Romanian Teacher Programme

Călin Alexa,
Particle Physics Dept., IFIN-HH
Faculty of Physics, University of Bucharest (associate with)

Romanian Minister of Education, Research, Youth and Sport, Daniel Petru Funeriu, and CERN Director General, Rolf Heuer, signed an agreement that formally recognises Romania as a Candidate for Accession to membership of CERN.

***Date*: 11 Feb 2010**

https://cds.cern.ch/record/1240264?ln=en

CERN welcomes Romania as its twenty-second Member State

On 17 July 2016, Romania became the twenty-second Member State of CERN

17 JULY, 2016

President of Romania K.W. Iohannis on the occasion of the flag-raising ceremony to mark the accession of Romania as a Member State of CERN with President of CERN Council 2016-2018 S. De Jong and CERN Director-General 2016-2025 F. Gianotti.

https://home.cern/news/news/cern/cern-welcomes-romania-its-twenty-second-member-state

Member States of CERN

Member States (date of accession)

- Austria (1959)
- Belgium (1953)
- Bulgaria (1999)
- Czech Republic (1993)
- Denmark (1953)
- Finland (1991)
- France (1953)
- Germany (1953)
- Greece (1953)
- Hungary (1992)
- Israel (2014)
- Italy (1953)
- Netherlands (1953)
- Norway (1953)
- Poland (1991)
- Portugal (1986)
- Romania (2016) ???
- Slovakia (1993)
- Spain (1961-1968, 1983-)
- Sweden (1953)
- Switzerland (1953)
- United Kingdom (1953)

States in accession to Membership and Associate Members

- Cyprus (2016)
- India (2017)
- Lithuania (2018)
- Pakistan (2015)
- Serbia (2012)
- Slovenia (2017)
- Turkey (2015)
- Ukraine (2016)

BREAKDOWN OF CERN USERS ACCORDING TO THE COUNTRY OF THEIR HOME INSTITUTE, AS OF 31 DECEMBER 2022

NUMBER OF USERS: 11 860

MEMBER STATES (7147)

Austria 85 – **Belgium** 129 – **Bulgaria** 43 – **Czech Republic** 244 – **Denmark** 49 – **Finland** 90 – **France** 844 – **Germany** 1225 – **Greece** 119 **Hungary** 73 – **Israel** 64 – **Italy** 1527 – **Netherlands** 169 – **Norway** 79 – **Poland** 305 – **Portugal** 100 – **Romania** 109 – **Serbia** 33 – **Slovakia** 70 **Spain** 383 – **Sweden** 103 – **Switzerland** 406 – **United Kingdom** 898

ASSOCIATE MEMBER STATES IN THE PRE-STAGE TO MEMBERSHIP (69)

Cyprus 15 – **Estonia** 30 – **Slovenia** 24

ASSOCIATE MEMBER STATES (382)

Croatia 38 – **India** 132 – **Latvia** 16 – **Lithuania** 14 – **Pakistan** 35 – **Türkiye** 122 – **Ukraine** 25

OBSERVERS (2991)

Japan 216 – **Russian Federation** 873 (the Observer status of the Russian Federation has been suspended in accordance with the Resolution adopted by the CERN Council on 8 March 2022) – **United States of America** 1902

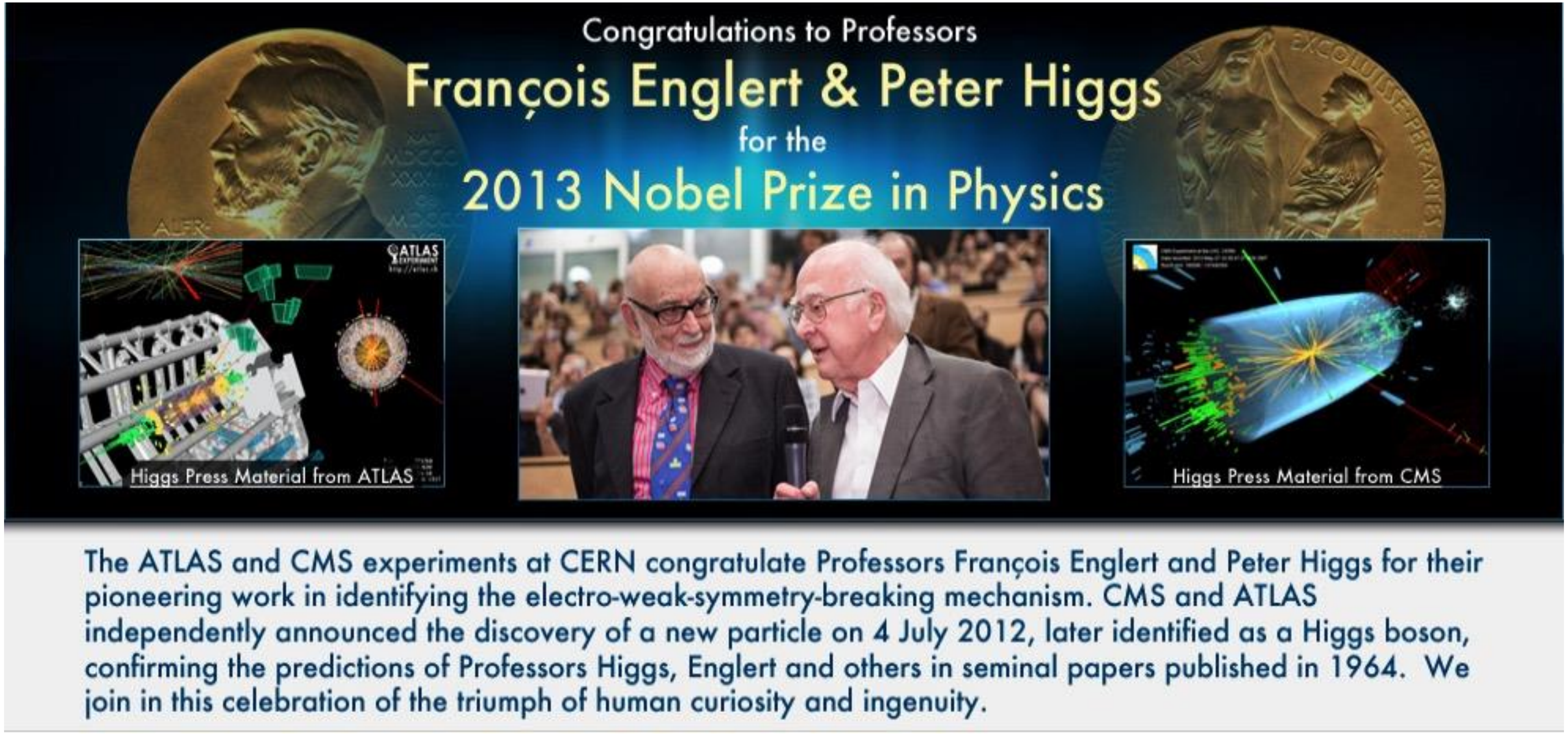
OTHER COUNTRIES (1271)

Algeria 2 – **Argentina** 13 – **Armenia** 8 – **Australia** 21 – **Azerbaijan** 2 – **Bahrain** 4 – **Belarus** 18 – **Brazil** 122 – **Canada** 199 – **Chile** 34 **Colombia** 21 – **Costa Rica** 2 – **Cuba** 3 – **Ecuador** 4 – **Egypt** 20 – **Georgia** 32 – **Hong Kong** 15 – **Iceland** 3 – **Indonesia** 5 – **Iran** 11 – **Ireland** 5 **Jordan** 5 – **Kuwait** 4 – **Lebanon** 13 – **Madagascar** 1 – **Malaysia** 4 – **Malta** 1 – **Mexico** 49 – **Montenegro** 4 – **Morocco** 19 – **New Zealand** 5 **Nigeria** 1 – **Oman** 1 – **Palestine** 1 – **People's Republic of China** 333 – **Peru** 2 – **Philippines** 1 – **Republic of Korea** 147 – **Singapore** 2 **South Africa** 52 – **Sri Lanka** 10 – **Taiwan** 45 – **Thailand** 17 – **Tunisia** 2 – **United Arab Emirates** 7 – **Vietnam** 1 https://www.ifa-mg.ro/cern/programul-cern-ro.php

MINISTERUL CERCETĂRII, INOVĂRII ȘI DIGITALIZĂRII

Proiecte in derulare

Experiment	Conducator proiect(CO)/ Parteneri	Director proiect
ALICE	CO: IFIN-HH	Mihai PETROVICI mpetro@ifin.nipne.ro
	CO: ISS	Alexandru Florin DOBRIN alexandru.florin.dobrin@cern.ch
ATLAS EXPERIMENT and RD51	CO: IFIN-HH	Calin ALEXA calin.alexa@cern.ch
	P1: ITIM-CJ	
	P2: UPB	
	P3: UAIC	
	P4: UVT	
	P5: UTB	
	P6: UB	
LHCb	CO: IFIN-HH	Florin MACIUC florin.maciuc@cern.ch
	P1: USV	
WLCG	CO: IFIN-HH	Mihnea DULEA mihnea.dulea@nipne.ro
	P1: ISS	
	P2: ITIM-CJ	
	P3: UAIC	
	P4: UPB	
ISOLDE	CO: IFIN-HH	Constantin MIHAI constantin.mihai@nipne.ro
n_TOF	CO: IFIN-HH	Alexandru NEGREȚ alnegret@tandem.nipne.ro
NA62	CO: IFIN-HH	Alexandru-Mario BRAGADIREANU mario.bragadireanu@nipne.ro
RD50	CO: INCDFM	Ioana PINTILIE ioana@infim.ro
MoEDAL	CO: ISS	Vlad POPA vpopa@spacescience.ro
WA105	CO:UB-FF	Ionel LAZANU ionel.lazanu@g.unibuc.ro
DsTau NA65	CO:ISS	Elena FIRU elena.firu@spacescience.ro

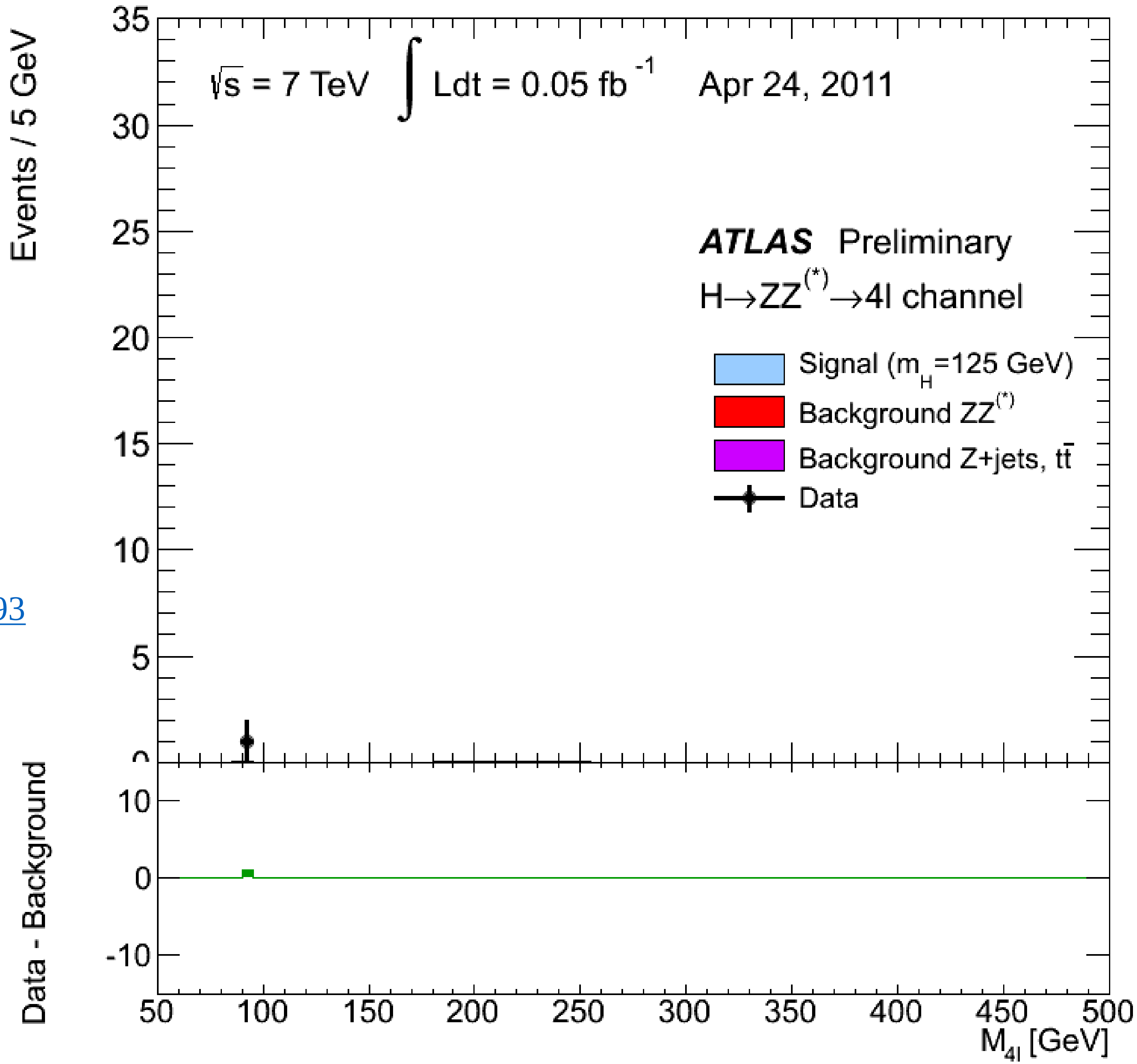


Higgs boson discovery was the culmination of the decades of dedicated and intense work by so many collaborators in designing, building and operating **ATLAS**, and in understanding and analysing the data. None of it would have been possible without the huge dedication also of the LHC accelerator team, the worldwide distributed computing teams, and the continuing support of the governments and funding agencies of the 38 countries home to our 177 member institutes.

