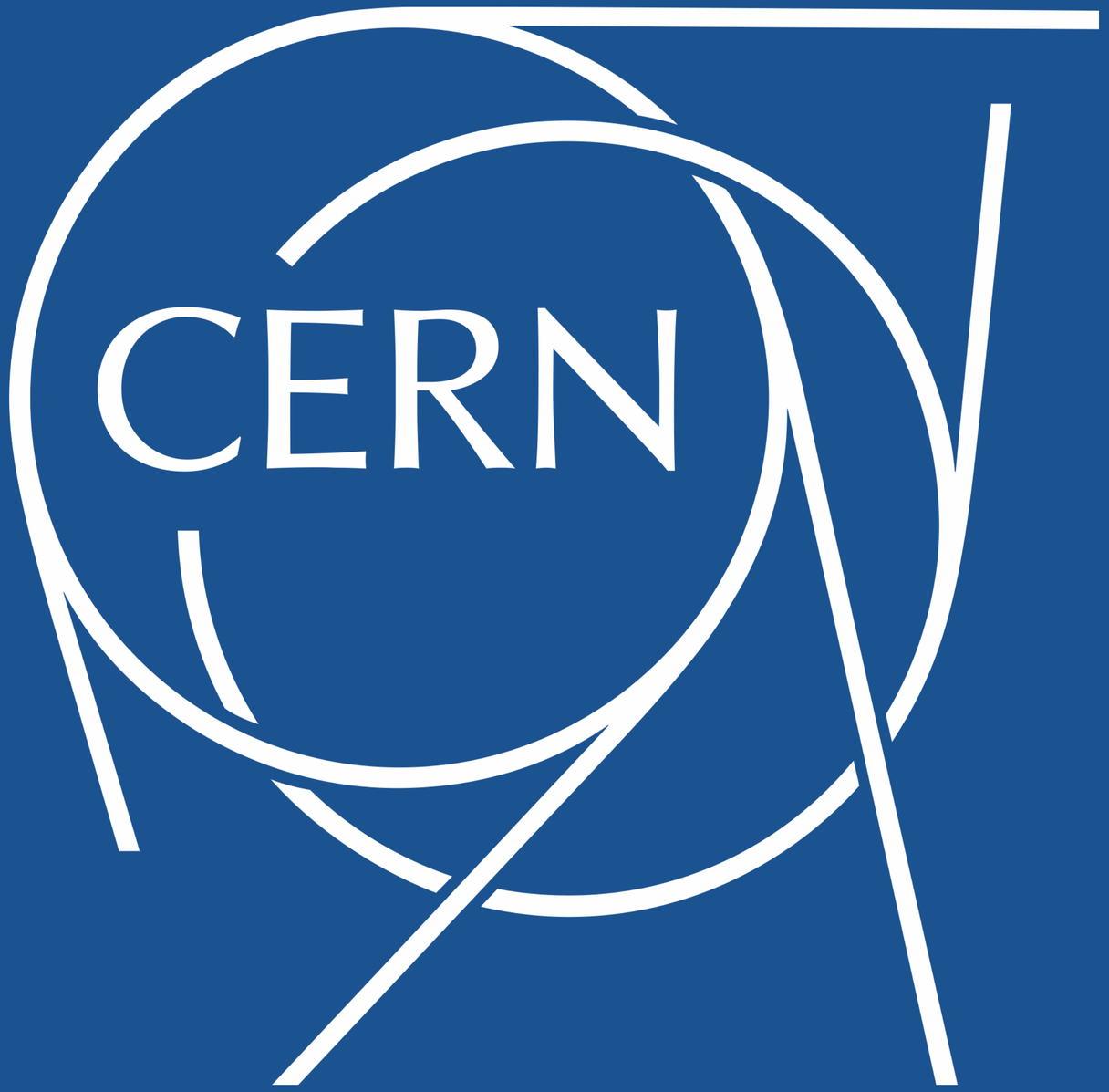

CERN

# CERN

## Past - Present - Future

Prof. Christoph Schäfer
CERN

# Contents

- CERN: What are we and what is our Mission?
- A brief History of CERN
- What is the future for CERN?

# The Mission of CERN

# Science is getting more and more global

## 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

# Science is getting more and more global

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

### 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

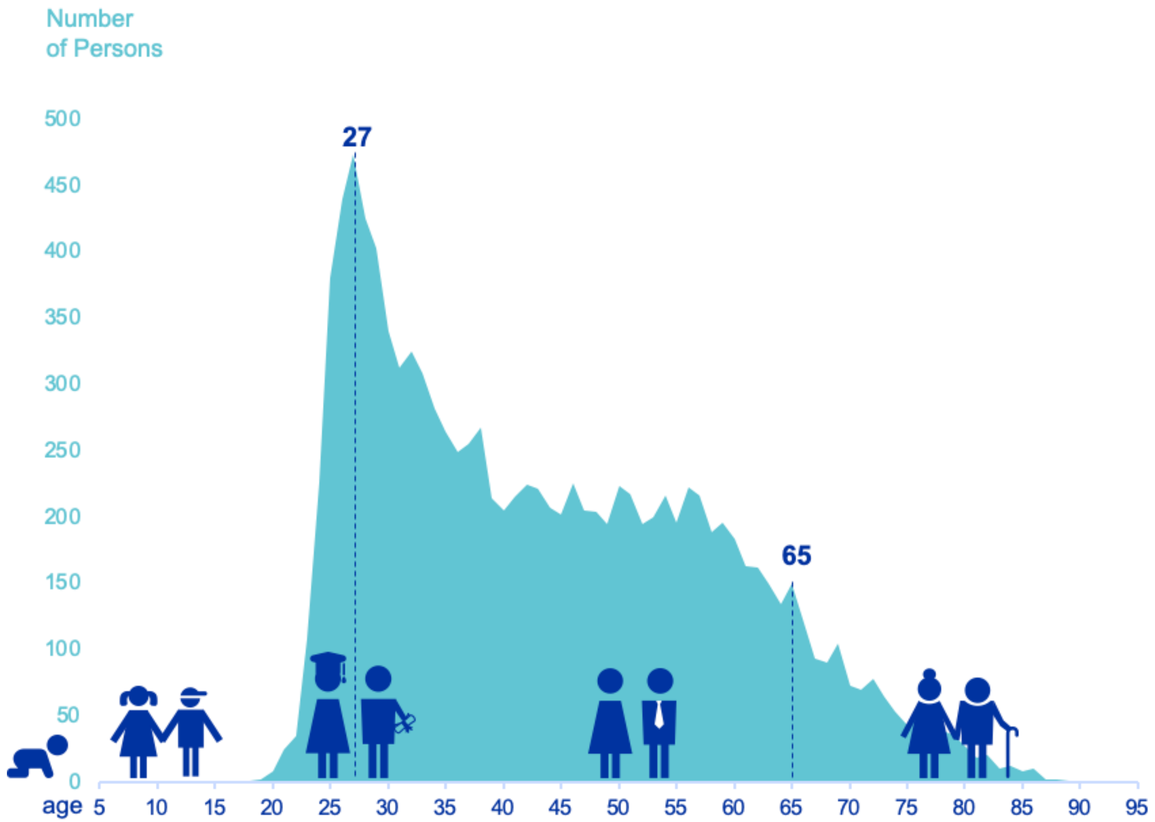
### Observers **2991**

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

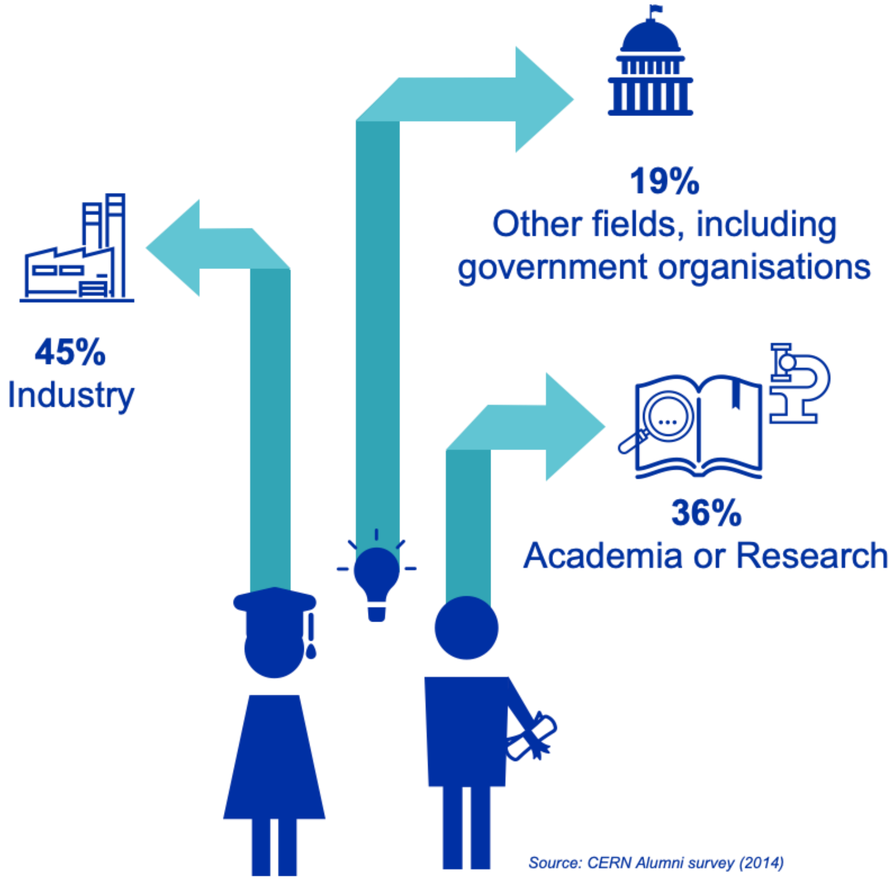
### Non-Member States and Territories **1271**

**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

# A world of career opportunities



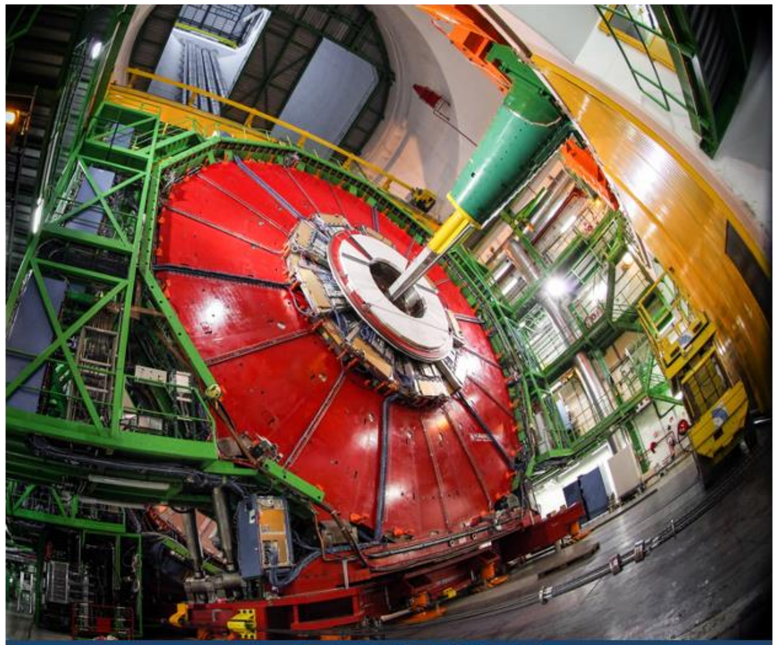

***Age Distribution of Scientists working at CERN***



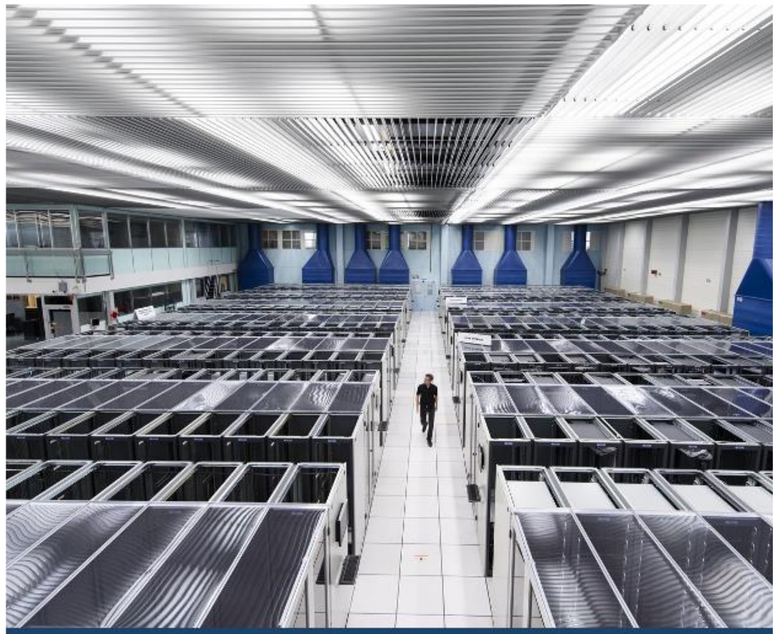

***PhD and Technical students leaving CERN***

# CERN: Our Core Competences

ACCELERATORS



DETECTORS



COMPUTING

# CERN Education & Outreach

300 Undergraduate students in Summer programmes
>3000 registered PhD students.

>1000 Fellows, Technical and Doctoral Students in research and applied physics, engineering and computing.

13 871 teachers since 1998 and 2000 participants in the webinar since 2020.

151 000 visitors on guided tours of CERN in 2019, from 95 countries.

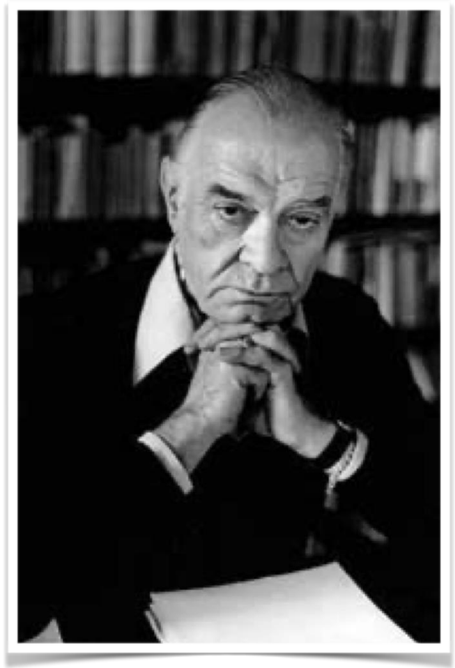
CERN engages with citizens across the globe:
on-site and travelling exhibitions in 15 countries, > 1 million visitors

Science Gateway will open in 2023, expanding CERN's outreach reach and impact, locally and globally.

