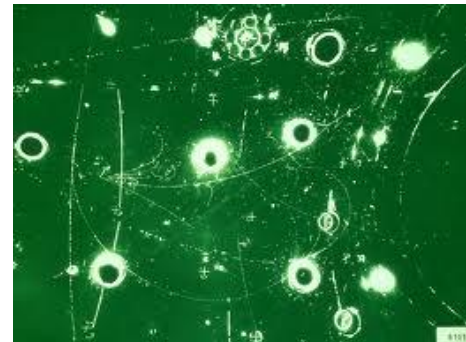
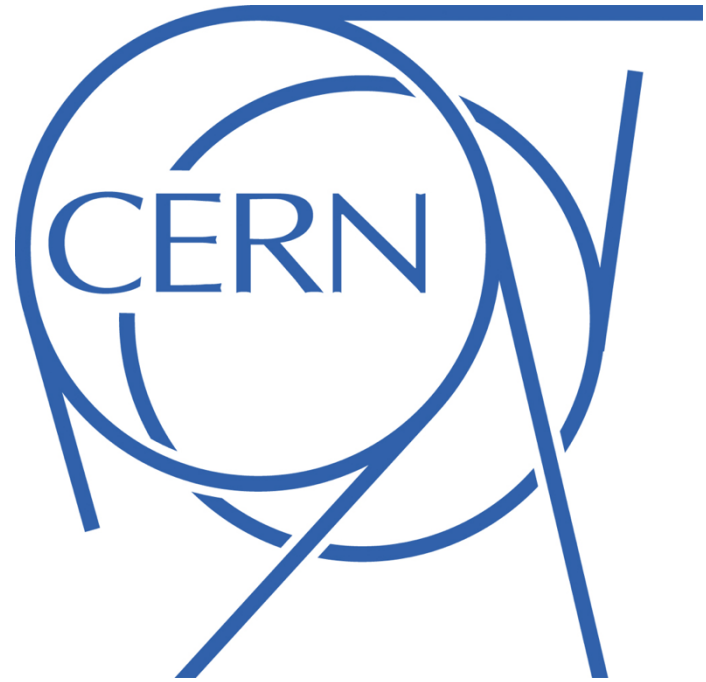


Velkommen til CERN

- European Organization for Nuclear Research
- Kjernefysikk
- Teorien om alt ...
- [“The God particle”](#)

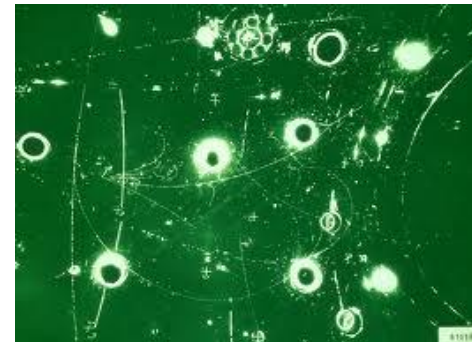


Velkommen til CERN

C

Centre ...

Stor diskusjon i København
i juni 1952 ...



Velkommen til CERN

C

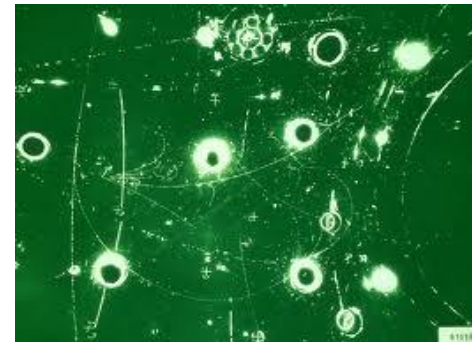
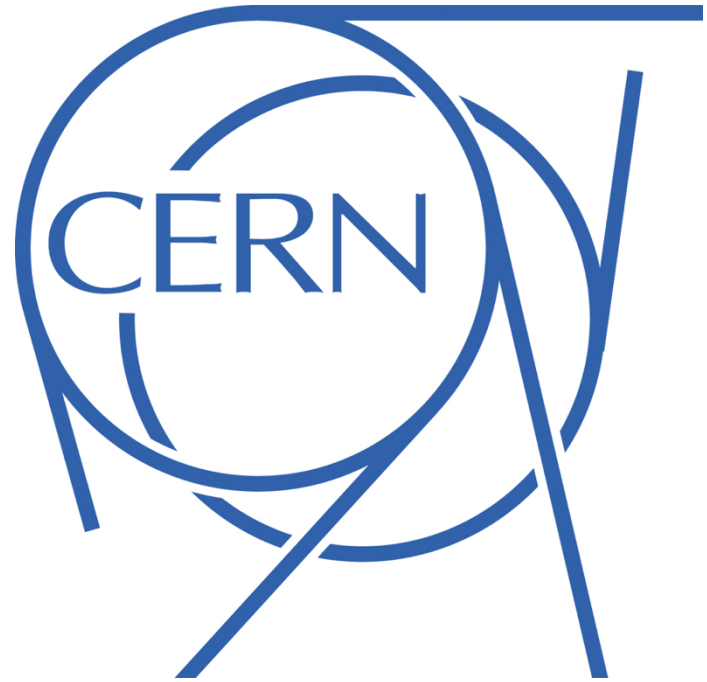
Centre ...

