Science Education in an International Context

Dr. Sascha Marc Schmeling

Head of Teacher and Student Programmes, CERN, Geneva
Chairperson of the Physics Education Division Board, EPS

Joint Annual Meeting of the Austrian and Swiss Physical Societies
Basel, 08.09.2023

Science for peace

CERN was founded in 1954 with 12 European Member States

23 Member States

Austria – Belgium – Bulgaria – Czech Republic
Denmark – Finland – France – Germany – Greece
Hungary – Israel – Italy – Netherlands – Norway
Poland – Portugal – Romania – Serbia – Slovakia
Spain – Sweden – Switzerland – United Kingdom

3 Associate Member States in the pre-stage to membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Latvia – Lithuania – Pakistan
Türkiye – Ukraine

6 Observers

Japan – Russia (suspended) – USA
European Union – JINR (suspended) – UNESCO

CERN's annual budget is 1200 MCHF (equivalent to a medium-sized European university)

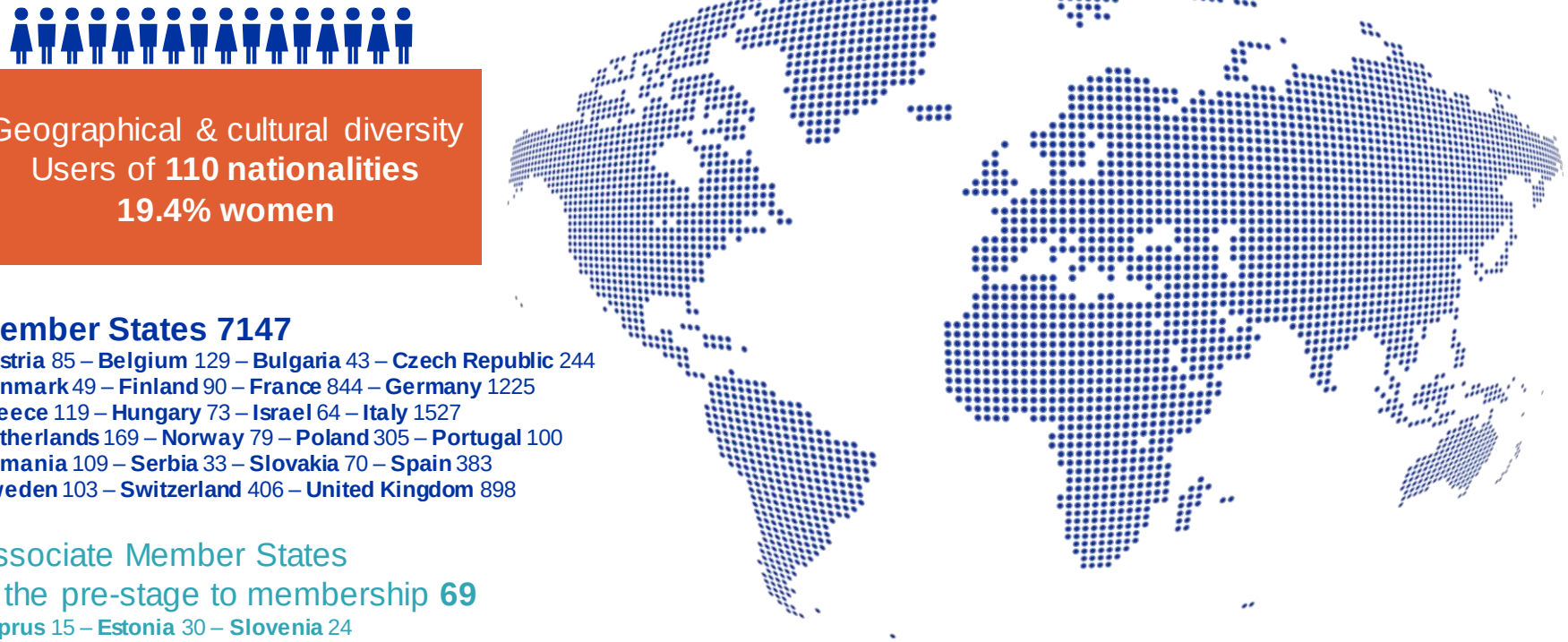
As of 31 December 2022
Employees:
2658 staff, **900** fellows
Associates:
11 860 users, **1516** others

Around 50 Cooperation Agreements with non-Member States and Territories

Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bangladesh – Belarus – Bolivia
Bosnia and Herzegovina – Brazil – Canada – Chile – Colombia – Costa Rica – Ecuador – Egypt – Georgia – Honduras
Iceland – Iran – Jordan – Kazakhstan – Lebanon – Malta – Mexico – Mongolia – Montenegro – Morocco – Nepal
New Zealand – North Macedonia – Palestine – Paraguay – People's Republic of China – Peru – Philippines – Qatar
Republic of Korea – Saudi Arabia – Sri Lanka – South Africa – Thailand – Tunisia – United Arab Emirates – Vietnam

A laboratory for people around the world

Distribution of all CERN Users by the country of their home institutes as of 31 December 2022



Geographical & cultural diversity
Users of **110 nationalities**
19.4% women

Member States 7147

Austria 85 – **Belgium** 129 – **Bulgaria** 43 – **Czech Republic** 244
Denmark 49 – **Finland** 90 – **France** 844 – **Germany** 1225
Greece 119 – **Hungary** 73 – **Israel** 64 – **Italy** 1527
Netherlands 169 – **Norway** 79 – **Poland** 305 – **Portugal** 100
Romania 109 – **Serbia** 33 – **Slovakia** 70 – **Spain** 383
Sweden 103 – **Switzerland** 406 – **United Kingdom** 898

Associate Member States in the pre-stage to membership **69**

Cyprus 15 – **Estonia** 30 – **Slovenia** 24

Associate Member States **382**

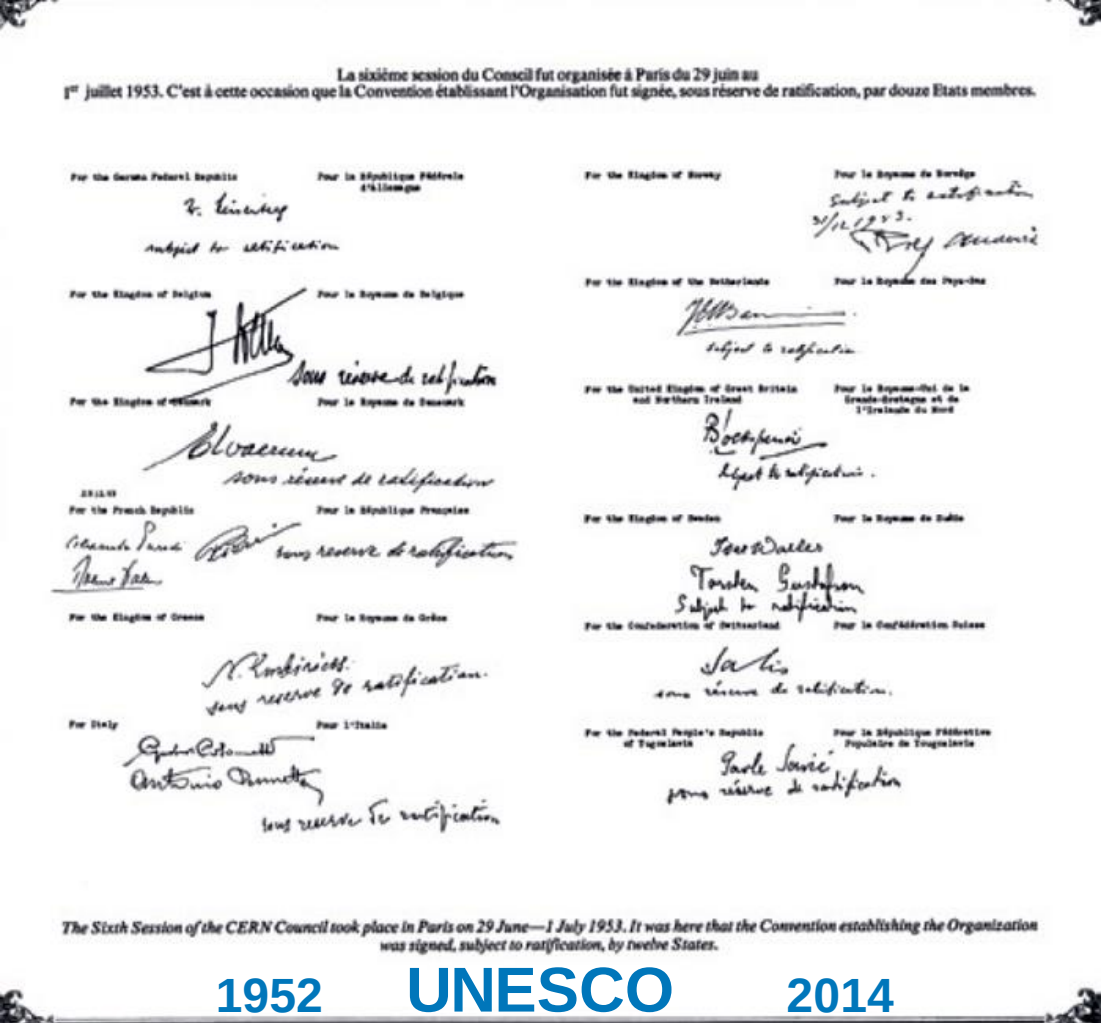
Croatia 38 – **India** 132 – **Latvia** 16 – **Lithuania** 14 – **Pakistan** 35
Türkiye 122 – **Ukraine** 25

Observers **2991**

Japan 216 – **Russia** (suspended) 873 – **United States of America** 1902

Non-Member States and Territories **1271**

Algeria 2 – **Argentina** 13 – **Armenia** 8 – **Australia** 21 – **Azerbaijan** 2 – **Bahrain** 4 – **Belarus** 18 – **Brazil** 122
Canada 199 – **Chile** 34 – **Colombia** 21 – **Costa Rica** 2 – **Cuba** 3 – **Ecuador** 4 – **Egypt** 20 – **Georgia** 32
Hong Kong 15 – **Iceland** 3 – **Indonesia** 5 – **Iran** 11 – **Ireland** 5 – **Jordan** 5 – **Kuwait** 4 – **Lebanon** 13 – **Madagascar** 1
Malaysia 4 – **Malta** 1 – **Mexico** 49 – **Montenegro** 4 – **Morocco** 19 – **New Zealand** 5 – **Nigeria** 1 – **Oman** 1
Palestine 1 – **People's Republic of China** 333 – **Peru** 2 – **Philippines** 1 – **Republic of Korea** 147 – **Singapore** 2
South Africa 52 – **Sri Lanka** 10 – **Taiwan** 45 – **Thailand** 17 – **Tunisia** 2 – **United Arab Emirates** 7 – **Viet Nam** 1



La sixième session du Conseil fut organisée à Paris du 29 juin au 1er juillet 1953. C'est à cette occasion que la Convention établissant l'Organisation fut signée, sous réserve de ratification, par douze Etats membres.

