



Kako je svet postao globalno selo?

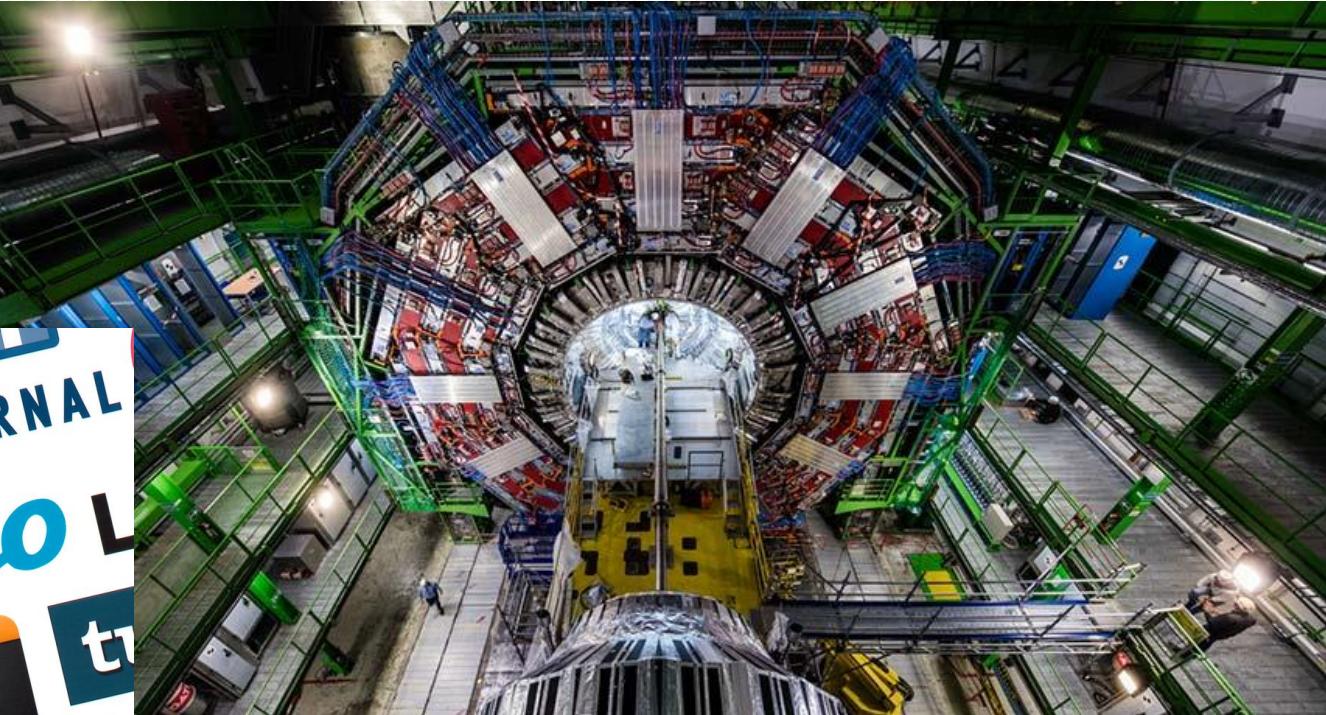
30 godina od nastanka World Wide Weba

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Departman za fiziku, PMF u Nišu

EU info kutak Niš, 23. jul 2019.

WWW i CERN ???



Credits: Max Brice/CERN

Malo fizike ☺ ... ☹

CERN? ...kolajderi



Malo hemije

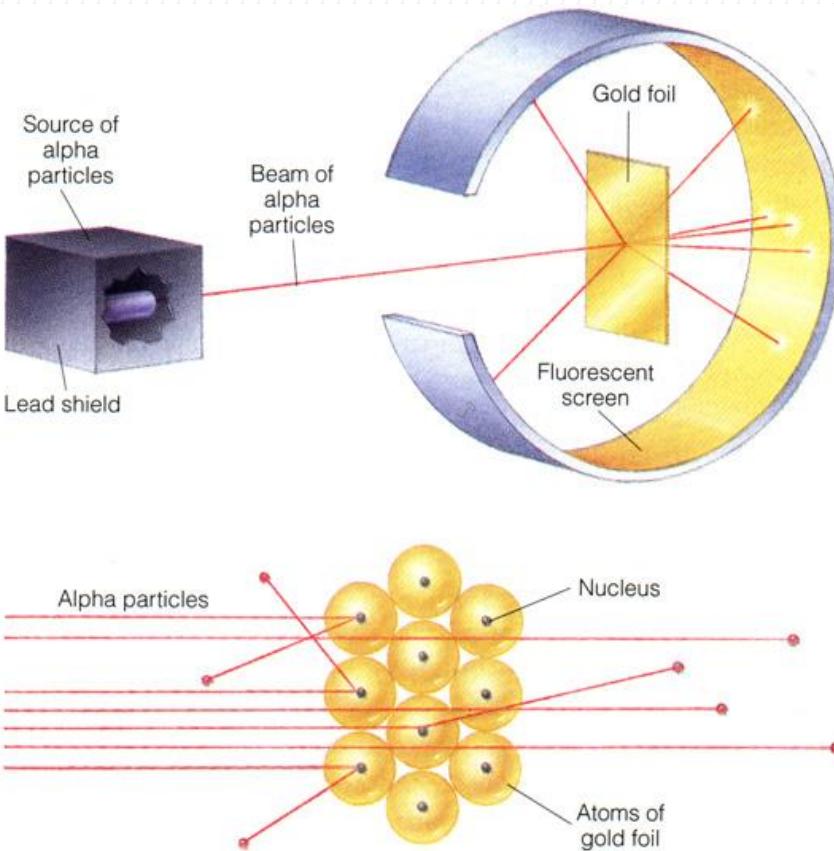
- Dmitrij Ivanovič Mendeljejev (1834 - 1907)
 - Periodni sistem – 1869. god.



1 1IA 11A	Periodic Table of the Elements																	18 VIIIA 8A	
1 H Hydrogen 1.0079	2 IIA 2A	3 Li Lithium 6.941	4 Be Beryllium 9.01218	5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797										
11 Na Sodium 22.989776	12 Mg Magnesium 24.305	3 IIIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIIB 7B	8	9 VIIIA 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	2 He Helium 4.00260		
19 K Potassium 39.083	20 Ca Calcium 40.078	21 Sc Scandium 45.9591	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.932	28 Ni Nickel 58.6934	29 Cu Copper 63.548	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.04	33 As Arsenic 74.92159	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.85		
37 Rb Rubidium 85.4673	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium 98.9072	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8982	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.780	52 Te Tellurium 127.8	53 I Iodine 126.90447	54 Xe Xenon 131.29		
55 Cs Cesium 132.90543	56 Ba Barium 137.327	57-71 Hf Hafnium 178.49	72 Ta Tantalum 180.9479	73 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.8383	82 Bi Lead 207.2	83 Po Bismuth 208.98037	84 At Polonium 208.9824	85 Rn Radon 222.0176				
87 Fr Francium 223.0197	88 Ra Radium 226.0254	89-103 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium [289]	114 Uuo Ununquadium [289]	115 Uup Ununpentium [298]	116 Uuh Ununhexium [298]	117 Uus Ununseptium [298]	118 Uuo Ununoctium [298]			
Lanthanide Series		57 La Lanthanum 138.9055	58 Ce Cerium 140.115	59 Pr Praseodymium 140.9075	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.9685	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.28	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967			
Actinide Series		89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0368	92 U Uranium 238.0289	93 Np Neptunium 237.0482	94 Pu Plutonium 244.0642	95 Am Americium 243.0614	96 Cm Curium 247.0703	97 Bk Berkelium 247.2703	98 Cf Californium 249.0796	99 Es Einsteinium 251.0796	100 Fm Fermium 252.0851	101 Md Mendelevium 253.1	102 No Neptunium 253.1099	103 Lr Lawrencium 252.0852			
		Alkali Metal		Alkaline Earth		Transition Metal		Basic Metal		Semimetals		Nonmetals		Halogens		Noble Gas		Lanthanides	
																		Actinides	

Atom i “atom”

- Ernest Rutherford (1871-1937)



Akceleratori

- Elektrostatički, linearni, ciklotroni, sinhrotroni...

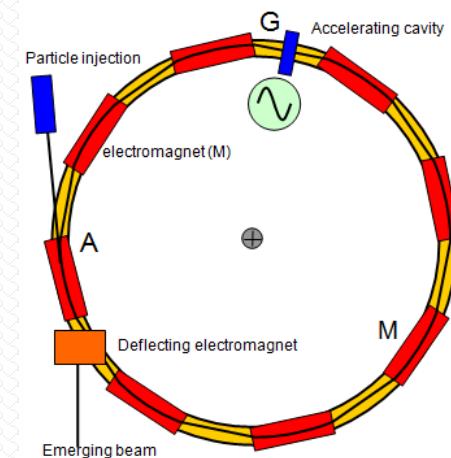
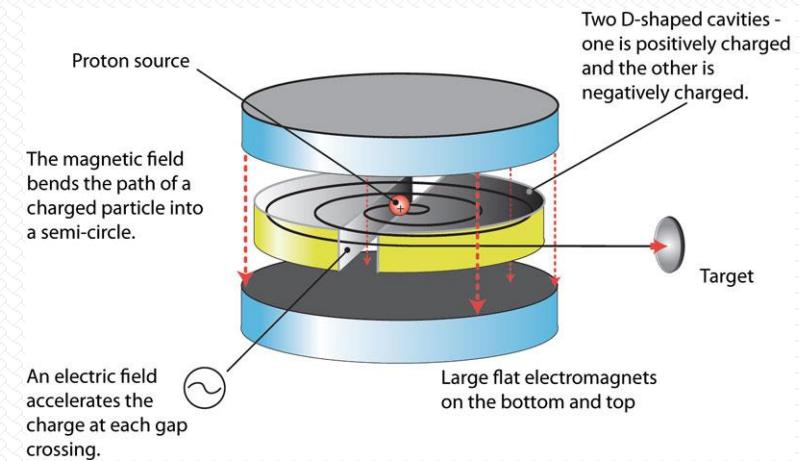
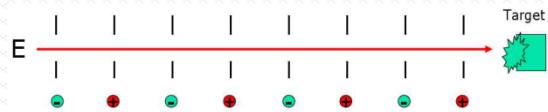
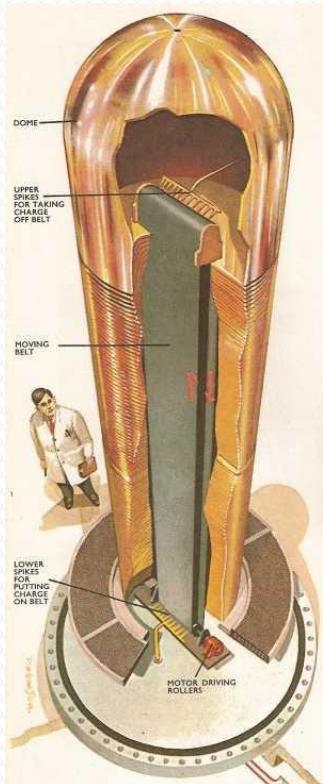
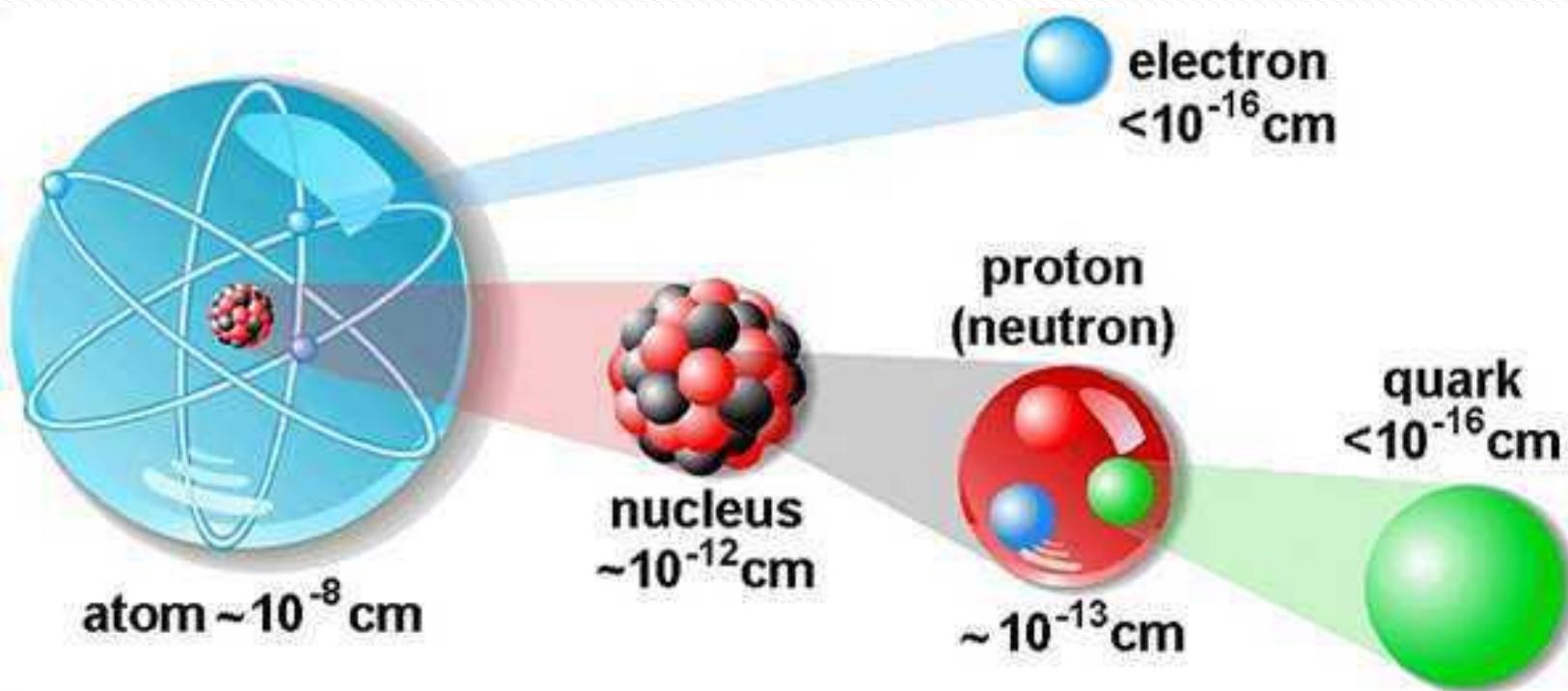


Figure 1

Struktura materije

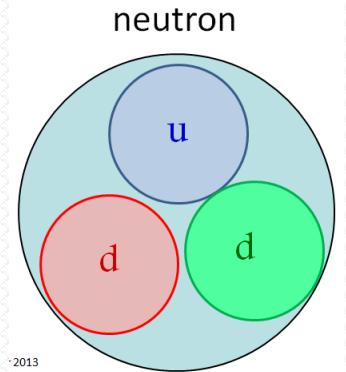
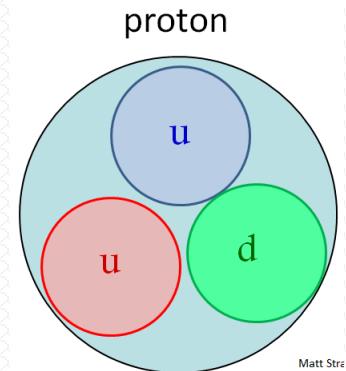
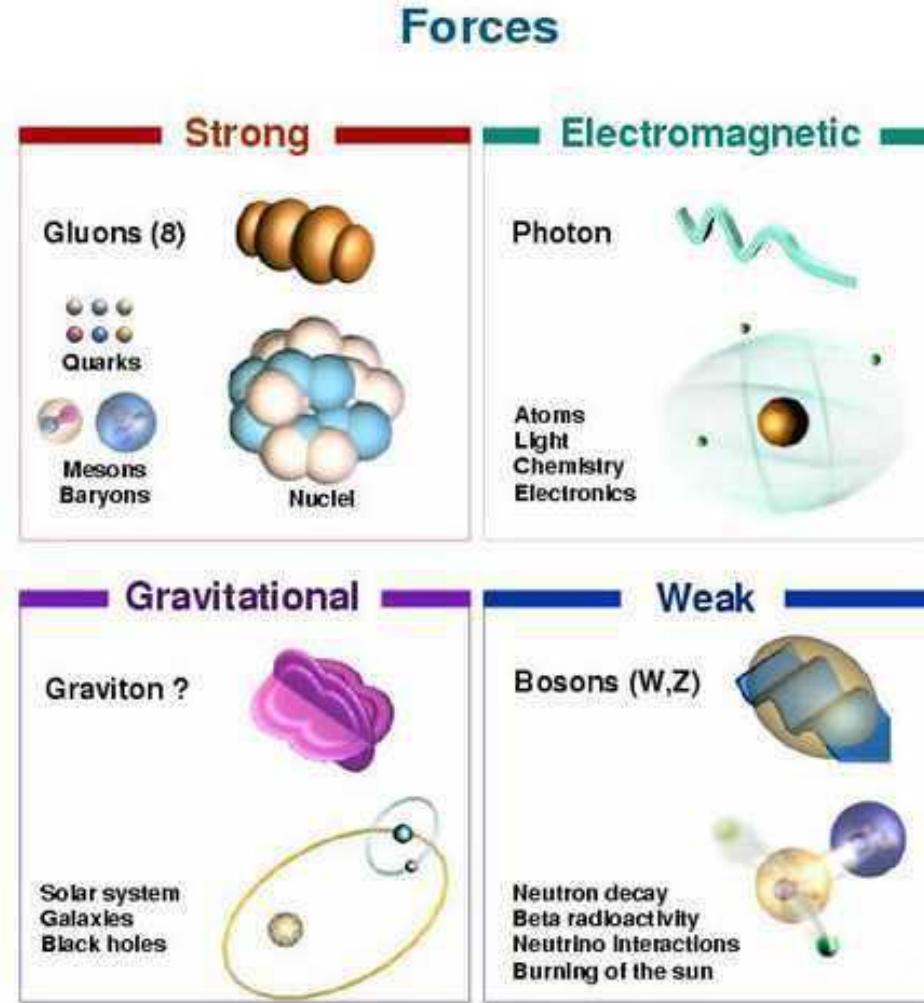


Čestice i sile

Particles			
Leptons			
Tau		-1	Tau Neutrino
Muon		-1	Muon Neutrino
Electron		-1	Electron Neutrino

