

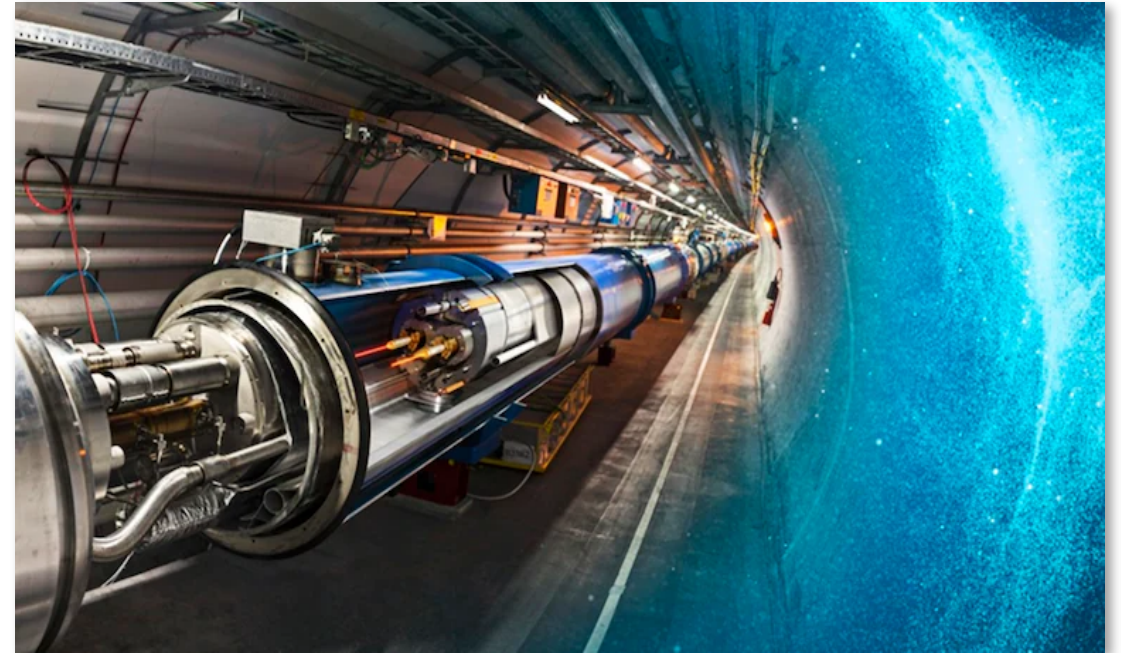


# The Relentless Pursuit of Openness

Dr. Kamran Naim  
Head of Open Science

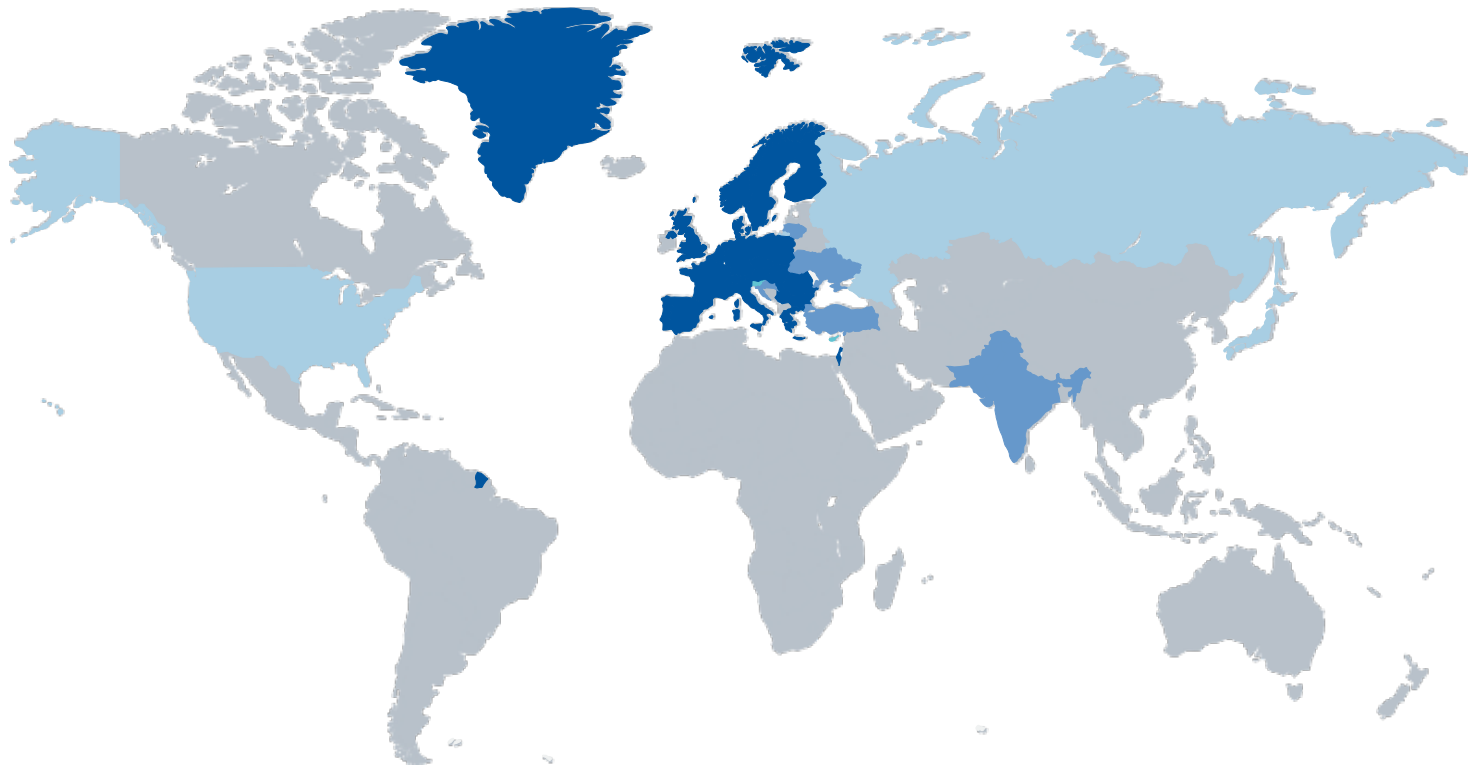
# CERN's Mission is to:

- **Perform** world-class research in fundamental physics;
- **Provide** a unique range of particle accelerator facilities that enable research at the forefront of human knowledge, in an environmentally responsible and sustainable way;
- **Unite** people from all over the world to push the frontiers of science and technology, *for the benefit of all*;
- **Train new generations** of physicists, engineers and technicians, and engage all citizens in research and in the values of science.



**In 1954 CERN started with 12 Member States**

**Today CERN has 23 Member States and is still growing**



**23** Member States

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

**8** Associate Member States



**Geographical & Cultural Diversity**  
**110** Nationalities, from **77** Countries

~ **2,600** Staff Members

~ **2,000** Contractors' Employees

~ **13,000** Physicists / Users



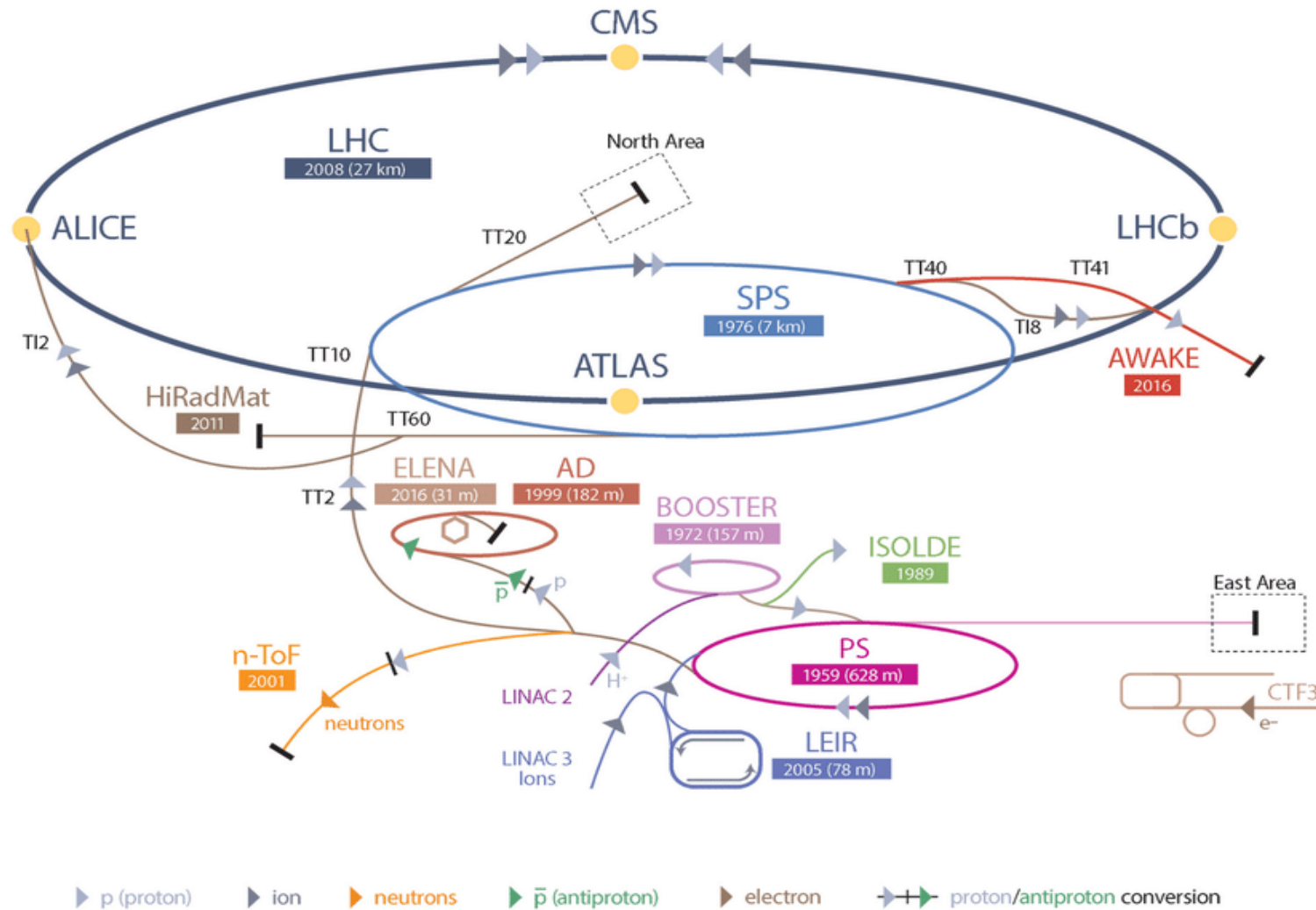
**Yearly budget:**  
~ **1.100** Million CHF

# CERN's Flagship: The Large Hadron Collider

- Ca. 100m underground
- 27 km circumference
- Coldest known place in the universe (Magnets cooled down to  $-271^{\circ}\text{C}$ )
- Hottest place in the solar system (Collision
  - temperature 100'000x hotter than the sun)
- 1 Billion particle collisions per second
- Detectors collect 1PB/sec of data



# The CERN Detector Complex





**“...and the results of its  
experimental and  
theoretical work shall be  
published or otherwise  
made generally available”  
CERN Founding Convention (1953)**

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE  
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

