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OUTREACH, EDUCATION AND EDI

KATE SHAW
UNIVERSITY OF SUSSEX

European Physical Society Conference on High Energy Physics, Marseille, France, July 2025

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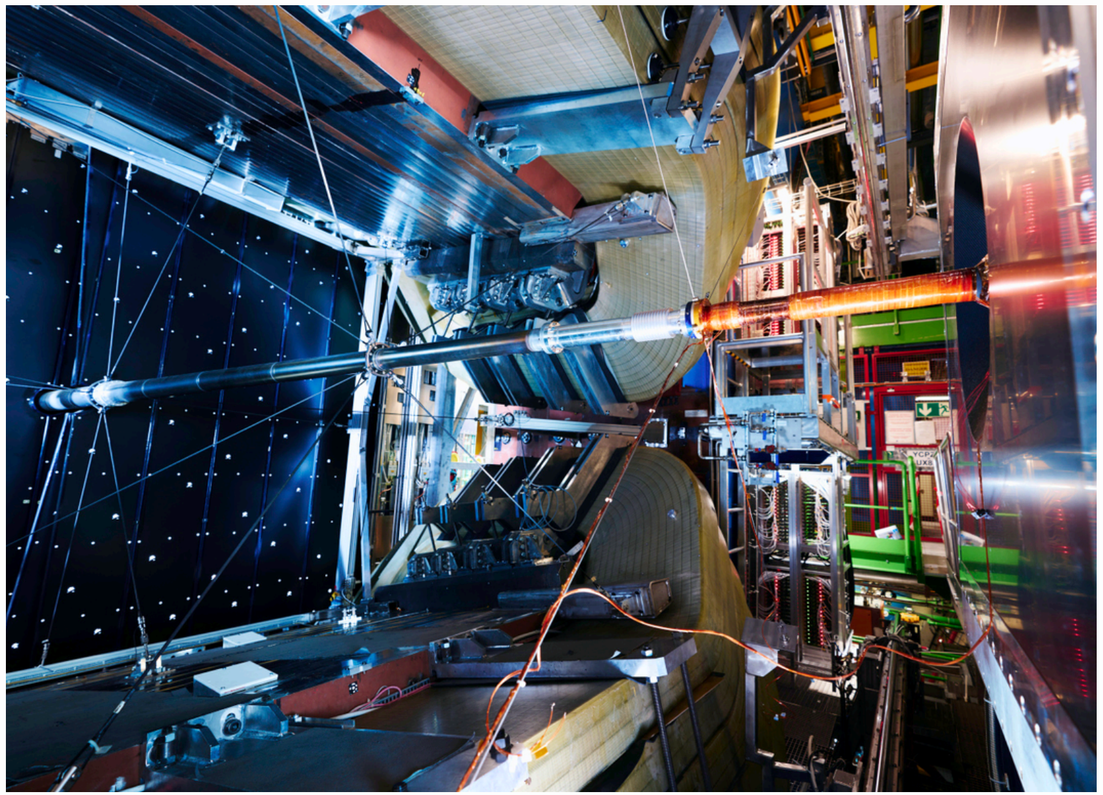
Diversity and Outreach in High Energy Physics



High Energy Physics is inherently **international**, and our community understands that to get the **best talent** we need to encourage diversity, equity and inclusion!

To achieve our ambitious goals in HEP we need **international support** and funding.

As scientists we know its our responsibility to reach out to the public, students and policy makers to **communicate** what we do and why!

EDI: Very important for our community

Equity: Treating people of all identities and backgrounds fairly and respectfully with regard to opportunities, access, treatment, power, outcomes, and resources.

Diversity: Embracing differences, which may include ethnicity, gender identity or expression, family status, disability status, sexual orientation, age, and socioeconomic situation.

Inclusion: Intentionally creating welcoming and respectful environments and systems in which inequities in power and privilege are addressed and everyone is given an opportunity to flourish.

CERN EDI

"Diversity is an asset of humanity, it's our richness, and we have to use it in the best possible way."
diversity-and-inclusion.web.cern.ch
– Fabiola Gianotti, Director-General

Appreciating differences

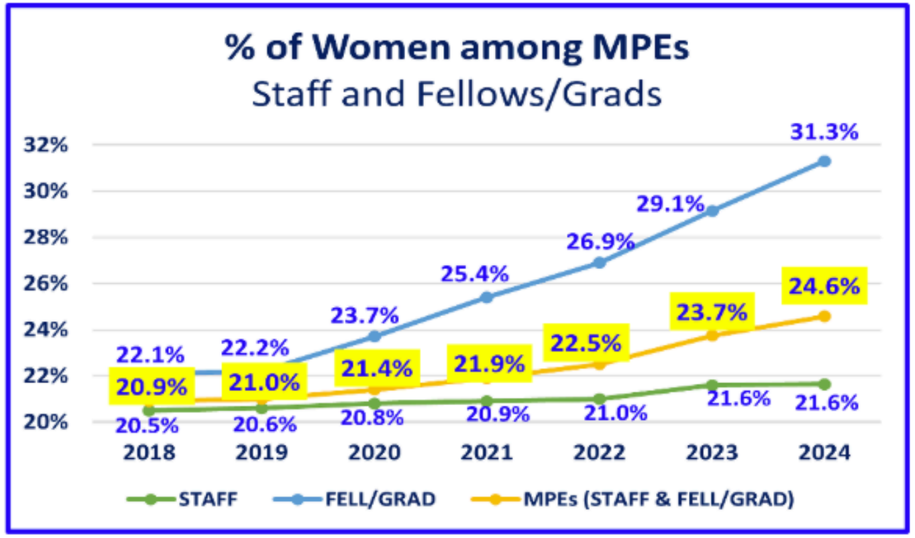
Leveraging the added value that comes from bringing together people of different nationalities, genders, professions, ages, as well as their individual differences, and enabling them all to contribute to their full potential.

Fostering equality

Optimising talent and performance through a leadership culture that focuses on fair treatment and rules out all forms of discrimination and bias.

Promoting collaboration

Creating an inclusive work environment based on mutual respect and exchange, in order to ensure that no one is isolated and that everyone feels encouraged to contribute and participate actively in the Organization.



= **0.4%** from target!

Mark Thomson, CERNs next Director General

“I am really passionate about the importance of diversity in all its forms and this includes national and regional inclusivity.”

“It is an agenda that I pursued in my last two positions. At the Deep Underground Neutrino Experiment, I was really keen to engage the scientific community from Latin America, and I believe this has been mutually beneficial. At STFC, we used physics as a way to provide opportunities for people across Africa to gain high-tech skills. “

DIVERSITY IS THE KEY TO SUCCESS OF PHYSICS

Monoculture can create mono approaches

A group of people with different experiences and **perspectives** brings **innovation** and creativity

If certain groups are under-represented, our **talent pool** is smaller

We see that the more diverse a group is, the more **inclusive** it becomes for everyone, and more people are attracted to a **welcoming** environment

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Is Physics Diverse?

Well.. not as much as we would like

<u>Nationally</u>

-> Many **under-represented groups** in physics (aspects such as gender, sexuality, ethnicity, social-economic background, geographical location)

->Its not enough for under-represented groups to be welcomed, they must also have a seat and a **voice** at the **table**

Is Physics Diverse?

Well.. not as much as we would like

Internationally countries in the **Global South** fare much worse (in general!!)

