
CERN

A radiological study at the CERN Anti-proton decelerator

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Content

- Aim
- Introduction into the topic
- Implementation with FLUKA and Flair
- Comparison of the particles in the secondary radiation
- Activation of the target

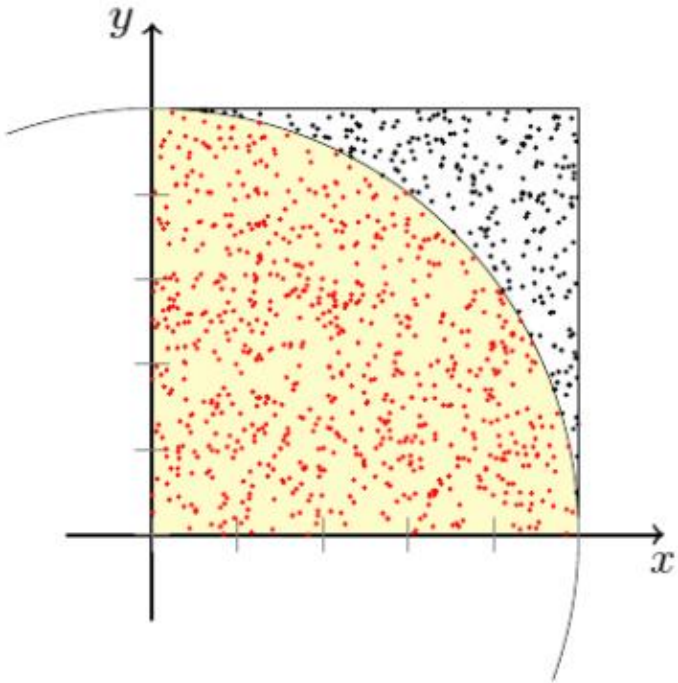
Aim

- modelling collisions of particles (base: ELENA)
- analysis of the secondary particle fields
- shielding design

→ radiation protection at CERN

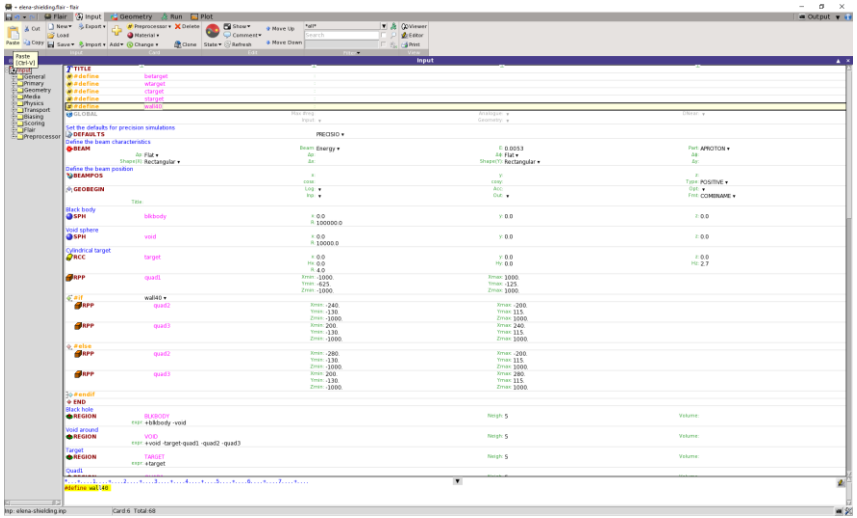
Introduction into the topic

- Monte-Carlo Simulations
  - Example: Approach to pi
  - FLUKA MC code for radiation transport
  - Cluster & GitLab
- Anti-proton beam
  - steel target
  - $3*10^7$ Anti-protons every 60s

