



# CERN – a short and sweet introduction

Dr Jeff Wiener  
7 October 2024

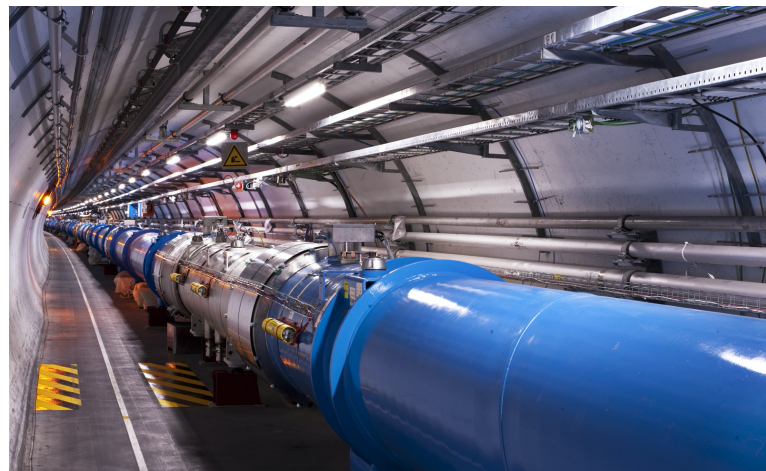
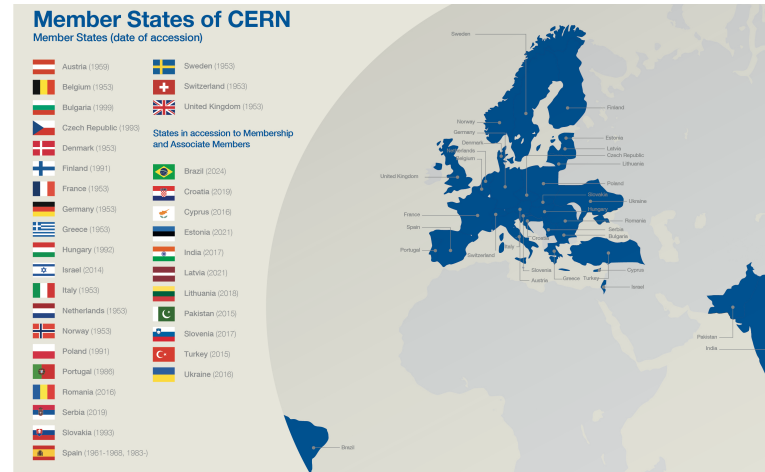
# Conseil Européen pour la Recherche Nucléaire

International **C**ollaboration

**E**ducation

Fundamental **R**esearch

**N**ew 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 convention

1954

Completion of the ratification process of the 12 Member States

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



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.

# CERN Today

## Member States

-  Austria
-  Belgium
-  Bulgaria
-  Czech Republic
-  Denmark
-  Estonia
-  Finland
-  France
-  Germany
-  Greece
-  Hungary
-  Israel
-  Italy
-  Netherlands
-  Norway
-  Poland
-  Portugal
-  Romania
-  Serbia
-  Slovakia
-  Spain
-  Sweden
-  Switzerland
-  United Kingdom

## Associate Member States

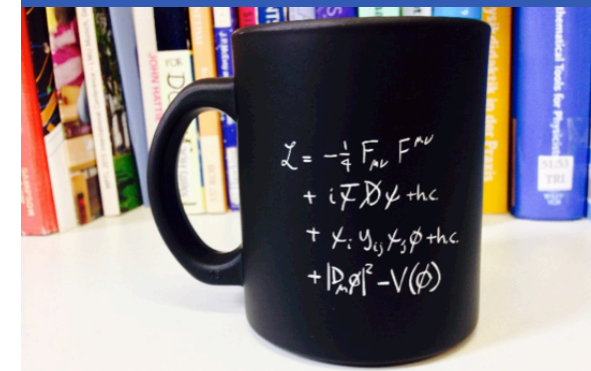
-  Brazil
-  Croatia
-  Cyprus
-  India
-  Latvia
-  Lithuania
-  Pakistan
-  Slovenia
-  Türkiye
-  Ukraine

