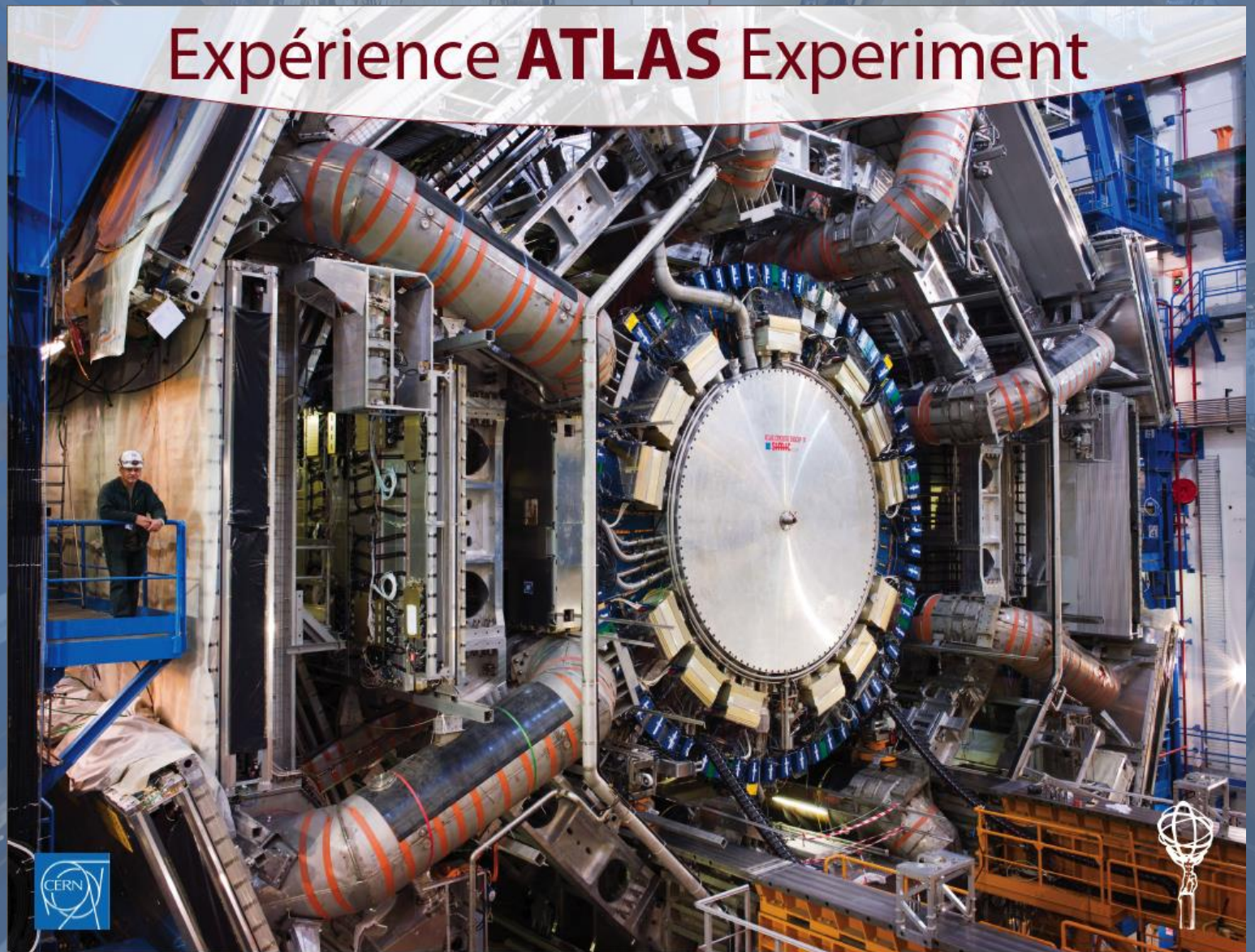
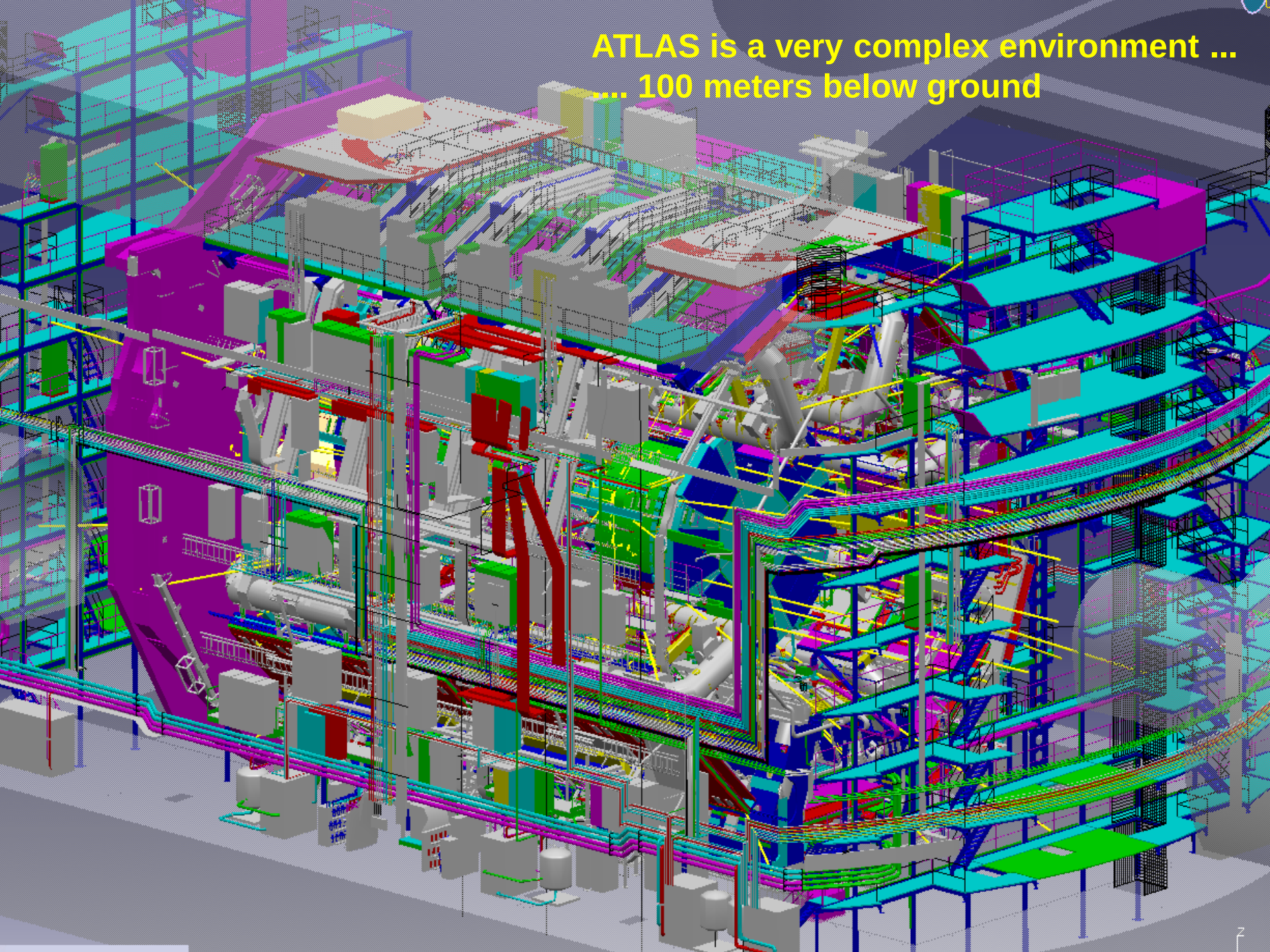
ATLAS DETECTOR SAFETY/RADIATION PROTECTION PROBLEMATIC AND STRATEGY FOR THE FUTURE SHUTDOWNS

