



CERNUM: AN ADVANCED TRAINING TOOL IN THE SERVICE OF RADIATION PROTECTION 2013 FIRST APPLICATIONS : SIMULATION OF IRRADIATING SOURCES

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CONTEXT AND AIMS

- **Realistic training tool to provide a radioactive environment area without risk of exposition for the trainees .**
 - For the collective and individual dose monitoring.
 - To measure an ambient dose and/or hot spots / To mark out a area with a high or very high ambient dose.
- **To avoid the use of radioactive sources.**
- **Simulation of the physical effect of radiological protections.**
 - Lead protection / Pipe full of water



SOLUTION PROPOSED BY EDF R&D

- To develop an advanced method for a realistic training, providing the trainees with high-quality dose readings.

Transmission of the position of the trainees by geolocalization.

Dose assessment based on a calculated virtual dose.

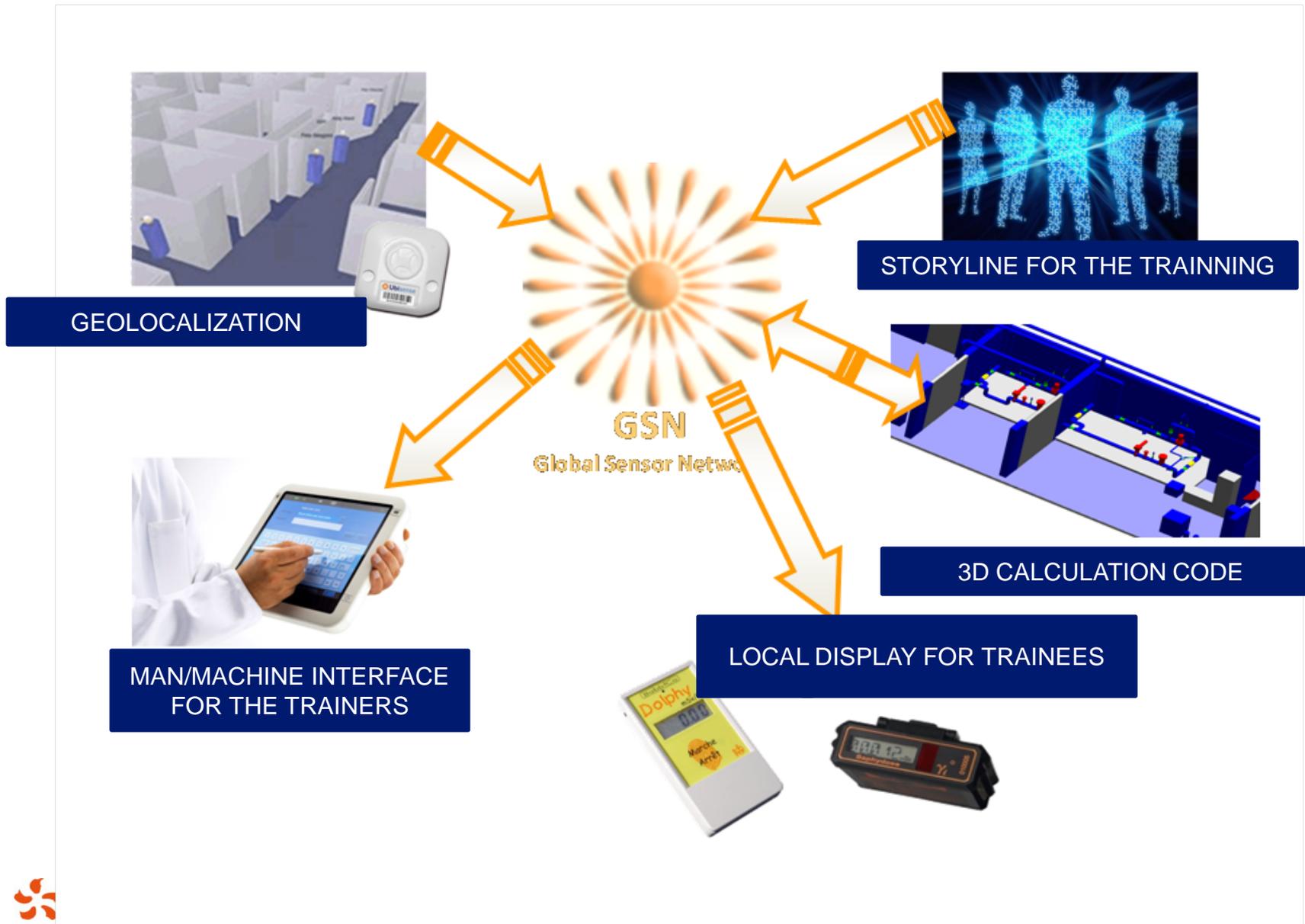
Software solution for implementation and communication

