Welcome to CERN!

- Conference will start shortly
- Switch off camera and microphone
- Open the *chat* tool (down-right)

Your virtual conference

Format

- Presentation (40 minutes in total)
- Questions and answers (20 minutes in total)

During presentation

- Ask questions using the chat
- Use microphone or camera only if needed

After presentation

- Please fill out survey on Indico page
- Material and links available on Indico page

Despina Hatzifotiadou

First Researcher at
INFN Bologna, Italy
and CERN EP Department

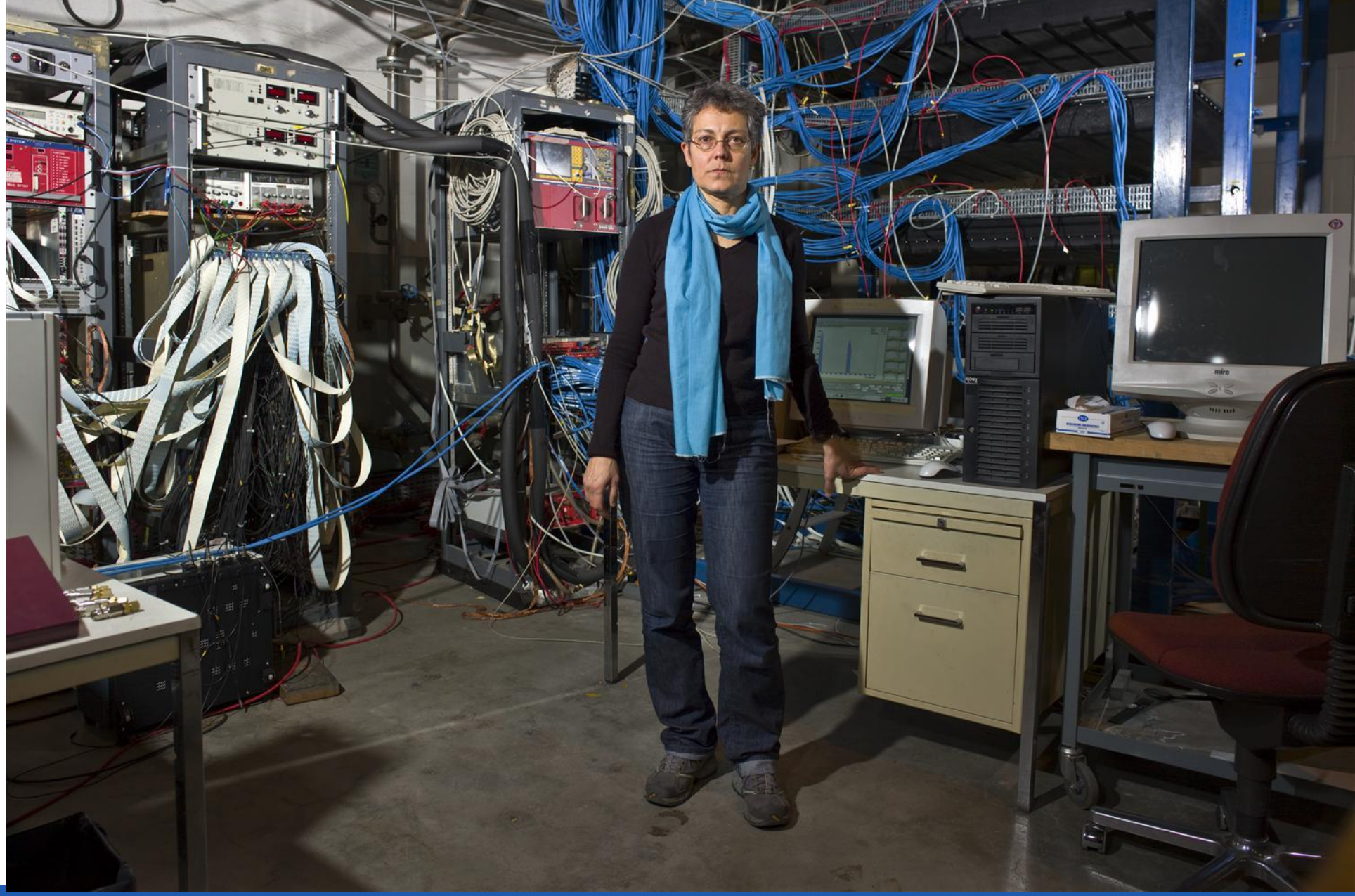
Outreach Coordinator
ALICE experiment

studies:

Physics Department, Aristotle University (AUTH)
of Thessaloniki, Greece

PhD at AUTH (PS182 experiment@CERN)

despina.hatzifotiadou@cern.ch



What does *CERN* stand for ?

What does *CERN* stand for ?

Organisation
Européenne pour la
Recherche
Nucléaire

European
Organization for
Nuclear
Research

1954

Nuclear?

European laboratory for particle physics

Member States

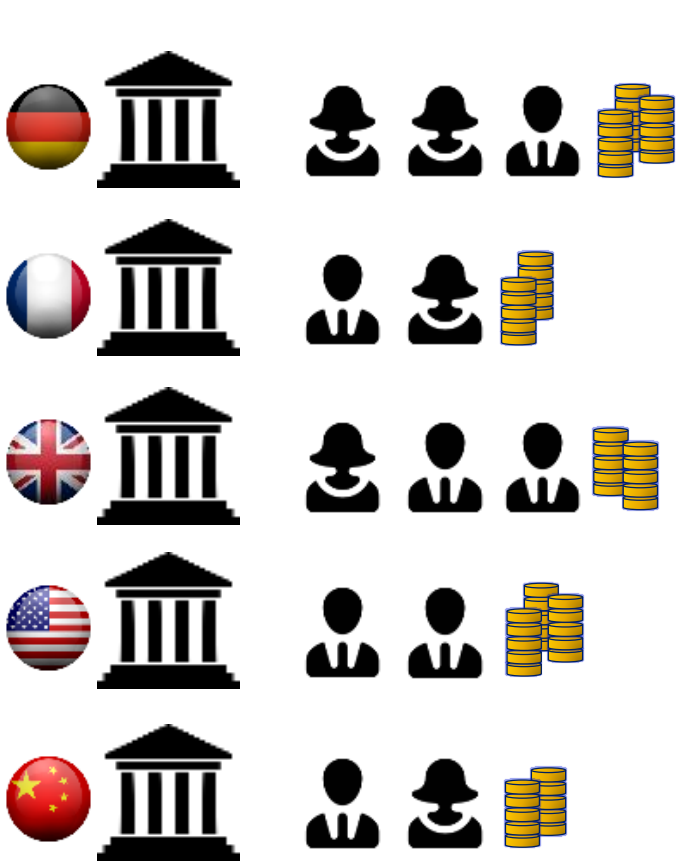
Budget (2020)
1,168 billion CHF
0,970 billion GBP
1,210 billion USD

Austria (1959)
Belgium (1953)
Bulgaria (1999)
Czech Republic (1993)
Denmark (1953)
Finland (1991)
France (1953)
Germany (1953)
Greece (1953)
Hungary (1992)
Israel (2014)
Italy (1953)
Netherlands (1953)
Norway (1953)
Poland (1991)
Portugal (1986)
Romania (2016)
Serbia (2019)
Slovakia (1993)
Spain (1961-1968, 1983-)
Sweden (1953)
Switzerland (1953)
United Kingdom (1953)

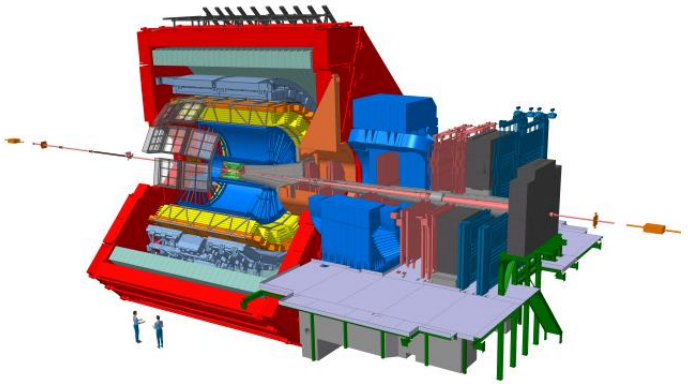
Associated

Croatia (2019)
Cyprus (2016)
India (2017)
Lithuania (2018)
Pakistan (2015)
Slovenia (2017)
Turkey (2015)
Ukraine (2016)