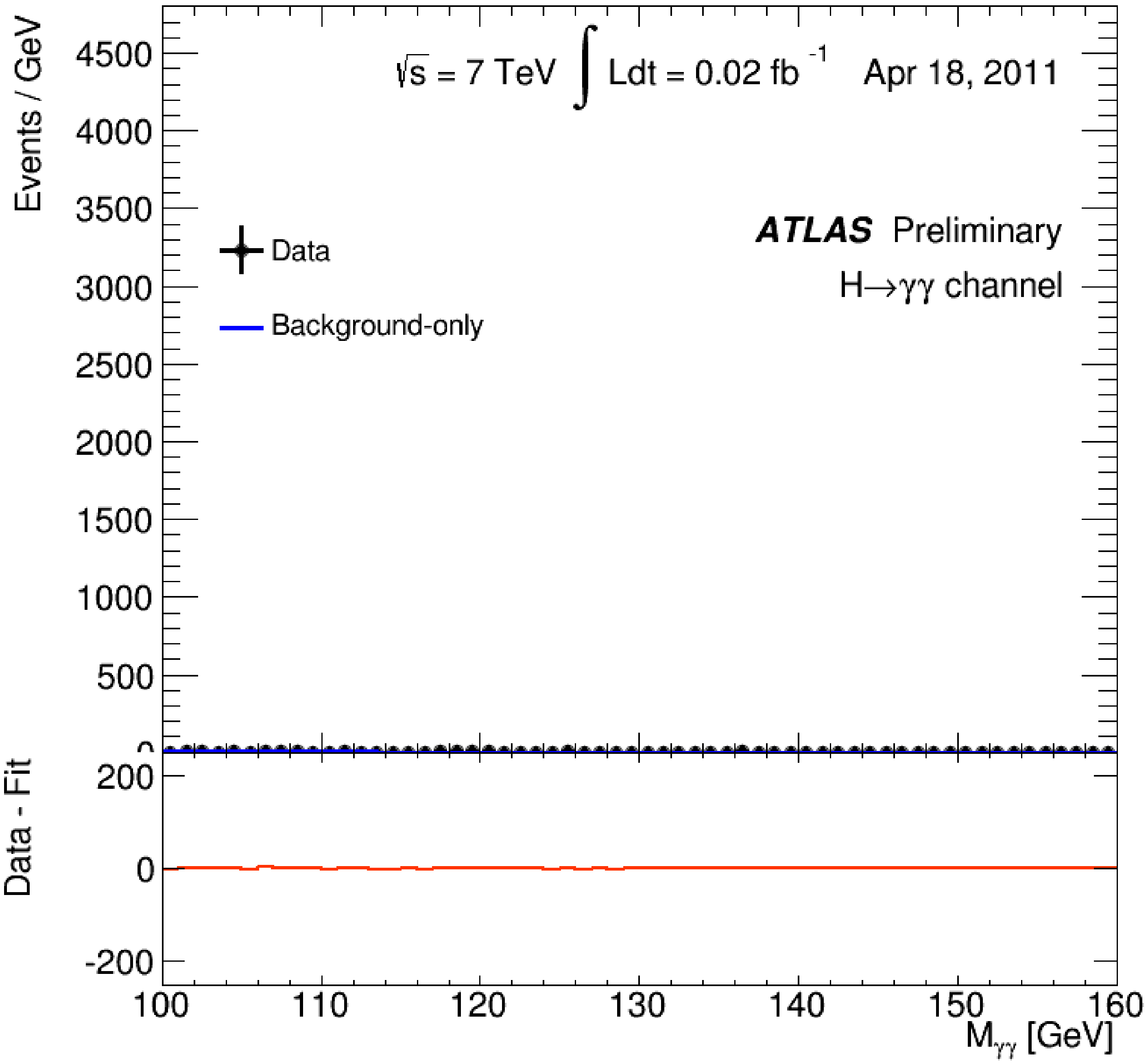
We can all feel proud that our experimental observations demonstrated that the insights rewarded by the Nobel prize are realised in nature.

Animation of the reconstructed mass from Higgs candidate events in four-lepton decays.

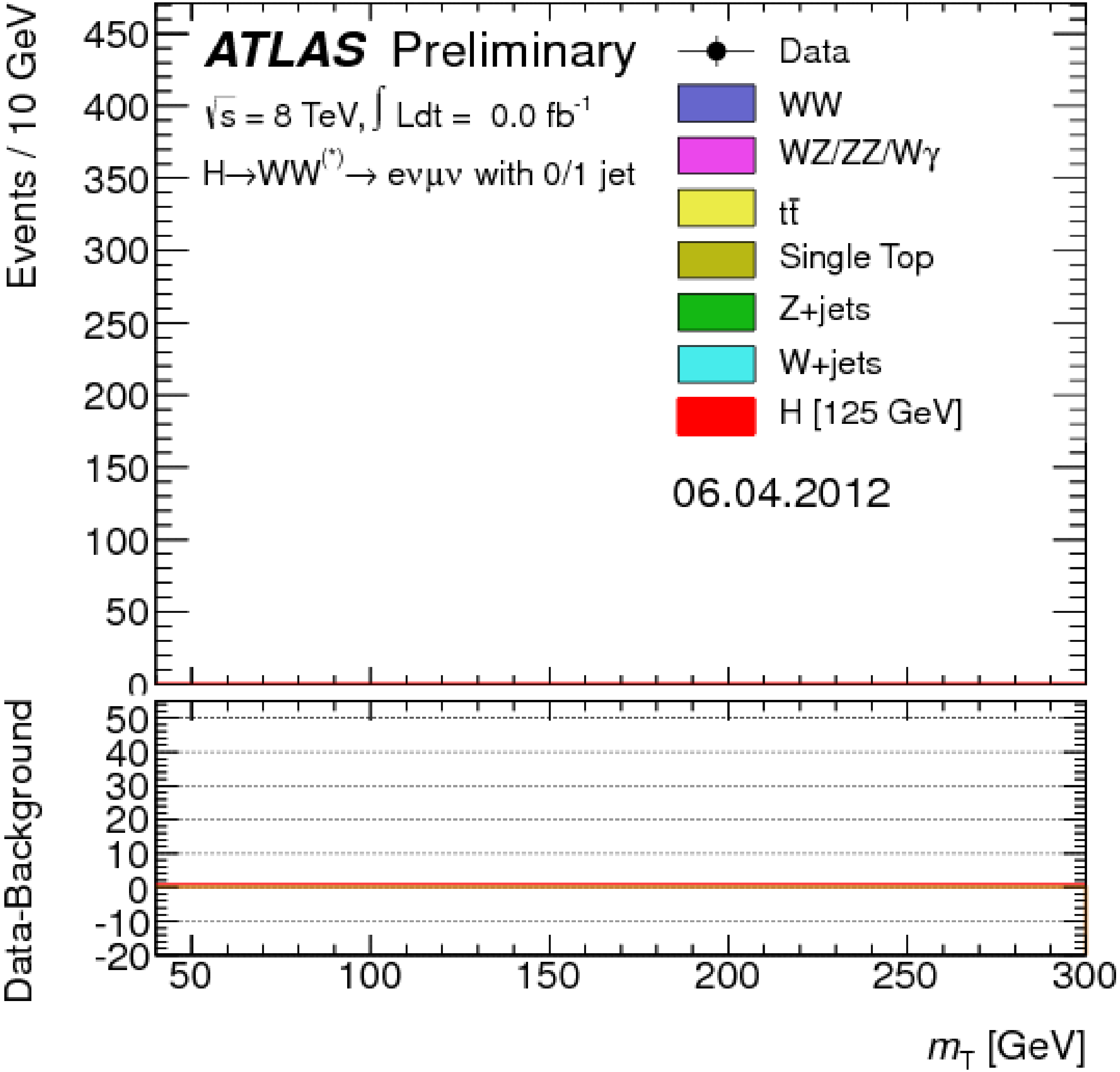
https://cds.cern.ch/record/2230893



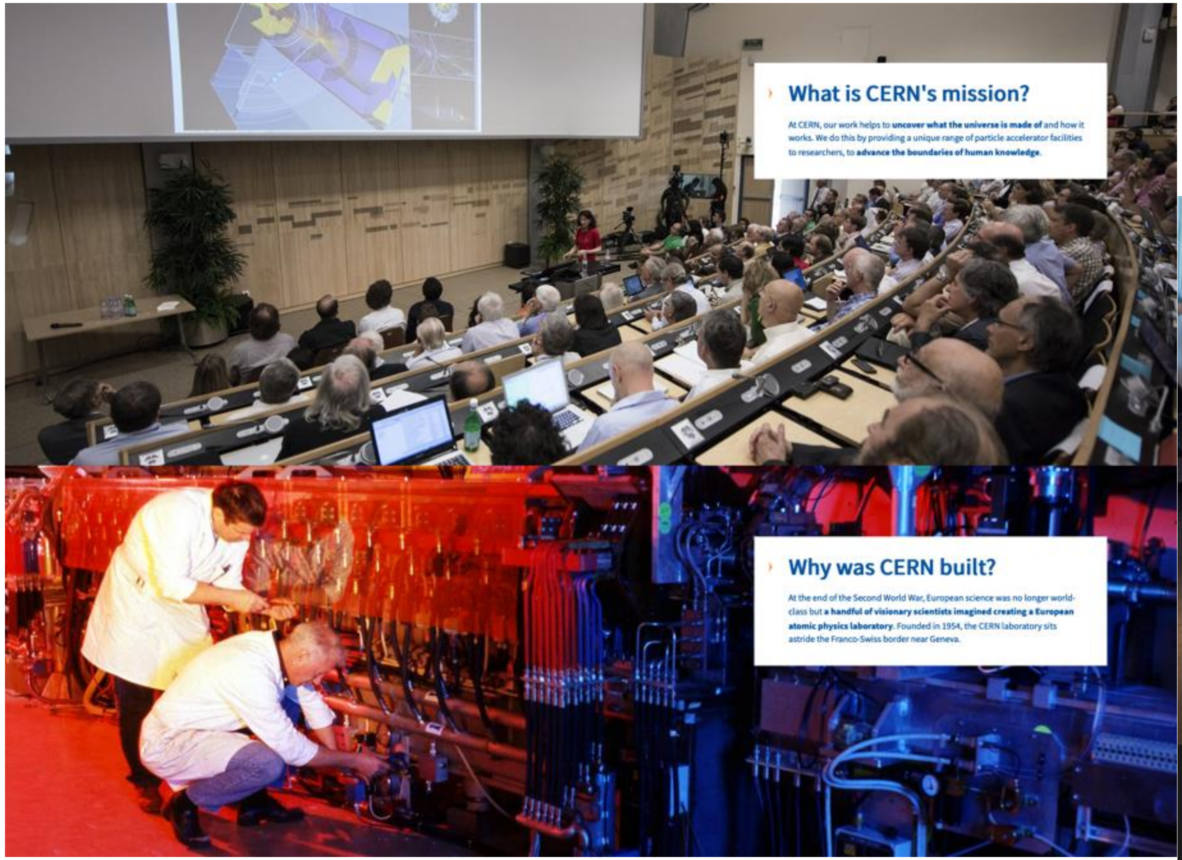
Animation of the reconstructed mass from Higgs candidate events in two-photon decays.

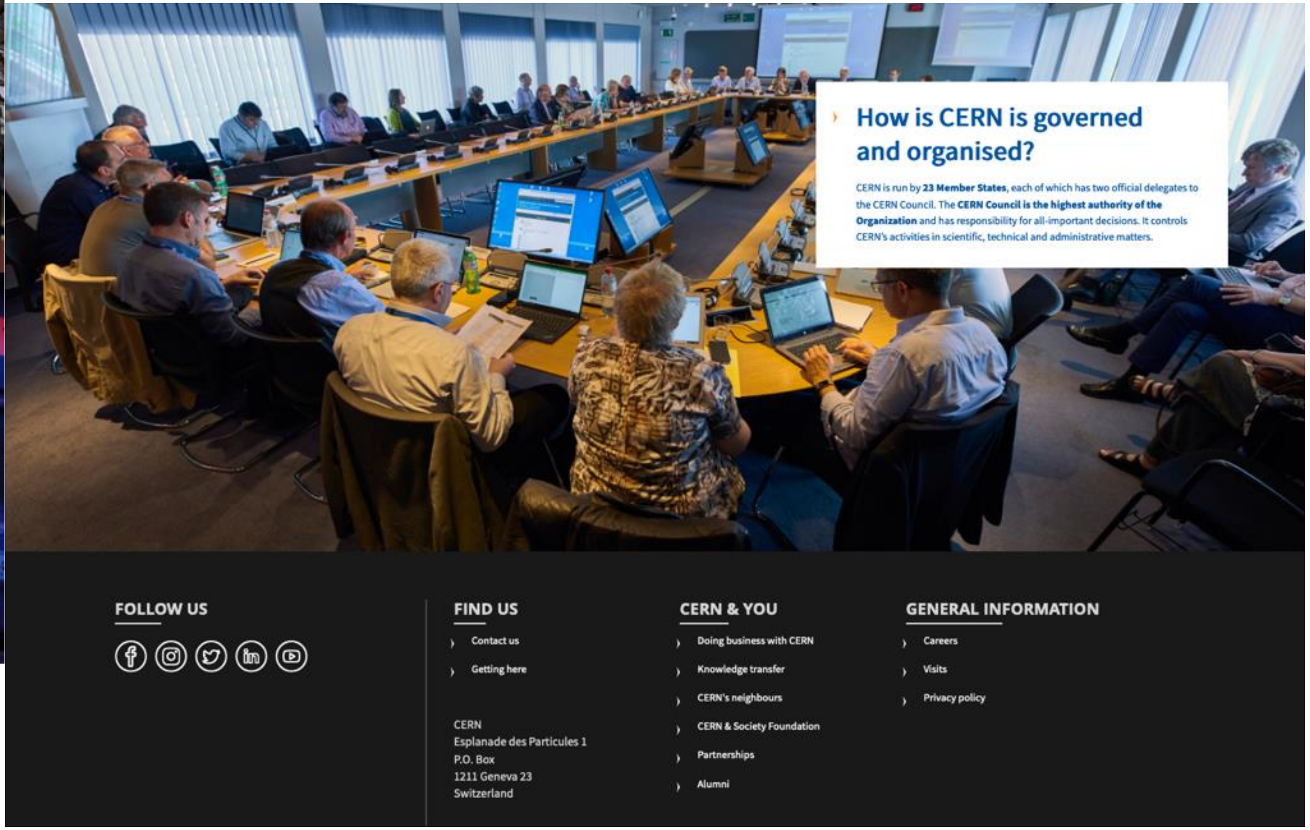


Animation of the reconstructed mass from Higgs candidate events in W-boson-pair decays.



CERN (*Conseil Européen pour la Recherche Nucléaire 1954*)
este Laboratorul European pentru Fizica Particulelor.





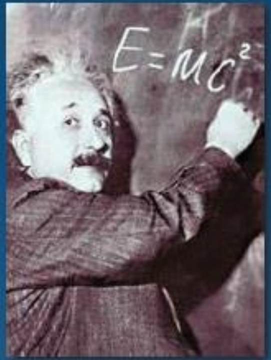
https://home.cern/

Innovation Education
CERN
uniting people
Research

The Mission of CERN

- **Push back** the frontiers of knowledge

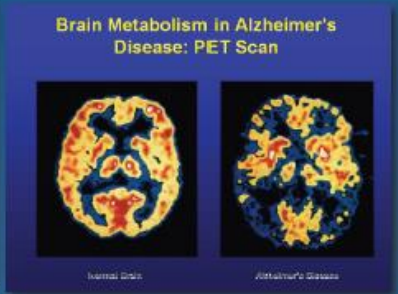
  E.g. the secrets of the Big Bang …what was the matter like within the first moments of the Universe's existence?



