

Welcome to the  
Engineering Department  
at CERN

Diego Perini, MME Deputy, 10th March 2016

Who are we ???



# Conseil Européen pour la Recherche Nucléaire World largest Particle Physics Laboratory (1954)

## Yearly Budget

~1100 MCHF (~ 1000 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

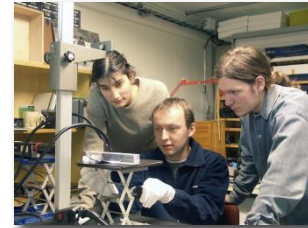
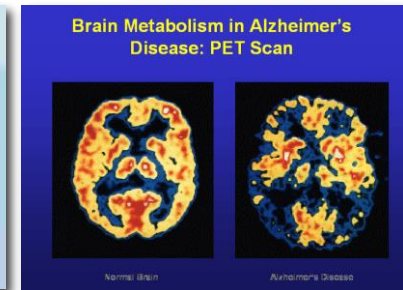
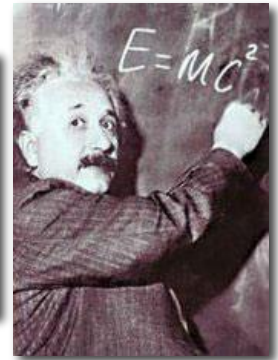
Romania and Serbia

## 1 Associate Country

Pakistan

# The Missions 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



# The instruments used

## 1. Particle accelerator :

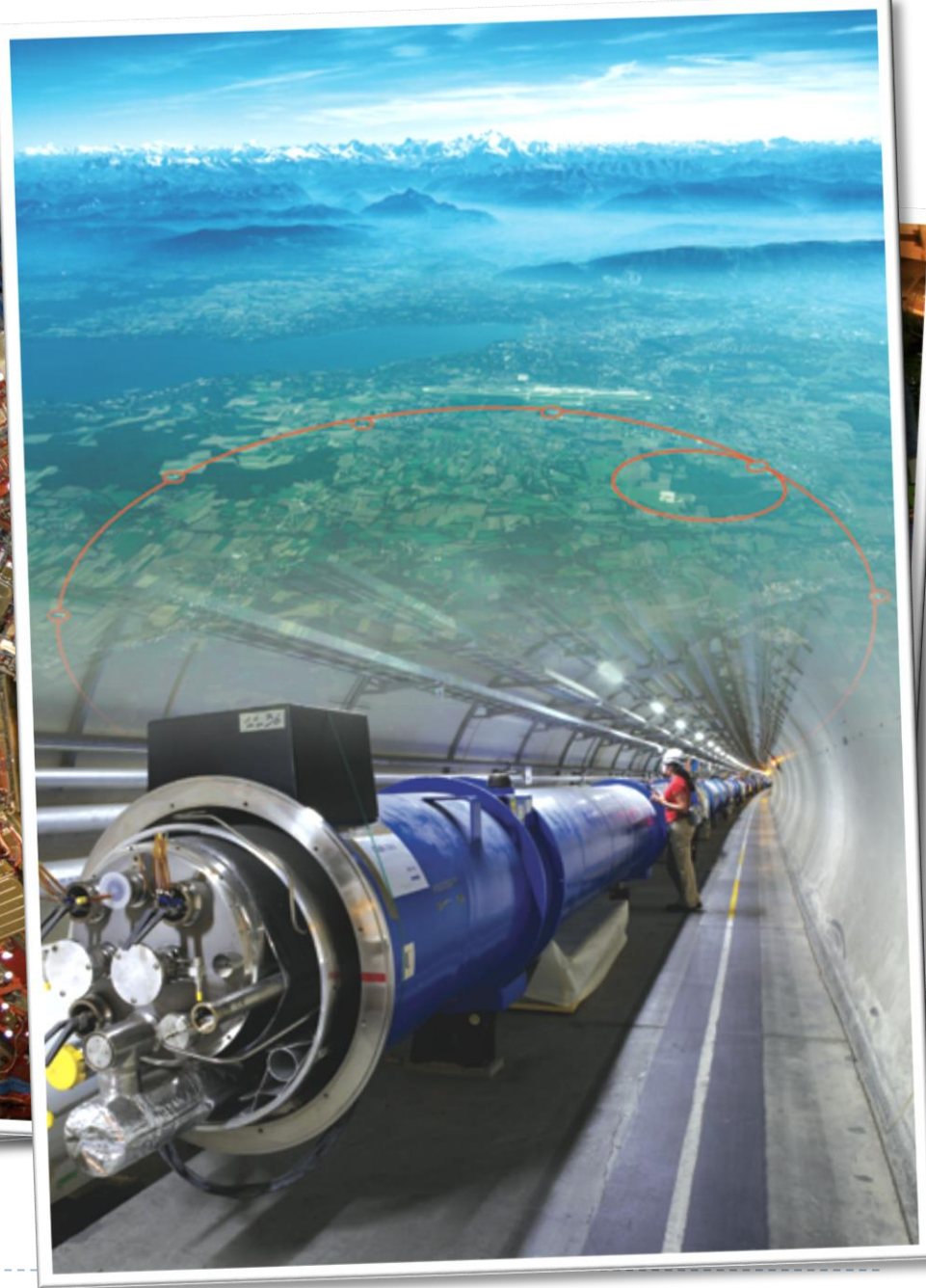
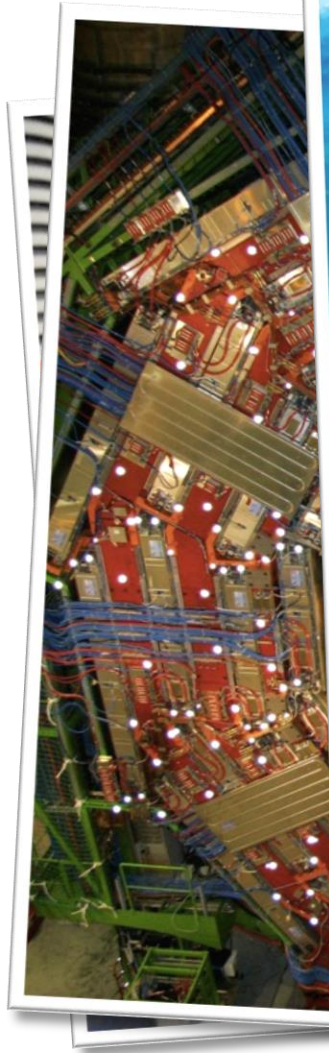
Boost particles to high energies and make them collide

## 2. Detectors :

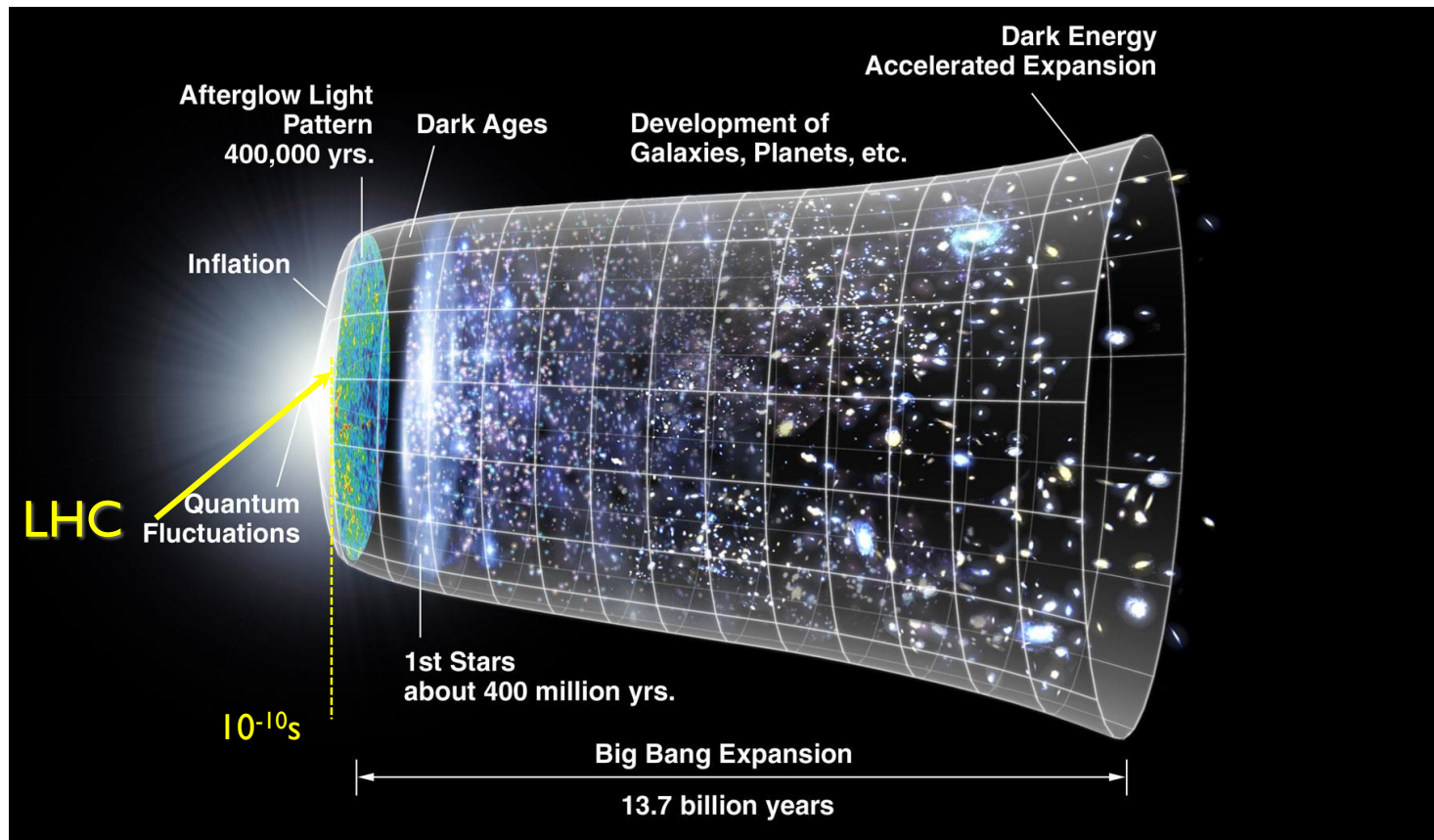
Gigantic instruments that observe and record the results of the collisions (particle trajectories, energy, charge...)

