Particle Physics – what's in it for society?

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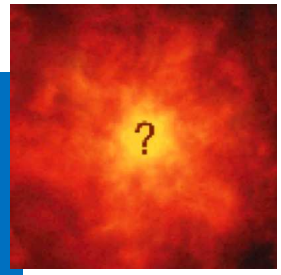
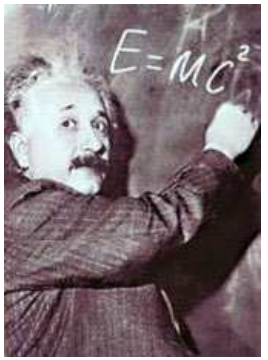
The Mission of CERN

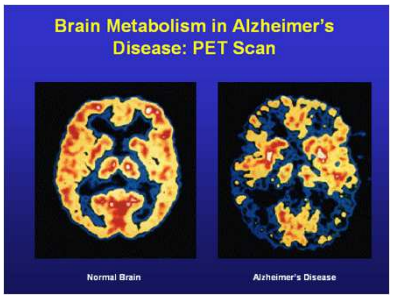
- Push forward the frontiers of knowledge

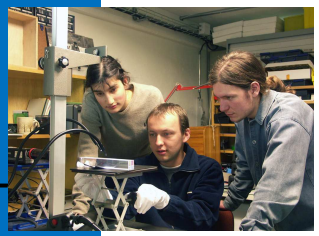
  E.g. the secrets of the Big Bang …what was the matter like within the first moments of the Universe's existence?





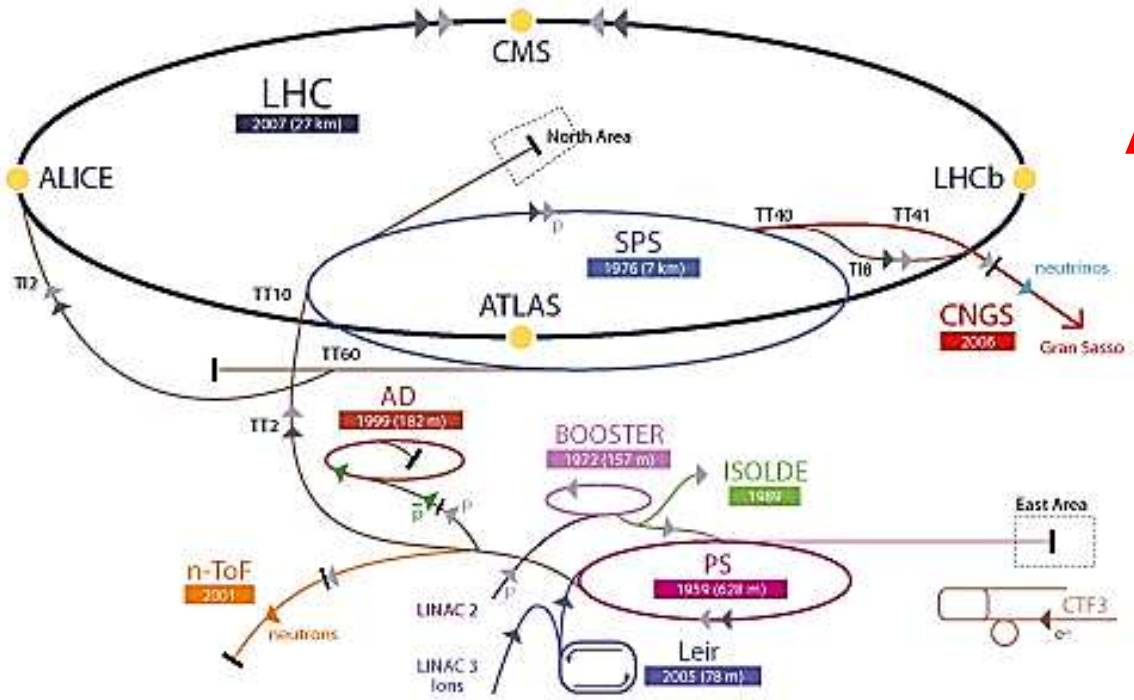
- ✓ Develop new technologies for accelerators and detectors
- ✓ Train scientists and engineers of tomorrow
- ✓ Unite people from different countries and cultures





Report: *"Accelerating science and innovation – Societal benefits of European research in particle physics" presents activities in this domain, some examples and pictures in the following pages are taken from this report.*