Interaction in real time between the trainer and the training storyline.

Simulation of the measure system for the virtual dose restitution

Real training area on each nuclear power plant with every material that trainees could see in controlled area

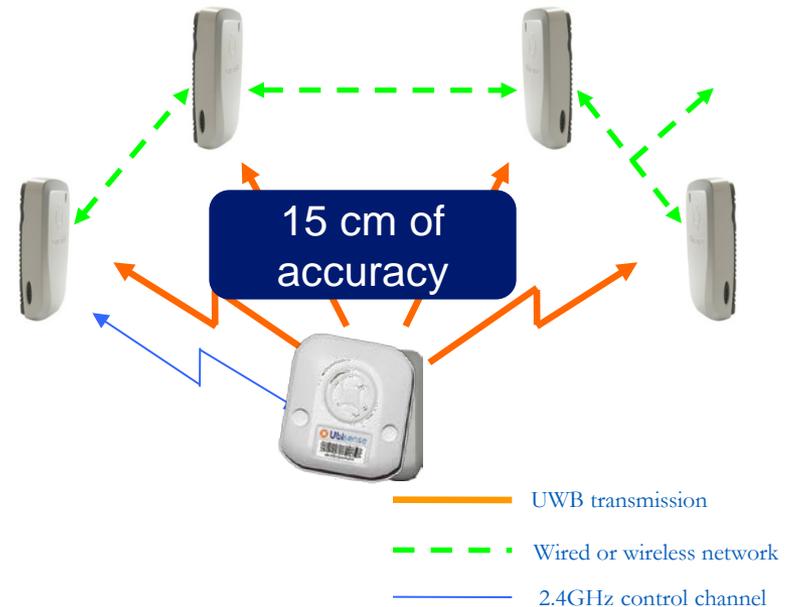
CERNUM : PRINCIPLE



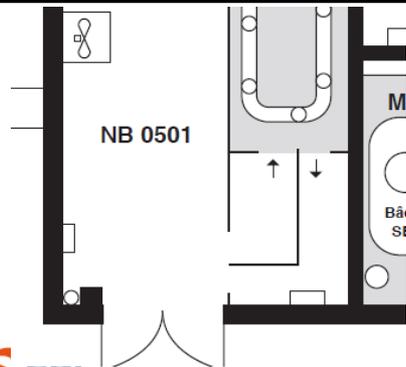
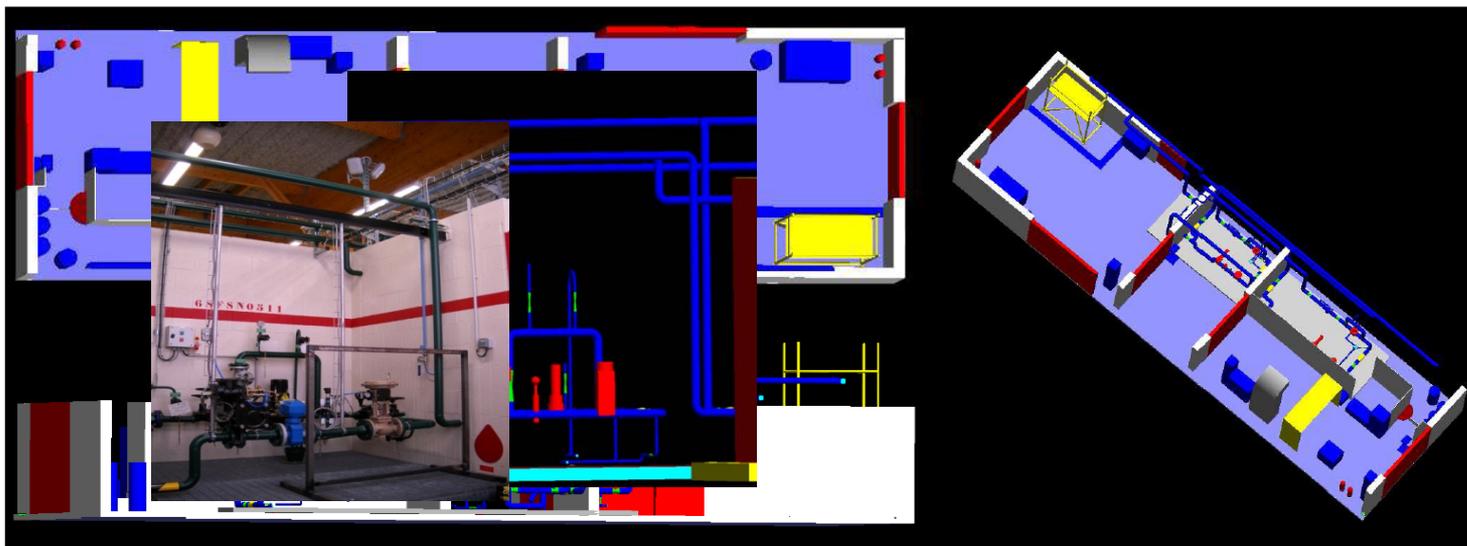
