



What's next?

Austrian Teacher Programme

18 November 2023

Outcome and To-Do-List

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Outcome and To-Do-List

Share your experience with your students, your colleagues, and the general public.



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Share your experience with your students, your colleagues, and the general public.

Act as ambassadors for science/engineering and in particular for particle physics.



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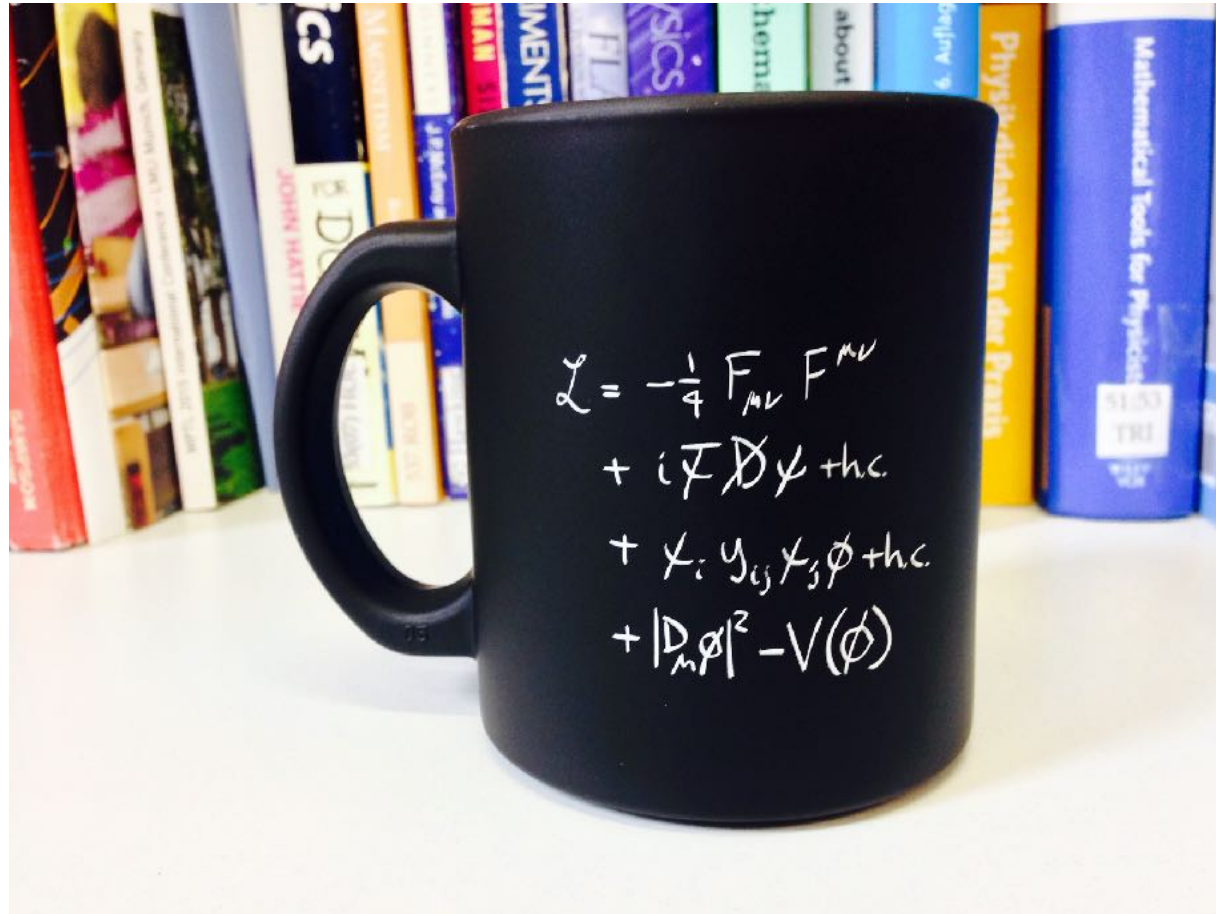
Organise follow-up activities.



A decorative graphic consisting of several colored circles and a semi-circle. There is a purple circle at the top, a green circle to its right, a yellow semi-circle on the right side, an orange circle at the bottom left, and a cyan circle at the bottom right. A white circle outline is positioned to the left of the text.

PARTICLE IDENTITIES

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

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 Veken¹

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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

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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).

