# From LEP to LHC

**At the occasion of the retirement of Lyn Evans**

Herwig Schopper

## BBC interview with Lyn Evans:

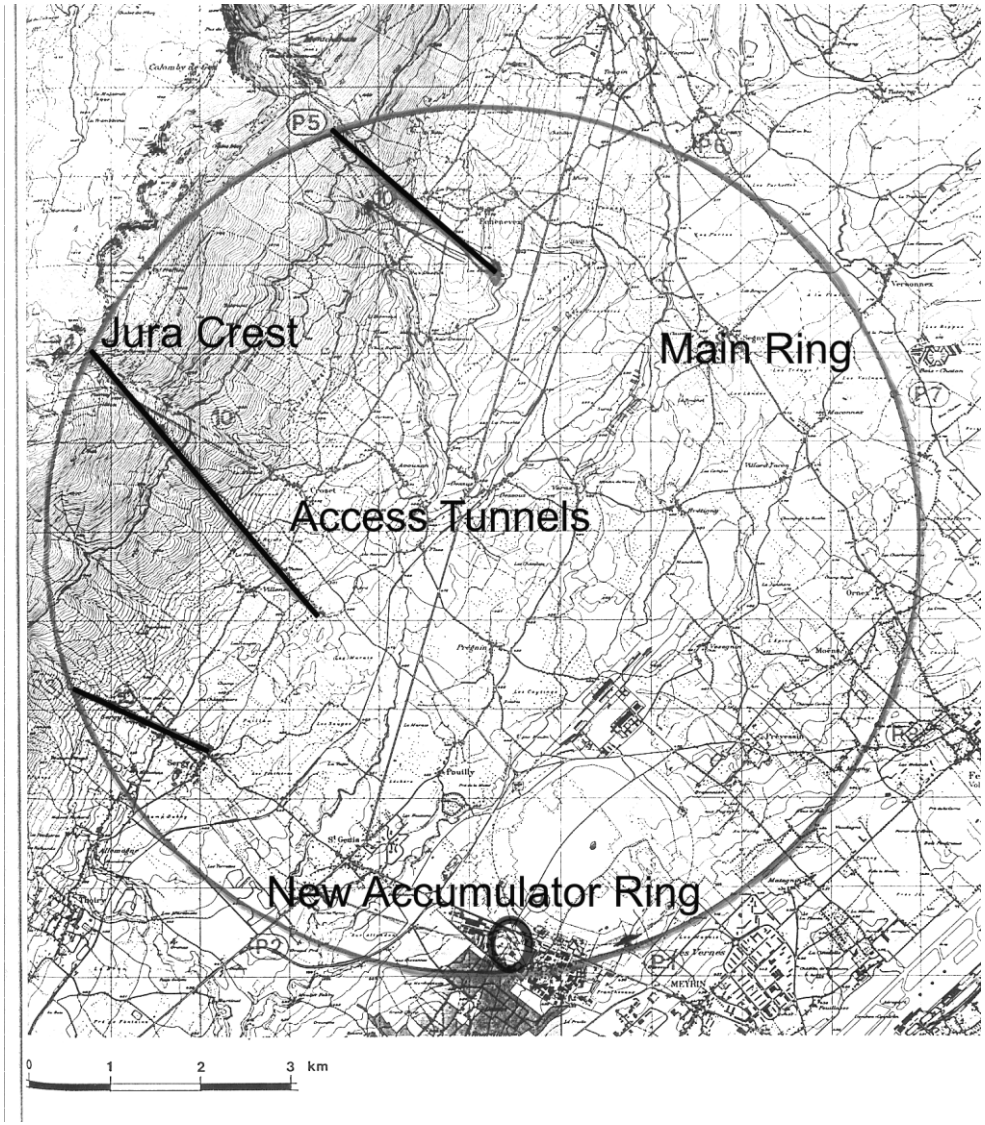
**'I've been around a long time and seen big projects, but when I go into that tunnel I feel really overawed……My job involves quite a bit of travel. Recently, I met the President of China and thought to myself, "Not bad for a bloke from Aberdare!"**


**Inspired: 'Evans the Atom' at school in Wales in 1962**

**'My biggest career hurdle was passing O Level French which was a requirement for university. It was a nightmare. Ironically, since joining CERN, I spend half of my time working in French.'**

# LEP was cradle for LHC

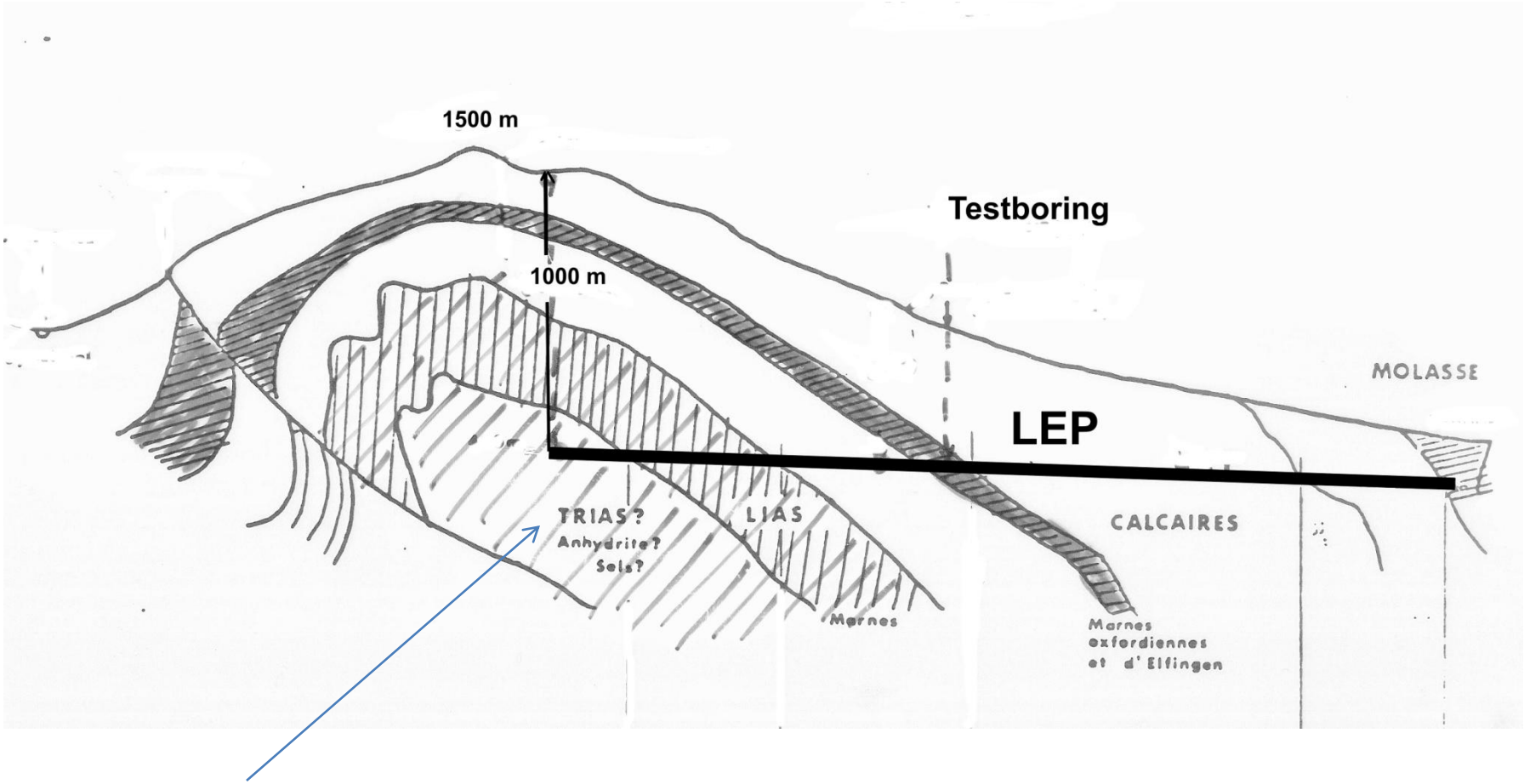
1. **Tunnel size was chosen for LHC**
2. **LEP Experiments precursors of LHC Experiments**
3. **Create confidence with neighbouring population and local authorities**
4. **Management and infrastructure**
   **first project with constant lab budget**
   **mass production**




