

CERN

European Organization for Nuclear Research

Organisation Européenne pour la Recherche Nucléaire

**Welcome to CERN
the
European Organization for Nuclear Research**

doing Science for Peace since 1954

André David, CERN



1. Start with this introduction. (25 min)
2. A short movie about CERN. (10 min)
3. "The" guided visit to our sites. (2 hours)

During your visit

"There is no such thing as a stupid question"

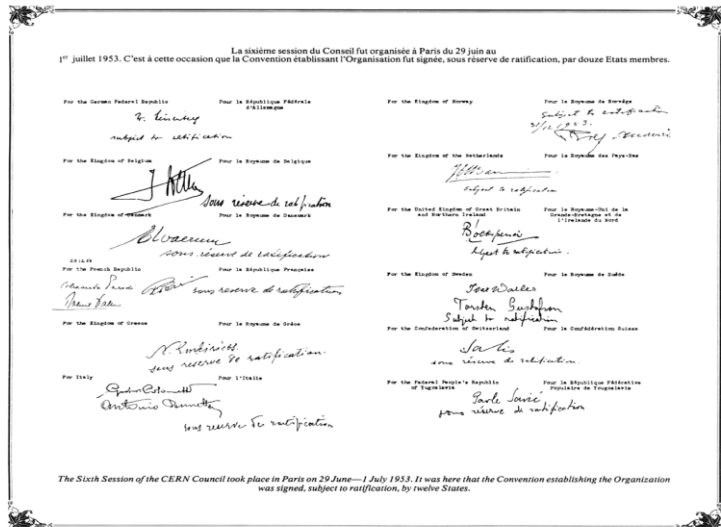


CERN European Organization for Nuclear Research

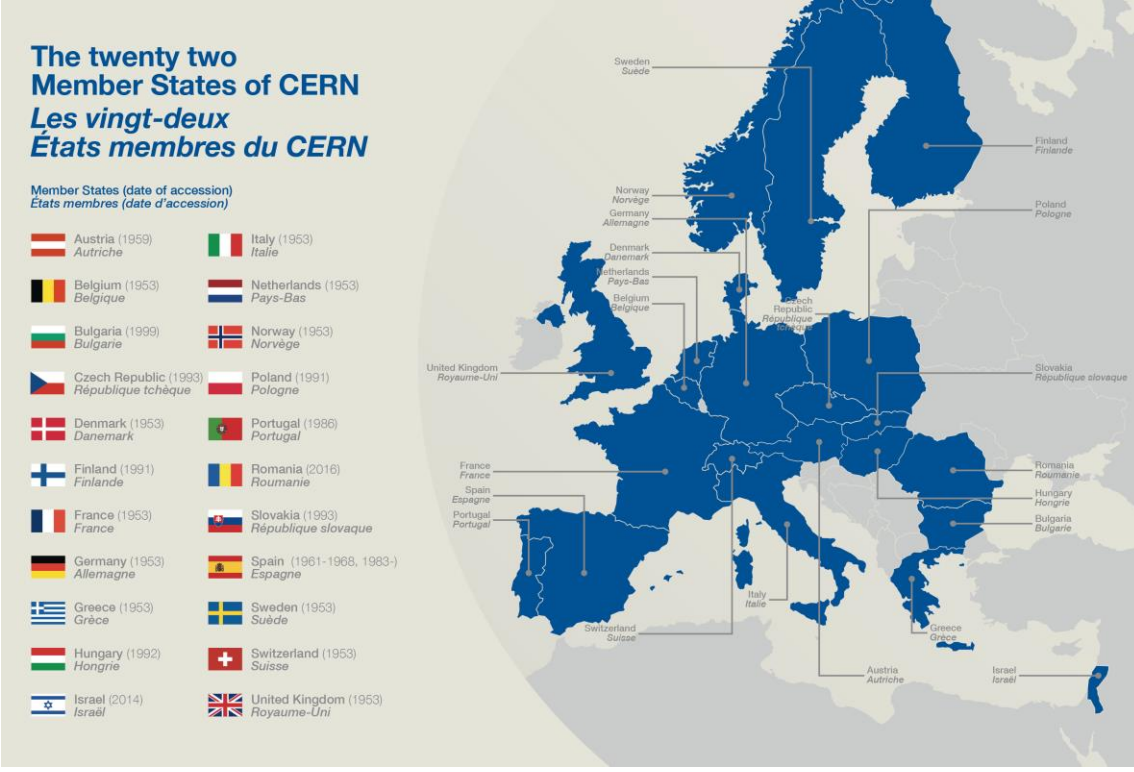
• Founded in 1954 by 12 European countries. **22 member states in 2016.**

- ~ **2'500 staff**
- ~ **13'800 fellows, students, users, etc**
- **Budget: ~10⁹ CHF (2015)**

- **Member States:** (see map) Total population: 510 × 10⁶ (2014)
- **Associate Members in Pre-Stage to Membership:** Serbia.
- **Applicant States:** Cyprus, Slovenia, Turkey.
- **Observers to Council:** India, Japan, Russia, USA, Turkey, the European Commission and UNESCO.



1954: Convention establishing the organisation - original signatures

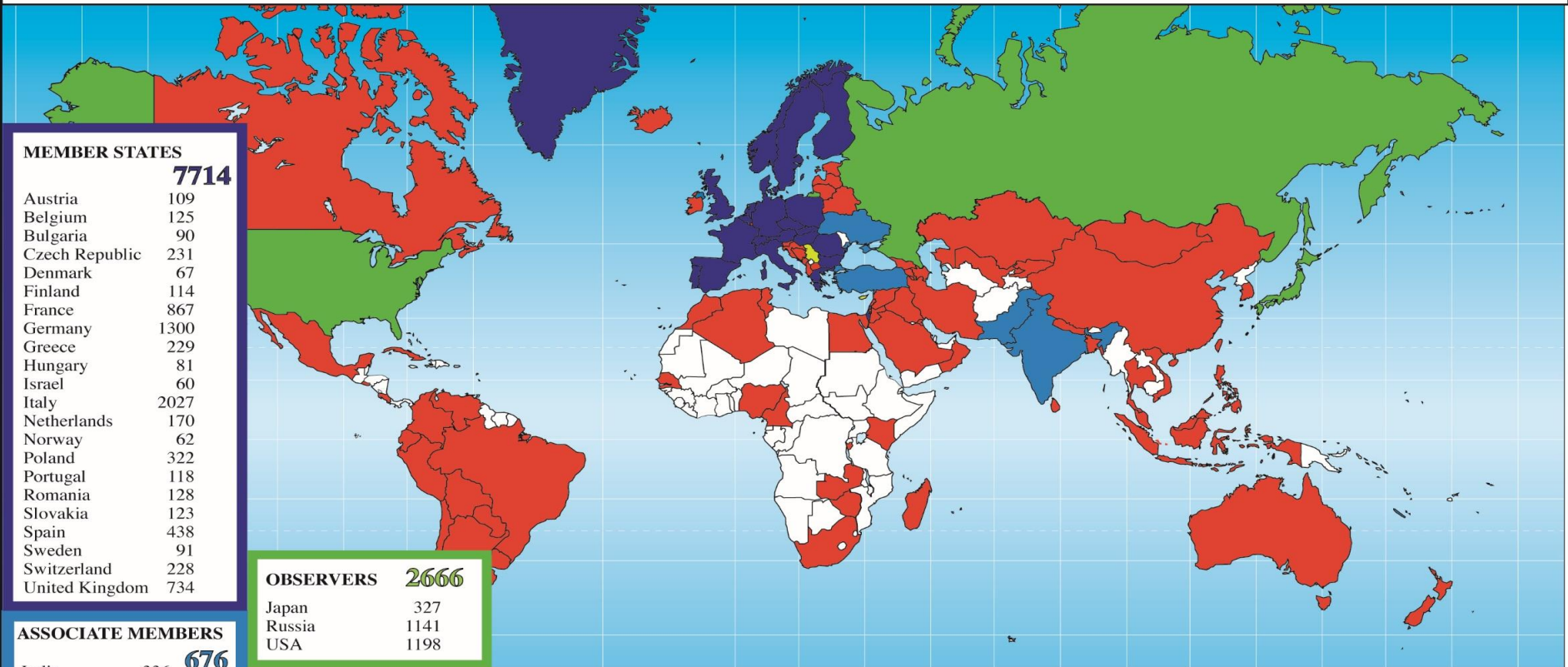


2016: The 22 member states



Who uses CERN ?