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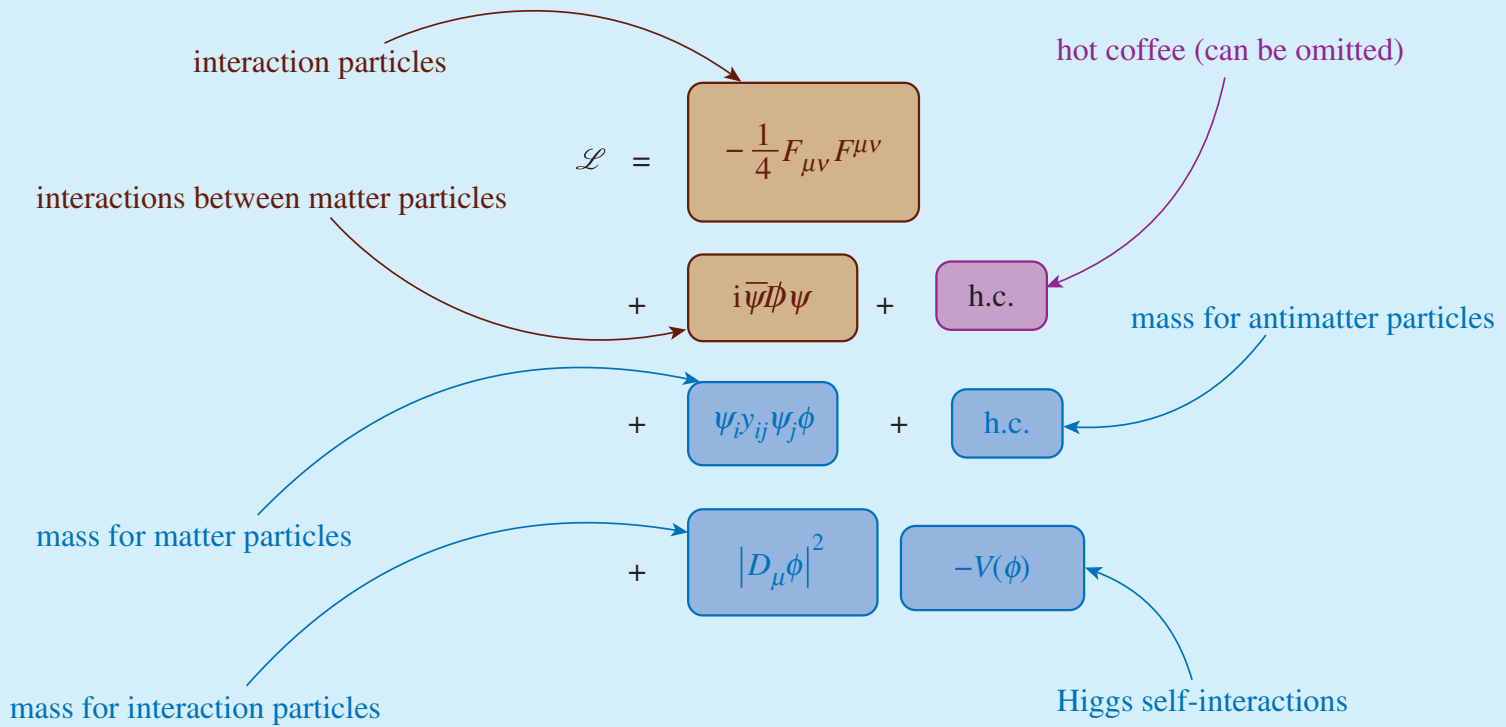
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