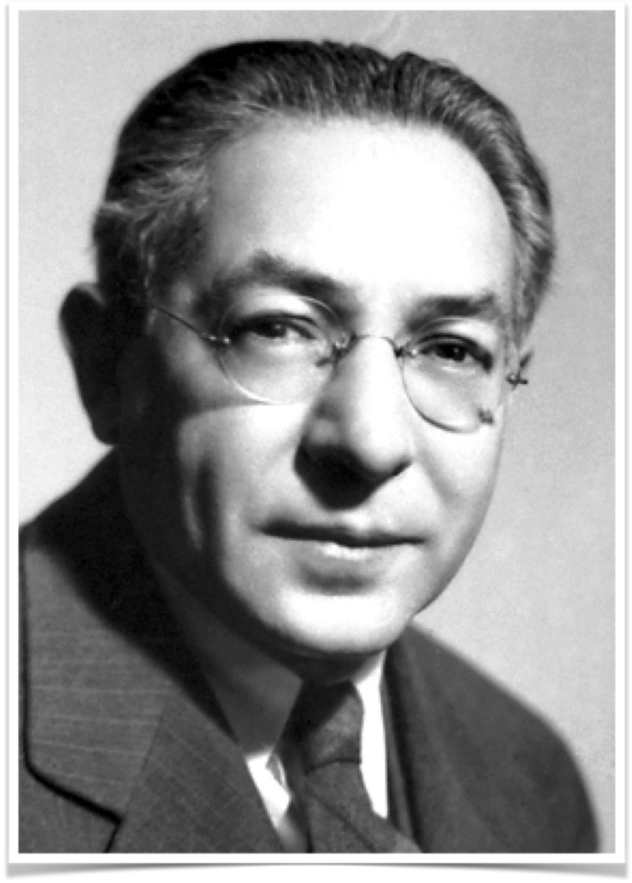
# A brief History of CERN

# 1949: The Origins of CERN

- European science was depleted after the war
- Nuclear scientists wanted to do something for peace
- Political and scientific consensus
- Denis de Rougemont and Louis de Broglie put forward a proposal at the European Cultural Conference in Lausanne in 1949



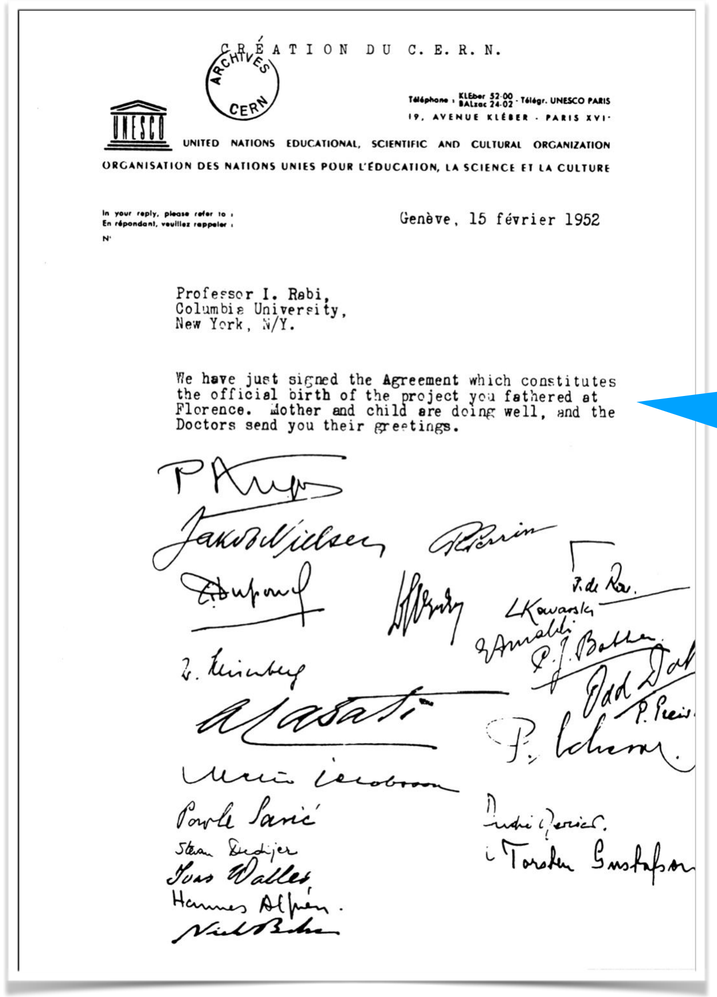
# 1950: UNESCO



At the UNESCO General Conference in Florence, American Noble laureate, Isidor Rabi tables a resolution authorising UNESCO to:

*“assist and encourage the formation of regional research laboratories in order to increase international scientific collaboration …”*

# 1951: UNESCO



CRÉATION DU C. E. R. N.

ARCHIVES CERN

UNESCO

Téléphone : KLÉber 52-00 - Télégr. UNESCO PARIS
BALzac 24-02
19, AVENUE KLÉBER - PARIS XVI[e]

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
ORGANISATION DES NATIONS UNIES POUR L'ÉDUCATION, LA SCIENCE ET LA CULTURE

In your reply, please refer to :
En répondant, veuillez rappeler :
N°

Genève, 15 février 1952

Professor I. Rabi,
Columbia University,
New York, N/Y.

We have just signed the Agreement which constitutes the official birth of the project you fathered at Florence. Mother and child are doing well, and the Doctors send you their greetings.

At a me… …ember 195… …he la… …the estab… …the acronym …

**We have just signed the Agreement which constitutes the official birth of the project you fathered at Florence. Mother and child are doing well, and the Doctors send you their greetings**

# 1952: The choice of Geneva

**Sur le terrain du futur institut nucléaire**

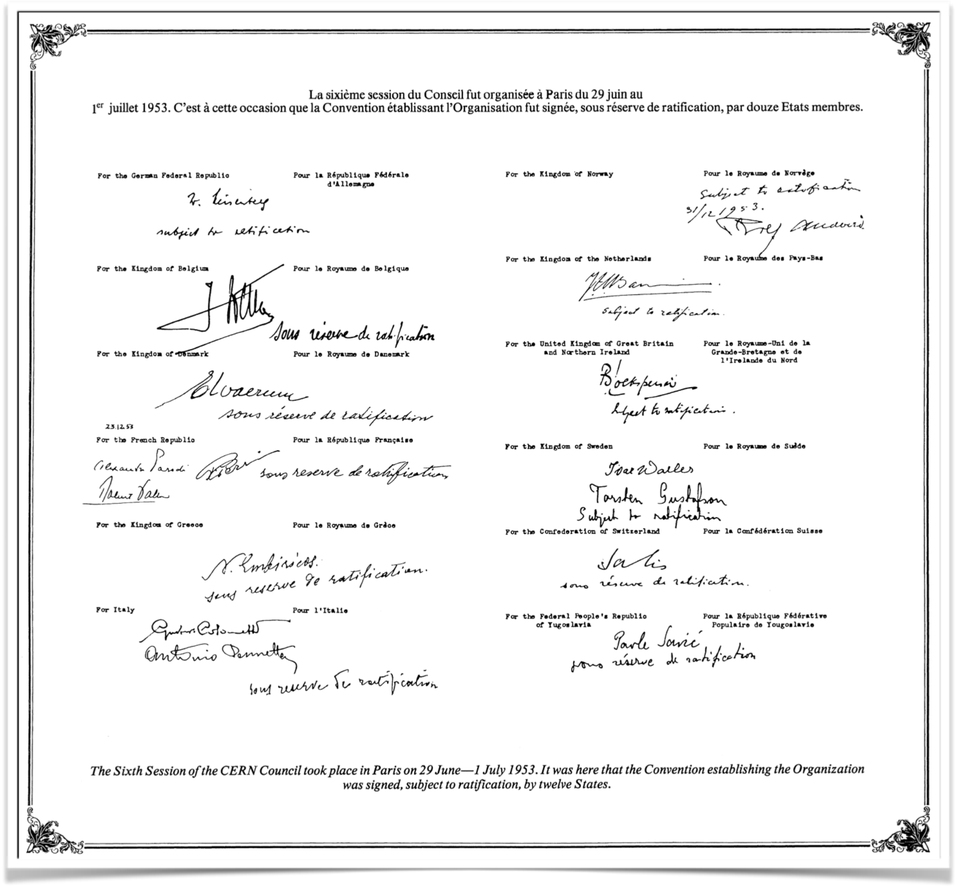
Sous la conduite de M. A. Picot, les membres du Conseil européen pour la recherche nucléaire se sont rendus hier à Meyrin pour reconnaître le terrain où s'élèvera le Centre nucléaire (voir en Dernière heure)

(Photo Freddy Bertrand, Genève)

*La Suisse* du 30 octobre 1953

At the provisional Council's third session in October 1952, Geneva was chosen as the site of the future Laboratory. This choice was finally ratified in a referendum organized by the Canton of Geneva in June 1953.

# 1954: The Organization is Born



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.

For the German Federal Republic — Pour la République Fédérale d'Allemagne
subject to ratification

For the Kingdom of Belgium — Pour le Royaume de Belgique
sous réserve de ratification

For the Kingdom of Denmark — Pour le Royaume de Danemark
sous réserve de ratification
23.12.53

For the French Republic — Pour la République Française
sous reserve de ratification

For the Kingdom of Greece — Pour le Royaume de Grèce
sous reserve de ratification.

For Italy — Pour l'Italie
sous reserve de ratification

For the Kingdom of Norway — Pour le Royaume de Norvège
Subject to ratification
31/12 1953.
Accepted

For the Kingdom of the Netherlands — Pour le Royaume des Pays-Bas
subject to ratification.

For the United Kingdom of Great Britain and Northern Ireland — Pour le Royaume-Uni de la Grande-Bretagne et de l'Irelande du Nord
Subject to ratification.

For the Kingdom of Sweden — Pour le Royaume de Suède
Subject to ratification

For the Confederation of Switzerland — Pour la Confédération Suisse
sous réserve de ratification.

For the Federal People's Republic of Yugoslavia — Pour la République Fédérative Populaire de Yougoslavie
sous réserve de ratification

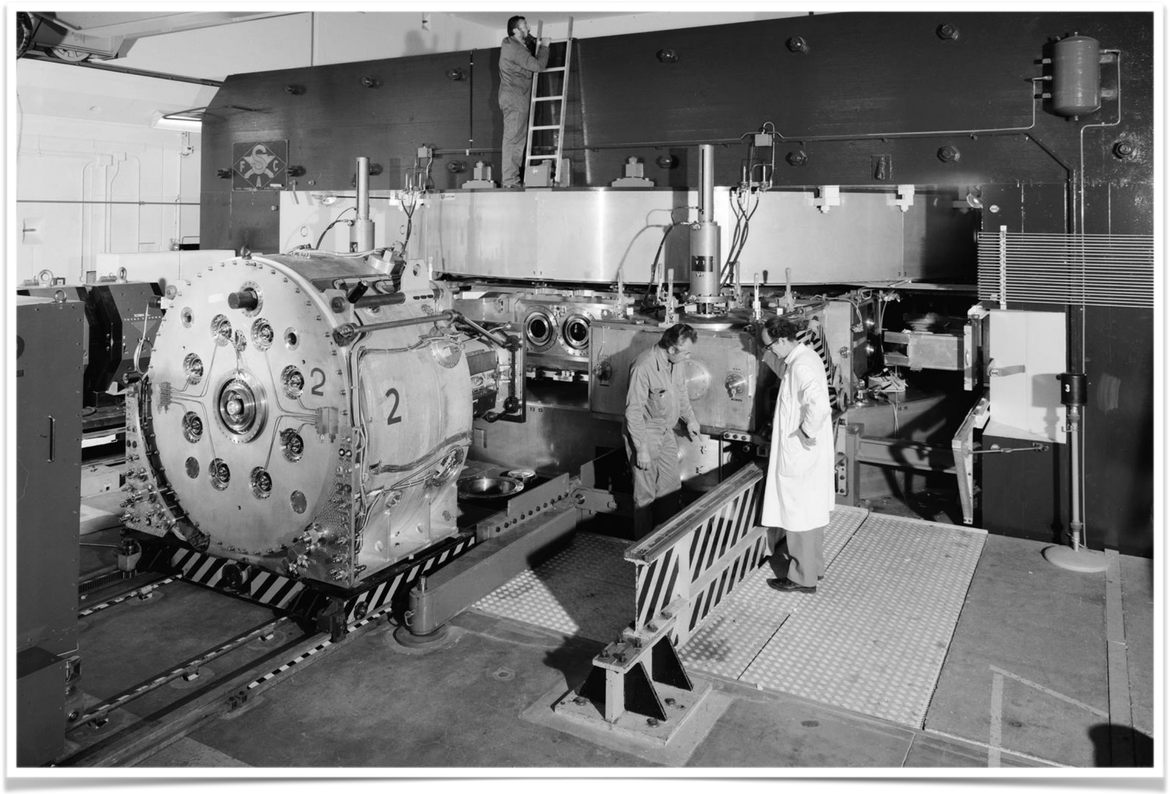
*The Sixth Session of the CERN Council took place in Paris on 29 June—1 July 1953. It was here that the Convention establishing the Organization was signed, subject to ratification, by twelve States.*

The CERN Convention, established in July 1953, was ratified by the 12 founding Member States: Belgium, Denmark, France, the Federal Republic of Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the UK, and Yugoslavia. On 29 September 1954, the European Organization for Nuclear Research officially came into existence.

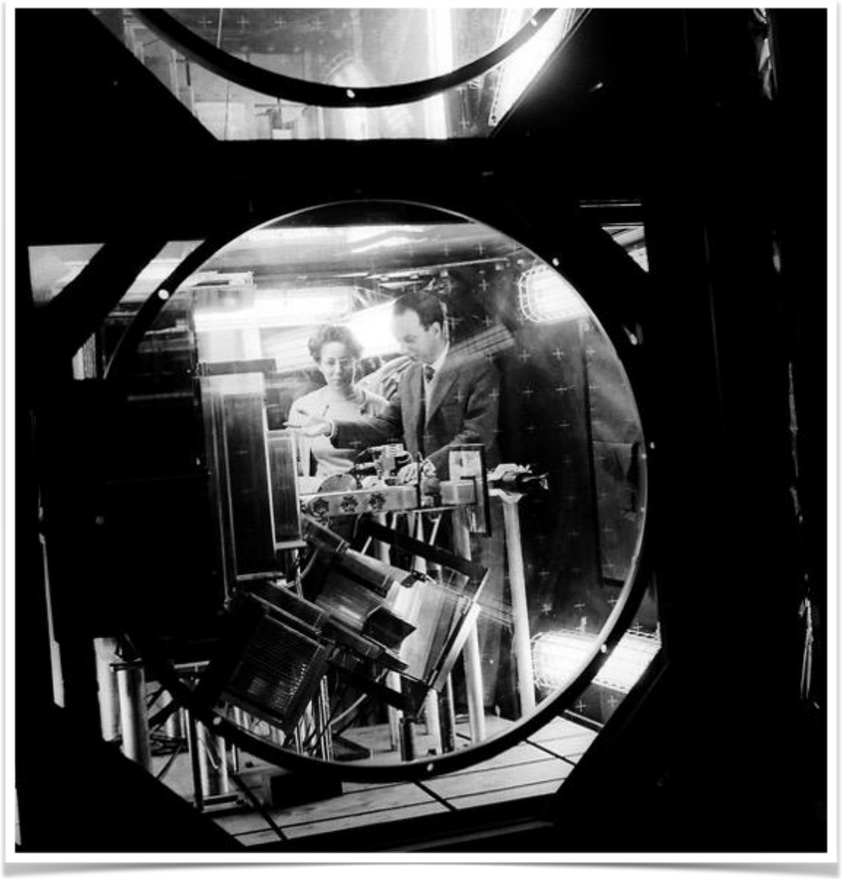
CERN was dissolved but the acronym remains.

