

Particle Physics Outreach with Masterclasses

Belle II Academy
5. August 2022

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Motivation for Outreach



Leon Lederman, 1980ies

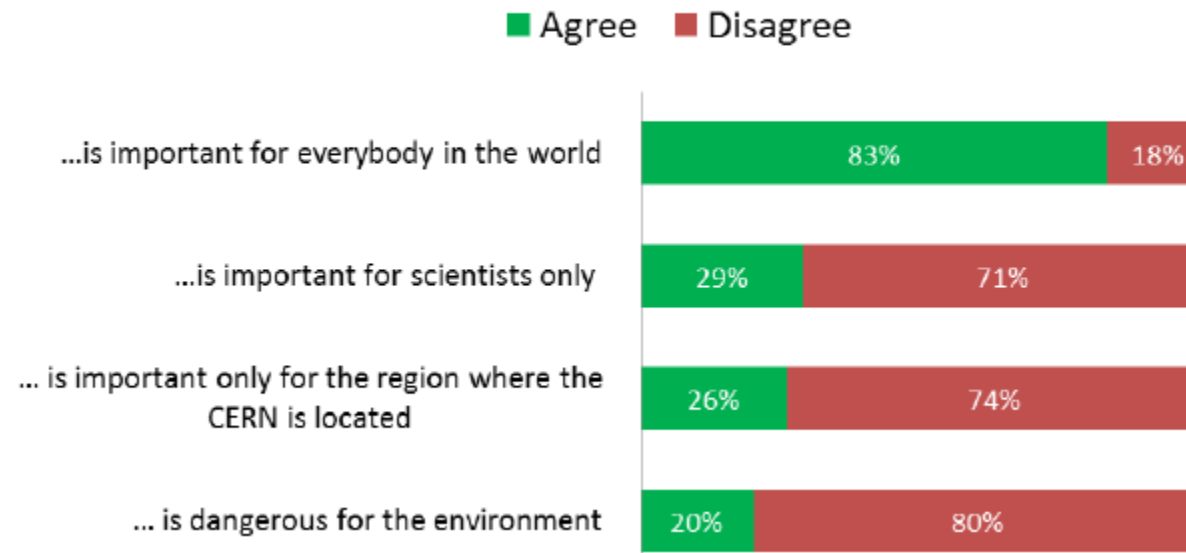


Recruitment of
future scientists

Motivation for Outreach

- Secure funding for our projects (“1 coffee/year”)
- **A price worth paying** R. Heuer (2020) <https://cerncourier.com/a/a-price-worth-paying/>
- **Scientific Research at CERN as a Public Good: A Survey to French Citizens** M. Florio et al. (2018) <http://cds.cern.ch/record/2635861>

Figure 8. Scientific research at CERN ... (n=1,005)



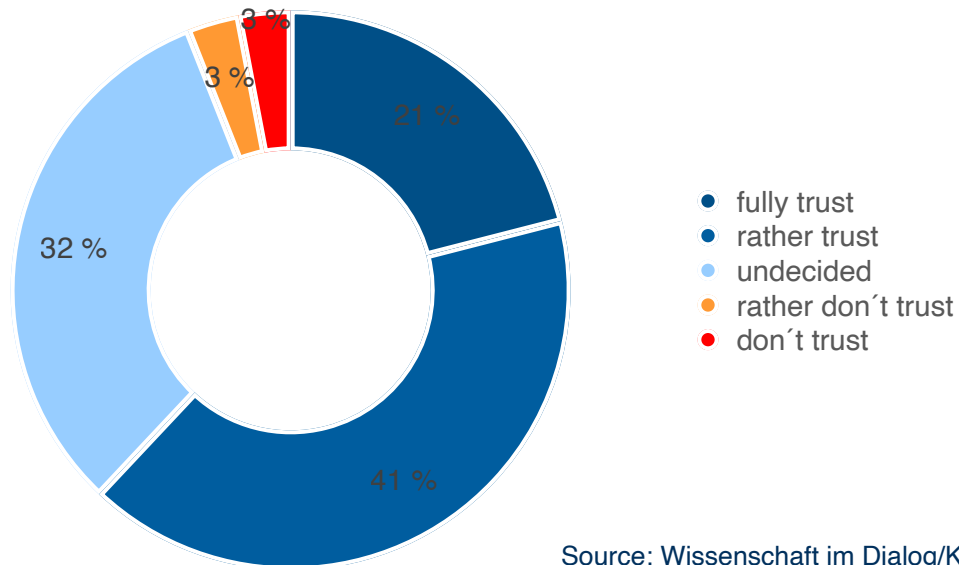
Recruitment of
future scientists

Explanation &
legitimation

Motivation for Outreach

“How much do you trust science and research?”

