# Design of Radiation Shielding For the PBP-CMU Electron Linac Laboratory

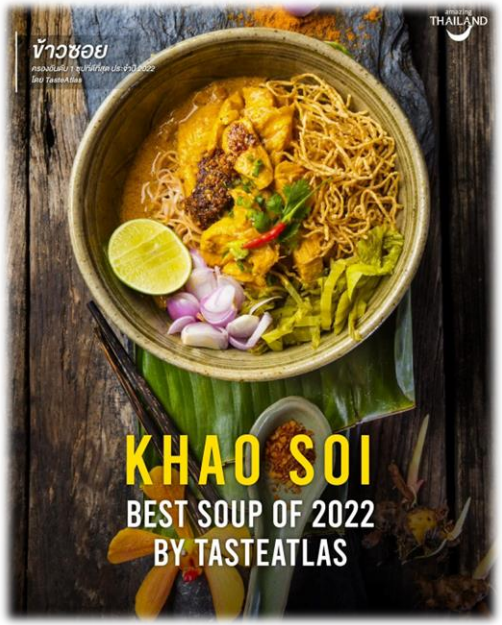

**Phanthip Jaikaew**

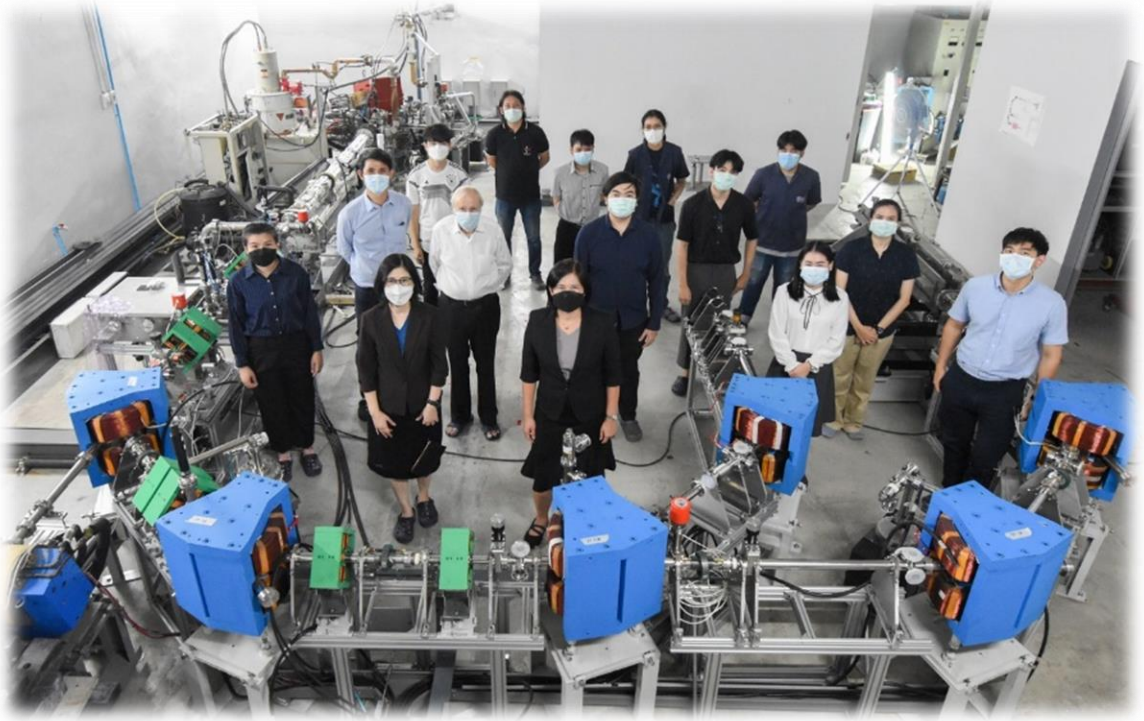
IPA, Nuclear and Structure Research Group, RIKEN, Japan

