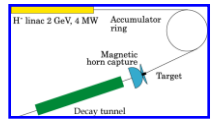
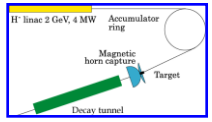


WP2 progress on safety

E. Baussan

EUROnu CB Meeting
Monday 10th & Tuesday 11th June 2011
CERN, Geneva, Switzerland



Outlines:

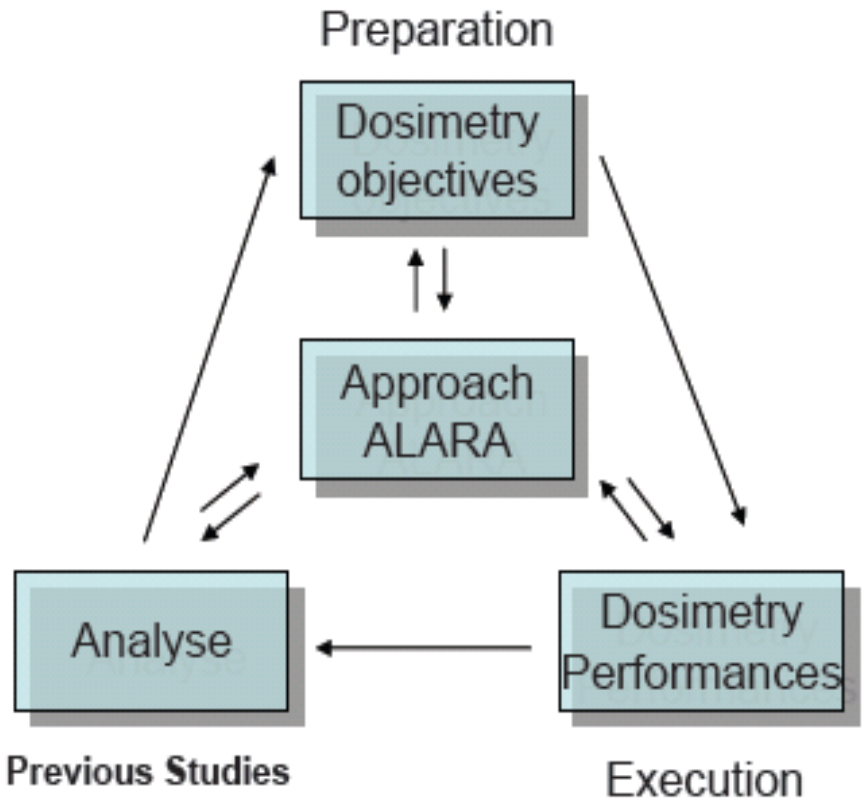
- Introduction
- SB layout facility simulation
- One horn simulation
- Next steps

Toward a safety WP2 roadmap

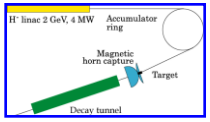
- **ALARA approach :**

⇒ **Anticipate and reduce individual and collective exposition to radiation**

- **Iterative processes :**
  - Préparation
    - Building Structure lists of materials
    - Dose Equivalent Rate Estimation
    - Optimize procedure during operation and maintenance phases
    - Evaluate residual activity of wastes ....
  - Execution
  - Safety Analyse from previous facilities (WANF, CNGS, NuMi, J-PARC…)



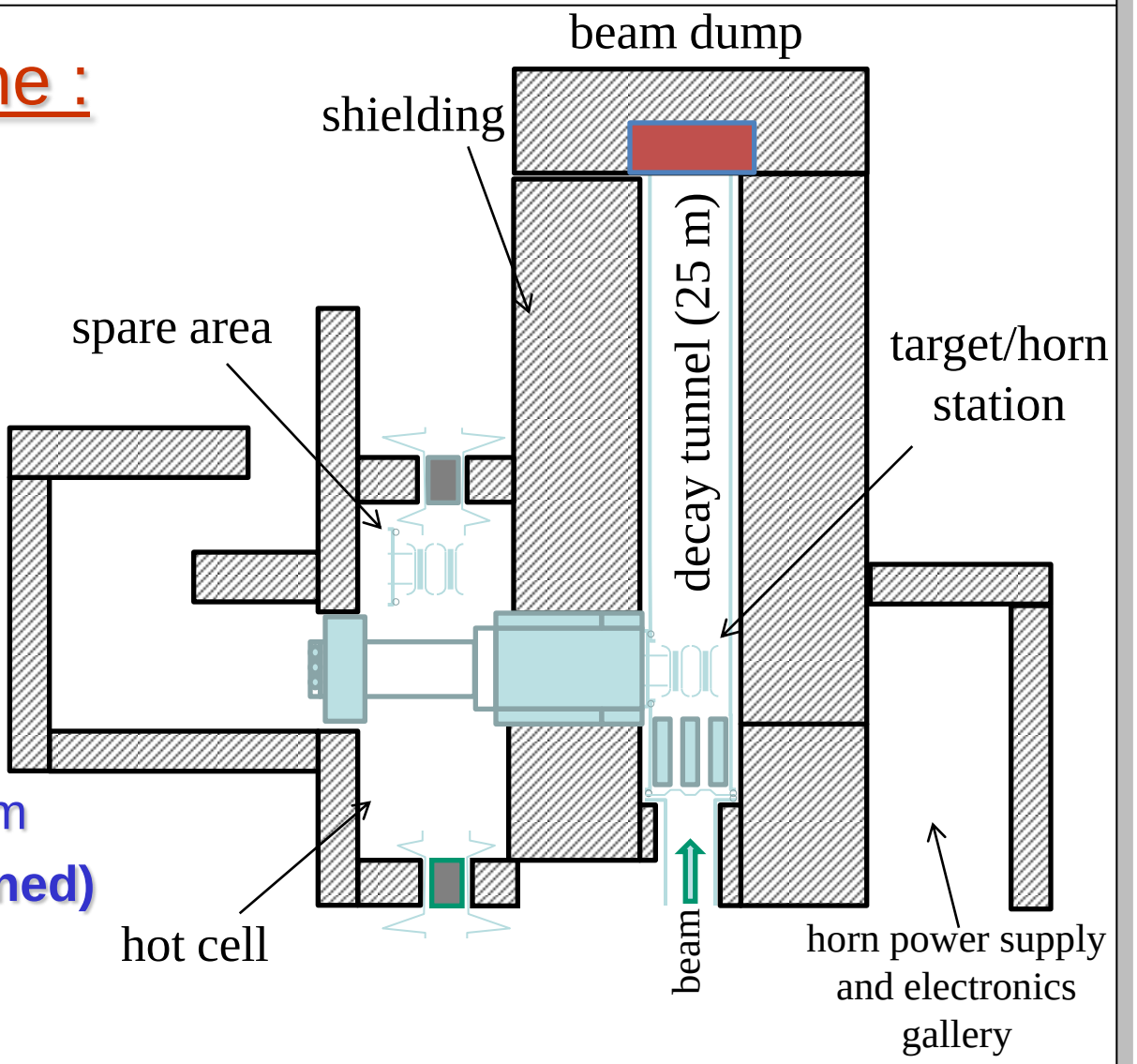
As Low As Reasonably Achievable



- **Safety : preparation phase**
  - Radiological risks
    - Determine the radiological risks (external or internal contamination) for each part of the facility.
    - Investigate biological protections with respect to the prompt dose and residual dose
    - Environmental impact studies
  - Non-radiological risks
    - Electrical risks, cooling system, maintenance operation….