Wissenschaftsbarometer 2021



Source: Wissenschaft im Dialog/Kantar



Recruitment of
future scientists

Explanation &
legitimation

Create
trust in science

Motivation for Outreach

Quotes from Masterclasses moderators:

“The best thing is actually answering the questions and seeing how excited and how happy they are, waving at the camera. They're really excited to be talking to physicists based at CERN!”

“It is very satisfying, because we do many video conferences and rarely do people cheer on the other side if you say something. Here they do!”



Recruitment of
future scientists

Explanation &
legitimation

Create
trust in science

Intrinsic
motivation

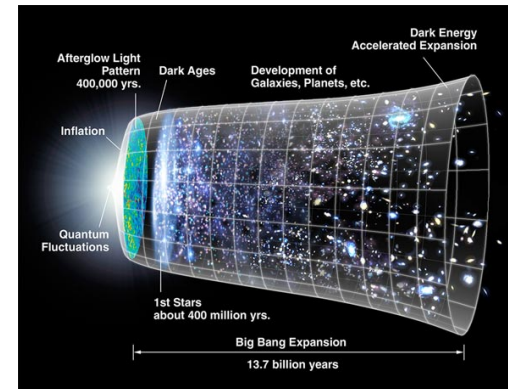
A Research Area with a lot of Potential

Strength and chances:

- Strong media interest
- Many people are interested in fundamental questions
- Unique research methods and experimental setups
- Is connected to captivating terms, e.g. Big Bang, Antimatter

Challenges:

- Modern physics often not in school curricula
- Many new concepts and perceptions
- Large number of new terms
- Connection to everyday experience



The Idea behind Masterclasses

Act as a "scientist for a day"

- Close to current research
- Own "hands-on" activities (listen = forget, see = remember, do = understand)

Get insight into the research process

- Use of relevant methods and tools
- Comparisons between experiment and theory

Authentic experiences

- Analysis of real scientific data
- Meeting and discussion with scientists



Why “Masterclass”?

As in a Masterclass in the arts, students work with an expert

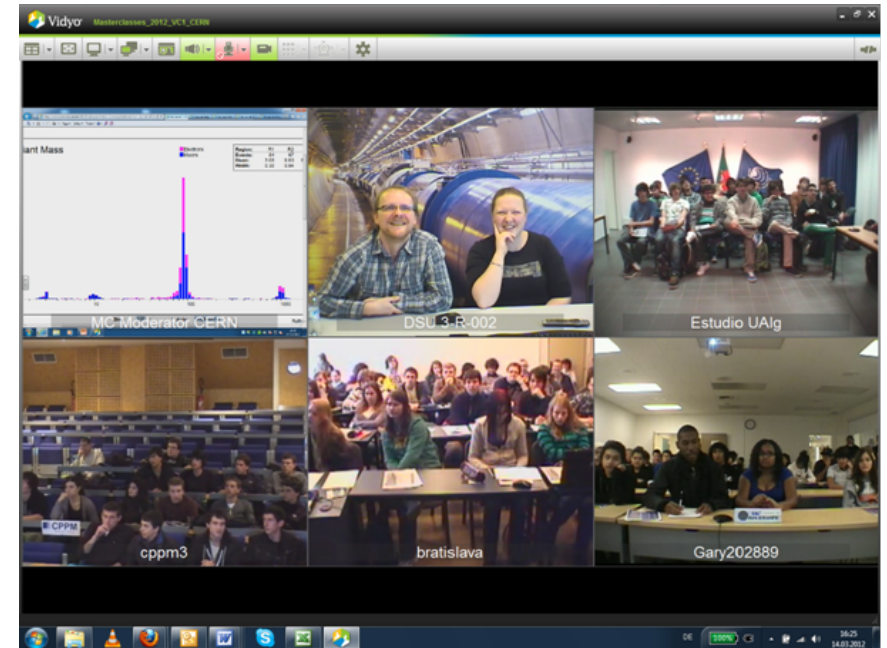
Expert = particle physicist

Instead of, say, a violin, the subject is particle physics data analysis



Concept of International Masterclasses

- High school students (15 – 19) are „scientists for one day“
- Get invited to a research institute or university
- Introductory talks (standard model, detectors, accelerators)
- Measurement with data
- International video conference (3 – 5 inst. + moderators)



