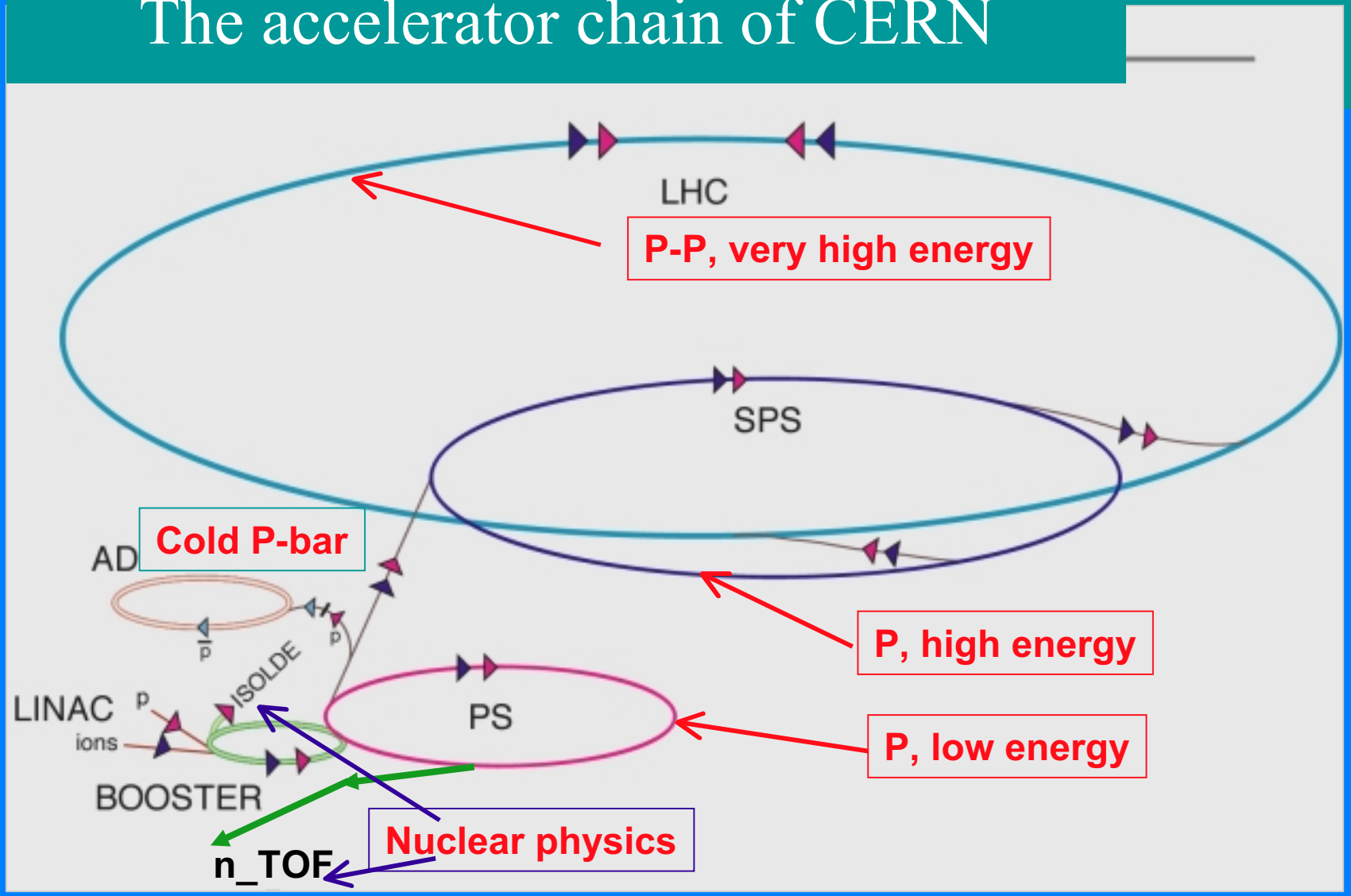

CERN: present and
??? future ???
Snowmass, July19, 2001
Luciano Maiani
CERN. Geneva

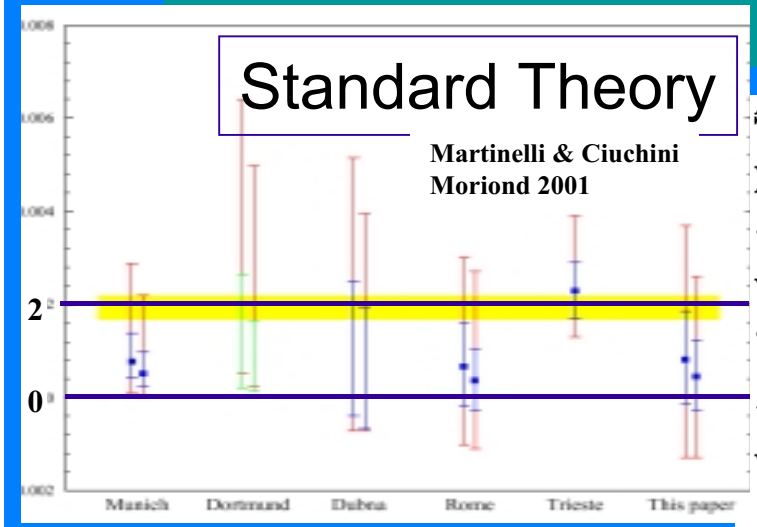
Summary

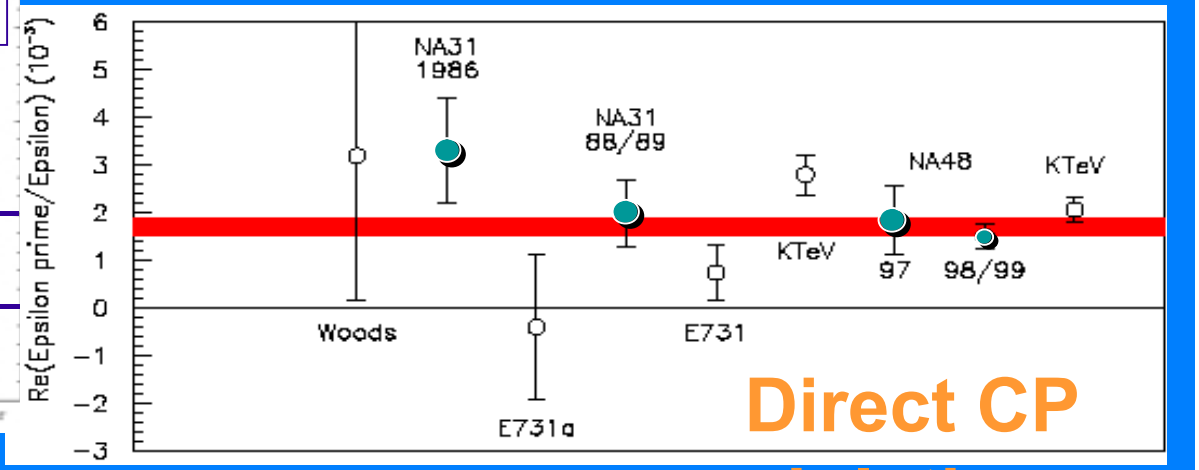
- CERN today
- LHC
- LHC computing
- Accelerator R&D
- A forward look

The accelerator chain of CERN



ε'/ε: - new (~final) result reported by NA48
- KTeV and NA48 now consistent



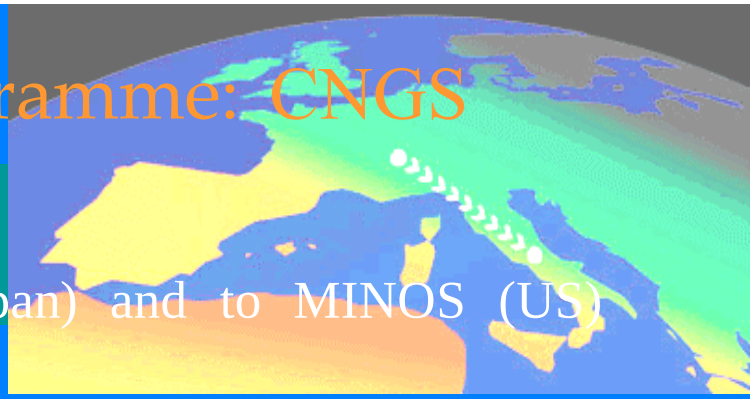


•**2002(NA48/1)** : $K_S \to \pi^0 + e^+ + e^-$ (CP even, determines mixing part of CP odd K_L decay)

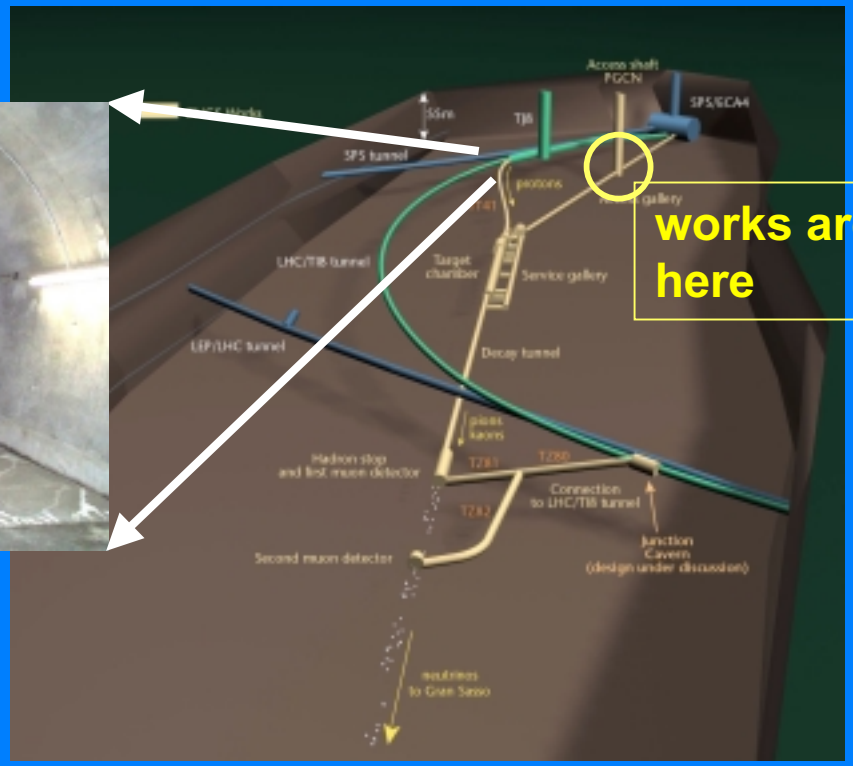
• neutral hyperon decays (3 10^{10} neutral kaon decays);

•**2003 (NA48/2)** : high statistics study of CP violating slope in $K^\pm \to \pi^\pm + \pi^+ + \pi^-$ (to O(10^{-4})).

