Archeology of our Universe

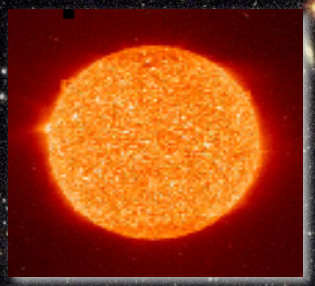
the mystery of matter, space and time

Quito, July 2011

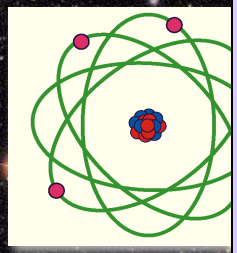
Felicitas Pauss
CERN and ETH Zurich

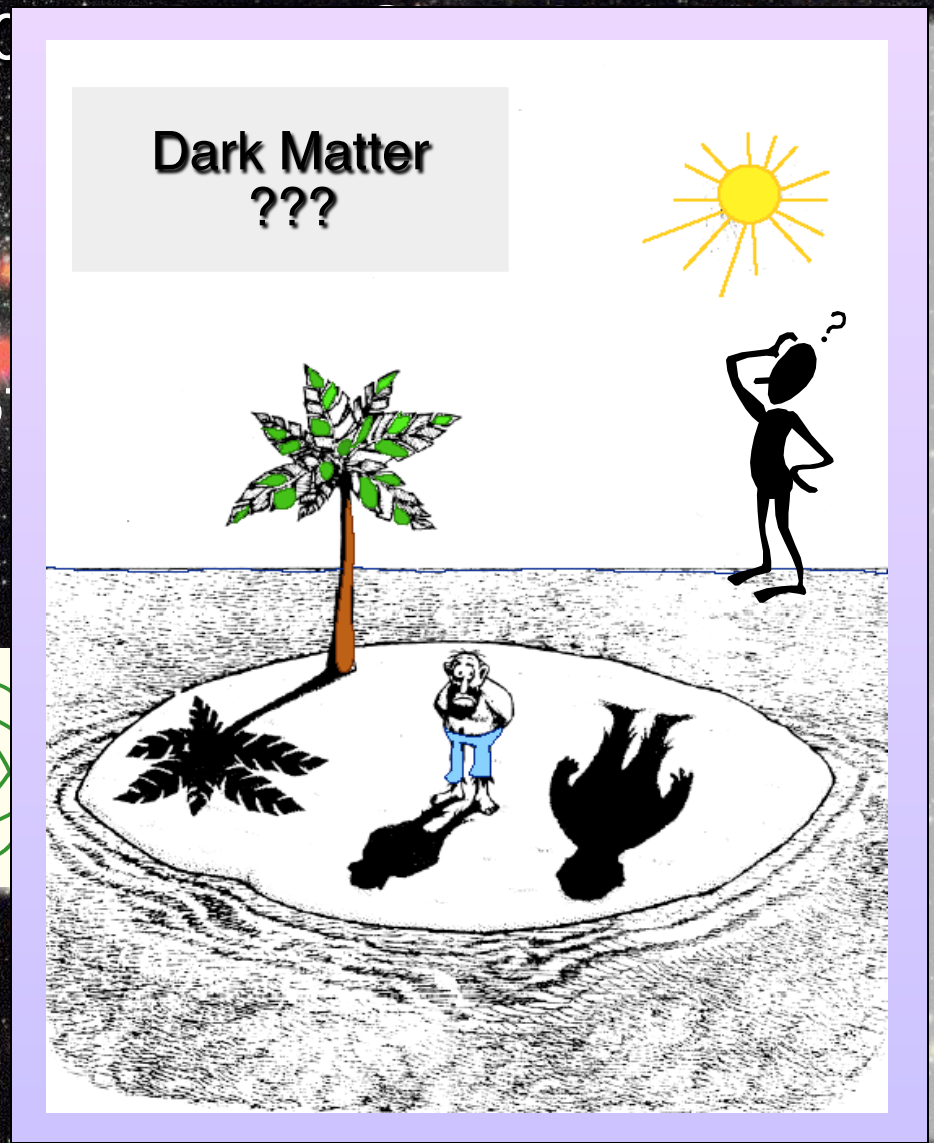
Our Visible Universe

~10^{11} = 100'



