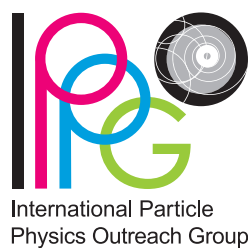




IPPOG Annual Report 2019





PREFACE

Each year, since its founding in 1997, IPPOG has reported its goals and accomplishments through formal presentations to the European Committee for Future Accelerators (ECFA) and, since 2013, to the CERN Council. This year, we have chosen to complement and expand upon these actions with a written report. We feel that the continued growth of the collaboration and its recent formalisation as an international collaboration warrant the effort, which will also help to maintain a historical record of our development.

IPPOG's growth in 2019 has manifested itself in several important directions. New members include the country of Montenegro and the HAWC collaboration. They were joined by Candidate Members CMS, United Kingdom, Hungary and Spain, in signing the IPPOG Memorandum of Understanding to formalise their commitment and secure representation. Participation in the first joint ECFA, NuPPEC, APPEC Symposium and the first meeting of IGRAV underlined IPPOG's commitment to develop and maintain coordinated efforts with our colleagues in the Nuclear Particle Physics, Astroparticle Physics and Gravitational Physics communities.

The extended reach of IPPOG's educational activity was evident in sustained growth of the International Masterclass programme, hosting 14,000 students in 54 countries worldwide, increased global activity in International Cosmic Day, popularity of our public events in science and cultural festivals, and enthusiastic participation in our online competition encouraging girls and young women to pursue STEM careers.

This document begins with a brief introduction to IPPOG, including an overview of its history, its organisation and core support, its major programmes and activities, and our vision for the future. We plan to highlight a few of our

working groups, each year. This year's focus is on activities of the "Explaining Particle Physics Hot Topics to a Lay Audience" and "Outreach of Applications for Society" working groups, and the Speakers and Publications Committee.

The document also features a one-page report from each of our member countries. In reading these reports, one senses an independence in the style that reflects the rich diversity of the collaboration, the members of which each employ methodologies optimal for the cultural, social, historical and pedagogical nature of their regions. However, the common threads of continual development and improvement of worldwide educational standards, the drive to expand the reach of our programmes to new global audiences, and the tireless dedication of all members to instil a sense of awe in fundamental research and a deep appreciation for science and evidence-based decision-making in our youth, are evident throughout.

This preface has been prepared by the 2019 IPPOG chairs, Hans Peter Beck and Steven Goldfarb. Although Goldfarb will begin his second term as IPPOG chair in 2020, Beck concluded his second term at the end of 2019. His seven years at the helm saw many important changes to IPPOG and his experience brings a unique perspective that he would like to share.



SEVEN YEARS IN IPPOG

These are a few reflections from my past seven years as IPPOG chair, starting from the day I took office on 1 Jan 2013, as co-chair alongside Marge Bardeen from FNAL. At the time, IPPOG had recently completed its transition from EPPOG with the addition of several non-European members, serving to bolster its mission globally. In 2013, as is the case today in 2020, the European Strategy Group (ESG) was preparing a new strategic roadmap for particle physics. This time, in addition to statements concerning the future physics program and infrastructure developments, the strategic relevance of communication and public engagement was recognized and for the first time stated explicitly:

“...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.” (CERN-Council-S/106)


These words stemmed from productive discussion between leaders of the two organisations with the ESG working group. Notably, past IPPOG co-chairs, Dave Barney (CERN) and Michael Kobel (TU Dresden) provided key influence. At the time, however, IPPOG did not have a sustainable source of “adequate funding” and a solution needed to be found to comply with the recommendations. It was up to the newly elected co-chairs to propose that

the members pay a small recurring fee to put IPPOG on sustainable ground and to bolster its mission in a scalable manner. This was easily said but not easily realized. IPPOG would need to re-structure itself, and it made sense to follow the model of an international experimental scientific collaboration.

To succeed, key decisions would need to be taken, while keeping all IPPOG members informed and on board. Writing the constitution, budget needs and goals for IPPOG's future as a collaboration turned out to be more complex and time-consuming than imagined. In discussions with RECFA and CERN, important structural support was attained. CERN agreed to provide IPPOG with half a fellow and other logistic support. These resources were used to add Barbora Gulejova as our scientific secretary, significantly bolstering the IPPOG coordination team. Her help re-writing the draft constitution, editing newsletters, organizing IPPOG meetings, being there for all small and big needs, having more hands, eyes, and deepening the exchange of ideas proved to be invaluable.

CERN Legal Service took over our draft constitution, shortening the page count considerably, while sharpening the paragraphs and reformulating its content in a legalistic way, where a typical physicist would simply wave a white flag and surrender. At last, the IPPOG Memorandum of Understanding was born and was accepted by vote. This was not without discussion: Fears of breaking IPPOG by becoming (too) formal were countered with demands to establish a stronger self-funded structure, and it was not clear how all this would evolve.

Fears aside, IPPOG continued to evolve its core activities, with the ever-popular International Masterclasses growing



steadily in numbers of participating countries, institutes, and, most importantly, participating high-school students, reaching numbers of over 14,000 annually. While particle accelerators and large-scale experiments are out of reach for most high-school students, cosmic rays are not. The idea of seeking synergies among the many diverse educational programs based on cosmic muons culminated in the 'Global Cosmics' initiative. It provides a means for experts and leaders of local and national programs to meet and exchange ideas under IPPOG's umbrella, finding their way towards a truly global initiative.

Realizing the importance of engaging the next generation of young scientists, stakeholders, and the public at large to convey the values that fundamental science research, such as particle physics, generates for society is an IPPOG mandate. With IPPOG bolstered as a collaboration, recognition also comes from outside. Organizers of more and more conferences in particle physics explicitly invite IPPOG representatives to share ideas and report on their activities.

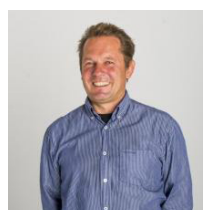
During my seven years, new members joining IPPOG include Australia, Belle II, Brazil, HAWC, Ireland, Montenegro, Slovenia, and South Africa, with Georgia on its way. Allowing for national laboratories to become close to IPPOG, associate membership was defined, and with it, DESY, GSI and Centro Fermi will soon join. As IPPOG membership grows, it becomes stronger, more widely respected, and strengthens its global reach.

With member representatives meeting twice a year, fruitful discussions on various topics follow almost naturally. Some of these are as simple as the organisational aspects of developing and running IPPOG activities. Others are on critical topics, such as how particle physics, with its large-scale infrastructure and international collaborations, is perceived from outside. Further discussions, such as those examining how to best explain the Higgs mechanism, or delving into deep questions on ethics, the beauty of science, or the meaning of "theory" in science compared to its meaning to the public at large, will stay in my memory as highlights.

Looking back at these seven years, I am happy to see how IPPOG evolved into a true scientific collaboration that is successfully tackling its mission in concerted global outreach, that is conducting inspiring discussions on relevant topics, writing articles and conference proceedings, and that is continuing to raise its impact in an ever-growing community over a larger and larger geographical global scope.

Looking forward, I am happy to see the new co-chairs, Steve Goldfarb and Pedro Abreu, together with Barbora Gulejova and Claudia Marcelloni, forming the IPPOG coordination team, taking IPPOG further, broadening its scope and impact globally.

All the best to IPPOG and to all who are active in IPPOG!



