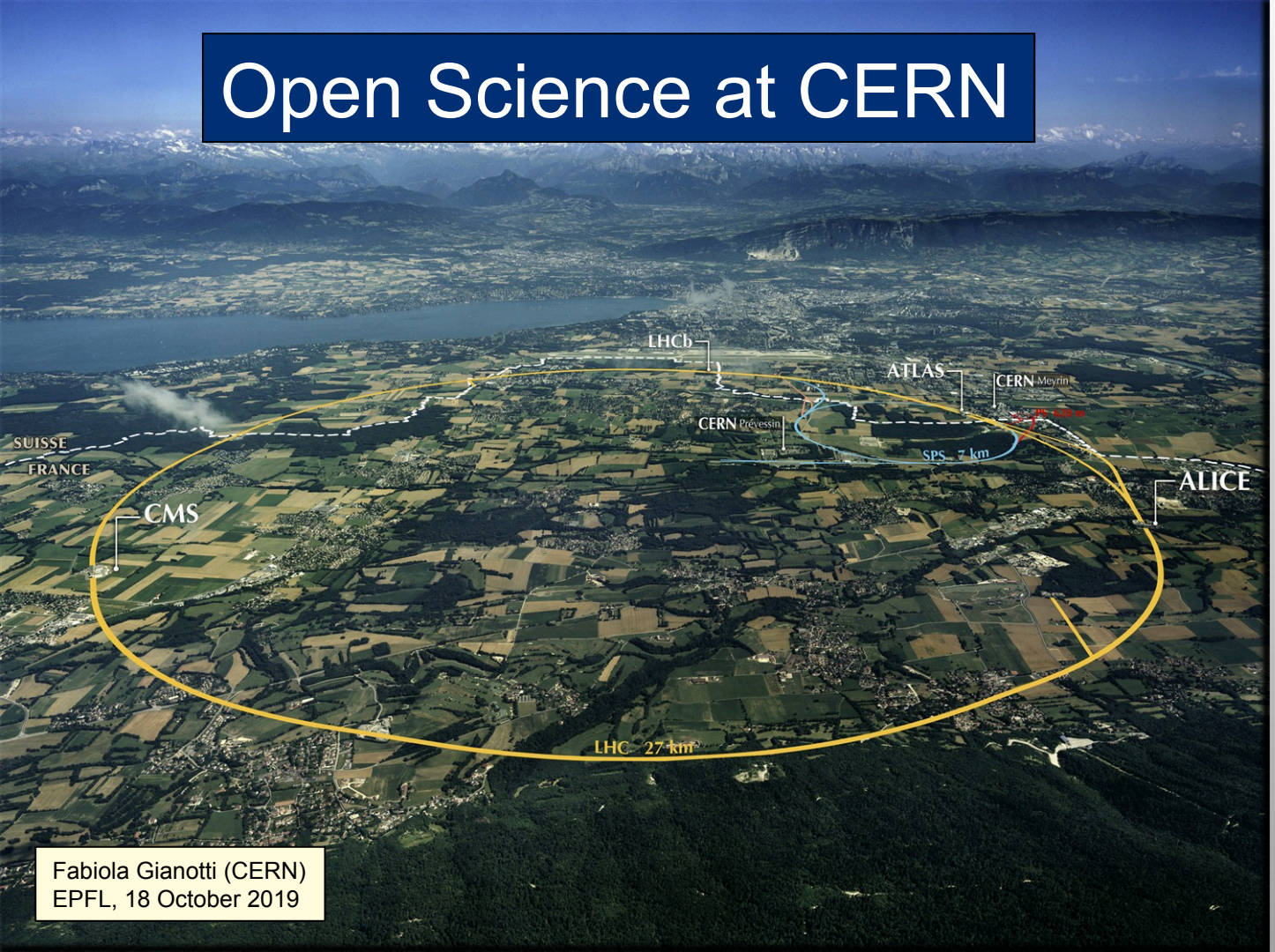
Open Science at CERN



Fabiola Gianotti (CERN)
EPFL, 18 October 2019

Why Open Science ?

- Scientific results should be available to anyone to scrutinise, reproduce, build upon, etc.
  → sharing of information and transparency are a foundation of scientific method and better science

- Open science is a way to accelerate scientific and technological development and to maximise their impact on society

- Science and knowledge belong to humanity, not just to the scientists pursuing them
  Scientific institutions are usually funded with public money → their results belong to everybody

- Open science is also one of most powerful tools to reduce inequalities across the world.
  Technology and innovation grow fast in modern society → ~ 50% of current jobs will disappear in next 30 years (replaced by automation, machines, AI);"low-skill" jobs will disappear first
  → Danger of increasing gap between developed and developing countries, rich and poor, those who have access to education and those who don't → exacerbating inequalities

→ Open science and open access education are crucial to spread STEM and other knowledge around the world, reaching out in particular to people from less privileged regions.

