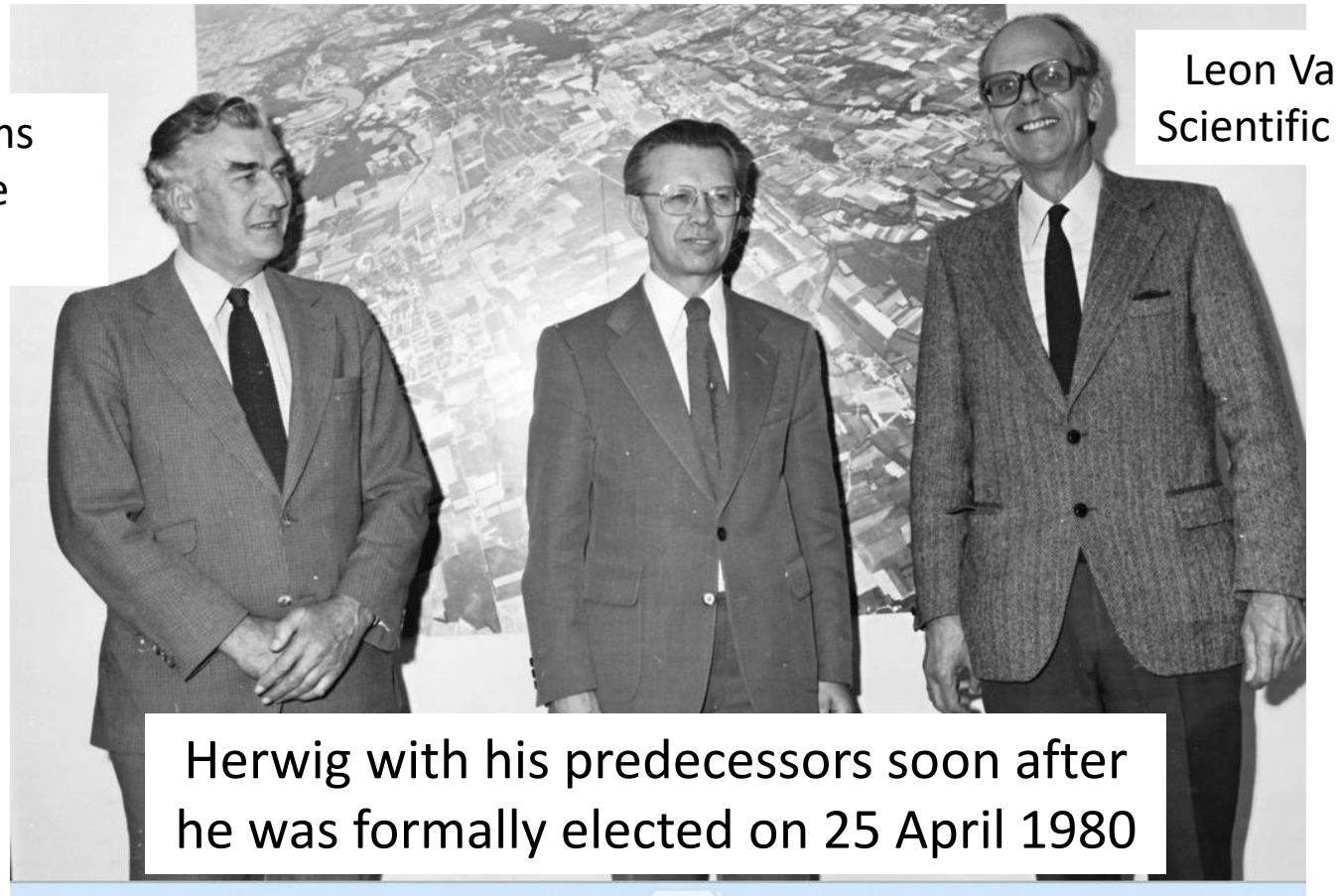
Herwig Schopper as Director General of CERN 1981-1988

Chris Llewellyn Smith

John Adams
Executive
Director



Leon Van Hove
Scientific Director

Herwig with his predecessors soon after he was formally elected on 25 April 1980

Origin of LEP

In 1975, while on sabbatical at CERN, Burt Richter wrote this note:

VERY HIGH ENERGY ELECTRON-POSITRON COLLIDING BEAMS
FOR THE STUDY OF THE WEAK INTERACTIONS

B. Richter*)

CERN

ABSTRACT

We consider the design of very high energy electron-positron colliding-beam storage rings for use primarily as a tool for investigating the weak interactions. These devices appear to be a very powerful tool for determining the properties of these interactions. Experimental possibilities are described, a cost minimization technique is developed, and a model machine is designed to operate at centre-of-mass energies of up to 200 GeV. Costs are discussed, and problems delineated that must be solved before such a machine can be finally designed.

which was published on 19 March 1976 as CERN/ISR-LTD/76-9

This led to a major study set up in April 1976:

CERN 76-18
8 November 1976

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

PHYSICS WITH VERY HIGH ENERGY
e^+e^- COLLIDING BEAMS

L. Camilleri, D. Cundy, P. Darriulat, J. Ellis, J. Field, H. Fischer, E. Gabathuler, M.K. Gaillard, H. Hoffmann, K. Johnsen, E. Keil, F. Palmonari, G. Preparata, B. Richter, C. Rubbia, J. Steinberger, B. Wiik, W. Willis and K. Winter

355 page report, which includes Burt Richter's paper as the first of 8 Appendices

Origin of the LHC

The LEP idea, which was enthusiastically taken up by ECFA, was initially resisted by John Adams

He relented, on the basis that LEP should be seen as a step to putting a proton machine in the same tunnel:

John's note goes on the describe possible sets of parameters

27 July. An accelerator complex for Europe.

- ECFA is pressing at the moment for an e+e- machine of 100 + 100 GeV energy. Nobody is pressing for a fixed target p machine or pp. Russians plan for UNK USA for ISABELLE
- An e+e- machine for the whole of Europe with an ageing SPS in the late 1980's it offers a very specialised set of facilities
- Can one imagine a more flexible new complex for Europe which could offer a wider range of experimentation in the 1990s ?
- The solution must lie in a complex which can accelerate and store both electrons & protons. It need not be built all at the same time but decided be realisable in due course & following the priorities of physics.

LEP Approval

- Herwig immediately began working on the proposal to build LEP, which was approved on 30 October 1981, for construction in stages with a constant budget, at a lower level than requested, with no contingency – except time

  This obliged him to make unpopular cuts to the rest of the CERN programme, including closing BEBC and stopping the ISR in 1983, and to shift the target date for completing LEP to the end of 1988 to flatten the peak cash flow

- The length of the tunnel was a controversial issue

  Herwig sided with those who argued it should be as long as practicably feasible to have the best chance of finding the Higgs boson, and to allow it to house a proton collider with the highest possible energy later, and chose 27 km which involved going under the edge of the Jura

  This was opposed by John Adams, Carlo Rubbia and others who thought it too risky, and argued for 22 km

  Luckily Herwig took the risk which materialised, when water broke in to the tunnel (which was the longest tunnel in Europe until the Channel Tunnel was built)

September 1986

LEP Construction

Many technical challenges:

very high vacuum, energy efficient radio frequency system with energy stored in spheres when bunches were not passing (later superconducting cavities), concrete magnets,...

But apart from the leak all went well:

Meanwhile the Detectors

were being built with (unprecedentedly) only 15% funding from CERN, by collaborations of unprecedented size, initially involving 100 institutions and some 1000 researchers, mostly from the CERN member states (who funded 47%), but also from Canada, China, East Germany, Hungary, Israel, India, Japan, Poland, the USA and the USSR (who funded 38%)

Excavation of the tunnel was completed on 8 February 1988. After the last explosion removed a thin wall, Herwig stepped through it to meet Emilio Picasso who was waiting on the other side, and they cut a blue ribbon

First Collisions

were observed during the night of 13 August 1988

1st beam circulating July 1988

First Results

From the start it was known that measuring the width of the Z would determine the number of light neutrinos

In August 1989, 233 events observed at the SLAC's Single Pass Collider were used to set an upper limit of 4.4

This was trumped when, on 13 October 1989, CERN issued a press release with the title "First Physics Results from LEP." that included the news

"there are no other neutrino types in nature beyond the three associated with the electron, muon and tau particles"

The final result from all four experiments at the end of LEP was that the number of light neutrinos is 2.9840 ± 0.0082

