DELPHI Collaboration
and
The Physics Legacy of LEP

Symposium to celebrate Ugo
CERN, April 4, 2025
Alessandro De Angelis
Most of the material from Gerald Myatt and from Ugo

The game of the name

In the beginning it was COLLEPS
COLlaboration for LEP Studies
But this was judged unsuitable

So DELPHI was chosen
DEtector with Lepton Photon and Hadron Identification
(a proposal by Gerald Myatt)
and then a logo was needed

Logo by Angelo Rampazzo (Padua)
Apollo traveled to Delphi in the form of a dolphin (delfino in Italian)

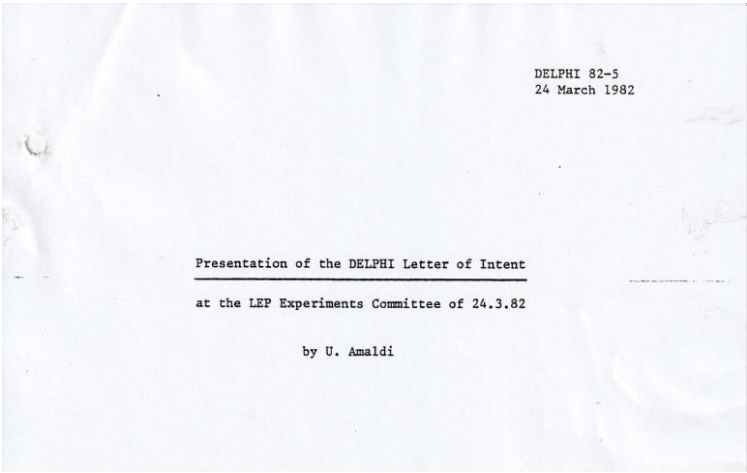
A complex experiment with a lot of information

One key question was whether to play safe, or to plan for a detector which looked forward to new horizons. Ugo had a major influence along the second direction, particularly on the particle identification which was DELPHI's strongest points.

Tom Ypsilantis, Jacques Seguinot and then Tord Ekelof, RICH specialists, joined the collaboration. By 1992, the Barrel Rich was established.

Ugo insisted that there be sufficient space inside the Inner Detector to allow for 3 layers of Silicon strips.
There is one and only one experimental line passing through three points (anonymous).
The b quarj had just been discovered, and there was little information on the b lifetime

TPC was chosen as main tracking device.


DELPHI 82-5
24 March 1982

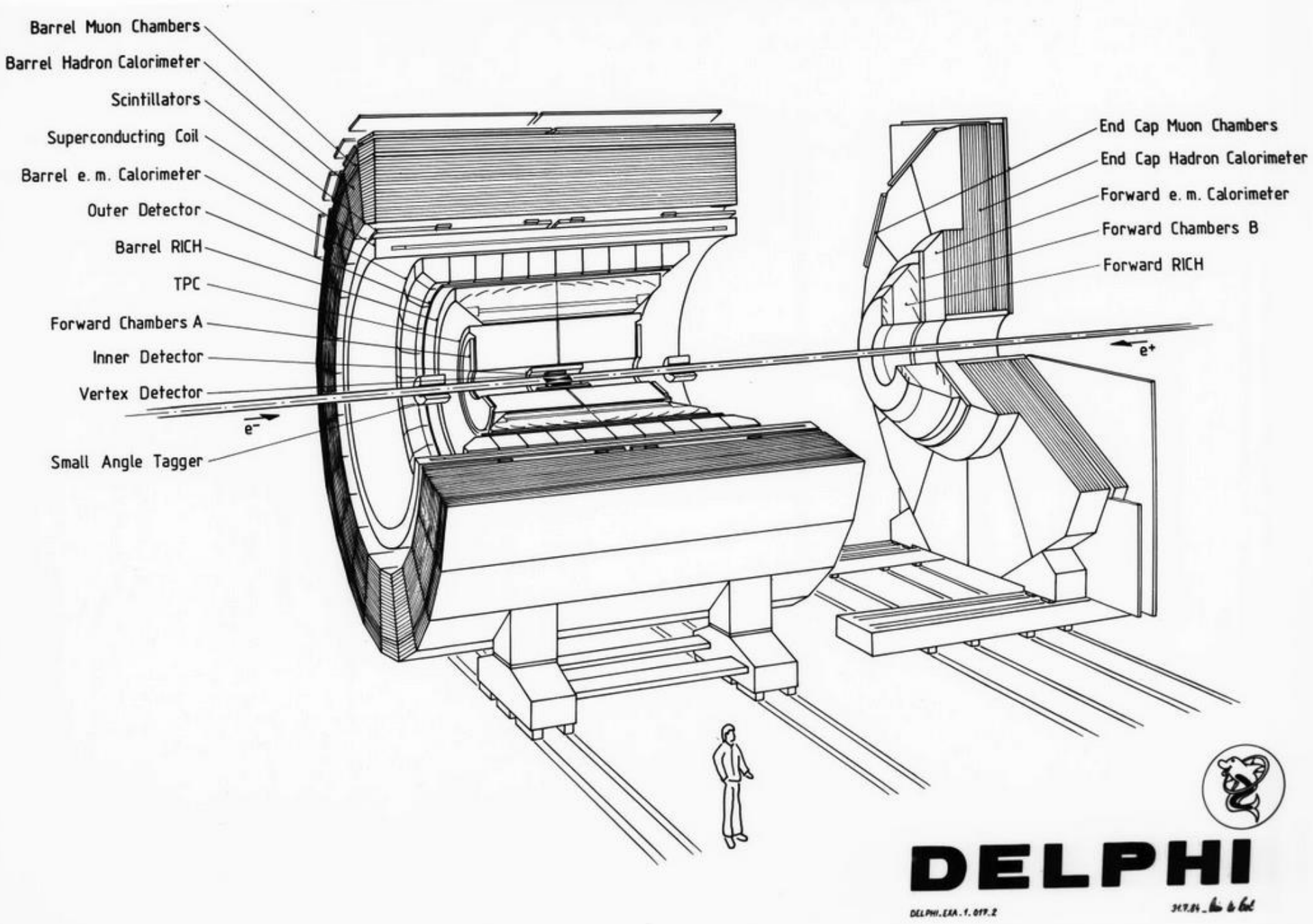
Presentation of the DELPHI Letter of Intent