**First proposal by J.Adams 'Pink Book'**

**( E.Keil, W.Schnell and C.J.Zilverschoon) summer 1979**

**30 km circumference**
**Deep under Jura**
**1000 m cover by rocks**
**3 long access galleries**




**Terrible rock, impossible for tunneling**
**Move out**

# Advice from geological experts

## Prof. Giovanni Lombardi,

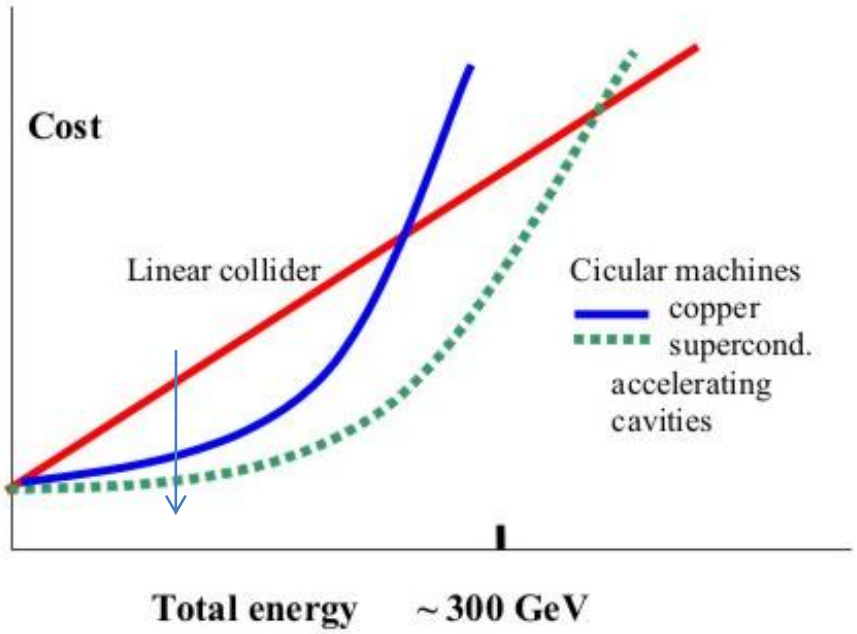
**a worldwide expert in tunnelling**

**When he learned about the boundary conditions for LEP (e.g. Time schedule, 'constant' budget) he replied:**

***'you either get the tunnel out of the mountain,***
***or my advice is to let others build this tunnel'.***

**Proposal for 27 km tunnel**

**1983 Thatcher at CERN: ‚Do not treat me as Prime Minister, but as fellow scientist‘**




**Mrs.Thatcher‘s 2 questions:**

1. **Why is LEP round?**
2. **What is size of next tunnel at CERN?**

# New Aspect: SSC in USA

**After discovery of W and Z at CERN in 1983**

***Nobel Prize for C.Rubbia and S. van der Meer***

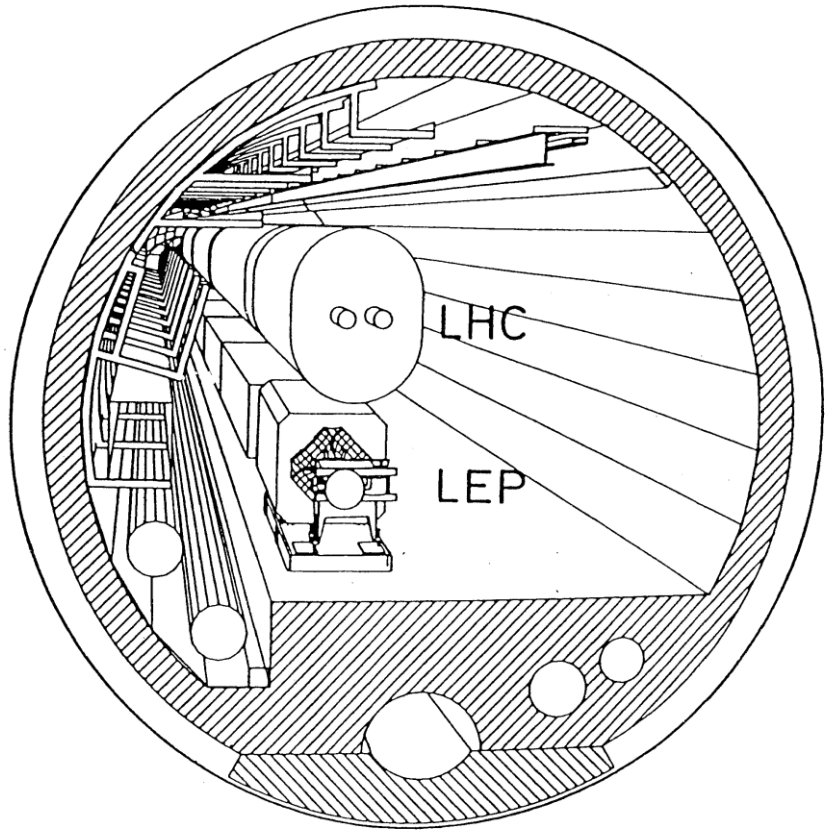
**NY Times: „Europe 3, US Not Even Z-Zero“**