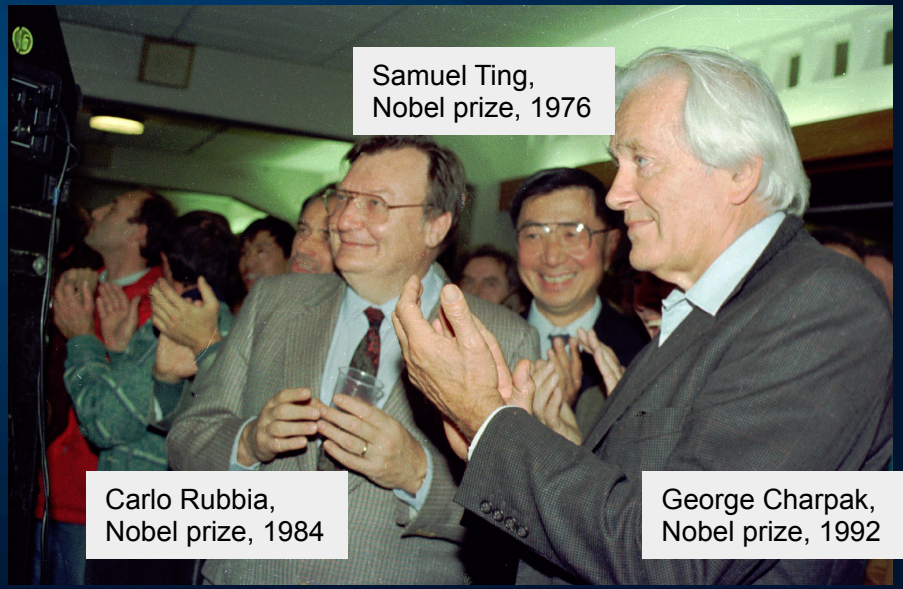
CERN : the largest particle physics laboratory in the world

Intergovernmental organisation based in Geneva

Mission:

- science: fundamental research in particle physics → discoveries (e.g. Higgs boson in 2012), Nobel prizes
- technology and innovation → transferred to society (e.g. World Wide Web, medical applications)
- training and education
- bringing the world together: ~ 18000 scientists, > 110 nationalities

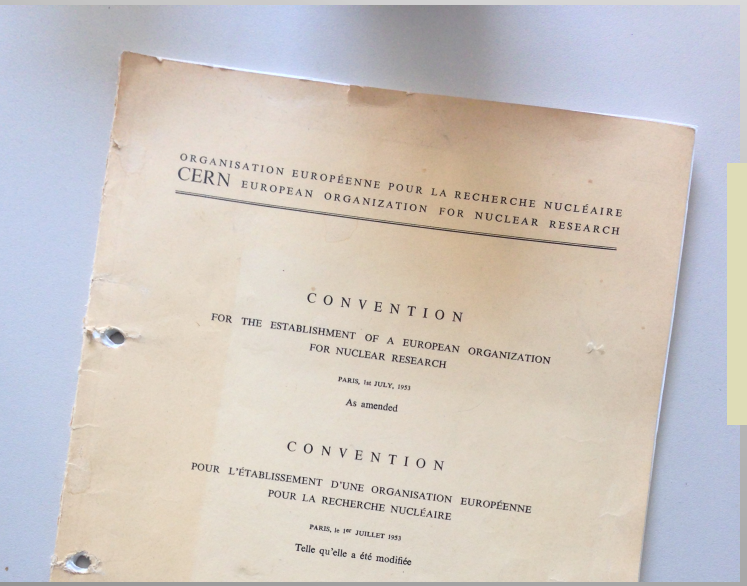
WEB@30 celebration, 12 March 2019 at CERN, with T. Berners-Lee, former CERN staff member



Open Science is enshrined in CERN's Convention

CERN founded in 1954 in the aftermath of World War II, with two goals:

- ❑ relaunch scientific research in Europe
- ❑ foster peaceful collaboration among European countries



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

CONVENTION

FOR THE ESTABLISHMENT OF A EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

PARIS, 1st JULY, 1953

As amended

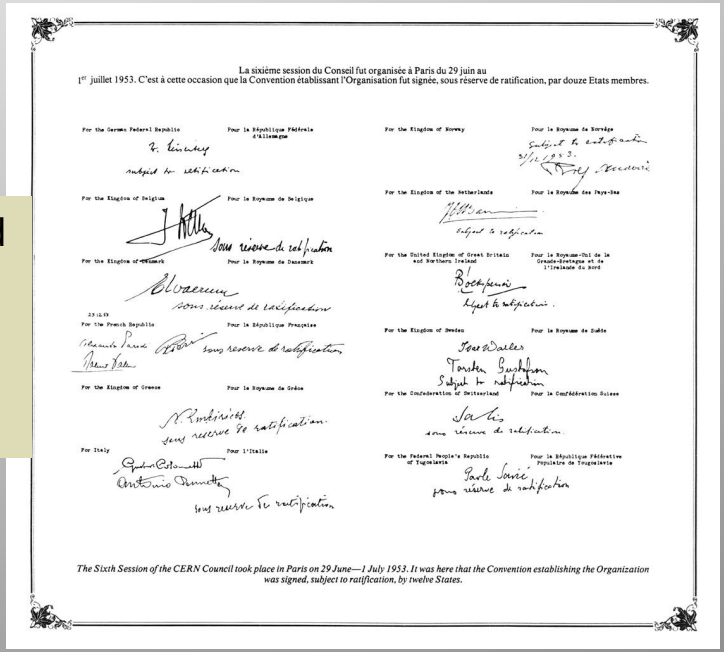
CONVENTION

POUR L'ÉTABLISSEMENT D'UNE ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

PARIS, le 1er JUILLET 1953

Telle qu'elle a été modifiée

CERN Convention signed
by 12 Member States
in Paris on 1 July 1953
→ entered into force
on 29 Sept 1954



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.

