

CERN

European Organization for Nuclear Research

Organisation Européenne pour la Recherche Nucléaire

CERN – Research, Innovation and Education

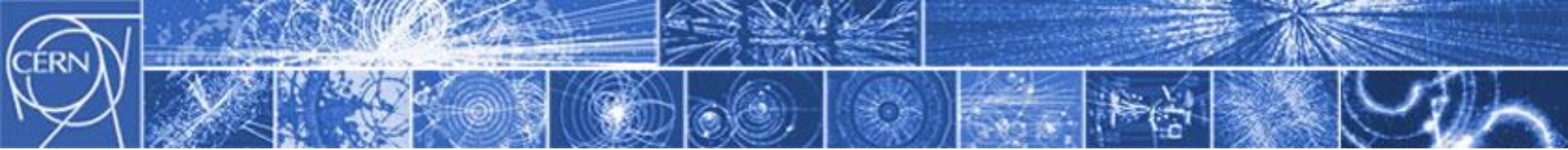
Mick Storr

Head Teacher Programmes and Visits Service

CERN

Geneva, Switzerland





30th November 2009 LHC sets new world record

Early this morning CERN's Large Hadron Collider become the world's highest energy particle accelerator, having accelerated its twin beams of protons to an energy of **1.18 TeV**. This exceeds the previous world record of 0.98 TeV, which had been held by the US Fermi National Accelerator



CERN was founded 1954: 12 European States Today: 20 Member States



~ 2300 staff
~ 790 other paid personnel
> 10000 users
Budget (2011) ~1000 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

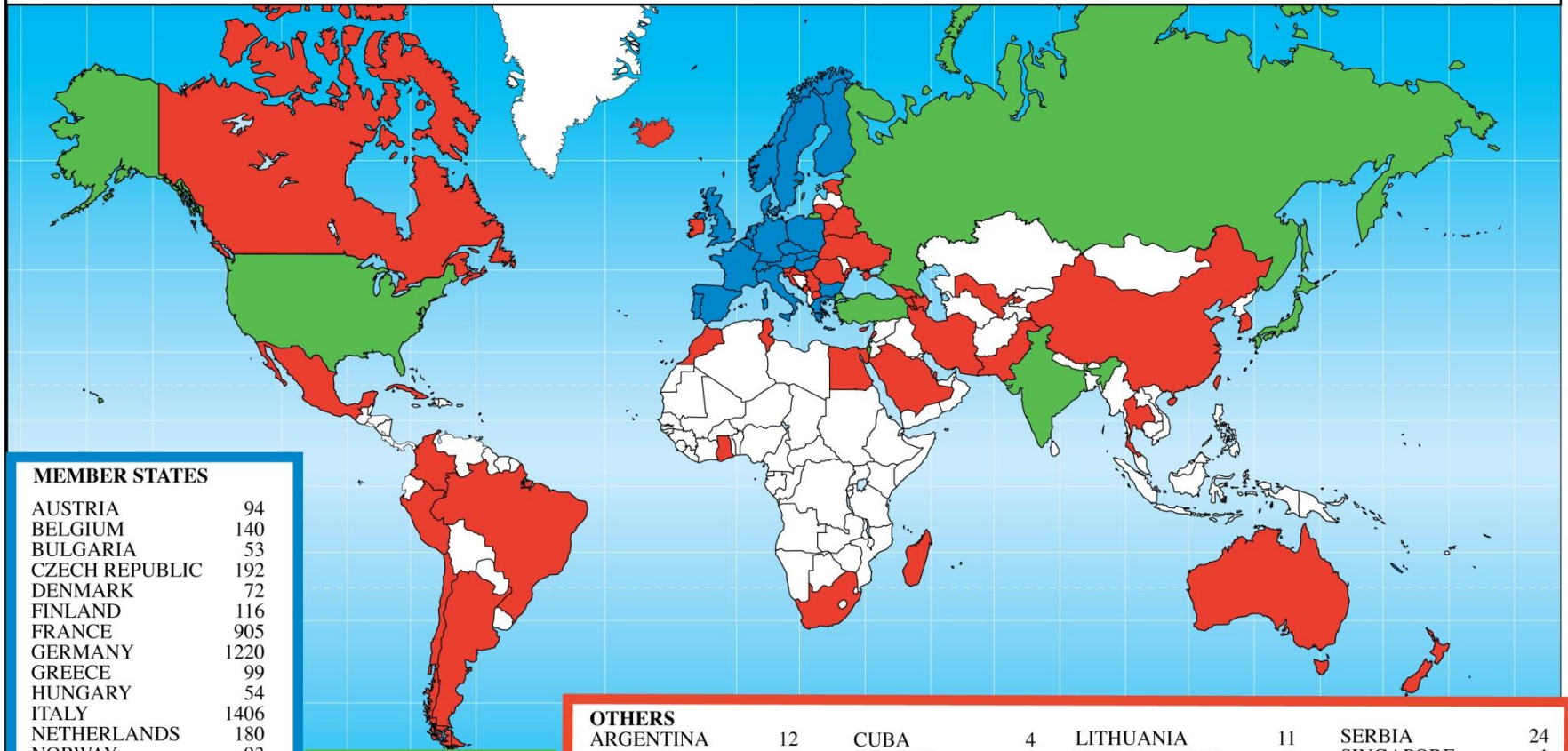
1 Candidate for Accession: Romania

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



Science is ever more global

Distribution of All CERN Users by Nation of Institute on 27 June 2011



MEMBER STATES

AUSTRIA	94
BELGIUM	140
BULGARIA	53
CZECH REPUBLIC	192
DENMARK	72
FINLAND	116
FRANCE	905
GERMANY	1220
GREECE	99
HUNGARY	54
ITALY	1406
NETHERLANDS	180
NORWAY	93
POLAND	205
PORTUGAL	141
SLOVAKIA	63
SPAIN	339
SWEDEN	79
SWITZERLAND	359
UNITED KINGDOM	732

OBSERVER STATES

INDIA	109
ISRAEL	60
JAPAN	190
RUSSIA	822
TURKEY	79
USA	1786

OTHERS

ARGENTINA	12	CUBA	4	LITHUANIA	11	SERBIA	24
ARMENIA	12	CYPRUS	6	MADAGASCAR	1	SINGAPORE	1
AUSTRALIA	22	EGYPT	6	MALTA	1	SLOVENIA	31
AZERBAIJAN	1	ESTONIA	18	MEXICO	39	SOUTH AFRICA	15
BELARUS	19	GEORGIA	10	MONTENEGRO	1	THAILAND	1
BRAZIL	79	GHANA	1	MOROCCO	7	F.Y.R.O.M.	3
CANADA	160	HONG KONG	1	NEW ZEALAND	9	TUNISIA	1
CHILE	3	ICELAND	3	PAKISTAN	19	UKRAINE	19
CHINA	87	IRAN	15	PERU	2	UZBEKISTAN	1
CHINA (TAIPEI)	53	IRELAND	13	QATAR	1		
COLOMBIA	13	KOREA	85	ROMANIA	66		
CROATIA	15	LEBANON	1	SAUDI ARABIA	2		

