

International Research Centres

- Status of the LHC Programme - *JE*
 - Superconductivity & Cryogenics @ LHC & beyond - *Lucio Rossi*
 - Moroccan PhD Students @ CERN - *Patrick Fassnacht*
- Status of the SESAME Programme - *Chris Llewellyn-Smith*
- Round-Table Discussion:
 - *Abdeslam Hoummada (MA)*
 - *Ilham Al-Qaradawi (QA)*
 - *Wafaa Khater (PA, + Arwa Bannoura, Mohammad Hattawy)*
 - *Abdenour Lounis (DZ)*
 - *Eliezer Rabinovici (IL)*

Status of the LHC programme



Accelerating Science and Innovation



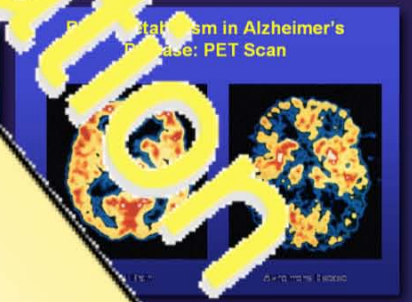
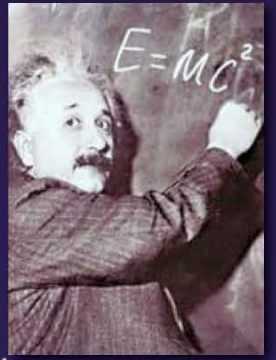
The Missions of CERN

- **Push back the frontiers of knowledge**
E.g. the secrets of the universe, the matter-antimatter asymmetry, the life of the universe?

- **Develop new technologies**
E.g. Information Technology
E.g. Medicine

- **Prepare for the challenges of tomorrow**

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



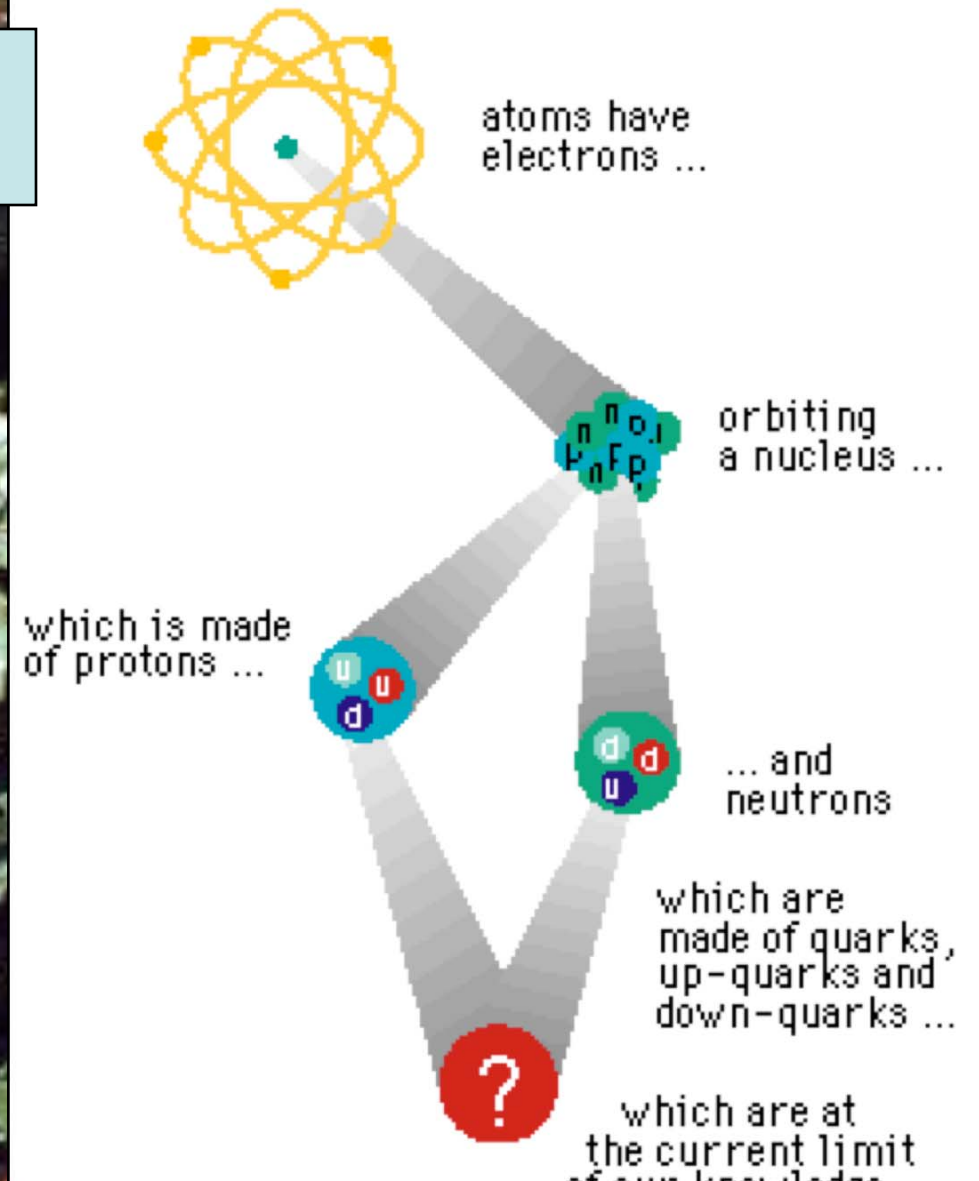
CERN

uniting people

Research

Innovation Education

Inside Matter



All matter is made of the same constituents

What are they?
What forces between them?

The 'Standard Model'

= Cosmic DNA

The matter particles



The fundamental interactions



Gravitation electromagnetism

weak nuclear force

strong nuclear force

Open Questions beyond the Standard Model

- What is the origin of particle masses?
due to a Higgs boson? **LHC**
- Why so many types of matter particles? **LHC**
- Unification of fundamental forces? **LHC**
- Quantum theory of gravity? **LHC**

The Large Hadron Collider (LHC)

Proton- Proton Collider

7 TeV + 7 TeV



1,000,000,000 collisions/second

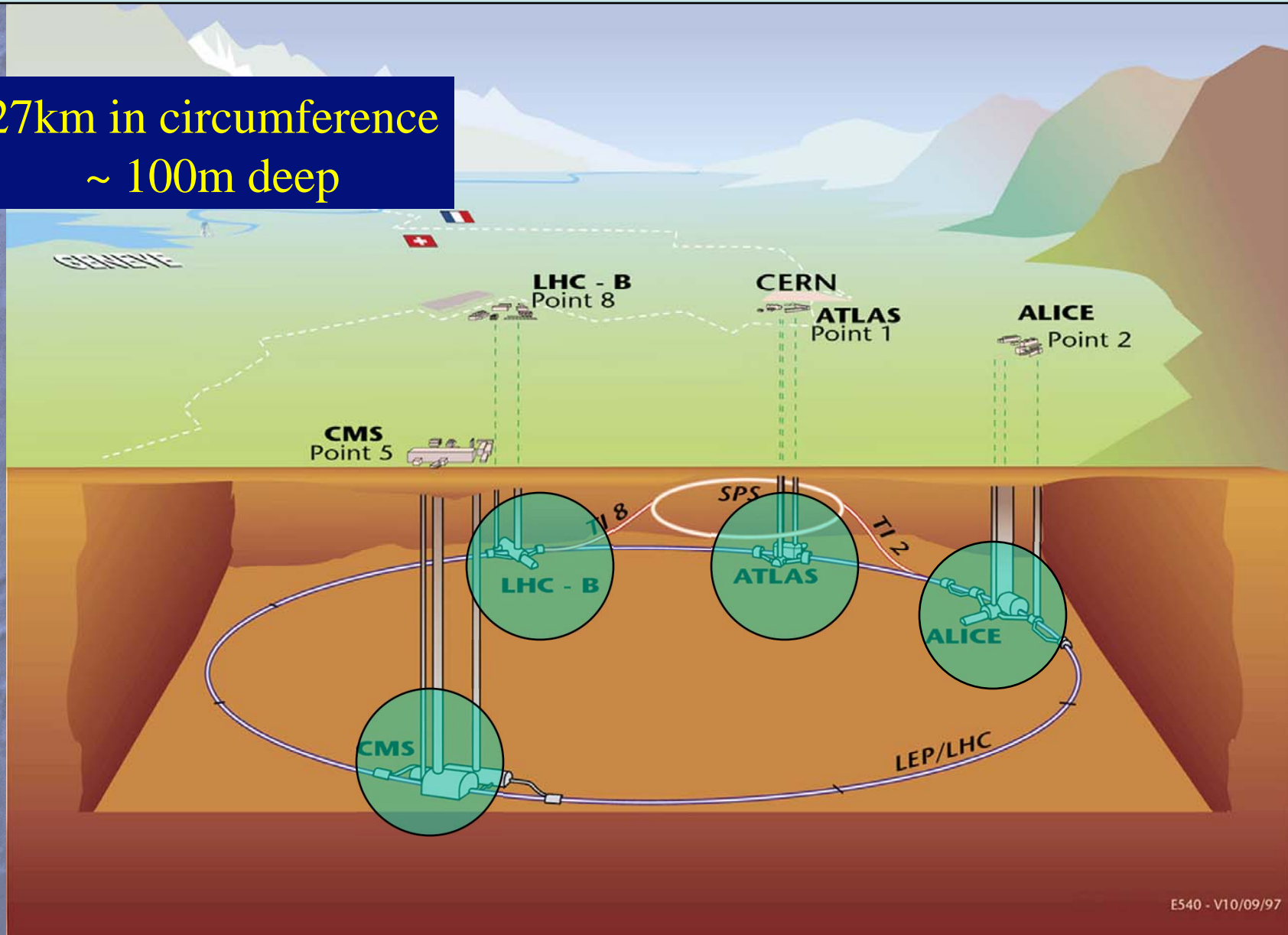
Total energy over 14,000 proton masses

Primary targets:

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

General View of LHC & its Experiments

27km in circumference
~ 100m deep



CMS Collaboration

TRIGGER & DATA ACQUISITION

Austria, CERN, Finland, France, Greece, Hungary, Italy, Korea, Poland, Portugal, Switzerland, UK, USA

TRACKER

Austria, Belgium, CERN, Finland, France, New Zealand, Germany, Italy, Japan*, Switzerland, UK, USA

CRYSTAL ECAL

Belarus, CERN, China, Croatia, Cyprus, France, Ireland, Italy, Japan*, Portugal, Russia, Serbia, Switzerland, UK, USA

Cyprus

PRE SHOWER

Armenia, Belarus, CERN, Greece, India, Russia, Taipei, Uzbekistan

RETURN YOKE

Barrel: Czech Rep., Estonia, Germany, Greece, Russia
Endcap: Japan*, USA, Brazil

SUPERCONDUCTING MAGNET

All countries in CMS contribute to Magnet financing in particular:
Finland, France, Italy, Japan*, Korea, Switzerland, USA