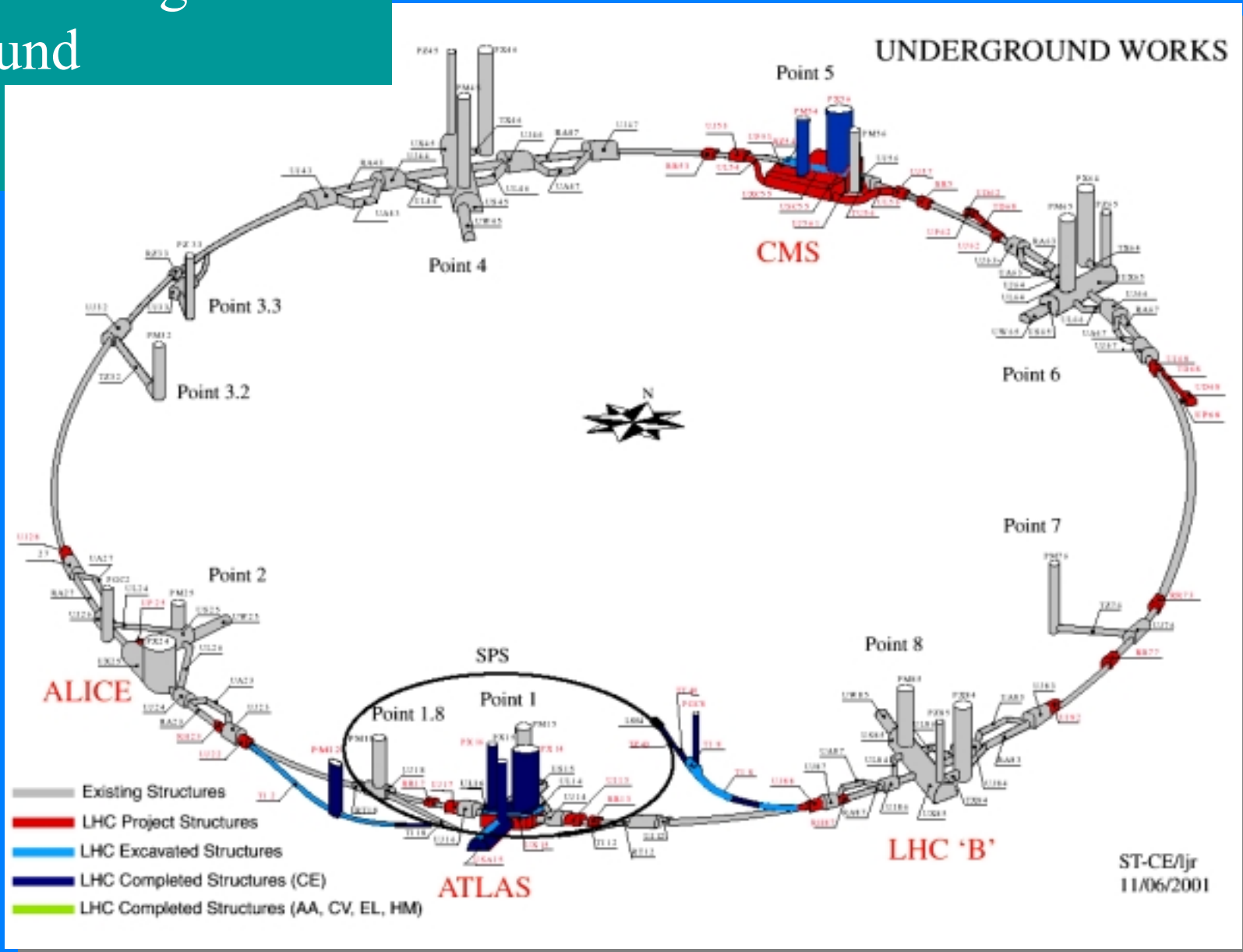
Long-Baseline Neutrino Programme: CNGS



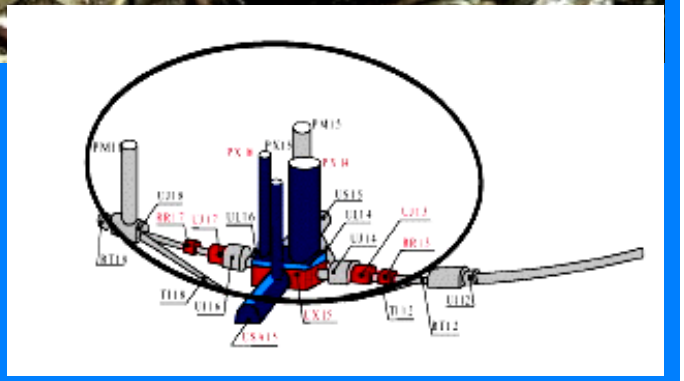
- To observe the appearance of tau leptons;
- complementary to the lower-energy K2K (Japan) and to MINOS (US) focussed on n_m disappearance;
- OPERA approved by the CERN Research Board and by INFN (Jan. 2001);
- CERN will support a in-house group in OPERA, building on the experience accumulated in CHORUS and NOMAD.



Civil engineering status - underground

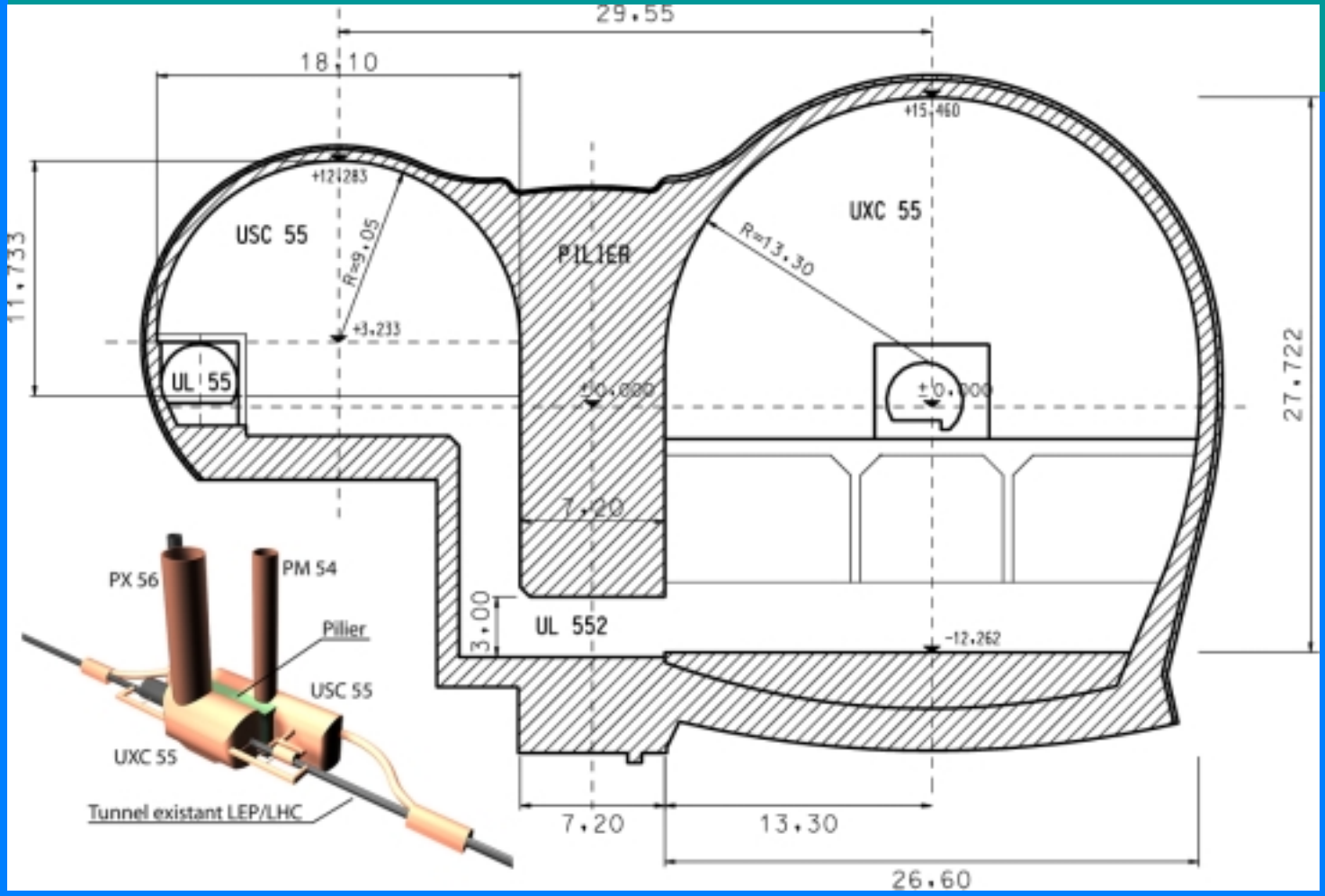


Civil engineering at Point 1

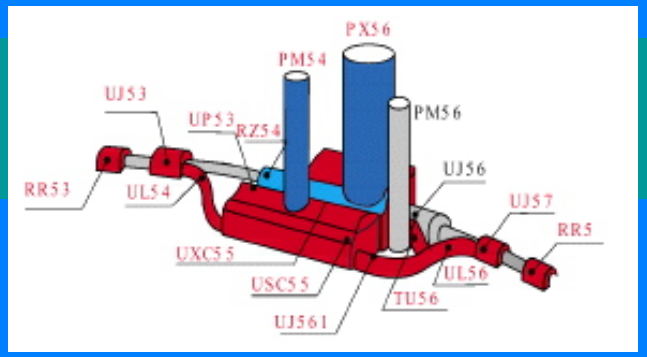


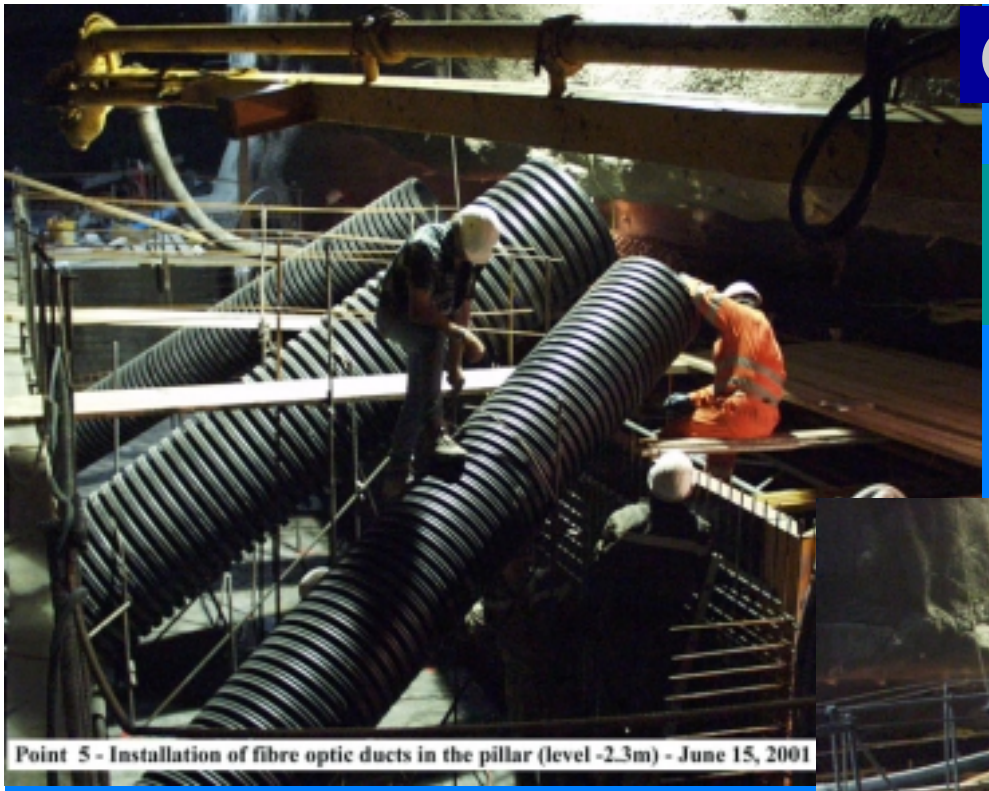
Concreting vault end in August 01
Bench Escav. Starts until April 02