PhD program in Physics, Chiang Mai University, Thailand

E-mail : phanthip.jaikaew@riken.jp

# Where is Chiang Mai, Thailand ???

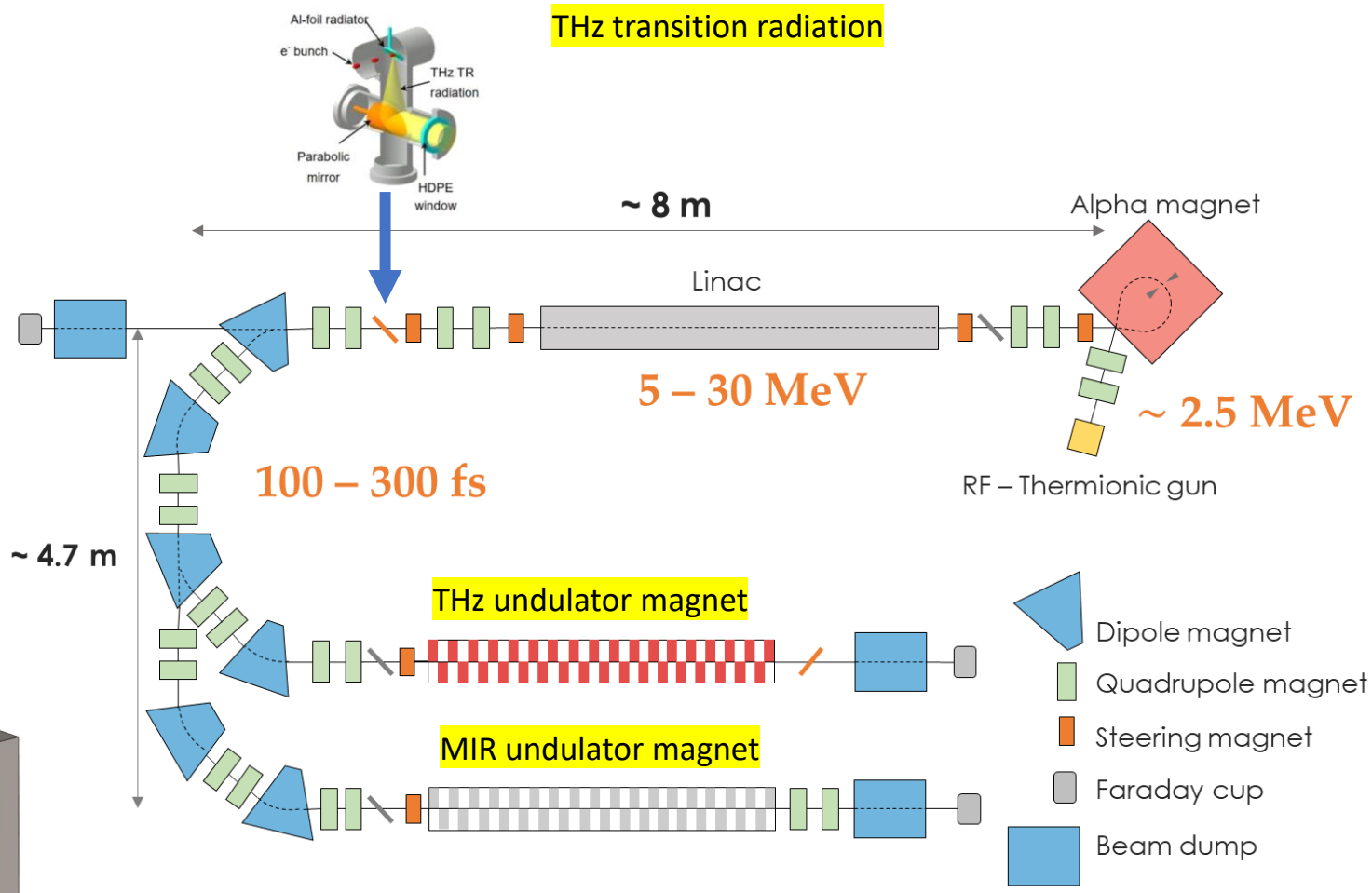



# The Electron Linac Laboratory of the Plasma and Beam Physics Research Facility (PCELL)

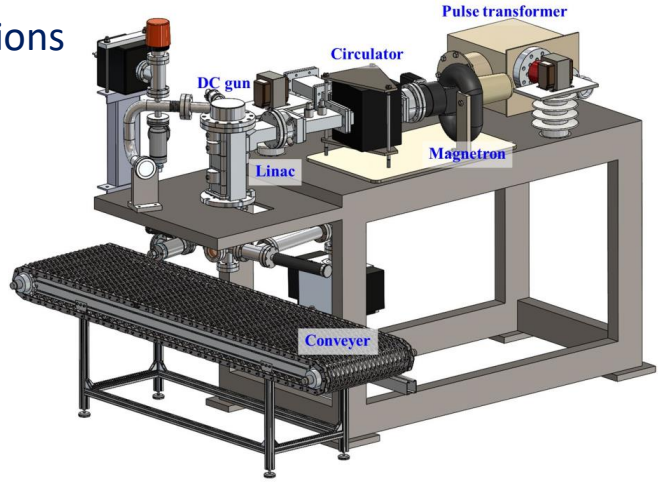
## 1. The 25 MeV linac (2856 MHz)

- Terahertz transition radiation (THz TR)
- mid-infrared and terahertz free-electron lasers



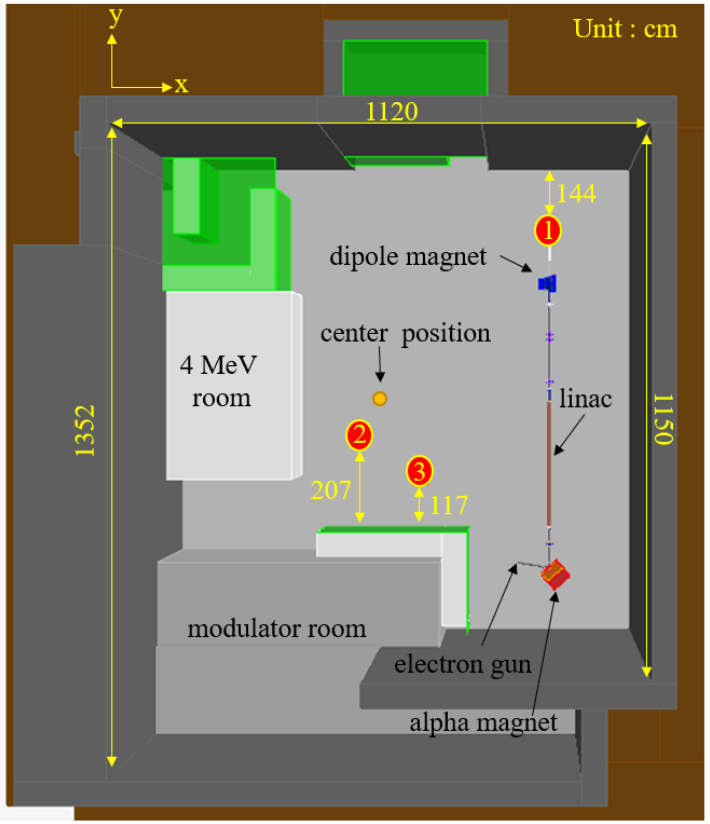

## 2. The 4 MeV linac (2998 MHz)

Irradiation applications



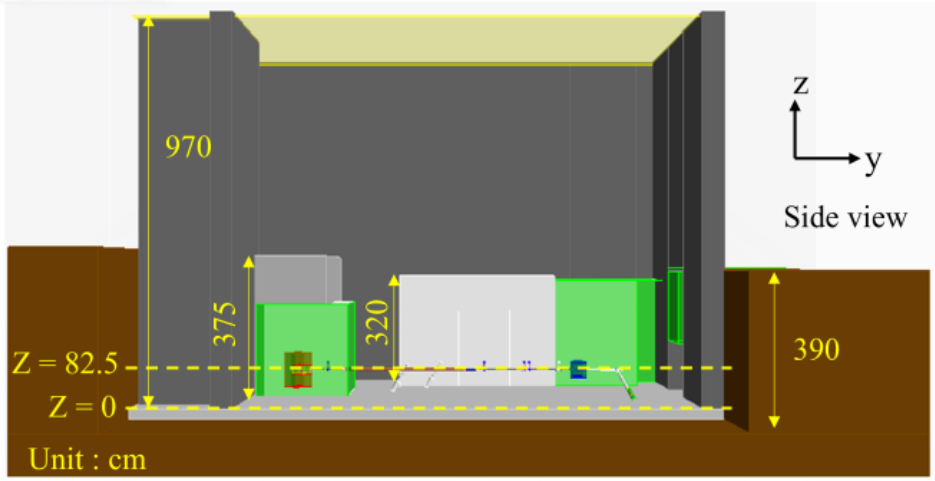
# Design of Radiation Shielding for the PBP-CMU Electron Linac

We got a new accelerator hall



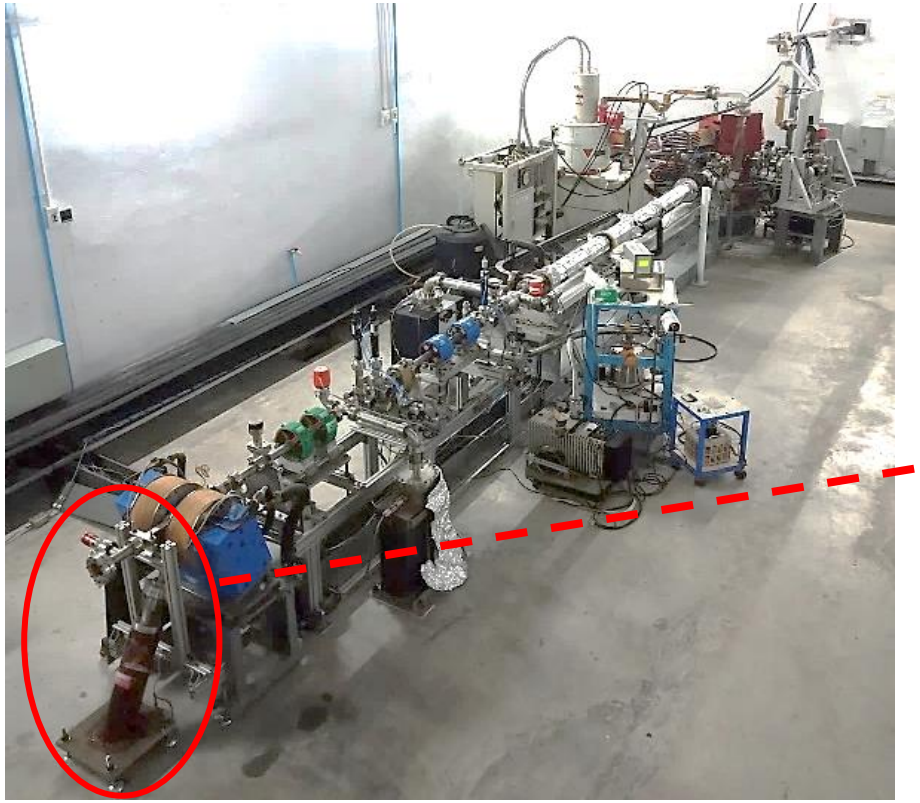

Challenge:

- Thin ceiling (~ 1 cm of gypsum)
- 52 cm of concrete wall
- Only half of the hall is in underground
- Limitation of budgets ( try to reducing lead )

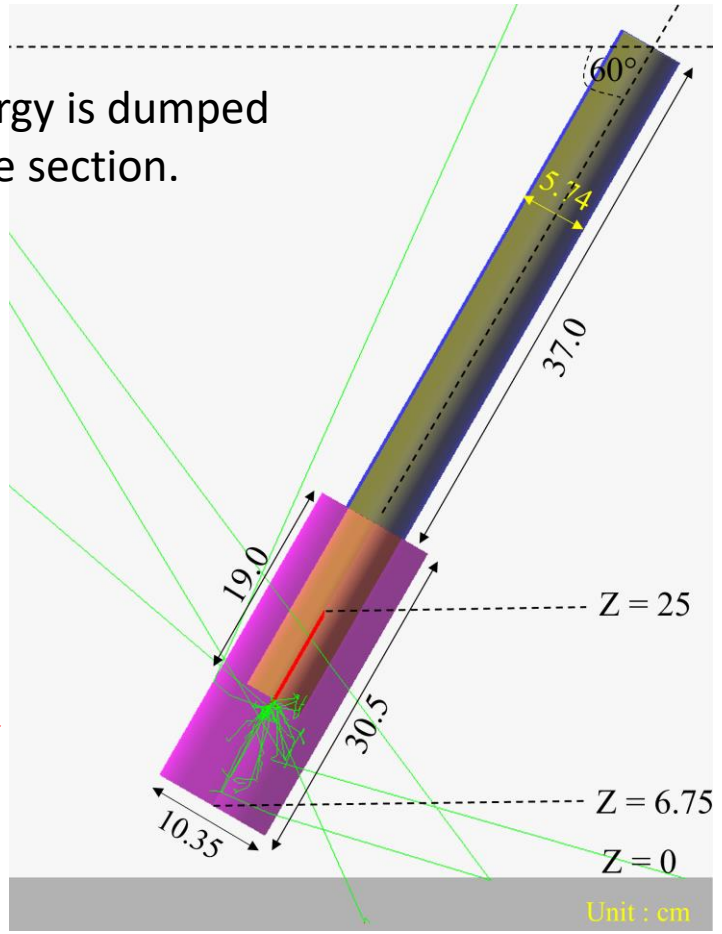


# We considered the worst-case scenario

When the monogenic electron beam with corresponding maximum energy is dumped into the ungrounded copper Faraday cup located at the end of beam line section.



Beam dump No.1




| Parameter | beam dump No.1 and No.2 | beam dump No.3 |
|---|---|---|
| Beam energy | 25 MeV | 16 MeV |
| Beam radius | 0.6 cm | 0.6 cm |
| Macro-pulse length | 6 $\mu$s | 5 $\mu$s |
| Bunch charge | 60 pC | 80 pC |
| $n_b/pulse$ | 17136 | 14280 |
| ppt | 10 Hz | 10 Hz |
| number of electrons per second | $6.408 \times 10^{13}$ | $7.12 \times 10^{13}$ |

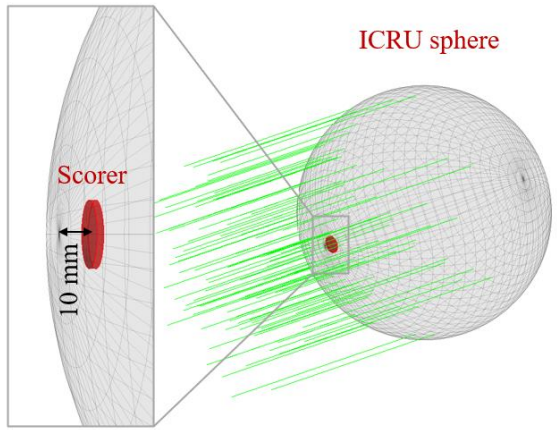
# Calculation of The fluence to ambient dose equivalent conversion coefficients (F)

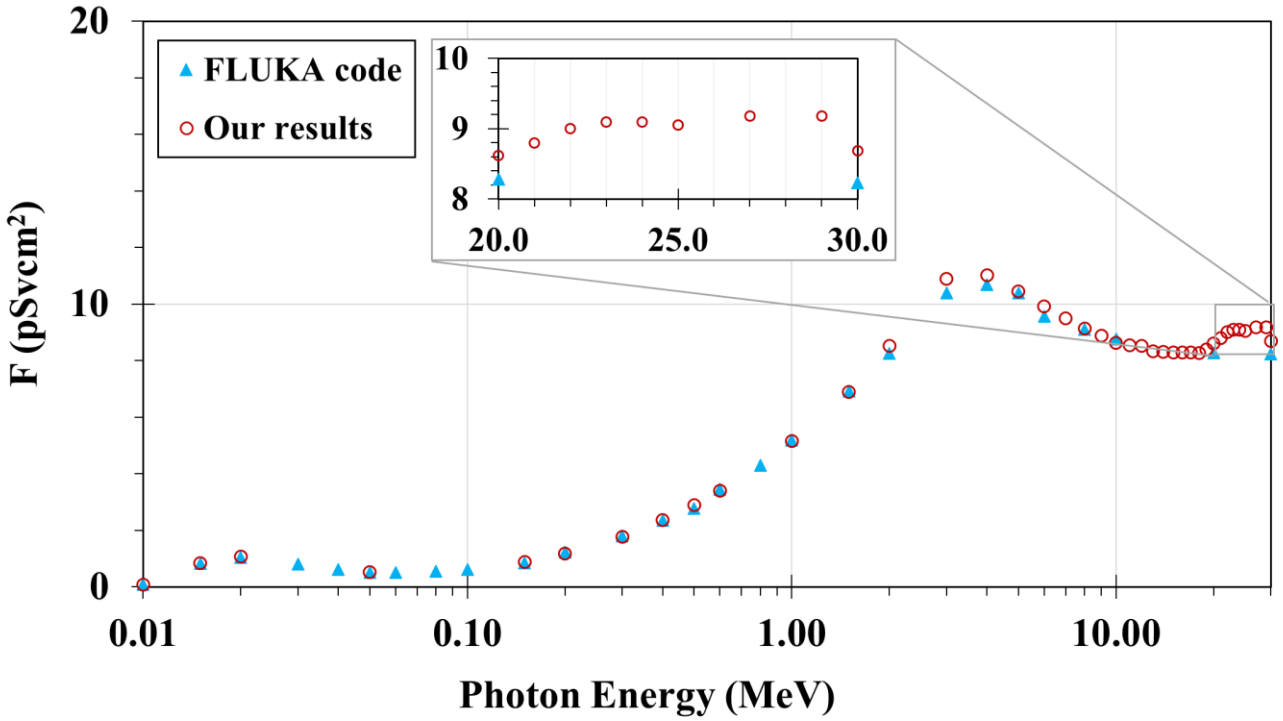
$H^*(d)$ is the ambient dose equivalent which generally used in radiation protection work,
it is used to link the external radiation field with the effective dose.

