

The International Particle Physics Outreach Group (IPPOG) Engaging the world with science

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on behalf of the IPPOG Collaboration

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Lattice 2024 – 41st Lattice Conference
The University of Liverpool, United Kingdom, 29th July – 3rd August 2024

OUTREACH AND COMMUNICATION

Outreach and communication are essential to the scientific process

➤ WHY do we do outreach?

What are the GOALS?

➤ WHOM do we address?

Who is the TARGET?

➤ WHAT do we communicate?

What are THE MESSAGES?

➤ HOW do we communicate?

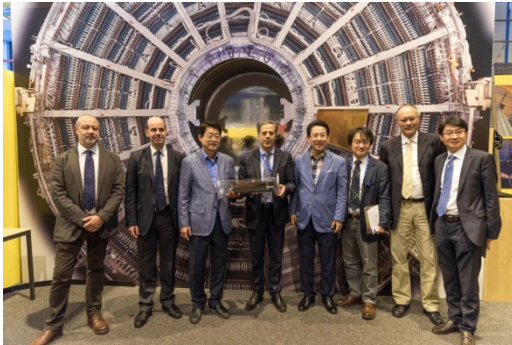
What are THE METHODS / TOOLS?

THE GOALS

- Be open – demystify scientific research
- Inform public – increase awareness / scientific literacy
- Inform public – appreciation of our work
- Inspire youth – prepare next generation of scientists
- Ensure (continuation of) support and funding
- Tell taxpayers how their taxes are used
- Inform media (strong amplification factor)

THE TARGET

- General public
- Students and teachers
- The scientific community
- The media
- The stakeholders



THE MESSAGES

- Necessity of science in society
- Role/impact of science in society
- Scientific method & results
- Enthusiasm and love of science
- Excitement of discovery
- Science is for all
- Collaboration across borders
- Diversity (eg female role models to increase female involvement)

THE METHODS & TOOLS

➤ “TRADITIONAL”

- Visits, Exhibitions, Public talks
- Events (European Researchers Night, Open Days, Science Fairs)

➤ “ONLINE (web-based) “

- Web pages
- Blogs / Newsletters
- Social Media
- Virtual Visits

➤ “HANDS-ON” / EDUCATIONAL

- Masterclasses
- CERN Open Data portal
- Citizen Science



International Particle Physics Outreach Group (IPPOG)



Network of scientists, science educators and communication specialists working across the globe in informal science education and public engagement for particle physics

<https://ippog.org>

IPPOG's HISTORY

EPOG (European Particle Physics Outreach Group), established in 1997 under the auspices of ECFA and EPS-HEP, after proposal by CERN DG Chris Llewellyn Smith

Members : Representatives from CERN member states, CERN and DESY

LHC experiments representatives joined; EPOG => EPPOG

November 2010 : EPPOG evolved to IPPOG (International)

USA joined in 2012; Israel, Ireland, Slovenia, Australia and South Africa joined soon after

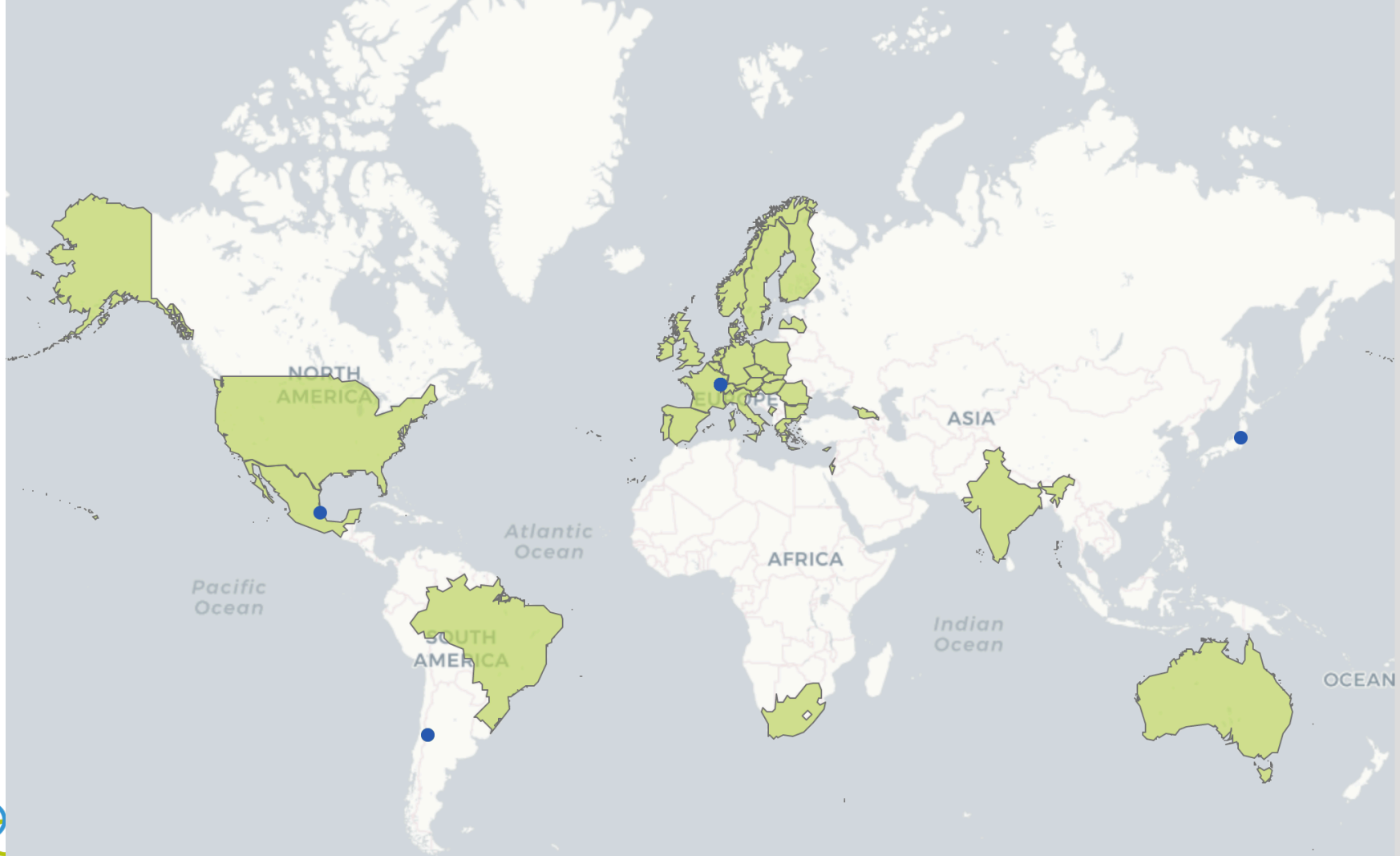
December 2016 : IPPOG became international collaboration

Members (42) : 34 countries, one international laboratory (CERN), 7 International Collaborations (ALICE, ATLAS, CMS, LHCb, Belle II, HAWC, Pierre Auger Observatory)

Associated members : DESY, GSI (national laboratories)

Members sign MoU; Countries contribute financially; experiments “in kind”

Meetings twice a year: spring (organised by a member) and autumn (usually at CERN) to exchange ideas and best practices, share experiences and material, define common goals



IPPOG celebrates 25 years of engagement



The Birth of IPPOG
Chris Llewellyn Smith
(former CERN Director-General 1994–1998)



Our First Steps
Frank Close (former Chair 1997–2001)



Growing Up
Erik Karl Johansson
(former Chair 2002–2008)



<https://indico.cern.ch/e/ippog25>



Adolescence
Michael Kobel
(former Chair 2009–2012)



Teen Spirit
David Barney
(former Chair 2009–2012)



Coming of age
Marge Bardeen
(former Chair 2013–2016)



Adulthood
Hans Peter Beck
(former Chair 2013–2019)



Master(class)es of the Universe
Kenneth William Cecire, Uta Bilow
(IMC coordinators)



Celebration
Erik Karl Johansson, David Barney, Marge Bardeen, Hans Peter Beck, Steven Goldfarb, Pedro Abreu, Claire Adam

<https://cerncourier.com/a/ippog-celebrates-25-years-of-engagement/>



Day of immersion in particle physics for high-school students; the aim is to inspire and motivate them by introducing them to the world of research