Technologies – development and transfer to other fields of research, industry and society



Accelerators

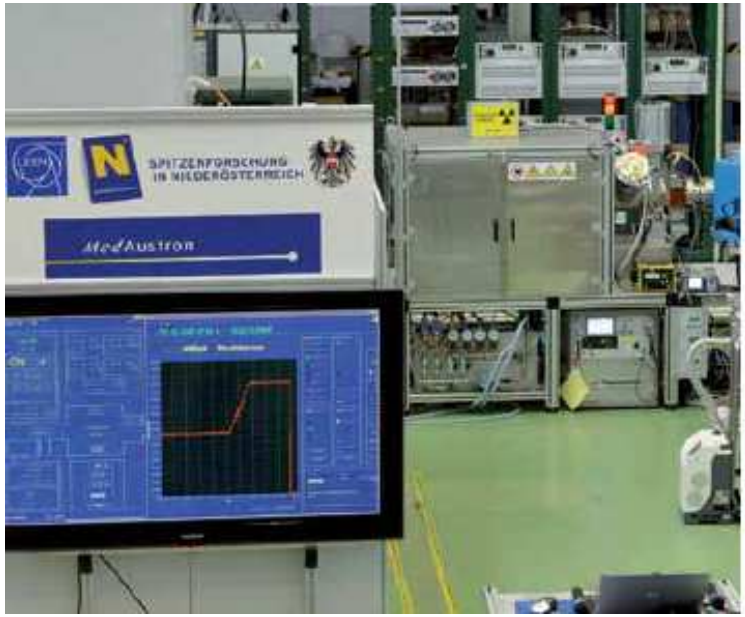
Detectors

Computing

Accelerators from the past

Low energy synchrotrons and cyclotrons are now commonly used in industry, e.g. food industry (around 20000) and in hospitals (around 10000). Their annual commercial output is valued at up to €500 billion.

The Proton Ion Medical Machine Study (PIMMS) at CERN produced an accelerator design optimized for hadron therapy, deployed in MedAustron and CNAO.



A test facility at CERN
for the MedAustron project

The synchrotron at Italy's CNAO facility

From accelerators to solar panels

A kind of molecular flypaper was developed to keep perfect vacuum inside the LEP accelerator pipe. This technology, applied to solar collectors, provides ultra-efficient thermal insulation and delivers 10 times the efficiency of standard rooftop solar panels.

Inside the LEP beam pipe.
The metal ribbon acts as molecular flypaper.

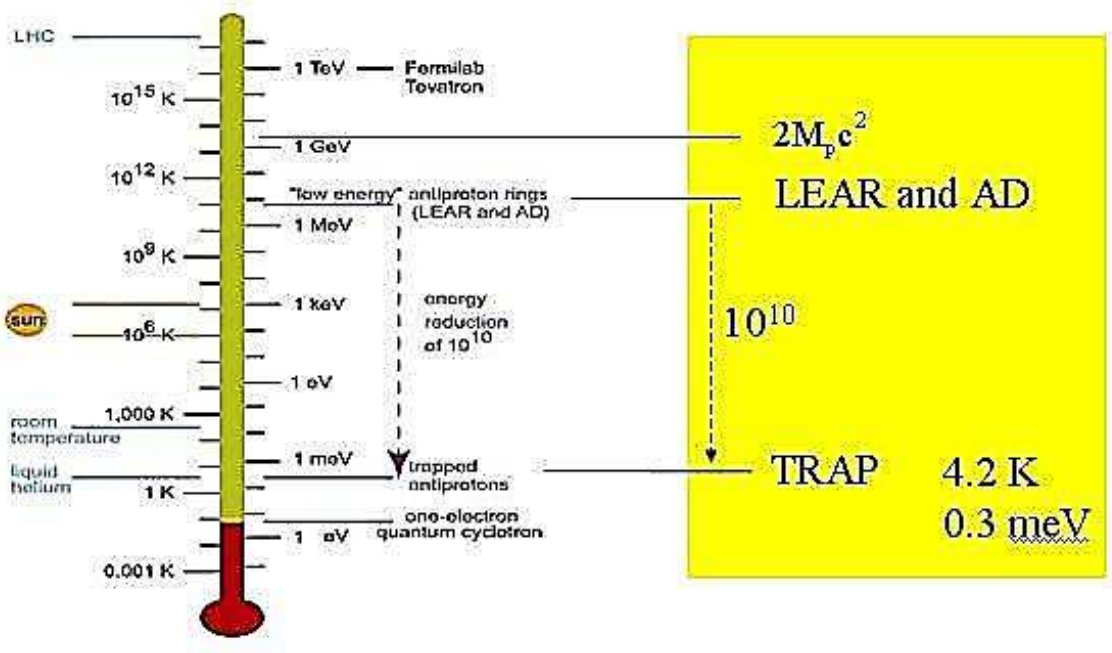
The same technology is at work inside solar panels on the roof of Geneva airport.