6542

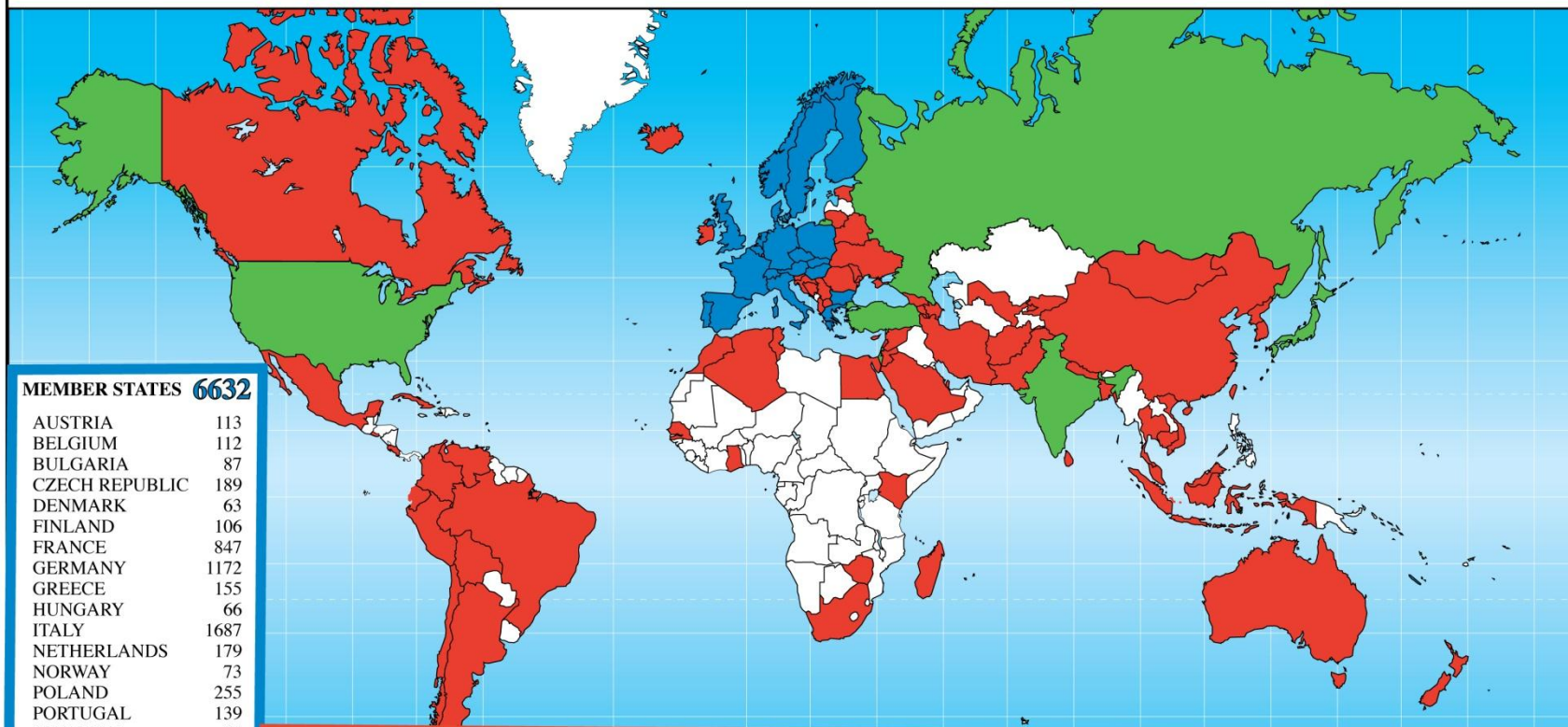
3046

894



Science is ever more global

Distribution of All CERN Users by Nationality on 27 June 2011



MEMBER STATES 6632

AUSTRIA	113
BELGIUM	112
BULGARIA	87
CZECH REPUBLIC	189
DENMARK	63
FINLAND	106
FRANCE	847
GERMANY	1172
GREECE	155
HUNGARY	66
ITALY	1687
NETHERLANDS	179
NORWAY	73
POLAND	255
PORTUGAL	139
SLOVAKIA	94
SPAIN	358
SWEDEN	79
SWITZERLAND	216
UNITED KINGDOM	642

OBSERVER STATES 2537

INDIA	192
ISRAEL	61
JAPAN	223
RUSSIA	955
TURKEY	106
USA	1000

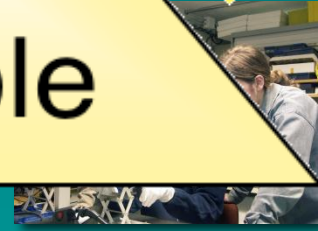
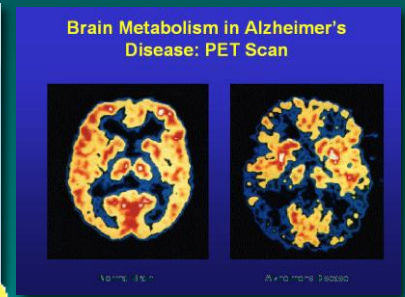
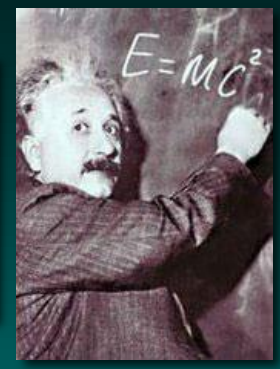
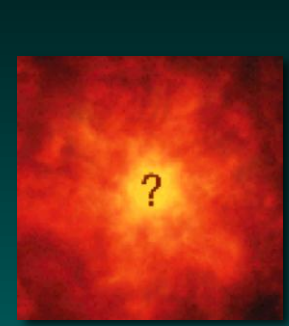
OTHERS 1364

AFGHANISTAN	1	BRAZIL	83	EL SALVADOR	1	KOREA REP.	103	NEW ZEALAND	9	SRI LANKA	5
ALBANIA	3	CAMBODIA	1	ESTONIA	15	KYRGYZSTAN	1	PAKISTAN	39	SYRIA	2
ALGERIA	12	CANADA	143	GEORGIA	32	LEBANON	10	PALESTINE (O.T.)	1	THAILAND	3
ARGENTINA	13	CHILE	3	GHANA	1	LITHUANIA	17	PERU	4	F.Y.R.O.M.	2
ARMENIA	22	CHINA	232	GIBRALTAR	1	LUXEMBOURG	4	QATAR	1	TUNISIA	7
AUSTRALIA	20	CHINA (TAIPEI)	42	HONG KONG	1	MADAGASCAR	4	ROMANIA	106	UKRAINE	40
AZERBAIJAN	6	COLOMBIA	31	ICELAND	3	MALAYSIA	4	SAN MARINO	1	UZBEKISTAN	3
BANGLADESH	2	COSTA RICA	2	INDONESIA	2	MALTA	2	SAUDI ARABIA	3	VENEZUELA	11
BELARUS	36	CROATIA	22	IRAN	23	MEXICO	54	SENEGAL	1	VIET NAM	9
BOLIVIA	2	CUBA	5	IRELAND	25	MOLDOVA	1	SERBIA	38	ZIMBABWE	1
BOSNIA AND HERZEGOVINA	1	CYPRUS	14	JORDAN	1	MONGOLIA	1	SINGAPORE	1		
		ECUADOR	2	KENYA	1	MOROCCO	15	SLOVENIA	32		
		EGYPT	9	KOREA, D.P.R.	3	NEPAL	2	SOUTH AFRICA	11		

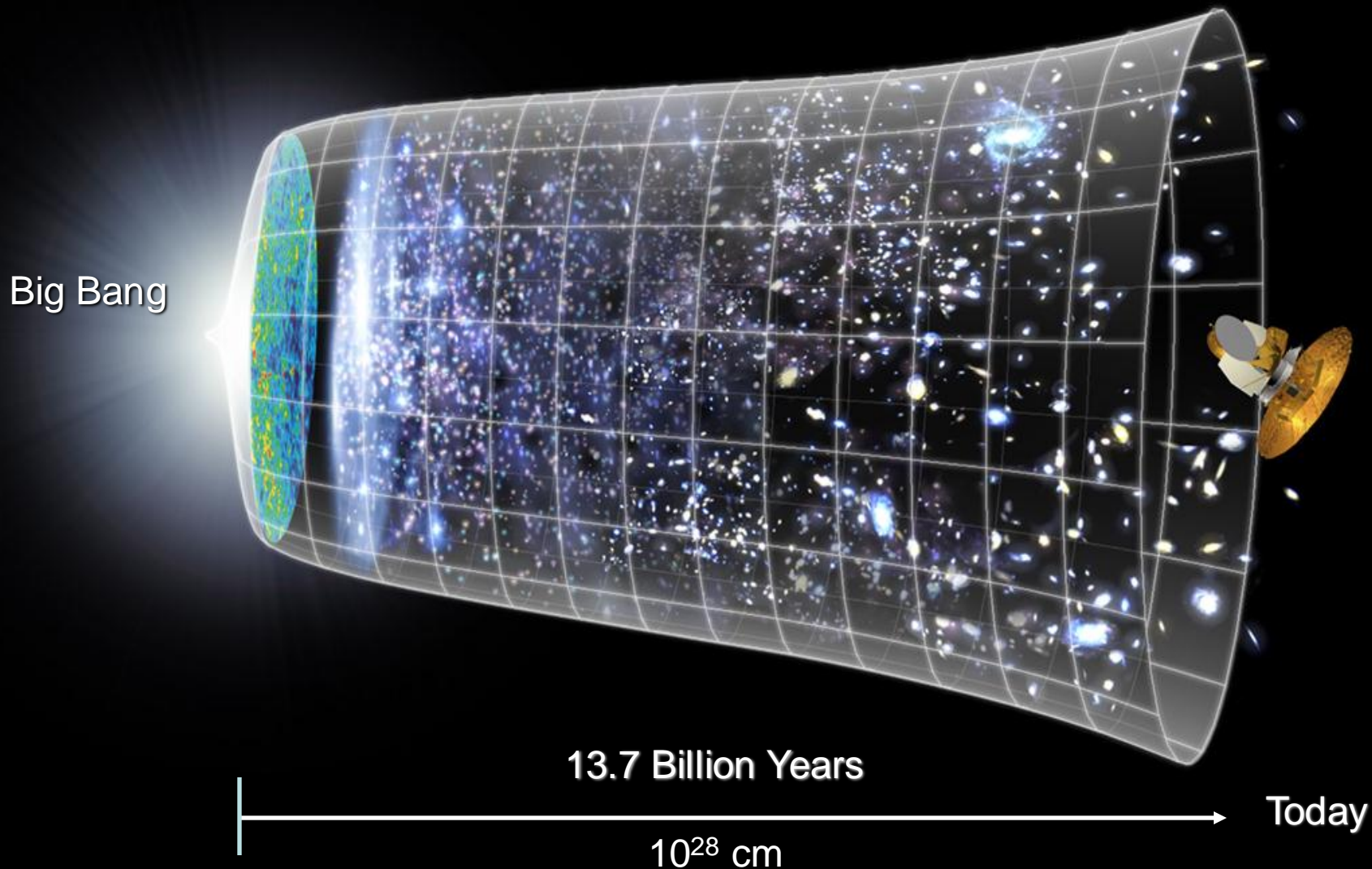


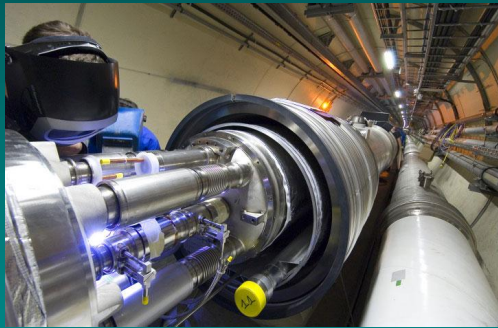
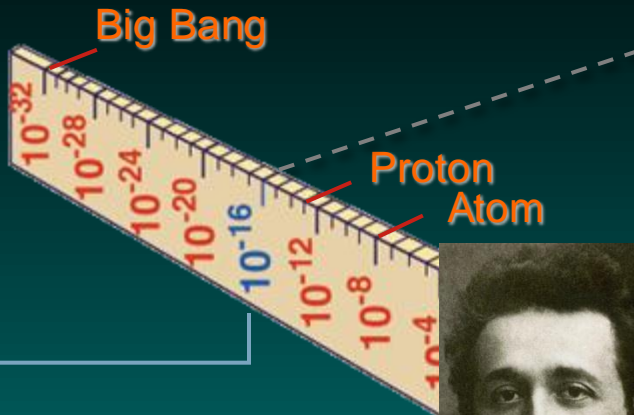
The Mission of CERN

- **Push back** the frontiers of knowledge
 E.g. the secrets of the Big Bang - what was it like within the first moments of the Universe's existence
- **Develop** new technologies
 accelerators and detectors
 Information technology - the Internet
 Medicine - diagnosis and treatment
- **Train** scientists
 tomorrow
- **Unite** people from different countries and cultures



Evolution of the Universe



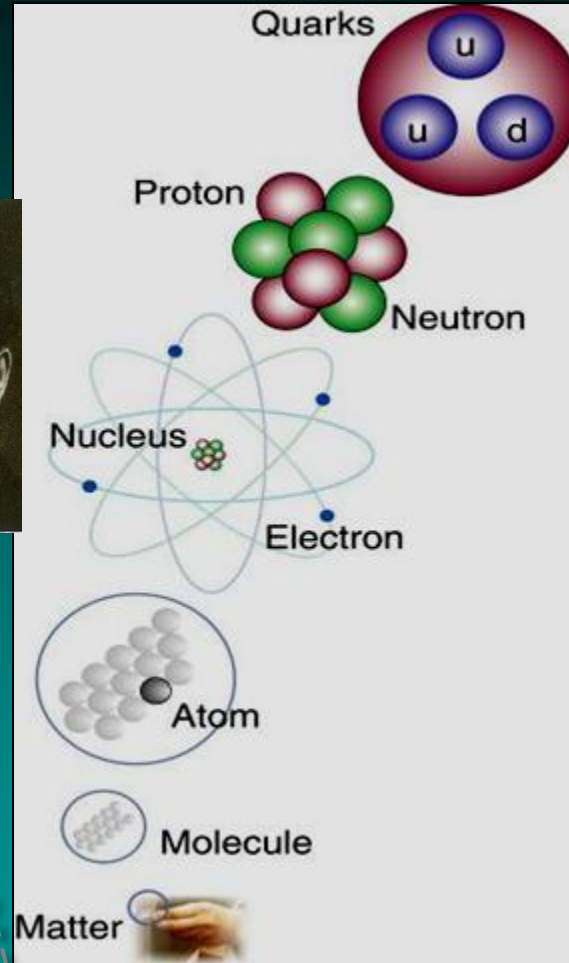


LHC

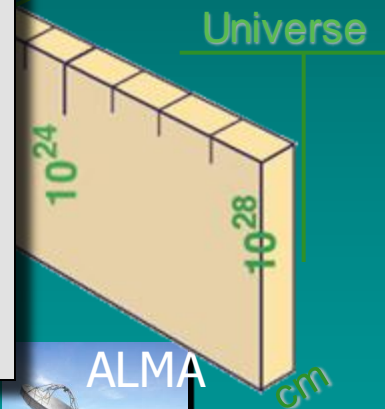
Super-Microscope



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



Radius of Galaxies



Hubble

AMS



ALMA



VLT



**“Where do we come from?
What are we?
Where are we going?”**



**The aim of particle physics, CERN & the LHC:
What is the Universe made of?**



The Large Hadron Collider (LHC)

Proton- Proton Collider

7 TeV + 7 TeV



1,000,000,000 collisions/second

Total energy over 14,000 proton masses

Primary targets:

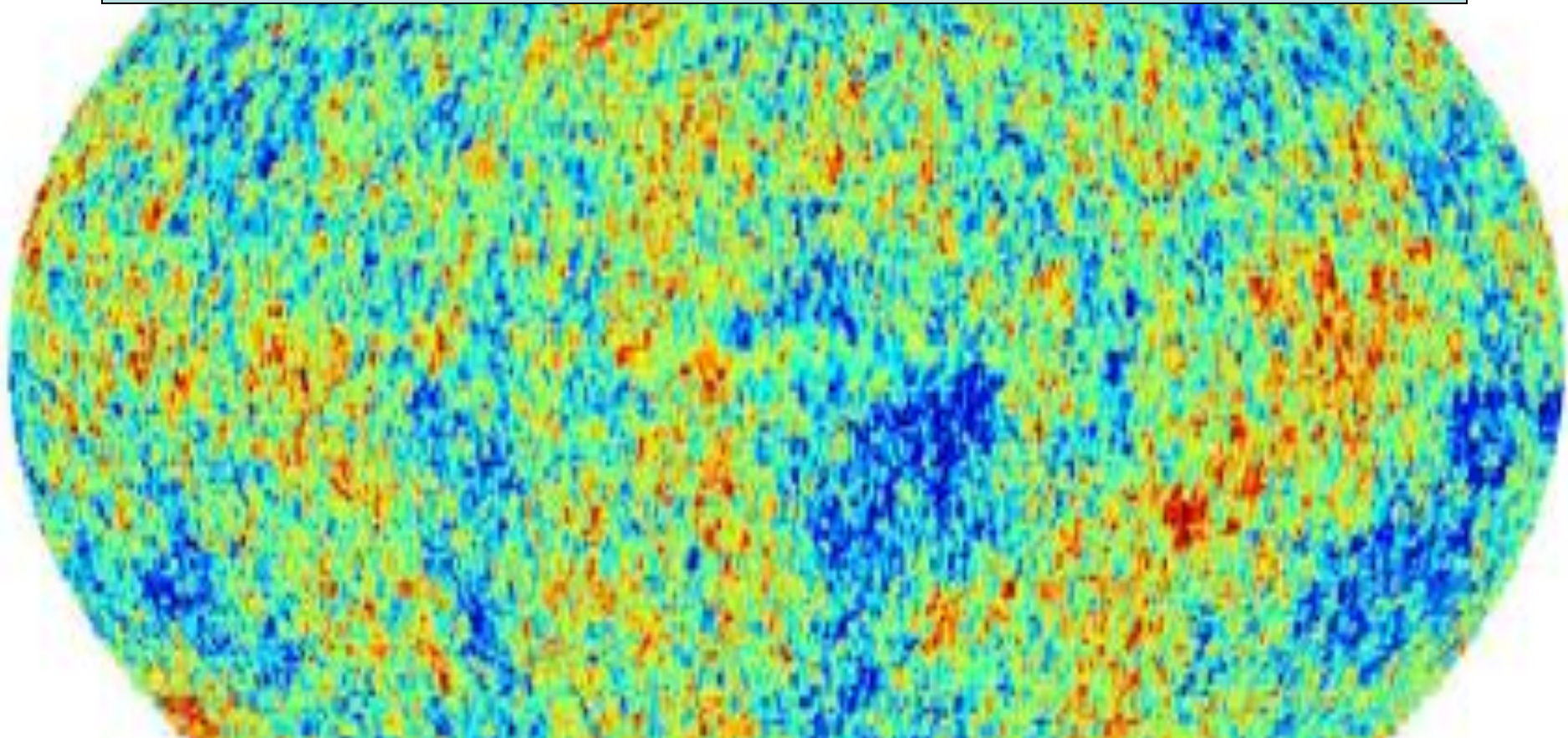
- Origin of mass
- Nature of Dark Matter
- Primordial Plasma
- Matter vs Antimatter

The Emptiest Space in the Solar System

A photograph of a long, brightly lit tunnel, likely a particle accelerator. The tunnel is filled with various pipes, machinery, and equipment. The perspective is from the end of the tunnel, looking down its length. The lighting is warm and yellowish, creating a sense of depth and scale. The machinery is complex and metallic, with various pipes and components visible. The overall atmosphere is one of a high-tech, industrial environment.

**Vacuum similar to interplanetary space:
the pressure in the beam-pipes will be
ten times lower than on the Moon.**

Colder than Outer Space

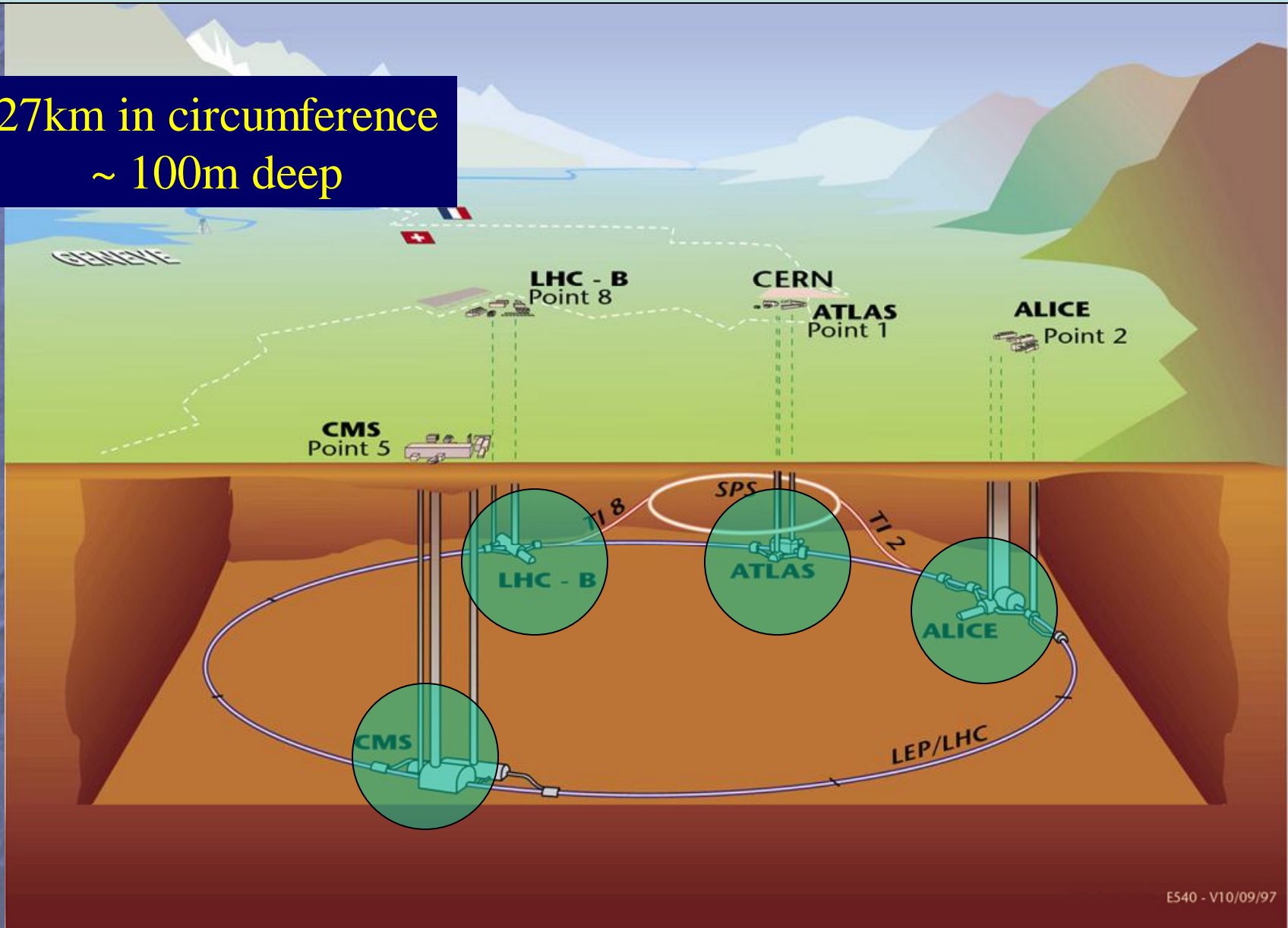


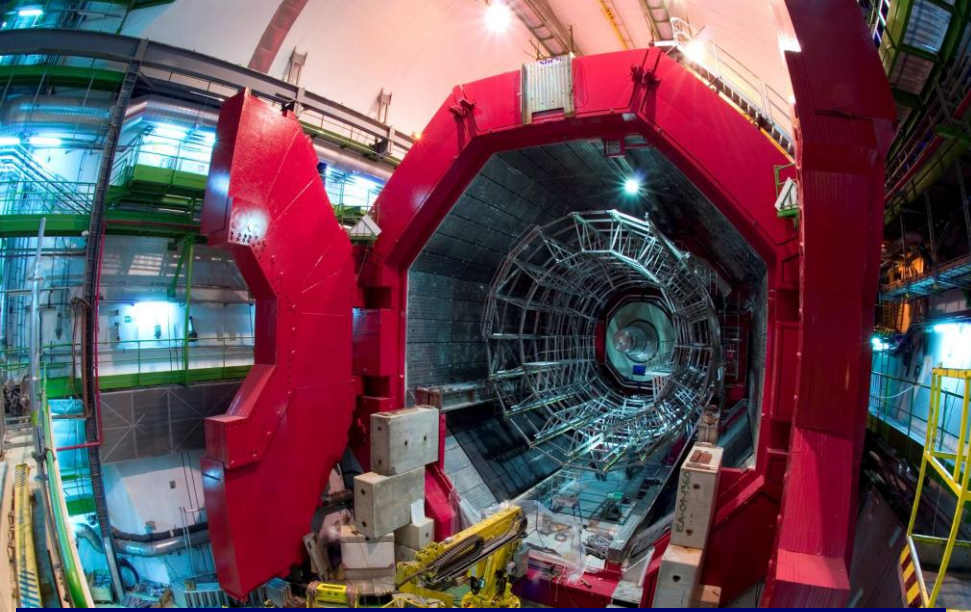
LHC 1.9 degrees above absolute zero = - 271 C

Outer space 2.7 degrees above zero = - 270 C

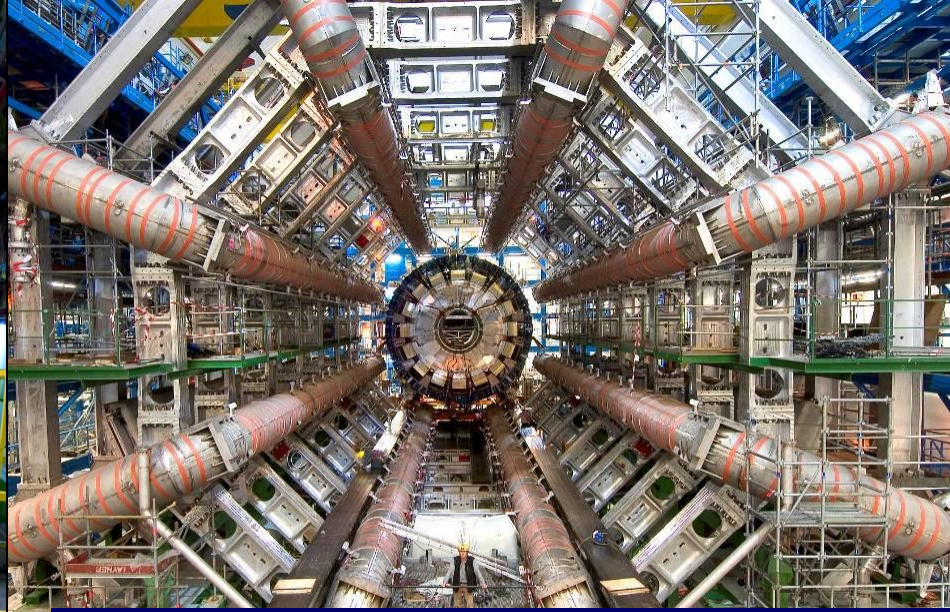
General View of LHC & its Experiments

27km in circumference
~ 100m deep

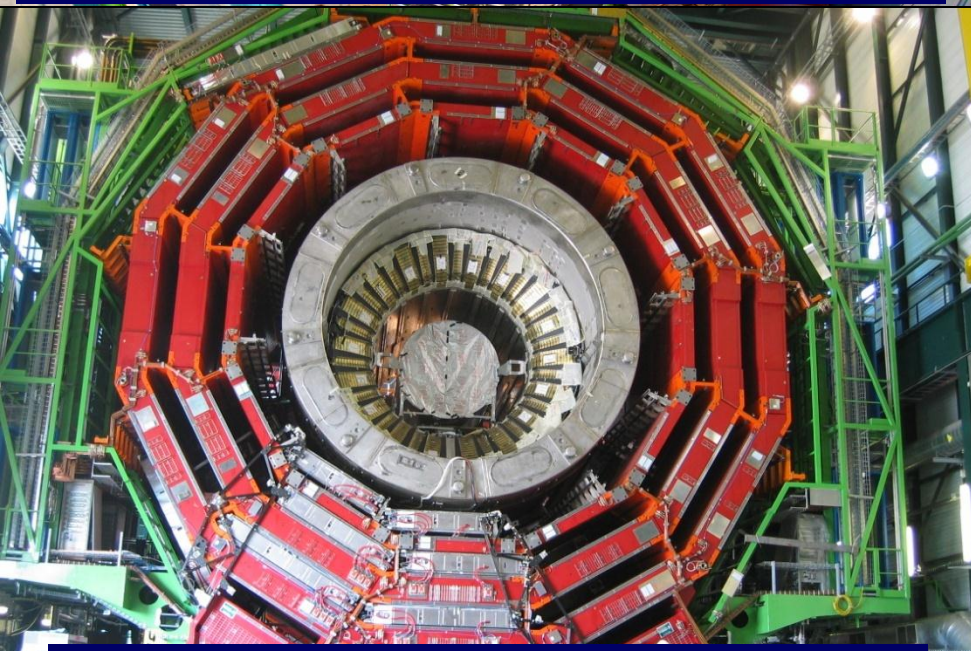




ALICE: Primordial cosmic plasma



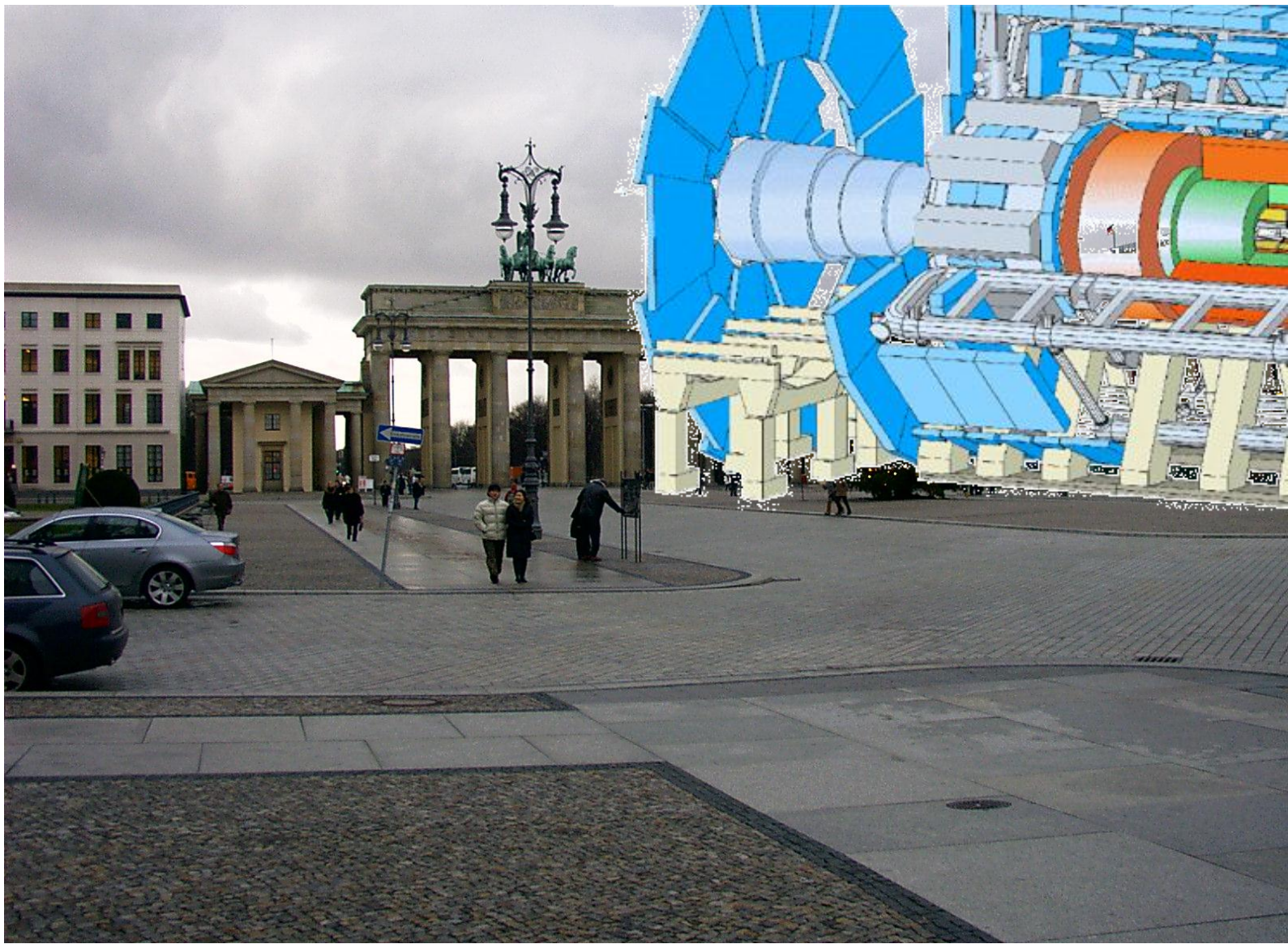
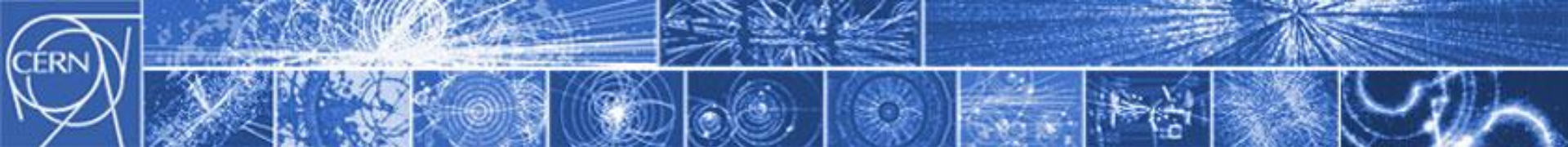
ATLAS: Higgs and supersymmetry



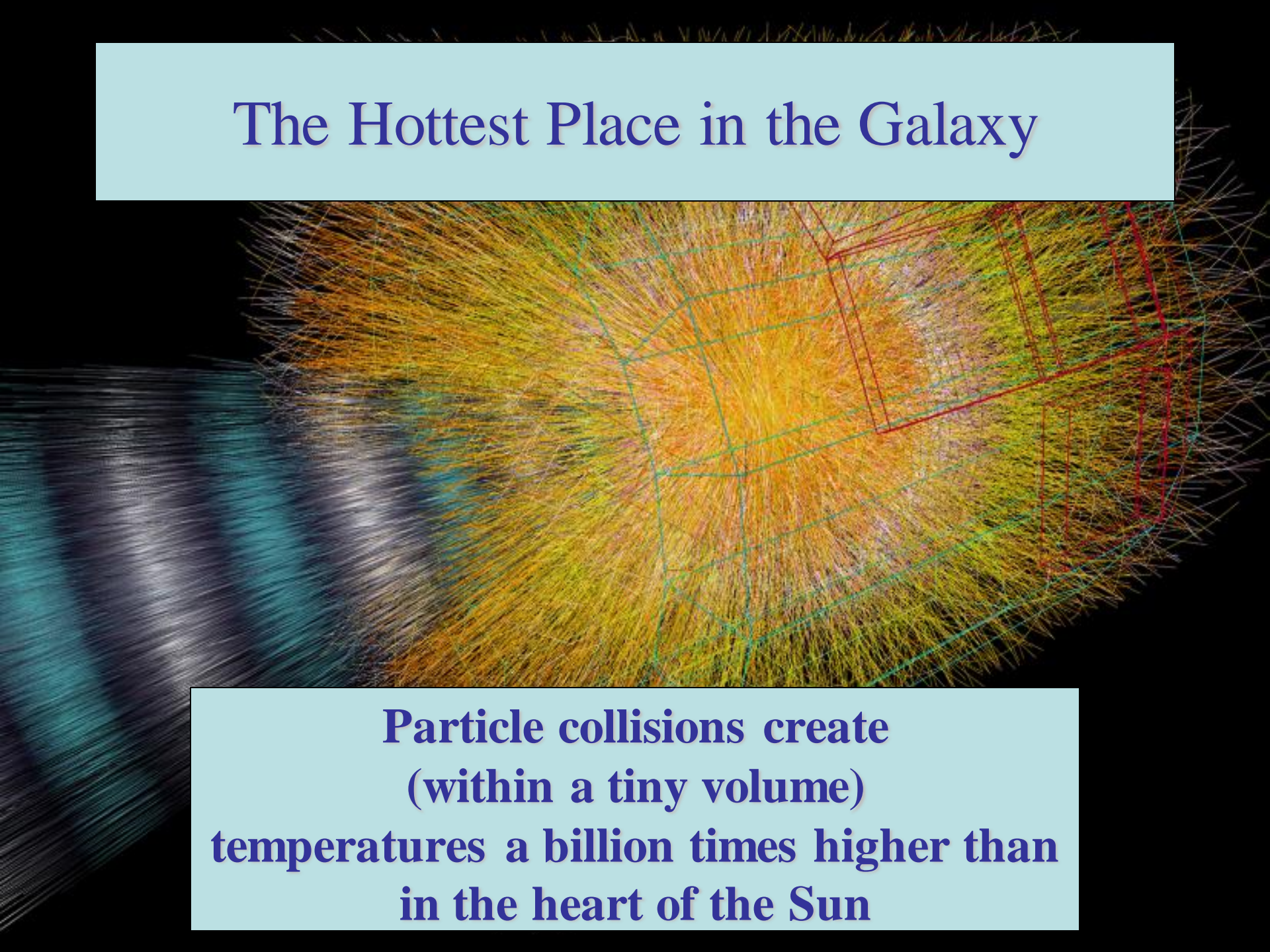
CMS: Higgs and supersymmetry



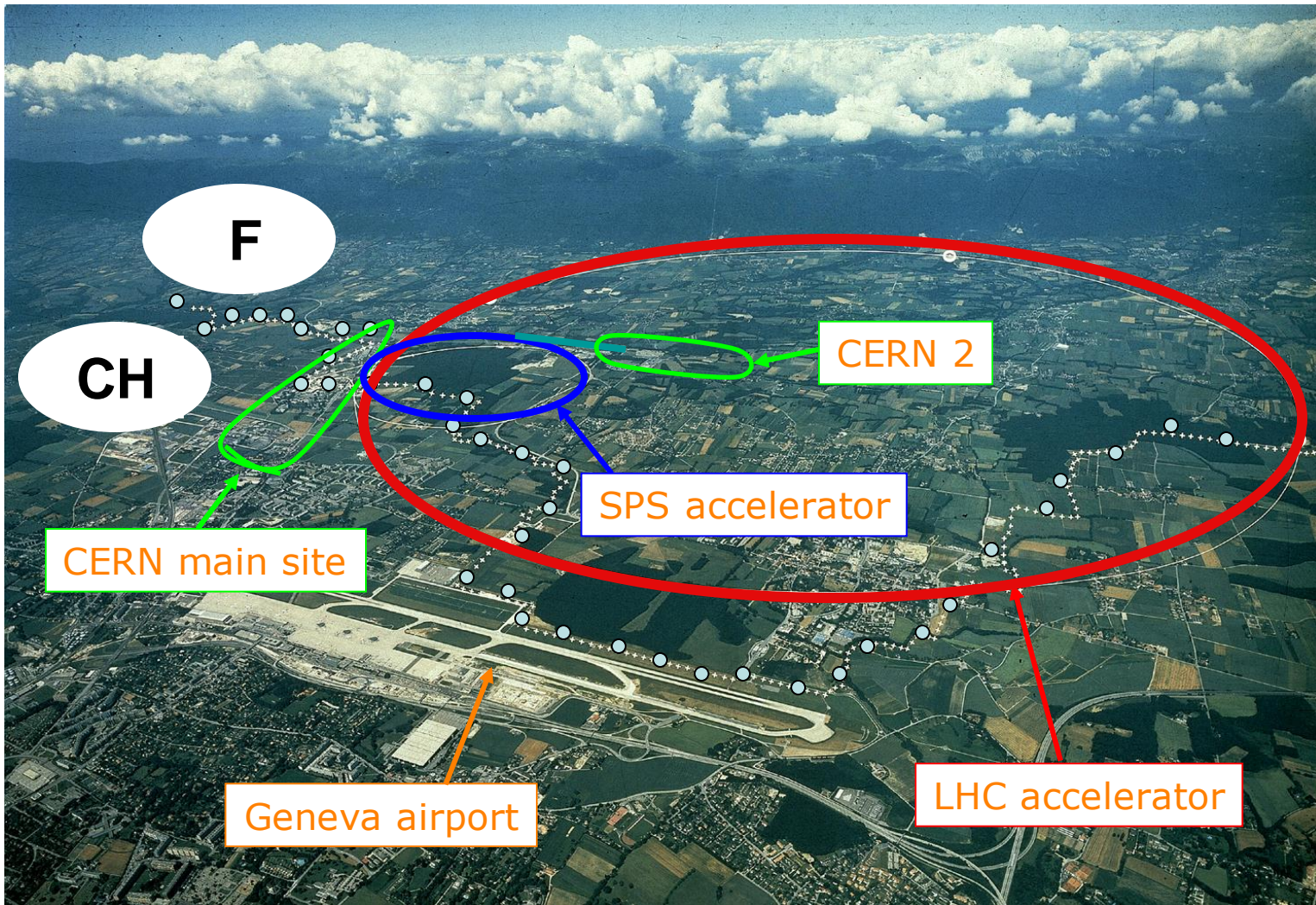
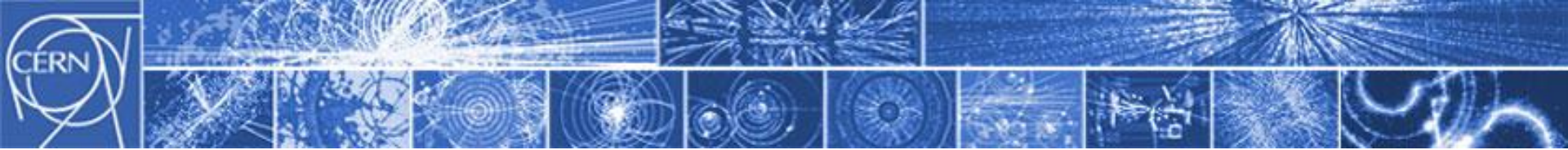
LHCb: Matter-antimatter difference

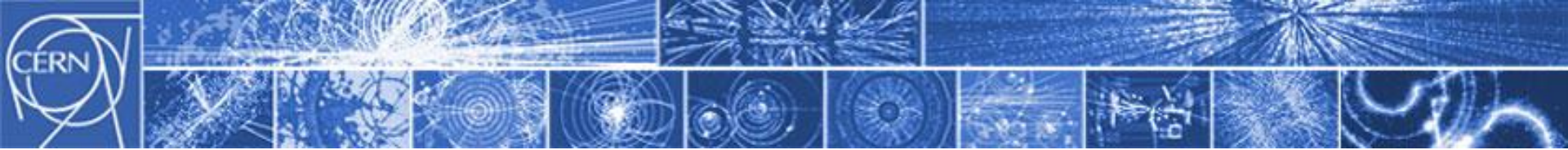


The Hottest Place in the Galaxy

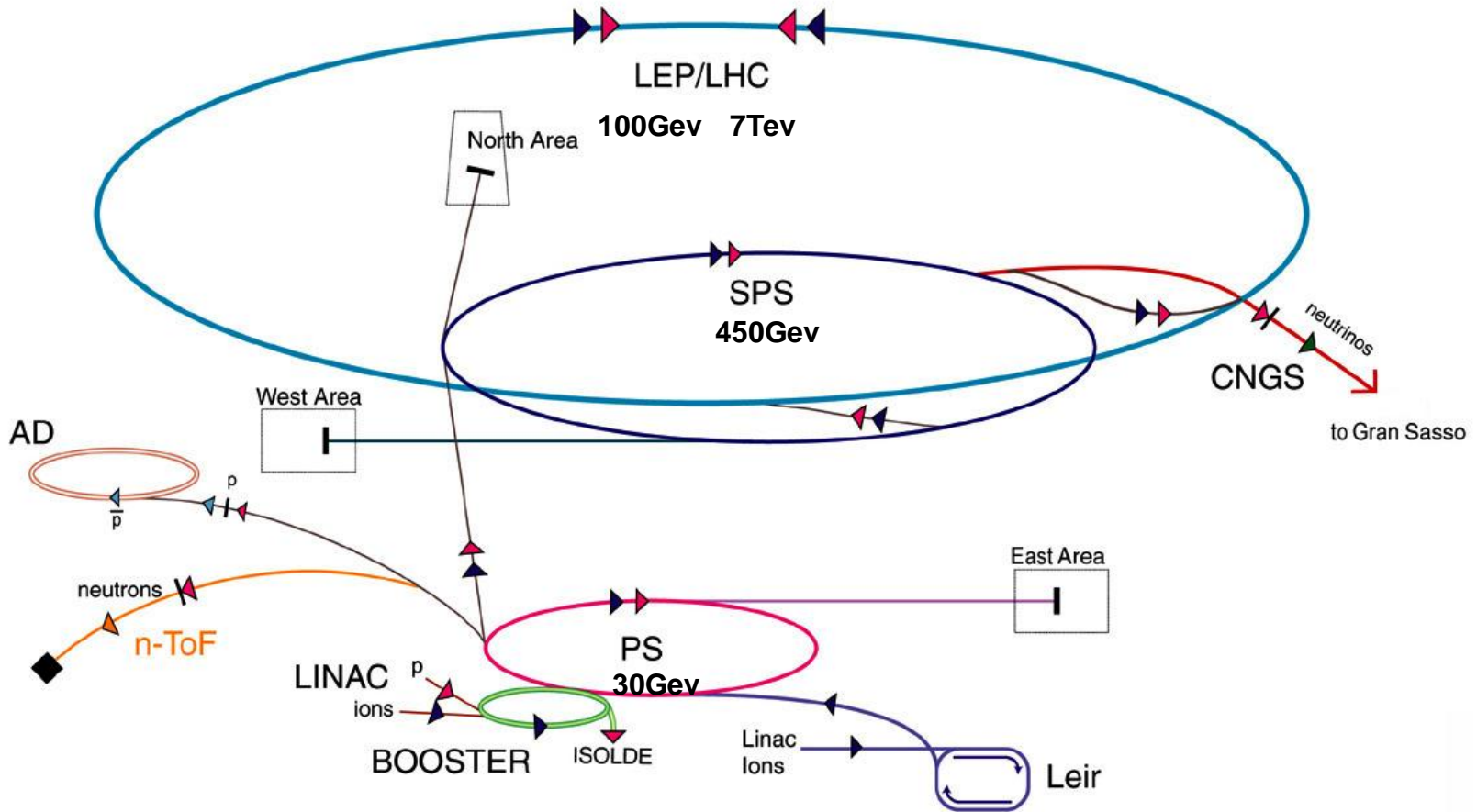
A visualization of a galaxy's core, showing a dense field of particles and a grid of colored lines. The particles are represented by a dense field of thin, colored lines (yellow, orange, green, red) that converge towards a central point. The background is dark, with a blue and white streaked area on the left side, suggesting a high-speed flow or a different region of the galaxy. The grid lines are colored in green and red, forming a 3D-like structure that appears to be a coordinate system or a volume element within the particle field.

**Particle collisions create
(within a tiny volume)
temperatures a billion times higher than
in the heart of the Sun**





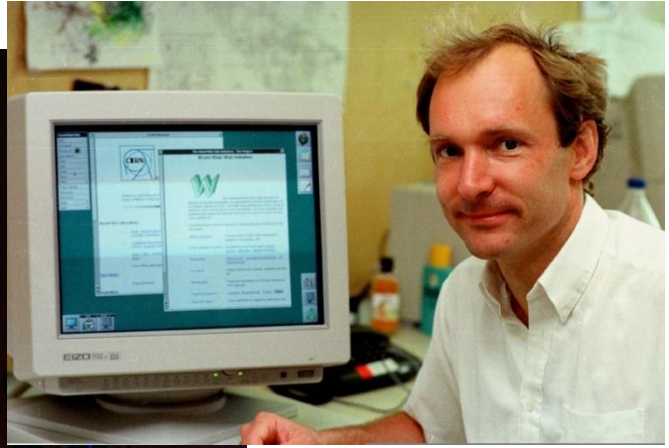
Accelerator chain at CERN, a complex business



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

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

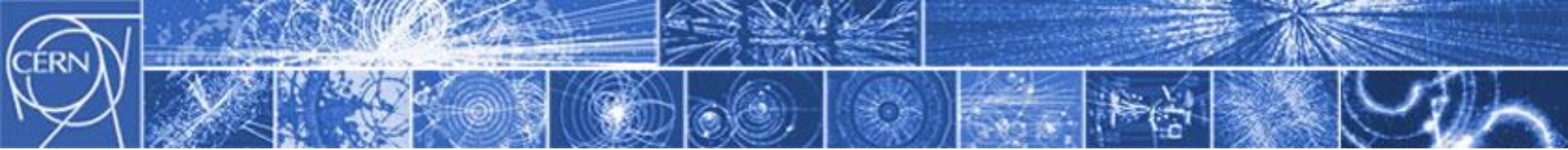
- LHC Large Hadron Collider
- n-ToF Neutron Time of Flight
- CNGS Cern Neutrinos Gran Sasso



Tim Berners-Lee
World Wide Web
1989

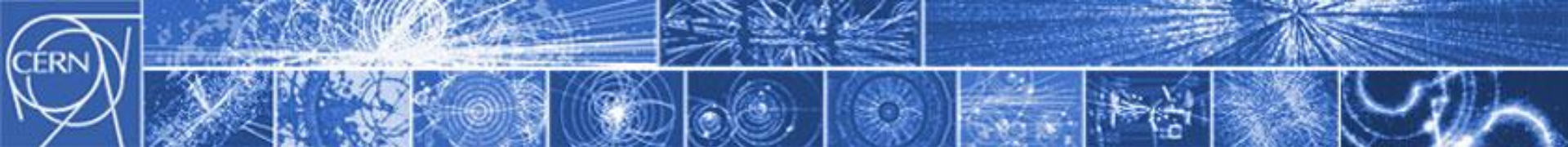
www.cern.ch

Computing
GRID



Personnel

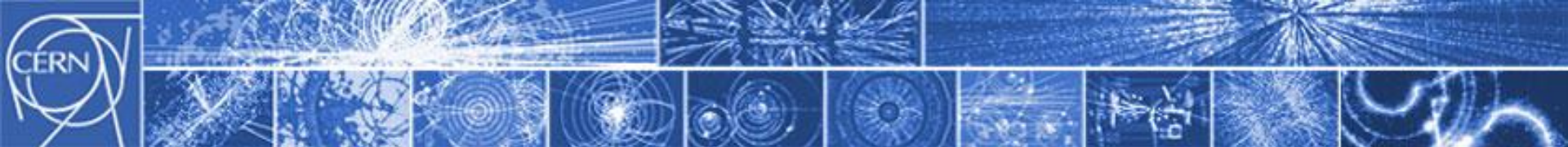




Workforce

- **Physicists**
 - **Experimental**
 - **Theoretical**
- **Applied Physicists and Engineers**
- **Technicians**
- **Craftsmen**
- **Administrative personnel**
- **Fellows**
- **Doctoral Students**
- **Technical Students**
- **Associates**
- **Summer Students**
- **Employees of CERN**
- **Users**





CERN Education Activities

Scientists at CERN

Academic Training Programme

Young Researchers

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

CERN Personnel

Training Programmes
Language, Management, Technical



CERN School of Computing
Uxbridge, UK, 2010

Physics Students

Summer Students Programme

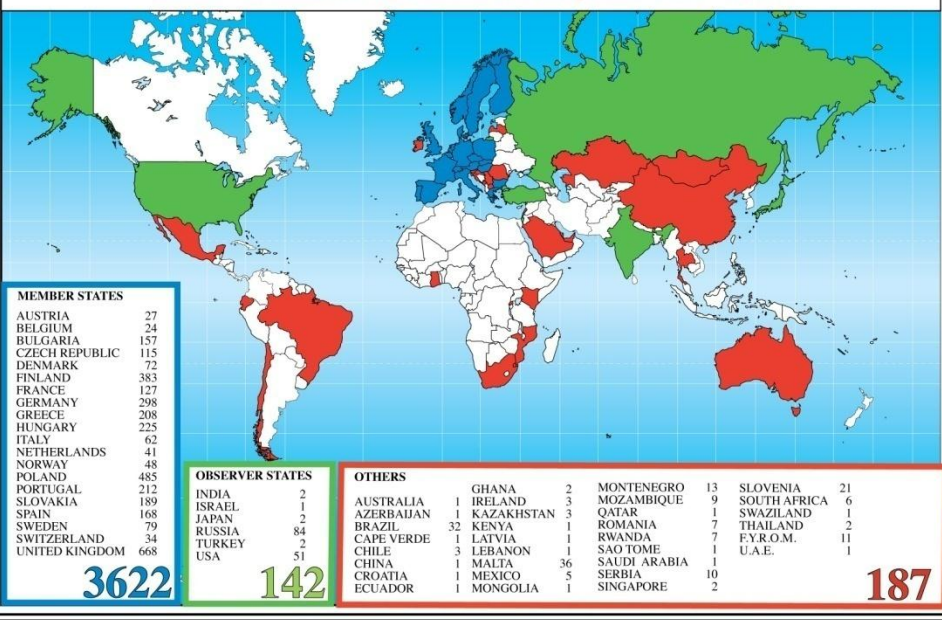


CERN Teacher Schools

International and National Programmes

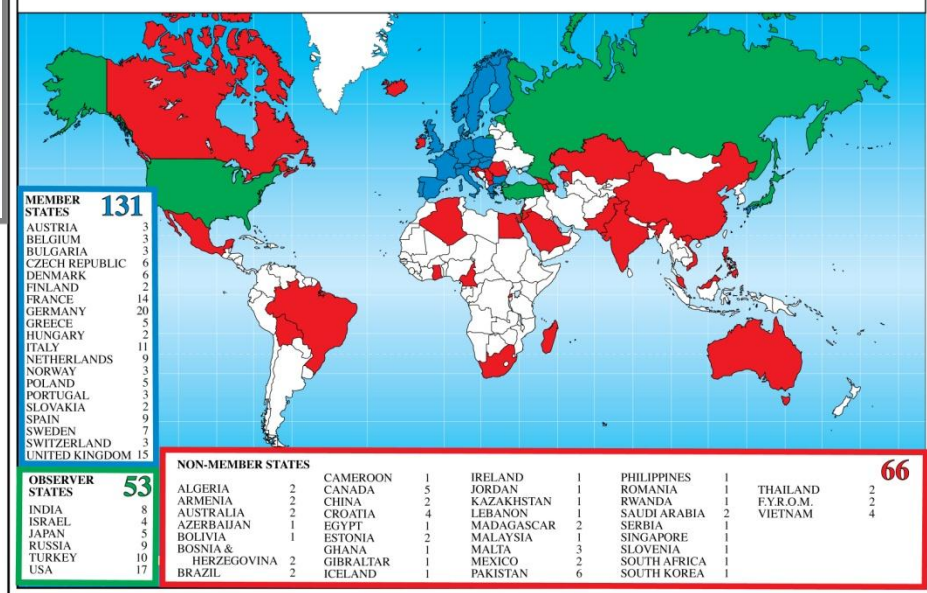


CERN Teacher Programme Participants 1998 - 2010



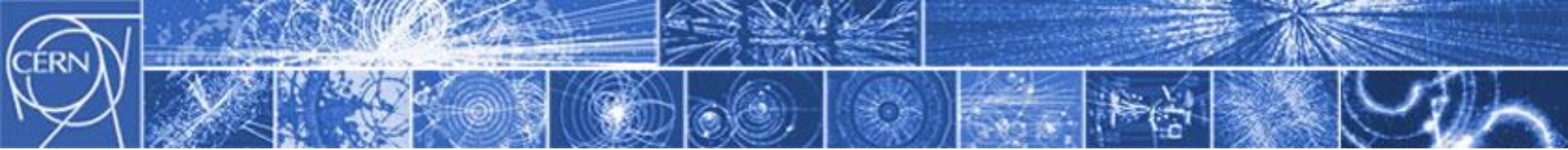
CERN Teacher Programme Participants: 1998 – December 2010

Distribution of Summer Students 2010



CERN Summer Students in 2010



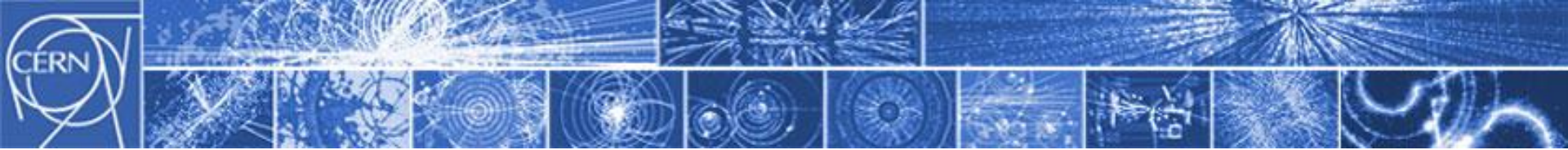


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What next ?



OPERA experiment invites scrutiny of unexpected results