Pakistan
China

FEET

China

FORWARD CALORIMETER

Hungary, Iran, Russia, Turkey, USA

HCAL

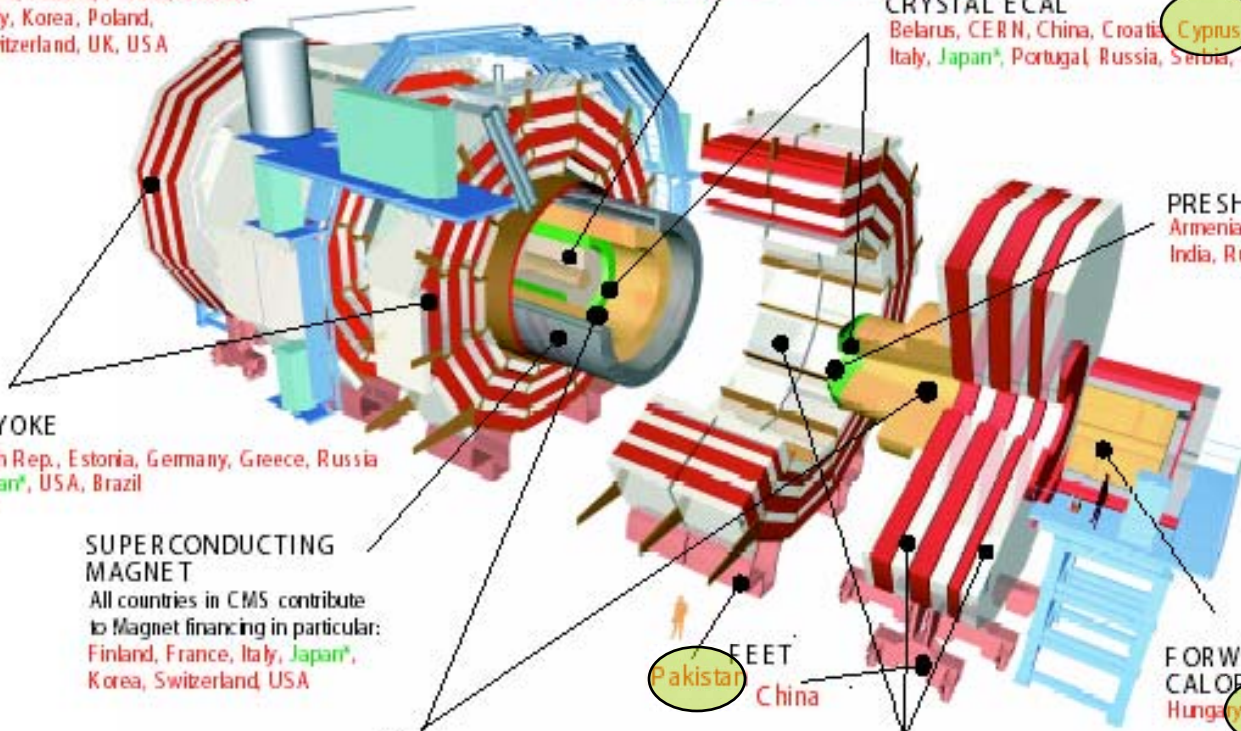
Barrel: Bulgaria, India, Spain*, USA
Endcap: Belarus, Bulgaria, Russia, Ukraine
HO: India

MUON CHAMBERS

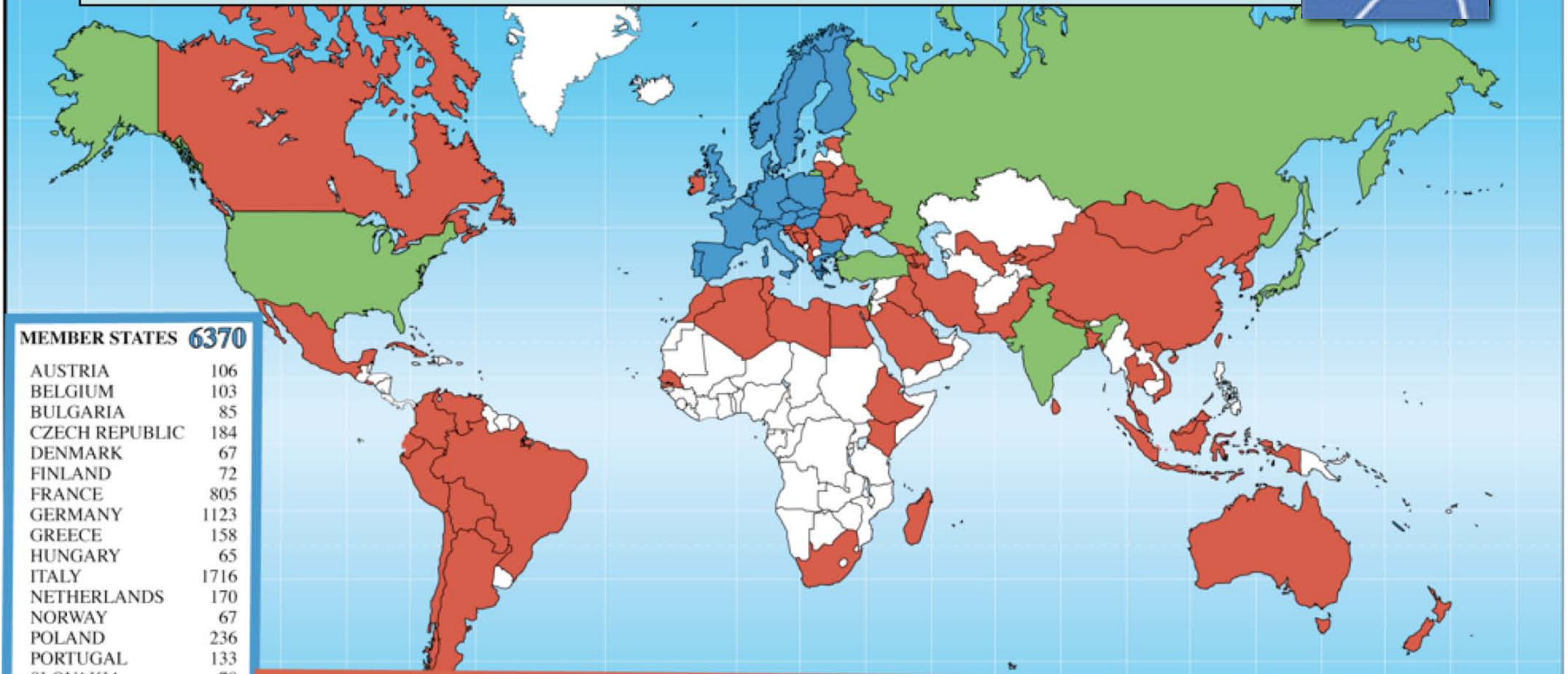
Barrel: Austria, Bulgaria, CERN, China, Germany, Hungary, Italy, Spain
Endcap: Belarus, Bulgaria, China, Korea, Pakistan, Russia, USA

* Only through industrial contracts

Total weight : 12500 T
Overall diameter : 15.0 m
Overall length : 21.5 m
Magnetic field : 4 Tesla



Origins of Scientists @



MEMBER STATES 6370

AUSTRIA	106
BELGIUM	103
BULGARIA	85
CZECH REPUBLIC	184
DENMARK	67
FINLAND	72
FRANCE	805
GERMANY	1123
GREECE	158
HUNGARY	65
ITALY	1716
NETHERLANDS	170
NORWAY	67
POLAND	236
PORTUGAL	133
SLOVAKIA	78
SPAIN	330
SWEDEN	67
SWITZERLAND	200
UNITED KINGDOM	605

OTHERS 1205

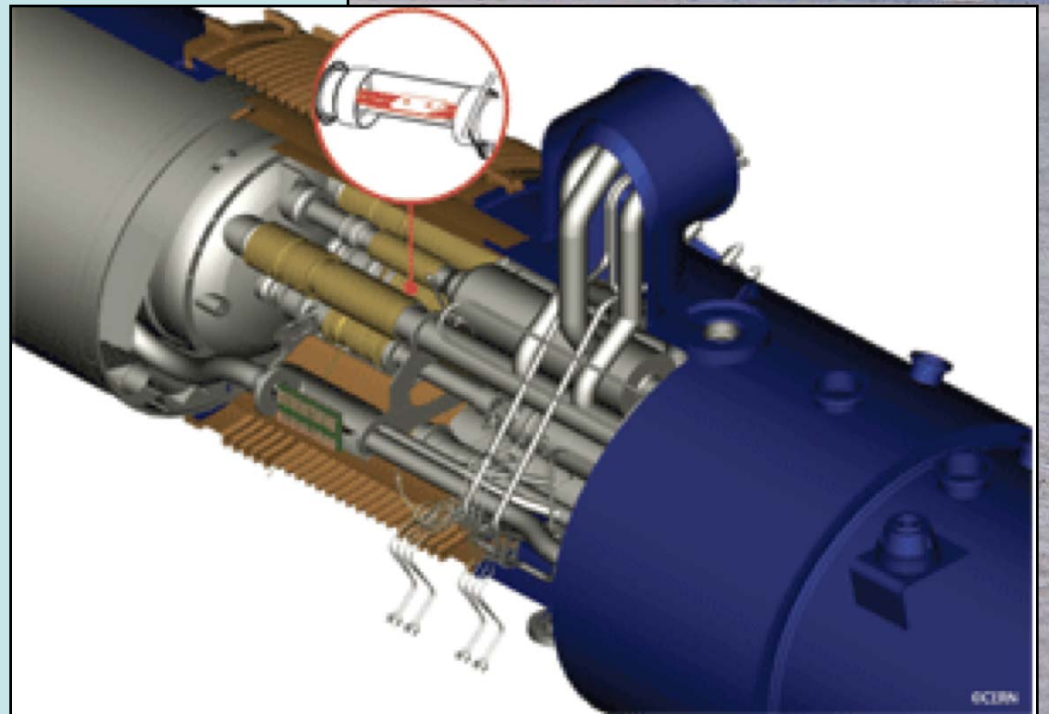
ALBANIA	2	BRAZIL	79	ESTONIA	9	KYRGYZSTAN	1	MOROCCO	16	RUSSIA	1027	SLOVENIA	1
ALGERIA	8	CANADA	136	ETHIOPIA	1	LEBANON	8	NETHERLANDS	170	SAUDI ARABIA	2	SOUTH AFRICA	9
ARGENTINA	11	CHINA	202	GEORGIA	31	LITHUANIA	9	NEW ZEALAND	10	SENEGAL	1	THAILAND	1
ARMENIA	24	CHINA (TAIPEI)	41	GIBRALTAR	1	LUXEMBOURG	5	PAKISTAN	33	SAN MARINO	1	TUNISIA	5
AUSTRALIA	20	COLOMBIA	19	HONG KONG	2	LIBYA	1	PALESTINE (O.T.)	1	SAUDI ARABIA	2	UKRAINE	40
AZERBAIJAN	5	CROATIA	24	INDONESIA	1	MADAGASCAR	3	PARAGUAY	1	SENEGAL	1	UZBEKISTAN	2
BANGLADESH	3	CUBA	4	IRAN	20	MADAGASCAR	3	PERU	1	SERBIA	34	VIET NAM	6
BELARUS	36	CYPRUS	12	IRAQ	1	MEXICO	46	ROMANIA	101				
BOLIVIA	2	ECUADOR	2	IRELAND	20	MEXICO	46	SAN MARINO	1				
BOSNIA AND HERZEGOVINA	1	EGYPT	6	KENYA	2	MOLDOVA	1	SAUDI ARABIA	2				
		EL SALVADOR	1	KOREA REP.	85	MONGOLIA	1	SAUDI ARABIA	2				