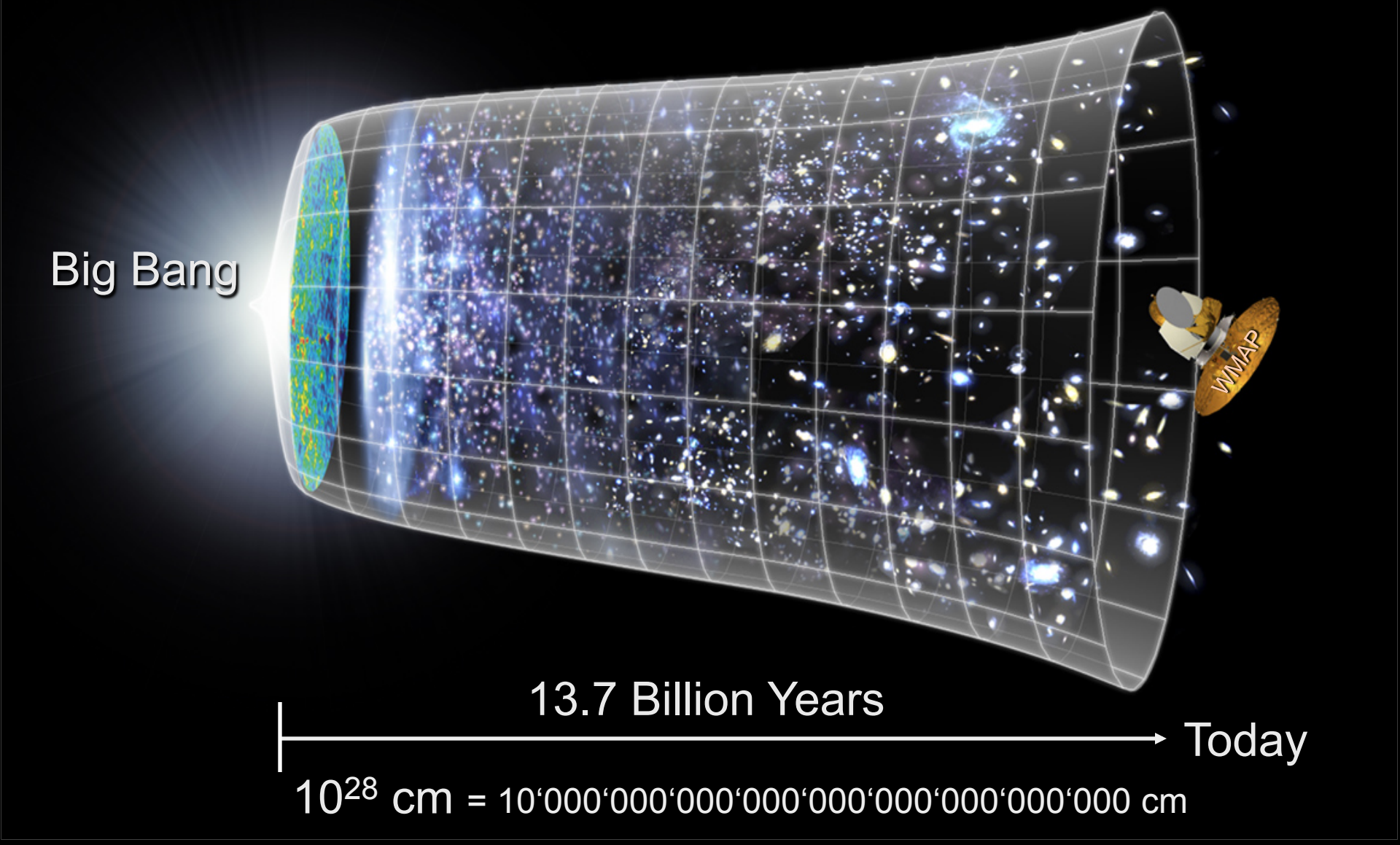
~10^{21} S





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

What is it made of?



