Industrial Control @ CERN

CERN

YEARS / ANS CERN

EN
ENGINEERING
DEPARTMENT

Conseil **E**uropéen pour la **R**echerche **N**ucléaire

World largest Particle Physics Laboratory (1954)

Yearly Budget

~1100 MCHF (~ 900 MEUR)

Experiments financed externally.

Personnel

2300 Staff

730 Fellows & Associates

200 Students

11000 Users from 500 universities

2000 External companies

21 Member Countries

Austria, Belgium, Bulgaria, Check Republic, Denmark, Finland, France, Germany, Greece, Italia, Israel, Hungary, Holland, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, UK.

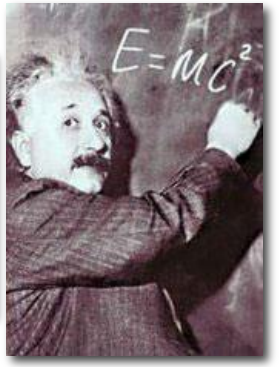
7 Observers Countries

EU, USA, Russia, India, Japan, Turkey, UNESCO

2 Candidate Countries

Romania and Serbia

The Mission of CERN



- Push forward the frontiers of knowledge

  e.g. the secrets of the Big Bang …what was the matter like within the first moments of the Universe's existence?

- Develop new technologies for accelerators and detectors

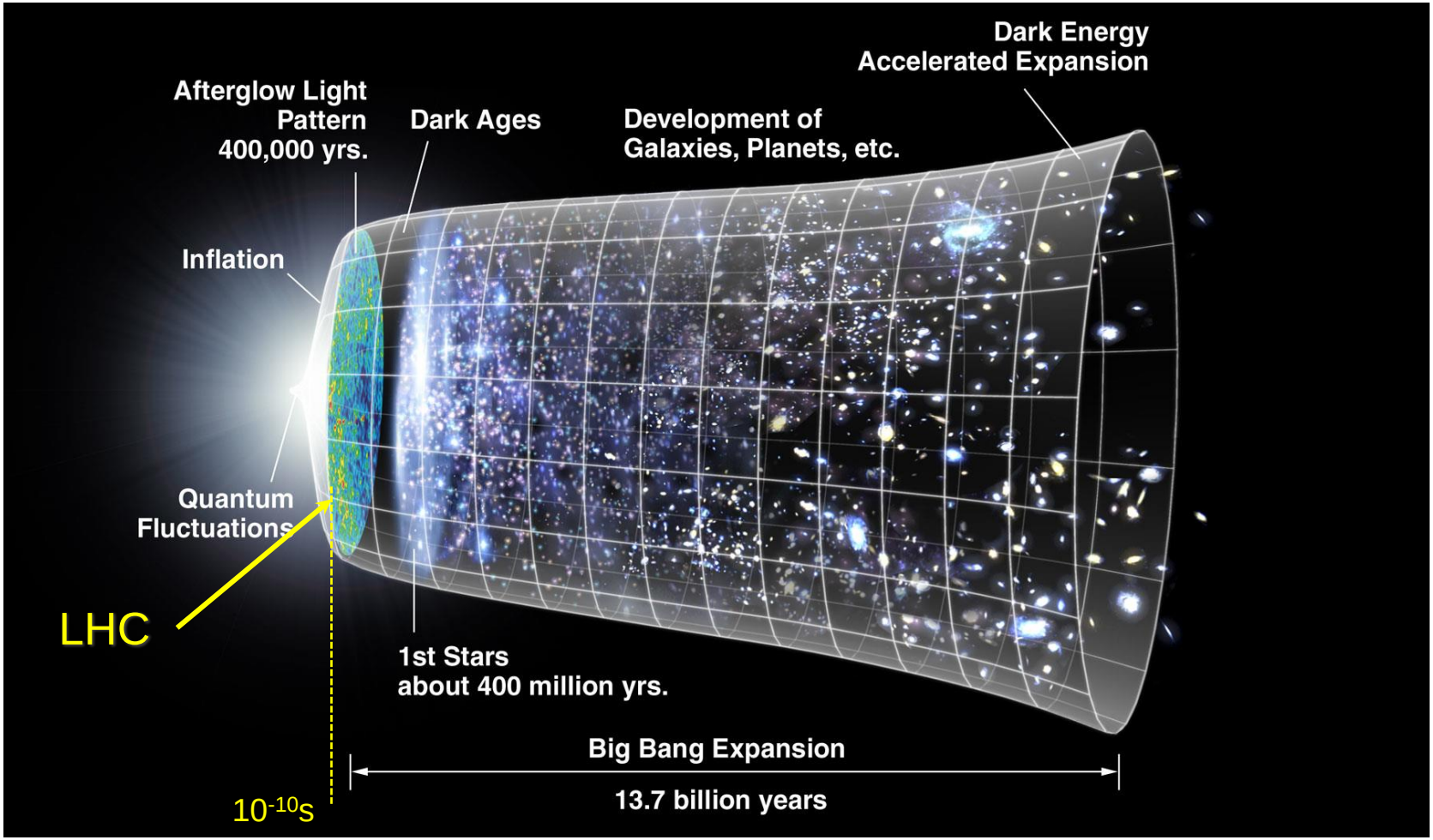
  Information technology - the Web and the GRID

  Medicine - diagnosis and therapy

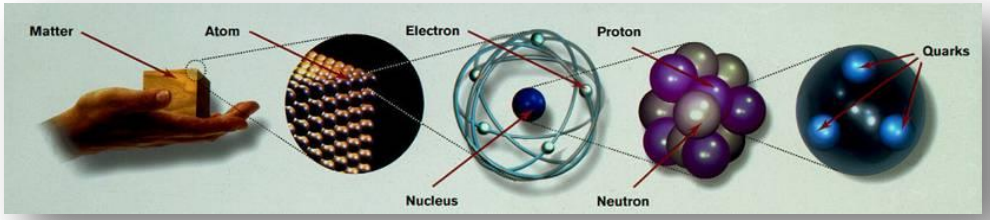
- Train the scientists and the engineers of tomorrow

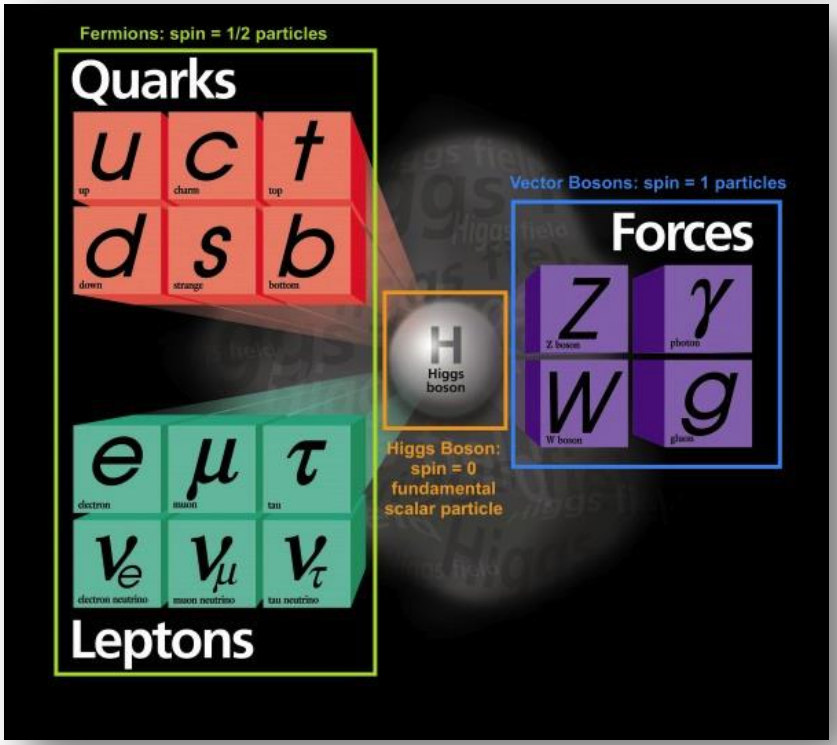
- Unite people from different countries and cultures

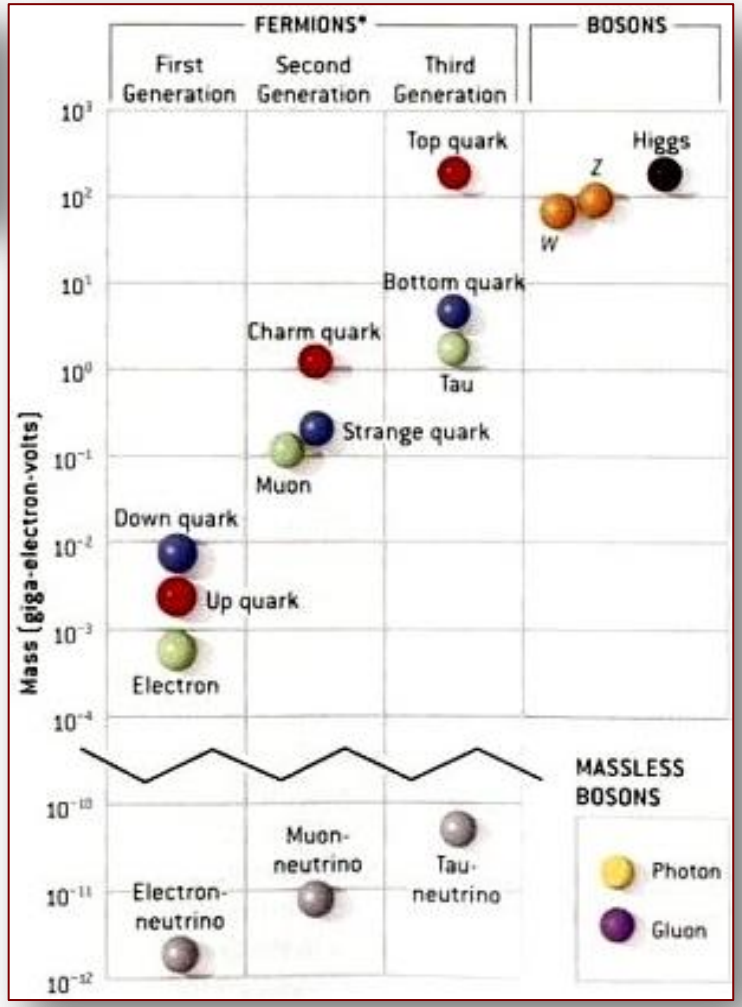
Understand the very first moments of our Universe after the Big Bang