Cabale

Casino

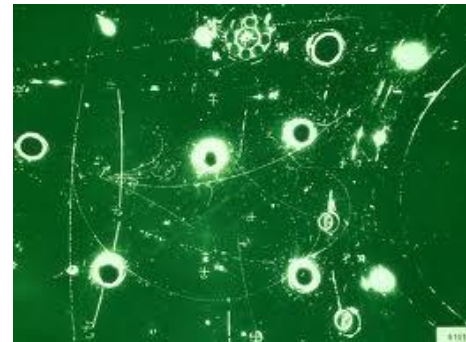
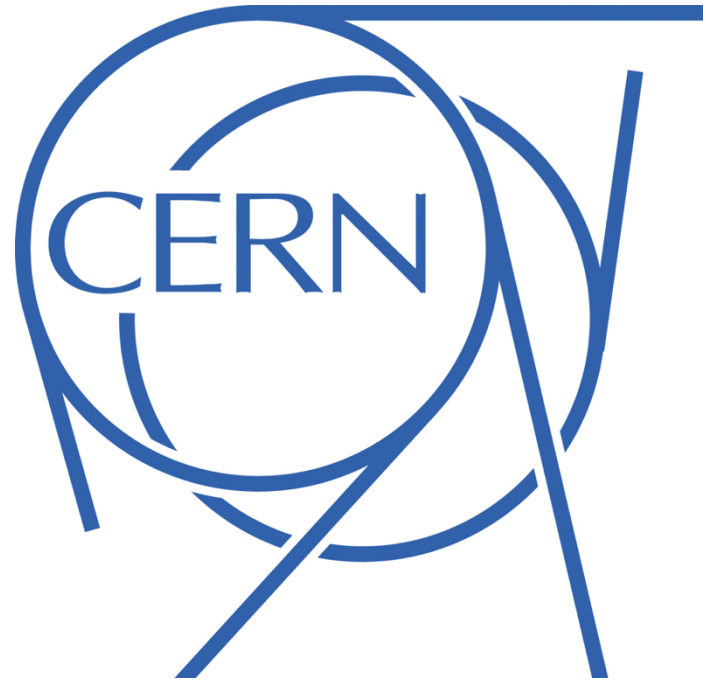
Concubinage

Cirque



Velkommen til CERN

- European Organization for Nuclear Research
- Kjernefysikk
- Teorien om alt ...
- [“The God particle”](#)





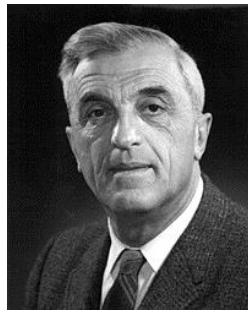
Da hun var liten kikket CERN-sjef Fabiola Gianotti filosofisk opp på stjernene. I dag er hun selv blitt en fysiker-stjerne.
FOTO: Martin Slottemo Lyngstad

En kort samtale med den
store partikkel-
popstjernen

CERN Director-Generals



Edoardo Amaldi
1952-1954



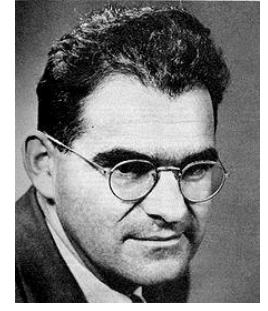
Felix Bloch
1954-1955



Cornelis Bakker
1955-1960



John Adams
1960-1961, 1971-1980



Victor Weisskopf
1961-1965



Bernard Gregory
1966-1970



Willibald Jentschke
1971-1975



Léon van Hove
1976-1980



Herwig Schopper
1981-1988



Carlo Rubbia
1989-1993



Christopher Llewellyn Smith
1994-1998



Luciano Maiani
1999-2003



Robert Aymar
2004-2008



Rolf Heuer
2009-2015



Fabiola Gianotti
2016-2020

What is CERN?