Distribution of All CERN Users by Nationality on 20 January 2017



MEMBER STATES

7714

Austria	109
Belgium	125
Bulgaria	90
Czech Republic	231
Denmark	67
Finland	114
France	867
Germany	1300
Greece	229
Hungary	81
Israel	60
Italy	2027
Netherlands	170
Norway	62
Poland	322
Portugal	118
Romania	128
Slovakia	123
Spain	438
Sweden	91
Switzerland	228
United Kingdom	734

OBSERVERS

2666

Japan	327
Russia	1141
USA	1198

ASSOCIATE MEMBERS

676

India	336
Pakistan	67
Turkey	173
Ukraine	100

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP

70

Cyprus	25
Serbia	45

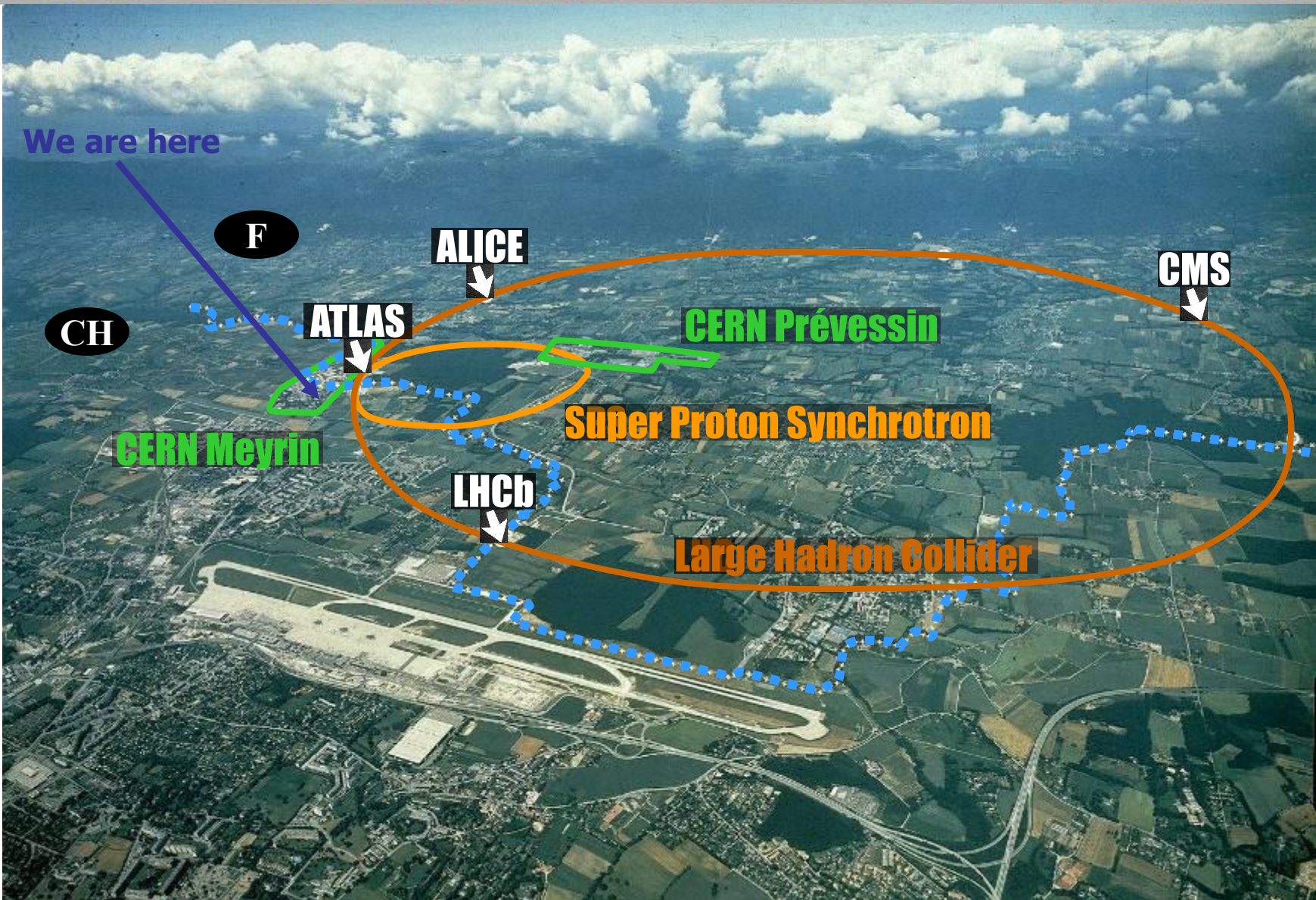
OTHERS

1803

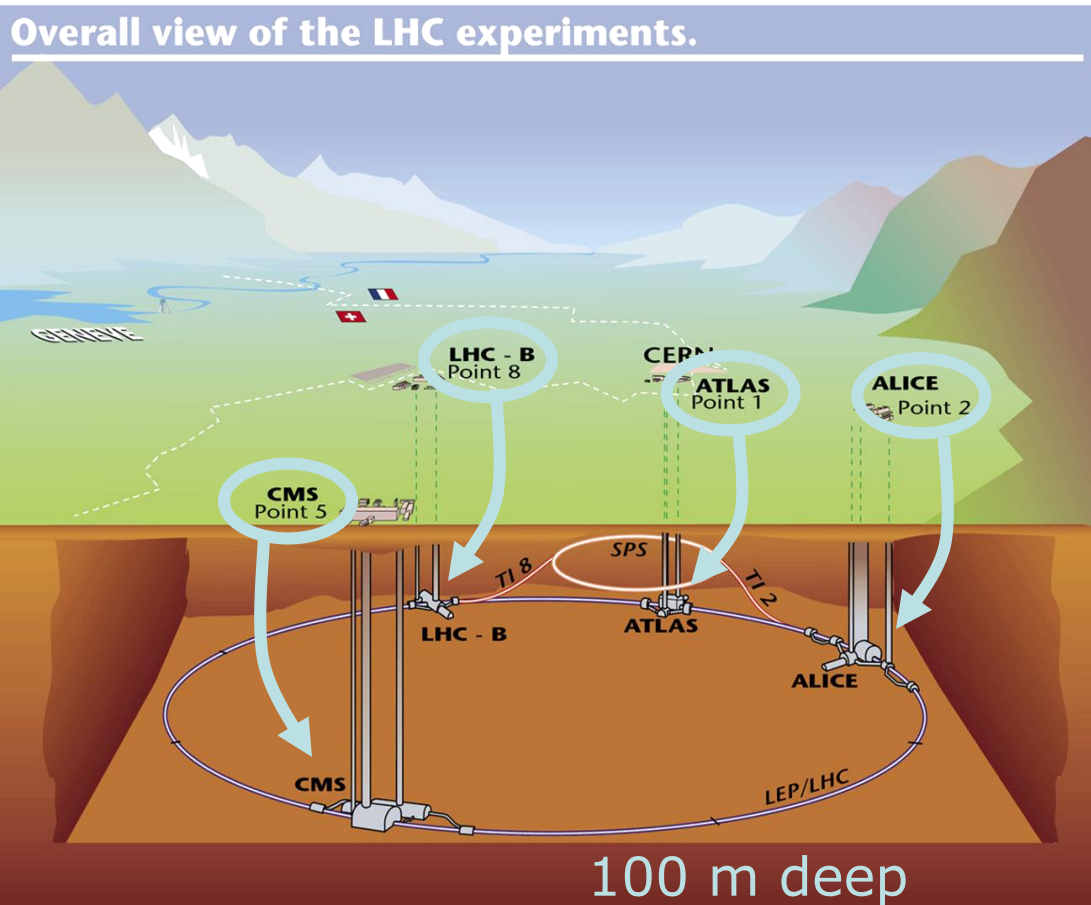
Albania	4	Burundi	1	Ecuador	4	Kazakhstan	1	Mauritius	2	Peru	6	Taiwan	54
Algeria	13	Cameroon	1	Egypt	31	Kenya	3	Mexico	82	Philippines	3	Thailand	23
Argentina	21	Canada	152	El Salvador	1	Korea Rep.	172	Mongolia	2	San Marino	1	T.F.Y.R.O.M.	2
Armenia	25	China	439	Estonia	13	Kyrgyzstan	1	Montenegro	4	Saudi Arabia	1	Tunisia	6
Australia	32	Colombia	43	Georgia	47	Latvia	2	Morocco	18	Senegal	2	Uruguay	1
Azerbaijan	9	Costa Rica	2	Iceland	5	Lebanon	17	Nepal	9	Singapore	6	Uzbekistan	4
Bangladesh	11	Croatia	41	Indonesia	12	Lithuania	32	New Zealand	6	Sint Maarten	1	Venezuela	10
Belarus	46	Cuba	16	Iran	59	Luxembourg	1	Nigeria	3	Slovenia	31	Viet Nam	11
Bolivia	4			Iraq	1	Madagascar	2	Oman	3	South Africa	39	Zambia	1
				Ireland	16	Malaysia	19	Palestine (O.T.)	7	Sri Lanka	3	Zimbabwe	4
				Jordan	2	Malta	10	Paraguay	1	Syria	1		



The physical extents of CERN

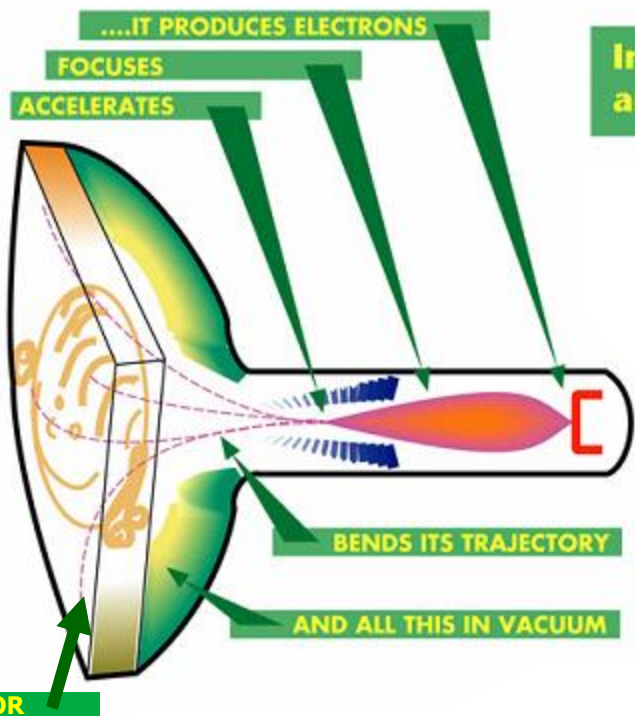


The Large Hadron Collider (LHC) will be the most powerful instrument for the investigation of particle properties ever built.