## 3. Computers :

Collect, store, and send around the world the big quantity of data received from the detectors for data analysis

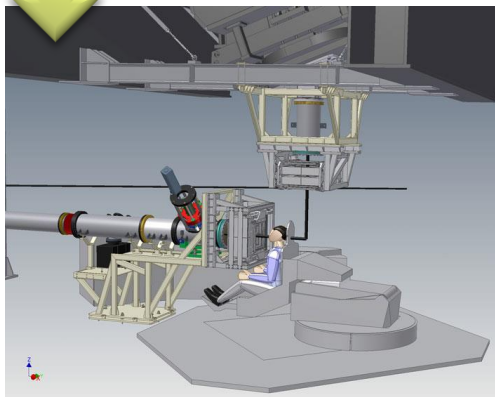
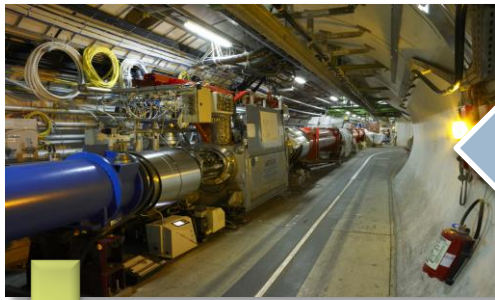


# The next scientific challenge is to understand the very first moments of our Universe after the Big Bang

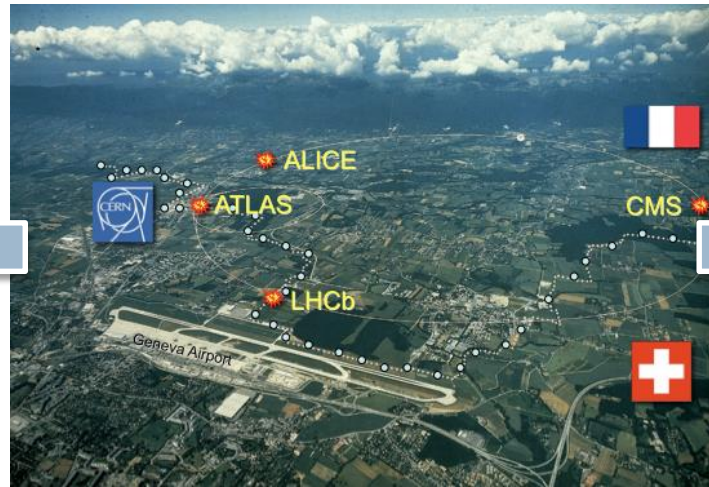


# The technologies developed at CERN generate innovation

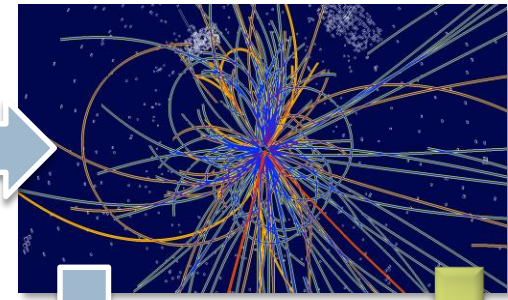
## Accelerators



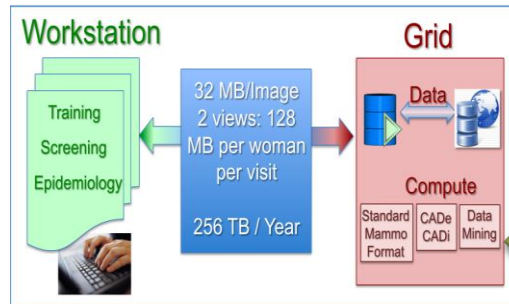
Hadron therapy



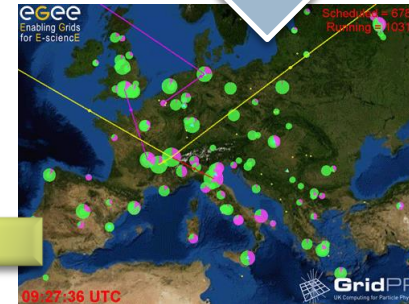
## Detectors



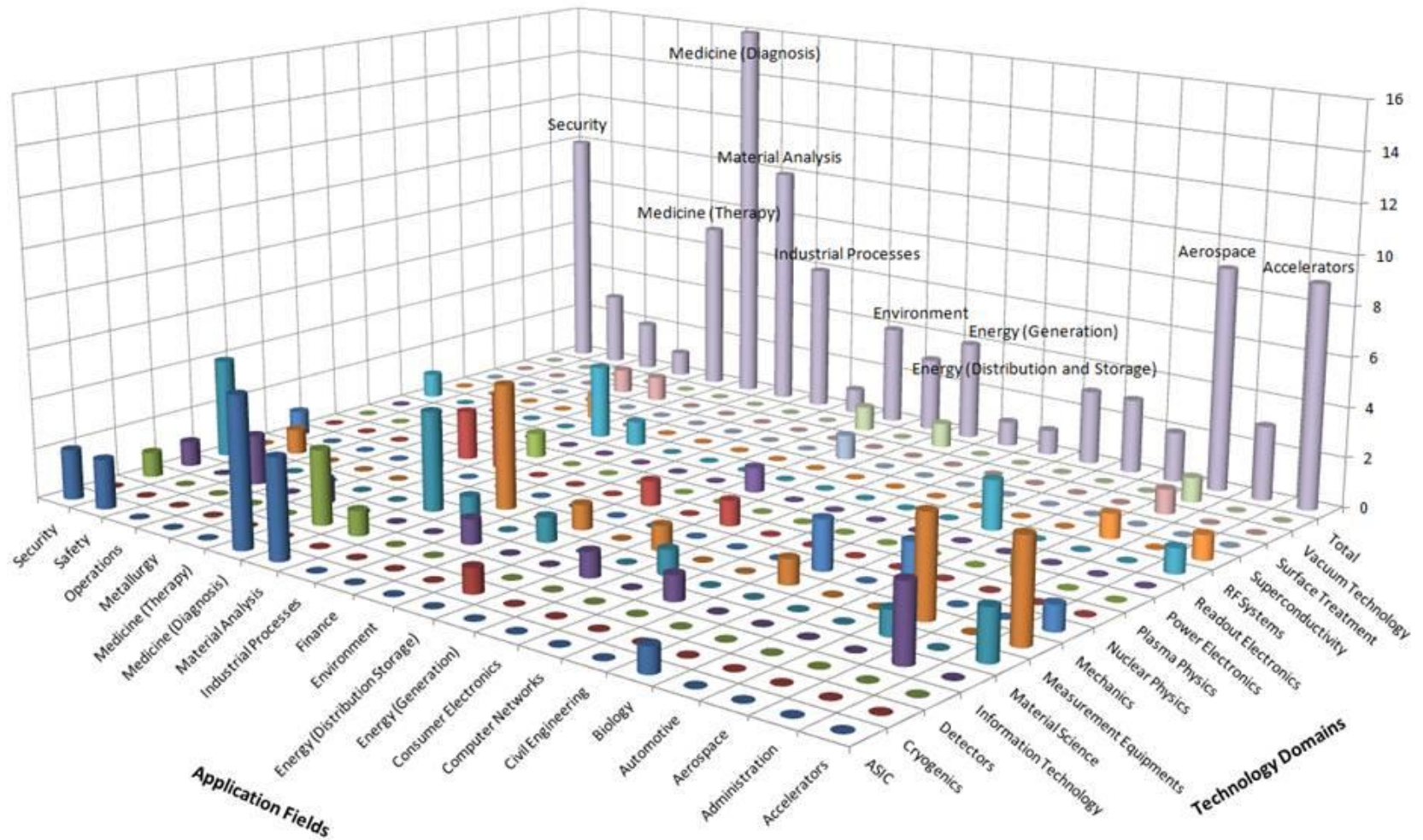
CAT



The Computing Grid



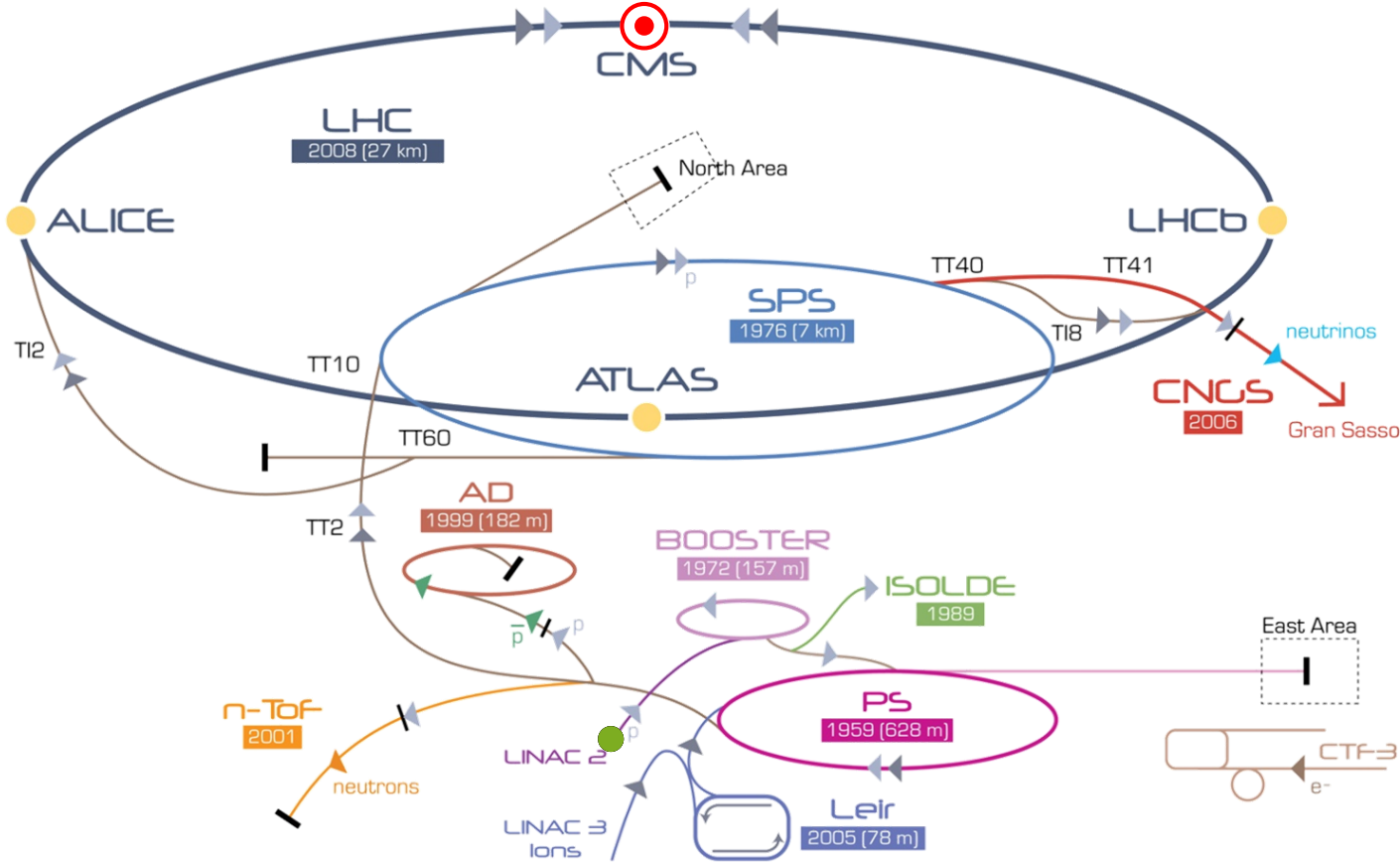
# The impact of the technologies developed at CERN





# The CERN Accelerator Complex

▶ LHC, A huge machine accelerating tiny particles...



