

Education Resources

Finnish Teacher Programme 2018



Virtual Visits

Virtual Visits

ATLAS
LHC EXPERIMENT
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 structure, delivering our understanding of the basic building blocks and fundamental forces of nature.

Five thousand physicists from about 150 institutions in 38 countries around the world participate in ATLAS. When the LHC is in operation, up to 600 million proton collisions every second inside the detector. ATLAS Virtual Visits gives the public a unique opportunity to be part of the great scientific adventure.

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:

None!

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 Find ATLAS on

ATLAS
LHC EXPERIMENT

cern.ch/atlas-live-virtual-visit

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

cern.ch/atlas-live-virtual-visit

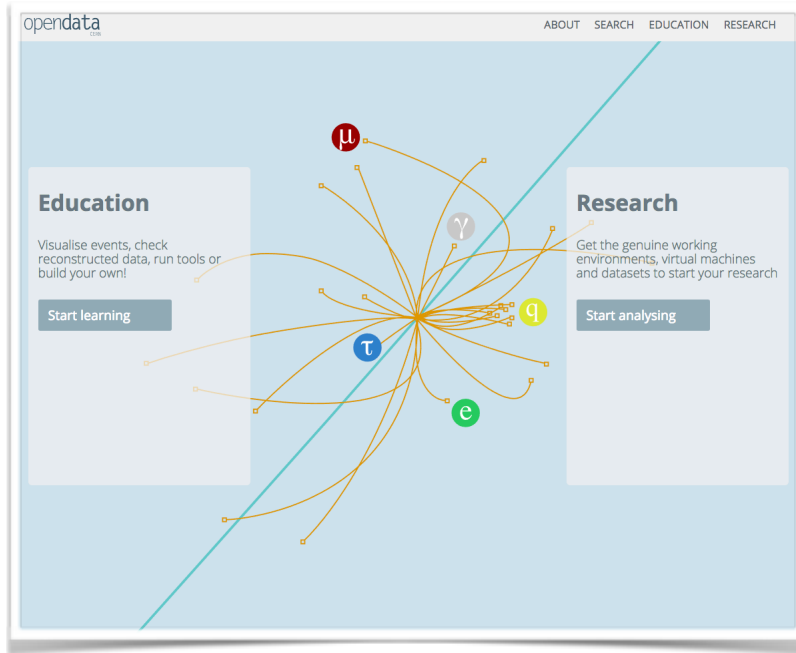
cms.web.cern.ch/content/virtual-visits

visit.cern/tours/online-visits



Open Data

Open Data



opendata.cern.ch

Open Data

opendata.cern.ch

physicsmasterclasses.org

Online Resources

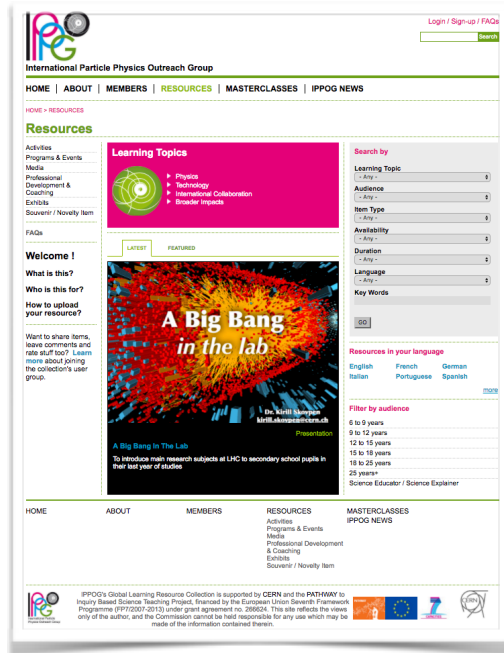
Online Resources

The screenshot shows the IPPOG website's resources page. At the top, there is a navigation bar with links for HOME, ABOUT, MEMBERS, RESOURCES, MASTERCLASSES, and IPPOG NEWS. Below this, a 'Resources' section is highlighted. On the left, there is a sidebar with a menu of categories: Activities, Programs & Events, Media, Professional Development & Coaching, Exhibits, and Souvenir / Novelty Item. The main content area features a featured resource titled 'A Big Bang in the Lab' with a vibrant, colorful abstract image. To the right of this featured item is a search and filter panel. The search panel includes dropdown menus for Learning Topic, Audience, Item Type, Availability, Duration, Language, and Key Words, along with a search button. Below the search panel, there are sections for 'Resources in your language' (listing English, French, German, Italian, Portuguese, Spanish) and 'Filter by audience' (listing age groups from 6 to 9 years to 25 years and Science Educator / Science Explainer). At the bottom of the page, there is a footer with the IPPOG logo, a paragraph of text about the Global Learning Resource Collection's funding, and several partner logos including CERN, the European Union, and others.