I will return to LEP/Herwig's legacy later

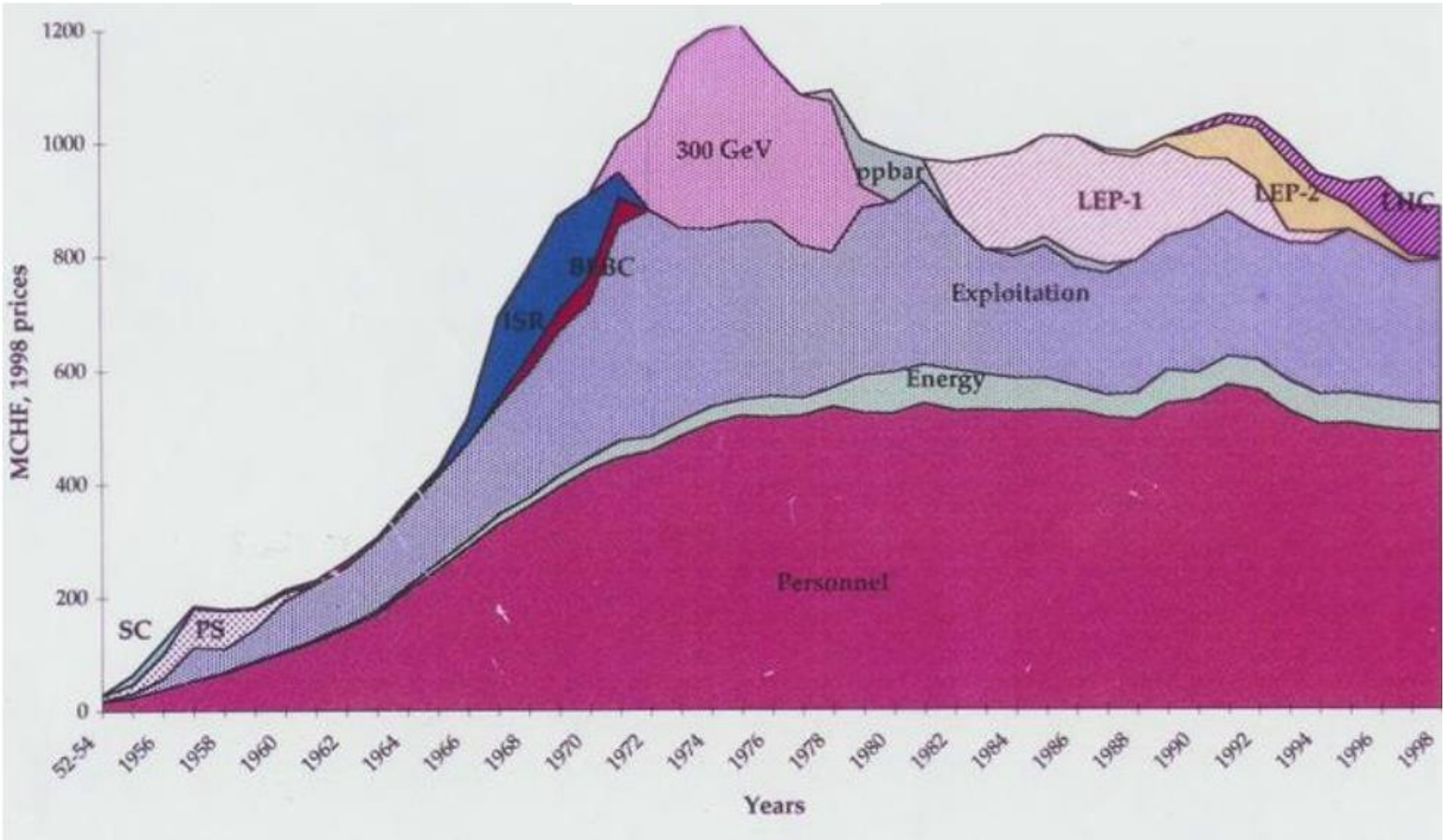
LEP was

- built almost on budget (despite compensating the contactor for the delays due to the flood) , and
- completed almost on time: collisions on 13 August 1989 vs. target date of end 1988

With fixed funding from the Member States:

+ money borrowed from the CERN pension fund

Thatcher Peak



Back to 21 January 1983

Press Conference announcing the discovery of the W

Followed by discovery of the Z, announced on 1 June 1983l

Meanwhile in the USA

..construction of the 2 in 1 magnets for the 200 GeV x 200 GeV proton-proton collider (Isabelle) at Brookhaven was running into problems. On 6 June 1983 the New York Times published this opinion piece:

Europe 3, US Not Even Z-zero

CERN announced discovery of the two W bosons last January and has now found the Z-zero. With that and the previous discovery of ''gluons'' at a German machine, European accelerators have established a better record of success than any of the three American laboratories.

