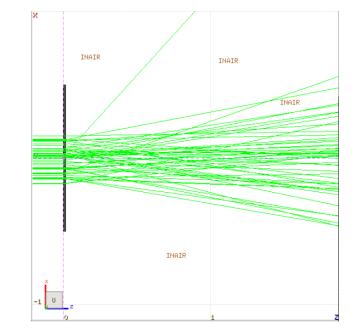


# **Exercise : Thresholds**

Aim of the exercise:

- Examine the effect of setting different threshold values
- Further interaction with the FLUKA manual
- Practice the use of preprocessor directives
- Strengthen plotting skills



### Beginner course – ULB, May 2022

# **Input file**

input me	×	
<ul> <li>10 MeV electron beam</li> <li>Circular beam with 2 mm radius</li> <li>Starting at x=0 cm, y=0 cm, z=-1 cm</li> </ul>	0.5	
<ul> <li>Cylindrical target along z, 5-mm radius, split in three layers, each 50 μm thick</li> <li>Set to H<sub>2</sub>O – Pb – Al</li> </ul>	0.2	
<ul> <li>Thin layers require high tracking precision. Thus, we set</li> <li>DEFAULT PRECISIOn</li> </ul>	0 -0.1	
<ul> <li>Notice that three preprocessor variables are defined</li> <li>HI-THR, LOW-THR, VLOW-THR</li> </ul>	-0.2	
<ul> <li>USRBIN scoring DOSE over the entire target</li> <li>1 µm bins in z, 1 bin in R, unformatted unit 55</li> </ul>	-0,4 -0,5 -0,1 0 0,1 Z	-



## Add EMFCUT cards

- Set both production and transport thresholds in all materials
  - Hint: when specifying the range of materials/regions, use @LASTMAT/@LASTREG as needed to refer to the last
    material or region, respectively
- Use preprocessor instructions to prepare three runs, one for each threshold case, exploiting the already defined preprocessor variables:

#if HI-THR		
photons: 1 keV ,	electrons: 1 MeV kinetic energy,	FUDGEM=1
#elif LOW-THR		
photons: 1 keV ,	electrons: 100 keV kinetic energy,	FUDGEM=1
#elif VLOW-THR		
photons: 1 keV ,	electrons: 10 keV kinetic energy,	FUDGEM=0.5
#endif		

- Note that the electron threshold is 100 keV in case of PRECISIOn, corresponding to our LOW-THR case
- Reminder: stopping powers and ranges for electrons, protons, and He ions are available on the NIST webpage: <u>https://physics.nist.gov/PhysRefData/Star/Text/intro.html</u>



### Run

	🔀 /Users/luillo/cernbox/shared/FLUKA_c	ourse/2020_fall/ex_Threasholds/solution/ex_threashold	s.flair - flair					
🔚 🧐 👻 📔 🚆 Flair 🛛 🔞 Input	💕 Geometry 🛛 🚴 Run 🛛 🛄 Plot		🗐 Calculator 🔻 🇊					
Paste Copy Runs Files Di Clipboard View	Image: Second	ontinue No: 5 🔹 🏷 👜 Run Gruph Voitach To: 5 🔹 Clean 🗙 Kill Refresh Star Job Action						
0	l Querida	Run	▲ ×					
+ Run Spawn <ex_threasholds> high_thresholds low_threasholds vlow_threasholds</ex_threasholds>	<ul> <li>Override</li> <li>Title:</li> <li>Primaries: 100000</li> <li>Mode:</li> <li>Defines: Default Defines</li> <li>Name</li> <li>Ⅲ-THR</li> <li>LOW-THR</li> <li>ULOW-THR</li> <li>VLOW-THR</li> </ul>		Rnd: 0 Exe:					
	-Progress							
	Status: Finished OK Started: 2020.09.11 16:35:49	Input: high_thresholds ETA:	Dir: Time/prim:					
	Elapsed:	Cycle:	Run:					
	Cycles:							
	Primaries:							
Fluka: ex_threasholds.flair • (Running 1 out of 4								

Run three simulations corresponding to high, low, or very low threshold values, with 5 cycles × 100000 primaries for each case The three runs are already set up in the Flair project

Should take less than ~5 minutes on a reasonably up-to-date machine.