$$H^*(d) = F \cdot \phi$$

$F$ = Conversion factor ; (Sv/cm$^2$)

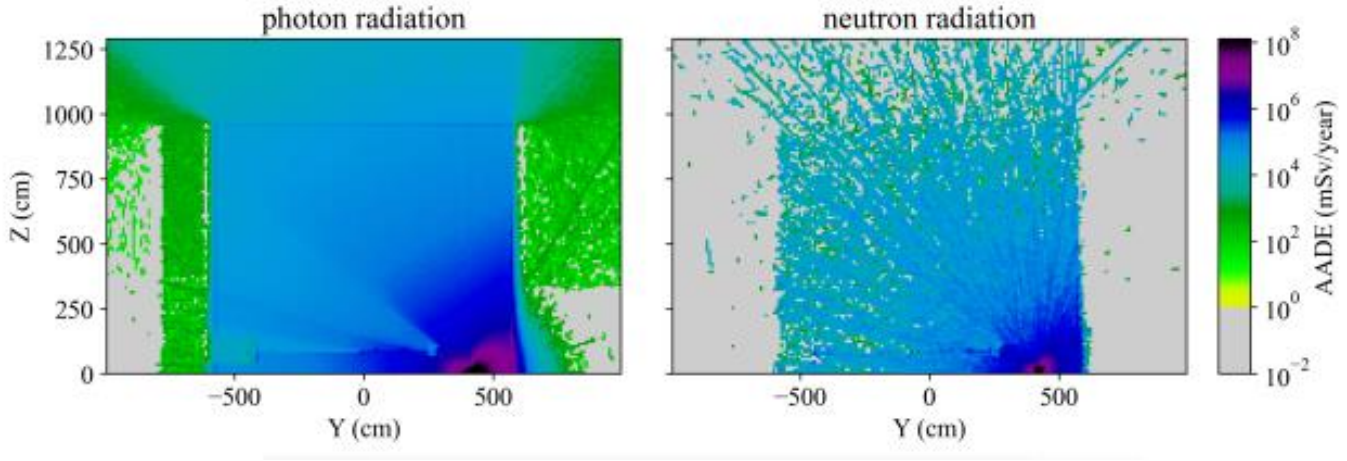
$\phi = fluence = \frac{dN}{da}$ ; (cm$^{-2}$)

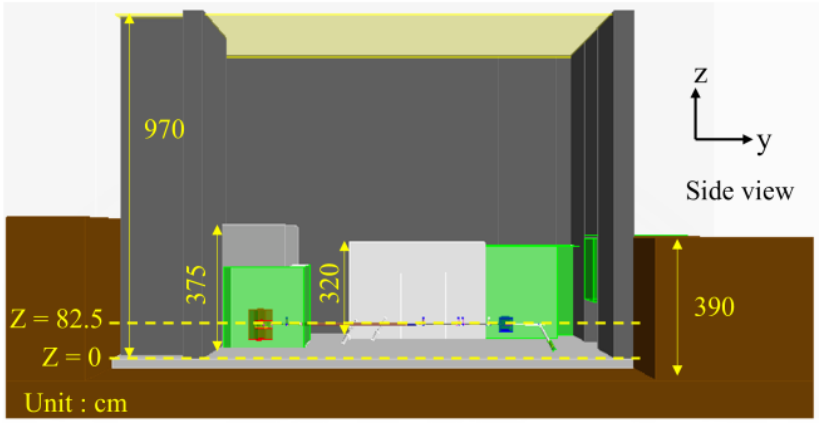


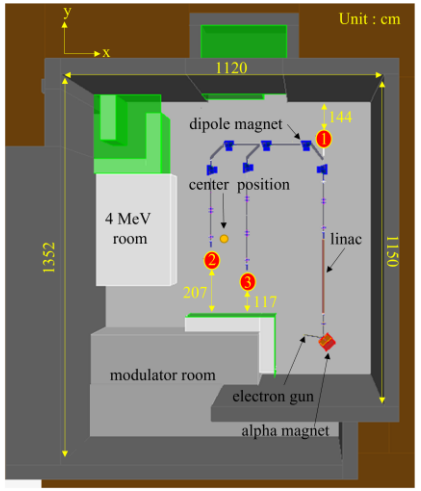

$H^*(10)$ = the dose equivalent at a depth of 10 mm inside **ICRU sphere** (tissue equivalent) which irradiated by expanded and aligned radiation field.

# The annual ambient dose equivalent area maps of photon and neutron caused by the primary electrons dumping into beam dump No.1

