

Education Resources

Bulgarian Engineering and IT Teacher Programme 2019



Virtual Visits

Virtual Visits

The ATLAS Experiment at CERN is one of the largest most complex scientific instruments ever constructed. It is designed to explore the inner workings, offering our understanding of the basic building blocks and fundamental forces of nature.

Five thousand physicists from about 160 institutions in 38 countries around the world participate in ATLAS. When the LHC is in operation, up to 800 million proton collisions every second break the detector. ATLAS Virtual Visits gives the public a unique opportunity to be part of the great scientific endeavour.

Using web-based video conferencing tools, participants talk with an ATLAS physicist, receive a tour of the control room, and get answers to their questions.

Next Events

June 8

Knowledge Explorers - Brazil

ATLAS Experiment
Discover one of the world's greatest scientific adventures

Future Events
A list of upcoming Virtual Visits

Past Events
Some recordings from past Virtual Visits

Book Your Visit
How to organise your own Virtual Visit

About ATLAS
Some images to prepare your visit.

Visit CERN
Come see the world's largest particle physics laboratory

Contacts and booking

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ATLAS ATLAS

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Compact Main Selenoid experiments at CERN's LHC

PUBLIC WEBSITE COLLABORATION WEBSITE

CERN | CMS Experiment | For Everybody | Education and Outreach | CMS Virtual Visits

CMS Virtual Visits

CMS Virtual Visit Teaser

The CMS Collaboration at CERN is a global scientific endeavour that is pushing the boundaries of fundamental research. CMS Virtual Visits offer students, teachers and the general public a unique opportunity to explore the experimental site of the CMS detector. The tours are guided by CMS scientists, who will explain the physics and technology behind the experiment and answer questions from the remote visitors.

For whom?

- School or university classes
- Exhibition visitors
- Conference participants

With scientists from around 80 countries in our collaboration, we are doing our best to provide tours in your native language.

How to participate?

Check-list for remote locations interested in participating in the virtual visit:

1. Equipment:
 - recent computer with a (preferably wired) network of minimum 1.0 Mbps

cms.web.cern.ch/content/virtual-visits

Virtual Visits

ATLAS
VIRTUAL VISITS

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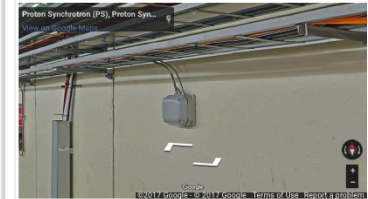
Online Visits

Virtual visitors worldwide can now explore many CERN sites directly from Google Maps via Google Street View. From the CERN Meyrin campus, which sits astride the Franco-Swiss border near Geneva, to CERN's first synchrotron: the Proton Synchrotron, users can now navigate their way around CERN directly from Google Maps.



Google Street Views are now available for many of CERN's sites above ground, including the Meyrin campus (Image: Google Street View)

CERN and Google began collaborating on this project in 2010. The first release of images was in 2013, with Google Street Views of the Large Hadron Collider tunnel as well as the underground caverns of the ALICE⁺, ATLAS⁺, CMS⁺ and LHCb⁺ experiments, accessible through a dedicated CERN part of Google Street View.



New to Google Street View the Proton Synchrotron (Image: Google Street View)

"Google Maps Street View allow[s] anyone, anywhere in the world to take a peek into [CERN's] laboratories, control centers and its myriad underground tunnels housing cutting-edge experiments" said Pascale Millie, an operations lead at Google.

The new above-ground images, integrated into Google Maps, enable people to navigate the streets of CERN's Meyrin site, named after prominent physicists, view the different points⁺ around the 27-km Large Hadron Collider and peer inside the control rooms of the experiments⁺ and the CERN Control Centre⁺, as well as the CERN Data Centre⁺, which was the focus of an online scavenger hunt in 2015.

visit.cern/tours/online-visits

Open Data

Open Data

The screenshot shows the homepage of the CERN Open Data portal. At the top left is the 'opendata' logo, and at the top right are navigation links for 'ABOUT', 'SEARCH', 'EDUCATION', and 'RESEARCH'. The main content area features a central network diagram with a central node and numerous lines radiating outwards to smaller nodes. Several nodes are highlighted with colored circles: a red circle with the Greek letter μ , a blue circle with τ , a green circle with 'e', a yellow circle with 'q', and a grey circle with γ . A diagonal teal line runs from the top right towards the center. On the left side, there is an 'Education' section with the text 'Visualise events, check reconstructed data, run tools or build your own!' and a 'Start learning' button. On the right side, there is a 'Research' section with the text 'Get the genuine working environments, virtual machines and datasets to start your research' and a 'Start analysing' button.

opendata.cern.ch

Open Data

opendata

ABOUT SEARCH EDUCATION RESEARCH

Education

Visualise events, check reconstructed data, run tools or build your own!