Quarks			
Bottom		-1/3	Top
Strange		-1/3	Charm
Down		-1/3	Up

each quark:    3 colors

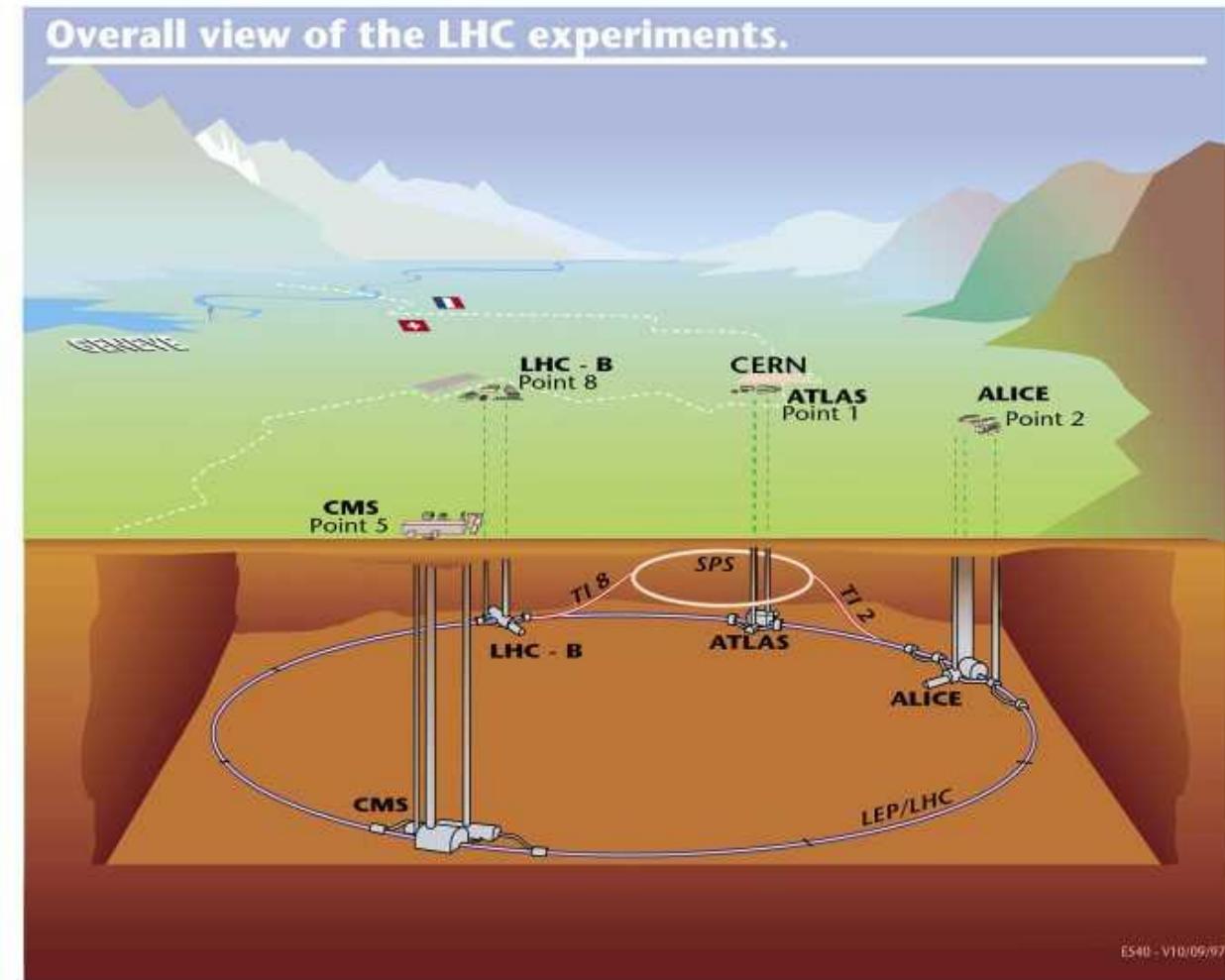


The particle drawings are simple artistic representations

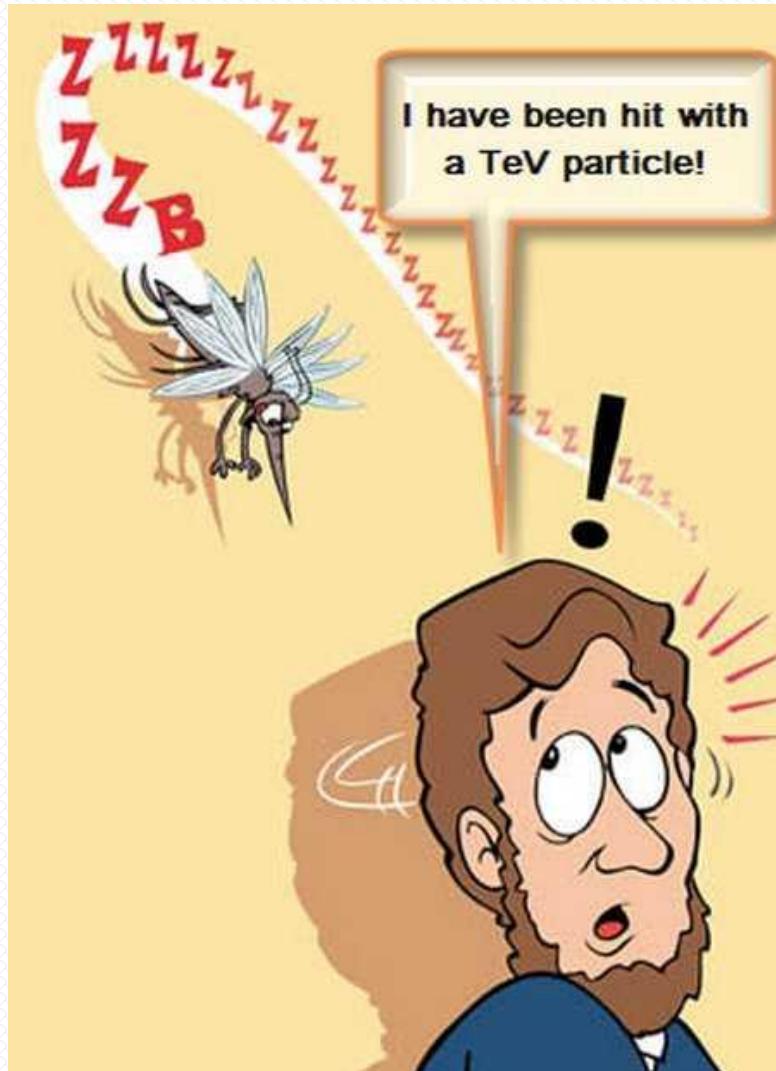
The particle drawings are simple artistic representations

Ukratko o LHC

- Temperatura: 1.8K
- Dužina: 27 km
- 1300 magneta (~ 13 metara, ukupno 24 kilometara)
- Struja: 6500 – 9000 A
- Magnetno polje: 8.5 T
- Energija – max 14 TeV



Šta je TeV?



$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

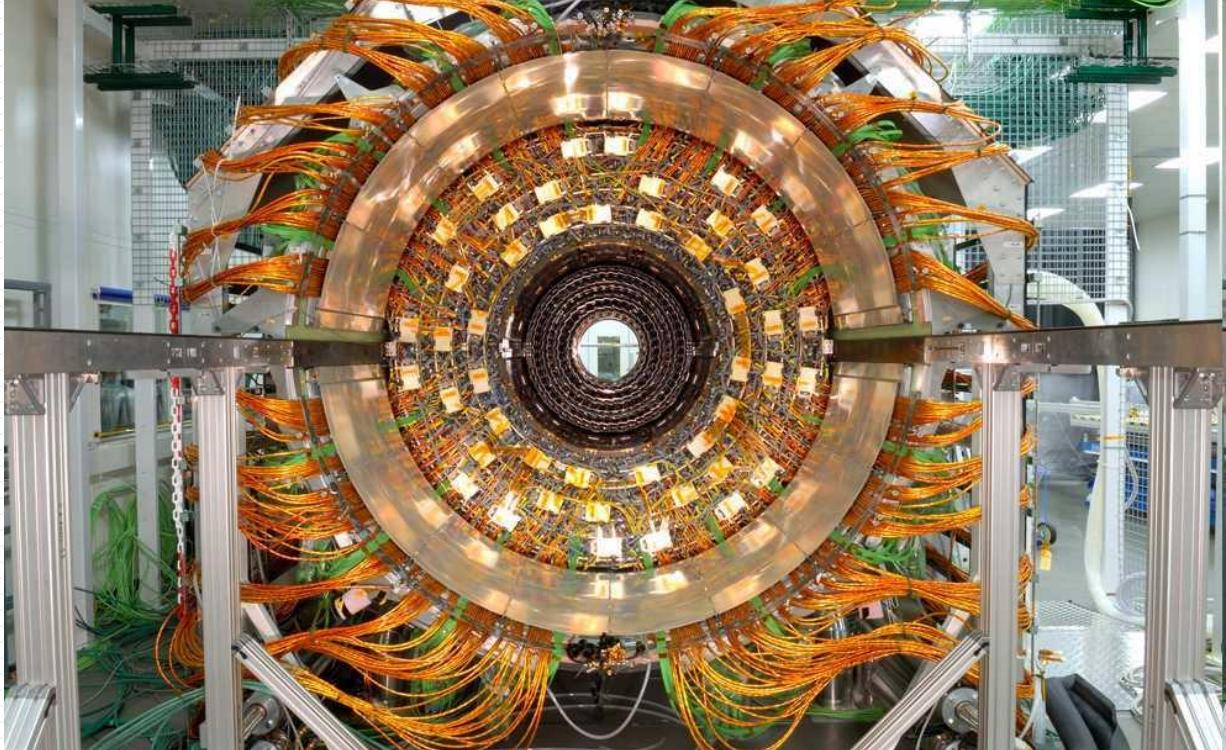
$$\begin{aligned}1 \text{ TeV} &= 1.6 \times 10^{-19} \times 10^{12} \text{ J} \\&= 1.6 \times 10^{-7} \text{ J}\end{aligned}$$

$$1/2 m v^2 = 1.6 \times 10^{-7} \text{ J},$$

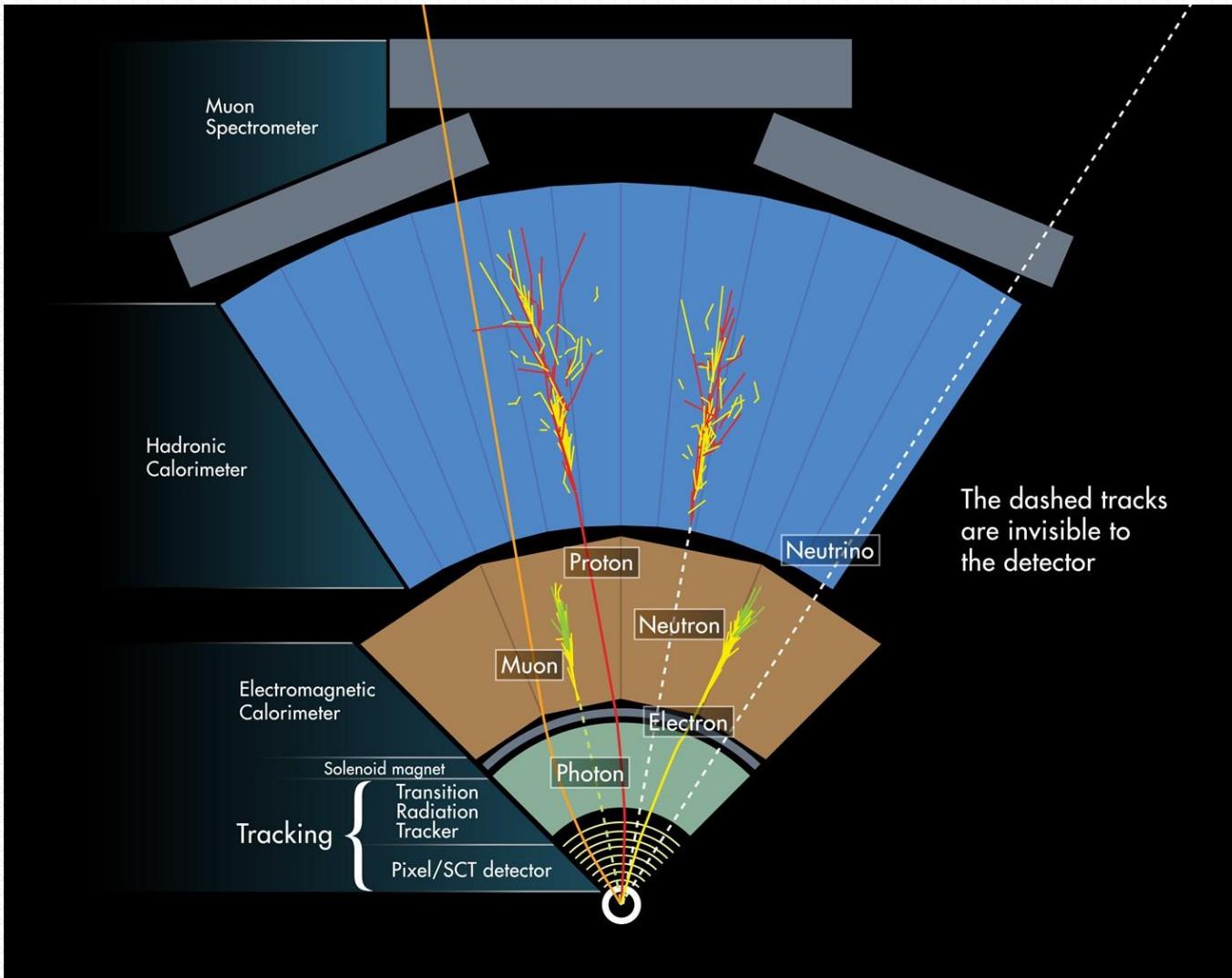
$$m = 2 \times 10^{-6} \text{ kg}$$

$$v = 0.4 \text{ m/s} = 1.4 \text{ km/h}$$

Detektori – ATLAS i CMS

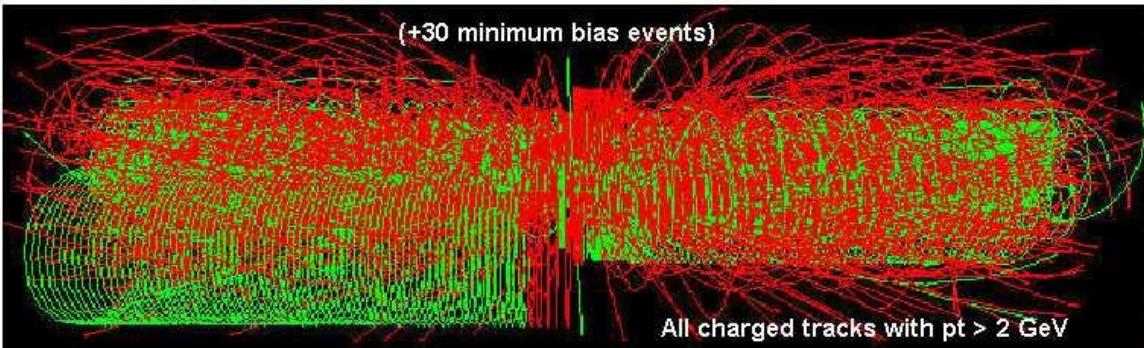


Detektovanje čestica

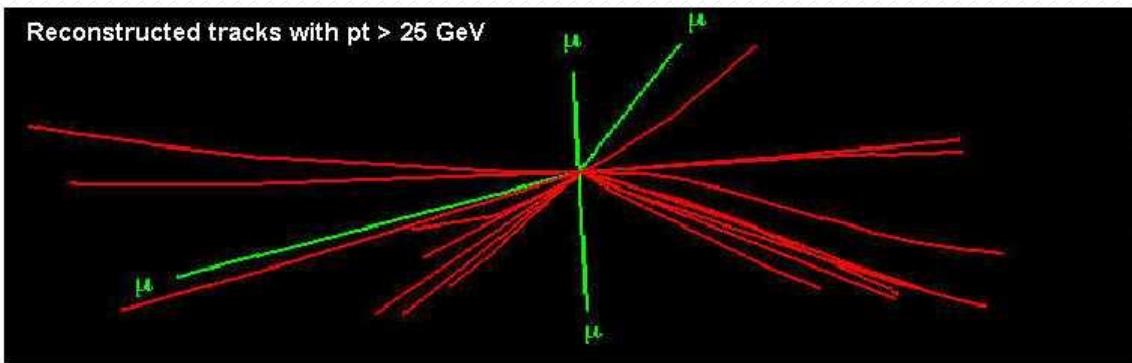


Mnogo podataka...

- U ovome:



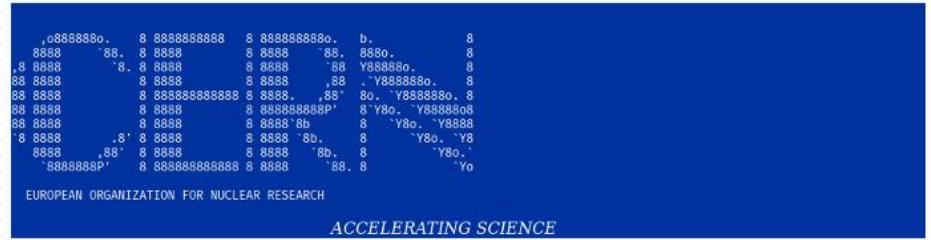
- Treba pronaći:



- Pretraga: 1×10^{13}
- Jedna osoba na 1000 „Zemlji“

CERN i internet

www.home.cern



1. april 2019

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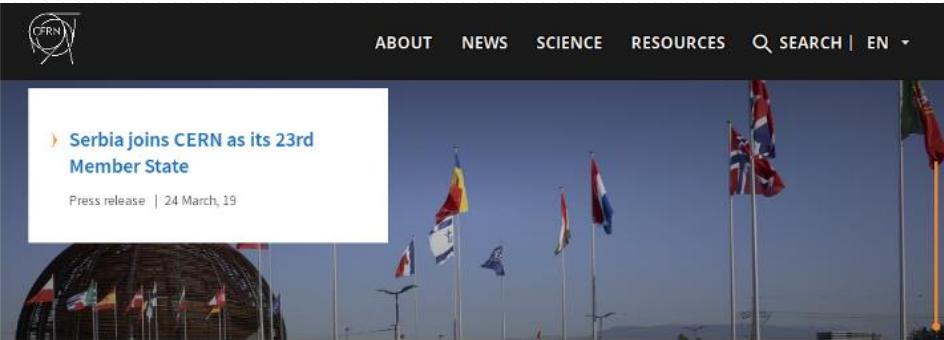
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Svi ostali (normalni) dani ☺