ippog.org/resources

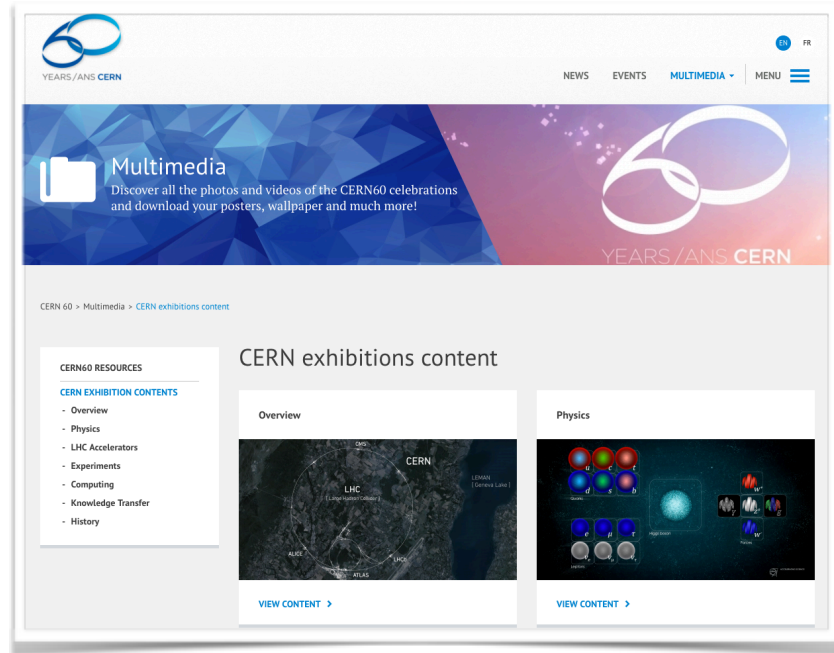


Online Resources



The screenshot shows the IPPOG Resources page. At the top, there is a navigation bar with links for HOME, ABOUT, MEMBERS, RESOURCES, MASTERCLASSES, and IPPOG NEWS. Below this, there is a 'Resources' section with a 'Learning Topics' sidebar on the left and a main content area. The main content area features a featured resource titled 'A Big Bang in the Lab' with a colorful abstract image. To the right of the main content is a search filter section with dropdown menus for Learning Topic, Audience, Item Type, Availability, Duration, Language, and Key Words. At the bottom of the page, there is a footer with the IPPOG logo and a disclaimer.

ippog.org/resources



The screenshot shows the CERN60 Multimedia page. At the top, there is a navigation bar with links for NEWS, EVENTS, MULTIMEDIA, and MENU. Below this, there is a large banner with the text 'Multimedia' and 'Discover all the photos and videos of the CERN60 celebrations and download your posters, wallpaper and much more!'. The banner features the CERN logo and the text 'YEARS / ANS CERN'. Below the banner, there is a section titled 'CERN60 RESOURCES' and 'CERN EXHIBITION CONTENTS'. The 'CERN EXHIBITION CONTENTS' section has two columns: 'Overview' and 'Physics'. The 'Overview' column has a thumbnail image of the LHC and a 'VIEW CONTENT >' link. The 'Physics' column has a thumbnail image of particle tracks and a 'VIEW CONTENT >' link.

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

Preselected Resources

Preselected Resources

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Phys. Educ. 51 (2016) 035001 (7pp) iopscience.iop.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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⁵ Institute of Nuclear and Particle Physics, TU Dresden, Germany

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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-scribed 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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PAPERS

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PAPER

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

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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 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 Higgs mechanism (the Higgs mechanism) is 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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PAPER

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PAPER

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 basis 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 the learning unit and fundamental interactions [2].

