

saqarTvelos fizikis maswavleblebis 2023 wlis programa  
Ppirveli gacnoba cern-Tan



irakli minaSvili

1945w damTavrda meore msofljo omi, meore didi omi  
evropaSi bolo 78 wlis ganmavlobaSi



UmecnierTa umravlesobam datova evropa,  
umetesad gadavidnen amerikisa da sabWoeTSi.

vin varT Cven?

- **CERN: Conseil Européen pour la Recherche Nucléaire**
- cerni – birTvuli kvlevebis evropuli organizacia
- OsaerTaSoriso organizaciis statusiT (rogoricaa iunesko, gaero, mso, ..)
- Camoyalibda 1954w 12 evropul qveynebs Soris SeTanxmebis safuZvelze.
- amJamad 23 qveyanaa gawevrianebuli cern-Si



wliuri biujeti - 1,170 miliardi Sveic.franki  
 saqarTvelos biujeti - 6 miliardi amerikuli dolari

## Member States of CERN

Member States (date of accession)

- |                                                                                                              |                                                                                                         |
|--------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
|  Austria (1959)             |  Sweden (1953)         |
|  Belgium (1953)             |  Switzerland (1953)    |
|  Bulgaria (1999)            |  United Kingdom (1953) |
|  Czech Republic (1993)      |                                                                                                         |
|  Denmark (1953)             | <b>States in accession to Membership and Associate Members</b>                                          |
|  Finland (1991)             |  Croatia (2019)        |
|  France (1953)              |  Cyprus (2016)         |
|  Germany (1953)             |  Estonia (2021)        |
|  Greece (1953)              |  India (2017)          |
|  Hungary (1992)             |  Lithuania (2018)      |
|  Israel (2014)              |  Pakistan (2015)       |
|  Italy (1953)               |  Slovenia (2017)       |
|  Netherlands (1953)         |  Turkey (2015)         |
|  Norway (1953)            |  Ukraine (2016)      |
|  Poland (1991)            |                                                                                                         |
|  Portugal (1986)          |                                                                                                         |
|  Romania (2016)           |                                                                                                         |
|  Serbia (2019)            |                                                                                                         |
|  Slovakia (1993)          |                                                                                                         |
|  Spain (1961-1968, 1983-) |                                                                                                         |





Member state	Status since	Contribution (million CHF for 2019)	Contribution (fraction of total for 2019)	Contribution per capita <sup>[note 1]</sup> (CHF/person for 2017)
<b>Founding Members</b> <sup>[note 2]</sup>				
Belgium	29 September 1954	30.7	2.68%	2.7
Denmark	29 September 1954	20.5	1.79%	3.4
France	29 September 1954	160.3	14.0%	2.6
Germany	29 September 1954	236.0	20.6%	2.8
Greece	29 September 1954	12.5	1.09%	1.6
Italy	29 September 1954	118.4	10.4%	2.1
Netherlands	29 September 1954	51.8	4.53%	3.0
Norway	29 September 1954	28.3	2.48%	5.4
Sweden	29 September 1954	30.5	2.66%	3.0
Switzerland	29 September 1954	47.1	4.12%	4.9
United Kingdom	29 September 1954	184.0	16.1%	2.4
Yugoslavia <sup>[note 3]</sup>	29 September 1954 <sup>[104][105]</sup>	0	0%	0.0
<b>Acceded Members</b> <sup>[note 4]</sup>				
Austria	1 June 1959	24.7	2.16%	2.9
Spain <sup>[note 5]</sup>	1 January 1983 <sup>[105][107]</sup>	80.7	7.06%	2.0
Portugal	1 January 1986	12.5	1.09%	1.3
Finland	1 January 1991	15.1	1.32%	2.8
Poland	1 July 1991	31.9	2.79%	0.8
Hungary	1 July 1992	7.0	0.609%	0.7
Czech Republic	1 July 1993	10.9	0.950%	1.1
Slovakia	1 July 1993	5.6	0.490%	1.0
Bulgaria	11 June 1999	3.4	0.297%	0.4
Israel	6 January 2014 <sup>[99]</sup>	19.7	1.73%	2.7
Romania	17 July 2016 <sup>[108]</sup>	12.0	1.05%	0.6
Serbia	24 March 2019 <sup>[109]</sup>	2.5	0.221%	0.1
<b>Associate Members in the pre-stage to membership</b>				
Estonia	1 February 2020 <sup>[110][111]</sup>	1.0	N/A	N/A
Cyprus	1 April 2016 <sup>[112]</sup>	1.0	N/A	N/A
Slovenia	4 July 2017 <sup>[113][114]</sup>	1.0	N/A	N/A
<b>Associate Members</b>				
Turkey	6 May 2015 <sup>[115]</sup>	5.7	N/A	N/A
Pakistan	31 July 2015 <sup>[116]</sup>	1.7	N/A	N/A
Ukraine	5 October 2016 <sup>[117]</sup>	1.0	N/A	N/A
India	16 January 2017 <sup>[118]</sup>	13.8	N/A	N/A
Lithuania	8 January 2018 <sup>[119]</sup>	1.0	N/A	N/A
Croatia	10 October 2019 <sup>[120]</sup>	0.25	N/A	N/A
Latvia	2 August 2021 <sup>[121]</sup>		N/A	N/A
<b>Total Members, Candidates and Associates</b>		<b>1,171.2</b> <sup>[101][122]</sup>	<b>100.0%</b>	N/A

# Distribution of All CERN Users by Nationality on 27 January 2020

## MEMBER STATES

**7 149**

Austria	95
Belgium	113
Bulgaria	71
Czech Republic	216
Denmark	52
Finland	72
France	778
Germany	1 177
Greece	216
Hungary	77
Israel	59
Italy	1 856
Netherlands	170
Norway	59
Poland	311
Portugal	94
Romania	144
Serbia	49
Slovakia	128
Spain	405
Sweden	74
Switzerland	204
United Kingdom	729

## OBSERVERS 2 506

Japan	274
Russia	1 126
USA	1 106

## ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP 54

Cyprus	21
Slovenia	33

## ASSOCIATE MEMBERS 770

Croatia	47
India	367
Lithuania	31
Pakistan	63
Turkey	162
Ukraine	100

<b>OTHERS</b>	Bolivia	2	Egypt	26	Ireland	14	Montenegro	8	Saint Kitts and Nevis	1	Uzbekistan	3	
	Bosnia & Herzegovina	2	El Salvador	1	Jamaica	1	Morocco	26	Saudi Arabia	2	Venezuela	10	
	Bostwana	1	Estonia	16	Jordan	2	Myanmar	1	Senegal	1	Viet Nam	10	
Albania	4	Brazil	121	<b>Georgia</b>	<b>54</b>	Kazakhstan	12	Nepal	8	Singapore	4	Yemen	1
Algeria	8	Burundi	1	Ghana	1	Kenya	1	New Zealand	6	Singapore	4	Zambia	1
Argentina	22	Canada	155	Gibraltar	1	Korea	161	Nigeria	2	South Africa	54	Zimbabwe	1
Armenia	18	Chile	21	Guatemala	1	Kyrgyzstan	1	North Korea	3	Sri Lanka	6		
Australia	28	China	569	Guatemala	1	Latvia	4	North Macedonia	2	Sudan	2		
Azerbaijan	7	Colombia	35	Honduras	1	Lebanon	23	Oman	1	Syria	2		
Bahrain	3	Congo	1	Iceland	5	Luxembourg	3	Palestine	7	Taiwan	47		
Bangladesh	5	Costa Rica	1	Indonesia	11	Malaysia	19	Paraguay	1	Thailand	24		
Belarus	49	Cuba	16	Iran	46	Malta	5	Peru	6	Tunisia	5		
Benin	1	Ecuador	11	Iraq	1	Mexico	80	Philippines	4	Uruguay	1		

**1 822**



"Conseil Européen pour la Recherche Nucléaire", or  
European Council for Nuclear Research

COLLABORATION

EDUCATION

FUNDAMENTAL RESEARCH

NEW TECHNOLOGIES



cern-is misia

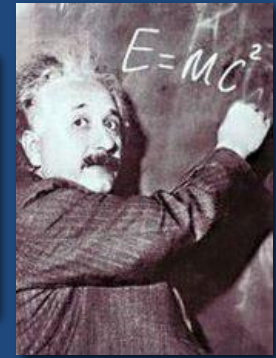


Research



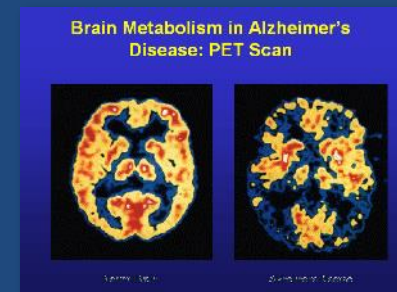
# cern-is misia

**Caxedva warsulSi** – codnis sazRvrebis gafarToeba  
didi afeTqebis saidumloebebi – rogori iyo materia  
samyaros Seqmnis pirvel momentSi



**axali teqnologiebis ganviTareba** - amaCqareblebisa da  
deteqtorebisTvis

teqnologია informatikaSi - **Web** da **GRID**  
medicina – diagnostika da Terapia



**Treiningi** – momaval mecnierTa da inJinerTaTvis



svadasxva kulturisa da qveJnebis xalxTa **gaerTianeba**



- saidan varT
- vin varT
- saiT mivdivarT?

pol gogeni

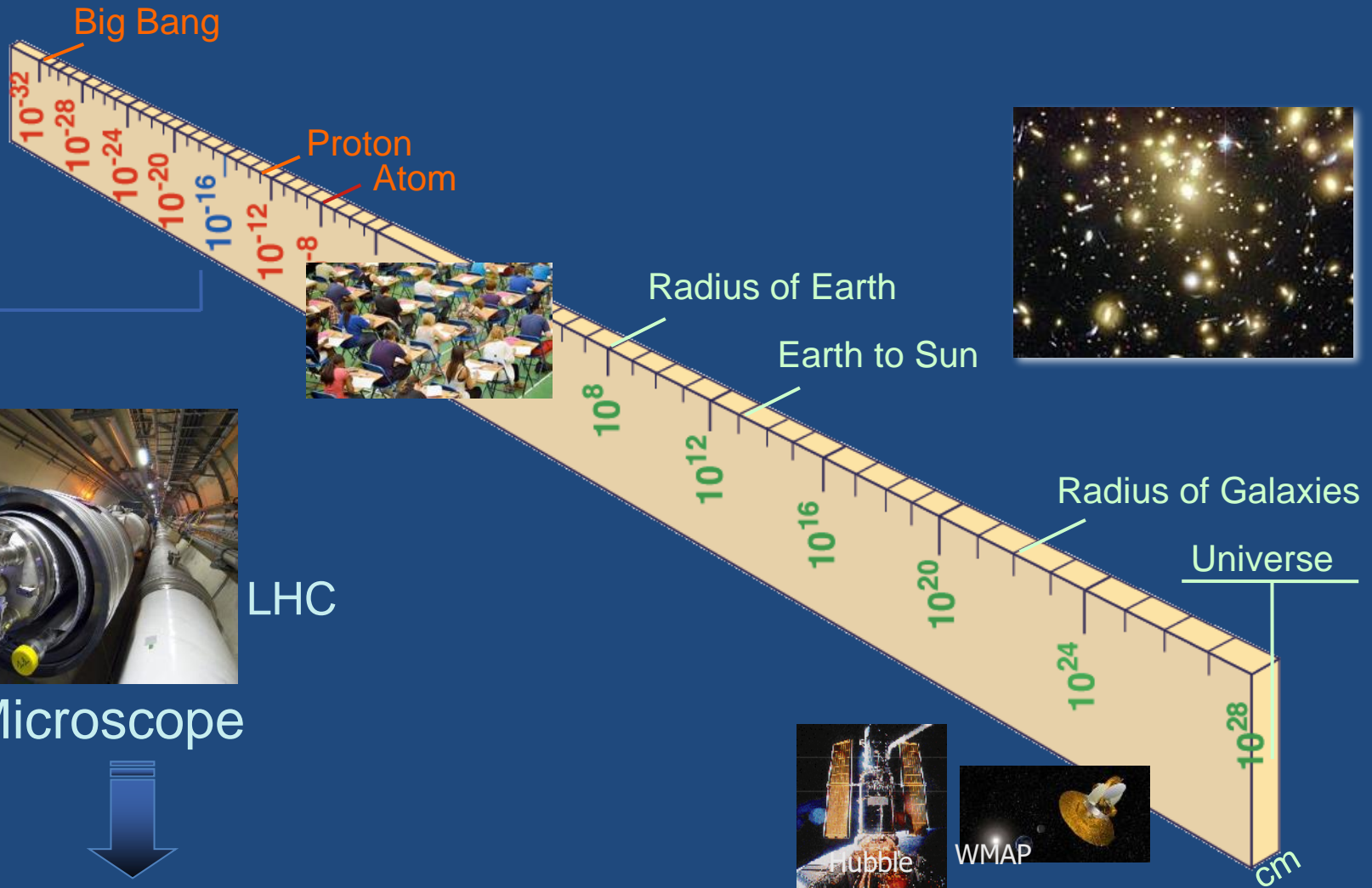
Where Do We come from?  
What Are We? Where Are  
We Going?



nawilakebis fizikis mizani, **CERN & the LHC:**  
risganaa samyaro Sedgenili?







