

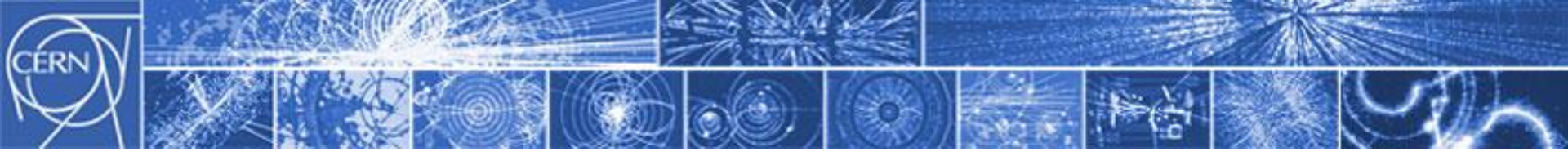
CERN

European Organization for Nuclear Research

Organisation Européenne pour la Recherche Nucléaire

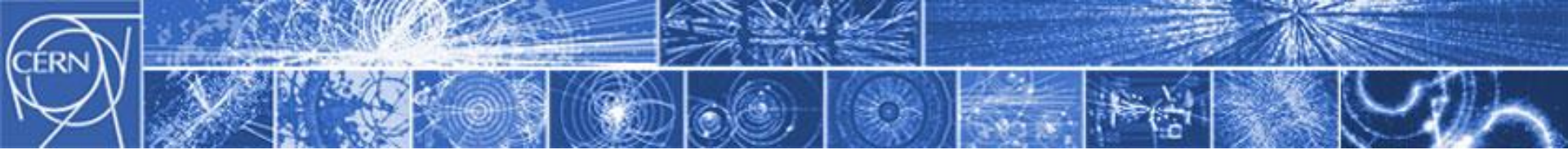
Välkommen till CERN

Lennart Jirden
CERN PH Department



En introduktion till CERN

- Vad
- Varför
- Hur
- Spin-off
- Senaste nytt

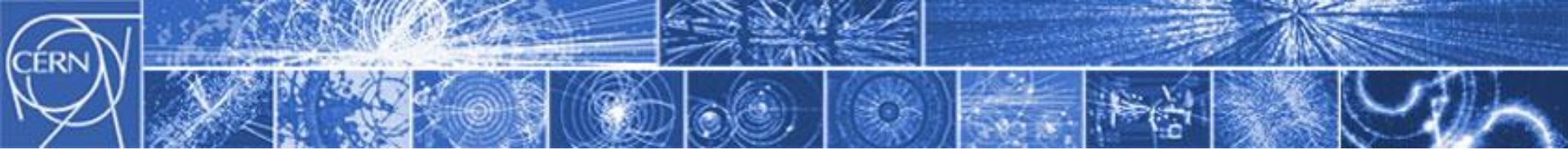


Vad betyder « **CERN** »?

1952

C onseil	European
E uropéen pour la	Council for
R echerche	Nuclear
N ucléaire	Research





Vad betyder « CERN »?

1954

Organisation

European

Européenne pour la Organization for

Recherche

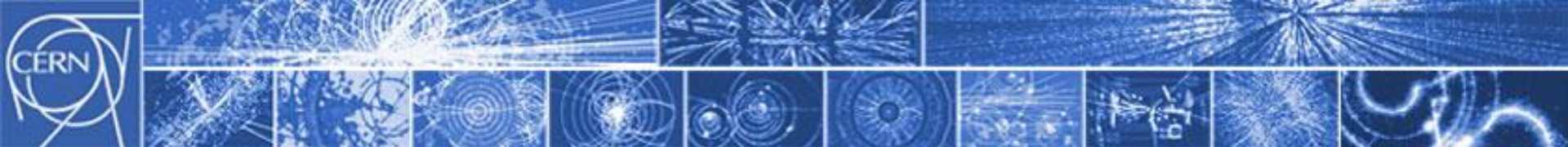
Nuclear

Nucléaire

Research

*European Laboratory
for Particle Physics*





Världens **största** partikelfysik laboratorium

Årlig budget

c:a 1200 MCHF (2013)

c:a 10 Miljarder SEK

Dessutom:

*extern finansiering
för experimenten*



People

2500 Staff
900 Fellows och
associates
350 Studenter
11000 Användare
2000 Externa Firmor

c:a 16 000 personer

21 Medlemsländer

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

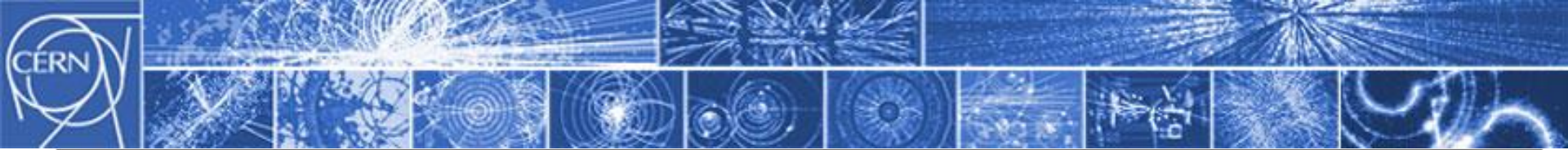
8 Observatörer

USA, Russia, India, Japan, Serbia, Turkey, UNESCO

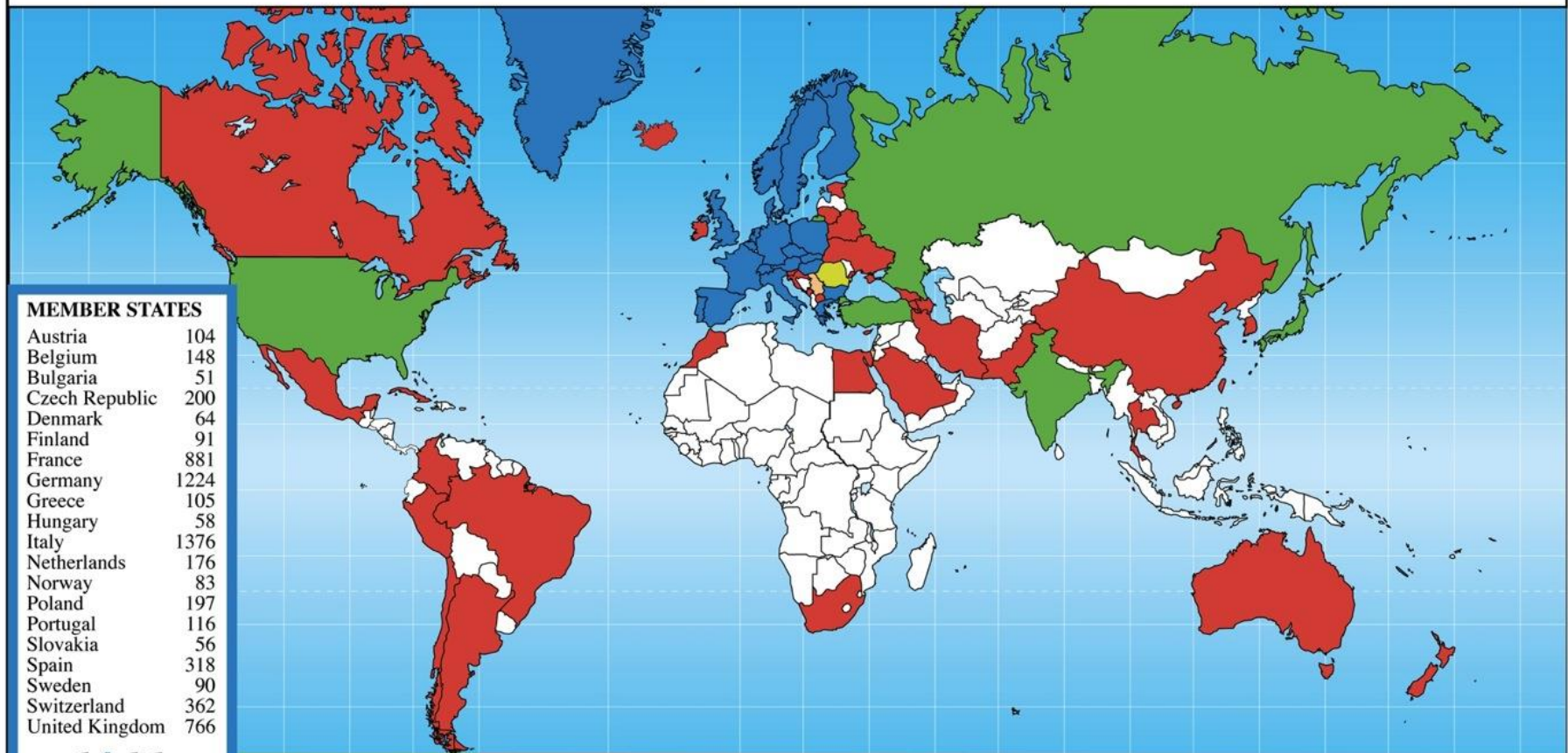
5 Kandidater

Romania, Serbia, Ukraine, Slovenia, Turkey

72 Användarländer



Distribution of All CERN Users by Location of Institute on 2 September 2013



MEMBER STATES

Austria	104
Belgium	148
Bulgaria	51
Czech Republic	200
Denmark	64
Finland	91
France	881
Germany	1224
Greece	105
Hungary	58
Italy	1376
Netherlands	176
Norway	83
Poland	197
Portugal	116
Slovakia	56
Spain	318
Sweden	90
Switzerland	362
United Kingdom	766

6466

OBSERVERS

India	154
Japan	224
Russia	899
Turkey	106
USA	1787

3170

CANDIDATE FOR ACCESSION

Romania	82
---------	----

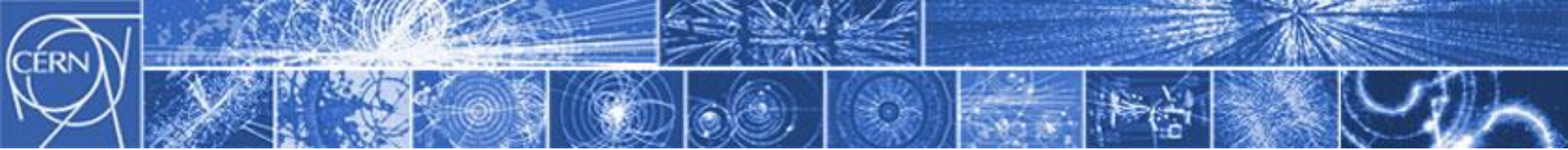
ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Israel	57
Serbia	30

OTHERS

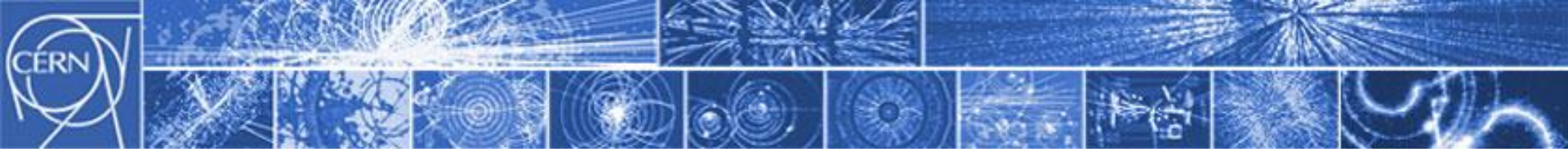
Argentina	17	Chile	7	Georgia	10	New Zealand	6
Armenia	17	China	130	Iceland	4	Pakistan	21
Australia	39	China (Taipei)	70	Iran	22	Peru	2
Azerbaijan	2	Colombia	11	Ireland	7	Saudi Arabia	3
Belarus	23	Croatia	25	Korea	103	Slovenia	25
Brazil	110	Cuba	3	Lithuania	16	South Africa	31
Canada	154	Cyprus	10	Mexico	40	Thailand	6
		Egypt	18	Montenegro	1	T.F.Y.R.O.M.	1
		Estonia	18	Morocco	9	Ukraine	26

987

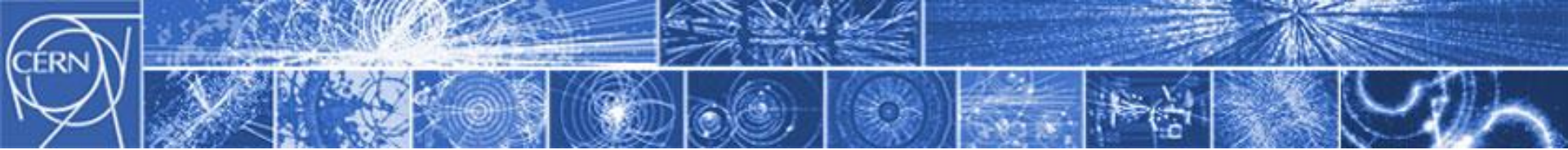


Som en liten stad...