➜ Many students, researchers and scientists live in countries that lack educational and **training resources**, their universities lack investment

➜ Many scientists do not have any access to research / travel **funding,** or governmental support

➜ Many students and young people lack **exposure** to research, and access to research **opportunities**

➜ This costs us valuable talent and scientists!

Physics for Sustainable Development

Physics **outreach** and **communication** in all countries around the world is vital to promote **scientific literacy** in the population:

School students benefit from **enquiry based learning** (observation, measurement and experimentation)

Understanding scientific discovery requires continual **readjustment** with new **facts**

Democracy relies on a scientific literate population

Physics Training & Outreach

We must reach out to students and researchers across the **world**

→ Seek out & provide **study** (MSc/PhD) or training **opportunities**

→ **Provide funding** for students/scientists to come to your **conference or workshop** (or/and provide free online access)

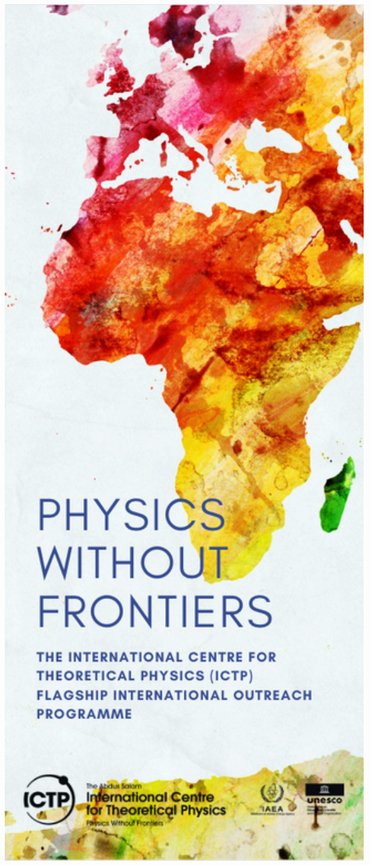
→ Build cooperation and **networks** with new collaborators

→ Go to conferences in **underrepresented** regions

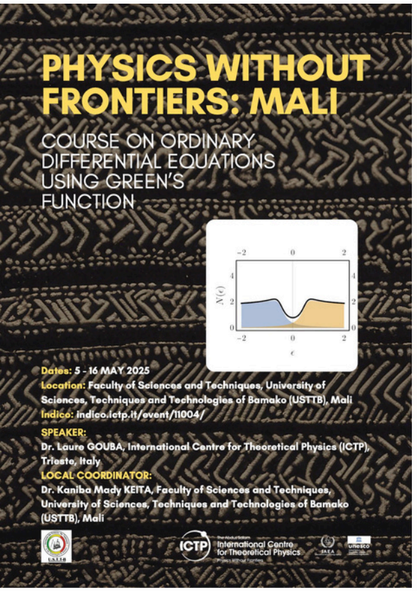
Physics Without Frontiers ictp.it/home/physics-without-frontiers	**AIMS** nexteinstein.org	**African School of Physics** africanschoolofphysics.org/	**Scholar Rescue Fund** scholarrescuefund.org/

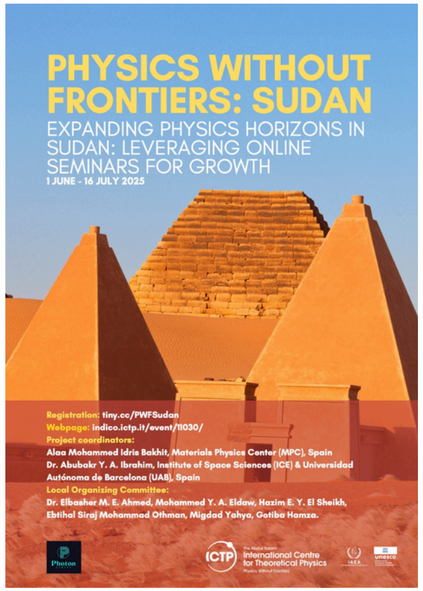
ICTP Physics Without Frontiers @ictpPWF

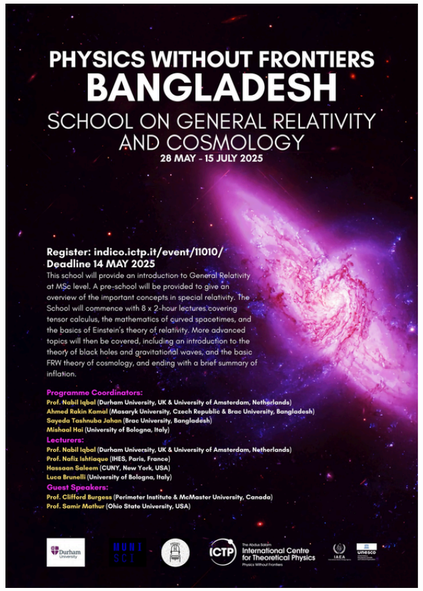
We run around 25 PWF projects around the world every year, in all areas of physics with some focus on least developed countries and conflict regions

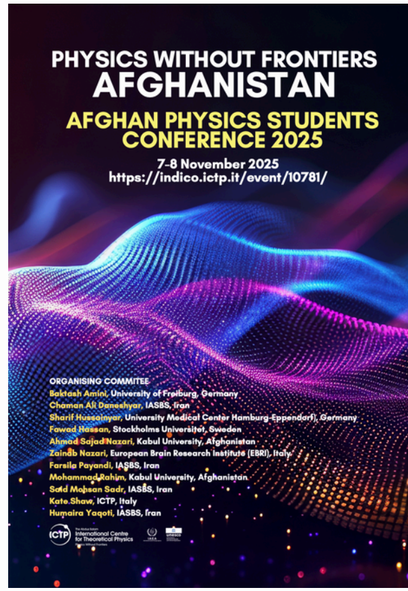


ICTP Physics Without Frontiers @ictpPWF









We work to bring physics to each corner of the Globe, with focus on:

- **Economic** Frontiers: Low income & science & technology lagging countries
- **Social** Frontiers: Women and Girls, cultural frontiers
- **Geographical** Frontiers: Rural and remote areas
- **Sociopolitical** Frontiers: under represented ethnicities and conflict regions or political turmoil

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European Strategy for Particle Physics

Talk from the Open Symposium on the European Strategy for Particle Physics

General guiding principles

Outreach and Communication

- Strengthen public trust in science through outreach that fosters critical thinking, counters misinformation, and inspires future scientists.
- Shift science communication from scientific discoveries to research processes, personal stories, and the value of international collaboration and DEI.
- Expand outreach to diverse and underrepresented audiences to boost interest in STEM. Use social media to ensure a broad reach.
- Communicate effectively and transparently to build public and political support for the next European flagship project.

Training and Education

- Strengthen training in instrumentation (and thereby support a timely execution of the ESPP).
- Establish closer ties with industry.
- Integrate modern physics into school curricula.