LHC

Super-Microscope



Դժիճ աբեՒգբիճ Տեմդեգ քիճվելի մոմեճեբիճ ֆիզիկուրի կաճոճեբիճ Տեճվաճա թրո ճա թրո աՒՒմաճեբճ Տիմբիոճճ նաճիճկեբիճ ֆիզիկաճ, կոճմոլոգիաճա ճա աճտրոֆիզիկաճ Տոճիճ



# როგორ ვაკეთებთ ამას?

**ამაყვარებლები:** ანივეზენ ნაწილებს დიდ ენერჯას;

ენერჯია გარდაიქმნება მატერიაში  $E=mc^2$

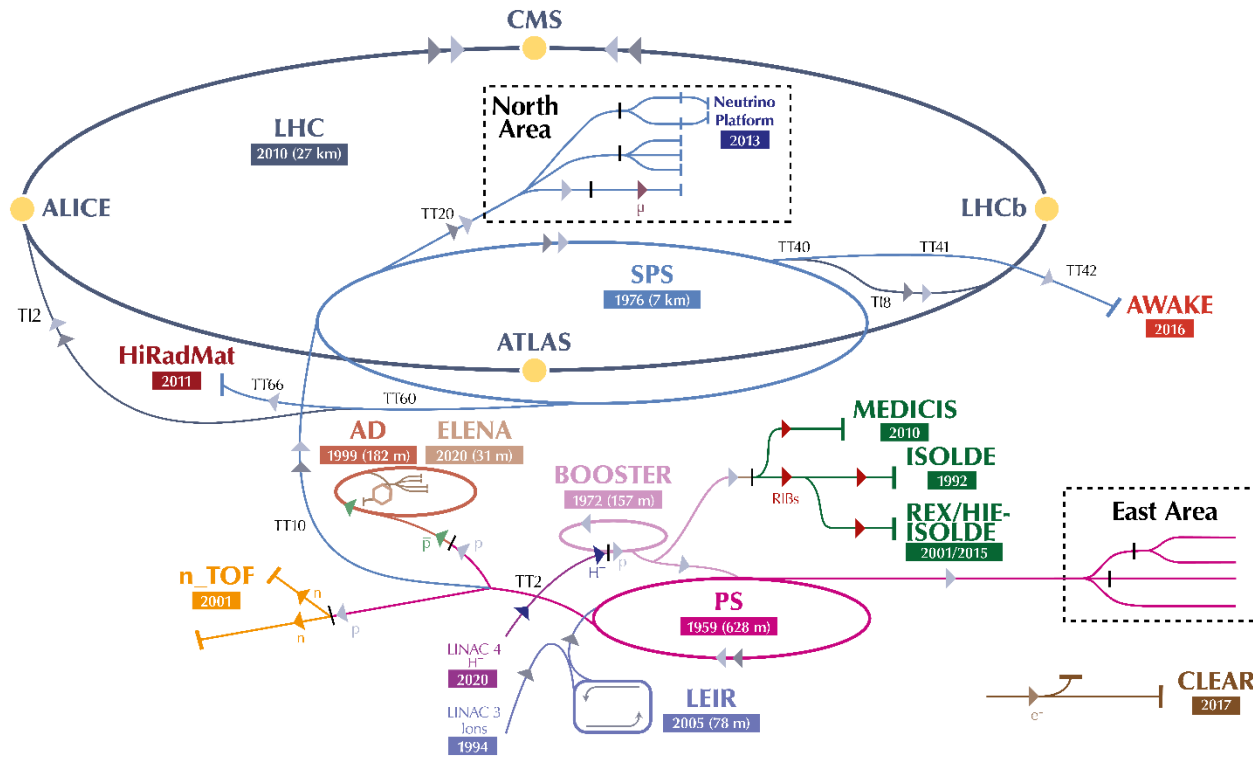
**დეტექტორები:** ნაწილებს იდენტიფიკაცია და  
დეტექტირება

**კომპიუტერები:** მონაცემთა ანგარიშა, მათი ანალიზი და  
საწყისი სურათის აგება



# CERN – msofliosi amaCqareblebis yvelaze didi kompleksi

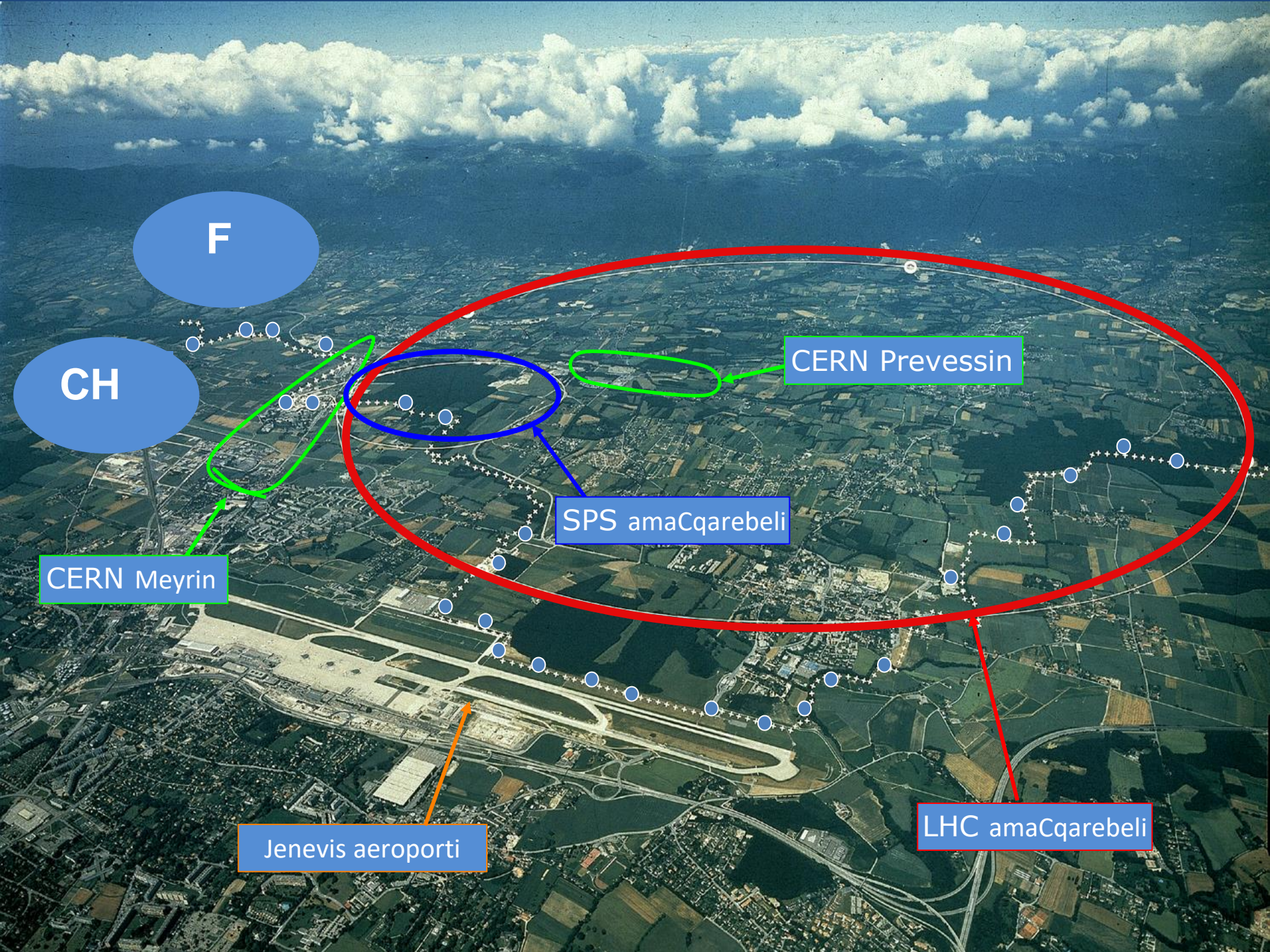
## The CERN accelerator complex Complexe des accélérateurs du CERN



▶  $H^-$  (hydrogen anions) ▶ p (protons) ▶ ions ▶ RIBs (Radioactive Ion Beams) ▶ n (neutrons) ▶  $\bar{p}$  (antiprotons) ▶  $e^-$  (electrons) ▶  $\mu$  (muons)

LHC - Large Hadron Collider // SPS - Super Proton Synchrotron // PS - Proton Synchrotron // AD - Antiproton Decelerator // CLEAR - CERN Linear Electron Accelerator for Research // AWAKE - Advanced WAKEfield Experiment // ISOLDE - Isotope Separator OnLine // REX/HIE-ISOLDE - Radioactive Experiment/High Intensity and Energy ISOLDE // MEDICIS // LEIR - Low Energy Ion Ring // LINAC - LINear ACcelerator // n\_TOF - Neutrons Time Of Flight // HiRadMat - High-Radiation to Materials // Neutrino Platform





F

CH

CERN Meyrin

CERN Preveessin

SPS amaCqarebeli

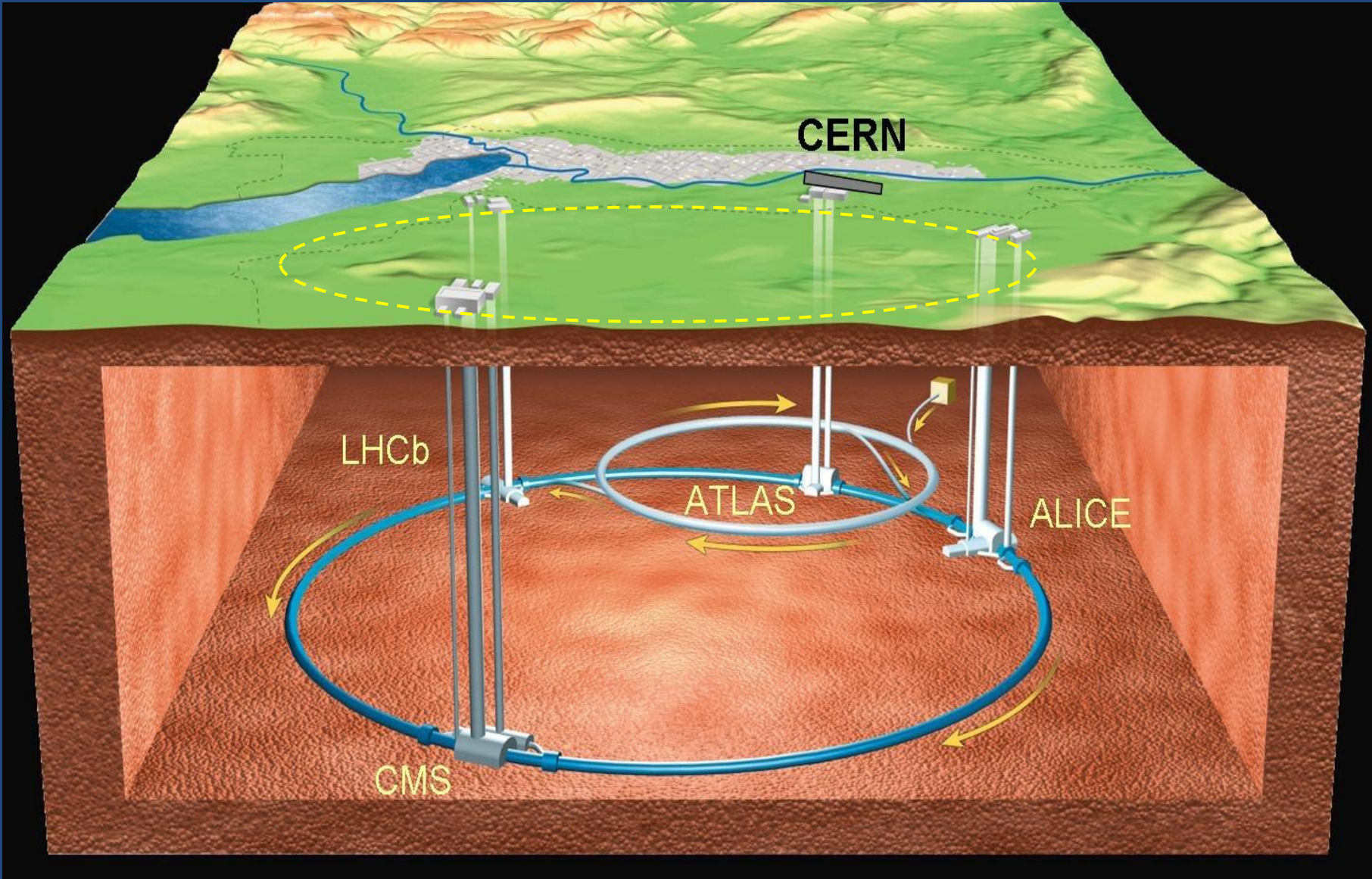
Jenevis aeroporti

LHC amaCqarebeli



# LHC – Large Hadron Collider

didi adronuli kolaideri





# დიდი ადრონული კოლაიდერი (LHC)

proton-protonული კოლაიდერი

$7 \text{ TeV} + 7 \text{ TeV}$



$1,000,000,000$  დაჯახება/წამში

ძირითადი მიზნები:

- მასის წარმოშობა
- ბნელი მატერია
- ტავდაპირველი პლაზმა
- მატერია/ანტიმატერია

erTerTi yvelaze metad gauXSoebuli  
sistema samyarosi

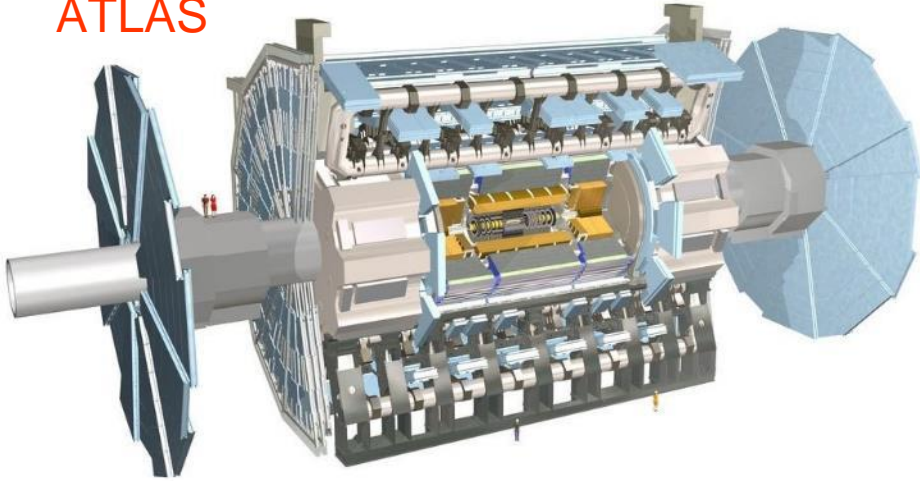


planetaSorisi siveSi msgavsi vakuumi:  
nakadis milebSi wneva aTjer ufro dabilia vidre mTvareze

