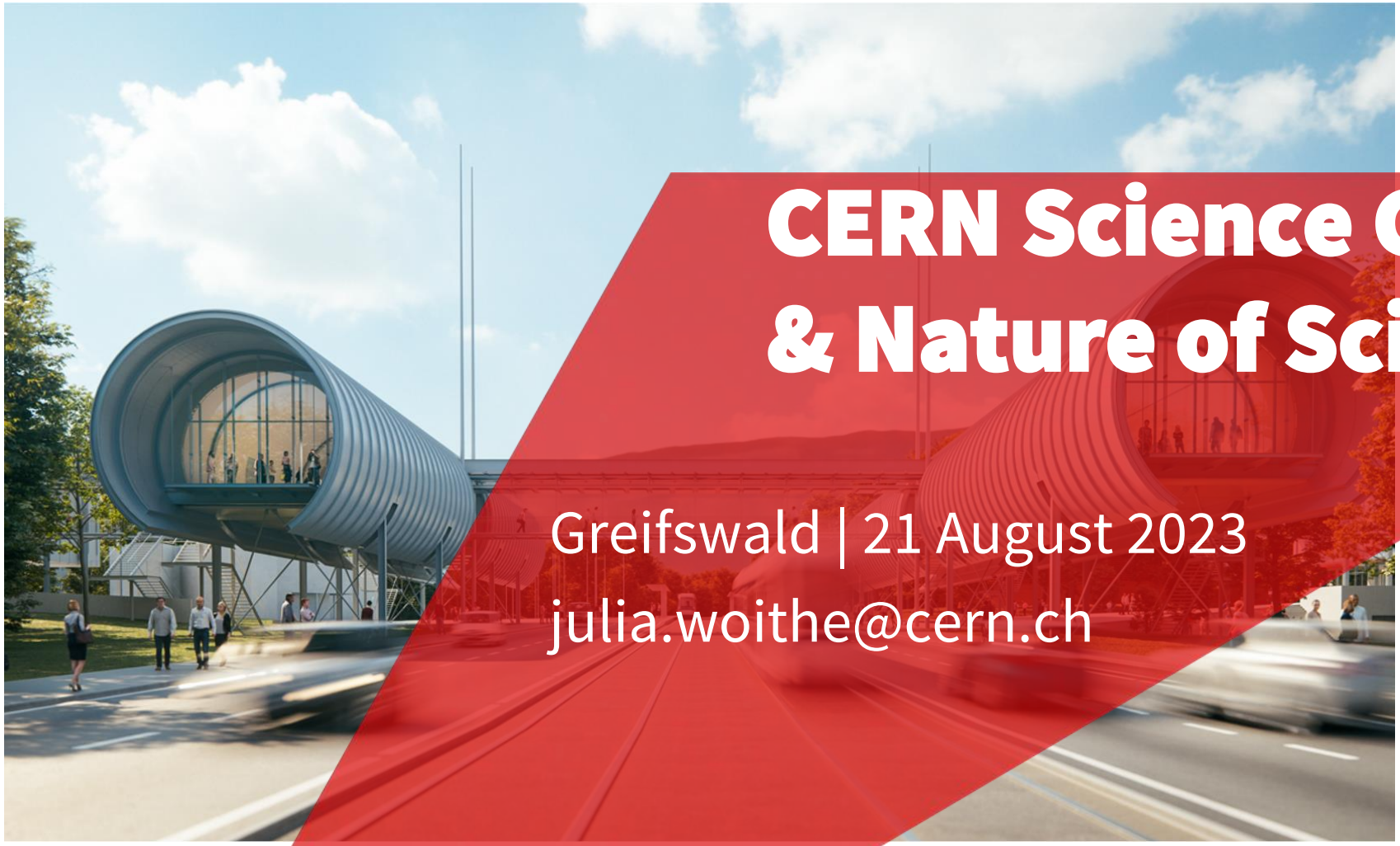


CERN Science Gateway & Nature of Science

Greifswald | 21 August 2023

julia.woithe@cern.ch

CERN | CERN Science Gateway

A world where science and learning

ARE INTEGRAL TO CULTURE AND TO THE LIVES OF ALL CITIZENS

A BRIDGE BETWEEN BUILDINGS AND MINDS

“A bridge, forever bridges!
A glass bridge, which links the different themes and parts of Science Gateway while also allowing a physical encounter between researchers and children, visitors and physicists, tourists and scientists, all driven by curiosity and the thirst for knowledge” .

