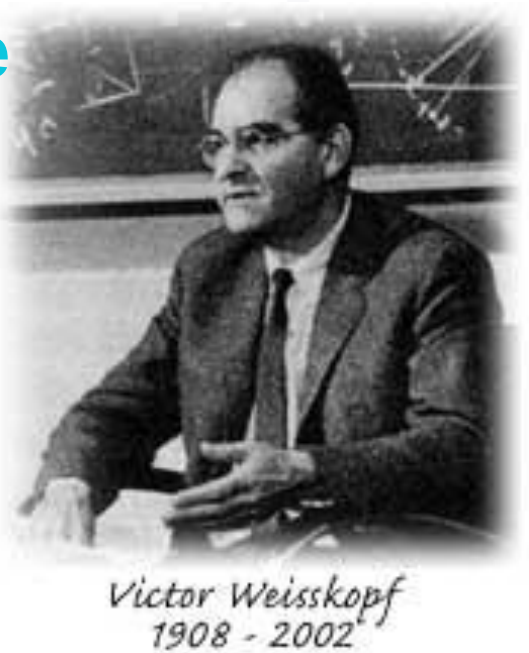
Report to ECFA, November 19th 2015

Hans Peter Beck: IPPOG Co-chair, Bern University
Marjorie Bardeen: IPPOG Co-chair, Fermilab

The Significance of Science

Victor F. Weisskopf

14 APRIL 1972
SCIENCE,VOL.176



*"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."*

IPPOG – an International Network

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

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 nee **advice**, **help**, **support**, in your education and outreach activities.

IPPOG Spring meeting 2015 – Paris, Orsay LAL

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
Half-day session + dinner with EPPCN

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 t
Higgs boson; CMS approved 13 Higgs candidates in th
of interest, which are mixed with a more abundant san
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; I
students how to measure the lifetime of the D meson;
containing b and c quarks are studied extensively to sh
mystery of antimatter in the universe.

Students quickly master real event-display progra

International Masterclasses, the flagship activity of IPPOG trained over **10'000 students in Spring every year !**

Over 200 institutions in over 46 countries participating.

CERN Courier June 2015

Faces & Places

IPPOG

Reaching out with particle physics

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

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

CERN Courier
June 2014 edition
&
June 2015 edition

IPPOG is recognized internationally

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)*
  - EPS-HEP Outreach Prize (see next slide)

- **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)*

- **CERN Council congratulates IPPOG in its 177th meeting in the RESTRICTED SESSION - EUROPEAN STRAGEGY 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.*
- …

EPS-HEP 2015 Outreach Prize

Physics without Frontier

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.*

IPPOG NEWSLETTER

SEPTEMBER 2015 Number 1

International Particle Physics Outreach Group

A word from the coordination team

Dear IPPOGers!

We are very happy to share with you this first issue of the IPPOG newsletter, which will appear twice a year between IPPOG meetings. The aim of this new tradition is to keep IPPOG spirit alive also in between the meetings and maintain you informed about the most important happenings in our community, and thus to facilitate even closer collaboration of our team. This little periodical would also allow us to show to the interested external eyes what IPPOG is and does.

IPPOG meeting, 18-18 April 2015, Paris

fter a very interactive and productive spring meeting in Paris https://indico.cern.ch/event/354555/ PPOG is now ready to take several new actions and continue its mission with full power and new ources! The future of IPPOG is very promising and a lot of upcoming initiatives are in the pipeline!

Ve hope you enjoy this first number of IPPOG newsletter and looking forward to see you at the ext meeting in automne at CERN.

Hans Peter, Marge and Barbora

IN THIS ISSUE

IPPOG worldwide
- EPS outreach prize
- Article about IPPOG in CERN Courrier
- IPPOG at conferences
- IPPOG outreach session at EPS

IPPOG internas
- IPPOG on the way towards official collaboration
- New support in IPPOG coordination team
- 10th IPPOG meeting at CERN

IPPOG activities
- Masterclasses 2015 and 2016
- Cosmic rays becoming global

' Universe of Particles : Explore, Discover, Understand, be Inspired!'

International network of scientists, science educators and explainers engaged in informal science and education and outreach for particle physics across the globe.

Vision for the future:

Understanding and enthusiastic support of particle physics and related sciences from all audiences.