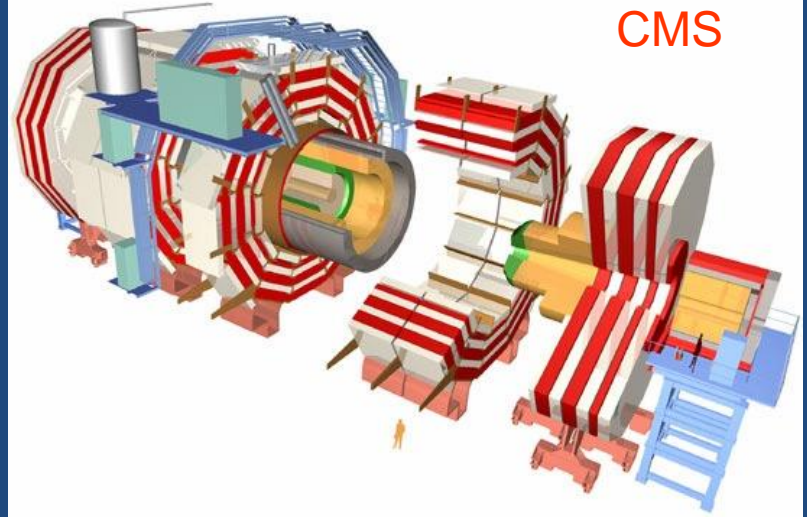


# LHC-is o'xi ZiriTadi detektorlari

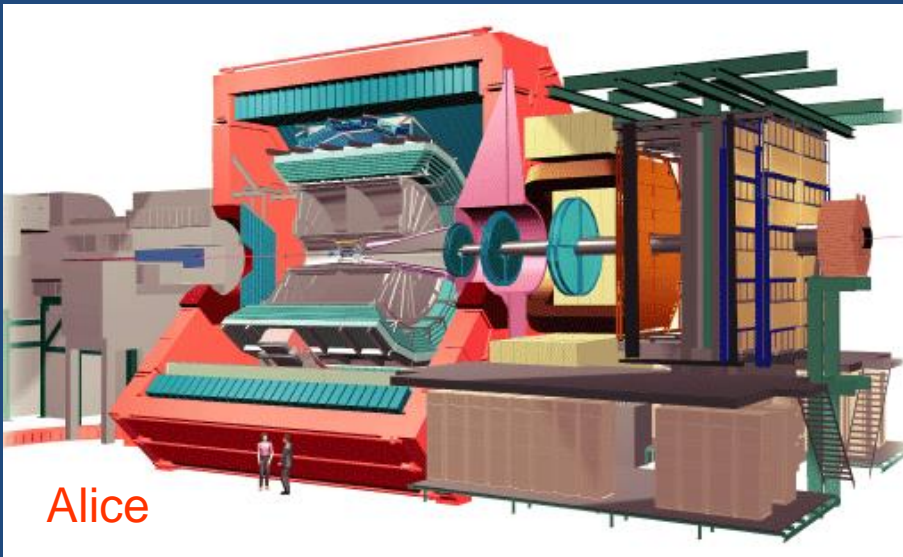
ATLAS



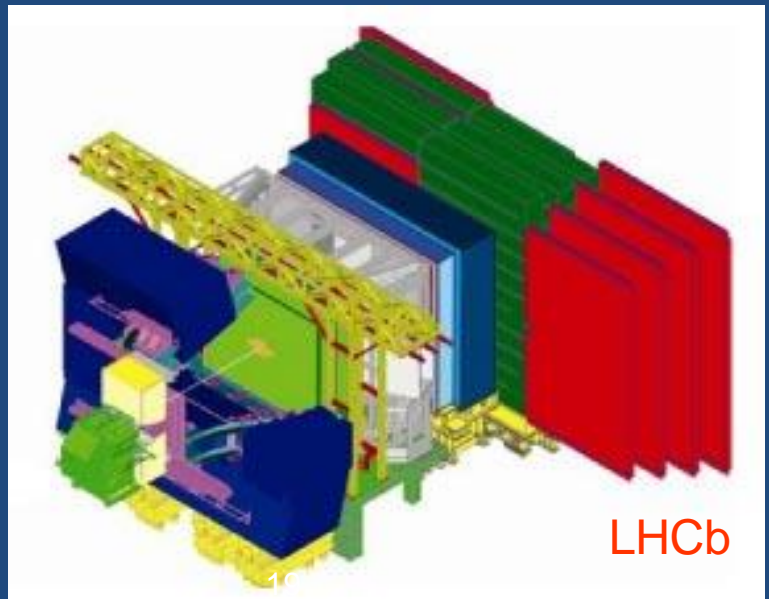
CMS



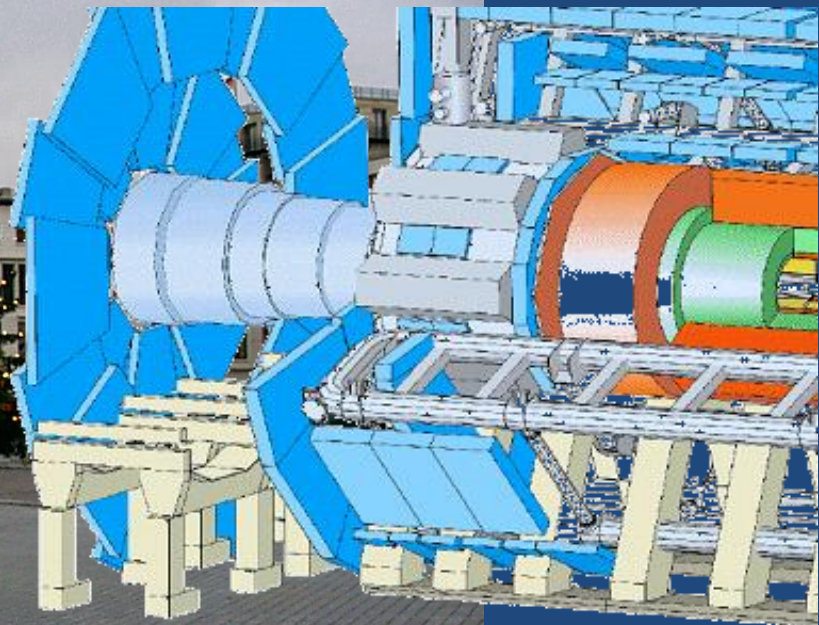
Alice



LHCb

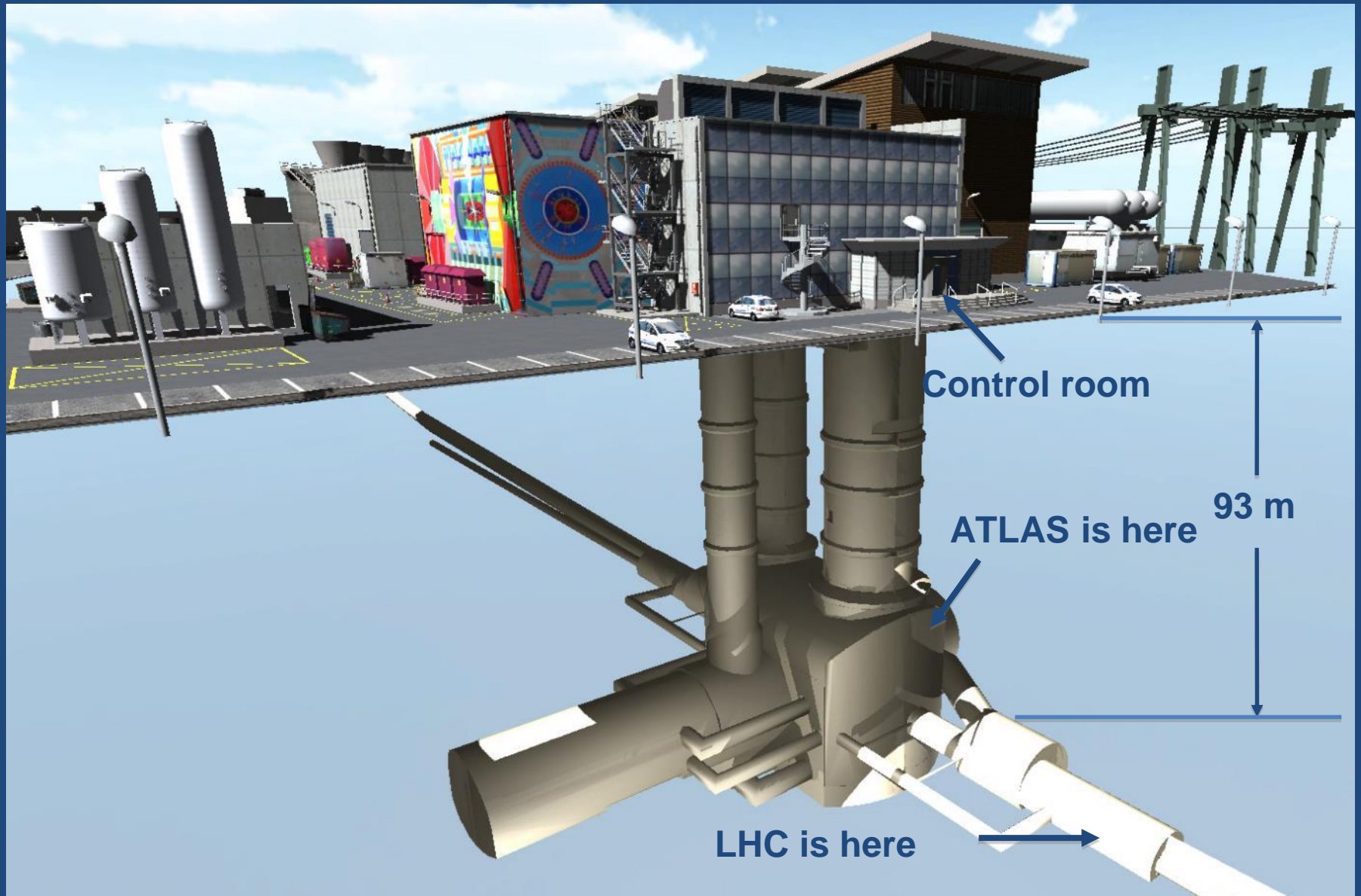






<https://atlas.cern>

# ATLAS eqsperimenti

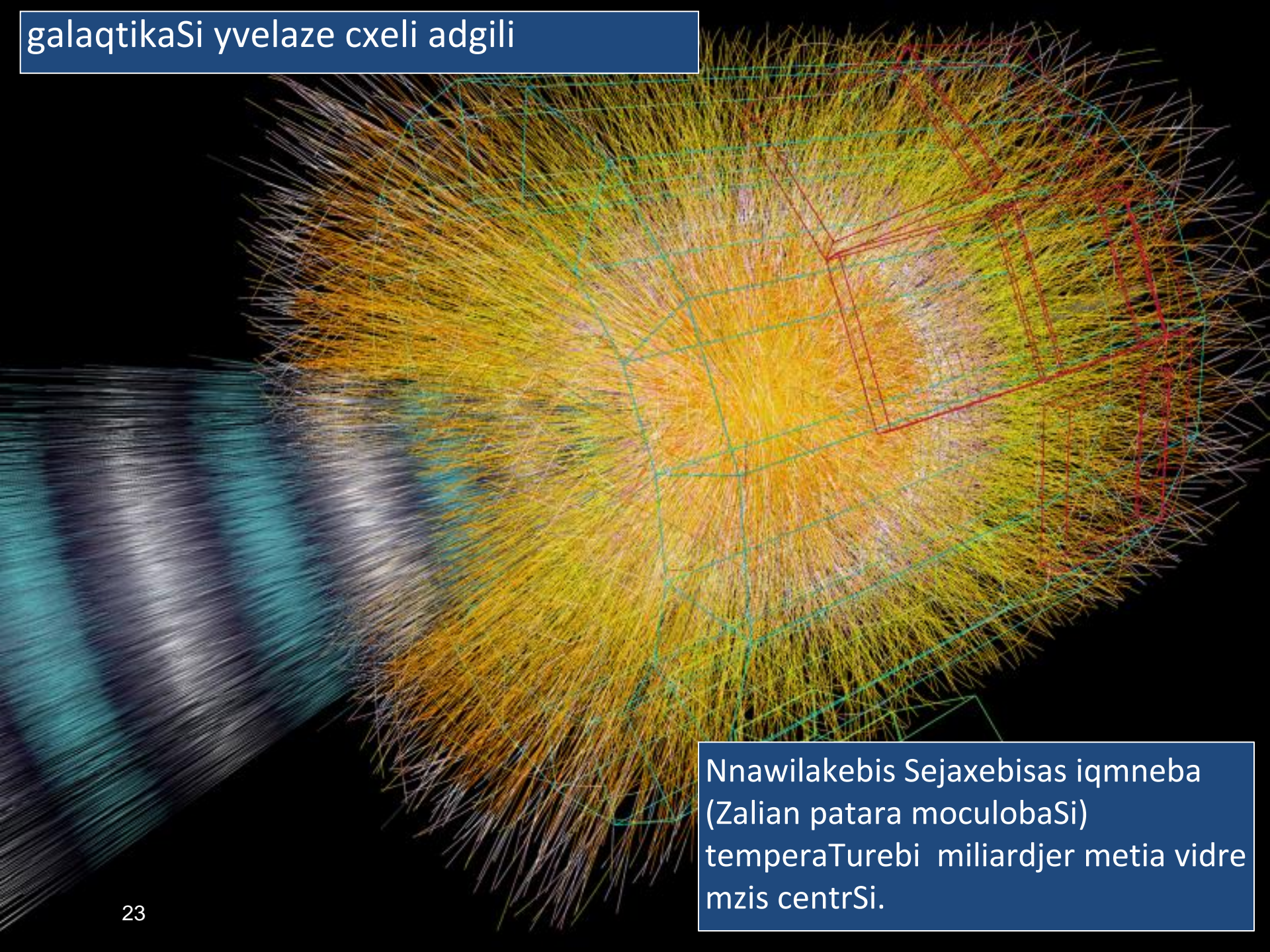




# CMS detektoru daxurvamde



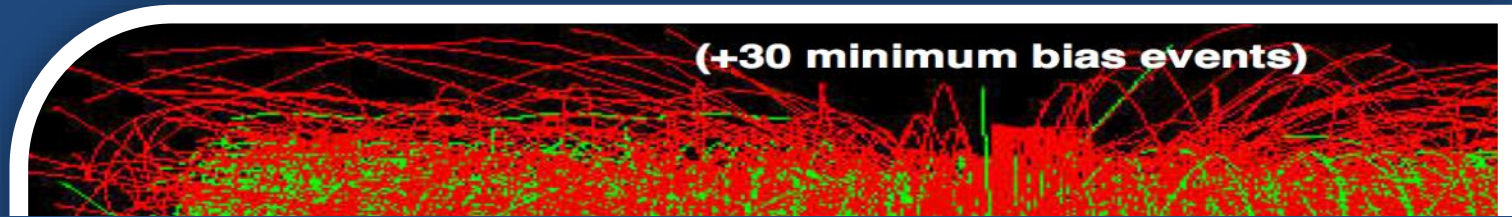




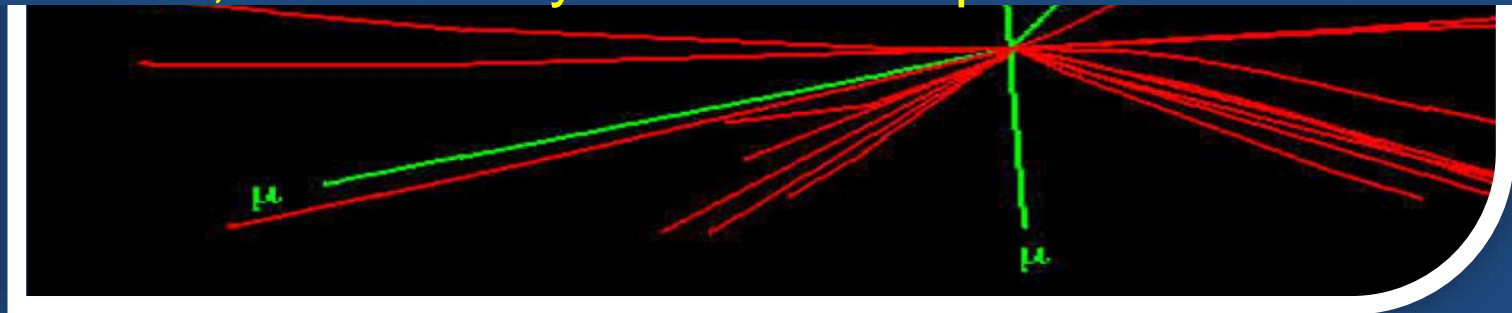
Nnawilakebis Sejaxebisas iqmneba  
(Zalian patara moculobaSi)  
temperaTurebi miliardjer metia vidre  
mzis centrSi.



# Searching for new particles requires selection and analysis of enormous quantity of data from LHC detectors



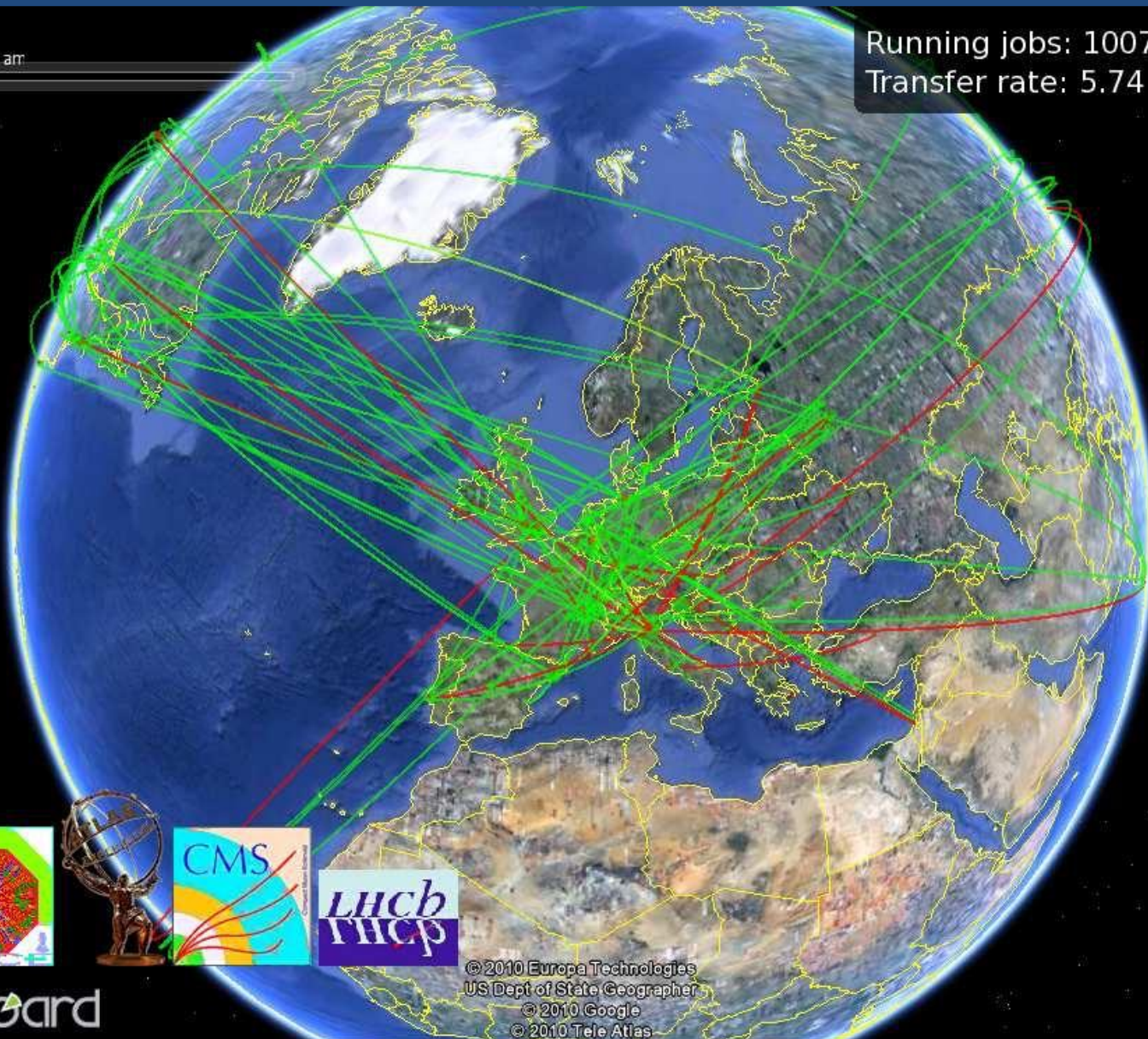
- LHC experiments produce 10-15 million Gigabytes of data each year (about 20 million CDs!)
- LHC data analysis requires a computing power equivalent to ~100,000 of today's fastest PC processors.



