



# Exercise 8: Importance biasing

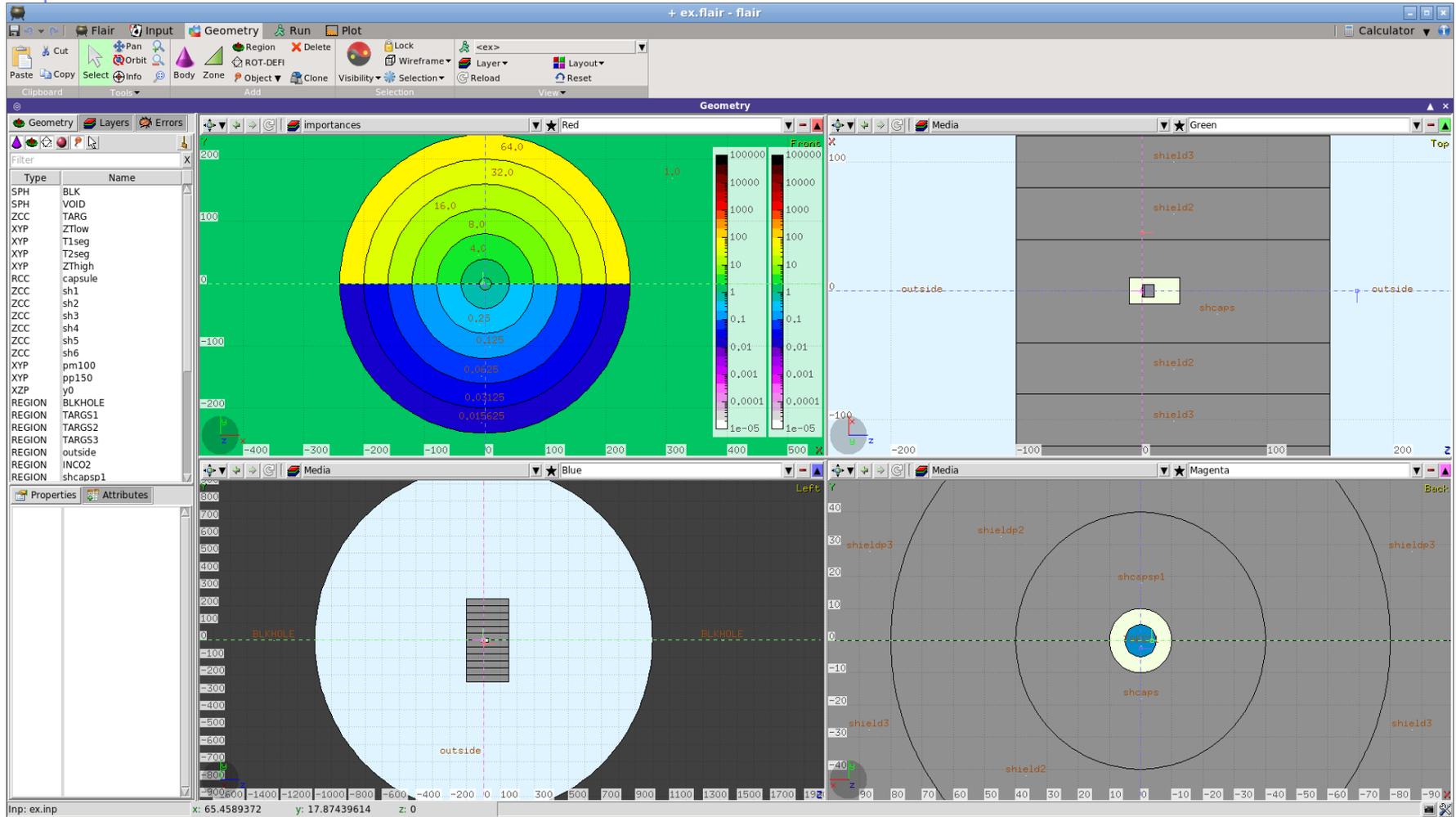
FLUKA Beginner's Course

# Exercise: Importance biasing

## **Aim of the exercise:**

- 1- Discover biasing power
- 2- Experience region importance
- 3- Use of cylindrical mesh USRBIN
- 4- Plot USRBIN in the Geometry Editor
- 5- Use of Conditional Directives

# Exercise: Importance biasing



# Exercise: Importance biasing

- ❑ Start from the solution of `ex_Geo1` (Copy both `.inp` and `.flair` files).:  
`mkdir ex_Biasing`  
`cp ex_Geo1/ex_Geo1_final.inp ex_Biasing/ex_Biasing.inp`  
`cd ex_Biasing`  
`flair ex_Biasing.inp` (and immediately save flair project)
- ❑ Set a 3.5 GeV proton beam, Gaussian momentum profile, 0.8 GeV/c FWHM, 0.8 mrad divergence.
- ❑ Set BEAMPOS  $z=-0.1$  cm
- ❑ Materials in target: water, Al, Pb.
  