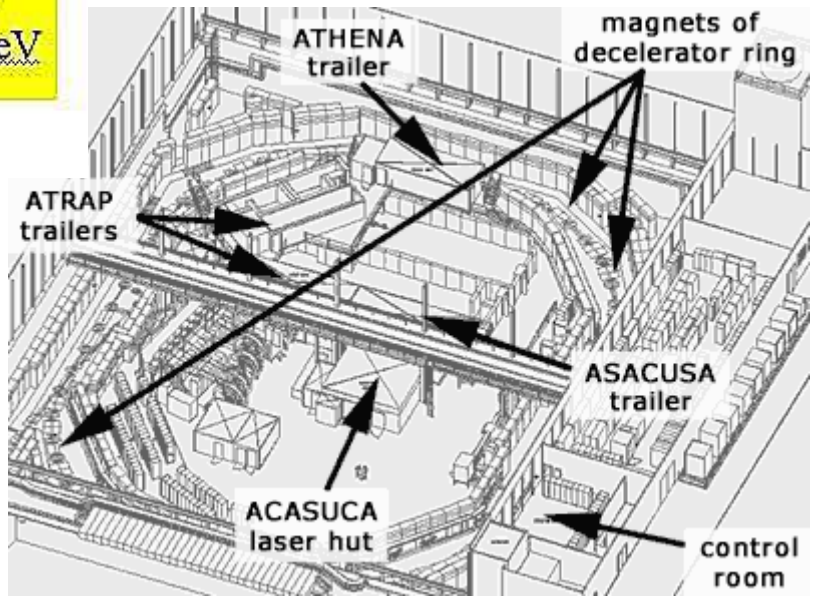
Accelerators for the future

CERN and other major European laboratories in 2011 at the workshop in Lund committed themselves to making the best and most efficient use of power that drives accelerators: to concentrate on the best ways to deliver and recover energy, to store it, to recycle heat and save water etc.

Important studies in this direction: R&D for superconducting cables of magnesium diboride that can have similar parameters at 25^0K as the LHC cables at around 3^0K. This will result in a considerable reduction of accelerators' power consumption.

Antiproton Decelerator – a unique facility for studies of antiatoms at CERN

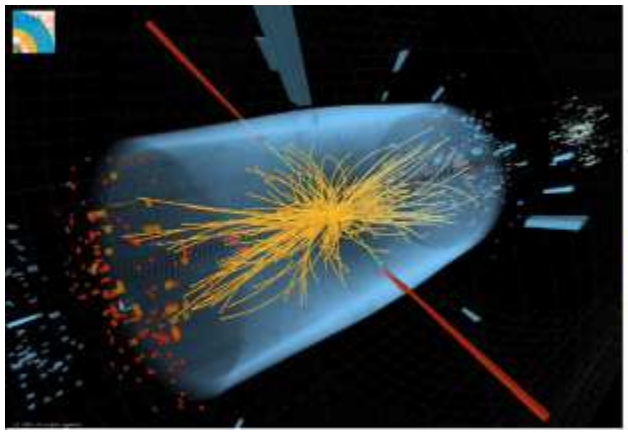


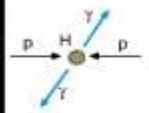


But also for the ACE experiment studying the potential use of antiprotons in cancer therapy

Detectors – from LHC to medicine

Silicon pixel detectors, used for tracking at LHC, and crystals of lead tangstate, used for energy measurements in CMS, have already found various applications, especially in medicine. For example, Silicon pixels are deployed as Medipix, for medical imaging and diagnosis. The CMS electronics to read out these crystals in a magnetic field opened the way to combined PET/MRI scanners.