Hans Peter Beck
(IPPOG co-chair
2013-2019)



OUR VISION FOR 2020

We in IPPOG are fortunate. We play a role in one of the most fascinating fields of science, one that lies at the very core of human understanding of the universe: particle physics. Furthermore, our hardware, electronics and computing challenges are forever pushing limits and, in many cases, the solutions lead to advances that improve our daily lives.

Equally important, the expertise needed to address these challenges goes beyond the capabilities of any one institution or nation. It requires a concerted worldwide effort, involving international teams of researchers, engineers and technicians working together, each bringing their own cultural backgrounds and points of view to the table.

We at IPPOG thus have a golden opportunity to teach the scientific process and to promote the values of international collaboration around the globe. Towards these goals, the aspirations of particle physics provide a powerful catalyst to engage and interest the public. We, as scientists, educators, and communicators can provide the public, especially younger generations, with the tools they need to differentiate fact from fiction, an increasingly important task today. In fact, it is one of IPPOG's duties and missions to do exactly that.

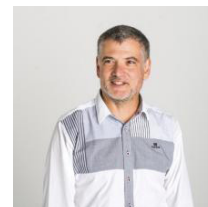
As always, primary support for IPPOG will come from ourselves and our peers, dedicating significant time, effort and in-kind resources to the education and outreach programs. Core support, provided by the member countries, collaborations and laboratories will continue to grow, as our global membership increases and diversifies.

A key milestone in the coming year will be the European Particle Physics Strategy Update, submitted to CERN Council this Spring. It is our hope that the document will provide a clear path towards greater recognition and support of scientific education, public engagement, and communication by recognising them as strategic pillars of our field.

Beyond the words of that document, however, we in IPPOG already understand and appreciate the importance and urgency of our work, not only in support of particle physics, but for the future of our planet. We will continue to play a vital role bringing the excitement of fundamental research into the classroom and instilling a deep appreciation of science into the public. And, fortunately, we will continue to enjoy doing just that.



Pedro Abreu (*chair*)



Steven Goldfarb (*chair*)

A blue ink signature that reads "Pedro T. Abreu".

A blue ink signature that reads "Steven Goldfarb".



ABOUT IPPOG

INTRODUCTION

IPPOG¹ is a network of scientists, science educators and communication specialists working across the globe in science education and public engagement for particle physics. Particle physics is the science of matter, energy, space and time; it seeks to identify and understand the basic building blocks of our universe. IPPOG brings new discoveries in this exciting field to young people and conveys to the public the beauty of nature that is manifested in the interactions of its most fundamental components - the elementary particles.

IPPOG holds regular meetings to share ideas and best practices, with the primary goal of raising the standards of science education and public engagement. Its globally coordinated outreach programmes contribute to strengthening cultural awareness, understanding and support of particle physics and related sciences, and developing the next generation of researchers.

IPPOG ACTIVITIES

The collaboration forum, comprising member representatives and their associates, meets twice a year, holding topical panel sessions, working group discussions and presentations of key activities. The meetings are organised by the chairs and the scientific secretary and alternatively hosted by member or aspiring member institutions. These meetings provide a key platform for the development and sharing of ideas and coordination of the programmes.

Well-established IPPOG activities, including International Particle Physics Masterclasses² and Global Cosmics³, reach thousands of students in dozens of countries around the world, every year. More recent programmes bringing particle physics to music and other cultural festivals, reach new audiences, including members of the public already interested in science, as well as those who have yet to realise they are.

¹ <http://ippog.org>

² <https://physicsmasterclasses.org/>

³ <https://icd.desy.de/>

IPPOG also maintains strong visibility at major particle physics conferences, participating in and convening dedicated sessions in education and outreach, and organising associated public events and exhibitions. These activities increase awareness with both the public and members of the physics community, encouraging and helping young scientists to participate in public engagement.

Through these activities, IPPOG not only communicates the excitement of our research, but it instils young minds with a better understanding of the scientific method and a deeper appreciation of evidence-based decision making. This is essential today, in a world, in which these human values are continually under attack by public figures and the media. Thus, the repercussions of IPPOG activities go far beyond that of simply supporting and popularising our field, but help to create a key strategic basis for the future.

IPPOG MEMBERS

IPPOG forum membership includes a rare mix of scientists and researchers, science educators and communicators from prominent laboratories and institutions engaged in particle physics. Members also represent links to several important national-level science networks. As a whole, the forum constitutes a global network of countries, laboratories, institutions, organisations and individuals, all passionate about particle physics.

There are currently 33 IPPOG members⁴: 26 countries, 6 experiments and CERN as an international laboratory. These representatives compose the Collaboration Board, which meets twice a year to discuss and vote on IPPOG matters.



Group photo of participants of the 18th IPPOG meeting - 28-30 November - CERN



Group photo of participants of the 17th IPPOG meeting - 22-25 May - GSI

⁴ http://ippog.org/ippog_membership



IPPOG HISTORY

ORIGINS

In 1997, then CERN Director General Chris Llewellyn-Smith, made the following statement during a council meeting “...the particle physics community has a moral obligation to inform the public on its activities. To do this well, experiences must be shared among countries in view of the need to optimize the use of resources.” These words launched the European Particle Physics Outreach Group (EPOG, then later EPPOG), formed under the joint auspices of the European Committee for Future Accelerators¹ (ECFA) and the High Energy Particle Physics Board of the European Physical Society² (EPS-HEPP).

The original group comprised one delegate from each CERN member state, one additional CERN and DESY member, a Chair and a Deputy Chair appointed by ECFA and EPS-HEPP, and associate members from within the community, currently active in public outreach and communication. The group agreed to meet twice a year, to exchange ideas and best practices in particle physics education and outreach, to define common activities, and to develop and share material supporting their activities.

INTERNATIONAL MASTERCLASSES

Researchers in the U.K. working on the DELPHI and OPAL experiments at LEP³ at CERN developed an educational tool called Particle Physics Masterclasses. This activity brought secondary school students together into research labs and institutes, gave them short lessons in current particle physics methods, then provided access to current tools to look at real data from the experiments. EPPOG members quickly embraced this activity and, in 2005, created a global programme called International Masterclasses (IMC), adding, at the end of each day, a video conference in which

students shared and discussed their results moderated by scientists at CERN and Fermilab. The programme grew in number, geographic reach and physics scope every year since its inception, and quickly became the flagship programme of EPPOG.

During these years, EPPOG membership also grew, as countries involved in the experiments, but not members of CERN, requested participation. Further, as the LHC started taking data in 2010, the new experiments themselves came on board, offering usage of their own new data and tools. By 2011, LHC Masterclasses were being developed and integrated into the IMC programme⁴.

IPPOG

Activities of the group also attracted the interest of non-European members of the particle physics community active in outreach, such as Israel, Australia and the USA. This global expansion put EPPOG into international terrain and in 2011 the group changed its name to the International Particle Physics Outreach Group (IPPOG). Along with the name change, IPPOG adopted a visual identity, including a logo and website, to serve the global community. A new component of the website was its resource database, allowing the effective global sharing of content, one of the original motivations for IPPOG's formation.