The Sixth Session of the CERN Council took place in Paris on 29 June—1 July 1953. It was here that the Convention establishing the Organization was signed, subject to ratification, by twelve States.

1952 **UNESCO** 2014

The Mission

Fundamental Research
at the frontier of human knowledge

Innovative Technologies
for fundamental research

Collaboration
for the good of humanity

Education & Inspiration
training of future generations

What we do at CERN …

QUEST

ORIGIN

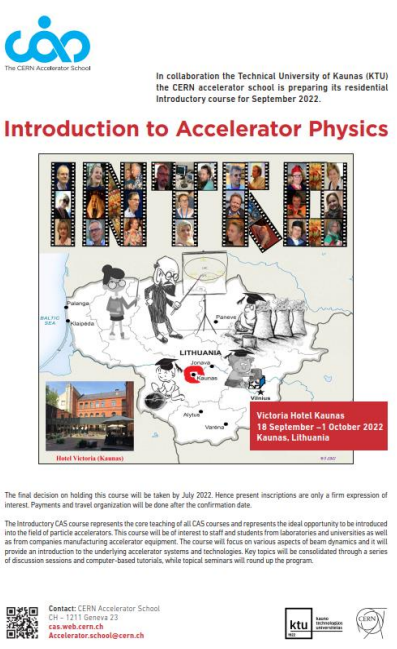
Research Fellowships

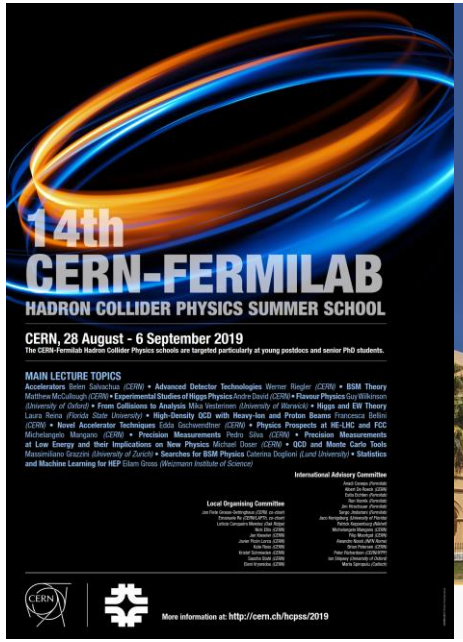
25 by '25

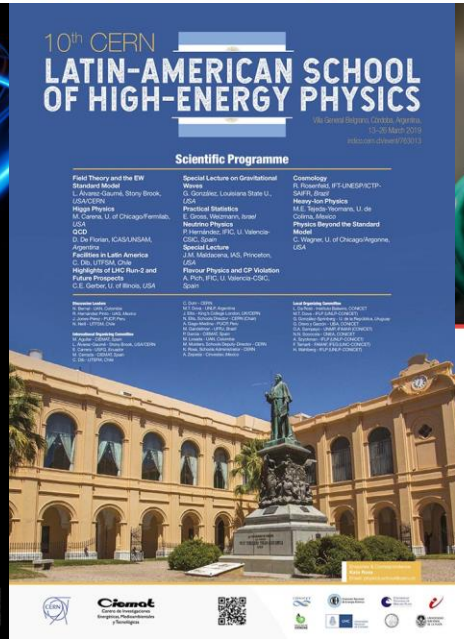
4 QUALITY EDUCATION

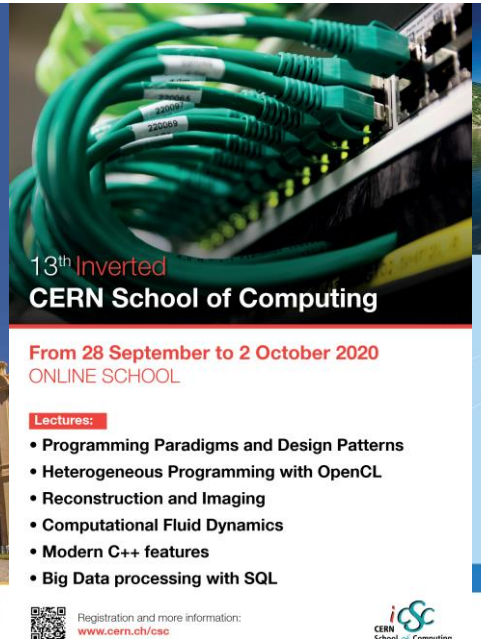
5 GENDER EQUALITY

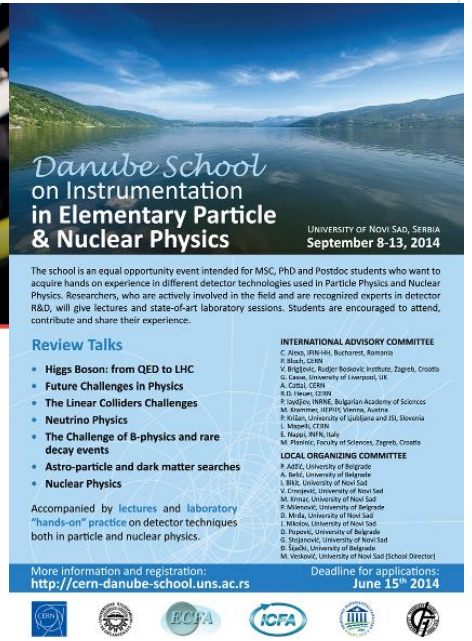
Training Opportunities – Tertiary and Beyond











CERN Schools

17 PARTNERSHIPS FOR THE GOALS

4 QUALITY EDUCATION

Is that “Education”?

Formulated by Ernst Mach firstly in 1886, what needs to be “educated” is the

Nature of Science

I have no doubt that if, somewhere in the universe a creature organized like ourselves could make observations
… it would perceive a universe working similarly to that we ourselves describe …

Ernst Mach, “The Guiding Principles of My Scientific Theory of Knowledge and Its Reception by My Contemporaries”, 1910

Everyone!

Who to reach, who to educate?

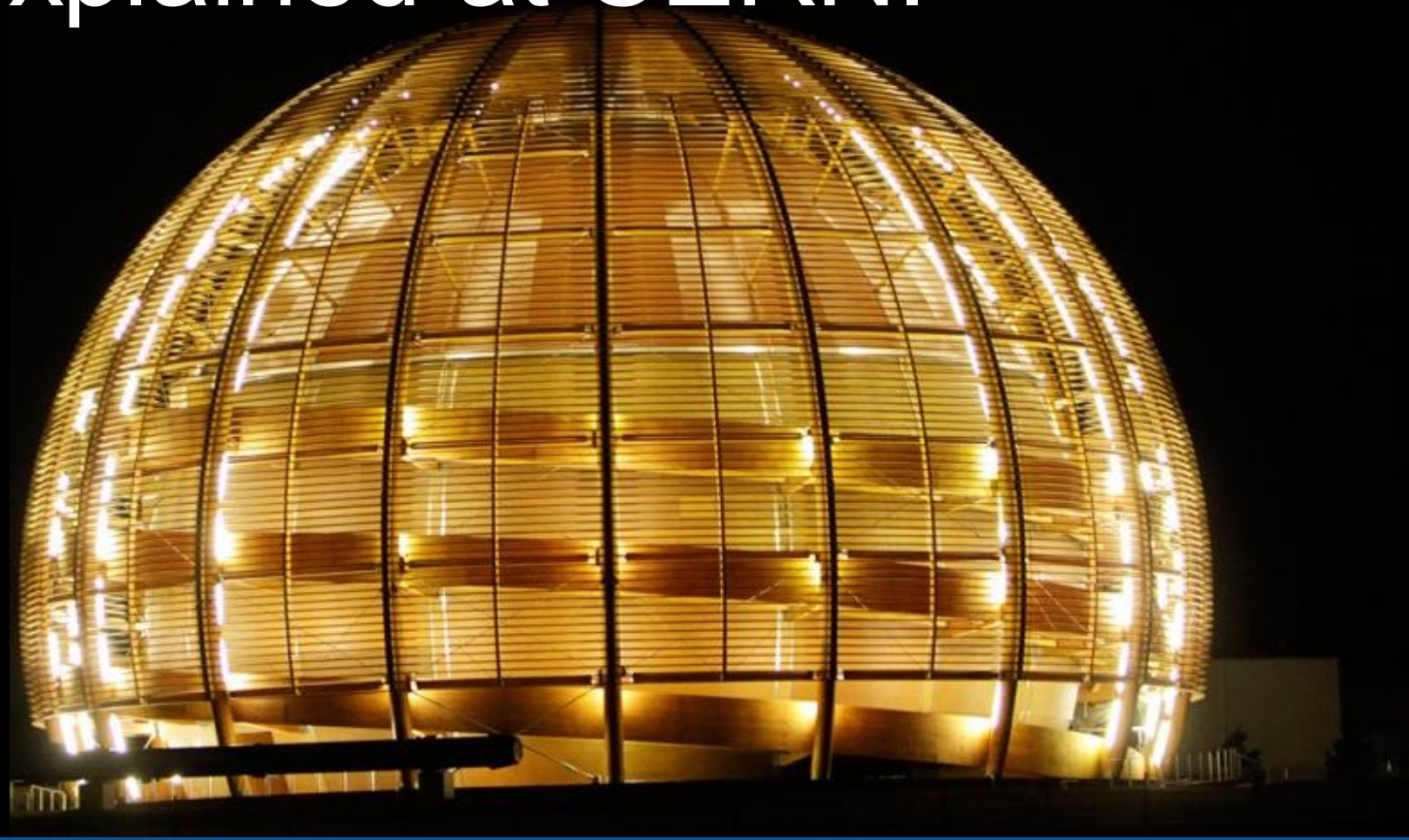
Students? Which age?