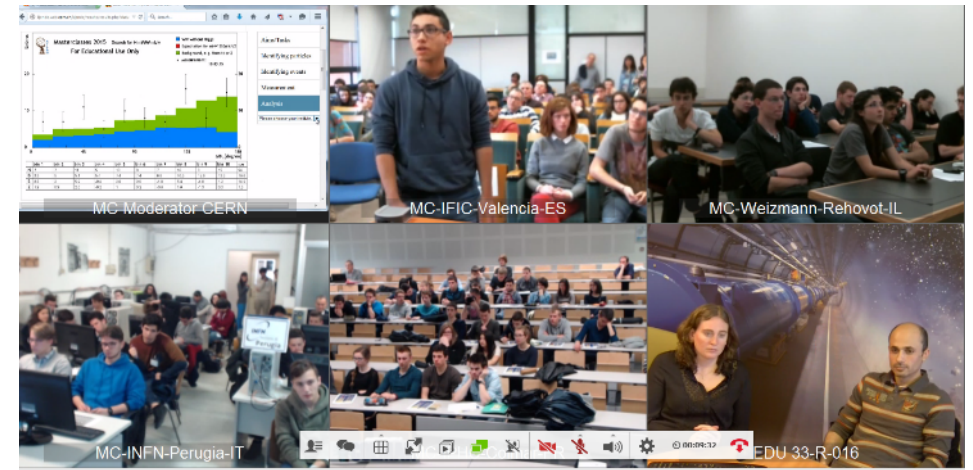
Sample Agenda

Local time	Activity
8:30 - 9:00	Registration & Welcome
9:00 - 10:00	Introduction to Particle Physics
10:30 - 11:30	Second talk or tour
12:00 - 13:00	Lunch
13:00 - 15:00	Data analysis
15:00 - 16:00	Local combination + Discussion
16:00 - 17:00	International video conference



Video Conference

- 45-60 min
- 3-5 institutes, reflecting international collaboration
 - Same measurement, different data
- 2-3 Moderators (PhD students, Postdocs)
- Moderation centers: CERN, Fermilab, KEK, GSI, TRIUMF
- Agenda of the video conference
 - Welcome
 - Combination and discussion of results
 - General Q & A
 - Quiz



Belle II International Masterclasses 2022

And How you can Join!

- ▶ **Remote Sessions were offered on March 7, March 16 and March 23**
 - [Link](#) for this year's IM

- ▶ **For General Information contact:**
 - [Link](#)
 - Uta Bilow
 - uta.bilow@tu-dresden.de

- ▶ **Contact your local institute to check if they participate**
 - Join next year's International Masterclass as a facilitator

Worldwide Program

- Organized by IPPOG (International Particle Physics Outreach Group)
- 60 countries involved
- 220 research labs
- 2019: 15.000 high school students
- Coordination: Ken Cecire (QuarkNet) / TU Dresden



Broad Physics Scope

Today:

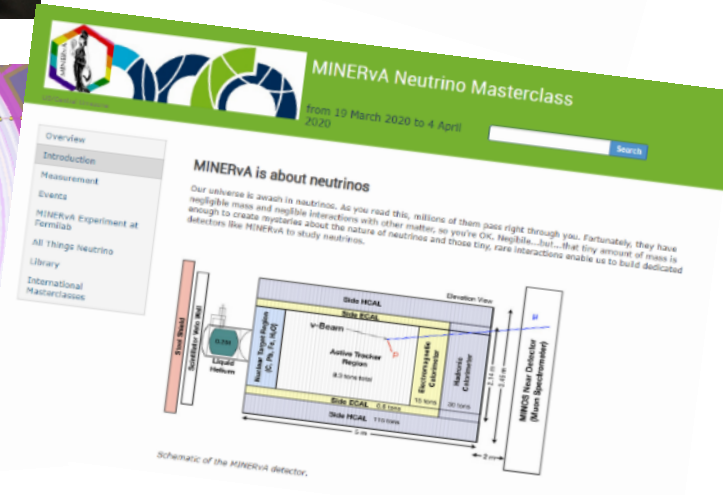
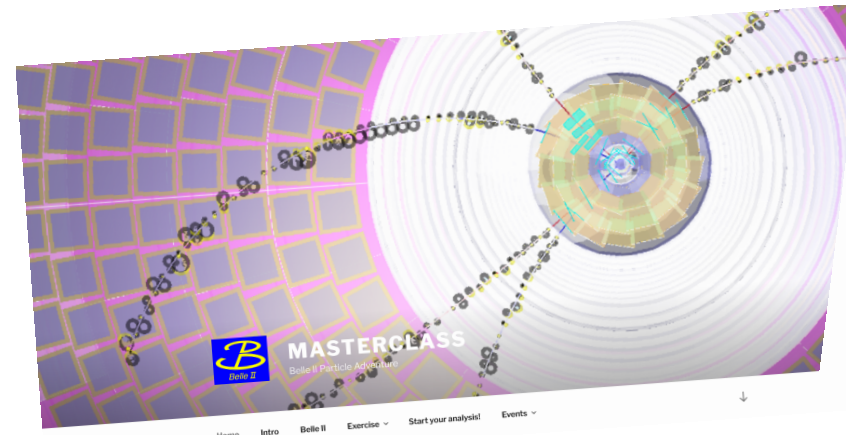
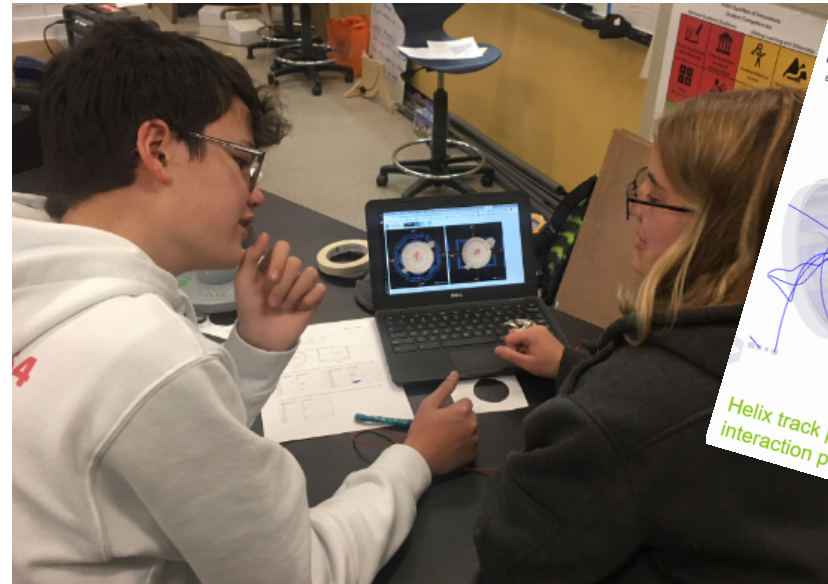
- LHC (since 2005)
- MINERvA (since 2019)
- Belle II (since 2020)
- Particle Therapy (since 2020)

Under development:

- NOvA
- MicroBooNE

More Masterclasses:

- [IceCube](#)
- [Pierre Auger](#)
- [DarkSide](#)
- ...



International Scientific Collaboration

- Active Researchers with Experience in Education & Public Engagement
- Experts in Communication & Education

Global Network

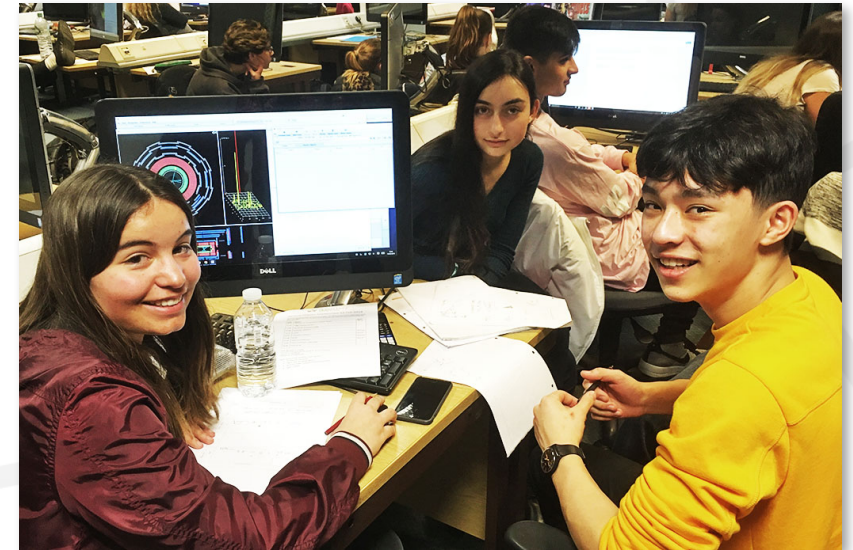
- 37 members: 30 countries, 6 experiments, 1 intl lab (CERN)
- 2 associate members: 2 national labs (DESY, GSI)

