Welcome – Vitajte

Slovakia at CERN

to *Accelerating Science and Innovation*

Short History of CERN

- CERN Laboratory was conceived on July 1st, 1953, by and at UNESCO (itself 8 years old at that time, still they consider us as their baby)
- Born after 15 month, on September 29th, 1954 (we are some months after 60 birthday!)
- In the mean time excavation works started on May 17th, 1954

United Nations Educational, Scientific and Cultural Organization

- …and I was born

CERN was founded 1954: 12 European States

"Science for Peace"

Today: 21 Member States

~ 2300 staff
~ 1600 other paid personnel
~ 10500 scientific users

Budget (2014) ~1000 MCHF

Member States: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom

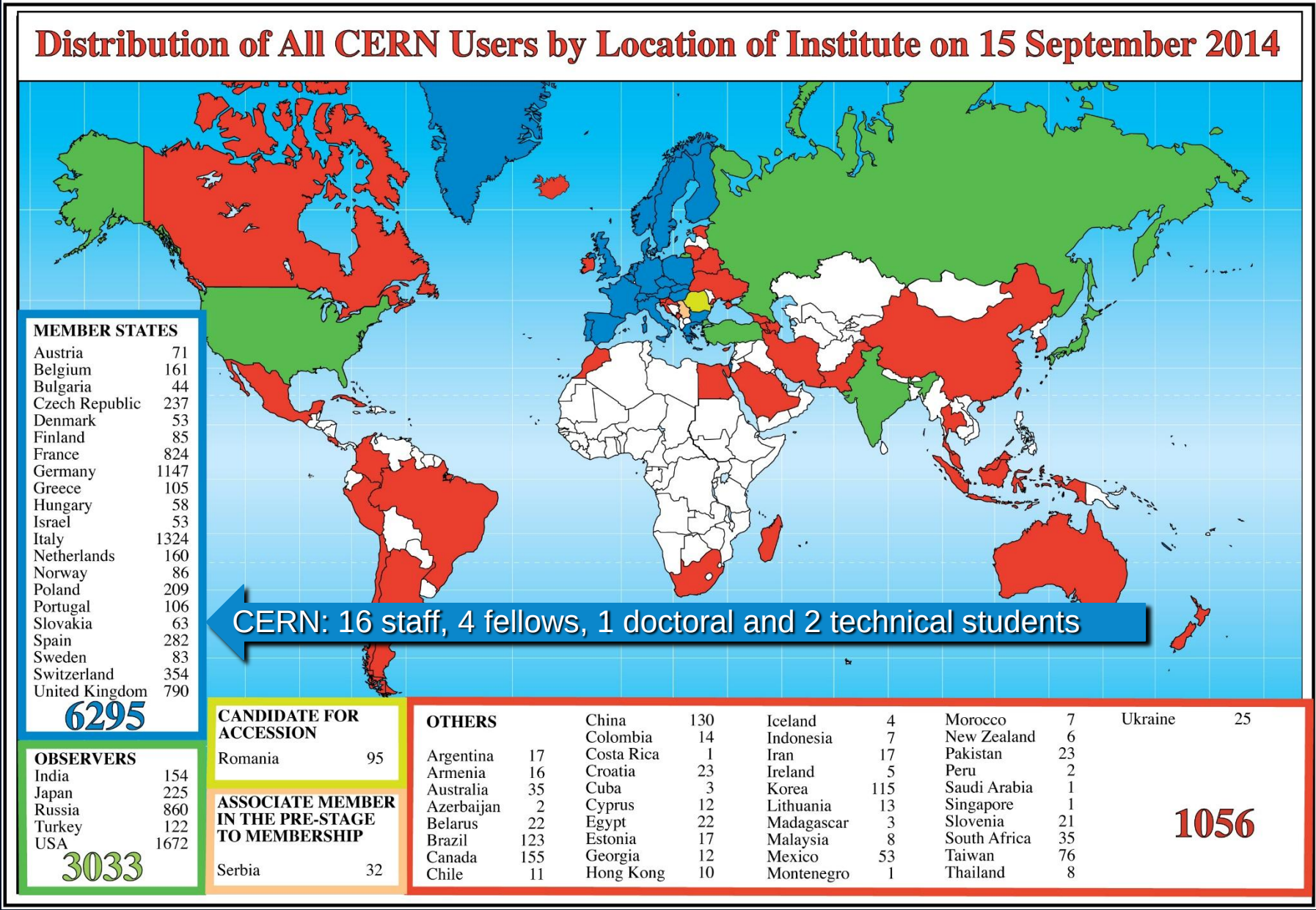
Candidate for Accession: Romania

Associate Member in Pre-Stage to Membership: Serbia

Applicant States for Membership or Associate Membership: Brazil, Croatia, Cyprus, Pakistan, Russia, Slovenia, Turkey, Ukraine

Observers to Council: India, Japan, Russia, Turkey, United States of America; European Commission and UNESCO

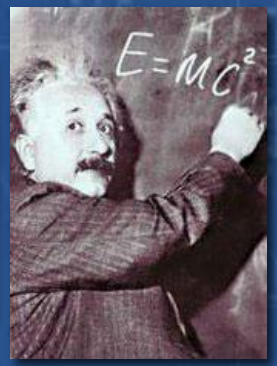
Science is getting more and more global



Mission of CERN

- **Push forward** the frontiers of knowledge

  The secrets of the Big Bang …what was the matter like within the first moments of the Universe's existence?



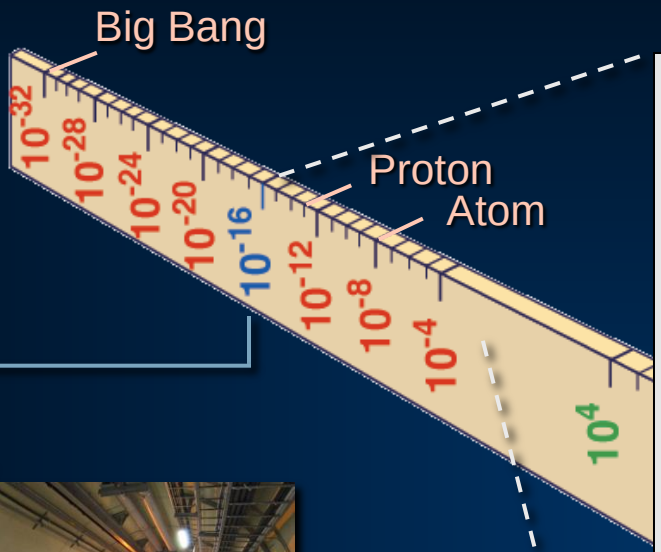
- **Develop** new technol… accelerators and de…

