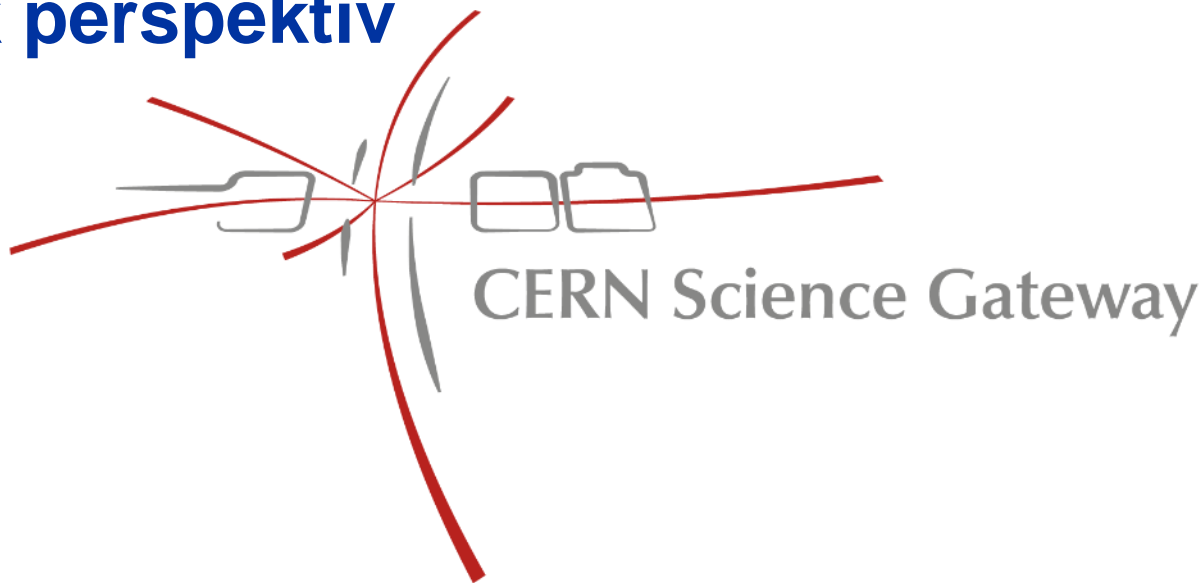


## Introduksjon til CERN i norsk perspektiv

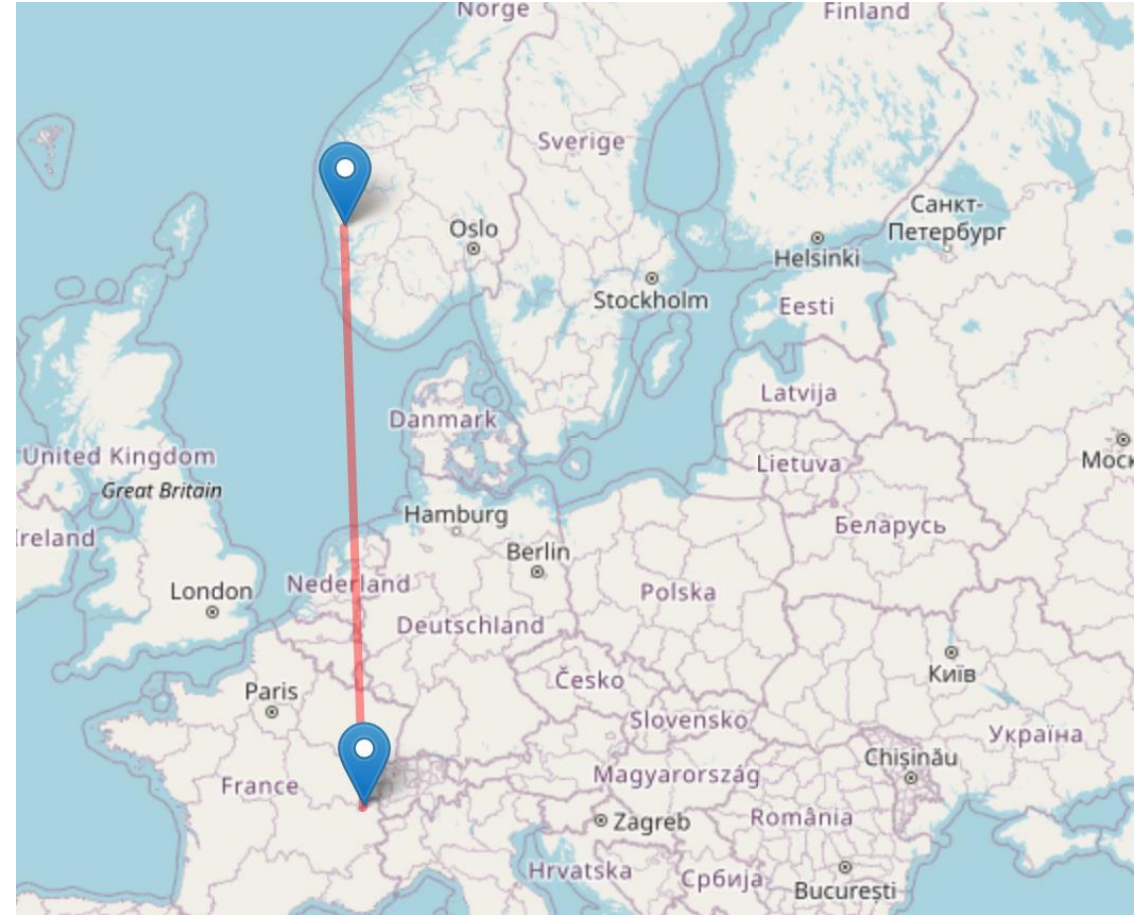
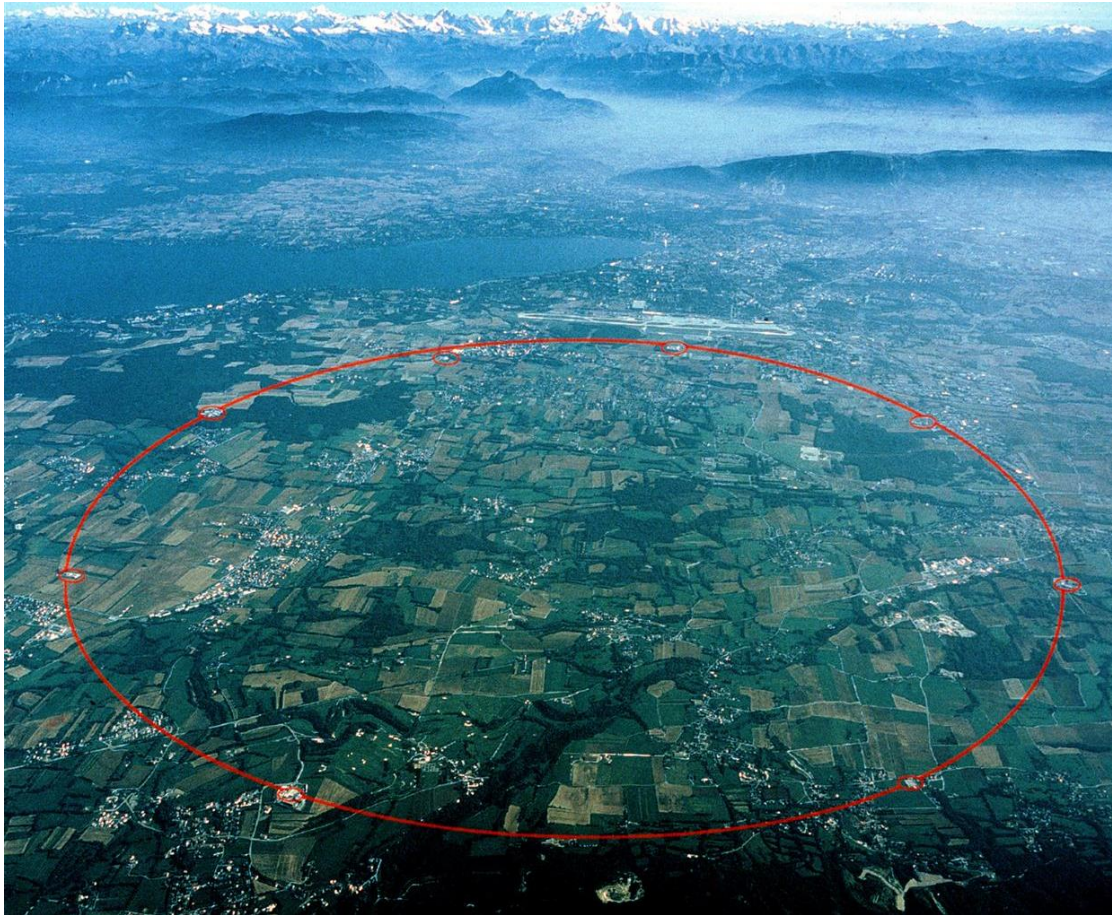