Dimensions in Physics

Big Bang

Radius of Galaxies

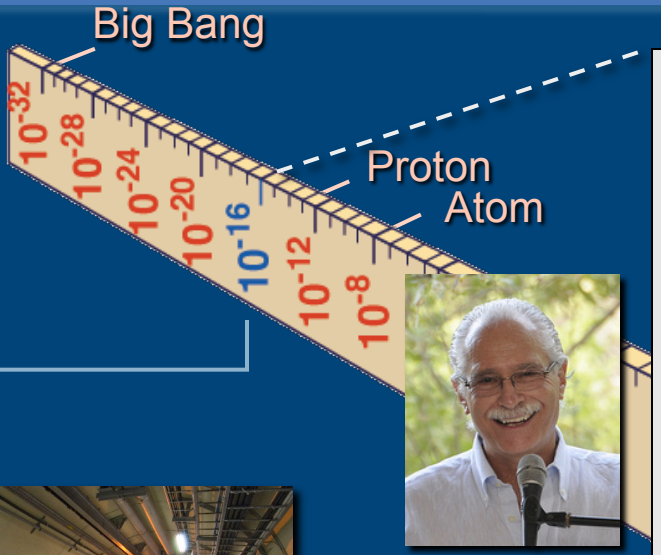
Universe

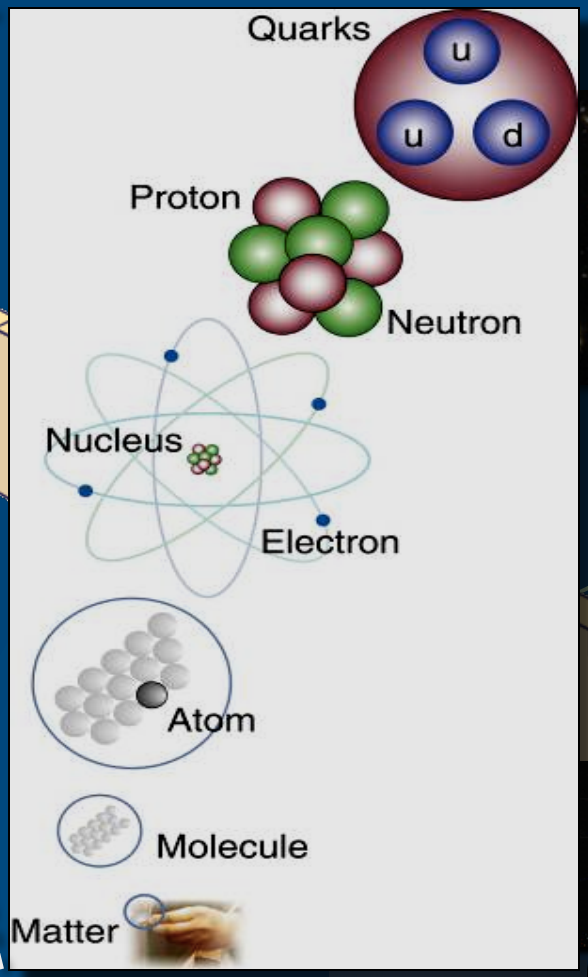
10^{24}

10^{28}

cm

Dimensions in Physics





Radius of Galaxies

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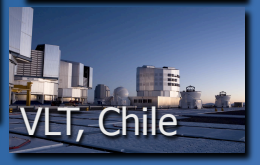
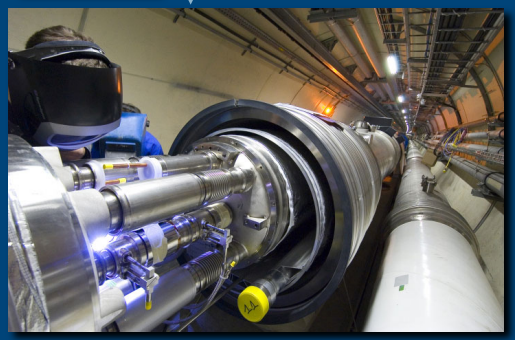
cm





LHC

Super-Microscope

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

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

What is the LHC?
What is CERN?