OBSERVER STATES 2444

INDIA	158
ISRAEL	51
JAPAN	229
RUSSIA	1027
TURKEY	87
USA	892

Incident of Sept. 19th, 2008

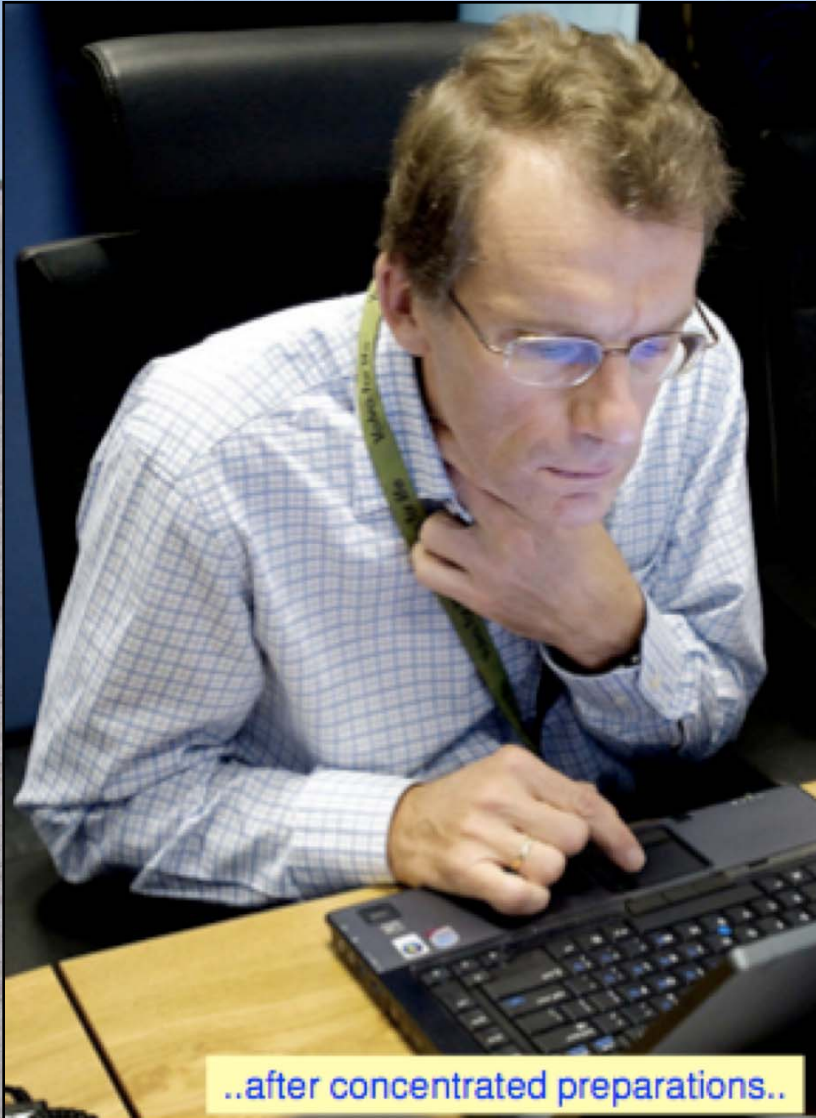
- Electrical fault in connection between two magnets
- Ohmic heating broke cryostat, vacuum pipe
- Repairs during 14-month shutdown
- Precursor diagnostic identified
- Simple rewiring to avoid recurrence
- Relief valves being installed



LHC Accelerator Progress in 2009

Nov 20	1	Each beam circulating. Key beam instrumentation working.
Nov 23	4	First collisions at 450 GeV. First ramp (reached 560 GeV).
Nov 26	7	Magnetic cycling established (reproducibility).
Nov 27	8	Energy matching.
Nov 29	10	Ramp to 1.18 TeV.
Nov 30	11	Experiment solenoids on.
Dec 04	15	Aperture measurement campaign finished. LHCb and ALICE dipoles on.
Dec 05	16	Machine protection (Injection, Beam dump, Collimators) ready for safe operation with pilots.
Dec 06	17	First collisions with STABLE BEAMS, 4 on 4 pilots at 450 GeV, rates around 1Hz.
Dec 08	19	Ramp colliding bunches to 1.18 TeV
Dec 11	22	Collisions with STABLE BEAMS, 4 on 4 at 450 GeV, $> 10^{10}$ per bunch, rates around 10Hz.
Dec 13	24	Ramp 2 bunches per beam to 1.18 TeV. Collisions for 90mins.
Dec 14	25	Collisions with STABLE BEAMS, 16 on 16 at 450 GeV, $> 10^{10}$ per bunch, rates around 50Hz.
Dec 16	27	Ramp 4 on 4 to 1.18 TeV. Squeeze to 7 m.

Tense Anticipation ...



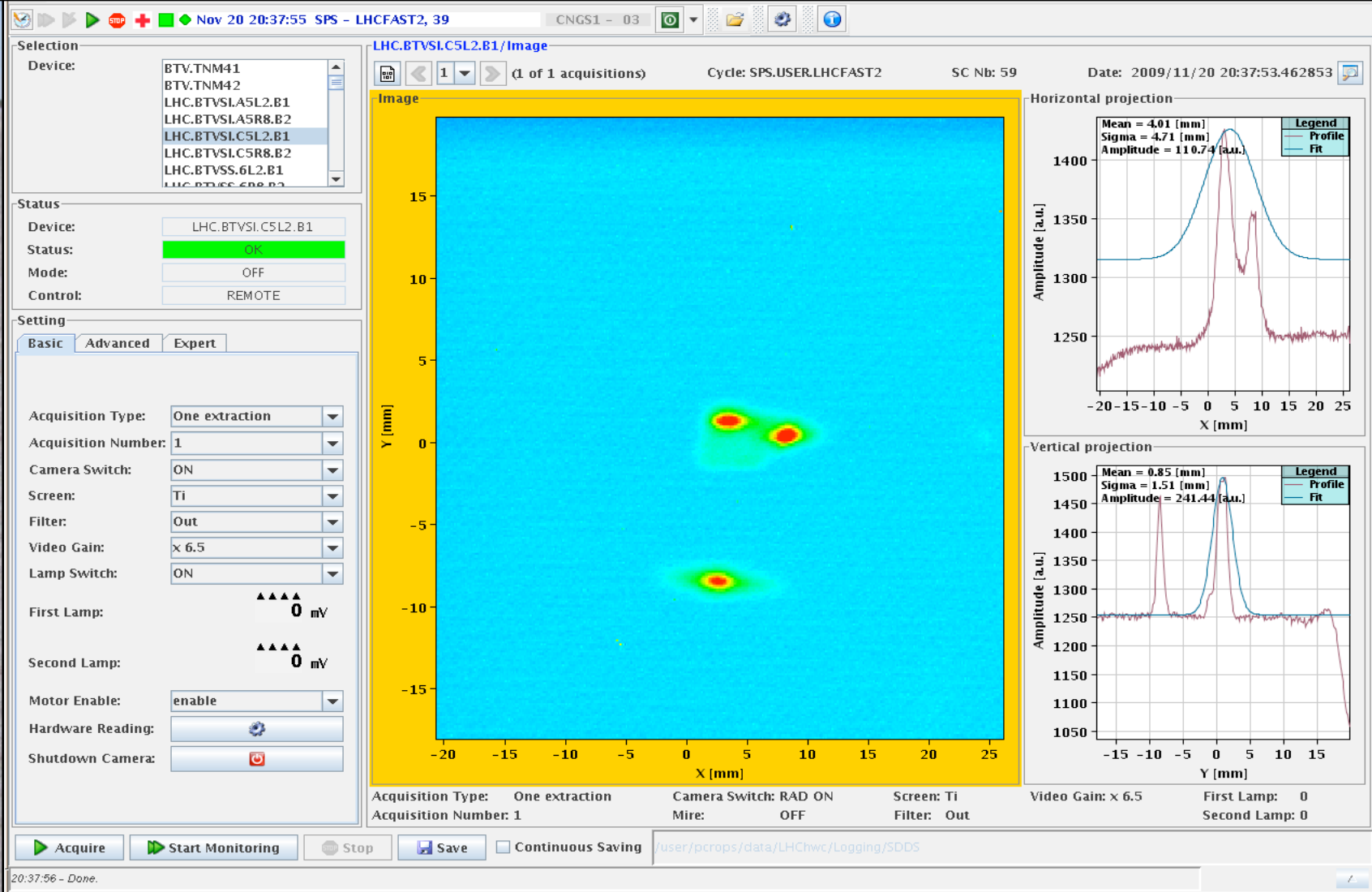
..after concentrated preparations..



.. and tense anticipation..

Monday, 23rd November, ~15:30
in the ALICE Control Room

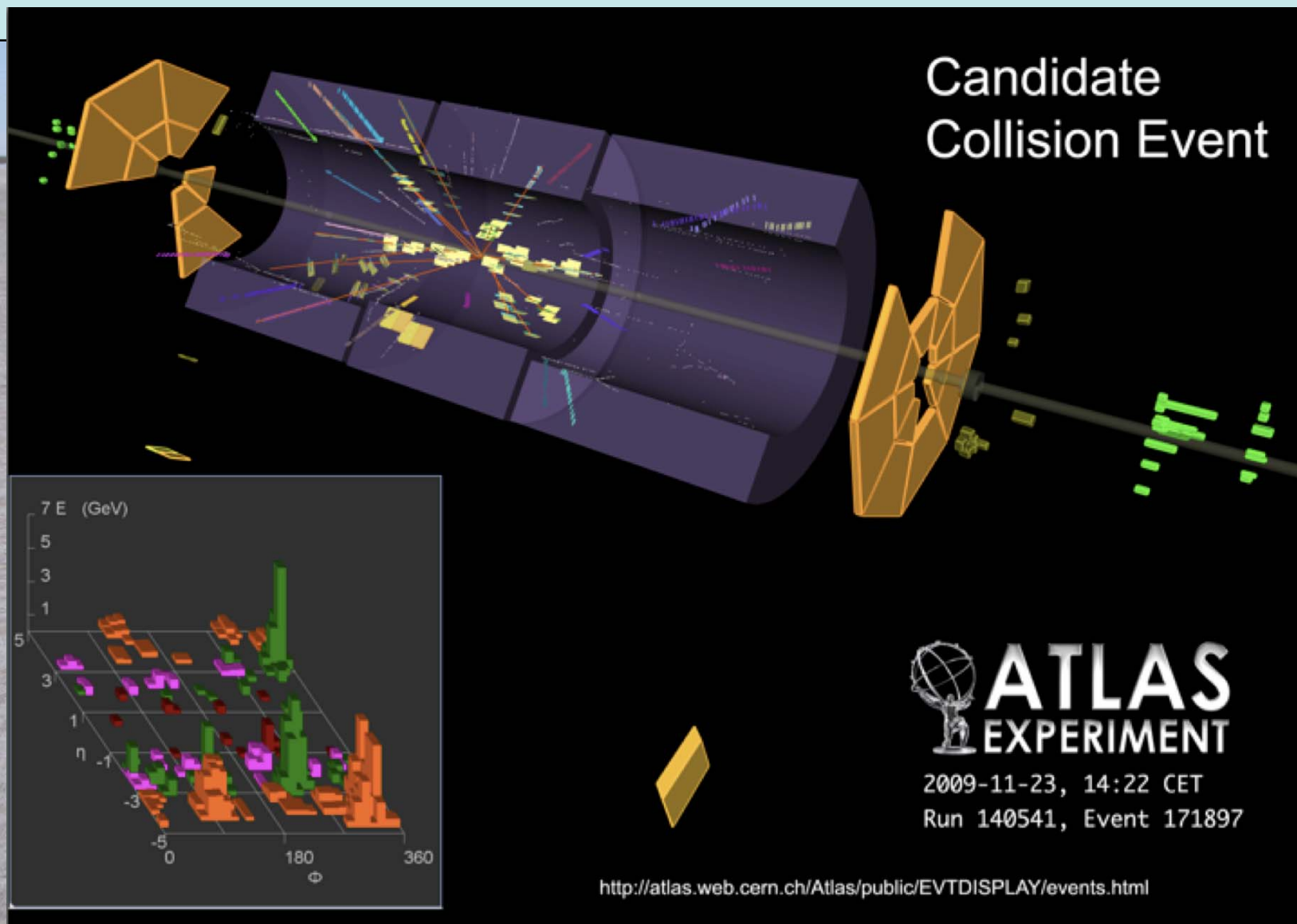
First 2009 Beam Circuits: Friday Nov. 20th @ 8.15pm



