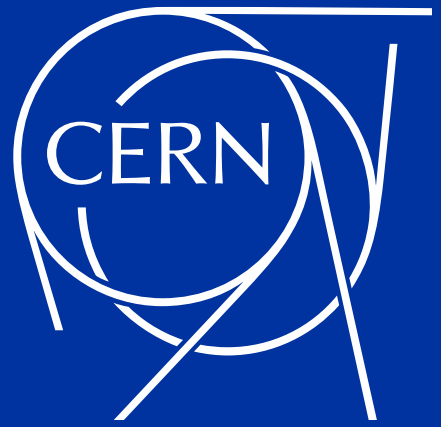


CERN – a short and sweet introduction

Dr **Jeff Wiener**
9 June 2024

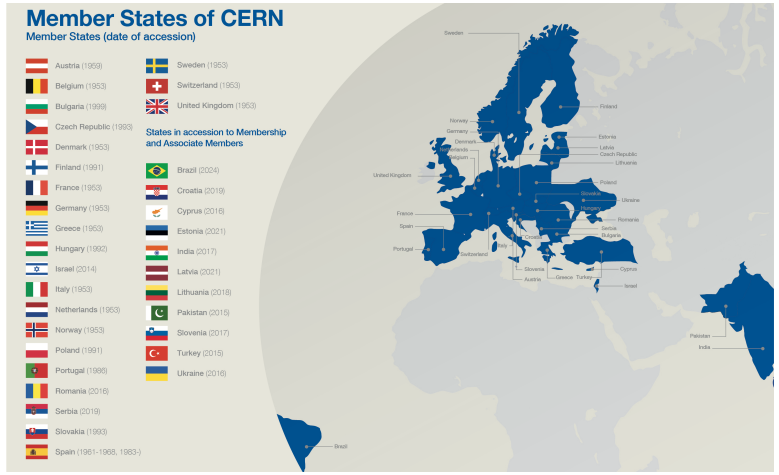
Conseil Européen pour la Recherche Nucléaire

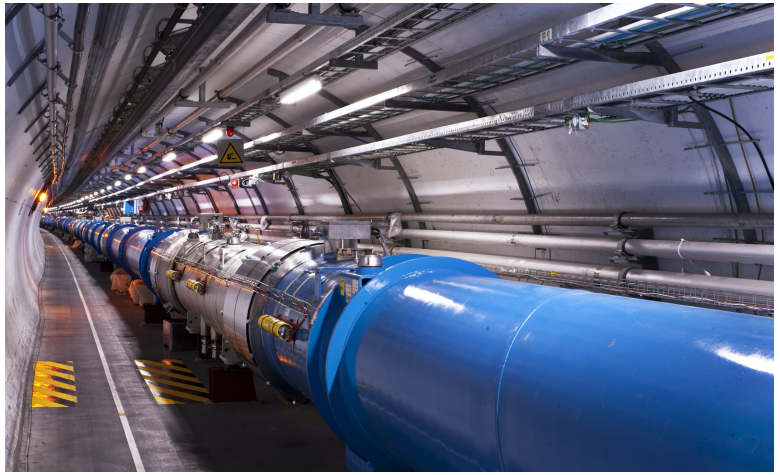
International Collaboration

Education

Fundamental Research

New Technology





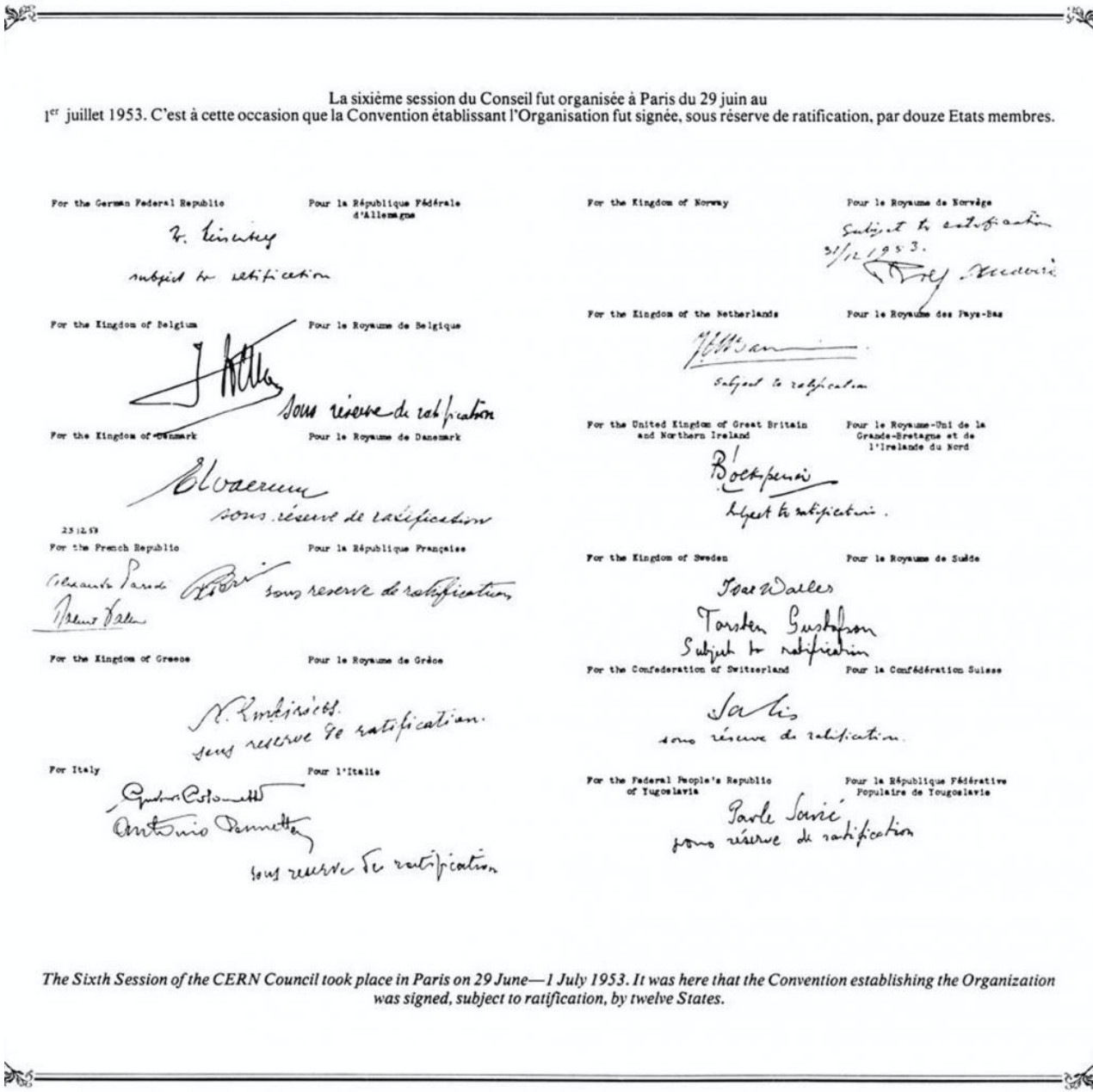
History

1949
First steps towards civilian research in the field of nuclear technology

1952
Foundation of CERN under the auspices of UNESCO in Geneva

1953
Signing of the CERN charta

1954
Completion of the ratification process of the 12 Member States


La sixième session du Conseil fut organisée à Paris du 29 juin au 1er juillet 1953. C'est à cette occasion que la Convention établissant l'Organisation fut signée, sous réserve de ratification, par douze Etats membres.

For the German Federal Republic — Pour la République Fédérale d'Allemagne
subject to ratification

For the Kingdom of Norway — Pour le Royaume de Norvège
Subject to ratification
31/12 1953.

For the Kingdom of Belgium — Pour le Royaume de Belgique
sous réserve de ratification

For the Kingdom of the Netherlands — Pour le Royaume des Pays-Bas
Subject to ratification

For the Kingdom of Denmark — Pour le Royaume de Danemark
sous réserve de ratification

For the United Kingdom of Great Britain and Northern Ireland — Pour le Royaume-Uni de la Grande-Bretagne et de l'Irlande du Nord
Subject to ratification.