O. Beltramello – 19.01.2015

What is ATLAS detector environment and what is our problematic ?

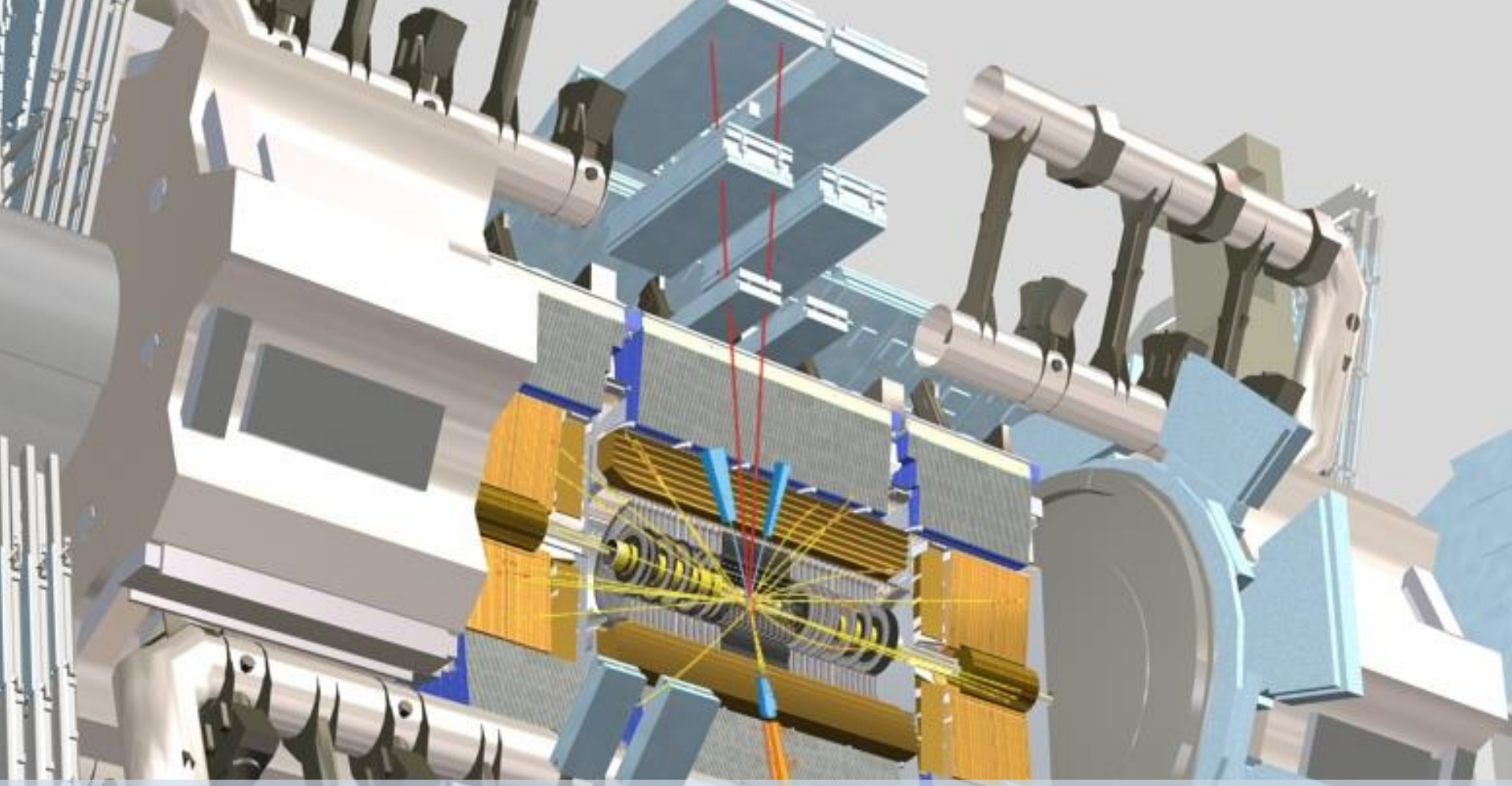



ATLAS is a very complex environment ...
... 100 meters below ground

Hundred meters of platforms, ladders, holes,
Scaffoldings...
Confined spaces

Lightening changing and not always optimum ...

The activities are very different
from very detailed detector expertise work
..
...to heavy loads transport

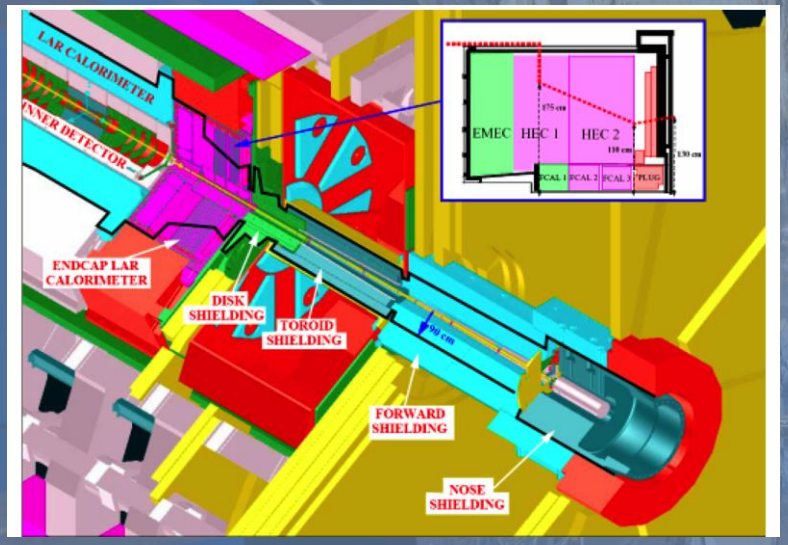


ATLAS detector is full of potential dangers:

- ✓ **Magnetic field (1.2 Tesla in the environment)**
- ✓ **Cryogenics: Liquid Argon (*90 m³, –183°C*), Liquid Helium, (11000 l, –268°C), Liquid Nitrogen (*15 m³*)**
- ✓ **Gases (Argon,...) and flammable gases (n-pentene)**
- ✓ **CO2 in the heart of the detector (from 0.1 % to 2 %)**

... and increasing with the beam luminosity: radiations

➔ The radiations levels and generally the level of risks faced by our personnel in the coming years will increase by a lot during the future maintenance and upgrade shutdown periods.



Environmental dose rates for future shutdowns

LS3 – 2022 - a scaling factor of 4 vs LS1 doses

LS4 – 2028 – a scaling factor of 20 vs LS1 doses

This will lead to few hundreds of µSv/h in the working areas close to beam pipe for LS4

Note:
Public annual collected dose between 1 to 3 mSv

We are developing a strong ATLAS safety upgrade program to face these risks. It is based on ALARA "As Low As Reasonably Achievable" strategy:

1. trying to reduce the doses collected to a strict minimum
2. assisting our workers while working in these radioactive environment
3. and eventually replacing them to perform these tasks.

This is done in a several steps …

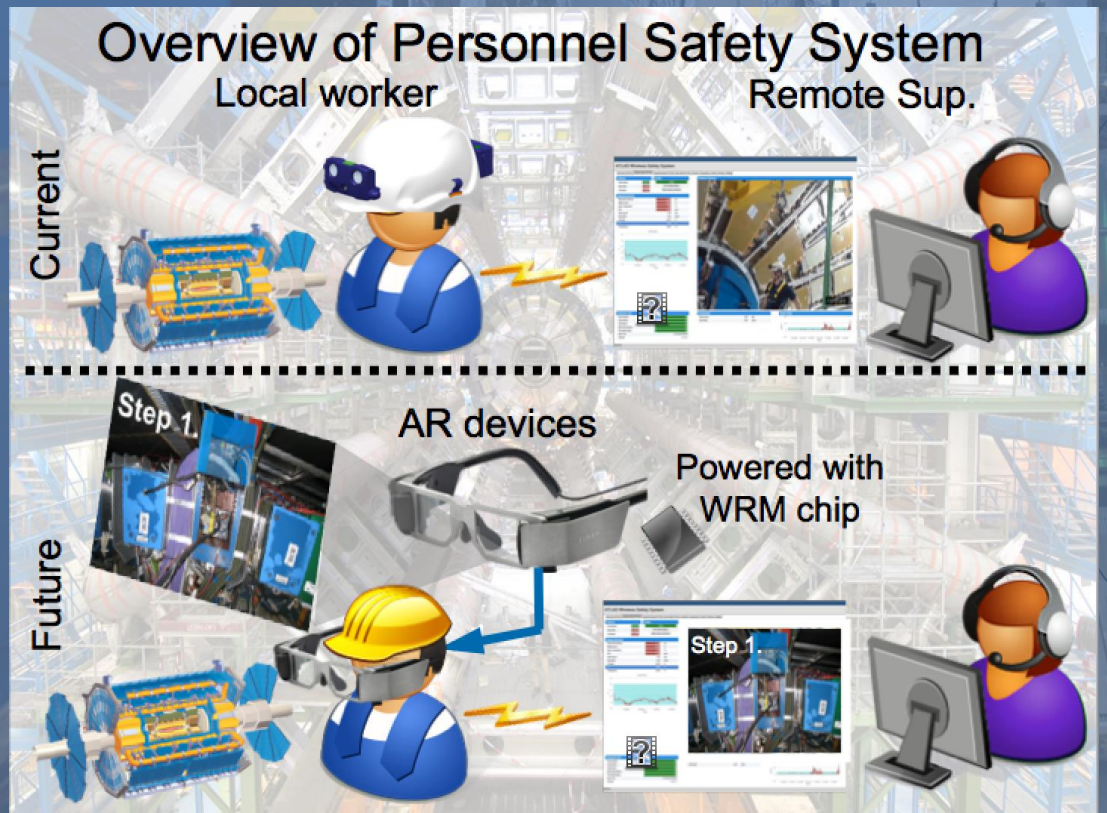
➢ Assist people working in extreme environment