IPPOG PART OF EUROPEAN STRATEGY

In 2013, the European Strategy Group⁵ updated the strategic roadmap for particle physics launched in 2006, and the relevance of good communication and public engagement was clearly expressed:

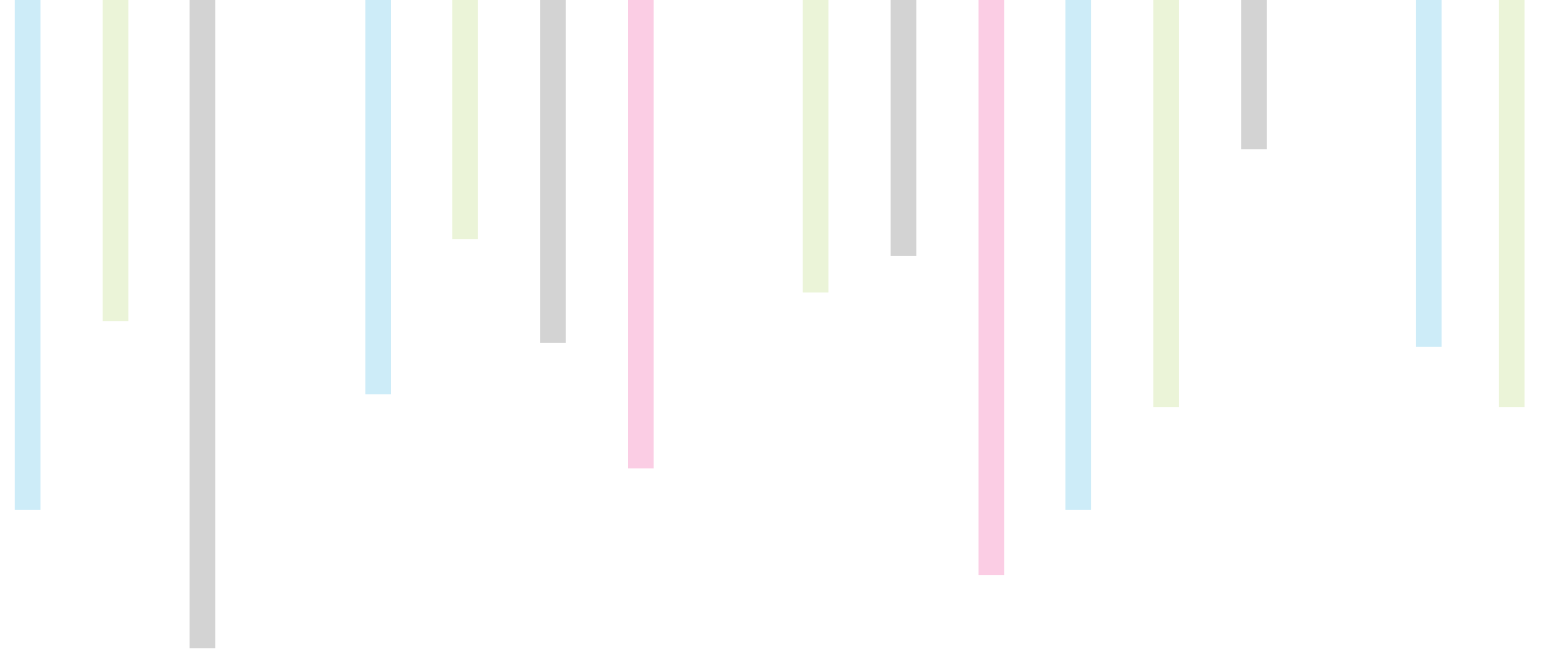
¹ <https://ecfa.web.cern.ch/>

² <https://eps-hepp.web.cern.ch/eps-hepp/>

³ <https://home.cern/science/accelerators/large-electron-positron-collider>

⁴ <https://physicsmasterclasses.org/>

⁵ <https://europeanstrategyupdate.web.cern.ch/european-strategy-group-esg>



“...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.*” (CERN-Council-S/106)

The strategic relevance of IPPOG was thus explicitly recognised and it was made clear that the group should receive adequate funding. To comply, IPPOG members decided to formalise the group’s status as an international collaboration, and to seek sustainable funding through the various bodies supporting outreach within their own countries. In 2015, with the help of the CERN legal office, an official Memorandum of Understanding (MoU) was prepared, defining the structure, terms of membership and operation of the collaboration.

INTERNATIONAL COLLABORATION

The MoU, which became valid in December 2016⁶ with the 10th new member signature, specifies an agreement between IPPOG and the national bodies representing the member countries, collaborations and international laboratories. A national body is a scientific laboratory, institution, or ministry, which represents the particle physics community in the country. In brief, the MoU asks the member to recognise and support particle physics outreach and education in that country, to actively contribute to the IPPOG programmes, to appoint a representative to attend collaboration meetings and to contribute with a small monetary fee to help support the core infrastructure and activities. An international collaboration agrees to recognise and support efforts in education and outreach within the collaboration, provides access to its data, tools and expertise for IPPOG activities, and also appoints an official representative. International laboratories are negotiated on a case-by-case basis, with agreements written up in the form of addenda to the MoU. CERN is currently the only one, providing IPPOG with funding and access to CERN legal and financial services. National laboratories and other scientific bodies can join IPPOG as associate members.

⁶ <https://cds.cern.ch/record/2652227>

GLOBAL COSMICS

A workshop organised in Rome in 2017 brought together experts from a global spectrum of cosmic-ray related educational activities. There, it was agreed to create an IPPOG Global Cosmics group, the goal of which would be to develop and promote worldwide activities, connecting classrooms through their cosmic ray studies. Current activities include International Cosmic Day (ICD)⁷, organised by DESY, and Muon Week, organised by QuarkNet⁸. Both events are promoted and supported by IPPOG and its members. Follow-up discussions with the Astroparticle Physics European Consortium (APPEC) in 2019 have solidified their partnership and aim to improve coordination of activities between the two groups.

TIMELINE



⁷ <https://icd.desy.de/>

⁸ <https://quarknet.org/content/international-muon-week>

IPPOG CENTRAL ACTIVITIES 2019

COORDINATION TEAM

The IPPOG Coordination Team in 2019 comprised Hans Peter Beck (Univ. Bern, Switzerland) as elected chair, Uta Bilow (TU Dresden, Germany) as masterclass coordinator, Barbora Bruant Gulejova (Univ. Bern) as communication strategy and content development lead, Kenneth Cecire (Univ. Notre-Dame, USA) as masterclass coordinator, Steven Goldfarb (Univ. Melbourne, Australia) as elected chair and Claudia Marcelloni (CERN) as scientific secretary. The team is responsible for organising global IPPOG activities by coordinating twice-yearly collaboration meetings in cooperation with IPPOG members, proposing and managing the core budget, coordinating the International Masterclasses in particle physics programme and related projects (reported on separately), and developing infrastructure and activities in support of the collaboration, in line with the strategic vision set forth by the chairs.