# 1957: CERN's first accelerator: The Synchrocyclotron


Transport of the coil



# 1958: CERN’s first experiment



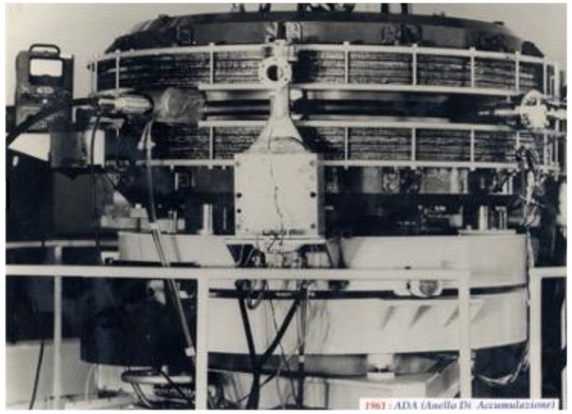
**July 1958:**
**Evidence that one pion in ten thousdands decayed into an electron and a neutrino as predicted by the weak interaction.**
**The first of CERN’s great discoveries.**

# 1959: CERN's first big machine

Start up of the CERN Proton Synchrotron, assisted by Hildred Blewett from Brookhaven….

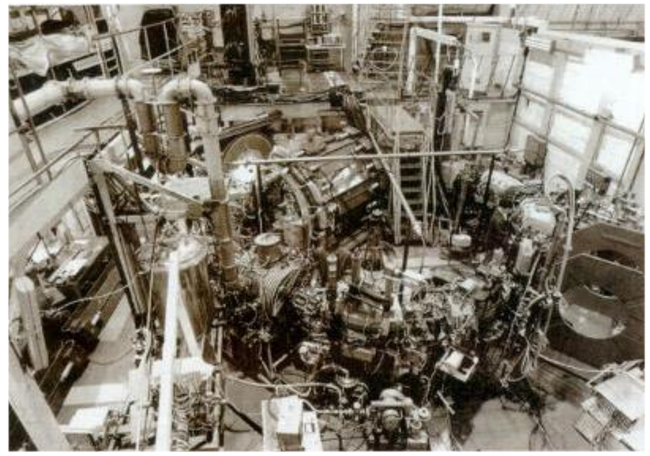
… who shared the technique of strong focusing, invented at Brookhaven, with her European colleagues.

The late 1950s saw the healthy competitive collaboration between the US and Europe that continues to this day…




1961: ADA at Frascati…

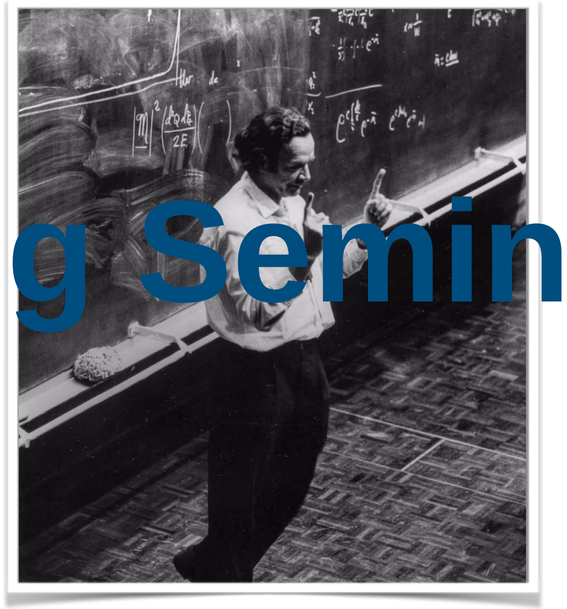
… and VEPP-1 at Novosibirsk



# 1960s: Advances in theory

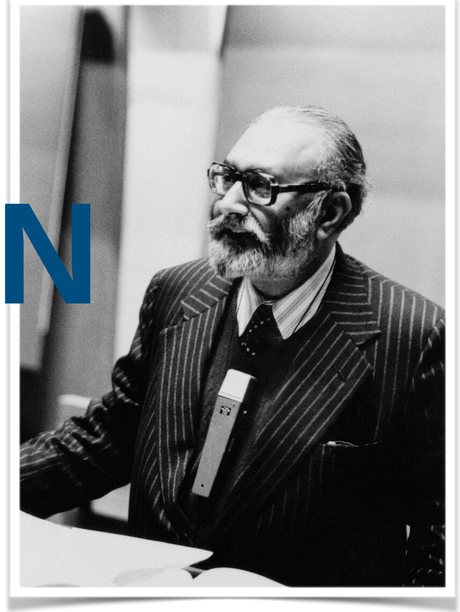
## Giving Seminars at CERN

Sheldon Lee Glashow

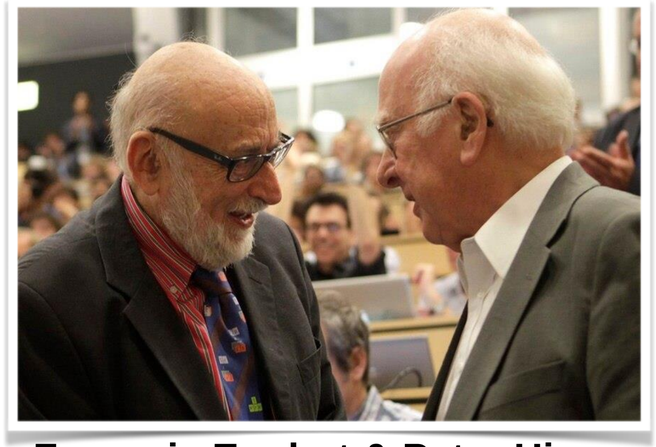


Richard Feynman

Murray Gell-Mann



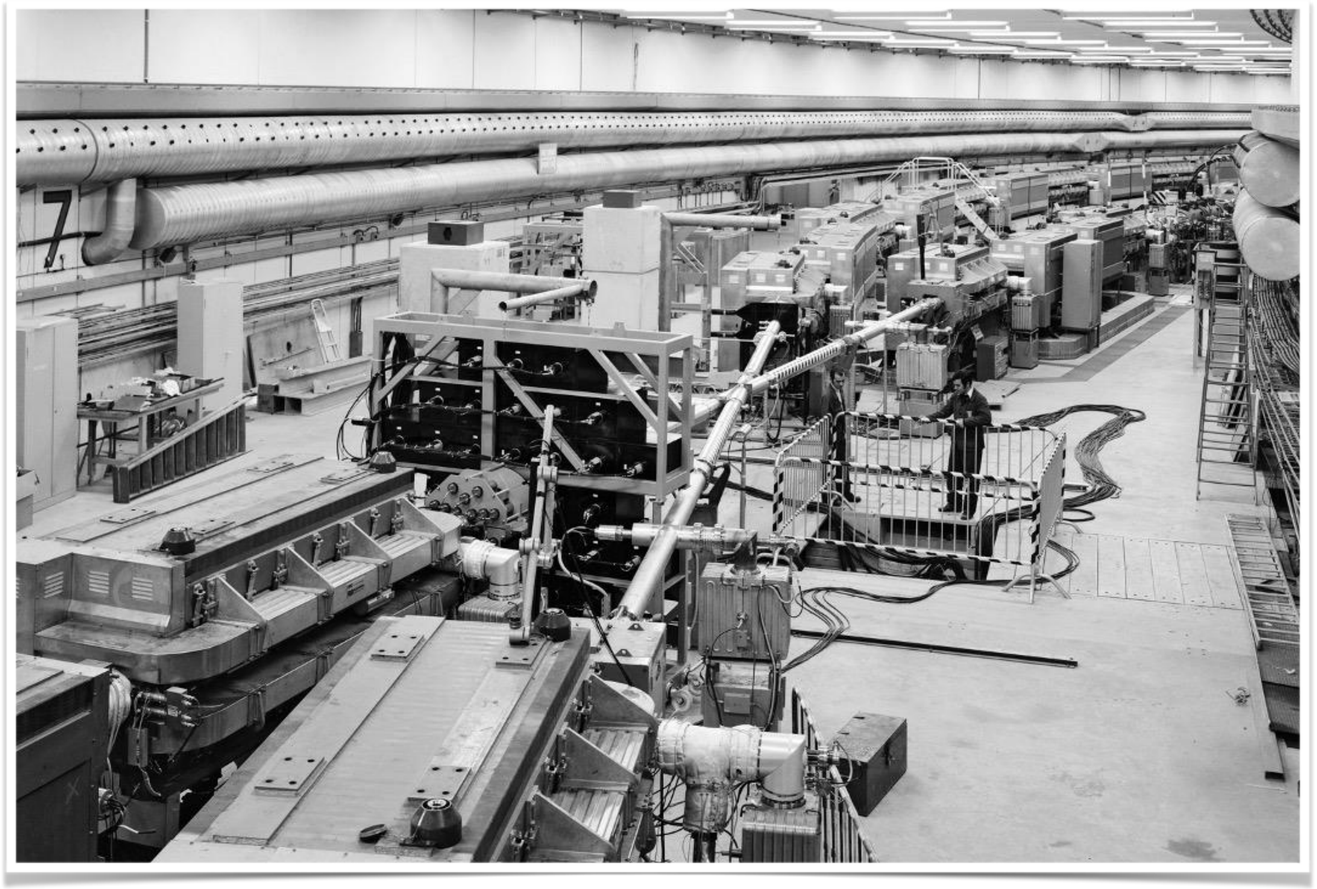
Abdus Salam



Francois Englert & Peter Higgs

Steven Weinberg

# 1965: Approval of the ISR: The world's first hadron collider



# 1967: Looking to the East…

In 1967, CERN signed an agreement with the USSR that led to exchanges of personnel and equipment between CERN and Serpukhov.

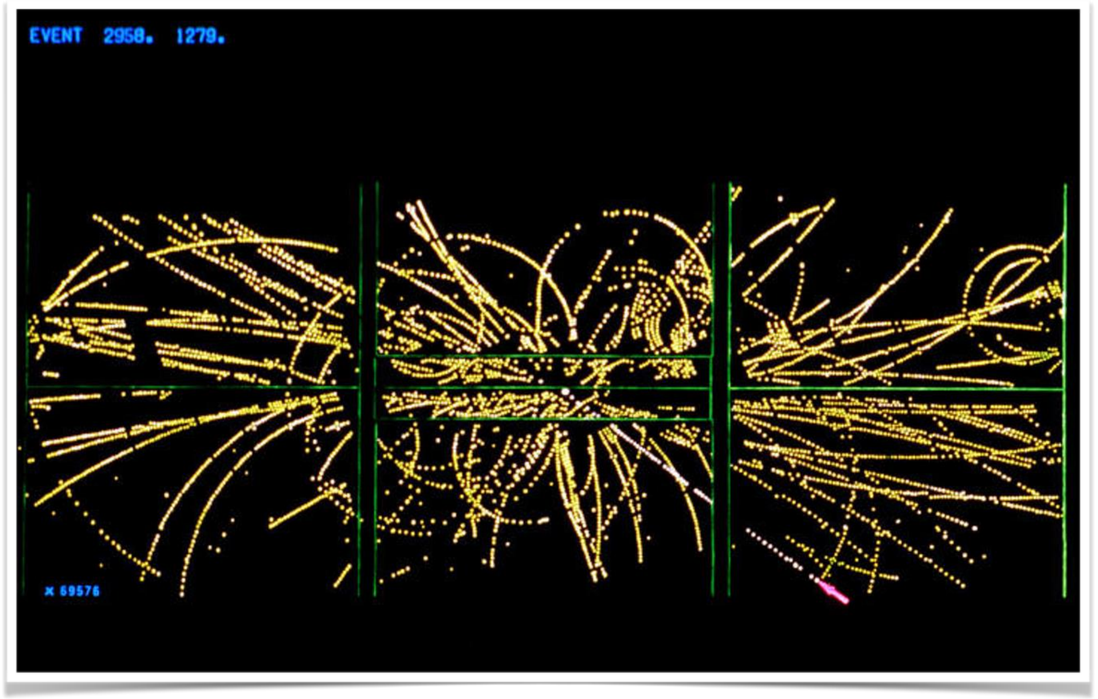
**This Antonov 22 transporter caused quite a stir when it arrived at Geneva airport in 1970.**
**A top-secret military aircraft, its first mission beyond the Soviet Union was to collect a state-of-the-art experiment from CERN and take it to Russia where it was to be installed at the worlds' highest energy particle accelerator at the time in Serpukhov.**

Earlier in the decade, CERN had been the scene of the first scientific contacts between East and West Germany following the erection of the Berlin wall..

# 1967: The arrival of a new friendly rival: Fermilab

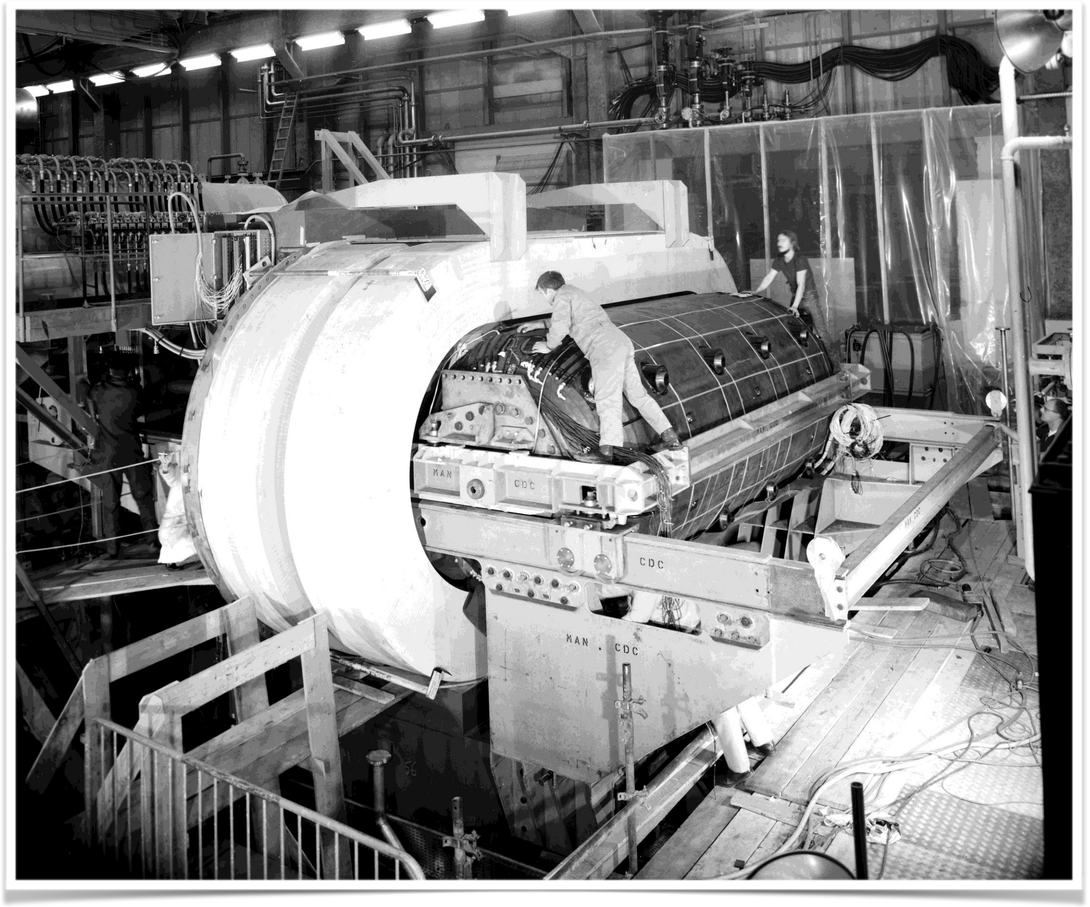
# 1968: Multi-wire proportional chamber: Revolutionising the way particle physics is done

