
SUMMER STUDENTS
LECTURE PROGRAMME
1st : WHAT IS CERN?
Luciano Maiani. CERN. Geneva
July 4, 2001

A few facts...

- **1935: H. Yukawa predicts the π-meson, $M_{\pi} \approx 1/7\ M_{P}$**
- **1937: Street & Stevenson, Anderson & Neddermeyer discover the mesotron (μ- lepton) in cosmic ray: $\mu \rightarrow e$**
- **Feb. 1947: Conversi, Pancini, Piccioni: $\mu \neq \pi$**
- **May 1947 : Lattes, Occhialini, Muirhead and Powell discover the π - meson: 2 events with $\pi \rightarrow \mu$**
- **Dec. 1947: Rochester & Butler: observe the V-particles (strange particles)**

THE NEED TO STUDY THE NEW PARTICLES GAVE IMPETUS TO THE CONSTRUCTION OF MORE POWERFUL ACCELERATORS

The first proposal (De Broglie, 1949)

"...a laboratory or institution where it would be possible to do

scientific work, but somehow beyond the framework of the

different participating states.

…this body could be endowed with more resources than national

laboratories and could, consequently, undertake tasks…beyond their scope…"

Collaboration could be easier due to the "true nature of science"

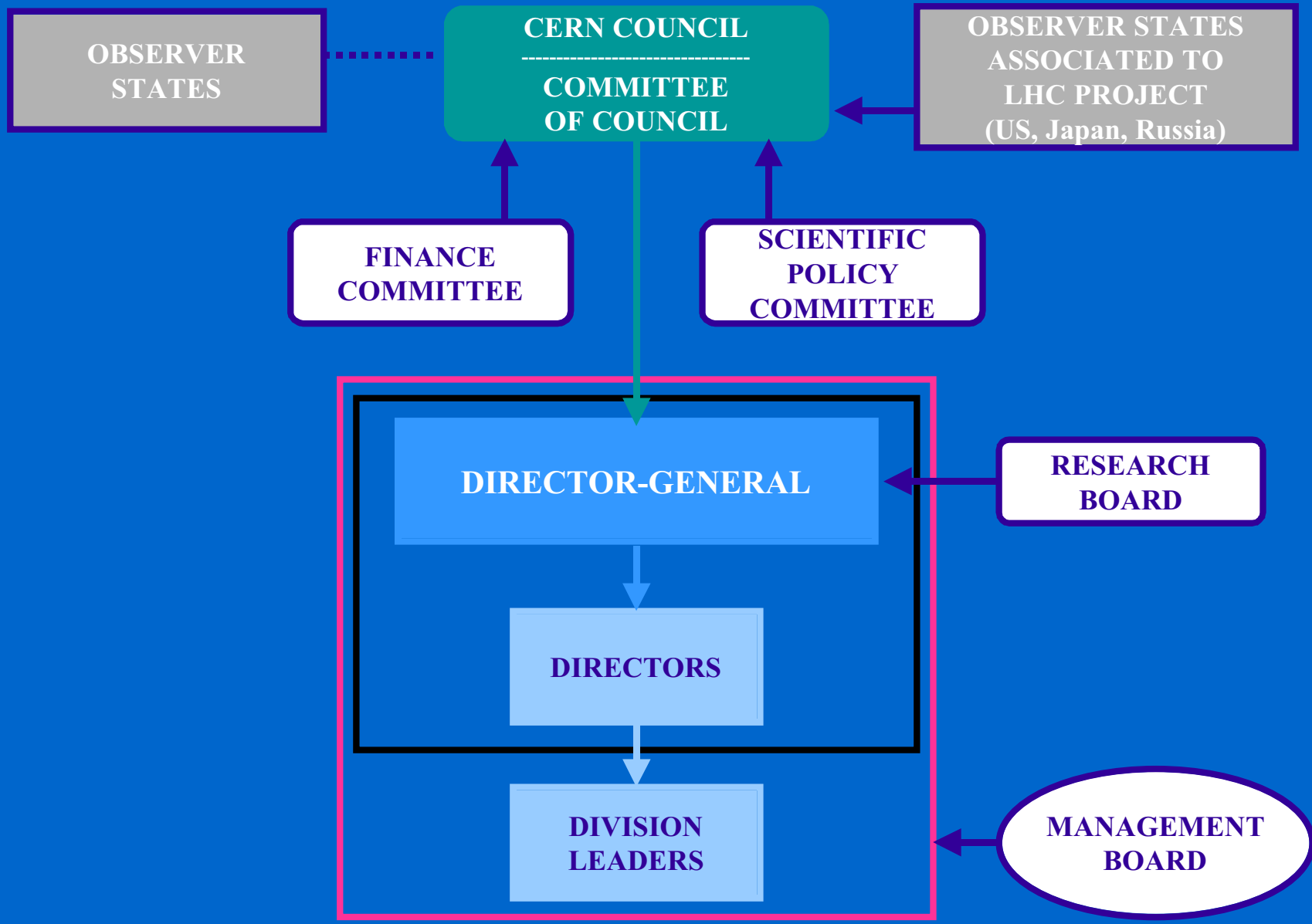
This kind of cooperation would serve also other disciplines

Left to Right: Pierre Auger, Edoardo Amaldi and Lew Kowarski, at the first session of the provisional CERN Council (1952)

The twenty Member States of CERN (2001)

OBSERVERS:
UNESCO, EU, Israel, Turkey, USA, Japan, Russia

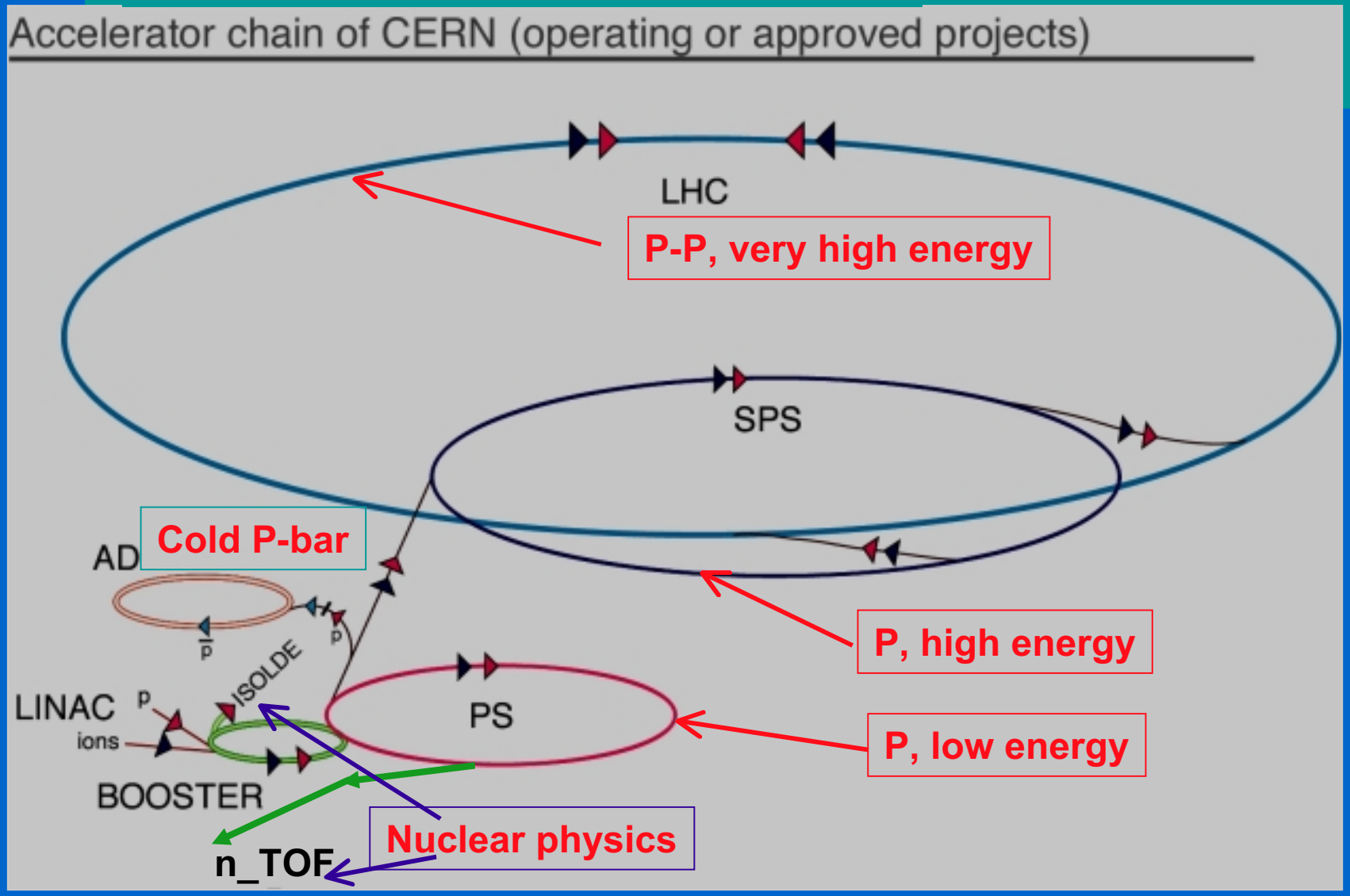
CERN STRUCTURE



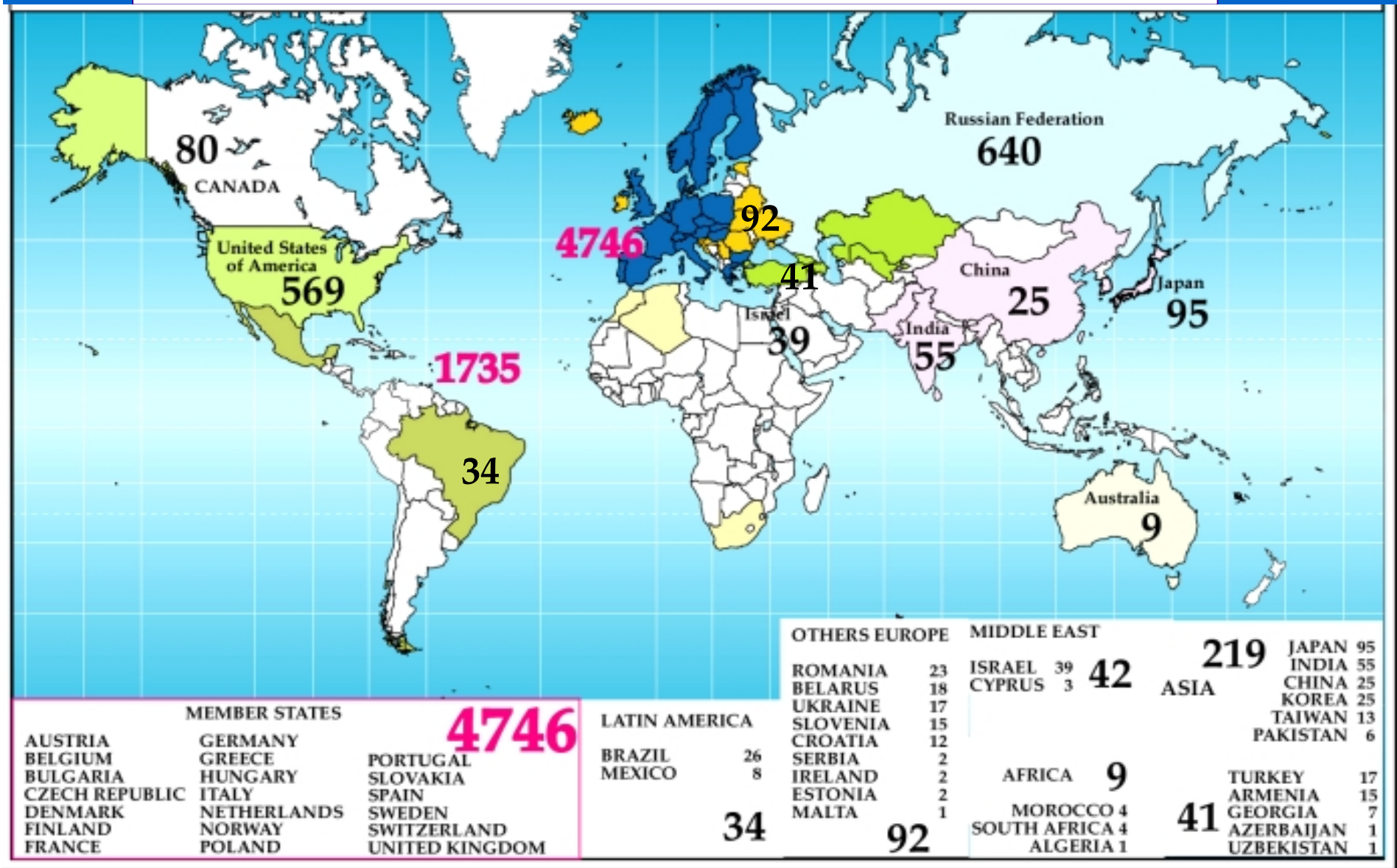
What is CERN?
Summary

- The CERN accelerator menu
- The LHC project
- Cold antiprotons & Long base neutrinos
- The LHC computing challenge
- Technology Transfer
- Why science?