Teachers?

Multipliers?

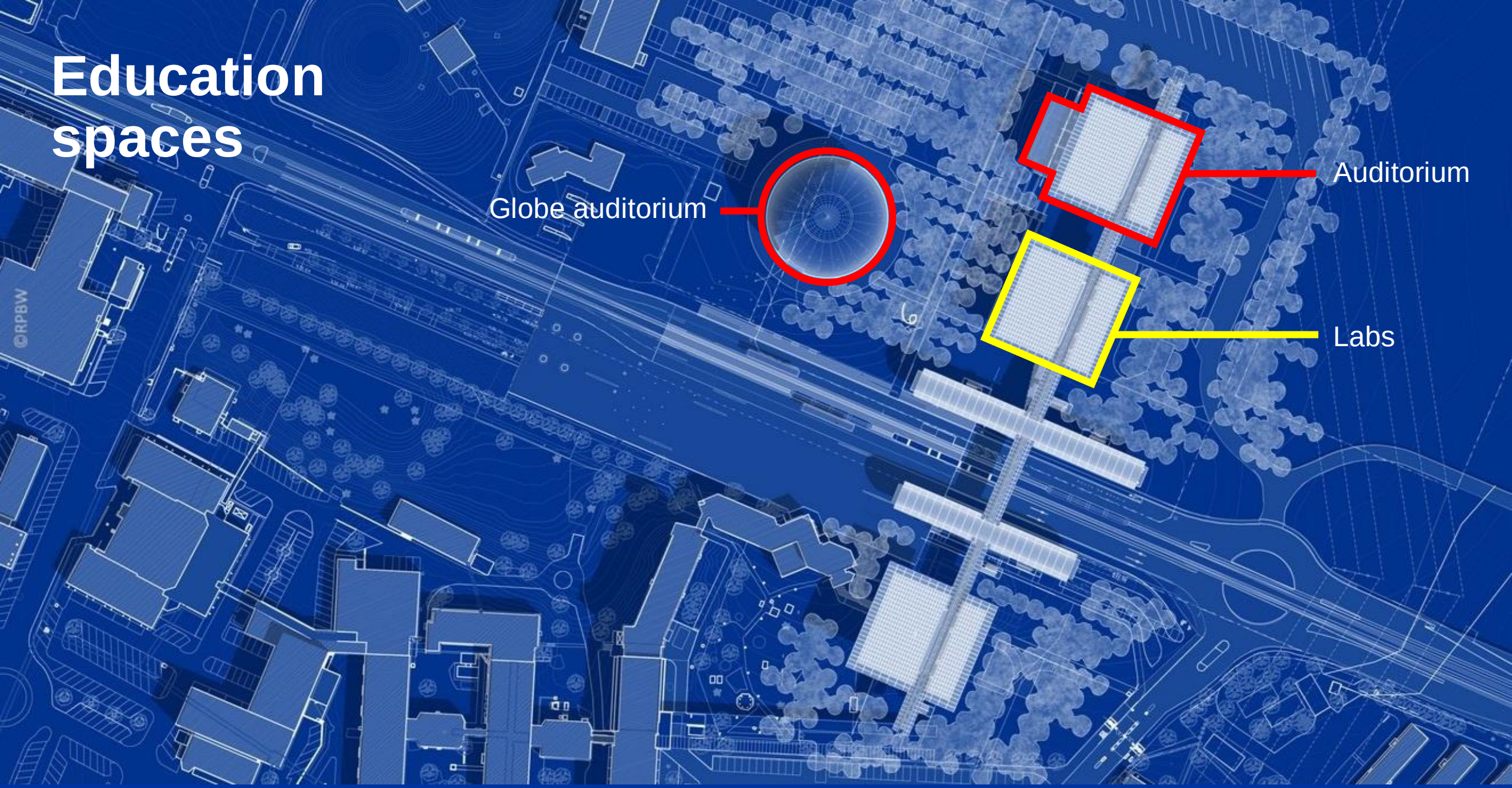
“Magic is not happening at CERN, magic is being explained at CERN.”

Tom Hanks




CERN Science Gateway
7 AFFORDABLE AND CLEAN ENERGY
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
17 PARTNERSHIPS FOR THE GOALS
4 QUALITY EDUCATION

Education spaces



Lab workshops

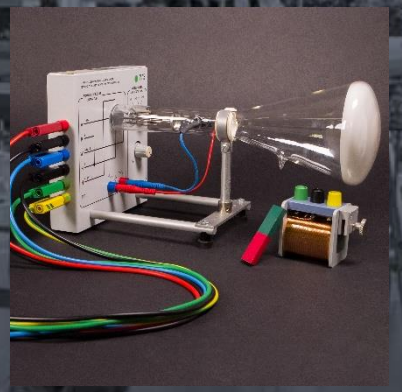
Lab workshops












SCIENCE SHOWS

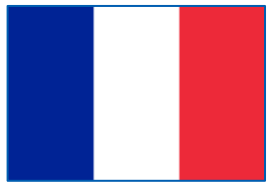
Discover the science and technology of CERN in a theatre setting

See science happening on stage

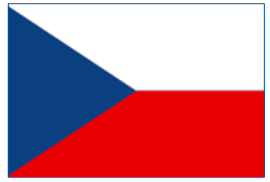
Take part in fun activities, facilitated by CERN scientists

For ages 5 and up

2017


2018



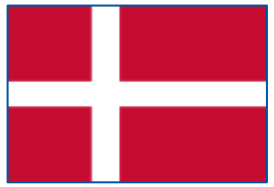


2019





2021

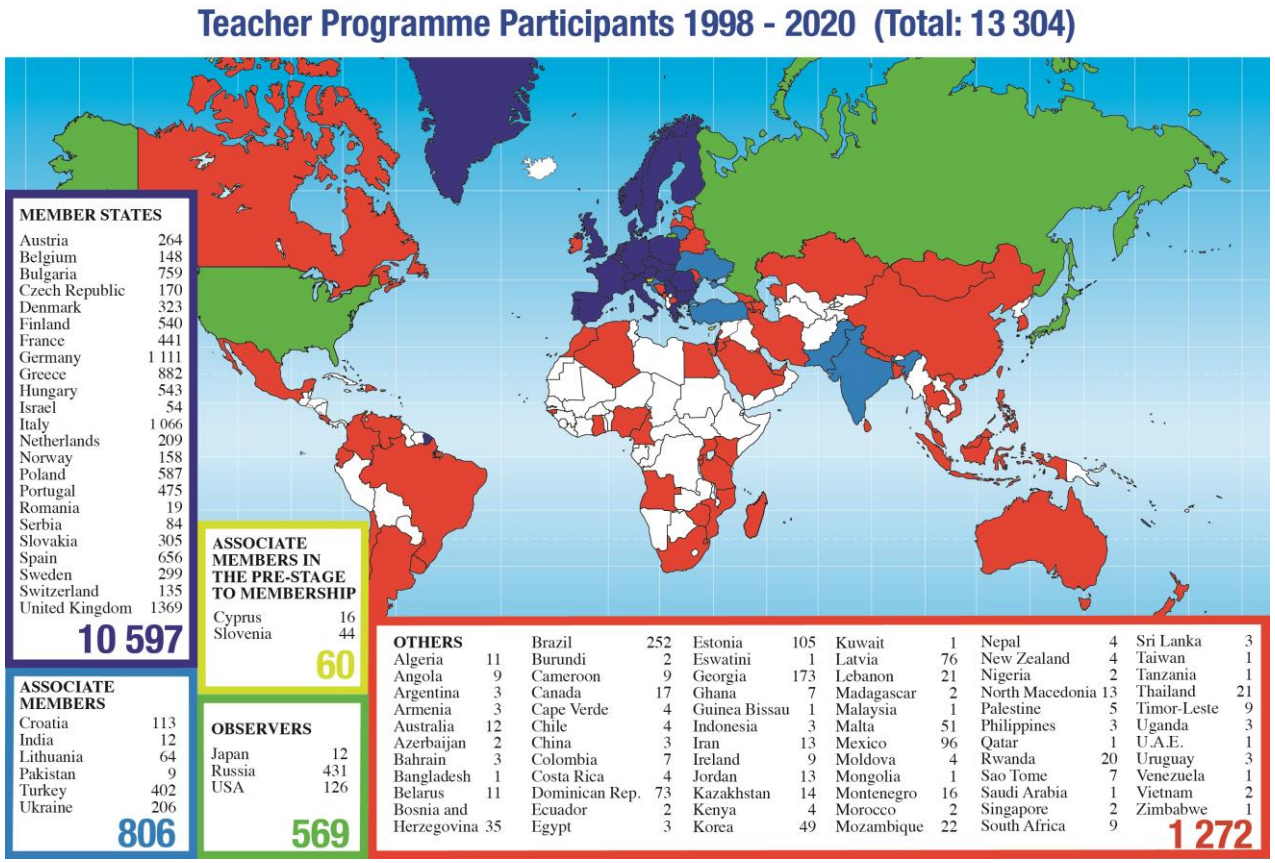




2022


Internship Programmes

17 PARTNERSHIPS FOR THE GOALS
5 GENDER EQUALITY
4 QUALITY EDUCATION

Reaching next generations
Multiplying through teachers



35 national teacher programmes & 2 international teacher programmes per year, reaching ~1000 teachers from >65+ countries.

