



SUMMER STUDENTS
LECTURE PROGRAMME

1st : WHAT IS CERN?

Luciano Maiani. CERN. Geneva

July 3, 2002

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

The twenty Member States of CERN



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



Member States (Dates of Accession)

AUSTRIA (1959)	DENMARK (1953)	GREECE (1953)	NORWAY (1953)	SPAIN (1/1961-12/1962-1/1963)
BELGIUM (1953)	FINLAND (1991)	HUNGARY (1992)	POLAND (1991)	SWEDEN (1953)
BULGARIA (1993)	FRANCE (1953)	ITALY (1953)	PORTUGAL (1980)	SWITZERLAND (1953)
CZECH REP. (1992)	GERMANY (1953)	NETHERLANDS (1953)	SLOVAK REP. (1993)	UNITED KINGDOM (1953)

CERN AC/D/99M - E/99C 1999 - 10/10/99



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

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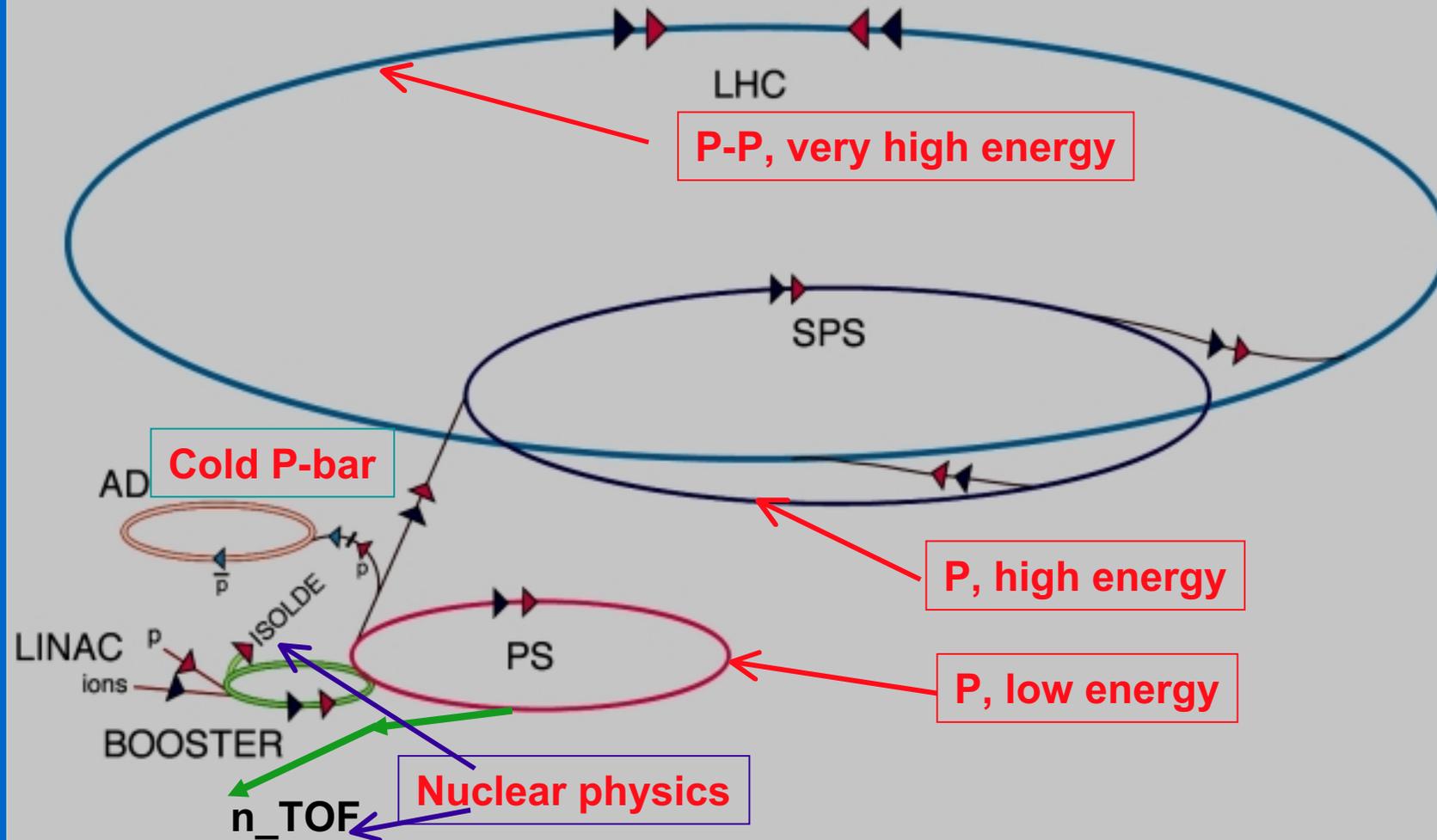
What is CERN?

Summary

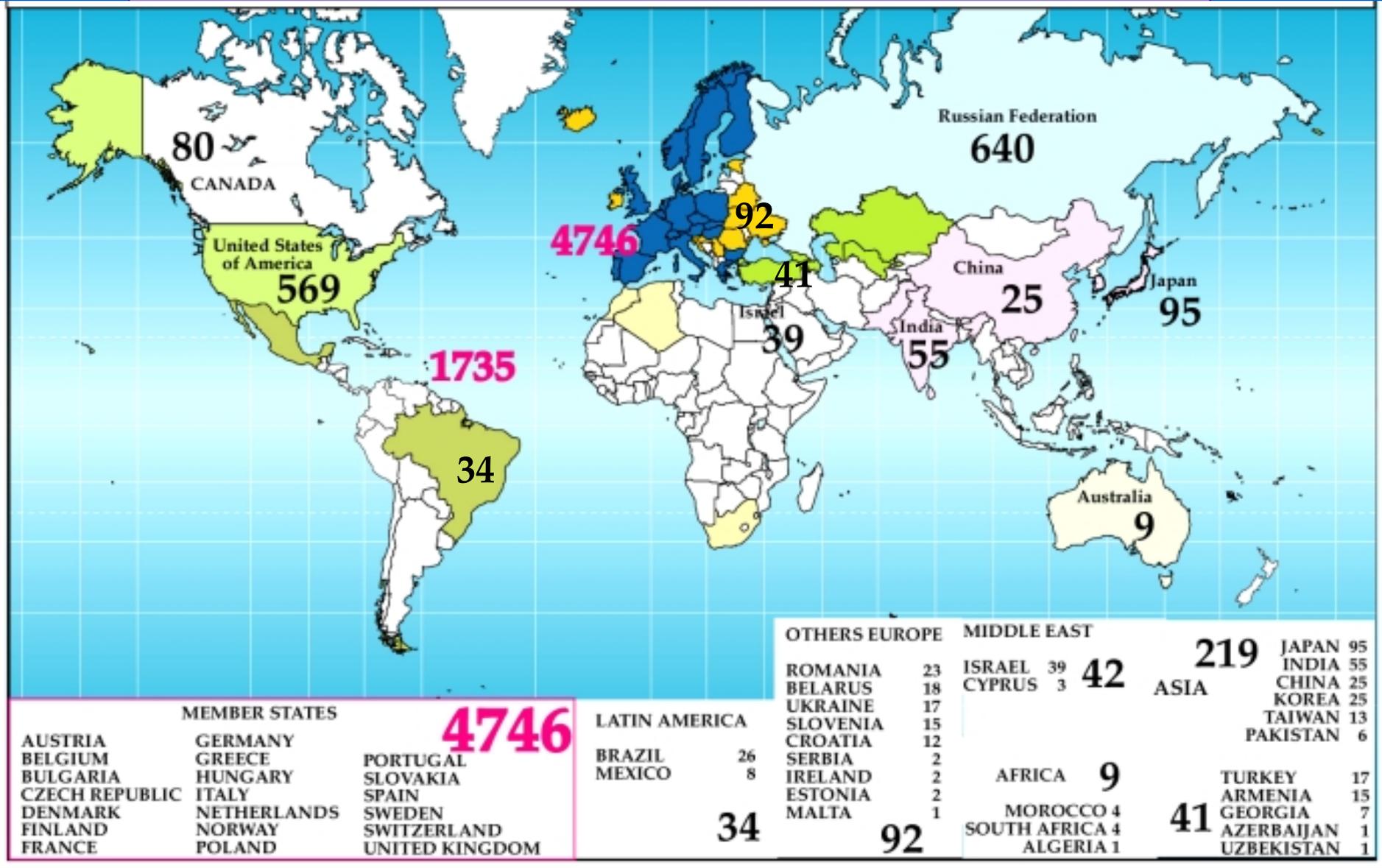
- The CERN accelerator menu
- The LHC project
- Cold antiprotons & Long base neutrinos
- The LHC computing challenge
- Technology Transfer
- Why science?

Accelerator chain of CERN

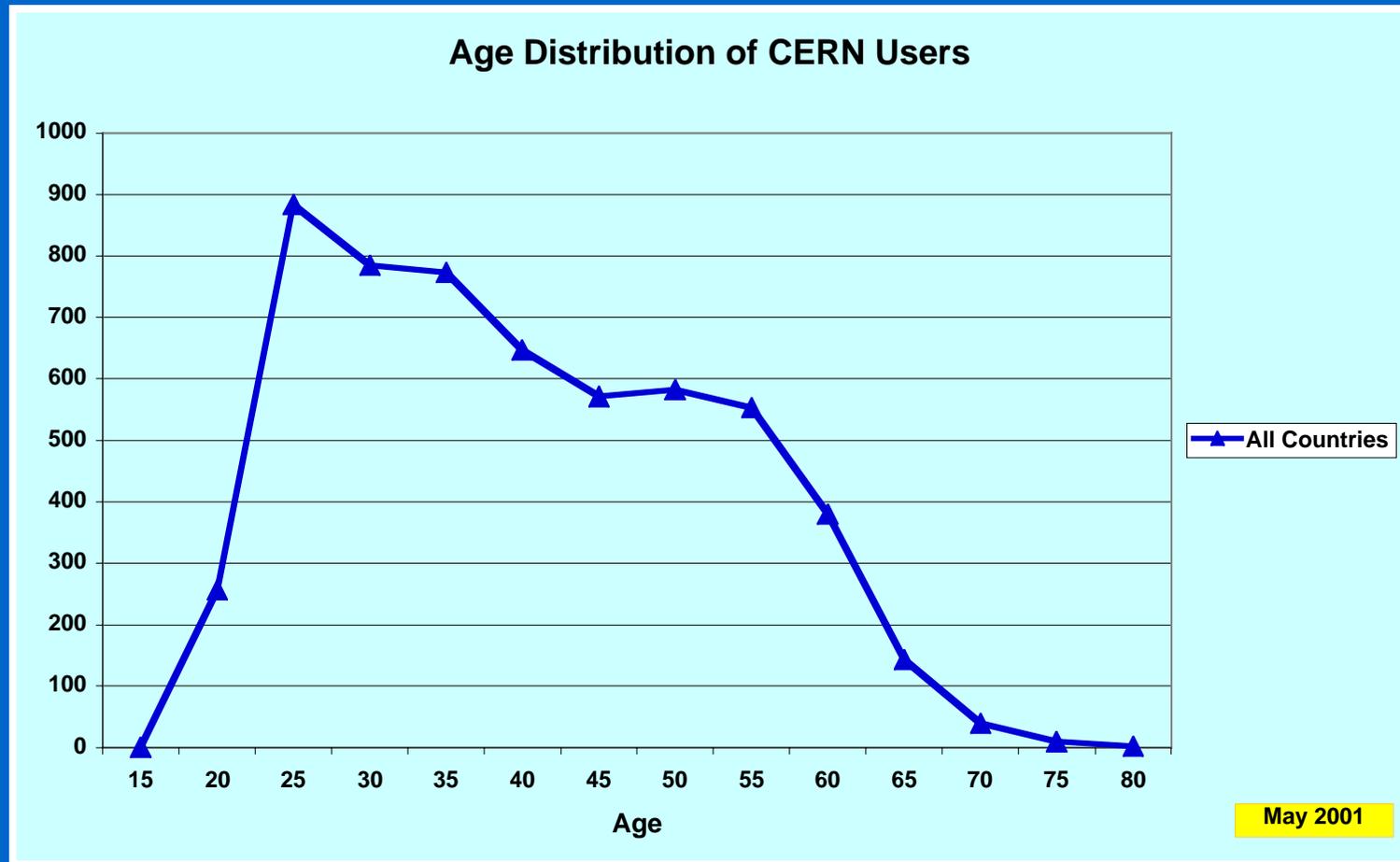
Accelerator chain of CERN (operating or approved projects)