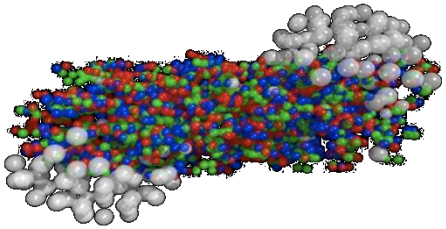
Complete the Standard Model

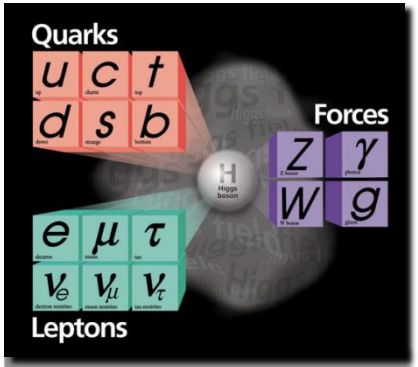






The Primordial State of Matter





The Higgs Boson

Matter-Antimatter Asymmetry

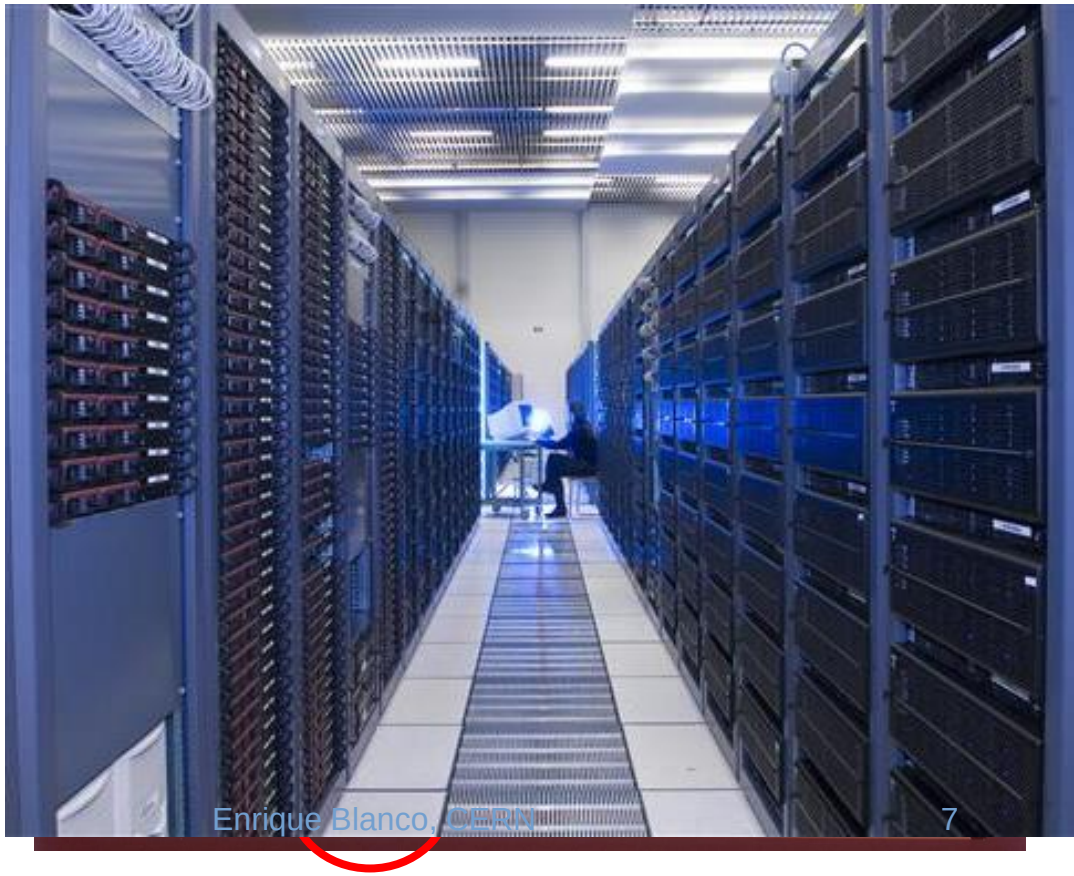
Dark Matter

The “Tools” of CERN

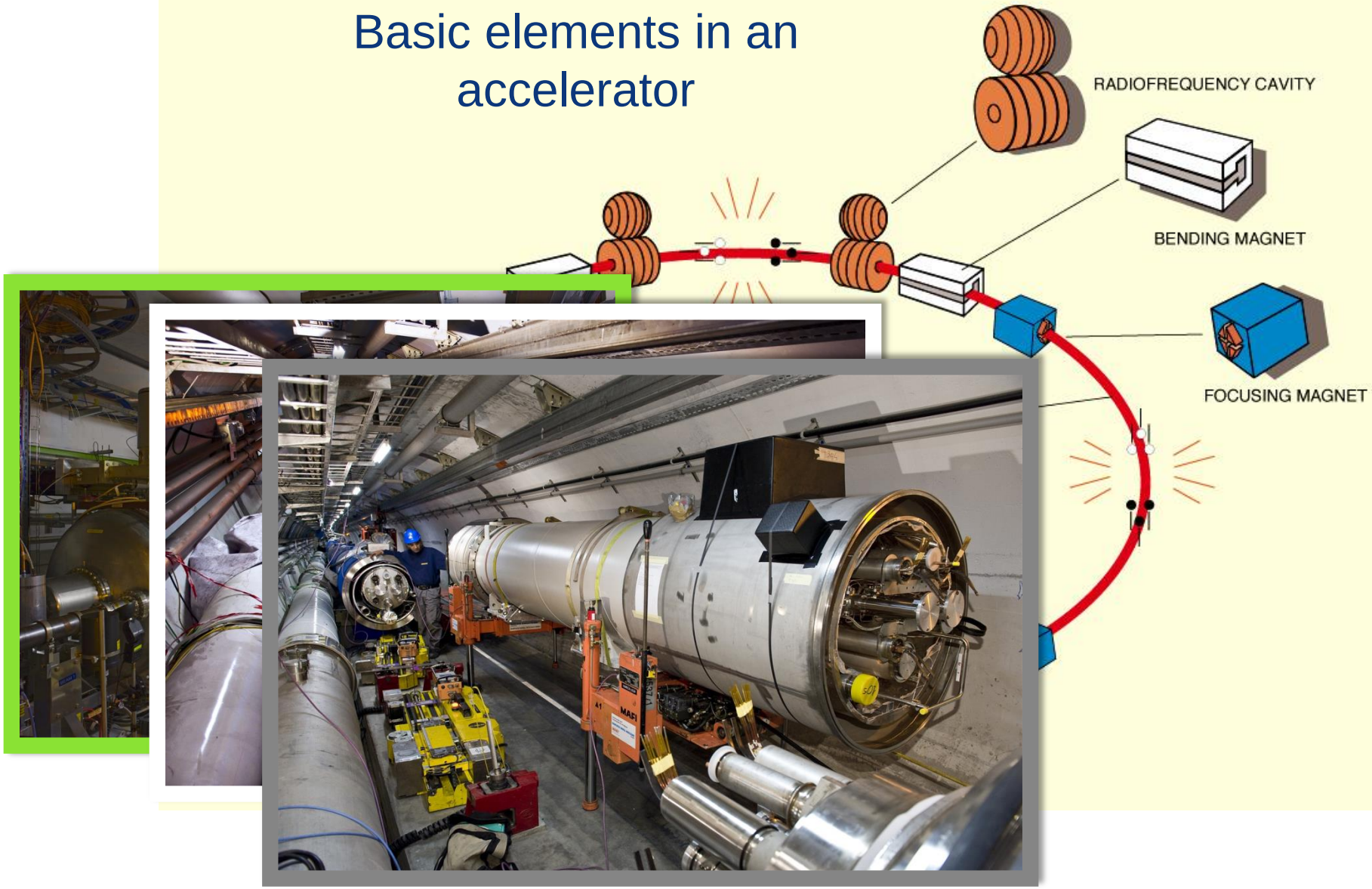
1. Accelerators: Machines capable of accelerating particles to high energies and make them collision.

2. Detectors: Huge instruments which record the traces of the particules

3. Computers: Store, distribute and analyze huge amounts of data produced by the detectors



Basic elements in an accelerator



The CERN Accelerator Complex

1eV -> 1.602 10^{-19} J

14 TeV -> 22.4 x 10^{-7} joules

Accelerator complex

LHC accelerator

World Largest accelerator

27km length
100m underground

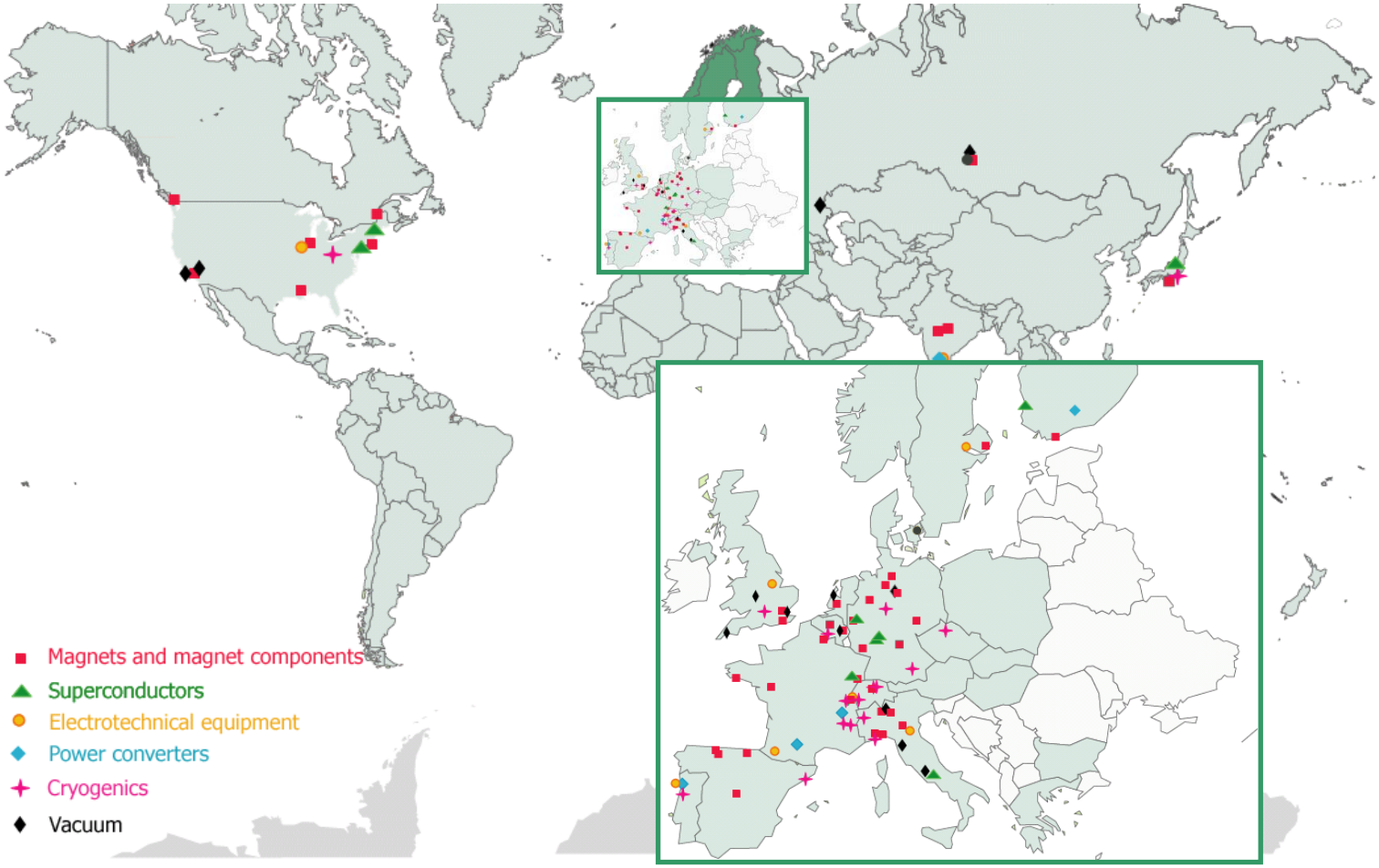
Thousands of Superconducting magnets
(1.8 x 10^9 km of superconducting filaments)

Ultra vacuum:
10x less the moon vacuum
(10^{-13} atm*)*

Coldest place in Universe:

-271° C

The LHC Major Projects



LHC Detectors

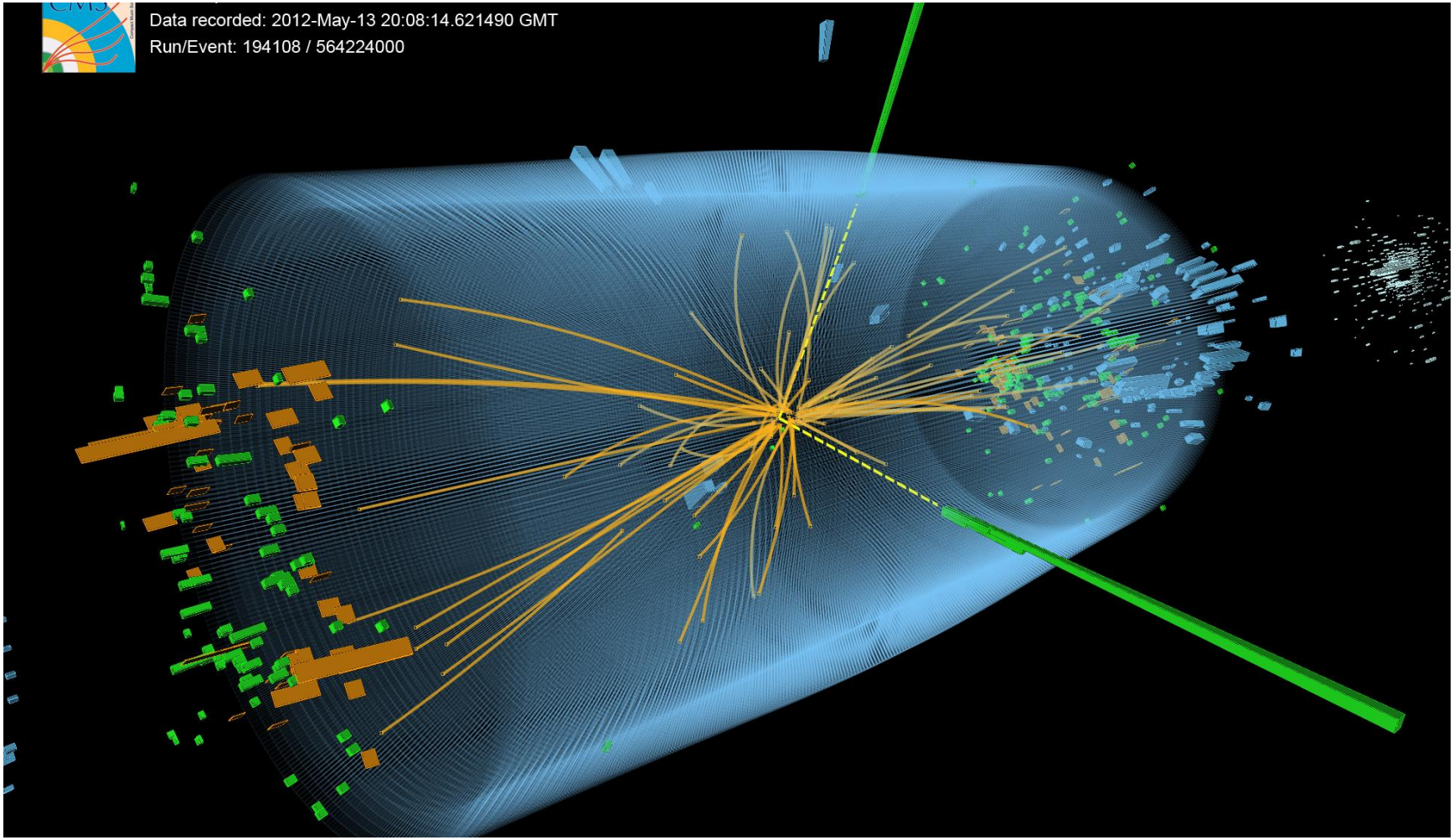
Huge and sophisticated

100m underground science cathedrals

600 millions of detected collisions/s by cents of millions of sensors.

Thousands of collaborators.

H → γ γ

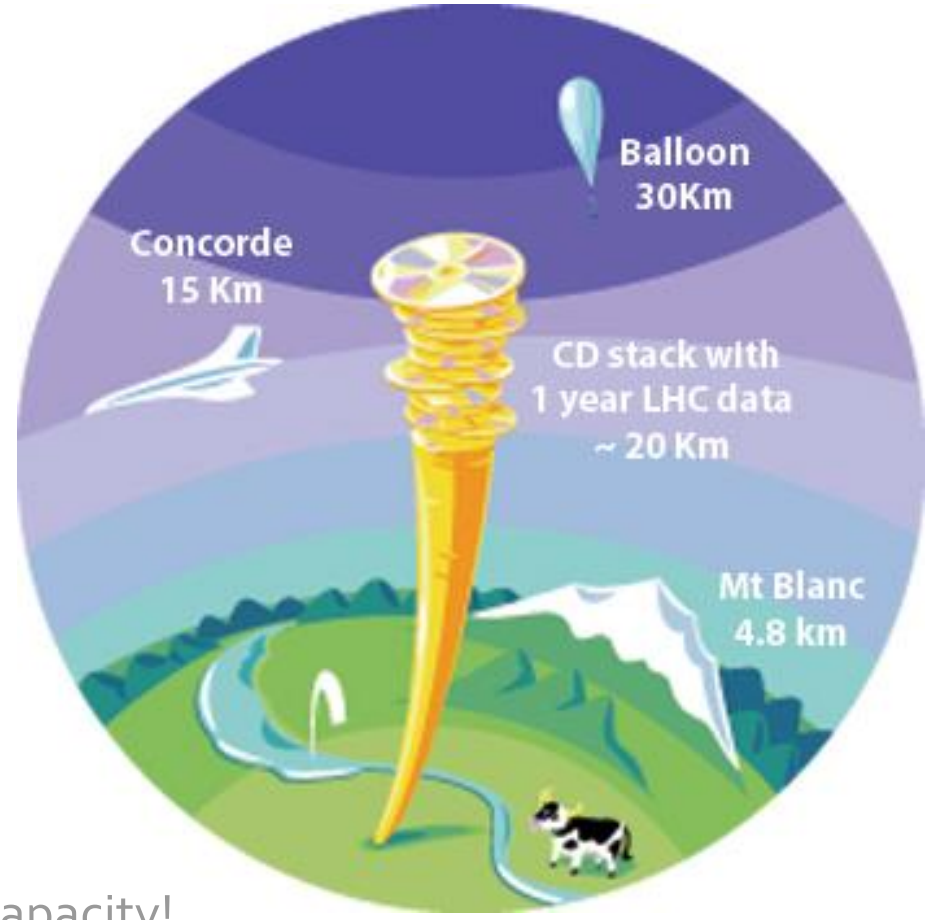

Data recorded: 2012-May-13 20:08:14.621490 GMT
Run/Event: 194108 / 564224000

Nobel Prize for F.Engler & P.Higgs

LHC data

- 100 interesting collisions/second
- 1 Mbyte of data/collision
  Storage speed
  of 0.1 Gbytes/sec
- 10^{10} stored collisions/year
by experiment

15 Petabytes/year of new data

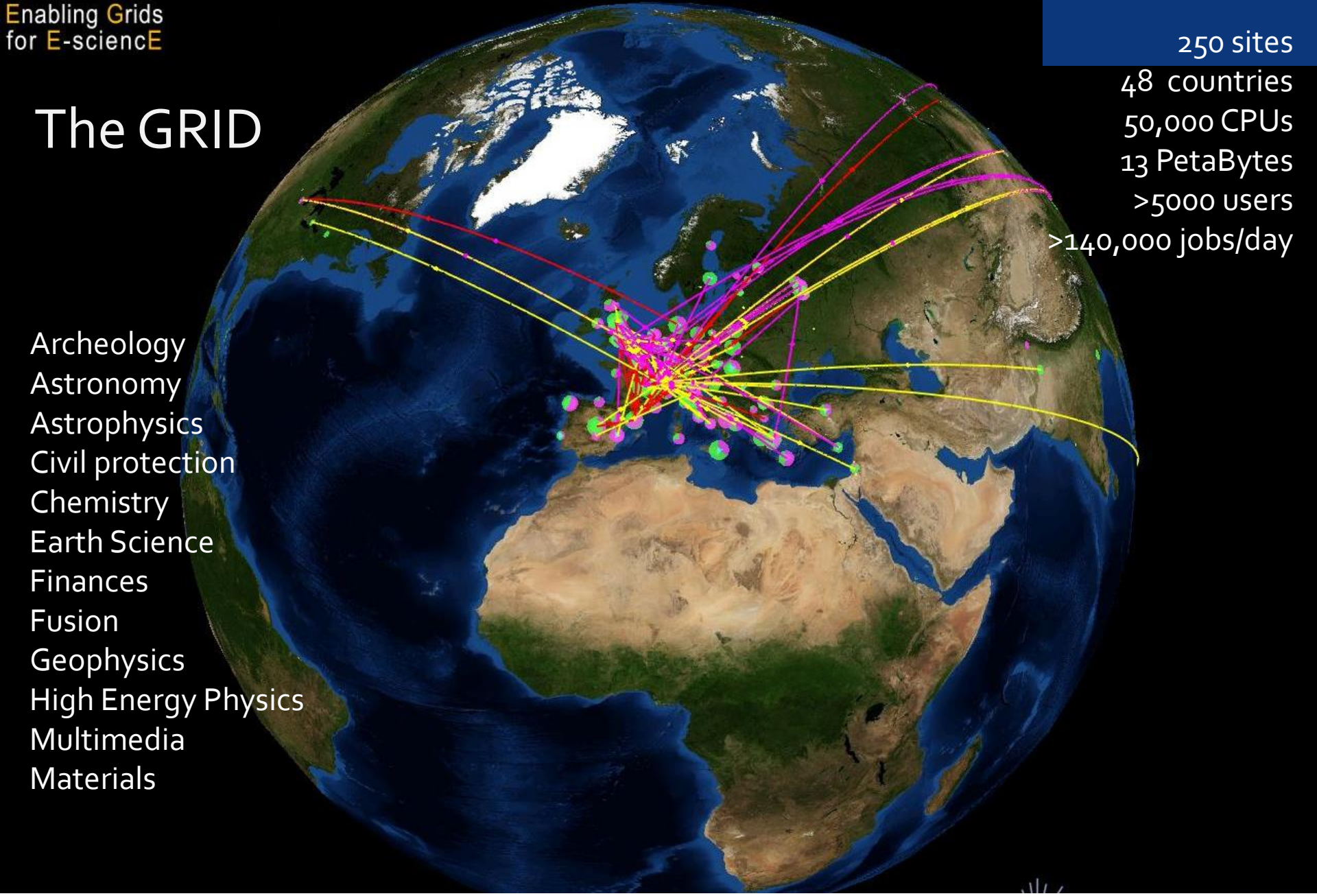


- CERN computing center:
  - More than 5000 PCs.
  - Store capacity over 4-5 PB

¡ Only a fraction of the needed storage capacity!