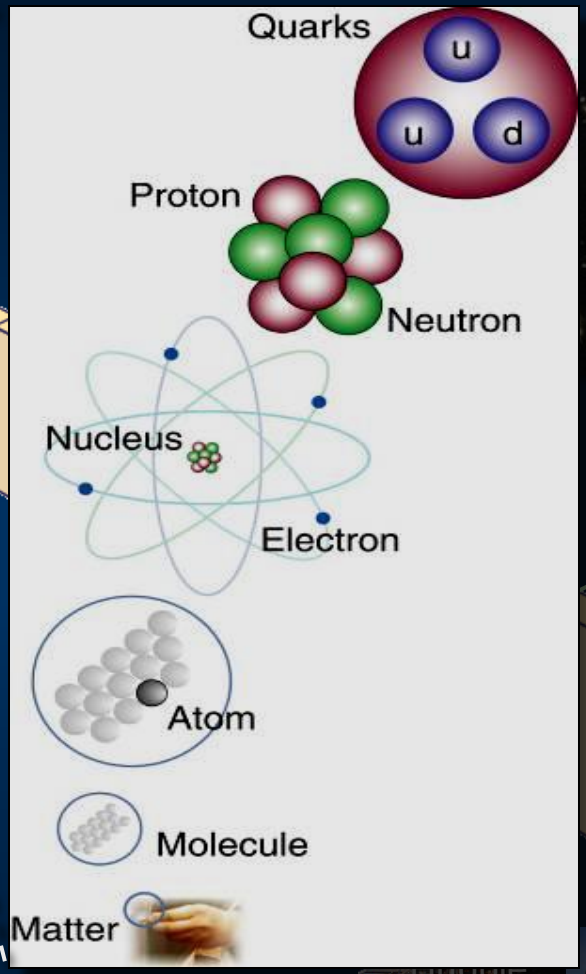
  Information technology…

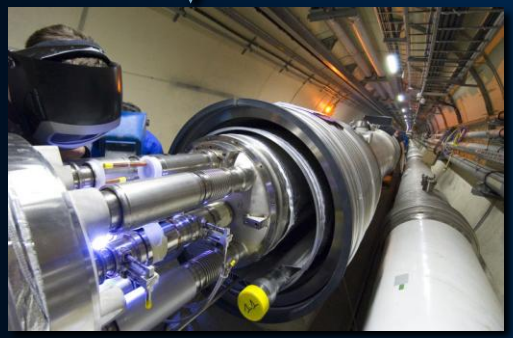
  Medicine - diagnosis and therapy…

- **Train** scientists and engineers of tomorrow

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

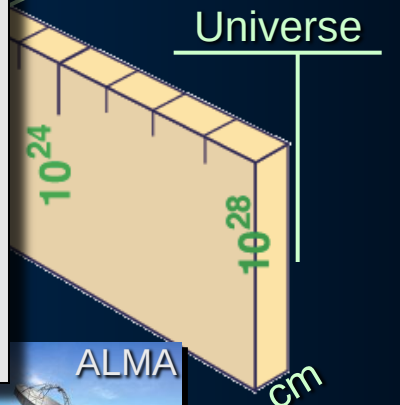


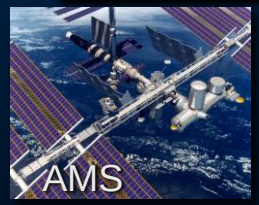




LHC

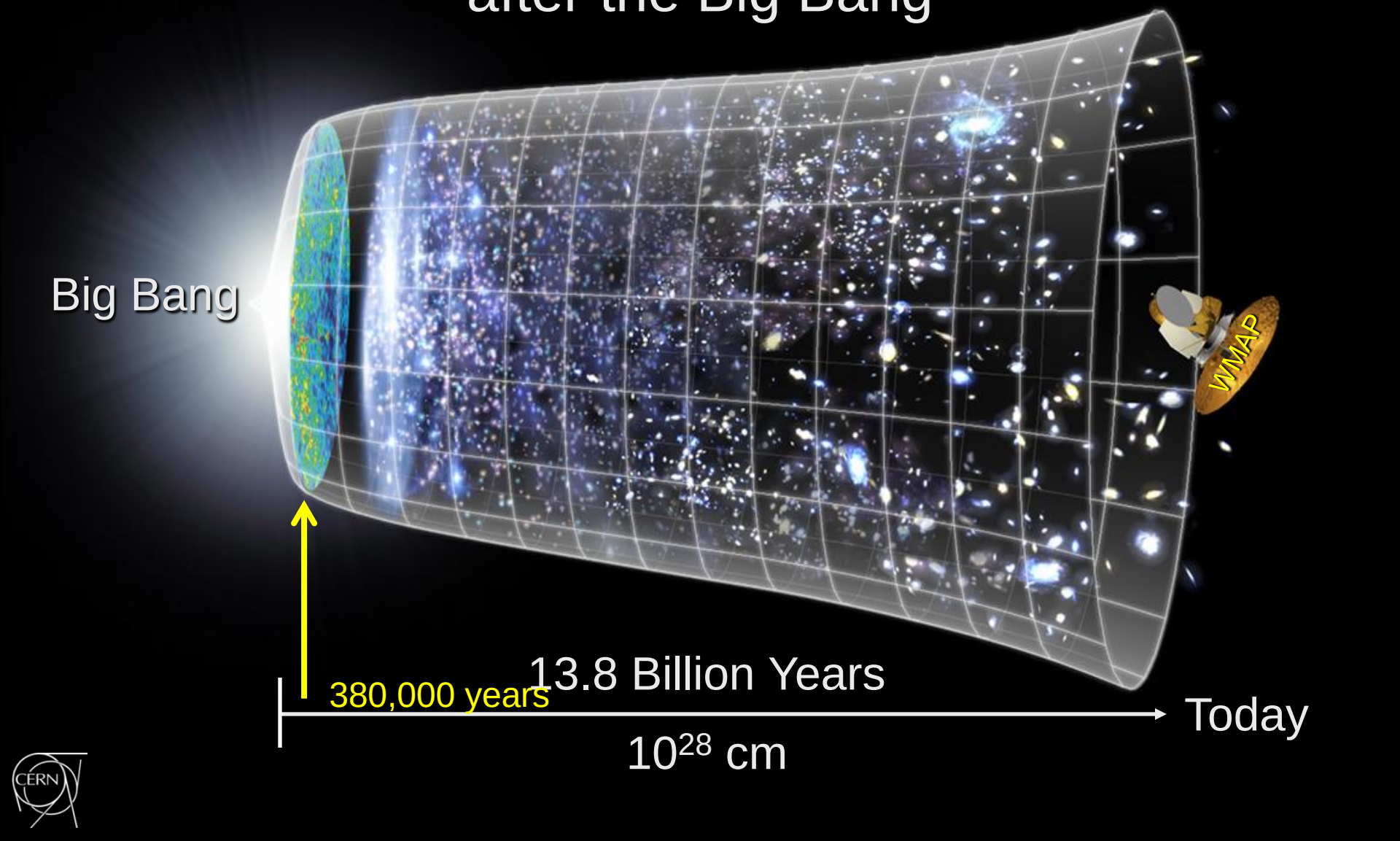
Super-Microscope





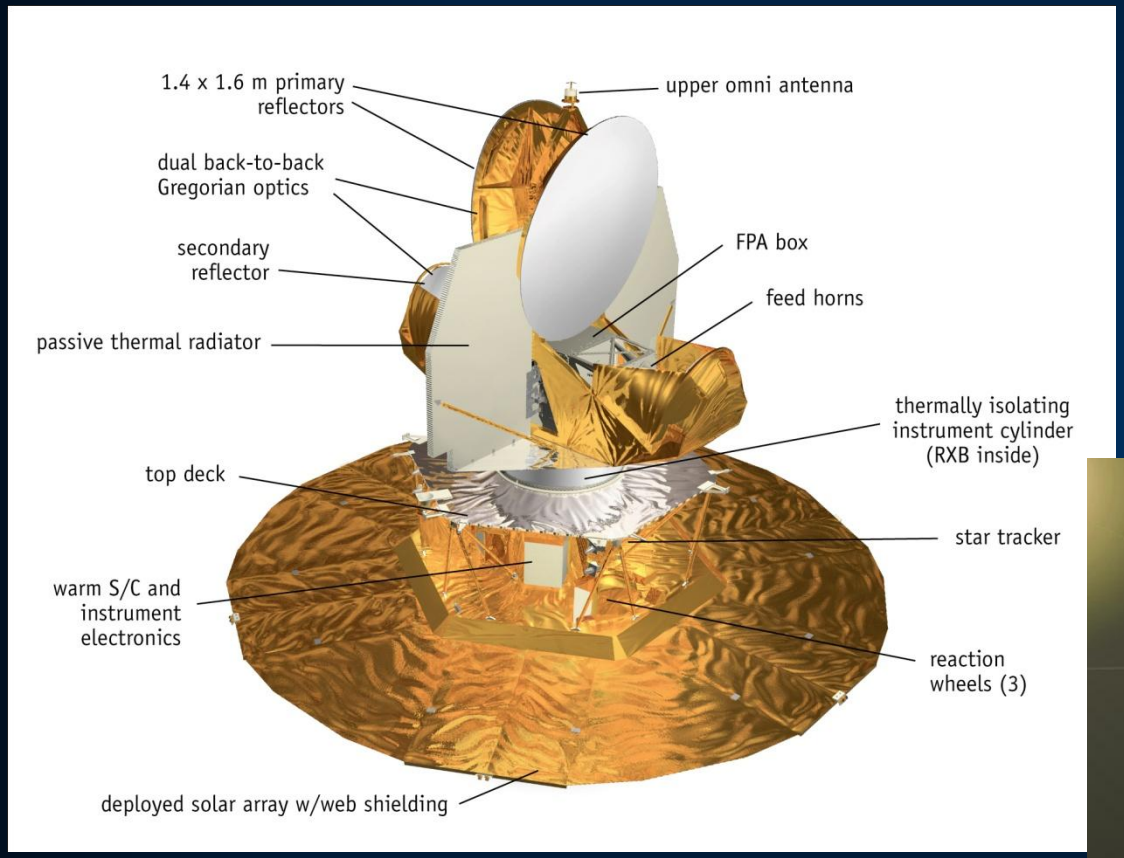
Study physics laws of first moments after Big Bang
increasing Symbiosis between Particle Physics,
Astrophysics and Cosmology

