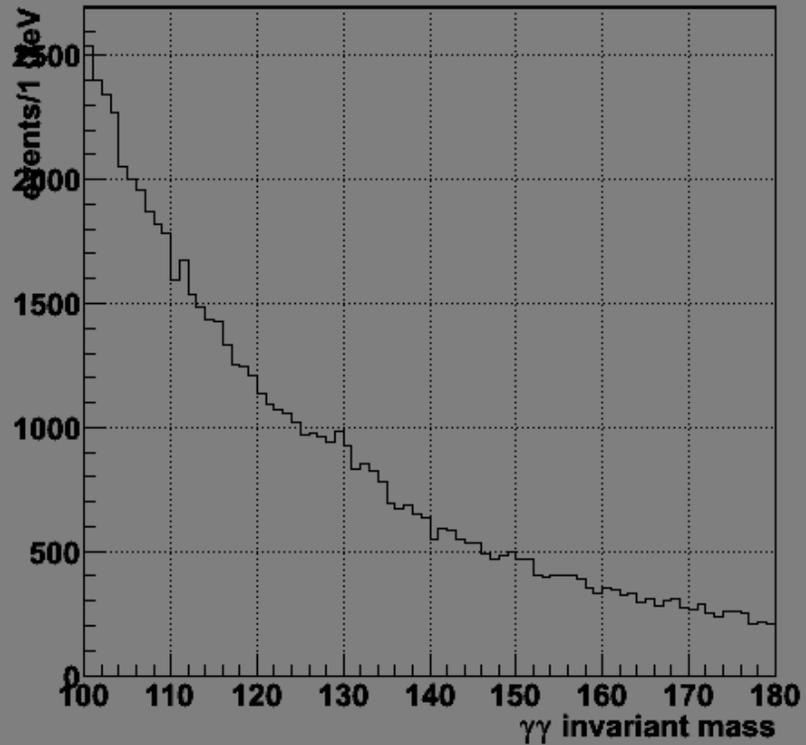


One of these plots contains the (simulated) Higgs boson signal.

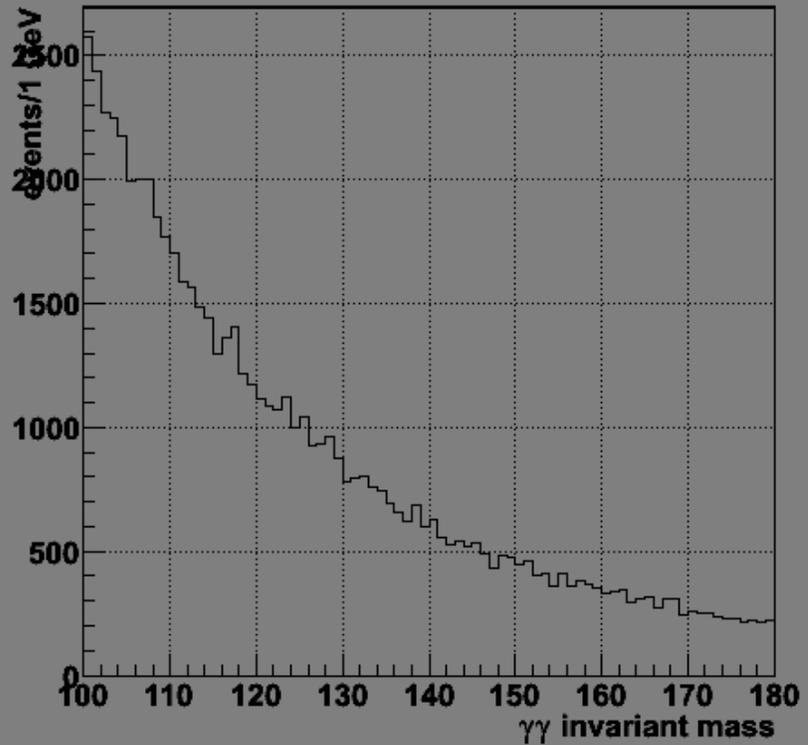
Can you spot it?

by Piotr Traczyk

$L=16.00 \text{ fb}^{-1}$



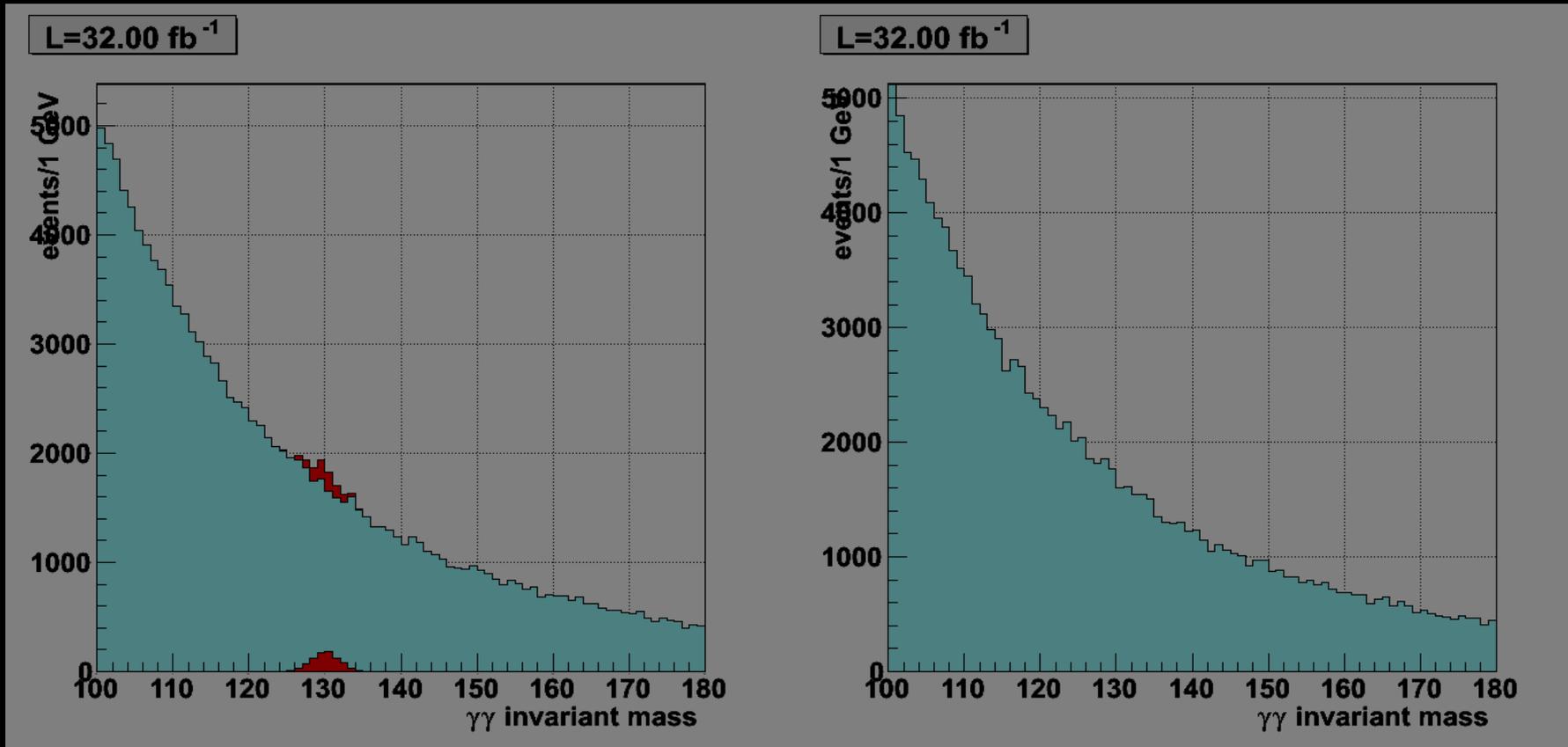
$L=16.00 \text{ fb}^{-1}$



One of these plots contains the (simulated) Higgs boson signal.

Can you spot it?

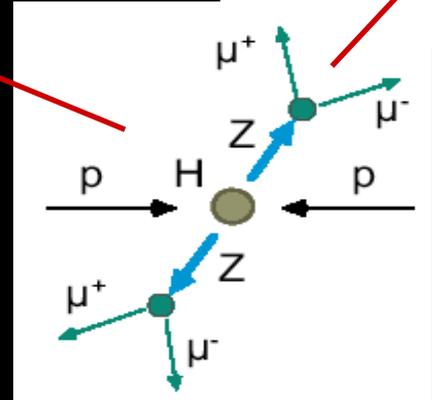
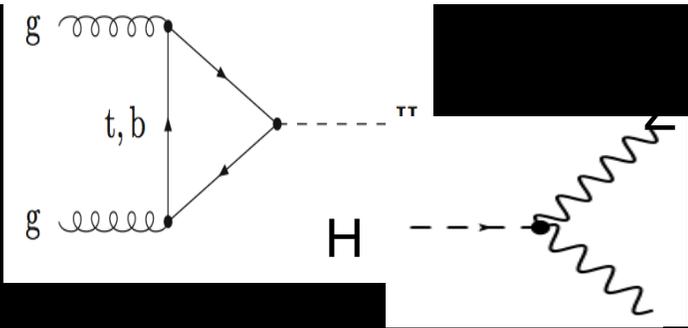
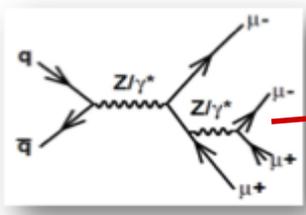
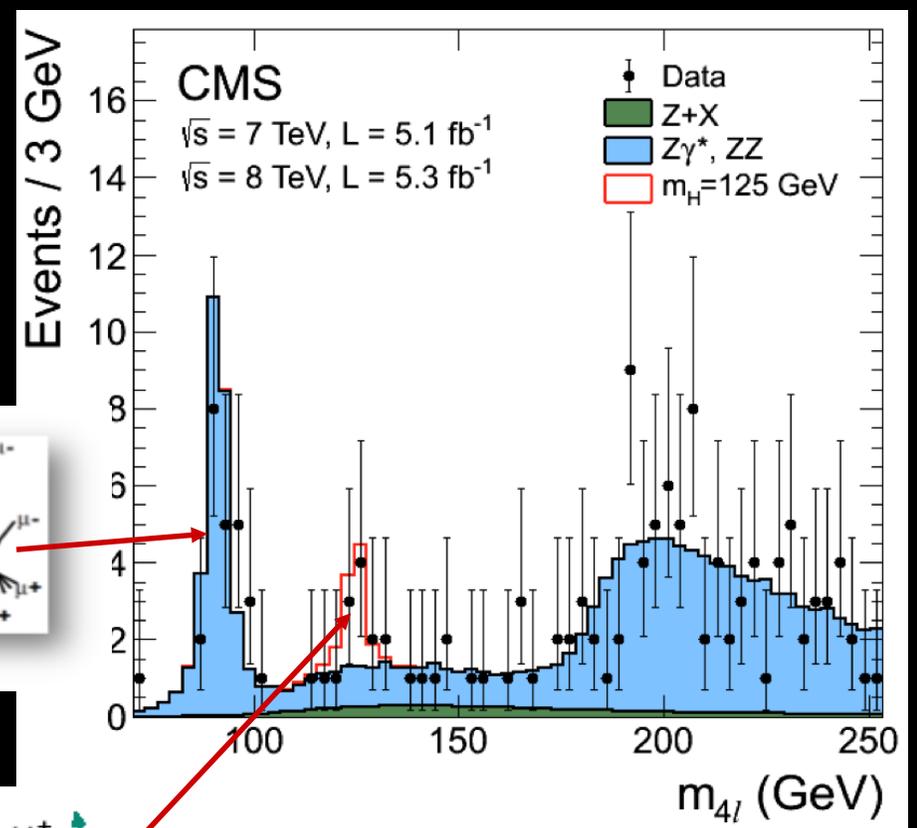
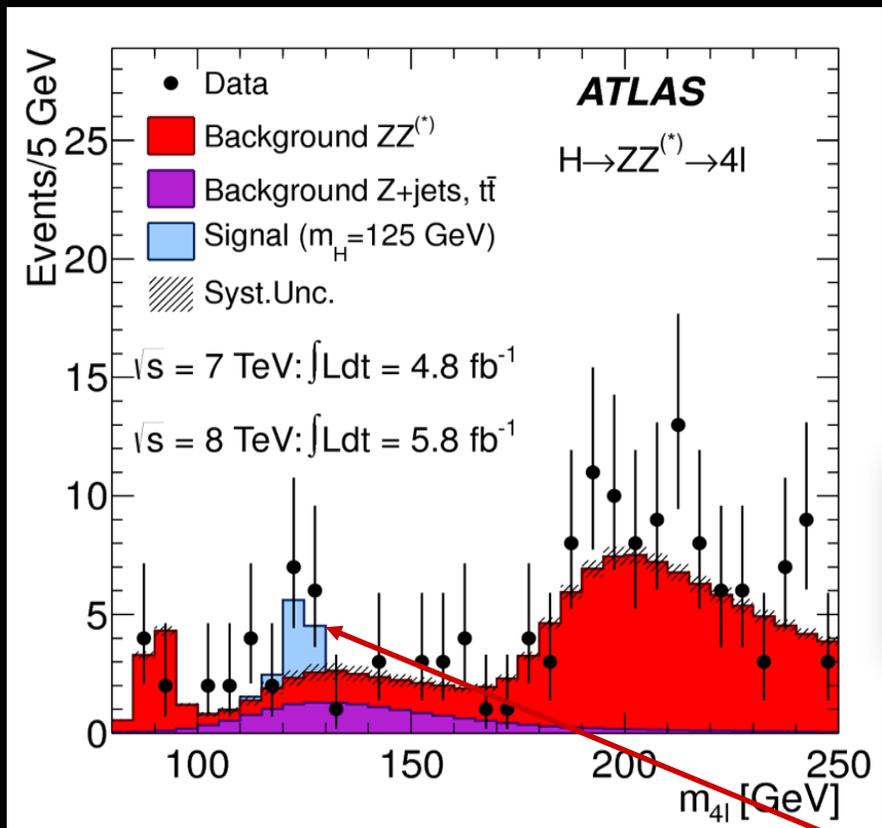
by Piotr Traczyk