**SSC was proposed in USA**

**Cicumference 87 km, beam energy 20 TeV**

**Beat a Hadron Collider in LEP Tunnel?**

ECFA 84/85
CERN 84–10
5 September 1984




LARGE HADRON COLLIDER
IN THE LEP TUNNEL

# Workshop at Lausanne September 1984

## „Large Hadron Collider in the LEP tunnel“

**On top of LEP**

**About 9 TeV /beam**

**LHC could be faster realised than SSC,**
**use tunnel and infrastructure (cheaper)**

**Lower energy partly compensated by higher luminosity**

# Tunnel circumference ?

**Letter from John Adams to Herwig Schopper (12 March 1981):**

**„It seems to me that your choice now is either to battle on with the 27 km circumference LEP with possible delays in starting construction, continous trouble with the French authorities at all levels and a serious risk of delays and overspending on the project, or to go flat out for a smaller LEP …..which would avoid all these problems“**

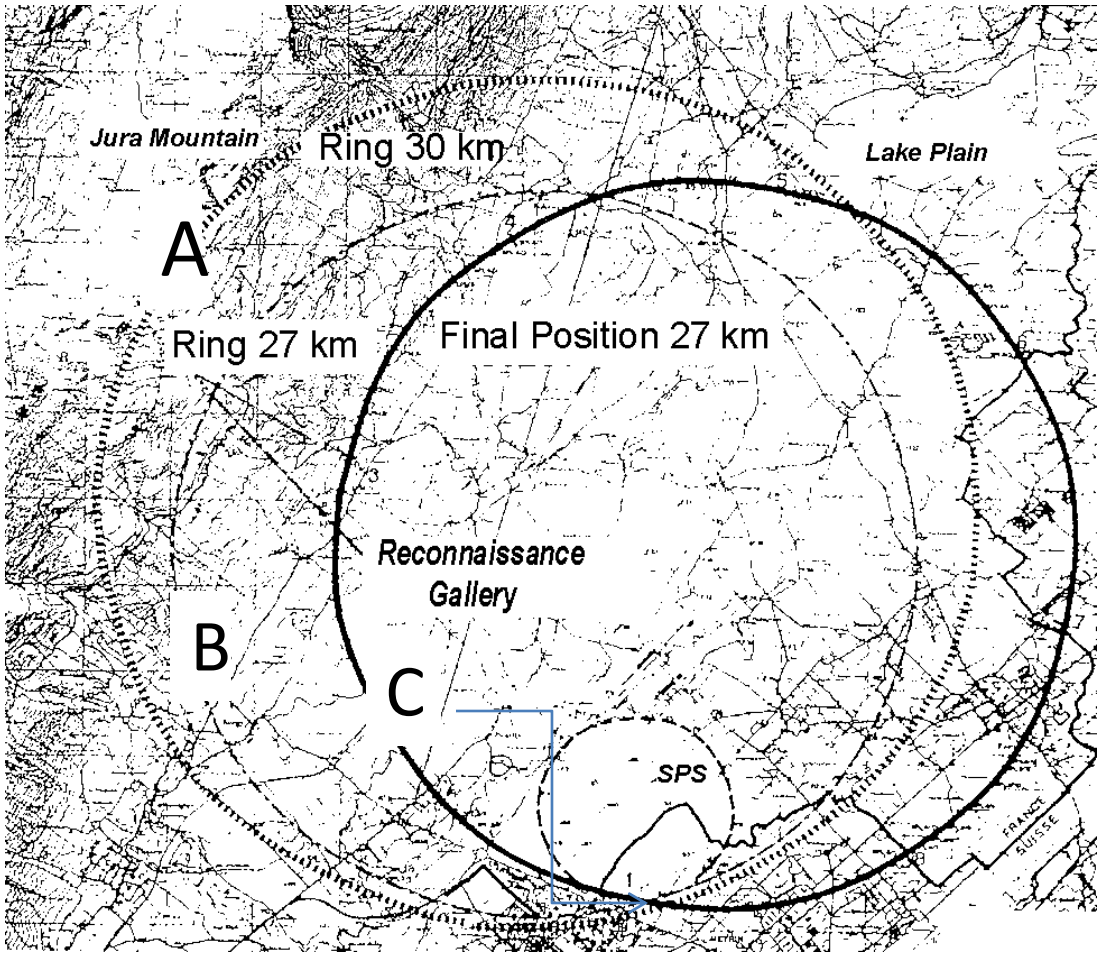
**Adams proposed 22 km circumference**

**Similar letters by others**

In spite of warnings with Emilio Picasso
we took decision **(without committees!)**
to keep 27 km tunnel
to allow highest possible energy for LHC

