



IPPOG – International Particle Physics Outreach Group

Worldwide Outreach

LHCP 2016

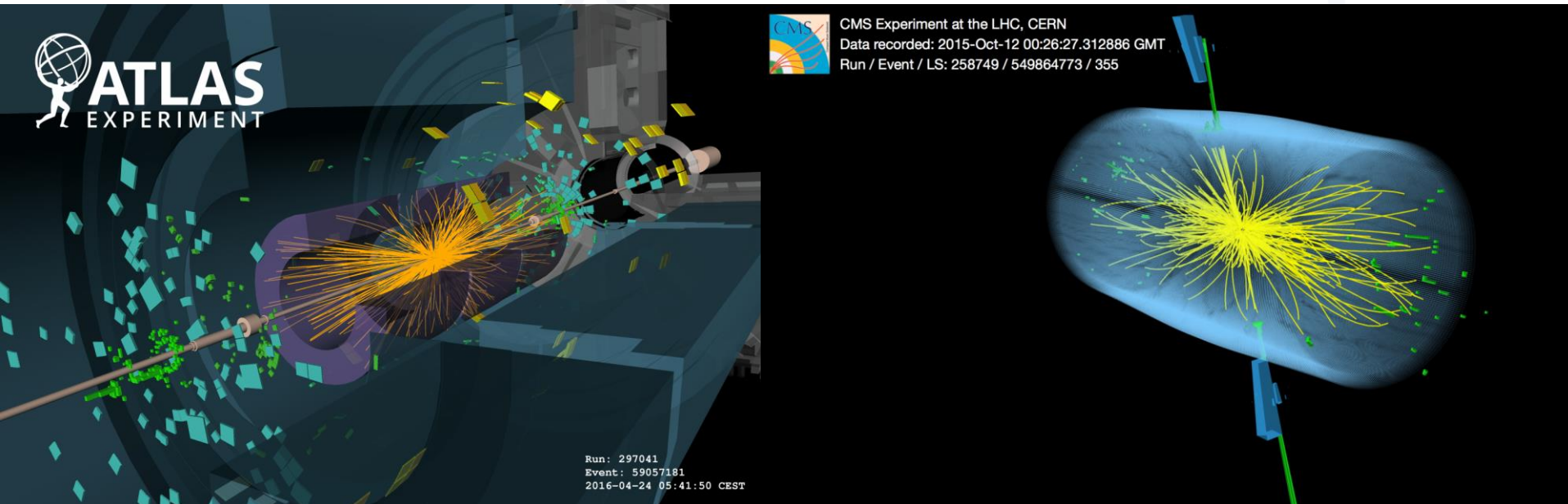
4th Annual Large hadron Collider Physics, 13-18 June 2016

Lund, Sweden

Hans Peter Beck, IPPOG co-chair
University of Bern, Switzerland



13 TeV pp Collisions



Truly an amazing achievement
the biggest complex machinery ever built
possible with a world-spanning collaborative effort,
advancing knowledge in the most fundamental questions
about our Universe!



Critical Outreach

Explaining and reaching out particle physics is a critical necessity for all involved in particle physics research to engage in.

- **Planting seeds**
 - building up the next generation of curious minds
 - some may even chose particle physics
- **Satisfying the curios minds**
 - Curious minds want to get fed
 - and particle physics is offering a lot of food
 - Fundamental physics and the whereabouts of the Universe
 - Human endeavor and human culture
 - Bridging cultures and nations in world-wide collaborations and show-casing how we can work together
 - Advances and pushes technology and creating spin-offs (www, medical, and much, much more)



Critical Outreach

Whom to reach out

- **Young students**
 - Planting seeds in **young curious minds** is most effective
 - these will continue being **curious minds in society**, some may become **scientists** or even **particle physicists**, some will become **decision makers**
 - all will be **tax payers** and **voters**
- **Broad public**
 - To allow for transparency as is natural in all open, democratic societies
 - Be aware that not all are interested
- **Decision makers**
 - **Politicians and funding agencies**

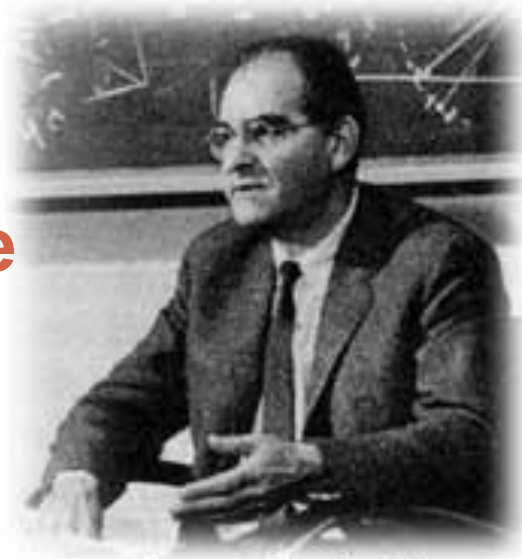
The right level of language is crucial to whomever you talk and needs reflecting the message and complexity you want to convey



The Significance of Science

Victor F. Weisskopf

14 APRIL 1972
SCIENCE, VOL. 176



Victor Weisskopf
1908 - 2002

*“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.**”*



Don't care and don't want to know

Not everybody wants to know and not everybody cares in advancing knowledge

some ignore science

some are even against science

Should we care ?

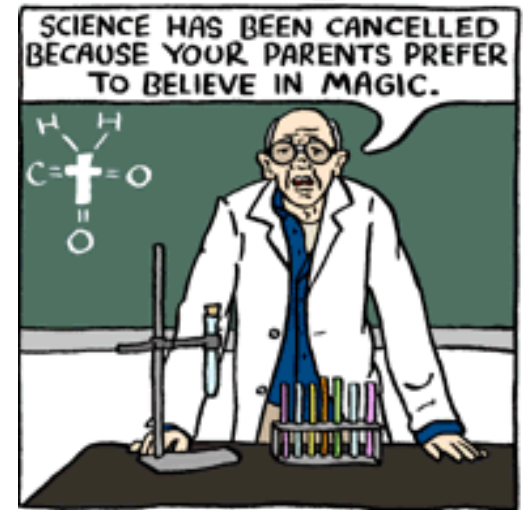
Yes !

