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
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 choose particle physics

- **Satisfying the curious 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
“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 live is indeed relevant

If we fail, we risk an unbridgeable gap in society
Reaching out further

How to reach out to the noninterested?

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 peoples 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.

Hans Peter Beck

Xavier Cortada (2013)
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.

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

http://ippog.web.cern.ch

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

International Masterclasses, the flagship activity of IPPOG, trained over 13,000 students and 1,000 teachers in Spring every year! Over 200 institutions in over 46 countries participating.

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 (IMC) began in 2005 as an ini-

CERN Courier

Hans Peter Beck
LHCP 2016

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.

IPPOG Reaching out with particle physics

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 NuDay Week. These are crucial when the goal is to have more modern and
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.
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!
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 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](http://icecube.wisc.edu/masterclass/home)

**Auger Masterclass**
[http://auger.colostate.edu/ED/](http://auger.colostate.edu/ED/)
- Pilot tests in German Netzwerk Teilchenwelt

**International Muon Week**
[Quarknet](http://Internationalmuonweek.org)

**International Cosmic Day**
[http://icd.desy.de](http://icd.desy.de)
Competition: 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 an insurmountable hurdle.

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

Competition for 2016
Winners chosen – CERN press release today

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

Where have we been

Egypt 2013
Lebanon 2015
Vietnam 2014
Nepal 2014
Algeria 2013
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 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
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.*

EPPCN and IPPOG should both report regularly to the Council.
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
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.
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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’

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 straightforward 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.
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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 relay on knowing \( R_{\text{earth}} \) 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.