Design of the SB line :

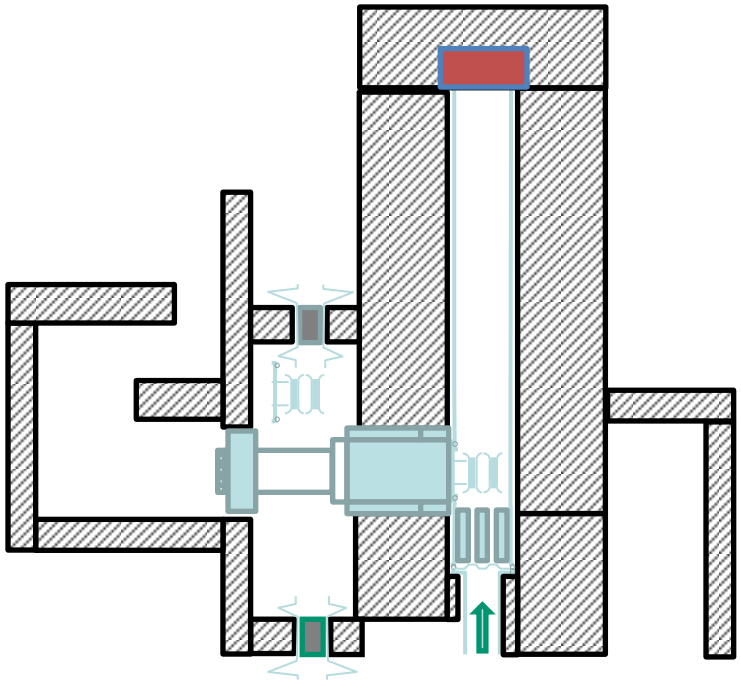
- **Proton Driver line**
- **Experimental Hall**
  - MW Target Station
  - Decay Tunnel
  - Beam Dump
- **Hot Cell / Spare area**
- **Service Gallery**
  - Power supply
  - Cooling system
  - Air-Ventilation system
- **Waste Area (to be defined)**



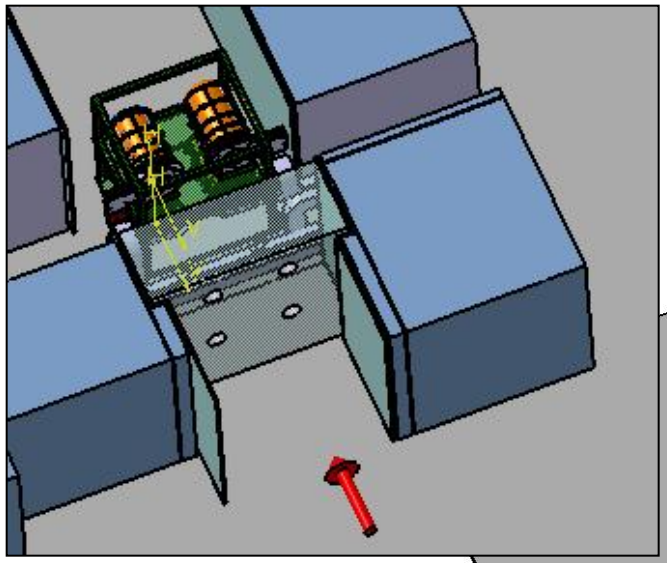
Safety : MW Target Station

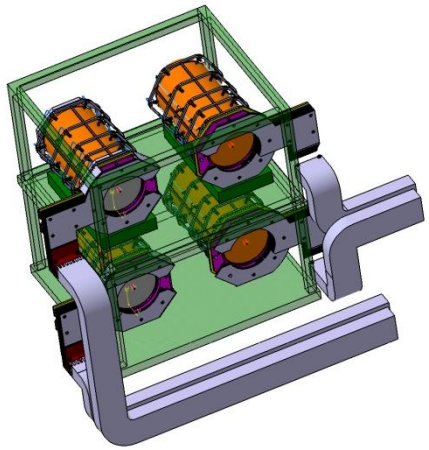
MW Target Station :

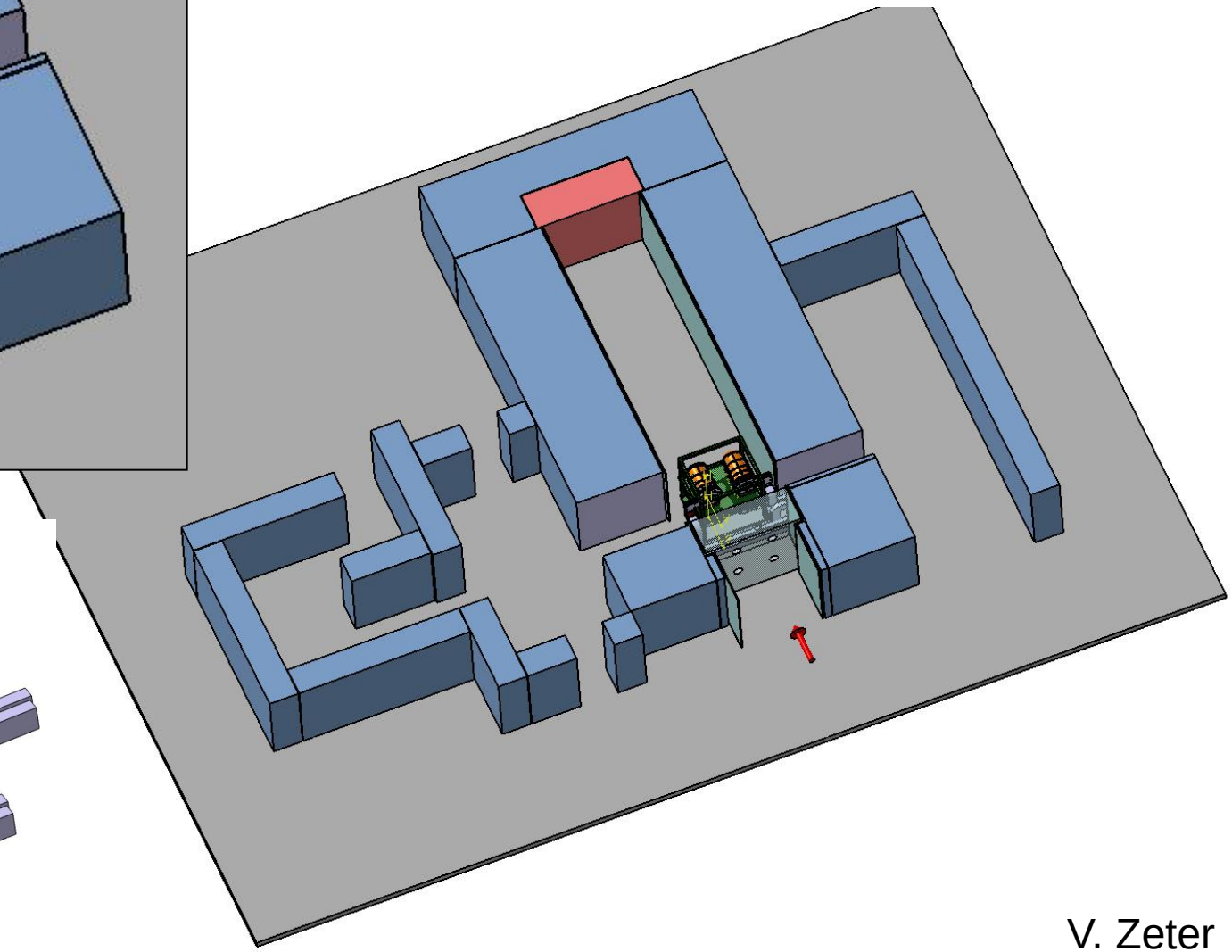
- Focusing System
- Crane System
- Automated robot
- Mechanical structure for the four horns
- Dose Rate Monitoring System
- Residual Dose Rate Plateform
- Operation under helium Atmosphere
  - flushing with air
  - filter to measure radioactive pollution (dust, tritium …)
- Investigation of other radionucleide transport (environmental constraint)
- …



Superbeam Facility







V. Zeter

Superbeam Facility

Chemical composition of Material:

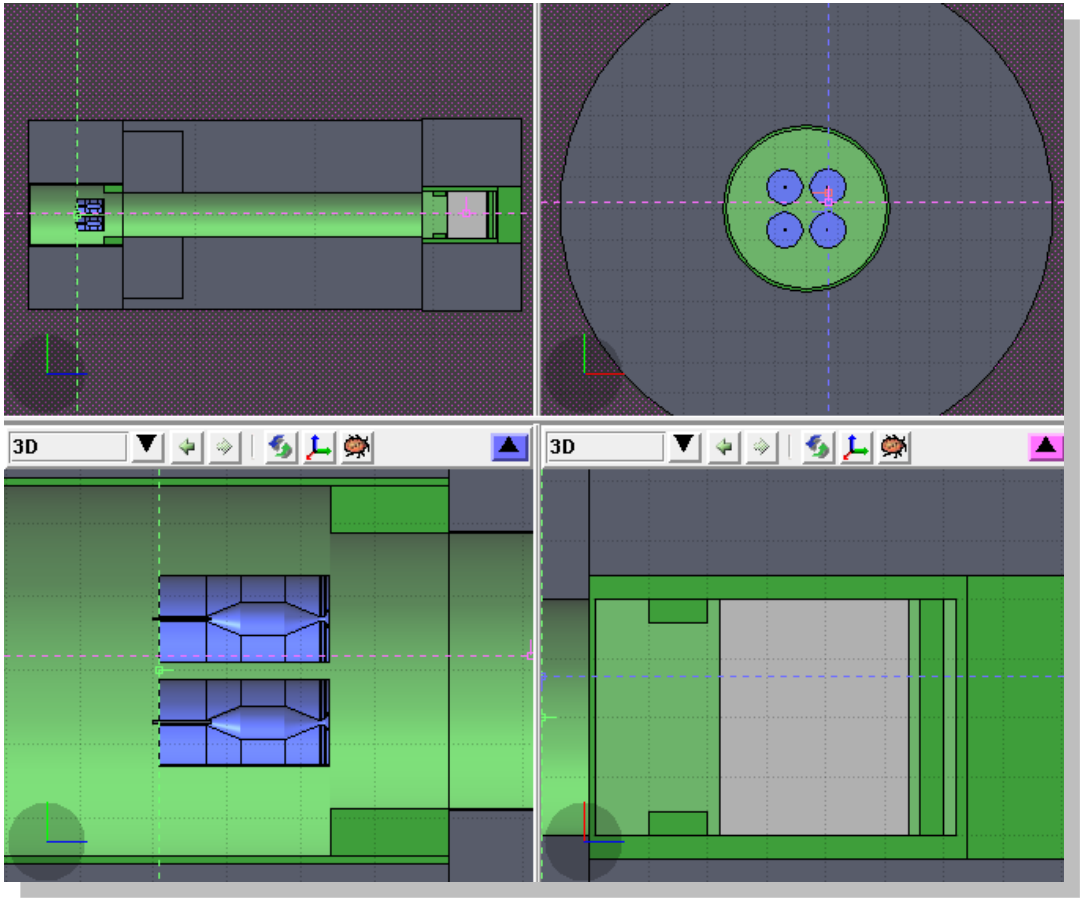
Target => Titanium

Horn => Anticorodal 110 alloy
Al (95.5%), Si(1,3%), Mg(1,2%), Cr(0.2%), Mn(1%), Fe (0.5%), Zn(0.2%), Cu(0.1%)

Decay Pipe => Steel P355NH
Fe(96.8%), Mn(1.65%), Si(0.5%), Cr(0.3%), Ni(0.3%), C(0.2%)

Tunnel => Concrete
O(52.9%), Si(33.7%), Ca(4.4%), Al(3,49%), Na(1,6%), Fe(1.4%), K(1,3%), H(1%), Mn(0.2%), C(0.01%)

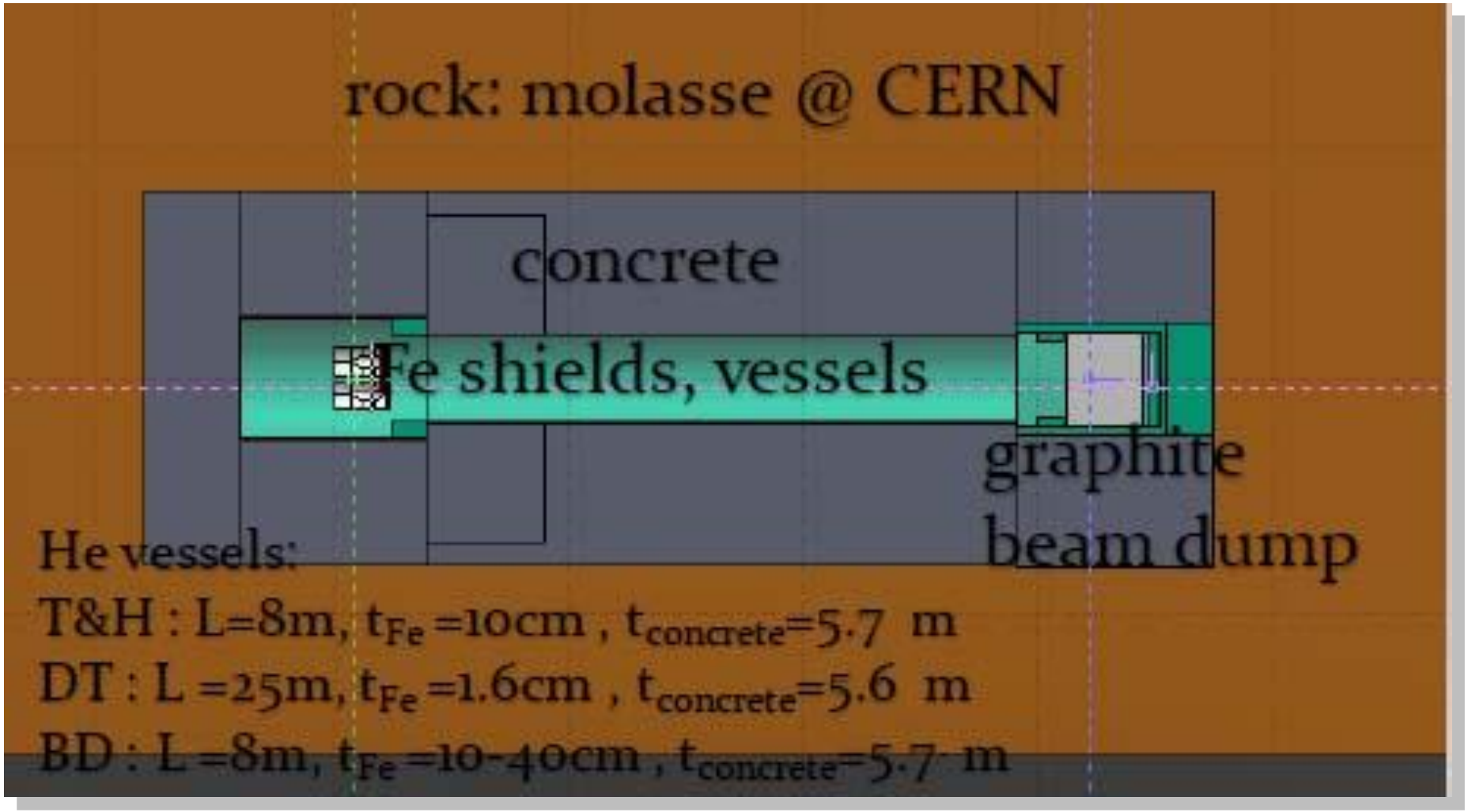
Surrounding Environment => Molasse
O(49%), Si(20%), Ca,(9.7%), Al(6.4%), C(5%), Fe(3.9%), Mg(3.2%), K(1%), Na(0.5%), Mn(0.1%)



