Radiation protection assessments for the PW laser-based experiments

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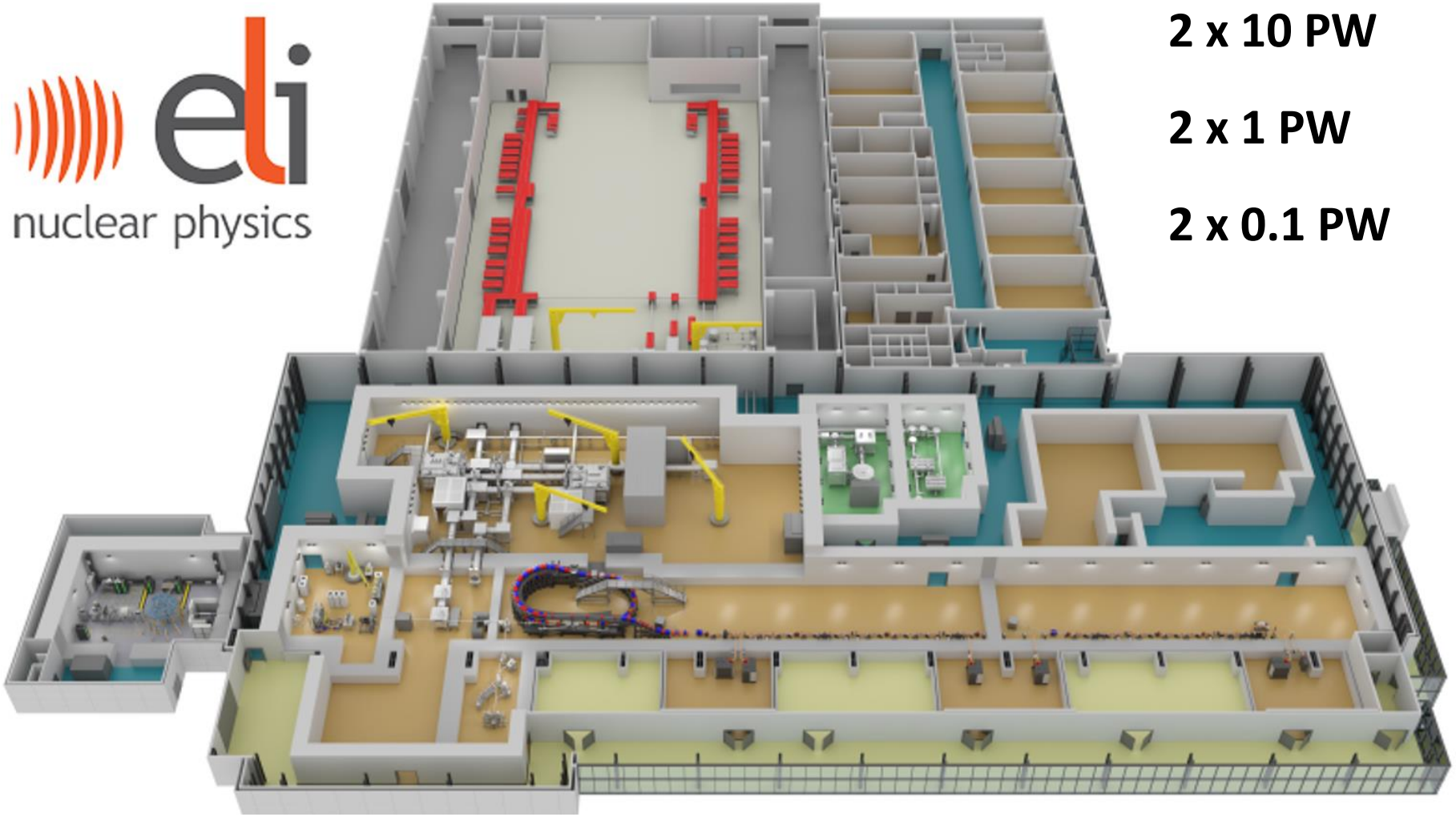
- Nuclear physics with high power lasers
- Laser based experiments setups
- Complex sources of ionizing radiations
- Assessments performed and challenges
- Modelling the best working conditions
- Radiation monitoring system
- Challenges

