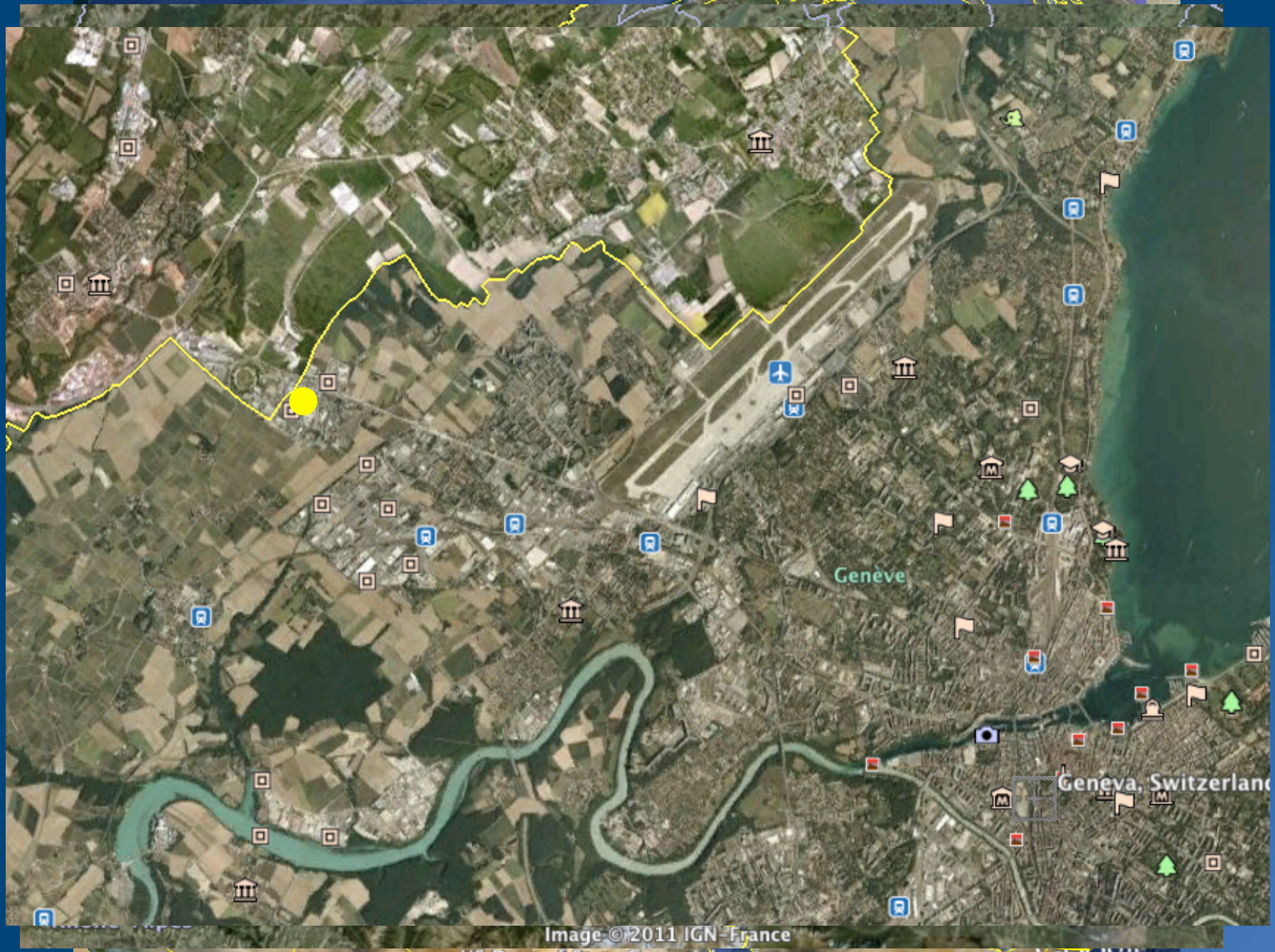
Science without Borders

CERN – an example of a scientific, technical and training co-operation on a global scale

Sultan Qaboos University
Oman
25 February 2012

Felicitas Pauss / CERN and ETH Zurich


Genève
Image © 2011 IGN-France
US Dept of State Geographer

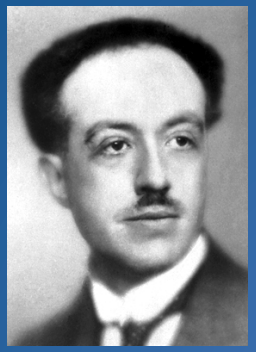

LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km
CERN

CERN – and intergovernmental Organization

CERN was founded in 1954 (12 European States)
with a dual mission:
research and collaboration for the betterment of humanity

Louis De Broglie:

"A laboratory where it would be possible to carry out scientific work above and beyond the framework of the various nations taking part …… an engine for peaceful collaboration across borders"



De Broglie
1892 – 1987

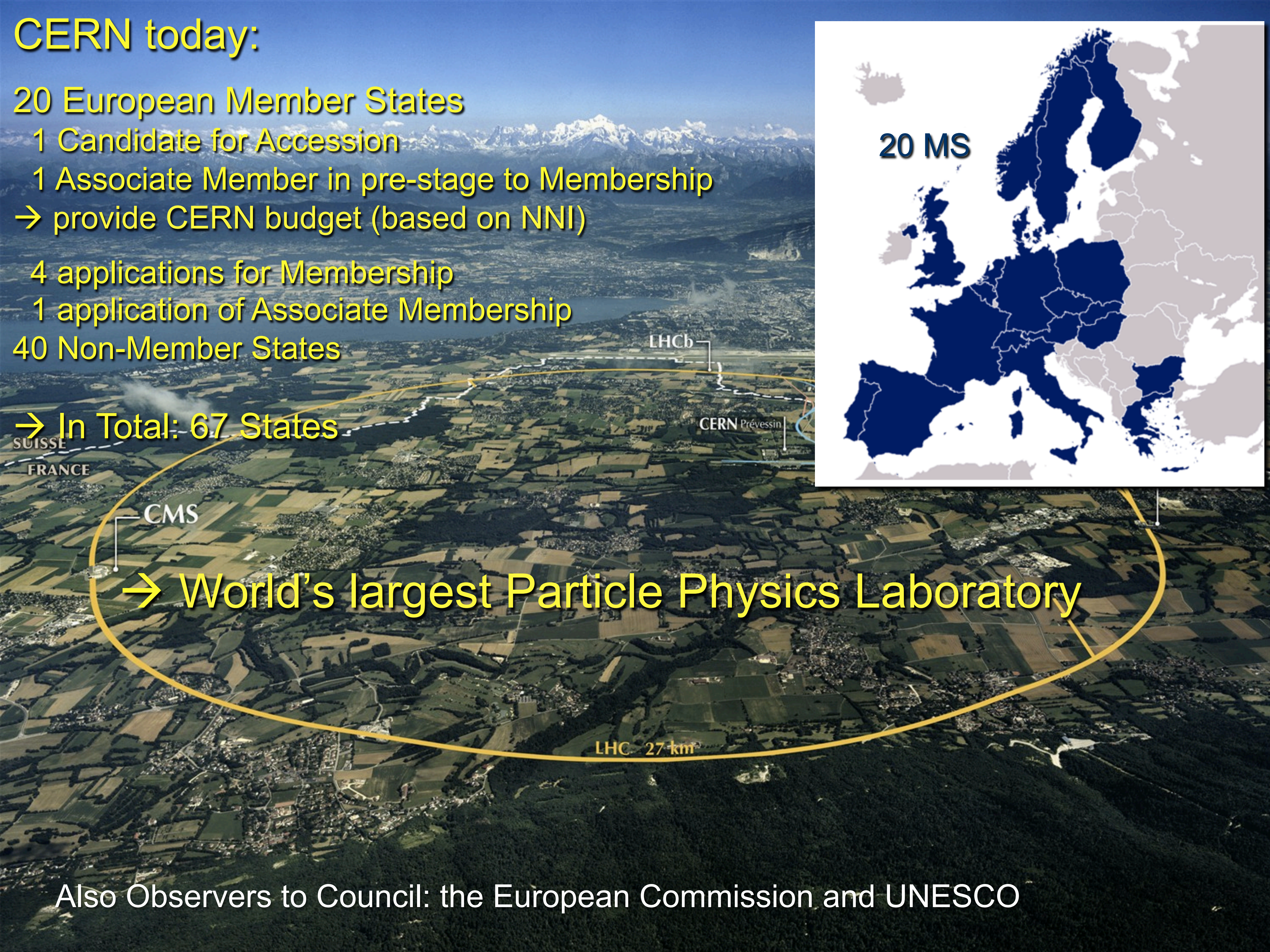
NP in 1929 for his discovery of the wave nature of electrons