**Jens Vigen**

**UiB PHYS119-studenter@CERN**

**19. november 2024**

# Et laboratorium på grensen mellom Sveits og Frankrike (Genève) med ekstraterritoriell status



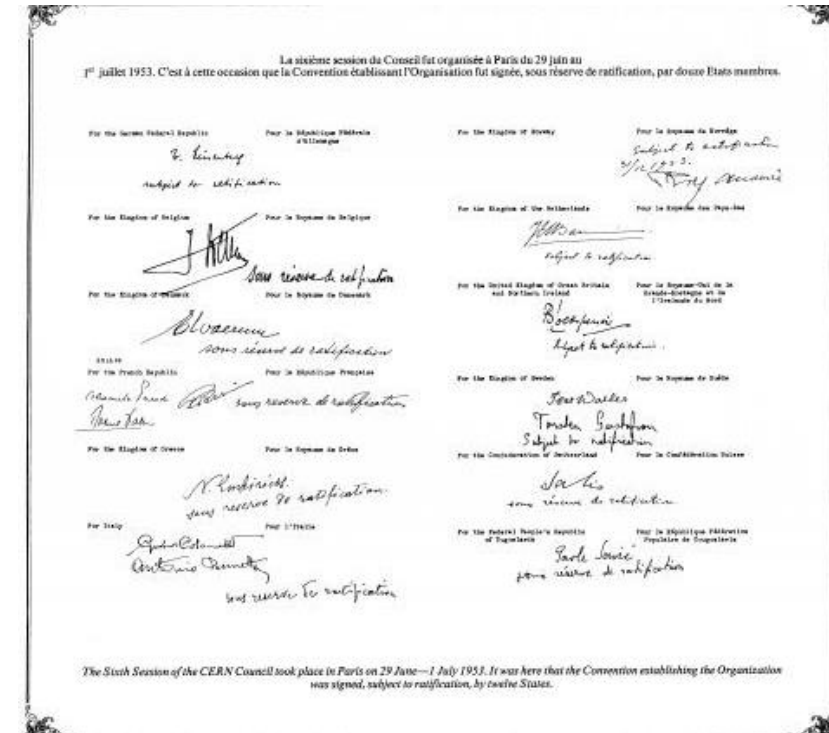


# Etableringen av et multinasjonalt laboratorium



George Collins ved Brookhaven i 1952 med Odd Dahl, Rolf Widerøe og Frank Goward

Idéens far  
Louis de Broglie



Signaturer på CERN konvensjonen 1 juli 1953

# Pre-CERN\*

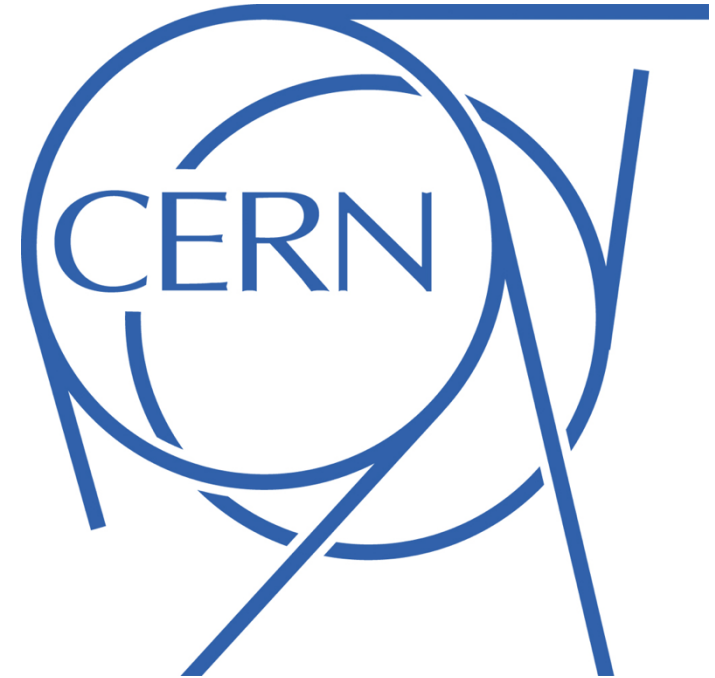
## Conseil européen pour la recherche nucléaire

C

Centre ...

Heftig diskusjon i København allerede i 1952 ...

\* Prof Bjørn Trumpy (UiB) møtte i det preliminnære rådet for Norge ved fire av de totalt ni møtene