23/12/53
For the French Republic — Pour la République Française
sous reserve de ratification

For the Kingdom of Sweden — Pour le Royaume de Suède
Subject to ratification

For the Kingdom of Greece — Pour le Royaume de Grèce
sous réserve de ratification.

For the Confederation of Switzerland — Pour la Confédération Suisse
sous réserve de ratification

For Italy — Pour l'Italie
sous reserve de ratification

For the Federal People's Republic of Yugoslavia — Pour la République Fédérative Populaire de Yougoslavie
sous réserve de ratification

The Sixth Session of the CERN Council took place in Paris on 29 June—1 July 1953. It was here that the Convention establishing the Organization was signed, subject to ratification, by twelve States.

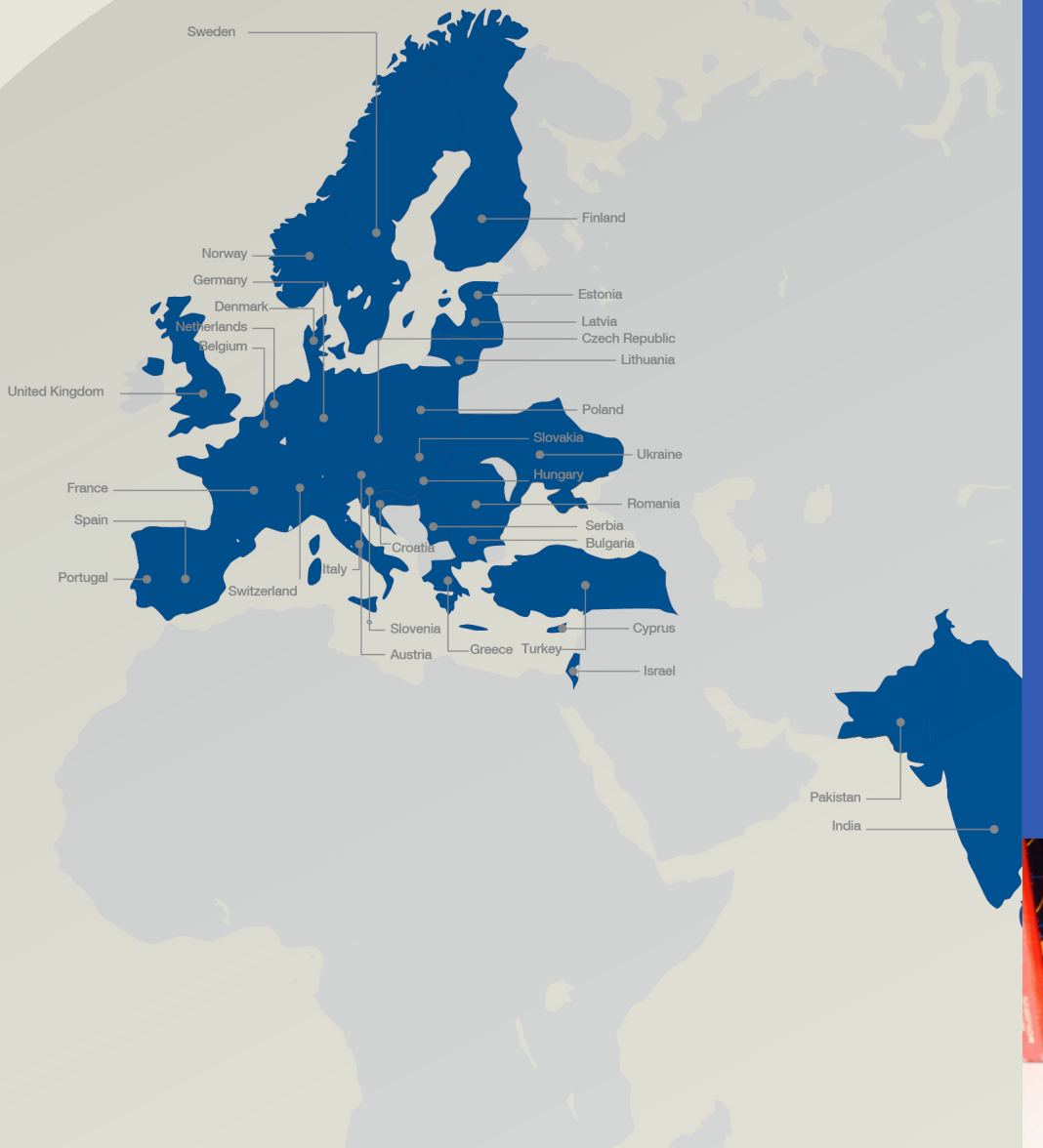
Member States of CERN

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)
- Serbia (2019)
- Slovakia (1993)
- Spain (1961-1968, 1983-)
- Sweden (1953)
- Switzerland (1953)
- United Kingdom (1953)

States in accession to Membership and Associate Members

- Brazil (2024)
- Croatia (2019)
- Cyprus (2016)
- Estonia (2021)
- India (2017)
- Latvia (2021)
- Lithuania (2018)
- Pakistan (2015)
- Slovenia (2017)
- Turkey (2015)
- Ukraine (2016)

