

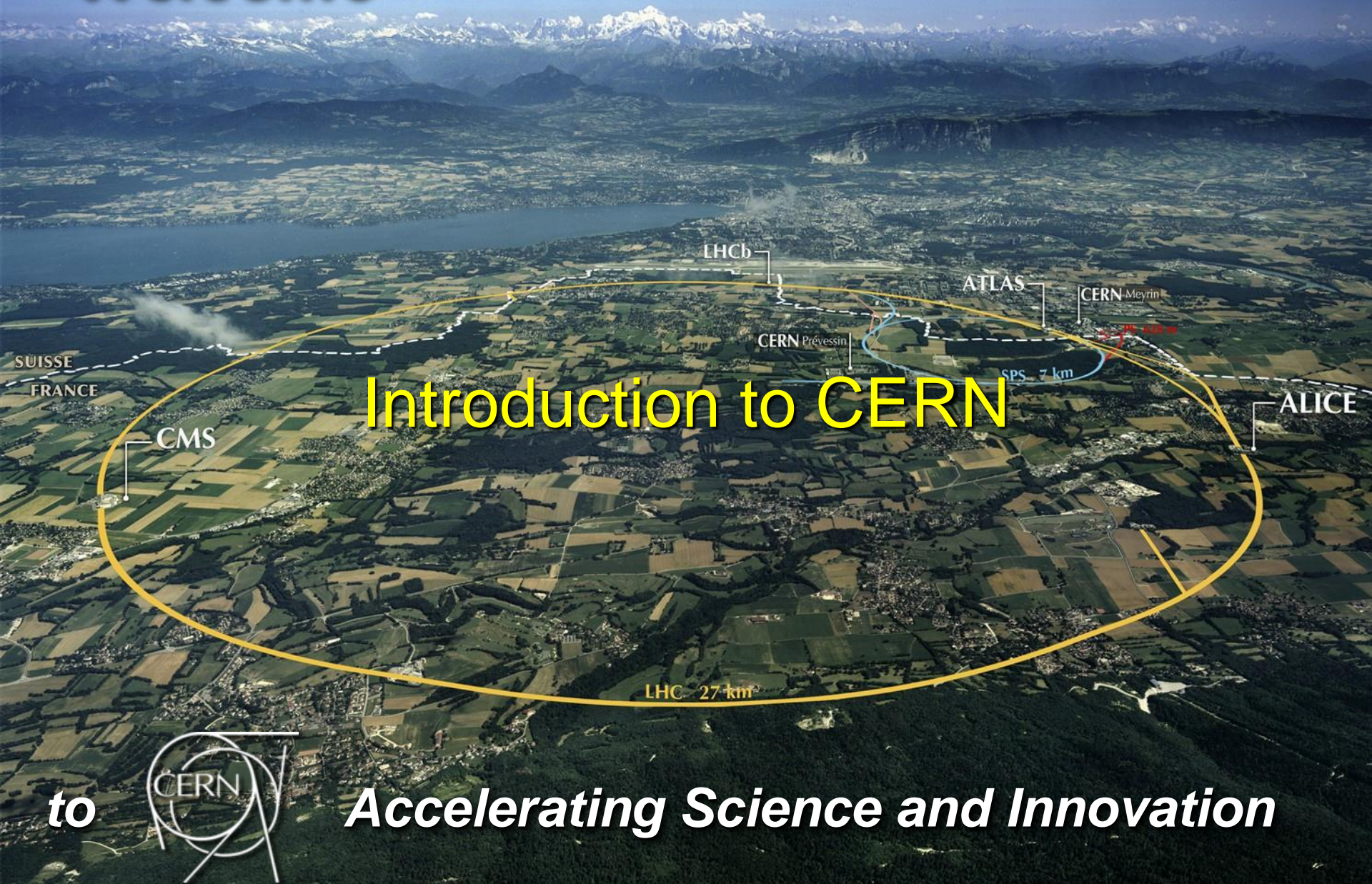


# Ukrainian Teachers Programme



**CERN, 15 October 2012**

# Welcome

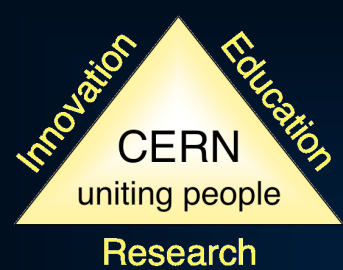


## Introduction to CERN

to



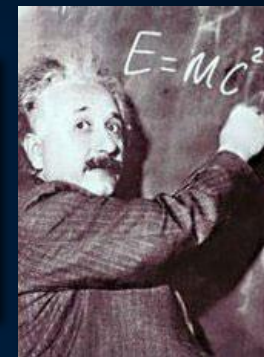
**Accelerating Science and Innovation**



# The Mission of CERN

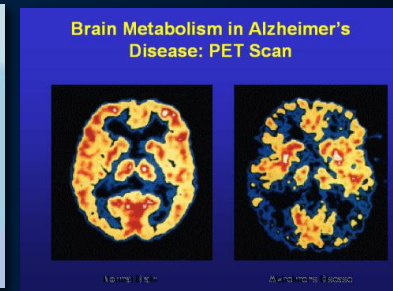
- ❑ **Push forward** the frontiers of knowledge

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

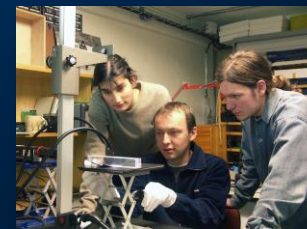


- ❑ **Develop** new technologies, accelerators and detectors

Information technology  
Medicine - diagnosis and therapy



- ❑ **Train** scientists and engineers of tomorrow



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



# CERN was founded 1954: 12 European States

“Science for Peace”

## Today: 20 Member States

~ 2300 staff

~ 1050 other paid personnel

> 11000 users

Budget (2012) ~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

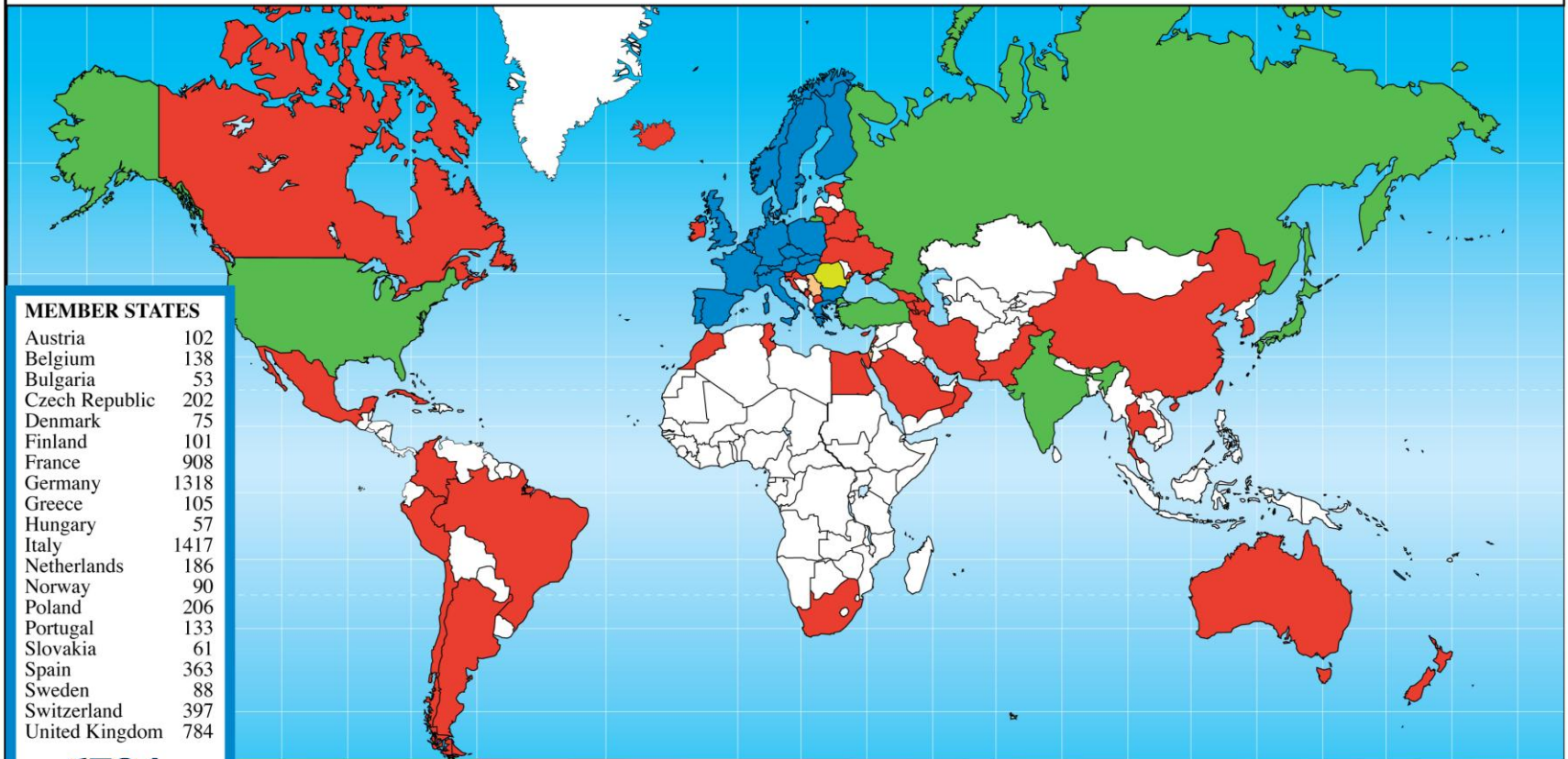
**Associate Members in the Pre-Stage to Membership:** Israel, Serbia

**Applicant States:** Cyprus, Slovenia, Turkey

**Observers to Council:** India, Japan, the Russian Federation, the United States of America, Turkey, the European Commission and UNESCO

# Science is getting more and more global

## Distribution of All CERN Users by Nation of Institute on 4 April 2012



### MEMBER STATES

Austria	102
Belgium	138
Bulgaria	53
Czech Republic	202
Denmark	75
Finland	101
France	908
Germany	1318
Greece	105
Hungary	57
Italy	1417
Netherlands	186
Norway	90
Poland	206
Portugal	133
Slovakia	61
Spain	363
Sweden	88
Switzerland	397
United Kingdom	784

**6784**

### OBSERVERS

India	134
Japan	225
Russia	859
Turkey	83
USA	1749

**3050**

### CANDIDATE FOR ACCESSION

Romania	78
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### ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Israel	67
Serbia	26

### OTHERS

Argentina	18
Armenia	13
Australia	28
Azerbaijan	1
Belarus	22
Brazil	102
Canada	170
Chile	4

China	115
China (Taipei)	70
Colombia	10
Croatia	21
Cuba	4
Cyprus	9
Egypt	7
Estonia	17
Georgia	10
Iceland	3

Iran	16
Ireland	10
Korea	91
Lebanon	1
Lithuania	13
Malta	1
Mexico	43
Montenegro	1
Morocco	6
New Zealand	11