22 km circumference would have been
sufficient for Z and W physics

**LEP tunnel size was chosen in view of LHC !!**

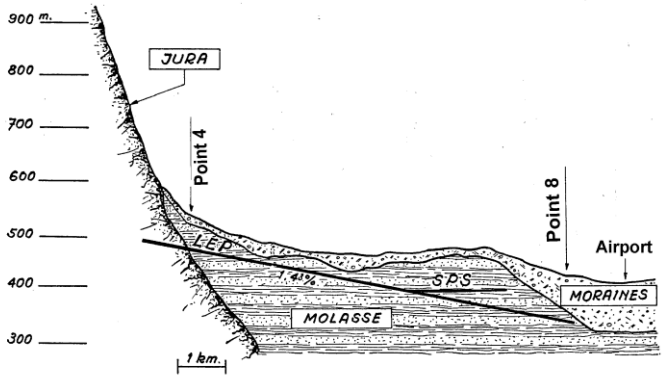



## To make the risk tolerable:

**Rotate the ring somewhat out of Jura**

**(3 km remained difficult)**

**Put tunnel on inclined plane**

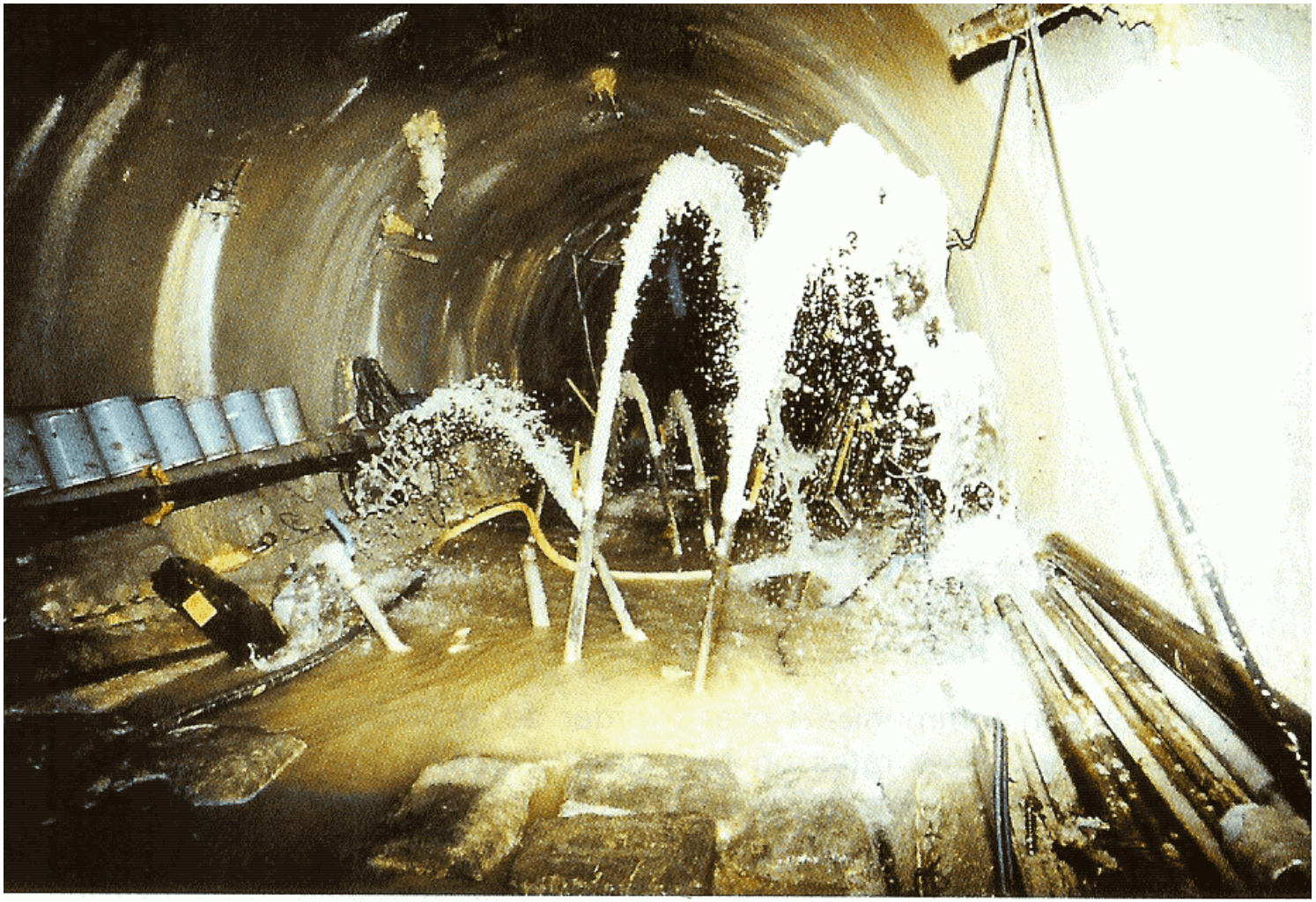



**Position:**

**A impossible**

**B approved by Council, still 8 km under Jura**

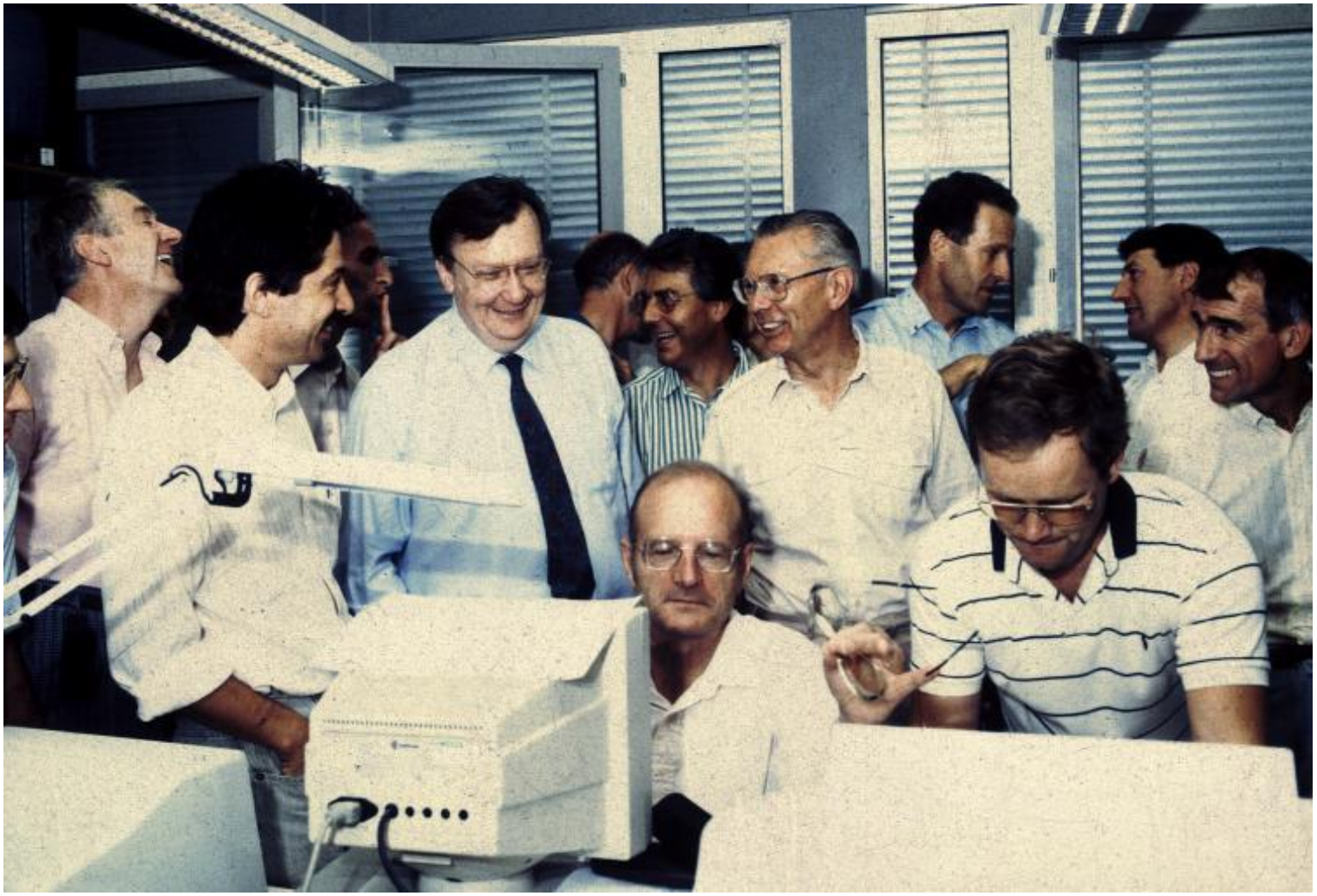
**C Final , after Council approval, 3 km under Jura, no access shafts**