Students are invited to a University or research institute

Lectures on standard model and beyond, accelerators, detectors

Hands-on activity : analysis of real data from an experiment

(using dedicated software packages)

Videoconference at the end of the day (≤ 5 institutes, 2 moderators)

to combine and discuss results, answer questions, quiz

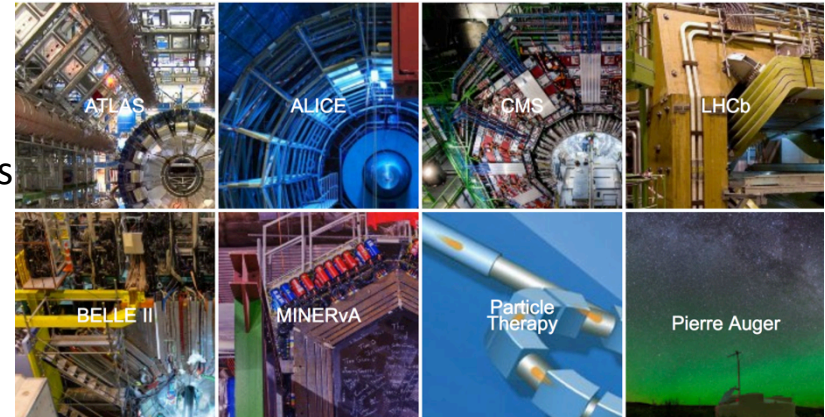
Organised every year during
a period of 6-7 weeks in
February – March – April

<https://physicsmasterclasses.org>



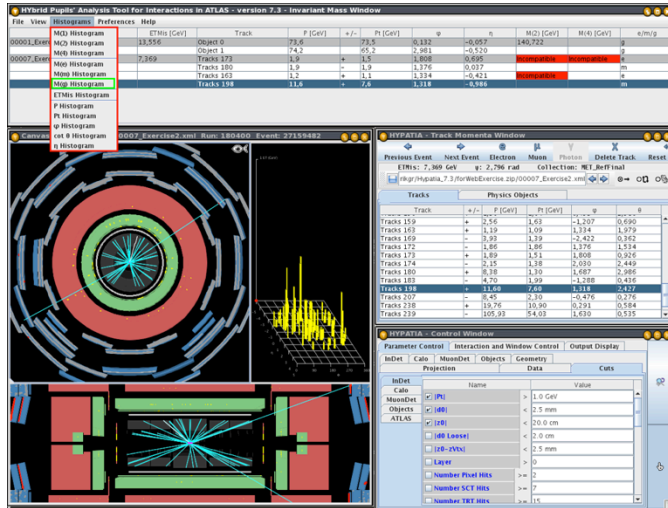
History of particle physics masterclasses

- 1996: Started in the UK <https://cerncourier.com/a/how-the-particle-physics-masterclasses-began/>
- 2005: Adopted by EPPOG for all Europe
Use LEP data (1989-2000) <https://cerncourier.com/a/masterclass-spreads-the-word-for-physics/>
OPAL Identifying Particles
DELPHI Hands on CERN
Z0 decays / calculation of branching ratios
- 2006: U.S. joined the programme
- 2010: Decided to move to LHC-based Masterclasses
- 2011: Started using data from LHC
ALICE strange particles, R_{AA}
ATLAS W^+W^- (MINERVA), Z^0 (HYPATIA)
CMS J/ψ , Z
- 2014: **LHCb** Measurement of the D^0 lifetime
<https://cerncourier.com/a/international-masterclasses-in-the-lhc-era/>
- Exercises from other experiments were introduced in the following years

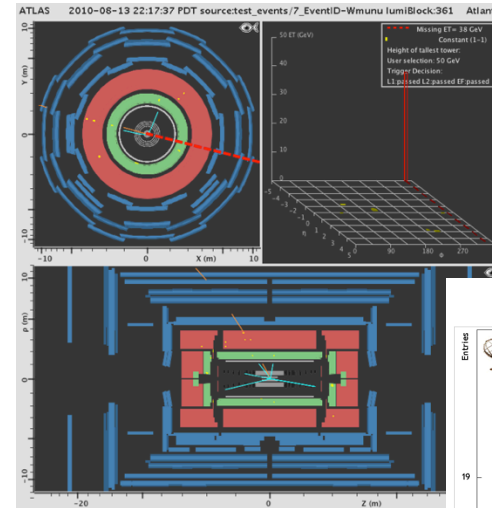


LHC Masterclasses : ATLAS

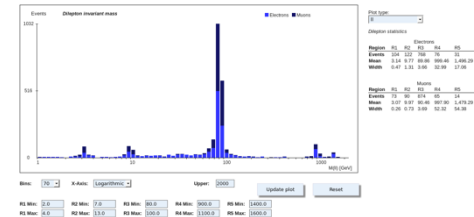
Z-path HYPATIA



W-path MINERVA



OPlot - MasterClass - Combination for all institutes on 2016-03-09



Identify γ , e, μ
Find $Z \rightarrow e^+e^-, \mu^+\mu^-$, Higgs
Distinguish from background

$$W^- \rightarrow e^- + \bar{\nu}_e$$

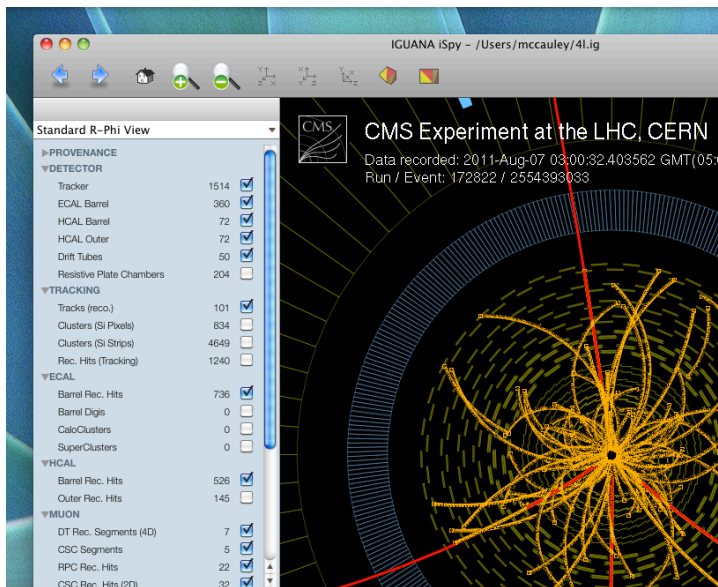
W⁺/W⁻

<https://atlas.physicsmasterclasses.org/start.htm>



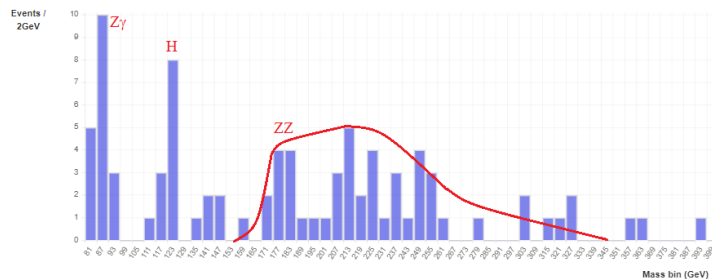
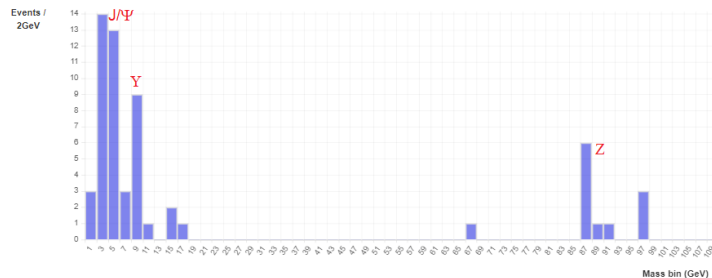
LHC Masterclasses : CMS

i-Spy



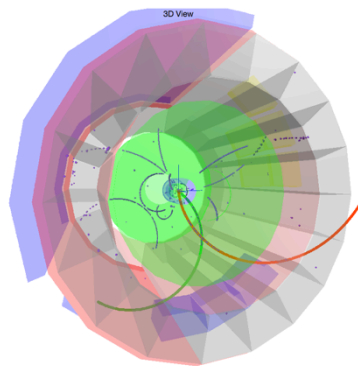
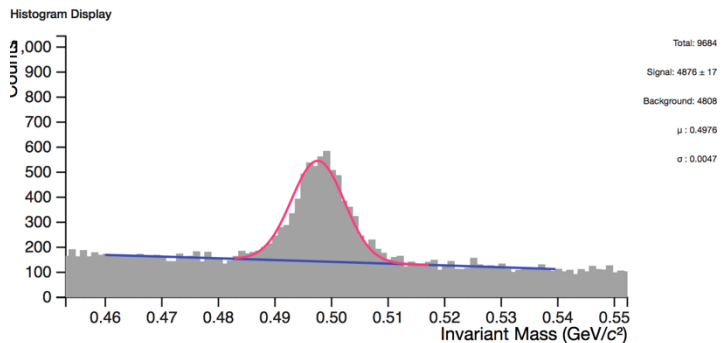
<https://web.quarknet.org/mc/cms/>