# **Plot and compare the results**

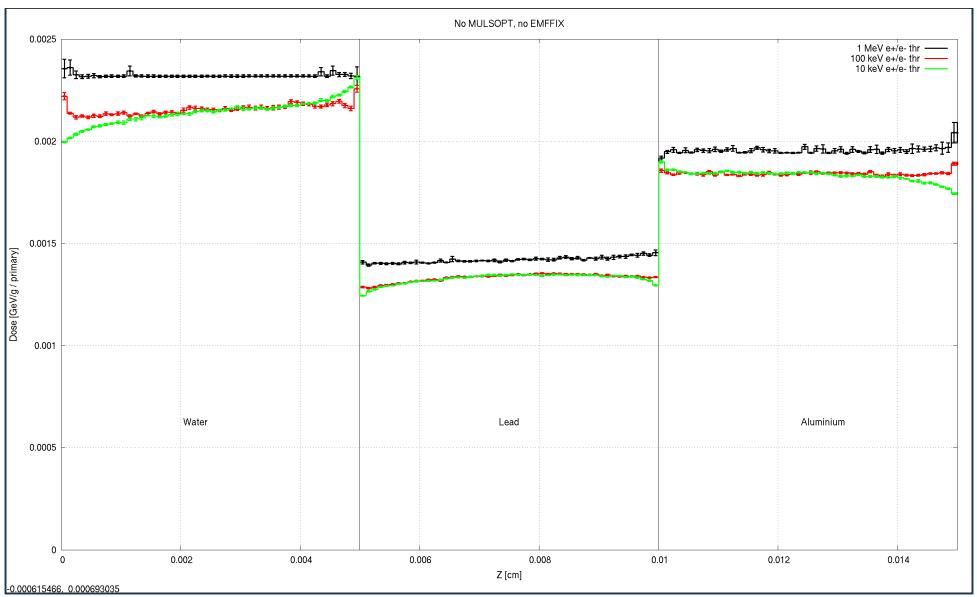
### Plots are already set up in the Flair project

		📉 + /Users/luillo/cernbox/shared/FL	.UKA_course/2020_fall/ex_Thresholds/solution/ex_thresholds.flair -	flair
	🔒 🧐 🔻 🥐 📔 🚆 Flair	🧐 Input 💕 Geometry 👌 Run  🔛 Plot		🛛 🗐 Calculator 🔻 🇊
	Paste Copy Add •	<sup>1</sup> Move Up         × Delete <sup>1</sup> Move Down             → Move Down		
	e	Plot List Action	Plot	▲ ×
First plot these three	<ul> <li>Red</li> <li>Green</li> <li>Blue</li> <li>Magenta</li> <li>high</li> </ul>	Axes Label X: Z [cm]		Display: 0
	📜 📥 low	y: Dose [GeV/g / primary]		[
	verylow	Detectors	Detector Info	
to make sure all needed	*	1 MeV e+/e- thr 100 keV e+/e- thr 10 keV e+/e- thr	ave File: verylow.dat 2012 Det: 1 D	
files are there for the			■       ▼ graph       Type: histerror       ▼ X Norm:         ▼ legend       Value: Y       ▼ Y Norm:         Options       ■	<b>V</b>
comparison plot!			Image: Second secon	
		set grid		
	Fluka: ex_thresholds.flair	Saved: compare_thresholds.png		



#### **Exercise:** Thresholds

### **Depth-dose distribution for various threshold settings**





**Exercise:** Thresholds

## **Compare depth-dose curve for various thresholds**

- Premature dose deposition for 1-MeV threshold
- Correct deposition on average for 100-keV threshold (the value with DEFAULTS->PRECISION), but lacking details
- More refined result for 10-keV threshold
- Net flow of low energy electrons across boundary from high Z to low Z materials
- Physical effect!