Open Science

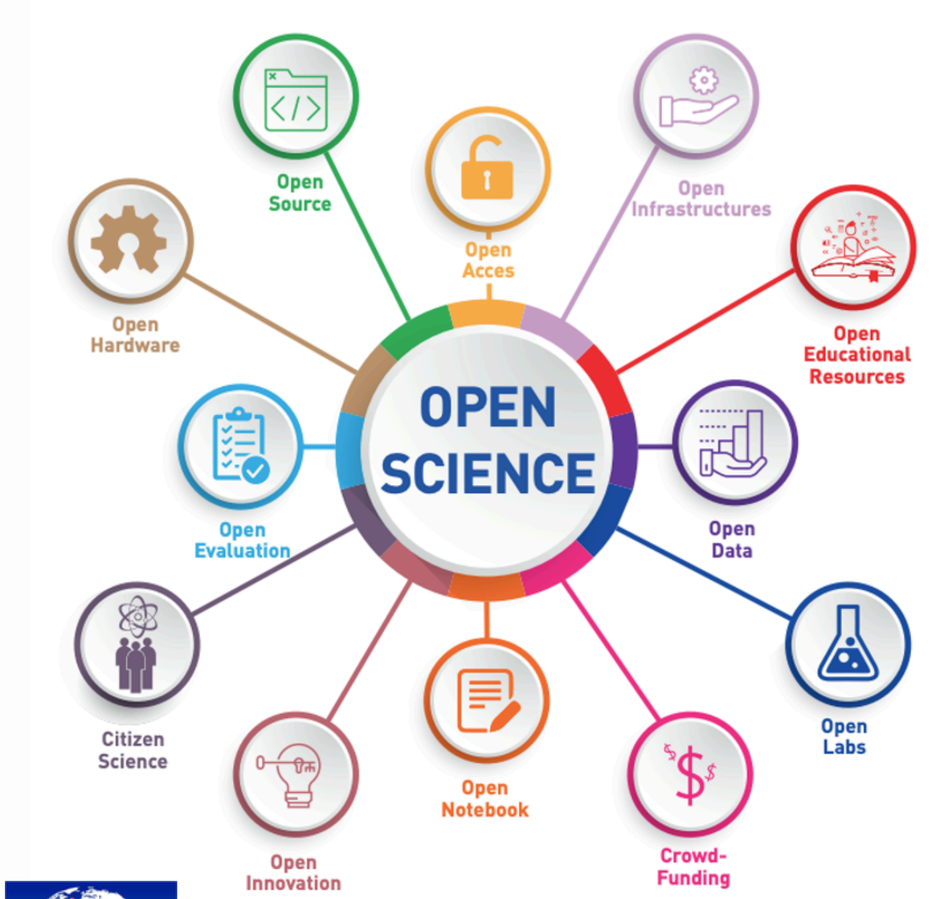
- Promote Open Access to scientific knowledge.
- Encourage the use of Open Data in education, outreach, and citizen science.

WG6 Composition

- M. Bombara (Slovakia)
- M.J. Costa (Spain)
- L. de Paula (Brazil)
- S. Özkorucuklu (Türkiye)
- M. Pimenta (Portugal)
- P. Van Mechelen* (Belgium)
- L. Zivkovic (Serbia)

* chair

Open Science Movement



[UNESCO Open Science website]

Open science is an **accelerator** for the **Sustainable Development Goals (SDGs) 2030** and a powerful tool to bridge the science divide between and within countries

Open science aims at making scientific knowledge openly **available**, **accessible** and **reusable**.

The key elements include open access to scientific publications, **data**, educational resources, software and hardware, and open infrastructures

[Open Science at CERN website]

Open Science at CERN website

CERN OPEN DATA POLICY

Level 1: Published Results

- Available with Open Access
- HEPData: Repository for publication-related HEP data
- Rivet toolkit: Robust Independent Validation of Experiment and Theory

Level 2: Outreach and Education

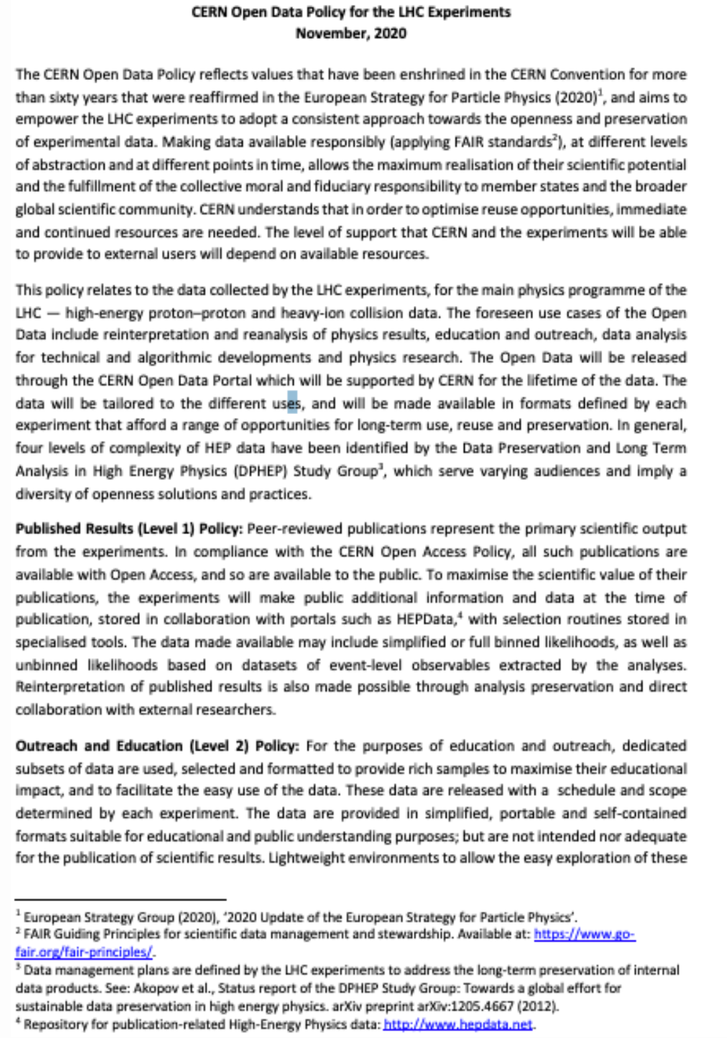
- Dedicated subsets of data selected and formatted to provide rich samples to maximise their educational impact, and to facilitate the easy use of the data.

Level 3: Reconstructed Data

- Experiments release calibrated reconstructed data useful for algorithmic, performance and physics studies

Level 4: Raw Data - Not feasible

CERN Open Data Policy for the LHC Experiments." https://cds.cern.ch/record/2745133 , November 2020



CERN Open Data Policy for the LHC Experiments
November, 2020

The CERN Open Data Policy reflects values that have been enshrined in the CERN Convention for more than sixty years that were reaffirmed in the European Strategy for Particle Physics (2020)[1], and aims to empower the LHC experiments to adopt a consistent approach towards the openness and preservation of experimental data. Making data available responsibly (applying FAIR standards[2]), at different levels of abstraction and at different points in time, allows the maximum realisation of their scientific potential and the fulfillment of the collective moral and fiduciary responsibility to member states and the broader global scientific community. CERN understands that in order to optimise reuse opportunities, immediate and continued resources are needed. The level of support that CERN and the experiments will be able to provide to external users will depend on available resources.