Renzo Piano, Architect

WITH THANKS TO OUR SUPPORTERS

Stellantis Foundation • The LEGO Foundation • Ernst Göhner Stiftung • Carla Fendi Foundation • Rolex Loterie Romande • Fondation Gelbert • Solvay • Fondation Meyrinoise du Casino • Meyrin

THE VISITOR EXPERIENCE

- Immersive exhibitions
- Hands-on Lab Workshops
- Science Shows
- Guided tours of CERN
- Events for ages 5-105+
- Online resources

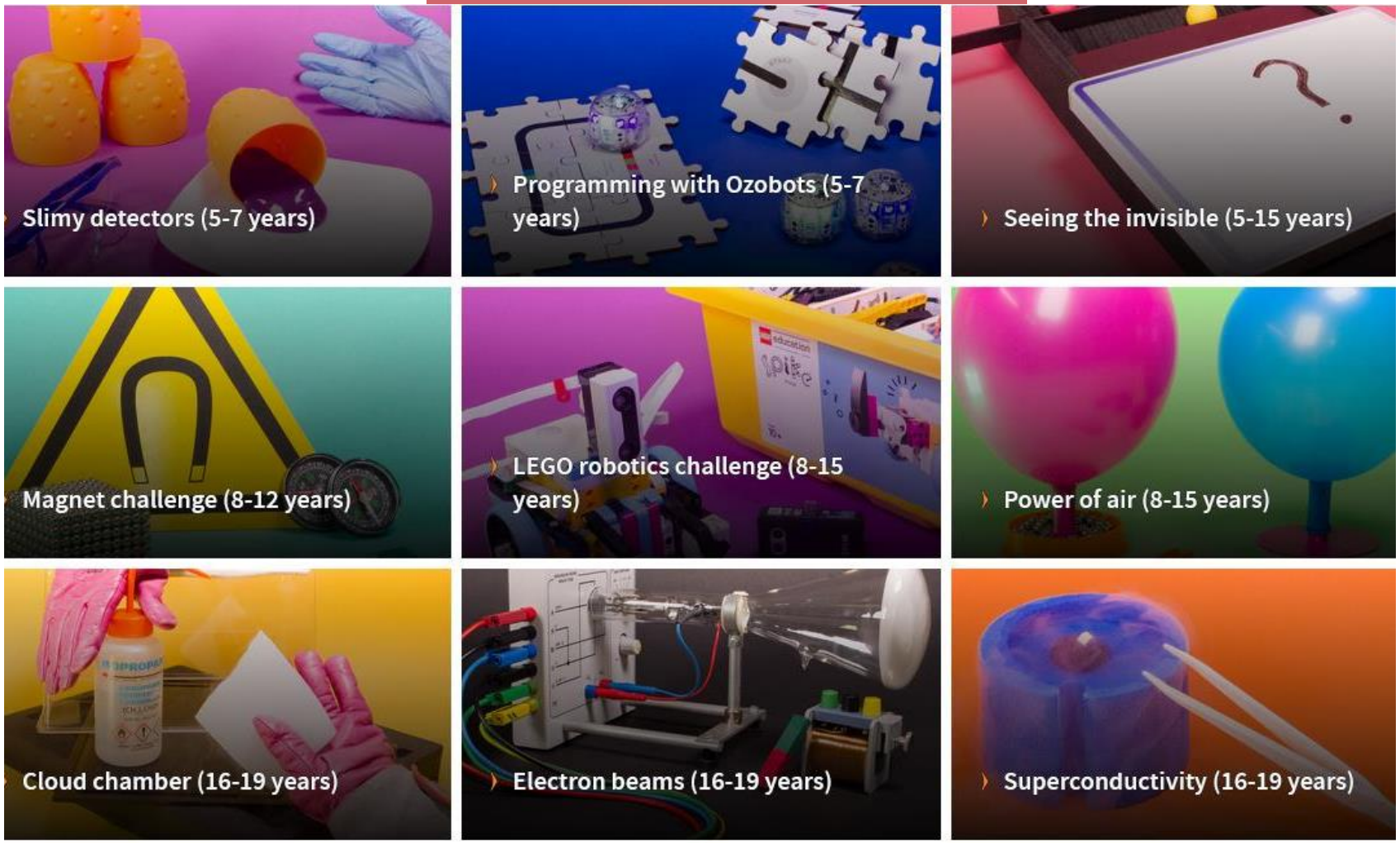
TWO MODULAR LABS

Discover your inner scientist

Get hands-on with the science and technologies of CERN

Conduct scientific investigations through enquiry-based learning

For ages 5 and up



A VARIED PORTFOLIO OF HANDS-ON LAB WORKSHOPS

Slimy detectors
Programming with Ozobots
Seeing the invisible
Magnet challenge
LEGO robotics challenge
The power of air
Cloud chamber
Electron beams
Superconductivity
Positron Emission Tomography