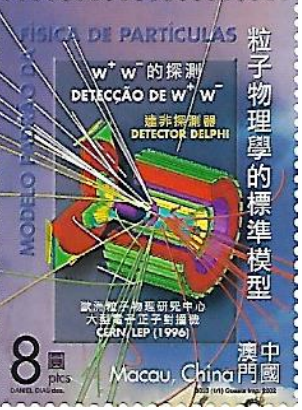
at the LEP Experiments Committee of 24.3.82

by U. Amaldi

Ugo presented the DELPHI Letter of Intent to the LEPC in March 1982 and it was approved.

The largest superconducting coil (by RAL)
7.4 m long, 6.2 m in diameter, a 1.2 T field


Barrel Muon Chambers
Barrel Hadron Calorimeter
Scintillators
Superconducting Coil
Barrel e. m. Calorimeter
Outer Detector
Barrel RICH
TPC
Forward Chambers A
Inner Detector
Vertex Detector
Small Angle Tagger
End Cap Muon Chambers
End Cap Hadron Calorimeter
Forward e. m. Calorimeter
Forward Chambers B
Forward RICH
e⁻
e⁺
DELPHI
DELPHI.EXA.1.017.2



(drawing by Gabriele Cosmo, Erik Vallazza, AdA, from the DB)

Forward Chamber A
Forward RICH
Forward Chamber B
Forward EM Calorimeter
Forward Hadron Calorimeter
Forward Hodoscope
Forward Muon Chambers
Surround Muon Chambers
Barrel Muon Chambers
Barrel Hadron Calorimeter
Scintillators
Superconducting Coil
High Density Projection Chamber
Outer Detector
Barrel RICH
Small Angle Tile Calorimeter
Quadrupole
Very Small Angle Tagger
Beam Pipe
Vertex Detector
Inner Detector
Time Projection Chamber

DELPHI

- Installation times were very tense! Ugo was sleeping at the Novotel. In the control room, he was behind a yellow tape line that people were authorized to cross only if invited

  And un-understandable protocols like “roman one, roman two”
- LEP operation began in July 1989. DELPHI was ready, more or less
- First events were observed in August. On August 14, 3 out of 4 experiments had seen a Z. DELPHI, despite its wishful logo, none! This was traced to a misalignment of the beams in our crossing region, and within hours also DELPHI was observing its first Zs
- Until the end of the year LEP operated at 5 energies at 1 GeV spacing on and around the Z peak and soon (early November) results on the mass and width of the Z boson were published as well a determination of the number of light neutrino species. The first DELPHI paper, sketched before the observations (Ugo’s protocol, again), contained the sentence “the trigger efficiency is believed to be (98 ± 2)% [...]”
- “Measurement of the Mass and Width of the Z Particle from Multi-Hadronic Final States Produced in e+e- Annihilations, Phys. Lett. B 231 (1989) 539.