Distribution of CERN users, May 1, 2001

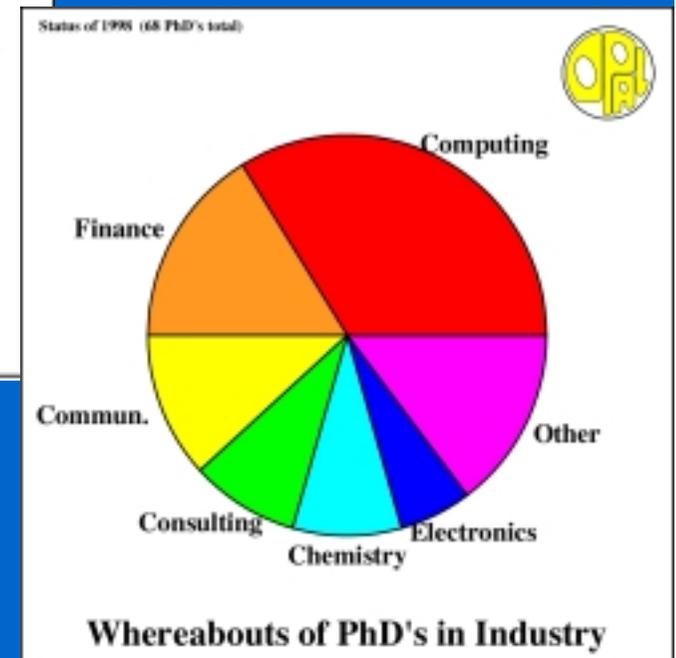
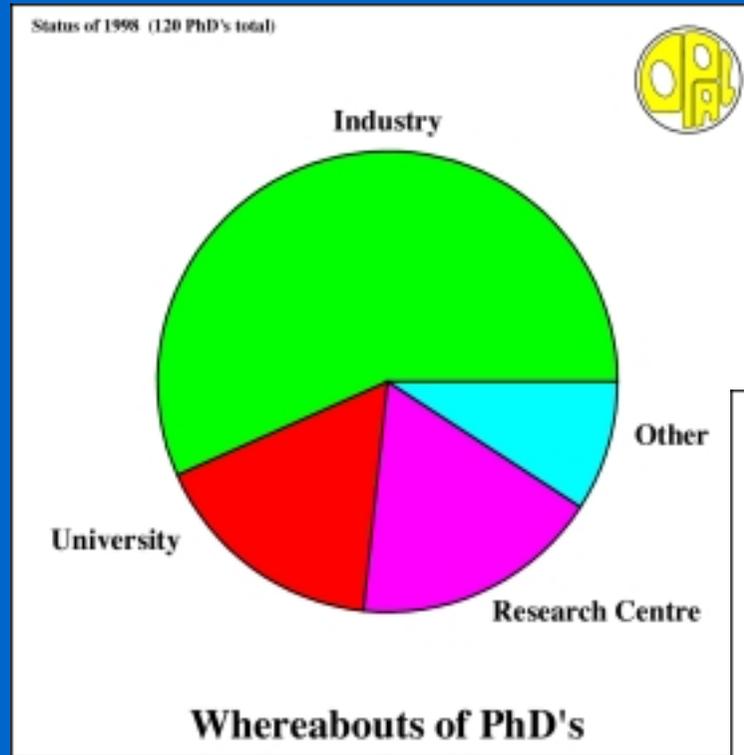


Age Distribution of CERN Users (May, 2001)

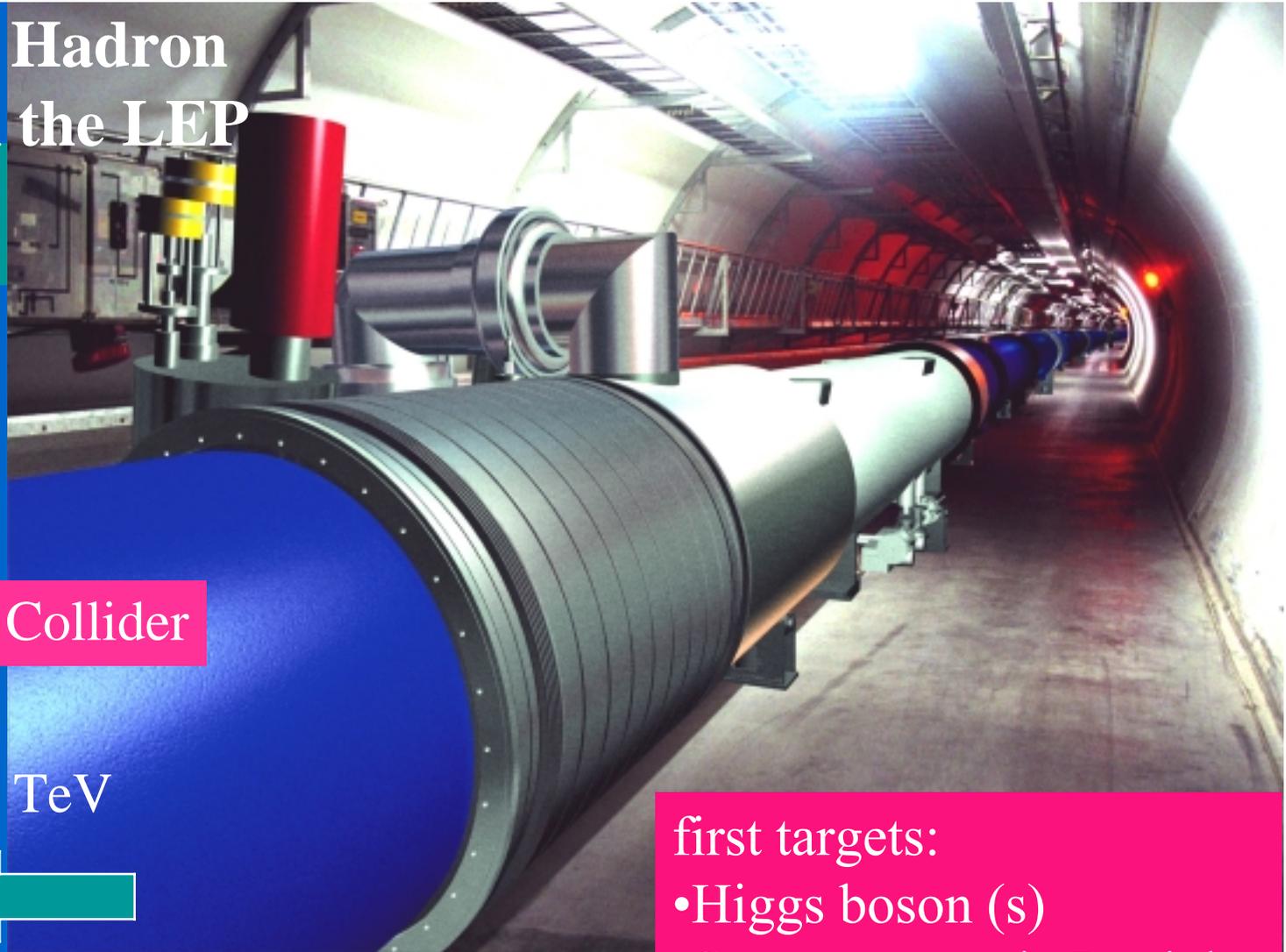


PhD thesis in LEP experiments (over ten years):

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



The Large Hadron Collider in the LEP Tunnel



Proton- Proton Collider

7 TeV + 7 TeV



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

first targets:

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



String 2



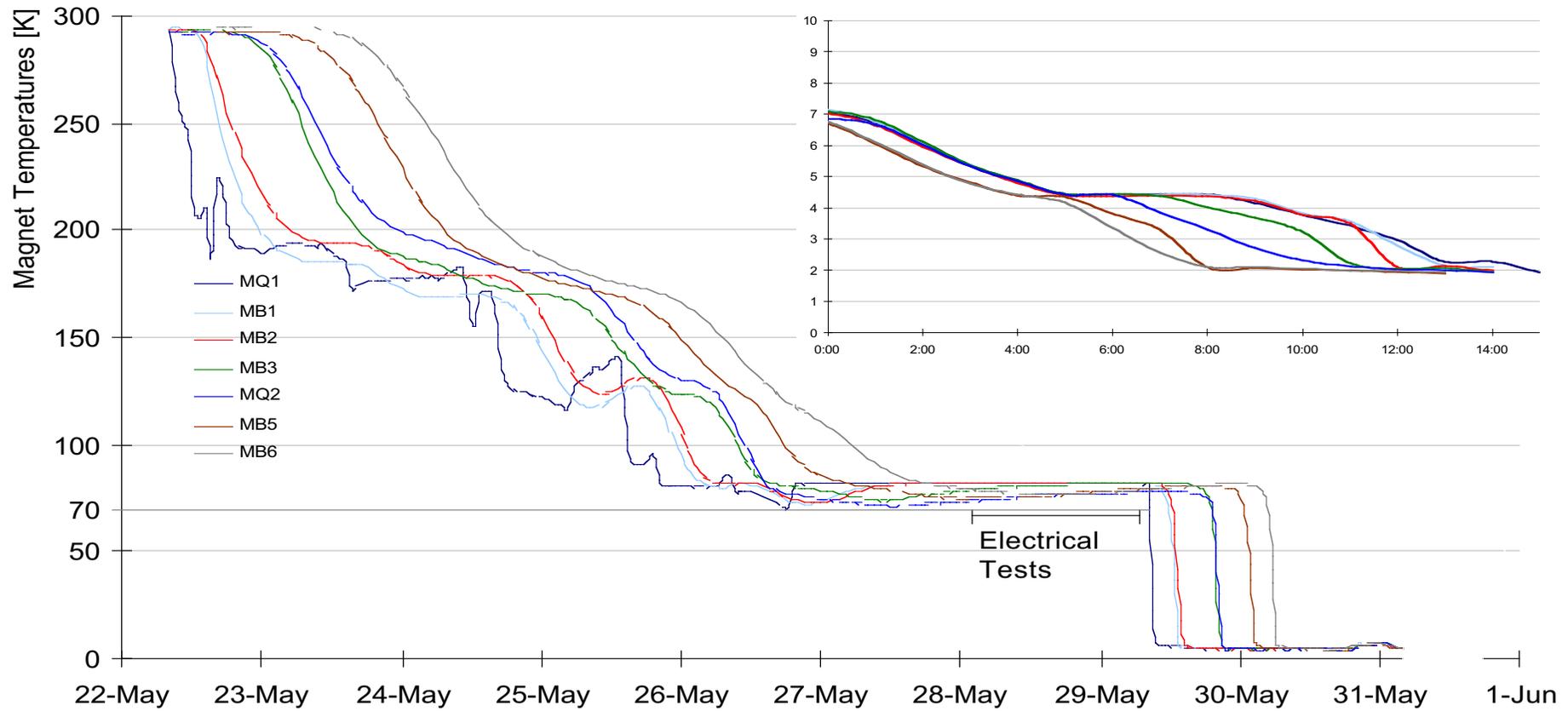
Being operated now !