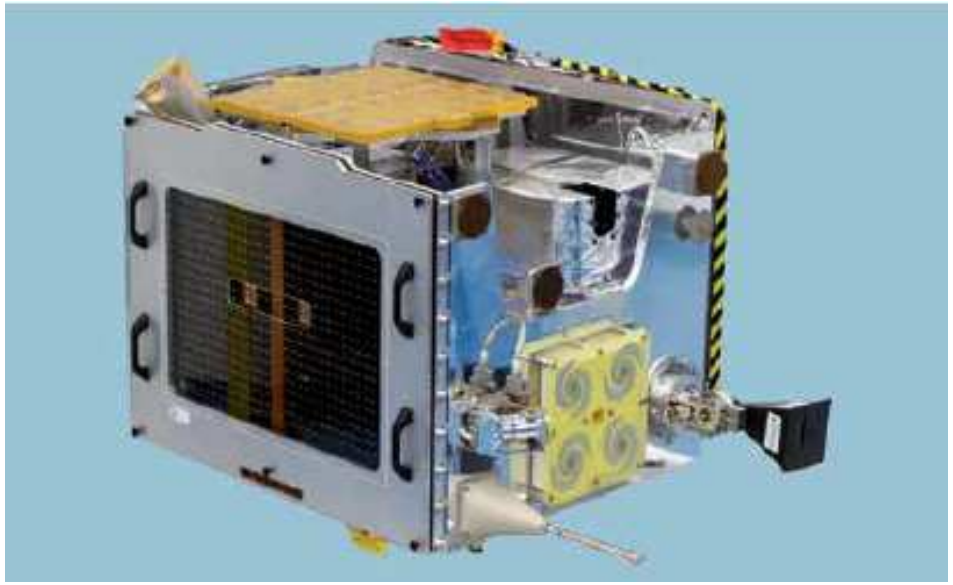
A Higgs or a 'background' process without a Higgs?

In yellow – particle tracks measured by Silicon detectors
In red – energy deposits in crystals of CMS's calorimeter

Silicon pixels in ATLAS and crystals In CMS under test

Detectors – from LHC to education

Medipix chips are used in the LUCID (Langton Ultimate Cosmic ray Intensity Detector) experiment, designed by pupils from a School in Canterbury, UK. They are also being developed for educational use by a Czech company.



TechDemoSat1, scheduled for launch this year, will have the LUCID detector on board

Medipix packaged by Czech company Jablotron for educational use in schools.

Computing – WWW in the past

World Wide Web was developed at CERN to help share information among scientists working at the Large Electron Positron collider, at institutes all around the globe. Twenty years ago it was made publicly available.

This was a generous gift from CERN to the mankind.

Web-inventor Tim Berners-Lee with student Nicola Pellow and the world's first Web browser.

The Web's international annual economic value is now estimated at €1.5 trillion

Computing – LHC Grid now

Worldwide LHC Computing Grid was launched by CERN in 2002 in view to processing more than 20 petabytes of data generated each year by LHC experiments. The system integrates thousands of computers and storage systems all over the world.

In 2010, Cloud and Grid computing was valued €35 billion. By 2015 it could be €120 billion.

A 2010 snapshot of European traffic on Worldwide LHC Computing Grid.

CERN – education activities

This mission of CERN is treated very seriously and new initiatives are born all the time.

- CERN has state-endorsed programmes for primary schools in France and Switzerland
- The particle physics community runs particle physics masterclasses for high-school students, which effectively complement school visits to CERN
- CERN runs high-school teachers programmes
- Summer courses at CERN are addressed to university students
- Technical Student programmes and Schools of Particle Physics, Computing and Accelerators are organised for young researchers and engineers
- An Academic Training Programme is dedicated to scientists at CERN
- Special initiatives are developed to help train engineers from Member States