**Before: Scanning of images by hand**

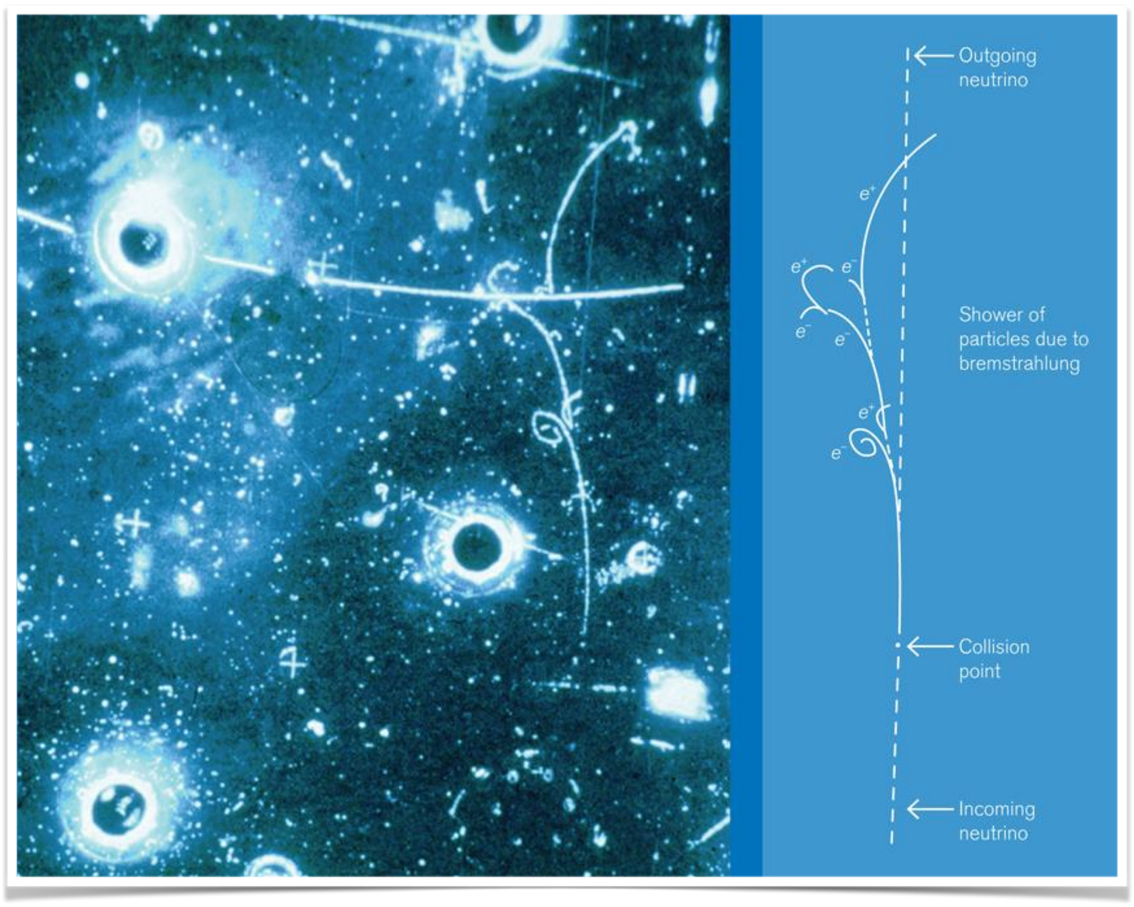



**Now: automatic digital images**

# 1973: Discovery of Neutral currents




Gargamelle Bubble Chamber




Discovery of weak neutral current

# 1976: The SPS begins operation

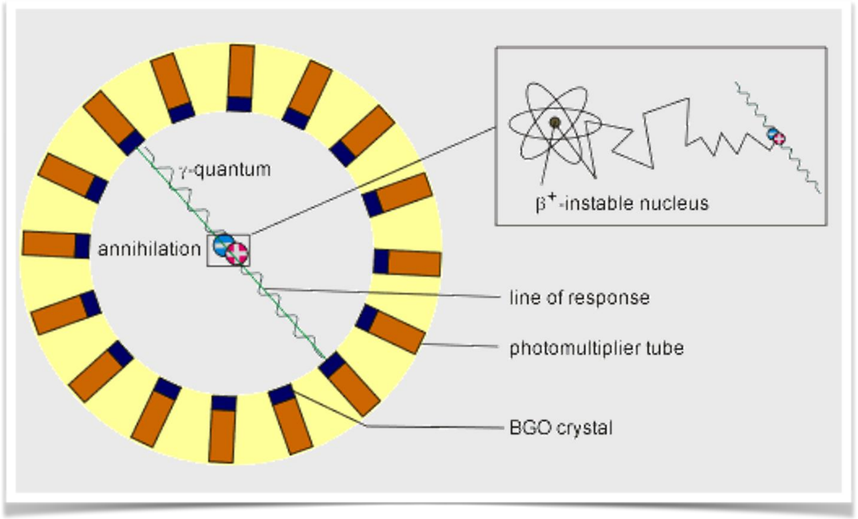
The PS becomes super:

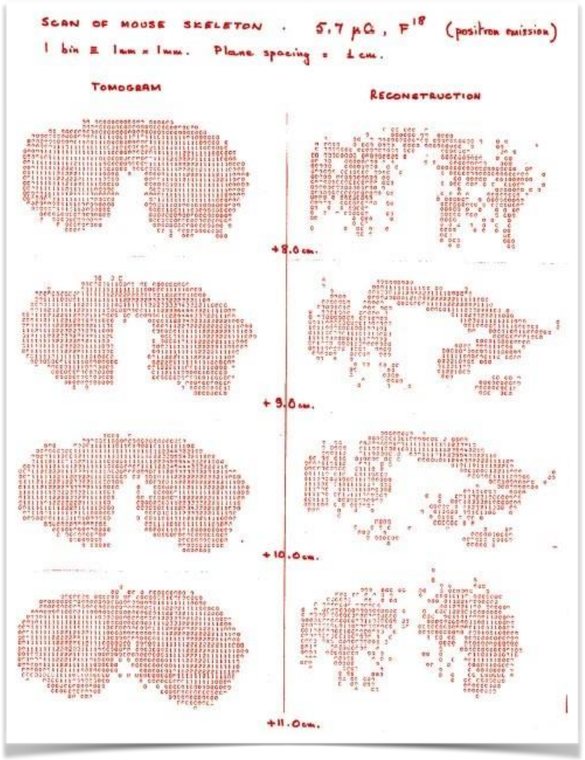
CERN needed to extent its premisses into France

# 1977: CERN built a detector for a hospital

**PET: Positron Emission Tomography**

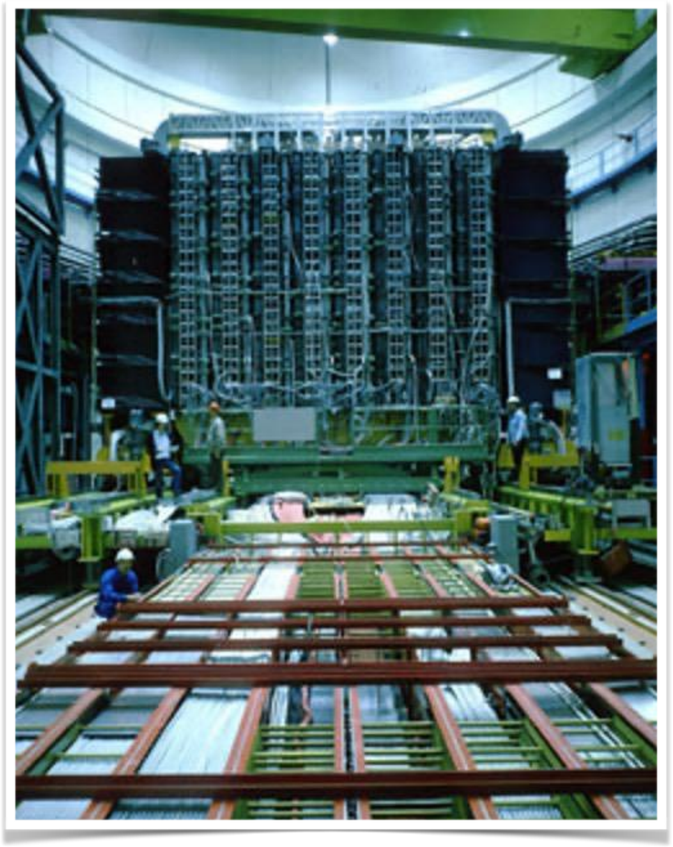
**Detection of two photons**
**created during matter-antimatter annihilation**
**in the human body**




**First PET image at CERN**

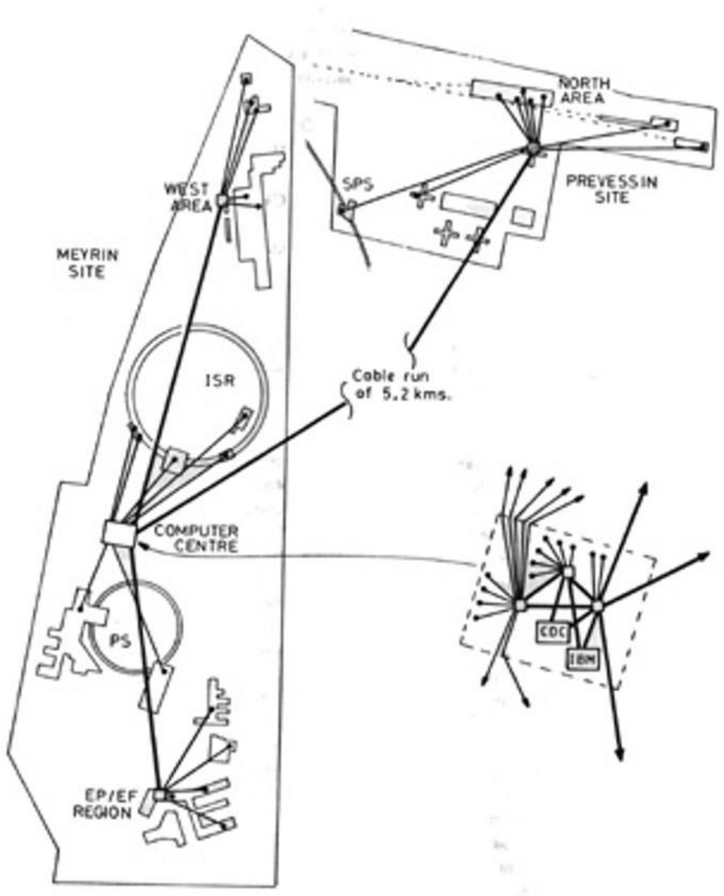
# 1983: CERN’s first golden age



**UA1 detector**

- The SPS working as a collider discovers the W and Z particles, mediators of the weak interaction.
- This experimental confirmation of the electroweak theory leads to the award of the Nobel prize the following year…
- … and continues CERN’s tradition of electroweak science.

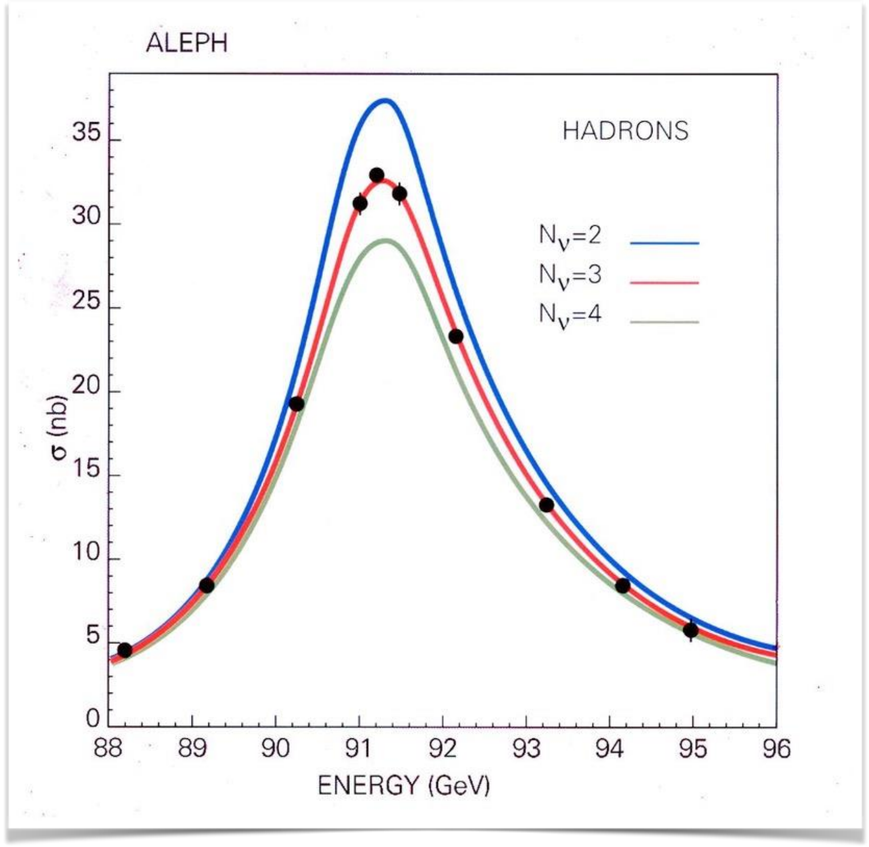
# 1987: CERNET gives way to INTERNET




**CERN Computer Centre**

# 1989: LEP and SLC
# Circle or linear

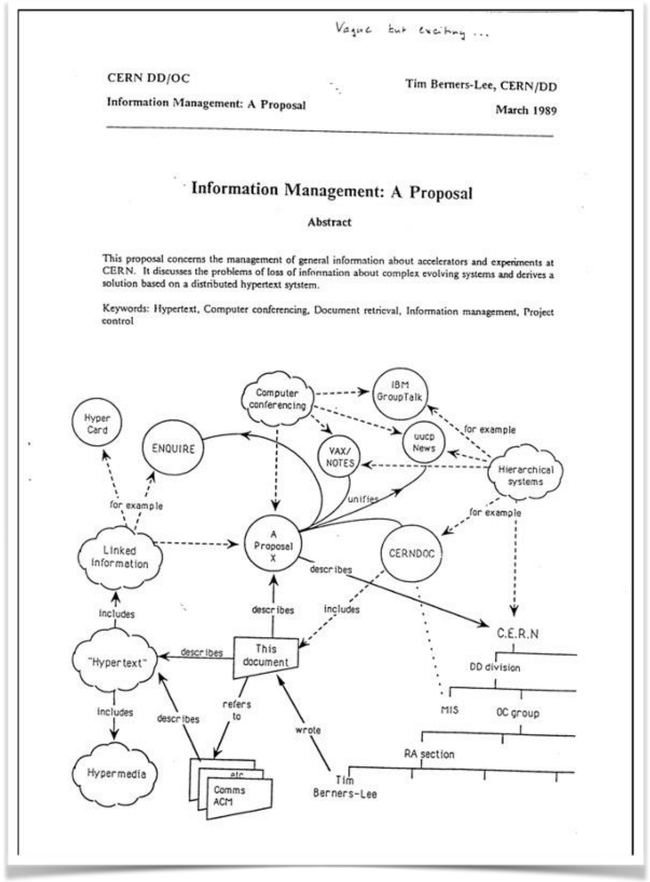

# 1989: LEP and SLC
# The W and Z factories




**Unprecedented precision measurement**

**The Z line shape, error bars hardy visible!**

# 1989: The WWW



Vague but exciting ...

