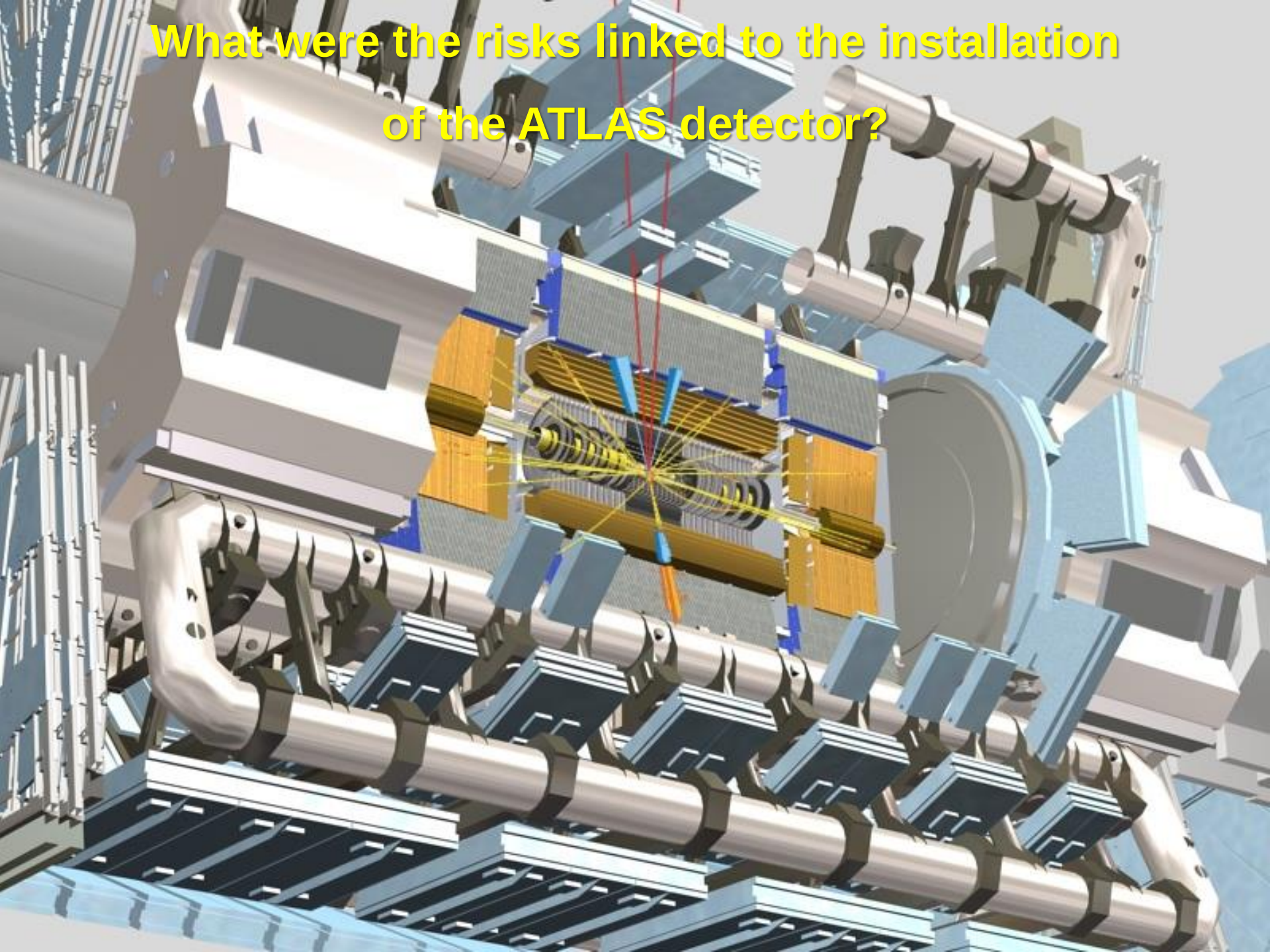
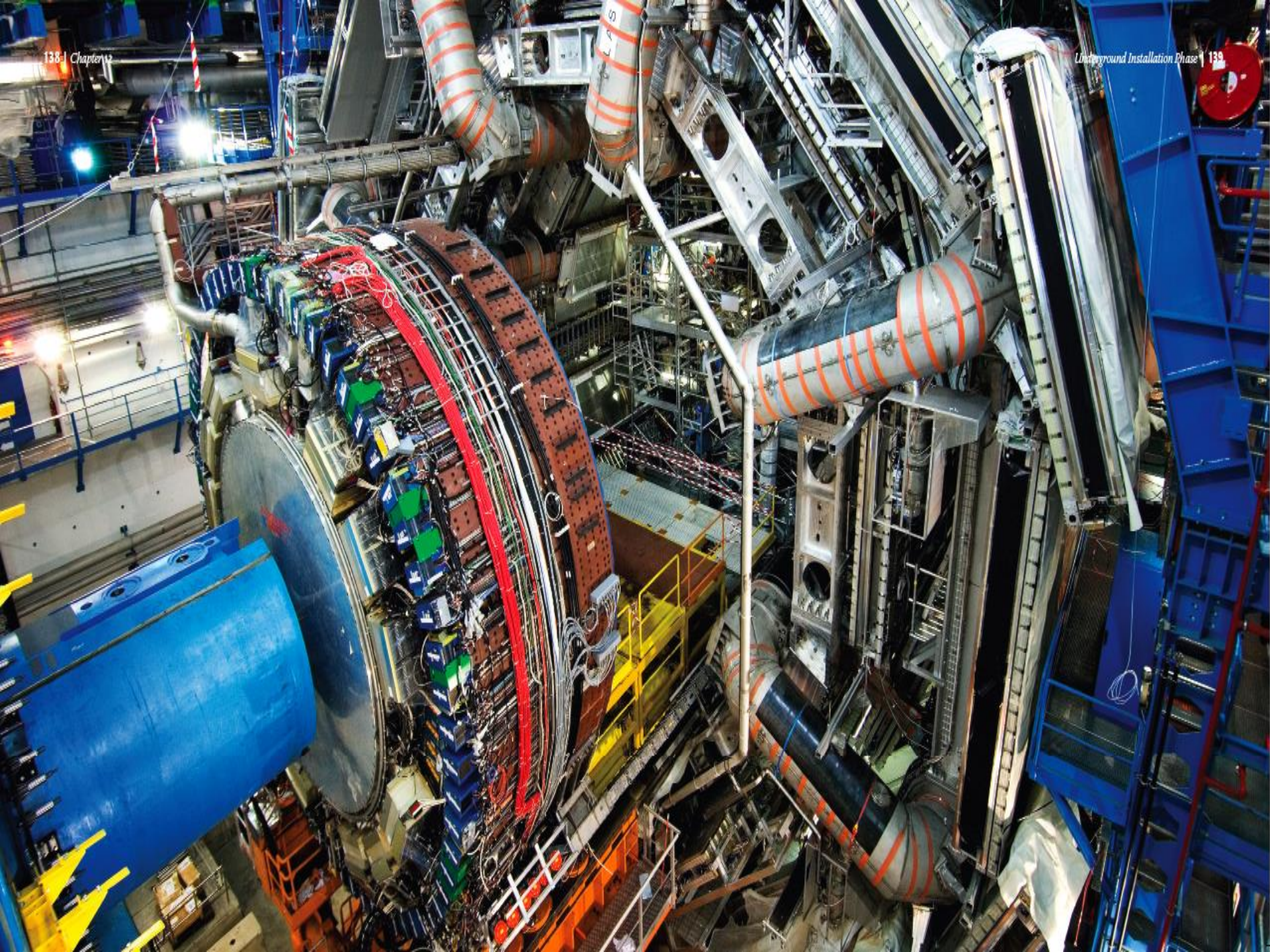
Safety Organization of the ATLAS Experiment

Asset and Maintenance Management Workshop
CERN, Geneva, Switzerland
13-15 November 2013

What were the risks linked to the installation of the ATLAS detector?



Expérience **ATLAS** Experiment



Civil Engineering and cavern excavation

A cavern excavated 92 m below ground!
53m long, 35m high, 30m wide

- 300’000 tones of excavated rocks
- 50’000 tones of concrete
- The cavern vault: 10’000 tones of concrete
- After 4 years of work the was cavern ready for the detector installation at the end of 2003

Risks linked to the transport of detectors, from surface, to their final place in the underground cavern

Very huge components but
very delicate and very costly!