**No disastrous event, but we had to pay for our decision:**
**water delayed project by about 1 year**

„Ende gut,
Alles gut“

Inauguration
of tunnel



**First LEP beam 14 July 1989**

# New technologies for LEP

## e.g.„Concrete Magnets“
## 3400 dipoles
**Designed for 125 GeV beam**

**Mass production:**

**Testing large quantities**

- **Intermediate storage**
- **Transportation to tunnel**

# Long Range Planning Committee

**Set up by Council in 1985** **Chair Carlo Rubbia**

**To study:**

- **p-p collider (G.Brianti)**
- **Linear collider**

**Proposal presented in 1987:**

**p-p collider with 8 TeV Beam energy (on top of LEP)**

**Start development programme for SC magnets**

**„If a decision to construct LHC could be taken in 1989….**
**one would expect first collisions by 1995“**

# SSC international project??

G.Montanet, D.Colley, D.Stairs
J.Horowitz, V.Soergel, N.Cabibbo, P.Fasella, H.Schopper
J.Rembser, A.Trivelpiece, H. Attkinson, T.Nishikawa

**1987 Meeting at Washington to discuss**
**European, Canadian and Japanese participation in SSC**

**Our Question: What is the possible influence of partners, e.g. on SSC design, experiments?**

**Answer: „ The President (Reagan) has decided to build SSC, You join the project or leave it“**

## The end of SSC as international project

**On 21 October 1993 SSC cancelled by US Congress**

**From now on LEP without competition**

**But not without problems!**

# LEP Experiments

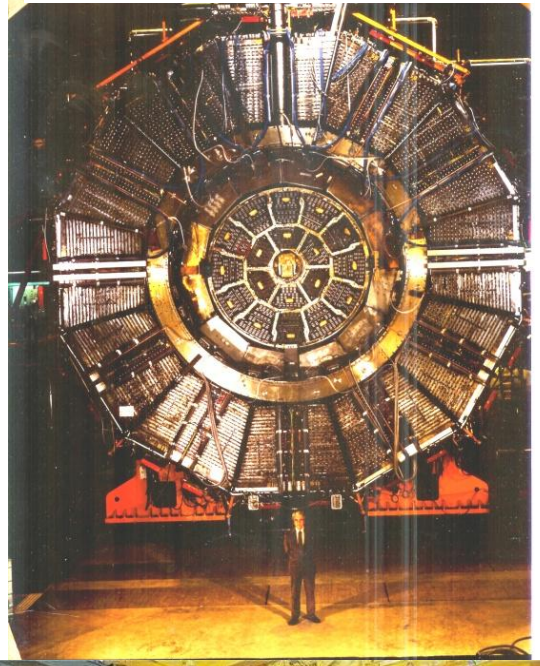
## Precursors to LHC experiments:

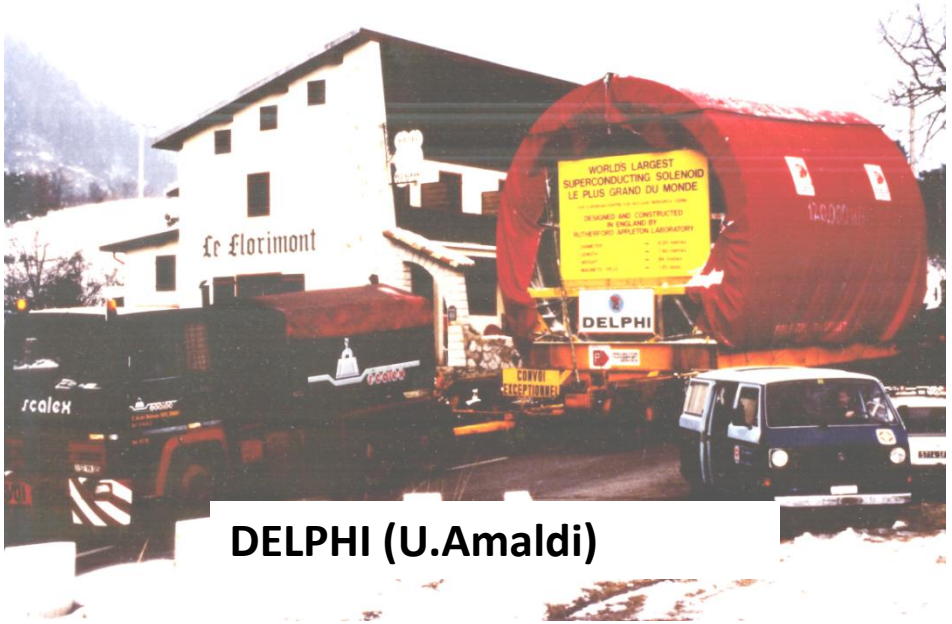
- Major part of financing from outside
- Finance Committee for each Experiment
  (to involve national funding authorities)
- Organisation (spokesperson, technical coordinator)
- Data distribution (WEB!)

**‚Experiments' become institutions by themselves**

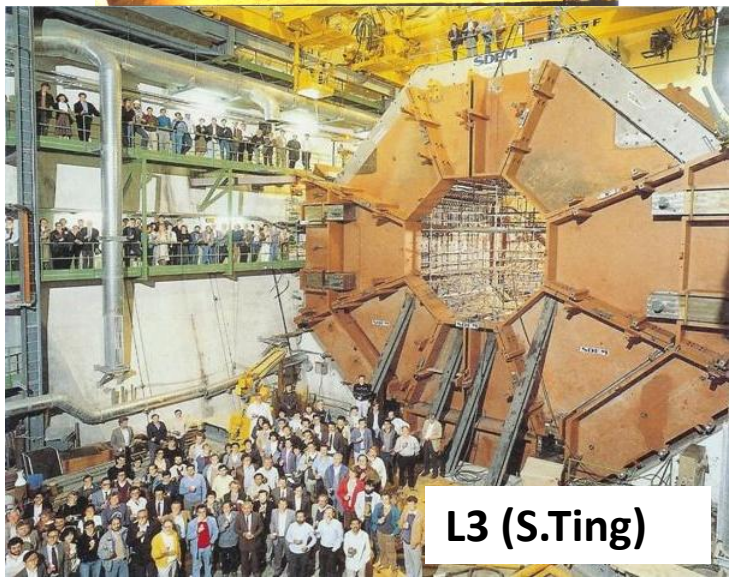
**Worldwide participation since LEP unique**