One of these plots contains the (simulated) Higgs boson signal.

Can you spot it?

by Piotr Traczyk

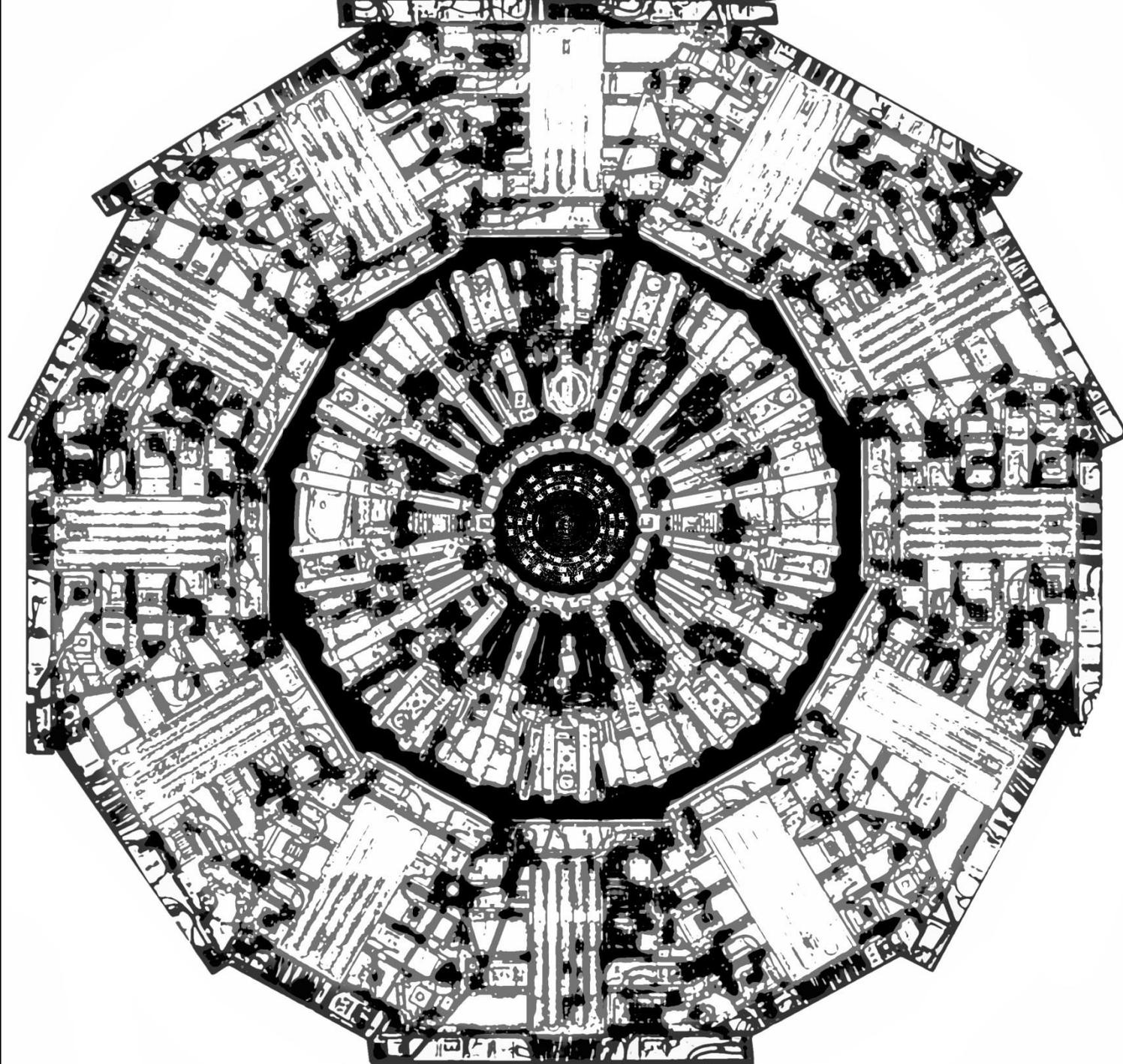


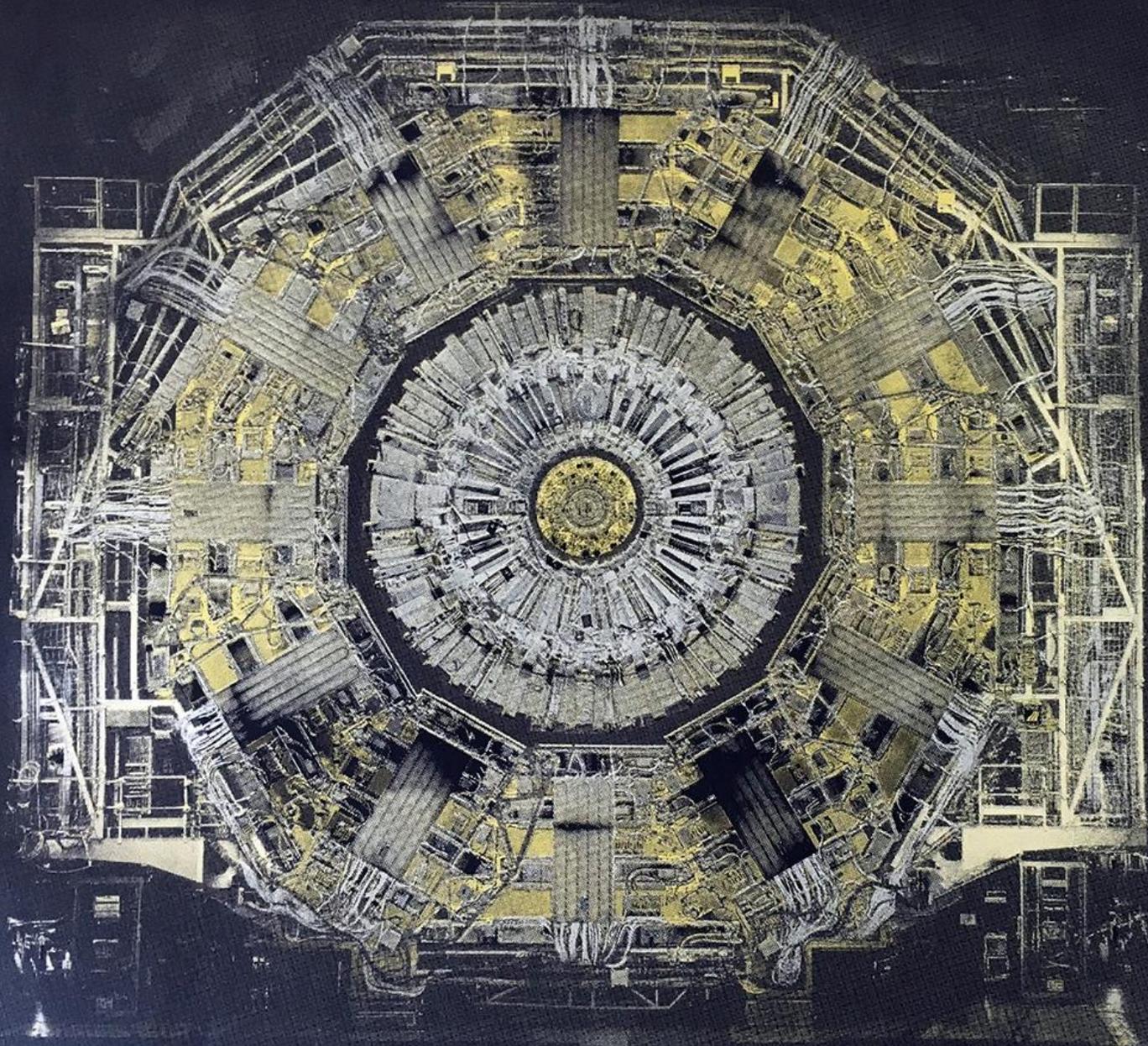
“Where do we come from? What are we? Where are we going?”