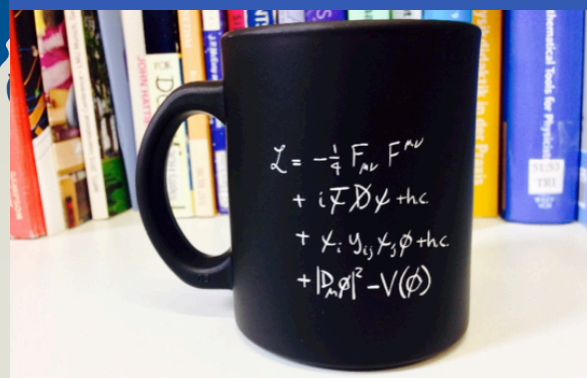


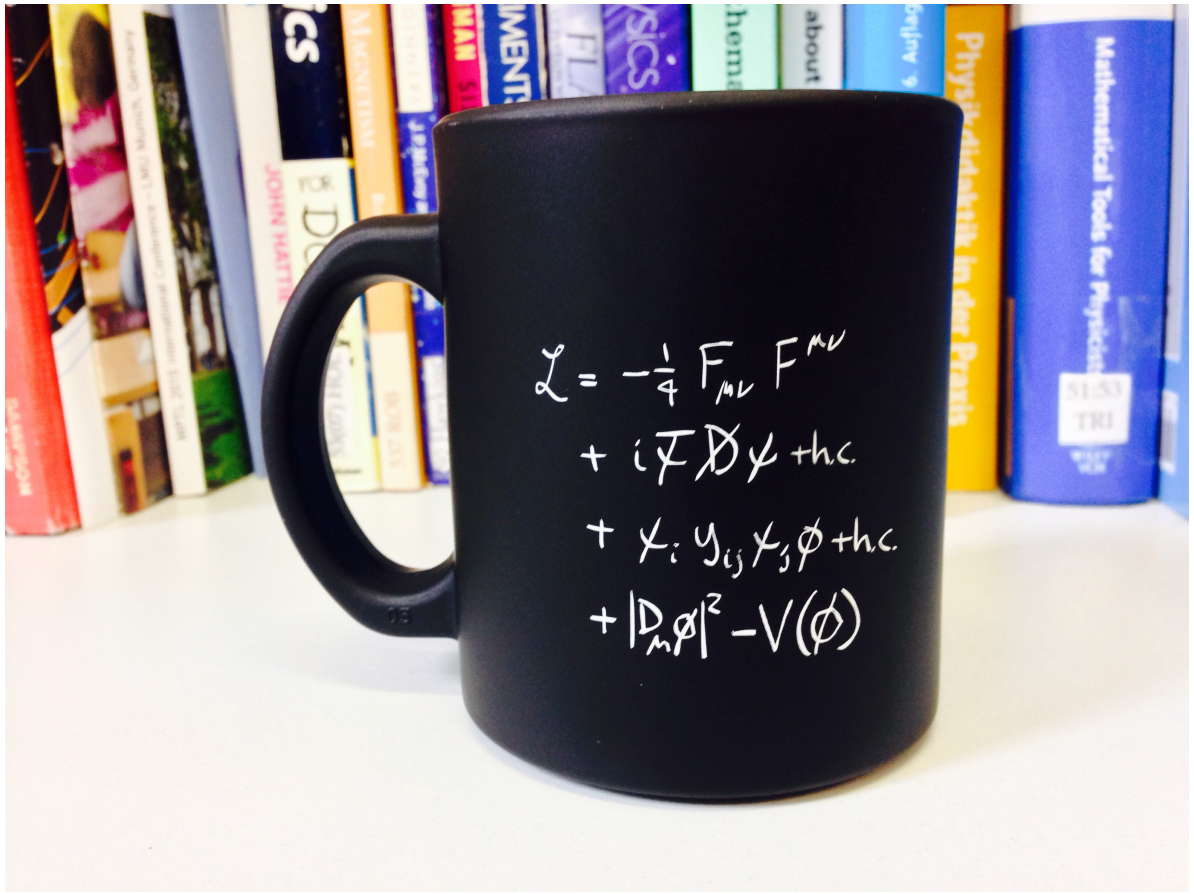
CERN Today

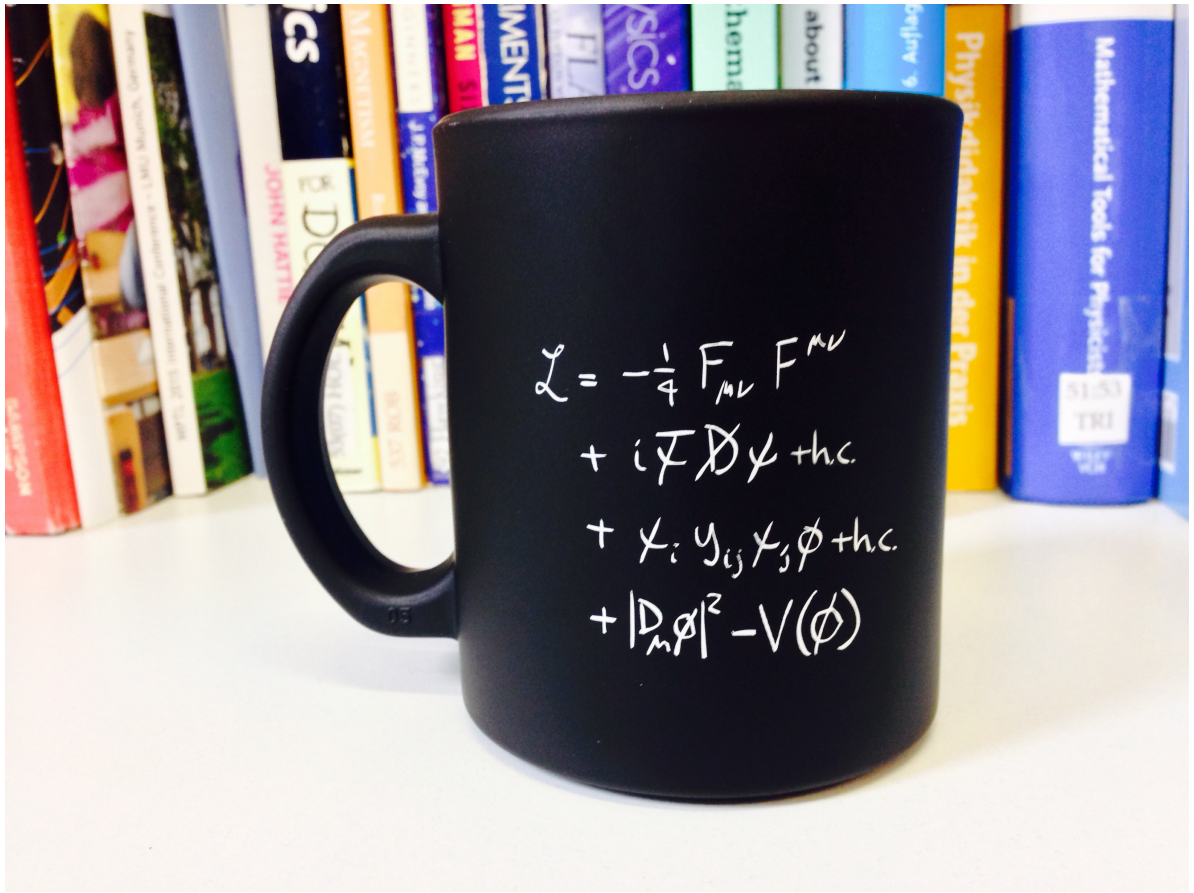
23 Member States

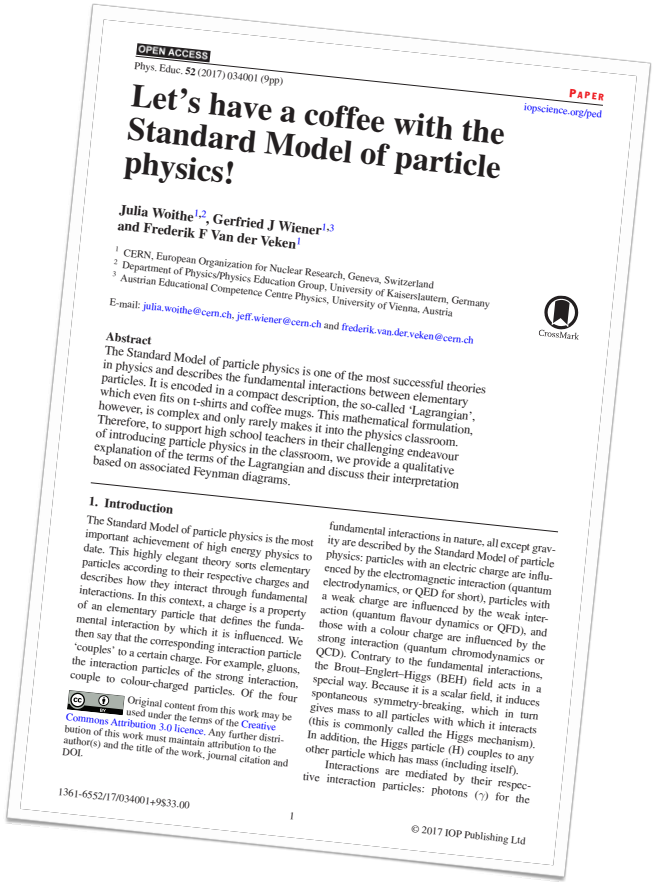
11 Associate Member States

Annual budget
1.2 billion CHF
1.2 billion EUR
1.3 billion USD




$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu}$
$+ i \bar{\psi} \not{D} \psi + h.c.$
$+ \psi_i y_{ij} \psi_j \phi + h.c.$
$+ |D_\mu \phi|^2 - V(\phi)$
Mathematical Tools for Physicists
Physik





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PAPER
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Let's have a coffee with the Standard Model of particle physics!

Julia Woithe[1,2], **Gerfried J Wiener**[1,3] and **Frederik F Van der Veken**[1]

[1] CERN, European Organization for Nuclear Research, Geneva, Switzerland
[2] Department of Physics/Physics Education Group, University of Kaiserslautern, Germany
[3] Austrian Educational Competence Centre Physics, University of Vienna, Austria

E-mail: julia.woithe@cern.ch, jeff.wiener@cern.ch and frederik.van.der.veken@cern.ch

Abstract

The Standard Model of particle physics is one of the most successful theories in physics and describes the fundamental interactions between elementary particles. It is encoded in a compact description, the so-called 'Lagrangian', which even fits on t-shirts and coffee mugs. This mathematical formulation, however, is complex and only rarely makes it into the physics classroom. Therefore, to support high school teachers in their challenging endeavour of introducing particle physics in the classroom, we provide a qualitative explanation of the terms of the Lagrangian and discuss their interpretation based on associated Feynman diagrams.