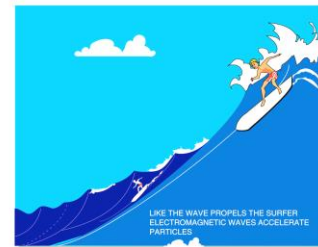


- Four **large underground caverns** for the detectors.
- The accelerator that produces **the highest particle energy of movement** in the world.
- The **most intense beams** for particle collisions.
- The LHC will operate at a temperature **below that of the outer space**.

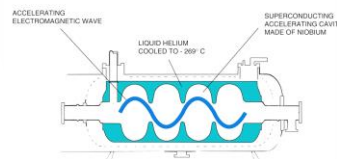
A Particle Accelerator at Home



In your TV set, the electrons are accelerated to 20000 volts.

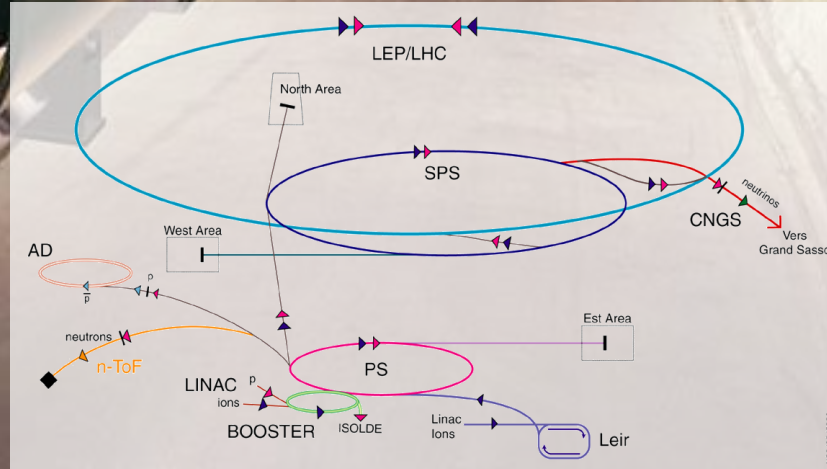
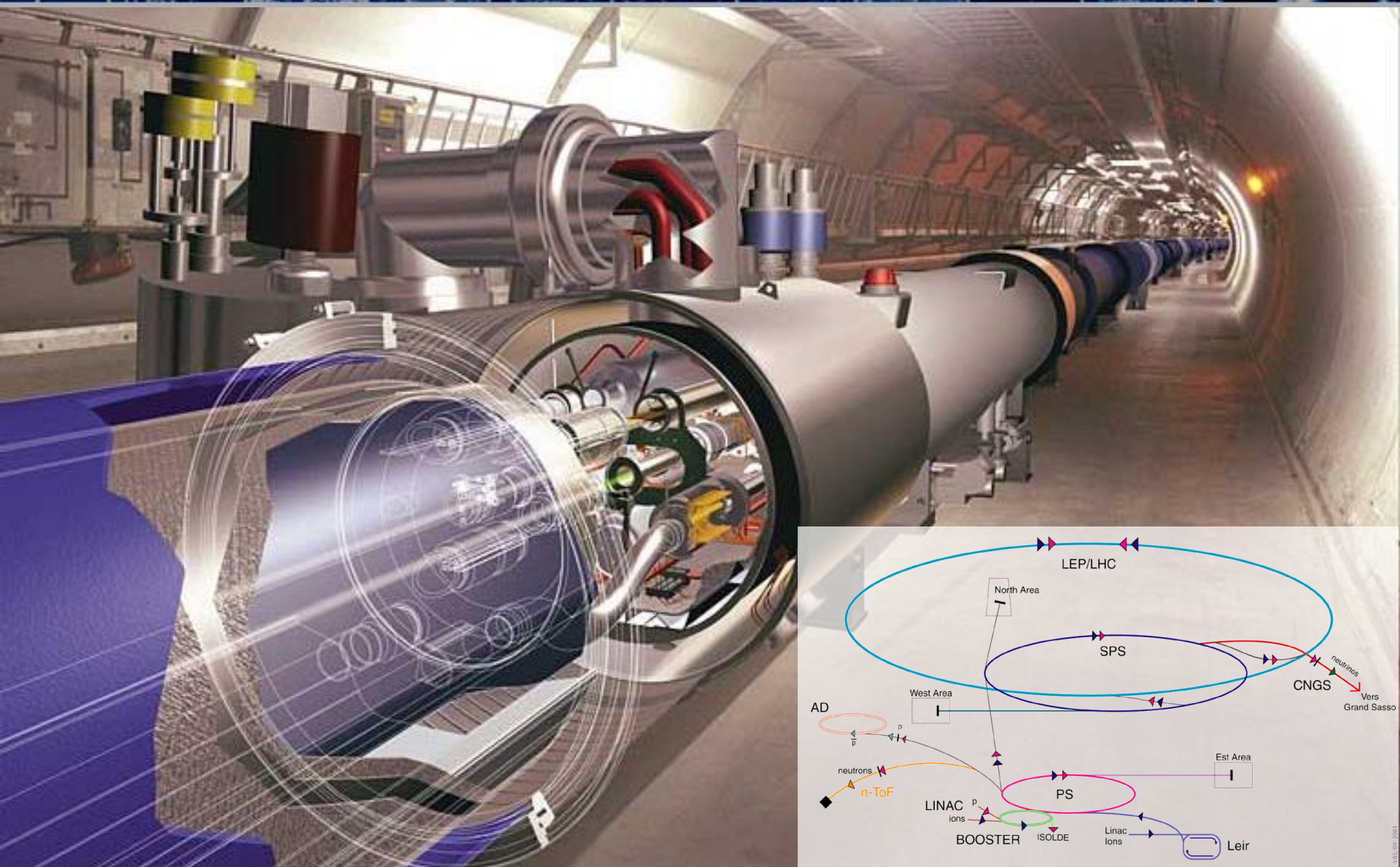


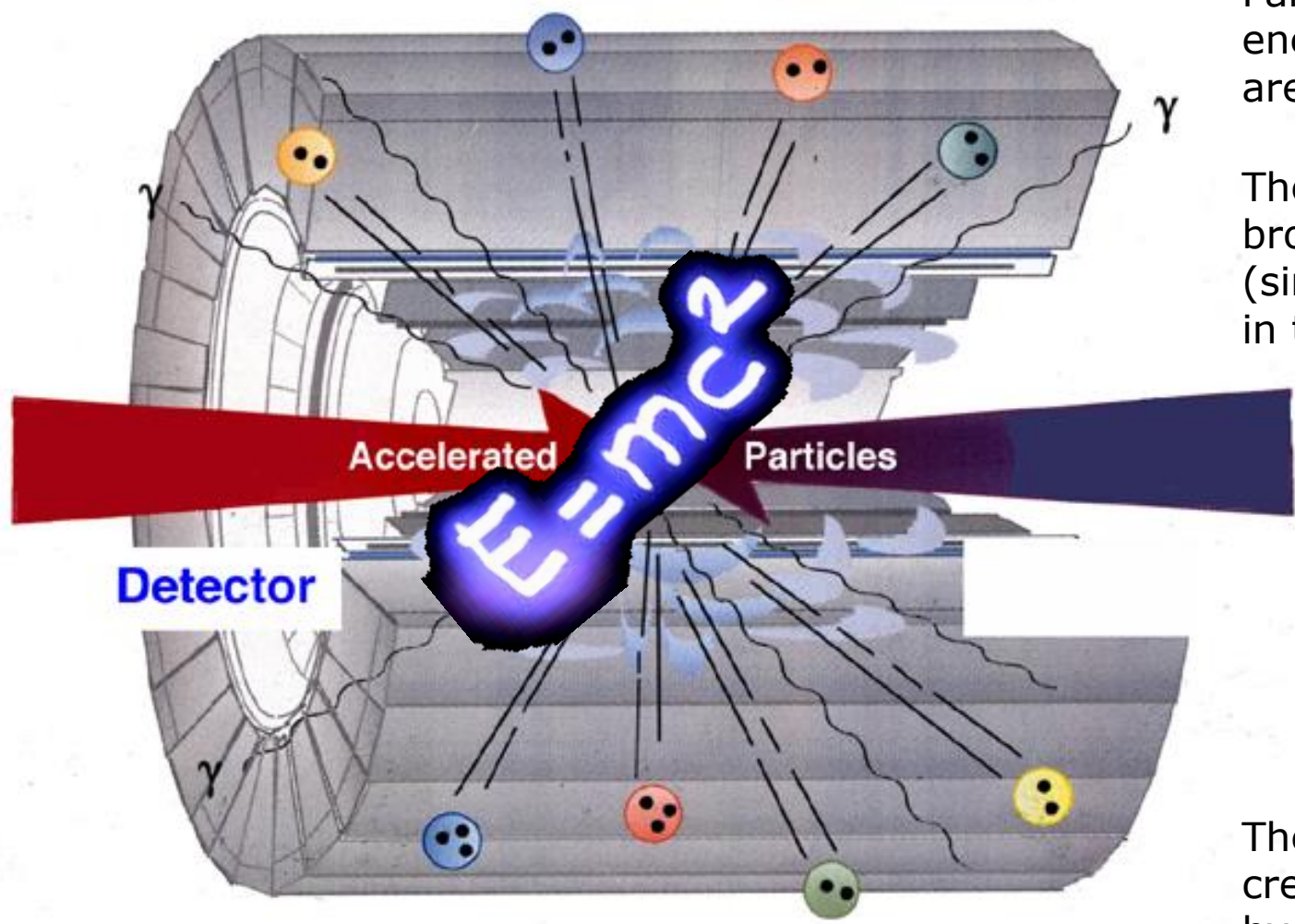
THE USE OF SUPRACONDUCTIVITY TO INCREASE PERFORMANCES AND CONSIDERABLY REDUCE ELECTRICITY CONSUMPTION.