Ipak, imaju veze ☺

12. mart 1989 – 12. mart 2019

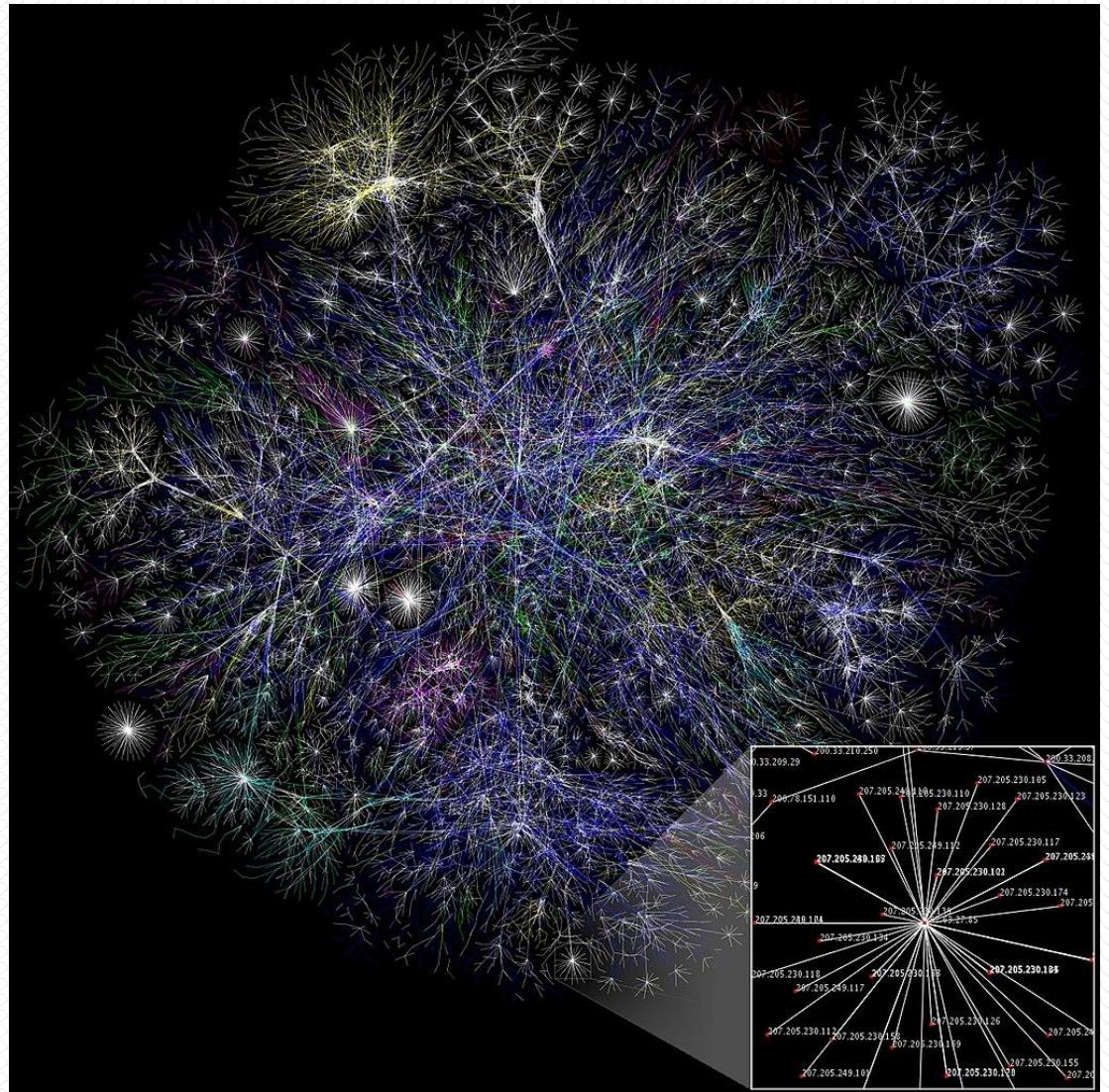
<http://info.cern.ch/>



CERN, mesto gde je nastao „internet“?



Deo „Puteva na internetu“ 15. januar 2005, opte.org



WWW nije internet!



Server not found

Firefox can't find the server at www.google.com.

- Check the address for typing errors such as ww.example.cc or www.example.com
- If you are unable to load any pages, check your computer's connection.
- If your computer or network is protected by a firewall or proxy, make sure that Firefox is permitted to access the Web.

[Try Again](#)



Unable to connect to the Internet

[More](#)



You're not connected

And the web just isn't the same without you.

Let's get you back online

- Check that your network cables are plugged in.
- Make sure you're not in airplane mode.
- See if your wireless switch is turned on.
- Restart your router.

[Help me fix it](#)

OSI model

Layer	Function	Example Protocols
7 Application Layer	network process to application	HTTP, SFTP, SSH
6 Presentation Layer	data representation & encryption	XML, JSON
5 Session Layer	interhost communication	Mostly theoretical
4 Transport Layer	end-to-end connections & reliability	TCP, UDP
3 Network Layer	path determination & logical addressing	IP Addresses
2 Data Link Layer	physical addressing	MAC Addresses
1 Physical Layer	medial signal & transmission	Ethernet, Bluetooth, Wireless

Kako je nastao internet?

- Početak, 1950 – 1960. godina
- Veće institucije i univerziteti u SAD i Evropu imale svoje mreže
 - Često sejavljala potreba za mrežama koje bi omogućile komunikaciju između različitih institucija
 - Svaka mreža funkcionala je na specifičan način i komunikacija između dve mreže bila je teško izvodljiva ili potpuno nemoguća.
- **Robert Taylor**, direktor DARPA (*Defense Advanced Research Projects Agency*) bio je inicijator prve mreže koja je povezala više institucija

Kako je nastao internet?

- **Larry Roberts** (MIT) i **Robert Taylor** su uspostavili **prvi link** između Univerziteta Kalifornija (Los Anđeles) i Istraživačkog instituta Stanford
- Tako je nastao **ARPANET**, 29. oktobra 1969. godine
- Dupliranje čvorova, 5. decembar 1969. godine:
 - Univerzitet Juta
 - Univerzitet Kalifornija (Santa Barbara)
- Brzina: 50 kbps
- Komunikacija između mreža bila je još uvek problem!
- **Vint Cerf** (Univerzitet Stanford) počeo je da radi (1973) na protokolu koji bi omogućio komunikaciju između različitih mreža

Kako je nastao Internet?



Reč „Internet“, prvi put 1974. godine, u specifikaciji TCP protokola ([RFC675](#))

[Docs] [txt|pdf] [Tracker]

Obsoleted by: [7805](#)

Network Working Group
Request for Comments: 675
NIC: 2
INWG: 72

HISTORIC

Vinton Cerf
Yogen Dalal
Carl Sunshine
December 1974

SPECIFICATION OF INTERNET TRANSMISSION CONTROL PROGRAM

December 1974 Version

1. INTRODUCTION

This document describes the functions to be performed by the internetwork Transmission Control Program [TCP] and its interface to programs or users that require its services. Several basic assumptions are made about process to process communication and these are listed here without further justification. The interested reader is referred to [CEKA74, TOML74, BELS74, DALA74, SUNS74] for further discussion.

The authors would like to acknowledge the contributions of R. Tomlinson (three way handshake and Initial Sequence Number Selection), D. Belsnes, J. Burchfield, M. Galland, R. Kahn, D. Lloyd, W. Plummer, and J. Postel all of whose good ideas and counsel have had a beneficial effect (we hope) on this protocol design. In the early phases of the design work, R. Metcalfe, A. McKenzie, H. Zimmerman, G. LeLann, and M. Elie were most helpful in explicating the various issues to be resolved. Of course, we remain responsible for the remaining errors and misstatements which no doubt lurk in the nooks and crannies of the text.

Processes are viewed as the active elements of all HOST computers in a network. Even terminals and files or other I/O media are viewed as communicating through the use of processes. Thus, all network communication is viewed as inter-process communication.

Since a process may need to distinguish among several communication streams between itself and another process [or processes], we imagine that each process may have a number of PORTs through which it communicates with the ports of other processes.

Since port names are selected independently by each operating system, TCP, or user, they may not be unique. To provide for unique names at each TCP, we concatenate a NETWORK identifier, and a TCP identifier with a port name to create a SOCKET name which will be unique throughout all networks connected together.

Kako je nastao internet?

- Razvoj protokola: krajem 1978 – konačna forma i naziv TCP/IP
- Do 1981. godine
 - Konačna forma TCP/IP protokola (RFC791, 792 i 793)
 - ARPANET - **213 čvorova** na mreži
 - Brzina nepromenjena, dodata komunikacija preko satelita i radio veza
- DARPA je počela da finansira i podstiče sve korisnike ARPANET-a da svoje sisteme prilagode TCP/IP protokolu.
- Od 1. januara 1983. godine **TCP/IP** u potpunosti je **potisnuo prethodni NCP protokol** i tako je postao jedini protokol čija je upotreba bila dozvoljena na ARPANET-u.

Kako je nastao internet?

- Iste godine (1983) na Univerzitetu Wisconsin napravljen je prvi DNS (*Domain Name System*) što je omogućilo da se prilikom komunikacije sa računarima koriste imena, a ne IP adrese (brojevi).
- Za to vreme **u Evropi**
 - Paralelno sa razvojem ARPANET-a
 - Projekat je razvijala Norveška seizmička mreža (NORSAR).
 - **Juna 1973.** godine **NORSAR** postao je **prvi čvor ARPANET-a van SAD**.
 - U istom periodu Pošta Velike Britanije, Wester Union i Tymnet rade na svojoj mreži.
 - Za razliku od ARPANET-a Evropska mreža nije bila namenjena samo korisnicima sa univerziteta (vojska SAD koristila je sličnu mrežu MILNET) već i **za poslovnu upotrebu**.



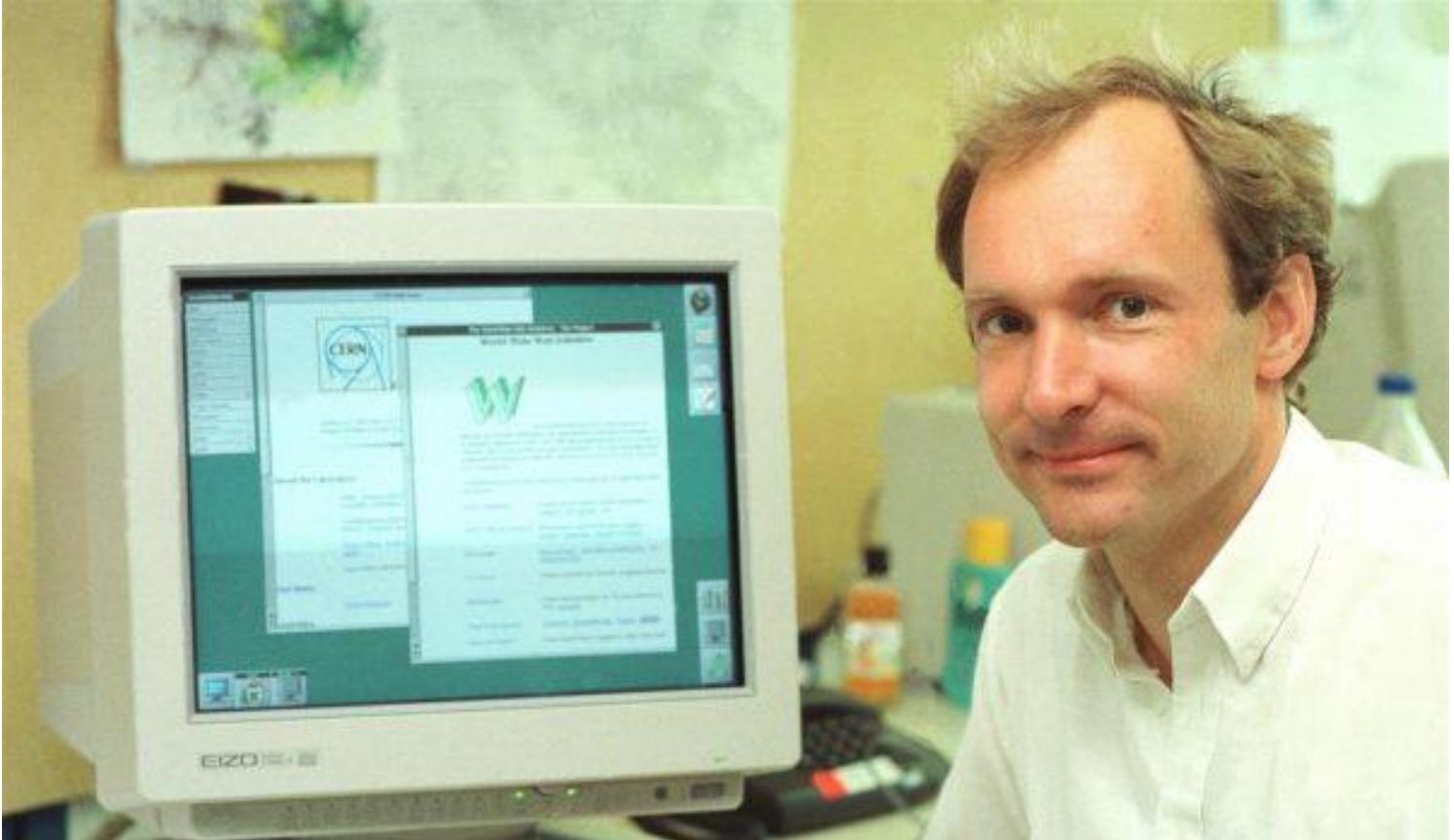
NORSAR TIP

TCP/IP u Evropi

- NORSAR - dva IBM računara povezana na ARPANET
- Prihvatanje TCP/IP protokola išlo sporije
- **CERN** - prihvatio i implementirao TCP/IP protokola unutar svoje mreže u periodu 1984 – 1989. godina
 - Mreža izolovana, tj. „nije bila na internetu“
- Kraj 1989. godine - **CERN otvorio “vrata” svoje mreže** ka Internetu krenulo je i masovno prihvatanje TCP/IP protokola širom Europe, a nešto kasnije i sveta
- Ulaskom u poslednju deceniju XX veka sve mreže na planeti polako su postajale deo Interneta, “mreže svih mreža”.

Kako je tada izgledao internet?

- Otprilike **kao prethodnih nekoliko slajdova** ☺
 - Tekst, tekst, tekst.... i još teksta, u najboljem slučaju
- Korišćeni su servisi od kojih su mnogi nepoznati većini današnjih korisnika: **POP3/SMTP, FTP, gopher, telnet** itd.
- Nije bilo **ni traga** od slika, boja, grafike.
- Sve se dešavalo u komandnoj liniji
- Nije bilo ničega što bi bar malo ličilo na sadržaj današnjih sajtova, na poznate adrese koje počinju sa www....
- Internet je nastao, a to WWW je tek trebalo da bude stvoreno.

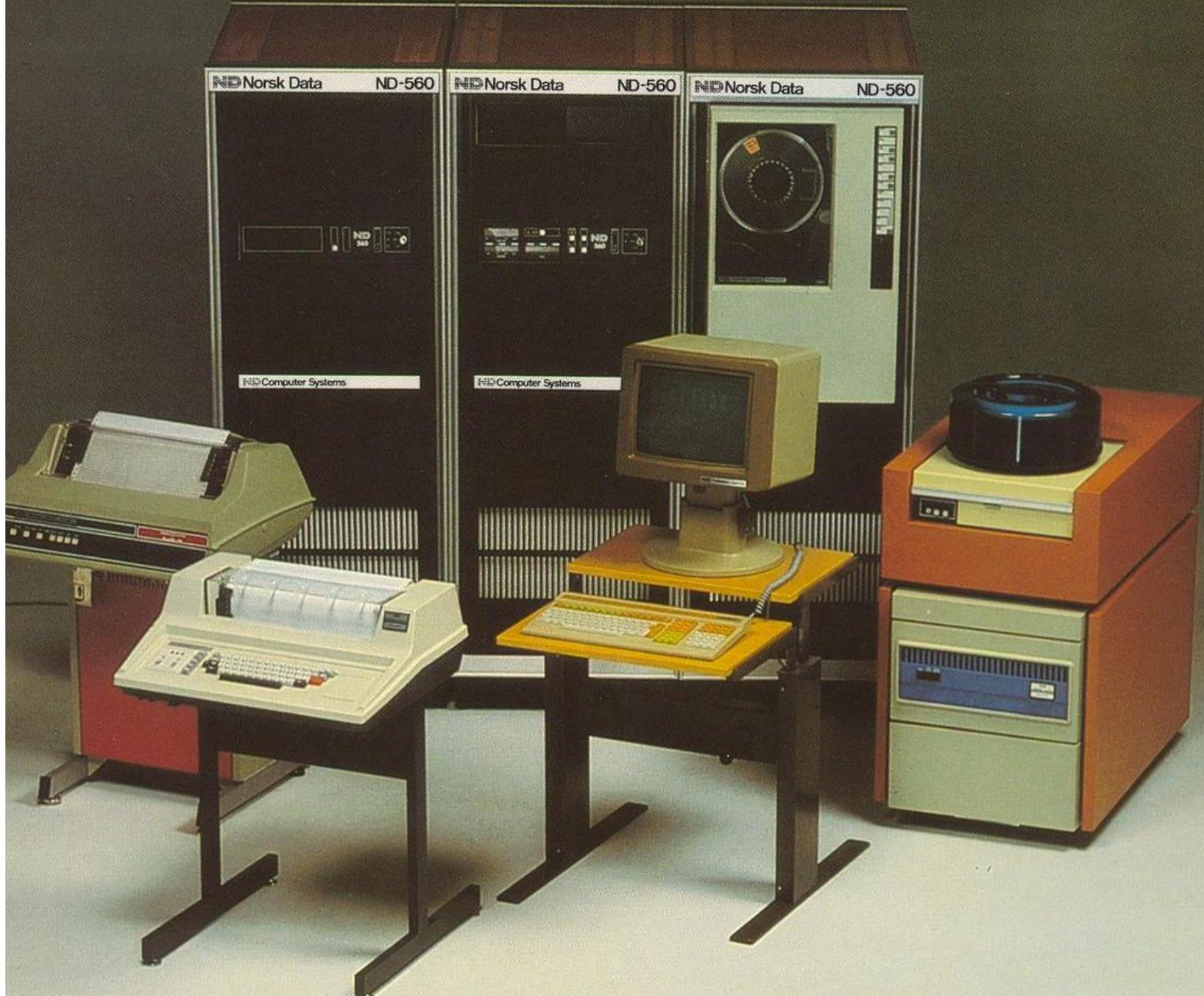


Kako je nastala „Mreža“? (Web)

- CERN, fizika čestica → neophodna razmena ogromne količine podataka
 - Brojke, slova, fotografije, grafikona, tekstovi, povezani podaci itd.
- Par godina pre definisanja TCP/IP protokola
 - **Tim Berners-Lee** - radio je na projektu koji bi omogućio **jednostavniju i bržu razmenu informacija** između naučnika angažovanih u oblasti fizike elementarnih čestica.
- Projekat **ENQUIRE** (1980)
 - Preteča World Wide Web-a
 - Nije bio namenjen javnoj upotrebi
 - Više je ličio na „**Wiki**“ nego na druge sajtove
- Za skladištenje podataka koristio je **baze podataka** a tokom čitanja bilo je moguće i menjati sadržaj stranica
- Preteča današnjih linkova
- Napisan u programskom jeziku **Pascal**, a pokretala ga je **Norsk Data** mašina.