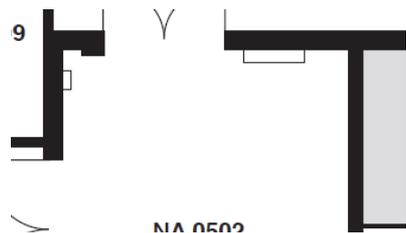
CERNUM: GEOLOCALIZATION SYSTEM IN THE CIVAUX AREA TRAINING



- Covering 4 rooms of the training areas
 - 3 during 2011 (blue)
 - Last one in 2014 with capacity element (pink)
- The geolocation system with 16 static tags and 30 mobiles



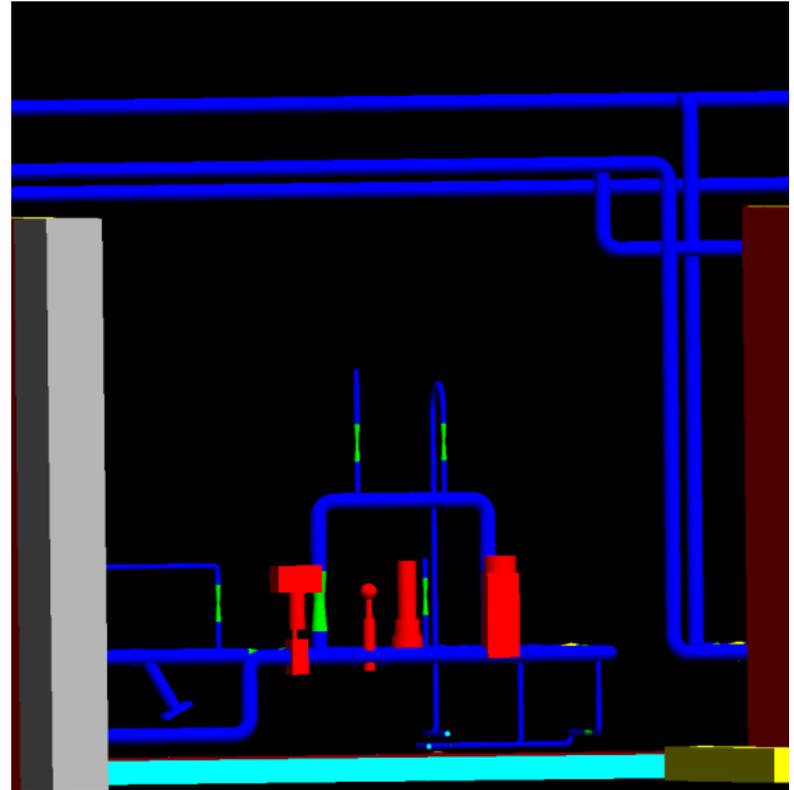
CERNUM: MODELING OF THE TRAINING AREA THANKS TO MODERATO