Search for J/ψ , W , Z , H

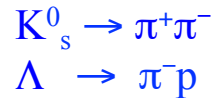


CIMA for histograms

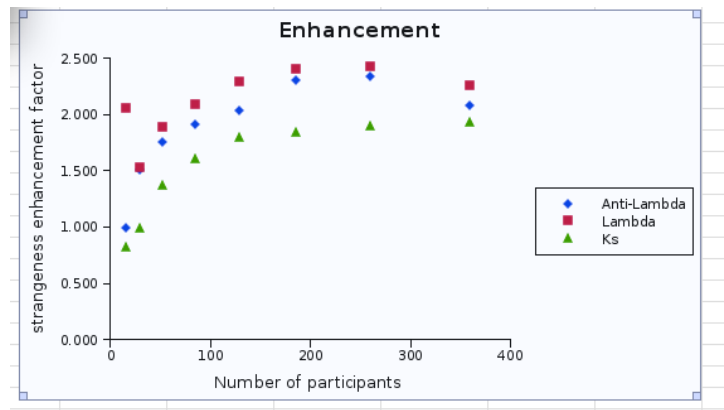
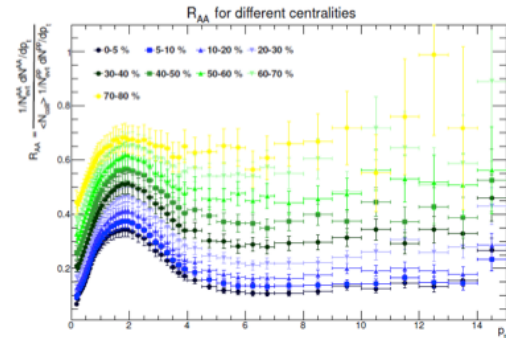
LHC Masterclasses : ALICE



Search for V^0 decays

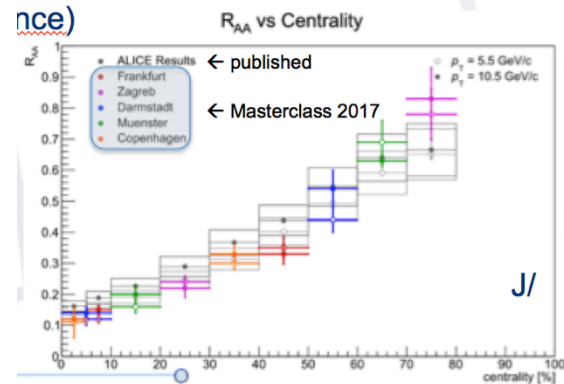


DEMONSTRATION
Tuesday 30.7.2024
13:45 – 15:45



Observation of strangeness enhancement in Pb-Pb collisions

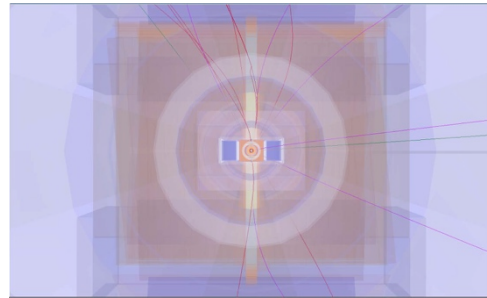
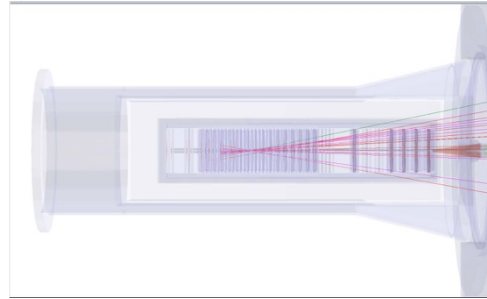
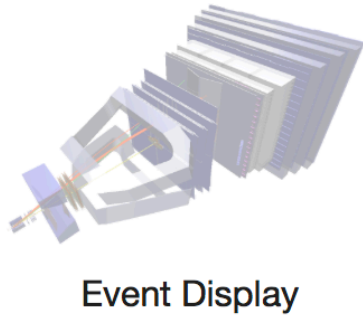
<https://alice-masterclass.web.cern.ch/>



Nuclear modification factor R_{AA}

<http://www-alice.gsi.de/masterclass/>

LHC Masterclasses : LHCb

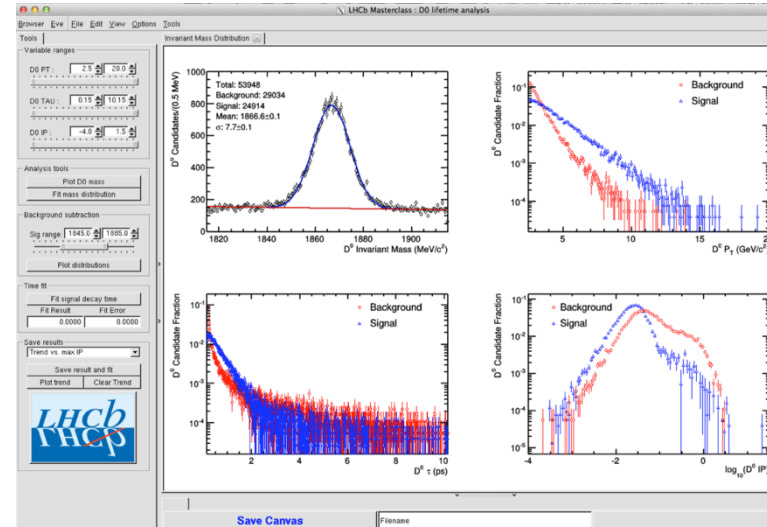


Study of D^0 decays

$D^0 \rightarrow K^- \pi^+$

D^0 mass distribution

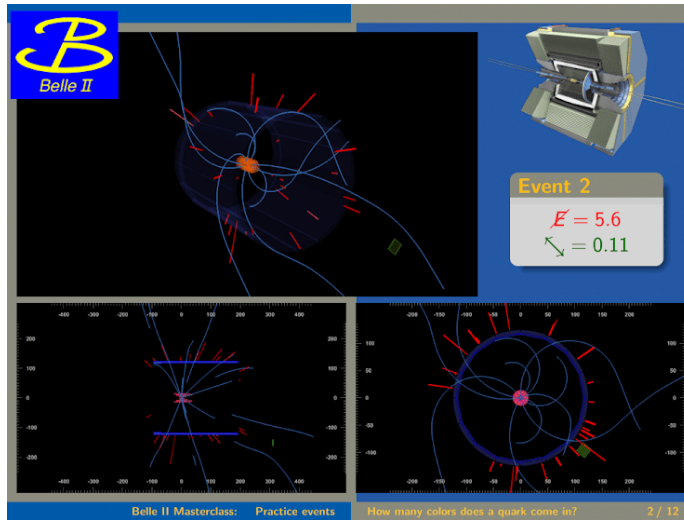
D^0 lifetime measurement



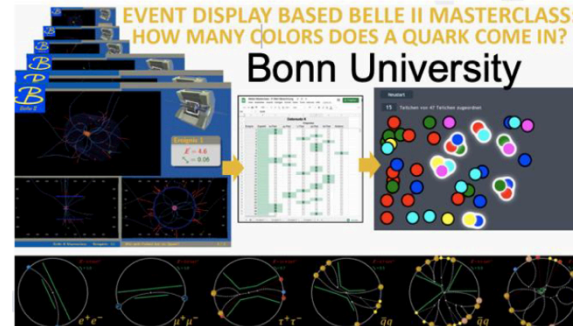
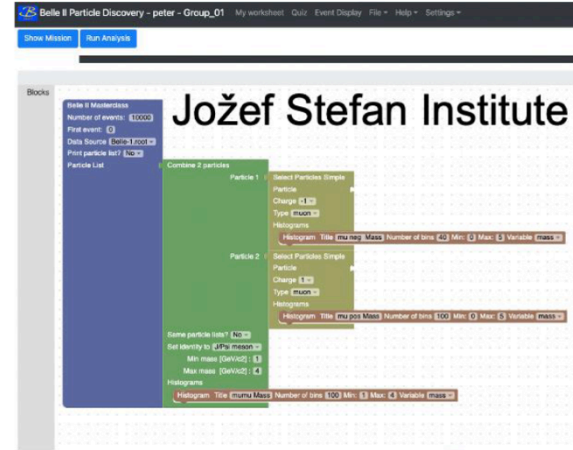
<https://lhcb-outreach.web.cern.ch/lhcbinternationalmasterclasses/d0-lifetime/>