ECT Forward Magnet suspended
from the surface crane 2x140 tones

Transport of the ECT Forward Magnet
240 tones

Conception and certification of the lifting tools
Detailed analysis of the working and lifting procedures - (PPSPS)

Safety team on the field integrated in the working team

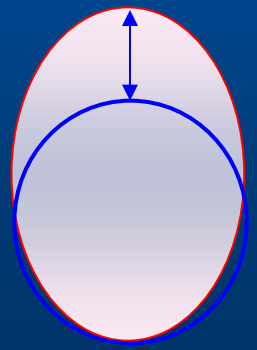
An example of a difficult installation activity: the central toroid magnet

11 months of an intensive and highly precise engineering work:

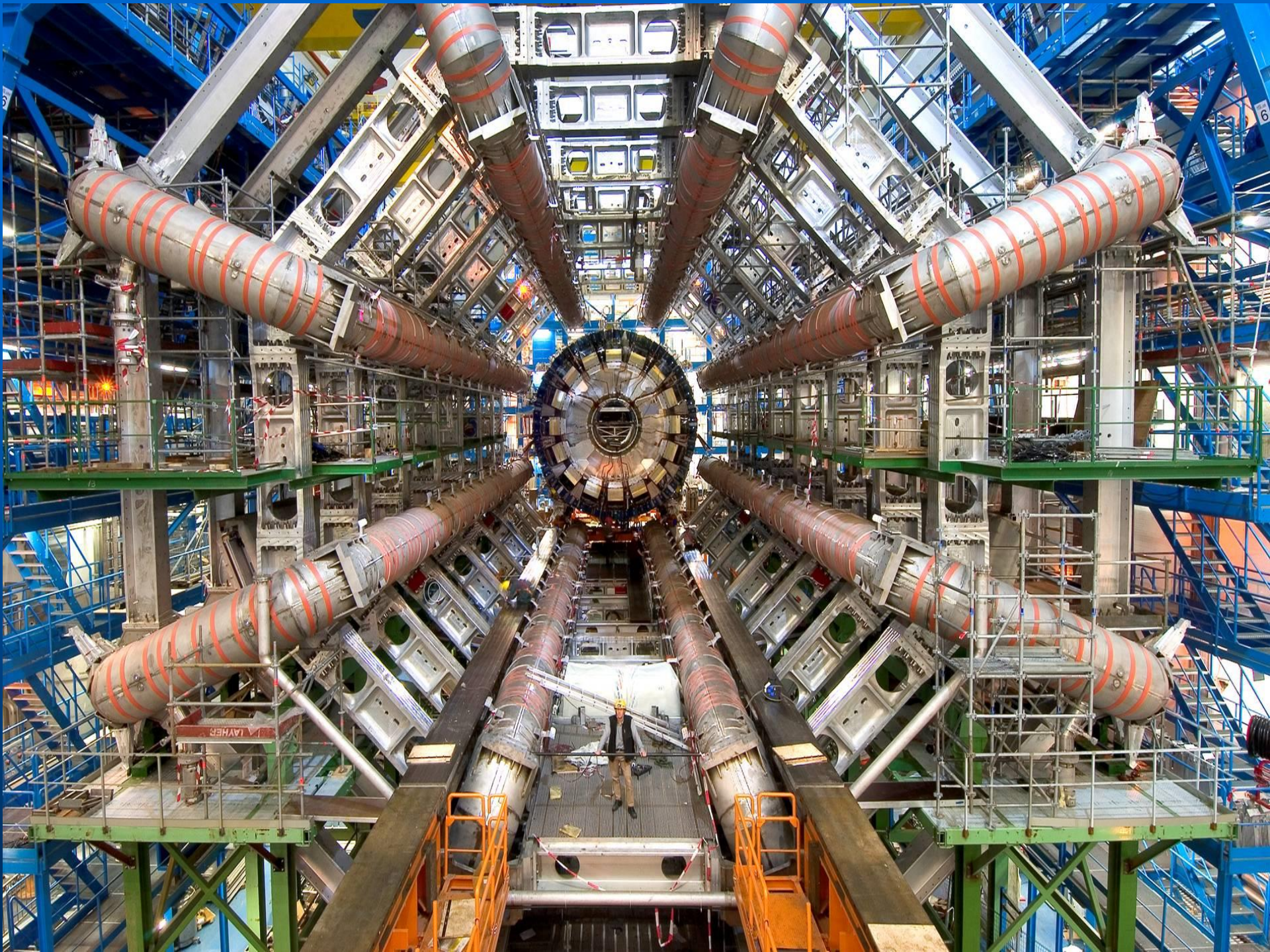
- *Working at height*
- *Heavy loads transport*
- *Risks of falling objects*
- *Control of coactivities*

No Accidents !

30 mm calculated



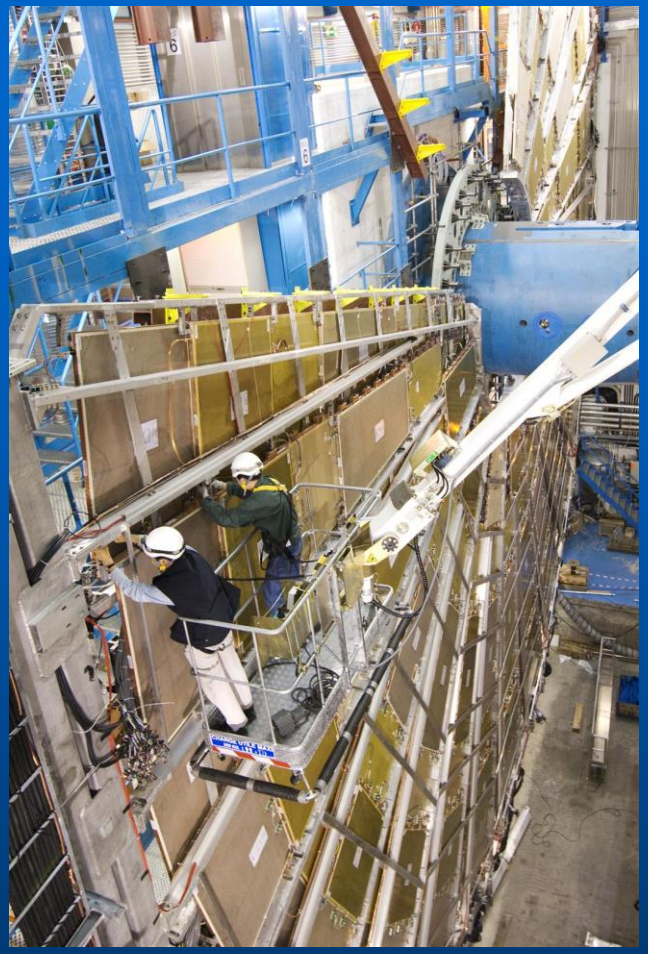
~27 mm measured

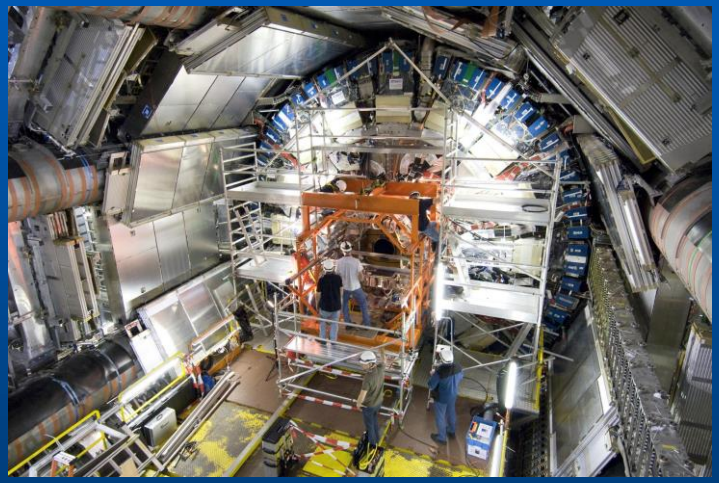


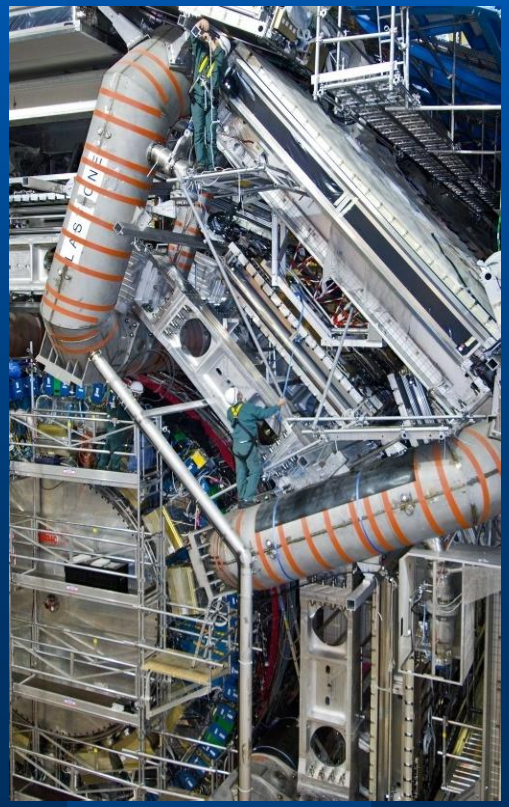
An installation work inside the cavern more and more difficult while the space reduces

The safety team was always on the field to assist the workers and control in real time the possible changes in the working environment

Control of the scaffoldings
Working at height (signalization, safety lines, etc.)
Management of co-activity
Protection against falling objects
Safety signalization, etc.







