

**Welcome - Добро
пожаловать**

**Second CERN-JINR Dubna
School Teachers Programme –
November 2009**

to



Accelerating Science and Innovation



Introduction to

CERN-European Organization for Nuclear Research



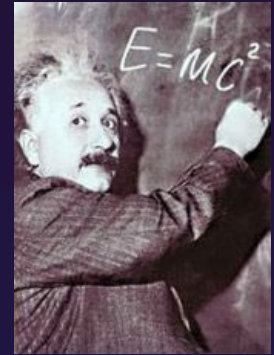
**Tadeusz KURTYKA – CERN - Projects Office of Accelerator Sector /
International Relations Office**



The Mission of CERN

- **Push back** the frontiers of knowledge

E.g. the secrets of the Big Bang ...what was the matter like within the first seconds of the Universe's life?

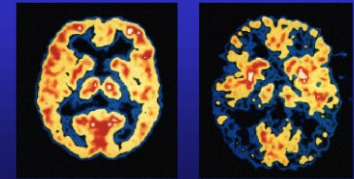


- **Develop** new technologies

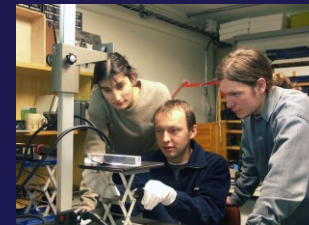
Information technology - the Web and the GRID
Medicine - diagnosis and therapy



Brain Metabolism in Alzheimer's Disease: PET Scan

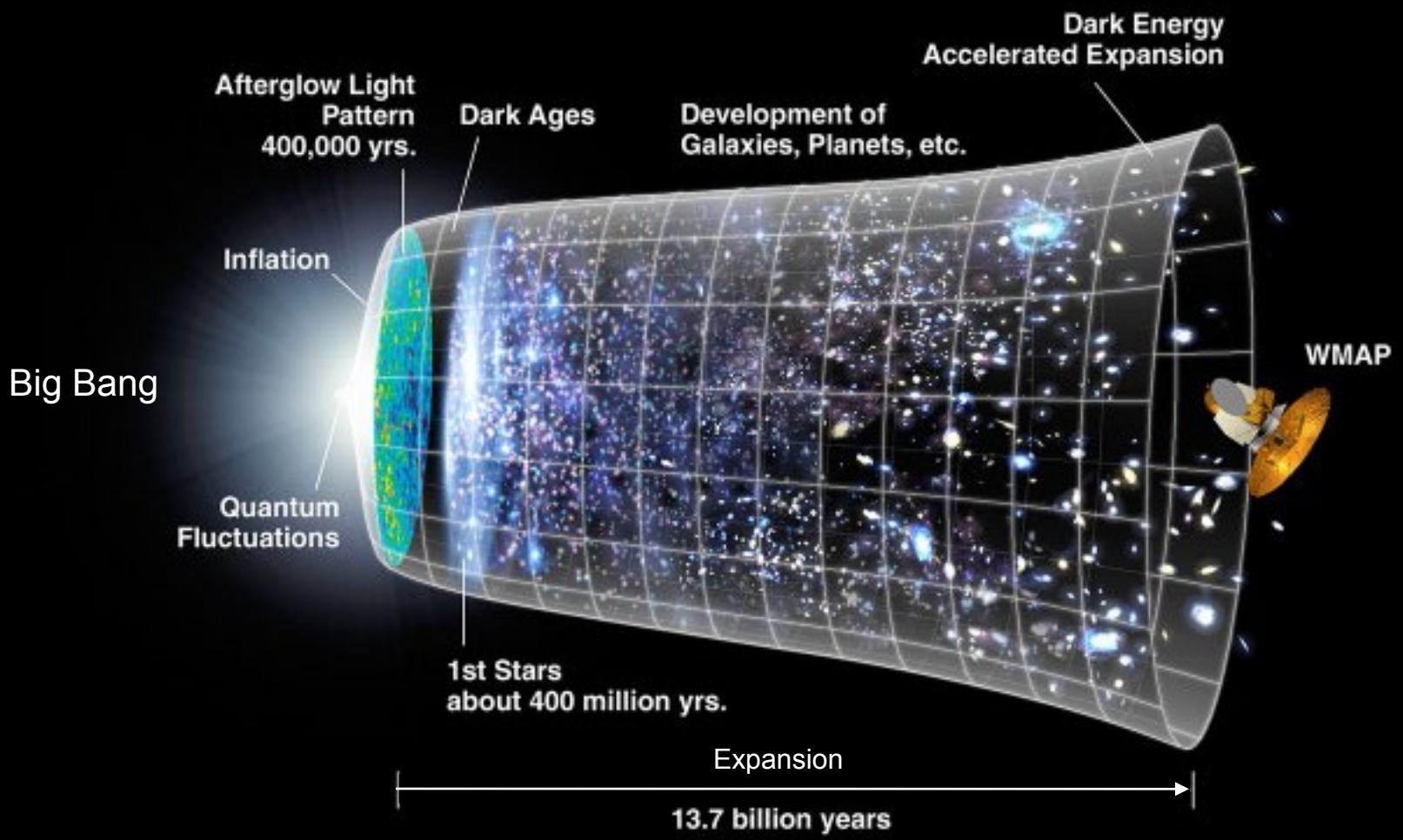


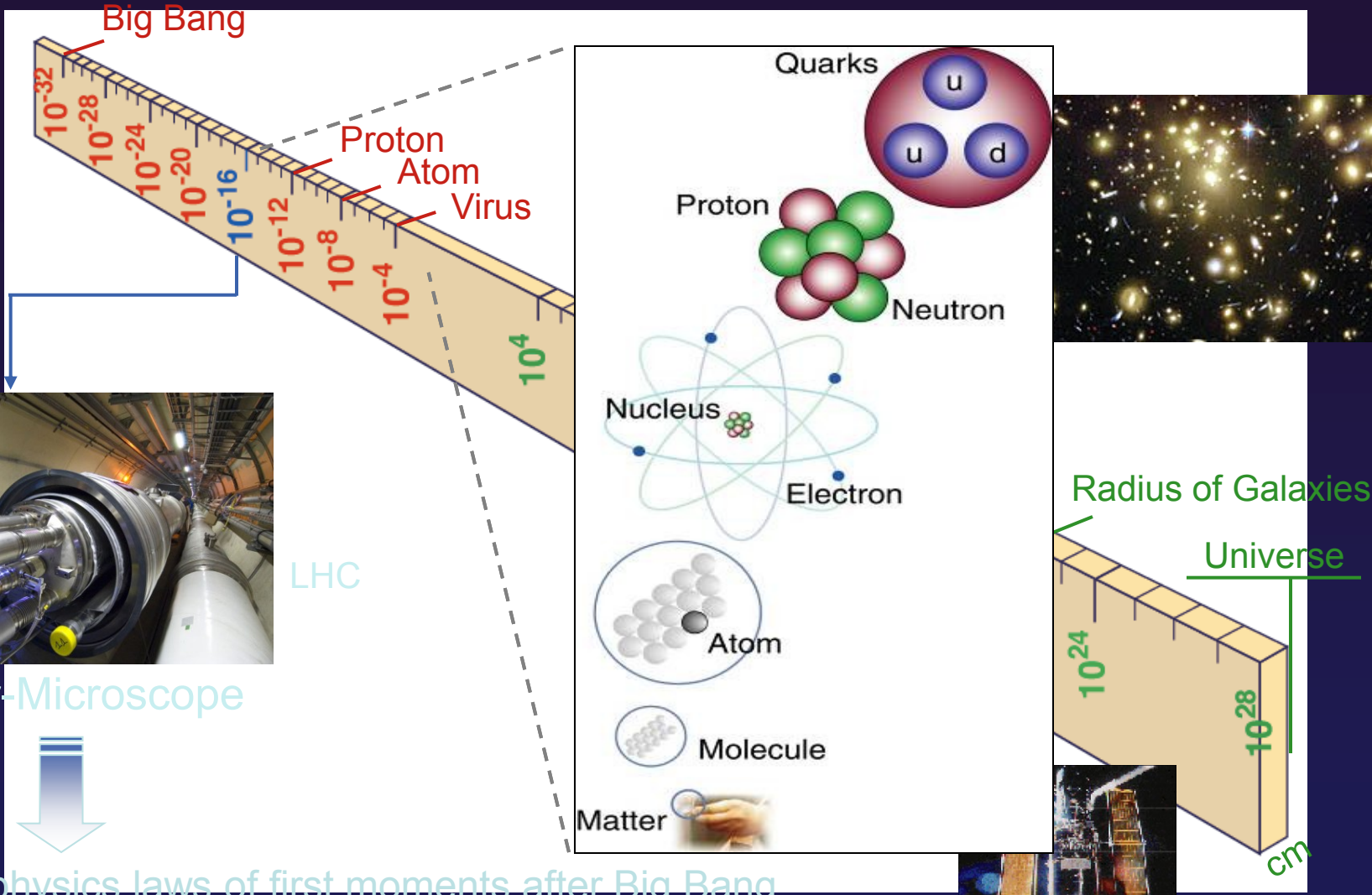
- **Train** scientists and engineers of tomorrow



- **Unite** people from different countries and cultures







Super-Microscope

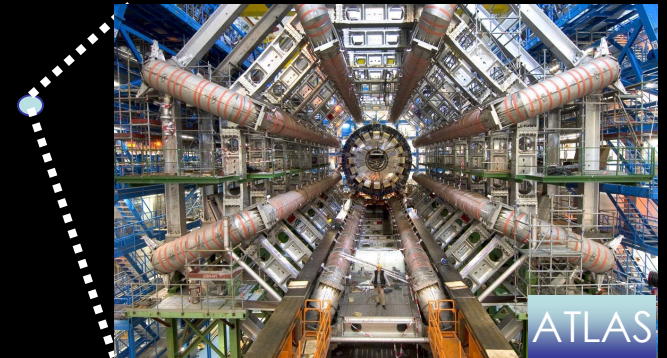
Study physics laws of first moments after Big Bang
 ↙ increasing Symbiosis between Particle Physics,
 Astrophysics and Cosmology

Enter a New Era in Fundamental Science

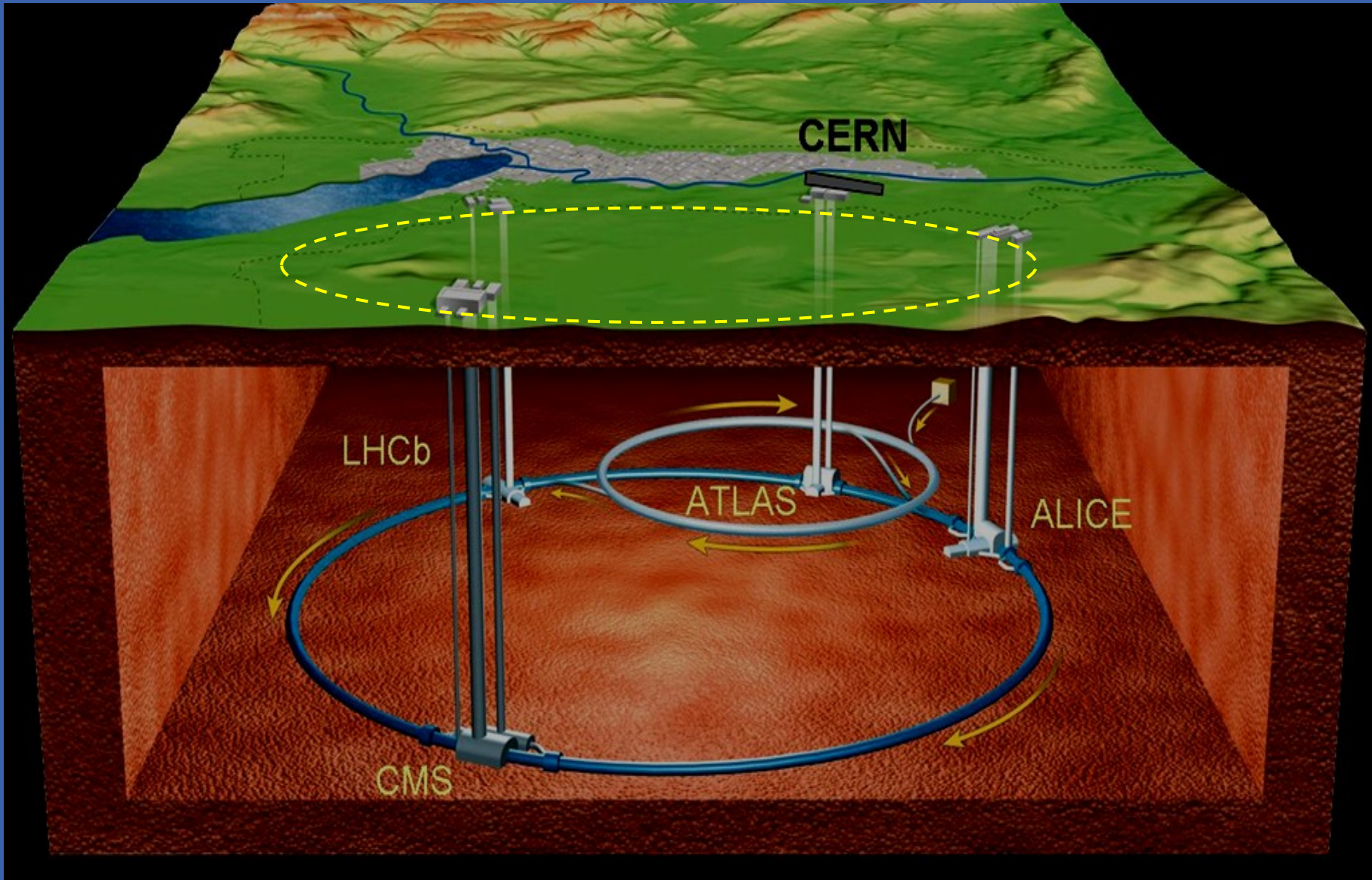
Start-up of the **Large Hadron Collider (LHC)**, one of the largest and truly global scientific projects ever, is the most exciting turning point in particle physics.