At the LHC, protons will be accelerated to 7 000 000 000 000 volts.

The accelerator "gearbox"



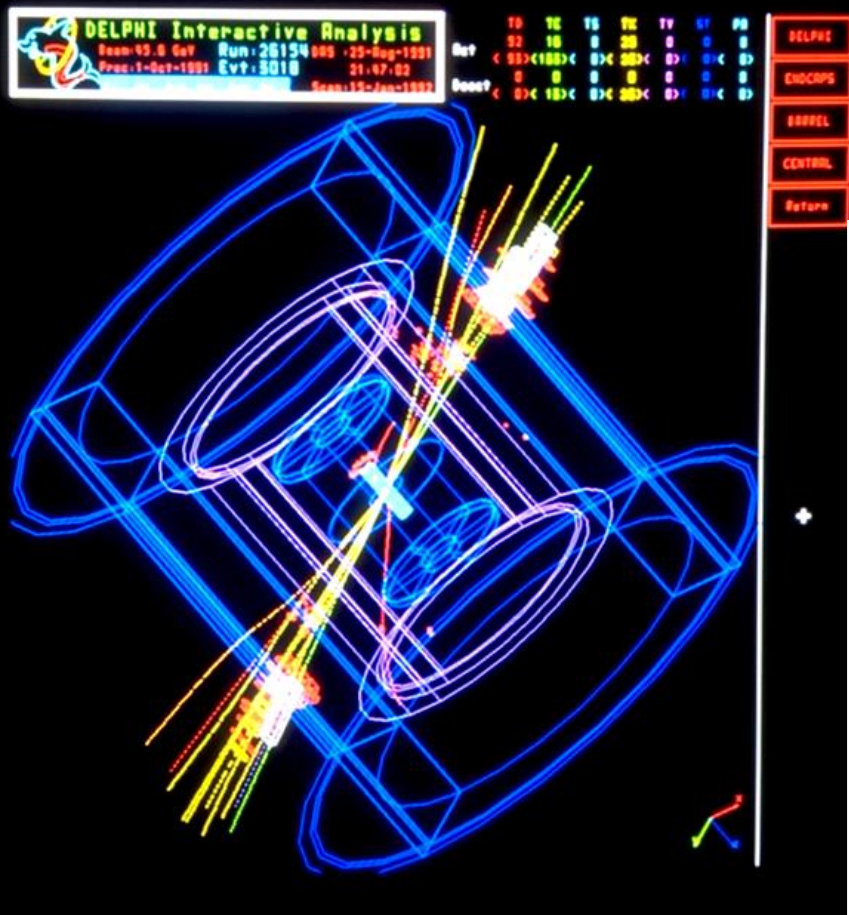


Particles with very high energy of movement are produced.

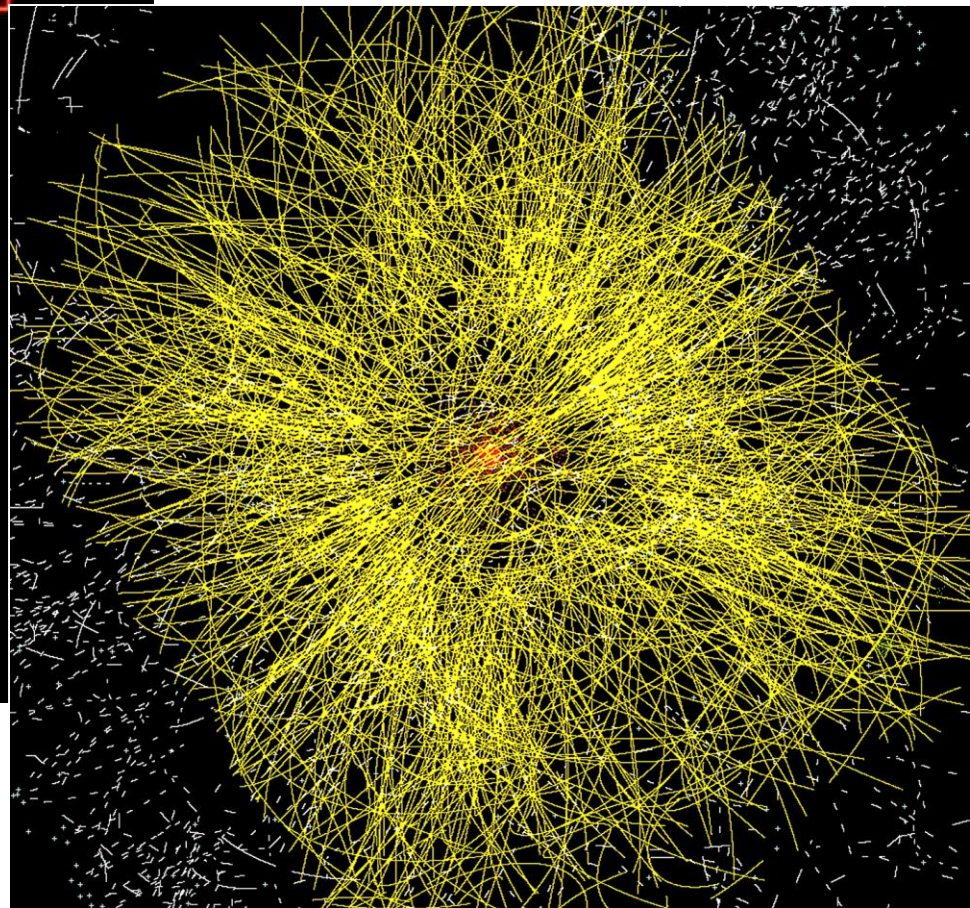
The particles are brought to collision (similar conditions as in the big bang).

The particles that are created are recorded by detectors.

