

CERN

European Organization for Nuclear Research
Organisation Européenne pour la Recherche Nucléaire

CERN – Research, Innovation and Education

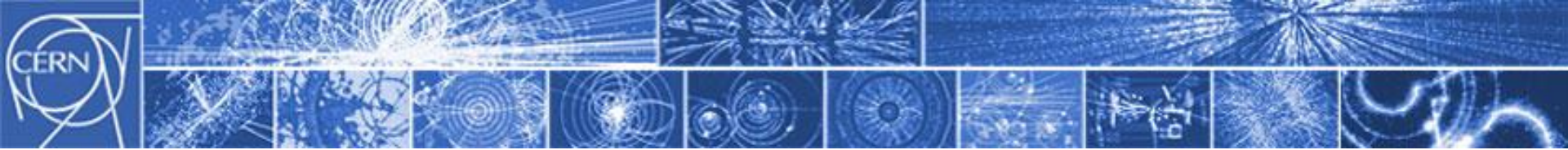
Mick Storr

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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

Candidate for Accession: Romania

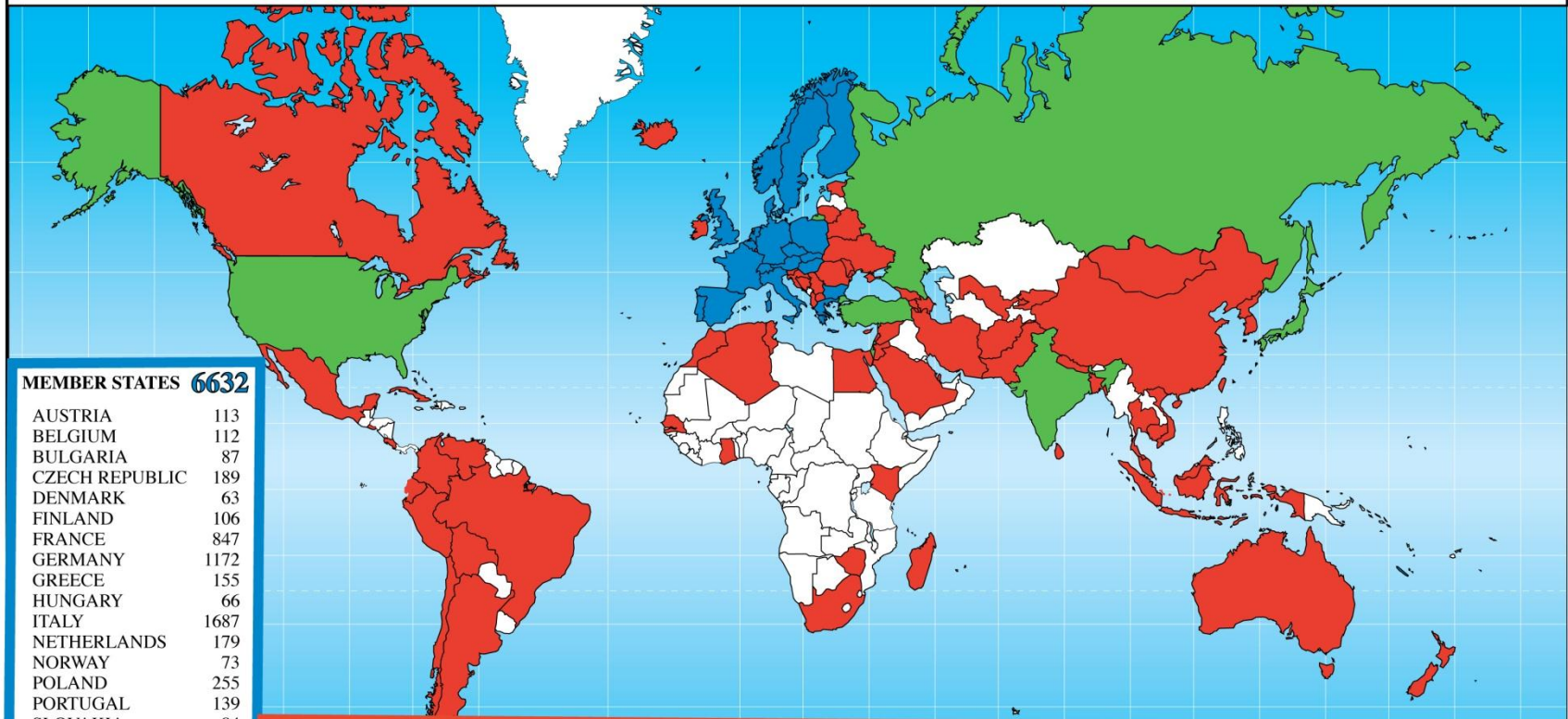
Associate Member States : Israel, (Serbia)

Observers to Council: India, 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 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

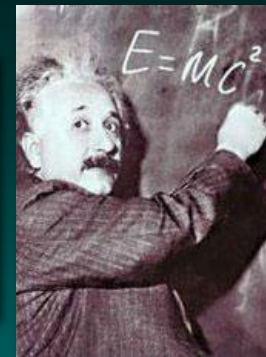
INDIA	192
ISRAEL	61
JAPAN	223
RUSSIA	955
TURKEY	106
USA	1000

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

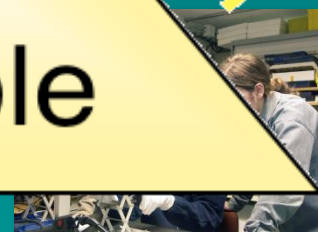
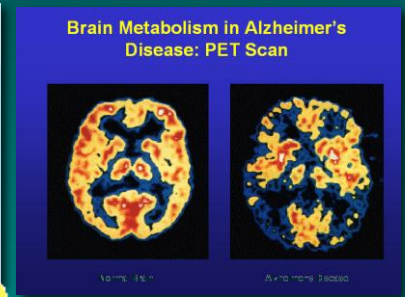


- **Push back** the frontiers of knowledge
 E.g. the secrets of the Big Bang - what was it like within the first moments of the Universe's existence