Exploration of a new energy frontier
Proton-proton collisions at $E_{\text{CM}} = 14 \text{ TeV}$

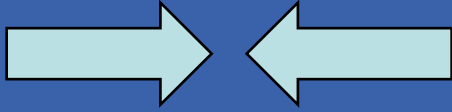


LHC – Large Hadron Collider

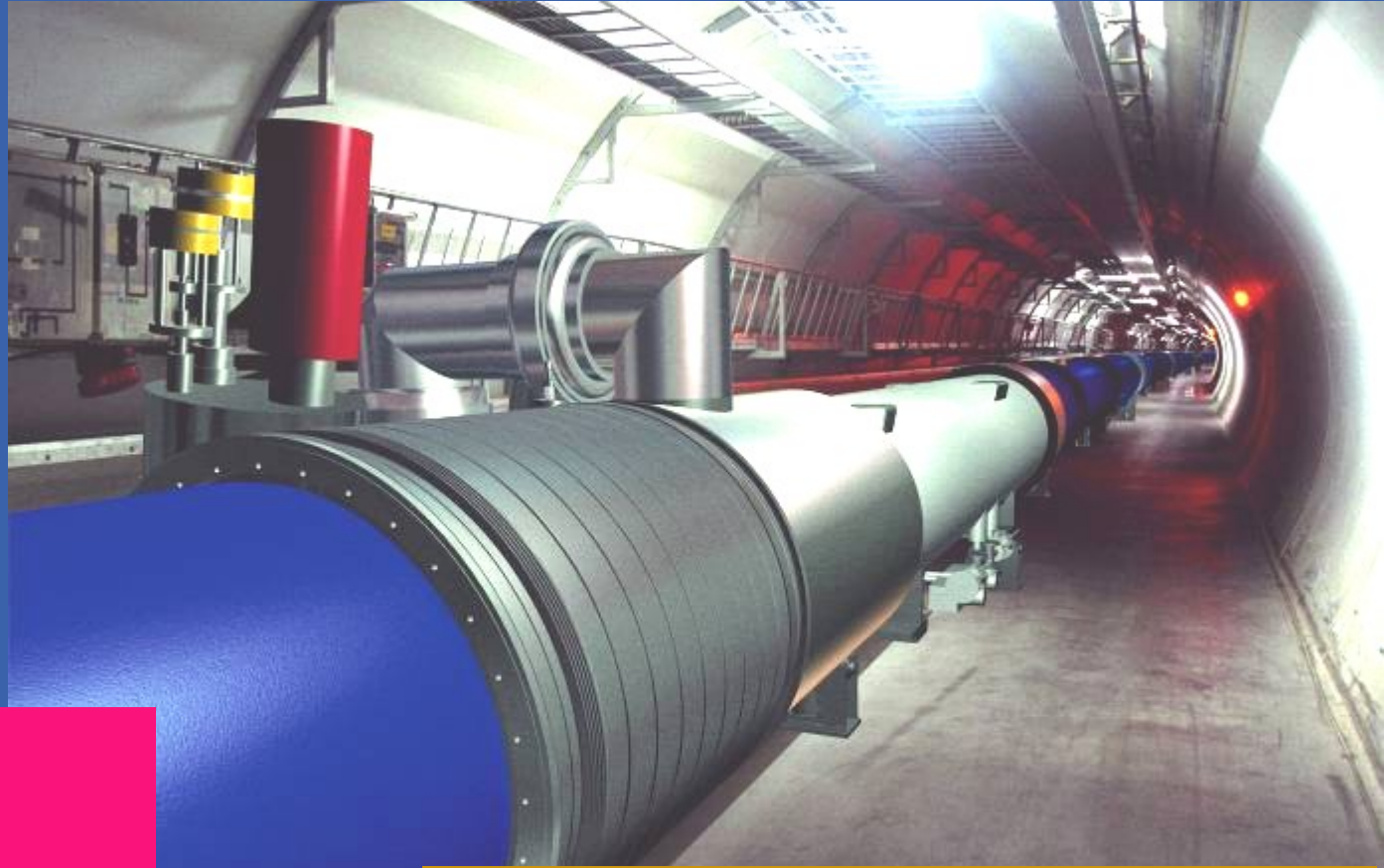


LHC - Large Hadron Collider

7 TeV + 7 TeV



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



Primary targets:

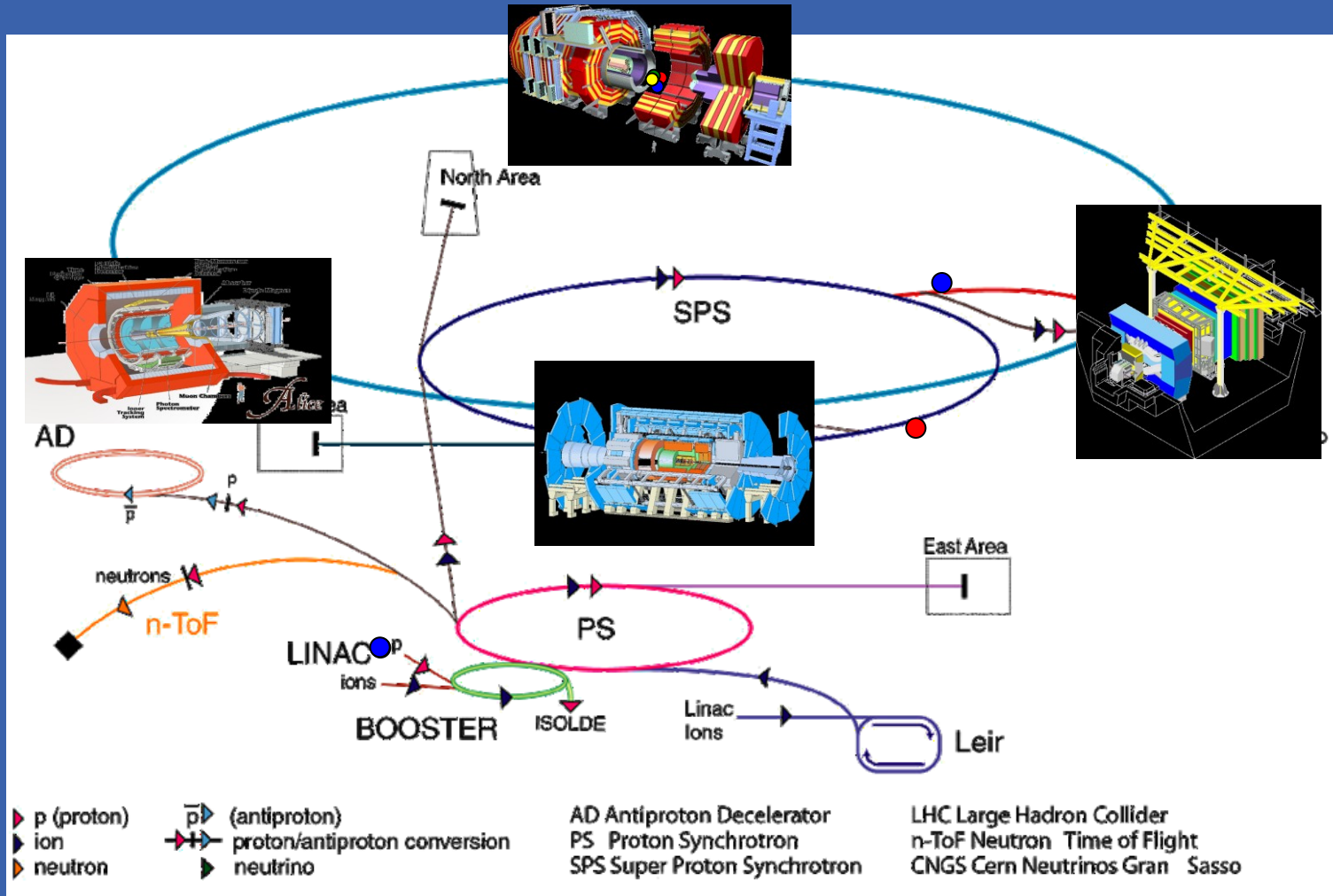
- Origin of mass
- Nature of Dark Matter
- Primordial Plasma
- Matter vs Antimatter

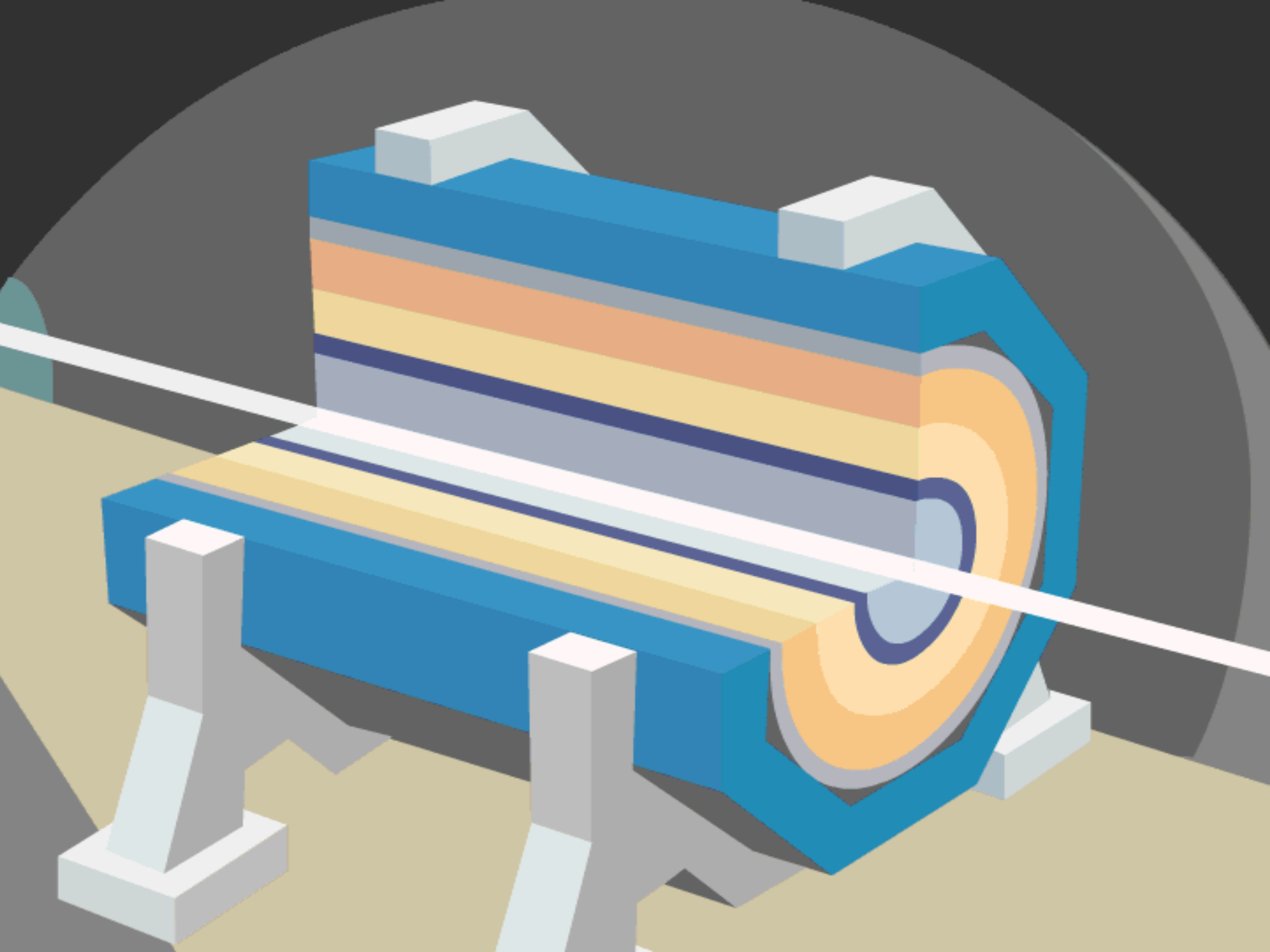
The LHC results will determine the future course of High Energy Physics

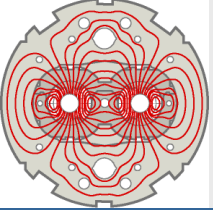
The large Hadron Collider

Collision of proton beams...

