

SPENVIS Tutorial: Geant4 package

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Outline

- Introduction - Geant4 tools available in SPENVIS
- Geant4 tools SPENVIS interface
- Updates & current developments
 - Gras Interface
- Discussion/Conclusions

1. Geant4 Tools in SPENVIS



Geant4 Tools in SPENVIS: Motivation

- User friendly interface - No prior knowledge of Geant4.
- Generation of a g4mac file that can be used directly in a locally installed Geant4 application.
- Applications use outputs from other SPENVIS applications.
- Applications provide input to other SPENVIS applications.

Currently implemented models:

- Mulassis, GEMAT, SSAT, Magnetocosmics & Planetocosmics - MarsREM (third party).

Geant4 Tools in SPENVIS: A brief tour

Multi-Layered Shielding Simulation (Mulassis)

- Developed by QinetiQ
- Definition of a multi-layered, one-dimensional shield and incident particle source.
- Simulates radiation transport through the geometry, treating electromagnetic and nuclear interactions.
- Can directly include radiation environment spectra (Earth & Jupiter)
- **Outputs:**
 - Mulassis g4 macro file ← SPENVIS
 - Report file
 - CSV file (outputs from all analysis modules)
 - Mulassis log file
 - Plot of analysis results ← SPENVIS



Geant4 Tools in SPENVIS: A brief tour

Geant4-based Microdosimetry Analysis Tool (GEMAT)

- Developed by QinetiQ
- Microdosimetry effects of space radiation on micro-electronics and micro-sensors.
- **Outputs:**
 - GEMAT g4 macro file ← SPENVIS
 - Report file
 - CSV file (outputs from analysis modules)
 - GEMAT log file
 - VRML representation geometry ← SPENVIS
 - Plot of analysis results ← SPENVIS

Geant4 Tools in SPENVIS: A brief tour

Sector Shielding Analysis Tool (SSAT)

- Developed by QinetiQ
- Ray tracing from user defined point within geometry to determine shielding levels and shielding distributions.
- Upload GDML file or create one using the **geometry definition tool**.
- Shielding distributions can be folded with flux and dose models (e.g. from SHIELDOSE or NIEL)
- **Outputs:**
 - SSAT g4 macro file ← SPENVIS
 - SSAT output (1D & 2D shielding distribution)
 - SSAT log file
 - VRML view of geometry ← SPENVIS
 - Plots of dose distribution & shielding distribution as a function of shielding thickness, etc ← SPENVIS

Geant4 Tools in SPENVIS: A brief tour

MAGNETOCOSMICS

- Developed at the University of Bern
- Using the Geant4 toolkit to simulate the motion of charged particles:
 - computation and visualisation of charged particle trajectories & magnetic field lines
 - computation of cut-off rigidities as a function of position
- Can directly include SAPRE orbit generator and/or geographical coordinate grid outputs.
- **Outputs:**
 - **MAGNETOCOSMICS g4 macro file** ← SPENVIS
 - CSV result file
 - Program log file
 - VRML representation of particle trajectories or magnetic field lines
 - **Plot of rigidity cut-offs** ← SPENVIS



Geant4 Tools in SPENVIS: A brief tour

PLANETOCOSMICS

- Developed at the University of Bern
- Hadronic and electromagnetic interactions of particles with planetary environment (Mercury, Earth & Mars)
- Fluence & Energy deposition analysis.
- SPENVIS trapped particle or solar proton spectrum.
- **Outputs:**
 - PLANETOCOSMICS g4 macro file ← SPENVIS
 - CSV result file
 - Program log file
 - VRML representation of particle trajectories



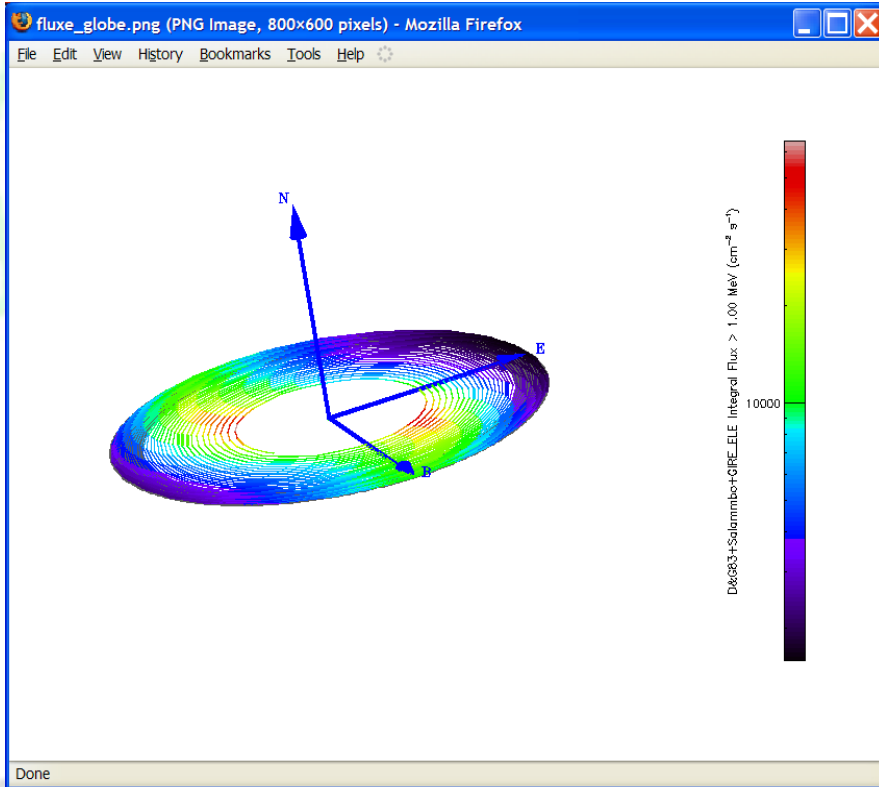
Example 1: NIEL analysis for Galileo encounter with Europa (24 Feb 1997)



```
Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://dev.spenvis.oma.be/spenvis/htusers/my/messios/GEANT4/1242840122/spenvis_sao.txt
'PRJ_HDR', -1, ' '
'MOD_ABB', -1, 'ORB'
'MIS_PLA', 1, 5, ' '
'PLA_RAD', 1, 69911.00, 'km'
'PLA_DIS', 1, 5.203, 'AU'
'MIS_NTR', 1, 1, ' '
'MIS_STA', 1, 17221.29166667, ' '
'MIS_END', 1, 17245.29166667, ' '
'MIS_DUR', 1, 2.400000E+01, 'days'
'ORB_HDR', -1, ' '
'ORB_TYP', -1, 'GEN'
'ORB_MJD', 1, 17221.29166667, ' '
'ORB_YEA', 1, 1997, ' '
'ORB_MON', 1, 2, ' '
'ORB_DAY', 1, 24, ' '
'ORB_HOU', 1, 7, ' '
'ORB_MIN', 1, 0, ' '
'ORB_SEC', 1, 0.0, ' '
'ORB_APO', 1, 6.304186E+06, 'km'
'ORB_PER', 1, 5.811178E+05, 'km'
'ORB_INC', 1, 0.78, 'deg'
'ORB_RAA', 1, 177.50, 'deg'
'ORB_ARG', 1, 343.35, 'deg'
'ORB_TRA', 1, 133.86, 'deg'
'ORB_FRD', 1, 1.020818E+03, 'hrs'
'ORB_DUR', 1, 1.700000E+01, 'days'
'ORB_TSE', 1, 17245.29166667, ' '
'ORB_AXM', 1, 0
'ORB_MJR', -1, '1 Jan 1950, 00:00 UT'
'ORB_GDR', -1, 'Astron. J. 66, 15, 1961'
'FS Annotation', 8, 1
'Mission start: 24/02/1997 07:00:00'
0.05, 0.00, 0.00
'Mission end: 20/03/1997 07:00:00'
0.95, 0.00, 1.00
'Nr. of segments: 1'
0.05, 1.50, 0.00
'Duration: 24.00 days'
0.95, 0.00, 1.00
'FS Annotation', 24, 0
Done
```

