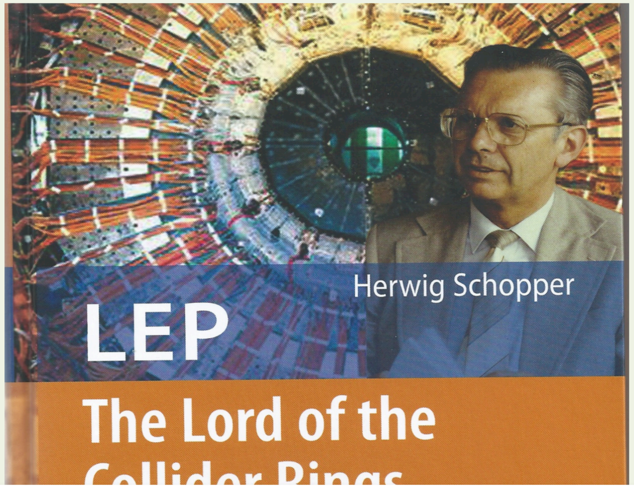
Happy Birthday

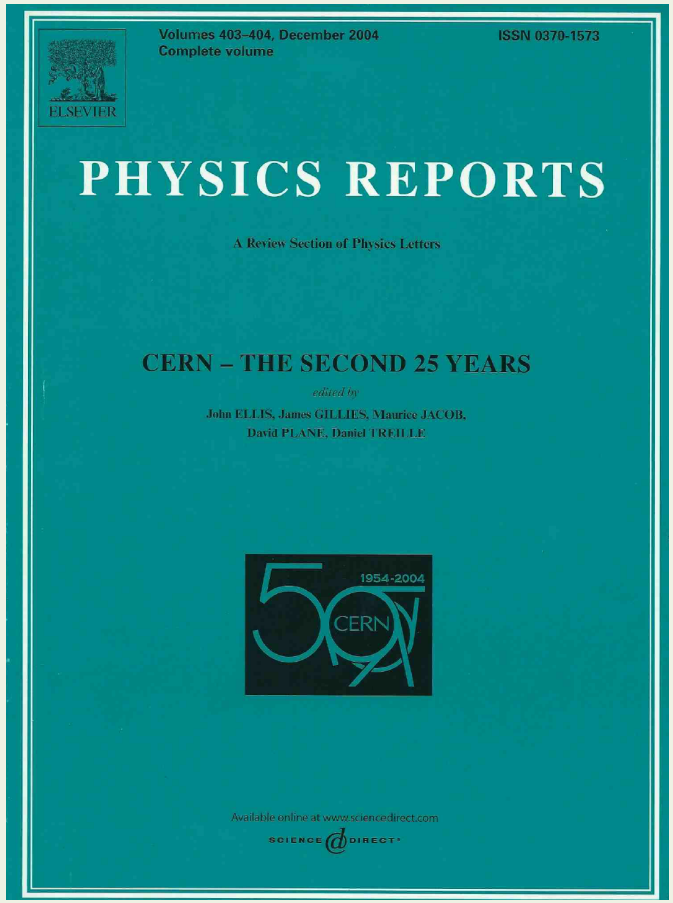
Herwig Schopper

Courtesy H.Schopper from his talk to CERN Students, 13 August 2004

LEP I - period 1984 to 1994



I could stop here since all what has to be told about LEP 1984 to 1994
has been written up in the book by Herwig Schopper



There exists another complete overview on LEP including physics covered by John Ellis

Kurt Hübner decribes the accelerator
&
Fabio Sauli describes the detectors

YEARS/ANS CERN

CERN 91-08

CERN 91-08
10 October 1991

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

CAS CERN ACCELERATOR SCHOOL

Sixth John Adams Memorial Lecture

THE LEP COLLIDER, FROM DESIGN TO APPROVAL AND COMMISSIONING

Lecture delivered at CERN on 26 November 1990

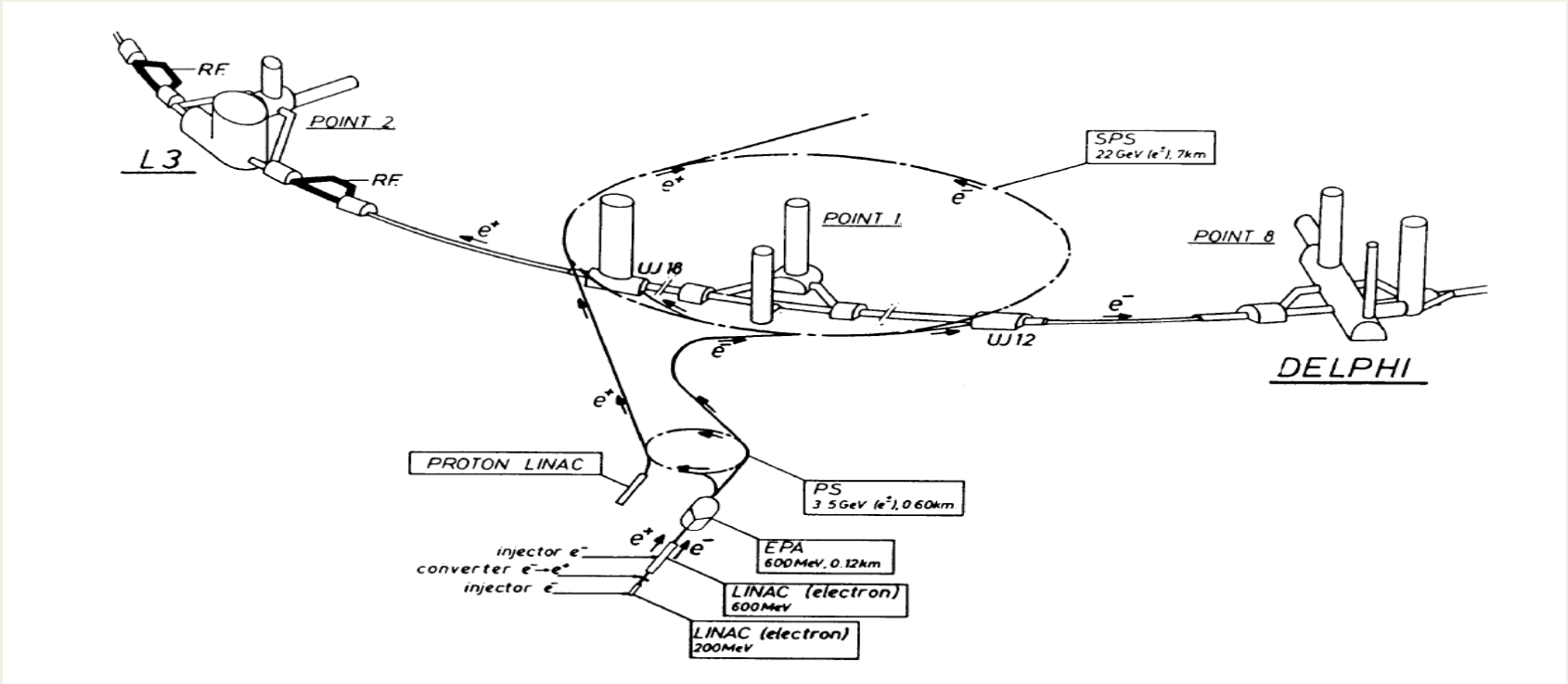
Stephen Myers

GENEVA
1991

Based on contributions from colleagues, I will add details about the support for the LEP machine and highlight CERN's technical involvement with the collaborations of the four experiments during the LEP construction period
1984 to 1989.

I will also talk about the preparations for the LEP energy upgrade and for the LHC during the LEP I operation period
1989 to 1994.

The SPS As LEP Injector Author(s) Baconnier, Yves ; Gröbner, Oswald ; Hübner, Kurt
CERN-LEP-Note-212 ; LEP-Note-212. - 1980. - 13 p.



Use the PS and SPS without disturbing SPS fixed-target programmes,

No new Synchrotrons needed as LEP injectors

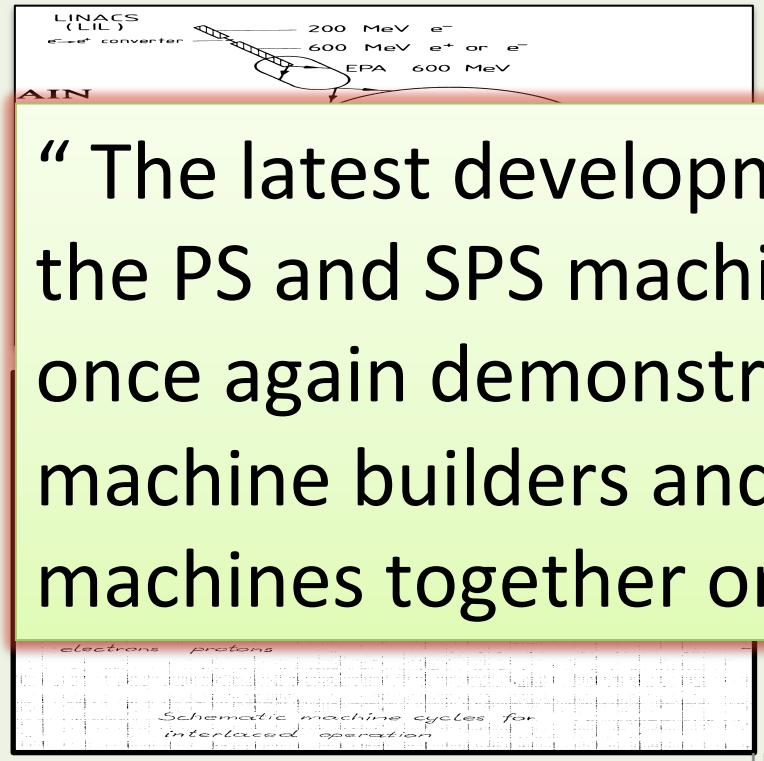
An important input to the decision to have LEP at CERN

together with the **ECFA-LEP** Working Group recommendation of 27km tunnel for LEP & LHC – published 15 April 1980, Chairman A. Zichichi

Bas de Raad was afraid to spoil his nice SPS with synchrotron radiation

He therefore protected personally his coils with tungsten sheets.

LEP Injection System
From LEP Design Report, Vol 1., 1983.



John Adams "The Development of CERN, 1970 to 1980", Annual Report 1980, p.25

published in 1976. By this time, due to the discovery of the J/psi particle and the new theories unifying the weak and electromagnetic interactions, the interest of the physics community swung sharply towards a very large

" The latest development of the LEP Project is to use the PS and SPS machines as the injector for LEP, once again demonstration the ingenuity of the CERN machine builders and the wisdom of keeping all the machines together on one site. "

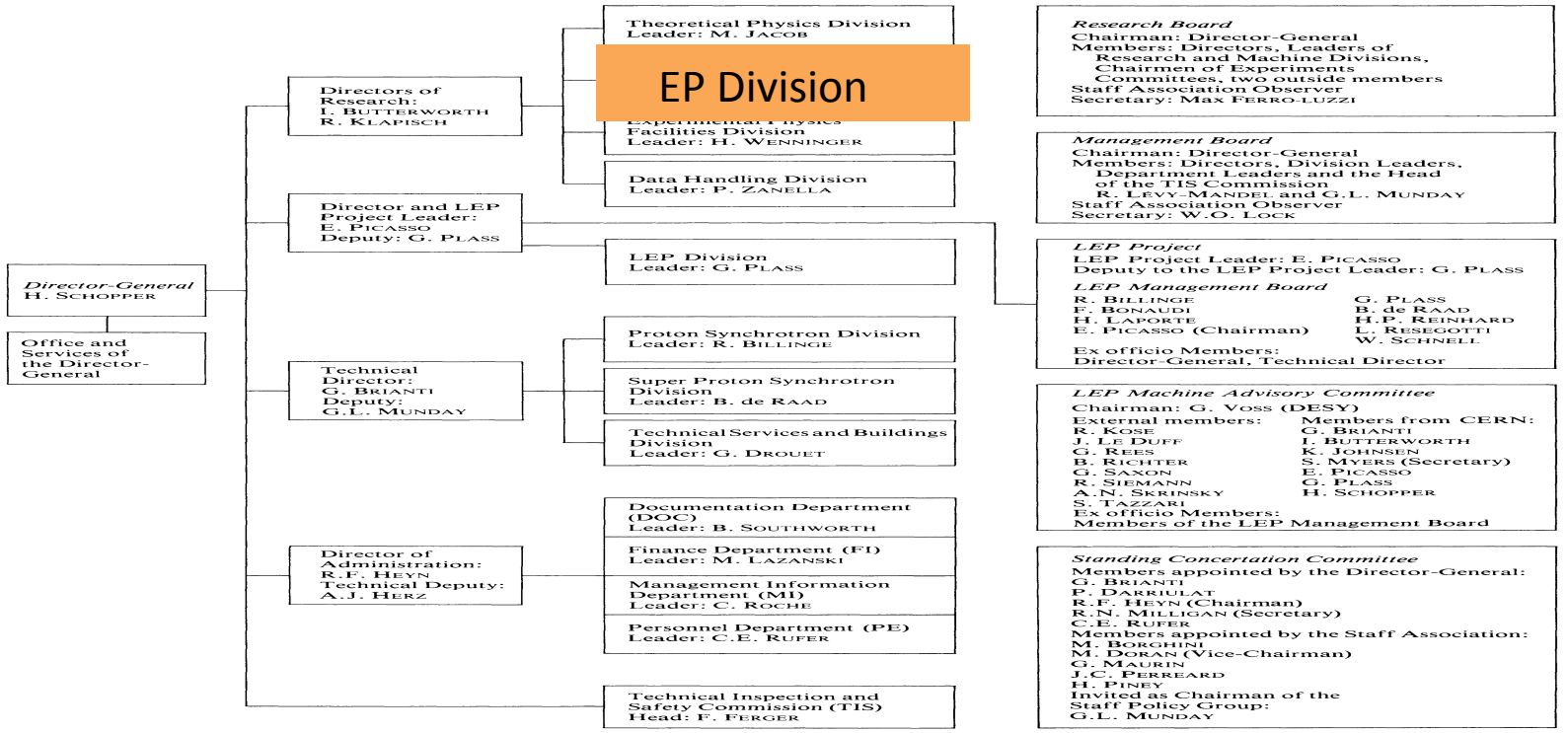
important part of a review such as this given to Council by the Director–General of CERN at that time.

CLOSE DOWN OF
BEBC - ISR - EHS - GARGAMELLE ETC.

Bubble Chamber Conference CERN 14 to 16 July 1993

Enter LEP era with DG Herwig Schopper

Internal organization as at 31 December 1984



11

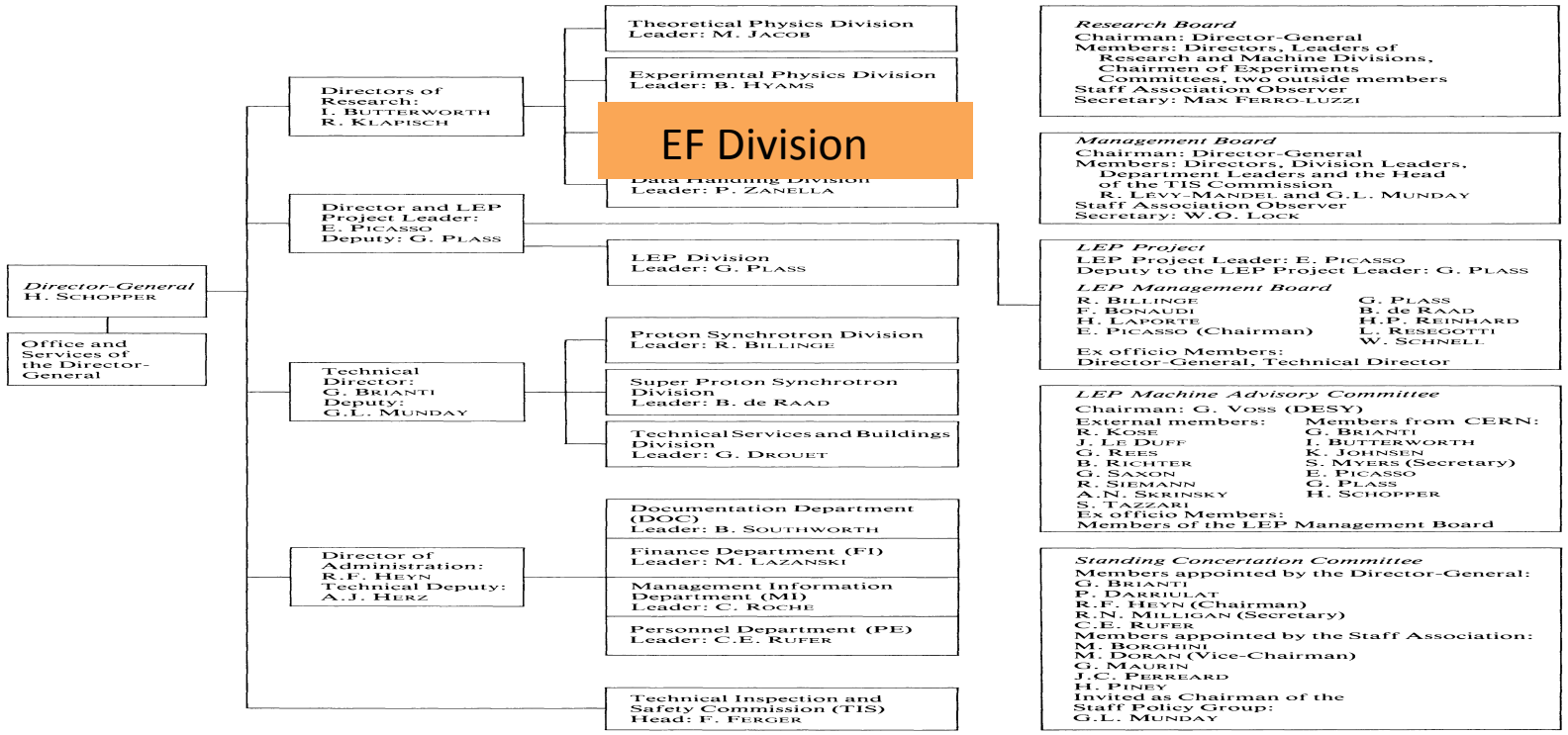
Experimental Physics Division EP

responsible for carrying out research in the field of particle physics, and R&D programs in the domain of of detector technologies.

Host Division for outside users of CERN facilities and has a **participation and coordination of LEP experiment collaborations**.

provided technical, administrative and logistics support to experimental teams.

Internal organization as at 31 December 1984



11

Experimental Facility Division **Activities in 1984**

Fixed Target Experiments

Detectors: BEBC, EHS, OMEGA operations / closure preparation….

NA31 / NA34 liquid argon photon calorimeter, WA44 free quark search

UA1, UA2, UA4, UA5 upgrades

Film Development, Erasme

4 LEP detectors EF

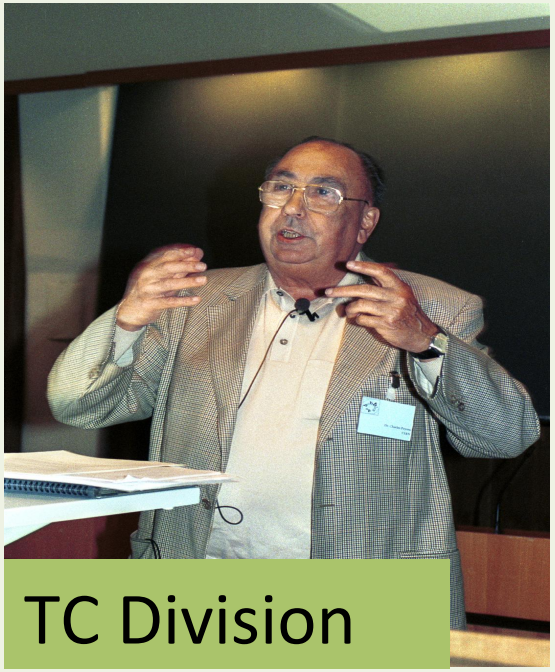
EF general technical support, detector design & construction support, prepare infrastructure, safety & experimental areas

LEP machine support:

lead cladding of vacuum chambers, field mapping of magnets, automation several survey instruments (DISTINVAR)

RF superconducting cavities, Cryogenics, mechanical workshops …

The history of LEP is also part of
the history **of EF Division** and its staff members



TC Division

The soul of TC and EF Division

In January 1984 A. Minten handed over to me a well organised

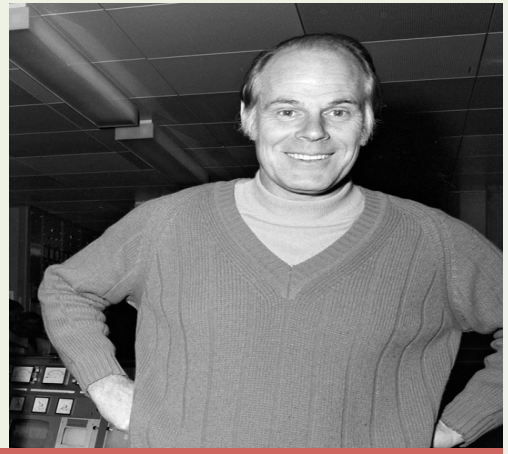
EF Division

EF Annual Report 1984

1984 has been a year of transition for EF. Although support for fixed-target experiments has continued, greater emphasis has been applied to the design and the construction work of the four LEP experiments ALEPH, DELPHI, L3 and OPAL and additional help given in the preparation of the LEP accelerator. A special effort went into the development of super-conducting accelerating cavities.

Albert Burger - Chef of the Administration and Advisor

FROM EF Division to LEP Division

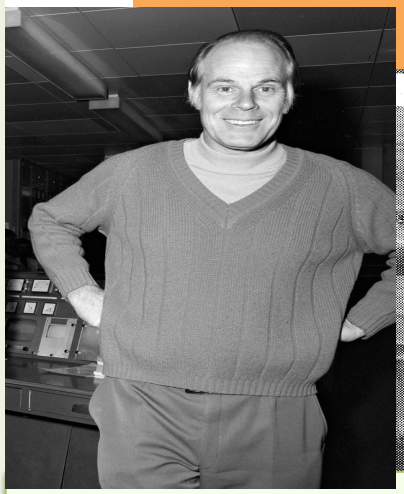


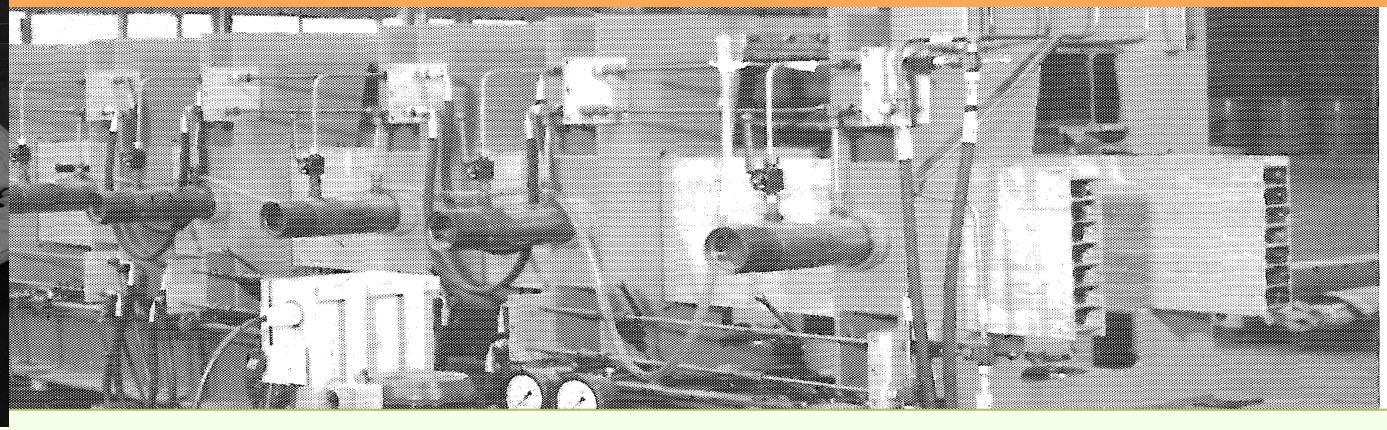
BEBC
to
LEP VACUUM

GARGAMELLE
to
LEP COOLING
VENTILLATION

BEBC
to
LEP INSTALLATION

Four meter long hydraulic press for lead-cladding of vacuum chambers for the LEP accelerator





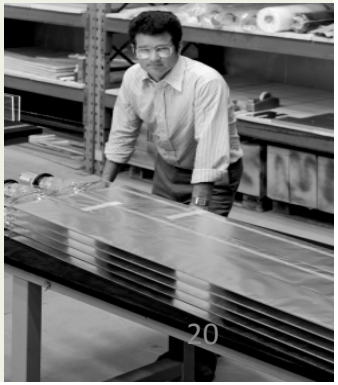
1740 dipole Vacuum chambers - Al alloy extruded in Germany - welding of fittings in Austria - back for lead cladding in Germany – testing at CERN (5 firms involved) *J.Billan demagnetization in situ*

COOLING & VENTILLATION

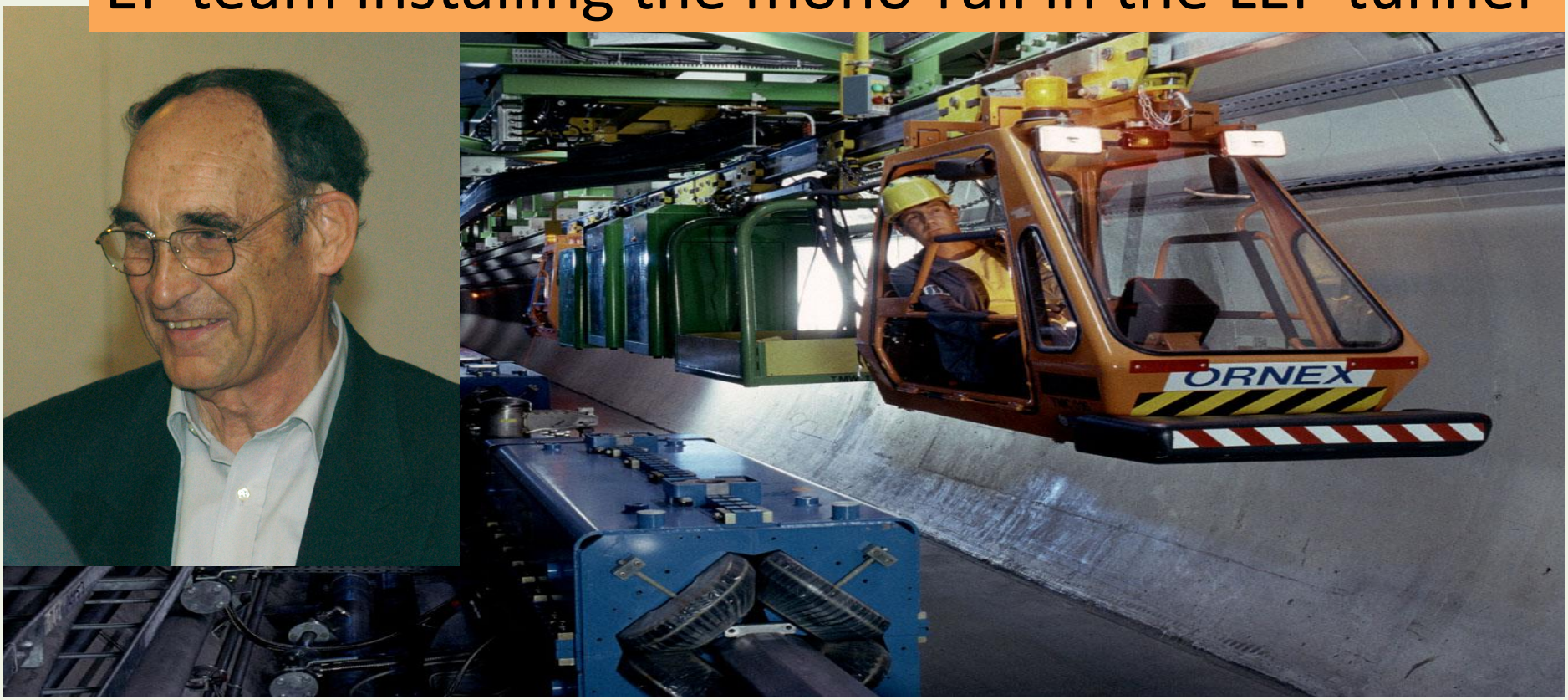
Fresh air enters through even access points circulates through ducts in shafts and tunnel discharged through odd access point

Total volume ensures that all air in the machine (1 million cubic meters) is changed once an hour.