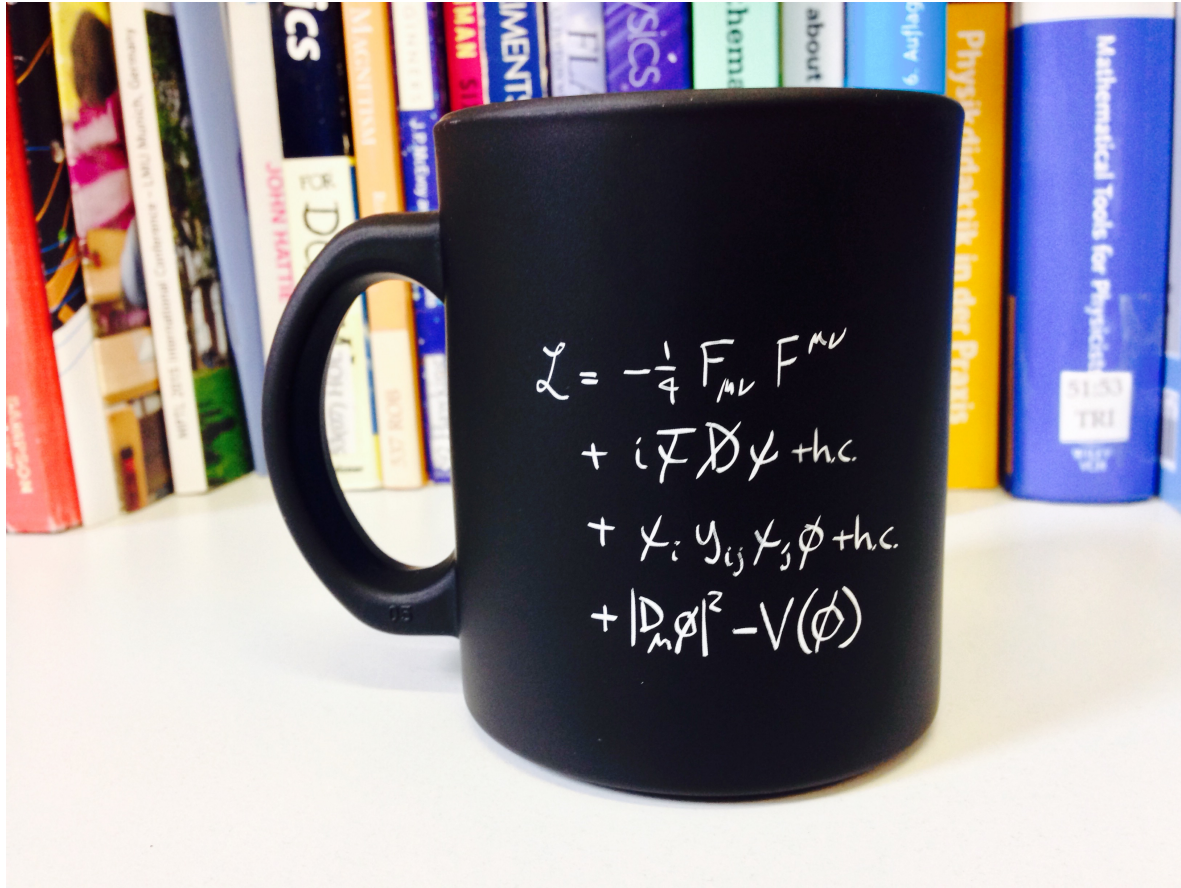
## Observer Status

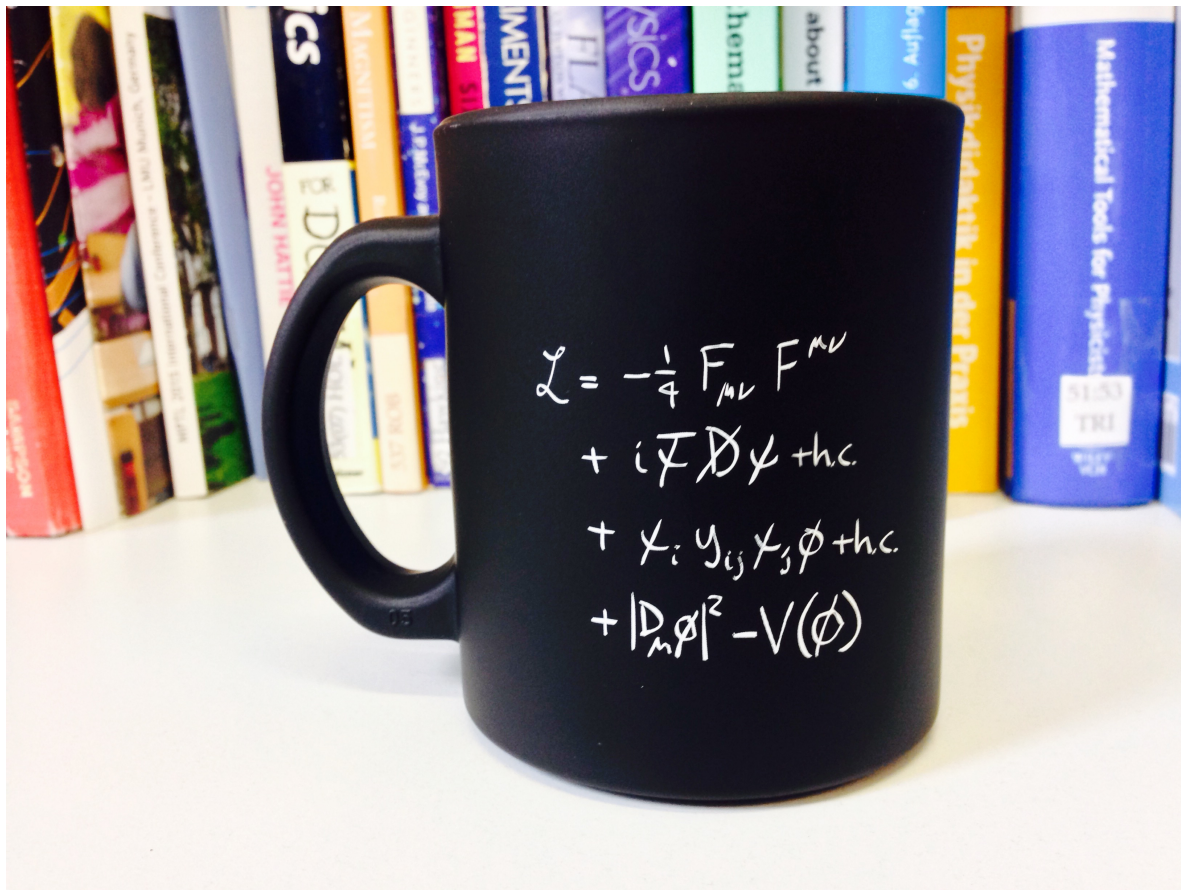
-  Japan
-  USA
-  European Union
-  UNESCO

## Annual budget

**1.2 billion CHF**  
*1.2 billion EUR*  
*1.3 billion USD*







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

Julia Woithe<sup>1,2</sup>, Gerfried J Wiener<sup>1,3</sup> and Frederik F Van der Veken<sup>1</sup>

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<sup>2</sup> Department of Physics/Physics Education Group, University of Kaiserslautern, Germany  
<sup>3</sup> Austrian Educational Competence Centre Physics, University of Vienna, Austria

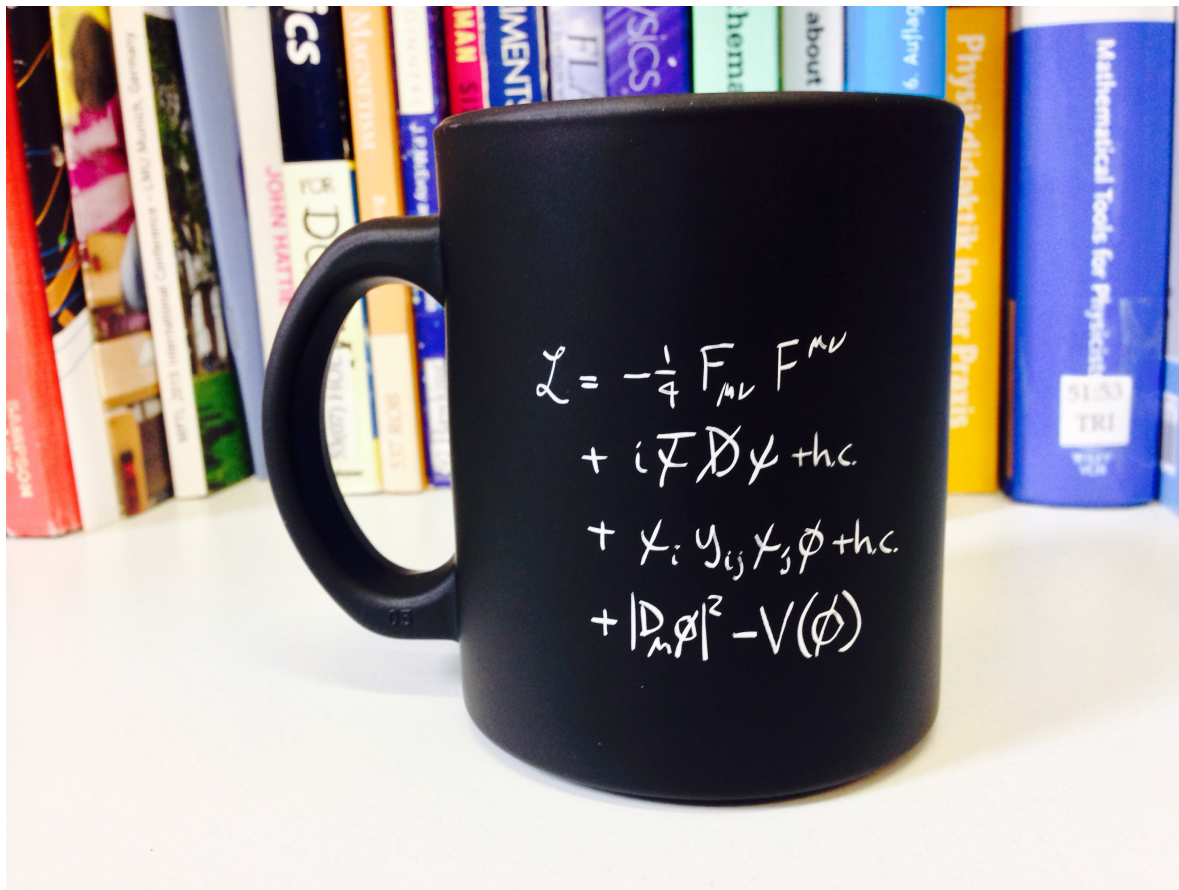
E-mail: [julia.woithe@cern.ch](mailto:julia.woithe@cern.ch), [jeff.wiener@cern.ch](mailto:jeff.wiener@cern.ch) and [frederik.van.der.veken@cern.ch](mailto:frederik.van.der.veken@cern.ch)

**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 sets 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 ( $\gamma$ ) for the

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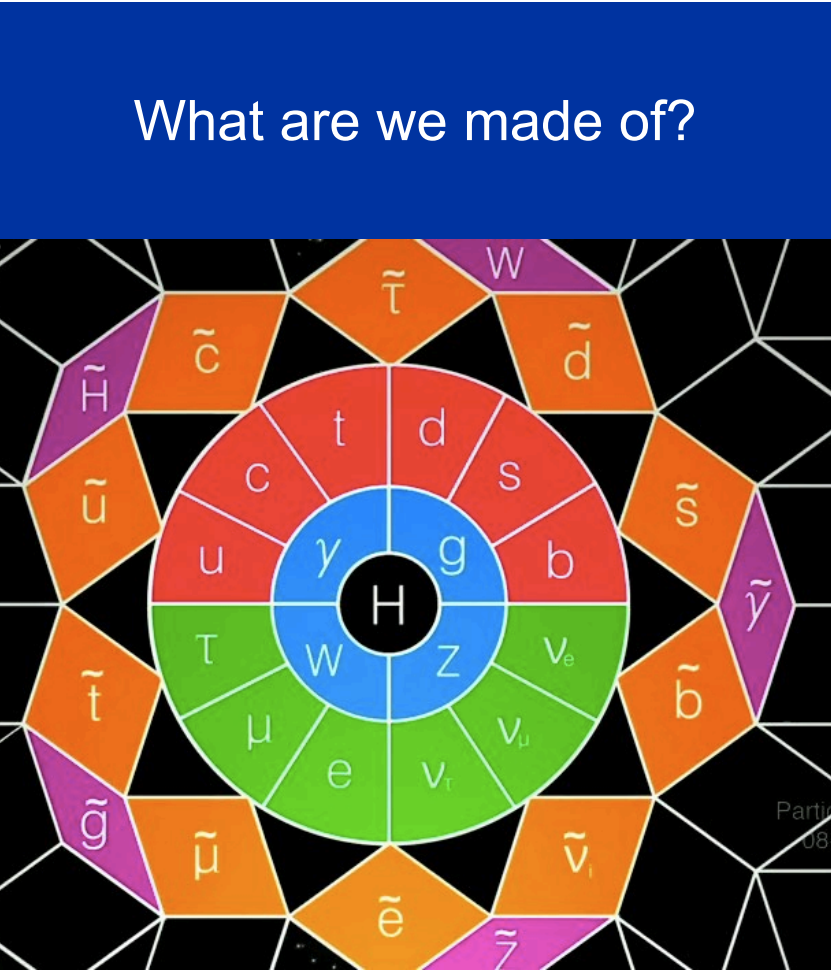
**12,000 Users**  
**2,000 Externals**