- **Develop** new technologies for accelerators and detectors

  Information technology - the Web and the GRID

  Medicine - diagnosis and therapy

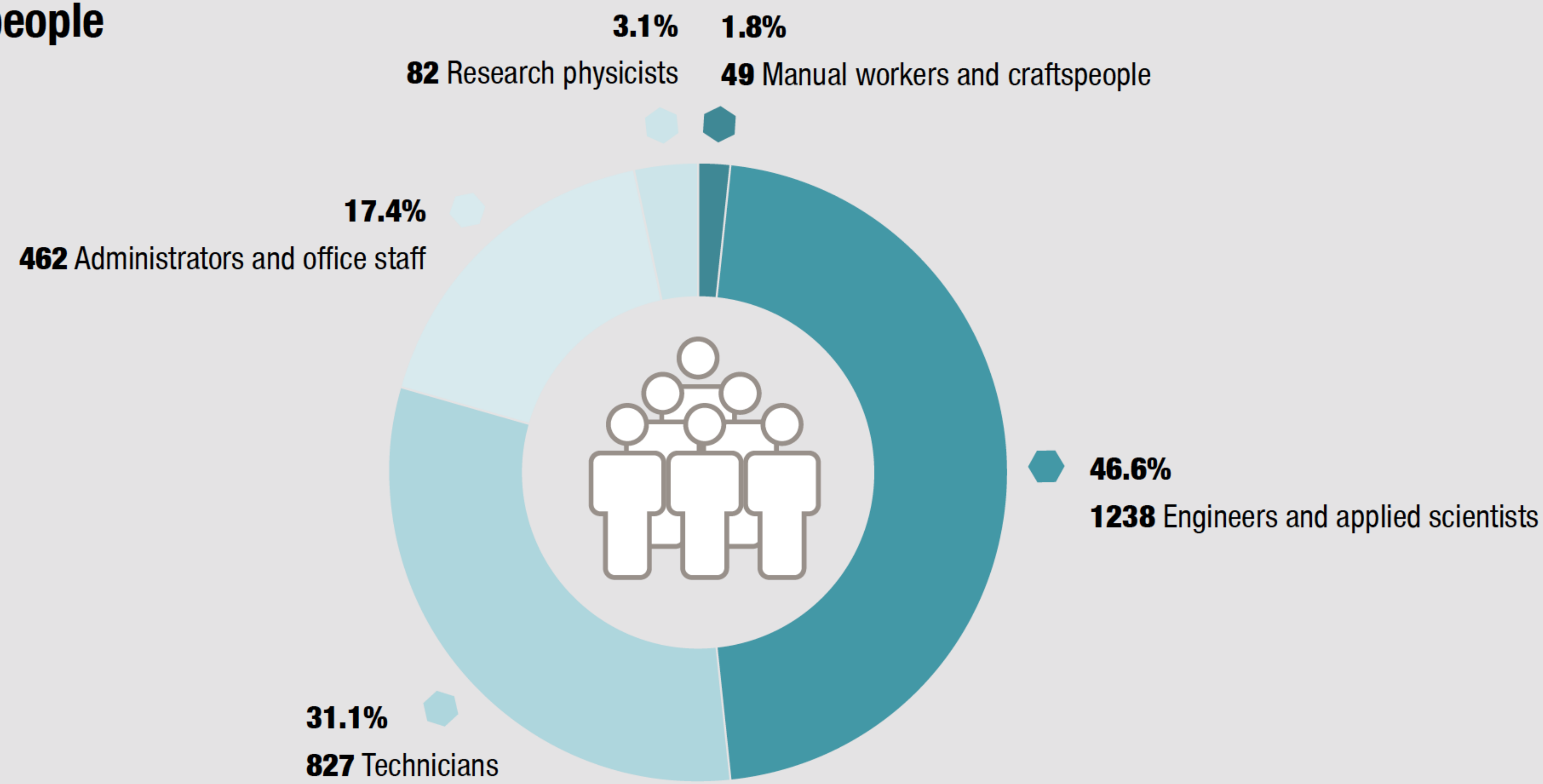



- **Train** scientists and engineers of tomorrow


- **Unite** people from different countries and cultures

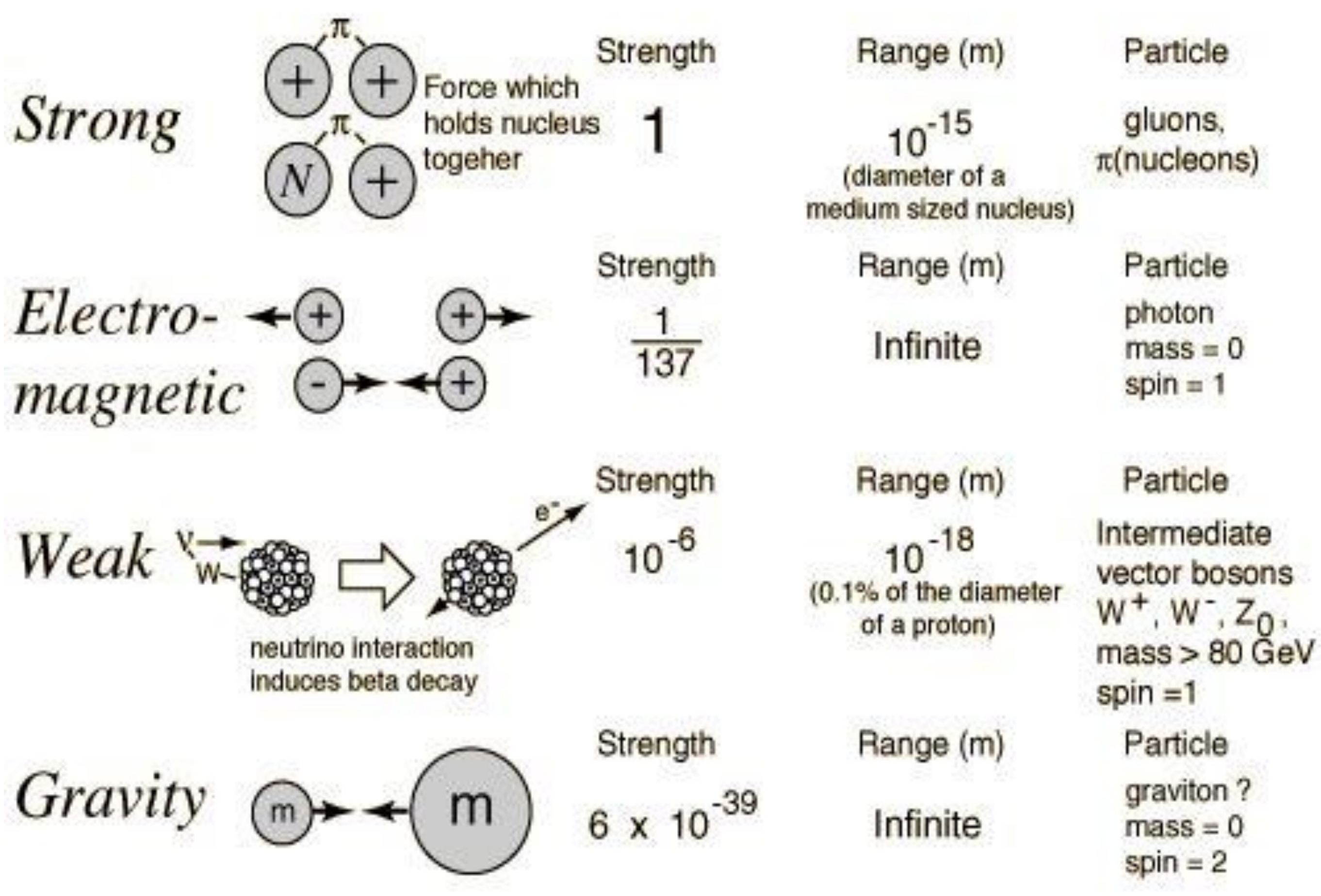
CERN STAFF

Total: 2658 people



https://cds.cern.ch/record/2857560/files/CernAnnualReport_2022_EN.pdf

Fundamental Forces



Force	Diagram	Strength	Range (m)	Particle	
Strong	Force which holds nucleus togeher	1	10^{-15} (diameter of a medium sized nucleus)	gluons, π(nucleons)	10^{-22} sec
Electro-magnetic		$\frac{1}{137}$	Infinite	photon mass = 0 spin = 1	10^{-15} sec
Weak	neutrino interaction induces beta decay	10^{-6}	10^{-18} (0.1% of the diameter of a proton)	Intermediate vector bosons W^+, W^-, Z_0, mass > 80 GeV spin =1	10^{-8} sec
Gravity		6×10^{-39}	Infinite	graviton ? mass = 0 spin = 2	10^{-2} sec

Alpha (α) is not the Only Charge Associated with Particle

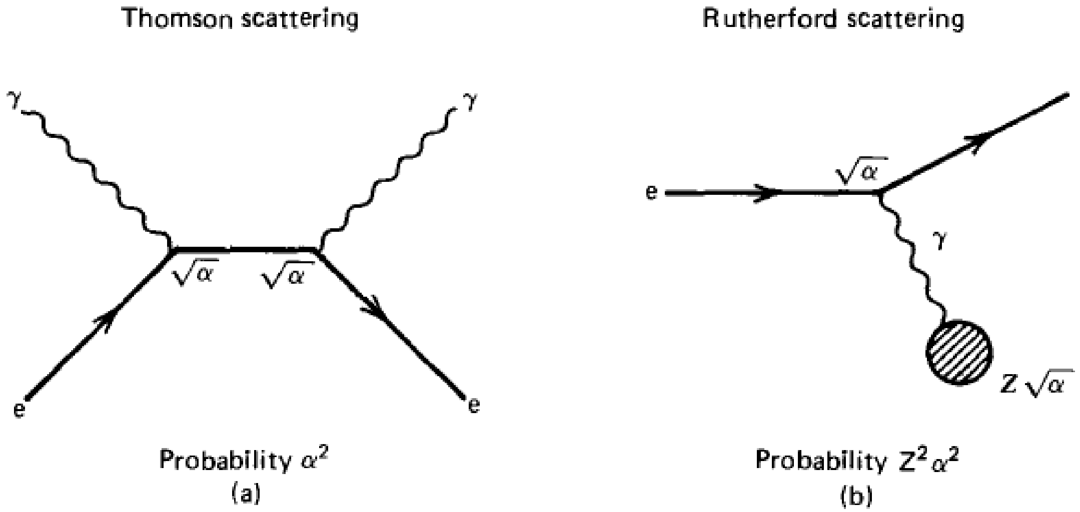


Fig. 1.7 (a) Thomson scattering. (b) Rutherford scattering.

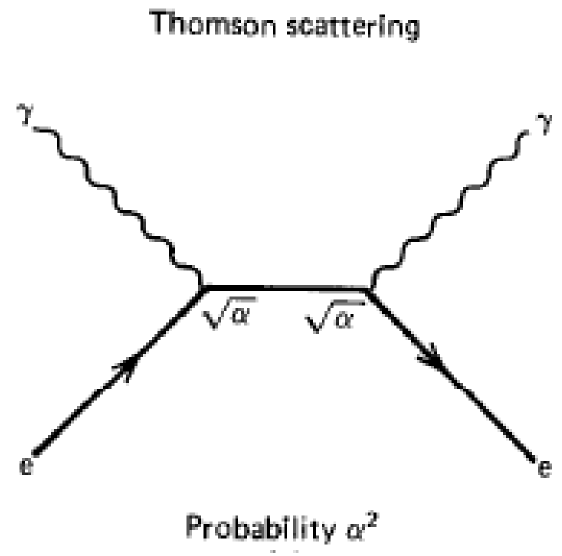
$$\frac{d\sigma_R}{d\Omega} = \frac{Z^2\alpha^2}{4E^2}\frac{1}{\sin^4(\theta/2)}$$

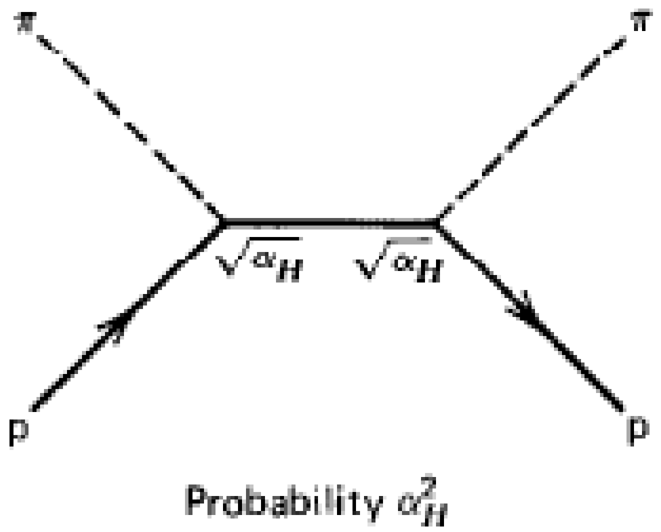
$$\sigma_{TH} = \frac{8\pi}{3}\left(\frac{\alpha}{m_e}\right)^2 = \frac{2}{3}\alpha^2(4\pi R_e^2)$$

α is a measure of the strength of the e.m. interaction
or,
in particle exchange language,
the probability for emitting or absorbing a photon

$$R_e = \frac{\hbar}{m_e c} = \frac{1}{m_e}$$

is the Compton wavelength of the electron, it is the value of the charge (or **α**) when probed with a low-energy probe from a large distance





$$\sigma_{TH} = \frac{2}{3}\alpha^2 \left(4\pi\ R_e^2 \right)$$

where $R_e = \dfrac{1}{m_e}$

and $\alpha^2 = \dfrac{e^2}{4\pi\ \hbar c} \cong \dfrac{1}{137}$

$$\sigma_{\text{Thomson}}(\gamma\ p) = \frac{2}{3}\alpha^2 \left(4\pi\ R_p^2 \right) \text{ where } R_p = \frac{1}{m_p}$$

$$\sigma_T(\pi\ p) = \alpha_H^2 \left(4\pi\ R_p^2 \right) \cong 1 \text{ mb}$$

$\sigma_T(\pi\ p) >> \sigma_{\text{Thomson}} \Rightarrow \alpha_H >> \alpha \Rightarrow$ **π – p not electromagnetic**

because from the experimental

measurement $\sigma_T(\pi\ p) \cong 1\ mb \Rightarrow \alpha_H \approx 1 - 10$

α_H the probability for absorbing and emitting π-mesons, exceeds **α** by two to three orders of magnitude

a new "charge" and a new field has to be invoked to explain πN interaction cross sections is inevitable

gauge symmetries: spontaneous breaking of a local SU(2) gauge symmetry

$$L = (\partial_\mu \Phi)^+ (\partial_\mu \Phi) - \mu^2 \Phi^+ \Phi - \lambda (\Phi^+ \Phi)^2 \text{ where } \Phi = \begin{pmatrix} \Phi_\alpha \\ \Phi_\beta \end{pmatrix} = \sqrt{\frac{1}{2}} \begin{pmatrix} \Phi_1 + i\,\Phi_2 \\ \Phi_3 + i\,\Phi_4 \end{pmatrix}$$