Masterclasses : Belle II

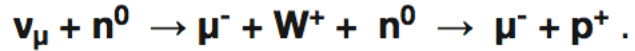
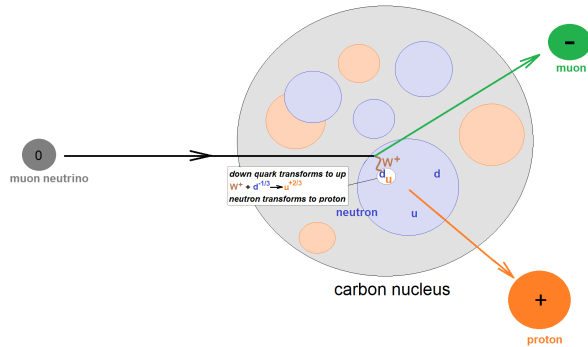
Spectroscopy – search for new particles
Measure quark colour



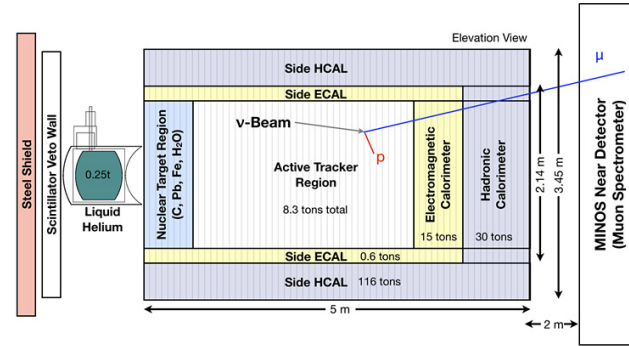
<https://belle2.ijs.si/public/>



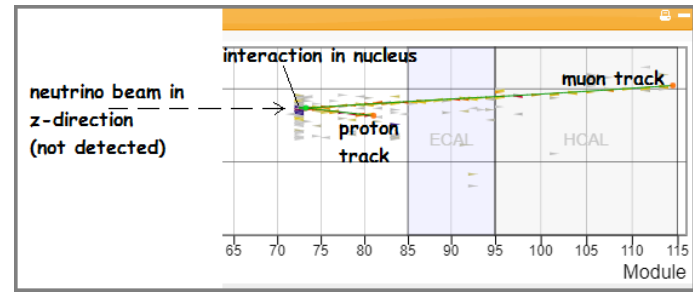
Masterclasses : MINERvA



<https://indico.fnal.gov/event/22340/>



Main Injector Neutrino Experiment to study ν-A interactions



Masterclasses : Auger

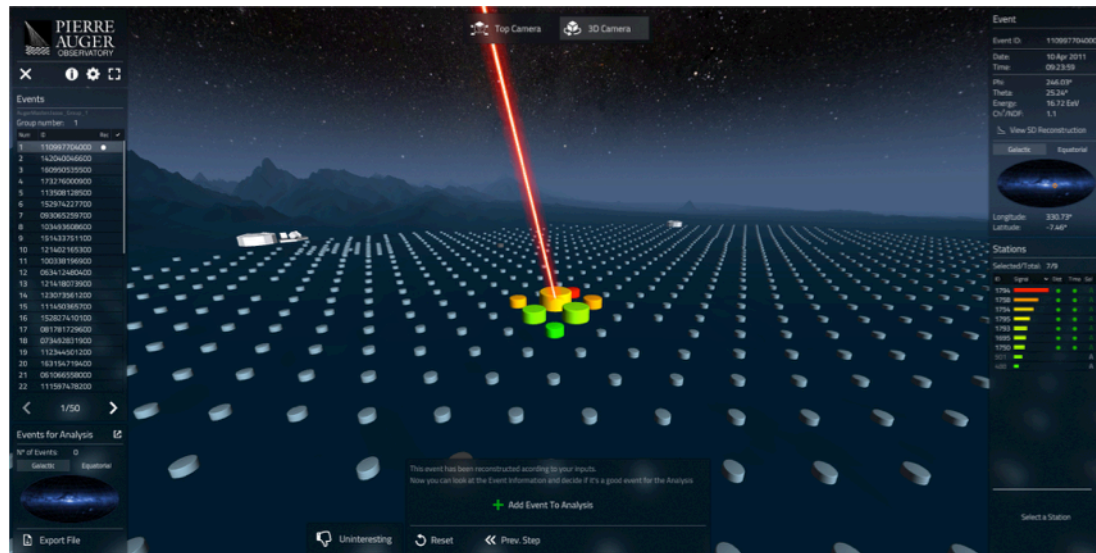
Interactive tool to visualize events

Arrival direction of primary cosmic ray

Determine energy of primary cosmic ray

Select events pointing to source in the sky

Pierre Auger Observatory

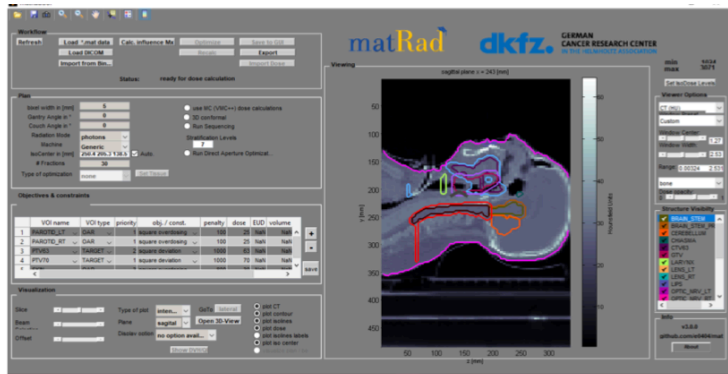


<https://augermasterclasses.lip.pt/>

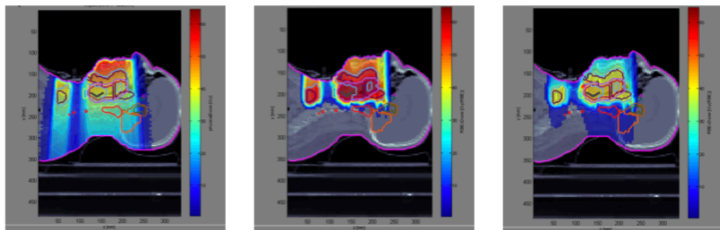
Particle Therapy Masterclass

Hands-on Treatment Planning

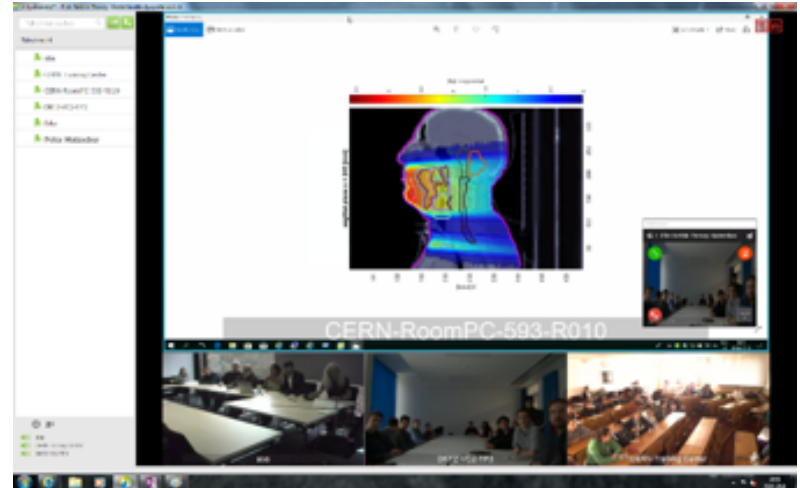
based on professional open source treatment planning: [matRad](http://www.matrad.org) (www.matrad.org) developed by DKFZ, Heidelberg Simplified version for PTMC



Demo⁴ of the matRad software kit for Treatment Planning .