Workers safety training

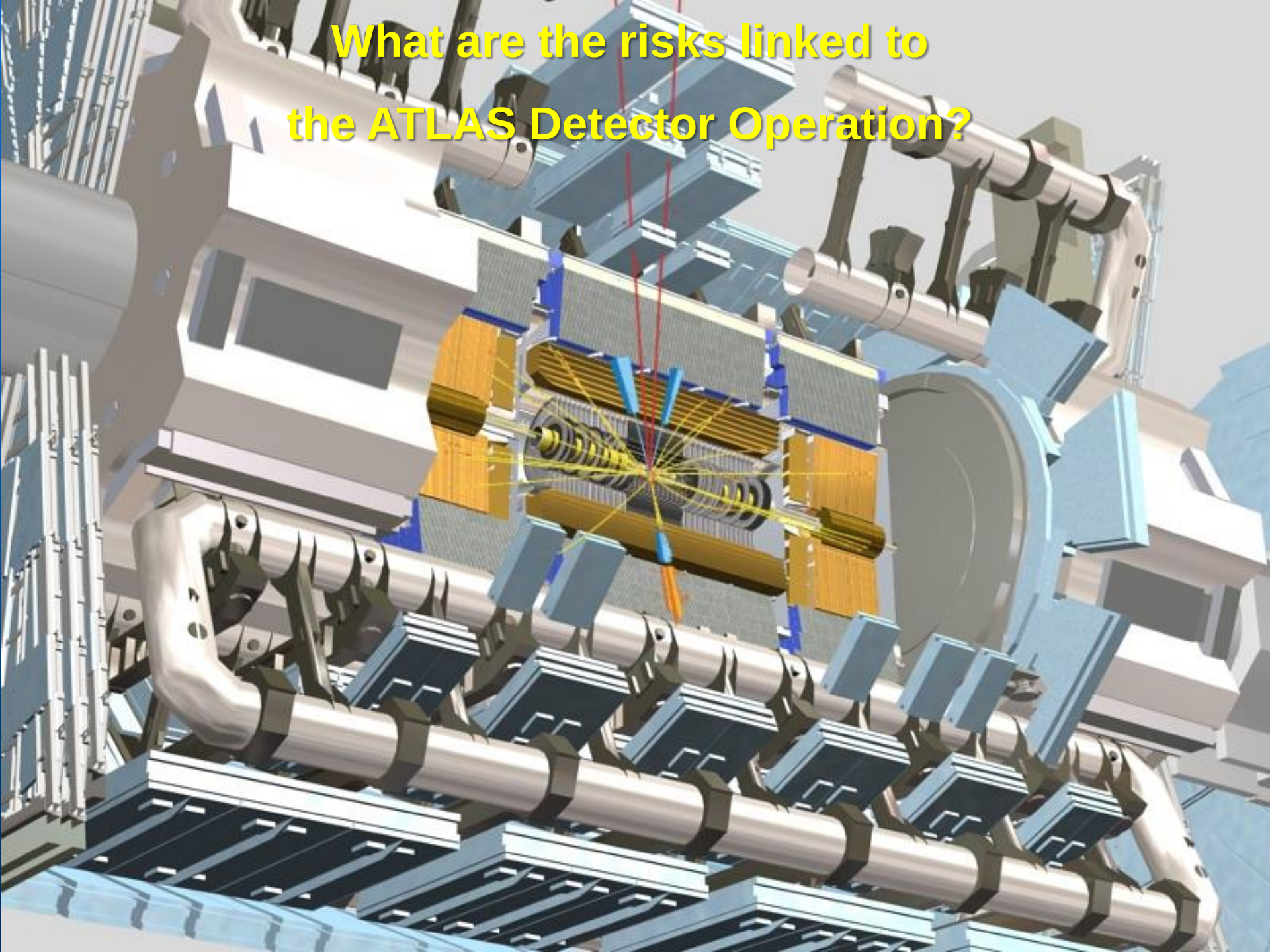
✓ATLAS specific safety training
evacuation, cryogenic, installation risk,..
✓ working at height
✓ scissor lift training
✓ nacelle training
✓ biocells training
✓ magnetic field

In august 2008, the detector was ready for operation

- ✓ 7’000 tones of detectors
- ✓ > 15 million of components
- ✓ > 50 000 cables
- ✓ 6 years of work
- ✓ > 1’000 technicians

And - no major accidents!!!

What are the risks linked to the ATLAS Detector Operation?