How we address selected aspects of NoS in lab workshops

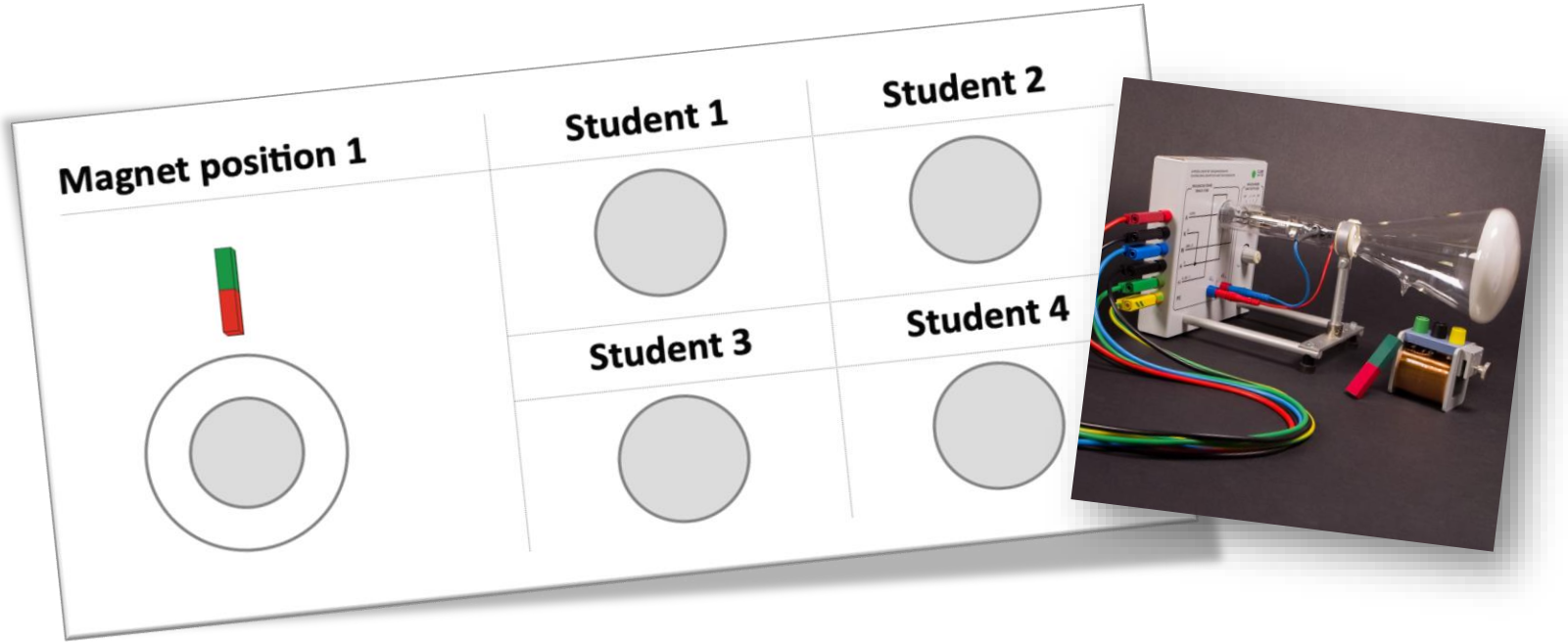
Theory-laden NoS

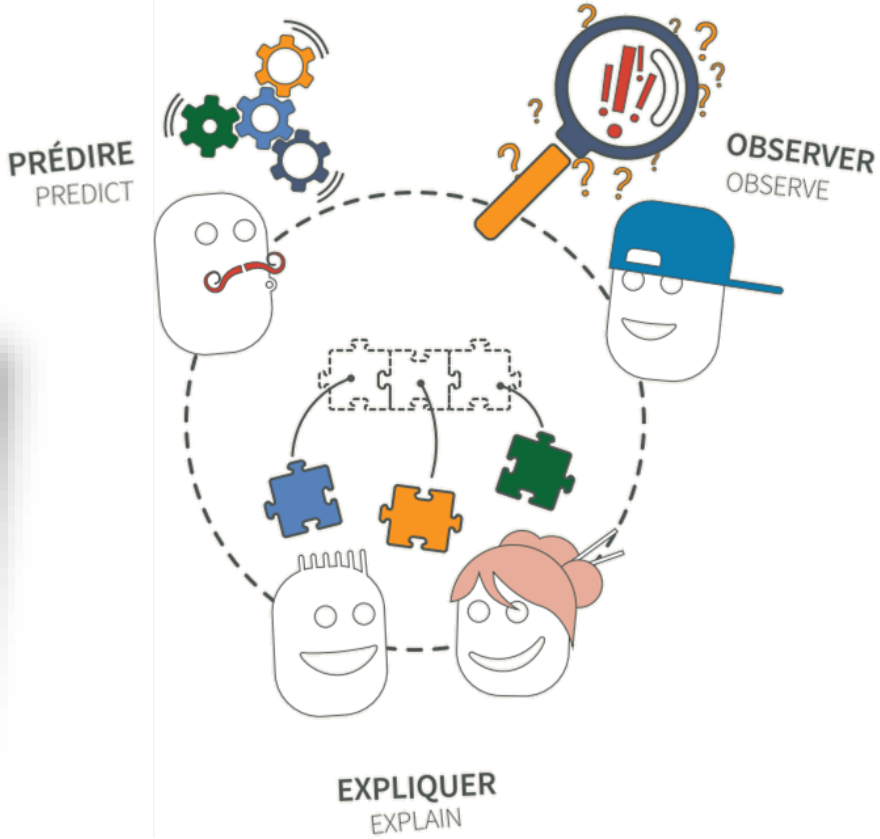
"Science progresses best when observations force us to alter our preconceptions."

