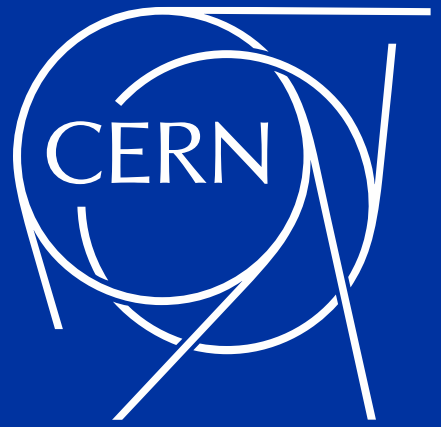


ISOLDE – MEDICIS Robots KUKA discovery day

Jean-Louis GRENARD – SY-STI - CERN

28-03-2022

Content

A few words on ISOLDE facility

How the system has been designed

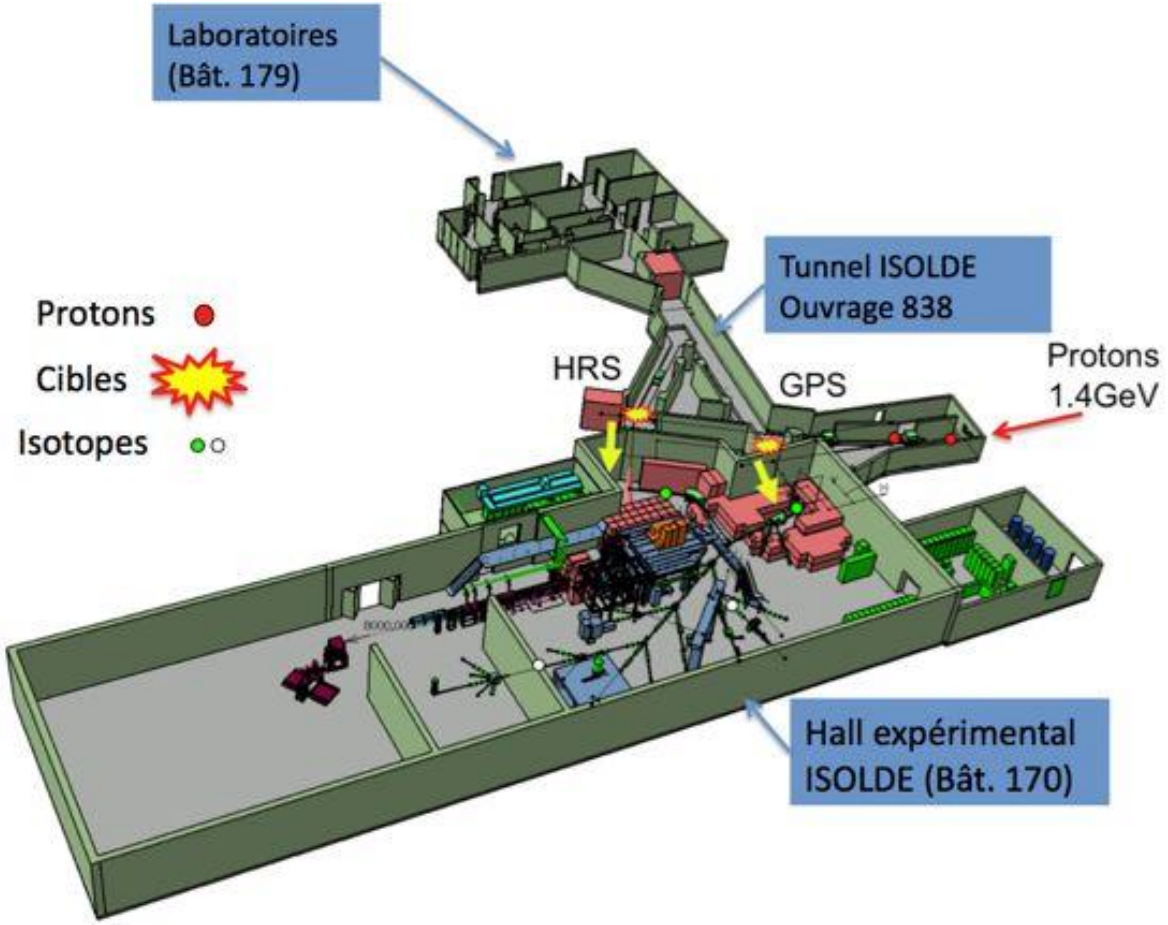
The implementation of the robots

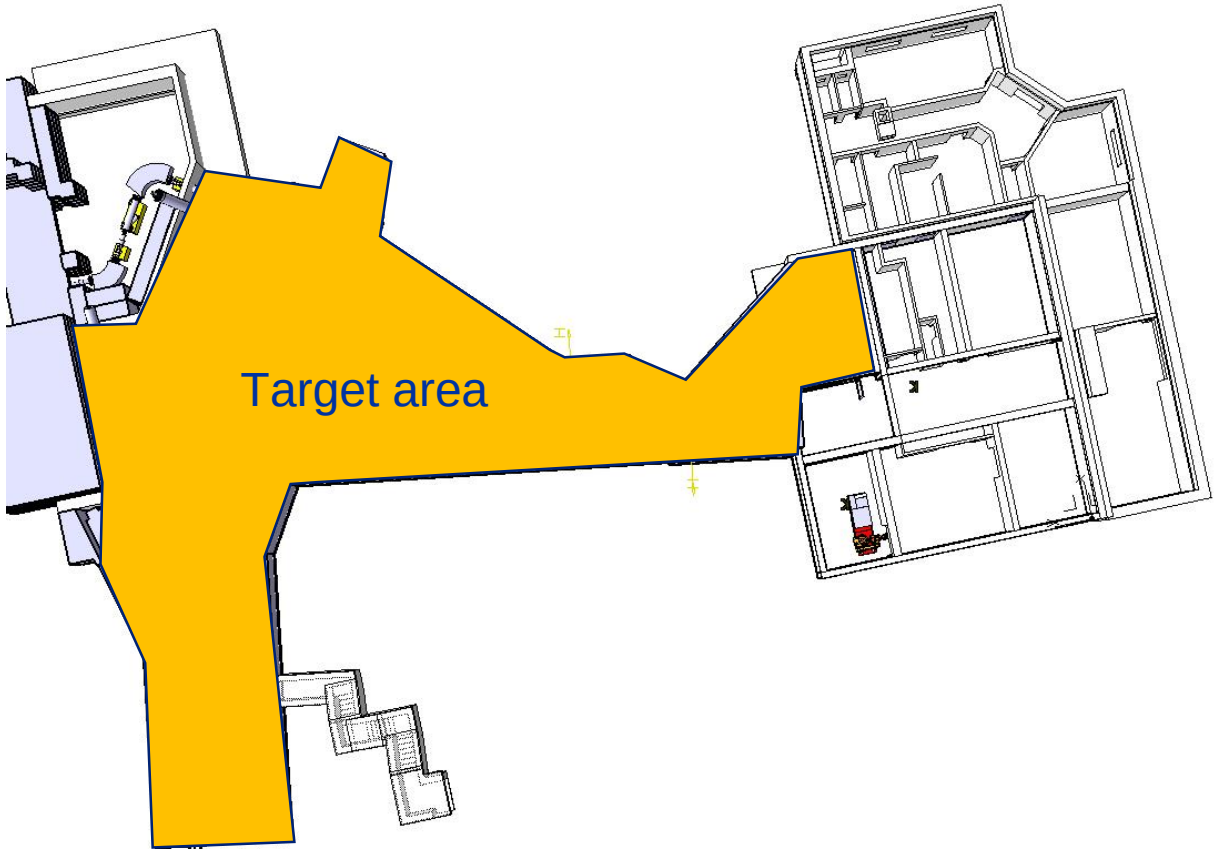
Recovery methods

Operational feedback

A few word on MEDICIS

General layout of the ISOLDE facility





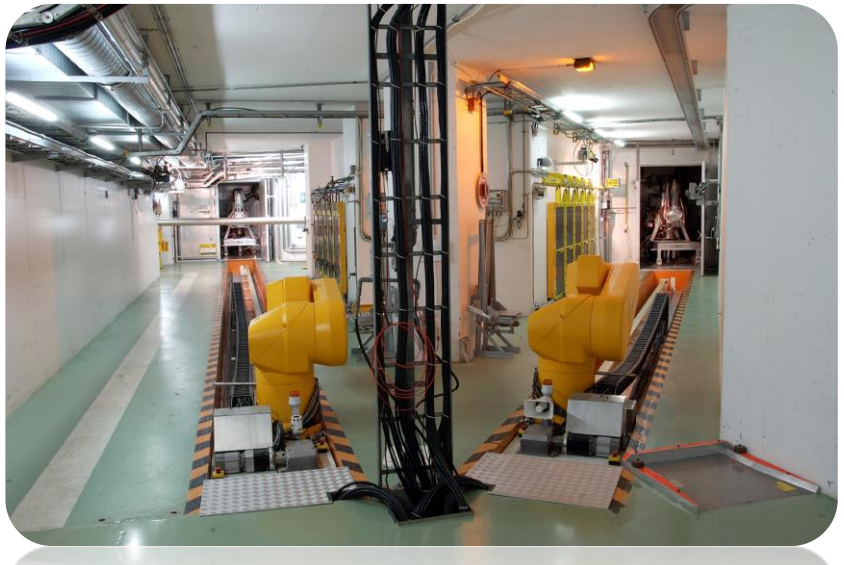
What was the aim of the project