ALEPH (J.Steinberger)






DELPHI (U.Amaldi)



L3 (S.Ting)

OPAL (A.Michelini/R.Heuer)

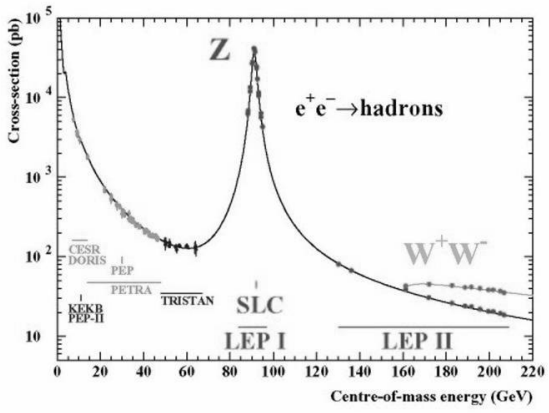
# Rolf Heuer, DG

CERN Bulletin,24 May 2010

**With LEP, the scale of experiments at CERN took a big leap forward, as did the degree of collaboration between them. From operating as independent entities when LEP switched on in 1989, they went on to develop common working groups on many physics topics. And when LEP switched off in 2000, it was these working groups that had the last word. It's a model that works well. Sharing best practice and combining results delivers the best physics in the long run while not compromising the healthy spirit of competition that exists between the experiments. ……. the LHC community is picking up where LEP left off.**