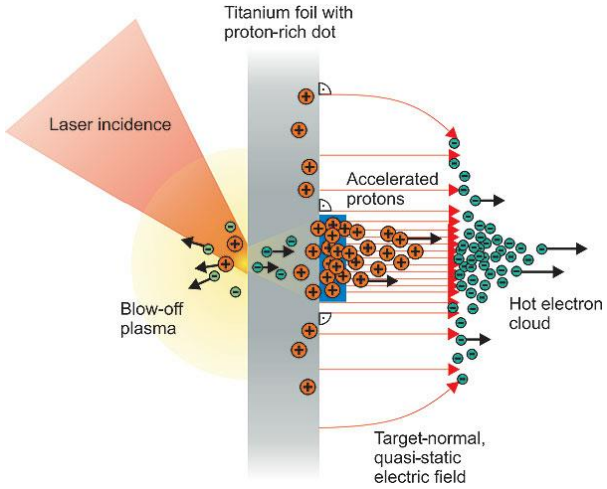
Nuclear physics with high power lasers

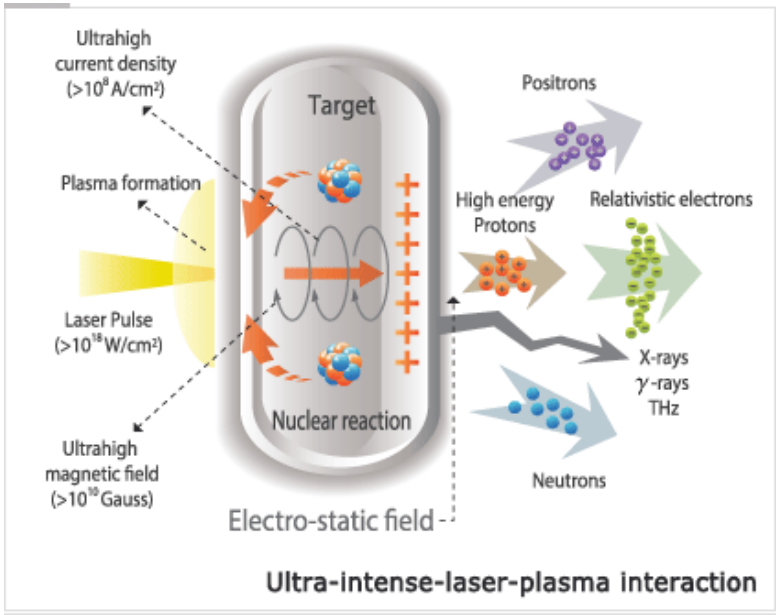


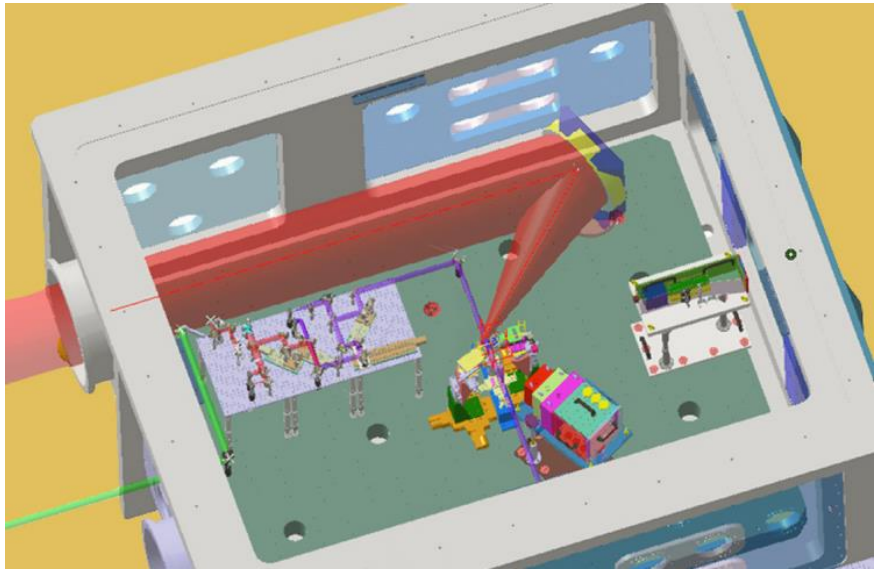
Laser based experimental setups

Experiments with HPLS: (10 PW, 1 PW and 0.1 PW)

- Strong field QED (10 PW)
- Materials in extreme radiation environments (1 PW)
- Nuclear physics experiments (10 PW)
- Laser-Wakefield acceleration experiments (0.1 PW)