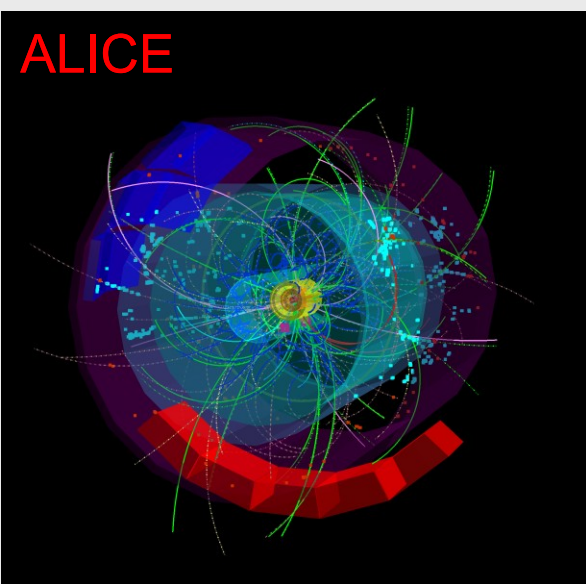
...observed in giant detectors



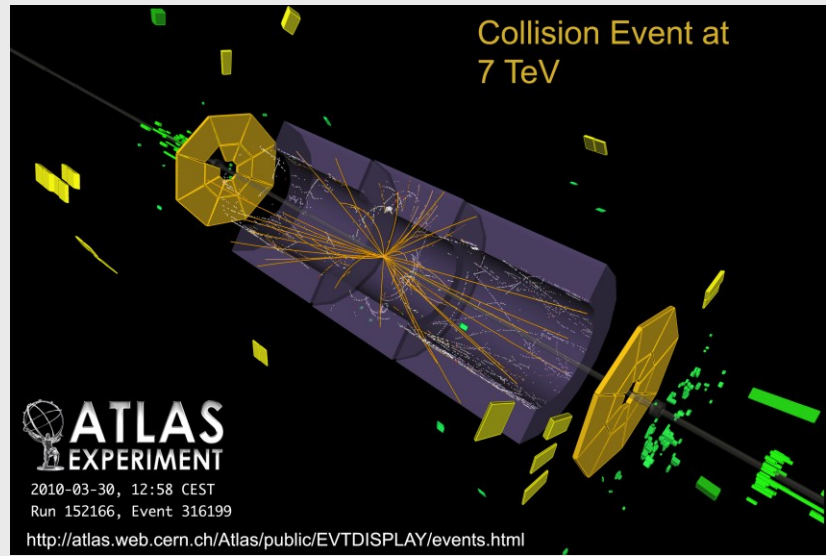




LHC: First collisions at 2x3.5 TeV: 30 March 2010



ALICE



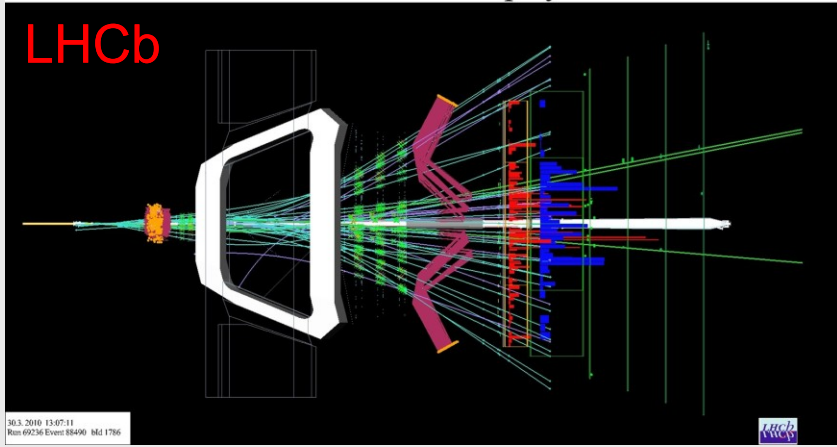
Collision Event at 7 TeV

ATLAS EXPERIMENT

2010-03-30, 12:58 CEST
Run 152166, Event 316199

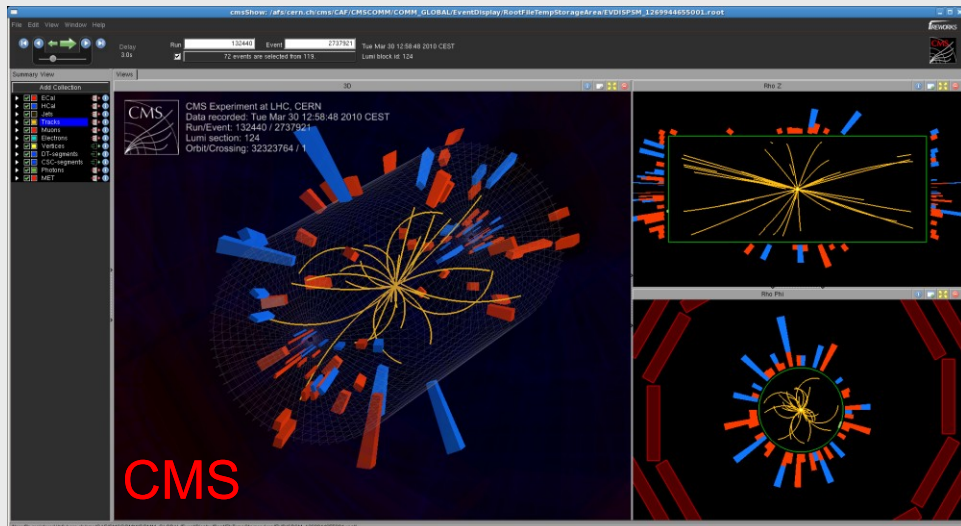
<http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html>