L is invariant under SU(2) phase transformations $\Phi \to e^{i\,\alpha_a \tau_a / 2}\, \Phi$

for local transformations $\alpha \to \alpha(x): \partial_\mu \to D_\mu = \partial_\mu + ig \frac{\tau_a}{2} W_\mu^a$

for an infinitesimal transformation : $\Phi(x) \to \Phi'(x) = (1 + i\,\alpha(x) \cdot \tau / 2)\,\Phi(x) \Rightarrow W_\mu \to W_\mu - \frac{1}{g} \partial_\mu \alpha - \alpha \times W_\mu$

$$L = \left(\partial_\mu \Phi + ig \frac{1}{2} \tau \cdot W_\mu \Phi \right)^+ \left(\partial^\mu \Phi + ig \frac{1}{2} \tau \cdot W^\mu \Phi \right) - \underbrace{\left(\mu^2 \Phi^+ \Phi + \lambda (\Phi^+ \Phi)^2 \right)}_{V(\Phi)} - \frac{1}{4} W_{\mu\nu} W^{\mu\nu}; \text{ where } W_{\mu\nu} = \partial_\mu W_\nu - \partial_\nu W_\mu - g\, W_\mu \times W_\nu$$

for $\mu^2 > 0 \Rightarrow$ four scalar particles Φ_i each of mass μ interacting with three massless gauge bosons W_μ^a

for $\mu^2 < 0$ and $\lambda > 0$ the potential $V(\Phi)$ has its minimum at $|\Phi| : \Phi^+ \Phi = \frac{1}{2} (\Phi_1^2 + \Phi_3^2 + \Phi_3^2 + \Phi_4^2) = -\frac{\mu^2}{2\lambda}$

we can choose $\Phi_1 = \Phi_2 = \Phi_4 = 0$ and $\Phi_3^2 = -\frac{\mu^2}{2\lambda} \equiv v^2$; we can expand $\Phi(x)$ for this particular vacuum $\Phi_0 = \sqrt{\frac{1}{2}} \begin{pmatrix} 0 \\ v \end{pmatrix}$

$$\Phi(x) = \sqrt{\frac{1}{2}} \begin{pmatrix} 0 \\ v + h(x) \end{pmatrix} \to e^{i\,\tau \cdot \theta(x) / v} \begin{pmatrix} 0 \\ \frac{v + h(x)}{\sqrt{2}} \end{pmatrix} \cong \sqrt{\frac{1}{2}} \begin{pmatrix} \theta_2 + i\,\theta_1 \\ v + h - i\,\theta_3 \end{pmatrix} \to \text{ substitute in the Lagrangian } \Rightarrow$$

real fields $\theta_{1,2,3}(x)$

$$\left| ig \frac{1}{2} \tau \cdot W_\mu \Phi \right|^2 = \frac{g^2 v^2}{8} \left[(W_\mu^1)^2 + (W_\mu^2)^2 + (W_\mu^3)^2 \right] \to \text{ boson mass term } M = \frac{1}{2} gv$$

the Lagrangian describes three massive gauge fields and one massive scalar h

10th anniversary of the Higgs boson discovery
https://indico.cern.ch/event/1135177/timetable/?view=nicecompact

Prospects for the future - the Standard Model and beyond
Nima Arkani-Hamed (IAS)
https://indico.cern.ch/event/1135177/contributions/4788694/attachments/2474678/4246383/HiggsJul4CERN2022_NAH.pdf

Higgs is Really New Physics!

* We've never seen anything like it

Higgs is first "really new" particle we've seen!

Simplest possible elementary particle

[Higgs is Special! Does NOT naturally arise in Cond. Matter!]

Never Seen Point-Like Scalar

Never Seen Self-Interacting Fundamental Particles

In (not just) my view, the scientific issues we face today are the most difficult + profound ones our field has seen since the 1930's

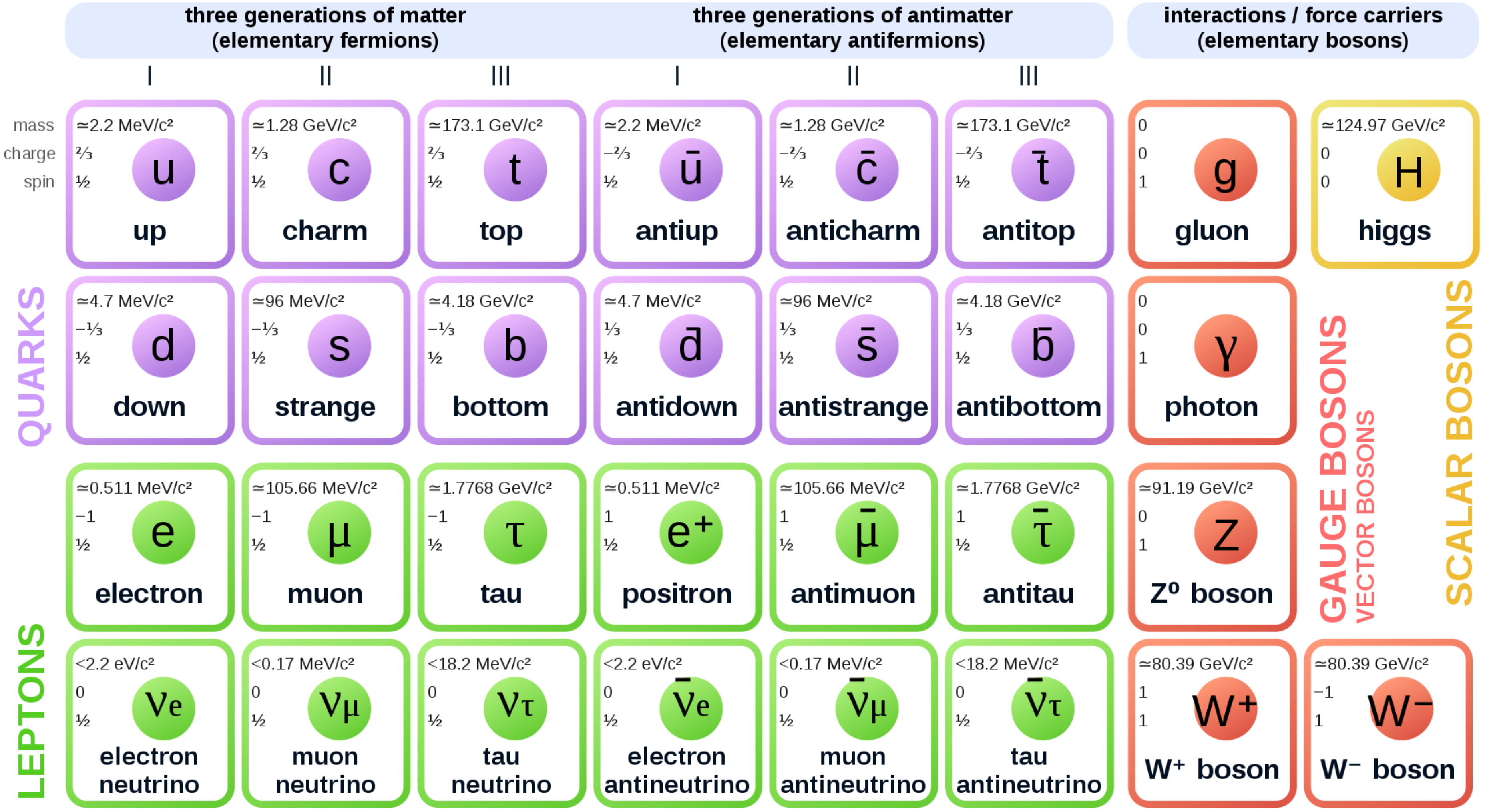
Prospects for the future - the Standard Model and beyond

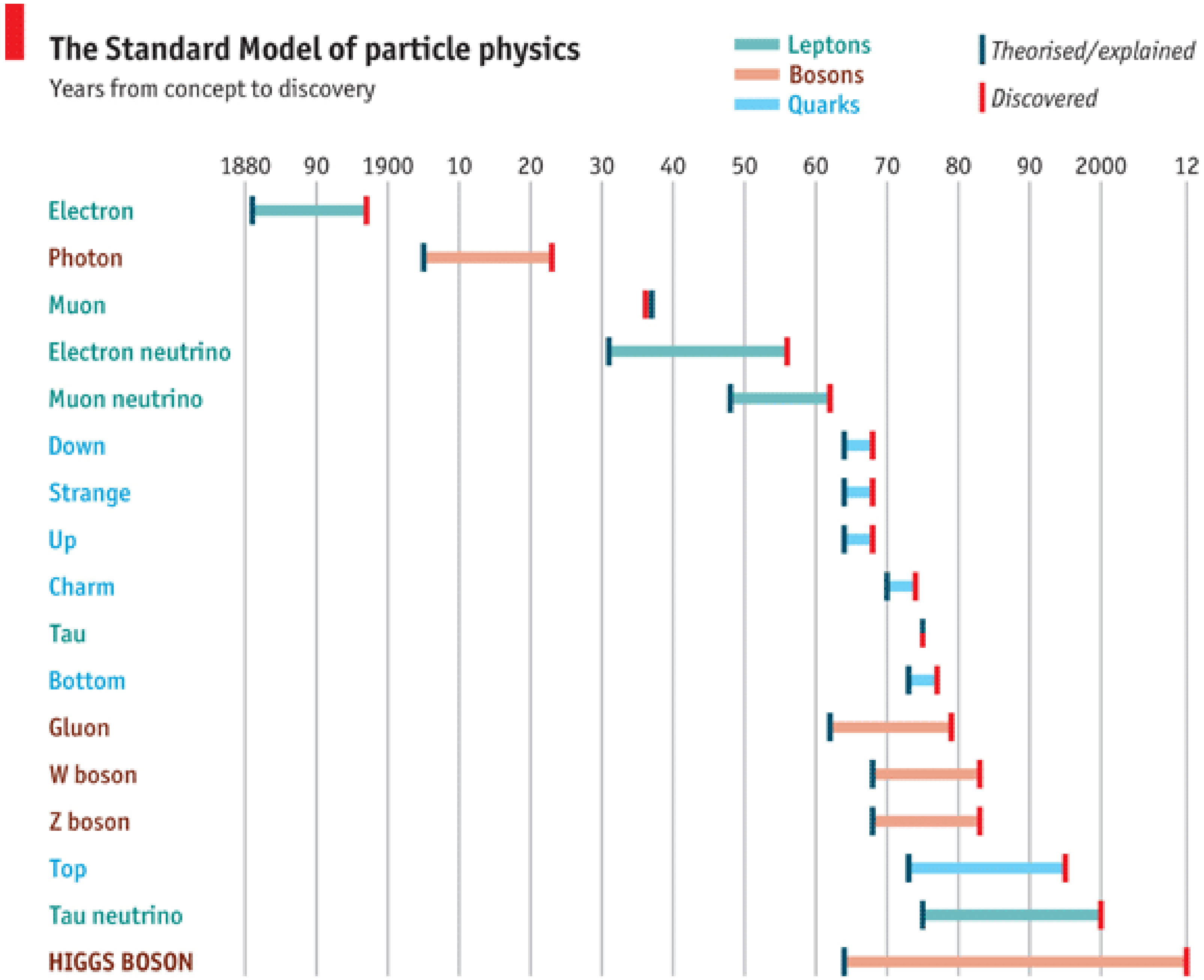
Nima Arkani-Hamed (IAS)

https://indico.cern.ch/event/1135177/contributions/4788694/attachments/2474678/4246383/HiggsJul4CERN2022_NAH.pdf

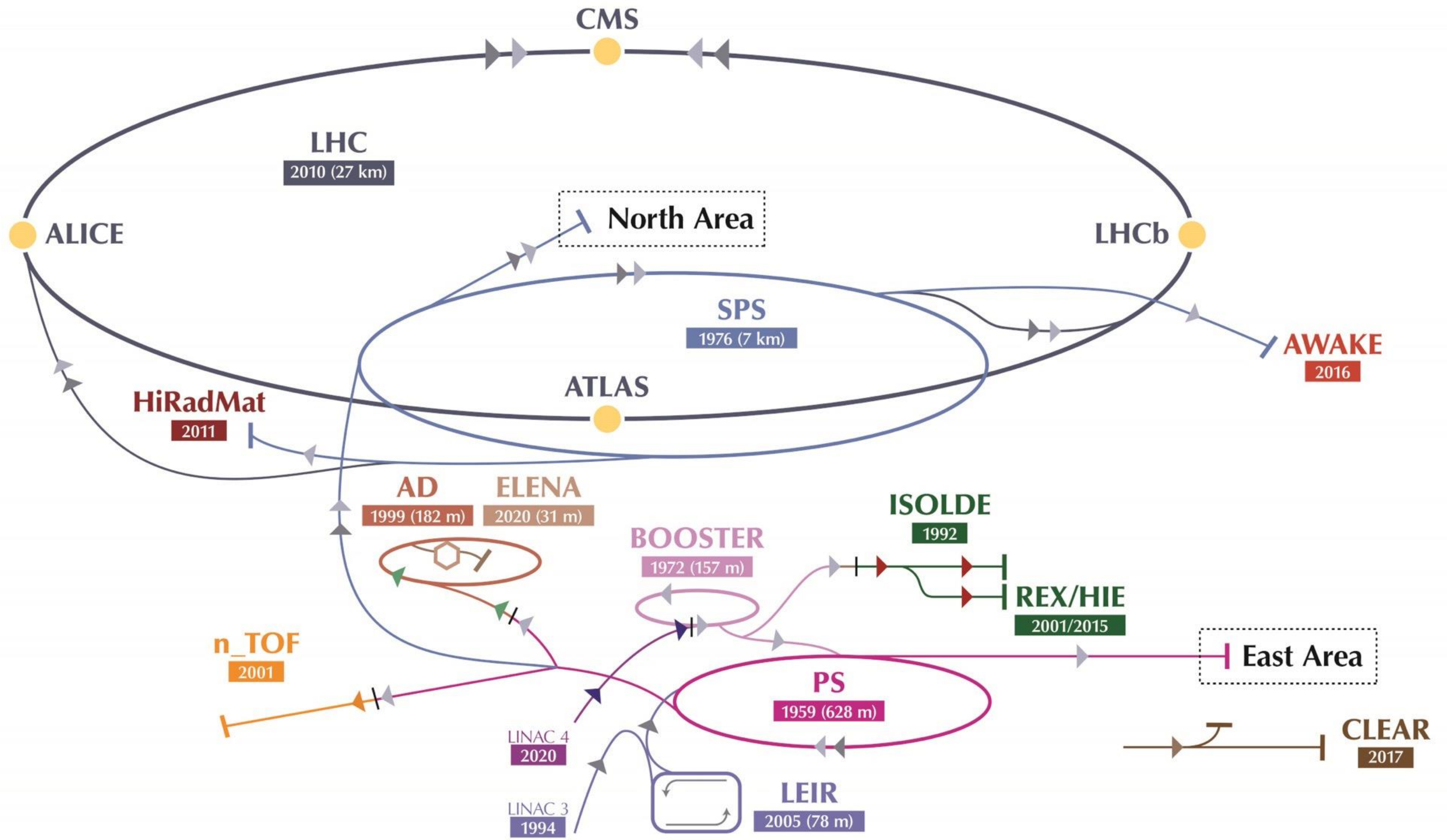
The questions raised by the accelerating universe, and the higgs discovery, both go to the heart of our understanding of the nature of spacetime, quantum mechanics + the vacuum.