Accelerator chain of CERN



Distribution of CERN users, May 1, 2001



MEMBER STATES			4746
AUSTRIA	GERMANY	PORTUGAL	
BELGIUM	GREECE	SLOVAKIA	
BULGARIA	HUNGARY	SPAIN	
CZECH REPUBLIC	ITALY	SWEDEN	
DENMARK	NETHERLANDS	SWITZERLAND	
FINLAND	NORWAY	UNITED KINGDOM	
FRANCE	POLAND		

LATIN AMERICA		34
BRAZIL	26	
MEXICO	8	

OTHERS EUROPE		92
ROMANIA	23	
BELARUS	18	
UKRAINE	17	
SLOVENIA	15	
CROATIA	12	
SERBIA	2	
IRELAND	2	
ESTONIA	2	
MALTA	1	

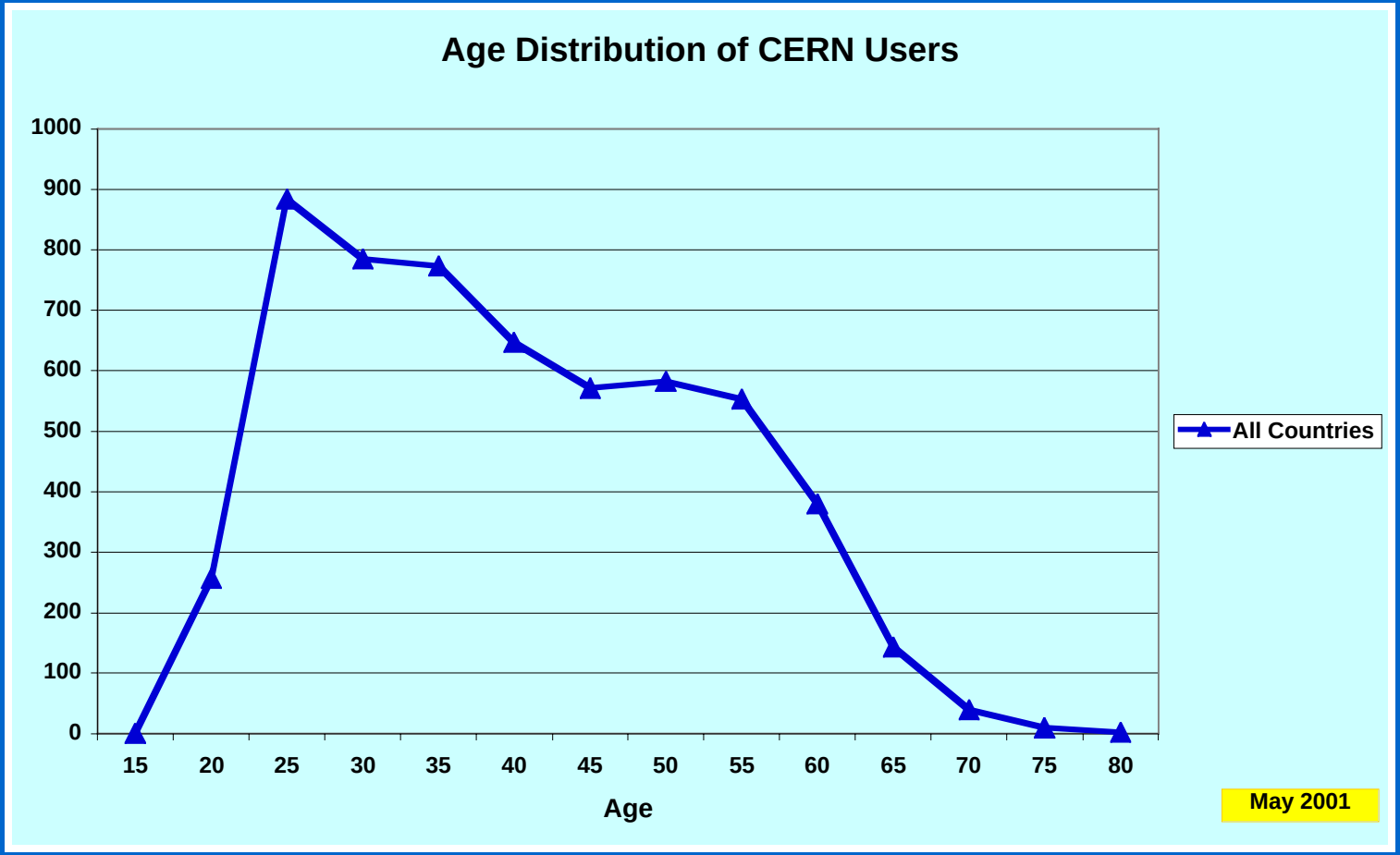
MIDDLE EAST		42
ISRAEL	39	
CYPRUS	3	

AFRICA	9
MOROCCO	4
SOUTH AFRICA	4
ALGERIA	1

ASIA	219
JAPAN	95
INDIA	55
CHINA	25
KOREA	25
TAIWAN	13
PAKISTAN	6

		41
TURKEY	17	
ARMENIA	15	
GEORGIA	7	
AZERBAIJAN	1	
UZBEKISTAN	1	

Age Distribution of CERN Users (May, 2001)

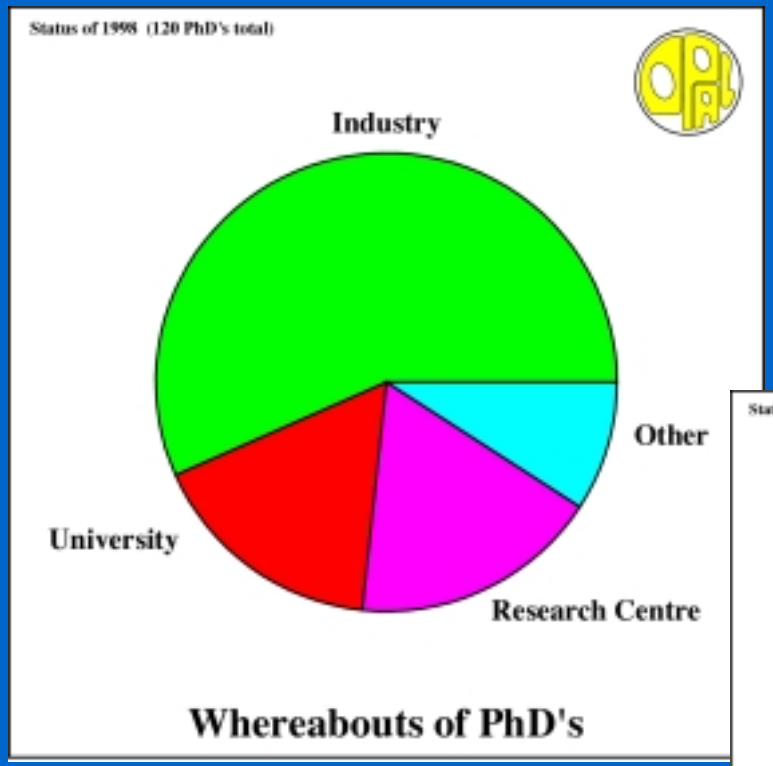


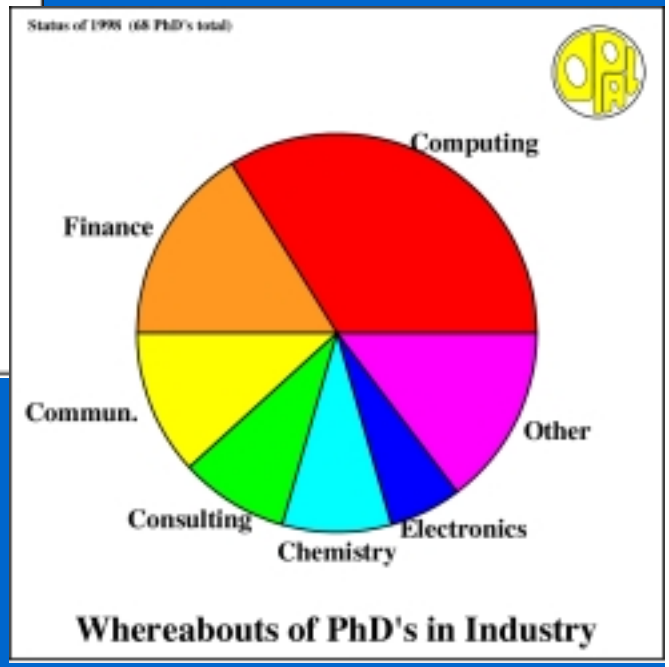
PhD thesis

in LEP experiments

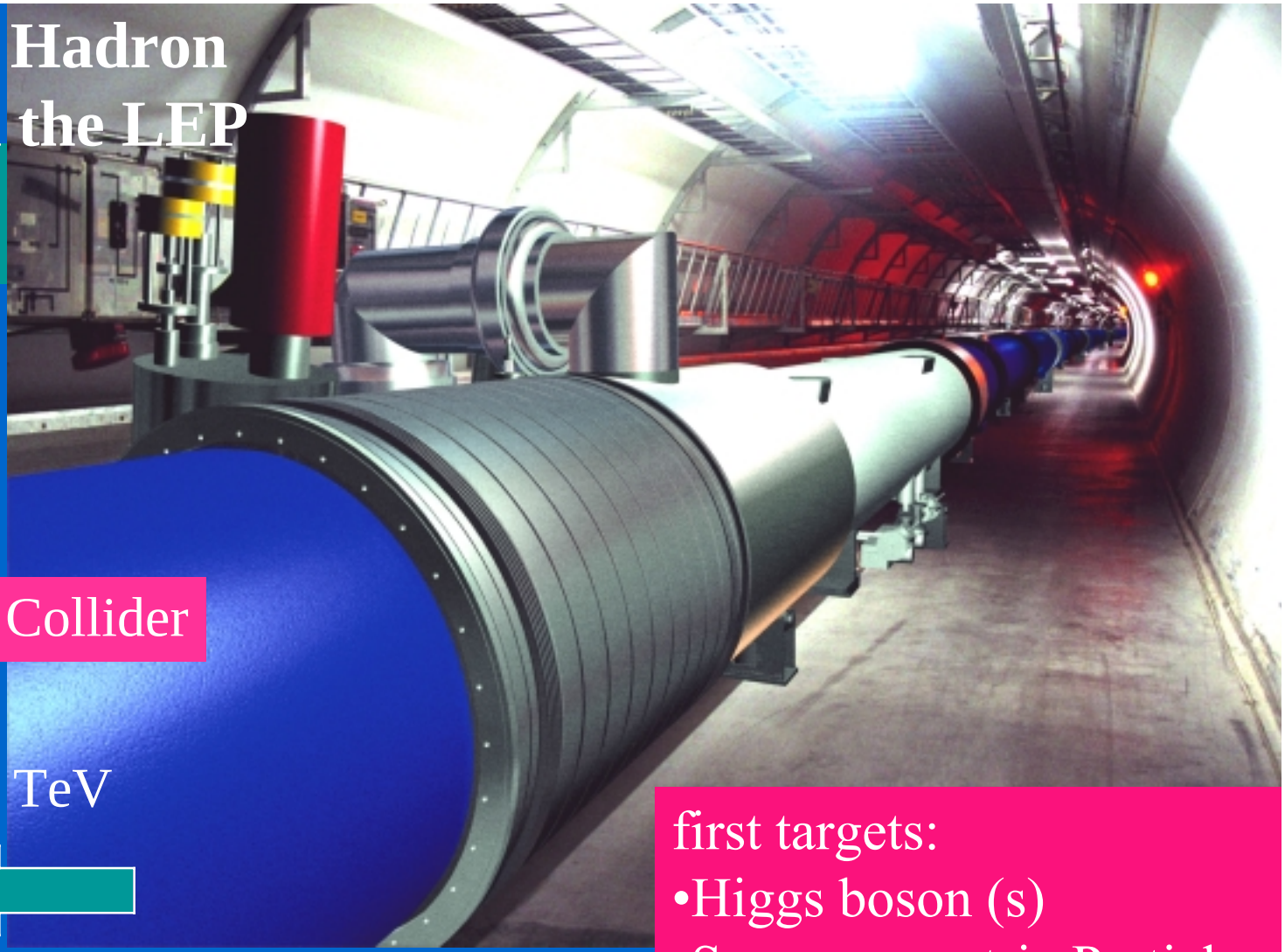
(over ten years):