- ❑ In the next slide we enclose the target in a cylindrical capsule filled with CO<sub>2</sub> and arrange coaxial cylindrical layers of concrete surrounding the capsule, acting as shielding material

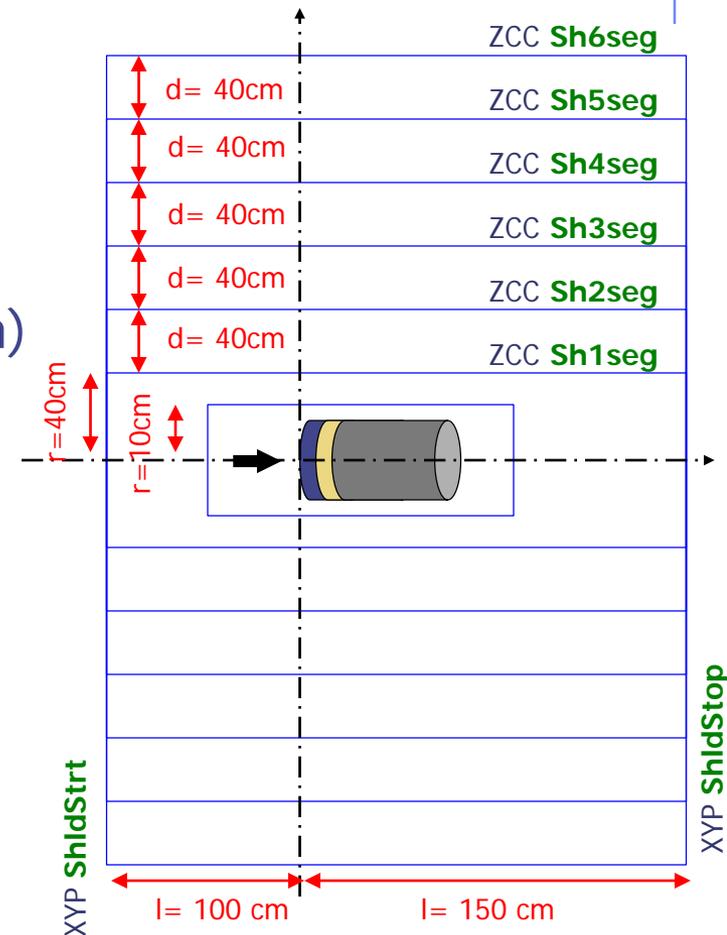
# Exercise: Importance biasing

- Start from the solution of `ex_Geometry` (Copy both `.inp` and `.flair` files).:  
`mkdir ex_biasing ; cp ex_geometry/exgeo1.inp ex_biasing ; cd ex_biasing`

- Geometry modifications:  
**create a coaxial shielding**

- e.g.:
  - Add 1 RCC surrounding the target  
( $R=10\text{cm}$  ;  $Z_{\min}=-10\text{cm}$  ;  $Z_{\max}=30\text{cm}$ )
  - Add 6 ZCC (radius =  $n \times 40\text{cm}$ )
  - Add 2 XYP planes  
( $z=-100\text{cm}$  and  $z=150\text{cm}$ )
  - Add 1 XZP plane ( $y=0$ )

Define a region for each shielding "shell"



# Exercise 10: Importance biasing

## Materials

- ❑ Shielding will be made of concrete
- ❑ Concrete is not a FLUKA predefined material
- ❑ It has to be defined

**Concrete:** (mass fraction)

Hydrogen	0.01	Aluminum	0.034
Carbon	0.001	Silicon	0.337
Oxygen	0.529	Potassium	0.013
Sodium	0.016	Calcium	0.044
Magnesium	0.002	Iron	0.014