- Run SAPRE (17 days)

Example 1: NIEL analysis for Galileo encounter with Europa (24 Feb 1997)



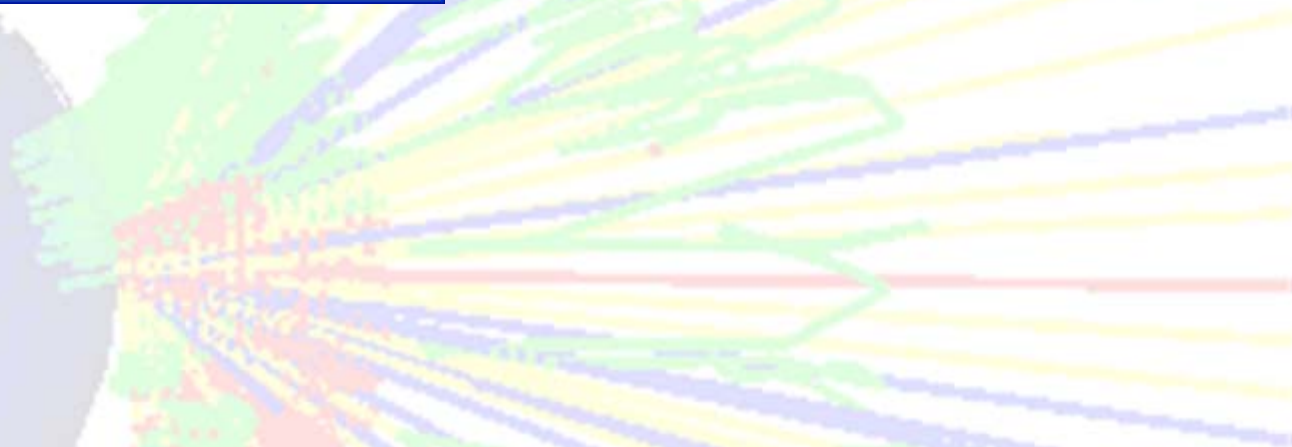
- Run SAPRE (17 days)
- Run Jovian trapped radiation models

Example 1: NIEL analysis for Galileo encounter with Europa (24 Feb 1997)



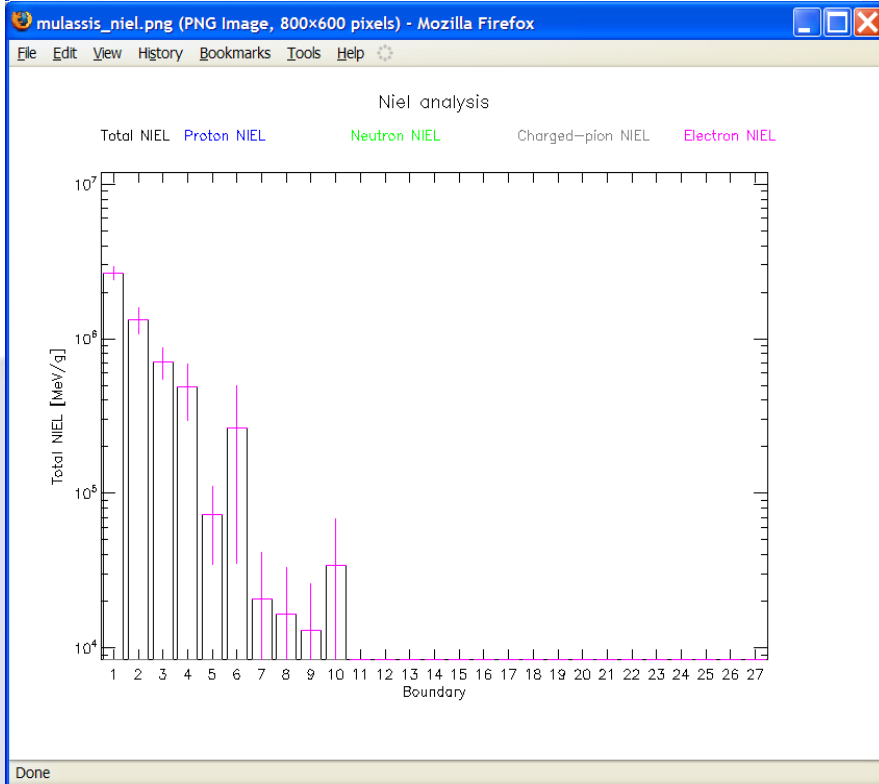
```
Mozilla Firefox
File Edit View History Bookmarks Tools Help
/analysis/niel/functionByLayer 27 cern
/analysis/niel/unit MeV/g
/geometry/update
/phys/cuts/global/default 1.000E+00 um
/phys/scenario em
/gps/particle e-
/gps/ene/type Arb
/gps/hist/type arb
/gps/ene/min 6.000E-02 MeV
/gps/ene/max 3.000E+01 MeV
/gps/hist/point 6.000E-02 3.941E+06
/gps/hist/point 1.000E-01 3.340E+06
/gps/hist/point 5.000E-01 1.196E+05
/gps/hist/point 6.500E-01 2.951E+04
/gps/hist/point 8.000E-01 1.815E+04
/gps/hist/point 1.000E+00 1.106E+04
/gps/hist/point 1.300E+00 6.313E+03
/gps/hist/point 1.600E+00 4.203E+03
/gps/hist/point 2.000E+00 2.718E+03
/gps/hist/point 3.000E+00 1.085E+03
/gps/hist/point 4.000E+00 4.675E+02
/gps/hist/point 5.000E+00 2.390E+02
/gps/hist/point 6.000E+00 1.372E+02
/gps/hist/point 7.000E+00 8.557E+01
/gps/hist/point 8.000E+00 5.677E+01
/gps/hist/point 9.000E+00 3.950E+01
/gps/hist/point 1.000E+01 2.900E+01
/gps/hist/point 1.200E+01 1.698E+01
/gps/hist/point 1.400E+01 1.042E+01
/gps/hist/point 1.600E+01 6.842E+00
/gps/hist/point 1.800E+01 4.728E+00
/gps/hist/point 2.000E+01 3.399E+00
/gps/hist/point 2.200E+01 2.523E+00
/gps/hist/point 2.400E+01 1.923E+00
/gps/hist/point 2.600E+01 1.498E+00
/gps/hist/point 2.800E+01 1.189E+00
/gps/hist/point 3.000E+01 9.271E-01
/gps/hist/inter Lin
/gps/ang/type cos
/gps(ang/mintheta 0.000E+00 deg
Done
```