CERN DD/OC

Tim Berners-Lee, CERN/DD

Information Management: A Proposal

March 1989

## Information Management: A Proposal

**Abstract**

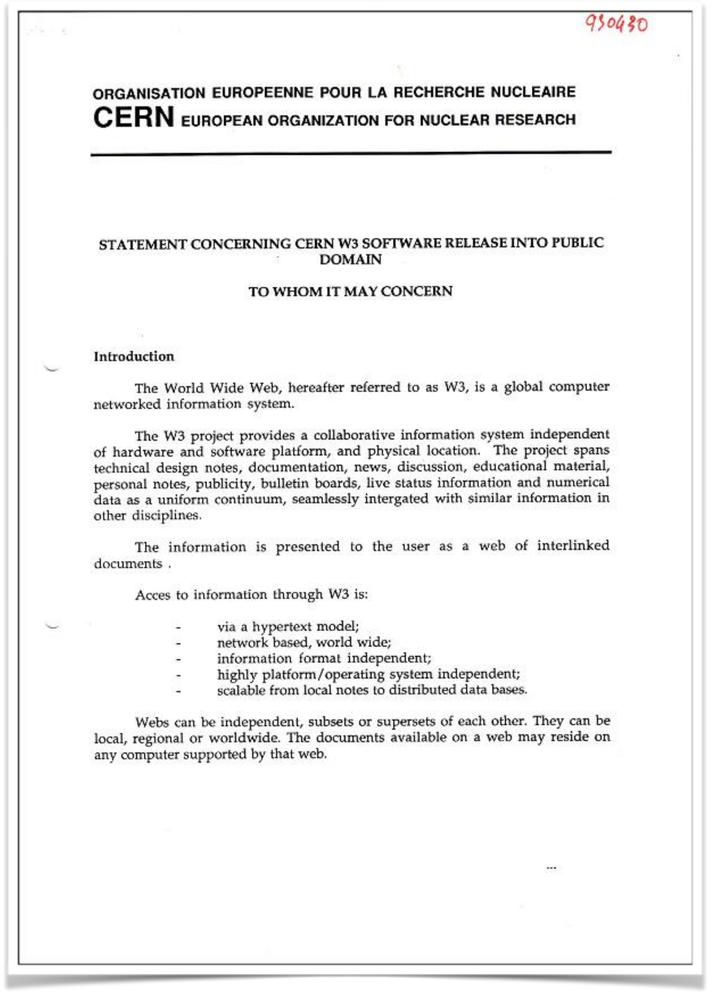
This proposal concerns the management of general information about accelerators and experiments at CERN. It discusses the problems of loss of information about complex evolving systems and derives a solution based on a distributed hypertext sytstem.

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



**Tim Berners Lee in front of his original NEXT computer**

# The most valuable document ever?



930430

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
**CERN** EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

STATEMENT CONCERNING CERN W3 SOFTWARE RELEASE INTO PUBLIC DOMAIN

TO WHOM IT MAY CONCERN

**Introduction**

The World Wide Web, hereafter referred to as W3, is a global computer networked information system.

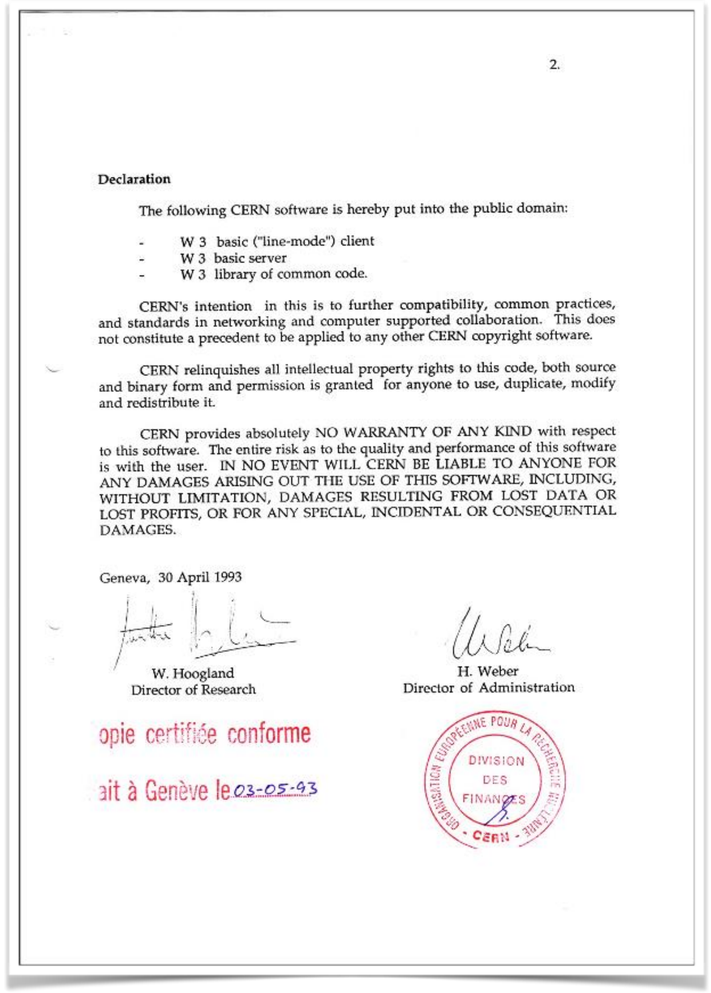
The W3 project provides a collaborative information system independent of hardware and software platform, and physical location. The project spans technical design notes, documentation, news, discussion, educational material, personal notes, publicity, bulletin boards, live status information and numerical data as a uniform continuum, seamlessly intergated with similar information in other disciplines.

The information is presented to the user as a web of interlinked documents .

Acces to information through W3 is:

- via a hypertext model;
- network based, world wide;
- information format independent;
- highly platform/operating system independent;
- scalable from local notes to distributed data bases.

Webs can be independent, subsets or supersets of each other. They can be local, regional or worldwide. The documents available on a web may reside on any computer supported by that web.



2.

**Declaration**

The following CERN software is hereby put into the public domain:

- W 3 basic ("line-mode") client
- W 3 basic server
- W 3 library of common code.

CERN's intention in this is to further compatibility, common practices, and standards in networking and computer supported collaboration. This does not constitute a precedent to be applied to any other CERN copyright software.

CERN relinquishes all intellectual property rights to this code, both source and binary form and permission is granted for anyone to use, duplicate, modify and redistribute it.

CERN provides absolutely NO WARRANTY OF ANY KIND with respect to this software. The entire risk as to the quality and performance of this software is with the user. IN NO EVENT WILL CERN BE LIABLE TO ANYONE FOR ANY DAMAGES ARISING OUT THE USE OF THIS SOFTWARE, INCLUDING, WITHOUT LIMITATION, DAMAGES RESULTING FROM LOST DATA OR LOST PROFITS, OR FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES.

Geneva, 30 April 1993

W. Hoogland
Director of Research

H. Weber
Director of Administration

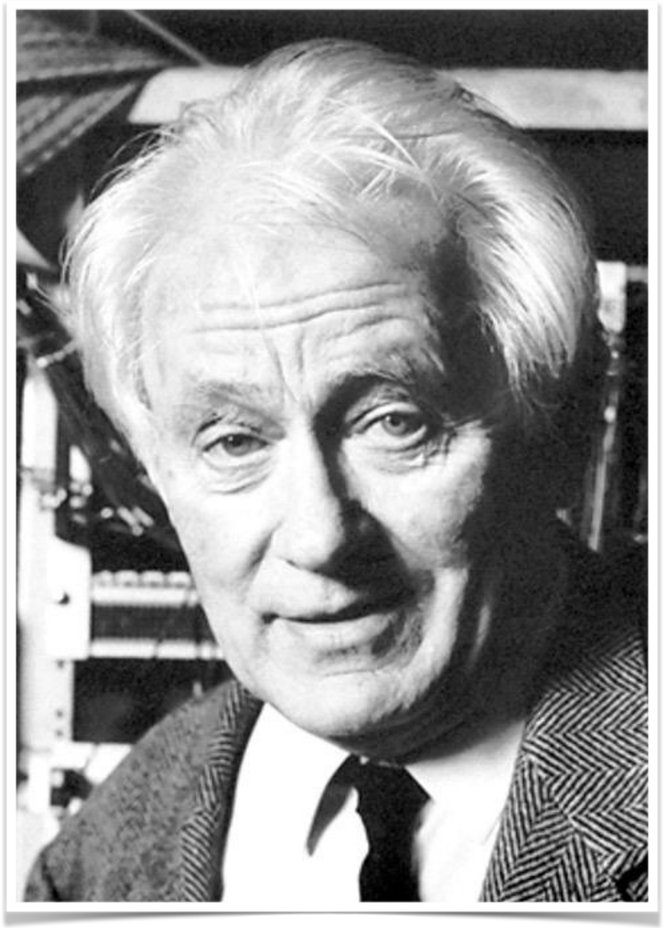
opie certifiée conforme

ait à Genève le 03-05-93

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
DIVISION DES FINANCES
CERN

**Release of the WWW into public domaine**

# 1992: George Charpak wins the Nobel Price



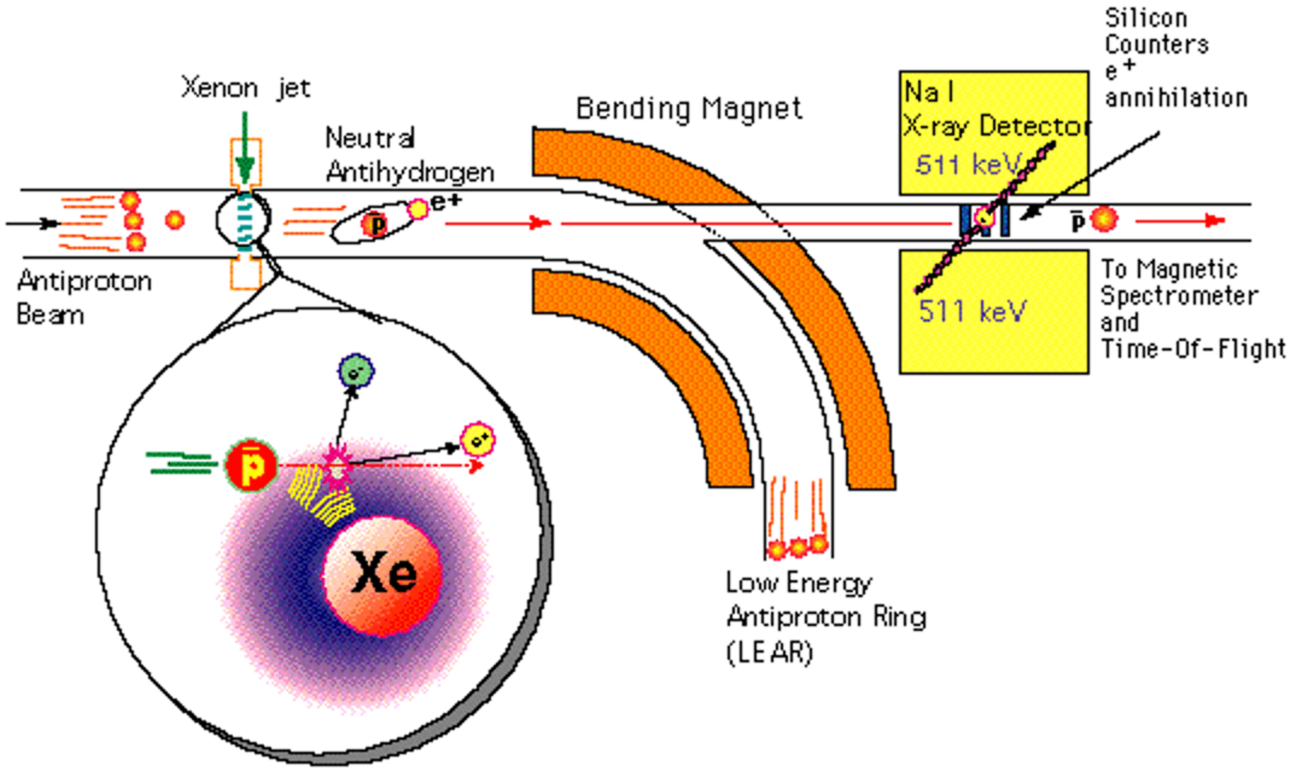
**For the construction of the**
**Multi Wire Proportional Chamber**

# 1993: A tiny preference for matter

- CERN experiment NA31 publishes the first indication at the particle level that nature has a preference for matter over antimatter… accompanied by Fermilab experiment E731.
- This result was refined in 2001 by NA48 at CERN and KTeV at Fermilab.

# 1995: First observation of Antihydrogen

**LEAR: Low Energy Antiproton Ring**



# 1995: A discovery at FERMILAB
# The top quark

**FERMILAB**
A Department of Energy National Laboratory

**NEWS RELEASE**

**News Release - March 2, 1995**

**NEWS MEDIA CONTACTS:**
Judy Jackson, 708/840-4112 (Fermilab)
Gary Pitchford, 708/252-2013 (Department of Energy)
Jeff Sherwood, 202/586-5806 (Department of Energy)

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E-Mail TOPQUARK@FNAL.GOV

**PHYSICISTS DISCOVER TOP QUARK**

Batavia, IL--Physicists at the Department of Energy's Fermi National Accelerator Laboratory today (March 2) announced the discovery of the subatomic particle called the top quark, the last undiscovered quark of the six predicted by current scientific theory. Scientists worldwide had sought the top quark since the discovery of the bottom quark at Fermilab in 1977. The discovery provides strong support for the quark theory of the structure of matter.

Two research papers, submitted on Friday, February 24, to Physical Review Letters by the CDF and DZero experiment collaborations respectively, describe the observation of top quarks produced in high-energy collisions between protons and antiprotons, their antimatter counterparts. The two experiments operate simultaneously using particle beams from Fermilab's Tevatron, world's highest energy particle accelerator. The collaborations, each with about 450 members, presented their results at seminars held at Fermilab on March 2.

"Last April, CDF announced the first direct experimental evidence for the top quark," said William Carithers, Jr., cospokesman, with Giorgio Bellettini, for the CDF experiment, "but at that time we stopped short of claiming a discovery. Now, the analysis of about three times as much data confirms our previous evidence and establishes the discovery of the top quark."

The DZero collaboration has discovered the top quark in an independent investigation. "The DZero observation of the top quark depends primarily on the number of events we have seen, but also on their characteristics," said Paul Grannis, who serves, with Hugh Montgomery, as DZero cospokesman. "Last year, we just did not have enough events to make a statement about the top quark's existence, but now, with a larger data sample, the signal is clear."

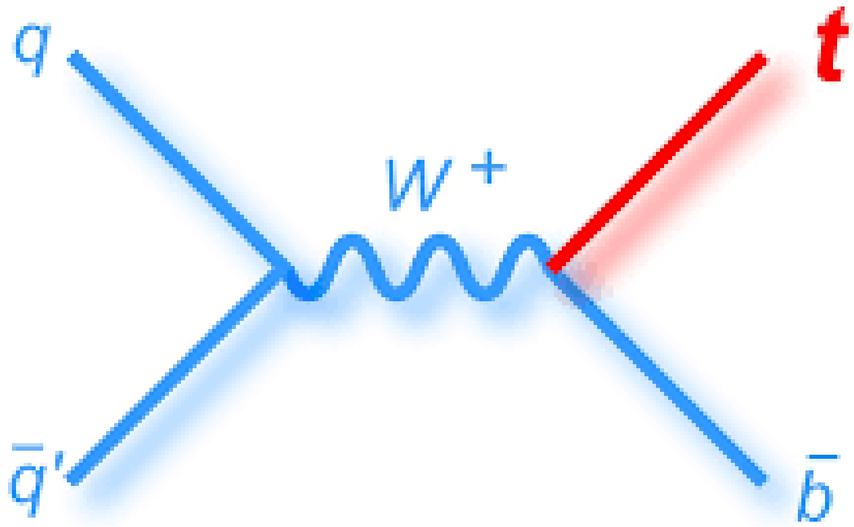
Physicists identify top quarks by the characteristic electronic signals they produce. However, other phenomena can sometimes mimic top quark signals. To claim a discovery, experimenters must observe enough top quark events to rule out any other source of the signals.