# Forkortelsen CERN

**C**

**Centre ...**

**Pierre Auger:**

**et utvalg av alternative forslag**

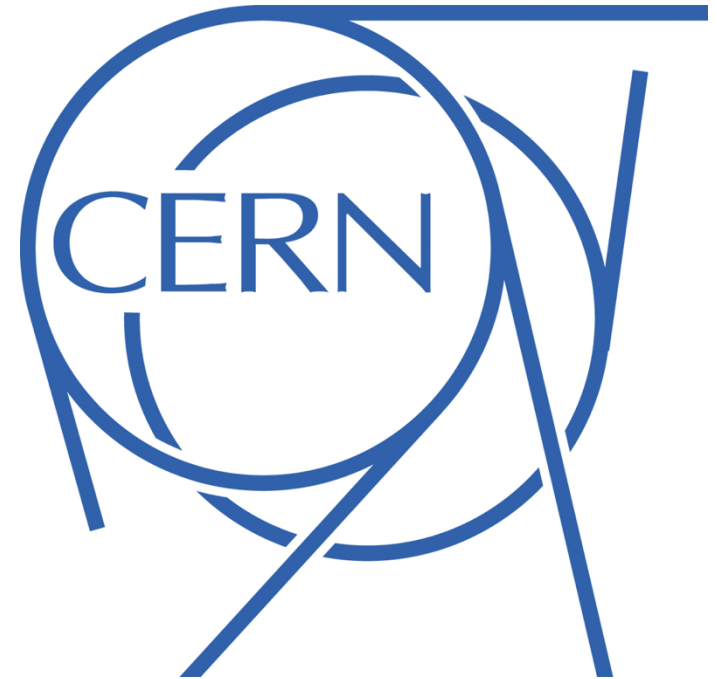
**Cabale**

**Casino**

**Catholicité**

**Concubinage**

**Cirque**



# 1954: pre-CERN blir til CERN

## Organisation européenne pour la recherche nucléaire

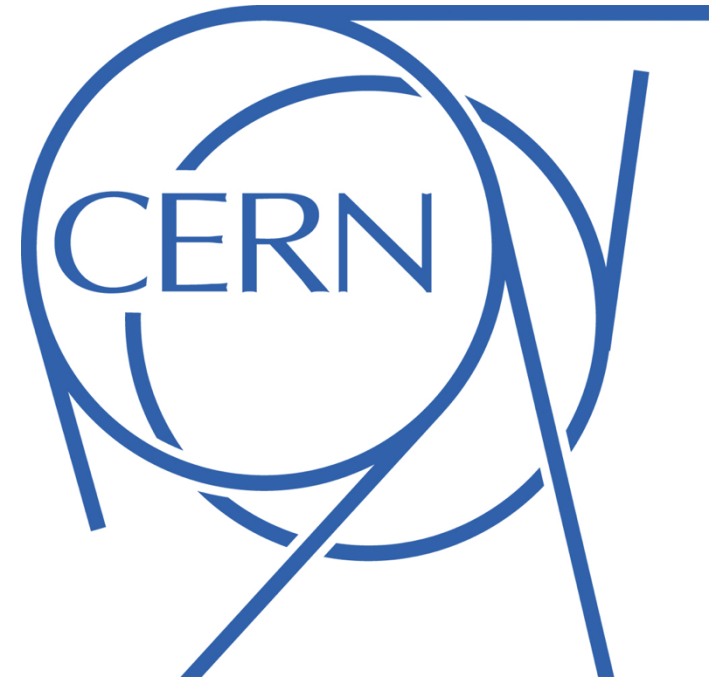
Kowarski:

«CERN—silly as to be intolerable»

**CERN → OERN?**

Elegant parert av Felix Bloch

**OERN ≈ CERN**



# Norske forskere var “på ballen” fra første stund

CONSEIL EUROPEEN POUR LA RECHERCHE NUCLEAIRE  
CERN EUROPEAN COUNCIL FOR NUCLEAR RESEARCH  
PROTON-SYNCHROTON GROUP

ADDRESS:  
CHR. MICHELSENS INSTITUTT  
CERN-PS  
ALLÉGATEN 70, BERGEN  
NORWAY

Comments on Widerøe's Memo of 4/1-53.

I.

Ad. 1: I have done that, but have not written in report yet. The main result is that in cases we can use the old theory using for value of the straight sections. The approximation is quite good.

Ad. 2: Courant has done some rough calculation showing that the damping is strong. He transition energy is approached, more calculations will be needed. Very lit



Dahl, Widerøe og Goward hadde en visjon om å bygge en maskin for fremtiden —med lyktes de til de grader!  
PS kjører den dag i dag etter 65 års tjeneste!



MINISTERE ROYAL  
DES  
AFFAIRES ETRANGERES

(Original: English)

Oslo, 22 July 1952

Professor E. Amaldi,  
Secretary-General of the Council  
of Nuclear Research  
Istituto di Fisica  
Rome

Sir,

With reference to your letter of 21st May, 1952, I have the honour of informing you that the Norwegian Government on 17th July decided to reply as follows to the Council:

Norway is interested in the plans for the establishment of a European Laboratory for Nuclear Research. As far as Norway is concerned it will, therefore, be considered to offer a suitable site for this purpose. However, the Government does not at the present time have sufficient information regarding these plans in order to make a final decision. It is therefore requested that such information be furnished. As the National Assembly is not in session, no offer to place a site at disposal can be made at present.

I have the honour to be,

Sir,

Your obedient Servant,

For the Minister  
(signed)

Secretary-General

MINISTERE ROYAL  
DES  
AFFAIRES ETRANGERES

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I have the honour to be,  
Sir,  
Your obedient Servant,

For the Minister  
(signed)  
Secretary-General

Så hadde ikke Stortinget vært på ferie, så kunne CERN ha havnet i Norge (og da, hvorfor ikke i Bergen ...?)







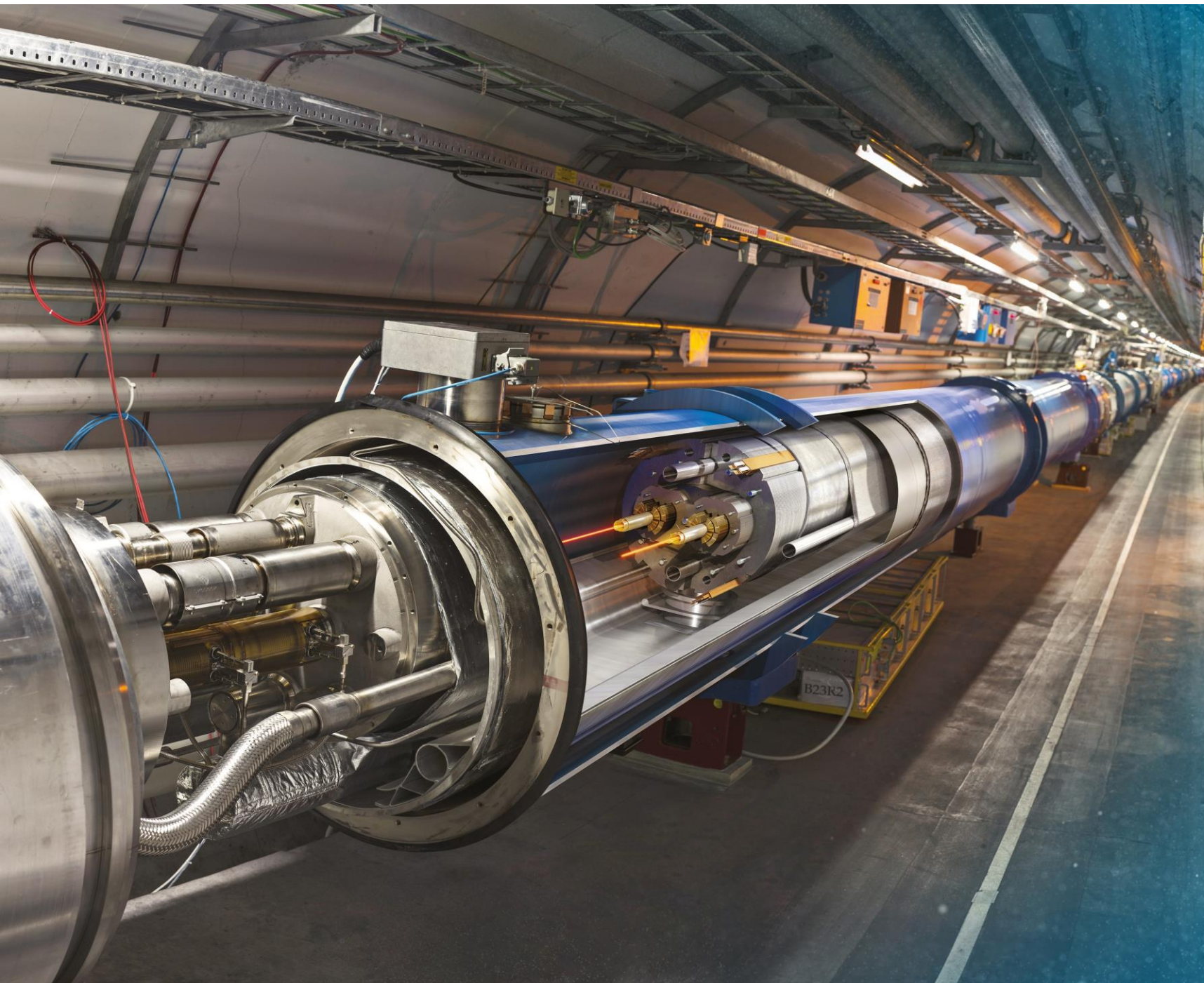
opp på stjernene. I dag er hun selv blitt en fysiker-stjerne.



