

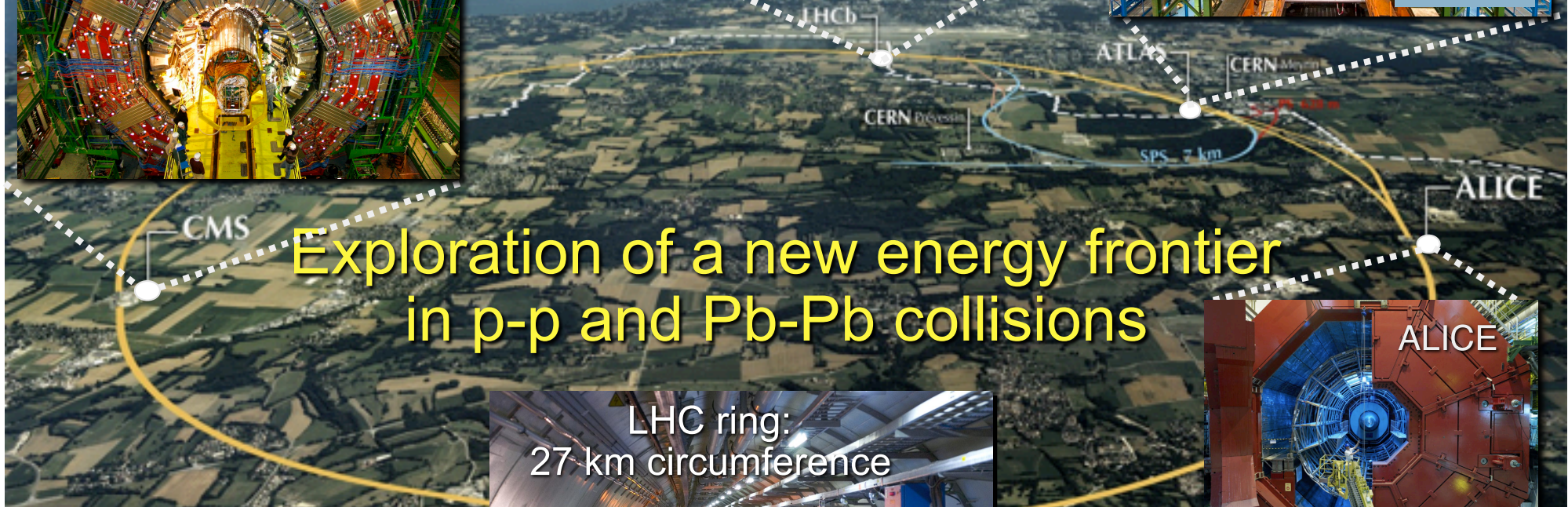
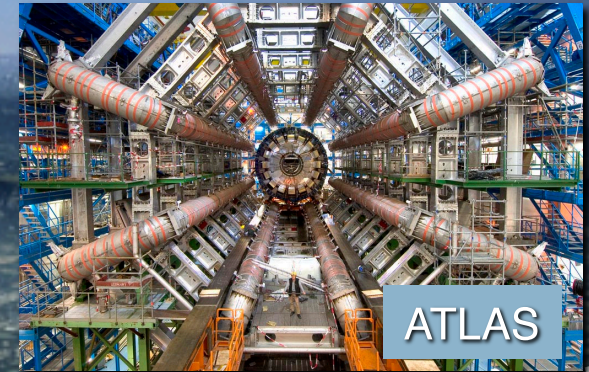
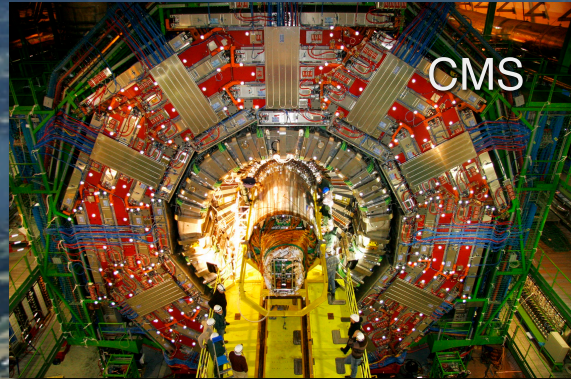


The Large Hadron Collider: A Global Endeavor

Felicitas Pauss
20 February 2011
AAAS Meeting, Washington

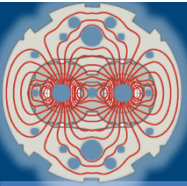


Enter a New Era in Fundamental Science



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

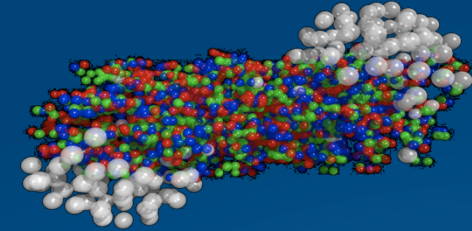




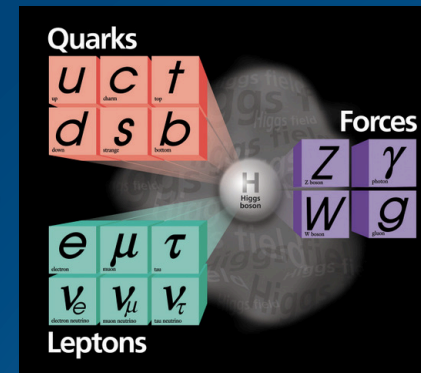
The study of LHC data will allow us to answer some of the big questions ...