IPPOG's current members come from CERN's 21 member states, plus Ireland, Romania, South Africa and USA, prominent laboratories and institutions in Europe and USA and 5 major experiments at LHC. Since 2013 the co-chairs of IPPOG are Marge Bardeen and Hans Peter Beck.

'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 LHC as a discovery machine

"Higgs-what now?"

IPPOG feels the need for LHC Run 2 communication strategy especially in the context of the future of fundamental research in particle physics and non-scientific audience acceptance.

"How to prepare/approach the discoveries beyond the Standard Model?"

"The nature of dark matter cannot be explained without the LHC upgrade..."

- IPPOG on LHC as a discovery machine

Page 1

Professionalizing IPPOG

Newsletter twice a year in-between IPPOG meeting.

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

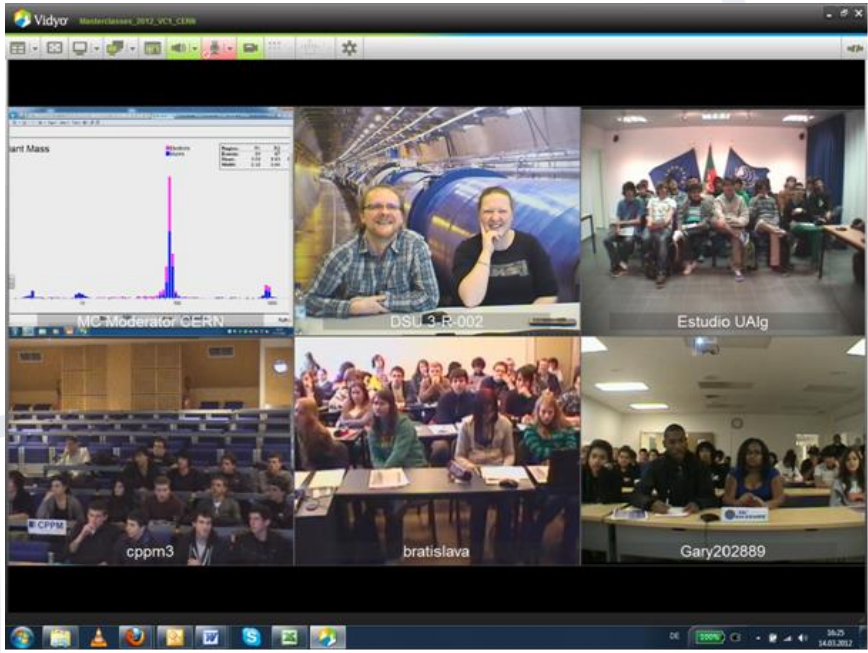
Well defined **IPPOG structure** and tasks.

IPPOG Working groups, with action items.

All these advances would be unthinkable without the help from Barbora Gulejova! (Fellow from CERN education; 50%FTE on IPPOG)

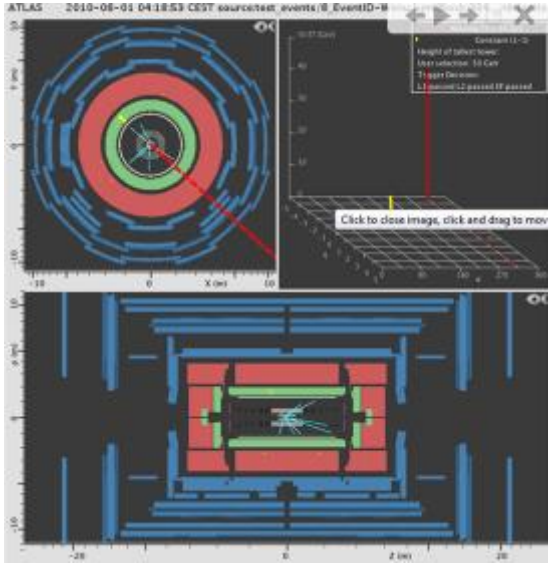
International Masterclasses IPPOG's Flagship