Obsolete controls leading to unacceptable failure rate

No remote recovery options

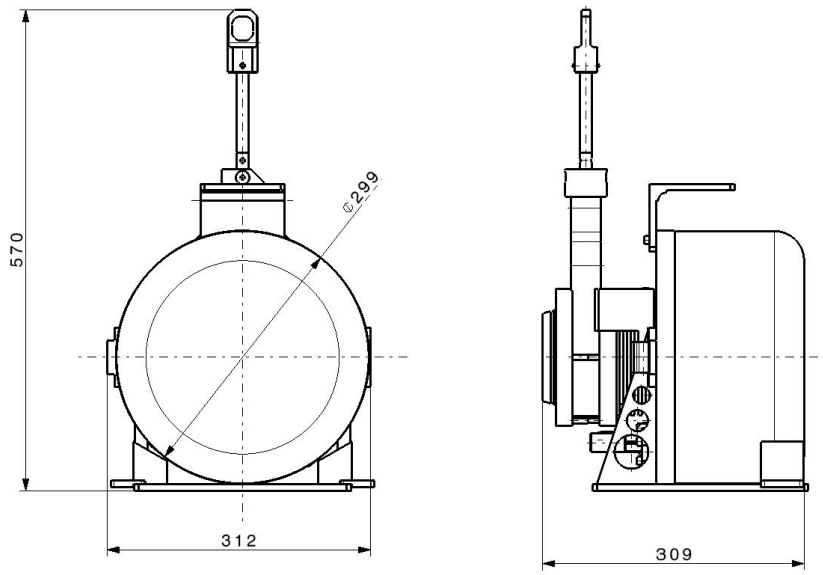
Needs of evolution regarding the evolution of the facility

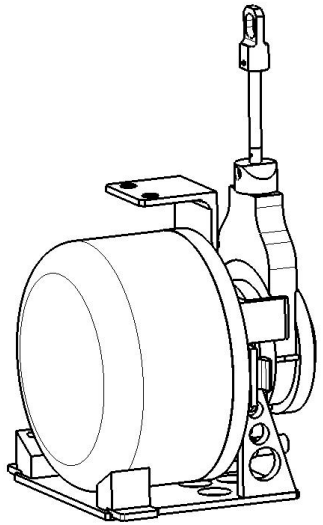
In operation since 1992



What do the robots do?

Exchange of the targets of the ISOLDE facility





ISOLDE Target
Maximum weight: 26.5 Kg

The robots are part of the process of the facility

At ISOLDE ~30 targets exchange/years

How the robot have been selected?