# Fundamental questions of humankind



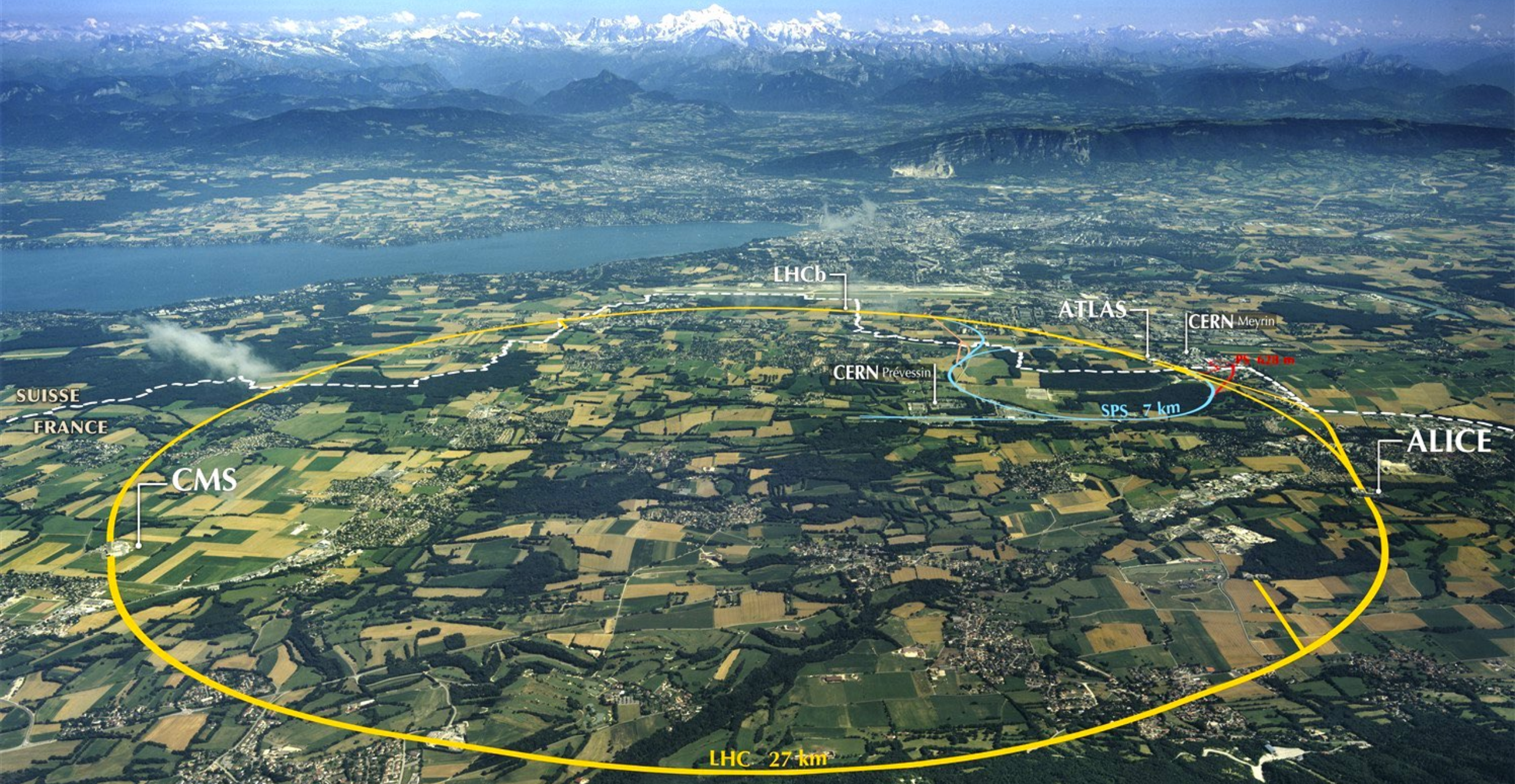
Where do we come from?



What are we made of?



Where are we going?