Hans Peter Beck (*Chair*)



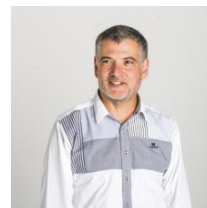
Uta Bilow
(*Masterclass coordinator*)



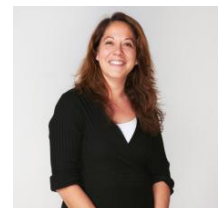
Barbora Bruant Gulejova
(*Communication
Strategy and Content
Development Lead*)



Kenneth Cecire
(*Masterclass coordinator*)



Steven Goldfarb (*Chair*)



Claudia Marcelloni
(*Scientific secretary*)



ORGANISATION OF COLLABORATION MEETINGS

The 17th IPPOG took place at GSI-FAIR¹ on May 2019 with 54 participants² and the 18th IPPOG meeting took place in November at CERN with 53 participants³. The meetings featured the regular reports from the Masterclass and Global Cosmics Steering Groups, the Working Groups and the Committees, presentations proposed by members of the IPPOG forum, and special panels focussing on selected topics at each meeting. In the Spring meeting the focus was on GSI-FAIR and “Outreach on the benefits to society from fundamental research.” In the autumn meeting, the focus was on ‘Expanding Borders’ and featured presentations by representatives of the Astroparticle Physics European Consortium (APPEC)⁴, the Nuclear Physics European Collaboration Committee (NuPECC)⁵ and the International Gravitation Outreach Group (IGRAV), as well as CERN International Relations. As usual, the meetings ended with the Collaboration Board (CB) closed sessions for discussion and decisions involving resources, membership and operation of IPPOG, including approval of the 2018 financial report by the spring CB and the 2020 budget by the autumn CB.

INFRASTRUCTURE DEVELOPMENT

The IPPOG website is hosted on CERN servers, as part of the laboratory’s in-kind contribution. It was agreed in 2018 that major upgrades to the system at CERN and aging design of the existing IPPOG website merited investment in a new implementation of the website and its resource database. The coordination team, with help from the CERN webmaster, drew up specifications and tendered a firm in 2019 to develop the site. Preliminary designs were shown to the collaboration and there was agreement to continue the work. This is a high priority item in the core budget, and major progress is expected in 2020.

¹ <https://www.gsi.de/en/researchaccelerators/fair.htm>

² <https://indico.cern.ch/event/767060>

³ <https://indico.cern.ch/event/855335>

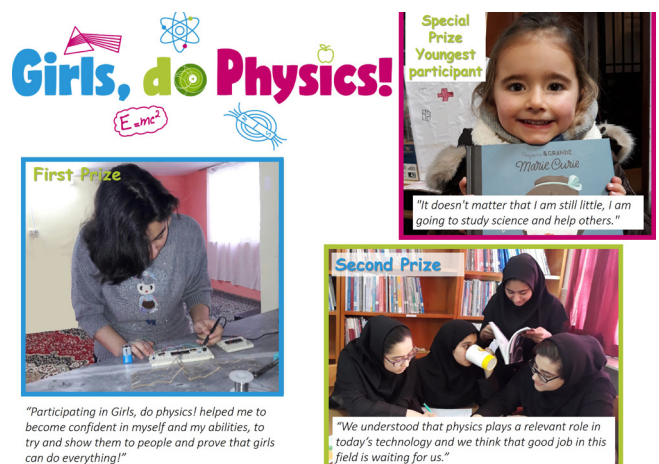
⁴ <https://www.appec.org/>

⁵ <http://www.nupecc.org/>

STRATEGIC DEVELOPMENT ACTIVITIES IN 2019

Girls, do physics!

“Girls, do physics!” was a social media campaign and competition run in 2019, with the aim of empowering, inspiring and motivating girls in primary and secondary school to pursue studies in physics and related STEM subjects. It took place between February 11th (International Day of Women and Girls in Science) and March 8th (International Women’s Day) and was organised under the umbrella of IPPOG by forum members and volunteers. Female physicists pursuing careers in academia, business and industry were presented on the project website⁶ and IPPOG Instagram channel⁷ as inspirational role models.



Participants were asked to present a physics project on Instagram with hashtags #girlsdophysics and #girlsdoparticlephysics. Several hundred girls and young women from around the world (including a four year-old) participated in the campaign, with some receiving thousands of “likes” on their posts. Seven individual winners or winning teams were awarded certificates, merchandise and virtual visits from the CERN experiments, as well as in-person visits to their classroom from a local physicist.

The project highlighted IPPOG’s continuing efforts to promote diversity and to engage in social issues affecting particle physics and the broader science community, and was modelled on the UN Sustainable Development Goals.

⁶ <https://ippogorg.wixsite.com/girlsdophysics>

⁷ <https://www.instagram.com/ippogorg>

It also widened IPPOG's global reach by activating its presence on Instagram, a platform that attracts a younger audience, and increasing activity on its existing Facebook and Twitter accounts. Significant contributions were made by students of Geneva International High School (ECOLINT), as follow-up to a 2018 IPPOG workshop "Creating Ambassadors for Science in Society"⁸.



IPPOG workshop "Creating Ambassadors for Science in Society"

The IPPOG Friends Network

In recent years, IPPOG worked with the CERN International High School Teacher programme, to offer projects to teams of participant teachers. These teams provided input for the development of the new IPPOG website by proposing a structure for the site and by helping to procure content and offer recommendations for the interface of the resource database. Those teachers have since helped to disseminate knowledge of IPPOG to their colleagues, creating the IPPOG Friends mailing list and Facebook group hosting hundreds of members. This growing network allows IPPOG a direct means to reach high school teachers and students, its primary audience, and has created a strong following in non-member locations, such as Iran.

⁸ <https://indico.cern.ch/event/736469>



IPPOG WORKING GROUPS, STEERING GROUPS AND COMMITTEES

The IPPOG collaboration meets twice a year to share, exchange and expand knowledge on worldwide initiatives in particle physics education and public engagement. In addition to presentations from the members and coordination team, topical panel discussions, and other networking opportunities, the meetings feature reports from established working groups, steering groups and committees. The working groups, which meet during and/or between meetings, focus on various aspects of particle physics outreach, with the goal of improving the effectiveness of current methodology or implementing new ideas. The steering groups address specific IPPOG programmes, focusing on their growth, improvement and evolution. The committees support the various organisational activities of the collaboration.

In 2019, active groups and committees in IPPOG included:

- Bringing Masterclasses to New Countries Working Group
- Explaining Particle Physics Hot Topics to a Lay Audience Working Group
- Exhibits and Exhibitions Working Group
- Outreach of Applications for Society Working Group
- European Particle Physics Strategy Update Document Working Group
- International Masterclasses Steering Group
- Global Cosmics Steering Group
- Speakers and Publications Committee
- Finance Advisory and Auditing Board

Here we present descriptions and brief summaries of the 2019 activities for a sample of these groups and committees. In 2019 the collaboration worked in four

different working groups. Below you will find a report of the activities for two of them since the working group on Exhibitions and Exhibits were being redefined and most of the activities of the working group on Expansion of Masterclasses to new countries are reported under the International Masterclasses activities.

EXPLAINING PARTICLE PHYSICS HOT TOPICS TO A LAY AUDIENCE WORKING GROUP

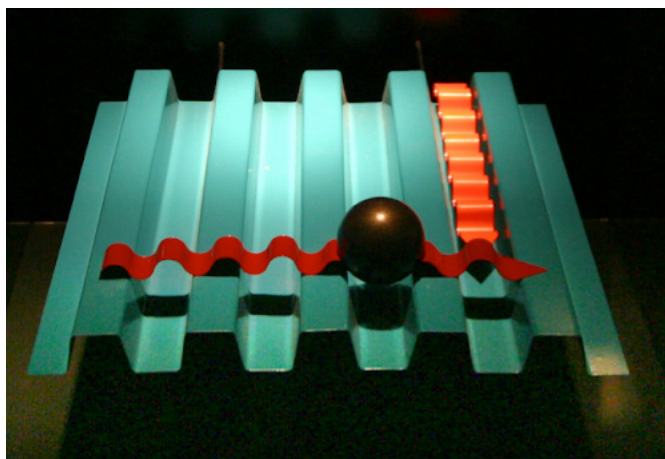
Introduction

This working group with a long tradition in IPPOG regularly discusses how to explain complex particle physics questions to a lay audience. The highlights of the discussions in past years include how to explain best the Higgs mechanism, spin, particle-wave duality, or gravitational waves; how to communicate the importance of precision, and “What if no new discovery / Higgs – what now?”. The WG also dived into deep questions on ethics, beauty as a criterion of truth in science, or what means theory in science and what it means in the broad public at large, how to sell a new European Strategy for Particle Physics and how to justify the costs of always-bigger machines (HL-LHC, LC, FCC).