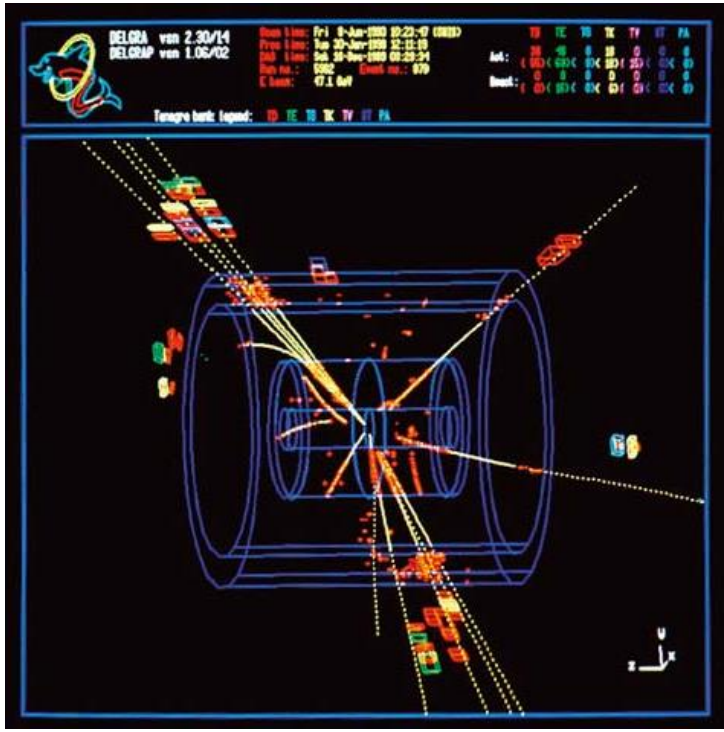
  Ugo was calm again, and listening a lot

LEP Official Inauguration Nov 1989

Alla Cerimonia di inaugurazione del collisore LEP-
incontro con il Presidente Francese Francois Mitterand,
il Presidente Svizzero Pierre Aubert.
Al centro il Direttore del CERN Herwig Schopper.

Necessity is the mother of invention

- The fact that DELPHI was more complicated than other detectors (complex geometry, scattered information) imposed creativity (that Ugo encouraged a lot)
  - Careful software studies
  - Graphic interface
  - Database
  - Analysis tools
- Merging inhomogeneous information for PID was a challenge. The first physics analysis paper in HEP based on Artificial Neural Networks has been by DELPHI
  - Classification of the hadronic decays of the Z into b and c quark pairs using a neural network, Phys. Lett. B295 (1992) 383