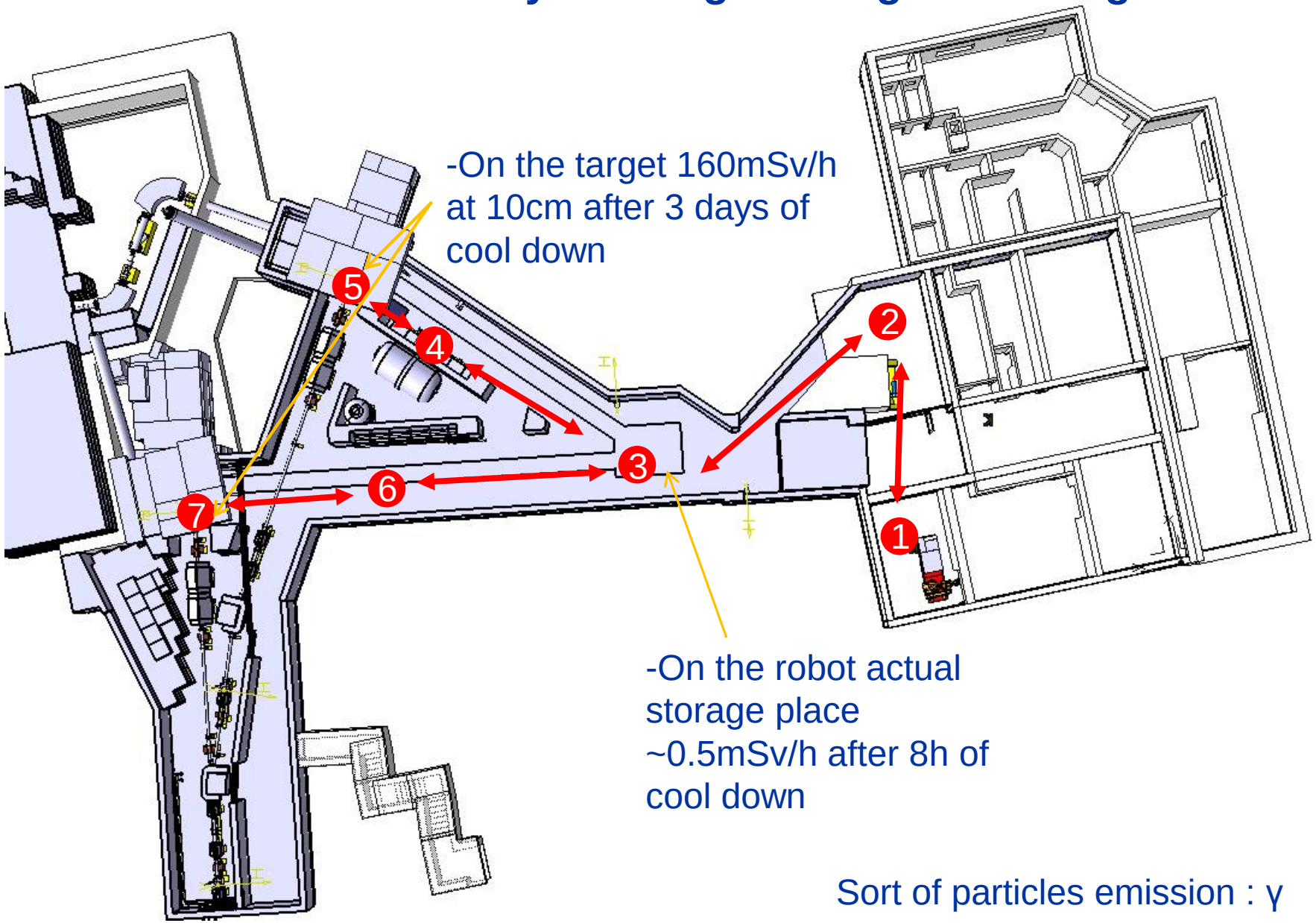
Study of the radioactive environment

- Based on operational records
- Fluka simulation

➢ **Major constrain for the system in term of operation, maintenance and failures scenarios**

➢ Approach on Radiation To Electronics (and Radiation To Material) : see Ruben Garcia Alia talk