LHCb Event Display



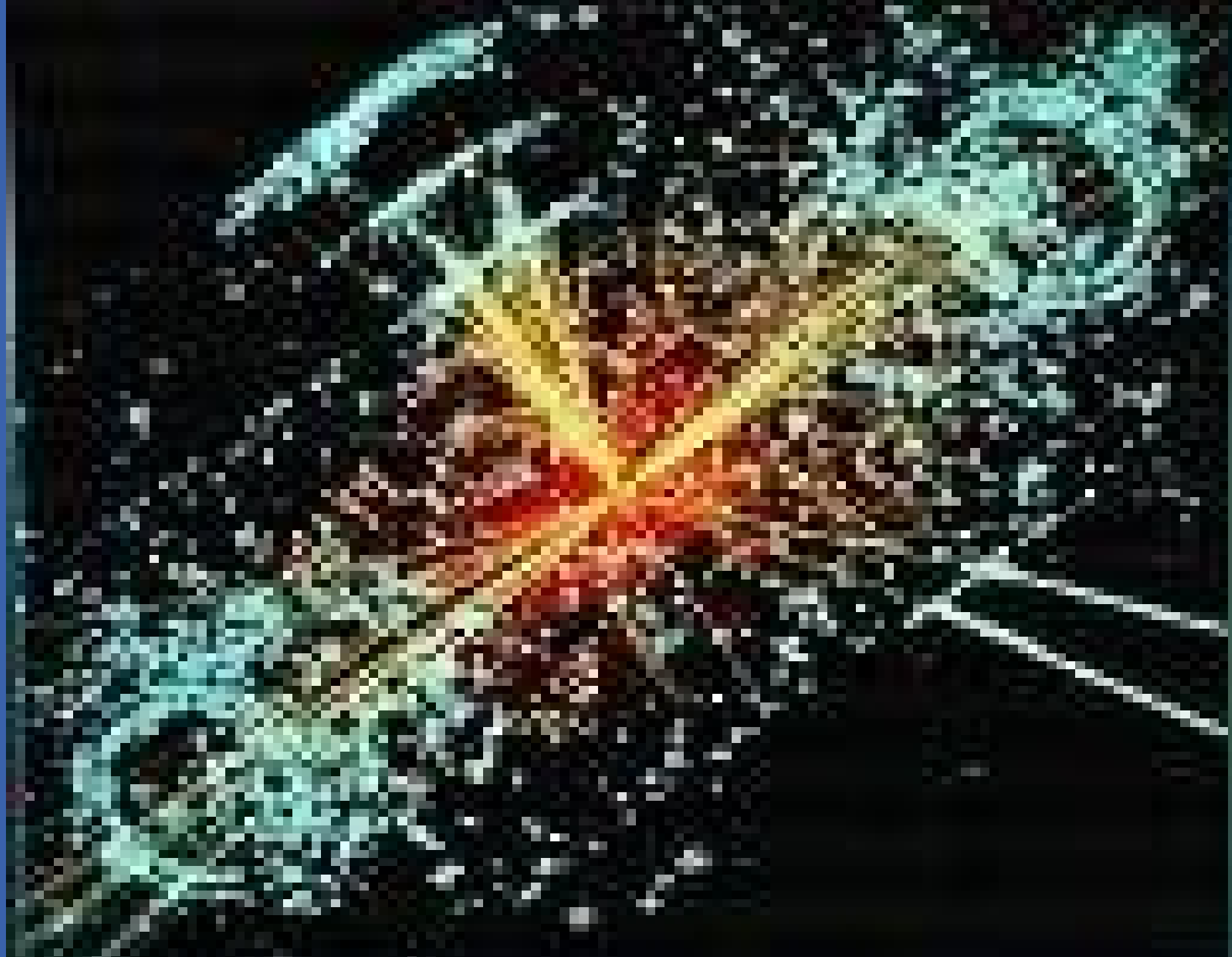
LHCb

30.3.2010 13:07:11
Run 00250 Event 00490 MC 1756

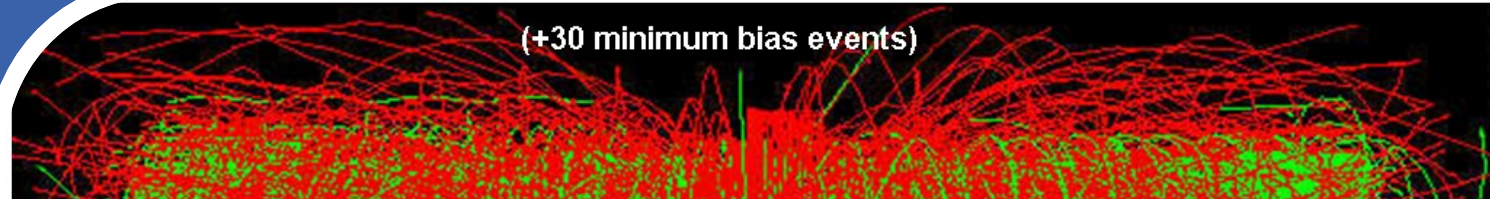


CMS

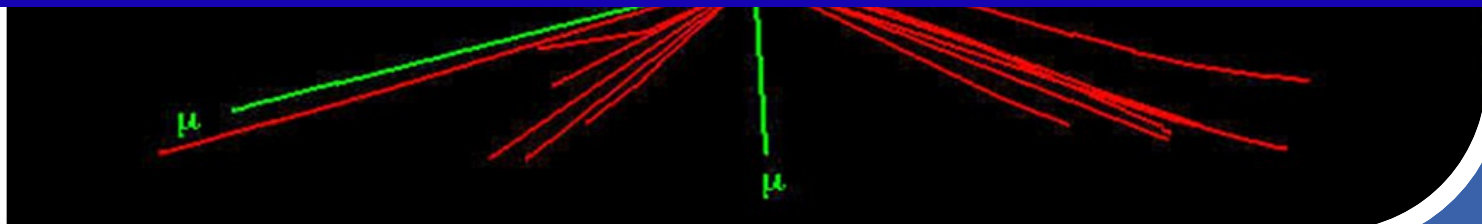


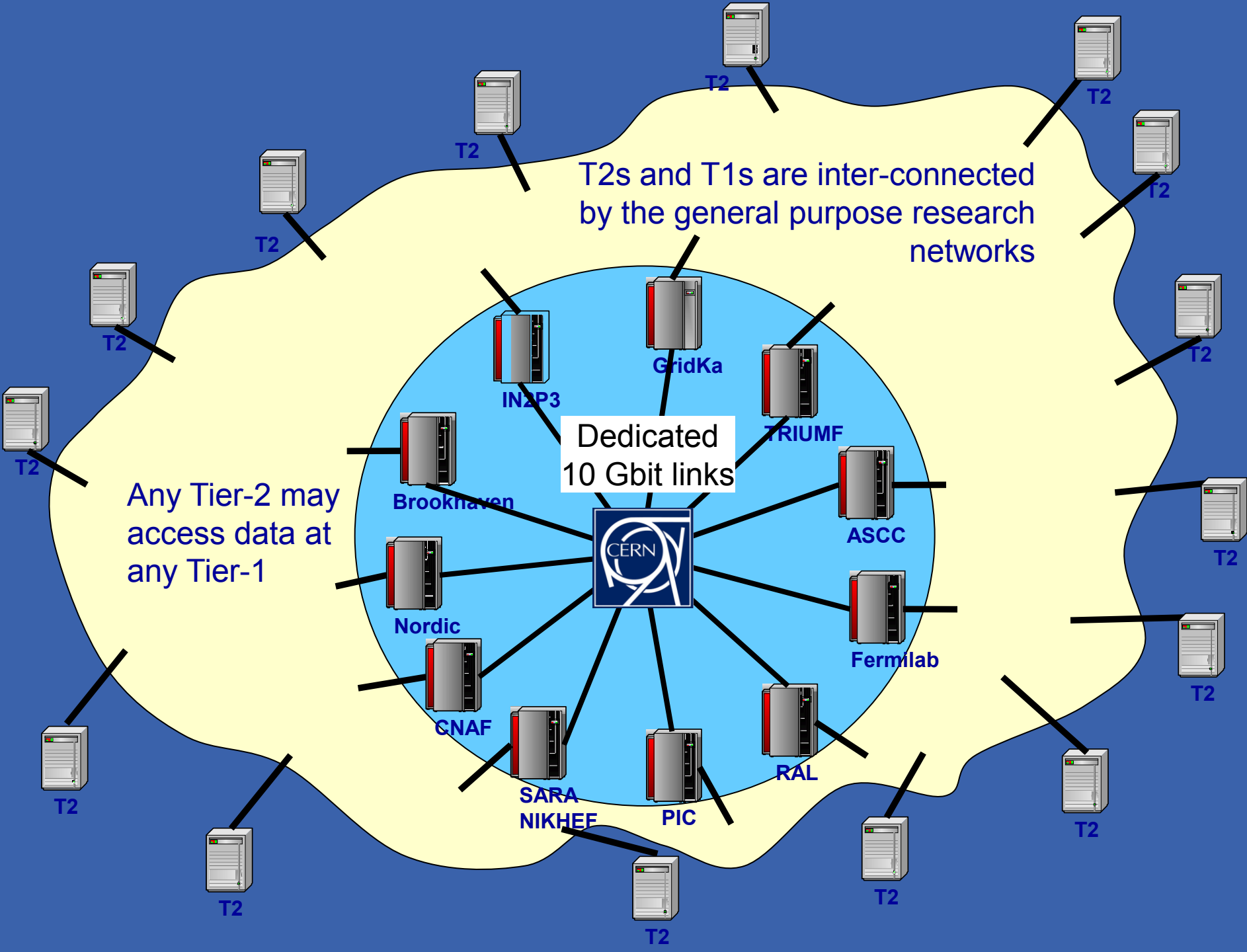


❑ Searching for new particles requires **selection and analysis** of enormous quantity of data from LHC detectors



- LHC experiments will produce **10-15 million Gigabytes** of data each year (about 20 million CDs!)
- LHC data analysis requires a computing power equivalent to **~100,000 of today's fastest PC processors.**





T2s and T1s are inter-connected by the general purpose research networks

Dedicated 10 Gbit links

Any Tier-2 may access data at any Tier-1



Brookhaven

IN2P3

GridKa

TRIUMF

ASCC

Fermilab

RAL

SARA

NIKHEF

PIC

GNAF

Nordic



The Worldwide LHC Computing Grid

The LHC physics data analysis service distributed across the world

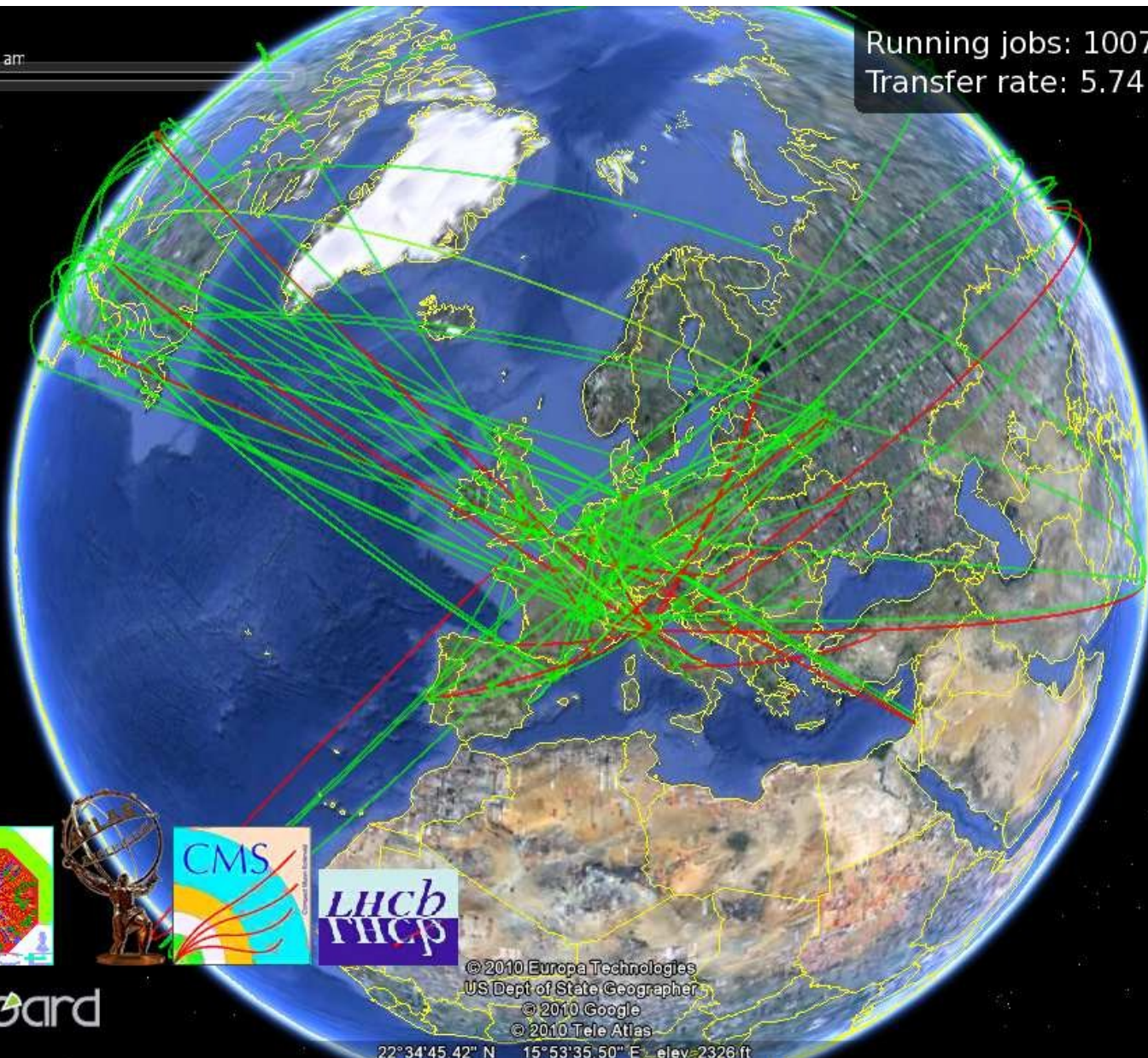
- CERN, 11 large *Tier-1* centres, over 200 *Tier-2* centres