Civil engineering at Point 5



CMS cavern (Point 5)





Point 5 - Installation of fibre optic ducts in the pillar (level -2.3m) - June 15, 2001

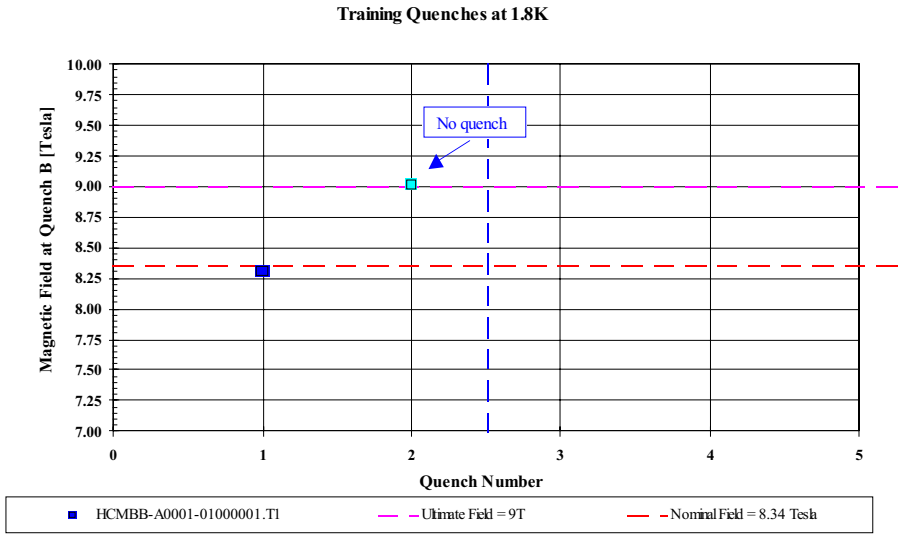
Point 5 - Pillar concreting up to level -2.3m - June 15, 2001 - CERN ST-CE

Pillar concreting ends in August 01
Cavern excavation starts

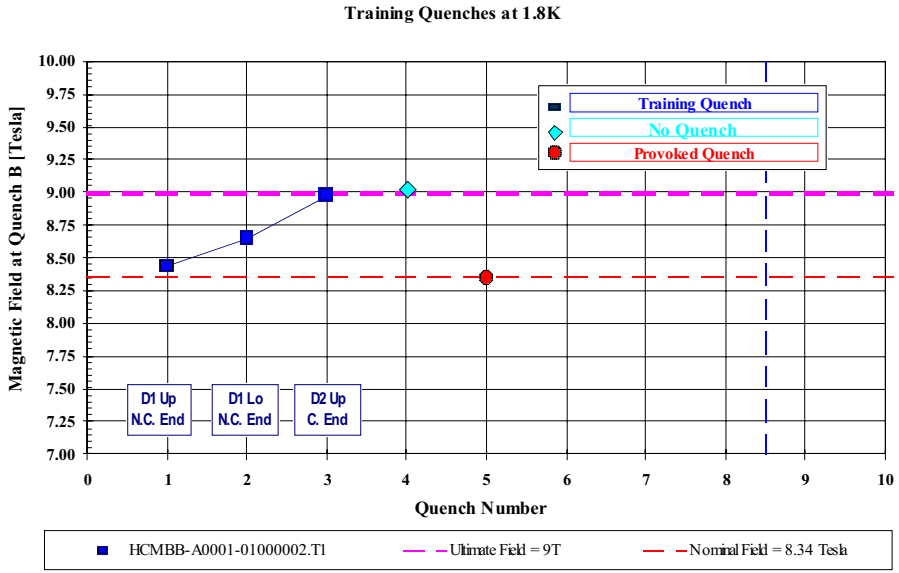
The LHC dipoles n. 0002 and 003

Training Curves

Series dipole #1



Series dipole #2



Dipole tested in June 2001 - A. Siemko/LHC-MTA

A. Siemko/LHC-MTA

Magnets

In production

Name	Quantity	Purpose
MB	1232	Main dipoles
MQ	400	Main lattice quadrupoles
MSCB	376	Combined chromaticity/ closed orbit correctors
MCS	2464	Dipole spool sextupole for persistent currents at injection
MCDO	1232	Dipole spool octupole/decapole for persistent currents
MO	336	Landau octupole for instability control
MQT	256	Trim quad for lattice correction
MCB	266	Orbit correction dipoles
MQM	100	Dispersion suppressor quadrupoles
MQY	20	Enlarged aperture quadrupoles

Sound design, call for tender out now
Concern: sc cable production rate

US LHC ACCELERATOR PROJECT

brookhaven - fermilab - berkeley

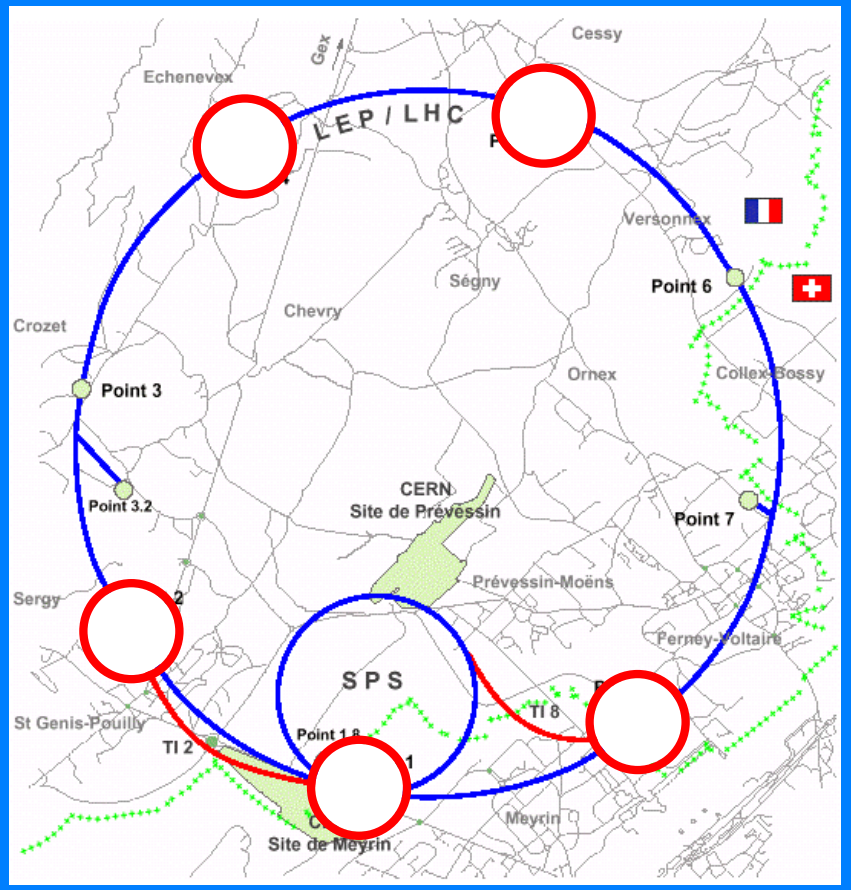
IR Final Focus Systems: Points 1, 2, 5, 8
- –US-built quadrupoles (FNAL)
- –Japanese-built quadrupoles (KEK)
- –CERN-provided correctors
- –Cryostats for all quadrupole assemblies (FNAL)
- –US-built beam separation dipoles (BNL)
- –US-built IR feed boxes (LBNL)
- –US-built specialized absorbers (LBNL)

RF Region: Point 4
- –Beam separation dipoles (BNL)

Wire and Cable for Main Magnets:
- –Measurement of SC wire & cable (BNL)
- –Cable production support (LBNL)

Accelerator physics (all 3 labs)

Project management and oversight (FNAL)



Reported by P. Pfund at "LHC Board", May 2001

Non-Member States - FNAL, United States

Low-β prototype coil

Q2P1 is currently under test at FNAL

Cold mass related parameters confirmed

- 4.5K Quench performance OK--consistent w/ good model magnets
- Harmonics OK
- Quench protection OK