- In the International Teacher Programmes, usually 25-30% from non-Member States, with specific effort made to ensure **geographical reach** & **diversity**.
- With new online programmes, developed during global pandemic, programmes reach further => 2021: 15 online programmes, 1900 participants, 82 countries, including:
  - Online **Spanish Language Teacher Programme** => 23 countries
  - Online **French Language Teacher Programme** 2021-2022 => 27 countries
  - Online **Portuguese Language Teacher Programme** => 6 countries
- 

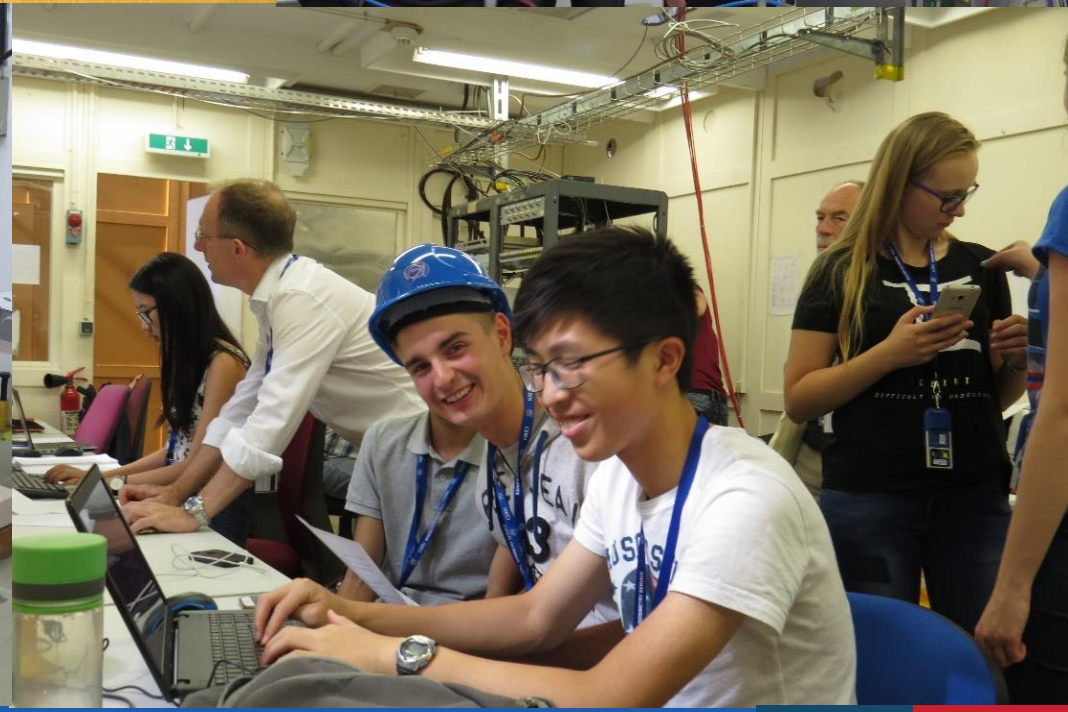
South Asia Science Education Programme

beamline for schools

cern.ch/bl4s

10th EDITION

powered by CERN & DESY



Beamline for Schools Competition

17 PARTNERSHIPS FOR THE GOALS

4 QUALITY EDUCATION

What about those who cannot come?

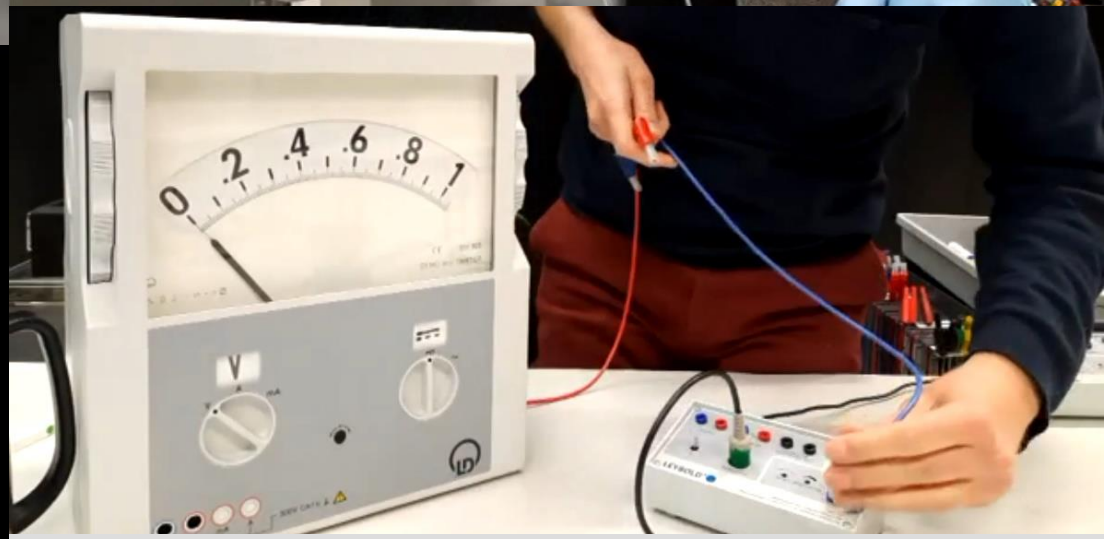
Live interactive demonstrations of scientific phenomena

Links to CERN research

Questions and answers

Various languages

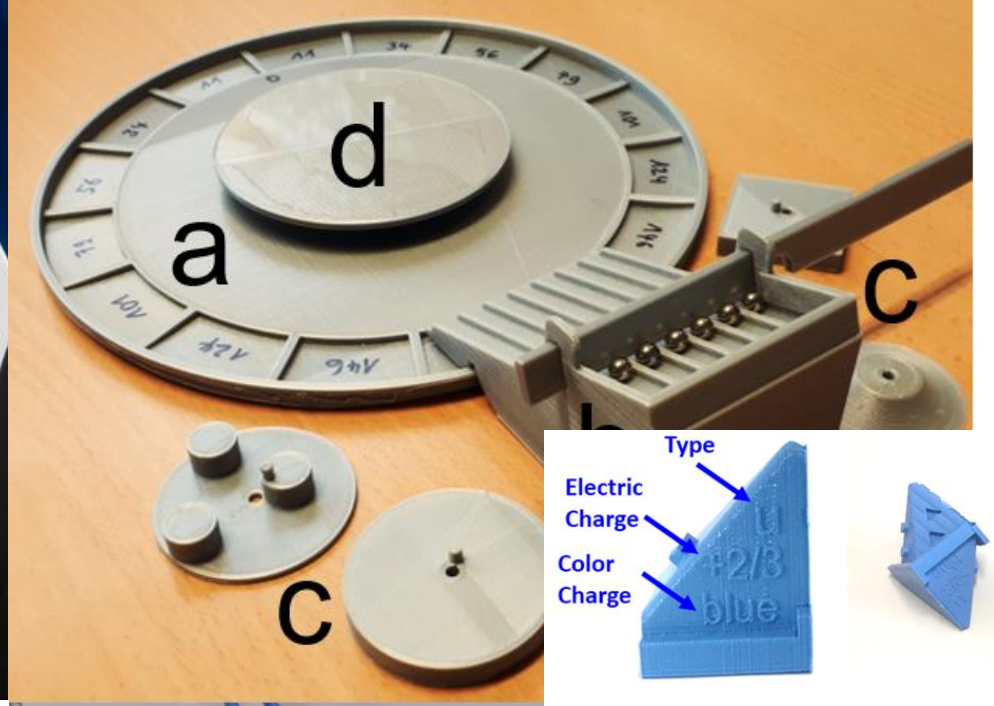
It's Just a Phase!

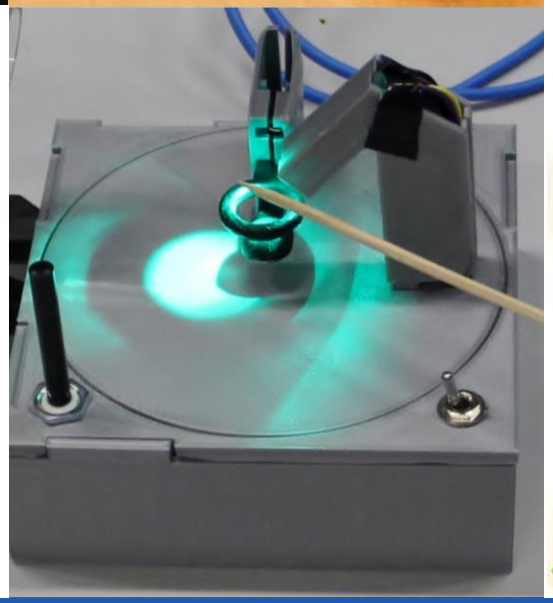


Superconductors Take Off!