The GRID

250 sites
48 countries
50,000 CPUs
13 PetaBytes
>5000 users
>140,000 jobs/day

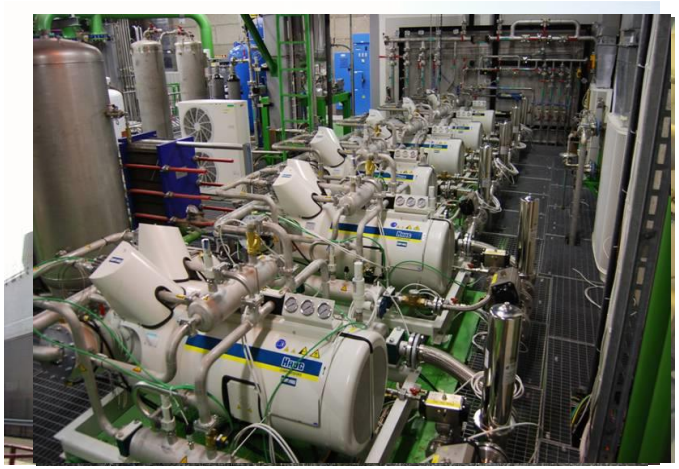


Archeology
Astronomy
Astrophysics
Civil protection
Chemistry
Earth Science
Finances
Fusion
Geophysics
High Energy Physics
Multimedia
Materials

Hi-tech

but also conventional industrial installations

Cooling plants (raw, demineralised water, C_3F_8, C_6F_{14})	150
Pipelines	800 km
Hydrants	800 points
Cooling towers (450 MW)	22
Chilled water plants 6-12 °C (73 MW)	35
Water network with three pumping stations	5'400 m^3/h



Equivalent to a small town of 45'000 inhabitants
10% of the water needs of Geneva

Hi-tech

but also conventional industrial installations

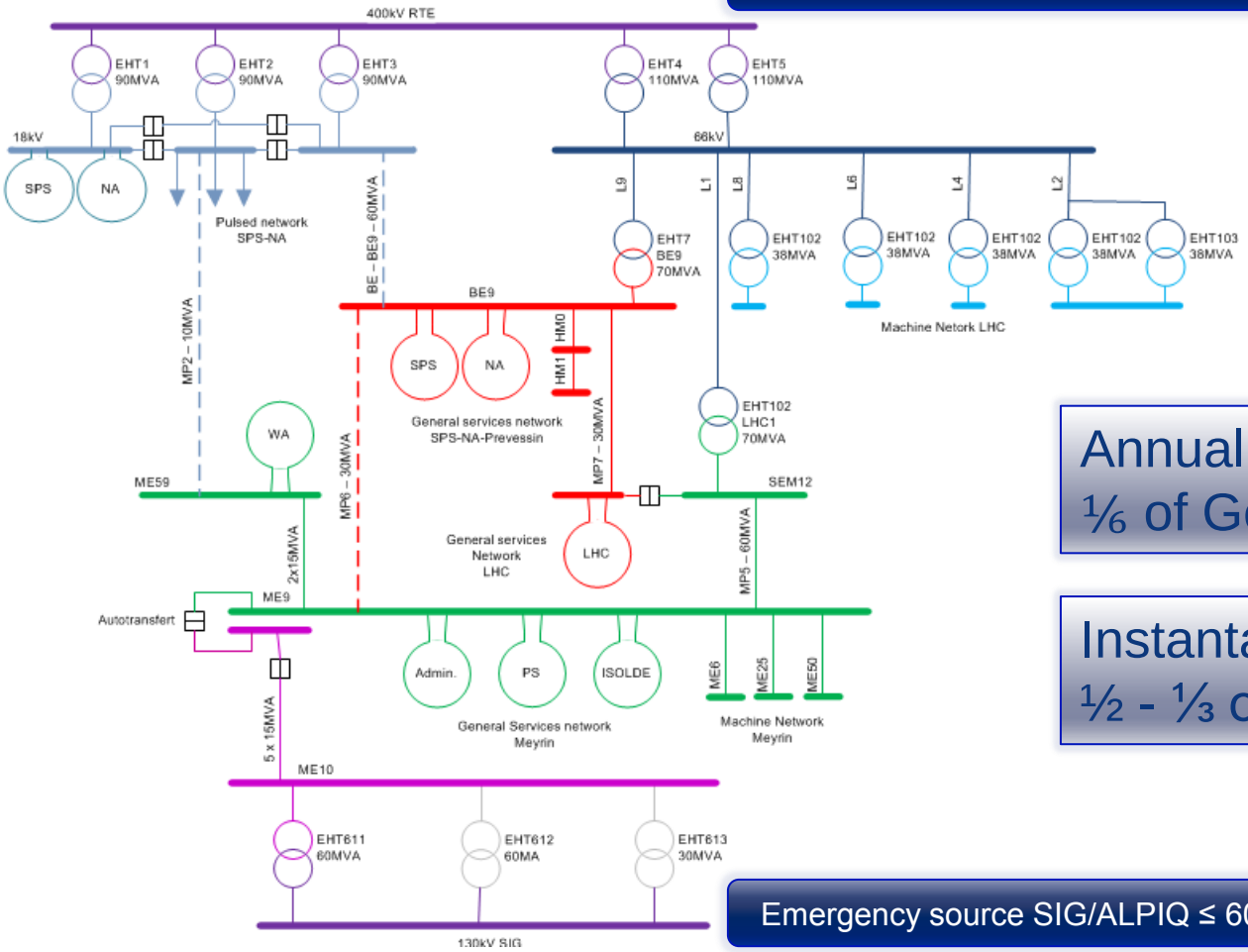
Heating, ventilation and air conditioning	1’500 units from 2’000 to 120’000 m^3/h each
Compressed air	14 stations 200 km network

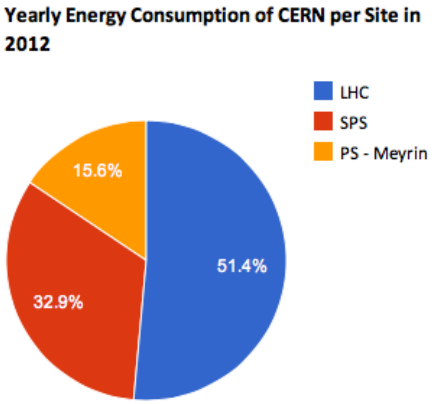
	km	m^3/h
Eurotunnel	50	*540’000*
LHC	27	*290’000*

Hi-tech

but also conventional industrial installations

Normal source EDF > 300 MW





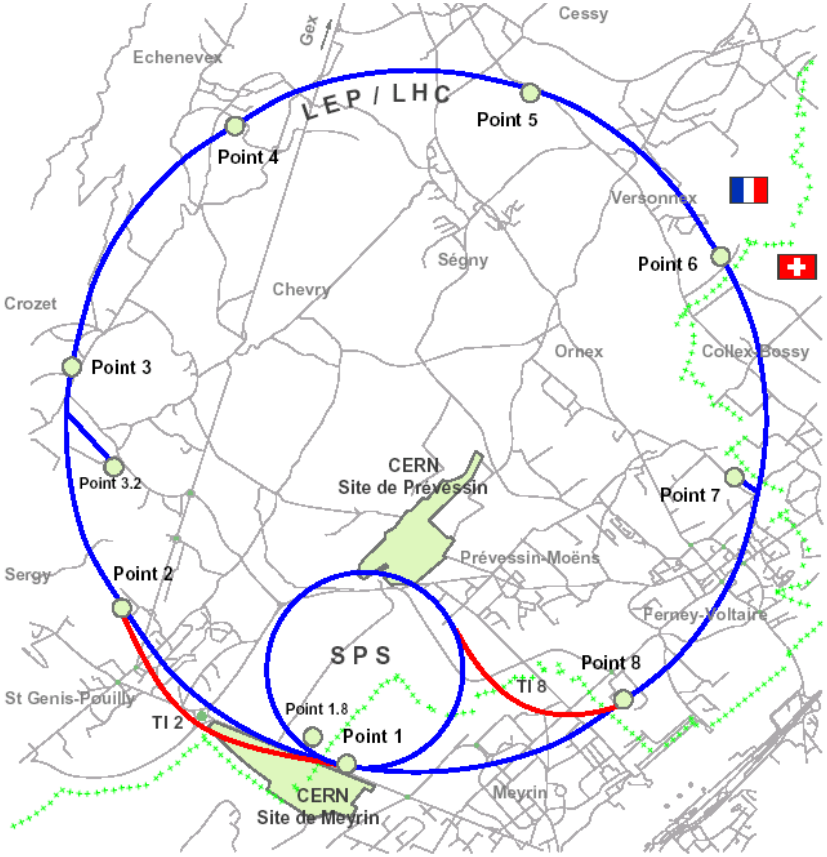
Annual Consumtion 1.26 TWh
⅙ of Geneva

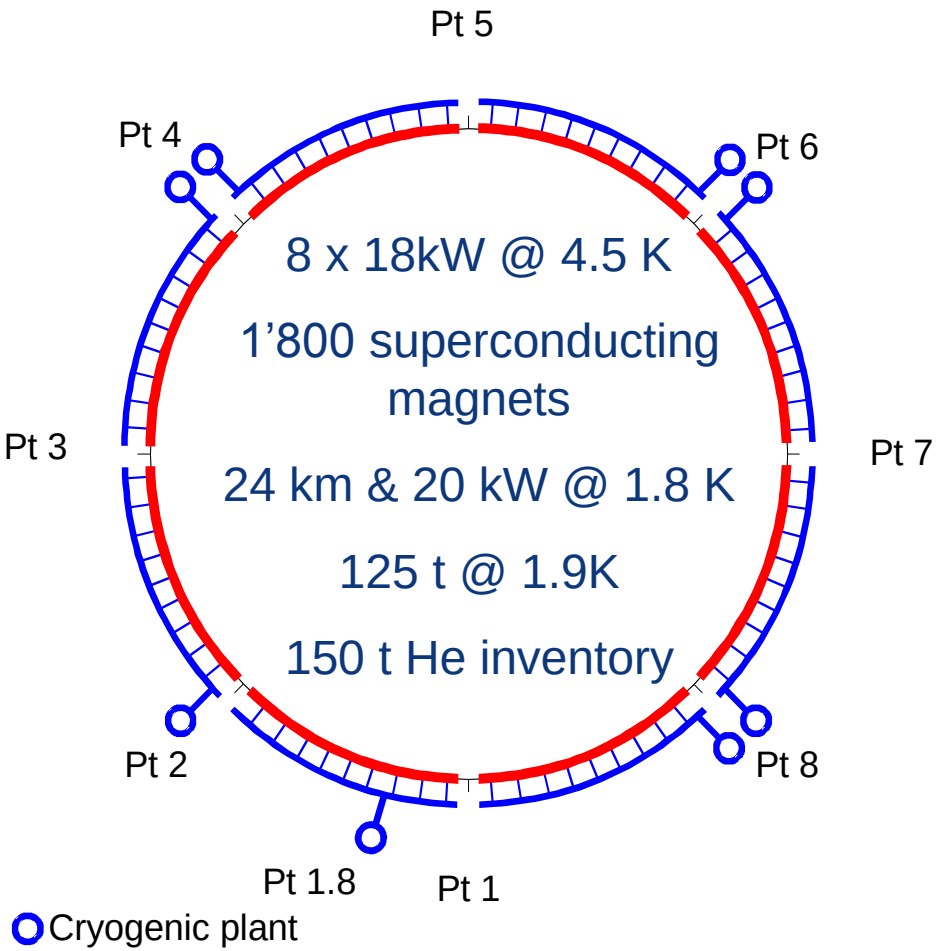
Instantaneous Power 180 MW
½ - ⅓ of Geneva

Emergency source SIG/ALPIQ ≤ 60 MW

Hi-tech but also not so conventional industrial installations : The Cryogenics

50% of the world's helium liquefaction capacity



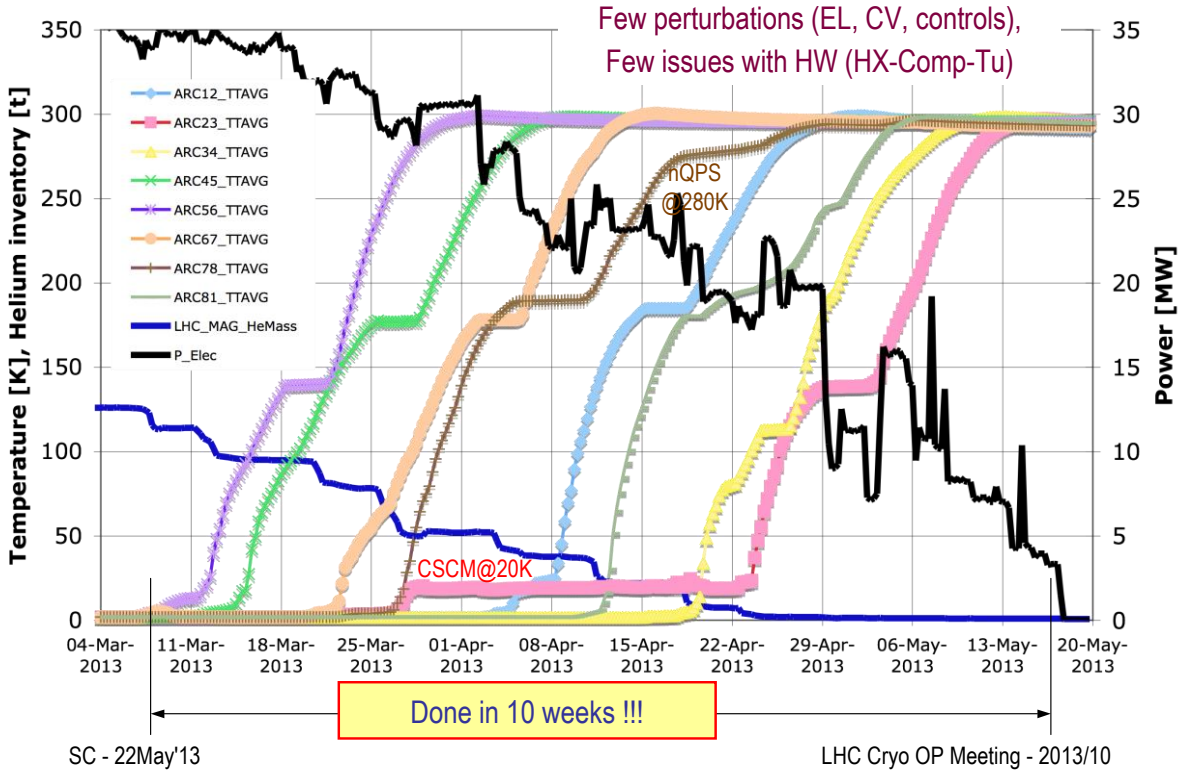


Courtesy Serge Claudet

Hi-tech but also not so conventional industrial installations : The Cryogenics

It takes one month to cool down an LHC sector from 300 K to 1.9 K.
This is followed by two weeks of tuning of the control loops.