- CERN is the world's largest particle physics centre
- Particle physics is about:
 - elementary particles which all matter in the Universe is made of
 - fundamental forces which hold matter together
- Particle physics requires:
 - special tools to create and study new particles

CERN is:
-~ 2424 staff scientists (physicists, engineers, ...)
-2000 Sub-contractors
- Some 11500 visiting scientists (half of the world's particle physicists)

They come from 500 universities representing 80 nationalities.



På leting etter Higgs



The Nobel Prize 2013 in Physics



Here, at last!

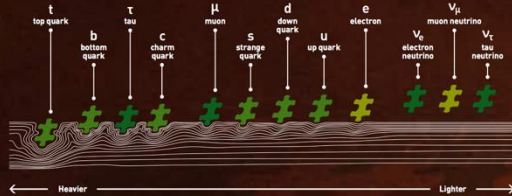
François Englert and Peter W. Higgs are jointly awarded the Nobel Prize in Physics 2013 for the theory of how particles acquire mass. In 1964, they proposed the theory independently of each other (Englert did so together with his now-deceased colleague Robert Brout). In 2012, their ideas were confirmed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



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

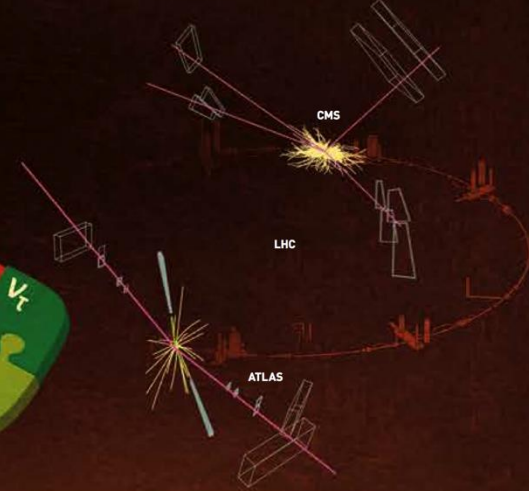
The Higgs mechanism relies on the concept of spontaneous symmetry breaking. Our universe was probably born symmetrical (1), with a zero value for the Higgs field in the lowest energy state – the vacuum. But less than one billionth of a second after the Big Bang, the symmetry was broken spontaneously 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).

Potential energy of the Higgs field



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.



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.

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.



BROKEN SYMMETRIES, MASSLESS PARTICLES AND GAUGE FIELDS

P. W. HIGGS

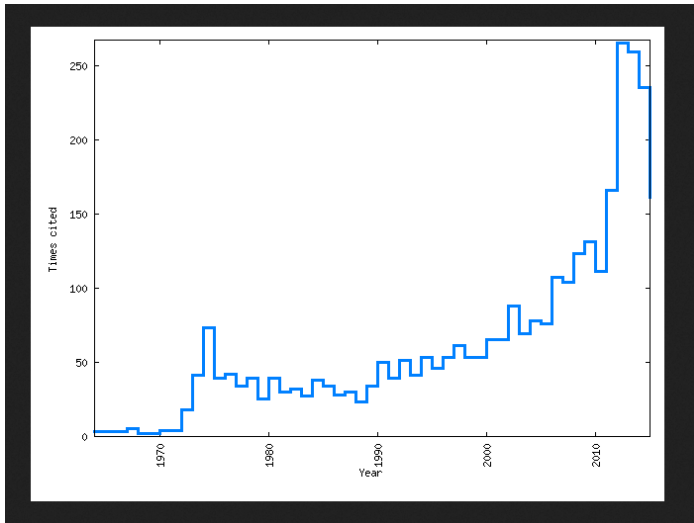
Tait Institute of Mathematical Physics, University of Edinburgh, Scotland