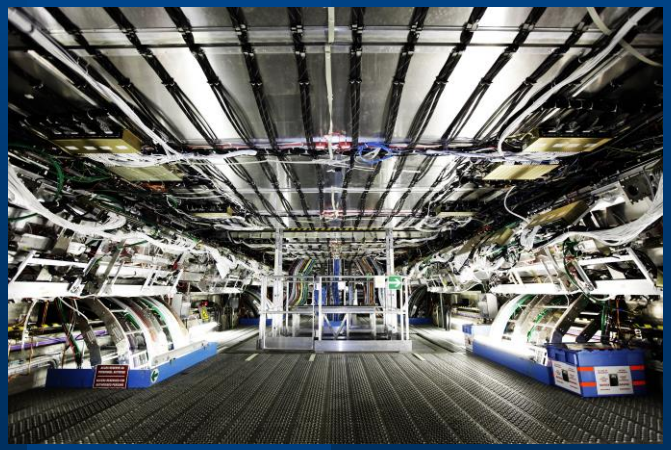


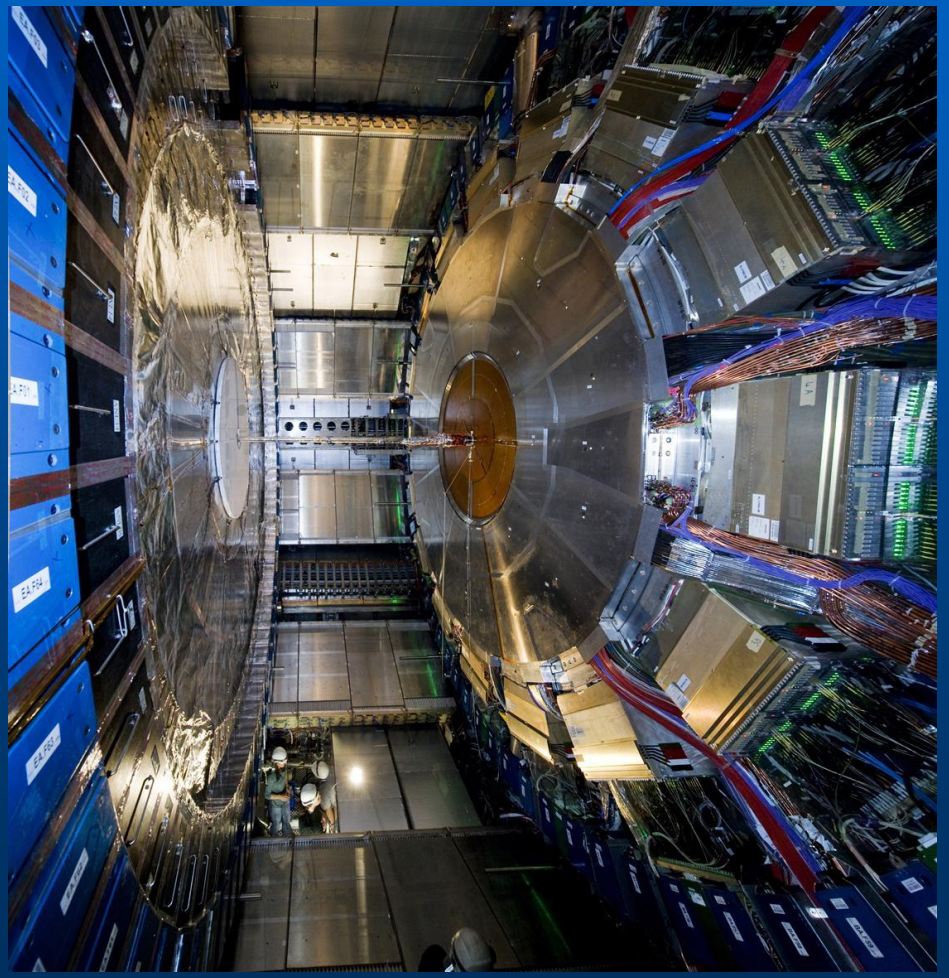
Fire risk

3’000 Km of cables installed in the undergrounds

~ 300 connection racks

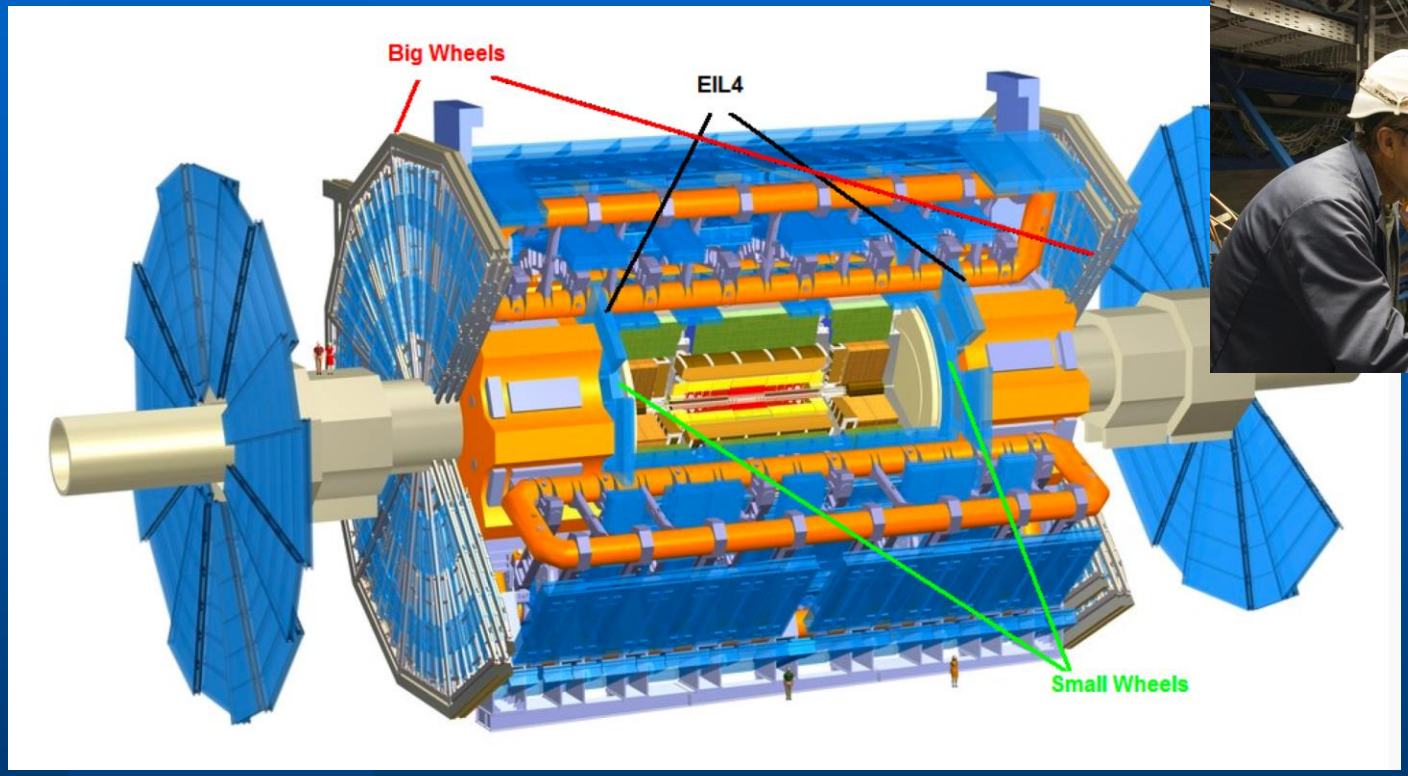
10 MW of electrical distribution





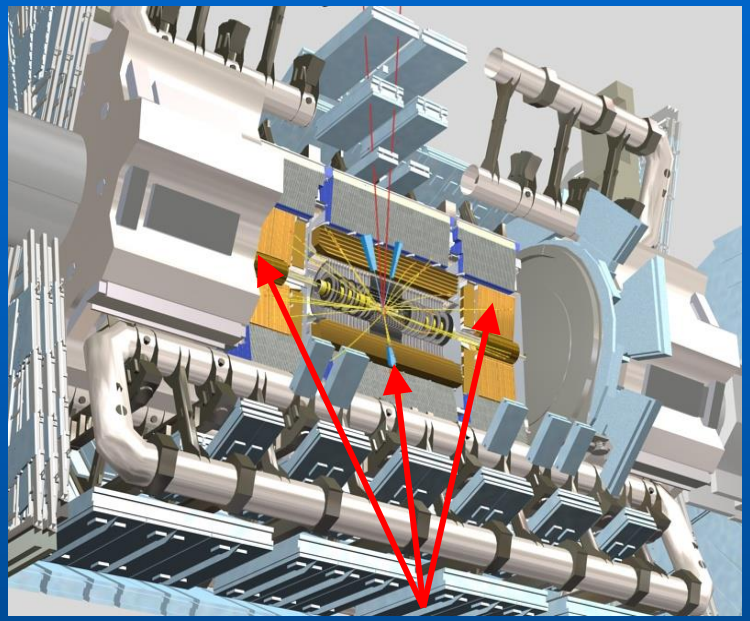
Flammable and inert gases

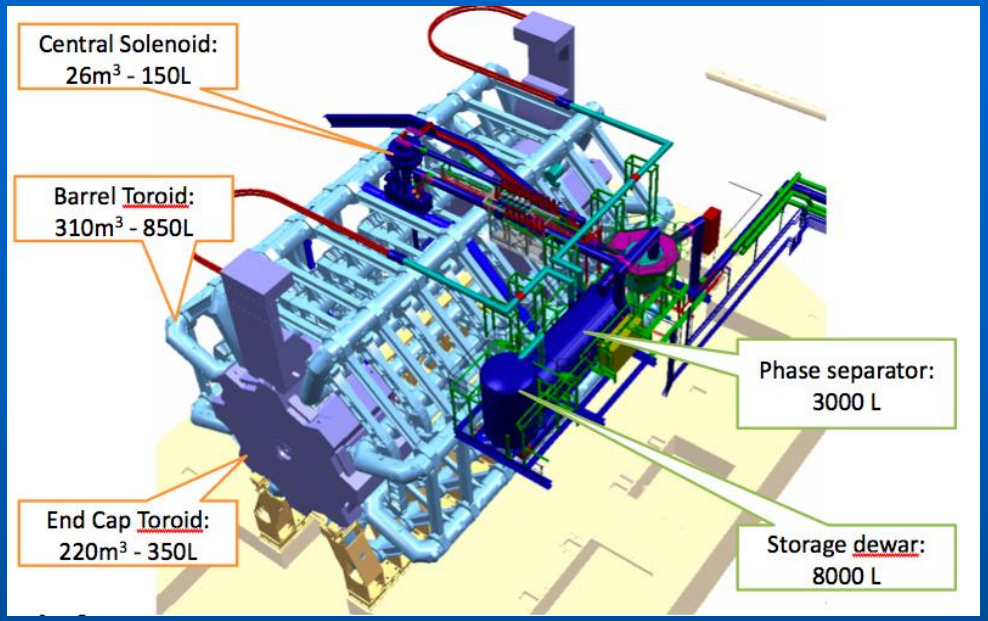
17 m^3 of flammable gases (n-penten 45 %)
inside the ATLAS big wheels



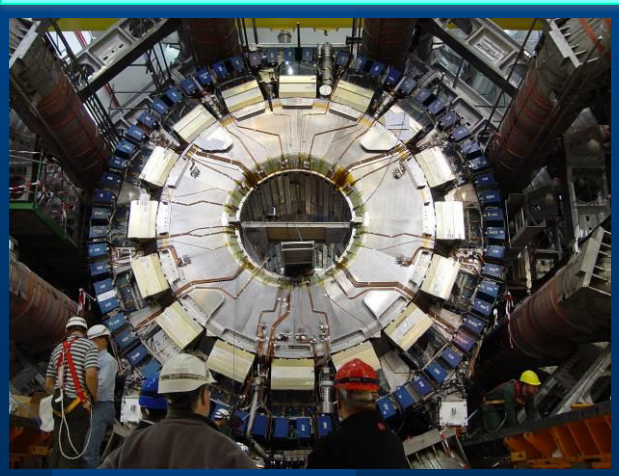
850 m^3 of non flammable gas
inside the central Muon Chambers, the Big wheels and inside the Inner Detector

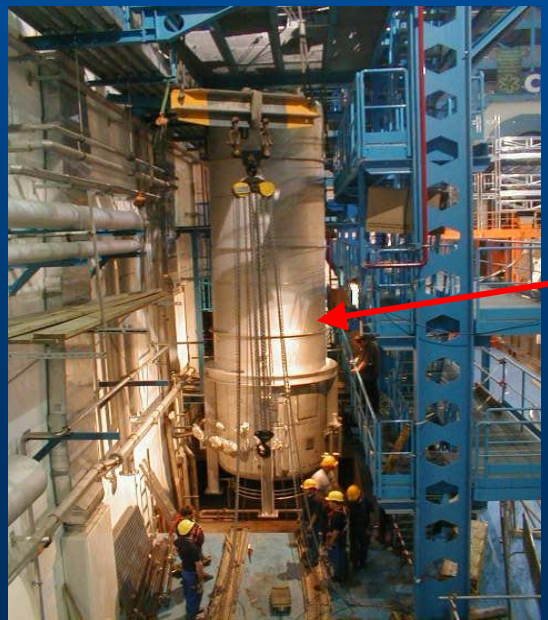
Cryogenic fluids in the experimental cavern, A risk of lack of oxygen and of cold burns