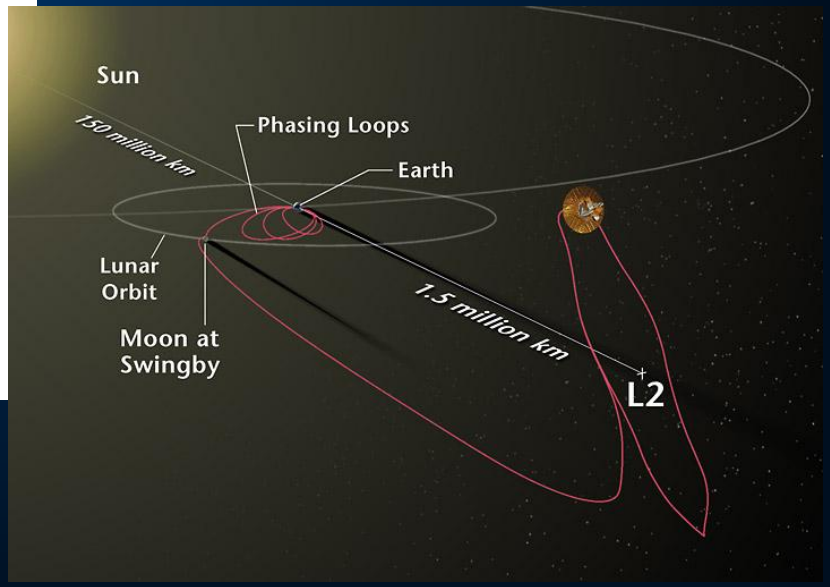
Next Scientific Challenge:
to understand the very first moments of our Universe after the Big Bang



WMAP

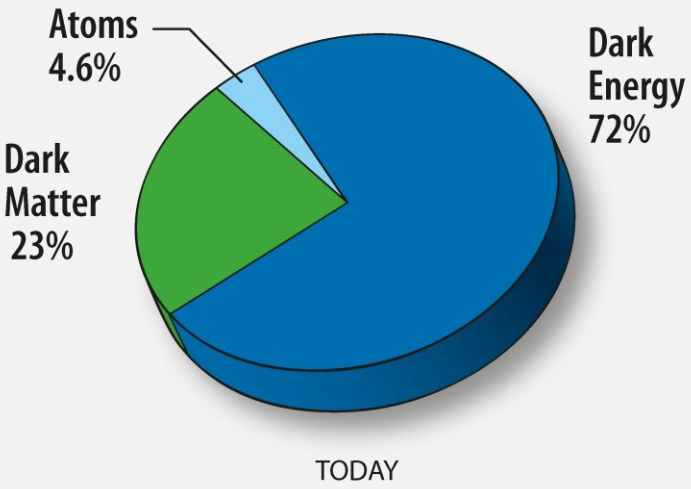
- Wilkinson Microwave Anisotropy Probe

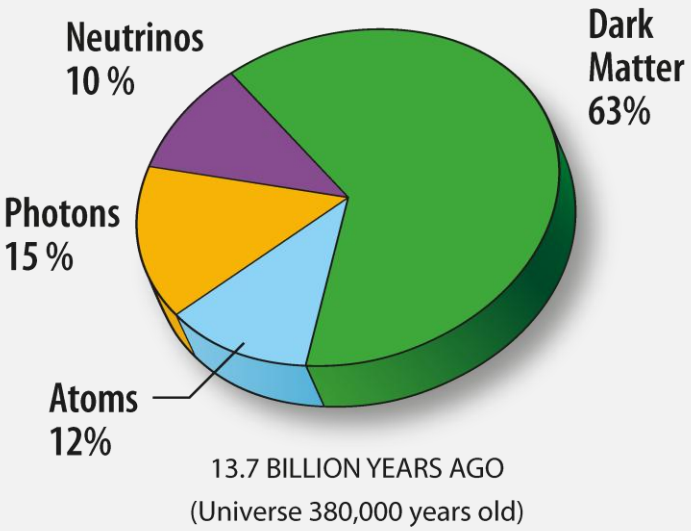




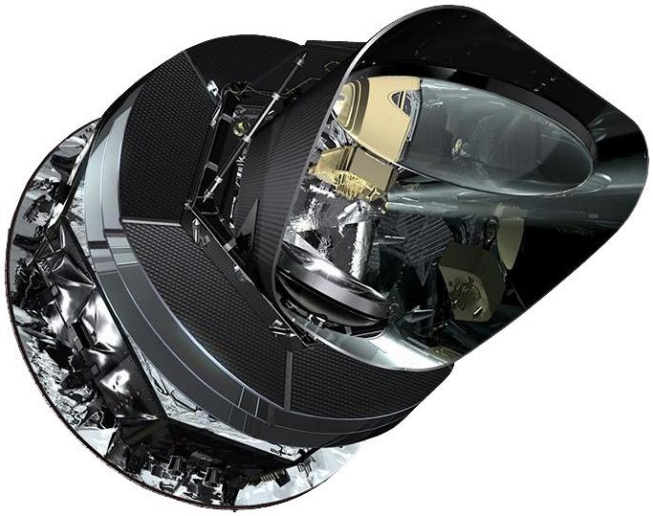
Composition of matter

- today 72% of matter of the Universe – dark energy
- before ~7 x 10^9 years the Universe accelerated its expansion
- 23% is (cold) dark matter, what is it?
- vacuum energy? scalar field? cosmological constant?