Start learning

Research

Get the genuine working environments, virtual machines and datasets to start your research

Start analysing

opendata.cern.ch

IPPOG
International Particle Physics Outreach Group

INTERNATIONAL MASTERCLASSES

hands on particle physics

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In the Media
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International Masterclasses

13th International Masterclasses 2017

Each year more than 13 000 high school students in 52 countries come to one of about 200 nearby universities or research centres for one day in order to unravel the mysteries of particle physics. Lectures from active scientists give insight in topics and methods of basic research at the fundamentals of matter and forces, enabling the students to perform measurements on real data from particle physics experiments themselves. At the end of each day, like in an international research collaboration, the participants join in a video conference for discussion and combination of their results. See [if](#) here for media coverage.

International Masterclasses 2017 will take place from 1.3. - 11.4.2017.

Discover the world of Quarks and Leptons with real data

International Masterclasses

- get out of school for one day and come to a nearby university or research centre
- get insight into topics and methods of basic research at the fundamentals of matter and forces
- perform measurements on real data from particle physics experiments at CERN
- participate in an international video conference for discussion of results

International Masterclasses

provide an opportunity for 15- to 19-year old students to discover particle physics

- take place in more than 200 cities in 52 countries with more than 13 000 participants worldwide
- are organized every year in March
- are organized at TU Dresden in the framework of the International Particle Physics Outreach Group (IPPOG)

This program is organized at [TU Dresden](#) and at [QuarkNet Trento Centre](#) in the framework of the International Particle Physics Outreach Group [IPPOG](#). The video linkup between the institutes is realized with valuable topical support from the [if](#) video support at CERN IT and at [if](#) Fermilab IT. We gratefully acknowledge financial support from [if](#) CERN, [if](#) EIC High-Energy and Particle Physics Division of the European Physical Society, and from [if](#) TU Dresden and from the [if](#) US National Science Foundation and the [if](#) US Department of Energy. An offline version of this website is available as DVD from the organizers.

TECHNISCHE UNIVERSITÄT DRESDEN [QuarkNet](#) [Vidyo](#) [if](#) [if](#) [if](#) [if](#) [if](#) [if](#) [if](#)

physicsmasterclasses.org

Online Resources

Online Resources

International Particle Physics Outreach Group

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Resources

Learning Topics

- Physics
- Astronomy
- International Collaboration
- Broader Impacts

Search by

Learning Topic

Audience

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Duration

Language

Key Words

Resources in your language

English French German Italian Portuguese Spanish

Filter by audience

6 to 9 years

9 to 12 years

13 to 15 years

16 to 18 years

18 to 25 years

25 years

Science Educator / Science Explainer

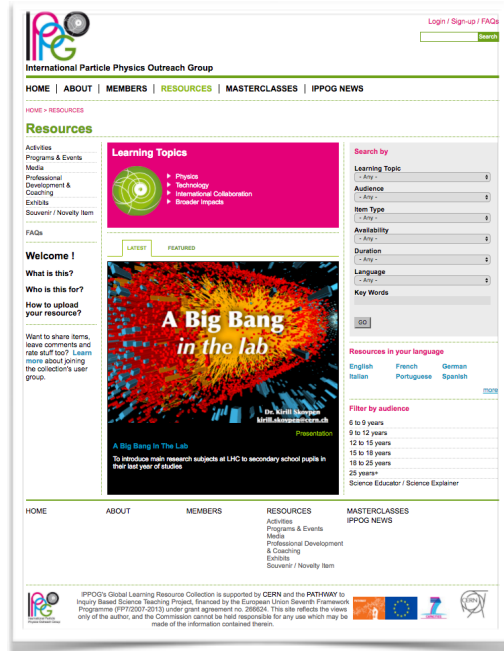
A Big Bang in the Lab

20 teachers made research subjects at LHC to secondary school pupils in their last year of studies

IPPOG's Global Learning Resource Collection is supported by CERN and the PATHWAY to Inquiry Based Science Teaching Project, financed by the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 266624. This site reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