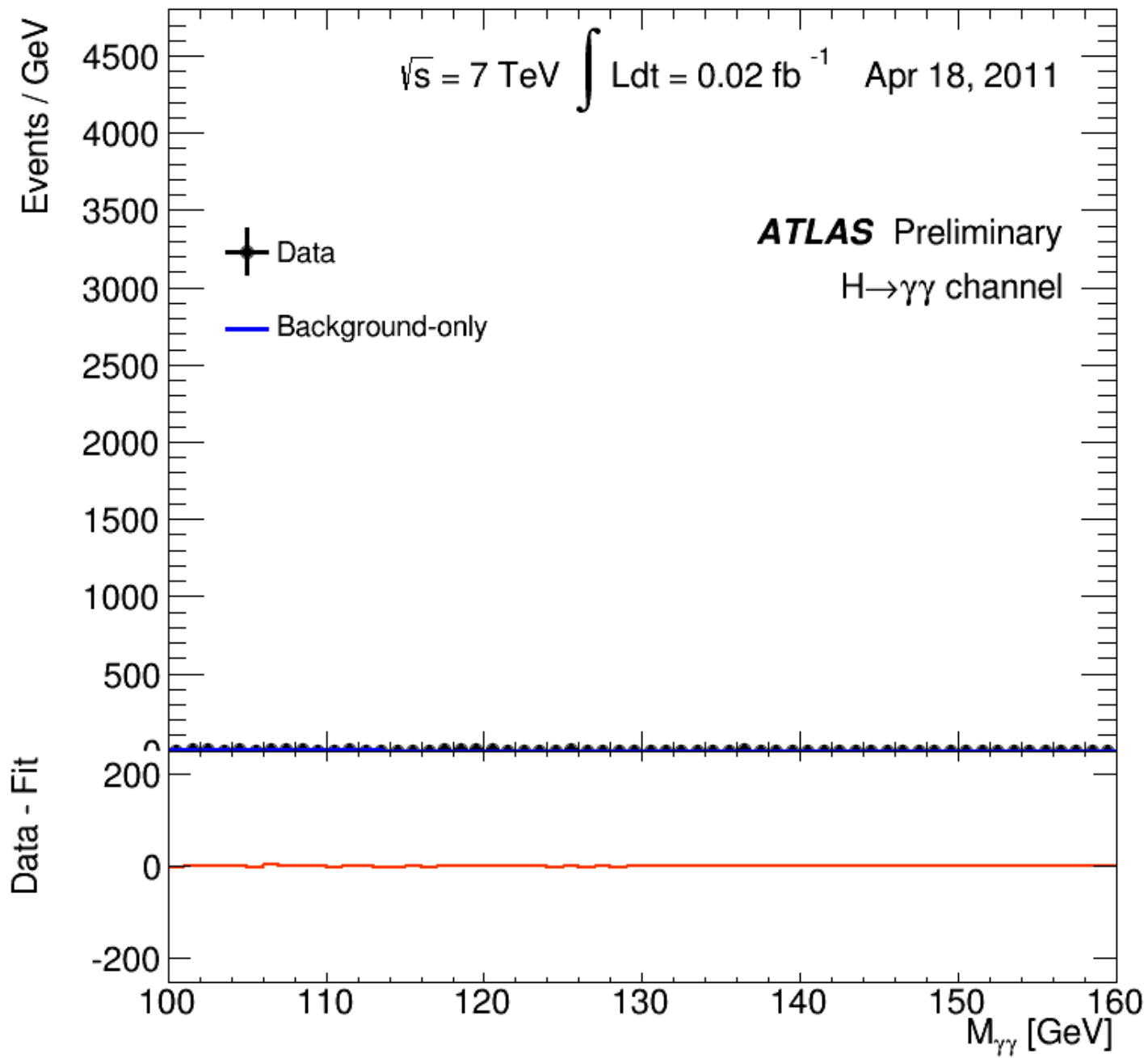
Received 27 July 1964

Recently a number of people have discussed the Goldstone theorem ^{1, 2)}: 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 ³⁾ 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 ⁴⁾, 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 ⁴⁾, let us consider a theory of two hermitian scalar fields







Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC ☆

Universally Available

This paper is dedicated to the memory of our colleagues who worked on CMS but have since passed away. In recognition of their many contributions to the achievement of this observation.

CMS Collaboration*

CERN, Switzerland

32 siders artikkel – 16 sider med forfattere 😊

S. Chatrchyan, V. Khachatryan, A.M. Sirunyan, A. Tumasyan

Yerevan Physics Institute, Yerevan, Armenia

W. Adam, E. Aguilo, T. Bergauer, M. Dragicevic, J. Erö, C. Fabjan¹, M. Friedl, R. Frühwirth¹, V.M. Ghete, J. Hammer, M. Hoch, N. Hörmann, J. Hrubec, M. Jeitler¹, W. Kiesenhofer, V. Knünz, M. Krammer¹, I. Krätschmer, D. Liko, W. Majerotto, I. Mikulec, M. Pernicka[†], B. Rahbaran, C. Rohringer, H. Rohringer, R. Schöfbeck, J. Strauss, F. Szoncsó, A. Taurok, W. Waltenberger, G. Walzel, E. Widl, C.-E. Wulz¹

Institut für Hochenergiephysik der OeAW, Wien, Austria

V. Chekhovsky, I. Emeliantchik, A. Litomin, V. Makarenko, V. Mossolov, N. Shumeiko, A. Solin, R. Stefanovitch, J. Suarez Gonzalez