Independent air conditioning in halls (temperature and humidity controlled) complete exchange every two hours.



EF team installing the mono-rail in the LEP tunnel



INSTALLATION MANAGEMENT OF LEP AT CERN

G. Bachy, C. Genier

– *The number of accelerator components* — around 30,000 components weighting nearly 40,000 tons (60,000 tons if the equipment for experimental devices are added) — that had to be transported and installed in a relatively confined space. The tunnel cross section (see *Figure 4*) is a good illustration of this.

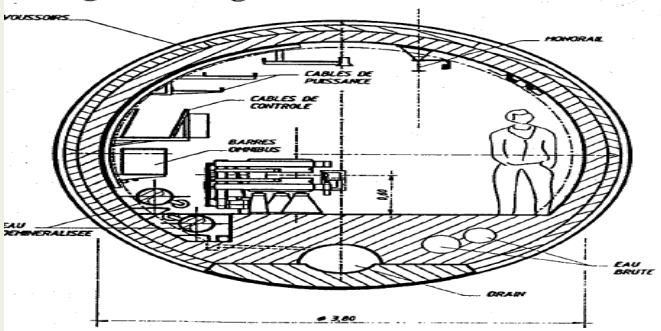


Figure 4 – LEP tunnel cross section

THE SYNTHESIS OF FOUR YEARS OF INSTALLATION

The LEP installation, which has been completed over a total period of four years, required more than 2.5 million working hours; nearly 2 million of which were worked underground, in the LEP tunnel. At the installation peak, more than 650 persons employed by about 75 different companies and their sub-contractors (including CERN staff itself) worked simultaneously in the tunnel. *Figure 9* shows the evolution of the number of persons involved in the LEP underground installations during the period from October 1985 to July 1989.

Particle Accelerators, 1990, Vol. 29, pp. 183–190
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THE LEP CONTROL SYSTEM: ARCHITECTURE, FEATURES AND PERFORMANCE

P. G. INNOCENTI
CERN - European Organisation for Nuclear Research - CH-1211 Geneva 23 - Switzerland

Abstract: The architecture of the LEP Control System is strongly influenced by the large size of the accelerator and by the (economy) requirement of multiplexing many signals over a limited number of high bandwidth links. The use of microprocessors as local controllers of practically every piece of equipment offers unprecedented distributed control and surveillance possibilities, but at the same time enhances problems of communications and date coherence. Performance of the system is analysed in the light of the design goals and of experience gained during the LEP start-up.

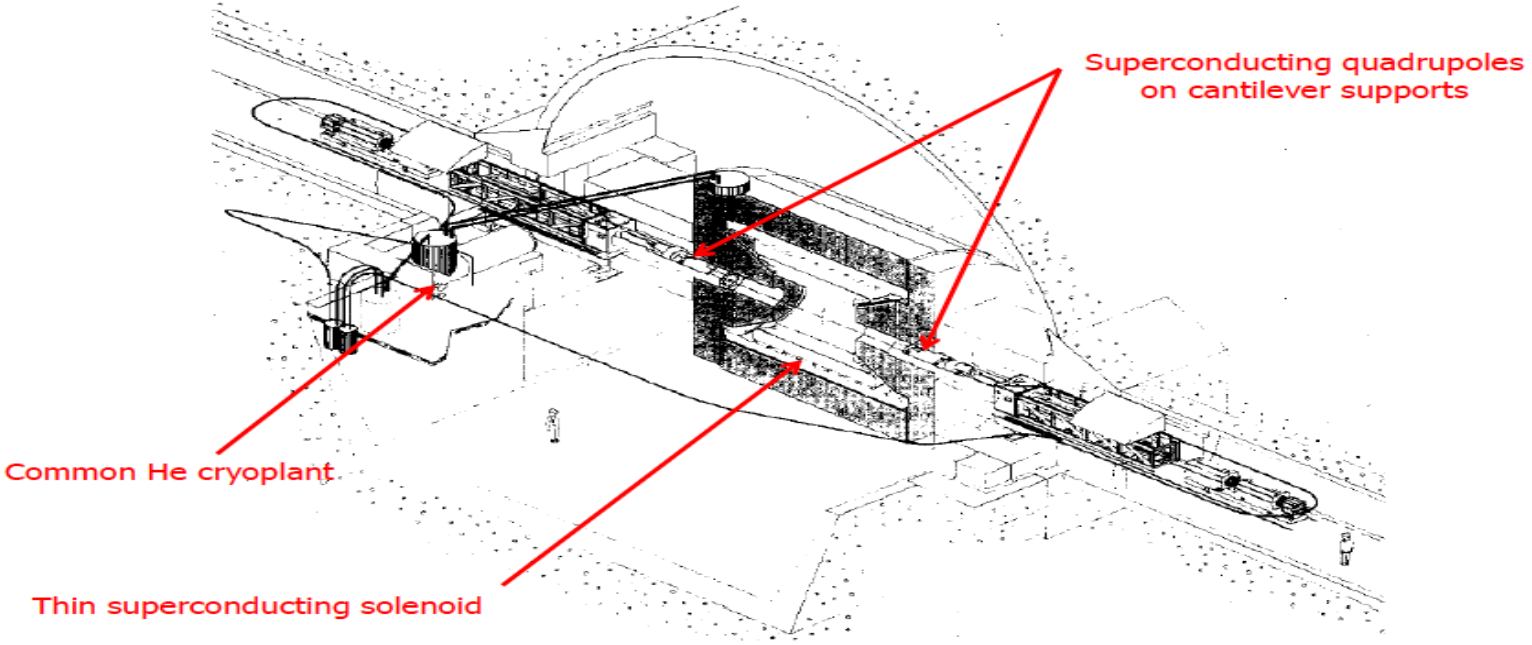
EF LI BEULEVELT ALBERT
EF LI BERGKVIST ANNA
EF LI BERTUZZI VINCENT
EF LI BOUAD JACQUES
EF LI BROLLI MARCEL
EF LI CHAMOT MARCEL
EF LI CONFORTO GIOVANNI
EF LI DALLA SANTA FERDINANDO
EF LI DAVIES ROBIN
EF LI DECHELETTE CHRISTIAN
EF LI DEMORNEX MONIQUE
EF LI DESMARIS CLAUDE
EF LI DEVILLE DANIEL
EF LI DI PIETRO SALVATORE
EF LI DONNINI ALFONSO
EF LI DUTRUEL ETIENNE
EF LI FABBRETTI ROBERTO
EF LI FERREIRA DE CASTRO AUGUSTO
EF LI FILLION MICHEL
EF LI GORLITZ WOLFGANG
EF LI LARCOMBE TIMOTHY
EF LI LEONARD JEAN-PIERRE
EF LI LUCON THIERRY
EF LI MARIE JEAN-CHRISTOPHE
EF LI NEBOUT JOSEPH
EF LI PARROTT DAVID
EF LI PERRET BERNARD
EF LI RENAUD JEAN
EF LI SBRISSA EDO
EF LI SCHMITT DIDI
EF LI STEINBERG KARL-HEINZ

EF LI BONAUDI FRANCO
EF LI KANTARDJIAN GREGOIRE **DELPHI**
EF LI LEISTAM LARS **L3**
EF LI POTTER KEITH MICHAEL **Radiation**
EF LI TAUREG HANS M **ALEPH**
EF LI SMITH ALASDAIR M **OPAL**

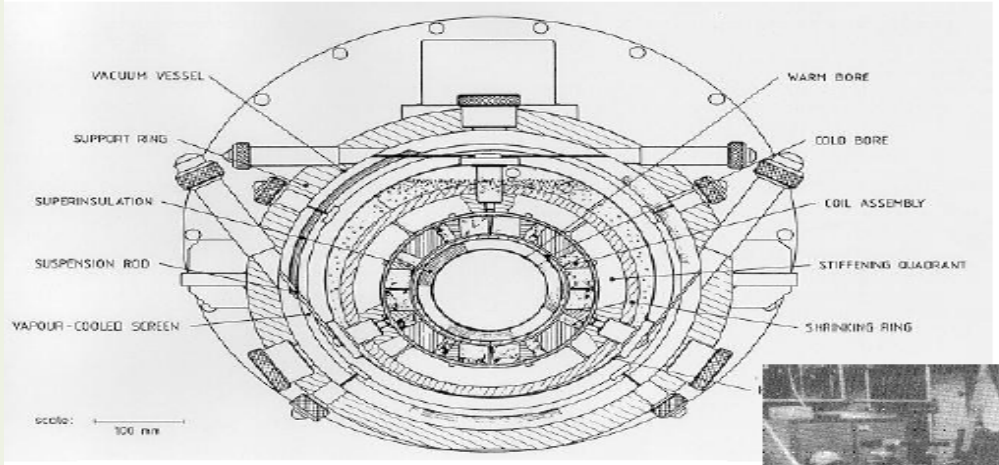
Franco Bonaudi from ISR to EF to link into LEP Project


YEARS/ANS CERN
AMBRE A VIDE
BLINDAGE EN PLOMB
TROU DE POMPAGE
POMPE GETTER
SUPPORT GETTER
CERAMIQUE
A CHAMBRE A VIDE DIPOLE

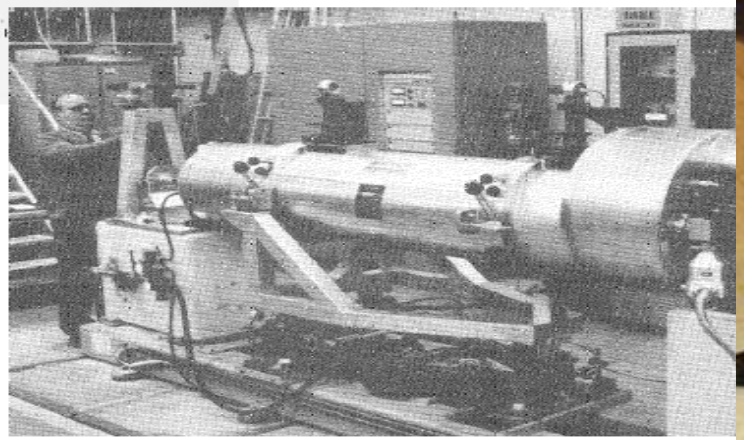
Layout of typical LEP experimental area (1989)
Magnets in « data-taking » positions



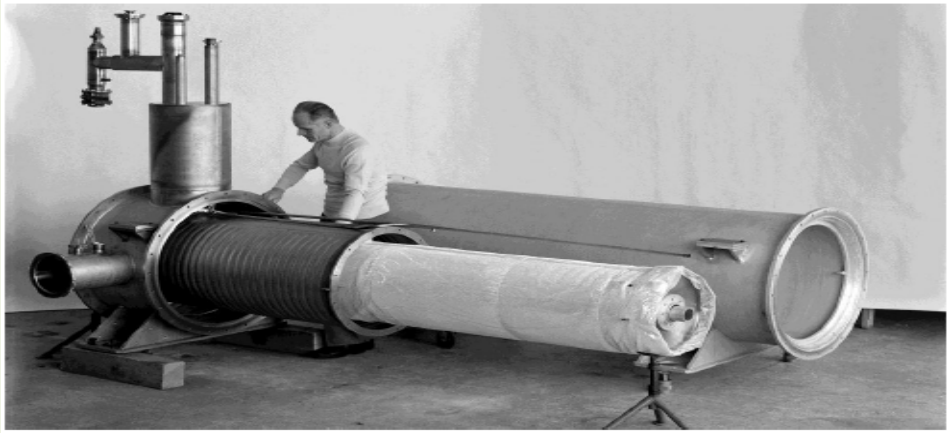
Two generations of 8 slim « low-β » quadrupoles for LEP
T. Taylor *et al.* (1988 and 1994)



Nominal gradient (for 65 GeV beams)	36	T m^{-1}
Minimum operational gradient	10	T m^{-1}
Magnetic length	2	m
Good field aperture (diameter)	100	mm
Tolerance on integrated gradient (at limit of useful aperture)	0.2	%
Minimum clear aperture (background)	120	mm
Length of cryostat (along axis)	2.5	m
Maximum superimposed field	0.6	T
Maximum ramp rate	0.3	T m^{-1} s^{-1}
Nominal current	1625	A
Peak field in winding (at nominal current, with external field)	4	T
Stored energy (at nominal current)	310	kJ
Maximum test current	2000	A
Warm bore (inside diameter)	130	mm
Inner coil diameter	180	mm
Outer coil diameter	240	mm
Maximum tilt of magnet in service (transverse or longitudinal)	1.5	%

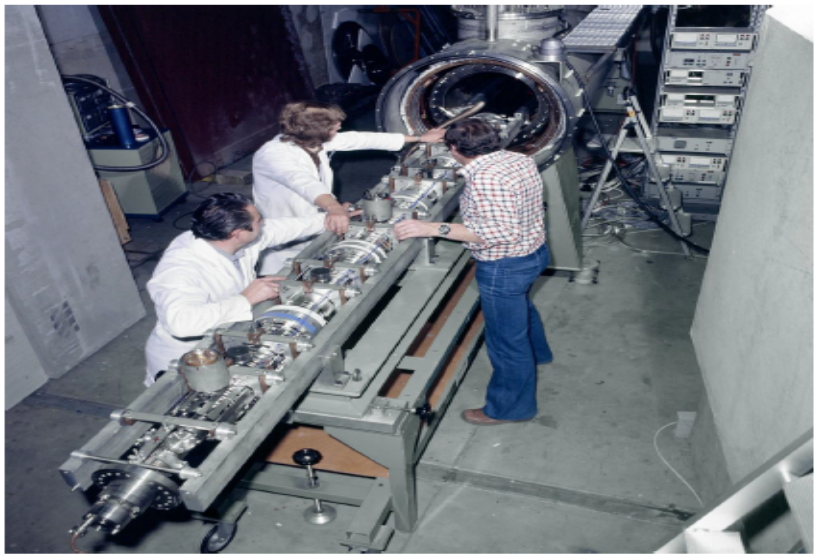


Superconducting devices for West Area beam lines



One of three cos θ SC dipoles (1975-77)
Central field 4.75 T
Magnetic length 2.28 m
Nominal current 700 A
Cold bore aperture 74 mm

G. Kesseler



SC RF separator (1977) built by KfK Karlsruhe
2.87 GHz (S-band)
Deflecting field 1 MV/m
Operated in superfluid helium at 1.8 K

H Schopper A. Citron (KfK) & H. Lengeler (CERN)

CERN

Ref.: EF/PHB/HL/tj

Date: 11.12.1978

M E M O R A N D U M

To : Dr. J.B. Adams, Executive Director-General

From : Ph. Bernard, H. Lengeler (EF)

Subject : Tentative programme for studies of superconductivity in view of LEP-applications

---

1. AIM

Recent studies of large e^+e^- storage rings have shown the interest of a superconducting (SC) acceleration system as regards to both power consumption and achievable maximum particle energy. Unfortunately the present status of r.f.-SC and the technical know-how accumulated hitherto in SC accelerator and r.f. separator projects appears to be an insufficient basis for a large scale application involving many hundred metres of SC accelerator structures. Therefore we consider that the first stage of a programme aiming at a large SC electron storage ring should be a feasibility study.

We propose that such a study should be under-taken at CERN and in close association with European research centres and universities already working in the field of r.f.-SC.

EF RF AMALDI EDOARDO
EF RF ARNOLDS-MAYER GABRIELE
EF RF BAPST RAYMOND
EF RF BASSAN MASSIMO
EF RF BERNARD PHILIPPE
EF RF BLOESS DIETRICH
EF RF BOLORE MICHEL
EF RF BONIFAZI PAOLO
EF RF BOURBONNEUX JEAN
EF RF BRONZINI FRANCO

EF RF CALATRONI SERGIO
EF RF CANDOLFI MICHEL
EF RF CARELLI PASQUALE
EF RF CASTELLANO MARIA GABRIELLA
EF RF CAVALLARI GIORGIO
EF RF CHARRIER JEAN-PIERRE
EF RF CHIAVERI ENRICO
EF RF CHIPAUX

EF RF GRABOWSKI FRANCOIS
EF RF HABEL ROBERTO
EF RF HAEBEL ERNST

EF RF INSOMBY ALBERT
EF RF JUILLARD MICHEL
EF RF KUBLY MICHEL
EF RF LAMY-CHAPPUIS GUY
EF RF LE SCORNET JEAN-CLAUDE
EF RF LEFEVRE MICHEL
EF RF LEGENDRE PHILIPPE
EF RF LENGELER HERBERT
EF RF LIEBE ANDRE-JACQUES
EF RF MALO JEAN-FRANCOIS

EF RF MARTINELLI GIANC
EF RF MENCI NIC

HELMUT
EF RF PIZZELLA GUIDO
EF RF PONTO LUDWIK
EF RF PREIS JOHANNES ULRICH
EF RF PULLIA MARCO
EF RF RAPAGNANI PIERO
EF RF REINHARD DIETRICH
EF RF RICCI FULVIO
EF RF RIETDORF THOMAS M 20
EF RF ROMYN ROLF M 48

EF RF RUIVET CLAUDE
EF RF SAGGESE ANIELLO
EF RF SCHARDING ARTUR
EF RF SERRANI EUGENIO
EF RF SIMONETTI ROBERTO
EF RF SITENI MAUR
EF RF STIE

ANDREAS
ZAMPA FABIANA
EF RF ZHU NING

RF group EF Division
Philippe Bernard / Herbert Lengeler
77 physicists, engineers, technicians

EF CR ANTONIOLI JEAN-CLAUDE
EF CR BAUD RICHARD
EF CR BEL JEAN-FRANCOIS
EF CR BERNARD PIERRE
EF CR BIRCHLER FRANZ
EF CR BLAIR DAVID
EF CR BONGIOVANNI MARC
EF CR CAMBON ALAIN
EF CR CHAFFARD PAUL
EF CR CHANUT ROBERT

EF CR CUCCURU GIOVANNI
EF CR CYVOCT ARMAND
EF CR DAUVERGNE JEAN-PIERRE
EF CR DELPECH CLAUDE
EF CR DUCIMETIERE ALBERT
EF CR EATON ROBERT
EF CR ENARD HUBERT
EF CR FIRTH MALCOLM
EF CR FRACHET ROLAND
EF CR FRANDSEN POUL KJ

EF CR GAILLAR
EF CR GAUS
EF CR GOIFFO
EF CR GONZAL
EF CR GORCE PI
EF CR GRILLET JE
EF CR GROSSI MA
EF CR GUERIN ROGE
EF CR GUYON ROLAN
EF CR GOIFFON THIERRY M

EF CR GONZALEZ MESTRES LUIS
EF CR GORCE PIERRE
EF CR GRILLET JEAN-PAUL
EF CR GROSSI MARIO-NATALE
EF CR GUERIN ROGER
EF CR GUYON ROLAND
EF CR HAUG FRIEDRICH
EF CR JOUVE CHRISTIAN
EF CR JUILLERAT ALAIN
EF CR KIRCHNER CLAUS

EF CR LEGRAND DOM
EF CR LETORT JA
EF CR MA

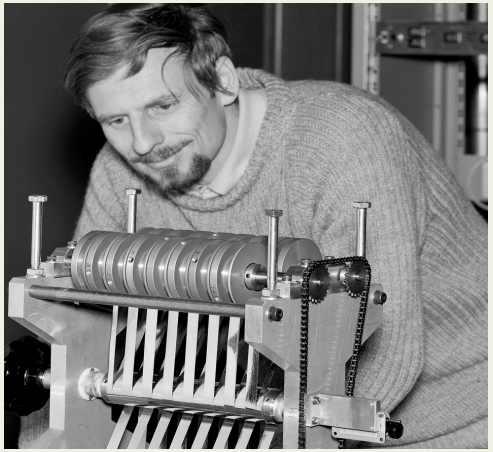
BERANGE
DETZKY ZOLTAN
CR RENOUX ALAIN
EF CR RIEUBLAND JEAN MICHEL
EF CR ROBIN MICHEL
EF CR TRANCHINO GIOVANNI
EF CR VOUATOUX JEAN
EF CR WINKLER GUNTER

EF CRC BENETTI FERNAND
EF CRC CONTIVAL ROB T
EF CRC DROUYE
EF CRC FR

DAVID
LLER JEAN-PIERRE

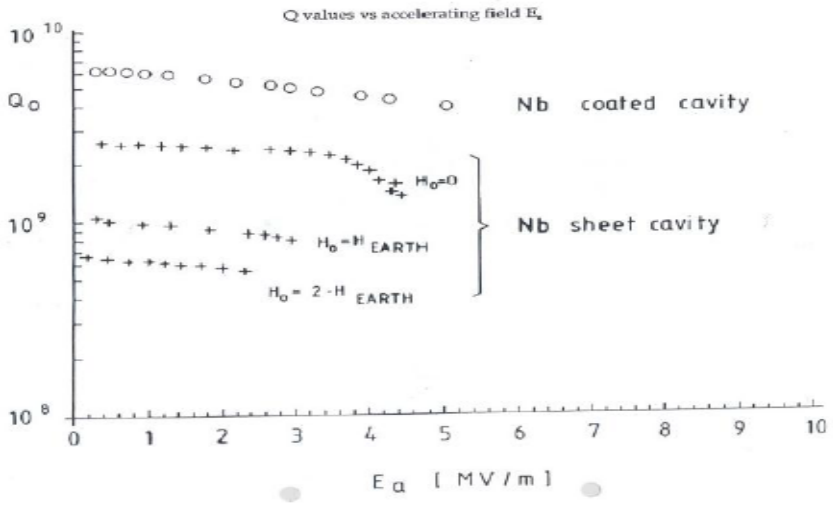
EF Division Magnet and Cryogenics groups under Mario Morpurgo and Jorg Schmid