... and Jubilation



First LHC Collision in ATLAS



Accelerating 2 Beams to 1.18 TeV

LHC Page1

Fill: 916.0

E: 1180 GeV

14-12-2009 02:40:39

BEAM SETUP: RAMP

Energy:

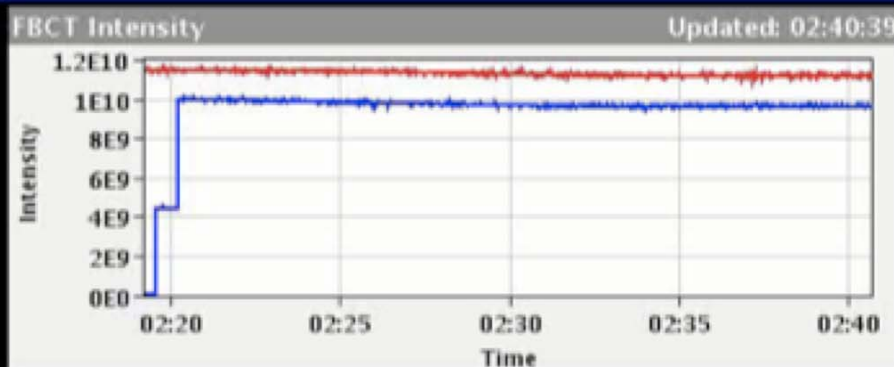
1180 GeV

I(B1):

0.00e+00

I(B2):

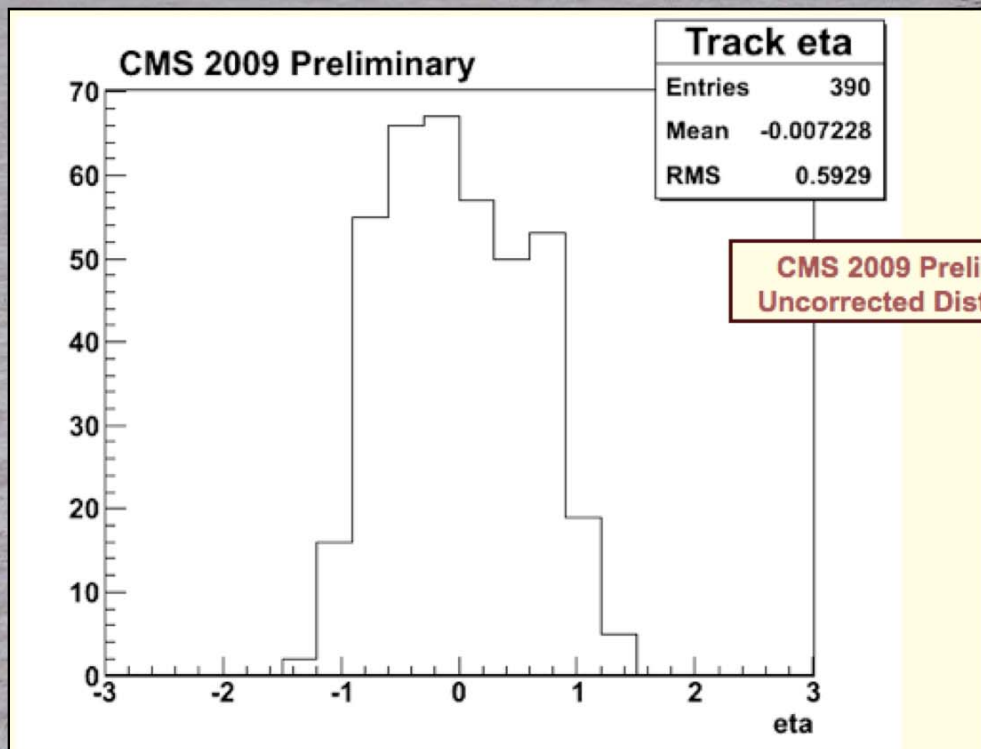
7.80e+09



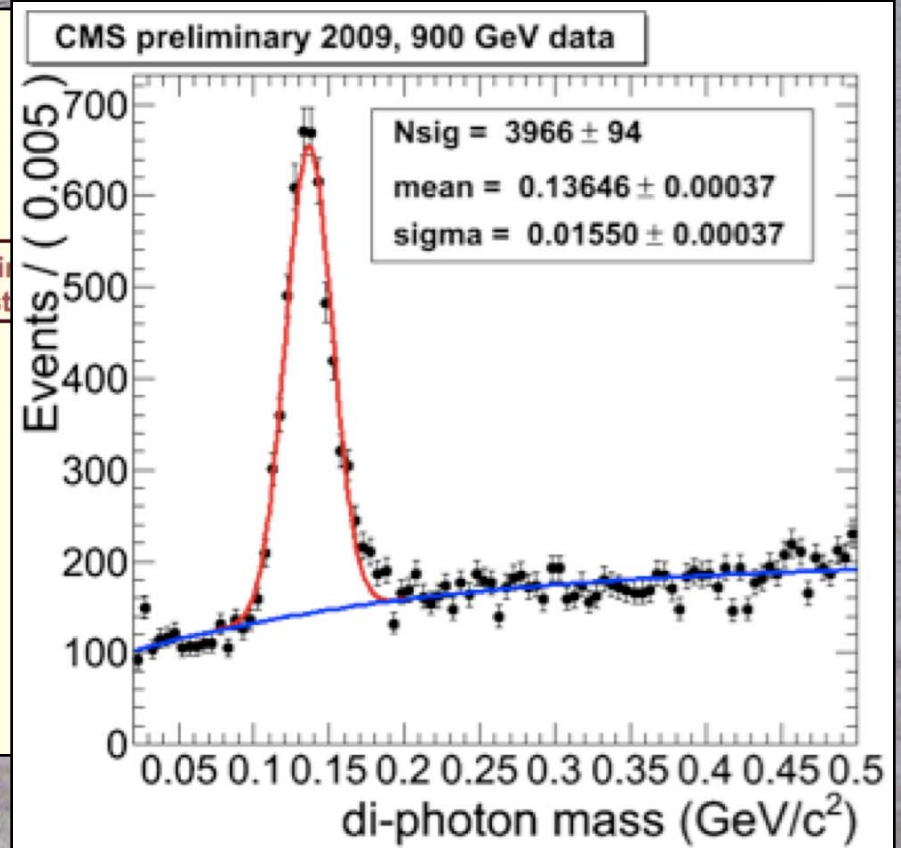
- Smooth increase of magnet current to 2000 Amps
- Few protons lost during the acceleration

No Higgs yet!

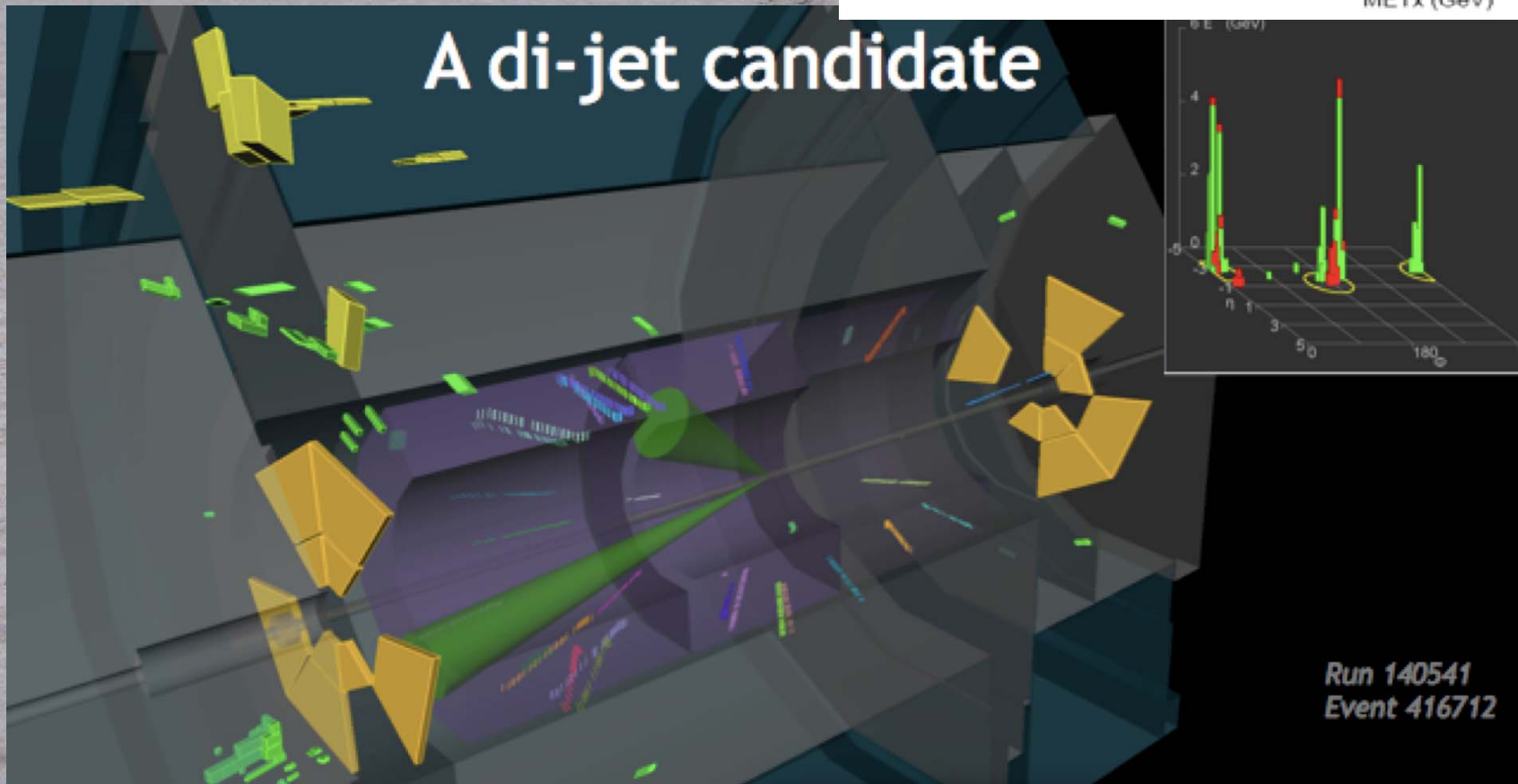
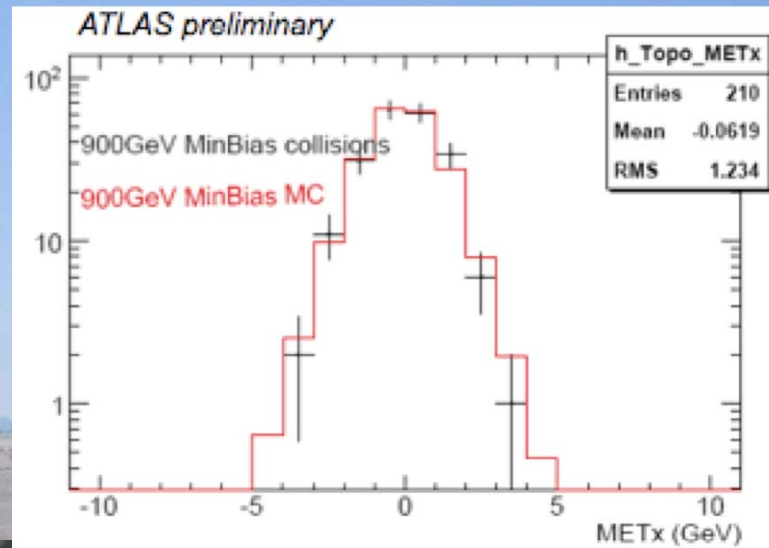
Pseudo-rapidity distribution



$\gamma\gamma$ invariant mass distribution



No
Supersymmetry
yet!