Liquid Argon: 90 m³ at -183 ° C inside the LAr Calorimeter





Liquid Helium: 11000 litters, -268 ° C

15 m³ of Liquid Nitrogen

To control these risks

A very strict control of the material in the undergrounds

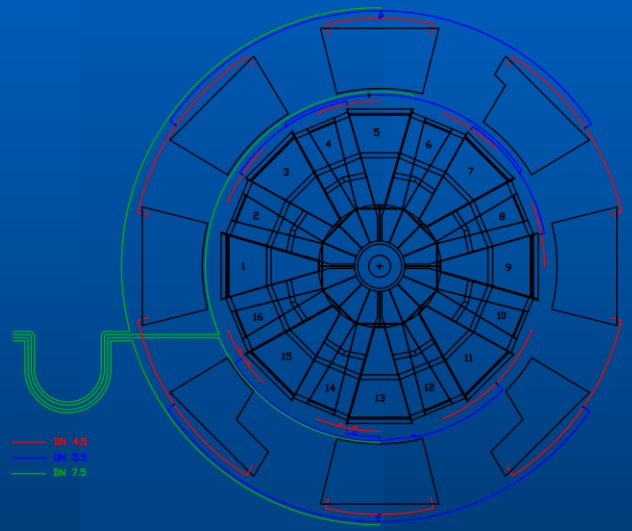
A very dense network of fire detection system

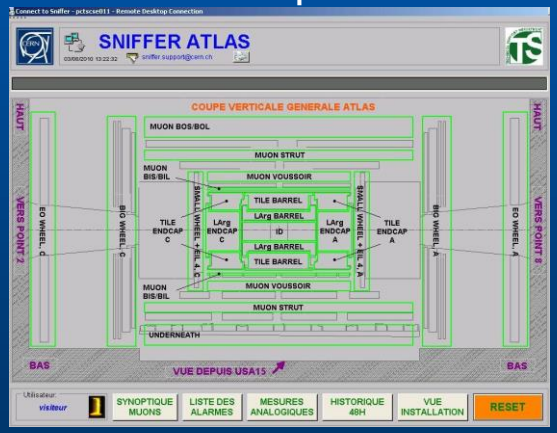
But also oxygen deficiency, CO_2 and flammable gases detection systems

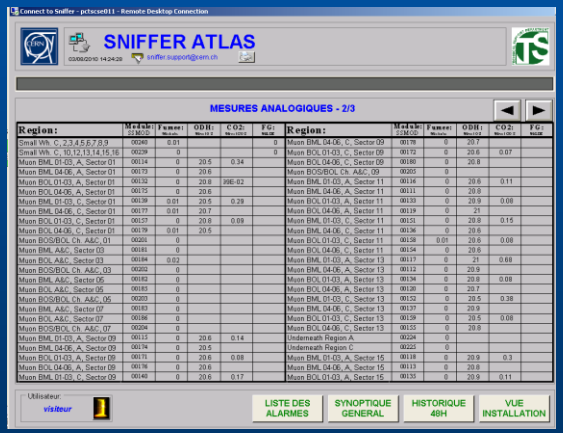
Inside the detector an « home made » SNIFFER system

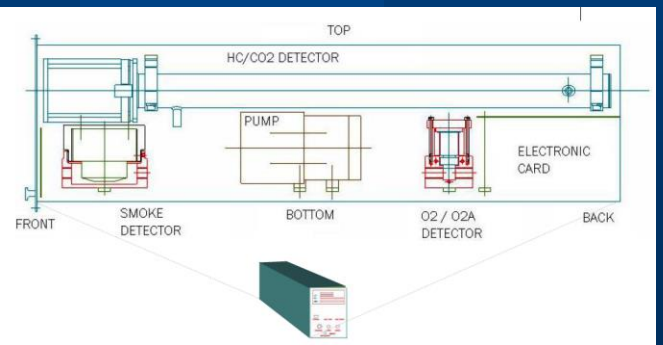
composed of pipes sniffing and analysing the air composition continuously in the heart of our detectors

Sniffer air sampling system – 137 main lines of detection, 572 detection points









They are detecting the presence of smoke, CO_2, flammable gases or lack of oxygen in real time

Maximum detection time: 60 seconds

Associated to these detection systems

An immediate transmission of all alarms to the CERN Fire Brigade, the CERN Control Room and ATLAS Control Room via – CSAM (CERN Safety Alarm Monitoring System, a Level 3 safety system)

and automatic actions:

- ✓ defined in the safety matrix in collaboration between the sub detectors responsible and the safety commission at CERN
- ✓ implemented directly

  ✓ **Caverns evacuation**
  ✓ **Flammable gases cut-off**
  ✓ **Modification to the caverns ventilation mode**

- ✓ or triggered by the DSS (Detector Safety system)

A safety system for equipment and personnel safety which acts already at Level 2

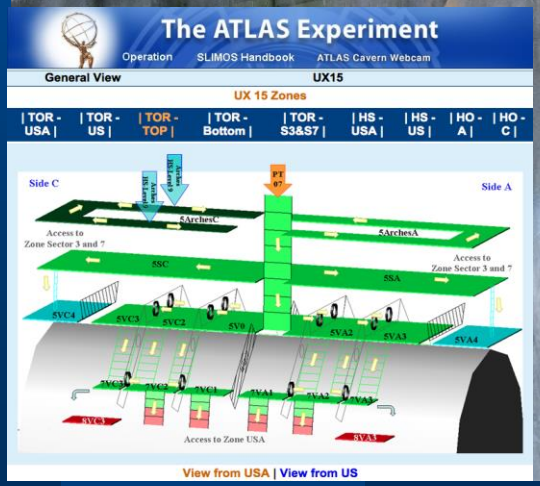
✓ **Cut off the electrical power**
✓ **Etc.**

Collaboration program with the CERN Fire Brigade

Due to the complexity of the experimental area, we have developed a training of half day which we deliver to each Fire Brigade intervention team member and all new comers which includes:

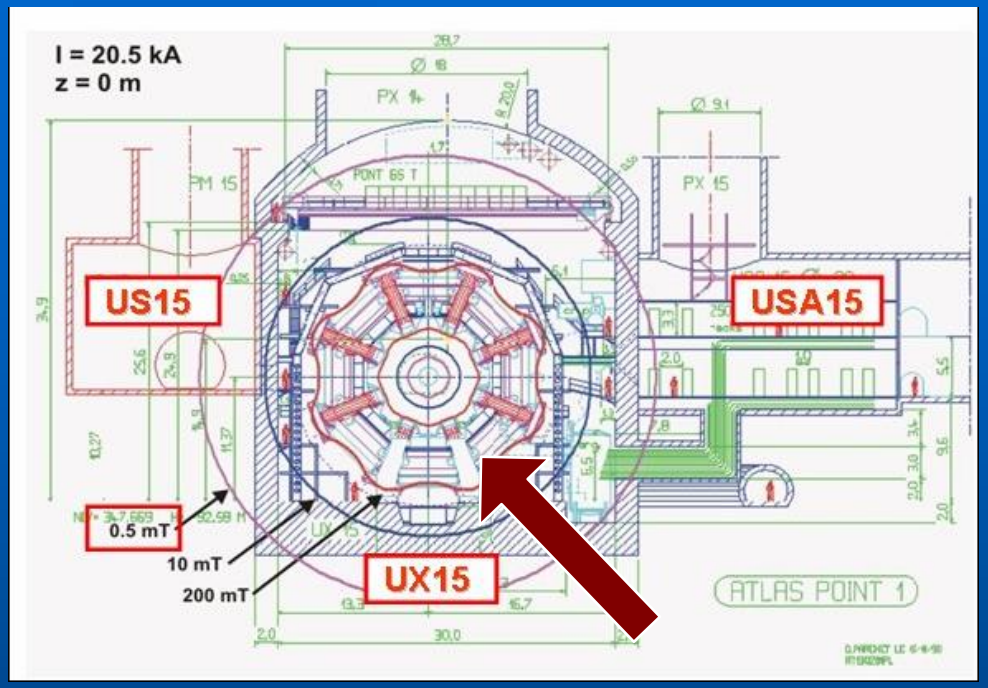
- A presentation of the main risks and the corresponding emergency procedures , site topology and how to orientate inside ATLAS
- A presentation of the SLIMOS desk and the protocol of interaction between the Fire Brigade and the SLIMOS
- A “tour” in selected difficult areas of ATLAS
- A practical test of orientation inside the detector