LCG-LHC Computing GRID

Oct 6, 2010 7:20:00 am

Running jobs: 100767.0
Transfer rate: 5.74 GiB/sec



© 2010 Europa Technologies
US Dept of State Geographer

© 2010 Google
© 2010 Tele Atlas

22°34'45.42" N 15°53'35.50" E elev=2326 ft

©2010 Google

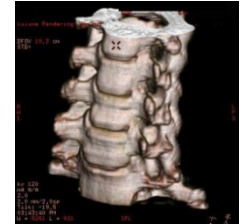
Eye alt 6720.01 mi



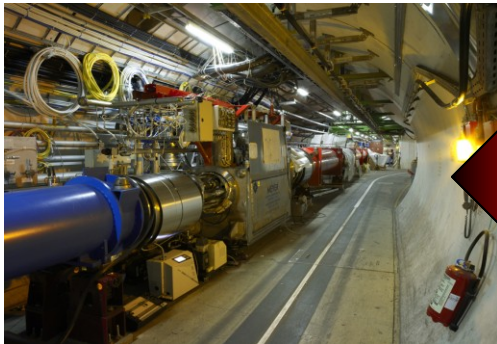
CERN Technologies - Innovation

Medical imaging

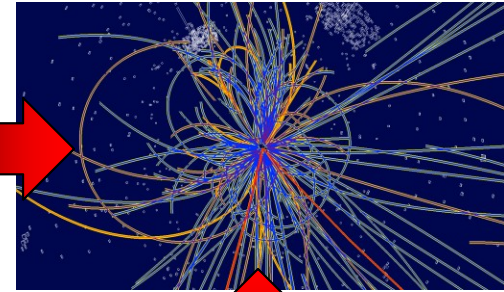
Example: medical application



Accelerating particle beams



Detecting particles

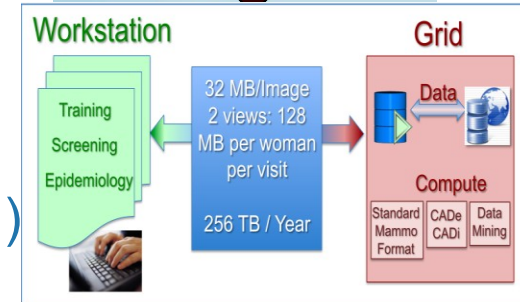


Tumour Target



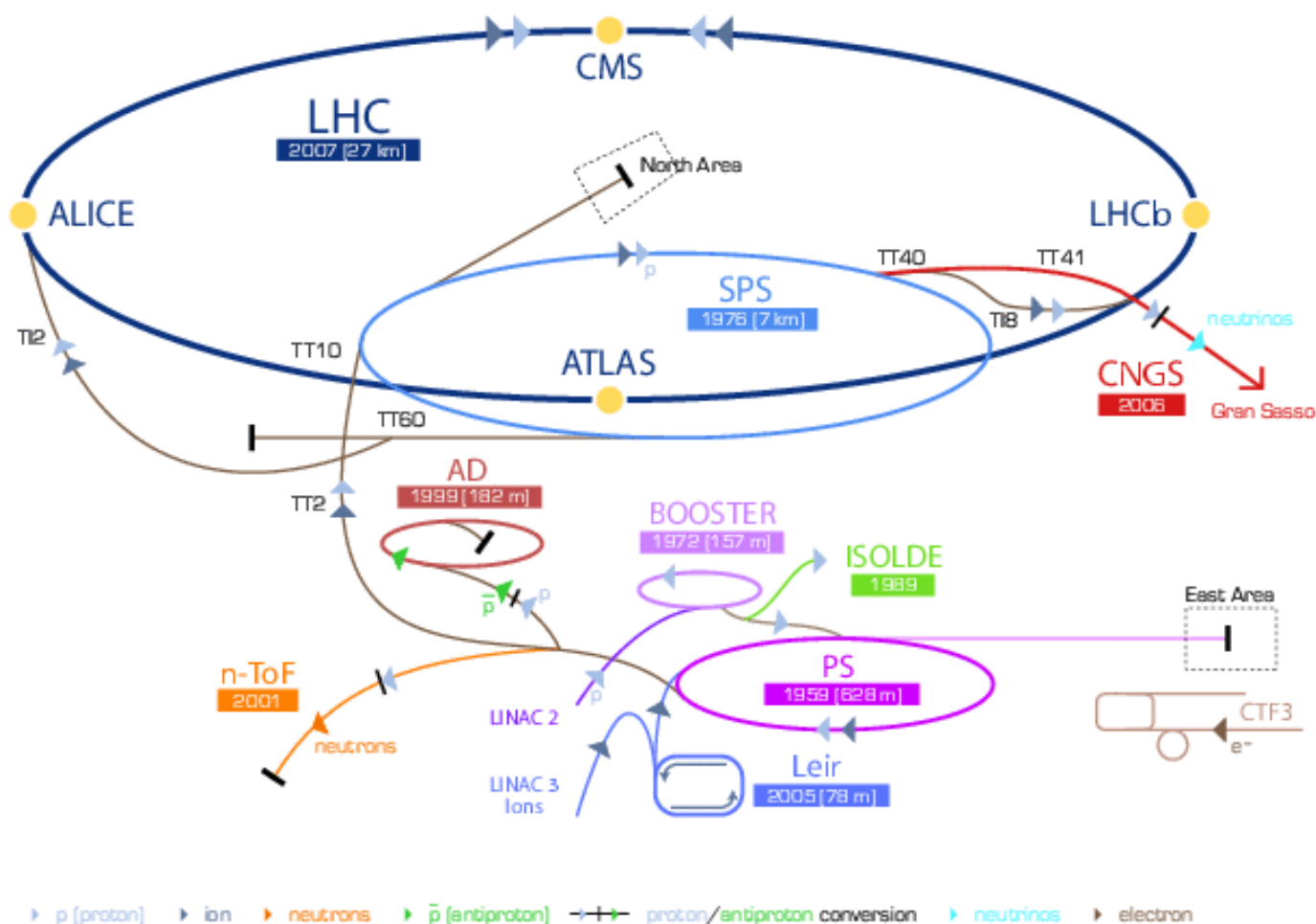
Charged hadron beam that loses energy in matter

Large-scale computing (Grid)