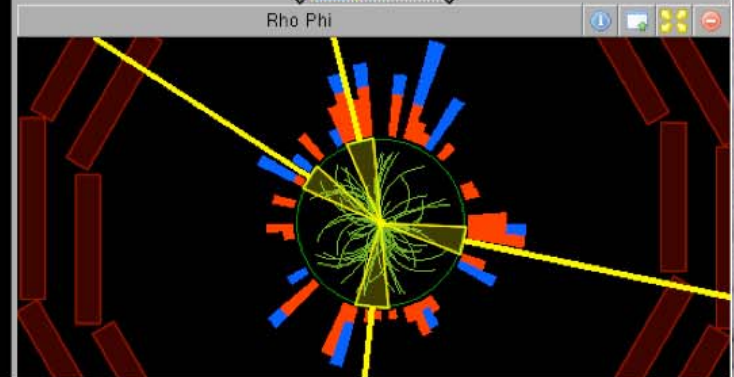
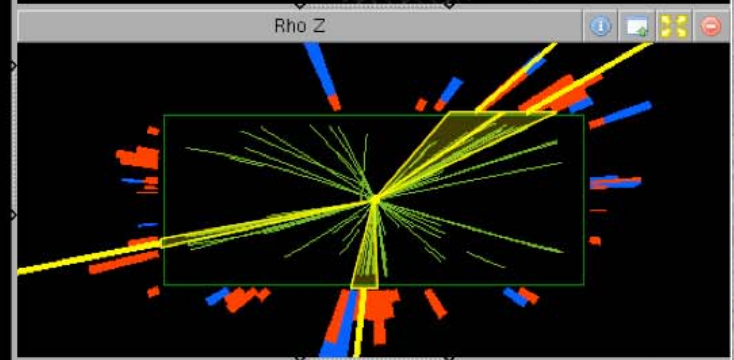
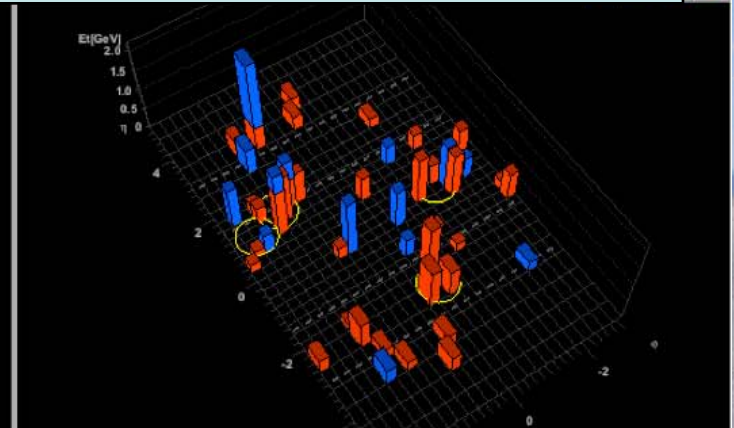
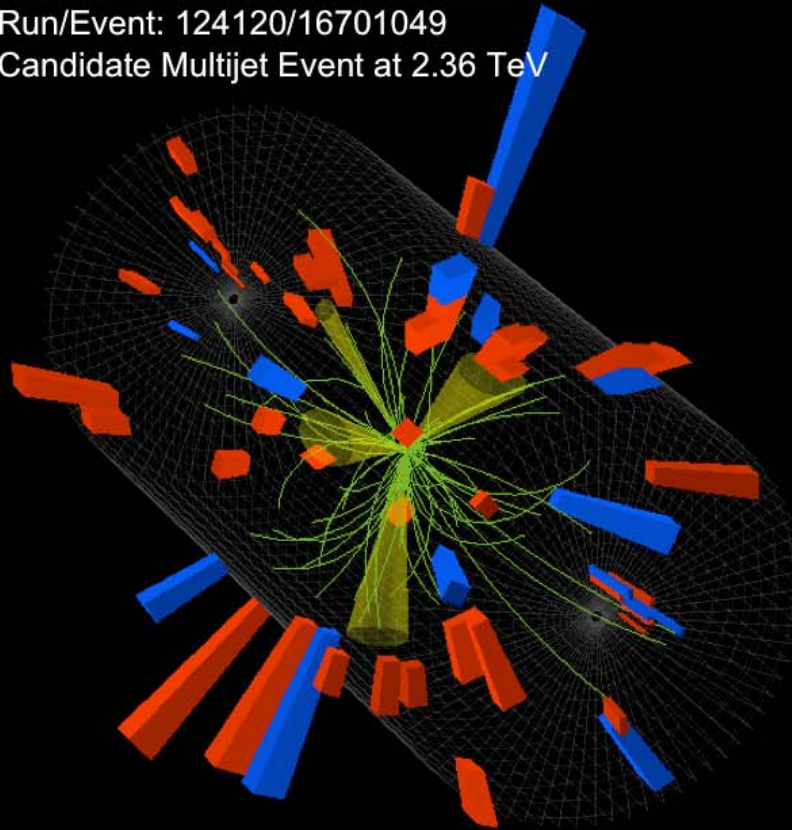


No Black Holes yet!

CMS 4-Jet Event @ 2.36 TeV



CMS Experiment at the LHC, CERN
Date Recorded: 2009-12-14 05:41 CET
Run/Event: 124120/16701049
Candidate Multijet Event at 2.36 TeV



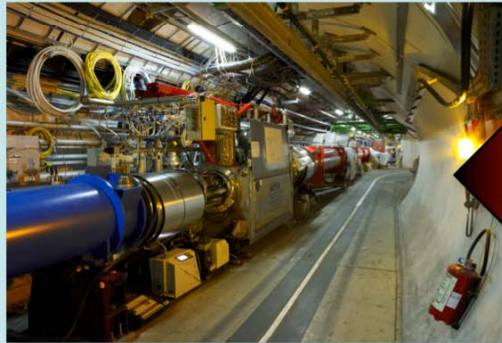
What will the Future bring?

- Default scenario:
 - 2010/2011
 - Run @ 3.5 TeV + 3.5 TeV
 - Aim for $> 1/\text{fb}$ integrated luminosity
- Plan long shutdown before increasing energy
- At least one major upgrade:
 - Linac4, new collision insertions
- Scope of second upgrade under discussion
 - SPL? PS2? Collision insertions? Crab cavities?

CERN Technologies

Examples: medical applications

Accelerating particle beams

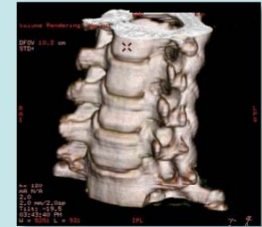


Charged hadron beam that loses energy in matter

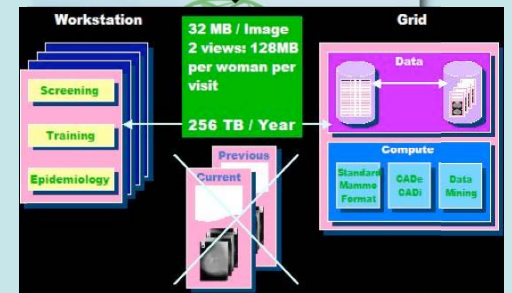
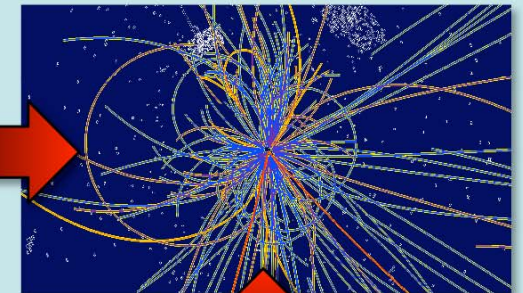


Large-scale computing

Medical imaging



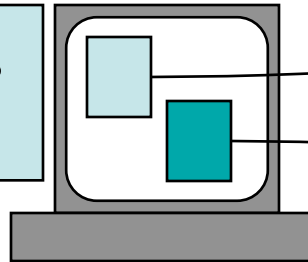
Detecting particles



Grid computing for medical data management and analysis

From the Web to the Grid

Web: Uniform access to HTML documents



http://

http://

Grid: Flexible, high-performance access to all significant resources



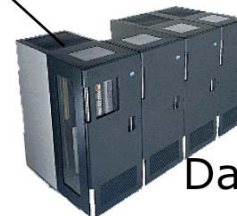
Software catalogs



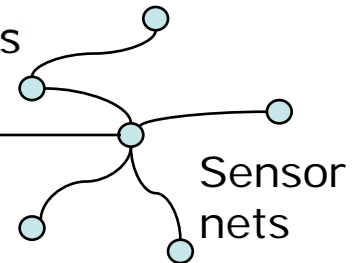
Computers



Colleagues



Data archives

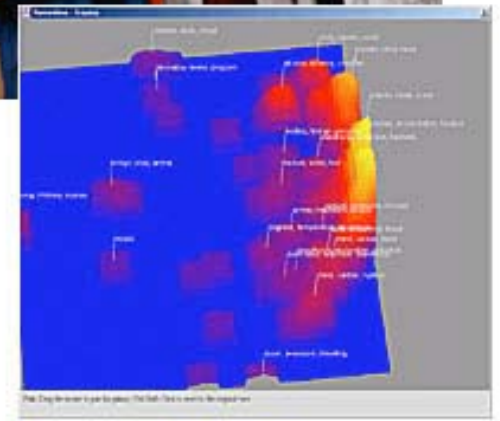


Sensor nets

On-demand creation of powerful virtual computing systems

The Grid is also useful for ...

- **Medical/Healthcare** (imaging, diagnosis and treatment)
- **Bioinformatics** (study of the human genome and proteome to understand genetic diseases)
- **Nanotechnology** (design of new materials from the molecular scale)
- **Engineering** (design optimization, simulation, failure analysis and remote Instrument access and control)
- **Natural Resources and the Environment** (weather forecasting, earth observation, modelling and prediction of complex systems earthquakes)



Support by European Union: EGEE programme

CERN Education Activities

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

High-School Teachers @ CERN

1998 to 2009

MEMBER STATES

AUSTRIA	11
BELGIUM	24
BULGARIA	106
CZECH REPUBLIC	99
DENMARK	72
FINLAND	349
FRANCE	100
GERMANY	256
GREECE	118
HUNGARY	181
ITALY	60
NETHERLANDS	30
NORWAY	47
POLAND	406
PORTUGAL	165
SLOVAKIA	145
SPAIN	122
SWEDEN	79
SWITZERLAND	12
UNITED KINGDOM	344