Dose prescription using photons, protons and carbon ions; differences



<https://indico.cern.ch/event/840212/>

International Masterclasses videoconferences

Hands on Particle Physics Masterclasses SCHEDULE 2024

At the end of each Masterclass day a videoconference between the institutes and with moderators at CERN, at Fermilab, TRIUMF, KEK, GSI, or at Pierre Auger Observatory in Malargue. is established. Choose your moderation center to see the schedule for 2024!



© CERN



© Fermilab



© G. Otto/GSI Helmholtzzentrum für
Schwerionenforschung GmbH



© KEK



organisation of videoconference in 5 moderation centres

CERN : Uta Bilow (TU Dresden)
for LHC-based masterclasses

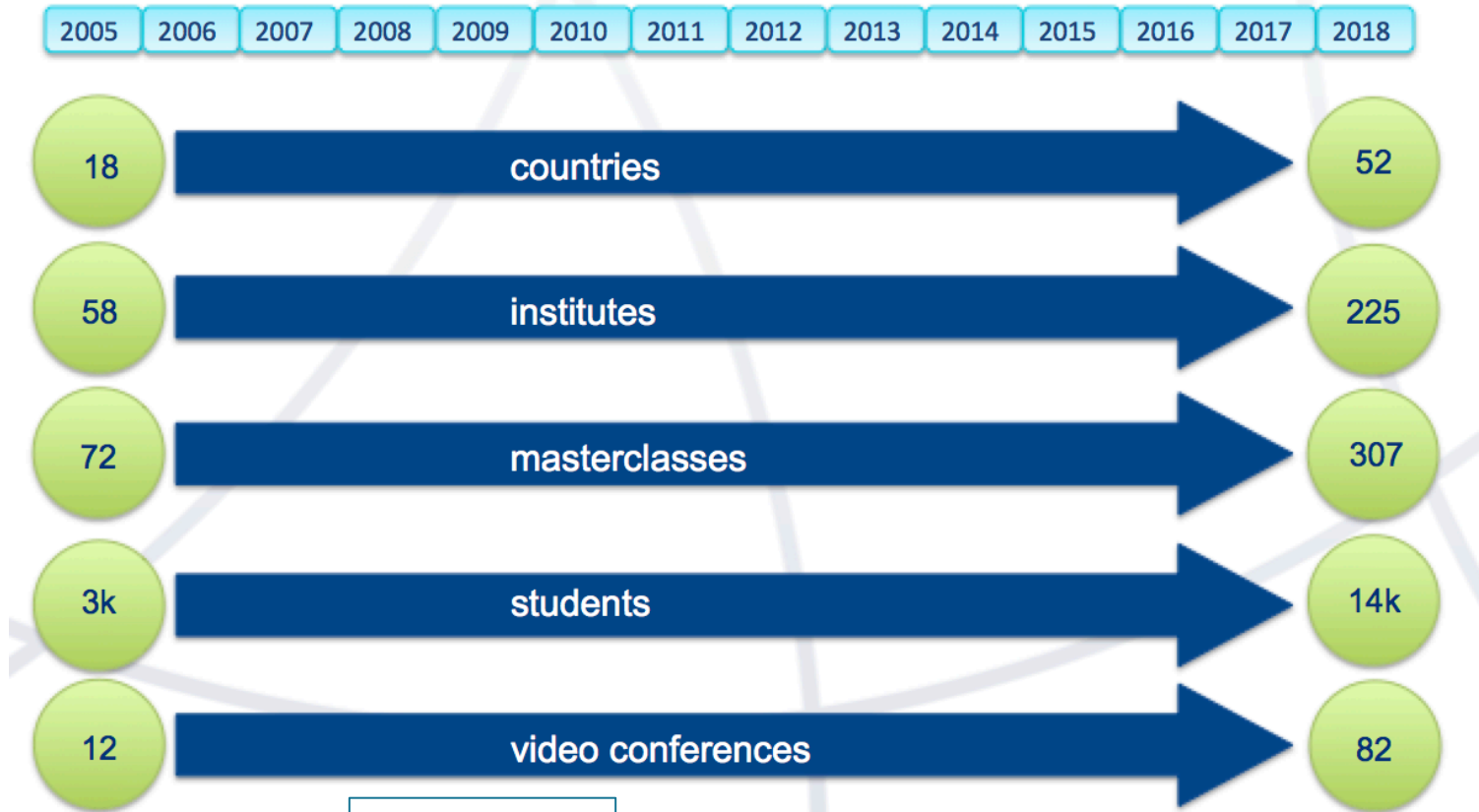
Fermilab : Ken Cecire (Quarknet)
for the USA

GSI : Yiota Foka (GSI)
For Particle Therapy Masterclass

KEK For Belle II Masterclass

Pierre Auger Observatory, Malargue,
Argentina for Auger Masterclass

Evolution of International Masterclasses



from Uta Bilow

Statistics for IMC24 (numbers from 2023 in brackets)

CERN LHC Masterclasses

233 MCs with
CERN VC (211)

- 115 ATLAS (99)
- 67 CMS (56)
- 26 LHCb (26)
- 36 ALICE (30)

10.570 participants

Fermilab LHC Masterclasses

40 MCs with
Fermilab VC (40)

- 28 CMS (29)
- 9 ATLAS (11)

**MINERvA
Masterclasses**
8 MCs (8)

**NOvA
Masterclasses**
5 MCs (2)

1.440 participants

GSI Hadron Therapy Masterclasses

47 MCs (30)
8 VCs (9)

1.500 participants

KEK Belle II Masterclasses

16 MCs (16)
7+2 VCs (5)

630 participants

Malargue Pierre Auger Masterclasses

17 MCs (12)
5 VCs (3)

530 participants

In total: 14.670 participants

from Uta Bilow



Masterclasses for Girls

International Day of Women and Girls in Science (11 February)

- LHC MCs for girls
- On Feb 9th (Friday)
- 14 groups participating (14)
- ~ 700 students (500)
- Female lecturers and tutors
- 3 videoconferences at CERN (5)
- 5 female moderators (10)

from Uta Bilow

	Feb 09, 2024	Feb 09, 2024	Feb 09, 2024
	VC 1 ATLAS W + Z	VC 2 CMS	VC 3 ALICE
moderators	Ana P.	Sudeshna	Despina
moderators	Eleanor	Ana V. B.	N.N.
	Valencia (ATLAS Z) 🇪🇸	Vama, Astronomical Observatory 🇮🇹	Thessaloniki (ALICE) 🇬🇷
	Rome Tor Vergata (ATLAS Z) 🇮🇹	Rome Sapienza 🇮🇹	Cape Town, iThemba LABS (ALICE) 🇿🇦
	Cosenza (ATLAS W) 🇮🇹	Santiago de Compostela 🇪🇸	CTU Prague (ALICE) 🇨🇪
	Alexandria (ATLAS Z) 🇪🇬	Sao Paulo, SPRACE 🇧🇷	Darmstadt Frankfurt Muenchen (ALICE R_AA) 🇩🇪 webpage
		Debrecen 🇮🇪	
		University of Barcelona 🇪🇸	



Masterclasses for Girls

International Day of Women and Girls in Science (11 February)

75 Years of Independent India

2nd International Hands-on Particle Physics Masterclasses @ JU

on occasion of International Day of Women and Girls in Science

INTERNATIONAL MASTERCLASSES
hands on particle physics

75 Azadi Ka Amrit Mahotsav

International Day of Women and Girls in Science

Registration open till Feb. 8, 2022

Azadi Ka Amrit Mahotsav is a series of events organized to commemorate the 75th Anniversary of India's Independence.