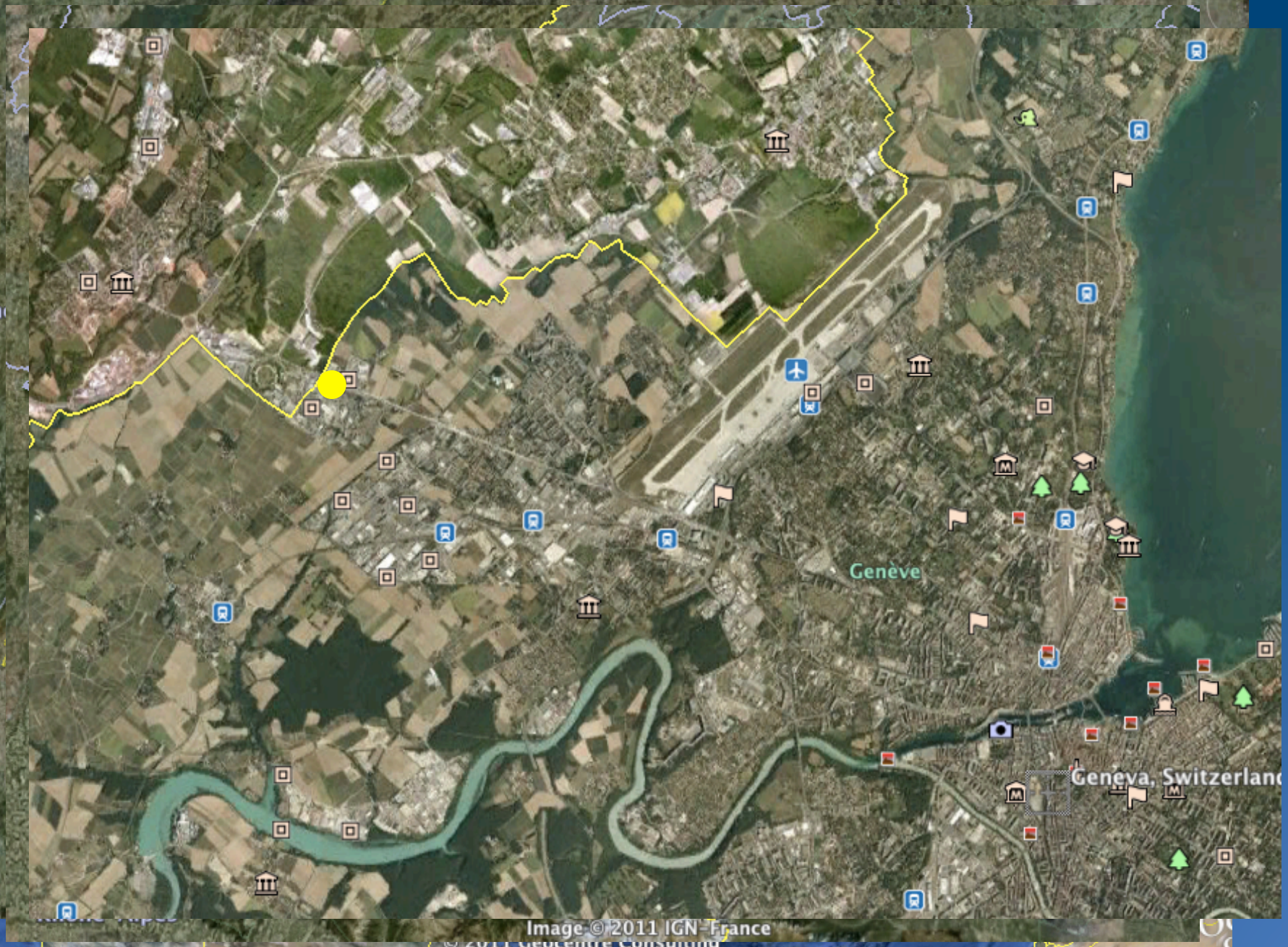
Big Bang

WMAP (2001)
COBE (1989)