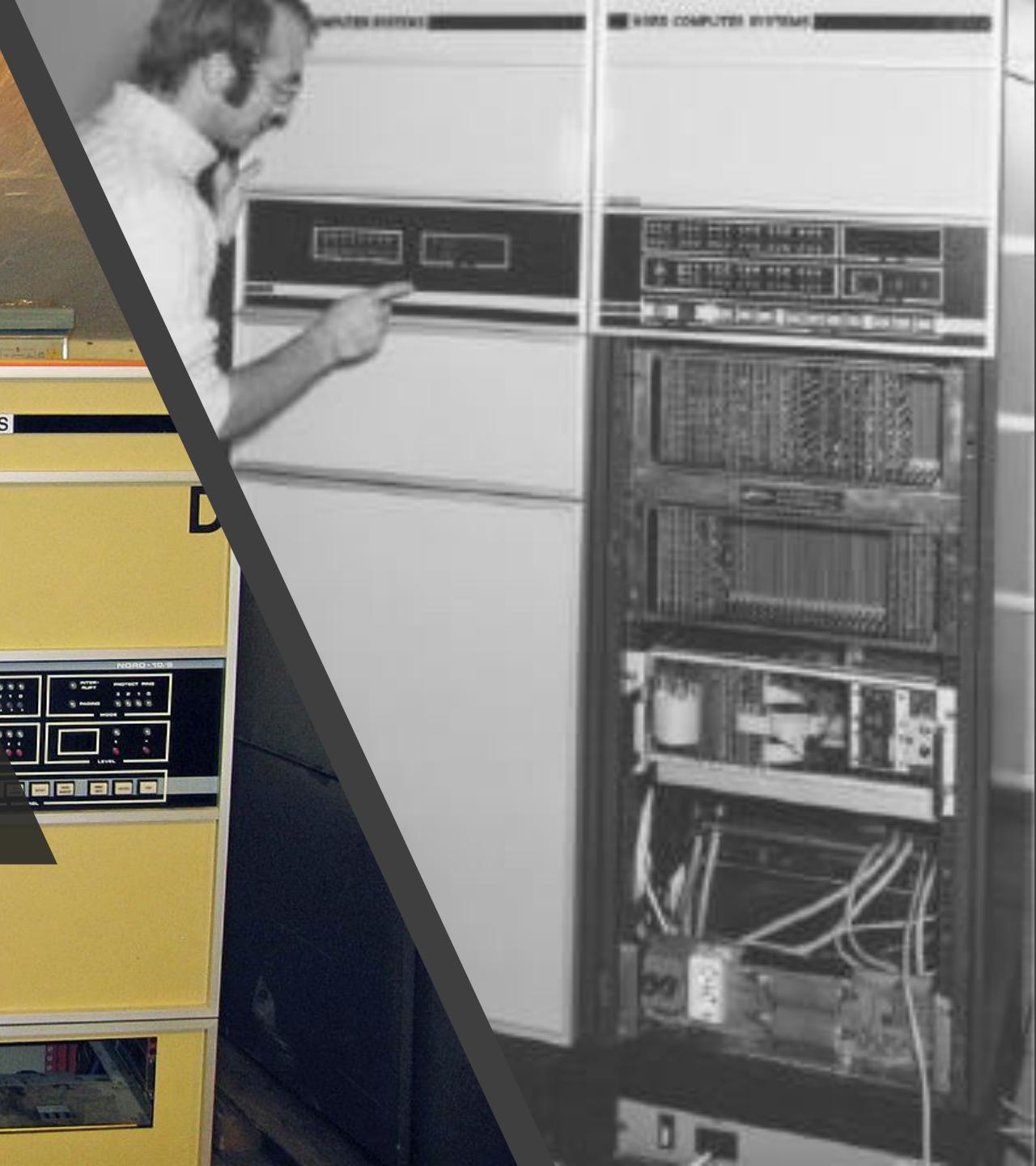
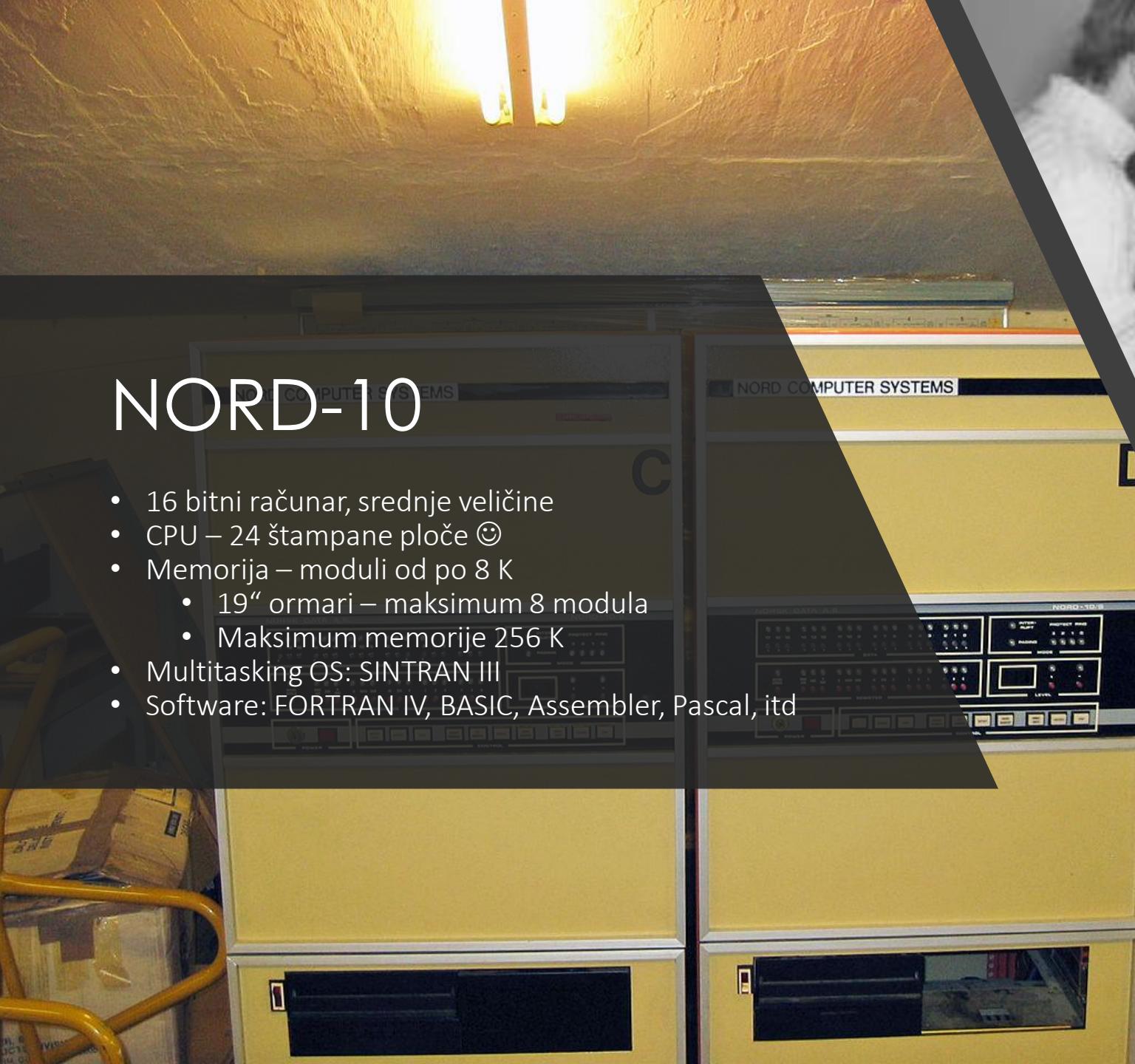
Računar?

- ... na kome je napisan **ENQUIRE**
- Na slici - tipičan Norsk Data računar treće generacije ND-500 (1981)
- 32 bitni superminikompjuter, do 4 CPU sa deljenom memorijom
- Ali... ENQUIRE je napisan na NORD-10 računaru (1973)



NORD-10

- 16 bitni računar, srednje veličine
- CPU – 24 štampane ploče ☺
- Memorija – moduli od po 8 K
 - 19“ ormari – maksimum 8 modula
 - Maksimum memorije 256 K
- Multitasking OS: SINTRAN III
- Software: FORTRAN IV, BASIC, Assembler, Pascal, itd



Web@30

- Ubrzo nakon pokretanja ENQUIRE projekta (1981) ugovor **Tim Berners-Lee** sa CERN-om ističe i on napušta CERN.
- Naredne tri godine radio je na drugom mestu, a onda se **1984.** godine vraća u CERN gde dobija stalan posao.
- **12. marta 1989.** godine, **Tim Berners-Lee** i **Robert Cailliau** (CERN), nezavisno jedan od drugog, upućuju **predlog projekta novog hypertext sistema** slične funkcionalnosti kao ENQUIRE.

CERN DD/OC

Information Management: A Proposal

Vague but exciting ...

Tim Berners-Lee, CERN/DD

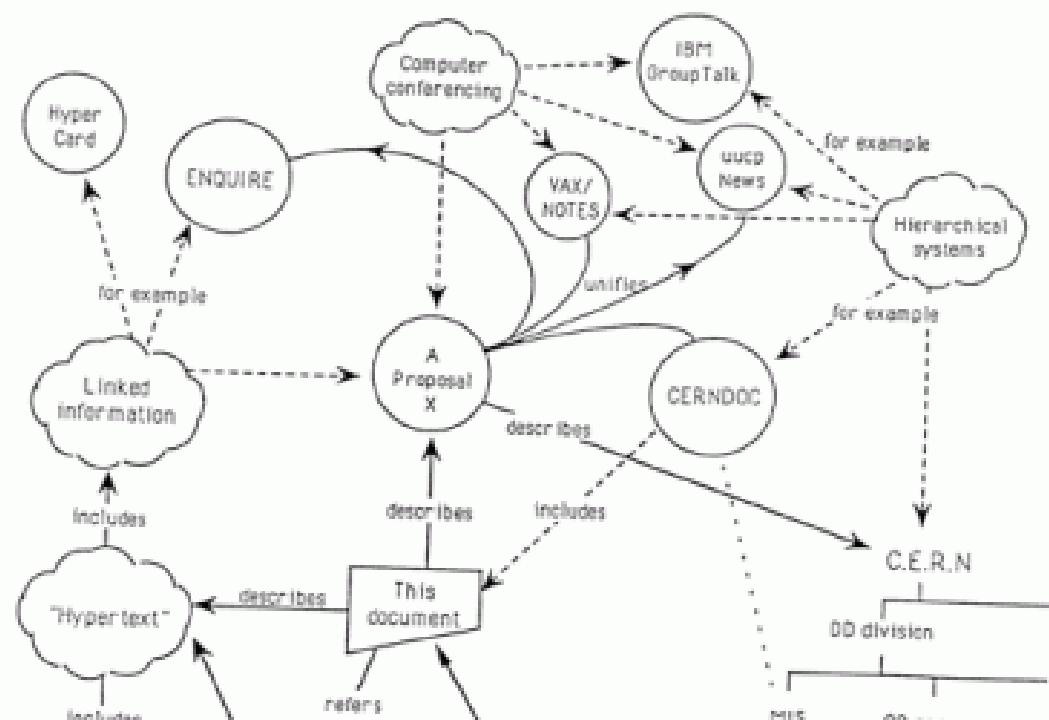
March 1989

Information Management: A Proposal

Abstract

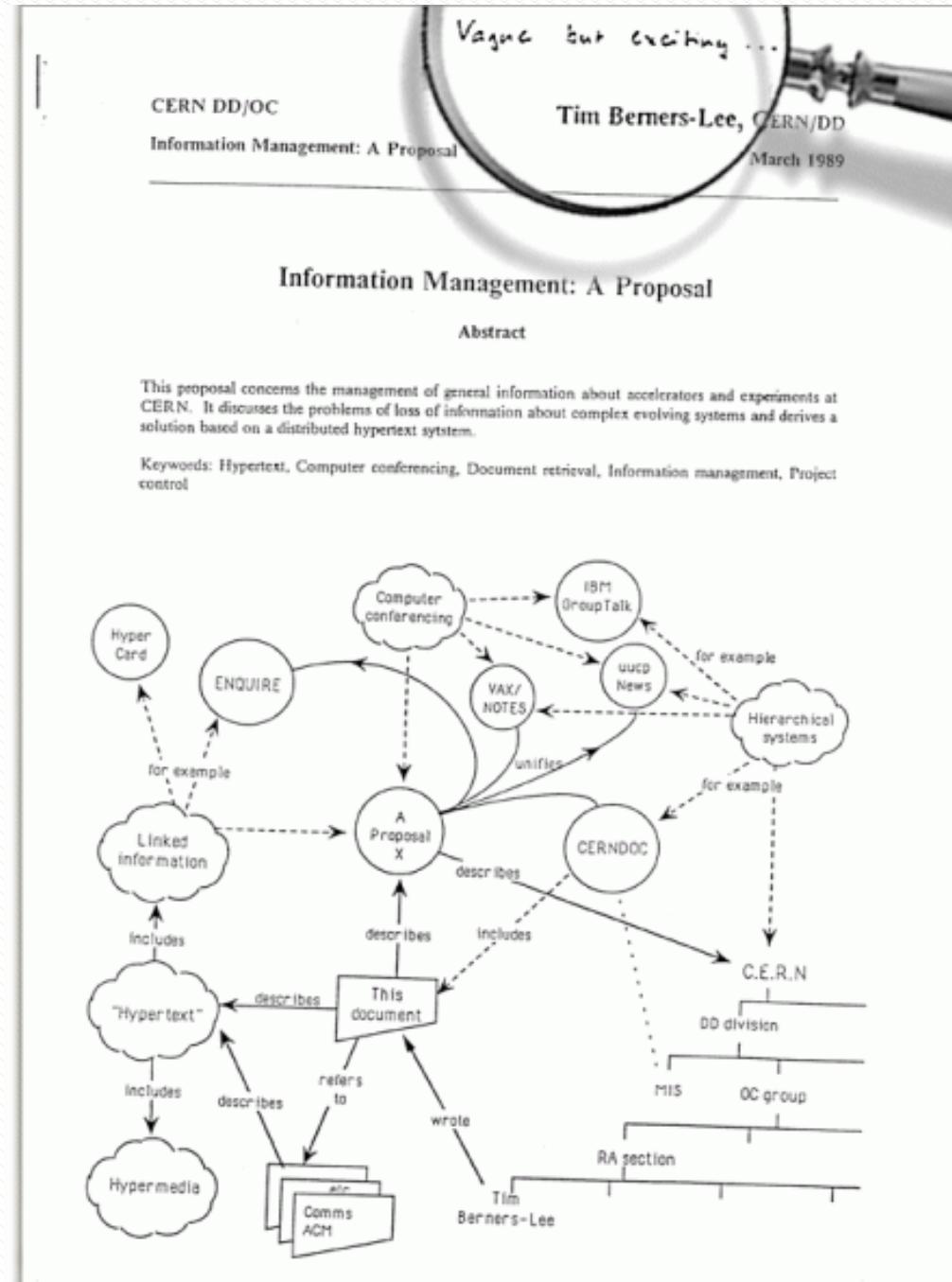
This proposal concerns the management of general information about accelerators and experiments at CERN. It discusses the problems of loss of information about complex evolving systems and derives a solution based on a distributed hypertext system.

Keywords: Hypertext, Computer conferencing, Document retrieval, Information management, Project control



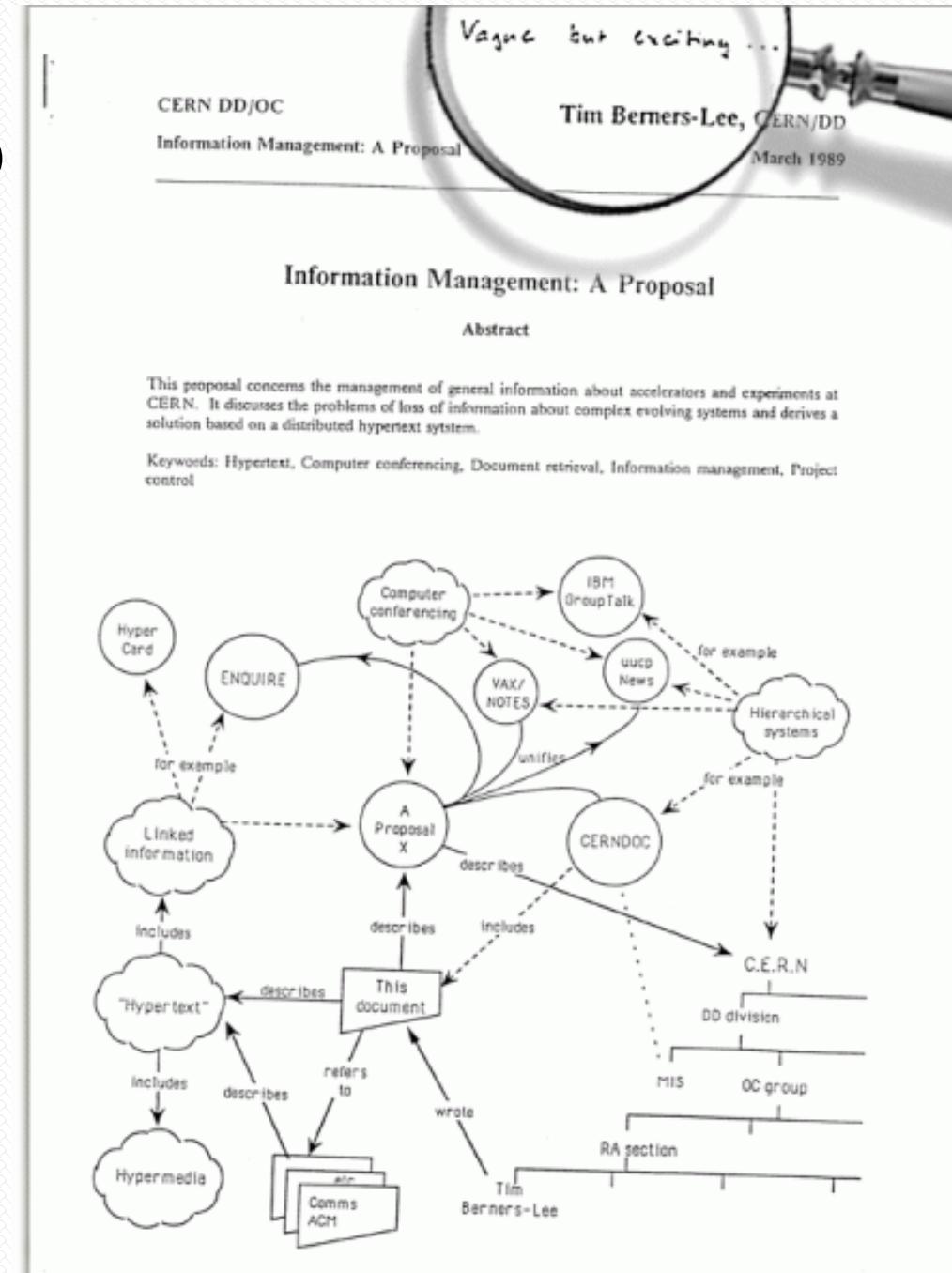
„Vague, but exciting“

- „Nejasno, ali uzbudljivo“
- Prvi opis predloga, stigao kao odgovor 30. marta
- Originalni predlog
 - www.w3.org/History/1989/proposal.html
- Od „gomile izgubljenih podataka“ do današnjeg „Interneta“...