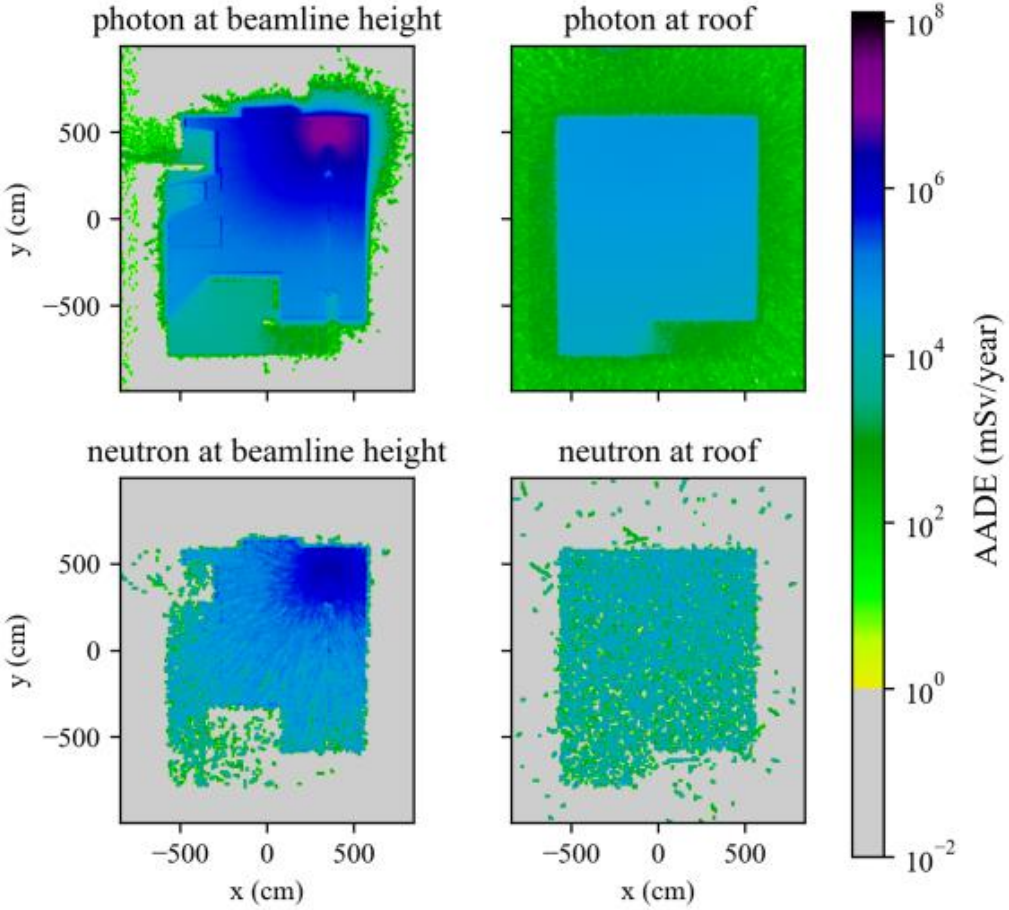



A schematic side view of the hall

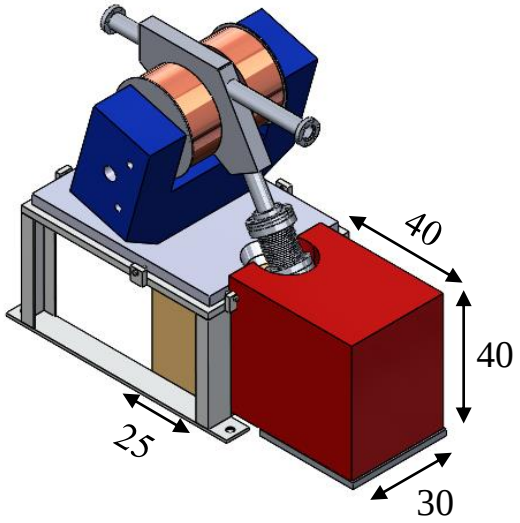


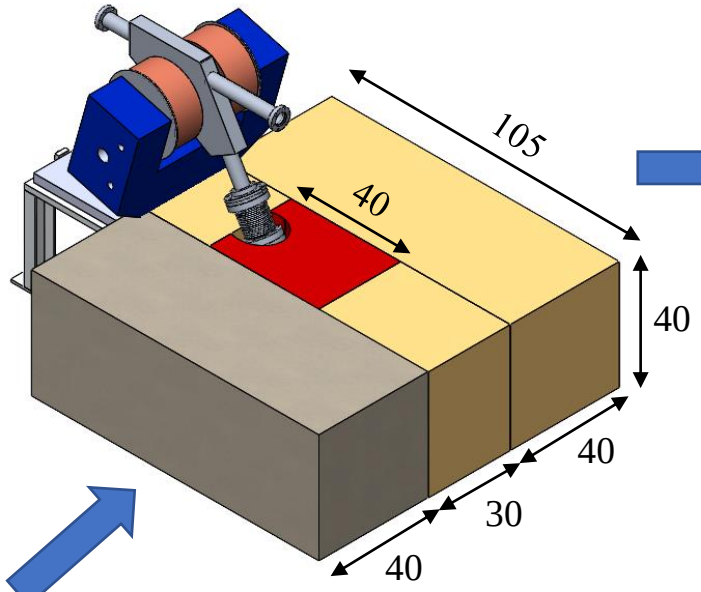

A schematic top view of the hall

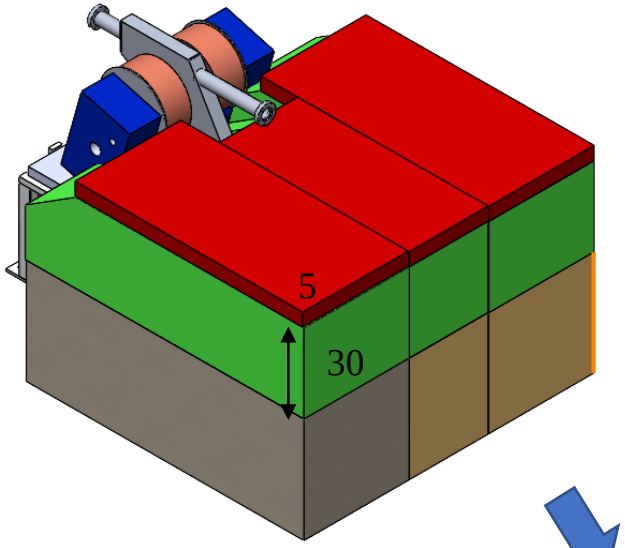


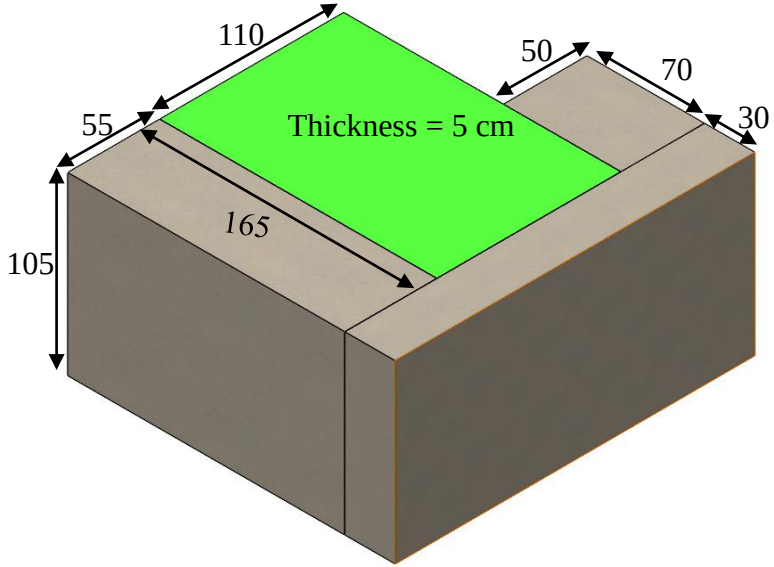
# Local shielding design for Beam dump No.1