Initial cryostat information good

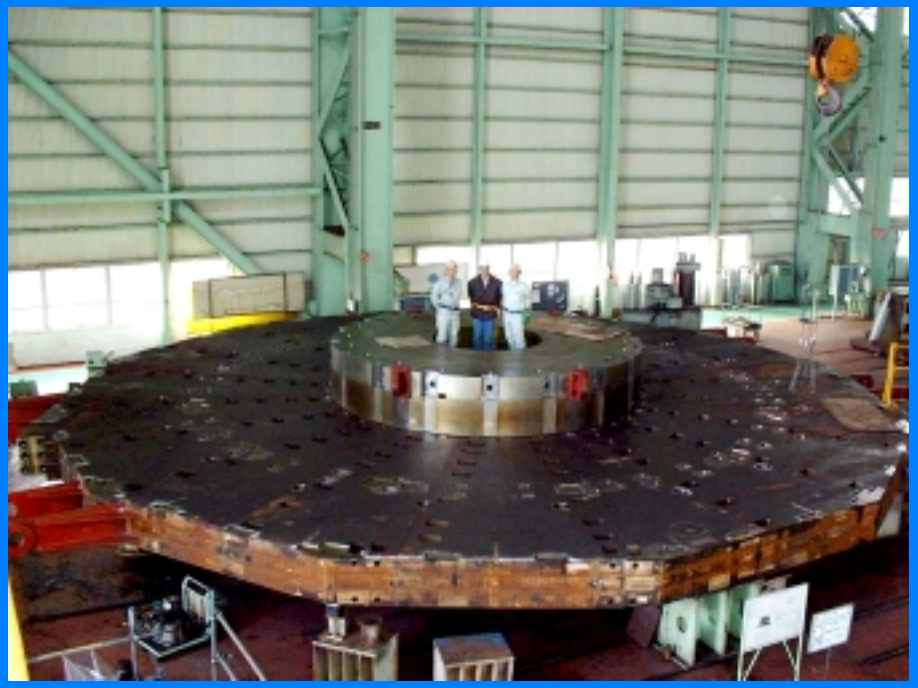
- Roll within 0.6mrad of true

Reported by P. Pfund at "LHC Board", May 2001

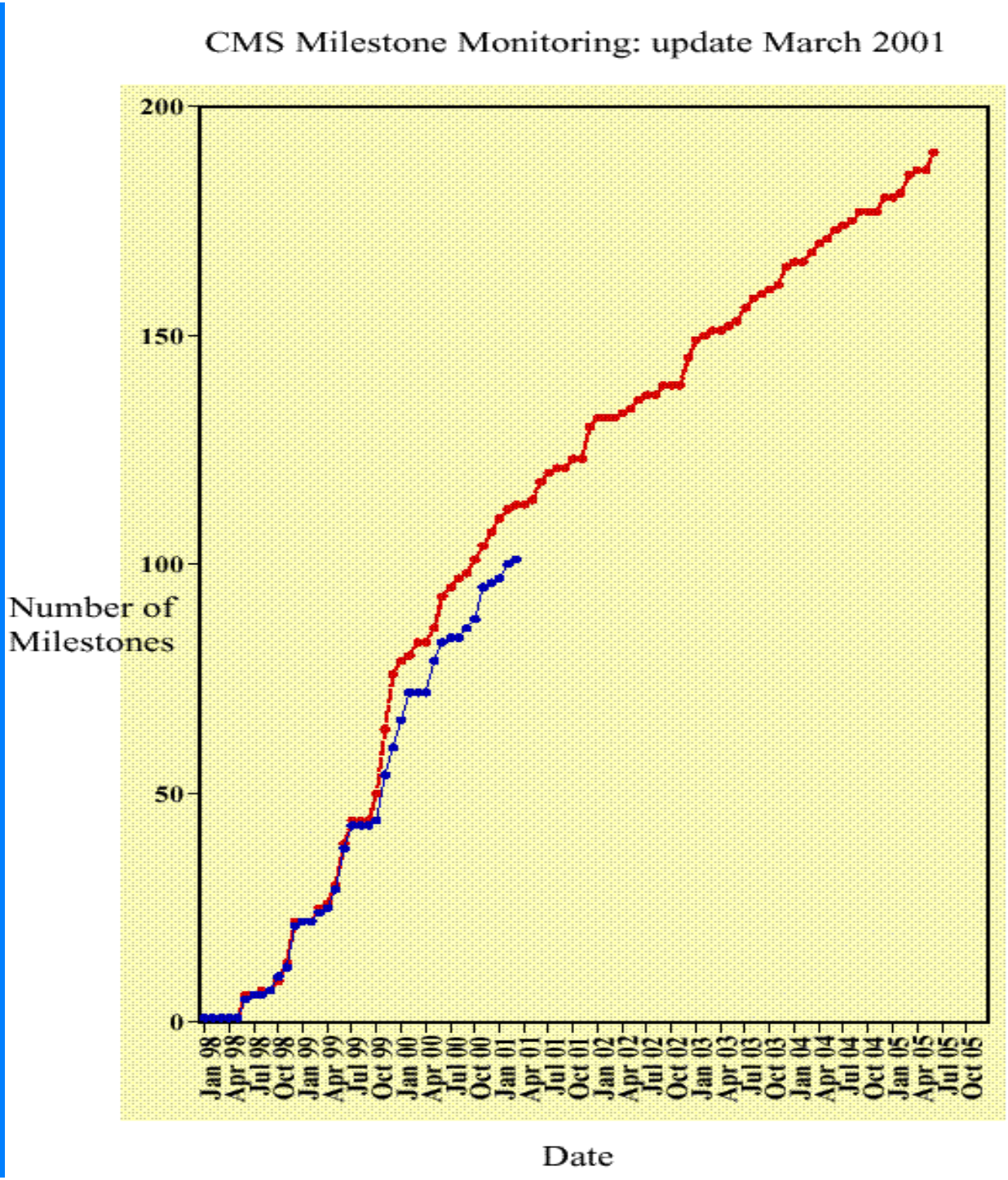
Jessica
29 Mar 01
1500 Chicago Time

Magnet Yoke

YE-1 & nose trial assembly Nov '00
In Kawasaki (Japan)



YB-2, YB-1, YB0 ready, YB1 started.
Central wheel YB0, supporting the vacuum tank. **Web camera: http://cmsdoc.cern.ch/outreach/**

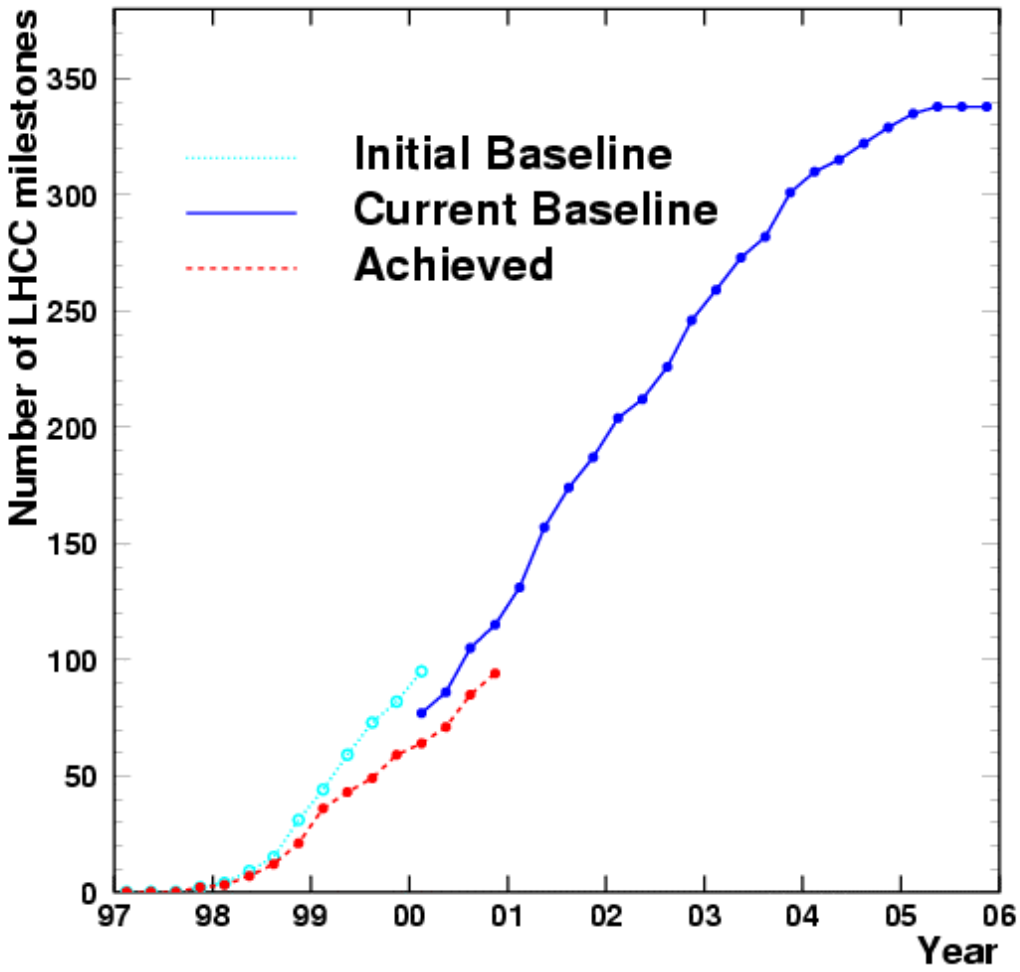


89% of the L1/L2 V26 Milestones are complete.
CMS can have the complete detector for the physics run starting August 2006, except for the 4th Endcap Muon station ME4, which is staged.
The limitation comes essentially from funding shortfalls or cash flow problems.

ATLAS

Completed solenoid and cryogenics chimney during tests at Toshiba (for KEK)

ATLAS Milestones



Joos Engelen, SPC, June 11, 2001

The LHC experimental programme as of 11/06/01:
In general good progress

- **ATLAS and CMS are learning how to go into (*mass*) production**
- **ALICE completing RD, starting construction; one more TDR to go: the TRD**
- **LHCb completing RD, starting construction; producing TDR's as foreseen**

Schedule, funding

No major concerns, but:

- electronics (rad hard; front end) more difficult than anticipated
- these (in particular ATLAS and CMS) are enormous enterprises and the resources are very tight…
- still a long way to go

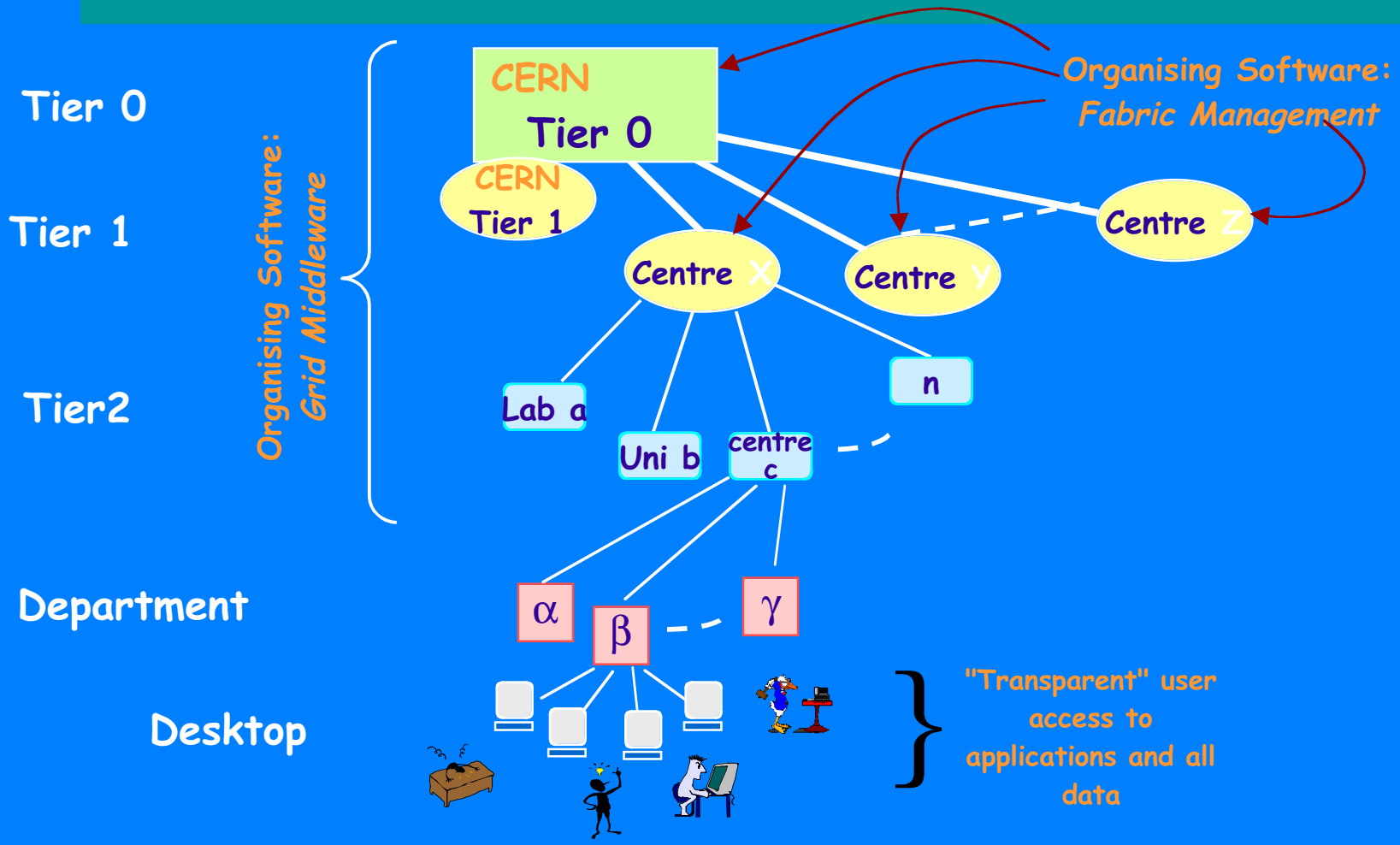
LHC

• call for tender for Cryo-dipoles assembly and for cryo-lines are out, adjudication in September/November.