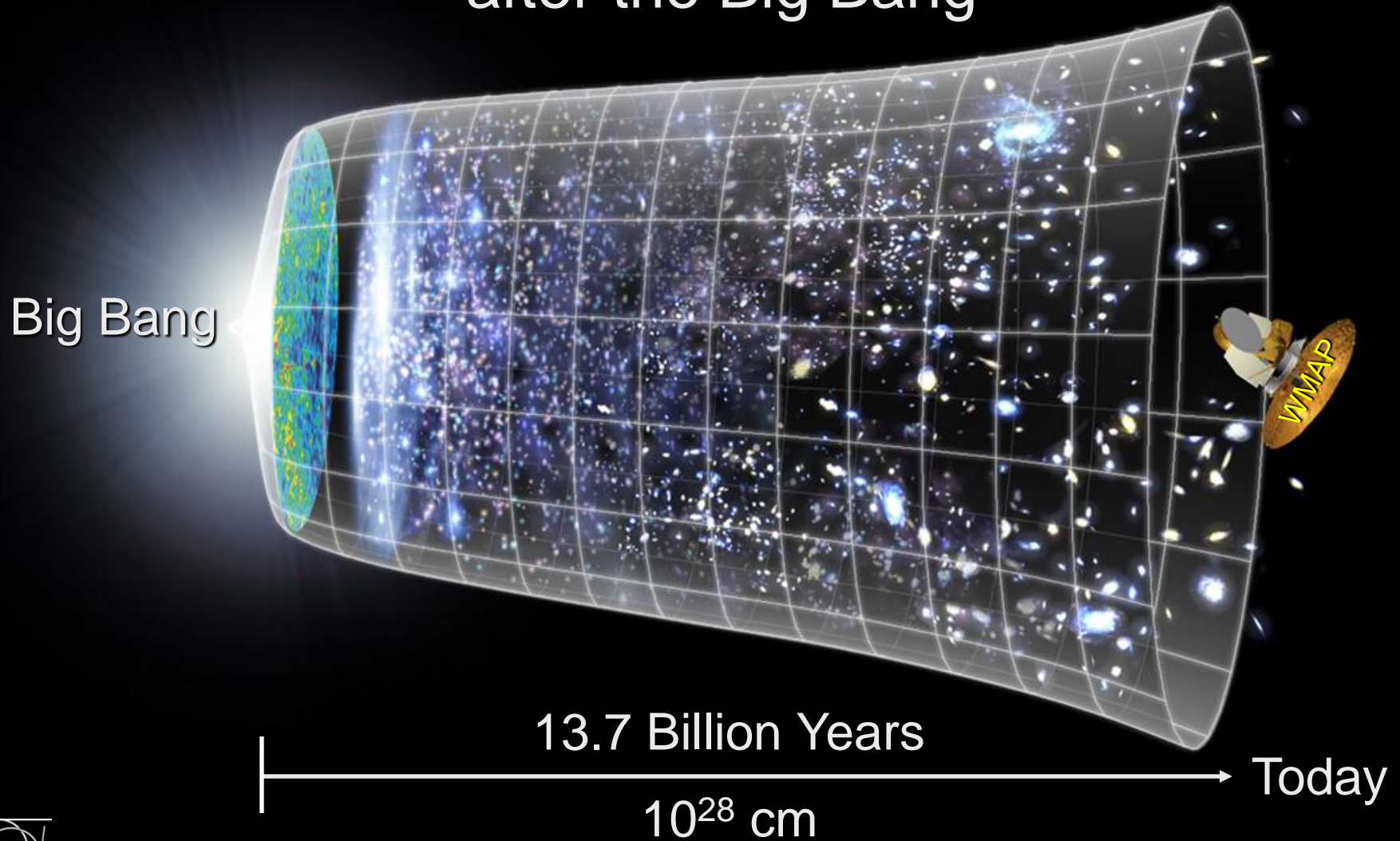
Oman	1
Pakistan	22
Peru	2
Qatar	1
Saudi Arabia	3
Slovenia	38
South Africa	21
Thailand	5
T.F.Y.R.O.M.	2
Tunisia	1

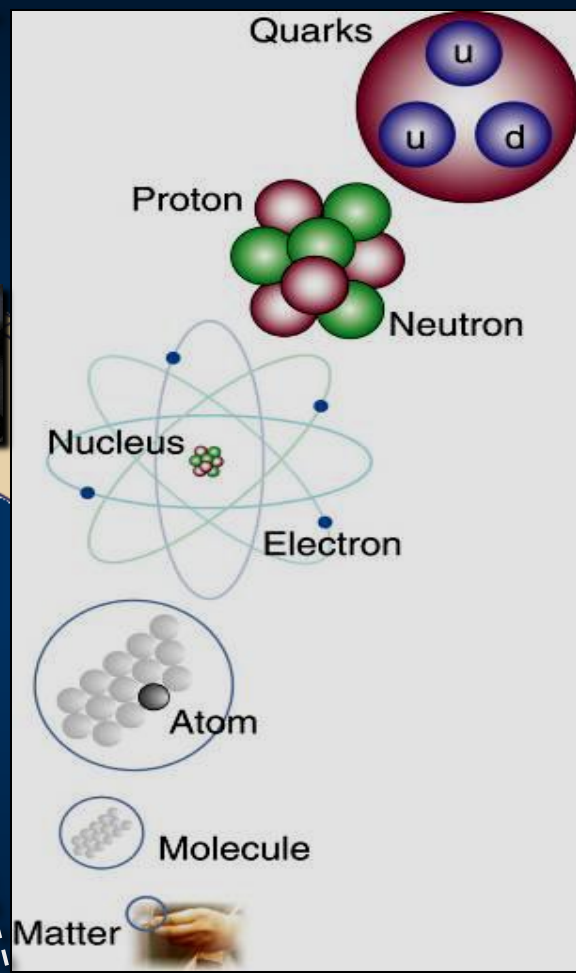
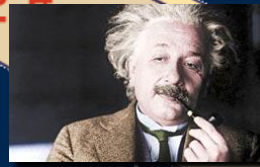
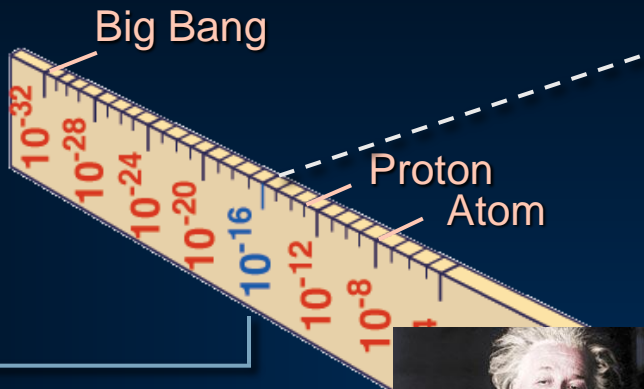
Ukraine	21
Uzbekistan	1

**934**

# Next Scientific Challenge:

to understand the very first moments of our Universe  
after the Big Bang





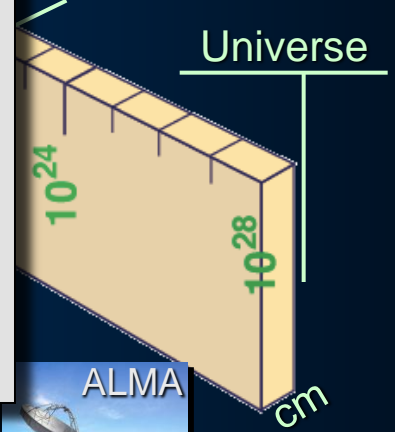
LHC

Super-Microscope



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

Radius of Galaxies

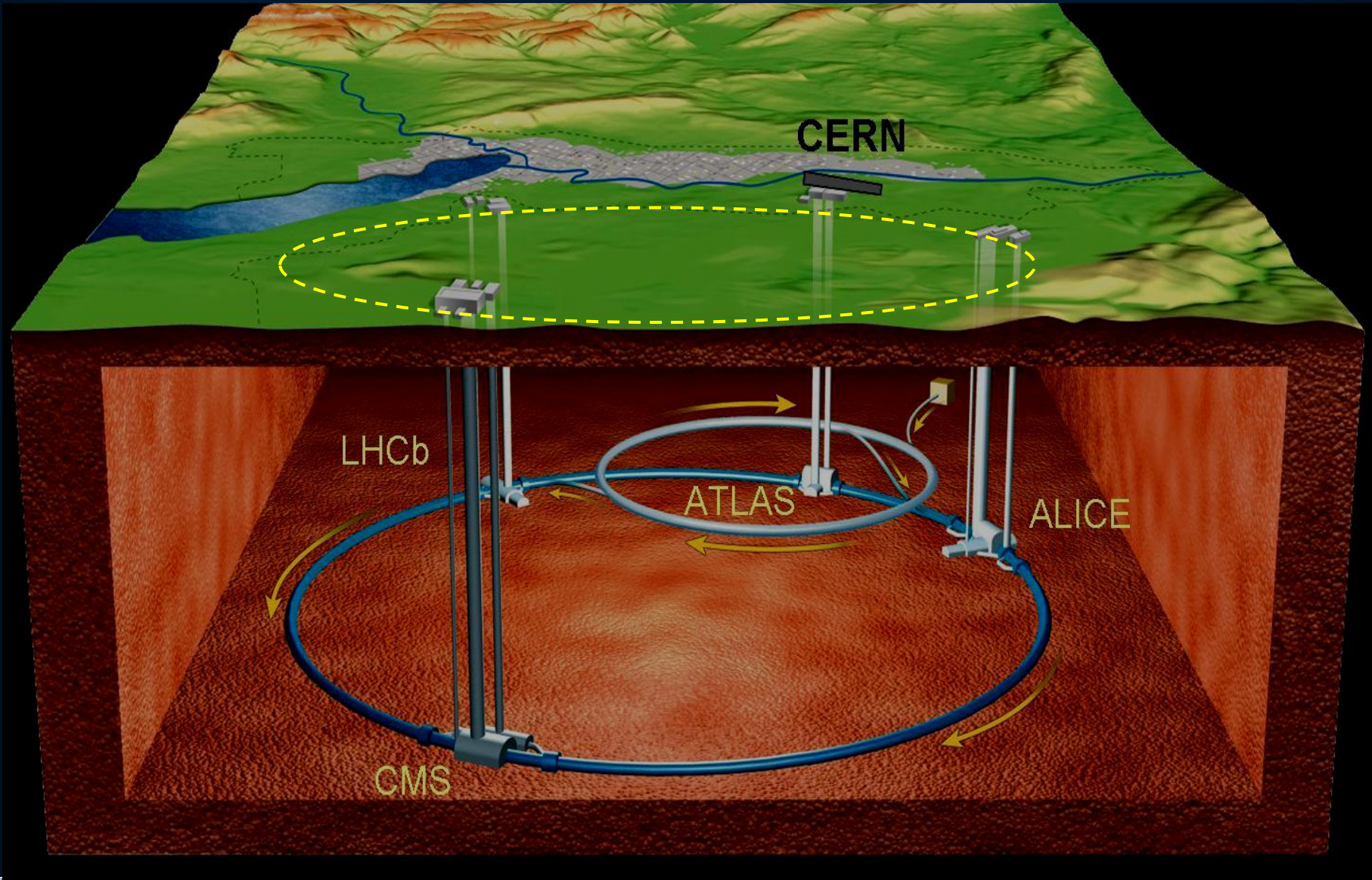


# Enter a New Era in Fundamental Science



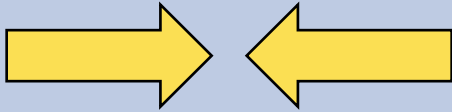


# LHC – Large Hadron Collider

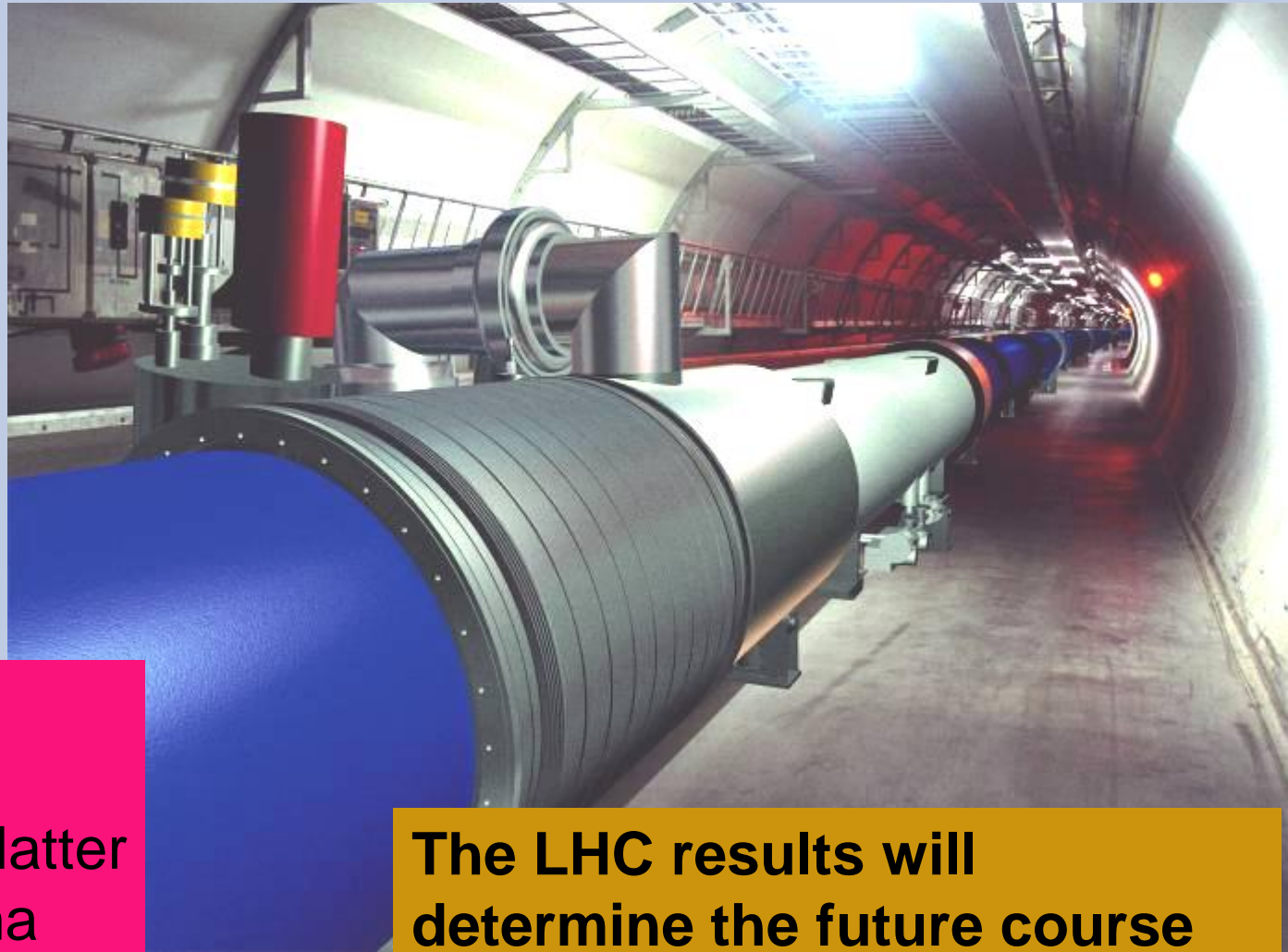


# LHC - Large Hadron Collider

7 TeV + 7 TeV



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



Primary targets:

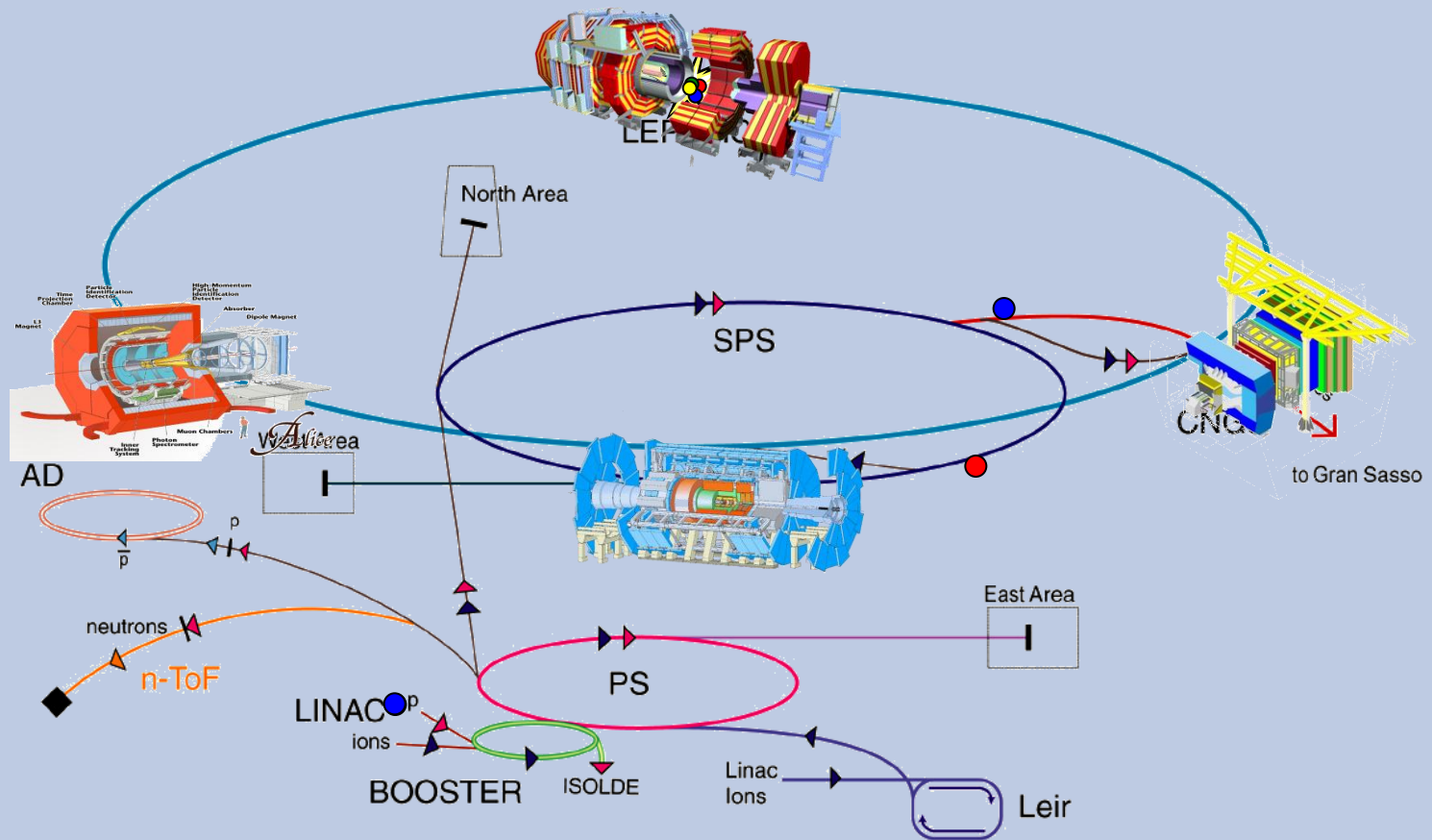
- Origin of mass
- Nature of Dark Matter
- Primordial Plasma
- Matter vs Antimatter

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

# Large Hadron Collider

Collision of proton beams...

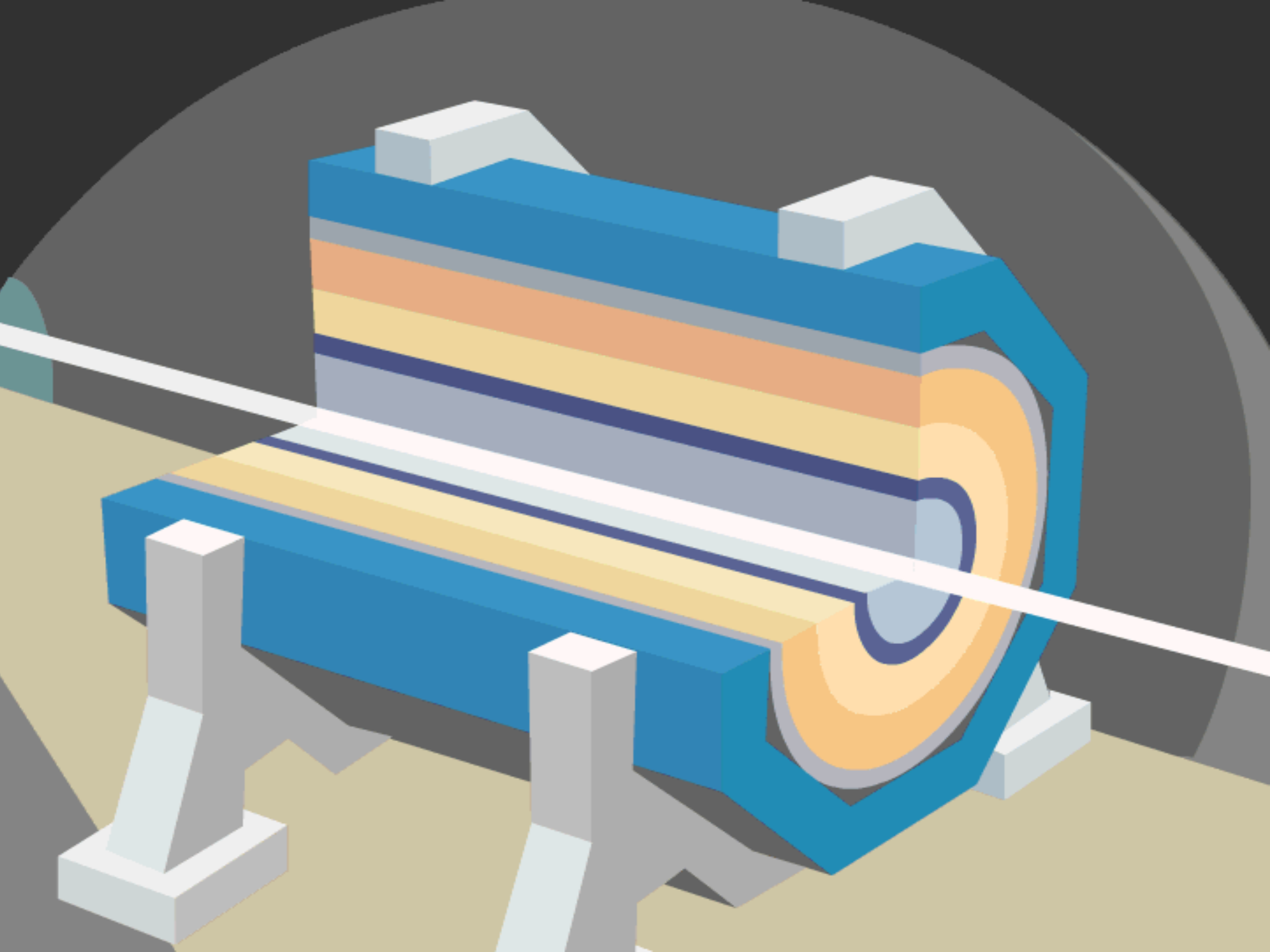
...observed in giant detectors



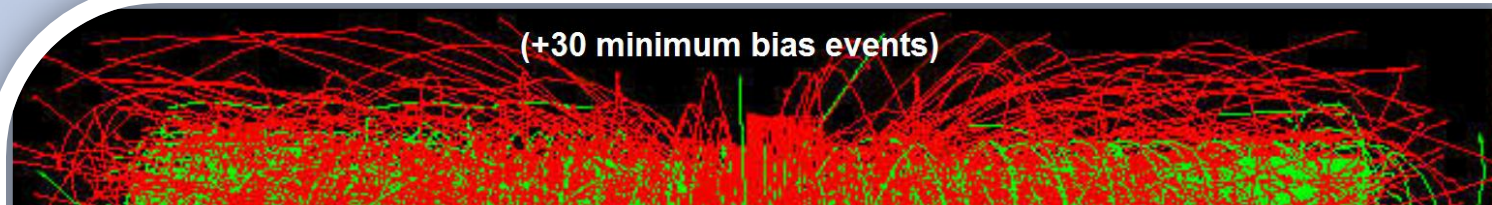
- ▶ p (proton)
- ▶ ion
- ▶ neutron
- ▶  $\bar{p}$  (antiproton)
- ▶  $\bar{\nu}$  proton/antiproton conversion
- ▶ neutrino

- AD Antiproton Decelerator
- PS Proton Synchrotron
- SPS Super Proton Synchrotron

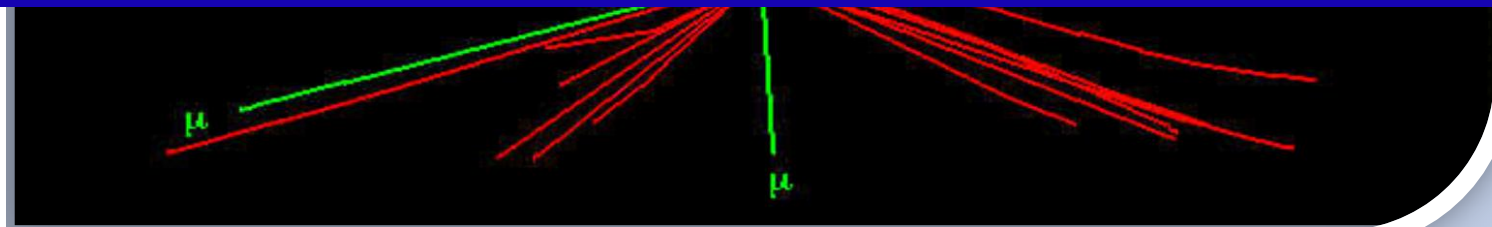
- LHC Large Hadron Collider
- n-ToF Neutron Time of Flight
- CNGS CERN Neutrinos to Gran Sasso