CERN today:

20 European Member States
 1 Candidate for Accession
 1 Associate Member in pre-stage to Membership
→ provide CERN budget (based on NNI)

 4 applications for Membership
 1 application of Associate Membership
40 Non-Member States

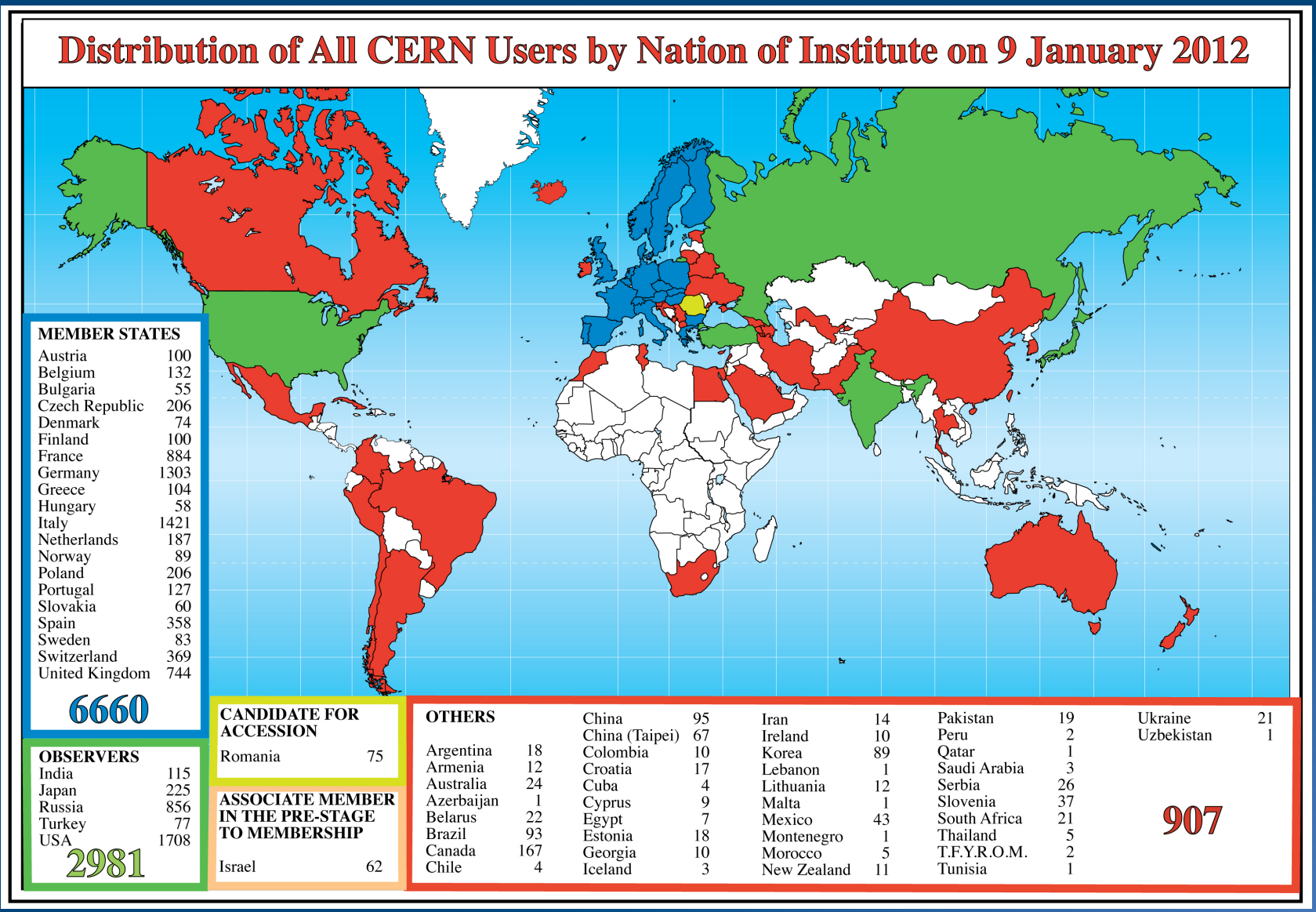
→ In Total: 67 States



→ World's largest Particle Physics Laboratory

Also Observers to Council: the European Commission and UNESCO

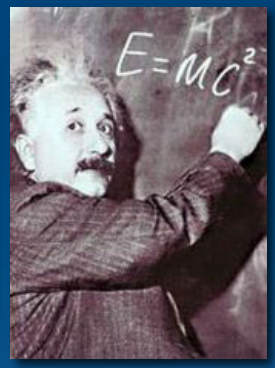
Science is getting more and more global



The Mission of CERN

- **Push forward** the frontiers of knowledge

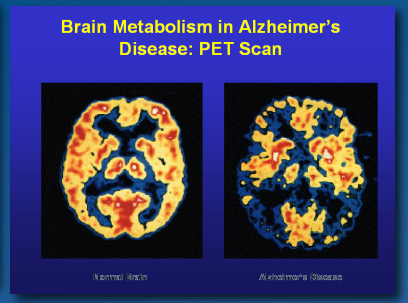
  E.g. the secrets of the Big Bang ... what was the matter like within the first moments of the Universe's existence?