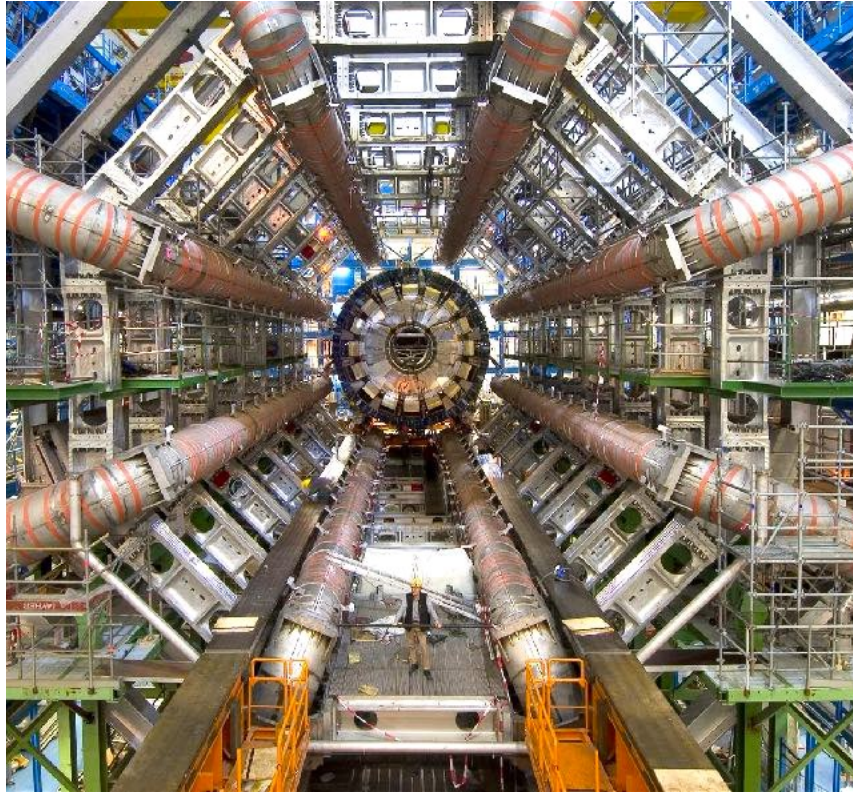
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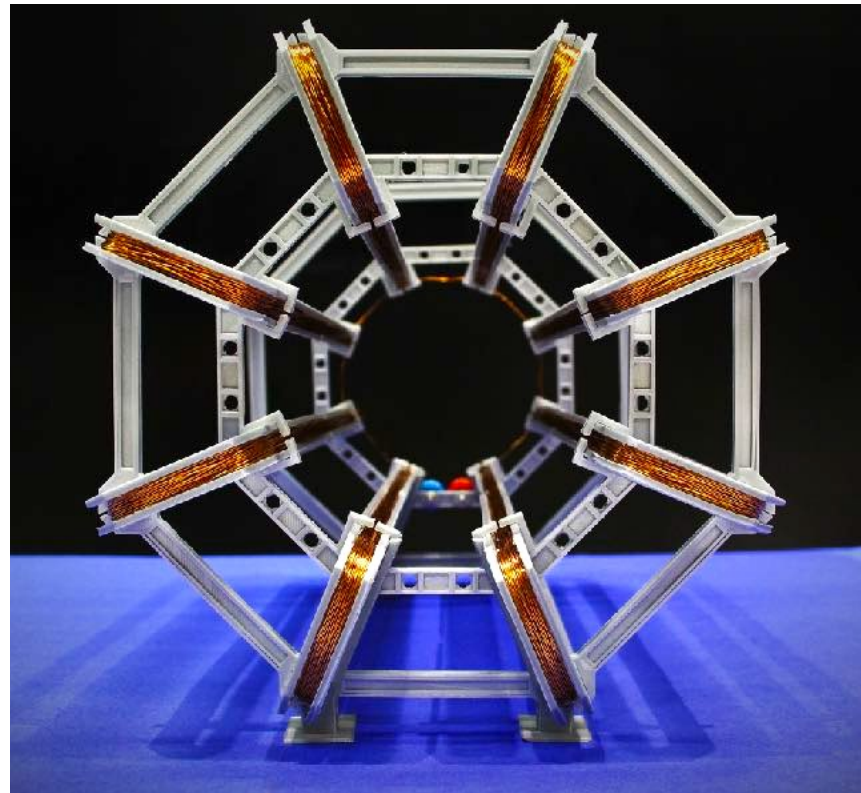