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



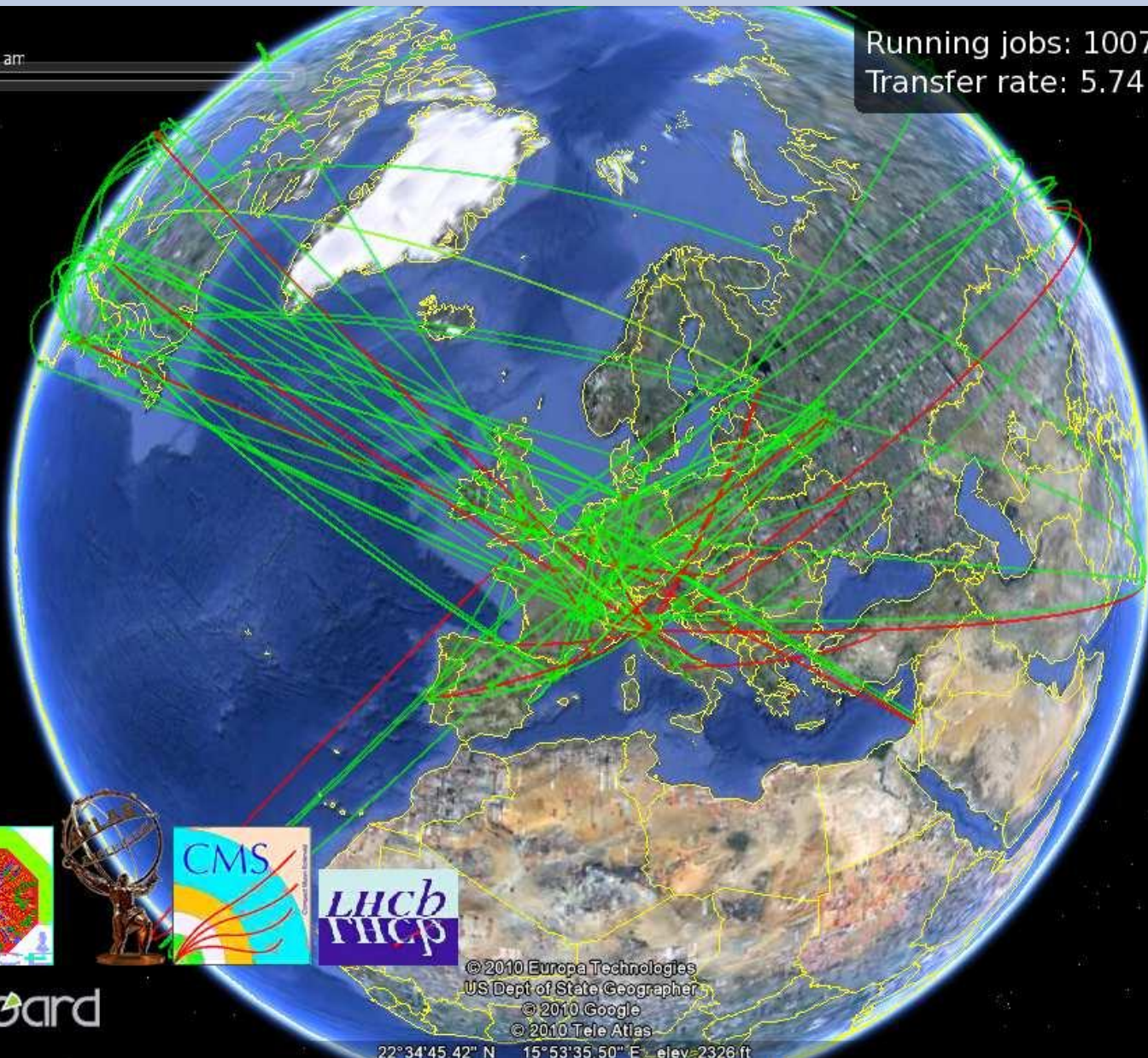
- LHC experiments produce **10-15 million Gigabytes** of data each year (about 20 million CDs!)
- LHC data analysis requires a computing power equivalent to **~100,000 of today's fastest PC processors.**



# LCG-LHC Computing GRID

Oct 6, 2010 7:20:00 am

Running jobs: 100767.0  
Transfer rate: 5.74 GiB/sec



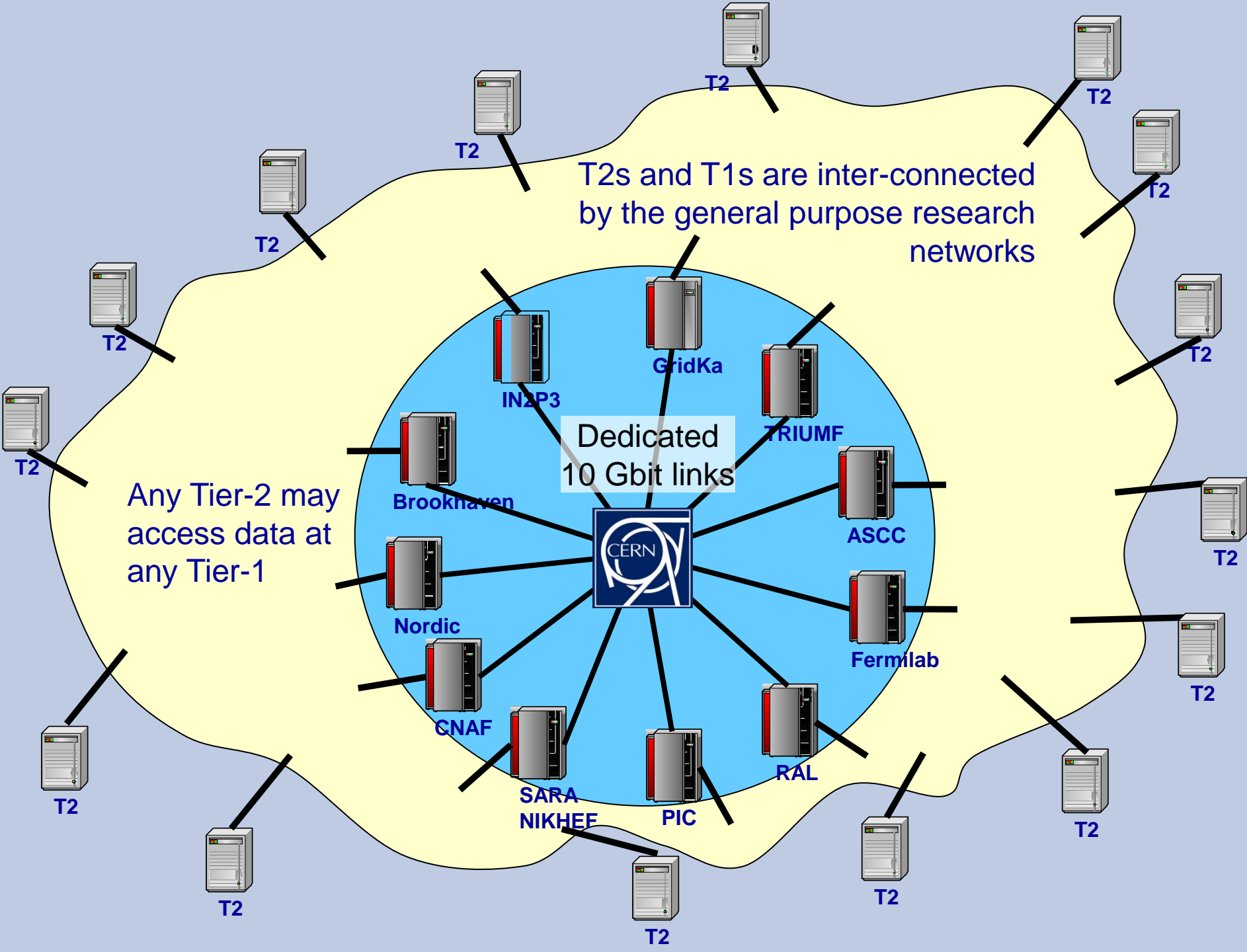
© 2010 Europa Technologies  
US Dept of State Geographer

© 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



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

CNAF

Nordic

T2

T2

T2

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T2

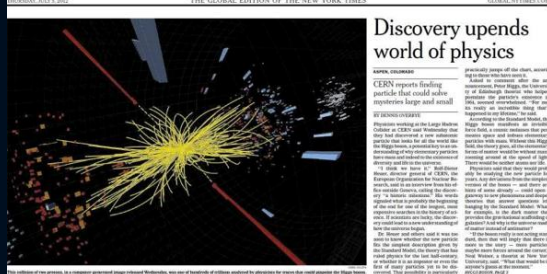
T2

T2

T2

T2

4 JULY 2012 CERN Press conference



Discovery opens world of physics

CERN reports finding particle that could solve mysteries large and small



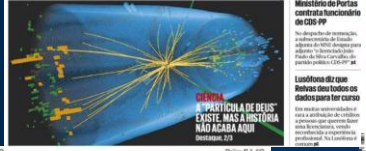
A giant leap for science

Finding the Higgs boson



ヒッグス粒子発見か 新素粒子検出 年内に結論

Milhares de moradores de bairros sociais em risco de perderem RSI



Le Monde Science : la matière dévoilée

Science : la matière dévoilée

MK newspaper cover with headline 'ПОСЛЕДНИЙ КИРПИЧ В СТЕНУ МИРОЗДАНИЯ' and other news items.

AD ALGEMEEN DAGBLAD newspaper cover featuring a portrait of a man and a particle detector visualization.

Frankfurter Allgemeine newspaper cover with headline 'Zieke Kaj en zij moeder toch samen in de VS'.

CHINADAILY newspaper cover with headline 'fallada la partícula clave para a comprensión del universo'.

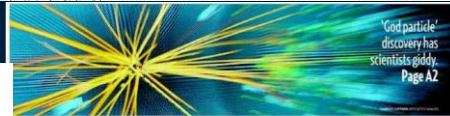
THE TIMES OF INDIA newspaper cover with headline 'Big bang moment: Scientists may have found 'God particle''.

THE HINDU newspaper cover with headline 'Elusive particle found, looks like Higgs boson'.

CORRIERE DELLA SERA newspaper cover with headline 'La particella che può svelare i segreti dell'universo'.

gazeta WYBORCZA.PL newspaper cover with headline 'Czastke Higgsa fizycy najpierw wymyślił, potem szukali 40 lat'.

বিশ্বনাথ 'স্বপ্ন' দর্শন newspaper cover with headline 'বিশ্বনাথ 'স্বপ্ন' দর্শন'.



The Gazette EL PAIS

fallada la partícula clave para a comprensión del universo

La Aduencia Nacional imputa a toda la cúpula de Bankia

CHINADAILY newspaper cover with headline 'MOVIE PLOT Iron Man film company looks to China for screen success'.

THE TIMES OF INDIA newspaper cover with headline 'Big bang moment: Scientists may have found 'God particle''.

বিশ্বনাথ 'স্বপ্ন' দর্শন newspaper cover with headline 'বিশ্বনাথ 'স্বপ্ন' দর্শন'.