Activities in 2019

Since 2019, work started on the project ‘IPPOG wisdom collection,’ which aims to collect the best IPPOG recommended explanations, analogies, metaphors and examples on how to explain complex particle physics issues to the public. All categories in IPPOG resource database will be reviewed. This tool for the scientific outreach community (everybody who wants to explain these issues to the public, students, politicians...or convince media or decision makers, why it is important and interesting) would also include arguments to be used

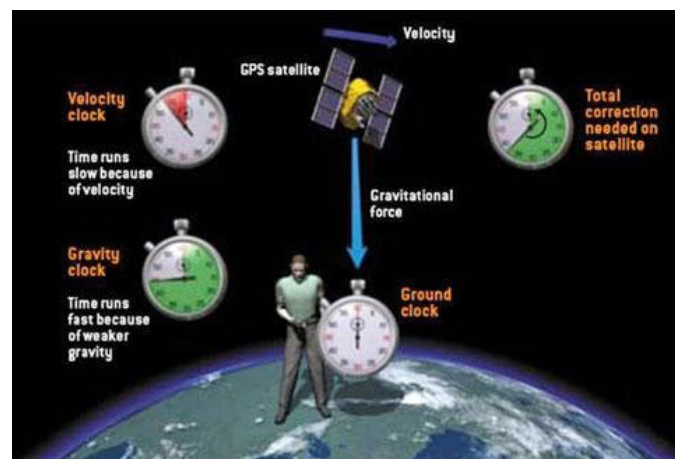
when talking to media or decision makers who are putting into question the funding of research projects and its relevance. Relevant stories about applications of particle physics and fundamental research in general in everyday life will be also included. In the past two years, the working group also concentrated on recommendations concerning outreach to be given to the European Strategy for Particle Physics Update 2020 communication group on behalf of IPPOG. The input from the IPPOG Collaboration for the open call for the European Particle Physics Strategy Update 2020 has been summarised in the publication “Future Challenges in Particle Physics and Outreach”. It emphasises the strategic relevance of concerted, global outreach activities in particle physics¹ today and beyond when envisaging new large-scale projects.



A model symbolizing the propagation of a massive and a massless particle in the Higgs field. Credit: “Die Reise zum Urknall” (DESY, Urania Berlin, 2000)

OUTREACH OF APPLICATIONS FOR SOCIETY WORKING GROUP

In today’s world of instant communication, in which we have become accustomed to a rapid and continual flow of information, concrete examples on the impact of science need to be readily available to address a variety of target audiences. In addition to the quest for knowledge and satisfying curiosity, there will always be demand from taxpayers for justification of fundamental research funding, requesting tangible examples of return to society.



In 2019, the Outreach of Applications for Society Working Group focused on the need to produce engaging stories with a human touch. These often present the most impactful and effective means to communicate successful applications for the benefit of society from fundamental research to the public. The aim of this initiative is to offer short stories with clear messages connecting science to everyday lives of citizens and to make them available through the IPPOG web page and resource database. The goal is to also show, through them, the importance of fundamental research and related sciences for global

¹ https://indico.cern.ch/event/765096/contributions/3295747/attachments/1785273/2906293/EPPSU_IPPOG_final.pdf

sustainable development and to inspire the young generation. These stories provide a powerful tool when approaching non-scientifically educated stakeholders.

After collecting material from a variety of sources, including the CERN knowledge Transfer collection, as well as individual contributions, the group worked on story-building around the available facts, while trying to find a human touch and anecdotes for each of them. While most know the story behind World Wide Web, we plan to offer stories behind a variety of other applications, such as PET scanners, cancer therapy, UNOSAT, touch screen, GPS, and many more.

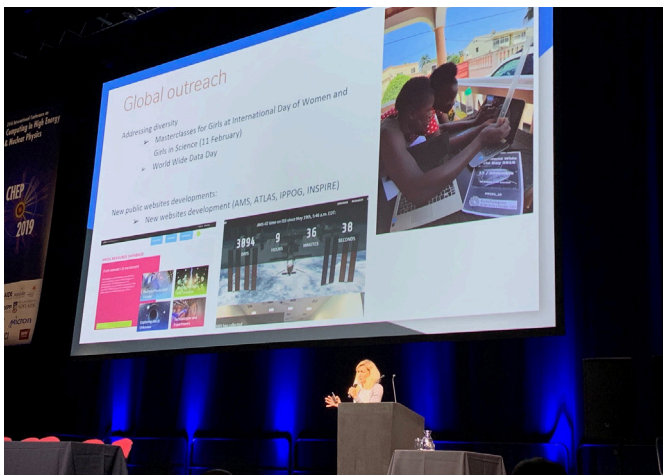


As a most recent example, an on-board system for cleaning the exhaust of marine diesels was successfully developed in an accelerator R&D project². Stories like this inspire and help the public to better understand the benefits of our research directly to society. Even less known is the fact that there are tens of thousands of medium and high energy accelerators operating worldwide, solely for the direct benefit of society, based on breakthrough developments of a handful of those dedicated to fundamental research. Applications of these devices vary from medical to industrial, security, and environmental applications, with many other potential possibilities. Creating stories and clear explanations of such applications help to secure support for fundamental research and the particle physics community, and will prove to be an invaluable strategic pillar during the roll-out of the EPPSU proposals.

² <http://acceleratingnews.web.cern.ch/article/bringing-particle-accelerators-ships>

SPEAKERS AND PUBLICATIONS COMMITTEE

This committee of elected IPPOG members takes a regular survey of conferences of interest for IPPOG participation, including conferences on physics education or the Outreach & Education tracks at major particle physics conferences. Then abstracts are prepared and sent to these conferences. For the accepted abstracts, speakers are identified and selected to attend the conference and present the communication on behalf of IPPOG (in plenary, parallel, or poster sessions). The committee also helps with preparing the presentation, in terms of the contents, the style and the speech, and after the conference helps prepare and finalise the proceedings and/or other publications.