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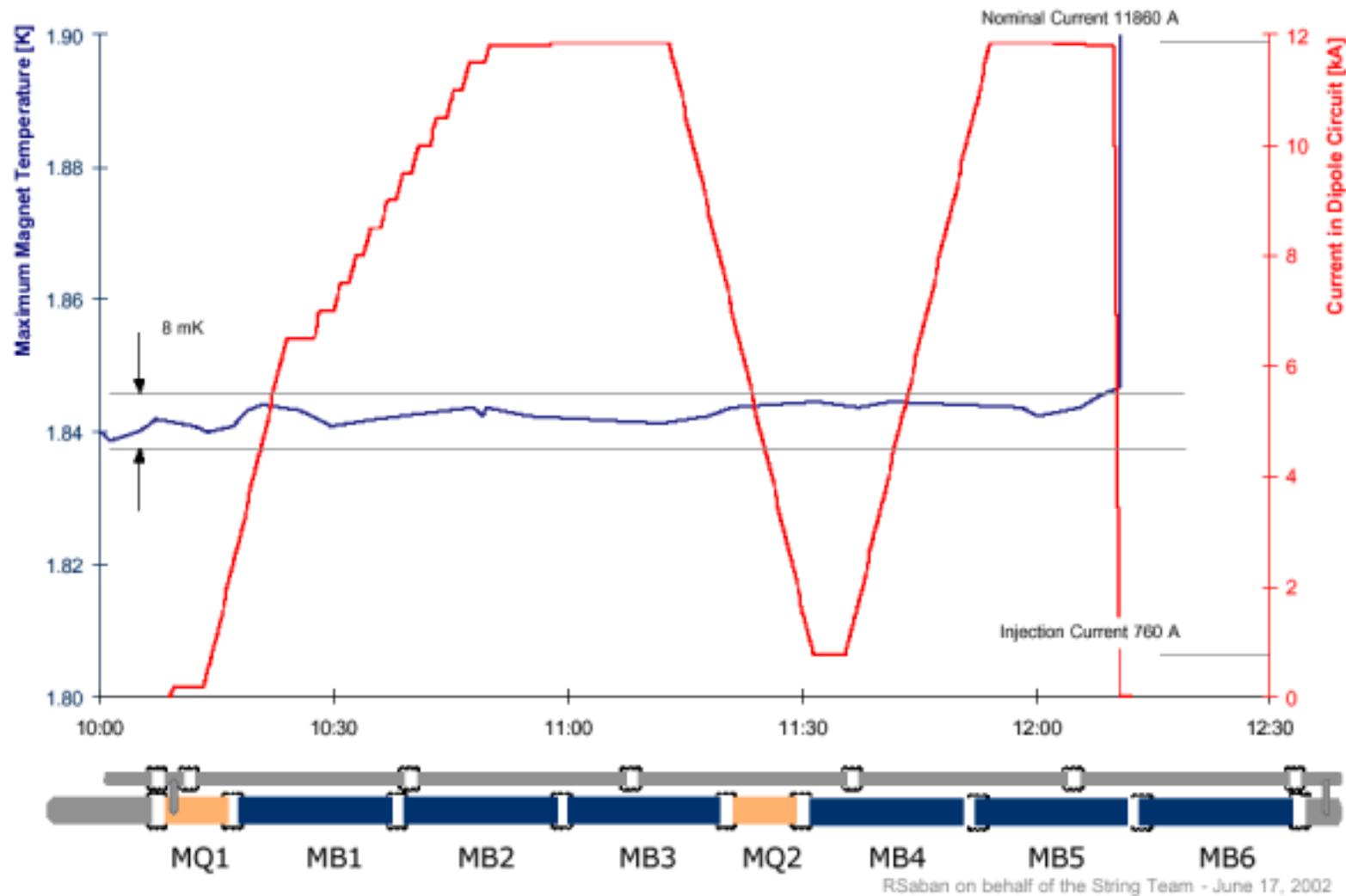
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String 2