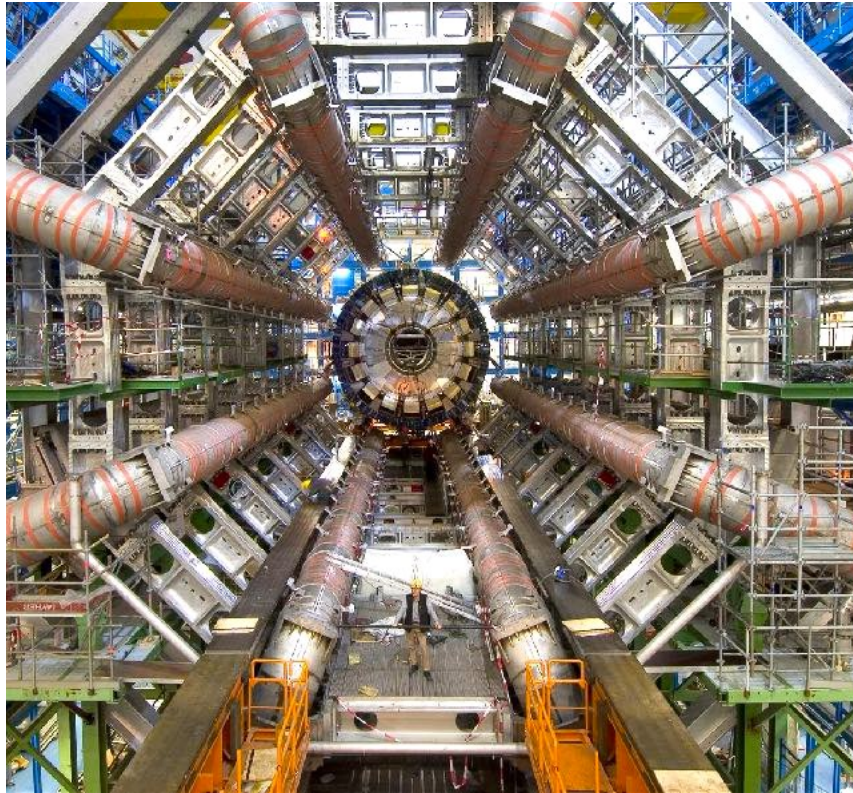
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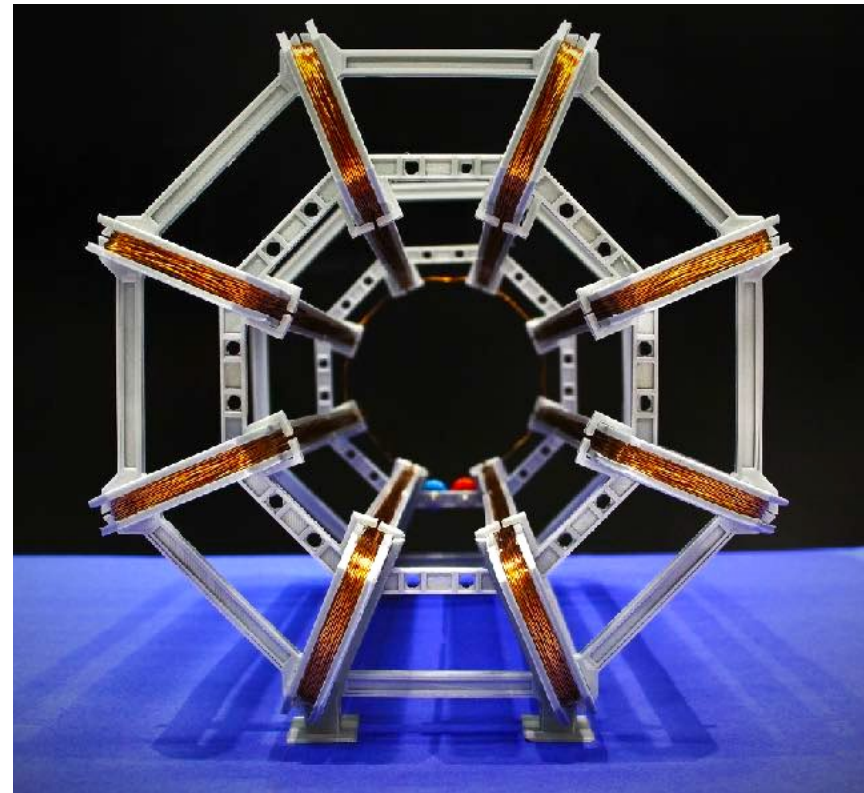