Doserate decay - During the target exchange

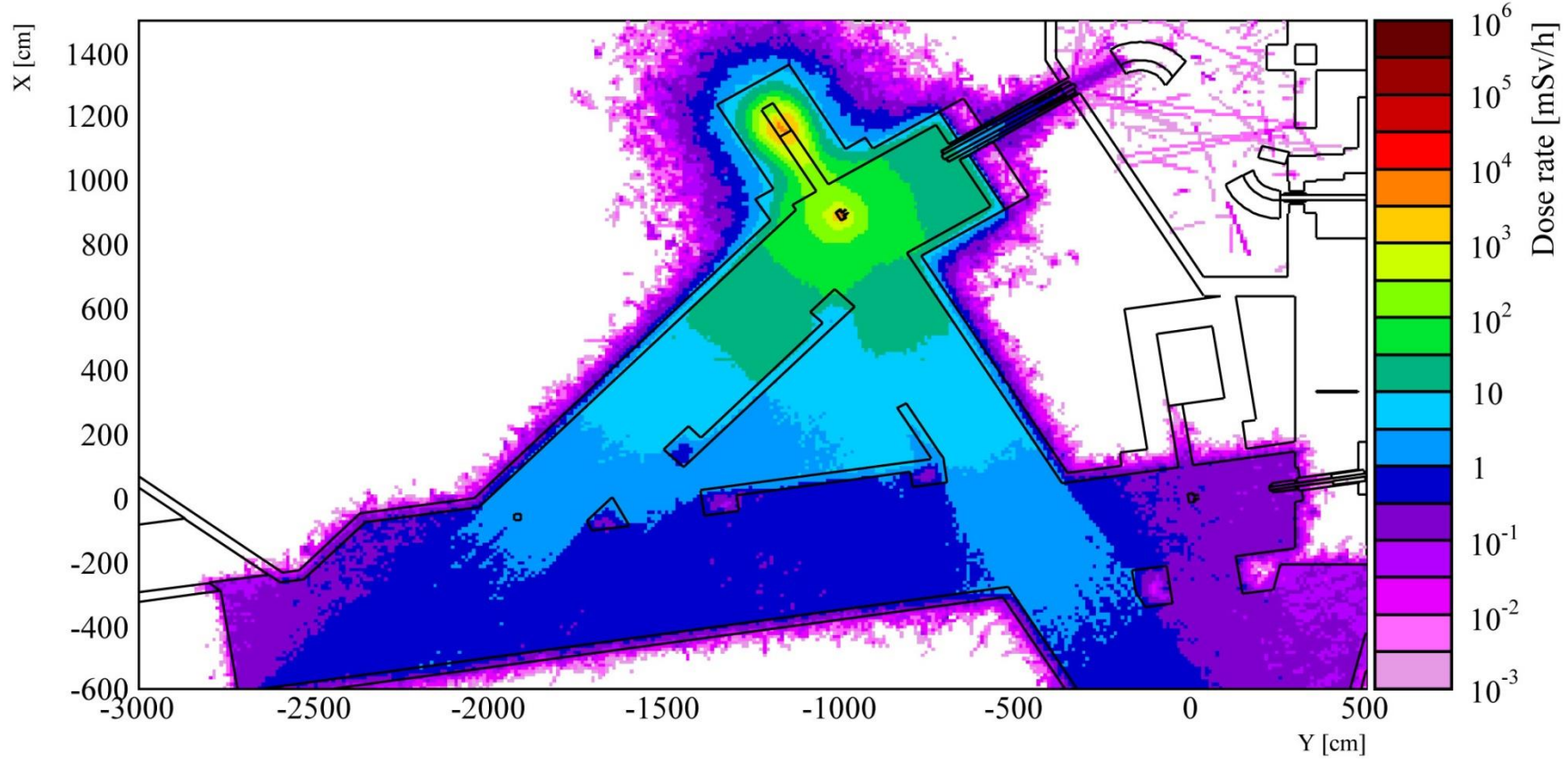


Sort of particles emission : γ

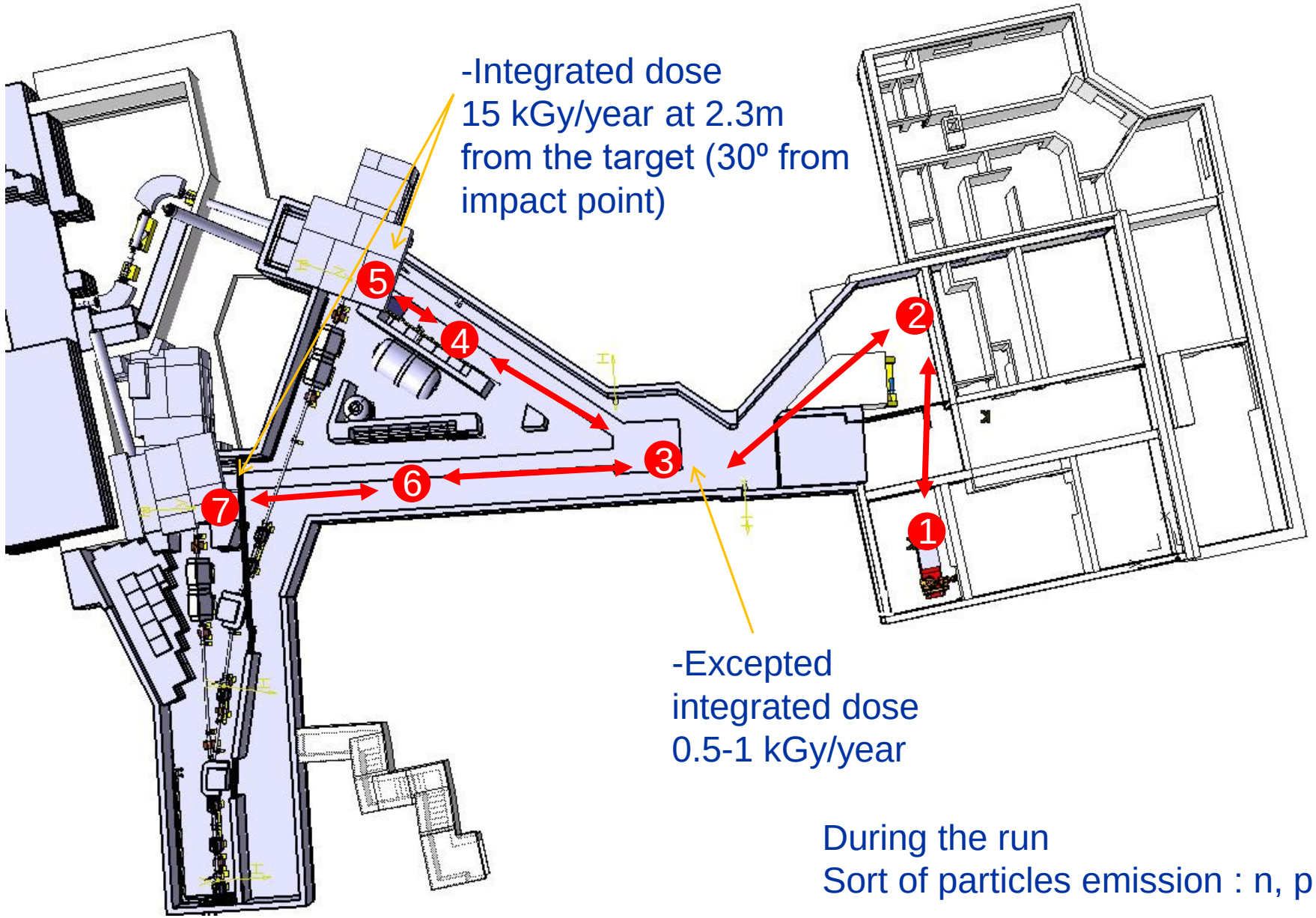
Example of residual dose rate map (72 h CT)

Most of the beam absorbed in the beam dump (shielded)

Several Sv/h on contact of the target (after 72 h of decay)