- Run SAPRE (17 days)
- Run Jovian trapped radiation models
- Use trapped e- spectrum as input for Mulassis



Example 1: NIEL analysis for Galileo encounter with Europa (24 Feb 1997)

```
Mozilla Firefox
File Edit View History Bookmarks Tools Help
/analysis/niel/functionByLayer 27 cern
/analysis/niel/unit MeV/g
/geometry/update
/phys/cuts/global/default 1.000E+00 um
/phys/scenario em
/gps/particle e-
/gps/ene/type Arb
/gps/hist/type arb
/gps/ene/min 6.000E-02 MeV
/gps/ene/max 3.000E+01 MeV
/gps/hist/point 6.000E-02 3.941E+06
/gps/hist/point 1.000E-01 3.340E+06
/gps/hist/point 5.000E-01 1.196E+05
/gps/hist/point 6.500E-01 2.951E+04
/gps/hist/point 8.000E-01 1.815E+04
/gps/hist/point 1.000E+00 1.106E+04
/gps/hist/point 1.300E+00 6.313E+03
/gps/hist/point 1.600E+00 4.203E+03
/gps/hist/point 2.000E+00 2.718E+03
/gps/hist/point 3.000E+00 1.085E+03
```



- Run SAPRE (17 days)
- Run Jovian trapped radiation models
- Use trapped e- spectrum as input for Mulassis
- Run Mulassis

Example 2: Proton interaction with Mercury's soil

Geant4 Tools: Parameter definition for Planetocosmics - Mozilla Firefox

SPENVIS DEVELOPER Project: GEANT4
Geant4 Tools
Planetocosmics (Mercury)

Output
Help

Planetocosmics allows the definition of a planetary magnetic field, atmosphere and soil (currently only Mercury, Earth and Mars are implemented) and is using the Geant4 toolkit to simulate the hadronic and electromagnetic interactions of cosmic rays with the planetary environment. Planetocosmics is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
defined	<u>Source particles</u>	mono-energetic, proton
defined	<u>Planetary settings</u>	Magn. field: dipole ($B_0=300$ nT) Atmosph.: None Soil: default
defined	<u>Geometry</u>	Spherical, PLA
defined	<u>Analysis parameters</u>	Energy deposition
Advanced settings		
defined	<u>Material definition</u>	4 material defined
default	<u>Stopping conditions</u>	---

Create macro

Model developed by

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^b UNIVERSITÄT
BERN

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Done

Run PLANETOCOSMICS:

- 5 GeV primaries
- 10 events
- 10 m thick layer with 1.3 [g/cm³] density
- Layer composition:
SiO₂(45%), MgO(35%),
Al₂O₃(7%), CaO (7%),
FeO(5%), Na₂O(0.7%),
TiO₂(0.3%)

Example 2: Proton interaction with Mercury's soil



Geant4 Tools: Parameter definition for Planetocosmics - Mozilla Firefox

SPENVIS DEVELOPER Project: GEANT4
Geant4 Tools
Planetocosmics (Mercury)

Output
Help

Planetocosmics allows the definition of a planetary magnetic field, atmosphere and soil (currently only Mercury, Earth and Mars are implemented) and is using the Geant4 toolkit to simulate the hadronic and electromagnetic interactions of cosmic rays with the planetary environment. Planetocosmics is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
defined	<u>Source particles</u>	mono-energetic, proton
defined	<u>Planetary settings</u>	Magn. field: dipole ($B_0=300$ nT) Atmosph.: None

spenvis_pco.wrl (model/vrml Object) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://dev.spenvis.oma.be/spenvis/htusers/m/messios/GEANT4/1242722455/spenvis_pco.wrl

Octaga™

Stopped

Run PLANETOCOSMICS:

- 5 GeV primaries
- 10 events
- 10 m thick layer with 1.3 [g/cm³] density
- Layer composition:
SiO₂(45%), MgO(35%),
Al₂O₃(7%), CaO (7%),
FeO(5%), Na₂O(0.7%),
TiO₂(0.3%)

Geant4 Tools in SPENVIS: Limitations

- Simulations can be highly time-consuming.
- CPU time available on SPENVIS for a single user is limited and calculations are stopped if program exceeds a limit.
- This can be often the case for calculations on maps or orbit trajectories.
- Users are welcome to utilise SPENVIS to produce and download the macro-file but is recommended that they download the stand-alone version of the Geant4 application to make a run.



2. SPENVIS Geant4 Tools Interface

Geant4 tools interface: entry point



SPENVIS Project: GEANT4
Model packages
Planet: Earth

UP Output Help

Coordinate generators
Radiation sources and effects
Spacecraft charging
Atmosphere and ionosphere
Magnetic field
Meteoroids and debris
Miscellaneous
Geant4 Tools
General models
Multi-Layered Shielding Simulation (Mulassis)
Geant4-based Microdosimetry Analysis Tool (GEMAT)
Sector Shielding Analysis Tool (SSAT)
Planet specific models
Magnetocosmics
Planetocosmics
Common settings
Definition of source particles
Definition of physical models
User defined materials
Geometry definition tool
ECSS Space Environment Standard

The models implemented in SPENVIS are combined in the packages listed above. Clicking on a package name will expand the table with a list of models. Some model suites have to be executed in a prescribed order. Model links will not be available when pre-required runs have not been executed yet. Most models run on both a spacecraft trajectory and a geographical coordinate grid. Clicking on the coordinate generator links and returning to this page toggles between the two sets of coordinates. The model links will adapt to the choice of coordinates.

Geant4 tools interface: entry point

SPENVIS Project: GEANT4
Model packages
Planet: Earth

UP

Output
Help

Coordinate generators
Radiation sources and effects
Spacecraft charging
Atmosphere and ionosphere
Magnetic field
Meteoroids and debris
Miscellaneous
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Planetocosmics
Common settings
Definition of source particles
Definition of physical models
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Geometry definition tool
ECSS Space Environment Standard

- **General models:**
Accessible for all planets included in SPENVIS

The models implemented in SPENVIS are combined in the packages listed above. Clicking on a package name will expand the table with a list of models. Some model suites have to be executed in a prescribed order. Model links will not be available when pre-required runs have not been executed yet. Most models run on both a spacecraft trajectory and a geographical coordinate grid. Clicking on the coordinate generator links and returning to this page toggles between the two sets of coordinates. The model links will adapt to the choice of coordinates.