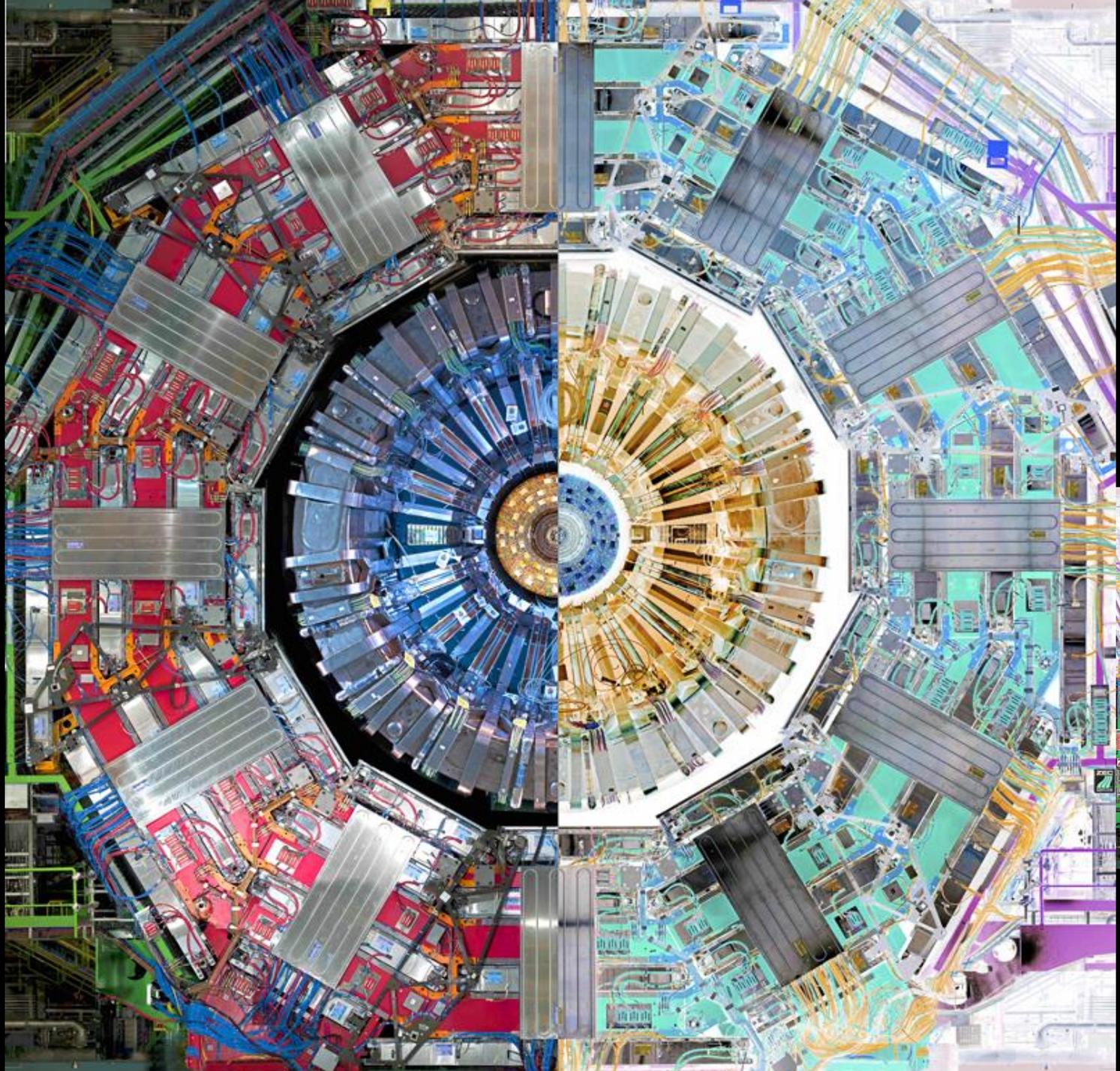


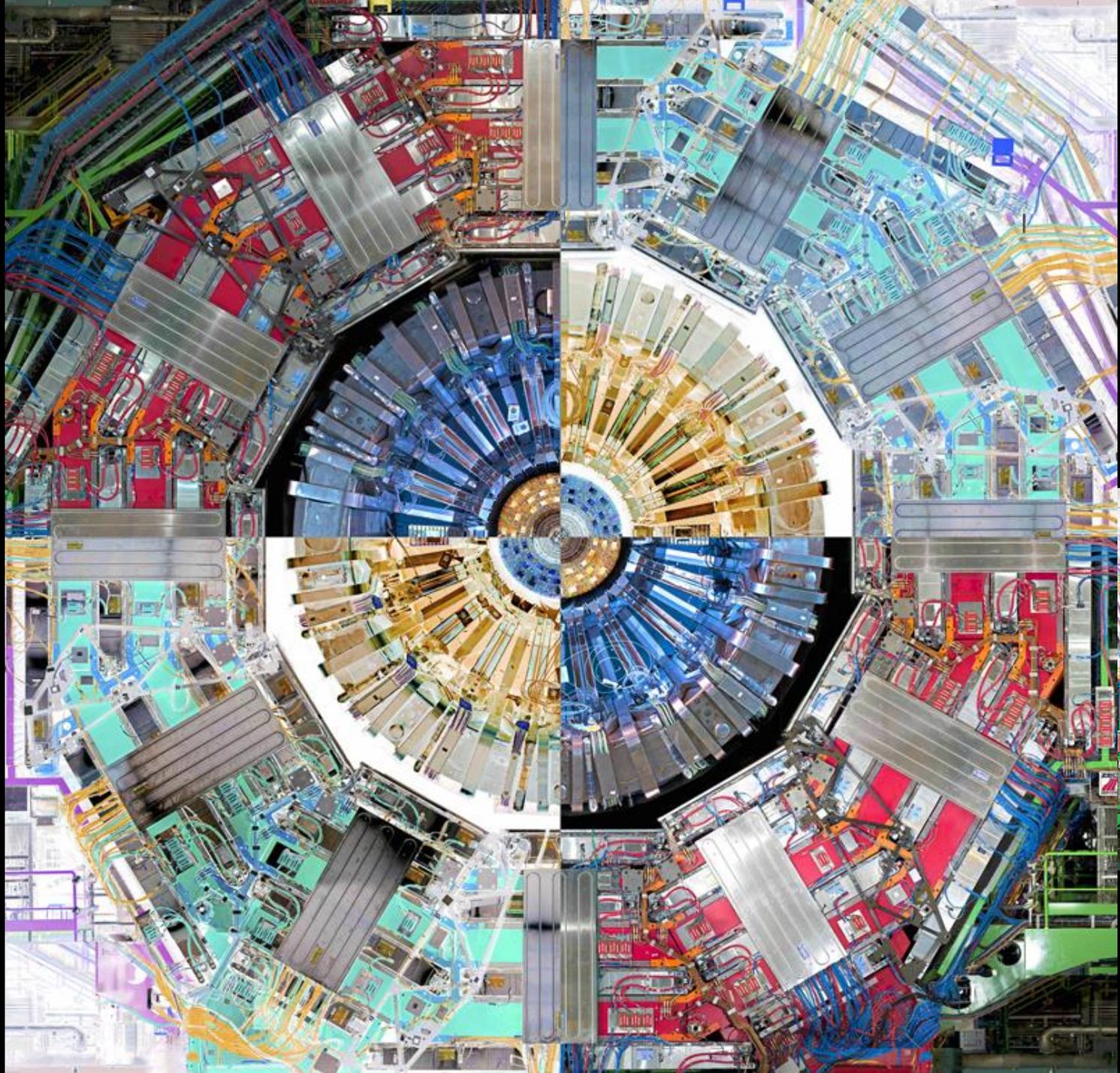
**The aim of particle physics, CERN & the LHC:
What is the Universe made of ?**