•Status Report in December 2001 will integrate the most important elements of the project:

- •most important adjudications
- •LHC computing
- •Discussion of Maintenance &Operation costs.

The LHC Computing Model



Grid Initiatives World-wide

USA:

Scientific Simulation Initiative (SSI) - DoE2000 funded to further information technology research for applications.

National Computational Science Alliance (NCSA, the Alliance) - partnership of ~50 US centres to provide an integrated computing, data and visualisation grid environment.

Accelerated Strategic Computing Initiative (ASCI) - DoE funded initiative to create leading-edge computational modelling and simulation capabilities. Goal: replace nuclear tests with computer based methods

NASA Information Power Grid

GriPhyn, PPData Grid

Grid Forum

Europe:

E-Grid - European Grid initiative, first workshop in Poland in April 2000. Goal: focus European research activities to connect to and match US developments.

LHC Challenge: Data Grid - European/ US collaboration to explore the results of a large scale experiment using Grid technology. First preparations have started, prototype development planned.

Software Available:

Globus, Legion, STA, Condor, UNICORE

Message-passing:

MPICH-G, STAMPI, PACX-MPI

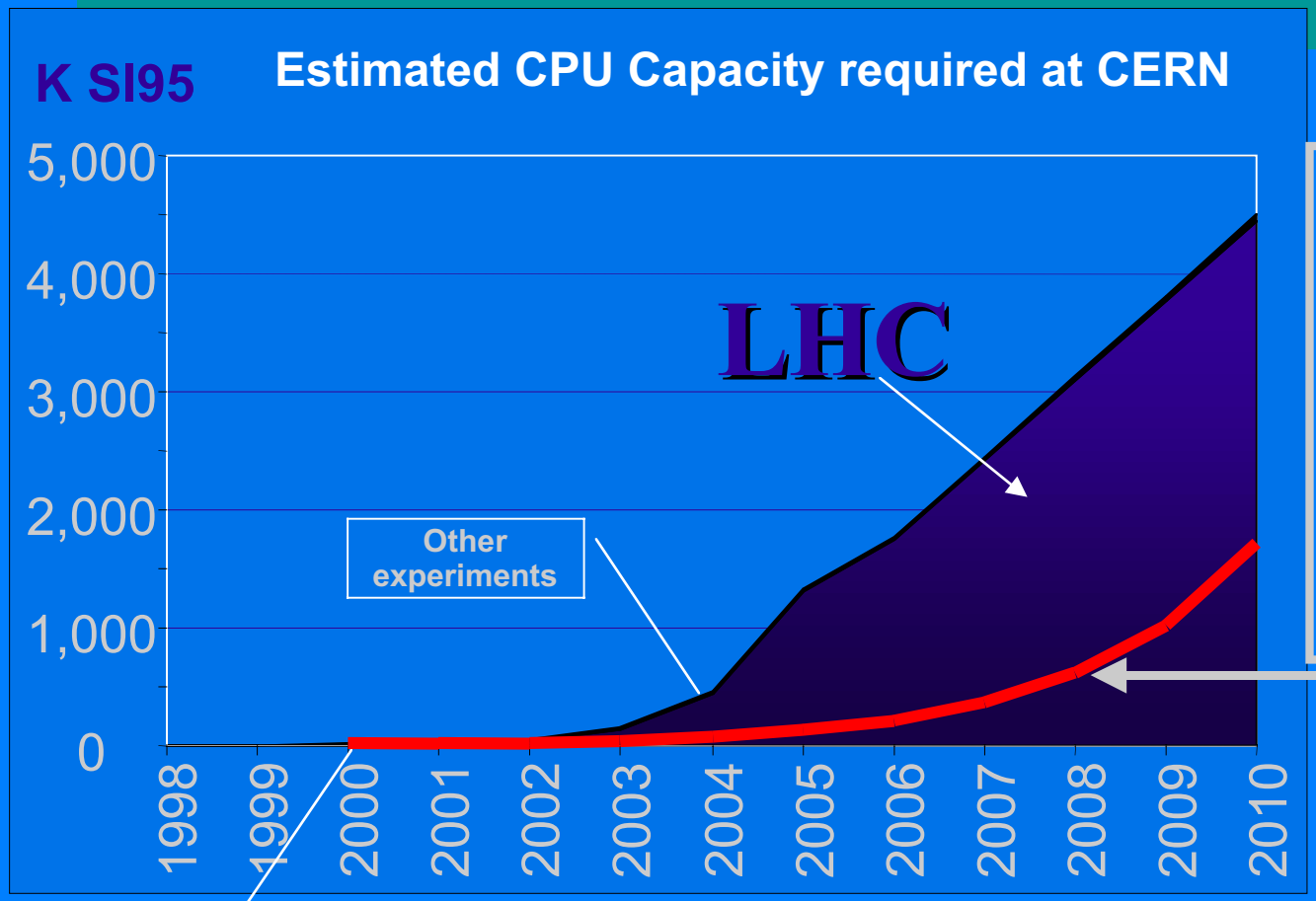
Local Resource Allocation Managers:

LoadLeveller, PBS, LSF, NQE

"Collaboratory" and VR Software

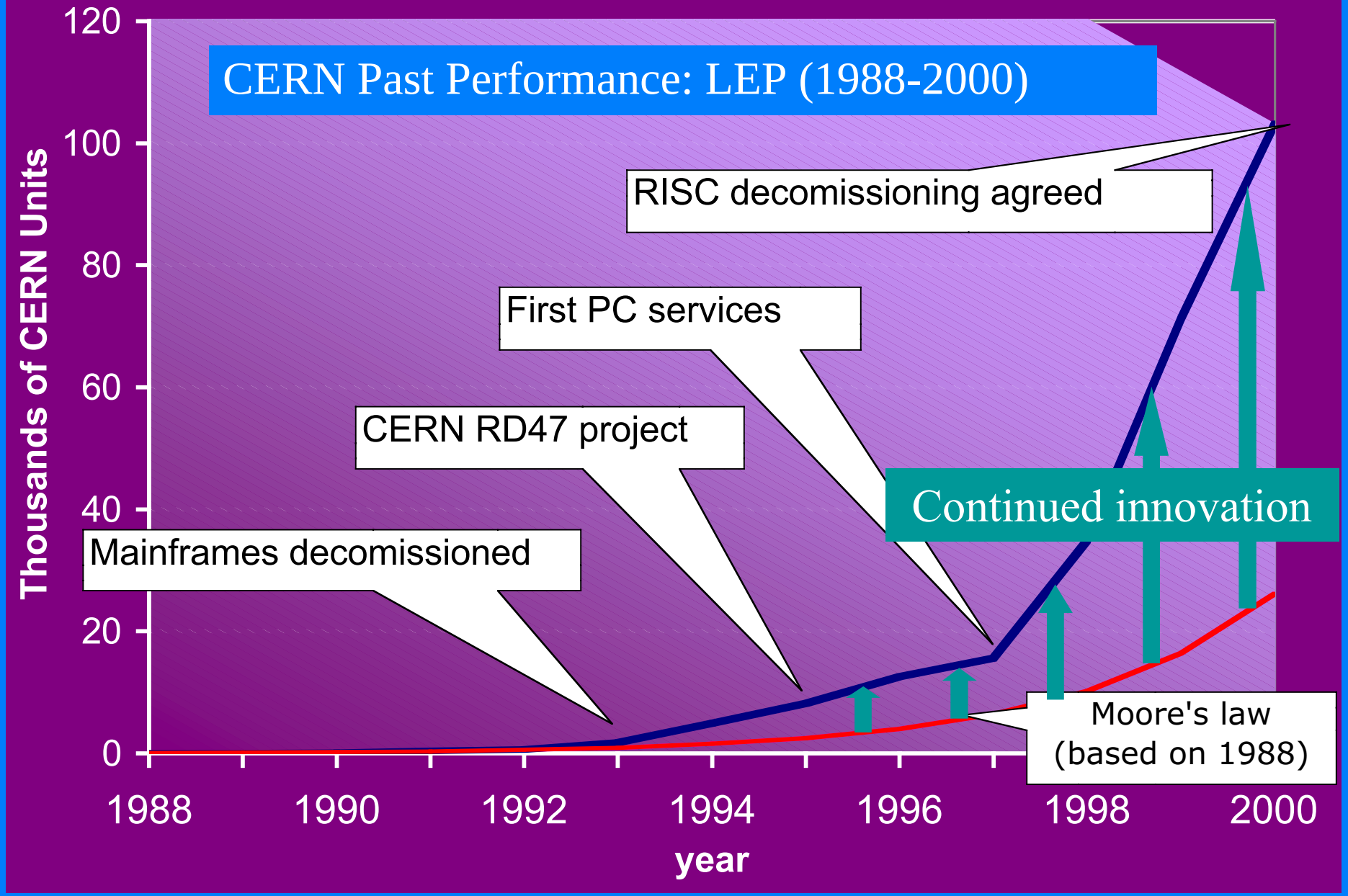
CORC, Manicoral, VIVRE, Amira

Tier 0 @ CERN

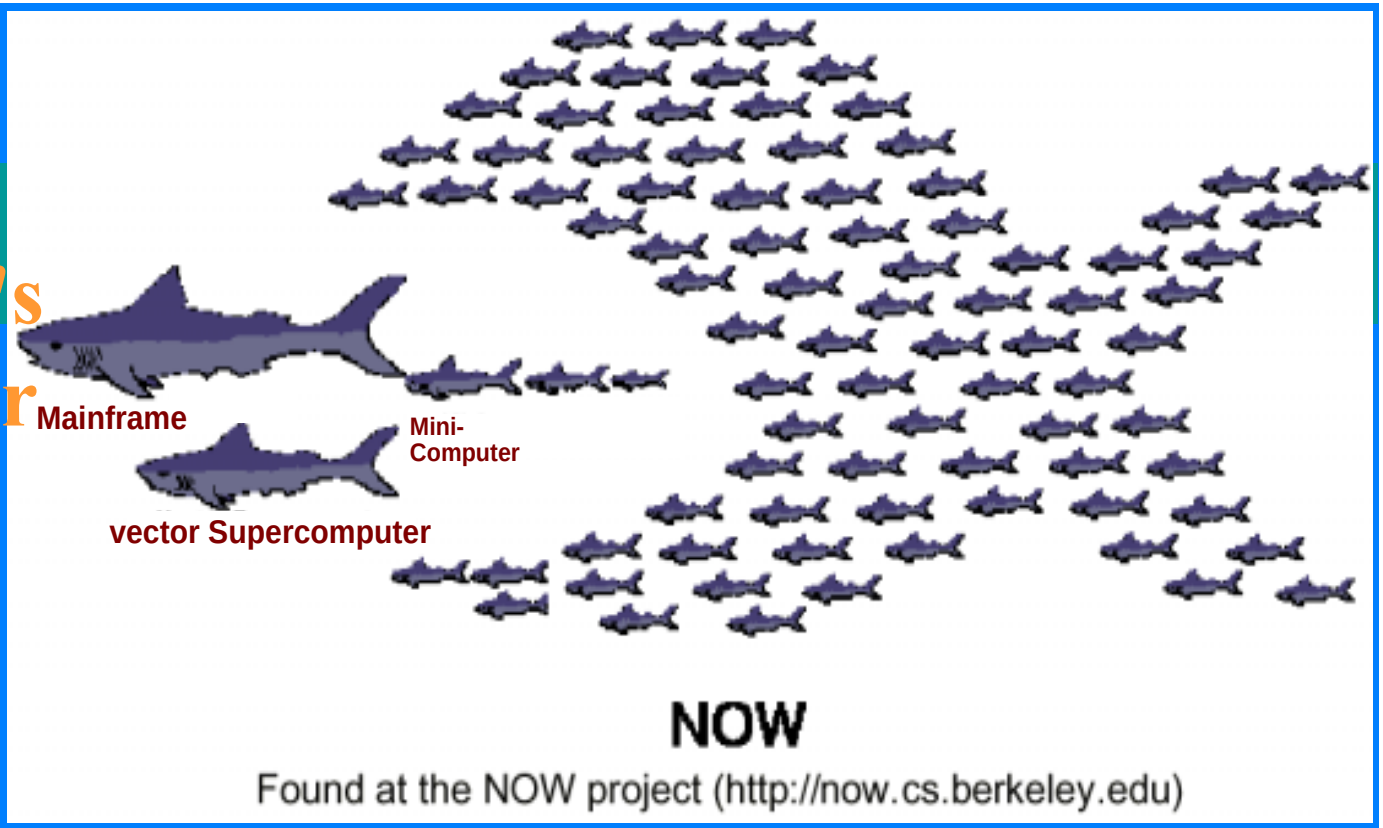


Jan 2000: 3.5K SI95

Moore's law – some measure of the capacity technology advances provide for a constant number of processors or investment