70 physicists, engineers, technicians

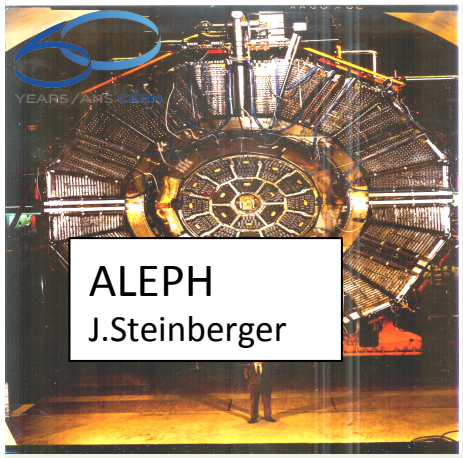


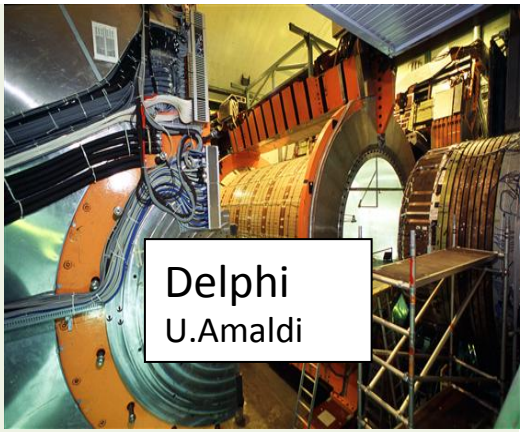
Development of Nb-on-Cu coated cavities for LEP

C. Benvenuti and his team, with
cut-away magnetron and coated cavity

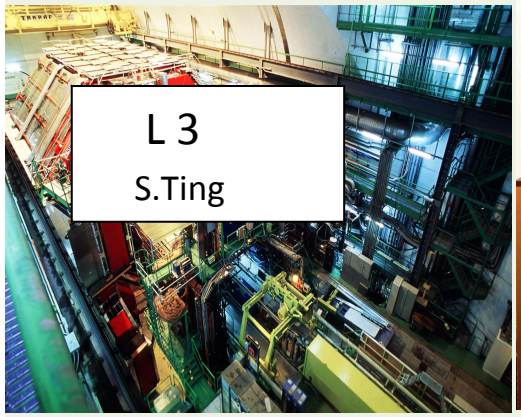


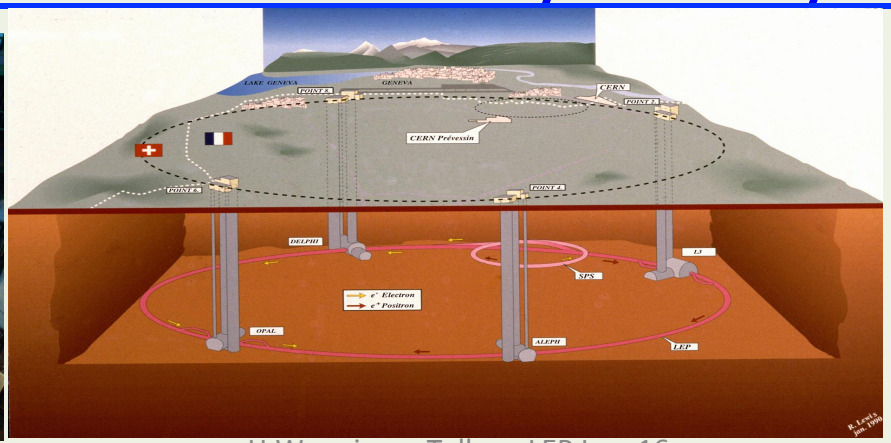
LEP Tunnel

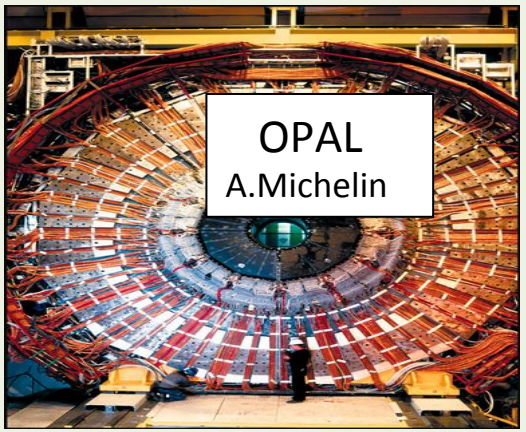




http://home.web.cern.ch/about/experiments

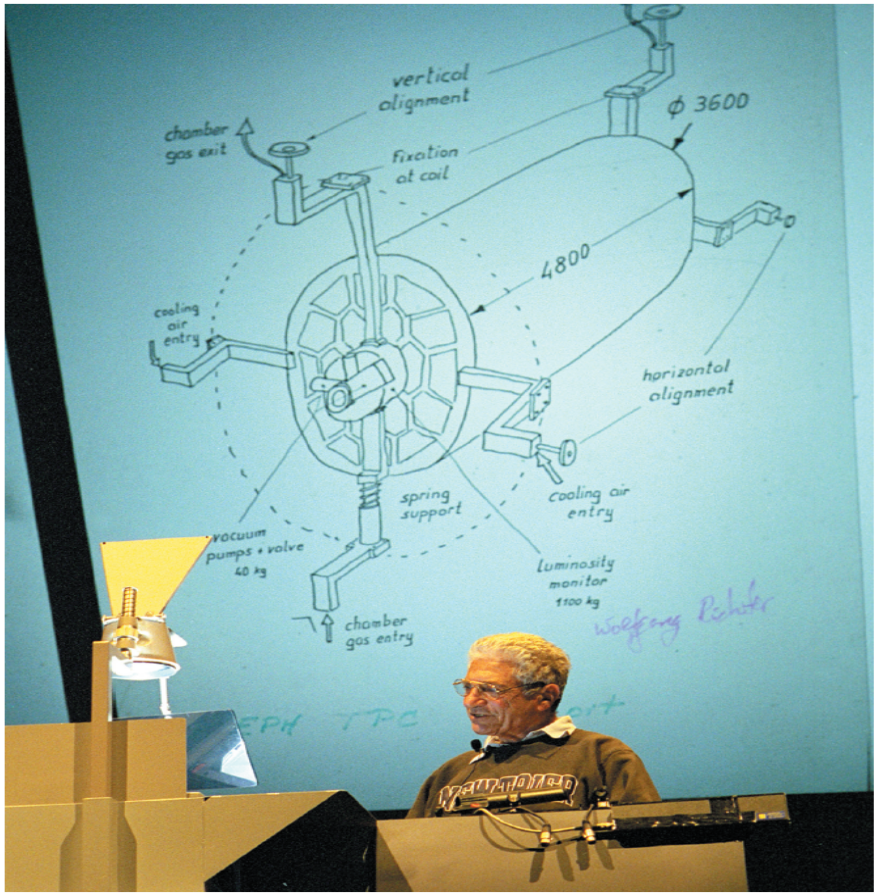






APPARATUS FOR LEP PHYSICS

ALEPH



Jack at the LEPC.

During the lifetime of Aleph, the Spokesmen were

1980 –> 1990	Jack Steinberger
1990 –> 1993	Jacques Lefrançois
1993 –> 1994	Lorenzo Foà
1994 –> 1997	Gigi Rolandi
1997 –> 2000	Peter Dornan
2000 –> 2001	Dieter Schlatter
2001 –> 2005	Roberto Tenchini

Technical Coordinator Jean-Paul FABRE

Installation Coordinator Peter SCHILLY

GLIMOS Patrick JANOT

1980–1982

Formation of the Aleph Collaboration

DECEMBER 1980

First Plenary meeting

JUNE 1981

First Steering Committee meeting

MARCH 1982

Letter of Intent to LEPC

NOVEMBER 1982

THE COLLABORATION

The Aleph Collaboration formed during the years 1980–82. At the time of the Letter of Intent (CERN/LEPC/82-3) dated 25.3.82, the Collaboration consisted of 19 founding Institutes with 275 signing members. The so-called 'Instrument of Understanding' with all legal details was dated 18.4.1984. There was no list of names on the Letter of Intent, only Bari, CERN, Demokritos Athens, Dortmund, Ecole Polytechnique Palaiseau, Edinburgh, Glasgow, Heidelberg, Lancaster, MPI-München, Orsay, Pisa, Rutherford, Sheffield, Torino, Trieste, Westfield College London, Wisconsin.

With the passage of time:

– Westfield College became Royal Holloway

– Dortmund transferred to Mainz

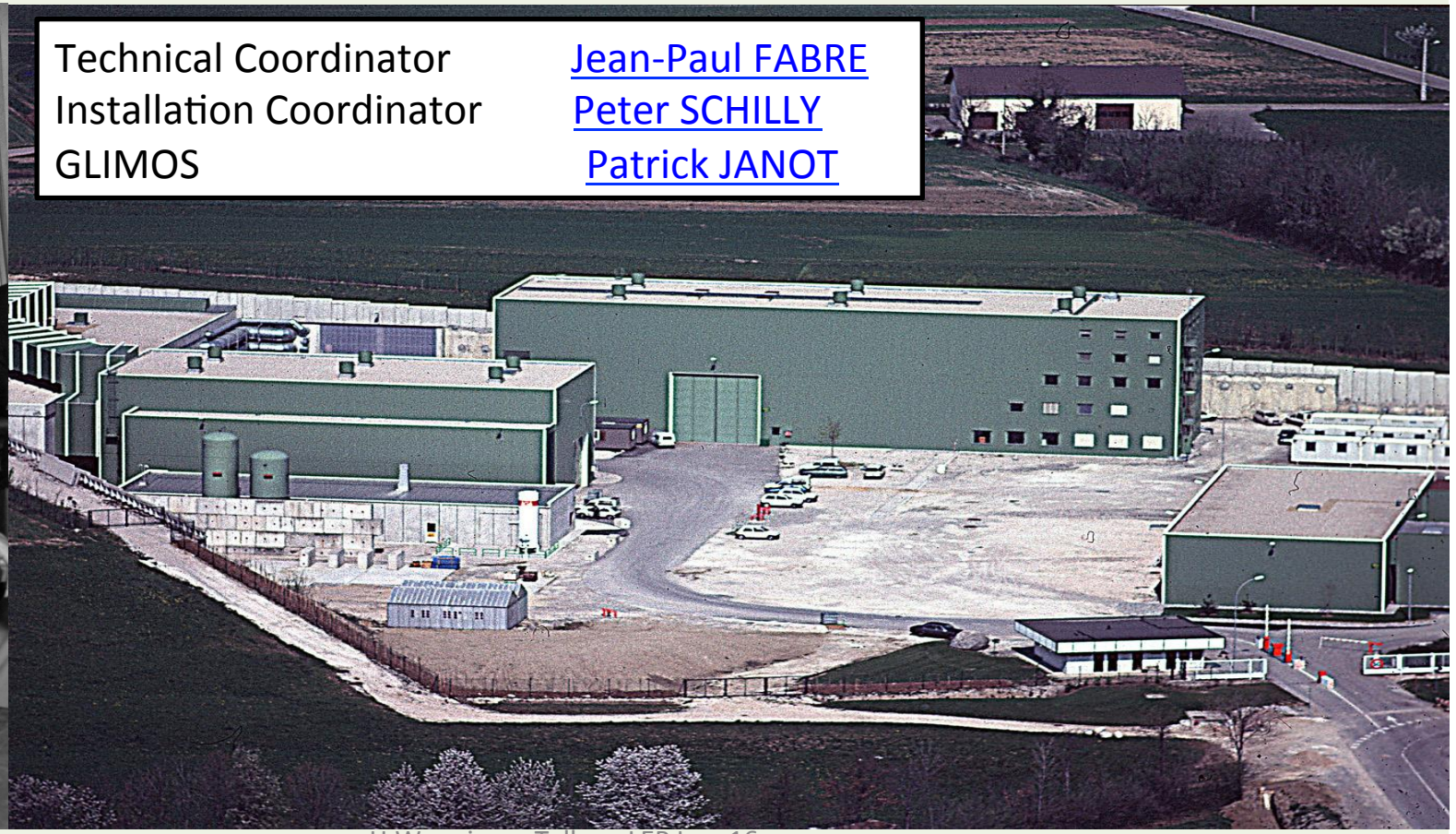
– Torino transferred to Frascati

– 14 new institutes joined…

By 1989 the ALEPH Collaboration had evolved to
32 institutes with 360 members signing publications

ALEPH area : Pierre Lazeyras and support group

Technical Coordinator	Jean-Paul FABRE
Installation Coordinator	Peter SCHILLY
GLIMOS	Patrick JANOT



INSTRUMENT OF UNDERSTANDING

Adolph Minten

In the Instrument of Understanding, the Aleph maintenance and repair was mentioned, but it was foreseen that it would be an addendum to the IOU to be agreed upon at a later time.

A first discussion took place at the Finance Review in November 1985, where the basic principles were defined, at least on responsibility, and stating that the cost should be somehow shared by the whole Collaboration and not only by the builders of the various parts.

At the following meeting a more detailed discussion took place, where some members of the FRC proposed that CERN should take care of all the maintenance costs *for the parts coming to CERN from the Member States institutions.* In November 1986 we had a proposal that the contribution of each Institute should be proportional to its contribution to the construction. The total budget had two parts, one for detector maintenance, the other for the common operation, gas, magnetic tapes, magnet, etc.

The money foreseen for detector maintenance was kept 'at home'; the rest was paid to a common pot. Long discussions took place concerning the sharing of the cost between Institutions, depending on the contribution to the detector construction, number of physicists or anything else.

In May 1988, the Director of Research was in a position to announce to the FRC that all participants but China had signed the document concerning maintenance and operation. China was anyhow a special case.

(Editor's note-RS: This way of managing the maintenance and operation budget was very successful, with Aleph receiving enough money to finance the operations and having some surplus to make several important upgrades, e.g. replace the Fastbus ROCs with VME, buy more powerful computers for online and offline.)

EF ALE ALBERT JEAN-NOEL M
EF ALE AMESKAMP MARTIN M
EF ALE AN JINGXIAN M
EF ALE ARNAULT CHRISTIAN M
EF ALE BATTAIOTTO GRACIELA F
EF ALE BATTAIOTTO PEDRO M
EF ALE BATTISTONI GIUSEPPE M
EF ALE BERG BERNHARD M
EF ALE BERTHOLET PIERRE M
EF ALE BLONDIN CYRIL M

EF ALE BUDDE REINHARD M
EF ALE CAMERON WILLIAM M
EF ALE CAMPANA PIERLUIGI M
EF ALE CAPT JEAN-DANIEL M
EF ALE CASTRO ANDREA M
EF ALE CHARITY TIMOTHY M
EF ALE CHEN YUAN BO M 27
EF ALE CHEVALIER JEAN-MARIE M
EF ALE CHIARELLA VITALIAN
EF ALE CLAAS LINDA

EF ALE D
EF
AS M
AN CLAUDE M
AN RAFAEL M
AGERSTROM JAN M
EF ALE FARILLA ADDOLORATA F
EF ALE PATRICK LOUIS M

EF ALE GAILLARD SILVERMAN LYNN
EF ALE GANIS GERARDO M
EF ALE GHISELLI ANTONIA F
EF ALE GOBBO BENIGNO M
EF ALE GREGOIRE RAYMOND M
EF ALE GREMAUD PAUL M
EF ALE GRUB RUDOLF M
EF ALE HANKE PAUL M
EF ALE HARVEY JOHN M
EF ALE IVESDAL BJORN M

EF ALE KLEIN OLIVI
EF ALE LARSS
EF ALE
SSANDRO M
LYON M
VILA PERE M
MATTHEWSON ROY M

EF ALE MCCLATCHEY R. HOWARD M
EF ALE MCPHERSON GEORGE M
EF ALE MIANA STEPHANE M
EF ALE MILLER DEREK GEORGE M
EF ALE MINTEN ADOLF M
EF ALE MIOTTO ALESSANDRO M
EF ALE MONNAMI JEAN-DENIS M
EF ALE MONNIER EMMANUEL M
EF ALE MURER ERNST M
EF ALE PAPPER MICHAEL M

EF ALE PETIT ERIC M
EF ALE PIETRZYK
EF ALE PIL
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M
G M
HAUSLER OTTO M
BKOWSKI FREDERIC M

EF ALE SCHWARZ MONIKA F
EF ALE SIMONE VINCENZO M
EF ALE SIMONET LUC M
EF ALE SPANIER STEFAN MANUEL M
EF ALE STRONG JOHN ANTHONY M
EF ALE SWEETLAND EMMA F
EF ALE TAKASHIMA MAKOTO M
EF ALE TEJESSY WOLFGANG M
EF ALE THOMAS JENNIFER ANNE F
EF ALE VON RUEDEN WOLFGANG M

EF ALE WASEM ALBIN M
EF ALE WEISZ JEROME M
EF ALE WHEELER SARAH JANE F
EF ALE WITZELING WERNER M

ALEPH support group EF Division under Pierre LAZEYRAS,
84 physicists, engineers, technicians

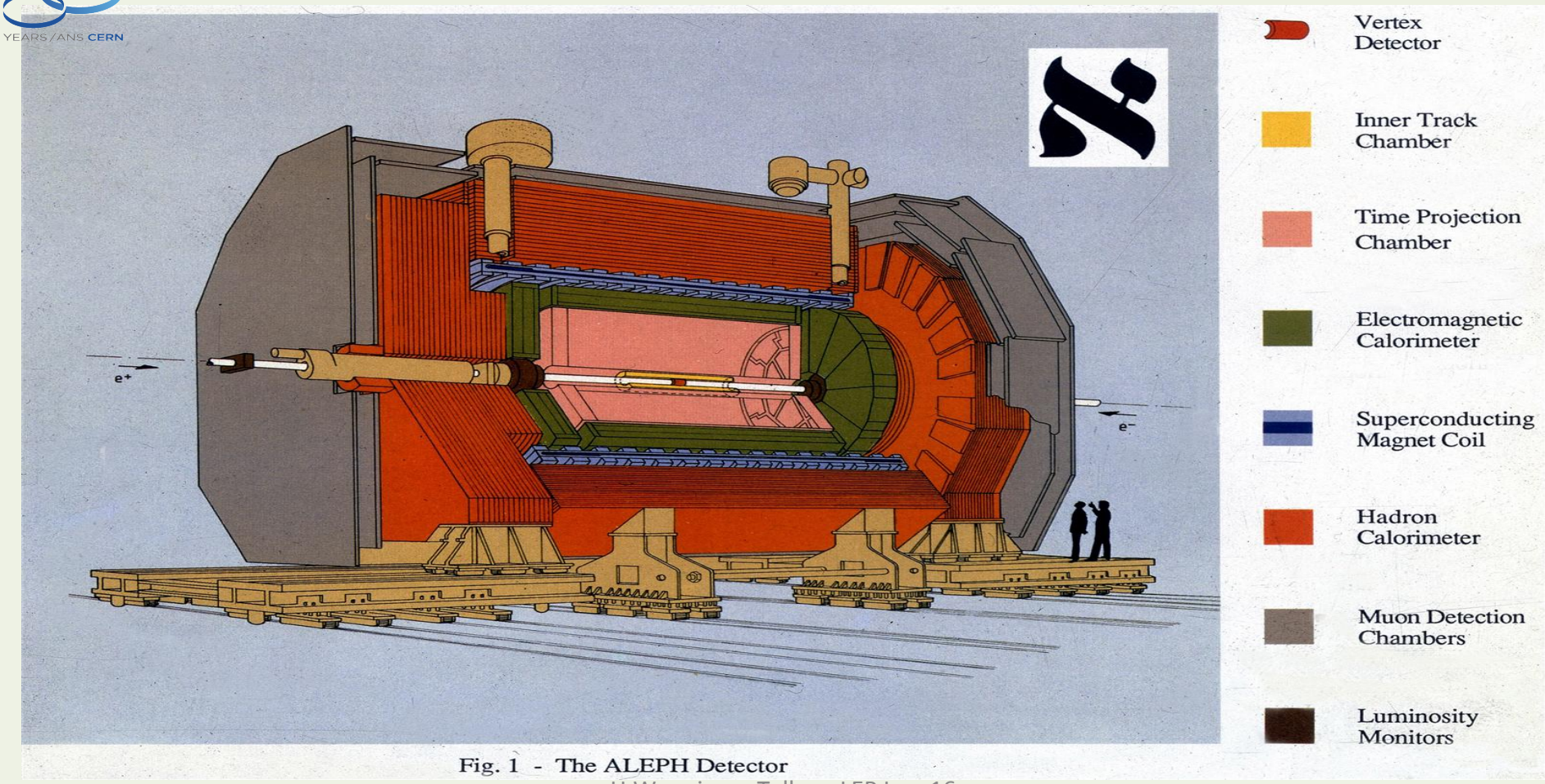


Fig. 1 - The ALEPH Detector

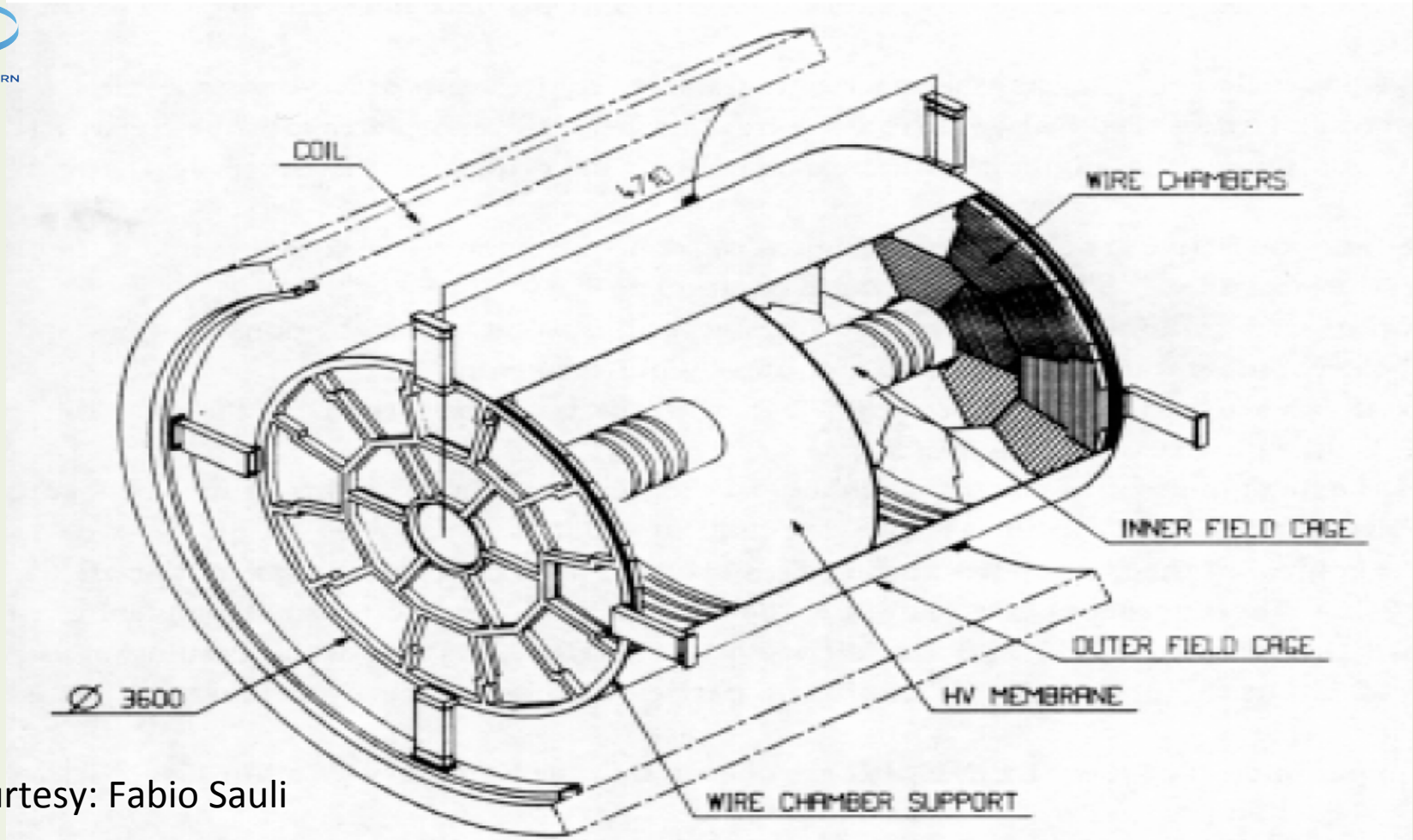
CERN-PPE 96-41

The ALEPH Silicon Vertex Detector is the first detector operating in a colliding beam environment that uses silicon strip detectors which provide readout on both sides and hence a three– dimensional point measurement for the trajectory of charged particles.
The detector system was commissioned successfully at the e^+e^- collider LEP at the research centre CERN, Switzerland, during the year 1991 while taking data at the Z^0 resonance. The achieved spatial resolution of the complete 73 728 channel device (intrinsic plus alignment) is 12 μm in the $r \cdot \phi$ view and 12 μm in the z view.

it was in 1974 that Nygren invented the time projection chamber TPC , a simple and brilliantly conceived device to record 3D tracking data for charged particles in a large gas-filled volume equipped with parallel electric fields (in which ionization electrons drift and magnetic fields (in which charged reaction products move on helical paths.

The first TPC, built at Berkeley, was used in the PEP-4 experiment at SLAC to study e+e– annihilation interactions at, what was then, high energy.
TPCs were essential elements in the ALEPH and DELPHI experiments at CERN's Large Electron–Positron collider and are now used in ALICE at the LHC, ICARUS (filled with liquid argon rather than gas) at the Gran Sasso National Laboratory, and STAR at Brookhaven National Laboratory.