LHC Warm-UP 2013

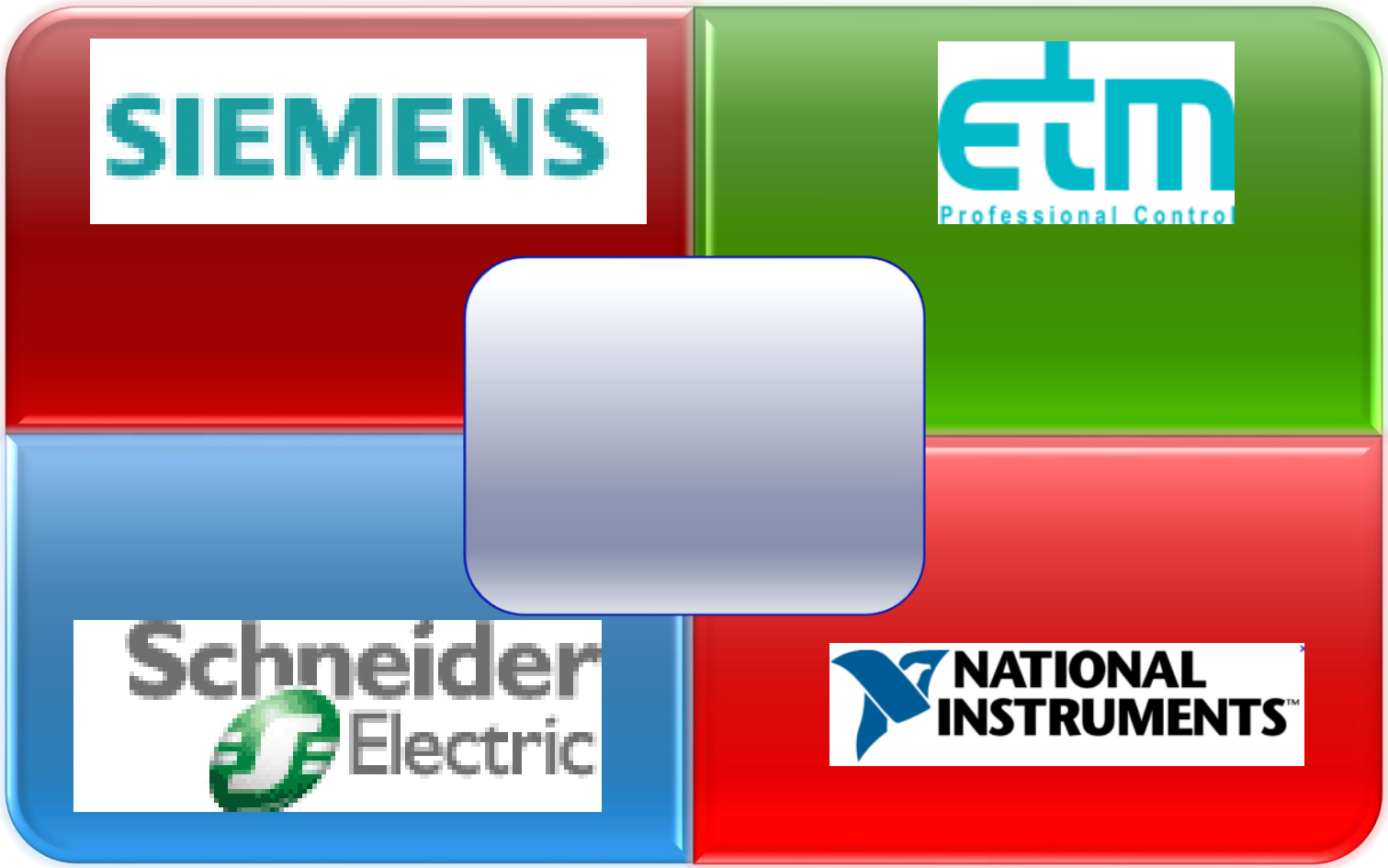


Industrial components

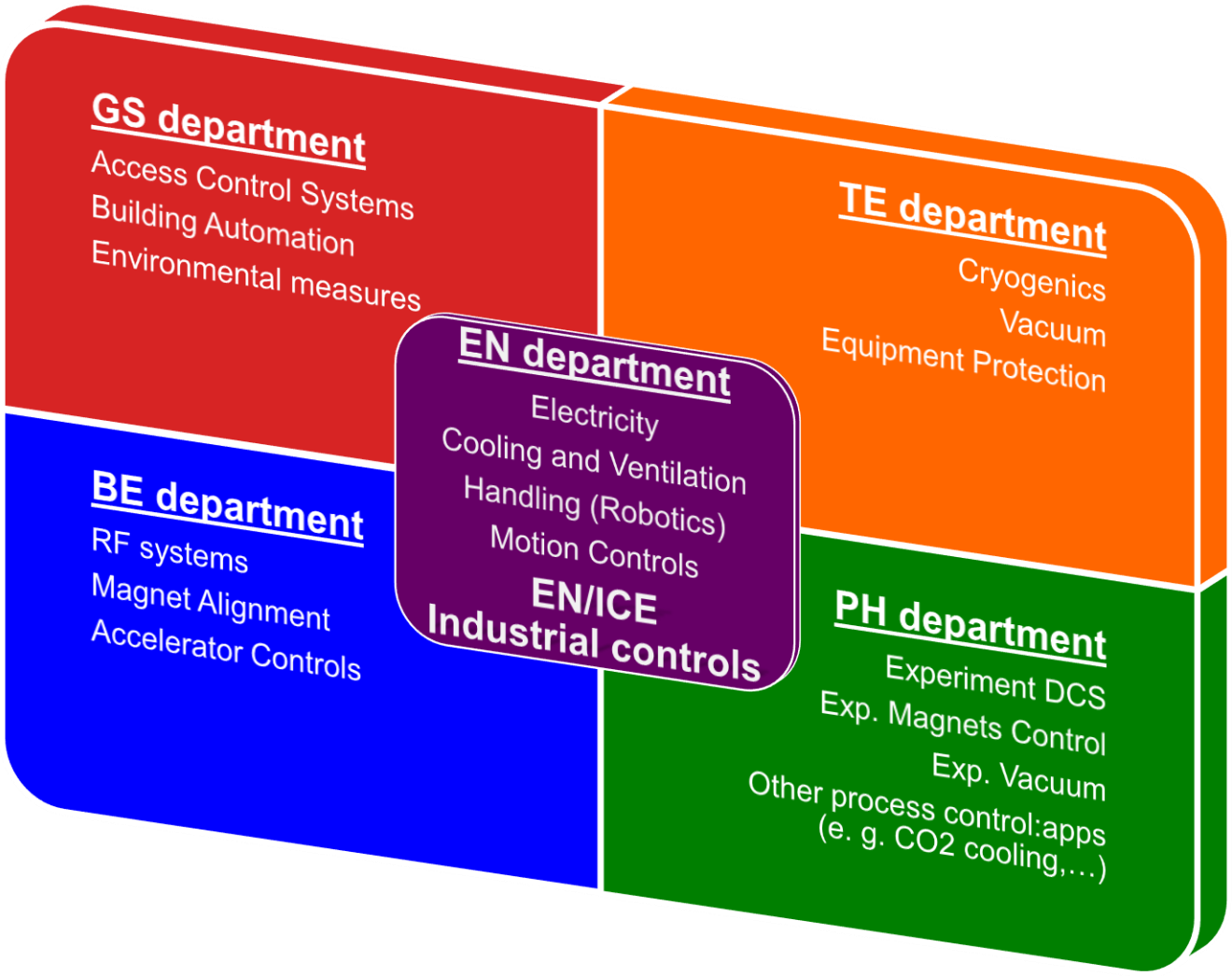
- SUPERVISION, Visualization and programmir
  - WinCC OA (PVSS) SCADA (standard)
  - Legacy systems: PCVue32, FactoryLink, WinCC
  - Labview
- CONTROL
  - SIEMENS, Schneider (standards)
  - NI CompactRIO, PXI
  - Industrial PCs: SIEMENS IPC, Kontron
- FIELD LAYER
  - Industrial instrumentation: Sensors, actuators
  - Industrial dedicated actuators: Profibus PA positioners
  - Home made electronics: ELMB, Electronic Signal Conditioners (CRYO)
- COMMUNICATIONS
  - Fieldbuses: Profibus, WorldFIP, CAN (standard)
  - Ethernet based: Profinet, Ethernet/IP
  - Home made: White rabbit

WorldFIP
LabVIEW
EtherNet/IP
CoDeSys
NATIONAL INSTRUMENTS
SIEMENS
PROFINET
Schneider Electric
PROFIBUS
PVSS