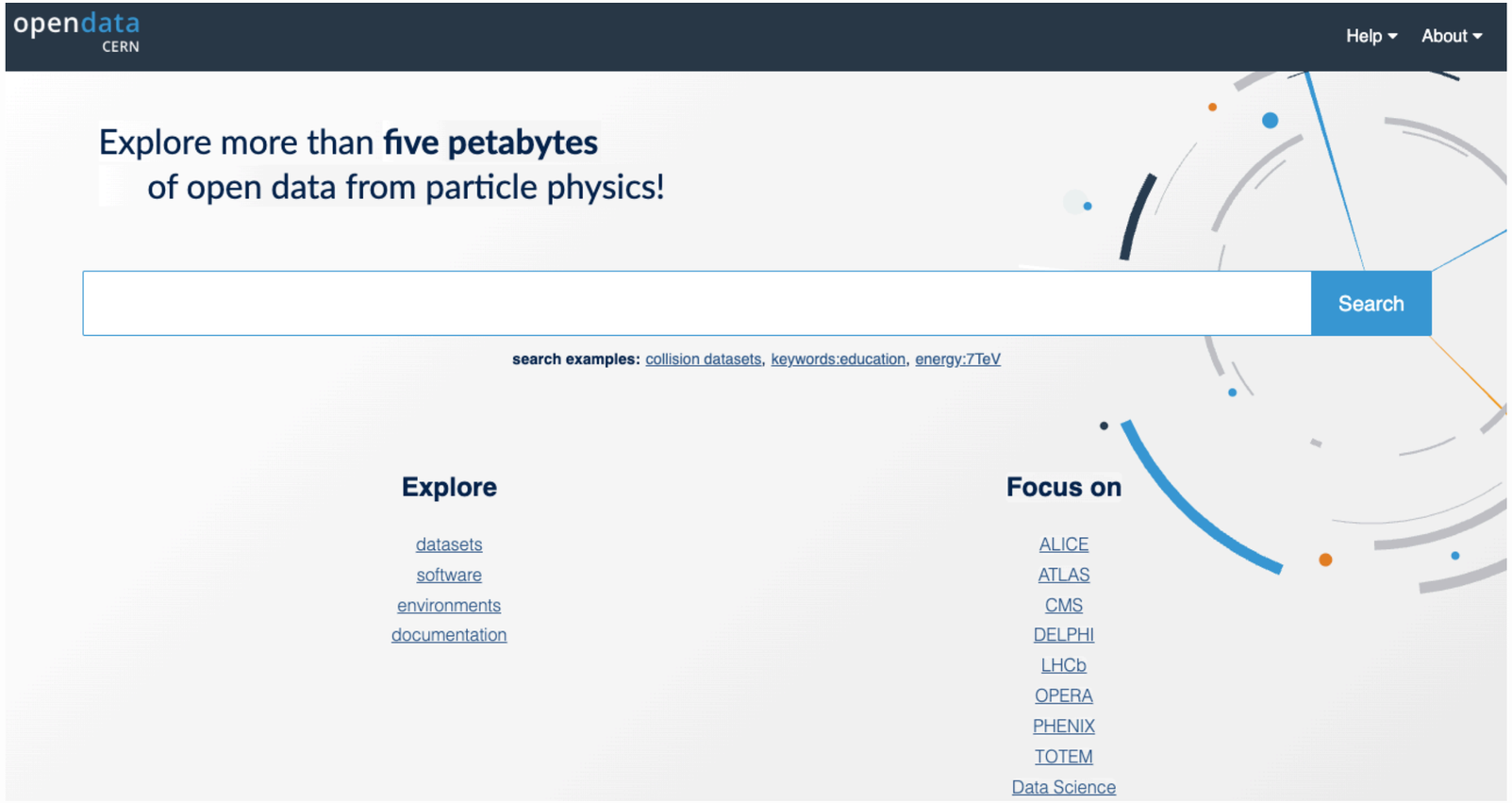
This policy relates to the data collected by the LHC experiments, for the main physics programme of the LHC — high-energy proton–proton and heavy-ion collision data. The foreseen use cases of the Open Data include reinterpretation and reanalysis of physics results, education and outreach, data analysis for technical and algorithmic developments and physics research. The Open Data will be released through the CERN Open Data Portal which will be supported by CERN for the lifetime of the data. The data will be tailored to the different uses, and will be made available in formats defined by each experiment that afford a range of opportunities for long-term use, reuse and preservation. In general, four levels of complexity of HEP data have been identified by the Data Preservation and Long Term Analysis in High Energy Physics (DPHEP) Study Group[3], which serve varying audiences and imply a diversity of openness solutions and practices.

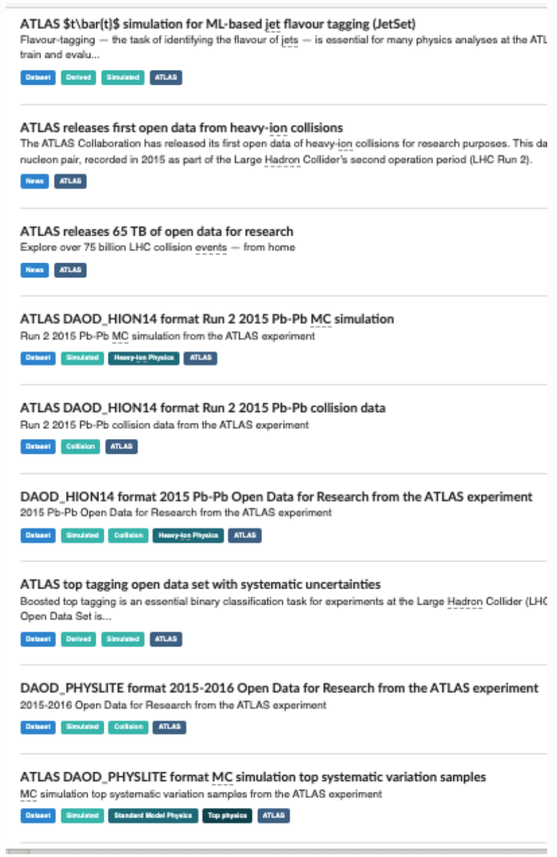
Published Results (Level 1) Policy: Peer-reviewed publications represent the primary scientific output from the experiments. In compliance with the CERN Open Access Policy, all such publications are available with Open Access, and so are available to the public. To maximise the scientific value of their publications, the experiments will make public additional information and data at the time of publication, stored in collaboration with portals such as HEPData,[4] with selection routines stored in specialised tools. The data made available may include simplified or full binned likelihoods, as well as unbinned likelihoods based on datasets of event-level observables extracted by the analyses. Reinterpretation of published results is also made possible through analysis preservation and direct collaboration with external researchers.

Outreach and Education (Level 2) Policy: For the purposes of education and outreach, dedicated subsets of data are used, selected and formatted to provide rich samples to maximise their educational impact, and to facilitate the easy use of the data. These data are released with a schedule and scope determined by each experiment. The data are provided in simplified, portable and self-contained formats suitable for educational and public understanding purposes; but are not intended nor adequate for the publication of scientific results. Lightweight environments to allow the easy exploration of these

[1] European Strategy Group (2020), '2020 Update of the European Strategy for Particle Physics'.
[2] FAIR Guiding Principles for scientific data management and stewardship. Available at: https://www.go-fair.org/fair-principles/.
[3] Data management plans are defined by the LHC experiments to address the long-term preservation of internal data products. See: Akopov et al., Status report of the DPHEP Study Group: Towards a global effort for sustainable data preservation in high energy physics. arXiv preprint arXiv:1205.4667 (2012).
[4] Repository for publication-related High-Energy Physics data: http://www.hepdata.net.