▶ p (proton) ▶ ion ▶ neutrons ▶  $\bar{p}$  (antiproton)  $\leftrightarrow$  proton/antiproton conversion ▶ neutrinos ▶ electron

LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron  
 AD Antiproton Decelerator CTF-3 Clic Test Facility CNCS Cern Neutrinos to Gran Sasso ISOLDE Isotope Separator OnLine DEvice  
 LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight

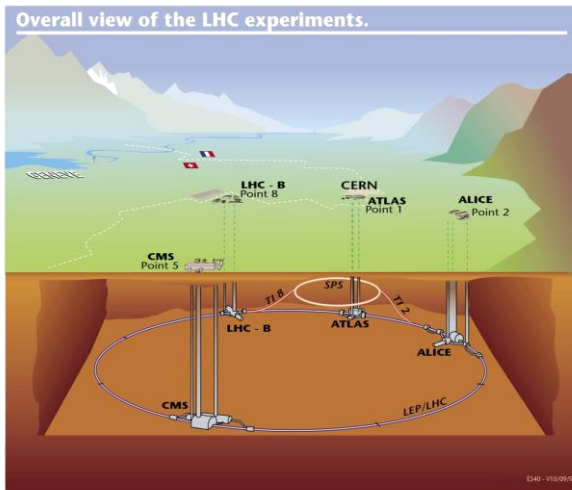
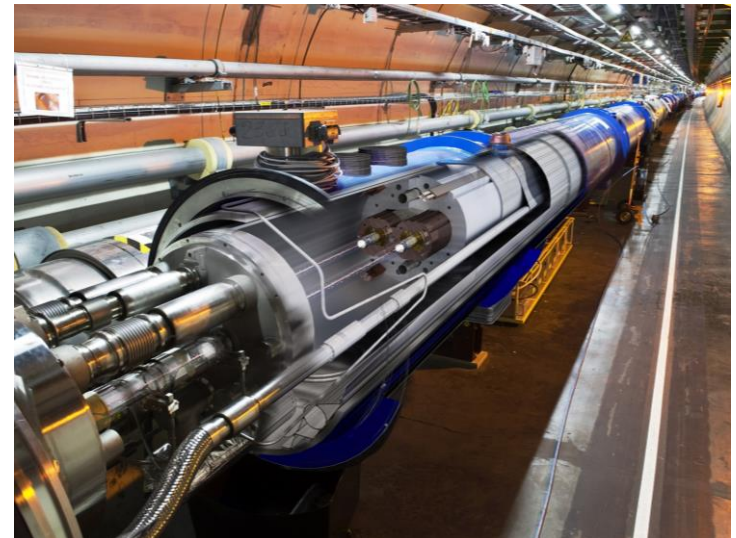


# The LHC

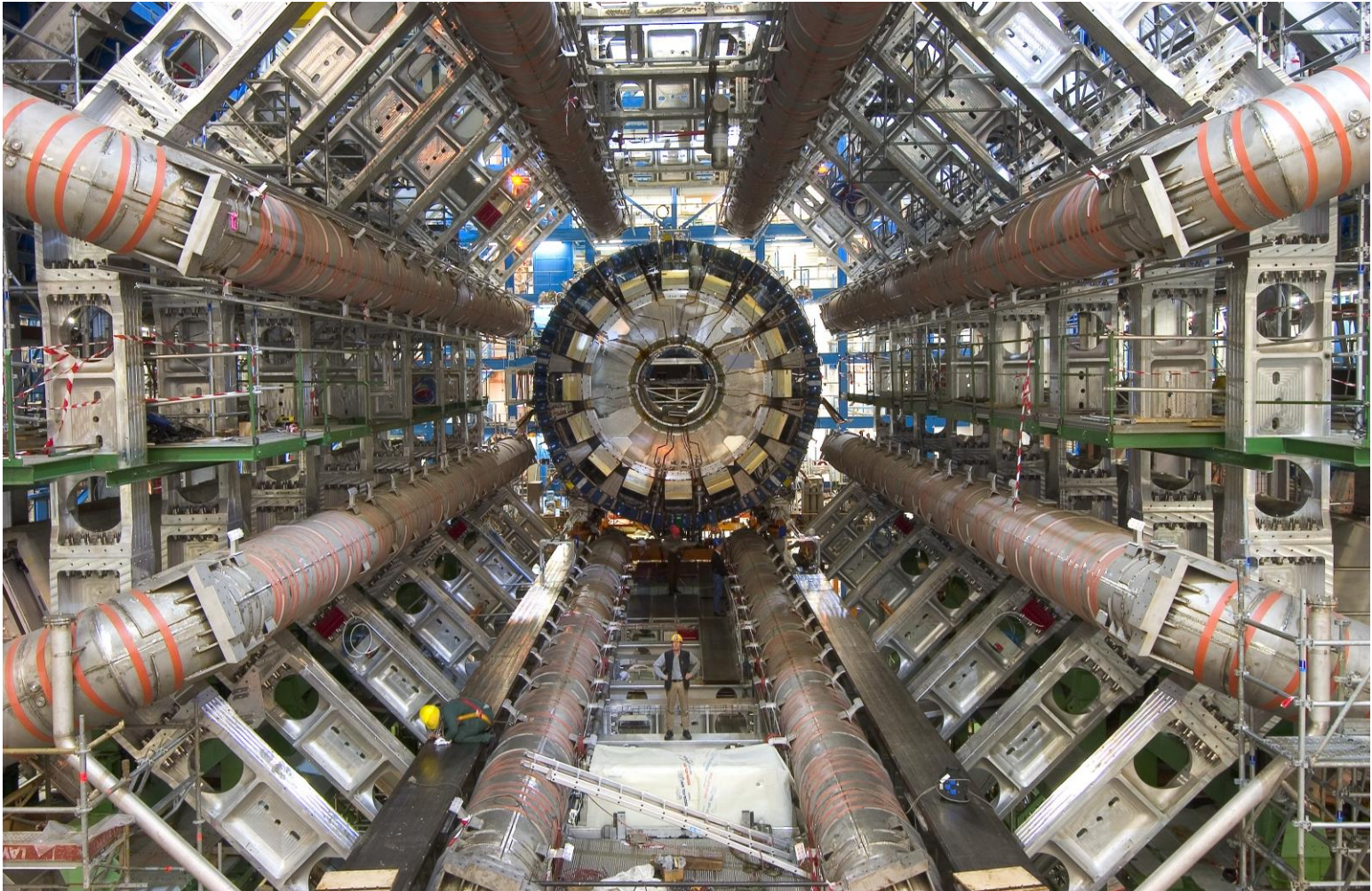
A collider situated in an underground 27 km in an almost circular tunnel designed to accelerate two proton beams to 7 TeV

+ than 25 years

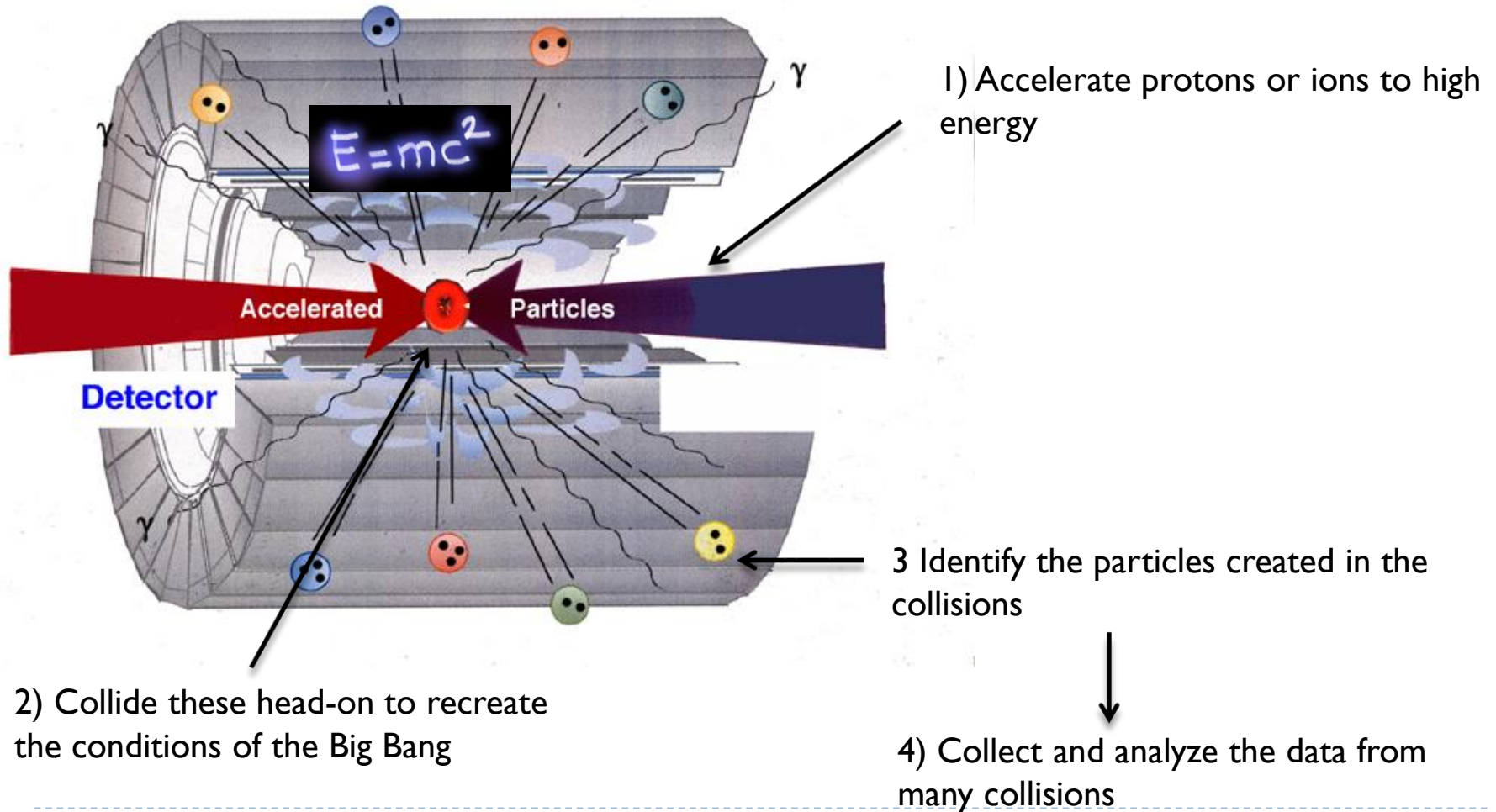
- 1982 : First studies
- 1994 : Project Approved by the CERN Council
- 1996 : Final Decision and start of the construction
- 2004 : Installation Starts
- 2006 : Hardware Commissioning Starts
- 2008 : End of Hardware Commissioning
- 2009-2030: Physics