SUISSE  
FRANCE

CMS

LHCb

CERN Prévessin

ATLAS

CERN Meyrin

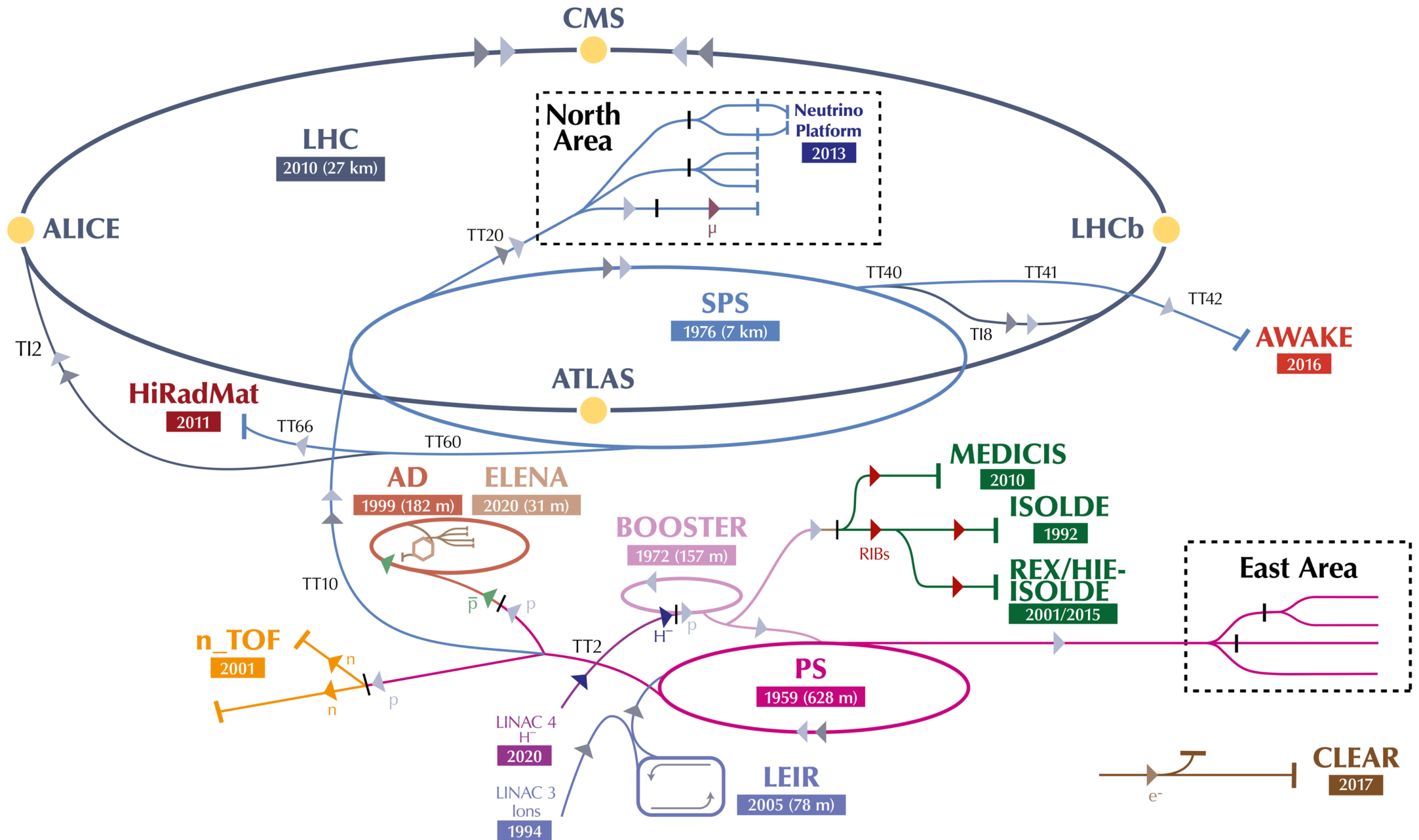
SPS 7 km

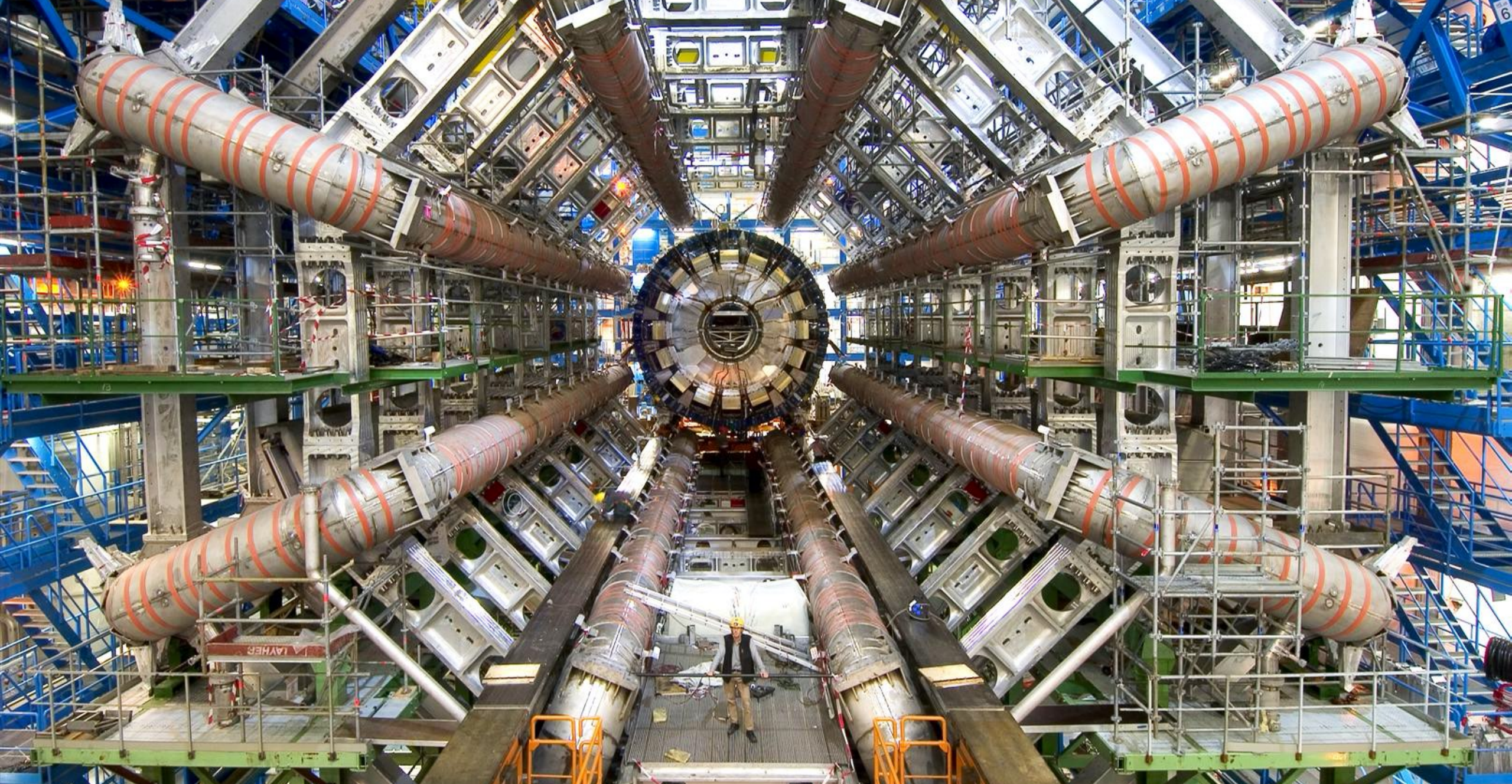
PS 6.28 km