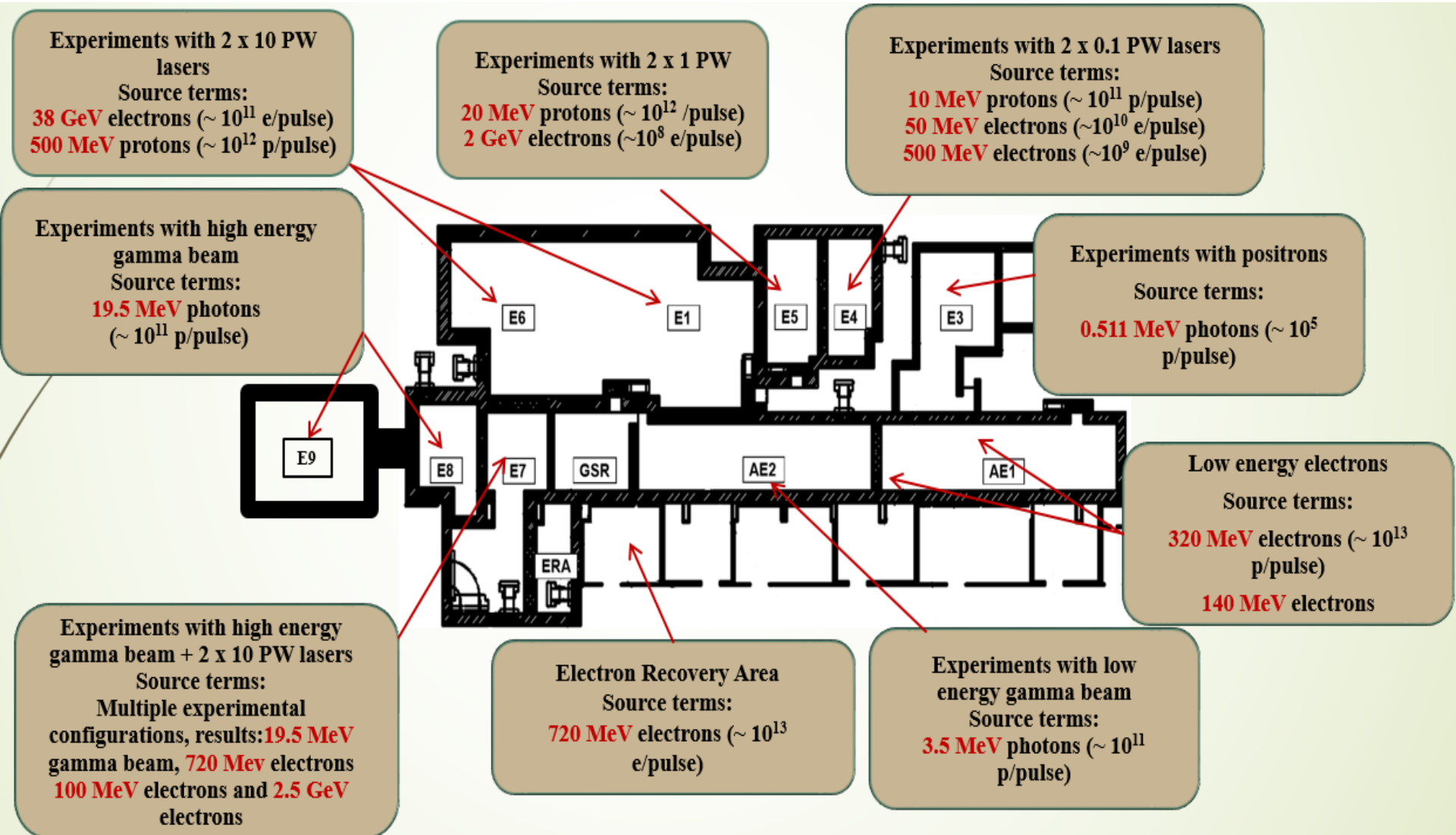




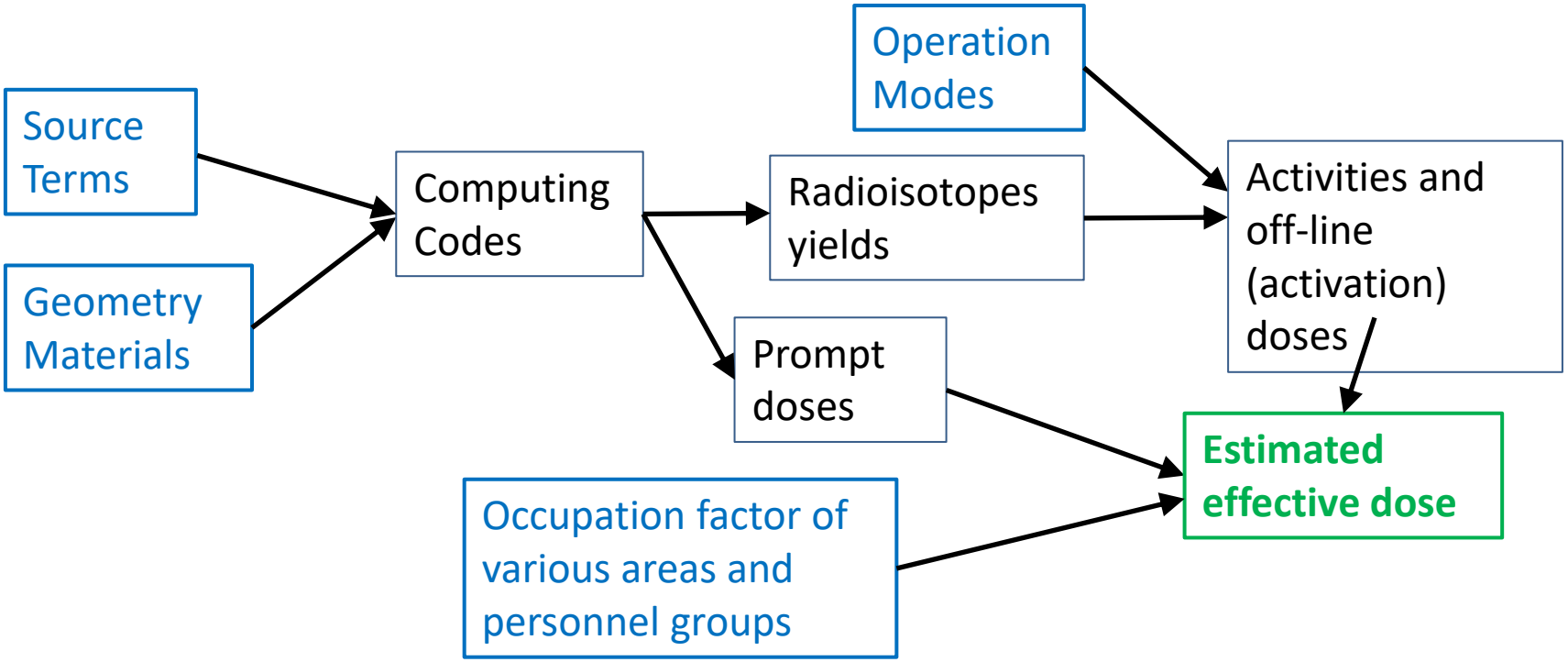


Intensities <u>>10^{18} W/cm^2</u>

Complex sources of ionizing radiations



Performed assessments and challenges

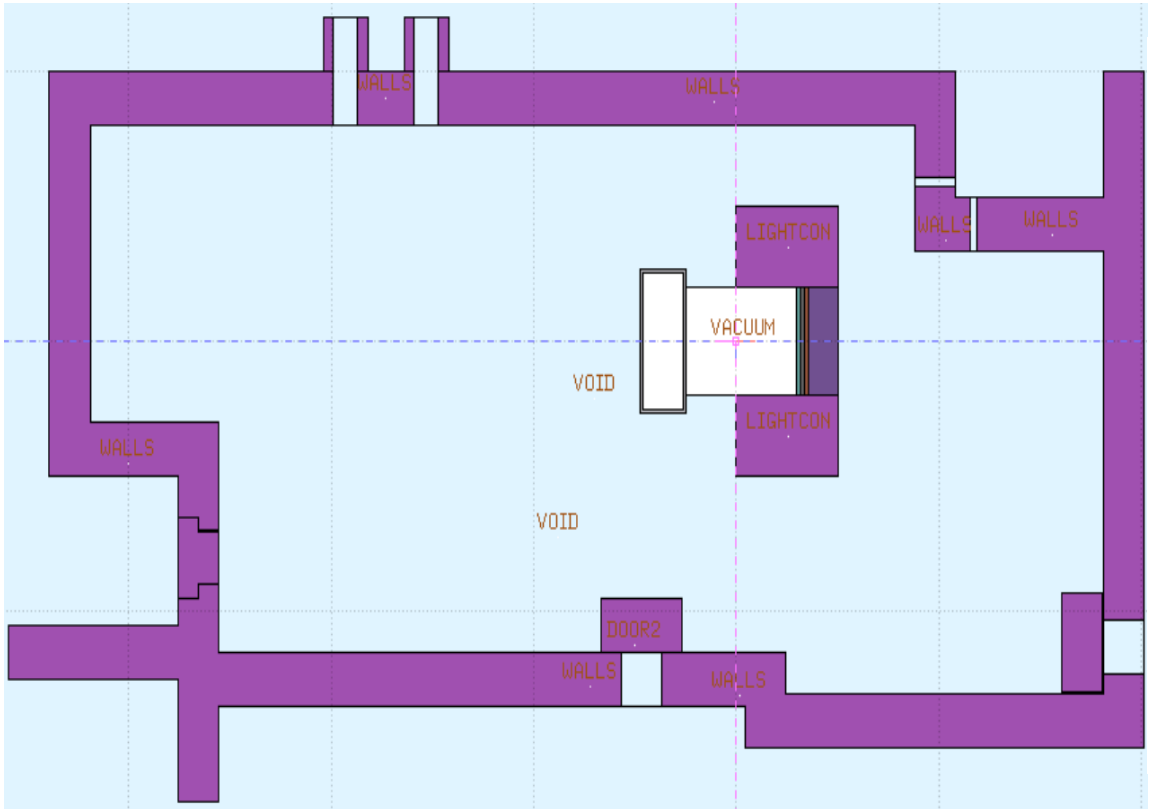


The input data are adjusted in a loop till compliance with legal limits and design targets is achieved.

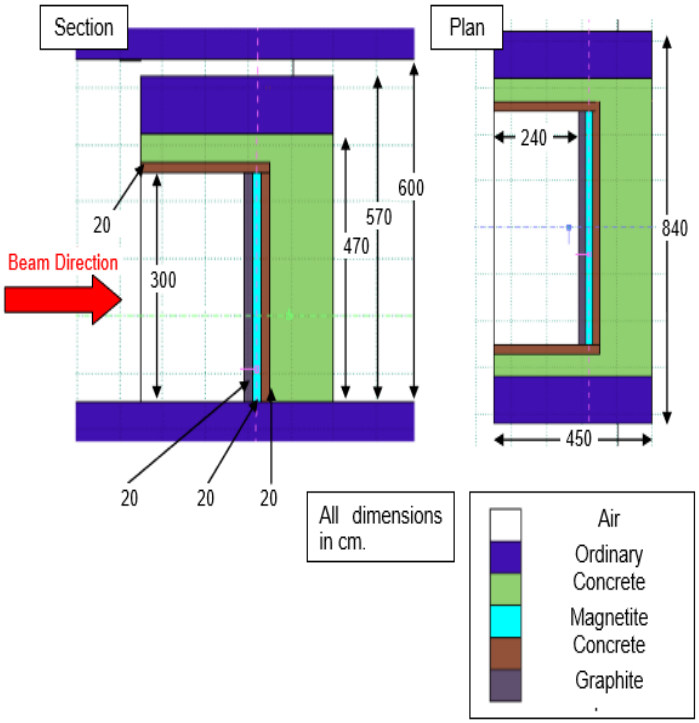
- design targets: **2 mSv/year** for nuclear workers at ELI-NP
  1 µSv/h at exterior of ELI-NP bunker
  0.1 µSv/h at exterior of ELI-NP building

Modelling the best working conditions

Assessments of the E1 experiments – old (NT design)