We supervise workers, their environment and their activities

- ✻ audio / video connection
- ✻ environment parameters
- ✻ health data

We provide information to worker

- ✻ various display: tablets, HMD
- ✻ from various nature: working procedures, dose maps
- ✻ using Augmented Reality technologies



➔ **increase safety levels**

➔ **reduce human errors**

➔ **decrease intervention time (.. and doses)**

➔ **reduce intervention stress**

EDUSAFE FP7 Marie Curie ITN Project

A Collaboration of 12 Partners

3.2 MEuros, 4 years program (started in Sept. 2012)
CERN / ATLAS is coordinator
10 PhD Fellows
2 Post Doc. Fellows

- Athens University of Economics and Business, Greece
- Canberra, France
- CERN / ATLAS
- EPFL, Switzerland
- Novocaptis, Greece
- IASA / National Technical University Athens, Greece
- Prisma Electronics, Greece
- Technical University of Munich, Germany
- Universita Degli Studi Di Roma Tor Vergata, Italy
- Aristotle University of Thessaloniki, Greece
- CAEN University, France
- Democritus University of Thrace, Greece

What is the status of our developments?

The Worker Supervision System is ready, already used during LS1

EduPix gamma imaging camera prototype is ready and tested

360° scan, remotely controlled, motorized, light 3 Kg

We are able to detect the gamma hot spots in the environment !

Augmented Reality developments are on going and under integration process

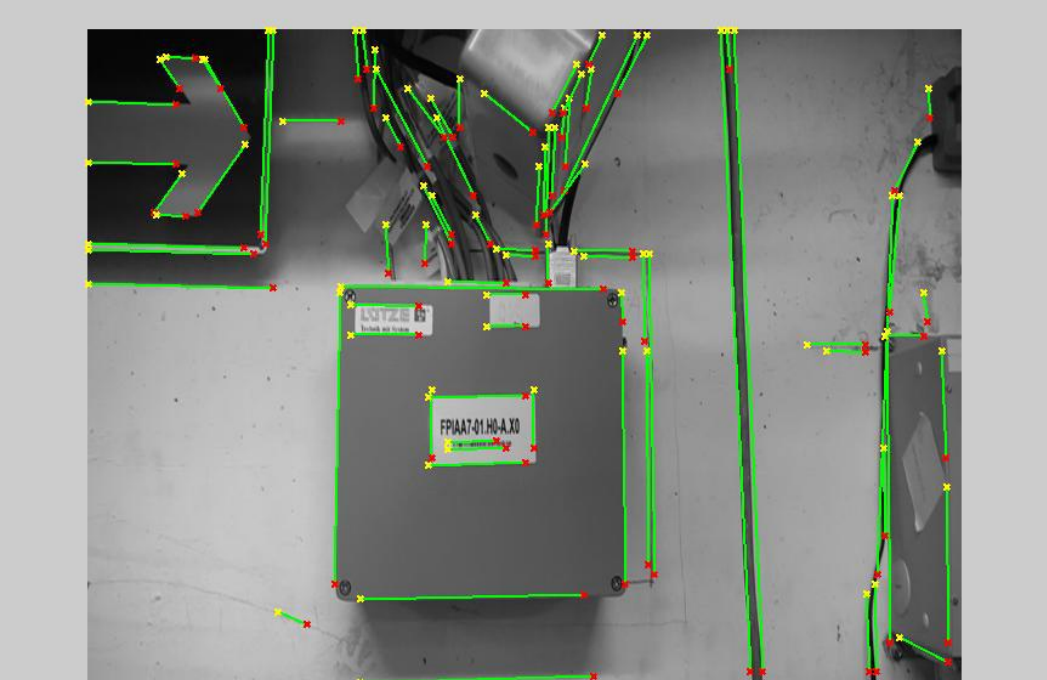
✓ Computer vision state of the art algorithms for a (very) fast worker position determination - EPFL

✓ **The WRM, the analogic Weighting Resistive Matrix–Roma II Development are on going, the results are very promising !**

WRM is directly derived from the CERN high energy physics technology, used in LHC to make pattern recognition at nanosecond level ...