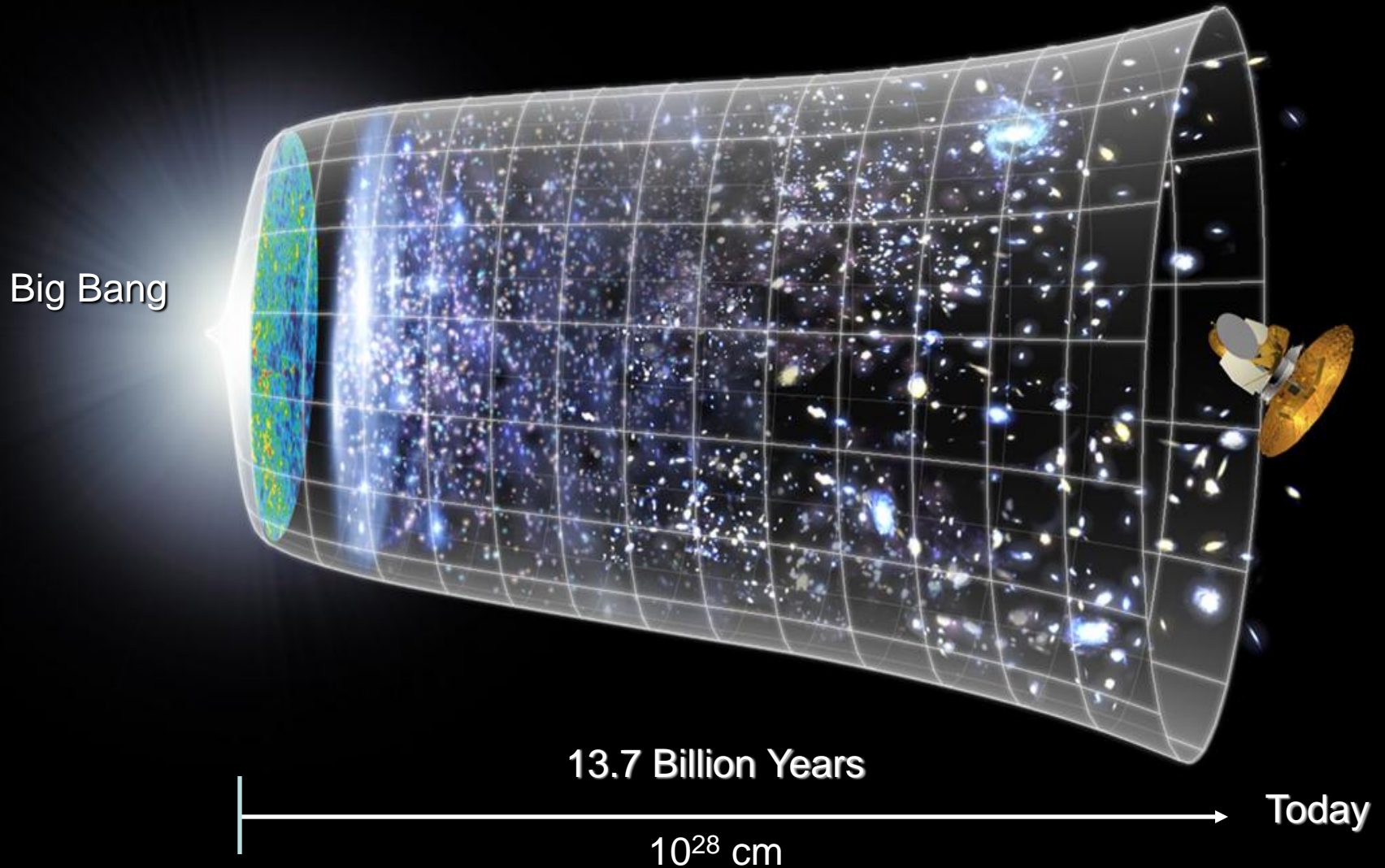
- **Develop** new technologies
 accelerators and detectors
 Information technology - the Internet
 Medicine - diagnosis and treatment

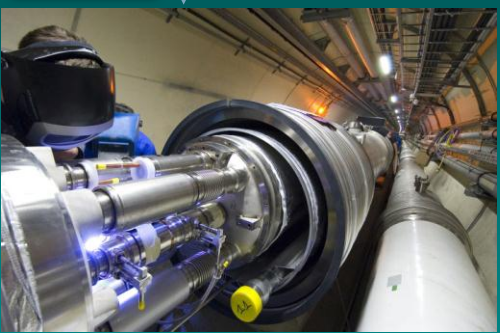
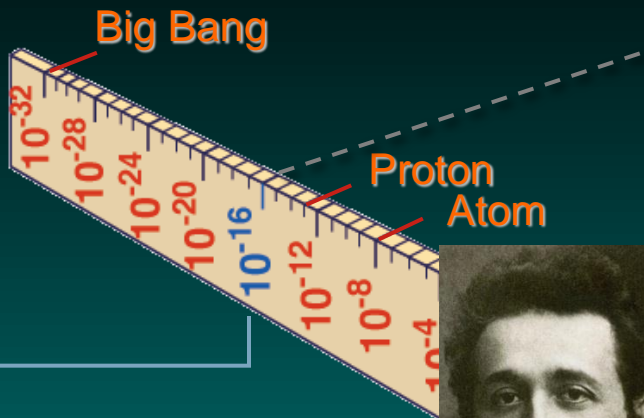
- **Train** scientists
 tomorrow

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



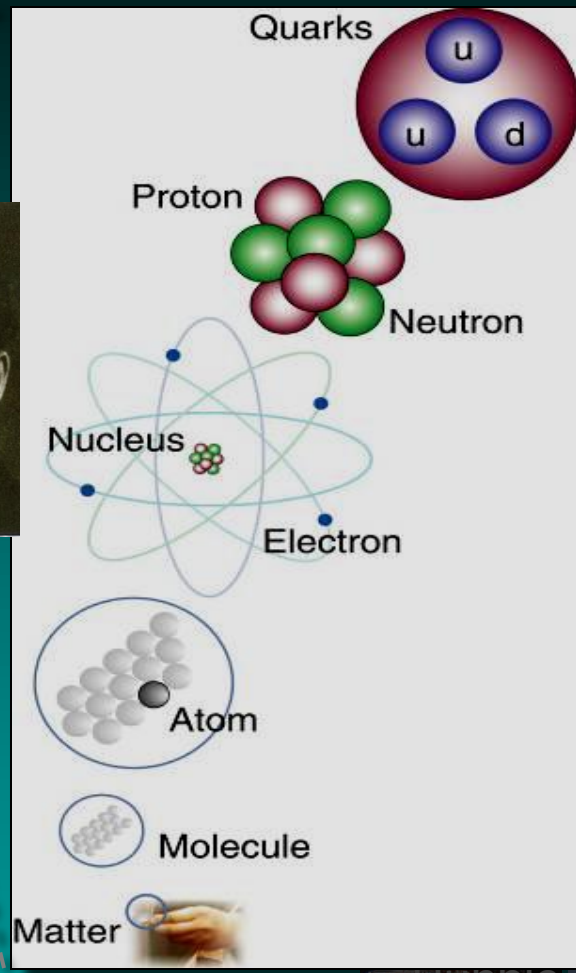
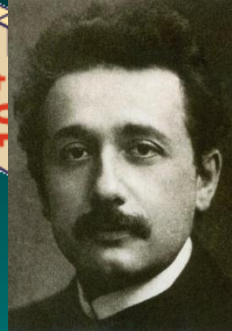
Evolution of the Universe