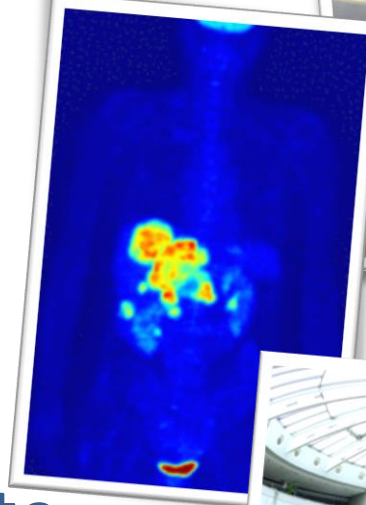


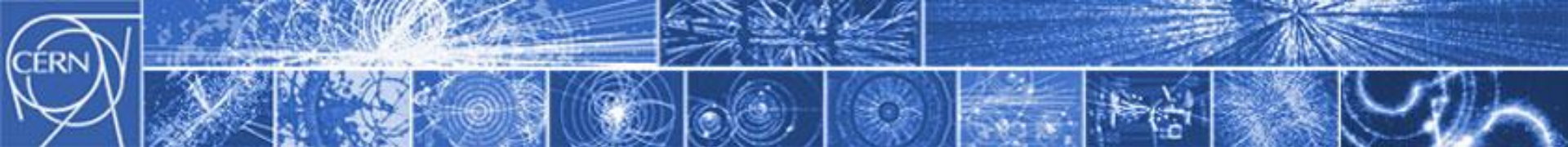
Varför?



CERN's målsättning

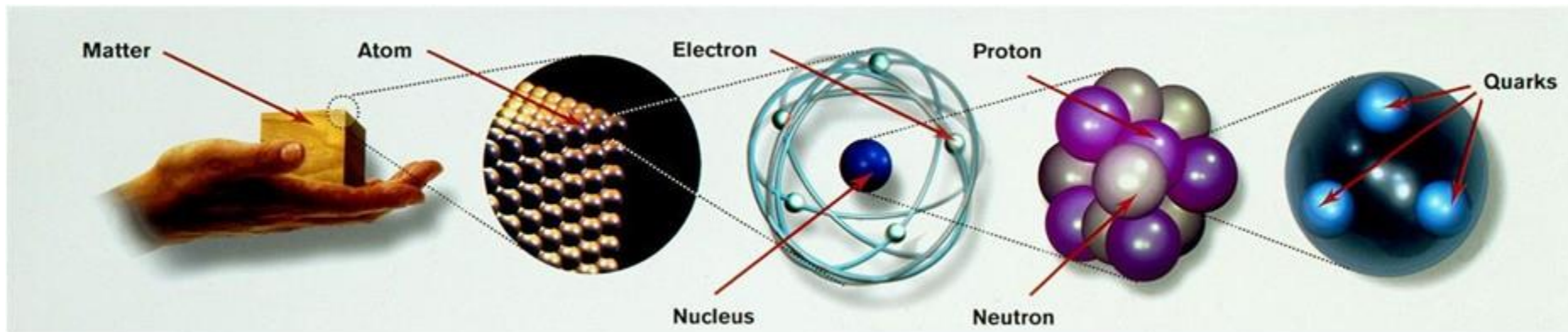
- Grundforskning
- Utbildning
- Teknologikutveckling
- Internationellt samarbete





Grund-forskning

Svara på frågor om materias struktur...



Atom
teori: 4000 bc
upptäckt: 1808

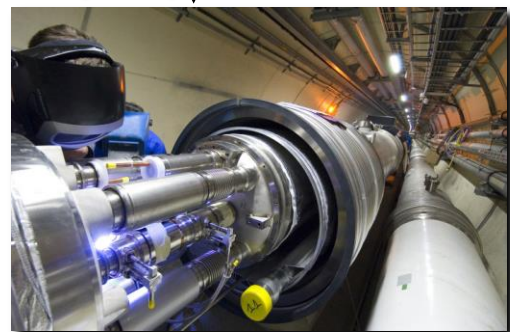
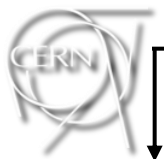
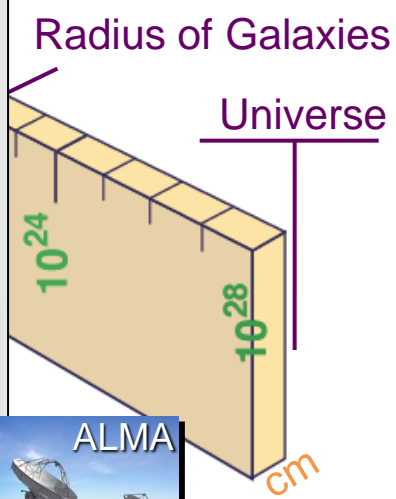
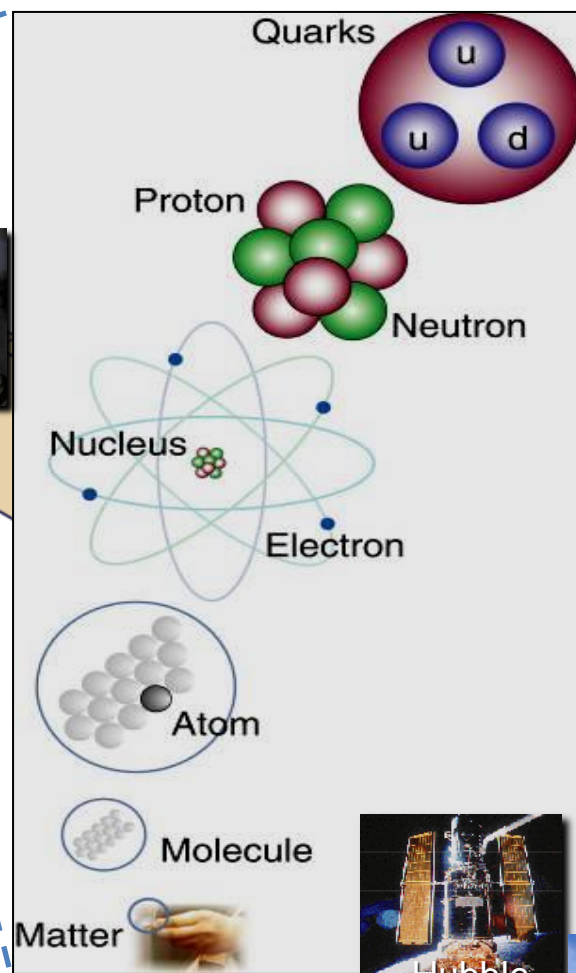
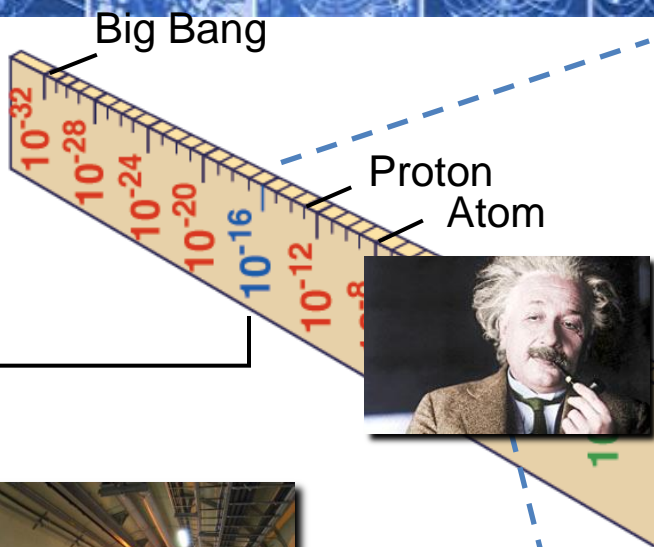
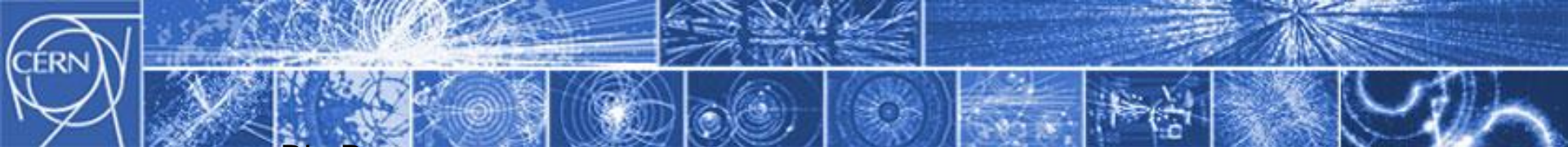
Elektron: 1897

Proton: 1919

Neutron: 1932

Kvark: 1960's

Alla dessa upptäckter gjordes i Europa!!

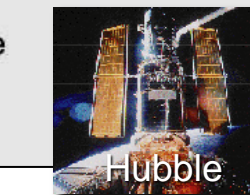


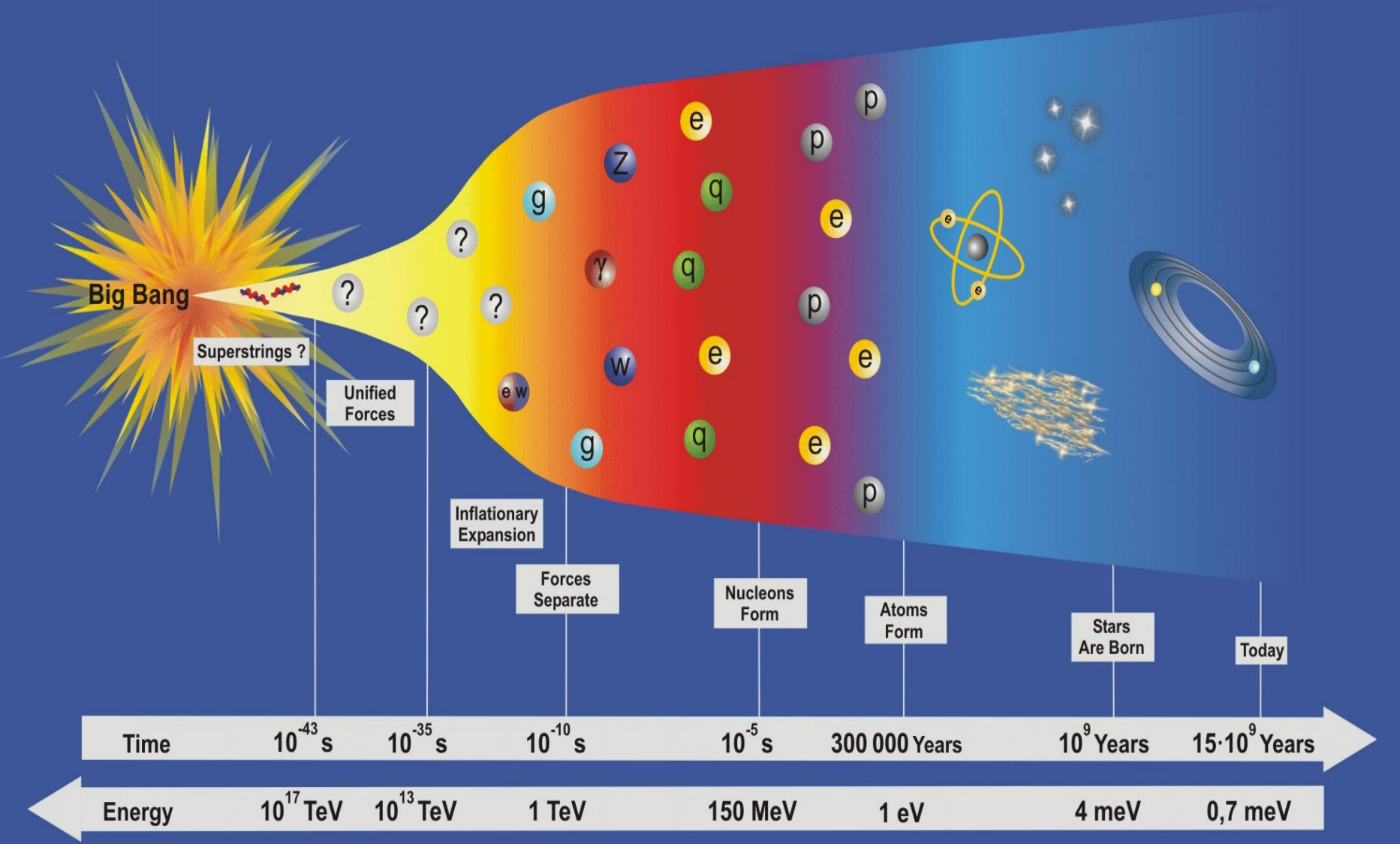
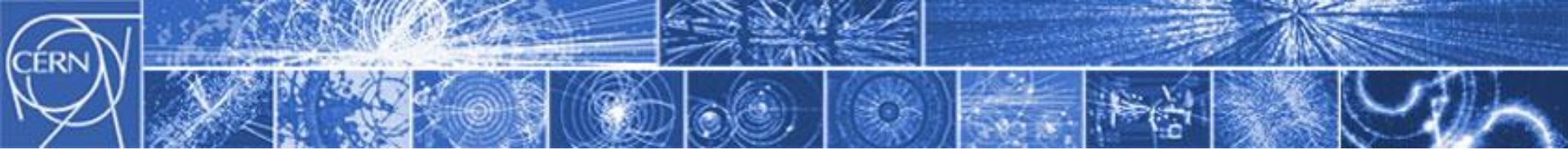
LHC