Today

Experiments in Astrophysics & Cosmology

~300‘000 years


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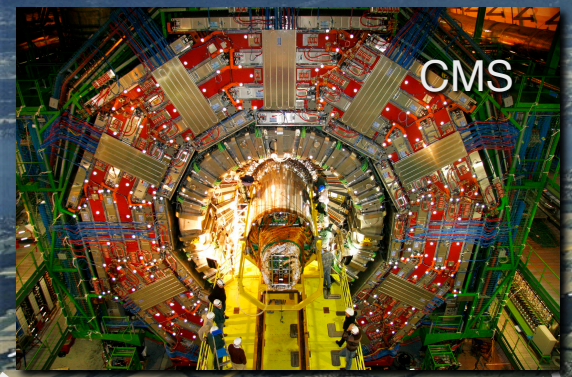
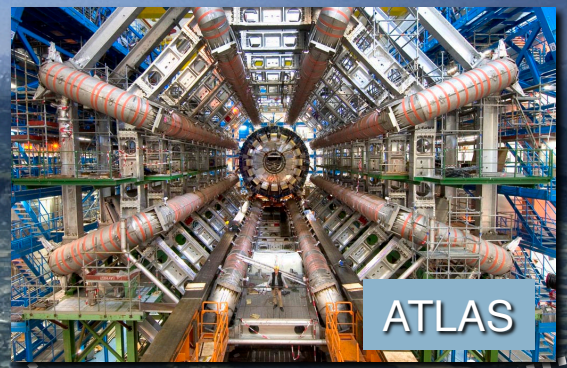
LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km
CERN

LHC → a New Era in Fundamental Science





Exploration of a new energy frontier

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: Exploration of a New Energy Frontier

Innovative technologies developed

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 for example:

What are the particle(s) that make up the mysterious ‘dark matter’ in our Universe?


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

What is CERN ?

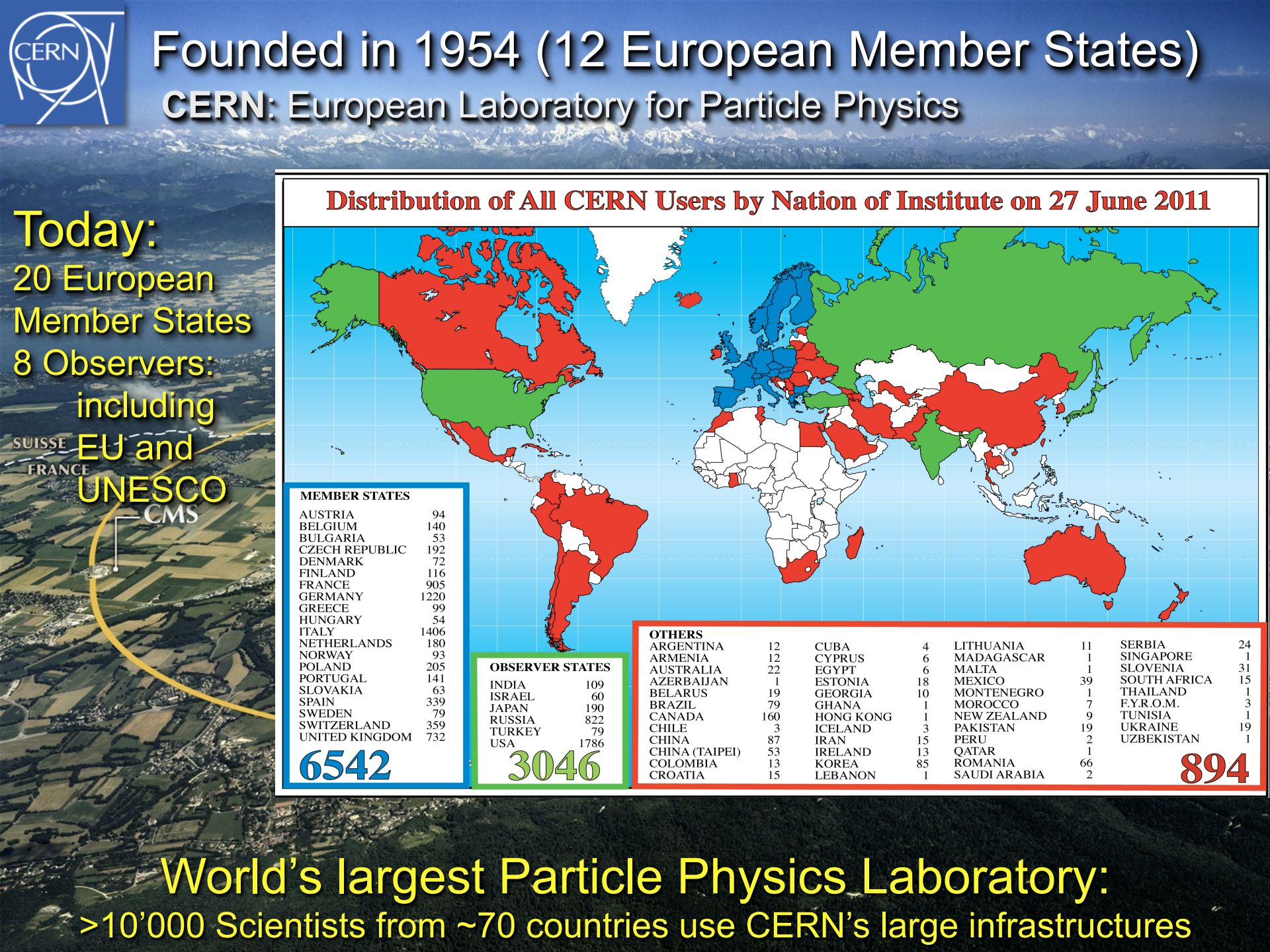
Founded in 1954 (12 European Member States)