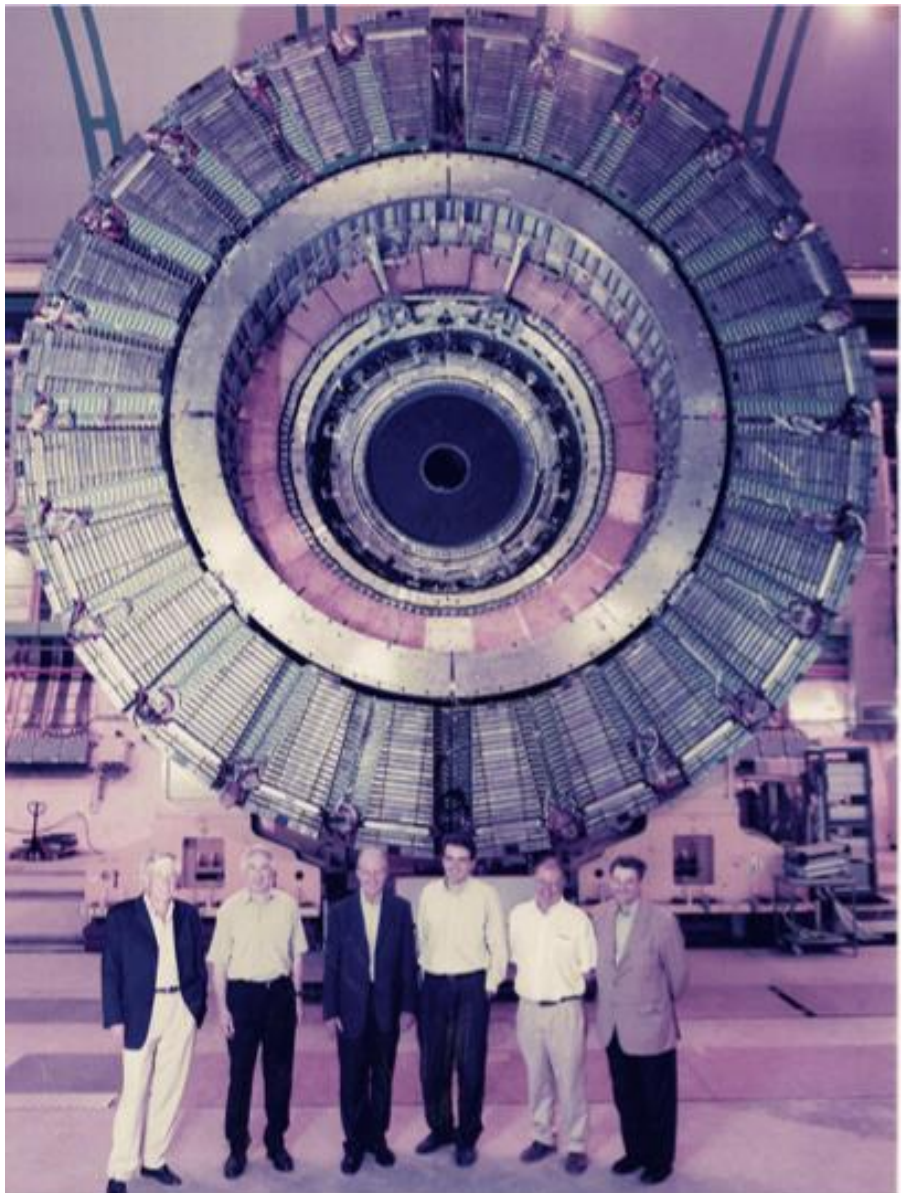


Changing the spokesperson

By 1993 Ugo had been Spokesman for 13 years and he felt it was time for a change. The Collaboration moved to a scheme of Spokesman who served for two years alongside of a Spokesman Elect who succeeded

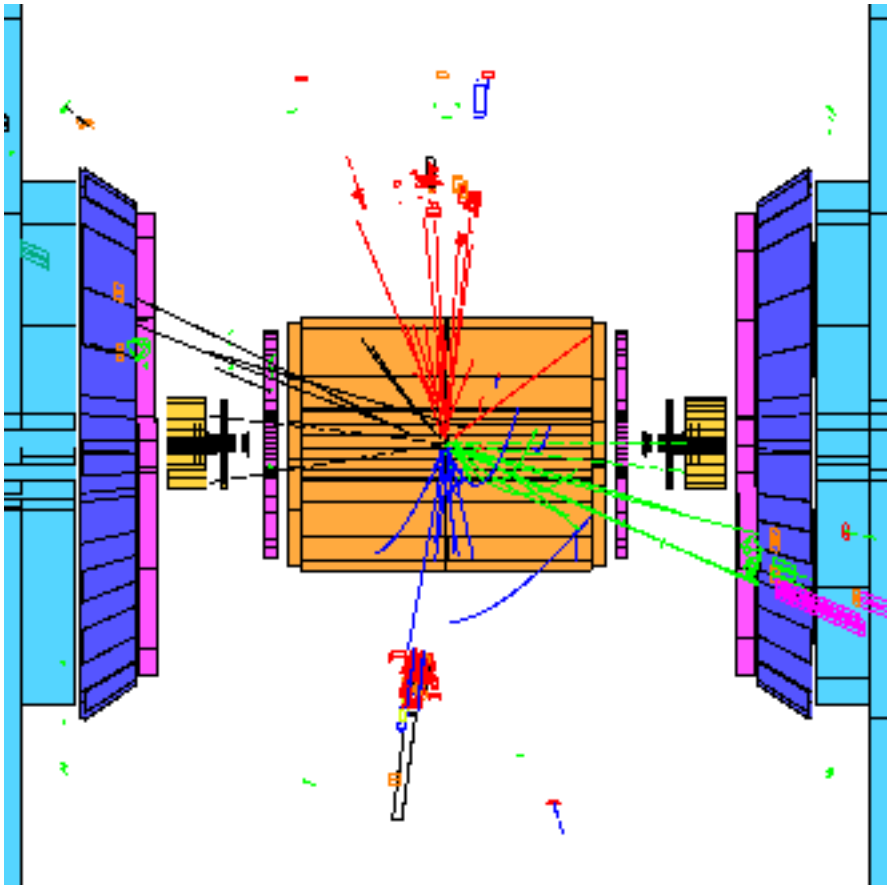
The DELPHI Spokesmen were

Ugo Amaldi
Jean-Eudes Augustin
Daniel Treille
Wilbur Venus
Tiziano Camporesi
Jan Timmermans



Energy increase, W studies and Higgs hunting

Date	E_beam
1990	45
Nov 1995	70
June 1996	80.5
Oct. 1996	86
May 1997	91.5
May 1998	94.5
May 1999	96
Nov 1999	101
May 2000	104.5



On July 9, 1998, LEP achieves 161 GeV c.m. energy. DELPHI observes the first WW pair

The end (?)