STRING 2

Nominal Current in the Dipole Circuit

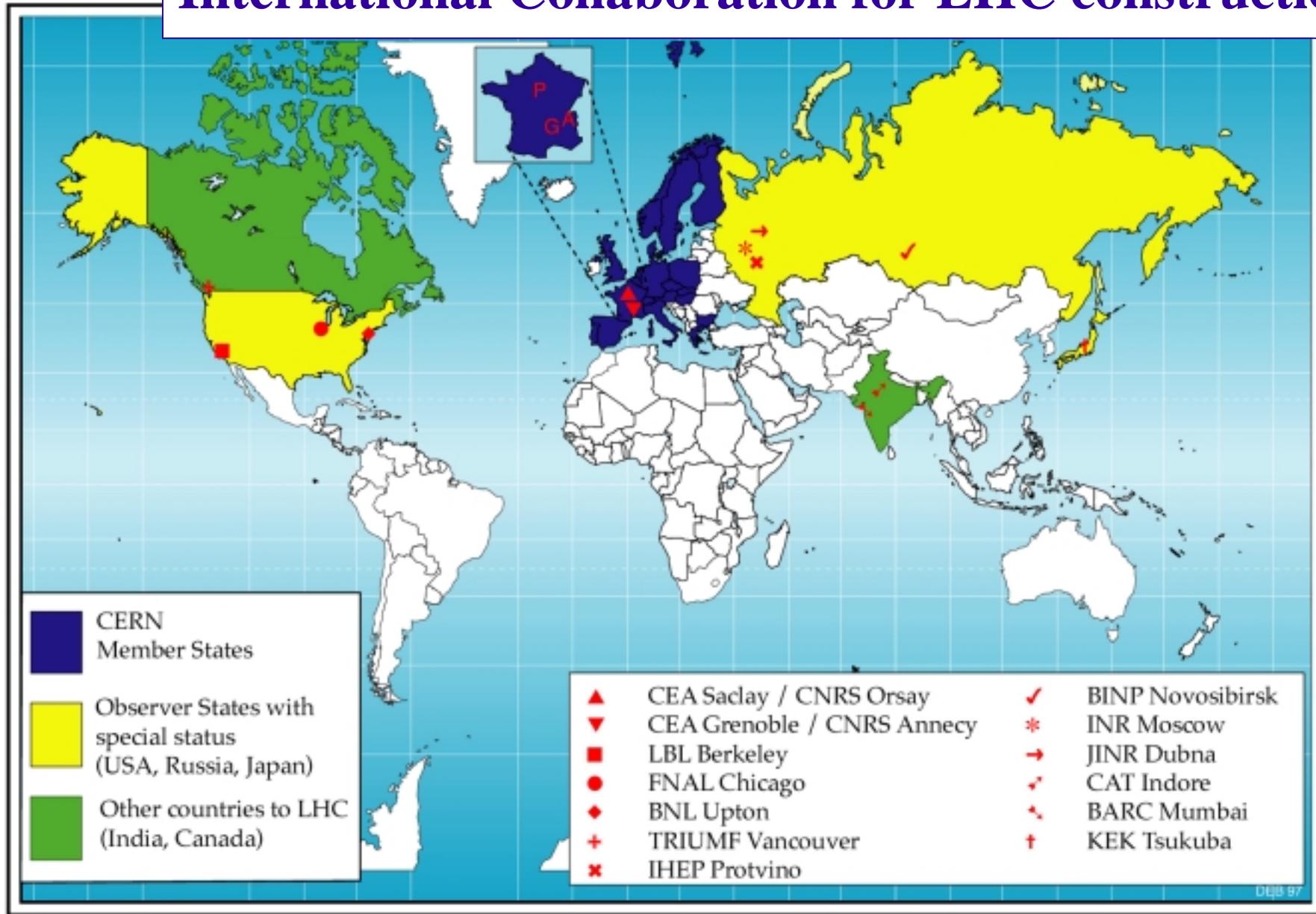


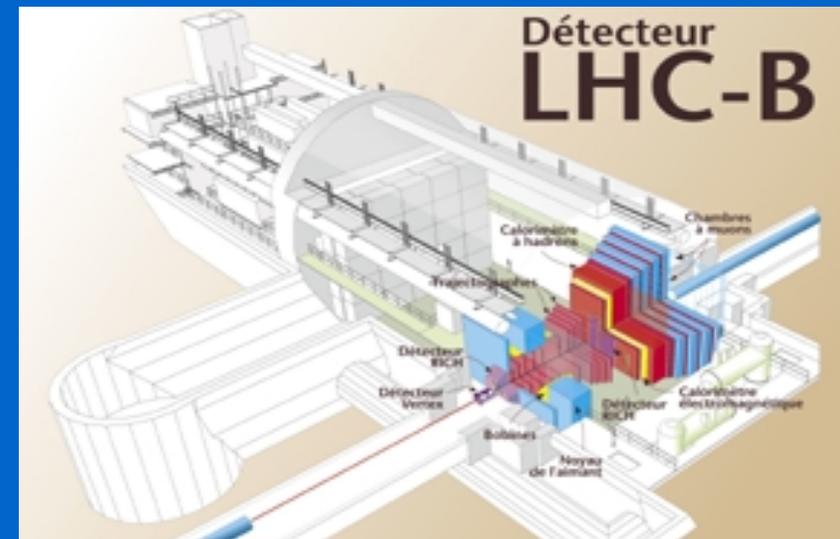
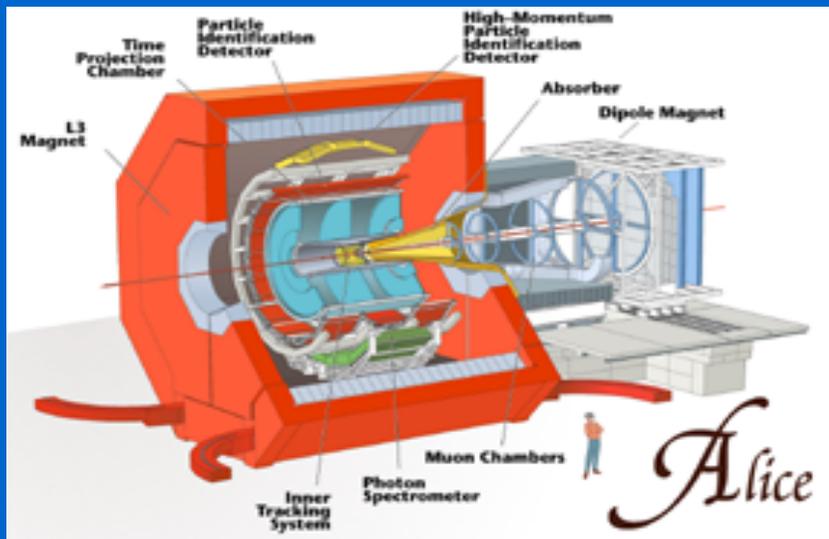
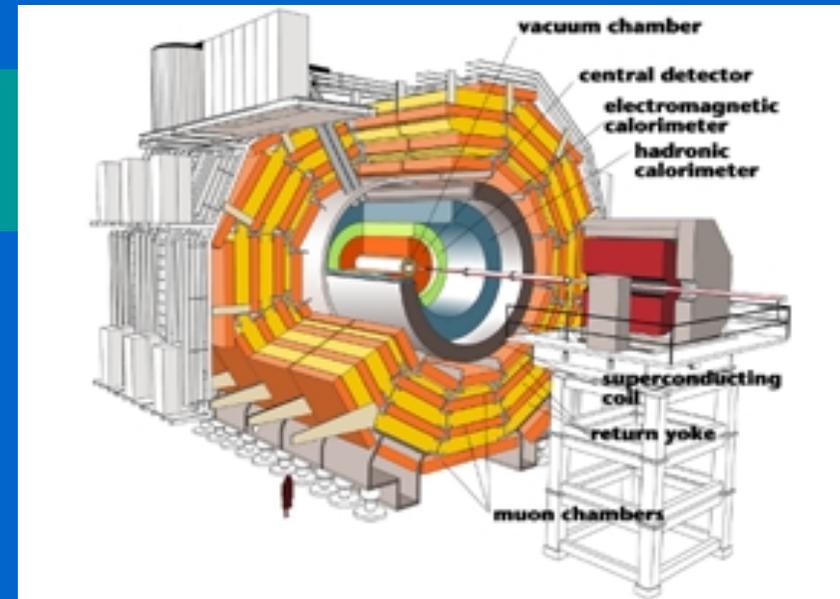
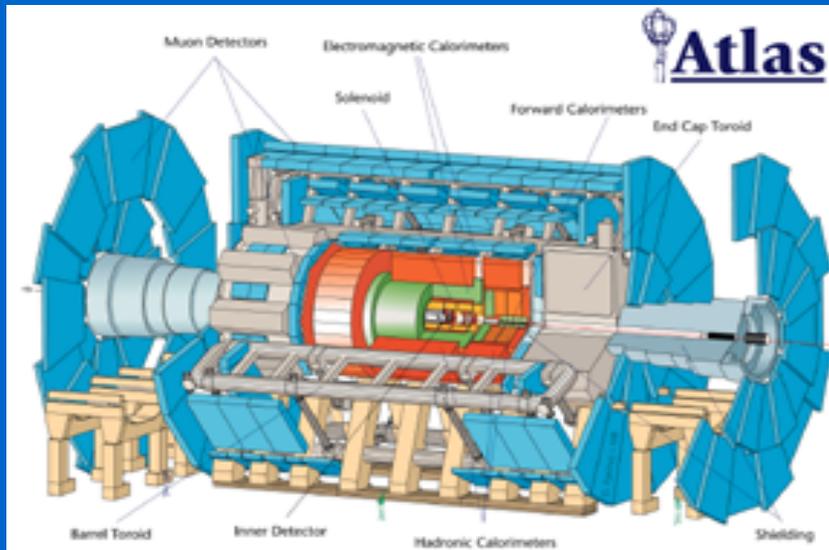
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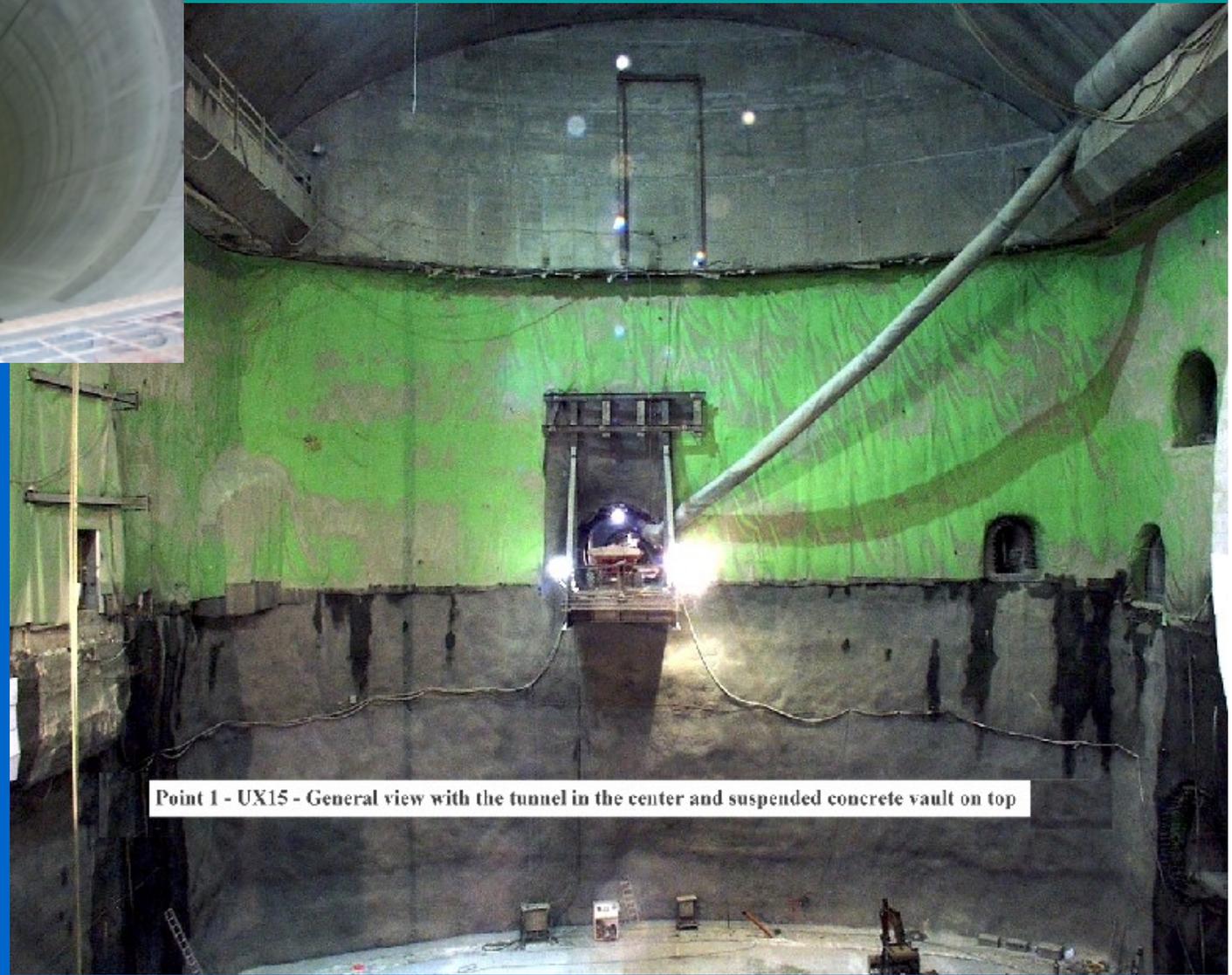
International Collaboration for LHC construction







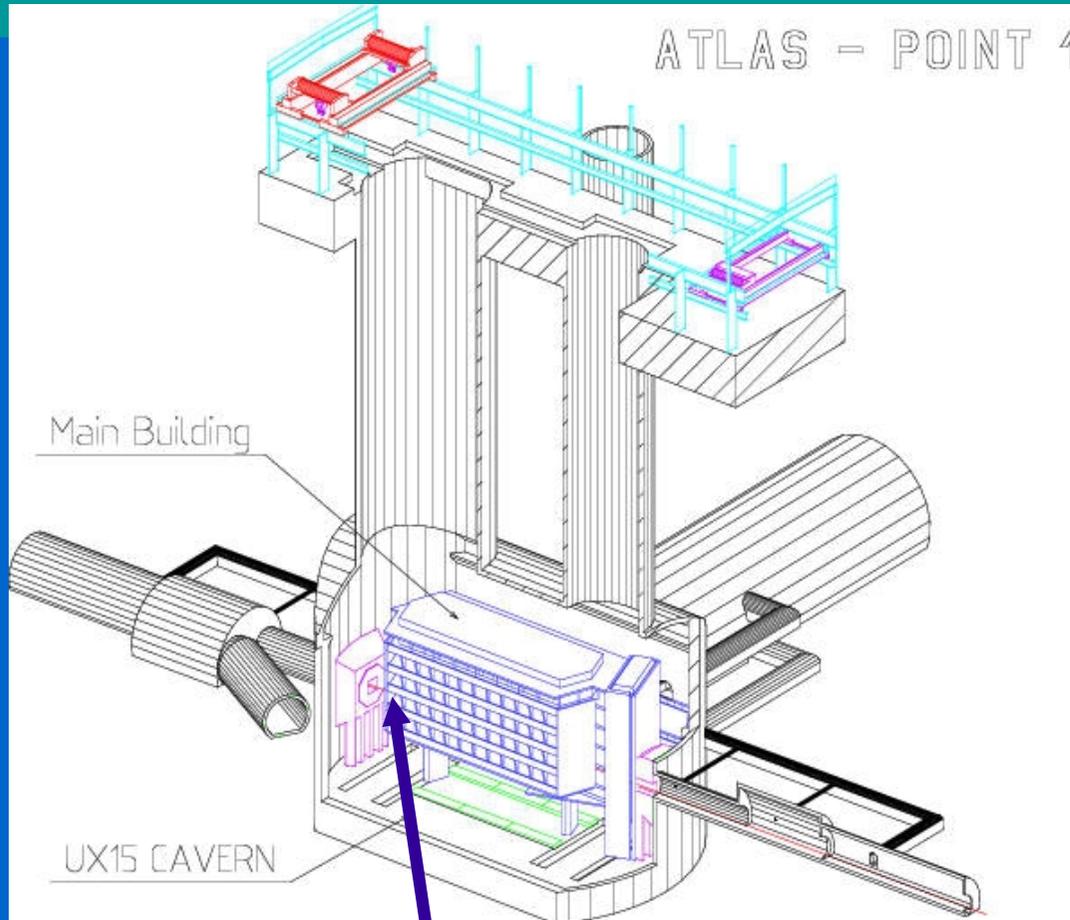
Point 1 - PX14 shaft - July 18, 2000 - CERN SECE



Point 1 - UX15 - General view with the tunnel in the center and suspended concrete vault on top

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The ATLAS Cavern and Building 60