ALEPH:	**210**
DELPHI:	**227**
L3:	**250**
OPAL:	**198**





The Large Hadron Collider in the LEP Tunnel



Proton- Proton Collider

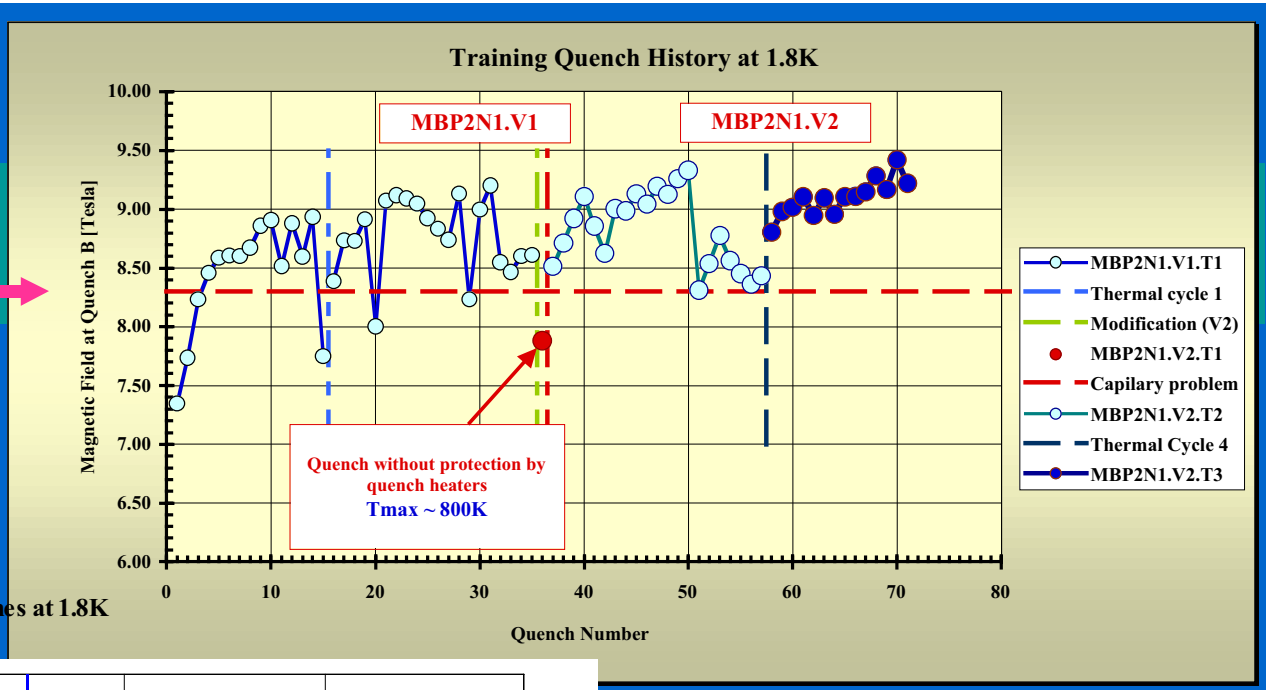
7 TeV + 7 TeV

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

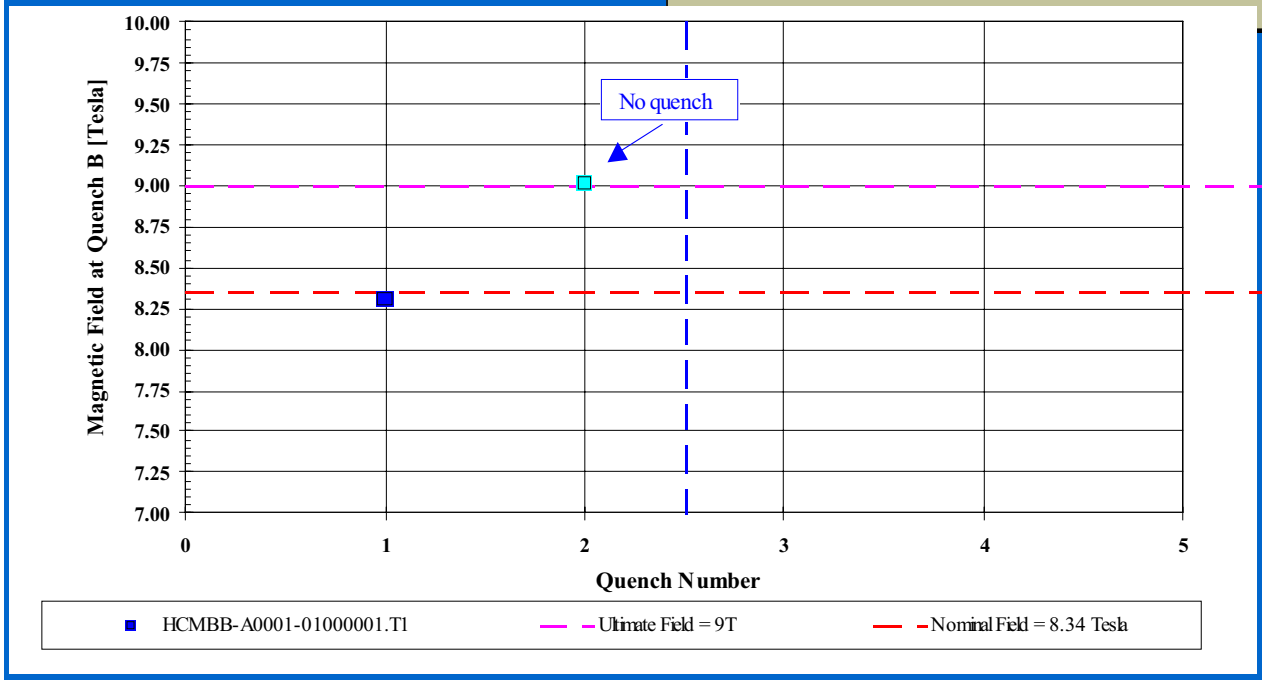
first targets:
- Higgs boson (s)
- Supersymmetric Particles
- Quark-Gluon Plasma
- CP violation in B

The LHC dipole n. 0001

Prototypes



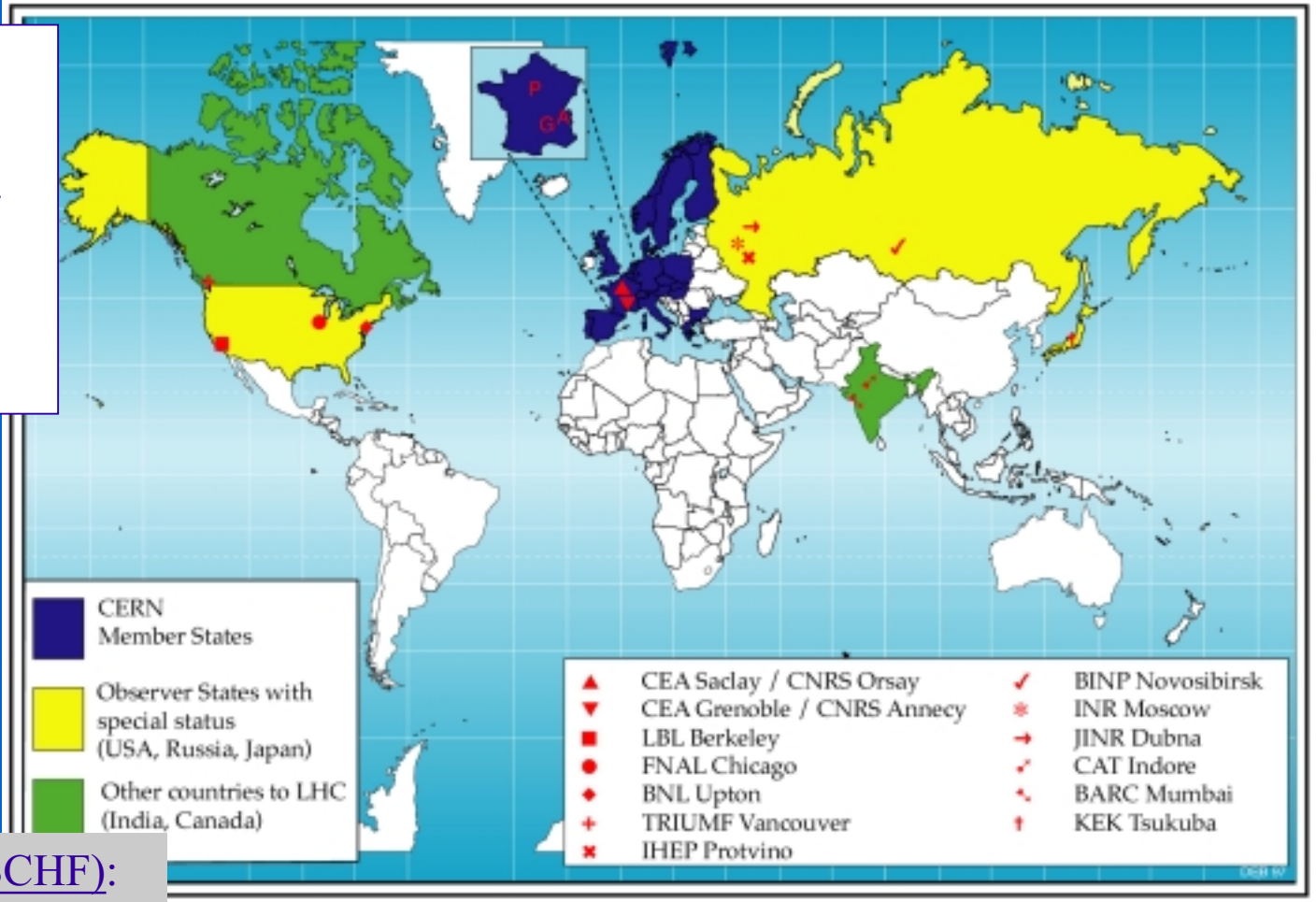
Training Quenches at 1.8K



Training Stories

Dipole n. 0001

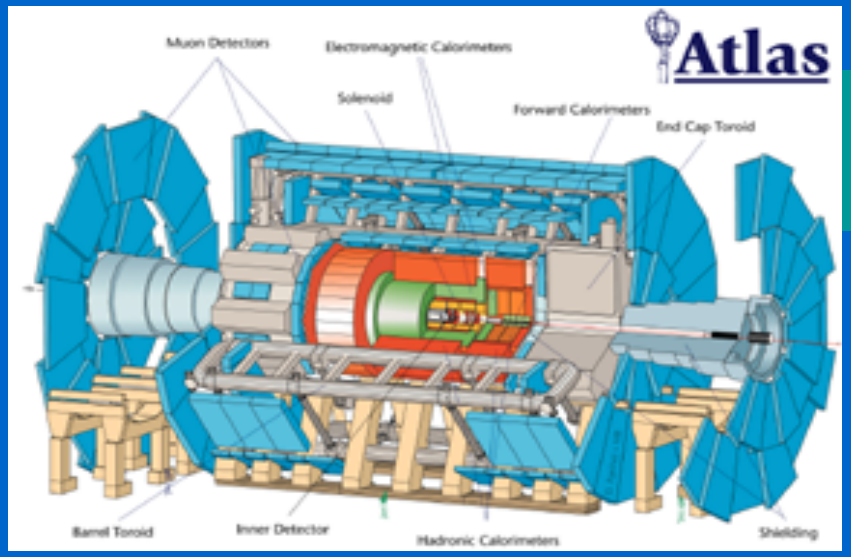
International Collaboration for LHC construction