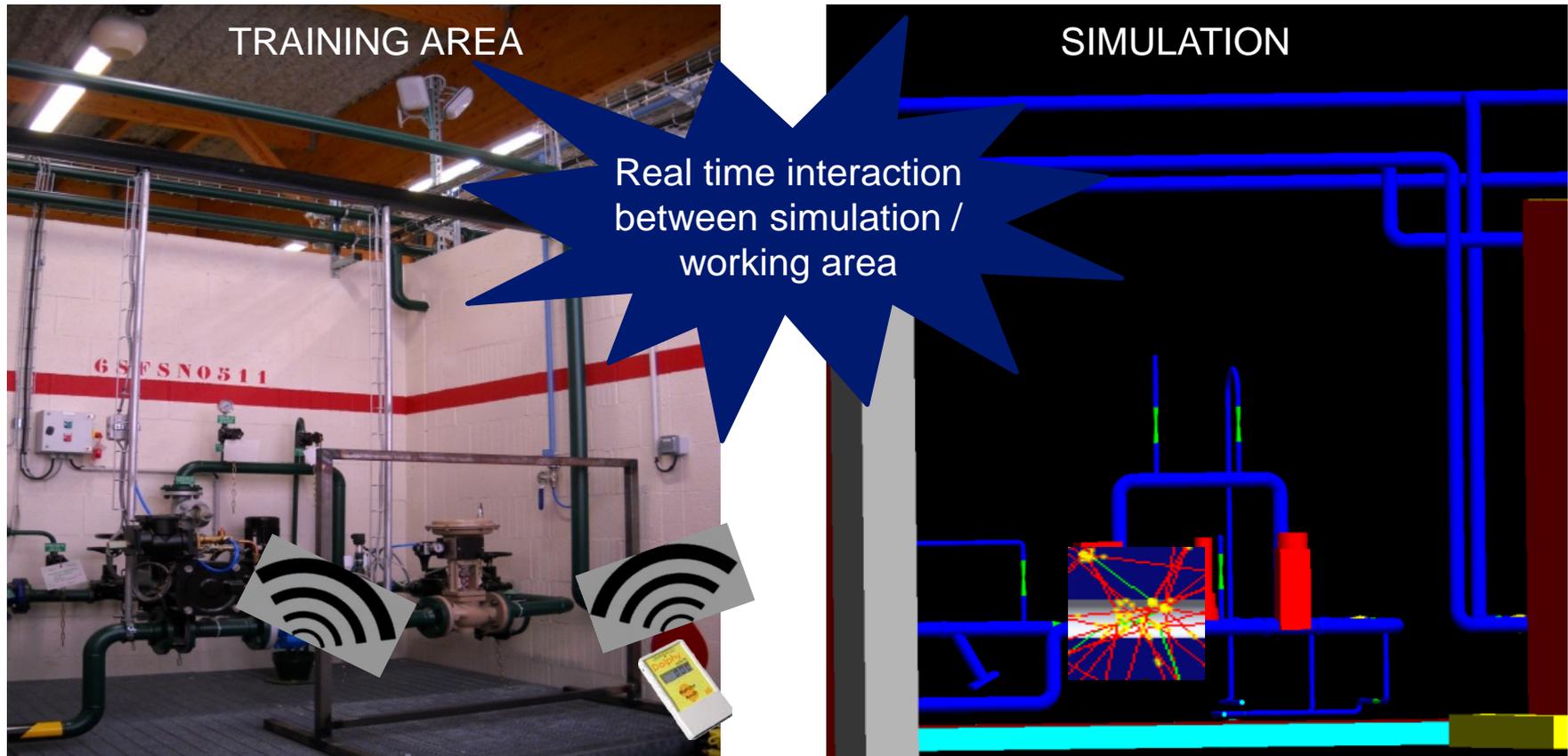
CERNUM: FOCUS ON THE CALCULATION CODE

■ MODERATO

- Straight line model calculation code.
- Developed by EDF.
- Graphical interface in order to construct the geometry easily
- Creation of hot spots.