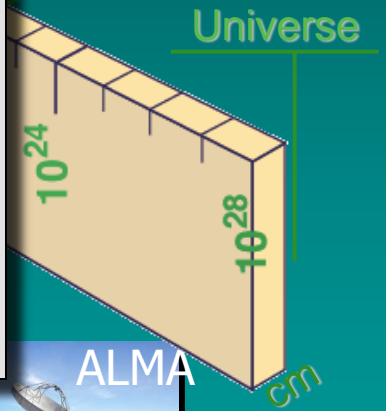


LHC

Super-Microscope



Radius of Galaxies



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



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

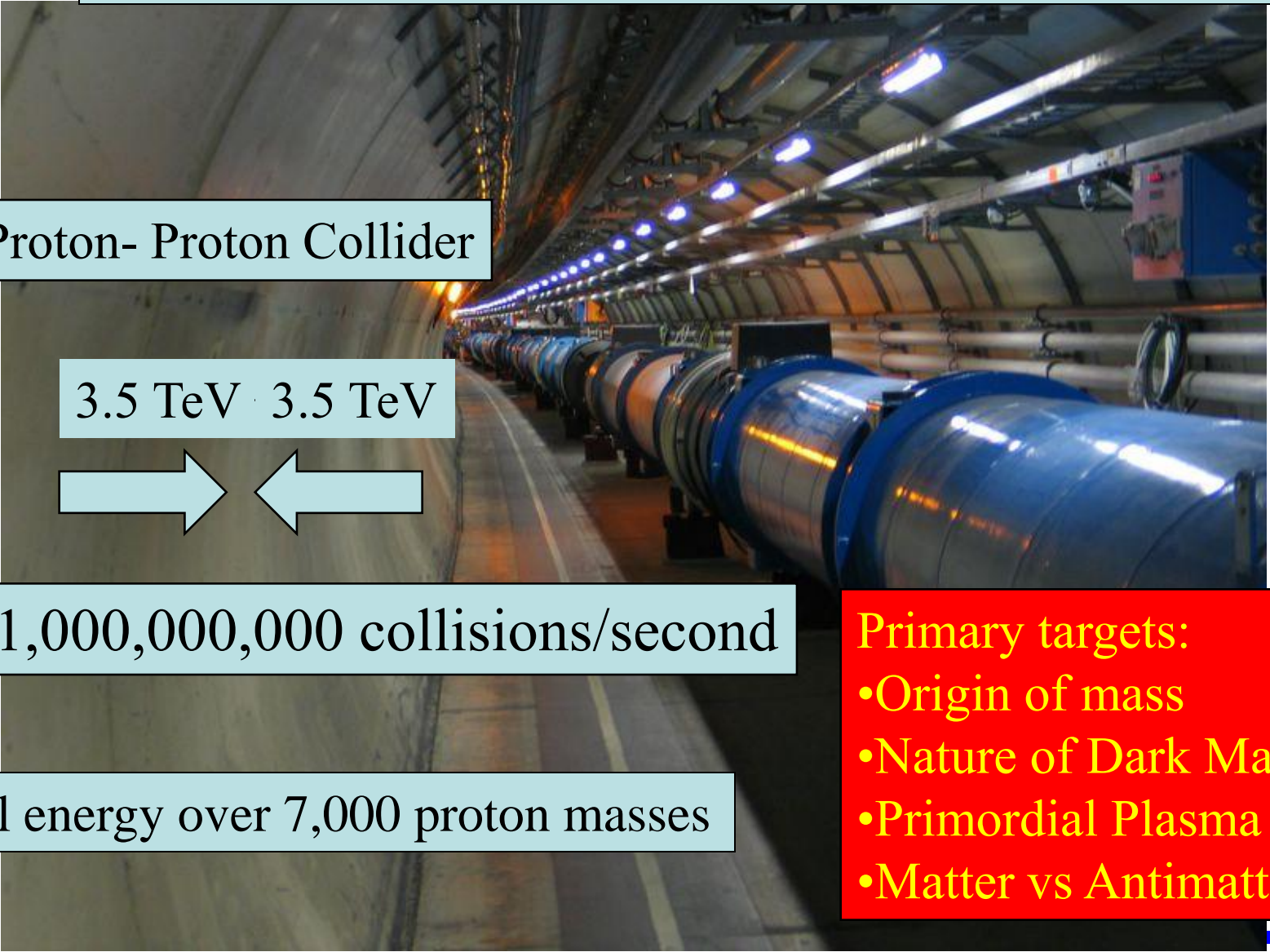
3.5 TeV 3.5 TeV



1,000,000,000 collisions/second

Total energy over 7,000 proton masses

- Primary targets:
- Origin of mass
 - Nature of Dark Matter
 - Primordial Plasma
 - Matter vs Antimatter