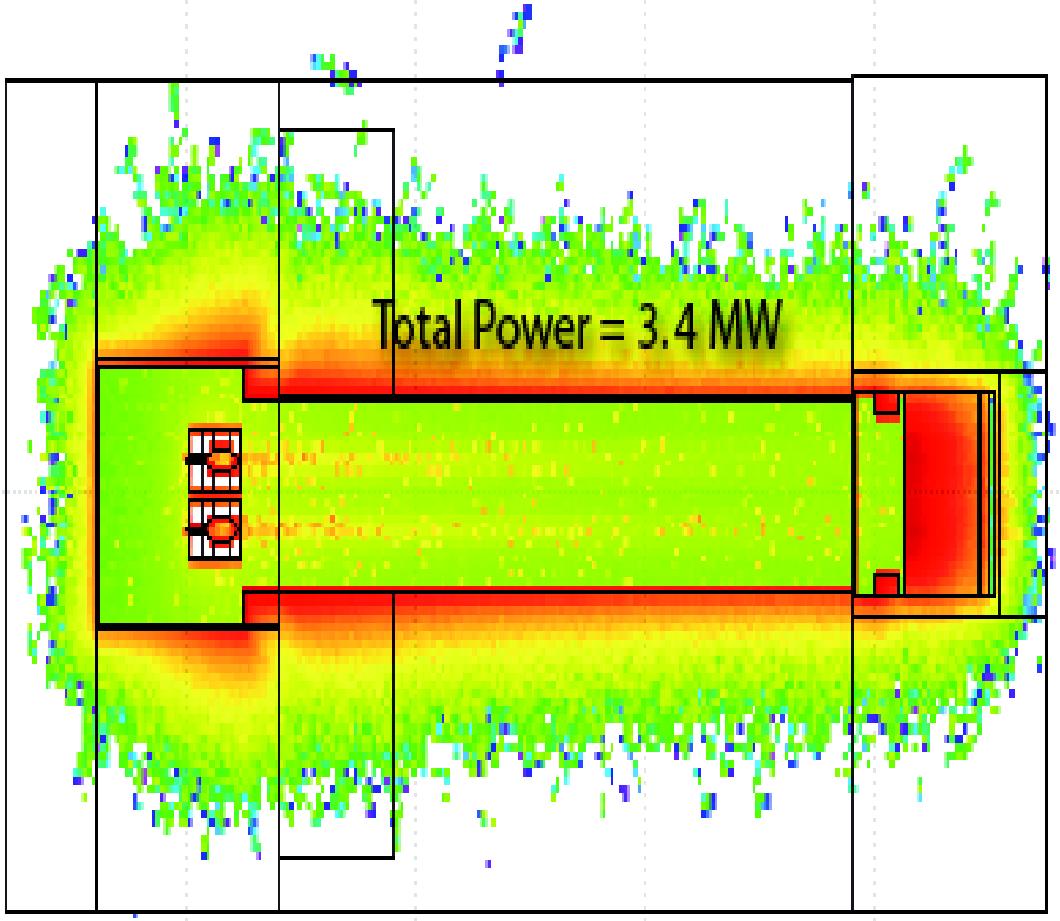
Four horn station layout

Energy deposition in the SB Layout

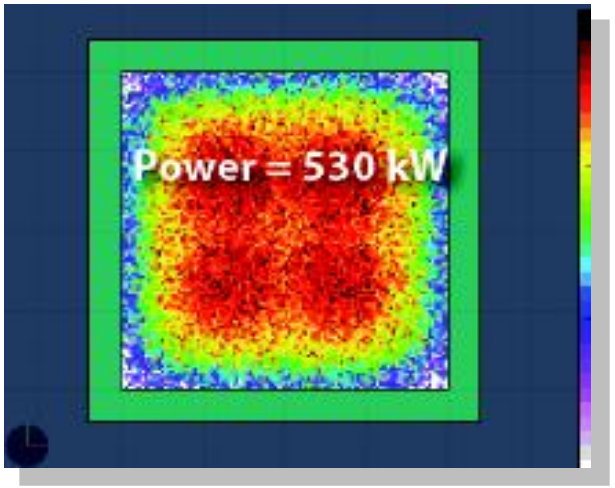
Geometrical Dimension ot the SB Layout:



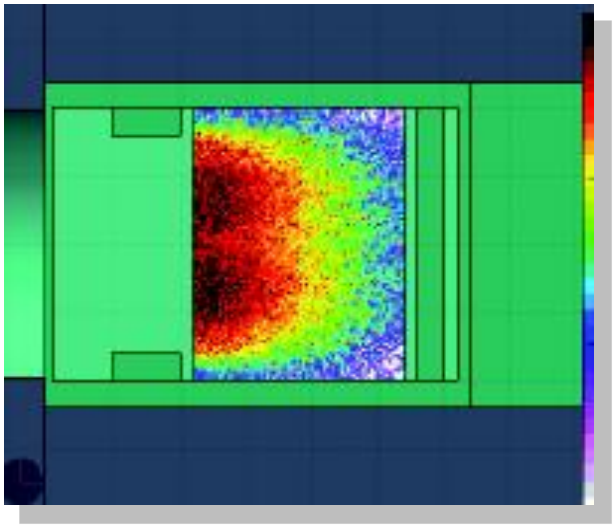
Energy deposition in the SB Layout



Energy confined in the SB facility

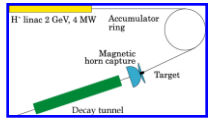


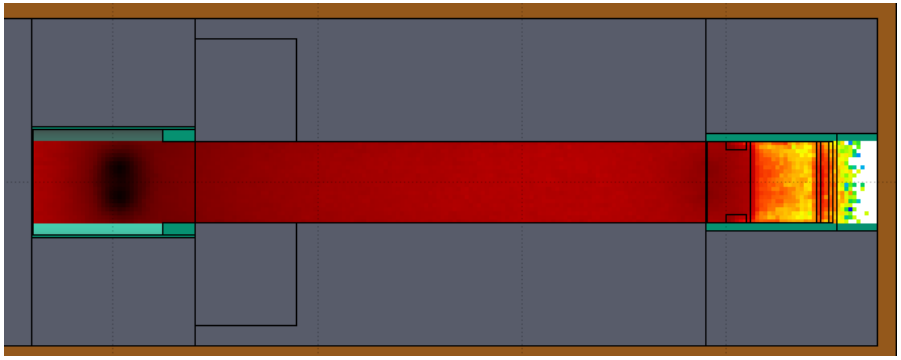
Beam dump (front view)



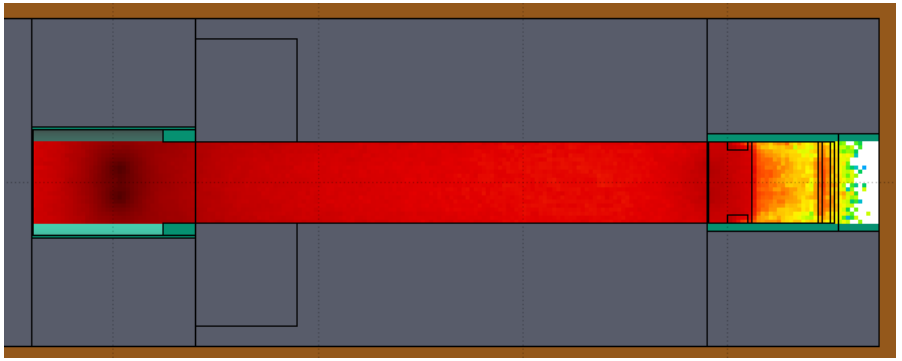
Beam dump (profile view)