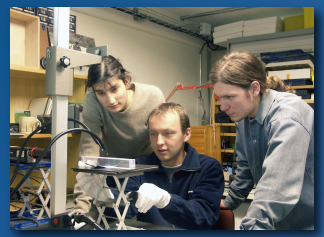


- **Develop** new technologies for accelerators and detectors

  Information technology - the Web and the GRID

  Medicine - diagnosis and therapy



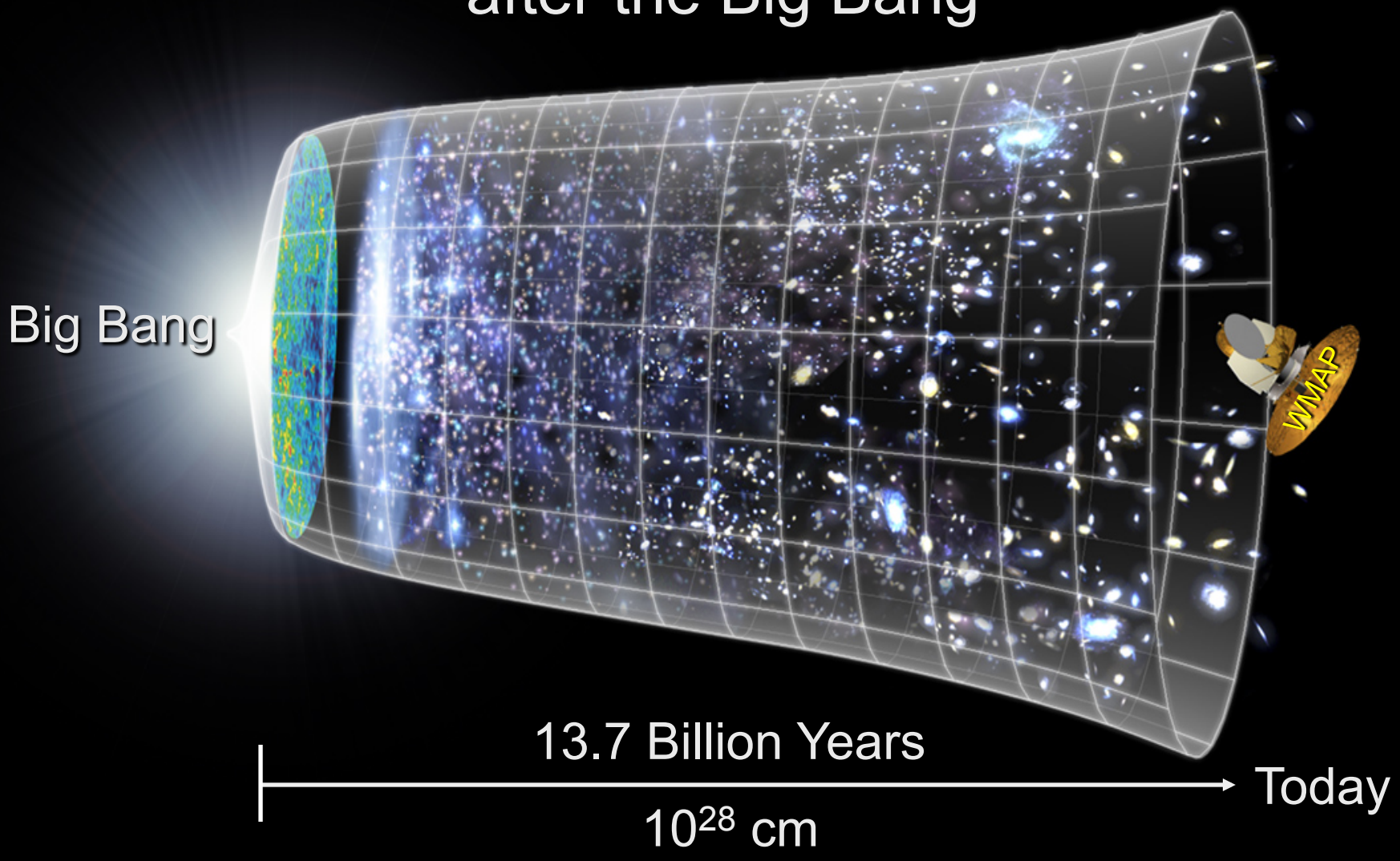


- **Train** scientists and engineers of tomorrow

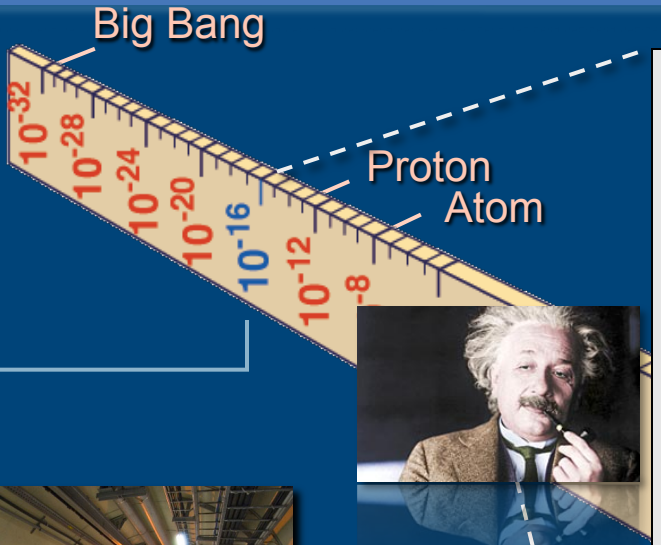
- **Unite** people from different countries and cultures

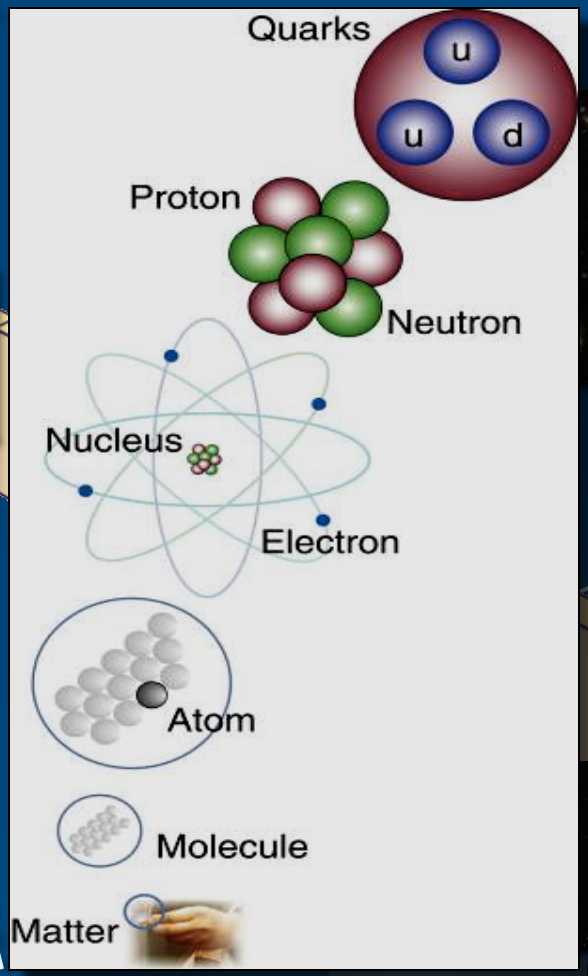
Next Scientific Challenge:

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



Dimensions in Physics





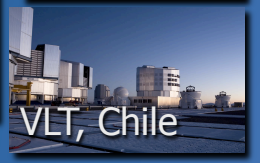
Radius of Galaxies

Universe

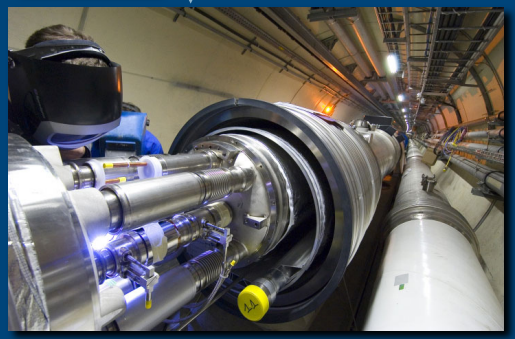
10^{24}

10^{28}

cm



CERN



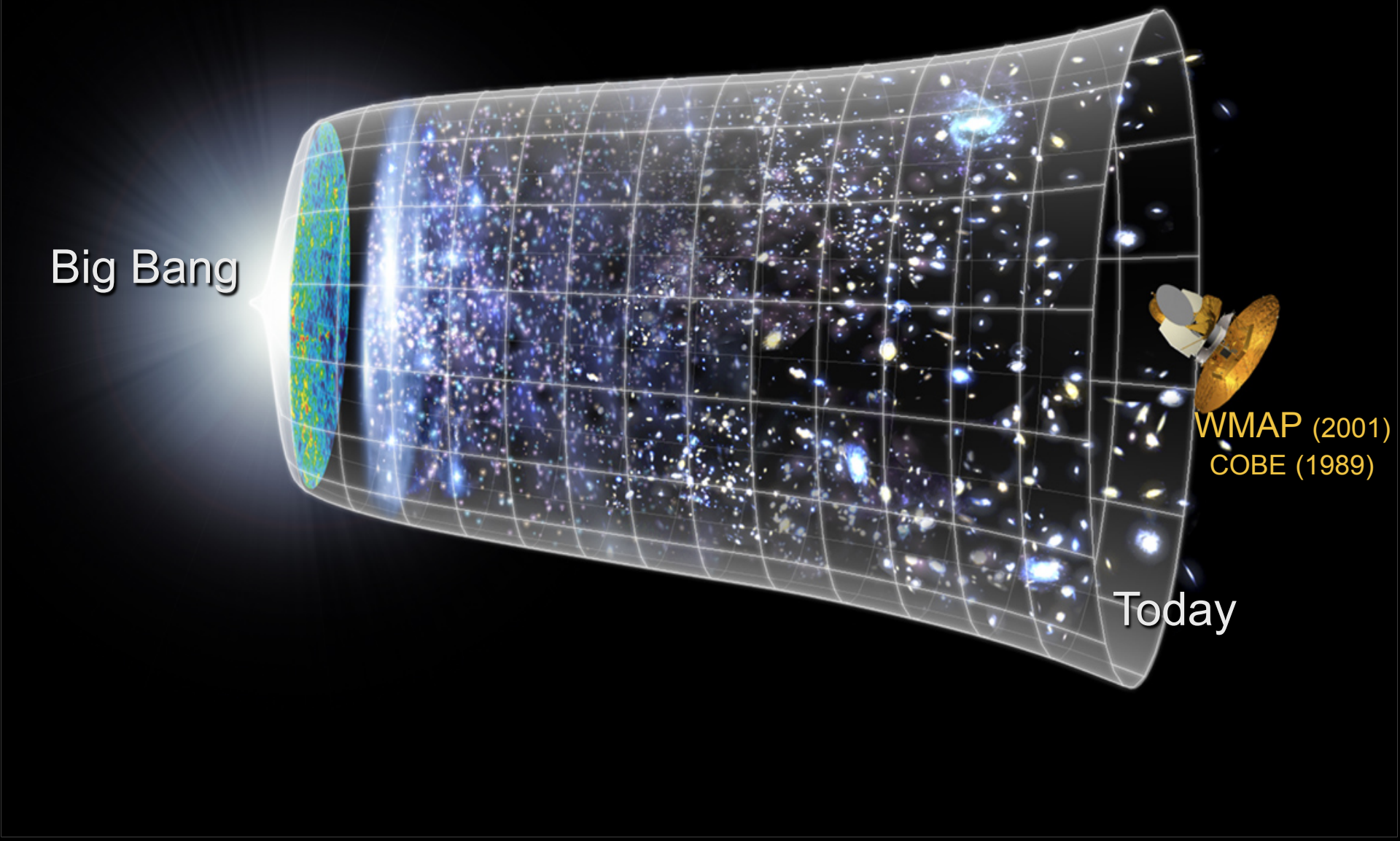
LHC

Super-Microscope

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

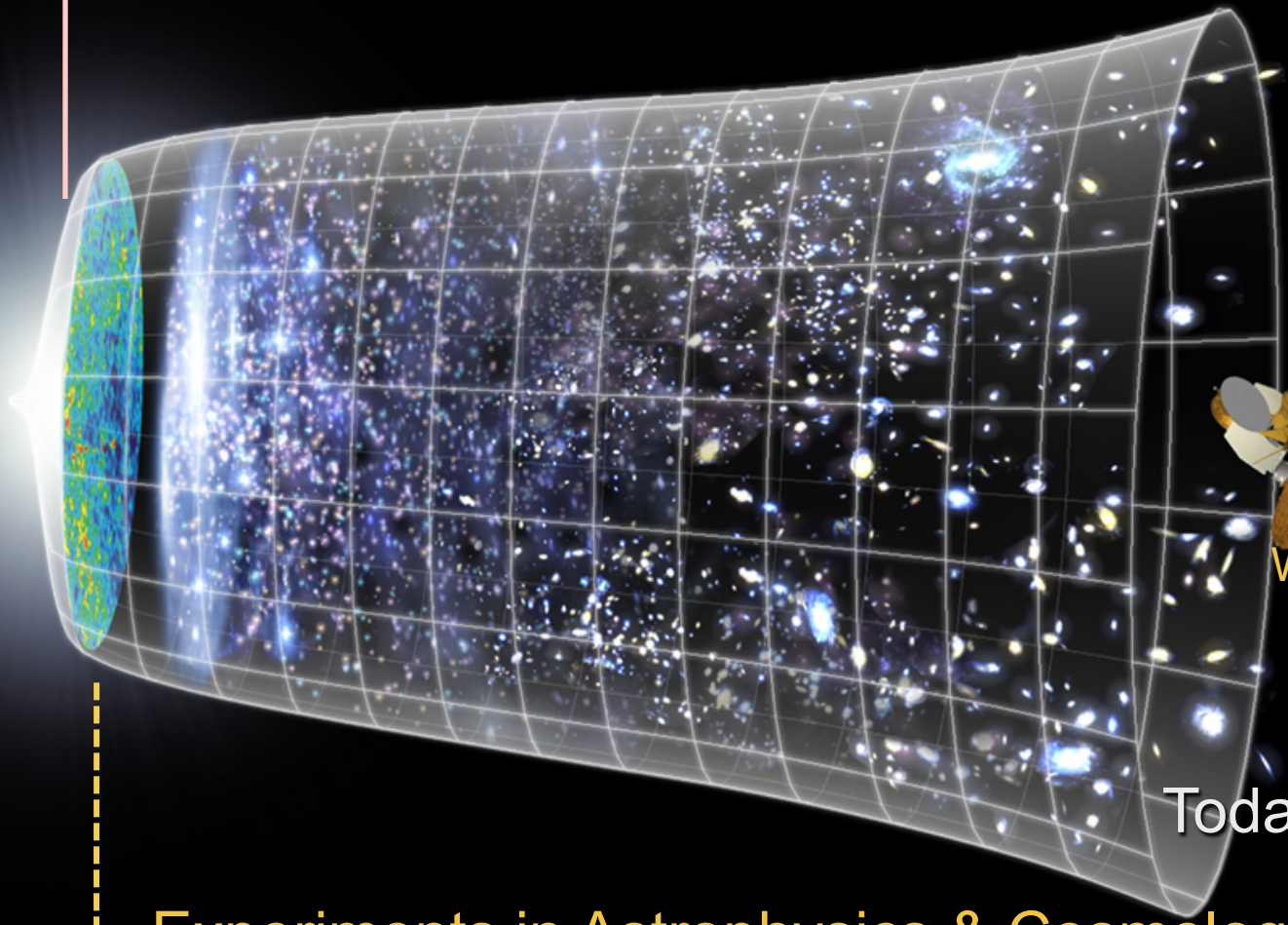
Our Universe ..... How did it evolve after BB?

What is it made of?