CERNUM: METHODOLOGY OF INTERACTION BETWEEN THE MODELING AND THE TRAINING AREA



CERNUM: REALISTIC RESTITUTION ON THE TRAINING AREA

Dosimeter



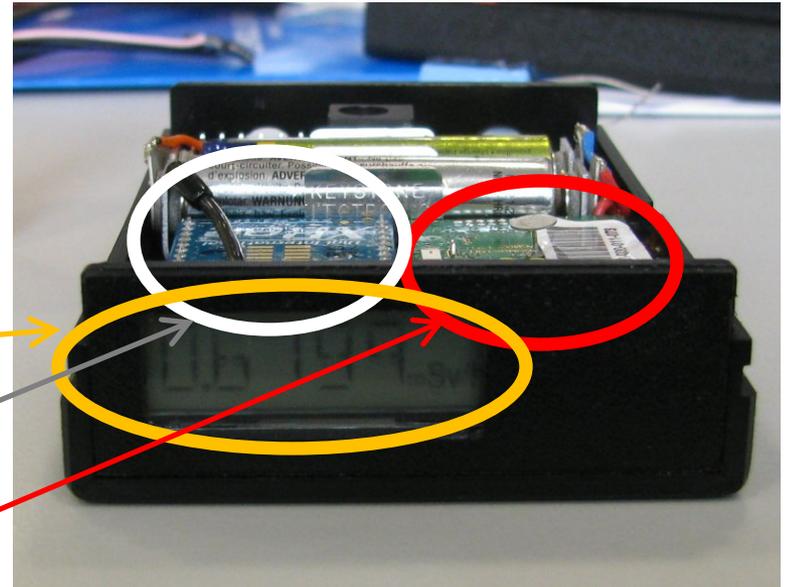
Radiameter



Screen

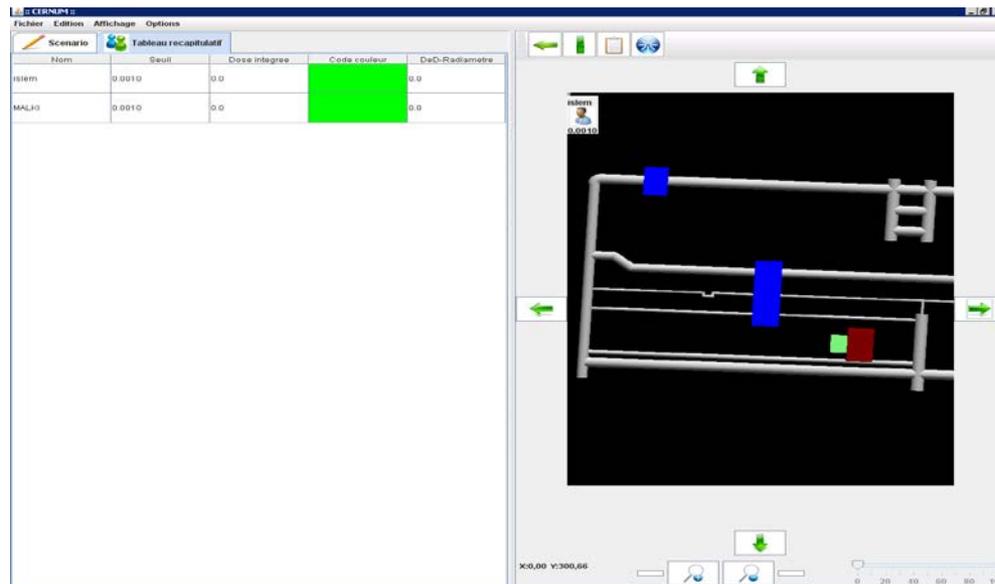
Reception

Geolocalization



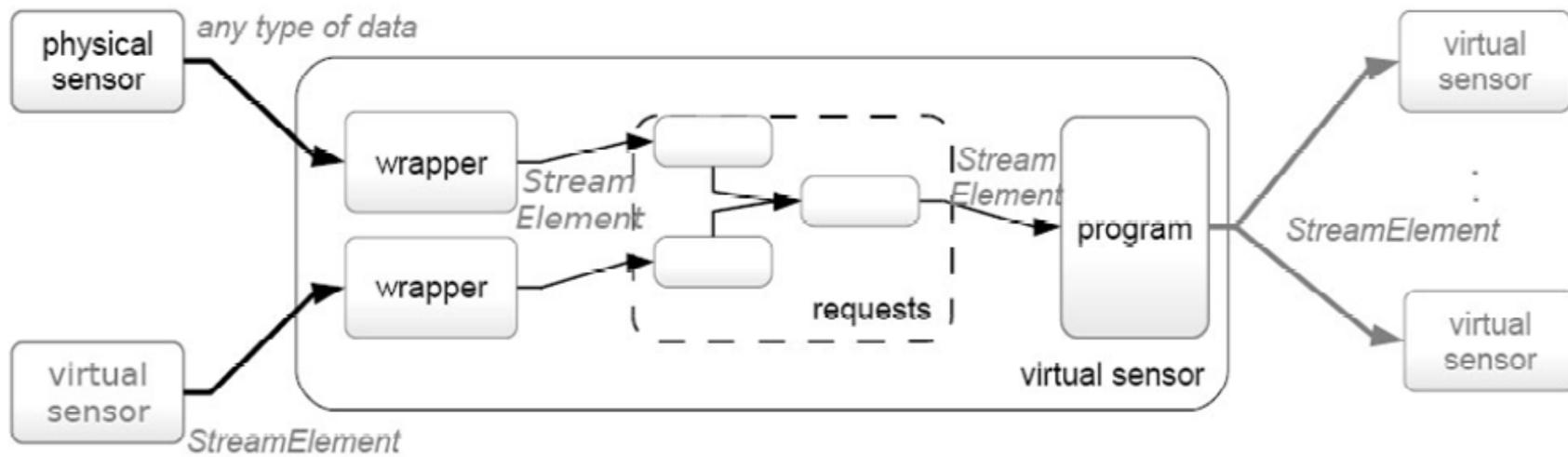
CERNUM: REFLEXION FOR THE IMPLEMENTATION OF MAN/MACHINE INTERFACE

- The trainer needs an interface to play the storyline of the scenario of the training