You are here

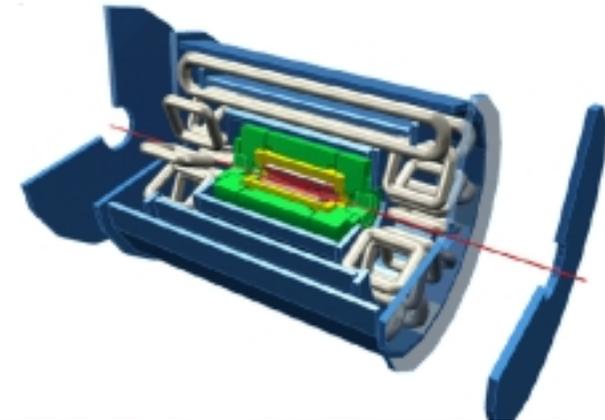
Civil engineering at Point 5



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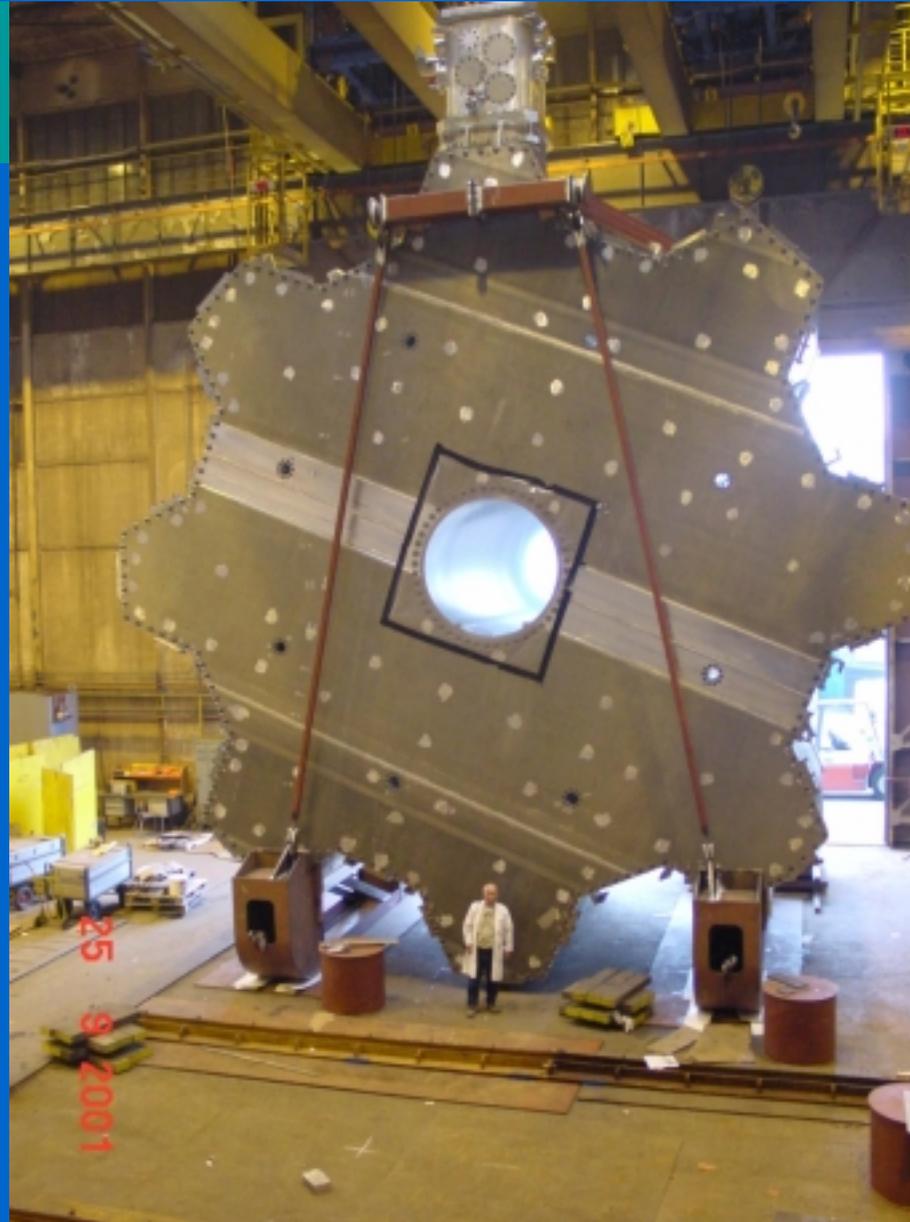


making the ATLAS coils



B0 prototype (1/3 length)

End-Cap Toroid Magnet



**End-Cap cryostat
during construction**

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La Rousse Bridge



Magnet Yoke

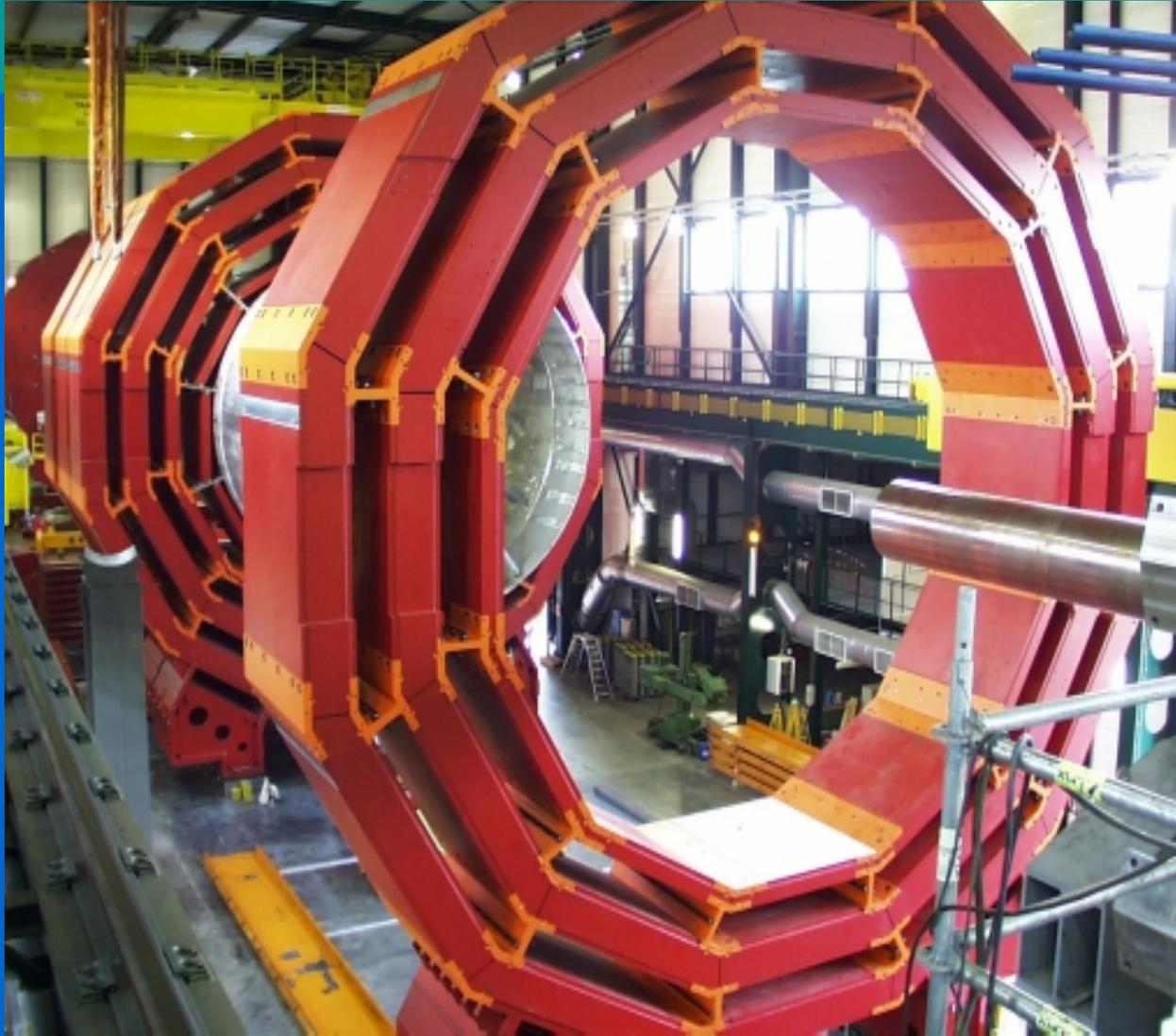
YE-1 & nose trial assembly Nov '00
In Kawasaki (Japan)



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



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- Magnet Barrel Yoke finished

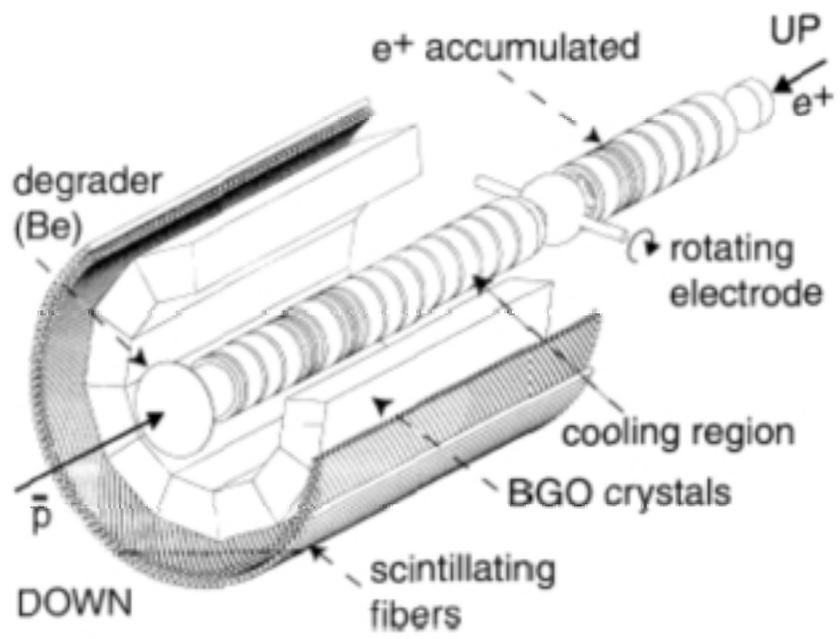


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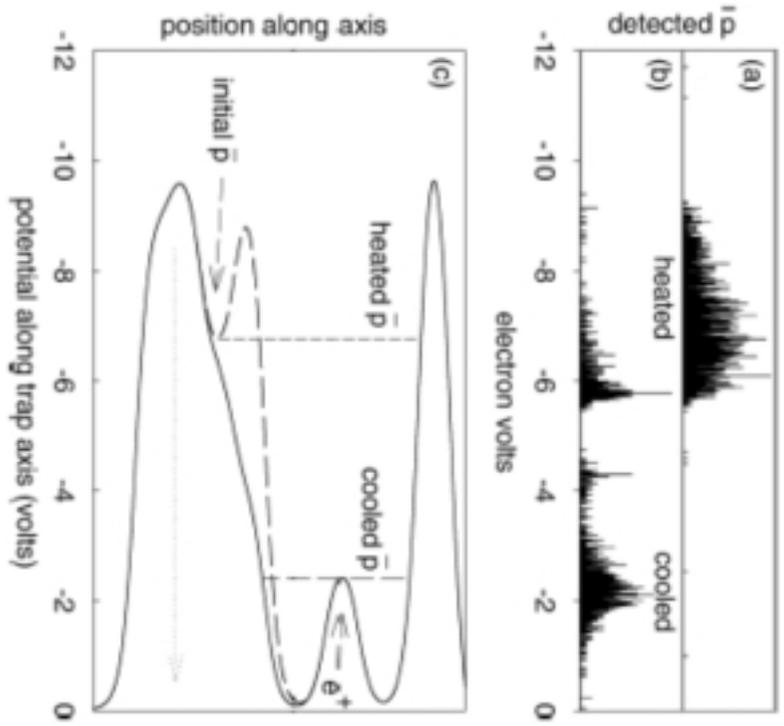
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ATRAP: cooling antiprotons with positrons