Collaborations



ALICE



The ALICE Collaboration consists of

- 39 countries
- 174 institutes
- 1927 members

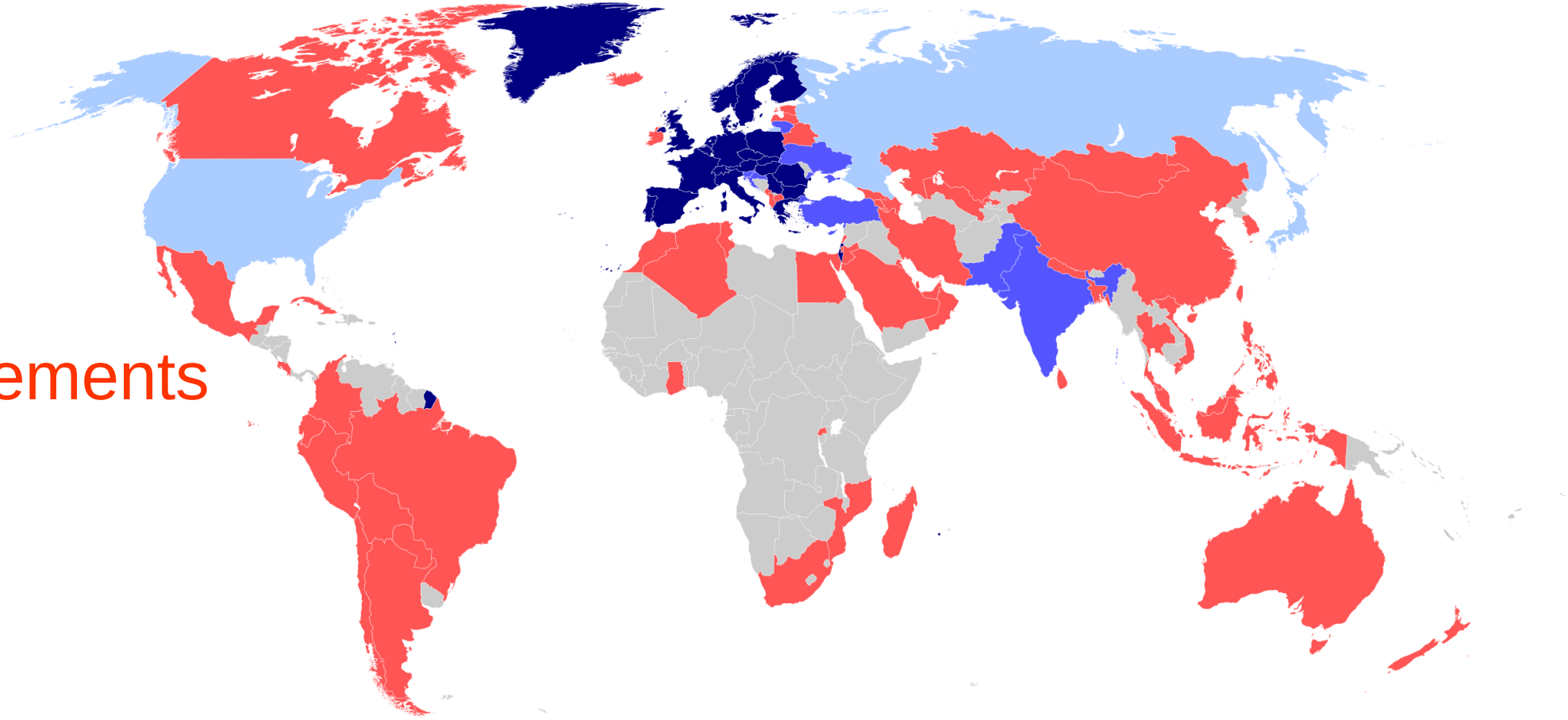
A world collaboration

23 members

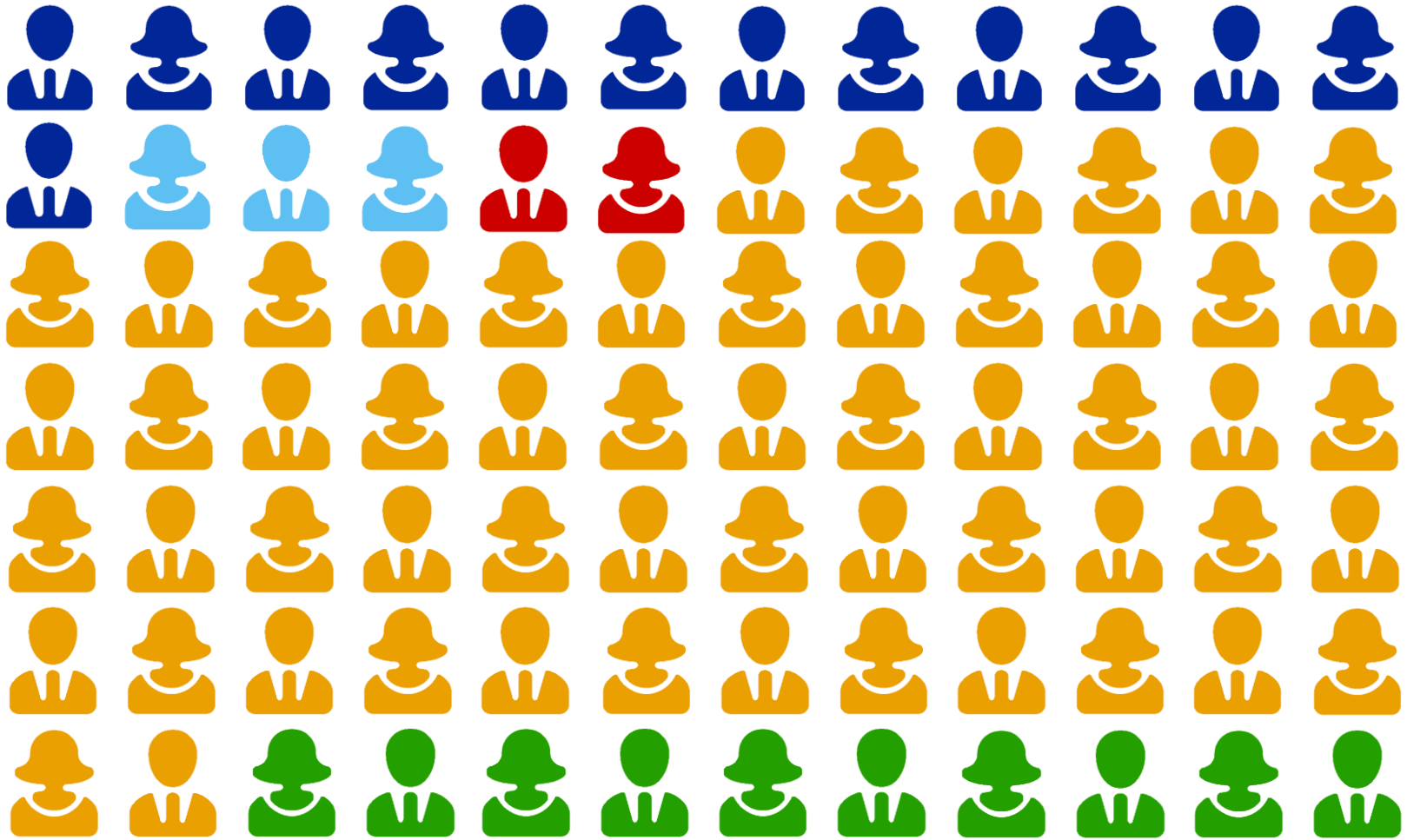
8 associated

3 observers

61 with agreements



How many persons?



20 000!

2 600 staff

800 fellows
apprentices

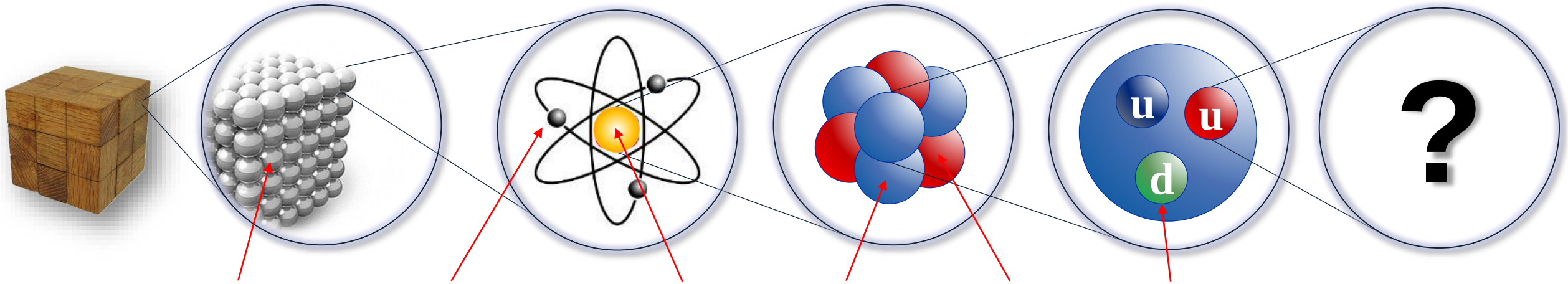
550 students

15 000 users

2 000 external
companies

Fundamental research

What is matter made of



atom — 4th - 5th BCE

electron — End of 19th century

nucleus — End of 19th century

proton — Begining of 20th century

neutron — Begining of 20th century

quark — 1960s

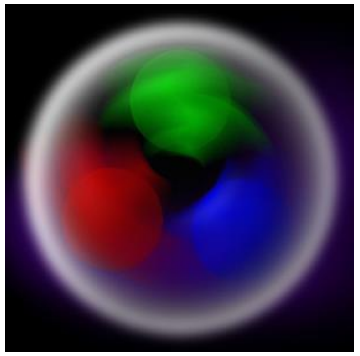
Standard model

Images: www.particlezoo.net

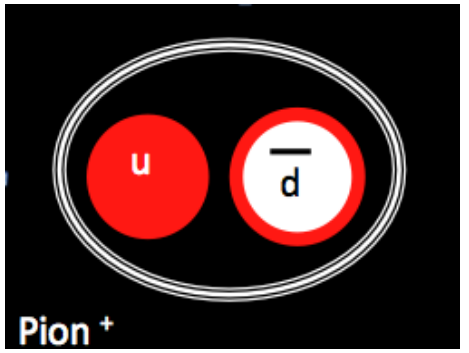
	LEPTONS		QUARKS	
Ordinary matter	**ELECTRON** 	**ELECTRON NEUTRINO** 	**UP** 	**DOWN** 
	MUON 	**MUON NEUTRINO** 	**CHARM** 	**STRANGE** 
	TAU 	**TAU NEUTRINO** 	**TOP** 	**BOTTOM** 

GLUONS	PHOTONS	BOSONS	GRAVITONS
			
Strong force	*Electromagnetic force*	*Weak force*	*Gravity*

Quark Confinement : Quarks can not exist free. We find them confined inside hadrons



Baryons
Made of 3 quarks

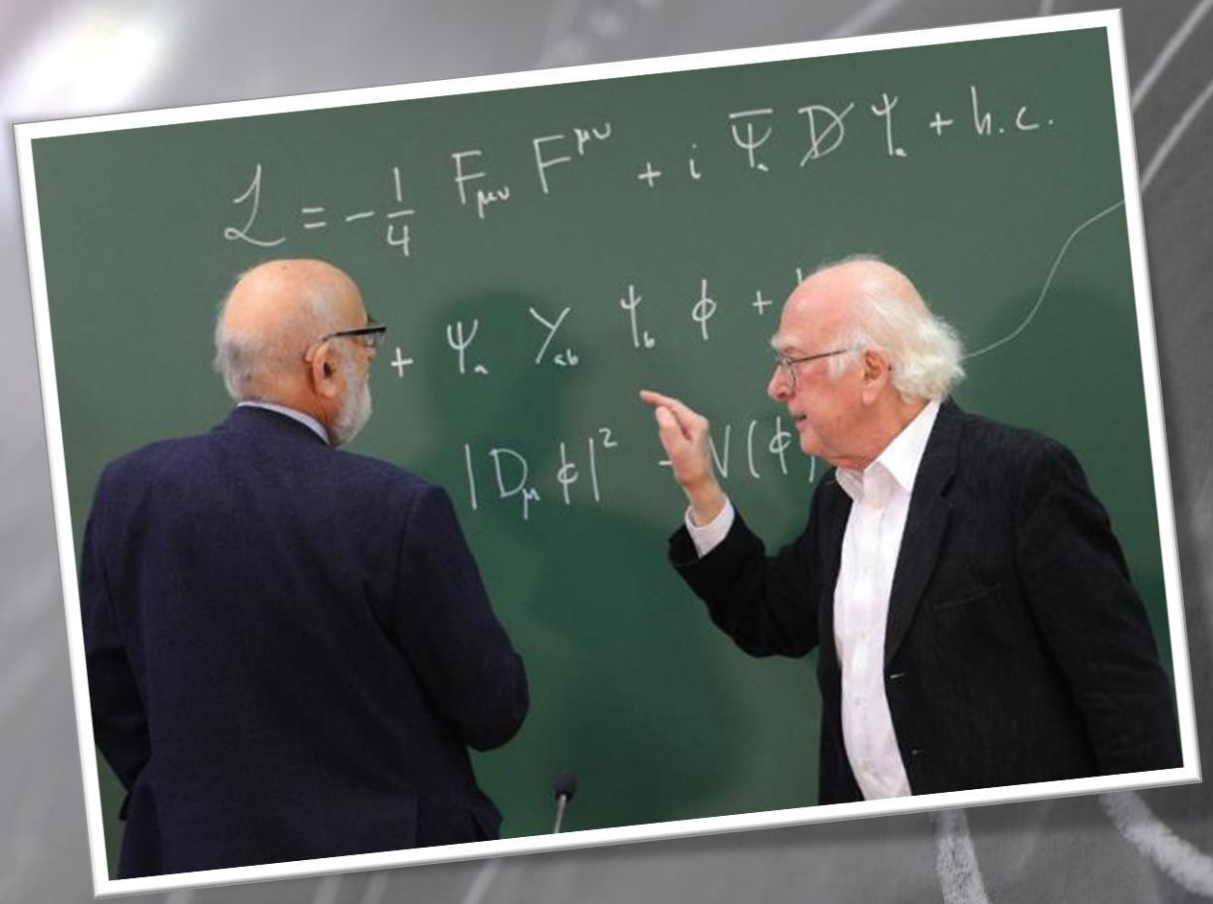


Mesons
Made of a quark-antiquark pair

Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$ Baryons are fermionic hadrons. These are a few of the many types of baryons.					
Symbol	Name	Quark content	Electric charge	Mass GeV/c^2	Spin
p	proton	**uud**	1	0.938	1/2
$\bar{\mathbf{p}}$	antiproton	$\bar{\mathbf{u}}\bar{\mathbf{u}}\bar{\mathbf{d}}$	–1	0.938	1/2
n	neutron	**udd**	0	0.940	1/2
Λ	lambda	**uds**	0	1.116	1/2
Ω^-	omega	**sss**	–1	1.672	3/2