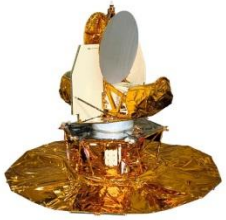
Planck satellite

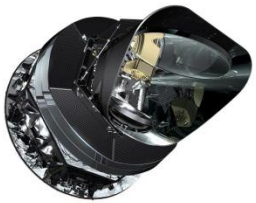


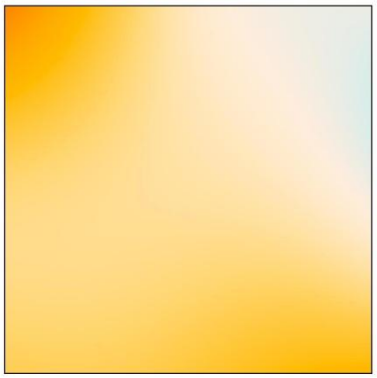
Porovnanie rozlíšania:

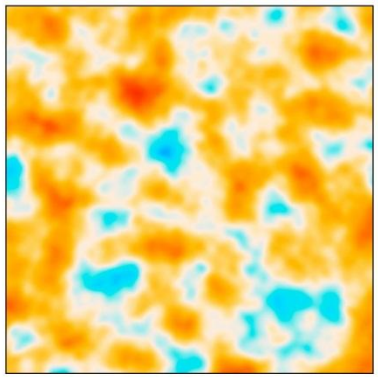
10 x lepšie rozlíšenie než WMAP

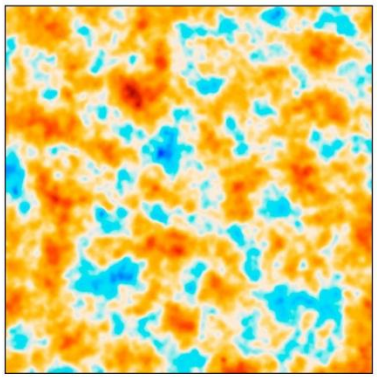
9 frequency band (WMAP 5)





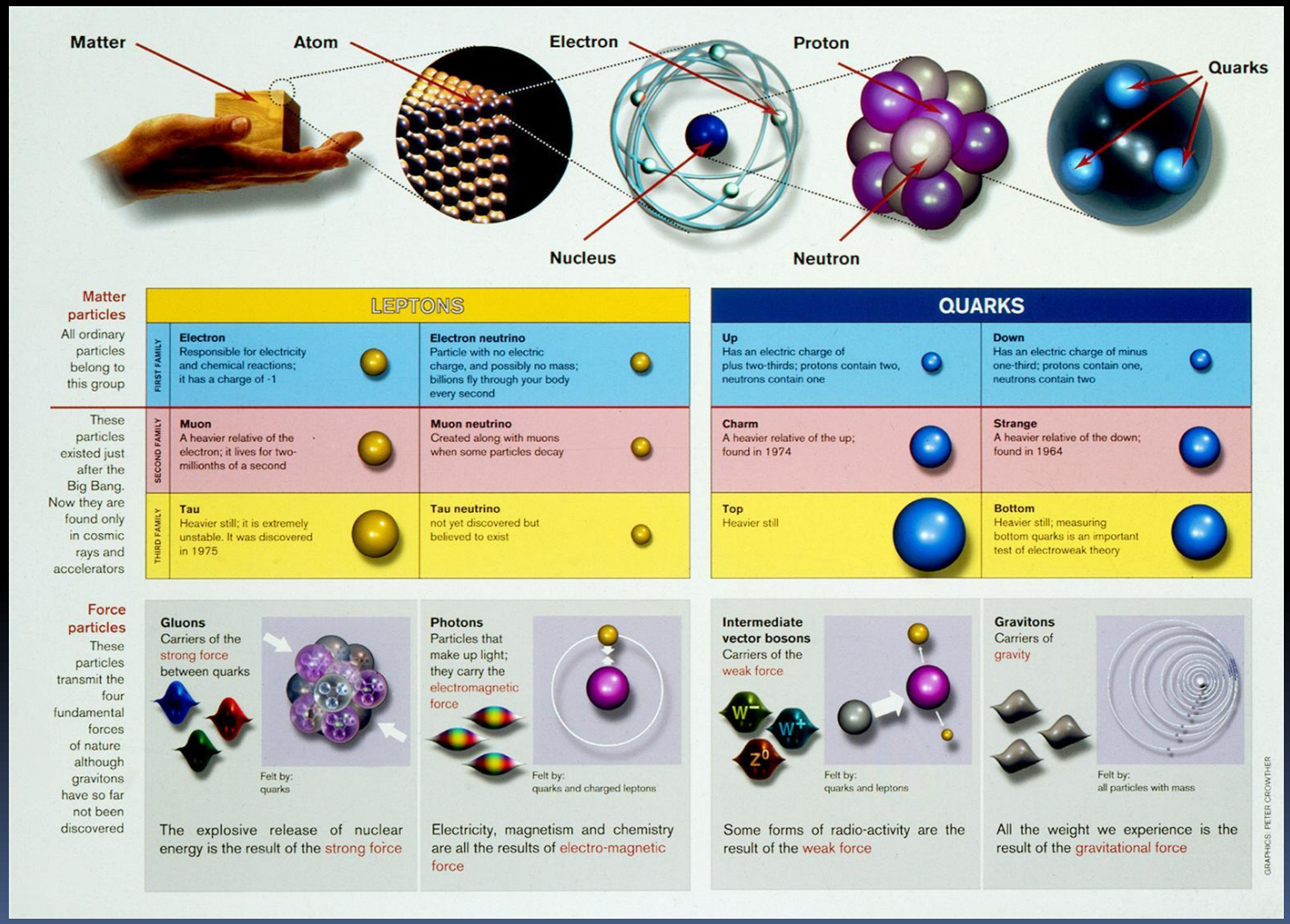






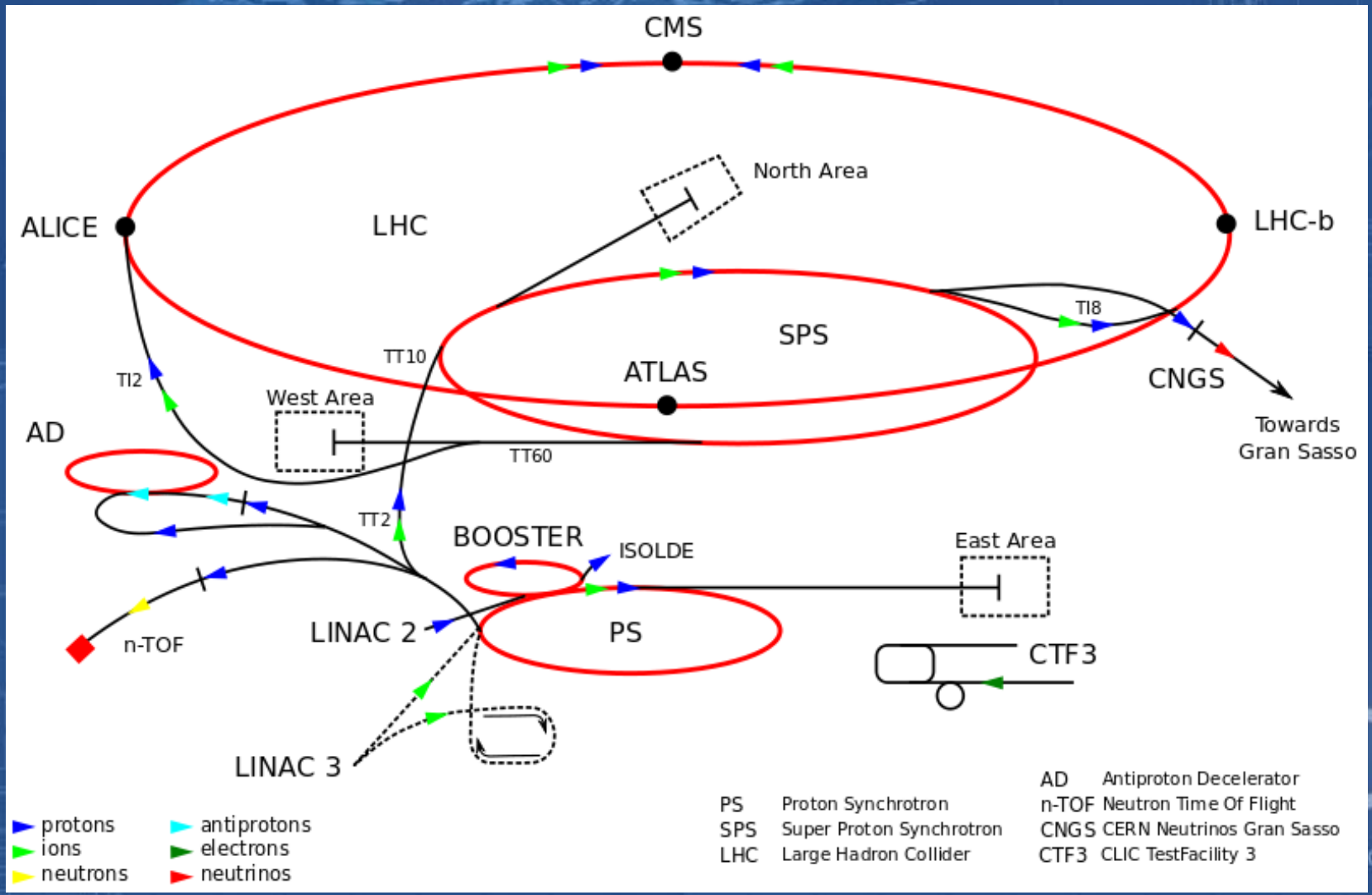
COBE WMAP Planck

Z čoho sa skladáme ?