# En kort samtale med den store partikkel-popstjernen



On 6 November, the CERN Council selected British physicist Mark Thomson as the Organization's next Director-General. The appointment will be formalised at the December session of the Council and Professor Thomson's five-year mandate will begin on 1 January 2026.



# Large Hadron Collider (LHC)

- 27 km i omkrets
- Omlag 100 m under bakken
- Superledende magneter styrer partiklene rundt ringen
- Partiklene akselereres til en hastighet helt opp i mot lysets hastighet
- Operasjon levetid frem til 2041 (HL-LHC)

Det knytter seg nå spenning til hva som eventuelt blir det neste store CERN-prosjektet

- FCC (90–100 km omkrets)
- CLIC (opp til 50 km lang)
- Muon collider (10 km omkrets)

# På letting etter Higgs

## Peter Higgs

Article Talk Read Edit Edit source View history Tools  
From Wikipedia, the free encyclopedia

**Peter Ware Higgs** CH FRS FRSE HonFInstP (29 May 1929 – 8 April 2024) was a British theoretical physicist, professor at the University of Edinburgh, [8][9] and Nobel laureate in Physics for his work on the mass of subatomic particles.[10][11]

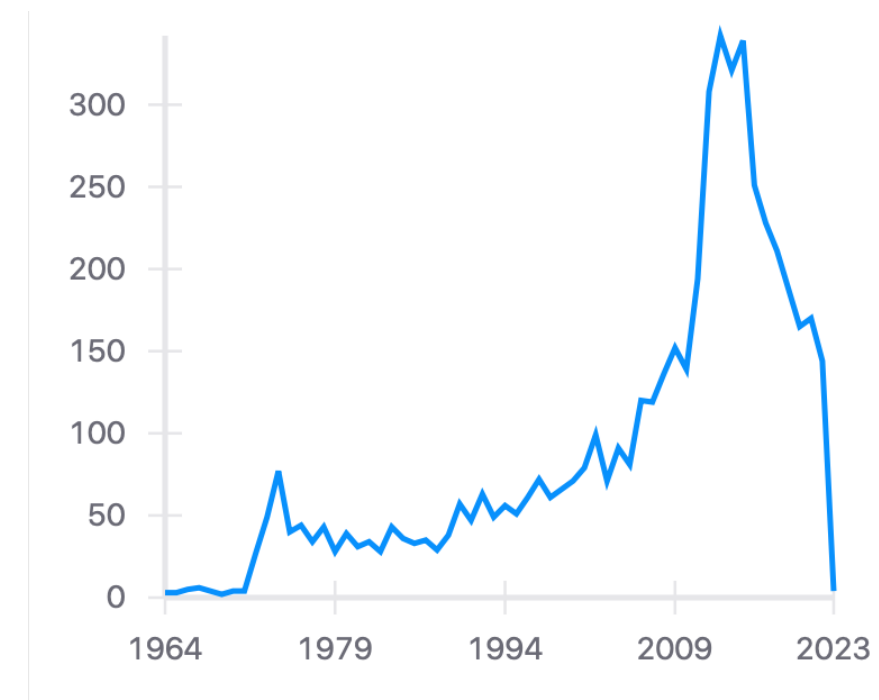
In the 1960s, Higgs proposed that *broken symmetry* in *electroweak theory* could explain the origin of mass of *elementary particles* in general and of the *W* and *Z bosons* in particular. This so-called *Higgs mechanism*, which was proposed by several physicists besides Higgs at about the same time, predicts the existence of a new particle, the *Higgs boson*, the detection of which became one of the great goals of physics.[12][13] On 4 July 2012, CERN announced the discovery of the boson at the Large Hadron Collider. [14] The Higgs mechanism is generally accepted as an important ingredient in the *Standard Model* of particle physics, without which certain particles would have no mass.[15]



Higgs in 2013







## BROKEN SYMMETRIES, MASSLESS PARTICLES AND GAUGE FIELDS

P. W. HIGGS

*Tait Institute of Mathematical Physics, University of Edinburgh, Scotland*

Received 27 July 1964

Recently a number of people have discussed the Goldstone theorem <sup>1, 2)</sup>: that any solution of a Lorentz-invariant theory which violates an internal symmetry operation of that theory must contain a massless scalar particle. Klein and Lee <sup>3)</sup> showed that this theorem does not necessarily apply in non-relativistic theories and implied that their considerations would apply equally well to Lorentz-invariant field theories. Gilbert <sup>4)</sup>, how-

ever, gave a proof that the failure of the Goldstone theorem in the nonrelativistic case is of a type which cannot exist when Lorentz invariance is imposed on a theory. The purpose of this note is to show that Gilbert's argument fails for an important class of field theories, that in which the conserved currents are coupled to gauge fields.

Following the procedure used by Gilbert <sup>5)</sup> we consider a theory of two hermitian scalar



Contents lists available at [SciVerse ScienceDirect](#)

## Physics Letters B

[www.elsevier.com/locate/physletb](http://www.elsevier.com/locate/physletb)



# Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC <sup>☆</sup>

ATLAS Collaboration <sup>☆</sup> **2932 forfattere hvorav 10 fra UiB**

This paper is dedicated to the memory of our ATLAS colleagues who did not live to see the full impact and significance of their contributions to the experiment.