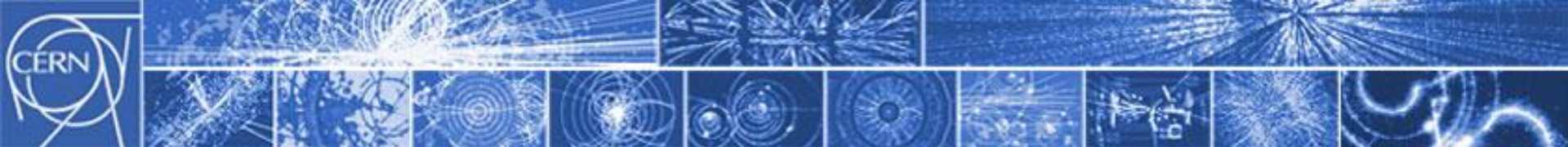
Super-Microscope



Studie av fysiska lagar
 vid första ögonblicken efter Big Bang
 Ökande samarbete mellan
 Partikelfysik, Astrofysik och Kosmologi



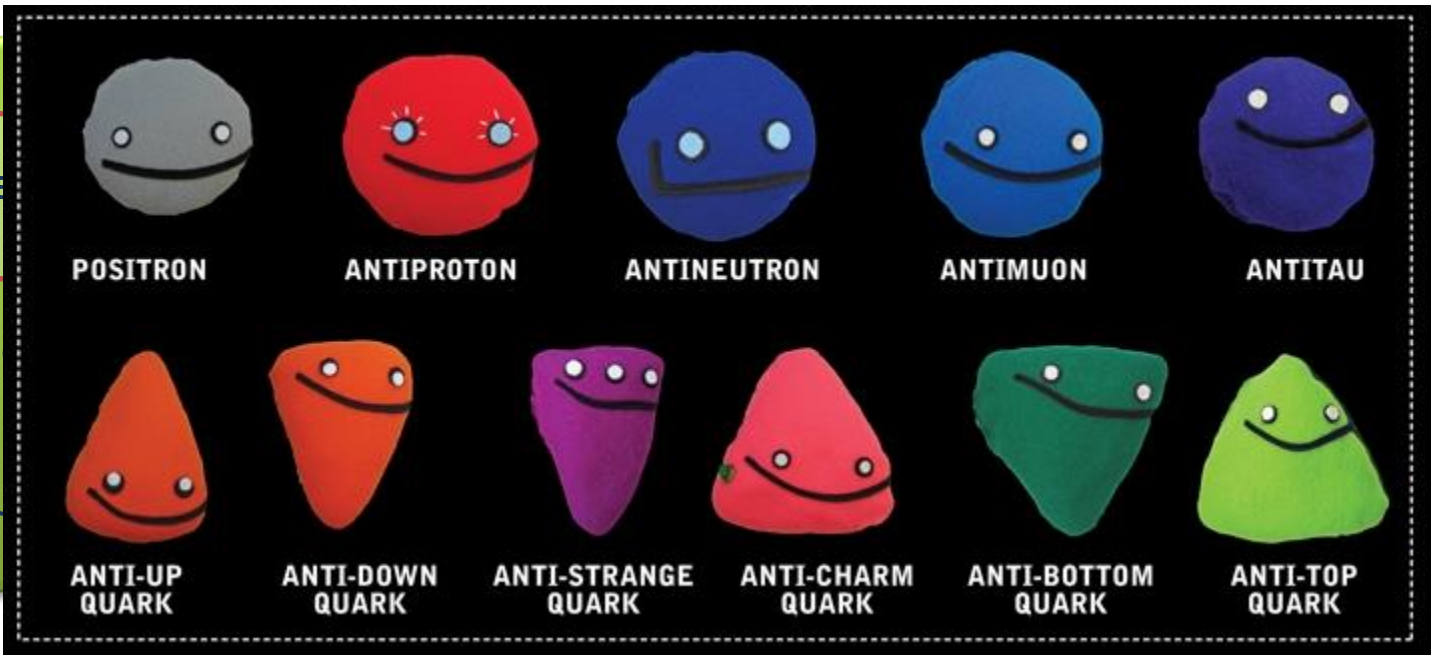




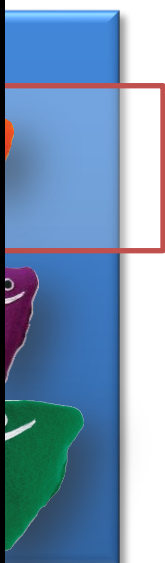
Verifiera existerande teorier: « standardmodellerna »

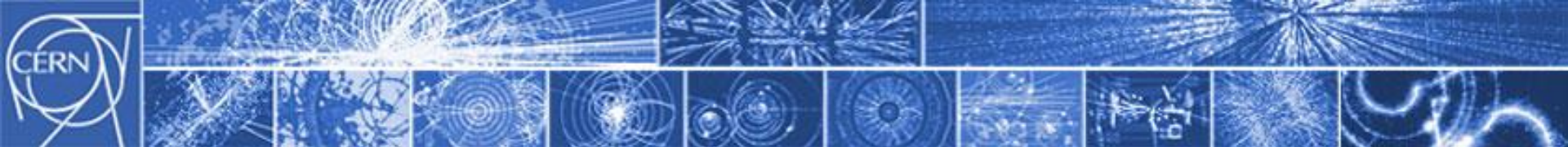
dom fundamentala byggstenarna

VANLIG
MATERIA



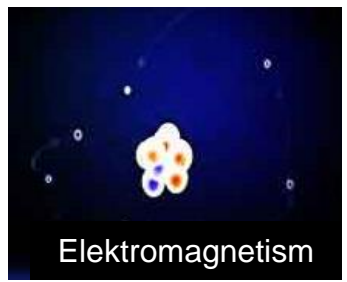
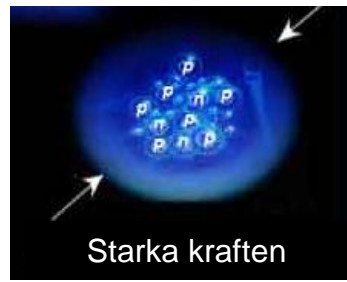
ELE
MU
TAU





« Standardmodellen »

de 4 grundläggande krafterna



Krafterna är resultatet av ett utbyte av partiklar

Utbytes-partiklarna kallas **Bosoner**

GLUON

Starka Kraften

PHOTON

Electro-Magnetiska Kraften

W och Z BOSON

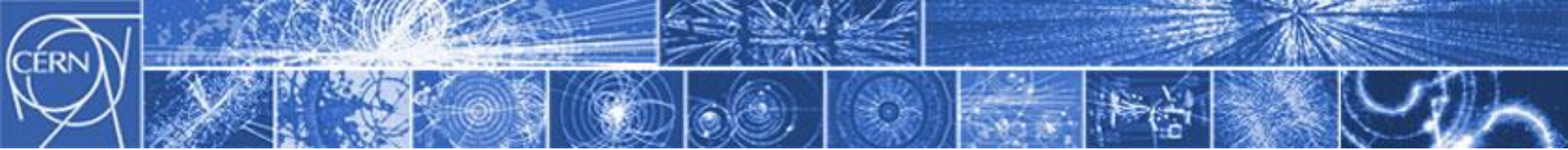
Svaga Kraften

HIGGS BOSON

Brout-Englert-Higgs fält

GRAVITON ?

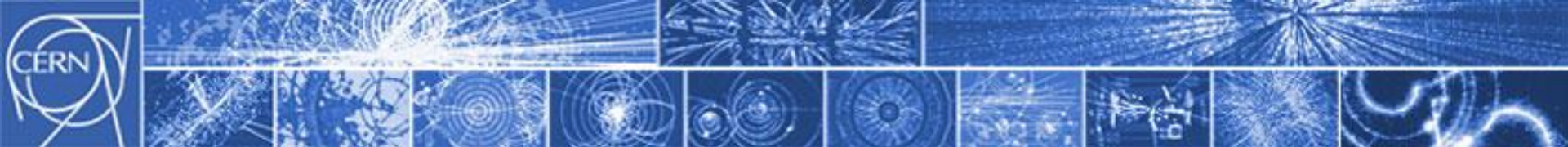
Tyngdkraften



Svara på grundläggande frågor...

Varför finns det ingen anti-materia i Universum?

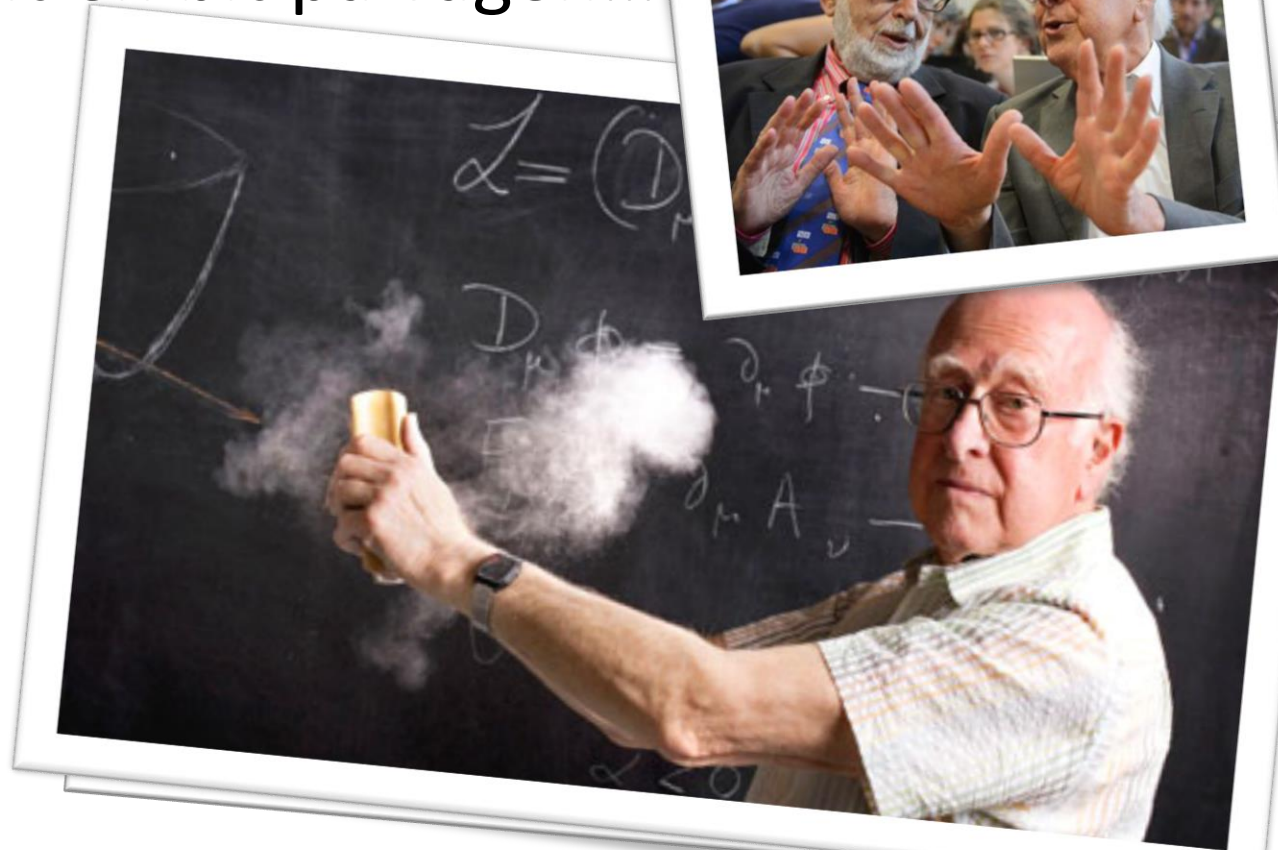




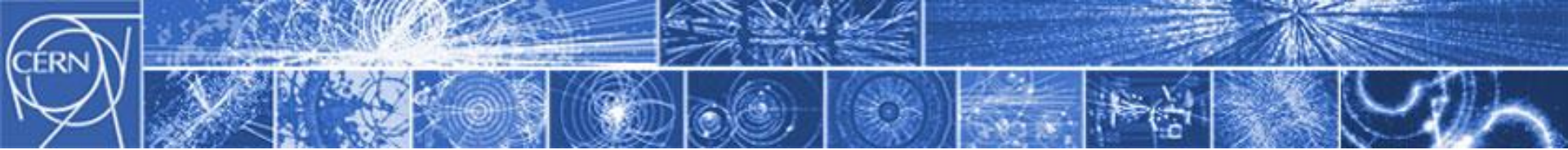
Svara på grundläggande frågor...

Hur förklara att partiklar har massa?

Vi har nu kommit en bit på vägen...



*Brout-Englert-Higgs
Boson*



Svara på grundläggande frågor...

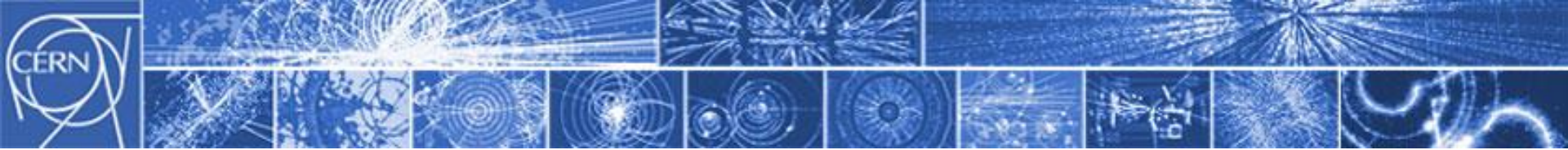
Vad är universums massa gjord av?