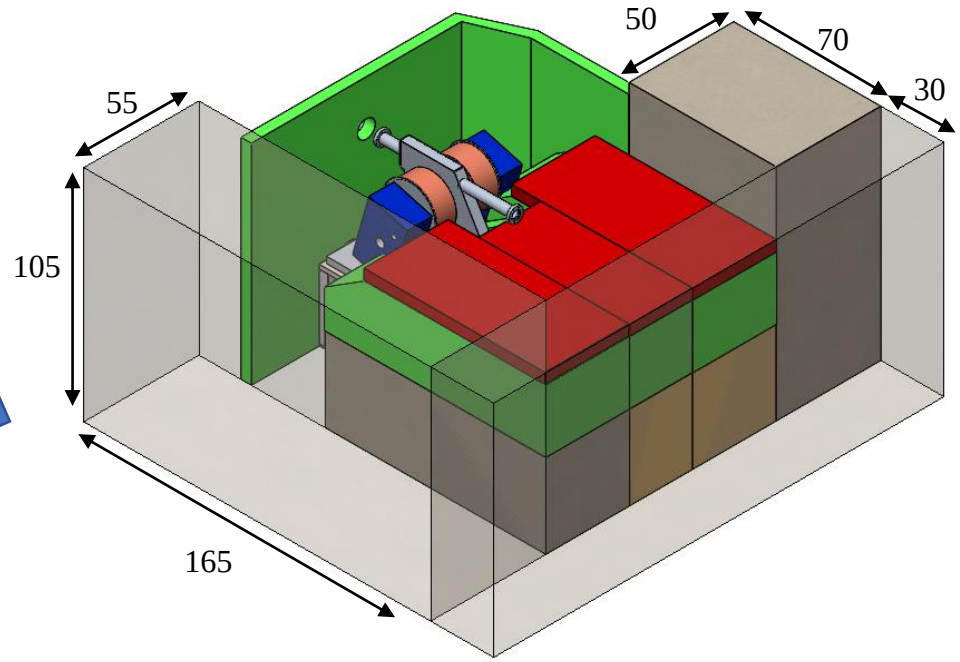
Iron
Lead
Polyethylene
Concrete



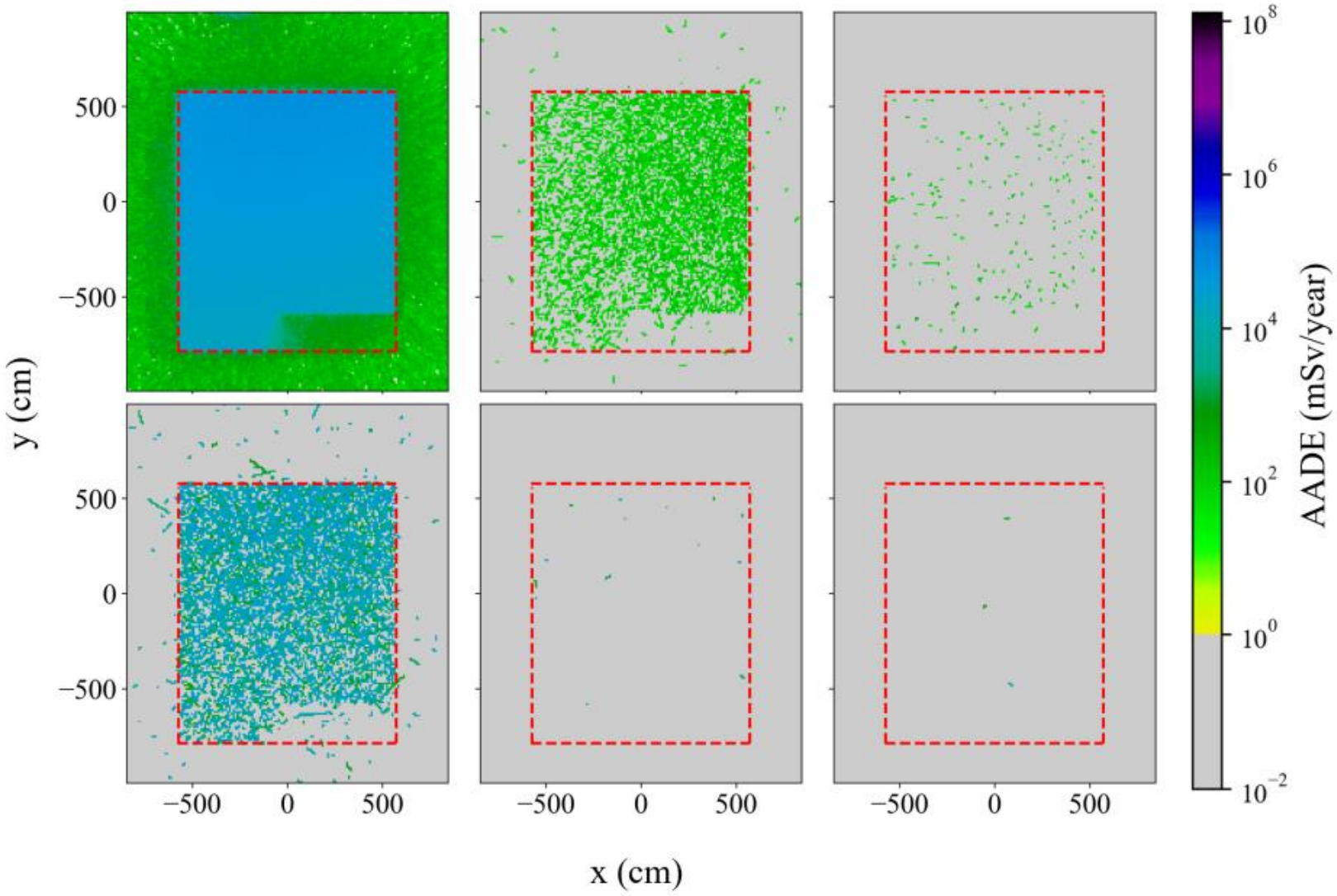



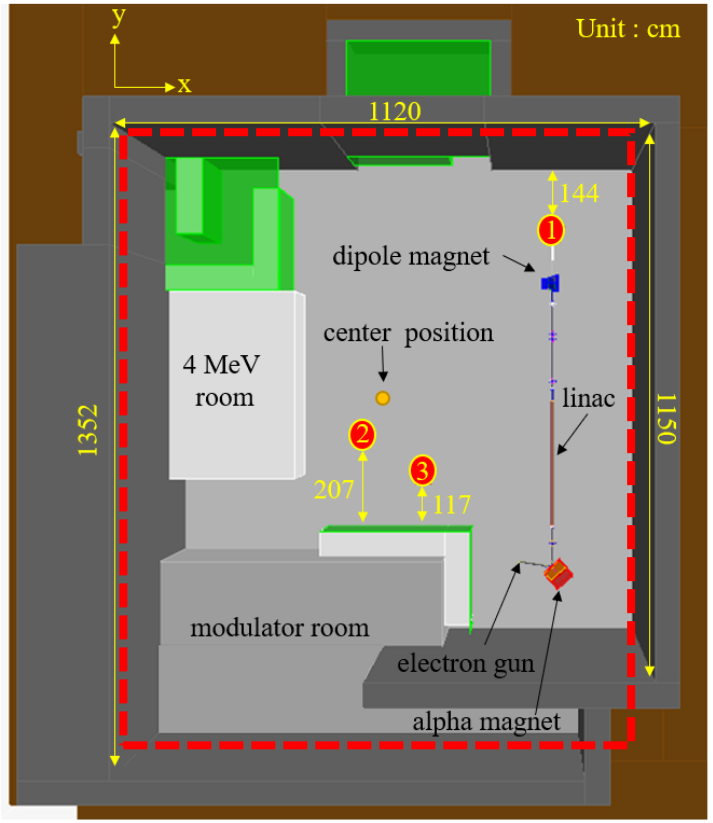




Original model

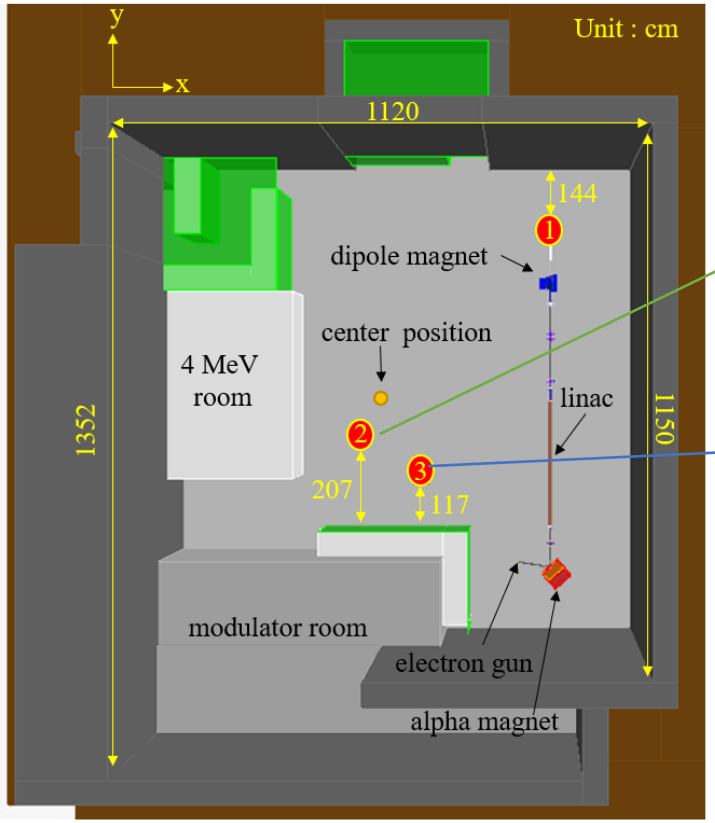
# *AADE* maps of photon (top) and neutron (bottom) at the