ARTICLE II : Purposes

1. The Organization shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of its experimental and theoretical work shall be published or otherwise made generally available.

b. the organization and sponsoring of international co-operation in nuclear research, including co-operation outside the Laboratories; this co-operation may include in particular:

   a. work in the field of theoretical nuclear physics;

   b. the promotion of contacts between, and the interchange of, scientists, the dissemination of information, and the provision of advanced training for research workers;

   c. collaborating with and advising other research institutions;

   d. work in the field of cosmic rays.

CERN Today

23 Member States: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and the United Kingdom

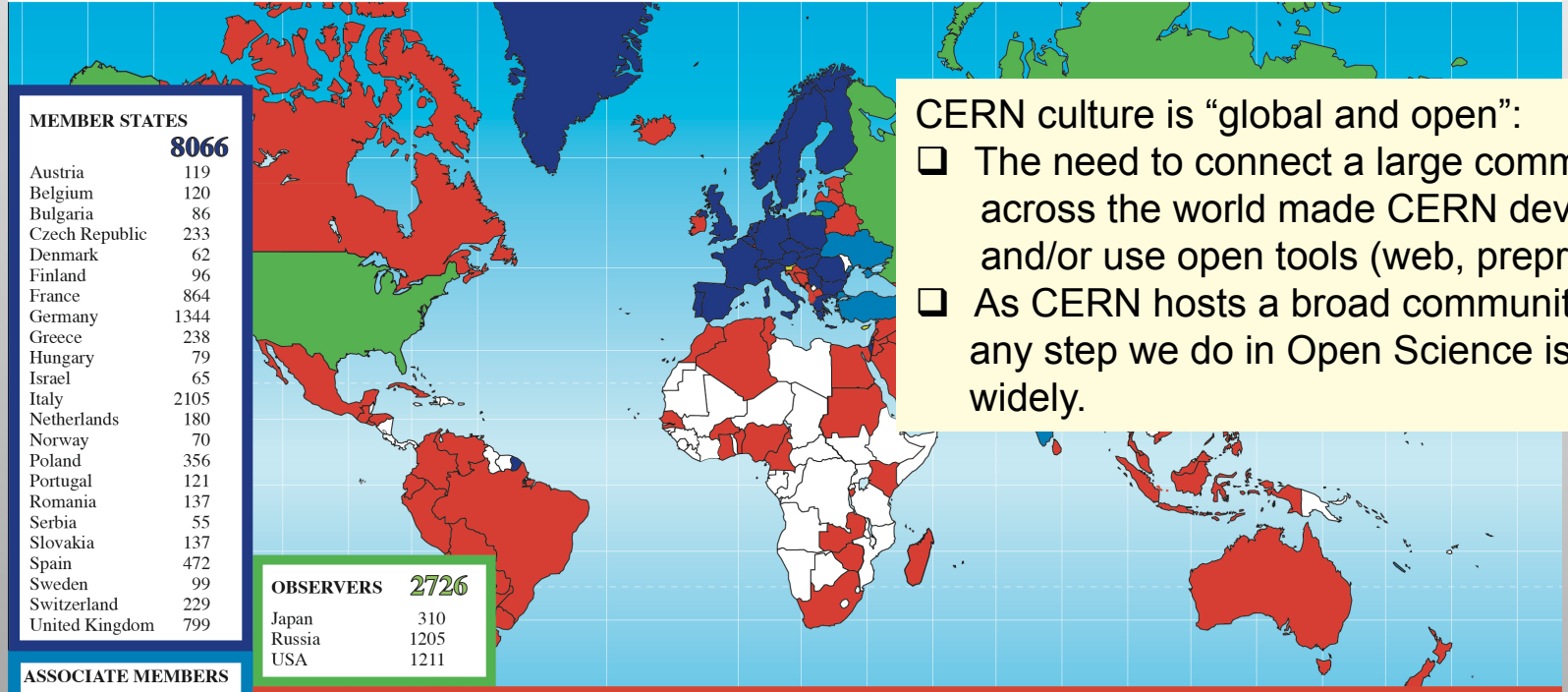
8 Associate Member States: Croatia, Cyprus, India, Lithuania, Pakistan, Slovenia, Turkey, Ukraine

6 Observers to Council: Japan, Russian Federation, USA, EU, JINR/Dubna, UNESCO

~ 50 International Cooperation Agreements: more and more developing countries (recent examples: Paraguay, Sri Lanka, Nepal) sign cooperation agreements with CERN → engaging internationally on fundamental research is part of their efforts towards development, building knowledge-based economies and strengthening scientific relations with other countries.