<sup>1</sup> Department of Physics, University of Arizona, Tucson, AZ, United States

<sup>8</sup> Department of Physics, The University of Texas at Arlington, Arlington, TX, United States

<sup>9</sup> Physics Department, University of Athens, Athens, Greece

<sup>10</sup> Physics Department, National Technical University of Athens, Zografou, Greece

<sup>11</sup> Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan

<sup>12</sup> Institut de Física d'Altes Energies and Departament de Física de la Universitat Autònoma de Barcelona and ICREA, Barcelona, Spain

<sup>13</sup> <sup>(a)</sup> Institute of Physics, University of Belgrade, Belgrade; <sup>(b)</sup> Vinca Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

<sup>14</sup> Department for Physics and Technology, University of Bergen, Bergen, Norway

<sup>15</sup> Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley, CA, United States

<sup>16</sup> Department of Physics, Humboldt University, Berlin, Germany

<sup>17</sup> Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland

<sup>18</sup> School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom



# Here, at last!

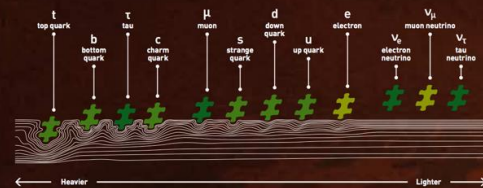
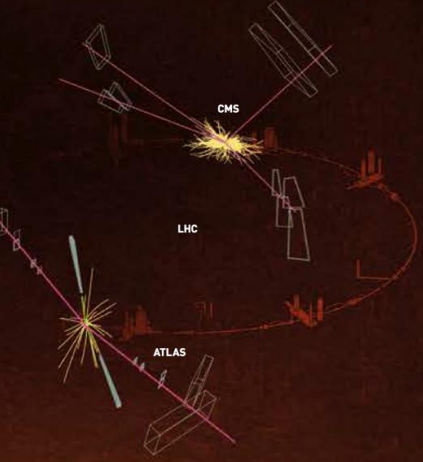
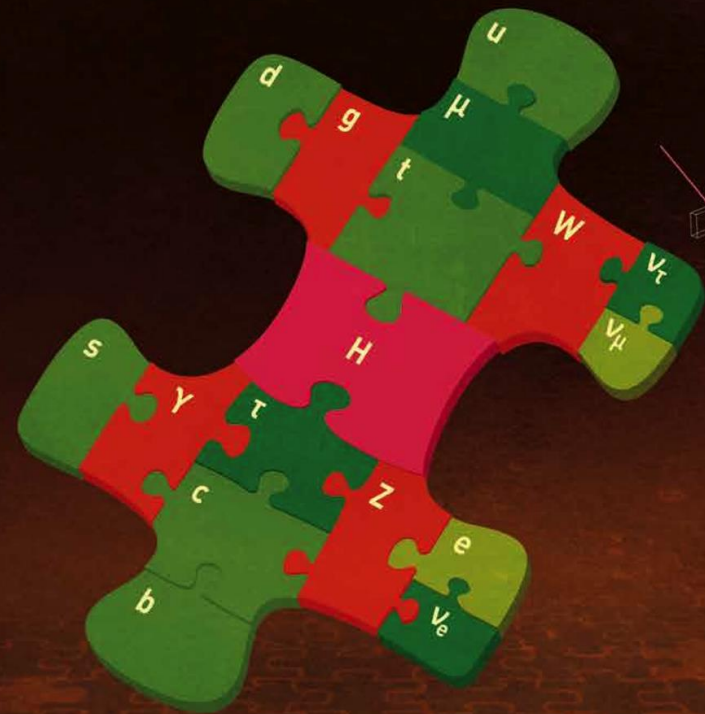
François Englert and Peter W. Higgs are jointly awarded the Nobel Prize in Physics 2013 for the theory of how particles acquire mass. In 1964, they proposed the theory independently of each other (Englert did so together with his now-deceased colleague Robert Brout). In 2012, their ideas were confirmed by the discovery of a so-called Higgs particle, at the CERN laboratory outside Geneva in Switzerland.

The awarded mechanism is a central part of the Standard Model of particle physics that describes how the world is constructed. According to the Standard Model, everything – from flowers and people to stars and planets – consists of just a few building blocks: matter particles which are governed by forces mediated by force particles. And the entire Standard Model also rests on the existence of a special kind of particle: the Higgs particle.

The Higgs particle is a vibration of an invisible field that fills up all space. Even when our universe seems empty, this field is there. Had it not been there, nothing of what we know

would exist because particles acquire mass only in contact with the Higgs field. Englert and Higgs proposed the existence of the field on purely mathematical grounds, and the only way to discover it was to find the Higgs particle.

The Nobel Laureates probably did not imagine that they would get to see the theory confirmed in their lifetimes. To do so required an enormous effort by physicists from all over the world. Almost half a century after the proposal was made, on July 4, 2012, the theoretical prediction could celebrate its biggest triumph, when the discovery of the Higgs particle was announced.



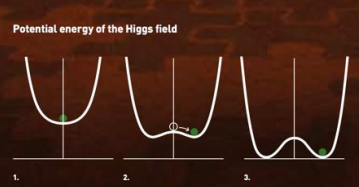
**ATLAS**  
In the collision, a short-lived Higgs particle is created, which decays into two muons (tracks in red) and two electrons (tracks in green).

**CMS**  
A short-lived Higgs particle is created in the collision and decays into four muons (tracks in red).

**The Particle Collider LHC**  
Protons – hydrogen nuclei – travel at almost the speed of light in opposite directions inside the circular tunnel, 27 kilometres long. The LHC (Large Hadron Collider) is the largest and most complex machine ever constructed by humans. In order to find a trace of the Higgs particle, two huge detectors, ATLAS and CMS, are capable of seeing the protons collide over and over again, 40 million times a second.

**The Field**  
Matter particles acquire mass in contact with the invisible field that fills the whole universe. Particles that are not affected by the Higgs field do not acquire mass, those that interact weakly become light, and those that interact strongly become heavy. For example, electrons acquire mass from the field, and if it suddenly disappeared, all matter would collapse as the suddenly massless electrons dispersed at the speed of light. The weak force carriers, W and Z particles, get their masses directly through the Higgs mechanism, while the origin of the neutrino masses still remains unclear.

**Broken Symmetry**  
The Higgs mechanism relies on the concept of spontaneous symmetry breaking. Our universe was probably born symmetrical (1), with a zero value for the Higgs field in the lowest energy state – the vacuum. But less than one billionth of a second after the Big Bang, the symmetry was broken spontaneously as the lowest energy state moved away (2) from the symmetrical zero-point. Since then, the value of the Higgs field in the vacuum state has been non-zero (3).



**The Puzzle**  
The Higgs particle [H] was the last missing piece in the Standard Model puzzle. But the Standard Model is not the final piece in the cosmic puzzle. One of the reasons for this is that the Standard Model only describes visible matter, accounting for one sixth of all matter in the universe. To find the rest – the mysterious so-called dark matter – is one of the reasons why scientists continue to chase unknown particles at CERN.



**François Englert**  
Belgian citizen. Born 1932 in Etterbeek, Belgium. Professor emeritus at Université Libre de Bruxelles, Brussels, Belgium.

**Peter W. Higgs**  
British citizen. Born 1929 in Newcastle upon Tyne, United Kingdom. Professor emeritus at University of Edinburgh, United Kingdom.