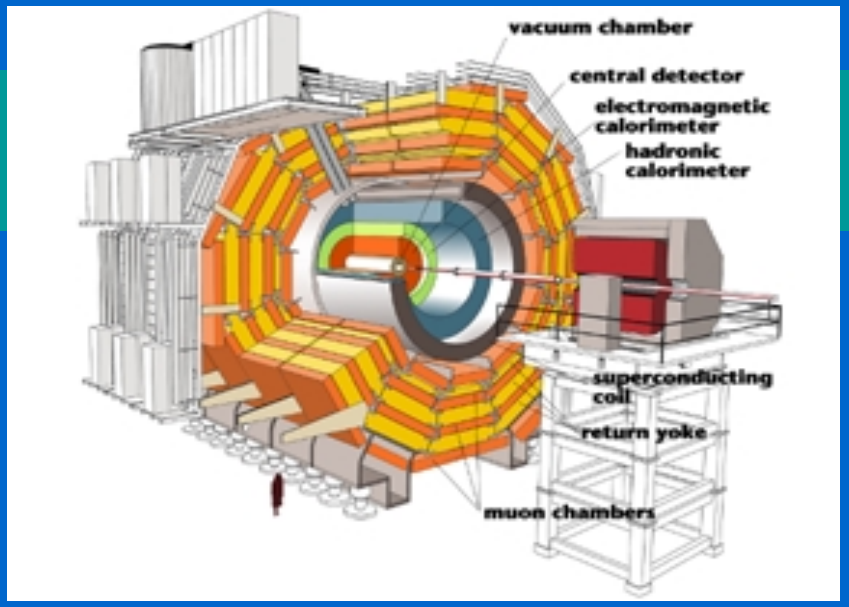


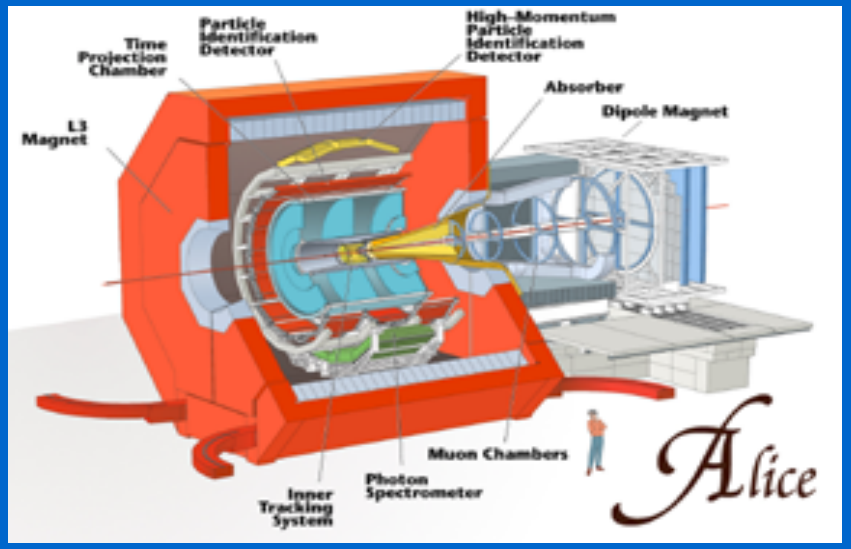
Cost sharing for LHC (BCHF):

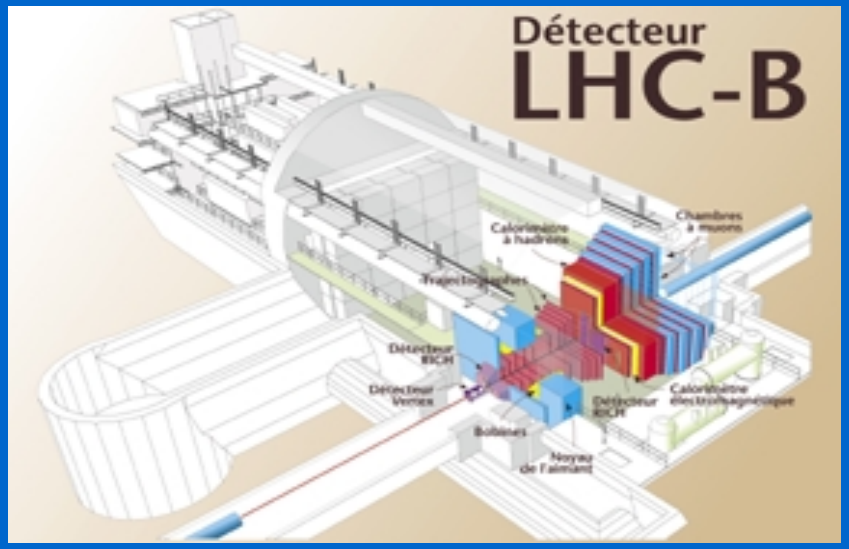
MS, Material:	2.1
MS, Personnel:	1.1 (approx.)
Host States:	0.2
NMS (net):	0.6 (≈15%)
	4.0

USA, Japan, Russia: participate in the decision process for LHC in Committee of Council
Free access to LHC experiments


Atlas
Muon Detection
Electromagnetic Calorimeters
Solenoid
Forward Calorimeters
End Cap Toroid
Barrel Toroid
Inner Detector
Hadronic Calorimeters
Shielding

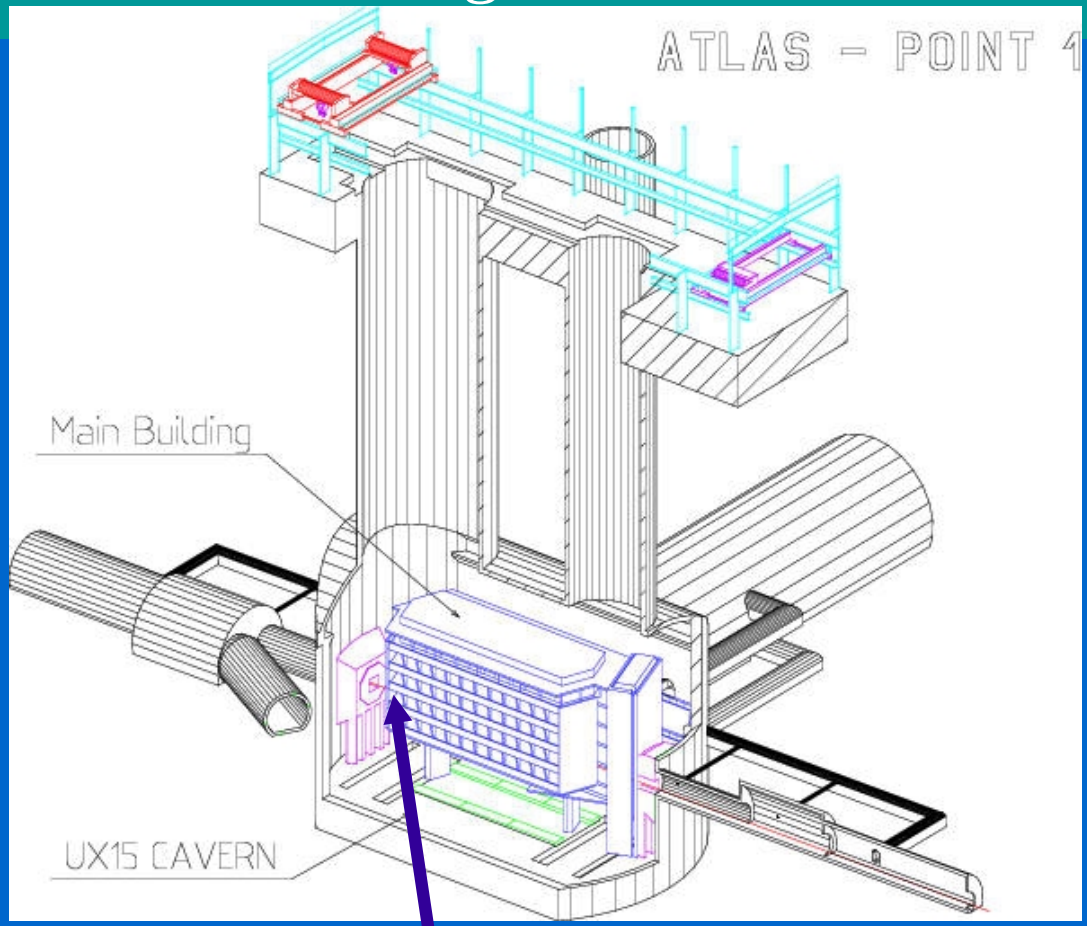

vacuum chamber
central detector
electromagnetic calorimeter
hadronic calorimeter
superconducting coil
return yoke
muon chambers


Time Projection Chamber
Particle Identification Detector
High-Momentum Particle Identification Detector
Absorber
Dipole Magnet
L3 Magnet
Muon Chambers
Photon Spectrometer
Inner Tracking System
Alice

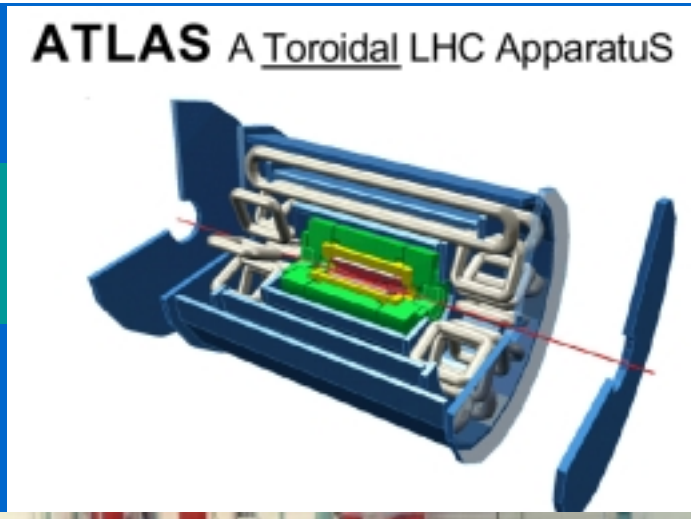

Détecteur
LHC-B

ATLAS shaft and service cavern

The ATLAS Cavern and Building 60



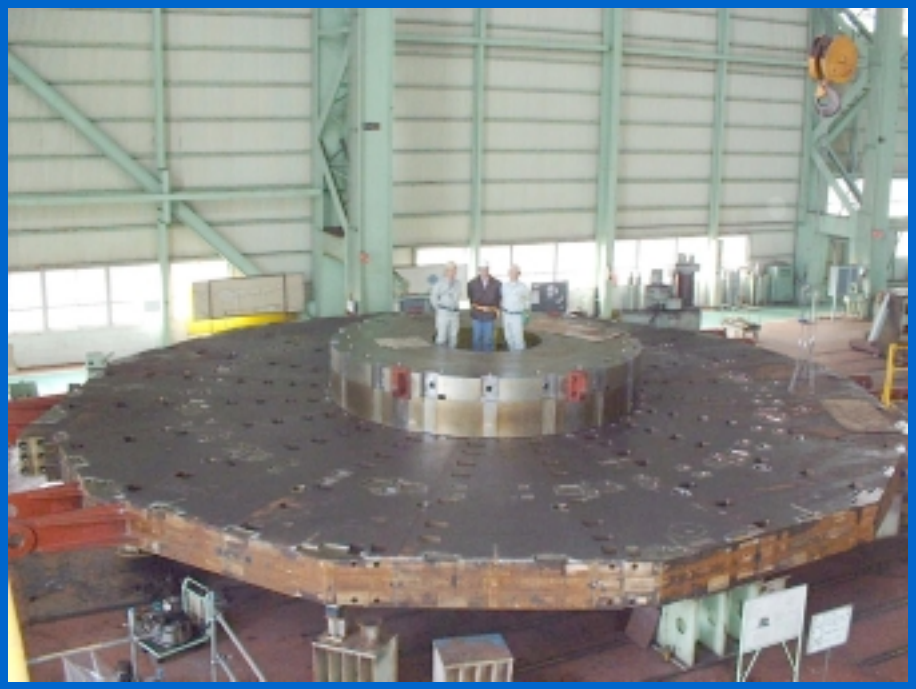
making the ATLAS coils



B0 prototype (1/3 lenght)