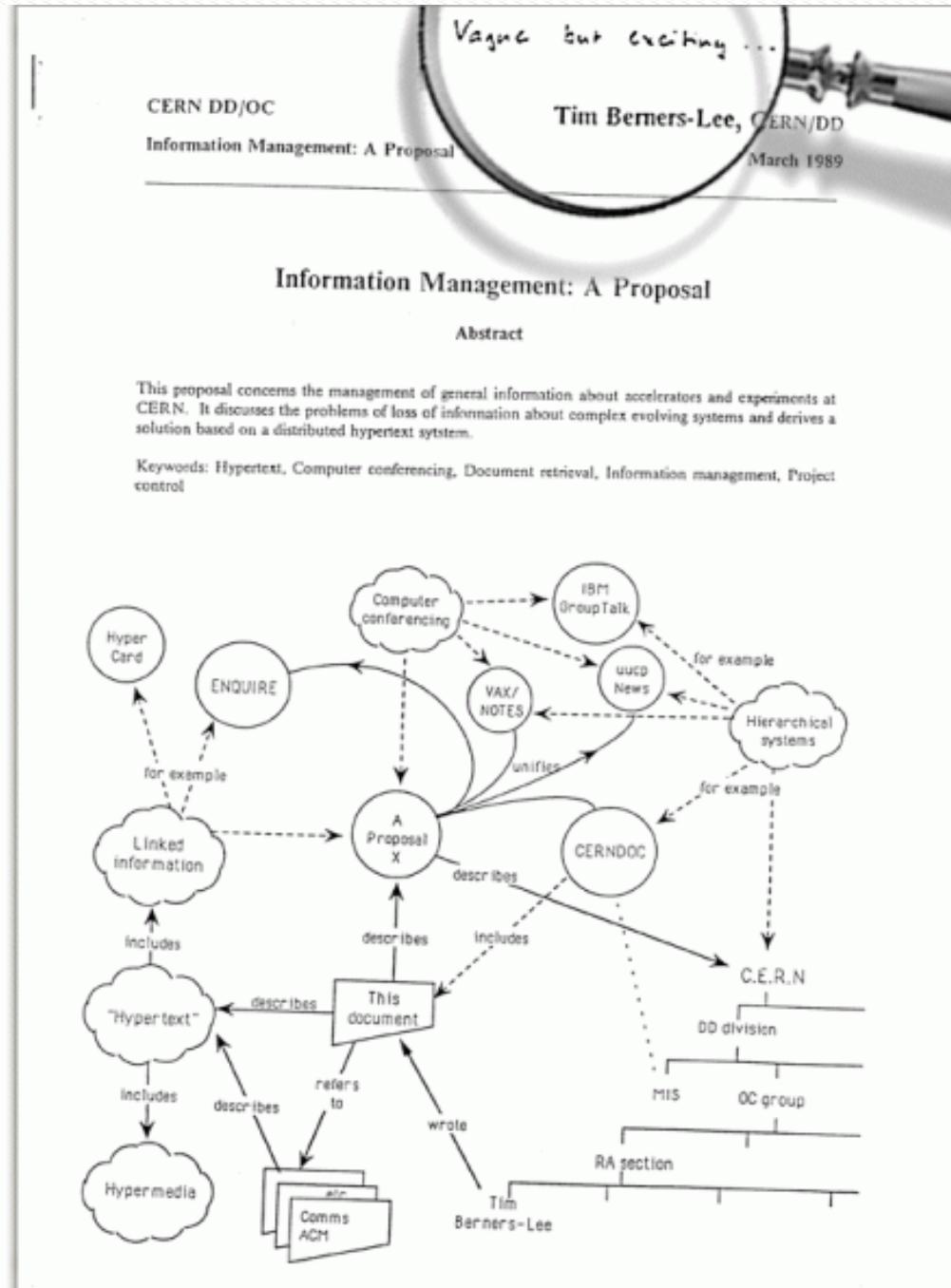
„Nejasno, ali uzbudljivo

- CERN bio i ostao **ogromna institucija**.
- Broj onih koji u CERN-u stalno rade nije tako veliki, ali **ogroman je broj ljudi koji stalno posećuju CERN**, tamo provedu neko vreme i onda putuju nazad u svoje matične institute ili fakultete.
- Veliki broj ljudi koji rade zajedno rade neki posao sa sobom nosi i **određene probleme**
 - kako organizovati podatke o gostima
 - kako organizovati dokumentaciju
 - kako beležiti ko je šta i kada radio
 - saznati koje laboratorije rade na kojim projektima
 - koji sistemi zavise od nekog uređaja
 - gde se šta nalazi, gde šta ide, kome šta pripada...
- Mnogo pitanja i mnogo informacija koje je trebalo čuvati, organizovati i... od kojih su se neke **stalno gubile i nestajale**.



„Nejasno, ali ubudljivo“

- Upravo tu, u mnoštvu naizgled nepovezanih informacija i podataka Tim Berners-Lee našao je logiku i vezu.
- Predlog je uveo mnoge simbole:
 - Dijagrami su označavali hijerarhiju podataka
 - Čvorovi: ljude, softver, module, zadatke
 - Strelice: relacije – “roditelje”, pravce kretanja, zavisnost, obaveze, izveštaje.
- Povezao različite vrste i baze podataka.
 - Povezao je ljude, projekte, softver, grupe ljudi, ideje, dokumente, tipove hardvera, specifične objekte...
- Sve to je povezao “vezama” – **hiperlinkovima**, koji su se nalazili u različitim dokumentima.
- Dokumenti, osim teksta i hiperlinkova, mogli su da sadrže i slike – multimediju.



„Where the Web was Born“

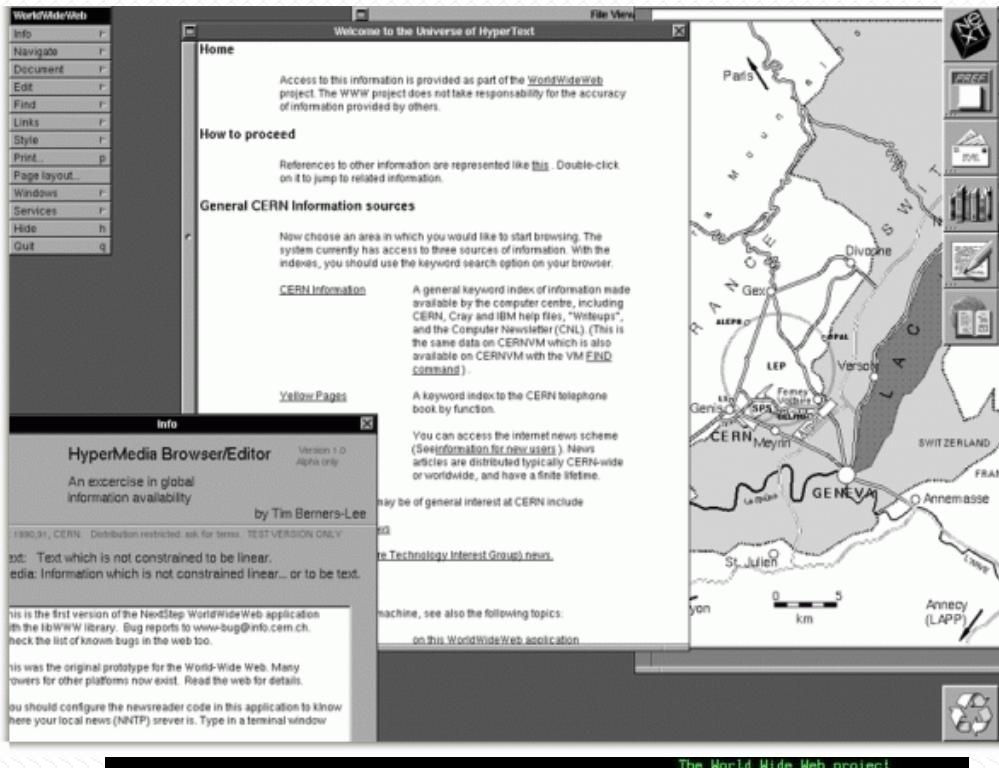
- CERN - mesto gde je rođen World Wide Web
- Prvi Internet sajt nalazio se na adresi <http://info.cern.ch/>
 - Prvi IP: 128.141.201.74
- Prva verzija sajta nije sačuvana, ali kopija istog sajta iz 1992. godine nalazi se na istoj adresi!



Credits: Maximilien Brice/CERN

Browser

- Prvi browser 1990, Tim Berners-Lee
- Radio na „superračunarima“
- „Linijski“ browser 1991. godina
- Radio na „običnim“ računarima tog vremena
- Demo verzija
 - <http://line-mode.cern.ch/www/hypertext/WWW/TheProject.html>



Server

- NeXTcube – prva dva web servera
- Karakteristike:
 - Ekran: 1120×832, 17“ grayscale
 - OS: NeXTstep 2.2 ili noviji
 - CPU: 25 MHz, 68040 with integrated floating-point unit
 - RAM: 16 MB, proširivo do 64 MB
 - HDD: 400 MB, 1.4GB ili 2.8GB SCSI



Foto: M. Milošević

CERN httpd

- Prvi web server **CERN httpd**
 - u CERN biblioteci od 1991
 - U upotrebi do 1996. godine
 - Web browser, Alati za dalji razvoj
- 1992 - počeo je da radi prvi web server u SAD. Korisnici su opet bili naučnici, fizičari elementarnih čestica, a server je bio smešten u Linearnom akceleratoru Stanford (SLAC), Kalifornija.
- CERN je **1993.** godine **softver** za korišćenje World Wide Web-a ustupio u **javno vlasništvo**.
- Nakon toga World Wide Web i Internet nastavili su da se **šire ogromnom brzinom** i dolaze prvo na računare a zatim na telefone i ostale uređaje.
- Godine **1994.** na Internetu se nalazilo oko **10000 web servera** i bilo je **10 miliona korisnika**.
- Tako je sve počelo a stiglo je do... to već znate i vidite sami. **Malo je onih koji danas mogu da zamisle jedan** dan bez World Wide Web-a.



NOTE WELL: We no longer maintain the CERN httpd. In particular, there is at least one known Y2K-related [bug](#) in the latest (July 1996) release of this software.

In May 1996, we released [Jigsaw](#), W3C's leading-edge Web server platform, providing a sample HTTP 1.1 implementation and a variety of other features on top of an advanced architecture implemented in Java.

CERN httpd

The CERN httpd (also known as W3C httpd) is a generic public domain full-featured hypertext server which can be used as a regular HTTP server. The server is typically running on port 80 to serve hypertext and other documents but it can also serve as a proxy -- a server on a firewall machine -- that provides access for people inside a firewall to the outside world. When running as proxy httpd may be configured to do caching of documents resulting in faster response times.

Authors

[Ari Luotonen](#), [Henrik Frystyk Nielsen](#), [Tim Berners-Lee](#)

Status

Version 3.0A is the final version. It was generated *July 15 1996*. We may give out security patches but future server work has been moved to the Java based [Jigsaw](#) server. You can also read the [W3C position statement](#) on the CERN server

Platforms

The server runs on most Unix platforms. See also the [VMS version](#).

Getting the Source Code

The latest source code is available in the following formats:

- [compressed tar file](#)
- [gzip'ed tar file](#)

You can also browse through the [latest source files](#) on our server!

A packet contains the following components:

- The code definitions (*.c)
- The interface definitions (*.h)
- A Makefile for building the daemon

You can see how to unpack and compile the software in the [README](#) file, and you can find more information on how to install the daemon in the [Installation Guide](#) and how to use it in the [User's Guide](#).

Copyright

W3C httpd is covered by the [MIT Copyright Statement](#), and with [acknowledgement to CERN](#)
Patches, Bug fixes, etc..

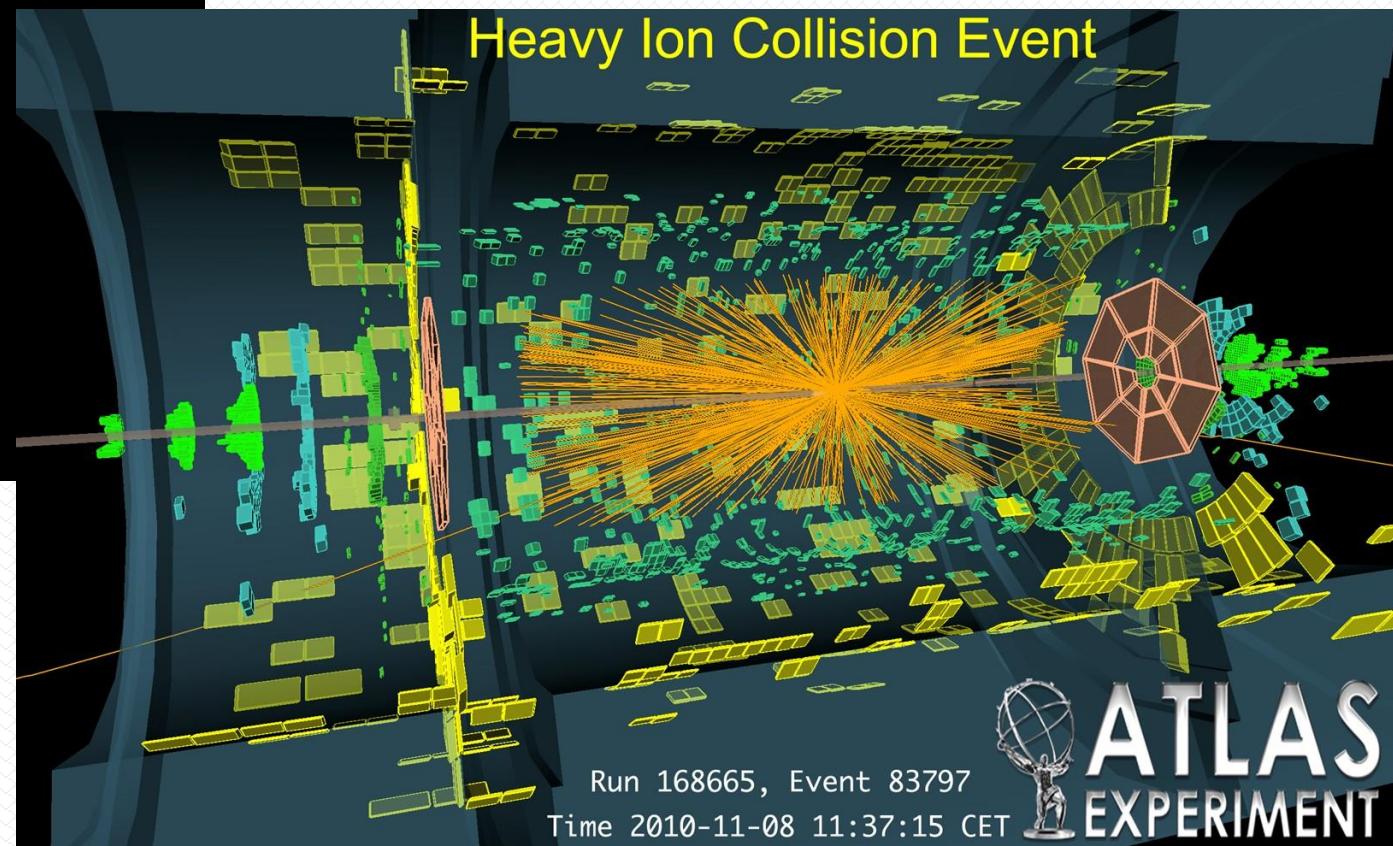
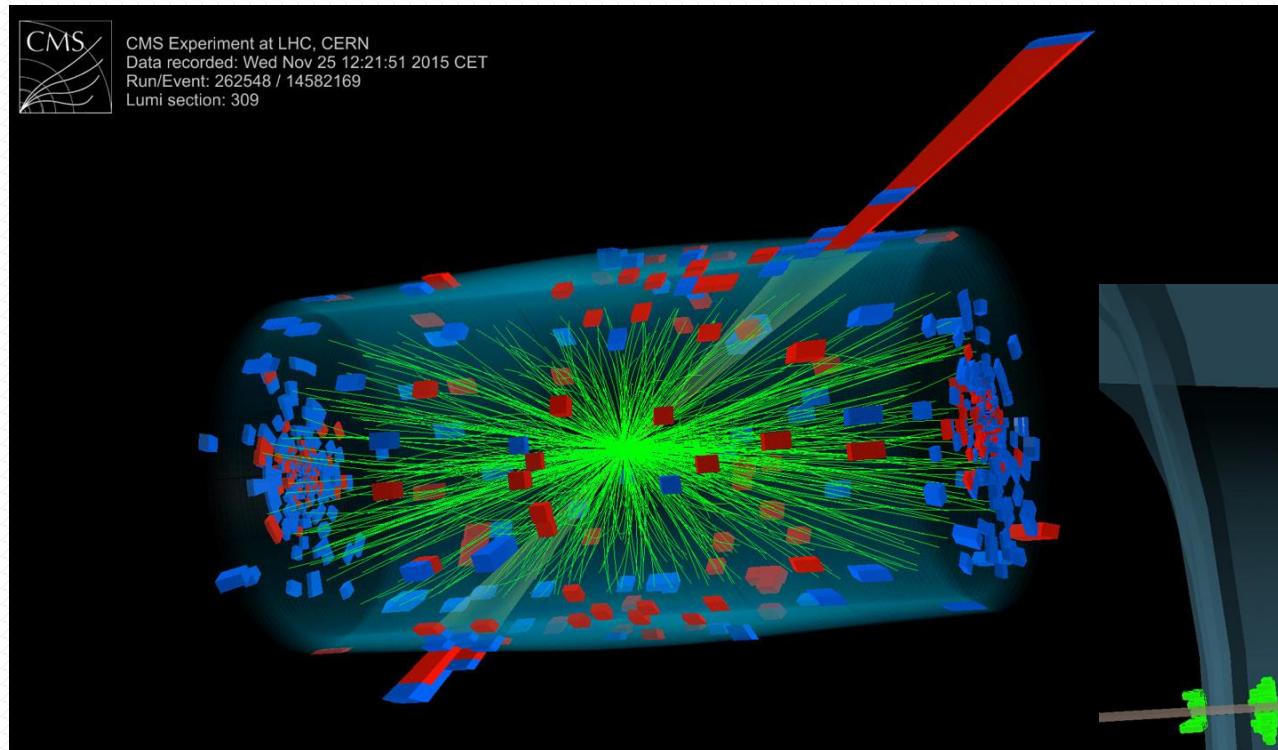
When you have modifications and want them to go into our code base then please fill out the form for [Corrections, Modifications, and Patches](#) and send it to us. Otherwise we can not use the patch!

Internet u CERN-u, danas...

Mnogo podataka...