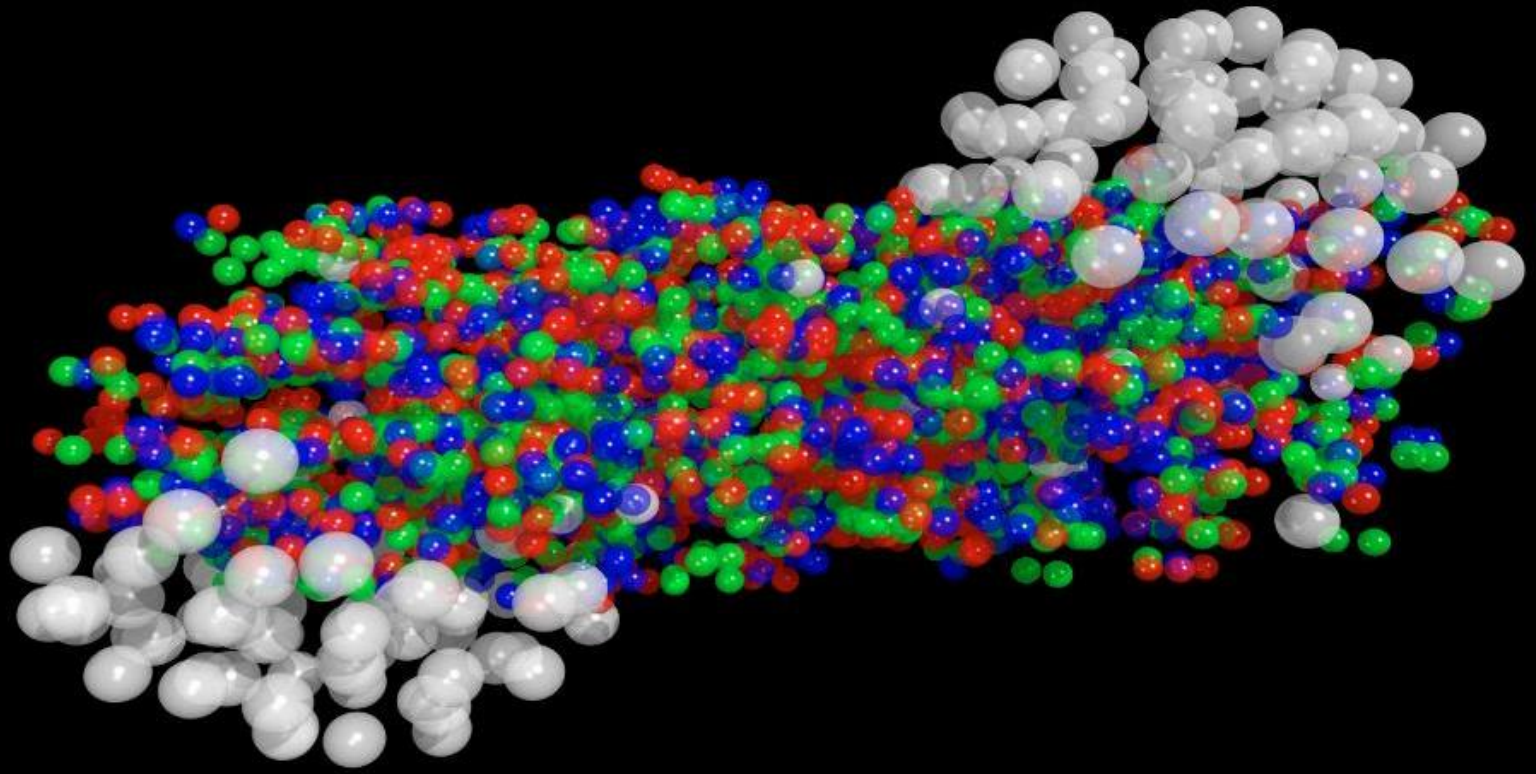
Mesons $q\bar{q}$ Mesons are bosonic hadrons These are a few of the many types of mesons.					
Symbol	Name	Quark content	Electric charge	Mass GeV/c^2	Spin
π^+	pion	$\mathbf{u\bar{d}}$	+1	0.140	0
$\mathbf{K^-}$	kaon	$\mathbf{s\bar{u}}$	–1	0.494	0
ρ^+	rho	$\mathbf{u\bar{d}}$	+1	0.776	1
B^0	B-zero	$\mathbf{d\bar{b}}$	0	5.279	0
η_c	eta-c	$\mathbf{c\bar{c}}$	0	2.980	0

Answering questions…



The Higgs boson

Answering questions …

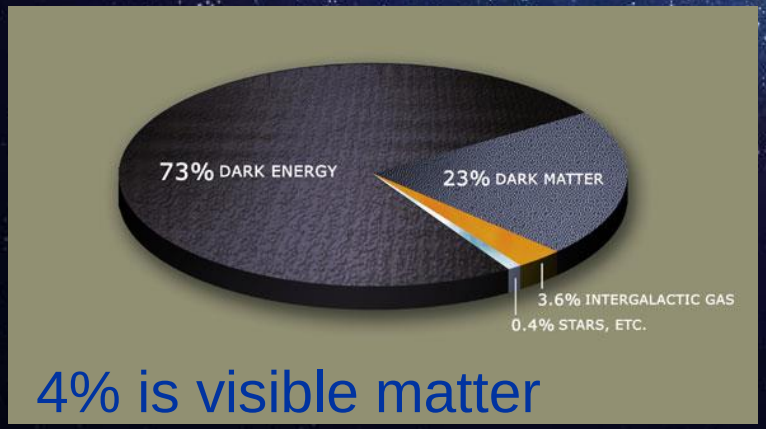


Quark gluon plasma?

Answering questions…

Antimatter ?

Answering questions…



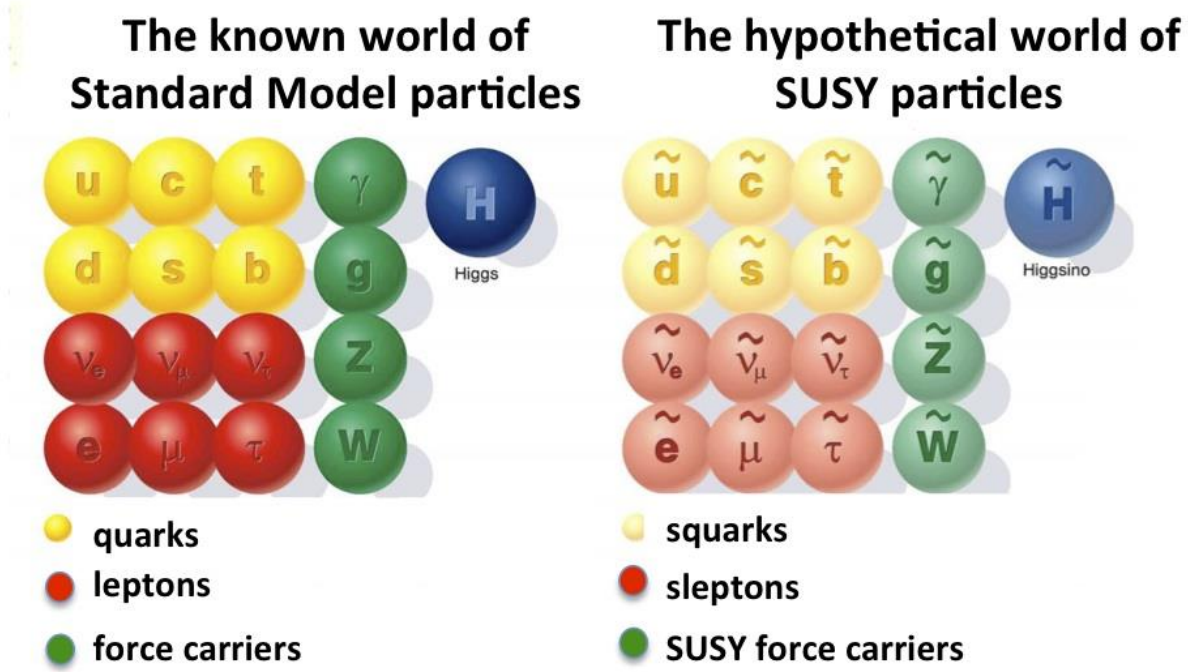
4% is visible matter

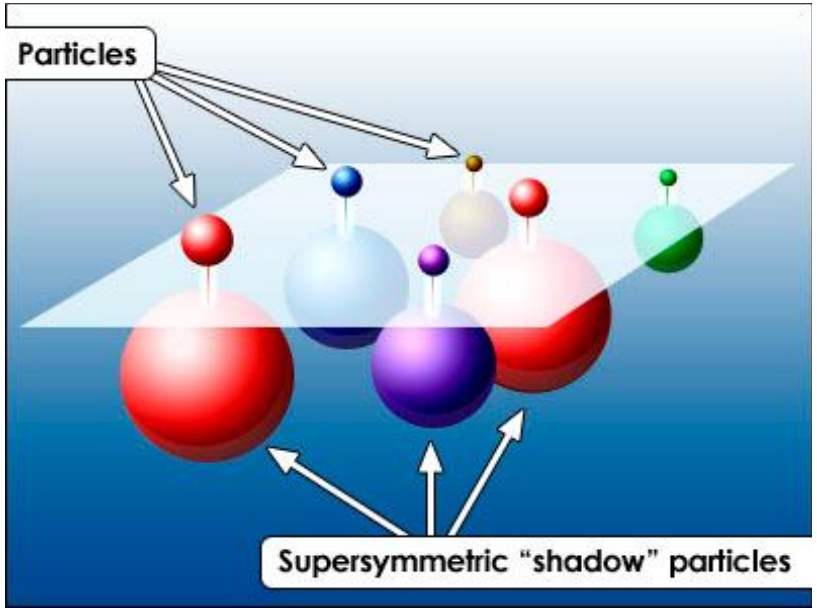
Dark matter?

SUperSYmmetry (SUSY)?

Symmetry between matter (elementary particles -> fermions) and forces (force carriers -> bosons)

To unify the forces
To solve problems in the Standard Model (deviations in the Higgs mass)





Every particle with spin s has its supersymmetric partner with spin s-1/2

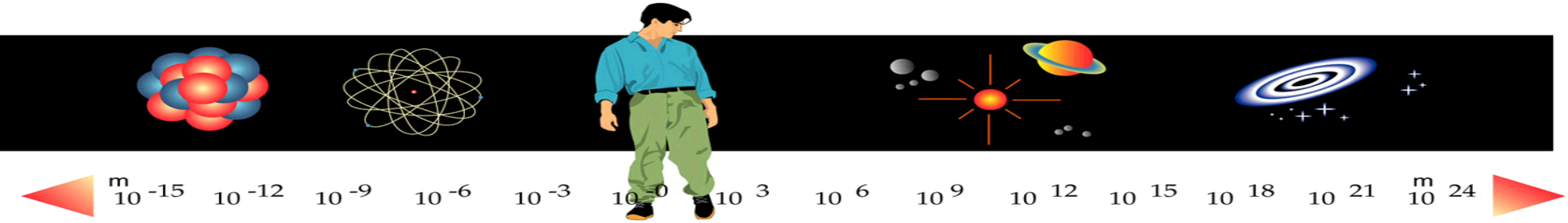
Quark (s=1/2) -> squark (s=0)
Gluon (s=1) -> gluino (s=1/2)

La physique des particules étudie la matière dans ses dimensions les plus petites.

Particle physics looks at matter in its smallest dimensions.

L'astrophysique étudie la matière dans ses dimensions les plus grandes.

Astrophysics looks at matter in its largest dimensions.



m
10^{-15} 10^{-12} 10^{-9} 10^{-6} 10^{-3} 10^{0} 10^{3} 10^{6} 10^{9} 10^{12} 10^{15} 10^{18} 10^{21} m 10^{24}

Microscopes
Microscopes

Jumelles
Binoculars

Telescopes optiques & radio
Optical & radio telescopes

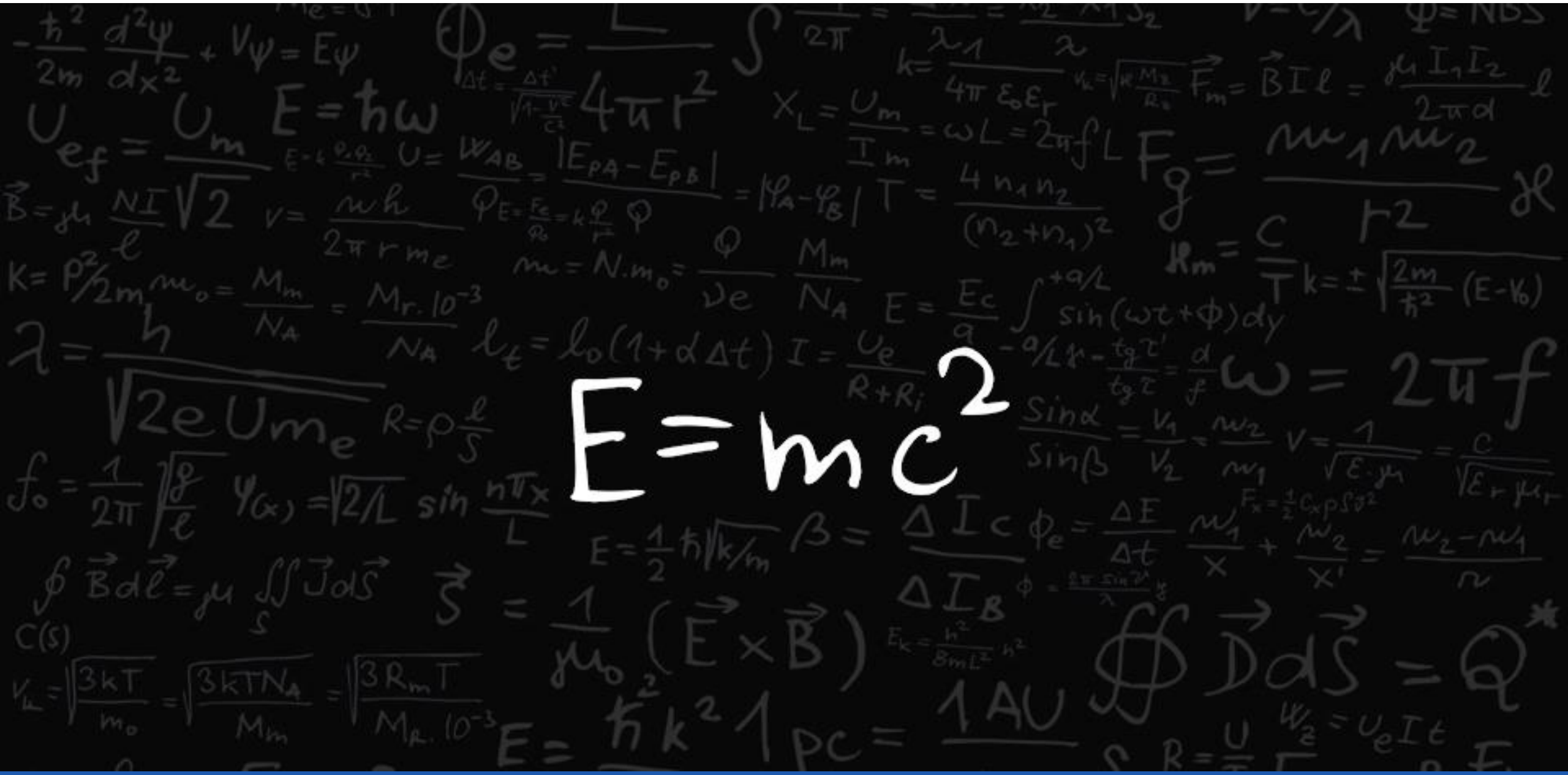
et détecteurs
Accelerators
and detectors