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?



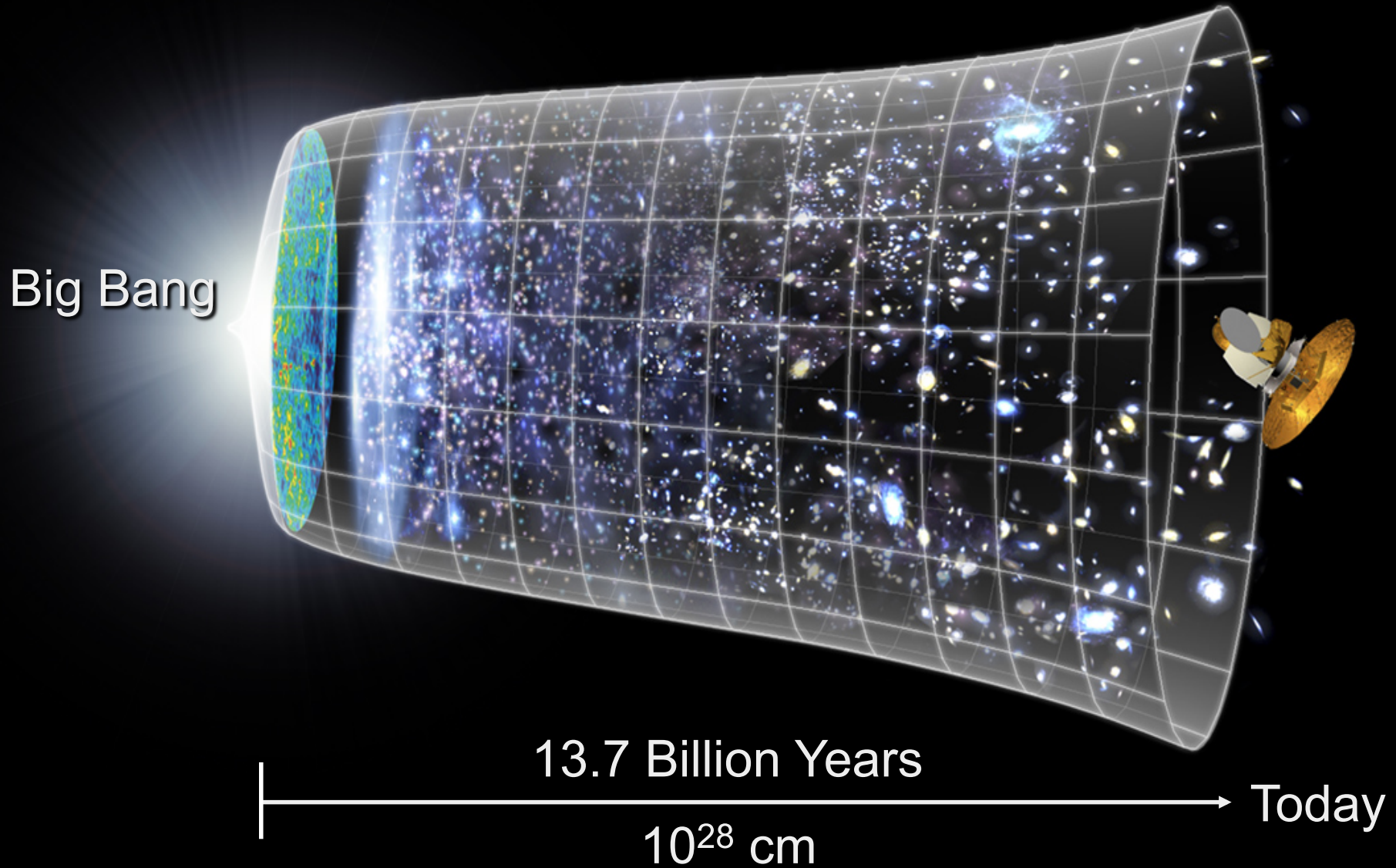
Will we find the reason why **antimatter and matter** did not completely destroy each other?