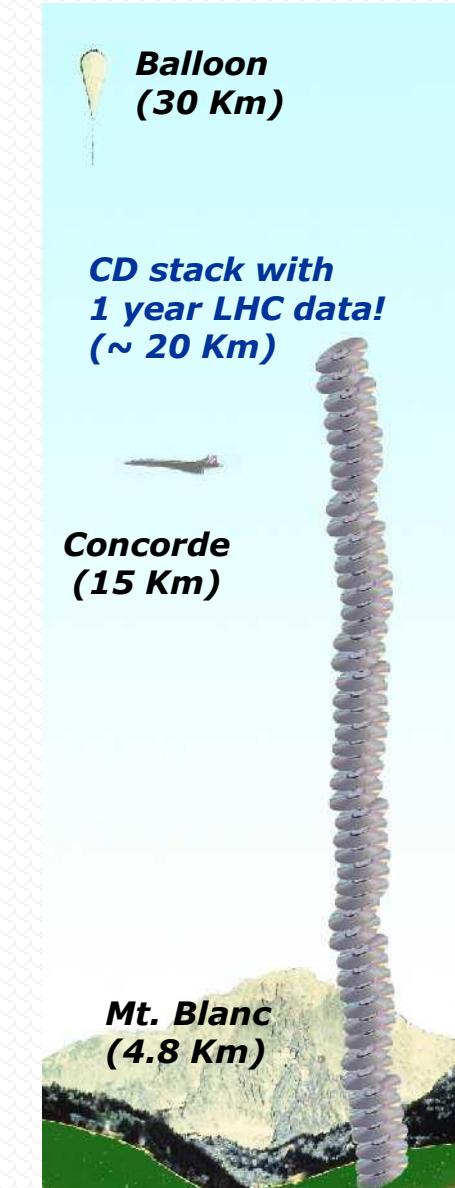


CMS Experiment at LHC, CERN
Data recorded: Wed Nov 25 12:21:51 2015 CET
Run/Event: 262548 / 14582169
Lumi section: 309



Koliko podataka?

- LHC
 - 600 miliona sudara u sekundi, svaki sudar oko 1 Mb
 - Značajno događaji - 1 u milion!
 - 1. faza: filtriranje na 100.000 događaja/sekundi (idu na digitalnu rekonstrukciju)
 - 2. faza: sofisticirani algoritmi → 100-200 događaja/sekundi
 - Ovi sirovi podaci snimaju se u data centru (približno 1,5 CD-a / sekundi)
- Protok podataka, oko 25 GB/s
 - ALICE: 4 GB/s (Pb-Pb running)
 - ATLAS: 800 MB/s – 1 GB/s
 - CMS: 600 MB/s
 - LHCb: 750 MB/s



Obrada i čuvanje podataka

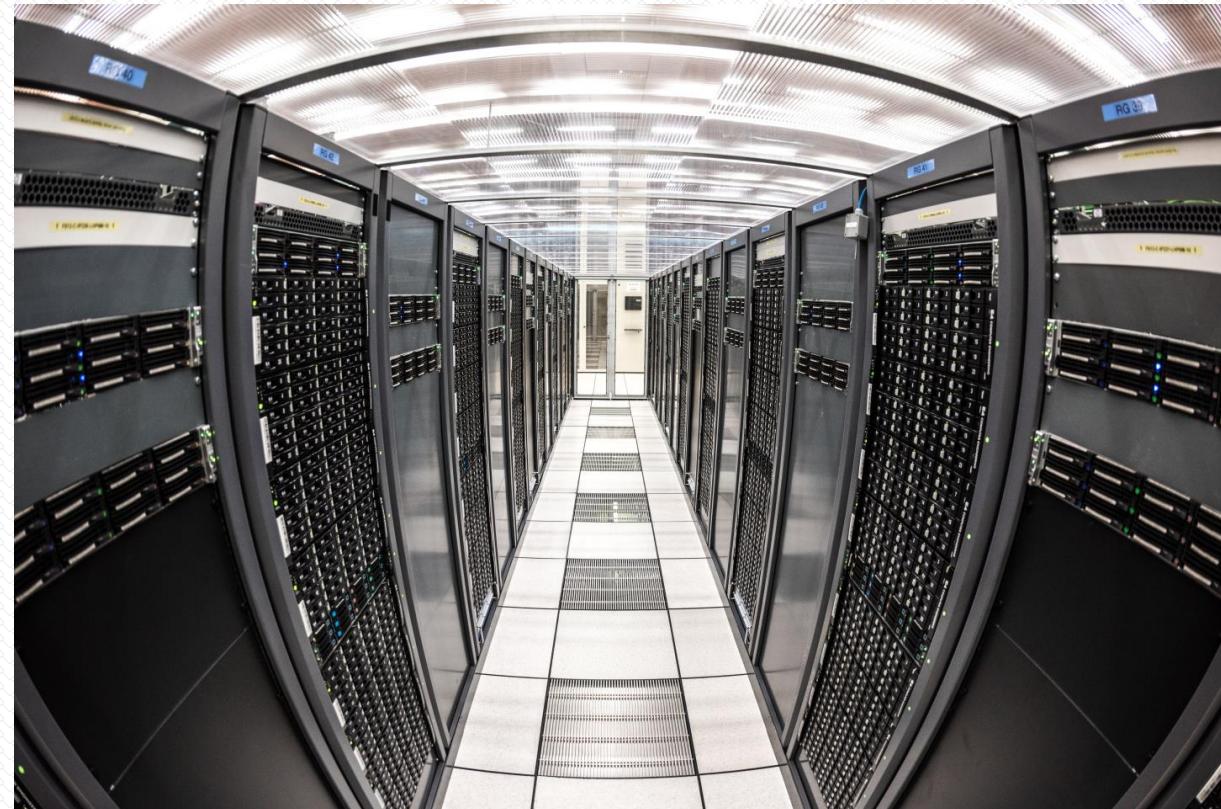
- Do kraja 2017. godine **trajno sačuvano 230 PB podataka**
 - U **2017** – 40 PB LHC podataka, ukupno **72 PB** (max: 12,3 PB u julu)
- Najviše podataka sačuvano na **magnetnim trakama** (32.200 kasete, 400 PB kapacitet)
- Ukupno **90.000 diskova** u CERN-u, kapacitet 280 PB, 10-15% SSD (prostor mnogo manji od 10%)
 - 230 PB na trakama (kapacitet 400 PB)
 - 173 PB na diskovima (u proseku 30 diska otkazuje nedeljno!)
 - Sve se kopira dva puta na disk!



Credits: Bennett, Sophia Elizabeth / CERN

Obrada i čuvanje podataka

- Dva data centra
 - Meyrin Data Centre
 - Wigner Extension
 - 1200 km dalje (Budimpešta)
- 11.500 + 3.500 servera
- 174.300 + 56.000 CPU
- 61.900 + 29.700 diskova



Credits: Bennett, Sophia Elizabeth / CERN

COMPUTING

STORAGE

NETWORK

Servers (Meyrin)

11.5 K

Cores (Meyrin)

174.3 K

Disks (Meyrin)

61.9 K

Tape Drives

103

Routers

262

Star Points

724

Servers (Wigner)

3.5 K

Cores (Wigner)

56.0 K

Disks (Wigner)

29.7 K

Tape Cartridges

28.9 K

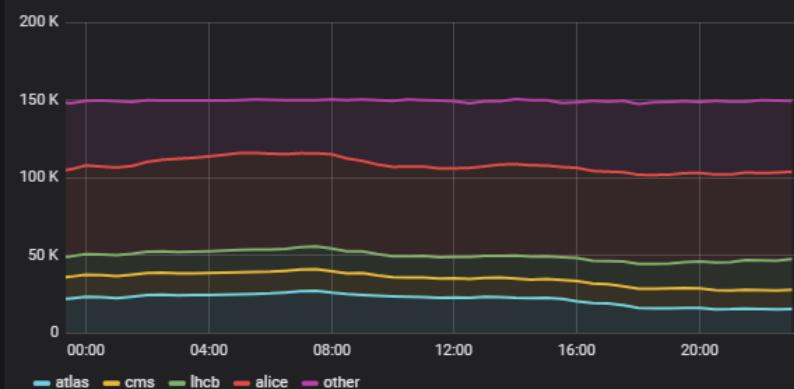
Switches

4.2 K

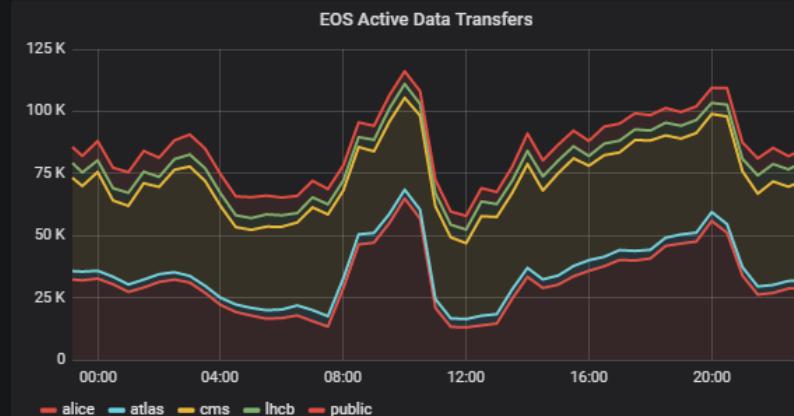
Wifi Points

731

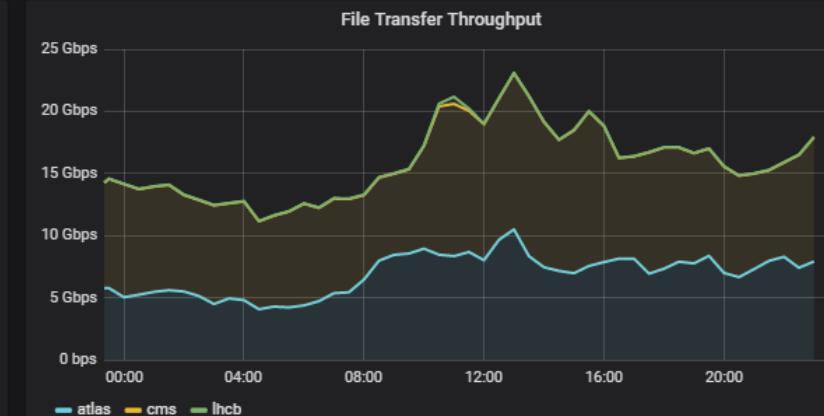
Batch Jobs



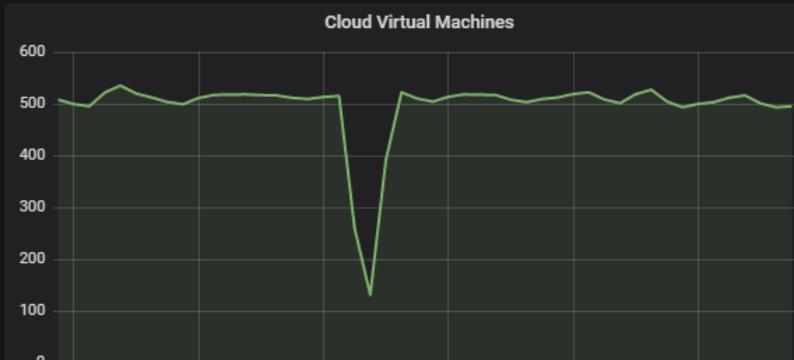
EOS Active Data Transfers



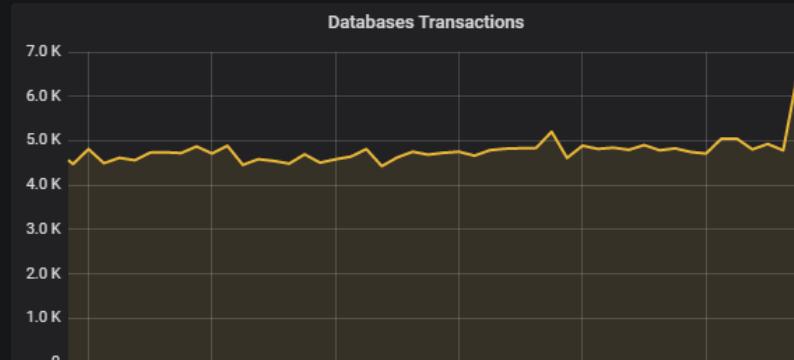
File Transfer Throughput



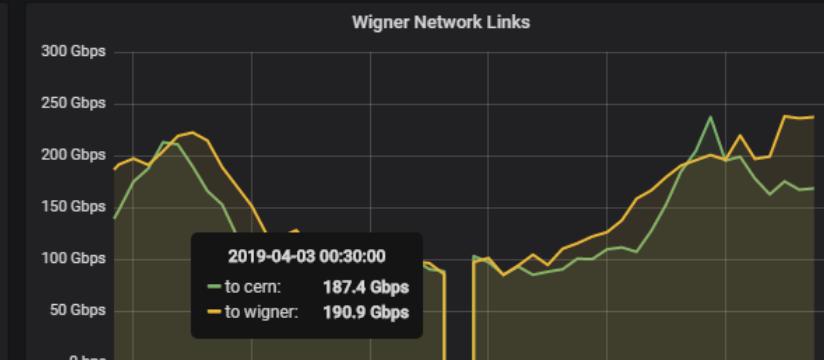
Cloud Virtual Machines

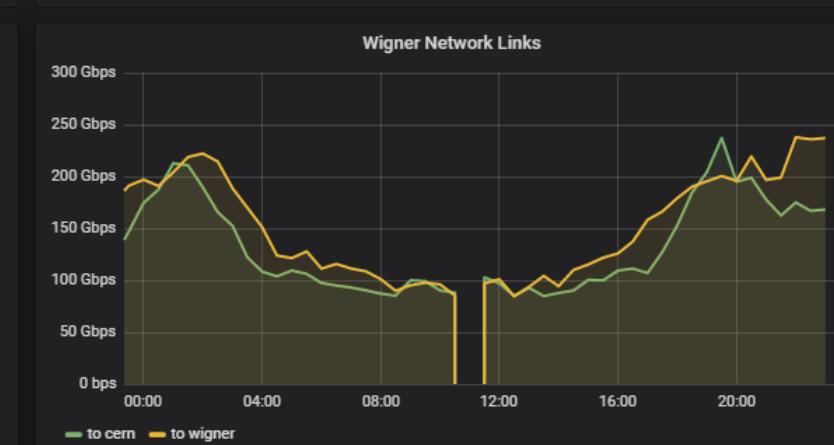
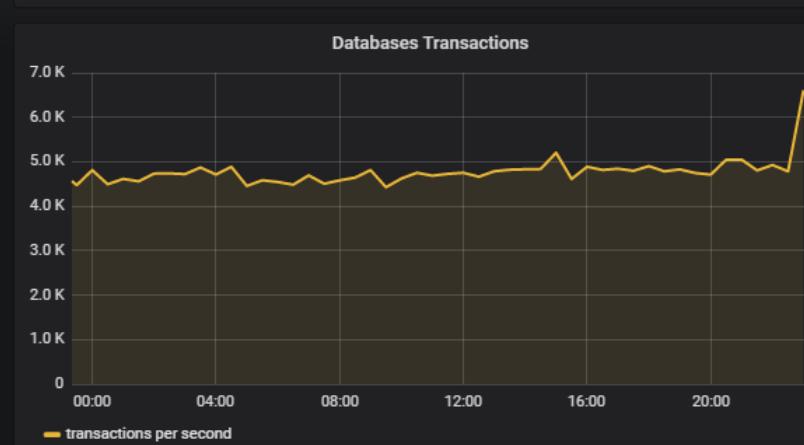
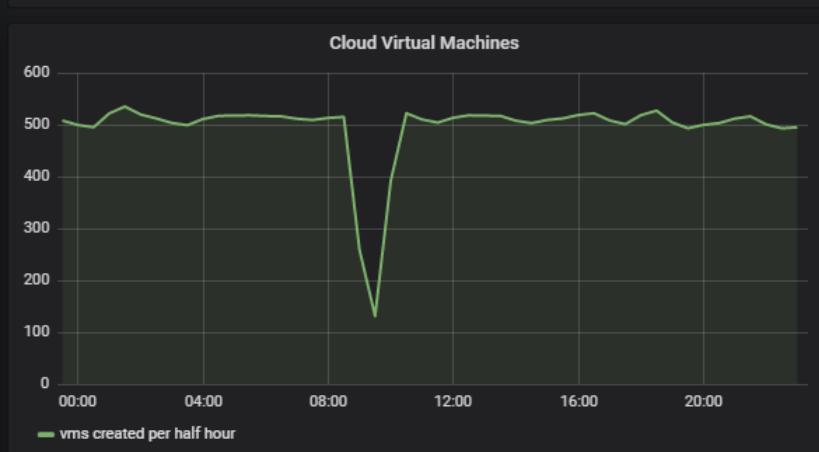


Databases Transactions



Wigner Network Links





▼ Details

Meyrin

Metric	Avg
Servers	11 K
Processors	22 K
Cores	174 K
Disks	62 K
Memory Modules	86 K
1GB NICs	17 K
10GB NICs	16 K

Wigner

Metric	Avg
Servers	4 K
Processors	6 K
Cores	56 K
Disks	30 K
Memory Modules	28 K
1GB NICs	7 K
10GB NICs	3 K

Network

Metric	Avg
Routers	262
Start Points	724
Switches	4 K
Wifi Points	731
UTP Outlets	82 K
Devices	326 K