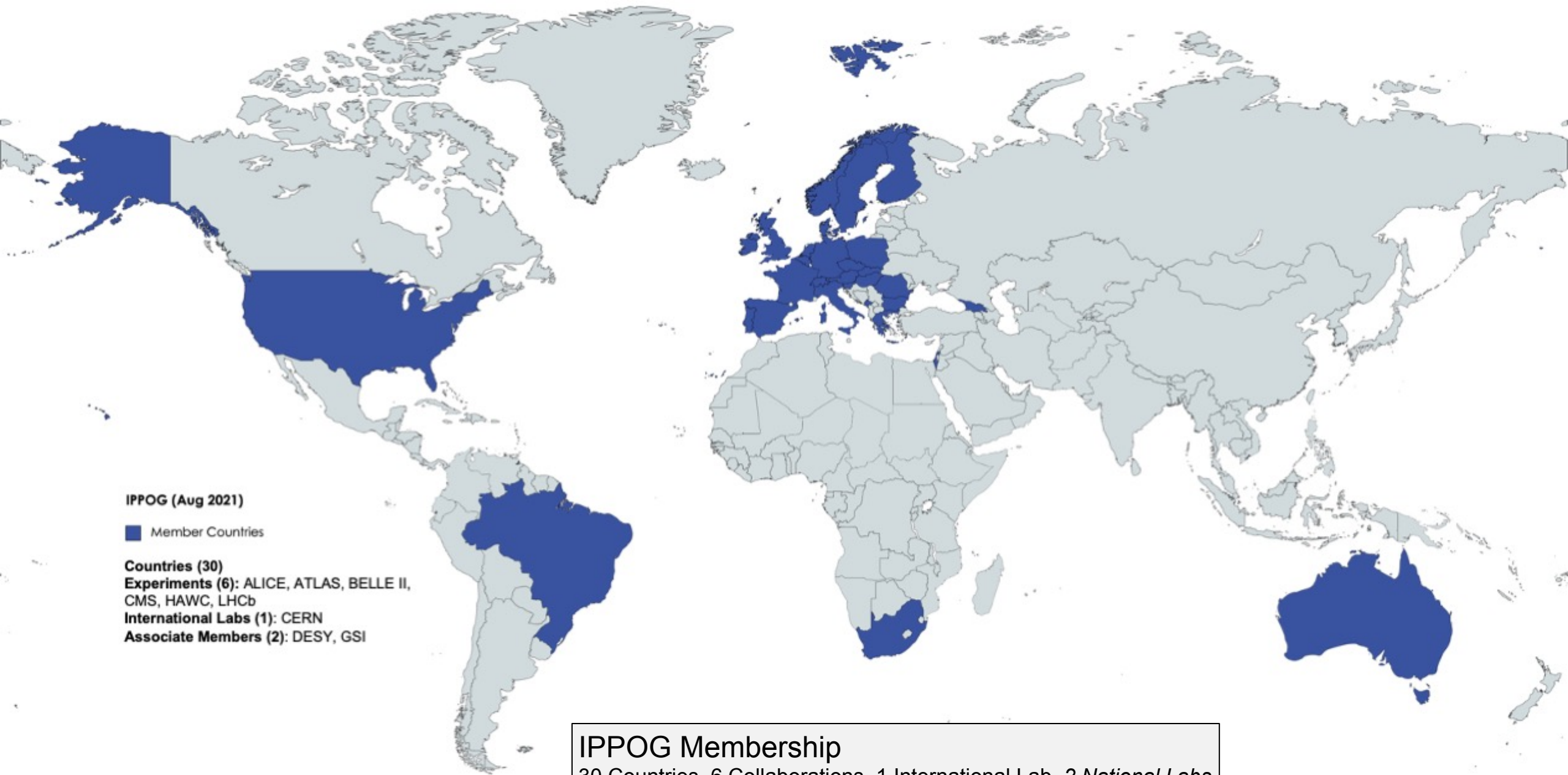
Organise Global Activities

- International Particle Physics Masterclasses
- World-Wide Data Day, Global Cosmics, etc.