C O N V E N T I O N

FOR THE ESTABLISHMENT OF A EUROPEAN ORGANIZATION  
FOR NUCLEAR RESEARCH

PARIS, 1st JULY, 1953

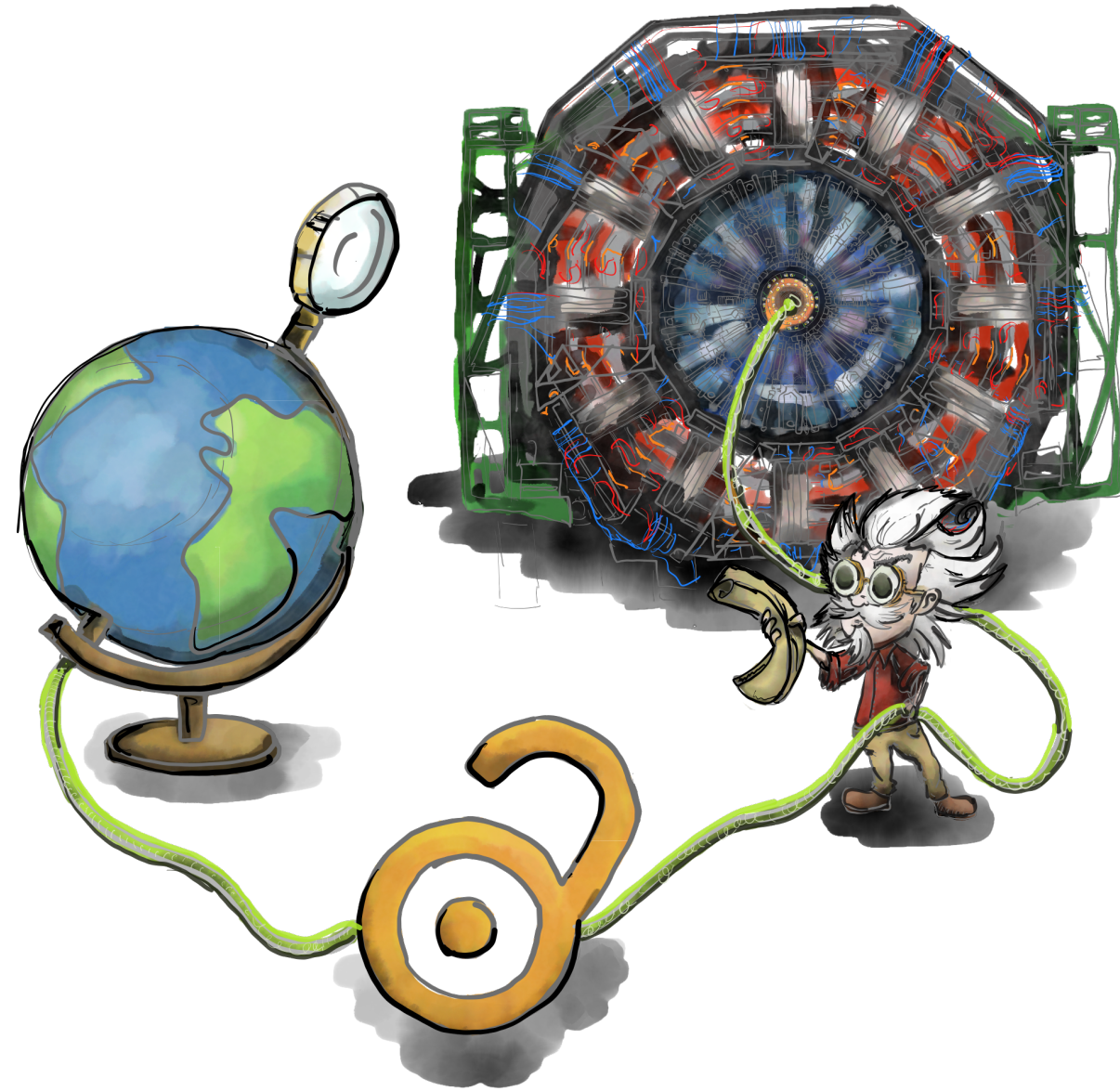


Illustration by Stephanie van de Sandt

# What is Open Science?

## The UNESCO definition

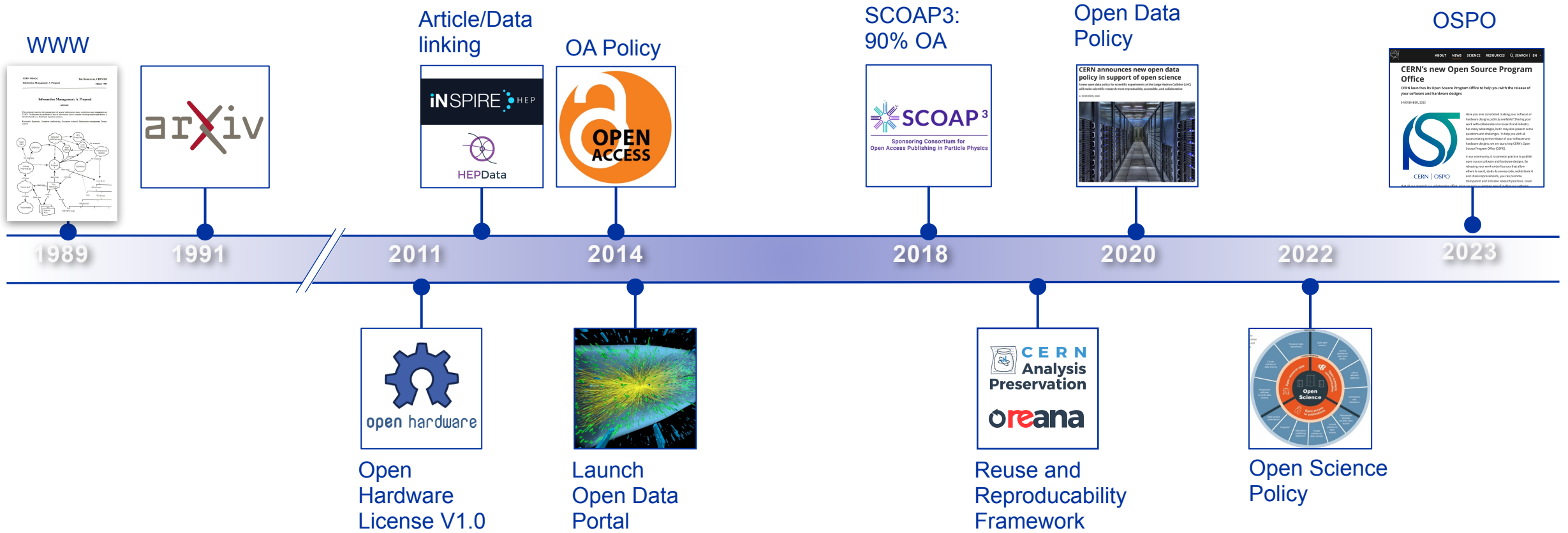


- Open science is defined as an inclusive construct that combines various movements and practices aiming to...
  - Make multilingual scientific knowledge openly available, accessible and reusable for everyone,
  - Increase scientific collaborations and sharing of information for the benefits of science and society, and
  - Open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community.
- [...] it builds on the following key pillars: open scientific knowledge, open science infrastructures, science communication, open engagement of societal actors and open dialogue with other knowledge systems.

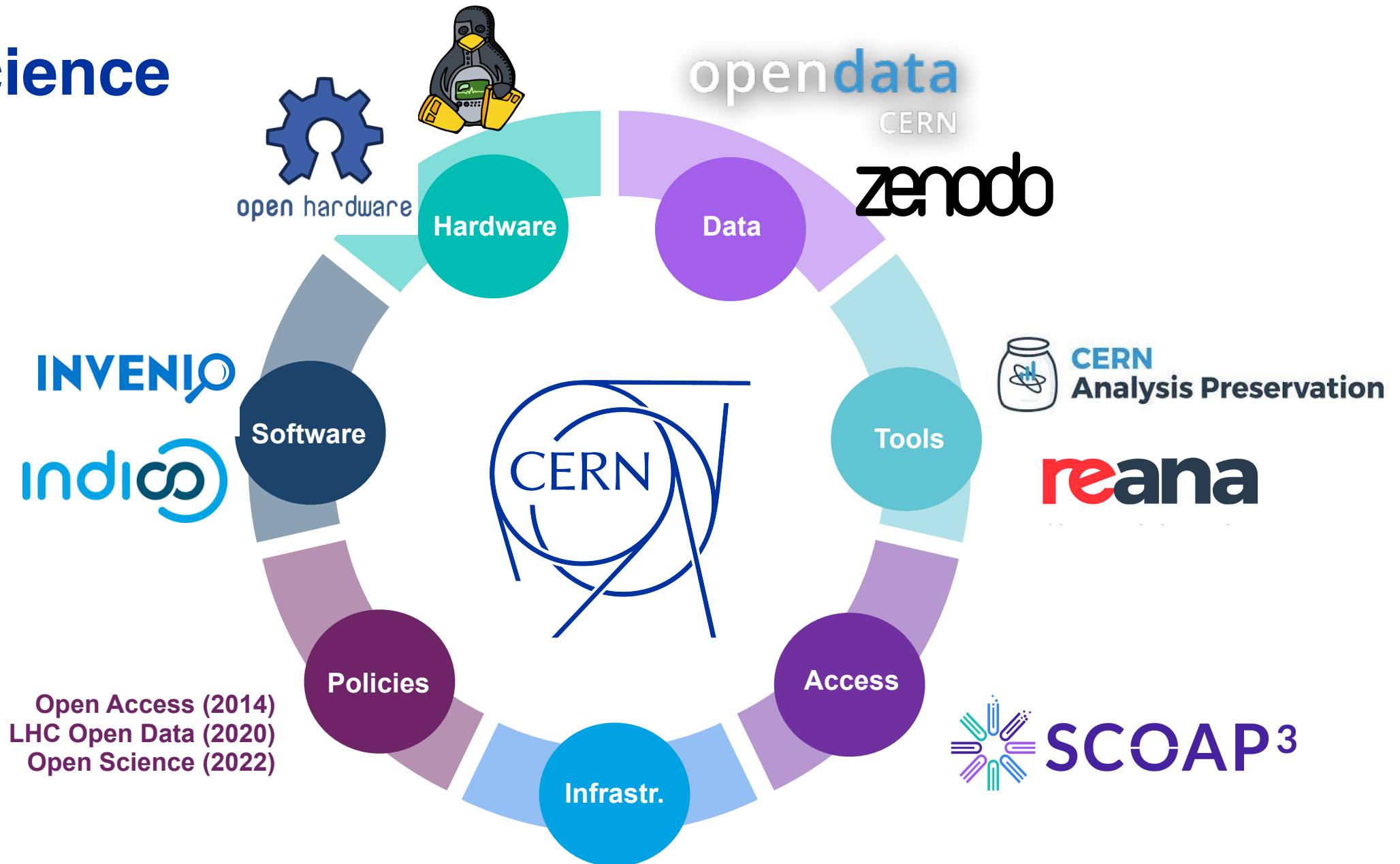
<https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en>