# Searching for new particles requires selection and analysis of enormous quantity of data from LHC detectors

Oct 6, 2010 7:20:00 am

Running jobs: 100767.0  
Transfer rate: 5.74 GiB/sec



© 2010 Europa Technologies  
US Dept of State Geographer

© 2010 Google  
© 2010 Tele Atlas

dashboard

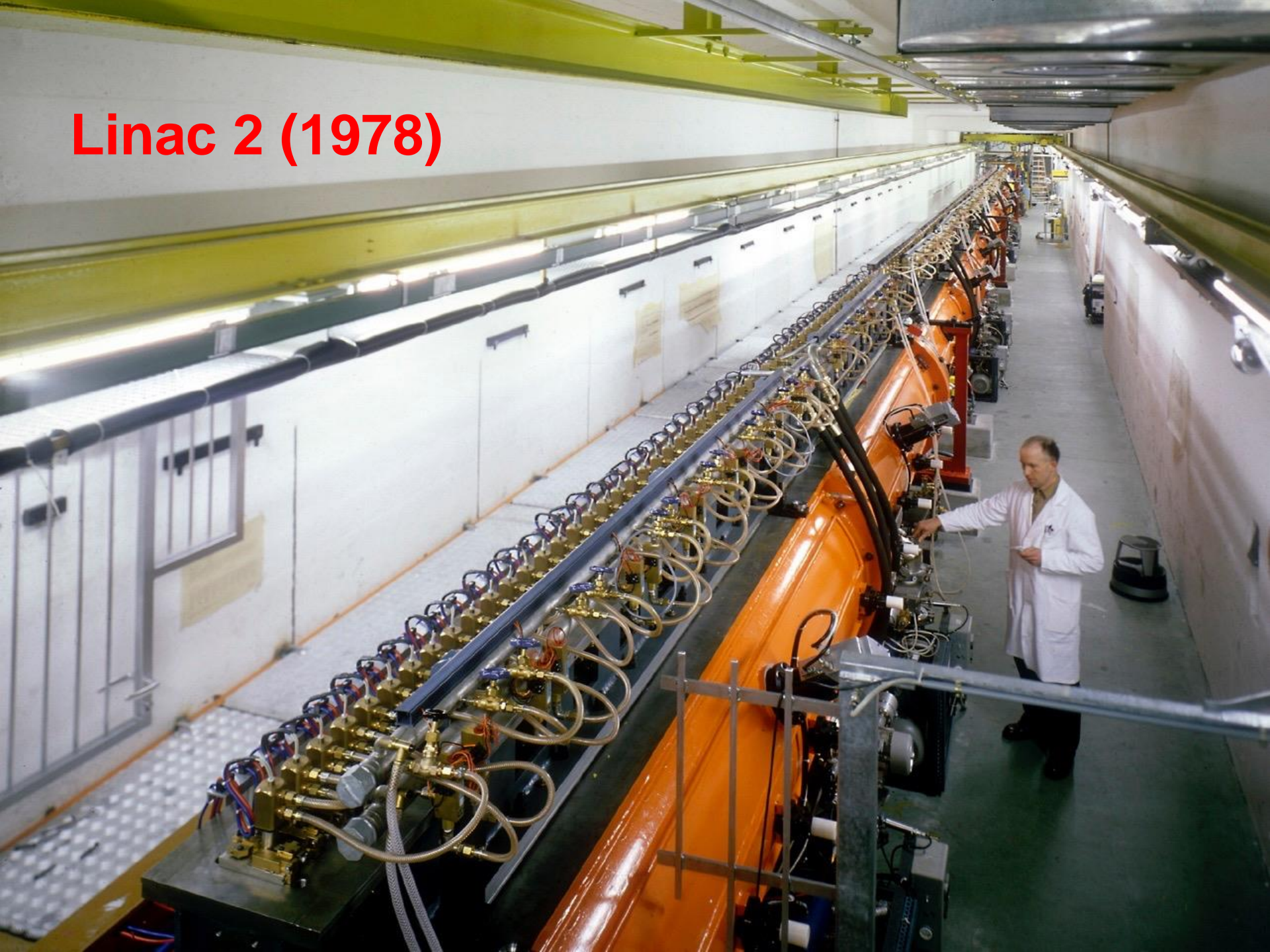
22°34'45.42" N 15°53'35.50" E elev=2326 ft

©2010 Google

Eye alt 6720.01 mi



# Linac 2 (1978)





# Protoni sinqrotronis Bbusteri 1972







**PS - 60** welia  
muSaobs



# super protonuli singrotroni 1976



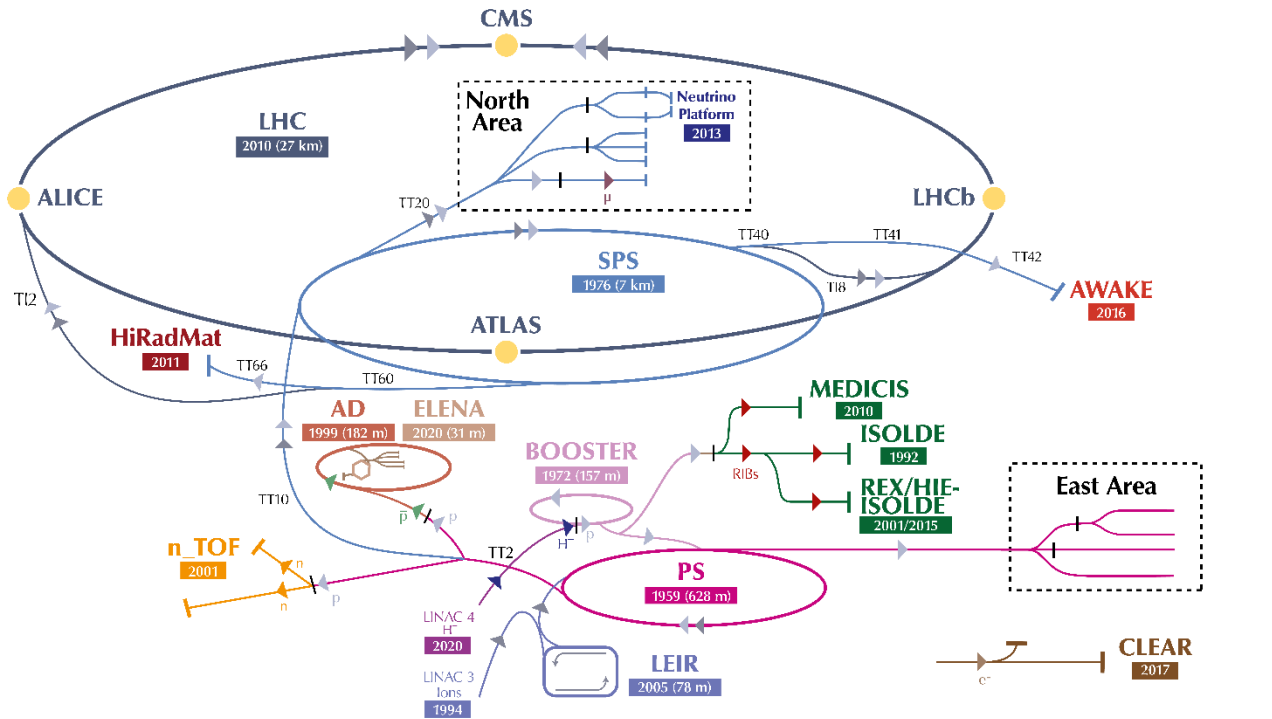




**Ddidi adronuli kolaideri 2008**

# CERN amaCqareblebis kompleqsi ara mxolod didi adrobuli kolaidertvis muSaobs:

## The CERN accelerator complex Complexe des accélérateurs du CERN



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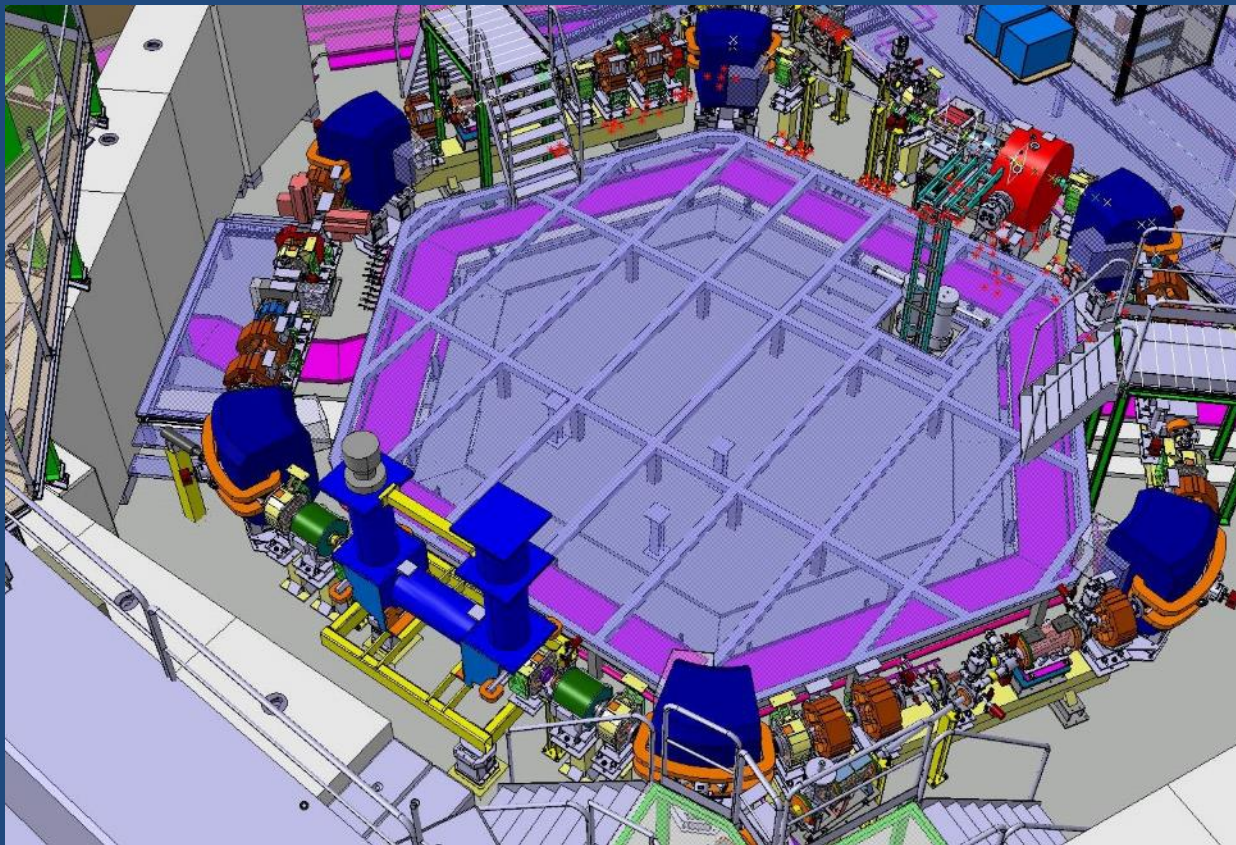
LHC - Large Hadron Collider // SPS - Super Proton Synchrotron // PS - Proton Synchrotron // AD - Antiproton Decelerator // CLEAR - CERN Linear Electron Accelerator for Research // AWAKE - Advanced WAKEfield Experiment // ISOLDE - Isotope Separator OnLine // REX/HIE-ISOLDE - Radioactive Experiment/High Intensity and Energy ISOLDE // MEDICIS // LEIR - Low Energy Ion Ring // LINAC - LInear ACcelerator // n\_TOF - Neutrons Time Of Flight // HiRadMat - High-Radiation to Materials // Neutrino Platform



# Antiproton Decelerator 1999







elena

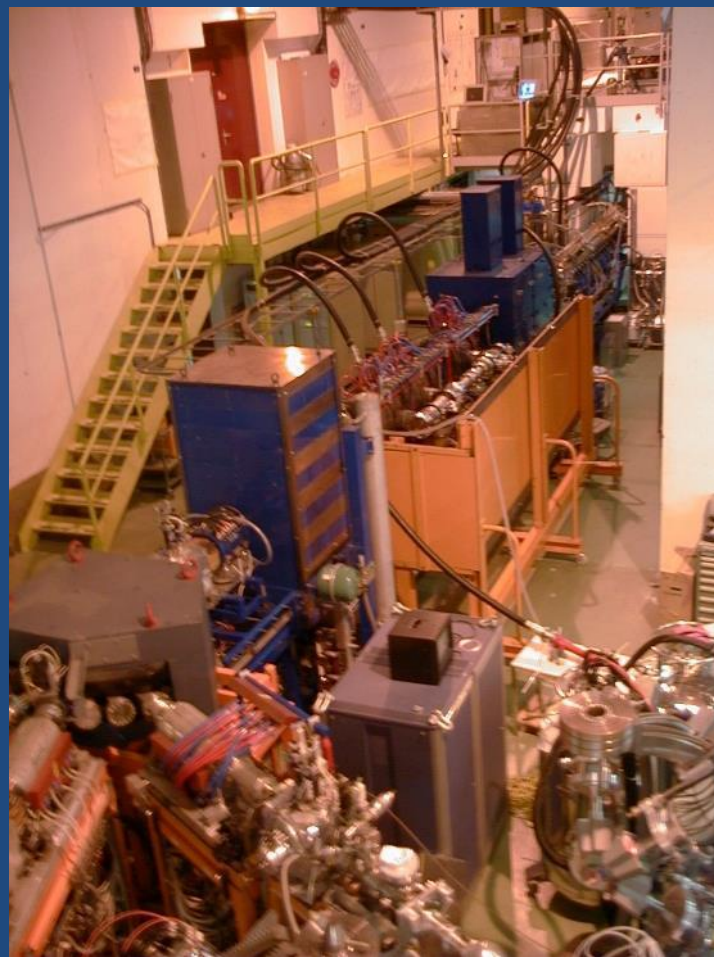
## ELENA Project

ELENA aris CERN Antiproton Decelerator- dan miRebuli 5.3mev antiprotonebis Semdegi Senelebis kompaqturi wriuli amaCqarebeli. misi mizania, Seiswavlos uZravi antiwyalbadis atomebis speqtroskopia da gamoikvlion nivTierebisa da antinivTierebis gravitaciuli Zalebis efeqti.