Dave Nygren: "inspirational and wise beyond his years". (Image credit: Jerry Przybylski.)



Courtesy: Fabio Sauli

Fig. 24: Schematics of the ALEPH Time Projection Chamber.

Ready to go!!

Management styles of experiment leaders:

Ron Settels:

I remember a meeting with Jack, in 1984 roughly, in which I was explaining to him how much extra difficulty was caused by the little corners ('earlobes', we called them—'Ohrwaschl' in Bavarian) on the very inside radius of the K sectors

hoping Jack would say:

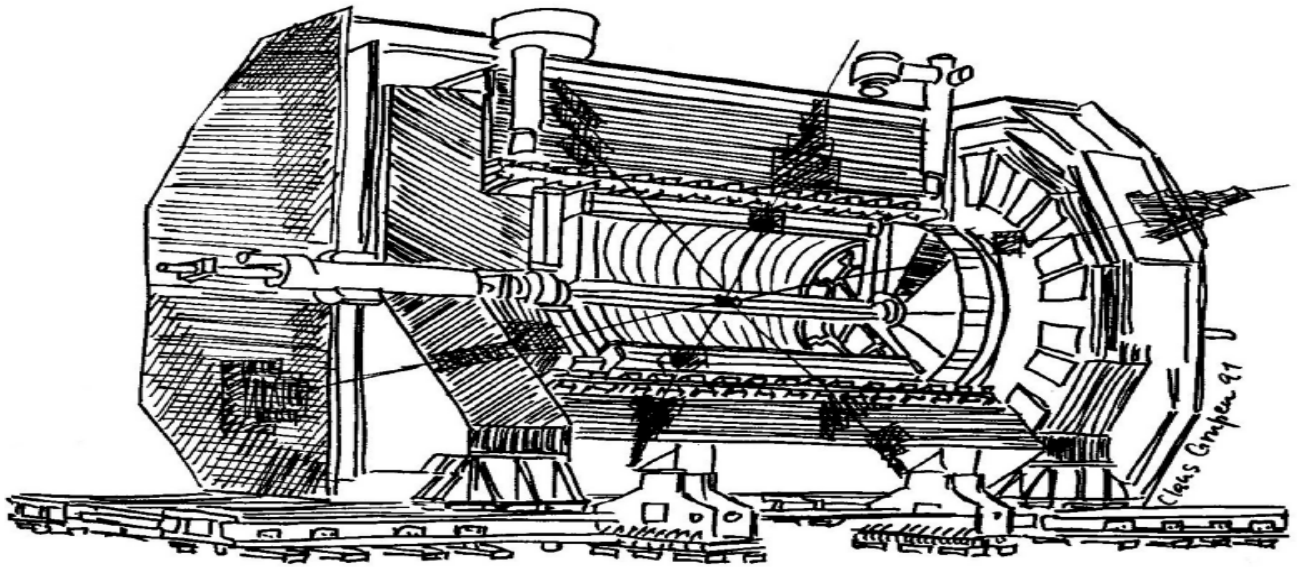
'Well, they are not really that important…' so that we could remove them from the design and make life easier.

However, Jack's response was,

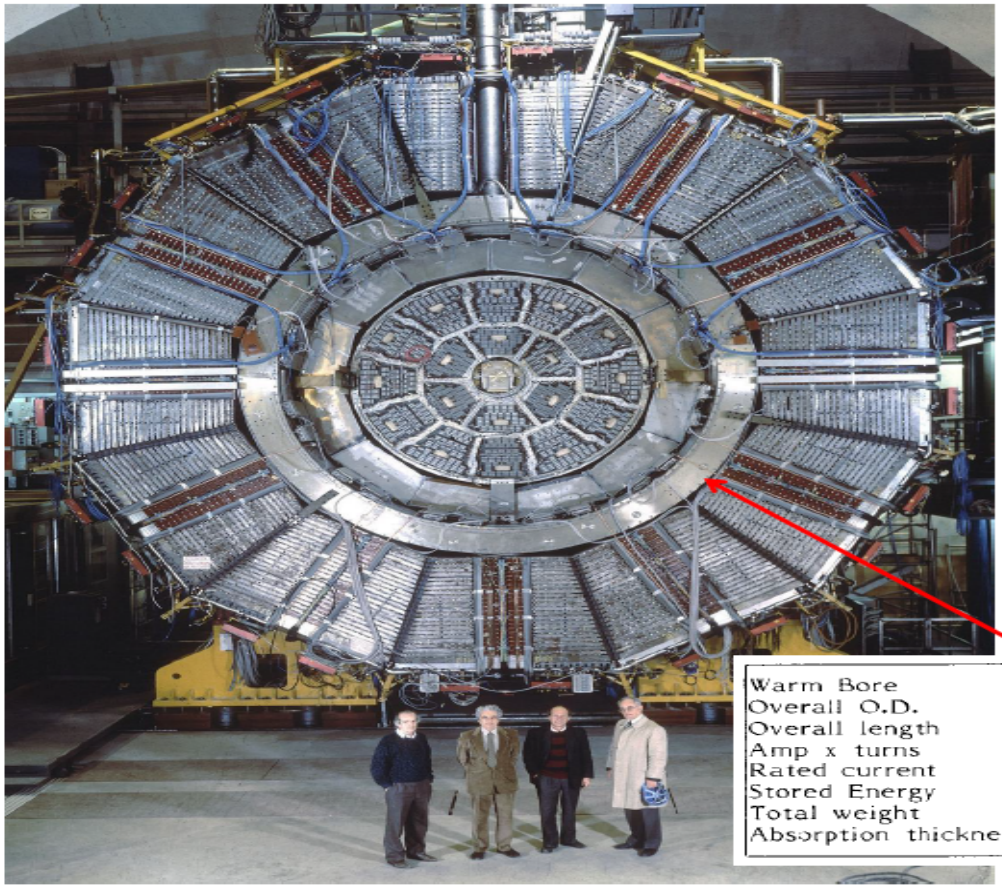
'I'm not worried about the amount of work you guys at MPI have to do…' which ended the discussion and the design was kept as it was in the drawing

(one thing nice about many discussions with Jack was that they were short and to the point - *but I doubt if the 'ear-lobes' really made much difference to the performance*

Calorimeters, Coil, Muon



SACLAY SC SOLENOID



ALEPH solenoid
CEA Saclay (1988)

Thin superconducting solenoid
Central field 1.5 T
Al-stabilized Nb-Ti conductor
Bobbinless winding
Al external support cylinder
Indirect cooling

Warm Bore	5 m
Overall O.D.	5.8 m
Overall length	7 m
Amp x turns	$9.5\ 10^6$
Rated current	5000 Amps
Stored Energy	136 MJ
Total weight	65 ton
Absorption thickness	0.5 λ abs

The Presidents of the Swiss Confederation, Jean-Paul Delamuraz, the French Republic, François Mitterand, and the Mayor of Echenevex in the Aleph pit.

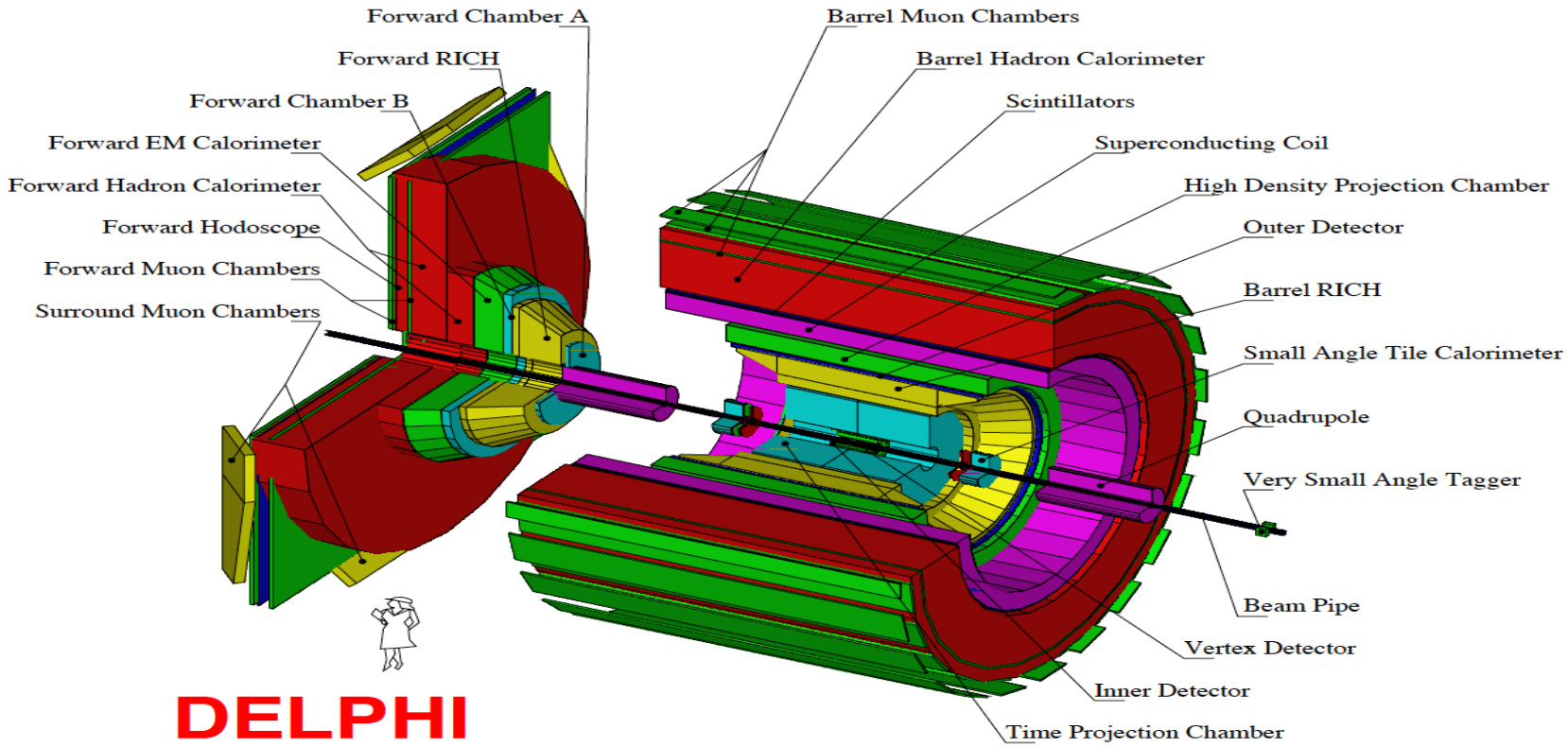
There were always plenty of occasions to celebrate at Echenevex!
(Editor's note-JL: Before the 'safety' cleanup!)

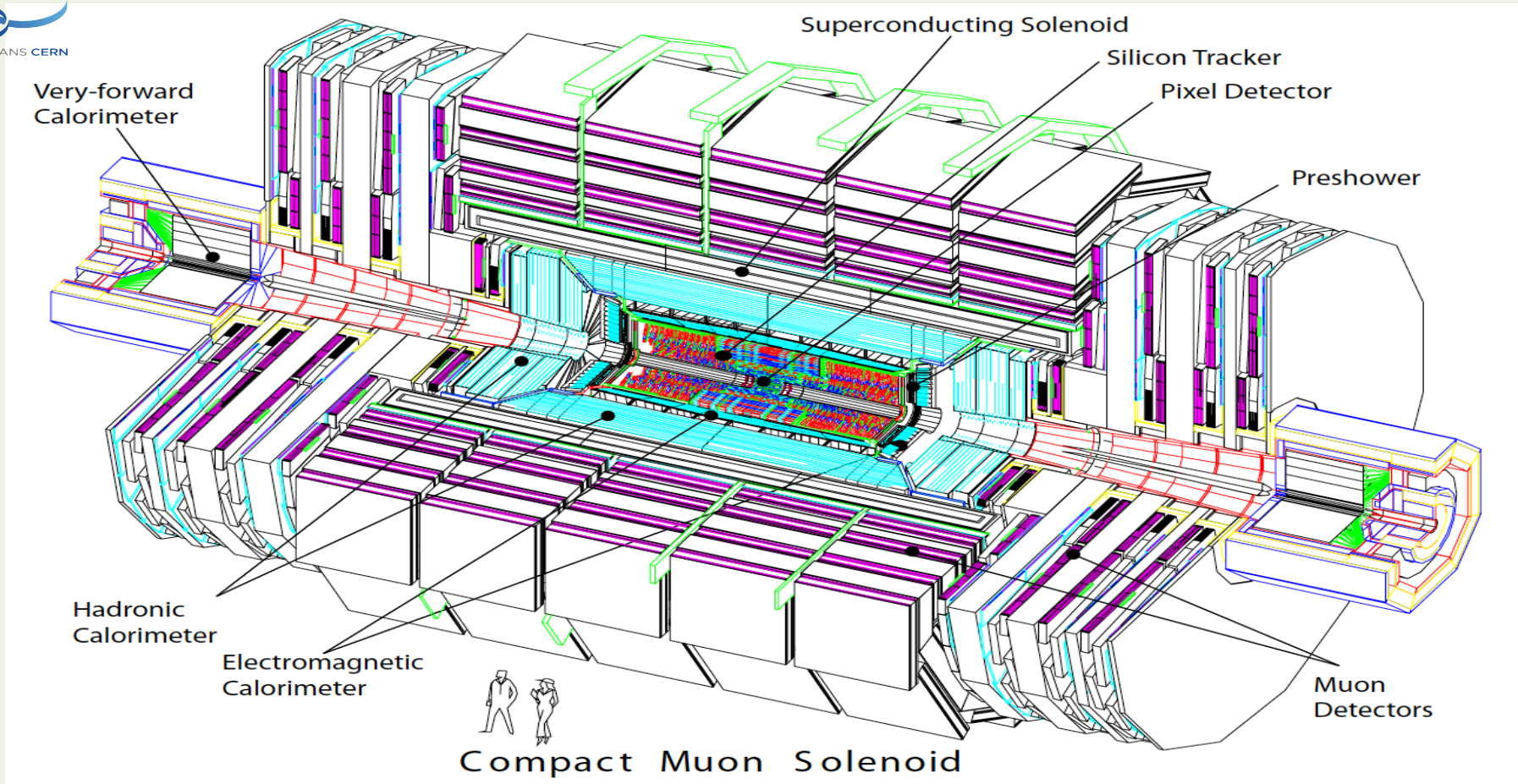
http://delphiwww.cern.ch/Welcome.html

DELPHI

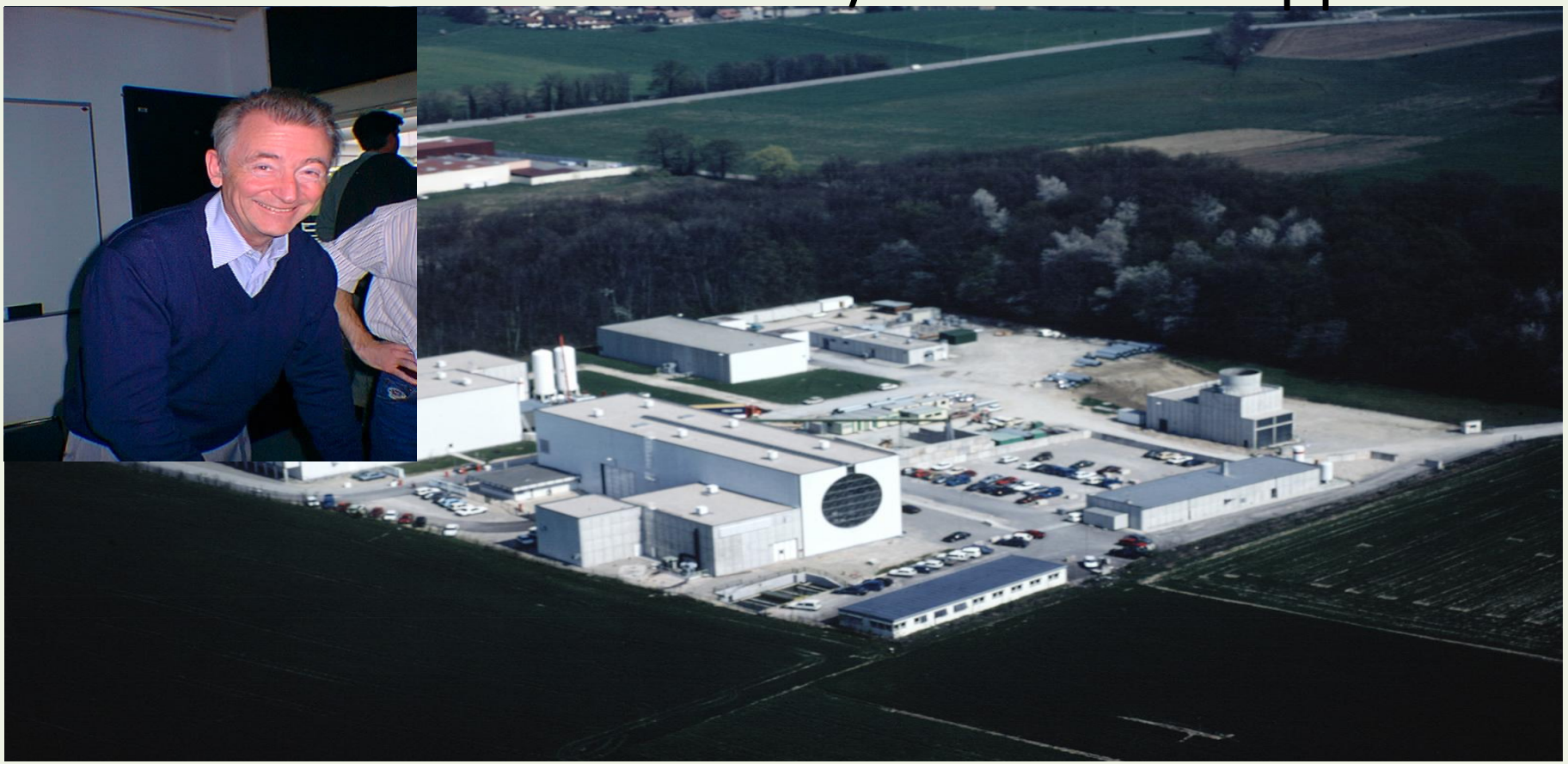
DEtector with Lepton Photon and Hadron Identification

http://delphiwww.cern.ch/delphi$www/public/detectors/www_det.html


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


Superconducting Solenoid
Silicon Tracker
Pixel Detector
Very-forward Calorimeter
Preshower
Hadronic Calorimeter
Electromagnetic Calorimeter
Muon Detectors
Compact Muon Solenoid

DELPHI area with Hilke / Foeth and support



EF DEL AKHTAR NAVEEDA F 18
EF DEL ALBRECHT ERICH M 35
EF DEL ALOUPIS ANASTASSIOS M
EF DEL ALVSVAAG SVERRE M 22
EF DEL ANASSONTZIS EFSTRATIOS M
EF DEL ANDERSEN CARSTEN M 19
EF DEL AUGUSTINUS ANDRE M 21
EF DEL BALCERZAK TADEUSZ M 46
EF DEL BASTIE CHRISTIANE F 37
EF DEL BATTISTONI GIUSEPPE M 29

EF DEL BELL WILLIAM M 48
EF DEL BLASZCZAK ZDZISLAW JOZEF M
EF DEL BOWEN PHILIP M 20
EF DEL BRAND CLAUDE M 46
EF DEL BROAD ROBIN M 20
EF DEL BROWN ROBIN M 46
EF DEL BRYLLE CHRISTIAN M 18
EF DEL BRZOZOWSKI KRZYSZTOF JAN
EF DEL CAIRANTI SERGIO M 48
EF DEL CAMPANA PIERLUIGI M 26

EF DEL CARTIER FRANC
EF DEL CATT

EF DEL DENNI UBALDO M 31

EF DEL DIEPERINK EDGAR M 16
EF DEL DOROBA KRZYSZTOF M 36
EF DEL FAVRE JOELLE F 18
EF DEL FISCHER HANS GERHARD
EF DEL FLAMMIER MARCEL M 42
EF DEL FOETH HENRIK M 43
EF DEL GAVILLET PHILIPPE M 42
EF DEL GILLIS NANNA F 19
EF DEL GORINE IOURI M 42
EF DEL GORSKI MACIEJ M 34

EF DEL GRANT ALAN M 44
EF DEL GRUHN CHARLES M 49
EF DEL HAHN FERDINAND M 24
EF DEL HAIDER STEFAN M 23
EF DEL HANKE PAUL M 24
EF DEL HECK RUD

EF DEL KONTAXIS IOANNIS M 33
EF DEL KORNELIS YSBRAND M 52
EF DEL KOSMAOGLU PLATON M
EF DEL KOUTENTAKIS JOHN M
EF DEL KROLIKOWSKI JAN M 31
EF DEL KUHN GUSTAVO M 57
EF DEL KYRE SUSANNE ANTONIE
EF DEL LALLOZ REGIS M 22

EF DEL LANGE WOLFGANG M 21
EF DEL LAUGWITZ FRANZ M 23
EF DEL LEGRAND JEAN-CLAUDE
EF DEL LENZEN GEORG M 34
EF DEL LESUEUR JACKIE M 43
EF DEL LETTRY MICHEL M 50
EF DEL LIGOCKI JOZEF M 41
EF DEL MARSZAL TADEUSZ M 37
EF DEL MATOS F. HORACIO M
EF DEL MAZUR ZDZISLAW

EF DEL PETROFF PIERRE G. M
EF DEL PIETRZAK WIESLAW M 42
EF DEL PRIVITERA PAOLO M 17
EF DEL ROS ZYGMUNT M 52
EF DEL ROSSO ETTORE M 42
EF DEL SALGARELLA BRUNO M
EF DEL SANCHEZ MIGUEL M 17
EF DEL SANCHO ANTONIO M 20
EF DEL SCHELLBACH MARTIN M
EF DEL SCHULER ROLAND M 50
EF DEL SINQUIN XAVIER M 20
EF DEL SKARKE HARALD M 20
EF DEL SMIALOWSKI TADEUSZ M
EF DEL STEININGER MARTINE F

EF DEL STODULSKI MAREK M
EF DEL STREK MIECZYSLAW M
EF DEL SULOWSKI KRZYSZTOF
EF DEL SZEPTYCKA MARIA F
EF DEL SZYMANSK
EF DEL TA

DELPHI support group EF Division Technical Coordinator
Hans-Juergen Hilke,
110 physicists, engineers, technicians