Geant4 tools interface: entry point

SPENVIS Project: GEANT4
Model packages
Planet: Earth

UP Output Help

Coordinate generators
Radiation sources and effects
Spacecraft charging
Atmosphere and ionosphere
Magnetic field
Meteoroids and debris
Miscellaneous
Geant4 Tools
General models
Multi-Layered Shielding Simulation (Mulassis)
Geant4-based Microdosimetry Analysis Tool (GEMAT)
Sector Shielding Analysis Tool (SSAT)
Planet specific models
Magnetocosmics
Planetocosmics
Common settings
Definition of source particles
Definition of physical models
User defined materials
Geometry definition tool
ECSS Space Environment Standard

- **General models:**
Accessible for all planets included in SPENVIS
- **Planet specific models:**
Appear only for a specific planet

The models implemented in SPENVIS are combined in the packages listed above. Clicking on a package name will expand the table with a list of models. Some model suites have to be executed in a prescribed order. Model links will not be available when pre-required runs have not been executed yet. Most models run on both a spacecraft trajectory and a geographical coordinate grid. Clicking on the coordinate generator links and returning to this page toggles between the two sets of coordinates. The model links will adapt to the choice of coordinates.

Geant4 tools interface: entry point

The screenshot shows the SPENVIS Project: GEANT4 interface. At the top, there is a dark blue header bar with the text "SPENVIS Project: GEANT4", "Model packages", and "Planet: Earth". On the left side of the header is an "UP" button, and on the right are "Output" and "Help" buttons. Below the header is a vertical menu of model packages, each in a dark blue box with white text. The packages are: Coordinate generators, Radiation sources and effects, Spacecraft charging, Atmosphere and ionosphere, Magnetic field, Meteoroids and debris, Miscellaneous, Geant4 Tools, General models, Multi-Layered Shielding Simulation (Mulassis), Geant4-based Microdosimetry Analysis Tool (GEMAT), Sector Shielding Analysis Tool (SSAT), Planet specific models, Magnetocosmics, Planetocosmics, Common settings (circled in red), Definition of source particles, Definition of physical models, User defined materials, Geometry definition tool, and ECSS Space Environment Standard.

- **General models:**
Accessible for all planets included in SPENVIS
- **Planet specific models:**
Appear only for a specific planet
- **Common settings:**
 - Defined for various Geant4 tools
 - Available for all planets

The models implemented in SPENVIS are combined in the packages listed above. Clicking on a package name will expand the table with a list of models. Some model suites have to be executed in a prescribed order. Model links will not be available when pre-required runs have not been executed yet. Most models run on both a spacecraft trajectory and a geographical coordinate grid. Clicking on the coordinate generator links and returning to this page toggles between the two sets of coordinates. The model links will adapt to the choice of coordinates.

Geant4 tools interface: navigation



SPENVIS Project: GEANT4
Geant4 tools
Multi-Layered Shielding Simulation (Mulassis)

UP

Output
Help

Mulassis allows the definition of a multi-layered, one-dimensional shield and incident particle source, and using the Geant4 toolkit simulates radiation transport through the geometry, treating electromagnetic and nuclear interactions. Mulassis is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
default	Source particles	---
default	Geometry	---
missing	Analysis parameters	Need user selection
Advanced settings		
default	Material definition	---
default	Region cut-offs	---
default	Physical models	---

Create macro

Model developed by



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- Model main page:
 - summary of setting status
 - access to different setting sections
- Users can modify the settings by clicking on a particular section.
- Automatic check of the user's input.
- Create macro & run model

Geant4 tools interface: navigation



SPENVIS Project: GEANT4

Geant4 tools
Source particles

UP

Output
Help

These settings are used as an input by Multi-Layered Shielding Simulation (Mulassis), Geant4-based Microdosimetry Analysis Tool (GEMAT), Geant4 Radiation Analysis for Space (Gras) and Planetocosmics.

Source particle type and spectrum	
Incident particle type:	electron
Number of primary particles to simulate:	1,000
Warning: Particle track visualisation will be disabled!	
Incident energy spectrum:	mono-energetic
Mono-energetic energy:	100.0
Fluence/(Flux) intensity:	1.0
Angular distribution (1D):	mono-energetic trapped electrons linear power law exponential user-defined
Minimum angle:	0.0 [degrees]
Maximum angle:	90.0 [degrees]
Reset	Save >>

Geant4 tools interface: navigation



SPENVIS Project: GEANT4

Geant4 tools

Multi-Layered Shielding Simulation: Geometry

Output

Help

▲ UP

Geometry: Default

The default geometry is a single planar slab with 26 aluminium layers and boundaries equivalent to the default SHIELDOSE thicknesses.

Visualisation

Format: Encapsulated PostScript (EPS)

Particle tracks: Display

Warning: Particle track visualisation will be disabled!

Reset Save >>

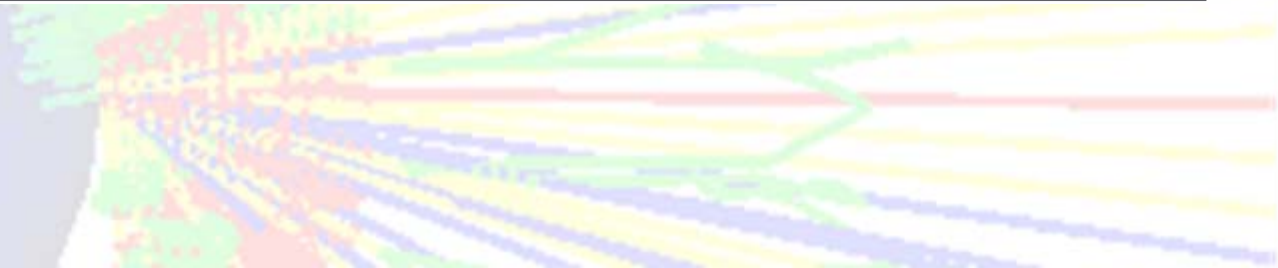
Model developed by

QinetiQ

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Geant4 tools interface: navigation



SPENVIS Project: GEANT4
Geant4 tools
Multi-Layered Shielding Simulation: Geometry

UP Output Help

Geometry: User defined

Shape: planar slab Number of layers: 2

Layer number	Material	Thickness (unit)	Visualisation colour
Layer 1	G4_Al	0.10 g/cm2	grey
Layer 2	G4_Si	0.023 g/cm2	red

Visualisation

Format: Virtual Reality Modelling Language (VRML)

Particle tracks: Display

Warning: Particle track visualisation will be disabled!