- Bases of the storyline with ambiance dose and potentially several hot spots.
- Creation of additional hot spots
- Modification of the ambiance of the area during the operation
- Monitoring of the virtual dosimetry of the trainees thanks to the transmissions from the dosimeters and radimeters



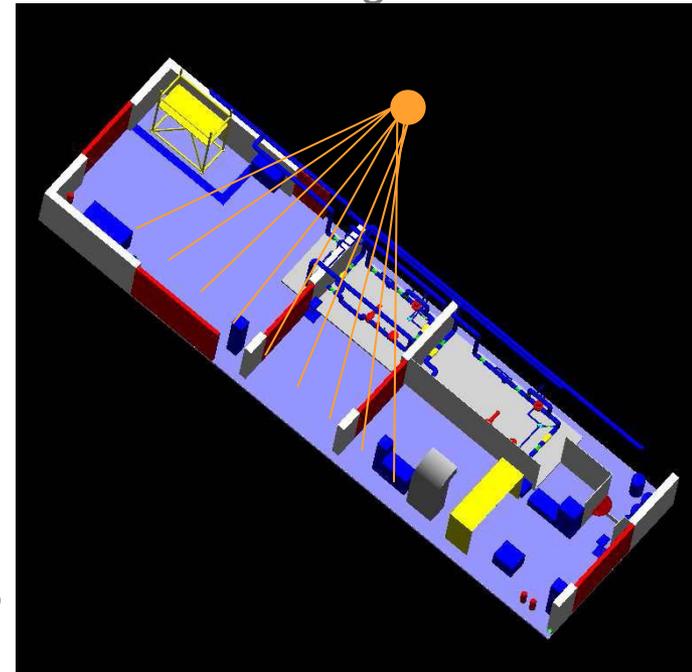
CERNUM: SOFTWARE ABLE TO MANAGE EACH ELEMENT: GSN (GLOBAL SENSOR NETWORK)