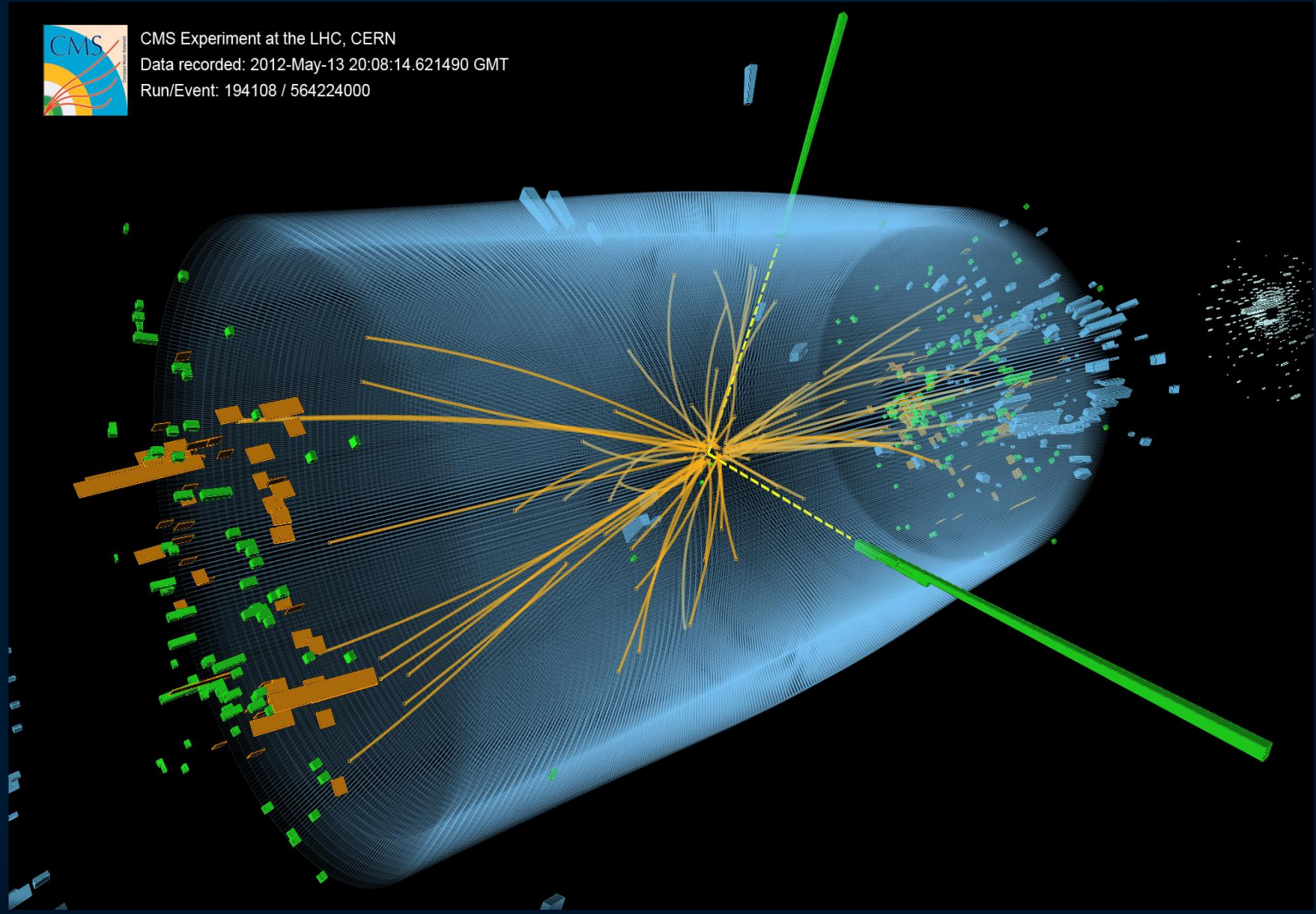




4 July 2012: CERN press conference



# “CERN experiments observe particle consistent with long-sought Higgs boson”



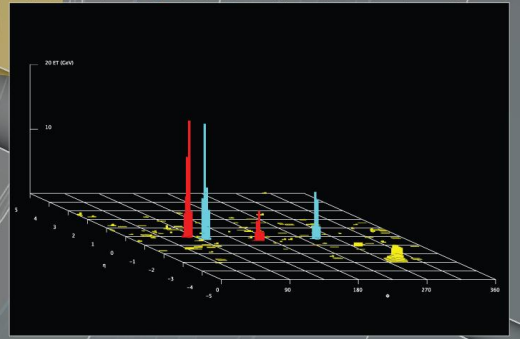
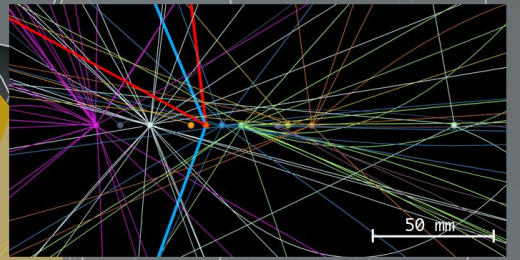
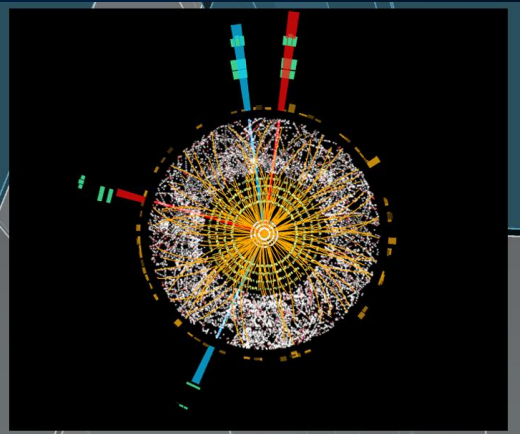
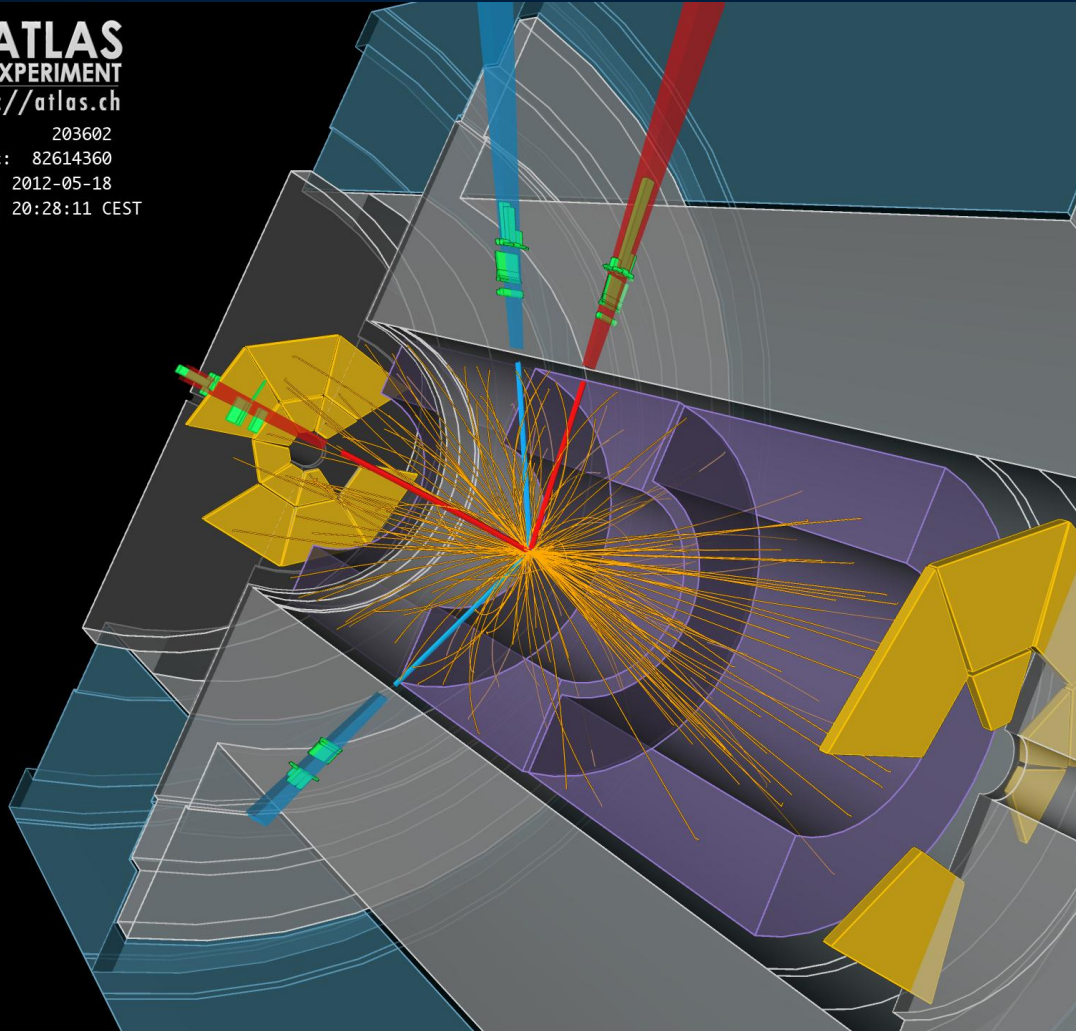