FLUKA geometry of the E1/E6 experimental area

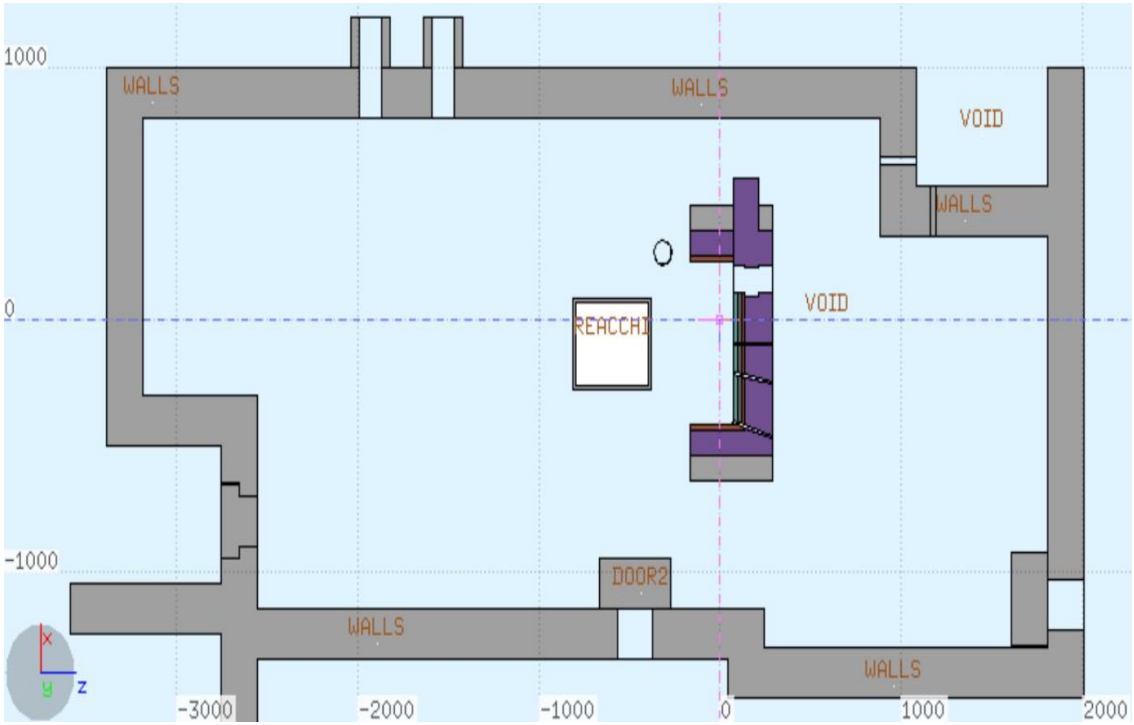


Beam dump design

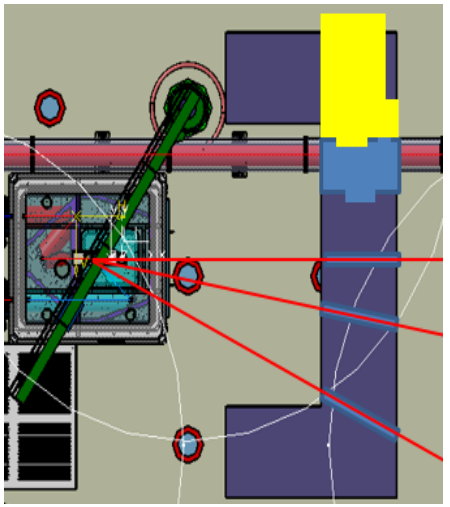
Cold side doses reach up to 9 µSv/hour!!!

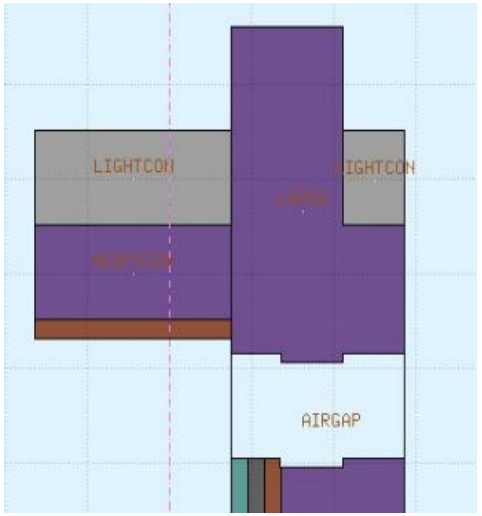
Modelling the best working conditions

Assessments of the E1 experiments – some time ago



FLUKA geometry of the E1/E6 experimental area



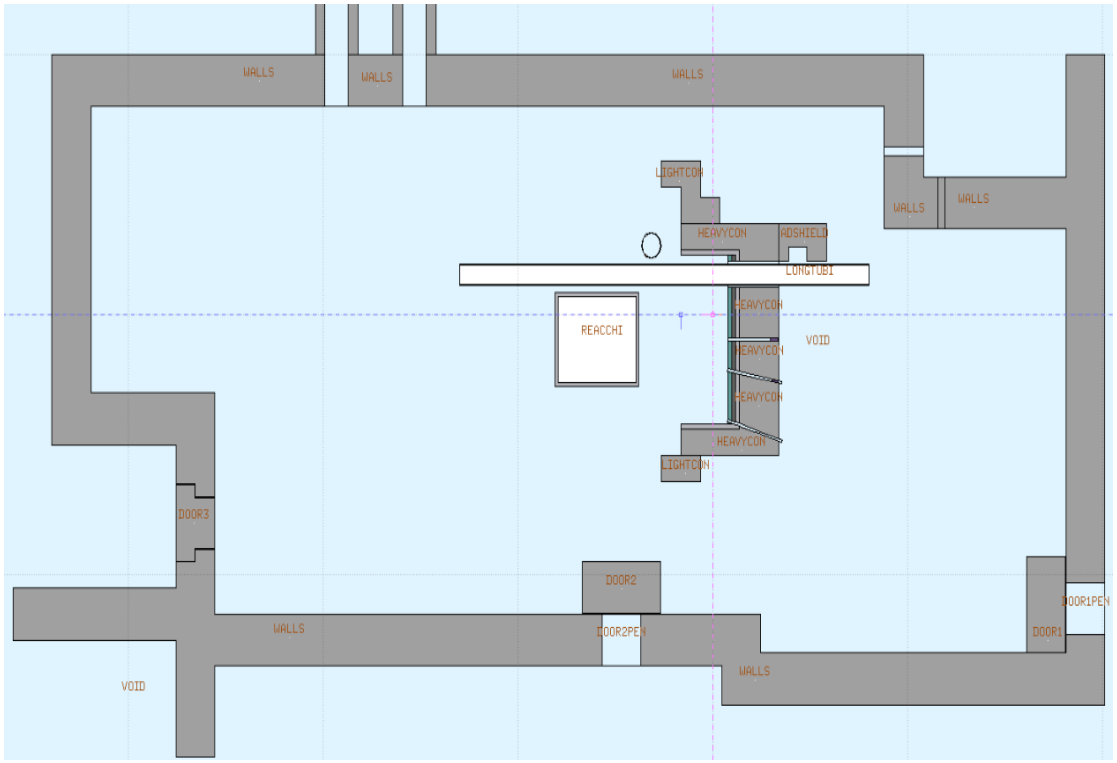


Beam dump design

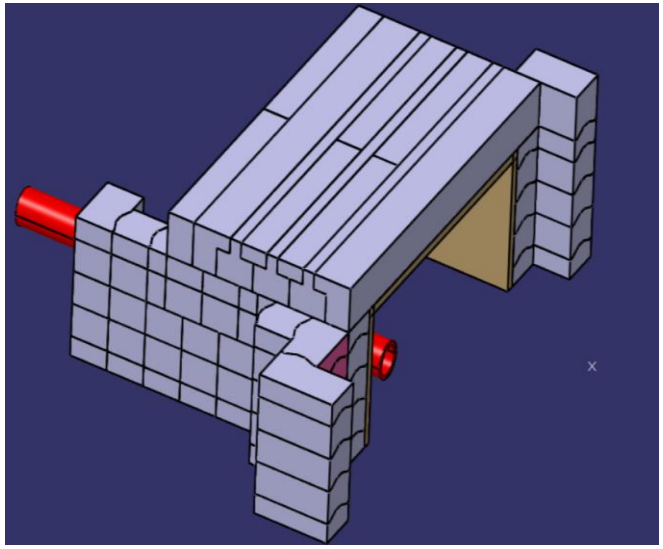
Cold side doses about the same level!!!