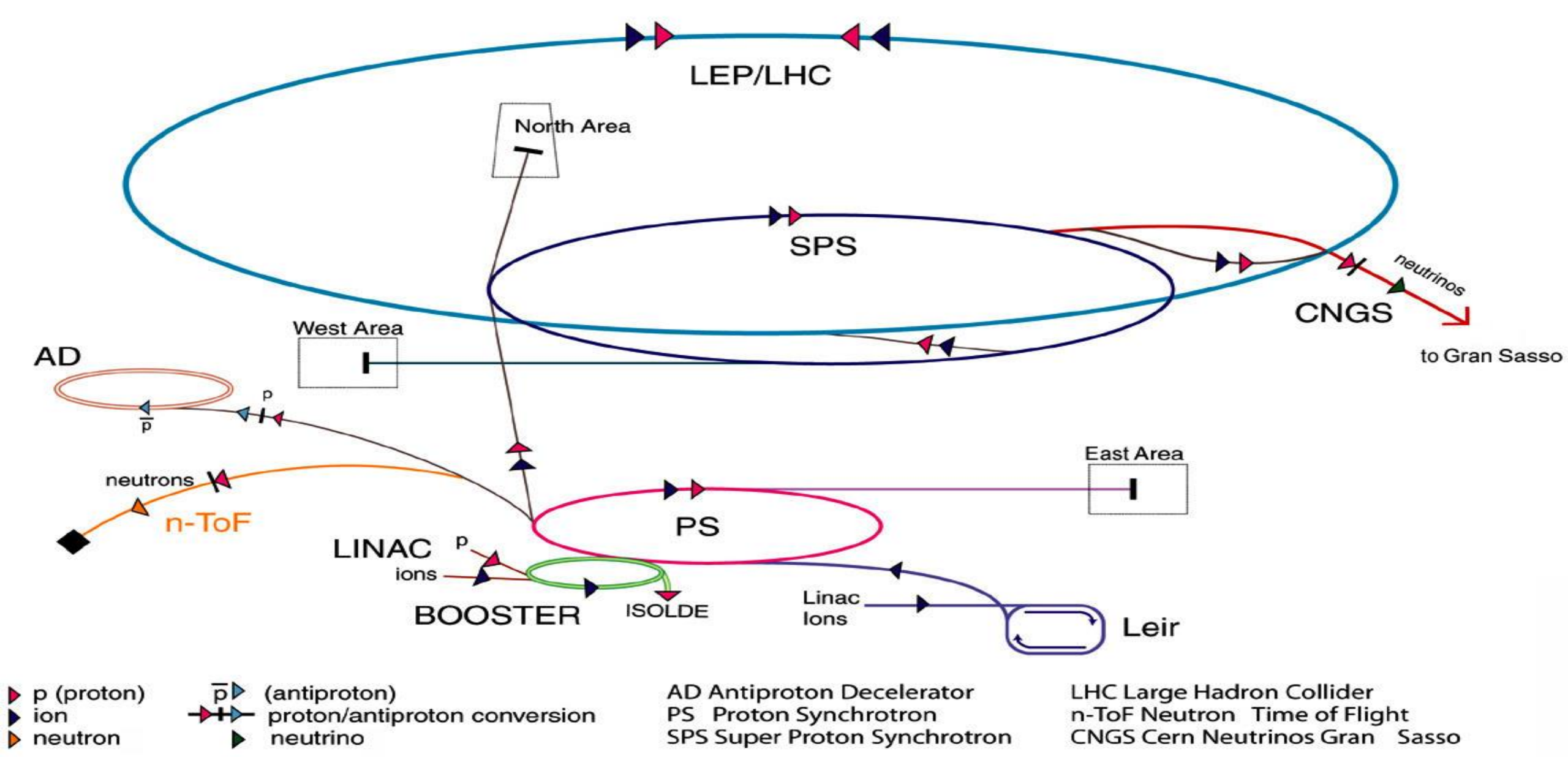
nu.
Naked eye

THE TWO FRONTIERS OF PHYSICS

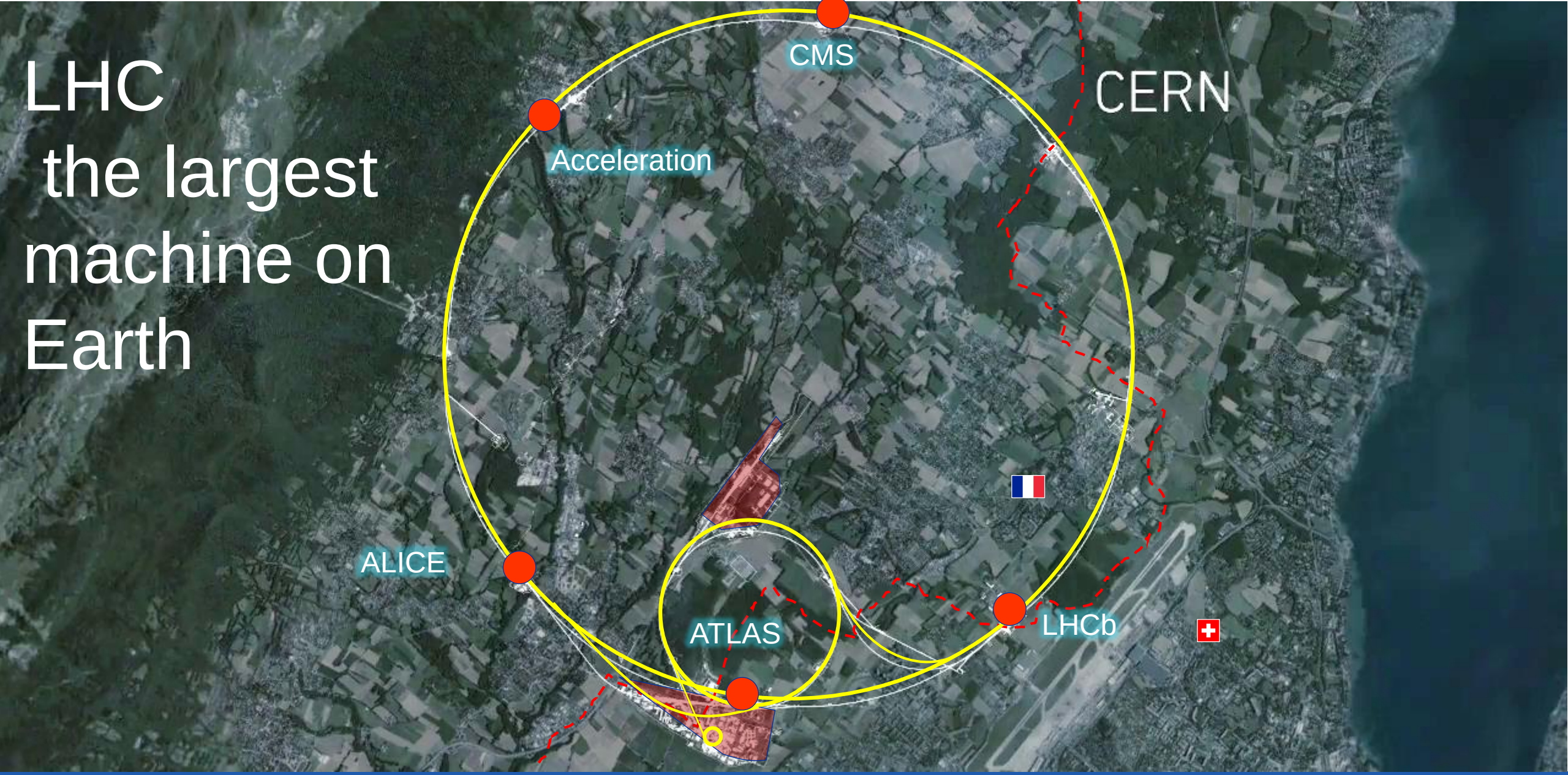
LES DEUX FRONTIERES DE LA PHYSIQUE

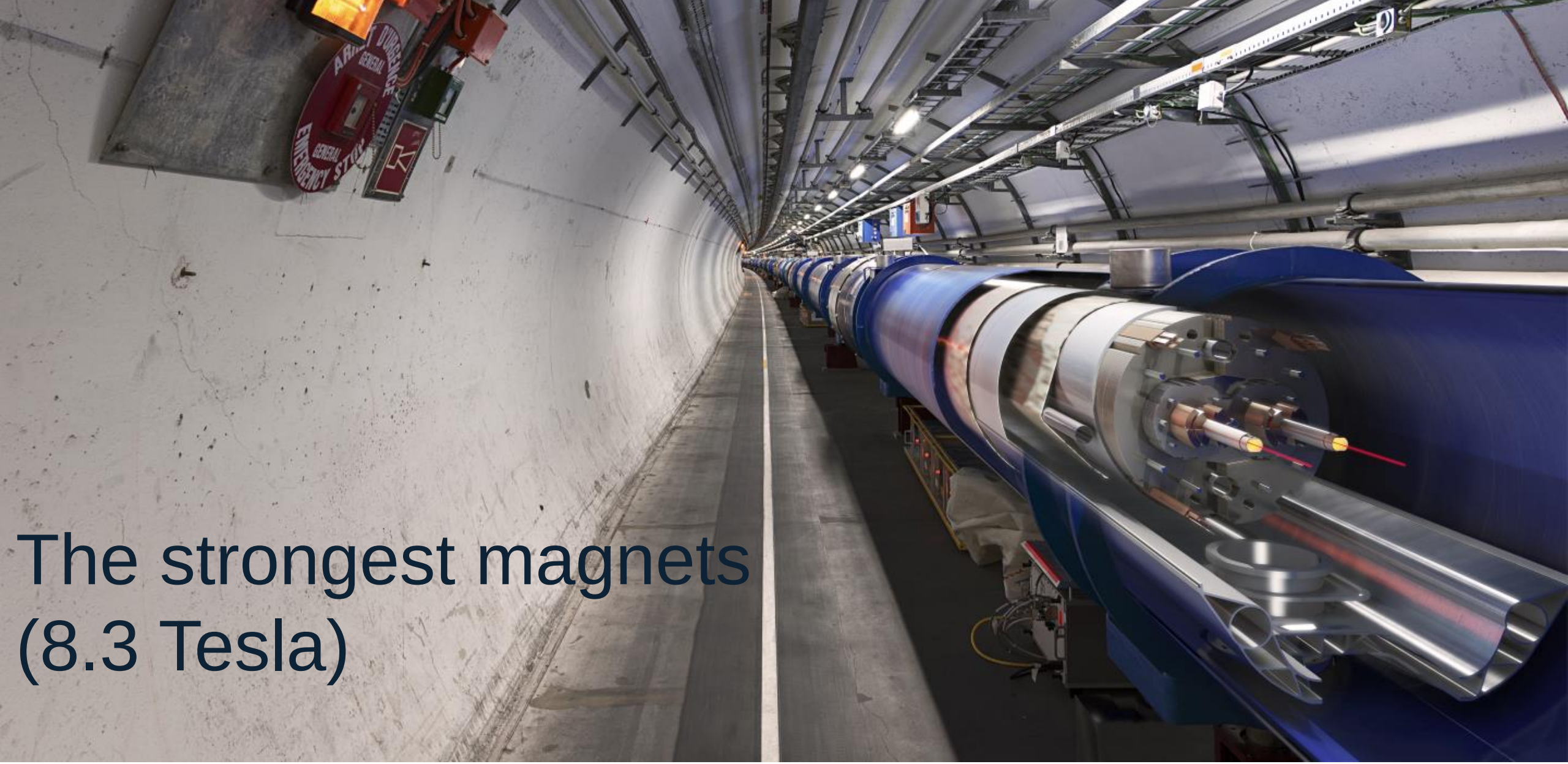
CERN AC - Z11 - V


E=mc²


LEP/LHC
North Area
SPS
neutrinos
CNGS
to Gran Sasso
West Area
AD
p
p̄
neutrons
n-ToF
East Area
PS
LINAC
p
ions
BOOSTER
ISOLDE
Linac
Ions
Leir
p (proton)
ion
neutron
p̄ (antiproton)
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