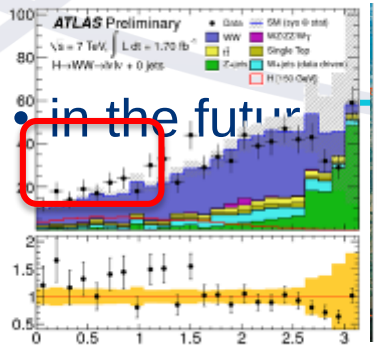
- High school students (15 – 19) are „scientists for one day“
- Get invited to a research institute or university
- Introductory talks (standard model, detectors, accelerators)
- 2 h measurement with LHC data
  - New also with Icecube data
- International video conference (2 – 5 inst. + CERN/Fermilab)

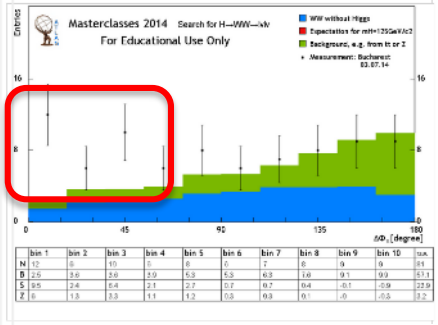


High-school students analyze LHC data

- **ATLAS**
  - W path (Higgs → WW)
  - Z path (discover Extra Z' Bosons)
- **CMS**
  - WZH measurements
- **ALICE**
  - Looking for Strange Particles
  - R_AA
- **LHCb**
  - $D^0 \rightarrow K\pi$ measurement







- in the futur

Analyses are kept up to date and improve
- Exploit known Standard Model Processes, e.g.
  - W^+/W^- ratio corresponding to (uud) quarks in proton
  - Understand mass peaks of J/Psi and Z
- On the way to discover new particles
  - Higgs → WW
  - Extra Z Bosons
  - …

For example: The CMS WZH measurement

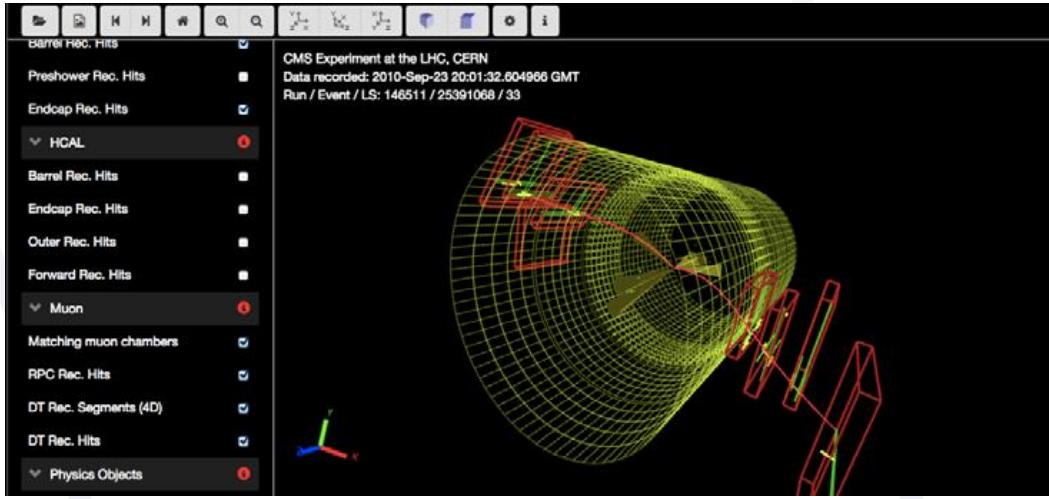
– Students visually characterize, W, Z, and H candidates in event display and extracting kinematics from objects ‘they see’ and fill spread sheets.