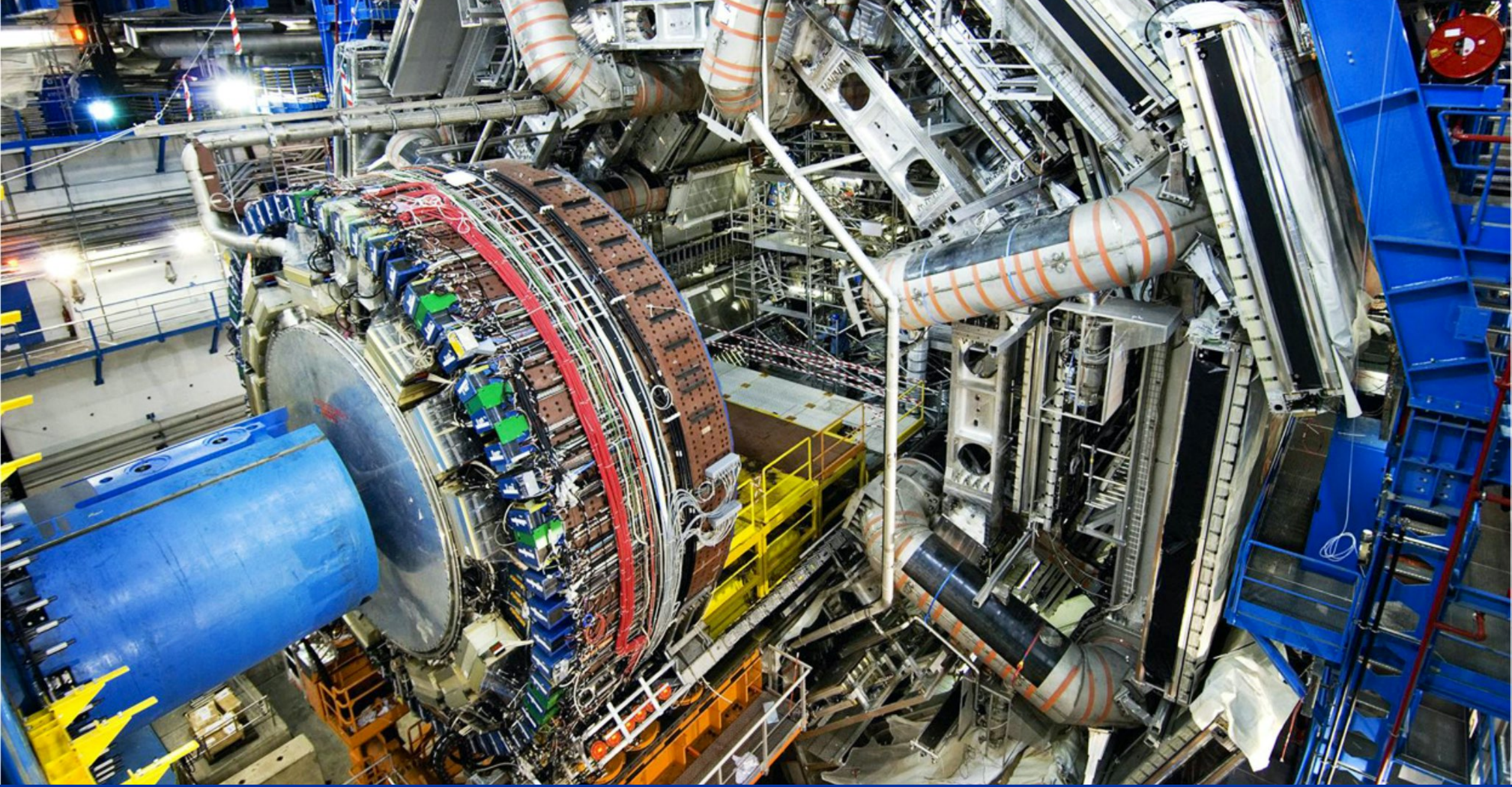
ALICE

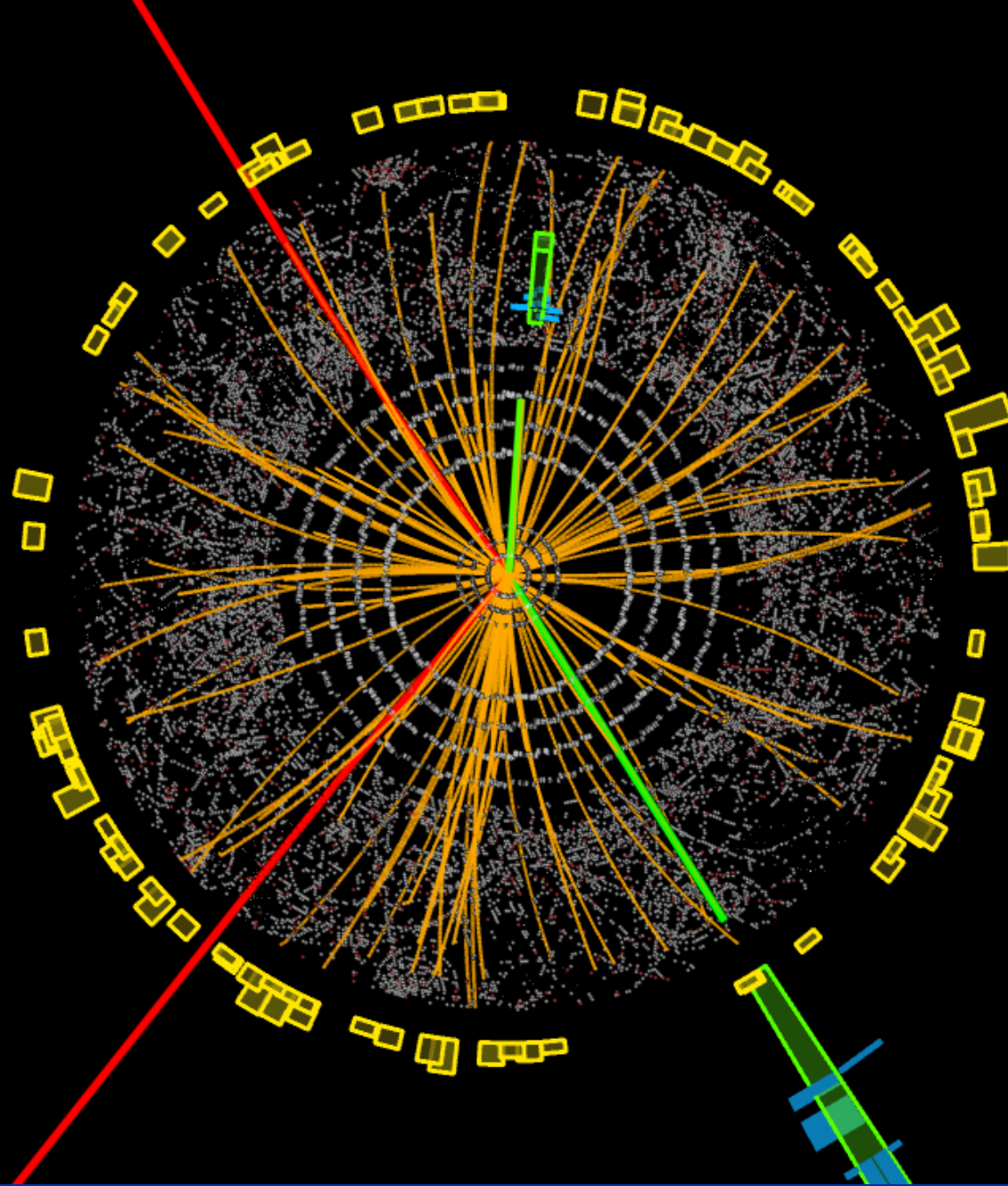
LHC 27 km

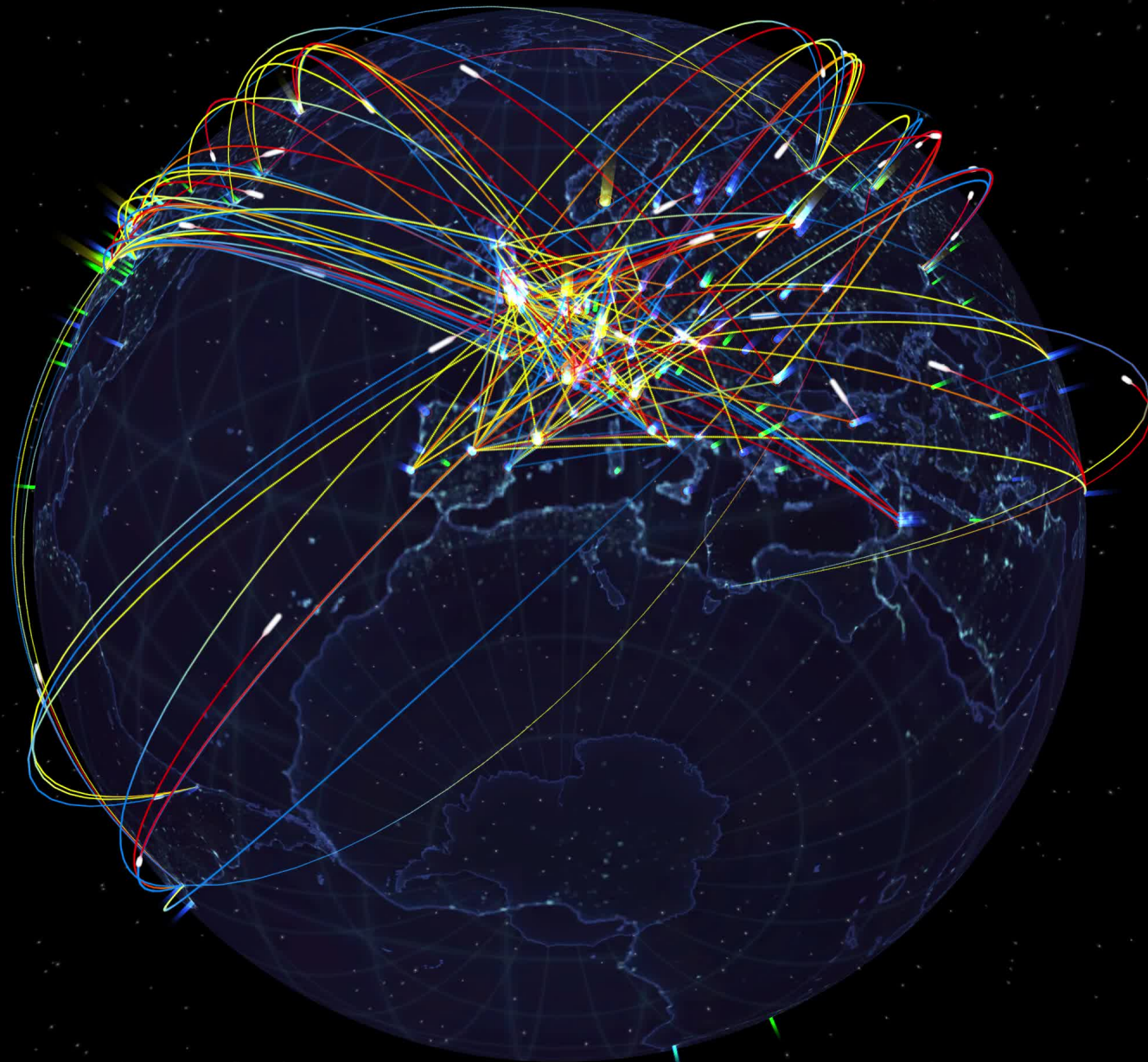
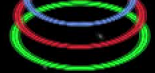