Standard Model of Elementary Particles

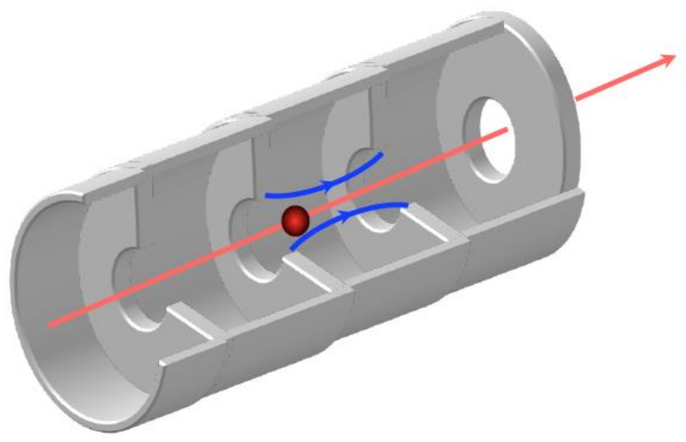




The Standard Model of particle physics
Years from concept to discovery
Leptons
Bosons
Quarks
Theorised/explained
Discovered
1880
90
1900
10
20
30
40
50
60
70
80
90
2000
12
Electron
Photon
Muon
Electron neutrino
Muon neutrino
Down
Strange
Up
Charm
Tau
Bottom
Gluon
W boson
Z boson
Top
Tau neutrino
HIGGS BOSON



CMS
LHC
2010 (27 km)
North Area
ALICE
LHCb
SPS
1976 (7 km)
AWAKE
2016
ATLAS
HiRadMat
2011
AD
1999 (182 m)
ELENA
2020 (31 m)
ISOLDE
1992
BOOSTER
1972 (157 m)
REX/HIE
2001/2015
n_TOF
2001
East Area
PS
1959 (628 m)
LINAC 4
2020
CLEAR
2017
LINAC 3
1994
LEIR
2005 (78 m)



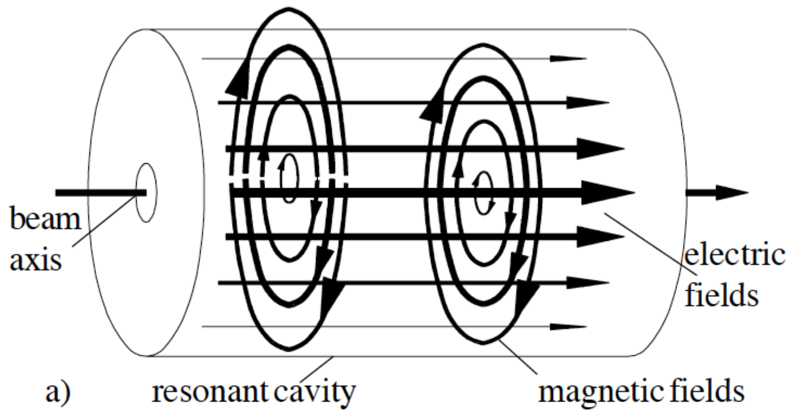
$$E(z,t) = E_0\, e^{i(\omega t - kz)}$$ Electric field

Wave number $k = \frac{2\pi}{\lambda_{RF}}$ Phase velocity $v_{ph} = \frac{\omega}{k}$ Group velocity $v_g = \frac{d\omega}{dk}$

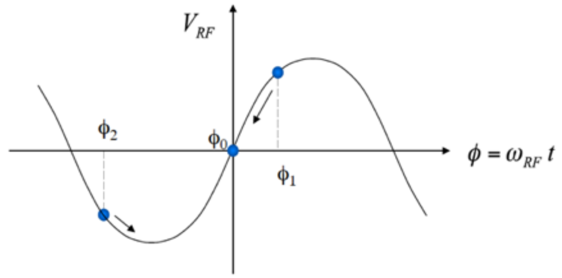
Synchronism condition ➡ $v_{el} \approx c = \frac{\omega}{k} = v_{ph}$

Synchronicity implies that the (time) distance between cavities is a multiple integer of the RF wavelength ω= kv.

The correspondent synchronous RF phase will be Ψ_s=ωt-kz

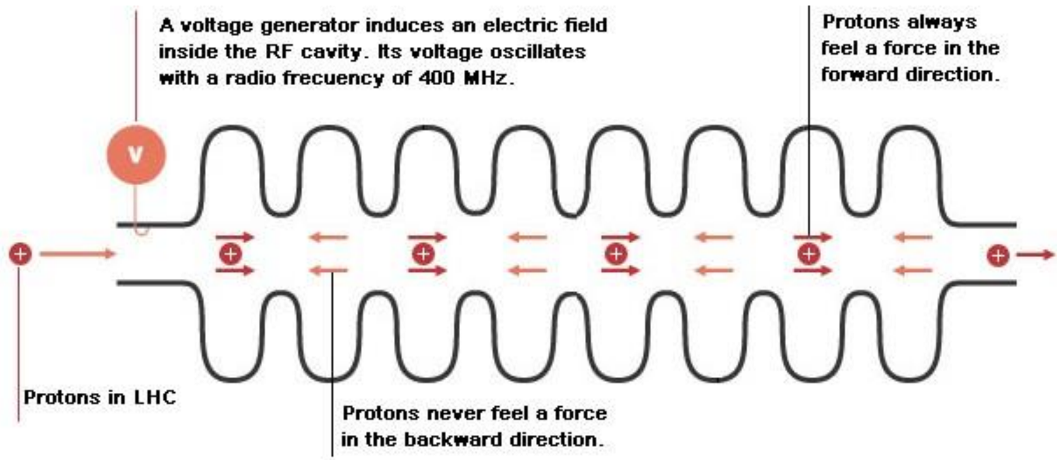


ϕ_1
- The particle is accelerated
- The particle arrives earlier – tends toward ϕ_0



ϕ_2
- The particle is decelerated
- The particle arrives later – tends toward ϕ_0

LHC superconducting radio-frequency cavity in the LHC tunnel

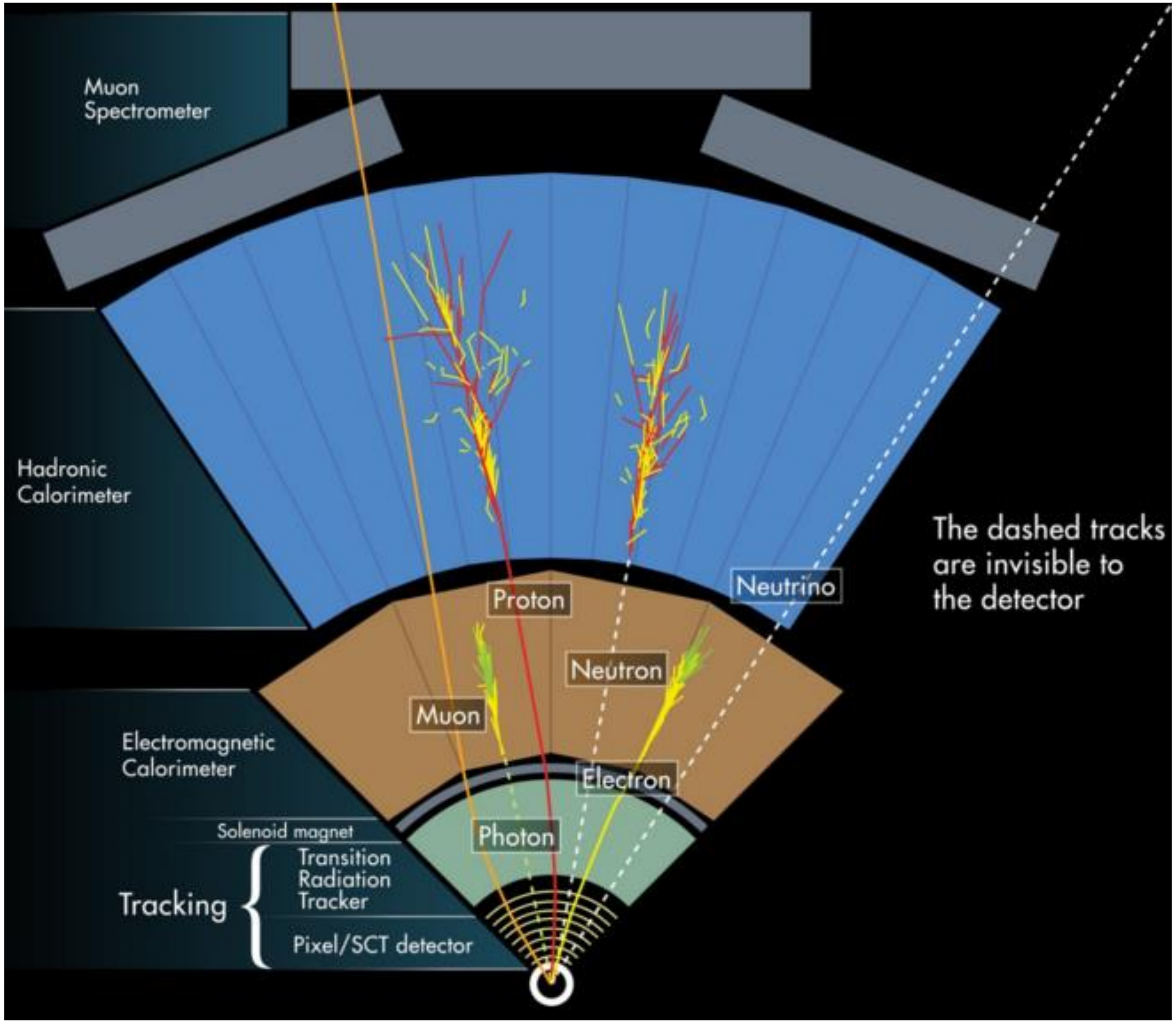


Circumference	26 659 m
Dipole operating temperature	1.9 K (-271.3°C)
Number of magnets	9593
Number of main dipoles	1232
Number of main quadrupoles	392
Number of RF cavities	8 per beam
Nominal energy, protons	6.5 TeV
Nominal energy, ions	2.56 TeV/u (energy per nucleon)
Nominal energy, protons collisions	13 TeV
No. of bunches per proton beam	2808
No. of protons per bunch (at start)	1.2 x 10^{11}
Number of turns per second	11245
Number of collisions per second	1 billion

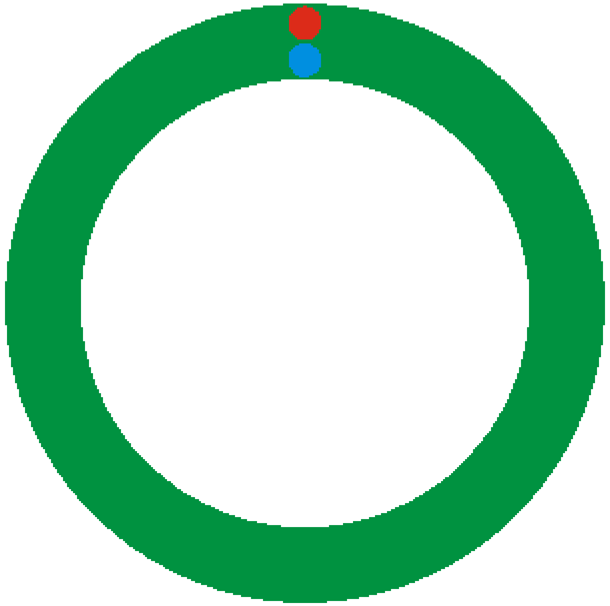
Table 6.1: The Main Beam and RF Parameters

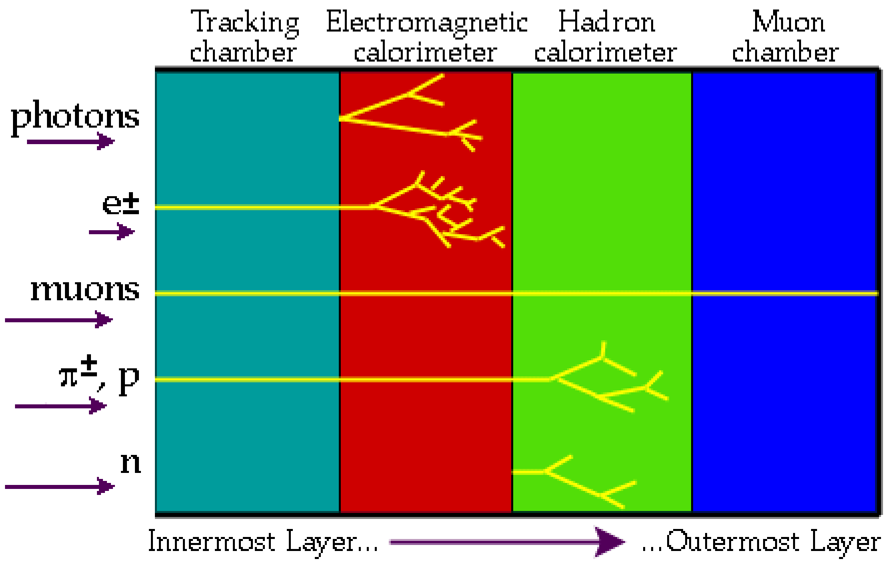
	Unit	Injection 450 GeV	Collision 7 TeV
Bunch area (2σ)*	eVs	1.0	2.5
Bunch length (4σ)*	ns	1.71	1.06
Energy spread (2σ)*	10^{-3}	0.88	0.22
Intensity per bunch	10^{11} p	1.15	1.15
Number of bunches		2808	2808
Transverse emittance V/H	µm	3.75	3.75
Intensity per beam	A	0.582	0.582
Synchrotron radiation loss/turn	keV	-	7
Longitudinal damping time	h	-	13
Intrabeam scattering growth time - H	h	38	80
- L	h	30	61
Frequency	MHz	400.789	400.790
Harmonic number		35640	35640
RF voltage/beam	MV	8	16
Energy gain/turn (20 min. ramp)	keV	485	
RF power supplied during acceleration/ beam	kW	~275	
Synchrotron frequency	Hz	63.7	23.0
Bucket area	eVs	1.43	7.91
RF (400 MHz) component of beam current	A	0.87	1.05