Time Evolution of the Dose Equivalent Rate

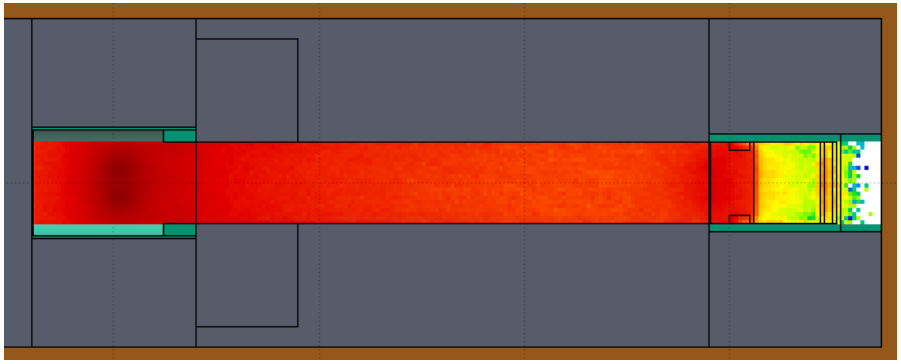




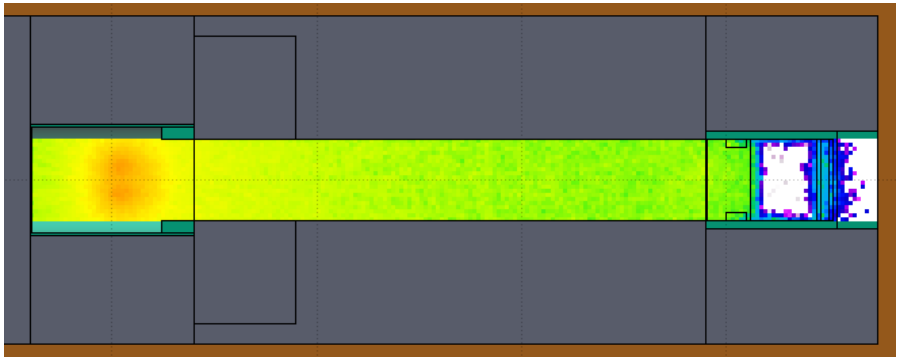
After one day



After one month



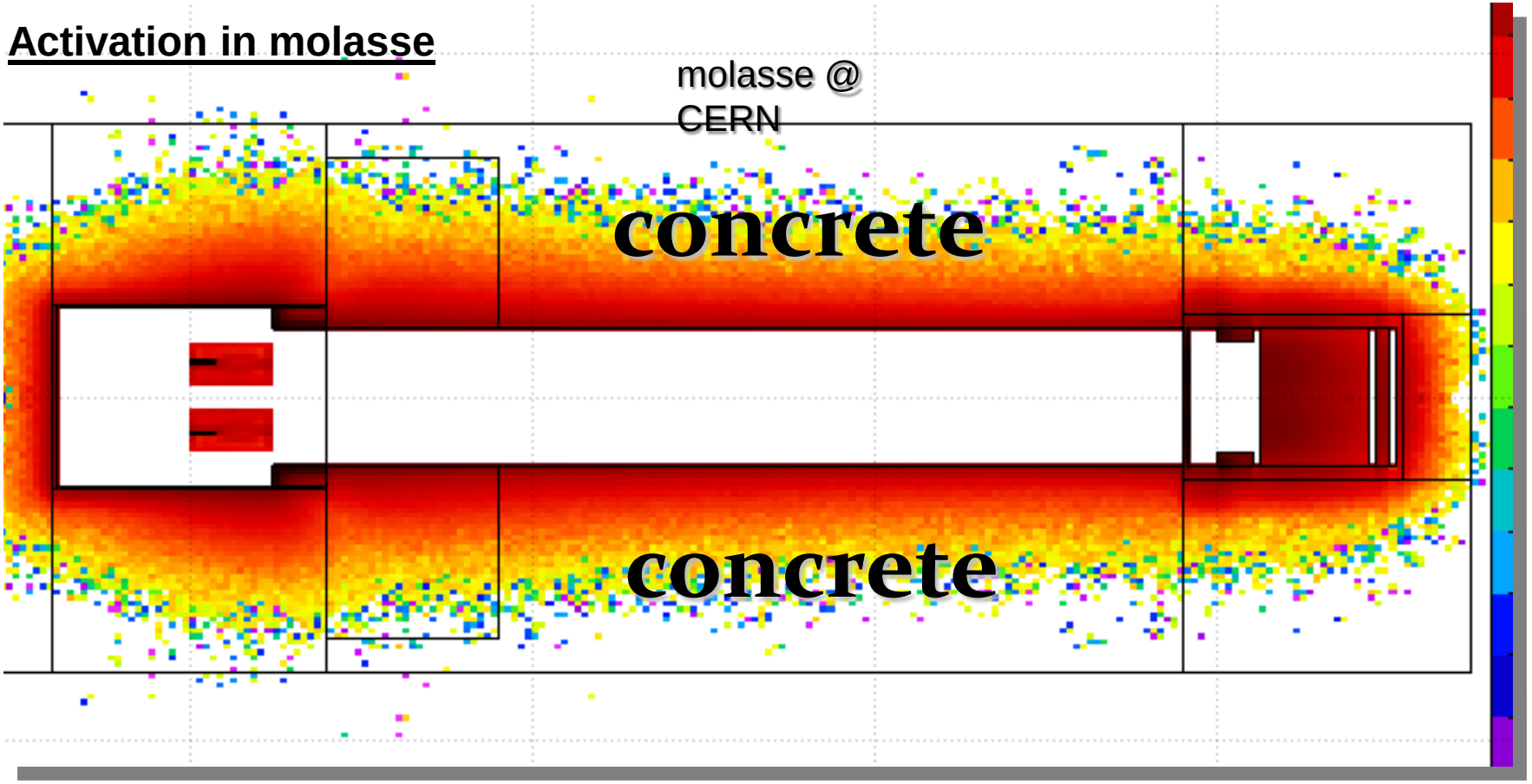
After half year



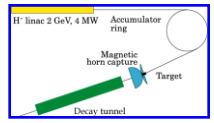
After a 10 year

Environmental impact

Activation in molasse



A 6m thichness concrete wall surrounding all the layout limit the production of radionucleides in the molasse. Especially, the production of ^{22}Na and tritium could represent a negative impact by contaminating the ground water.


H⁻ linac 2 GeV, 4 MW
Accumulator ring
Magnetic horn capture
Target
Decay tunnel

Target + Horn

Safety Issues

Working strategy :

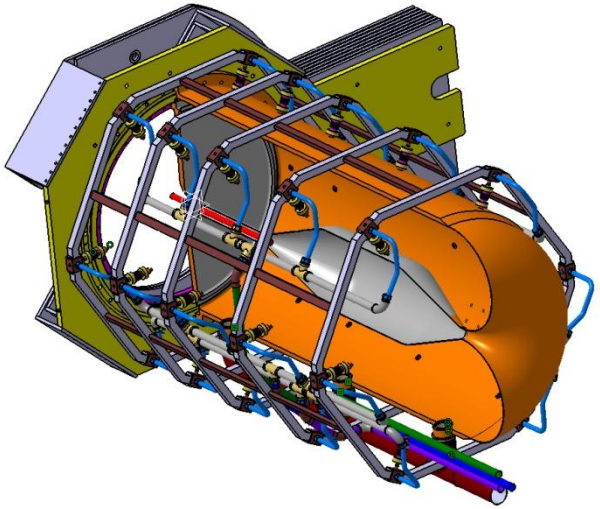
- **Normal intensity operation : 4 horns at 1.0 MW beam power**
- **High intensity operation : 3 horns at 1.3 MW beam power**

Optimisation of the horn design:

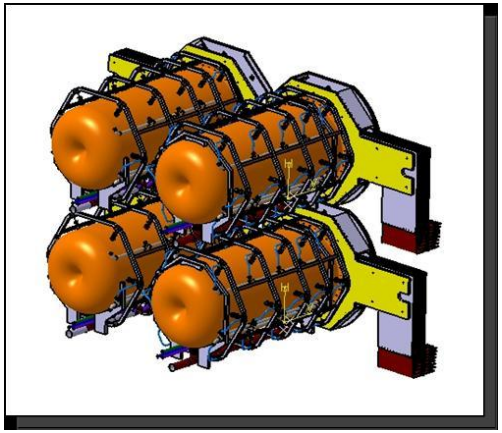
reduce maintenance operation on the four horn system:

- Identify points reducing the lifetime of horns (mechanical instability during beam operation,)
- Complex network of water pipes, difficulty to repair in case of leaks
- Fast electrical connector
- …