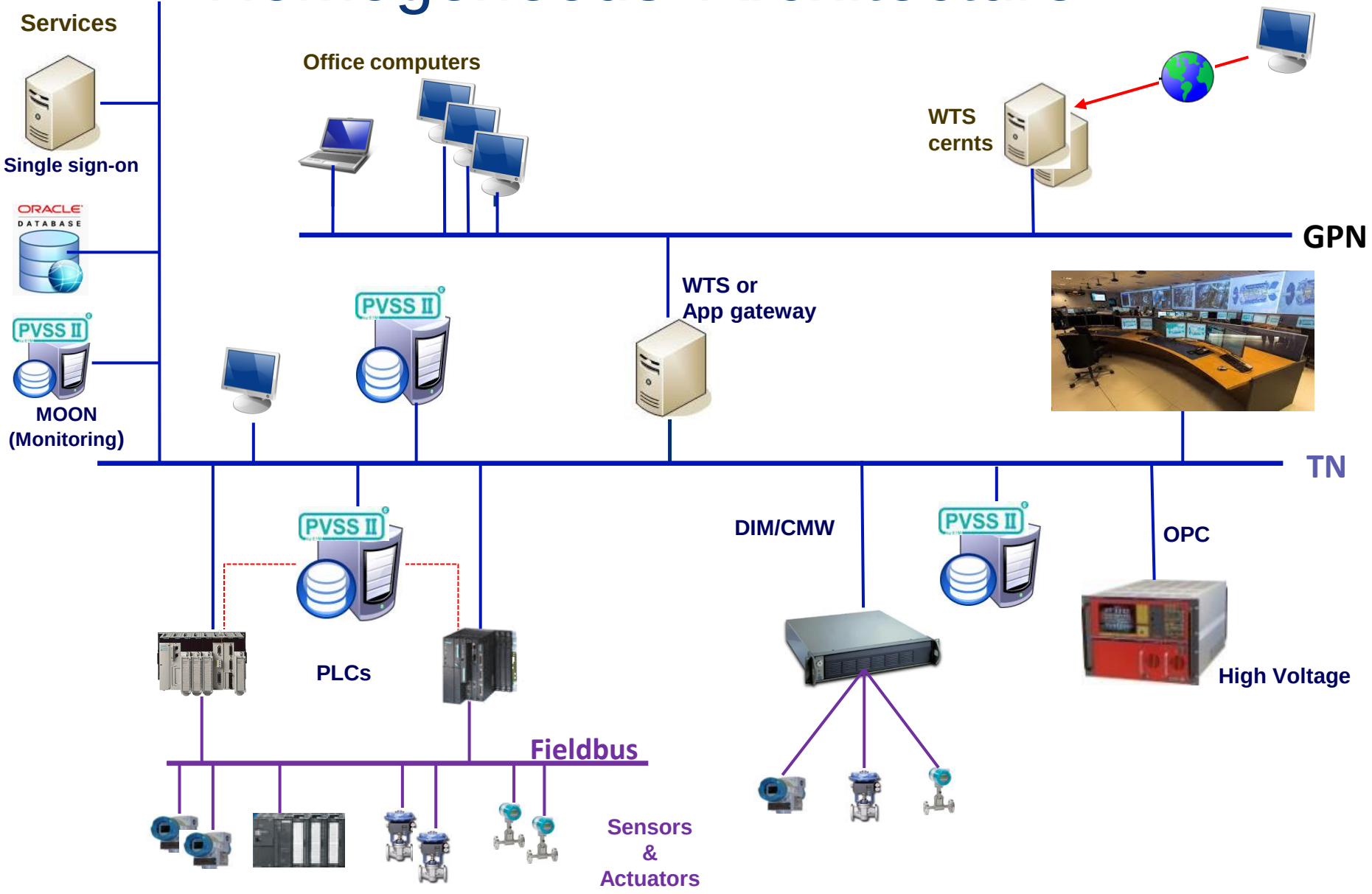
Industrial Partneship



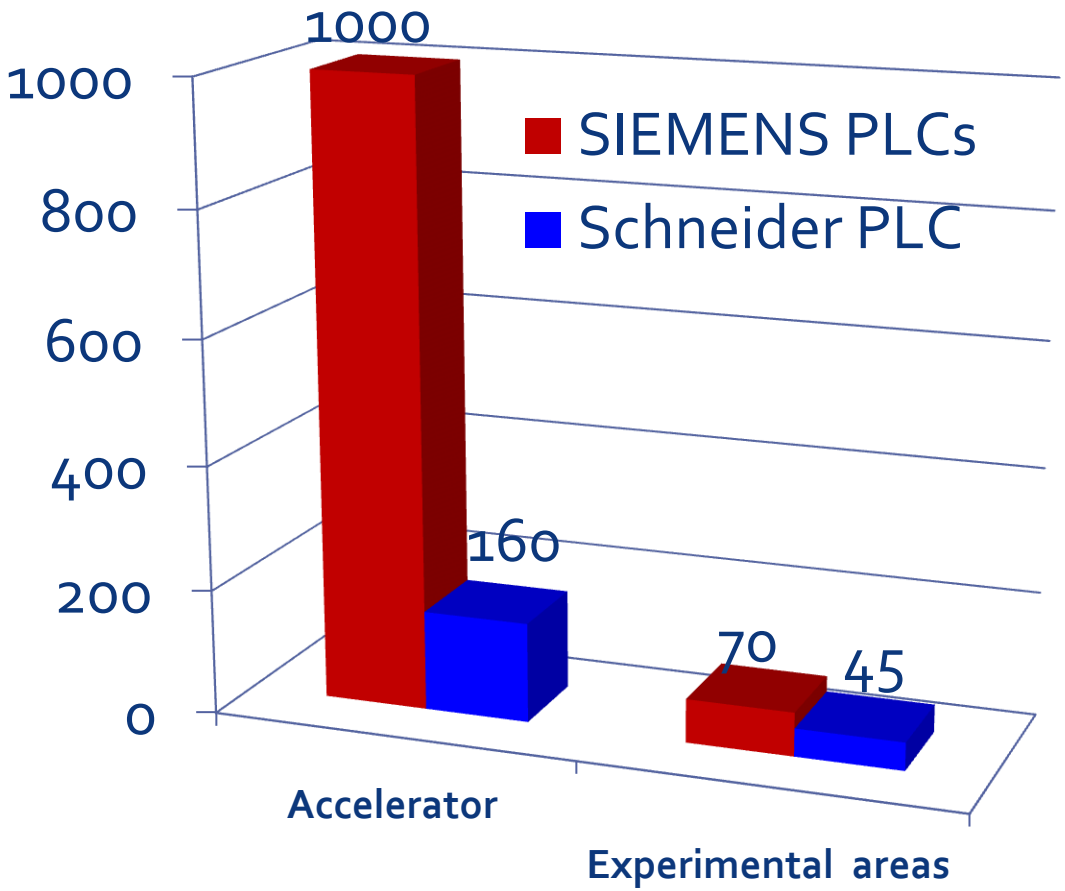
Central Support



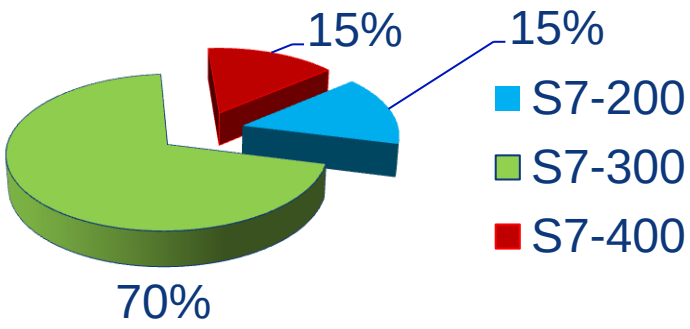
Homogeneous Architecture



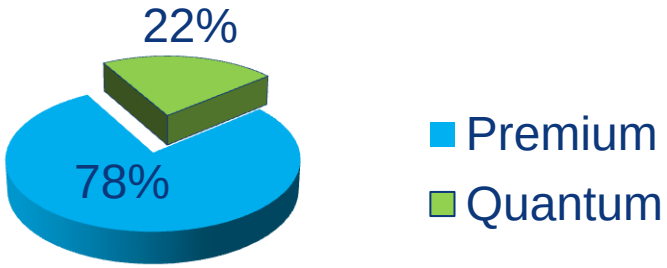
LOW PLCs diversity



Siemens PLC



Schneider PLC



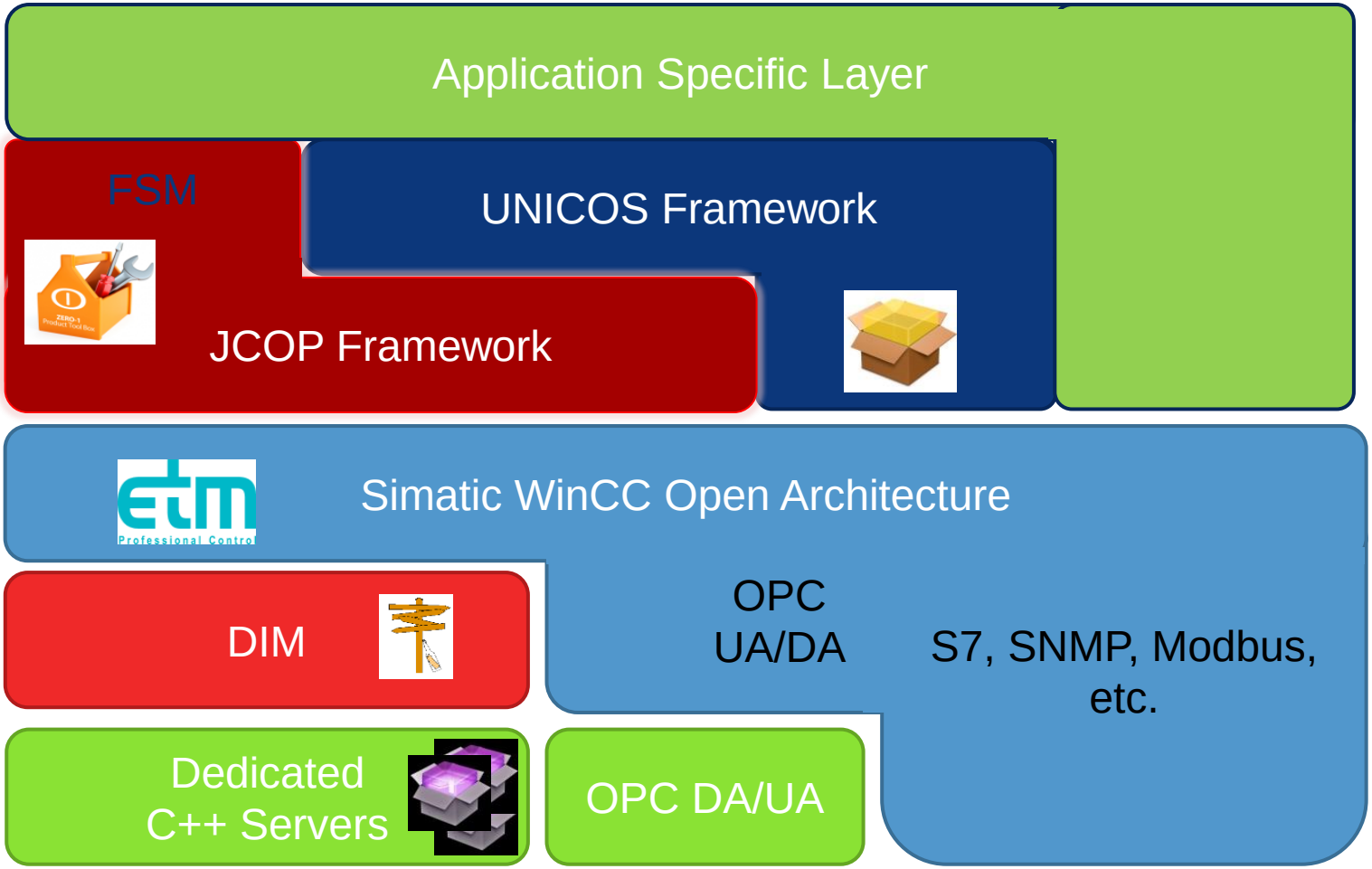
Convergence toward WinCC OA

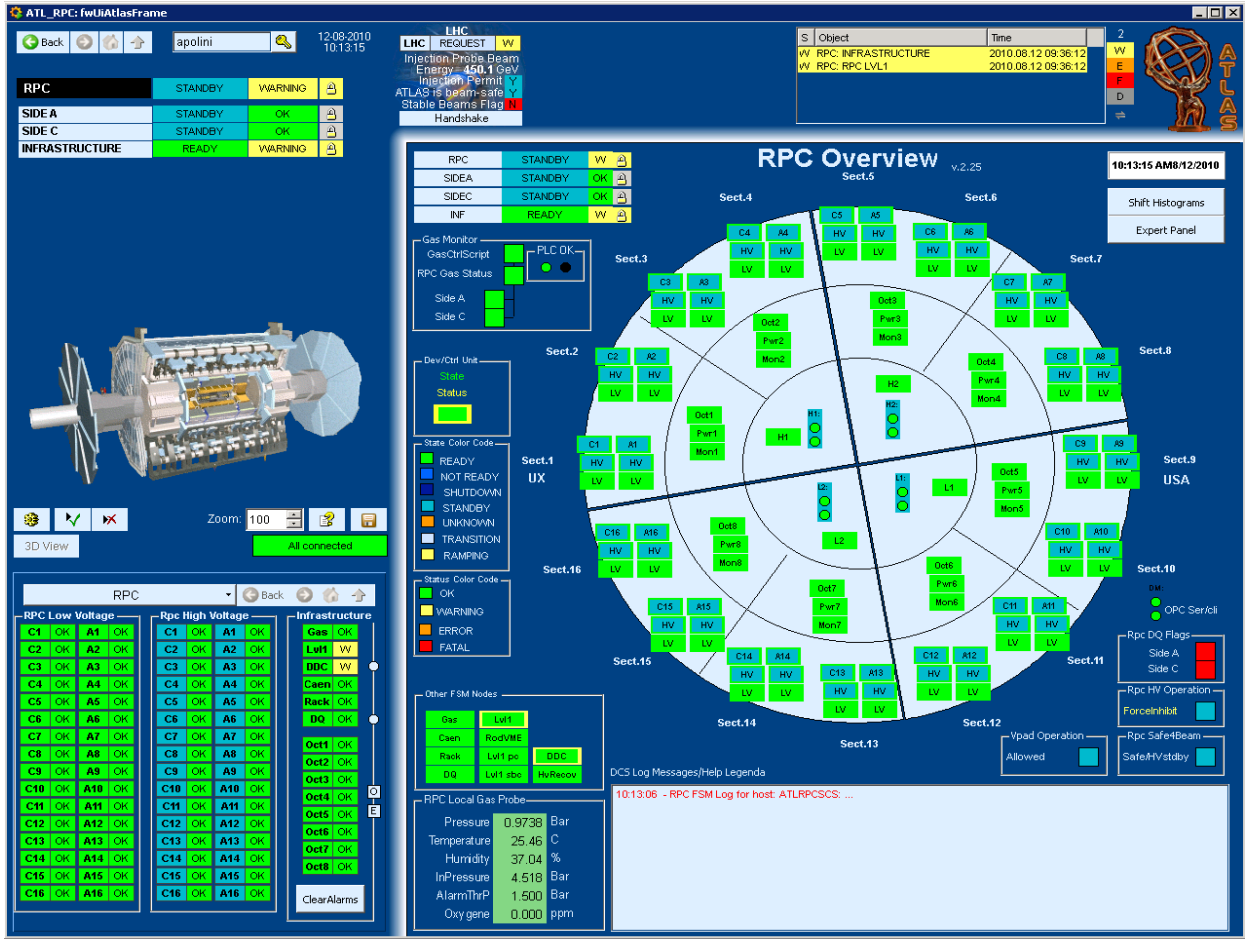
- ~800 active developers worldwide (1300 ever)
  - 130 institutes in 30 countries
  - 110 CERN internal courses

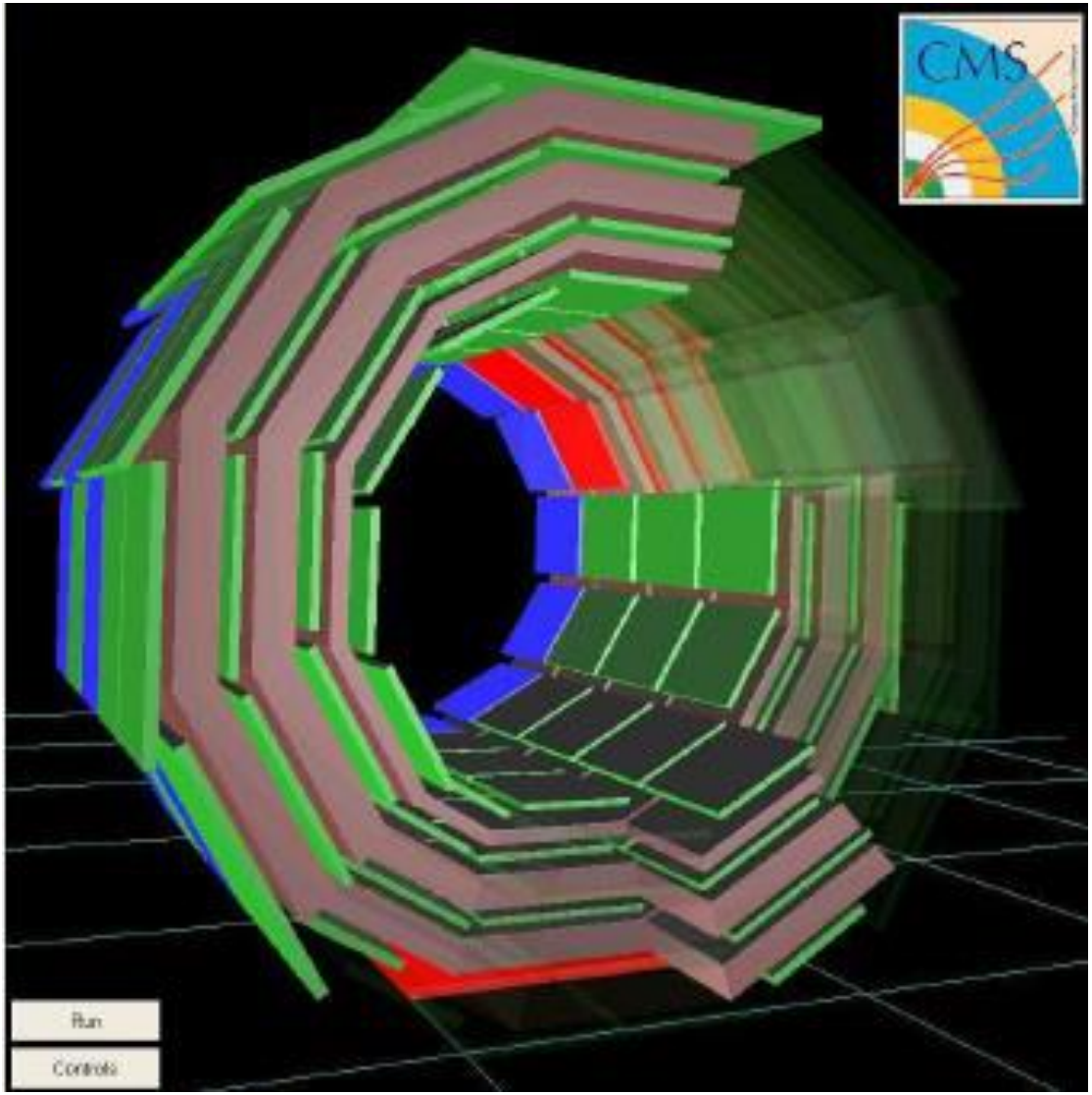
Application	WinCC OA Systems	Parameters (Million dpes)
ALICE	100	3
ATLAS	130	12