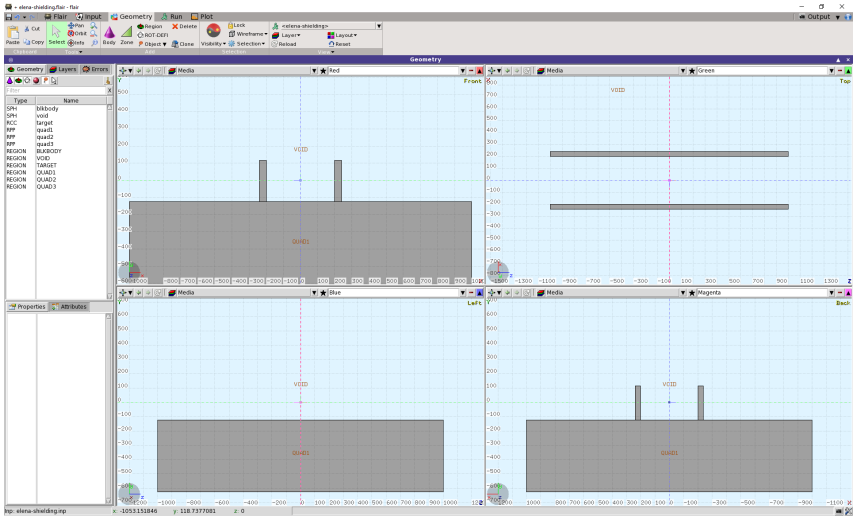


https://de.wikipedia.org/wiki/Monte-Carlo-Simulation

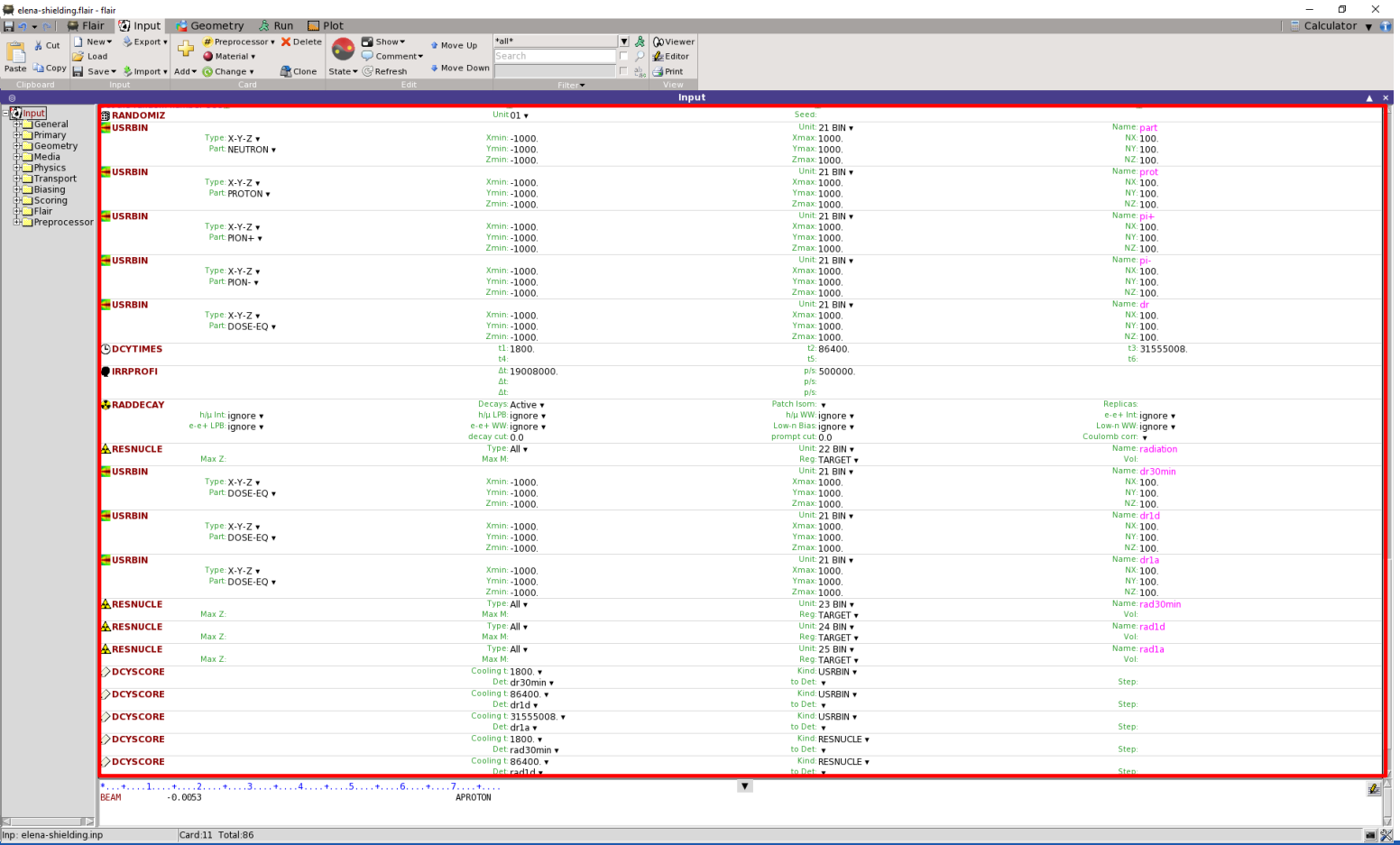