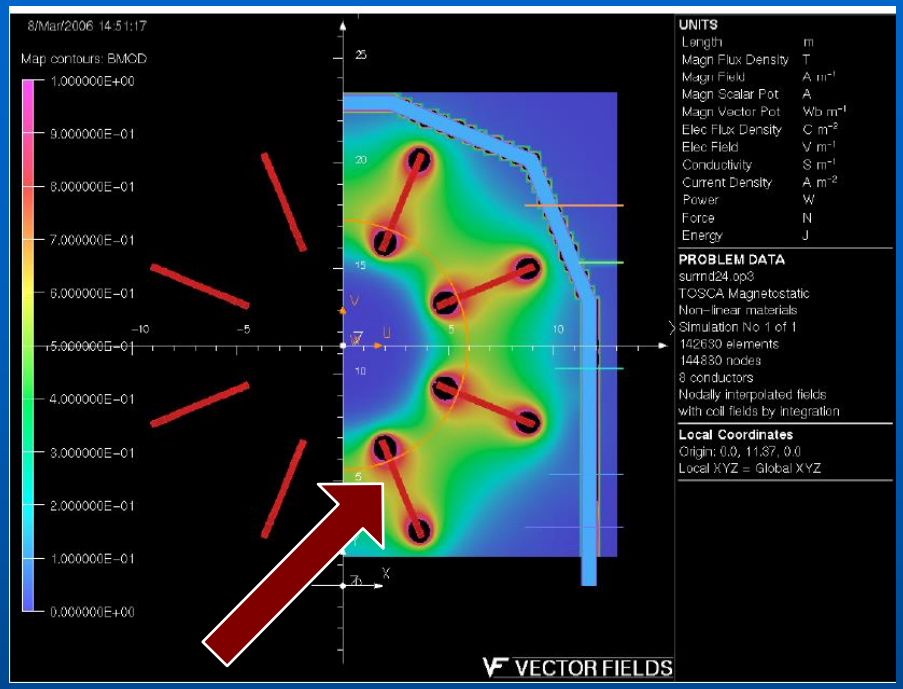
The Foam System



- How to access quickly the intervention zone?
- What are the risks and the difficulties ?

The Magnetic Field





Up to 1 Tesla in the accessible areas of the detector

✓A very strict control of the magnetic material inside the experimental cavern

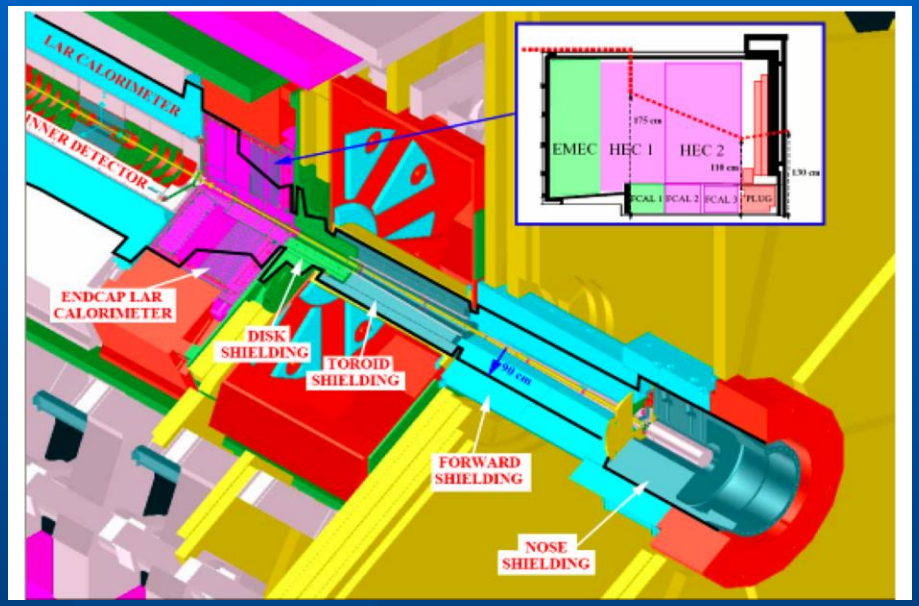
✓ Access in the field in the heart of the detector authorised only in exceptional cases, only for expert personnel, under an appropriate medical overlooked and who have followed a specific training

✓ The ALARA (As Low As Reasonably Achievable) philosophy applied to non ionising radiations exposure (magnetic field higher than 200 mT)

Radiological Risks

The experimental cavern is radiology classified

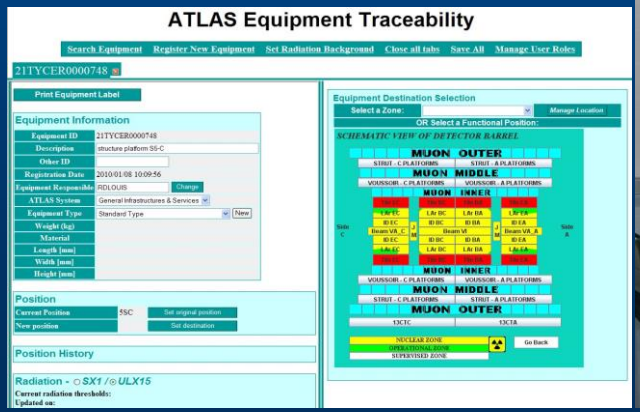
- The personnel is trained for the risks
- Under medical surveillance
- With passive dosimeters



A special zone, at the canter of the detector is classified and declared by the Swiss and French nuclear authorities as “radioactive waste” area

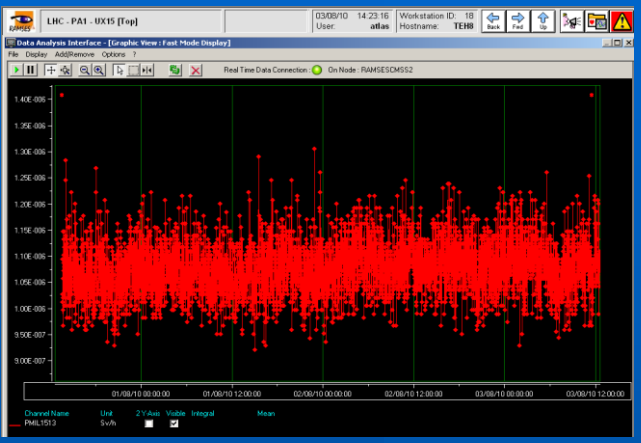
A systematic control for possible activation of all material leaving the experimental area including a traceability

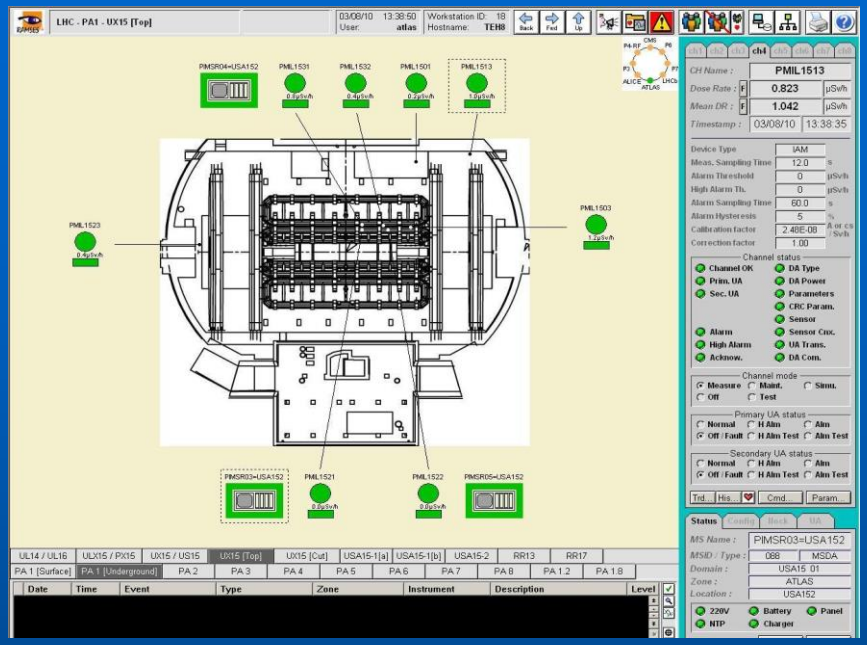
RPE - Radioprotection Experts, trained by the national authorities (IRA – Lausanne) are on standby service 24/7



The level of radiation is under constant surveillance of RAMSES

Alarms when the thresholds are exceeded





« Gate Monitors » are installed at the experimental cavern exits, with constant link to ACR, to monitor the level of radiation of the equipment leaving the cavern