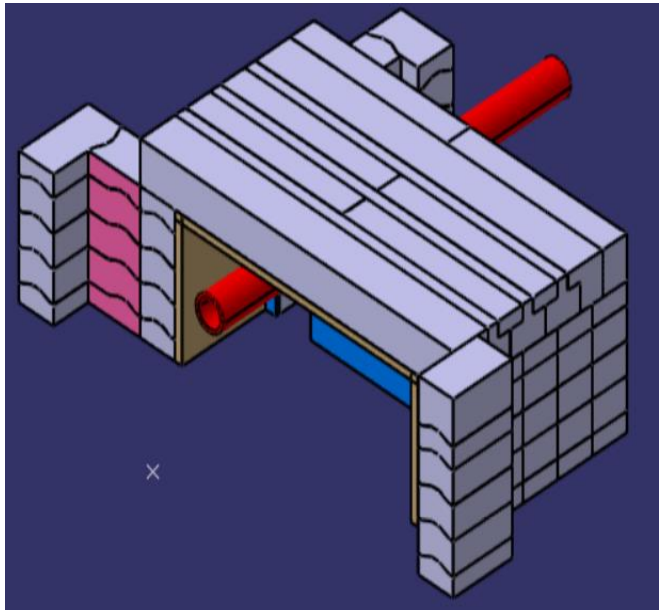
Modelling the best working conditions

Assessments of the E1 experiments – final



FLUKA geometry of the E1/E6 experimental area

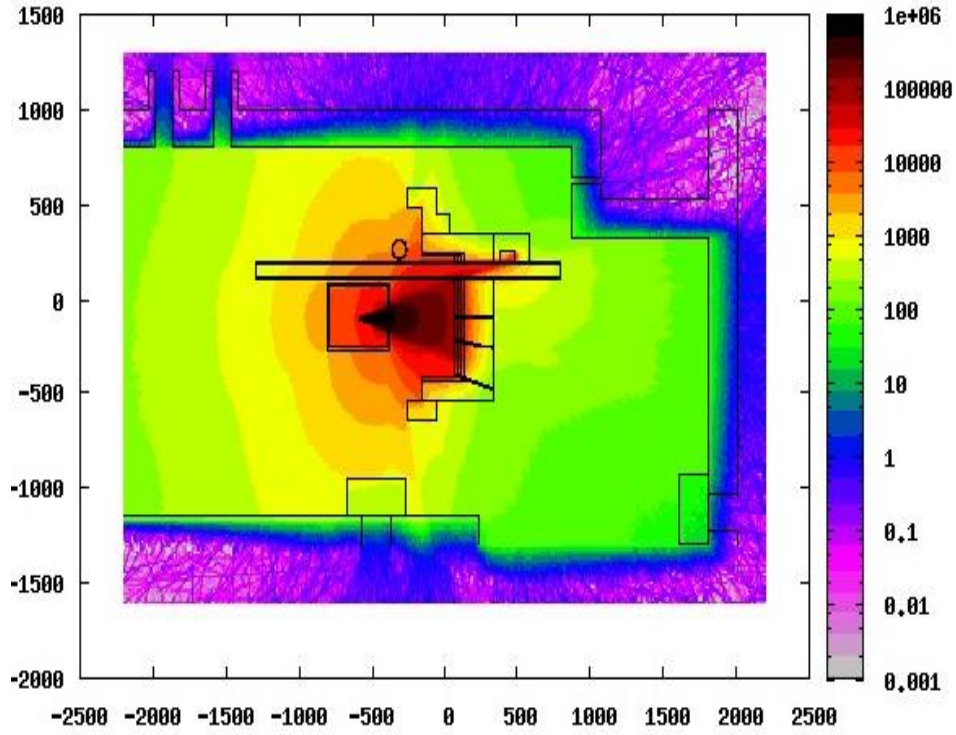




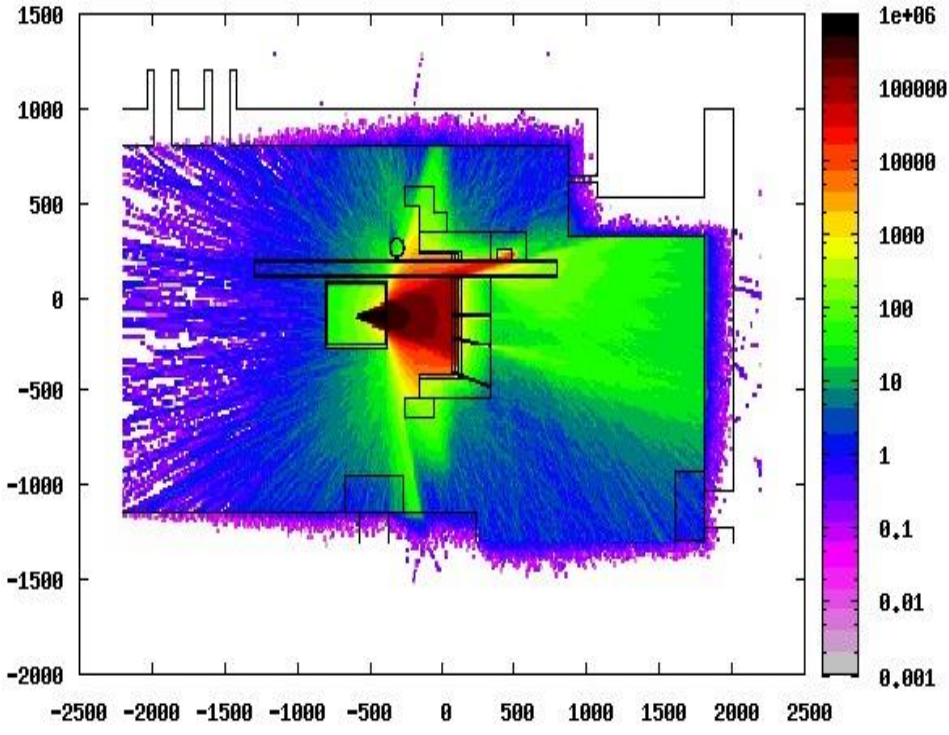
Beam dump design

Modelling the best working conditions

Assessments of the E1 experiments – final design