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



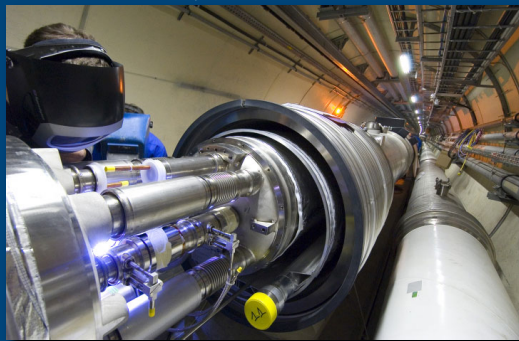
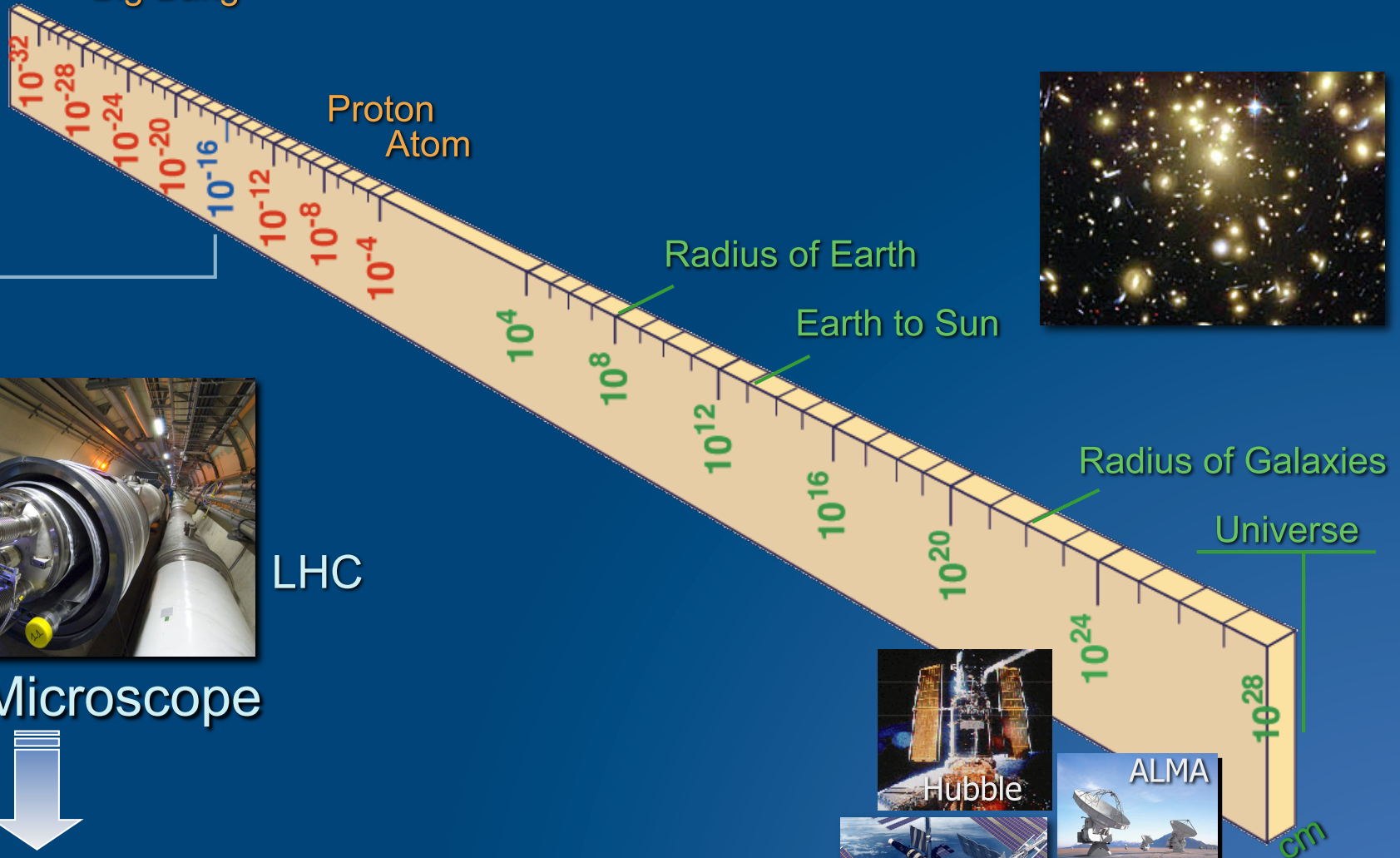
Our Universe How did it start? What is it made of?



Dimensions in Physics



Big Bang

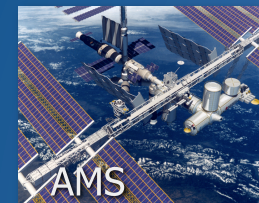


LHC

Super-Microscope



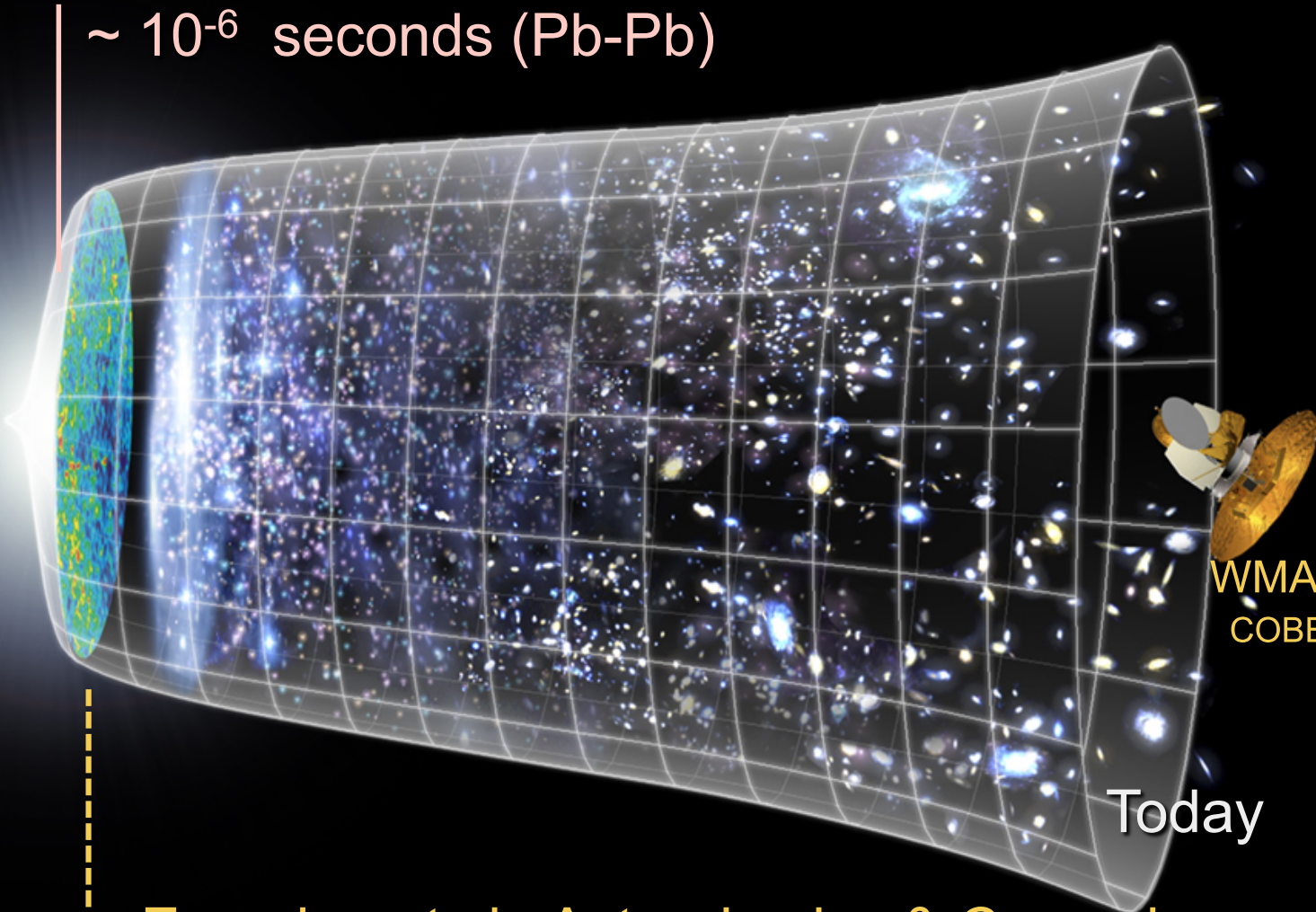
Study physics laws of first moments after Big Bang
increasing Symbiosis between Particle Physics,
Astrophysics and Cosmology