# CERN – Driving Open Science Globally



# Open Science at CERN





# Open Access at CERN

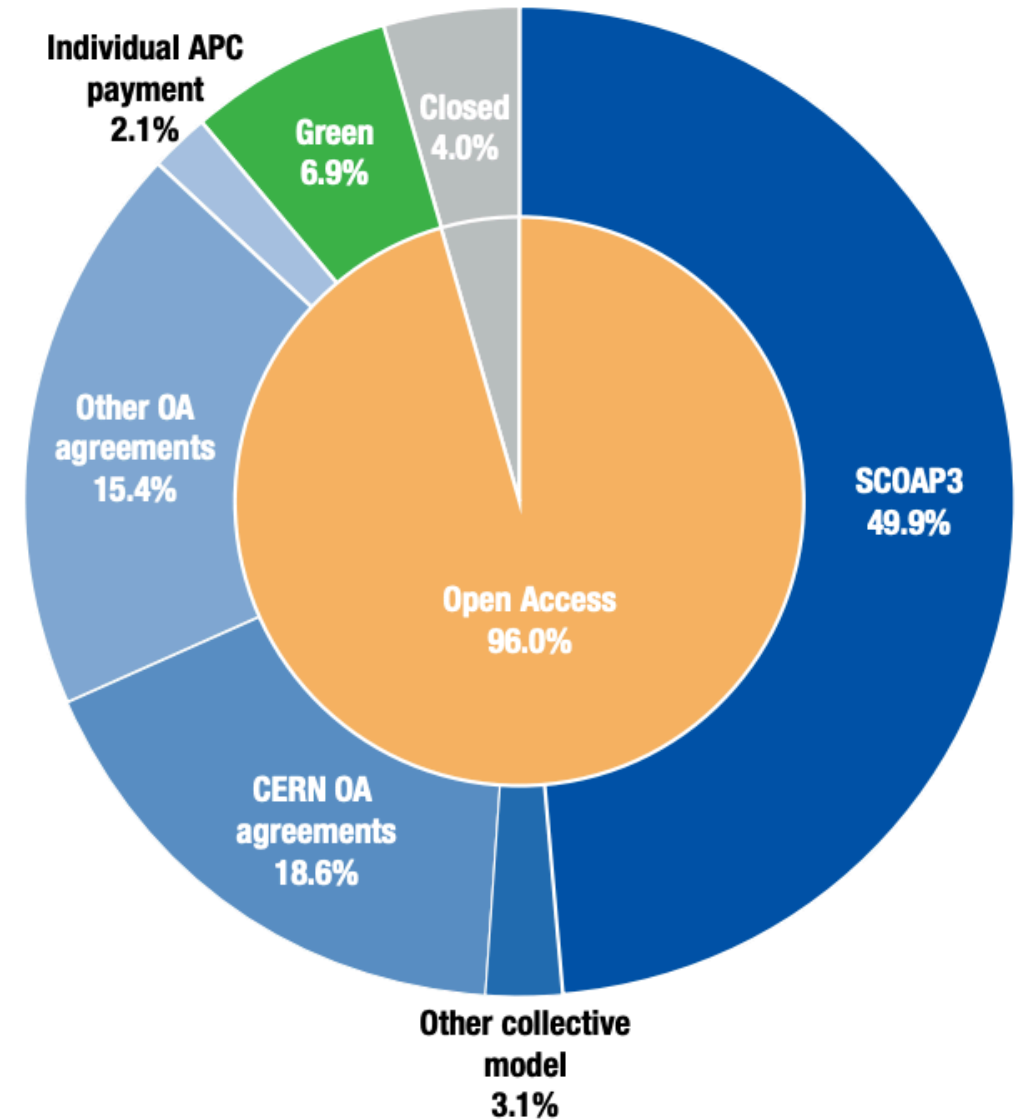
Flipping the Discipline

# High-Energy Physics has always had a preprint culture



# The CERN Open Access Policy (2014)

- Requires all research publications to be made fully open
- CC-BY licenses required
- Multiple mechanisms to achieve compliance
  - Green OA
  - Individual APC payment
  - Transformative agreements with publishers
  - Collective models
  - SCOAP3
- At approximately 96% compliance



*OA share of CERN publications*

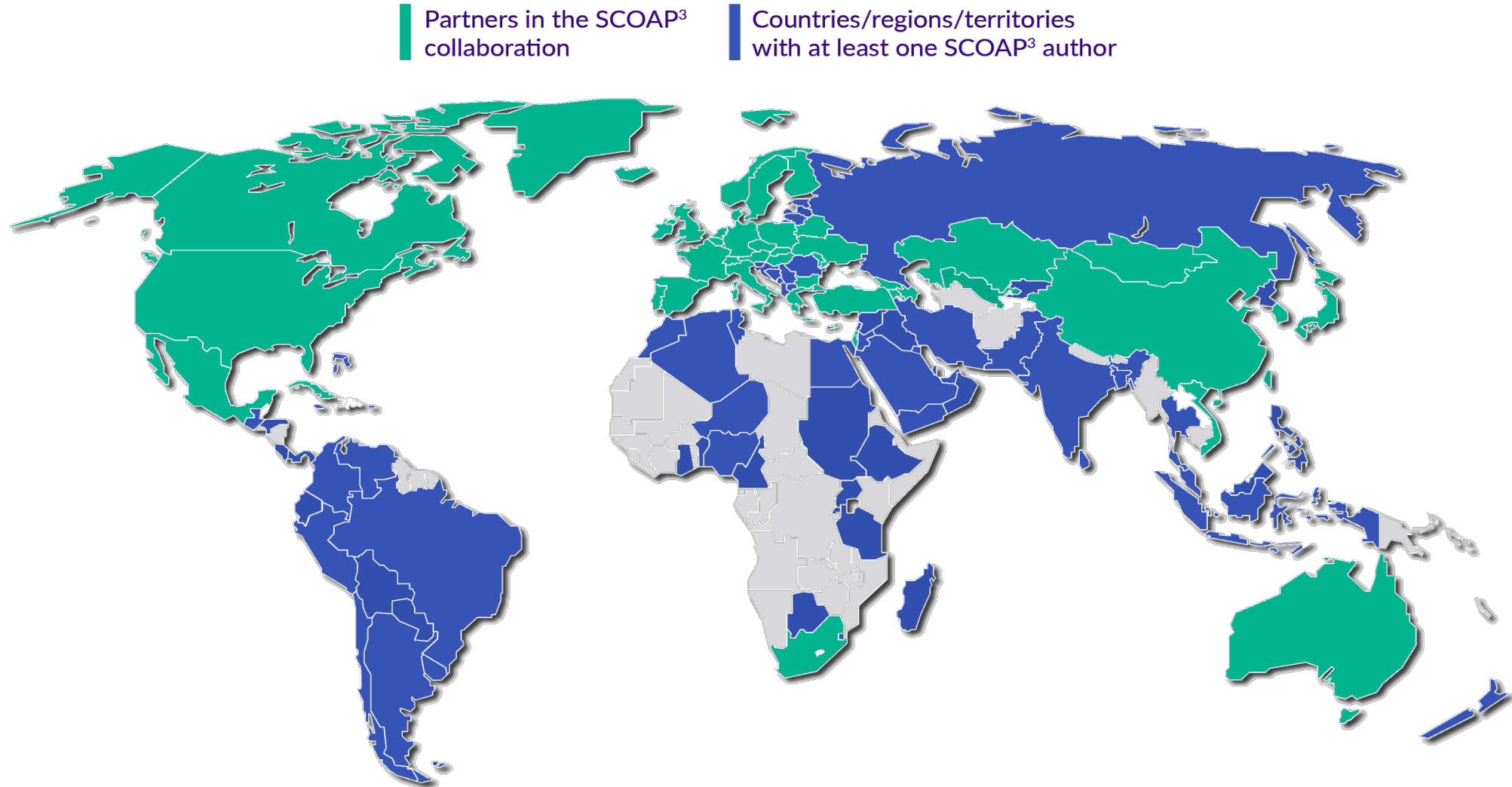
# What is SCOAP<sup>3</sup> ?



- Sponsoring Consortium for Open Access Publishing in Particle Physics
- **Mission:** SCOAP<sup>3</sup> enables open access publishing in the field of high-energy physics, helping to remove financial and administrative barriers to science
- International collaboration launched in 2014
- Partnership consisting of 3000+ libraries, research institutions and international research organizations from 45 countries (and growing)
- 11 of the leading journals in the discipline of high energy physics