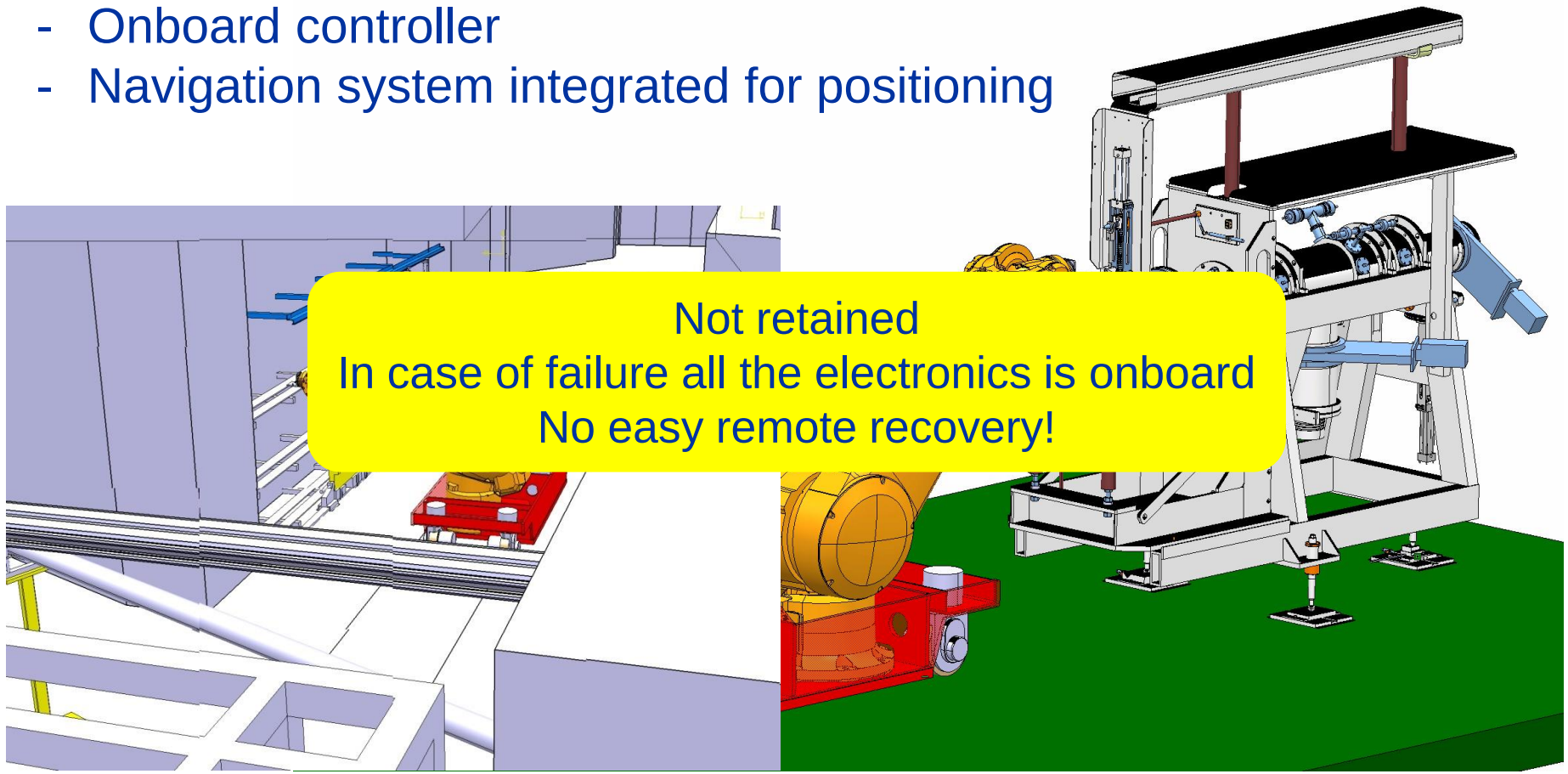
Actual integrated dose during 1 year of operation



During the run
Sort of particles emission : n, p, γ…

First idea: robot mounted on an AGV

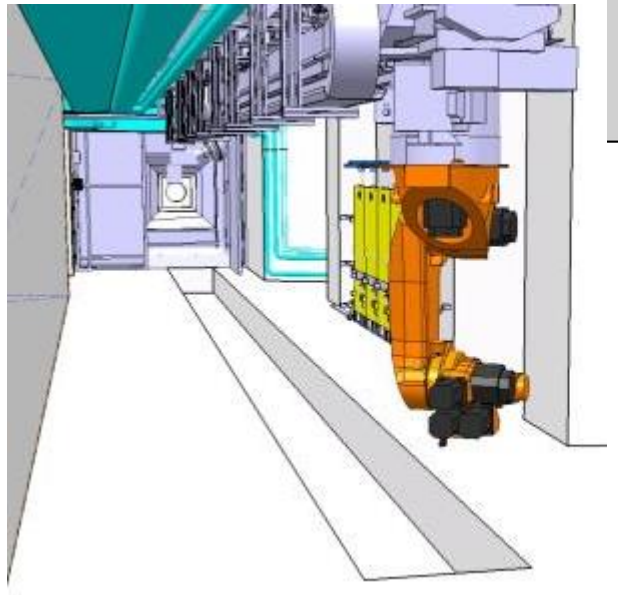
Autonomous vehicle
- Battery powered
- Onboard controller
- Navigation system integrated for positioning