Science literacy of a society is as important as literacy itself

We live in a modern world

A basic understanding of the tools and methods developed by a scientific approach that shape so much our daily life is indeed relevant

If we fail, we risk an unbridgeable gap in society



©Brian McFadden (2001-2009)



Reaching out further

How to reach out to the non-interested?

This is a **challenge** that cannot be addressed with exposing scientific tools and methods even stronger

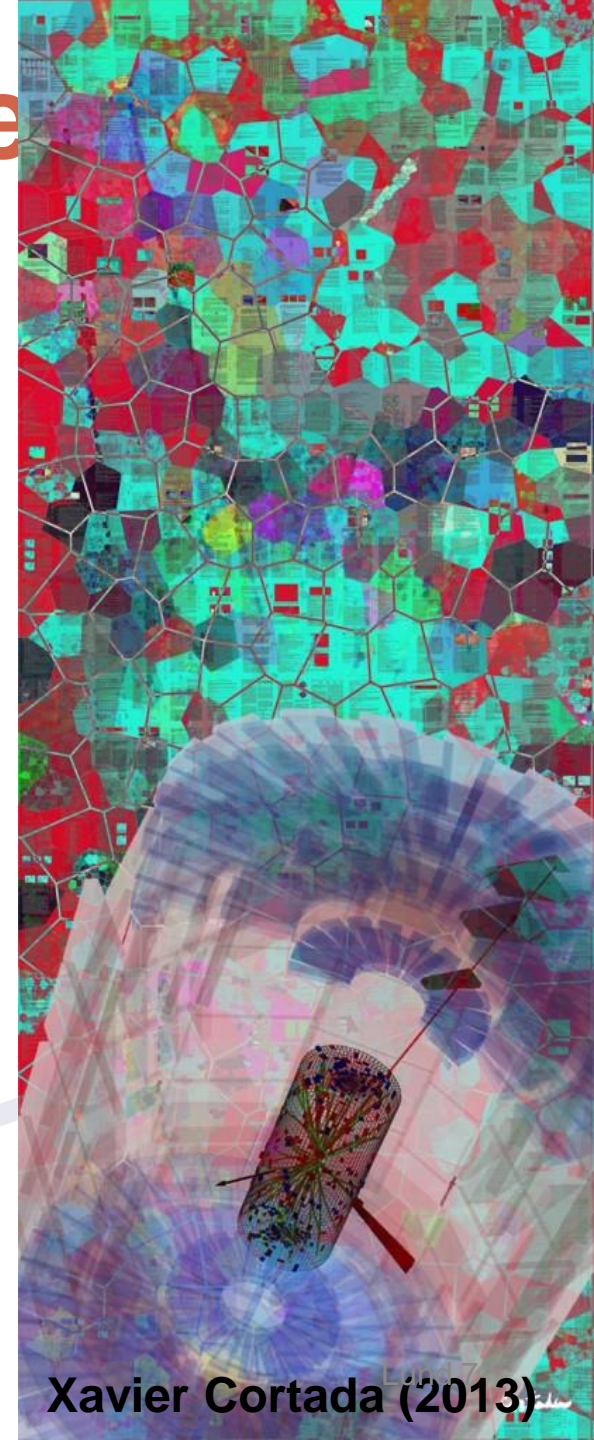
However, **different routes** can **share our enthusiasm** with a wider **audience**

Art involving science topics are a possible way to widen the audience

to share excitement

to trigger reflections inside people's minds on the universe, on science, etc. that otherwise would never happen

There is no need for everybody to become an expert – but **enabling curiosity and apprehension matters**





IPPOG

International Particle Physics Outreach Group

**an example for concerted and systematic
effort for outreach**

The International Particle Physics Network

*IPPOG was **formed in 1997** under the joint auspices of the European Committee for Future Accelerators ([ECFA](#)) and the High Energy Particle Physics Board of the European Physical Society ([EPS-HEPP Board](#)). Initially IPPOG was called European Particle Physics Outreach Group (EPPOG) **which transformed to IPPOG in 2011**, to reflect its true international stature.*

[HOME](#) | [ABOUT](#) | [MEMBERS](#) | [RESOURCES](#) | [MASTERCLASSES](#)

The International Particle Physics Outreach Group (IPPOG)

IPPOG is a network of scientists, science educators and communication specialists working across the globe in informal science education and outreach for particle physics. Particle physics is the science of matter, energy, space and time. IPPOG brings new discoveries in this exciting field to young people and conveys to the public that the beauty of nature is indeed becoming understandable from the interactions of its most fundamental parts - the elementary particles.


Current member come from the 21 member states of CERN, Ireland, Romania, South Africa, the USA, and from DESY, CERN and five of the major experiments at the Large Hadron Collider (LHC).

Marge Bardeen (FNAL) and Hans Peter Beck (University of Bern), co-chairs of IPPOG.


PhD TV: The Higgs Boson Explained

A clever animation explaining what the Higgs Boson is and how the LHC will find it (if it exists).


Film / Video, Book




Latest Resources



Hand-outs for...
to prepare secondary school children for Particle Physics Masterclasses
0 comments



Particle Physics:...
to teach secondary school children about research in particle physics
0 comments



The ATLAS-Detector
to inform secondary school children about the ATLAS Project
0 comments

<http://ippog.web.cern.ch>

– an International Network

34 members representing 26 countries + CERN, DESY, FNAL and 5 experiments

International network of (mainly) **physicists** who commit a fraction of their time in **education** and **outreach**.

These are your **local contacts** in your **country**, **laboratory**, and **experiment** when you need, **advice**, **help**, **support**, in your education and outreach activities.

IPPOG meets twice a year in Spring and Autumn to discuss and exchange **thoughts** and **success stories**, get **inspirational ideas**, and getting **organized world-wide**.