Implementation with FLUKA and Flair



Input for FLUKA

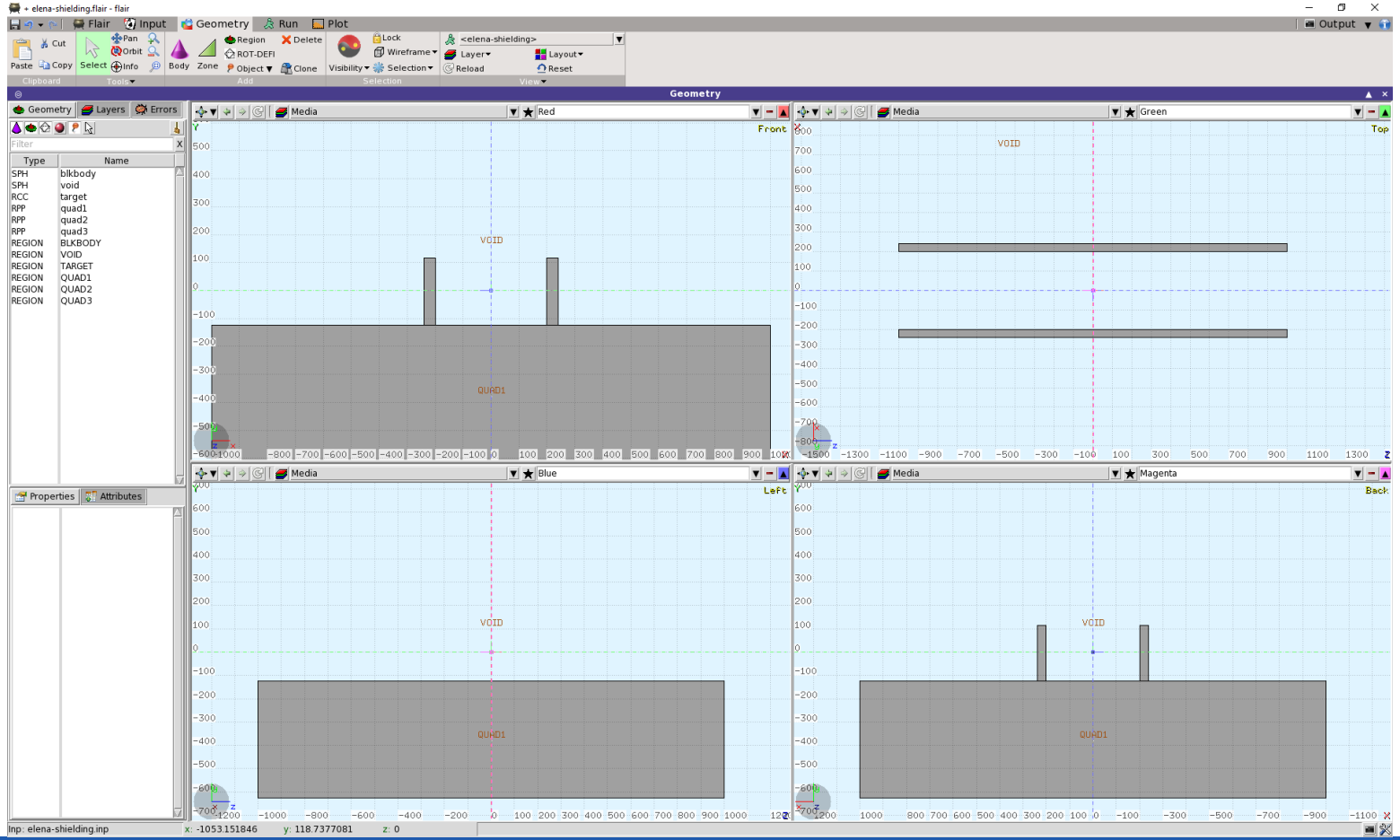


Geometry



Input:

- General
- Physics
- Primary
- Geometry
- Media
- Scoring


+ elena-shielding.flair - flair
Flair
Input
Geometry
Run
Plot
Output
Paste
Cut
Copy
Select
Pan
Orbit
Info
Body
Zone
Region
ROT-DEFI
Object
Delete
Clone
Lock
Wireframe
Selection
Visibility
<elena-shielding>
Layer
Reload
Layout
Reset
Clipboard
Tools
Add
Selection
View
Geometry
Geometry
Layers
Errors
Filter
Type
Name
SPH blkbody
SPH void
RCC target
RPP quad1
RPP quad2
RPP quad3
REGION BLKBODY
REGION VOID
REGION TARGET
REGION QUAD1
REGION QUAD2
REGION QUAD3
Properties
Attributes
Media
Red
Front
VOID
QUAD1
Media
Green
Top
VOID
Media
Blue
Left
VOID
QUAD1
Media
Magenta
Back
VOID
QUAD1
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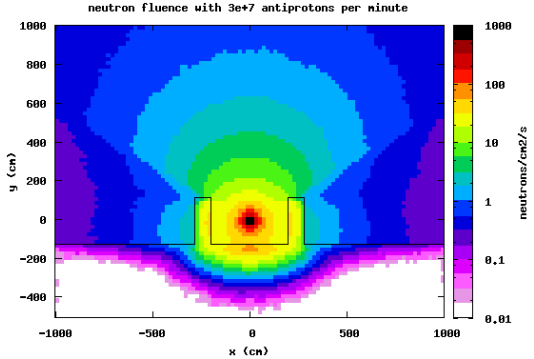
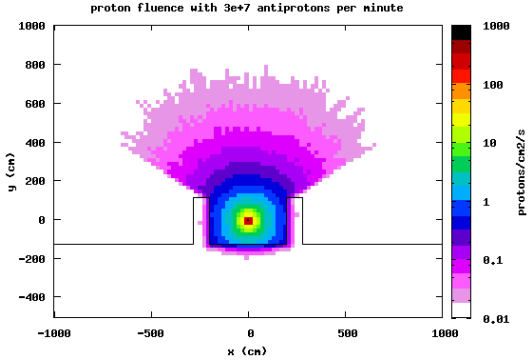
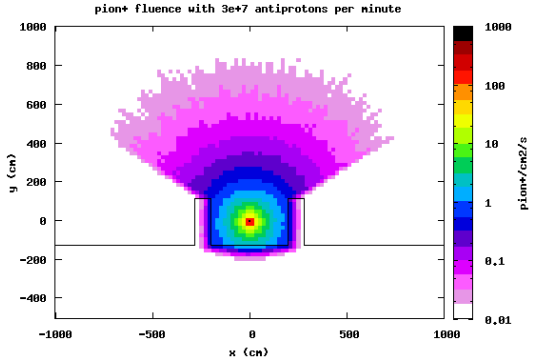
y: 118.7377081
z: 0

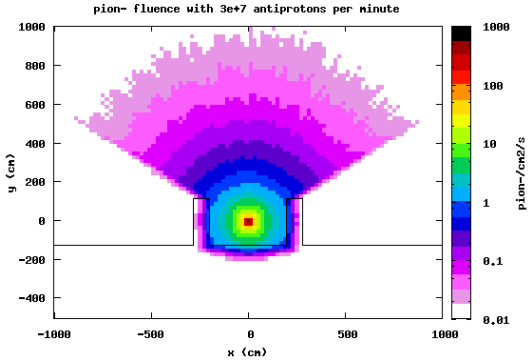
Comparison of the particles in the secondary radiation

80 cm shielding:



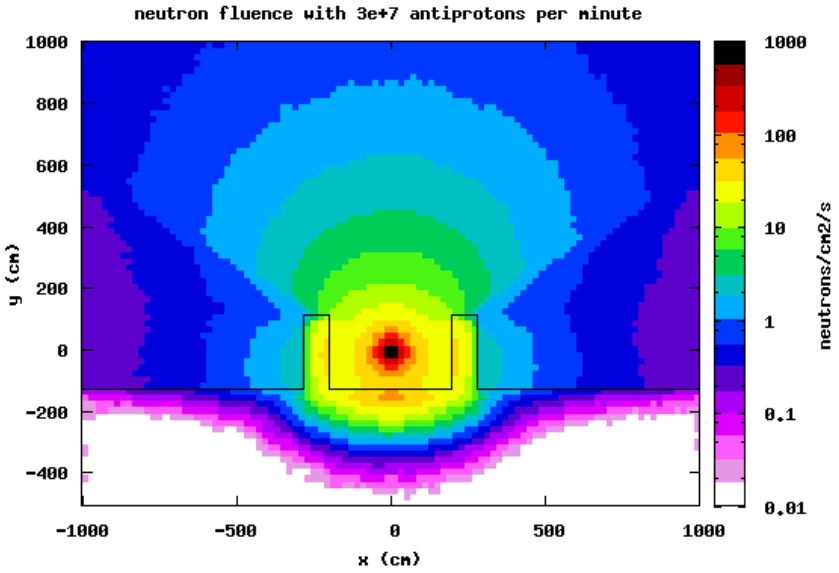


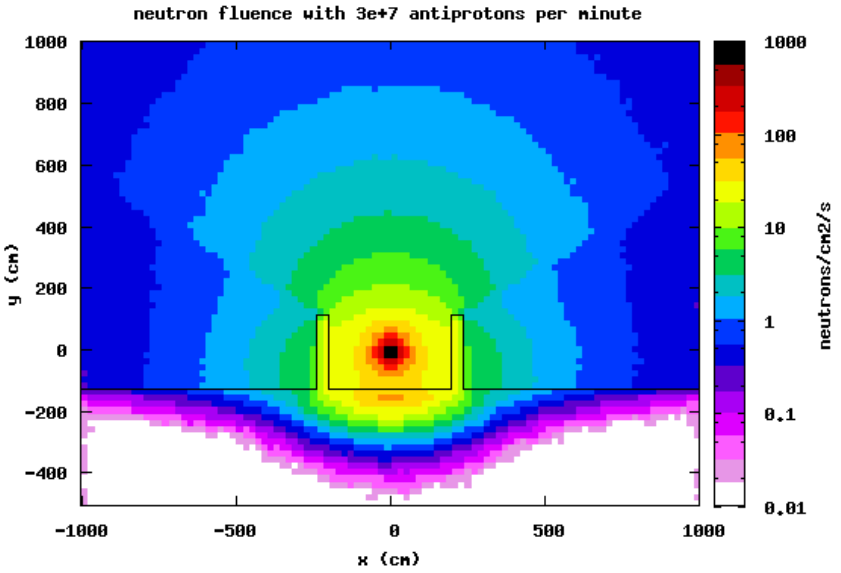




Comparison of the particles in the secondary radiation

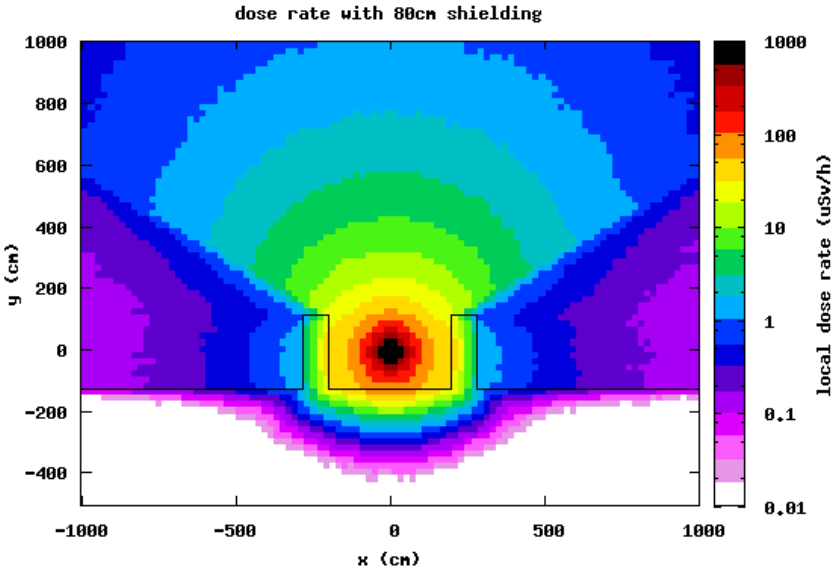
Neutrons:

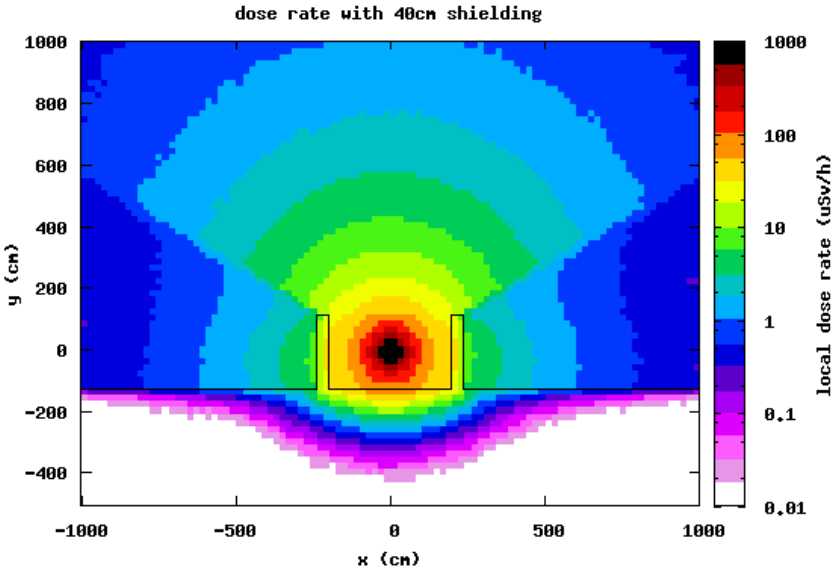




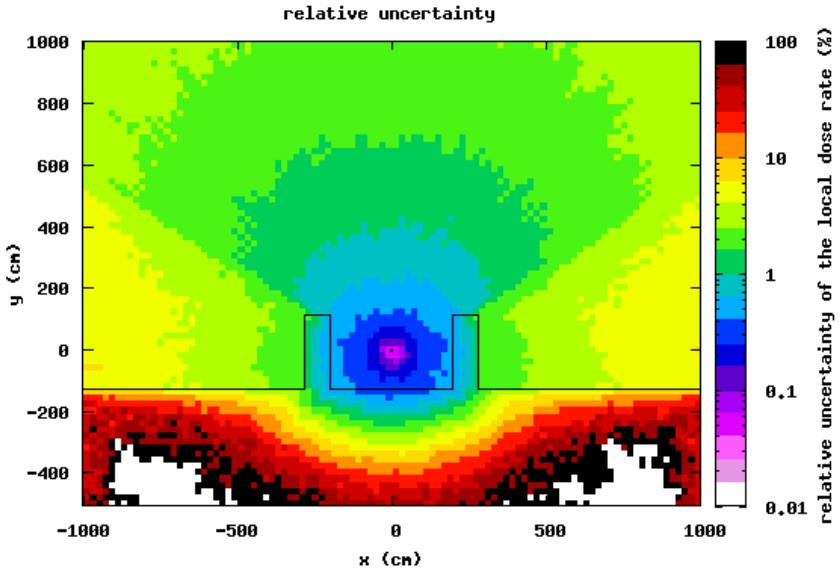
Comparison of the particles in the secondary radiation

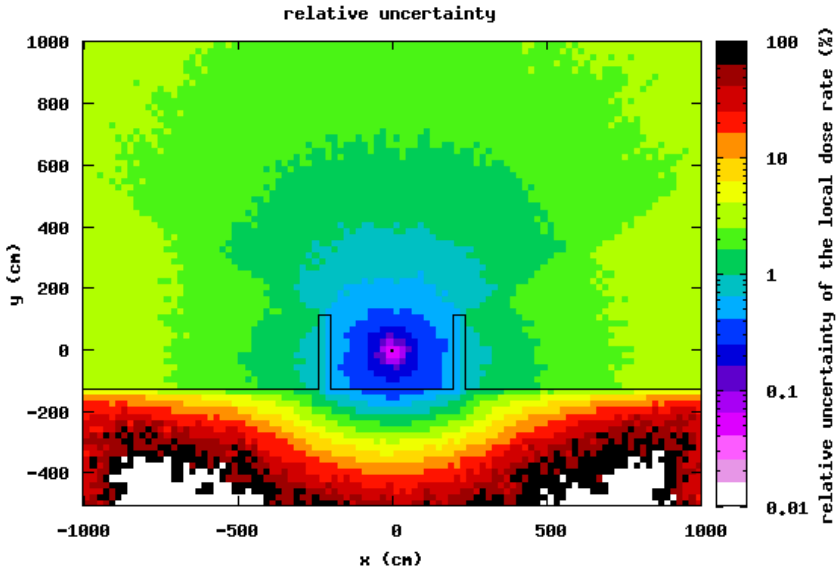
Dose rate:





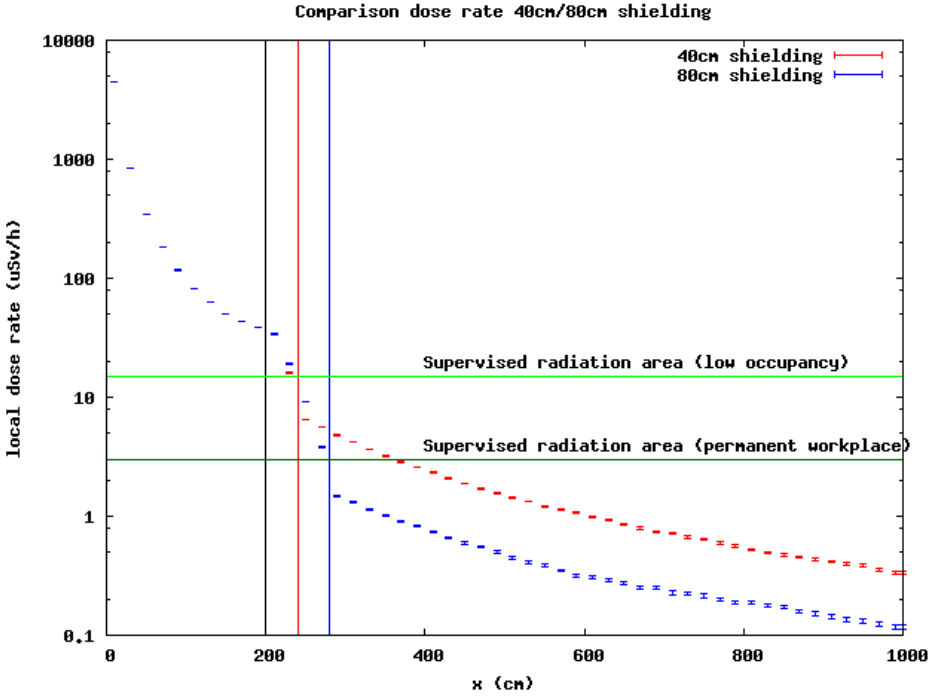
Relative uncertainty of the simulation





Comparison of the particles in the secondary radiation

Dose rate:



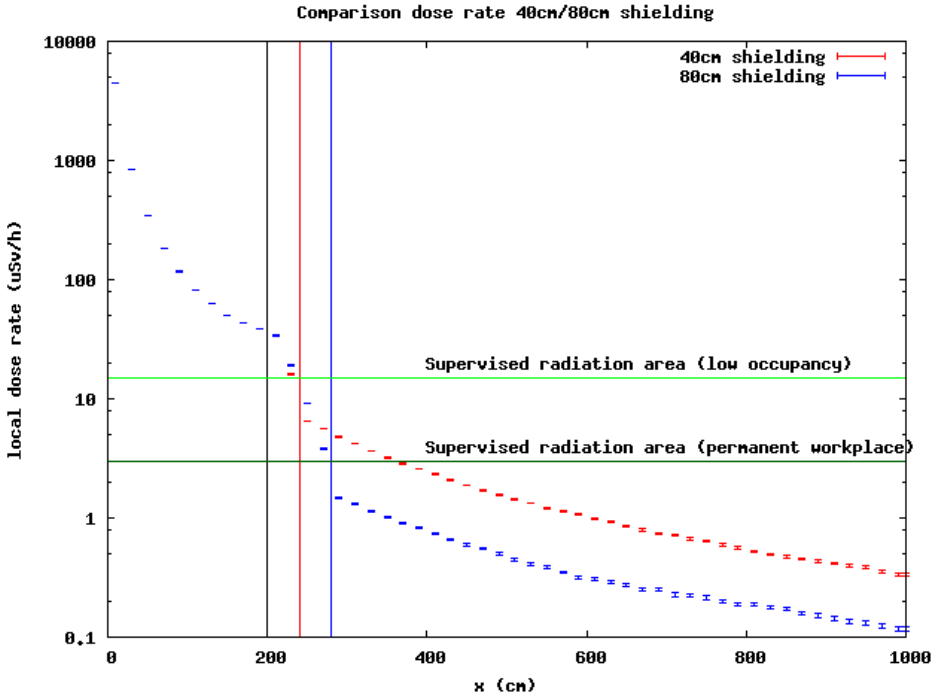
Comparison of the particles in the secondary radiation

Dose rate:

Design goal:

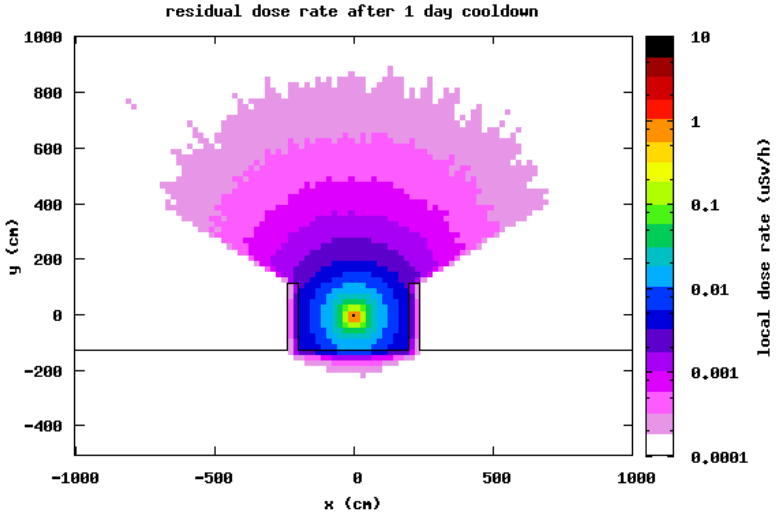
- Supervised Radiation Area
- Permanent workplace