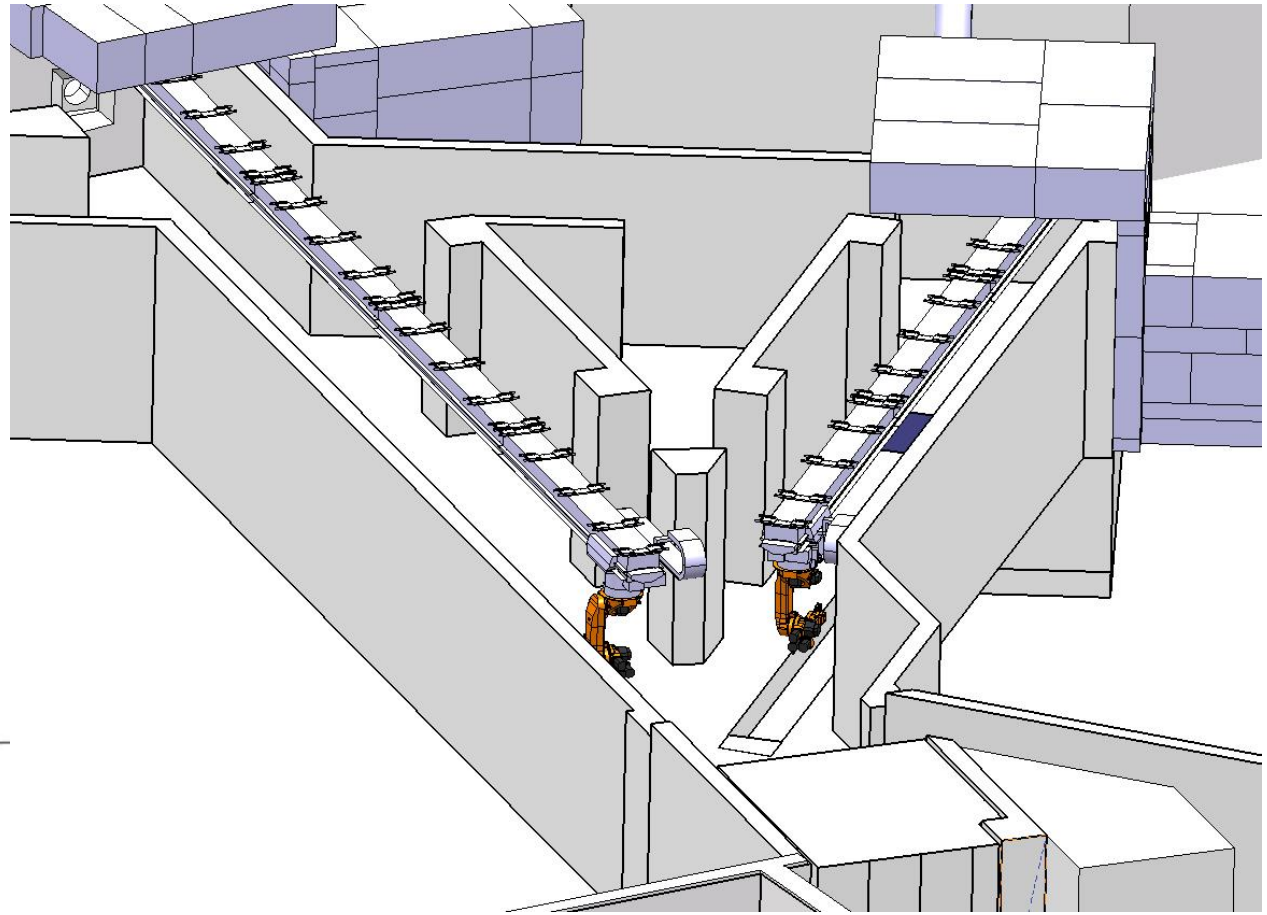


Not retained
In case of failure all the electronics is onboard
No easy remote recovery!