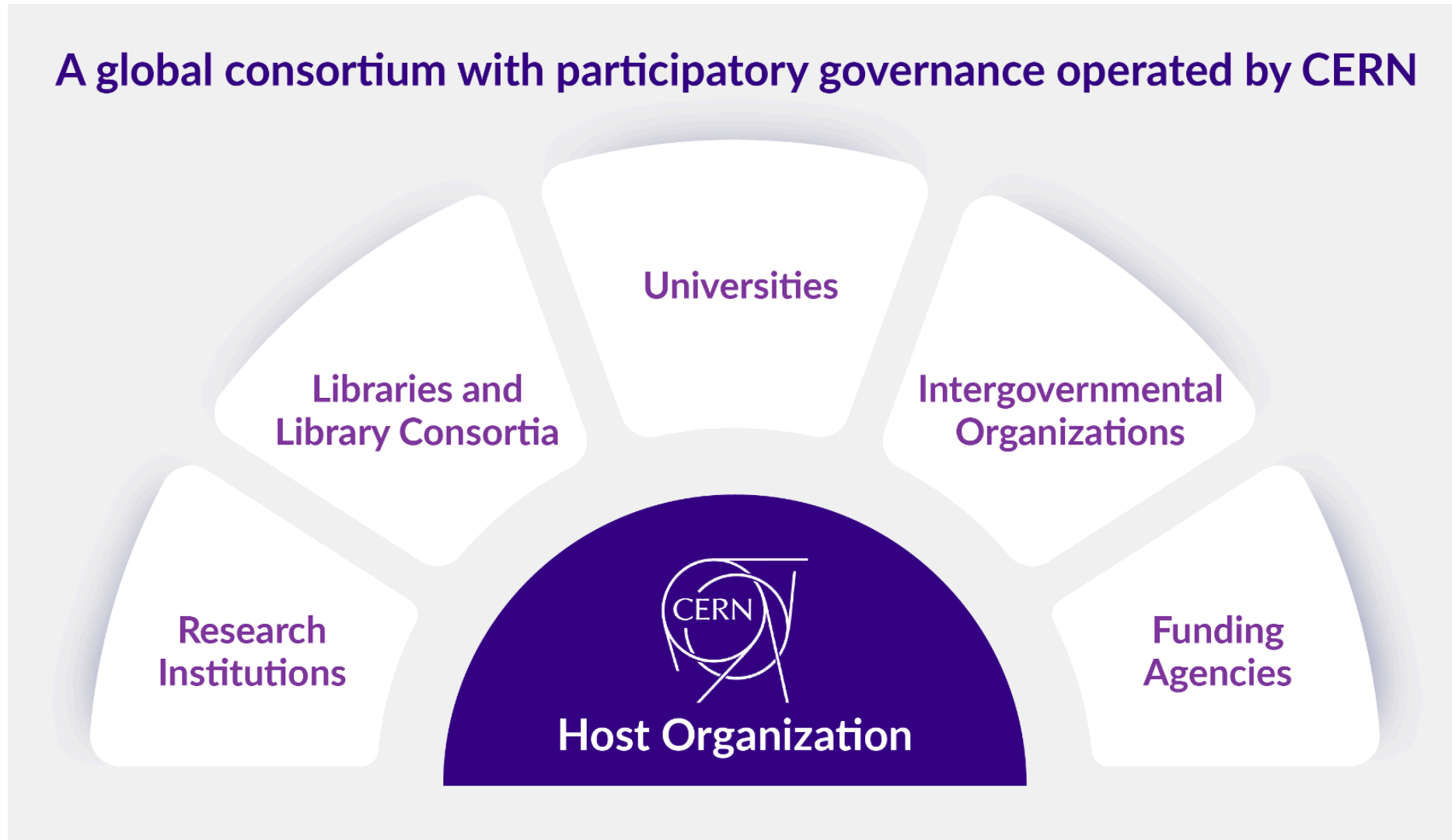
# A Global Collaboration

Achieving research communication in HEP as a global public good



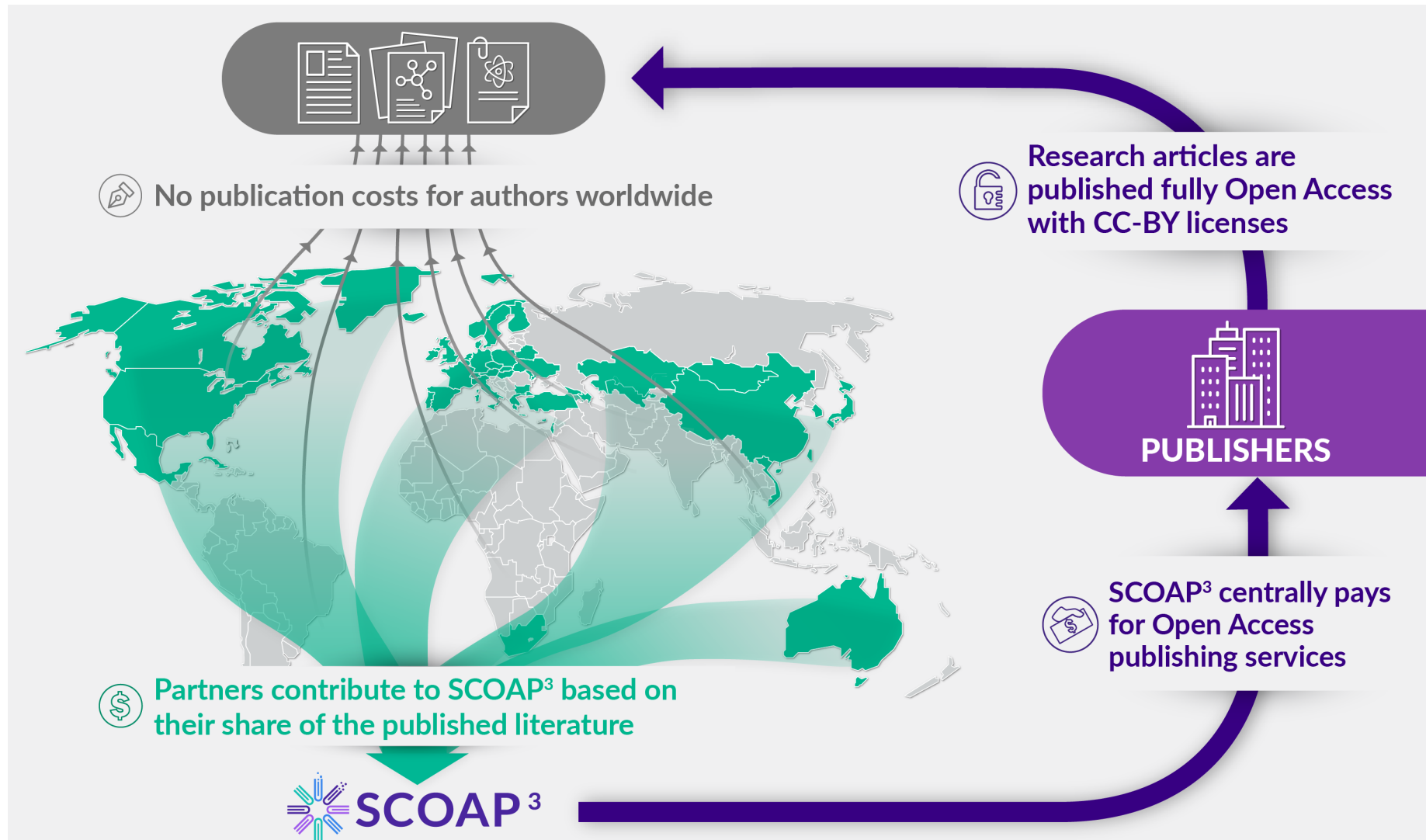
# Collective Governance Model

A global consortium with participatory governance operated by CERN





# The SCOAP<sup>3</sup> Model: How it Works



# Calculating Country Shares

## Principles

Relative fraction of authorship of HEP articles

If article has more than one author

pro-rata share

Total number of signatures of the country

Total number of signatures globally

Special case: 10% of authors affiliated with two or more institutions in different countries

If one of multiple author affiliations is CERN

CERN

If one of multiple author affiliations is a HEP laboratory

Host country of laboratory

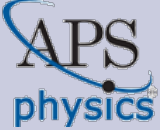

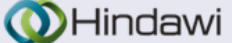




Countries of remaining multiple-affiliation cases

Highest GDP PPP

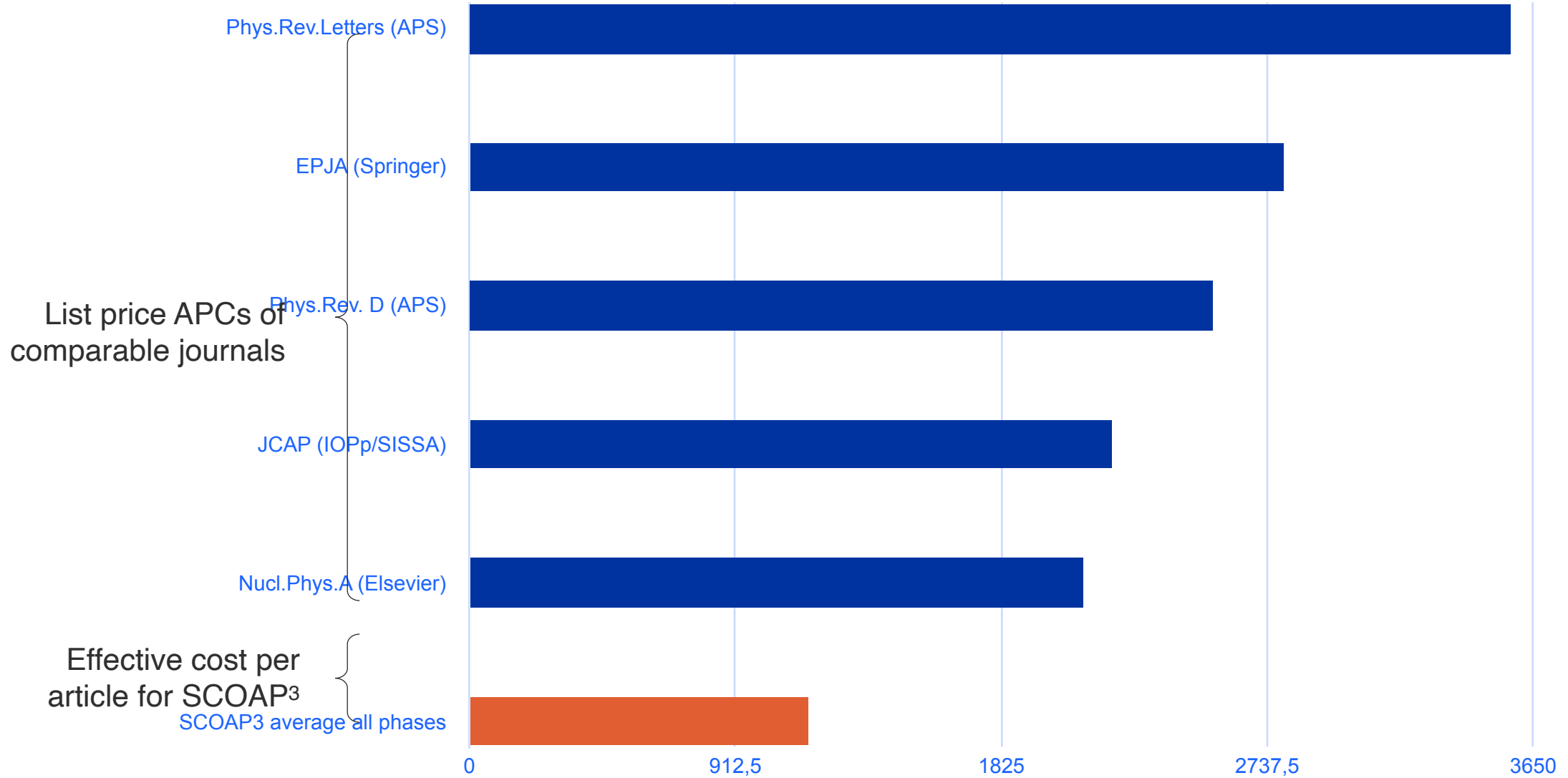
Additional allowance of 10% of the SCOAP<sup>3</sup> budget for countries that cannot be reasonably expected to contribute

E.g.: Y. Jing (CHN), L. Pavarotti (IT, DE), L. Bernstein (USA, CERN) → 1/3 CHN; 1/3 DE; 1/3 CERN

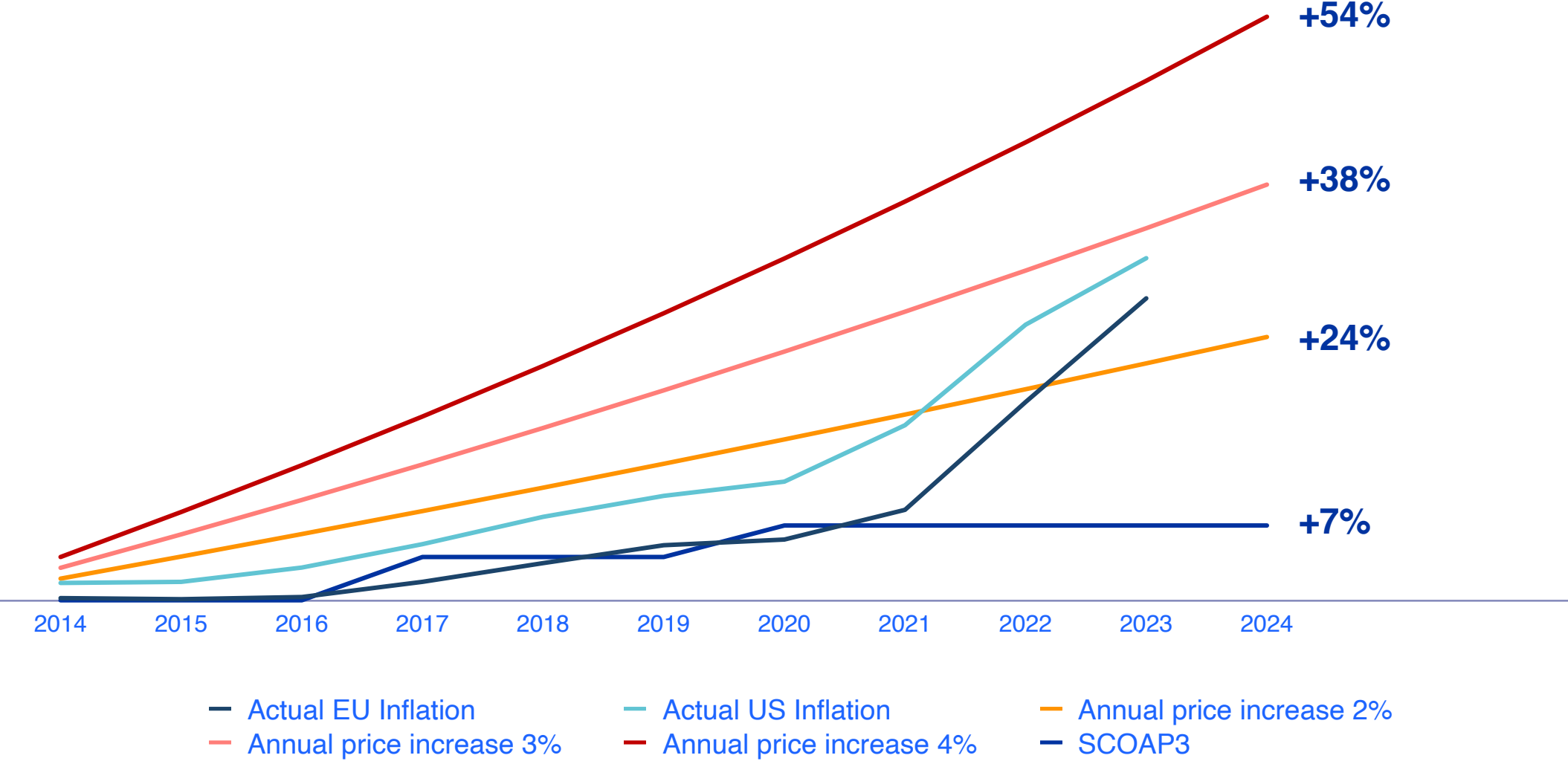
# First 10 years (2014-2023): 62,560 articles funded (90+ % of all HEP )

Publisher	Journal	Articles
 APS physics	Physical Review C	516
	Physical Review D	13,076
	Physical Review Letters	8,263
 ELSEVIER	Nuclear Physics B	3,060
	Physics Letters B	8,263
 Hindawi	Advances in High Energy Physics	1,120
 IOP Publishing	Chinese Physics C	740
	New Journal of Physics	25
	J. Cosm. and Astroparticle Physics	654
 JAGIELLONIAN UNIVERSITY IN KRAKOW	Acta Physica Polonica B	165
 OXFORD UNIVERSITY PRESS	Progress of Theor. and Exp. Physics	841
 Springer	European Physical Journal C	9,500
	J. High Energy Physics	22,949

# Continued best-in-class value for money...



# ...allows stable prices for SCOAP<sup>3</sup> partners



# Phase 4 of SCOAP<sup>3</sup>

## from Open Access to Open Science



**Disciplinary OA has been achieved and sustained for a decade**



**No new journals are to be considered for inclusion**



**Mechanism to financially incentivize publishers on delivery of Open Science Elements that situate publications in HEP more readily for OS future**

**Adjustment of financial compensation to publishers**  
Based on comparative scoring performance with other SCOAP<sup>3</sup> publishers  
Pioneering OS elements leading to better service quality and innovative compensation mechanism