American physicists blame lack of Federal support. But some observers, like the President's science adviser, George Keyworth, blame the physicists for routinely spreading funds among the three major American research centers. ''Our world leadership in high energy physics has been dissipated,'' he has said. .....'

A panel of American physicists is meeting this week at Woods Hole to decide the fate of the limping Brookhaven accelerator and to plan a new machine for the future. .....

The 3-0 loss in the boson race cries out for earnest revenge. The physics team needs to try harder, and coach Keyworth should reward any sensible new strategy with management's full support.

1 July 1983: a HEPAP subcommittee recommended cancelling Isabelle and, encouraged by Keyworth, pushing for a 40 TeV Superconducting Super Collider to 'regain US leadership'

Herwig's Reaction

At the International Conference on High Energy Physics in August, Herwig announced an intention to make a further study of a proton ring in the LEP tunnel

The study began later in 1983, in preparation for the International Committee on Future Accelerators (ICFA) seminar in Japan in May 1984. The climax of these studies was the Lausanne workshop in March 1984, at which I was theoretical convenor

CHAPTER I

THE PHYSICS CASE

Physics with a Multi-TeV Hadron Collider

C.H. Llewellyn Smith

1. INTRODUCTION

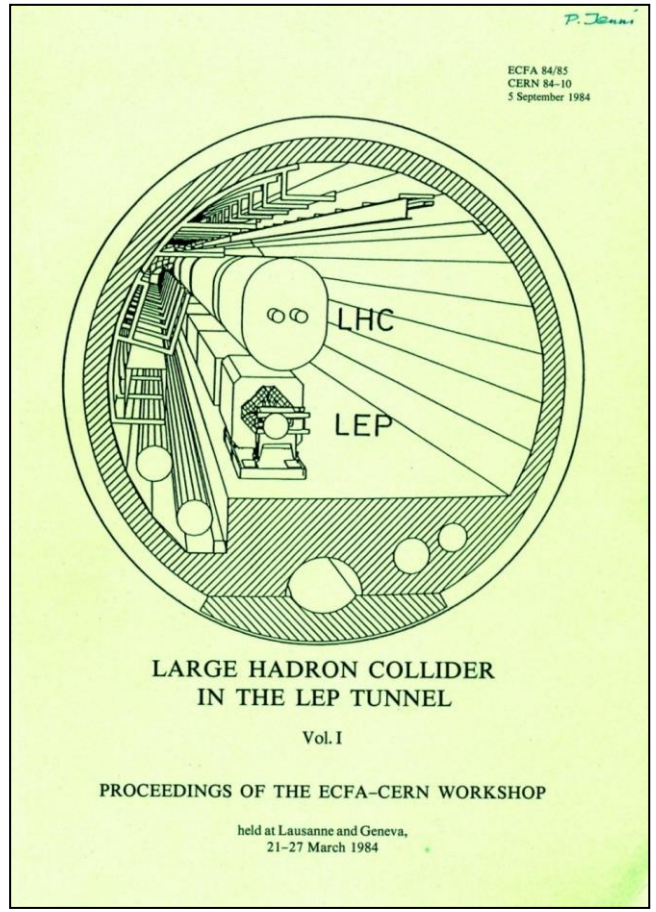
A large hadron collider (LHC) has always seemed an obvious option to follow LEP and it is clearly becoming time to start R and D on suitable magnets.

.....

11. SUMMARY AND CONCLUSIONS

A theoretical consensus is emerging that new phenomena will be discovered at or below 1 TeV. There is no consensus about the nature of these phenomena but it is interesting that many of the ideas which have been suggested can be tested in experiments at an LHC.

The physics case, much developed by John Ellis and collaborators, has remained essentially unchanged



Aside:

During the Lausanne meeting I had a call from Sir John Kendrew. He told me that he had agreed to lead a review of UK Participation in CERN, and asked me to act as consultant to the group. He told me that if I said no, they would go ahead without a consultant.