**FURTHER READING!** More information on the Nobel Prize in Physics 2013: <http://www.sfnobelprizephysics2013.org> and <http://nobelprize.org> **REVIEW ARTICLES:** ● **Ross, J.** (2013) *Indirect bottom Higgs*. *Fortschritte und Frametings*, nr 4 [Sweden]. ● **Uwerlyn-Smith, C.** (2013) *The Large Hadron Collider*. Scientific American, July. ● **Weinberg, S.** (1999) *A Unified Physics* by 2007. Scientific American, December. **BOOKS:** ● **Randall, L.** (2013) *Higgs Discovery: The Power of Empty Space*. Bodley Head. ● **Sarajedini, L.** (2013) *Massive: The Higgs Boson and the Greatest Hunt in Science*. Virgin Books. ● **Carroll, S.** (2012) *The Particle at the End of the Universe*. Dutton. ● **Cline, R.** (2011) *The Infinity Puzzle*. Oxford University Press. ● **Wizczak, F.** (2008) *The Lightness of Being: Mass, Ethics and the Unification of Forces*. Basic Books. **LINKS:** ● **LINK TV** (2012) *CERN Scientists Announce Higgs Boson*. <http://www.youtube.com/watch?v=00uqLDRH94>. ● **CERN** (2012) *CERN LHC* [Brochure]. <http://cds.cern.ch/record/1278169/files/en>. ● **Cham, J.** (2012) *The Higgs Boson Explained* [animation]. <http://www.photonics.com/comics/archive.php?comicid=1449>. ● **Higgs, Peter W.** (2010) *My Life as a Boson*. [transcribed speech]. <http://www.acl.ac.uk/news/physics/news/levent/MyLifeasaboson.pdf>. ● **More references can be found in the Scientific Background**. <http://kva.se/nobelprizephysics2013>

**Editors:** Lars Bergström, Lars Brink and Olga Borner. The Nobel Committee for Physics, The Royal Swedish Academy of Sciences. **Sarah Branson** and **Oliver Skae**, Stockholm University, Sweden. **Benno Blum**, Science Writer, Victoria University, Editor and Linda Walgren, Nobel Associates, The Royal Swedish Academy of Sciences. **Graphic design:** **Picture Illustrations:** Johan Jansson. **Swedish Graphics Press:** Årstad.

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# The Ashlad and His Good Helpers : illustrating the BEH Mechanism



By tomsalad

+ Follow

719 views



Add to

Share

Like

29

Tweet

0



Get me water, within 3 minutes, from the end of the world!”



Hold on – what is happening? The man removes his weights!



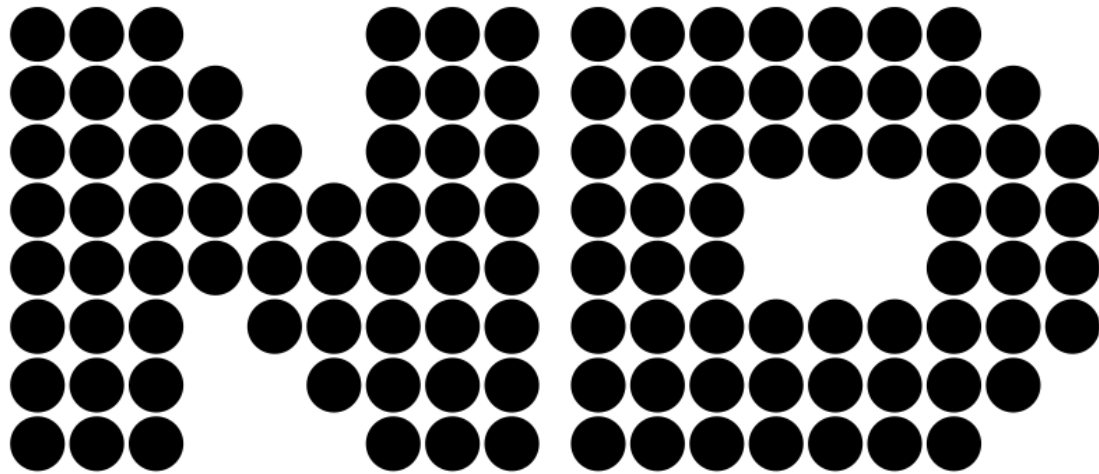
“Your Majesty, I will be straight back!”



Some 15 seconds after departure our friend is back!  
This man is certainly not made by matter influenced by the  
Brout-Englert-Higgs (BEH) mechanism.



# Styringssystemet til SPS ble et norsk industrieventyr



Vague but exciting ...

CERN DD/OC

Tim Berners-Lee, CERN/DD

Information Management: A Proposal

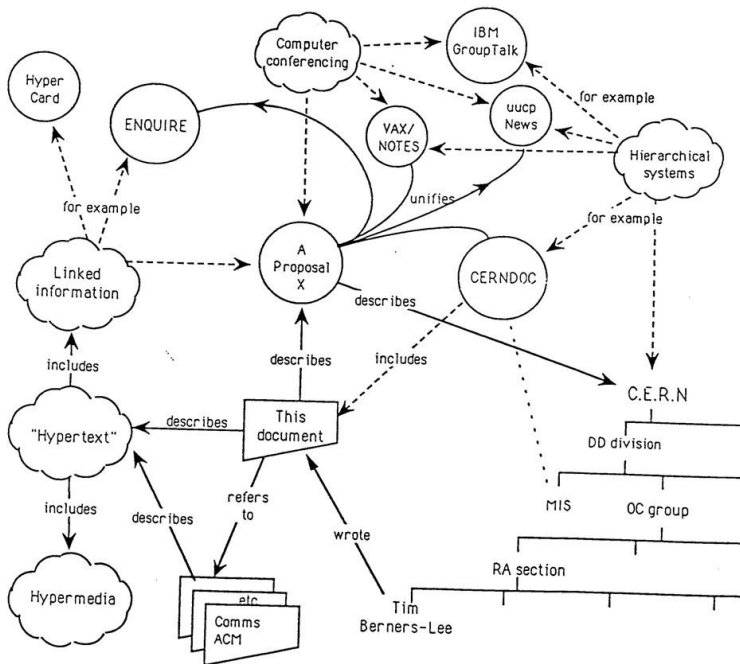
March 1989

### 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 system.

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



# Tim B-L skulle bare lage et verktøy for fysikerne ...

ENQUIRE—en forløper til WWW—ble implementert på en NORD-10 maskin

# Norge og CERN medlemskapet

**Medlem siden starten i 1954**

**Involverer en stor gruppe unge mennesker**

- Ikke bare fysikere
- Også ingeniører, administratorer osv.

**Bidrag 2024**

- Norge: 2,19 %

**CERNs totale budsjett:**

- 1,37 milliarder CHF




Norske studenter på tacotirsdag i Sjømannskirka

# Hvor mye er 1,37 milliarder CHF?

## Rekordresultat for Tesla Norway

Tesla Norway solgte og leaset biler for over 12 milliarder kroner i fjor.



Tesla Model 3 var fjorårets mest populære bil i Norge. Foto: Håkon Mosvold Larsen

Av Hans M. Jordheim  
Publisert: 22. juni 2022

Sep 2024: 17, 2 milliarder NOK  
2022: ~ 13 milliarder NOK



## Nav-anslag: Trygdesvindler for 8 milliarder kroner årlig

Anslag viser at det svindles trygd for rundt 8 milliarder kroner hvert år. I tillegg kommer skatte- og avgiftssvindler på flere titalls milliarder.