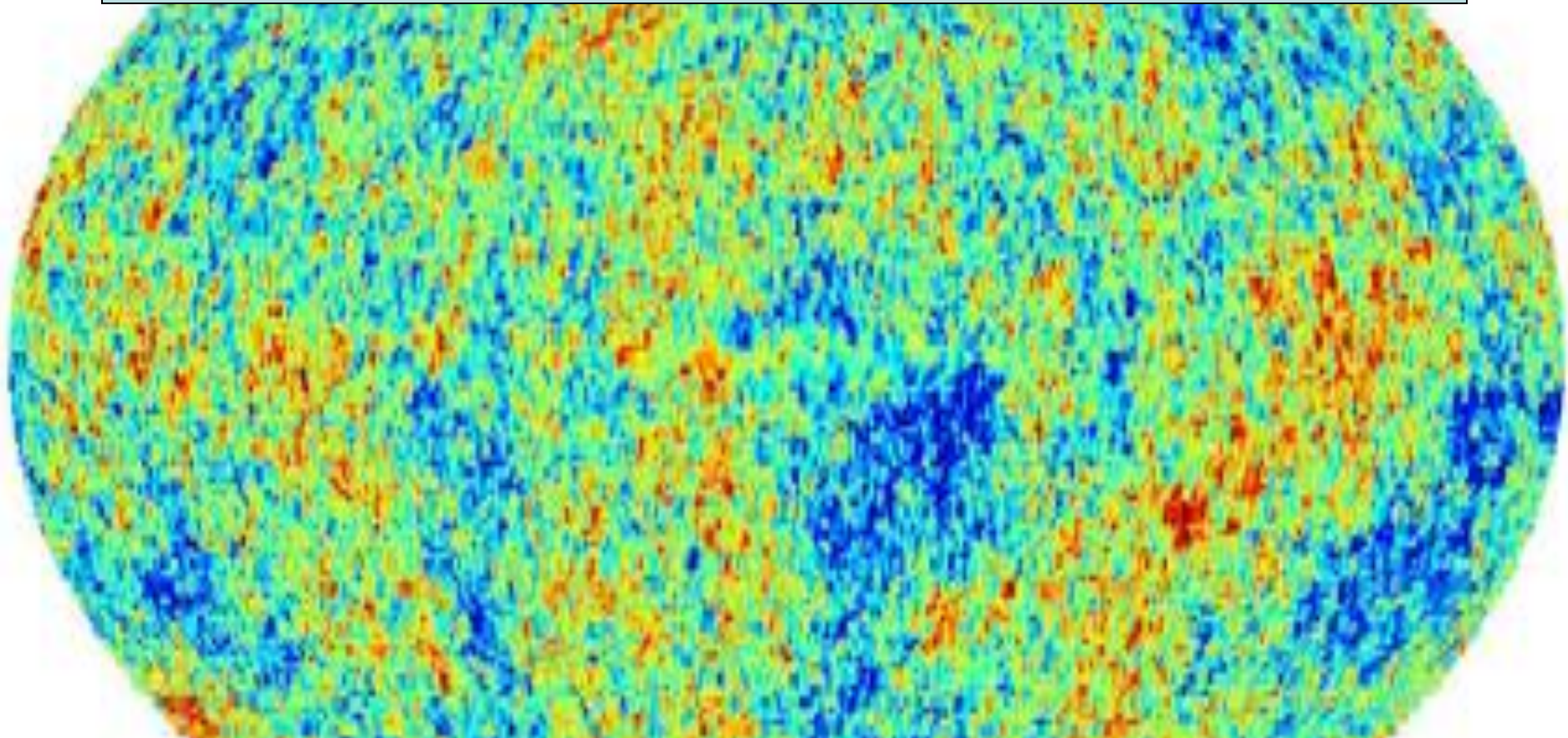


The Emptiest Space in the Solar System



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

Colder than Outer Space

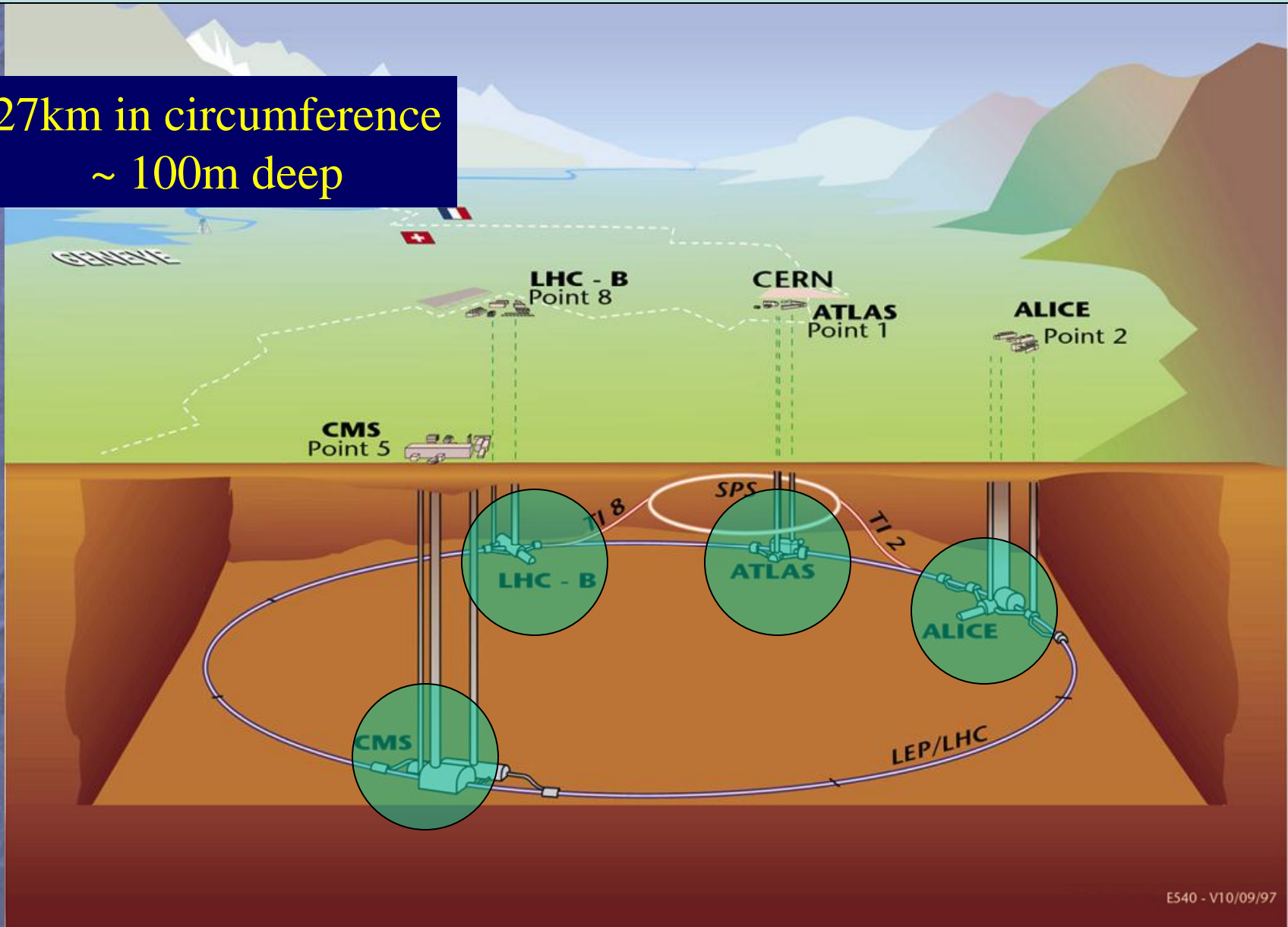


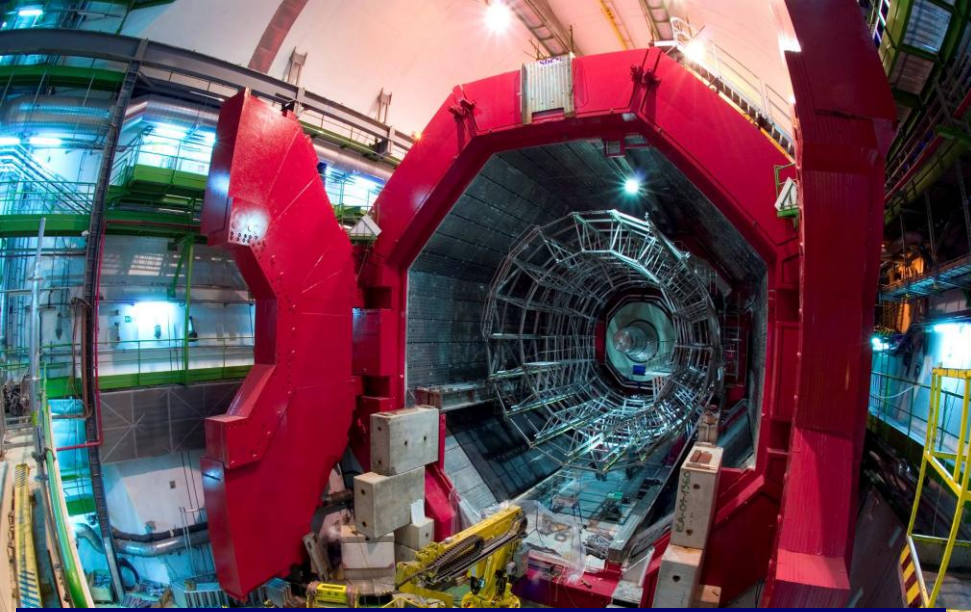
LHC 1.9 degrees above absolute zero = - 271 C