Annual budget (2018) ~1200 MCHF (on average: ~ 1 cappuccino/year per European citizen): Member States contribute in proportion to their income (NNI).

Distribution of All CERN Users by Nationality as of mid-April 2019



MEMBER STATES **8066**

Austria	119
Belgium	120
Bulgaria	86
Czech Republic	233
Denmark	62
Finland	96
France	864
Germany	1344
Greece	238
Hungary	79
Israel	65
Italy	2105
Netherlands	180
Norway	70
Poland	356
Portugal	121
Romania	137
Serbia	55
Slovakia	137
Spain	472
Sweden	99
Switzerland	229
United Kingdom	799

ASSOCIATE MEMBERS **778**

India	387
Lithuania	39
Pakistan	71
Turkey	165
Ukraine	116

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP **59**

Cyprus	26
Slovenia	33

OBSERVERS **2726**

Japan	310
Russia	1205
USA	1211

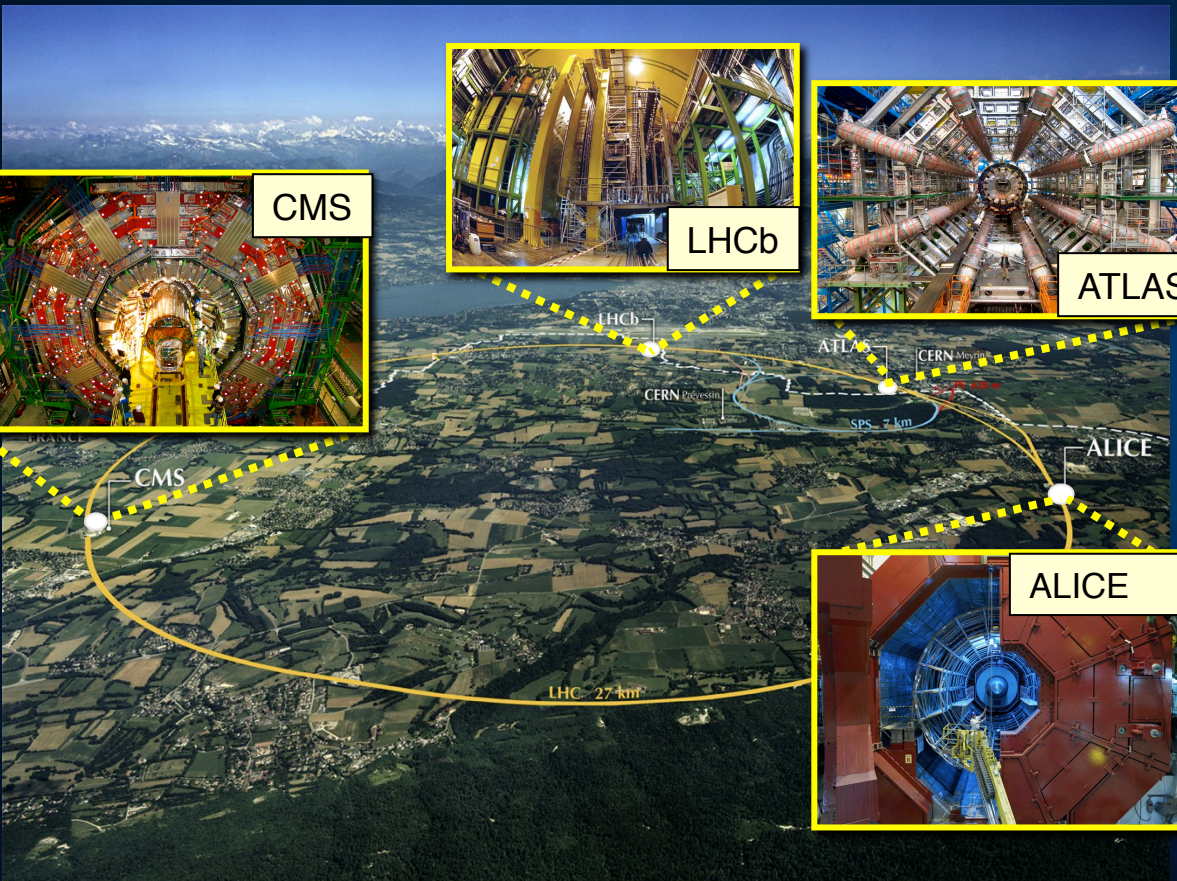
OTHERS **1999**

Albania	4	Bolivia	3	Ecuador	10	Iraq	1	Malta	9	Palestine	7	Sudan	1
Algeria	14	Bosnia & Herzegovina	3	Egypt	27	Ireland	13	Mexico	85	Paraguay	1	Syria	1
Argentina	26	Brazil	127	El Salvador	1	Jordan	2	Mongolia	2	Peru	6	Taiwan	56
Armenia	22	Burkina Faso	1	Estonia	15	Kazakhstan	10	Montenegro	11	Philippines	3	Thailand	26
Australia	36	Burundi	1	Georgia	51	Kenya	1	Morocco	24	Saint Kitts and Nevis	1	Tunisia	4
Azerbaijan	10	Cameroon	1	Ghana	1	Korea	183	Myanmar	2	San Marino	1	Uruguay	1
Bahrain	1	Canada	170	Guatemala	1	Kyrgyzstan	1	Nepal	7	Saudi Arabia	4	Uzbekistan	3
Bangladesh	8	Chile	21	Hong Kong	1	Latvia	4	New Zealand	5	Senegal	1	Venezuela	9
Belarus	45	China	576	Honduras	1	Lebanon	27	Nigeria	4	Singapore	5	Viet Nam	11
Benin	1	Colombia	44	Iceland	4	Luxembourg	4	North Korea	4	South Africa	56	Zambia	1
		Croatia	50	Indonesia	11	Madagascar	1	North Macedonia	3	Sri Lanka	10	Zimbabwe	2
		Cuba	16	Iran	58	Malaysia	22	Oman	3				

CERN culture is “global and open”:

- The need to connect a large community across the world made CERN develop and/or use open tools (web, preprints, etc.).
- As CERN hosts a broad community today, any step we do in Open Science is propagated widely.

The Large Hadron Collider (LHC): the most powerful accelerator ever



- 27 km ring, 100 m underground