Vi kan bara se 4%
av dess beräknade
massa!

Mörk massa?

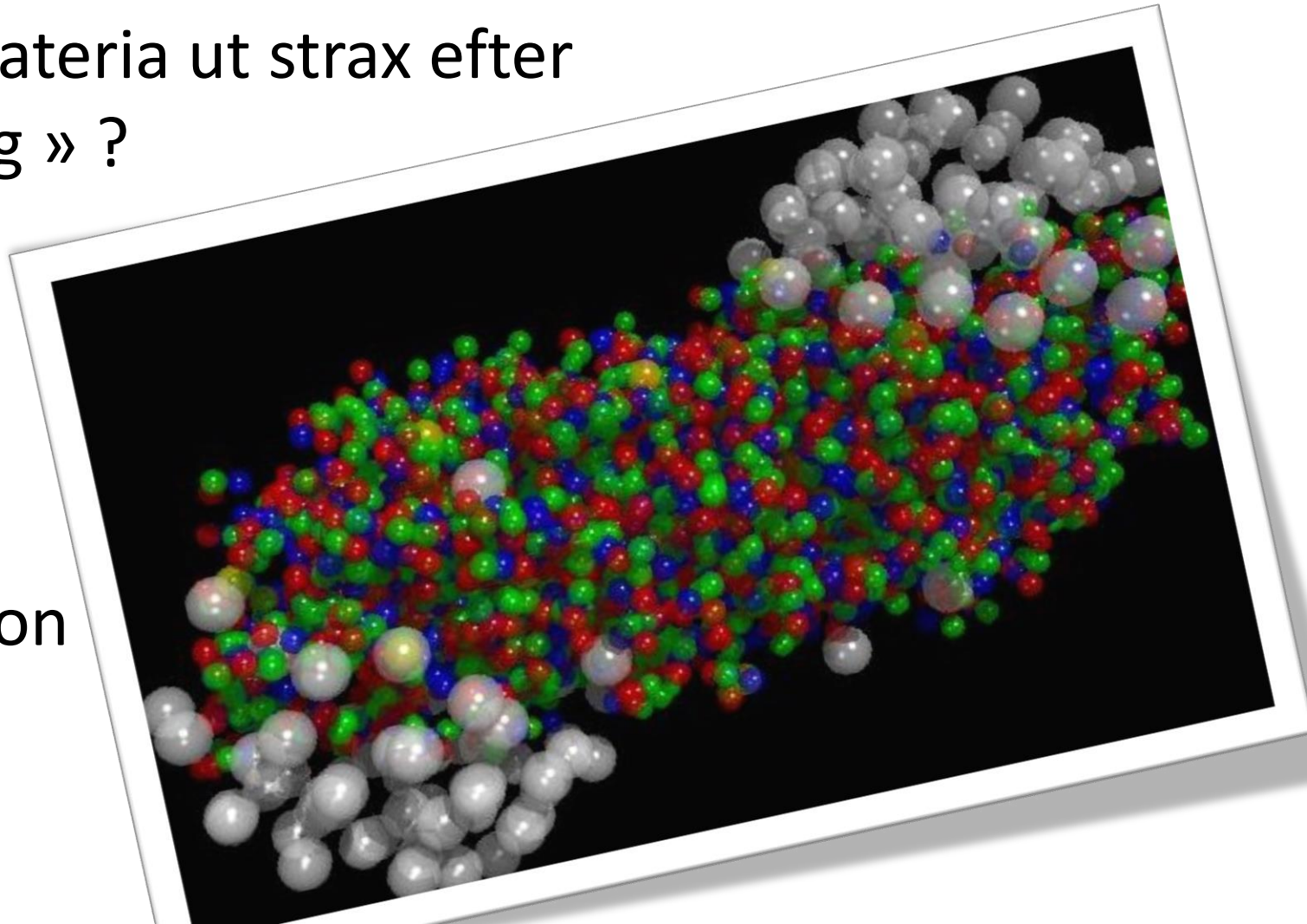
Mörk energi?



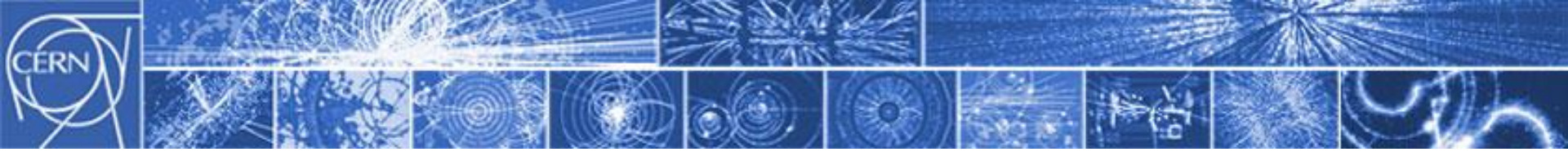


Svara på grundläggande frågor...

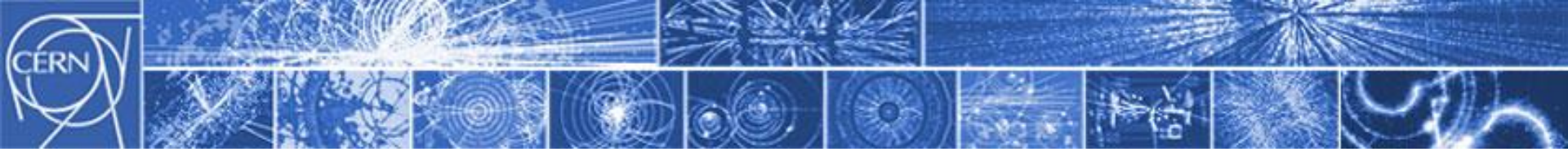
Hur såg materia ut strax efter
« Big Bang » ?



Quark-gluon
plasma

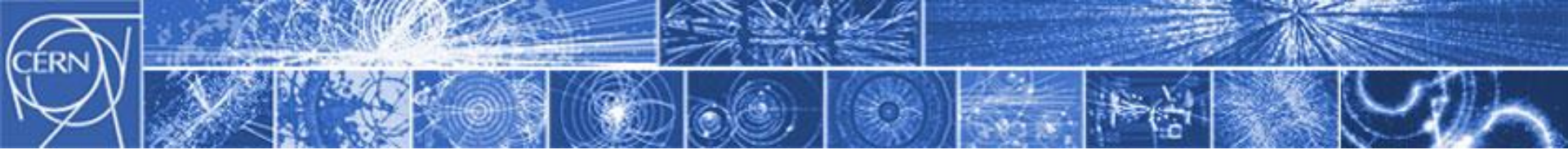


Hur ?

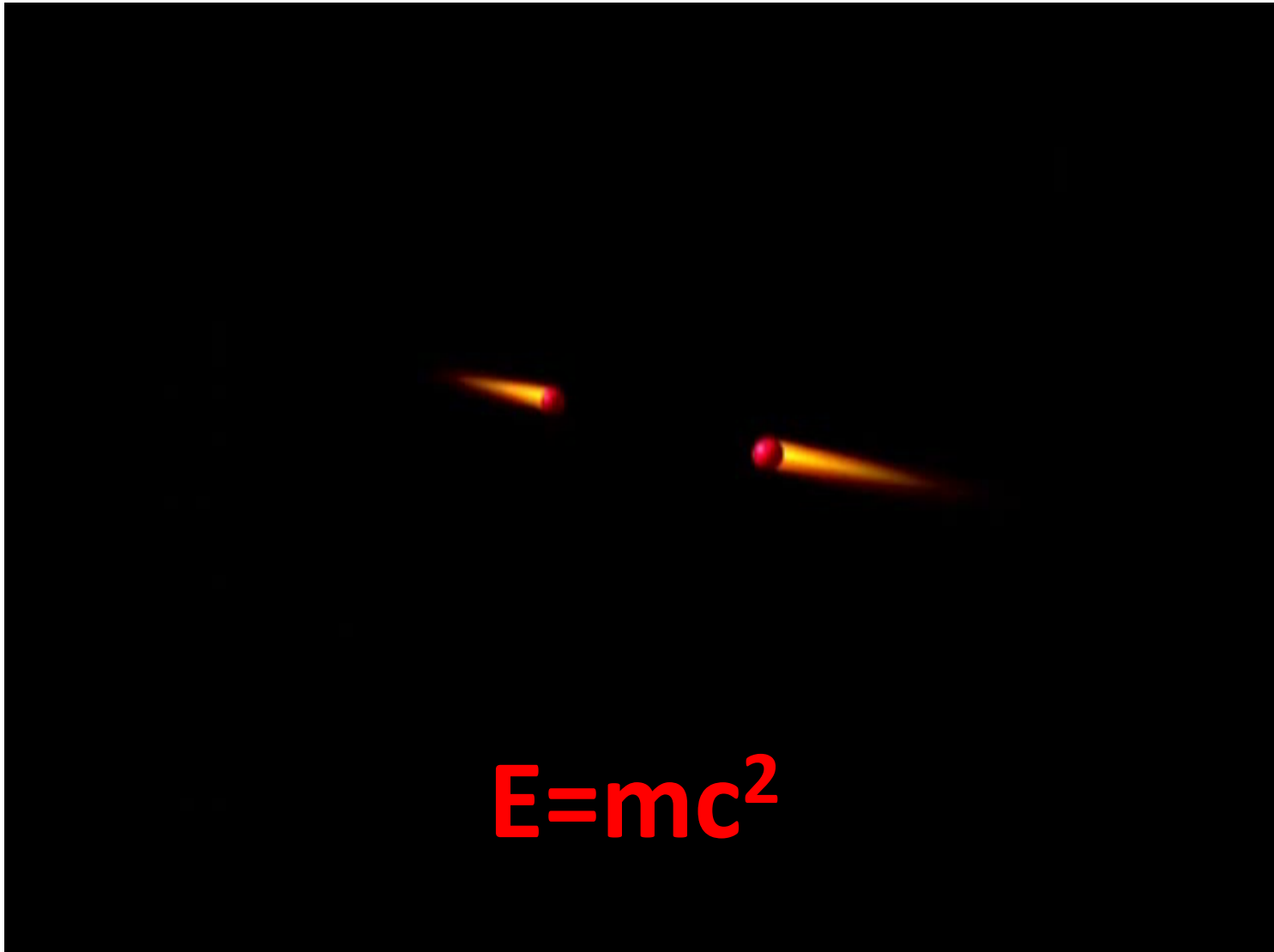


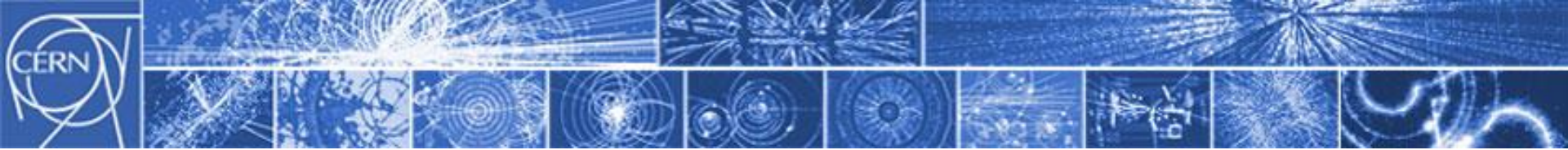
Genom att **accelerera** och **kollidera** objekt...