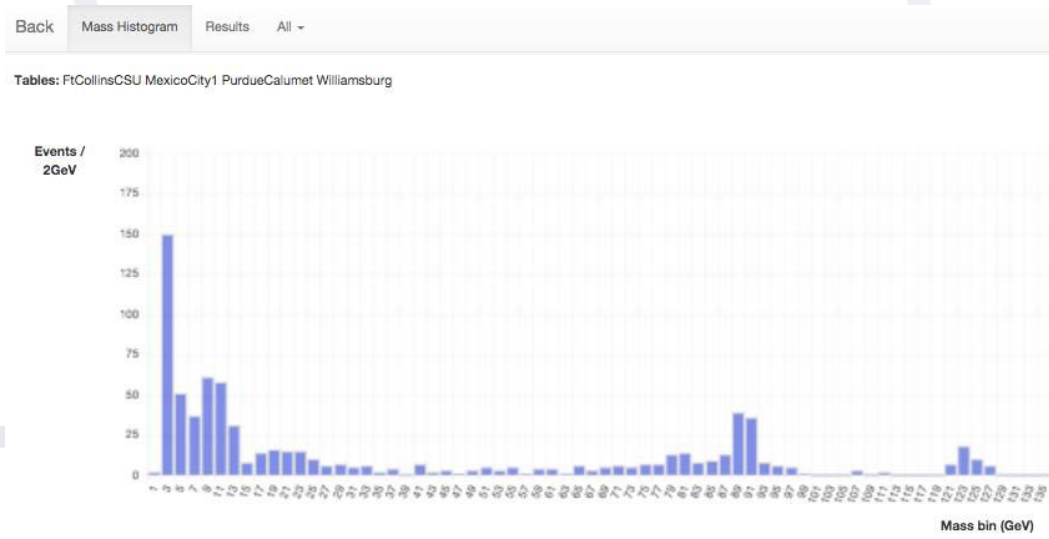
– Create mass plots of SM particles that decay in 2 leptons plus H