CERN Past Performance: LEP (1988-2000)
Thousands of CERN Units
120
100
80
60
40
20
0
1988
1990
1992
1994
1996
1998
2000
year
RISC decomissioning agreed
First PC services
CERN RD47 project
Mainframes decomissioned
Continued innovation
Moore's law
(based on 1988)

Processor farms : the 90's supercomputer



- PC+Linux: the new supercomputer for scientific applications

obswww.unige.ch/~pfennige/gravitor/gravitor_e.html

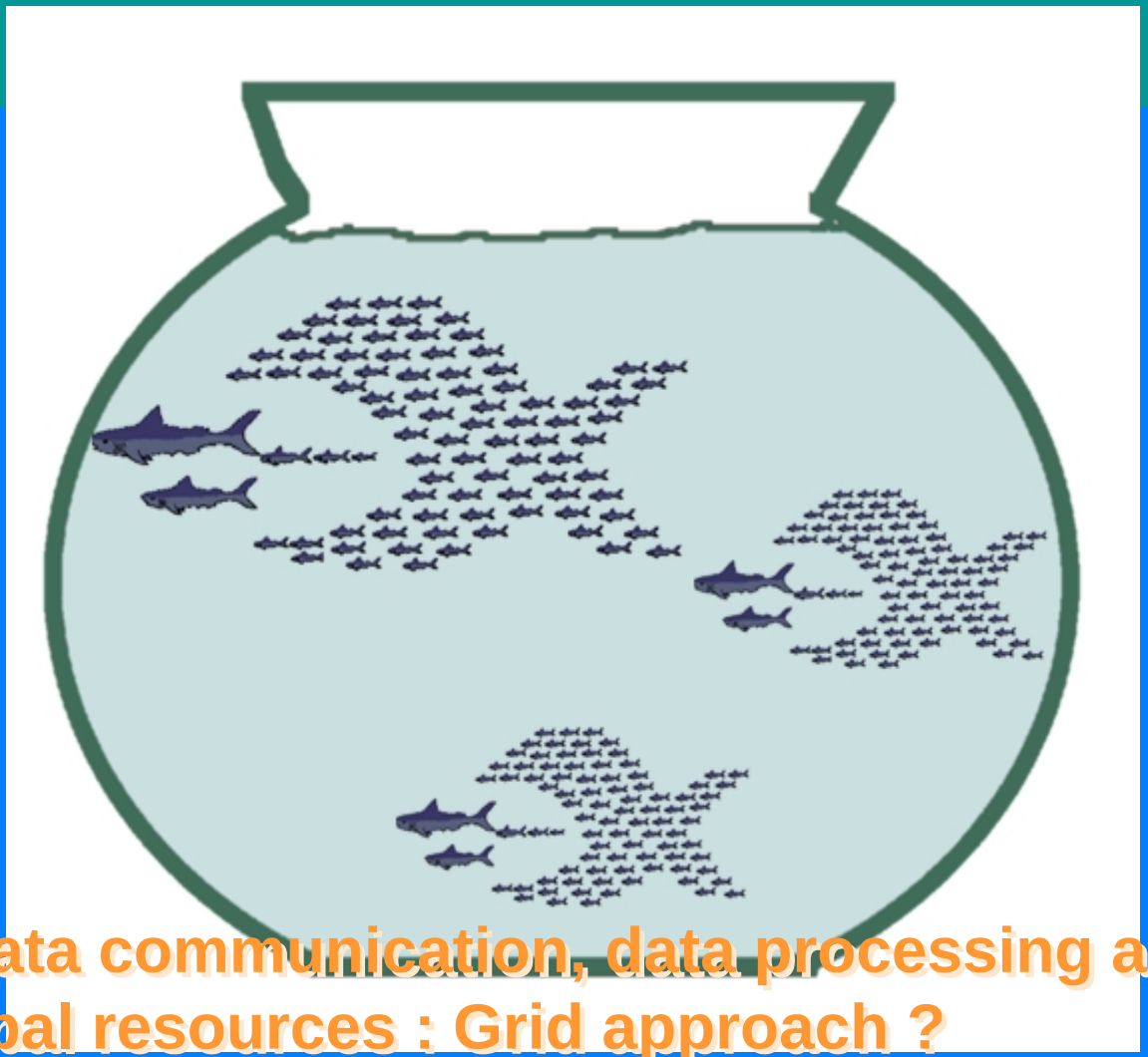
www.cs.sandia.gov/cplant/

- Principle well established; farm examples abound

now.cs.berkeley.edu

www.ncsa.uiuc.edu/General/CC/ntcluster/

After commodity farms what next?

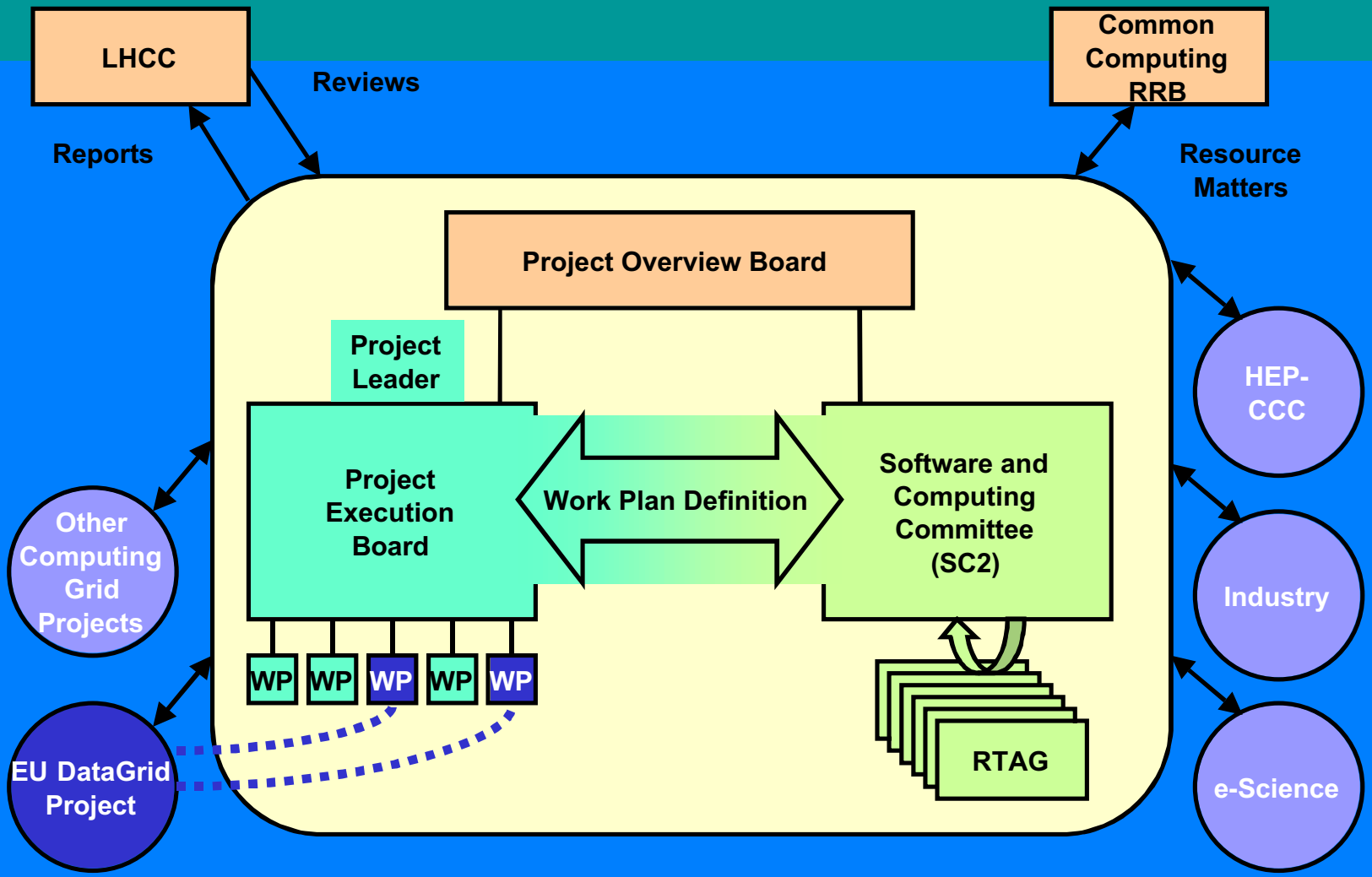


Fusion of data communication, data processing and data archive global resources : Grid approach ?