CERN OPEN DATA PORTAL





https://opendata.cern.ch

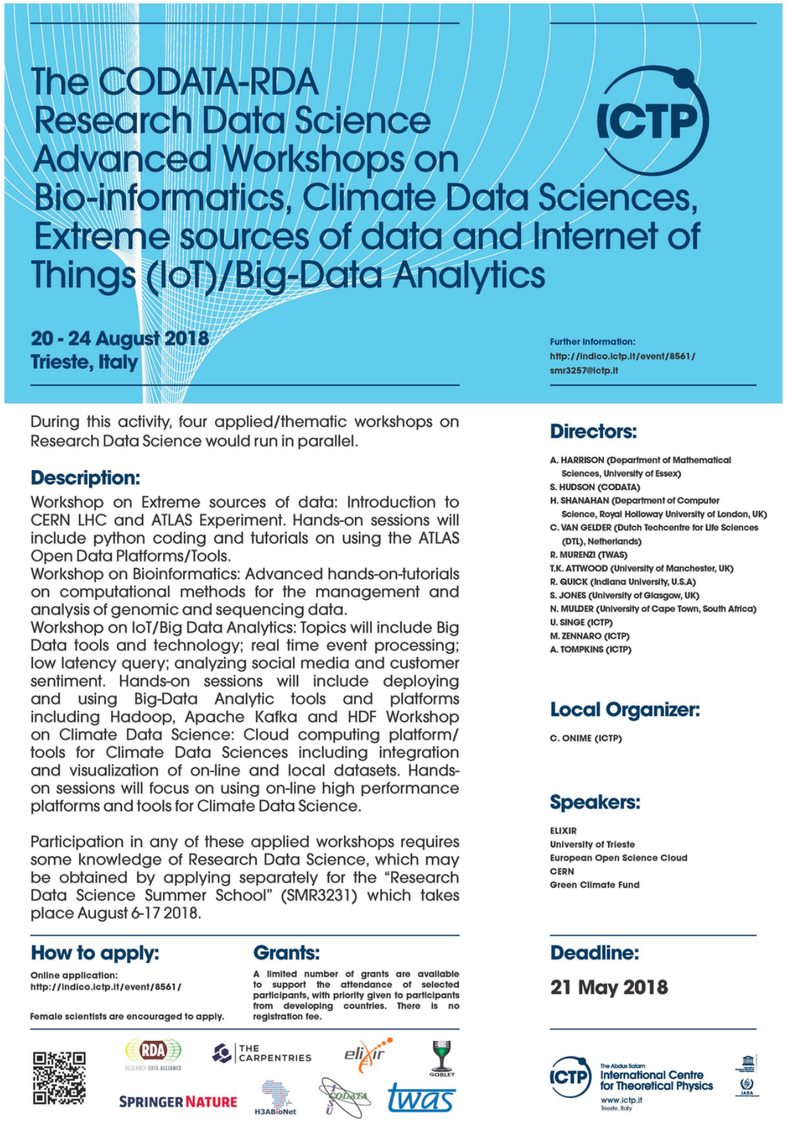
OPEN DATA: How is it used?

Theorists/ scientists wanting to do studies

PhD training, undergraduate courses and BSc and MSc projects

- Students can dive into the learning objectives immediately (physics, statistics, analysis skills such as fitting and machine learning);

Training and **outreach** activities such as **hackthons** and **workshops**, with PhD students, university students, 16-18 year olds or even younger



The CODATA-RDA Research Data Science Advanced Workshops on Bio-informatics, Climate Data Sciences, Extreme sources of data and Internet of Things (IoT)/Big-Data Analytics

ICTP

20 - 24 August 2018
Trieste, Italy

Further information:
http://indico.ictp.it/event/8561/
smr3257@ictp.it

During this activity, four applied/thematic workshops on Research Data Science would run in parallel.

Description:

Workshop on Extreme sources of data: Introduction to CERN LHC and ATLAS Experiment. Hands-on sessions will include python coding and tutorials on using the ATLAS Open Data Platforms/Tools.
Workshop on Bioinformatics: Advanced hands-on-tutorials on computational methods for the management and analysis of genomic and sequencing data.
Workshop on IoT/Big Data Analytics: Topics will include Big Data tools and technology; real time event processing; low latency query; analyzing social media and customer sentiment. Hands-on sessions will include deploying and using Big-Data Analytic tools and platforms including Hadoop, Apache Kafka and HDF Workshop on Climate Data Science: Cloud computing platform/ tools for Climate Data Sciences including integration and visualization of on-line and local datasets. Hands-on sessions will focus on using on-line high performance platforms and tools for Climate Data Science.

Participation in any of these applied workshops requires some knowledge of Research Data Science, which may be obtained by applying separately for the "Research Data Science Summer School" (SMR3231) which takes place August 6-17 2018.

How to apply:

Online application:
http://indico.ictp.it/event/8561/

Female scientists are encouraged to apply.

Grants:

A limited number of grants are available to support the attendance of selected participants, with priority given to participants from developing countries. There is no registration fee.

Directors:

A. HARRISON (Department of Mathematical Sciences, University of Essex)
S. HUDSON (CODATA)
H. SHANAHAN (Department of Computer Science, Royal Holloway University of London, UK)
C. VAN GELDER (Dutch Techcentre for Life Sciences (DTL), Netherlands)
R. MURENZI (TWAS)
T.K. ATTWOOD (University of Manchester, UK)
R. QUICK (Indiana University, U.S.A)
S. JONES (University of Glasgow, UK)
N. MULDER (University of Cape Town, South Africa)
U. SINGE (ICTP)
M. ZENNARO (ICTP)
A. TOMPKINS (ICTP)

Local Organizer:

C. ONIME (ICTP)

Speakers:

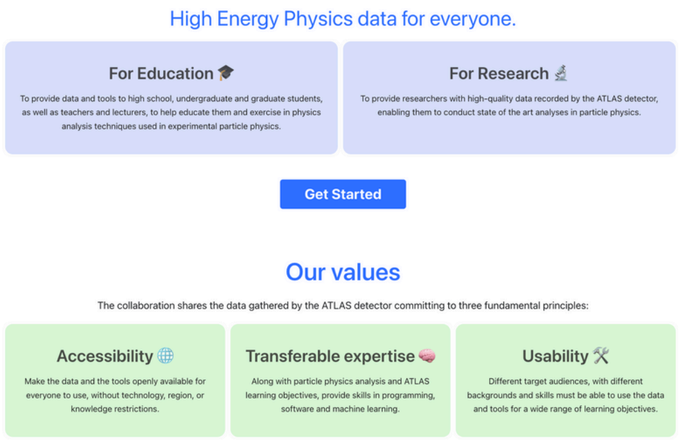
ELIXIR
University of Trieste
European Open Science Cloud
CERN
Green Climate Fund

Deadline:

21 May 2018

The Abdus Salam International Centre for Theoretical Physics
www.ictp.it
Trieste, Italy

ATLAS OPEN DATA



For Research Webpage

- **13 TeV Proton-Proton collision** datasets, 36 fb-1, 2015-2016, 65 TB in PHYSLITE files , with 2 billion events of simulated data
- **5 TeV Lead-Lead collision datasets,** 486μb-1 , 2015, 4 TB in DAOD_HION14 files, with corresponding simulations
- **Event generation data** in HEPMC format
- **Heavy ion data** from the hard probes stream with corresponding simulations

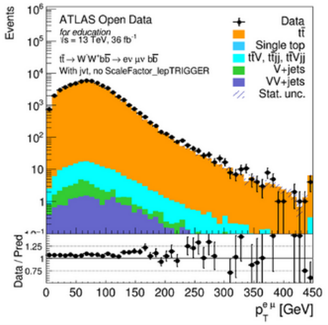
For Education Webpage

NEW

Open Data for Research release
65 TB, 36 fb-1
PHYSLITE

Open Data for Education release
2 TB, 36 fb-1
ROOT NTuples

Skimmed samples selecting dedicated final states
1.5 GB to ~350 GB
ROOT NTuples



Datasets on CERN Open Data Portal inlcuding first and second releases.