– Measure W^+/W^- ratio in e and μ leptonic channels

– 3000 events can be analyzed – with misfits, surprises, interpretation

– Website in 12 languages for 2016

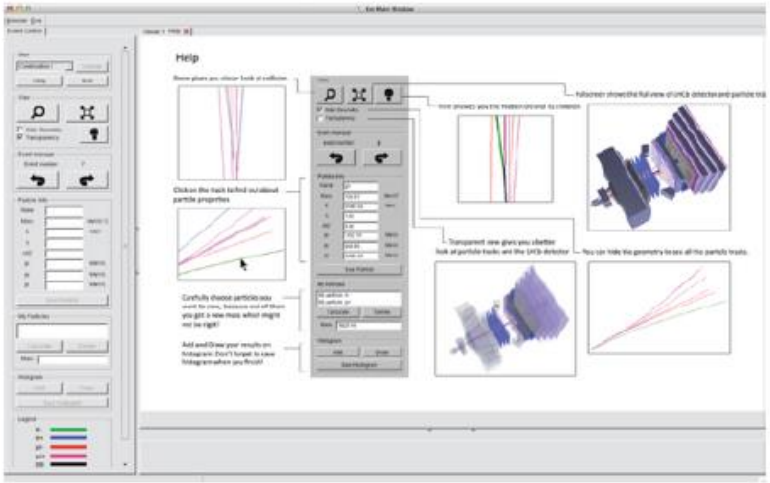


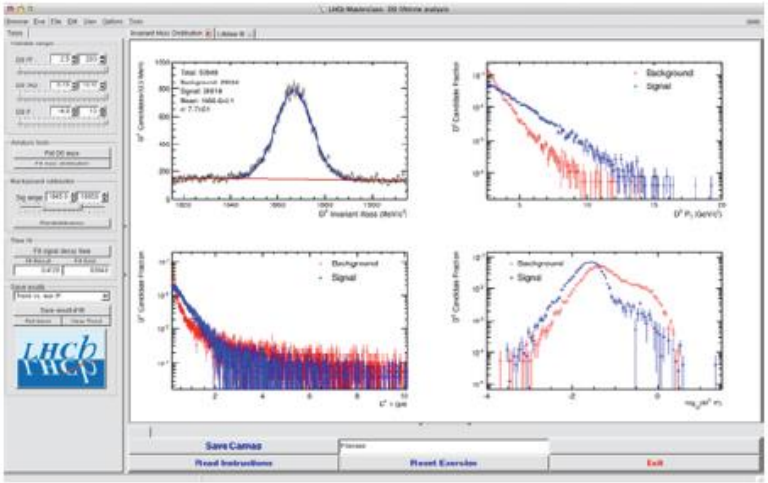


For example: The LHCb $D^0 \rightarrow K\pi$ measurement

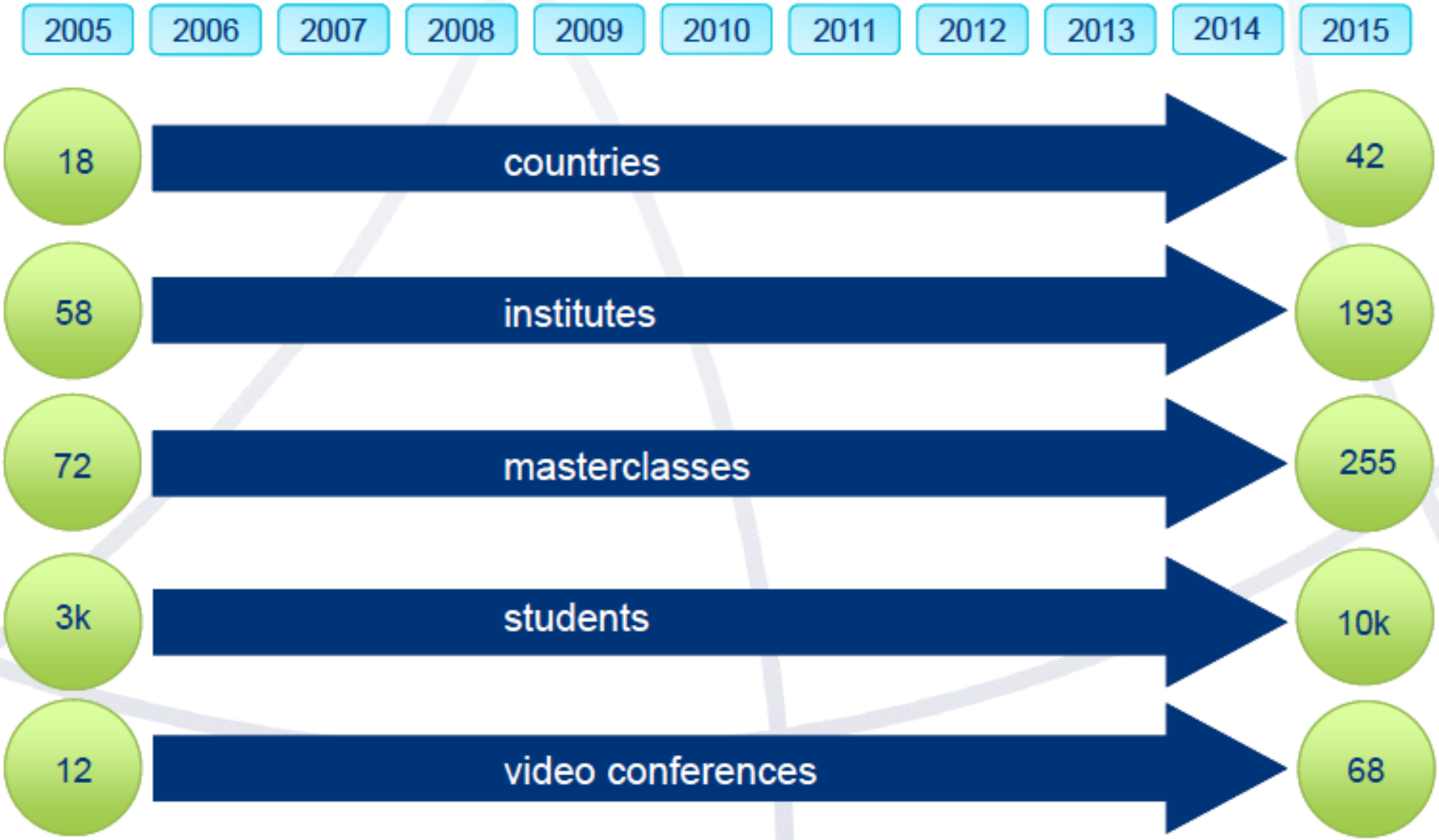
- LHCb experience has > 20 institutes involved, EU and US for 2015/2016.

- The experience is twofold:
  - The students search for the $D^0 \rightarrow K\pi$ decay using an event display.
  - The students also perform a lifetime measurement at the 1% level.