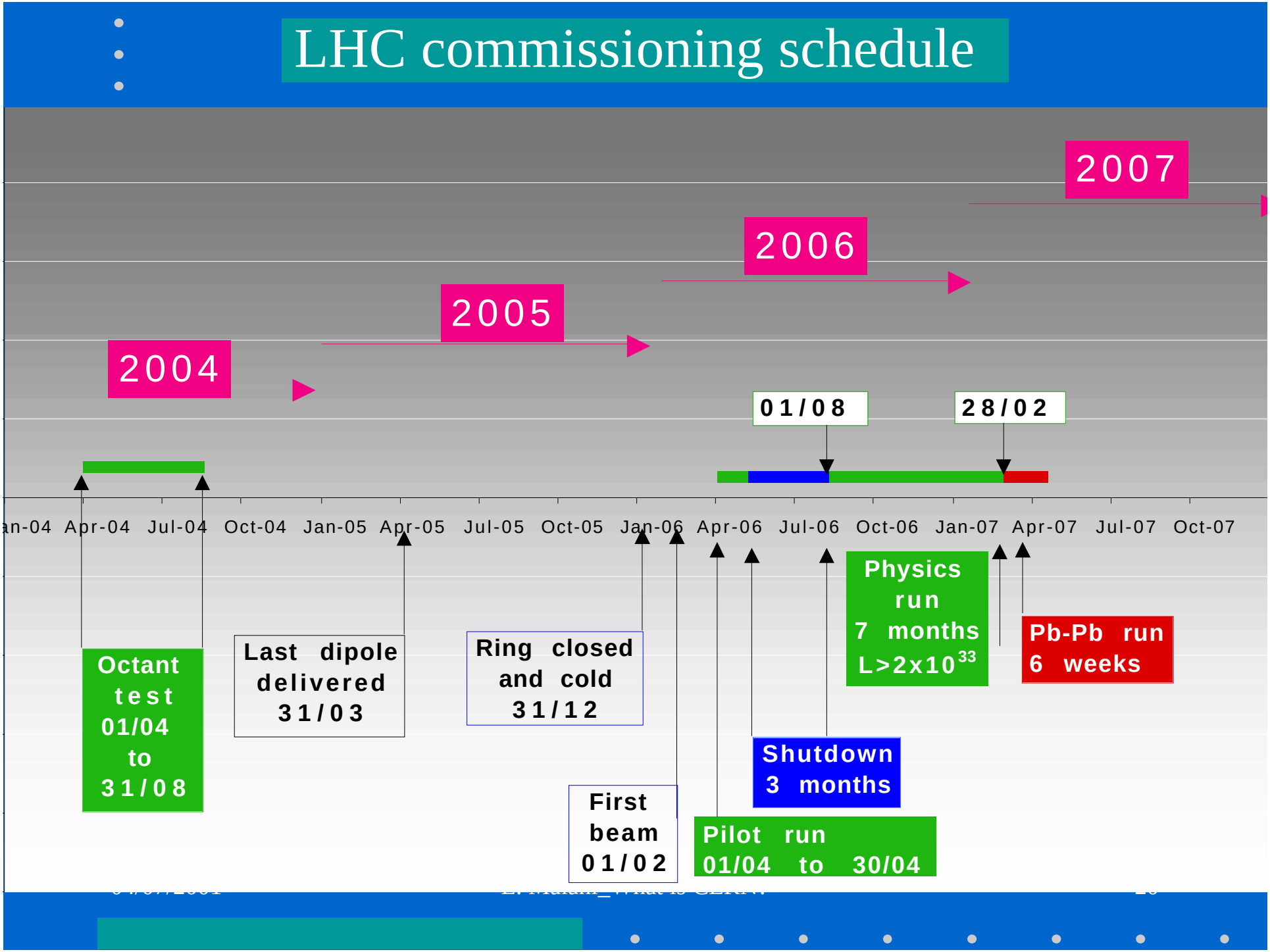
Magnet Yoke

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

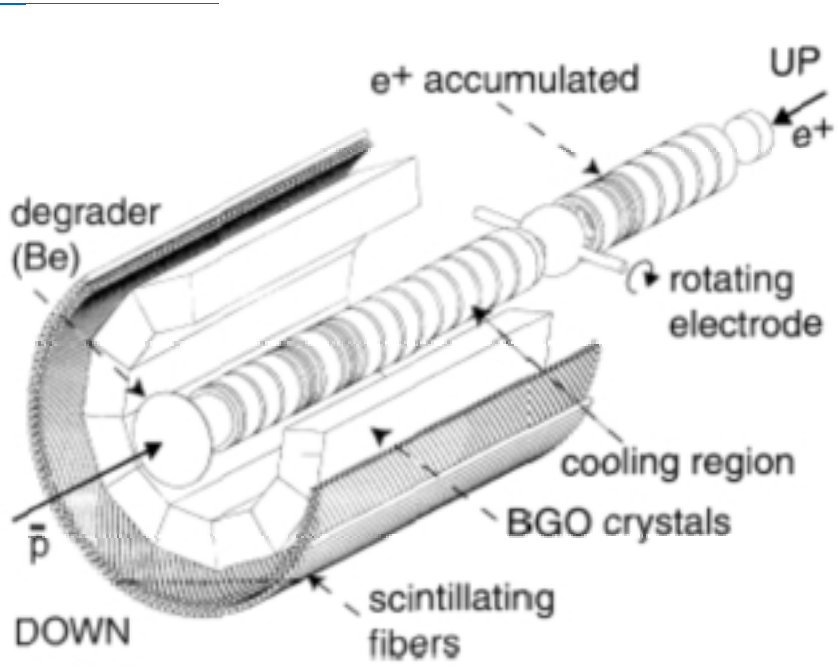


YB-2, YB-1, YB0 ready, YB1 started. Central wheel YB0, supporting the vacuum tank. Web camera !!! http://cmsdoc.cern.ch/outreach/

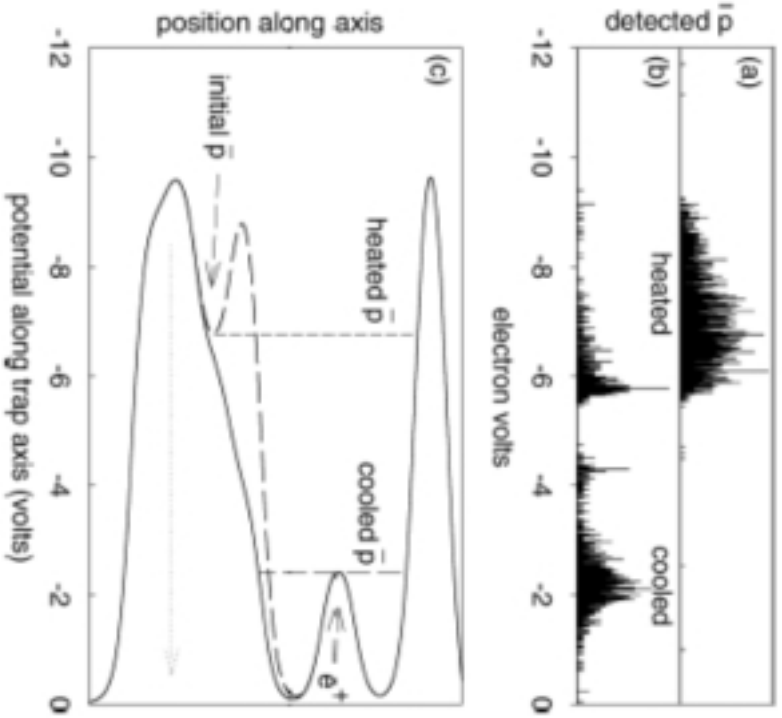
LHC commissioning schedule



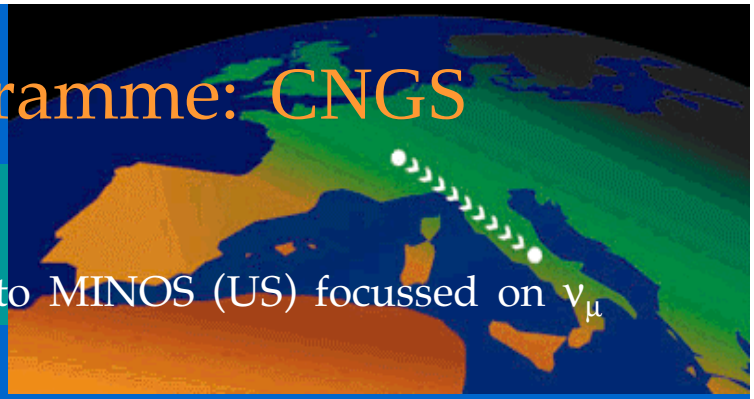
ATRAP: cooling antiprotons with positrons



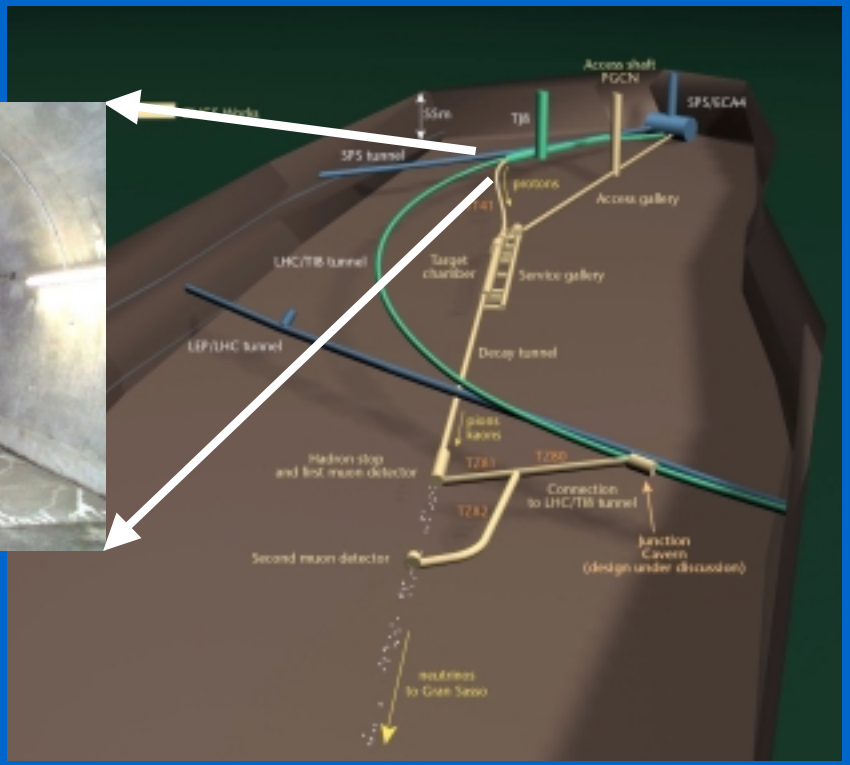
The ATRAP collaboration's antimatter trap: will it someday trap the $H\bar{H}$ molecule?