Grid computing for medical data management and analysis

CERN – world biggest accelerator complex





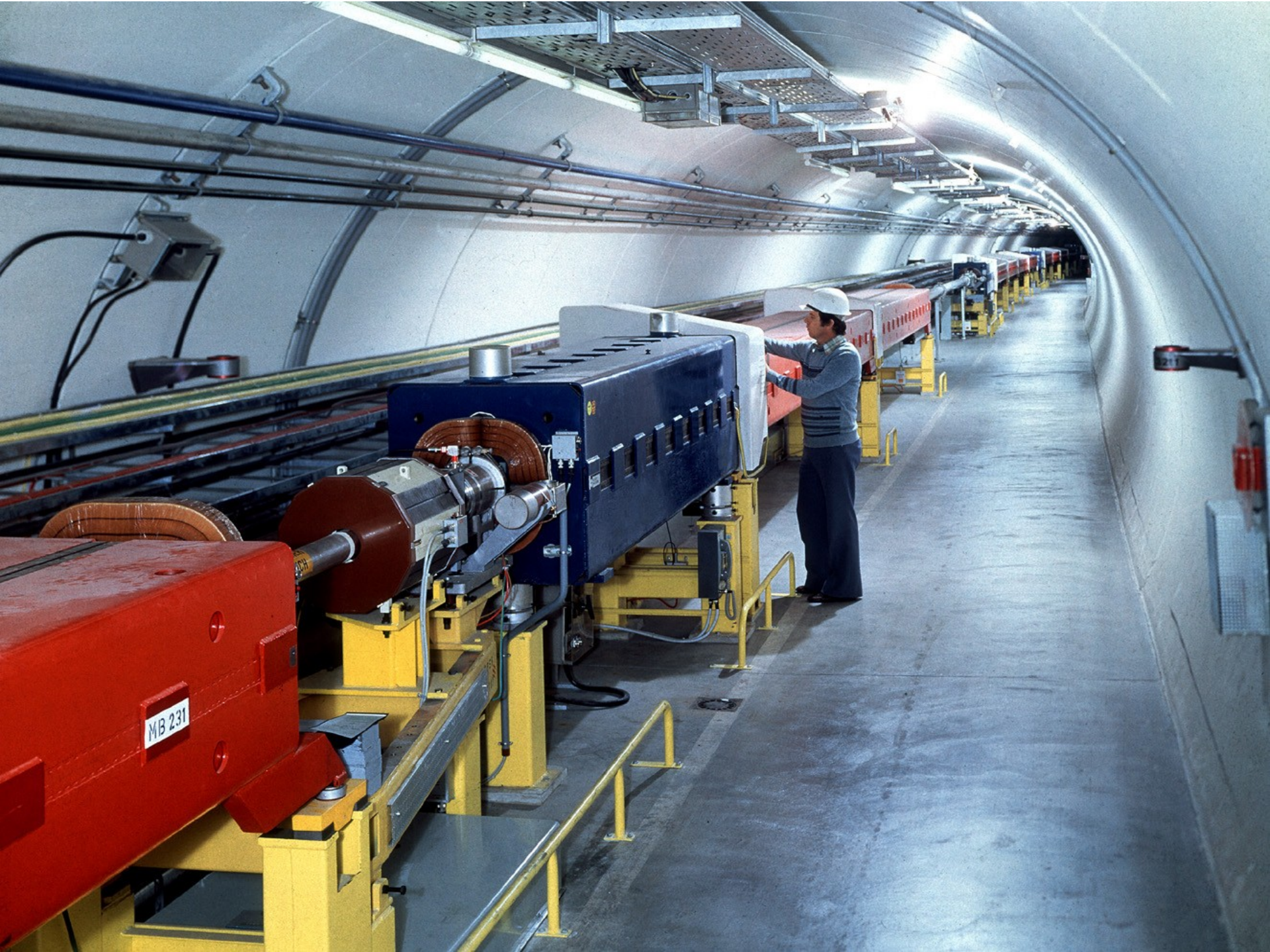


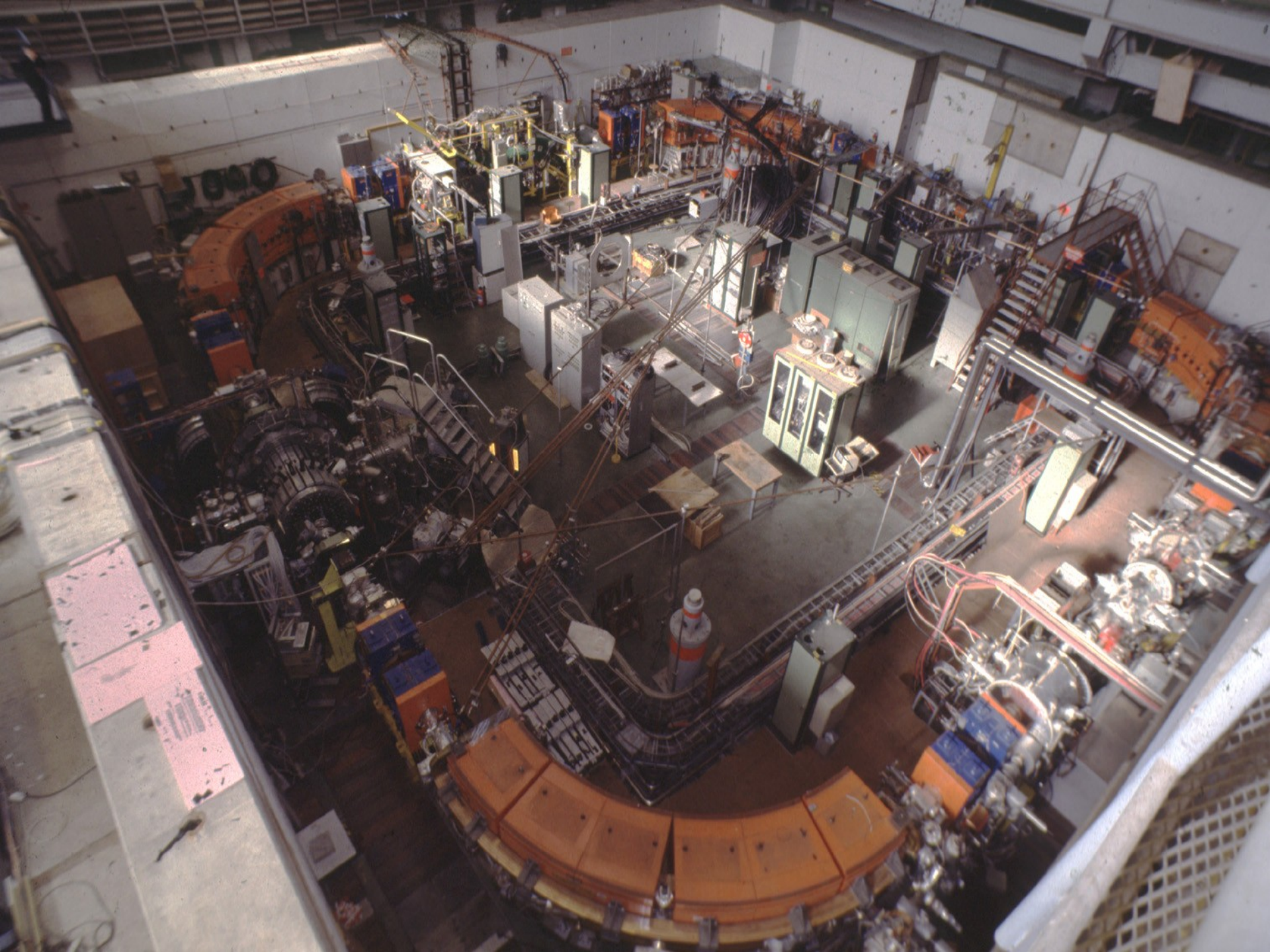
PA 312 3T

DANGER
RADIATION

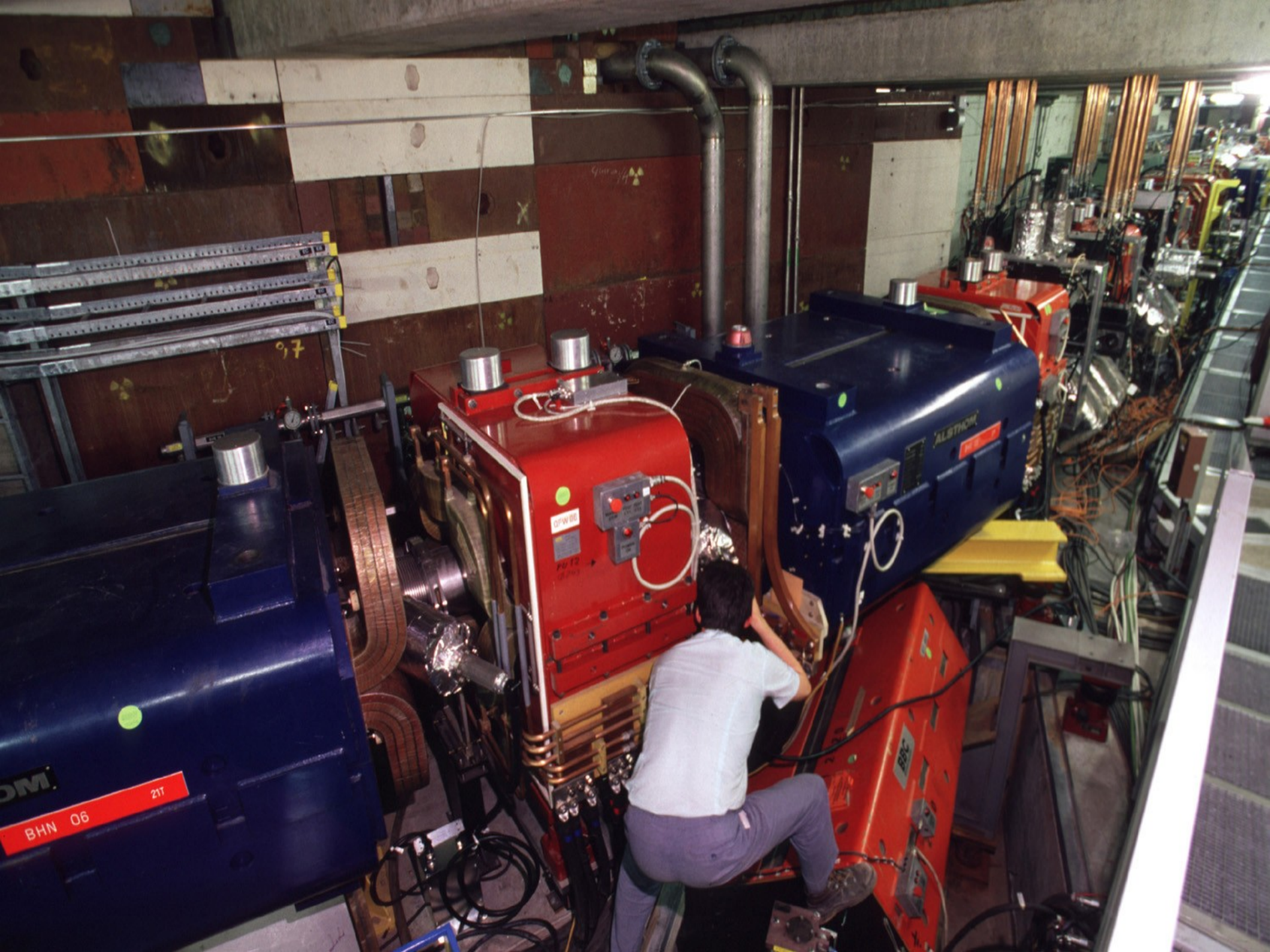


**PS - 50
years
of service!!**









BHN 06

21T

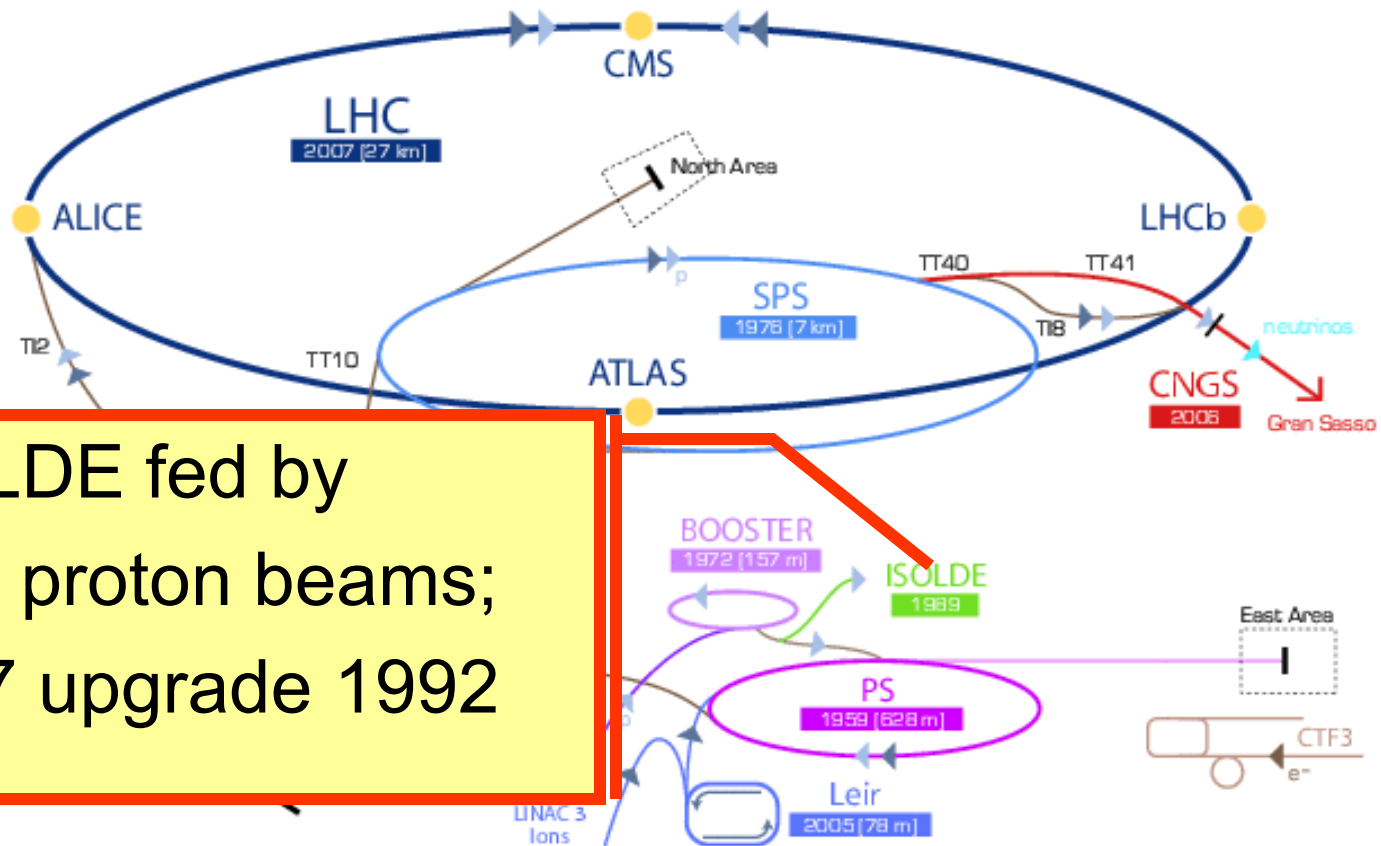
97

ALBTRON

OPWIS

FT2

CERN accelerator complex, working not only for LHC



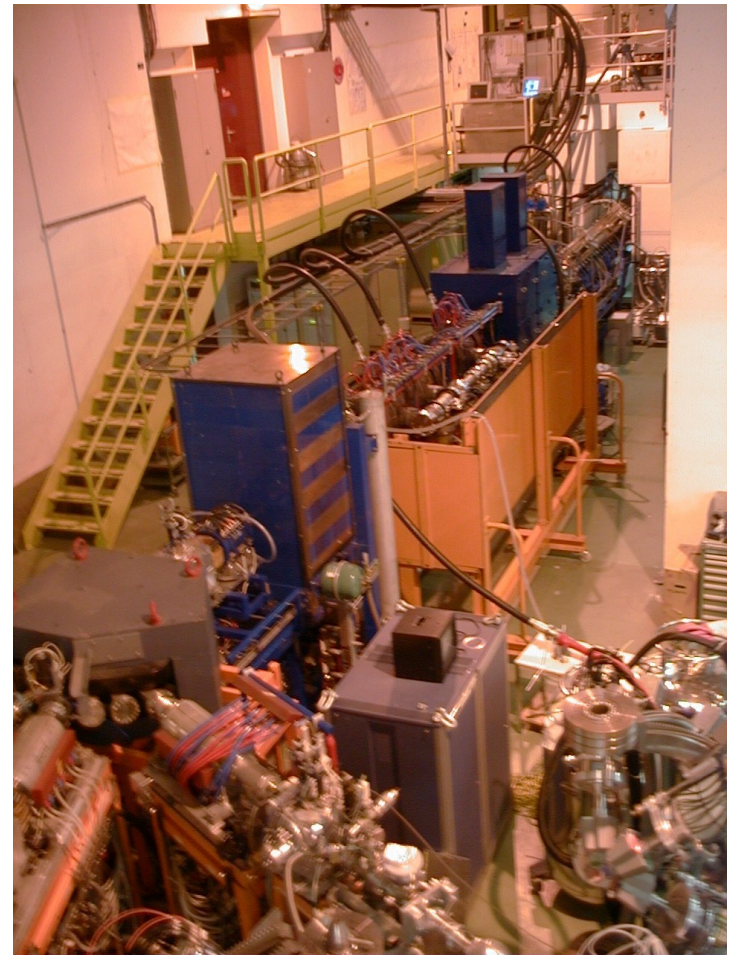
ISOLDE fed by
PSB proton beams;
1967 upgrade 1992

▶ p (proton) ▶ ion ▶ neutrons ▶ \bar{p} (antiproton) ▶ p/\bar{p} proton/antiproton conversion ▶ neutrinos ▶ electron

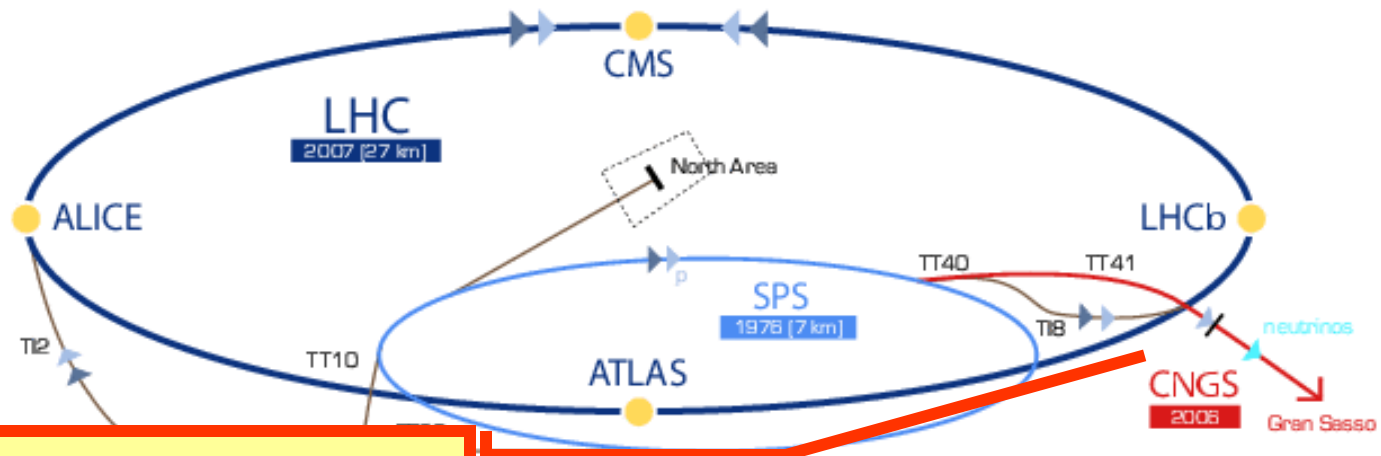
ISOLDE - Isotope Separator On Line, and Radioactive beam EXperiment (REX)

An alchemical factory for nuclear physics

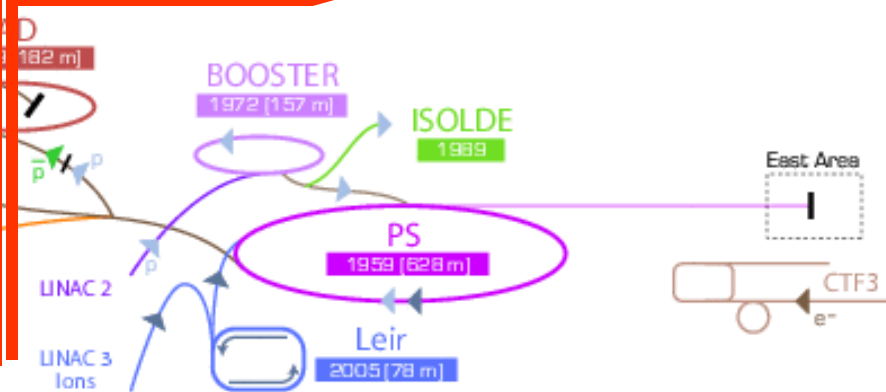
Low-energy beams of radioactive isotopes - atomic nuclei. The facility, located at the Proton-Synchrotron Booster (PSB), is like a small alchemical factory, changing one element to another. It produces a total of more than 1000 different isotopes for a wide range of research.