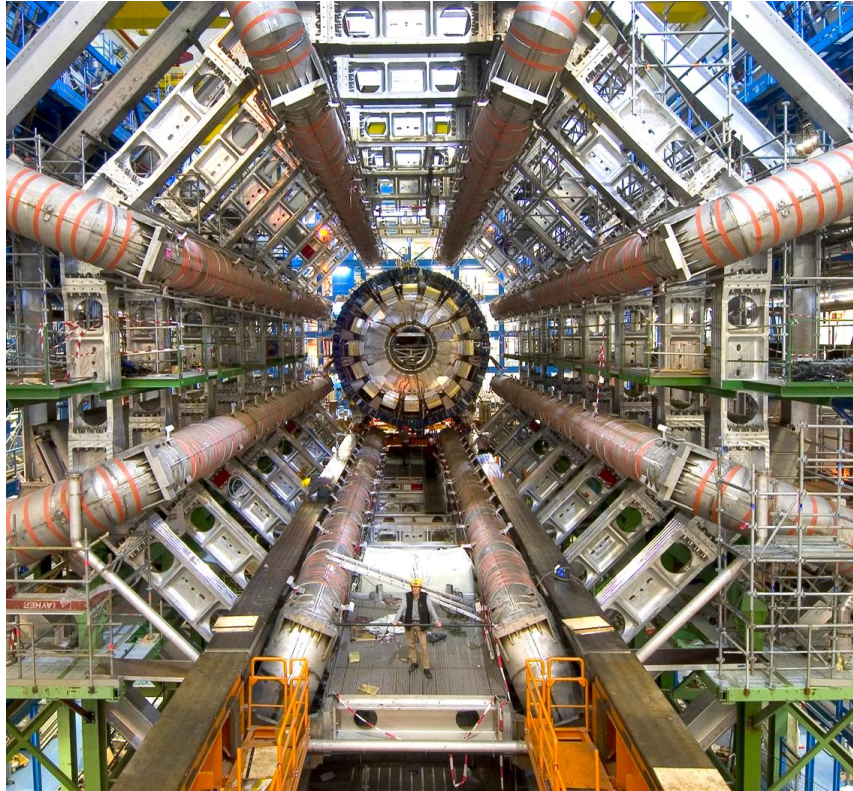




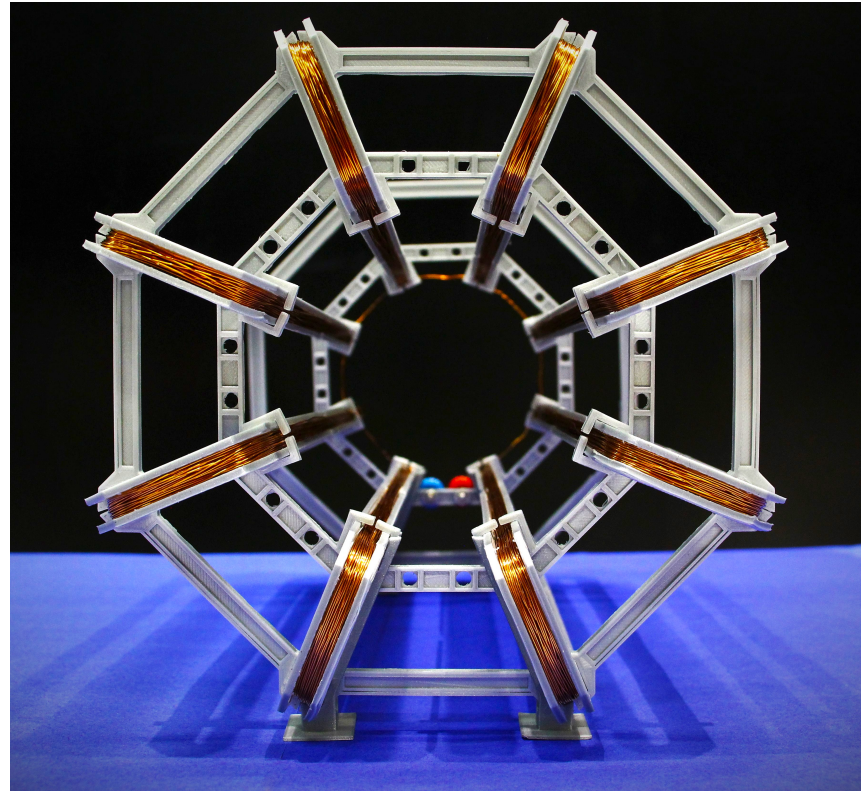
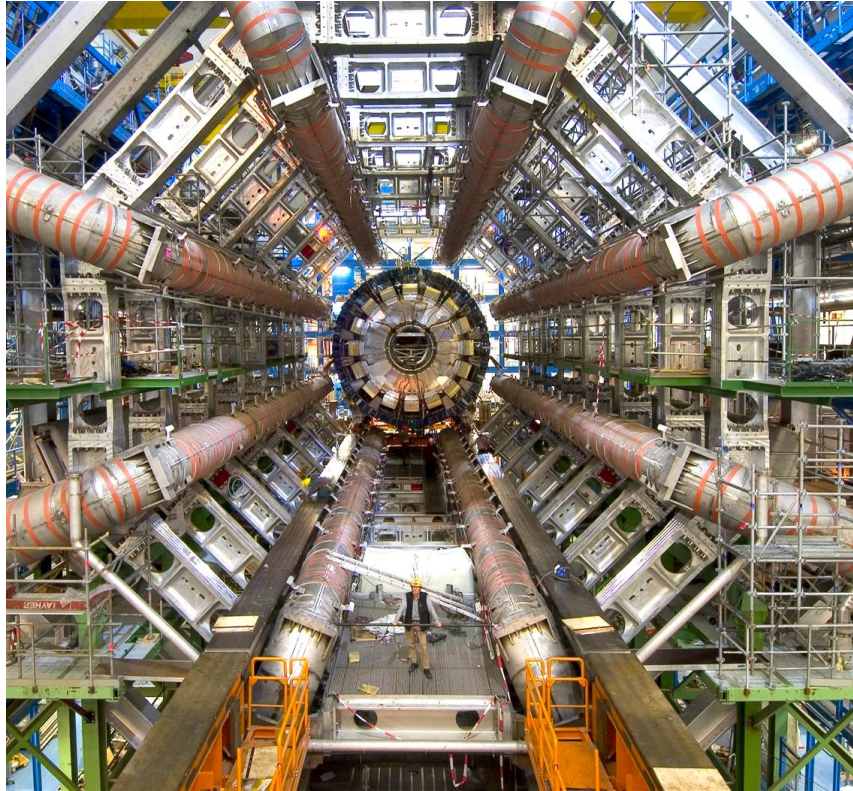


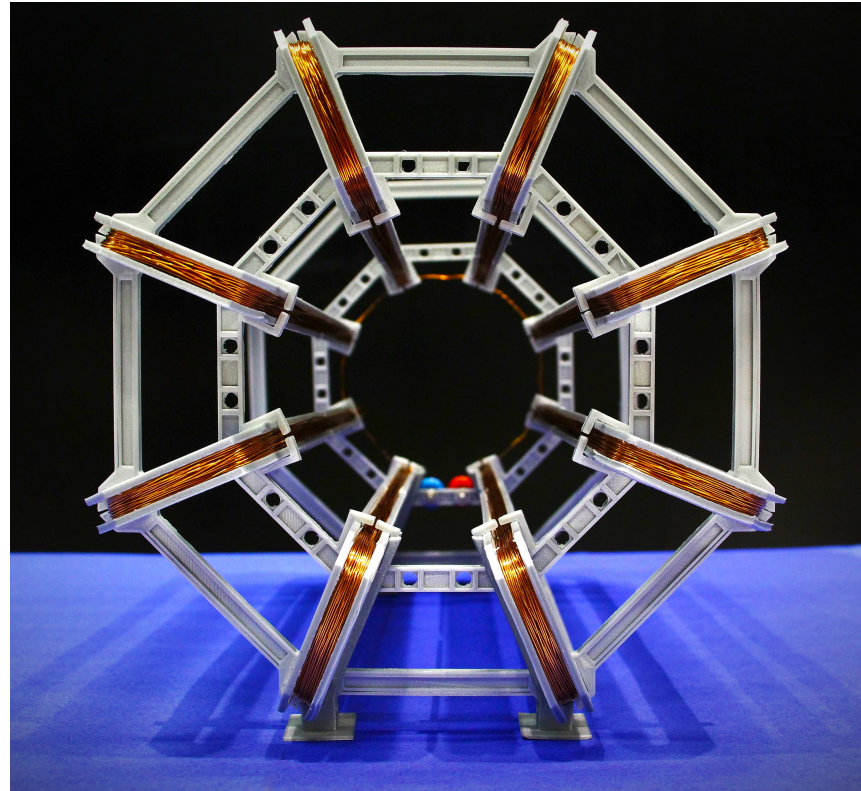
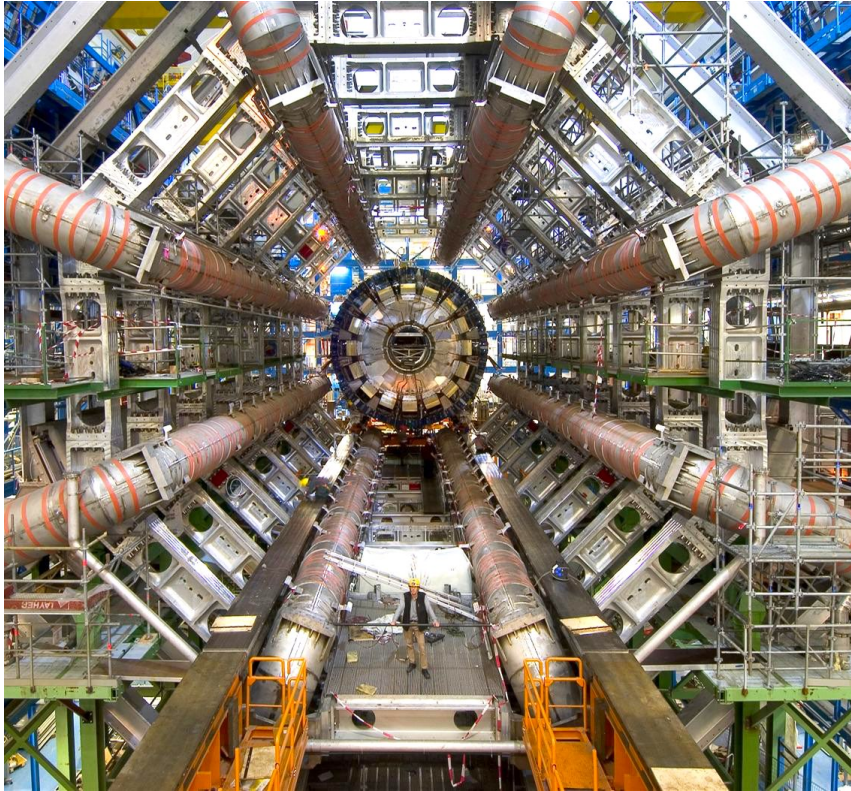


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Active CPU cores: 807139  
Transfer rate: 21.54 GiB/sec