LHC: $\sim 10^{-12}$ seconds (p-p)
 $\sim 10^{-6}$ seconds (Pb-Pb)

Big Bang

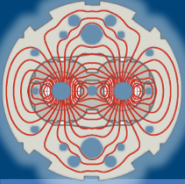


WMAP (2001)
COBE (1989)

Today

Experiments in Astrophysics & Cosmology

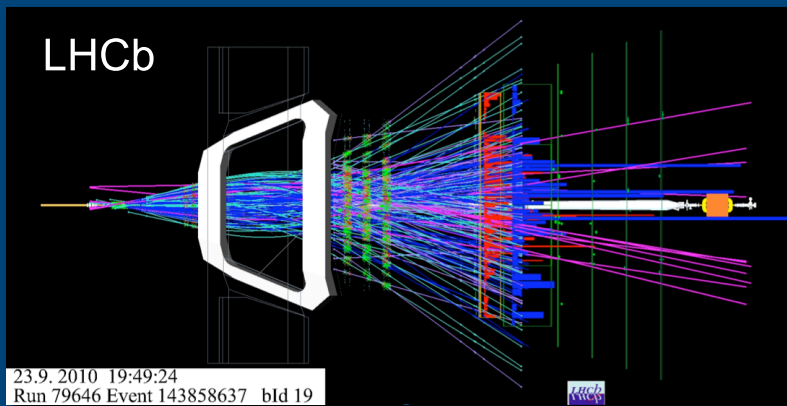
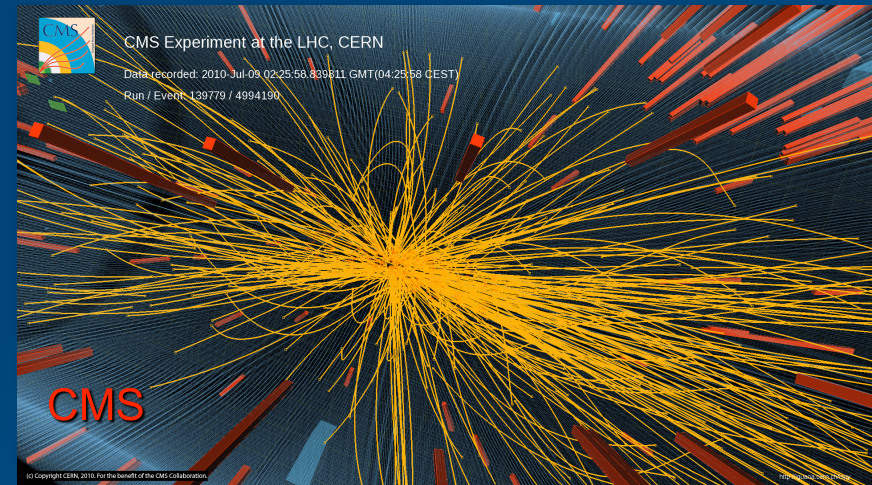
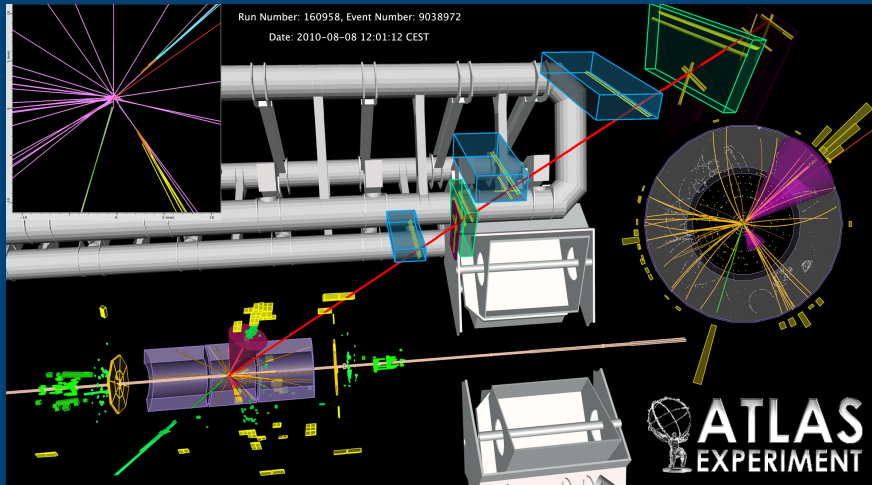
$\sim 300'000$ years