Foto: Terje Pedersen / NTB scanpix.

Artikkel av: NTB  
17. desember 2017 - 08:17

Lest av 1957

# Norsk personalstatistikk (september 2024)

Some statistics:

Country	Staff members		Fellows		Doc. students		Technical students		Admin. students		GRADs		Normalized contribution
	hc	%	hc	%	hc	%	hc	%	hc	%	hc	%	
NO	18	0.67	3	0.78	16	2.16	3	1.94			7	2.55	2.12

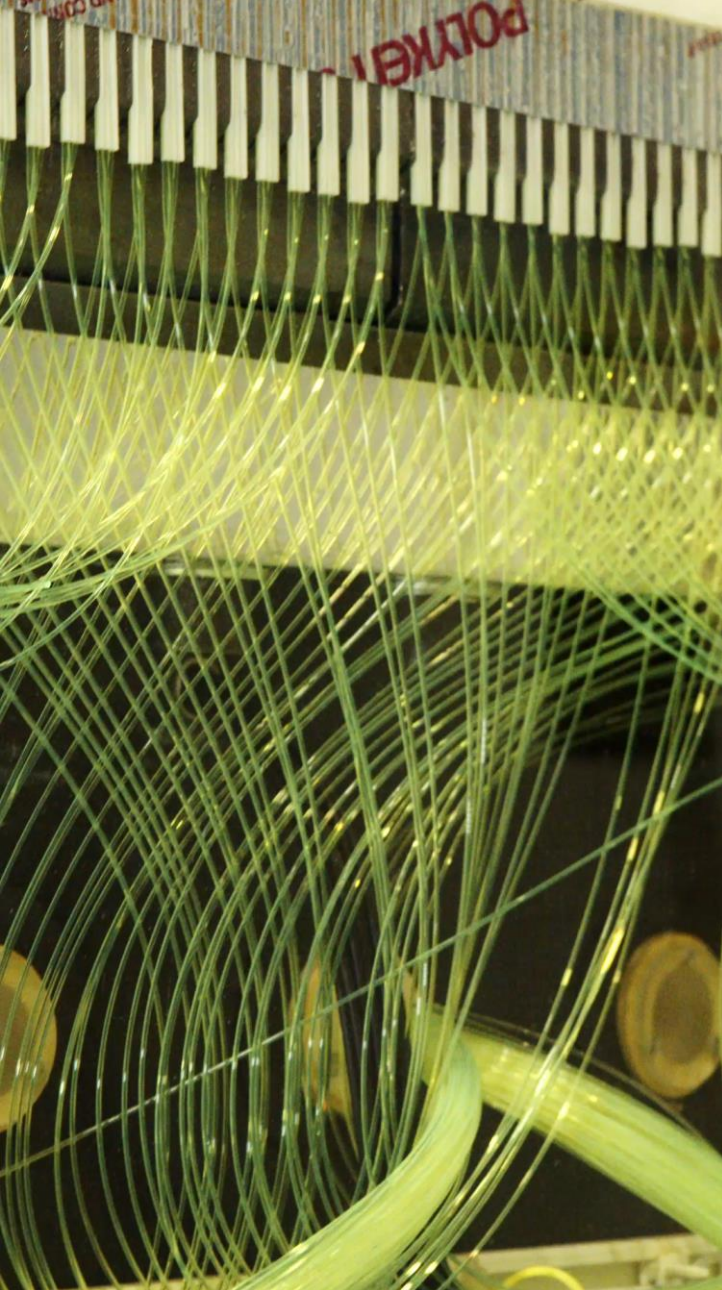
- Norge ligger med en **faktor 3 for lavt** med tanke på antall “fast” ansatte (staff)
- Norge gjør det godt med tanke på studenter
- Norske forskere er godt representert ved CERN

**Hva gjør vi for å tiltrekke den norske ungdommen til fysikkfaget og CERN?**

- 1) Rekruttering til fysikkfaget i VGS/universitetene
- 2) CERN: BESØK, BESØK, BESØK!
  - Pre-Covid: 1200 norske elever/år

“Fysikk-strikk” laget av  
Inga Hanne Dokka (Kongsberg videregående skole) og  
Jolanta Nylund (Akademiet Drammen)





Progress beyond



## CERN-Solvay Education Programme

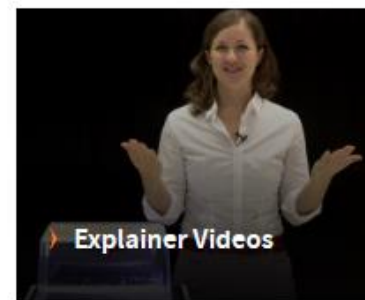
The CERN-Solvay Education Programme is designed to engage high-school students from around the world with exciting education content related to the scientific activities conducted at [CERN](#). Funded by the Belgian science company [Solvay](#), this programme combines the unique advantages of both online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

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

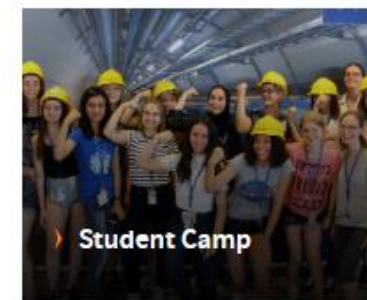
Happy browsing!



Short Videos



Explainer Videos



Student Camp



# CERN-Solvay Education Programme

17 PARTNERSHIPS FOR THE GOALS



4 QUALITY EDUCATION





# Nytt besøksenter: Science Gateway



# Et typisk CERN-besøk

## Foredrag



## Inspeksjon av lab-utstyr i felten







# WALT DISNEY Donald Duck

## Partikkelplunder

Ole, Dole og Doffen har vunnet en fysikkonkurrans der premien er en tur til KVERN (Kjernefysikk, Vitenskapelige Eksperimenter og Råkule Naturfag), der forskere jobber med å finne ut hva alt i universet er laget av ...

Så de har en slags karusell?

Den er ikke for mennesker! Knaseren gjør at ørsmå partikler blir kastet mot hverandre i en enorm hastighet, slik at det dannes enda mindre partikler!

Og den heter faktisk K.N.A.S. - Kjernefysisk Nedbryter og Atom-Smadrer!