All particles dose contours



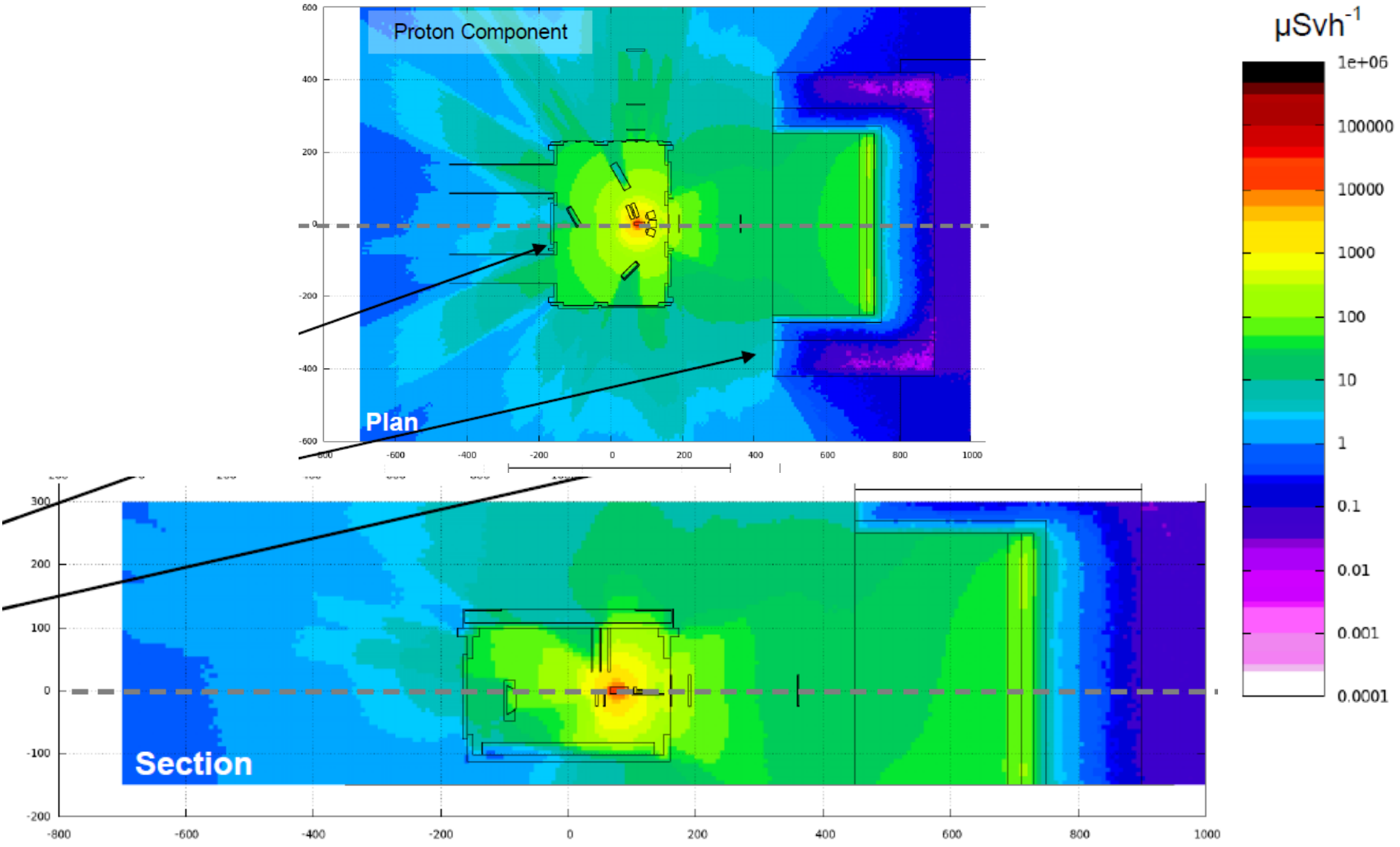
Protons distribution (dose contour)

Cold side dose levels are now approximately 3 µSv/hour and very localized!

Modelling the best working conditions

Residual dose rates calculated for source term A

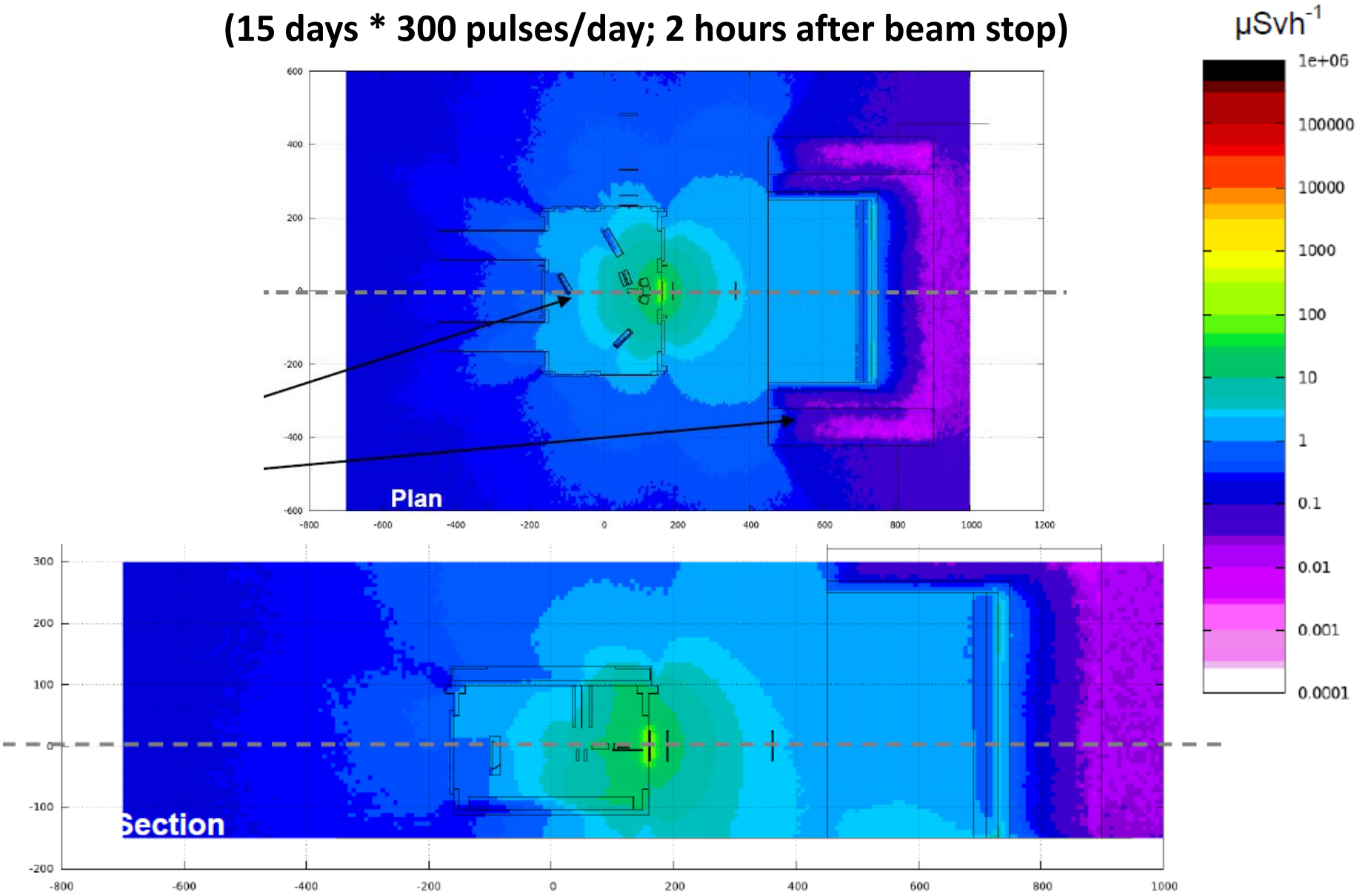
(15 days * 300 pulses/day; 1 minute after beam stop)