In July 1985 the group recommended that the UK should remain in CERN until LEP was completed, but (over my strong objections) thereafter only if the UK's particle physics budget were reduced by at least 25%.

This led to CERN (at the UK's insistence) setting up a Review Committee, charged with looking at CERN's organisation and management, chaired by Anatole Abragam, who asked me to act as advisor

Watching Herwig deal with these reviews was a wonderful apprenticeship, during which I learned a lot about the management of CERN, which stood me in good stead when I became DG

Lausanne Workshop and ICFA Seminar at KEK in Japan

- Luminosity/energy trade-off understood – but whether even 10^{33} cm^{2} s^{-1} could be used was questioned

  "Consensus at Lausanne Workshop that the number of events per bunch crossing should not exceed one"

  Today the number is typically 30, and it will be 140-200 at Hi Luminosity LHC. The experiments can cope thanks to a vigorous CERN R&D programme which started in 1986 with 40 MCHF funding from Italian government (Zichichi's LAA Project)

- The SSC was presented as a national project, to regain leadership, to the great annoyance of the Japanese

The CERN Long Range Planning Group 1985-87

Led by Carlo Rubbia

who kept the LHC flame burning although in 1987 the SSC was under construction

- Recommended 13-15 TeV proton-proton (not antiproton) collider, with 8-10 T magnets, luminosity of 10^{33}, as the next option for CERN – 'first collisions possible in 1995 if decision to proceed taken 1989'!

- Recommended intensify R&D on high field magnets

Some other events during Herwig's mandate

Spain re-joined in January 1983

Portugal joined 1985 - hoisting of the flag

Non-political VIP visitors, included

Pope John Paul II

Herwig used this model to explain how matter is created at CERN:

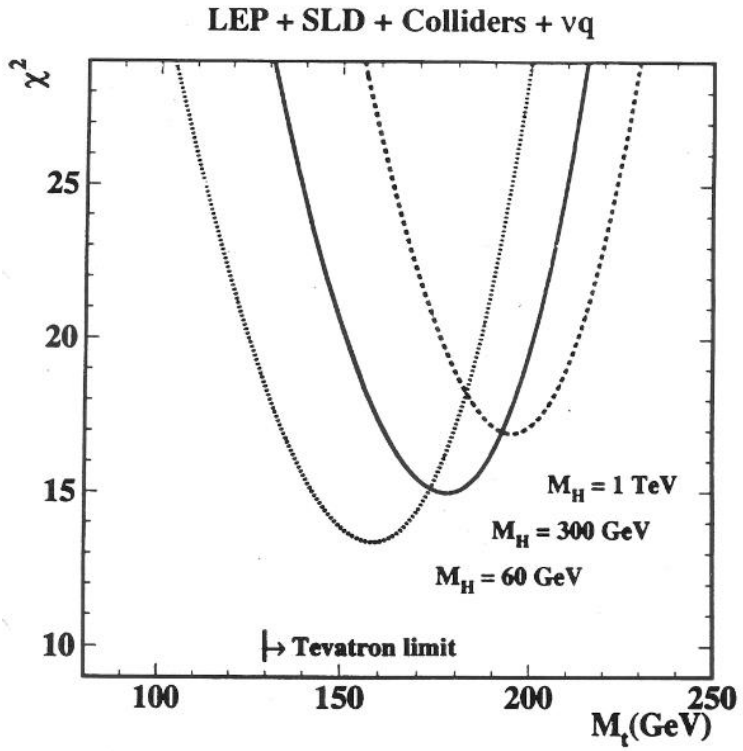
The Pope responded "You cannot create matter, creation is my business; you can only produce matter"