LHC + Experiments: spectacular start-up in 2010



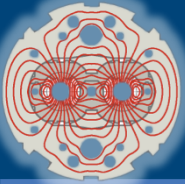
First p-p collisions at $\sqrt{s} = 7$ TeV on 30 March 2010



First Pb-Pb collisions at $\sqrt{s} = 2.76$ TeV/N on 7 Nov 2010



→ Brilliant performances of LHC and experiments



LHC: Exploration of a New Energy Frontier



From

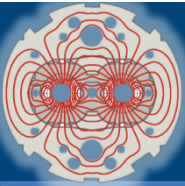
Tevatron ($p\bar{p}$ collisions at $\sqrt{s} \sim 2\text{TeV}$)
RHIC (heavy ion collisions at $\sqrt{s_{NN}} = 200\text{ GeV}$)
to LHC energies

Physics exploitation for the next 20 years



The LHC will illuminate a new landscape of physics, possibly answering some of the most fundamental questions in modern physics, like e.g.

- The origin of mass
- Unification of fundamental forces
- New layer of substructure
- Matter-Antimatter Asymmetry
- New forms of matter
- Extra dimensions of space-time



The LHC Project: how it all started



1984 Lausanne workshop **official starting** point for work at the LHC:
 $E_{\text{cm}} = 18 \text{ TeV ?}$, $L = 10^{33} \text{ cm}^{-2} \text{ s}^{-1} ?$

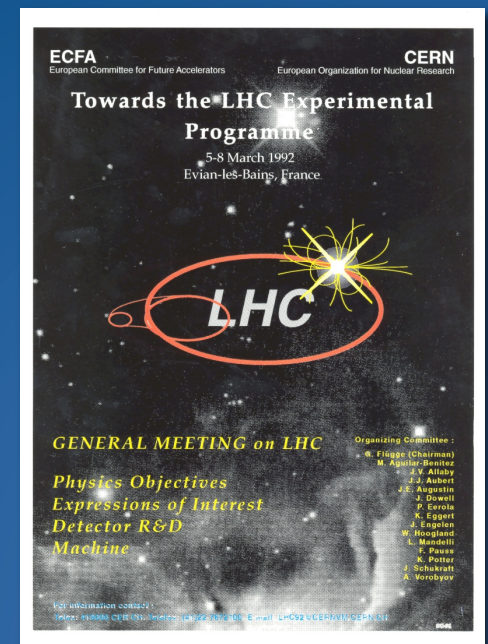
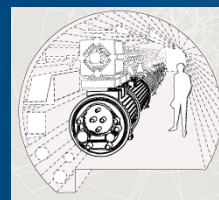
1987 La Thuile workshop: comparison of LHC, CLIC (e^+e^-), e-p option
LHC: $E_{\text{cm}} = 16 \text{ TeV}$, $L = 10^{33} \text{ cm}^{-2} \text{ s}^{-1} \rightarrow 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$
e-p: 1.3 - 1.8 TeV, CLIC: 2 TeV

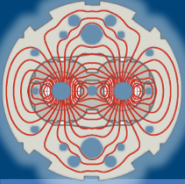
End 1980's the first embryonic collaborations started

1990 Aachen workshop (LHC physics and instrumentation)
 $E_{\text{cm}} \sim 16 \text{ TeV}$, $L = 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

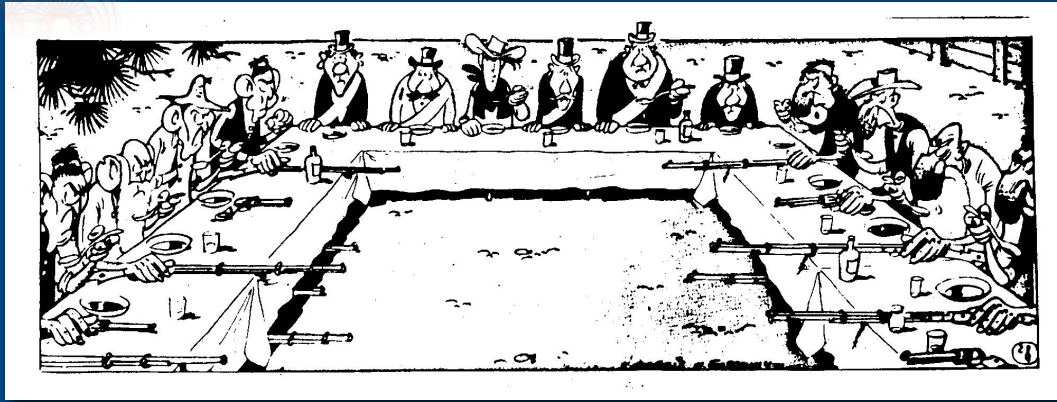
1992 Evian workshop presentation of EoI (in March)
proto-collaborations
LoI presentation at CERN (in October)