CERN Accelerators

- CERN accelerator complex always reused as much as possible previously built machines in the injection chain



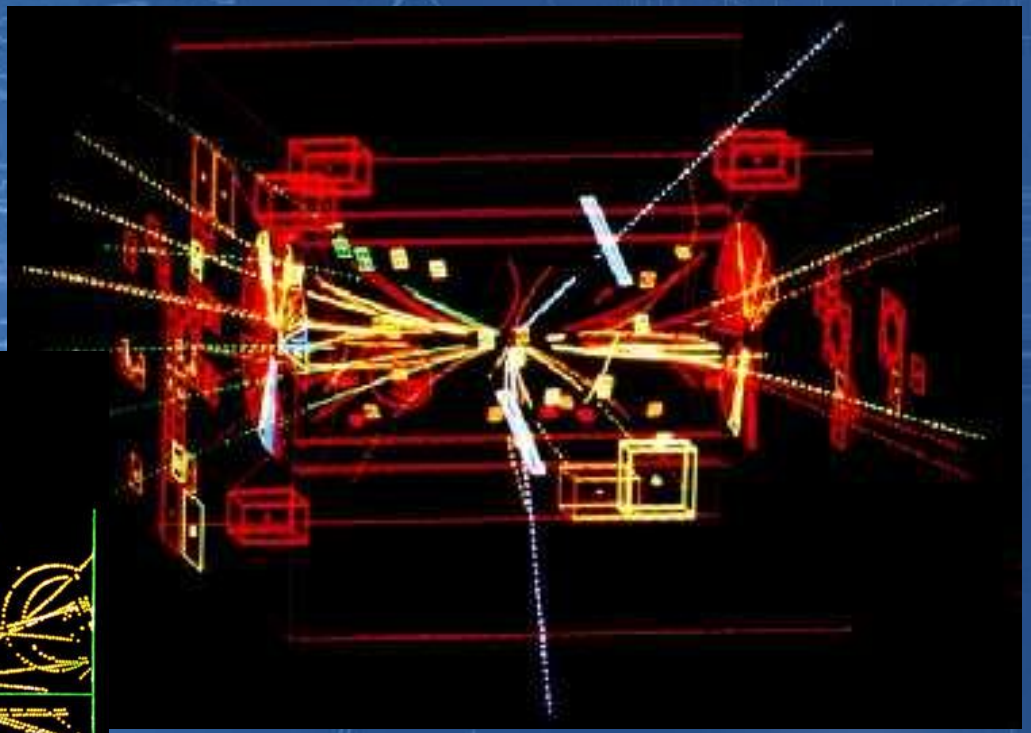
Neutral Currents

- Predicted as consequence of electro-weak unification
- Discovered in 1973 with Gargamelle bubble chamber exposed to ν_μ-beam from PS – neutrino scatters on electron without producing μ
- Indication for existence of Z boson

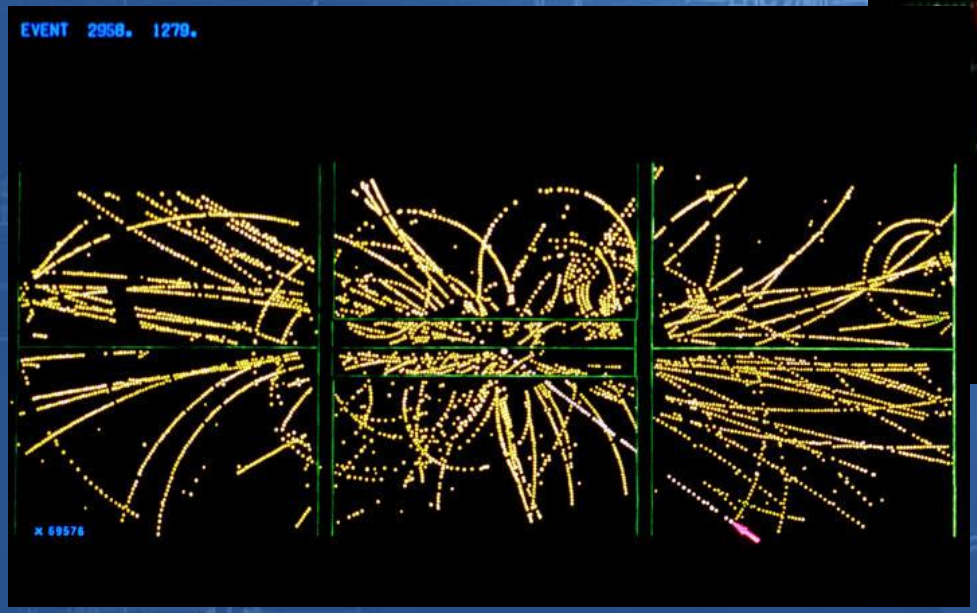
W and Z Bosons

- In 1983 discovery of W and Z bosons – the carriers of electro-weak interactions was announced by UA1 and UA2 experiments

UA1 Z-boson candidate

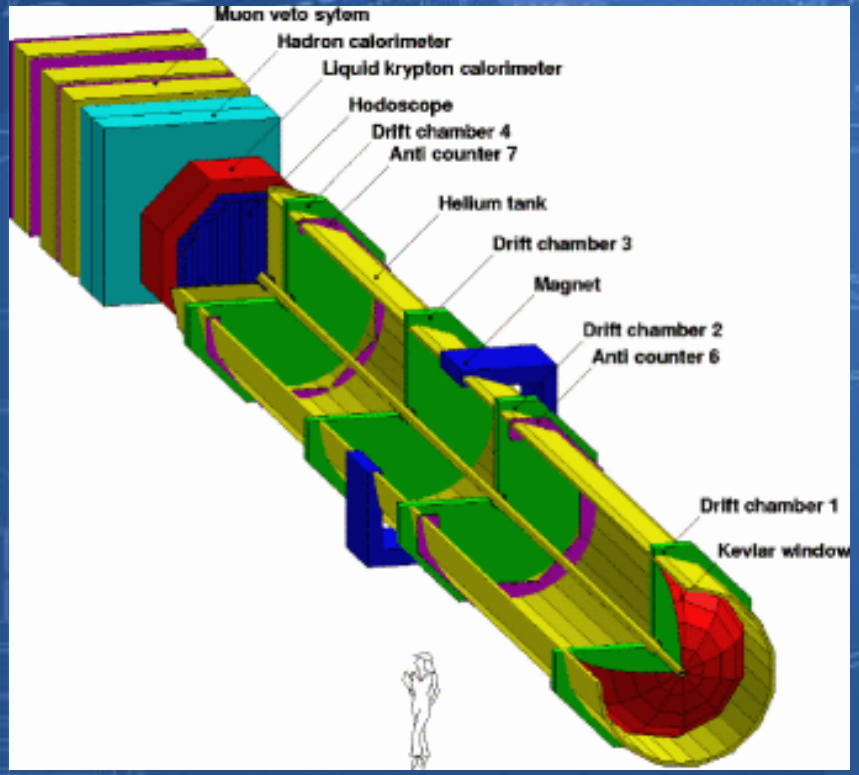


UA2 W-boson candidate



CP Violation

- Discovered in neutral kaon system in 1964
- In 1988 NA38 experiment at SPS evidence for direct CP violation
- Confirmed in 1999 by NA48 and KTeV at FermiLab
- Key to understand the asymmetry between matter and antimatter in early Universe