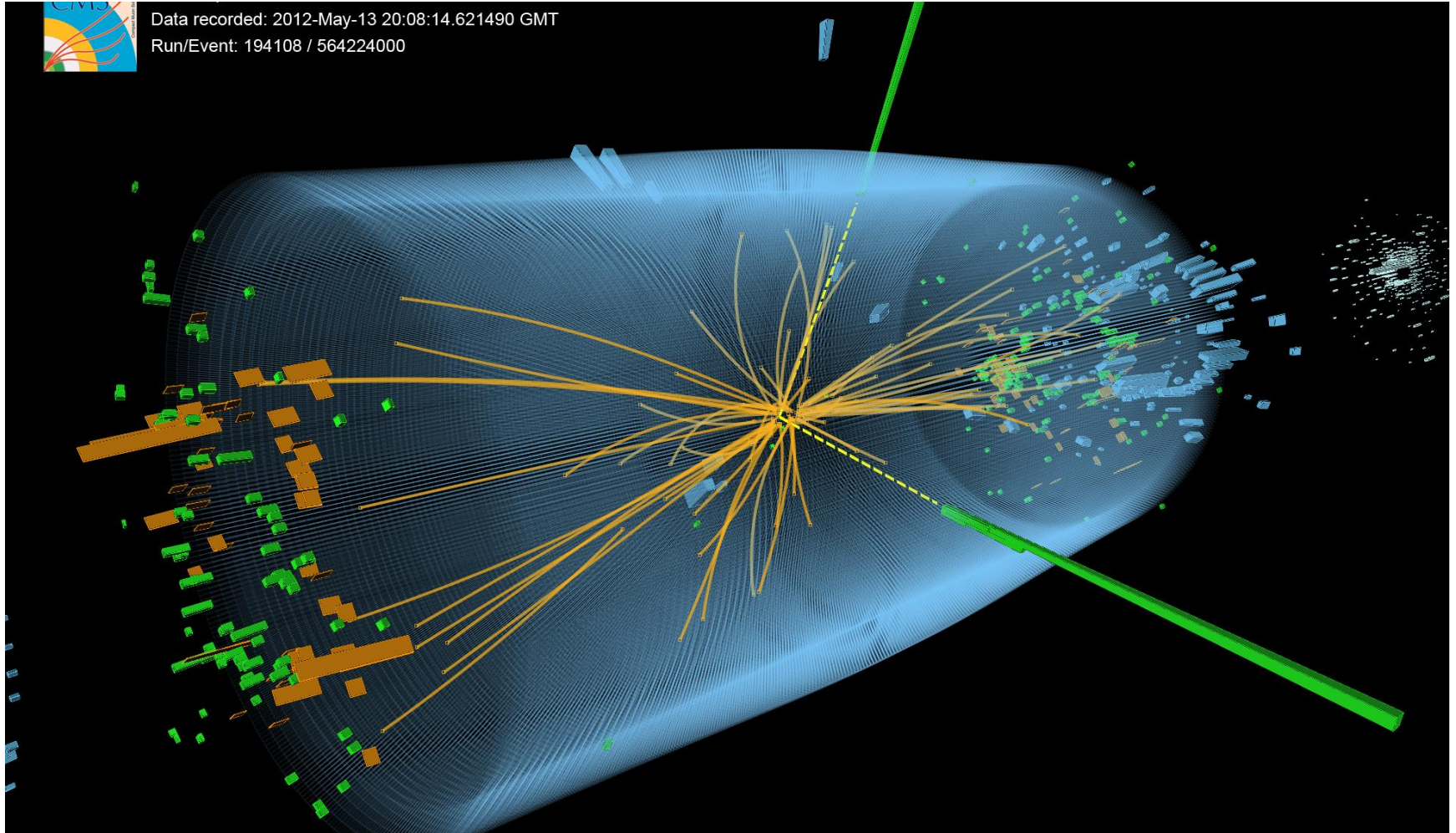
# A Big Experiment at the LHC : ATLAS



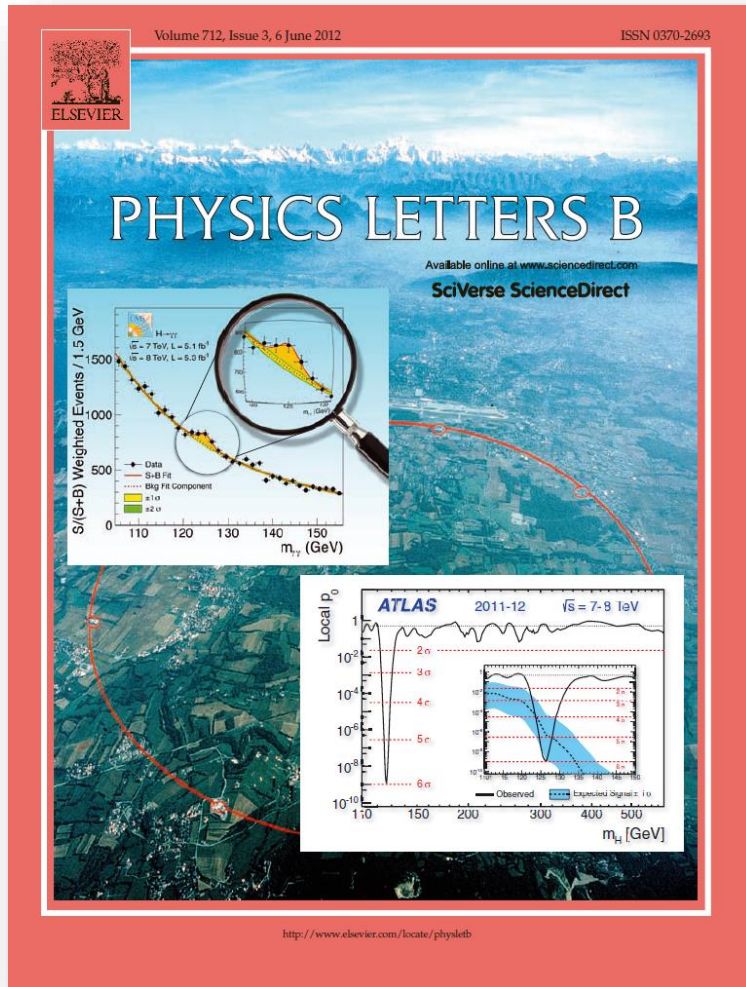
# How do we study the elementary particles?



H  $\rightarrow$   $\gamma\gamma$



# 2012 : The year of the Higgs Boson



# Occupational health and safety in EN

**At CERN Safety is our highest priority!**

To be allowed to work on CERN sites you must complete basic safety training.

You find it in the Safety Information Registration application, Type SIR in your browser's address window.

More advanced safety training is needed to perform certain tasks or to access certain areas.

The list is found in the HR webpage

The screenshot shows the SIR - Safety Information Registration application. It features a navigation menu on the left with options like 'Available courses and their current status' and 'Your safety contacts'. The main content area displays a list of courses with their descriptions and completion status (checked or unchecked). A sidebar on the right shows 'Your access authorizations' and 'Your access authorizations' with a list of names and roles.

The screenshot shows the CERN Human Resources Department website. The navigation menu includes 'General Information', 'Recruitment', 'Training', 'Staff Career', 'Services', and 'CERN Official Documents'. The 'Training' link is circled in red. The main content area features a section for 'General Information' with a photo of a man, a section for 'CERN Official Documents (internal)' with a list of documents, and a 'News' section with a headline about career changes at the CERN site.

# Occupational health and safety in EN

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## Your role in safety:

You are responsible for your own safety! If you take risks you are at fault. By taking up work at CERN you agree to work at minimum risk, and do everything to obtain the information that you need to do so.

## Your supervisors role in safety:

Your supervisor is responsible for the safety of your activities. Do not make his life difficult: Respect the rules; respect the signs!

Surely you would not ignore this sign?



So why ignore this one?  
This is also for your safety





# Occupational health and safety in EN

## Radiation safety

In the EN department there is a Radiation Safety Officer, or RSO. Each group has Radiation Support Safety Officers, or RSSO. Their job is to help their colleagues to prepare interventions in radiation areas.



## Access Control

The access to many areas at CERN, in particular underground, is controlled. In order to access these areas you need to complete the required safety training. Once you have done so, you must request access. When access has been granted by the access controller of the area, you may access.

Do not forget the obligatory Personal Protection Equipment!

# Occupational health and safety in EN

Should you witness, or be notified of, an accident or incident, you should immediately notify your Department Safety Officer (DSO) of your department. Find out who they are, so you can contact them immediately.

The screenshot shows the CERN EDH website interface. At the top, there is a navigation bar with links for Home, Tasks, Search, and News. Below this, there is a 'News' section with a headline: 'In light of the upcoming 2016 CERN reorganization... The EDH team are currently contacting departmental Safety Officers...'. A 'Tasks' section is visible at the bottom, with a red arrow pointing to the 'AOC Overview' link.

The screenshot displays the 'Internal Accident Report' form. The form is titled 'Internal Accident Report' and includes a toolbar with icons for Refresh, Clone, Attach, Print View, Save, Send, and Help. It also has checkboxes for 'Confidential' and 'Urgent'. The form is created by John PEDERSEN (EN-HDO) on 16.11.2015. The applicable administrative procedure is 'Accidents'. The form is divided into several sections: 'What' (Type of Safety Issue, Short description, Detailed Description, Immediate action taken), 'When' (Date, Time), 'Where' (On CERN site, Details about the location, Worksite), 'Who' (Context table), and 'Any other Information'.