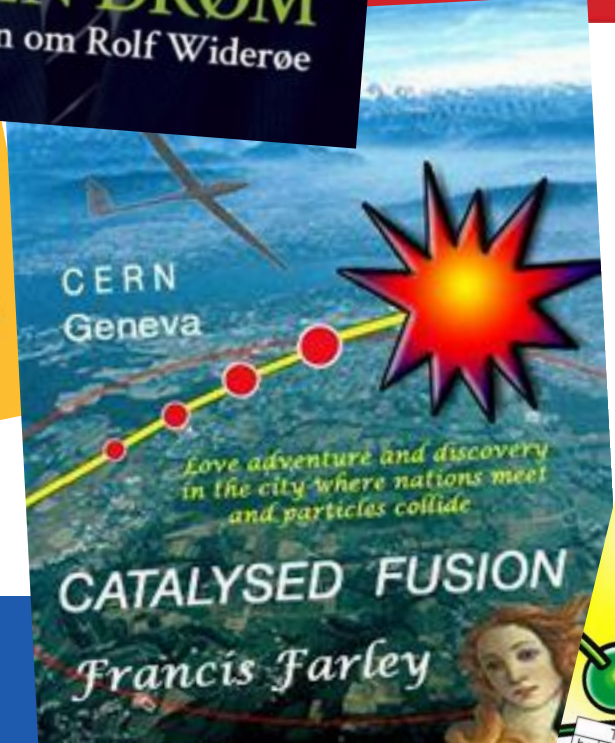
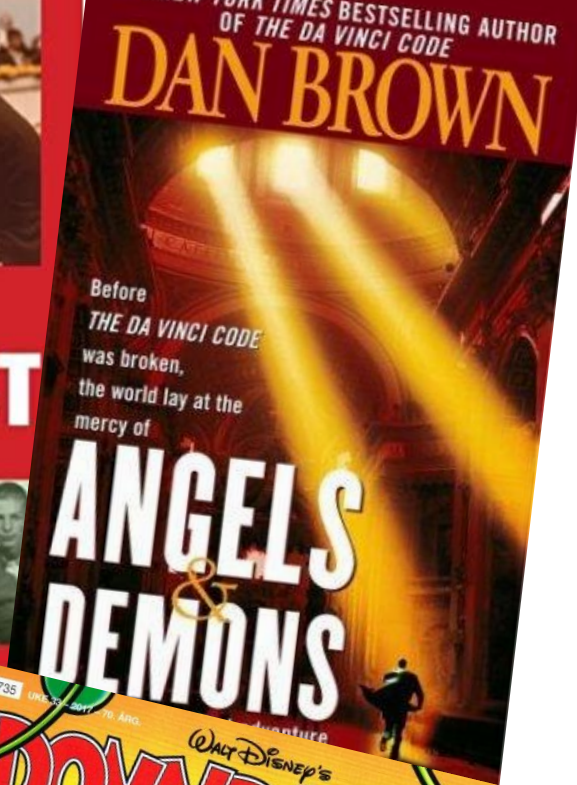
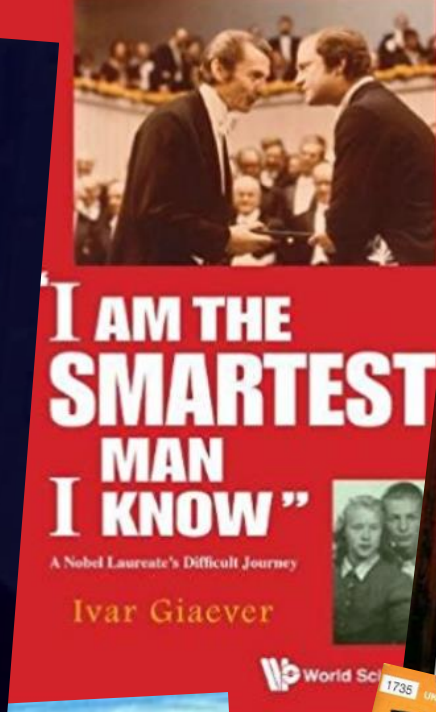
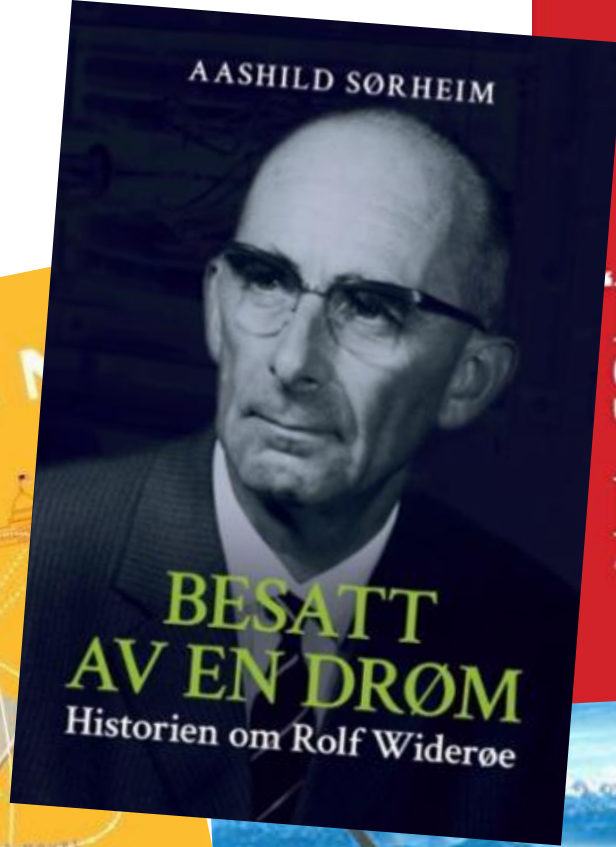
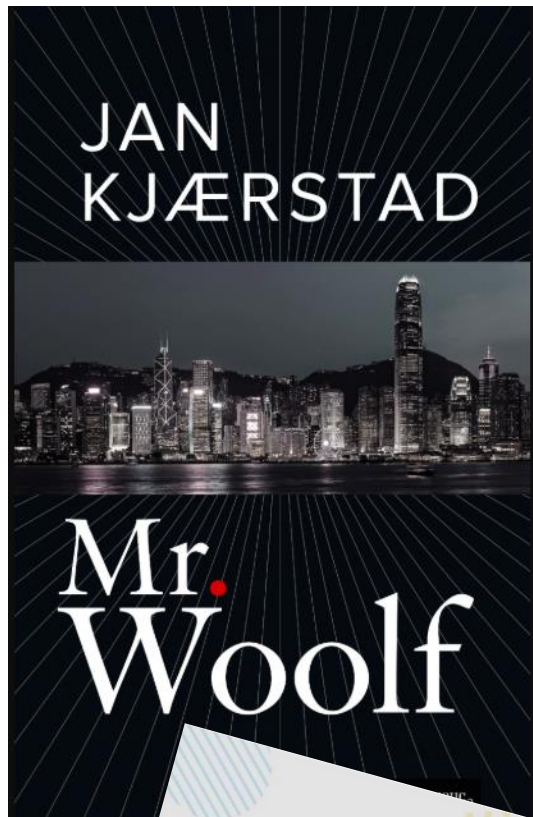
Der har vi Petter!

Velkommen til KVERN!



D 2016-334

Manus: Knut Nærum. Tegninger: Arlid Midthun.



# “Typisk norsk å være god ...”

*Gro Harlem Brundtland under de Olympiske leker i 1994*

- Stemmer dette også i fysikken?
  - Niels Henrik Abel (1802–1829); matematisk grunnlag
  - Sophus Lie (1842–1899); matematisk grunnlag
  - Kristian Birkeland (1867–1917); “The first space scientist”
  - Odd Dahl (1898–1994) “Trollmann og rundbrenner”
  - Rolf Widerøe (1902–1996); “Besatt av en drøm”
  - Kjell Johnsen (1921–2008); ledet byggingen av den første hadronakselleratoren
  - Bjørn Wiik (1937–1999); direktør ved DESY, Hamburg
- Hvem blir den neste nordmannen på lista?