IPPOG Fall meeting
2015 – CERN
Incl. half-day session
with EPPCN



IPPOG Spring meeting 2016 –
Krakow, IFJ PAN



IPPOG an umbrella for making outreach global

CERN Courier June 2014

Education



High-school students from all geographical regions master real event-display programmes, software tools and analysis methods. Having been introduced to the problem, they identify electrons, muons, photons and jets by exploiting their characteristic signals in various detector elements, perform event selection and categorization, and achieve the final analysis goals. (Image credits, left to right: Caroline Hamilton/CoEPP/University of Melbourne, Jayne Ion/ION creative, Franziska Viebach/TU Dresden.)

International Masterclasses in the LHC era

Each year in spring, the International Particle Physics Outreach Group organizes the International Masterclasses, which give students the opportunity to analyse data from the LHC.

The International Masterclasses (IMCs) began in 2005 as an ini-

ATLAS "discovery" data are available for students to Higgs boson; CMS approved 13 Higgs candidates in th of interest, which are mixed with a more abundant sam Z events, for "treasure hunt" activities; ALICE data a to study the relative production of strange particles, w a tell-tale signal of quark-gluon plasma production; L students how to measure the lifetime of the D meson; containing b and c quarks are studied extensively to slu mystery of antimatter in the universe.

Students quickly master real event-display progra

IPPOG

Reaching out with particle physics

How do we communicate about the LHC as a discovery machine, following the Higgs boson of 2012? How do we take the particle-physics masterclasses to new countries, age groups and settings? What makes a good educational game? How do we join in the existing national cosmic-ray-detector programmes, to take them further? These were some of the questions addressed at the 9th meeting of the International Particle Physics Outreach Group (IPPOG), which took place in Paris on 16–18 April.

common project or for an activity going on in only one country. Between the meetings, work continues and ideas are tested: do they work, for example, with real students and teachers? Other topics on the agenda of the recent meeting included discussions on how to boost the educational use of CERN open-access data, and how to bring science education and outreach to particle-physics conferences in a more effective way. There was also news on web resources, exhibits and programmes for teachers and students in the

the communication between researchers, teachers and participants goes on across a longer timescale, may become particularly important. At the other end of the spectrum are the "masterclasses in a box", which are based on printed images and foreseen for settings where no computers are available.

There were also presentations on activities such as the most recent edition of the International Cosmic Day and the International Muon Week. These are crucial when the goal is to have more modern and



IPPOG's participants in Paris. (Image credit: Dominique Longieras/LAL-Orsay.)

CERN Courier June 2015

Faces & Places

CERN Courier
June 2014 edition
&
June 2015 edition



IPPOG at conferences

Education & Outreach becoming an integral part in international HEP conferences

❑ **EPS HEP 2015 – Vienna**

- ❑ Parallel sessions on education and outreach
 - sessions chairs are IPPOG members
- ❑ Panel discussion *"IPPOG: Experts in bringing new discoveries to the public"* (Michael Kobel – IPPOG Germany)

❑ **Lepton Photon 2015 – Ljubljana**

- ❑ plenary talk *"education & outreach"* (Kate Shaw – IPPOG ATLAS)

❑ **ICNFP 2015 – Crete**

- ❑ Invited plenary talk on *"Particle Physics Outreach in the LHC Era: Higgs – What's next?"* (HPB)

❑ **LHCP 2016 – Lund**

- ❑ Parallel sessions on education and outreach ← this session here !

❑ **ICHEP 2016 – Chicago**

- ❑ Parallel sessions on education and outreach (IPPOG engaged and invited)

❑ ...

❑ **CERN Council congratulates IPPOG in its 177th meeting in the RESTRICTED SESSION - EUROPEAN STRATEGY MATTERS**

- ❑ REPORT FROM IPPOG (Item 11 of the Agenda) *The Council took note of the report by the IPPOG Co-Chair, Dr H. Beck, and congratulated the group on the continuing success and rapid growth of its Masterclass programme.*



IPPOG Newsletter

IPPOG NEWSLETTER

SEPTEMBER 2015

Number 1



International Particle
Physics Outreach Group

A word from the coordination team

IN THIS ISSUE

LABORATOIRE DE L'ACCÈS



IPPOG meeting, 18-19

After a very interactive and productive IPPOG is now ready to take several sources! The future of IPPOG is very We hope you enjoy this first number next meeting in autumn at CERN.



"Universe of international network science and education Understanding and enthusiasm!"

"The discovery of Higgs boson is not the end of the story... it is just the beginning of a new era... The scalar era!"

-- IPPOG on LHO as a discovery machine

IPPOG formation strategy of fundamental scientific "How to

IPPOG NEWSLETTER

FEBRUARY 2016

Number 2



International Particle
Physics Outreach Group

A word from the coordination team

Dear IPPOGers,



IPPOG meeting, 6-7 November at CERN, IPPOG & EPPCN family

Last year has been very rich and productive for IPPOG, and we can be proud of many achievements and successes. Thank you, all, for your contributions, which are crucial!

The Initiative of IPPOG to become an official body on its own right and with secured funding has advanced considerably. The Memorandum of Understanding is now with CERN Legal Service for scrutiny and will be soon ready for signatures. Thus, 2016 will be marked by at least two joyful events: IPPOG becoming a formal collaboration and our scientific secretary Barbara Gulejova, welcoming a little IPPOG baby boy!

Our membership is growing worldwide and IPPOG is becoming truly international. In 2015 we got one new member and several others intend to become members this year. Summer 2015 was memorable in terms of conference education and outreach contributions on behalf of IPPOG.

The last IPPOG meeting in November 2015 at CERN (<https://indico.cern.ch/event/446711/>) was very fruitful. Tradition from 2014 continued, and EPPCN colleagues joined us for a half-day session, which was opened by the new CERN DG, Fabiola Gianotti, who stressed the relevance of both IPPOG and EPPCN. The former Head of the Education and Outreach Group of CERN Directorate Office, Rolf Landua, also highlighted the importance of IPPOG and the willingness of CERN to support it in the future. The program of the meeting was very rich and diverse and we hope you will enjoy reading about the highlights in this second edition of the IPPOG Newsletter.

Wishing you a great and successful 2016. We look forward to see you at the next IPPOG meeting on 19-21 May in Cracow.