1. Introduction

The Standard Model of particle physics is the most important achievement of high energy physics to date. This highly elegant theory sorts elementary particles according to their respective charges and describes how they interact through fundamental interactions. In this context, a charge is a property of an elementary particle that defines the fundamental interaction by which it is influenced. We then say that the corresponding interaction particle 'couples' to a certain charge. For example, gluons, the interaction particles of the strong interaction, couple to colour-charged particles. Of the four fundamental interactions in nature, all except gravity are described by the Standard Model of particle physics: particles with an electric charge are influenced by the electromagnetic interaction (quantum electrodynamics, or QED for short), particles with a weak charge are influenced by the weak interaction (quantum flavour dynamics or QFD), and those with a colour charge are influenced by the strong interaction (quantum chromodynamics or QCD). Contrary to the fundamental interactions, the Brout–Englert–Higgs (BEH) field acts in a special way. Because it is a scalar field, it induces spontaneous symmetry-breaking, which in turn gives mass to all particles with which it interacts (this is commonly called the Higgs mechanism). In addition, the Higgs particle (H) couples to any other particle which has mass (including itself).

Interactions are mediated by their respective interaction particles: photons (γ) for the

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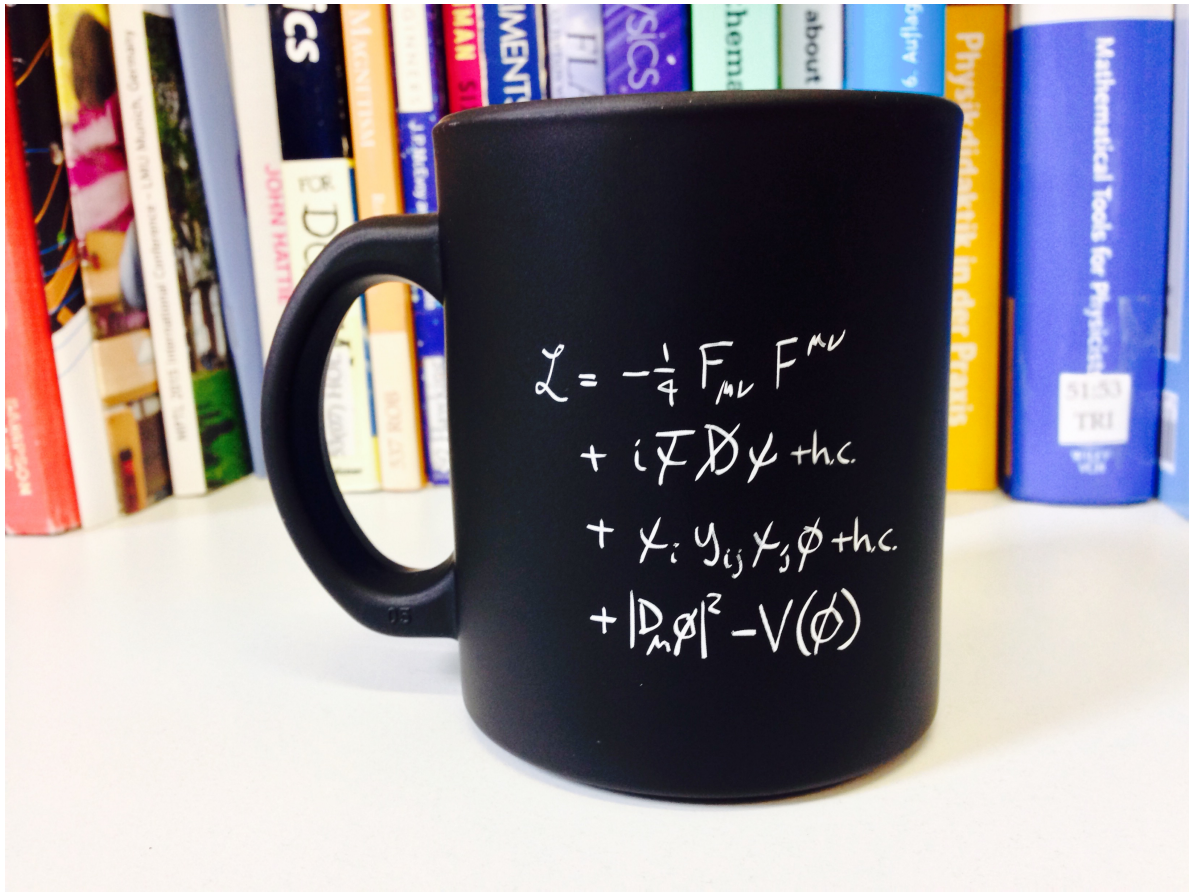