Hot Cell is mandatory to repair/replace the target+horn system

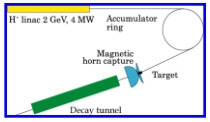


View of the horn



View of the four horns

Horn failure investigations

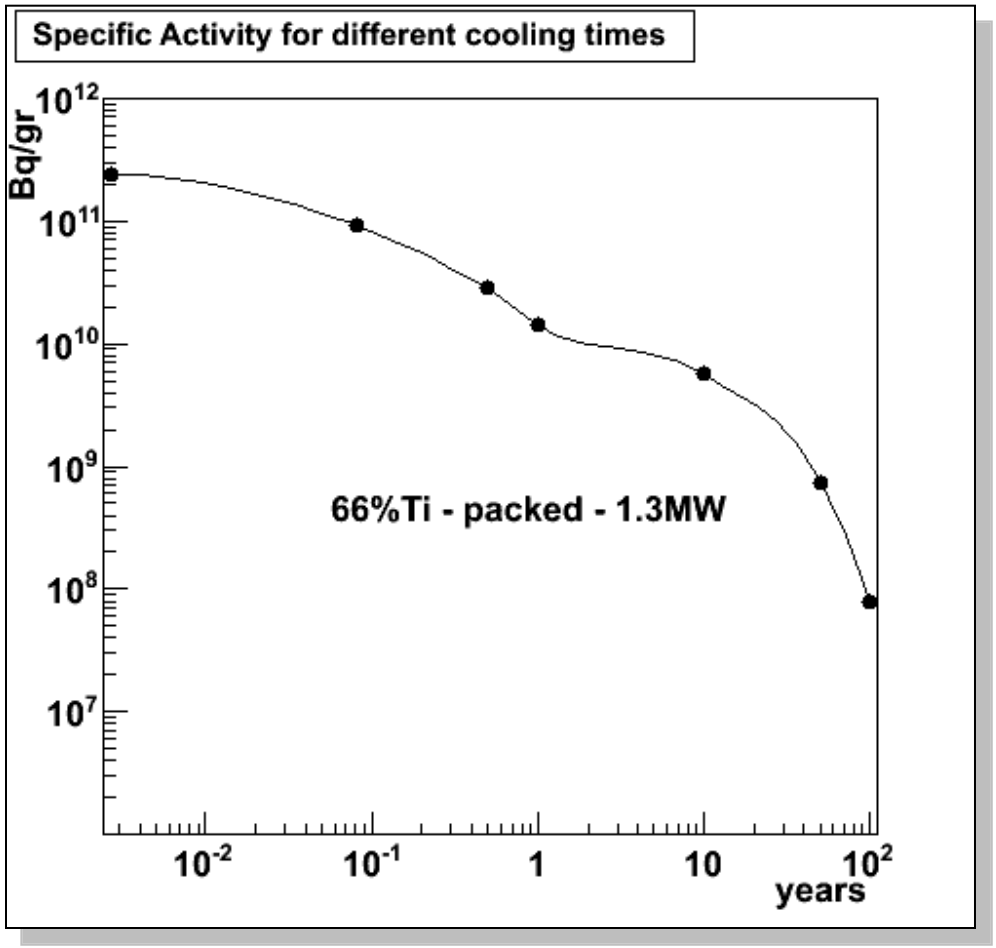


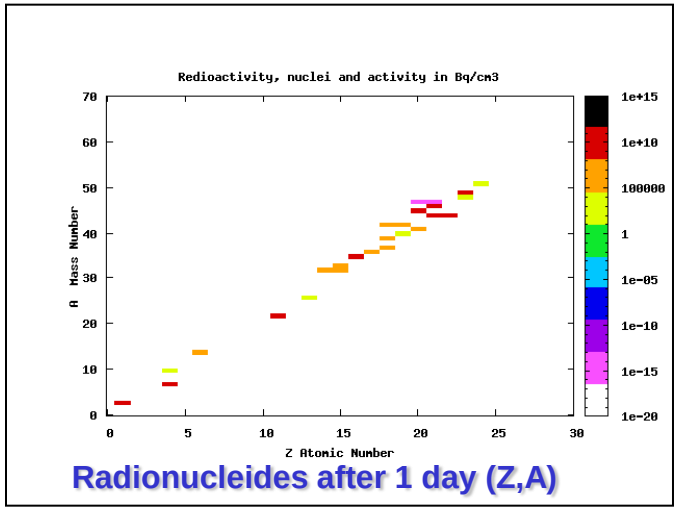
Failure	Causes	Consequences	Solution	Action/Safety
Cracks, weld junction	Material faults In the weld junction	Water leaks Current discontinuity	Check quality of weld junctions	Electrical shutdown Water flow shutdown
Cracks in the aluminium all, pipes connections	Peak stress too high	Water leaks Large displacement Crack growth Horn destruction	Stress analysis of the pipes connections; Of the details connections	Electrical shutdown Water flow shutdown
Cracks in the aluminium wall	High cyclic stress Fatigue cracks	Water leaks Large displacement Crack growth	R&D studies	Electrical shutdown Water flow shutdown
Striplines/horn connection cracks	Localised high cyclic Stress Corrosion Fatigue cracks	Electrical discontinuity Change in the magnetic field	R&D studies in the stripline horn/connection	Electrical shutdown Water flow shutdown
Striplines/connections Cracks initiation	Stress corrosion	Electric resistance increase	R&D studies	Electrical shutdown

B. Lepers

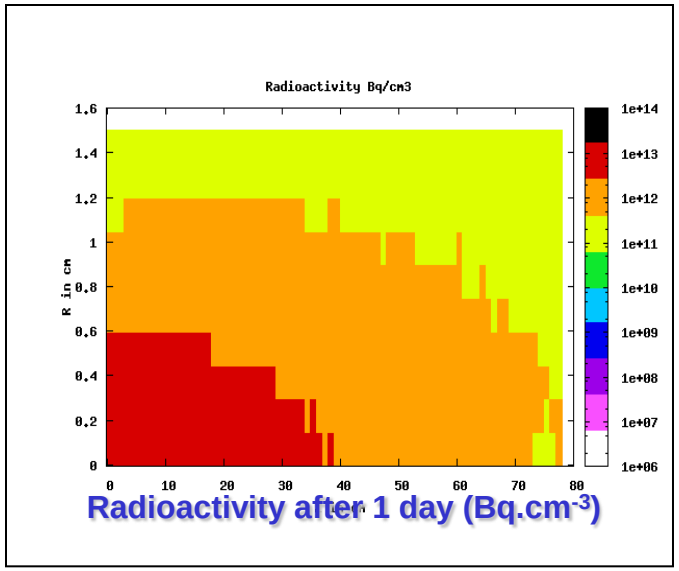
Radiation simulations : Target Activation

Evolution of the target activity with cooling time:





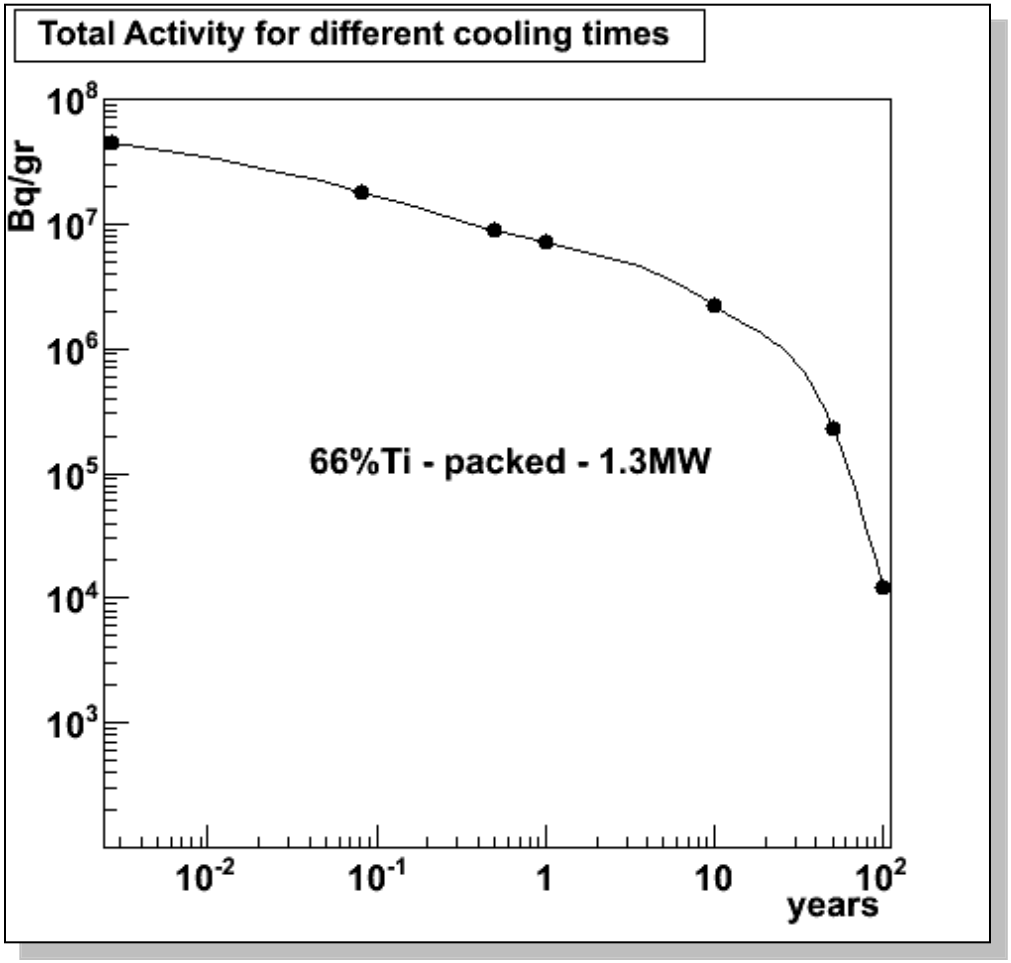
Radionucleides after 1 day (Z,A)

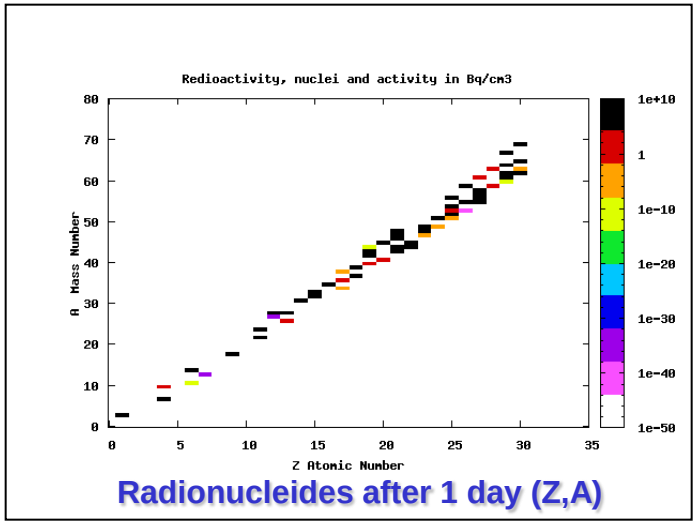


Radioactivity after 1 day (Bq.cm^{-3})