By late 2000 LEP had reached a CM energy of 209 GeV and some were seeing signs of an accumulation of Higgs candidates at about 114 GeV, the top end of the accessible region

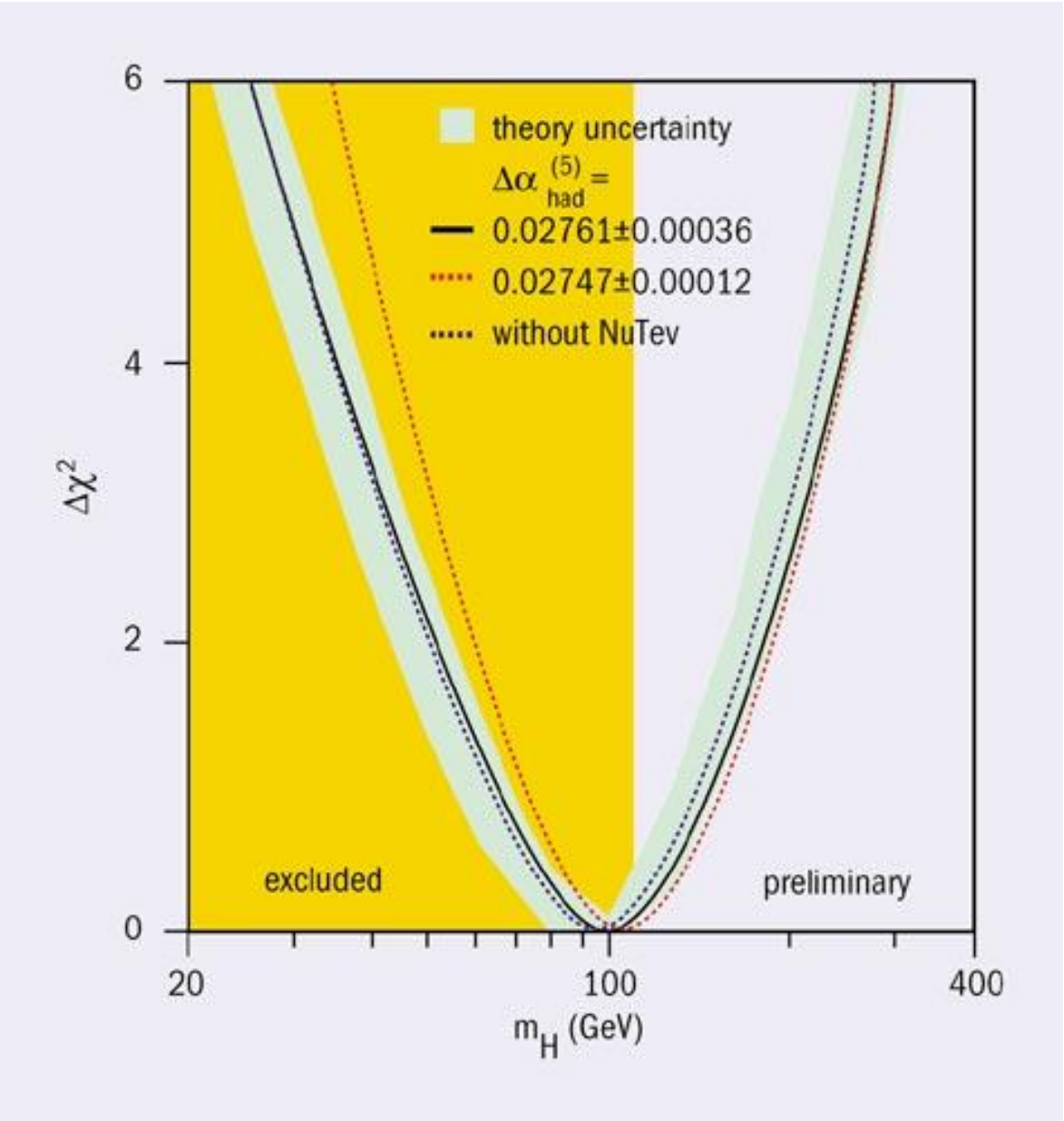
Researchers were split: some did not believe

The DG Luciano Maiani was required to make a decision. If he were to delay the end of LEP by one year, the people working on LHC could lose enthusiasm and CERN would have had to pay penalty of 100 million Swiss Francs to companies ready to dismantle LEP.