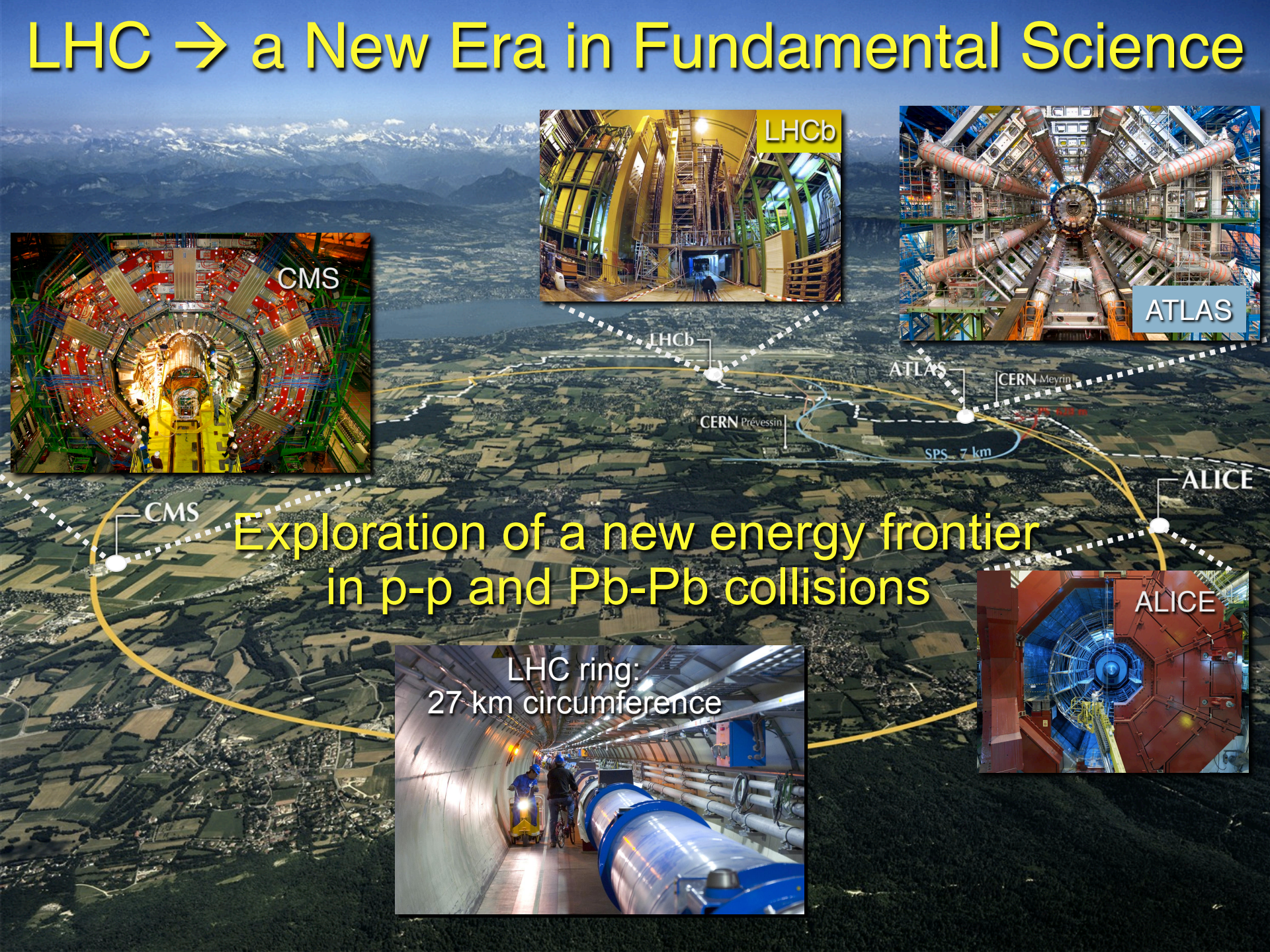


LHC: ~ 10^{-12} seconds (p-p)
~ 10^{-6} seconds (Pb-Pb)

What is the LHC?



LHC → a New Era in Fundamental Science



Exploration of a new energy frontier
in p-p and Pb-Pb collisions

LHC → a New Era in Fundamental Science

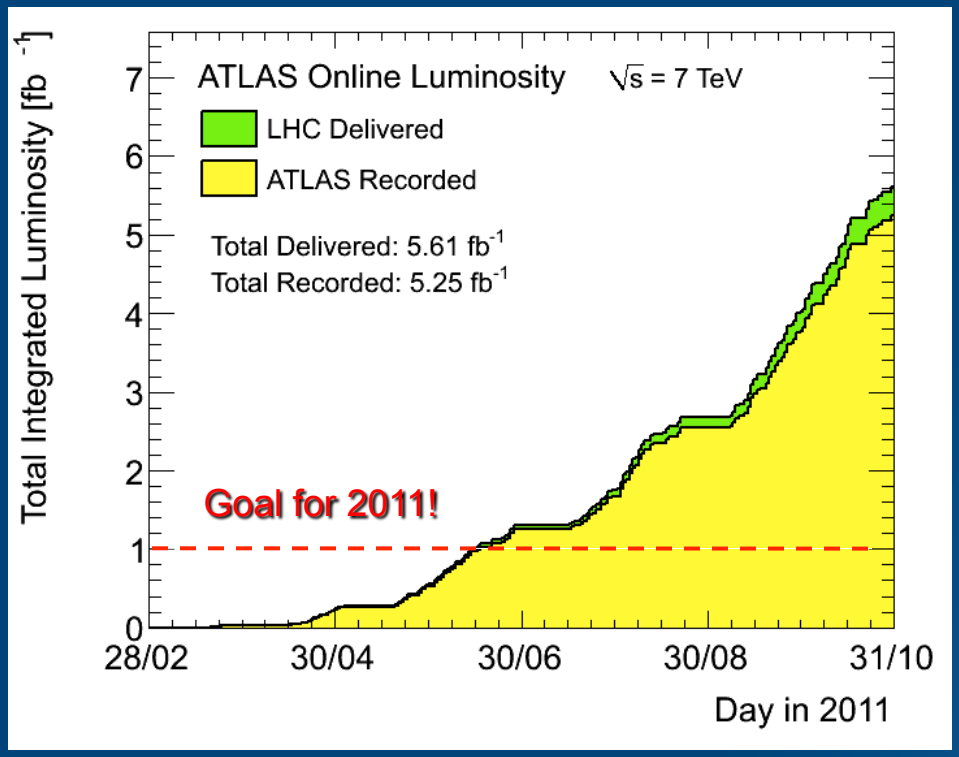
$E = m c^2$

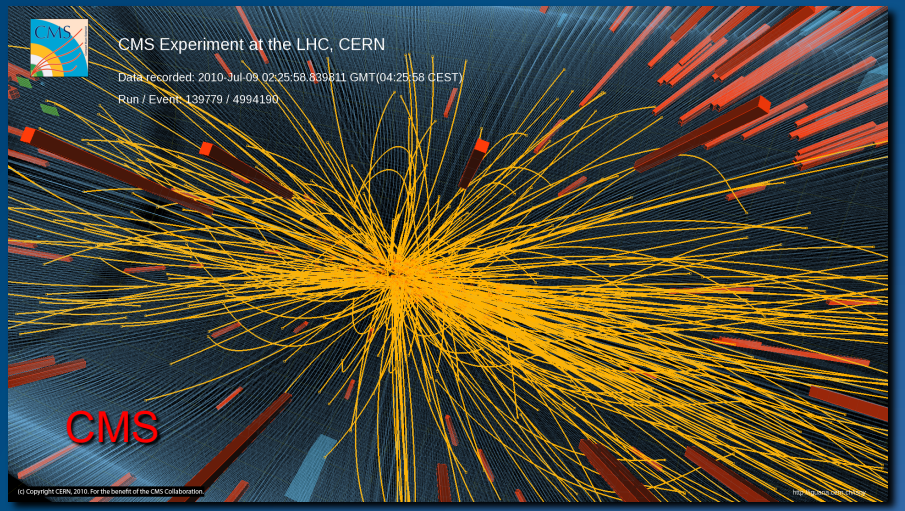
10^{11} Protons per bunch
~ 3000 bunches
collisions: $40 \cdot 10^{6}$ per second

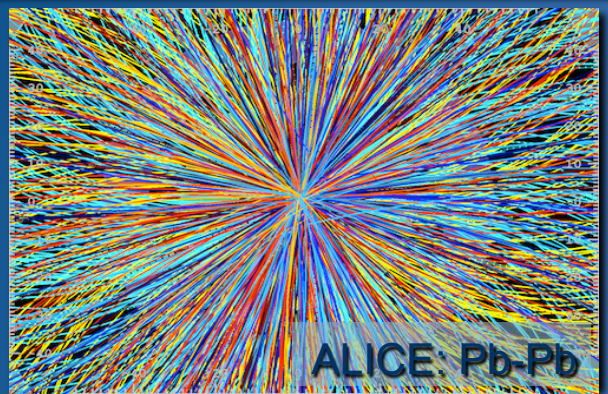
LHC and Experiments – CERN's Flagship project