Outer space 2.7 degrees above zero = - 270 C

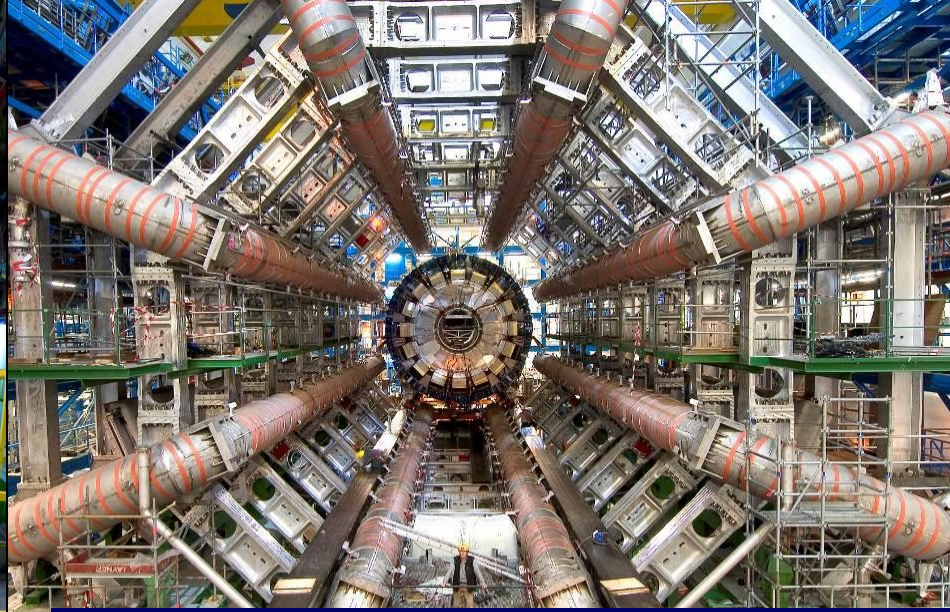
General View of LHC & its Experiments

27km in circumference
~ 100m deep

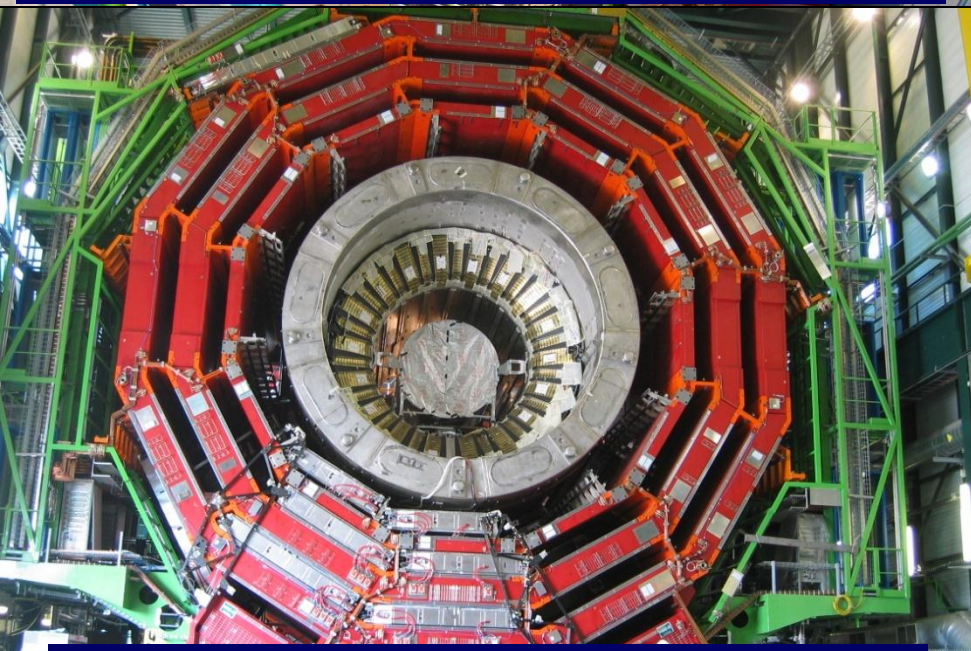




ALICE: Primordial cosmic plasma



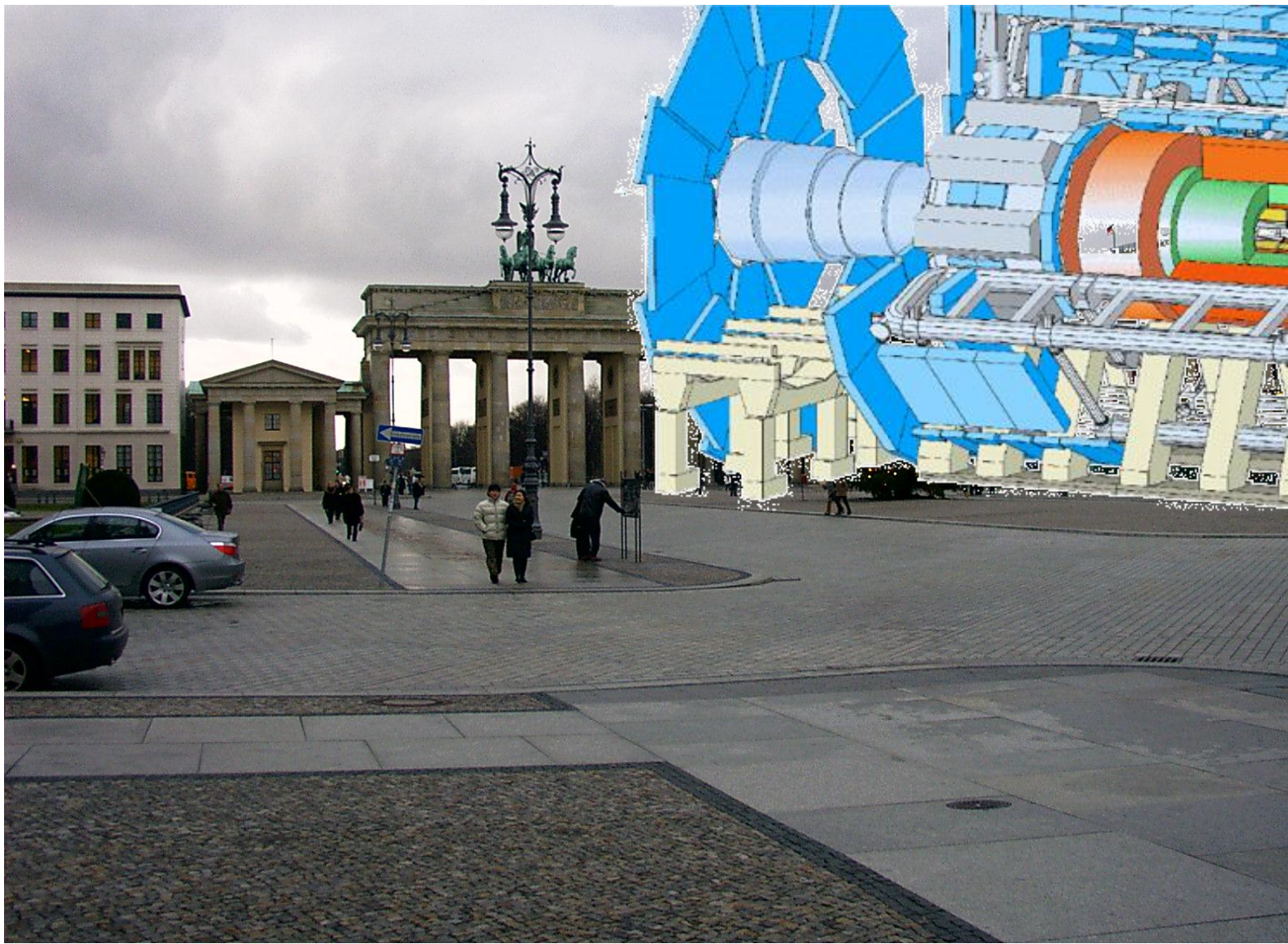
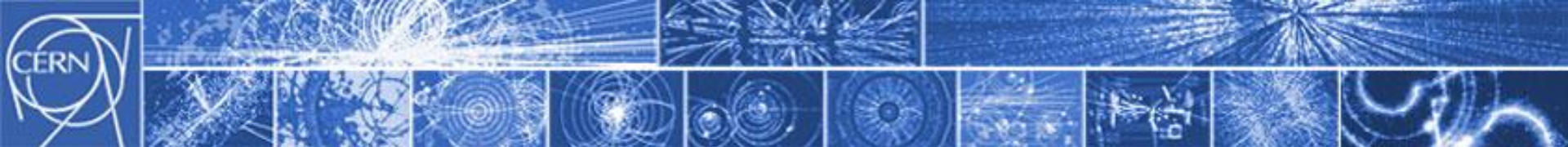
ATLAS: Higgs and supersymmetry