Meyrin

Metric	Avg
Disk Space (TB)	150135
Total Memory (TB)	1038

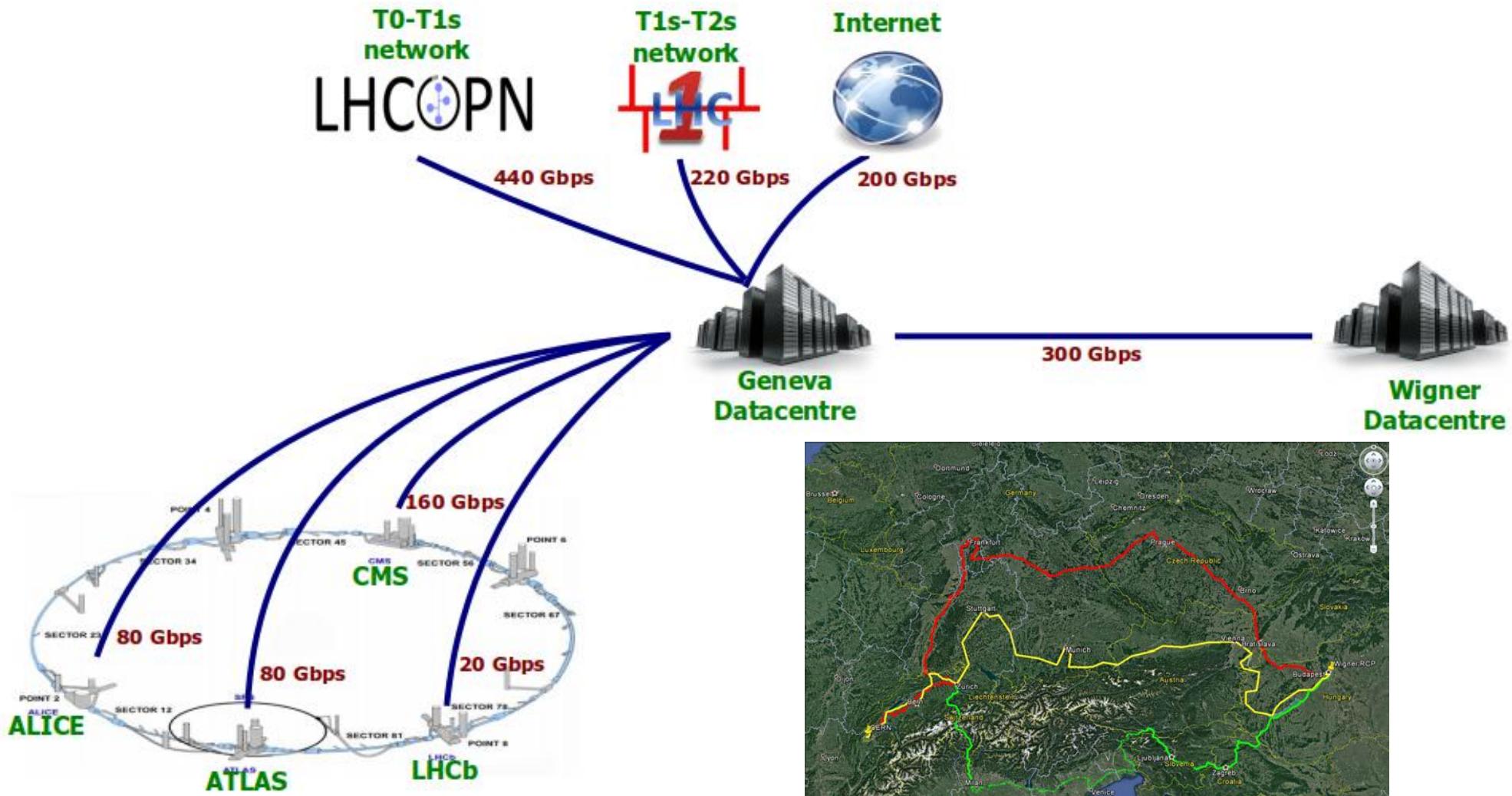
Wigner

Metric	Avg
Disk Space (TB)	97252
Total Memory (TB)	221

Tape Storage

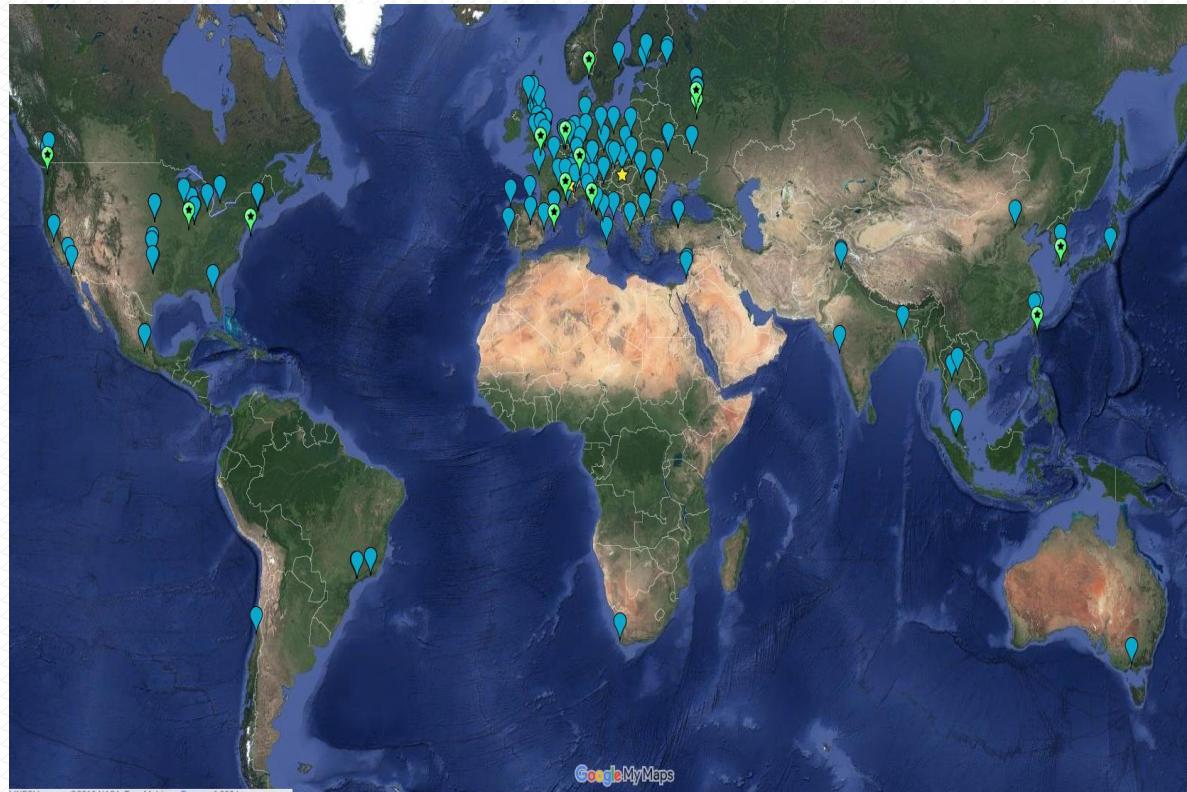
Metric	Avg
Drives	103
Cartridges	28934
Used Space (TB)	337258

Mreža – 35.000 km optičkih kablova ☺



Ali... ni ovo nije dovoljno

- WLCG – Worldwide LHC Computing Grid
 - <http://wlcg-public.web.cern.ch/>
- 170+ data centara, 42 države, 800.000 CPU
- CERN „samo“ 20% resursa
- Više od 10.000 fizičara ima pristup podacima
- 250.000 „jobs“ stalo radi na gridu
- Skladištenje: 400 PB diskovi + 400 PB trake (globalno) \sim 1 EB (exabyte)
- 2016. godine – transfer podataka 35+ GB/s (stalno)



Čemu sve ovo služi?



Čemu ovo služi,
a uz to i ~~ne~~ radi?

Higsovo polje

VOLUME 13, NUMBER 9

PHYSICAL REVIEW LETTERS

31 AUGUST 1964

*Work supported in part by the U. S. Atomic Energy Commission and in part by the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.

¹R. Feynman and M. Gell-Mann, Phys. Rev. 109, 13 (1958).

²T. D. Lee and C. N. Yang, Phys. Rev. 119, 1410 (1960); S. B. Treiman, Nuovo Cimento 15, 916 (1960).

³S. Okubo and R. E. Marshak, Nuovo Cimento 28, 56 (1963); Y. Ne'eman, Nuovo Cimento 27, 922 (1963).

⁴Estimates of the rate for $K^+ \rightarrow \pi^+ + e^+ + e^-$ due to induced neutral currents have been calculated by several authors. For a list of previous references see Mirza A. Baqi Bég, Phys. Rev. 132, 426 (1963).

⁵M. Baker and S. Glashow, Nuovo Cimento 25, 857

(1962). They predict a branching ratio for decay mode (1) of $\sim 10^{-6}$.

⁶N. P. Samios, Phys. Rev. 121, 275 (1961).

⁷The best previously reported estimate comes from the limit on $K_2^0 \rightarrow \mu^+ + \mu^-$. The 90% confidence level is $|g_{\mu\mu}|^2 < 10^{-3} |g_{\mu\nu}|^2$: M. Barton, K. Lande, L. M. Lederman, and William Chinowsky, Ann. Phys. (N.Y.) 5, 156 (1958). The absence of the decay mode $\mu^+ \rightarrow e^+ + e^-$ is not a good test for the existence of neutral currents since this decay mode may be absolutely forbidden by conservation of muon number: G. Feinberg and L. M. Lederman, Ann. Rev. Nucl. Sci. 13, 465 (1963).

⁸S. N. Biswas and S. K. Bose, Phys. Rev. Letters 12, 176 (1964).

BROKEN SYMMETRY AND THE MASS OF GAUGE VECTOR MESONS*

F. Englert and R. Brout

Faculté des Sciences, Université Libre de Bruxelles, Bruxelles, Belgium
(Received 26 June 1964)

It is of interest to inquire whether gauge vector mesons acquire mass through interaction¹: by a gauge vector meson we mean a

those vector mesons which are coupled to currents that "rotate" the original vacuum are the ones which acquire mass [see Fig. (B)].

VOLUME 13, NUMBER 16

PHYSICAL REVIEW LETTERS

19 OCTOBER 1964

BROKEN SYMMETRIES AND THE MASSES OF GAUGE BOSONS

Peter W. Higgs

Tait Institute of Mathematical Physics, University of Edinburgh, Edinburgh, Scotland
(Received 31 August 1964)

In a recent note¹ it was shown that the Goldstone theorem,² that Lorentz-covariant field theories in which spontaneous breakdown of symmetry under an internal Lie group occurs contain zero-mass particles, fails if and only if the conserved currents associated with the internal group are coupled to gauge fields. The purpose of the present note is to report that, as a consequence of this coupling, the spin-one quanta of some of the gauge fields acquire mass; the longitudinal degrees of freedom of these particles (which would be absent if their mass were zero) go over into the Goldstone bosons when the coupling tends to zero. This phenomenon is just the relativistic analog of the plasmon phenomenon to which Anderson³ has drawn attention: that the scalar zero-mass excitations of a superconducting neutral Fermi gas become longitudi-

about the "vacuum" solution $\varphi_1(x) = 0$, $\varphi_2(x) = \varphi_0$:

$$\partial_\mu^\mu \{\partial_\mu (\Delta\varphi_1) - e\varphi_0 A_\mu\} = 0, \quad (2a)$$

$$\{\partial^2 - 4\varphi_0^2 V''(\varphi_0^2)\}(\Delta\varphi_2) = 0, \quad (2b)$$

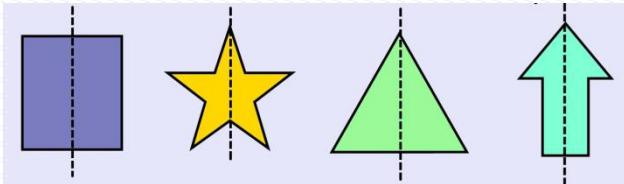
$$\partial_\nu F^{\mu\nu} = e\varphi_0 \{\partial_\mu^\mu (\Delta\varphi_1) - e\varphi_0 A_\mu\}. \quad (2c)$$

Equation (2b) describes waves whose quanta have (bare) mass $2\varphi_0\{V''(\varphi_0^2)\}^{1/2}$; Eqs. (2a) and (2c) may be transformed, by the introduction of new variables

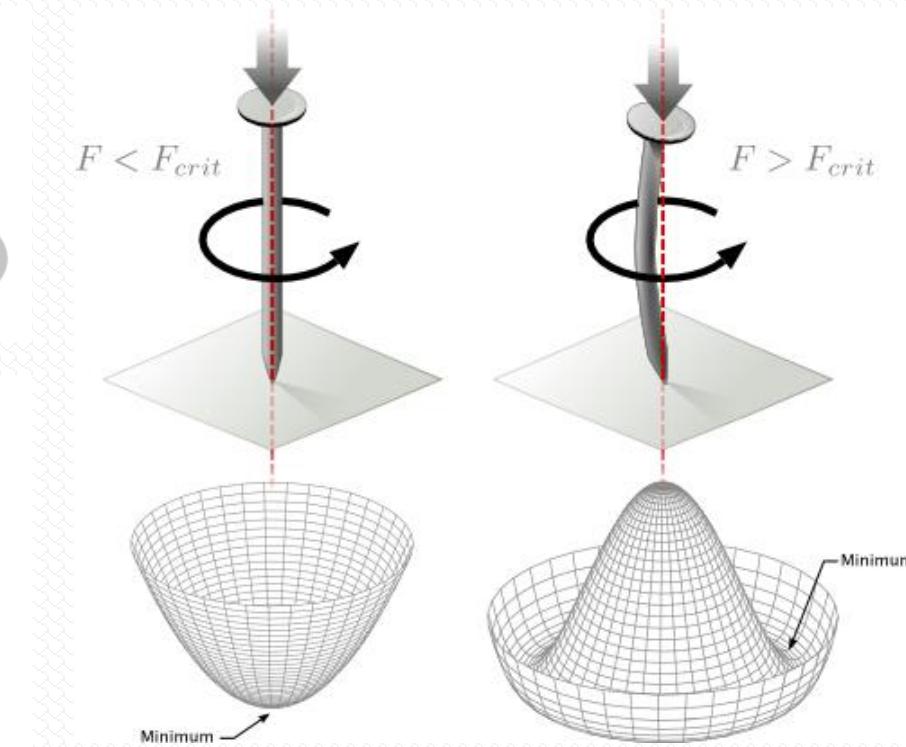
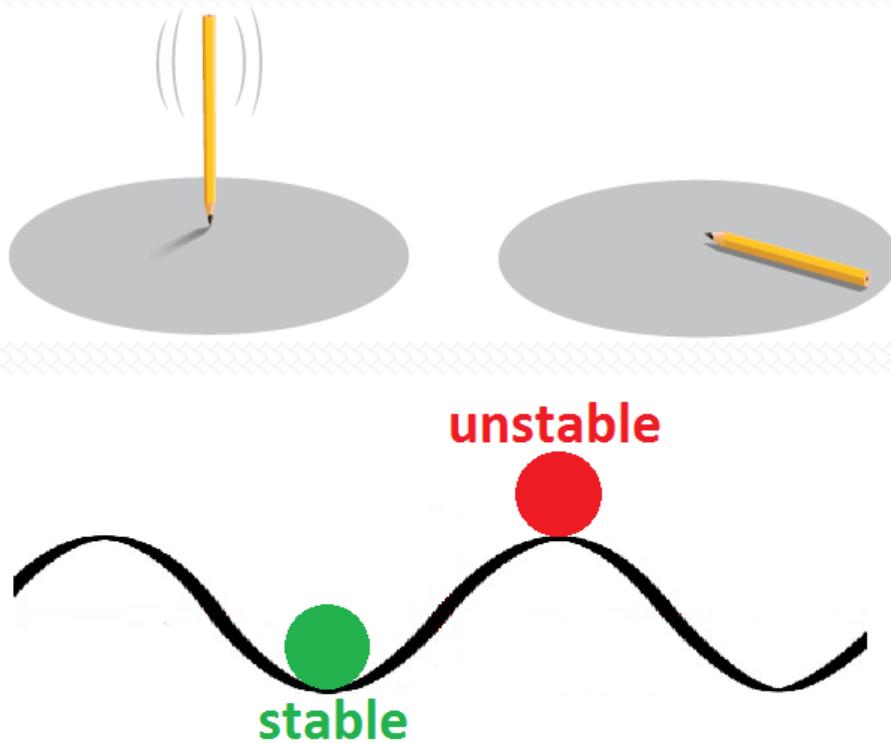
$$B_\mu = A_\mu - (e\varphi_0)^{-1} \partial_\mu (\Delta\varphi_1), \\ G_{\mu\nu} = \partial_\mu B_\nu - \partial_\nu B_\mu = F_{\mu\nu}, \quad (3)$$

into the form

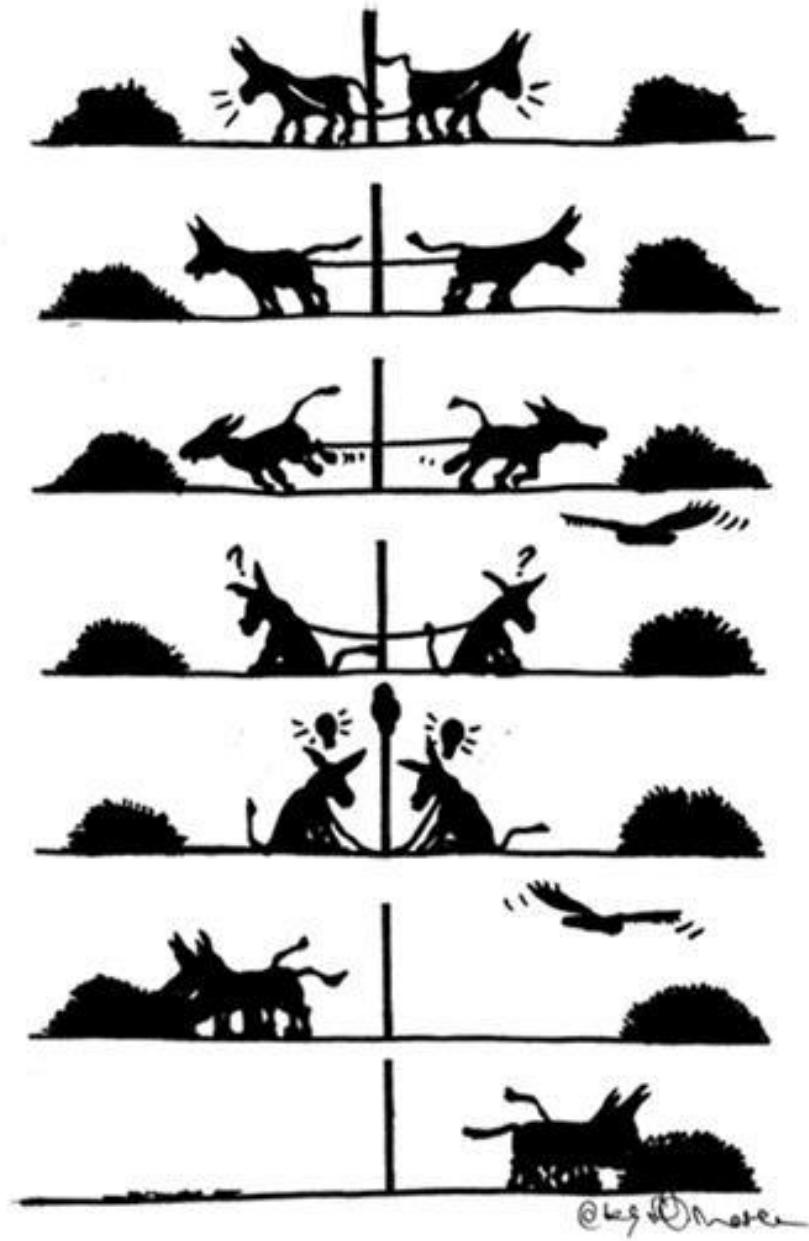
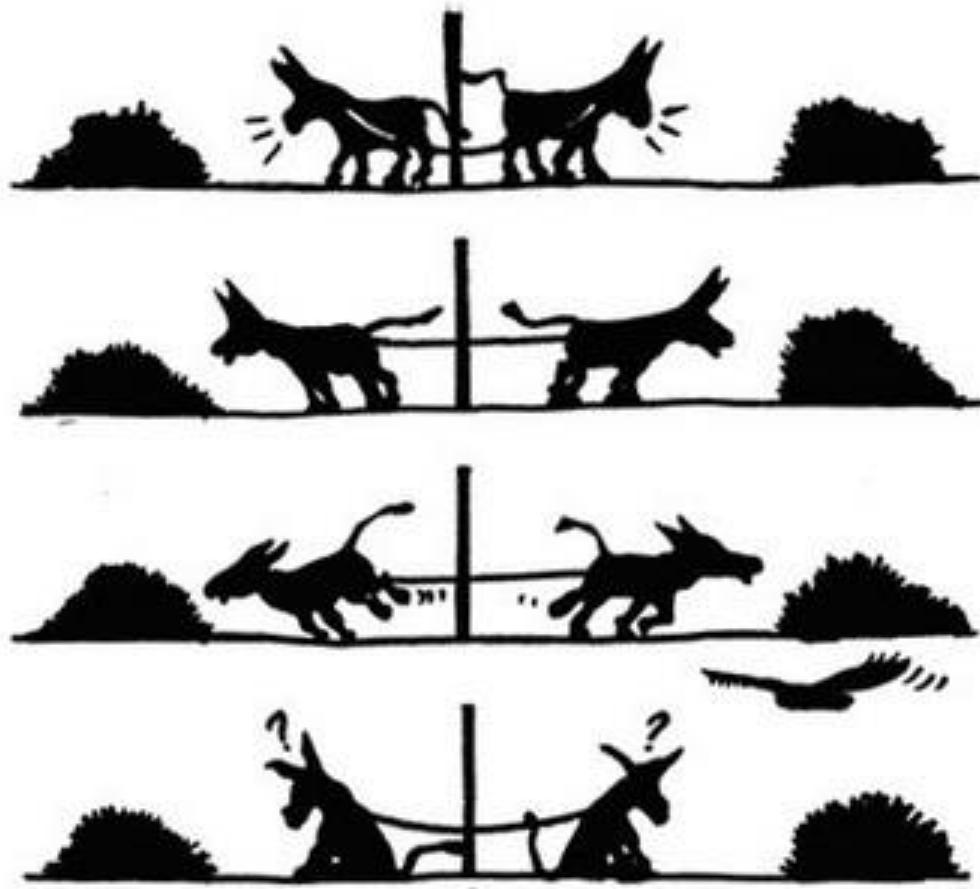
Simetrije