Virtual Science Shows – the pandemic as great opportunity

4 QUALITY EDUCATION



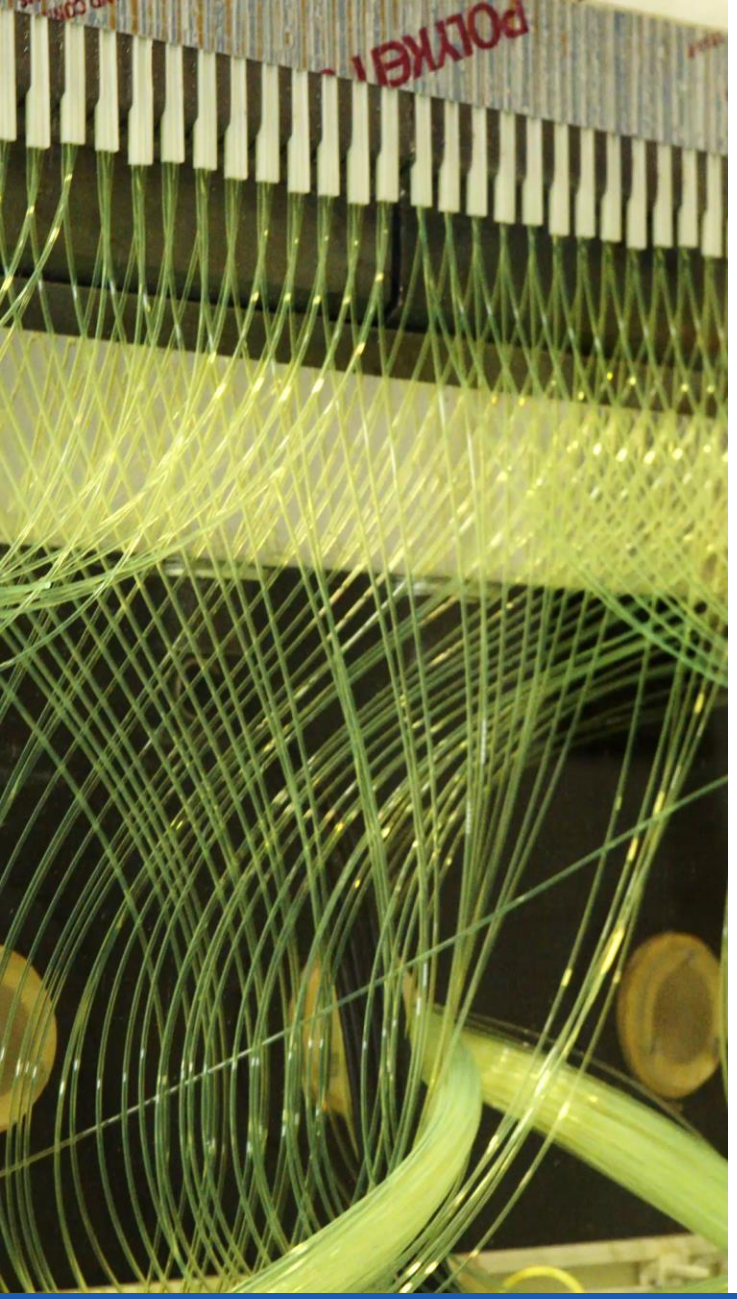


Low-Cost Material for the Classroom

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

10 REDUCED INEQUALITIES

4 QUALITY EDUCATION



CERN | SOLVAY Progress beyond

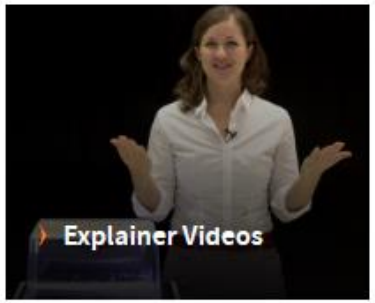
CERN Science Gateway

CERN-Solvay Education Programme

The CERN-Solvay Education Programme is designed to engage high-school students from around the world with exciting education content related to the scientific activities conducted at CERN. Funded by the Belgian science company Solvay, this programme combines the unique advantages of both online and on-site learning at CERN. It aims at triggering, fostering and building up the interest in STEM (science, technology, engineering, and mathematics) and in STEM careers among high-school students. On this website, you can find detailed information about each of the three levels which structure the programme:

- A collection of short videos for social media showcasing do-it-yourself STEM experiments aimed at a broad audience
- A series of explainer videos for 14 to 19-year-olds going beyond high-school physics to understand CERN physics
- A yearly student camp gathering 30 participants aged 16-19 from around the world for a week-long immersion at CERN

Happy browsing!



CERN-Solvay Education Programme

17 PARTNERSHIPS FOR THE GOALS

4 QUALITY EDUCATION

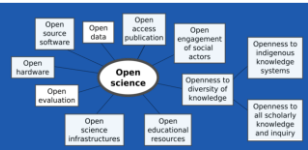
In addition to the programmes at CERN, the Education Team takes part in fairs, exhibitions, participates in research organisations and conferences, and international and national education programmes and projects.

just to name a few, see CERN PER for a full list

Coordination with Member States is assured through the Council's Thematic Forum on Teachers and Students.

CH Member
CERN TSF

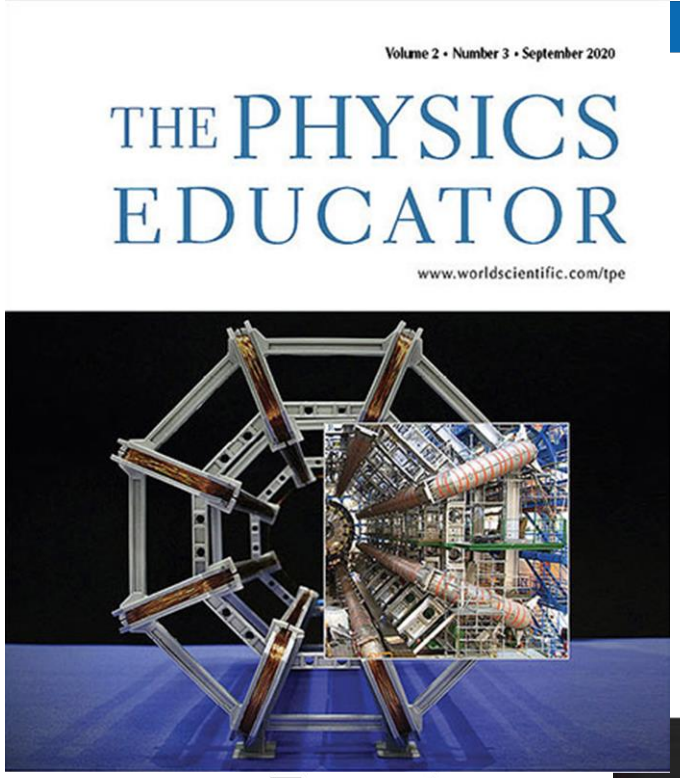
Open Engagement of Social Actors

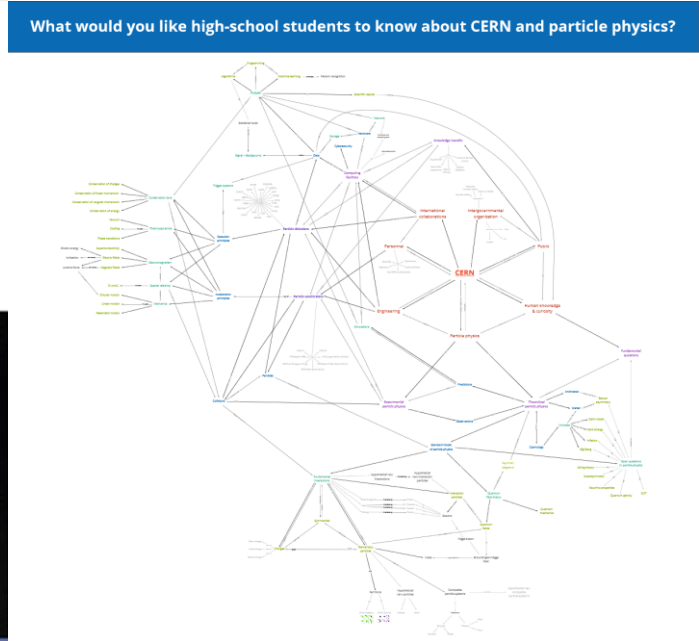


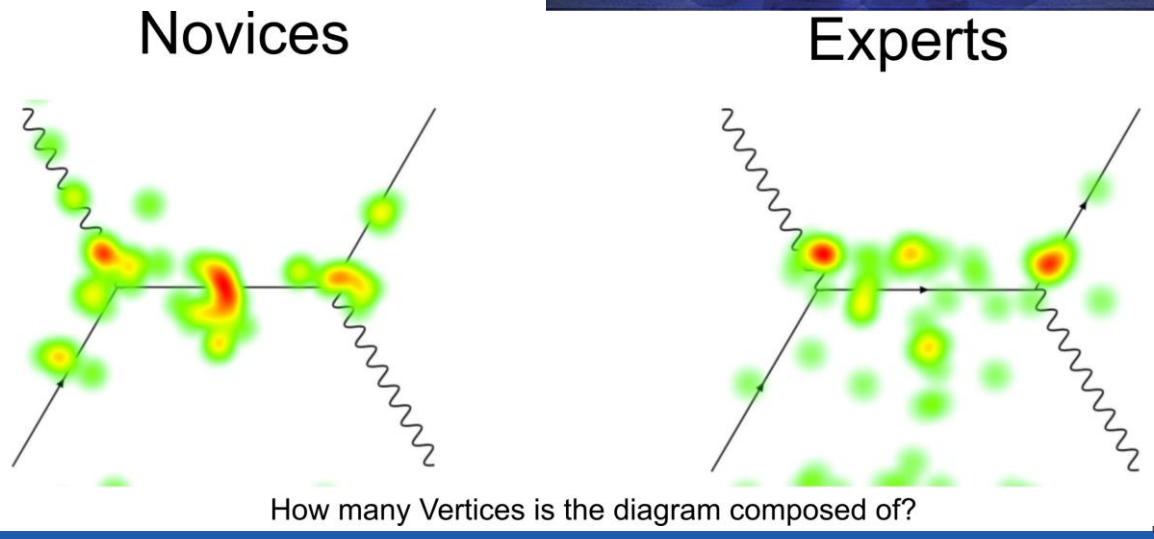
- Empirical Evaluation

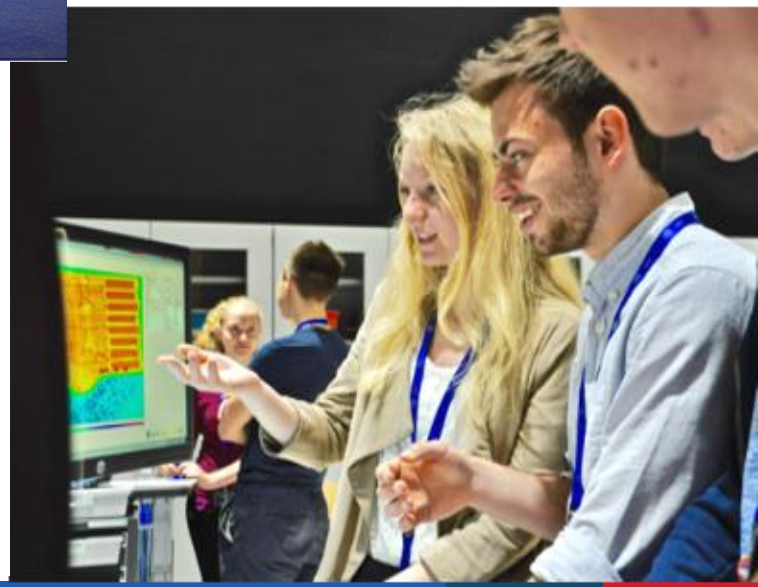
- Design-Based Research
  - Facilities at CERN
  - Material for Education
  - Education Programmes

- Research on
  - Motivation
  - Curiosity
  - Impact









Accompanied by Research

Particle Physics in High-School Education:

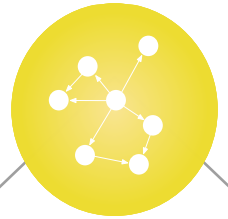
What should students and teachers learn?