CERN: European Laboratory for Particle Physics

Today:

20 European Member States

8 Observers: including EU and UNESCO



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

6542

OBSERVER STATES

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

3046

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		

894

World's largest Particle Physics Laboratory:

>10'000 Scientists from ~70 countries use CERN's large infrastructures

Founded in 1954 (12 European Member States)

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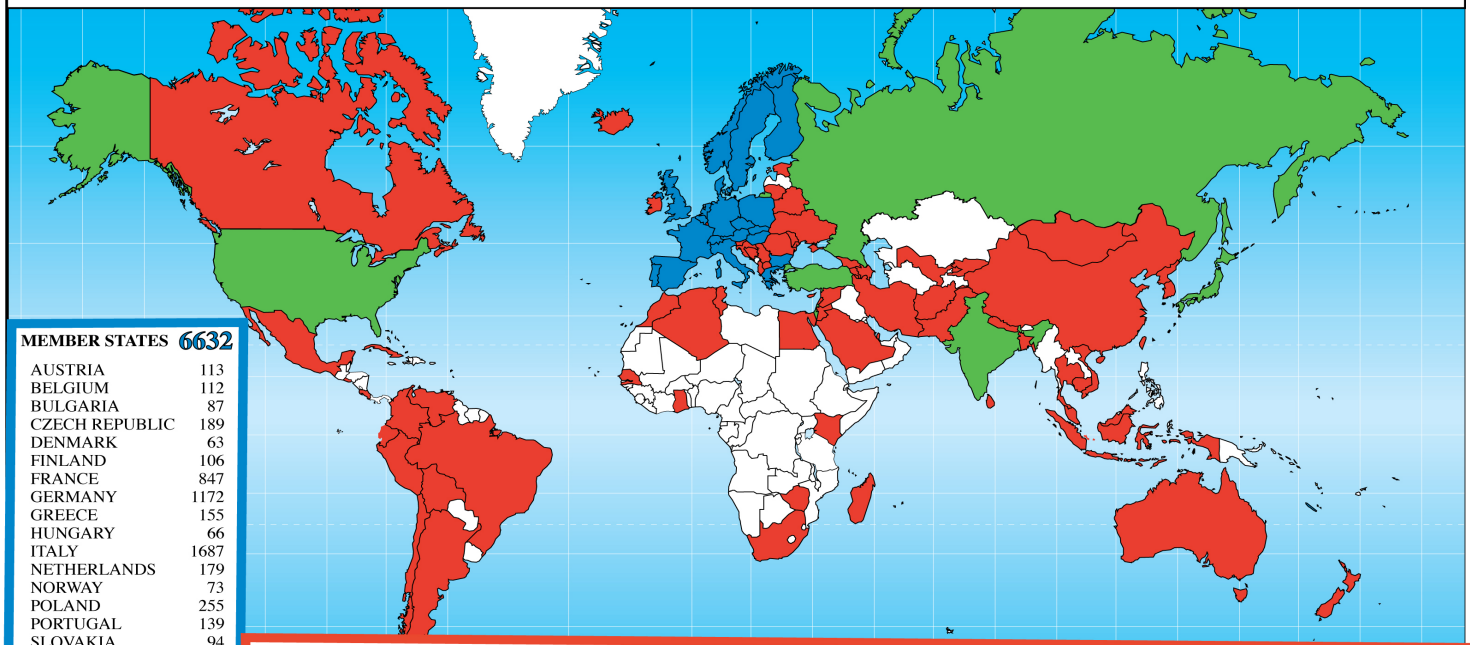
SUISSE
FRANCE
CMS