Support Local Activities

- Sharing of expertise, best practices, material database
- Resources to support events, kick-start activities





IPPOG (Aug 2021)

■ Member Countries

Countries (30)

Experiments (6): ALICE, ATLAS, BELLE II,
CMS, HAWC, LHCb

International Labs (1): CERN

Associate Members (2): DESY, GSI

IPPOG Membership

30 Countries, 6 Collaborations, 1 International Lab, 2 *National Labs*

Sustainable Development of Particle Physics Outreach

- Discussion forums for scientists active in Education and Public Engagement
- Information exchange between individuals, institutions and laboratories
- Active working groups addressing specific challenges of global Outreach

Improving Outreach Standards Worldwide

- Development of strategies based on current best practices and experience
- Long-Term links between scientists and education specialists
- Continual development & improvement of explanatory material

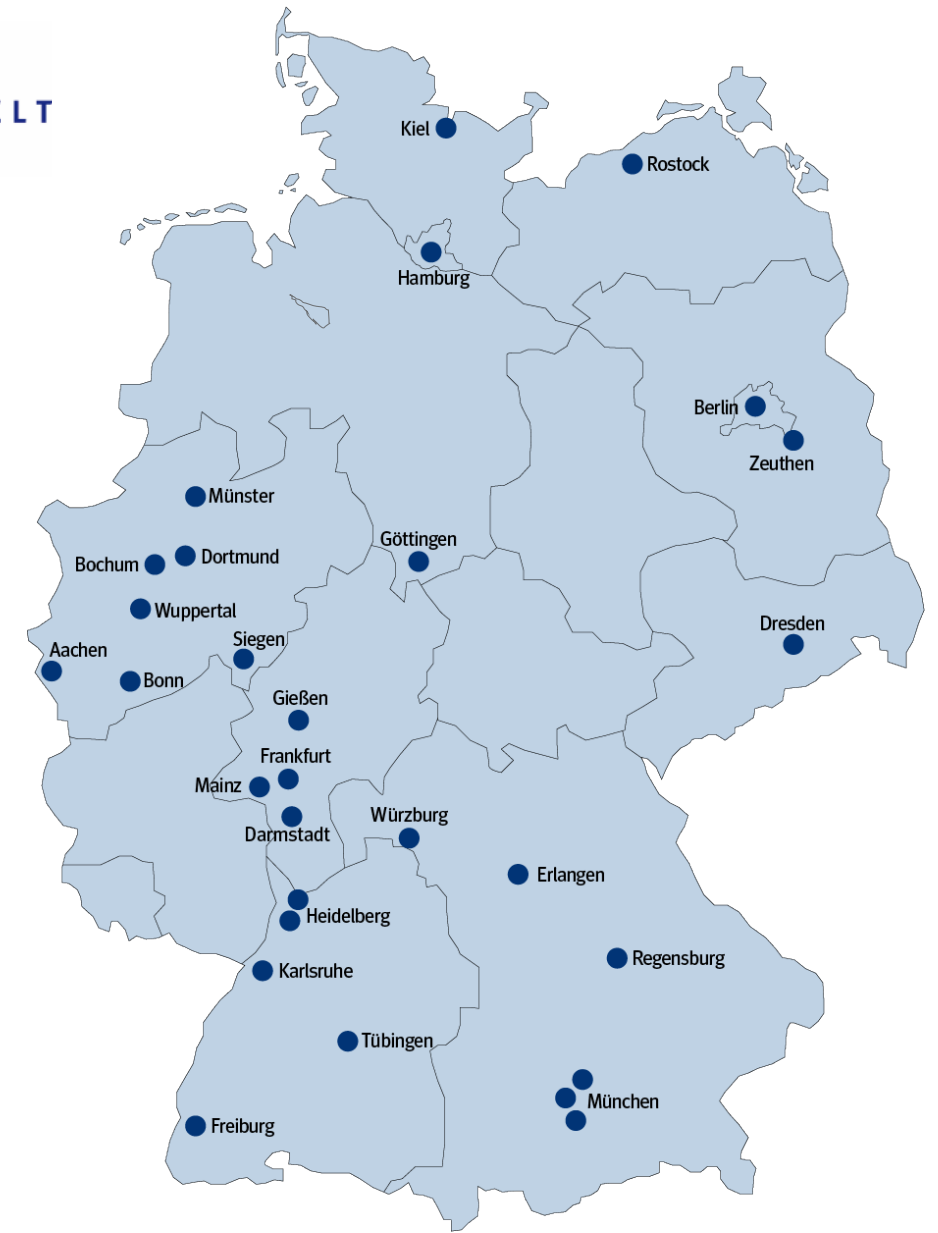
Extending Global Reach

- Expansion to countries and peoples underrepresented in particle physics
- Usage of new methods, activities and topics to reach broader audiences
- Active online communication platforms

Netzwerk Teilchenwelt



- 30 universities/research labs + CERN
- Joint outreach
 - Bundle existing activities
 - Share structures and programs
- **High visibility and impact**
- Project team: TU Dresden / DESY / CERN
- + hubs in U Bonn, U Mainz, U Münster
- 2010: Particle and Astroparticle Physics
- 2019: Nuclear and Hadron Physics
- Funded as integral part of research by the German Ministry of Education and Research



Core: Multi-step Program for High School Students



Masterclasses



Active engagement,
detector projects



4 days CERN or
5 days MAMI



Own research
projects

Number of students
per year

3500

250

75

15

Facilitators



- ~ 150 PhD and Master students
- Guide Masterclasses, supervise students' research projects
- Influence students' career-related aspirations and choices

- Reimbursement of expenses and travel cost
- Get training courses on communication, didactics, and presentation techniques