CMS	90	10
LHCb	160	10
Accelerator Complex	120	10

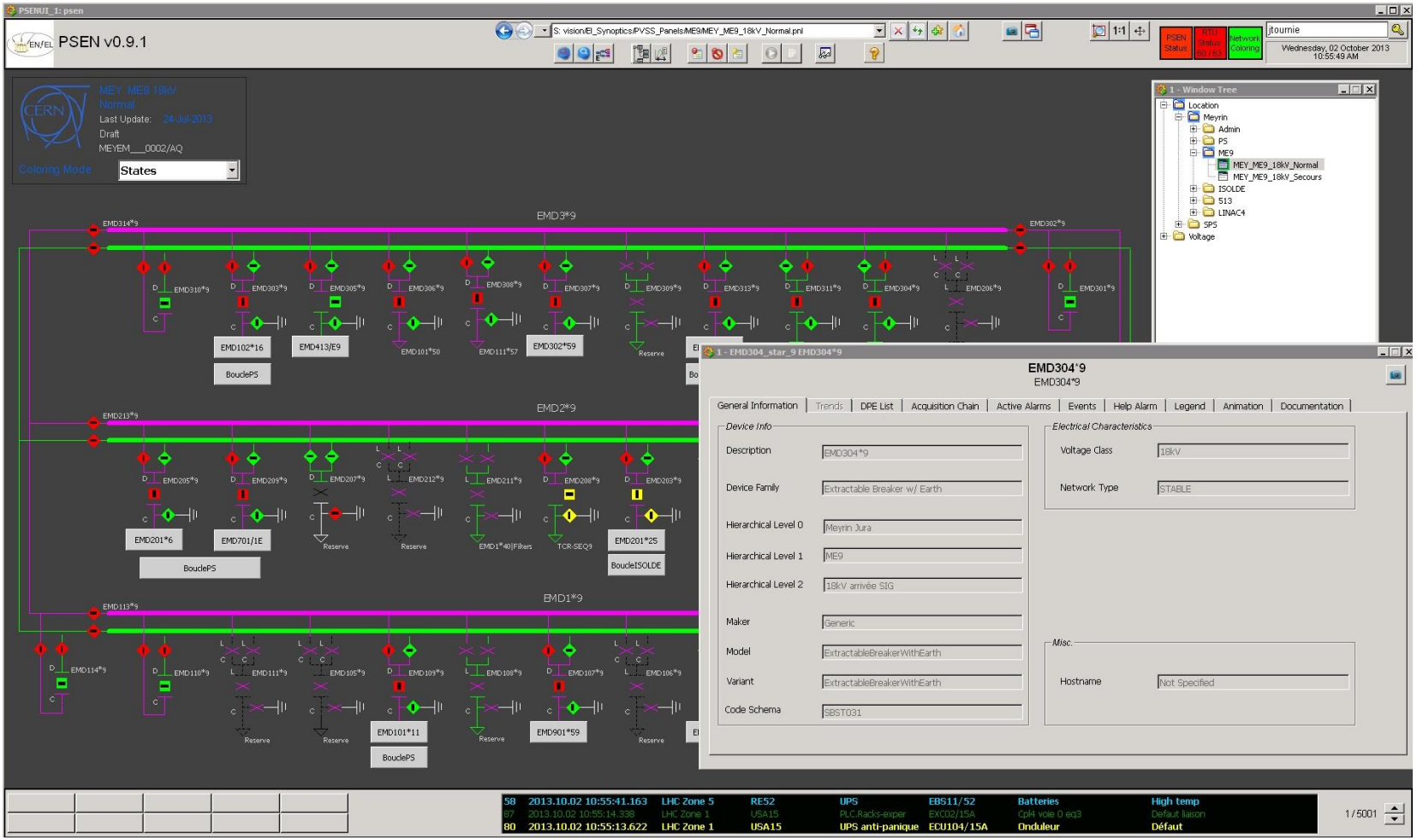
…and many smaller systems: Radiation Monitoring, Magnet Test, etc

Common Supervision Framework




ATL_RPC: fwUiAtlasFrame
RPC Overview
v.2.25
RPC
STANDBY
WARNING
SIDE A
SIDE C
INFRASTRUCTURE
READY
Sect.1
UX
Sect.2
Sect.3
Sect.4
Sect.5
Sect.6
Sect.7
Sect.8
Sect.9
USA
Sect.10
Sect.11
Sect.12
Sect.13
Sect.14
Sect.15
Sect.16
RPC Low Voltage
Rpc High Voltage
Infrastructure
RPC Local Gas Probe
Pressure 0.9738 Bar
Temperature 25.46 C
Humidity 37.04 %
InPressure 4.518 Bar
AlarmThrP 1.500 Bar
Oxygene 0.000 ppm
ClearAlarms
All connected
3D View