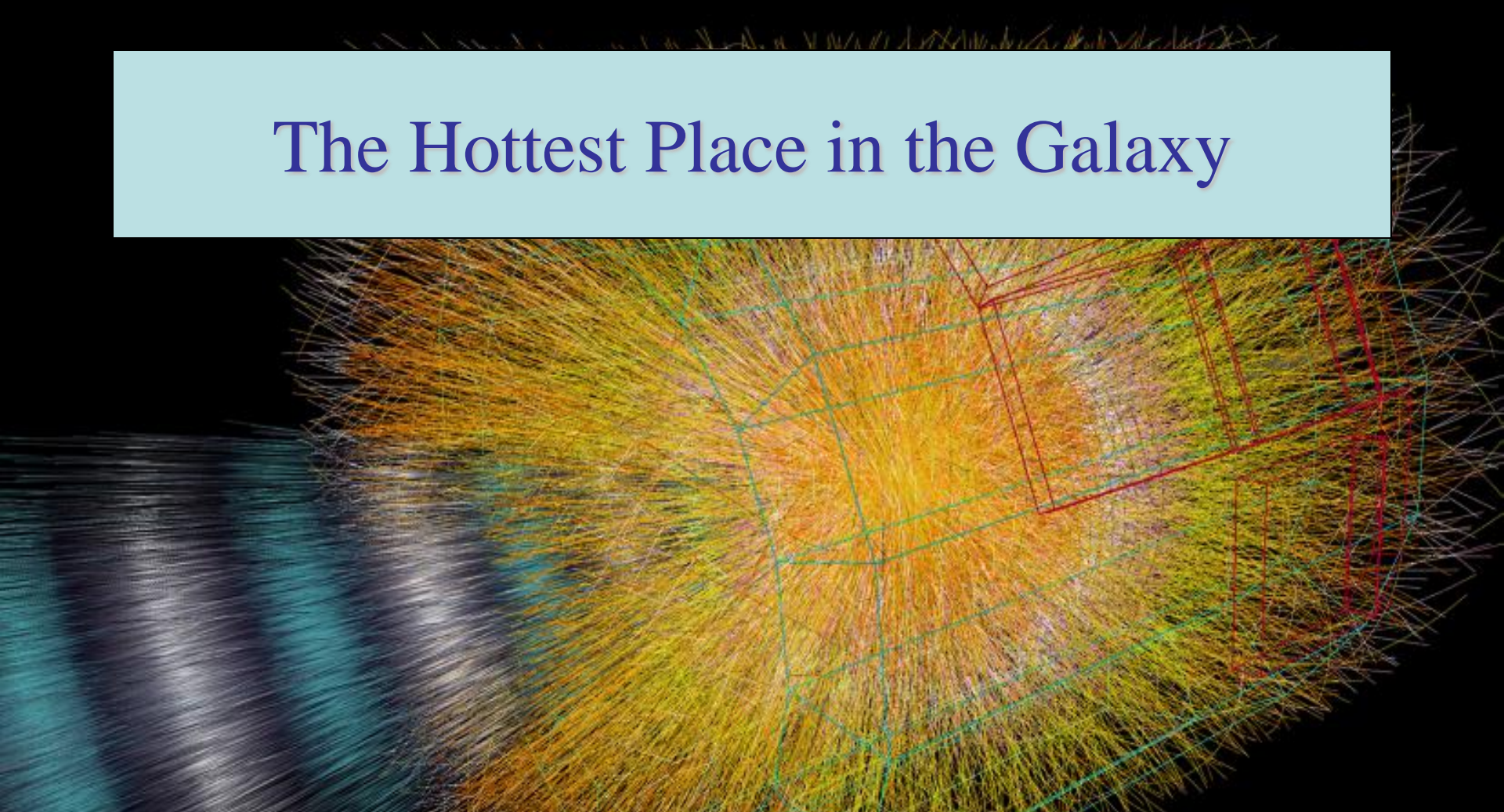
CMS: Higgs and supersymmetry



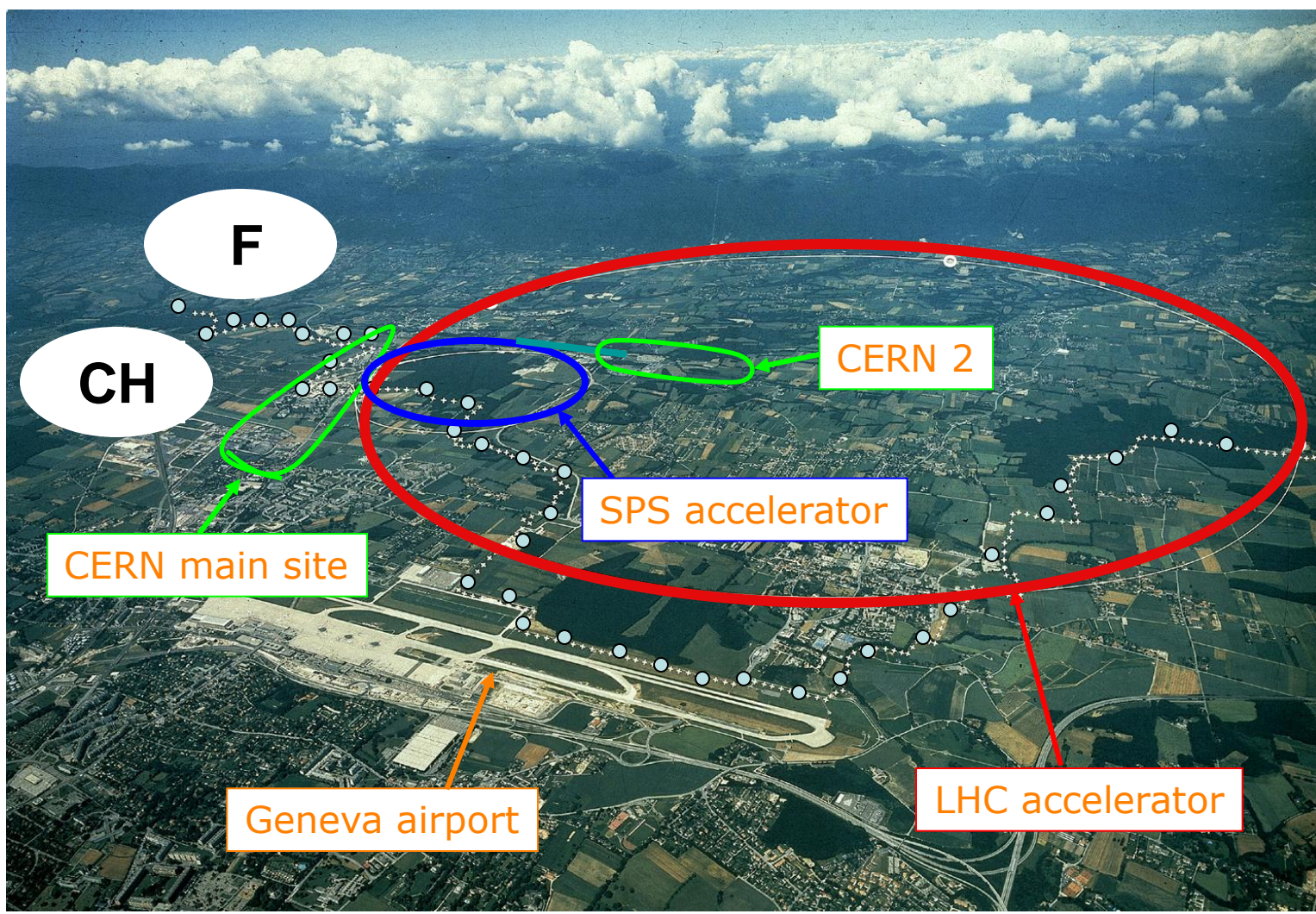
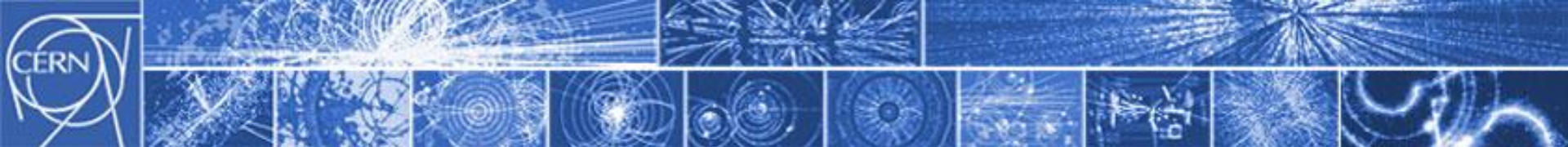
LHCb: Matter-antimatter difference