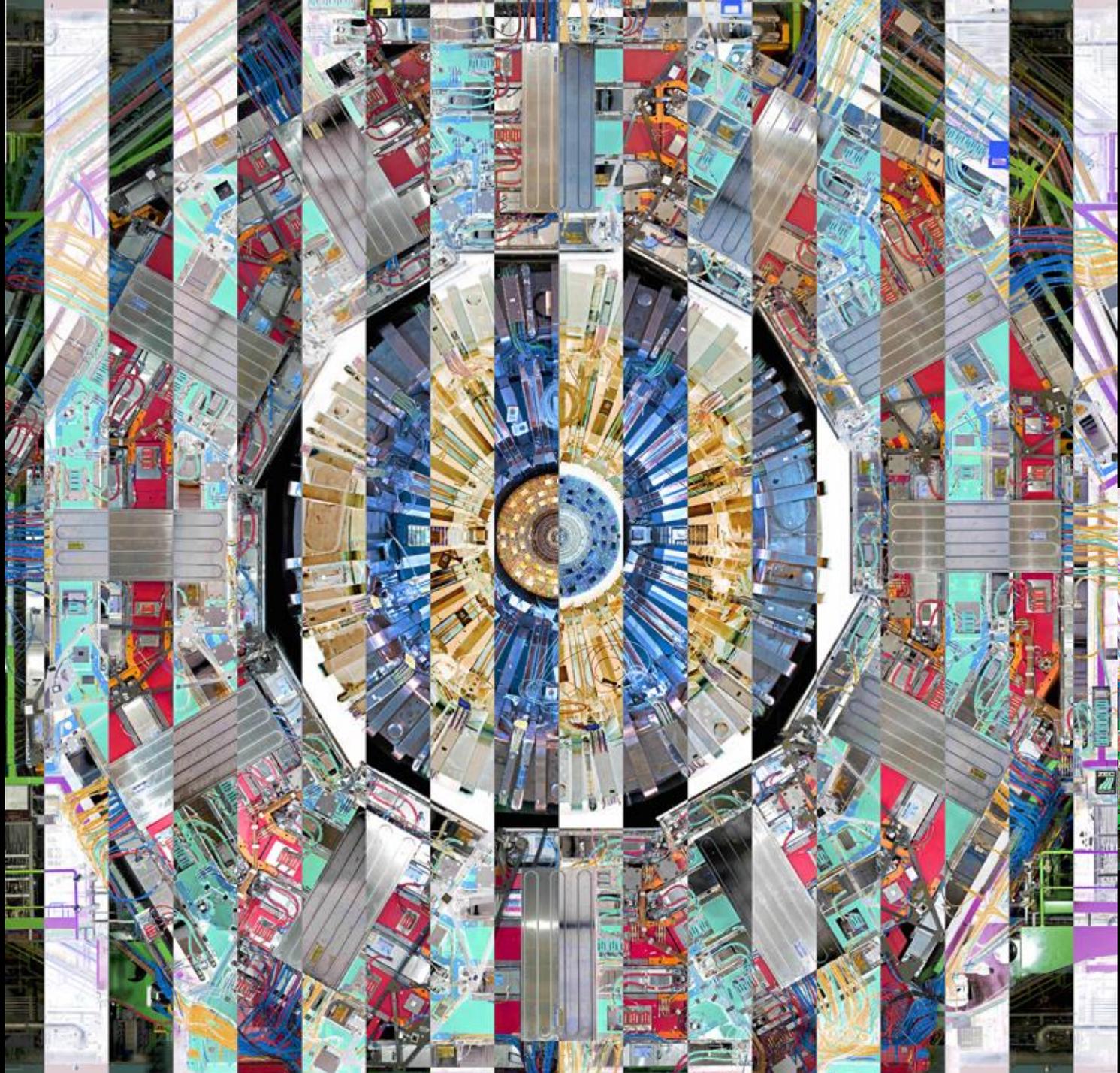


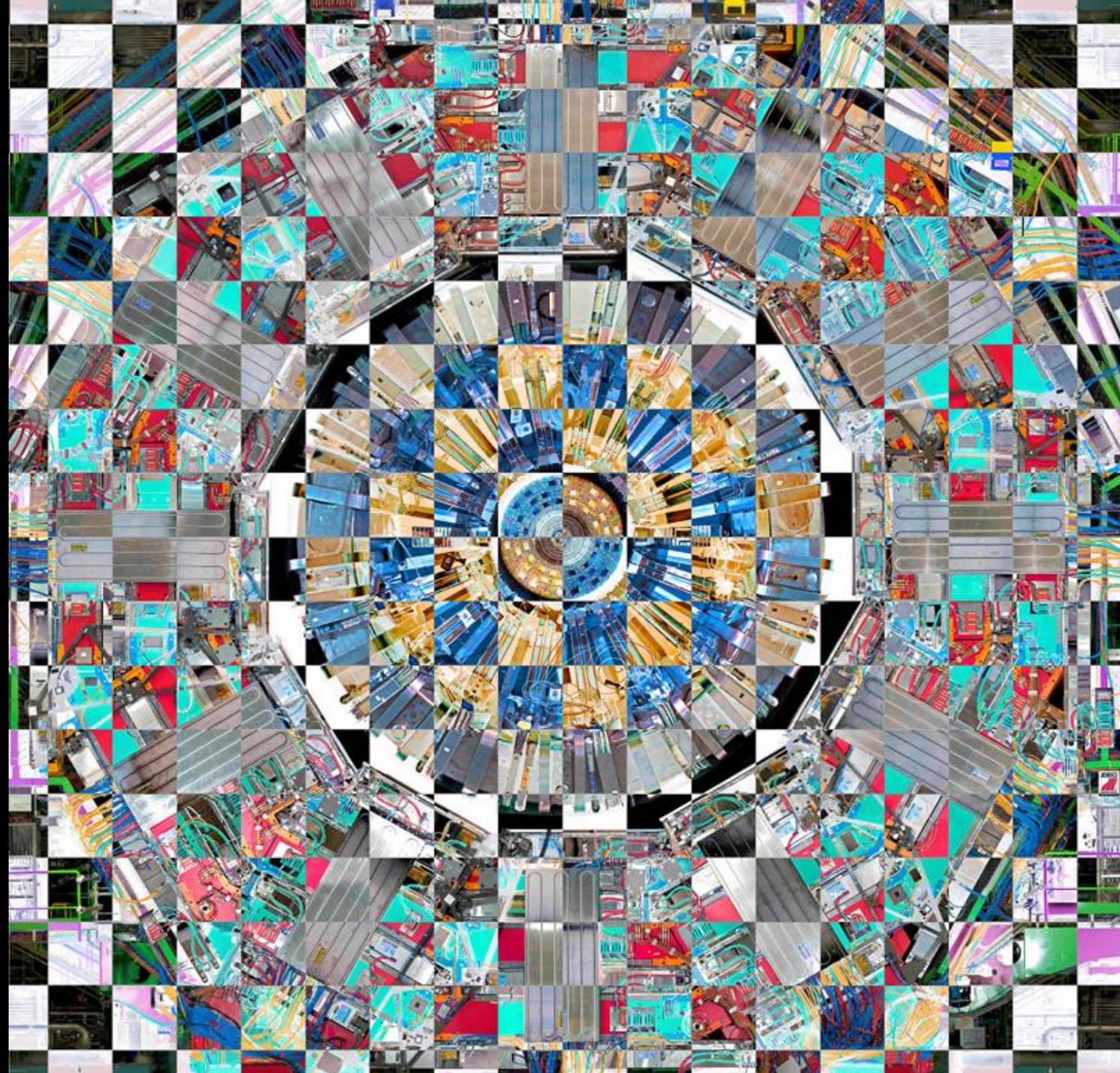




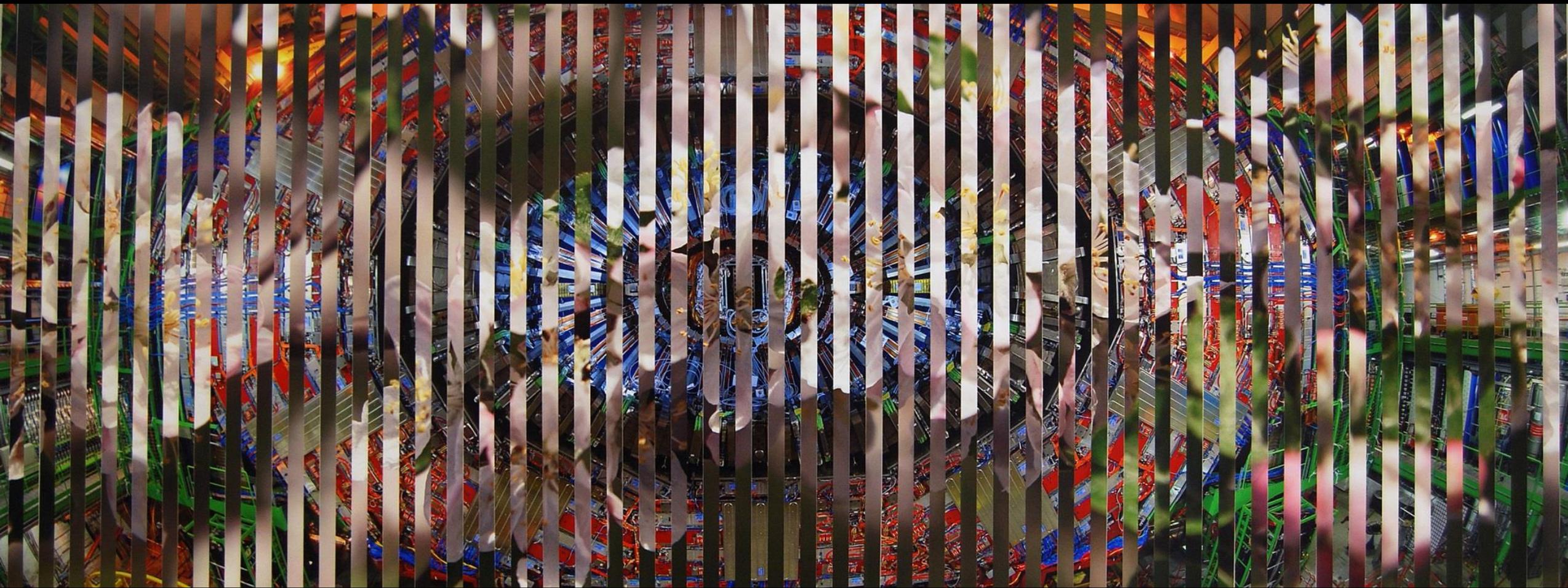


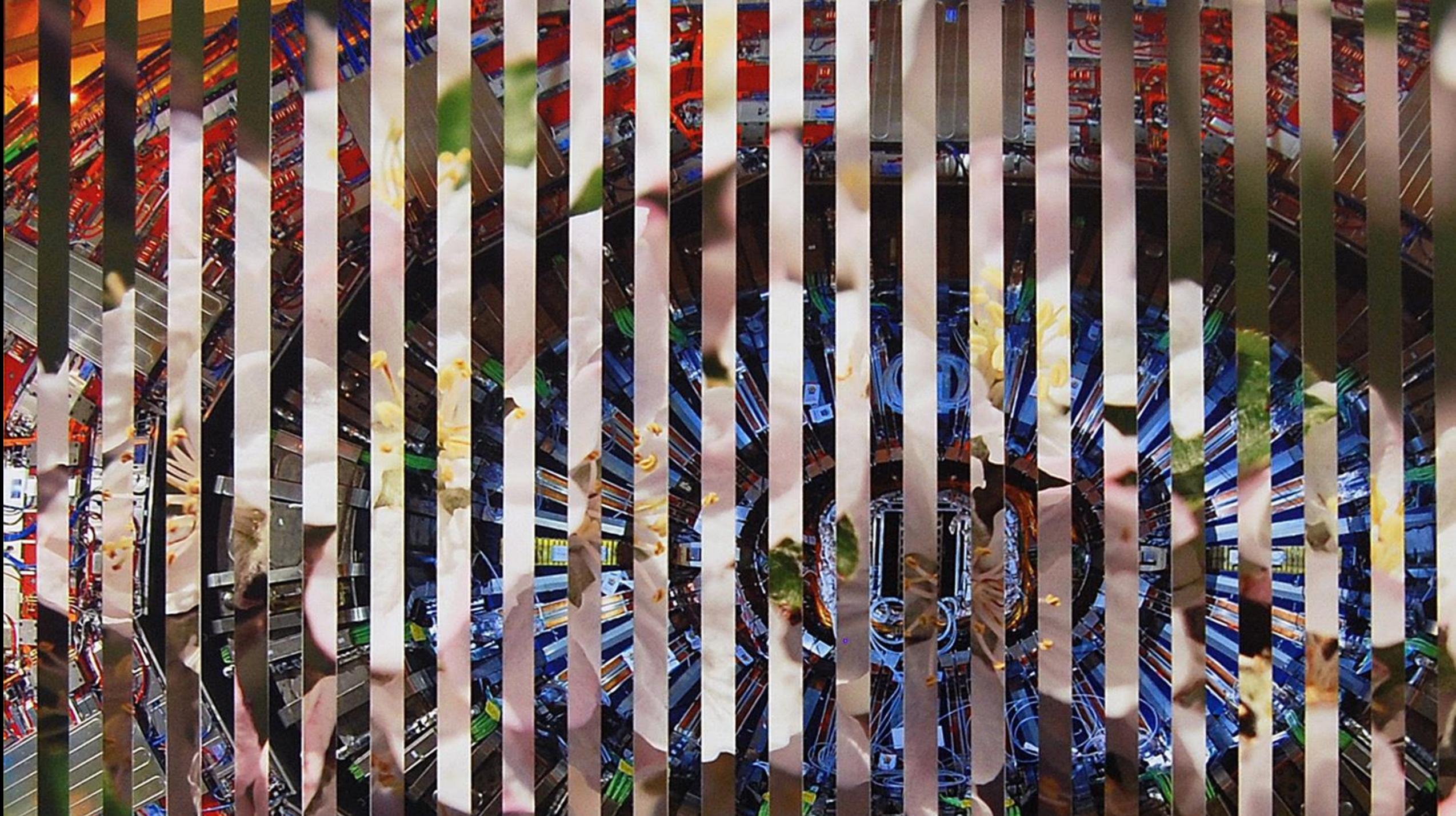






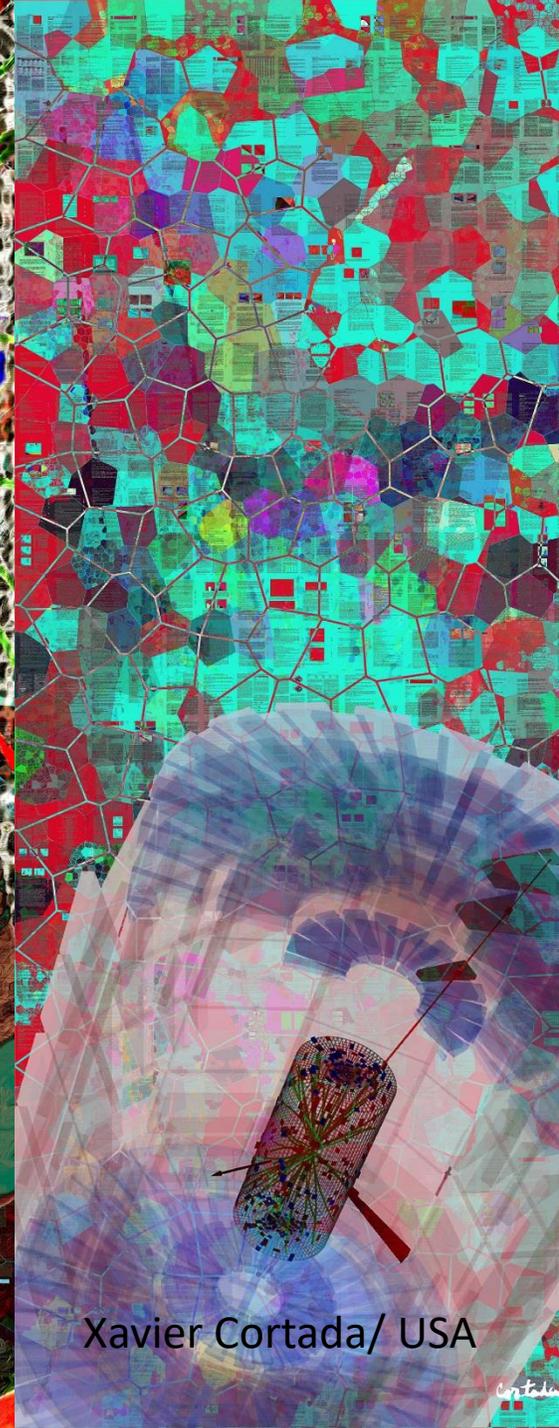
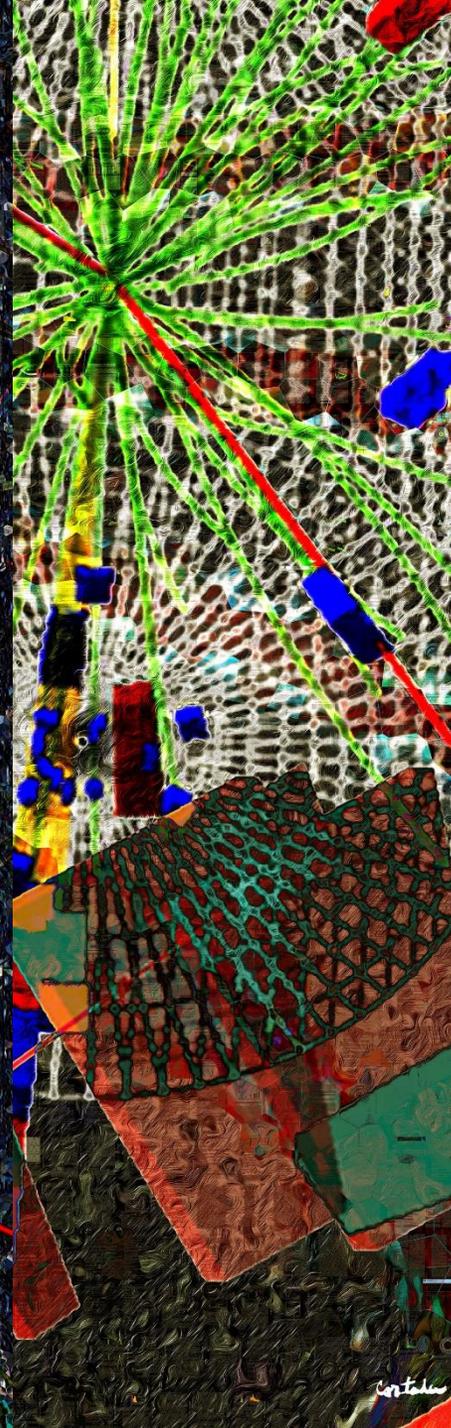
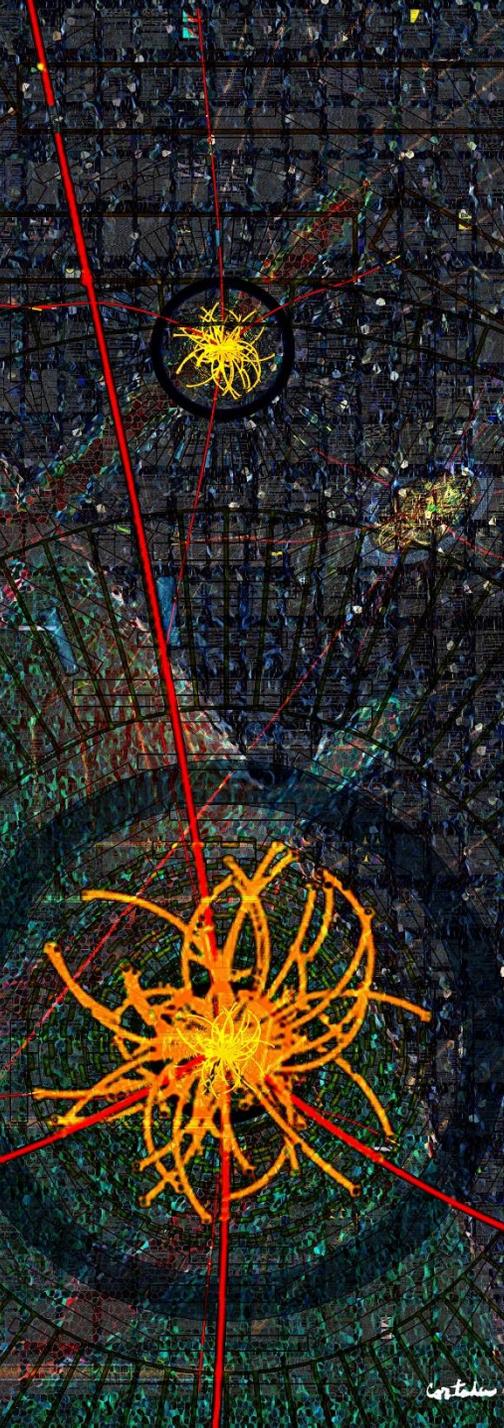
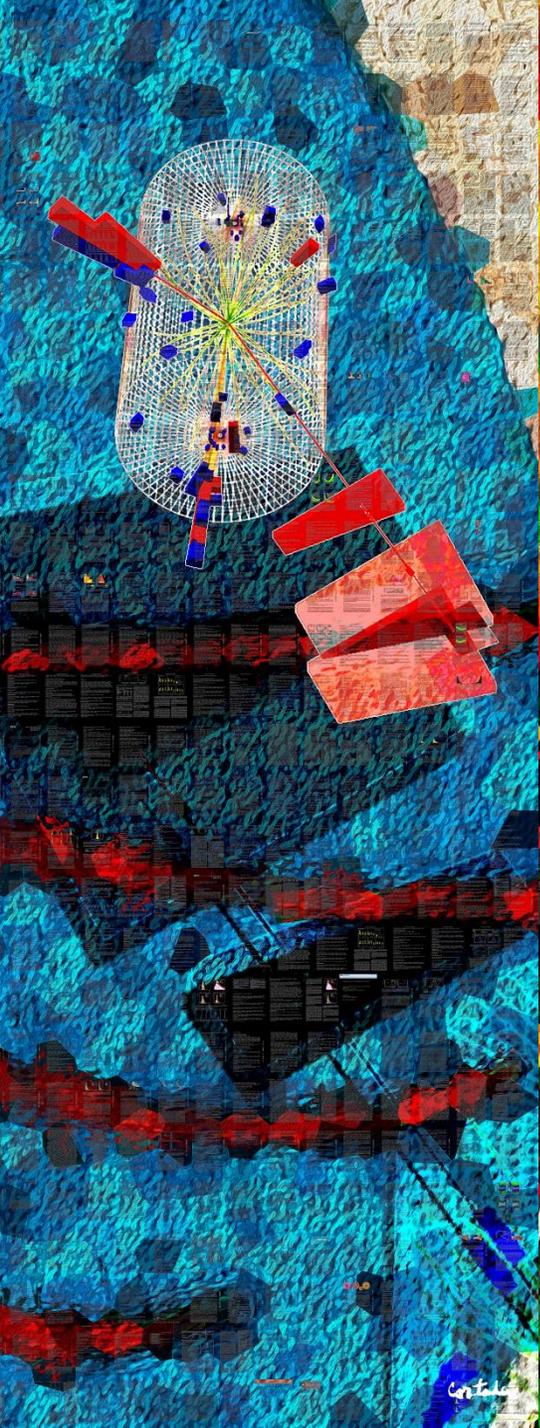