The Ashlad and His Good Helpers : illustrating the BEH Mechanism



By tomsalad



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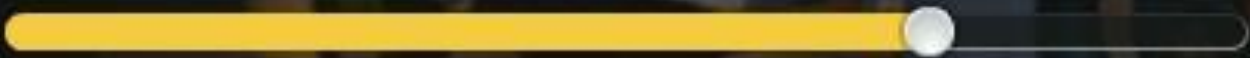
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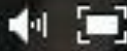
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Twitter



11:19 / 15:13



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



Subtitles



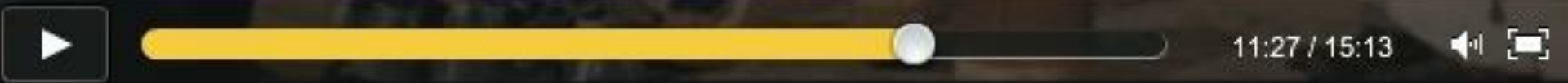
Export



Facebook



Twitter



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



CC Subtitles Export Facebook Twitter

▶ 11:36 / 15:13 🔊 📺

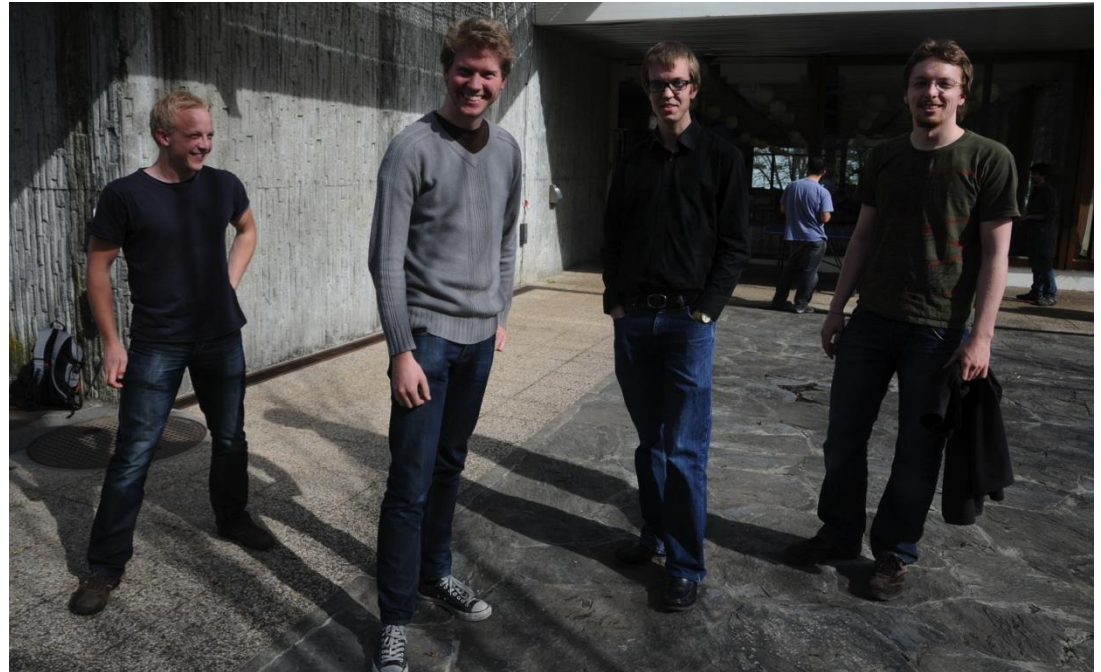
“Your Majesty, I will be straight back!”



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.

Norge og CERN

- Medlem siden starten i 1954
- Bidrag 2015
2,8 % (31 MCHF)
- CERNs totale budsjett:
1,1 milliarder CHF