- Vera Rubin

Predict-Observe-Explain stategies based on common students‘ conceptions

Example: Electron beams



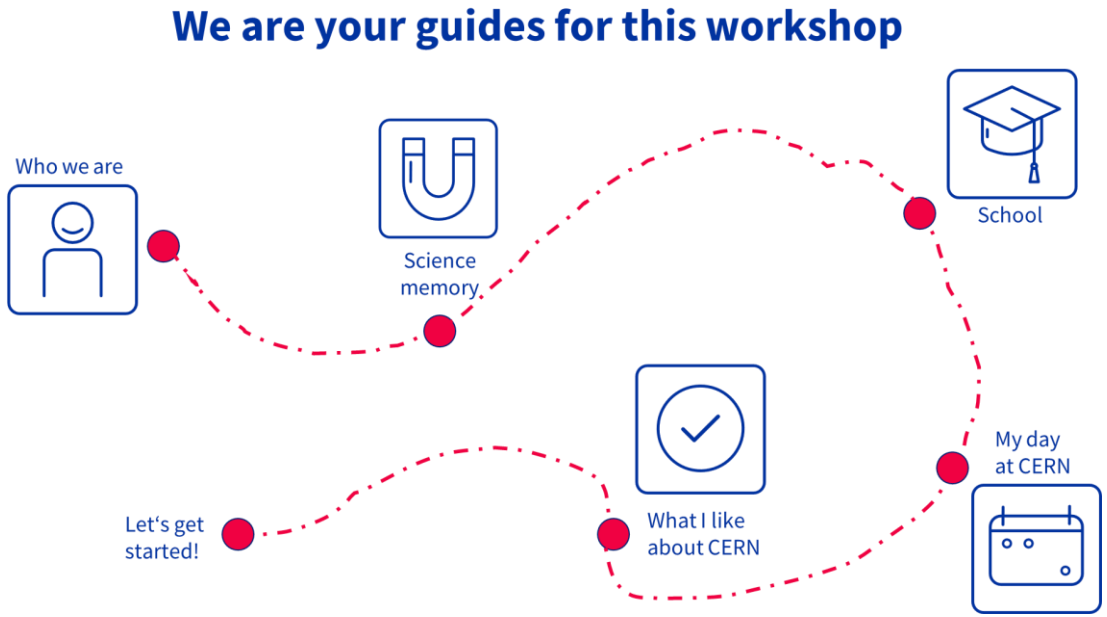


White, R., & Gunstone, R. (1992). Probing Understanding. The Falmer Press.