Evolution of Masterclass participation



International Masterclasses

Possible new candidates for 2016:

Mozambique, Madeira, Russia, India, Venezuela, Bangladesh, Mongolia, Korea, Albania

Expanding to Astroparticle physics – discussions and pilot tests ongoing

IceCube Masterclass

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

Auger Masterclass

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

- Pilot tests in German Netzwerk Teilchenwelt

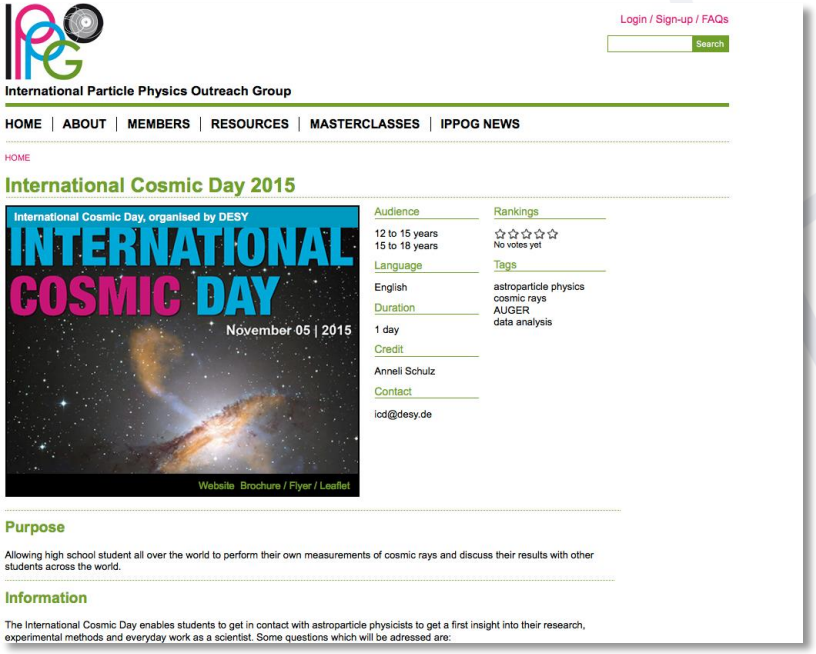
International Muon Week

Quarknet

http://Internationalmuonweek.org

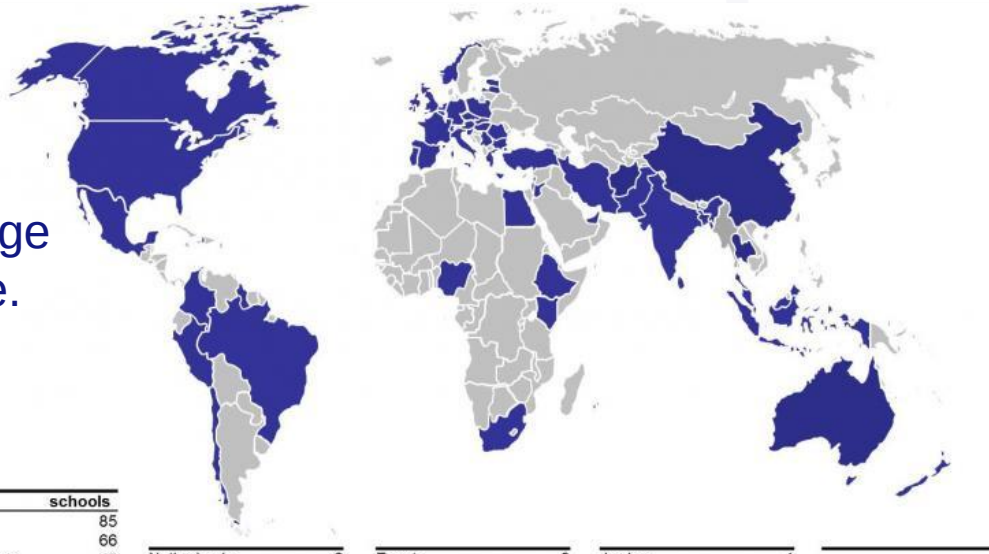
International Cosmic Day

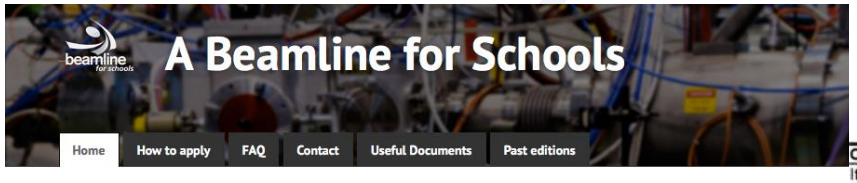
http://ippog.web.cern.ch/resources/2015/international-cosmic-day-2015



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 a insurmountable hurdle.