roof of the accelerator hall

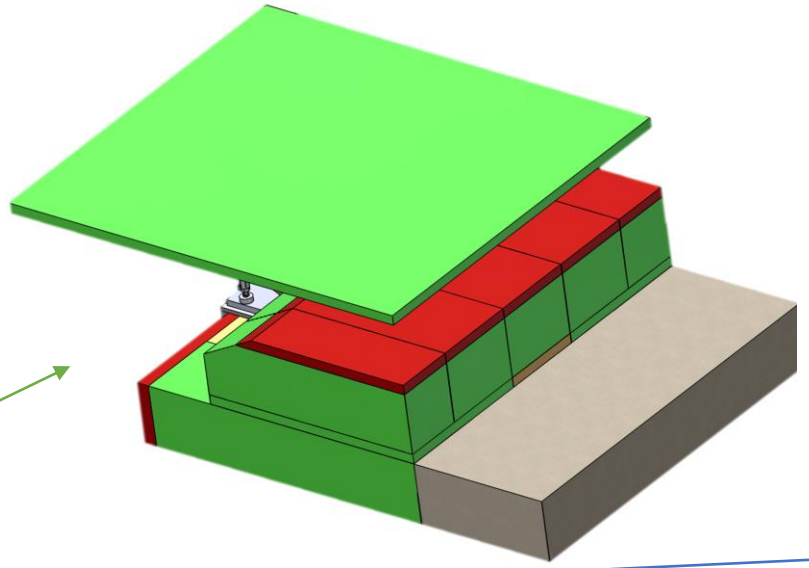
Without shielding  adding the first barriers  final model of shielding

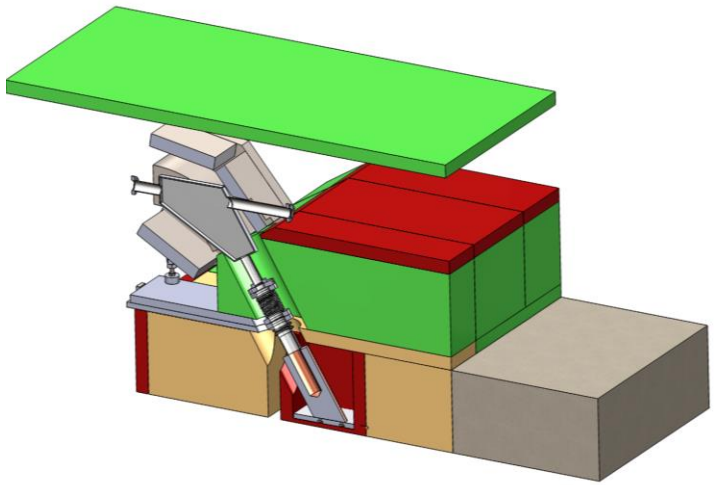


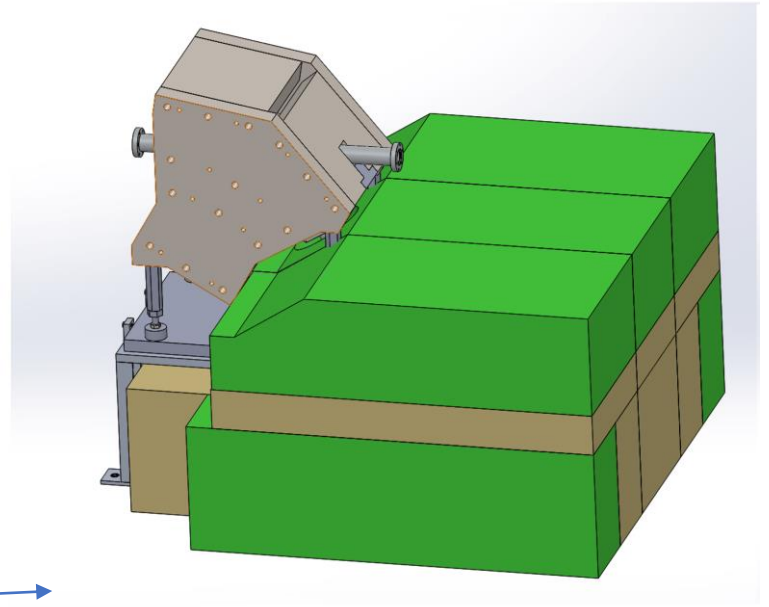
# Local shielding design for Beam dump No.2 and No.3