Fully accessible website with step-by-step tutorials, tools, videos, data visualisation (Histogram Analyser, Machine Learning online application, teacher workshop, Jupyter Notebook analyses, and analysis facilities.

CMS OPEN DATA

Collision Data

- 16 fb^{-1} of 13 TeV proton collision data from 2016
- Ultra-Legacy processing!
- MiniAOD and NanoAOD data formats

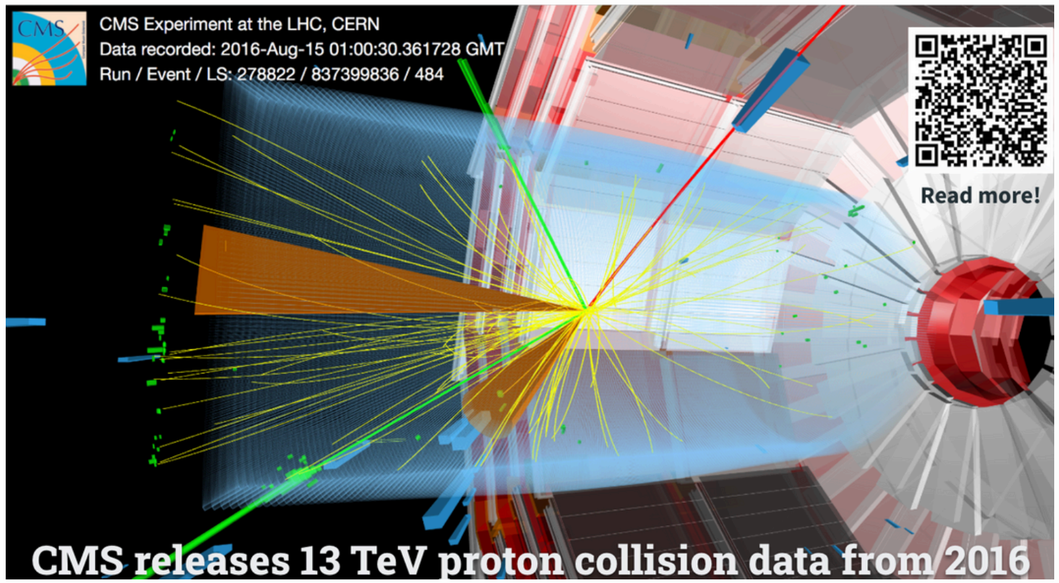
Simulation

- Broad array of SM & BSM simulation
- Over 20,000 unique processes!
- MiniAOD and NanoAOD formats

Software

- Container & VM for CMSSW 10
- Containers for ROOT & python
- New guides
- New analysis tools

First significant luminosity from 13 TeV collisions!



CMS Guide to education use of CMS Open Data

Documentation Guide

This page will guide you through contents of the CMS Open Data collections that are meant for educational use (or for physics enthusiasts!). It is roughly broken down into three levels of difficulty:

- Beginner: *Visualise collisions*
- Intermediate: *Make histograms with collision data*
- Advanced: *Dive deeper into the data*

https://opendata.cern.ch/docs/cms-guide-for-education

CMS Guide to research use of CMS Open Data

Documentation Guide

If you are interested in step-by-step instructions to start working with CMS Open Data, please consult these pages:

- Install Virtual Machine or Use a container
- Getting started with CMS AOD Data, for data collected during Run 1 of the LHC.
- Getting started with CMS MiniAOD Data or NanoAOD Data, for data collected during Run 2 of the LHC.
- Getting started with CMS Heavy Ion Data.

This page offers hints, tips and guidance for conducting a research-oriented analysis using CMS Open Data. More detailed

https://opendata.cern.ch/docs/cms-guide-for-research 2

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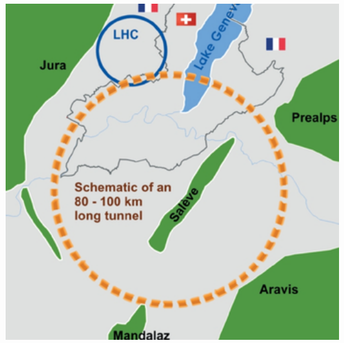
HEP Communication

We have big plans



→ We need to show the **societal impact** of our work

- Inspiration, education, high-level training, new technology, spin outs

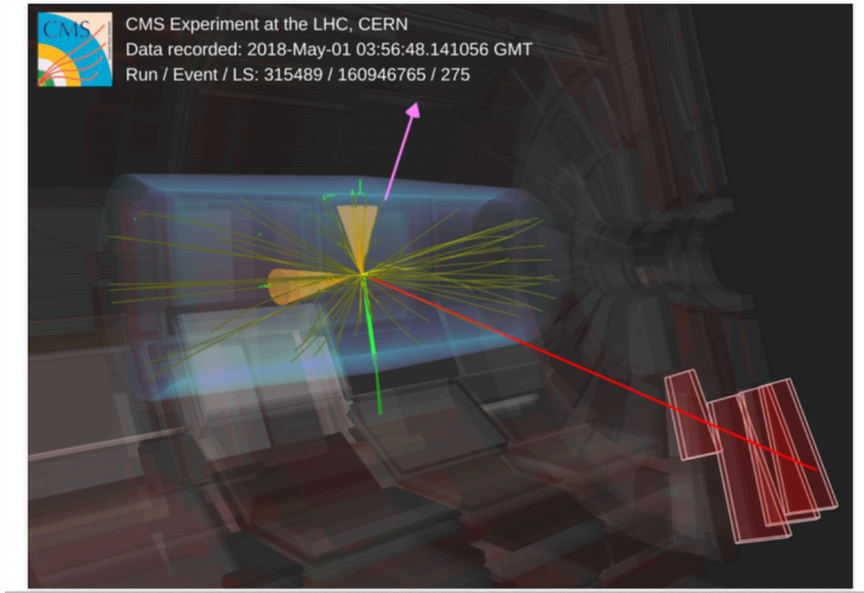
→ **Communicate** our news and updates from our collaborations and groups using press releases, websites and social media

→ Build **trust** with the public, **inspire** policy makers, **educate** and train young people

CMS finds unexpected excess of top quarks

Data from the CMS experiment at CERN's Large Hadron Collider reveals an intriguing excess of top-quark pairs, hinting at the first observation of a composite particle with unique properties

3 APRIL, 2025

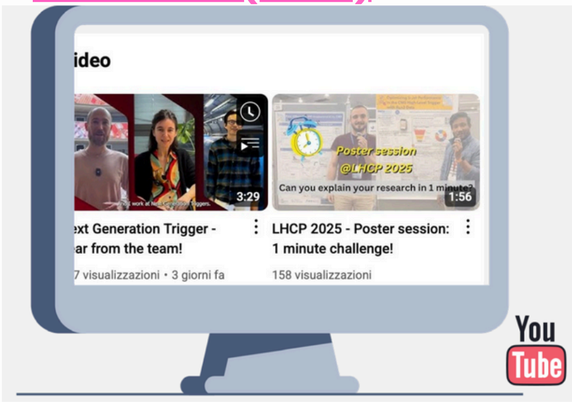


See CMS outreach overview Talk, Marina Passaseo (INFN Padova):
See LHCb overview of outreach activities Talk, Janina Nicolini (CERN)
See ATLAS Outreach and Education Talk, Leonardo Toffolin (CERN, University & INFN Trieste)
See Outreach, educational activities and communication of the ALICE collaboration Talk, Simone Ragoni (Creighton University)