Spectacular start-up at high energy on 30 March 2010

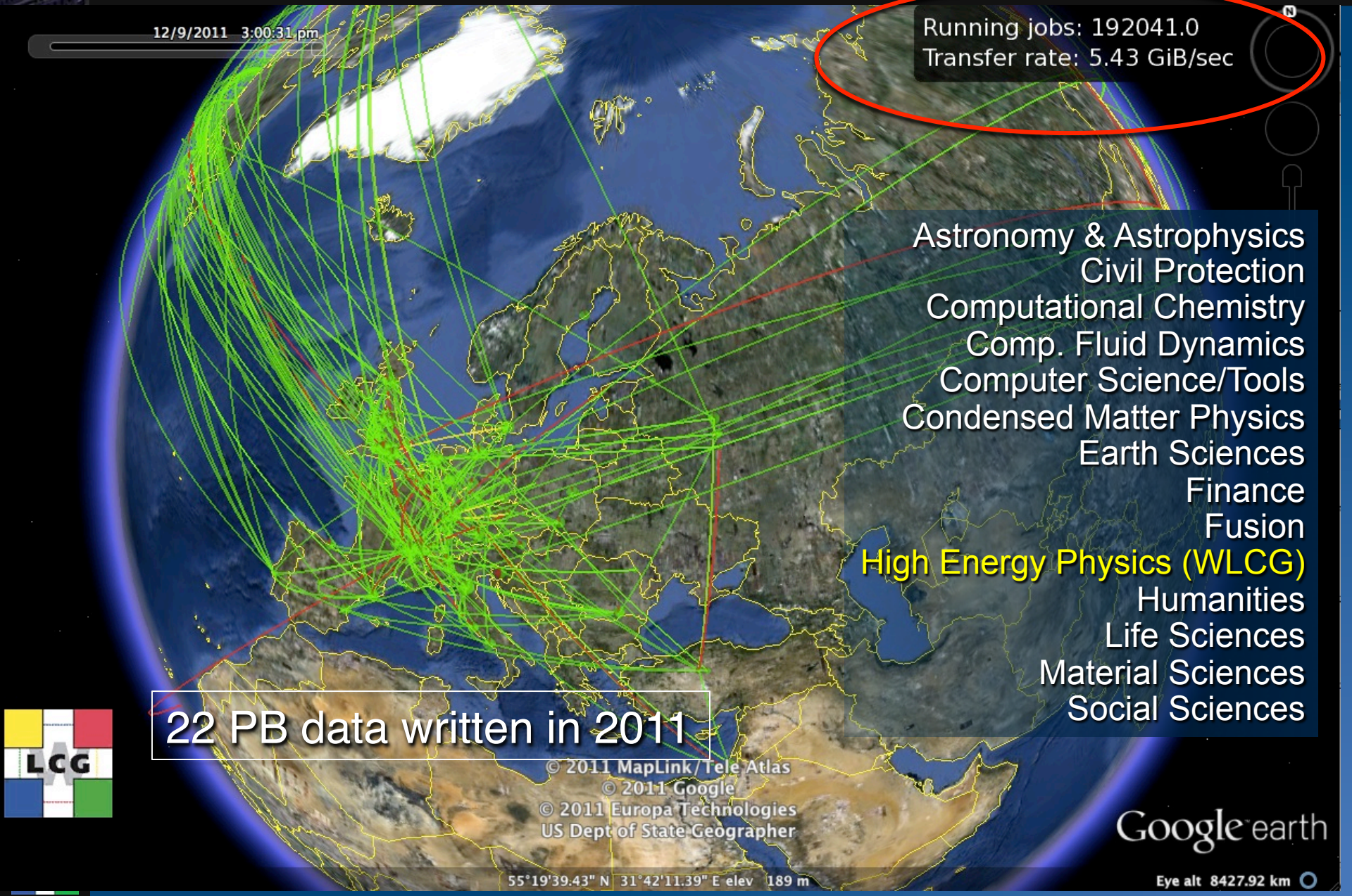
→ Brilliant performances of LHC, experiments and GRID computing during 2010 and 2011 data taking periods







LHC GRID Computing: Busy even without beam …



The 2012 run ….. and beyond

2012: start middle of March (beams circulating)

- E_{cm} = 8 TeV compared to 7 TeV up to now
- Goal: three times more data delivered by LHC (15 fb^{-1})

  → Should bring us closer to understanding how the fundamental particles acquire their mass.

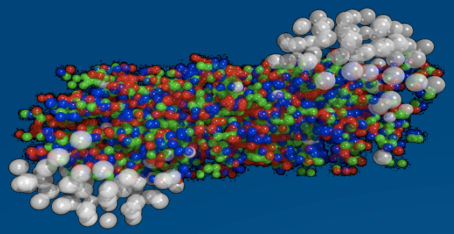
- A very Exciting year head of us!

P. Higgs

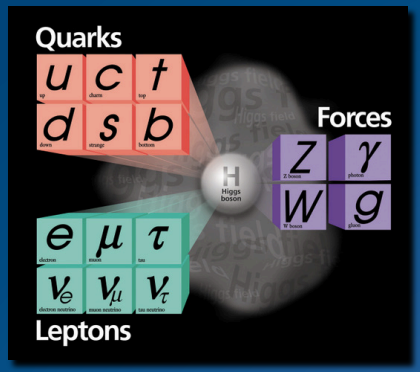
Beyond 2012

- Long technical stop of around 20 months, starting end of 2012
- Late in 2014 start with LHC close to its design energy (E_{cm} ~ 14 TeV)

The study of LHC data will allow us to answer some of the big questions ...



Will we understand the primordial state of matter after the Big Bang before protons and neutrons formed?



Will we find the Higgs particle that is responsible for giving mass to all particles?

Will we find the reason why antimatter and matter did not completely destroy each other?

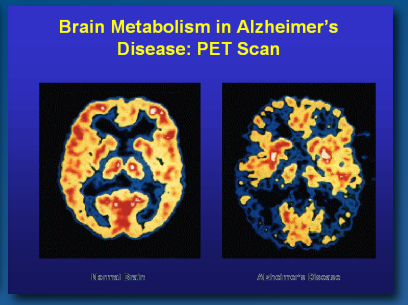
Will we find the particle(s) that make up the mysterious ‘dark matter’ in our Universe?