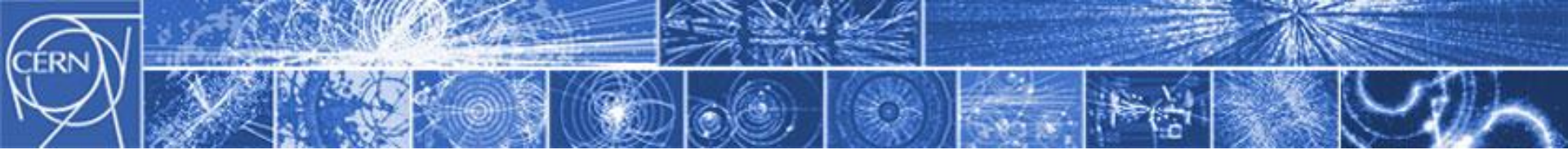


The Hottest Place in the Galaxy

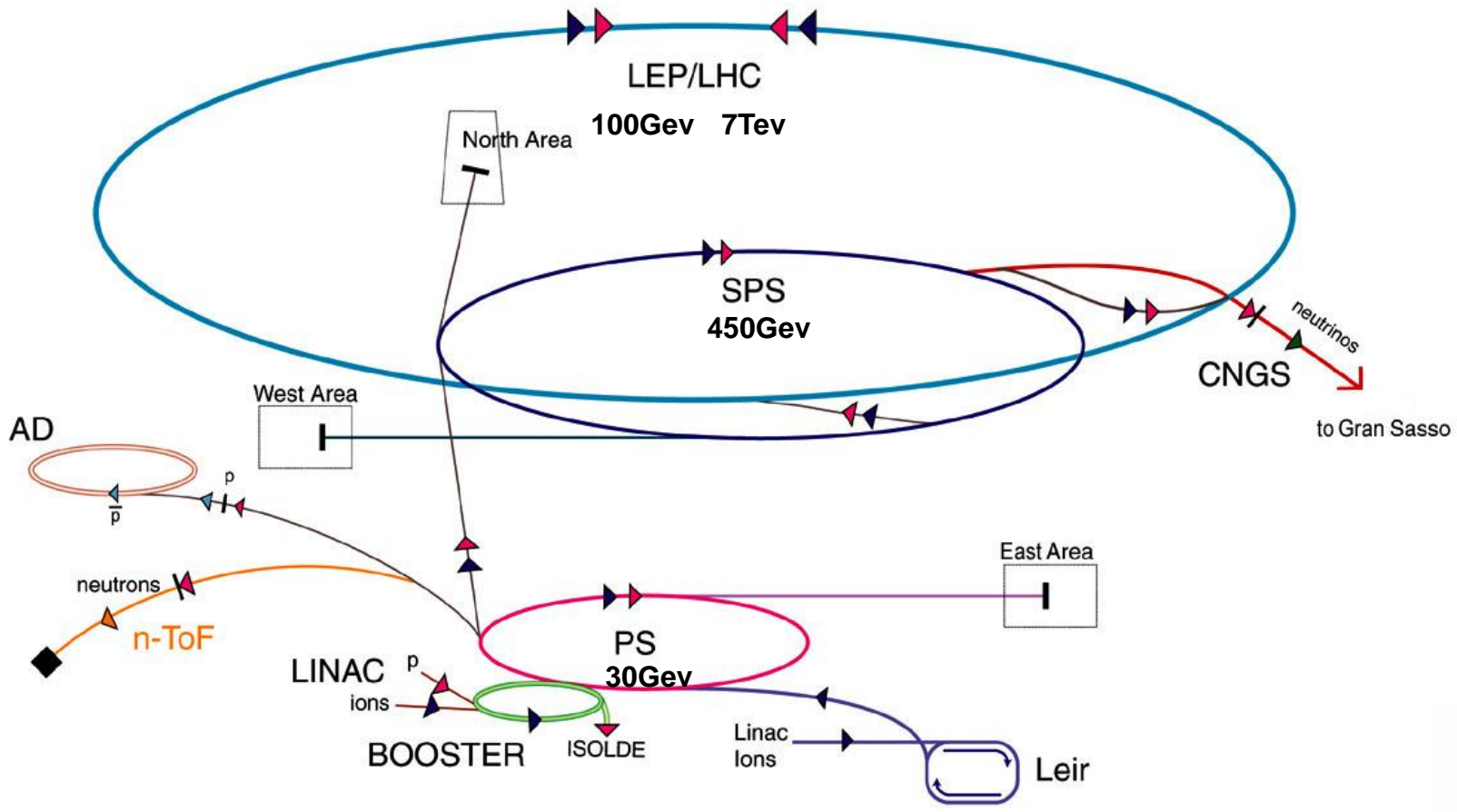


**Particle collisions create
(within a tiny volume)
temperatures a billion times higher than
in the heart of the Sun**





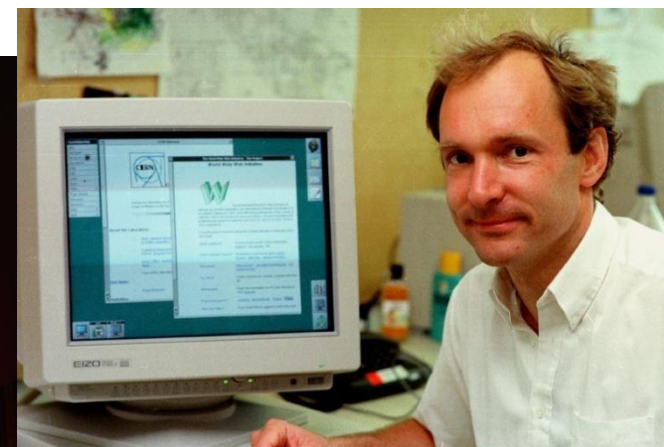
Accelerator chain at CERN, a complex business



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

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

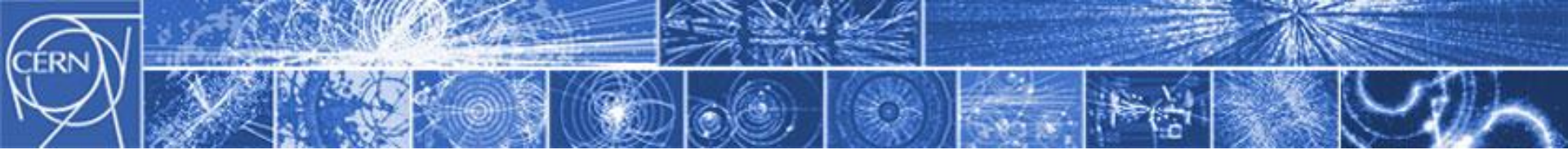
- LHC Large Hadron Collider
- n-ToF Neutron Time of Flight
- CNGS Cern Neutrinos Gran Sasso