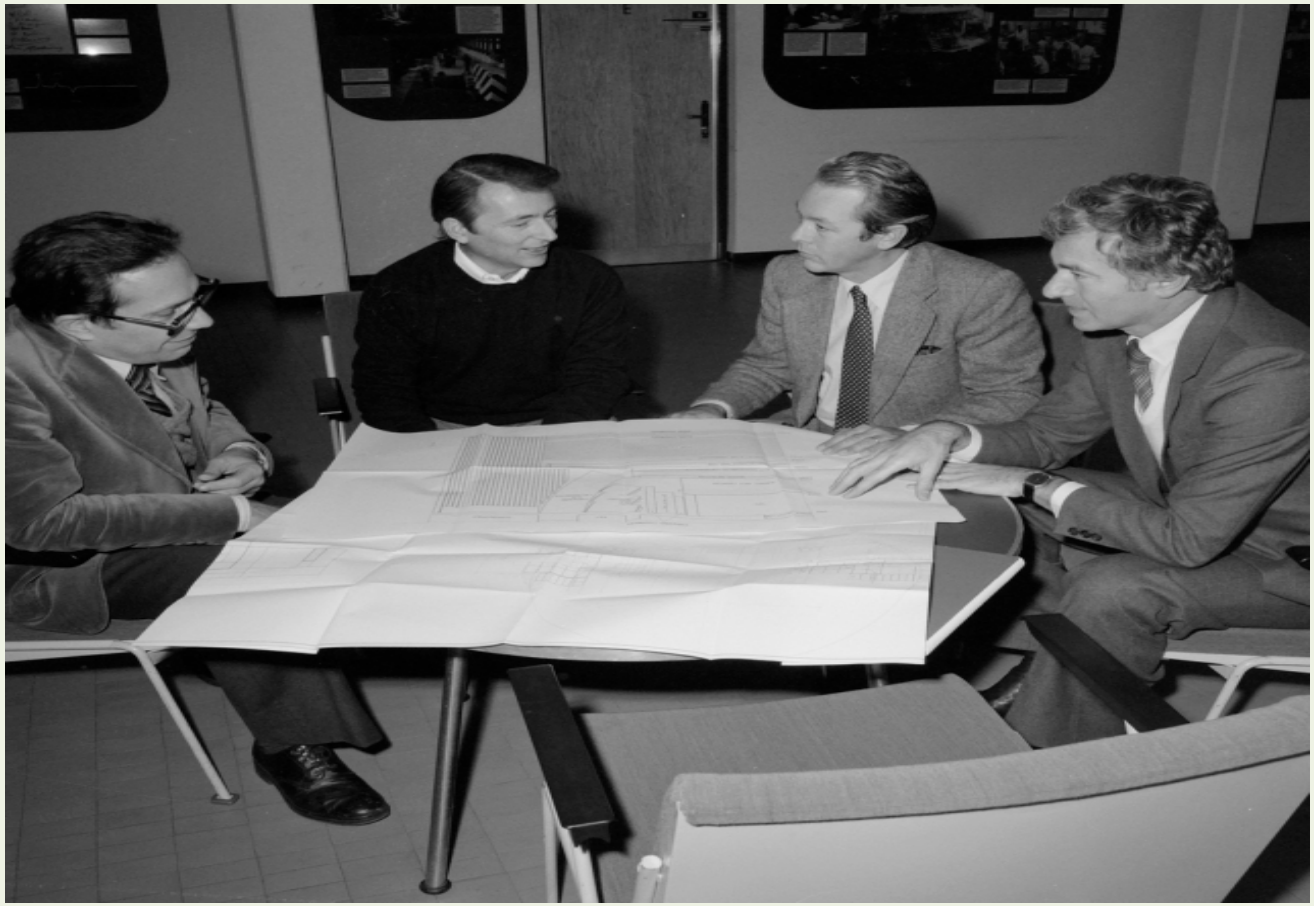
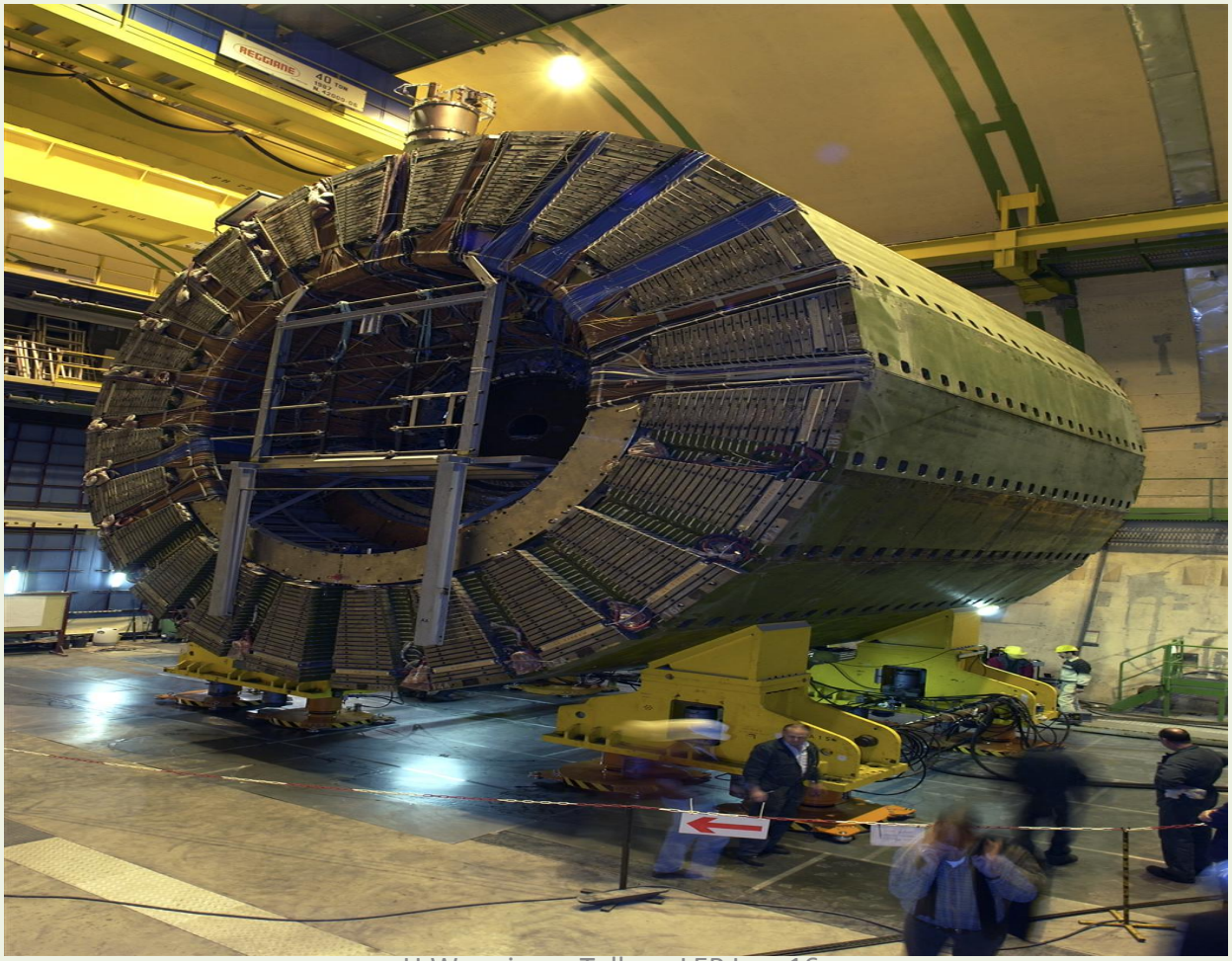
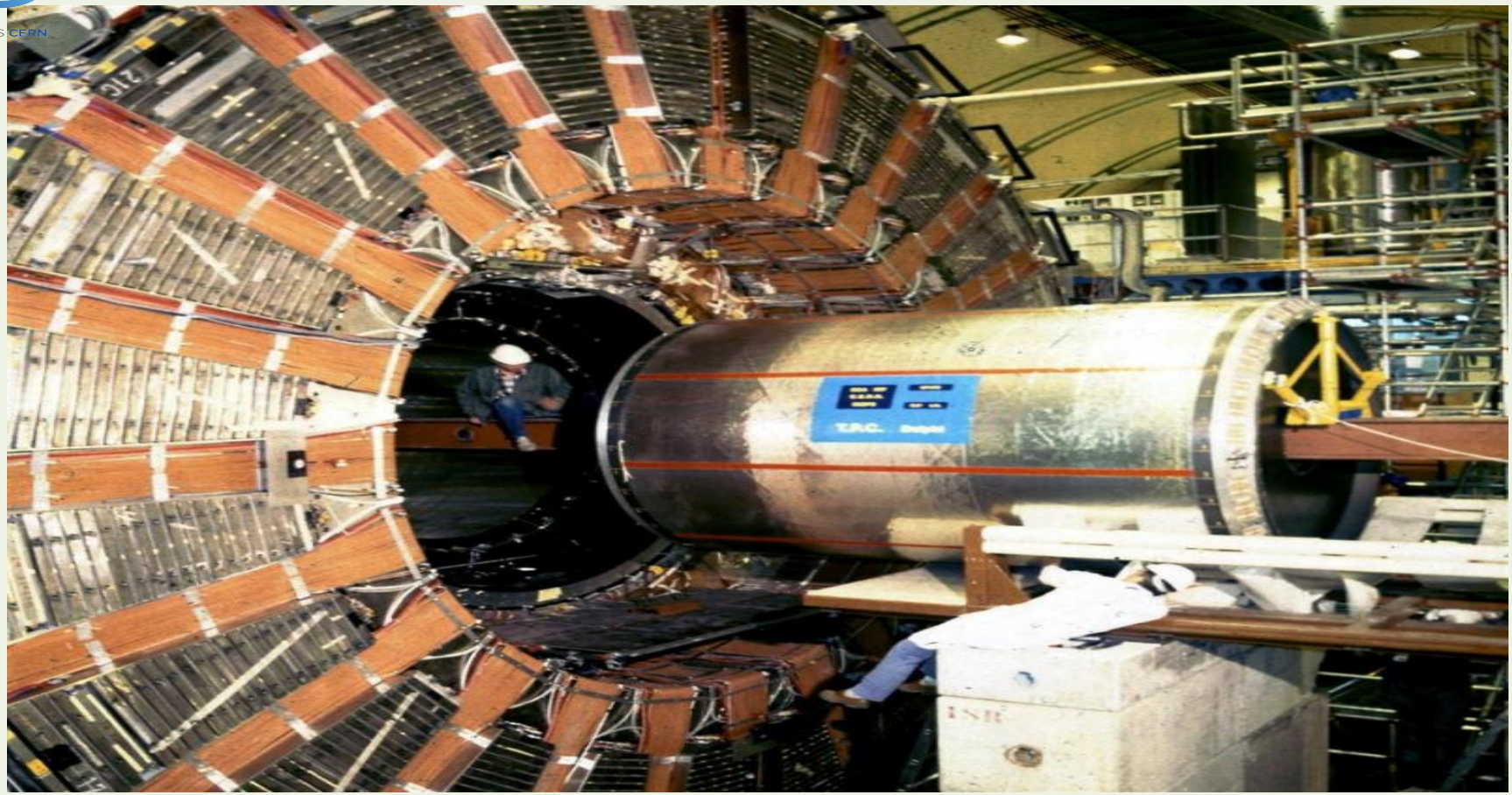


Fig. 20: DELPHI RICH detector being inserted into the mirror's barrel.


REGGIANE



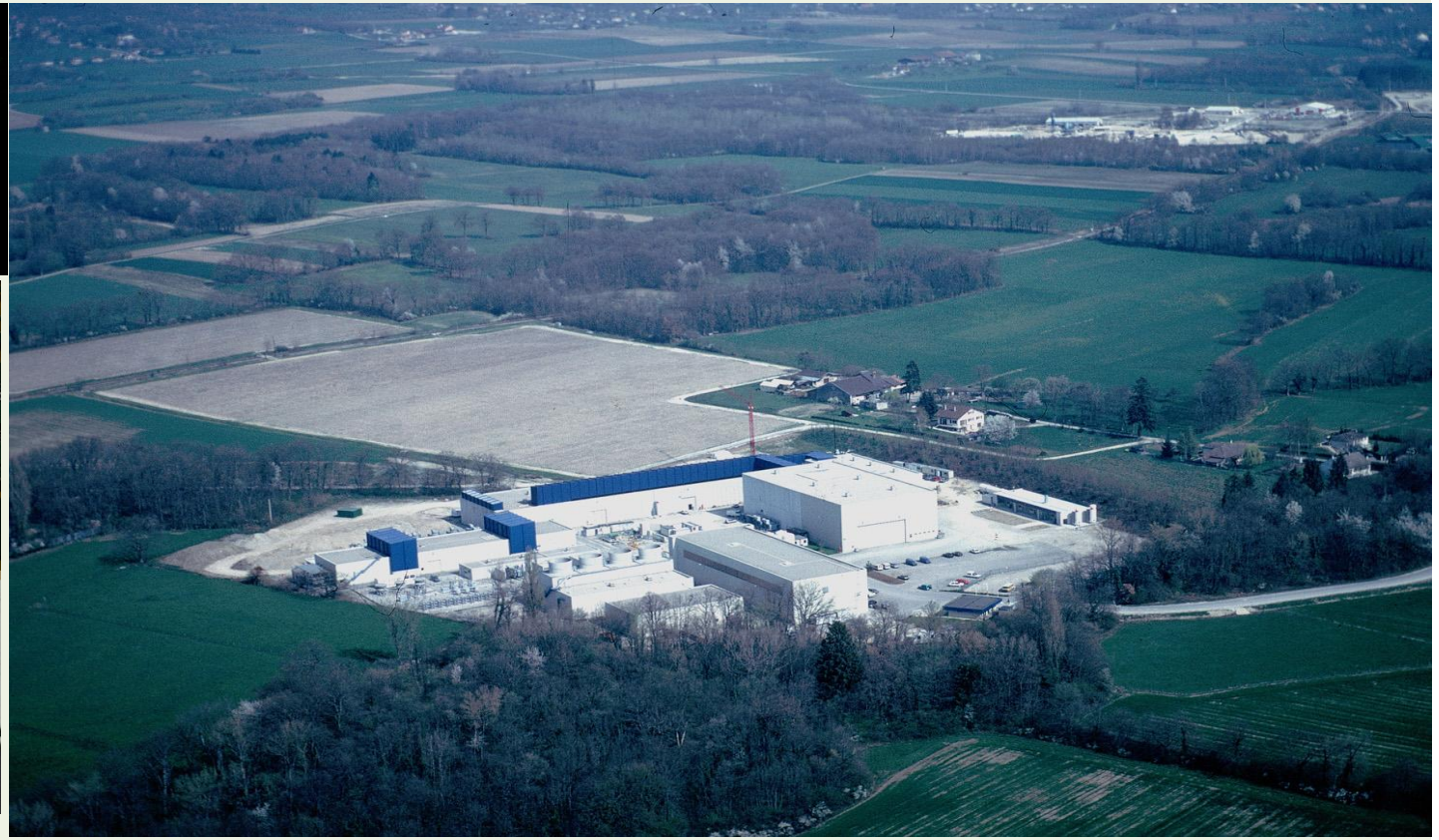
DELPHI solenoid
RAL (1987)

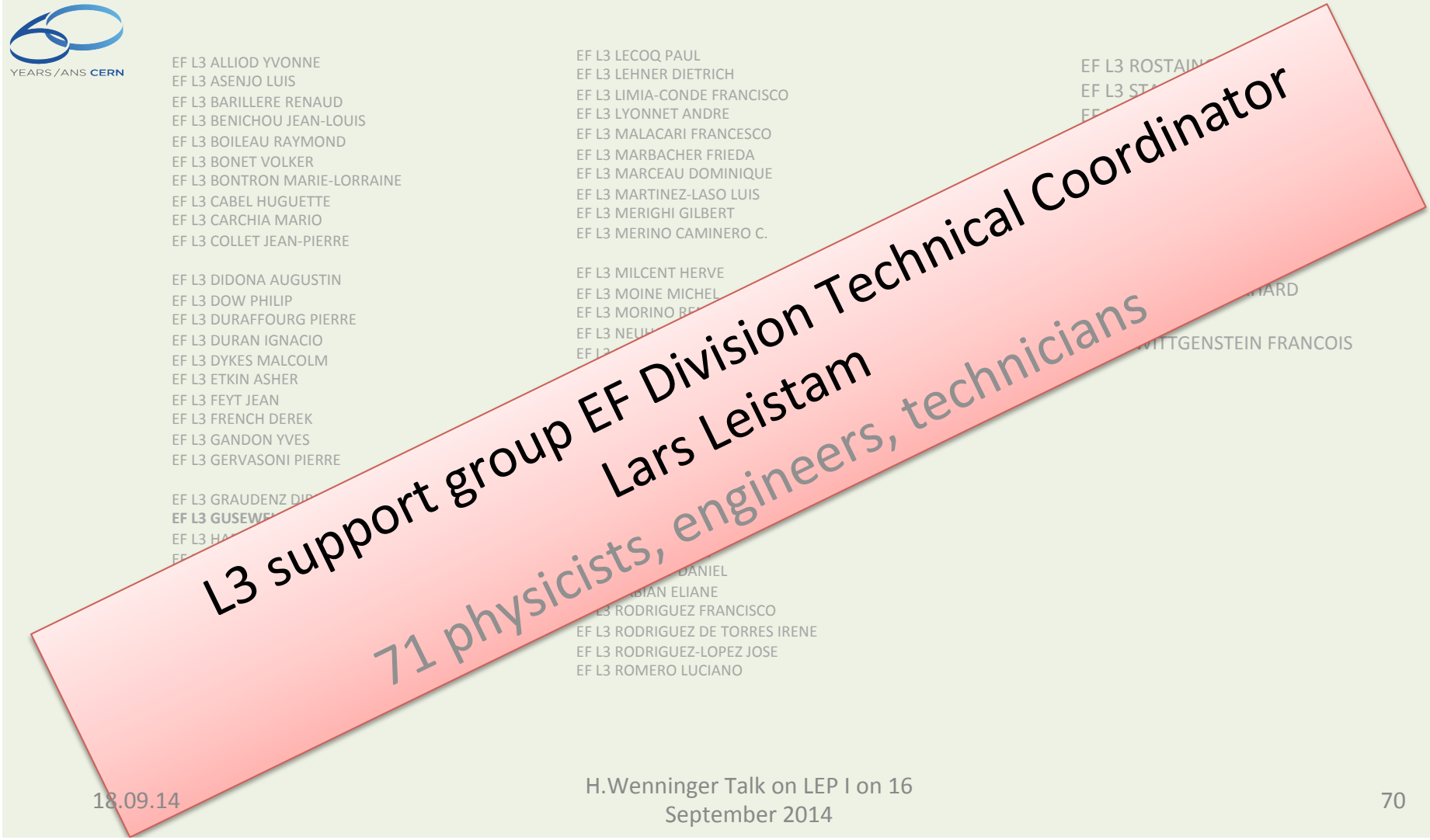
Thin superconducting solenoid
Central field 1.2 T
Warm bore 5.2 m
Length 6.8 m
Stored energy 110 MJ
Al-stabilized Nb-Ti conductor
Bobbinless winding
Al external support cylinder
Indirect cooling
Forced flow of two-phase He

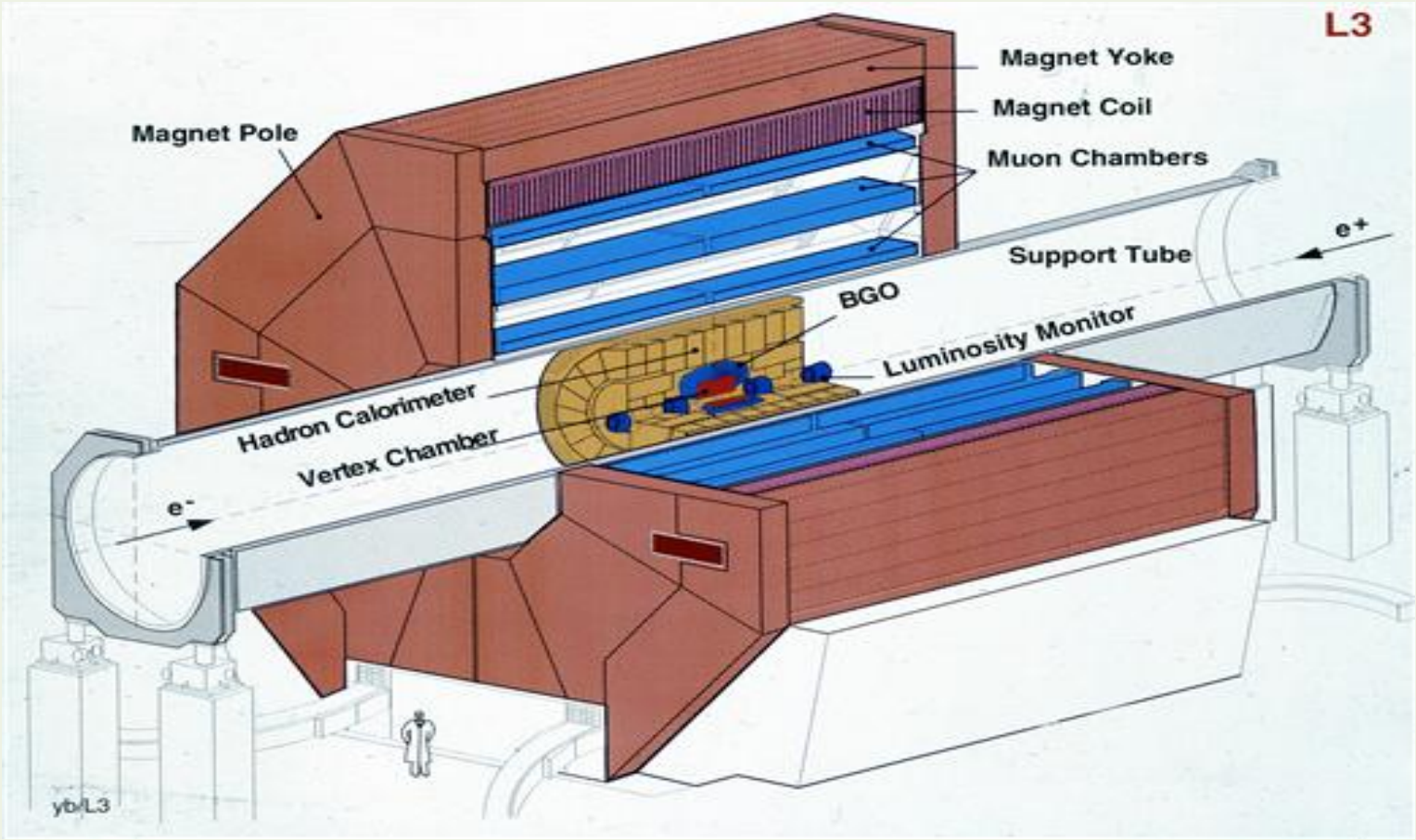

DELPHI
A
B
C

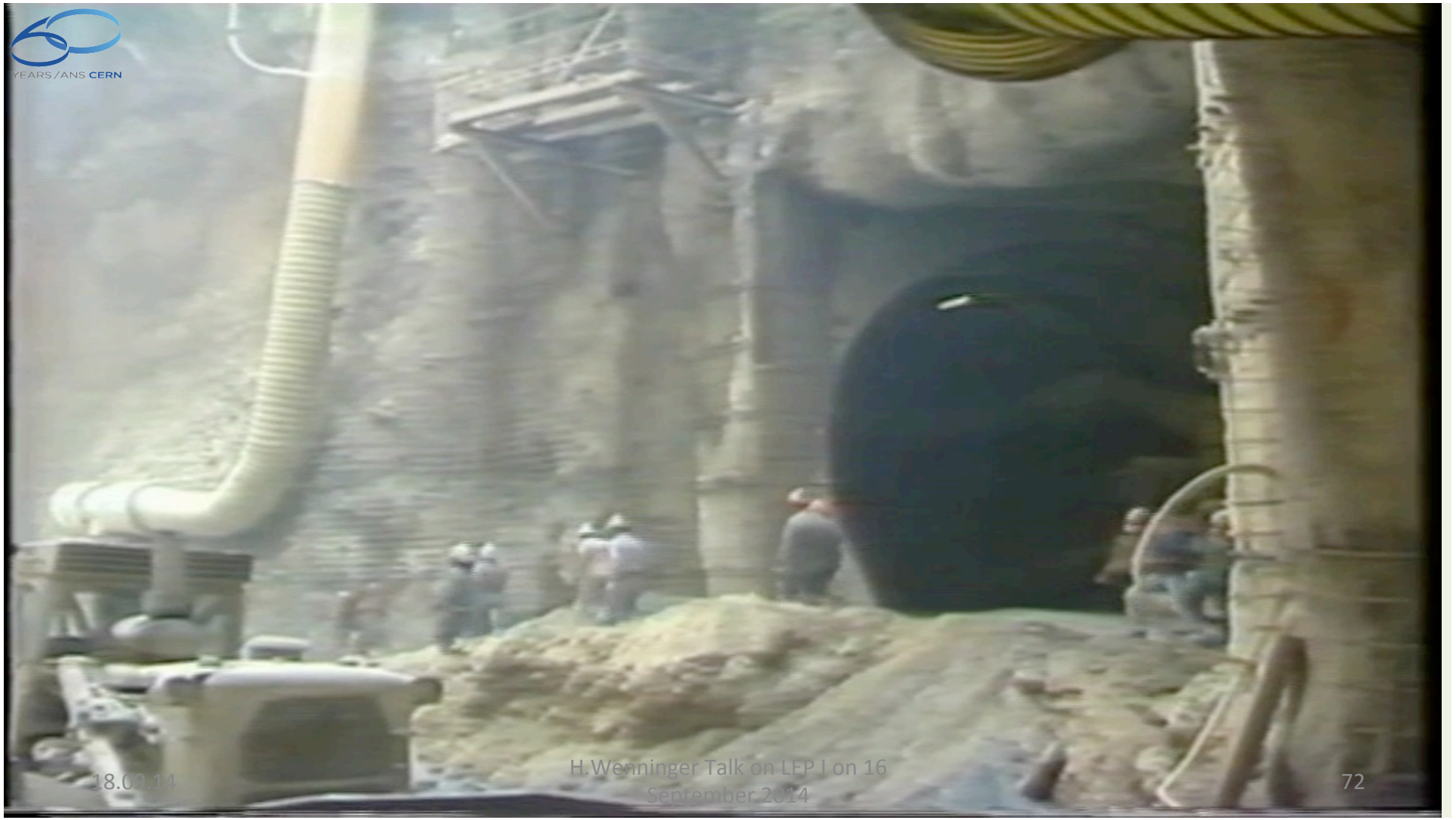
L3
LETTER OF INTENT # 3

L3 area with Gusewell /Hervé and support group




YEARS/ANS CERN
EF L3 ALLIOD YVONNE
EF L3 ASENJO LUIS
EF L3 BARILLERE RENAUD
EF L3 BENICHOU JEAN-LOUIS
EF L3 BOILEAU RAYMOND
EF L3 BONET VOLKER
EF L3 BONTRON MARIE-LORRAINE
EF L3 CABEL HUGUETTE
EF L3 CARCHIA MARIO
EF L3 COLLET JEAN-PIERRE
EF L3 DIDONA AUGUSTIN
EF L3 DOW PHILIP
EF L3 DURAFFOURG PIERRE
EF L3 DURAN IGNACIO
EF L3 DYKES MALCOLM
EF L3 ETKIN ASHER
EF L3 FEYT JEAN
EF L3 FRENCH DEREK
EF L3 GANDON YVES
EF L3 GERVASONI PIERRE
EF L3 LECOQ PAUL
EF L3 LEHNER DIETRICH
EF L3 LIMIA-CONDE FRANCISCO
EF L3 LYONNET ANDRE
EF L3 MALACARI FRANCESCO
EF L3 MARBACHER FRIEDA
EF L3 MARCEAU DOMINIQUE
EF L3 MARTINEZ-LASO LUIS
EF L3 MERIGHI GILBERT
EF L3 MERINO CAMINERO C.
EF L3 MILCENT HERVE
EF L3 MOINE MICHEL
EF L3 RODRIGUEZ FRANCISCO
EF L3 RODRIGUEZ DE TORRES IRENE
EF L3 RODRIGUEZ-LOPEZ JOSE
EF L3 ROMERO LUCIANO
L3 support group EF Division Technical Coordinator
Lars Leistam
71 physicists, engineers, technicians