Now to be used to boost Computer Vision algorithms

.. Increase robustness ... Decrease time of computation



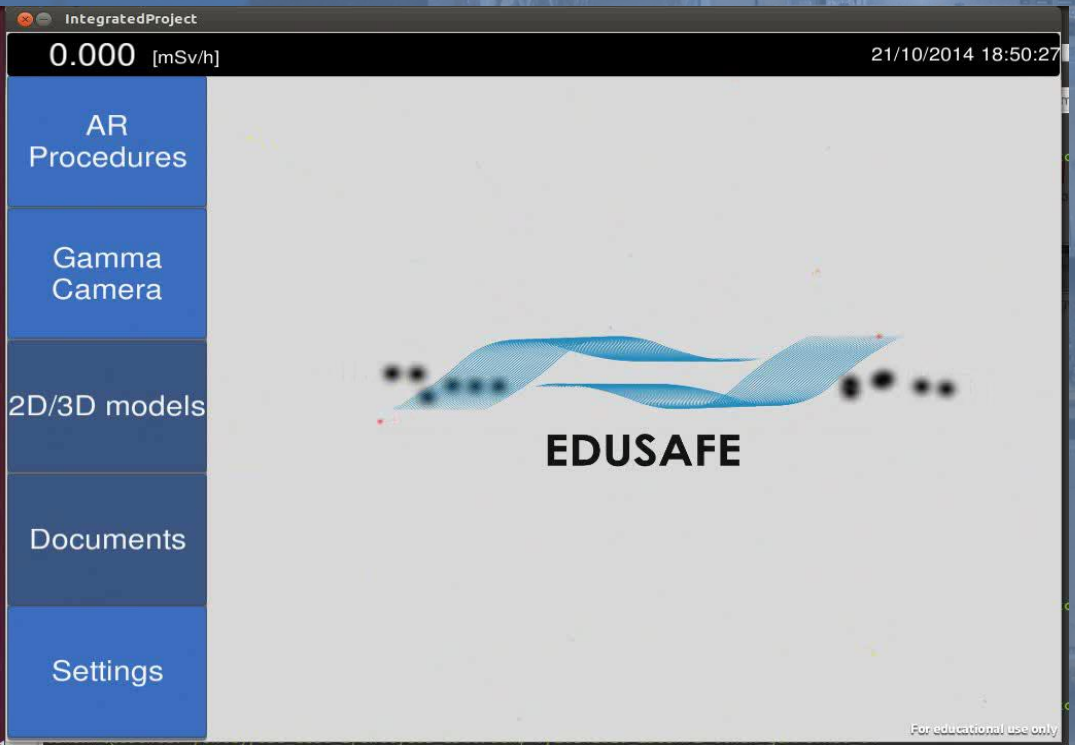
Augmented Reality developments are on going ...

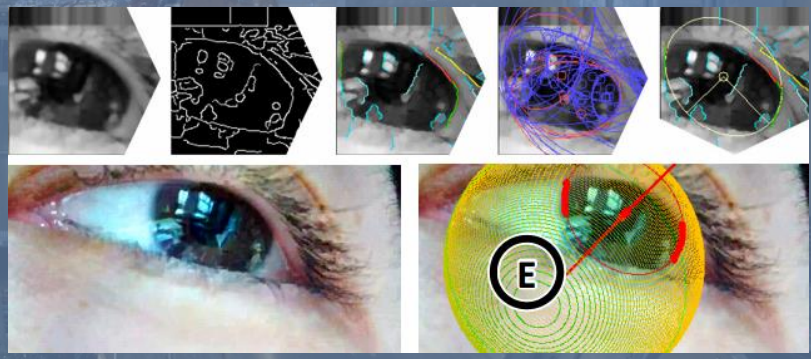
✓ **Sensor Fusion and rendering – CERN and TUM**

We fuse the data coming from image analysis with IMU sensor and provide rendering (procedure information) to the worker