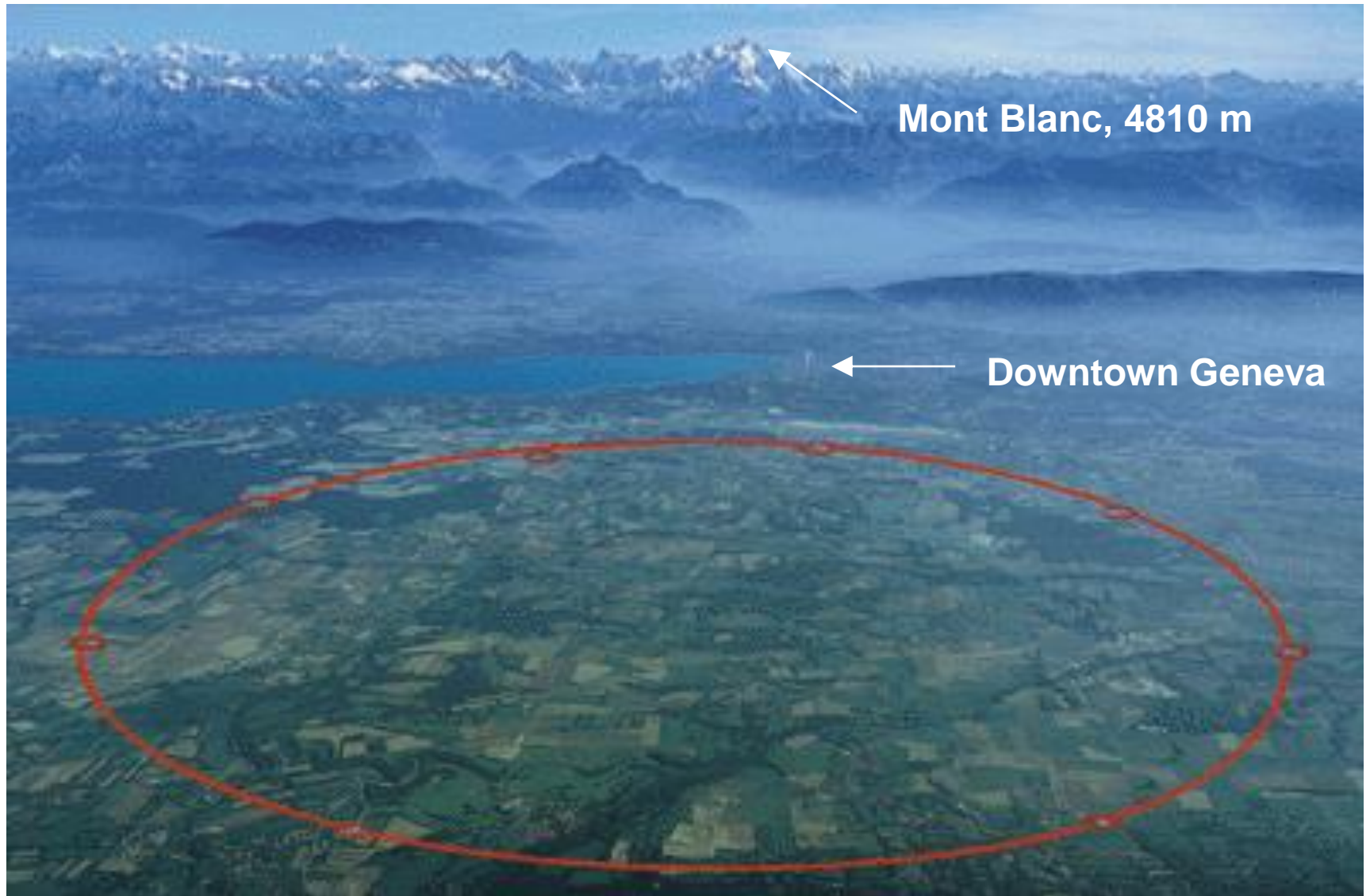
Norske tekniske studenter

Historikk

- UNESCO konferanse i Lausanne 1949
- Pre-CERN 1952
- CERN 1954



CERN Site



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

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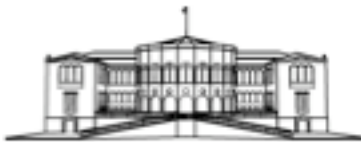
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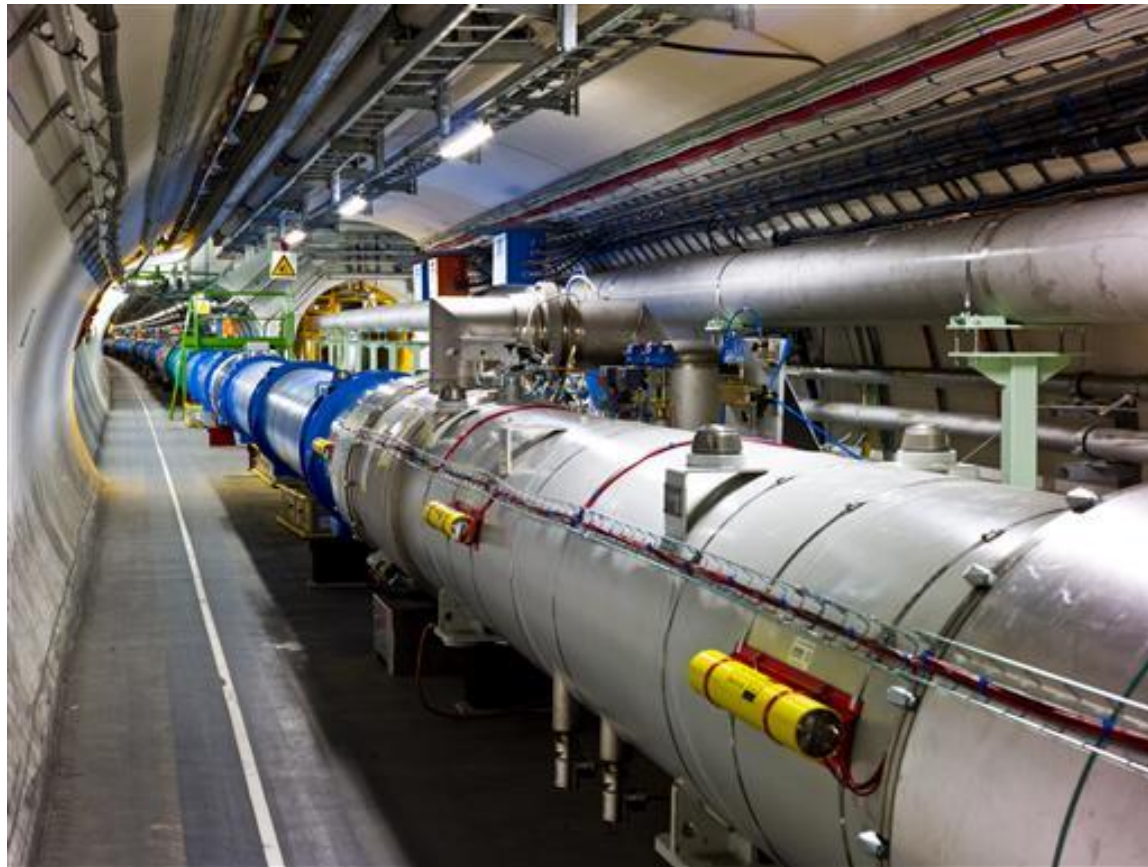