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



nature physicsportal launch

di Digital Instruments

Veeco Metrology Group

nature physicsportal

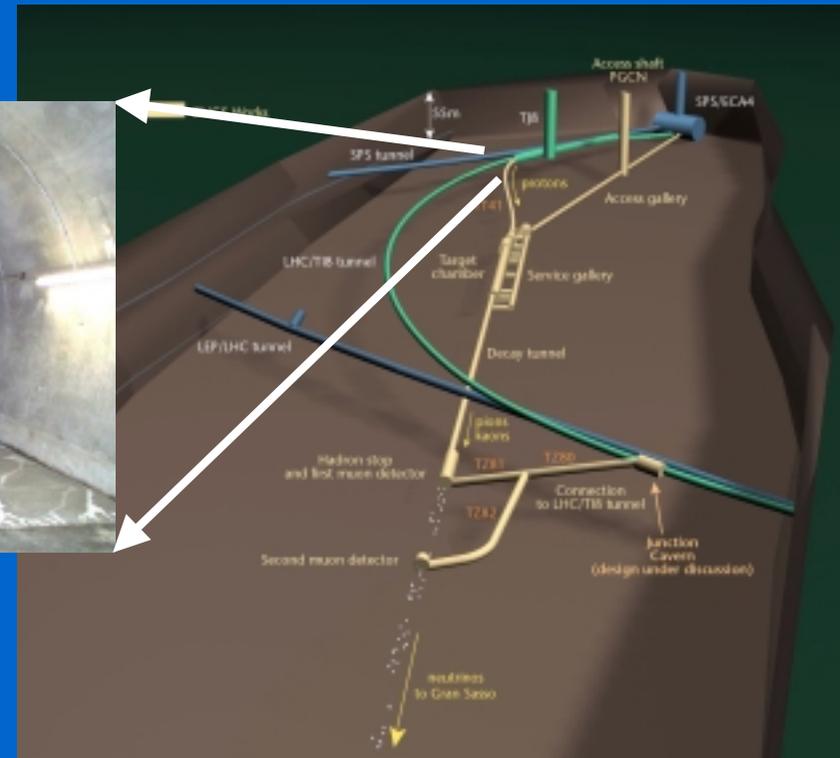
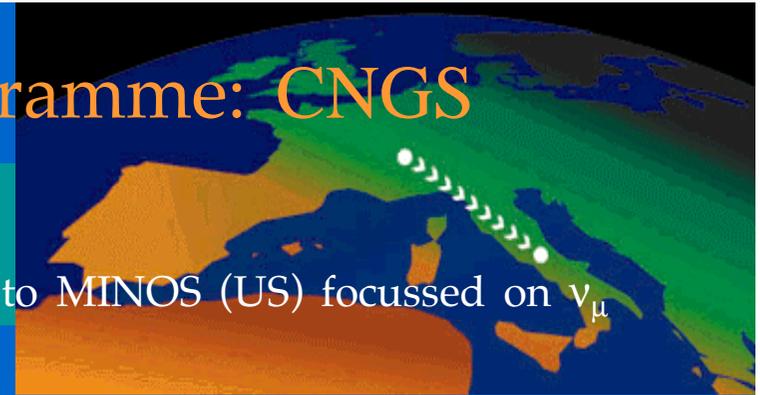
researchhighlights

Anticipating antihydrogen

home content

• 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);
- Other experiments are being devised

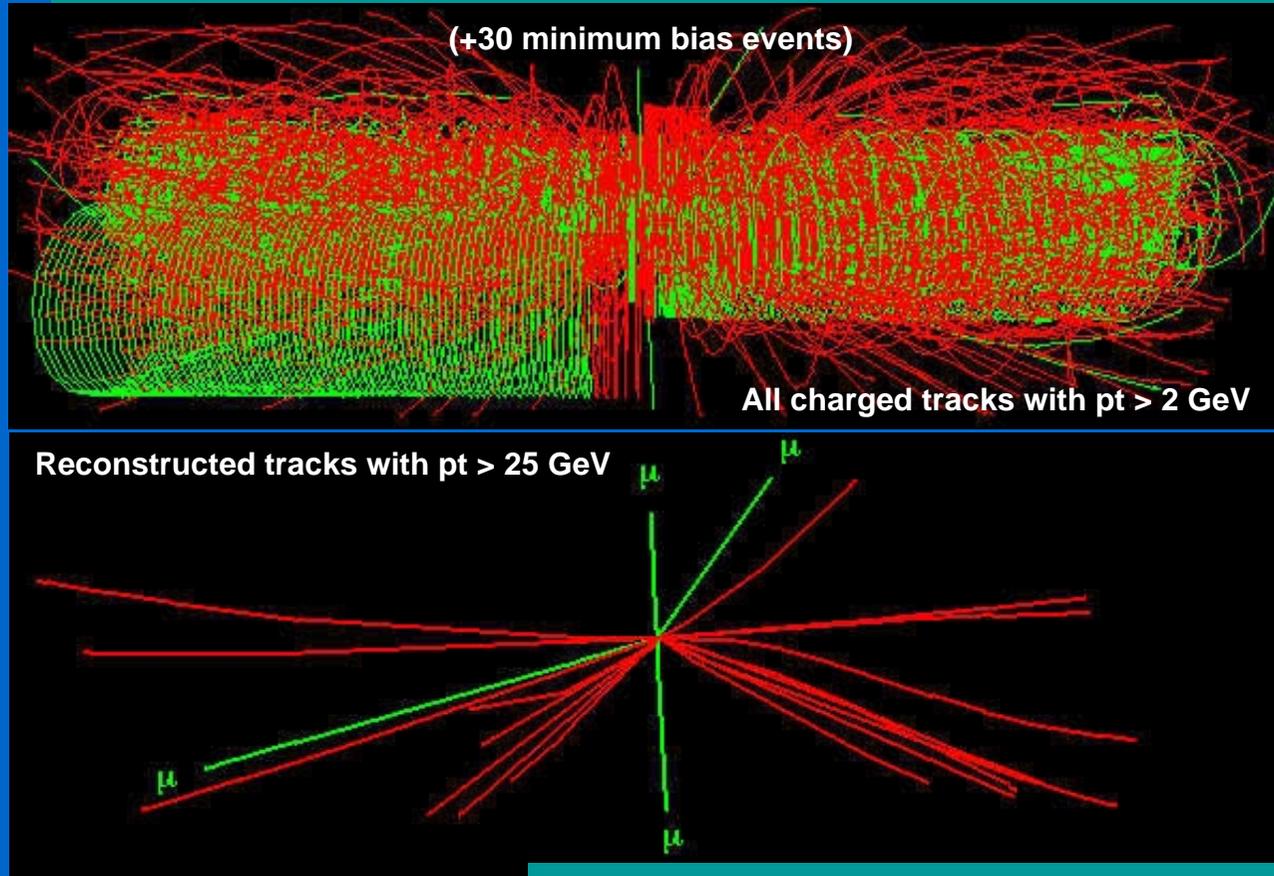


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Computing in LHC experiments



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

The data transmitted in **ONE SECOND** of LHC running

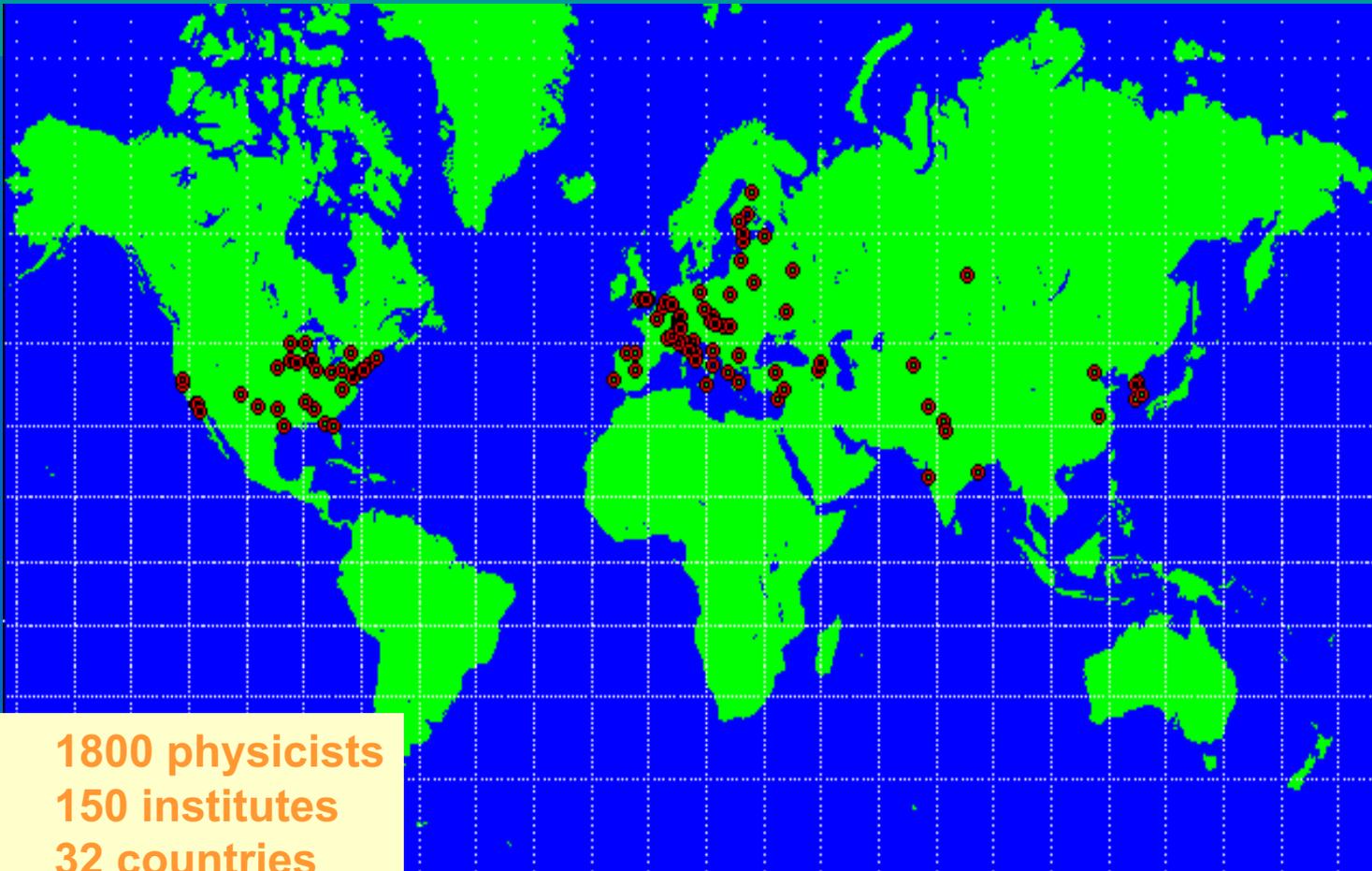
is equivalent to:

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

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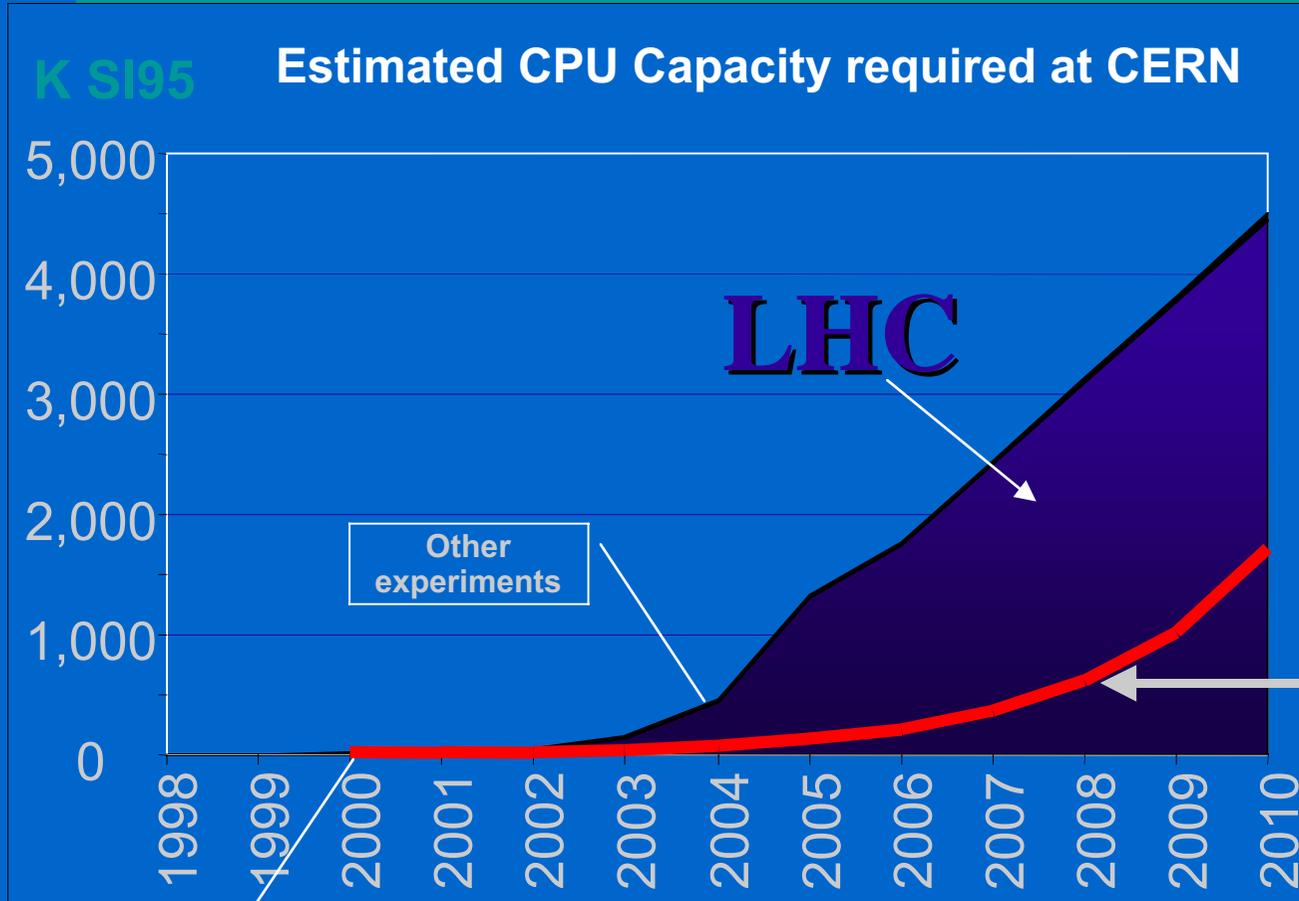
World Wide Collaboration

⇒ distributed computing & storage capacity



CMS: 1800 physicists
150 institutes
32 countries

Complex Data = More CPU Per Byte

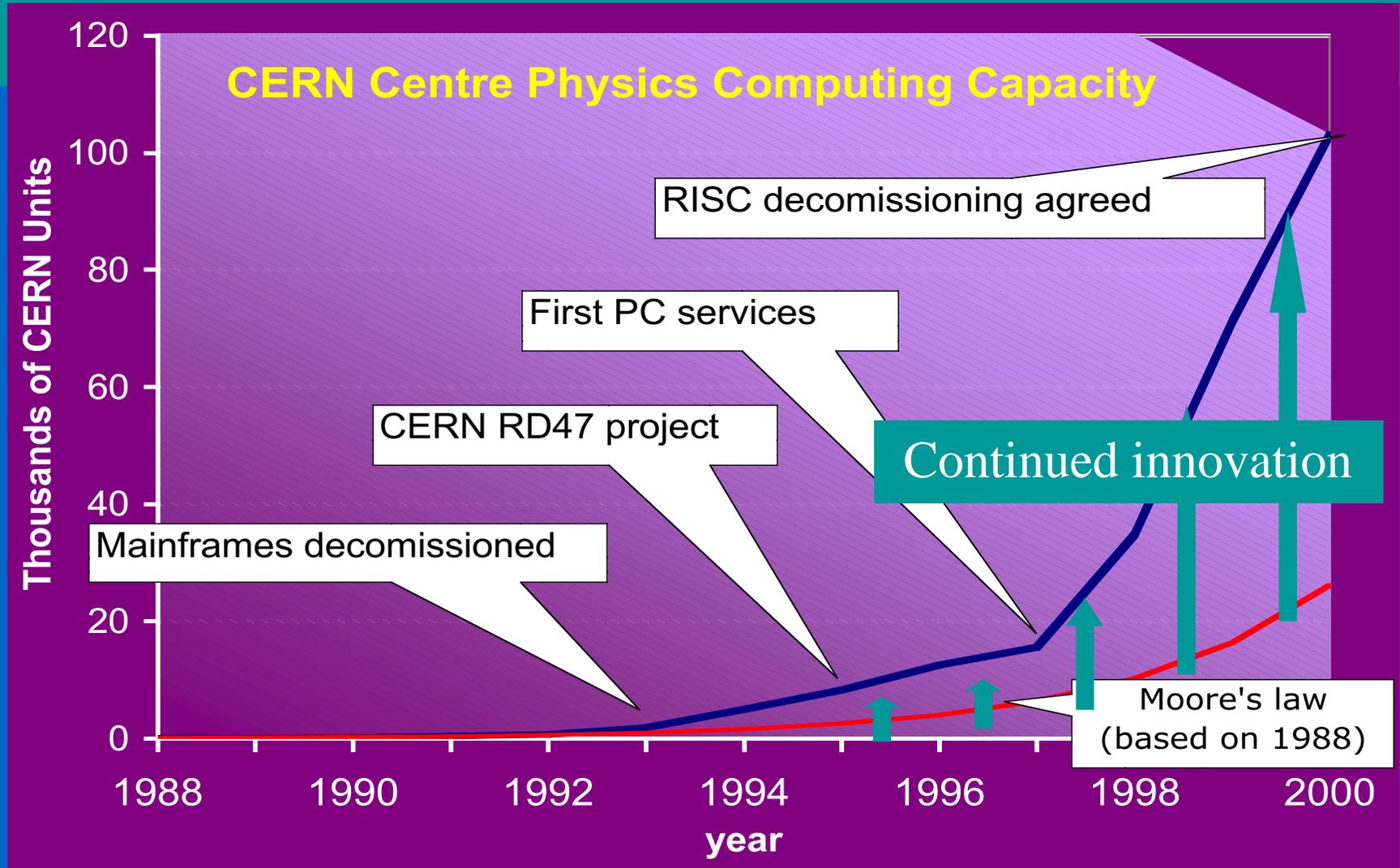


Moore's law – some measure of the capacity technology advances provide for a constant number of processors or investment