Anja Kranjc Horvat
University of Potsdam and CERN

PhD thesis defence, 27 June 2022

- example of an international science education research project
- thorough analysis of needs, existing competences, and goals
- the goals were collected through a Delphi analysis – go have a look!
- slide content courtesy of Dr. Anja Kranjc Horvat (from her thesis defence)

Methodology: Overview



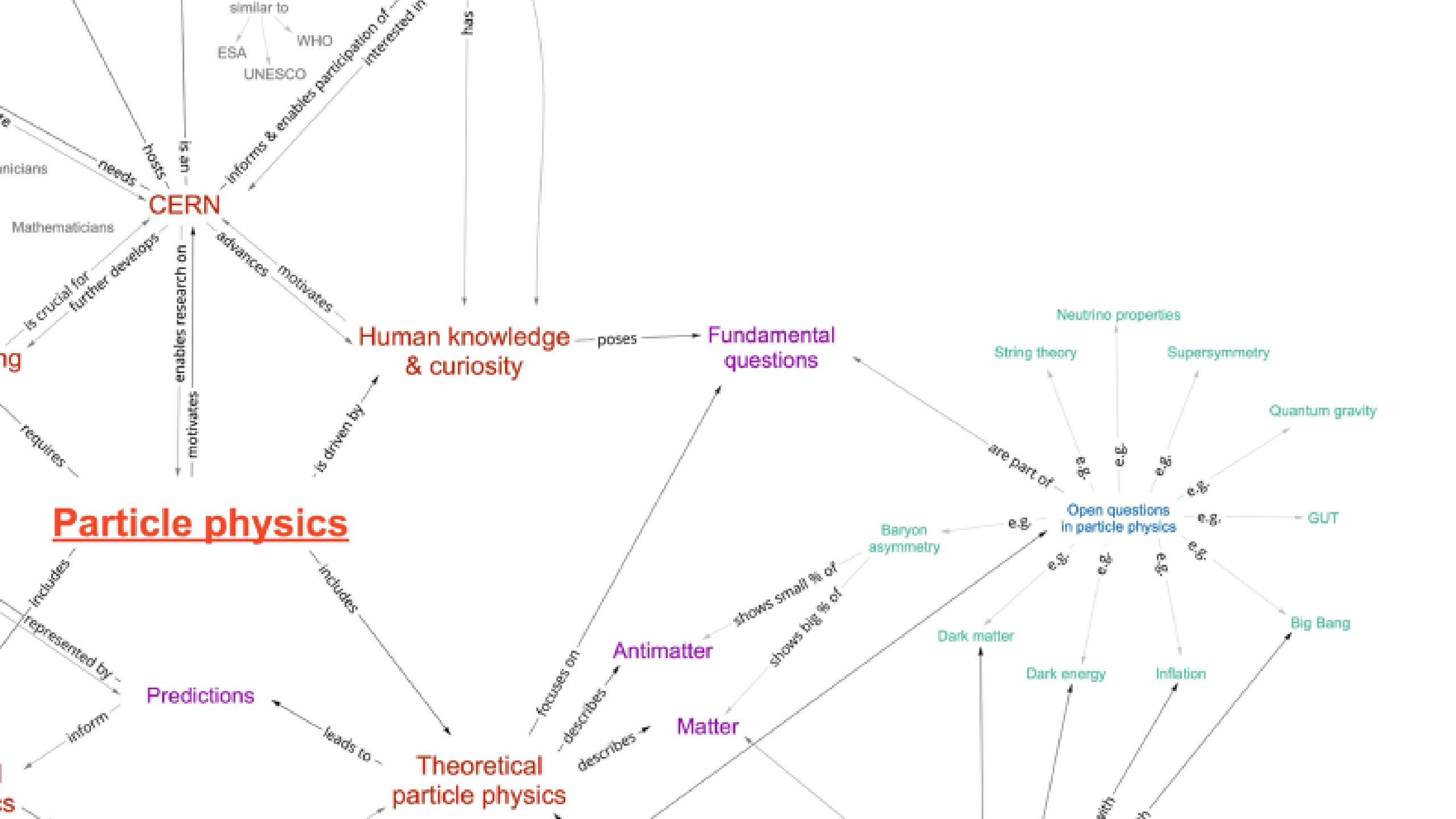
Expert Concept Map

Experts' expectations on what **high-school students** should learn

Curricular Review

Content of international **high-school physics curricula**

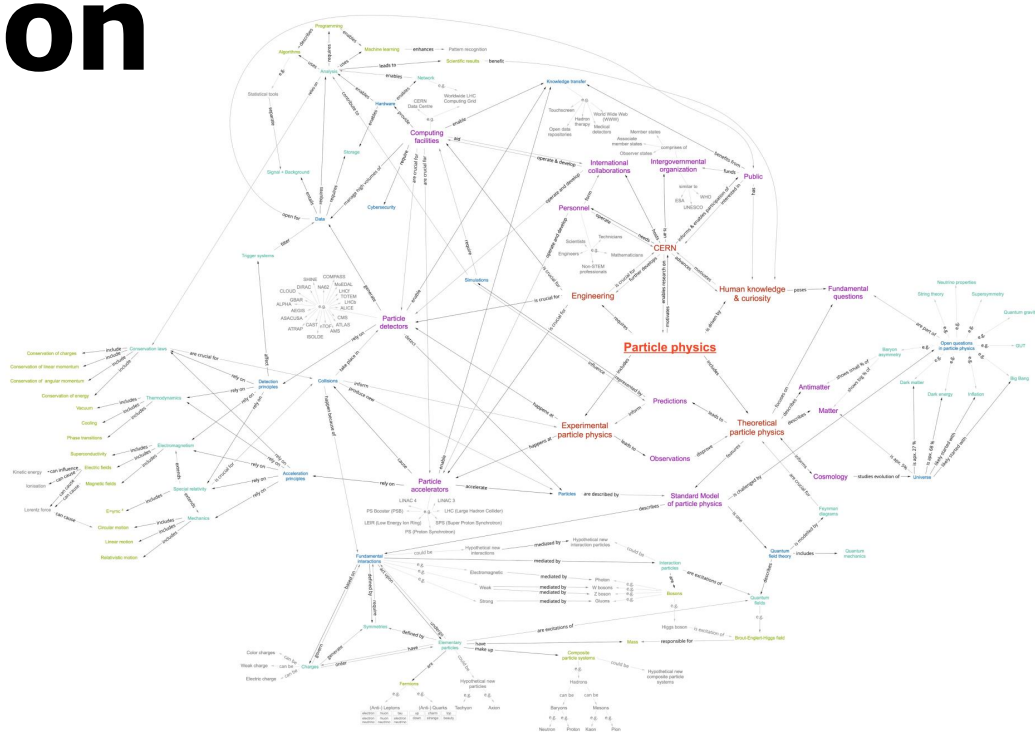
One research example


similar to
ESA
UNESCO
WHO
has
interested in
informs & enables participation of
is an
hosts
needs
nicians
CERN
Mathematicians
is crucial for
further develops
enables research on
motivates
advances
motivates
ng
requires
is driven by
Human knowledge
& curiosity
poses
Fundamental
questions
Particle physics
includes
represented by
includes
Predictions
inform
leads to
focuses on
Theoretical
particle physics
describes
describes
Antimatter
Matter
shows small % of
shows big % of
Baryon
asymmetry
are part of
Neutrino properties
String theory
Supersymmetry
Quantum gravity
e.g.
Open questions
in particle physics
GUT
Dark matter
Dark energy
Inflation
Big Bang

Expert concept map

Conclusion

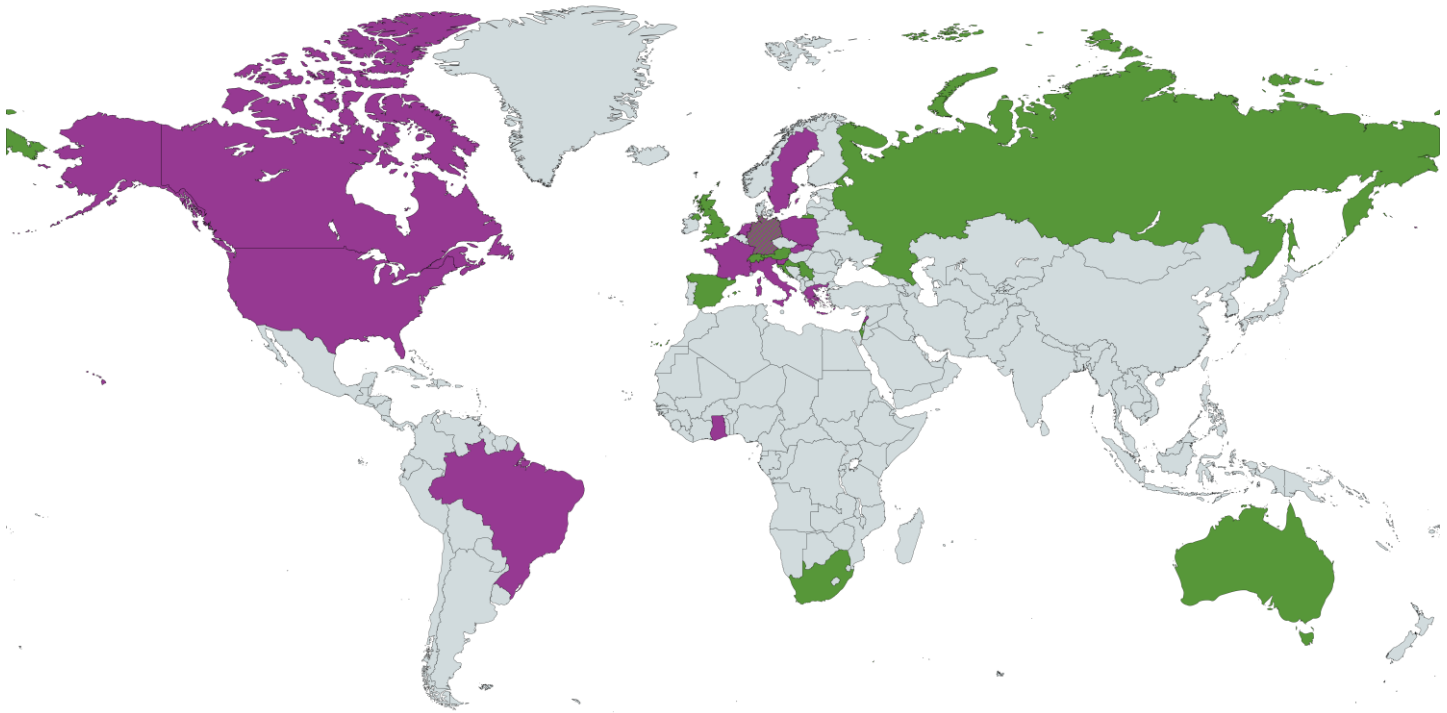
- Particle physics is a broad and well inter-connected topic
- Particle physics can be connected to various curricular topics (e.g., mechanics)