4 July 2012: CERN press conference

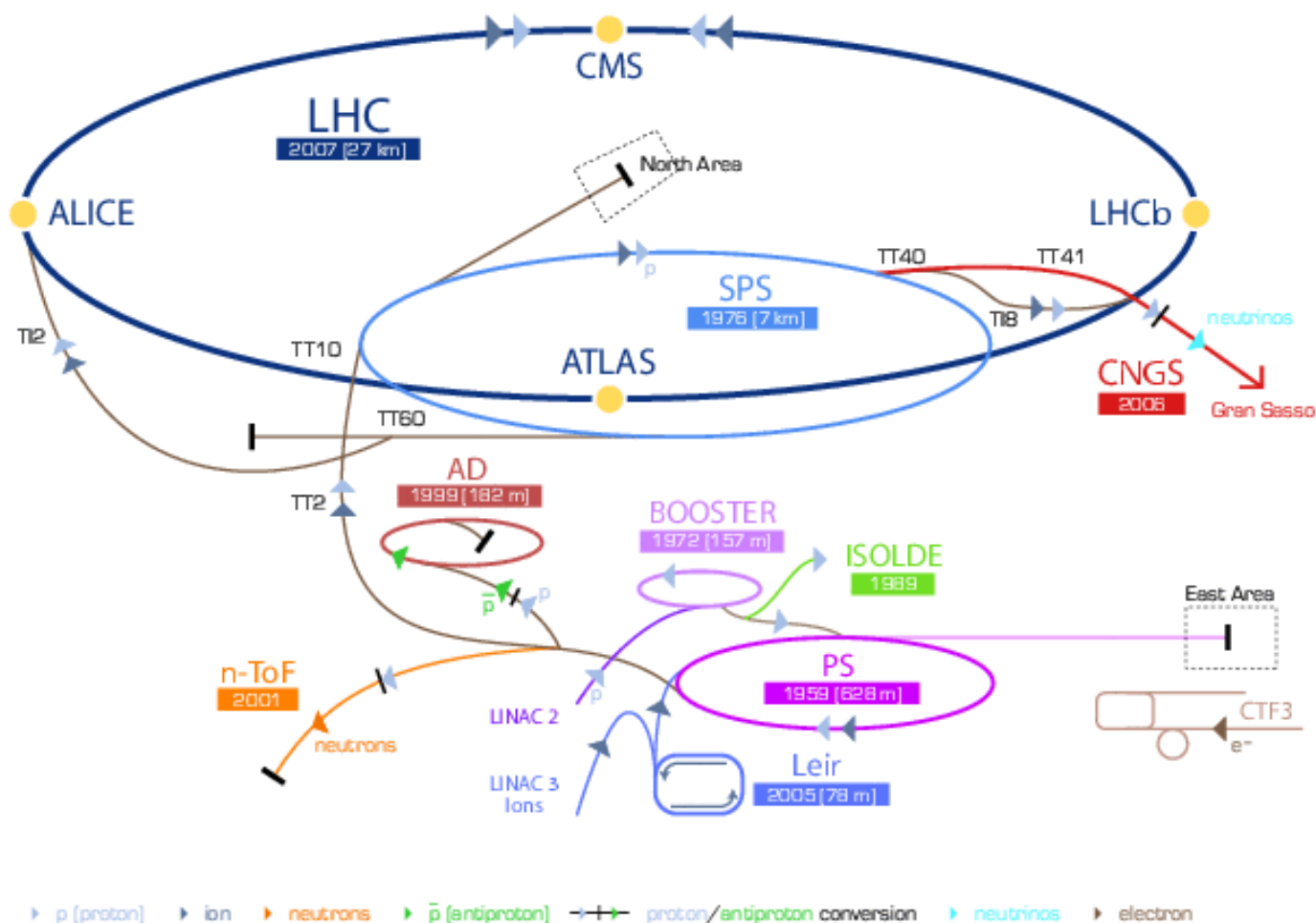


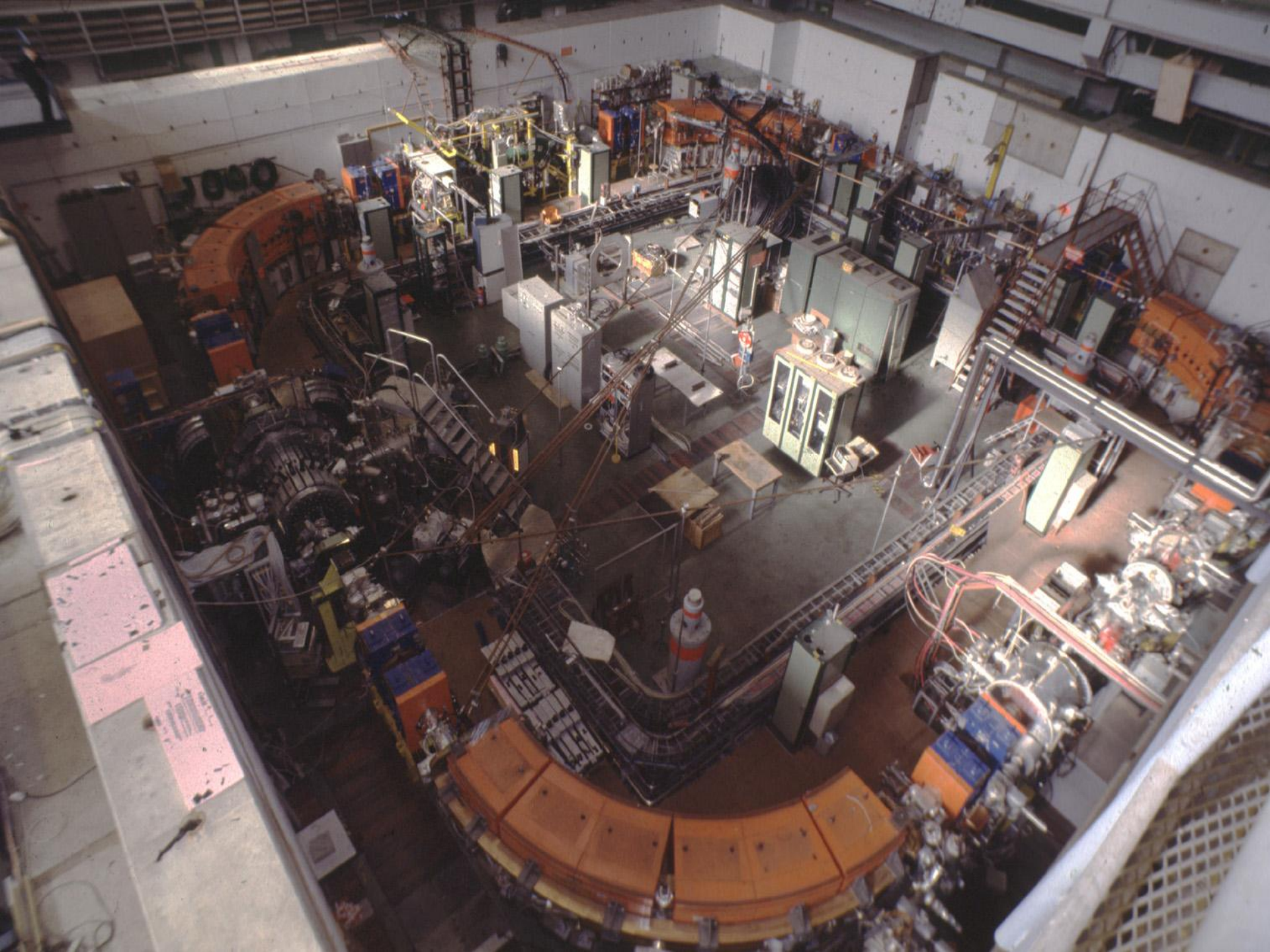
# “CERN experiments observe particle consistent with long-sought Higgs boson”

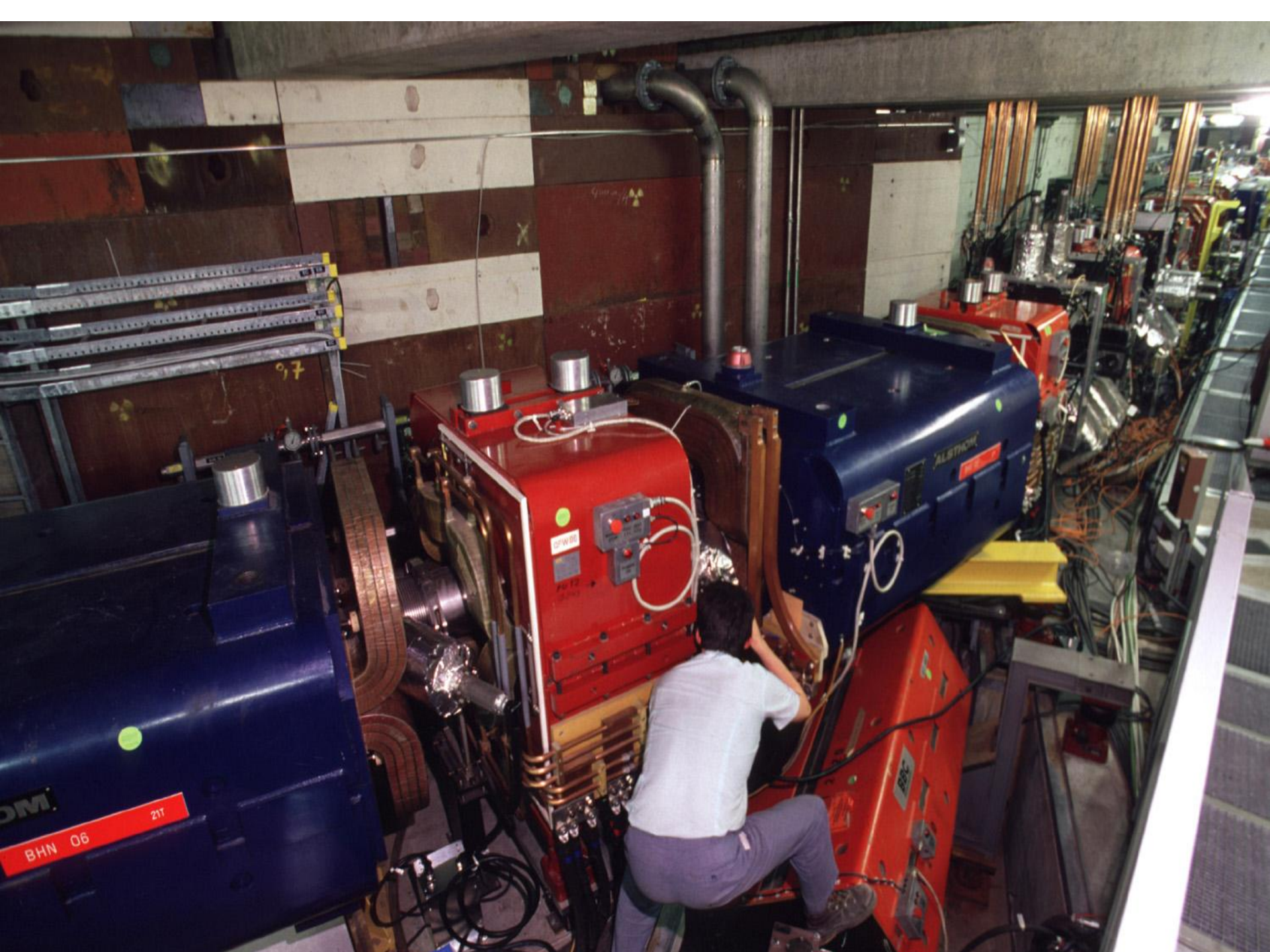
**ATLAS**  
EXPERIMENT  
<http://atlas.ch>  
Run: 203602  
Event: 82614360  
Date: 2012-05-18  
Time: 20:28:11 CEST



# CERN – world biggest accelerator complex







BHN 06 21T

4000

97

GW 10

1072

ALBTRON

1072

1072

1072

1072

1072

1072

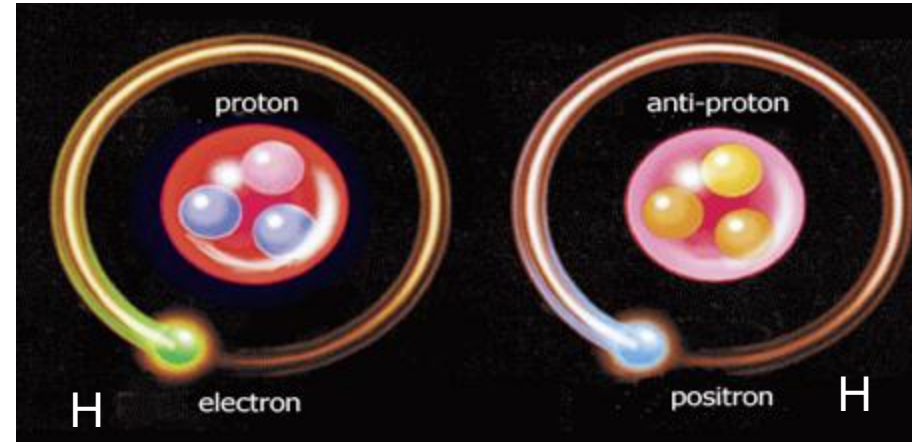
1072

# Antimatter Physics

## Matter-Antimatter comparison

*Very fundamental in our theory of physics*

$$m = \bar{m} \quad g = \bar{g}$$



ASACUSA  
ATRAP  
ALPHA

Trapping  $\bar{H}$  in a magnetic bottle

AEGIS

Look at  $\bar{H}$  free fall  
Galileo's experiment for antimatter !