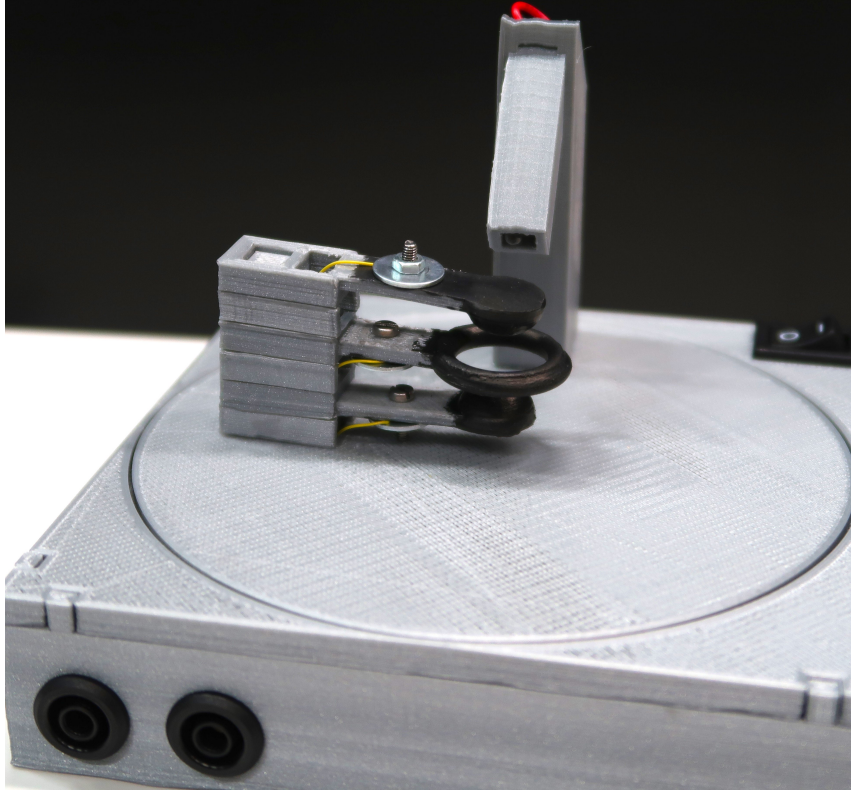


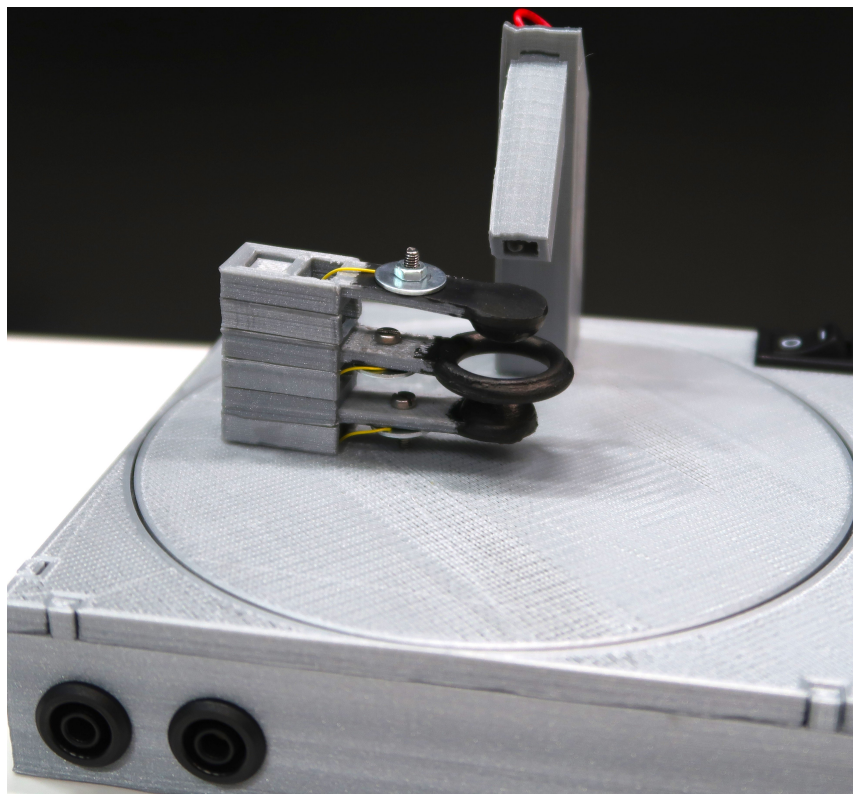


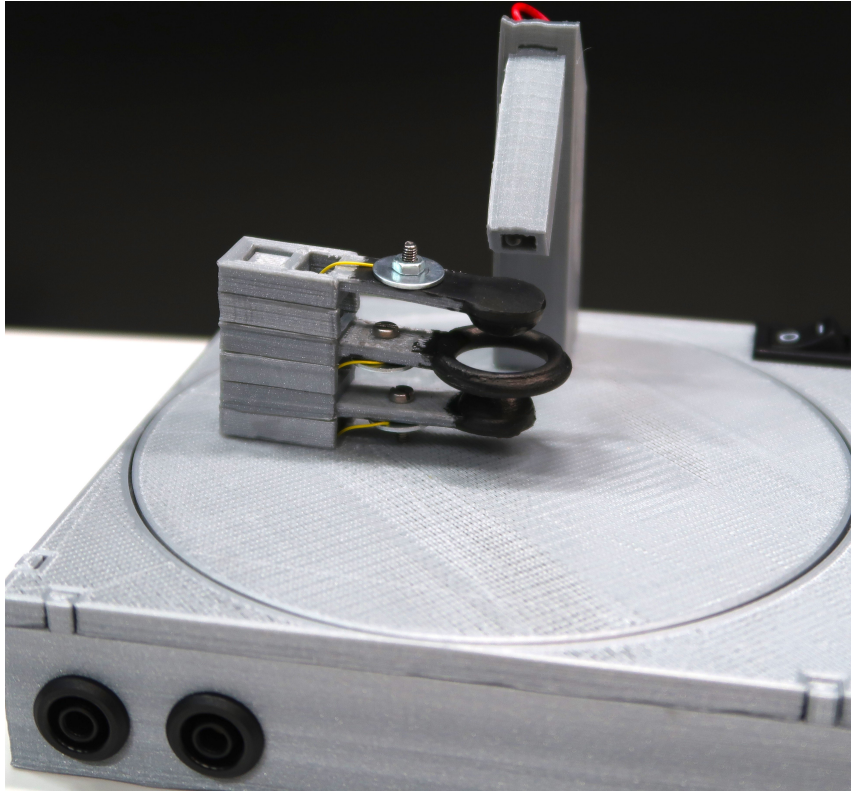




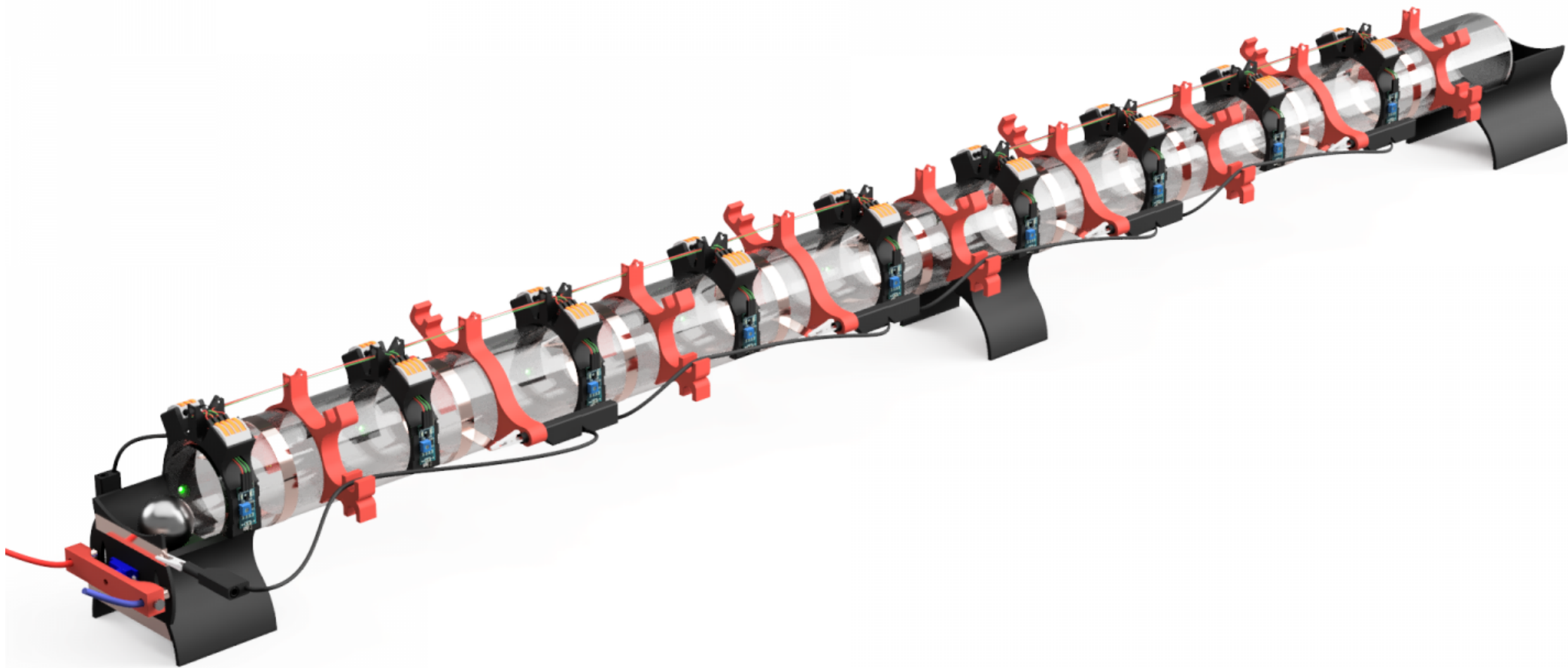
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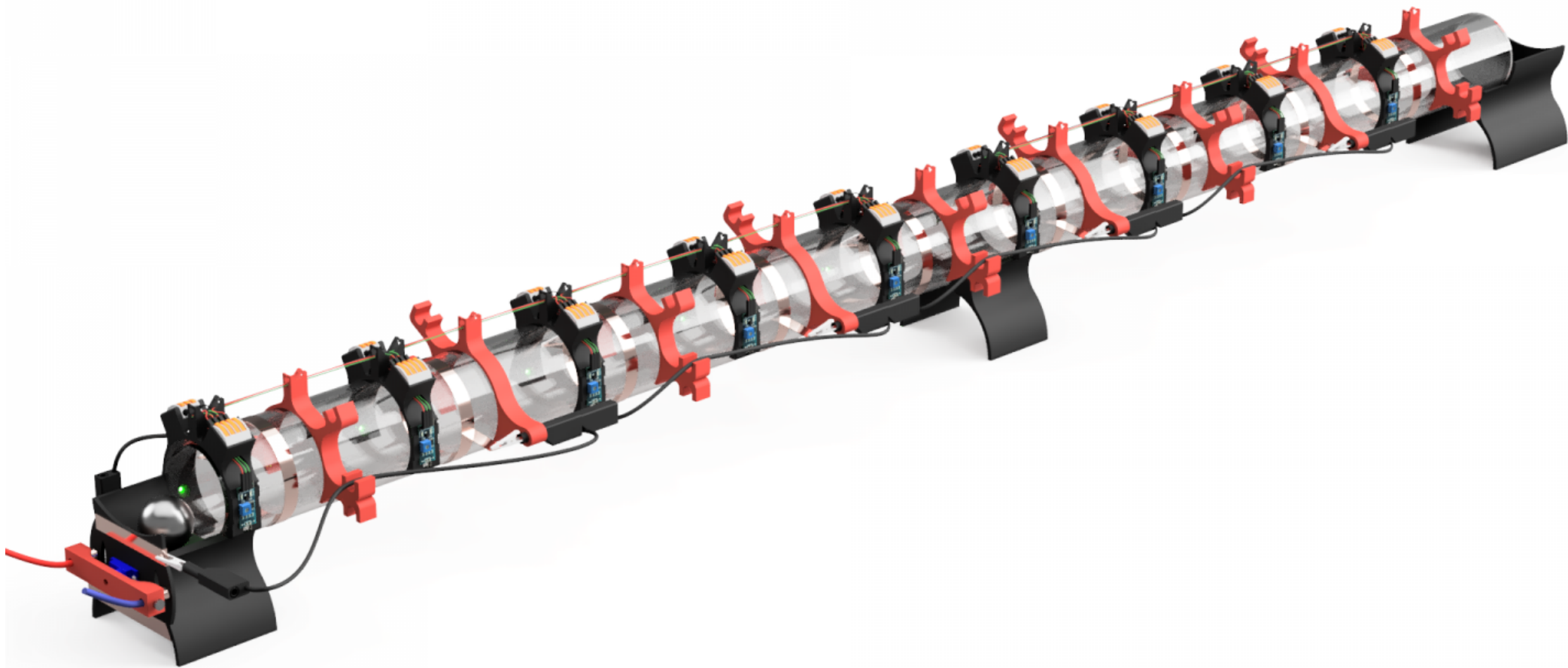