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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

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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doi.org/10.1088/1361-6552/aa6cfe



@ CERN



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The screenshot shows the homepage of the S'Cool LAB website. At the top, there is a navigation bar with a home icon and links for "S'Cool LAB Days at CERN", "S'Cool LAB Summer CAMP", "Cloud Chamber Workshops", "Resources", "Our Team", and "For CERNs". Below the navigation bar is a large header image of a modern, well-lit laboratory with several round tables and chairs. The main heading reads "Welcome to S'Cool LAB". Underneath, a section titled "What is S'Cool LAB?" provides a brief description of the facility. At the bottom, a diagram illustrates the relationship between "high school students" and "high school teachers" through "Physics Education Research" and "particle physics experiments", with "hands-on & minds-on" activities connecting them.

S'Cool LAB

Home | S'Cool LAB Days at CERN | S'Cool LAB Summer CAMP | Cloud Chamber Workshops | Resources | Our Team | For CERNs

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

@ CERN

S'Cool LAB

Home S'Cool LAB Days at CERN S'Cool LAB Summer CAMP Cloud Chamber Workshops Resources Our Team For CERNs

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

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cern.ch/scool-lab

Beamline for Schools

The competition Everything about BL4S 2018 Resources Prizes Editions Winners Supporters

Everything about BL4S 2018

Beamline for Schools Competition 2018 will be soon announced!

Everything about it can be found in the pages below:

Find out more about the competition in [your language!](#)

[Terms & Conditions](#)
[Useful Documents](#)
[Contacts](#)
[Prizes](#)
[FAQs](#)
[How to apply](#) *Pre-registration will start soon. Stay tuned!

**Some of the useful documents on this website are not yet up to date. We will update them as soon as possible.*

[Home](#)

cern.ch/BL4S

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cern.ch/scool-lab

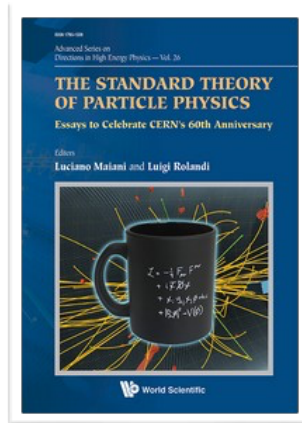
The screenshot shows the homepage of the Beamline for Schools website. The header features the 'beamline' logo and the title 'A Beamline for Schools'. Below the header is a navigation bar with links: The competition, Everything about BL4S 2018, Resources, Prizes, Editions, Winners, and Supporters. The main heading is 'Everything about BL4S 2018'. Below this, there is a section titled 'Beamline for Schools Competition 2018 will be soon announced!' with a paragraph of text. At the bottom, there is a 'Home' link.

cern.ch/BL4S

The screenshot shows the homepage of the High School Students Internship Programme website. The header features the title 'High School Students Internship Programme' and a navigation bar with links: National Programme, FAQ, and Contact. The main heading is '“There is nothing more enriching and gratifying than learning.”' with a quote by 'Pabloa Gianotti, CERN Director-General'. Below this, there is a section titled '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?' with a paragraph of text. At the bottom, there is a 'Home' link.

cern.ch/hssp

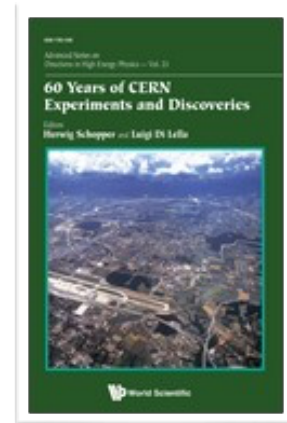
Books



dx.doi.org/10.1142/9878



dx.doi.org/10.1142/9921



dx.doi.org/10.1142/9441

TEDeD



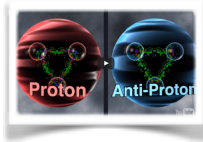
ed.ted.com/lessons/the-beginning-of-the-universe-for-beginners-tom-whyntie



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ed.ted.com/lessons/dark-matter-the-matter-we-can-t-see-james-gillies



ed.ted.com/lessons/what-happened-to-antimatter-rolf-landua



ed.ted.com/lessons/the-basics-of-boson-dave-barney-and-steve-goldfarb

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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