2726

OBSERVER STATES

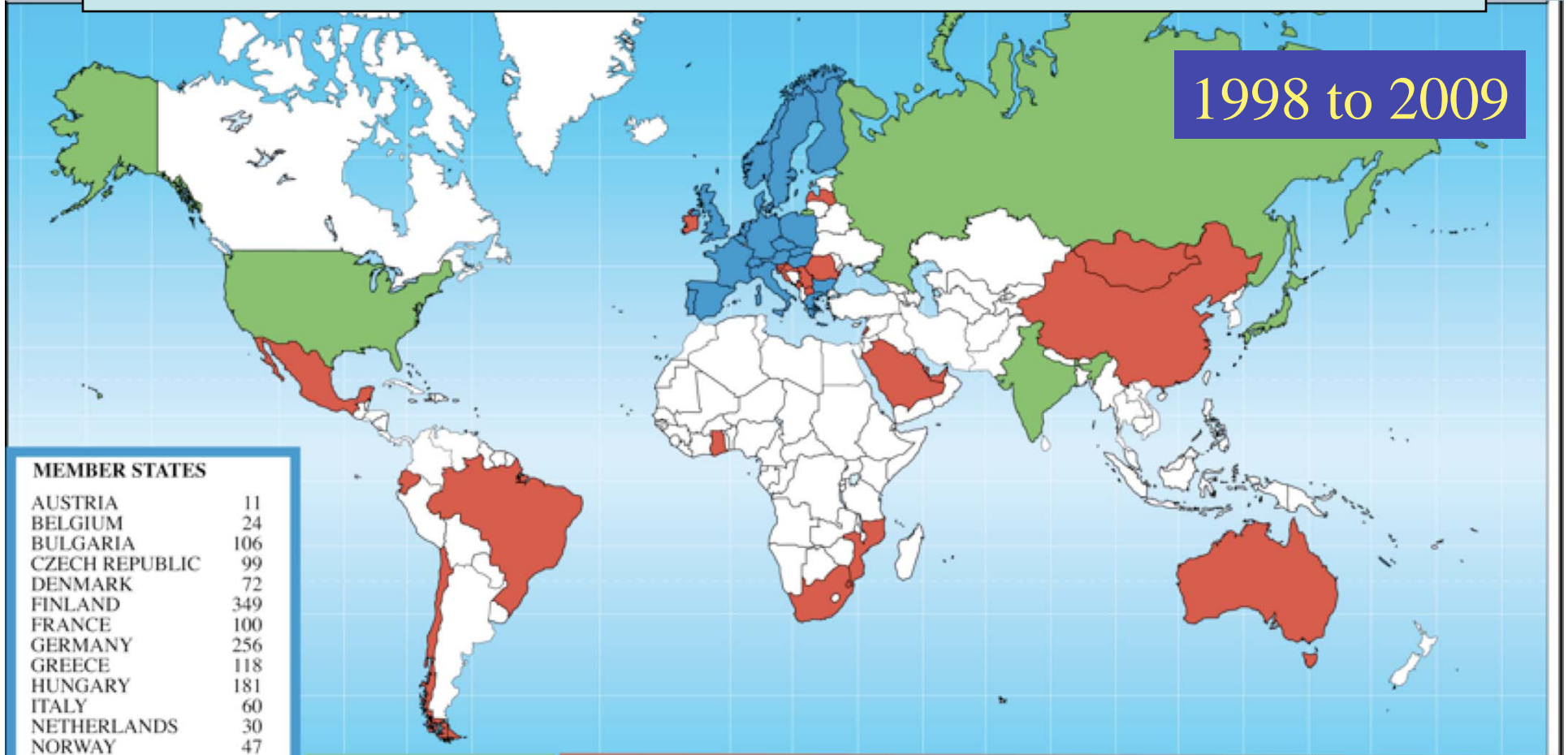
INDIA	2
JAPAN	1
RUSSIA	48
USA	46

97

OTHERS

AUSTRALIA	1	IRELAND	3	MONTENEGRO	13	SLOVENIA	21
AZERBAIJAN	1	LATVIA	1	MOZAMBIQUE	5	SOUTH AFRICA	6
BRAZIL	12	LEBANON	1	QATAR	1	U.A.E.	1
CHILE	3	MACEDONIA	10	ROMANIA	5		
CHINA	1	MALTA	36	SAUDI ARABIA	1		
CROATIA	1	MEXICO	5	SERBIA	10		
EQUADOR	1	MONGOLIA	1	SINGAPORE	2		

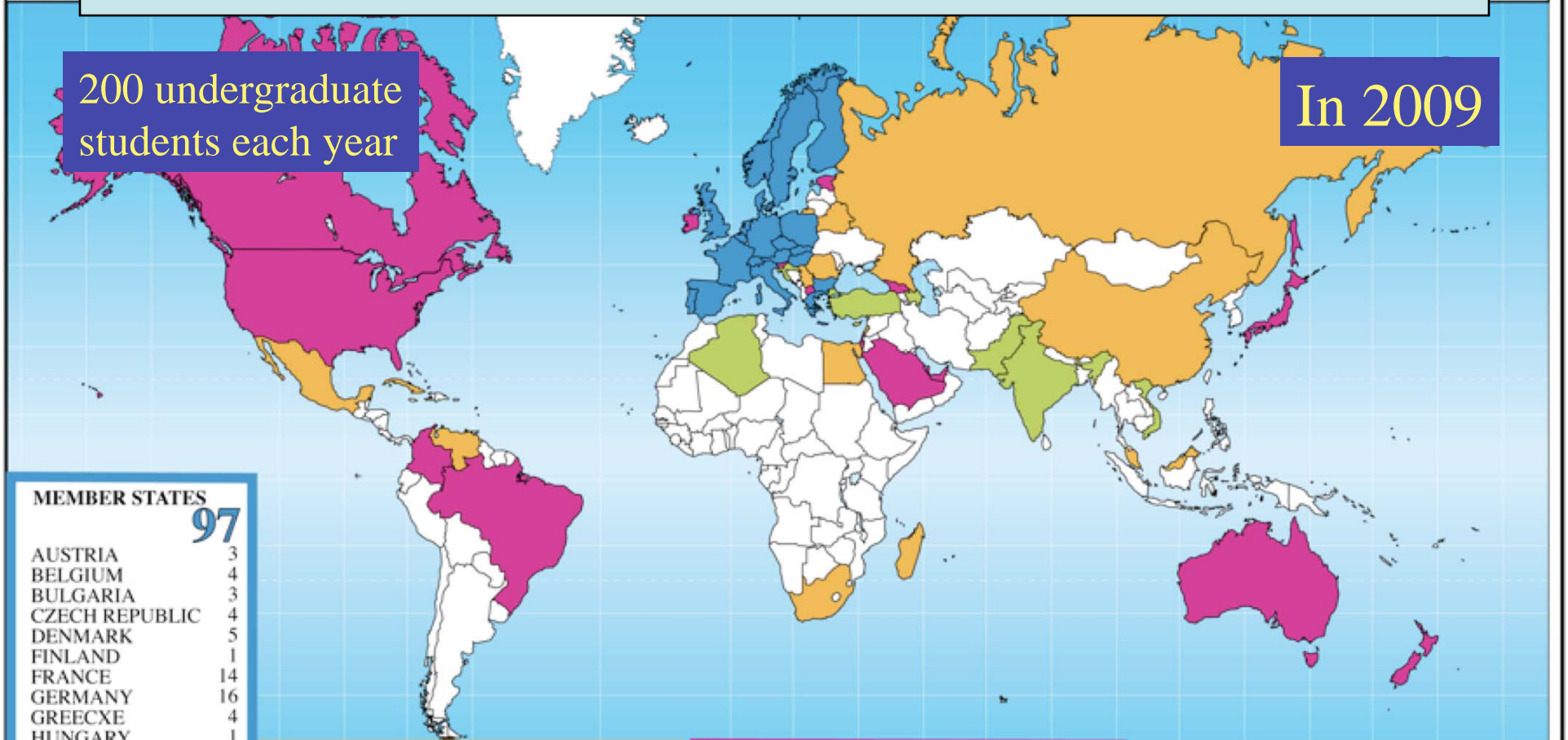
144



Summer Students @ CERN

200 undergraduate students each year

In 2009



MEMBER STATES **97**

AUSTRIA	3
BELGIUM	4
BULGARIA	3
CZECH REPUBLIC	4
DENMARK	5
FINLAND	1
FRANCE	14
GERMANY	16
GREECE	4
HUNGARY	1
ITALY	7
NETHERLANDS	5
NORWAY	3
POLAND	2
PORTUGAL	1
SLOVAKIA	3
SPAIN	4
SWEDEN	7
SWITZERLAND	1
UNITED KINGDOM	9

SUPPORTED BY CERN **22**

BELARUS	1	MAURITIUS	1
CHINA	1	MEXICO	1
CUBA	1	ROMANIA	1
EGYPT	1	RUSSIA	9
LEBANON	1	SOUTH AFRICA	1
MADAGASCAR	1	VENEZUELA	1
MALAYSIA	1		

EXTERNAL SUPPORT **52**

AUSTRALIA	2	JAPAN	5
BRAZIL	1	MACEDONIA	5
CANADA	6	N. ZEALAND	2
COLOMBIA	1	QATAR	2
ESTONIA	2	SAUDIA	2
GEORGIA	1	SLOVENIA	1
IRELAND	1	UAE	1
ISRAEL	4		16

BOTH SOURCES **38**

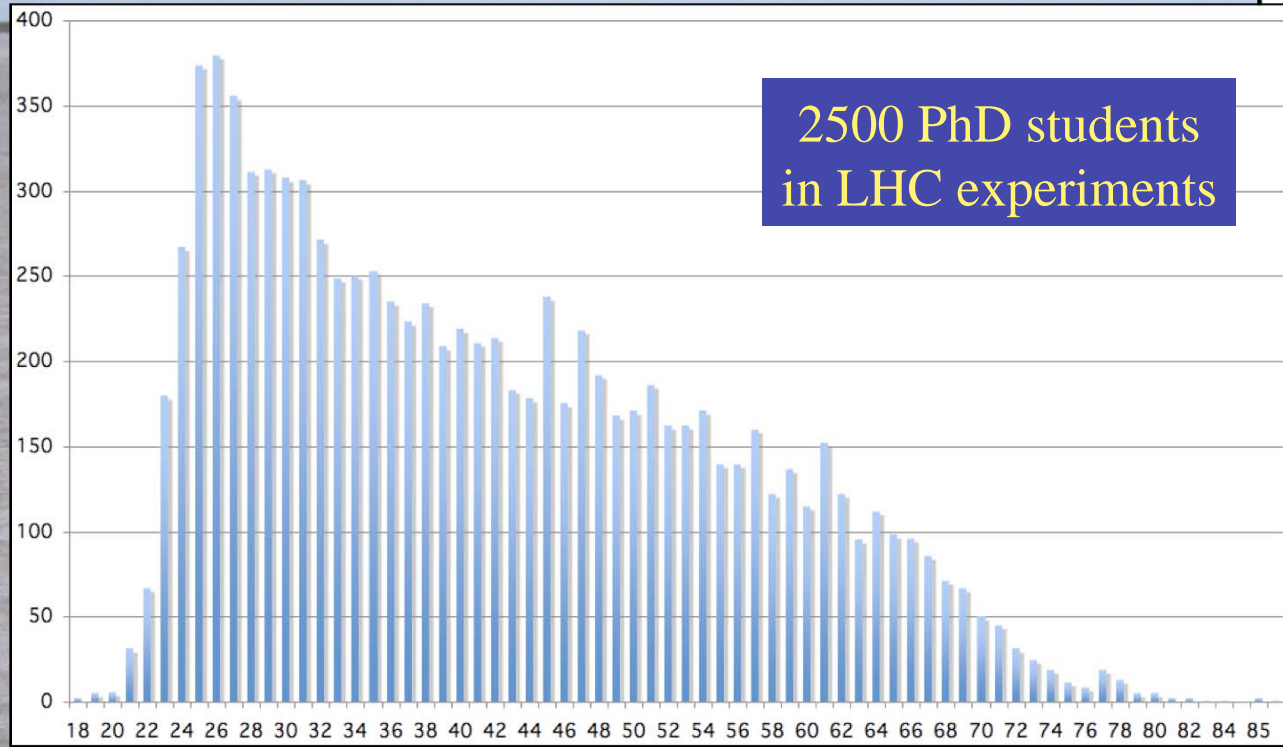
ALGERIA	2	INDONESIA	3
AZERBAIJAN	2	VIETNAM	4
CROATIA	3		
CYPRUS	3		
INDIA	11		
MALTA	3		
PALESTINE	4		
	3		