Reset Save >>

Model developed by



Geant4 tools interface: navigation



SPENVIS Project: GEANT4
Geant4 tools
Multi-Layered Shielding Simulation: Analysis parameters

Output
Help

▲ UP

Analysis type: Fluence

Fluence

Select particle type(s) for analysis: electron gamma

Output units: /cm2

Fluence density type: omni-directional

Select boundaries between layers for fluence analysis:
source 1 2 target

Energy binning mode: default

Angle binning mode: default

Reset Save >>

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Geant4 tools interface: navigation



SPENVIS Project: GEANT4
Geant4 tools
Physical models

Output
Help

UP

These settings are used as an input by Multi-Layered Shielding Simulation (Mulassis), Geant4-based Microdosimetry Analysis Tool (GEMAT) and Geant4 Radiation Analysis for Space (Gras).

Physics scenario

Standard EM **processes**

Show more options

Hadron **nuclear interactions**

No low-energy **neutrons**

No lepton-gamma **transport**

Global cut-offs

Cut units:

Default cut length:

Particle dependent cut:

Reset Save >>

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Geant4 tools interface: navigation



SPENVIS Project: GEANT4 Output
Geant4 tools Help
Multi-Layered Shielding Simulation (Mulassis)

Mulassis allows the definition of a multi-layered, one-dimensional shield and incident particle source, and using the Geant4 toolkit simulates radiation transport through the geometry, treating electromagnetic and nuclear interactions. Mulassis is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
defined	<u>Source particles</u>	mono-energetic, e-
defined	<u>Geometry</u>	Planar slab, 2 layers
defined	<u>Analysis parameters</u>	Fluence
Advanced settings		
defined	<u>Material definition</u>	2 material defined
default	<u>Region cut-offs</u>	---
defined	<u>Physical models</u>	Standard EM, Hadron




Create macro

Model developed by

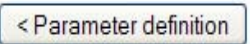



Geant4 tools interface: navigation



 **SPENVIS Project: GEANT4** 
Geant4 tools: 
Multi-Layered Shielding Simulation: Macro file

The following file contains the macro commands used as input for the Multi-Layered Shielding Simulation Software:
Macro file for the multilayered analysis tool
This macro file can be downloaded to run on your **local copy of the MULASSIS software.**
To run Mulassis on the SPENVIS server, click the Run button below.

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Geant4 tools interface: navigation



SPENVIS Project: GEANT4
Geant4 tools
Multi-Layered Shielding Simulation: Results

UP Output Help

Tables	Plots
Report file for the multilayered analysis tool	VRML representation of the geometry
Macro file for the multilayered analysis tool	Fluence/flux
Log file for the multilayered analysis tool	
Output file for the multilayered analysis tool	

New plots

Incident particle fluence/(flux) at layer boundary for angle bin

Plot as

<< Back

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Geant4 tools interface: help page



The [Geant4](#) source code is freely available, accompanied by an Installation Guide and an extensive set of documentation.^[2] In general, one needs to install the [Geant4](#) source code in order to recompile code for a particular [Geant4](#) application. However, this is not necessary when a static version of this program is available (e.g. the SPENVIS version of MULASSIS).

Geant4 tools in the SPENVIS environment

The following table gives an overview of the various [Geant4](#) tools available in SPENVIS.

Tool name	Version (Geant4 version)	Home page
MULASSIS	V1.19 (4.9.0)	http://reat.space.qinetiq.com/mulassis/
GEMAT	V2.4 (4.9.0)	http://reat.space.qinetiq.com/gemat/
SSAT	V2.1 (4.9.0)	http://reat.space.qinetiq.com/ssat/
MAGNETOCOSMICS	(4.7.1)	http://cosray.unibe.ch/~laurent/magnetocosmics/
PLANETOCOSMICS	(4.8.1)	http://cosray.unibe.ch/~laurent/planetocosmics/
GRAS	(4.9.1)	http://space-env.esa.int/index.php/geant4-radiation-analysis-for-space.html

The SPENVIS interface of all these tools simplifies the process of defining run parameters using a number of input pages (see the detailed tool help pages for more information).

Advanced users have the option to input a number of fine-tuning parameters.

The [Geant4](#) tools use a Monte-Carlo simulation-based code and execution times can be very long. In order to guarantee the consistency between the different models available in the SPENVIS system (e.g. particle spectrum vs. total ionising dose), the user project is 'blocked' while running any simulation. However, navigation remains possible. The execution is limited to ten minutes of CPU-time on the simulation machine. If the application run exceeds this limit, the simulation will be terminated and intermediate results returned to the user.

References

1. [QinetiQ website](#)
2. [Geant4 website](#)
3. [Geant4 Space Users Page](#)
4. [Geant4 Physics Reference Manual](#)

- Geant4 background information
- Overview of Geant4 tools in SPENVIS
- Links & references

Geant4 tools interface: Common tools

Material definition

- Define own material or choose from predefined lists.
- User defined material input fields:
 - material name (unique)
 - chemical composition (special syntax)
 - density
- Defined material available for all Geant4 applications.

Geant4 tools interface: Common tools

SPENVIS Project: GEANT4

Geant4 tools
Material definition

Output
Help

UP

No user materials have been defined

Adding new material

Source: User defined

Name^(*): User defined

Chemical formula: NIST pure elements

Density [g cm⁻³]: NIST compounds

Add

(*) should include only letters, digits or underscores and start with a letter

Reset Save >>

Geant4 tools interface: Common tools



SPENVIS Project: GEANT4

Geant4 tools

Material definition

UP

Output

Help

No user materials have been defined

Adding new material

Source: NIST pure elements

Material: Aluminium

Chemical formula: Al

Density [g cm⁻³]: 2.699

Add

Reset Save >>

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Geant4 tools interface: Common tools



SPENVIS Project: GEANT4

Geant4 tools
Material definition

Output
Help

UP

User defined materials (2)

G4_Al (Al) Del

G4_Si (Si) Del

Adding new material

Source: NIST compounds

Material: Graphite

Chemical formula: Eye Lens ICRP

Density [g cm⁻³]: Ferric Oxide

Rese Ferrobtoride

Ferrous Oxide

Ferrous Sulfate

Freon-12

Freon-12B2

Freon-13

Freon-13B1

Freon-1311

Gadolinium Oxysulfide

Gallium Arsenide

Gel Photo Emulsion

Pyrex Glass

Glass Lead

Glass Plate

Glucose

Glutamine

Glycerol

Graphite

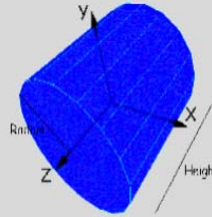
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User icons: Home, Settings, Tools, Chat, Mail, Info

Common tools: Geometry definition tool

SPENVIS Project: GEANT4
Geant4 tools
Geometry definition: Geometry parameters for shape 1