He did not risk, and LEP closed forever in November 2000.

A 125 HeV Higgs would have been detected with a very long LEP run, if the CM energy had reached 220 GeV

LEP Indirect measurement of m_H (2004)



M_H = 91+58-37 GeV

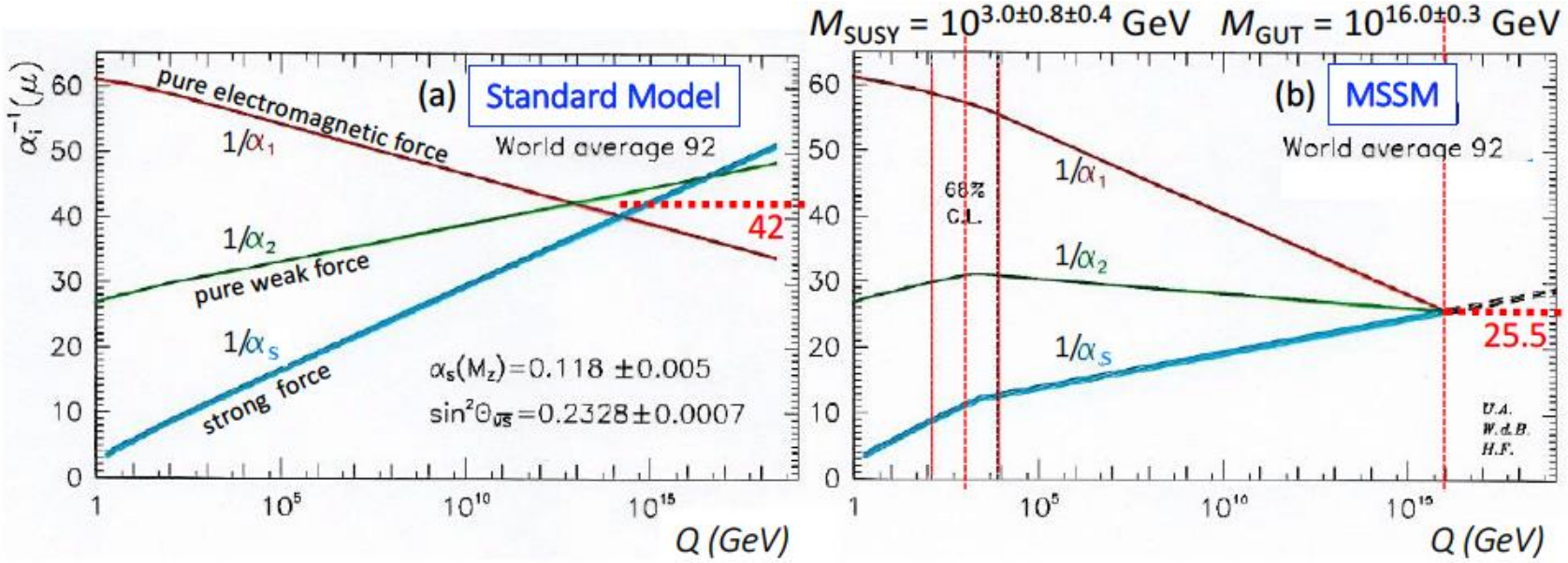
M_H >114.4 GeV (95% CL)
M_H < 202 GeV (95% CL)

One of the most quoted "DELPHI" papers comes from an idea by Ugo

By extrapolating coupling constants of em, weak and strong interactions, Ugo showed that unification was not possible without extensions of the SM, and SUSY could play the game

The visual power of the three converging lines and the novelty of the fitted masses M_GUT and M_SUSY with their errors caused overwhelming reactions

A very impacting plot to show in a particle physics course



A few thoughts on DELPHI and scientific policy

DELPHI was the largest of the LEP collaborations

Need for a mechanism of giving visibility to younger physicists (e.g. DELPHI Speakers Bureau)

Promoted the formation of LEP Working Groups to combine the published results of the 4 Collaborations and take proper account of correlated systematic uncertainties

Also Jack Steinberger insisted that the combination was a job for the experimentalists from the four collaborations

DELPHI promoted allowing access to the data by people outside the Collaboration, but with strict rules. This was an immense amount of work, and only recently became a reality.