# Open Science Elements

Open Science Elements	Definition
Accessibility	Removing barriers to accessing content for people with disabilities by following WCAG guidelines.
Dataset Linking	Enabling linking between articles and related datasets; improve/incentivize publishing of data as supplementary material associated with publications
Transparent Peer Review	Offer open or public peer-review services which provide both authors and reviewers options to publish peer-review reports
ORCID adoption	Integrate ORCID submission for all (co)authors into the publishing process and ensure systematic distribution of ORCIDs in subsequent metadata feeds
ROR adoption	Integrate ROR submission for institutional identification into the publishing process and ensure systematic distribution of RORs in subsequent metadata feeds
SCOAP <sup>3</sup> Community Values Disclosures	Provide transparent statements on core business practices related to defined community values (see next slide)
Software Linking	Enabling linking between articles and related research software; improve/ incentivize publishing of software as supplementary material associated with publications
Standardized metadata provision	Provide enriched article metadata in a consistent, standardized, community-determined format; include abstracts and references

# Open Science Elements (continued)

Open Science Element	Values
SCOAP <sup>3</sup> Community Values Disclosures	Diversity, Equity & Inclusion: in aspects ranging from the profile of authors/first-time submitters; diversity in career stages; geographical diversity (in publishing and editorial practices); gender equity; etc.
	Sustainability: adopting practices to reduce their carbon emissions and address sustainability issues within their operations towards becoming net-zero businesses.
	Data Privacy: adopting practices to protect the privacy of users consistent with the European Union's General Data Protection Regulation (GDPR).
	Financial Transparency: engaging in emerging price transparency frameworks.
	Referee Recognition/Compensation: demonstrating transparency in how the work of referees is acknowledged/ recognized/compensated.
Publication transparency: publication of journal metrics such as acceptance rates and desk rejection rates	





CERN  
Open Science

# Open Data at CERN

Enabling meaningful reuse and reproducibility

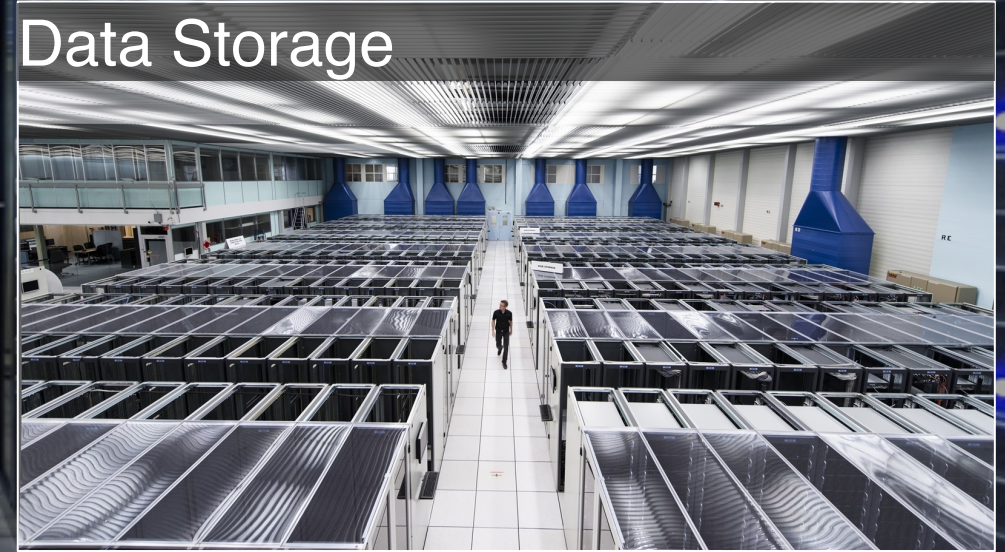
# CERN stores more than 100 PB of data per year

## Data Collection



- 1 PB/sec of collision data impossible to store
- Trigger systems at each of 4 main detectors:
  - Level 1: almost real-time (< 2.5 microseconds) reduction to 100'000 events/second
  - Level 2: within 200 microseconds further reduction to 1'000 events/second for storage
- **90 PB/year from LHC**  
+ 25 PB from other experiments

## Data Storage



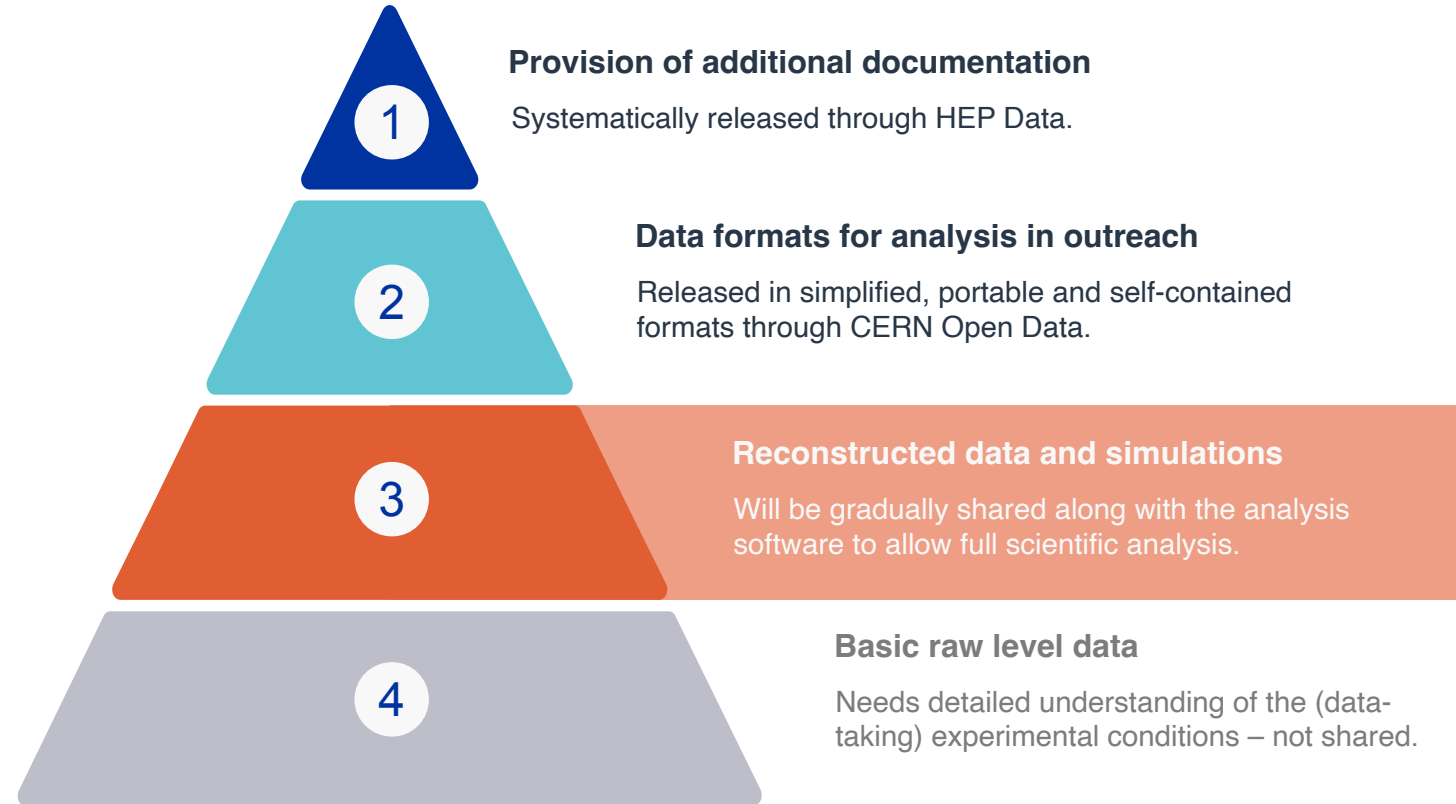
- CERN data center has 411 PB on tapes + 365 PB on disks (including duplicates)
- EOS (CERN's proprietary storage system) hosts now more than 5bn files and served 2.5 exabyte of data (in 2020)
- High **latency of tapes** problematic for open data services (1-3 minutes or even more)

# Expanded LHC data sharing practices

## CERN Open Data Policy (2020)

- To make scientific research more reproducible, accessible, and collaborative.
- Endorsed by all four LHC experimental collaborations; to be expanded to others.
- Level 1 and level 2 releases already common practice.
- New OD Policy commits to publicly releasing level 3 scientific data.
- Data will start to be gradually released five years after collection.

## (Open) Data Levels



# CERN Open Data Policy: License

The data will be released from the CERN Open Data Portal under the Creative Commons CC0 waiver, and will be identified with persistent data identifiers, and the data must be cited through these identifiers. Similarly, appropriate acknowledgements of the experiment(s) should be included in publications released using such data, and the publications made clearly distinguishable from those released by the collaboration. Any scientific claims in such publications are the responsibility of their authors and not of the experiments. It is expected that scientific results released using Open Data follow best scientific practices. The experiments may impose rules related to the use of the data by members of their respective collaborations.

---

<https://cds.cern.ch/record/2745133/files/CERN-OPEN-2020-013.pdf>

# CERN and its partners created a suite of tools for sharing and linking research data



- CERN Open Data Portal allows HEP experiments to share their data (collisions, simulations, related software, etc.)
- Already contains > 2PB of data

- Zenodo is a multi-disciplinary open research repository commissioned by the EC through OpenAIRE
- Hosts 80% of the world's software DOIs

- HEPData is the primary repository for tables and datasets related to ca. 10'000 publications
- Operated by Durham University in collaboration with CERN

# Open is not enough!

“The solutions adopted by the high-energy physics community to foster reproducible research are examples of best practices that could be embraced more widely. This first experience suggests that reproducibility requires going beyond openness.”

*Chen, X., Dallmeier-Tiessen, S., Dasler, R. et al. Open is not enough. Nature Phys 15, 113–119 (2019) <https://doi.org/10.1038/s41567-018-0342-2>*

# Three pillars of successful Open Data

**Publish &  
Share**

**Digital  
Repositories**

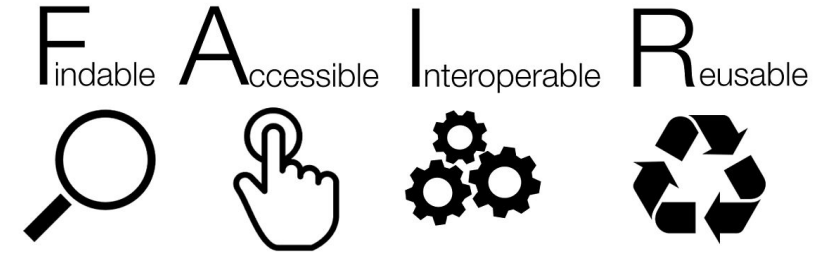
**Preservation &  
Long-term Access**

Archive and  
publication  
platforms

**Reproducibility**

Reproducible  
research data  
analysis  
platforms

# Digital Repositories



Sort by: **Best match** **asc.** Display: **detailed** **20 results**

Found 28 results.

**Configuration file for HLT step /cdaq/physics/Run2010HI/v1.5/HHLT/V1**

The configuration file used in data taking and HLT data processing step in 2010. Run number after 151238 (appr.), software version

[Supplementaries](#) [Configuration](#) [CMS](#)

**CMS list of validated runs Cert\_161366-161474\_2760GeV\_PromptReco\_Collisions11\_JSON\_v2.txt**

This file describes which luminosity sections in which runs are considered good and should be processed when used as reference data for heavy-ion data analysis.

This list covers 2011 p-p dat...

[Environment](#) [Validation](#) [CMS](#)

zenodo Search Upload Communities [help.holm.nelso@gem.ch](#)

Zenodo is continuing normal operation during the COVID-19 outbreak. All Zenodo staff are working remotely in accordance with preventive measures taken by CERN.

**COVID-19 related communities**

**Coronavirus Disease Research Community - COVID-19**

This community collects research outputs that may be relevant to the Coronavirus Disease (COVID-19) or the SARS-CoV-2. Scientists are encouraged to upload their outcome in this collection to facilitate sharing and discovery of information. Although Open Access articles and datasets are...