Hans Peter, Marge and Barbara

IPPOG growing truly international



Last year Australia has been unanimously voted in as the 26th country in IPPOG! Australia aims to introduce the IPPOG Masterclasses programme as part of their formal science education in high schools in New South Wales. We are glad to have on board such a proactive partner, and we welcome Paul Jackson, the Australian delegate to IPPOG.

Moreover, two new other countries, China and Slovenia expressed interest for membership and potential candidacy for membership from two other continents is in the pipeline!

IN THIS ISSUE

★ IPPOG worldwide

- IPPOG's growing international presence
- CERN Council congratulates IPPOG
- New CERN structure
- IPPOG members' testimonials
- Article about IPPOG in ALICE Matters and CERN Bulletin

IPPOG internal affairs

- Extension of terms of office of current chairs
- 11th IPPOG meeting in Cracow

IPPOG activities

- New Twitter account for International Masterclasses
- IPPOG working on particle physics future's communication strategy

Professionalizing IPPOG

Newsletter twice a year in-between IPPOG meeting.

Memorandum of Understanding between IPPOG members in an much advanced state.

Well defined **IPPOG structure** and tasks.

IPPOG Working groups, with action items.

All these advances would be unthinkable without the help from a dedicated scientific secretary to IPPOG!

IPPOG's Flagship

High school students (15 – 19) are „scientists for one day“

Get invited to a research institute or university

Introductory talks (standard model, detectors, accelerators)

2 h measurement with LHC data

New also with Icecube data

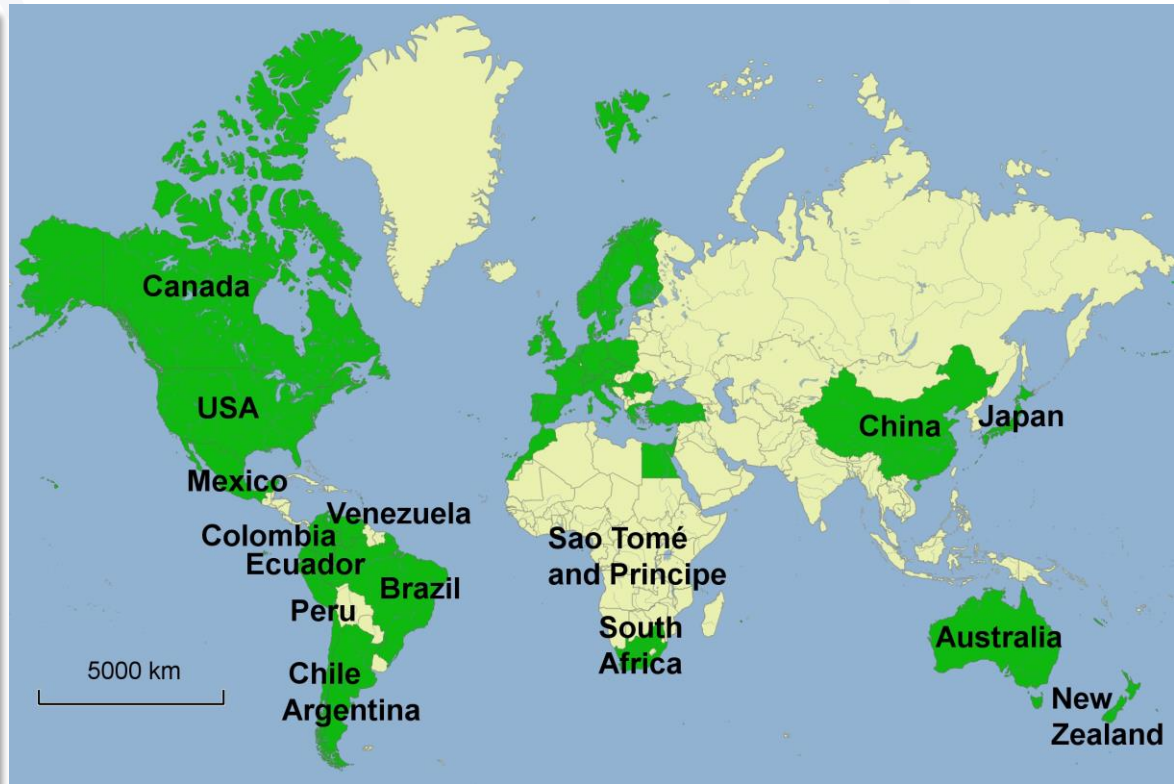
International video conference (2 – 5 inst. + CERN/Fermilab)

See Vladimir Gligorov's talk later this session





International Masterclasses



International Masterclass 2016 11 February – 23 March 2016

46 countries – 213 institutes – 13'000 high-school students – 1'100 teachers



Expanding to Astroparticle physics – discussions and pilot tests ongoing

IceCube Masterclass

<http://icecube.wisc.edu/masterclass/home>

International Muon Week

Quarknet

<http://Internationalmuonweek.org>

International Cosmic Day

<http://icd.desy.de>

Auger Masterclass

<http://auger.colostate.edu/ED/>

- Pilot tests in German Netzwerk Teilchenwelt

International Particle Physics Outreach Group

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International Cosmic Day 2015

International Cosmic Day, organised by DESY

INTERNATIONAL COSMIC DAY
November 05 | 2015

Website / Brochure / Flyer / Leaflet

| | |
|---|---|
| Audience 12 to 15 years 15 to 18 years | Rankings ☆☆☆☆☆ No votes yet |
| Language English | Tags astroparticle physics cosmic rays AUGER data analysis |
| Duration 1 day | |
| Credit Anneli Schulz | |
| Contact icd@desy.de | |

Purpose
Allowing high school student all over the world to perform their own measurements of cosmic rays and discuss their results with other students across the world.

Information
The International Cosmic Day enables students to get in contact with astroparticle physicists to get a first insight into their research, experimental methods and everyday work as a scientist. Some questions which will be addressed are:



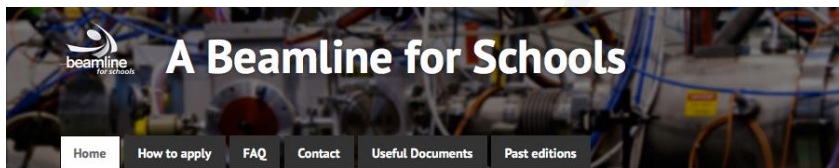
Competition:

<http://beamline-for-schools.web.cern.ch>

a beam line for schools

IPPOG acts as local contacts
to schools in many countries.