International Day of Women and Girls in Science - Masterclasses in Greece (Chania, Thessaloniki)

ALICE Friday 9 Feb 2024, 08:30 → 18:00 Europe/Athens

Description

INTERNATIONAL MASTERCLASSES
hands on particle physics

International Particle Physics Outreach Group

The United Nations General Assembly adopted a resolution in December 2015 and declared February 11th as the **International Day of Women and Girls in Science**. This date should be recognised as a global celebration on equal participation and the accomplishments of female scientists.

International Masterclasses are launching Masterclass activities on the International Day of Women and Girls in Science. By arranging a special Masterclass event for girls we plan to support and promote the access of women and girls to science education and research activities.

Videoconference

ALICE-Masterclasses

Join

International Masterclasses to New Countries

IPPOG Working Group : Bringing Masterclasses to New Countries
Effort to expand both geographically and in scope
Masterclasses at the University of Kenya in Nairobi were held in 2024

The school we have invited is in a poor area of Nairobi. For most of the students, if not all of them, it was their first time using a computer. I think they did very well



Masterclasses for other audiences

For physics teachers

- to familiarise them with the programme
- to encourage them to involve their students / use MC exercises as an extracurricular activity

Often such masterclasses at CERN in the frame of the national teachers programmes (Swedish, Italian, Greek)

For CERN (non-scientific) personnel

- To give those in administration, finance, etc. hands-on experience of what the experiments do
- Organised twice during IPPOG meetings at CERN

Demonstrations for conference participants

- To make them aware and encourage them to get involved with this programme

For students on the occasion of conferences

Example: upcoming “XVIth Quark Confinement and the Hadron Spectrum Conference”, Cairns, Queensland, Australia, 19-24 August 2024

World Wide Data Day

<https://quarknet.org/content/world-wide-data-day>

World Wide Data Day



INTERNATIONAL MASTERCLASSES
hands on particle physics

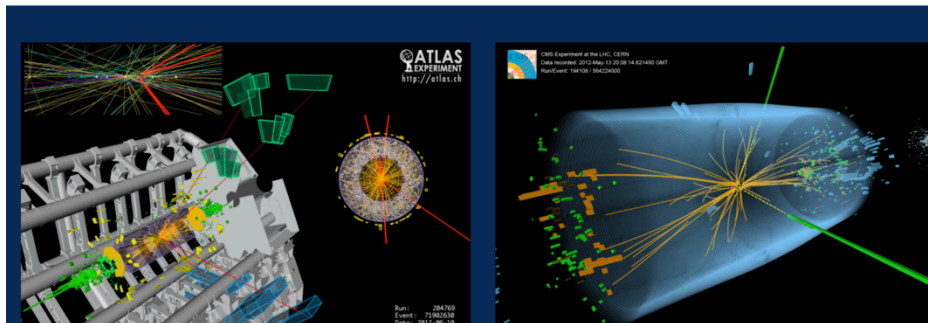
IPPOG

W2D2
World Wide Data Day

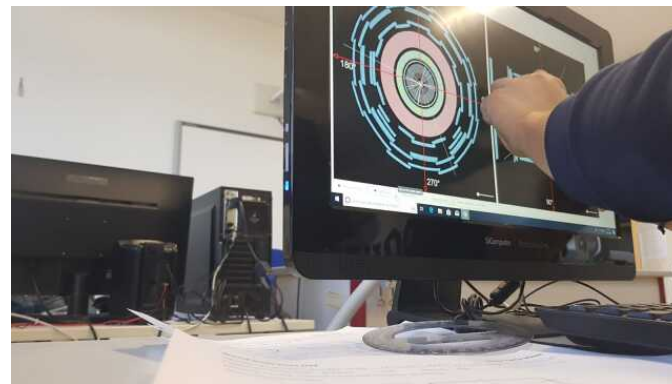
World Wide Data Day 2024: 14 November, 00:00-23:59 UTC

World Wide Data Day ATLAS CMS

Registration will open in September. To request late registration, please *send an e-mail*.



Simplified measurement with data from ATLAS and CMS to be done at school, facilitated by the teacher. A two-hour activity, possibility to join videoconference with physicist moderators during a 24-hour span.



NEWS

EPS Outreach Prize 2021 goes to IPPOGers

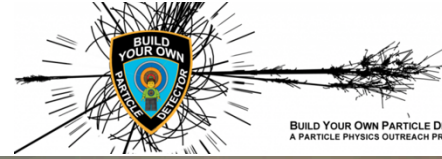
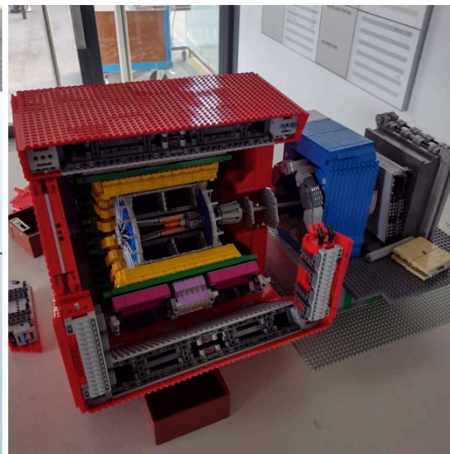
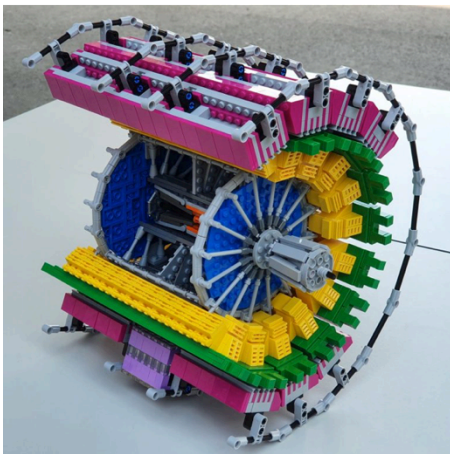


*"The 2021 Outreach Prize for outstanding achievement in outreach, including education and the promotion of diversity, in connection with High Energy Physics and/or Particle Astrophysics is awarded to **Uta Bilow** and **Kenneth Cecire** for the long-term coordination and major expansion of the International Particle Physics Master Classes to include a range of modern methods and exercises, and connecting scientists from all the major LHC and Fermilab experiments to school pupils across the world; and to **Sascha Mehlhase** for the design and creation of the ATLAS detector and other interlocking-brick models, creating an international outreach program that reaches to an unusually young audience."*

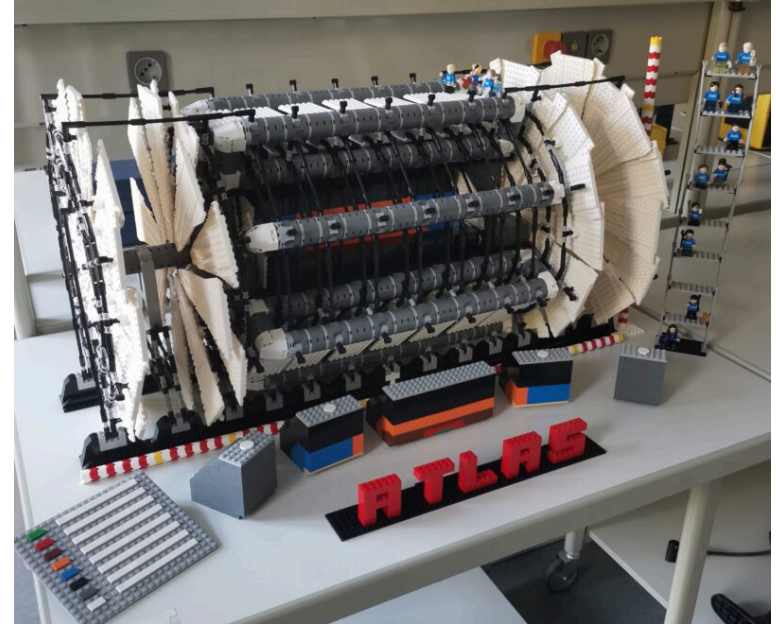
Build Your Own Particle Detector



Model und 'Architekten' in Münster – Christian Klein-Bösing

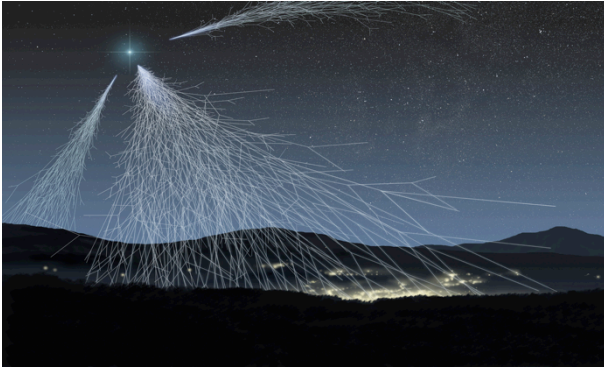


BUILD YOUR OWN PARTICLE DETECTOR
A PARTICLE PHYSICS OUTREACH PROGRAMME



<https://build-your-own-particle-detector.org>

GLOBAL COSMICS



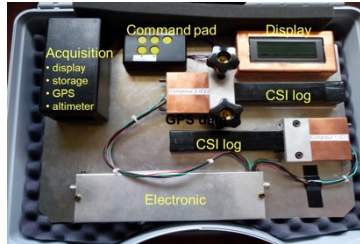
To bring a variety of cosmic ray school project under a common umbrella:
“High School Cosmic Ray Experiments”
Workshop at Centro Fermi, Rome,
February 2017