Age Distribution of Scientists - and where they go afterwards

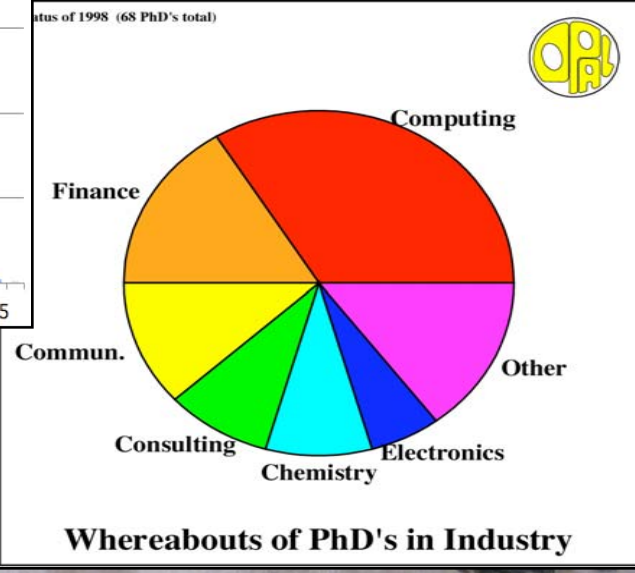
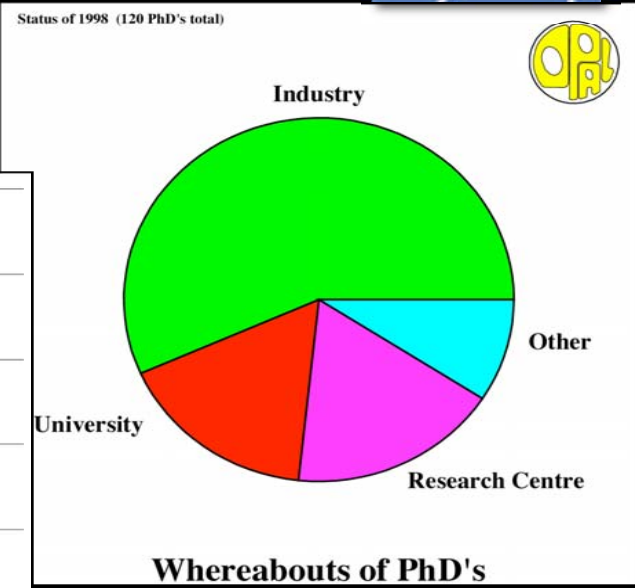


Survey in March 2009

2500 PhD students
in LHC experiments



They do not all stay: where do they go?



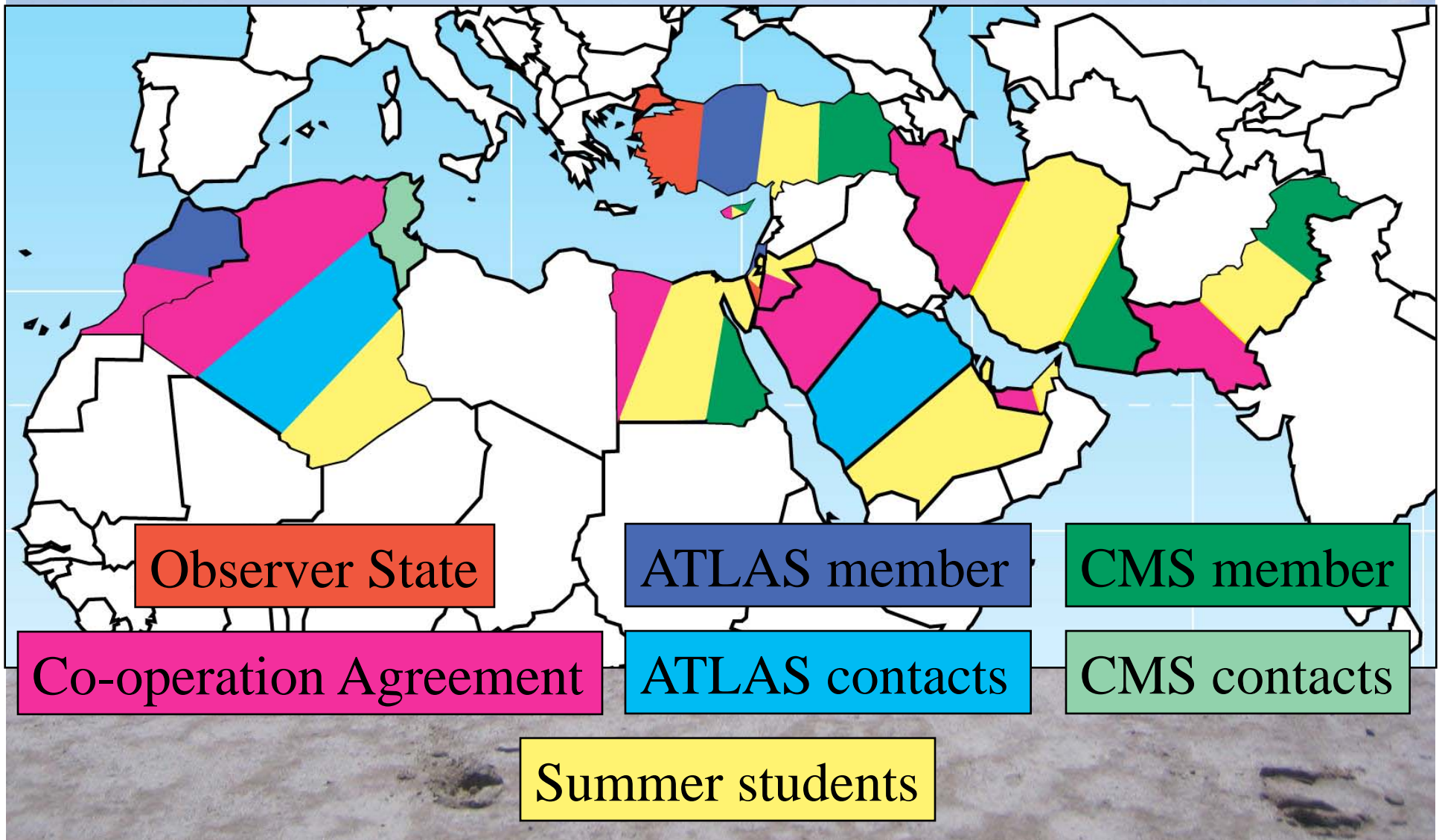
CERN in Numbers



- ~ 2300 staff
- ~ 730 other paid personnel
- ~ 10,000 users
- Budget (2010) 1150 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 to Membership:** Romania
- **8 Observers to Council:** India, Israel, Japan, the Russian Federation, the United States of America, Turkey, the European Commission and Unesco
- **5 Applications for Membership:** Cyprus, Israel, Serbia, Slovenia, Turkey

Regional Co-operation in the Middle East and North Africa



Where do we come from?

What are we?

Where are we going?



Universal questions addressed by the LHC
CERN is open to all interested scientists

Questions for Discussion

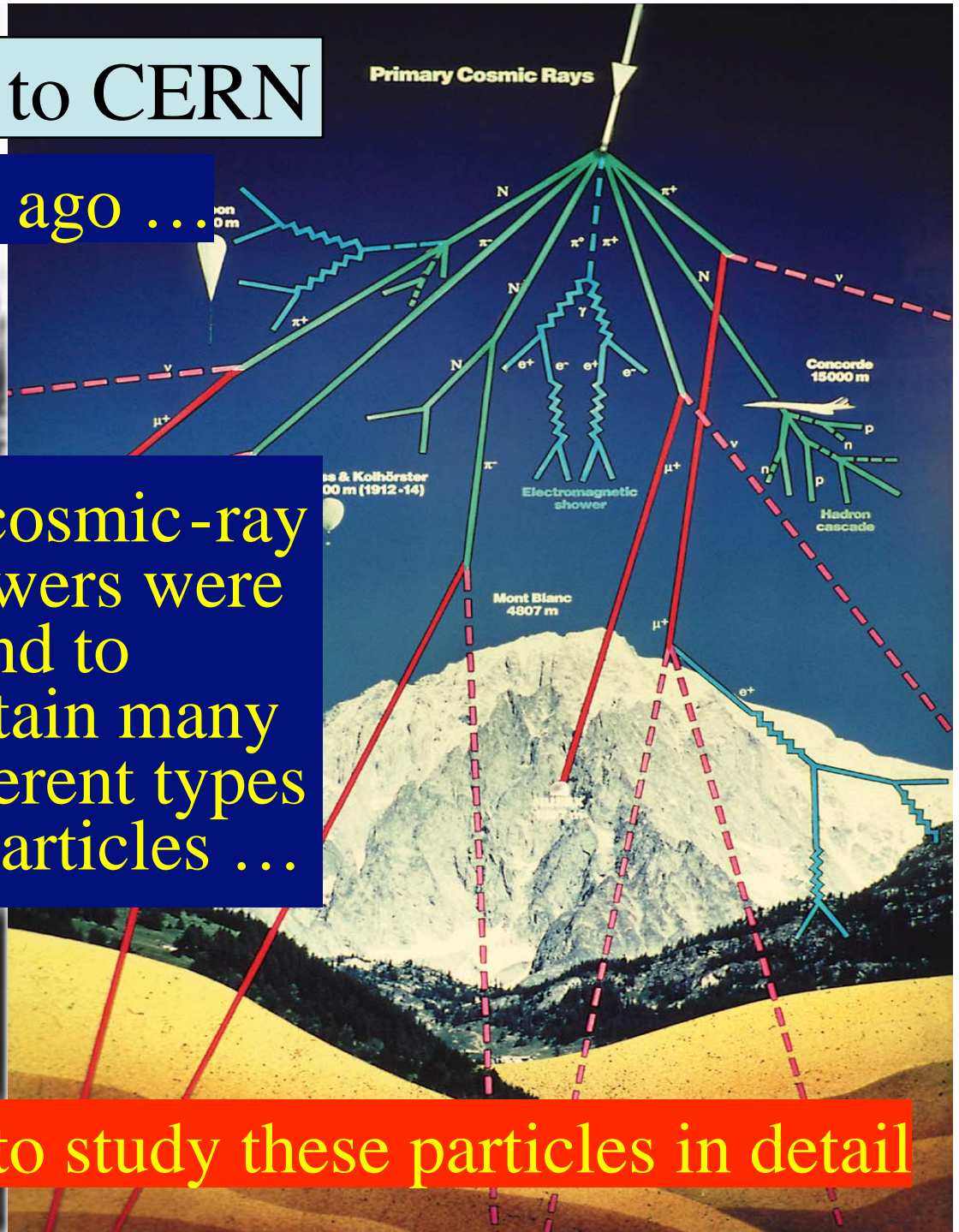
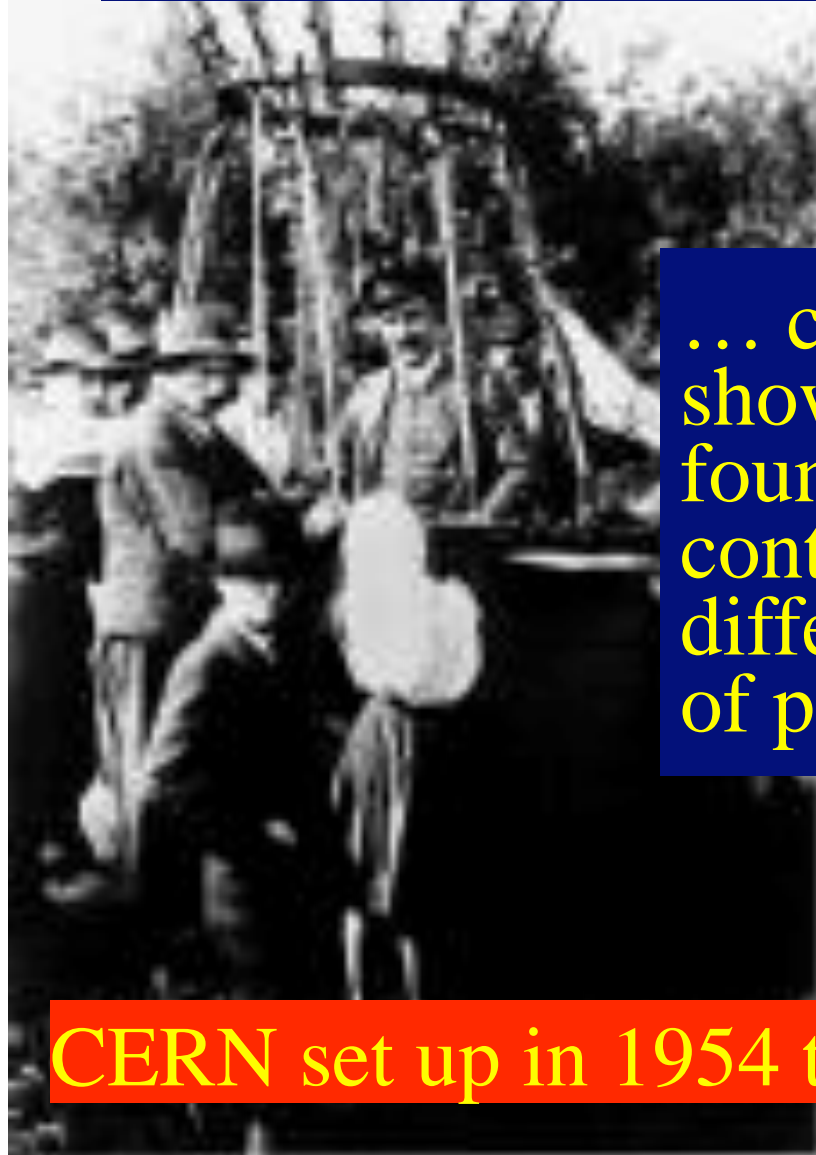
- What roles for international research centres?
 - Sharing new knowledge?
 - From science to deployable technologies?
 - Capacity-building?
- What future for SESAME?
 - Year 2010 is crucial?
 - How to support new initiative?
- Messages for other international organizations?
 - Climate science and WMO?