IPPOG members take responsibilities
for multiple countries to ensure that language
barriers will not be a insurmountable hurdle.



**Enter CERN's Beamline for Schools 2016
competition now**



| Country | schoools |
|----------------|----------|
| Italy | 85 |
| Spain | 66 |
| United States | 45 |
| United Kingdom | 43 |
| India | 28 |
| Greece | 19 |
| Germany | 17 |
| Canada | 13 |
| Poland | 10 |
| Switzerland | 8 |
| France | 7 |
| Portugal | 7 |
| Romania | 6 |
| Turkey | 6 |

| | |
|--------------|---|
| Netherlands | 6 |
| Singapore | 5 |
| South Africa | 5 |
| Indonesia | 4 |
| Hungary | 4 |
| Austria | 4 |
| Mexico | 4 |
| Ireland | 4 |
| Iran | 3 |
| Colombia | 3 |
| Estonia | 3 |
| Thailand | 3 |

| | |
|----------------|---|
| Egypt | 3 |
| Slovakia | 3 |
| New Zealand | 2 |
| Czech Republic | 2 |
| Brazil | 2 |
| Norway | 2 |
| Serbia | 2 |
| Slovenia | 2 |
| Bulgaria | 2 |
| Australia | 2 |
| Afghanistan | 2 |
| Peru | 2 |
| Lebanon | 1 |

| | |
|-----------|---|
| Jordan | 1 |
| Mauritius | 1 |
| China | 1 |
| Kuwait | 1 |
| Nigeria | 1 |
| Malaysia | 1 |
| Ethiopia | 1 |
| Haiti | 1 |
| Pakistan | 1 |
| Guyana | 1 |
| Chile | 1 |
| Kenya | 1 |
| Latvia | 1 |

| | |
|------------|---|
| Belgium | 1 |
| Sri Lanka | 1 |
| Cyprus | 1 |
| Malta | 1 |
| Qatar | 1 |
| UAE | 1 |
| Israel | 1 |
| Bangladesh | 1 |
| Total | 1 |

GENERATION OF SCIENTISTS AND INNOVATORS

17 Nov 2015 — Alcoa Foundation and

Competition for 2016

Winners chosen –CERN press release today

<http://home.cern/about/updates/2016/06/winners-2016-beamline-schools-competition-announced>



EPS-HEP 2015 Outreach Prize



2015 Kate Shaw

IPPOG Delegate and ATLAS Outreach Coordinator

*For her contributions to **the International Masterclasses** and for **her pioneering role** in bringing them to countries with no strong tradition in particle physics.*





A concerted and systematic effort for outreach

Outreach is crucial but good outreach is not easy

- **If overdone**
 - Particle Physics will be seen as over-advertized
 - the highly respected reputation of science is at stake
- **Getting the right level**
 - Being too close in a specific topic will easily drag you too far
 - keep your explanations simple but avoid being trivial
 - use good metaphors that relate with your audience
- **When engaging in outreach**
 - you will find your personal antidote against overspecialization and learn how to focus on the really relevant questions and topics and how to best explain and present these



Recommendations

If you are a young physicist

engage a small fraction of your time in EC&O activities

If you are a group leader

engage a small fraction of your time in in EC&O activities

support your group members who are active in EC&O

(not all will be active and not all do need to be active in EC&O)

If you are hiring a new postdoc or faculty member

make sure the person you will hire has good communication skills

in case this person has a track record in EC&O activities, even better!



Thank you for your attention

**Get in contact your IPPOG delegate
in your country**

<http://ippog.web.cern.ch>

for all about outreach

The European strategy update – 2013

CERN-Council-S/106

What the European Strategy for Particle Physics says on the

Wider impact of particle physics

- n) Sharing the excitement of scientific discoveries with the public is part of our duty as researchers. Many groups work enthusiastically in public engagement.

They are assisted by a network of communication professionals (EPPCN) and an **international outreach group (IPPOG)**.

For example, they helped attract tremendous public attention and interest around the world at the start of the LHC and the discovery of the Higgs boson.

Outreach and communication in particle physics should receive adequate funding and be recognised as a central component of the scientific activity.



IPPOG'S PURPOSE

Strengthening the sustainability, reproduction and growth of outreach activities in particle physics

through the provision of reliable and regular discussion forums and information exchange for science institutions and laboratories as well as for individual scientists engaged in science outreach and informal science education world-wide

Raising standards

for outreach and informal science education initiatives by proposing and implementing strategies designed to share lessons learned and best practices for outreach in particle physics and related fields

Providing explanatory materials

for helping disseminate results from particle physics and related subjects.



Things that need correcting

**prejudices and perceptions
of the broad public
that could come up**



'irrelevant science of things'

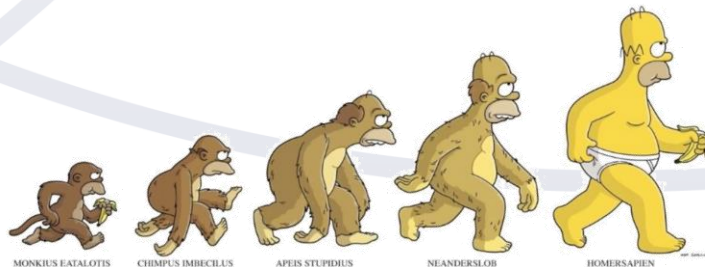
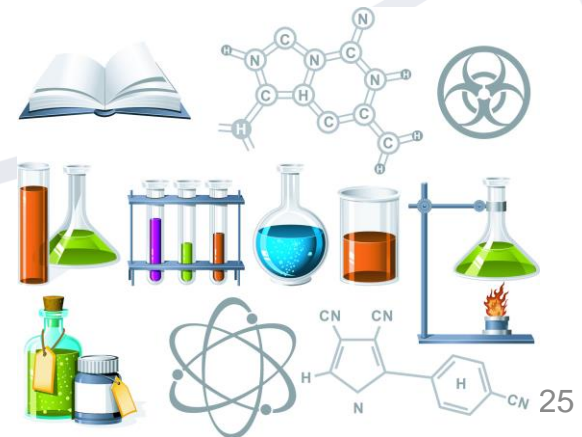
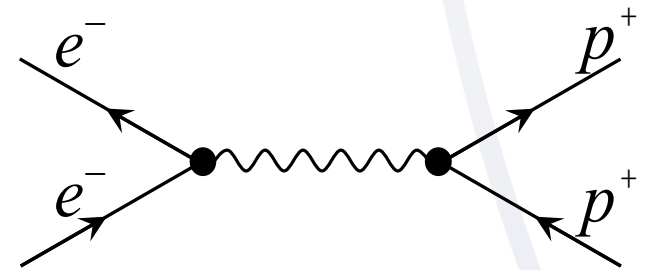
Prejudice: Physics is often perceived as the '**science of things**' and therefore detached (i.e. irrelevant) from life, the universe and everything.