One collision: past vs. future

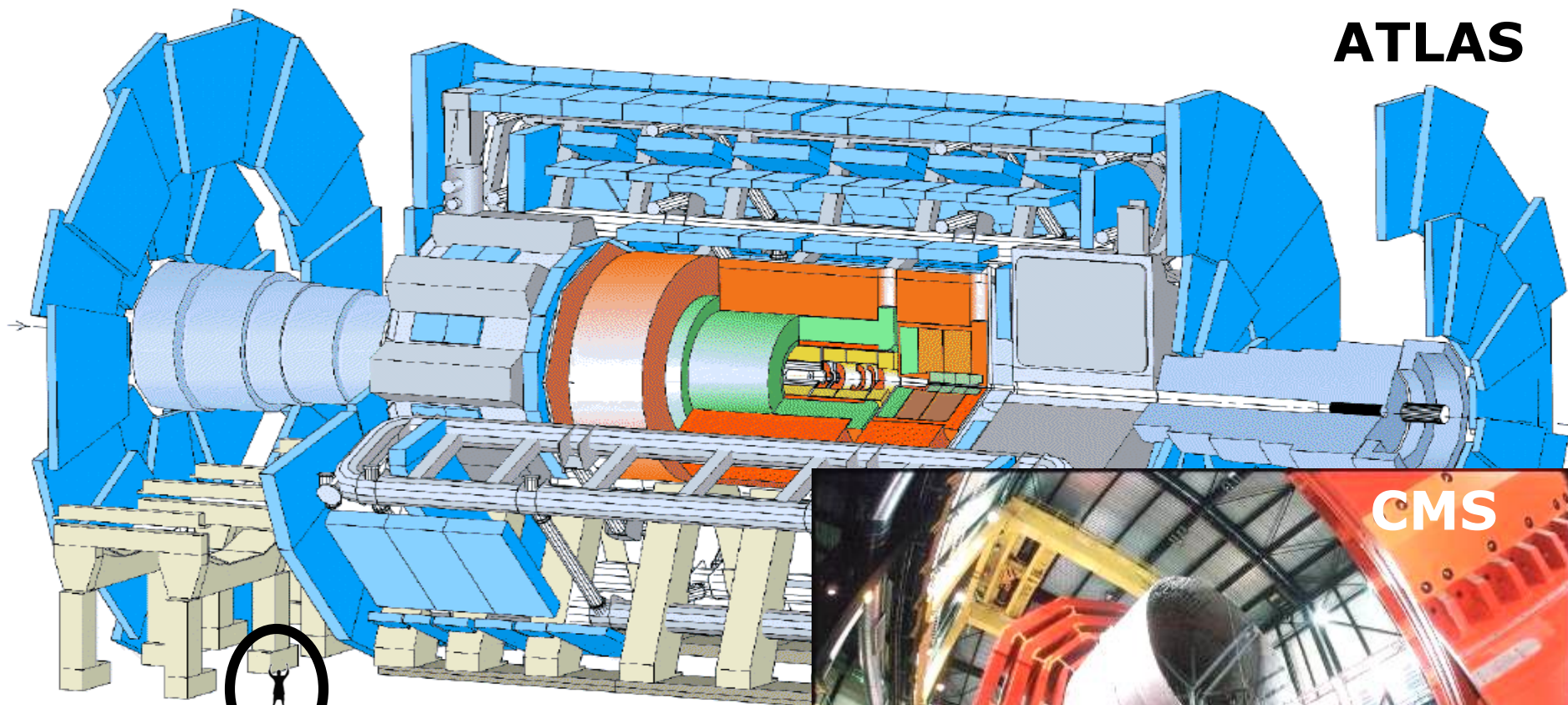


LHC
(ALICE)



Previous experiments
(DELPHI, LEP)

ATLAS

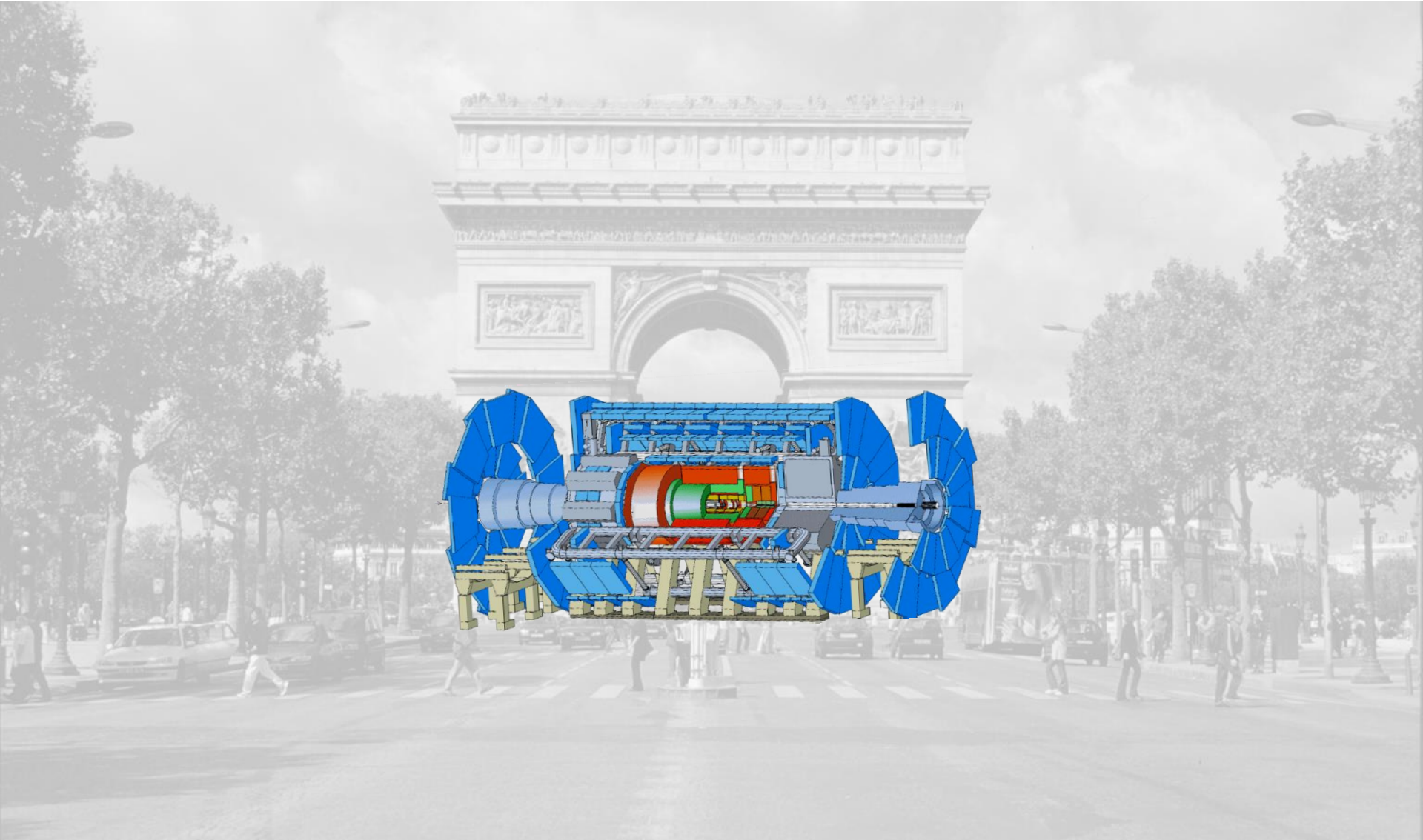


CMS

The size of people...