Shape 1: Cylinder

Dimensions	Illustration
<p>Volume type: solid</p> <p>Material: aluminium</p> <p>Radius: 2.000 [m]</p> <p>Height: 2.000 [m]</p>	 <p>Visualisation: Wire frame</p>
<p>Position relative to shape: World</p>	<p>Orientation</p> <p>Rotation axis vector components: X: 0.000 Y: 0.000 Z: 0.000</p> <p>Rotation angle: 0.000 [deg]</p>

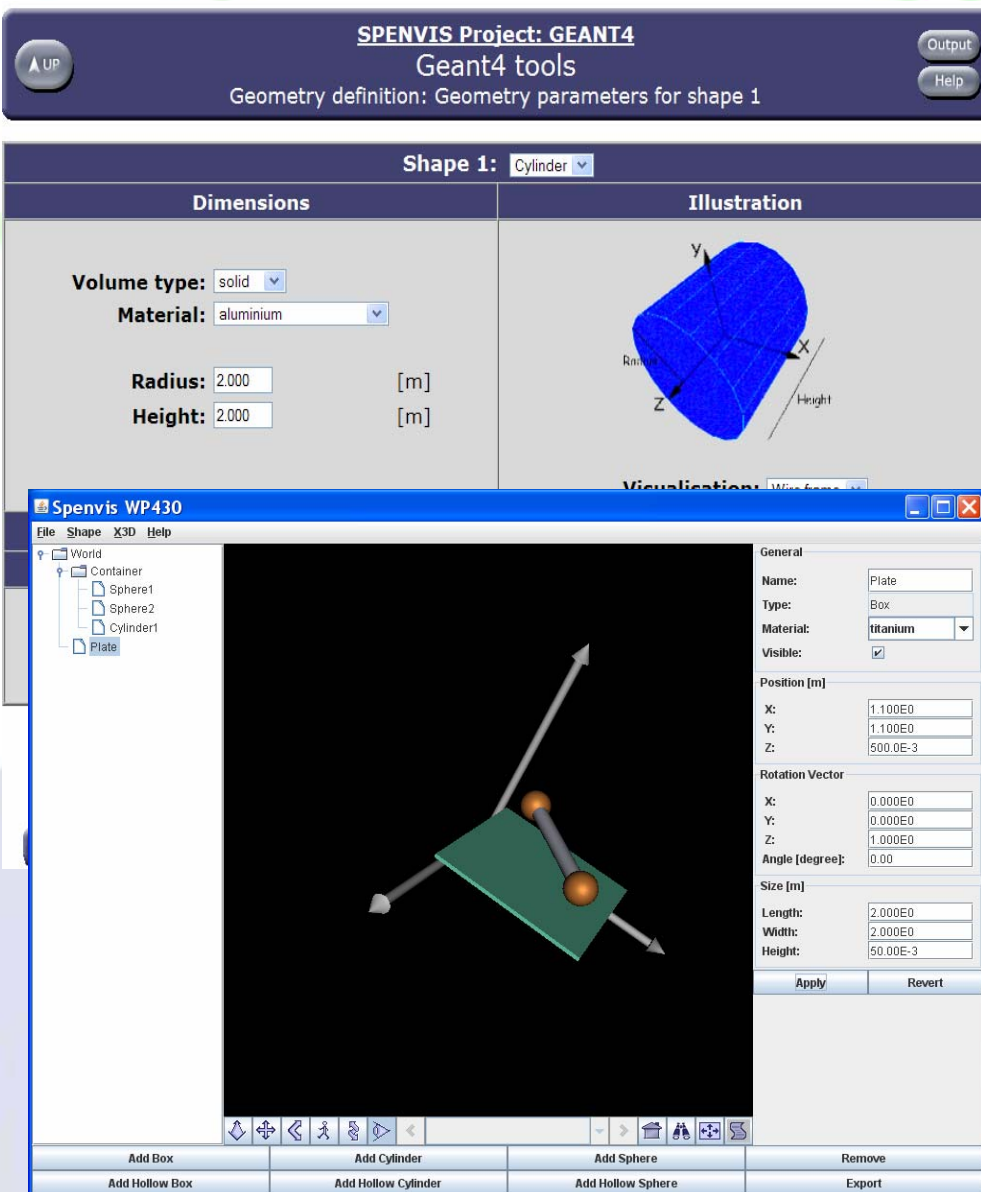
<< Back Visualize Next >>

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- Basic building blocks (sphere, box, cylinder) to construct 3D model.
- Create GDML file and VRML visualisation of the geometry definition.
- GDML upload SSAT only.

Common tools: Geometry definition tool

- Basic building blocks (sphere, box, cylinder) to construct 3D model.
 - Create GDML file and VRML visualisation of the geometry definition.
 - GDML upload SSAT only.
 - Java version of geometry definition tool.
- Future:**
- Extension of GDML upload.



3. Updates & Current Developments



Updates & Current Developments: Overview

- Some recent modifications of the new user interface for Geant4 tools in SPENVIS
- JoveREM (third party)
- Implementation of Gras



Updates & Current Developments : Gras



Geant4 Radiation Analysis for Space (Gras)

- Developed by ESA.
- Provides a general space radiation analysis for 3D geometry models.
- SPENVIS: Mulassis-like or GDML geometry
- Can directly include SPENVIS trapped particle or solar proton spectrum.
- **Outputs:**
 - Gras g4 macro file ← SPENVIS
 - CSV result file
 - Gras log file
- Upload GDML file

Updates & Current Developments : Gras



 **SPENVIS DEVELOPER Project: GEANT4**  
Geant4 tools
Geant4 Radiation Analysis for Space (Gras)

Gras is a Geant4-based tool that provides a general space radiation analysis for 3D geometry models. Gras is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
default	<u>Source particles</u>	---
default	<u>Geometry</u>	---
missing	<u>Analysis parameters</u>	Need user selection
Advanced settings		
default	<u>Material definition</u>	---
default	<u>Region cut-offs</u>	---
default	<u>Physical models</u>	---
not required	GDML definition	----

Create macro

Model developed by



Updates & Current Developments : Gras



SPENVIS DEVELOPER Project: GEANT4 Output
Geant4 tools Help
Geant4 Radiation Analysis for Space (Gras): Geometry

Geometry:
Default
1D layered geometry
GDML file

The GDML geometry is loaded or generated by the **Geometry definition tool**.