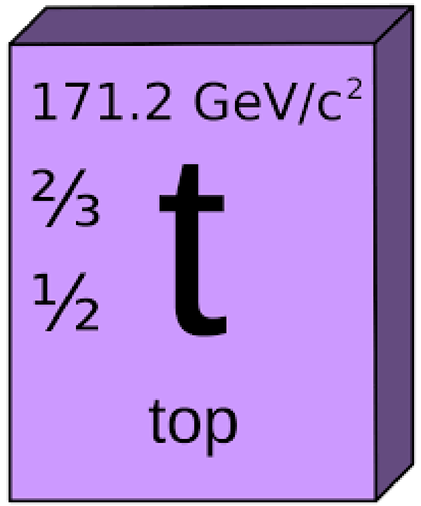
"This discovery serves as a powerful validation of federal support for science," said Secretary of Energy Hazel R. O'Leary. "Using one of the world's most powerful research tools, scientists at Fermilab have made yet another major contribution to human understanding of the fundamentals of the universe."

The Department of Energy, the primary steward of U.S. high-energy physics, provided the majority of funding for the research. The Italian Institute for Nuclear Physics and the Japanese Ministry of Education, Science and Culture made major contributions to CDF. Support for DZero came from Russia, France, India, and Brazil. The National Science Foundation contributed to both collaborations. Collaborators include scientists from Brazil, Canada, Colombia, France, India, Italy, Japan, Korea, Mexico, Poland, Russia, Taiwan, and the U.S.

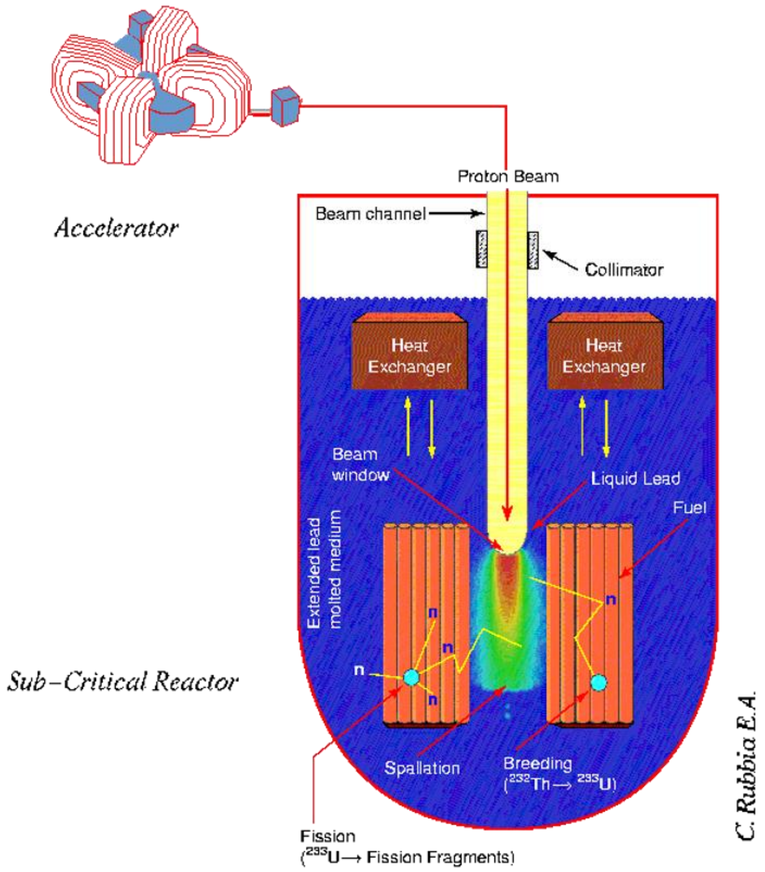
"The discovery of the top quark is a great achievement for the collaborations," said Fermilab Director John Peoples, "and also for the men and women of Fermilab who imagined, then built, and now operate the Tevatron accelerator. We have much to learn about the top quark, and more of nature's best-kept secrets to explore. We look forward to beginning a new era of research with the Tevatron, making the best use of the world's highest-energy collider."

Fermilab, 30 miles west of Chicago, is a high-energy physics laboratory operated by Universities Research Association, Inc. under contract with the U.S. Department of Energy.



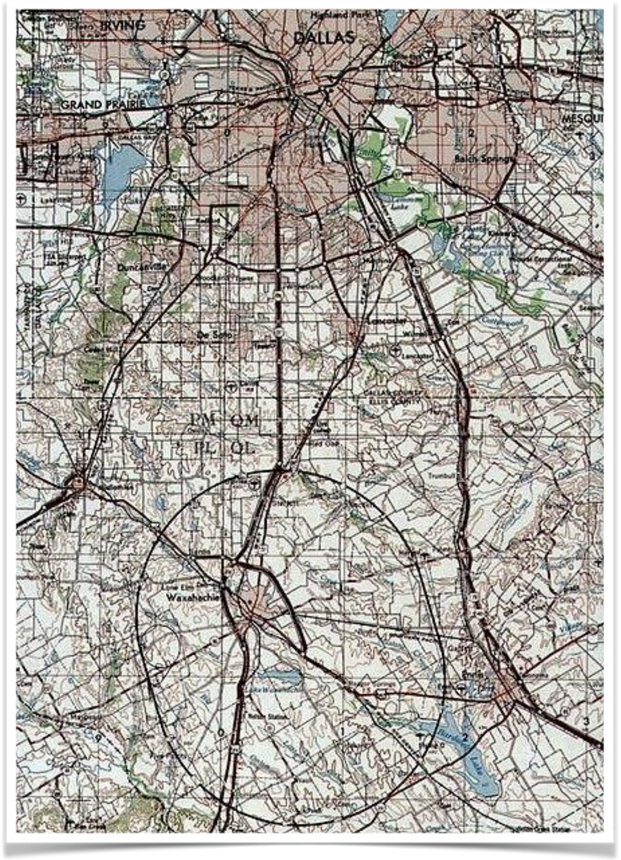



# 1997: Accelerator Driven Systems



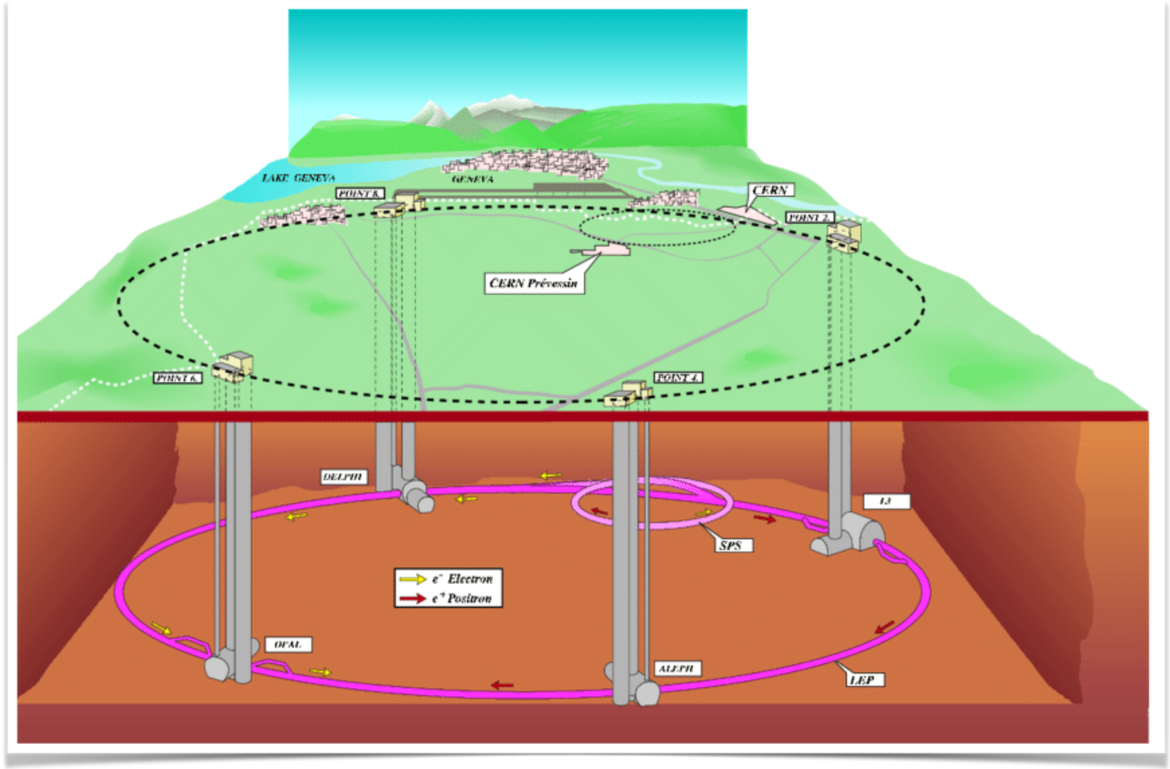

**“Energy Amplifier”**
**Proposal of Carlo Rubbia**

# 1993: US cancels the SSC project




**1994: CERN Council approves the LHC.. SSC was gone, but it shaped the LHC. CERN embraces US, Japan and others… LHC became a global project**

# 2000: The end of LEP




**2 November 2000: Steve Myers pulls the plug**

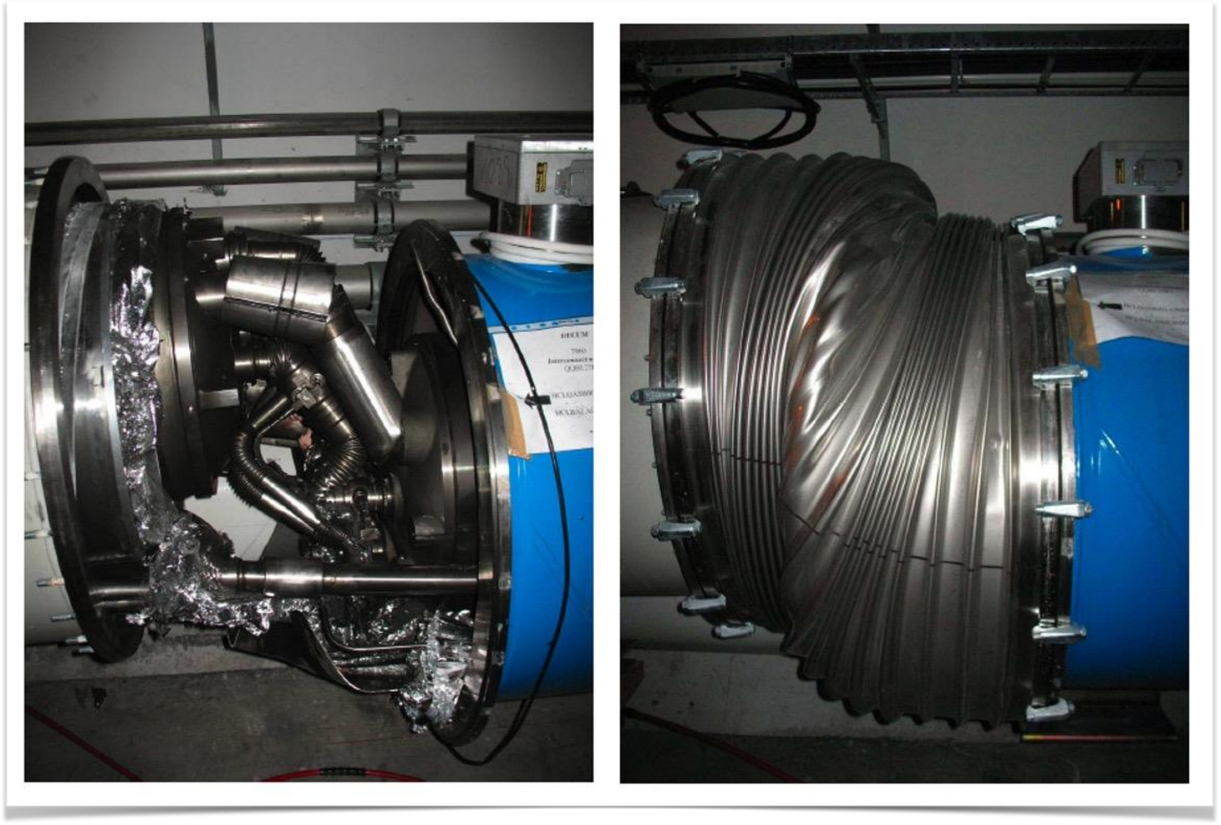
# 2003: Fear across the planet… are they going to end the world?

**Is the new LHC accelerator producing black holes?**

# 2008: LHC - First beam

**… and the world continues to exist!**

# 2008: LHC - Breakdown



**Only a few days later, the LHC broke down:**

**A helium release due to a electrical short showed the power of expanding gas**

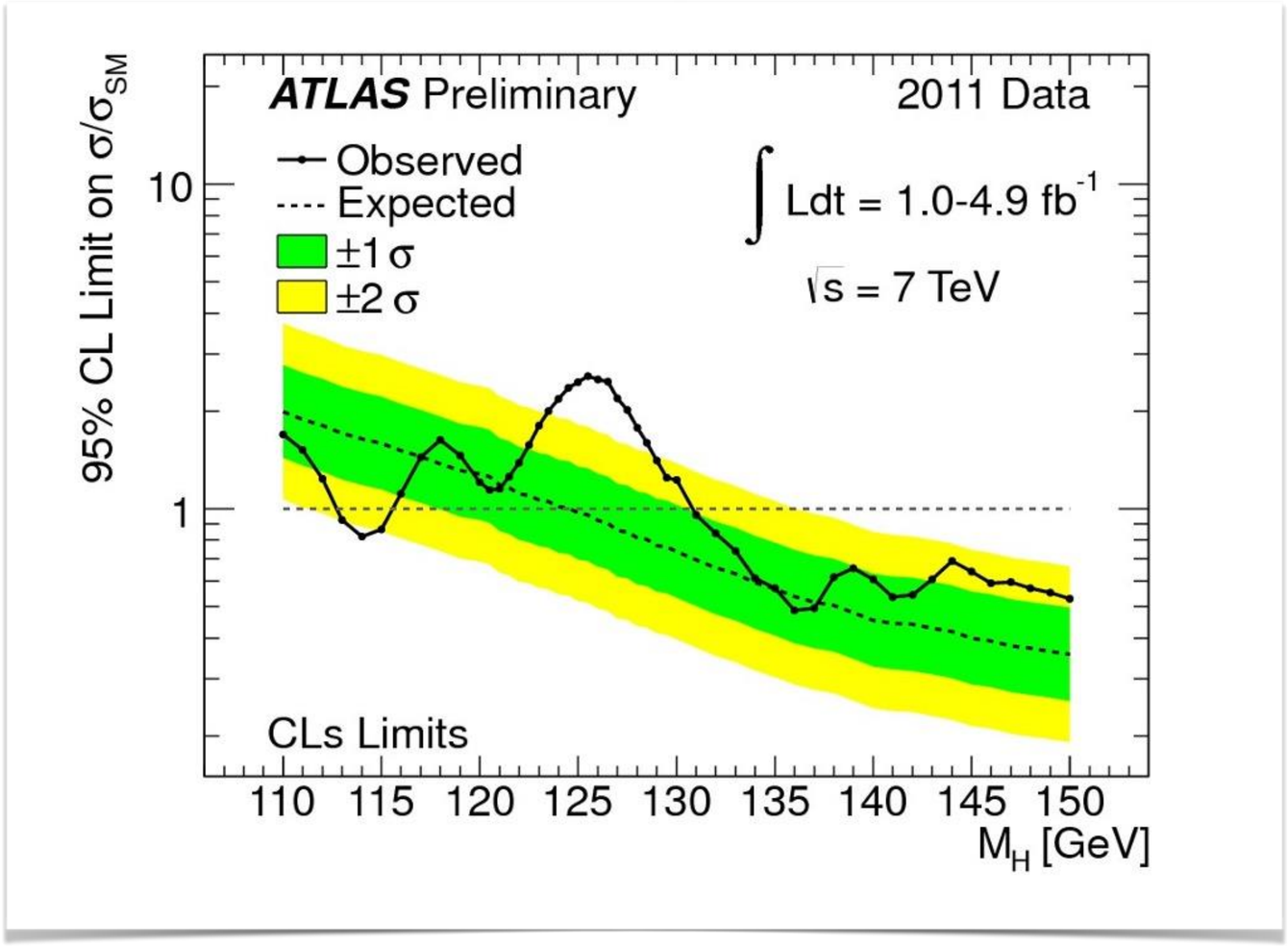
# 2010: The LHC overtakes the Tevatron
# High Energy running begins