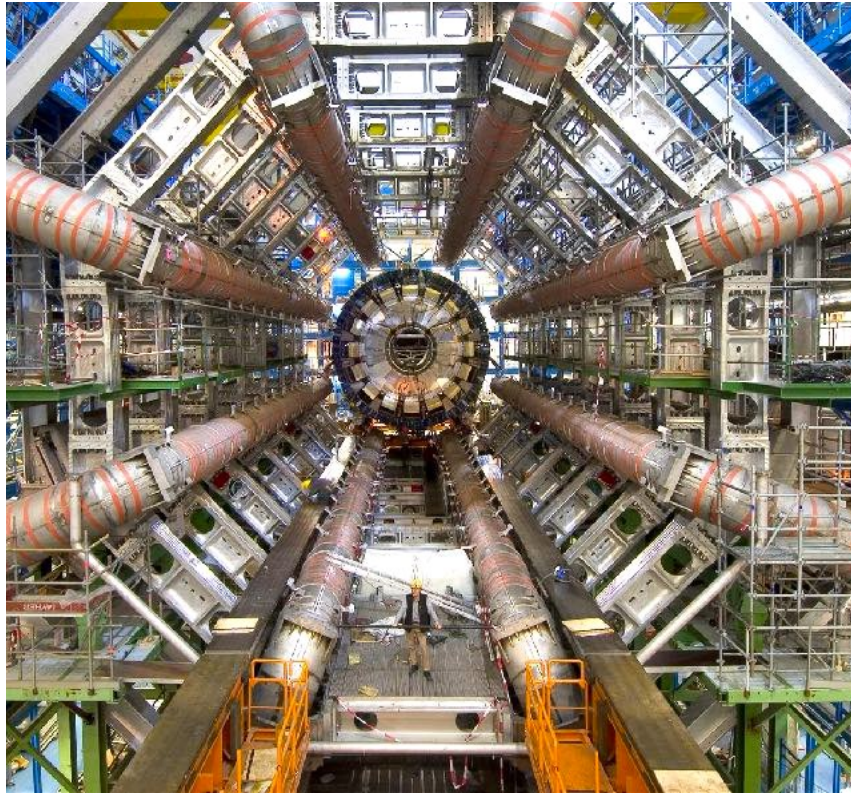
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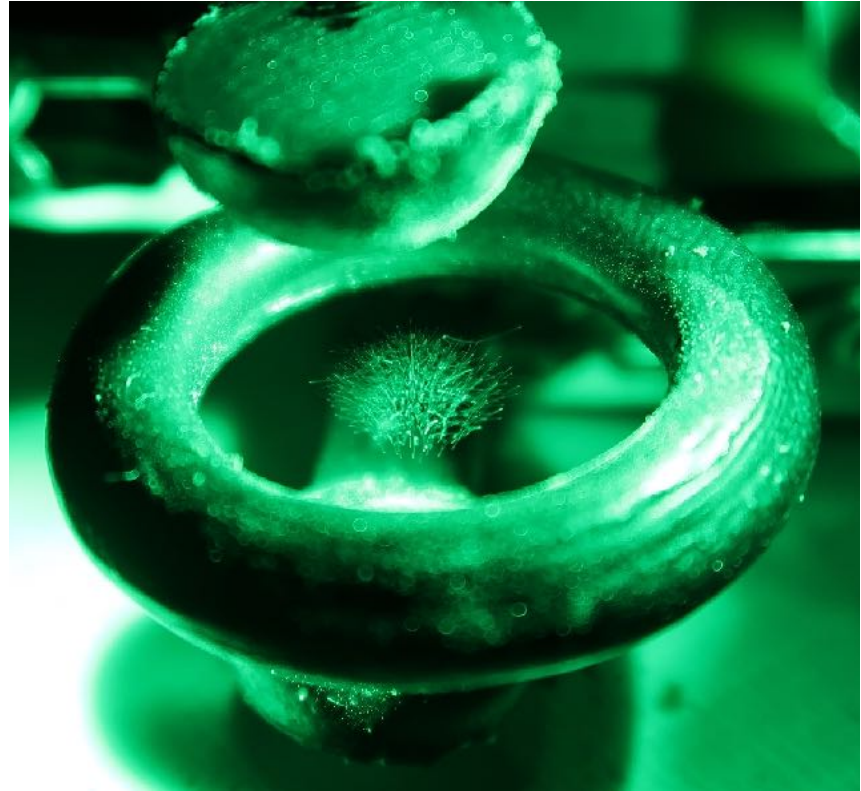