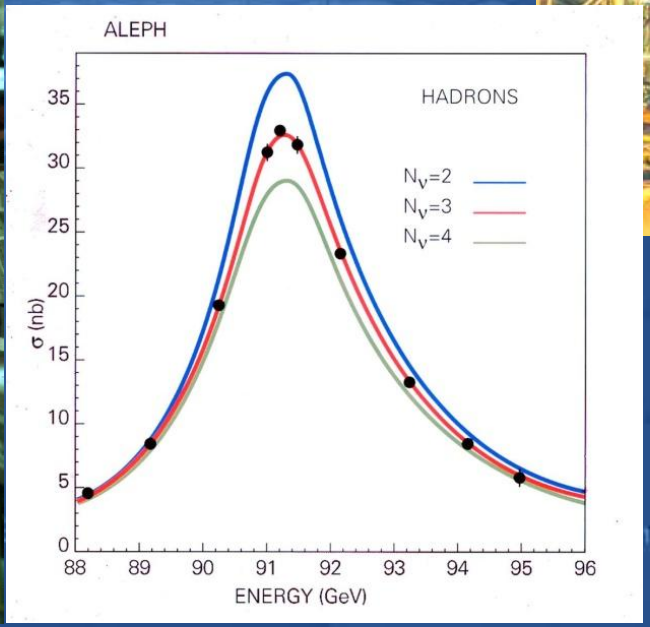


LEP

- Large Electron–Positron collider project approved in May 1981
- Built in 27 km tunnel between 1983 and 1988, commissioned in 1989
- Operated around 90 GeV, in second phase since 1995 topped at 209 GeV
- Closed down in 2000 to make way for LHC

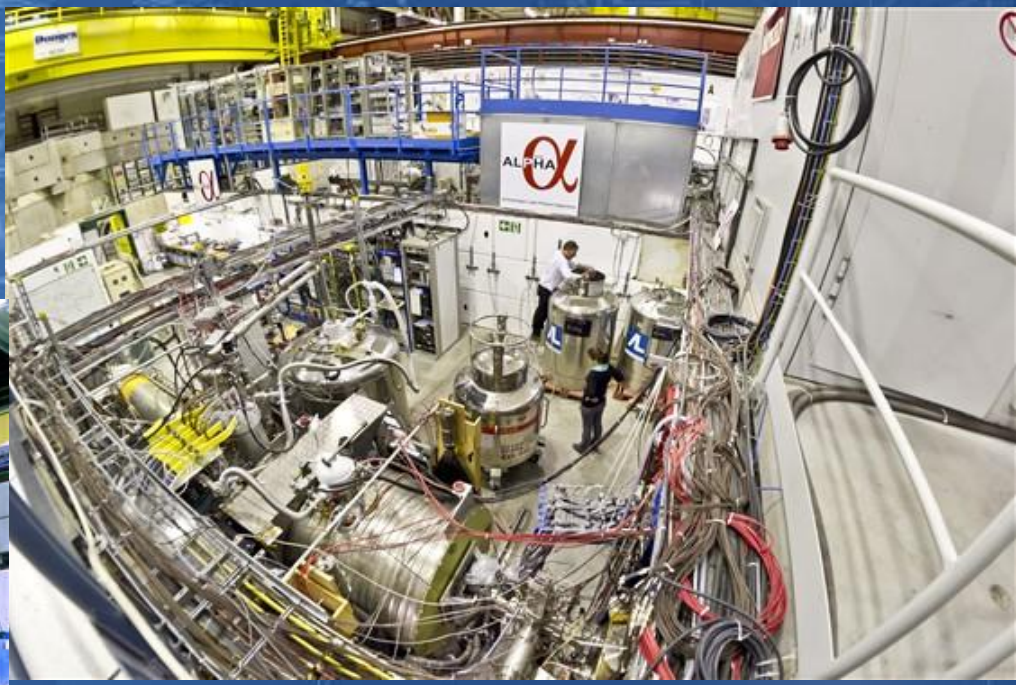
DELPHI

three generations



Antimatter

- In 1995 the first atoms of antihydrogen produced at LEAR in PS210
- ATHENA and ATRAP reported many antihydrogens in 2002
- In 2011 experiment ALPHA at AD captured antiatoms for more than 15’

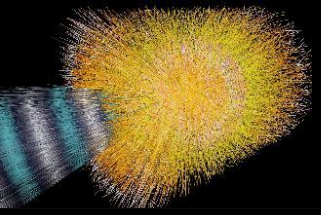


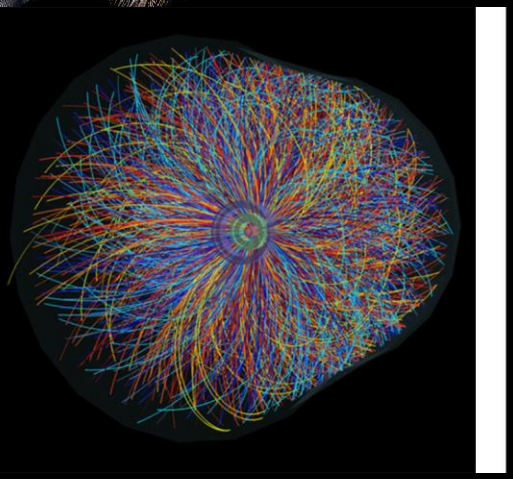
AMS – Alpha Magnetic Spectrometer

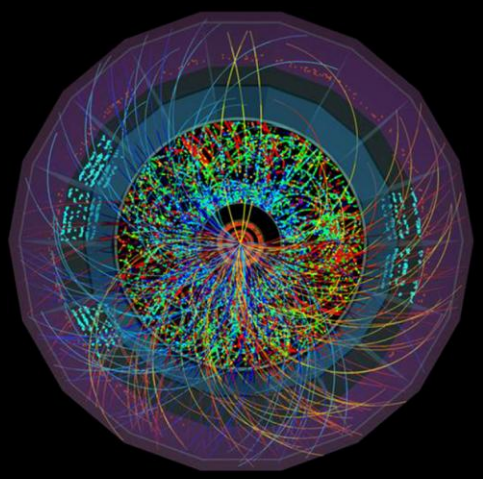
Experiment AMS potvrdil, že vidí signál, ktorý by mohol pochádzať od čiernej hmoty

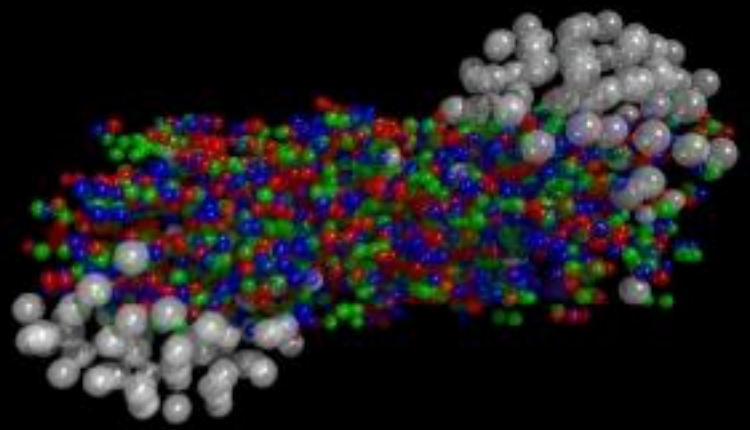
LHC ma potenciál tento jav zreprodukovať