Modelling the best working conditions

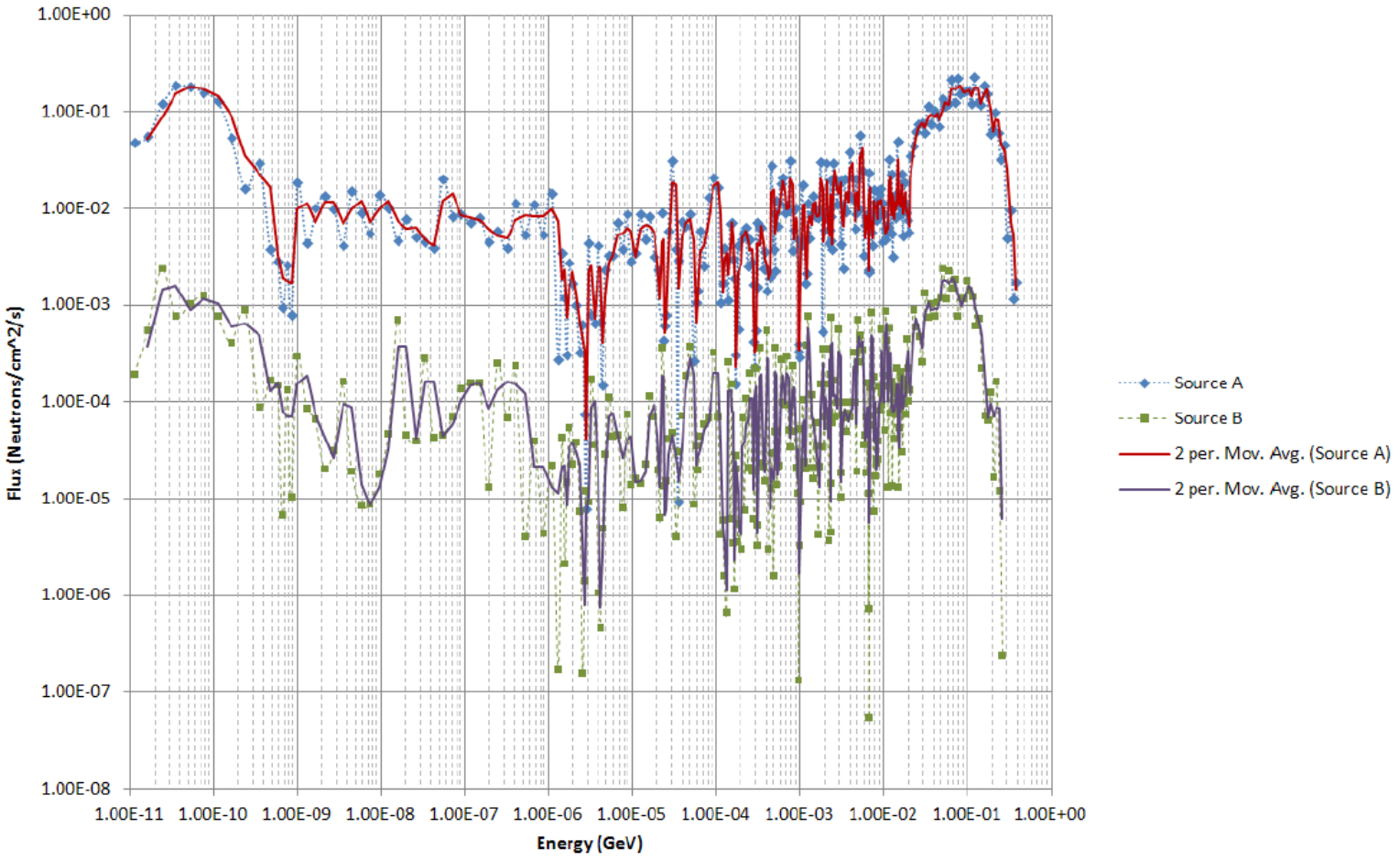
Residual dose rates calculated for source term A

(15 days * 300 pulses/day; 2 hours after beam stop)