In 2019 IPPOG was present at the following conferences:

- APS'2019 April Meeting, Denver Co., USA, April 13-16 (2 oral presentations)³
- LHCP'2019, Puebla, Mexico, 20-25 May (1 oral presentation, parallel)⁴
- EPS-HEP'2019, Ghent, Belgium, 10-17 July (3 oral presentations, parallel)⁵
- DPF'2019, Boston Ma., USA, 29 July-2 August (1 oral presentation, parallel)⁶
- ICNFP'2019, Kolympari, Crete, 21-29 August (1 oral presentation, parallel)⁷
- JENAS'2019, Orsay, France, 14-16 October (1 oral presentation, plenary)⁸
- CHEP'2019, Adelaide, Australia, 4-8 November (4 oral presentations, parallel)⁹

³ <https://meetings.aps.org/Meeting/APR19/Content/3673>

⁴ <https://indico.cern.ch/event/687651/>

⁵ <https://indico.cern.ch/event/577856/>

⁶ <https://indico.cern.ch/event/782953/>

⁷ <https://indico.cern.ch/event/754973/page/14616-region>

⁸ <https://jenas-2019.lal.in2p3.fr/>

⁹ <http://chep2019.org/>



INTERNATIONAL MASTERCLASSES

OVERVIEW

International masterclasses¹ (IMC) offer high school students the possibility to perform measurements on real data from particle physics experiments at CERN and other facilities and get insights into the methods and tools of cutting edge research in high energy physics. The programme is the flagship activity of the International Particle Physics Outreach Group (IPPOG)². The central coordination is done by Uta Bilow, Technische Universität Dresden, and Ken Cecire, QuarkNet/University of Notre Dame; Bilow and Cecire organised the 15th edition of IMC in spring 2019.

IMC were held over a period of six weeks from 07.03. –16.04.2019 plus two satellite events in February and two in May. Institutes in 54 countries from all continents except for Antarctica participated. A total of 188 institutes registered for the programme with CERN video conferences and were scheduled in 59 videoconferences with CERN, with a maximum of two video conferences in parallel and up to five institutes in each video conference. These included 266 individual International masterclasses with the following breakdown per experiment: ALICE: 30, ATLAS: 131, CMS: 64, LHCb: 39.

Fermilab physicists moderated an additional 19 videoconferences for institutes in countries from America, Asia, and Oceania. Another two video conferences were held in Spanish for participants in South America. In total, 51 research labs participated in videoconferences with Fermilab. TRIUMF held an additional video conference with groups from British Columbia, Canada.

SCOPE OF PARTICLE PHYSICS MASTERCLASSES

Within the framework of IMC, six different measurements with data from the four major experiments at the LHC are available: two from ALICE, two from ATLAS, one from CMS, one from LHCb³. In 2019, all measurements remained stable with minor updates.

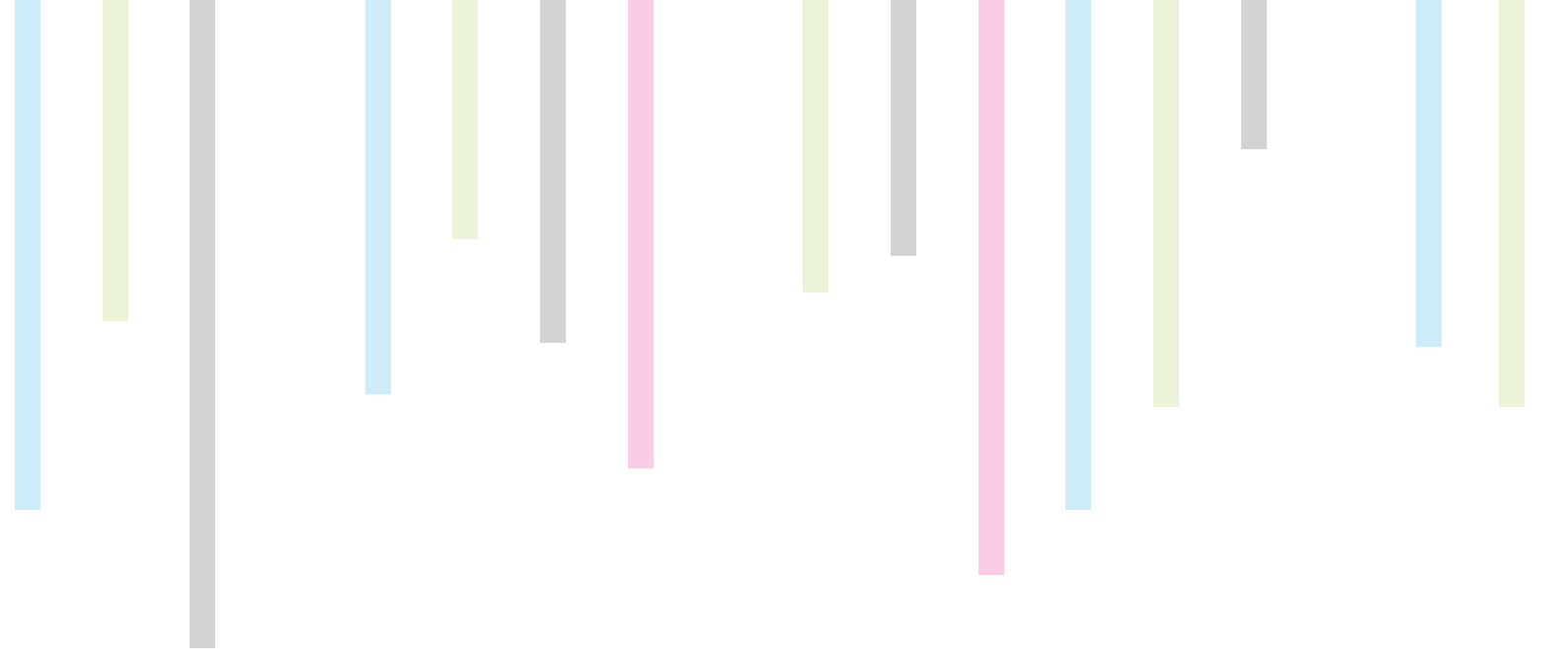
U.S. physicists have developed a neutrino masterclass⁴ with data from the MINERvA experiment. In this masterclass, students examine the interactions of muon neutrinos with a carbon target, using the MINERvA event display ARACHNE. They extract kinematic information to measure the properties of neutrons in the carbon nucleus. They use these data to test two simple interaction models (free neutrons and Fermi gas), discovering the Fermi motion of nucleons as they do so. QuarkNet and Fermilab

¹ www.physicsmasterclasses.org

² <http://ippog.org/>

³ http://physicsmasterclasses.org/index.php?cat=local_organisation&page=measurements

⁴ <https://quarknet.org/content/neutrino-masterclass-project-map-2019>



successfully piloted MINERvA neutrino masterclasses in 2018 and 2019, enabling their inclusion in the overall IMC schedule in 2019. Twelve institutes from the U.S., China, and Europe held neutrino masterclasses and participated in videoconferences at Fermilab.

In addition, members of the Belle II collaboration have developed a masterclass with data from Belle II at KEK⁵. Students can code B-physics analysis using the visual code editor Blockly to describe decays and apply cuts. An integration of Belle II masterclasses under the IMC umbrella in 2020 is planned. Scientists at GSI Darmstadt and DKFZ Heidelberg have developed a particle therapy masterclass⁶ where students can plan a treatment and calculate doses. After a successful test, this activity will be integrated under the IMC umbrella in 2020.

INTERNATIONAL MASTERCLASSES ON THE UNITED NATIONS INTERNATIONAL DAY OF WOMEN AND GIRLS IN SCIENCE

IMC organized masterclass activities targeted to female high school students on 11.02.2019, the UN International Day of Women and Girls in Science (IDWGS)⁷. In order to follow the idea of the IDWGS, institutes were encouraged to arrange masterclasses, preferentially for girls, and to involve as many female scientists as possible as role models.