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# Knowledge Transfer

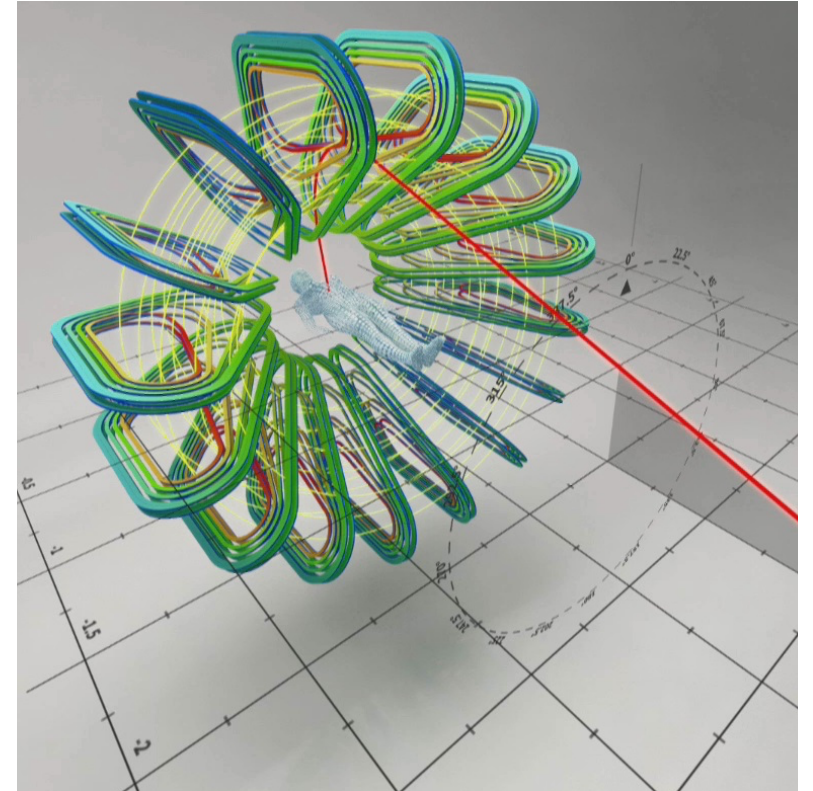
## WWW



## Touchscreens

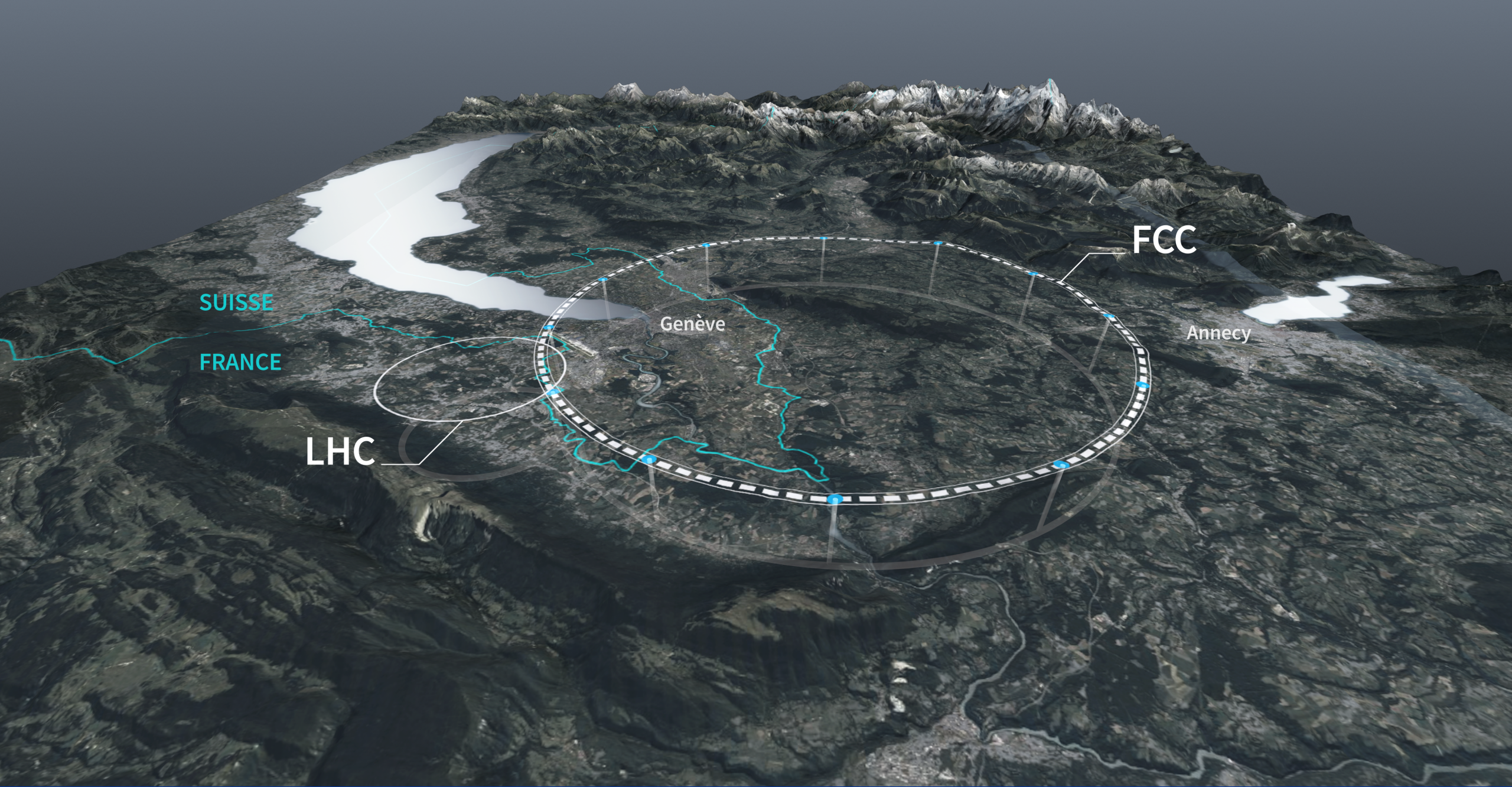


## Medical applications





# What's next?







A perspective view of a long, brightly lit tunnel, likely a particle accelerator. The tunnel is lined with metallic walls and has a series of large, shiny, cylindrical objects (possibly superconducting magnets) running along the length of it. The lighting is warm and comes from recessed fixtures in the ceiling and walls, creating a sense of depth and scale.

**We need the  
next generation  
of scientists and  
engineers!**

# Merci bien!

Questions?

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