Enter CERN's Beamline for Schools 2016 competition now

Country	schools
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	Egypt	3	Jordan	1		
Singapore	5	Slovakia	3	Mauritius	1	Belgium	
South Africa	5	New Zealand	2	China	1	Sri Lanka	
Indonesia	4	Czech Republic	2	Kuwait	1	Cyprus	
Hungary	4	Brazil	2	Nigeria	1	Malta	
Austria	4	Norway	2	Malaysia	1	Qatar	
Mexico	4	Serbia	2	Ethiopia	1	UAE	
Ireland	4	Slovenia	2	Haiti	1	Israel	
Iran	3	Bulgaria	2	Pakistan	1	Chile	
Colombia	3	Australia	2	Guyana	1	Bangladesh	
Estonia	3	Afghanistan	2	Peru	1	Kenya	
Thailand	3	Lebanon	1	Latvia	1	**Total**	

GENERATION OF SCIENTISTS AND INNOVATORS

17 Nov 2015 — Alcoa Foundation and the CERN & Society Foundation join forces for the third annual Beamline for Schools Competition

Search this site

Competition for 2016 announced
this week on 17 November 2015:

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

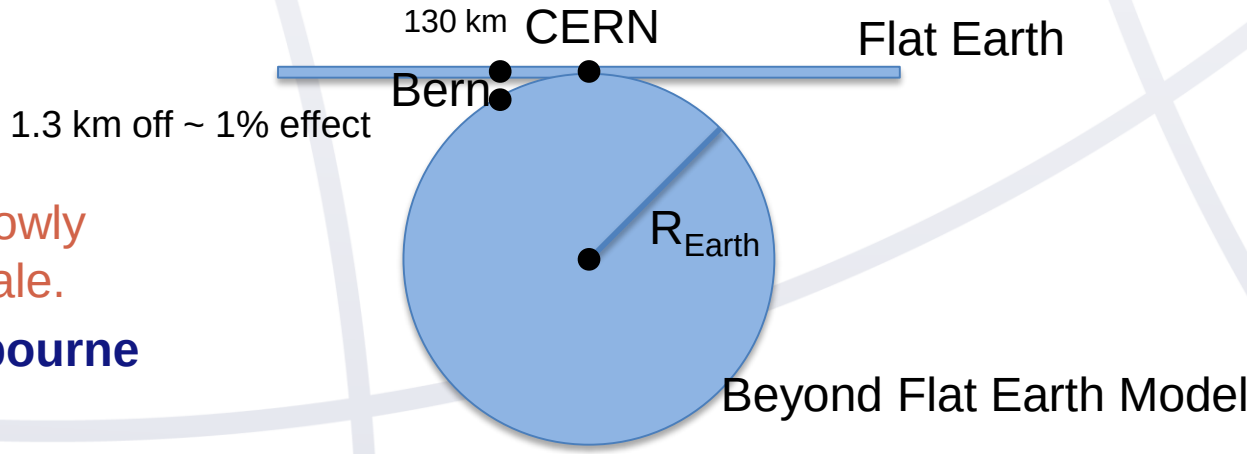
IPPOG – Beyond Flat Earth Model

Why Scales Matter

- 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 of Bern** in absolute space, given direction and distance, of Bern from CERN and assuming a Flat Earth **is straight forward to do**.
  Traveling to Bern and **carefully measuring via triangulation the true coordinates** of Bern **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 **Bern**.