I have the honour to be,
Sir,
Your obedient Servant,

For the Minister
(signed)
Secretary-General

Hadde ikke Stortinget vært på ferie,
så hadde kanskje CERN havnet i Norge ...



LHC akseleratoren, sep. 2008



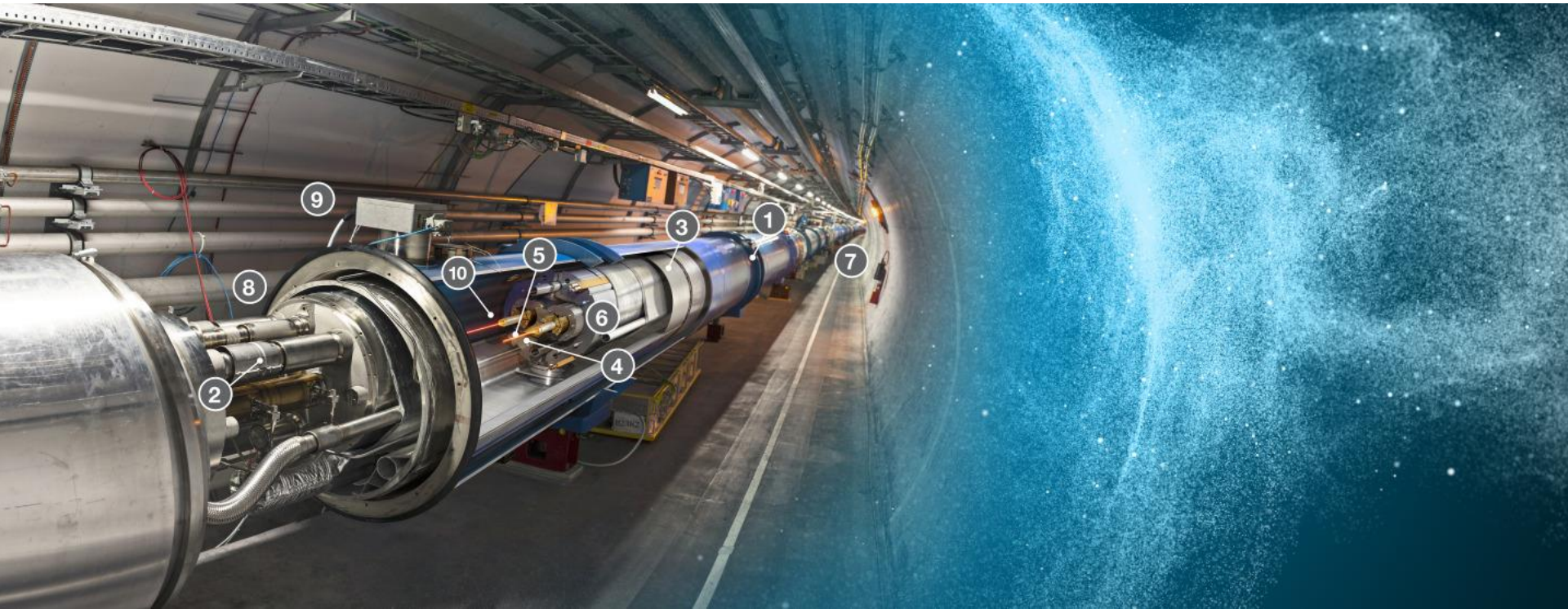
Et prosjekt diskutert og planlagt fra midt på 80-tallet

Og så ..., « the big bang »!