Don't be shy to state that
(particle-) **physics** is the fundamental
base for all understanding of life,
the universe and everything

I.e. **Chemistry** is based on **physics**
quantum mechanics, (quantum-)electrodynamics

Biochemistry is based on **chemistry**

Life is based on **biochemistry**



HOMERSAPIEN

Things that need correcting



'it's calculated – why measure?'

Prejudice: Everything can be calculated and there is no need for experiments
accelerators and other infrastructure are just toys for boys and girls

Use the **chess analogy** to counter state

Physics elaborates on **finding the rules**
on how the **Universe works**

These rules are like the rules of
the game chess

Knowing the rules opens up to understand
chess and play the game

However, an individual chess game is way open on how it can
evolve.



Further, the rules we found have been **validated only within a limited energy scale** (high energy frontier, low energy precision measurements), that we cannot rely on these rules beyond the limits these are validated.

New physics, i.e. **extending the rules we know**, is possible and is a big **driving force** in fundamental research.



'it's calculated – now its dull!'

Prejudice: Whatever is explained by science becomes dull and loses its mysteries, fascination and wonders.

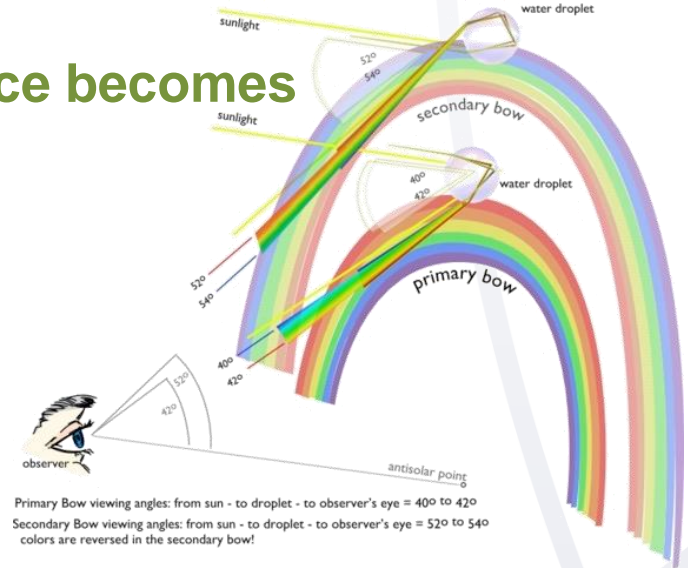
The contrary is true !

Use the **archeological site analogy**

If you don't know about the site you are visiting, all you see is a pile of old stones and perhaps some funny (maybe appealing) ornaments and scripture.

The more you know about the ancient culture, their habits and their lives, the more interesting the archeological site becomes.

Physics opens up understanding nature, and allows enjoy nature more and more.





'it's calculated – now its dull!'

Things that need correcting

Prejudice: Whatever is explained by science becomes dull and loses its mysteries, fascination and wonders.

The contrary is true !

Use the archeological site analogy



The Gannarve megalithic ship grave on the island Gotland in Sweden.

If you don't know about the site you are visiting, all you see is a pile of old stones and perhaps some funny (maybe appealing) ornaments and scripture.

The more you know about the ancient culture, their habits and their lives, the more interesting the archeological site becomes.

Physics opens up understanding nature, and allows enjoy nature more and more.



'particle physics detached from life'

Things that need correcting

Prejudice: New findings by particle physics experiments are so detached from real life and from real problems that these are of no concern anyhow and therefore of no use.

It's true that knowing the Higgs existing and its mass doesn't change every days life.

Knowing that there is a Higgs mechanism responsible for mass of elementary particles, and that mass is fundamentally needed for allowing structure to build up in the Universe, put's this knowledge on a different scale. We simply wouldn't exist without it!

All after all, it's all about the Universe in the end being Intelligible and in a combined effort, we can learn how it works.



'science findings don't last'

Things that need correcting

Prejudice: Established knowledge is only valid for a short moment in time and thrown over board immediately when new findings come in. As this happens iteratively, there will never be anything useful worth trusting. Science (and scientists) can't be trusted.

Although **bad examples do exist** e.g. in clinical studies based on too small or biased samples, **this is not true in general.**

The work and findings of e.g. Newton and many, many more, is still valid today;

although **general relativity supersedes Newtonian mechanics**, we now know exactly how good Newtonian mechanics works and where the limits are.

Empirical established knowledge will stay forever as part of human culture.

The existence of the Higgs boson will stay, but it's role in nature is still open for future refinements.