The Mission of CERN

- Develop new technologies for accelerators and detectors

  Information technology - the Web and the GRID

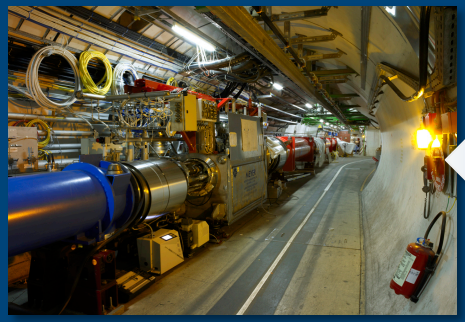
  Medicine - diagnosis and therapy



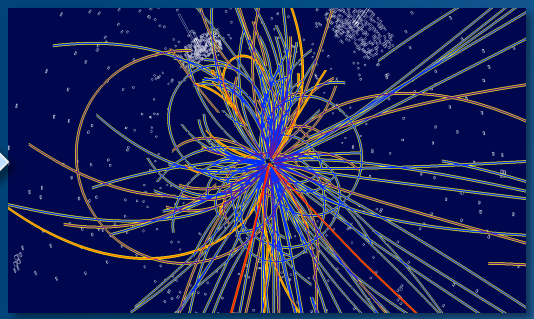
CERN: Particle Physics and Innovation

- Interfacing between fundamental science and key technological developments

- CERN Technologies and Innovation



Accelerating particle beams

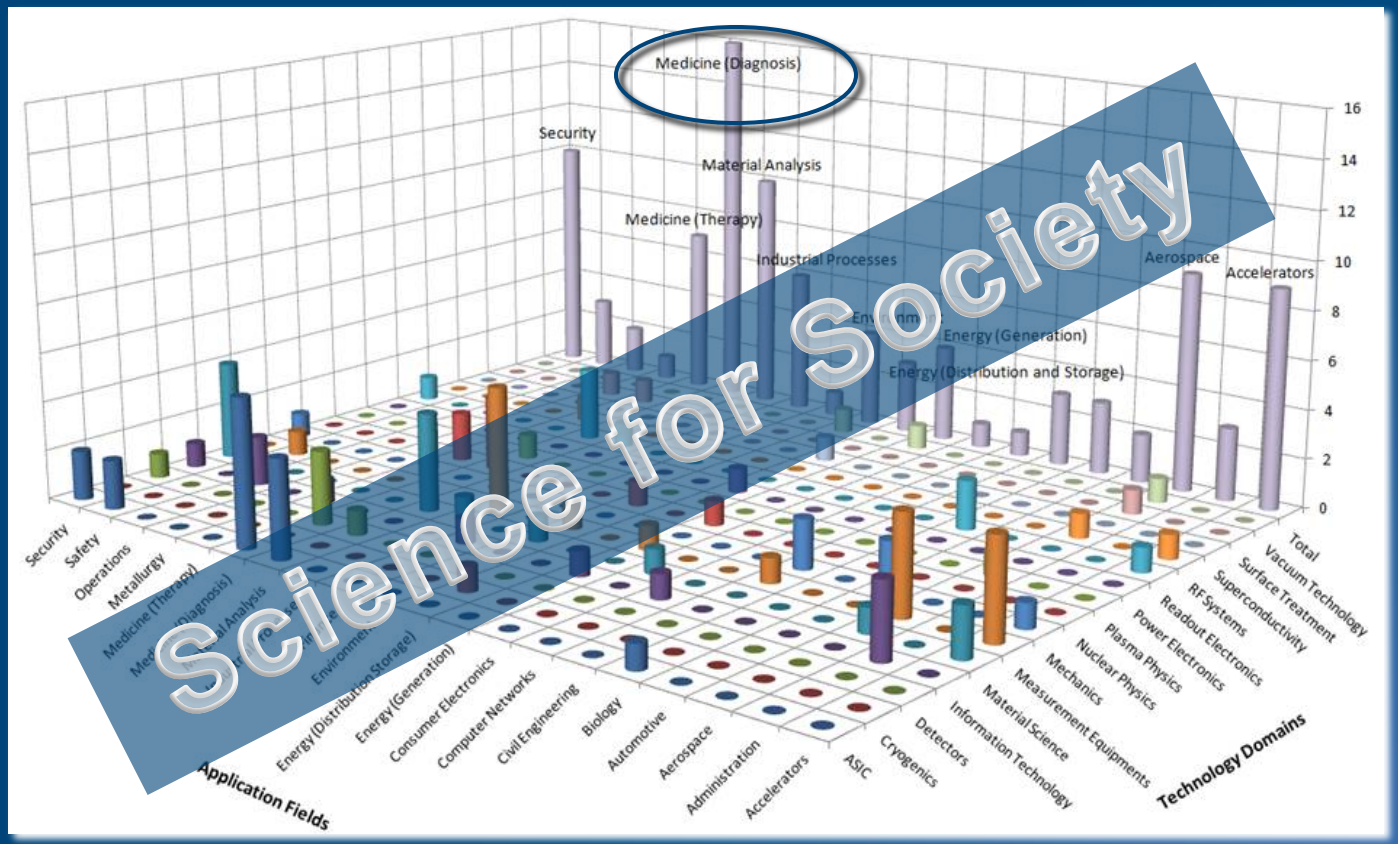


Detecting particles

Large-scale computing (Grid)

CERN Technologies and Innovation

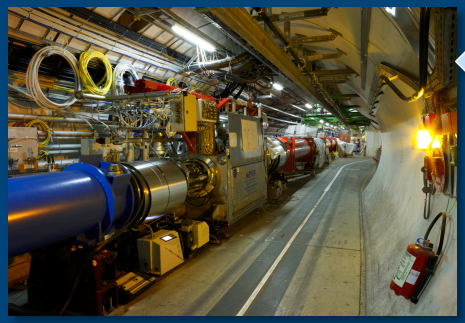
Cutting edge Research Infrastructures play a key role in a knowledge driven society



Knowledge is – and will be more and more – the most precious resource for a sustainable development

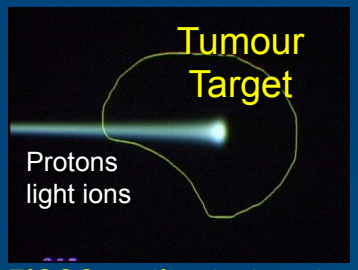
CERN Technologies and Innovation
Example: Medical applications

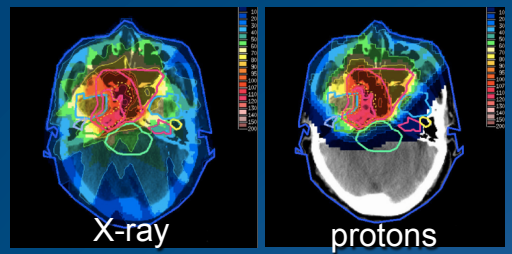
Combining Physics, ICT, Biology and Medicine to fight cancer



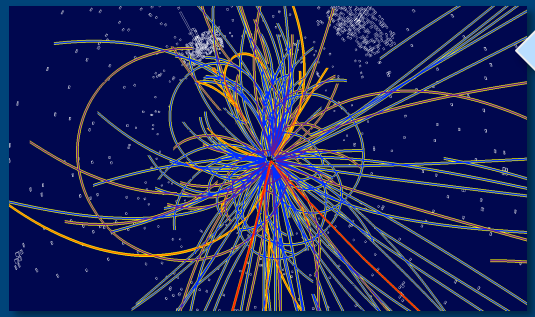
Accelerating particle beams
~30'000 accelerators worldwide
~17'000 used for medicine

Hadron Therapy (~85'000 patients treated up to now)





~65'000 patients treated worldwide (30 facilities in operation end 2010)
~16'000 patients treated in Europe (9 facilities in operation end 2010)

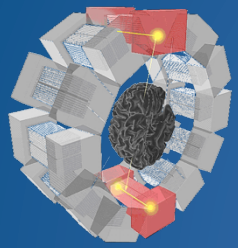


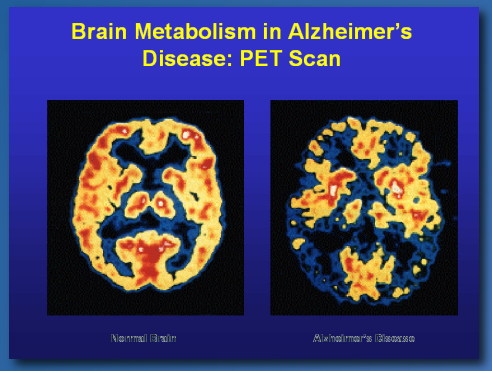
Detecting particles

Imaging

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

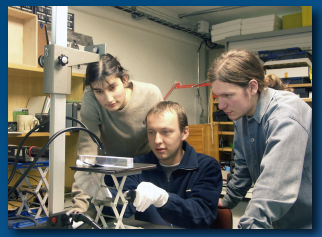
PET Scanner





The Mission of CERN

- Train scientists and engineers of tomorrow



CERN's Education Programme

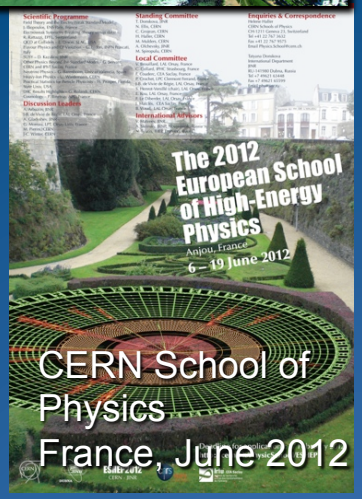
Scientists at CERN
Academic Training Programme