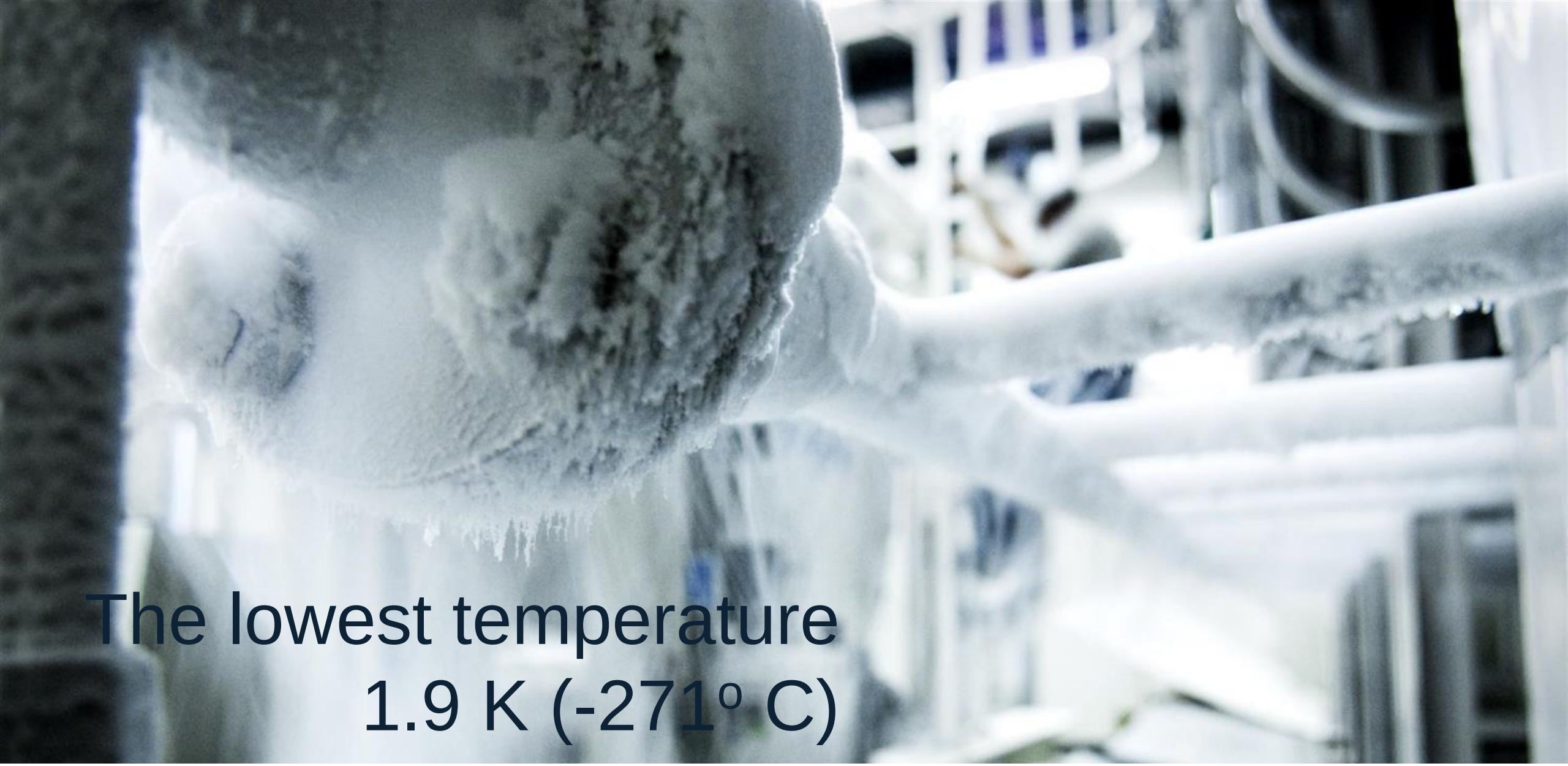
LHC the largest machine on Earth





The strongest magnets (8.3 Tesla)

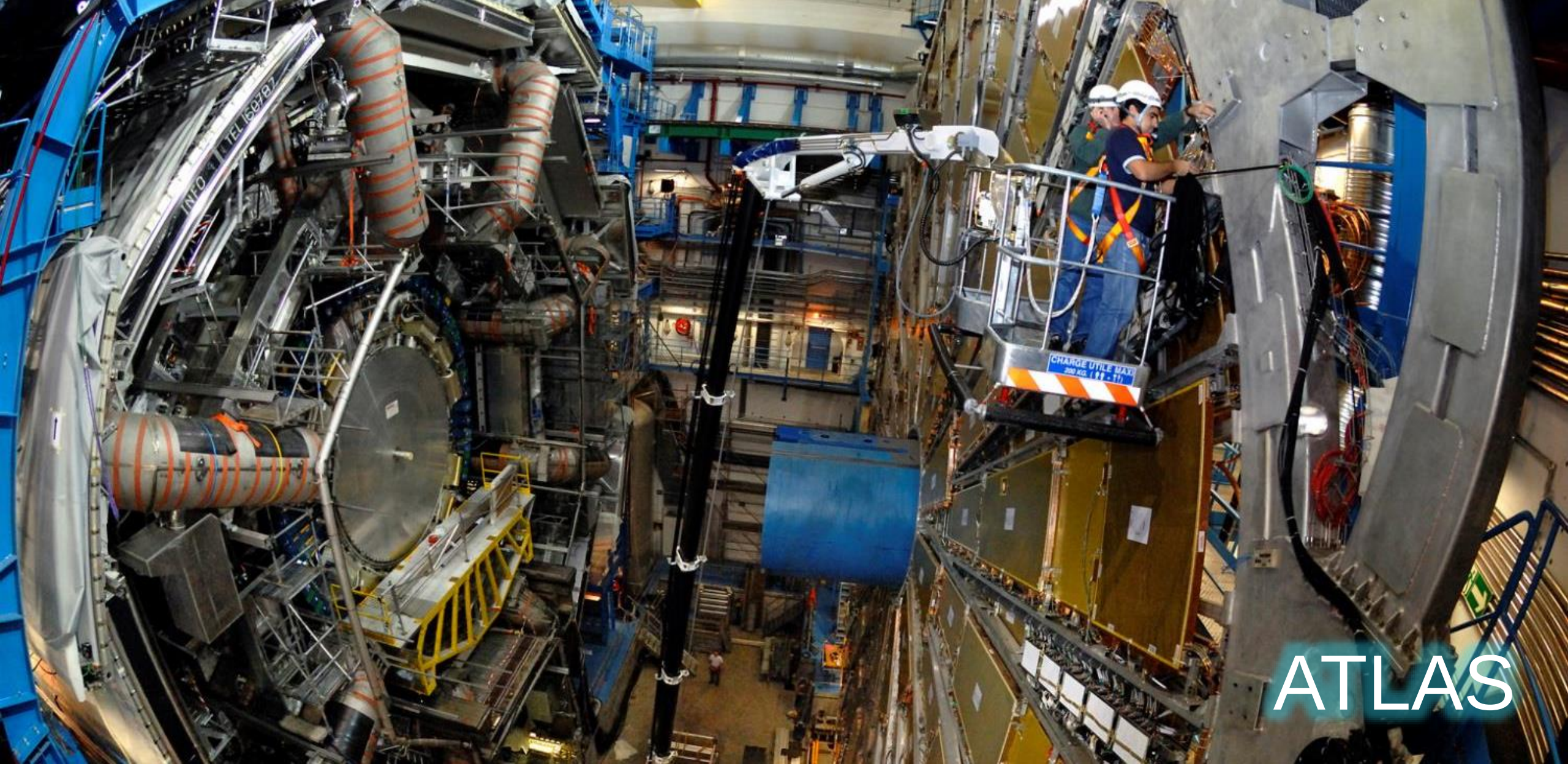
Υπεραγώγιμοι μαγνήτες (μηδενική αντίσταση) σε πολύ χαμηλή θερμοκρασία (καλώδιο από Νιόβιο – Τιτάνιο)

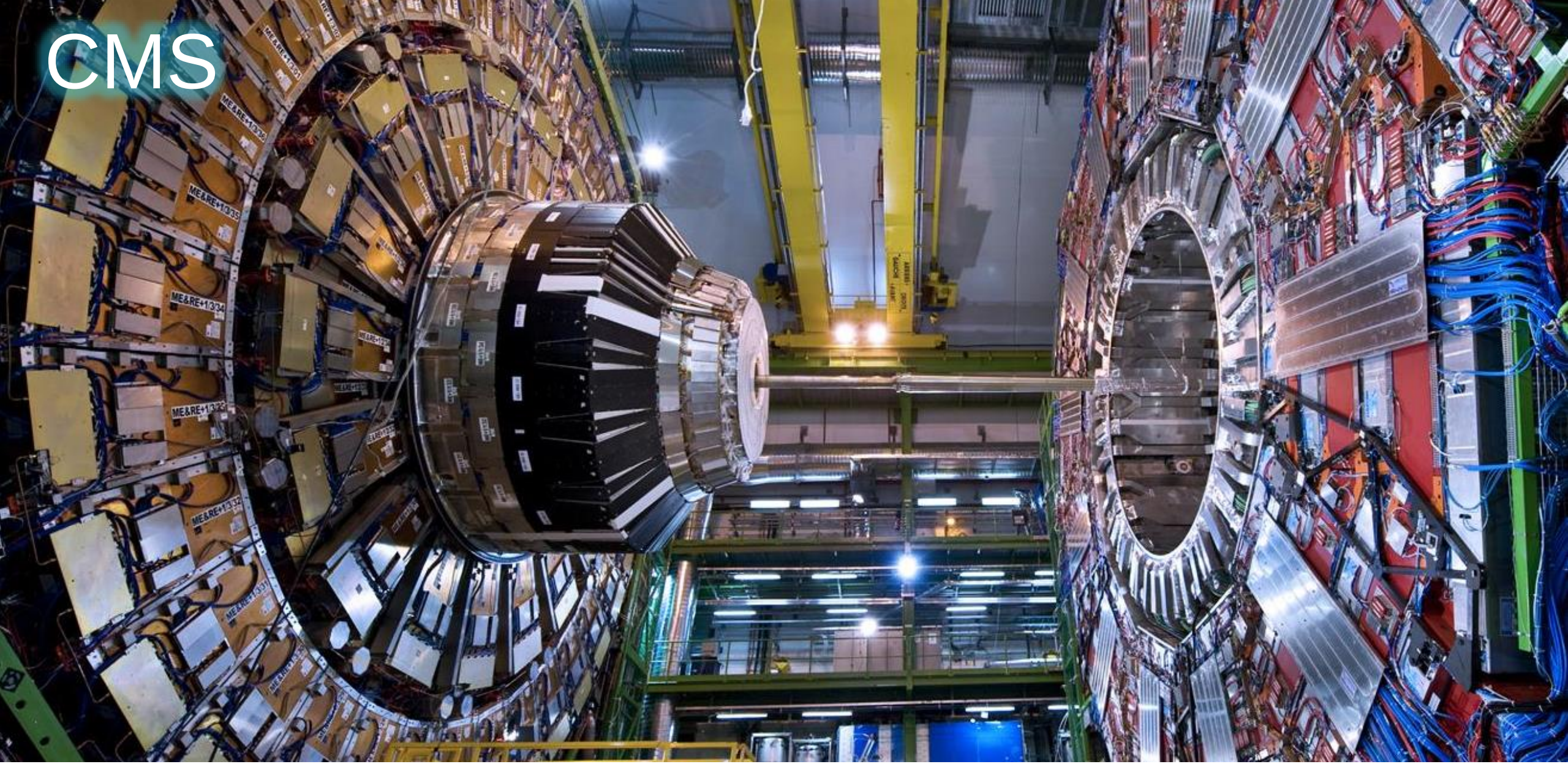


The lowest temperature
1.9 K (-271º C)