- operation started in 2010 → exploration of new energy frontier

July 2012, ATLAS and CMS announced the discovery of a new (very special!) particle: the Higgs boson

Since the beginning of its life, CERN implements and promotes Open Science:

open source software
open access publication
open data
open hardware
open education and training

With the goal of maximising knowledge transfer and dissemination rather than generating revenues for CERN

Here a few examples

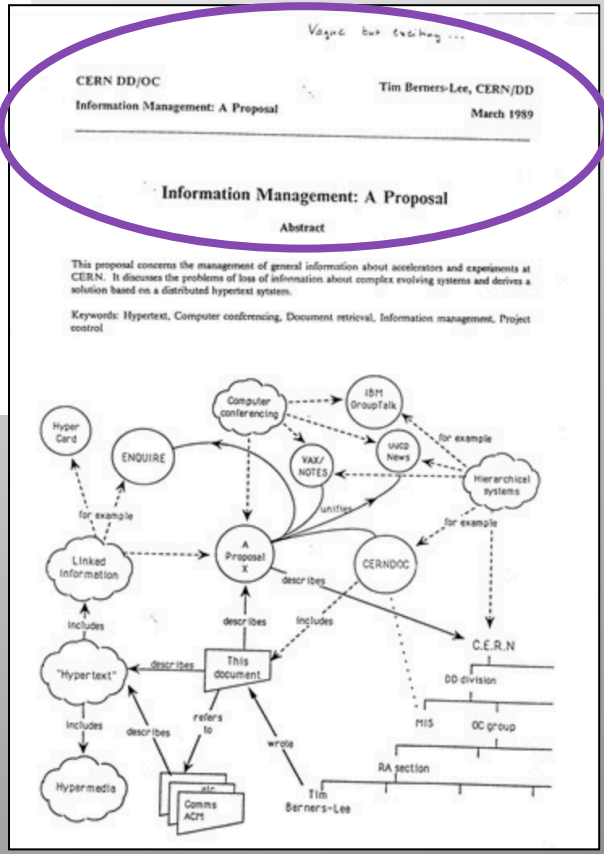
Note:
- ❑ CERN retains the Intellectual Properties (IP) of its work and results.
- ❑ Intellectual property generated by CERN employees belongs to CERN.

The World Wide Web

Developed by Tim Berners-Lee and collaborators (Robert Cailliau et al.) in 1989 to facilitate share of information among CERN's scientists
→ tool to support collaboration in science.
Demonstrates power of fundamental research to drive innovation to the benefit of society.

Crucial step: CERN's decision in 1993 to make WEB freely available to anyone to use and improve
→ fundamental to further development of the WEB and its dissemination (today: ~ 4 Billion people connected)

March 1989: First proposal for an internet-based hypertext system to link and access information across different computers



CERN DD/OC
Information Management: A Proposal

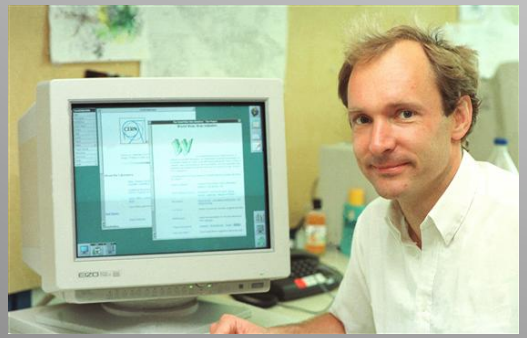
Tim Berners-Lee, CERN/DD
March 1989

Information Management: A Proposal

Abstract

This proposal concerns the management of general information about accelerators and experiments at CERN. It discusses the problems of loss of information about complex evolving systems and derives a solution based on a distributed hypertext system.

Keywords: Hypertext, Computer conferencing, Document retrieval, Information management, Project control



SCOAP3 : Open-access publishing

Sponsoring Consortium for Open Access Publishing in Particle Physics
Partnership of 3000 libraries, funding agencies and research institutions from 44 countries.
Governed by an International Council. Hosted at CERN.