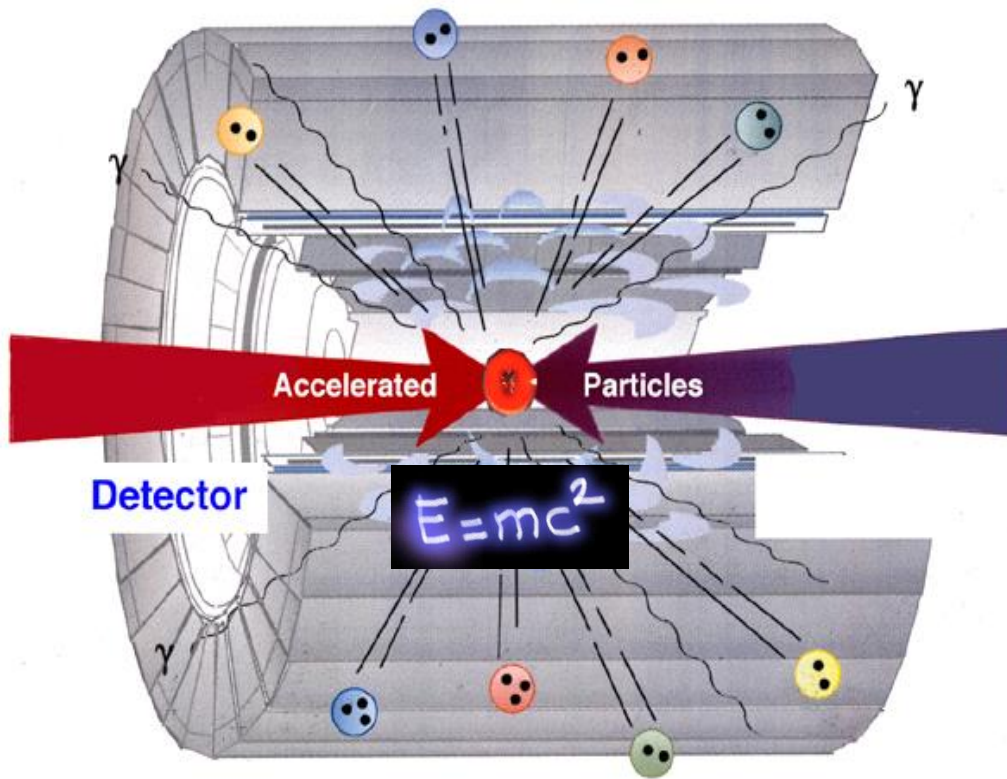


Vid ofantliga **energinivåer!**





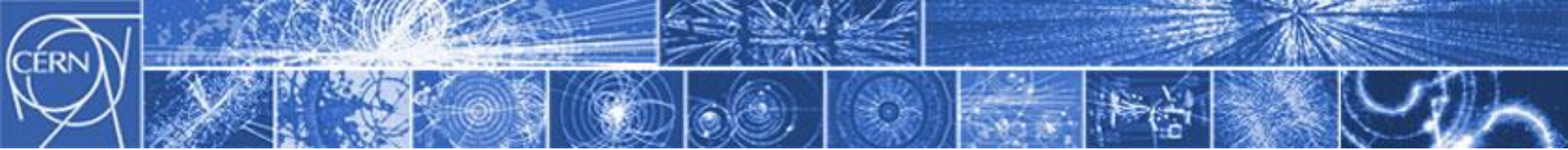
Dom huvudsakliga verktygen



(1) Partiklar accelereras up nästintill ljushastighet

(2) Bringas till kollision vid experimenten

(3) Dom resulterande partiklarna fångas upp av detektorerna



LHC - Världens **största** partikelaccelerator

27km lång tunnel

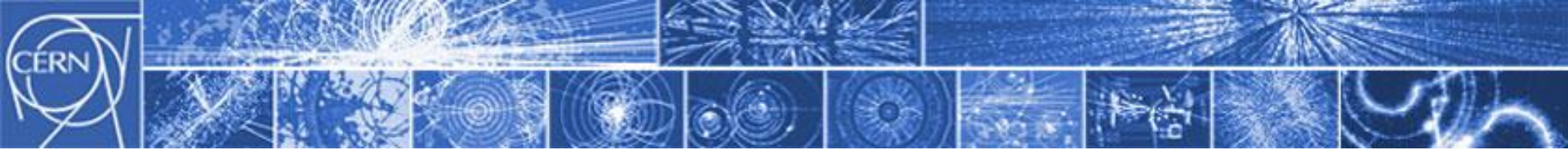
Tusentals
supraledande
magneter

Ultra vakum:
*10x högre
än på månen*

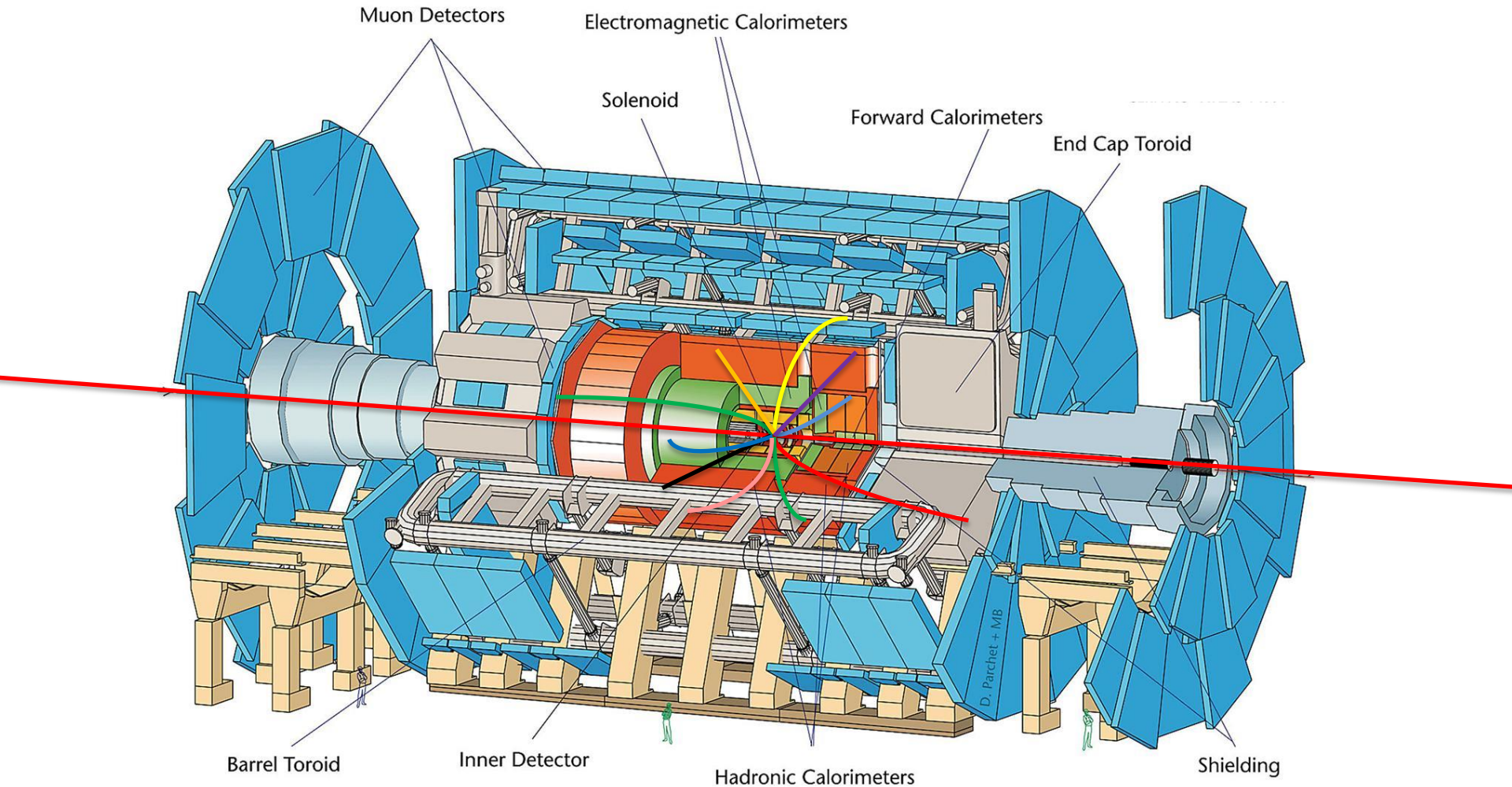
Kallaste plats i
Universum:
 $-271^{\circ}C$

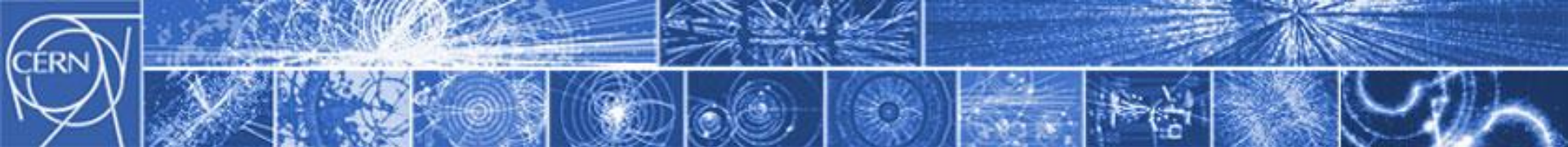
Under **säkra**
förhållanden!



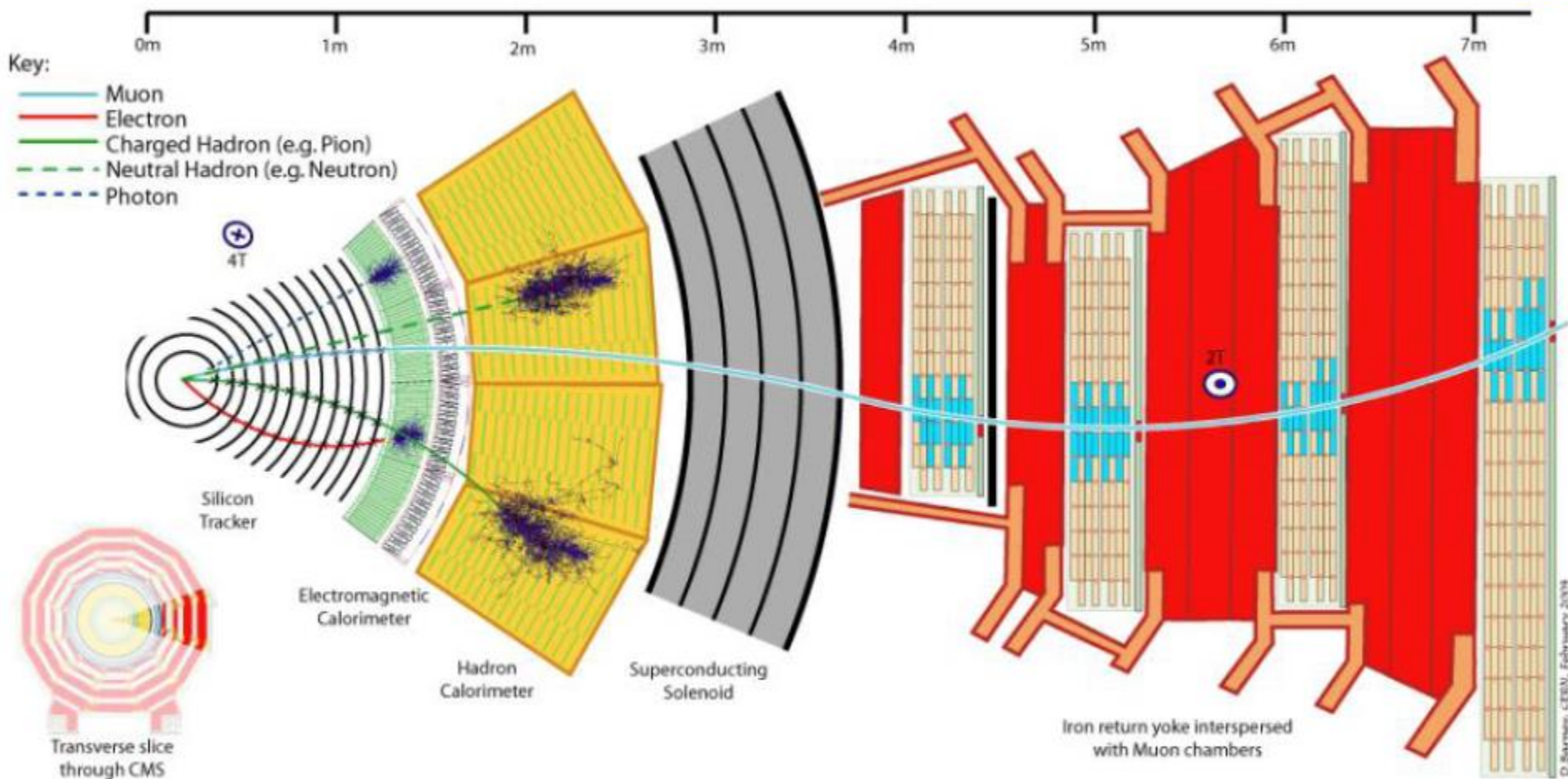


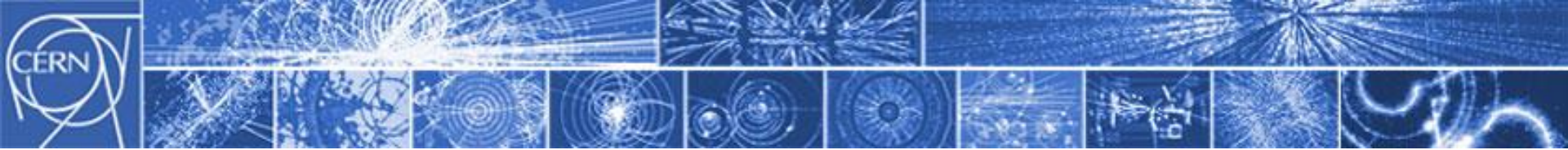
Största och mest sofistikerade detektorer