CERN Education Activities

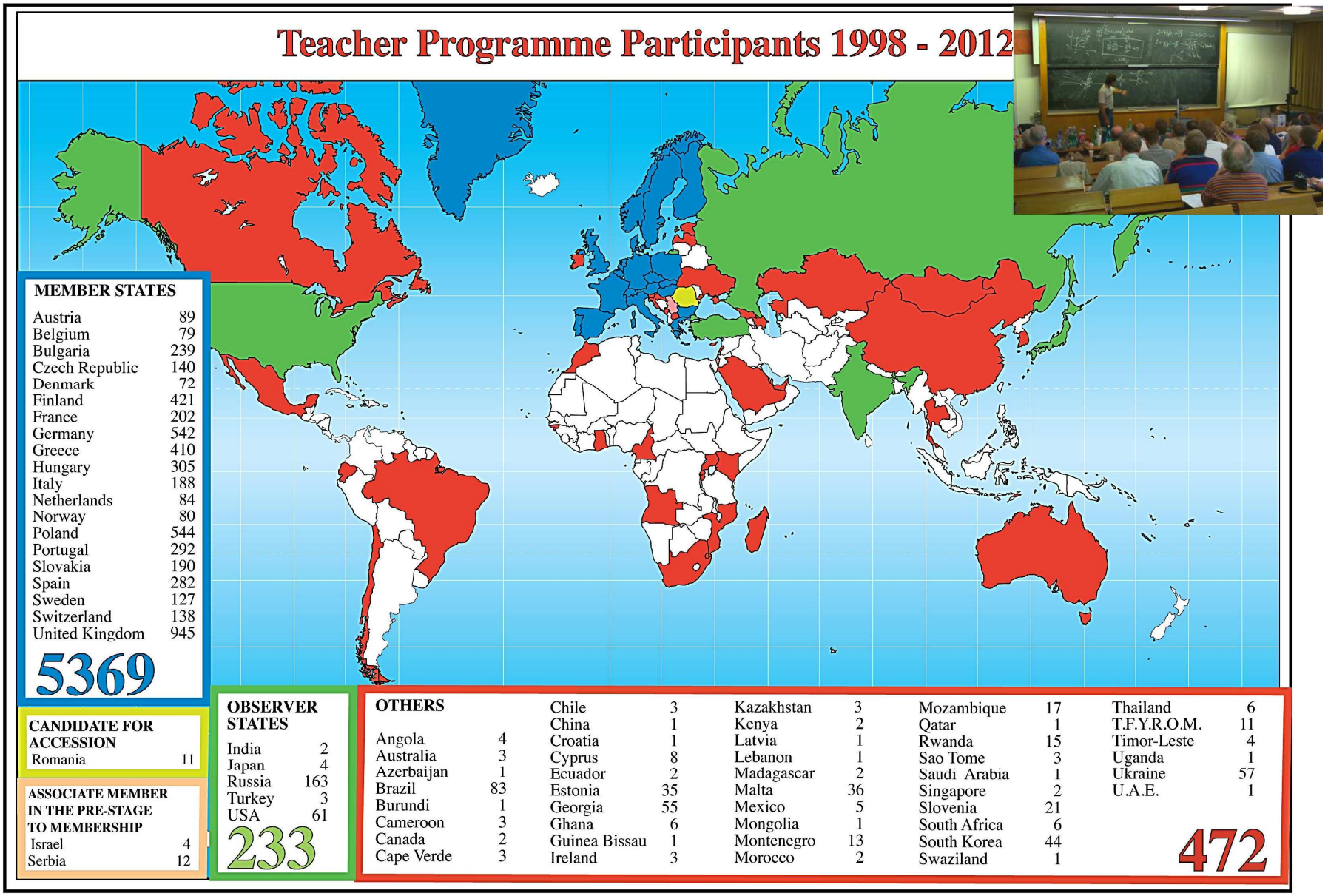
Scientists at CERN
Academic Training Programme

Young Researchers
CERN School of High Energy Physics
CERN School of Computing
CERN Accelerator School

Physics Students
Summer Students
Programme

CERN Teacher Schools
International and National
Programmes

CERN Teacher Programme



Summer Students 2012

Unite people of different nations and cultures

CERN was founded 1954: 12 European States

"Science for Peace"

Today: 20 Member States

~ 2300 staff
~ 1000 other paid personnel
> 11000 users

Budget (2013) ~1000 MCHF

Member States: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom

Candidate for Accession: Romania

Associate Members in Pre-Stage to Membership: Israel, Serbia

Applicant States for Membership or Associate Membership: Brazil, Cyprus (awaiting ratification), Pakistan, Russia, Slovenia, Turkey, Ukraine

Observers to Council: India, Japan, Russia, Turkey, United States of America; European Commission and UNESCO

We should never forget that

www.cern.ch

“There is no applied science without science to be applied”

(Bernardo Houssay, a Nobel Prize winner in medicine)