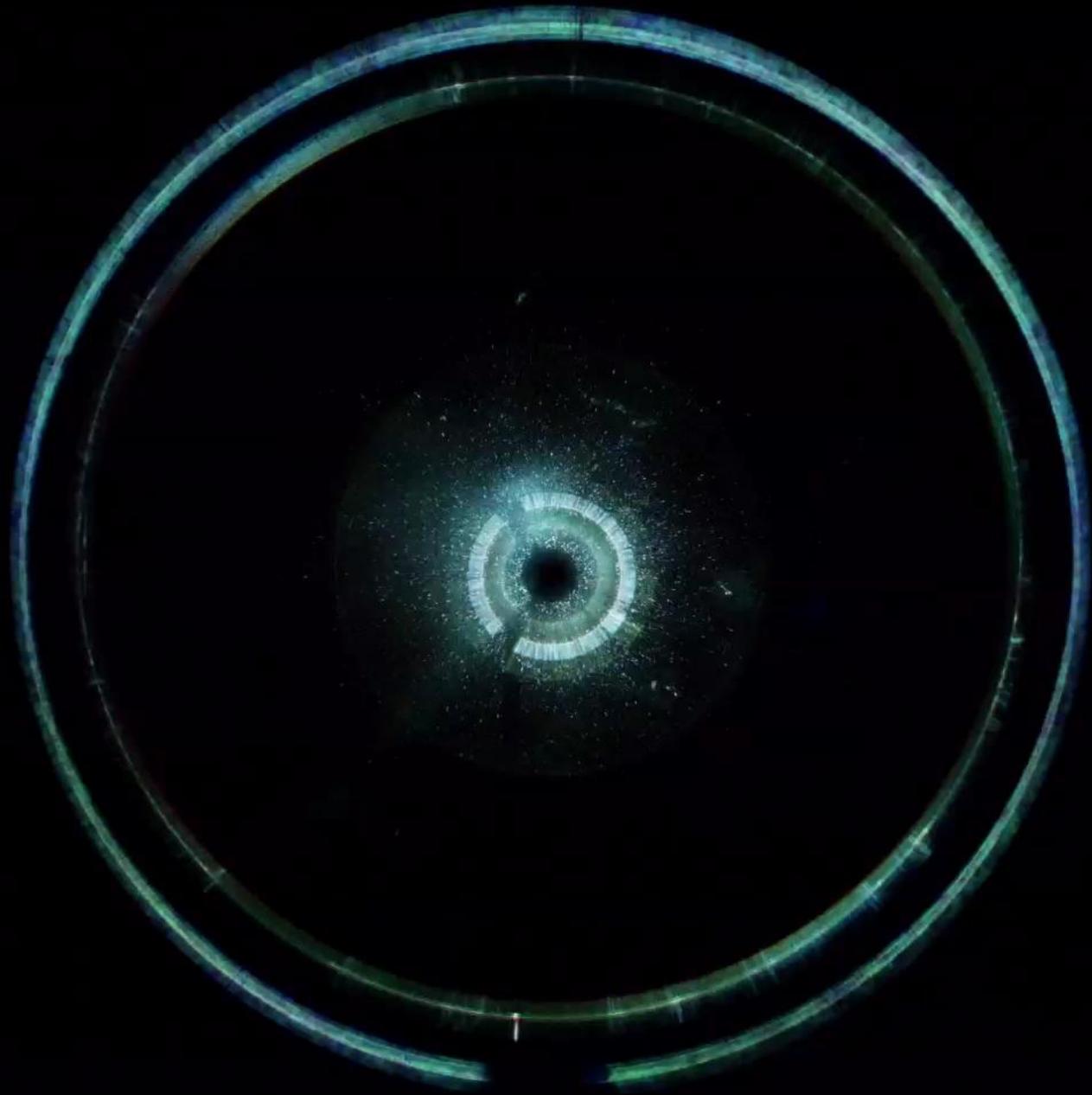






Xavier Cortada/ USA





Chris Henschke /AUS

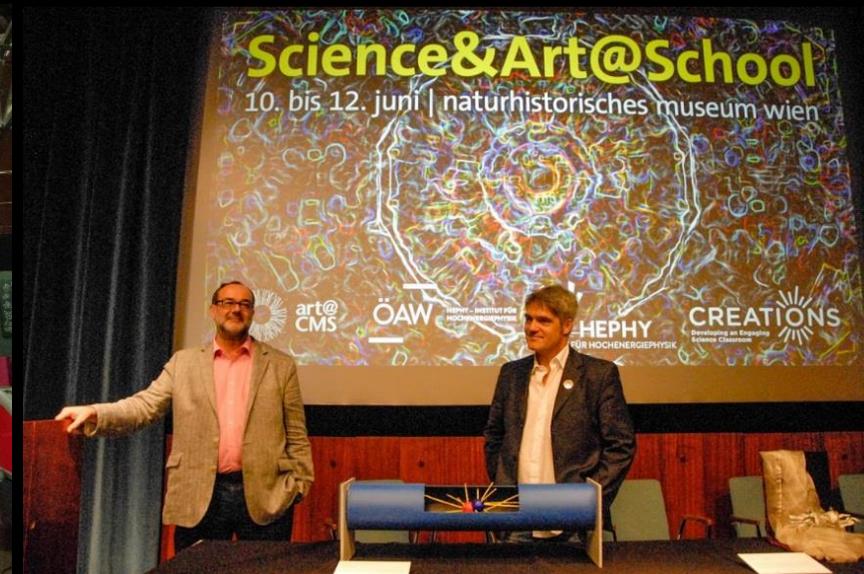
Science&Art@School – Cultural Collisions

You are cordially invited to
Cultural Collisions

An art exhibition, music and dance performance presented
by Austrian and Genevese students



Photos : CERN Bldg 40 became a stage for students



CERN Meyrin Bldg 40 February 24th 2017

In the presence of His Excellency Thomas Hajnóczi,
Permanent Representative of Austria to the international organizations in
Geneva / Switzerland

- 18h30 Opening
- 19h00 Welcome
- 19h15 art show & performance by Haydn Gym. Vienna,
Herz Jesu Gym. Salzburg, ECOLINT LGB Geneva,
- 20h00 Drinks
- 21h00 Close



art@CMS INFN Italian Tour has similar activities and creates synergies between various action to inspire students



Science&Art@School – Cultural Collisions

science&art@school event 2017 in Vienna (June) and the Cultural Collisions event at CERN (February) :

This is a Horizon 2020 EU project CREATIONS <http://portal.opendiscoveryspace.eu/creations>

Photos of the event in the Natural History Museum Vienna June 2017: <https://goo.gl/photos/esmfuMAx8Xr5K3V66>

Videos of the science&art@school event in the NHM :

Rhythm of Science : <https://youtu.be/DjKH7f1PNpI>

Cultural Collisions – dance : https://youtu.be/Bly_iERk5Ps

Science Rap “Particle Love” : <https://youtu.be/sdB2PydXUW8>

Cultural Collisions @ CERN February 2017

Photos: <https://goo.gl/photos/2tpnAg7TnsWEjq9q6> https://1drv.ms/f/s!Al-rN-l0kS2sg_gLpGmn7xOEnwjlFQ

Video of a student of the workshop @ CERN: <https://www.youtube.com/watch?v=TEsgtwUv6xk>

CCC Cultural Collisions CERN – a dance performance by students @ CERN: <https://youtu.be/ETjKwUS0yfg>

sciARTmasterclass – Science Festival

Otvoreni dani nauke
Mladi naučnik
5-9 godina



Ime: _____ Godine: _____



Students participating in the CMS Junior Scientist Program art@CMS interdisciplinary Exhibition with: real detector & accelerator equipment, art works, creative corners, lectures and detector workshops as well as sciART workshops.