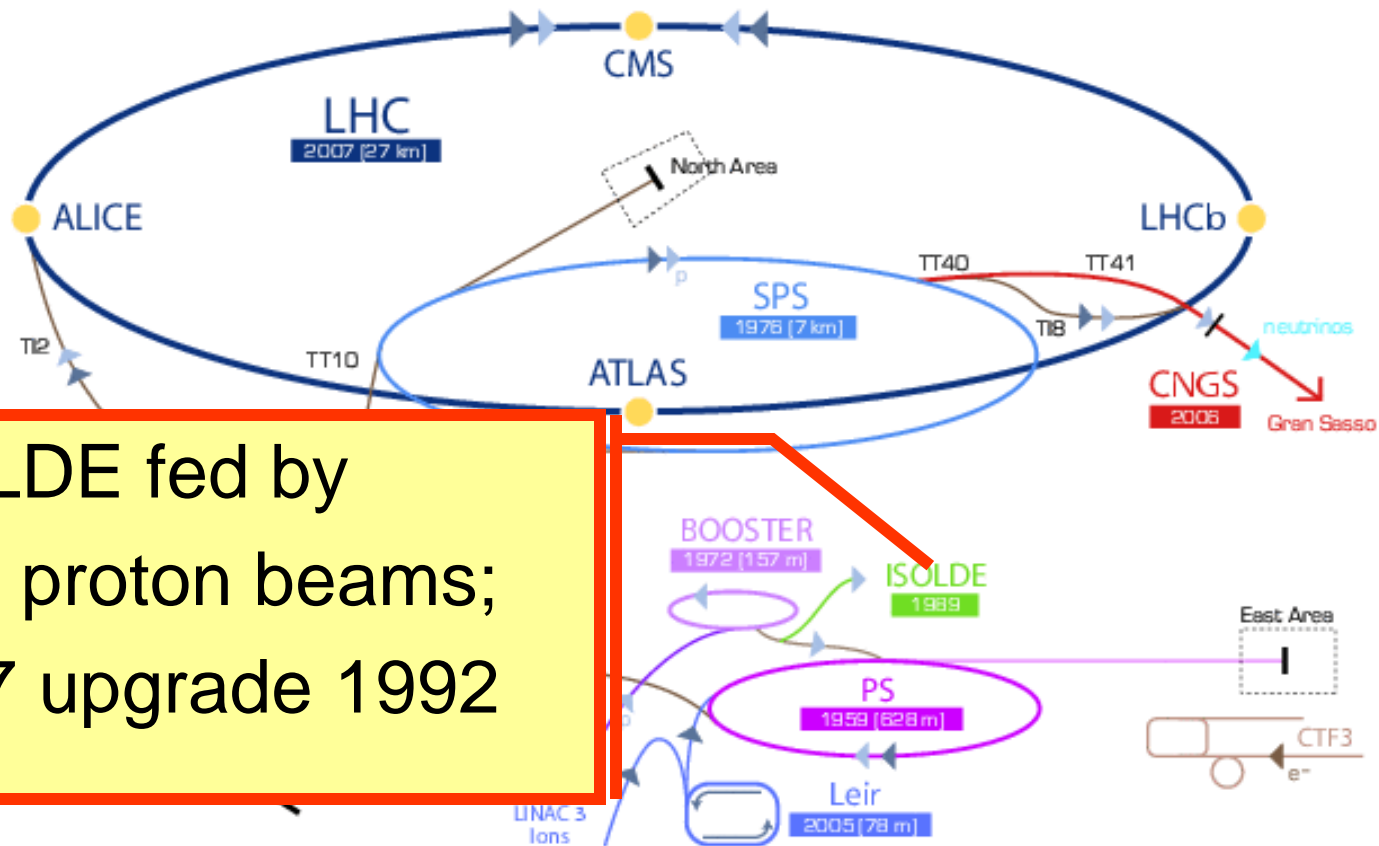


ACE

Biological effect of  $\bar{p}$   
Possible use for cancer therapy



# CERN accelerator complex, working not only for LHC



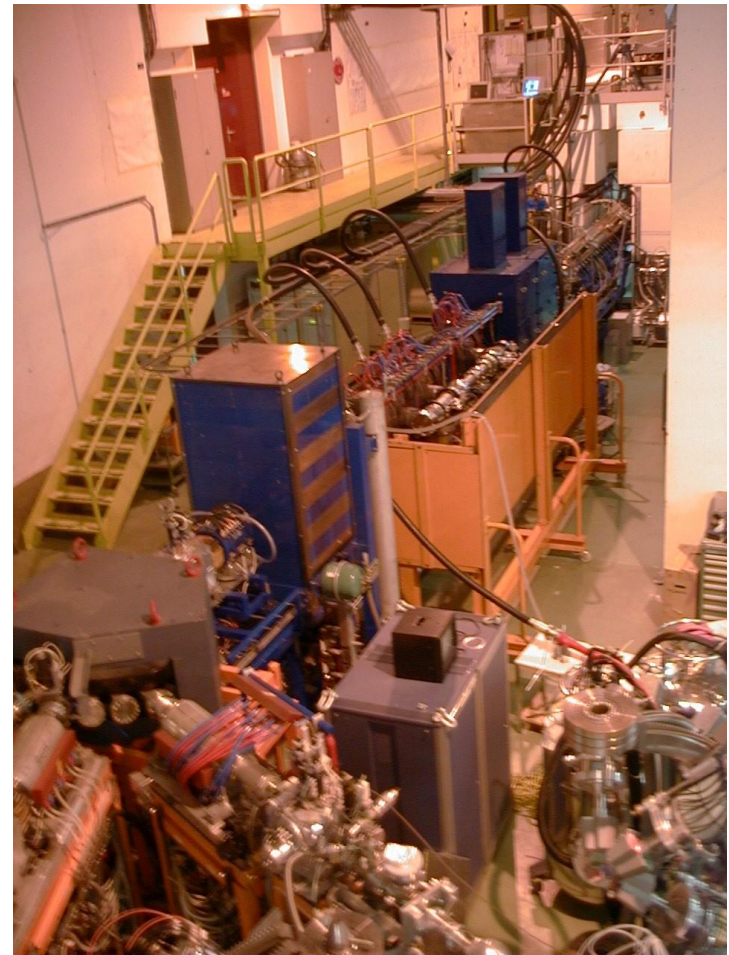
ISOLDE fed by  
PSB proton beams;  
1967 upgrade 1992

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

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

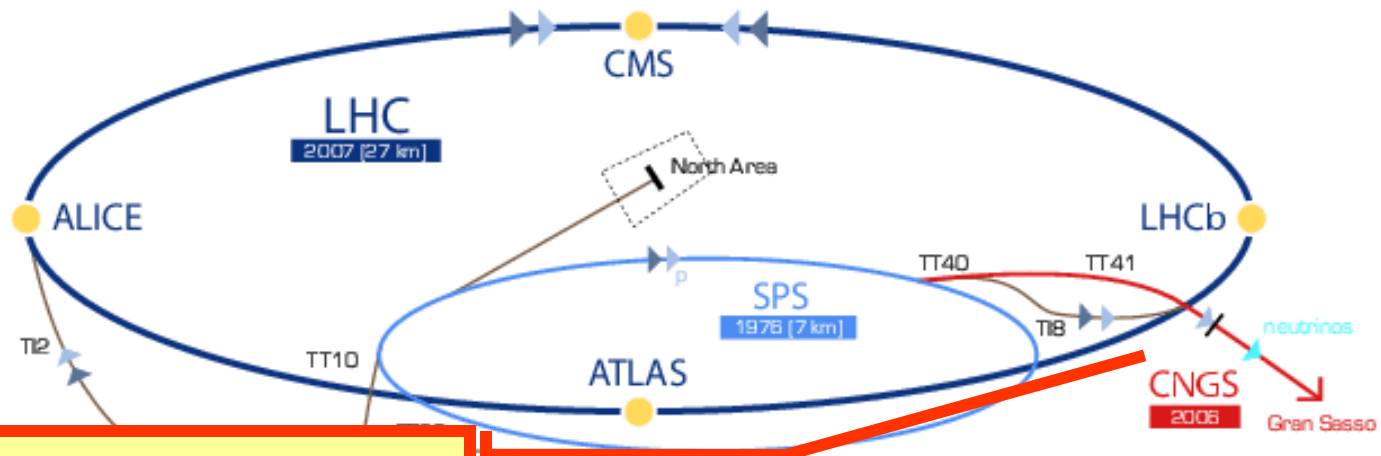
## An alchemical factory for nuclear physics

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.

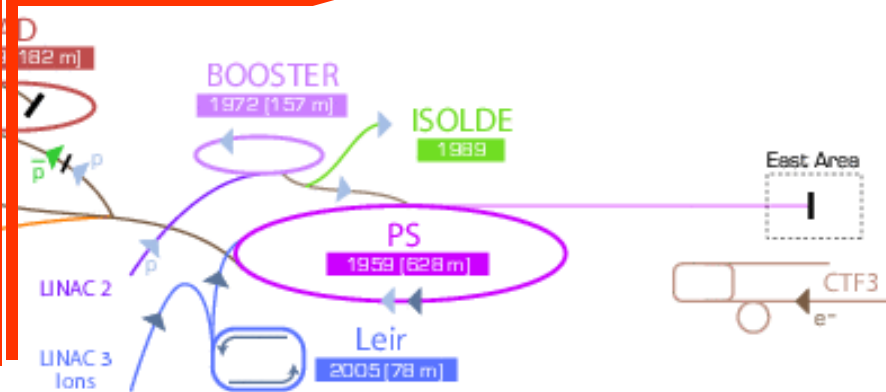




# CERN accelerator complex, working not only for LHC !



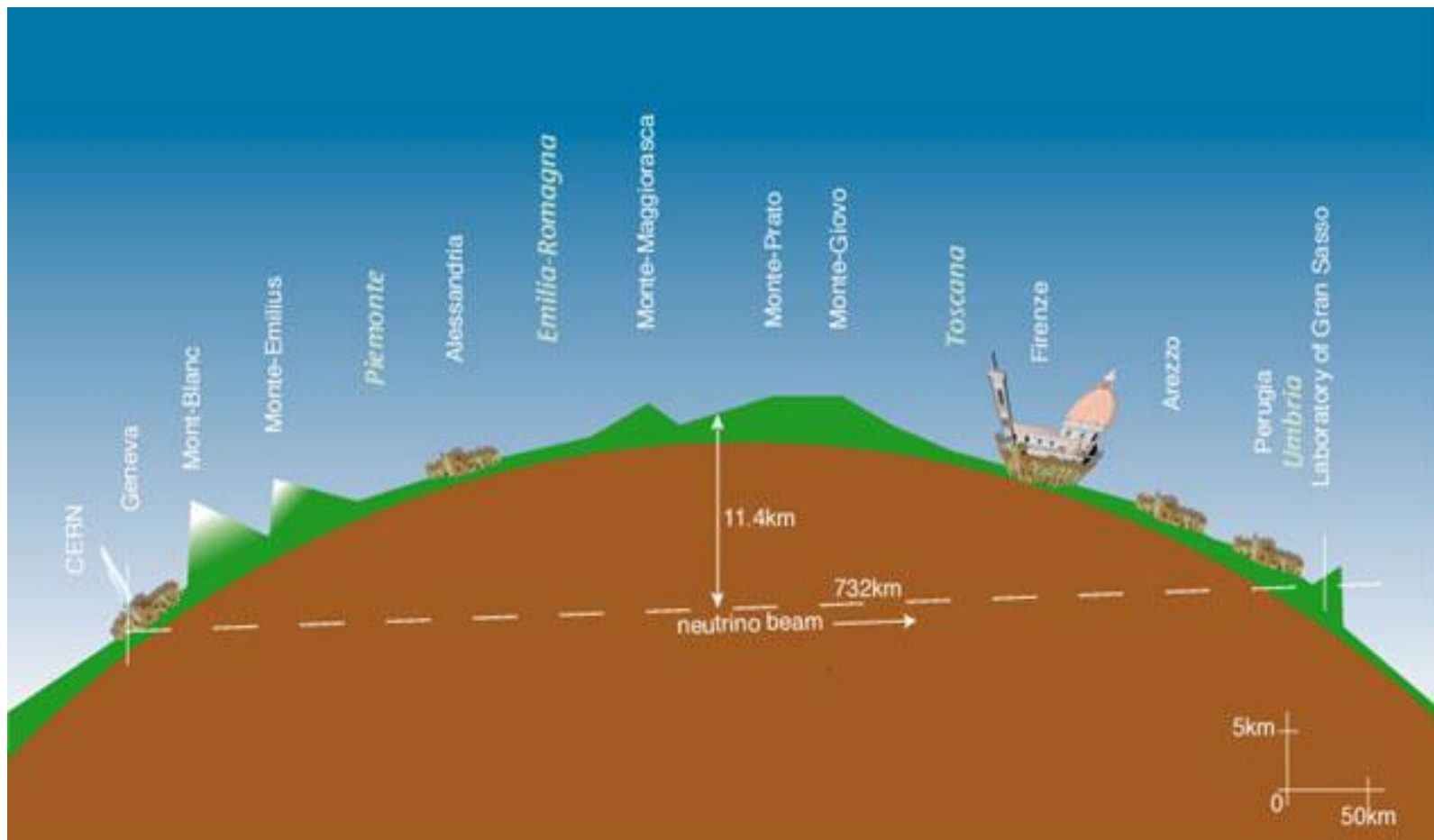
CNGS fed by  
SPS proton beams



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

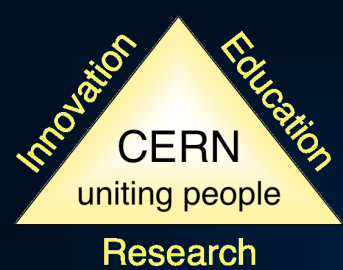
# CNGS – CERN Neutrino to Gran Sasso experiment - investigation of the nature of neutrinos

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.



**Study effect of cosmic rays on clouds formation**  
(cosmic rays “simulated “ by T11 beam, clouds  
created in a large climatic chamber





# CERN: Particle Physics and Innovation

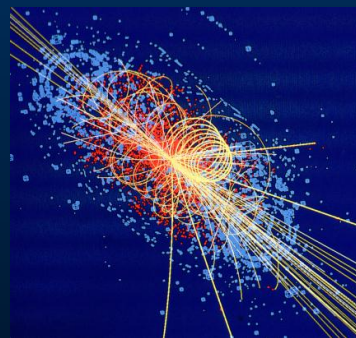
- **Interfacing** between fundamental science and key technological developments



- **CERN Technologies and Innovation**



Accelerating particle beams



Detecting particles



Large-scale computing (Grid)

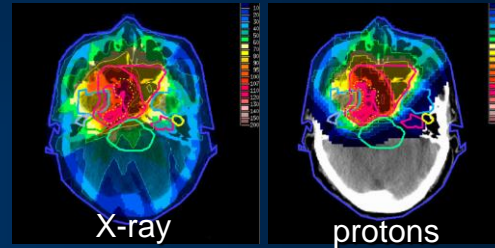
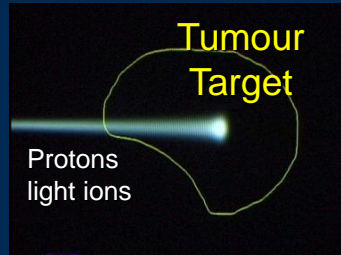
# Medical Application as an Example of Particle Physics Spin-off

Combining Physics, ICT, Biology and Medicine to fight cancer



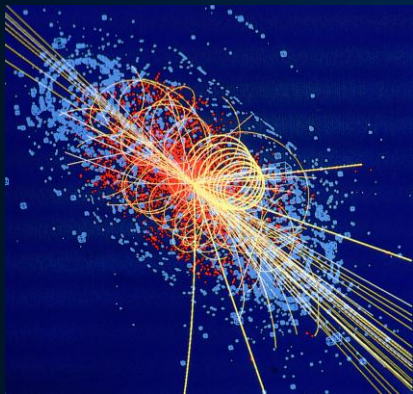
## Hadron Therapy

Accelerating particle beams  
~30'000 accelerators worldwide  
~17'000 used for medicine