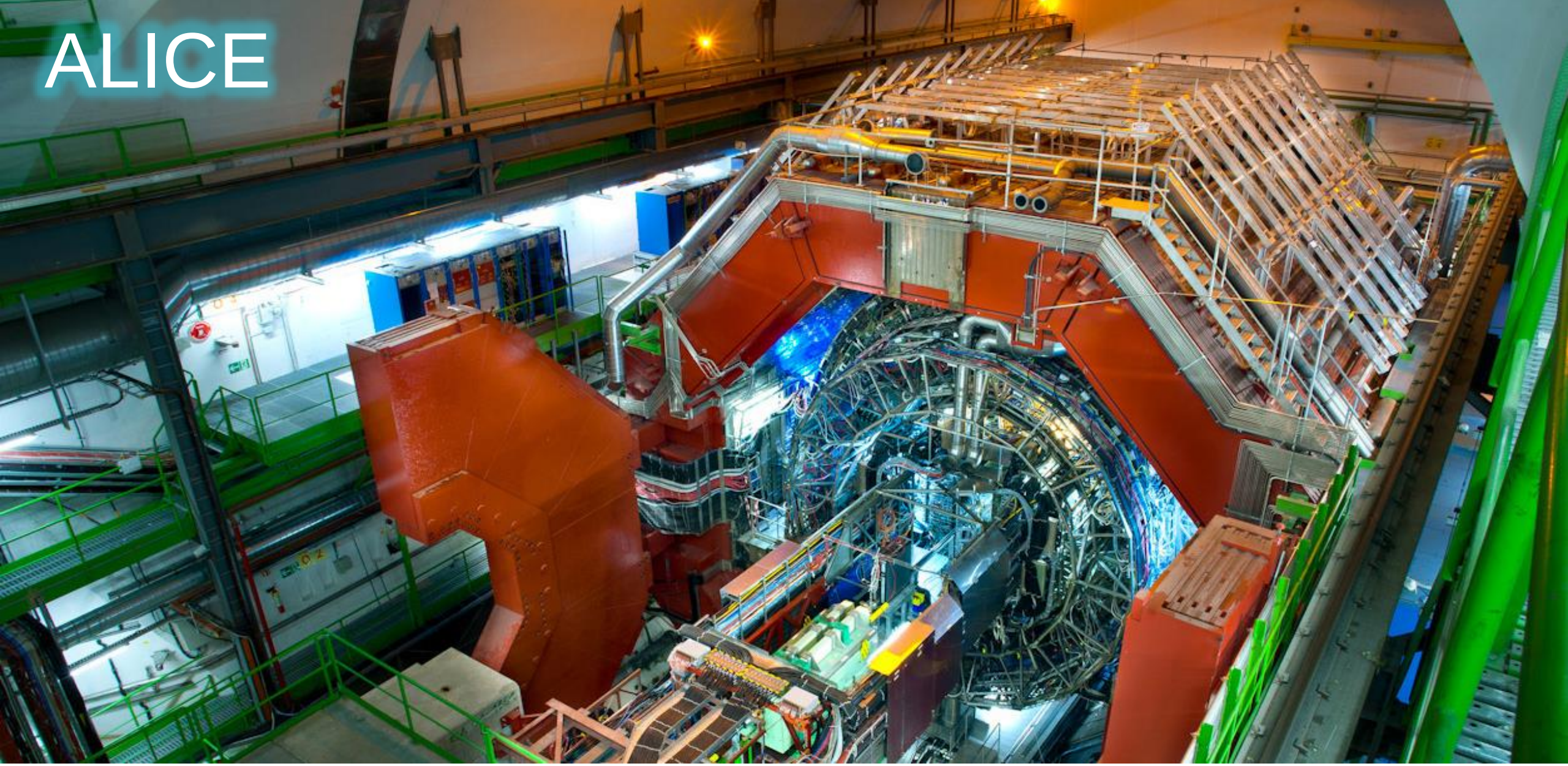
Η ψύξη γίνεται με υγρό ήλιο

The highest vacuum10^{-13} atm

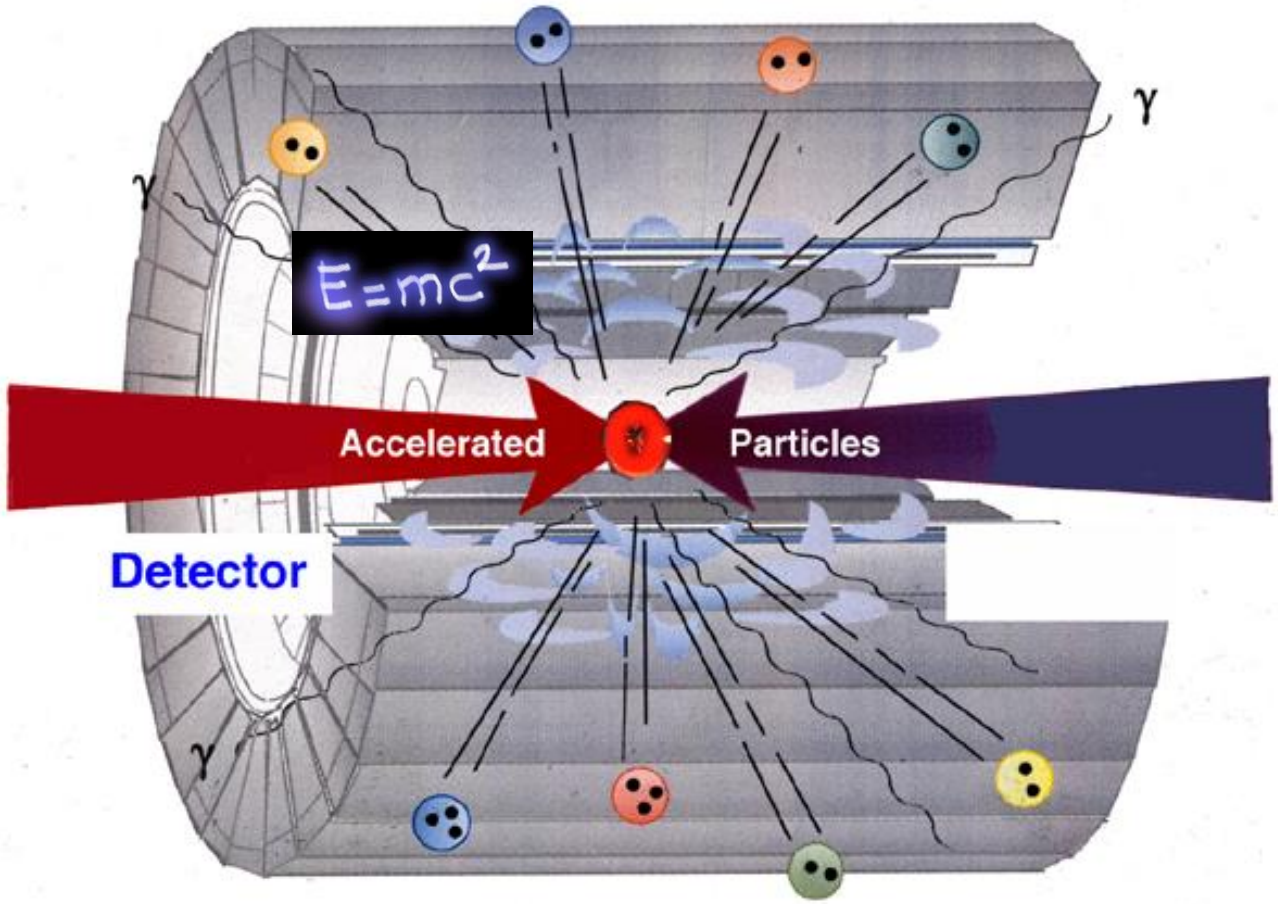

ATLAS


CMS

ALICE




LHCb



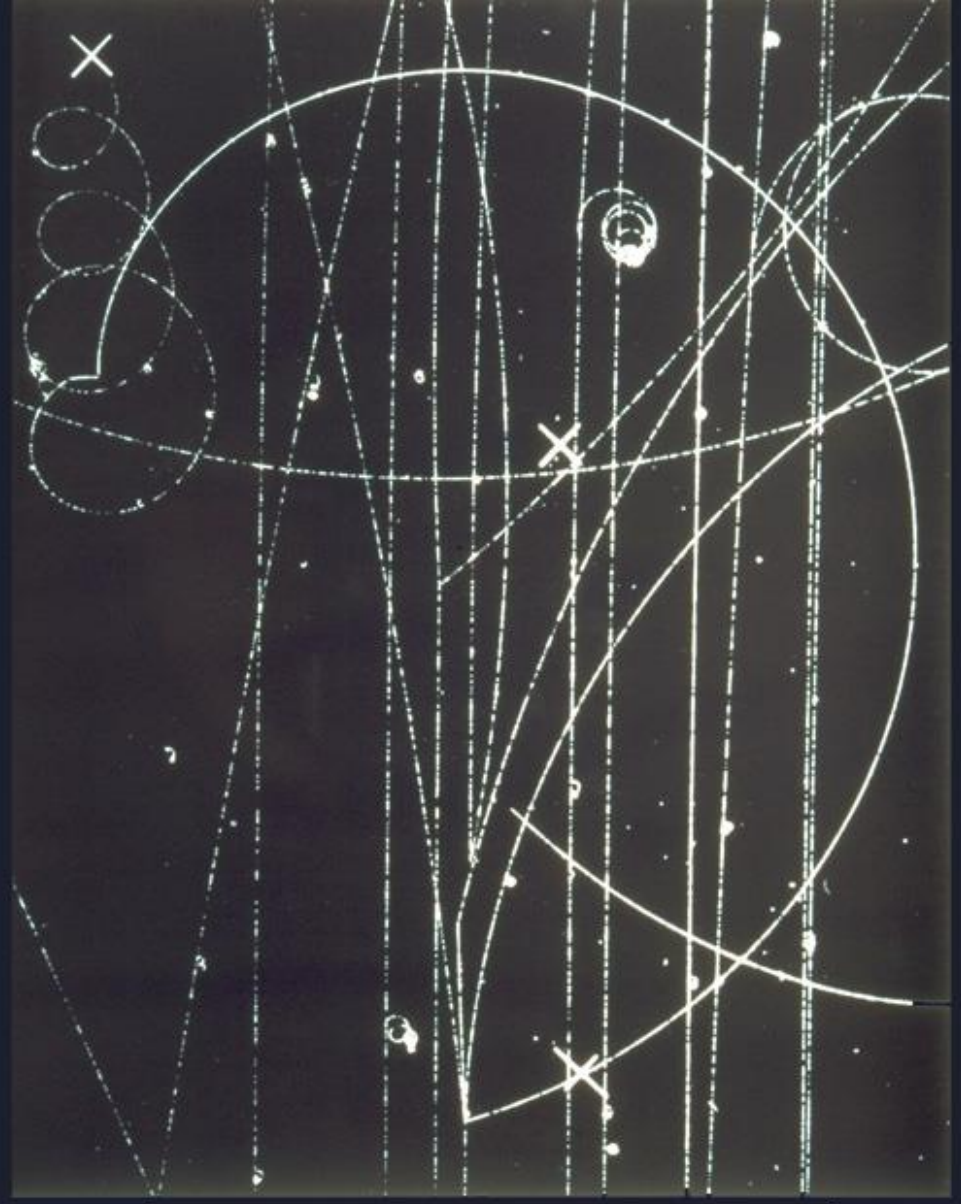
1) By accelerating protons we concentrate energy on them