Social NoS

Guides talk about themselves & typical workday at CERN

Students get assigned different roles during lab workshops, e.g. spokesperson



Key messages

- **Scientists are normal people**
- **Science is for everyone**

Fadigan, K. A., & Hammrich, P. L. (2004). A longitudinal study of the educational and career trajectories of female participants of an urban informal science education program. Journal of Research in Science Teaching, 41(8), 835-860.

Hochberg, K., & Kuhn, J. (2019). What do scientists do? Increasing Awareness of social and networking aspects in everyday activities of scientists. Progress in Science Education (PriSE), 2(1).

Empirical NoS

Example: Slimy detectors (5-7 years)

Key messages

- **Some properties of matter such as temperature are invisible, we cannot see them with our eyes.**
- **Scientists use special materials to make invisible properties visible.**
- **Scientists do experiments to find out how things work.**

Empirical NoS

Example: Cloud chamber (16-19 years)

Key messages

- **Elementary particles are invisible, we cannot observe them directly with our eyes. We need special devices called particle detectors to make observations.**
- **…**

Inferential NoS

Example: PET (16+)

„post-formal reasoning“ with unobservable entities

- **Observation:** peak at photon energy 511 keV
- **Inference:** presence of positrons

- **Observation:** higher coincidence count rate for photons when 2 detectors at 180° angle
- **Inference:** angular correlation of photons from positron annihilation (momentum conservation)

- **Observation:** higher coincidence count rate in certain detector positions
- **Inference:** location of positron source

Lawson, A. E. (2004). The nature and development of scientific reasoning: A synthetic view. International Journal of Science and Mathematics Education, 2(3), 307.

Creative NoS

Space for open exploration and finding creative solutions to challenges

Example: The power of air (8-15 years)

Key messages

- **Engineers and Physicists come up with creative solutions to all sorts of problems e.g. using the power of air to move really heavy things.**
- **…**

Tentative NoS and nature of scientific models

Example: Seeing the invisible (5-15 years)

Key messages

- **Based on our observations, we develop and refine our scientific models. Models get better and better the more observations we make and the better our detectors get.**
- **…**

Open questions

Difference between need for advanced detectors vs unobservable entities:

Are (all?) elementary particles entities that can only be observed indirectly (no matter how advanced our detectors)?
Versus: We simply need better detectors to observe them directly.

How can we train guides (volunteering CERN scientists) about NoS / make them aware of common misconceptions?

Adressing aspects of NoS vs teaching a holistic image of NoS?

How do we know whether it works? (Measuring impact)

Can students transfer any NoS learning to other contexts (e.g. current public debates in science)?

Finding the balance: understanding of physics/science concepts vs affective goals vs having fun vs learning more about NoS

Back-up

OUR GOALS

- **Engage** people of all ages with the science, the technologies and the people working at CERN
- **Inspire** the next generation of scientists
- **Empower visitors to** make sense of the science that shapes their lives
- **Convey the importance and relevance of** fundamental research to society
- **Build ties** across CERN Member States and beyond
- **Be a partner** for scientific and other events

A SPACE FOR AGES 5 TO 105+

Something for everyone

Students • Teachers • Families • Scientists • Science-passionate • Culture-seekers • Tourists • Businesses

Open Tuesday to Sunday

ENVIRONMENT AND SUSTAINABILITY AT THE CORE

- A carbon-neutral building
- 3876m^2 of solar panels provide energy to Science Gateway and other CERN buildings
- More than 400 trees provide habitats for animals and plants