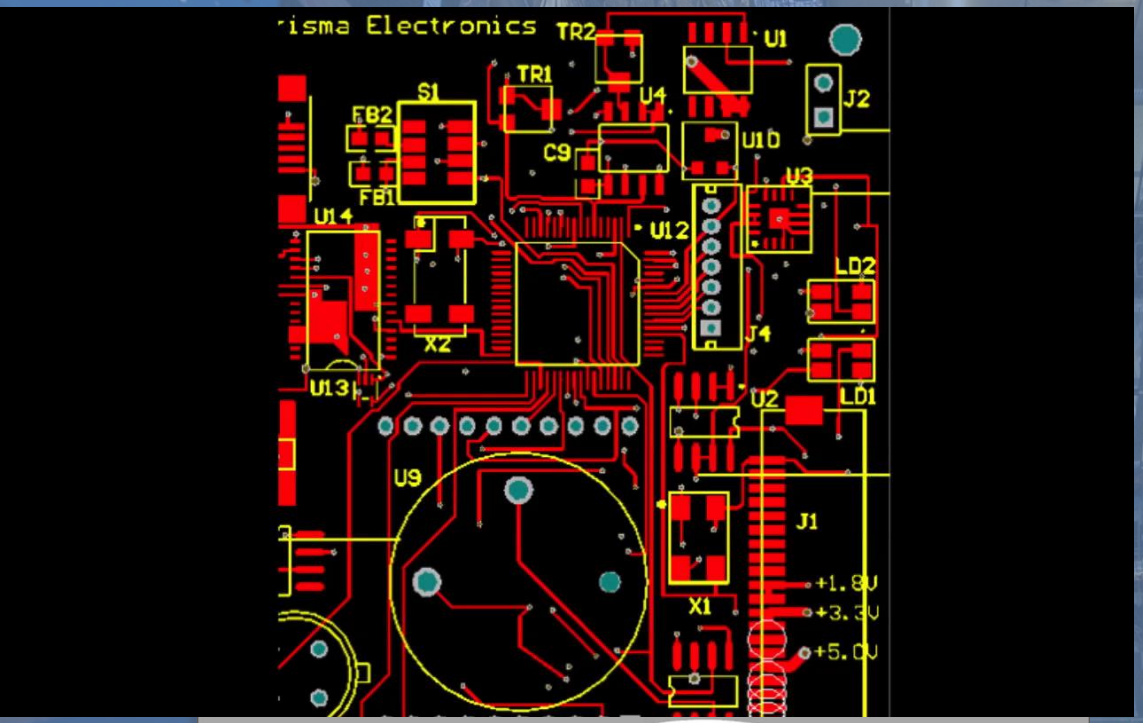
... every 30 ms...

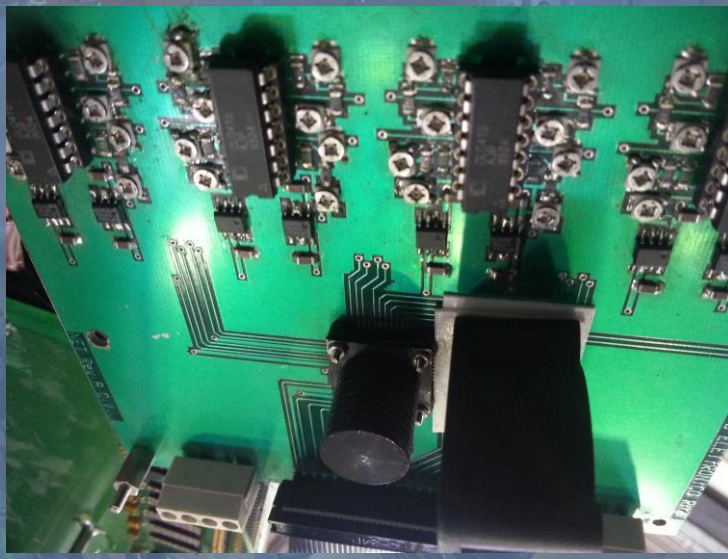
We track the eye and project information at right position

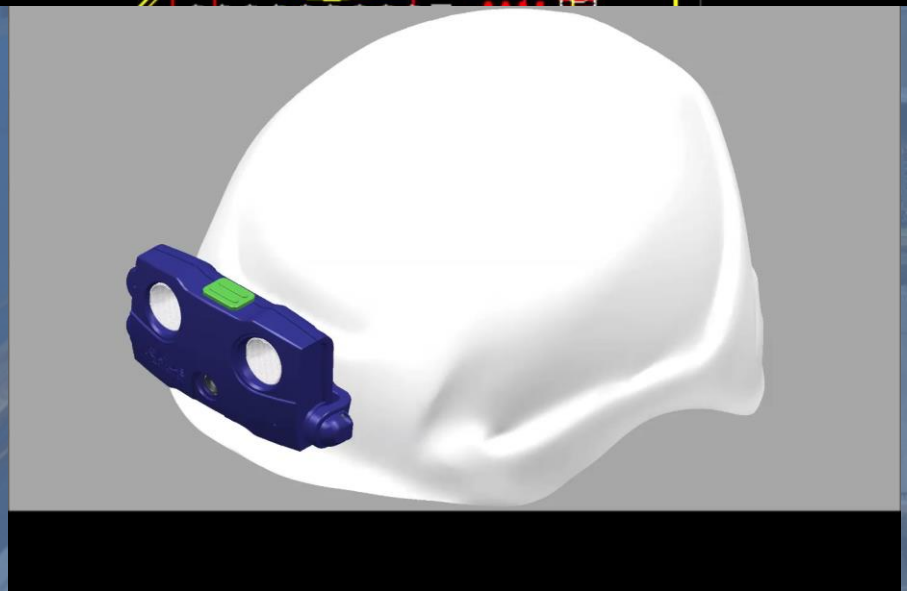




The System Hardware is under construction ...