Eleven institutes from Europe and South America followed the call and held IMC with 600 high school students. Three videoconferences with CERN were arranged where the girls talked to CERN women scientists and learned about the careers of these role models. Each video conference featured a special presentation on women in physics with some statistics from the American Physical Society and CERN. This was the third year in which IMC offered special masterclasses for IDWGS.

WORLD WIDE DATA DAY W2D2

On 16.10.2019, IMC facilitated the third annual World Wide Data Day (W2D2). In W2D2, teachers work with their students to examine dimuon events in either ATLAS or CMS and determine the direction angles of muon tracks. The teachers put their students' results into two histograms which are shared by all participants. On the actual day, there is a "24-hour shift" of scheduled videoconferences so that the students in their classrooms can discuss the measurement and the results as well as have a Q&A with particle physicists. In 2019, 42 schools participated with approximately 680 students, mostly from the U.S. and Europe. Videoconferences were moderated by 25 physicists from 16 institutions around the world.

⁵ <https://belle2.ijs.si/public/>

⁶ <https://indico.cern.ch/event/840212/>

⁷ https://physicsmasterclasses.org/index.php?cat=archive&page=women_in_science_2019



EXTERNAL COMMUNICATION AND PRESENTATION

The website of the project⁸ is an entry point for high school students, teachers and educators, and physicists. The social media platform used for communication is the twitter account @physicsIMC⁹ with hashtag #physicsIMC. The coordination team has presented regularly at major national and international conferences^{10,11}. Some activities to enhance the visibility of the program and attract new participants are particularly noteworthy:

- Both at the APS conference in Denver (April 2019) and at the EPS-HEP conference in Ghent (July 2019), a booth was installed in the coffee break area where conference participants could get information and material on IMC.
- Kenneth Cecire and Uta Bilow, respectively, gave talks on IMC at the APS¹² and EPS-HEP¹³ conferences and QuarkNet teacher Richard Dower gave a presentation on behalf of QuarkNet and IMC at DPF¹⁴ in Boston (July 2019).
- Two contributions for the magazine “Global insights”^{15,16} were written with the aim to attract physics teachers to the program. “Global insights” is issued by the Educational Collaborative for International Schools. International schools taking part in the International Baccalaureate program have particle physics in the IB physics curriculum.
- Introductory Masterclasses¹⁷ for IPPOGers and CERNOis were organized at CERN on 28.11.2019. Participants had the chance to try out Masterclass measurements in 45- min-sessions, guided by experts.

⁸ www.physicsmasterclasses.org

⁹ <https://twitter.com/physicsimc>

¹⁰ https://indico.cern.ch/event/577856/contributions/3419457/attachments/1877702/3092631/2019_07-eps-hep-Masterclasses.pptx

¹¹ <https://arxiv.org/abs/1910.00522>

¹² <http://absuploads.aps.org/presentation.cfm?pid=14846>

¹³ <https://indico.cern.ch/event/577856/contributions/3419457/>

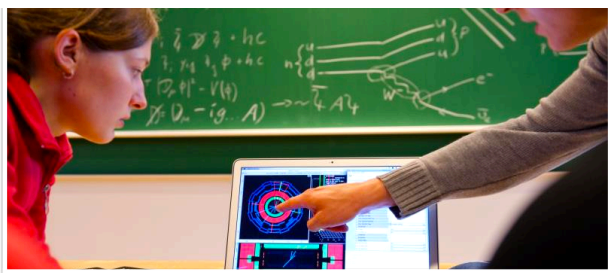
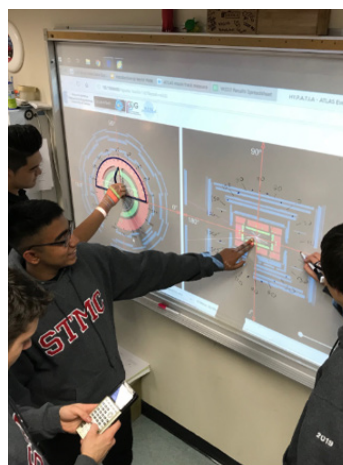
¹⁴ <https://indico.cern.ch/event/782953/contributions/3462630/>

¹⁵ Global Insights, 04/2019, p. 31-33

¹⁶ Global Insights, Nov. 2019, p. 49-51

¹⁷ <https://indico.cern.ch/event/865864/>

PHOTOS



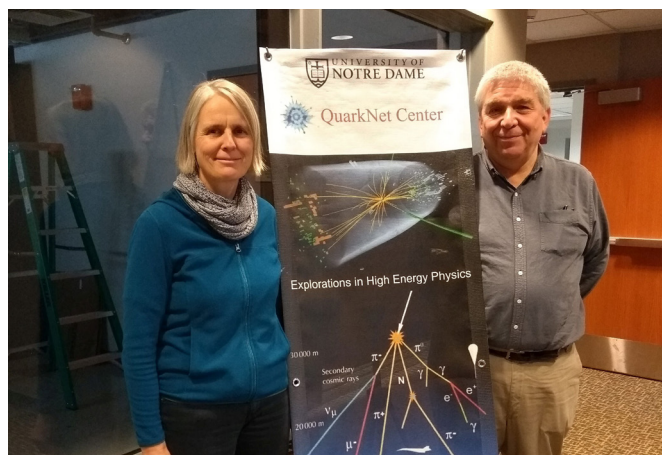
REGISTRATION INDICO EVENT 865864

Masterclasses Curious?

Your chance to see how students learn from real measurement from ATLAS, CMS, ALICE, LHCb, Belle II from KEK or MINERVA from Fermilab



When: Thursday 28 November at 11:00 and 11:45
Where: Room Georges Charpak, 60/6-015





GLOBAL COSMICS GROUP

The Global Cosmics Group was founded in order to bring together and enable closer cooperation between the worldwide existing informal science education and outreach programs in the field of astroparticle physics.

For this reason, all representative scientists from cosmic outreach, education and citizen science projects are invited to participate in the group. An overview of the projects involved can be found in Fig. 1. It is an open group that meets once a year at the annual IPPOG spring meeting. At this meeting, ideas are collected, exchange is encouraged and activities for long-term collaborations are discussed.

The attending scientists are disseminators by sharing the information to their local networks. A common website provides an overview of the existing projects worldwide. This website will be integrated into the new IPPOG website in the future. Moreover, the website will be expanded so that more content can be shared.

As examples of intensified international cooperation in recent activities, International Muon Week and the International Cosmic Day are highlighted in this report. Both events are organised once a year and focus on high school students. The primary aim is to bring together scientists, teachers, and students to perform an experiment with atmospheric muons and thereby to learn more about cosmic rays.

International Muon Week is organised by QuarkNet and this year's event took place April 1-5, 2019. During this week, all participating groups were asked to have their detectors running for 24 hours a day, 7 days a week. Subsequently, the data and measurement results were shared on a common website. This year, 54 groups participated worldwide which meant a significant increase

in participation and international cooperation compared to 2018 with 12 participating groups. A particularly large number of groups were integrated into the Italian EEE project of Centro Fermi in 2019³.

Subsequent to Muon Week, International Cosmic Day took place on November 6th, 2019, organised by DESY. Here, all participating groups investigated an identical question. The students were encouraged to work together as an international collaboration and then to discuss their results in joint videoconferences. To create a lasting event, all participating groups were asked to document their results for the day with images, comments or notes, and their measurement results were recorded on one common page. All proceedings were published in a booklet and distributed to the participants. Similarly, in this event, the Italian groups played a major role, organised by the EEE project and by the OCRA project from INFN. In summary, International Cosmic Day is a growing event that is gaining in popularity (see Fig. 2). A quiz on Kahoot!, a game-based learning platform, and a selfie contest on Instagram and Facebook accompanied the day on social media.