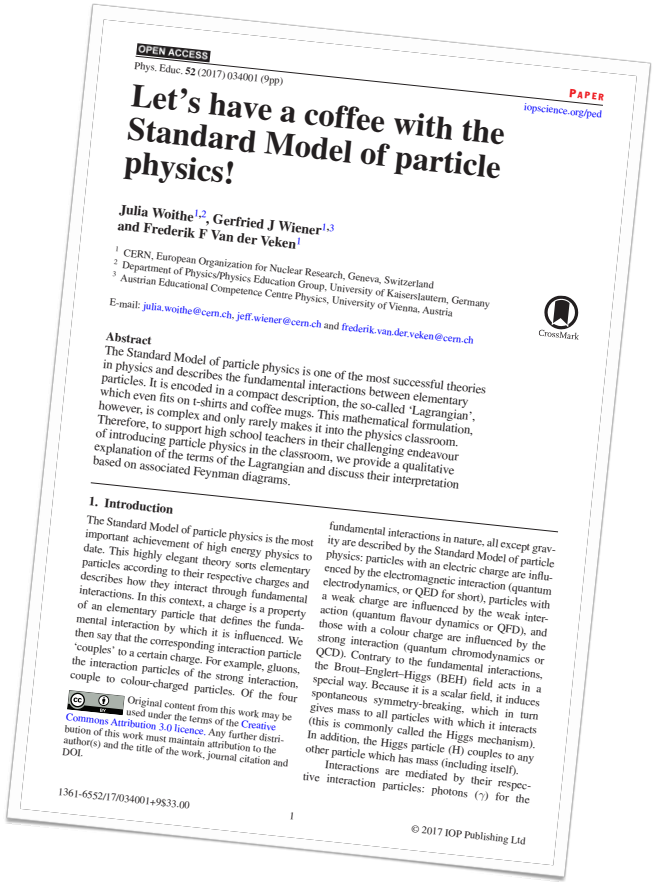

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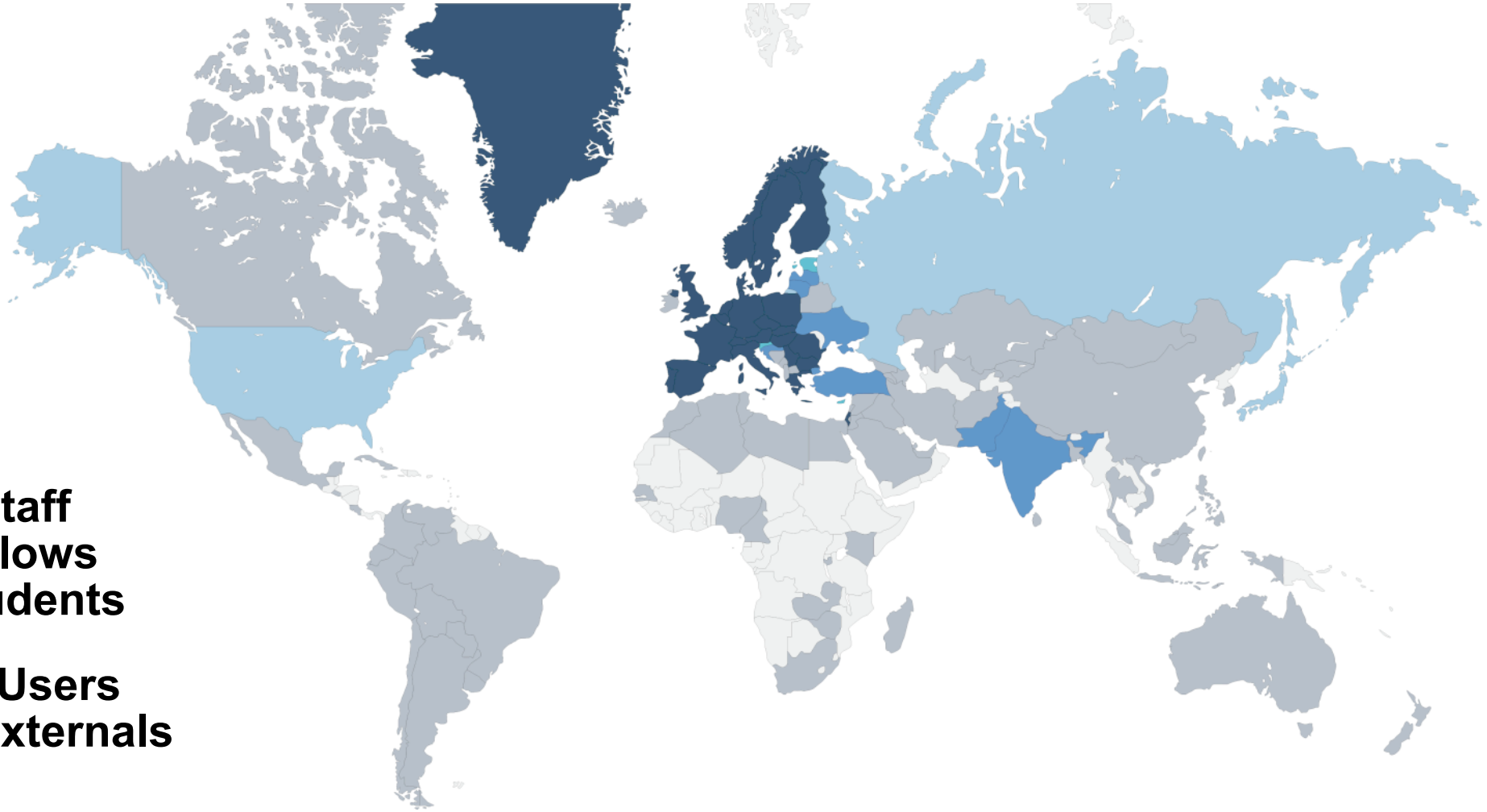
More than 20,000 scientists from around the world