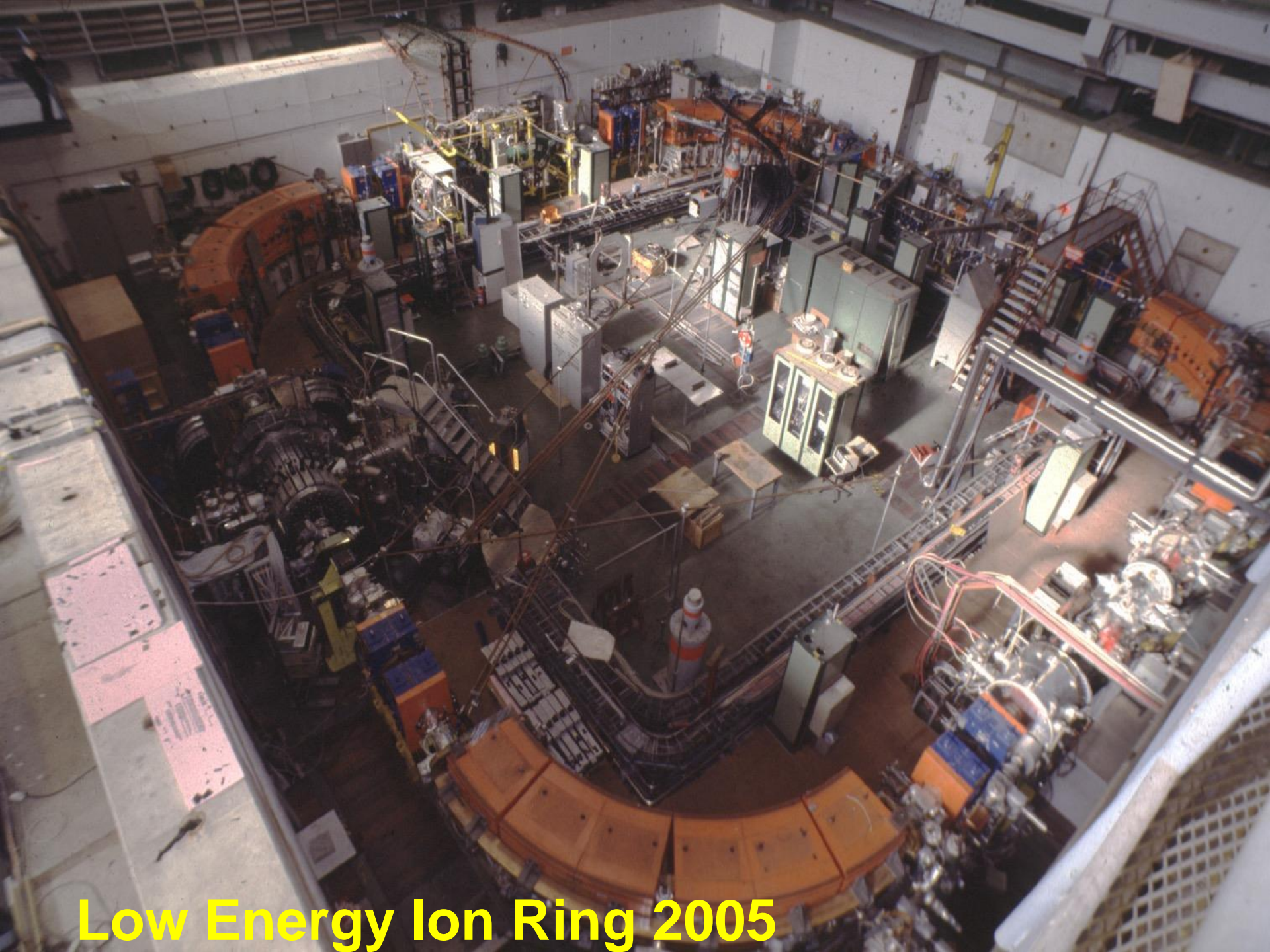
# ISOLDE - Isotope Separator On Line, and Radioactive beam EXperiment (REX)

ალქიმიური ქარხანა  
ბირთვულ ფიზიკისაში

რადიოაქტიური იზოტოპების  
დაბალი ენერგეტიკული სხივები  
- ატომური ბირთვები.  
მდებარეობს პროტონ-  
სინქროტრონის **Booster-**  
**ზე(PSB)**. დანადგარი აწარმოებს  
**1000-ზე** უფრო მეტ სხვადასხვა  
იზოტოპის კვლევის ფართო  
სპექტრისათვის.





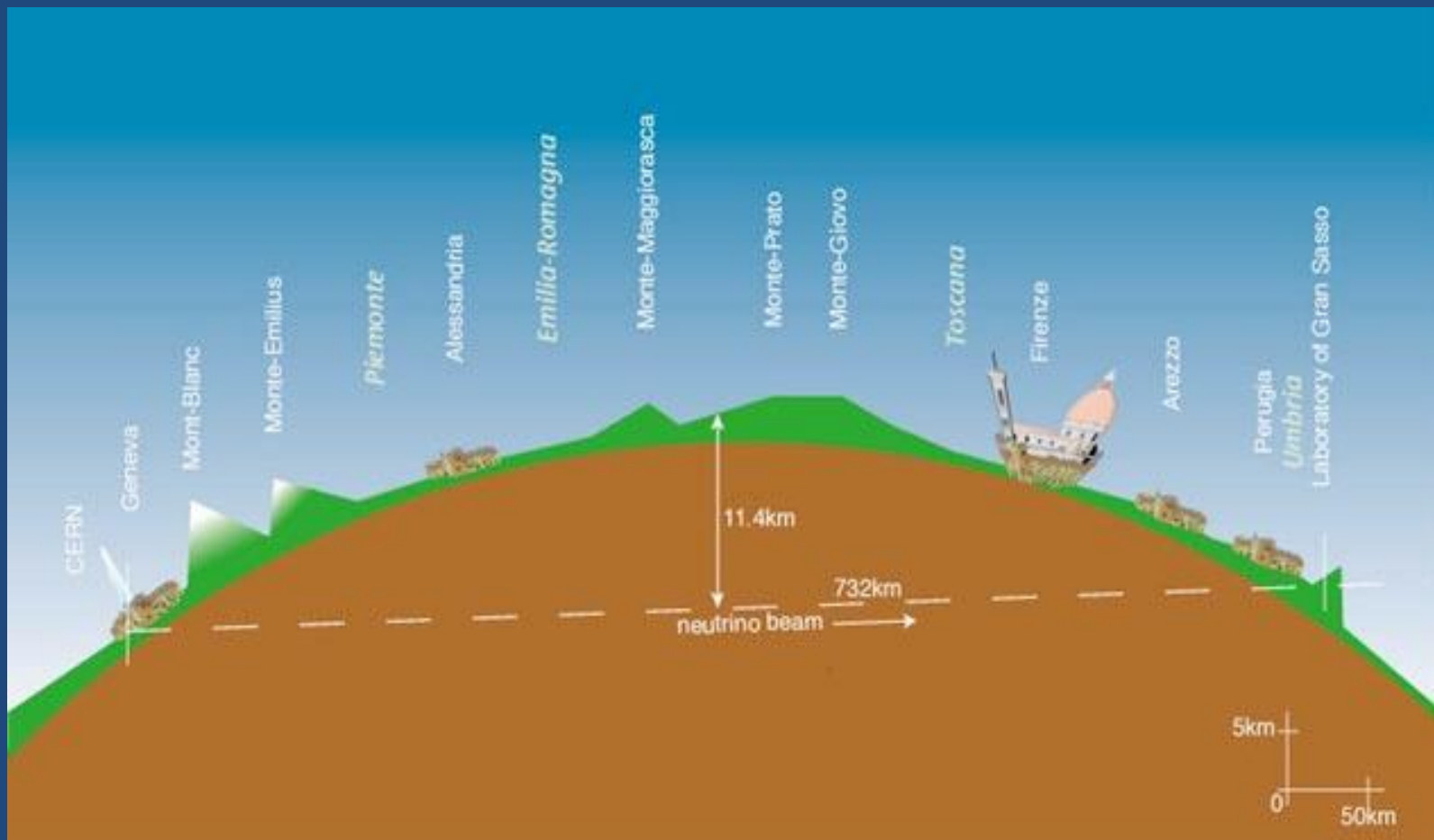


**Low Energy Ion Ring 2005**

# CNGS – CERN Neutrino to Gran Sasso experiment

- investigation of the nature of neutrinos

CERN sends muon neutrinos to the Gran Sasso National Laboratory (LNGS), 732 km away in Italy. There, two experiments, OPERA and ICARUS, wait to find out if any of the muon neutrinos have transformed into tau neutrinos. To create the neutrino beam, a proton beam from the Super Proton Synchrotron (SPS) is used.







# An experiment on climate

**Study effect of cosmic rays on clouds formation**  
(cosmic rays “simulated “ by a beam, clouds created in a large climatic chamber)



# Nobel prize 1984: CERN



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

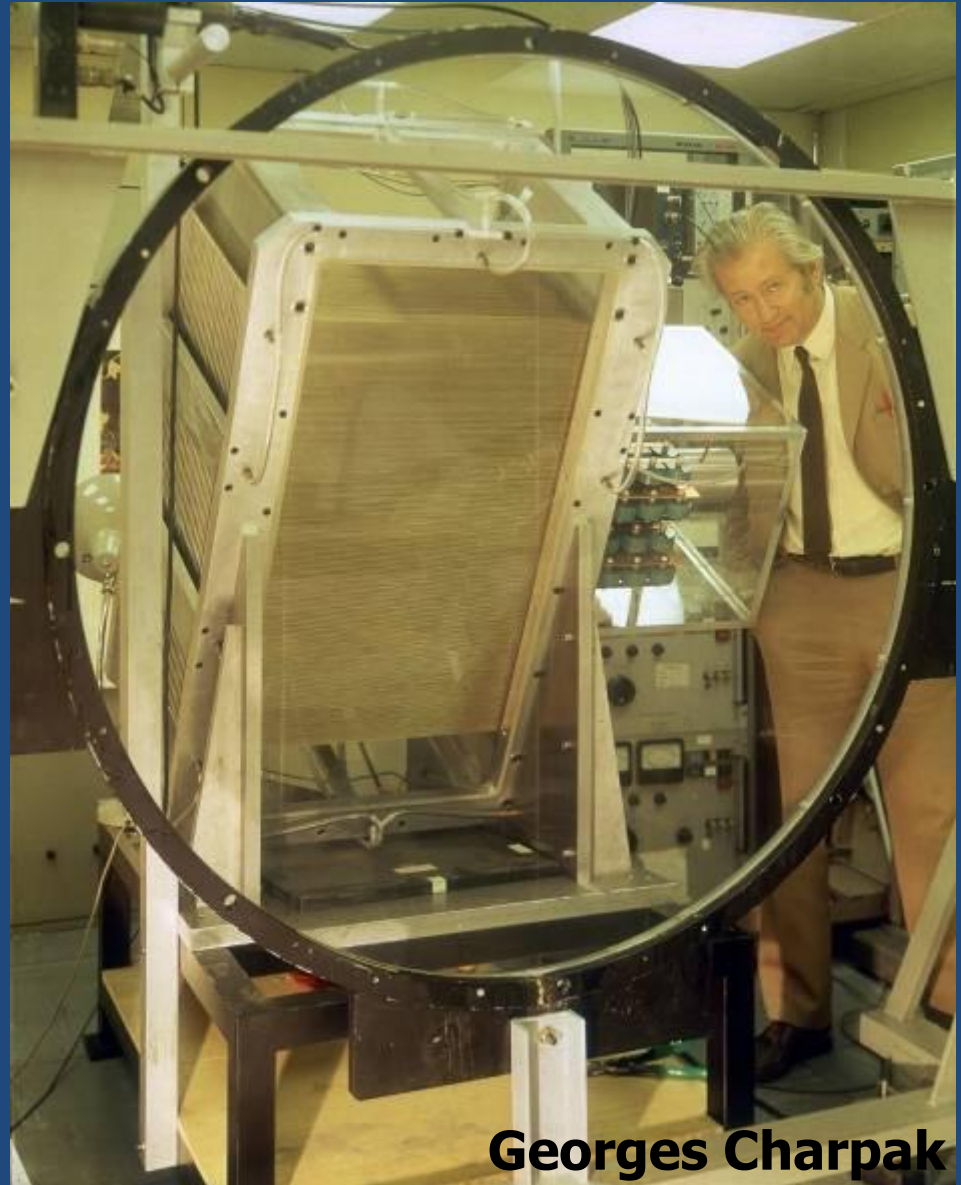


# Nobel prize 1992: CERN

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**

# Nobel prize 1988



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



# CERN Technologies - Innovation

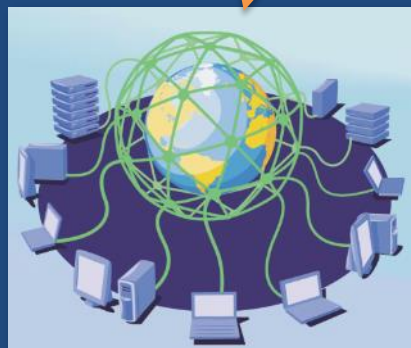
Accelerating  
particle beams

Tumour Target



Charged hadron beam that  
loses energy in matter

Grid computing for  
big data  
management and  
analysis



Detecting  
particles

Medical imaging



Drugs hidden inside the  
gas tank

# World Wide Web, GRID, Computing...



From the past...