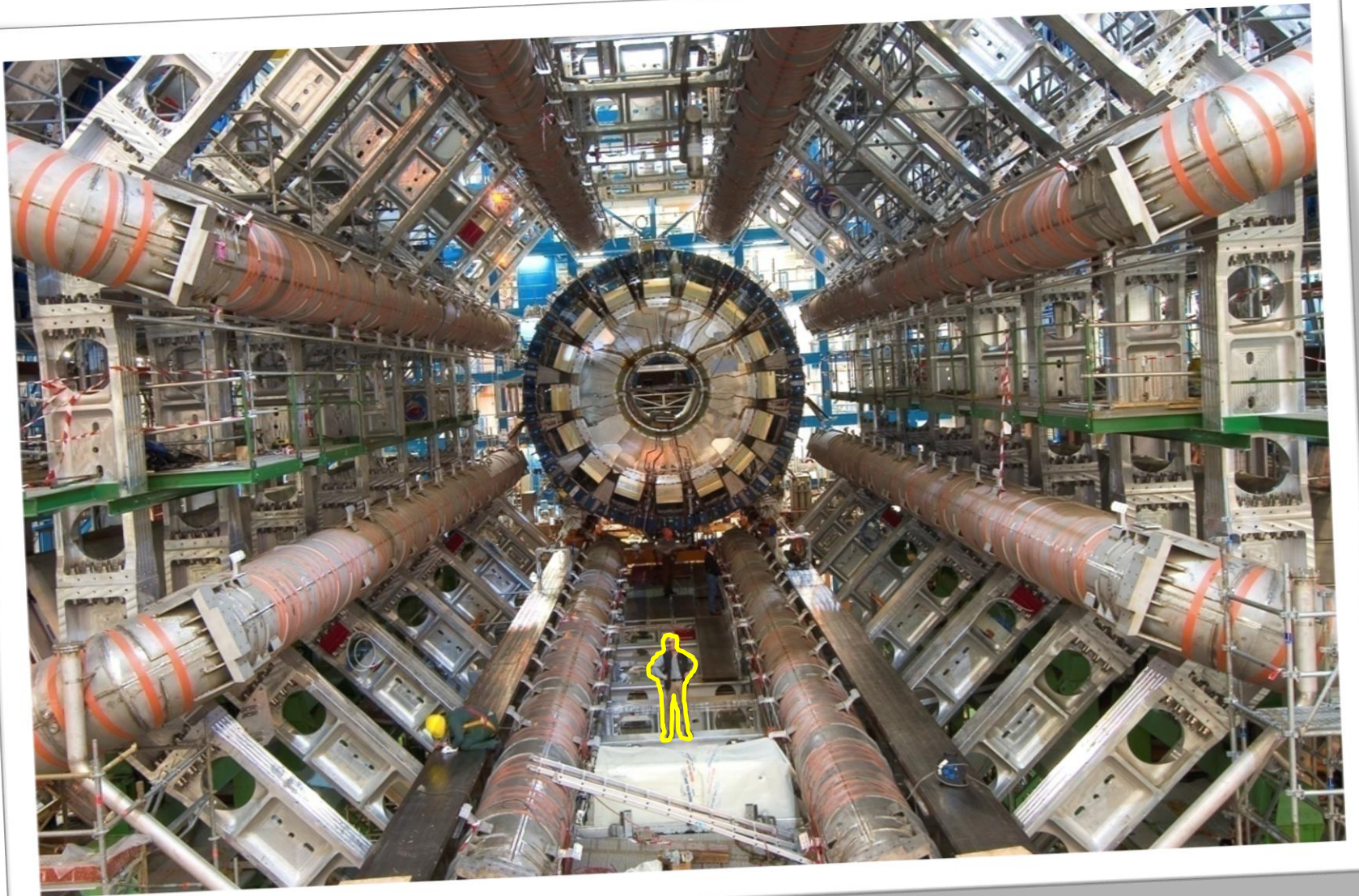


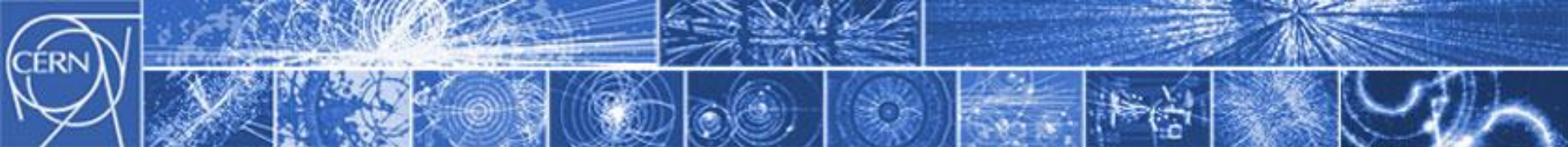
Partikeldetektorer



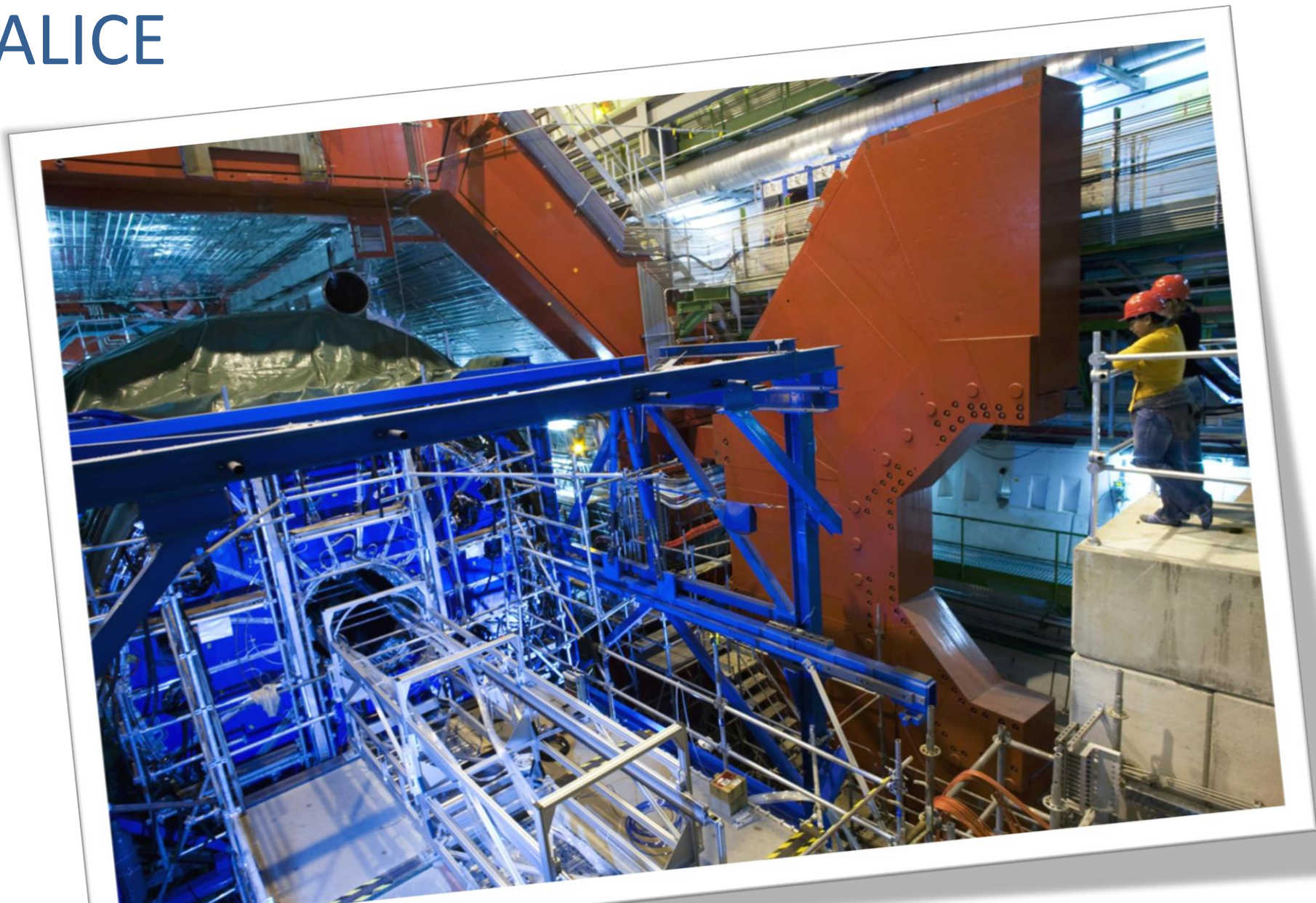


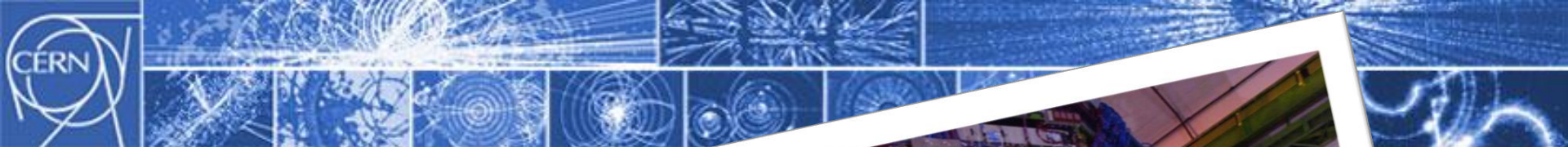
ATLAS



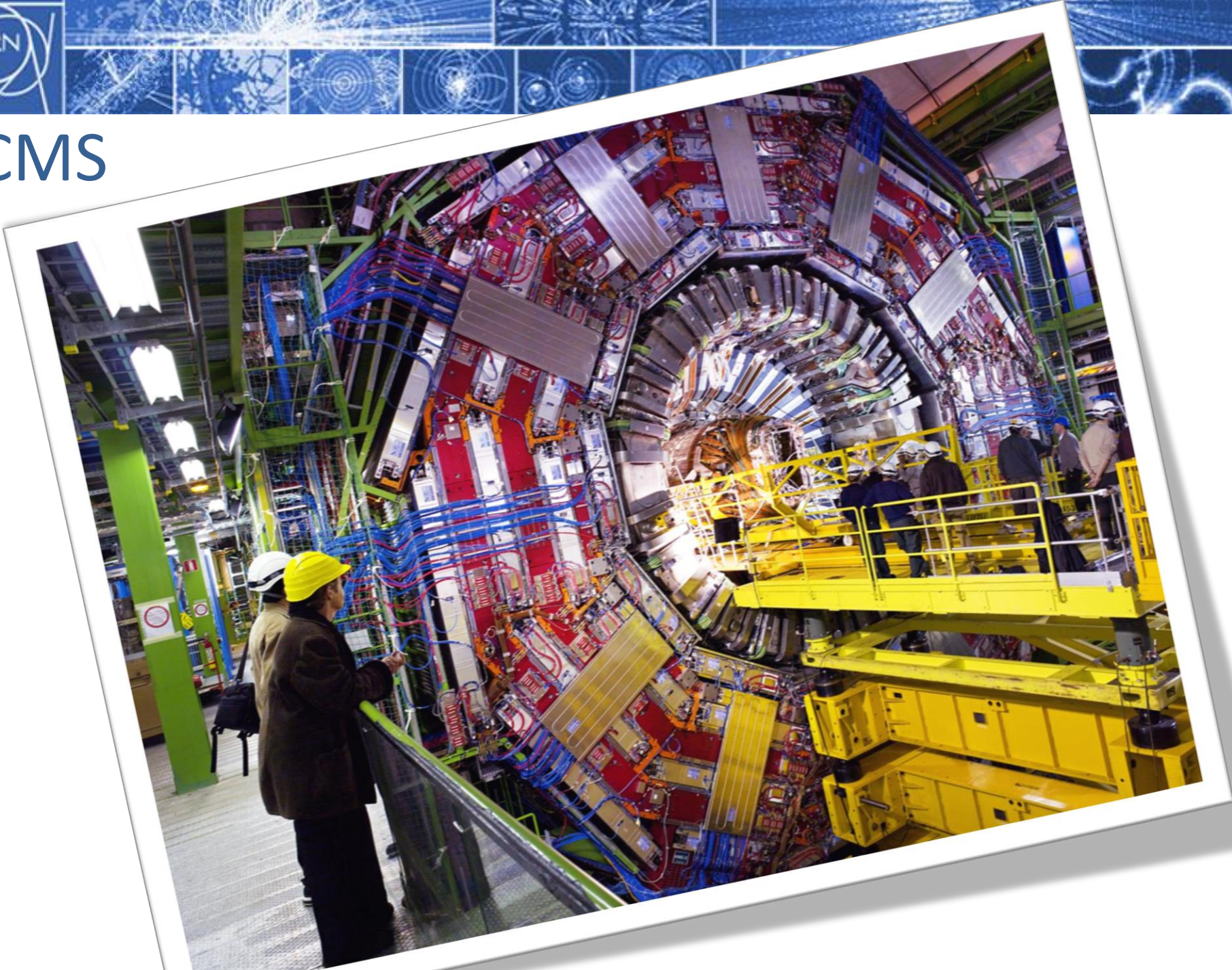


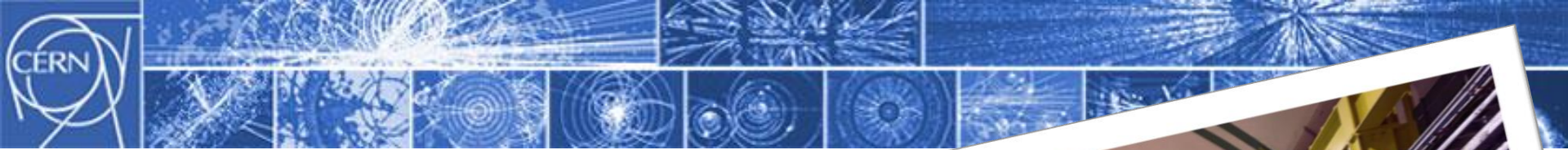
ALICE





CMS

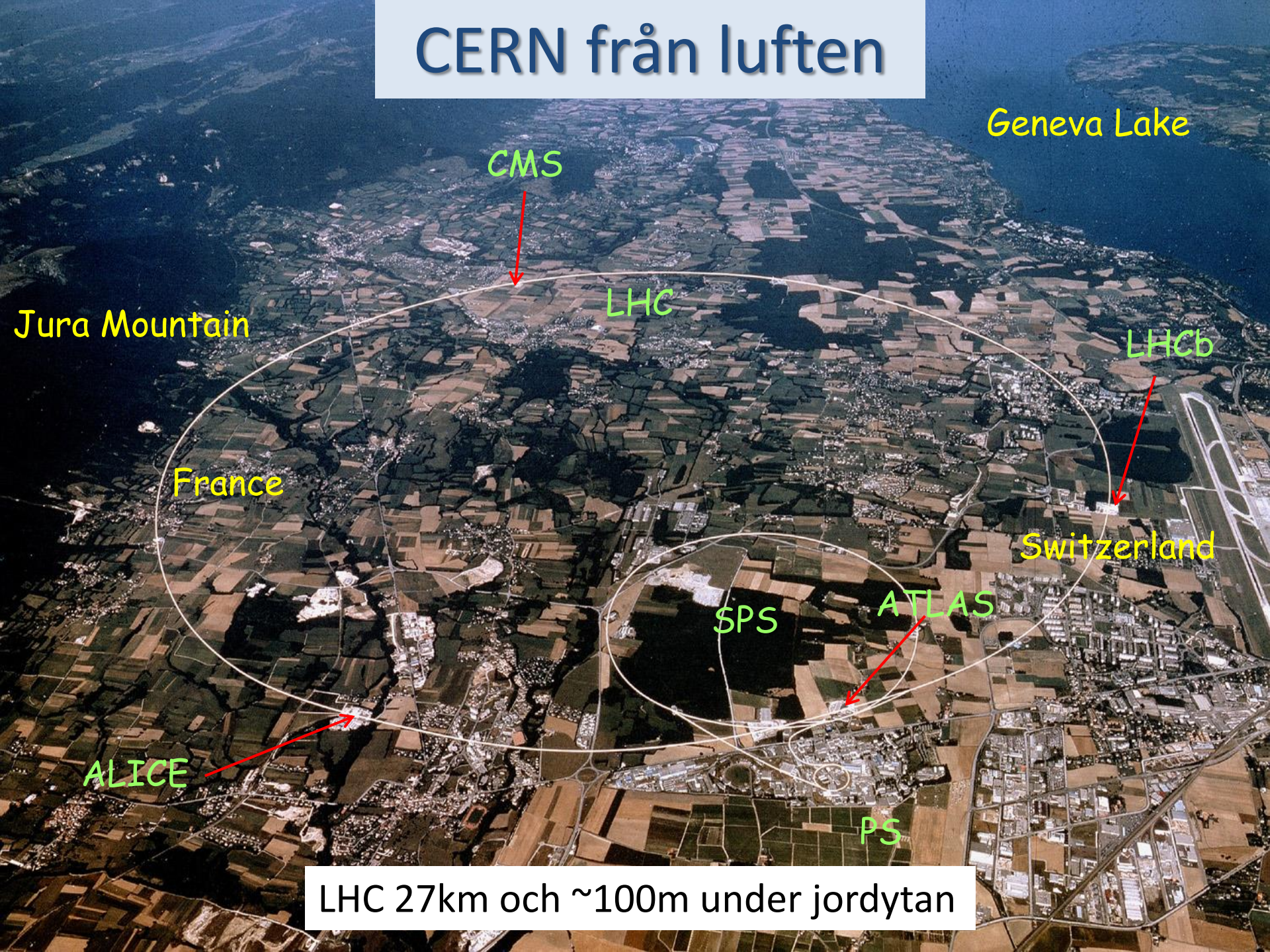




LHCb



CERN från luften



Geneva Lake

CMS

LHC

LHCb

Jura Mountain

France

Switzerland

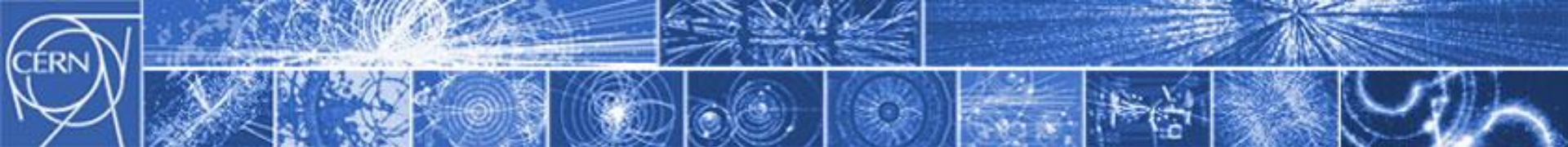
SPS

ATLAS

ALICE

PS

LHC 27km och ~100m under jordytan



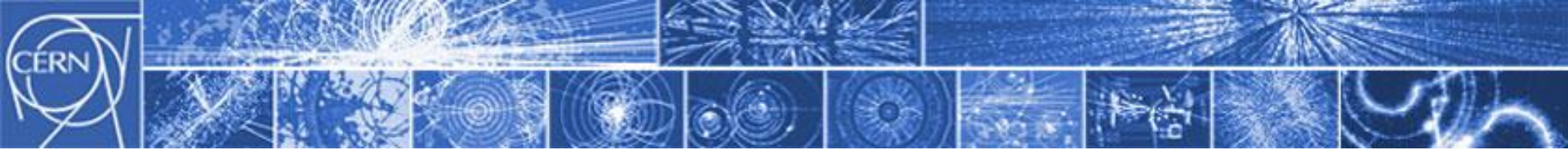
största vetenskapliga nätverk av datorer



15 Petabytes
(15 millioner GB)
data årligen

100'000
processorer

200 data-centers
runt hela jorden

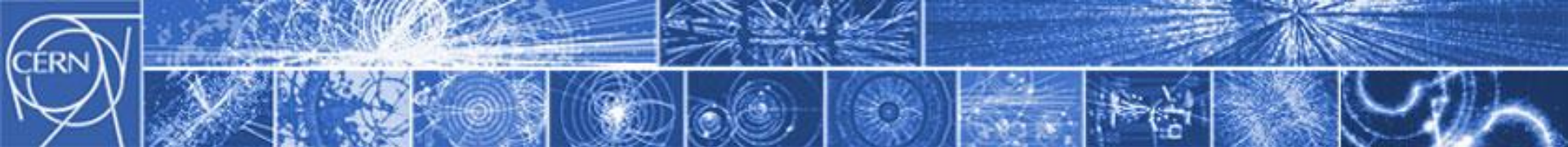


Bringa nationer **tillsammans** och **utbilda**

- Världens största internationella vetenskapliga samarbete
- Mer än 100 länder
- Hundratals fysikinstitut
- Hälften av världens partikelfysiker

Olika program för studenter





Utbildningsprogram för olika nivåer

Studenter

- Program för elever av alla åldrar
- Kort-tids praktik program (vetenskapligt, tekniskt och administrativt)
- Sommar-student program
- Doktorander och tekniska studenter



Unga Forskare

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



Vetenskapare vid CERN

Akademiskt Fortbildningsprogram