Name	Status	Location	Particles	E_{beam} (GeV)	E_{cm} (GeV)
ISR	1971–1984	CERN (Geneva)	$p\,p$	35 + 35	70 GeV
SPEAR	1972–1990	Stanford (USA)	$e^+\,e^-$	4 + 4	8 GeV
DORIS	1973–1993	DESY (Hamburg)	$e^+\,e^-$	5.6 + 5.6	11.2
CESR	1979–2002	Cornell (USA)	$e^+\,e^-$	6 + 6	12
VEPP-4M	1994–	Novosibirsk (Russia)	$e^+\,e^-$	6 + 6	12
PETRA	1978–1986	DESY (Hamburg)	$e^+\,e^-$	20 + 20	40
PEP	1980–1990	Stanford (USA)	$e^+\,e^-$	15 + 15	30
TRISTAN	1987–1995	KEK (Japan)	$e^+\,e^-$	32 + 32	74
Sp$\bar{\text{p}}$S	1981–1990	CERN (Geneva)	$p\,\bar{p}$	250 + 250	500
PEP II	1999–2008	Stanford (USA)	$e^+\,e^-$	3.1 + 9.0	10.58
KEK-B	1999–2010	KEK (Japan)	$e^+\,e^-$	3.5 + 8.0	10.58
LEP	1989–2000	CERN (Geneva)	$e^+\,e^-$	100 + 100	200
SLC	1989–1998	Stanford (USA)	$e^+\,e^-$	50 + 50	100
Tevatron	1987–2011	Fermilab (USA)	$p\,\bar{p}$	1000 + 1000	2 000
HERA	1992–2007	DESY (Hamburg)	$e\,p$	30 + 920	330
LHC	2008–	CERN (Geneva)	$p\,p$	7000 + 7000	14 000
LHC	2008–	CERN (Geneva)	$A\,A$	2500/N + 2500/N	5000/NN
RHIC	2001–	Brookhaven (USA)	$A\,A$	100/N + 100/N	200/NN
ILC	planned	not decided	$e^+\,e^-$	250 + 250	500

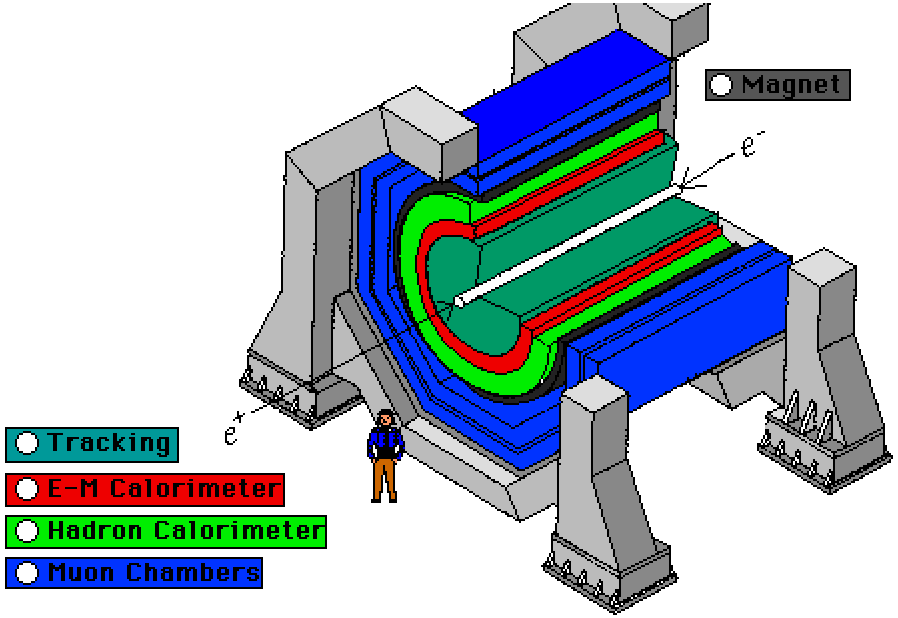


Muon Spectrometer
Hadronic Calorimeter
Electromagnetic Calorimeter
Solenoid magnet
Tracking
Transition Radiation Tracker
Pixel/SCT detector
Proton
Neutrino
Neutron
Muon
Electron
Photon
The dashed tracks are invisible to the detector



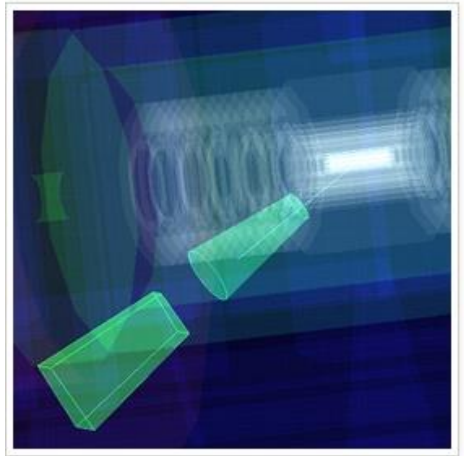


Tracking chamber
Electromagnetic calorimeter
Hadron calorimeter
Muon chamber
photons
e±
muons
π±, p
n
Innermost Layer...
...Outermost Layer



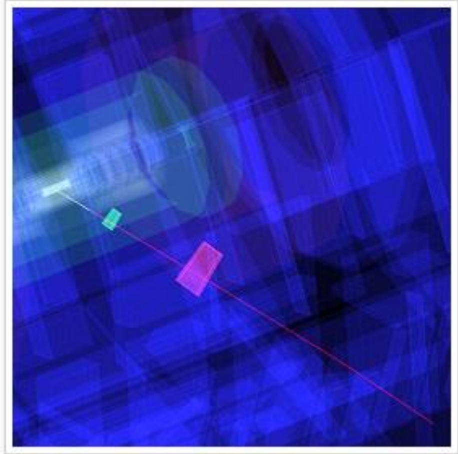
Magnet
e⁻
e⁺
Tracking
E-M Calorimeter
Hadron Calorimeter
Muon Chambers

Electron



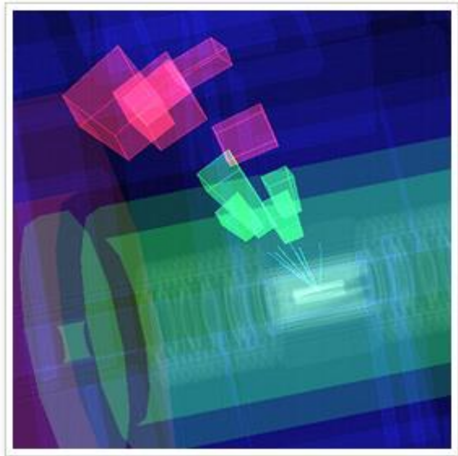
Electrons have a track and EM calorimeter energy deposit. **Collider** will draw a cone around recognised electrons.

Muon



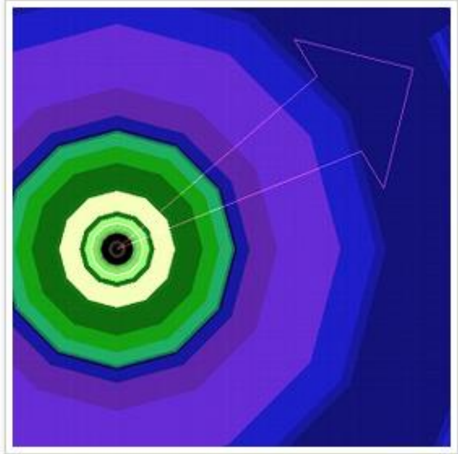
Muons have a track extending from the Inner Detector to the Muon Spectrometer. Muons may leave small energy deposits in the calorimeter.

Jet



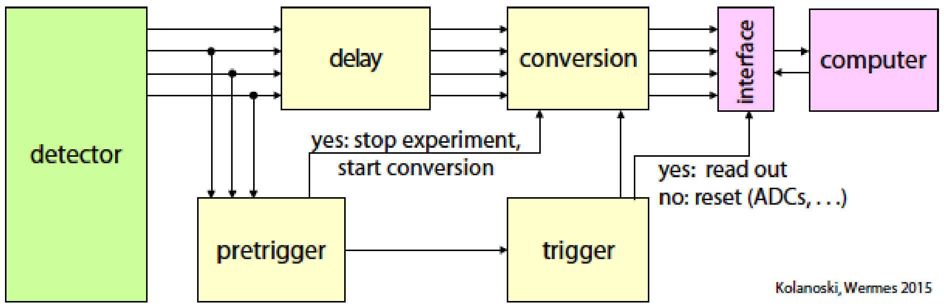
Jets contain multiple tracks leading to varying amounts of energy deposited in both calorimeters. Jets may be produced by quarks or gluons.

Neutrino

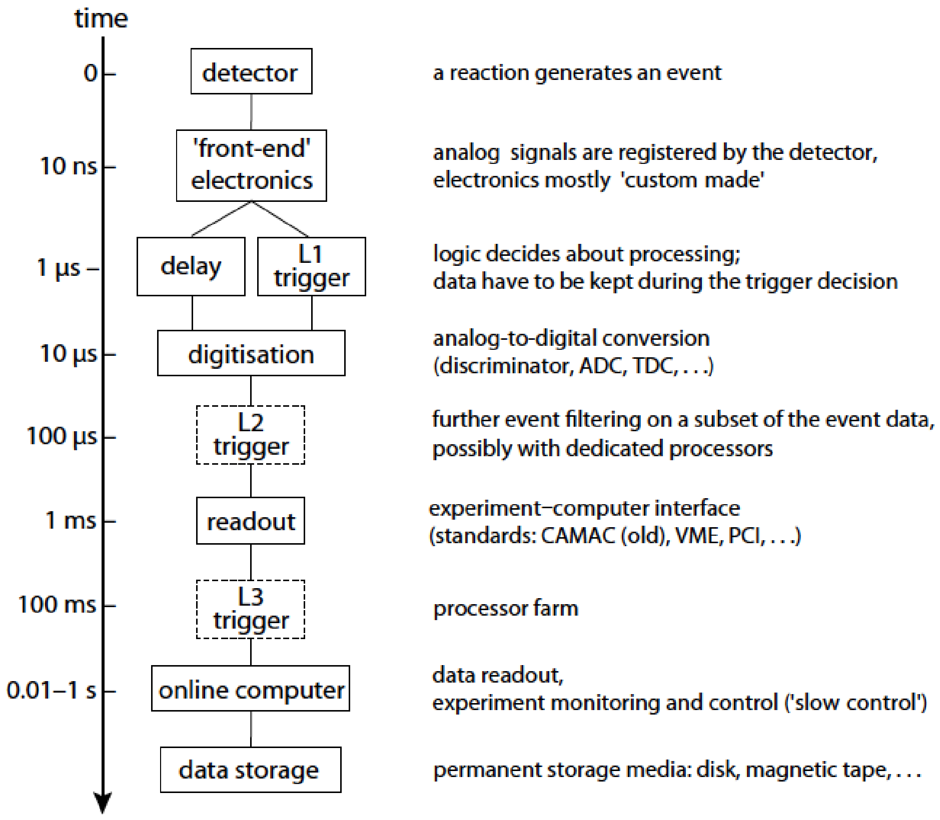


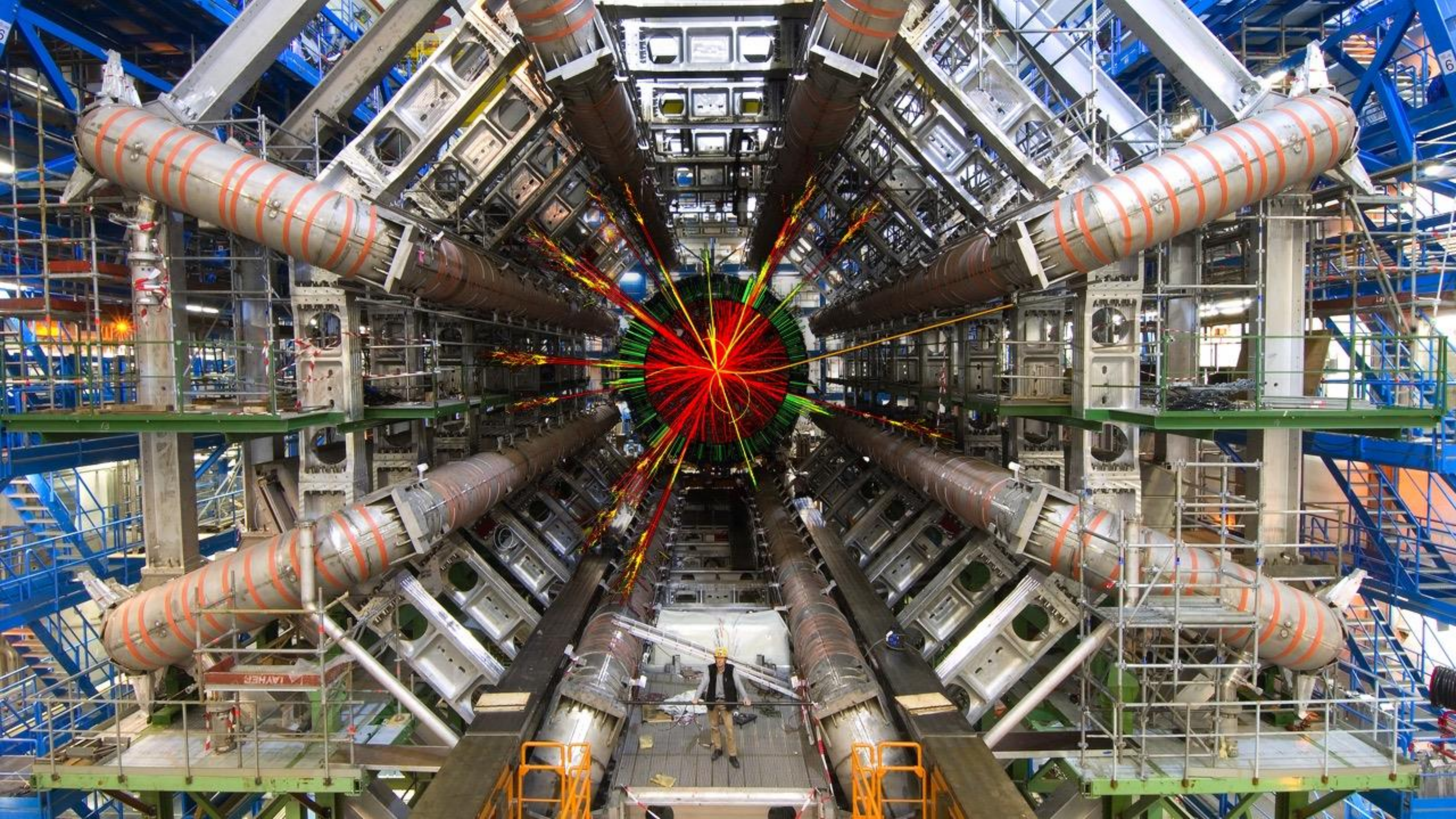
Neutrinos are not detected in ATLAS, though by looking for missing energy, we can infer when they are produced. Missing energy is shown as a pink arrow.