Having found the Higgs

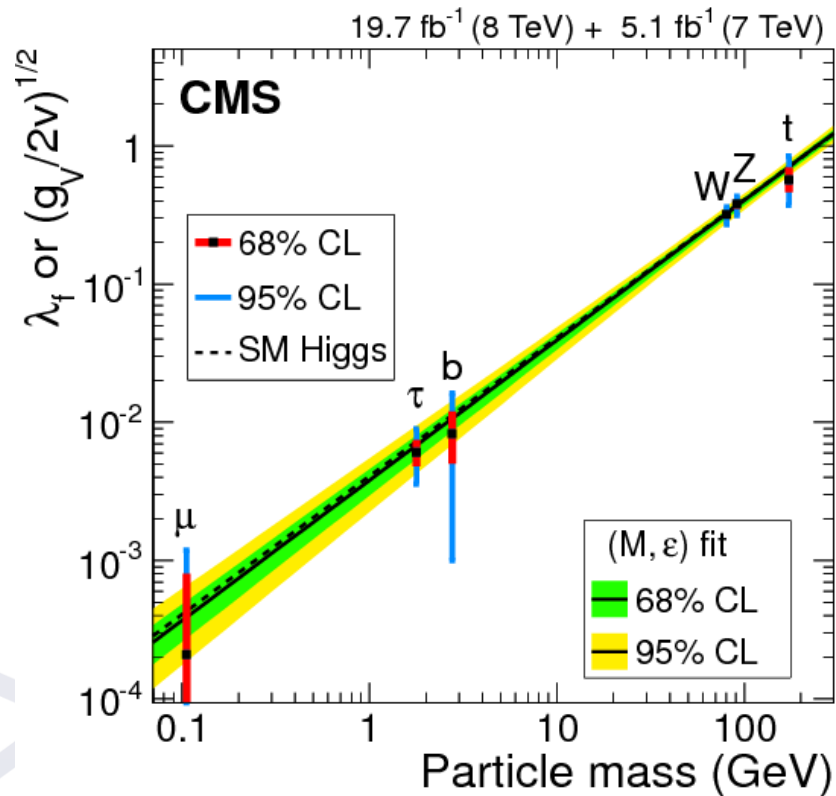
The end of Particle Physics ?

or

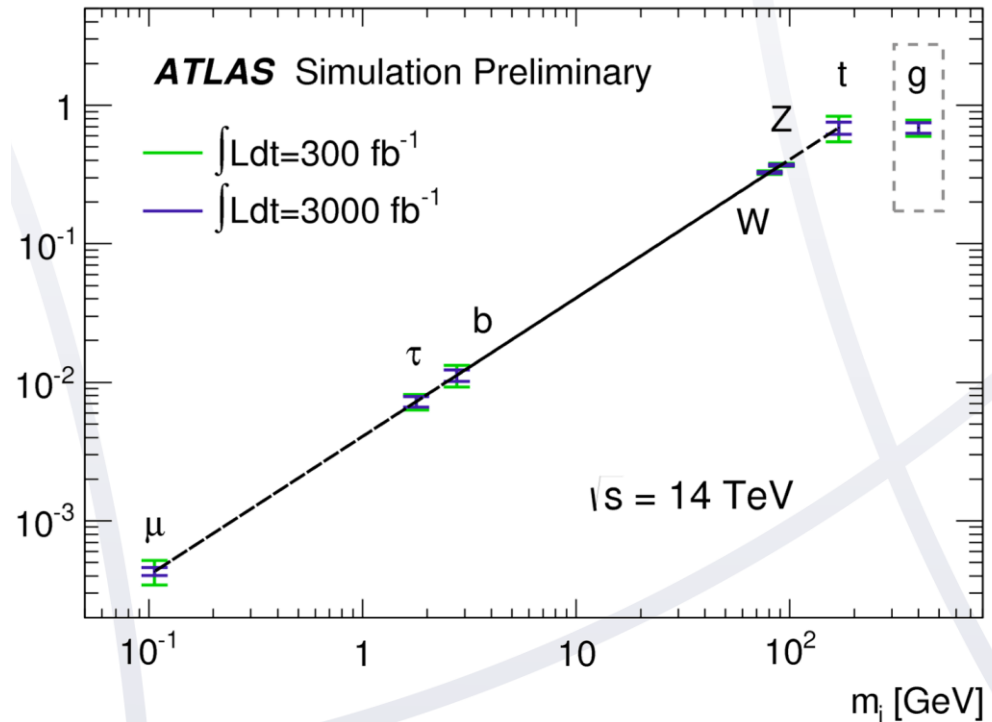
The beginning of a New Scalar Era ?



What if only one SM like Higgs ?



Today



LHC potential with 3 ab⁻¹



Only one SM Higgs – what now ?

Tendency in public + funding agencies:
now you have the Nobel + the Higgs - be happy + silent !

Needs a **LHC Run 2 communication strategy** and also paving the way for **future projects after LHC**

FCC ? (Geneva, China, ... ?)

ILC ?

Needs: **support from the public**, a next generation of **young physicists**, and support from the **funding agencies**

Higgs is the only elementary scalar particle (as we know today), and marks the **beginning of a new scalar era**.

There are more scalar fields out there, which need exploring:

Inflaton (?)

Cosmological constant ↔ Dark Energy (?)

Cosmological questions drive particle physics beyond Higgs ! !



Good Metaphors Help

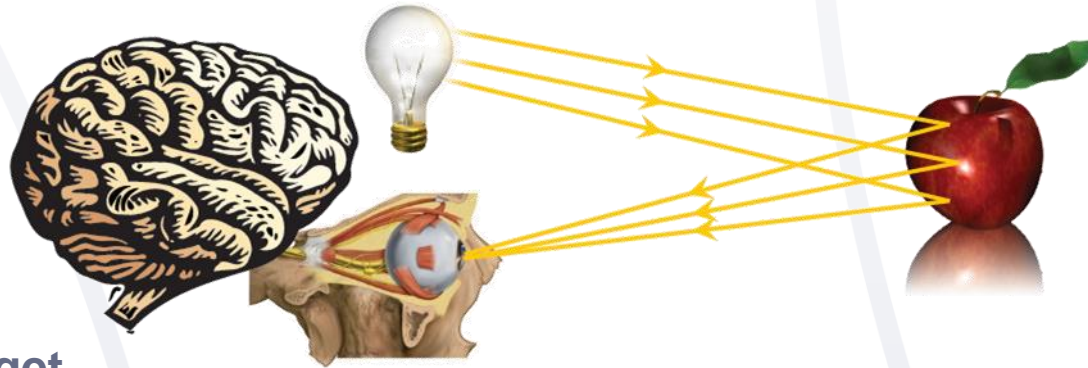
**When interacting with
the interested audience
and
the critical minds**



Humans are particle detectors too

The **act of 'seeing'** involves all elements of a modern particle physics experiment.