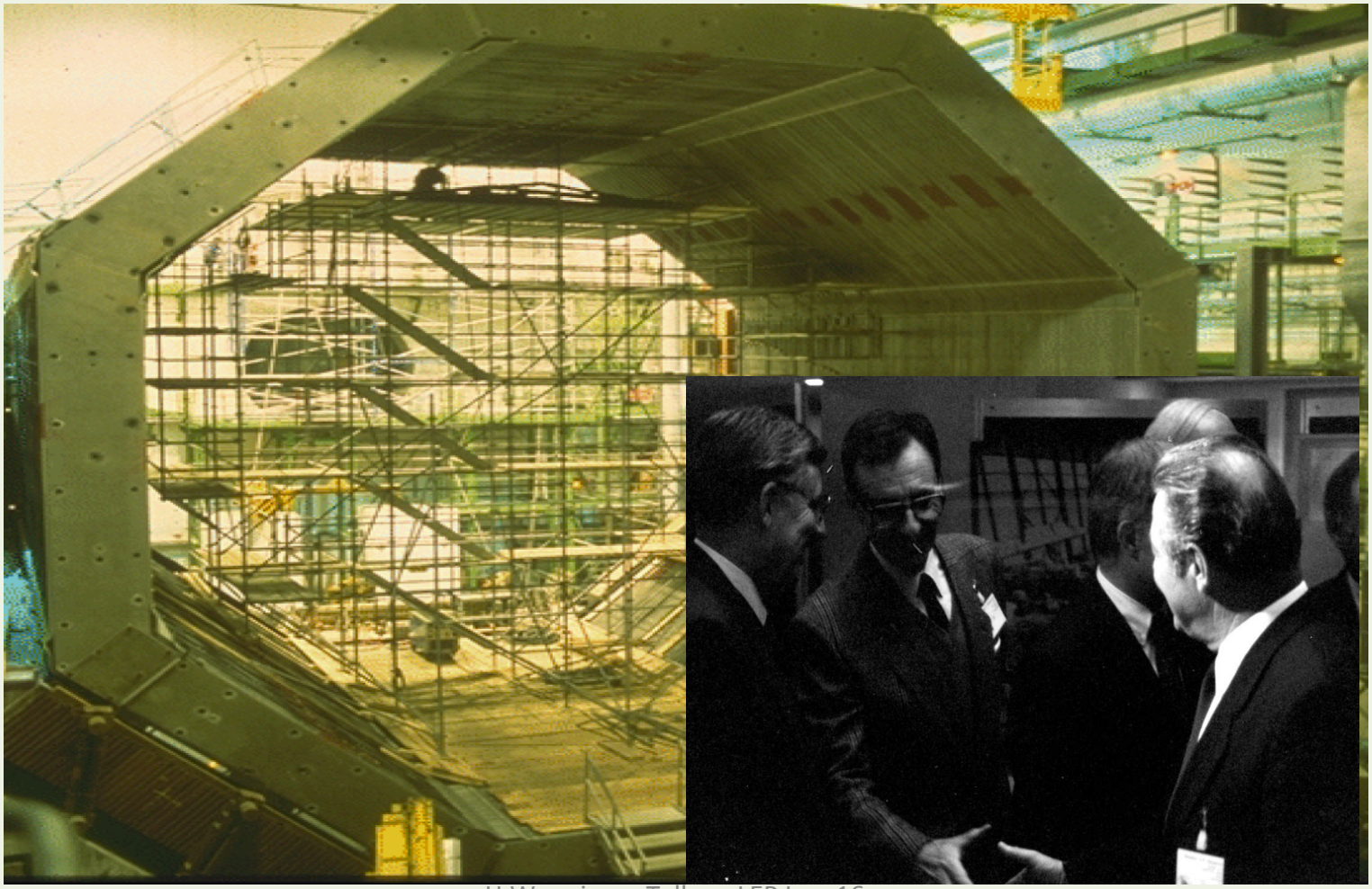

L3
Magnet Yoke
Magnet Coil
Muon Chambers
Magnet Pole
Support Tube
e+
BGO
Luminosity Monitor
Hadron Calorimeter
Vertex Chamber
e-
yb/L3

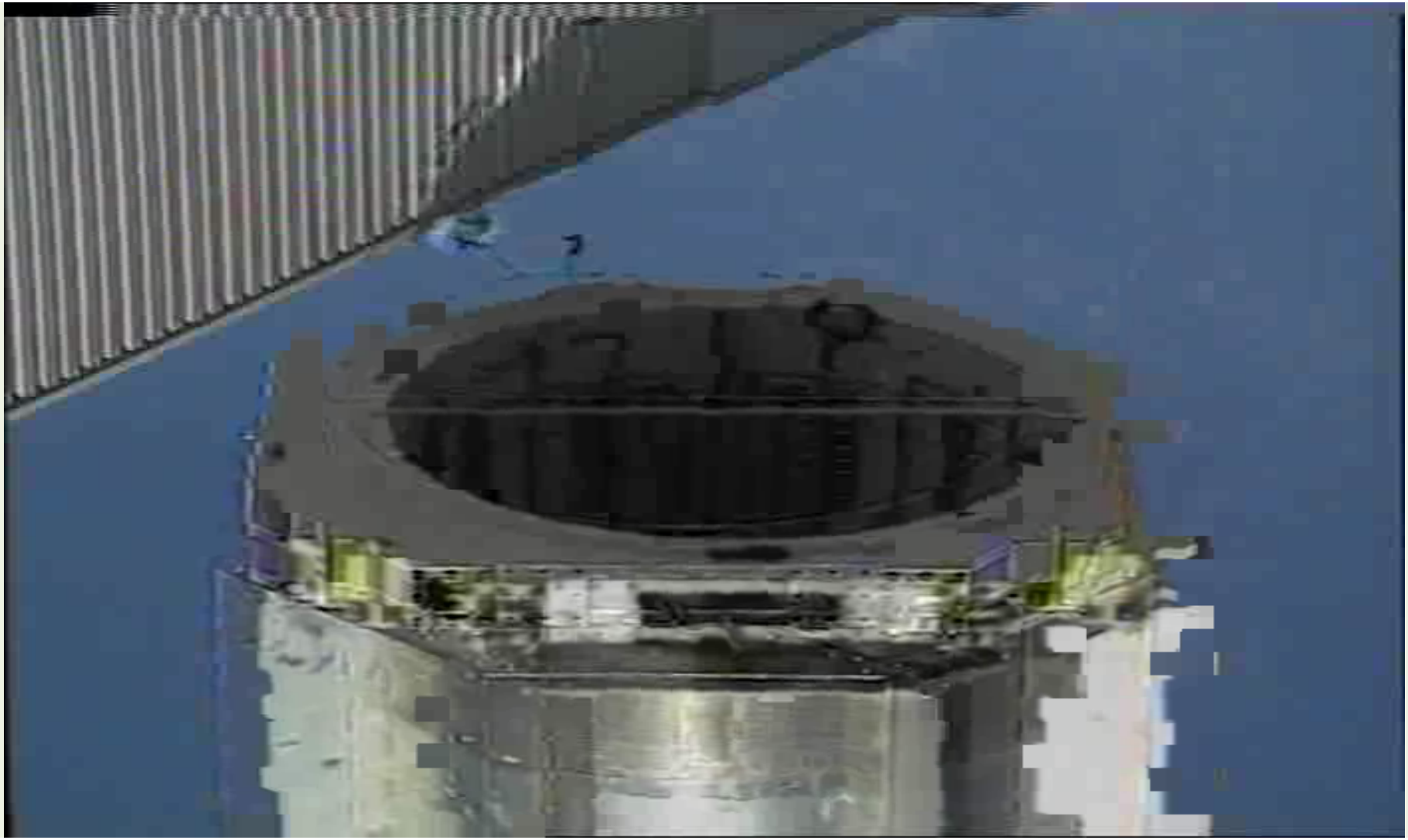


EF had the responsibility of the design, construction and tests of the L3 magnet

Le coil factory hall 867 Prevesinsite


Wittgenstein
Francois





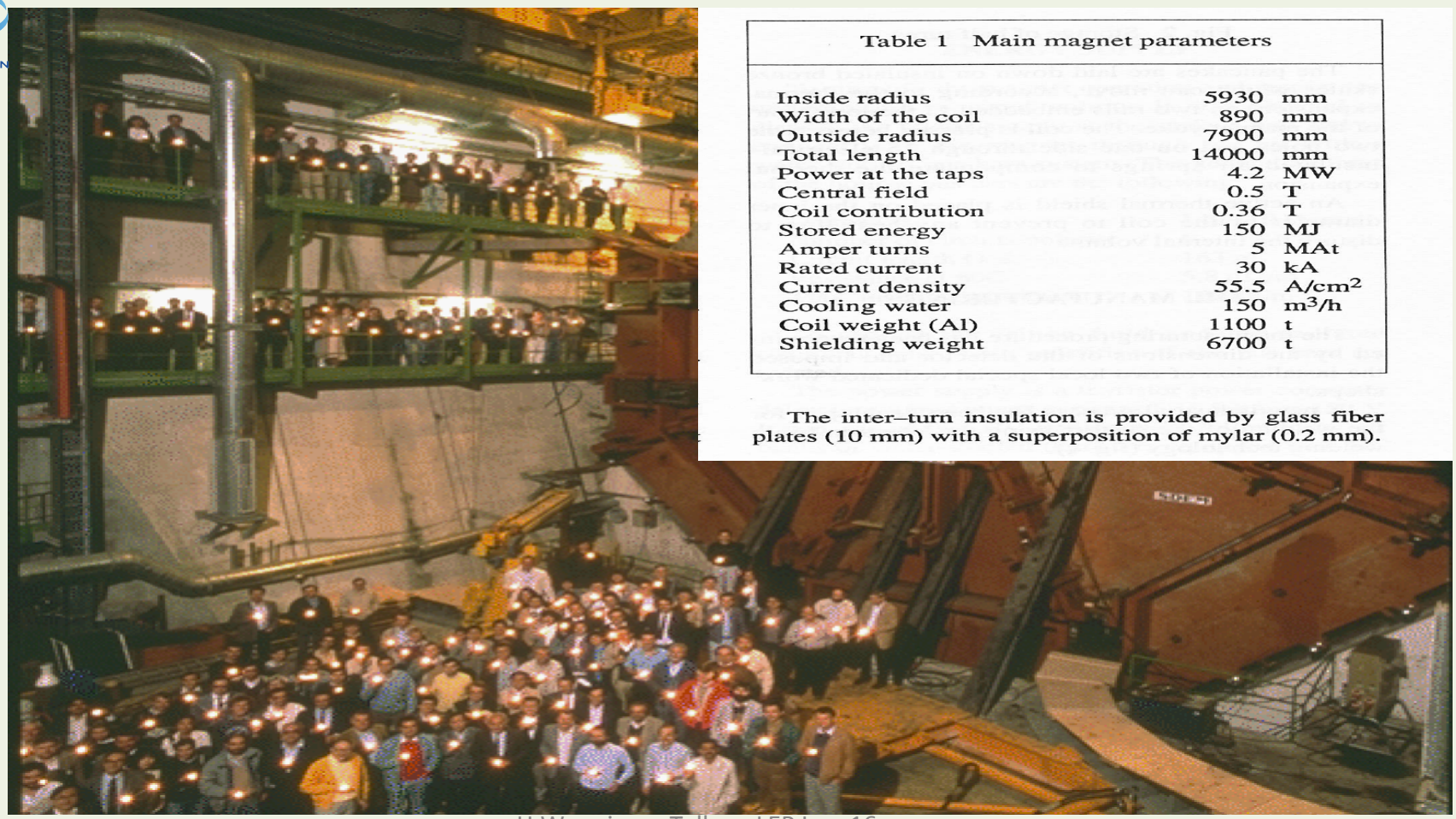
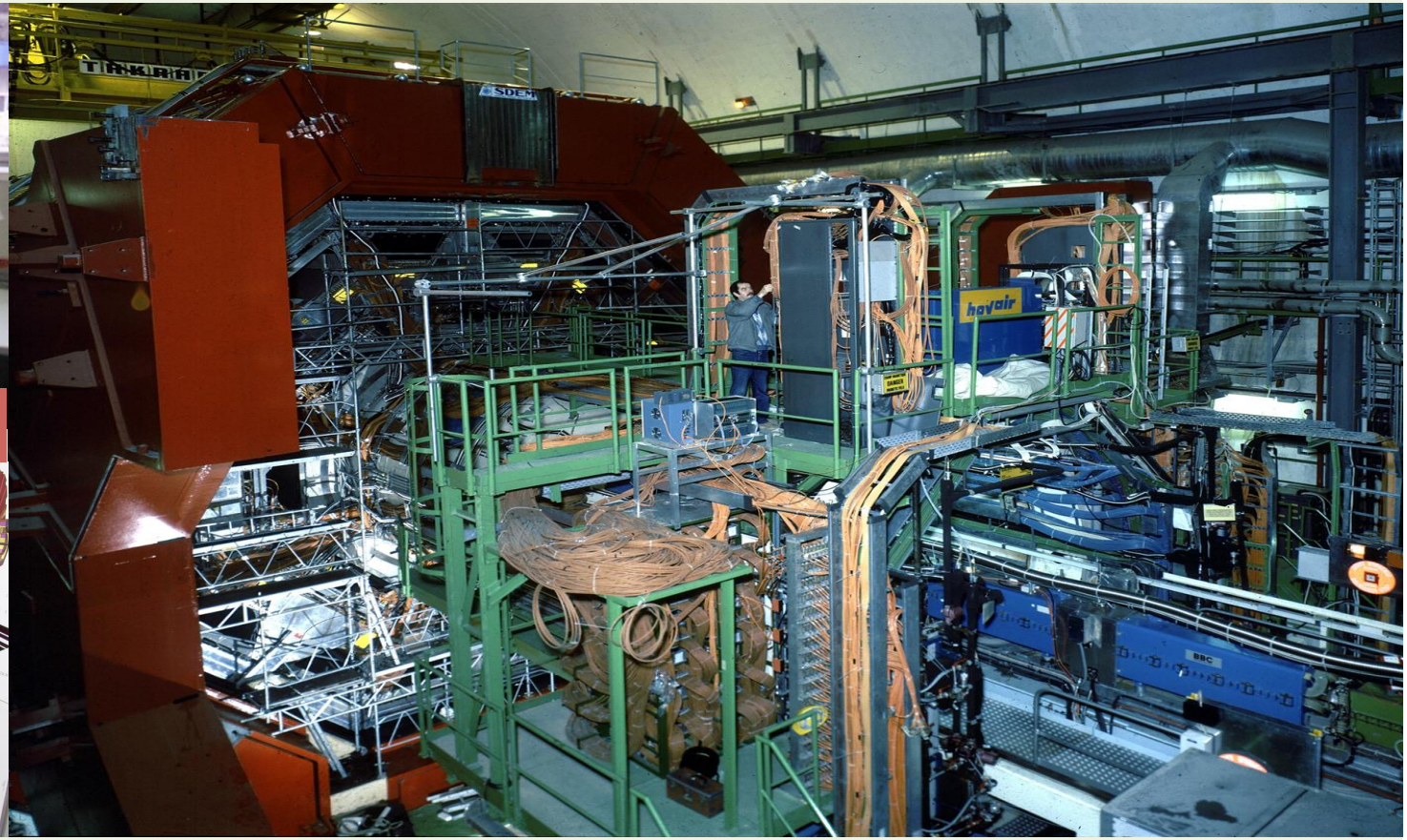


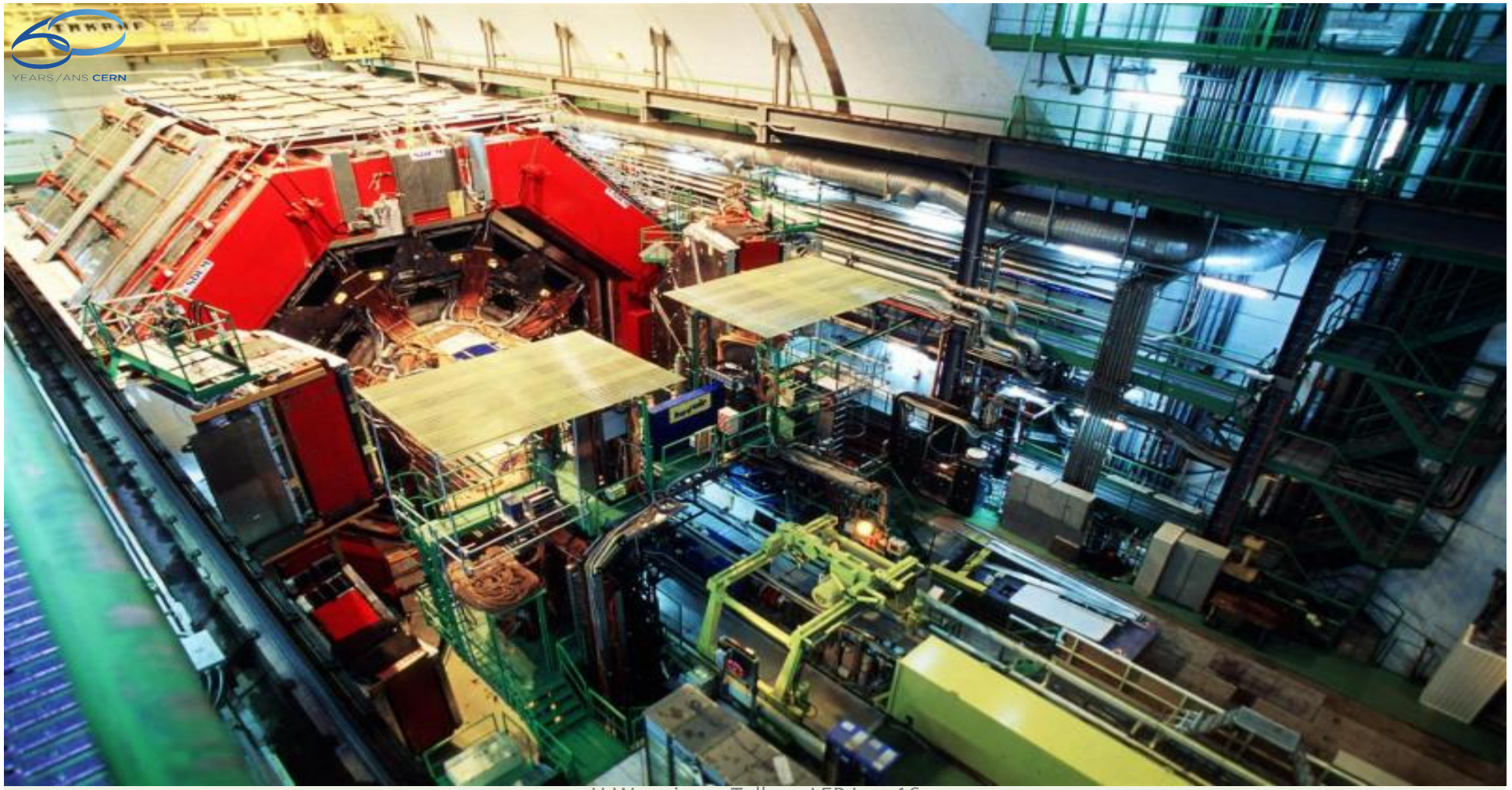
Table 1 Main magnet parameters

Inside radius	5930	mm
Width of the coil	890	mm
Outside radius	7900	mm
Total length	14000	mm
Power at the taps	4.2	MW
Central field	0.5	T
Coil contribution	0.36	T
Stored energy	150	MJ
Amper turns	5	MAt
Rated current	30	kA
Current density	55.5	A/cm^2
Cooling water	150	m^3/h
Coil weight (Al)	1100	t
Shielding weight	6700	t

The inter–turn insulation is provided by glass fiber plates (10 mm) with a superposition of mylar (0.2 mm).