# Physics Results from LEP

**LEP has turned HEP from 10 % precision into high precision science**

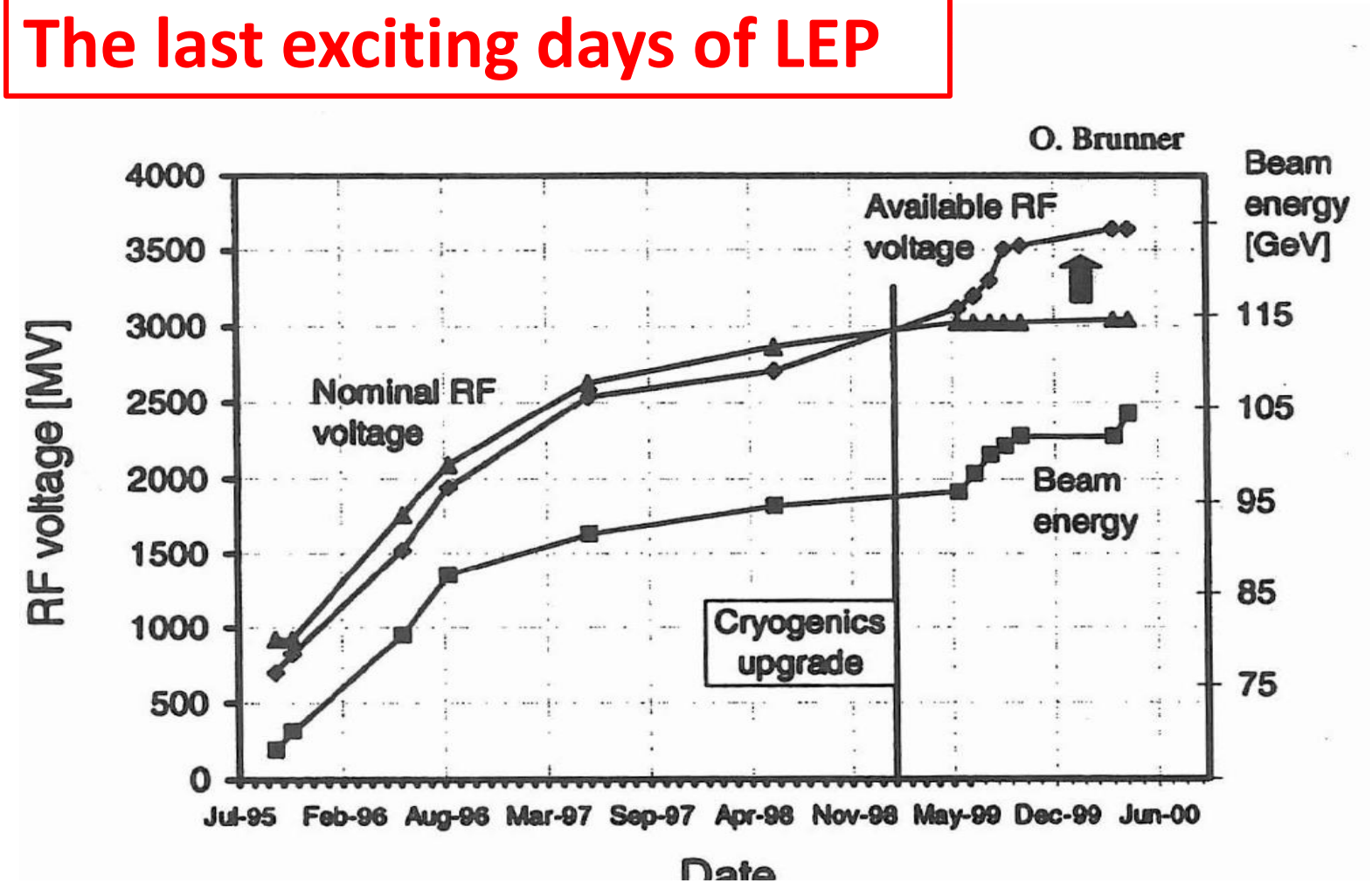



**Has shown that Standard Model is renormalizable field theory**

**The basis from which LHC physics starts**

**All Monte Carlos !**

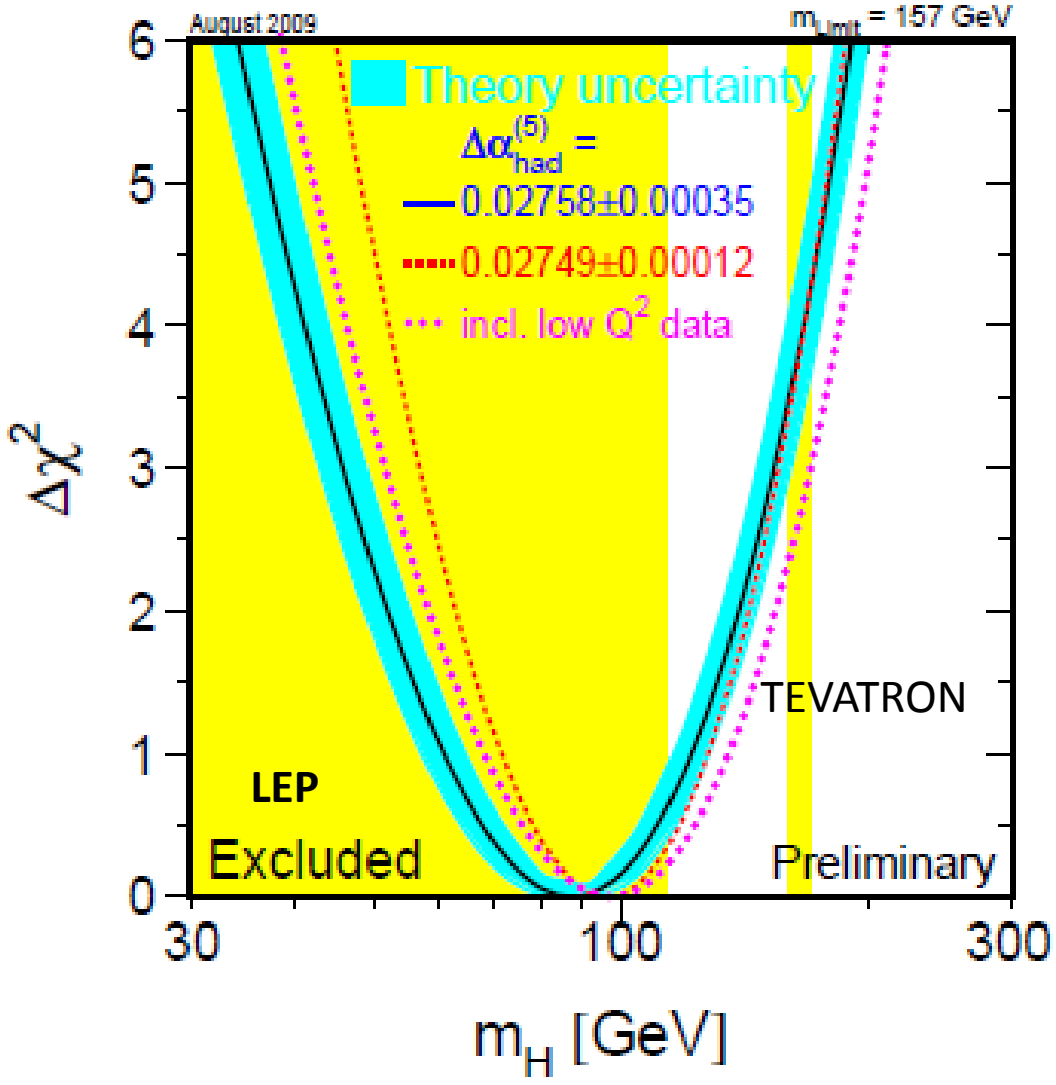
# The last exciting days of LEP




**The high energies could be achieved since Lyn Evans (LHC project leader) agreed to use cryogenics bought for LHC to cool LEP rf cavities.**