Montenegro 2017: <https://www.youtube.com/watch?v=9vflW-Pf7vg>
Athens 2015: <https://www.youtube.com/watch?v=t8MHsCaYks>



University of the Arts London - Saint Martins College of Art

local scientific partner: Imperial College

2 semester sciART course October 2016 – June 2017

- 22 students supervised by Prof. Nathan Cohen, Dr. Andrew Charalambous
- Weekly lectures at the UAL/CSM
 - Lectures from colleagues of Imperial College
 - Visit at CERN 5 days December 5 days May
 - Offered workshops at CERN during May visit
 - Final show in London June and November

Photos: <https://goo.gl/photos/VfSSqkg7cN7Ejzs97>

ARTISTS PRESENTATION EVENING

Central Saint Martins MA Art & Science students (London) present a

PechaKucha Night

Tuesday 9 May
drop in from 5pm

Restaurant 1, next to the glas box



PHOTOGRAPHY WORKSHOPS
with Central Saint Martins MA Art & Science (London) students at CERN this Wednesday – FREE

Wed 10 May 10.30–12.30pm UP TO 12 PEOPLE
Pinhole Camera Workshop
with Olga Suchanova

In this workshop, you will learn how to make a pinhole camera in a 30-minute demonstration using a special edition beer can designed and sold by Tate Modern and the basis of Olga's camera. We will take photographs with this device and develop them in a DIY darkroom. Also, you can become part of the project 'Chasing the Sun' and learn how to take Solargraphs. All materials provided.

To register, email Olga at olga.suchanova@hotmail.com
Meeting point Bldg 40 coffee area CMS side 10:25



Wed 10 May 2.30–3.30pm UP TO 12 PEOPLE
Solar Prints–Cyanotype Workshop
with Lisa Pettibone

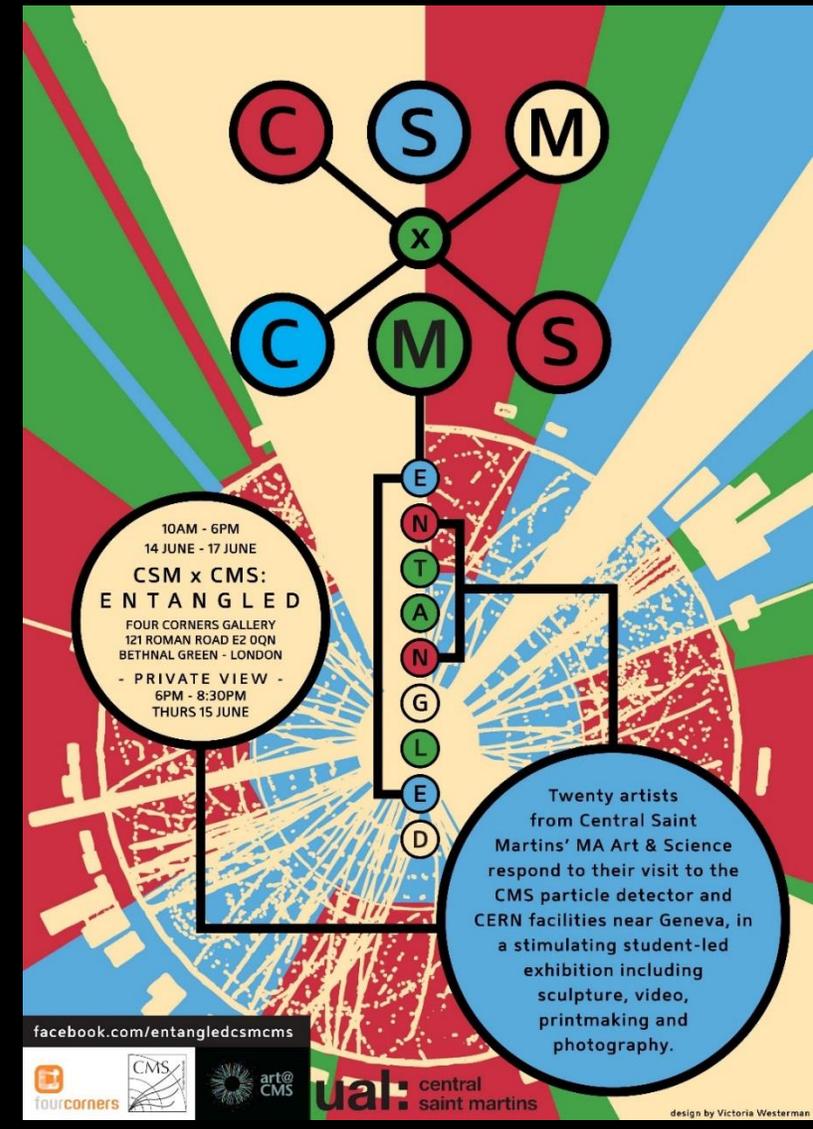
This workshop will use the sun's ultra-violet rays to interact with ferric-based chemicals on paper, creating beautiful images called cyanotypes, an early photographic process used by Sir John Herschel in 1842. We will make contact prints using objects arranged on pre-coated paper and placed in the sun. Mysterious shapes emerge from an intense blue background. **Please bring several objects to use, other materials are provided.**

To register email Lisa at lpettibone@btinternet.com
Meeting point Bldg 40 coffee area CMS side 14:25



Hosted by
CMS art@CMS

for any further questions please contact Michael.Hoch@cern.ch
CERN phone: 16 5720



ENTANGLED

10AM - 6PM
14 JUNE - 17 JUNE
CSM x CMS:
ENTANGLED
FOUR CORNERS GALLERY
121 ROMAN ROAD E2 0QN
BETHNAL GREEN - LONDON

- PRIVATE VIEW -
6PM - 8:30PM
THURS 15 JUNE

Twenty artists from Central Saint Martins' MA Art & Science respond to their visit to the CMS particle detector and CERN facilities near Geneva, in a stimulating student-led exhibition including sculpture, video, printmaking and photography.

facebook.com/entangledcsmcms

fourcorners CMS art@CMS ual: central saint martins

design by Victoria Westerman

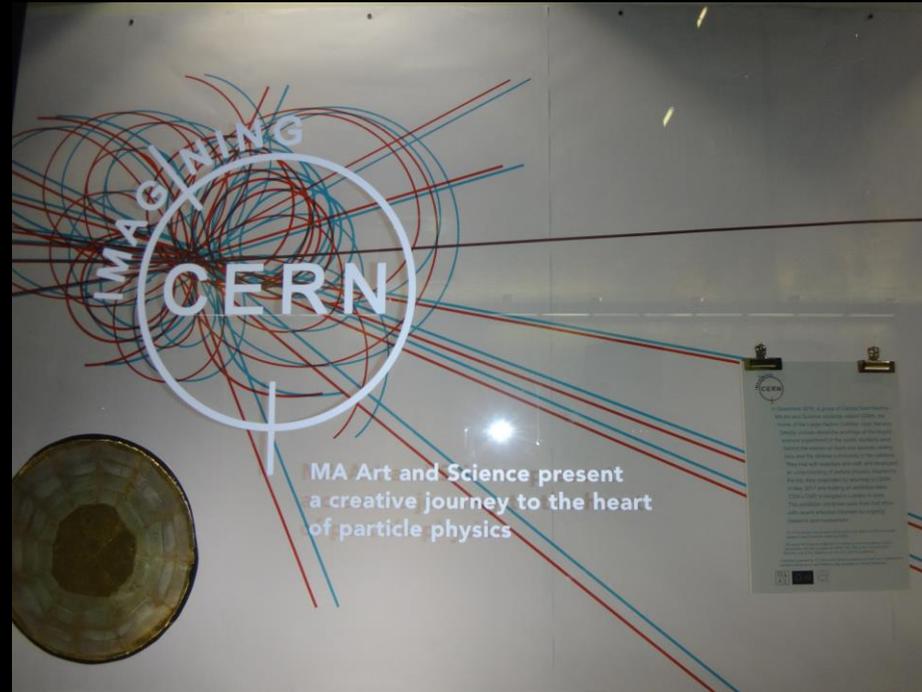
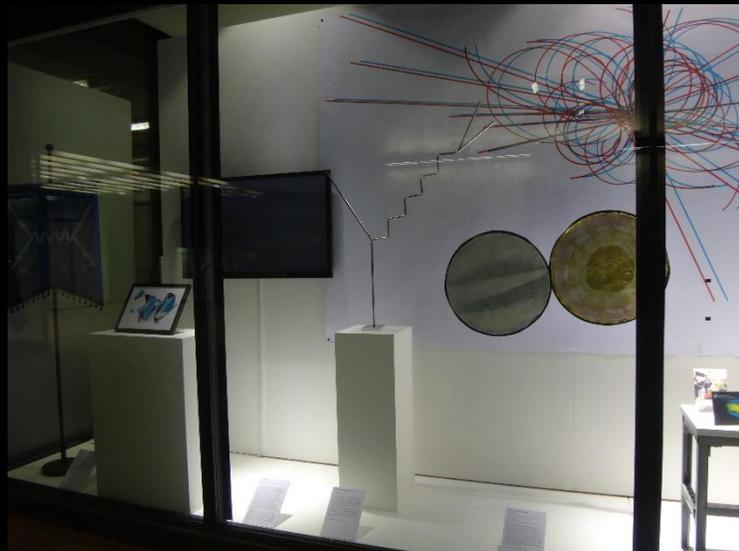
University of the Arts London -Saint Martins College of Art

local scientific partner: Imperial College

Vernissage / Exhibitions: June (Labyrinth) November (CSM) 2017



University of the Arts London -Saint Martins College of Art local scientific partner: Imperial College Windows Gallery Exhibition CSM –Nov 2017 Jan 2018 – Symposium No



Applied Arts University Vienna

local scientific partner: HEPHY

2 semester sciART course October 2016 – June 2017

- 2 x 11 students / 11 staff
- Weekly lectures at the Applied Arts University
 - Visit & Lectures from colleagues of HEPHY & TU
 - Visit at CERN 5 days December
 - Artwork rehearsal March
 - Particle detector construction workshop March
 - Final show in Vienna June

Photos : <https://goo.gl/photos/i6MqYfwCRgnNVs4N9>

Opening
June 6th 2017, 19:00

Accompanying Program
June 9th 2017

das weisse haus
Hegelgasse 14
1010 Vienna

Johanna Falkmann

Marko Markovic

Lela Nomada

Carmilia Tarlante Rodriguez

Denise Schellmann

Rafael Lippuner

Marina Rebhandl

Galnaz Bashiri

Andrea Vesgo

Canlı Ergün

Athanasios Gramoslis

Julia Mag

Lukas Gritznir

Nora Drumeva

Francesca Aldigiani

Andrea Budak

Daniela Brill

Benedikt Melzl

Rosie Beam

Frederique Neuts Leroy

EXHIBITION
JUNE 7th-17th 2017

CIRCUIT TRAINING

A FORAY INTO THE WORLD OF
THE LARGE HADRON COLLIDER

A project from students of the University of Applied Arts Vienna (ArtsScience and Site Specific Art) in cooperation with CERN (Art@CMS and HEPHY)