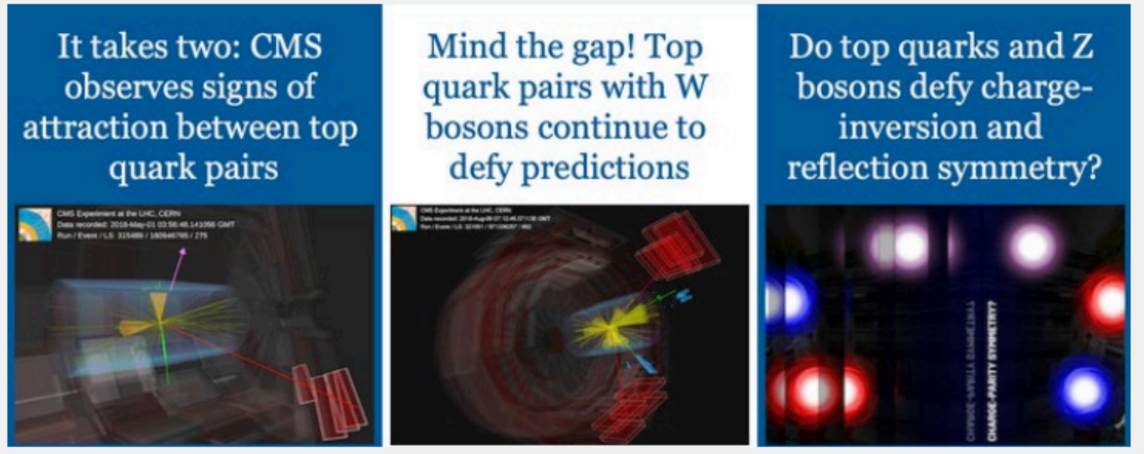
Online Collaboration News and Resources

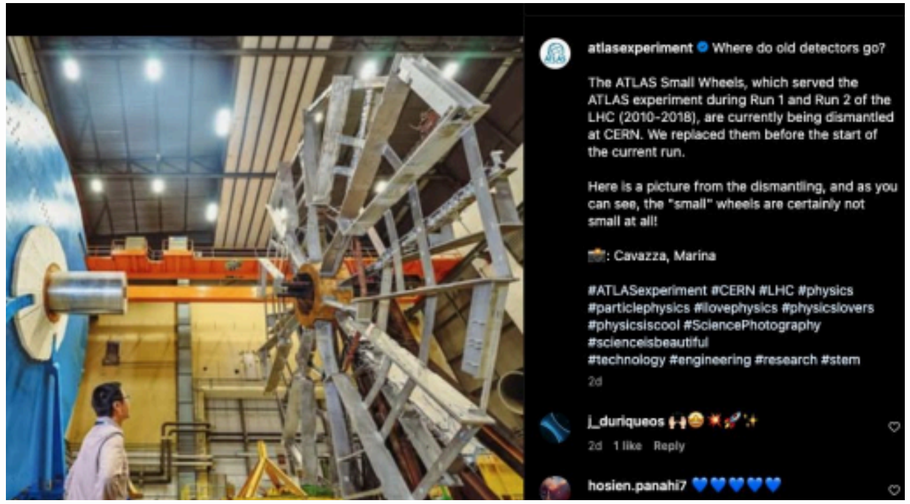
MicroBooNE

CMS Communications Talk Sofia Hurst (CERN)



CMS





ATLAS

LHCb

- **News** Features, Briefings, Updates
- On **websites**, and communicated through **social media**
- Highlighting the **collaboration**, new **physics** results, experimental/ **detector** updates

See CMS outreach overview Talk, Marina Passaseo (INFN Padova):
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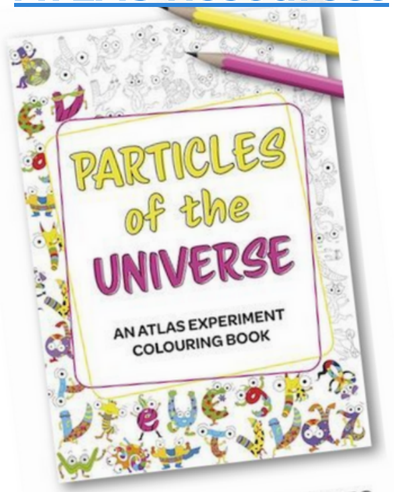
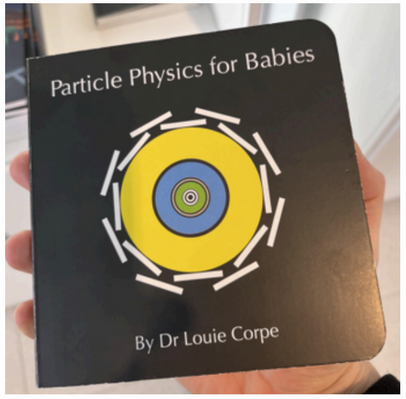
See ATLAS Outreach and Education Talk, Leonardo Toffolin (CERN, University & INFN Trieste)
See Outreach, educational activities and communication of the ALICE collaboration Talk, Simone Ragoni (Creighton University)