CERN accelerator complex, working not only for LHC !



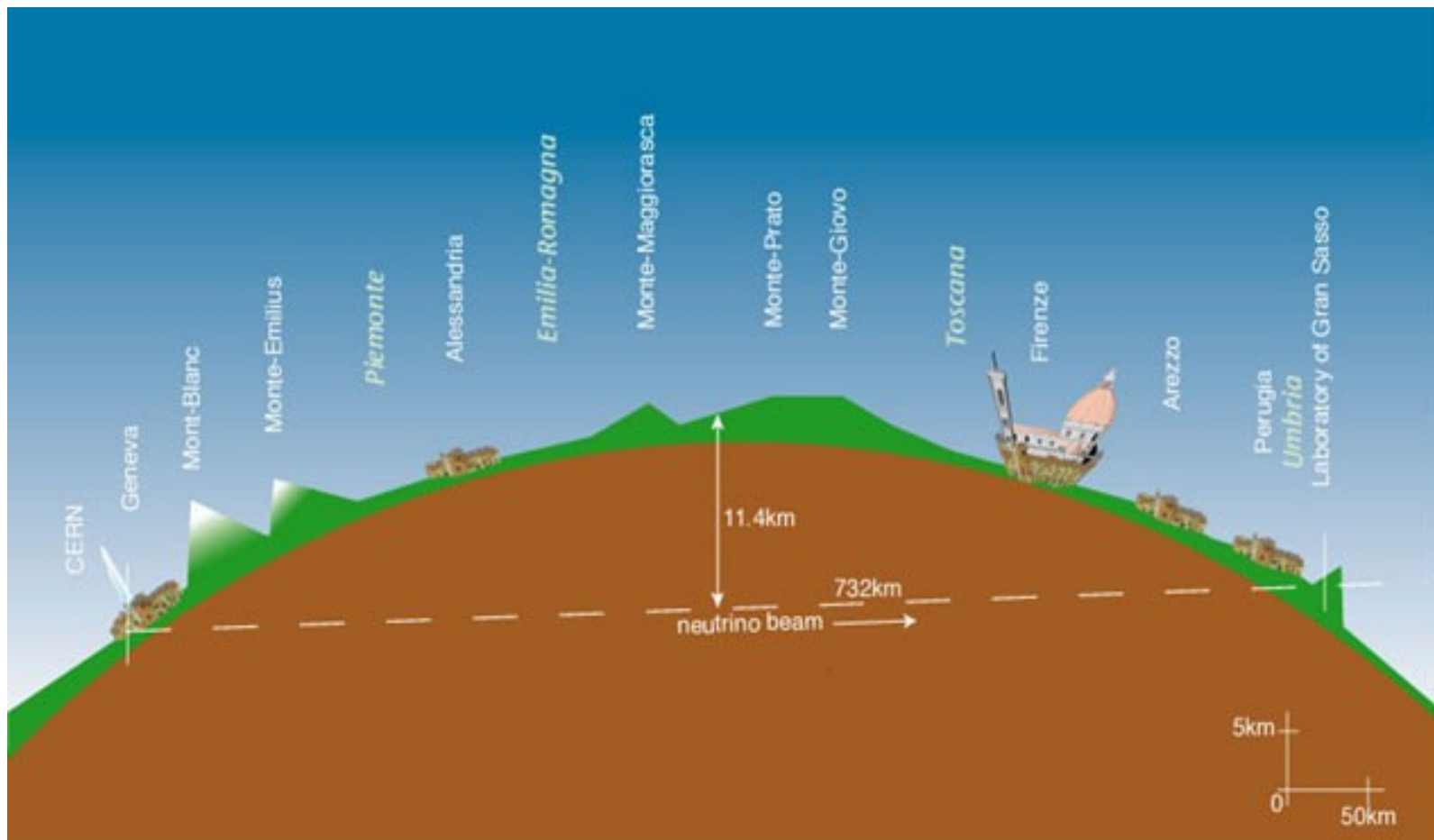
CNGS fed by
SPS proton beams



▶ p (proton) ▶ ion ▶ neutrons ▶ \bar{p} (antiproton) ▶ \leftrightarrow proton/antiproton conversion ▶ neutrinos ▶ electron

CNGS – CERN Neutrino to Gran Sasso experiment - investigation of the nature of neutrinos

CERN sends muon neutrinos to the Gran Sasso National Laboratory (LNGS), 732 km away in Italy. There, two experiments, OPERA and ICARUS, wait to find out if any of the muon neutrinos have transformed into tau neutrinos. To create the neutrino beam, a proton beam from the [Super Proton Synchrotron](#) (SPS) is used.



CERN was founded in 1954 by 12 European States

Today: 20 Member States



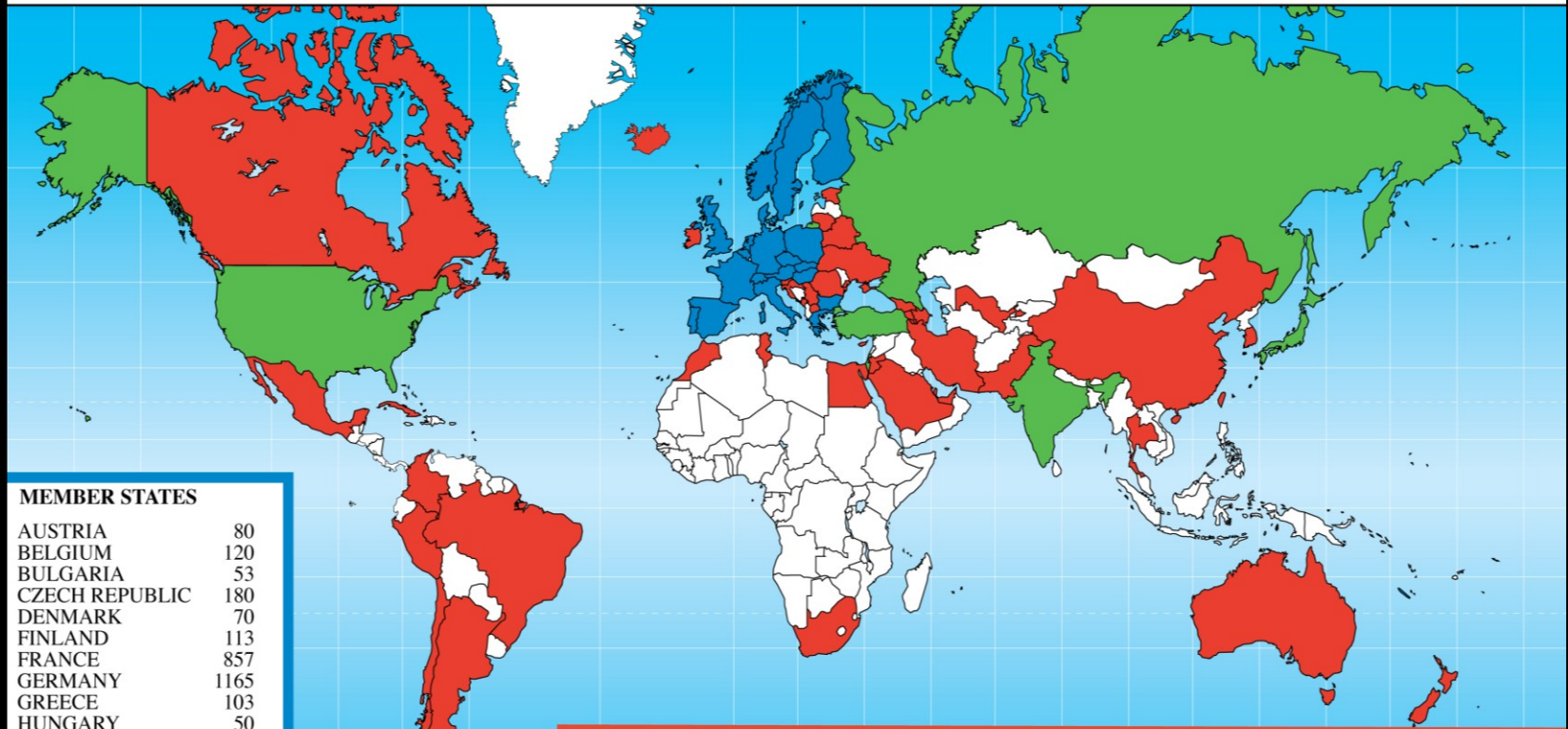
- ~ 2300 staff
- ~ 790 other paid personnel
- > 10000 users
- Budget (2010) ~1100 MCHF

- **20 Member States:** Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.
- **1 Candidate for Membership:** Romania.
- **8 Observers to Council:** India, Israel, Japan, the Russian Federation, the United States of America, Turkey, the European Commission and UNESCO

CERN in Numbers



Distribution of All CERN Users by Nation of Institute on 2 July 2010



MEMBER STATES

AUSTRIA	80
BELGIUM	120
BULGARIA	53
CZECH REPUBLIC	180
DENMARK	70
FINLAND	113
FRANCE	857
GERMANY	1165
GREECE	103
HUNGARY	50
ITALY	1409
NETHERLANDS	170
NORWAY	87
POLAND	189
PORTUGAL	137
SLOVAKIA	59
SPAIN	318
SWEDEN	70
SWITZERLAND	378
UNITED KINGDOM	713

OBSERVER STATES

INDIA	106
ISRAEL	46
JAPAN	177
USA	1774

OTHERS

ARGENTINA	9	CROATIA	15	MACEDONIA, F.Y.R.	1	SERBIA	22
ARMENIA	13	CUBA	4	MALTA	1	SLOVENIA	24
AUSTRALIA	18	CYPRUS	8	MEXICO	35	SOUTH AFRICA	8
AZERBAIJAN	1	EGYPT	5	MONTENEGRO	1	THAILAND	2
BELARUS	22	ESTONIA	11	MOROCCO	6	TUNISIA	1
BRAZIL	79	GEORGIA	10	NEW ZEALAND	10	UKRAINE	17
CANADA	159	ICELAND	1	PAKISTAN	19	U.A.E.	1
CHILE	5	IRAN	16	PALESTINIAN TERR.	1	UZBEKISTAN	1
CHINA	77	IRELAND	13	PERU	2		
CHINA (TAIPEI)	49	KOREA	59	QATAR	1		
COLOMBIA	12	JORDAN	1	ROMANIA	58		
		LITHUANIA	10	SAUDI ARABIA	1		