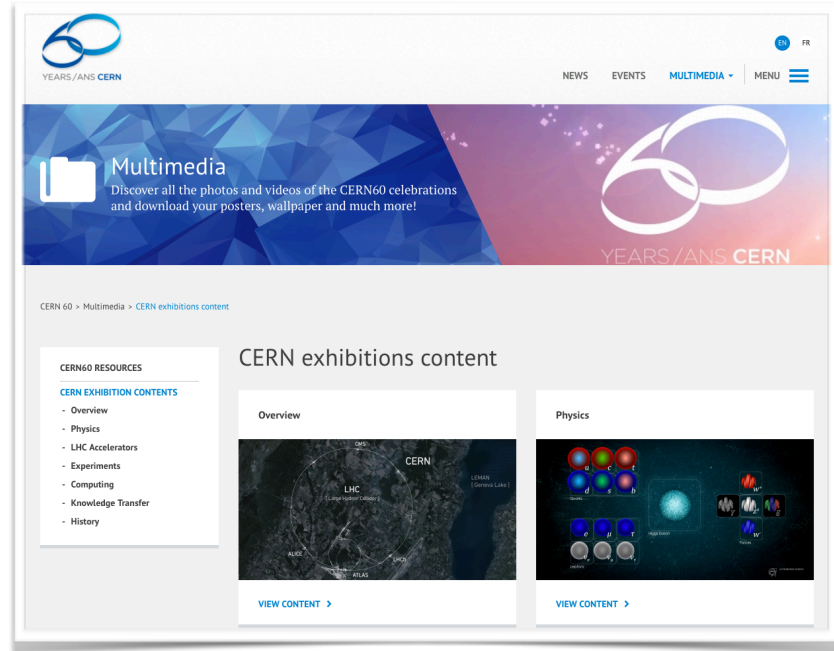
ippog.org/resources

Online Resources



The screenshot shows the IPPOG Resources page. At the top, there is a navigation bar with 'HOME | ABOUT | MEMBERS | RESOURCES | MASTERCLASSES | IPPOG NEWS'. Below this, the 'Resources' section is highlighted. On the left, there are links for 'Activities', 'Programs & Events', 'Media', 'Professional Development & Coaching', 'Exhibits', and 'Souvenir / Novelty Item'. The main content area features a 'Learning Topics' section with a green circular icon and a list of topics: 'Physics', 'Technology', 'International Collaboration', and 'Broader Impacts'. Below this is a 'Search by' section with filters for 'Learning Topic', 'Audience', 'Item Type', 'Availability', 'Duration', 'Language', and 'Key Words'. A featured resource titled 'A Big Bang in the Lab' is prominently displayed with a colorful abstract image. The bottom of the page includes a footer with the IPPOG logo and a statement of support from CERN and the PATHWAY to Inquiry Based Science Teaching Project.

ippog.org/resources



The screenshot shows the CERN60 Multimedia page. At the top, there is a navigation bar with 'NEWS | EVENTS | MULTIMEDIA | MENU'. Below this, the 'Multimedia' section is highlighted with a blue and purple background. The main content area features a large banner with the text 'Discover all the photos and videos of the CERN60 celebrations and download your posters, wallpaper and much more!'. Below the banner, there is a search bar and a list of 'CERN60 RESOURCES'. The 'CERN EXHIBITION CONTENTS' section is highlighted, and the 'Overview' and 'Physics' sections are visible. The 'Overview' section features a large image of the LHC and ATLAS detectors. The 'Physics' section features a large image of particle tracks. The bottom of the page includes a footer with the CERN logo and a statement of support from the European Union.

cern60.web.cern.ch/en/cern-exhibitions-content

Preselected Resources

Preselected Resources

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Phys. Educ. 51 (2016) 035001 (7pp) iopscience.org/ped

Introducing the LHC in the classroom: an overview of education resources available

Gerfried J Wiener^{1,2}, Julia Woithe^{1,3}, Alexander Brown^{1,4} and Konrad Jende^{1,5}

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⁴ Institut Universitaire pour la Formation des Enseignants, University of Geneva, Switzerland
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Abstract
In the context of the recent re-start of CERN's Large Hadron Collider (LHC) and the challenge presented by unidentified falling objects (UFOs), we seek to facilitate the introduction of high energy physics in the classroom. Therefore, this paper provides an overview of the LHC and its operation, highlighting existing education resources, and linking principal components of the LHC to topics in physics curricula.