1995 LHC conceptual design: **14 TeV**, $L = 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

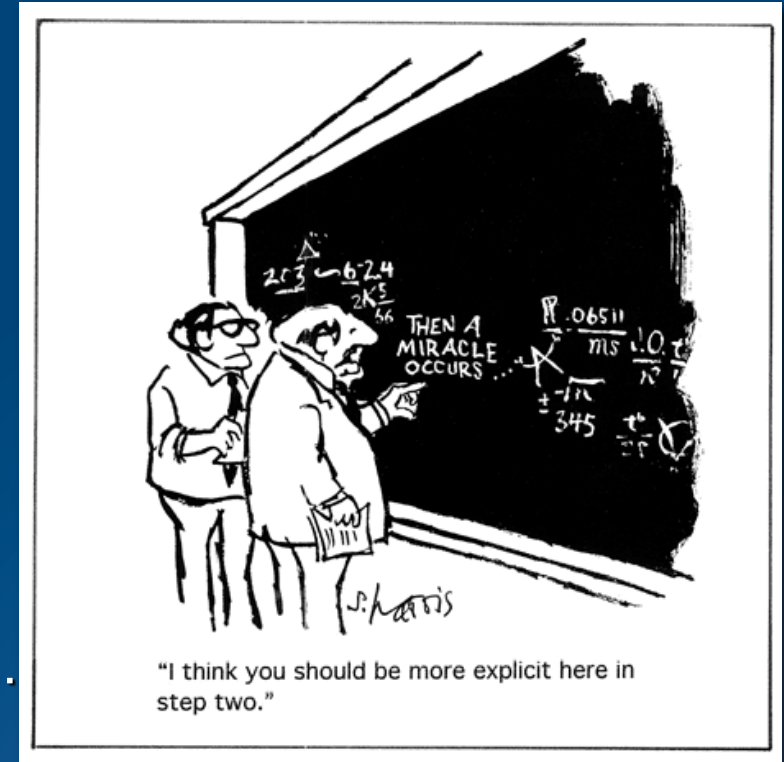




EoI → LoI → TP → TDRs



Period of negotiations

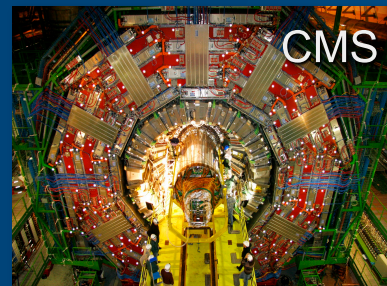


Period of evaluation

Approval



February 1996



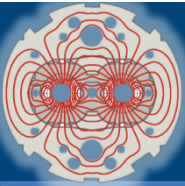
February 1996



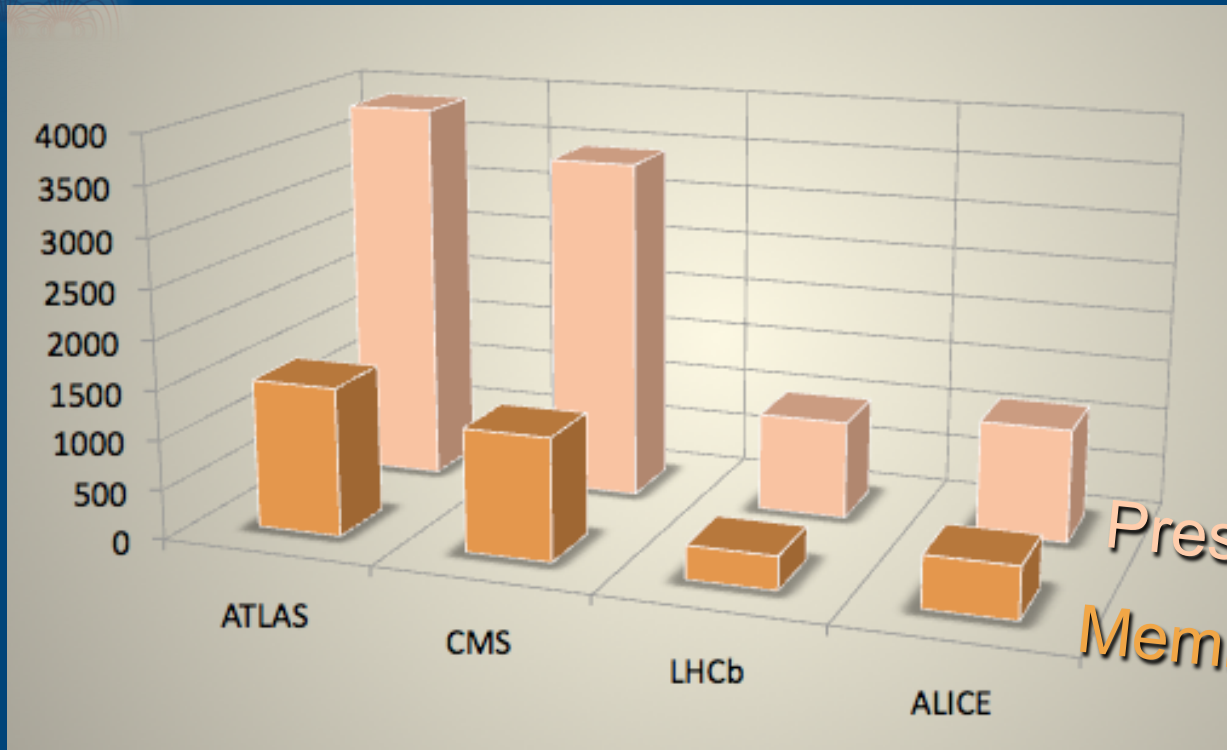
February 1997



September 1998



Evolution of LHC Collaborations



Today:

~ 8'000 members

~ 3000 PhD students

Present members
Members in TP

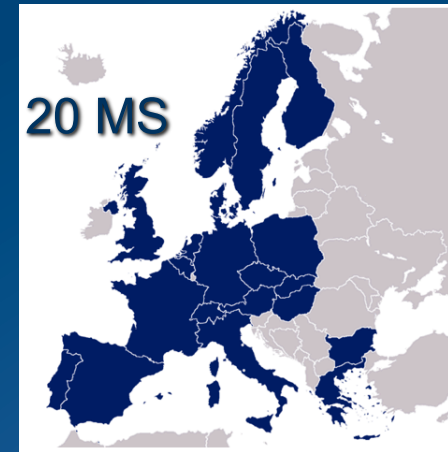
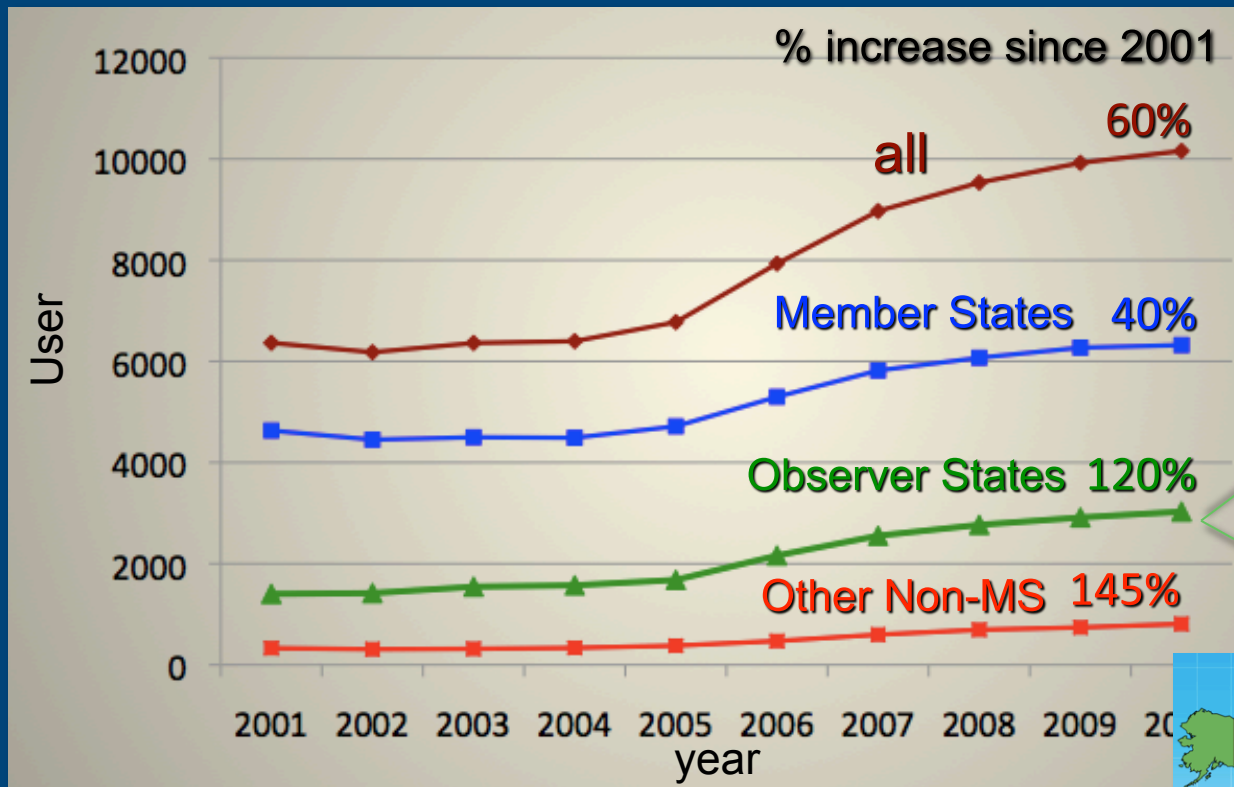
Increase of collaboration members since
Technical Proposals by a factor 2 to 3