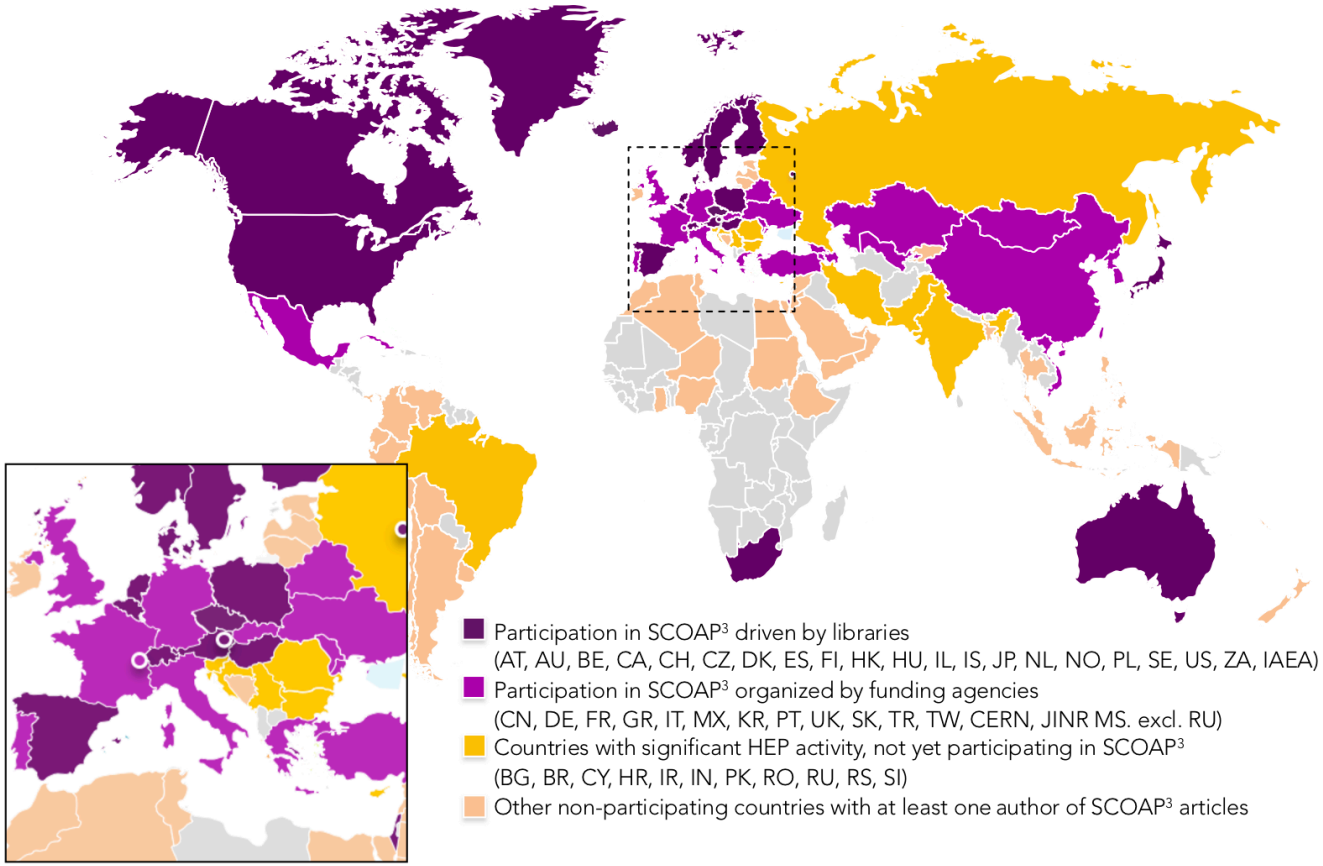
It allows publishing Open Access in high-quality journals at no direct cost for the authors, by redirecting subscription funds from about 3000 partner libraries to the Consortium, which then pays centrally for the (reduced) article publishing costs. Additional top-up money from funding agencies from some countries with large scientific output.

Phase 1: 2014-2016; Phase 2: 2017-2019; Phase 3: 2020-2022
Budget for Phase 3: ~ 30 MCHF