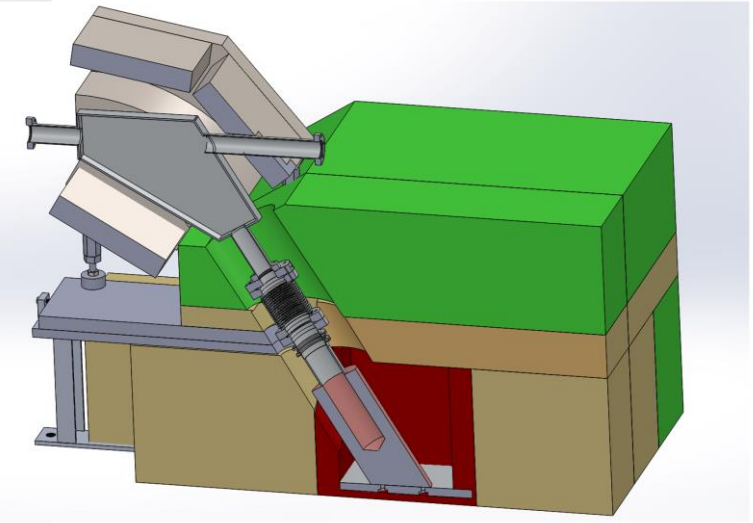




beam dump No.2





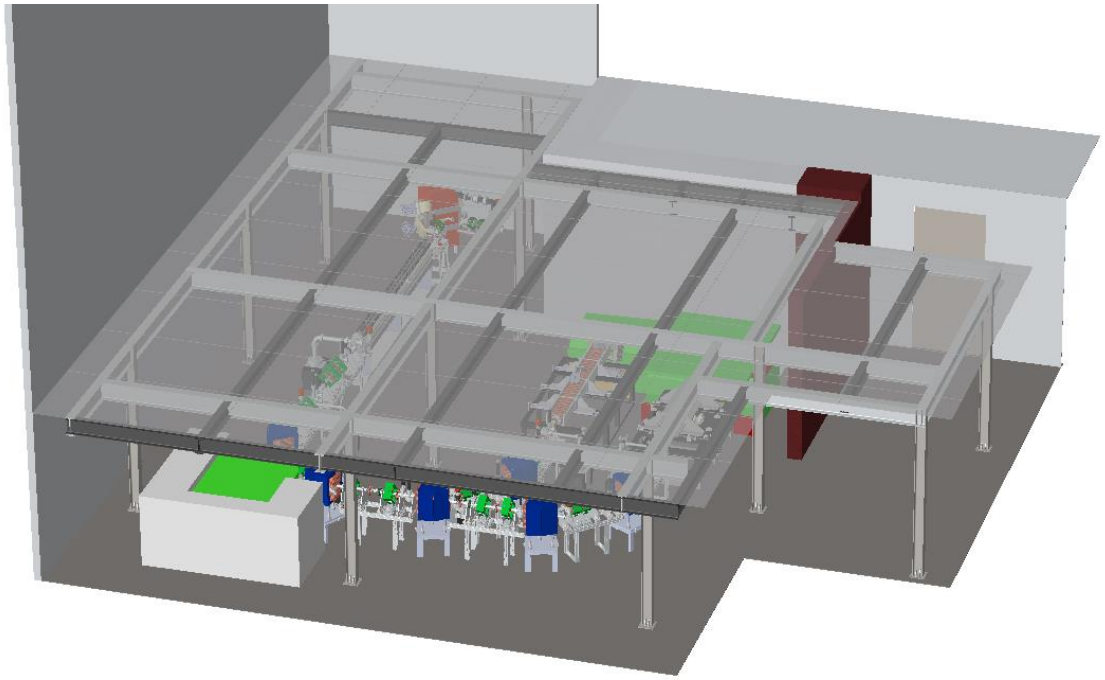
beam dump No.3

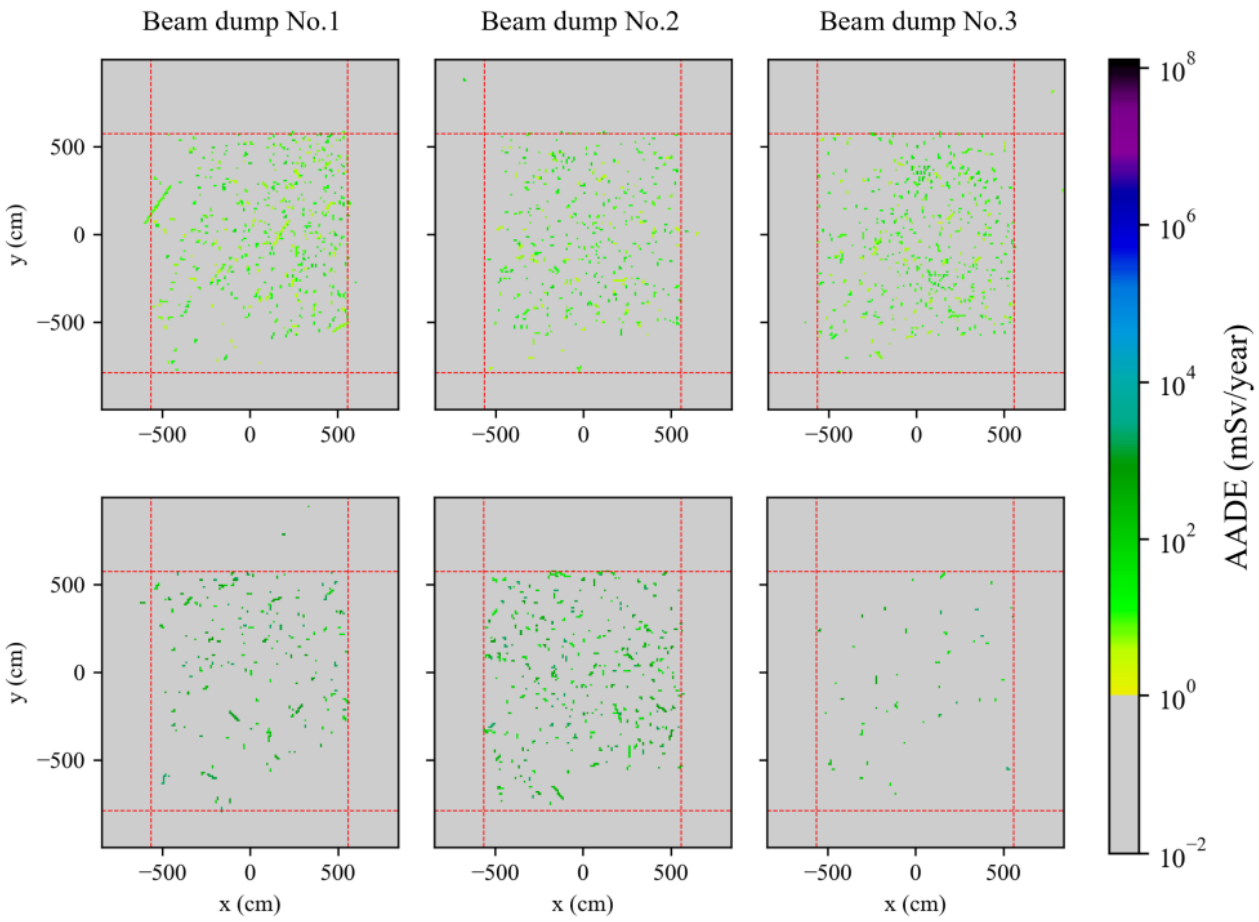
# Simulation results

The **sum of photon and neutron** radiation dose rate at the roof was **under 20 mSv/year**. Thus, we can conclude that the shielding design can reach the goal of a **controlled area** at the roof of the accelerator hall.

The 3D model of the accelerator system in the accelerator hall after adding

- local shielding for three beam dump
- 3-cm iron ceiling
- L-shape concrete walls





# Thank you for your attention