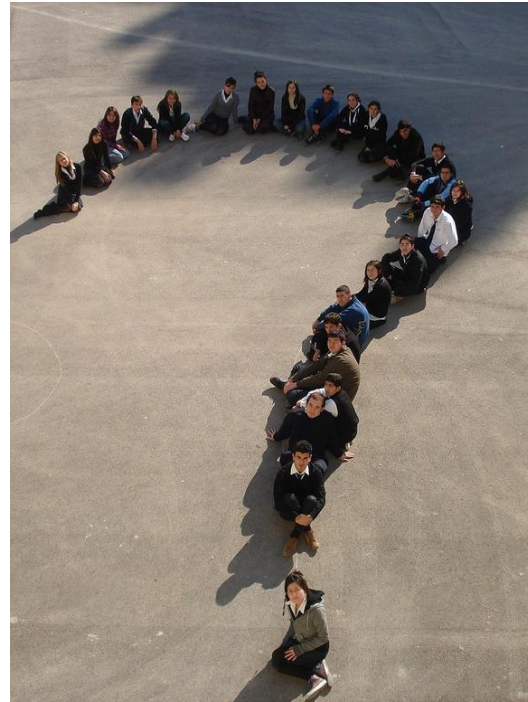
Tim Berners-Lee
World Wide Web
1989

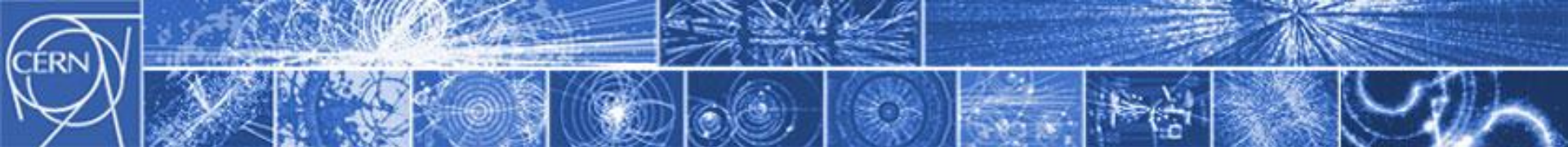
www.cern.ch

Computing
GRID



Personnel

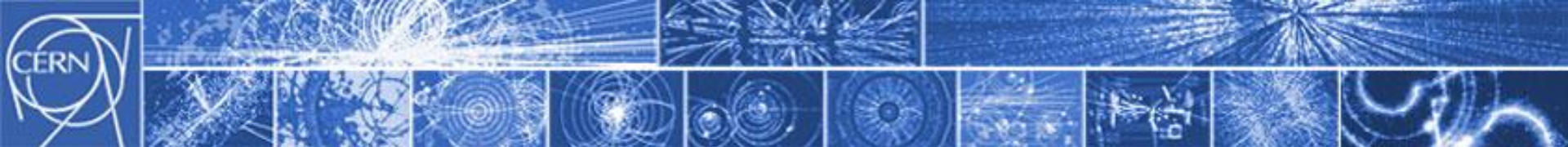




Workforce

- **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



Physics Students

Summer Students Programme

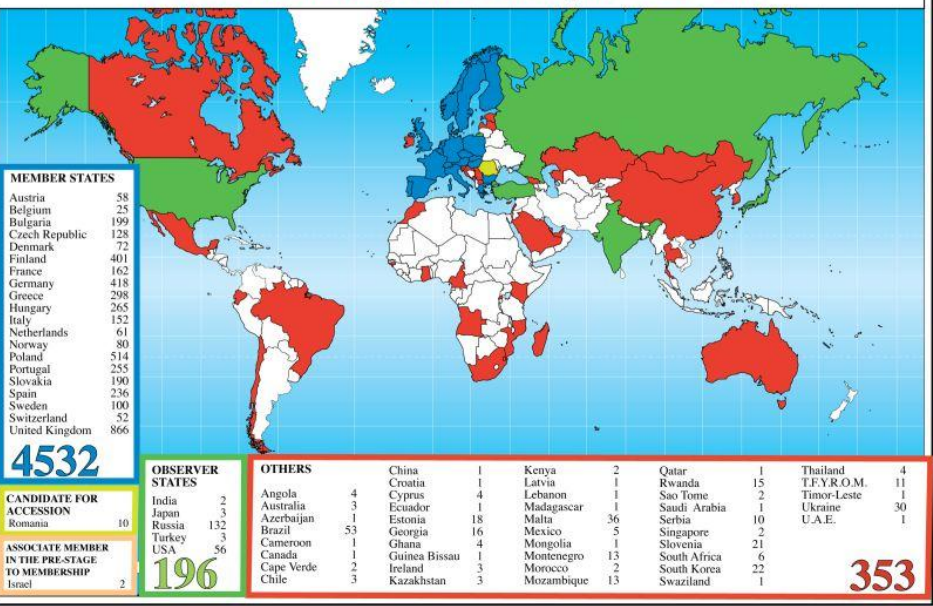


CERN Teacher Schools

International and National Programmes

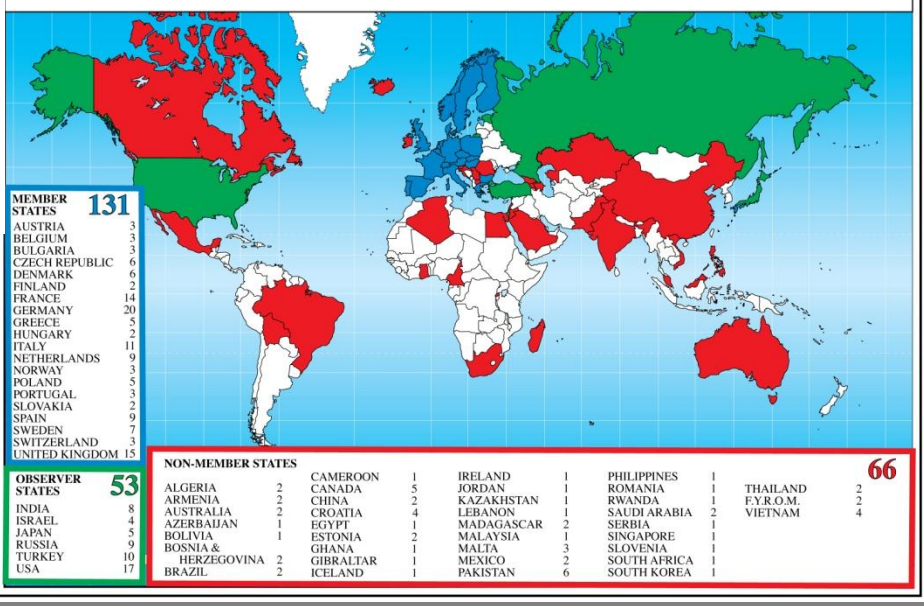


CERN Teacher Programme Participants 1998 - 2011



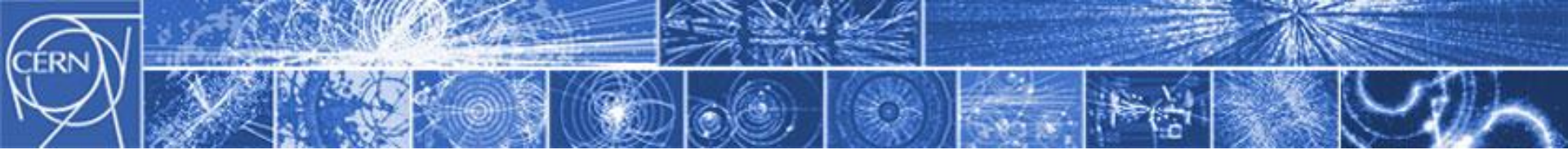
CERN Teacher Programme Participants: 1998 – December 2011

Distribution of Summer Students 2010



CERN Summer Students in 2010



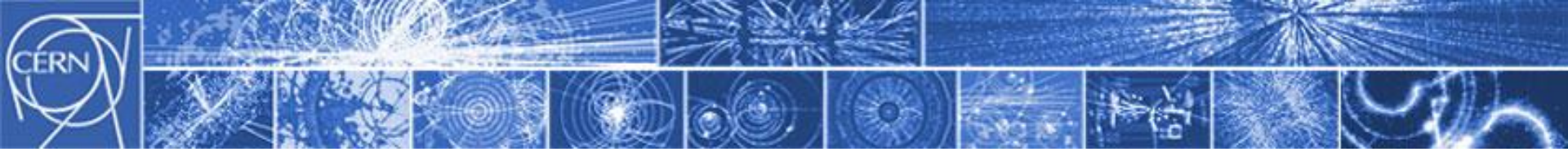


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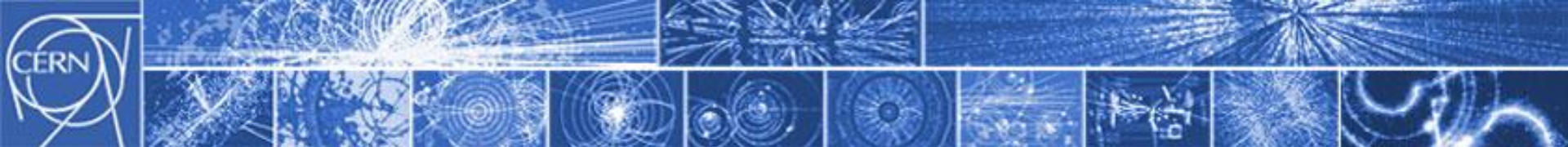
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What next ?



OPERA experiment invites scrutiny of unexpected results



ATLAS and CMS experiments present Higgs search status

13 December 2011. In a seminar held at CERN¹ today, the ATLAS² and CMS³ experiments presented the status of their searches for the Standard Model Higgs boson.

Their results are based on the analysis of considerably more data than those presented at the summer conferences, sufficient to make significant progress in the search for the Higgs boson, but not enough to make any conclusive statement on the existence or non-existence of the elusive Higgs.

The main conclusion is that the Standard Model Higgs boson, if it exists, is most likely to have a mass constrained to the range 116-130 GeV by the ATLAS experiment, and 115-127 GeV by CMS.

Tantalising hints have been seen by both experiments in this mass region, but these are **not yet strong enough to claim a discovery**.