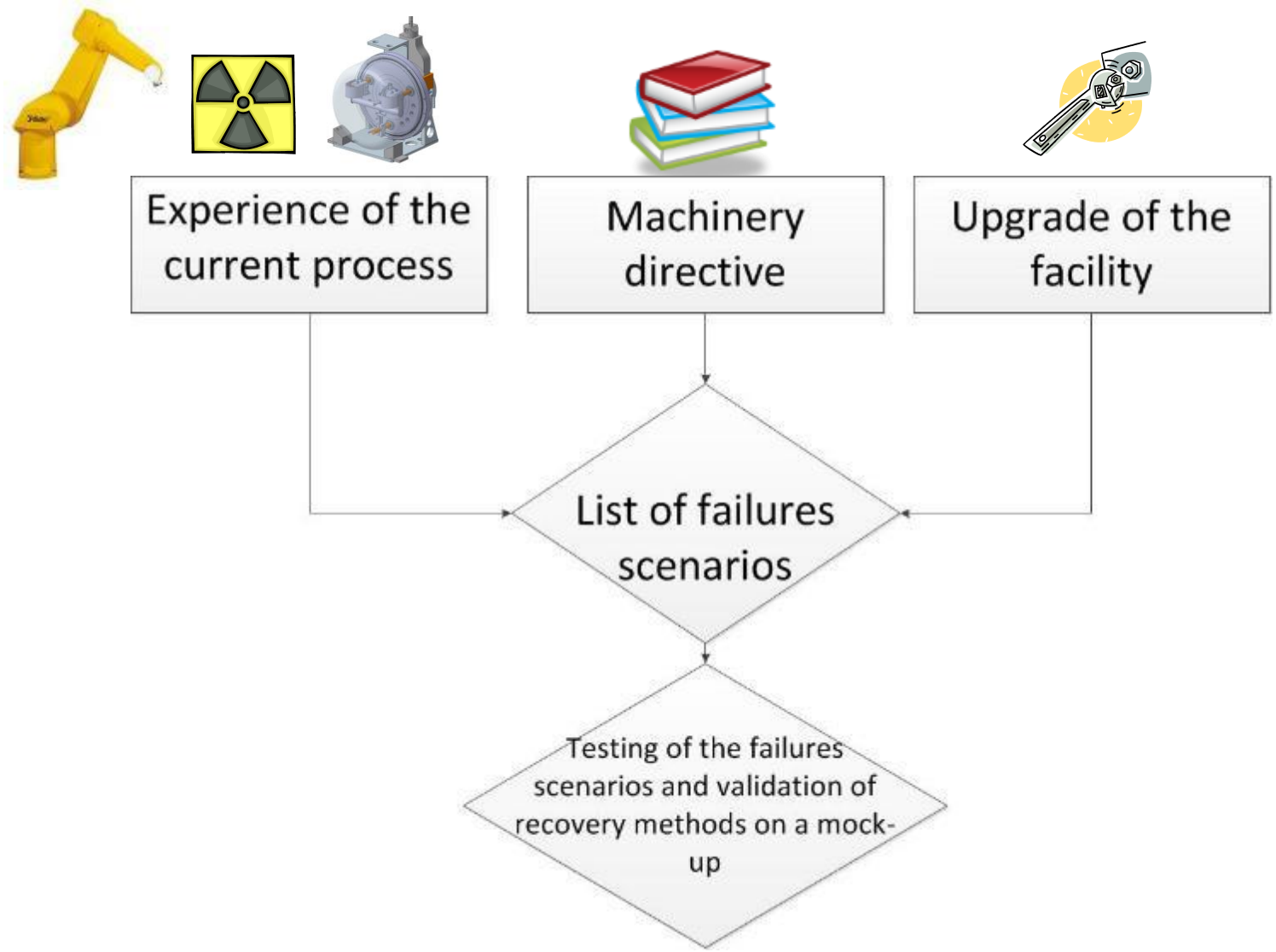
Solution adopted

Two industrial robots mounted on a linear axis



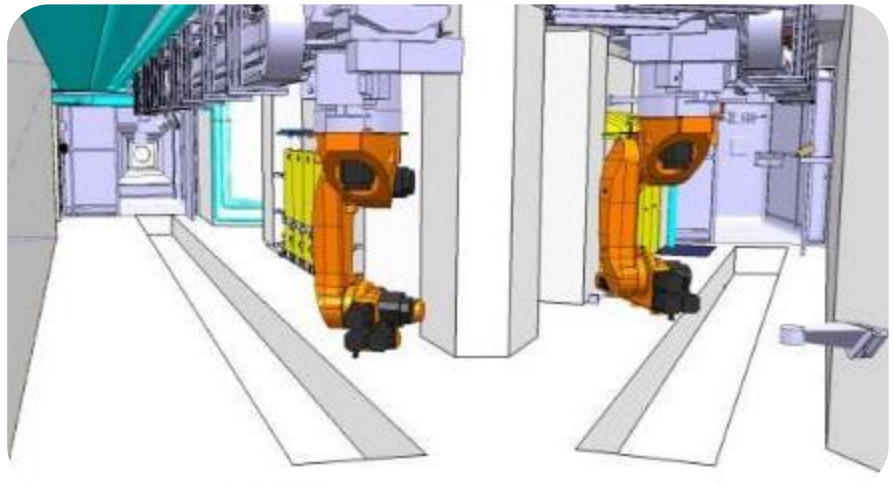


How to decide between those options



Specificity of the ISODLE robot

- Concept base on an industrial robot mounted on a linear axis
- KUKA K60L45-3CF (specific options to resist radiation)
- Resolver positioning technology
- No electronic* on board (see next slide)
- Safe robot



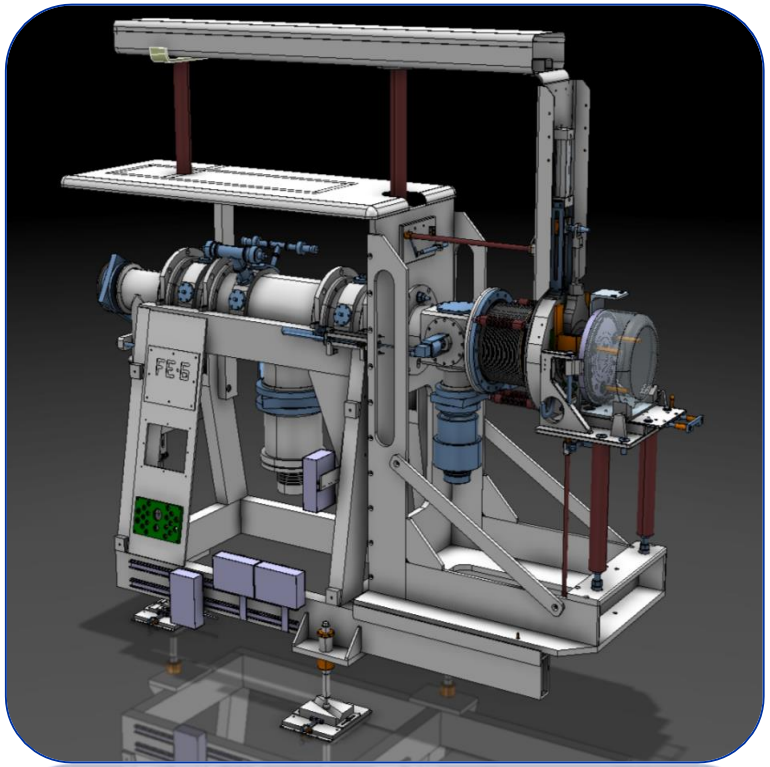
No electronic inside the target area

CERN has moved the electronic out of the target area ~60m distance between robot and electronic board

- Installation of longer cables tolerant to radiation for robot application (custom built cables from a cable manufacturer)
- Capability to bypass the embedded temperature sensor of each motor
- Installation of radiation tolerant connectors
- Design of a radiation tolerant specific gripper (interface between the target and the robot)
- Specific design of the trajectories and the control system
- Capability to replace all electronic components without intervening inside the target area

Design and integration of the system

Has to be compatible with the various interface of the facility



Front End

Storage shielded sleves

Risk analysis for the refurbishment of the target exchange system

Experience of the current process

- List of failures during operation with the existing system

Machine directive

- Standards (human aspect)
- Facility aspect (protection of equipment installed in the area)

Upgrade of the facility

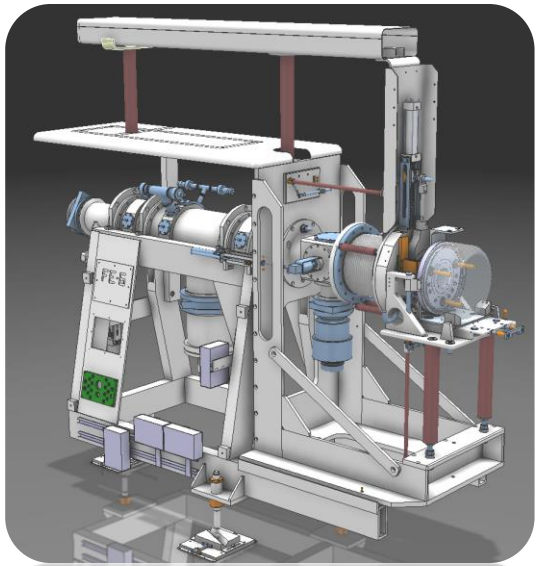
- New risks caused by the robots
- New risks caused by the change of the process

Risk analysis for the refurbishment of the target exchange system

List of 40 failures scenarios

- Include the robots
  - Motors
  - Cables
  - Control
  - Gripper

- The interfaces with the robots
  - Front ends
  - Shielded storage shelves
  - Exchange point
  - Faraday cage
  - Beam Line
  - Building

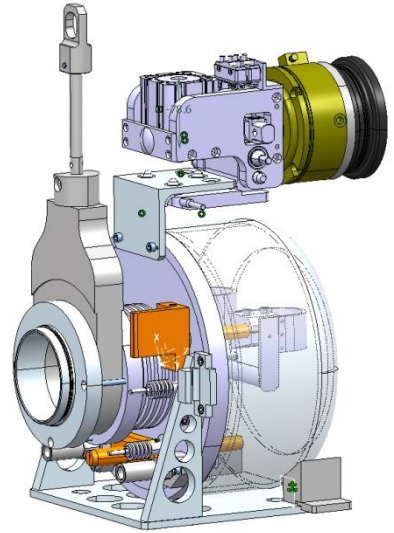


They all include the criticity, and a solution for correcting the failure identified