How extensively is **particle physics** featured in **high-school physics curricula**?

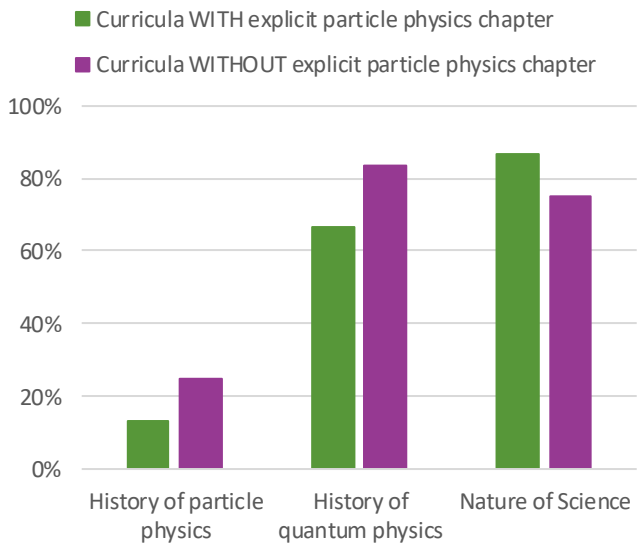
Methodology

27 high-school physics curricula
2 independent reviewers per curriculum



Overview

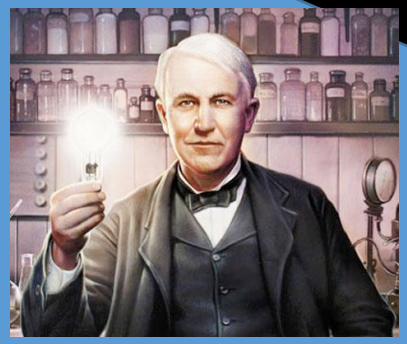
- **Concepts in particle physics** explicitly or implicitly present in all reviewed curricula
- Few differences when discussing the reviewed **other curricular topics**
- **History of Physics** more often in curricula with no explicit particle physics chapter
- **Nature of Science** implicit in most curricula

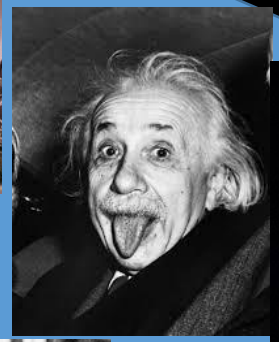


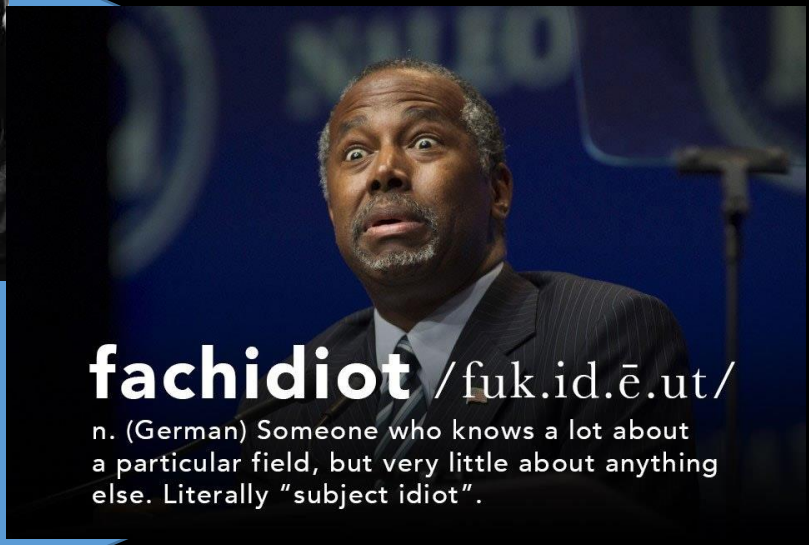
Some personal remarks

Does Education have A Future?