Source type:

Localisation:

Coordinates:
[mm]

Visualisation

Format:

Particle tracks:

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Updates & Current Developments : Gras



SPENVIS DEVELOPER Project: GEANT4
Geant4 tools
Geant4 Radiation Analysis for Space (Gras)

UP Output Help

Gras is a Geant4-based tool that provides a general space radiation analysis for 3D geometry models. Gras is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
defined	<u>Source particles</u>	Mono-energetic, e-
defined	<u>Geometry</u>	GDML
missing	<u>Analysis parameters</u>	Need user selection
Advanced settings		
not required	Material definition	----
default	<u>Region cut-offs</u>	---
default	<u>Physical models</u>	---
missing	<u>GDML definition</u>	Need user selection

Create macro

Model developed by



Updates & Current Developments : Gras

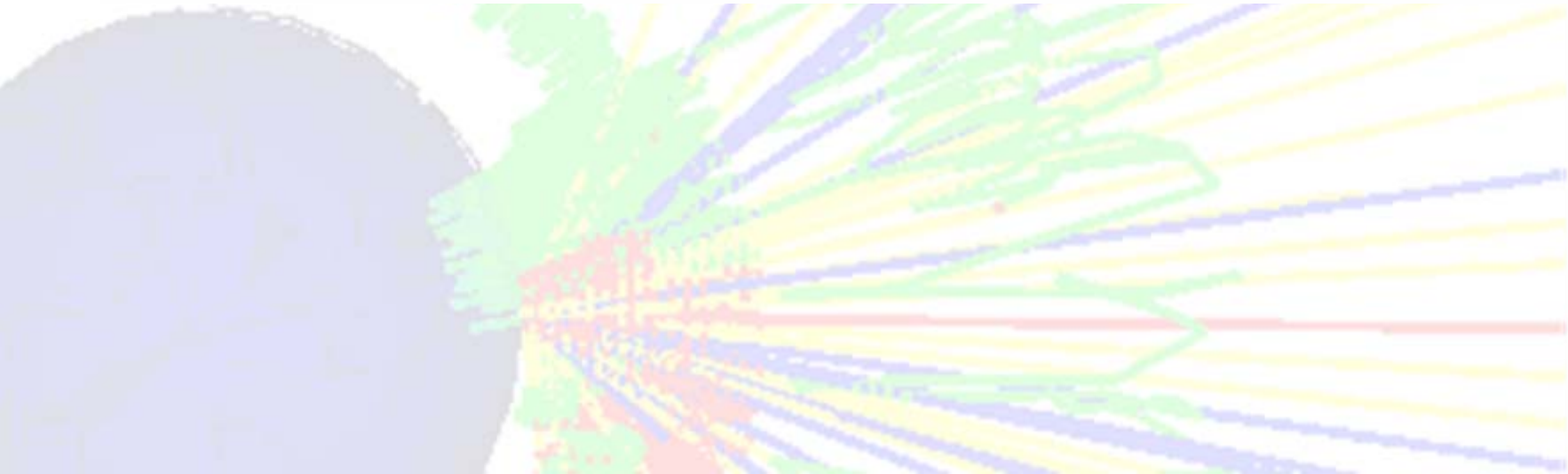


SPENVIS DEVELOPER Project: GEANT4 Output
Geant4 tools Help
Geant4 Radiation Analysis for Space (Gras): GDML definition

GDML files are used by Geant4 applications to describe the user geometry. Inside SPENVIS, GDML files can either be uploaded or generated by the [Geometry definition tool](#)

Source:	<input type="text" value="new file upload"/>	<input type="button" value="Browse..."/>
Title:	<input type="text"/>	
File:	<input type="text" value="C:\Documents and Settings\neophytos\Desktop\Geant4\GDML\GDML_001.gdml"/>	<input type="button" value="Browse..."/>

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Updates & Current Developments : Gras



SPENVIS DEVELOPER Project: GEANT4
Geant4 tools
Geant4 Radiation Analysis for Space (Gras): GDML definition

Output
Help

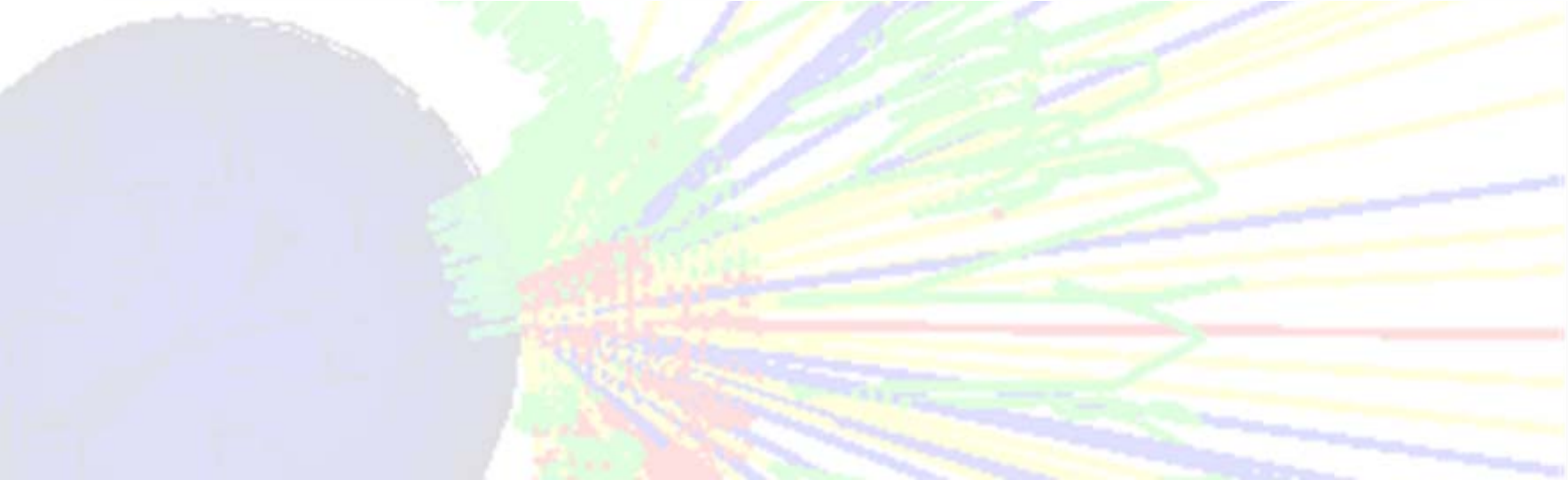
UP

GDML files are used by Geant4 applications to describe the user geometry. Inside SPENVIS, GDML files can either be uploaded or generated by the [Geometry definition tool](#)

Source: <input type="text" value="new file upload"/>	
Title:	<input type="text"/>
File:	<input type="text"/> <input type="button" value="Browse..."/>

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Updates & Current Developments : Gras



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SPENVIS DEVELOPER Project: GEANT4
Geant4 tools
Geant4 Radiation Analysis for Space (Gras)

Output
Help

Gras is a Geant4-based tool that provides a general space radiation analysis for 3D geometry models. Gras is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
defined	<u>Source particles</u>	Mono-energetic, e-
defined	<u>Geometry</u>	GDML
missing	<u>Analysis parameters</u>	Need user selection
Advanced settings		
not required	Material definition	----
default	<u>Region cut-offs</u>	---
default	<u>Physical models</u>	---
defined	<u>GDML definition</u>	upl, <u>Report file</u>

Create macro

Model developed by



Updates & Current Developments : Gras



GDML_to_NML project: GEANT4

Space (Gras)