and

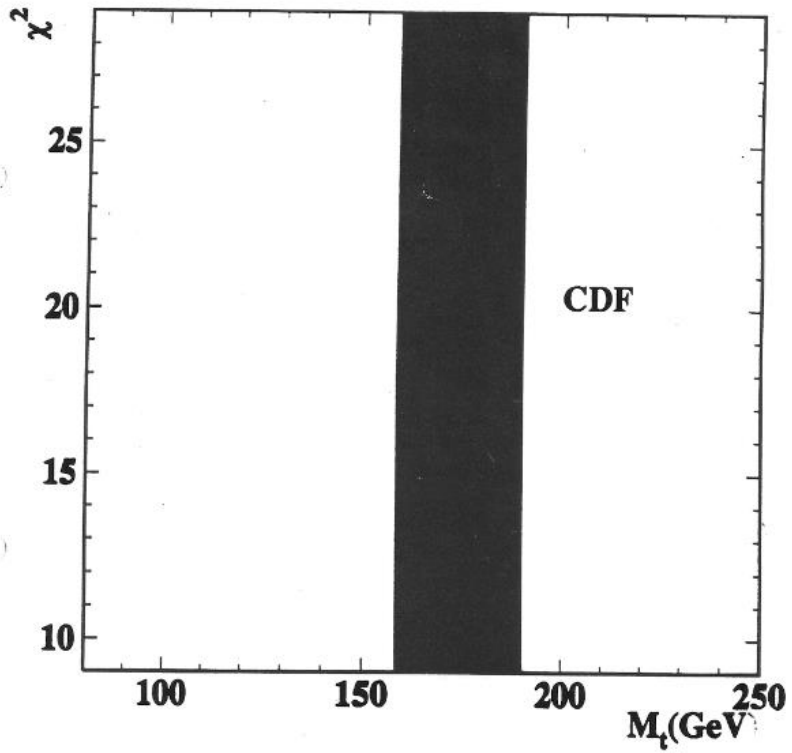
The Dalai Lama

Highlights of Herwig's Legacy at CERN

LEP → only 3 light neutrinos + **precision measurements showed that the standard model is a quantum (gauge) field theory**: this would have greatly surprised many leading theorists in the 1960s who thought that field theory would fade away (except as a phenomenological description of quantum electrodynamics) + ...



Results of precision measurements
- dominated by LEP. December 1994.



Top quark discovered at Fermilab. March 1995.

Highlights of Herwig's Legacy

Higgs : first time unlucky**:**

In December 1995, the CERN Council (although very nervous of new initiatives following the approval of the LHC) accepted a proposal to add more superconducting cavities (32 new + equip 16 spares) on the grounds that this would provide a good chance of finding the Higgs boson:

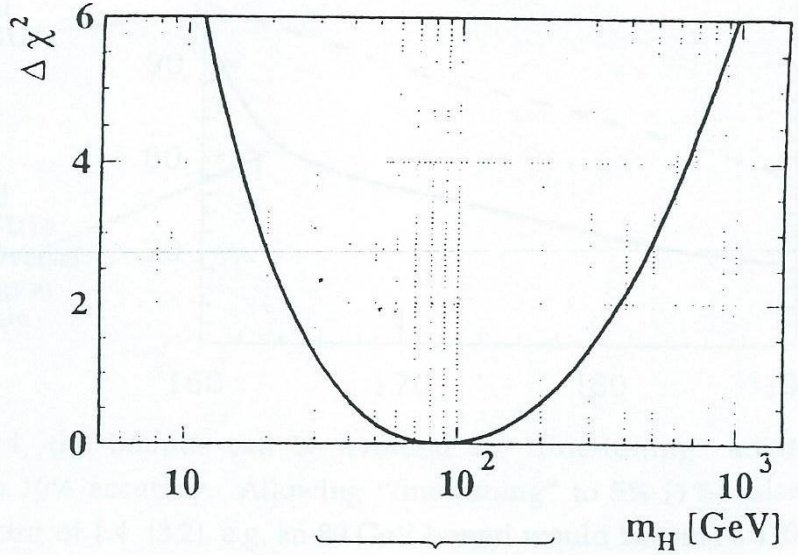
But Herwig left us the LEP tunnel

Second time, **the LHC did the job:**

LHC control room 10/9/2008

CERN Auditorium 4/7/2012

Figure 1 - The existing data are indirectly sensitive to the mass of the Higgs boson (M_H). The figure shows the quantity $\Delta\chi^2$ obtained from a fit to the best available data. The Higgs boson is most likely to be found in the region where $\Delta\chi^2$ is smallest



The most likely value of M_H is at the minimum of $\Delta\chi^2$ which is in the LEP2 region, although it should be cautioned that there is a 32% [5%] probability that the Higgs mass is in the region where $\Delta\chi^2$ is greater than 1 [4]. It is worth noting that a similar analysis was used by CERN to successfully predict the mass of the top quark (m_t) before it was observed in a real process – see the Director-General's Status Report for 1994 (CERN/2079).

Herwig: thank you for everything you did for CERN

and for your multiple contributions before you came to CERN and after you left