Risk analysis for the refurbishment of the target exchange system

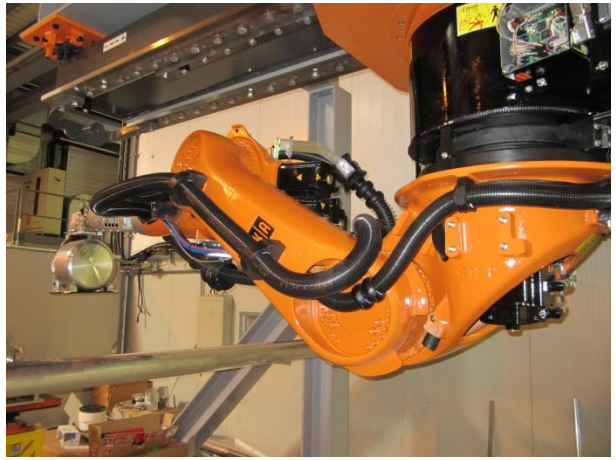
Design change of parts of the process to avoid failures

- New gripper with redundant functions
- Implementation of feedback of each status
- Control system include recovery method
- No electronic on the hot area
- Based on an industrial robot

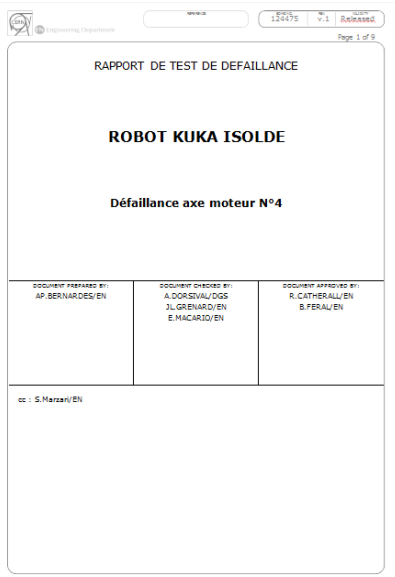


Risk analysis for the refurbishment of the target exchange system

- **Testing of the failures scenarios**
  - Simulation of failures on full scale mock up
  - Recovery methods
  - Test report



All this process are part of the safety file the target exchange system



RAPPORT DE TEST DE DEFAILLANCE

ROBOT KUKA ISOLDE

Défaillance axe moteur N°4

Design and integration of the system

- Has to fit (and enter) in the target area
- Has to fit with the radiation levels present in the target area
- Prevent any damage in case of a clash between any interface

Recovery capabilities

- Possibility to bypass all the conditions in order to finish a cycle or get read of the target
- Supervision system which guarantee a safe monitoring at any moment of all the actuators during the trajectories
- Collision release mechanism at the gripper flange
- Check of the conditions at the start of the execution of a cycle
- A series of tests has been made in a mock up

Advanced recovery capabilities

In case of major failures other remote recovery technics exist

- **Visual inspection with a remotely controlled ‘’train’’ or with a mobile robot**
- **Intervention with remotely controlled robot(s)**

➢ See Eloise Matheson talk

Feedback of about ~8 years of operation

- **About 700 operations performed for the ISOLDE target area**
- **Operation of the robot at 15% of maximum operational speed (sufficient for our operational needs)**
- **One failure directly linked to the robot:**
  - Presence of silicon based temperature sensor embedded on the robot motors (was not identified at the stage of robot selection)

Evolutions of the system

Additional experiment installed in 2017 inside ISOLDE -> MEDICIS

https://medicis.cern/

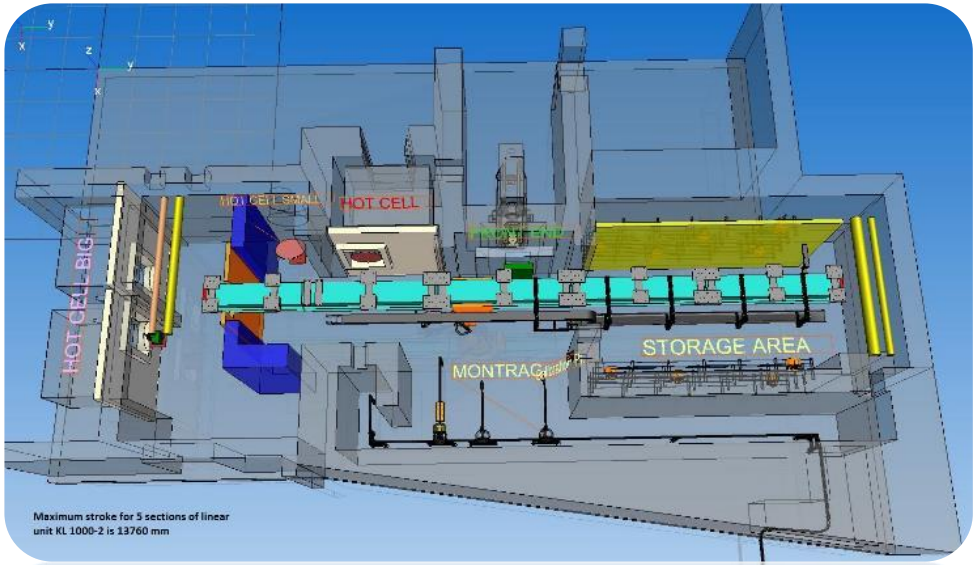
Production of radioactive isotopes for medical applications

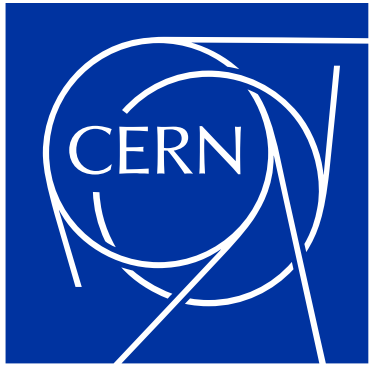
- New handling capability
- Highly activated targets
- Automatic transfer of targets from / to the target area

MEDICIS robot

Exactly same concept applied as at ISOLDE

Apart absence of prompt radiation





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