- **Accelerating particles**
 - You need a photon gun, i.e. a light bulb, a torch or simply the sun
 - **Particles scattering of a target**
 - These photons have to scatter off an object being watched
 - **Measuring scattered particles**
 - On your retina, photons within an energy range of 1.6-3.3 eV are measured and converted in electrical signals
 - **Reconstruction and analysis**
 - Energy, momentum, and the rate (i.e. intensity) of photons is the information content transported to the visual cortex via the optic nerve for online pattern recognition and reconstruction.
- we perceive an image of the target object in the brain with colour coding the energy of scattered photons.
Colour is truly perceived pseudocolour.





A flat earth is not completely wrong

Imaging the world as being flat yields a reasonably good approximation of our local environment

- **No need to know the earth radius to build a house or a bridge across a river or a valley**



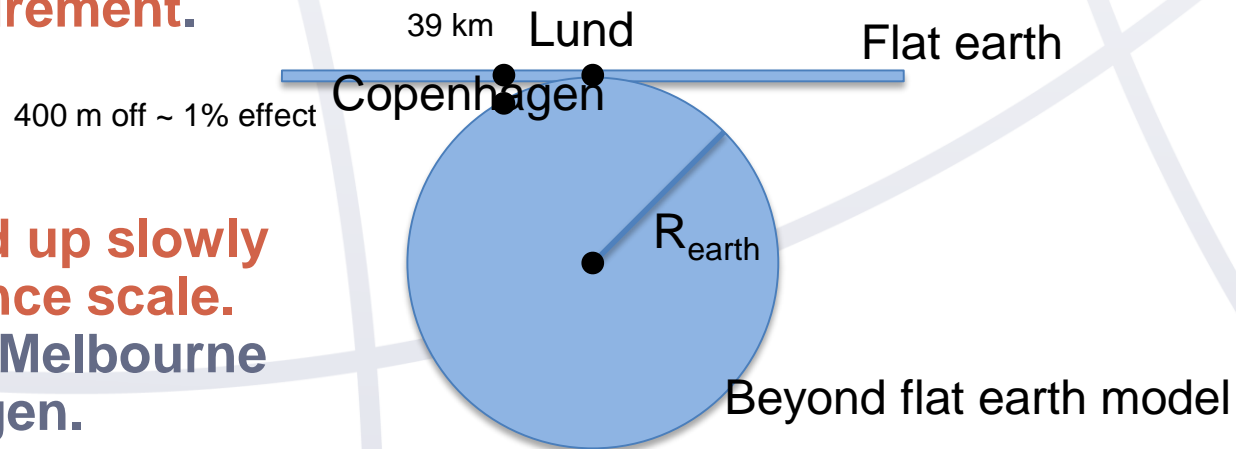


Measuring the Standard Model at unprobed energy scales

Even a good and axiomatically well motivated mathematical model i.e. flat earth – or, if you want, the Standard Model, is only as good as it has been tested by experiment.

Predicting the coordinates in absolute space, given direction and distance, of Copenhagen from Lund and assuming a flat earth is straight forward to do.

Traveling to Copenhagen and carefully measuring via triangulation the true coordinates of Copenhagen takes an effort and will lead to a sizeable discrepancy between theoretical prediction and measurement.



Discrepancy will build up slowly with increasing distance scale. i.e. take New York, or Melbourne rather than Copenhagen.



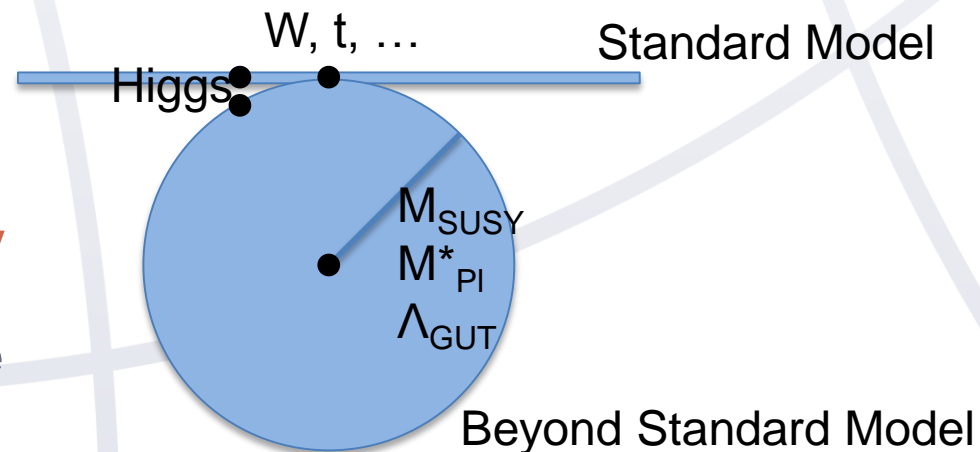
Measuring the Standard Model at unprobed energy scales

Even a good and axiomatically well motivated mathematical model i.e. flat earth – or, if you want, the Standard Model, is only as good as it has been tested by experiment.

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Measuring the Standard Model at unprobed energy scales

Scales matter – even when a model is axiomatically well defined

Expanding the scale at which a model is probed will either further strengthen the validity of the model or will tell when the model collapses and a new model will need to be found.

It is exactly the deviation from the predicted value that tells how a better model can be constructed.

Old models embed in the new and better model describing the world and keep their validity within a limited but now well understood scope.

As discussed already with Newtonian mechanics and Einstein's general relativity.



Measuring the Standard Model at unprobed energy scales

Why does it matter ?

Again the **flat earth analogy** helps:

Knowing the earth is round doesn't help building a better house – your architect doesn't rely on knowing R_{earth} when drawing your new house.

Reaching out to India via going West, however, is adding new concrete possibilities.

You may detect further unknown territory while on your way.

We may be in a position to **understand Dark Matter** or even **Dark Energy** once we know how to **expand out of the Standard Model**.