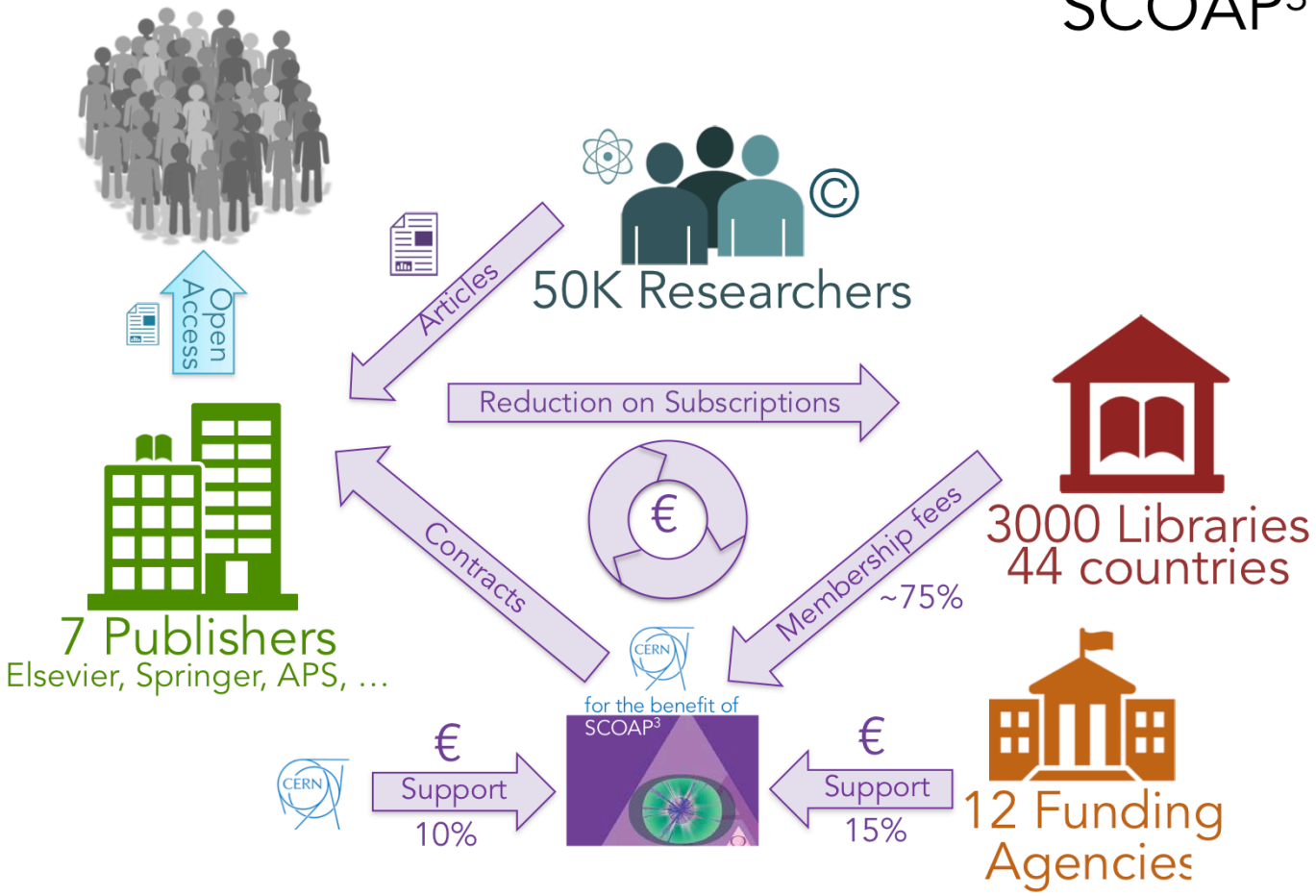
Journals involved in SCOAP3 include:
European Physical Journal C; Journal of High-Energy Physics (Springer)
Nuclear Physics B; Physics Letter B (Elsevier)
Physics Review Letter; Physics Review D; Physics Review C (American Physical Society)

SCOAP^3 partnership today, 44 countries, 3 IGO

IGO:
CERN
JINR/Dubna,
IAEA



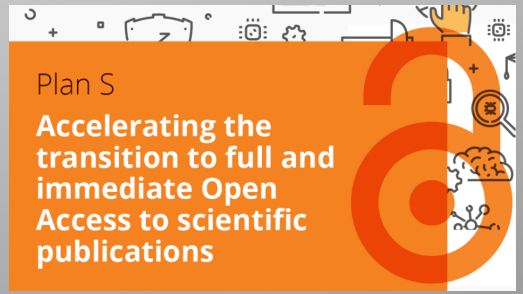
SCOAP³


Open Access
Articles
50K Researchers
Reduction on Subscriptions
3000 Libraries
44 countries
€
Contracts
Membership fees
~75%
7 Publishers
Elsevier, Springer, APS, …
CERN
for the benefit of
SCOAP³
€
Support
10%
€
Support
15%
12 Funding
Agencies

Main accomplishments of SCOAP3:

- Covers ~ 90% of all High-Energy-Physics articles
  Note: SCOAP3 benefits all HEP authors worldwide (not only CERN-related scientists)
- ~ 30,000 articles published since 2014 in 13 journals by authors from 100 countries

SCOAP3 is in line with Plan S (Robert-Jan Smith):
"From 2021, scientific publications that result from research funded by public grants must be published in compliant Open Access journals or platforms."
Supported by EC, funding agencies, foundations, etc.