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

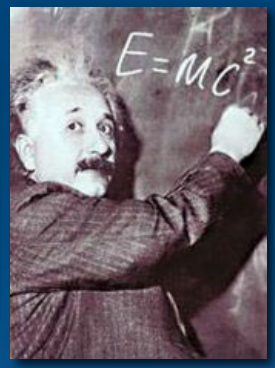
World's largest Particle Physics Laboratory:

>10'000 Scientists from ~70 countries use CERN's large infrastructures

The Mission of CERN

- **Push forward** the frontiers of knowledge

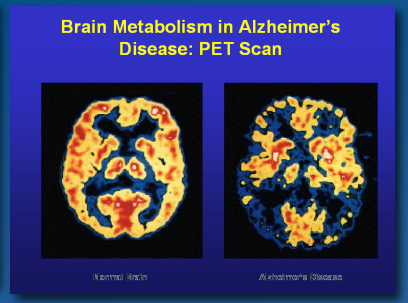
  E.g. the secrets of the Big Bang ... what was the matter like within the first moments of the Universe's existence?

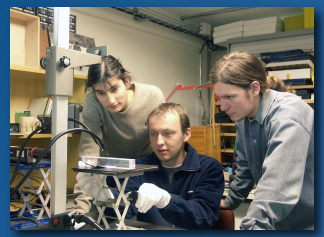


- **Develop** new technologies for accelerators and detectors

  Information technology - the Web and the GRID

  Medicine - diagnosis and therapy





- **Train** scientists and engineers of tomorrow

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

CERN's Education Programme

In 2013 in Peru

Scientists at CERN

Academic Training Programme

Young Researchers

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

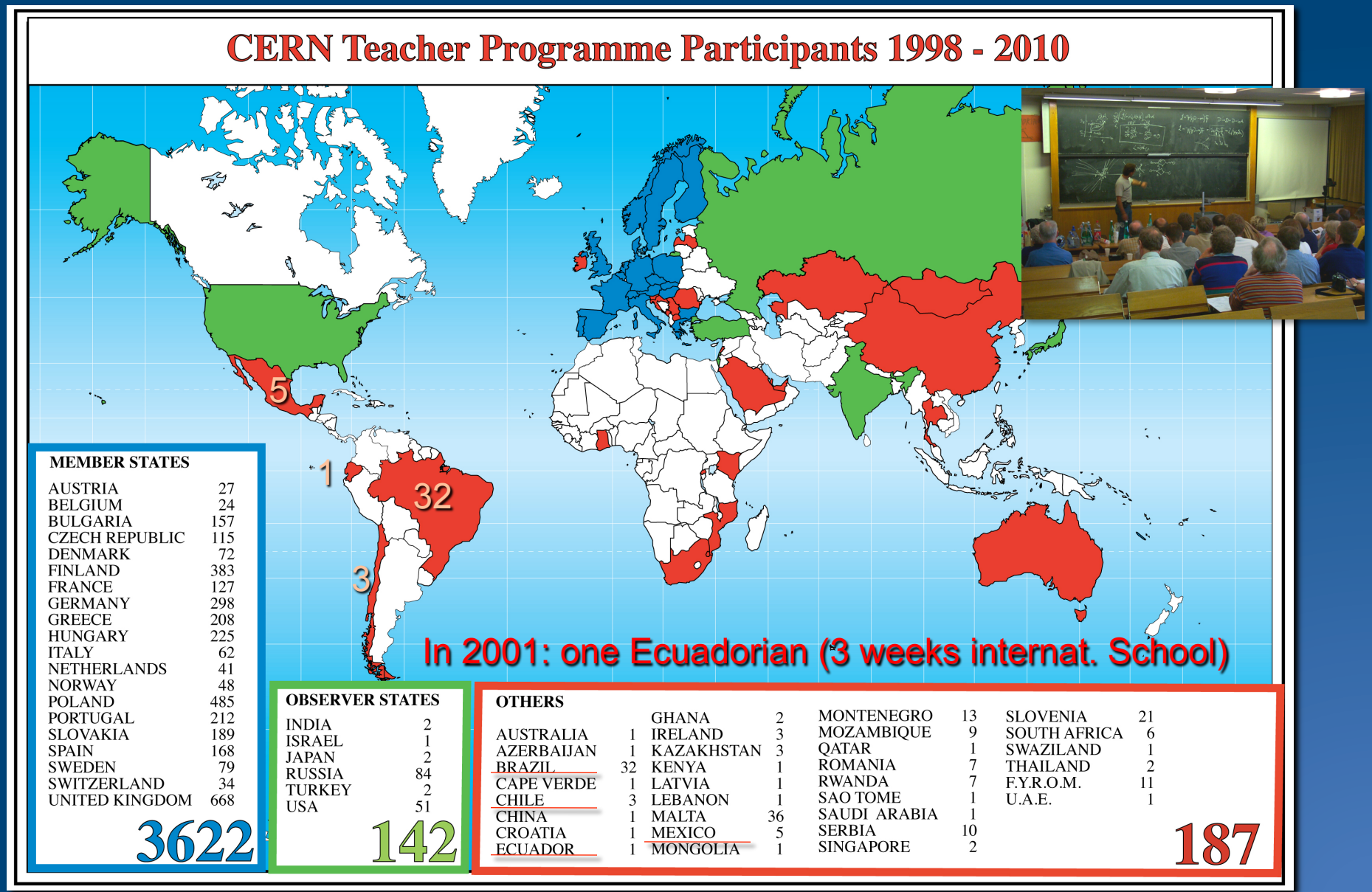
Physics Students

Summer Students Programme

CERN Teacher Schools

International and National Programmes

CERN Teacher Programme Participants:
1998 – December 2010



CERN Summer Students 2010

Distribution of Summer Students 2010

MEMBER STATES	131
AUSTRIA	3
BELGIUM	3
BULGARIA	3
CZECH REPUBLIC	6
DENMARK	6
FINLAND	2
FRANCE	14
GERMANY	20
GREECE	5
HUNGARY	2
ITALY	11
NETHERLANDS	9
NORWAY	3
POLAND	5
PORTUGAL	3
SLOVAKIA	2
SPAIN	9
SWEDEN	7
SWITZERLAND	3
UNITED KINGDOM	15

OBSERVER STATES	53
INDIA	8
ISRAEL	4
JAPAN	5
RUSSIA	9
TURKEY	10
USA	17

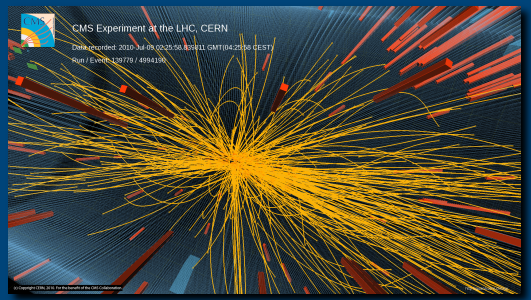
NON-MEMBER STATES — 66

ALGERIA	2	CAMEROON	1	IRELAND	1	PHILIPPINES	1	THAILAND	2
ARMENIA	2	CANADA	5	JORDAN	1	ROMANIA	1	F.Y.R.O.M.	2
AUSTRALIA	2	CHINA	2	KAZAKHSTAN	1	RWANDA	1	VIETNAM	4
AZERBAIJAN	1	CROATIA	4	LEBANON	1	SAUDI ARABIA	2		
BOLIVIA	1	EGYPT	1	MADAGASCAR	2	SERBIA	1		
BOSNIA & HERZEGOVINA	2	ESTONIA	2	MALAYSIA	1	SINGAPORE	1		
BRAZIL	2	GHANA	1	MALTA	3	SLOVENIA	1		
		GIBRALTAR	1	MEXICO	2	SOUTH AFRICA	1		
		ICELAND	1	PAKISTAN	6	SOUTH KOREA	1		

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 Ecuador to share the excitement of physics at the LHC and to train the next generation of scientists and engineers

Thank You!
¡ Gracias !