Quark gluónová plazma







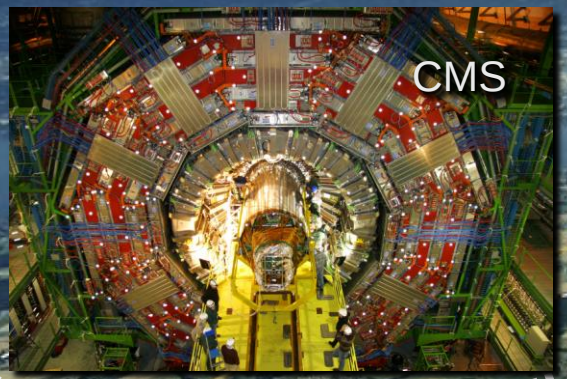


- Experimenty na SPS nepriamo ukázali, že existuje nová forma hmoty – quark gluónová plazma
- Vyrobili sme kvapku hmoty aká existovala niekoľko miliónтin sekundy po vzniku Vesmíru
- Experimenty na LHC potvrdili existenciu QGP priamo a začali skúmať jej vlastnosti

LHC

- Large Hadron Collider project – multiple staged approval since 1994
- Built in the former LEP 27 km tunnel between 2003 and 2008
- In the same period four main experiments installed
  - ALICE – specialized for heavy-ion collisions
  - ATLAS – general purpose pp experiment
  - CMS – general purpose pp experiment
  - LHCb – specialized experiment for beauty physics
- First proton beam circulated in LHC on September 10th 2008
- An incident due to faulty electrical connection interrupted commissioning
- Restarted one year later, first collisions on November 23rd 2009 at 0.9 TeV, till the end of that year increased to 2.3 TeV – new world record
- In 2010 pp collisions at 7 TeV, in the fall first PbPb collisions at 2.76 TeV/n
- In 2011 increase in luminosity, first high-lumunisity PbPb run
- Energy increase to 8 TeV in 2012, first pPb collisions, continued in 2013
- Till beginning of 2015 the first long shutdown to prepare further energy increase up to 13 TeV

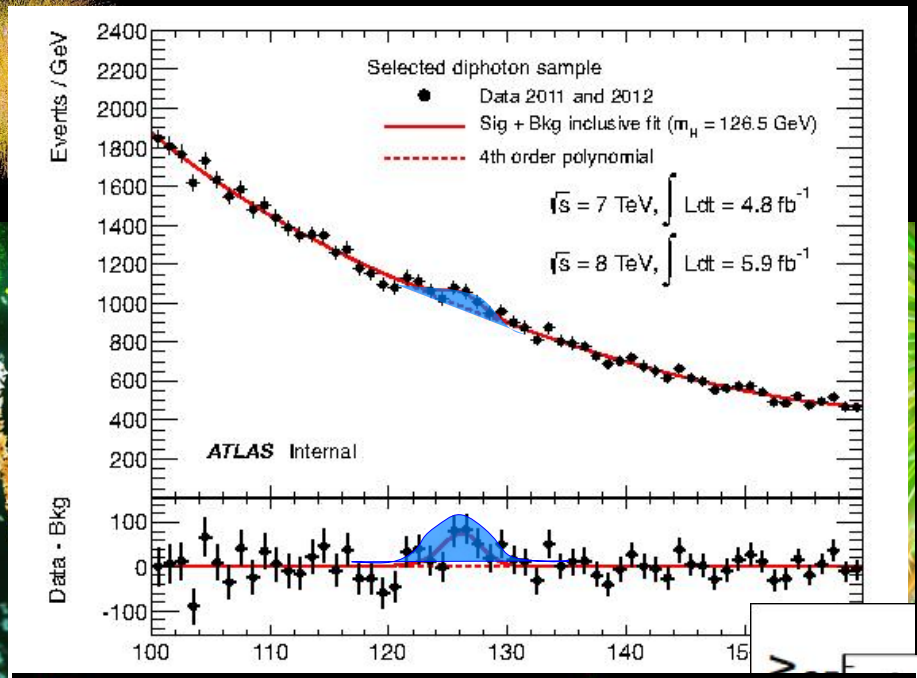
2010: a New Era in Fundamental Science

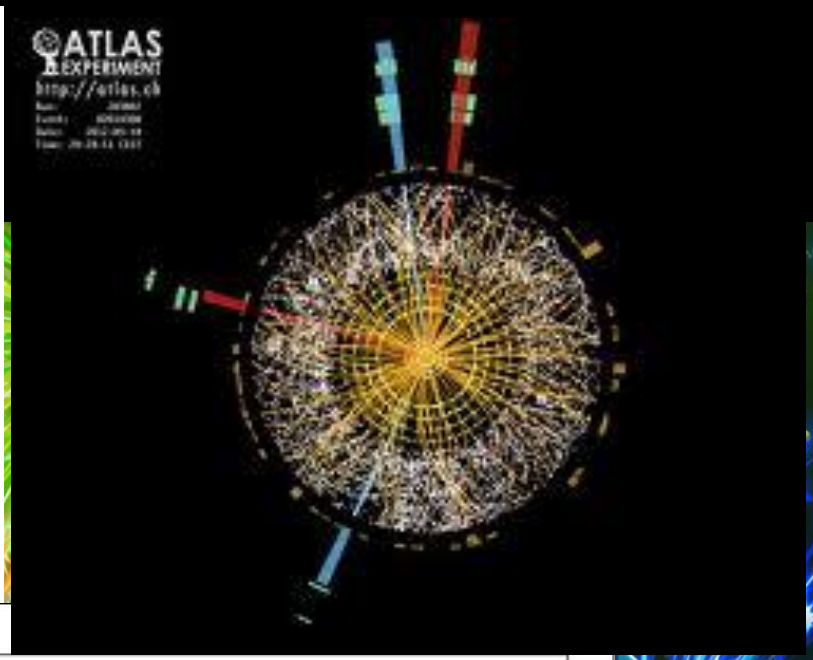


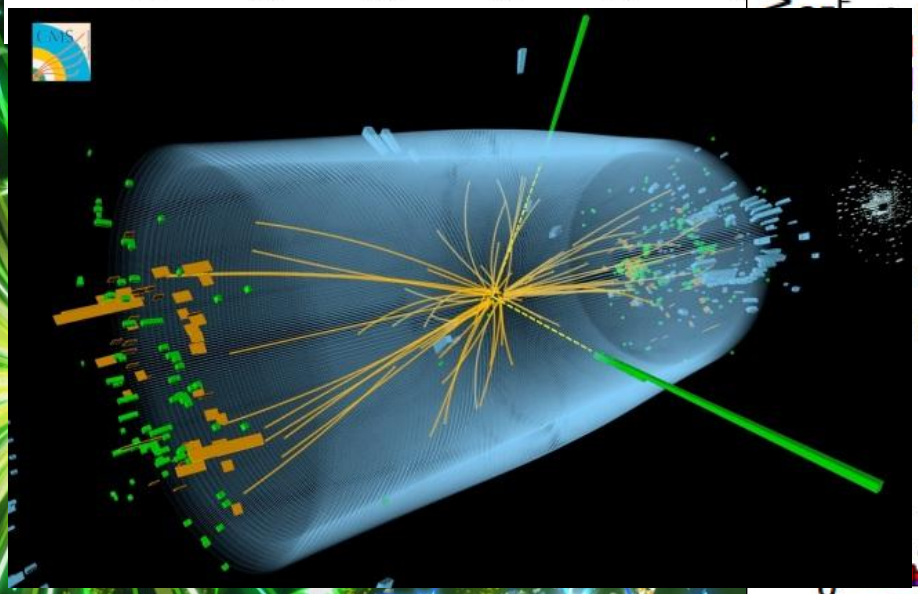
Exploration of a new energy frontier
in p-p and Pb-Pb collisions