Open Data

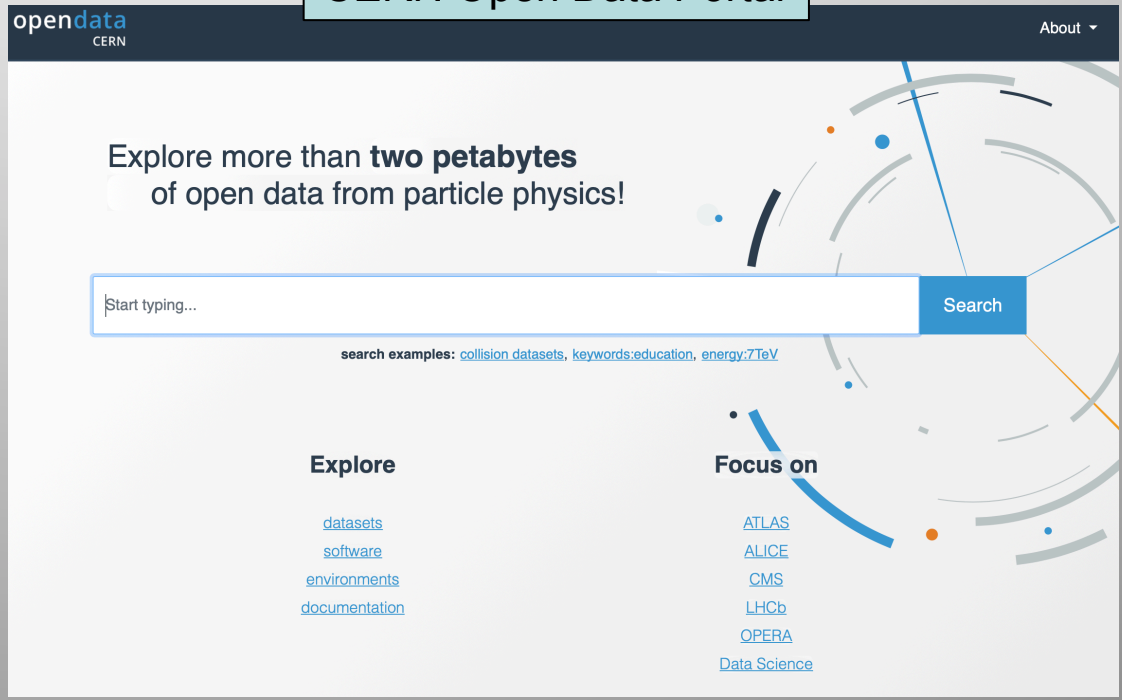
Data from the LHC experiments (> 2 PB) and necessary tools to analyse them are available through a dedicated portal. Used since the beginning of the LHC for educational purposes (Master Classes)

Open Data requires:

- ❑ dedicated infrastructure
- ❑ commitment of scientists to develop and maintain the needed SW tools
- ❑ documentation
- ❑ long-term data preservation policy and infrastructure
- ❑ human and financial resources

First article based on CMS open data:
https://arxiv.org/abs/1704.05842

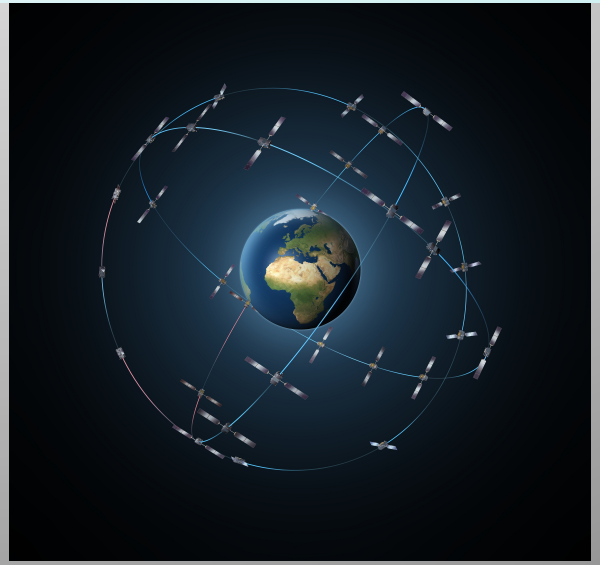
CERN Open Data Portal



Open Hardware: White Rabbit

Multi-laboratory, multi-company collaboration for development of a new Ethernet-based technology providing sub-nanosecond synchronization.
Project initiated and led by CERN, which needs execution of operations with tight time constraints and large distances between nodes.

ESA's Galileo Global Navigation Satellite System



Use of WR by research and other institutions improved technology also to the benefit of CERN use.

Note: CERN also pioneered a legal framework for open-hardware licensing

European VLBI (Very-Long Baseline Interferometry): synchronisation of radiotelescopes to one reference clock using WR protocol

Deutsche Börse uses WR for time-stamping of transactions for stock market

Open Science and capacity building: CERN-UNESCO schools on digital libraries

- Aimed at providing skills for running digital library systems → improve access to information for African researchers, increase global visibility of African research
- Based on Zenodo-Invenio open source digital platform developed by CERN
- Held so far in Rwanda, Morocco, Senegal, Ghana and Kenya

5th school: Oct 2018, University of Nairobi, Kenya: attended by librarians from Kenya, Cameroon, Somalia, Tanzania, Uganda, Zambia and Zimbawe.

Thank you

Acknowledgments: Giovanni Anelli, Salvatore Mele, Tim Smith and many other CERN colleagues