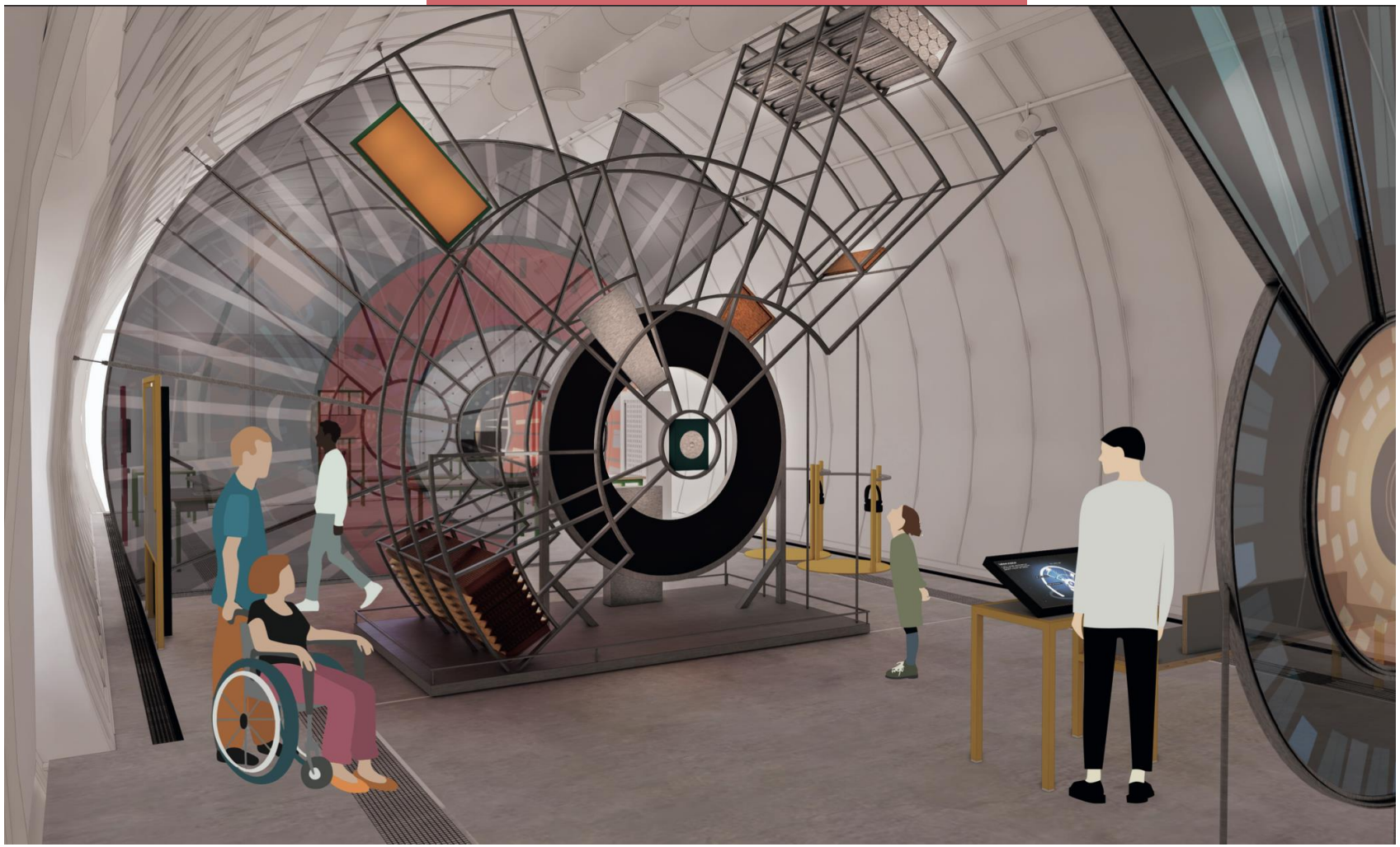
THREE EXHIBITIONS

Immersive scenographies and real pieces of equipment

Stories of and by CERN people

Hands-on experimentation

For ages 8 and up



EXHIBITION
DISCOVER CERN

Discover how scientists at CERN are answering some of the biggest questions about the universe

Explore CERN’s particle accelerators, detectors and computing technology

Meet the CERN people who make it happen

EXHIBITION
OUR UNIVERSE

Journey back to the Big Bang to discover how particles were formed and evolved to make us

Explore the unanswered questions about the universe through art installations by Arts at CERN resident artists

Discover creative dialogues between physicists and artists

EXHIBITION
QUANTUM WORLD

Explore the strange behaviours of the quantum world

Shrink down to the size of a particle and experience how the laws of physics are different in the world of the infinitely small

Learn how quantum phenomena have real consequences in our daily life.