# Higgs: best results still from LEP

**Where is it?**



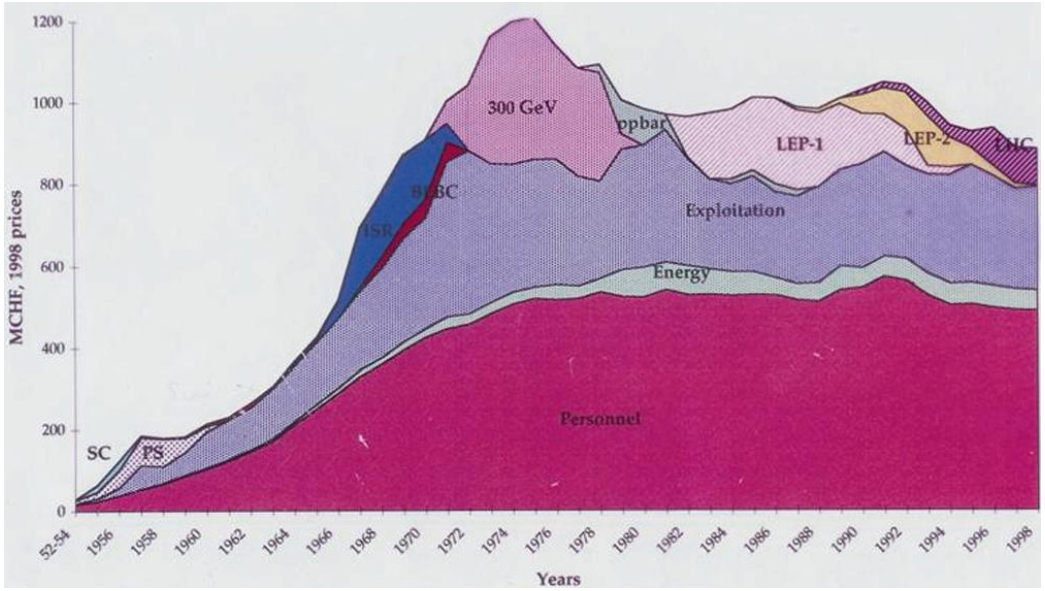

**Higgs mass in range of LEP ??**

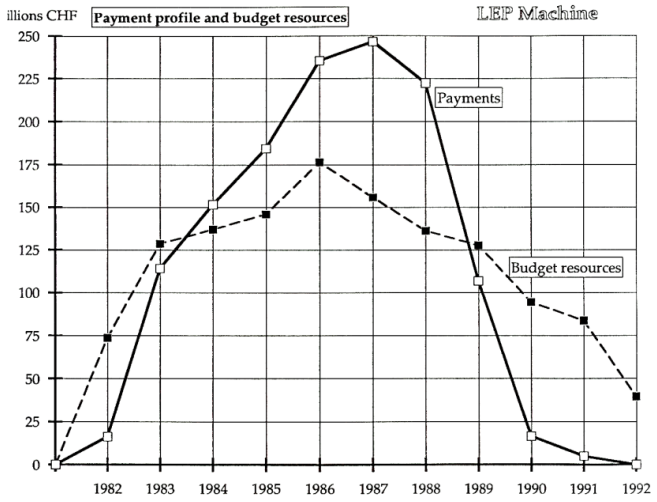
**Magnets could have gone to 125 GeV!**

# Many lessons for management

**The first project at CERN to be realised with constant budget**

**Cash flow, Debts!!**



# Public relations

**Population around CERN did not know what CERN was doing**

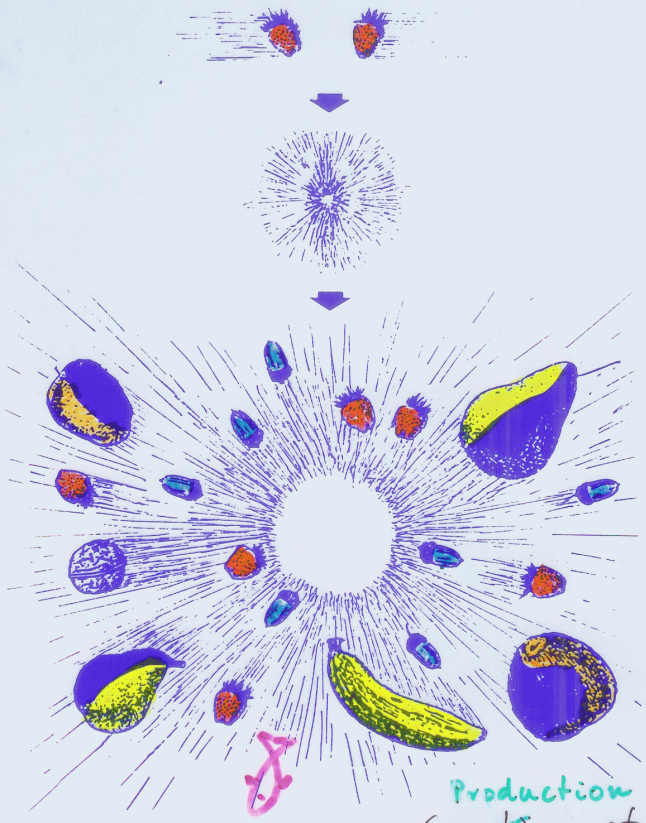
**‚N' nuclear energy??**

**CERN involved in military research?**

**Several hundered presentations in Geneva and neighbouring villages established new confidence**

# How energy becomes matter ...

*A first look at the world of particles*



Production
Creation of
Matter

CERN

# Closure of LEP in 2000

**The ministers unveiled a commemorative plaque :**

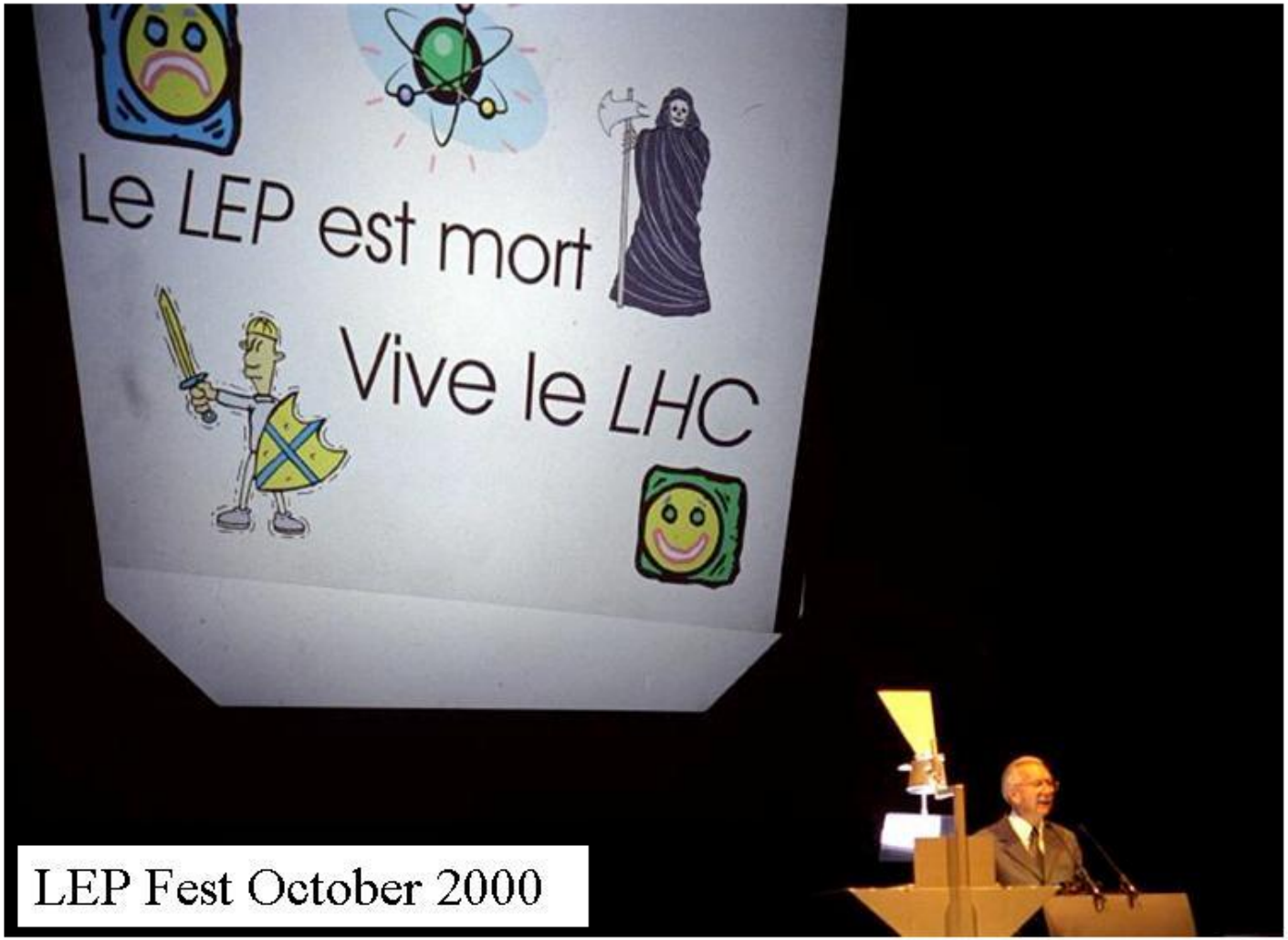
***We, the participating countries, recognise the outstanding scientific achievements of LEP that have illuminated the family structure of fundamental particles and the texture of our Universe.***

***LEP has stimulated new ideas and technologies with applications reaching far beyond the realms of fundamental physics. Best known is the World Wide Web.***

***LEP has set new standards for international scientific collaboration, giving scientists from all over the world the opportunity to work together and push back the limits of the unknown.***

***LEP achievements open the way for a new challenge: the Large Hadron Collider (LHC), which will allow us to go deeper in the exploration of the structure of matter, space and time.***

LEPmortHS



Picasso's Summary