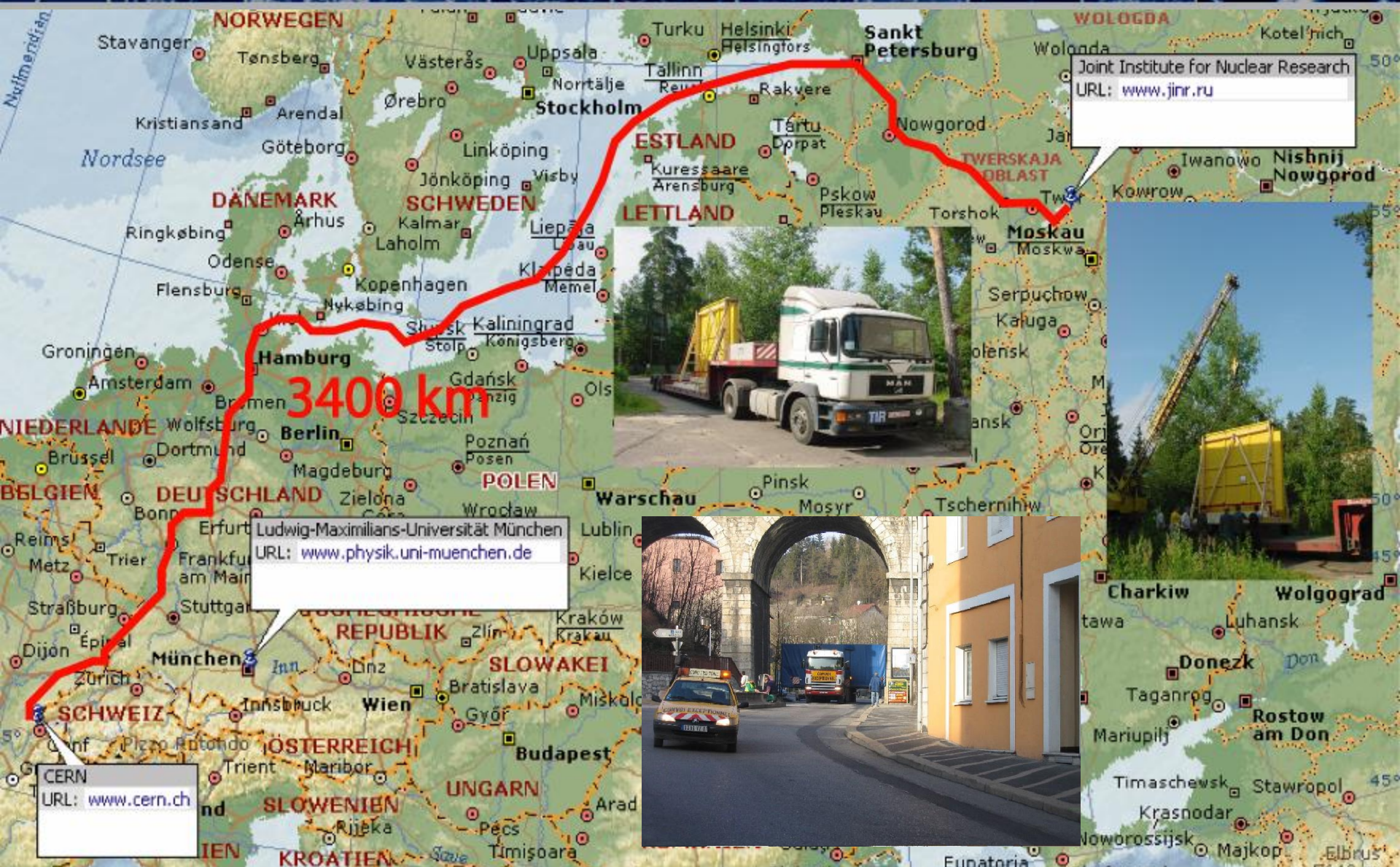


ATLAS – A Toroidal LHC ApparatuS





Delivery of Detector Elements

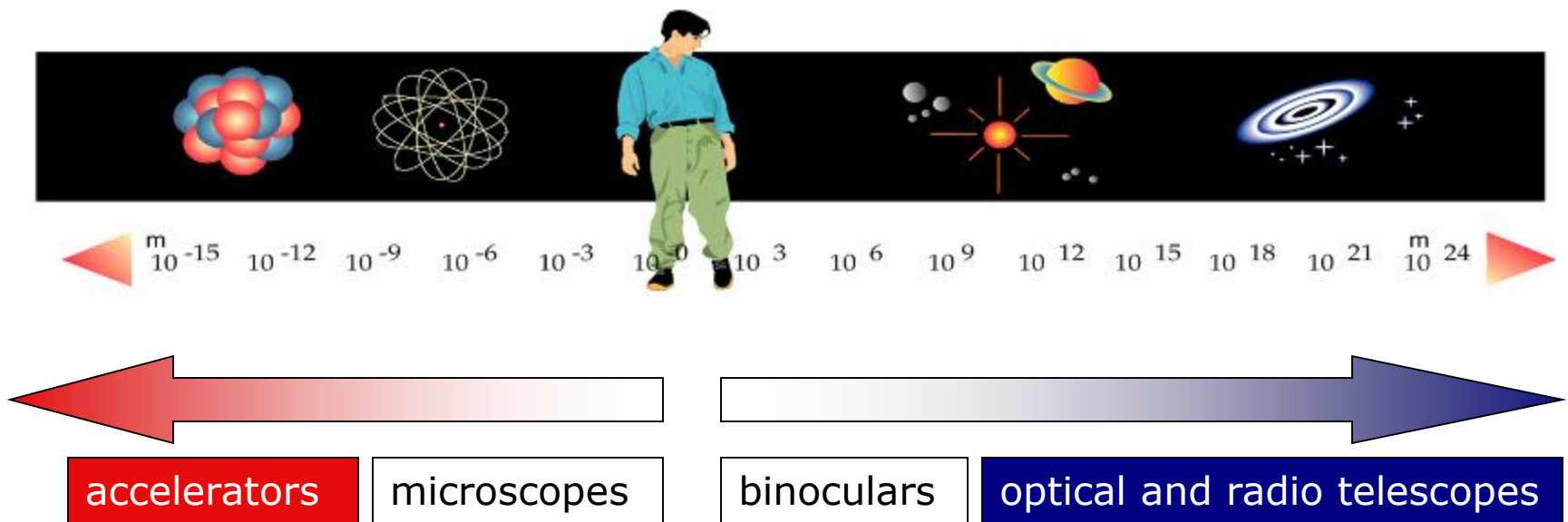


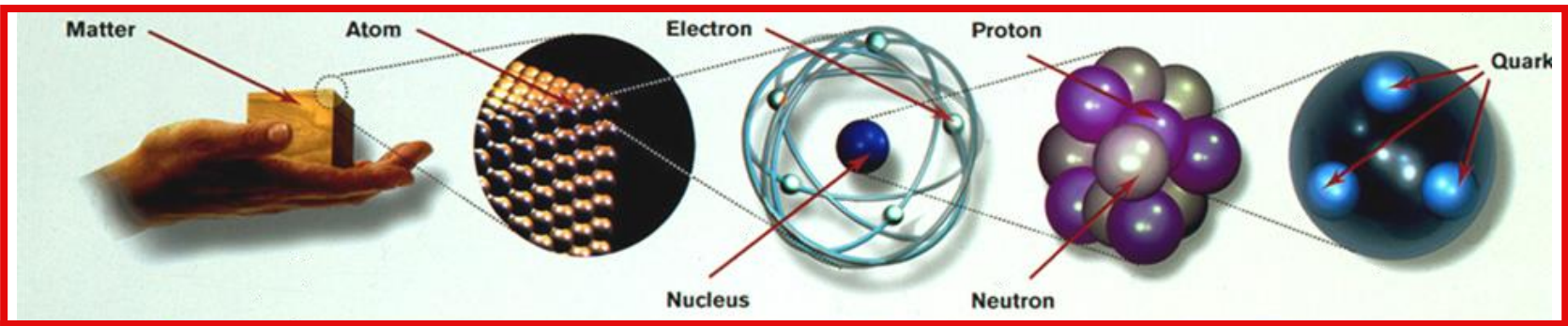
CERN
URL: www.cern.ch

Ludwig-Maximilians-Universität München
URL: www.physik.uni-muenchen.de

Joint Institute for Nuclear Research
URL: www.jinr.ru

Particle physicists need accelerators in order to investigate the fundamental constituents of matter, their creation and the forces that act between them.





Matter particles	LEPTONS				QUARKS			
	FIRST FAMILY							
All ordinary particles belong to this group	Electron Responsible for electricity and chemical reactions; it has a charge of -1		Electron neutrino Particle with no electric charge, and possibly no mass; billions fly through your body every second		Up Has an electric charge of plus two-thirds; protons contain two, neutrons contain one		Down Has an electric charge of minus one-third; protons contain one, neutrons contain two	
These particles existed just after the Big Bang. Now they are found only in cosmic rays and accelerators	Muon A heavier relative of the electron; it lives for two-millionths of a second		Muon neutrino Created along with muons when some particles decay		Charm A heavier relative of the up; found in 1974		Strange A heavier relative of the down; found in 1964	
	Tau Heavier still; it is extremely unstable. It was discovered in 1975		Tau neutrino not yet discovered but believed to exist		Top Heavier still		Bottom Heavier still; measuring bottom quarks is an important test of electroweak theory	

Force particles	Strong Force		Electromagnetic Force		Weak Force		Gravitational Force	
These particles transmit the four fundamental forces of nature although gravitons have so far not been discovered	Gluons Carriers of the strong force between quarks		Photons Particles that make up light; they carry the electromagnetic force		Intermediate vector bosons Carriers of the weak force		Gravitons Carriers of gravity	
		Felt by: quarks		Felt by: quarks and charged leptons		Felt by: quarks and leptons		Felt by: all particles with mass
		The explosive release of nuclear energy is the result of the strong force		Electricity, magnetism and chemistry are all the results of electro-magnetic force		Some forms of radio-activity are the result of the weak force		All the weight we experience is the result of the gravitational force



Nobel prize 1984: CERN

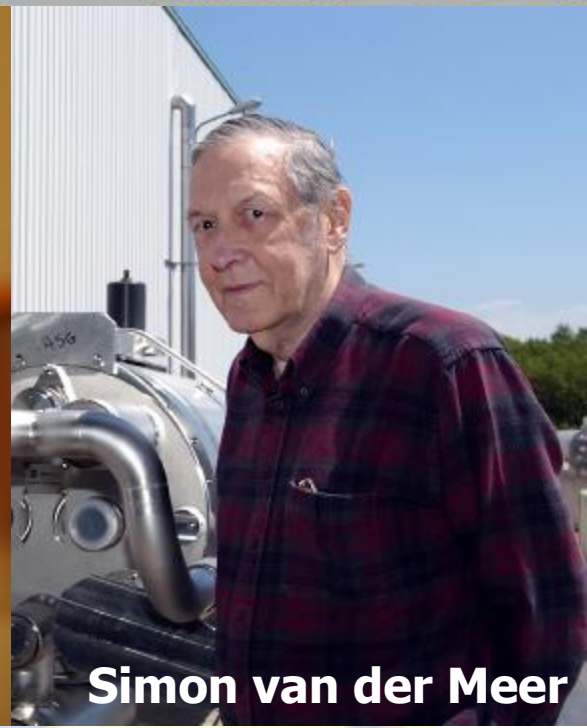
Matter

Atom

Matter particles	LEPTONS	QUARKS
<p>Primary particles that form the world as we know it</p> <p>They do not interact with each other</p>	<p>Electron Responsible for electricity and chemical reactions, it has a charge of -1</p> <p>Muon A heavier relative of the electron; it lives for two millionths of a second</p> <p>Tau neutrino</p>	<p>Electron neutrino Particle with no charge, and it follows by three every second</p> <p>Muon neutrino Created along with muons when some particles are produced</p>



Carlo Rubbia



Simon van der Meer

"for their decisive contributions to the large project, which led to the discovery of the field particles W and Z, communicators of weak interaction"