[www.cern.ch](http://www.cern.ch)



Tim Berners-Lee  
father of WWW



... into the future



# GqarTvel maswavlebelTa programebi cern-Si

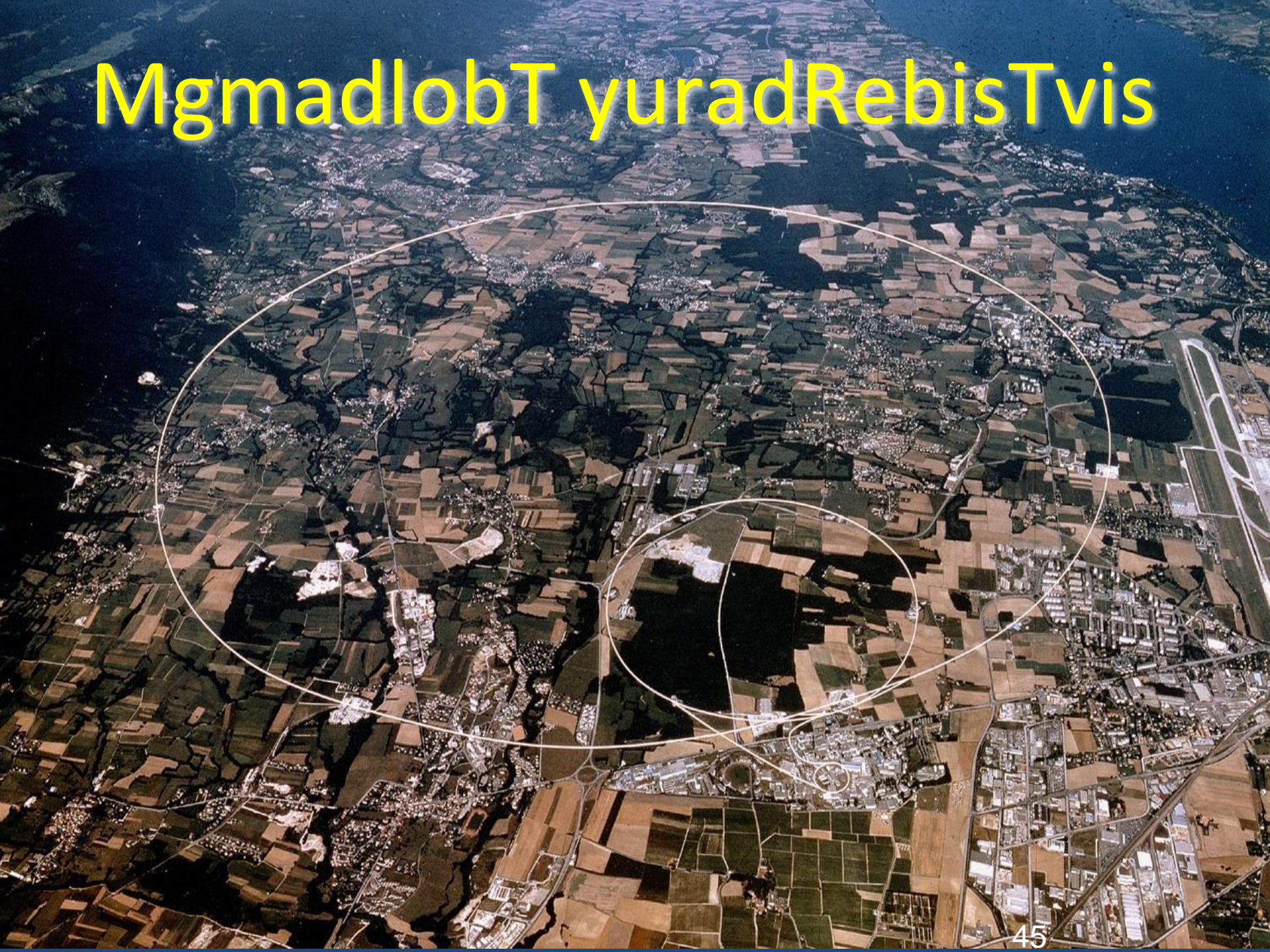
- 1 programa - 2011 Nnoemberi
- 2 programa - 2012 maisi
- 3 programa - 2012 noemberi
- 4 programa - 2013 noemberi
- 5 progrma - 2014 oqtomberi
- 6 progrma - 2015 oqtomberi
- 7 progrma - 2016 seqtemberi
- 8 progrma - 2017 noemberi
- 9 progrma - 2018 aprili
- 10 progrma - 2019 aprili
- 11 progrma - 2022 noemberi
- 12 progrma - 2023 marti

velodebiT axal aRmoCenebs rogorc standartul aseve mis miRma arsebul modelebSi romlebmac unda gagvcen pasuxebi iseT SekiTxvebze rogoricaa:

- sad aris anti materia
- sad da ra mdgomareobaSia damaluli samyaros 96% energiisa (Savi materia, bneli energia)
- aris Tu ara ganzomileba 4-ze meti
- sruliad axali aRmoCenebi
- 😊

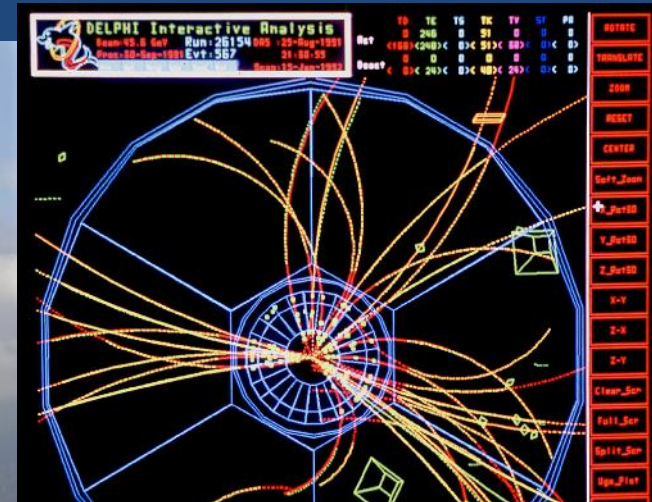


# MgmadlobT yuradRebisTvis





International Collaboration



Fundamental Research

Technology Transfer

Education Training the scientists of tomorrow





4 JULY 2012 CERN Press conference

Discovery upends world of physics. CERN reports finding particle that could solve mysteries large and small.

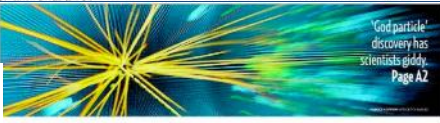
Physicists Find Elusive Particle Seen as Key to Universe. ROMNEY NOW SAYS HEALTH MANDATE BY OBAMA IS A TAX. SEVERE WEATHER CRITICISM.

The Economist. A giant leap for science. Finding the Higgs boson.

ヒッグス粒子発見か. 新素粒子検出 年内に結論. 日米欧2チーム.

Milhares de moradores de bairros sociais em risco de perderem RSI. Science: la matière dévoilée.

Le Monde. Science: la matière dévoilée. 7,2 milliards de plus dès 2012.



The Gazette. EL PAIS. EL PERIODICO GLOBAL EN ESPAÑOL.

MK. ПОСЛЕДНИЙ КИРПИЧ В СТЕНУ МИРОЗДАНИЯ. МЕТРО СПУСКАЕТ НА ВОДУ.

AD ALGEMEEN DAGBLAD. Eindelijk belijk na 48 jaar. Zieke Kaj en zijn moeder toch samen in de VS.

Frankfurter Allgemeine. Große Mehrheit im Deutschen Bundestag. Unter der Woche.

CHINA DAILY. Important Matter. Scientists claim to have discovered 'God particle'.

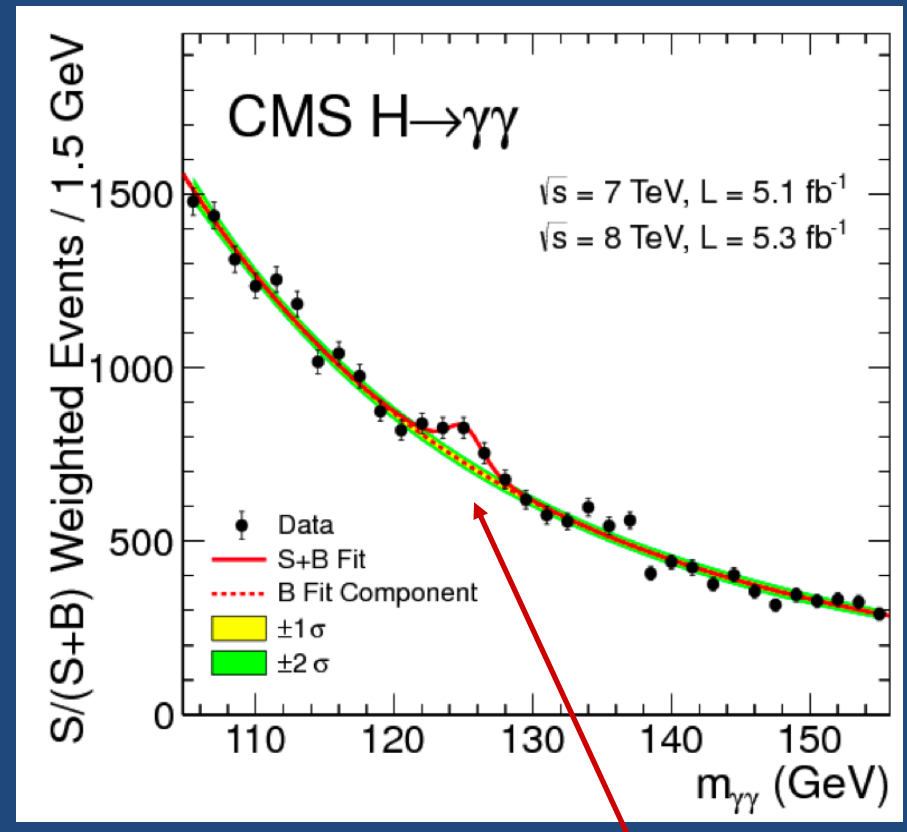
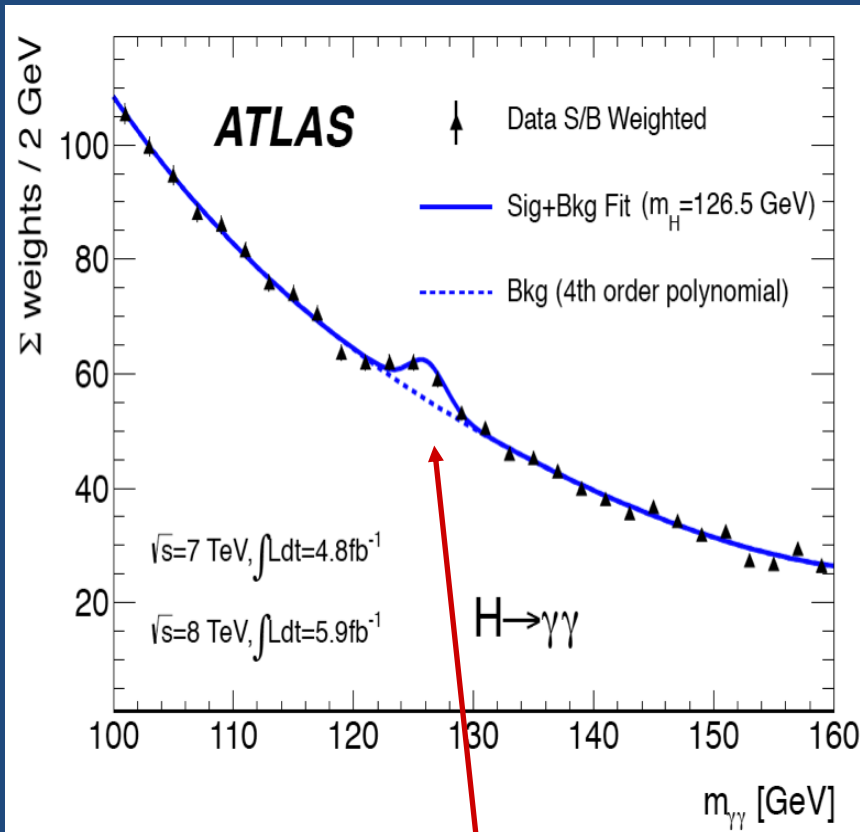
THE HINDU. Elusive particle found, looks like Higgs boson. CERN physicists had evidence of game-changing discovery of subatomic particle.