- GSN is an open source software developed by the polytechnic university of Lausanne
- Middleware designed to facilitate the deployment and programming of sensor networks
- Make connections with geolocalization/calculation and factice display devices



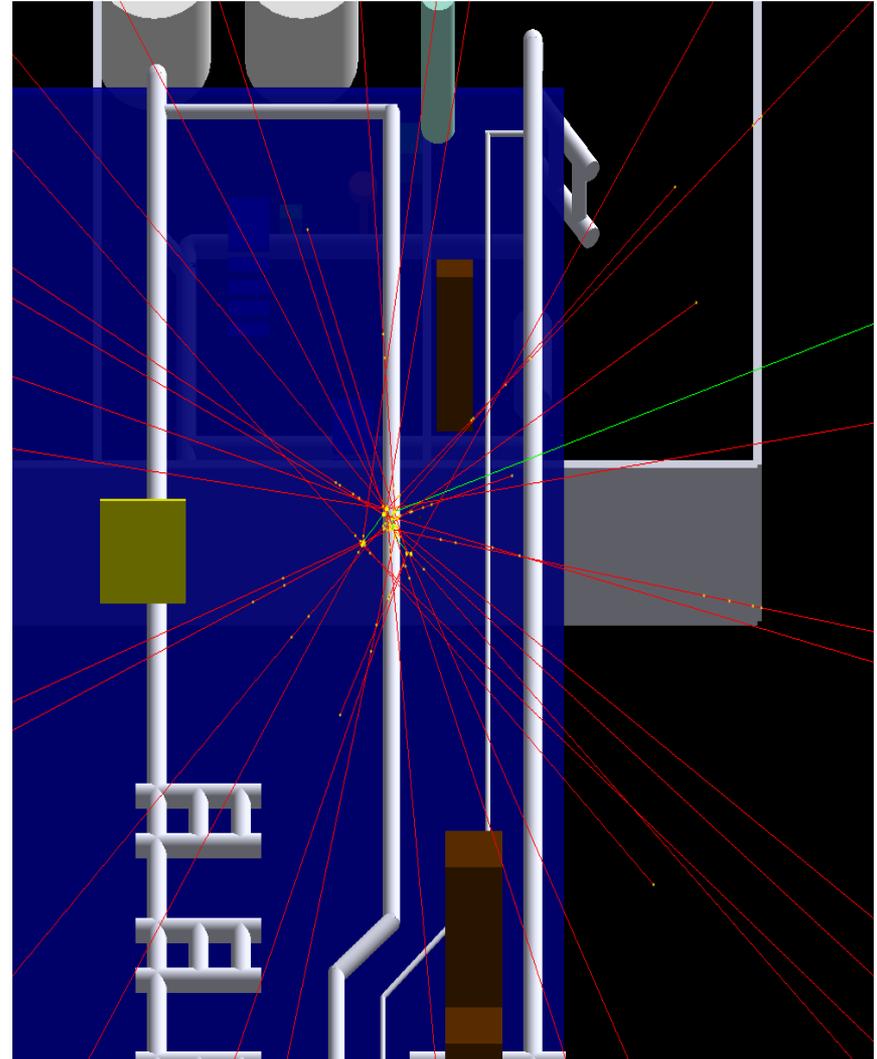
THE FIRST EXPERIMENTATION ON THE CIVAUX TRAINING AREA

- For different kinds of training (operator and working supervisor)
- 12 trainees by session with 2 trainers
- From mars 2013 to november 2013
 - Creation and deviation of a 0.2 mSv/h ambient dose in the working area
 - Research of additional hot spots thanks to radiameter
 - Real raise of the dose equivalent range
- Excellent feedback of the trainer and the trainees and very interesting behaviors of the trainees following the trigger alarm.
- Feedbacks of the observations in progress