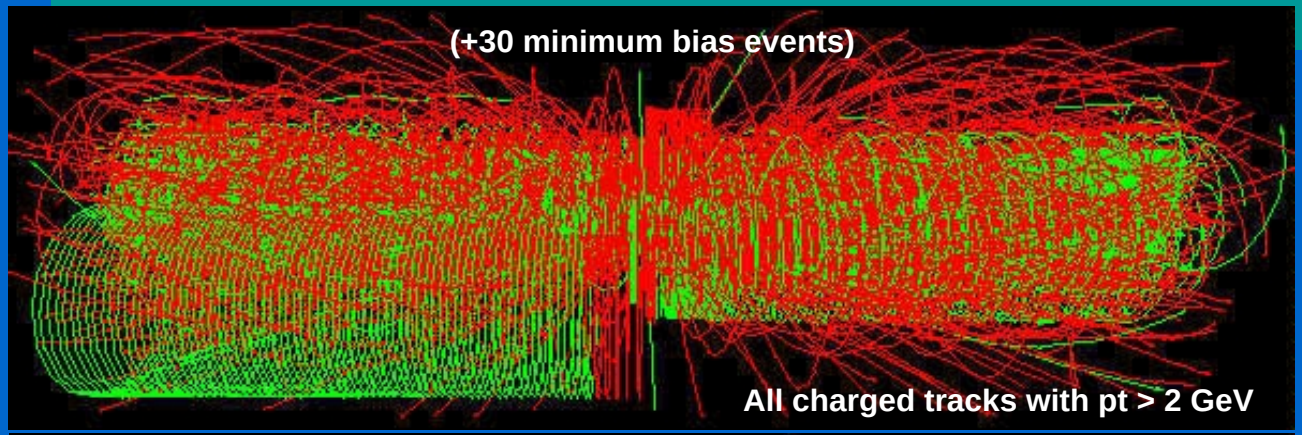
Long-Baseline Neutrino Programme: CNGS

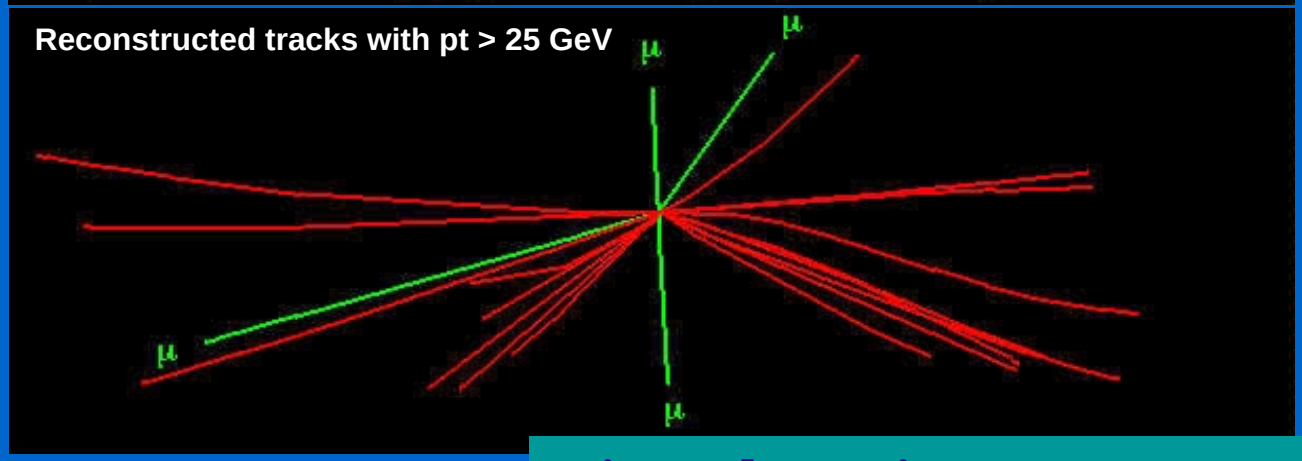


- To observe the appearance of tau leptons;
- complementary to the lower-energy K2K (Japan) and to MINOS (US) focussed on ν_μ disappearance;
- OPERA approved by the CERN Research Board and by INFN (Jan. 2001);
- CERN will support a in-house group in OPERA, building on the experience accumulated in CHORUS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



Computing in LHC experiments





Higgs decay in 4 muons
1 in 10 ^{13} events

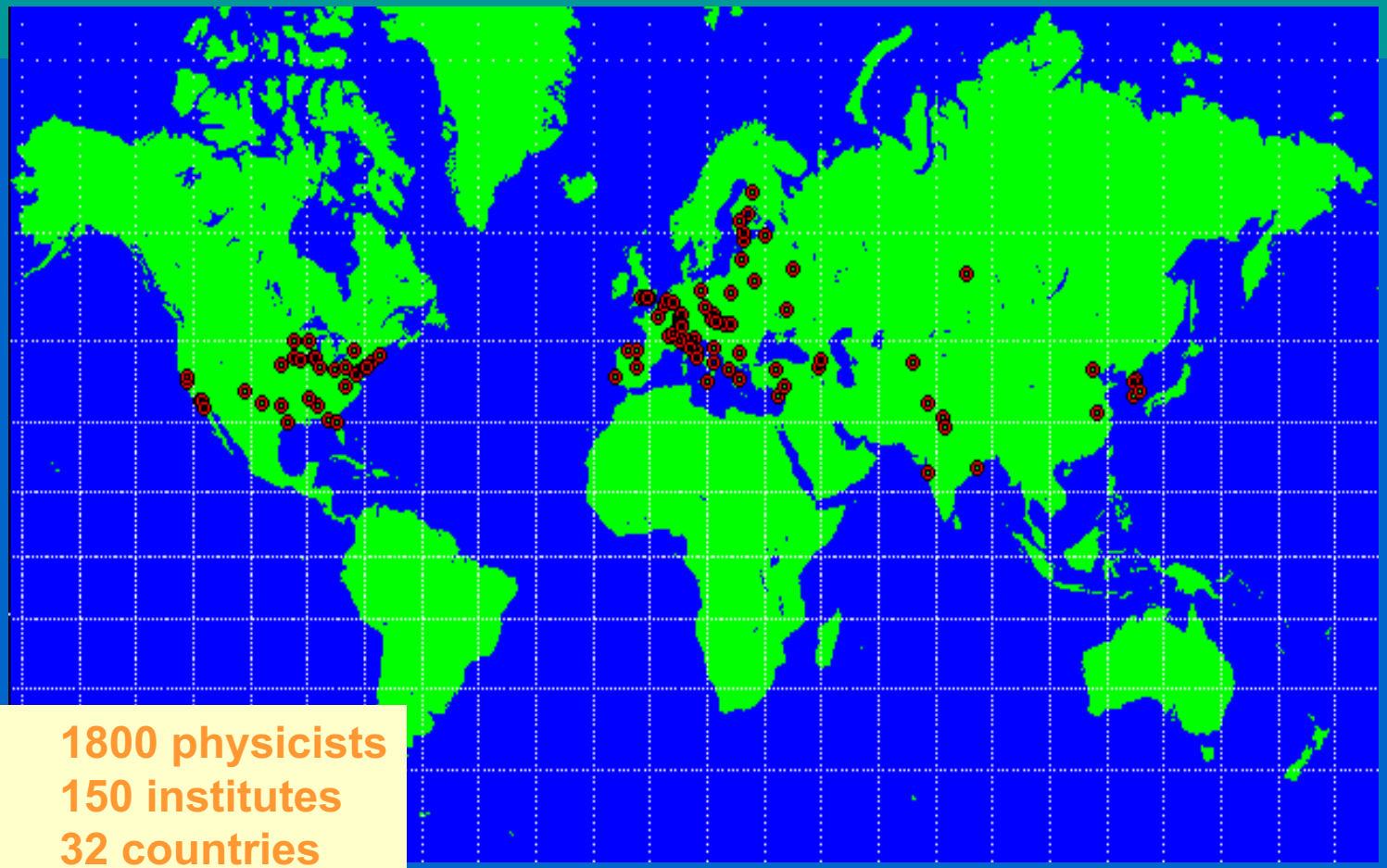
The data transmitted in ONE SECOND of LHC running

is equivalent to:

the information exchanged by WORLD TELECOM (≈ 100 million phone calls)

