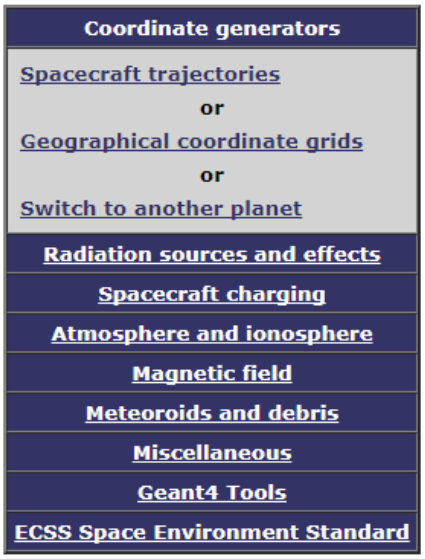
Instructions for SPENVIS

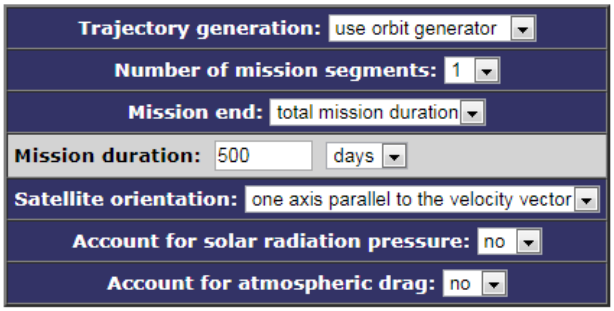
This will step you through getting set up and using the SPENVIS simulation for testing shields for a trip to Mars.

The website for Spenvis is https://www.spenvis.oma.be/intro.php You will need to register, it is free and educator friendly.

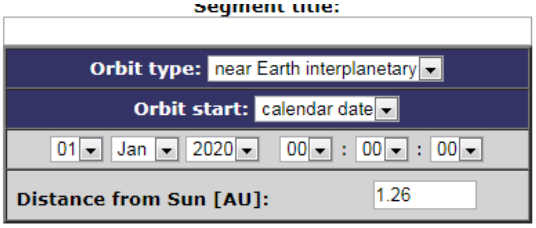
After logging in you will see a menu for different inputs to the simulation



Under “Spacecraft Trajectories” I set

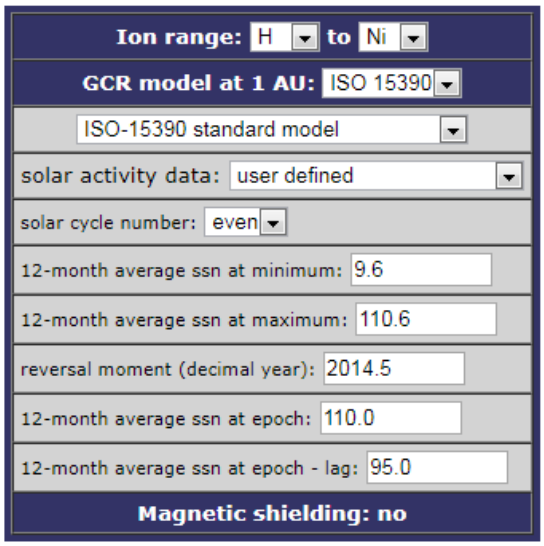


And after hitting “next”



Then hit “next” and then “run”.

This will create a trajectory file for your simulation, and you will be able to check it before you hit “up” to return to the main menu.

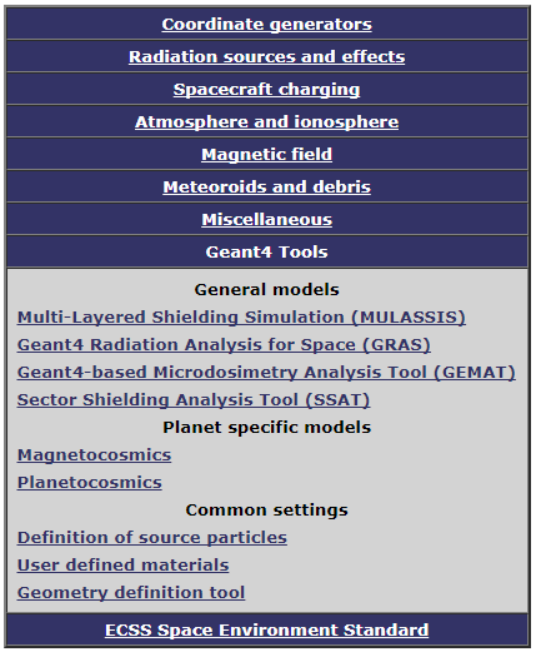


Then in “Radiation sources and effects” select “Galactic cosmic ray fluxes”. Solar particle radiation is usually lower energy and shielding against it is easier, creating a shield to protect against cosmic rays is more difficult, so that is what my project had students focused on.

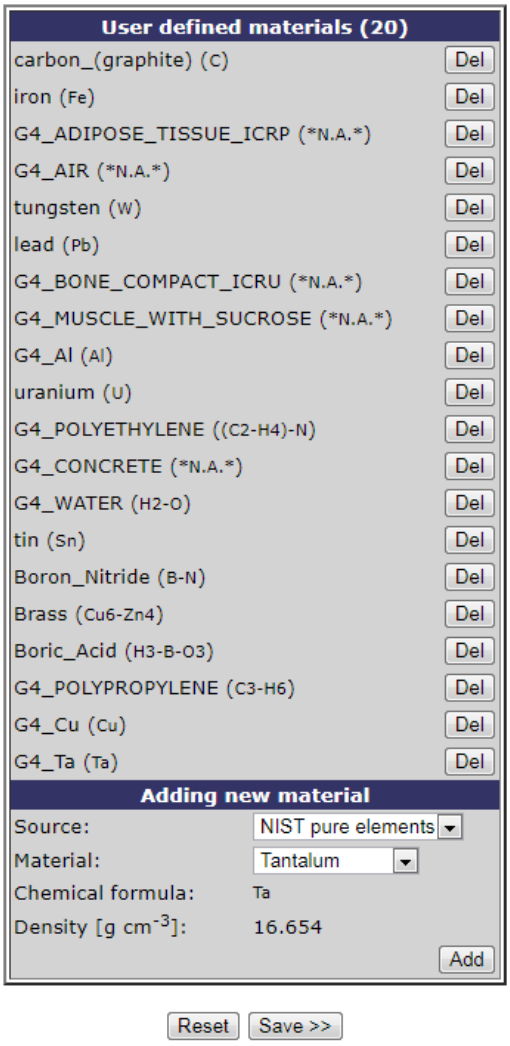
Then hit “run” to create a radiation flux file that your simulation will use. Once again you can look at your outputs before hitting “up” (twice) to get back to the menu.

I did not use any of the other features of the simulation, but certainly feel free to explore and experiment.

The set up



rest of the simulation is and run in “Geant4 Tools”.



Your simulation can only use up to 20 different materials at a time. These are set in "User defined materials". To use other materials you need to first "delete" a material from the list and then select a new material (or you can define your own).

I used the "Multi-Layered Shielding Simulation (MULASSIS)" simulation, mostly because of the features it had.

Status	Settings	Remarks
defined	Source particle macro	GCR, ion, GPS macro file
defined	Geometry	Sphere, 14 layers
defined	Analysis parameters	Total ionizing dose
Advanced settings		
defined	Material definition	20 material defined
defined	Cuts-in-range	No cuts-in-range

Create macro

Source particle type and spectrum	
Environment: Mission based / GCR particles	
Number of primary particles to simulate: 10,000,000 Warning: Particle track visualisation will be disabled!	
Incident particle type: ion	
Ion definition	
Atomic number:	1
Isotope:	H1
Incident energy spectrum	
Mission average spectrum	
Don't use energy biasing	
Angular distribution	
The angular distribution is omnidirectional.	

Reset Create GPS macro

This sets the what radiation hits the shield, you want to use "Mission based" with "GCR particles" as the environment.

When I tested my student's shields I did two simulations, one with protons (Atomic number = 1 and Isotope = H1), and one with alpha particles (Atomic number = 2 and Isotope = He4).

The "Geometry" part of MULASSIS is where you define the thickness and order of your shield layers.

Geometry: User defined

Shape: sphere Number of layers: 14

Layer number	Material	Thickness (unit)	Visualisation colour
Layer 1	Vacuum	0.1 mm	white
Layer 2	Vacuum	0.07 mm	white
Layer 3	Vacuum	0.06 mm	white
Layer 4	Vacuum	0.1 mm	white
Layer 5	Vacuum	0.1 mm	white
Layer 6	Vacuum	0.1 mm	white
Layer 7	Vacuum	0.2 mm	white
Layer 8	tungsten	0.05 m	white
Layer 9	carbon_(graphite)	3.2 m	white
Layer 10	lead	0.4 m	white
Layer 11	G4_AIR	5.65 m	white
Layer 12	G4_ADIPOSE_TISSUE_ICRP	.05 m	white
Layer 13	G4_MUSCLE_WITH_SUCROSE	.3 m	white
Layer 14	G4_BONE_COMPACT_ICRU	.2 m	white

The inner 3 layers (12, 13, and 14) represent the astronauts, the air represents their living space, and then the tungsten, carbon, and lead are the shield that is being tested.

Under “Analysis parameters” you want to select total ionizing dose, Grays (Gy), and all layers.

Analysis type: Total ionizing dose

Energy deposition / TID

Output units: Gy

Select layers for energy deposition/total ionising dose analysis:

1 ☑ 2 ☑ 3 ☑ 4 ☑ 5 ☑ 6 ☑ 7 ☑ 8 ☑ 9 ☑ 10 ☑ 11 ☑ 12 ☑ 13 ☑ 14 ☑

Layer	Thickness cm	Density g/cm3	Dose Gy	Error Gy
1	1.00000e-2	1.00000e-25	6.57226e-2	5.07860e-3
2	7.00000e-3	1.00000e-25	6.24039e-2	3.76586e-3
3	6.00000e-3	1.00000e-25	6.25233e-2	3.79178e-3
4	1.00000e-2	1.00000e-25	6.26924e-2	3.83063e-3
5	1.00000e-2	1.00000e-25	6.29479e-2	3.89389e-3
6	1.00000e-2	1.00000e-25	6.32834e-2	3.98493e-3
7	2.00000e-2	1.00000e-25	6.42799e-2	4.28912e-3
8	5.00000e+0	1.93000e+1	4.20874e-2	1.53229e-3
9	3.20000e+2	2.25000e+0	1.62660e-2	7.03529e-4
10	4.00000e+1	1.13000e+1	1.22512e-4	4.30382e-5
11	5.65000e+2	1.20479e-3	1.74555e-4	6.10778e-5
12	5.00000e+0	9.50000e-1	3.26498e-4	1.83591e-4
13	3.00000e+1	1.11000e+0	6.36362e-5	6.34038e-5
14	2.00000e+1	1.85000e+0	5.65828e-4	5.65828e-4

Then you click on “Create Macro” and “Run”. It takes a few minutes, but when it finishes you can look at the output. Just click on the little blue html button after the “Output file for the

multilayered analysis tool" and you will get this…

Then you add up the dose for layers 12, 13, and 14 and that will be the total dose in Grays.