From Cosmic Rays to CERN

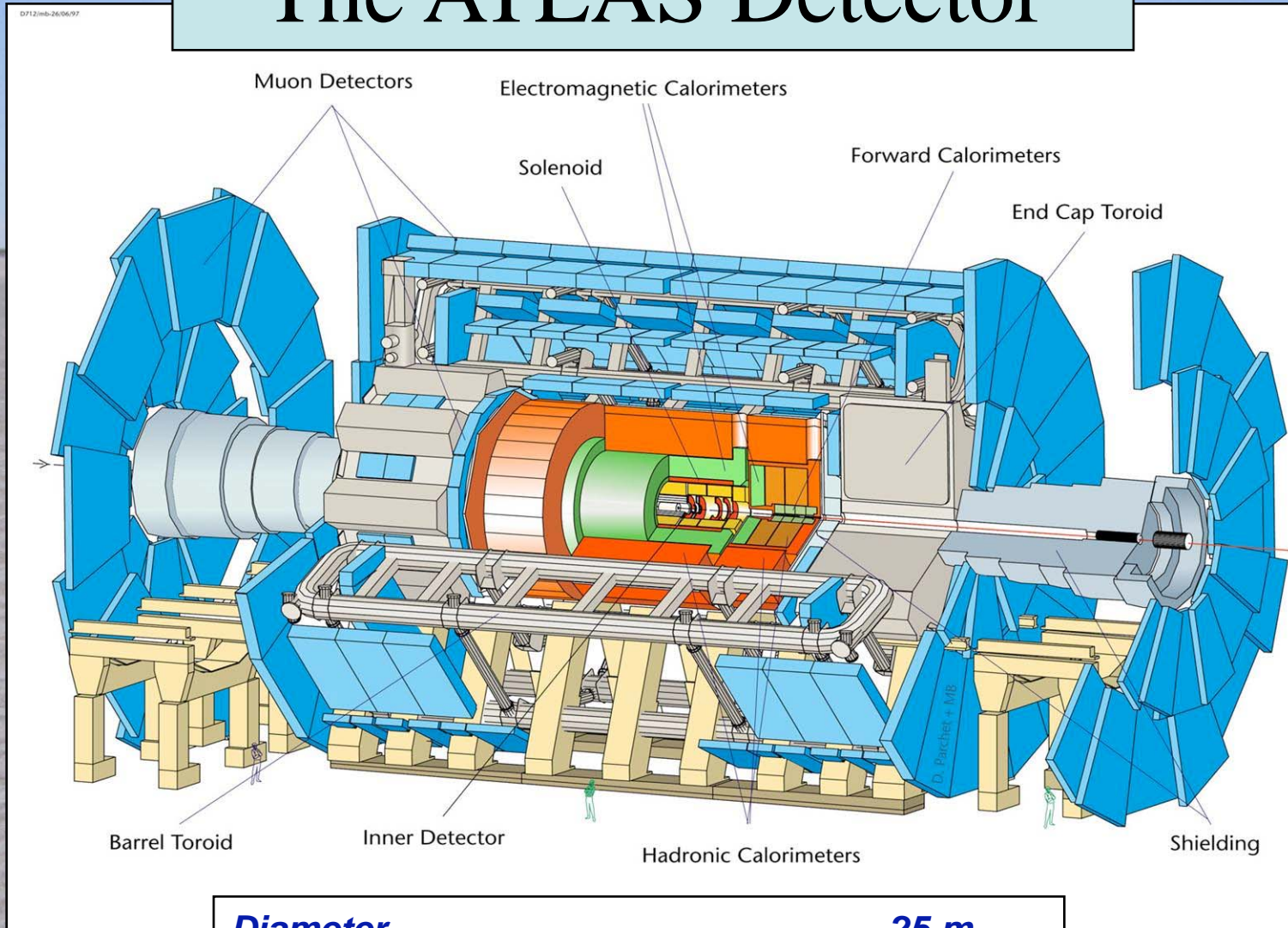
Discovered a century ago ...

... cosmic-ray showers were found to contain many different types of particles ...

CERN set up in 1954 to study these particles in detail



The ATLAS Detector



<i>Diameter</i>	25 m
<i>Barrel toroid length</i>	26 m
<i>End-cap end-wall chamber span</i>	46 m
<i>Overall weight</i>	7000 Tons

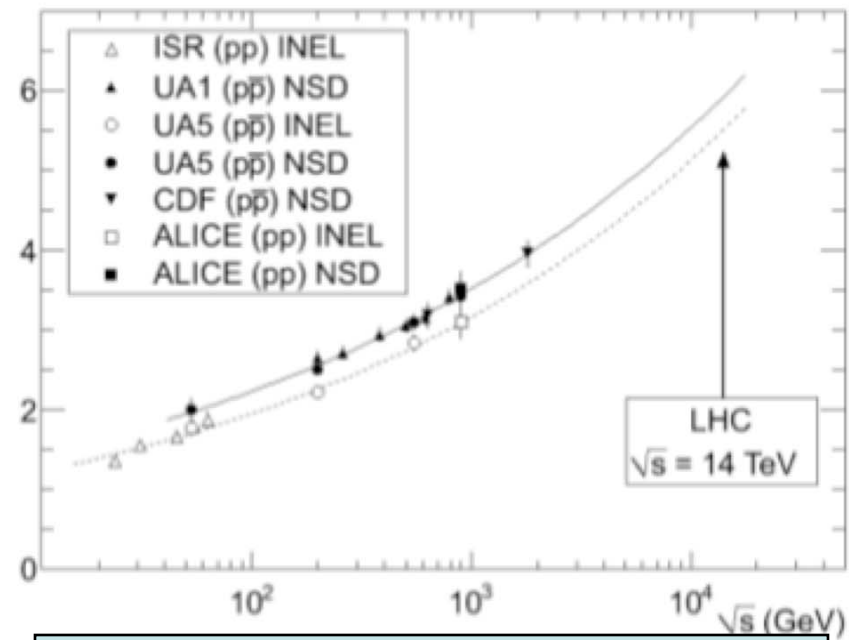
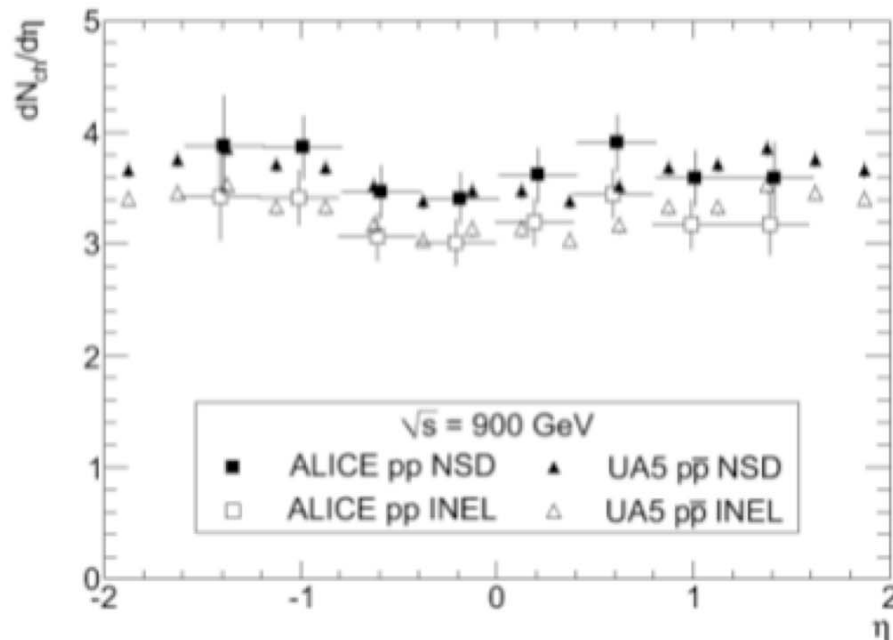
First LHC Physics Paper from ALICE

First proton–proton collisions at the LHC as observed with the ALICE detector: measurement of the charged particle pseudorapidity density at $\sqrt{s} = 900$ GeV

Based on 300 events from 23/11

ALICE collaboration

Experiment Model	ALICE pp	UA5 p \bar{p} [3]	QGSM [26]	PYTHIA [17]		PHOJET [8]	
				(109) [18]	(306) [27] (320) [28]		
INEL	$3.10 \pm 0.13 \pm 0.22$	3.09 ± 0.05	2.98	2.33	2.99	2.46	3.14
NSD	$3.51 \pm 0.15 \pm 0.25$	3.43 ± 0.05	3.47	2.83	3.68	3.02	3.61



Angular distribution of produced particles

Total number of produced particles

Regional Participation @



- **Observer States:**
Turkey, Israel
- **International Co-operation Agreements:**
Morocco, Pakistan, Iran, Cyprus, Egypt, Saudi Arabia, UAE, Malta,
Turkey, Algeria
- **LHC experiments:**
ATLAS, CMS
- **Accelerator R&D:**
Pakistan, Saudi Arabia, Turkey, Israel
- **LHC group @ ICTP (ATLAS: Algeria, ...)**
- **Other experiments:**
Qatar (ISOLDE, AEGIS)
- **Other contacts:**
Bahrain, Kuwait, Lebanon, Tunisia