Context	Name	Details
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# 2016 Injector Accelerator Schedule

Approved by the Research Board - September 2015

	Jan			Feb			Mar							
	Controls maintenance			Start ion source and Linac2			Beam to PSB			Beam to PS		Beam to SPS		Beam to LHC
Wk	1	2	3	4	5	6	7	8	9	10	11	12	13	
Mo	1	2	3	4	5	6	7	8	9	10	11	12	13	
Tu	4	5	6	7	8	9	10	11	12	13	14	15	16	
We	5	6	7	8	9	10	11	12	13	14	15	16	17	
Th	6	7	8	9	10	11	12	13	14	15	16	17	18	
Fr	7	8	9	10	11	12	13	14	15	16	17	18	19	
Sa	8	9	10	11	12	13	14	15	16	17	18	19	20	
Su	9	10	11	12	13	14	15	16	17	18	19	20	21	

	Apr			May			June								
	Beam to AD Start NA setup ISOLDE, nTOF, EA setup			Start NA proton physics			Start AD physics			Start physics East Area			Start LEIR		
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26		
Mo	14	15	16	17	18	19	20	21	22	23	24	25	26		
Tu	15	16	17	18	19	20	21	22	23	24	25	26	27		
We	16	17	18	19	20	21	22	23	24	25	26	27	28		
Th	17	18	19	20	21	22	23	24	25	26	27	28	29		
Fr	18	19	20	21	22	23	24	25	26	27	28	29	30		
Sa	19	20	21	22	23	24	25	26	27	28	29	30	31		
Su	20	21	22	23	24	25	26	27	28	29	30	31	1		

	July			Aug						Sep			
	Start AWAKE commissioning			Ions to PS						Ions to SPS			
Wk	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	27	28	29	30	31	32	33	34	35	36	37	38	39
Tu	28	29	30	31	32	33	34	35	36	37	38	39	40
We	29	30	31	32	33	34	35	36	37	38	39	40	41
Th	30	31	32	33	34	35	36	37	38	39	40	41	42
Fr	31	32	33	34	35	36	37	38	39	40	41	42	43
Sa	32	33	34	35	36	37	38	39	40	41	42	43	44
Su	33	34	35	36	37	38	39	40	41	42	43	44	45

	Oct			Nov						Dec			
	Start AWAKE physics			End proton physics						End of run (06:00)			
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	40	41	42	43	44	45	46	47	48	49	50	51	52
Tu	41	42	43	44	45	46	47	48	49	50	51	52	53
We	42	43	44	45	46	47	48	49	50	51	52	53	54
Th	43	44	45	46	47	48	49	50	51	52	53	54	55
Fr	44	45	46	47	48	49	50	51	52	53	54	55	56
Sa	45	46	47	48	49	50	51	52	53	54	55	56	57
Su	46	47	48	49	50	51	52	53	54	55	56	57	58

# LHC Schedule 2016

Approved by the Research Board, December 2015

	Jan			Feb				Mar					
Wk	1	2	3	4	5	6	7	8	9	10	11	12	13
Mo	4	11	18	25	1	8	15	22	29	7	14	21	28
Tu													
We										Powering tests		Recommissioning with beam	
Th				Year end technical stop									
Fr											Machine check-out	G. Friday	
Sa													
Su													

	Apr			May				June					
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	4	11	18	25	1	8	15	22	29	6	13	20	27
Tu							White	16	23				
We										TS1			
Th					Ascension							Special physics run	
Fr					May Day cong				MD 1				
Sa													
Su			1st May										

	July			Aug				Sep					
Wk	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	4	11	18	25	1	8	15	22	29	6	13	20	27
Tu													
We				MD 2					TS2	MD 3			
Th							MD			Jeune G.		Special physics run	
Fr													
Sa													
Su													

	Oct			Nov			Dec						
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	3	10	17	24	31	7	14	21	28	5	12	19	26
Tu													
We						TS3	Ions setup				Extended year end technical stop		
Th									Ion run (p-Pb)			Lab closed	
Fr				MD 4									
Sa													
Su											Xmas	New Year	

Technical Stop

Machine development

Recommissioning with beam

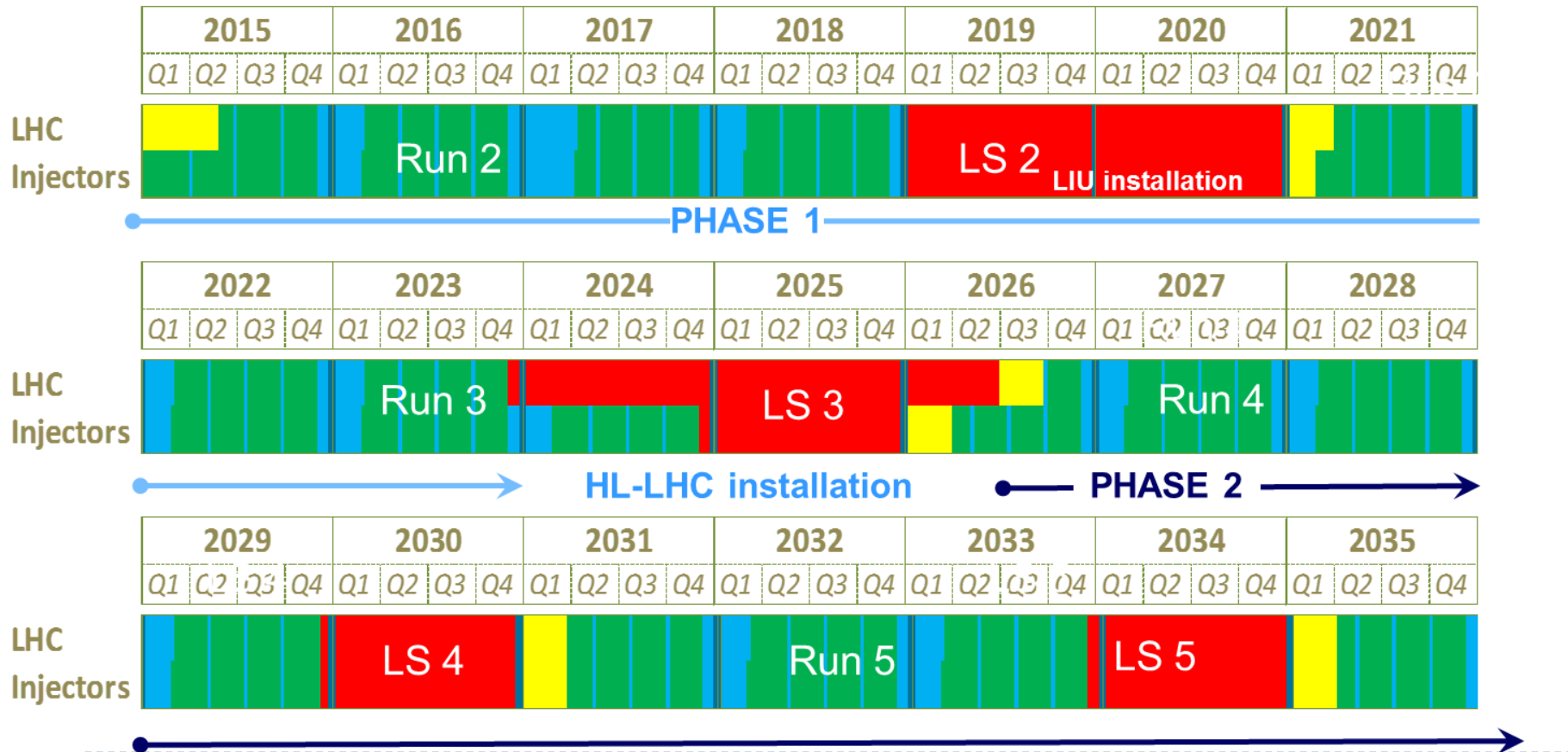
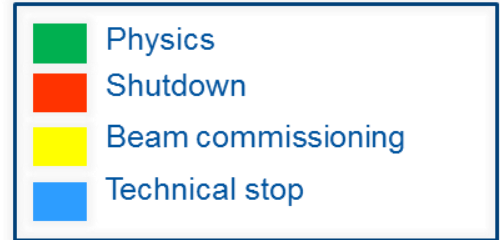
Special physics runs - schedule to be established

Scrubbing (indicative - dates to be established)

# A longer term perspective

## LHC roadmap: according to MTP 2016-2020 V1

LS2 starting in 2019 => 24 months + 3 months BC  
 LS3 LHC: starting in 2024 => 30 months + 3 months BC  
 Injectors: in 2025 => 13 months + 3 months BC



## Directorate in 2016

Director-General

Fabiola Gianotti

Director of International Relations

Charlotte Lindberg Warakaulle

Director for Research and Computing

Eckhard Elsen

Director for Accelerators and  
Technology

Frédéric Bordry

Director for Finance and Human  
Resources

Martin Steinacher

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Frédéric Bordry

Director for Finance and Human  
Resources

Martin Steinacher

## Heads of departments in 2016

Experimental Physics

Manfred Krammer

Theoretical Physics

Gian Giudice

Information Technology

Frederic Hemmer

## Directorate in 2016

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Charlotte Lindberg Warakaulle

Director for Research and Computing

Eckhard Elsen

Director for Accelerators and  
Technology

Frédéric Bordry

Director for Finance and Human  
Resources

Martin Steinacher

## Heads of departments in 2016

Beams – BE

Paul Collier

Technology – TE

José Miguel Jimenez

Engineering – EN

Roberto Losito



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Director of International Relations

Charlotte Lindberg Warakaulle

Director for Research and Computing

Eckhard Elsen

Director for Accelerators and  
Technology

Frédéric Bordry

Director for Finance and Human  
Resources

Martin Steinacher

## Heads of departments in 2016

Human Resources

Anne-Sylvie Catherin

Finance and Administrative Process

Florian Sonnemann

Industry, Procurement and Knowledge  
Transfer

Thierry Lagrange

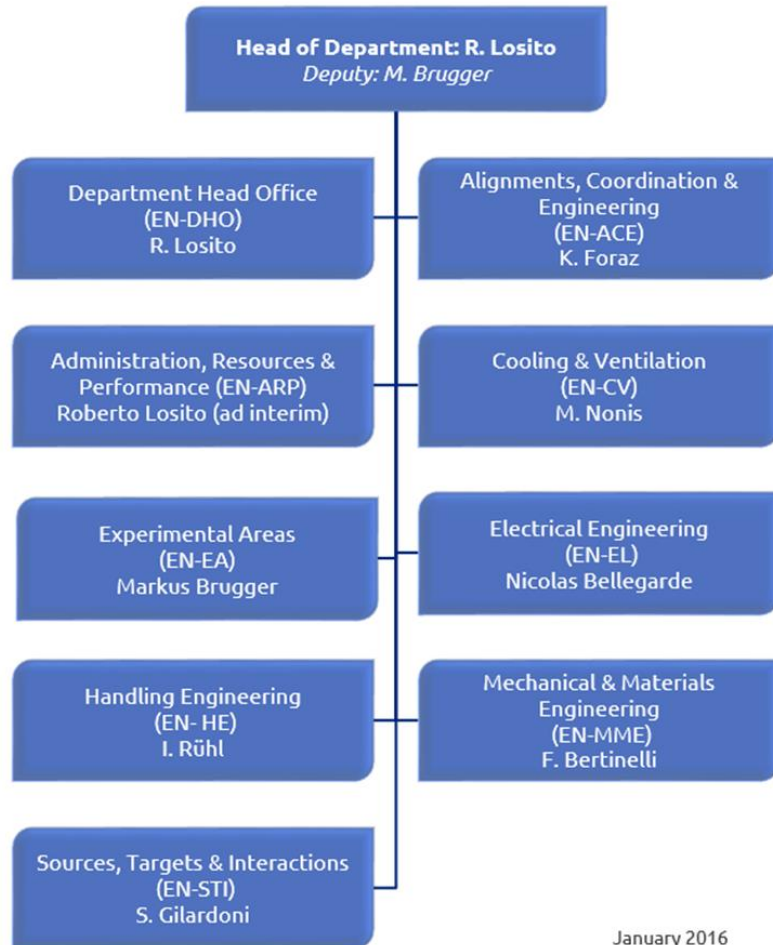
Site Management and Buildings

Lluís Miralles



Head of Department:  
Roberto Losito

- Operation
  - Infrastructure
  - Accelerators
  - Experimental Areas
- Projects
  - Consolidation
  - Upgrades
  - New facilities
  - Design & Manufacturing
- Studies