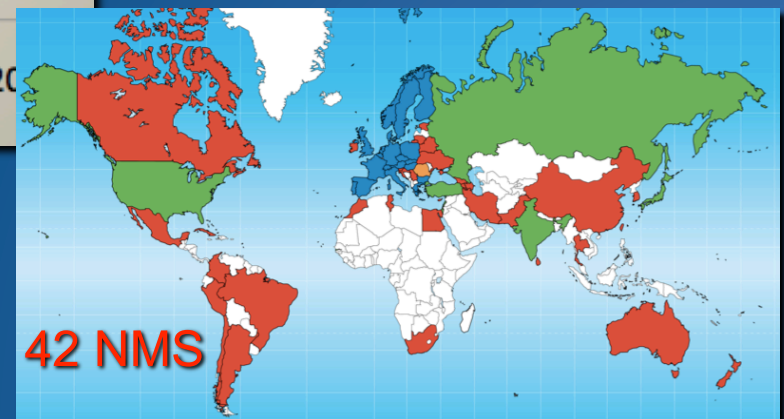
Evolution of CERN Users



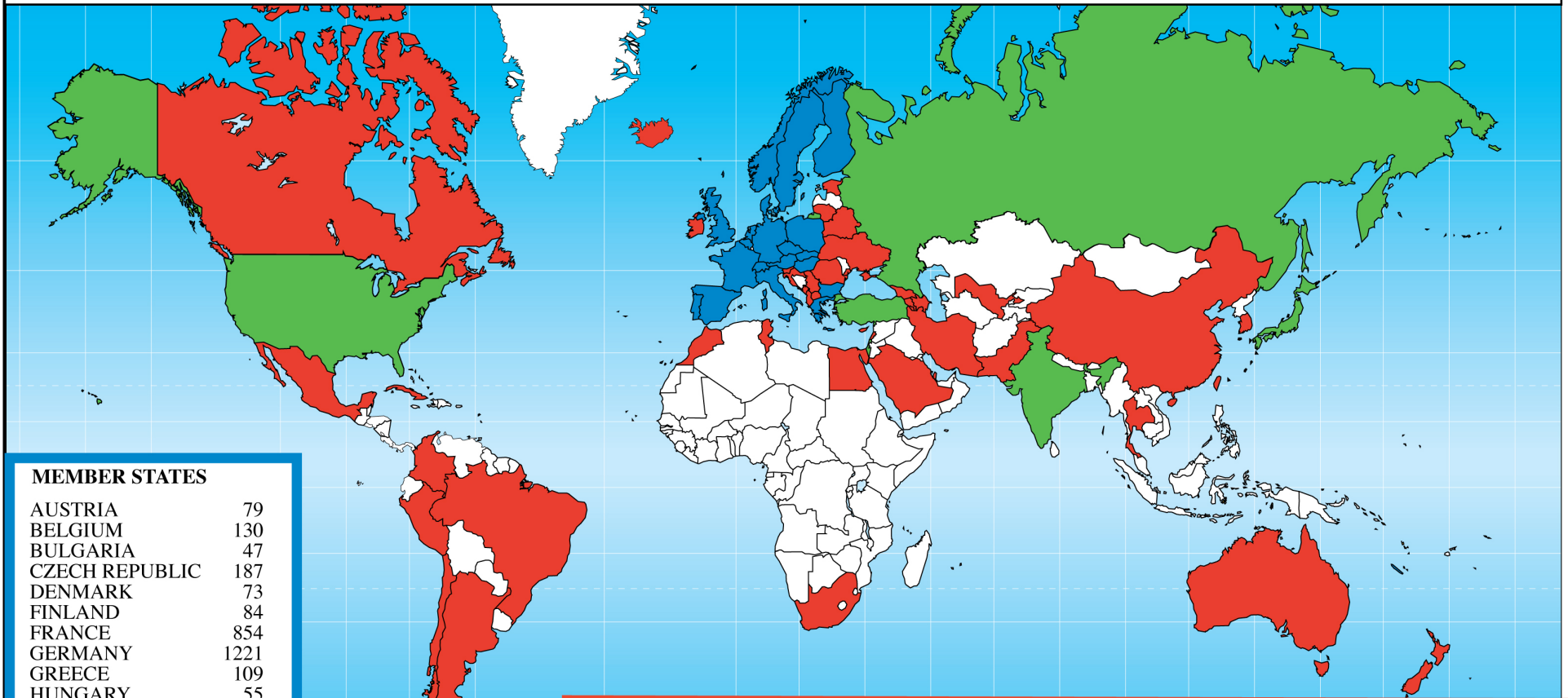
Evolution of the number of CERN users by geographical location of the home institute: 2001-2010



6 Observer States:
India, Israel, Japan,
Russia, Turkey, USA



Distribution of All CERN Users by Nation of Institute on 6 January 2011



MEMBER STATES

AUSTRIA	79
BELGIUM	130
BULGARIA	47
CZECH REPUBLIC	187
DENMARK	73
FINLAND	84
FRANCE	854
GERMANY	1221
GREECE	109
HUNGARY	55
ITALY	1428
NETHERLANDS	171
NORWAY	82
POLAND	193
PORTUGAL	134
SLOVAKIA	61
SPAIN	329
SWEDEN	72
SWITZERLAND	351
UNITED KINGDOM	701

6361

OBSERVER STATES

INDIA	91
ISRAEL	60
JAPAN	204
RUSSIA	829
TURKEY	67
USA	1684

2935

OTHERS

ALBANIA	2	CROATIA	16	LITHUANIA	12	SERBIA	22
ARGENTINA	11	CUBA	4	MALTA	1	SLOVENIA	29
ARMENIA	12	CYPRUS	8	MEXICO	32	SOUTH AFRICA	11
AUSTRALIA	19	EGYPT	5	MONTENEGRO	1	THAILAND	1
AZERBAIJAN	1	ESTONIA	11	MOROCCO	5	F.Y.R.O.M.	2
BELARUS	20	GEORGIA	8	NEW ZEALAND	8	TUNISIA	1
BRAZIL	79	ICELAND	3	PAKISTAN	16	UKRAINE	18
CANADA	150	IRAN	17	PERU	2	UZBEKISTAN	1
CHILE	3	IRELAND	14	QATAR	1		
CHINA	84	KOREA	74	ROMANIA	62		
CHINA (TAIPEI)	50	LEBANON	1	SAUDI ARABIA	2		
COLOMBIA	9						

828

The LHC experimental programme: a truly global scientific project



“Science without borders”