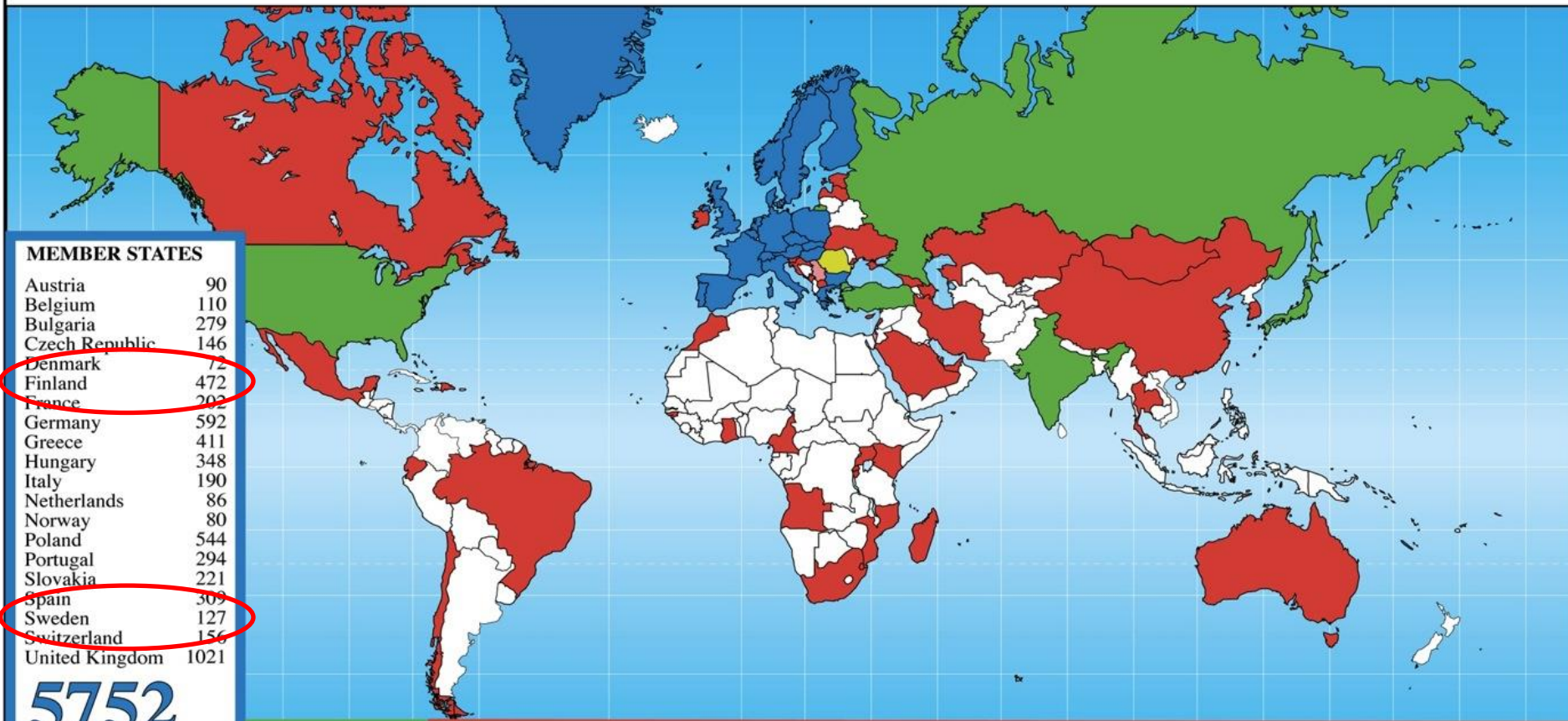


Skollärare

Internationellt och Nationellt program



Teacher Programme Participants 1998 - 2013



MEMBER STATES

Austria	90
Belgium	110
Bulgaria	279
Czech Republic	146
Denmark	72
Finland	472
France	202
Germany	592
Greece	411
Hungary	348
Italy	190
Netherlands	86
Norway	80
Poland	544
Portugal	294
Slovakia	221
Spain	309
Sweden	127
Switzerland	156
United Kingdom	1021

5752

CANDIDATE FOR ACCESSION

Romania	12
---------	----

ASSOCIATE MEMBER IN THE PRE-STAGE TO MEMBERSHIP

Israel	7
Serbia	14

OBSERVER STATES

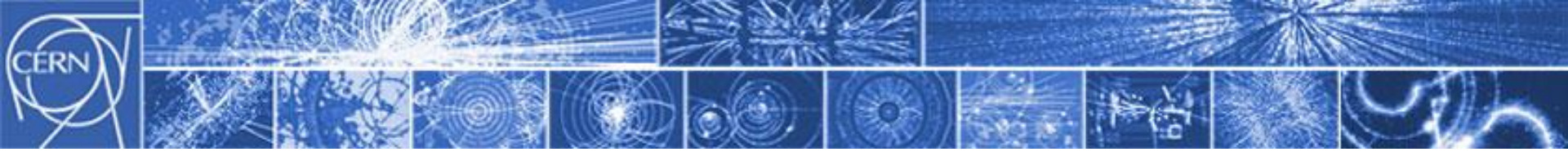
India	2
Japan	5
Russia	163
Turkey	3
USA	65

238

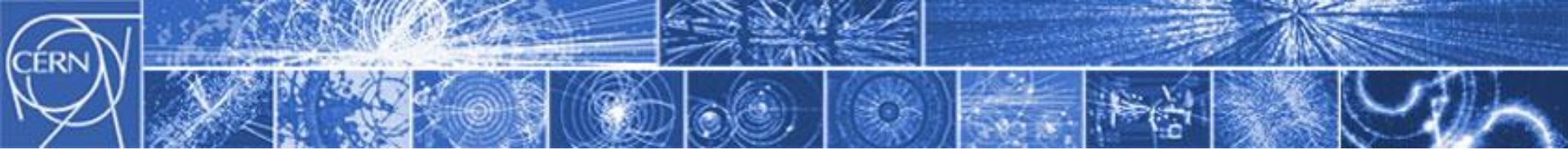
OTHERS

Angola	4	China	1	Ireland	5	Morocco	2	Swaziland	1
Australia	5	Croatia	1	Kazakhstan	3	Mozambique	17	Thailand	7
Azerbaijan	1	Cyprus	8	Kenya	4	Qatar	1	T.F.Y.R.O.M.	11
Brazil	83	Dominican Rep.	2	Latvia	1	Rwanda	17	Timor-Leste	4
Burundi	1	Ecuador	2	Lebanon	1	Sao Tome	3	Uganda	3
Cameroon	3	Estonia	37	Madagascar	2	Saudi Arabia	1	Ukraine	57
Canada	3	Georgia	55	Malta	36	Singapore	2	U.A.E.	1
Cape Verde	3	Ghana	6	Mexico	6	Slovenia	21		
Chile	3	Guinea Bissau	1	Mongolia	1	South Africa	6		
		Iran	1	Montenegro	13	South Korea	44		

490



Spin-off

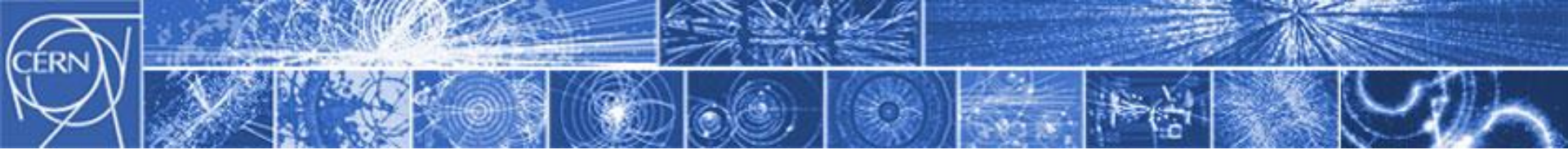


Praktiska tillämpningar: World Wide Web

Utvecklades på
CERN 1989 i ramen
av LHC !