## Who are we, in EN?

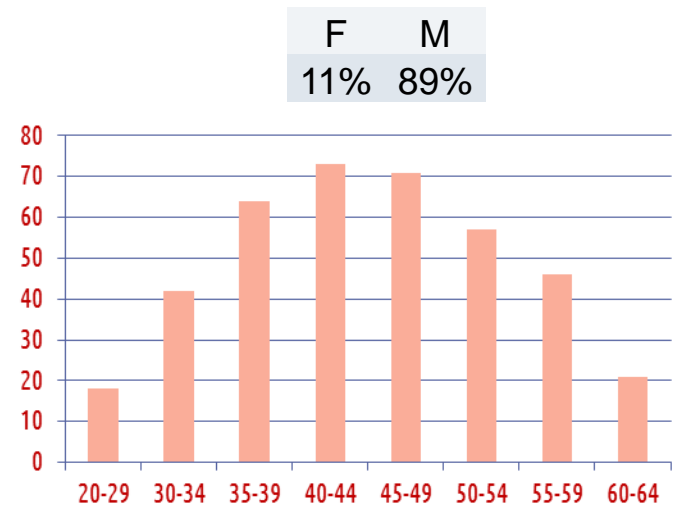
AT	BE	CH	D	DK	ES	FI	FR	GB	GR	IT	NL	NO	PL	PT	SE
4	22	11	17	2	17	3	225	22	3	41	8	2	5	9	3

Scientific & Engineering Work	150
Technical Work	200
Manual Work, Crafts & Trades	28
Administrative Work	16

38%

58%

4%



Staff	394
Fellows	79
Doctoral Students	20
Technical Students	30
Trainees	19
Associates	117
<b>Total</b>	<b>659</b>

+ many colleagues in industrial support contracts

+46 with respect to 2014

# CV: The Cooling and Ventilation Group

The mandate The operation and maintenance of the **cooling systems, pumping stations, air conditioning installations and fluid distribution systems** for the PS, SPS and LHC including their experimental areas and **special cooling systems of LHC sub-detectors**. It also provides service to the Computer Centre and some miscellaneous installations.



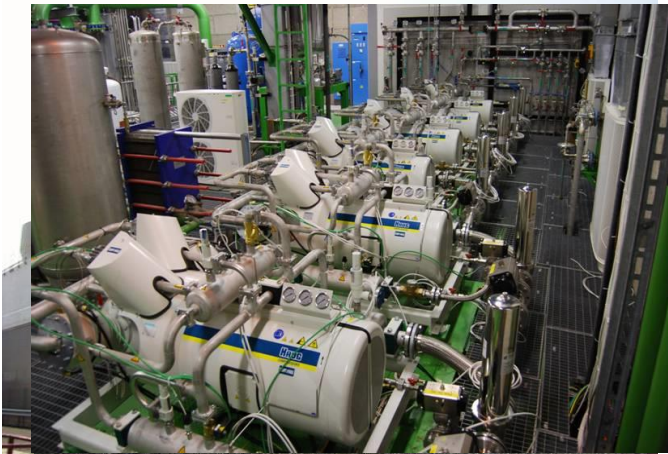
Group Leader  
Mauro Nonis



Cooling station

# Cooling

Cooling plants (raw, demineralised water, C <sub>3</sub> F <sub>8</sub> , C <sub>6</sub> F <sub>14</sub> )	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 <sup>3</sup> /h



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

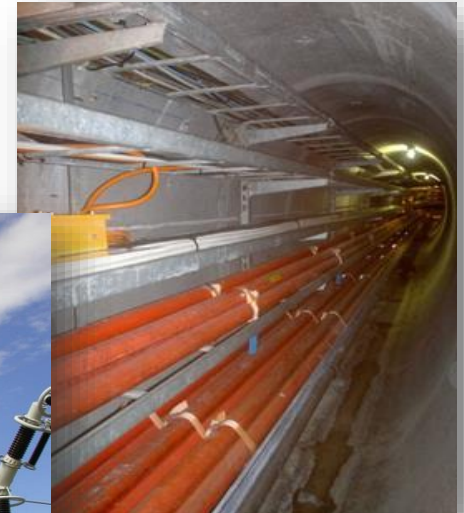
# Ventilation

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

	km	m <sup>3</sup> /h
<i>Eurotunnel</i>	50	540'000
LHC	27	290'000

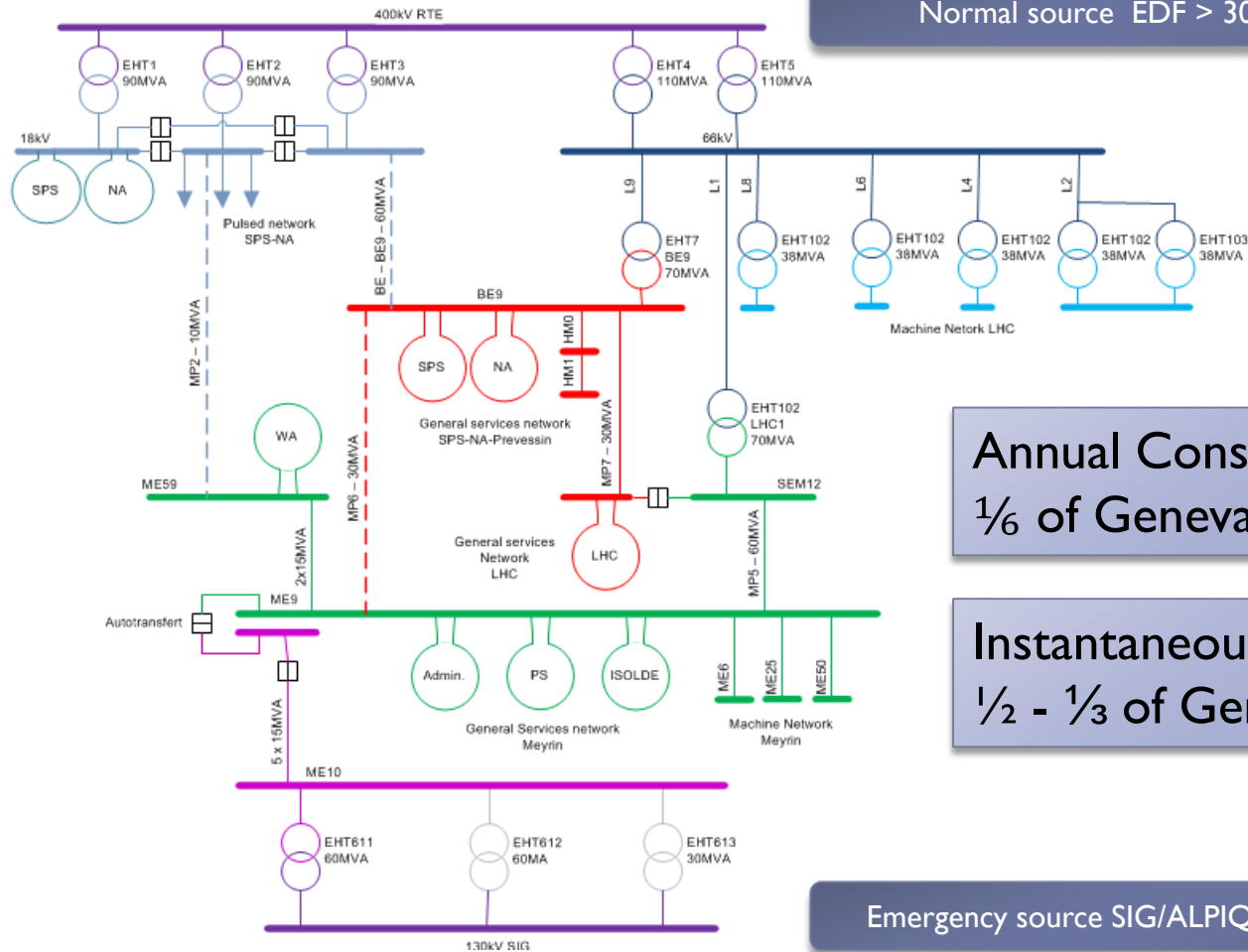


The EL group is responsible for the **CERN electrical distribution network** from 400 kV to 400/230 V. Its main missions are to operate, maintain, extend and renovate the network, analyse and make projections for CERN electrical energy consumption and manage relations with the energy suppliers.



Group Leader  
Nicolas Bellegarde

# Electricity Distribution



Normal source EDF > 300 MW

Annual Consumption 1.26 TWh  
1/6 of Geneva

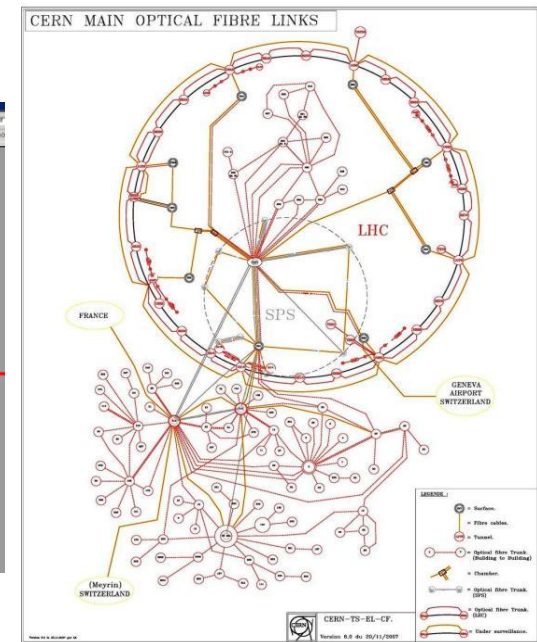
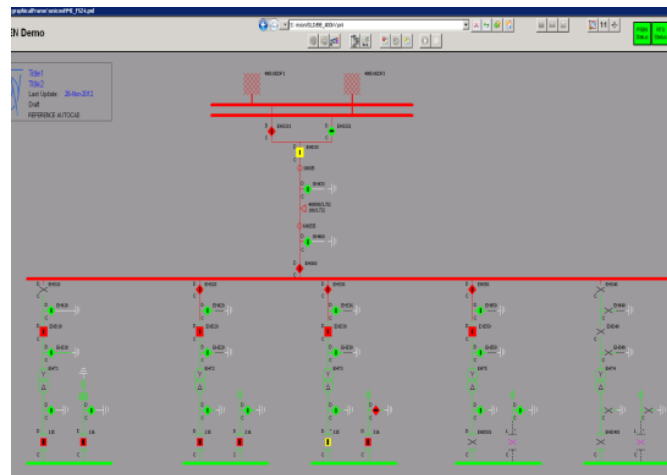
Instantaneous Power 180 MW  
1/2 - 1/3 of Geneva

Emergency source SIG/ALPIQ ≤ 60 MW



The EL group is also responsible for the **cabling activities**. Its main missions are to install control cables, Water cooled cables and fibre optics for users. This activities include the management of infrastructures (cable trays, ducts, patch panels,...) and the necessary removal of old and unused installations.