Area Coordinators



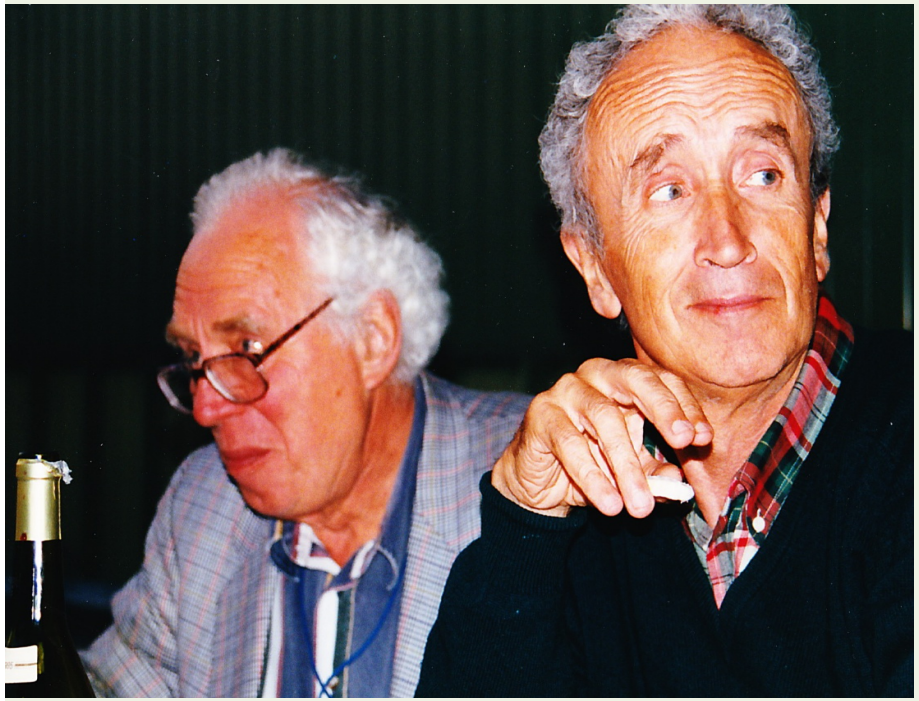

YEARS/ANS CERN

http://opal.web.cern.ch/Opal/

OPAL

OMNI PURPOSE APPARATUS FOR LEP

4.12.1980 S. Orito and J. Heintze meet with Aldo Michelini



Shuji Orito

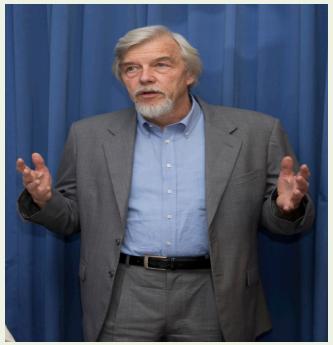
小柴 昌俊
Koshiba Masatoshi

before Wenninger met with Koshiba at DESY

… and the OPAL „Mother“

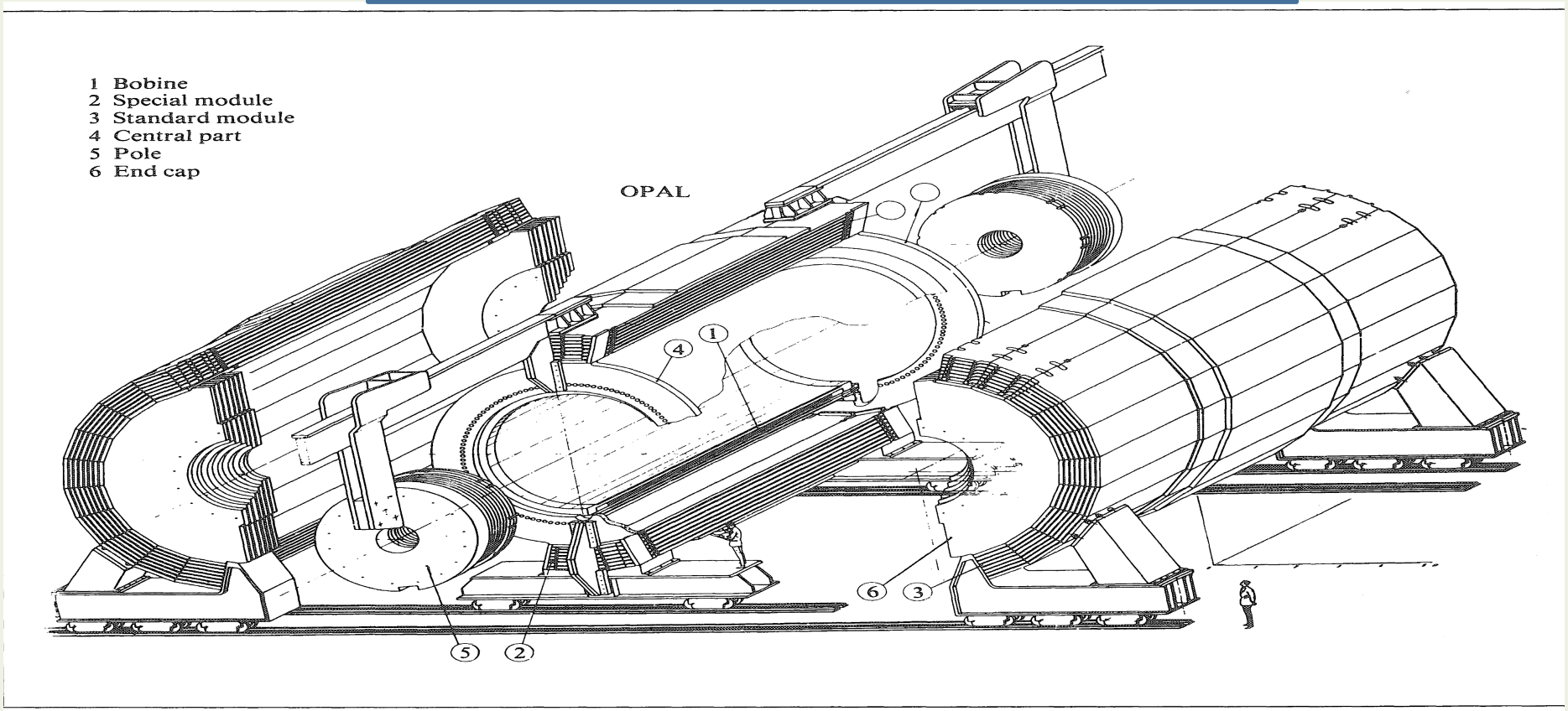
M. Hauschild

Mette Stuwe



OPAL area: Alasdair Smith & G.Linser support group

OPAL Detector Layout by W. Richter



OPAL Detector Layout

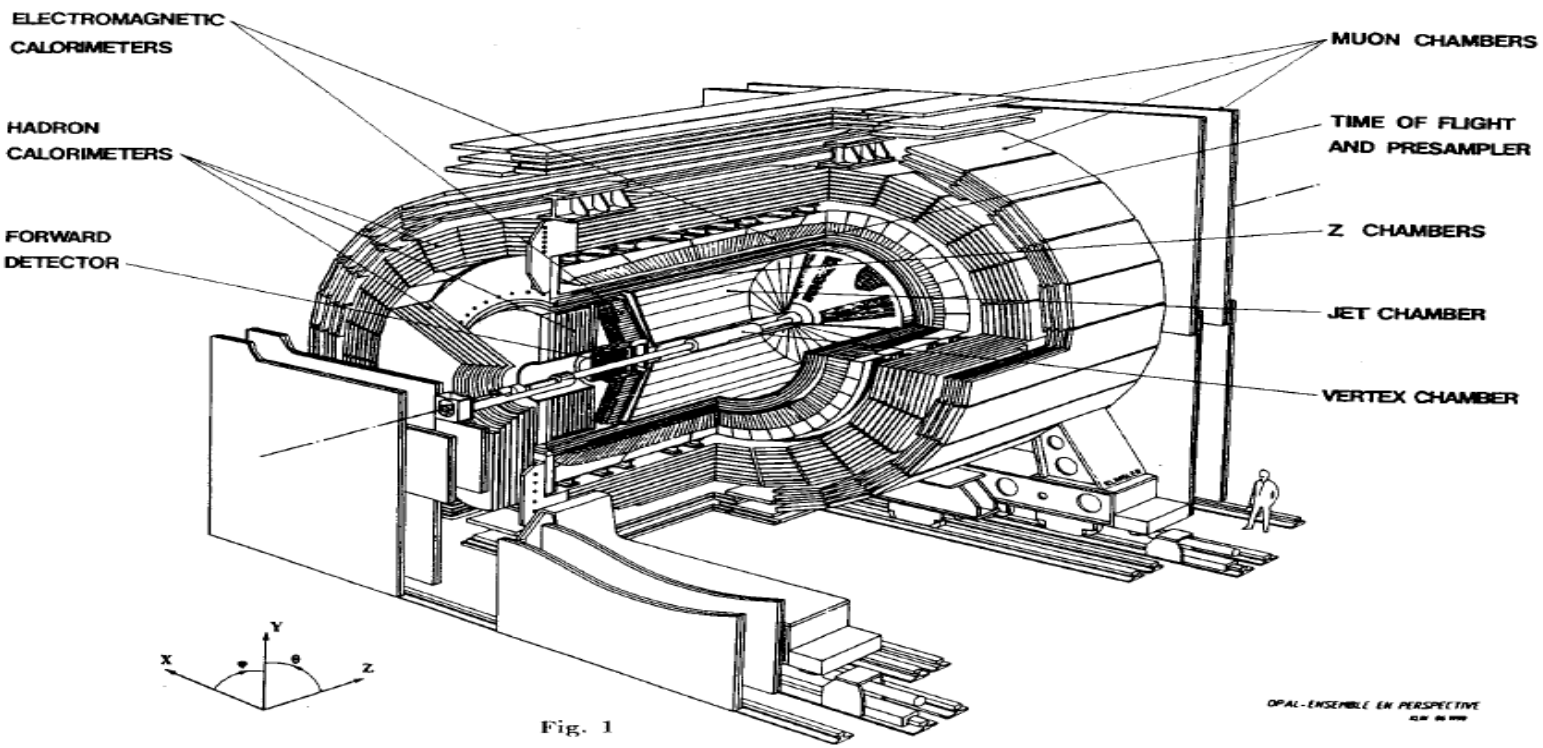
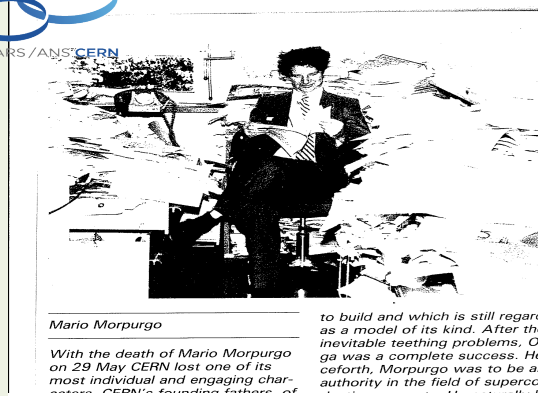


Fig. 1


38
36
Haut
35
35 Ba
haut



Mario Morpurgo

With the death of Mario Morpurgo on 29 May CERN lost one of its most individual and engaging char-

to build and which is still regar as a model of its kind. After th inevitable teething problems, C ga was a complete success. He ceforth, Morpurgo was to be a authority in the field of superco

Superconductivity and ancillary cryogenics at CERN: from bubble chambers to accelerators

Philippe Lebrun

CERN, Geneva, Switzerland

The Roots of LHC Technology:
CERN Centennial Superconductivity Symposium
CERN, Geneva, 8 December 2011

quid helium under pressure. For this he needed a pump which he himself designed and got his team

His former colleagues

Publications (18)

Sort by: Year

Dynamic beam based calibration of orbit monitors at LEP

I Barnett, A Beuret, Bernd Dehning, Peter Galbraith, K N Henrichsen, M Jonker, **Mario Morpurgo**, Massimo Placidi, R Schmidt, L Vos, J Wenninger, I Reichel

Published in 1995.

Advances in technology for high-energy subnuclear physics Contribution of the LAA project

D. Acosta, J. Alberty, J. Alsford, C. Alvisi, G. Ambrosi, F. Anghinolfi, F. Anselmo, G. Anzivino, M. Arneodo, R. Arnold, F. Arzarello, P. Aspell **M. Morpurgo**

Journal: Rivista Del Nuovo Cimento - RIV NUOVO CIMENTO, **vol. 13, no. 10, pp. 1-228, 1990**

The large hadron collider (LHC) in the LEP tunnel [shortened conference contribution]

Giorgio Brianti, Daniel Boussard, L Burnod, G Drouet, J B Jeanneret, Jacques Gareyte, P Lebrun, D Leroy, **Mario Morpurgo**, R Perin, Walter Scandale, E Weisse

Published in 1990.

Conceptual study of the superfluid helium cryogenic system for the CERN large hadron collider (LHC)

G Claudet, F Disdier, A Gauthier, P Lebrun, **Mario Morpurgo**, J Schmid

Published in 1988.

Preliminary study of a superfluid helium cryogenic system for the large hadron collider

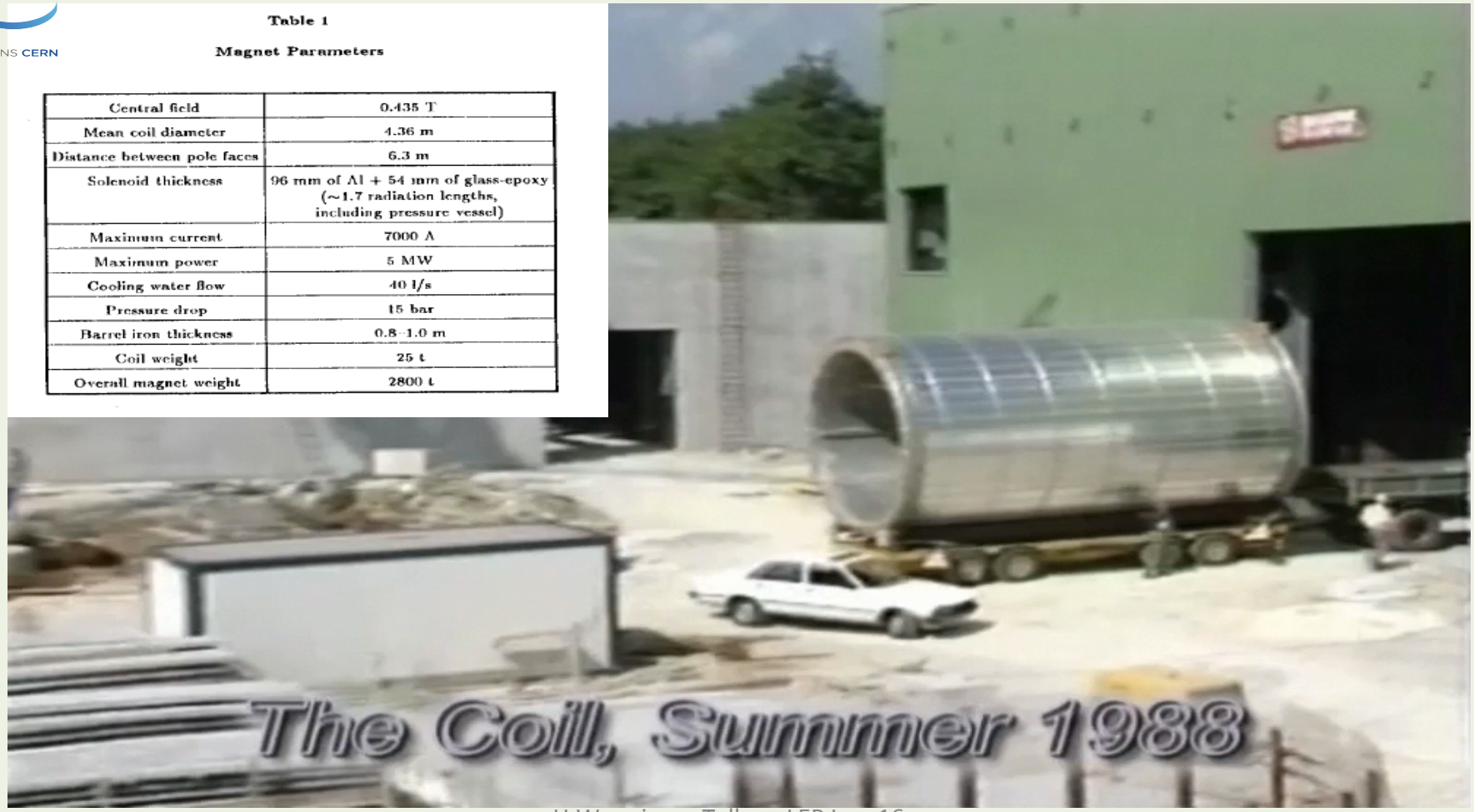
G Claudet, F Disdier, P Lebrun, **M Morpurgo**, P Weymuth

Published in 1985.

Table 1

Magnet Parameters

Central field	0.435 T
Mean coil diameter	4.36 m
Distance between pole faces	6.3 m
Solenoid thickness	96 mm of Al + 54 mm of glass-epoxy (~1.7 radiation lengths, including pressure vessel)
Maximum current	7000 A
Maximum power	5 MW
Cooling water flow	40 l/s
Pressure drop	15 bar
Barrel iron thickness	0.8–1.0 m
Coil weight	25 t
Overall magnet weight	2800 t



EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH

CERN-PPE/90-114
August 14, 1990

The OPAL Detector at LEP

The OPAL Collaboration.

Abstract

The OPAL detector at the e^+e^- storage ring LEP is designed to provide precise measurements of charged particles and of electromagnetic energy over nearly the full solid angle. Its main elements are a central tracking system, a solenoidal coil, an electromagnetic calorimeter made of lead glass, a hadron calorimeter made of iron and wire chambers, and a muon detector. A pair of forward detectors is used to measure the luminosity and to identify particles emitted at small angles with respect to the beam line. In this paper all detector elements are described and their performance is discussed.

This paper is dedicated to the memory of Mario Morpurgo, who died on May 29th 1990

Nucl.Instrum.Meth. A305 (1991) 275-319

EF BEC ALLIOD PATRICK M
EF BEC ARMAND JEAN-CHARLES M
EF BEC BENETTI FERNAND M
EF BEC BERRIDGE ROY M
EF BEC BICHLER WALTER M
EF BEC BOCHATON ANDRE M
EF BEC BOERNER HERBERT M
EF BEC BURCKHART HELFRIED M
EF BEC CANOVA GASTON M
EF BEC CARRERE ALFRED M

EF BEC CHEVALLEY JEAN-LOUIS M
EF BEC CONTIVAL ROBERT M
EF BEC CORNET BERNARD M
EF BEC COSTAL ANDRE M
EF BEC DROUYER YVES M
EF BEC DUMOLLARD GEORGES M
EF BEC DUPENLOUP ALBERT M
EF BEC DUPONT PIERRE M
EF BEC ERDT WOLFGANG M
EF BEC FAVRE JEAN M

EF BEC FISCHER NICOLAS M
EF BEC GAUTHERON PAUL M
EF BEC GRENU MARCEL M
EF BEC GRESSOT SIMON
EF BEC GUILLOT MARC M
EF BEC HEUER ROLF DIETE
EF BEC HUMBERT FRANCOIS
EF BEC JACOB ROBERT M
EF BEC KOZLOVSKY GREGORY
EF BEC LAMBLIN MARCEL M

EF BEC LAMOUREUX GUSTAVE M
EF BEC LANGOT MARCEL M
EF BEC LAUNAY GERARD M
EF BEC LEFRANCOIS AYMAR M
EF BEC LINSER GERHARD M
EF BEC LOUP PIERRE M
EF BEC MAST MANFRED M
EF BEC MICHELON JEAN-CLAUDE M
EF BEC MORET PHILIPPE
EF BEC MOURON GILBERT M

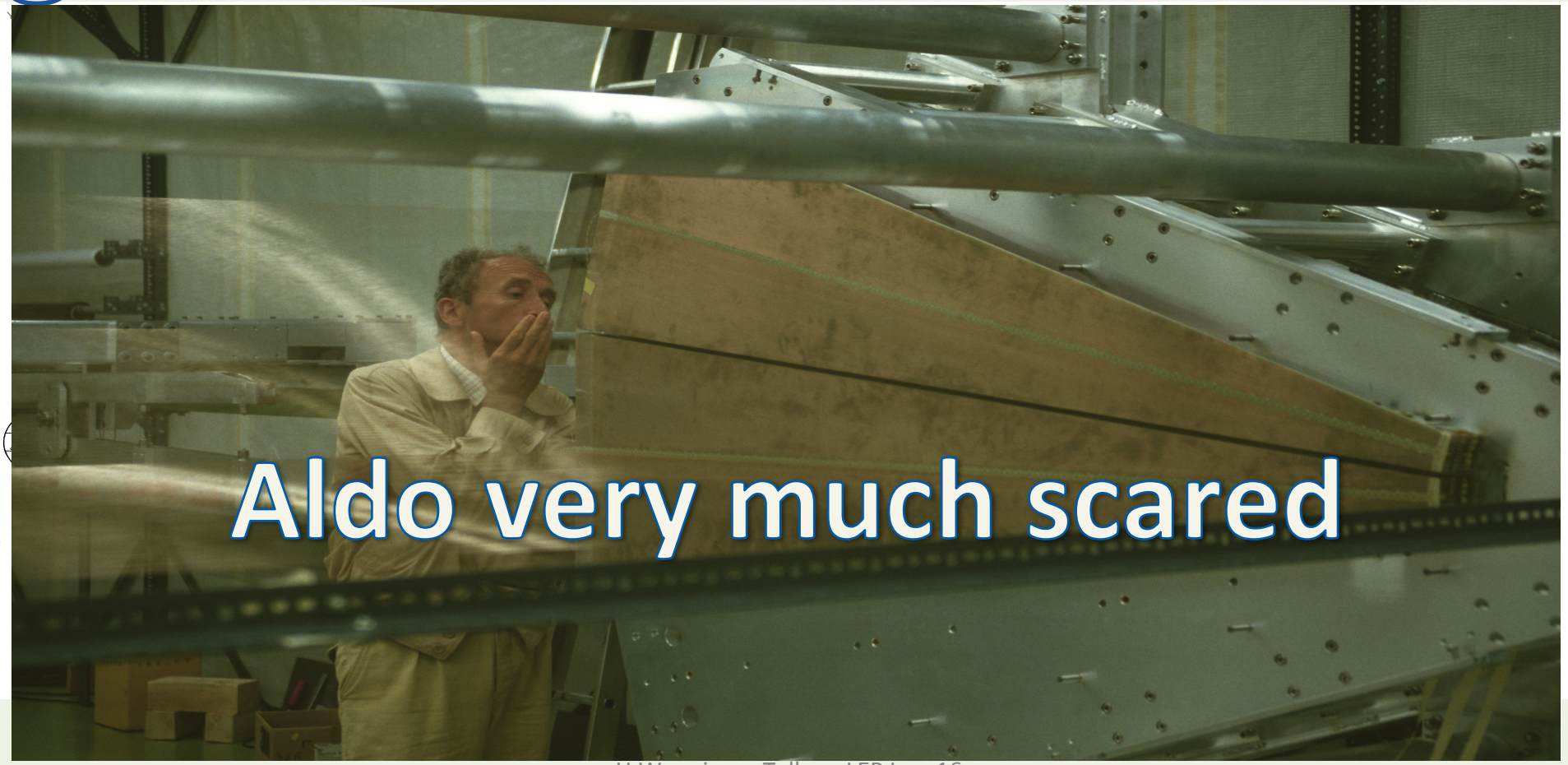
EF BEC MURER ERNST M
EF BEC ORLIC JEAN-PIER
EF BEC PASSARDI
EF BEC PER
EF BE

ILBERT M
NZ JURGEN M
EIDL WILHELM M
BEC TALBOT ROGER M
EF BEC TAYLOR DAVID M
EF BEC THEROND ANDRE M
EF BEC TRUHAN ROBERT M

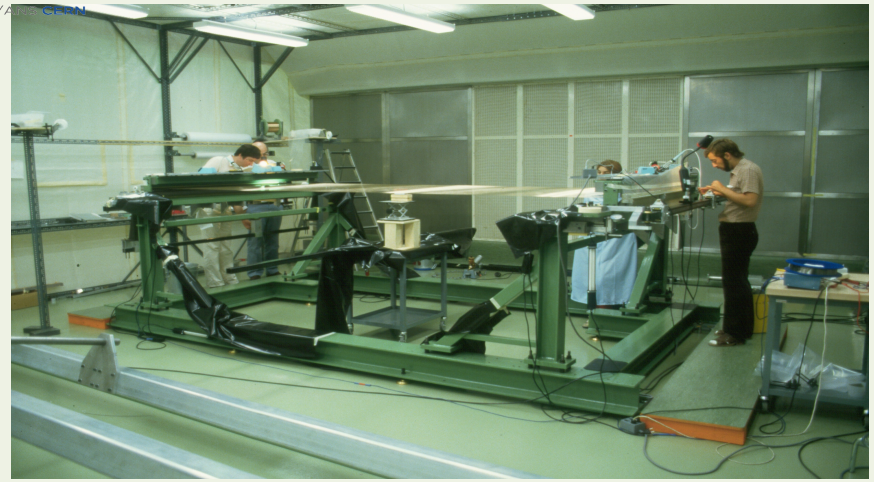
EF BEC VOILLAT DANIEL M
EF BEC WICHT PIERRE M
EF BEC WIGMANS
EF BEC WILK
EF BEC

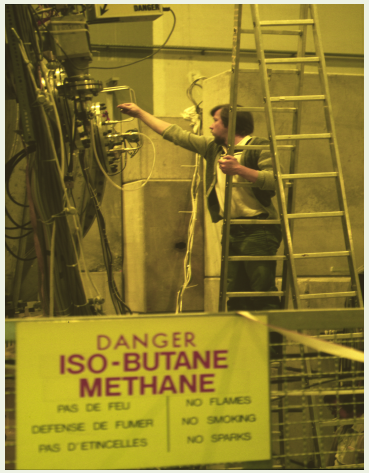
EF Division BEBC group engineering under Gerhard Linser