<https://indico.cern.ch/event/596002/>

EEE



HISPARC



COSMIX



COSMOS à l'école



TAN-Q

















GLOBAL COSMICS

Around 20 projects from 11 countries

Cooperation in events such as International Cosmic Day and International Muon Week

Exchange of measurement techniques and projects

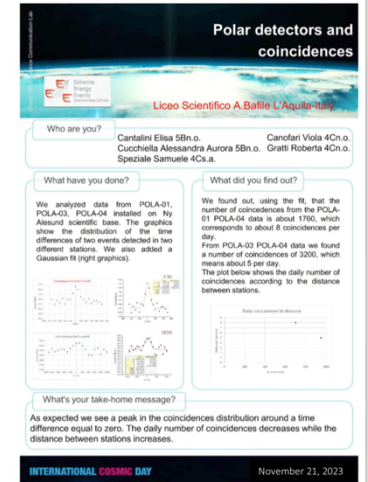
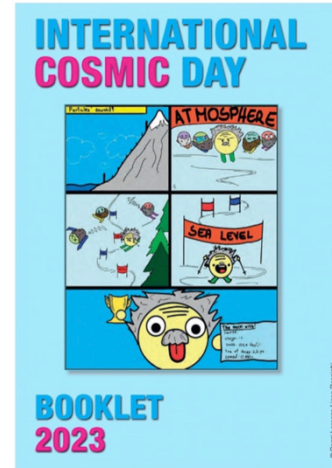
<https://ippog.org/global-cosmic-rays-portal>

Projects	
Finland	 CALLIO LAB <small>Interdepartment Center for Science and E.S.D.</small>
France	 Sciences à l'école  COSMIX  PERON <small>Fédération Education Supérieure cosmiques et muons</small>
Germany	 COSMIC@WEB <small>Das Webinterface von Physik angehen in Zuehen</small>  TEILCHENWELT <small>WISSENSCHAFT</small>
Italy	 Extreme Energy Events Science Inside Schools  INFN OCHA <small>Operational Cosmic Rays Observations</small>
Poland	 CREDO <small>The Great One The Underdog</small>
Japan	 探Q
Spain	 CAZADORES <small>EL MUNDO DE LA COSMICA</small>
Sweden	
Taiwan	 QuarkNet-TW
UK	 UNIVERSITY OF BIRMINGHAM  HSPARC QuarkNet Cymru
USA	 QuarkNet

INTERNATIONAL COSMIC DAY

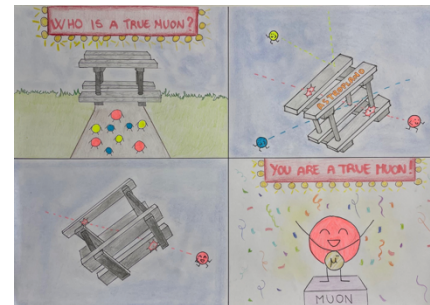


Lectures
Measurements
Data analysis
Videoconference
Drawing contest
Selfie contest
Report



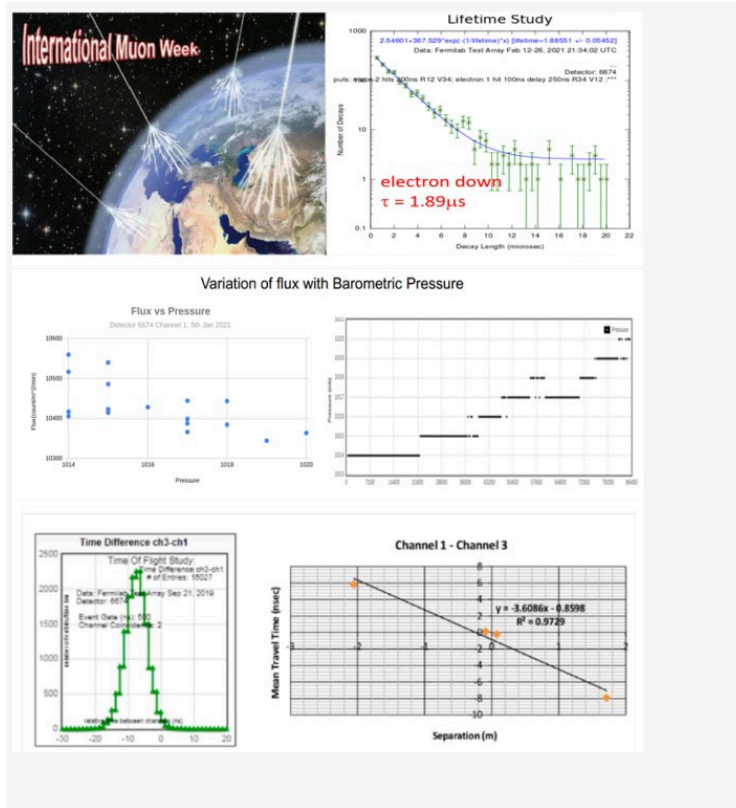
<https://icd.desy.de/>

Participants ICD2023
2600 students
19 countries
12 video calls around the clock



INTERNATIONAL MUON WEEK

<https://quarknet.org/content/international-muon-week>



High-school students do experiments using cosmic ray detectors, measuring:

- Muon time of flight
- Muon lifetime
- Cosmic ray flux

Discussion, questions via zoom

Held annually each spring

IPPOG RESOURCE DATABASE

IPPOG Resource Database

From wonders to excitement

A collection of high quality engaging materials e.g. videos, posters, talks, hands-on activities and more to help you share the wonders and excitement of particle physics with teachers, students and the general public.

The current DATABASE content is the testimony of years of IPPOG activities and was curated to celebrate the collaboration 25th anniversary, in November 2022. IPPOG Working Groups are currently collecting more.

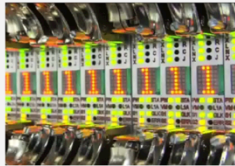
Matter, Particles and the Universe
(Known Physics)

Exploring the Unknown (Beyond
Known Physics)

Technologies and Experiments

Particle Physics and Society

Enjoy the selection of featured resources below. Search the database by clicking on topic tabs above or filter on the right.

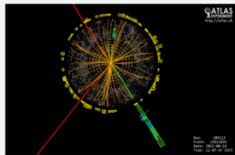


19 May, 2011

ATLAS - From Dream to Reality

Showcasing pictures and video from the building of the ATLAS Experiment to the first...

MATTER, PARTICLES AND THE UNIVERSE (KNOWN PHYSICS)
VIDEOS ENGLISH UPPER SECONDARY SCHOOL LEVEL

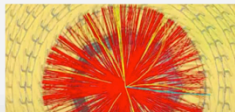


01 January, 2020

Discover the Z and Higgs bosons

Introduces students to CERN, LHC and ATLAS; instructions on how to use the HYPATIA event...

MATTER, PARTICLES AND THE UNIVERSE (KNOWN PHYSICS)
CLASSROOM MATERIALS / TUTORIALS / LESSONS PLANS / TEXT BOOKS ENGLISH UPPER SECONDARY SCHOOL LEVEL



20 September, 2010

ATLAS Event - How ATLAS Detects Particles

This is a segment of the movie 'Episode II, The Particles Strike Back', illustrating how

Search the RDB

KEYWORD

Topics

-Any-

Type / Category

-Any-

Audience

-Any-

Language

-Any-

Search

LATEST



07 June, 2022

De quoi est fait l'Univers ?