Measuring the Standard Model at unprobed energy scales

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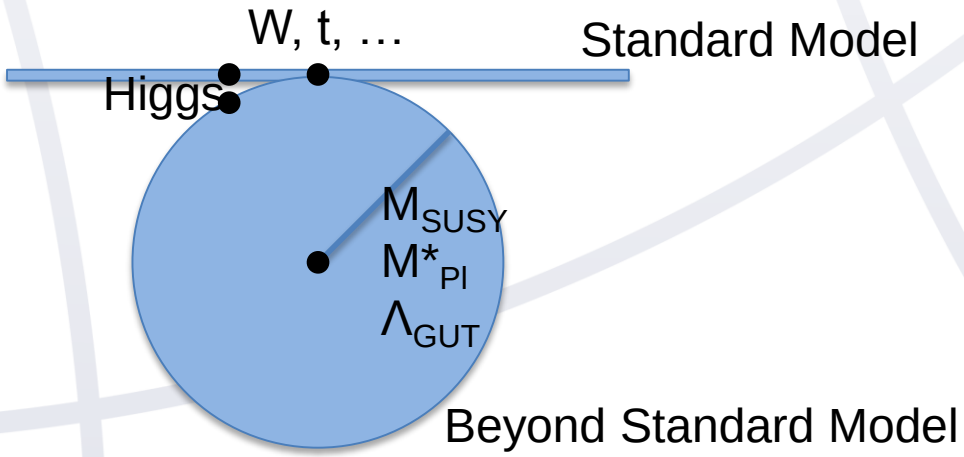

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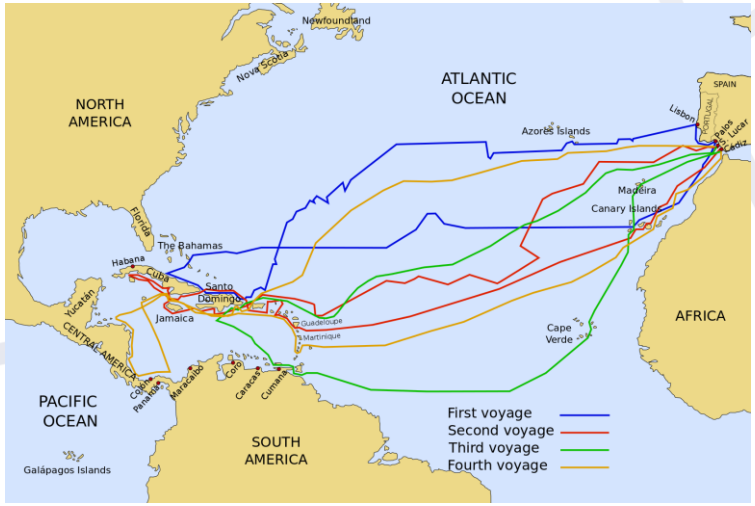
Measuring the Standard Model at unprobed energy scales

- **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 an example, take Newtonian mechanics which is truly embedded in Einstein's General Relativity.
- Abandon Popper – a pure falsification paradigm leads to nowhere !

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_{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.



SUMMARY

- **IPPOG**
  is an established successful outreach and education group with many activities and the International Masterclasses as its flagship

- provides tools & activities ready to be implemented at your institute

- is expanding internationally
  - Australia joined IPPOG
  - discussions with more new countries ongoing
  - Spreading programs and experiences

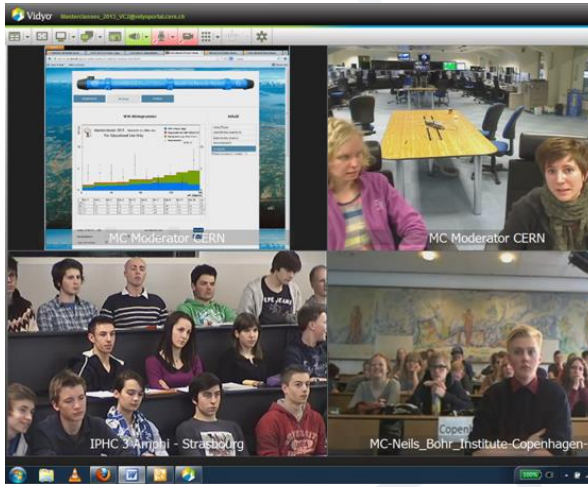
- is sharing experiences with existing successful national networks
  - QuarkNet (US, teachers)
  - Netzwerk Teilchenwelt (DE+CERN, teachers and students)
  - …

- **Is on its way of becoming a collaboration with a funding structure**

Victor Weisskopf,
“Physics in the 20th Century”,

14 APRIL 1972, SCIENCE,VOL.176

“lucid and impressive presentation of some aspect of modern science is worth more than a piece of so-called original research of the type found in many Ph.D. theses, and it may require more maturity and inventiveness."


Vidyo
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