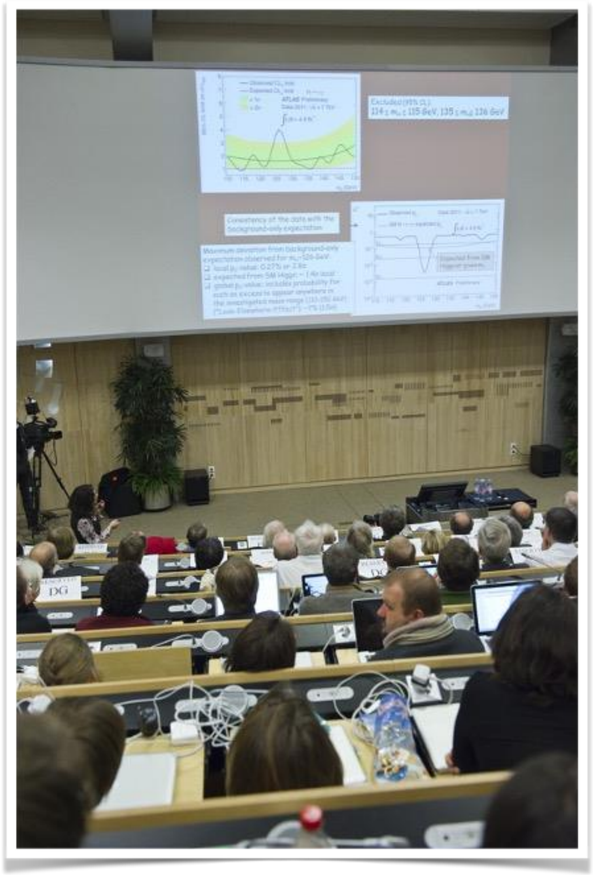

- LHC starts running at 3.5 TeV per beam
- Soon recording data far faster than the Tevatron

# 2011: Opening to the world

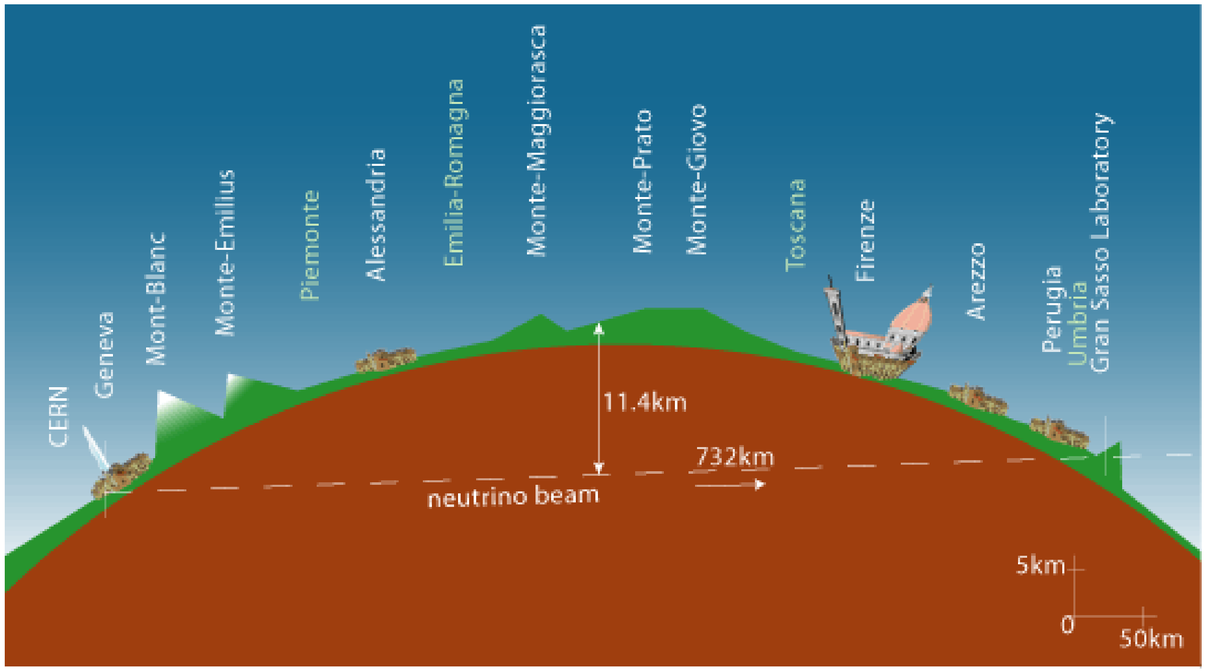

**16 September 2011:**
**First non European country becomes associated member of CERN**

# 2011: Hints of Higgs



# 2011: particles break speed of light limit: Really?




**OPERA experiment in Grand Sasso (Italy) claims that neutrinos from CERN travel with more than speed of light**

**Well, it was a faulty optical fibre connector**

**SPEED LIMIT**

**C**

**299792 km/s**

# 2012: A discovery!

*'The Large Hadron Collider at CERN is the largest most complex machine in the world, possibly the universe. By smashing particles together at enormous energies, it recreates the conditions of the Big Bang. The recent discovery of what looks like the "Higgs particle" is a triumph of human endeavour and international collaboration. It will change our perception of the world and has the potential to offer insights into a complete theory of everything.'*

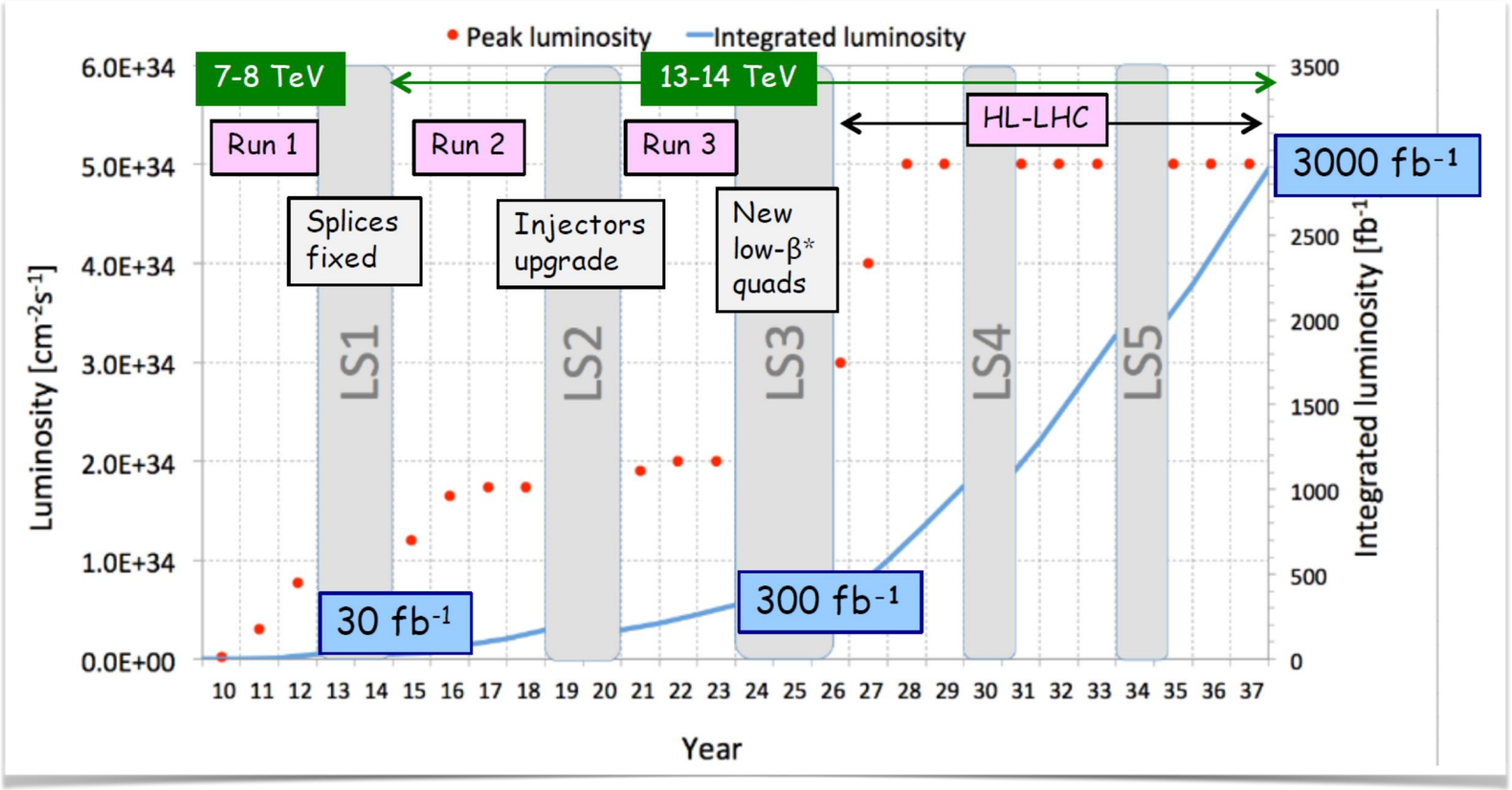
***Stephen Hawking***

# 2018: Look at the Swiss bank notes

**Switzerlands scientific expertise:**

**Looks like a particle collision at CERN**

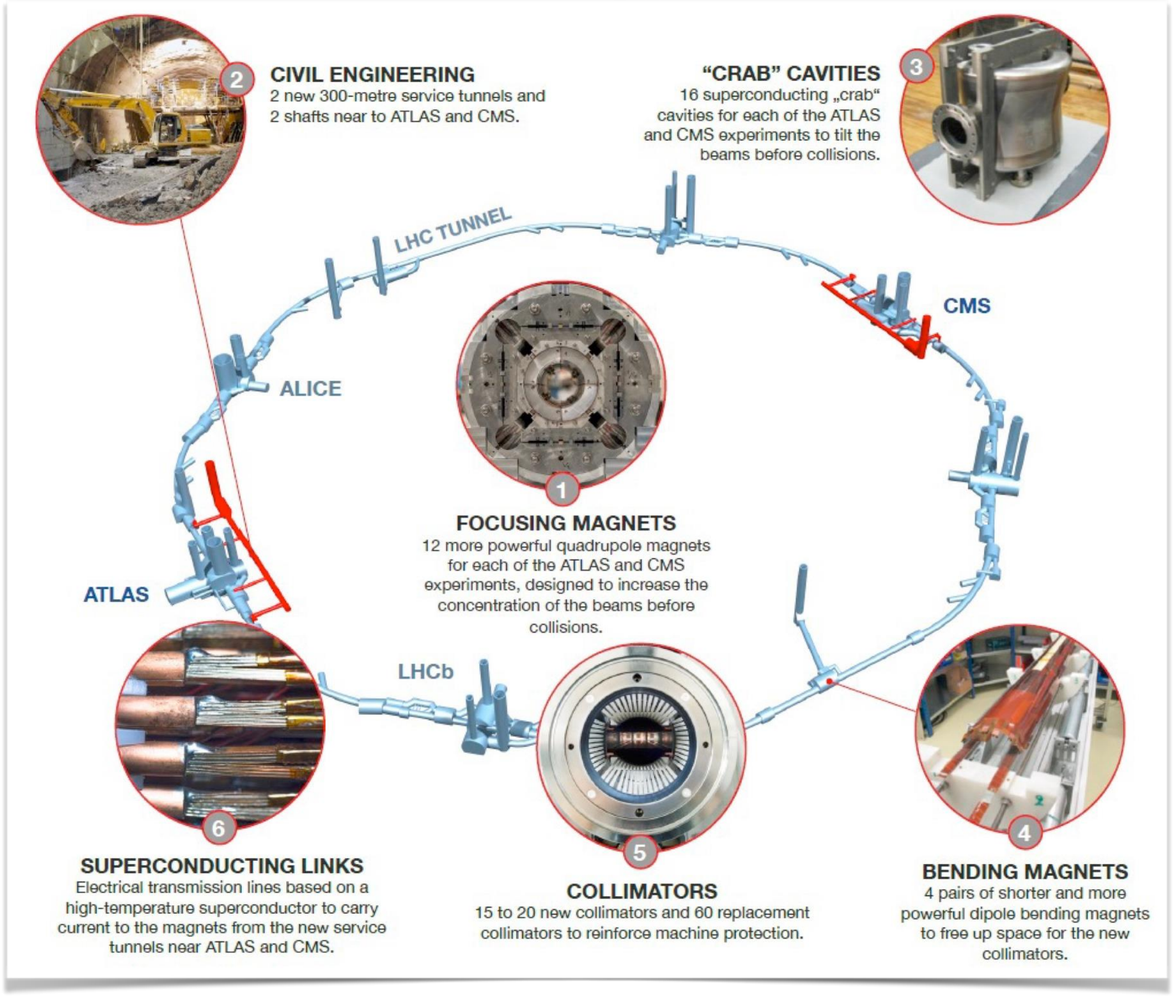

# 2023: What next?




Prepare for LHC upgrade:
High Luminosity LHC (HL-LHC)