Curated by: Covid19\_Team\_OpenAIRE

**Featured uploads related to COVID-19**

- March 31, 2020 (15:45) Report Open Access**  
Statistical review of Favipiravir versus Arbidol for COVID-19: A Randomized Clinical Trial  
Wilkinson, Jack, Dohly, Damien  
The following review has been prepared in collaboration with members of the MRC-NIHR Trials Methodology Research Partnership. The reviewers named above, and other, unnamed discussants of the...  
Updated on April 3, 2020
- March 16, 2020 (00:00-09:27) Dataset Open Access**  
COVID-19 Open Research Dataset (CORD-19)  
Sebastian Kohmeier, Kyle Lu, Lucy Lu Wang, JJ Yang  
A full description of this dataset along with updated information can be found here. In response to the COVID-19 pandemic, the Allen Institute for AI has partnered with leading research groups to...  
Updated on April 3, 2020
- March 25, 2020 Software Open Access**  
Code for Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing  
Ferrelli, Luca, Wymant, Chris, Fraser, Christophe  
This code implements the COVID-19 mathematical analysis of Ferretti, Wymant et al. Science 2020. Namely, inference of the generation time interval for transmission pairs, solving the...  
Updated on April 3, 2020

[Browse COVID-19 related research](#)

HEPData

Repository for publication-related High-Energy Physics data

Search on 9485 publications and 100131 data tables.

Search for a paper, author, experiment, reaction [Search](#) [Advanced](#)

e.g. reaction P-P → LQ L X, title has "photon collisions", collaboration is LHC or DD.

**Data from the LHC**

- ATLAS** [View Data](#)
- ALICE** [View Data](#)
- CMS** [View Data](#)
- LHCb** [View Data](#)





# Three pillars of successful Open Data

## Publish & Share

Digital  
Repositories

## Preservation & Long-term Access

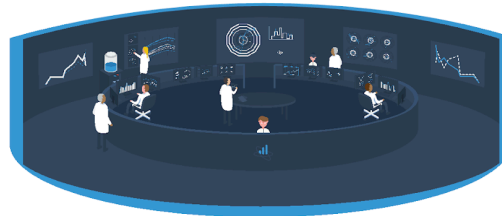
Archive and  
publication  
platforms

## Reproducibility

Reproducible  
research data  
analysis  
platforms

## CERN Analysis Preservation

capture, preserve and reuse physics analyses



### Capture



Collect and preserve elements  
needed to understand and  
rerun your analysis

### Collaborate



Share your analysis and  
components with other users,  
your collaboration or group

### Reuse



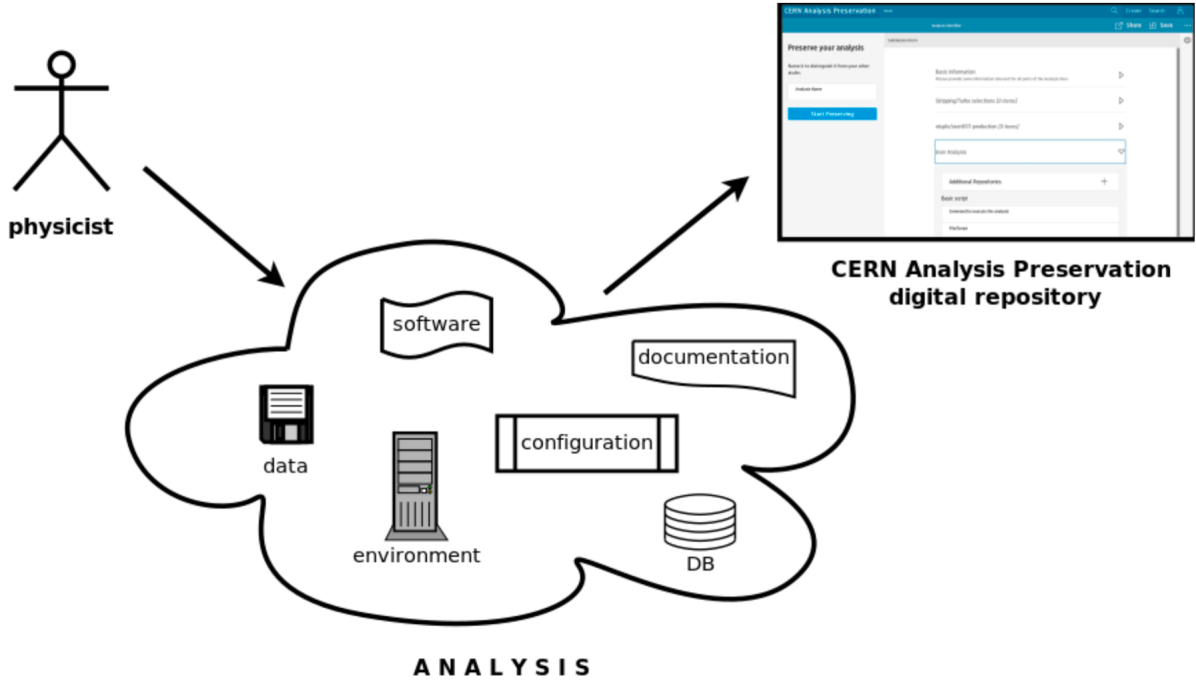
Run containerized workflows  
and easily reuse analysis  
components

# FAIR as the basis for Open

While Open Data is crucial, the **integrity of research results** is the foundation: preservation of outputs throughout the entire research process needed to ensure...

- Long-term accessibility
- Quality assurance
- (Re)usability

## Solution: CERN Analysis Preservation



# Three pillars of successful Open Data

## Publish & Share


Digital  
Repositories

## Preservation & Long-term Access







Archive and  
publication  
platforms

## Reproducibility

Reproducible  
research data  
analysis  
platforms



Reproducible research data analysis platform

Flexible	Scalable	Reusable	Free
Run many computational workflow engines.	Support for remote compute clouds.	Containerise once, reuse elsewhere. Cloud-native.	Free Software. MIT licence. Made with ❤️ at CERN.
 COMMON WORKFLOW LANGUAGE 	 kubernetes	 	

# REANA

## Four ingredients for reproducibility:

1. Input data
  - Input files
  - Input parameters
2. Analysis code
  - Software frameworks
  - User code
3. Compute environment
  - Operating system
  - Database calls
4. Analysis workflow
  - Single command
  - Complex workflows

### 1. Input CSV file

```
Region,1500,1600,1700,1750,1800,1850,1900,1950,1999,2000,2010,2012,2050,2150
World,100,100,100,100,100,100,100,100,100,100,100,100,100,100
Africa,18,8,19,7,15,5,13,4,10,9,8,8,8,1,8,8,12,8,14,5,14,8,15,2,19,8,23,7
Asia,53,1,58,4,63,9,63,5,64,9,64,1,57,4,55,6,60,8,60,4,60,4,60,3,59,1,57,1
Europe,18,9,19,1,18,3,20,6,20,8,21,9,24,7,21,7,12,2,10,9,10,7,10,5,7,5,3
Latin America and the Caribbean,8,5,1,7,1,5,2,2,5,3,4,5,6,6,8,5,8,6,8,6,9,1,9,4
Northern America,0,7,0,5,0,3,0,3,0,7,2,1,5,6,8,5,1,5,5,5,4,4,4,1
Oceania,0,7,0,5,0,4,0,3,0,2,0,2,0,4,0,5,0,5,0,5,0,5,0,5,0,5
```

### 2. Code: Jupyter notebook

```
Regional Analysis
We'll start with a histogram depicting the evolution of a specific region's portion of the world population, in percentage.

def histogram_by_region(region):
    local_pop=popl[["Region",str(region)]]
    local_pop.groupby("Year").sum()
    plot=local_pop.plot(kind='bar', legend=None, title="Percentage of World Population over time in "+str(region))
    plot.set_ylabel("% of world population")
    plot.set_xlabel("Year")

histogram_by_region("Africa")
```

### 3. Environment: CentOS7, IP5

```
FROM centos:7
RUN yum install -y epel-release
RUN yum install -y \
    gcc \
    python-devel \
    python-pip
RUN pip install ipython==5.0.0 jupyter==1.0.0
ADD world_population_analysis.ipynb /code/
ADD World_historical_and_predicted_populations_in_percentage.csv /code/
WORKDIR /code
CMD ["jupyter", "--no-browser", "--ip=0.0.0.0", "--port=8888", "--allow-root"]
```

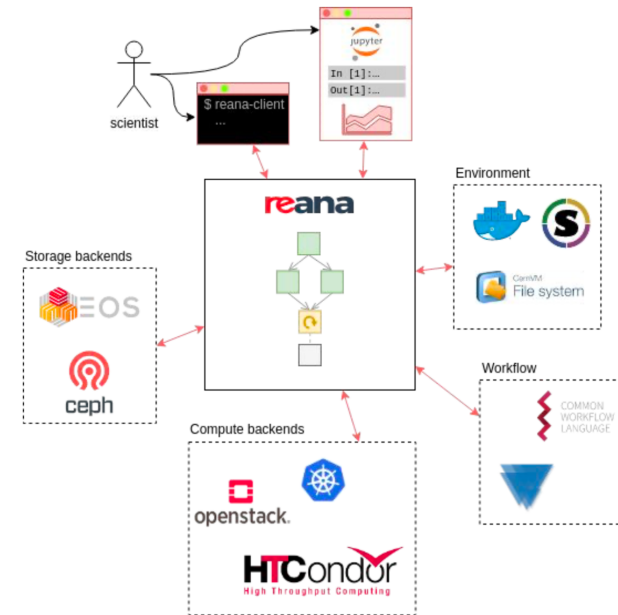
### 4. Workflow: papermill ...



<https://github.com/reanahub/reana-demo-worldpopulation>

## REANA architecture:

- Cloud-native, free application
- Flexible and scalable
  - Storage backends
  - Container technologies
  - Compute backends
  - Workflow engines



<http://reana.io>



CERN  
Open Science

# Open Software & Hardware at CERN

Ensuring optimal scientific and societal benefit

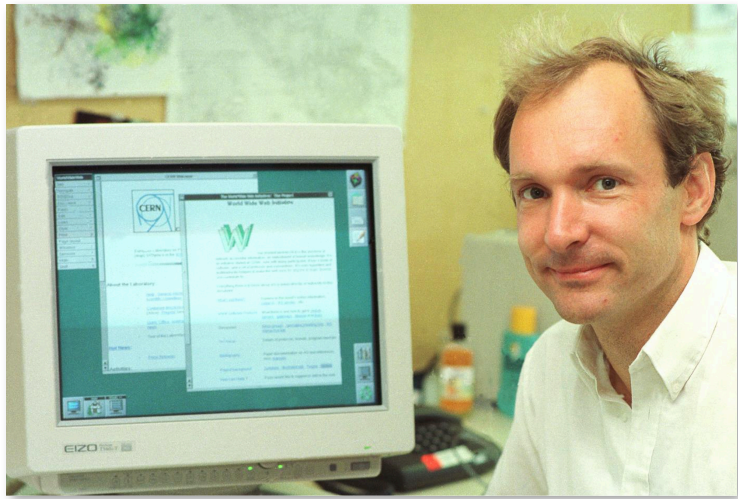
# Our Open-Source

## Philosophy

*“Recipients of technology should have access to all its building blocks, such as software code, schematics for electronics and mechanical designs, in order to study it, modify it and redistribute it to others”*

### CERN Tradition of developing software and placing it in the public domain

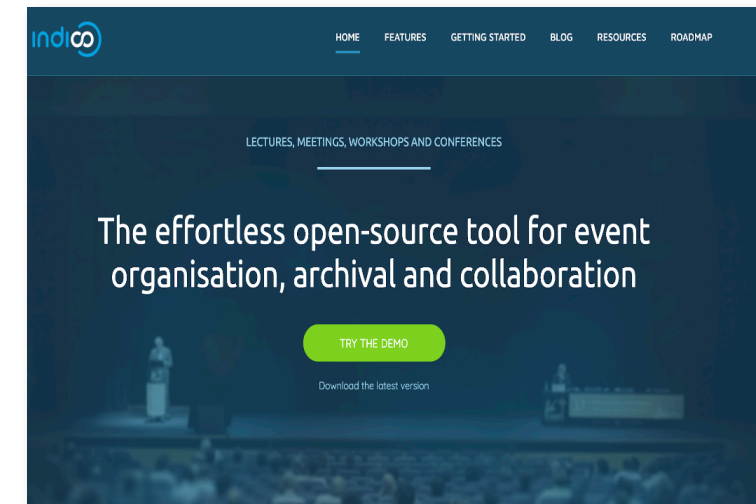
The www was created by Tim Berners-Lee at CERN