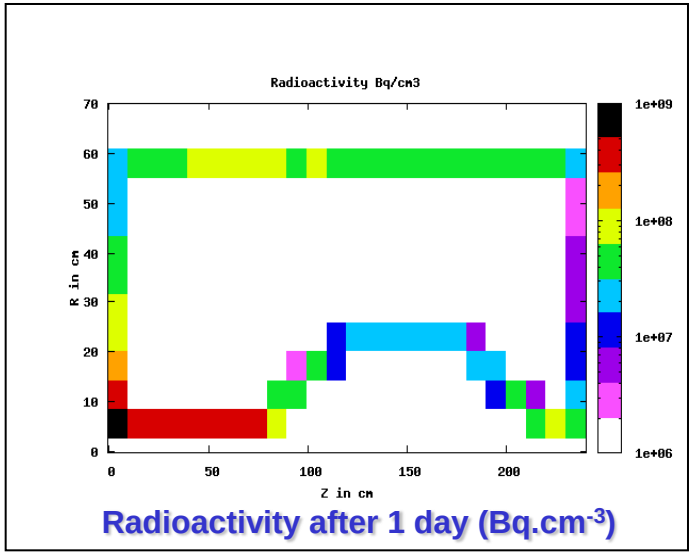
Radiation simulations : Horn Activation

Evolution of the horn activity with cooling time:



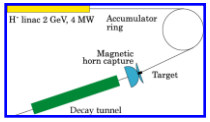


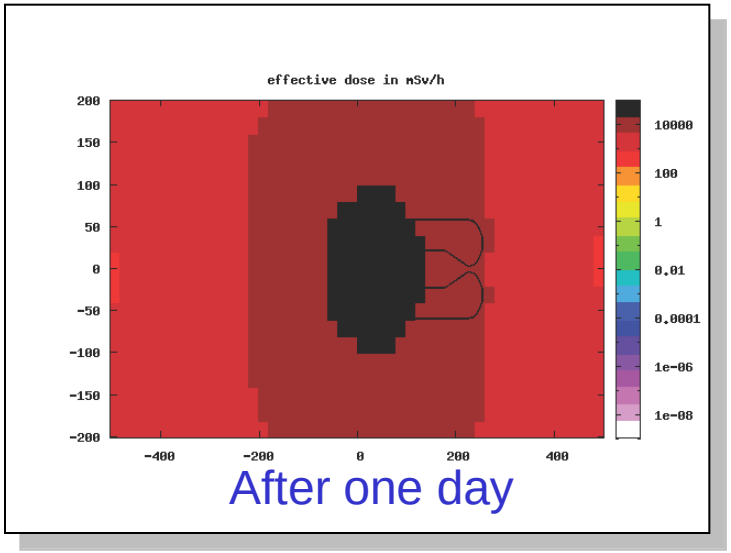
Radionucleides after 1 day (Z,A)



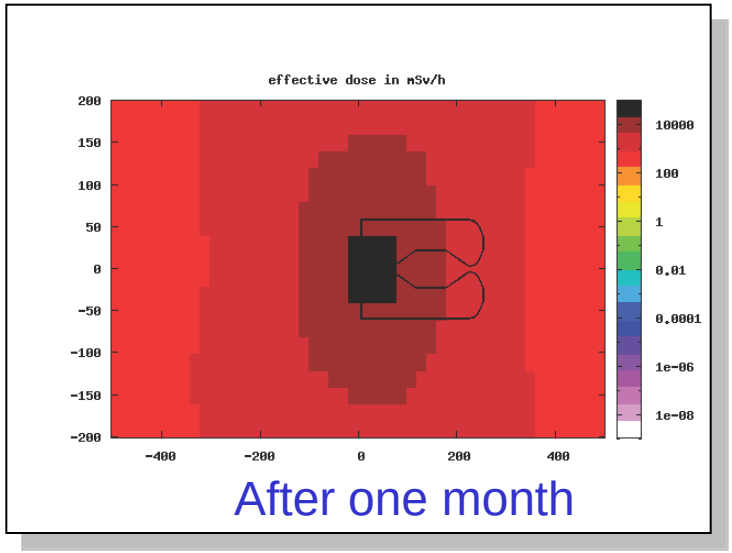
Radioactivity after 1 day (Bq.cm^{-3})