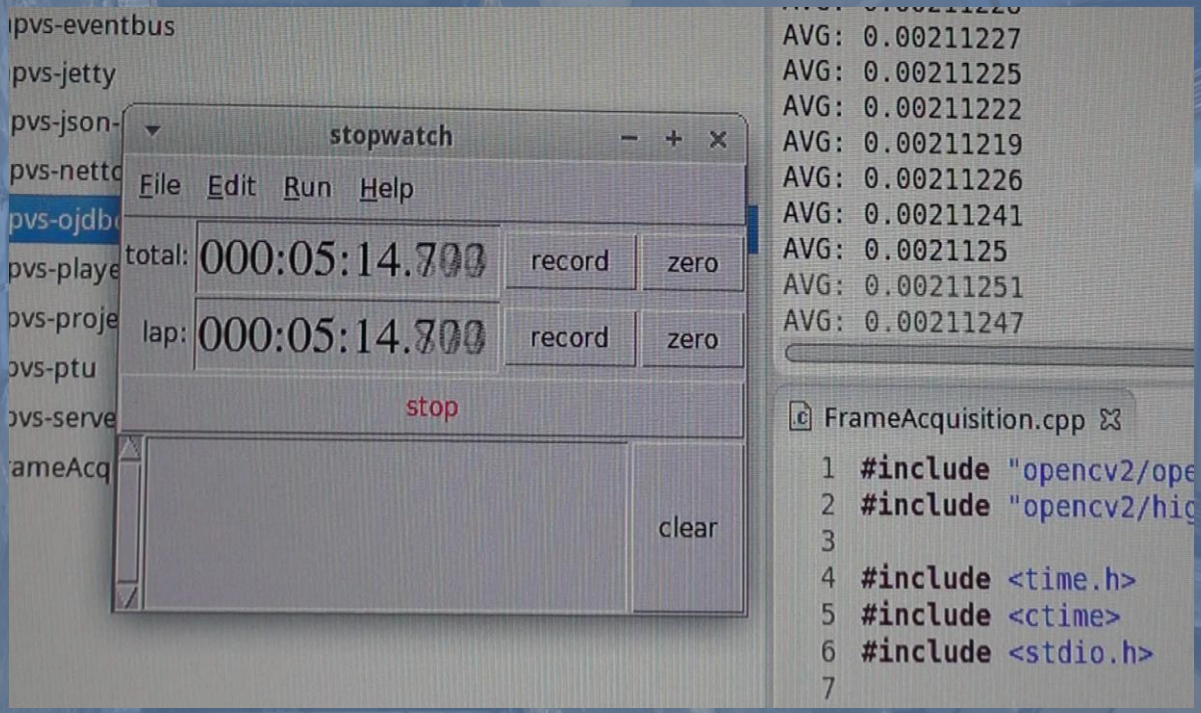




System integration and testing campaign has started ...

We start measuring performance ...

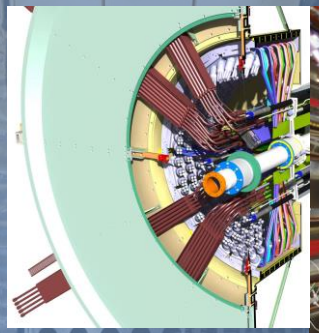
- ✓ data transfer
- ✓ system accuracy and fastness
- ✓ ease of use
- ✓ ergonomy, etc ...



The results are up to now
better than expected for the first prototype !

- **Development of remote handling and robotics technologies towards the ATLAS/CERN needs for the maintenance and upgrade activities with high radiation risks.**

For places where the instantaneous dose rates and/or the collected doses are too high ..



Identified activities :

- ✓ **LS3: Beam Pipes removal**
- ✓ **LS3: Inner Detector Removal**
- ✓ **LS3: ID services dismounting**
- ✓ **After LS3: Annual Inner Detector maintenance**

We are currently looking the best way to approach the problem within CERN : expert companies ? EU funded project dedicated to CERN problematic ?

This problematic has to be coordinated within CERN
A working group is currently being set up to tackle this problematic for HL-LHC