Narušenje simetrije



Narušenje simetrije

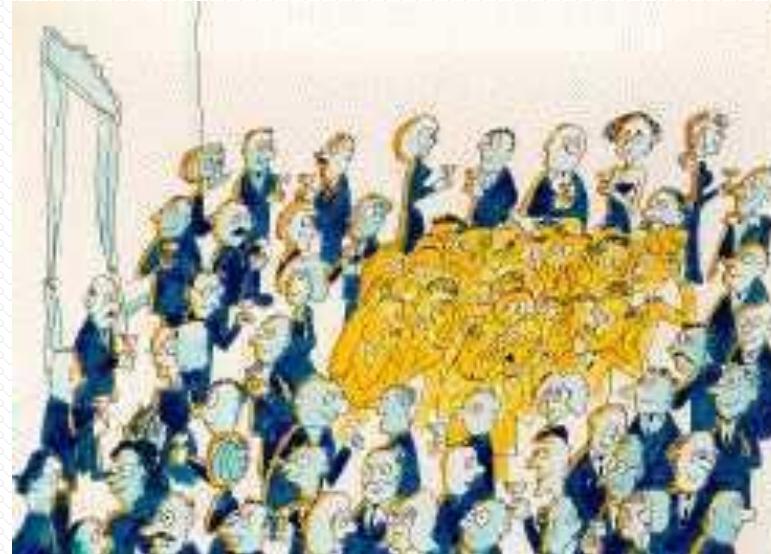


Higsov mehanizam za neupućene



Izvor: David Miller (University College London)

Higsov mehanizam za neupućene

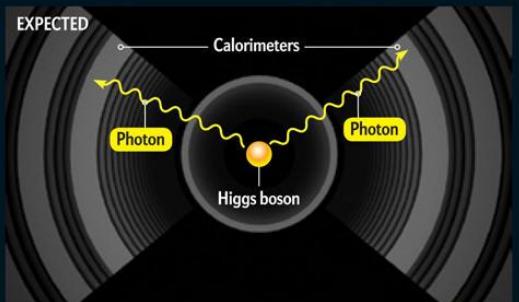


Izvor: David Miller (University College London)

Detekcija Higsove čestice?

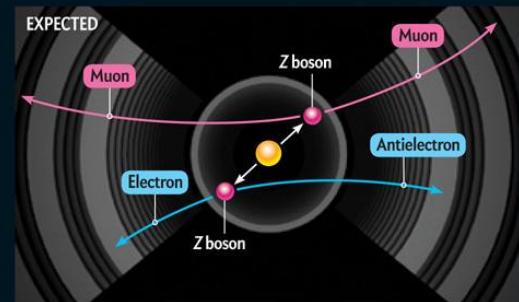
Photons

Each detector includes multiple calorimeters, devices for measuring the energy of particles. The innermost calorimeter is particularly alert for photons. These are absorbed in the calorimeter and create tiny electrical signals. If a Higgs decays into two photons, the detector can measure their total energy at extremely high accuracy, which helps to precisely reconstruct the mass of the newly found particle.



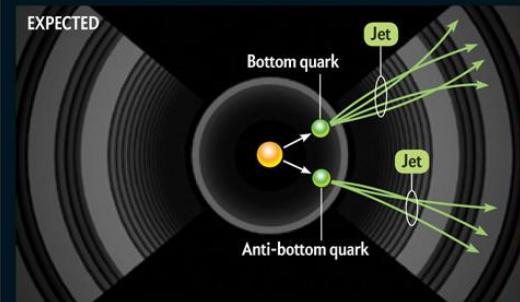
Z Bosons

The Higgs may decay into a pair of Z bosons, each of which can decay into an electron paired with an oppositely charged antielectron or two muons. An inner tracker and calorimeter measure the electrons, while muons fly out, leaving footprintlike tracks as they go. High magnetic fields bend the path of electrons and muons during their trip, allowing for a high-resolution measurement of their energy and the original Higgs mass.



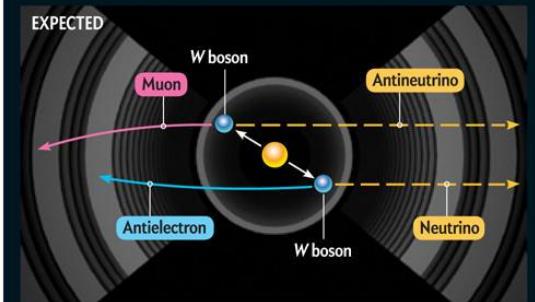
Bottom Quarks

The Higgs can also decay to a bottom quark and its antiparticle, each of which decays into a tight “jet” of secondary particles called hadrons (composite particles made of quarks). These hadrons fly through the detector’s inner layers and deposit their energy in the outer calorimeters. Unfortunately, many ordinary collisions also generate jets of hadrons from bottom quarks, which makes it difficult to separate these Higgs events out from the background.

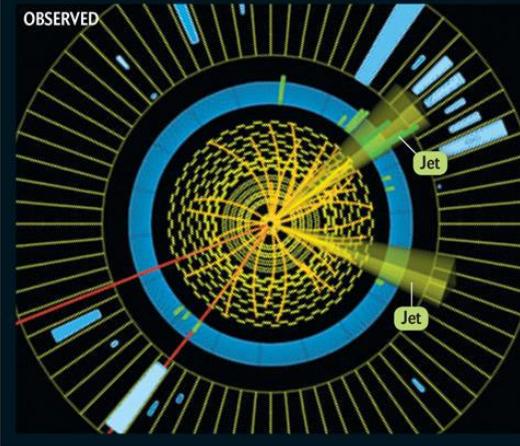


W Bosons

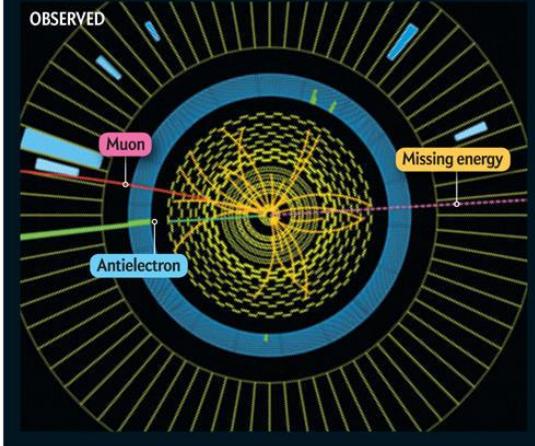
The Higgs can also decay to two W bosons, each of which can decay into an electron, antielectron or muon, plus a neutrino or antineutrino. Neutrinos are nearly impossible to detect—they fly out of the detector as if they were never there, taking with them some of the event's energy. Researchers use this missing energy to infer their presence, but the missing energy also prevents them from accurately reconstructing the mass of the original Higgs boson.



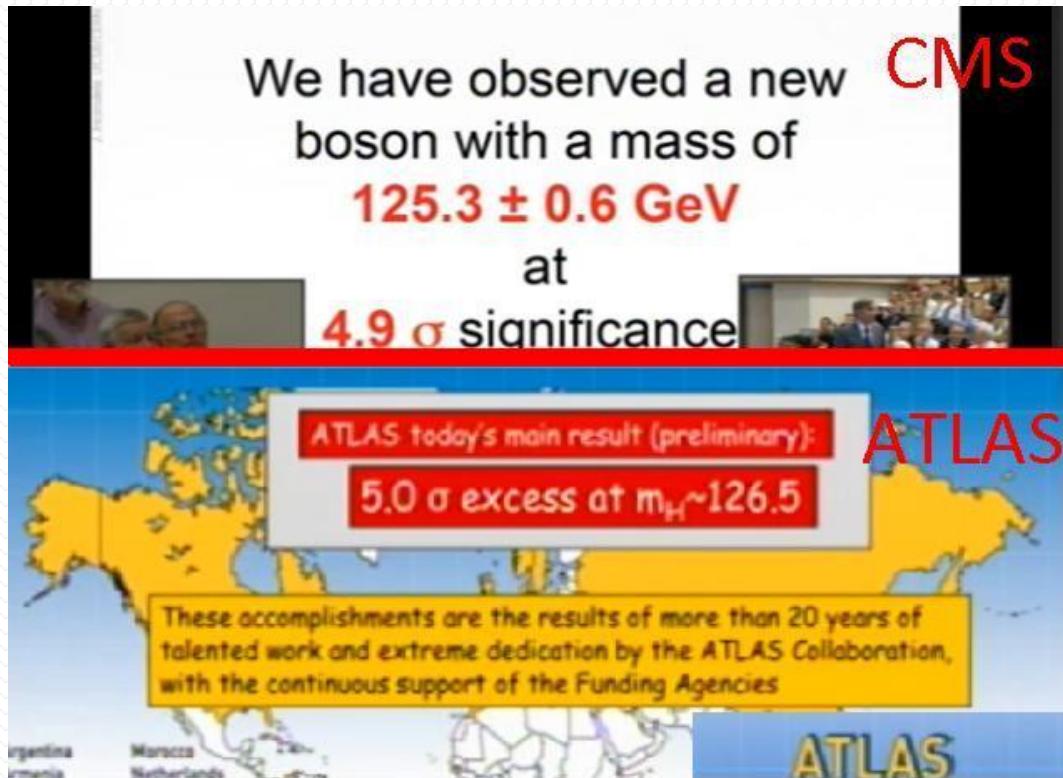
OBSERVED



OBSERVED



CERN: 4. jul 2012. godine



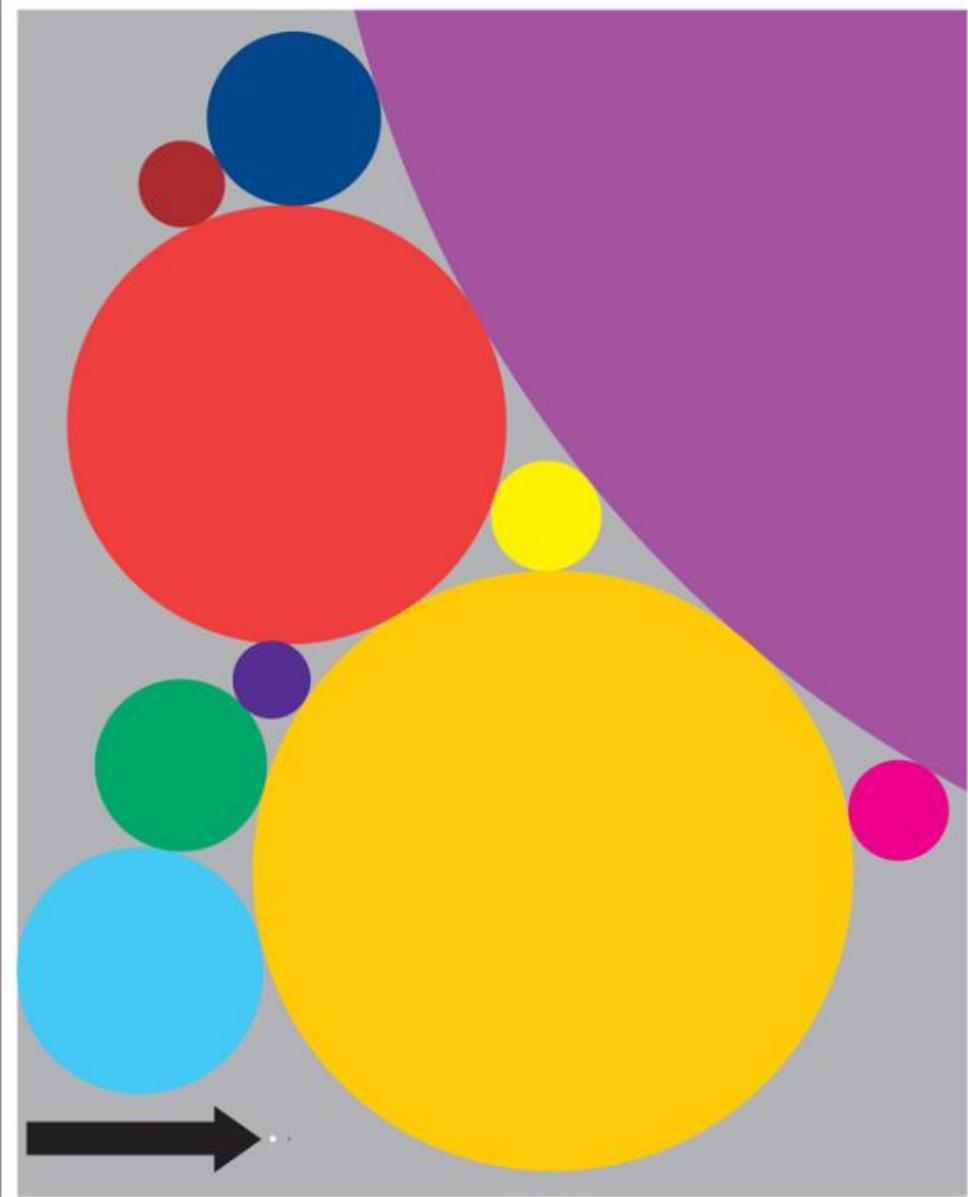
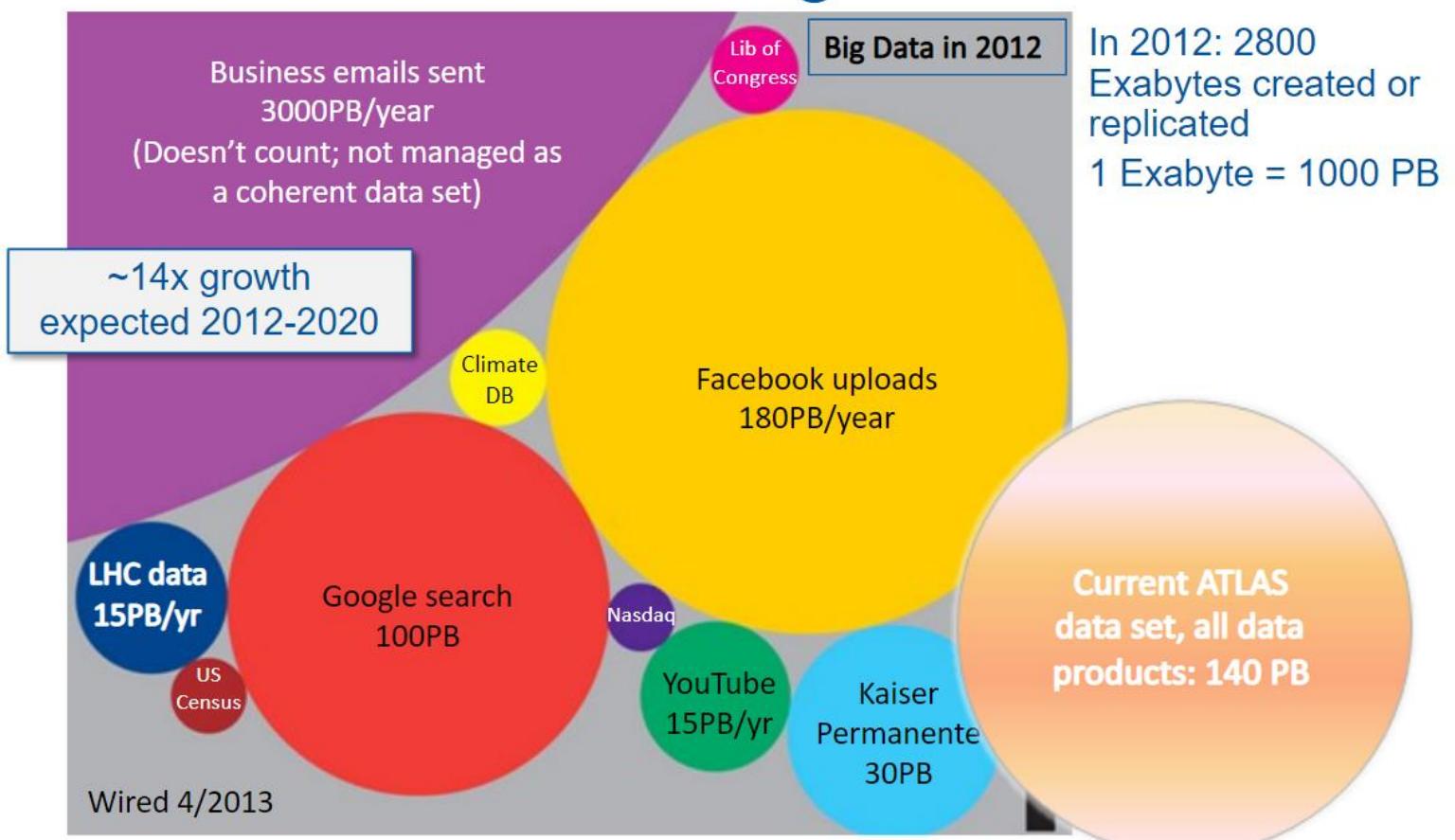
Nobelova nagrada za fiziku

- 2013. godina
- *“za teorijsko otkriće mehanizma koji daje značajan doprinos razumevanju porekla mase subatomskih čestica”*
- Franso Angler
University of Edinburgh, UK
- Piter Higs
Université Libre de Bruxelles, Brussels, Belgium



Internet, danas...

Where is LHC in Big Data Terms?



Size of data sets in terabytes	
Business email sent per year	2,986,100
Content uploaded to Facebook each year	182,500
Google's search index	97,656
Kaiser Permanente's digital health records	30,720
National Climactic Data Center database	6,144
Tweets sent in 2012	5,120
Library of Congress' digital collection	3,789
US Census Bureau data	3,072
Nasdaq stock market database	19
Contents of every print issue of WIRED	1.26
Videos uploaded to YouTube per year	15,000

<https://www.wired.com/2013/04/bigdata/>



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www.facebook.com/svetnauke.org