The Project Structure of LHC Grid Computing @ CERN

Version 1.3
M. Delfino
05.07.2001

DRAFT

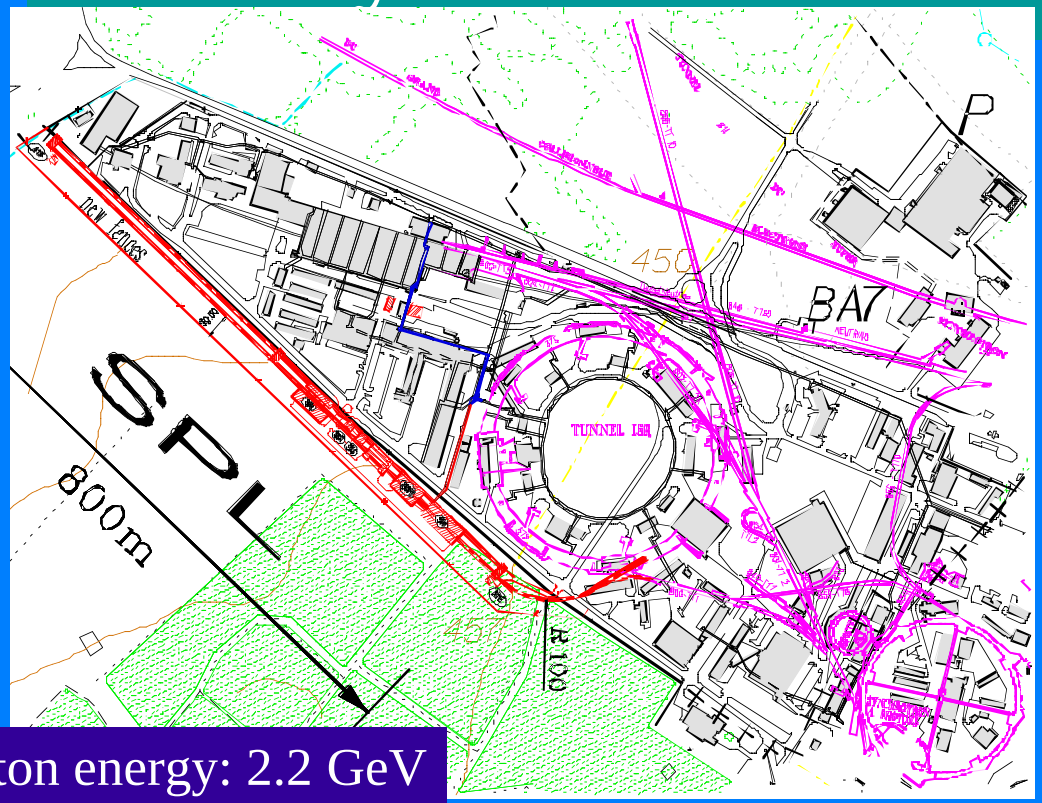


RoadMap

- **first ideas on Project Overview Board :**

- **- Chair: Director for Scientific Computing and Technology Transfer**
- **- Secretary: IT Div. Lead.**
- **- Members:**
- **Director for Collider Programmes**
- **LHC experiments spokespersons**
- **8 representatives from Member States**
- **1 representative from each Special Observer Country (USA, Russia, Japan).**

Superconducting Proton Linac: layout on the CERN site



Proton energy: 2.2 GeV
Power on target: 4MW
Re-use of LEP sc cav.s
Almost pure ν_μ beam

Linac + klystron gallery parallel to the fence of Meyrin site (Route Gregory)

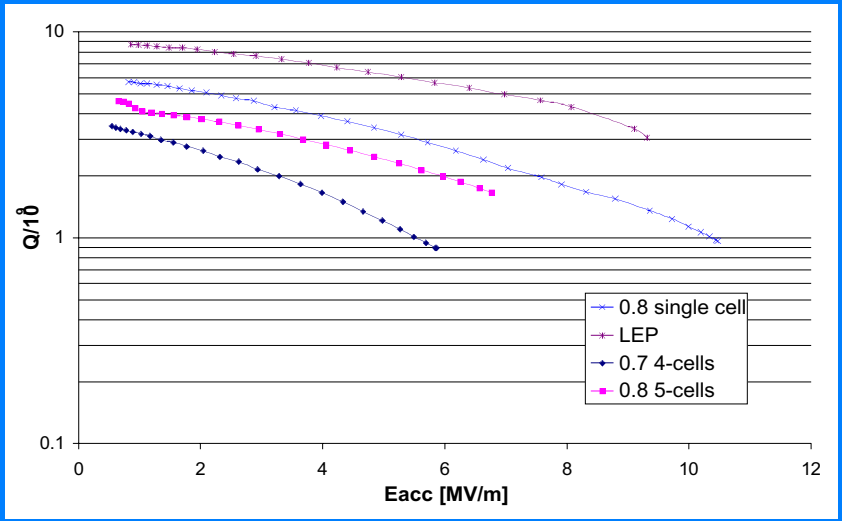
- Economic trench excavation
- Geological advantages (tunnel on“molasse”, no underground water)
- Minimum impact on the environment (empty field)
- Simple connection to PS & ISR via existing tunnels
- Use some of the old ISR infrastructure (electricity, cooling)

The SC cavities for $\beta < 1$

The β=0.7 4-cell prototype

☆ CERN technique of Nb/Cu sputtering for β=0.7, β=0.8 cavities (352 MHz):

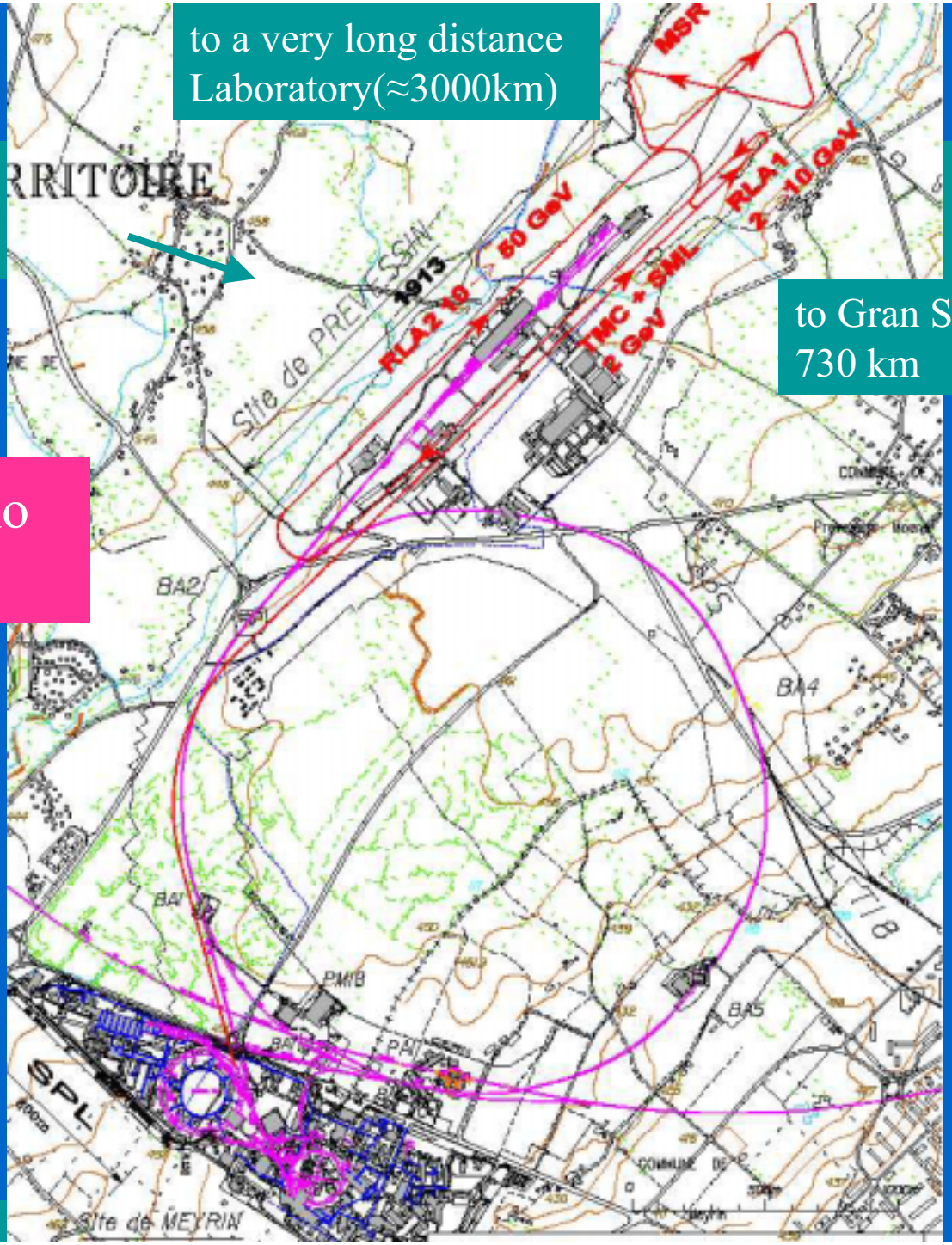
•lower material cost, large apertures, released tolerances, 4.5 °K operation with $Q = 10^9$



☆ Bulk Nb or mixed technique for β=0.52 (one 100 kW tetrode per cavity)

CERN design of a Neutrino Factory

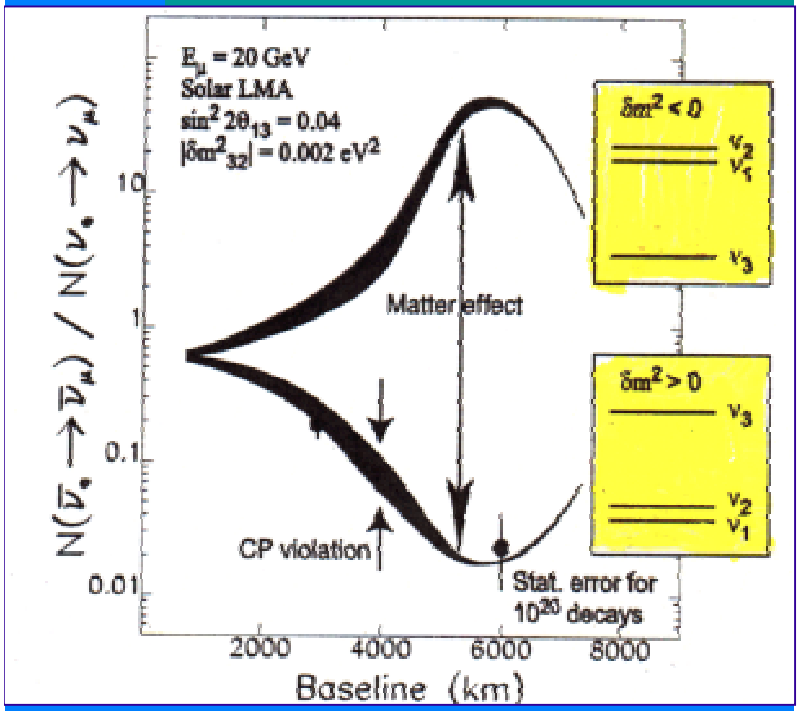
4MW on target



L. Maiani. 19/07/2001

Search for long-baseline detector laboratories

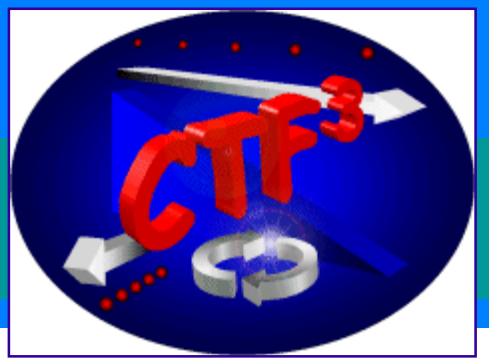
Best long baseline is around 3000km for CP violation + matter effects.



search for possible underground sites (H. Wenninger et al)
Gran Canaria (Spain); Spitzbergen (Svalbard,Norway);
Center for underground physics Pihäsalmi(Finland)