trigger and data acquisition system in a high-energy experiment



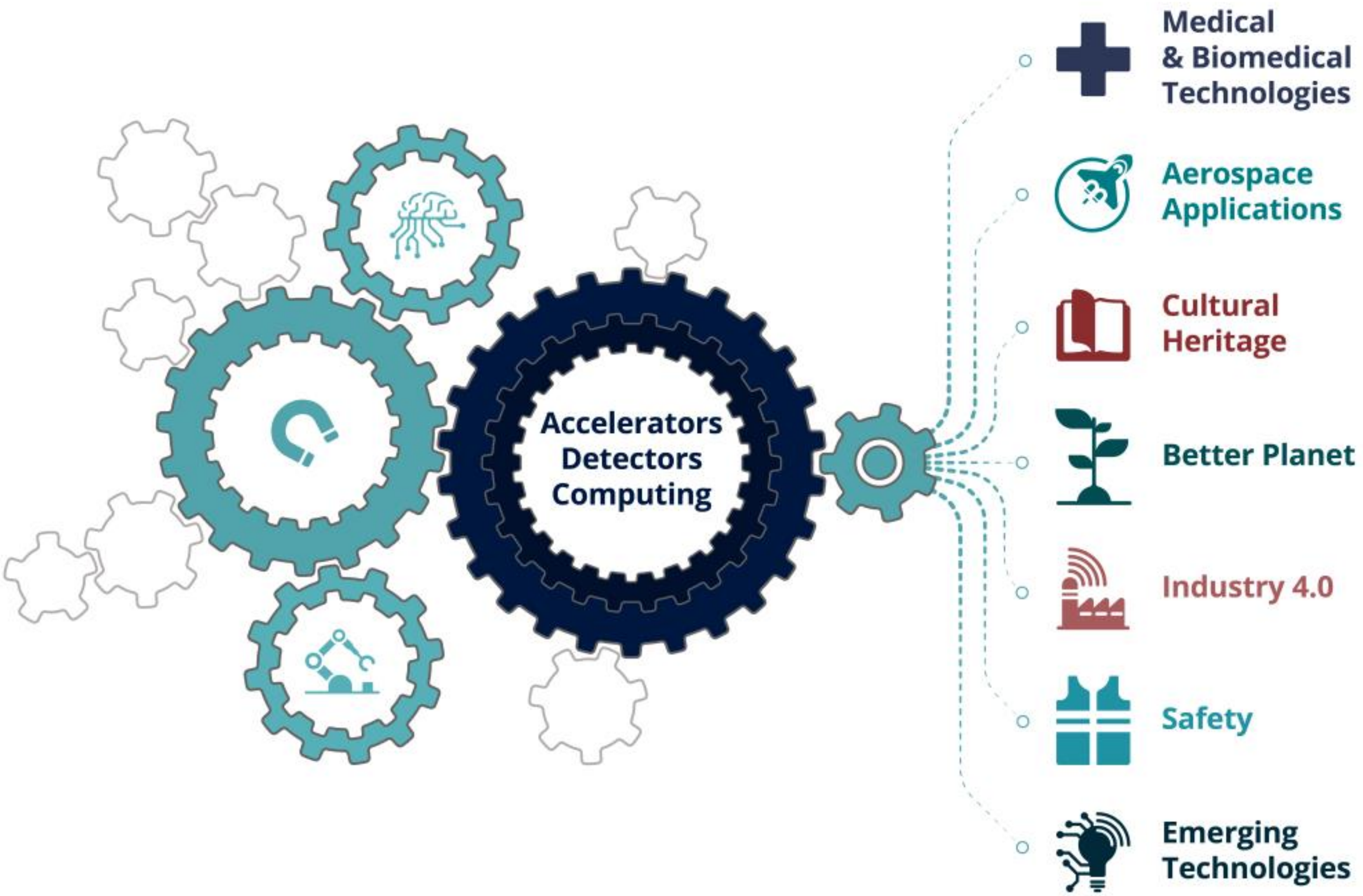
Beams	Machine	Luminosity ($cm^{-2}s^{-1}$)	ν_{beam} (MHz)	N_{pile}	$\nu_{storage}$ (Hz)	$N_{channel}$	D_{event} (kB)
e^+e^-	LEP	10^{31-32}	0.05	10^{-2}	1	10^5	100
ep	HERA	10^{30-31}	10	10^{-3}	10	10^5	100
e^+e^-	B-factory	10^{33-34}	120–240	10^{-5}	200	10^5	100
$p\bar{p}$	Tevatron	$> 10^{32}$	2.5	6	80	10^5	150
pp	LHC	10^{34}	40	25	200	10^7	1500





contribution to society: knowledge-transfer

https://home.cern/about/what-we-do/our-impact

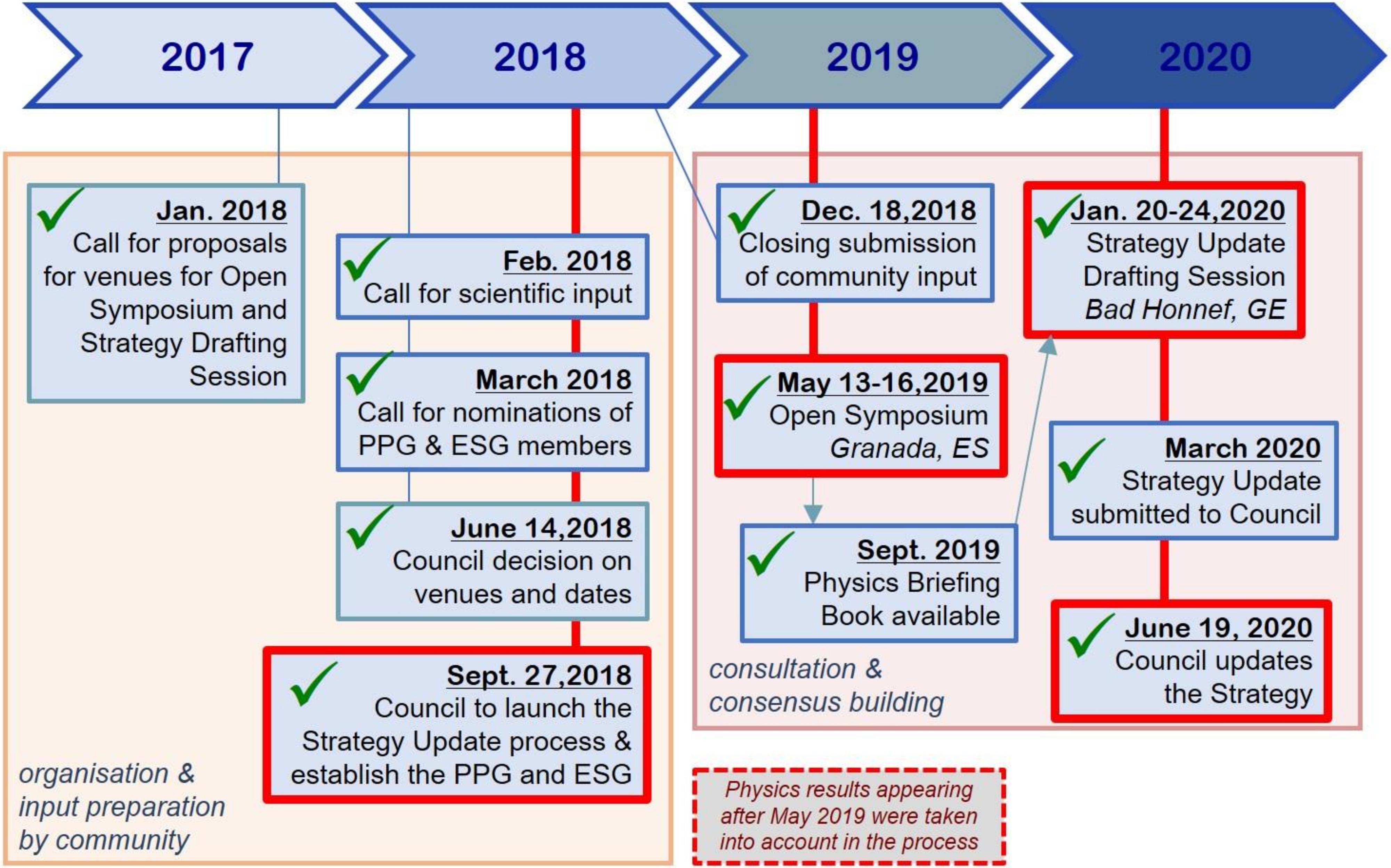


TOTAL MEASURED BENEFITS OF LHC

- Scientific publications 2%
- Human capital formation 33%
- Technological spillovers 32%
- Cultural effects 13%
- Existence value 20%

https://cds.cern.ch/record/2025538?ln=en

European Paricle Physics Strategy *Update*



European Strategy for Particle Physics Update 2018 - 2020

https://europeanstrategy.cern/european-strategy-for-particle-physics


_Contents

High-priority future initiatives

A. An electron-positron Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy. Accomplishing these compelling goals will require innovation and cutting-edge technology:

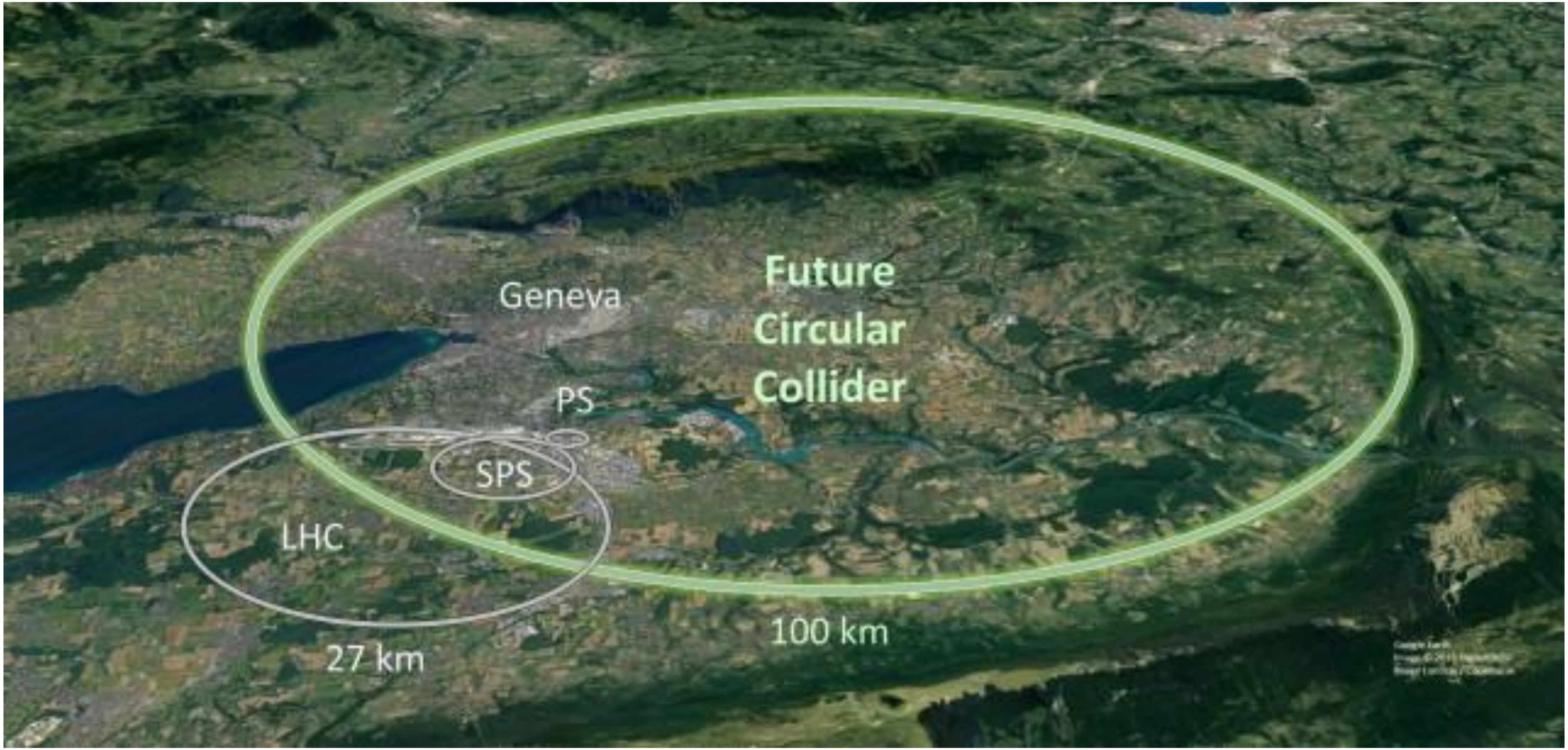
- **the particle physics community should ramp up its R&D effort focused on advanced accelerator technologies, in particular that for high-field superconducting magnets, including high-temperature superconductors;**

- **Europe, together with its international partners, should investigate the technical and financial feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage. Such a feasibility study of the colliders and related infrastructure should be established as a global endeavour and be completed on the timescale of the next Strategy update.**

Environmental and societal impact

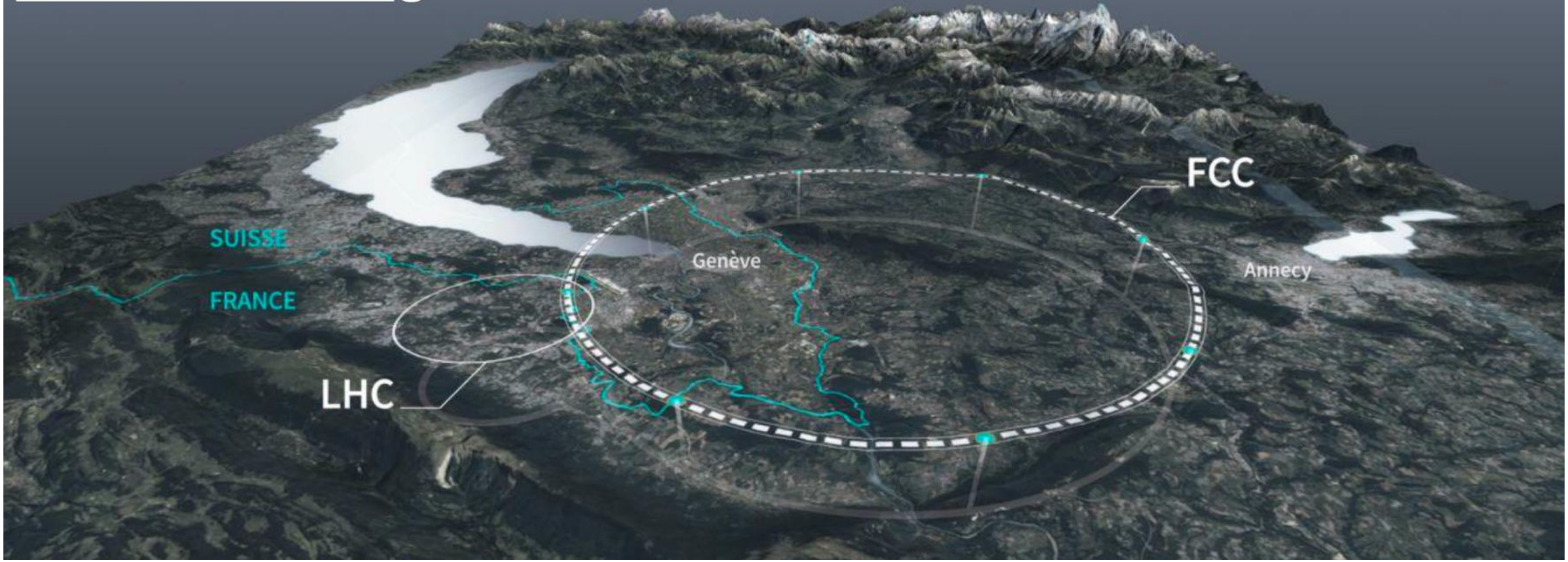
D. Exploring the fundamental properties of nature inspires and excites. It is part of the duty of researchers to share the excitement of scientific achievements with all stakeholders and the public. The concepts of the Standard Model, a well-established theory for elementary particles, are an integral part of culture. **Public engagement, education and communication in particle physics should continue to be recognised as important components of the scientific activity and receive adequate support. Particle physicists should work with the broad community of scientists to intensify engagement between scientific disciplines. The particle physics community should work with educators and relevant authorities to explore the adoption of basic knowledge of elementary particles and their interactions in the regular school curriculum.**