2) The protons collide – their energy is released at the point of collision

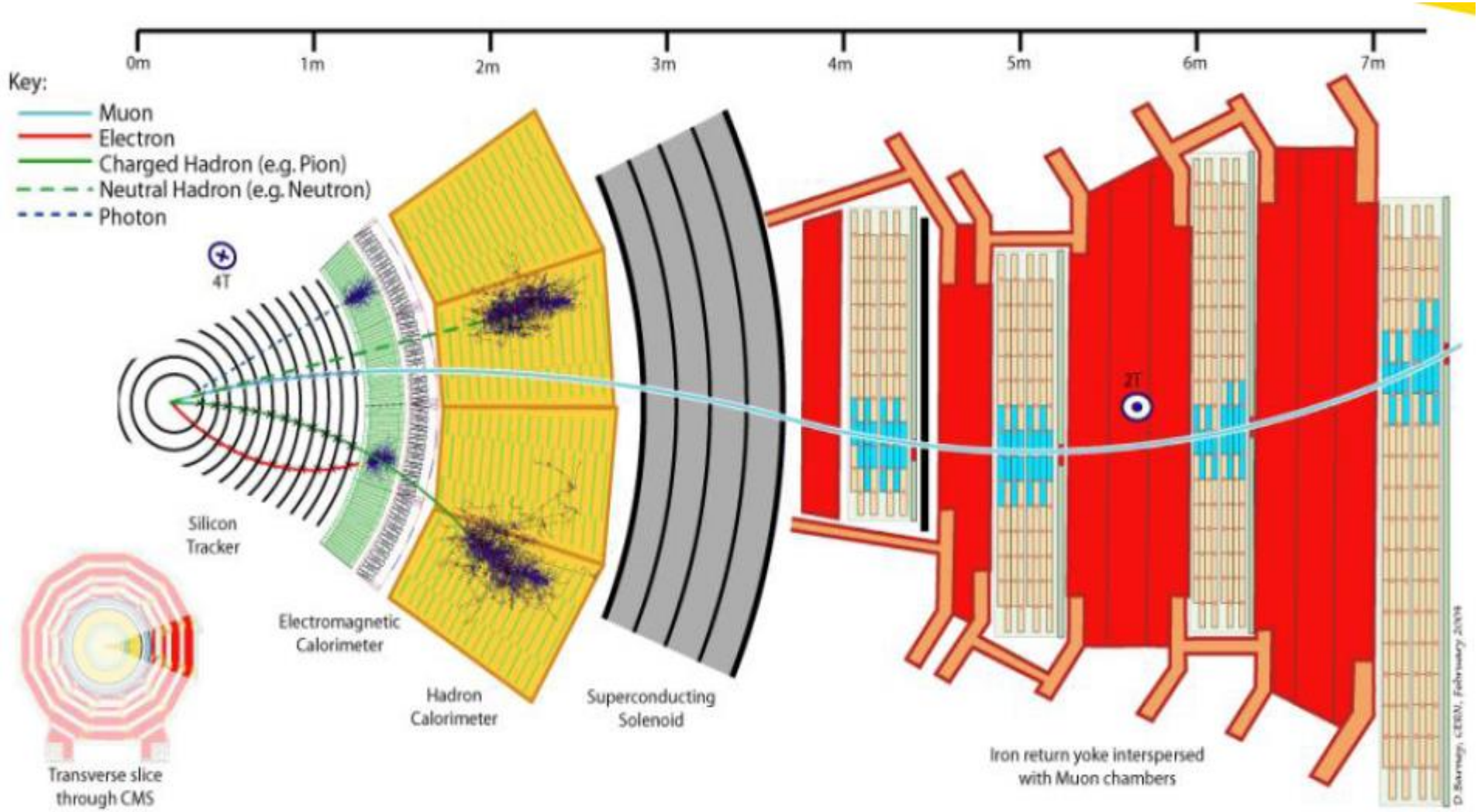
3) Energy is transformed into mass : new particles are produced

4) Detectors “see” these new particles, measure their characteristics (momentum, energy, charge) and identify them

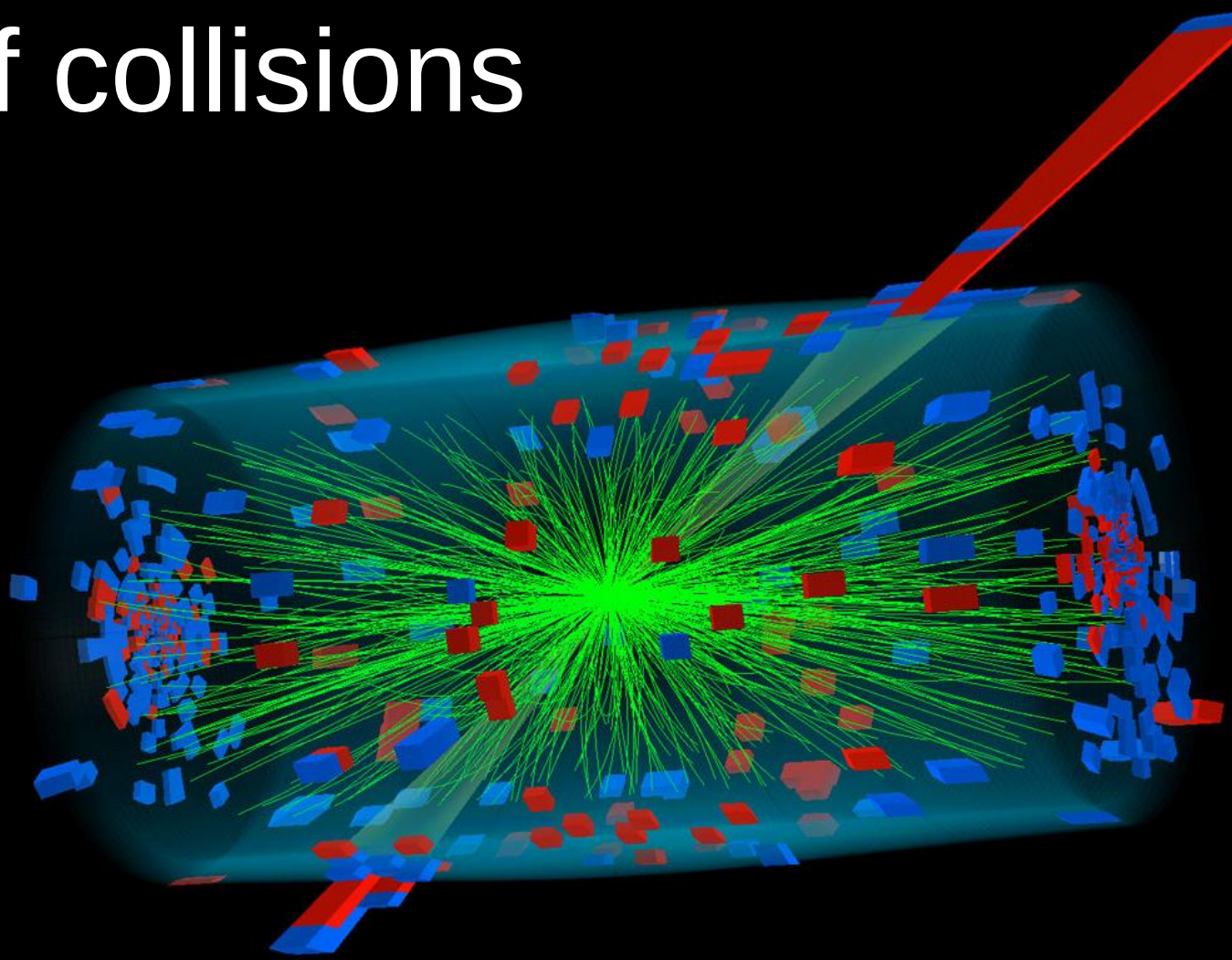
Bubble chamber photograph



A 8 GeV/c K^-p picture taken in the CERN 2m chamber


0m
1m
2m
3m
4m
5m
6m
7m
Key:
Muon
Electron
Charged Hadron (e.g. Pion)
Neutral Hadron (e.g. Neutron)
Photon
4T
2T
Silicon Tracker
Electromagnetic Calorimeter
Hadron Calorimeter
Superconducting Solenoid
Iron return yoke interspersed with Muon chambers
Transverse slice through CMS
D.Barney, CERN, February 2009

Billions of collisions



•Protons are injected into the LHC in bunches (100 billion protons) every 25 ns;

•They are accelerated from 450 GeV to 7 TeV

•They reach 99.9999991% of the velocity of light
•Protons go around the LHC 11245 times/s

•40 million times/s bunches pass each collision point
• 31.2 MHz crossing rate
• 20 collisions expected from (100 on 100 billion p)
•600 million particle collisions per second

• After filtering, 100-100 collisions of interest per second

• A Megabyte of data digitised for each collision
• recording rate of 0.1 Gigabytes/sec

• 10^{10} collisions recorded each year
= 10 Petabytes/year of data

1 Megabyte (1MB)
A digital photo

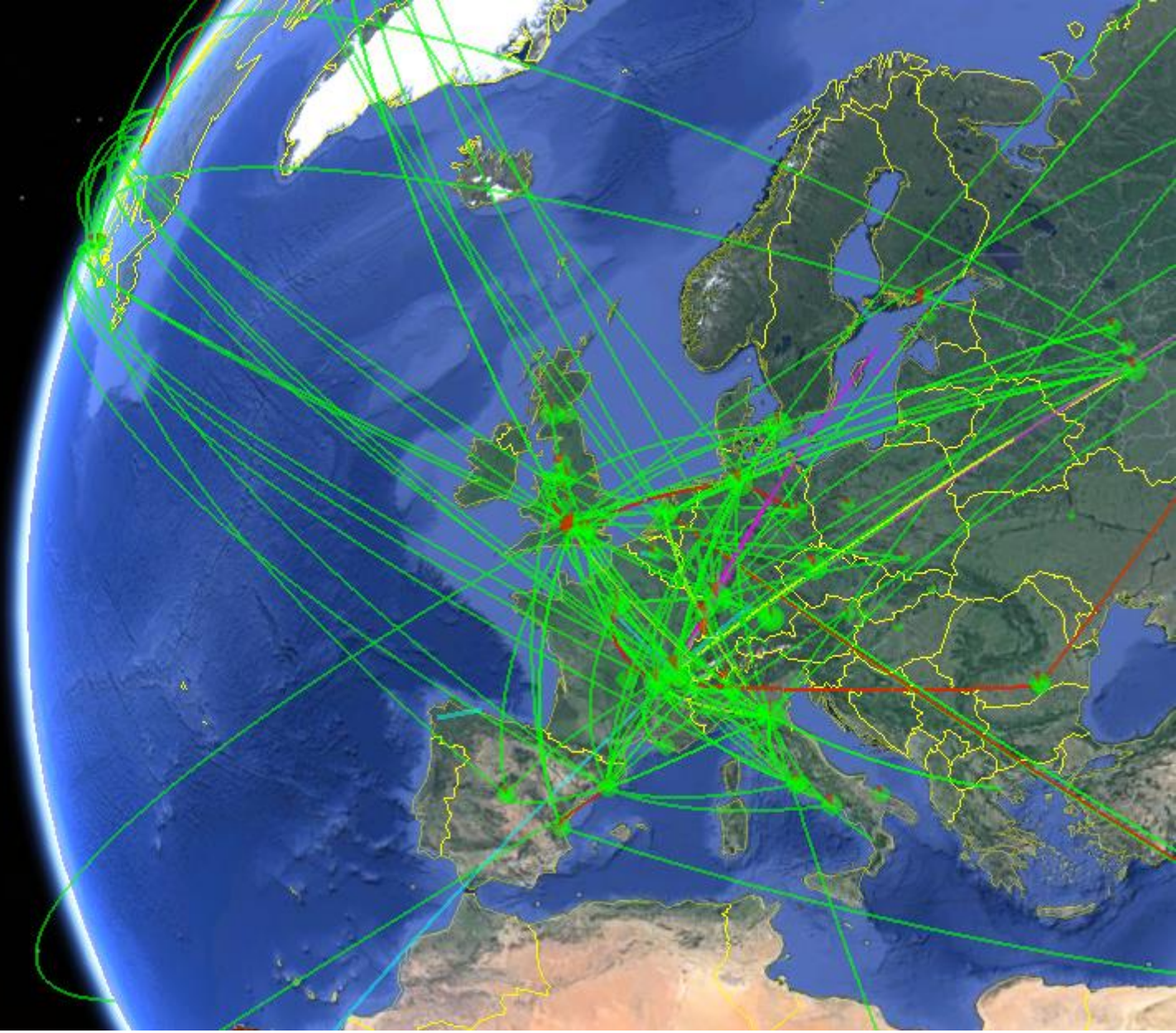
1 Gigabyte (1GB) = 1000MB
A DVD movie

1 Terabyte (1TB) = 1000GB
World annual book production

1 Petabyte (1PB) = 1000TB
Annual production of one LHC experiment

1 Exabyte (1EB) = 1000 PB
World annual information production

The largest computing grid



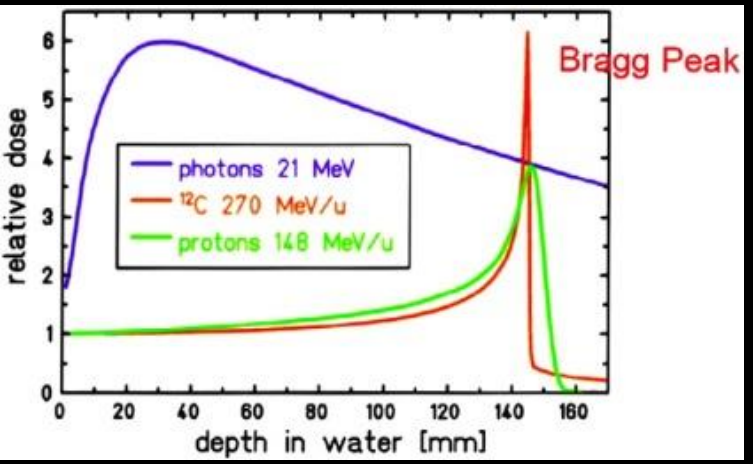
42 countries
170 data centres
Over 2 million tasks executed every day
1 million computer cores