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

THE STORIES OUR SCIENCE SHOWS WILL TELL

Fun with physics!
Seeing the invisible
Seize the data!
(Un)frozen
#science

EVENTS FOR THE PUBLIC

Bringing together science, art and culture

Exploring different formats for different audiences

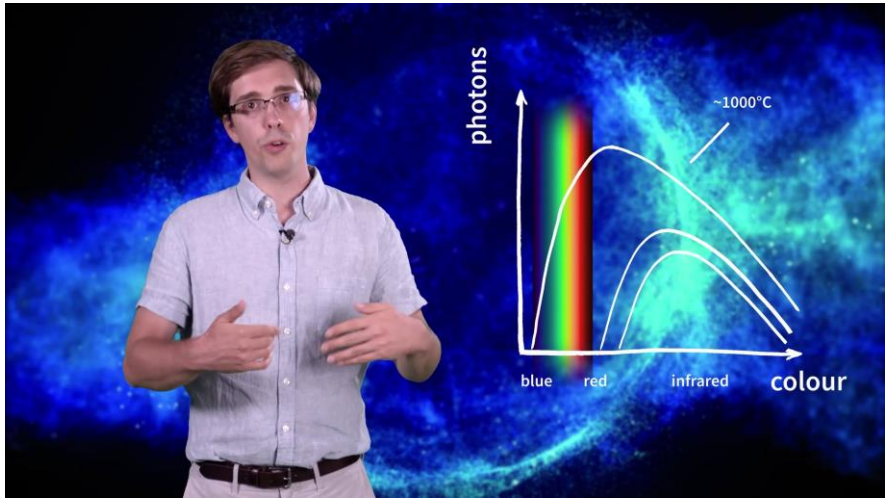
Experience CERN as a forum for open dialogue around societal challenges

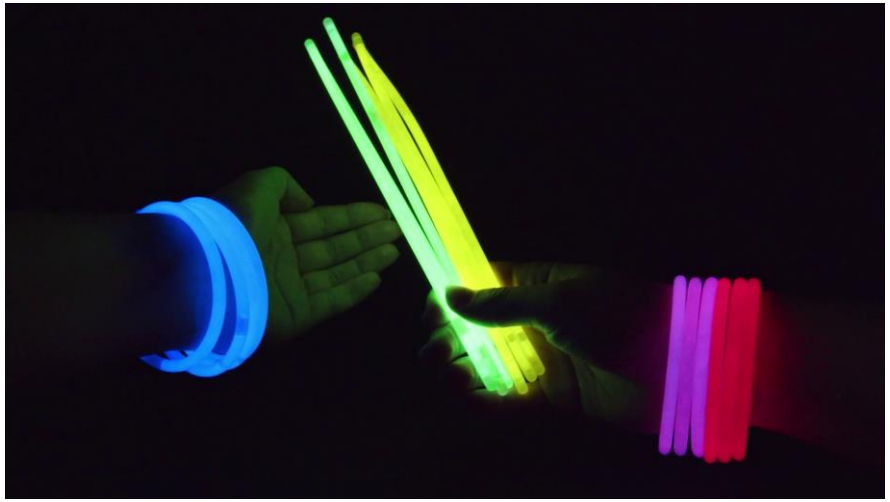
DAILY GUIDED TOURS

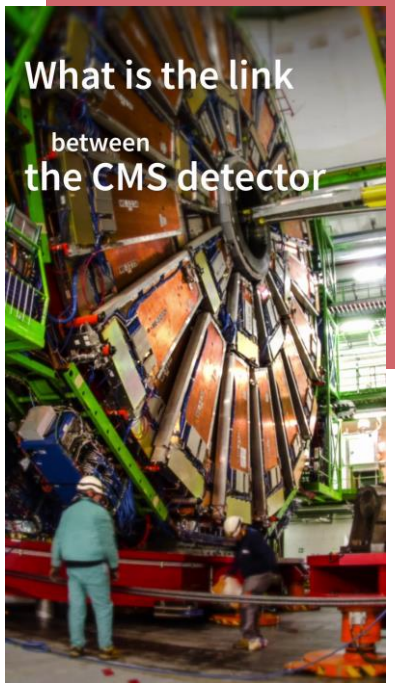
Come on site and discover some of CERN's facilities and experiments

Learn about CERN, it's research and technology through multimedia exhibits

Let CERN physicists, engineers, students and staff guide you







ONLINE RESOURCES

For those who cannot visit CERN, or to explore before or after visiting CERN Science Gateway

For educators, students, families, science communicators

Videos, virtual visits, activities, quizzes, reading material