Output Help

GDML file

File: spenvis_gdm.upl (6364)

Content summary

Surroundings: volume 'World'

material 'mat_Vacuum'

Statistics: 3 material(s)

11 unique volume(s)

0 empty volume(s)

Structure overview

Structure:

- World (mat_Vacuum)
 - +1.00 +0.00 +0.00 +0.00
 - +0.00 +1.00 +0.00 +0.00
 - +0.00 +0.00 +1.00 +0.00
 - +0.00 +0.00 +0.00 +1.00
- satellite_out (mat_Aluminium)
 - +1.00 +0.00 +0.00 +0.00
 - +0.00 +1.00 +0.00 +0.00
 - +0.00 +0.00 +1.00 +0.00
 - +0.00 +0.00 +0.00 +1.00
- satellite_in (mat_Vacuum)
 - +1.00 +0.00 +0.00 +0.00
 - +0.00 +1.00 +0.00 +0.00
 - +0.00 +0.00 +1.00 +0.00
 - +0.00 +0.00 +0.00 +1.00
- support (G4_ADIPOSE_TISSUE_ICRP)
 - +1.00 +0.00 +0.00 +0.00
 - +0.00 +1.00 +0.00 +0.00

Remarks

Mono-energetic, e-

GDML

Need user selection

s

upl, **Report file**

by

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Updates & Current Developments : Gras



SPENVIS DEVELOPER Project: GEANT4

Geant4 tools

Geant4 Radiation Analysis for Space (Gras): Analysis parameters

Output

Help

UP

Analysis type: Fluence

Fluence analysis

Select particle type(s): incident particle
electron
gamma

Select 2 interface(s) for analysis:

1. between v1_in (mat_Vacuum) and v2_out (mat_Aluminium)

2. between satellite_in (mat_Vacuum) and v4_out (mat_Aluminium)

Energy binning mode: default

Reset Save >>

satellite_out (mat_Aluminium)
satellite_in (mat_Vacuum)
support (G4_ADIPOSE_TISSUE_ICRP)
v1_out (mat_Aluminium)
v1_in (mat_Vacuum)
v2_out (mat_Aluminium)
v2_in (mat_Vacuum)
v3_out (mat_Aluminium)
v3_in (mat_Vacuum)
v4_out (mat_Aluminium)
v4_in (mat_Vacuum)

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Updates & Current Developments : Gras



SPENVIS DEVELOPER Project: GEANT4 Output
Geant4 tools Help
Geant4 Radiation Analysis for Space (Gras): Analysis parameters

Analysis type: Dose equivalent analysis

Dose equivalent analysis

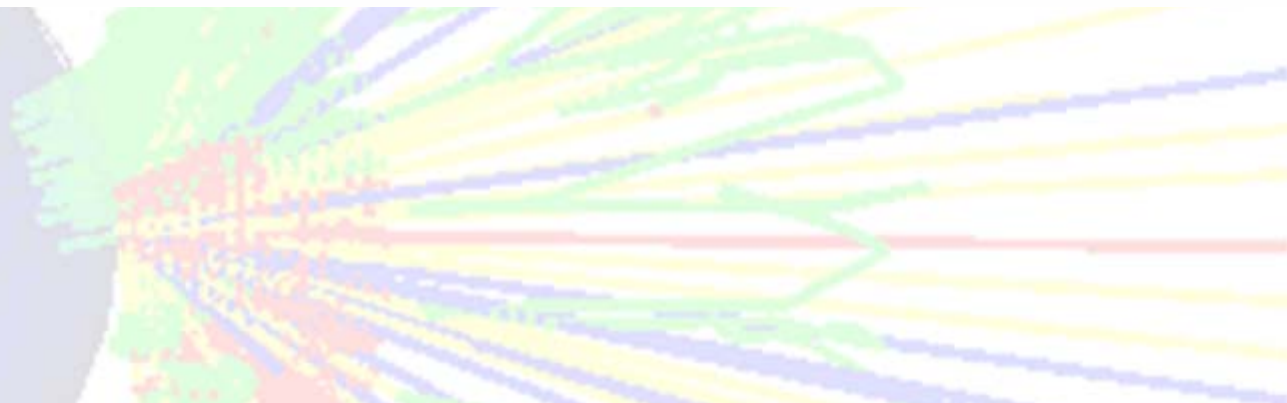
Output units: rad

Select 1 volumes for analysis:

Volume 1: support (G4_ADIPOSE_TISSUE_ICRP)

- satellite_out (mat_Aluminium)
- satellite_in (mat_Vacuum)
- support (G4_ADIPOSE_TISSUE_ICRP)
- v1_out (mat_Aluminium)
- v1_in (mat_Vacuum)
- v2_out (mat_Aluminium)
- v2_in (mat_Vacuum)
- v3_out (mat_Aluminium)
- v3_in (mat_Vacuum)
- v4_out (mat_Aluminium)
- v4_in (mat_Vacuum)

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Updates & Current Developments : Gras



SPENVIS DEVELOPER Project: GEANT4 Output
Geant4 tools Help
Geant4 Radiation Analysis for Space (Gras): Region Dependent Cut-offs

Region dependent cuts

Number of regions: 1
Cut units: μm

Region 1 particle cut length

region default : 1
 gamma
 electron : 0.4
 positron

Volumes

satellite_out (mat_Aluminium)	use global default
satellite_in (mat_Vacuum)	use global default
support (G4_ADIPOSE_TISSUE_ICRP)	use global default
v1_out (mat_Aluminium)	use global default
v1_in (mat_Vacuum)	use region 1 cutoff
v2_out (mat_Aluminium)	use global default
v2_in (mat_Vacuum)	use global default
v3_out (mat_Aluminium)	use global default
v3_in (mat_Vacuum)	use global default
v4_out (mat_Aluminium)	use global default
v4_in (mat_Vacuum)	use global default

Reset Save >>

Updates & Current Developments : Gras



SPENVIS DEVELOPER Project: GEANT4
Geant4 tools
Geant4 Radiation Analysis for Space (Gras)

Output
Help

▲ UP

Gras is a Geant4-based tool that provides a general space radiation analysis for 3D geometry models. Gras is a complex tool, so please consult the help page before using it.

Status	Settings	Remarks
defined	<u>Source particles</u>	Mono-energetic, e-
defined	<u>Geometry</u>	GDML
defined	<u>Analysis parameters</u>	Dose equivalent analysis
Advanced settings		
not required	Material definition	----
defined	<u>Region cut-offs</u>	1 region
defined	<u>Physical models</u>	Standard EM, No hadron
defined	<u>GDML definition</u>	upl, <u>Report file</u>

Create macro

Model developed by



Conclusions

- User friendly interface to Geant4 applications.
- Some difficulties during implementation:
 - macro command dependencies
 - model specific commands
 - static version of the model
- Interaction with Geant4 developers community.
- Gras will be available with a forthcoming release of SPENVIS!