CORRIERE DELLA SERA. La particella che può svelare i segreti dell'universo. Risultato a oggi il volto sul nuovo candidato.

gazeta WYBORCZA.PL. Czarstke Higgsa fizycy najpierw wynisili, potem szukali 40 lat. BOSKA MASA.

আনন্দবাজার পত্রিকা. বিজ্ঞানের 'ঈশ্বর' দর্শন. Big bang moment: Scientists may have found 'God particle'.

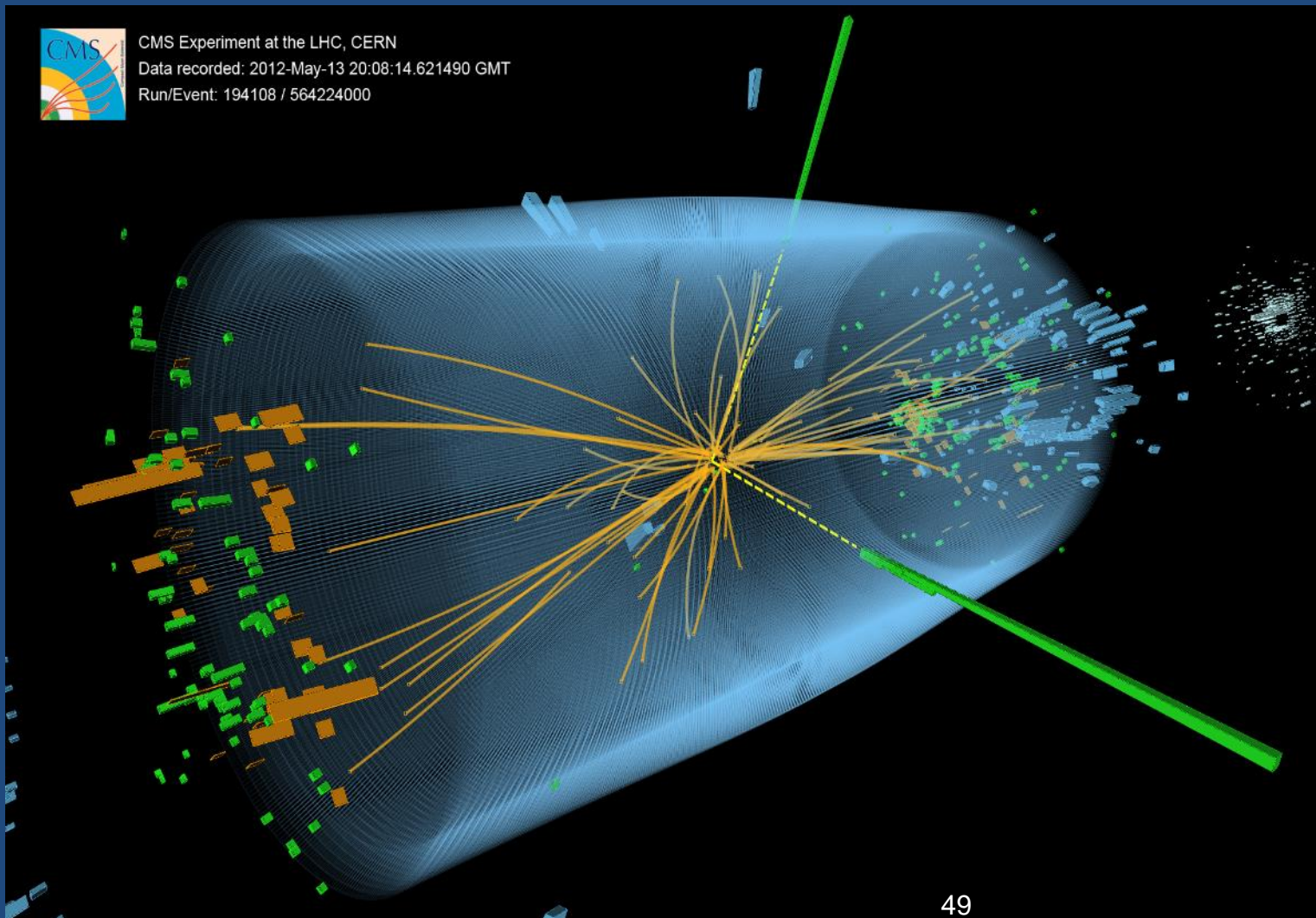
# Higgs decay to $\gamma\gamma$ , ATLAS and CMS, summer 2012 data





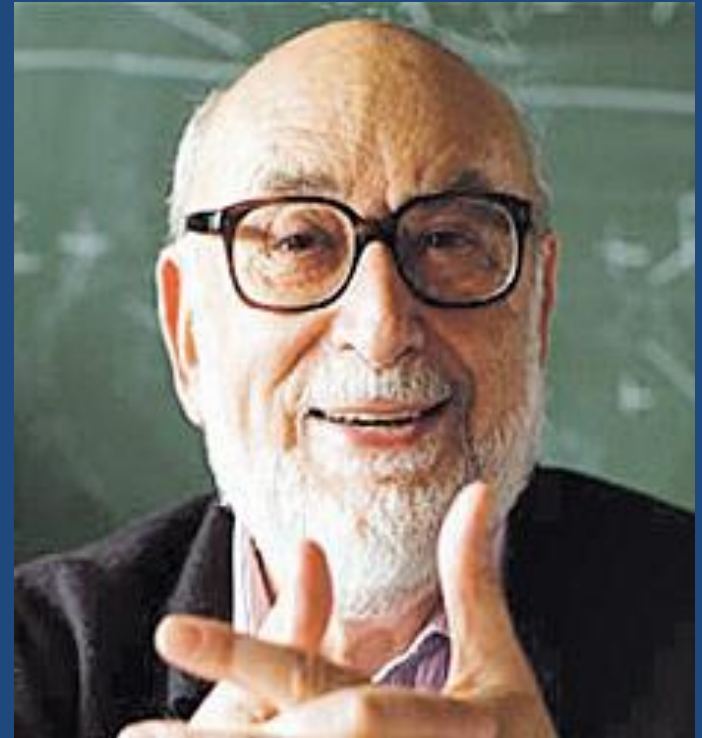
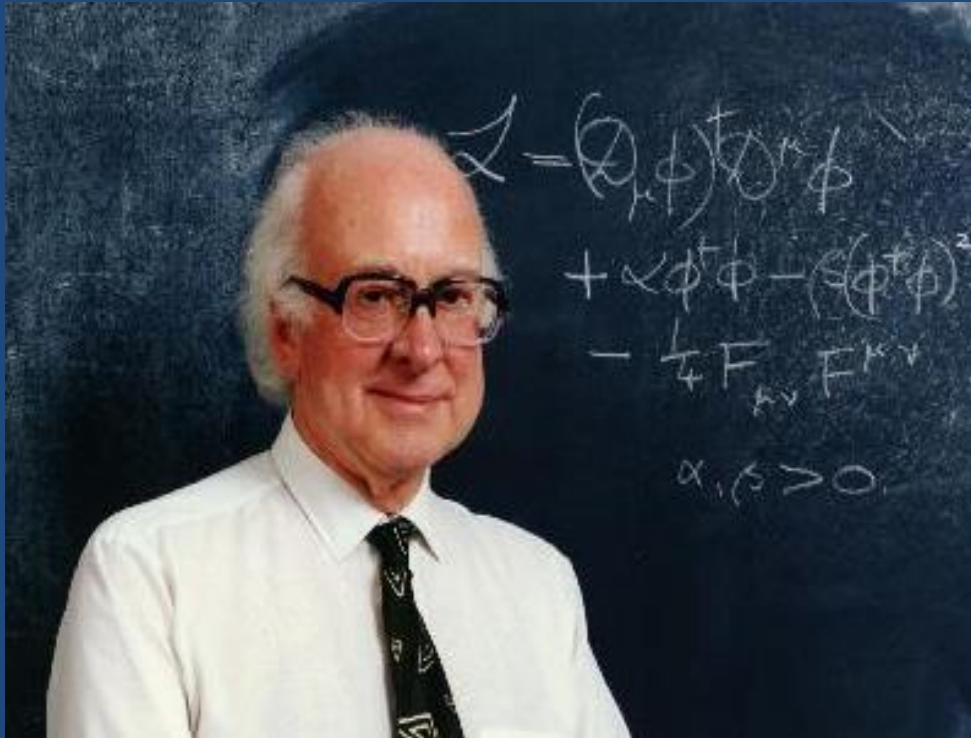
# 4 July 2012: CERN press conference

## “CERN experiments observe particle consistent with long-sought Higgs boson”



# Nobel prize in Physics 2013

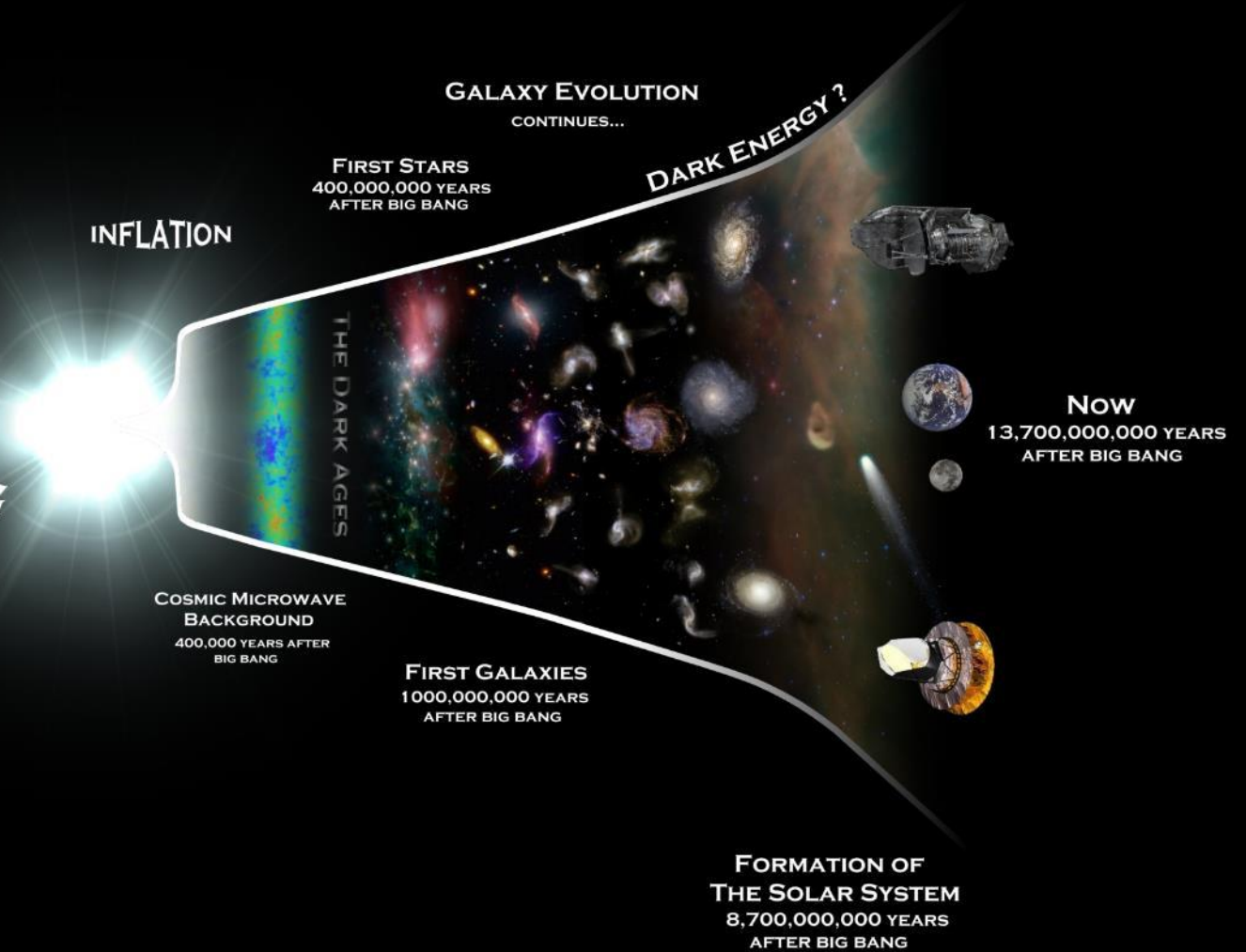
## Peter Higgs and Francois Englert



*"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"*



# THE BIG BANG



# samyaras ganviTarebis istoria