Introduction
Early in 2015, CERN's Large Hadron Collider (LHC) was awoken from its first long shutdown to be re-ramped for Run 2 at unprecedented beam energy and intensity. Intense scrutiny was required to verify the full and proper functioning of all systems. This included a special run of the machine to ensure a well-scrubbed LHC [1]. However, due to the increased beam currents, a critical but familiar issue reared its head during the run. Interactions between the beams and unidentified falling objects—so called UFOs—led to several premature protective beam dumps (see figure 1). These infamous UFOs are presumed to be micrometre-sized dust particles and can cause fast, localised beam losses with a duration on the order of 10 turns of the beam. This is a known issue of the LHC which has been observed before. Indeed, between 2010 and 2011, about a dozen beam dumps occurred due to UFOs and more than 10000 candidate UFO events below the dump threshold were detected [2]. Thus, UFOs presented more of an annoyance than a danger to the LHC, by reducing the operational efficiency of the machine. However, as beam currents increase, so does the likelihood of UFO-induced magnet quenches at high energy, creating a possible hazard to the machine. Therefore, particular care is taken to keep an eye on the timing and frequency of UFO occurrences. As the number of UFOs during Run 1 decreased over time, it is hoped that this will be the same in Run 2. The recent re-start of the LHC at higher collision energies and rates presents high school

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Phys. Educ. 52 (2017) 034001 (9pp)
[spscience.org/pd](https://doi.org/10.1088/0031-9120/52/3/034001)

PAPER

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

¹ CERN, European Organization for Nuclear Research, Geneva, Switzerland
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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, photons, 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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PAPERS

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PAPER

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Introducing 12 year-olds to elementary particles

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Abstract

We present a new learning unit, which introduces 12 year-olds to the subatomic structure of matter. The learning unit was iteratively developed as a design-based research project using the technique of probing acceptance. We give a brief overview of the unit's final version, discuss its key ideas and main concepts, and conclude by highlighting the main implications of our research, which we consider to be most promising for use in the physics classroom.

1. Introduction

Integrating modern physics into the curriculum is a question that has recently received ever increasing attention. This is especially true since in most countries the topic of modern physics is usually added at the end of physics education—if at all [1]. However, since these chapters—and here especially the Standard Model of particle physics—are considered to be the fundamental basics of physics, this situation might hinder the development of coherent knowledge structures in the physics classroom. Hence, one is faced with the question of whether it makes sense to introduce elementary particle physics early in physics education. Therefore, to investigate this research question, we have developed a learning unit, which aims to introduce 12 year-olds to elementary particles and fundamental interactions [2].

The learning unit consists of two consecutive chapters. It starts with an accurate description of the subatomic structure of matter by showcasing (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

an atomic model from electrons to quarks. This first chapter is followed by the introduction of fundamental interactions, which on the one hand complete the discussion of the atomic model, and on the other hand set up possible links to other physics phenomena. An integral component of the learning unit is its independence from the physics curriculum and students' prior knowledge about particle physics. Indeed, since every physics process can be traced back to fundamental interactions between elementary particles, the use of the learning unit is not restricted to a certain age group. Ideally, it can even be used at the beginning of physics education to enable an early introduction of key terms and principal concepts of particle physics in the classroom.

Following the framework of constructivism [3], the initial version of the learning unit was based on documented students' conceptions. Taking these into account enabled us to avoid potential difficulties for students, which might occur due to inadequate information input. As a next step, the initial version was developed by means of a design-based research [4] project with frequent adaptations of the learning unit. Here, we used the technique of probing acceptance [5] to conduct one-on-one interviews with 12 year-olds

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@ CERN

S'Cool LAB

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Welcome to S'Cool LAB

What is S'Cool LAB?

S'Cool LAB is a new **Physics Education Research** facility at CERN, the European Organization for Nuclear Research in Geneva, Switzerland. High school students and their teachers are invited to contribute to our research projects by taking part in hands-on & minds-on particle physics experiments on-site at CERN. Participating in S'Cool LAB research enables teachers to give their students a glimpse of life and work in a world-leading international research institute. By getting hands-on with physics in S'Cool LAB, students can make discoveries independently, learn to work scientifically and apply their knowledge in a new setting. Students also have the chance to engage directly with members of CERN's scientific community.

high school students

hands-on & minds-on

Physics Education Research

particle physics experiments

high school teachers

Our research interests include students' conceptions in particle physics, the impact of out-of-school learning on students' motivation, the use of online learning for preparing field trips, teachers' motivations for field trips, and low-cost experiments for classrooms. Details of our research findings to date are available on our [publications page](#).

cern.ch/scool-lab

S'Cool LAB

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Welcome to S'Cool LAB

What is S'Cool LAB?