DELPHI Collaboration releases its entire data collection

2024-08-15 by DELPHI Collaboration

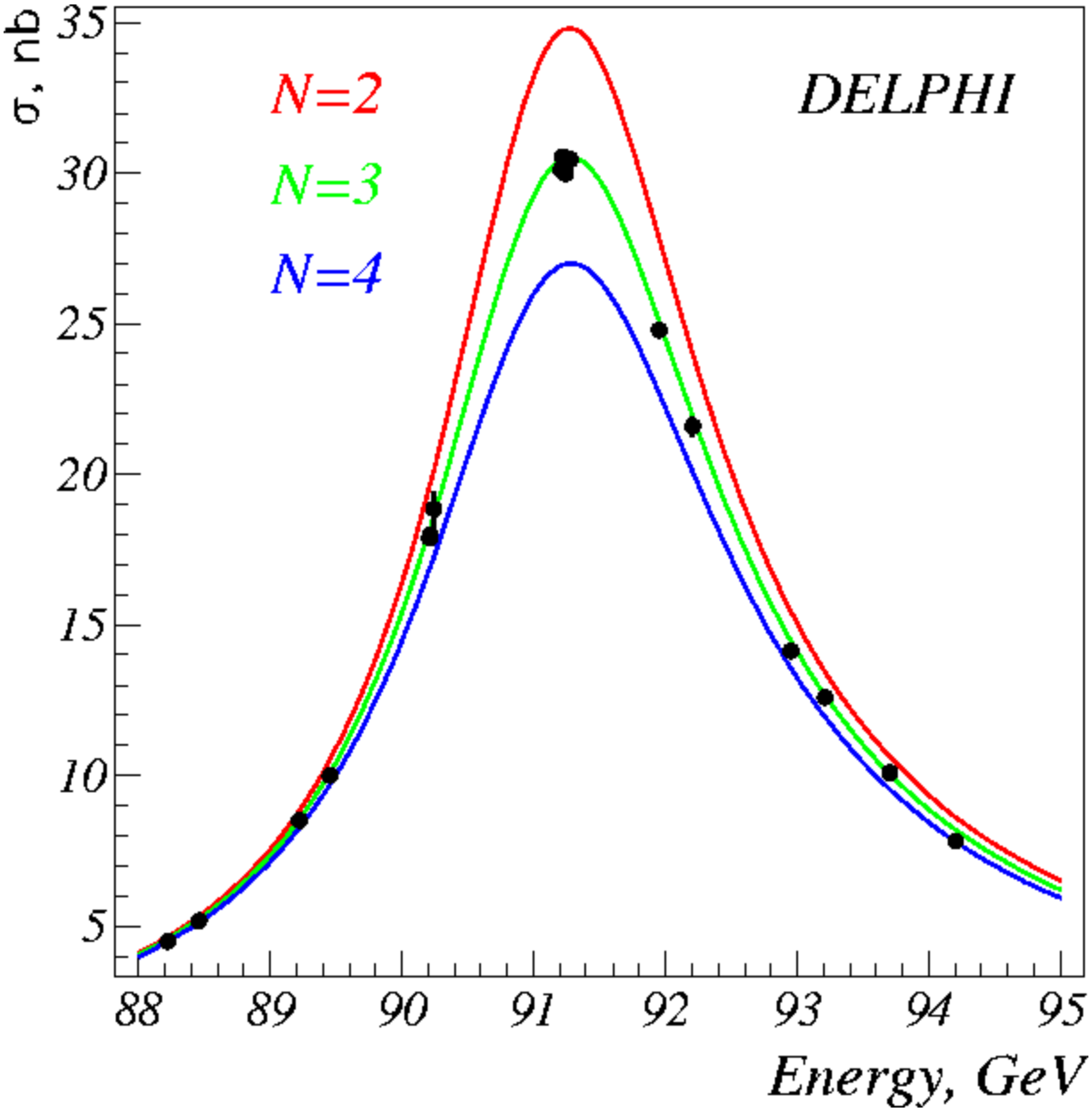
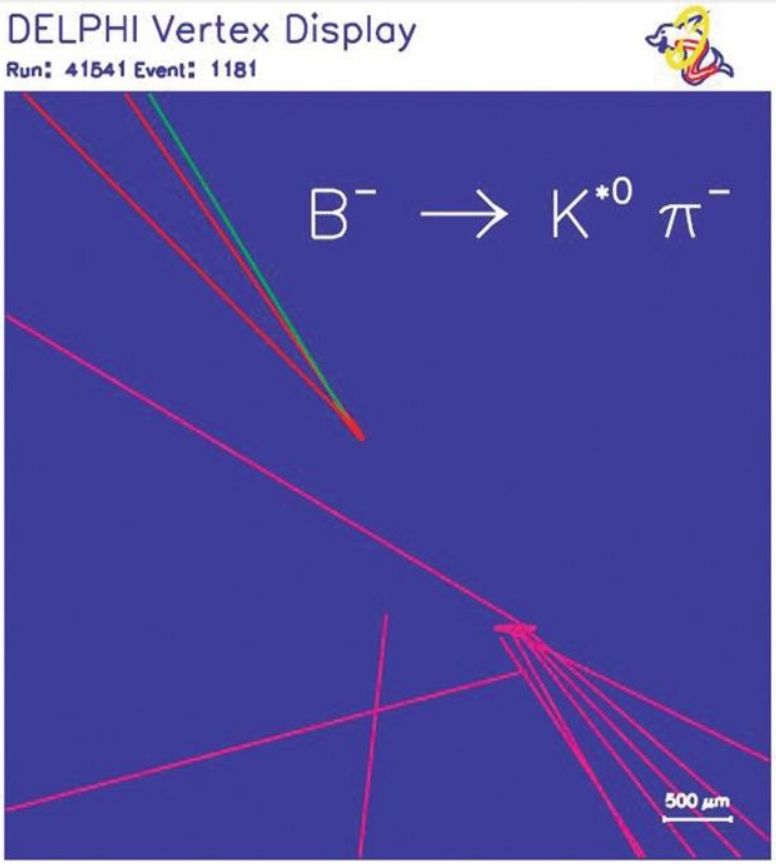
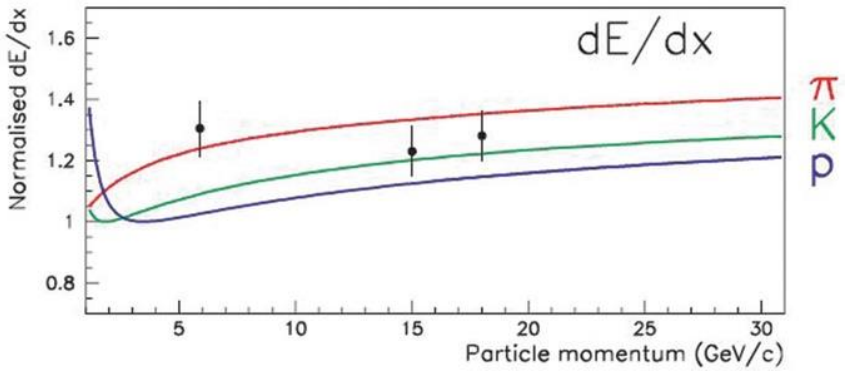
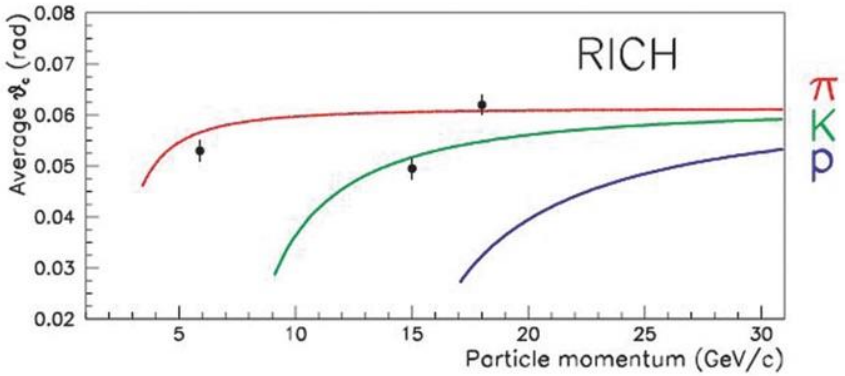
News

The DELPHI Collaboration decided to open their data and released it to the physics community for public access, following FAIR principles. DELPHI was one of four detectors at the LEP collider, which collided electrons and positrons, at until now unreached energies. Since the two particles annihilate entirely into pure energy, the total energy of the events is precisely known, and the end states are much cleaner than this is the case for hadron colliders like LHC.

Along with the data, the collaboration decided to open the original software stack, including simulation and reconstruction. This enables scientists to pass the output of decent generators through the detector simulation of the DELPHI detector, and

Congratulations Ugo on 90 years of achievements

And long live DELPHI!


σ, nb
35
30
25
20
15
10
5
N=2
N=3
N=4
DELPHI
88
89
90
91
92
93
94
95
Energy, GeV

DELPHI: the most precise b (and c) tagging