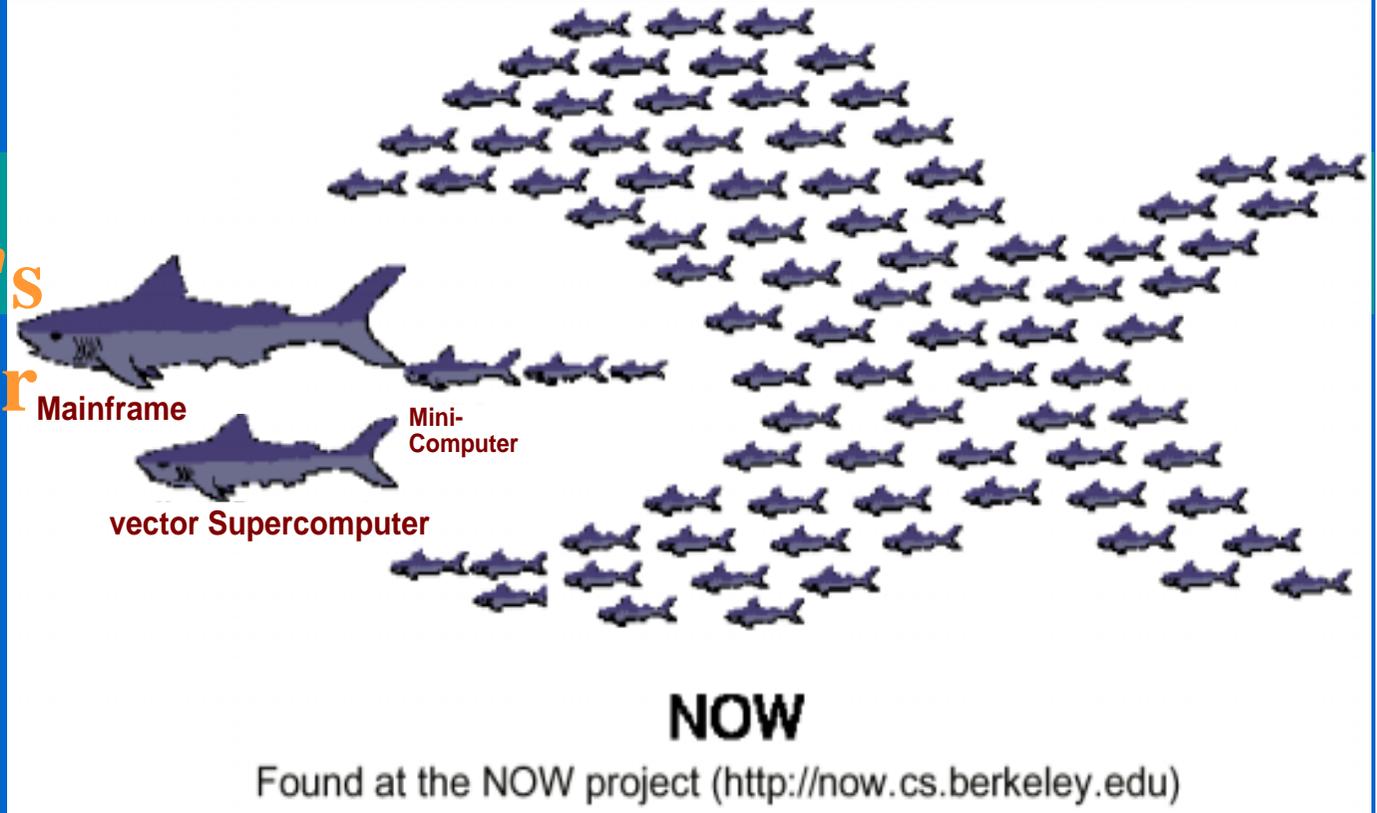


Jan 2000:
3.5K SI95

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

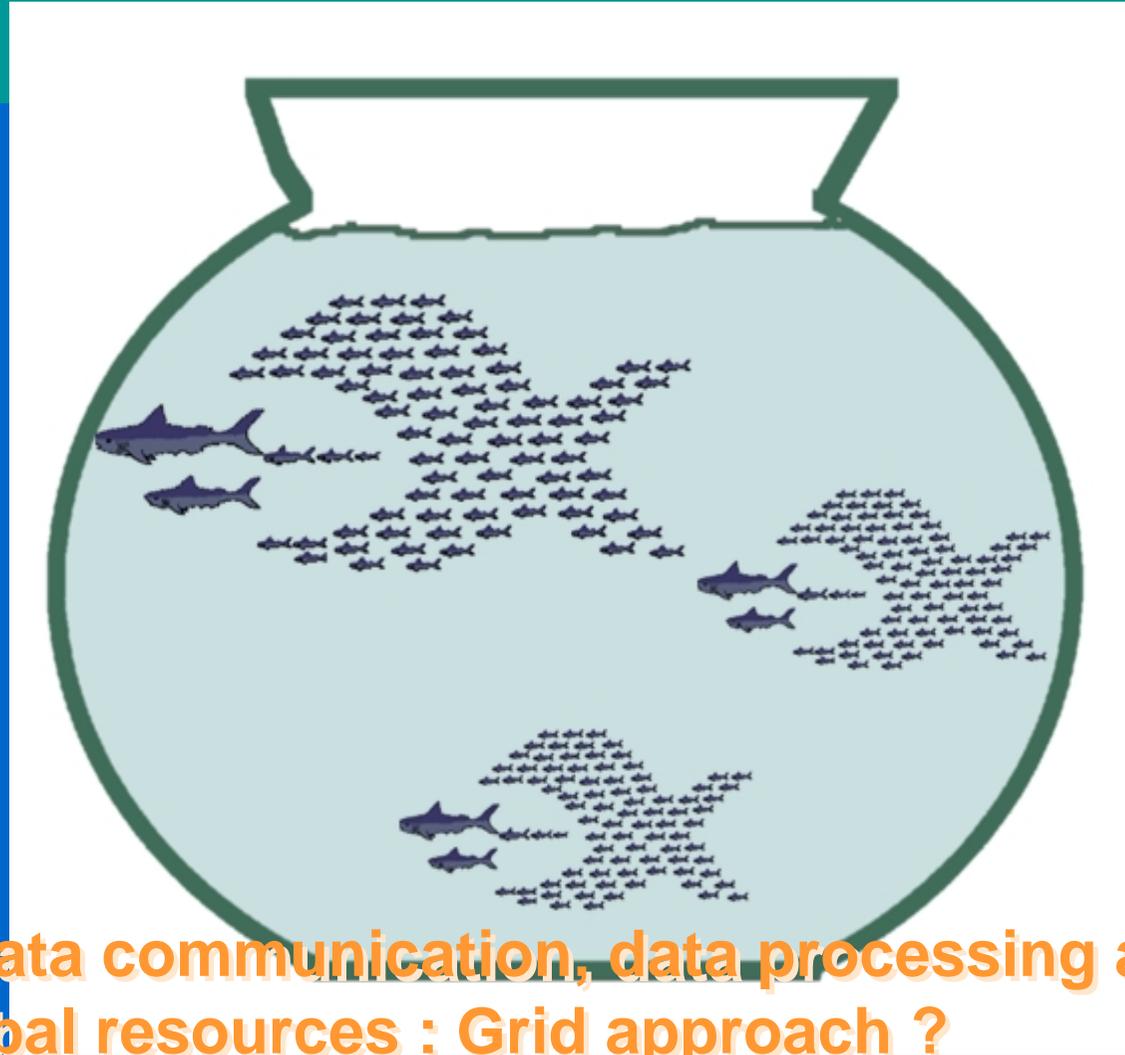


now.cs.berkeley.edu



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

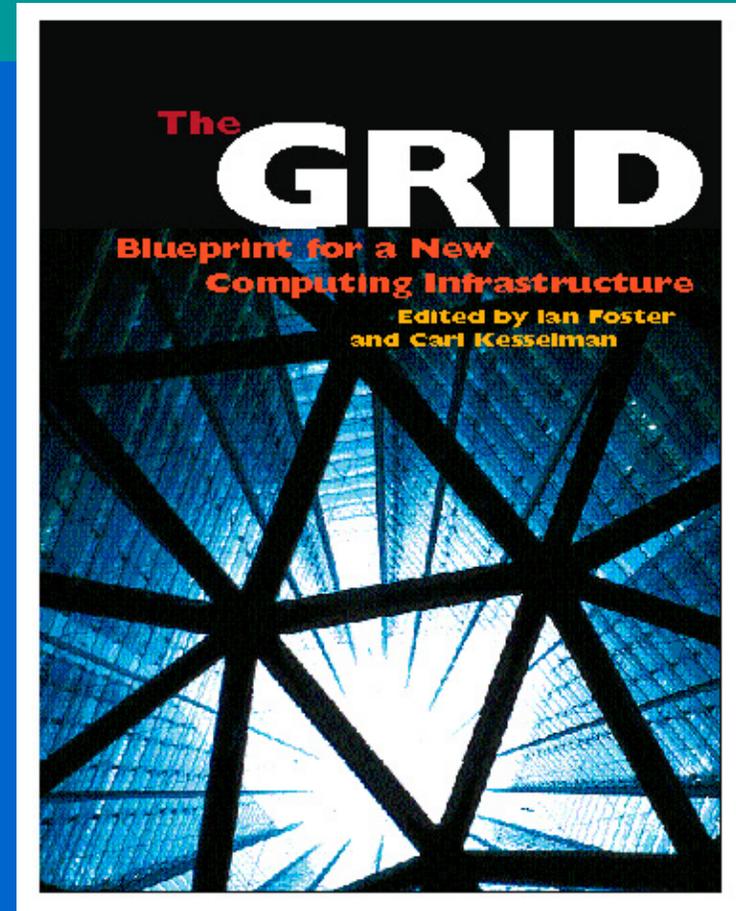
After commodity farms what next?



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>

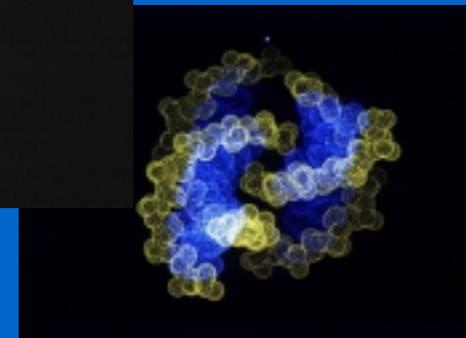
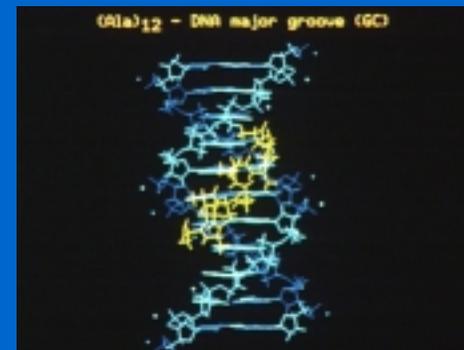
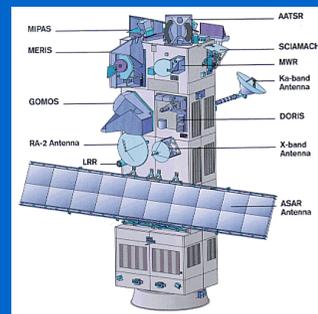
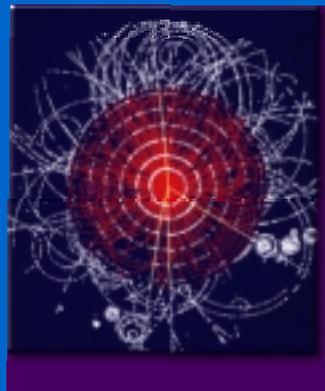


www.cern.ch/grid

Project start 01-01-01, duration 3 years, 21 partners

Deliverables: Middleware tried out with Particle Physics-, Earth Observation-, Biomedical Applications

1st review successfully passed



Applications - Distributed Fabric - "Transparent" Grid Middleware



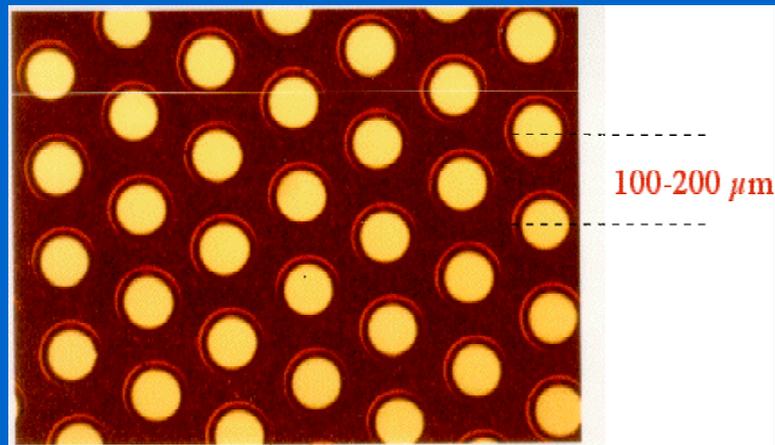
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Three ways to Technology Transfer

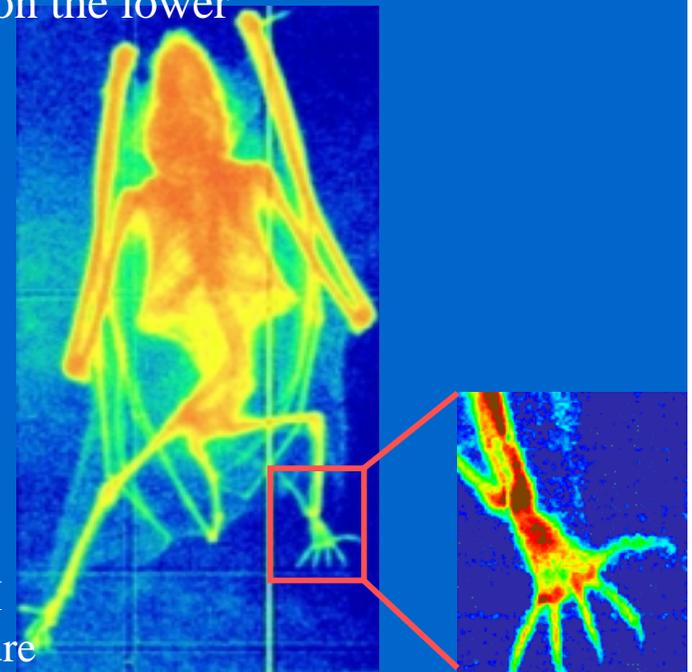
- Student Formation – **widely done at CERN**
- Orders to Industry – **new opportunities with the LHC**
- Transfer of new technologies developed for basic research
 - **WWW,**
 - **Hadron-Therapy,**
 - **Crystals....**

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).



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The WWW



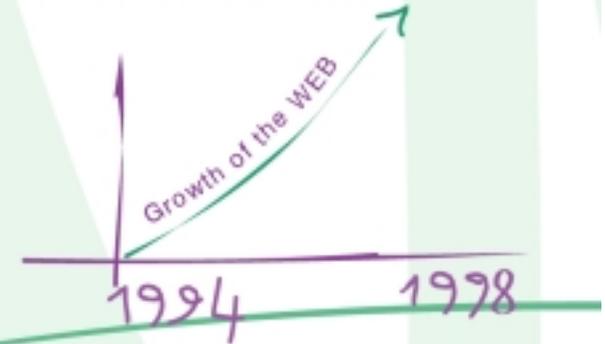
World-Wide Web :

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.

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- "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