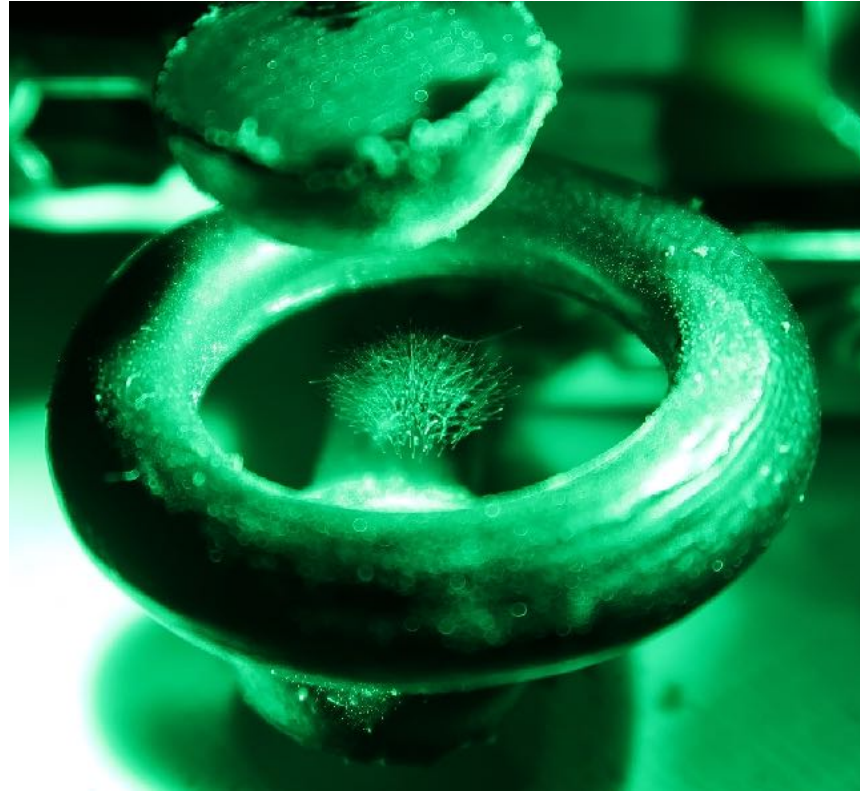




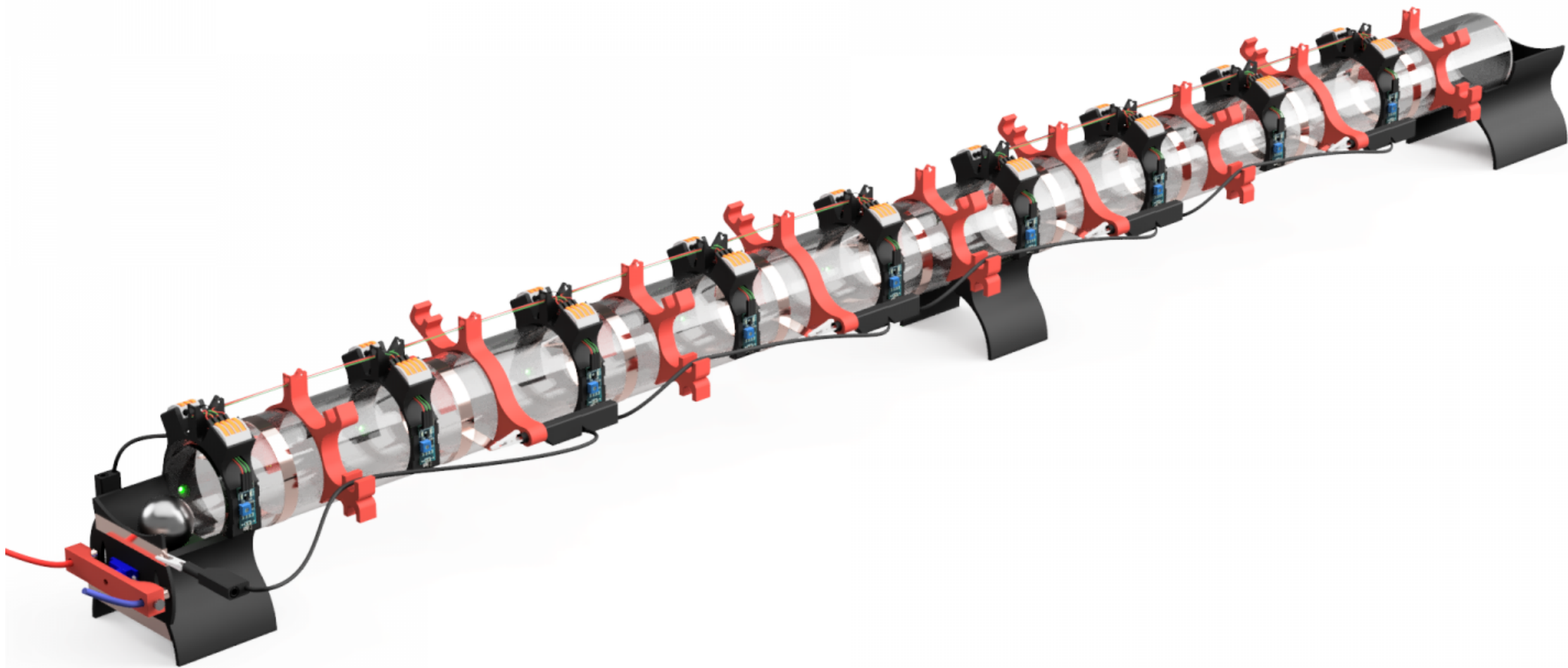