6321

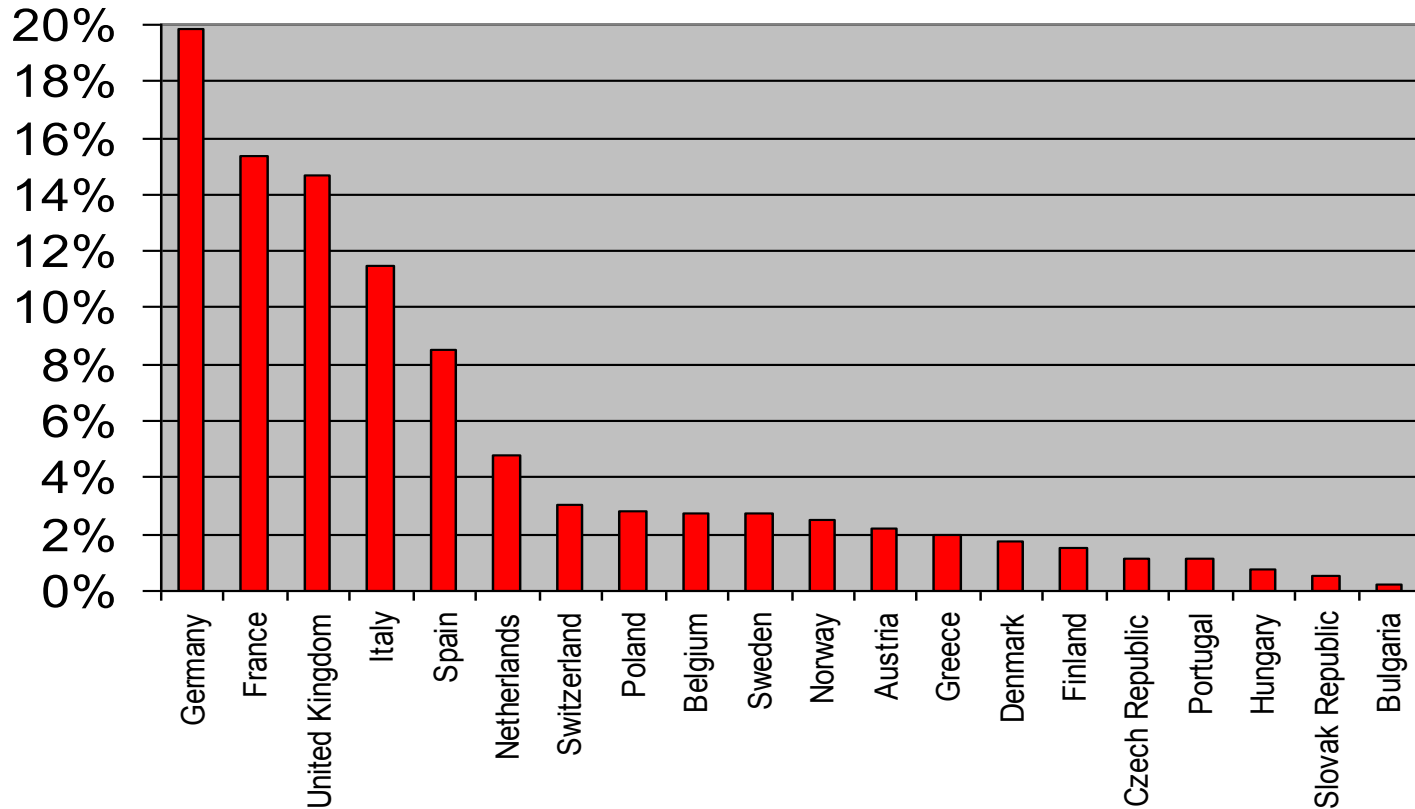
3029

810

Participation of Non-Member States in CERN scientific programmes

- **CERN is financed by 20 Member States, with annual contributions proportional to the Net National Income (or GDP), but has scientific and educational links with more than 100 countries!**
- **Non-Member States participate in financing selected Projects**
- **Over 40 Non-Member States participated in the LHC construction, providing around 1/6 th of its cost and over 3000 of physicists and engineers (over 1/3 of the total);**

CERN budget 2009 *



Annual Contributions to CERN as % of Total Budget

* 1098.49 MCHF

Contribution of CIS countries to LHC

(CIS - Содружество Независимых Государств, СНГ)

Important contribution of the Russian Federation

Estimated value for CERN: LHC Experiments & Accelerator – 160 MCHF

Highly appreciated contribution of other CIS countries.

Important role of JINR - Dubna in creating LHC collaborations with CIS countries →

**Armenia, Azerbaijan, Belarus,
Georgia, Ukraine (and also other JINR Members!)**

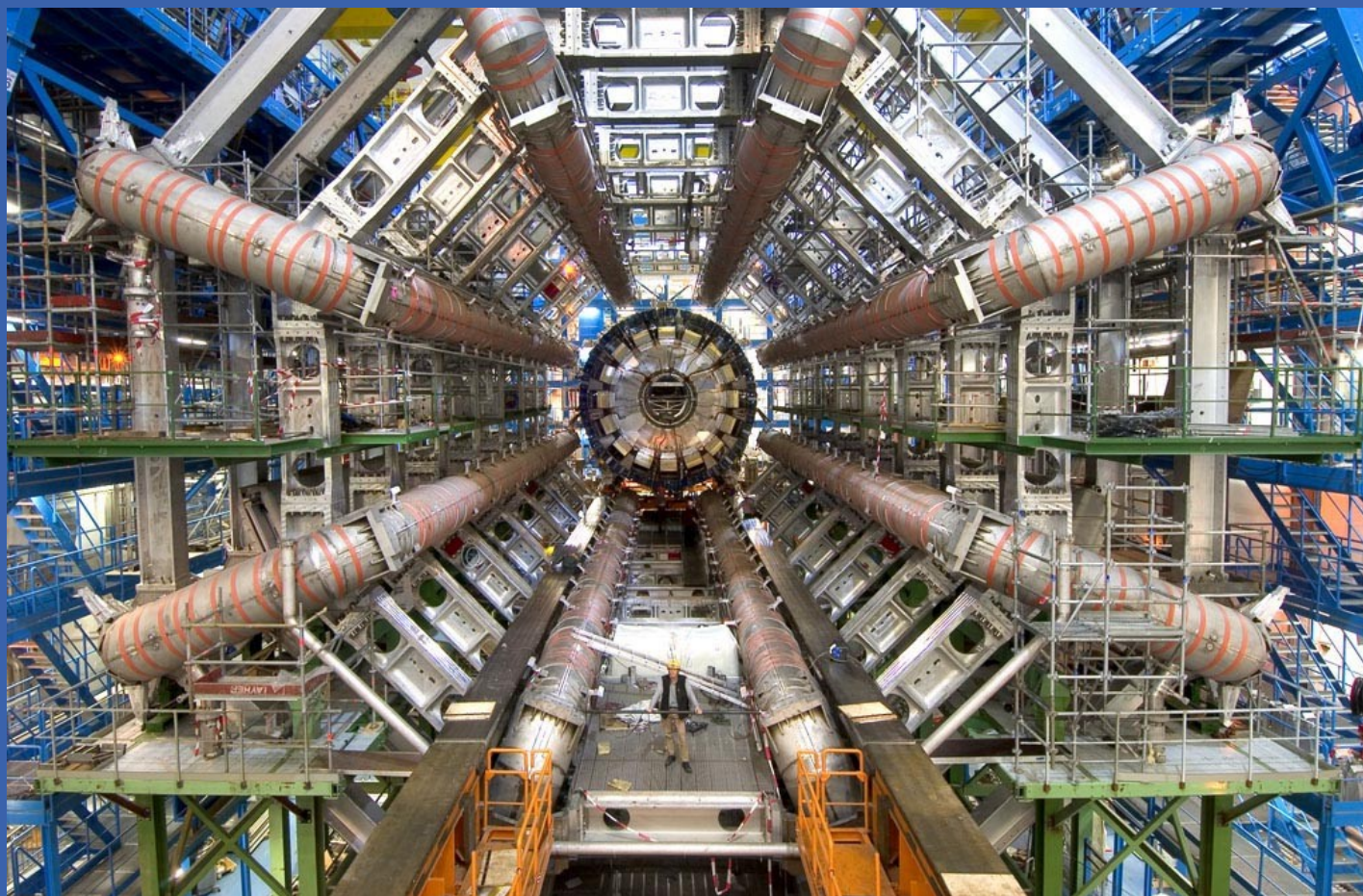
Example: Russia-Dubna Member States (RDMS) collaboration within CMS

Contribution of CIS countries to LHC

(CIS = Содружество Независимых Государств, СНГ)



Physicists and engineers from CIS countries have notably contributed to the construction of all LHC experiments (ATLAS, ALICE, CMS, LHCb) and to the LHC accelerator



Unique Technologies developed for LHC

Example: SCINTILLATING CRYSTALS - monocrystals of PbWO_4 developed and produced in Russia - the main elements (70'000 pieces!) in the Compact Muon Solenoid (CMS) detector at the CERN Large Hadron Collider (LHC)



CERN - Education

Apprentices

Accelerator School

Doctoral Students

Academic Training

Fellows

Physics School

Exhibitions

Computing School

CERN-Latin America School

Visits

Technical Students

Summer Students

Outreach

Microcosm

Science on Stage

Technical Training

Language Training

Conferences

Teachers programmes

Communications Training

Management Training





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





First course for Russian Teachers



CERN, November 2009
Family photo with
CERN,s Director
Prof. Heuer

TV "VESTI" reporting on
November 03, 2009

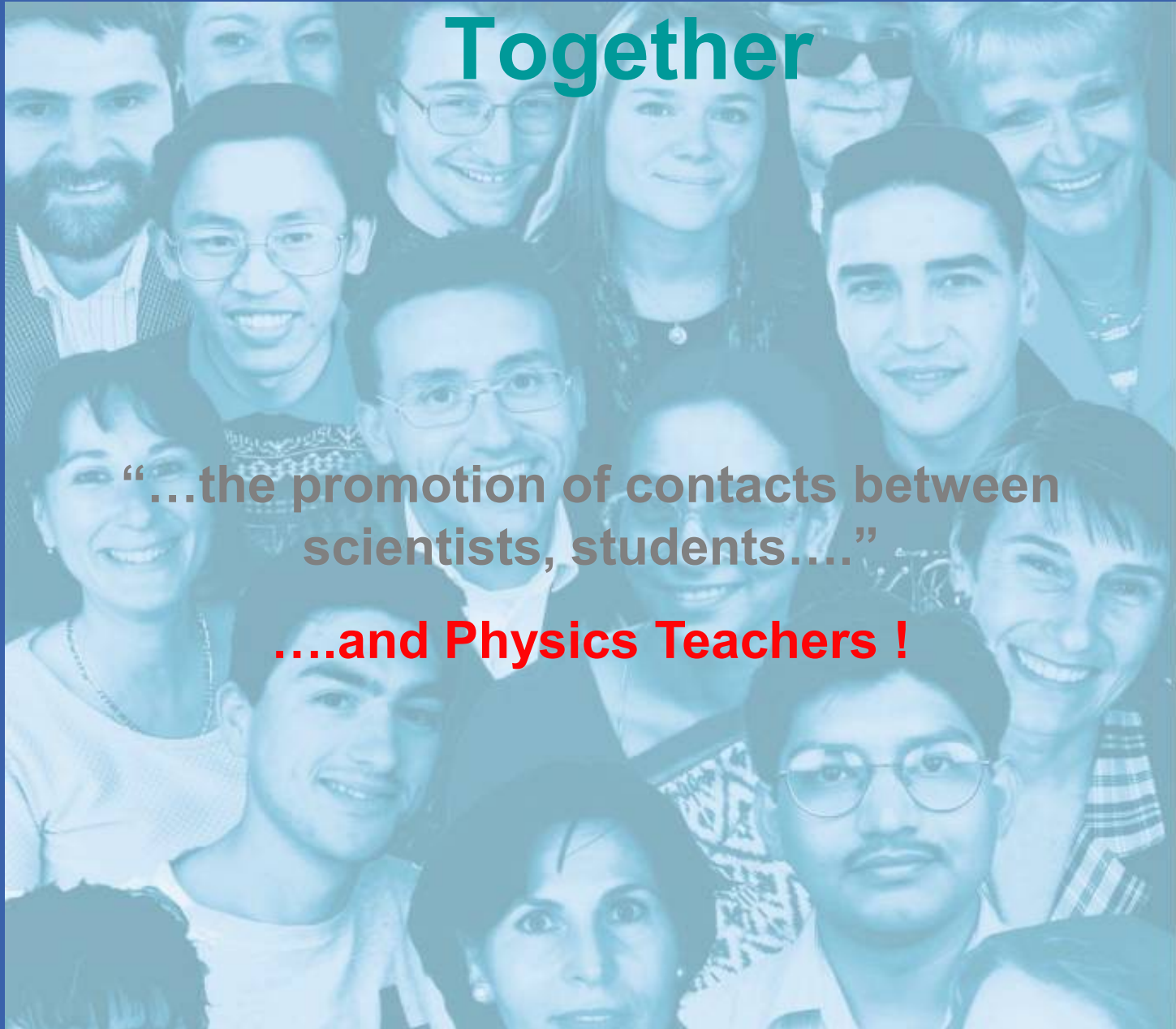


Science Bringing Nations

Together

“...the promotion of contacts between
scientists, students....”

....and Physics Teachers !



An aerial photograph of a rural landscape, likely in a valley, showing a patchwork of green and brown agricultural fields. A large, thin white circle is drawn over the center of the image, framing the text. In the background, a river flows through the valley, and a large body of water is visible on the right side. The foreground shows a more developed area with buildings and roads.

Thank you!
Спасибо!