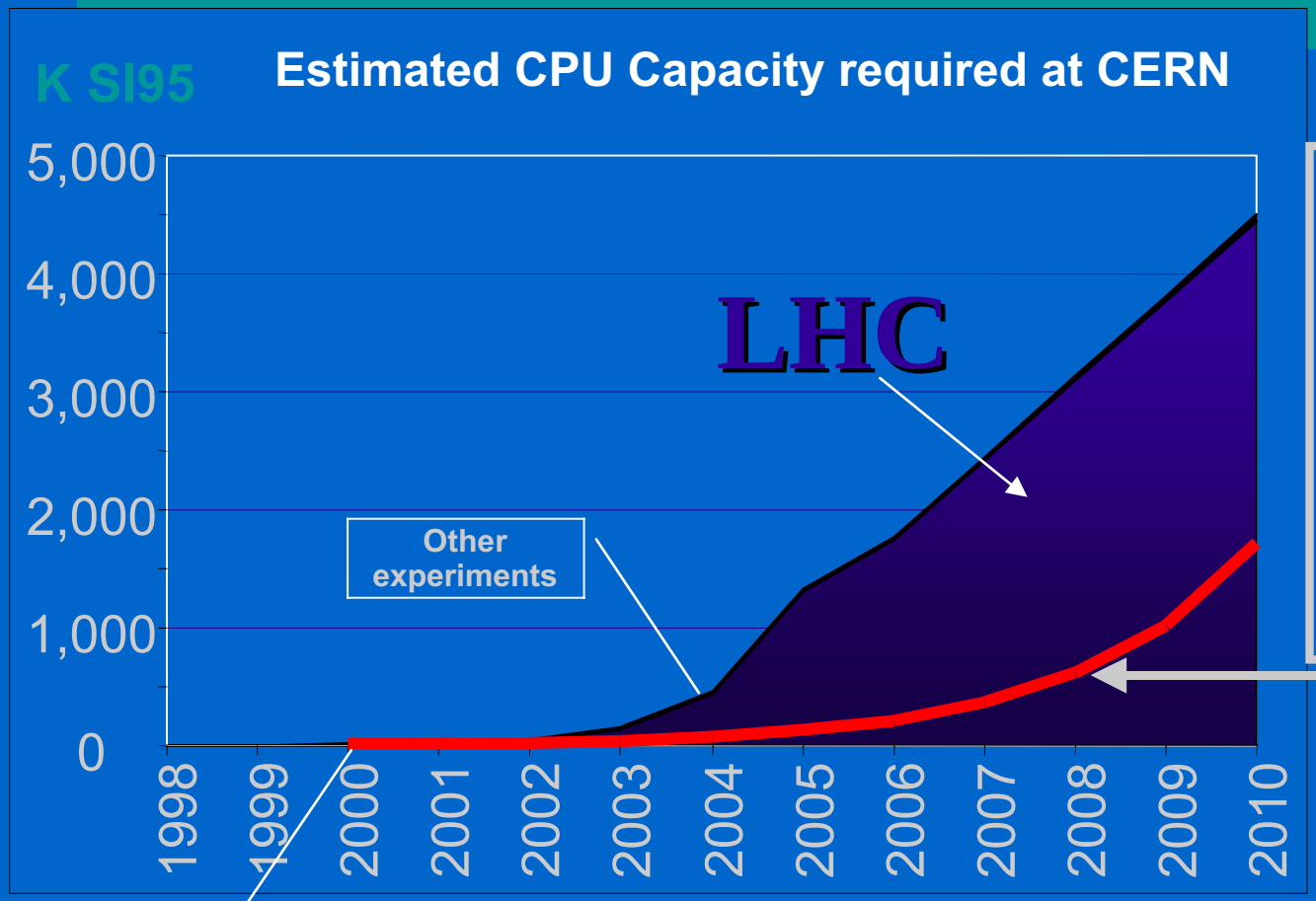
World Wide Collaboration

⇒ distributed computing & storage capacity



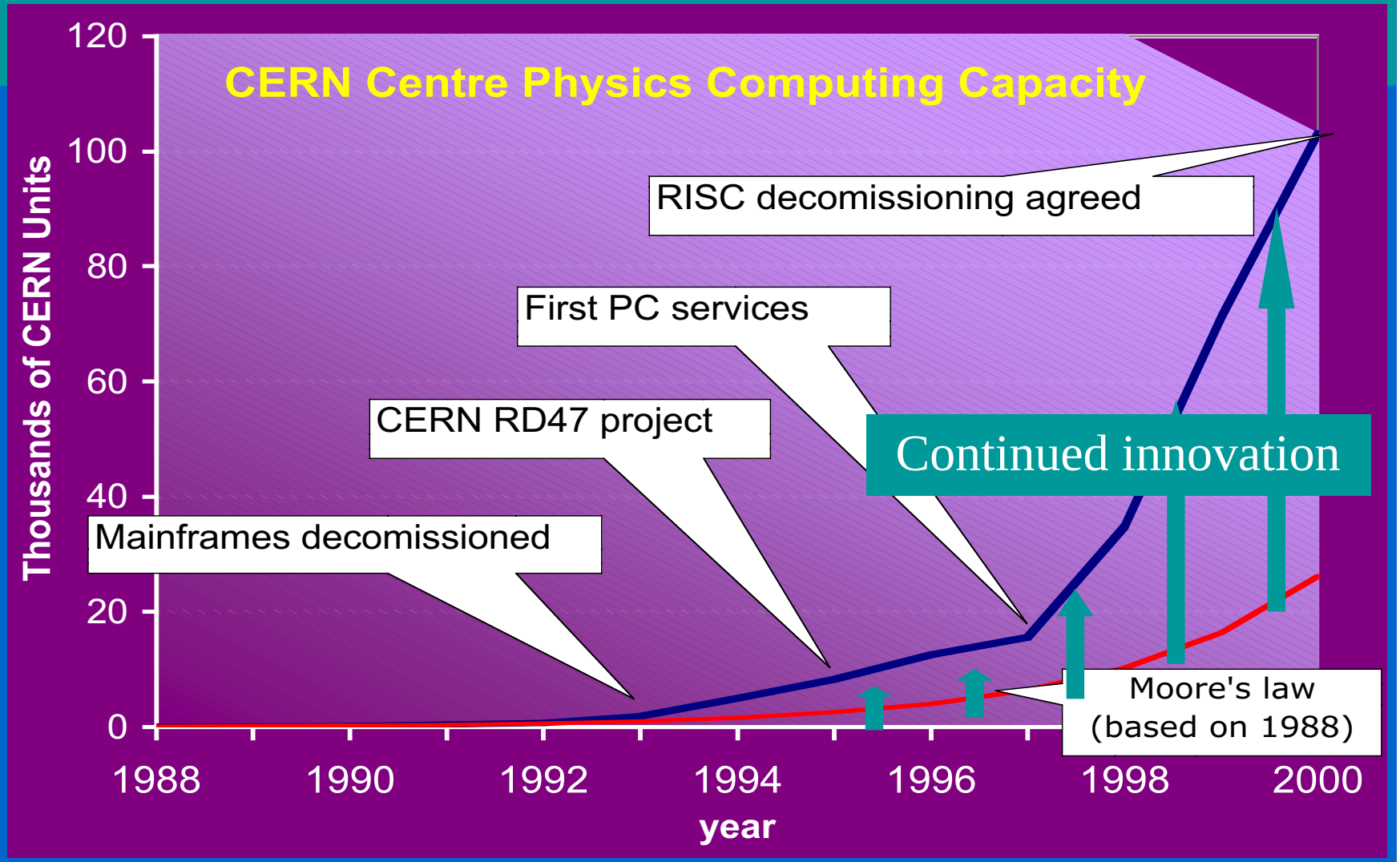
CMS: 1800 physicists
150 institutes
32 countries

Complex Data = More CPU Per Byte

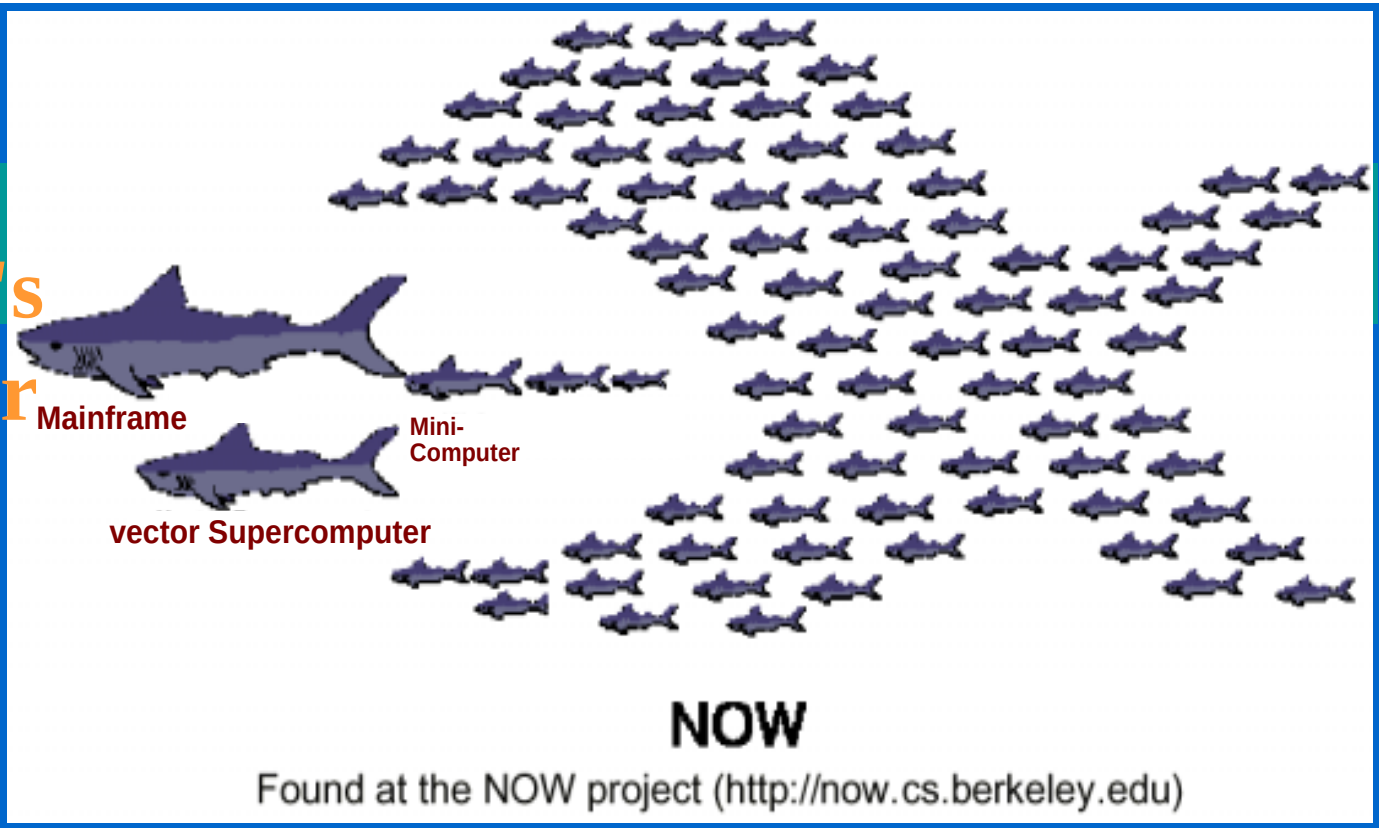


Moore's law – some measure of the capacity technology advances provide for a constant number of processors or investment