Author: Letizia Diamante Primary and Middle school English and French

Material for dissemination of particle physics, detectors, accelerators, applications

Target: scientists, teachers, students, media, general public

Initially launched > 10 years ago

Contents went through curation process

Articles, presentations, videos, posters, games,...

<https://ippog.org/ippog-resource-database>



International Physics Masterclasses

<https://ippog.org/>

Explore the foundations
of the universe!



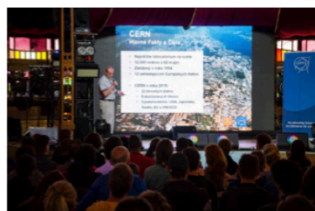
Feedback



IPPOG members in music festivals



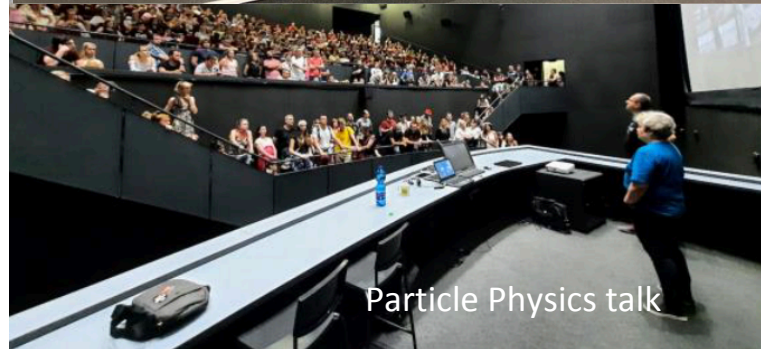
- **Saturday Jul 13, 9:00 -13:30**
- Cloud chamber workshop
- What's the matter with antimatter?
- Beating hearts of galaxies
- Mad science (simple experiments)
- Neural networks which paint like Picasso
- Smells, pheromones and passion



B. Sitar, What have CERN and the LHC ever done for you



Cloud chamber workshop



Particle Physics talk

Big Bang Stage at the Colours of Ostrava music festival (Czech Republic)

Pohoda festival, Slovakia, July 2019

29.07.2024

IPPOG

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Outreach events during IPPOG meetings

IPPOG meeting in Sofia, May 2023

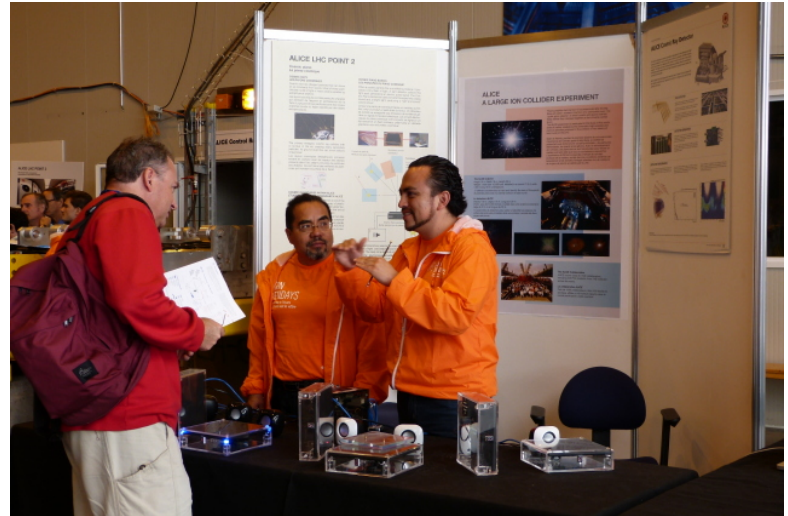
Talks about IPPOG,
Bulgarian participation at CERN

CMS masterclass; Particle therapy masterclass
Poster competition for students

The music of physics (outdoors event)
Talk about cosmic rays, cosmic piano etc

IPPOG meeting Madrid, April 2024

Particle therapy masterclass



VISITS



OG

VIRTUAL VISITS



29.07.2024

IPPOG

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LIVE EVENTS (on facebook, instagram etc,..)



29.07.2024

IPPOG

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Outreach in conferences







In the last years, outreach talks in plenary sessions and dedicated parallel sessions on outreach are included in the programme of most HEP major conferences.

Outreach events for the public are organised during the conference

ICHEP2024 : 5 parallel sessions on outreach
With 6 contributions in each, followed by discussion

Talk at plenary “Education and Outreach“

Lunch discussion

IPPOG and spin-offs from particle physics <i>Club C</i>	<i>Yiota Foka</i>  08:30 - 08:45
Virtual tours and videogames to showcase the ATLAS experiment <i>Club C</i>	<i>Kristin Lohwasser</i>  08:45 - 09:00
Exographer, a videogame based on particle physics <i>Club C</i>	<i>Raphael Granier De Cassagnac</i>  09:00 - 09:15
Leveraging virtual reality for visualising the CMS detector <i>Club C</i>	<i>Muhammad Ansar Iqbal</i>  09:15 - 09:30
Visiting CMS from your living room (virtually!) <i>Club C</i>	<i>Noemi Beni</i>  09:30 - 09:45
Sci-me! - board game and card game from the life of a scientist <i>Club C</i>	<i>Michal Jex</i>  09:45 - 10:00
Open discussion <i>Club C</i>	 10:00 - 10:15

agenda of 1st outreach parallel session at ICHEP2024

Beamline for Schools Competition

Beamline for Schools

Beamline for Schools (BL4S) is a physics competition for high school students from all around the world organised at CERN, the European Laboratory for Particle Physics, in Geneva, Switzerland, and DESY, the German Electron Synchrotron, in Hamburg, Germany. Teams of high school students can propose an experiment that they want to perform at a beamline, that is, a part of a particle accelerator. The teams that submit the three best proposals win a trip to CERN or DESY to perform their experiments at a fully-equipped beamline.

What is a beam and a beamline?

In particle physics, the term 'beam' refers to a large number of particles moving in the same direction. These particles can be accelerated to high energies. The term 'beamline' commonly refers to a straight section of a particle accelerator leading the particles to an experimental area.

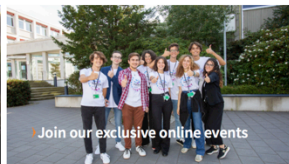
Beamline for Schools 2024 - Happy 10th anniversary!

In 2024 two experiments will be performed at a beamline of CERN's [Proton Synchrotron](#) and one experiment will be performed at a beamline of the [DESY-II synchrotron](#).

All participants who submitted an eligible proposal will receive a participation certificate. [Additional prizes](#) will be awarded to the shortlisted teams and the teams with the best video and outreach proposals. Discover the winning teams of BL4S 2024 [here!](#)

Exclusive online events

We heartily invite the teams who submitted a proposal for BL4S 2024 to a series of [online events](#).



IPPOG forum members involved as:
contact persons, to answer students' questions during the preparation of the proposals
evaluators of the proposals during the pre-selection process

Students from Estonia, Japan and the USA win the 11th edition of Beamline for Schools

Three teams of secondary school pupils from Estonia, Japan and the United States have been selected to carry out their own experiments using accelerator beams at CERN and DESY

25 JUNE, 2024



Winners of the 2024 CERN Beamline for Schools competition: Sakura Particles* from Japan (left), *Mavericks* from Estonia (top right) and *SPEEDers* from the USA (bottom right) *(Images: Sakura Particles, Mavericks, SPEEDers)

A big variety of activities and material is developed and used by the members of our community to meet our different goals and reach out to diverse audiences.

In the limited time of this presentation it is not possible to cover and give credit to all outreach projects.

A personal selection has been presented here.

Instead of conclusion

Significant progress in outreach these last years
New audiences were reached
IPPOG has a central role in this

We can do more

Let us encourage our colleagues to participate in outreach!

It is a rewarding experience, it is fun!

More concerted and systematic effort toward **presentation and popularization of science** would be helpful in many respects; it **would provide a potent antidote to overspecialization; it would bring out clearly what is significant in current research, and it would make science a more integral part of the culture of today.**

Victor Weisskopf Science, Vol. 176 (1972)

THANKS A LOT FOR YOUR ATTENTION