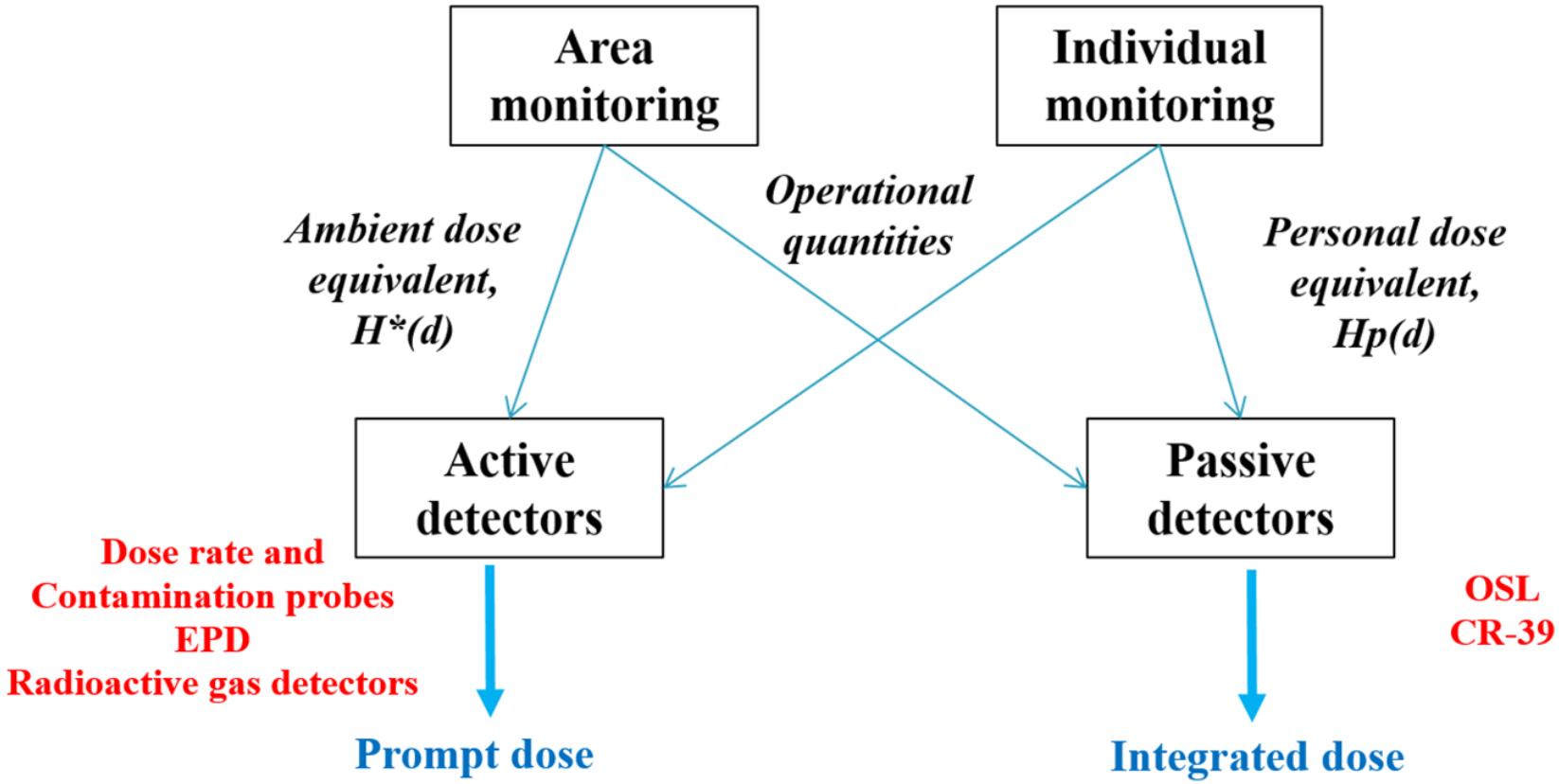


Modelling the best working conditions

Neutron Spectra



Radiation monitoring systems



Radiation monitoring systems

Radiation dosimetry methods used:

- ✓ Optically Stimulated Luminescence (**OSL**)
- ✓ Solid - State Nuclear Track Detection (**CR-39**)

Radiations Measured	Photon (X, gamma ray)	Beta particle	Neutron
Analysis method	OSL	OSL	CR-39
Energies Detected	16 keV – 10 MeV	100 keV – 10 MeV	Thermal → 40 MeV
Dose Measurement Range	50 µSv – 10 Sv	50 µSv – 10 Sv	100 µSv – 600 mSv

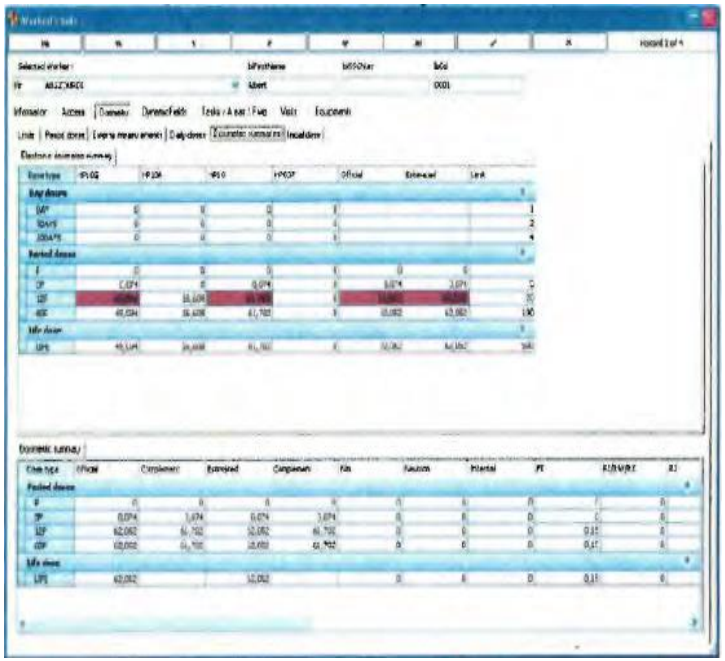
Radiation monitoring systems

Electronic personal dosimeters (EPD)

Type of radiation	X and Gamma	Neutron
Energy response	50 keV < E < 6 MeV	0.025 eV < E < 15 MeV
Dose range	1 µSv - 1 Sv	1 µSv - 1 Sv
Dose rate range	0.1 µSv/h - 1 Sv/h	0.1 µSv/h - 1 Sv/h

EPD DMC3000 (Gamma + Neutron)

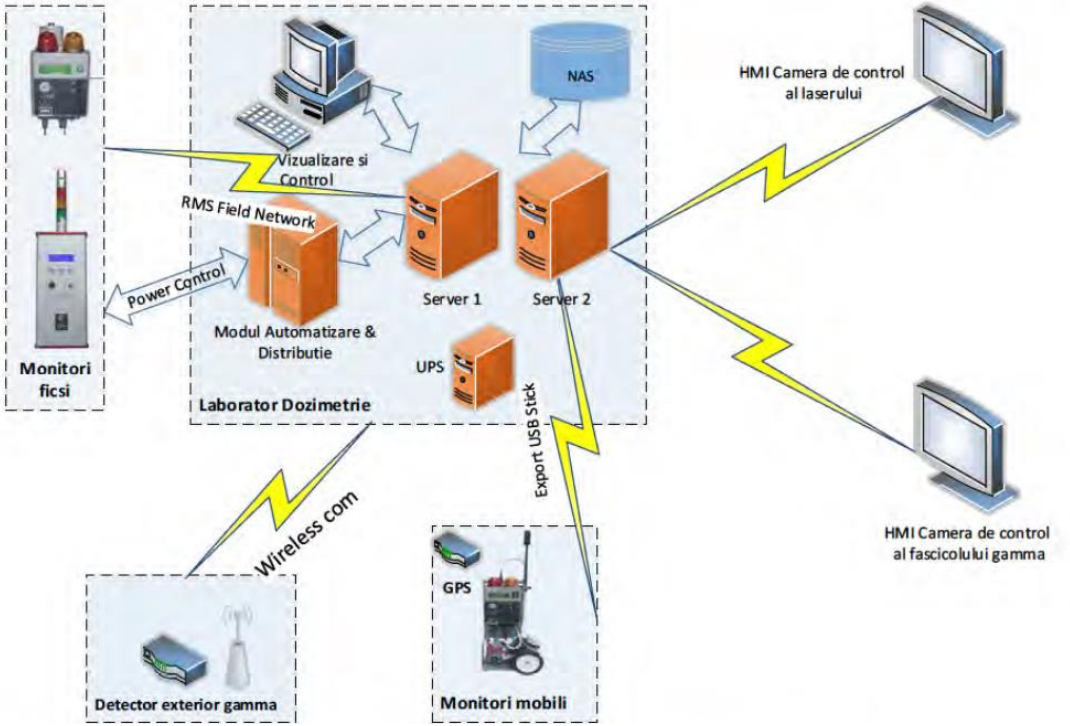
Software: DosiServ Express



Reader

Radiation monitoring systems

Active monitoring system: gamma, neutrons and gases



Dosimetry Lab

- Fully equipped for accommodation of all radiation monitoring systems presented
- Presently under licensing process for the passive BeOSL system
- Next step: CR-39 neutron passive dosimeters system licensing
- Implementation recently completed of the active radiation monitoring system

Challenges

- Identify the characteristics of the IR (accurately)
- Covering IR parameters: very short pulses, wide energy range and complexity (mixt)
- Safety culture development in accordance with the new features of IR
- Lined-up metrology services for newly developed monitoring techniques

Thank you!