Photons
Particles that make up light; they carry the electromagnetic force

Felt by: quarks and leptons

Electricity, magnetism and chemistry are all the results of very tiny magnetic forces

Intermediate vector bosons
Carriers of the weak force

Felt by: quarks and leptons

Some forms of radio-activity are the result of the weak force

Gravitons
Carriers of gravity

Felt by: all particles with mass

All the weight we experience is the result of the gravitational force

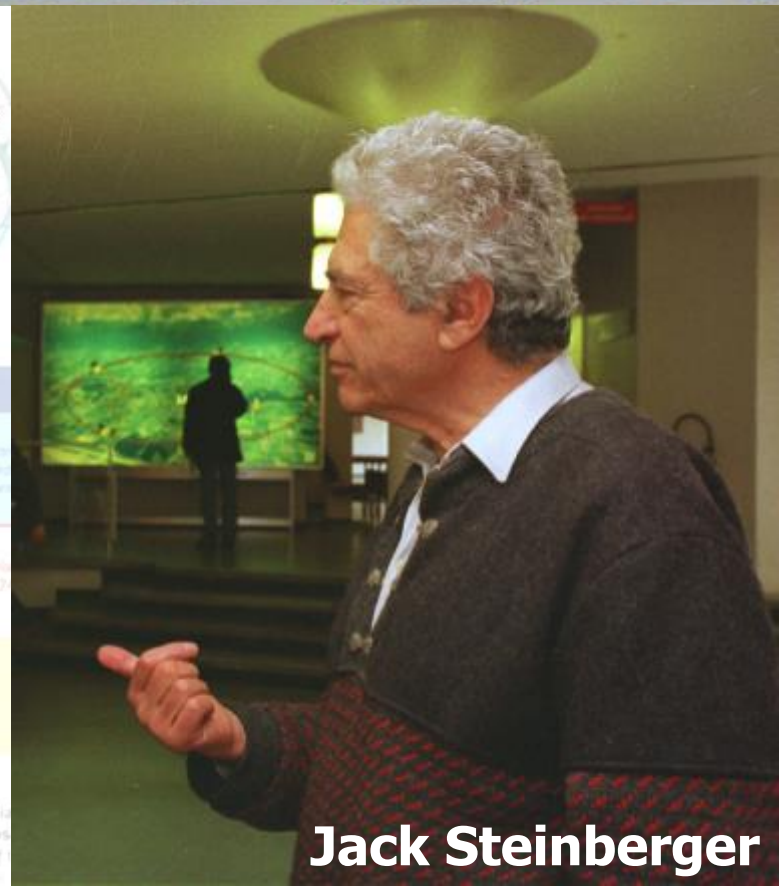
Matter

Atom

Electron

Nucleus

LEPTONS	
Electron Responsible for electricity and chemical reactions; it has a charge of -1	Electron neutrino Particle with no electric charge, and possibly no mass; follows by through your body every second
Muon A heavier relative of the electron; it lives for two-millionths of a second	Muon neutrino Created along with muons when some particles decay
Tau Heavier still, it is extremely unstable. It was discovered in 1975	Tau neutrino It is thought to be the heaviest of the neutrinos



"for the neutrino beam method and the demonstration of the doublet structure of the leptons through the discovery of the muon neutrino"

We (physicists) cannot just go to a shop and buy our detectors.

So we invent them !

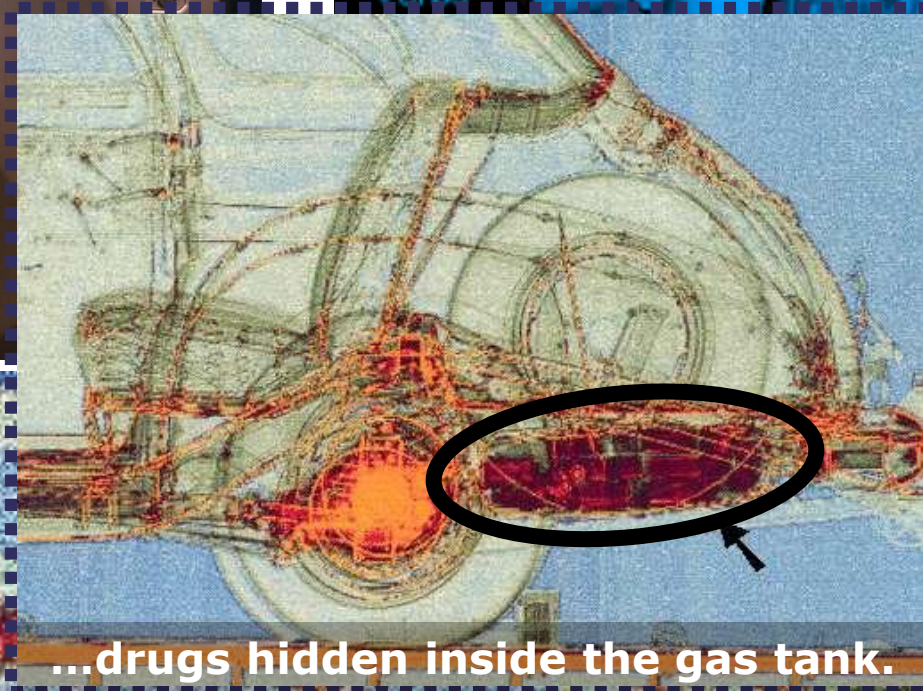
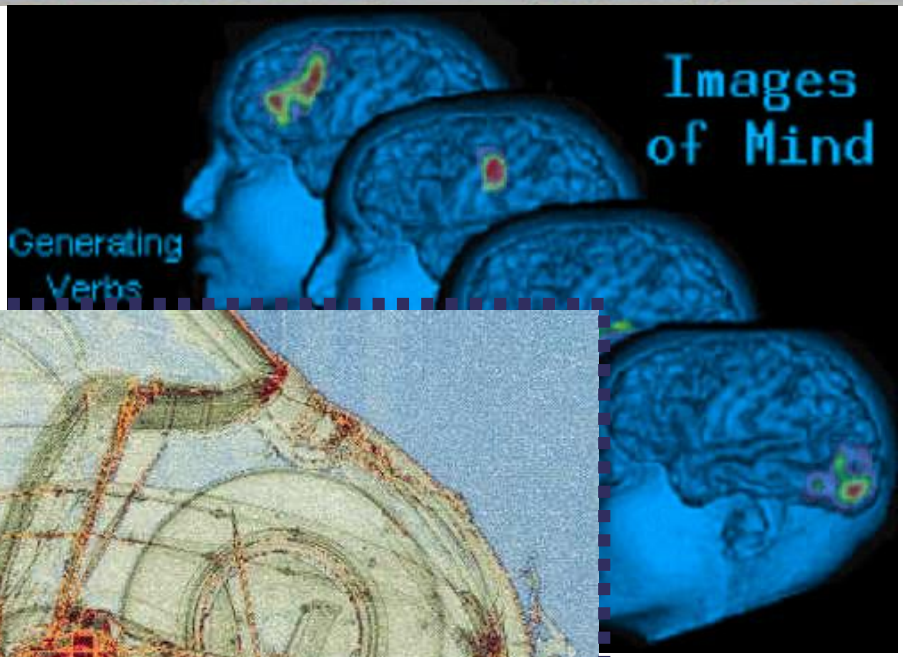
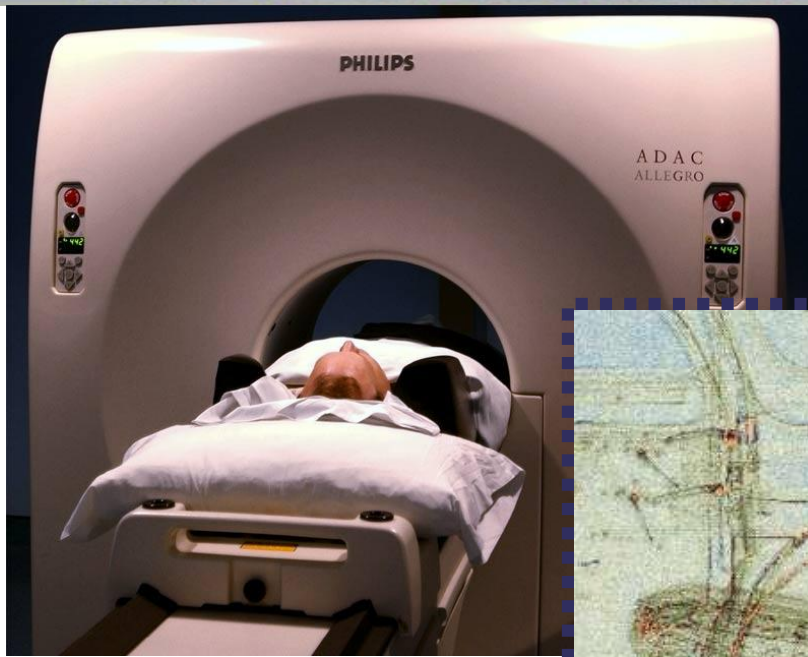
"for his invention and development of particle detectors, in particular the multiwire proportional chamber"



Georges Charpak



Other uses for CERN-made detectors



...drugs hidden inside the gas tank.