« Collateral damage: magnet displacements »



En palett med teknologier - nå klar for 13 TeV

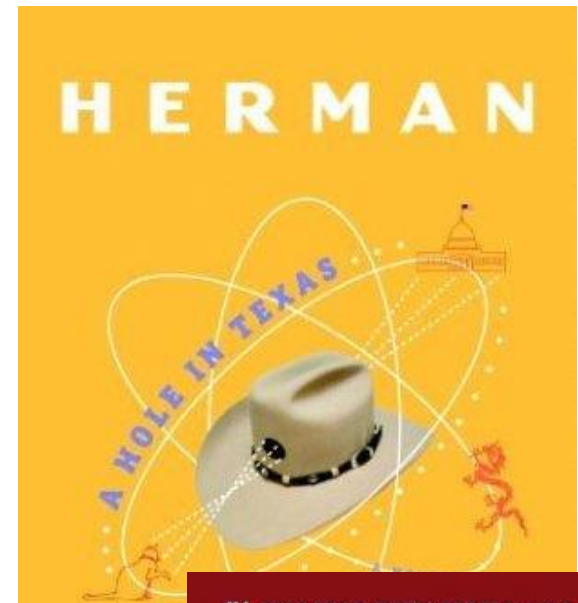


- 1) Nye magneter
- 2) Sterkere koblinger
- 3) Sikrere magneter
- 4) Høyere stråleenergi
- 5) Bedre fokusert stråle
- 6) Mindre og tettere proton pakker
- 7) Høyere spenning
- 8) Førsteklasses kuldeteknikk
- 9) Strålesikker elektronikk
- 10) Sikrere vakum

Litteratur: krim

A Hole in Texas

Herman Wouk



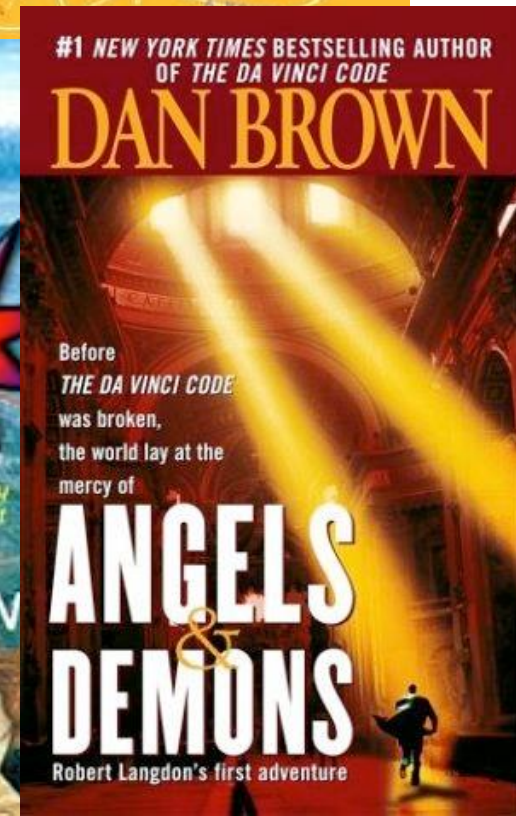
Engler og demoner

Dan Brown

eller hva med

Catalyzed fusion

Francis Farley



Film

DECAY

THE GREATEST DISCOVERY IN PHYSICS COULD BE OUR LAST.



PARTICLE FEVER



“Typisk norsk å være god ...”

Gro Harlem Brundtland under de Olympiske leker i 1994

- Gjelder dette også partikkelfysikk?
 - [Sophus Lie](#) (1842-1899) – [matematisk grunnlag](#)
 - [Kristian Birkeland](#) (1867-1917) - Aurora borealis
 - [Odd Dahl](#) (1898-1994) “Trollmann og rundbrenner”
 - [Rolf Widerøe](#) (1902-1996) – “Ringenes herre”
 - [Kjell Johnsen](#) (1921-2008) – Ledet ISR prosjektet
 - [Bjørn Wiik](#) (1937-1999) – Direktør ved DESY
- Hva med dere? Hvem blir den neste på lista?