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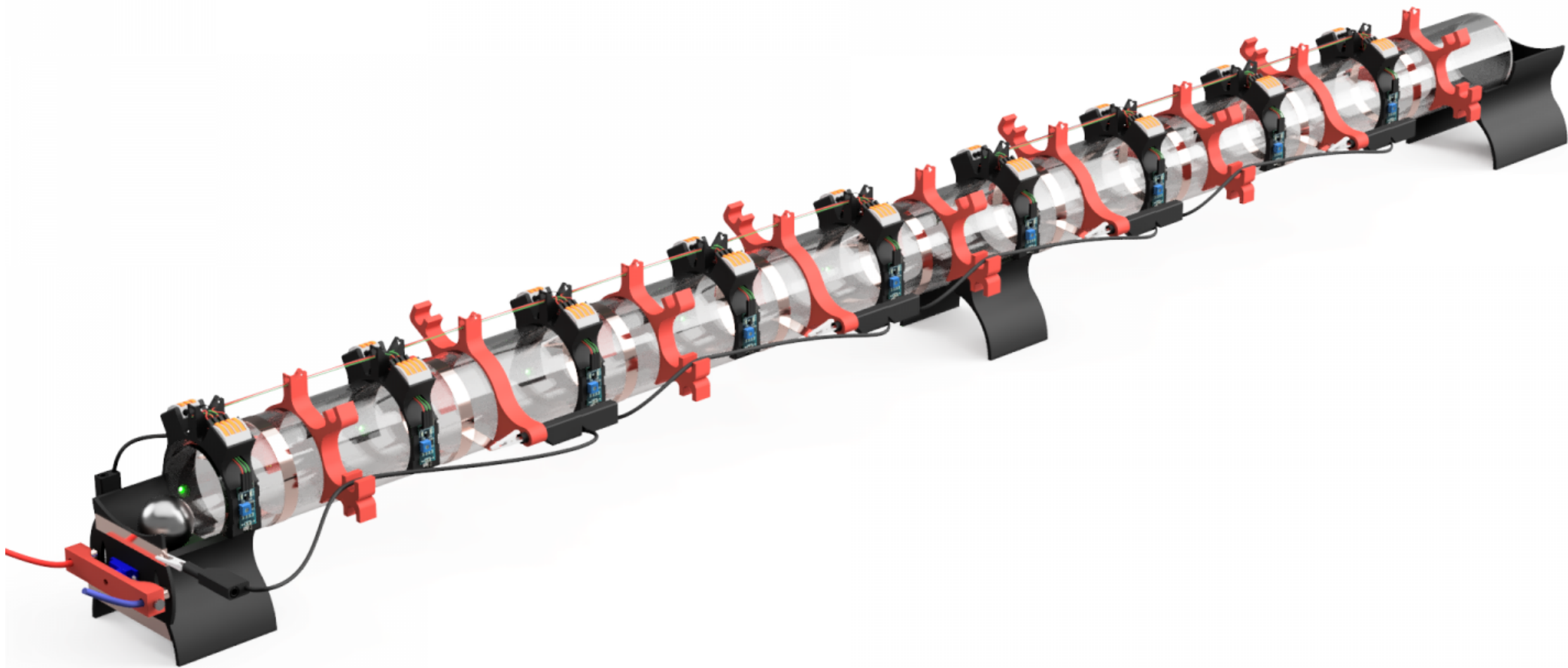