**Density: 2.42g/cm<sup>3</sup>**

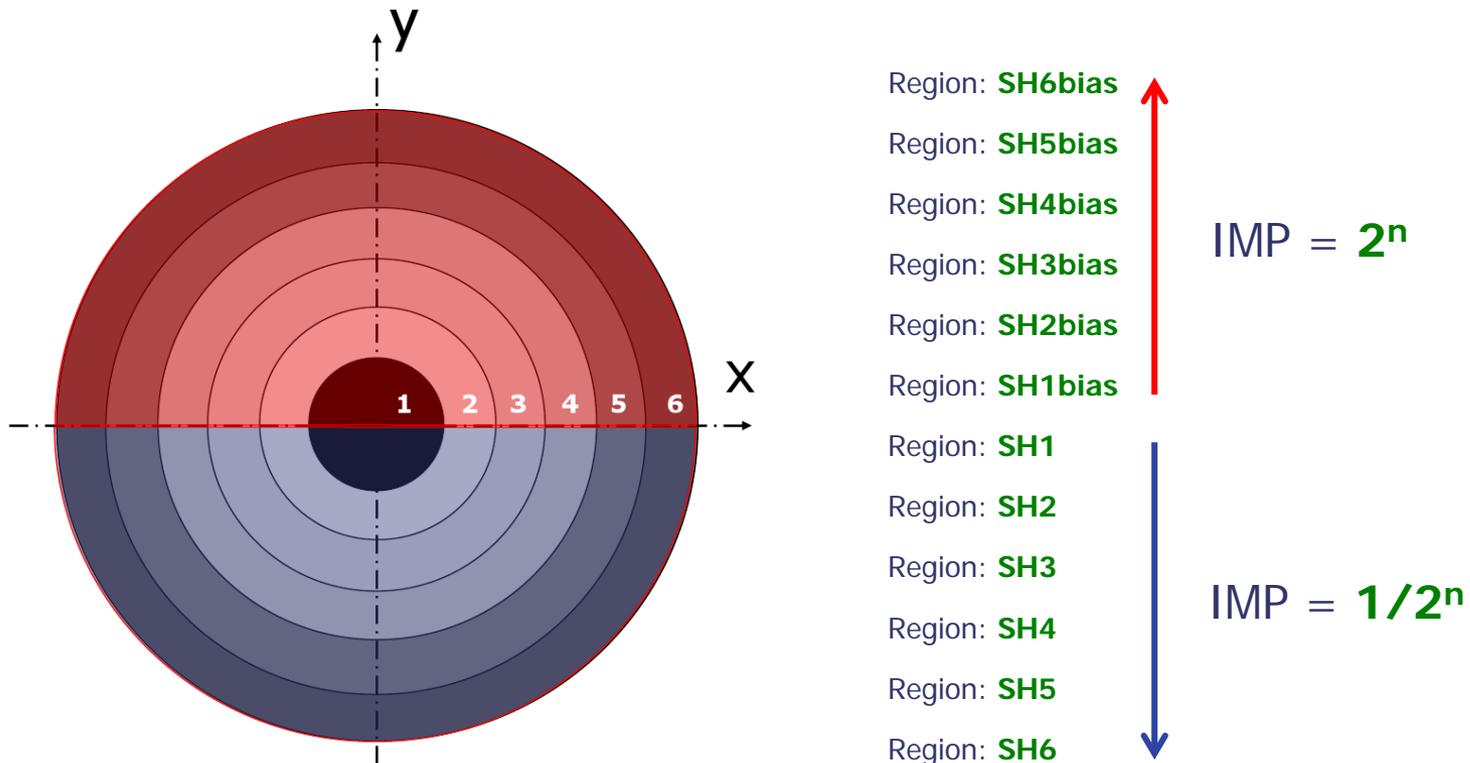
- ❑ Assign it to all the shielding regions
  - Try doing it in a minimum number of steps (hint: add material from Materials page in Flair and assign by CTRL+clicking on regions in the Geometry page or, alternatively, use the From-To capability)

# Exercise 10: importance biasing

- Set air as the material around the whole shielding structure.
- Examine the manual section for the {BIASING} card
- We will use importance biasing for low-energy neutrons  $WHAT(1)=3$ , and for all other hadrons and muons  $WHAT(1)=1$ .
- Add an initial BIASING card setting all region importances to 1 for all particles, and then set importance biasing for each shielding region (next slide)

# Exercise 10: Importance biasing

- ❑ Set the importance to 1, for all regions and particles
- ❑ For regions having  $y > 0$  set importance to  $2^n$  ( $n = \# \text{layer}$ )
- ❑ For regions having  $y < 0$  set importance to  $1/2^n$  ( $n = \# \text{layer}$ )
- ❑ Enclose biasing within a `#if Flag_BIAS` statement  
(to be activated through `#define`)



# Exercise 10: Importance biasing

How to display region importance in the Geometry Editor

The screenshot displays the Geometry Editor interface. The main window shows a circular geometry divided into concentric regions labeled SH1 through SH6. The regions are color-coded according to their importance, with a color scale on the right ranging from 0.1 (purple) to 10 (red). The regions are labeled as SH1 (center), SH2, SH3, SH4, SH5, and SH6 (outermost). The outermost region is labeled SH6bias. The background is labeled OUTAIR. The interface includes a menu bar with options like Flair, Input, Geometry, Run, Plot, and Compile. A toolbar contains various tools such as Cut, Copy, Paste, Select, Pan, Orbit, Info, Body, Zone, Object, Clone, Visibility, Wireframe, Lock, Layer, and Layout. The left sidebar shows the Geometry panel with the Bias(IMP) layer selected. The Options section is expanded, showing Show, Palette, and <add> options. The Show section is also expanded, showing Vertices, Labels: Region, Color: Importance-N, Lattices, Voxel, and Palette: Palette. The bottom status bar shows the input file 'Inp: ex10.inp' and coordinates 'x: 158.7387039 y: -70.53883114 z: 97.5113'.