Leadership in Ion Beam Therapy now in Europe and Japan

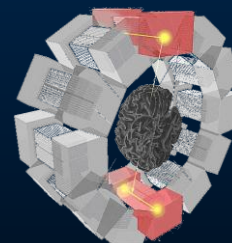
>70'000 patients treated worldwide (30 facilities)  
>21'000 patients treated in Europe (9 facilities)



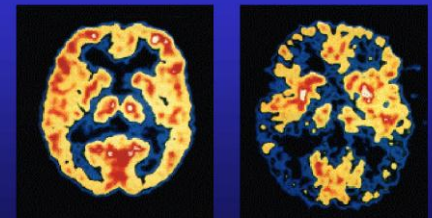
## Imaging

### PET Scanner

Clinical trial in Portugal for new breast imaging system (ClearPEM)



### Brain Metabolism in Alzheimer's Disease: PET Scan



Detecting particles

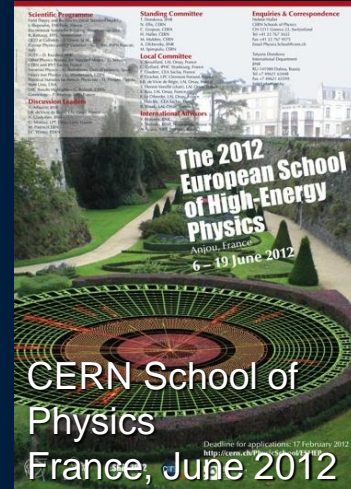
# CERN Education Activities

**Scientists at CERN**  
Academic Training Programme



## Young Researchers

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



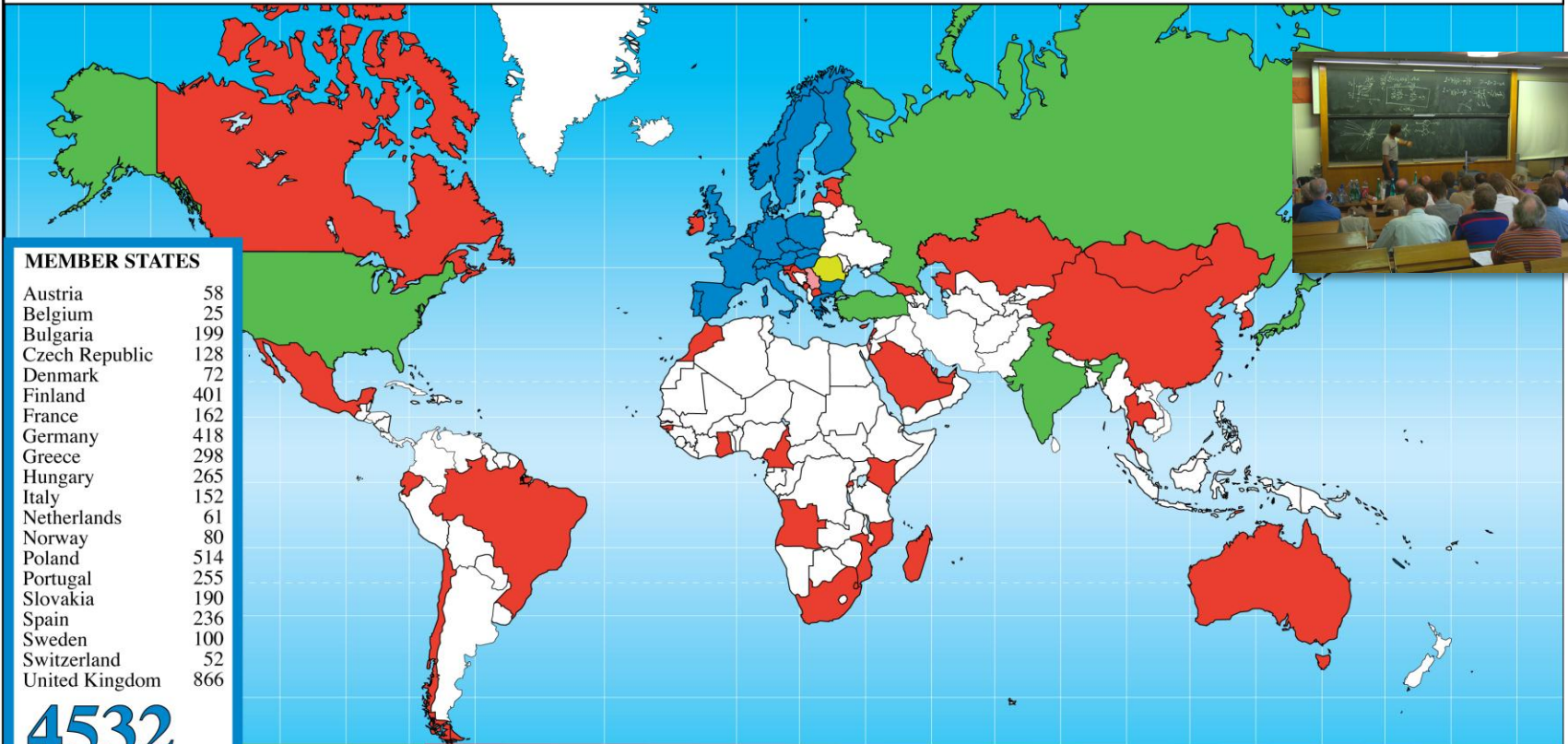
**Physics Students**  
Summer Students  
Programme



**CERN Teacher Schools**  
International and National  
Programmes

# CERN Teacher Programme

## CERN Teacher Programme Participants 1998 - 2011



### MEMBER STATES

Austria	58
Belgium	25
Bulgaria	199
Czech Republic	128
Denmark	72
Finland	401
France	162
Germany	418
Greece	298
Hungary	265
Italy	152
Netherlands	61
Norway	80
Poland	514
Portugal	255
Slovakia	190
Spain	236
Sweden	100
Switzerland	52
United Kingdom	866

**4532**

### CANDIDATE FOR ACCESSION

Romania	10
---------	----

### ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Israel	2
Serbia	10

### OBSERVER STATES

India	2
Japan	3
Russia	132
Turkey	3
USA	56

**196**

### OTHERS

Angola	4
Australia	3
Azerbaijan	1
Brazil	53
Cameroon	1
Canada	1
Cape Verde	2
Chile	3

China	1
Croatia	1
Cyprus	4
Ecuador	1
Estonia	18
Georgia	16
Ghana	4
Guinea Bissau	1
Ireland	3
Kazakhstan	3

Kenya	2
Latvia	1
Lebanon	1
Madagascar	1
Malta	36
Mexico	5
Mongolia	1
Montenegro	13
Morocco	2
Mozambique	13

Qatar	1
Rwanda	15
Sao Tome	2
Saudi Arabia	1
Singapore	2
Slovenia	21
South Africa	6
South Korea	22
Swaziland	1

Thailand	4
T.F.Y.R.O.M.	11
Timor-Leste	1
Ukraine	30
U.A.E.	1

**343**





# Ukraine and CERN



- ❑ Cooperation Agreement CERN-Minor Academy of Sciences of Ukraine signed mid 2011



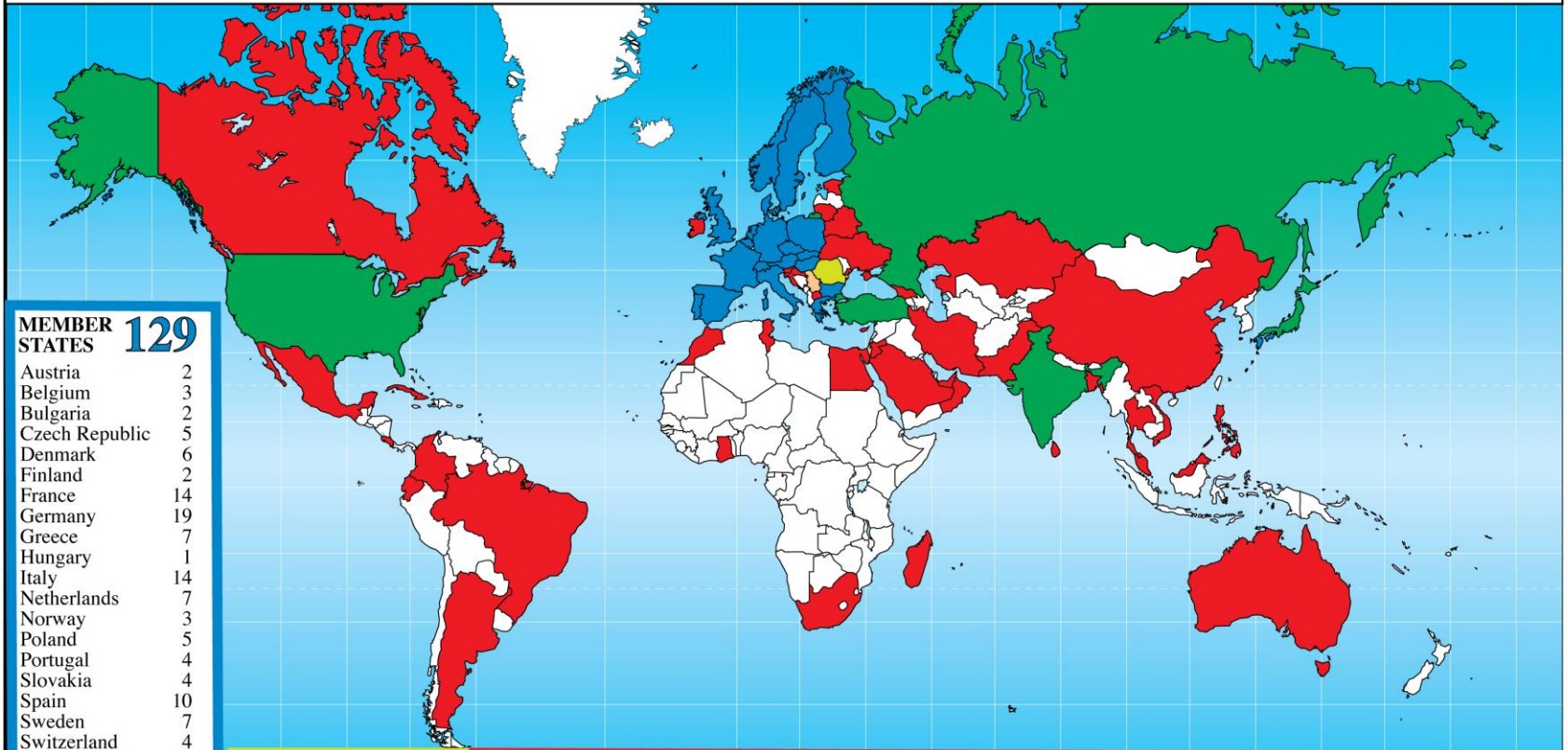
1st national Ukrainian Teachers Programme at CERN in November 2011





# Summer Students 2012

## Nationality of Summer Students 2012



### MEMBER STATES 129

Austria	2
Belgium	3
Bulgaria	2
Czech Republic	5
Denmark	6
Finland	2
France	14
Germany	19
Greece	7
Hungary	1
Italy	14
Netherlands	7
Norway	3
Poland	5
Portugal	4
Slovakia	4
Spain	10
Sweden	7
Switzerland	4
United Kingdom	10

### OBSERVERS 41

India	5
Japan	5
Russia	11
Turkey	6
USA	14

### CANDIDATE FOR ACCESSION

Romania	6
---------	---

### ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Israel	2
Serbia	2

### OTHERS

Argentina	1	Croatia	6	Iran	4	Morocco	2	Sri Lanka	1
Australia	2	Cuba	2	Ireland	1	Oman	1	Thailand	2
Bangladesh	1	Cyprus	3	Jordan	1	Pakistan	5	Tunisia	1
Belarus	1	Ecuador	2	Kazakhstan	1	Palestinian Territories	1	T.F.Y.R.O.M.	3
Brazil	1	Egypt	3	Lithuania	1	Philippines	1	Ukraine	1
Canada	5	Estonia	5	Madagascar	1	Saudi Arabia	1	U.A.E.	2
China	8	Georgia	1	Malaysia	3	Singapore	2	Vietnam	1
Colombia	1	Ghana	1	Malta	3	Slovenia	1		
Costa Rica	1	Hong Kong	2	Mexico	1	South Africa	2		

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# Summer Students 2012





Thank You  
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*Accelerating Science and Innovation*