S'Cool LAB is a new Physics Education Research facility at CERN, the European Organization for Nuclear Research in Geneva, Switzerland. High school students and their teachers are invited to contribute to our research projects by taking part in hands-on & minds-on particle physics experiments on-site at CERN. Participating in S'Cool LAB research enables teachers to give their students a glimpse of life and work in a world-leading international research institute. By getting hands-on with physics in S'Cool LAB, students can make discoveries independently, learn to work scientifically and apply their knowledge in a new setting. Students also have the chance to engage directly with members of CERN's scientific community.

high school students | hands-on & minds-on Particle physics experiments | Physics Education Research | high school teachers

Our research interests include students' conceptions in particle physics, the impact of out-of-school learning on students' motivation, the use of online learning for preparing field trips, teachers' motivations for field trips, and low-cost experiments for classrooms. Details of our research findings to date are available on our [publications page](#).

cern.ch/scool-lab

beamline for schools | A Beamline for Schools

Home | BL4S Competition | Resources | Editors

The winning and shortlisted teams of 2018 have been selected, congratulations!
The pre-registration for 2019 is open, proposal submission will open in September.

BEAMLINE FOR SCHOOLS (BL4S) is an official competition powered by CERN, the European Organization for Nuclear Research, in Geneva, Switzerland. It is open for all high-school students around the world.

The competition invites teams of high-school students to propose a scientific experiment that they want to perform. Because of the maintenance of CERN's accelerators starting at the end of 2018, the winning experiments in 2019 will be run at DESY in Hamburg, Germany, a world-leading accelerator center. The first prize for two winning teams is a trip to DESY to carry out their proposed experiments at a fully-equipped accelerator beamline. There are additional prizes for shortlisted teams and certificates for all participants. How to take part? Here's how...

Be inspired and take part in hands-on scientific experiments on-site at DESY, a world-leading research institute! Through BL4S, CERN and DESY offer a great opportunity for students to learn, make new discoveries and apply their knowledge into new settings. Get inspired by our [videos](#) and [previous winners](#) and stay tuned for news!

EDITION 2018
 The two winning teams of 2018 will come to CERN end of September to perform their proposed experiments.

PAST EDITIONS
 Would you like to be inspired by our previous winners? To discover more about the previous winners click [here](#).

NEWS
 Follow our latest news! You can also subscribe to our BL4S newsletter at the bottom of this page.

The two winning teams are coming from India and the Philippines.

Winner participants from the Beamline for schools competition in 2017.

High-school students performing their proposed experiments at CERN.

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S'Cool LAB

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high school students **Physics Education Research** hands-on & minds-on particle physics experiments high school teachers

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High School Students Internship Programme

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“There is nothing more enriching and gratifying than learning.” [Pablika Gianotti, CERN Director-General]

Are you a young and motivated high-school student? Did you ever want to know how fundamental research works? Did you ever want to get an insight into an international organization?

In a close collaboration with its member states, CERN invites high-school students (aged 16-19) to come to CERN for two weeks, to gain practical experience in science, technology, and innovation. It focuses on giving students the chance to discover STEM in the CERN context and environment, strengthening their understanding of science, and developing their skills in a high-tech environment.

This programme is a unique opportunity for high-school students to be introduced to CERN, its technologies and physics, as well as to learn through workshops and by shadowing, observing, and working with a member of personnel.

National Programmes

CONNECT WITH CERN

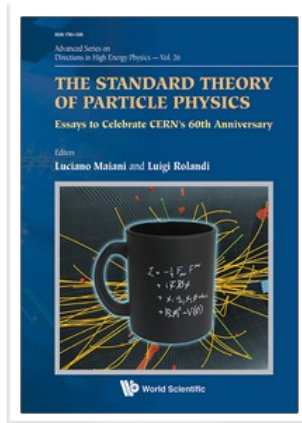
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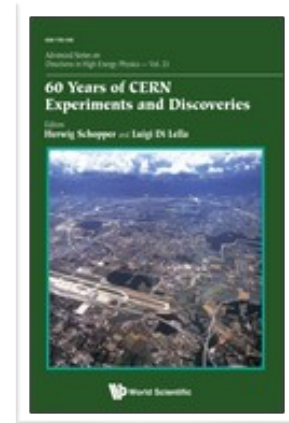
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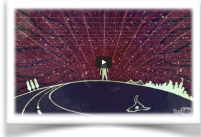
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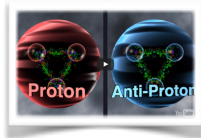
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Links

IOP Institute of Physics

Resources for the classroom
iop.org/education/teacher/resources

THE PARTICLE ADVENTURE
THE FUNDAMENTALS OF MATTER AND FORCE

The particle adventure
particleadventure.org

INTERACTIONS.ORG
PARTICLE PHYSICS NEWS AND RESOURCES

Particle physics news and resources
interactions.org

The Feynman

The Feynman lectures
feynmanlectures.info



VEGA science videos
vega.org.uk

Merci bien!

Questions?

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