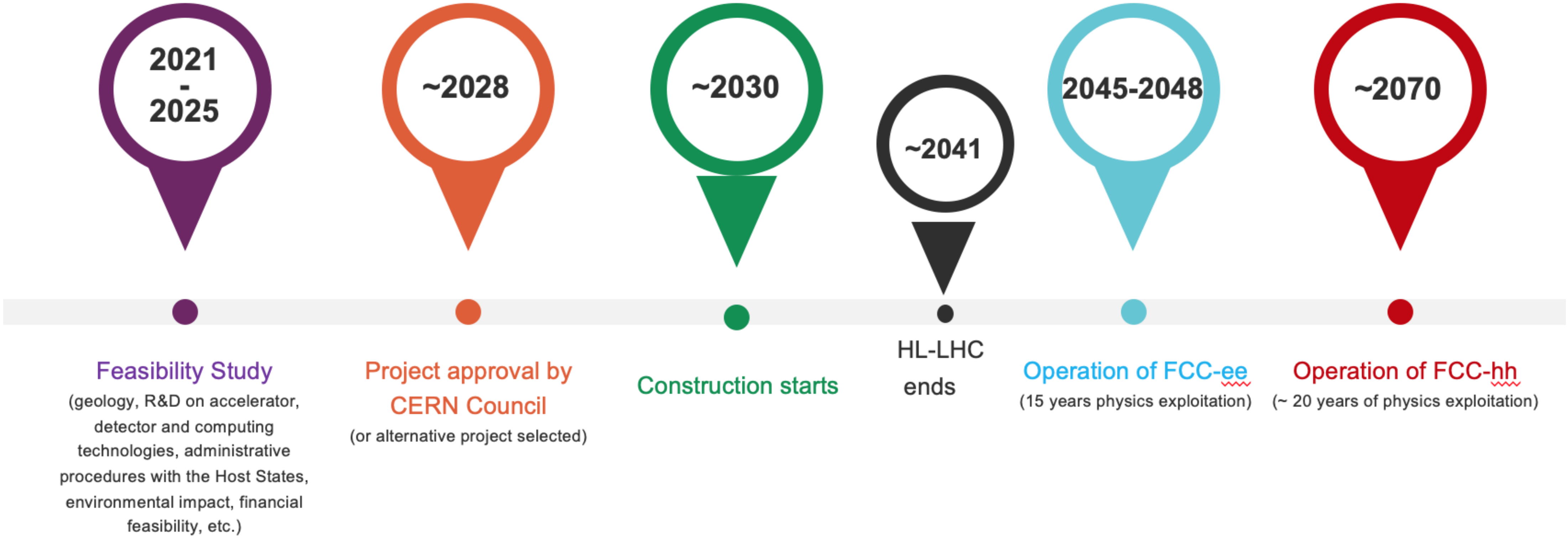
FCC Feasibility Study (2021 - 2025)



FCC research infrastructure for the 21st century

A new 91 km tunnel to host multiple colliders
100 – 300 m under ground, 8 surface sites
FCC-ee: electron-positron @ 91, 160, 240, 365 GeV
FCC-hh: proton-proton @ 100 TeV, and heavy-ions (Pb) @39 TeV
FCC-eh: electron-proton@ 3.5 TeV




2021 - 2025
~2028
~2030
~2041
2045-2048
~2070
Feasibility Study
(geology, R&D on accelerator, detector and computing technologies, administrative procedures with the Host States, environmental impact, financial feasibility, etc.)
Project approval by CERN Council
(or alternative project selected)
Construction starts
HL-LHC ends
Operation of FCC-ee
(15 years physics exploitation)
Operation of FCC-hh
(~ 20 years of physics exploitation)

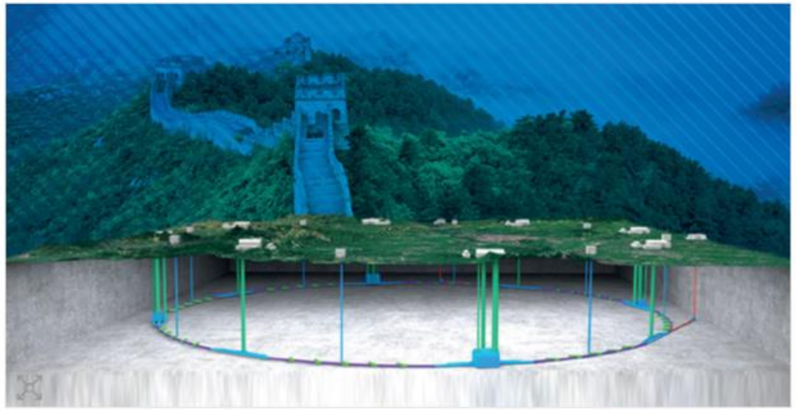
Status of CEPC in China

J. Gao, ICFA seminar, DESY, 30/11/2023

China's bid for a circular electron–positron collider

1 June 2018

Physicists in China have completed a conceptual design report for a 100 km-circumference collider that, in conjunction with a possible linear collider in Japan, would open a new era for high-energy physics in Asia.



Several sites in China are currently under study for a possible 100 km-circumference collider.
Image credit: IHEP

- 2 Interaction Points
- Operation starts at ZH energy
- Initially 30 MW, upgradable to 50 MW

Impressive technical progress recently:
SCRF, injectors, power source, etc.
Synergies between CEPC R&D and HEPS (High-Energy Photon Source) being built in Beijing.

CAS (Chinese Academy of Science) review:
4 different committees have classified CEPC first of all projects in nuclear and particle physics

Current plan:

- Accelerator TDR: to be released Dec 2023
- EDR: 2024-2027
- Application for 5-year funding: 2025
- Construction: 2027-2035
- Operation start: 2036

Such a schedule (if realistic) requires acceleration of FCC-ee to start early 2040s (if approved).
CERN Management is reflecting on how to achieve this → more at March SPC

European Strategy for Particle Physics Update 2024-2026

III. Strategy update timeline: the main steps

Based on the considerations set out in Section II above, the general timeline for the next Strategy update is proposed as follows:

March 2024 Council

- Council decision on the timeline for the Strategy update
- Call for nominations for the Strategy Secretary
- Call for nominations for the members of the ESG and PPG
- Announcement to the community that March 2025 is the deadline to submit input.

June 2024 Council

- Council appointment of the Strategy Secretary and establishment of the Strategy Secretariat
- Council establishment of the ESG
- Call for venues for the Open Symposium and the Strategy Drafting Session

September 2024 Council

- Council appointment of the members of the PPG

December 2024 Council

- Council decision on the venues for the Open Symposium and the Strategy Drafting Session

March 2025

- Deadline for the submission of input from the community

Early July 2025

- Open Symposium

End of September 2025

- Submission of the "Briefing Book" to the ESG

Early December 2025

- Strategy Drafting Session

End January 2026

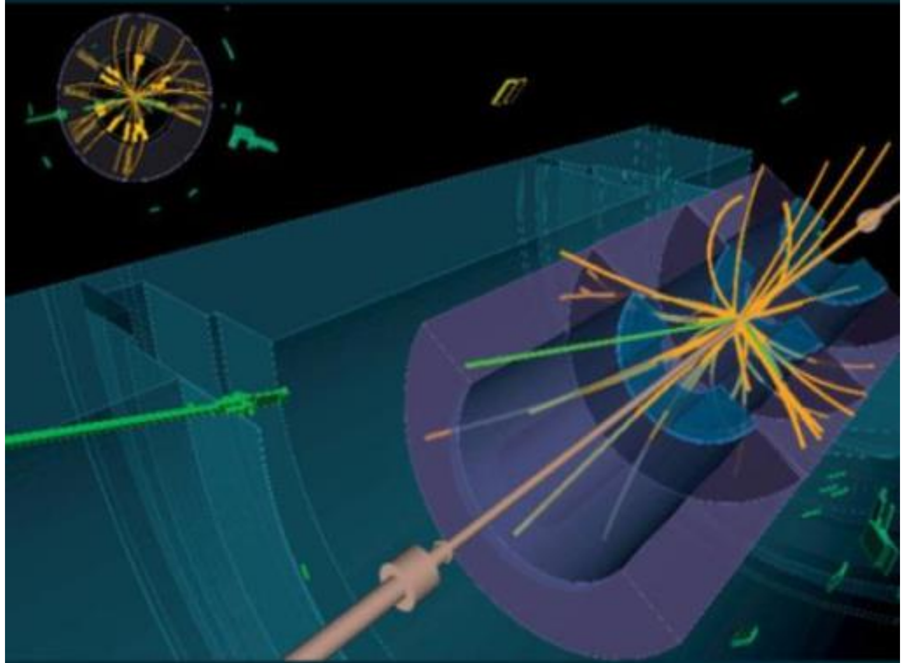
- Submission of the Draft Strategy Document to the Council for feedback

March-June 2026 Council Sessions

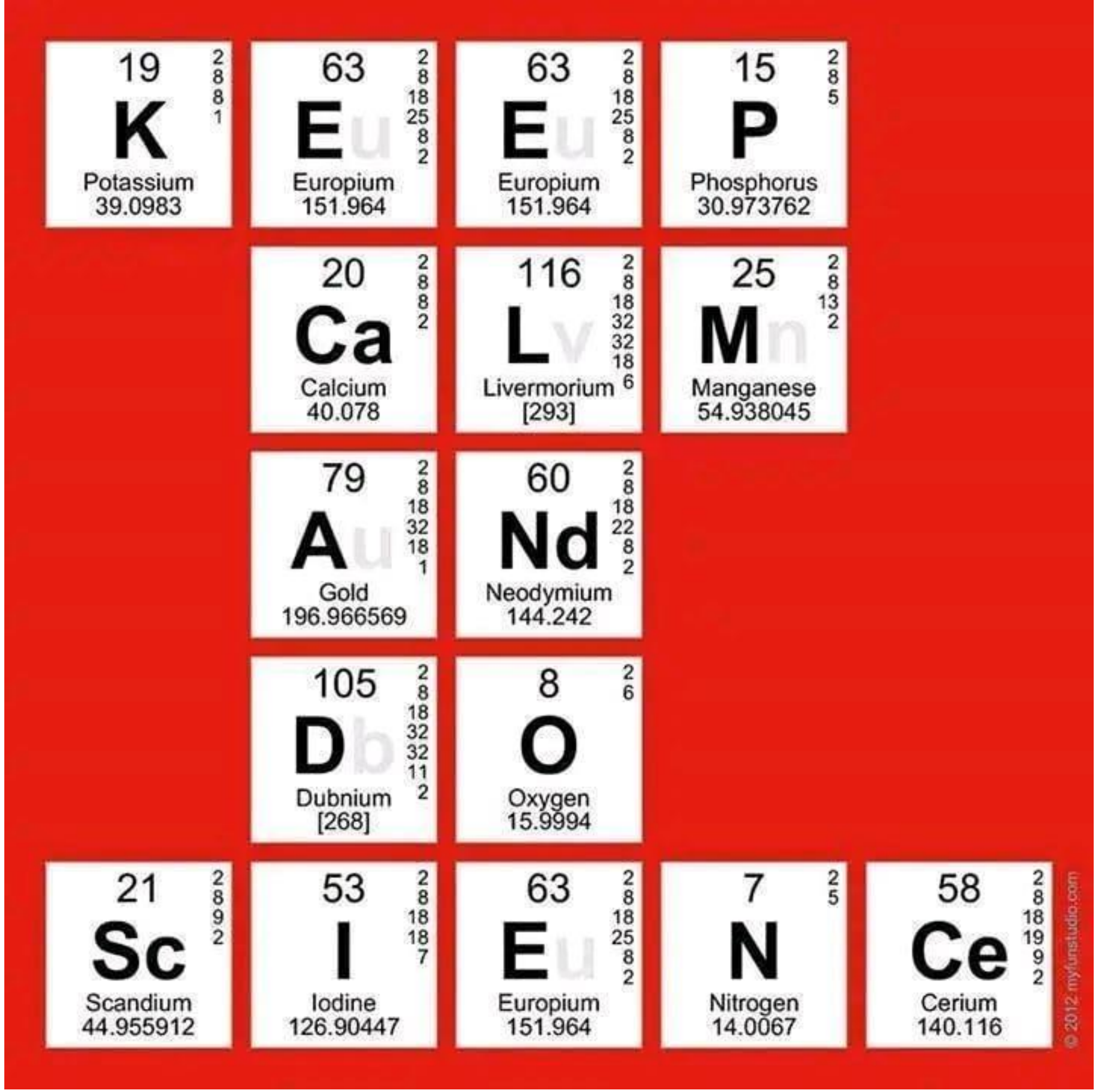
- Discussion of the Draft Strategy Document by the Council followed by the updating of the Strategy by the Council.

Fourth Edition

The Ideas of Particle Physics



James Dodd
Ben Gripaios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63 Eu Europium 151.964 2 8 18 25 8 2
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20 Ca Calcium 40.078 2 8 8 2
116 Lv Livermorium [293] 2 8 18 32 32 18 6
25 Mn Manganese 54.938045 2 8 13 2
79 Au Gold 196.966569 2 8 18 32 18 1
60 Nd Neodymium 144.242 2 8 18 22 8 2
105 Db Dubnium [268] 2 8 18 32 32 11 2
8 O Oxygen 15.9994 2 6
21 Sc Scandium 44.955912 2 8 9 2
53 I Iodine 126.90447 2 8 18 18 7
63 Eu Europium 151.964 2 8 18 25 8 2
7 N Nitrogen 14.0067 2 5
58 Ce Cerium 140.116 2 8 18 19 9 2
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Thank you !