Invenio is an open-source digital repository package



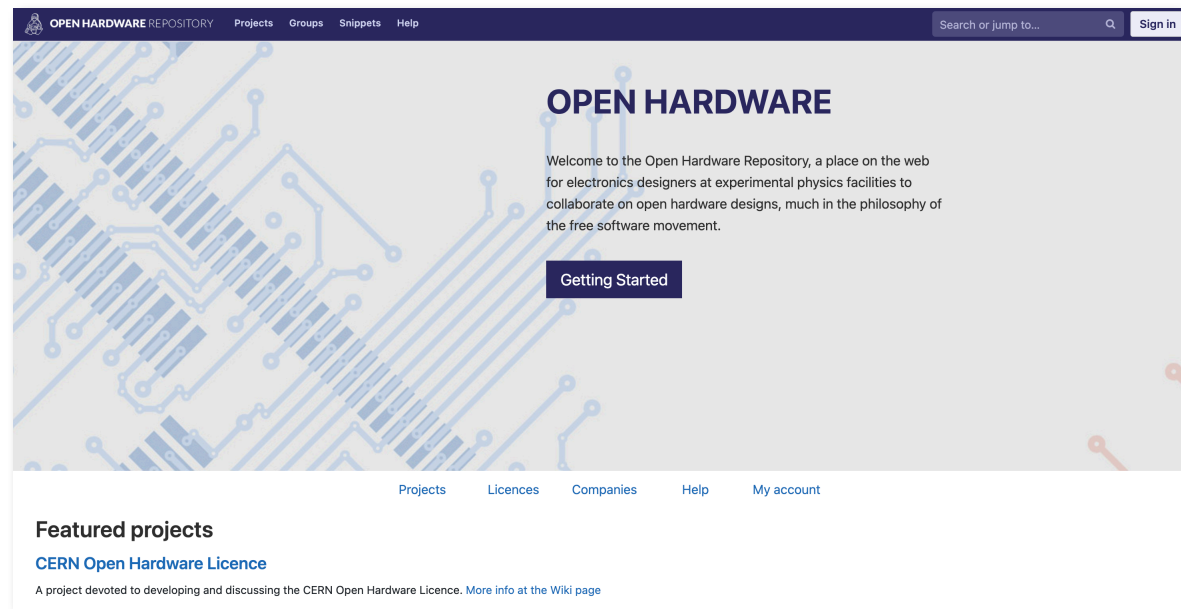
Indico is an open-source online conferencing tool



# Open Hardware

- Developed the Open Hardware Repository
- Created the CERN Open Hardware Licence
  - Anyone should be able to see the source – the design documentation in the case of hardware – study it, modify it and share it
  - Source includes schematic diagrams, designs, circuit or circuit-board layouts, mechanical drawings, flow charts and descriptive texts, as well as other explanatory material.

OHWR.org



A silicon mask produced using 3D printed molds designed and made at CERN (Image: CERN)





# Open Source at CERN

## Producer

CERN regularly creates or updates numerous open-source products, such as analysis or experiment software (e.g. root), general software projects (e.g. Indico) or hardware design (e.g. 3D-printed face mask)

## Contributor

CERN extensively contributes to a wide range of worldwide open-source initiatives

## Consumer

More than 70% of open-source software used at CERN is based on external projects\*; most CERN services rely on components such as Python, Kubernetes and the Linux Kernel

## Governance driver

Creation of the CERN Open Hardware licenses (CERN being member of major infrastructure projects governing bodies)

\* See IT 2022 report: <https://codimd.web.cern.ch/tbVJZyW7SVC1hsggmrAu6A>

# The OSPO Mandate



## Drive Open Source practices:

Promote CERN as a contributor  
Assert CERN as a user  
Enable Open Source due diligence



## Provide support for the entire CERN community



## Be an entry point to CERN's expertise



## Organise events, communication, support and training



## Act as interface for external partners

Internally

Externally

# CERN in-kind contributions to European Open Science Cloud

- Data culture - promote digital repository certification and data preservation across the research community
- Thematic areas - implement FAIR data principles in the particle physics domain
- Research data repositories – continue to support Zenodo as a trusted repository open to the world
- Service deployment - federate public e-infrastructures and commercial service providers to establish a hybrid cloud platform supporting open research
- Governance model - share the experience of more than a decade of operating a global data infrastructure





CERN  
Open Science

# Open Science Policies

Enabling internal synchronization and global alignment

# UNESCO Recommendations on Open Science created the momentum

**The Assistant Director-General for Natural Sciences**

United Nations Educational, Scientific and Cultural Organization  
 Organisation des Nations Unies pour l'éducation, la science et la culture  
 Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura  
 Организация Объединённых Наций по вопросам образования, науки и культуры  
 منظمة الأمم المتحدة للتربية والعلم والثقافة  
 联合国教育、科学及文化组织

Mr Alexander Kohls  
 Group Leader  
 Scientific Information Service  
 European Council for Nuclear Research (CERN)

10 March 2020

Ref.: SC/PCB/SPP/1053

Dear Mr Kohls,

During the 40th session of UNESCO's General Conference, Member States tasked the Organization with leading a global dialogue on Open Science with a view to developing a standard-setting instrument in the form of a Recommendation, to be adopted by the UNESCO General Conference in November 2021.

The Recommendation will be prepared through a regionally balanced, multistakeholder, inclusive and transparent consultation process. I would like to invite all UNESCO partners to contribute to this process.

**Pushing the Boundaries of Open Science at CERN: Submission to the UNESCO Open Science Consultation July 2020**

Kannan Nair<sup>1</sup> Tullio Banaglia<sup>2</sup> Jolana Brankari<sup>3</sup> Punita Pothan<sup>4</sup>  
 Jose Benito Gonzalez Lopez<sup>5</sup> Maria Garcia Pa<sup>6</sup> Alexander Kohls<sup>7</sup>  
 Artemis Lavasa<sup>8</sup> Lars Holm Nielsen<sup>9</sup> Stephanie van de Sandt<sup>10</sup> Javier Soriano<sup>11</sup>  
 Tim Smith<sup>12</sup>

CERN, the European Organization for Nuclear Research, is the world's largest high-energy physics (HEP) laboratory. Since its founding in 1954, the Laboratory has made significant contributions to our understanding of the world and the universe. The mission of the Organization is to provide a unique range of particle accelerator facilities and world-class research in fundamental physics, and to help people from all over the world to push the frontiers of science and technology, for the benefit of all. Supported through a global partnership of 23 member states, CERN is home to the world's largest scientific instrument, the Large Hadron Collider (LHC), and hosts over 12,000 scientists and engineers from across the world.

The frontier research conducted at CERN has long embodied the values that have been recently enshrined in the Open Science movement, which describes research and development that is collaborative, open access and reproducible and whose outputs are publicly available. European Commission Director Jolana Brankari was co-edited in 1970 in CERN's founding document, which states that "... the results of its experimental and theoretical work shall be published as extensively as possible and made generally available." CERN Council (1970) providing the Organization with an early Open Science mission.

The embrace of the values of Open Science at CERN is not considered an obligation, but rather an expression of the collective moral and financial responsibility to member states and the global scientific community to advance the frontiers of human knowledge. The community at CERN helped build the Open Science, with early adopters of Open Science, helped usher in the present culture, and helped to pioneer initiatives to allow Open Science to flourish. Yet, the complexity of the Laboratory makes the comprehensive pursuit of Open Science an ongoing and non-linear effort, supported by long-term human and financial investments by the international community. CERN hosts thousands of research teams consisting of thousands of researchers from around the world, who collectively publish almost 1,000 research articles per year. These activities are engaged in multiple experimental collaborations that operate largely independently of each other and have different goals and methods. The high-energy physics research conducted at CERN is one of the most data-intensive branches of science, periodic publications at CERN provide about 40 petabytes of collision data per year. The complexity, scale and value of these data present unique and unprecedented challenges for the research community at CERN. The responsible, verifiability, analysis and preservation of these data requires a supporting organizational research culture, not only a range of tools and services to optimize how data are used, verified, and built upon to advance knowledge.

On June 19th, 2020, CERN's highest governing authority, the CERN Council, approved its updated strategy for particle physics in the global landscape. This document, the European Strategy for Particle Physics represents the most important strategic document for CERN, setting the future strategy for the Organization. CERN's Open Science policy was given a strong endorsement from the CERN Council, with the strategy stating that: "European science policy is quickly moving towards Open Science, which promotes and accelerates the sharing of scientific knowledge with the community at large. Particle physics has been a pioneer in several aspects of Open Science. The particle physics community should work with the relevant authorities to help shape the emerging consensus on Open Science in the context of a policy of Open Science for the I4NF/European Strategy Group (2020)."

This paper aims to describe the ecosystem of initiatives, projects and technologies that have been developed at CERN to maximize the impact of our research through building an Open Science infrastructure that is efficient, collaborative and responsive to the needs of the scientific community. We aim to demonstrate that despite the complexity of the research undertaken at CERN, Open Science can be advanced through concerted efforts and as such, the CERN example could serve as an inspiration for the global scientific community.

<sup>1</sup>lavasa@cern.ch

United Nations Educational, Scientific and Cultural Organization  
 Organisation des Nations Unies pour l'éducation, la science et la culture  
 Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura  
 Организация Объединённых Наций по вопросам образования, науки и культуры  
 منظمة الأمم المتحدة للتربية والعلم والثقافة  
 联合国教育、科学及文化组织

**ESOF2020**  
 EUROSCIENCE OPEN FORUM  
 TRIESTE

**EuroDIG**  
 European Digital Infrastructure for Research Communities

**Towards a Global Consensus on Open Science**

Online Regional Consultation for Western Europe and North America to the UNESCO Recommendation on Open Science

**Online Consultation on Open Science**

UNESCO invites scientists, publishers, science policymakers or anyone with experience and interest in Open Science to participate in the online consultation on implications, benefits and challenges of Open Science across the globe.