Both activities, International Cosmic Day and Muon week, have proven to be successful and are referred to as unique experiences by teachers and students alike.

¹ <http://cds.cern.ch/record/2640785/files/>

² [201809-249_02.jpg?subformat=icon-1440](https://www.ippog.org/201809-249_02.jpg?subformat=icon-1440)

³ <https://eee.centrofermi.it/news>

Country	Name	Website
FINLAND	Callio Lab	https://calliolab.com
FRANCE	Cosmos à l'École	http://www.sciencesalecole.org
FRANCE	e-PÉRON	https://eperon.omp.eu
GERMANY	Netzwerk Teilchenwelt and Cosmic@ Web	https://www.teilchenwelt.de https://cosmic.desy.de
ITALY	Extreme Energy Events EEE	http://eee.centrofermi.it/
ITALY	OCRA	https://web.infn.it/OCRA/
NETHERLANDS	High School Project on Astrophysics Research with Cosmics (HiSPARC)	http://www.hisparc.nl/en/
POLAND	Cosmic-Ray Extremely Distributed Observatory (CREDO)	http://credo.science/ https://www.zooniverse.org/projects/credo/dark-universe-welcome
RUSSIA	Showers of Knowledge	http://credo.science/ https://www.zooniverse.org/projects/credo/dark-universe-welcome
SPAIN	Cazadores de Rayos Gamma	http://www.cazadoresderayosgamma.com/
SWEDEN	Cosmic ray outreach in Stockholm	http://vetenskapenshus.se.loopiadns.com/info-kosmisk-strålning
TAIWAN	QuarkNet-TW	http://hsiaoscu.pbworks.com/w/page/19665685/Quarknet-TW-page
UK	Detecting Cosmic Rays	http://www.ep.ph.bham.ac.uk/twiki/bin/view/General/QuarkNet
UK	High School Project on Astrophysics Research with Cosmics (HiSPARC)	http://www.hisparc.nl/en/
UK	QuarkNet Cymru	http://blogs.cardiff.ac.uk/physicsoutreach/2016/11/03/quarknet-cymru/
USA	Cosmic Ray e-Lab Studies	https://www.i2u2.org/elab/cosmic/home/project.jsp

Fig. 1: Projects involved in Global Cosmics Group

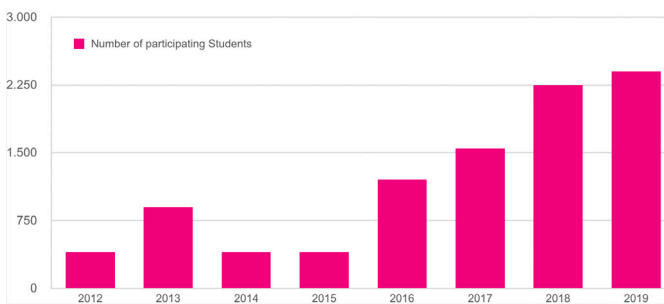


Fig. 2: Number of participating students from 2012 to 2019



Fig. 3.: Video conference at International Cosmic Day between school groups and scientists at the H.E.S.S. telescope

IPPOG PRESENCE AT CULTURAL FESTIVALS IN 2019

IPPOG supports its members to organise activities in music and science festivals, public sessions in conferences and other events reaching a wide variety of audiences. Below are a few of the outreach events in which IPPOG participated as one of the partners.

THE BIG BANG STAGE, CZECH REPUBLIC, JUL 17-20, 2019

The Big Bang Stage was an official part of the biggest Czech music festival, Colours of Ostrava. The entire stage was dedicated to particle and nuclear physics¹. It offered 28 hours of programme during four days, full of talks, workshops, discussions and shows. About 3000 visitors at the stage enjoyed the programme and rewarded organizers with feedback like “Absolutely loved it!” or “Very nice opportunity to extend knowledge in between concerts.” The organisation team also prepared additional accompanying activities for the festival visitors: two hands-on tents where people could touch and try simple physics experiments and virtual reality videos about CERN with VR glasses. These activities attracted an additional 1000 visitors. The Big Bang Stage was organised by four Czech Universities, Vojtech Pleskot (IPPOG Czech Representative), Connie Potter (CERN) and The Big Bang Collective, discussion forum Meltingpot, The Science and Technology Centre Ostrava, and IPPOG.



¹ <https://www.mff.uni.cz/cs/verejnost/aktuality/the-big-bang-stage-na-colours-of-ostava>

MAGICAL SCIENCE AT POHODA FESTIVAL, SLOVAKIA, JUL 11-13, 2019

Pohoda is the largest art/music festival in Slovakia with a limited capacity of 30 000 visitors. The physics programme in the Magical Science tent ran on Friday July 12th, 9:00 – 13:30 and Saturday July 13th, 9:00 - 13:30. It included seven lectures (from “What have CERN and the LHC ever done for you” to “Smells, pheromones and passion”) and five workshops (from “Cloud chamber workshop” to “The physics of beer workshop”). The programme was amazingly successful with a total audience of about 5000 people. The Magical science was organized by Connie Potter (CERN), Roger Jones (Lancaster U), Chris Thomas (Iowa U), Larry Lee (ATLAS) and a local team: T. Dado, R. Astalos, J. Tekel, S. Kovacik, B. Sitar, I. Melo (IPPOG Slovakia Representative) and 5 assistants. Financial support came from IPPOG and the Slovak committee for cooperation with CERN; in-kind contribution from Pohoda (Magical tent with all equipment, accommodation, food and beer for the beer workshop). Vedator.sk and FMFI Comenius University supplied speakers and volunteers, and CERN gave permission to use its logo.



Credit : "Martina Zimova @Pohoda Festival"

UNIVERSAL SCIENCE AT CHEP, ADELAIDE, AUSTRALIA, NOV 3, 2019

IPPOG hosted the 2nd edition of Universal Science on the eve of CHEP 2019, the International Conference on Computing in High Energy and Nuclear Physics. The event brings together the local public with participants of the conference, in order to maximise engagement between the groups. This is accomplished through a combination of hands-on exhibits, short presentations, and a highly interactive panel discussion. The public are presented current activities in particle physics research, worldwide computing and international collaboration, while our colleagues exercise their skills in public engagement. The full program can be viewed at <https://universalscience.web.cern.ch>. Participants and sponsors included the University of Adelaide, IPPOG, CERN, ATLAS, Belle II, CMS, and Women in Technology. Marzena Lapka (IPPOG CMS Rep) and Steven Goldfarb (IPPOG Chair) hosted speakers Lucia Silvestris (CMS), Hannah Short (CERN IT) and Paul Jackson (IPPOG Australian Rep). Joining them in the discussion panel were Tim Smith (CERN IT) and two local students. At the demand of the 250-person audience, the Q&A session was extended to an hour. Diversity in science was once more an overarching theme, and one we plan to continue to feature in future editions.



² <https://www.pohodafestival.sk/en/news/cern-comenius-university-and-the-big-bang-collective-present-magical-science-at-pohoda-2019>

³ <https://universalscience.web.cern.ch/>