P. Gruber

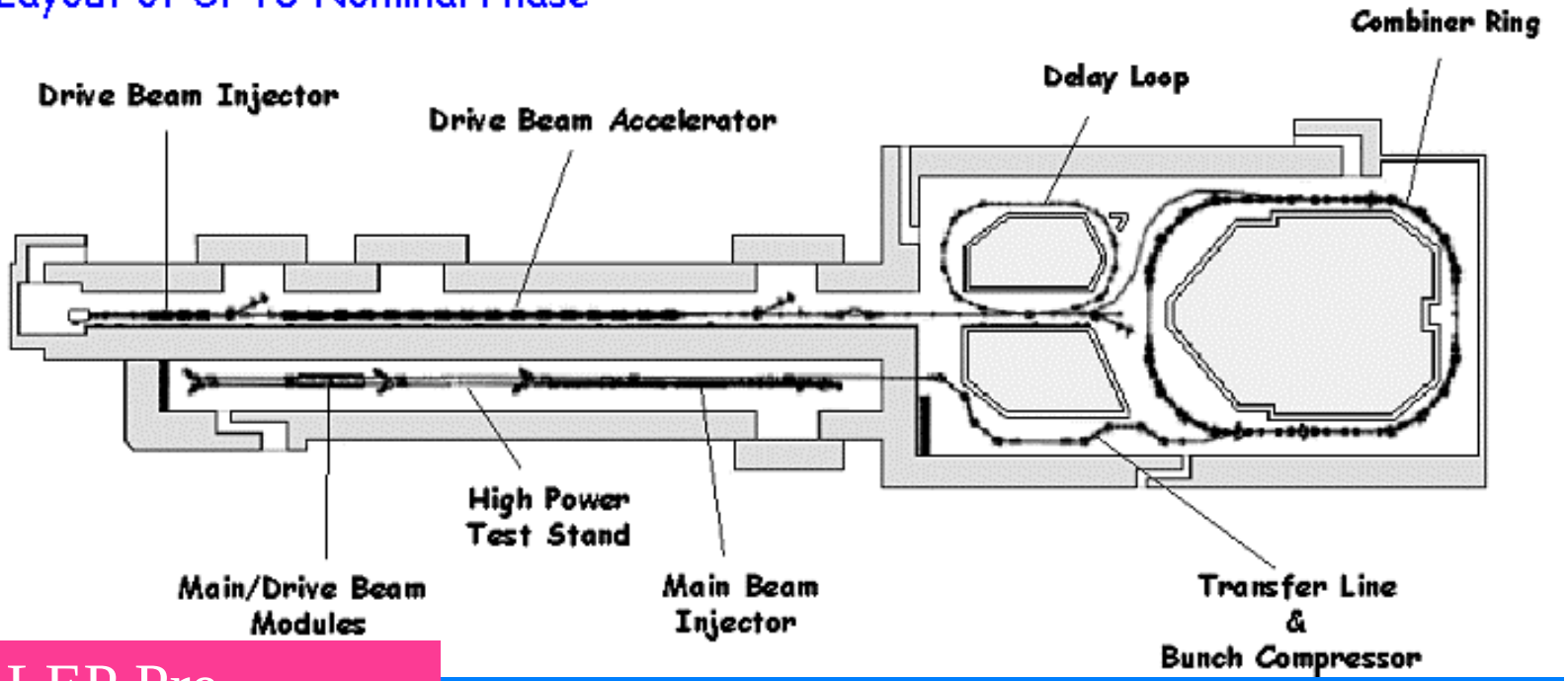
CLIC Test Facility 3



Two beam acceleration

150 MeV/m = 1.5 TeV/10km

Layout of CFT3 Nominal Phase

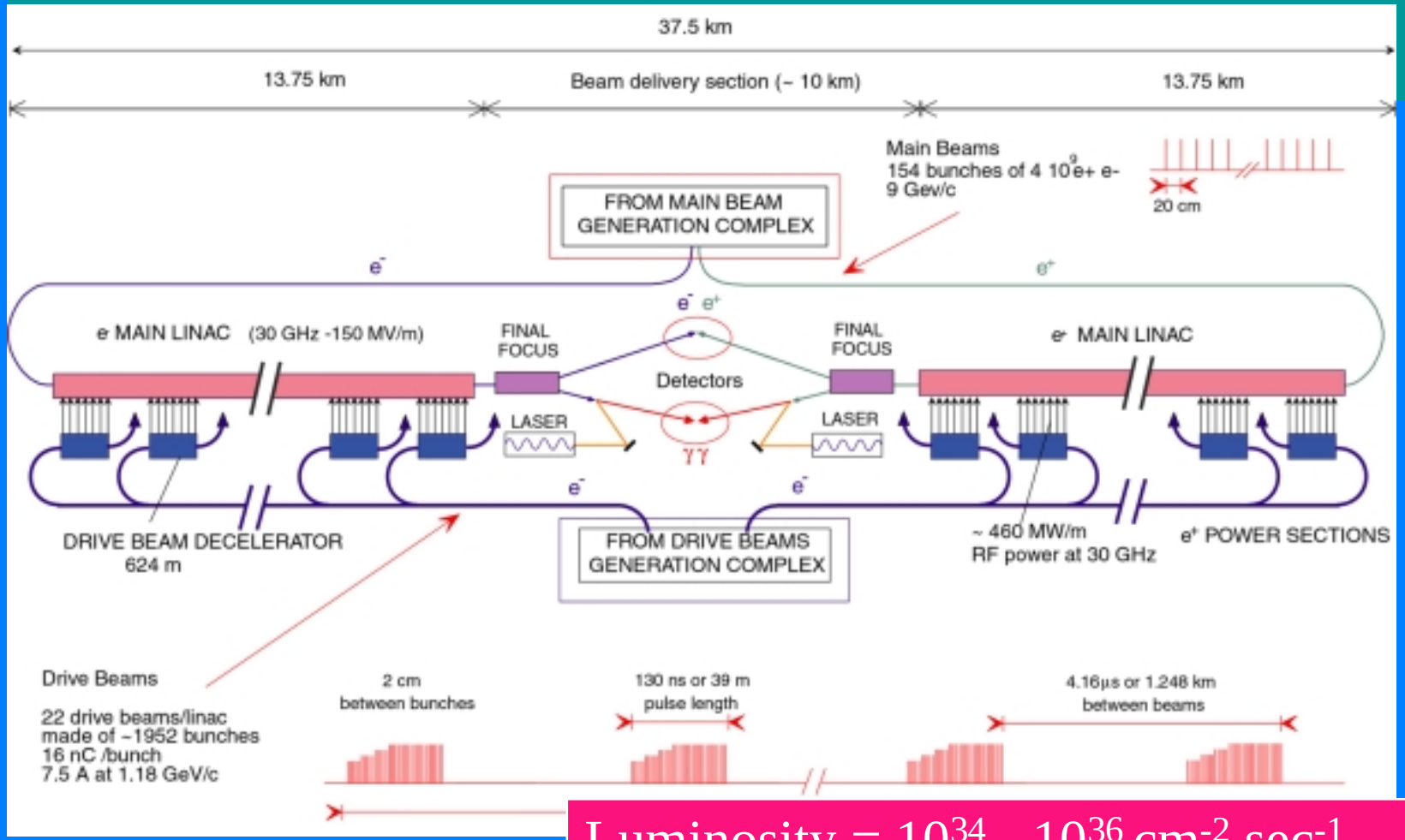


Housed in LEP Pre-Injector building

Construction 2001-2003

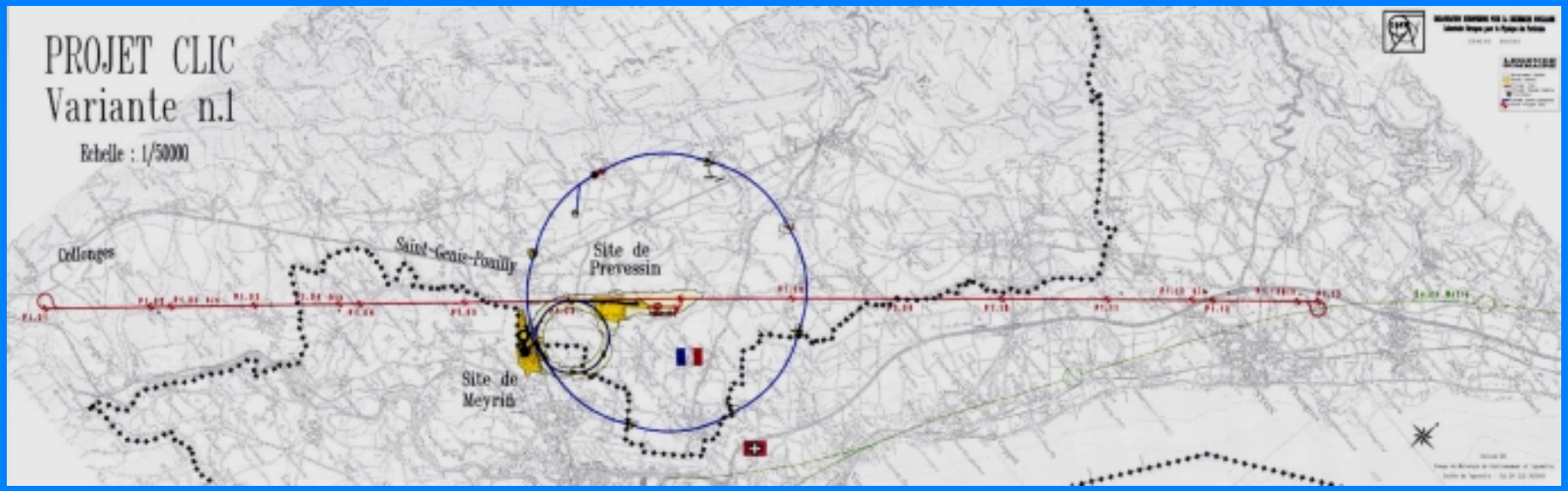
Technology tested: 2007

Overall Layout of the CLIC complex at E_{tot}= 3 TeV



Luminosity = 10^{34} - 10^{36} cm^{-2} sec^{-1}

Total Length = 39 km



Fitting CLIC at CERN

Projet 240 km - Variantes Est et Ouest

SITUATION

GADZ
GEOTECHNIQUE
APPLIQUEE
DERIAZ S.A.,
CH-1213 PETIT-LANCY 2

VLHC at CERN?
(Circ. = 240 Km)

Exploratory study shows prohibitive tunnel cost

A forward look:
(1) CERN in 2001-2010

- It is vital for CERN and for Particle Physics that the LHC is completed and fully exploited

THIS IS OUR MAJOR CONCERN

•The LHC programme has been quite tightly funded (contingencies: “time”, “staging & descoping”)

•No resources are available for other commitments (tight budget & manpower reduction).

A forward look :
(2) The long term future

- There are many fascinating problems in the High Energy Frontier and in Neutrino Physics.
- Particle Physics Programme:
  - i. LHC(phase 1+2), NLC/JLC/TESLA: TeV exploration
  - ii. CLIC, VLHC: multi-TeV (muon-collider later?)
  - ιιι. ν -superbeams, ν -factory
- The complex of these facilities would allow for a full exploration of the world beyond the Standard Theory, as we can conceive it today

Side programmes as gate-ways to other sciences & industrial applications:

- Free Electron Laser
- Neutron Spallation sources
- Data Grids

•CERN has the aspiration and the capability to be a major player in (ii) and (iii);

•R&D done today leaves open all possibilities.

The long term future (cont'd)

- A project "in the house" : CLIC is (today) the best runner;
- Not everything will/can be done at CERN (VLHC?): participation of CERN to outside projects is likely/necessary.

Rather than "The World Laboratory", I prefer to imagine a Network of Laboratories to plan, organise, finance and realise *The World Programme* sketched above

CAN WE DO IT ????