66 physicists, engineers, technicians


Aldo very much scared

EF recruits
a young physicist
from DESY
to build JET chamber




DANGER
ISO-BUTANE
METHANE
PAS DE FEU
DEFENSE DE FUMER
PAS D'ETINCELLES
NO FLAMES
NO SMOKING
NO SPARKS

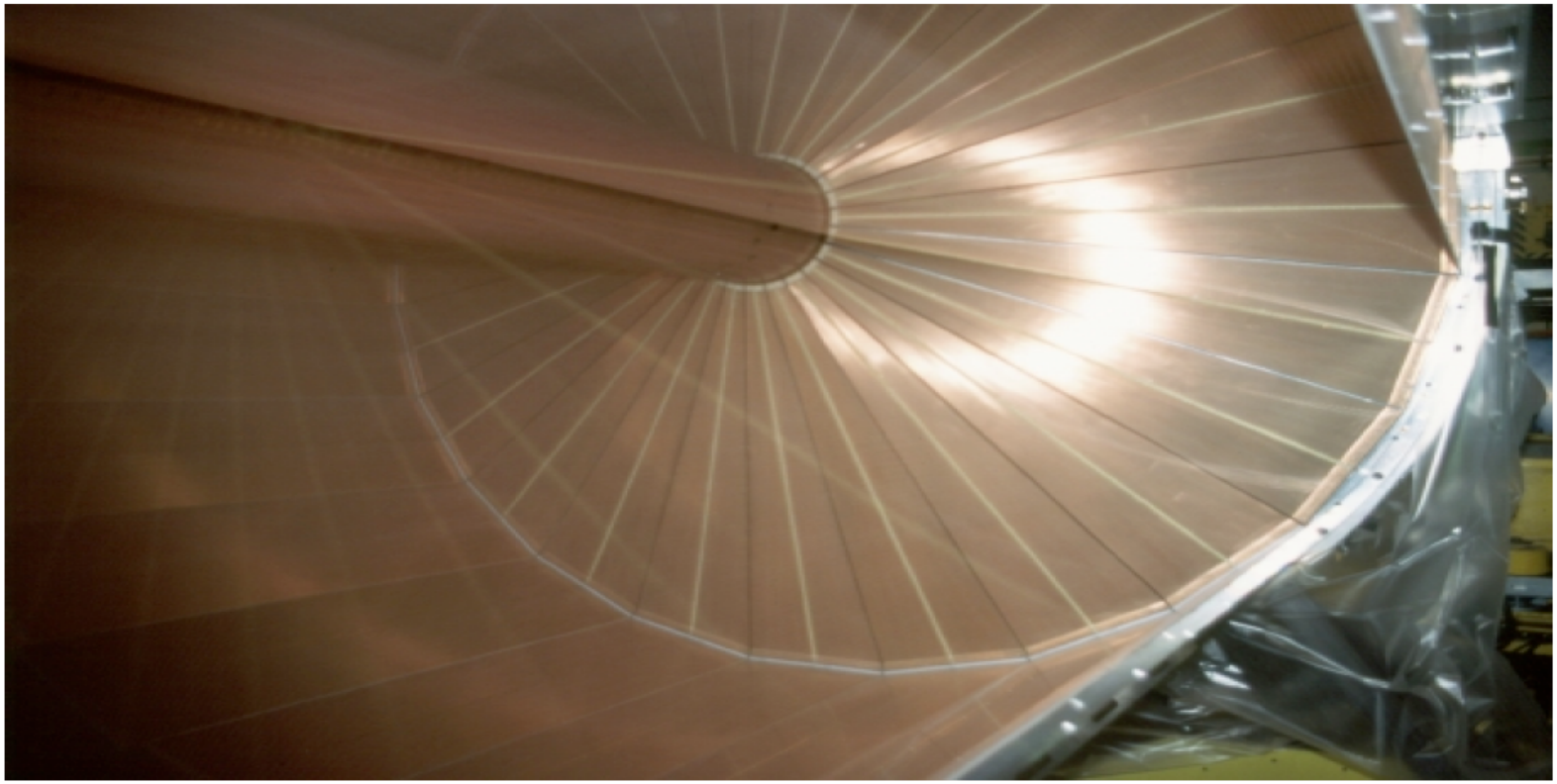
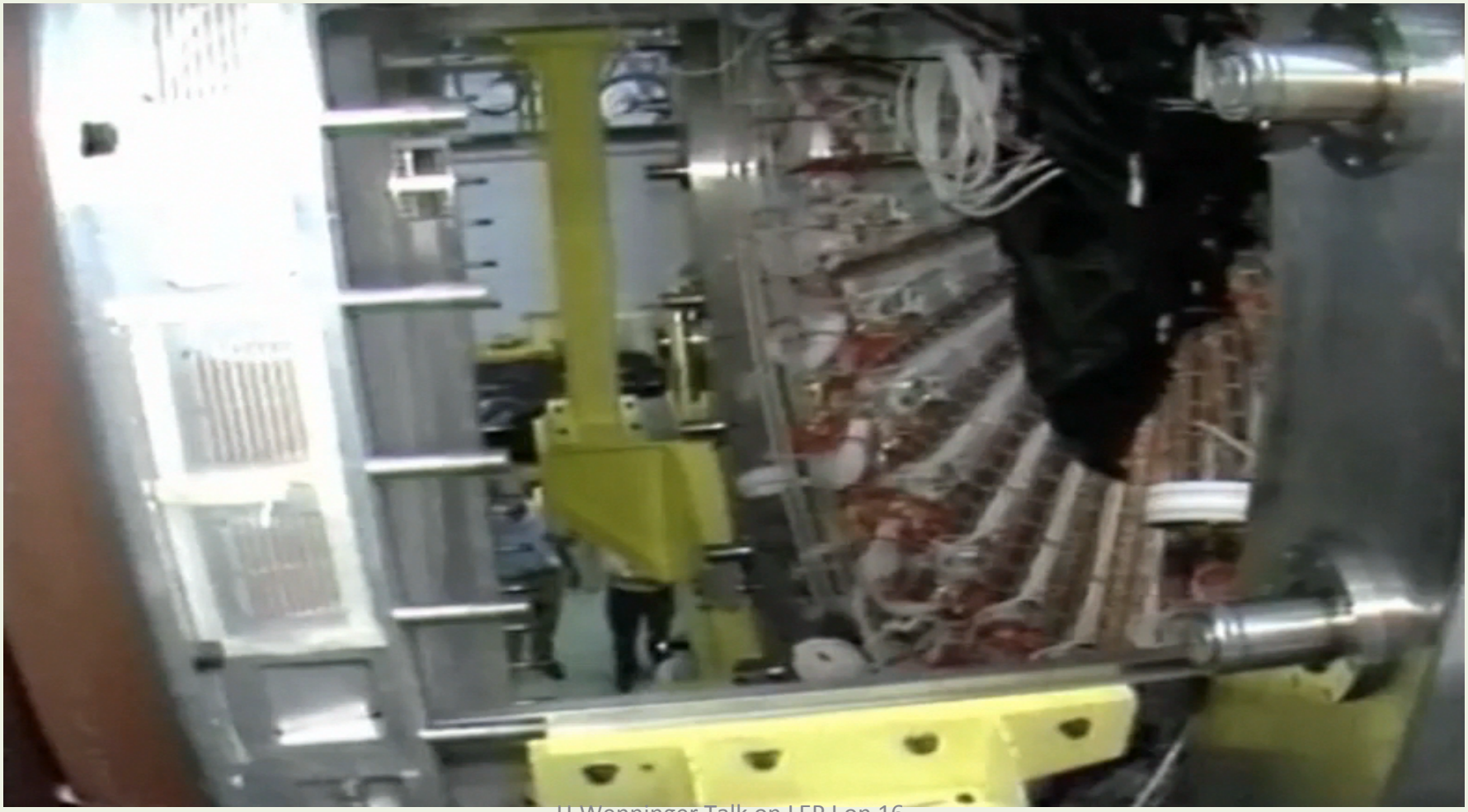


Fig. 27: View inside the OPAL JET chamber.

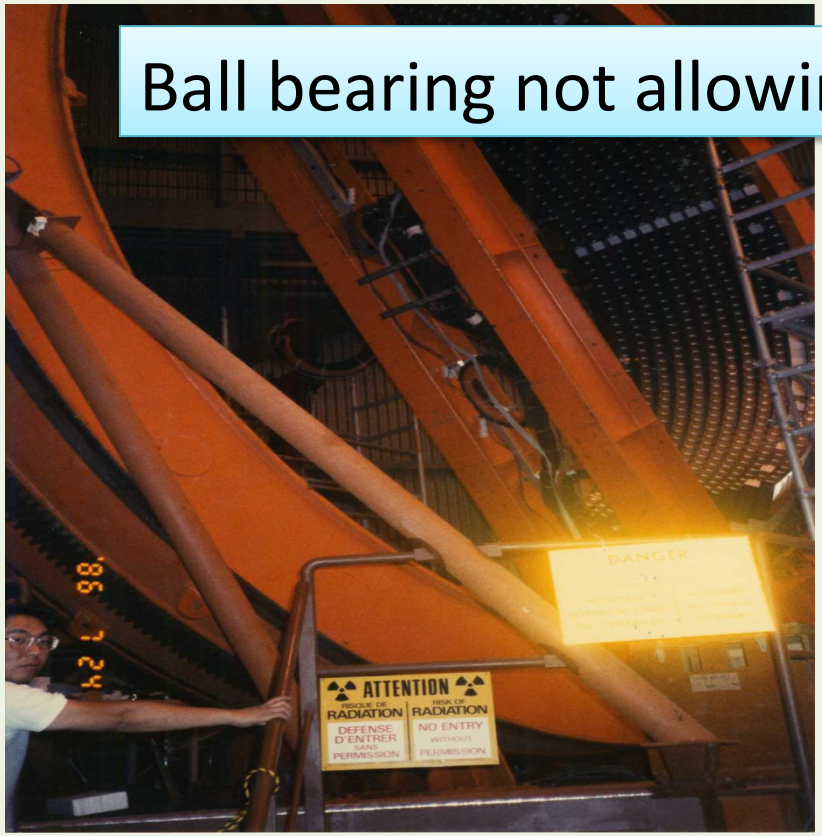


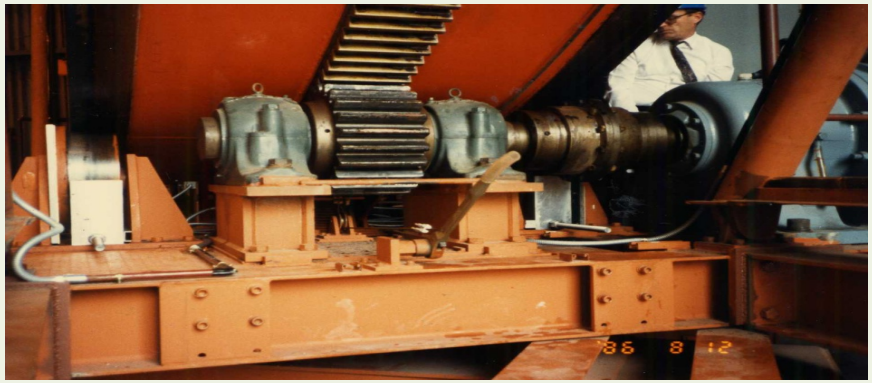
Assembly Line of LG Modules

B.192

"Incident" (July 1986)

Ball bearing not allowing for shearing stresses

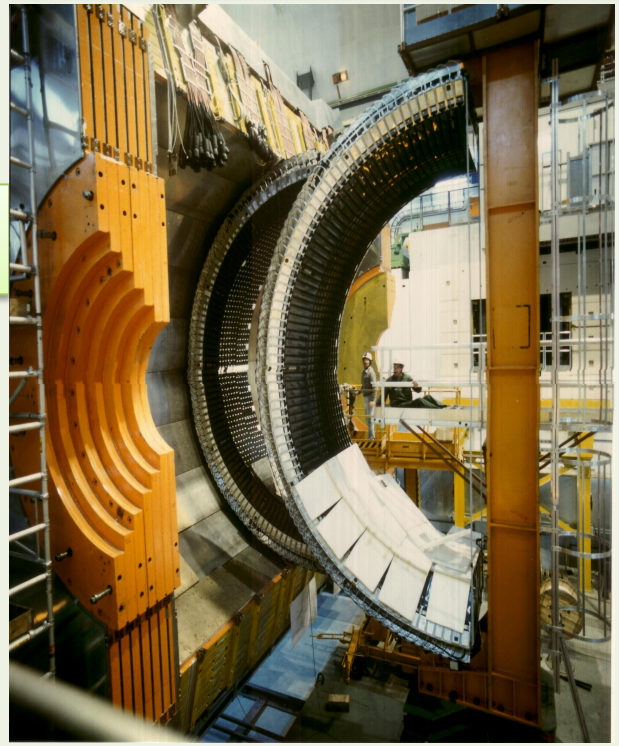




Si vertex detector

Hadron calorimeter

Installation of HR's in OPAL Pit with "Mitsui Mounting Device"



LEP Energy Calibration

Or the saga of 1001 shifts….

Pippa Wells, CERN

OPAL Collaboration

OPAL Activities

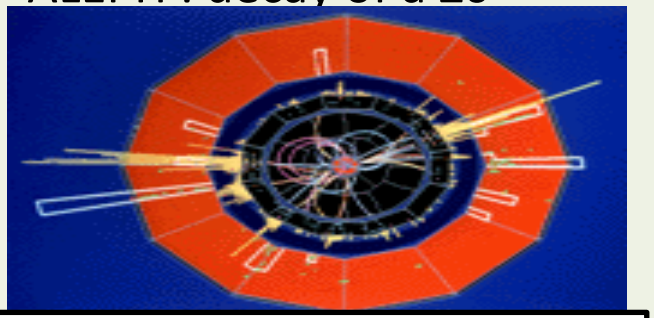
OPAL Pokal

1989 - commissioning

- 14th July: first beam
- 23rd July: circulating beam
- 4th August: 45 GeV
- 13th August: colliding beams

OPAL detector: decay of a Z0

ALEPH : decay of a Z0

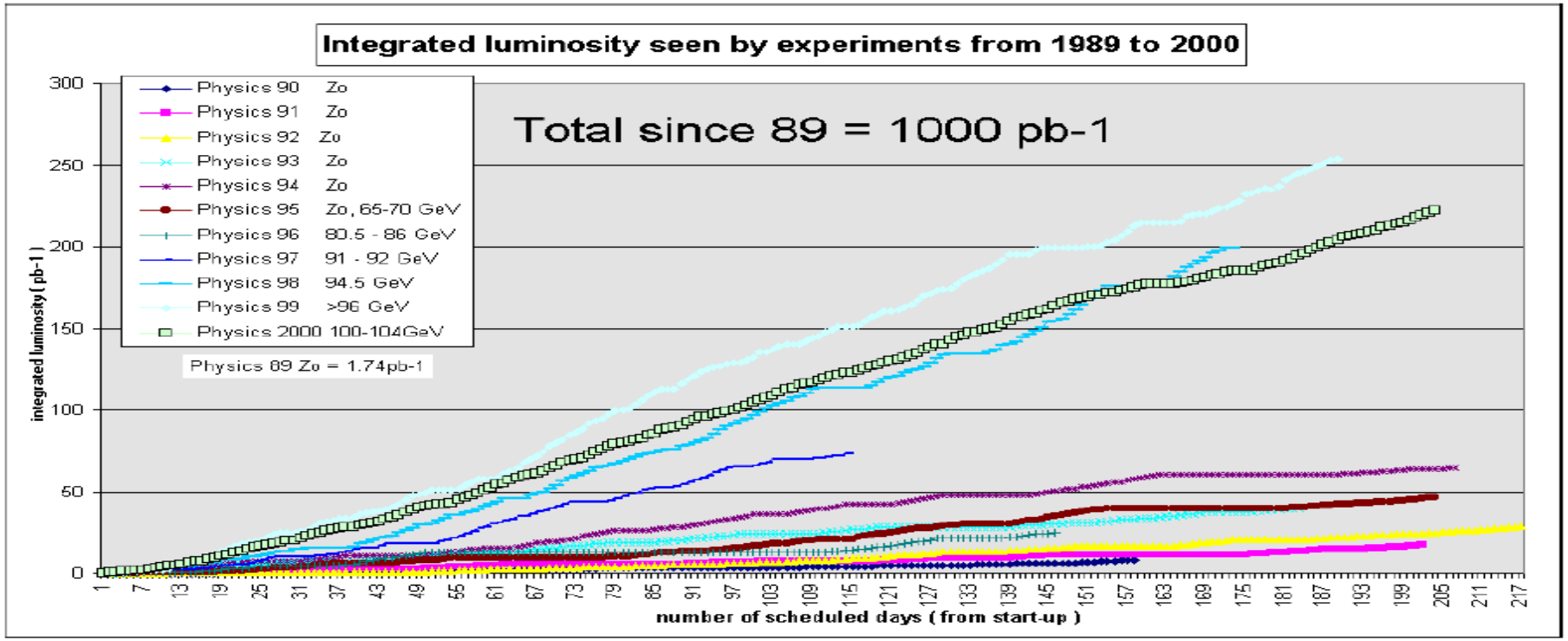


LEP physics talk by John Ellis

DELPHI : decay of a Z0

L3 detector : decay of a Z0

Talk by Steve Myers



What else happened from 1984 to 1994 ?

1984 Carlo Rubbia and Simon Van der Meer Nobel Prize

1987 LAA project started in EF allowing R&D for LHC

1988 Jack Steinberger Léon Lederman, Mel Schwartz Nobel Prize

1990--1994: LEP operation Z physics

Firstweb server: this machine - bought by EF – was used by Tim Berners-Lee in 1990 to develop and run first WWW server, multi-media browser web editor.

What else happened from 1989 to 1994 ?

1990 : SL Division was created, combining LEP & SPS (L. Evans)

AT Division was created to prepare LEP II and LHC

EF Division became ECP (P.G.Innocenti (90-94), M. Turala (95-97))
CN Division was established(D.Williams) - The WEB was born

1991The PINK BOOK (design Study of the LHC) was published

October 1993 SSC stopped by Congress / LHC proposal



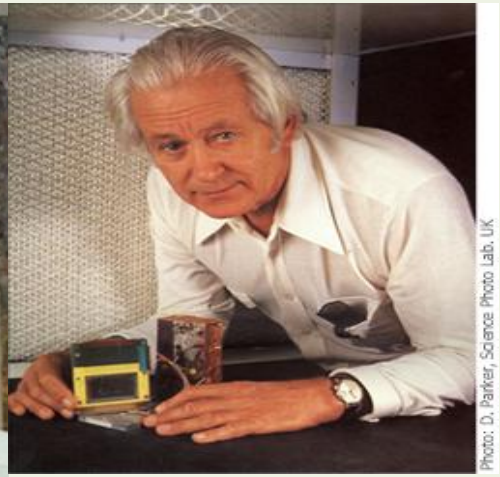



Photo: D. Parker, Science Photo Lab. UK

20

CERN scientific information service

In 1990 **EF Division disappeared**

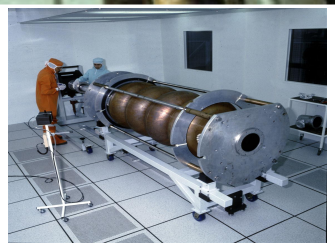
when an important part of the EF staff moved over from Research to the Accelerator Sector to ease the LEP energy upgrade and to prepare for the LHC .

Part of its staff moved to a newly created Electronics and Computing for Physics Division (ECP) whilst the other part of EF went to the Particle Physics Experiments Division (PPE).

In 1990 **AT Division appeared**, forming together with Mechanical Technologies, & Proton Synchrotron & SPS+LEP (SL) divisions the **Accelerator Sector (AC),** came into being as a result of the restructuring of CERN following the completion and commissioning of the LEP machine in the second half of 1989.
The AT division included all CERN activities in the fields of **cryogenics, superconducting accelerating cavities, accelerator magnets and vacuum systems, and surveying**. Other groups included the **former LEP cooling and ventilation group and some support activities (database applications, software engineering, controls, laser for the CLIC project etc.**). In their technological domains, the AT groups carried a CERN-wide responsibility for maintenance and operations support.
In December 1994 CERN's governing body, Council, officially approved the construction of CERN's Large Hadron Collider (LHC) ……. and hence in 1995 **AT became LHC Division**

LEP2 RF cryomodules

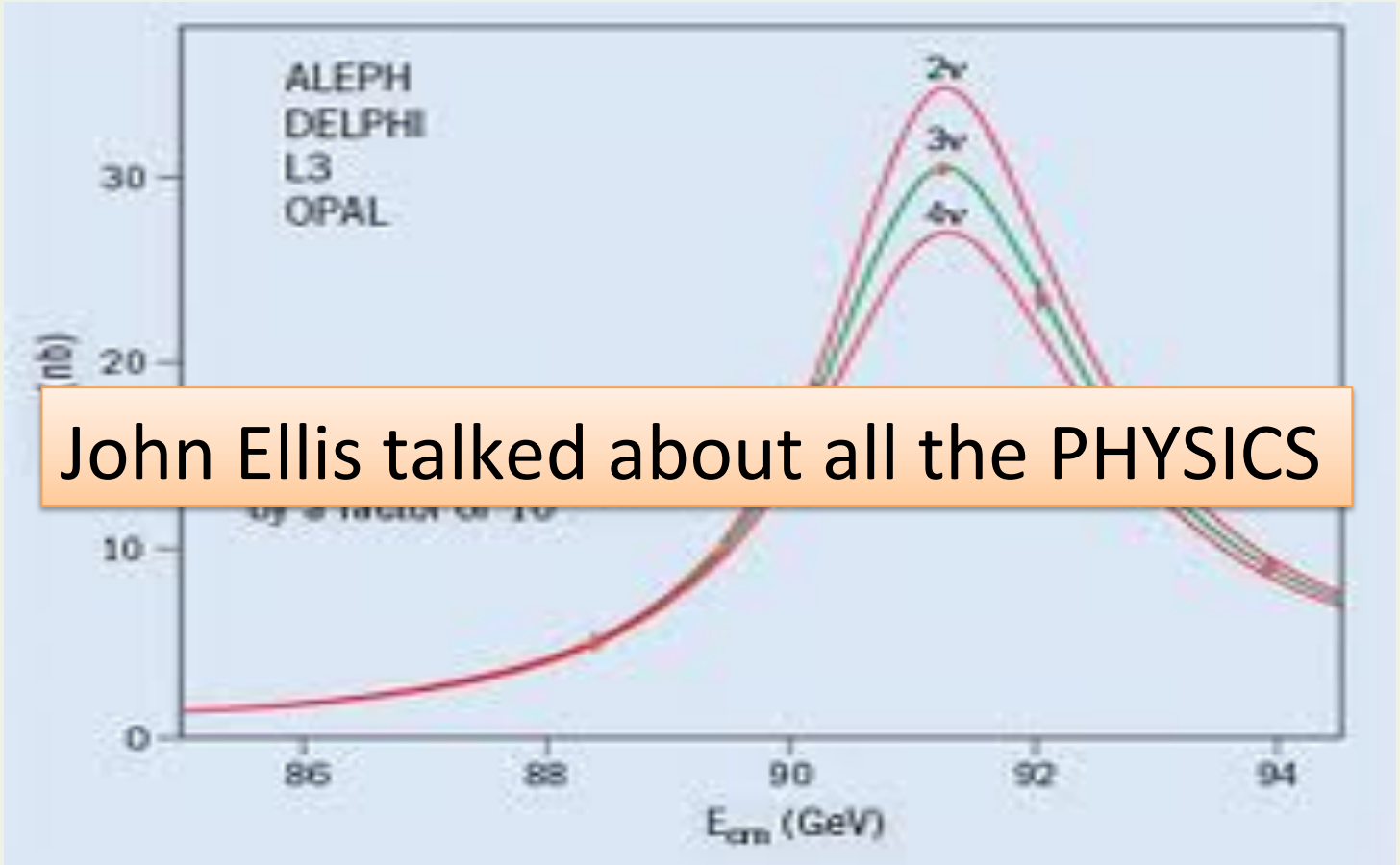
Cryomodule assembly in clean room



Cryomodule in LEP tunnel

RF frequency	352.209 MHz
No. of cells/cavity	4
No. of cavities/module	4
No. of modules installed	72
Module length	11.28 m
Liquid helium/module	800 l
R/Q (circuit Ohm)	232 Ω
Active length (four cells)	1.70 m
Nominal gradient	6 MV/m
Q_o at 6 MV/m (4.5 K)	3.2×10^9
Q_{ext} Main coupler (nominal)	2.2×10^6
Dynamic cryogenic losses at 6 MV/m per cavity	<70 W
Static cryogenic losses per complete module	<90 W

My successors as AT / LHC Division Leaders

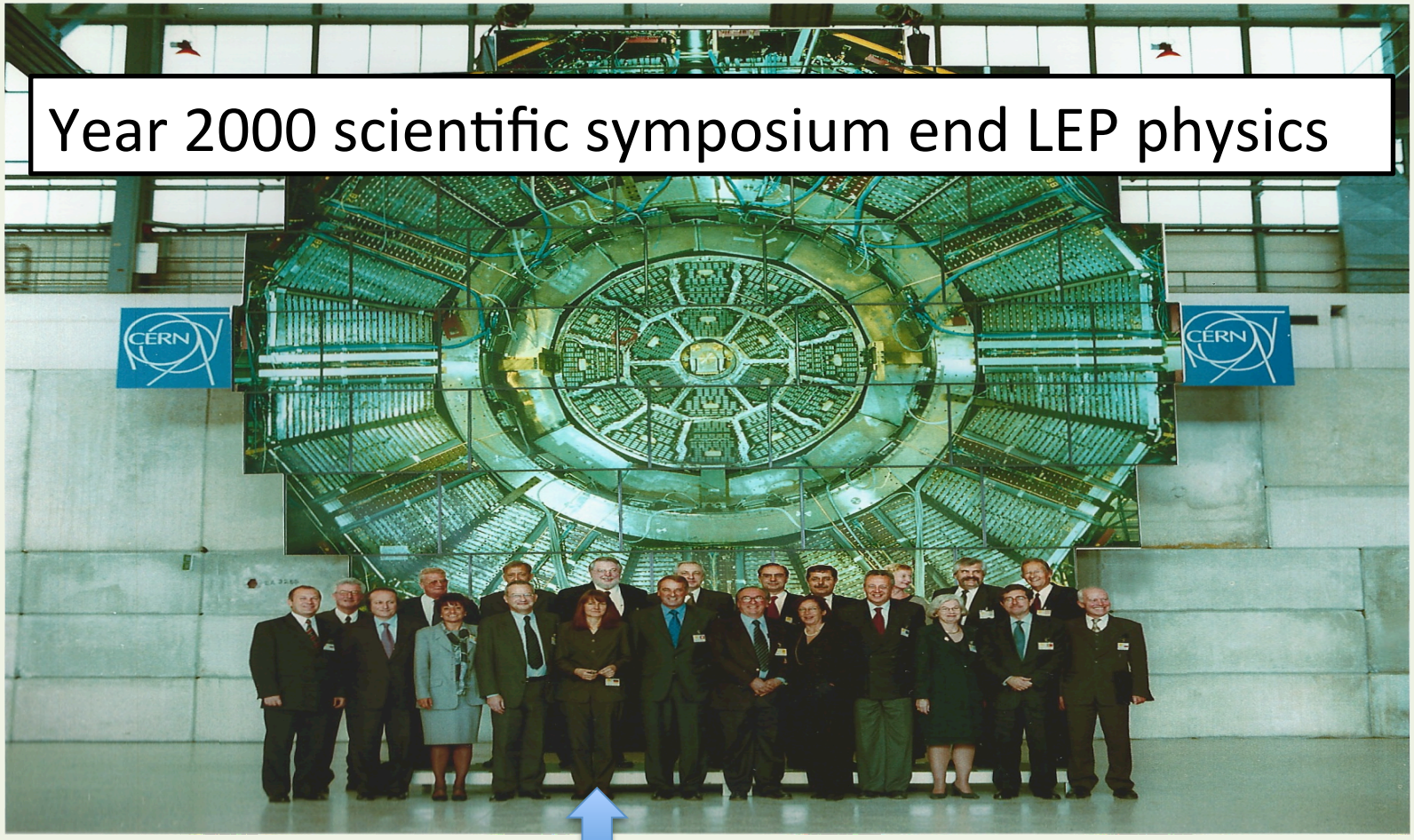


John Ellis talked about all the PHYSICS

another Nobel Prize winner

les Horribles CERNettes

Year 2000 scientific symposium end LEP physics



Visit of Prof. Dr. Manfred Popp, Chairman of the Executive Board Forschungszentrum Karlsruhe GmbH.

to propose GRID computing TIER 1 in Germany at KFZ

What next in physics ?

Happy Birthday

Herwig Schopper

I would like to thank my colleagues
who provided films and photos for this presentation

Michael Hauschild, Alain Hervé, Kurt Hübner, Francois Wittgenstein

several colleagues provided documents and information

Cristoforo Benvenuti, Jean-Claude Gouache , Pierre Lazeyras Tom Taylor, et al

Many pictures I found in the
CERN Archives / Photolab