Past CERN performance: computing for LEP experiments



Processor farms : the 90's supercomputer



- PC+Linux: the new supercomputer for scientific applications

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

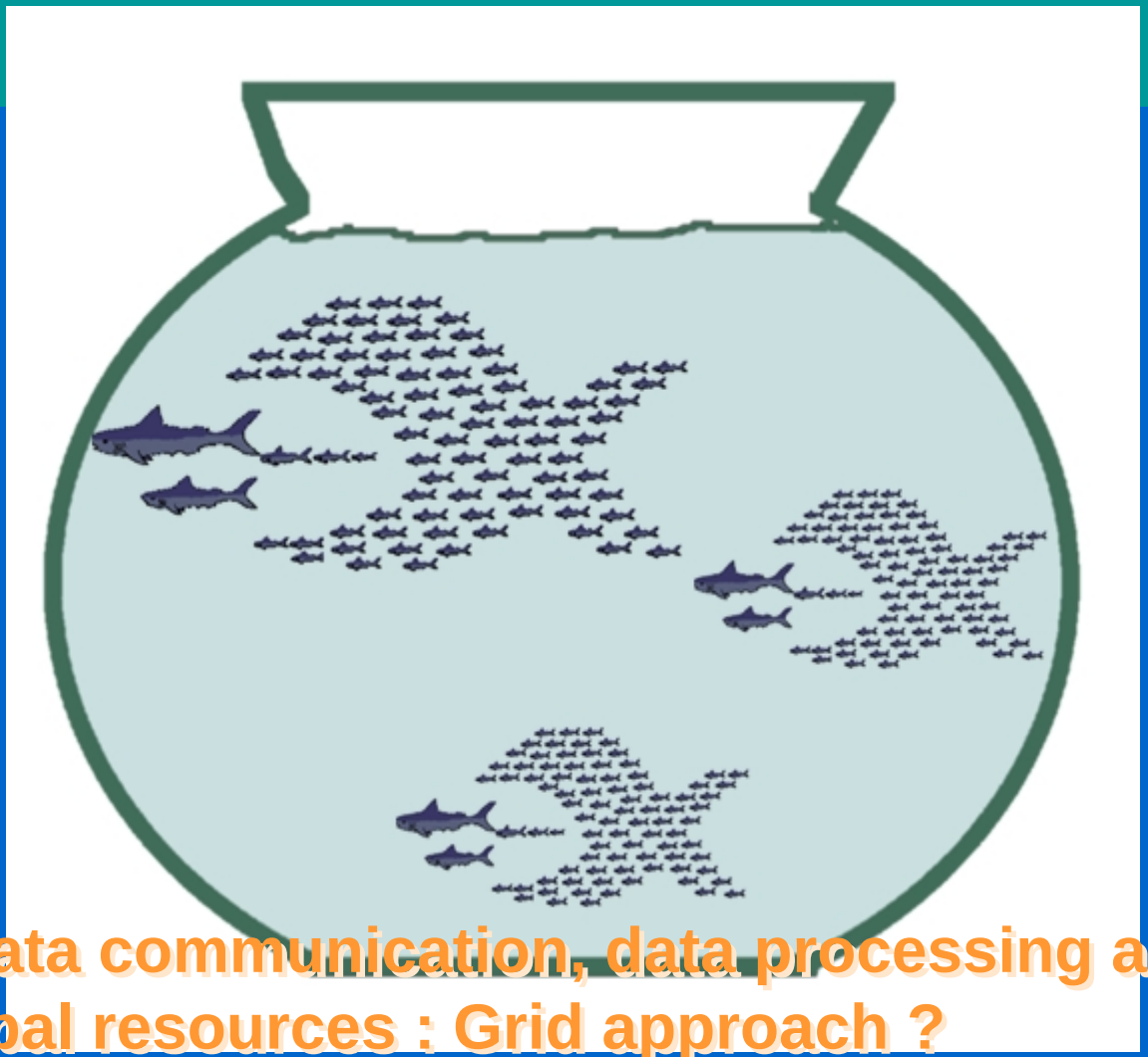
www.cs.sandia.gov/cplant/

- Principle well established; farm examples abound

now.cs.berkeley.edu

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

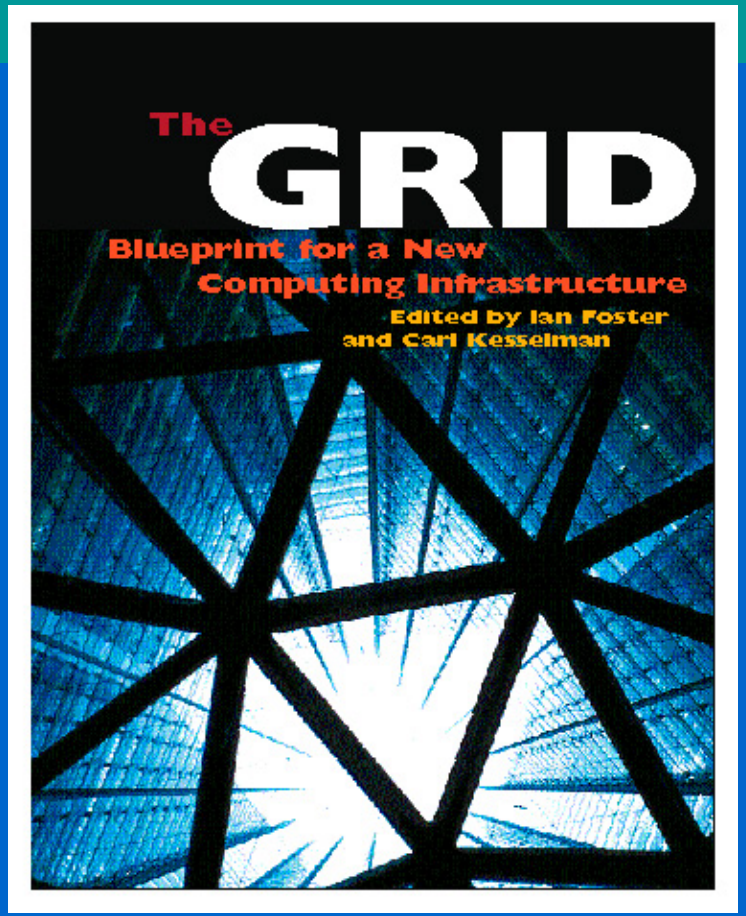
After commodity farms what next?



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

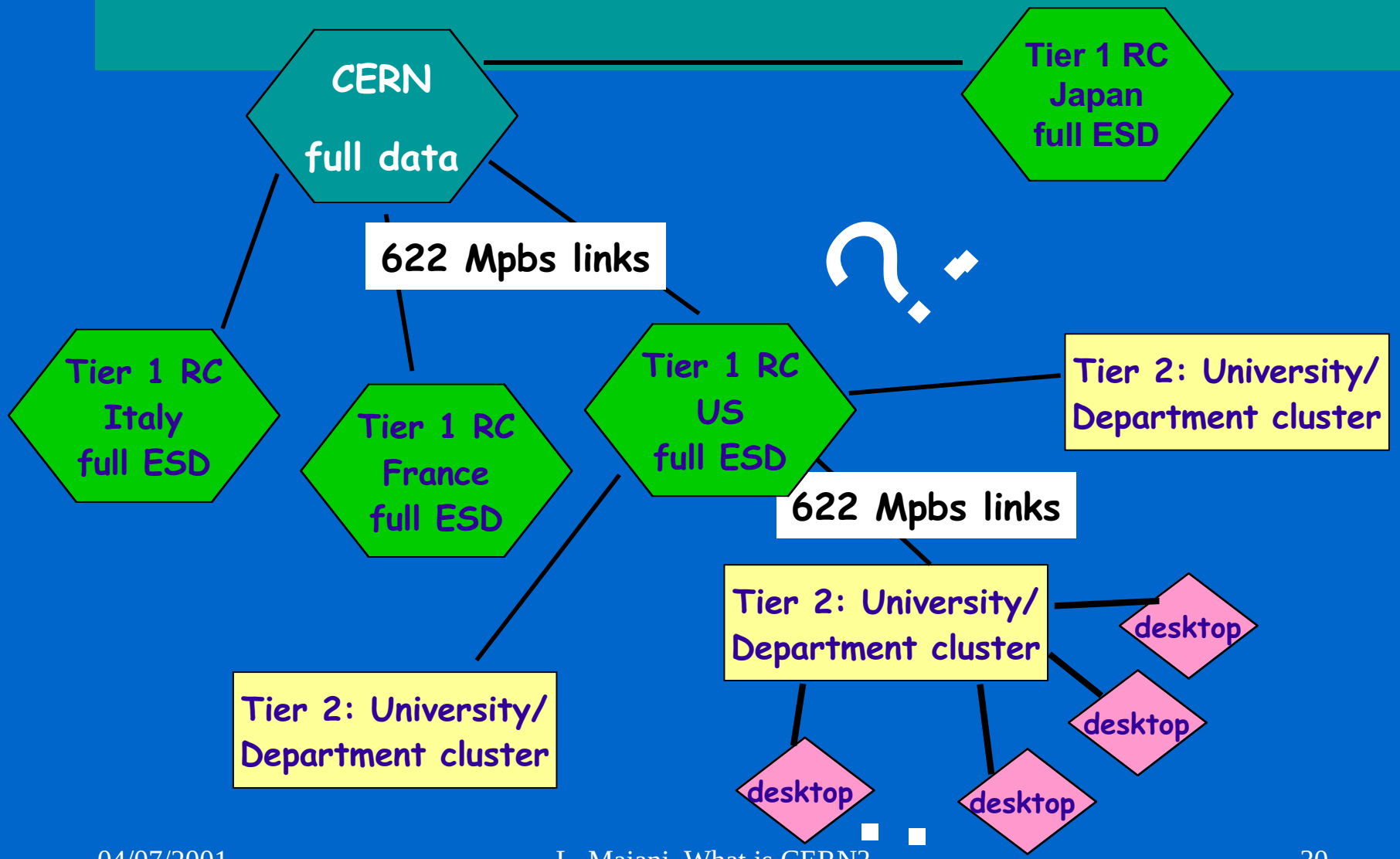
Five Emerging Models of Networked Computing From *The Grid*

- Distributed Computing
  - // synchronous processing
- High-Throughput Computing
  - // asynchronous processing
- On-Demand Computing
  - // dynamic resources
- Data-Intensive Computing
  - // databases
- Collaborative Computing
  - // scientists



Ian Foster and Carl Kesselman, editors, "The Grid: Blueprint for a New Computing Infrastructure," Morgan Kaufmann, 1999, http://www.mkp.com/grids

CERN offline computing
Regional Centres - a Multi-Tier Model

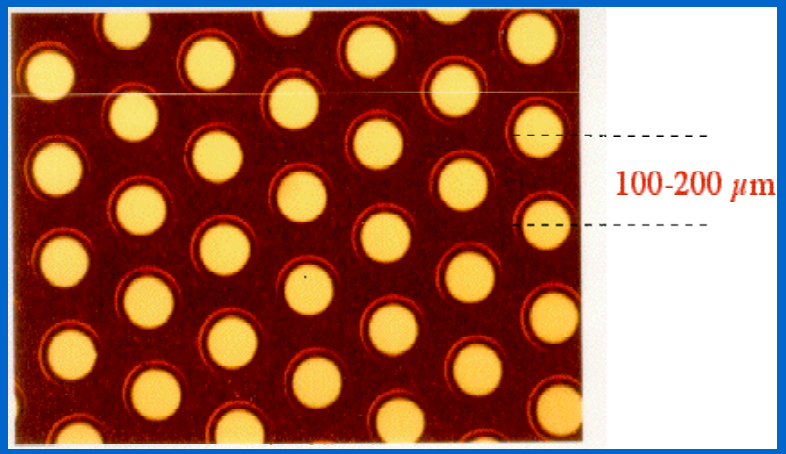


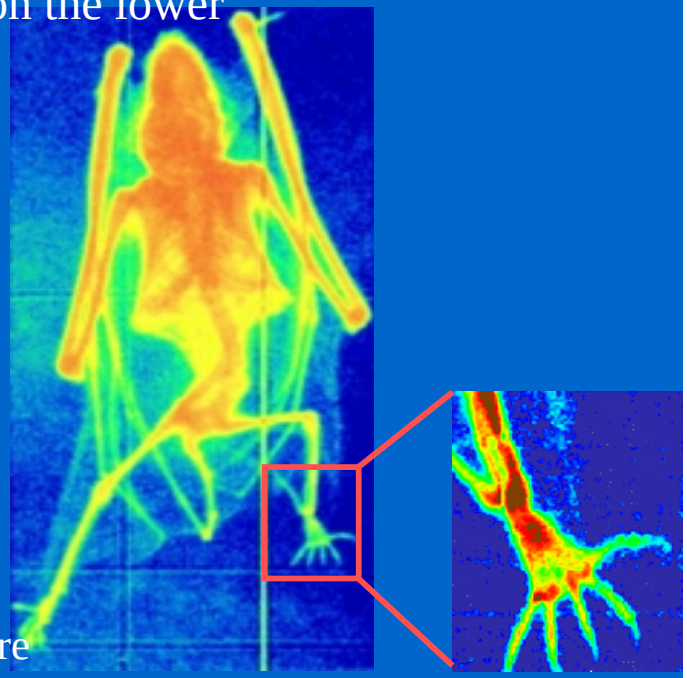
Three ways to Technology Transfer

- Student Formation
  - **widely done at CERN**
- Orders to Industry
  - **new opportunities with the LHC**
- Transfer of new technologies developed for basic research
  - **WWW,**
  - **Hadron-Therapy,**
  - **Crystals….**

Gas Electron Multiplier

The Gas Electron Multiplier consists of a thin polymer foil, metal-clad on both sides, and pierced by a high density of holes (typically 70 µm in diameter at 140 µm pitch). On application of a potential difference between the two sides, electrons from a drift region are collected into the holes, multiply in avalanche and emerge on the lower region





X-ray absorption radiography of a bat, recorded with a GEM detector. The insert shows the details of the bat's claw (picture size nine by eleven millimetres).

The WWW

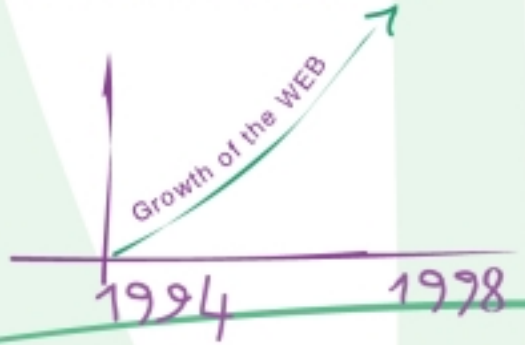
EUROPEAN LABORATORY FOR PARTICLE PHYSICS

CERN

World-Wide Web :

Invented at CERN

Everyone knows the World-Wide Web, but not everyone knows that it was invented at CERN. Conceived to give particle physicists easy access to their data wherever they happened to be, the Web has grown into a telecommunications revolution.



What is the Web ?

But what is the Web ? In short, it is a world of information at the click of a mouse. To use it, you need a computer, a connection to the Internet, and a browser programme. When you run your browser, it displays a page of information which might be held on your own computer or fetched from somewhere else, you needn't know or even care where it comes from. Certain words, phrases, or images are highlighted, and clicking on them causes the browser to go off and find another page, which probably contains more highlighted items, and so on. The Web knows no geographical boundaries. For example, starting from the CERN 'Welcome page' in Switzerland, your next click might take you to the other side of the world. All the information seems to be in the little box in front of you, and in a sense it is. When you click on a piece of highlighted text your browser connects to another computer, asks it for the requested information, and displays it on your screen. You are then free to browse the new page at leisure, the computers have finished their 'conversation'.

How did it start ?

It all began in 1989, when Tim Berners-Lee proposed a distributed information system for CERN based on hypertext. By hiding network addresses behind highlighted items on the screen, information could be linked between several computers. This system became the Web, with the world as its library.

"If this importance (of Science) has been cast sometime into doubts, it is because the efforts of mankind toward its most beautiful aspirations have been imperfect, as everything which belongs to the human sphere, and have been distracted from their path by the forces of national egoism and social regression. Above all, it is by this daily effort toward more science that mankind has reached the exceptional place that she occupies on Earth. We must belong to those who.... believe, invincibly, that science will triumph over ignorance and war."

Marie Curie , 1926