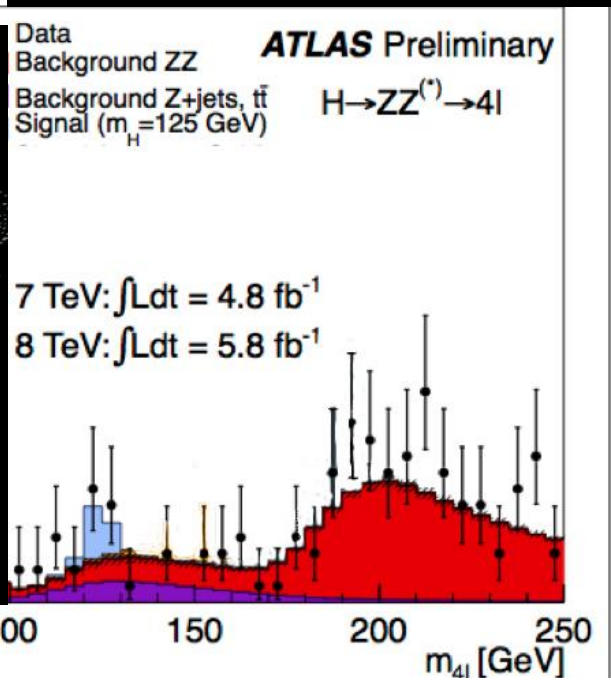
CERN

LHC









Experimenty ATLAS a CMS objavili novú časticu, vážiacu 126 GeV

Urýchľovače nie sú iba pre fyziku

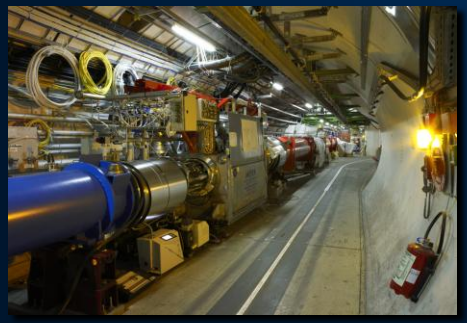
- Urýchľovače sa bežne využívajú mimo fyziky
- Vo svete je 17000 urýchľovačov z toho iba 100 slúži na výskum
- Využitie urýchľovačov
  - Výroba polovodičových obvodov
  - Výroba radiofarmák, terapia nádorov, medicínska diagnostika
  - Analýza štruktúr proteínov vo farmácii, výskum DNA
  - Likvidácia jadrových odpadov
  - ...

Innovation
Education
CERN
uniting people
Research

CERN: Particle Physics and Innovation

- Interfacing between fundamental science and key technological developments

- CERN Technologies and Innovation



Accelerating particle beams

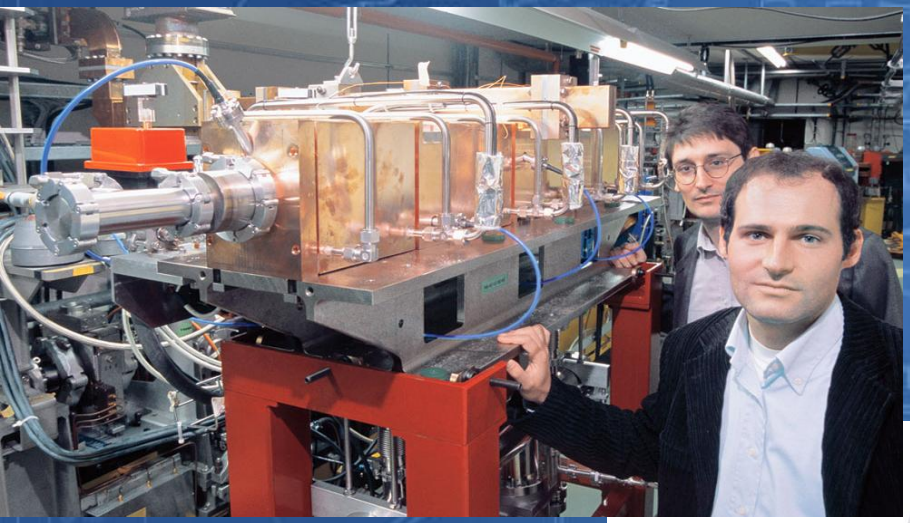
Detecting particles

Large-scale computing (Grid)

CERN

New Technologies

- Many examples of technological developments successfully transferred to society
- Medical applications: PET scanners, hadron therapy, diagnostic detection
- Computing technologies: World Wide Web, GRID



Slovakia and CERN

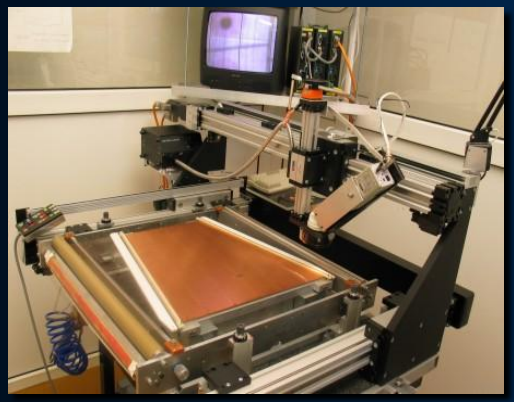
- Slovakia became CERN Member State in 1993
- Today research in particle physics is carried out mainly at 4 Institutes:
  - Comenius University Bratislava
  - Institute of Experimental Physics of the Slovak Academy of Sciences, Košice
  - Institute of Physics of the Slovak Academy of Science, Bratislava
  - Šafárik University Košice

Concentrated effort to participate in the LHC experiments ALICE and ATLAS:
Total 31 members from
Comenius University and
Institute of Experimental Physics of the Slovak Academy of Sciences, Košice

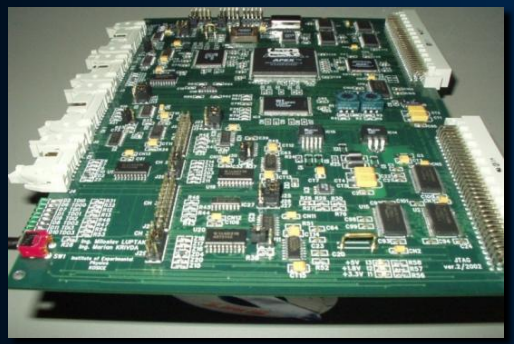
Slovakia and CERN

Contributions to ALICE

16 members



TPC: Bratislava
Production and test of 26 readout chambers at Bratislava Detector Laboratory

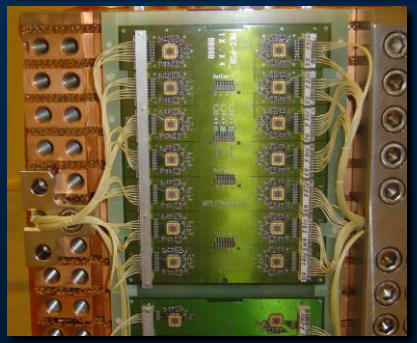


Pixel detector:
Košice
Electronics for readout

Contributions to ATLAS

15 members

Tile calorimeter:
Bratislava
Iron tiles produced in Dubnica



Electronics cards for LAr endcap calorimeter:
Košice

Lifting devices for calorimeter modules produced in Prešov

Slovakia and CERN

Contributions to LHC project from Industry in Slovakia

Blue cryostat for LHC dipoles produced at SES (Slovenské energetické strojárne, Tlmače)

Robots carry LHC magnets and align them with magnet support jacks made by ZŤS (Závody ťažkého strojárenstva, Košice)

LHC award to ZTS

KAŽDÁ LÁSKA ZAČÍNA VEĽKÝM TRESKOM

Ryba
MORE ZDRAVIA