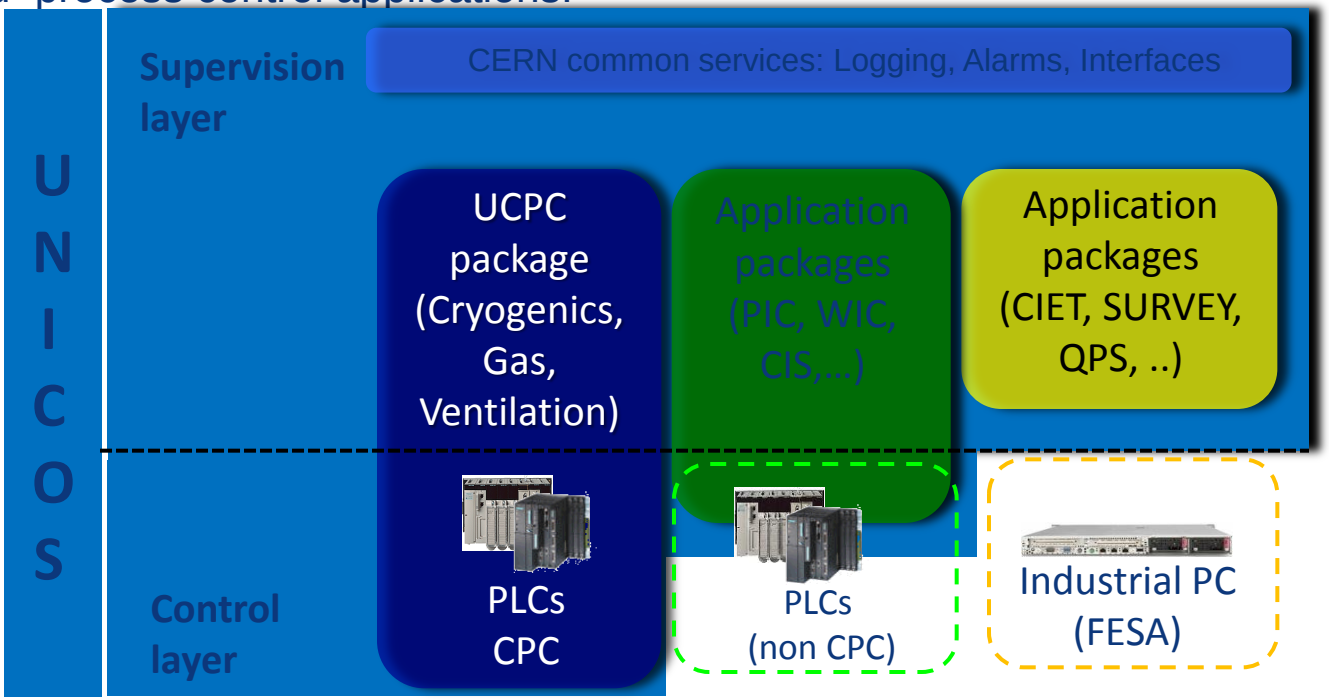

CMS
Run
Controls


PSENUI_1: psen
PSEN v0.9.1
MEY_ME9.18kV
Normal
Last Update: 24-Jul-2013
Draft
MEYEM___0002/AQ
Coloring Mode
States
EMD3*9
EMD2*9
EMD1*9
EMD102*16
BouclePS
EMD413/E9
EMD302*59
EMD201*6
EMD701/1E
EMD201*25
BoucleISOLDE
EMD101*11
EMD901*59
1 - Window Tree
Location
Meyrin
Admin
PS
ME9
MEY_ME9_18kV_Normal
MEY_ME9_18kV_Secours
ISOLDE
513
LINAC4
SPS
Voltage
1 - EMD304_star_9 EMD304*9
EMD304*9
EMD304*9
General Information
Trends
DPE List
Acquisition Chain
Active Alarms
Events
Help Alarm
Legend
Animation
Documentation
Device Info
Description
Device Family
Hierarchical Level 0
Hierarchical Level 1
Hierarchical Level 2
Maker
Model
Variant
Code Schema
Extractable Breaker w/ Earth
Meyrin Jura
ME9
18kV arrivée SIG
Generic
ExtractableBreakerWithEarth
ExtractableBreakerWithEarth
SBST031
Electrical Characteristics
Voltage Class
Network Type
18kV
STABLE
Misc.
Hostname
Not Specified
58 2013.10.02 10:55:41.163 LHC Zone 5 RE52 UPS EBS11/52 Batteries High temp
80 2013.10.02 10:55:13.622 LHC Zone 1 USA15 UPS anti-panique ECU104/15A Onduleur Défaut
1 / 5001

UNICOS : to Cover all control layers

- UNICOS is a framework to create control applications

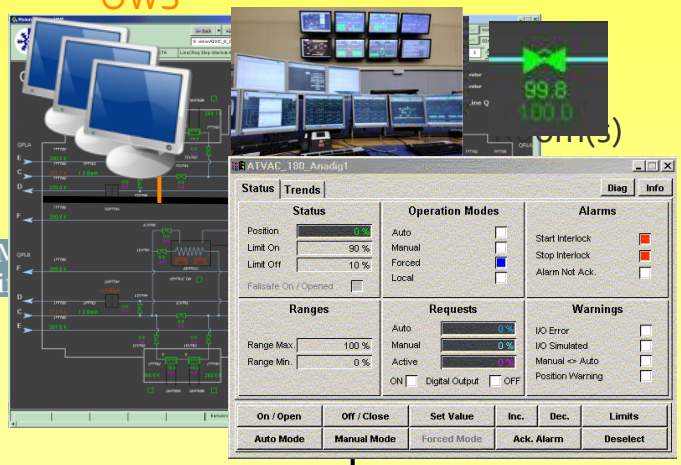
UNICOS CPC: A basic package (**Continuous Process Control**) to develop integrated process control applications.



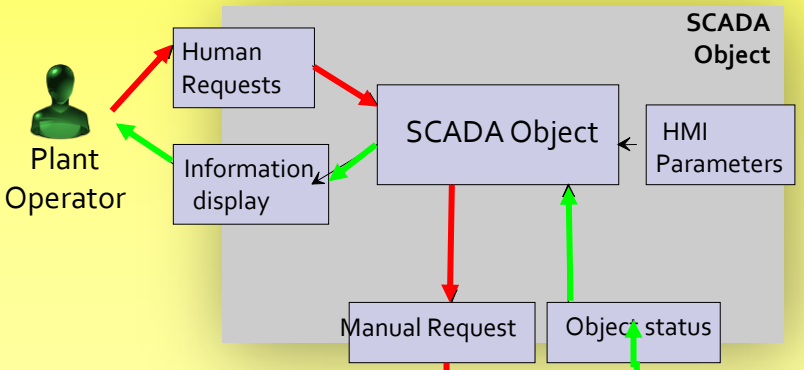
Objects & Layers Integration

Supervision Layer

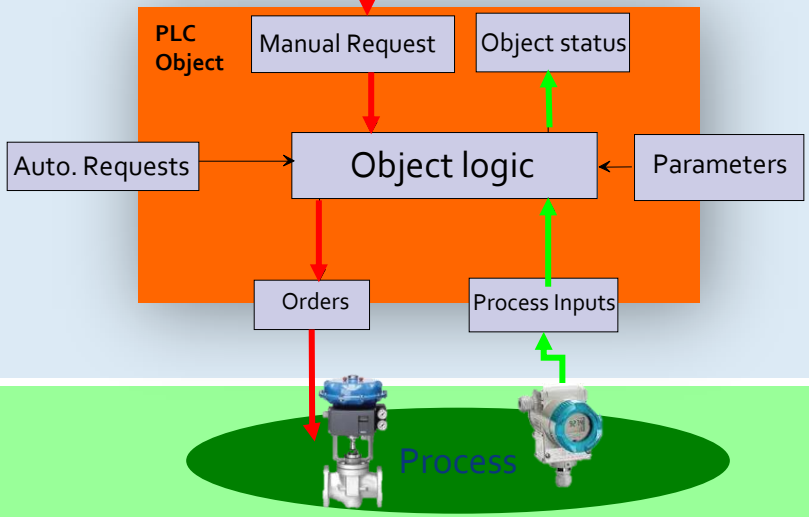
OWS



In the Supervision layer the object presents the relevant information to the operator and allow manual commands

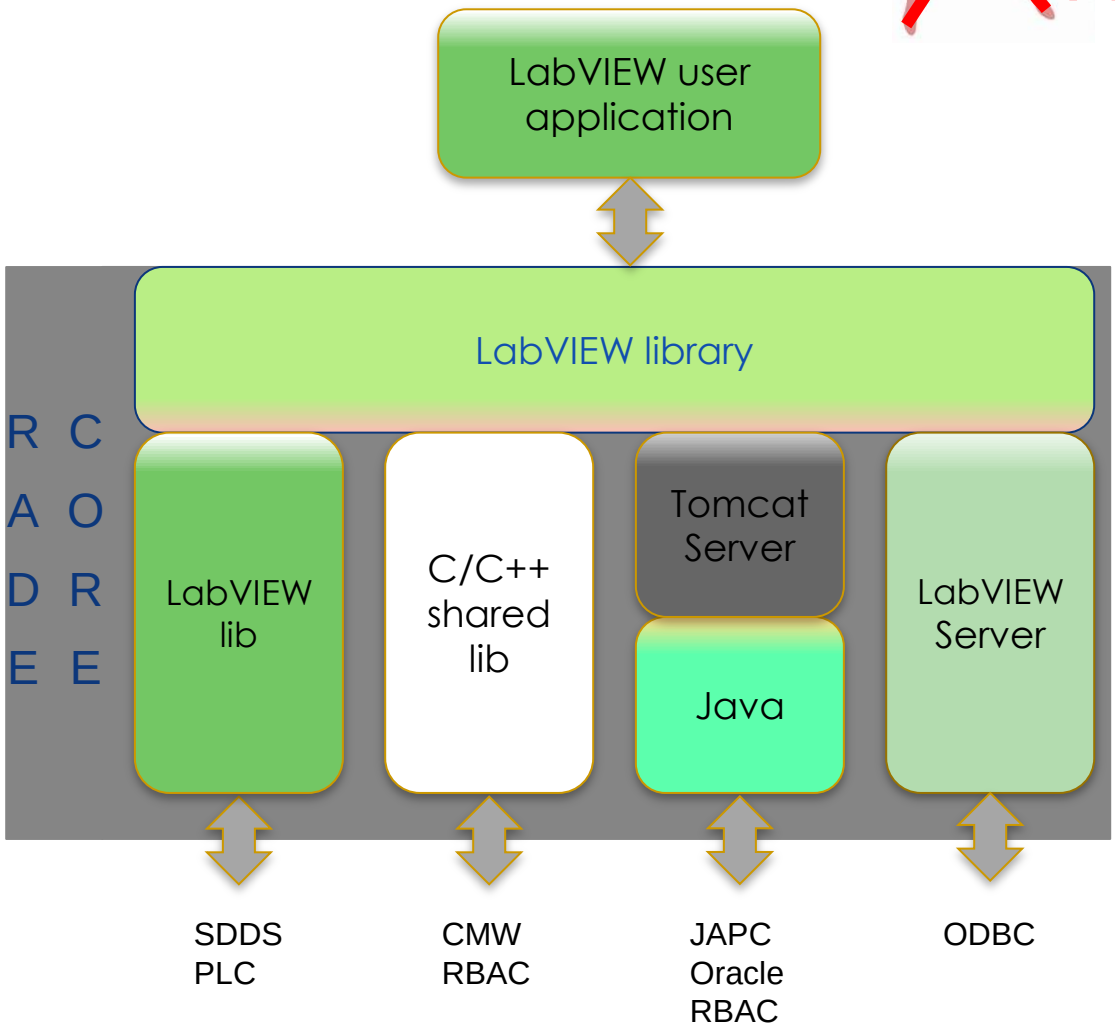


Control Layer

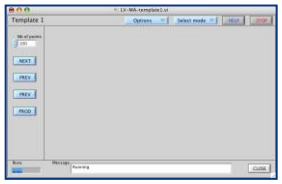


Field Layer

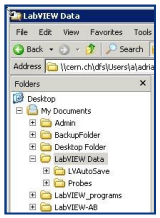
Measurement framework



Measurement framework



Defined GUI



Application templates

Configuration files

Documentation

Training

LabVIEW

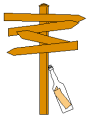
libs

Support

JAPC

SQL

SDDS



DIP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dcsc