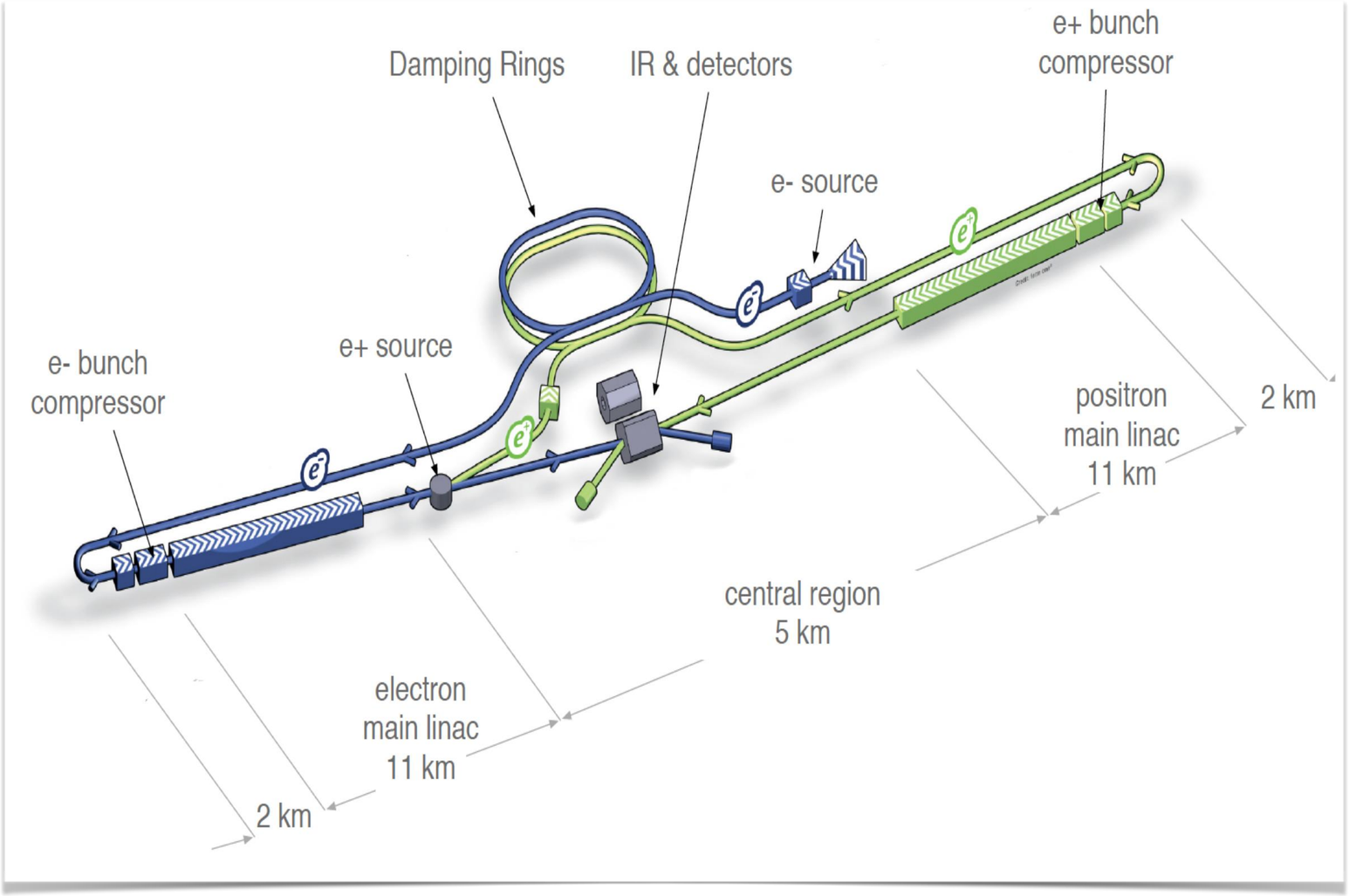
From 2029 to 2040

# HL-LHC Project




- New quadrupole magnets near the interaction points
- New 11 Tesla short dipole magnets
- Collimation upgrade
- Crab Cavities
- Accelerator safety upgrade
- Major interventions on 1.2 km of the LHC

# International Linear Collider (ILC) Study



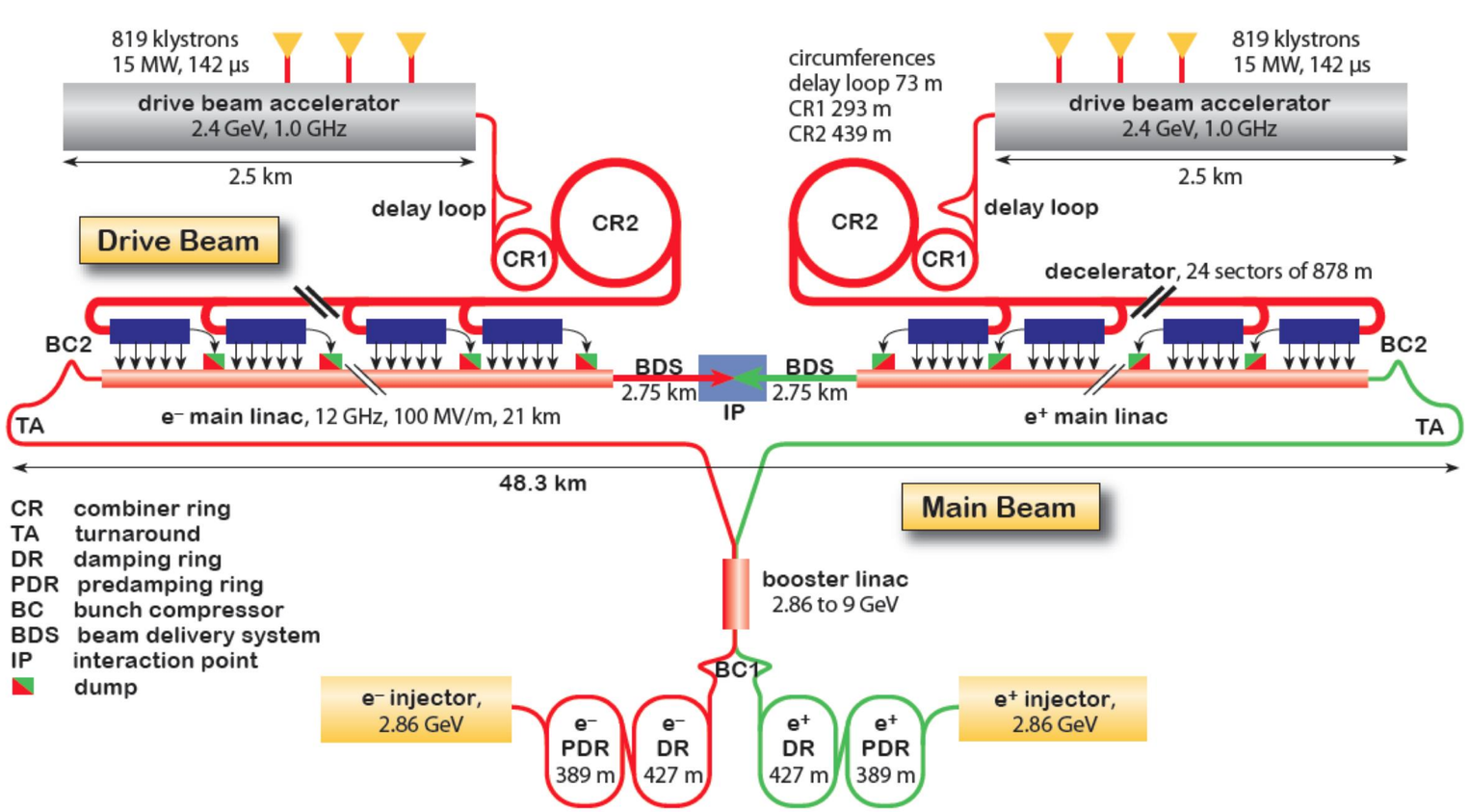

0.5 TeV collision energy, upgradable to 1 TeV

SC RF industry standard

mature design! (TDR in 2012)

Possibility of hosting is evaluated by Japanese government

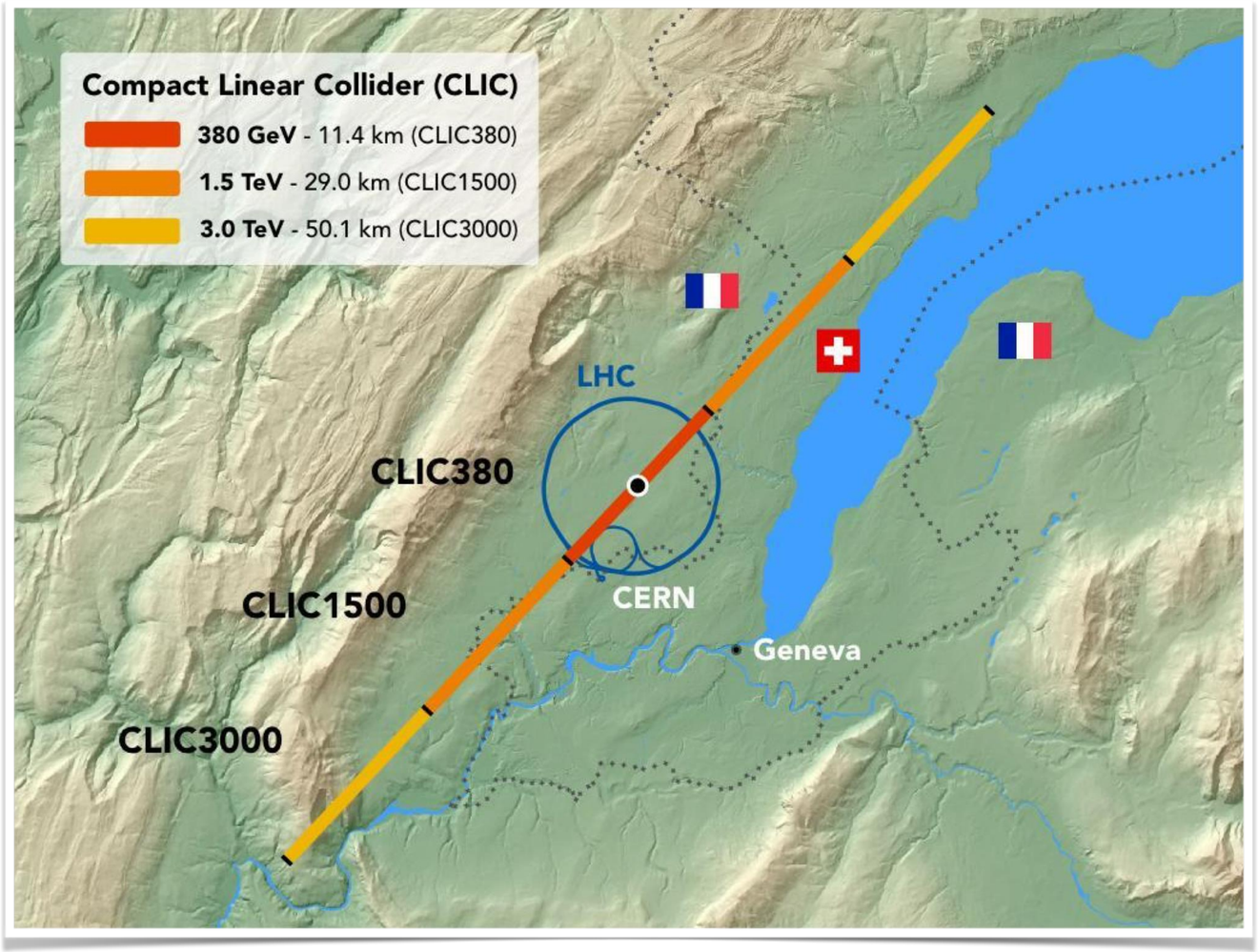
# Compact Linear Collider (CLIC) Study



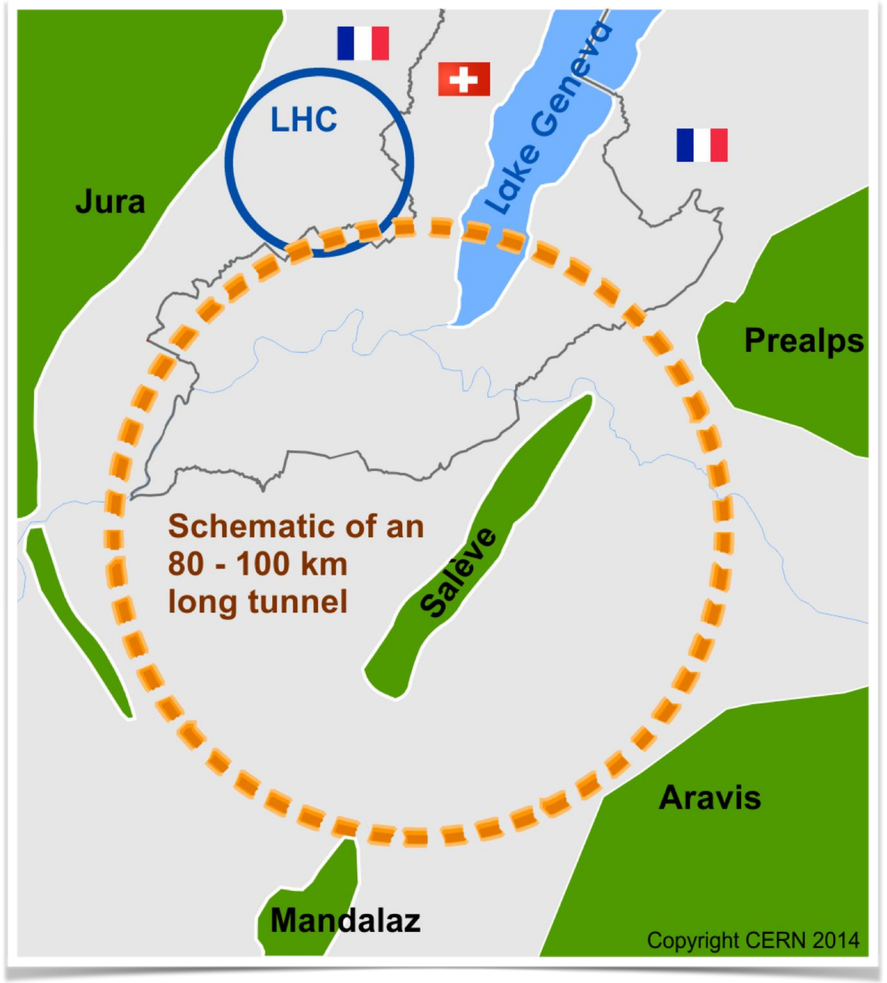

Two-beam scheme,
1-3 TeV collision energy
Option for 380 GeV explored
(top quark pair production)

CTF3 facility – key R&D done
Ready for demonstrator project

# Compact Linear Collider (CLIC) Study

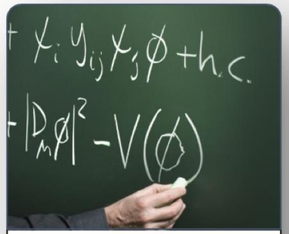


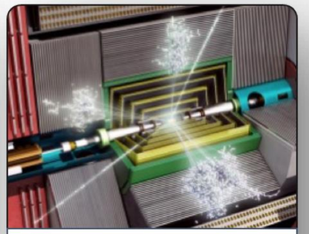
# Future Circular Collider (FCC) Study




- **International FCC collaboration to study:**
- pp collider *(FCC-hh)*,
  - 16 Tesla magnets,
  - 100 km circumference,

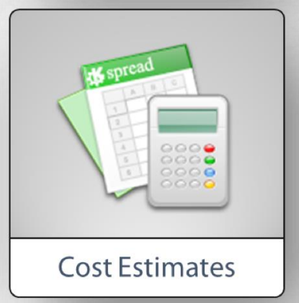
  100 TeV collision energy
- $e^+e^-$ collider *(FCC-ee)*
  potential first step
- pe collider *(FCC-he)*
- **If realised the project could last until 2090!**










LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS ~ 7 km
SUISSE
FRANCE
CMS
ALICE
LHC ~ 27 km
CERN
Accelerating Science and Innovation

# Thank You