<https://doi.org/10.17181/CERN.1SYT.9RGJ>

United Nations Educational, Scientific and Cultural Organization

# Open Science

CERN is proud to have joined UNESCO on the journey towards Recommendations on Open Science

# Policy framework for Open Science at CERN

## CERN Open Access Policy (2014)

- All CERN research articles published OA (CC-BY)
- Central fund available
- Different routes (SCOAP<sup>3</sup>, Read & Publish, APC payment)

## LHC Open Data Policy (2020)

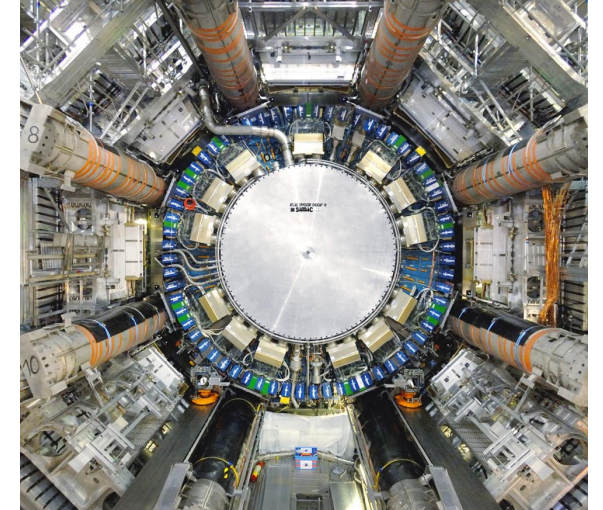
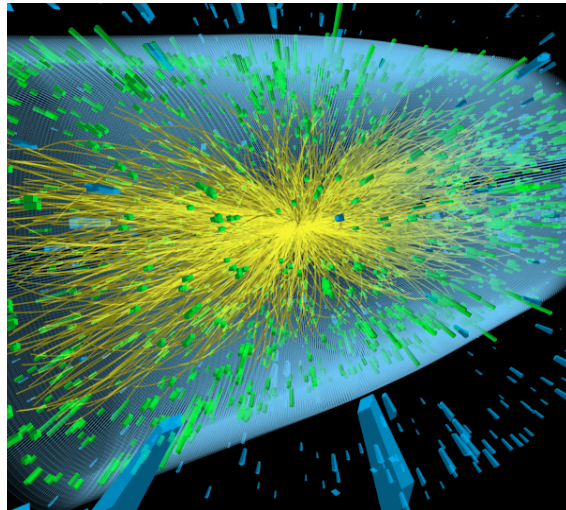
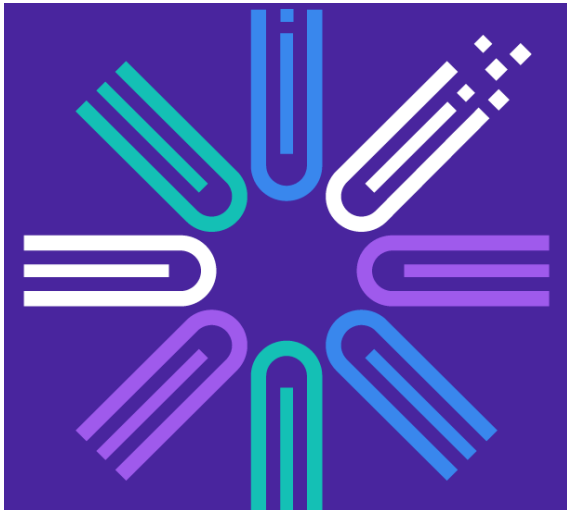
- 4 LHC collaborations will release all level 3 data (+ level 1 and 2)
- Gradual release will start ~5 years after collection
- Other experiments to follow

## CERN Open Science Policy (2022)

- Open...
  - Access
  - Data
  - Hardware
  - Software
- Reusability & reproducibility
- Research Assessment
- Education & Outreach

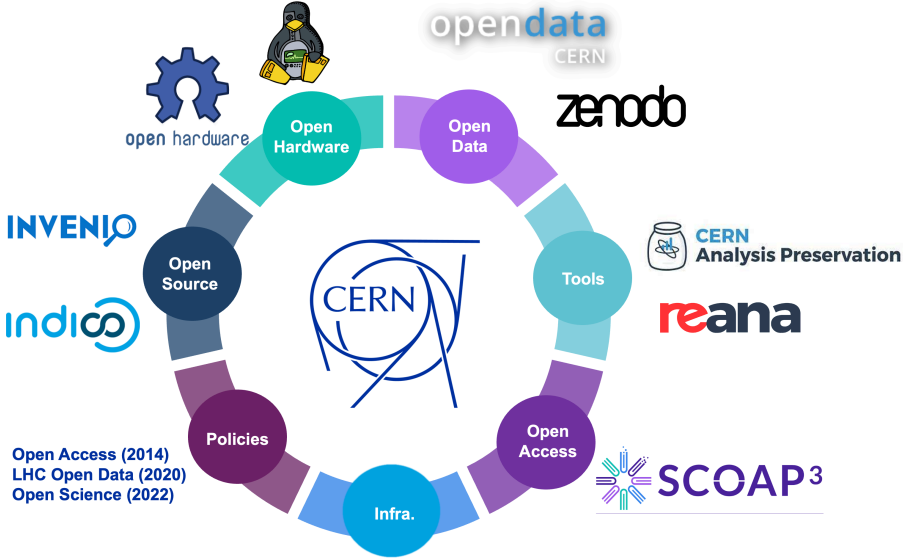
## Funder Open Science Policies

- Funding agencies supporting experimental collaborations have specific open data requirements
- CERN will establish central support office for compliance

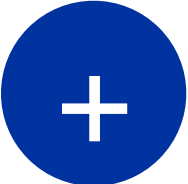


# Developing the CERN Open Science Policy

## Decentralised institutional efforts & grassroots movements



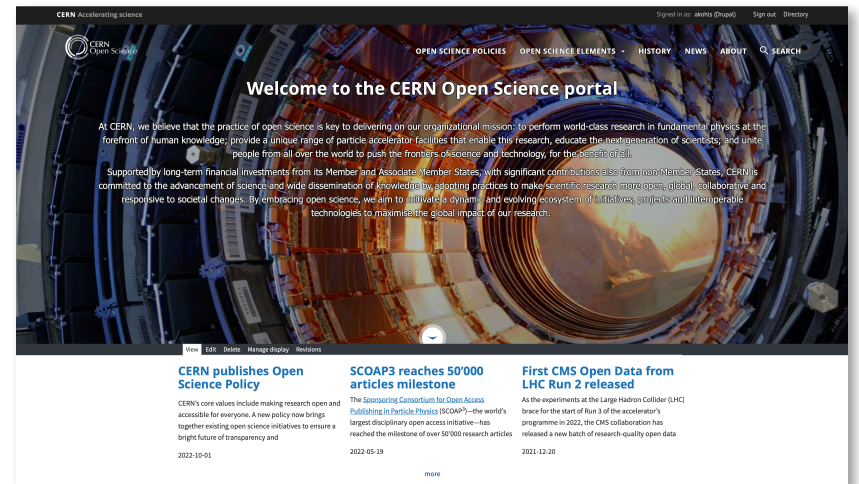
## Policy frameworks & best practices



Toolkit for policy makers on Open Science and Open Access  
**Model Policy on Open Science**  
for Research Performing Organisations (RPOs)

# CERN Open Science Policy

- **Captures current practice and states progressive vision across multiple Open Science domains:**
  - Open Access to Publications
  - Open Research Data
  - Open Software
  - Open Hardware
  - Research Integrity, Reuse & Reproducibility
  - Infrastructure for Open Science
  - Research Assessment & Evaluation
  - Education, Training & Outreach
  - Citizen Science
- **Policy is governed and implemented by the community**
- **Policy text (V1.0, Oct 2022) and more details available on the CERN OS website: <https://openscience.cern>**





# CERN Open Science Policy

## Examples of policy statements

### 1. Open access to publications

All CERN scientific publications are to be made immediately publicly available and reusable. The [Open Access Policy for CERN Publications \(2014, updated 2017 and 2021\)](#) requires that all original research publications by CERN authors are published open access, centrally supported by the [CERN Open Access fund](#). CERN users and visiting scientists are also encouraged to publish their work under similar terms, according to the [CERN General Conditions applicable to the Execution of Experiments](#).

CERN scientific publications, including submissions to trusted repositories (such as [arXiv](#)), should be released under an open licence, with [CC-BY](#) as the default standard. Publication-related metadata are made available for reuse under the [CC0](#) waiver in line with [FAIR principles](#) (findability, accessibility, interoperability, reusability). Open access publishing support is also provided for monographs related to CERN experiments or accelerators, applied research processes or technologies, and other areas of relevance.

### 2. Open data

CERN experimental collaborations are committed to making their research data publicly available. The [CERN Open Data Policy for the LHC Experiments \(2020\)](#) aims to support CERN experiments' consistent approach towards the openness and preservation of experimental data to maximise their long-term value. All data are released with persistent identifiers. [Data and associated data services apply open and FAIR principles](#). For experimental data releases, CC0 waivers are applied as standard. Researchers and experiments are expected to develop data management plans for their research activities.

<https://cds.cern.ch/record/2835057>

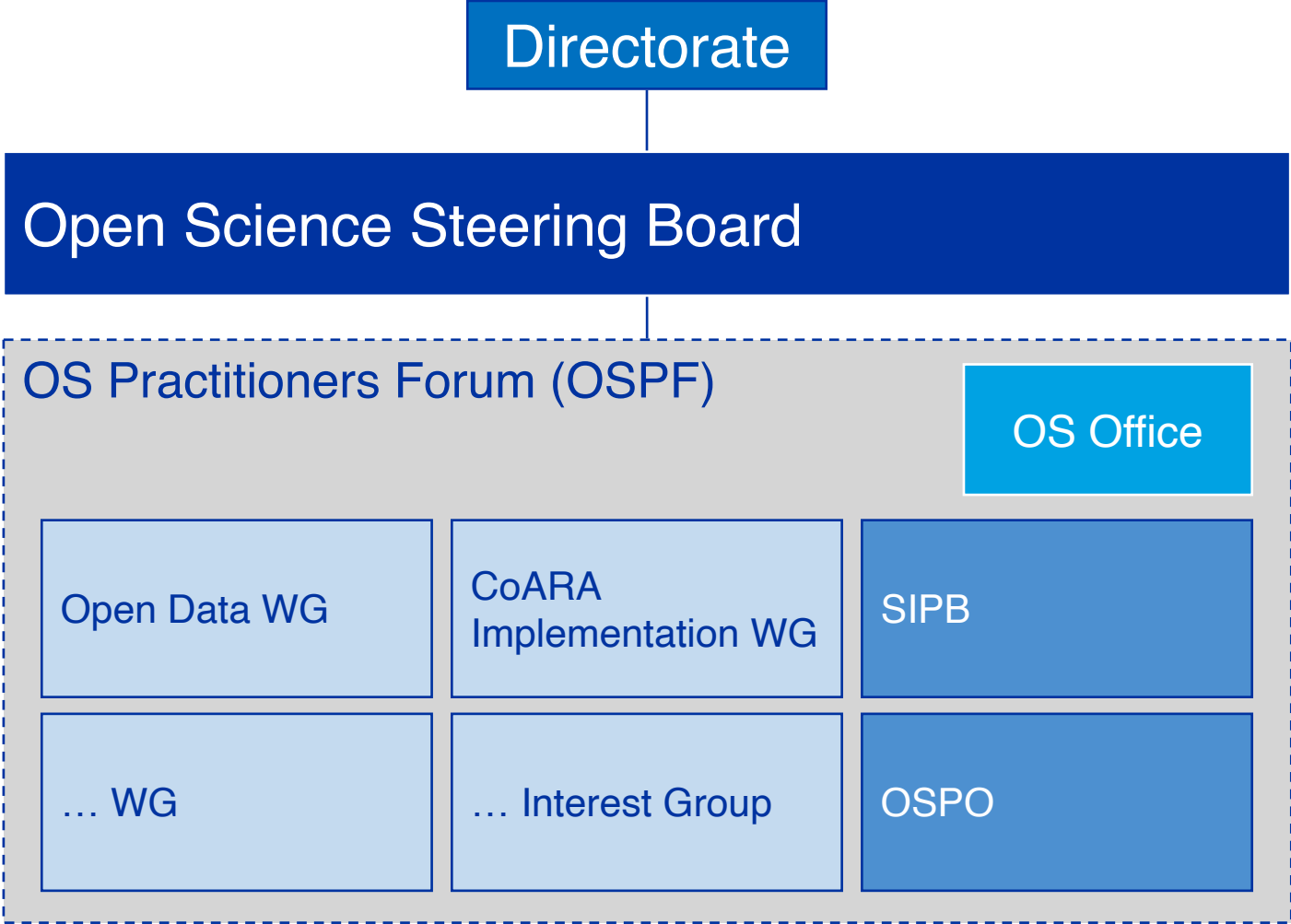
# Open Science Policy Implementation Plan

- Policy accompanied by implementation document outlining roles, responsibilities, mechanisms & resources
- Includes actionable measures to support the policy's implementation across the organization and in the experiments@CERN
- Implementation led by Communities of Practice across the various OS activities
- Each chapter with editors/shepherds of the OSWG, but everyone within the WG could contribute to the development of each part
- Identifies/surfaces both existing and required resources for policy implementation
- To be published openly

<https://cds.cern.ch/record/2856044/files/CERN-OPEN-2023-007.pdf>



# CERN OS Governance Framework



- Responsible for OS strategy & policy
- Consists of department/experiment reps

- Open forum for CERN-wide exchange
- Meets at least 2x per year

- Ensures OS implementation
- Provides input to annual OS Report



**Thank you!**

Contact: [kamran.naim@cern.ch](mailto:kamran.naim@cern.ch)

[openscience.cern](https://openscience.cern)