- Correct threshold values depend on the granularity of your geometry/scorings
- Do not blindly rely on default values
- Carefully set threshold values accordingly (range tables are helpful!)
- Do not forget to set the FUDGEM parameter

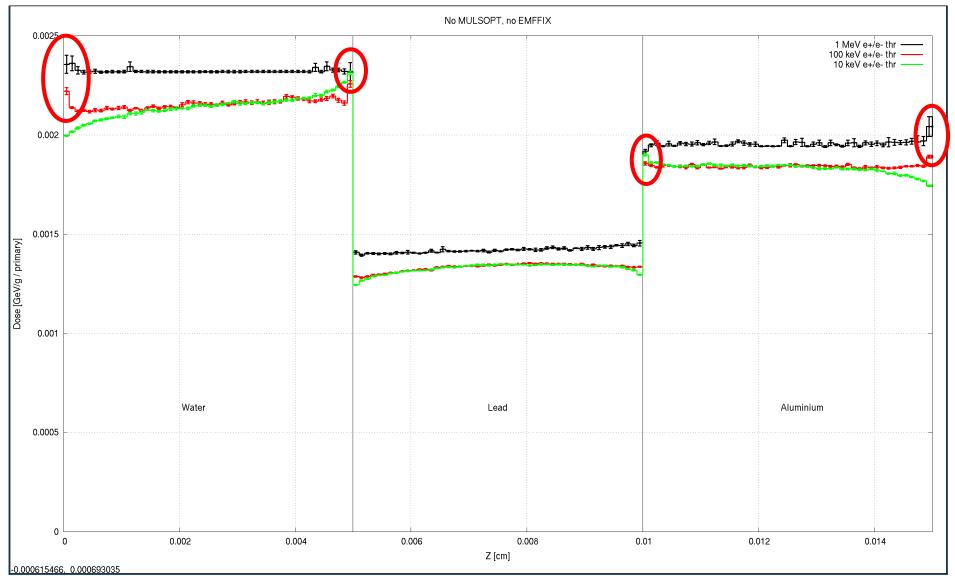


This concludes the exercise...



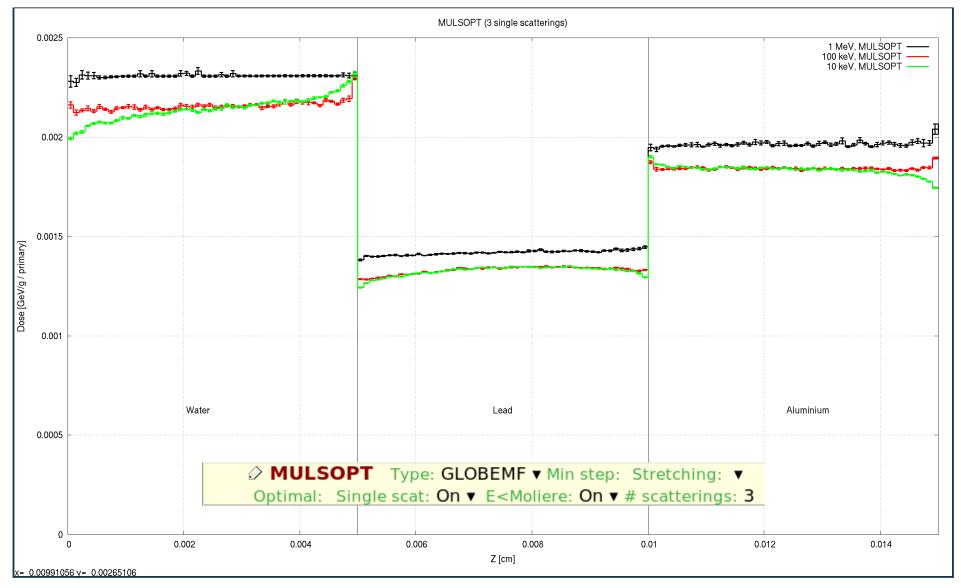
...but there's more!

## **Boundary artifacts (last bin before interface)**





### Further single scattering near boundaries (+MULSOPT)





## **Further restriction of stepsize (+EMFFIX)**