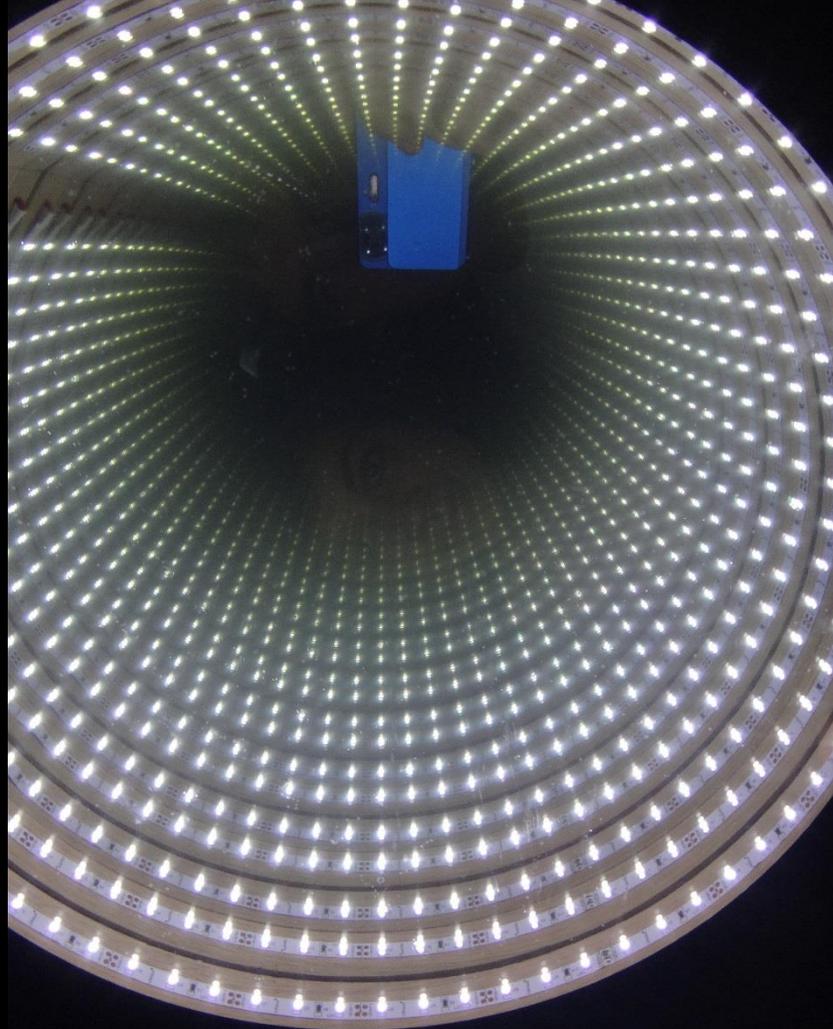
W dt:angewandte HEPHY art@CMS CMS



Applied Arts University Vienna

local scientific partner: HEPHY

Vernissage / Exhibition June 2017



Chelsea College of Arts London

1 semester sciART course October 2014-2015-2016

- supervision Prof. Dave Webster
- Weekly lectures and discussions at UAL
 - 2014/ 2015 Visit at CERN with 4 students + 4 trainees Shoreditch Trust
 - 2015/2016 - Visit at CERN 5 days, Final show TriangleSpace London June



OUR CONCERN

A collaborative project between the CMS collaboration at CERN, Camberwell, Chelsea and Wimbledon Colleges of Arts (part of UAL), the Shoreditch Trust and Allminds which involved recent Fine Art graduates from Wimbledon College of Arts and young people from the Shoreditch Trust Active Citizens programme visiting the CERN laboratory.

Friday 28th Nov 2014
 Private View: 9 - 8pm
 Restaurant Exhibition:
 • Performances
 • Food and drinks (canapes)

***Saturday 29th Nov to 9th Jan 2015**
 Restaurant Exhibition

Waterhouse, 10 Orsman Rd
 London N1 5QJ

*Please note Waterhouse will be closed for the holidays from Dec 25th - Jan 6th

Feynman inspired art

a construction manual

Andy Charalambous in collaboration with CERN HST Programme 2017



Fig.1: Coreen, 2012

1. Introduction

When I left school I went to work as a technician for the Physics and Astronomy department at a university in London. I trained as an engineer and spent many years designing and building equipment for the research groups there. My interest in science grew as I worked with these groups and got a better understanding of the science they were researching. I loved my job because it gave me so much insight into the science involved.

When I left that job and started as an artist I found that the excitement of science was something I didn't want to move away from. So, I decided to use science as the inspiration for my art. Most of the art I make comes from some bit of science that has seeded an idea. Science is a tool for letting us see our world more clearly, and for me it also inspires my work. By the way, I have not moved very far from the university I worked at. I am Artist in Residence for the Astronomy group and the High Energy Physics groups there, as well as being part of the art@CMS project run by Michael Hoch at CERN.

sciARTbooklet

a manual for an art and a science teacher to re- create and create topical artworks

art@CMS 2017

UK collaborative artists :
Rachael Nee , Andy Charalambous

in preparation:
"data sonification" by Federico IT,
"particle detection" by Ch. Henschke AU

Orders of Magnitude – Potato Powered Cosmos

a construction manual

Rachael Nee in collaboration with HST Programme 2017



1. Introduction

This booklet is written for science and art teachers with the aim of interdisciplinary learning. It assumes no knowledge of the other disciplines subject. In it you will read about the art installation from both the science and art viewpoints and how to reconstruct it. This becomes a jumping off point for the development of new artworks by High School students, with questions along the way.

Science and contemporary art have different end goals; however, they also have a lot in common. Both contemporary art and science have similar methodologies involving; investigation, research, testing out of ideas and theories through experiment. They share imagination, curiosity, quest for knowledge and are forms of inquiry. When successful both allow the world to be seen in new ways.

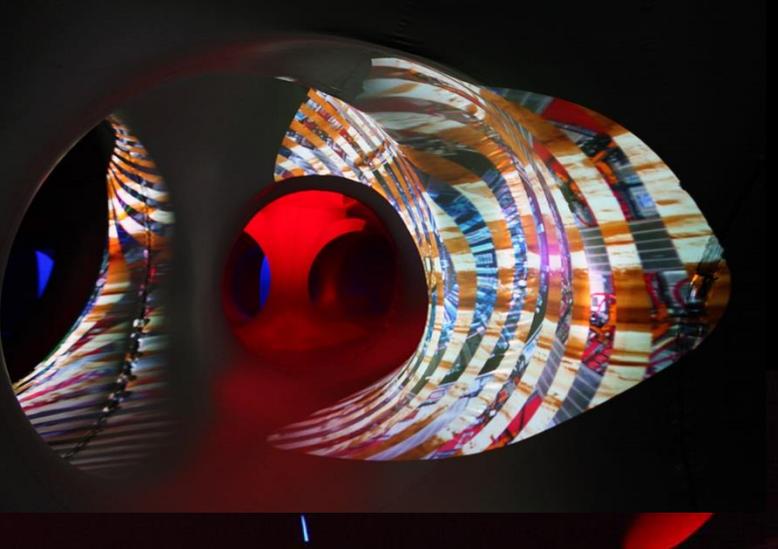
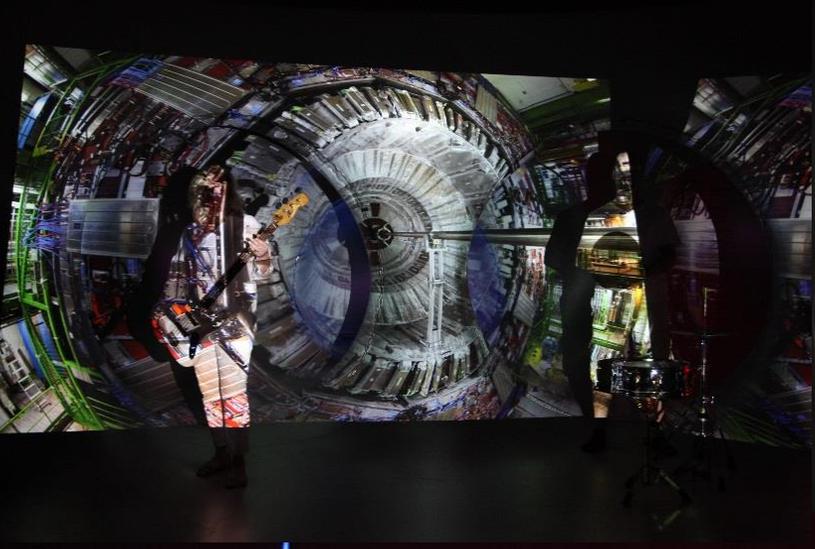
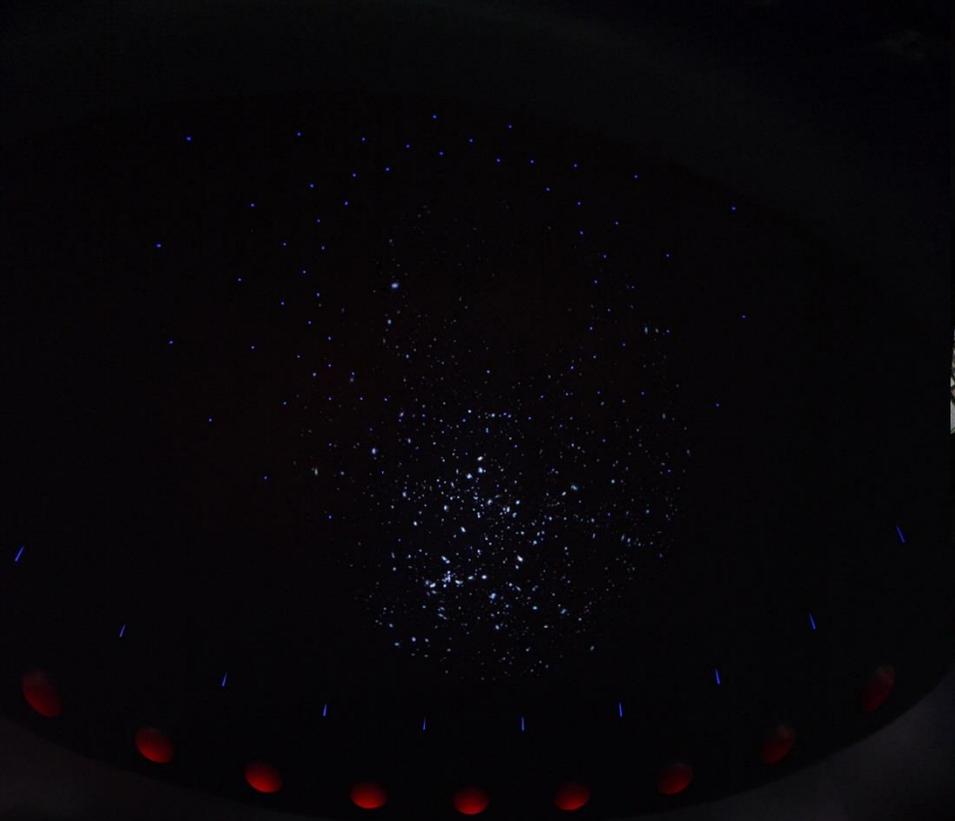


**art@CMS
&
Architects of Air**

is a synthesis of 2
unique partners whose
core activity address the
wonder of light and the
wonder of the universe.

Combining the
imageries of the
machinery of CERN
with the curvilinear
environment of the
Architects of Air dome
creates an incredibly
intriguing layer of
visual experience.





art@CMS: collaborative artist CONSENSUS

CONSENSUS participates as well in science & artworkshops



UK Rapper launches album CONCERNED

after 2 years of collaboration his science rap album ConCERNed. His scientific partner is Sudan Paramesvaran / CMS Bristol UK

CERN Article (all info):

<http://cms.cern/news/concerned-using-hip-hop-engage-new-audiences-particle-physics>