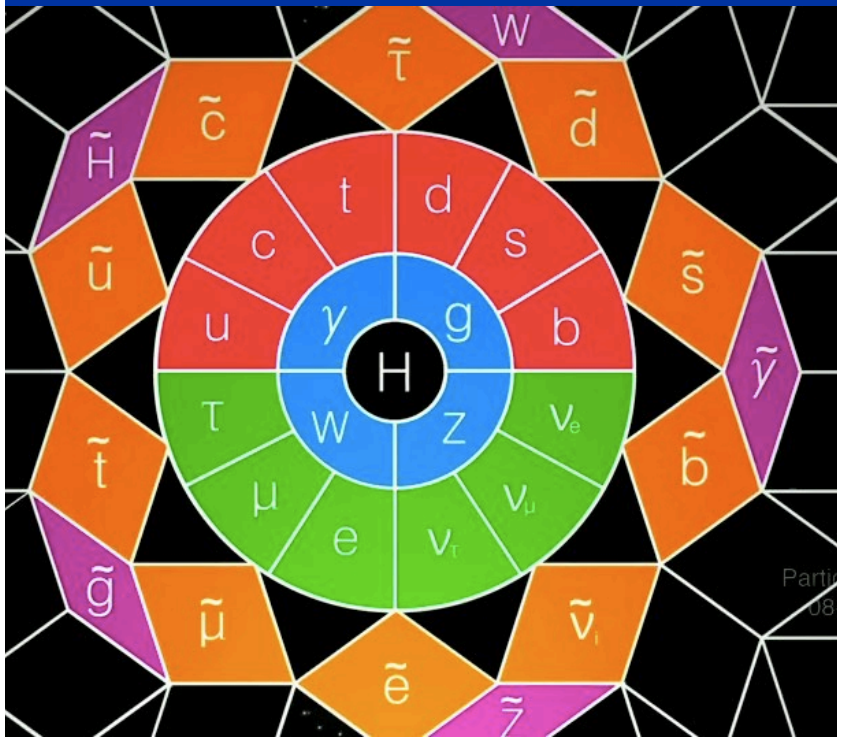
2,600 Staff
800 Fellows
550 Students

15,000 Users
2,000 Externals

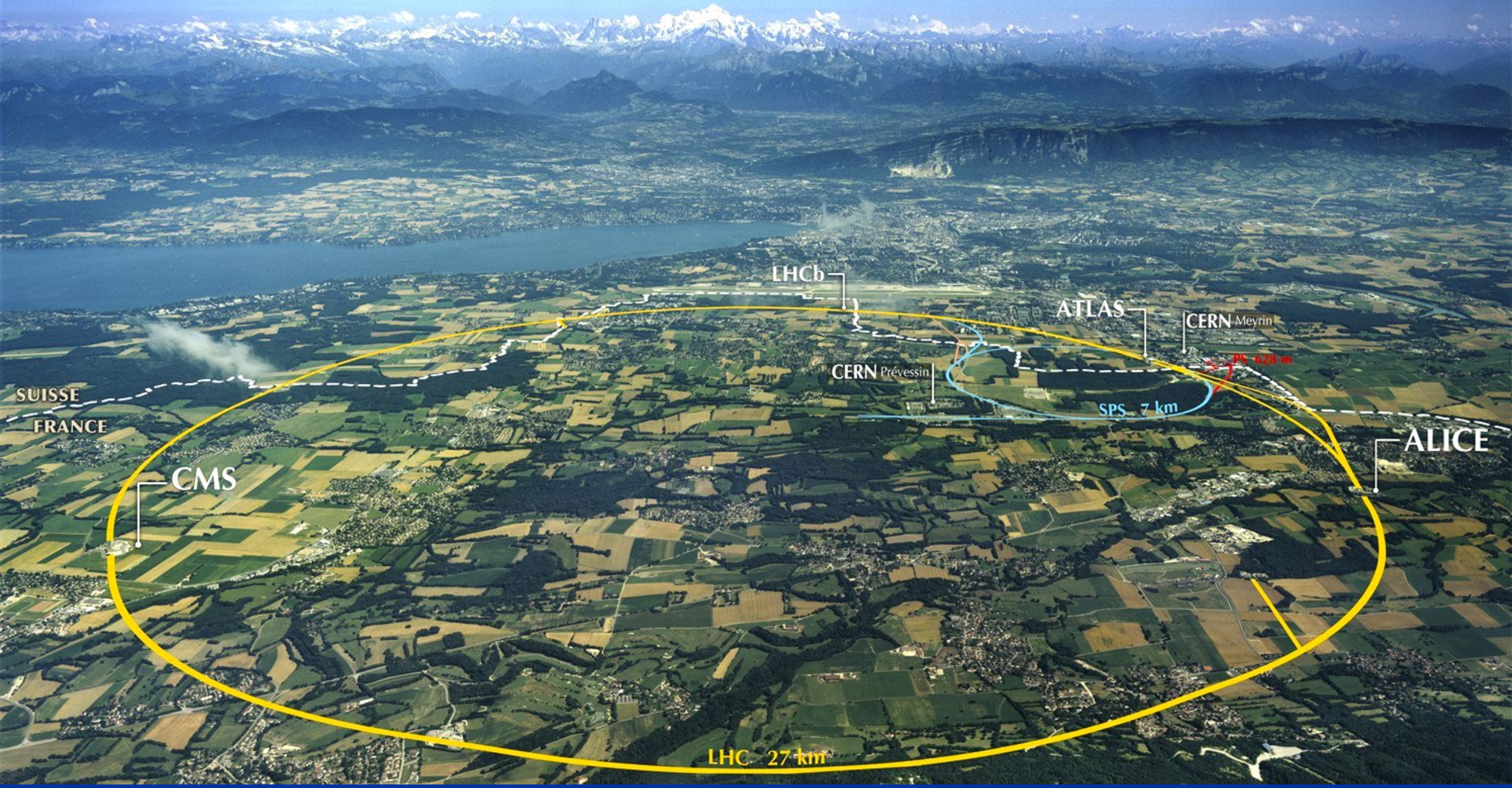
Fundamental questions of humankind

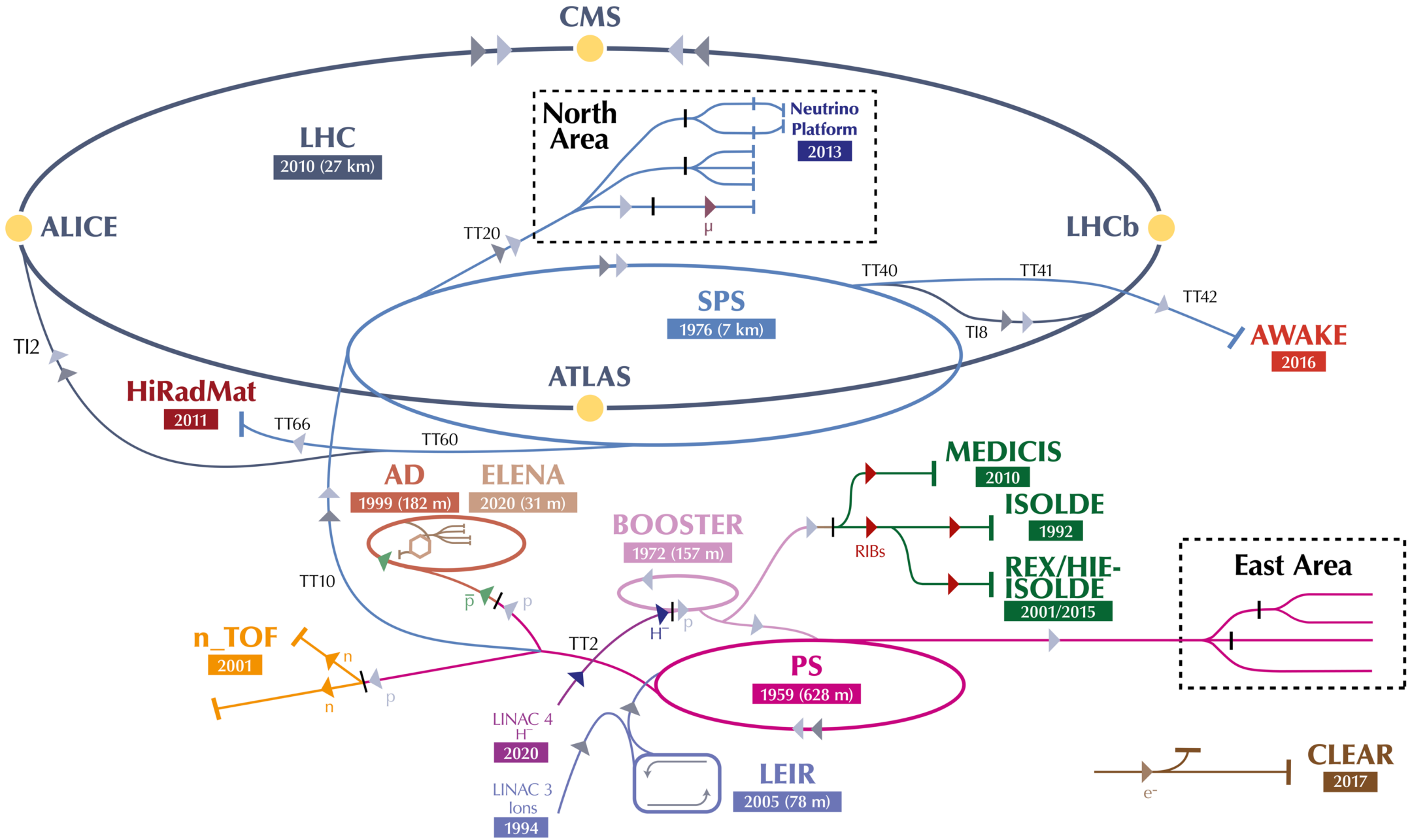
Where do we come from?

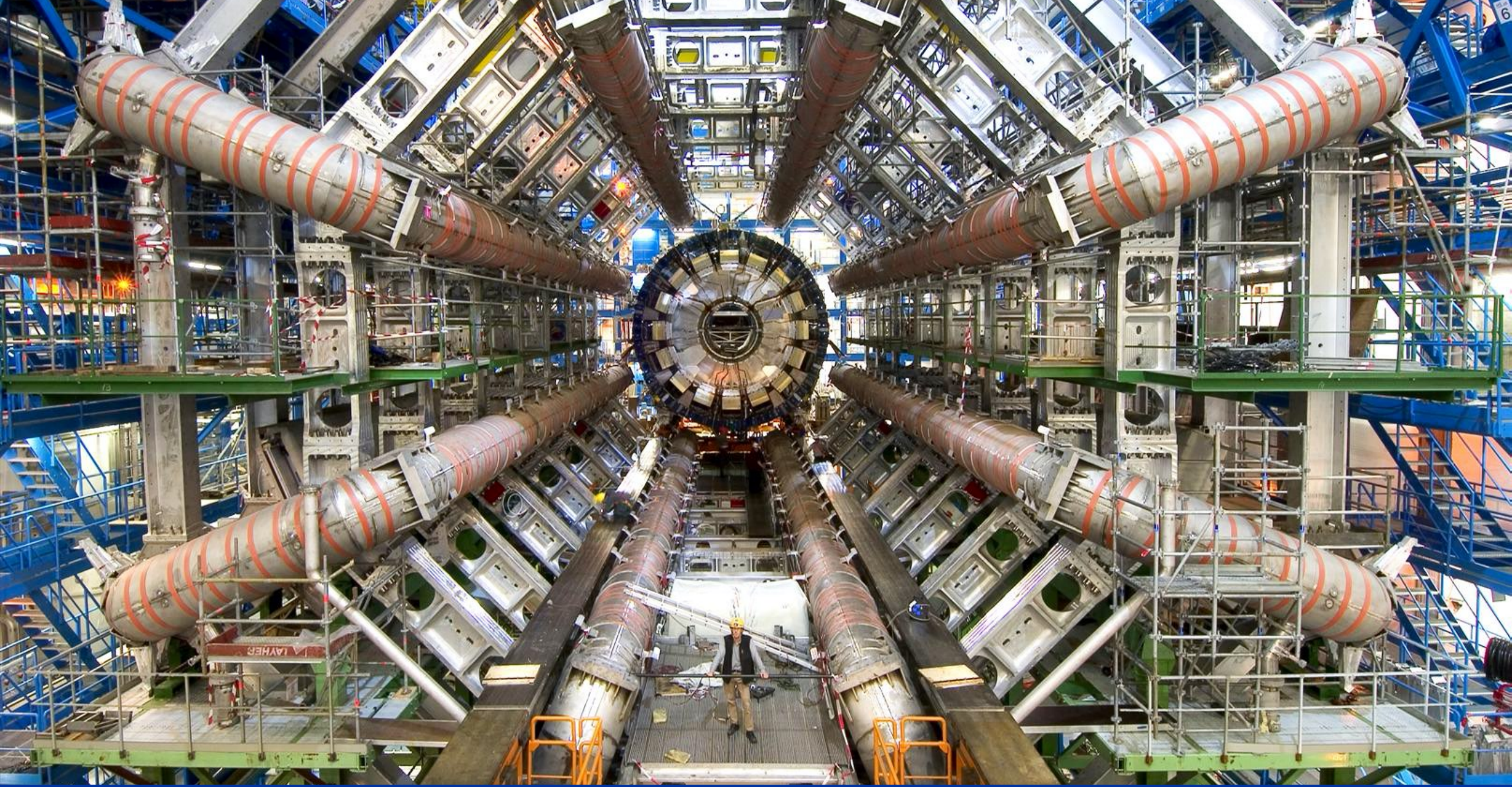
What are we made of?