- Be a role model
- Talk about your research!
- Acquire soft skills, for personal and professional development
- Experience interest in own research
- Practice supervision



Workshops for New Facilitators

► **The Basics 1x1** - On-boarding for new students

- 25.11.2022 10:00 - 11:00 am



► **Spotlight On** - Introduction into a new Masterclass

- Directly after the On-Boarding

► **Introductory Workshop for New Facilitators**

- Facilitator's workshop, once per year, introduction in didactics, science communication & interactive methods for Masterclasses
- [Link](#) for this year's workshop
- Next Workshop: Probably February 2023

How to Participate



- ▶ **Future Workshops will be offered in English**
 - Possibility for international students to join

- ▶ **Contact your Thesis Supervisor**
 - Check if your University is part of Netzwerk Teilchenwelt
 - Get in touch with the local contact person for outreach (Netzwerk Teilchenwelt)

- ▶ **Contact Us**
 - [Link](#)
 - Dr. Barbara Veleriani-Kaminski
 - bonn@teilchenwelt.de

How to Reach Us

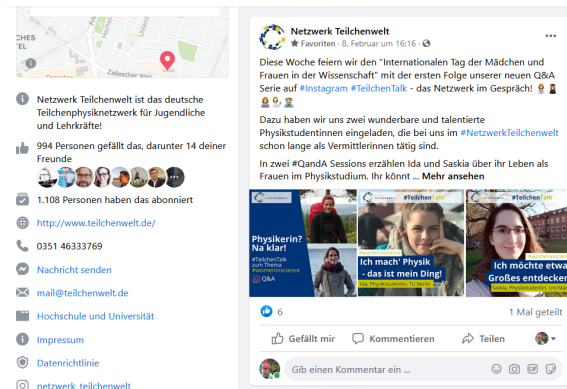
Webseite

Newsletter „Teilchenwelten“ 3 x per year (Abo)

YouTube-Videos „Netzwerk Teilchenwelt mit Moritz“

Facebook

Instagram



Summary

- Informing the **public** is our duty as scientists
- Inspiring the **next generation** is an important task
- **Masterclasses** are a proven and robust (COVID19!) tool for outreach and comes in many flavours
- **IPPOG** is a collaboration working on sustainable development of particle physics outreach and improving outreach standards worldwide
- The German network **Netzwerk Teilchenwelt** uses Masterclasses as the basic stage in a sustainable program to attract and promote young STEM talent
- Existing programs and structures create **multiple benefit**
 - win for **high school students**: experience modern research first-hand
 - win for **facilitators/PhD students**: train their communication skills, participate in a rewarding activity
 - win for **physicists**: get young talents for the research groups