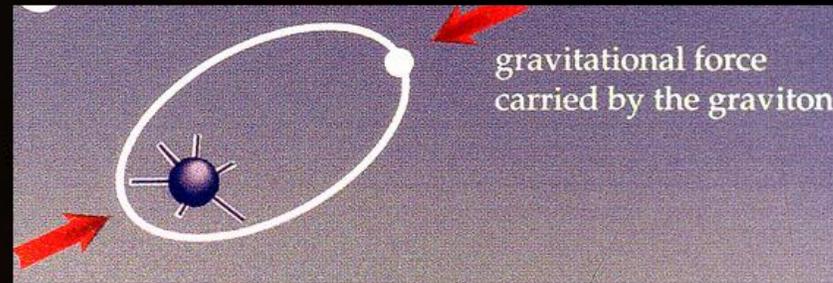
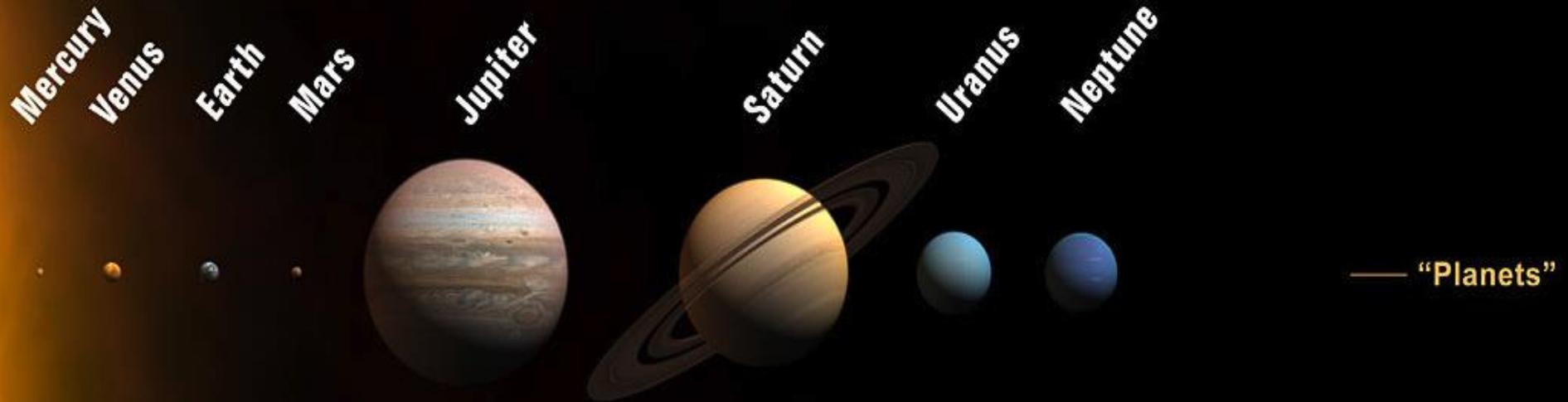
More Infor & Links:

- The BBC interview of ConSensus and Sudan [the sequence starts at 1:11.18 until 1h26.26]
<http://www.bbc.co.uk/programmes/p04zv0g0#play>
<https://www.youtube.com/watch?v=MJXaBq5VTNc>
- Press article in the journal “The Voice” here's the online version:
<http://www.voice-online.co.uk/article/south-london-geneva-hip-hop-science-lessons>
- Two music videos of the 9 tracks from the album is available on youtube
<https://www.youtube.com/watch?v=tJl8-ArzkBg&feature=youtu.be>
- <https://www.youtube.com/watch?v=1ju3fo37yLE&feature=youtu.be>
- Science Rap StudentsWorkshop “Particle Love”: <https://youtu.be/sdB2PydXUW8>

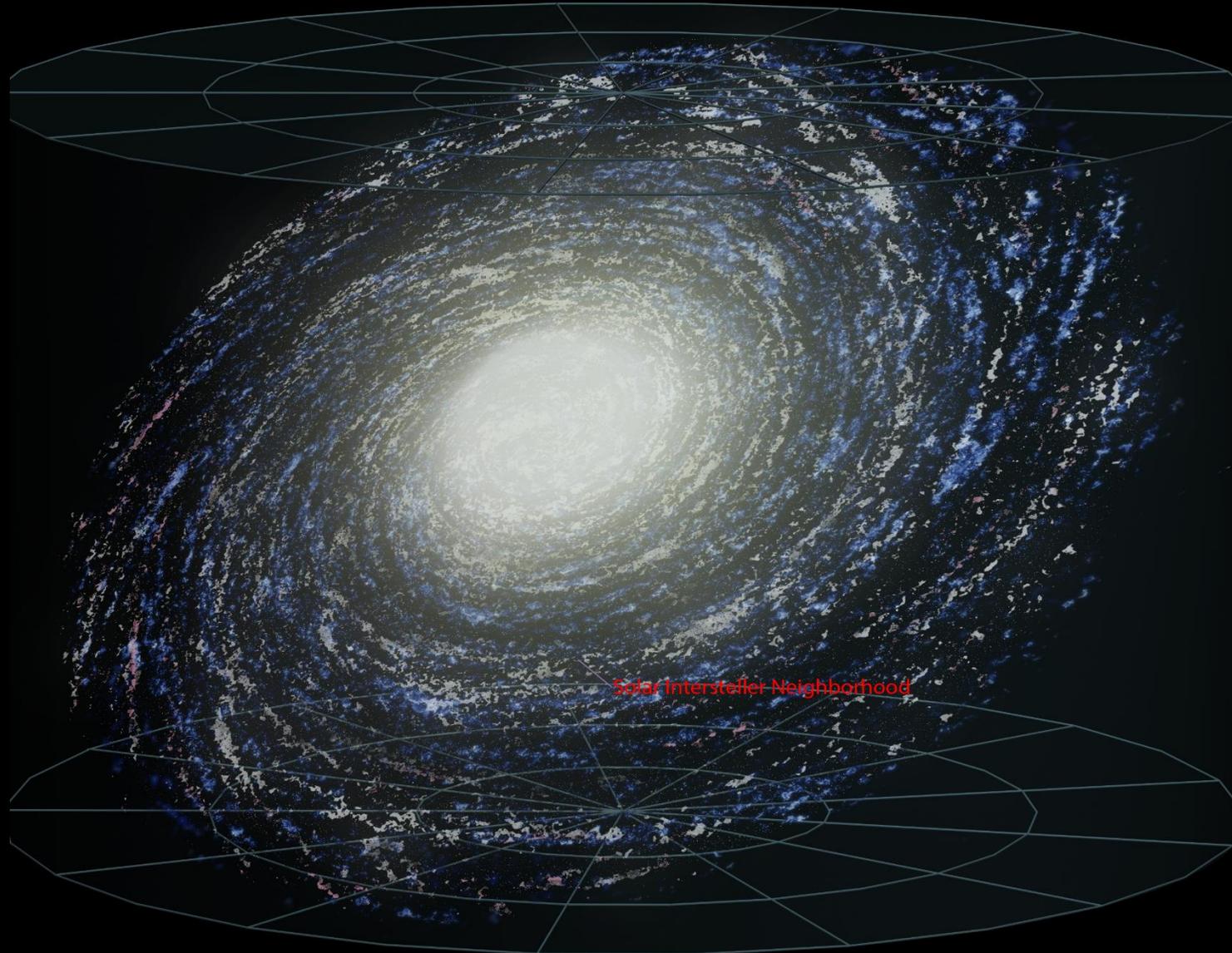
Thank you for you attention

Michael.Hoch@cern.ch phone: +41 75 411 5720

The Solar system - bound by gravity



Milky Way Galaxy



the Milky Way,
another system
bound by gravity

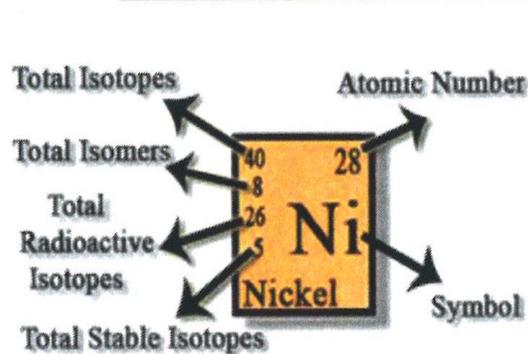


Nuclear Periodic Table

Chemical elements - elementary particles of 19-th century

7 0 5 2 2 H Hydrogen	8 0 6 2 2 He Helium																
12 2 8 2 2 Li Lithium	15 3 11 1 2 Be Beryllium	14 0 12 2 2 B Boron	15 6 13 2 2 C Carbon	17 7 14 2 2 N Nitrogen	17 8 14 3 2 O Oxygen	19 9 17 1 1 F Fluorine	19 10 16 3 3 Ne Neon										
22 2 19 1 1 Na Sodium	22 11 19 3 3 Mg Magnesium	25 3 23 1 1 Al Aluminium	25 14 20 3 3 Si Silicon	23 15 22 1 1 P Phosphorus	25 16 20 4 4 S Sulfur	26 17 22 2 2 Cl Chlorine	25 18 21 3 3 Ar Argon										
28 4 22 2 2 K Potassium	19 20 19 5 5 Ca Calcium	37 21 24 1 1 Sc Scandium	22 22 25 1 1 Ti Titanium	23 23 22 4 4 V Vanadium	28 24 25 1 1 Cr Chromium	25 25 24 4 4 Mn Manganese	26 26 24 5 5 Fe Iron	27 27 26 5 5 Co Cobalt	28 28 27 2 2 Ni Nickel	29 29 27 5 5 Cu Copper	40 30 25 5 5 Zn Zinc	38 31 29 2 2 Ga Gallium	31 32 28 4 4 Ge Germanium	44 33 32 1 1 As Arsenic	39 34 25 5 5 Se Selenium	47 35 29 2 2 Br Bromine	42 36 26 6 6 Kr Krypton
50 18 31 1 1 Rb Rubidium	37 38 29 4 4 Sr Strontium	38 39 25 1 1 Y Yttrium	40 40 32 7 7 Zr Zirconium	41 41 27 6 6 Nb Niobium	40 42 34 6 6 Mo Molybdenum	55 43 21 0 0 Tc Technetium	41 44 27 7 7 Ru Ruthenium	44 45 33 6 6 Rh Rhodium	45 46 33 2 2 Pd Palladium	71 47 33 2 2 Ag Silver	51 48 32 6 6 Cd Cadmium	85 49 46 1 1 In Indium	63 50 29 10 10 Sn Tin	62 51 35 2 2 Sb Antimony	56 52 33 5 5 Te Tellurium	51 53 14 2 2 I Iodine	50 54 12 9 9 Xe Xenon
68 28 39 1 1 Cs Cesium	55 56 37 3 3 Ba Barium	52 57 13 5 5 La Lanthanum	55 72 19 5 5 Hf Hafnium	64 73 28 3 3 Ta Tantalum	43 74 30 5 5 W Tungsten	55 75 20 1 1 Re Rhenium	42 76 29 6 6 Os Osmium	68 77 10 2 2 Ir Iridium	47 78 32 5 5 Pt Platinum	70 79 33 1 1 Au Gold	56 80 33 7 7 Hg Mercury	78 81 41 2 2 Tl Thallium	74 82 36 4 4 Pb Lead	75 83 40 0 0 Bi Bismuth	58 84 25 0 0 Po Polonium	53 85 22 0 0 At Astatine	46 86 12 0 0 Rn Radon
43 9 34 0 0 Fr Francium	87 88 10 3 3 Ra Radium	39 89 8 0 0 Ac Actinium	25 104 9 0 0 Rf Rutherfordium	21 105 5 0 0 Db Dubnium	20 106 4 0 0 Sg Seaborgium	18 107 2 0 0 Bh Bohrium	18 108 3 0 0 Hs Hassium	17 109 2 0 0 Mt Meitnerium	19 110 4 0 0 Ds Darmstadtium	12 111 0 0 0 Rg Roentgenium	9 112 0 0 0 Uub Ununbium	5 113 0 0 0 Uut Ununtrium	5 114 0 0 0 Uuq Ununquadium	5 115 0 0 0 Uup Ununpentium	4 116 0 0 0 Uuh Ununhexium	2 117 0 0 0 Uus Ununseptium	1 118 0 0 0 Uuo Ununoctium

- Fusion Products
- Fission Products
- Heavy Activation Products
- Cosmogenic Products
- Light Activation Products
- Natural Products



52 13 35 4 4 Ce Cerium	58 15 38 3 3 Pr Praseodymium	59 13 33 5 5 Nd Neodymium	60 19 38 0 0 Pm Promethium	61 12 33 5 5 Sm Samarium	62 13 36 1 1 Eu Europium	63 10 30 6 6 Gd Gadolinium	64 23 35 1 1 Tb Terbium	65 11 29 7 7 Dy Dysprosium	66 28 35 6 6 Ho Holmium	67 10 29 6 6 Er Erbium	68 23 34 1 1 Tm Thulium	69 12 27 7 7 Yb Ytterbium	70 36 34 1 1 Lu Lutetium
33 3 30 0 0 Th Thorium	90 3 29 0 0 Pa Protactinium	91 6 26 0 0 U Uranium	92 10 20 0 0 Np Neptunium	93 5 20 0 0 Pu Plutonium	94 7 19 0 0 Am Americium	95 7 20 0 0 Cm Curium	96 16 20 0 0 Bk Berkelium	97 3 16 0 0 Cf Californium	98 11 19 0 0 Es Einsteinium	99 6 18 0 0 Fm Fermium	100 13 17 0 0 Md Mendelevium	101 6 17 0 0 No Nobelium	102 7 16 0 0 Lr Lawrencium