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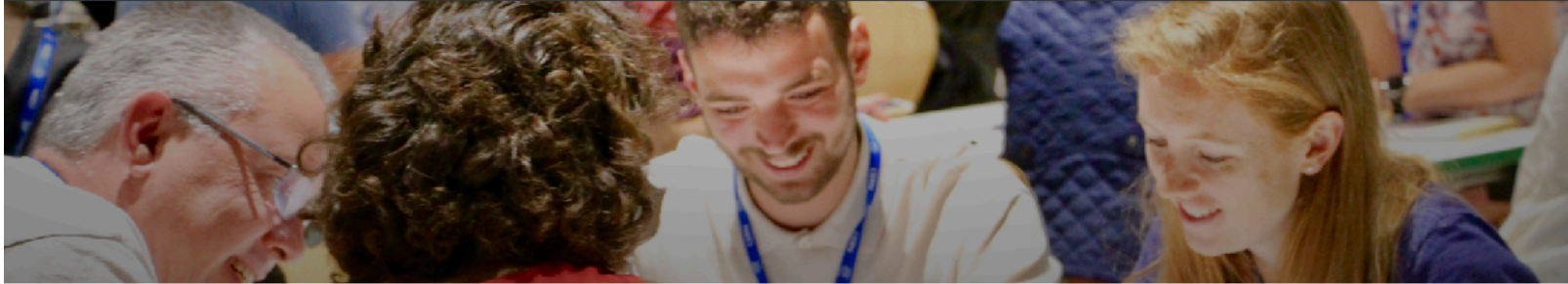
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“There is nothing more enriching and gratifying than learning.”

[Fabrizio Gianotti, CERN Director-General]

Every year, CLRN offers various professional development programmes for teachers to keep up-to-date with the latest developments in particle physics and related areas, and experience a dynamic, international research environment. All programmes are facilitated by experts in the field of physics, engineering, and computing and include an extensive lecture and visit itinerary.

Furthermore, CERN's teacher programmes enable you to meet with teaching colleagues from your country or from all around the world. We offer teacher programmes in either English or in one of the national languages of CERN Member States, lasting between 3 days and 2 weeks.



teachers.cern

International Teacher Programmes 2024

International High School Teacher Programme
30 June - 13 July 2024

International Teacher Weeks Programme
4 - 17 August 2024



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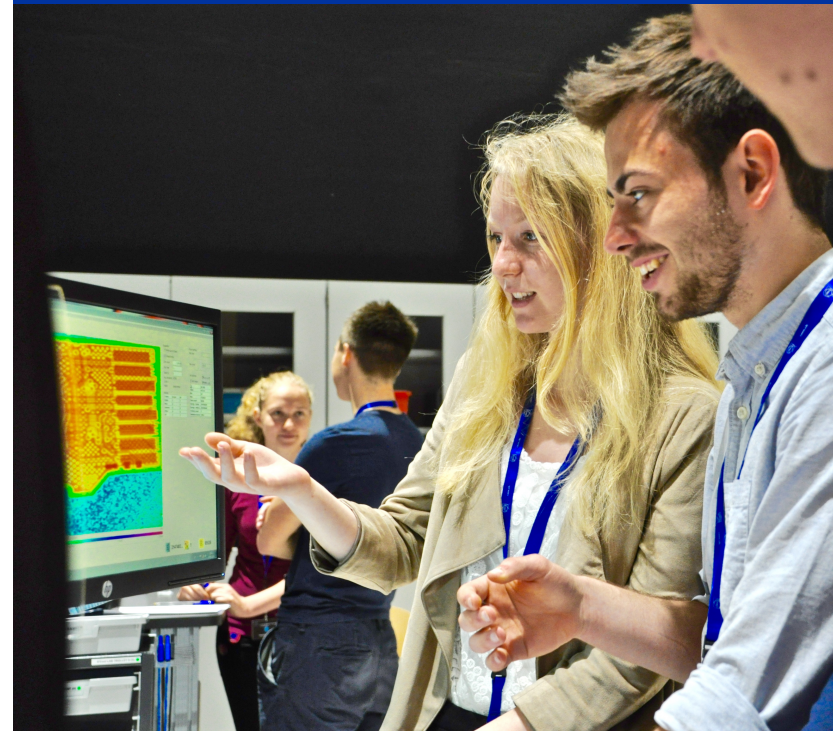
The application process for HST2024 & ITW2024 will be open until 14 January 2024! [teachers.cern](https://www.teachers.cern)

For your students



Beamline 4 Schools

CERN-Solvay Education Programme



Science Gateway

See you soon!

Questions?



cern.ch/jeff.wiener