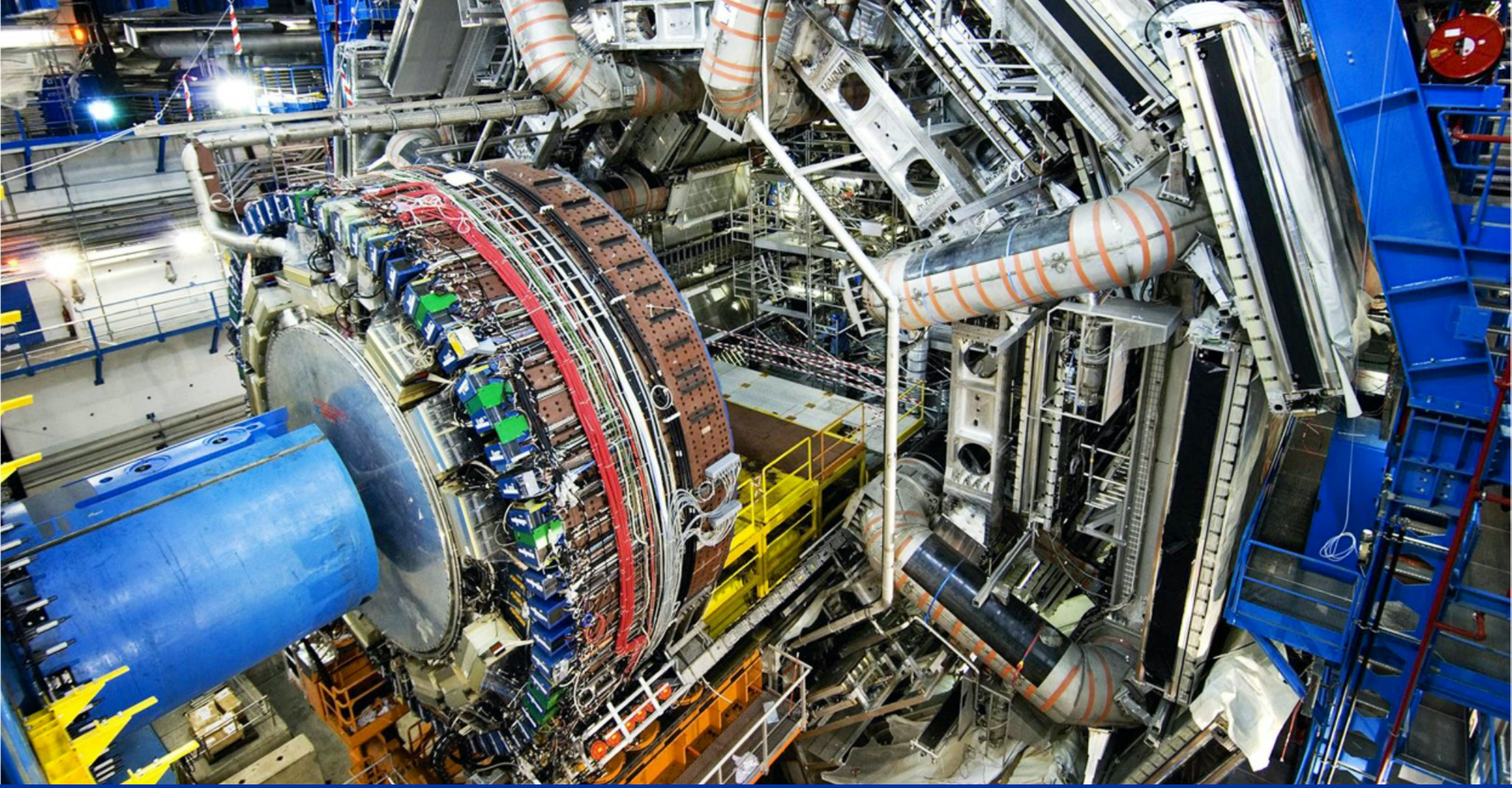


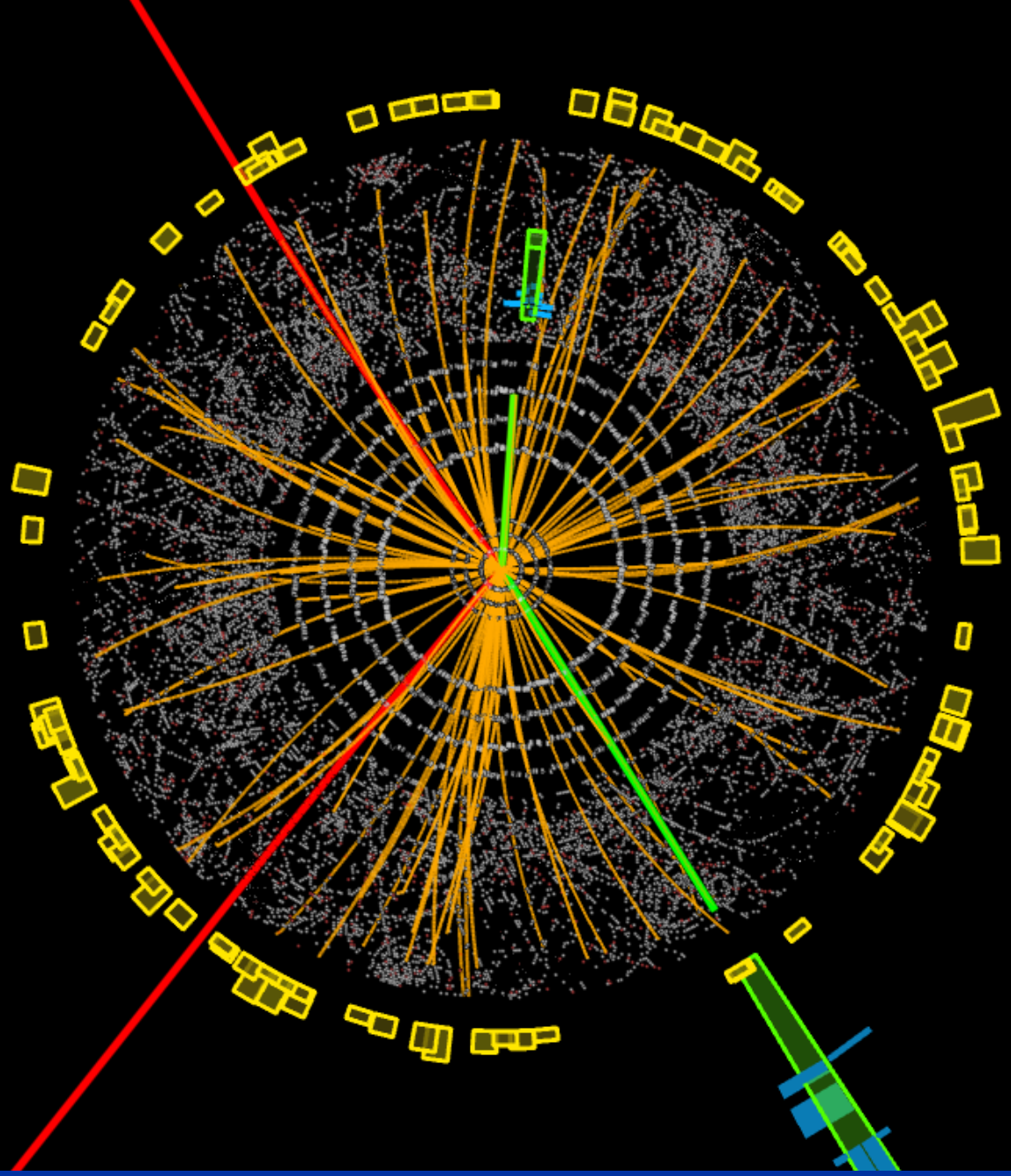
Where are we going?


LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SUISSE
FRANCE
SPS 7 km
ALICE
CMS
LHC 27 km


CMS
LHC
2010 (27 km)
North Area
Neutrino Platform
2013
μ
ALICE
LHCb
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)
BOOSTER
1972 (157 m)
MEDICIS
2010
ISOLDE
1992
RIBs
REX/HIE-ISOLDE
2001/2015
East Area
TT10
p̄
p
H⁻
p
n_TOF
2001
n
n
p
TT2
PS
1959 (628 m)
LINAC 4
H⁻
2020
LINAC 3
Ions
1994
LEIR
2005 (78 m)
e⁻
CLEAR
2017



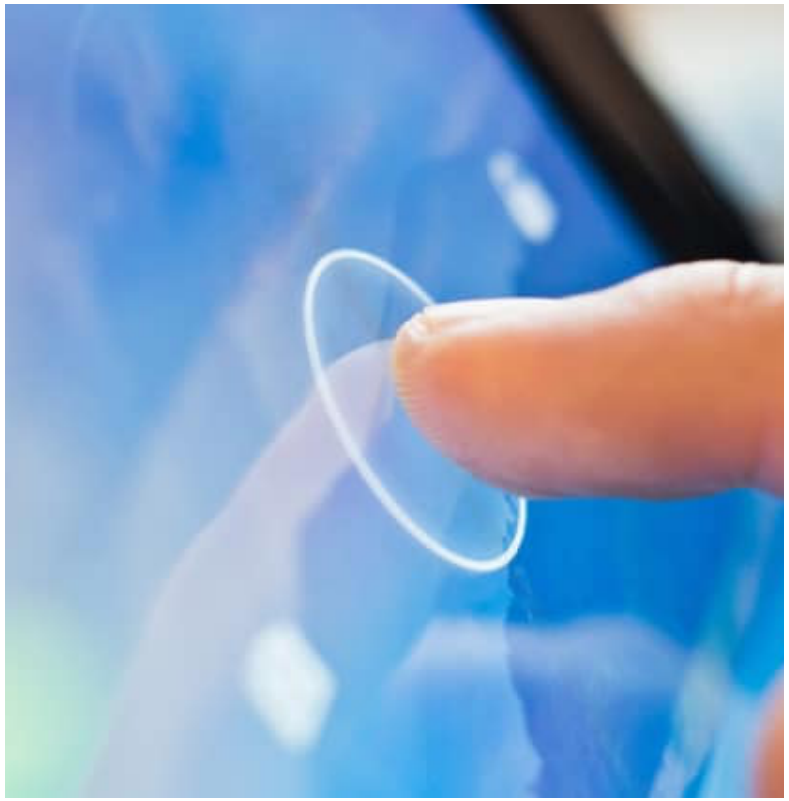




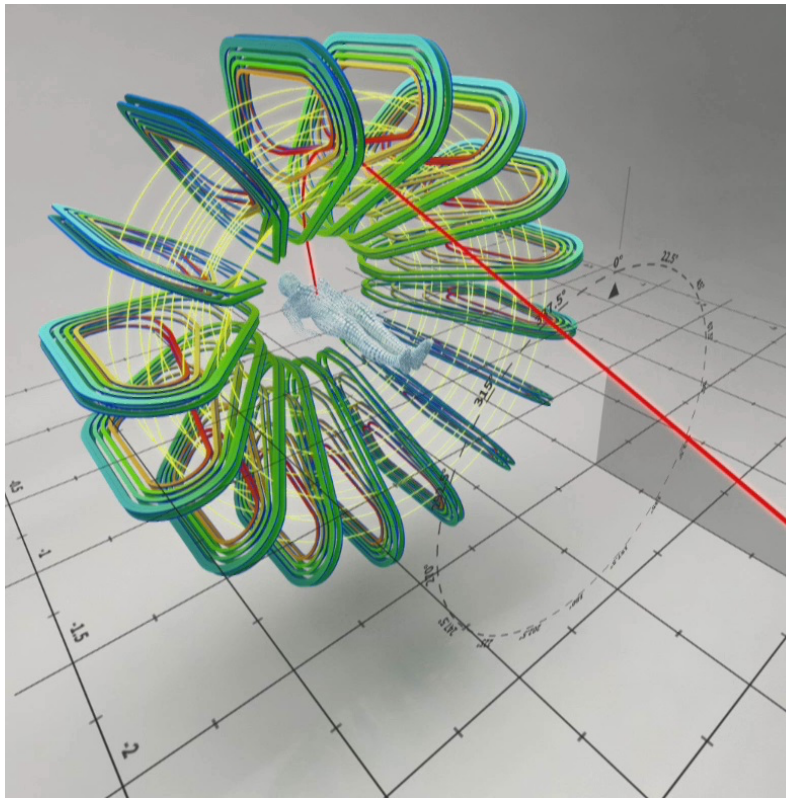
Knowledge Transfer

WWW

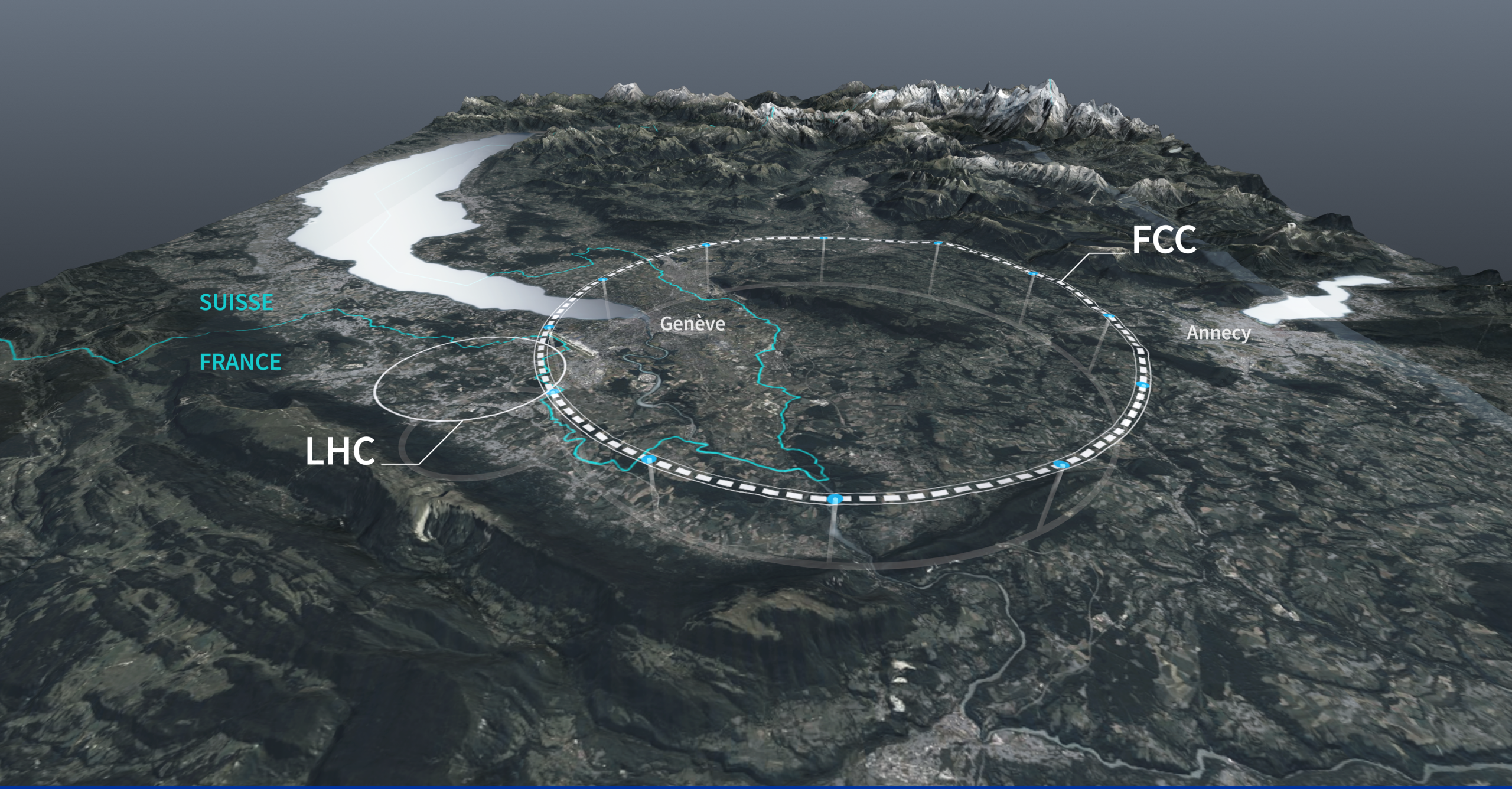
Touchscreens



Medical applications



What’s next?


FCC
SUISSE
FRANCE
Genève
Annecy
LHC

We need the next generation of scientists and engineers!

Merci bien!

Questions?

cern.ch/jeff.wiener