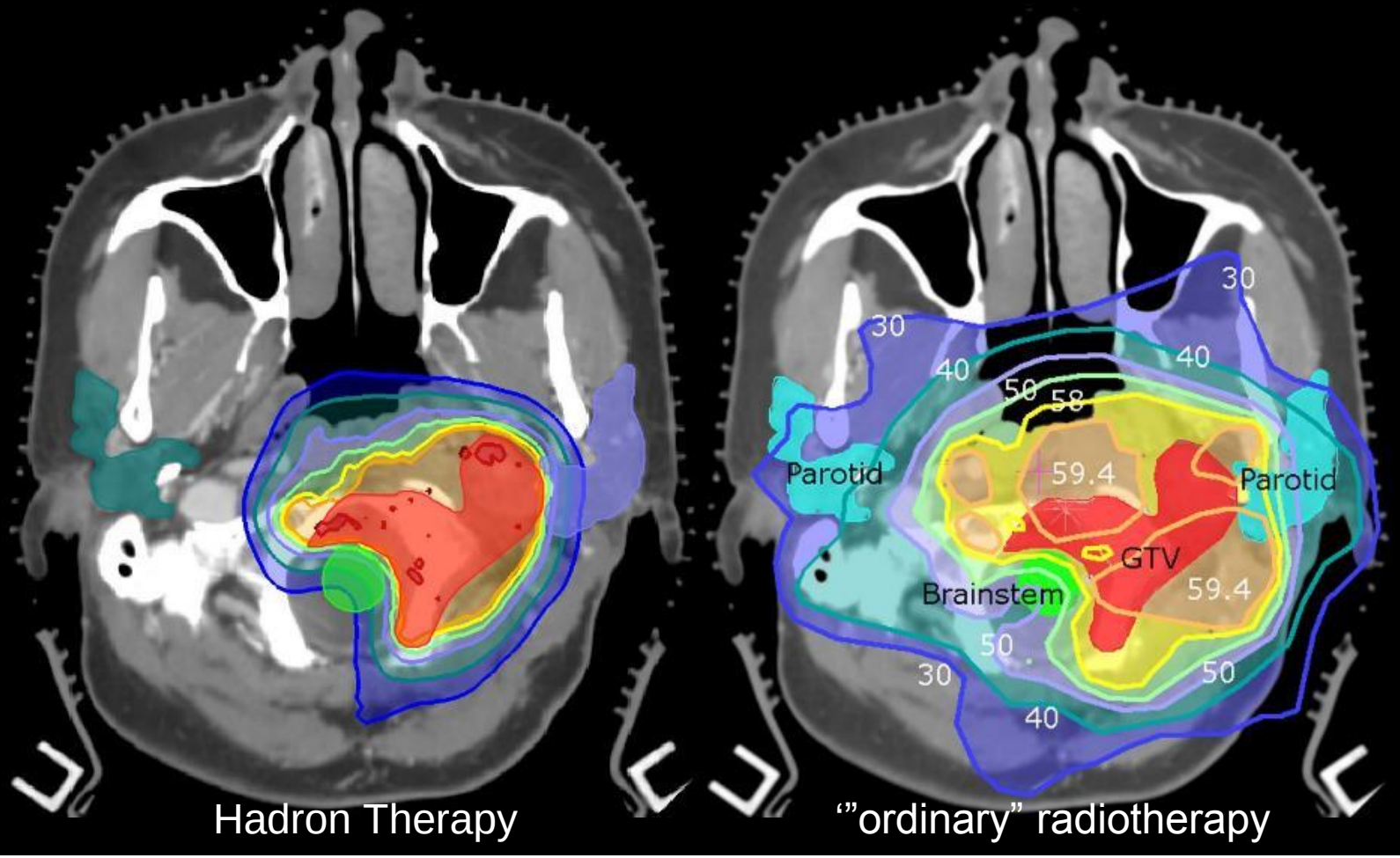
CERN spin-offs
What are the benefits for us?

Despina Hatzifotiadou

World Wide Web

Medical applications: hadron therapy

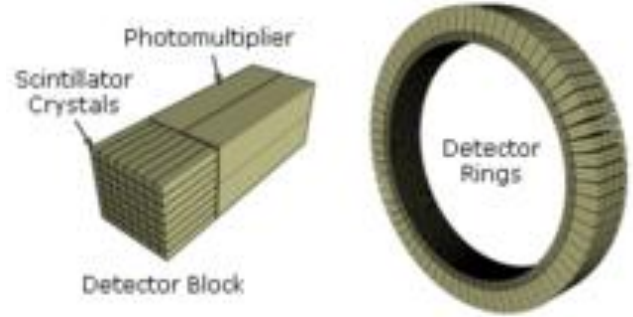


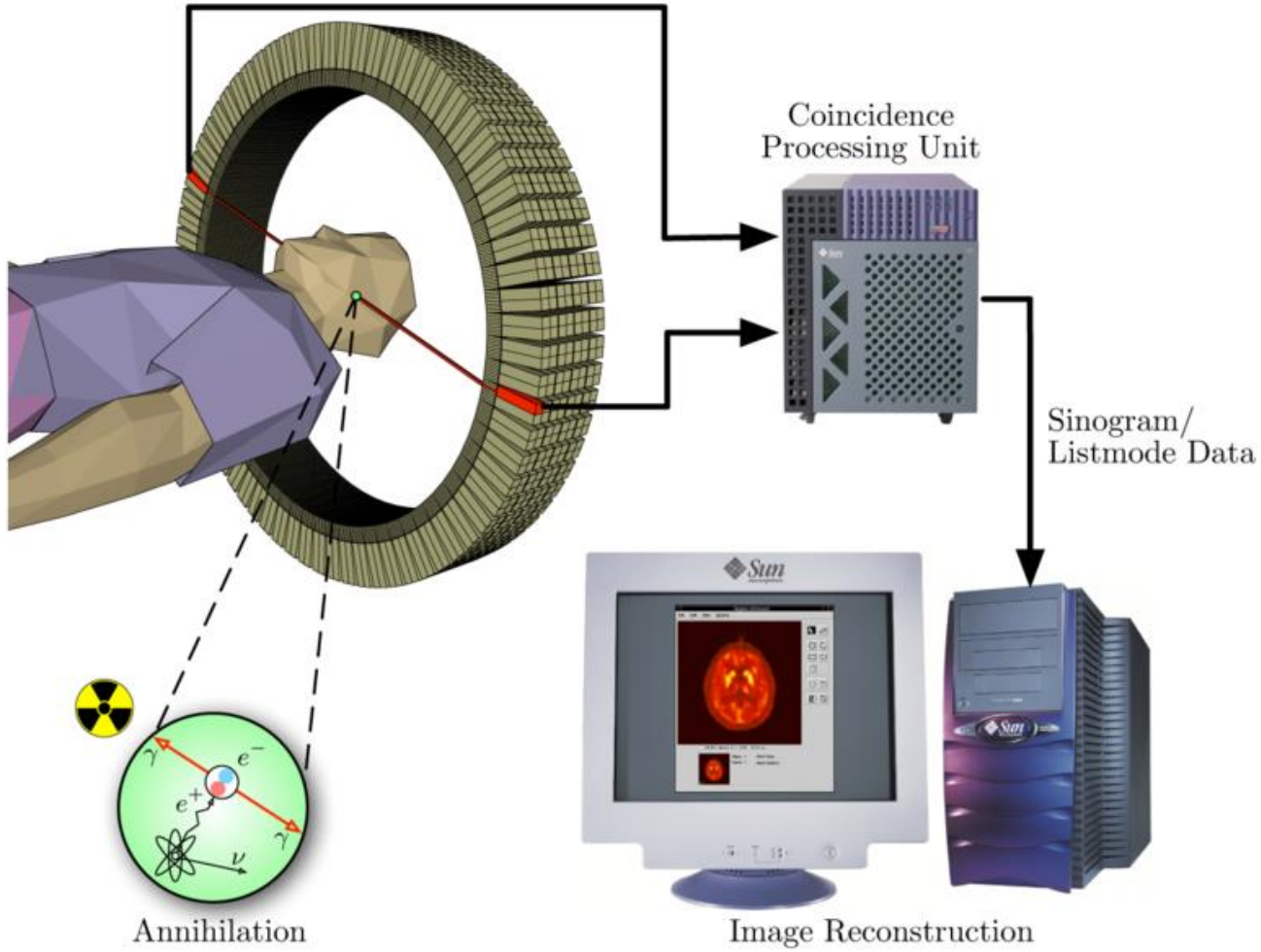


Hadron Therapy

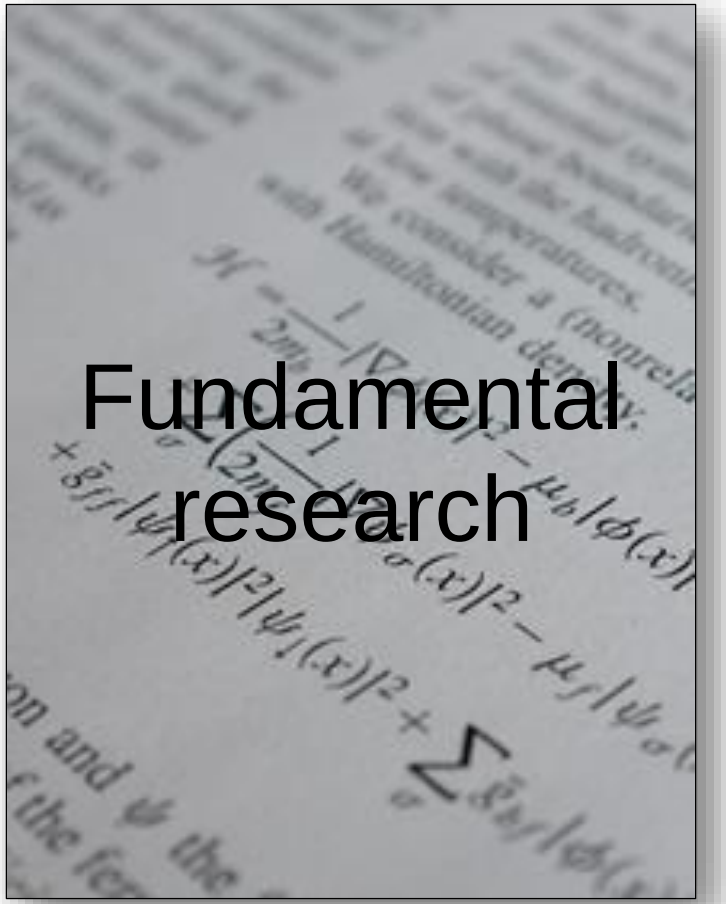
‘”ordinary” radiotherapy

Medical applications: Positron Emission Tomography (PET)





In a nutshell…



Educational and work opportunities at CERN

High School Students Internship Programme (national, two weeks)
Summer students
Doctoral students
Technical students
Administrative students
CERN fellows

High School Teachers' Programme (HST international 3 weeks, 2 weeks, national 1 week)

Positions (HR Department) web pages

Visits
Virtual visits
Participation in masterclasses

The Beam Line for Schools competition

A competition for teams of high school students (age 16 and up)

- Teams can propose a physics experiment
- CERN provides 1 week of mixed beam composed of pions, protons, antiprotons, electrons, positrons or muons at the PS accelerator
- One or two winning teams will be invited to CERN to carry out their experiment together with CERN scientists
- Registration closes end of March

Video: http://cds.cern.ch/record/1757251

Thanks for your attention!

Thanks for filling up the survey!

To learn more…

- home.cern
- visit.cern
- careers.cern
- despina.hatzifotiadou@cern.ch