broadness

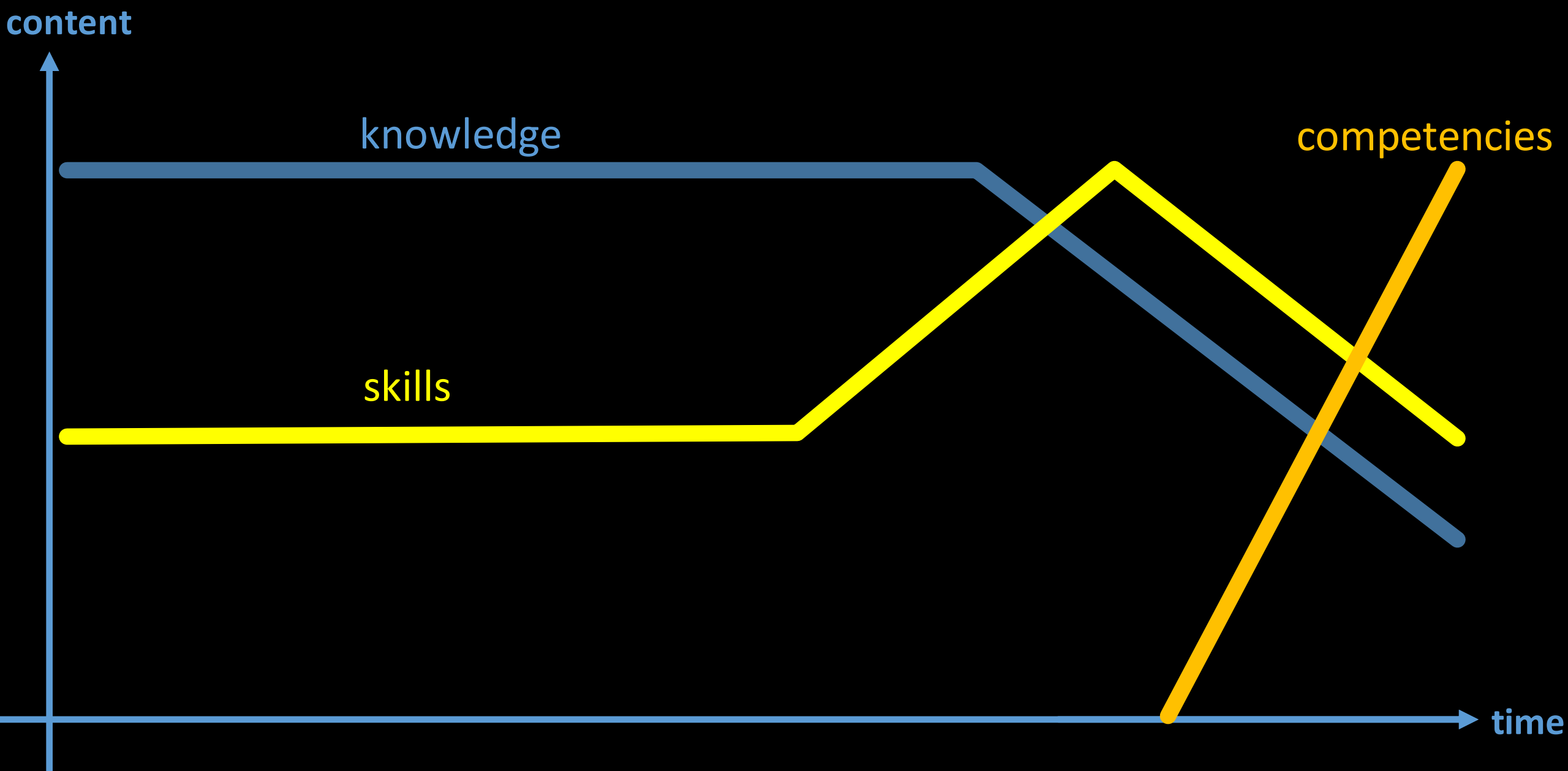


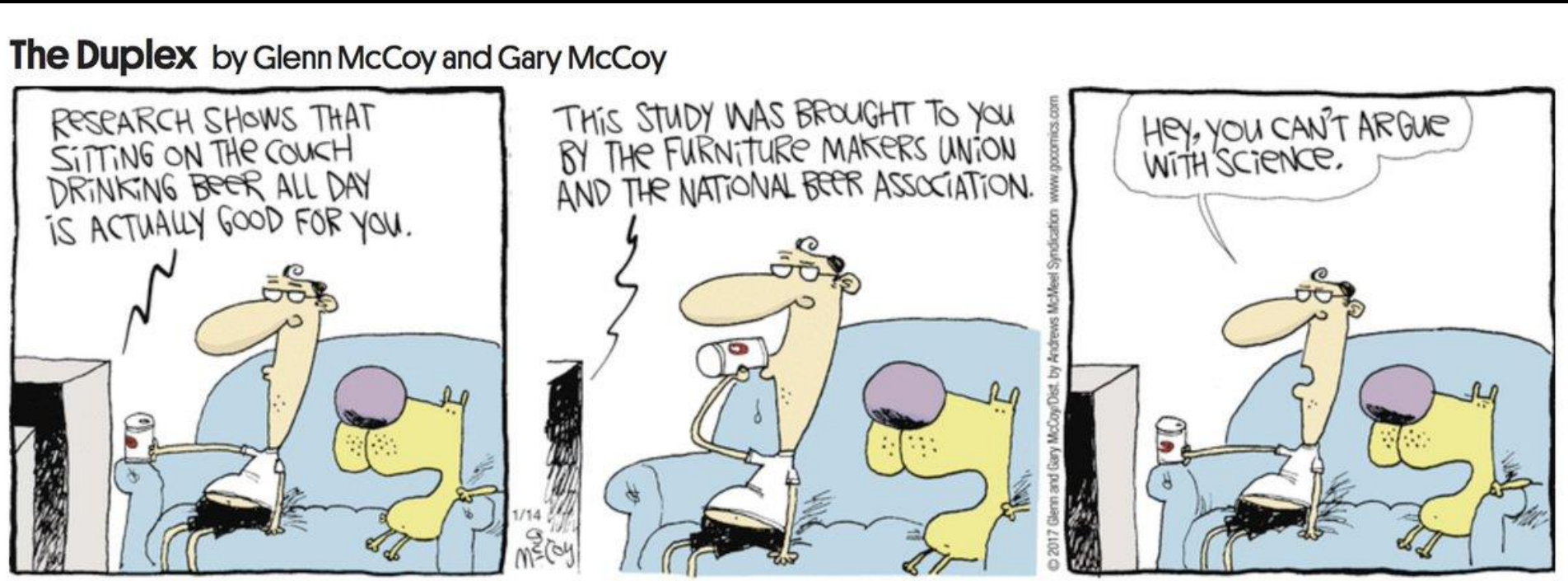




time

Does Education have A Future?





Competencies

e.g. search for relevant information and data from different sources, also in scientific publications, evaluate the results and compare them



Thinking is like googling …

… just more awesome



- What are the key topics in Science Education?
  - Education for Sustainable Development
  - Quantum Physics, Quantum Applications
  - Radiation
  - Artificial Intelligence

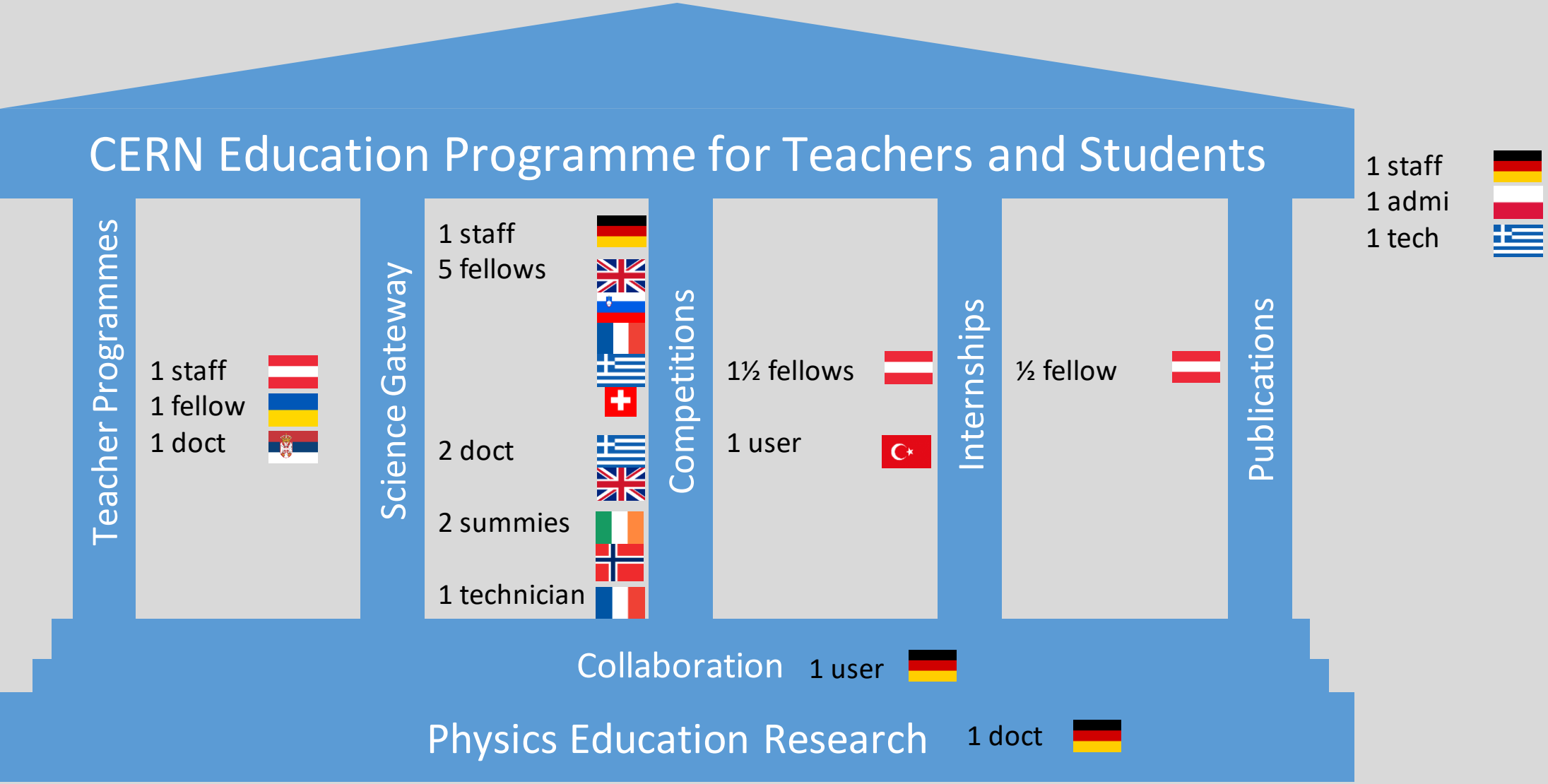
- How should we educate?

- How can we work together?

Some Personal Thoughts Questions

Your Time, Your Questions!

… maybe my answers …



Education Team Summer 2023

Sustainable Development Goals
Transforming our world

IYBSSD2022
International Year
of Basic Sciences
for Sustainable Development

CERN | THE GLOBAL GOALS For Sustainable Development

CERN Director-General Rolf Heuer addressing the Open Working Group on Sustainable Development Goals in December 2013.

The CERN input may be found at https://sustainabledevelopment.un.org/content/documents/4628cern.pdf

Mapping
CERN Contributions to the SDGs

SDG 3 - HEALTH
CERN helps to develop technologies that contribute to better healthcare for all, such as medical imaging and hadron therapy.

SDG 4 - EDUCATION
Education is one of CERN's core missions. We offer high quality programmes that inspire thousands of students, teachers and young researchers each year.

SDG 5 - GENDER
Diversity is a core value for CERN. Our diversity policy aims at leveraging the added value that comes from bringing together people of different nationalities, genders, professions and ages.

SDG 7 - ENERGY
CERN develops strategies for minimise the increase of energy consumed by the installations, increase energy efficiency and implement energy recovery.

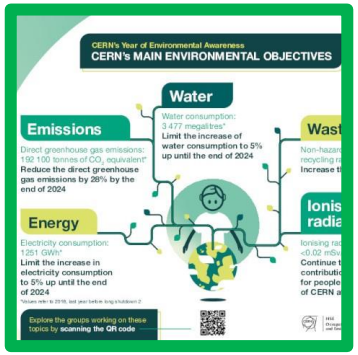
SDG 9 - INNOVATION
CERN inventions are brought to industry through knowledge transfer, to have a positive impact on society and innovation.

SDG 16 & 17 - INTERNATIONAL COOPERATION
CERN is a successful model for international collaboration. CERN gathers researchers from all over the world, contributing to human knowledge and peace, for the benefit of all.

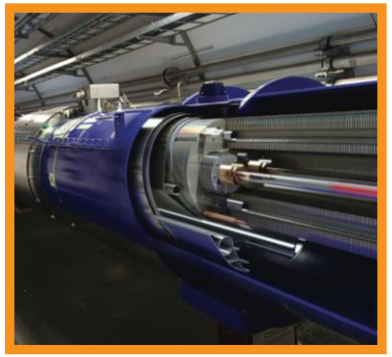
THERAPY
Accelerators provide particle beams for more targeted cancer treatment.

BEAMLINE FOR SCHOOLS COMPETITION
Students from the two winning teams spend a week at CERN to carry out their experiment using a CERN accelerator.

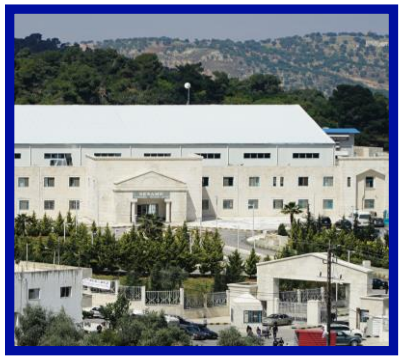
25 BY 25 DIVERSITY & INCLUSION INITIATIVE
First ever targets-based strategy to boost the nationality and gender diversity within the Staff and Fellows population.
.



HEATING LOCAL HOUSING
Heat recovered from CERN's accelerator cooling systems to heat a new residential area in the town of Ferney-Voltaire, benefiting up to 8000 people.



A MAGNET IN THE LHC TUNNEL
Exploring the universe requires new technologies and ingenious engineering to build the machines that explore physics at a new frontier.



SESAME
This new synchrotron light source in Jordan started operation in 2017. It is a unique collaboration between eight Middle East members, modelled on CERN's governance structure.