Time evolution of the DER : Target+Horn

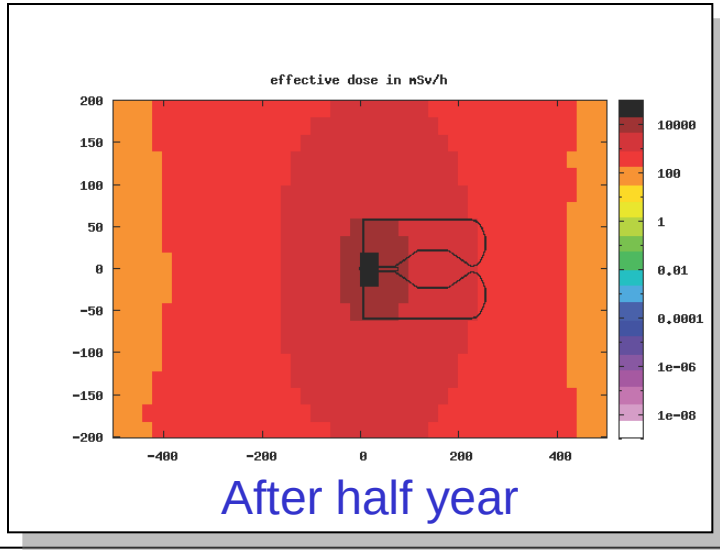




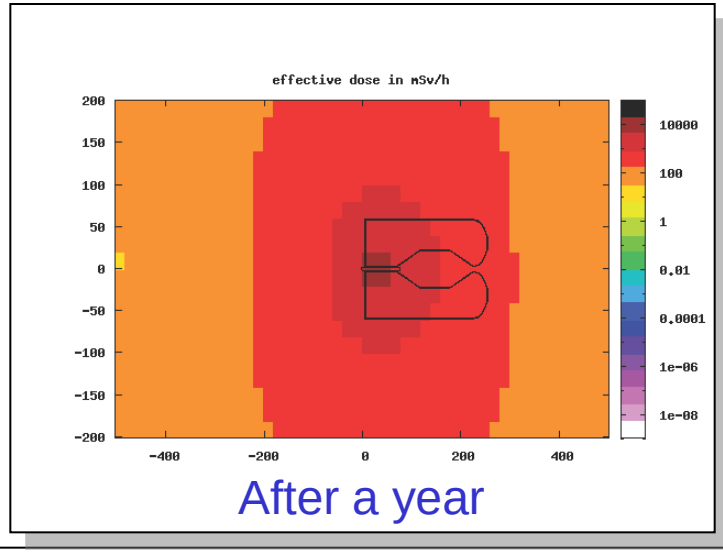
After one day



After one month



After half year

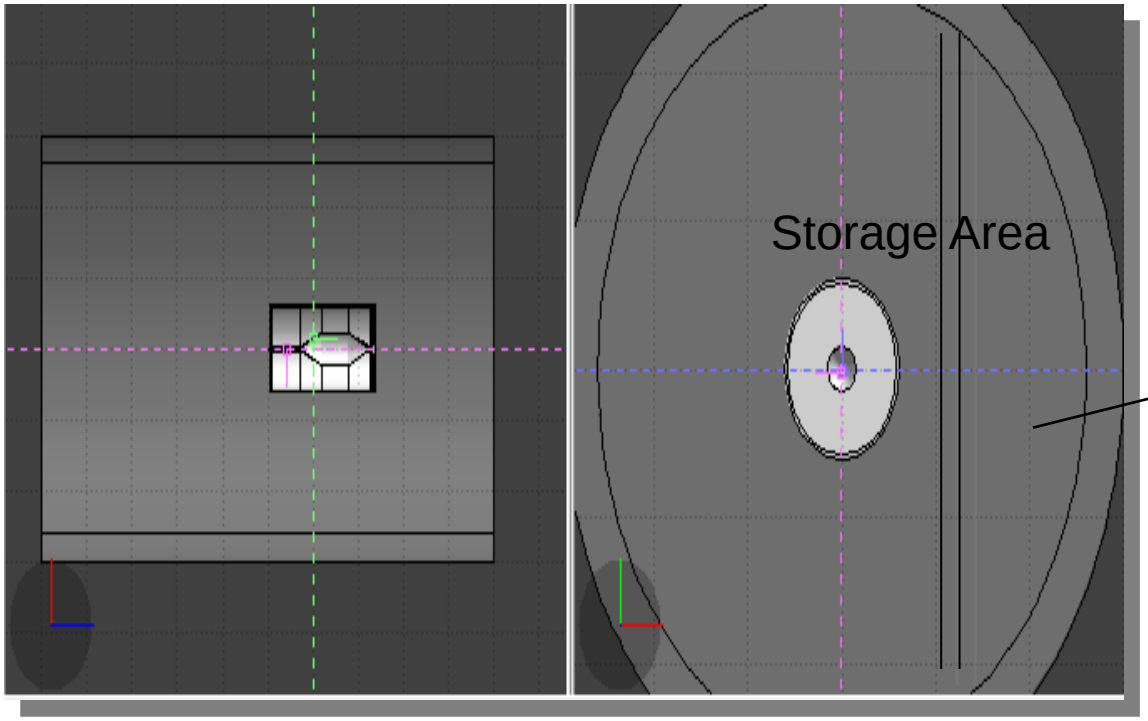


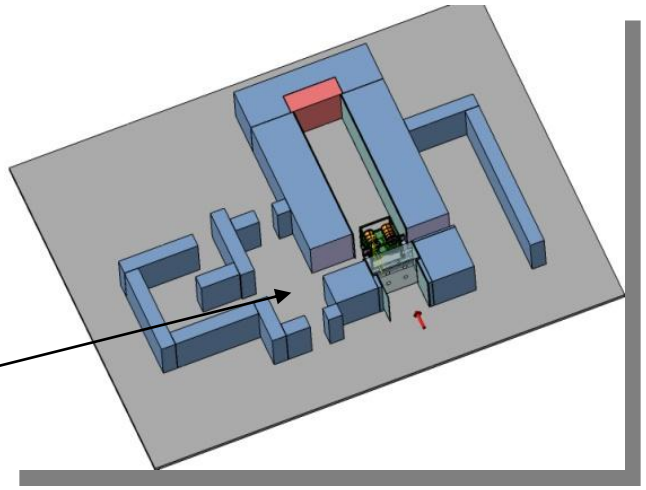
After a year

Storage Area : Investigation

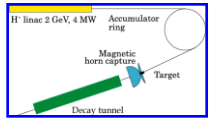
Hot cell preliminary investigation:

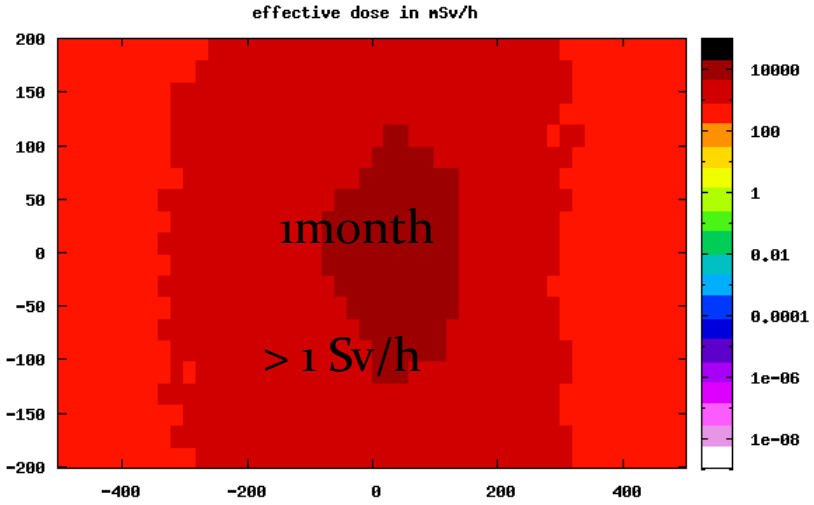
at 60cm distance from the outer conductor (calculation of the rates using 20cmx20cmx20cm mesh binning through out the layout
-> choose a slice of x-axis with 20cm thickness and 60cm away

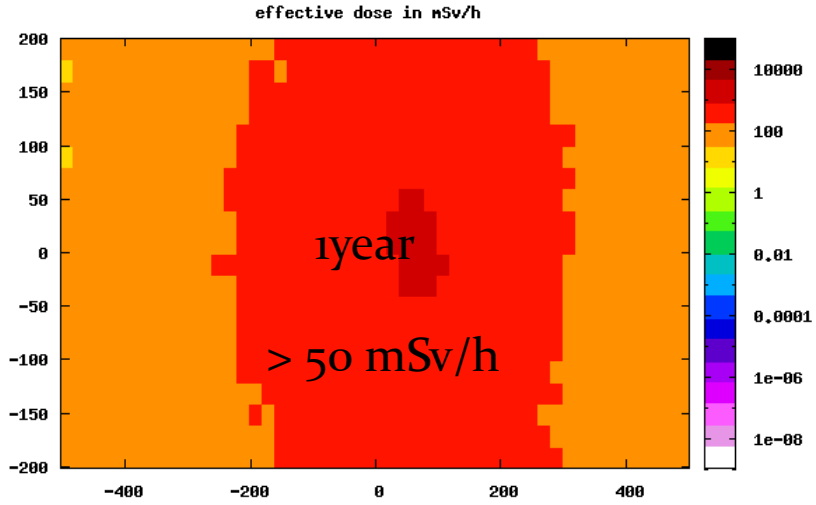


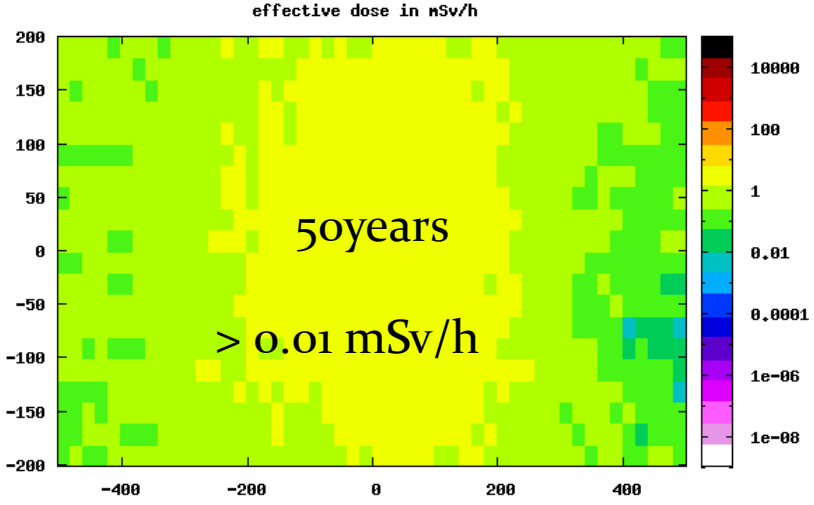


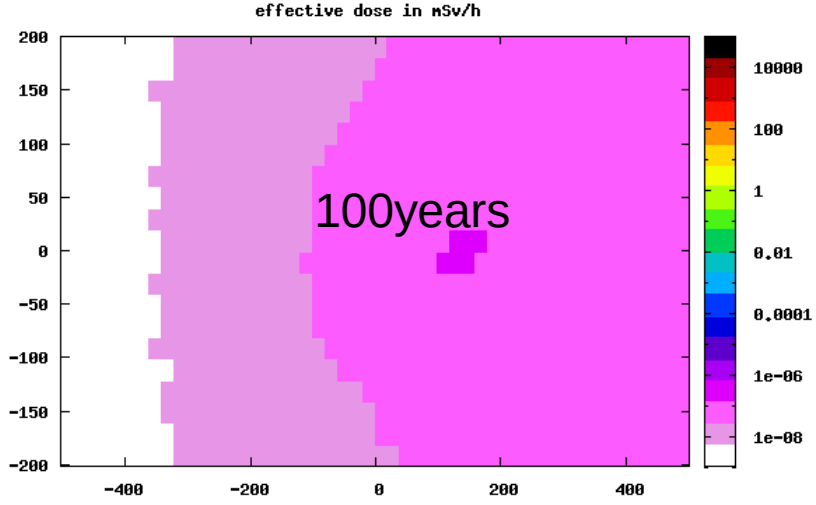
Storage Area : dose equivalent rate map

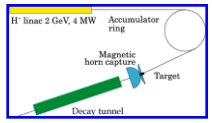












Next Steps :

- Estimate the contribution of each element to the dose rate
- Investigate the hot cell structure, maintenance operation
- Individual and collective dose rate calculation with cooling times
- Costing