Gåva till världen!

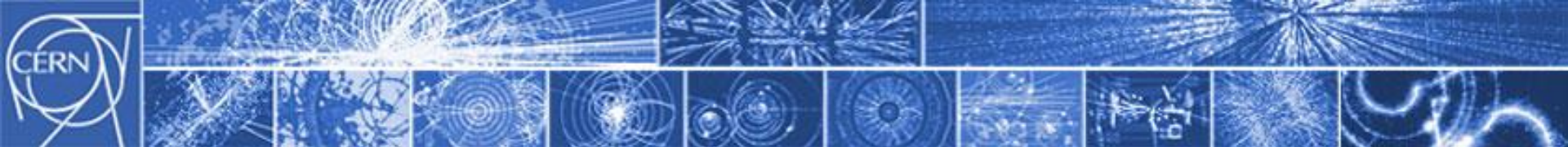




Praktiska **tillämpningar** : detektorer

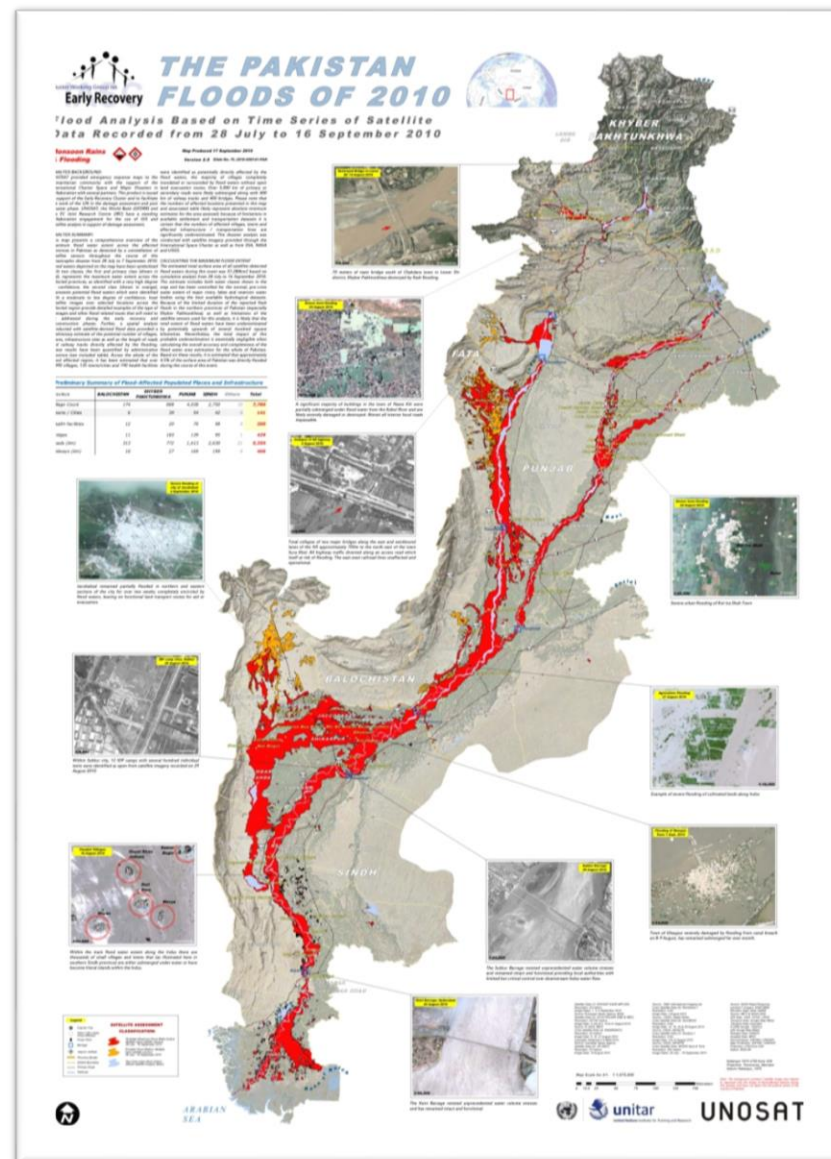
Scanna lastbilar utan att lasta av på mindre än 1 timme

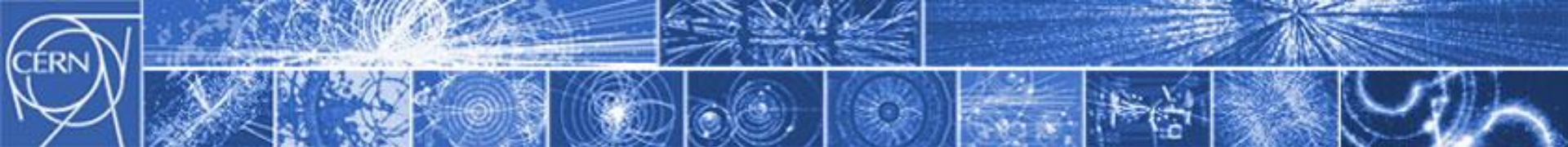




Praktiska tillämpningar : användning av « Grid »

Ultra-snabb behandling av
satelitbilder vid
naturkatastrofer





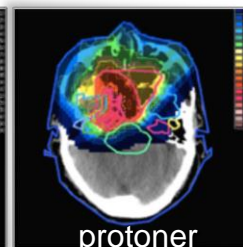
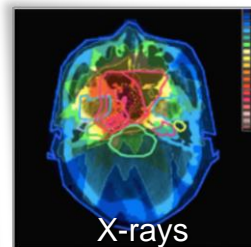
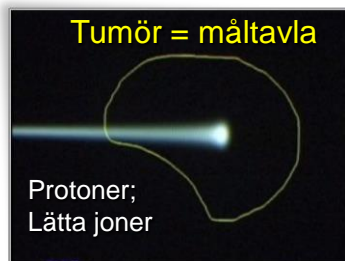
Praktiska **tillämpningar** inom Medicin

Kombination av Fysik, Medicinsk Visualisering, Biologi and Kirurgi för att bekämpa cancer

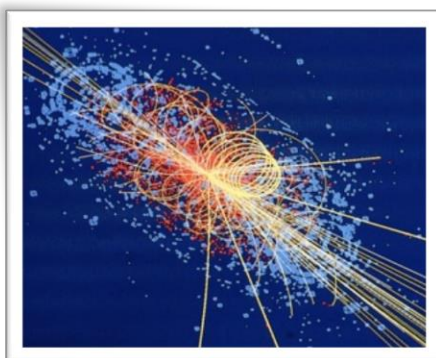


Accelererade partikelstrålar

↔ Hadron-terapi



>70'000 patienter behandlade i världen (30 installationer)
>21'000 patienter behandlade i Europa (9 installationer)

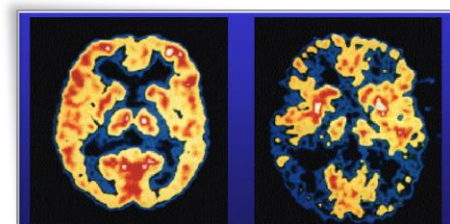
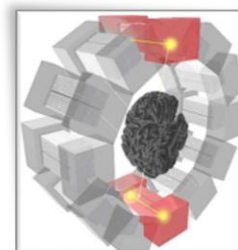


Partikeldetektering

↔ Visualisering

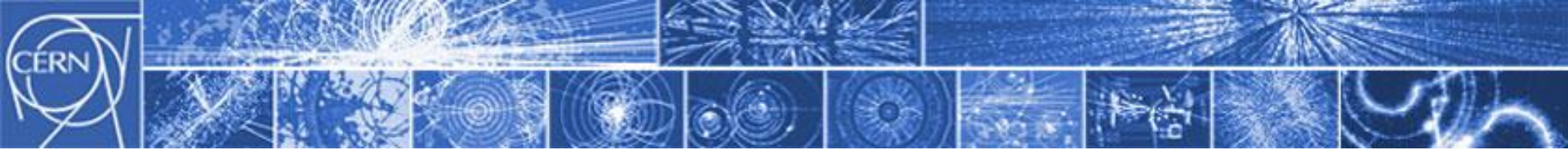
PET Scanner

Ny bröst imaging.
Kliniska försök i Portugal.
(ClearPEM)

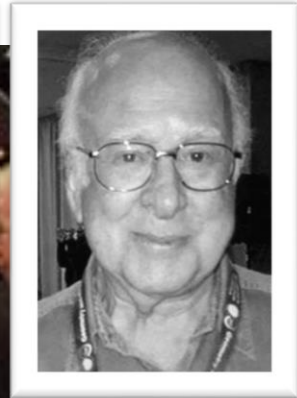
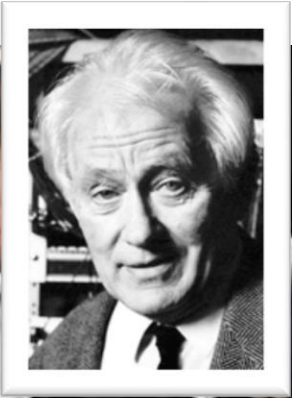


Normal
hjärna

Alzheimer's
sjukdom



Och några Nobelpris...



Carlo Rubbia and
Simon van der Meer

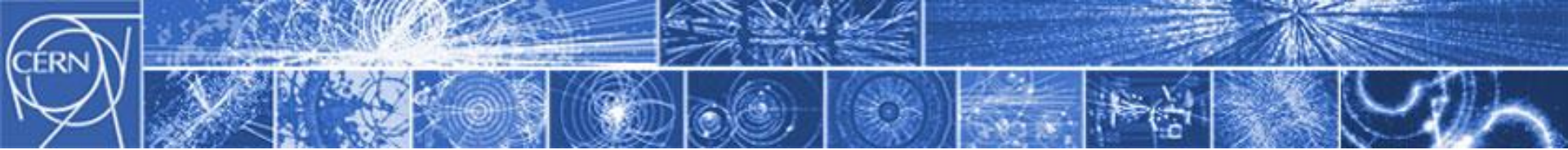
“for their decisive contributions to the large project, which led to the discovery of the field particles W^+ and Z^0 and the discovery of weak interactions”

Georges Charpak

“for his invention and development of particle detectors, in particular the multi-wire proportional chamber”

François Englert
Peter Higgs

“for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, in which the elementary particles acquire mass through the spontaneous breaking of the symmetry of the underlying laws of physics, by the ATLAS and CMS experiments at CERN's Large Hadron Collider”



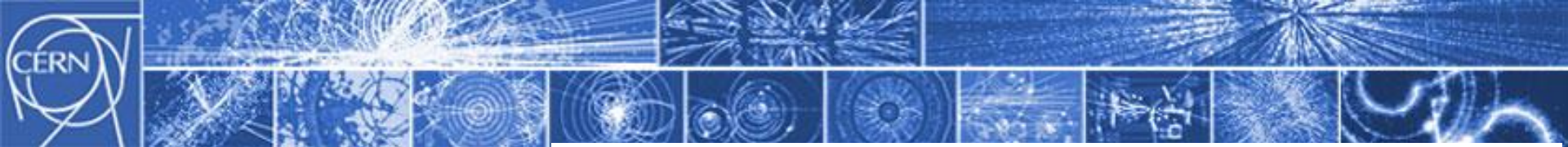
Senaste nytt från LHC



Higgs Boson-kompatibel partikel upptäckt 2012

20 månader tekniskt stopp 2013-2014 – uppgradering och underhåll

Körning med dubbel energi - 7 TeV per stråle - i 2015?



Sammanfattning

- Grundforskningslaboratorium
- Världens största internationella vetenskapliga samarbete
- Driver teknologin över dess gränser
- Många praktiska tillämpningar

websites:

Information: www.cern.ch

CERN TV: www.youtube.com/cern

Anställning: www.cern.ch/jobs