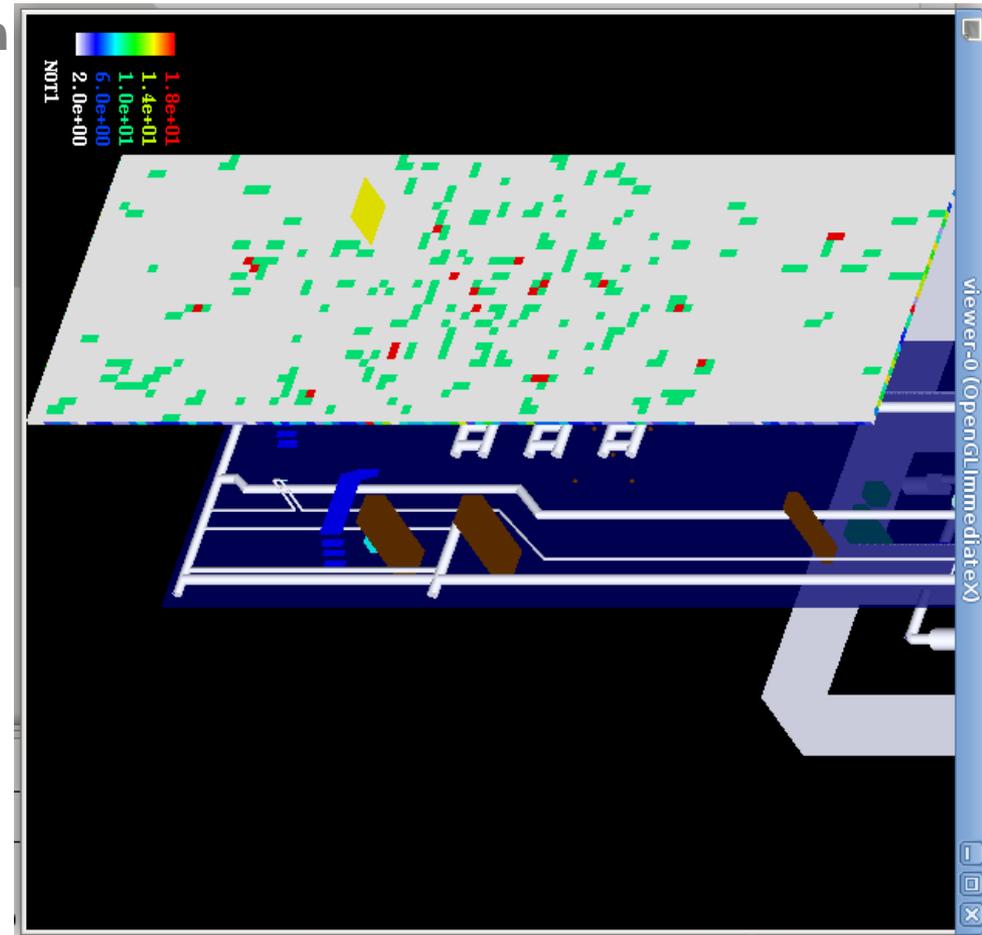
CONCLUSION AND PERSPECTIVES (1/2):

- A new solution for the training.
- Realistic radiological environment without exposition of the trainees.
- Association of several technologies:
 - Geolocalization
 - Middleware
 - Calculation code
- Developments of display devices with on site design measure tools.
- First training with CERNUM in progress at Civaux:
 - Very good feedbacks from the trainees and the trainers
 - New training sessions during 2014



CONCLUSION AND PERSPECTIVES (2/2):

- Implementation of a new calculation code based on the Monte Carlo simulation (Geant4).
- Creation of a mock-up on the R&D site (also used for new developments).
- Installation of a new version of CERNUM included the new calculation process in the Civaux training area.
- The installation of the CERNUM is considered on each EDF training area .



**Thank you for
your attention**