NEW:
Asia-Europe-Pacific School of High-Energy Physics
Fukuoka, Japan, Oct 2012

In 2013 in Peru


Latin American School
Natal, Brazil, 2011

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



CERN School of Physics
France, June 2012

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

OBSERVER STATES

India	2
Japan	3
Russia	132
Turkey	3
USA	56

196

OTHERS

Angola	4	China	1	Kenya	2	Qatar	1	Thailand	4
Australia	3	Croatia	1	Latvia	1	Rwanda	15	T.F.Y.R.O.M.	11
Azerbaijan	1	Cyprus	4	Lebanon	1	Sao Tome	2	Timor-Leste	1
Brazil	53	Ecuador	1	Madagascar	1	Saudi Arabia	1	Ukraine	30
Cameroon	1	Estonia	18	Malta	36	Serbia	10	U.A.E.	1
Canada	1	Georgia	16	Mexico	5	Singapore	2		
Cape Verde	2	Ghana	4	Mongolia	1	Slovenia	21		
Chile	3	Guinea Bissau	1	Montenegro	13	South Africa	6		
		Ireland	3	Morocco	2	South Korea	22		
		Kazakhstan	3	Mozambique	13	Swaziland	1		

353

CERN Summer Students 2011

Distribution of Summer Students 2011

In 2011: one SS from Oman (from SQU)

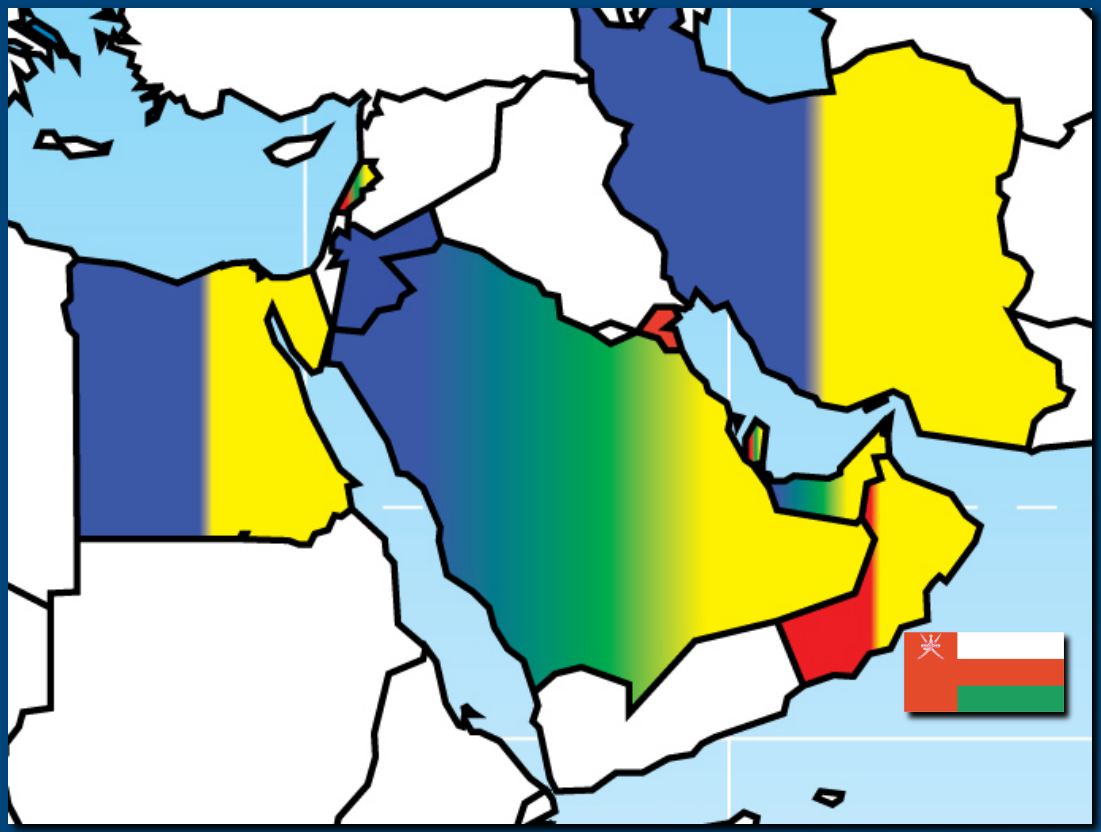
MEMBER STATES	122
AUSTRIA	3
BELGIUM	3
BULGARIA	2
CZECH REPUBLIC	5
DENMARK	5
FINLAND	1
FRANCE	11
GERMANY	21
GREECE	7
HUNGARY	2
ITALY	11
NETHERLANDS	7
NORWAY	5
POLAND	5
PORTUGAL	5
SLOVAKIA	2
SPAIN	7
SWEDEN	7
SWITZERLAND	2
UNITED KINGDOM	11

OBSERVER STATES	39
INDIA	7
ISRAEL	3
JAPAN	5
RUSSIA	9
TURKEY	6
USA	9

NON-MEMBER STATES — 81

ARGENTINA	1	BRAZIL	1	ESTONIA	2	MALTA	3	SERBIA	1
ARMENIA	1	CANADA	5	GHANA	1	MEXICO	2	SINGAPORE	3
AUSTRALIA	1	CHINA	3	GIBRALTAR	1	NIGERIA	1	SLOVENIA	1
AZERBAIJAN	2	COLOMBIA	1	HONG KONG	2	OMAN	1	SOUTH AFRICA	2
BAHRAIN	1	CROATIA	4	ICELAND	1	PAKISTAN	7	THAILAND	2
BENIN	1	CUBA	2	IRELAND	1	PHILIPPINES	2	TUNISIA	1
BOLIVIA	1	CYPRUS	4	JORDAN	3	ROMANIA	3	F.Y.R.O.M.	1
BOSNIA & HERZEGOVINA	1	ECUADOR	1	KAZAKHSTAN	2	RWANDA	1	VIETNAM	2
		EGYPT	2	MADAGASCAR	1	SAUDI ARABIA	1		

Relations with CERN



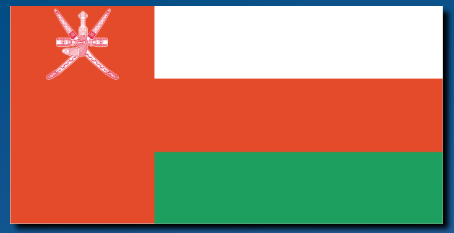
- **Governmental Co-operation Agreements**
  Egypt, Iran, Jordan (SESAME), Saudi Arabia, U.A.E.
- **Other scientific contacts**
  Bahrain, Kuwait, Lebanon, Oman, Palestine, Qatar
- **Teachers programme**
  Lebanon, Qatar, Saudi Arabia, U.A.E.
- **Summer Student Programme**
  Bahrain, Egypt, Iran, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, UAE

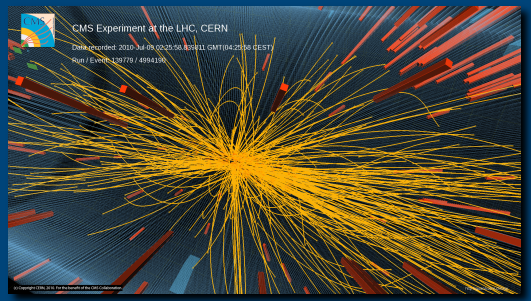
Looking forward to expanded collaboration with **SQU**

Concluding remarks

Fundamental science as carried out at CERN provides
the foundations for future knowledge and innovation

Research and technology + CERN Education Programmes =





Opportunities for SQU to share the excitement of physics at the LHC and to train the next generation of scientists and engineers


LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km

Thank You!