Geometry Editor interface showing the Bias(IMP) layer selected in the left sidebar. The main window displays a circular geometry divided into concentric regions labeled SH1 through SH6, with a color scale on the right indicating importance values from 0.1 to 10. The regions are color-coded according to their importance, with a color scale on the right ranging from 0.1 (purple) to 10 (red). The regions are labeled as SH1 (center), SH2, SH3, SH4, SH5, and SH6 (outermost). The outermost region is labeled SH6bias. The background is labeled OUTAIR. The interface includes a menu bar with options like Flair, Input, Geometry, Run, Plot, and Compile. A toolbar contains various tools such as Cut, Copy, Paste, Select, Pan, Orbit, Info, Body, Zone, Object, Clone, Visibility, Wireframe, Lock, Layer, and Layout. The left sidebar shows the Geometry panel with the Bias(IMP) layer selected. The Options section is expanded, showing Show, Palette, and <add> options. The Show section is also expanded, showing Vertices, Labels: Region, Color: Importance-N, Lattices, Voxel, and Palette: Palette. The bottom status bar shows the input file 'Inp: ex10.inp' and coordinates 'x: 158.7387039 y: -70.53883114 z: 97.5113'.

# Exercise 10: Importance biasing

## Scoring

- ❑ Add one region independent scoring for neutrons (USRBIN)
  - To span over the whole geometry
  - To have sufficient bins
  - To have cylindrical coordinates [i.e. **R-Phi-Z**]
  - Unformatted output on unit 54

## Run

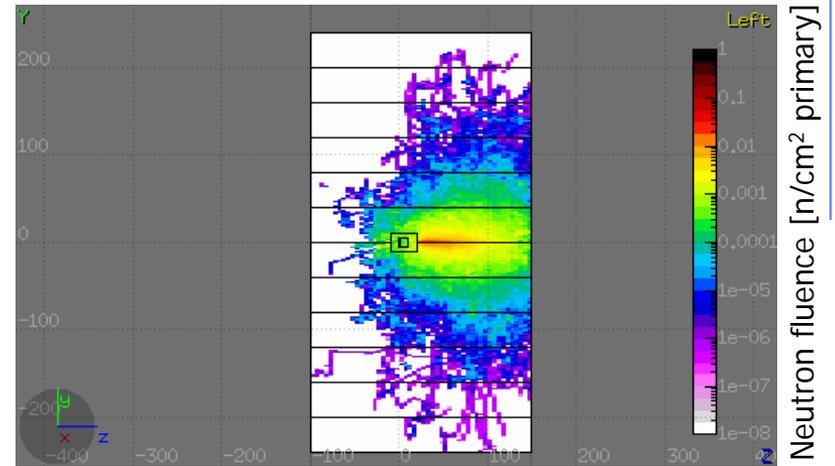
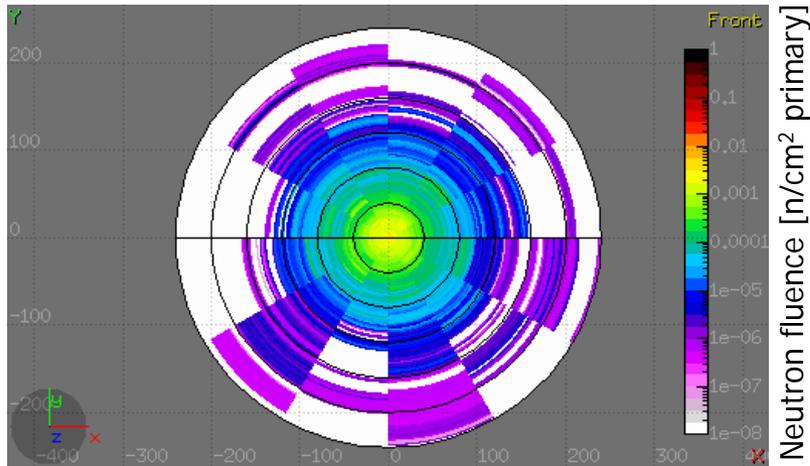
- ❑ 2 separate runs, w/ and w/o biasing (do not overwrite results)
- ❑ 5 cycles, 10000 primaries each

## Plot

- ❑ USRBIN results in Flair
- ❑ Region importance in the Geometry Editor
- ❑ USRBIN results in the Geometry Editor

# Exercise 10: Importance biasing - Results

## No BIAS



## Region Importance Biasing