EL is also in charge of the control of it's distribution network including a SCADA system and automation of process.



# ARP : Administration, Resources and Performance group

The ARP group is in charge of the **management of department resources** in terms of personnel, material, industrial support, as well as **group secretariats**.



**Group Leader**  
**Roberto Losito (ad-interim)**

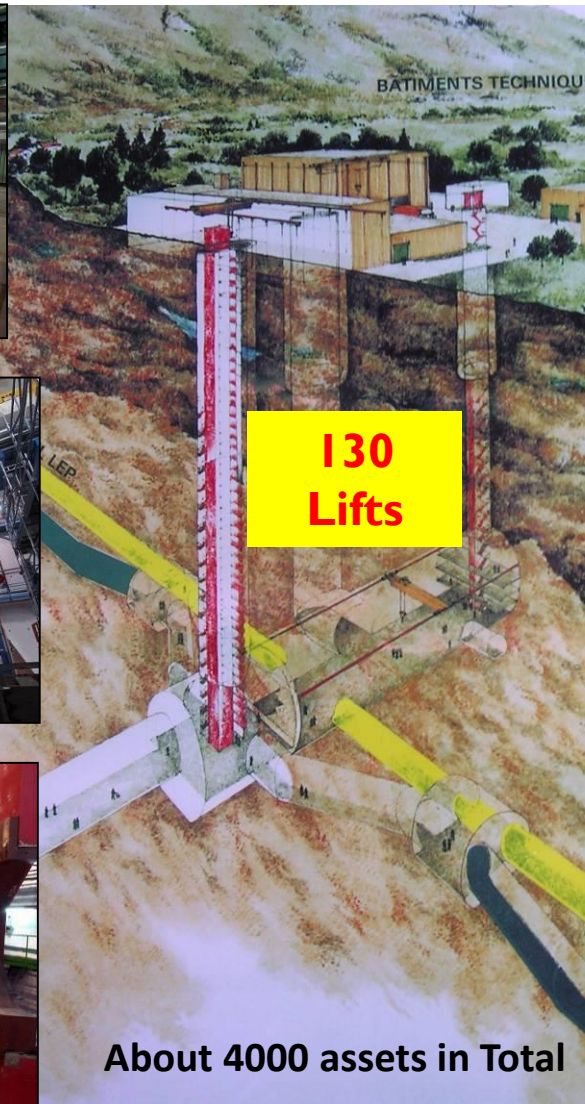
# HE : The Transport and Handling Group

The mandate : provide **transport and handling services** for the technical infrastructure of CERN, accelerators and experiments. This includes the design, the tendering/procurement, the installation, the commissioning, the operation, the maintenance and decommissioning of **standard industrial and custom built transport and handling equipment**.



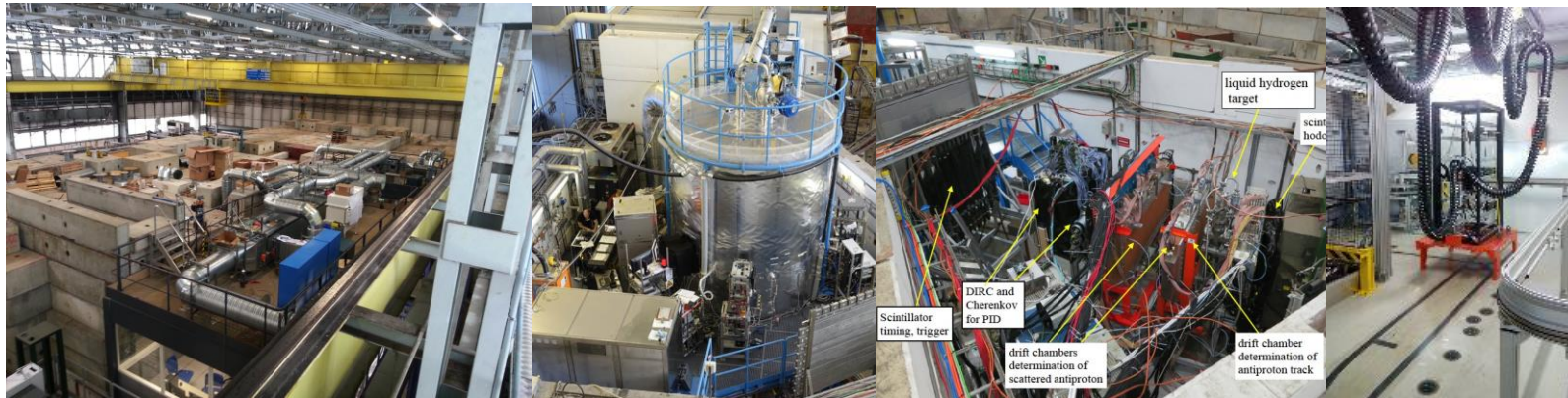
Group Leader  
Ingo Ruehl





# EA : Experimental Areas Group

The EA Group in the Engineering Department is responsible for the beamlines, infrastructure and management of CERN's experimental areas and provides engineering support and services including associated contracts. EA is furthermore supporting the LHC experiments and managing the respective ATS interface, as well as participating in and partly hosting the management of a number of CERN-wide projects (AWAKE, R2E, etc.).



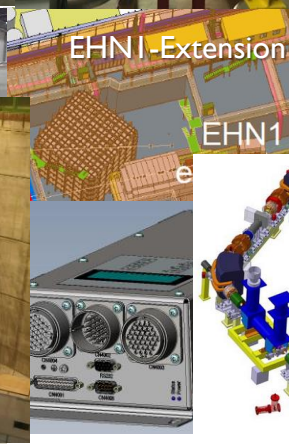
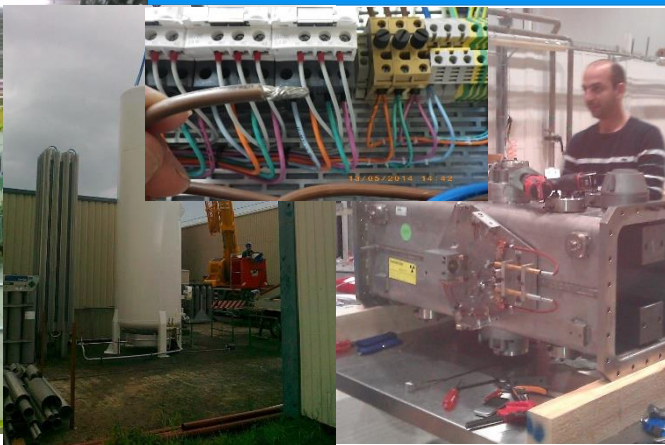
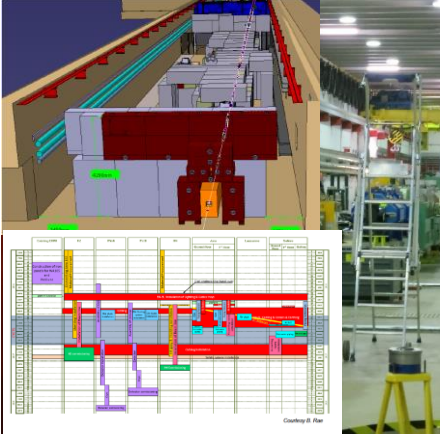
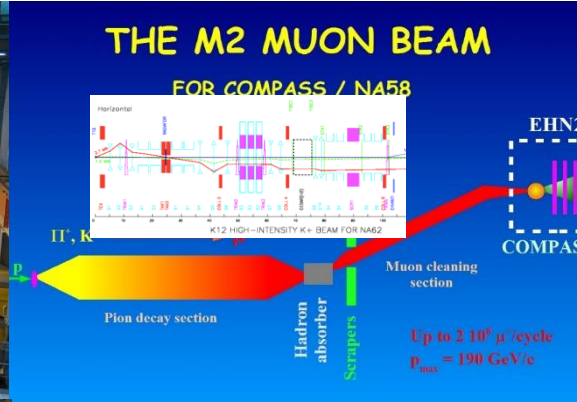
Group Leader  
Markus Brugger

**EXPERIMENTAL AREAS**

**BEAMLINES**

**FACILITIES**

**PROJECTS**



**SUPPORT ACTIVITIES**

**MECHANICS, VACUUM, CABLING, SCAFFOLDING, INTEGRATION, GAS, INSTRUMENTATION, DESIGN, PROTOTYPING, SHIELDING, PLANNING, COORDINATION, SAFETY**

# EN Engineering Department ACE : Alignment, Coordination and Engineering Group

The ACE group is responsible for

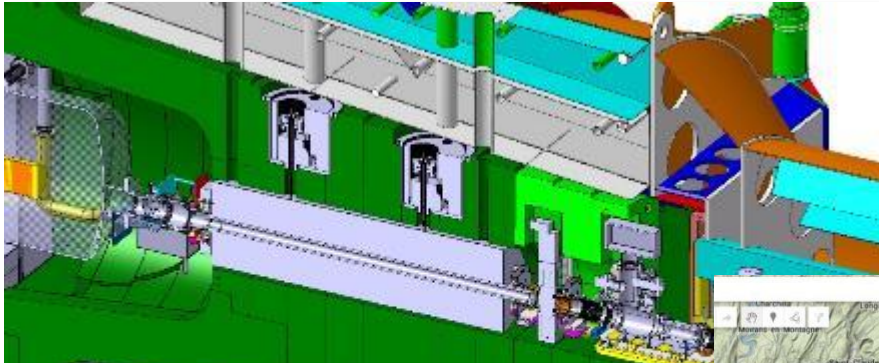
- Providing **overarching project coordination** for the accelerator complex, including layout management, integration, scheduling, work and safety coordination, as well as for different projects.
- Providing **support and expertise in matter of project, risks and quality** management as well as organizational process.
- Developing and supporting the Organization's **engineering, equipment data, maintenance management tools and mechanical CAD systems**.
- The **metrology and alignment** of the accelerators, of their associated beam transfer lines and of the detectors, for the whole CERN site.



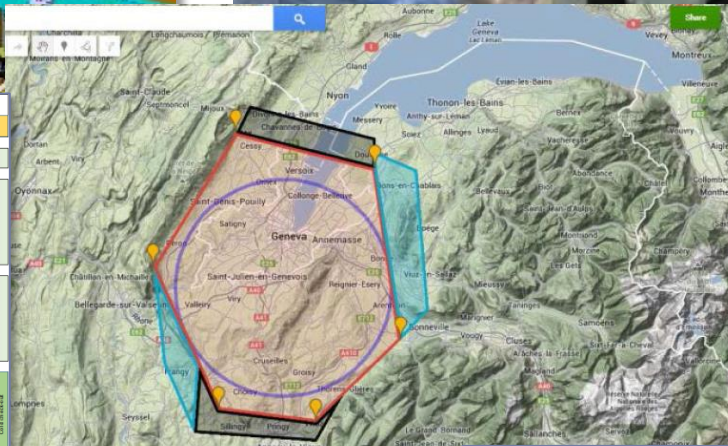
Group Leader  
Katy Foraz



# EN Engineering Department ACE : Alignment, Coordination and Engineering Group



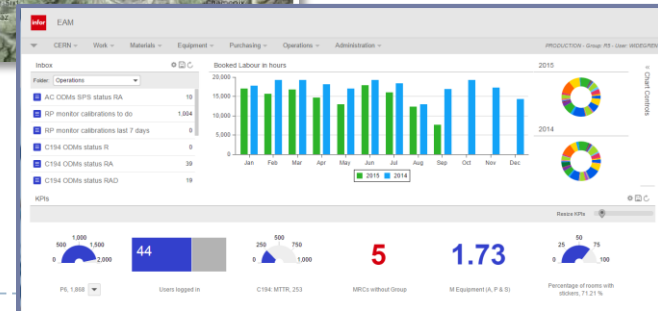
	2016	2017	2018	2019	2020
<b>YETS</b>	YETS	eYETS	YETS	LS2	
<b>L4</b>	100MeV, 160MeV, Beam dump, Beam dump & Extraction, HIT, HULDER, Re-assembly, Interconnectors, Beam dump, Connection, Beam dump, Shutdown, Beam dump				
<b>PSB</b>	Cable id., BR, BCTDC electronics, ring trajectory, BLM, tune pick-up, kickers	Cable removal	Cable rem.	Wire scanner @11, RF bypasses and BHZ jacks @12, Treatment cavity @13, Extraction kickers @14, PSB injection & extraction upgrade (under study: beam stoppers, vacuum window for PSB dump), Consolidation of PSB ventilation TBC	Hardware tests, Cold check-out
<b>PS</b>	Vacuum, fast BLM, Water cooling/10MHz cavity, wideband pick-up	Cable id., Vacuum, BLMs, skew quad, vertical connectors, BIG	Cable removal	T2 power converters, beam dumps, BWS, under study: position injection septum, bumper, injection kicker, 10MHz syst. of insertion quad., Consolidation of magnets- TBC	Hardware tests, Cold check-out
<b>SPS</b>	BAS Cable, Vacuum, kicker, MICE, Beam dump	BAS Cable removal	BAS Cable removal	BAS REMOVAL, SSI reconfiguration, new beam dump, BG, extraction retention, wire scanner, 200MHz RF power, ac coating, MOPOS electronics, ZS, Crab-cavities, high bandwidth pick-up	Hardware tests, Cold check-out
<b>LHC</b>		MJ proto		HL LHC: i25 @19, RF: cryo-by-pass & TLD, TCSPM, TAIN@PS, D1 & D2 mask, Cryogenic @ P4, ac-coating, BGV, FWS, high bandwidth pick-up, DIS, civil engineering	Hardware tests, Cold check-out



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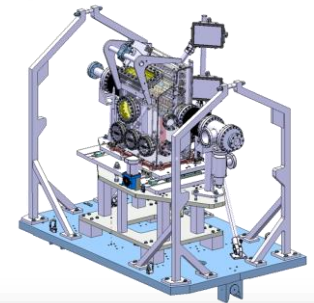
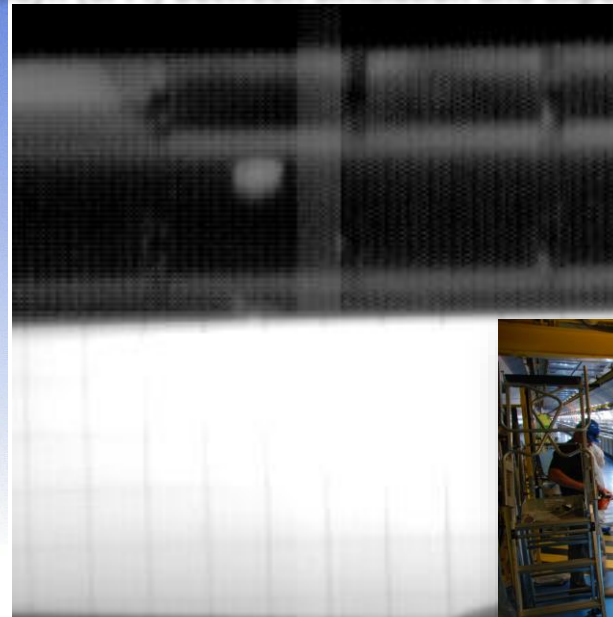
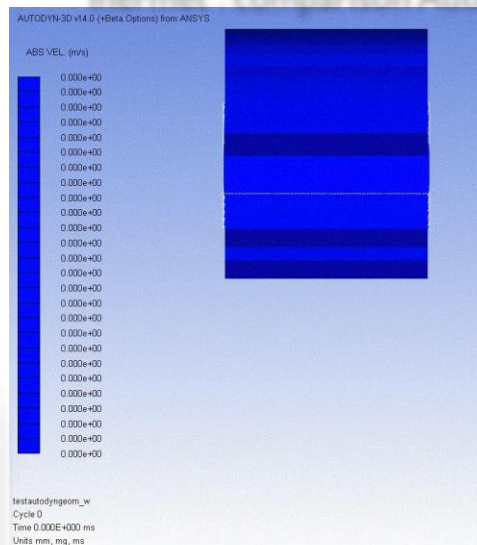




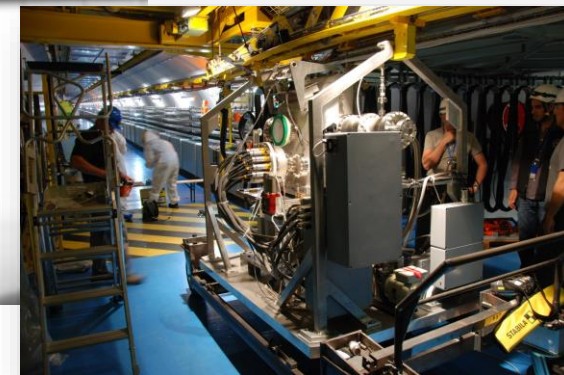
# EN Engineering Department MME : The Mechanical and Materials Engineering Group

The mandate : provide to the CERN community specific **engineering solutions combining mechanical design, production facilities and material sciences**. This group owns, maintains and develops the know-how on the mechanical constructions in the accelerators and the physics detectors.

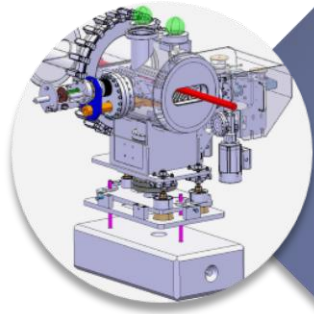
Inernet : comparison Autodyn (SPH) between simulation and experiment



**Group Leader**  
**Francesco Bertinelli**



### domains of activities



#### Engineering & Design

- Internal Design Office facilities, 40 designers (Staff and Industrial Support)
- CATIA / SmarTeam, ANSYS
- Mechanical measurements lab



#### Fabrication

- Machining & Maintenance
- Preparation & Subcontracting
- Assembly & Forming

- 4000 m<sup>2</sup> of internal workshop facilities, 50 technicians (Staff and Industrial Support): CNC machining, sheet metal work & welding, electron beam & laser, vacuum brazing
- External subcontracting service
- Free access Users workshop



#### Materials & Metrology

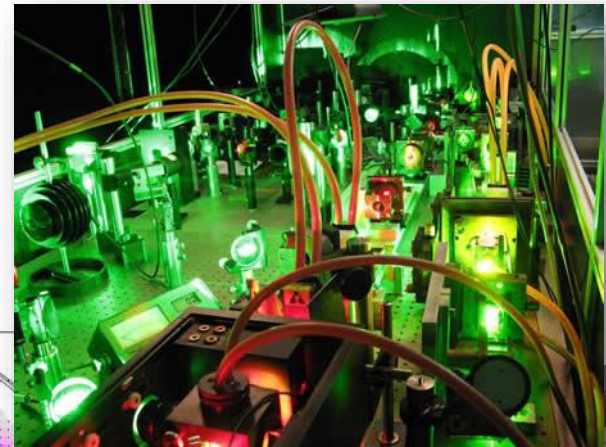
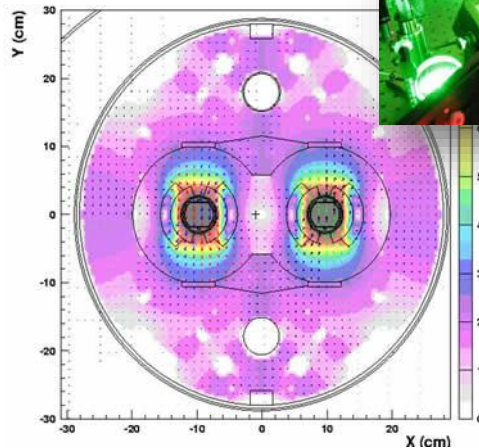
- Material selection, analysis & metallurgy: microscopy, mechanical testing
- NDT: US, radiography, tomography
- 350 m<sup>2</sup> of internal metrology facilities: CMM

# STI : The Sources, Targets and Interactions Group

The Sources, Targets and Interactions Group has as common ground the study of **beam interactions with matter**, aiming to apply its know-how to particle generation (ISOLDE Radioactive beam sources, CLIC photoinjectors and polarized  $e^+ e^-$  sources), and to particle interception (collimators, absorbers and dumps).



Group Leader  
Simone Gilardoni



# Welcome !

Presentation prepared by:

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S. Gilardoni.