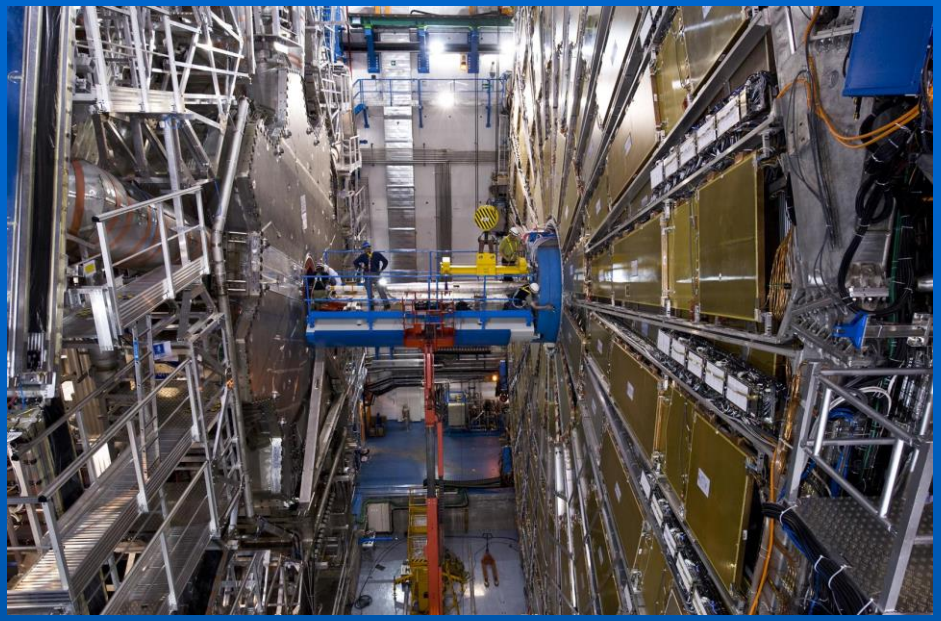
Regular campaigns to measure the radiation level:

- ✓Environmental dose levels
- ✓Spectroscopy of around 95 material samples
- ✓contamination

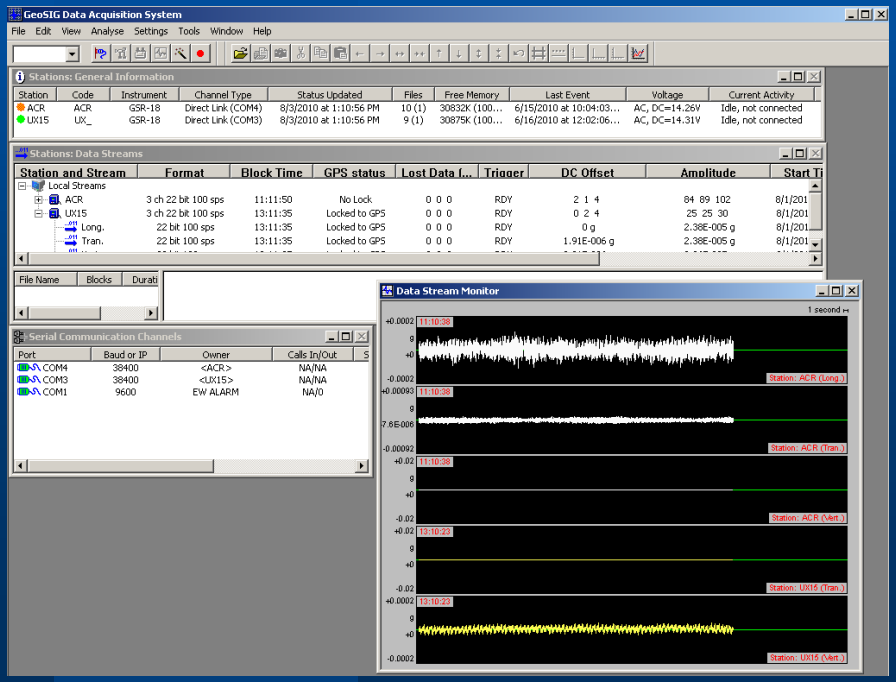
To authorise or not access to zones

To correlate the radiation calculations

But also



- ✓ Electrical risks
- ✓ A beam pipe in Beryllium
- ✓ Lasers (>100)
- ✓ Mechanical and Seismic risks (Eurocode 3 et 8)

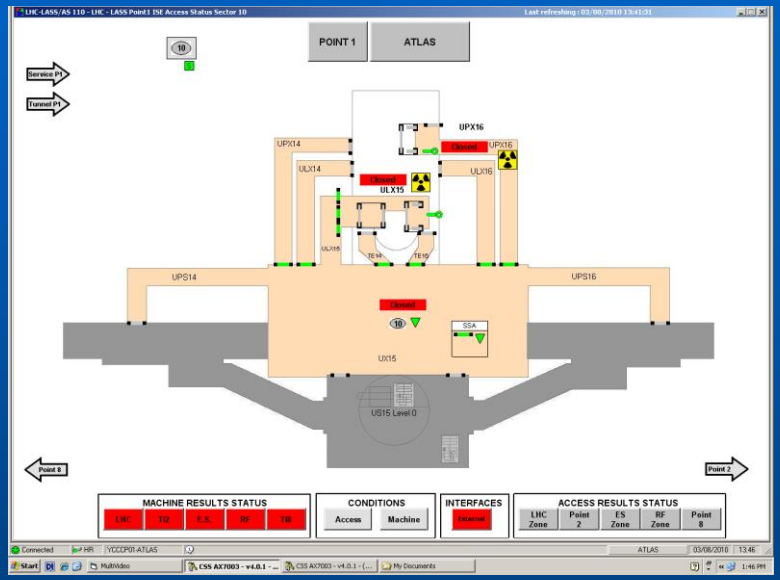


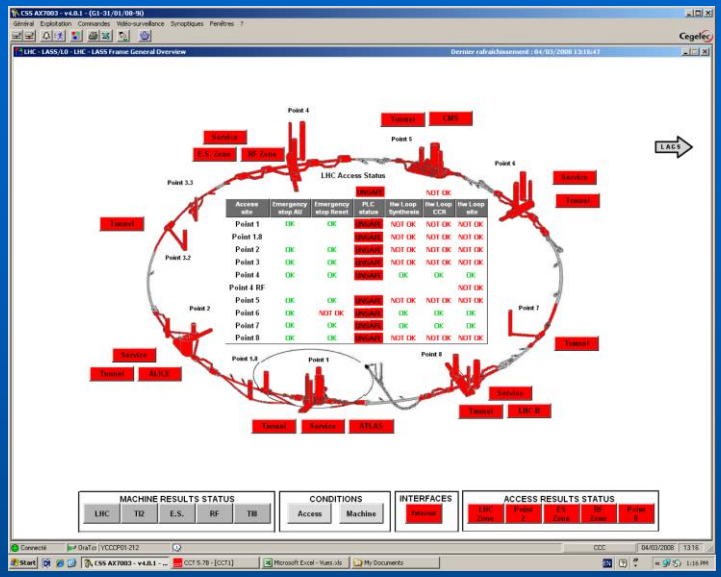
In collaboration with the Geneva University

4 seismographs
3 on surface et 1 in cavern (at -92 m)

And a very complex safety access system: LASS, “LHC Access Safety System”

A safety system that guaranties that there is nobody inside the experimental and accelerator areas while the beam is present.





During beam operation:
Immediate stop of the beam in case of intrusion inside the « beam » areas

During access periods:
The safety tokens taken from the LASS bays at the entrance of the area guaranty the safety of the personnel entering the experimental caverns.

If the tokens are not back in the bay, the beam can not be injected.

At all time the PATROL must be maintained too!

Associated to the LASS, the LACS, “LHC Access Control System ”

The LACS system controls:

- the validity of access rights and safety course associated to the area
- the biometry via the eye scan

IMPACT – additional access authorisation signed by safety and facility coordinators

The final access authorisation and the safety tokens delivery is done by the SLIMOS from the ATLAS control room.

SLIMOS - Shift Leader in Matter of Safety
A key role in the organisation of the experiment

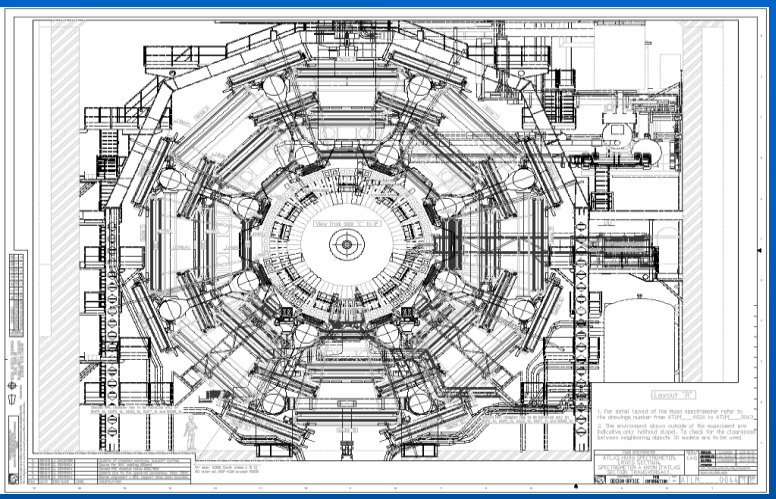
All the safety information, the access, and the infrastructure related information are converging to a central location: the SLIMOS desk at the ATLAS Control Room

The information is processed by SLIMOS to whom the GLIMOS has delegated a part of his functions of operational safety.

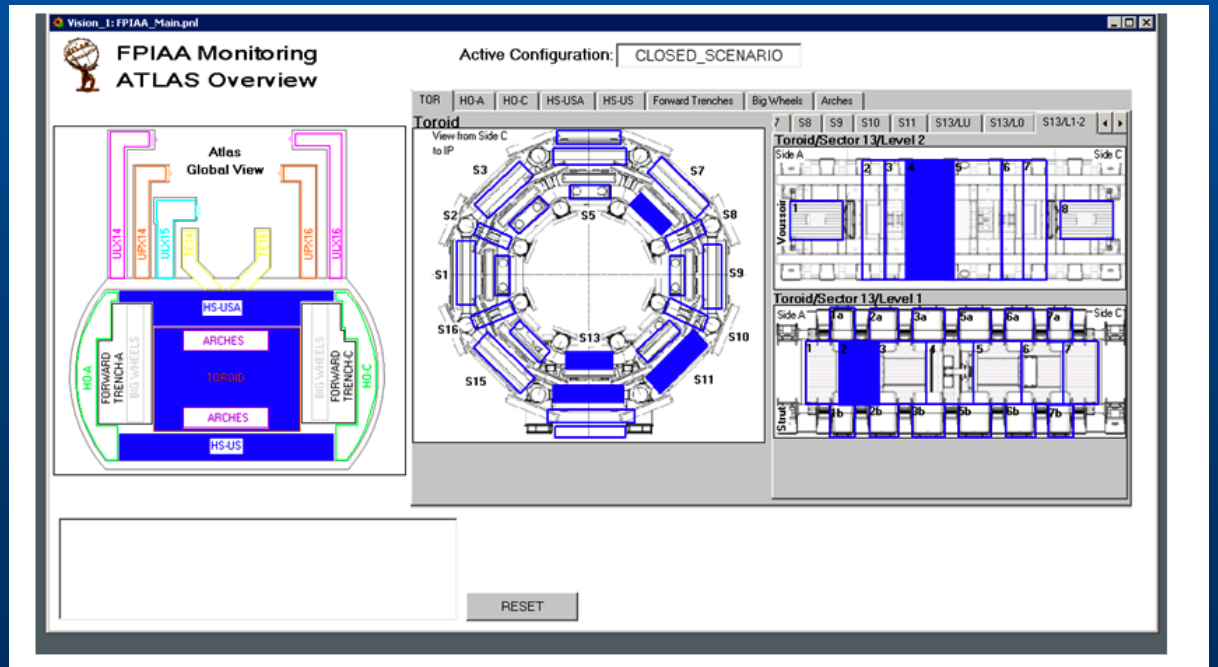
The SLIMOS are qualified persons (engineers or physicists) which has followed an extensive training on safety procedures.

The presence of the SLIMOS in the ATLAS Control Room is maintained 24/7.

Finally, to follow movement of personnel in the heart of the detector: FPIAA – Finding People Inside ATLAS Areas



- ✓ system developed by ATLAS
- ✓ hundreds of infrared detectors covering the ATLAS experimental cavern
- ✓ ability to check the presence of personnel underground from the ATLAS control room



ATLAS Safety Structure

Collaboration Institutes
Safety commission
CERN departments
All CERN Safety Committees, Fire Brigade, DSOs, etc.

GLIMOS
Group Leader in Matter of Safety

CSO
Cryogenic Safety Officer
ESO
Electrical Safety Officer
LSO
Laser Safety Officer
FGSO
Flammable Gas Safety Officer

RSO (Radioprotection Safety Officer)
ALARA Coordinator
RPE / RPA (radioprotection experts and assistant)
16 Technicians , Engineers or Physicists

Safety Engineering and DB Team
7 Engineers

SLIMOS
(Shift Leader in Matter of Safety)
Around 70 engineers or physicists

TSO
Territorial Safety Officers
17 Technicians or Engineers

Work Package analysis Structure

Safety training office

ATLAS Patrol Team
Around 20 persons

Safety Coordinator
For access periods

A systematic analysis of all activities happening in the ATLAS experimental areas:

The “Work Packages” Analysis

The activity responsible provides work declaration to the ATLAS technical coordination to request a working authorization and access to the caverns

He provides all data linked to the activity and the PPSPS - “Plan Particulier de Sécurité et de Protection pour la Santé”:

- ✓ Detailed working procedures, location, planning
- ✓ Risks linked to the activity (electrical, magnetic field, coactivities, hot works, transport of equipment, working at height, etc.)
- ✓ Criticality of the access request and work nature (maintenance, emergency access)
- ✓ List of intervening personnel and of their safety courses
- ✓ Equipment certification
- ✓ Requirements for scissor lifts or cranes
- ✓ List of all material entering and exiting the experimental cavern

All the risks are analysed and specific safety measures are proposed.

The work declaration are analysed and authorised day by day

And before start of the work -> a joint safety inspection in situ

ATLAS Safety organization for LS1

All ATLAS activities covered by:

- PPSPS and Work package analysis, 70 since the start of LS1

- IMPACT declarations signed by safety and facility coordinator on daily basis, 6'200 since start of LS1

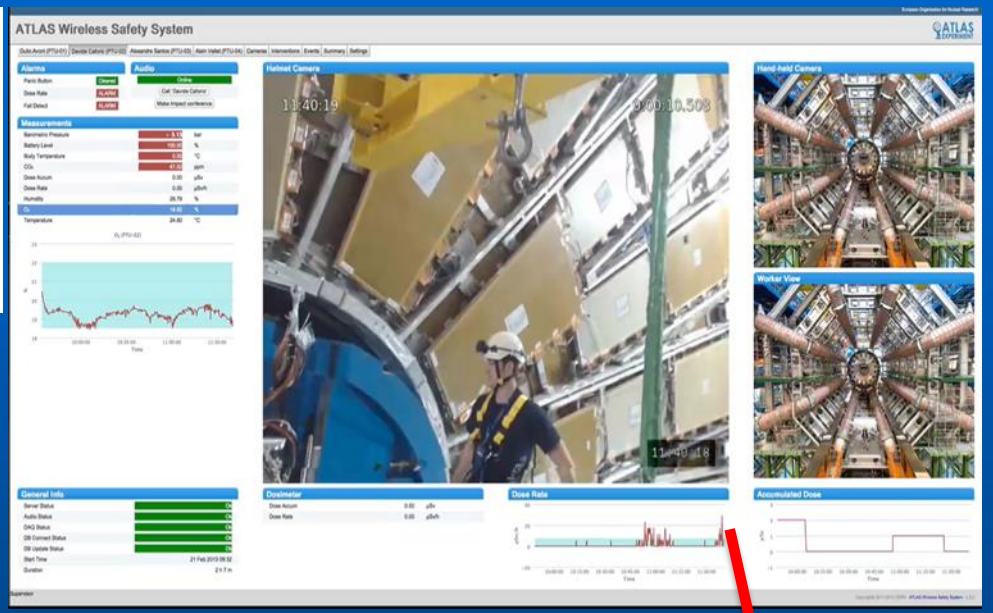
Safety is ensured by:

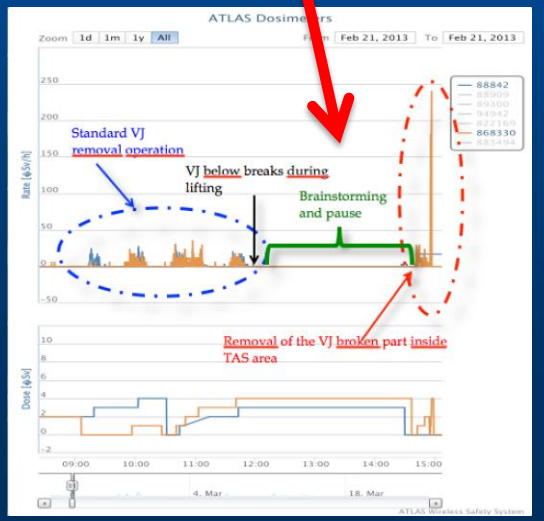
- **SLIMOS** in two shifts covering normal working hours
- **OPM** for the outside normal working hours
- **Safety shifters** inside the caverns assisting the working team and patrolling during normal working hours.
- **EOD (Engineer on Duty):** (weekly shifts) responsible to control schedule, activities, priorities the co-activities, crane usage, safety issues (with safety shifter)
- **RSO, RPE and RPA,** for gamma radiation measurements, access areas opening, checks of material activation, database filling, radioactive material transport assistance, contamination tests, etc.
- **ALARA team -** for follow up and assistance for the ALARA level 2 activities

... and of course under supervision of TC and GLIMOS ...

We use our WPSS system to assist the personnel in the “hottest” activities

We use WPSS for the Beam Pipe interventions at the start of LS1





We are investigating possible solutions to mitigate radiation issues for the coming shutdowns

- ✓ **Shielding**
- ✓ **Tooling**
- ✓ **Remote handling**

We are evaluating remote handling solutions using an old CERN Mantis manipulator.
In spite of its obsolescence it gives us some very interesting experience and knowledge about remote handling technologies.

We plan to build mock-ups to be manipulated and gain the necessary information to explore the modern solutions with the correct level of understanding.

Thank you!

And questions?

Asset and Maintenance Management Workshop
CERN, Geneva, Switzerland, 13-15 November 2013