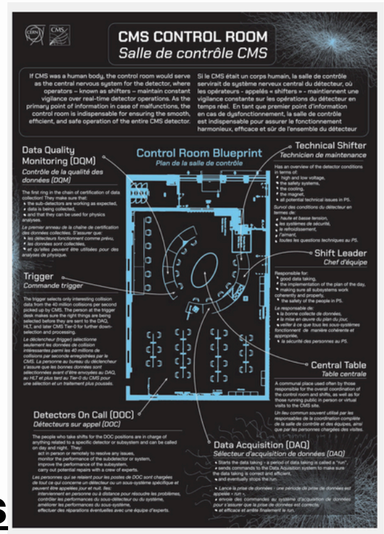
Physics for all ages

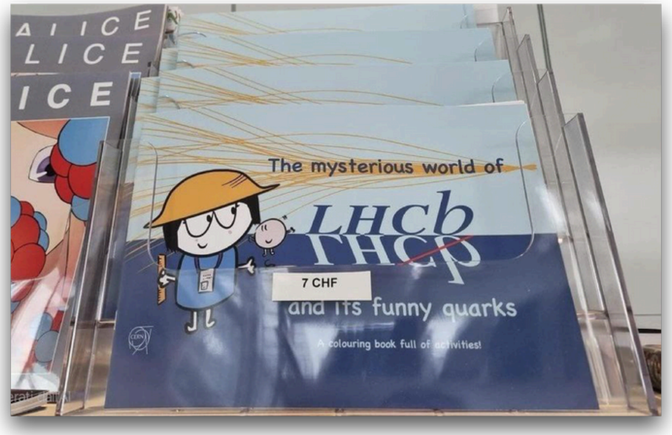
ATLAS Resources

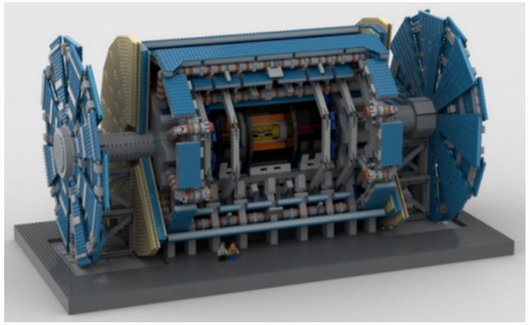


Particles of the Universe Colouring Book



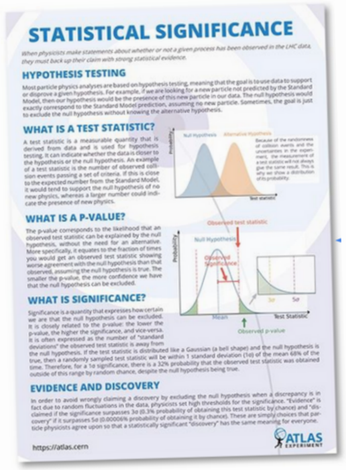


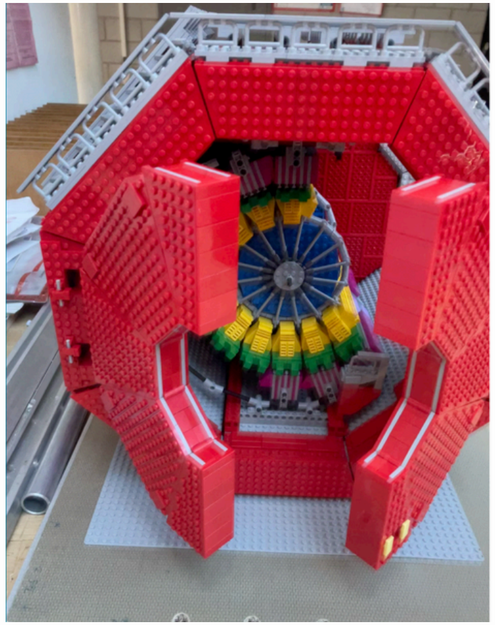




Building ATLAS with LEGO Talk, Nathan Readioff (Sheffield)

CMS Resources



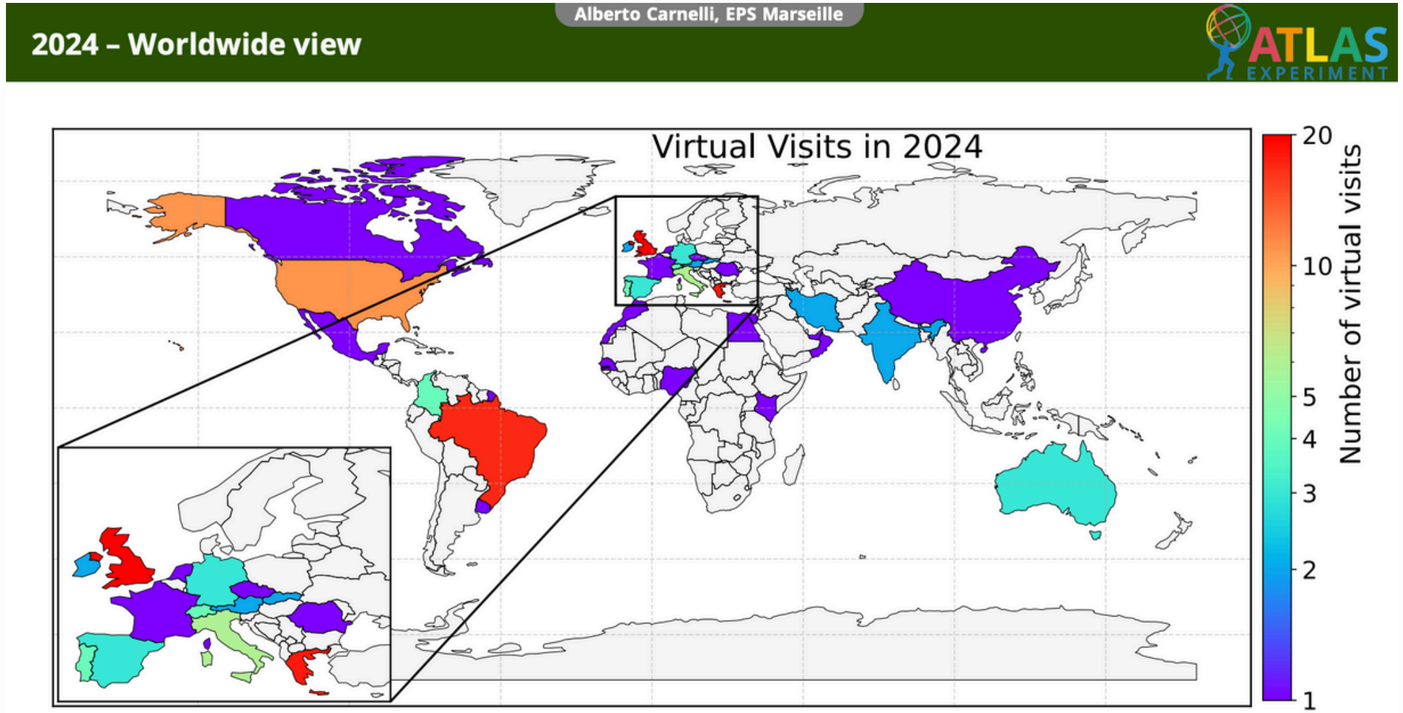


Virtual Visits

CMS Virtual Visits

ALICE Virtual Visits

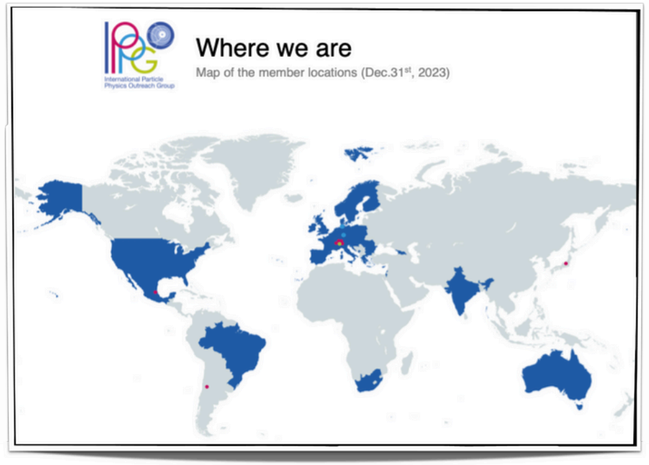
ATLAS On the Air! – Measuring the Success of the ATLAS Virtual Visit Programme Talk, Alberto Carnelli (LAPP (CNRS), CERN)



ATLAS Virtual Visits

In 2024, the VVs welcomed participants from all around the globe!

The International Particle Physics Outreach Group IPPOG Collaboration



International Scientific Collaboration

- Active researchers, experts in communication & education
- 34 countries, 7 experiments, 1 international lab (CERN) and 2 associate national labs (DESY, GSI)

Organise Global Activities

- International Particle Physics Masterclasses
- Global Cosmics Portal & International Cosmics Day
- NEW in 2024: Resources Portal

Support Local Activities

- Visit one country each year, to enhance HEP outreach visibility but also to foster transversal collaboration between projects / contributors
- Pool of volunteers and (limited) resources to support events

Brochures
https://cds.cern.ch/record/2903880

Reports and Proceedings
https://ippog.org/publications

Summary

EDI is such an important part of building our community, we all must invest in supportiing initiatives, and support the **international** community

Outreach and **Open Data** is an important part of our experiments deliverables, for research and education, to build trust and help secure support

Get in touch with your **collaboration EDI** team or **outreach** team, many resources out there.