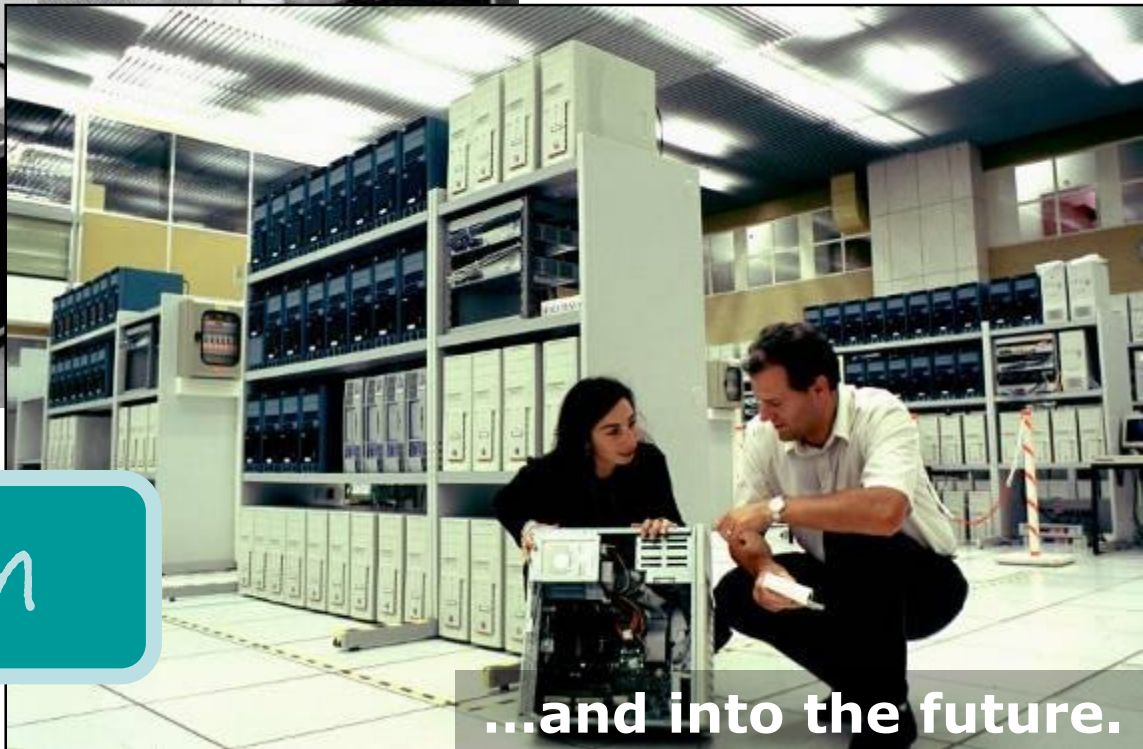
A truck, carrying two cars in a container and...



World Wide Web, GRID, Computing...



Tim Berners-Lee
father of the WWW

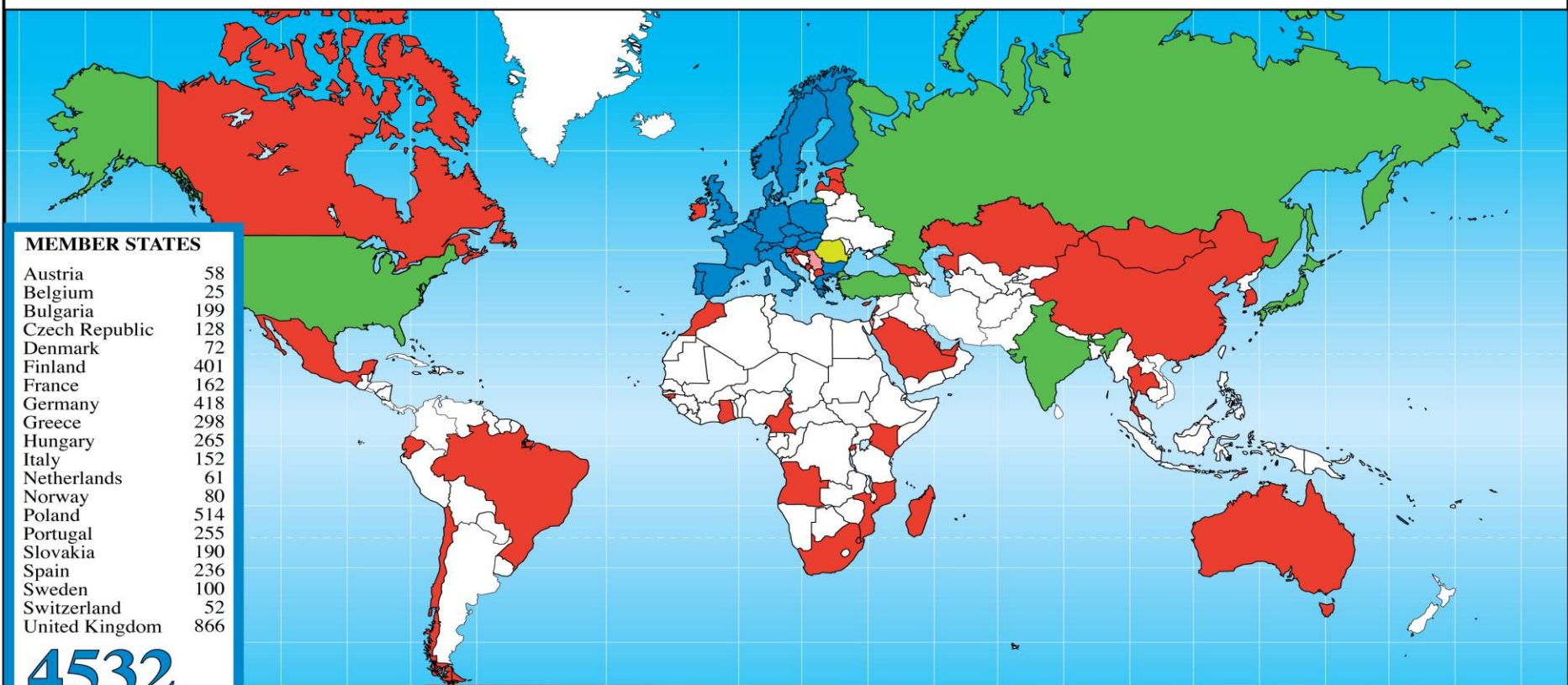


...and into the future.

From the past...

www.cern.ch

CERN Teacher Programme Participants 1998 - 2011



MEMBER STATES

Austria	58
Belgium	25
Bulgaria	199
Czech Republic	128
Denmark	72
Finland	401
France	162
Germany	418
Greece	298
Hungary	265
Italy	152
Netherlands	61
Norway	80
Poland	514
Portugal	255
Slovakia	190
Spain	236
Sweden	100
Switzerland	52
United Kingdom	866

4532

CANDIDATE FOR ACCESSION

Romania	10
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ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Israel	2
Serbia	10

OBSERVER STATES

India	2
Japan	3
Russia	132
Turkey	3
USA	56

196

OTHERS

Angola	4	China	1	Kenya	2	Qatar	1	Thailand	4
Australia	3	Croatia	1	Latvia	1	Rwanda	15	T.F.Y.R.O.M.	11
Azerbaijan	1	Cyprus	4	Lebanon	1	Sao Tome	2	Timor-Leste	1
Brazil	53	Ecuador	1	Madagascar	1	Saudi Arabia	1	Ukraine	30
Cameroon	1	Estonia	18	Malta	36	Singapore	2	U.A.E.	1
Canada	1	Georgia	16	Mexico	5	Slovenia	21		
Cape Verde	2	Ghana	4	Mongolia	1	South Africa	6		
Chile	3	Guinea Bissau	1	Montenegro	13	South Korea	22		
		Ireland	3	Morocco	2	Swaziland	1		
		Kazakhstan	3	Mozambique	13				

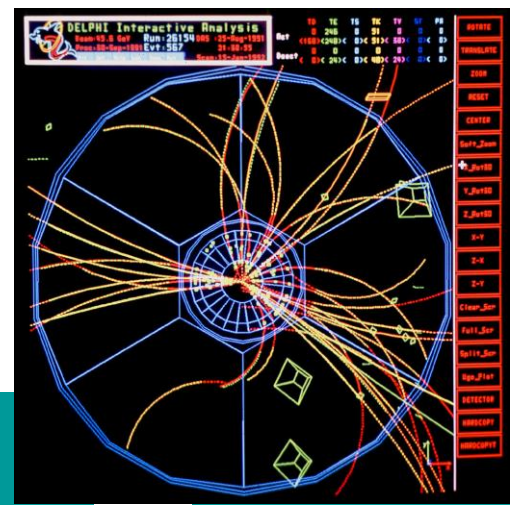
343



CERN in a nutshell



**International
Collaboration**



**Fundamental
Physics
Research**



Training



Technology



*Thank you
and
enjoy!*