→Shielding of 80cm needed

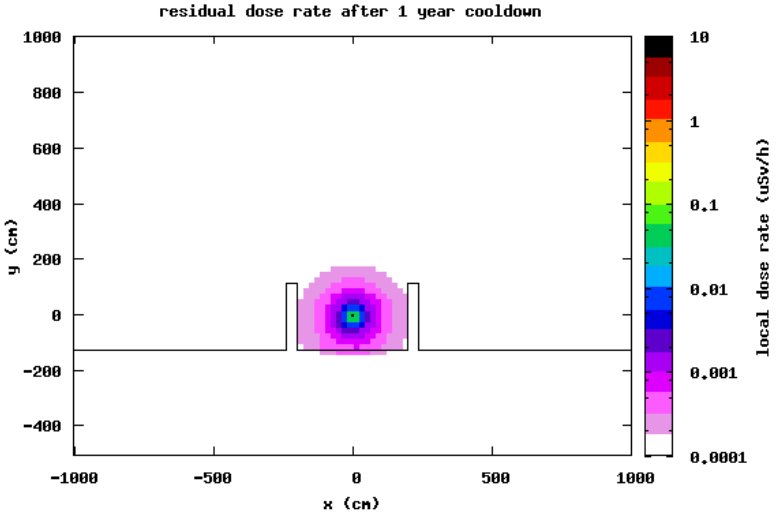


Comparison of the activation of the target

Dose rate:



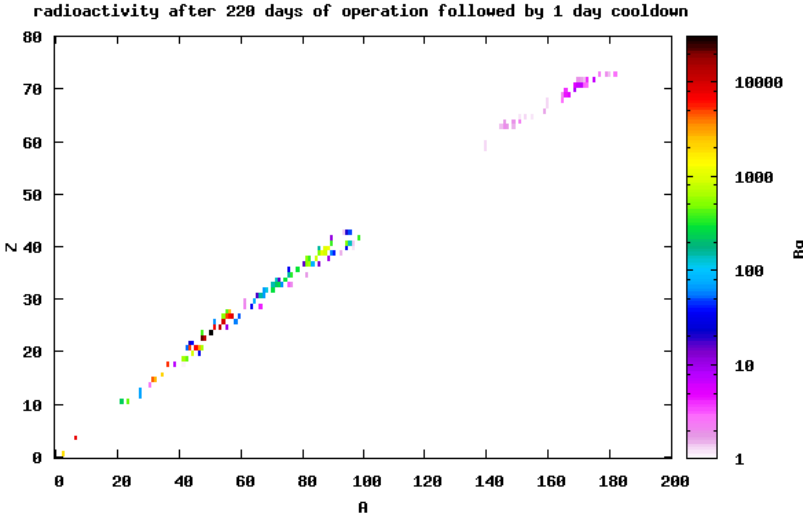
1 day



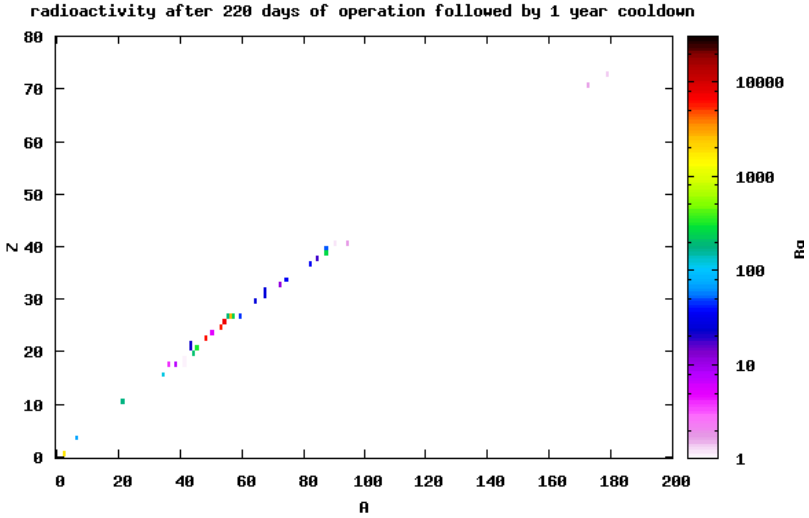
1 year

Comparison of the activation of the target

Radiological characterisation:



1 day



1 year

Activation of the target after 1 year

Radiological characterisation:

Isotope	Half-time	Activity (Bq)	LL (Bq*)	Activity/LL
Mn-54	312,1d	$5,84*10^3$	100	58,4
Co-56	77,31d	$2,95*10^2$	100	2,95
Co-57	271,8d	$2,54*10^3$	1000	2,54
Na-22	2,603a	$2,27*10^2$	100	2,27

*for objects with a mass not exceeding 1 kg

Activity/LL > 1 → Radioactive material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Comparison of the particles in the secondary radiation

Protons: