

28th Geant4 Collaboration Meeting
26 sept. 2023, Hokkaido University, Japan

FreeCAD: a potential **G4-GUI** from a Multi-Stage simulation framework

Speaker:

Alfonso Mantero

Swhard Srl, Genova (Italy)



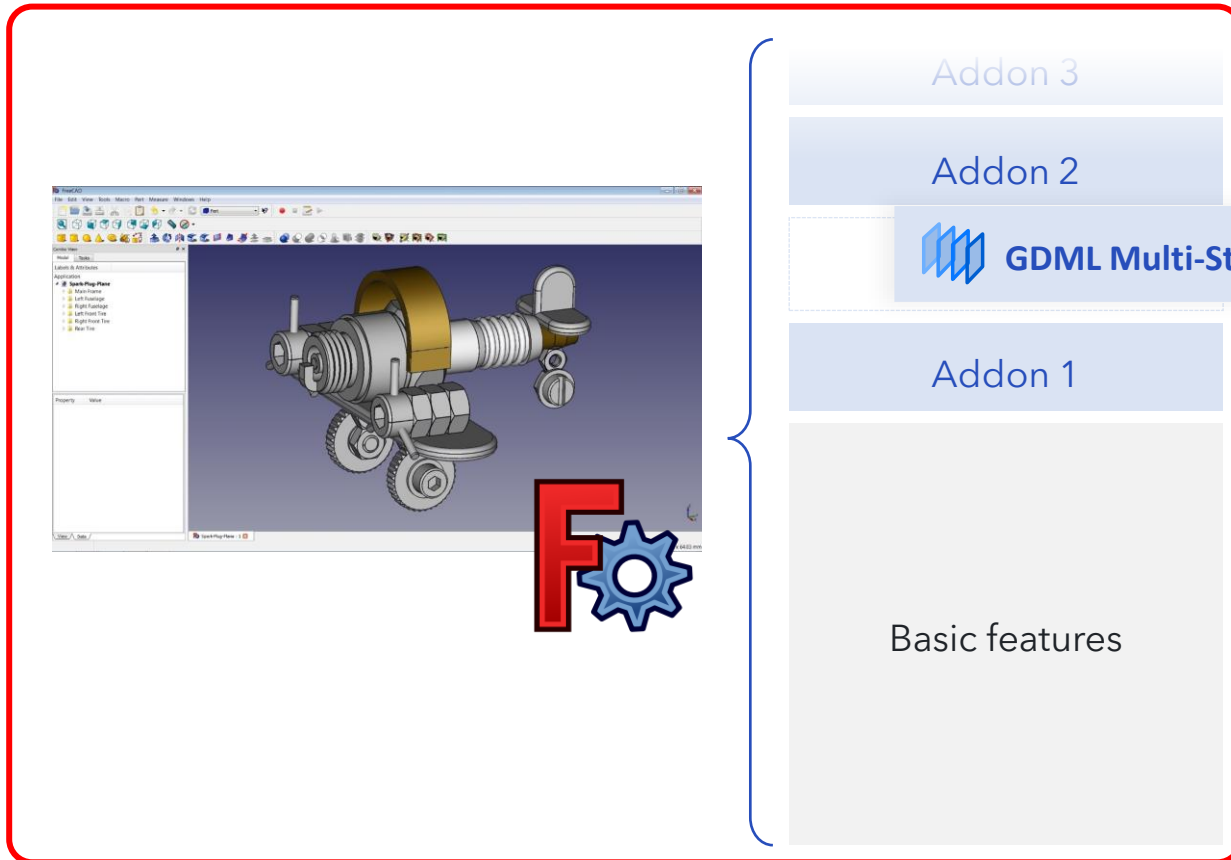
Why?

Geant4 is a software for **advanced users programmers!**

To expand the use of Geant4 to research groups from different backgrounds, the framework required by ESA aims to:

1. simplify the management of the geometries used in the simulations
2. simplify the development of Geant4 multi-stage simulations

FreeCAD: a potential G4-GUI

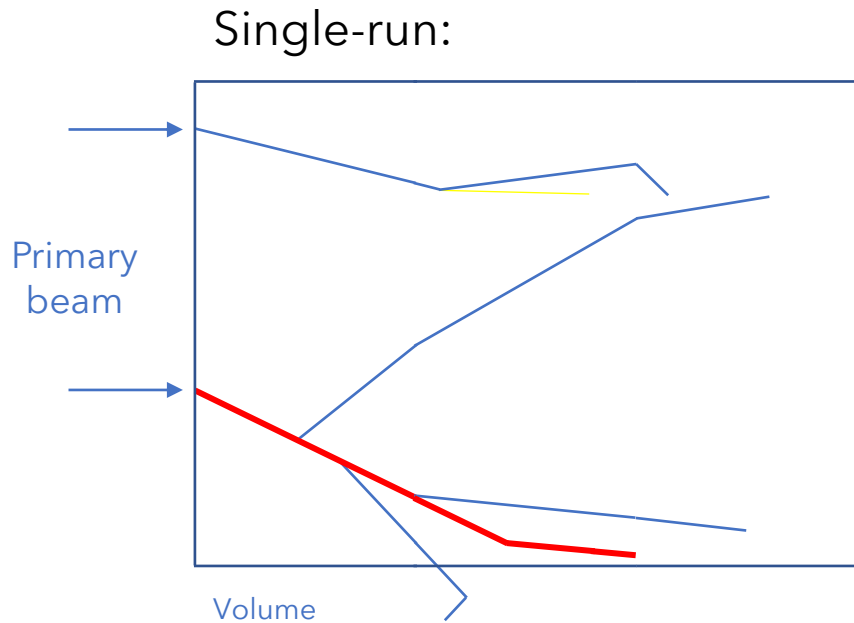


FreeCAD is a general-purpose parametric 3D computer-aided design (CAD) modeler. FreeCAD supports a collection of additional modules called **workbenches** adding functionalities, custom interfaces and commands.

The “**GDML Multi-Stage**” workbench is an **integrated framework** developed to execute both single-run and multi-stage Geant4 simulations thanks to an Add-On to FreeCAD.

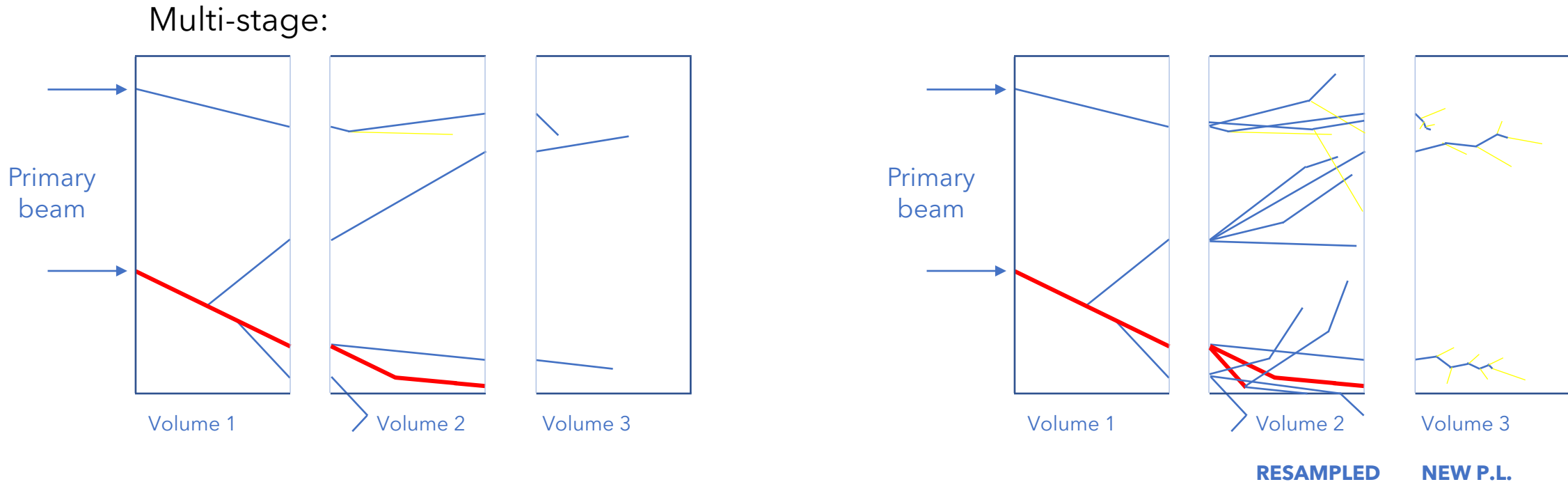
Multi Stage

The workbench (addon) supports two types of simulation: **single-run** and **multi-stage (GRAS)**. For each stage the user can **resample** the input particles and use **different physics**. Current release supports up to **4 stages**.



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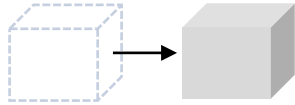


Helpful for **complex geometries** with **different scale** objects!

Create/Import & modify geometry

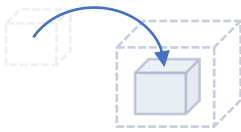
You can **create** a new scene from scratch or **import** an existing one. The scene can be intuitively modified from the interface, for example:

Change material



Choose from the included list (NIST db) or define your material.

Nesting



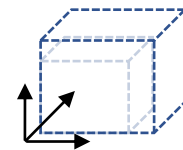
Create nesting by **dragging** one volume into another.

Define new volumes

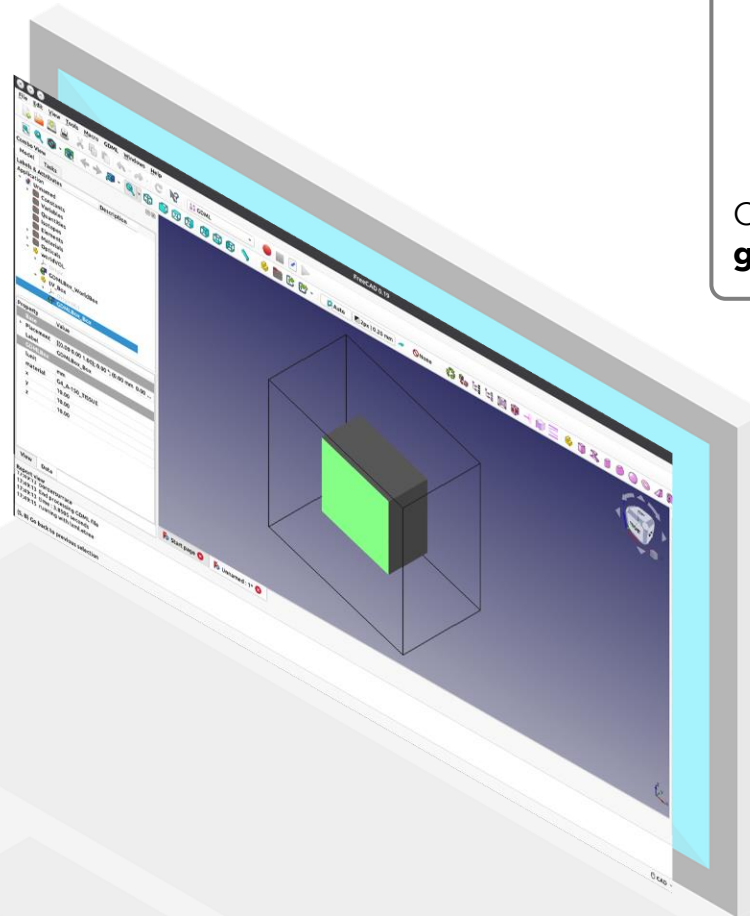


Choose from a list of available **geometrical shapes**.

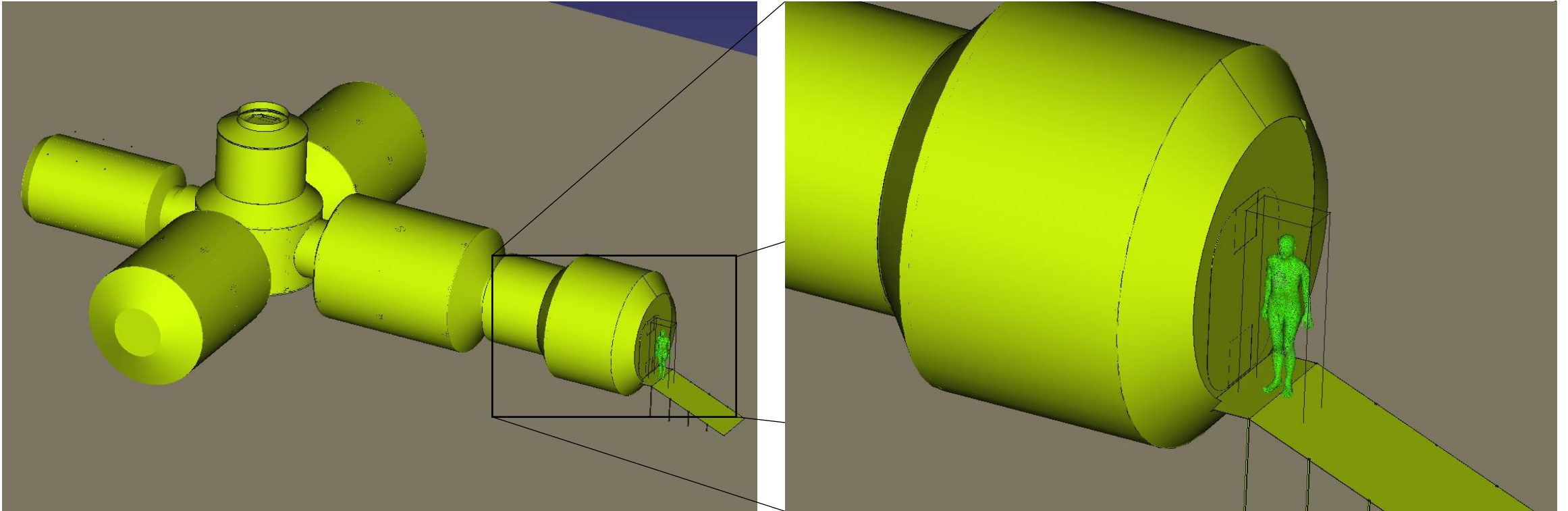
Change single volume parameters



Easy to change volume properties such as **position** and **shape**.



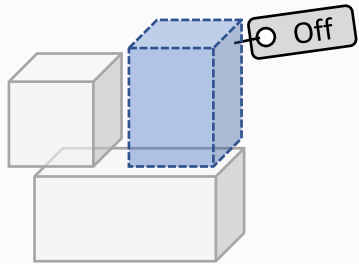
Create/Import & modify geometry



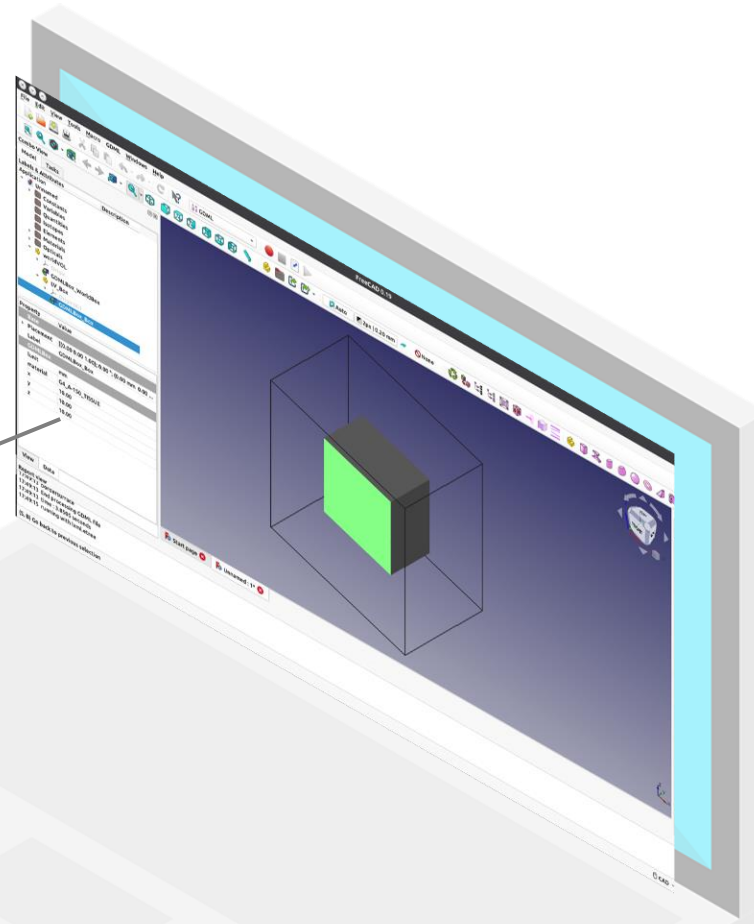
Example: full ESA Mars habitat geometry imported with realistic ICRP human phantom.

Tag volumes for multi-stage

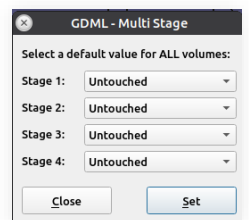
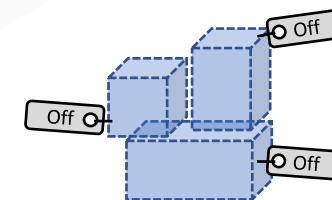
Single-volume Definition



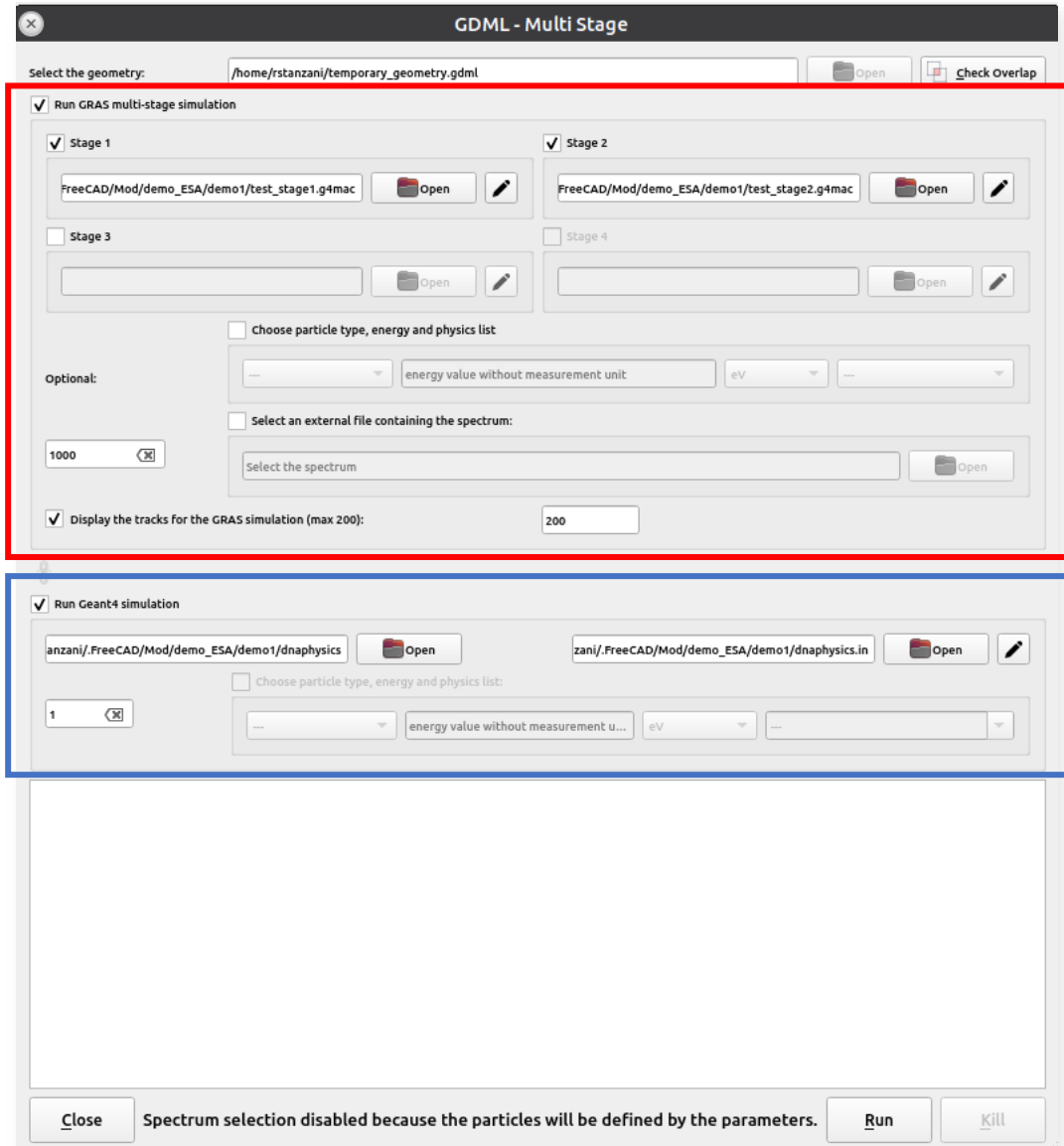
Origin	
GDMLBox_WorldBox	
LV_Box	
Origin001	
GDMLBox_Box	
Property Value	
Type	
Id	
License	
License URL	
Color	[255, 255, 255]
Placement	[(0.00 0.00 1.00); 0.00 °; (0.00 mm 0.00 mm 0.0...
Label	LV_Box
Group	GDMLBox_Box
Stages status	
Stage1	Bounding Surface
Stage2	Native
Stage3	Native
Stage4	Off



... or Bulk mode Tool



Change the simulation parameters



GRAS Multi-Stage Simulation:

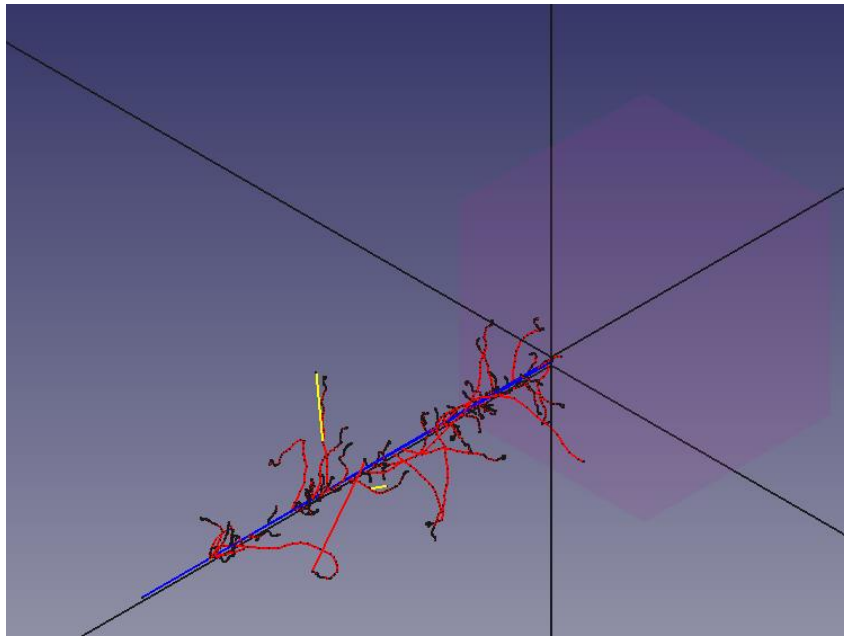
- Launch multiple stages
- Change the simulation parameters (e.g., **number of particles, particle type, energy, physics list**)
- Import a spectrum

Geant4 Simulation:

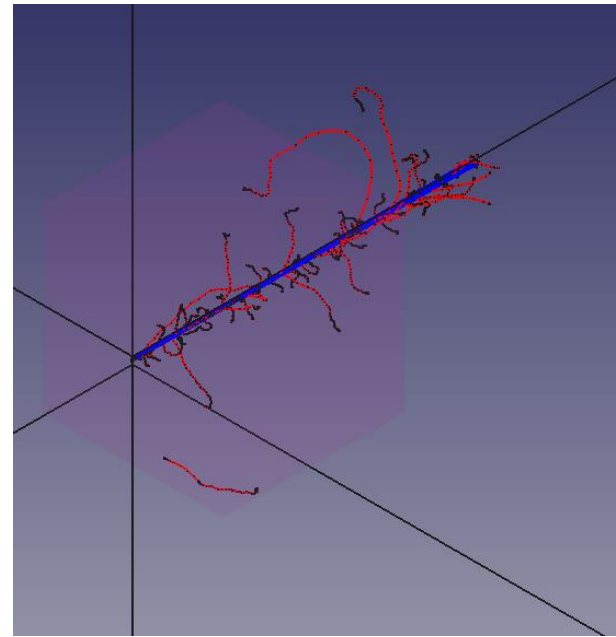
- Launch a Geant4 executable (e.g., a DNA simulation)
- Change the simulation parameters (e.g., number of particles, particle type, energy, physics list)

Explore the results

The plugin enables direct plotting of **trajectories** within FreeCAD, empowering users to utilize all the software's tools (e.g., zoom, pan, selection, etc.) for enhanced results exploration and convenient export of data in various 3D formats. It allows plotting tracks for individual stages sequentially.

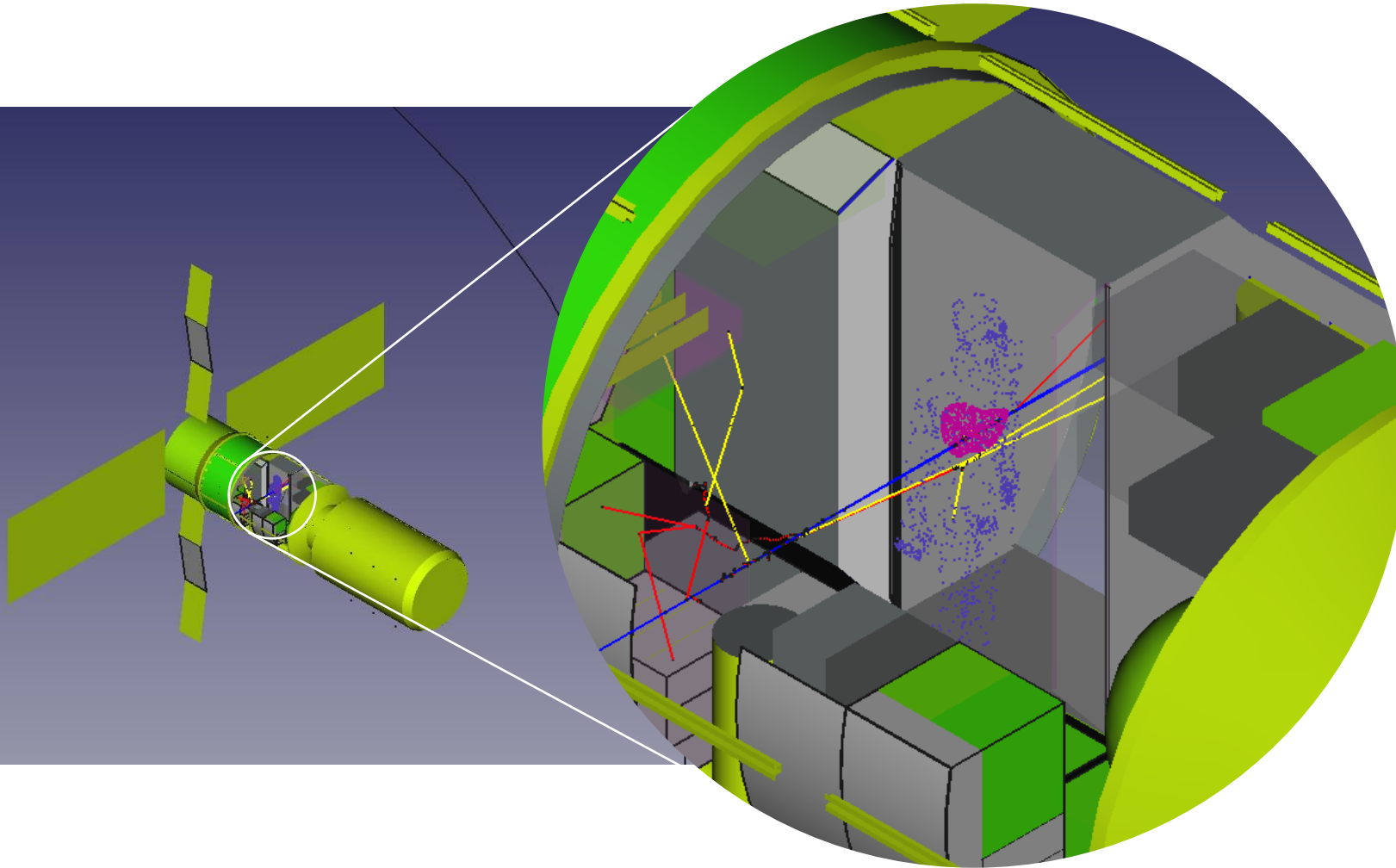


Stage1



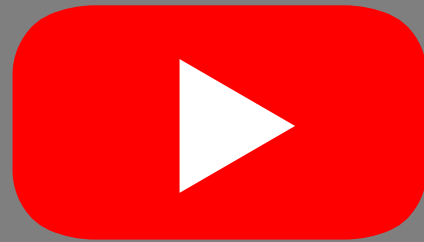
Stage 2

Explore the results



Facilitate seamless exploration and presentation of results in intricate scenarios by adjusting **visualization** properties, such as color and transparency, for volumes, all while keeping the original geometry file intact.

Quick video walkthrough



Future and Fate

HIGH POTENTIAL:

- Ease of use
- New users
- New domains

DO:

- Develop it to be a MVP
- Make it a self installing G4 exe
- Release and Maintain

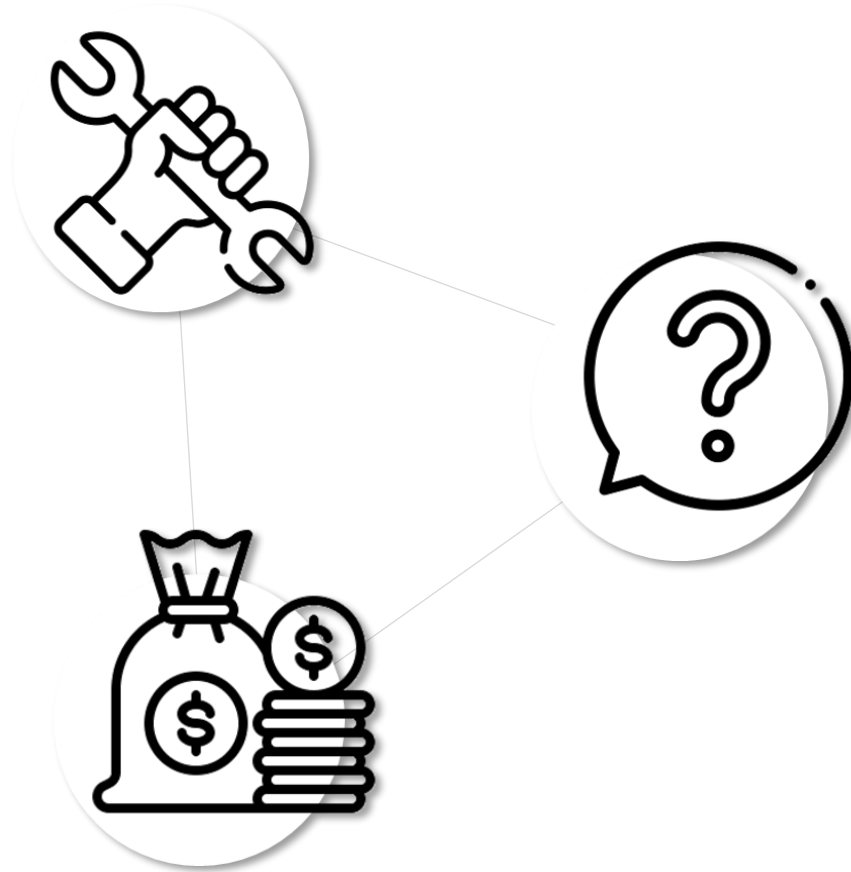
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- Make it the n-th G4 visualization tool
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Thank you!

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