

# MULASSIS in SPENVIS

## Demo

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Tokyo University, 13-15 Feb 2008

G.Santin - GRAS / MULASSIS in  
G4 Space Users', Tokyo, 13-15  
Feb 2008



# Outline

- SPENVIS intro
  
- SPENVIS demo
  - Mission definition
  - Mission radiation environment
  - MULASSIS configuration
  - MULASSIS output



The screenshot shows a web browser window with the address bar displaying "http://www.spennis.oma.be - Model packages - Mozilla Firefox". The page title is "SPENVIS Project: TOKYO Model packages". On the left side of the page, there is a circular button with an upward arrow and the text "UP". On the right side, there are two buttons labeled "Output" and "Help". The main content area features a vertical list of model packages, each in a dark blue box with white text. The packages are: "Coordinate generators", "Spacecraft trajectories", "OR", "Geographical coordinate grids", "Radiation sources and effects", "Spacecraft charging", "Atmosphere and ionosphere", "Magnetic field", "Meteoroids and debris", "Data base queries", "Miscellaneous", and "ECSS Space Environment Standard". Below this list, there is a paragraph of text explaining that the models are combined in the listed packages and that clicking on a package name will expand the table with a list of models. It also notes that some model suites require a prescribed order of execution and that most models run on both spacecraft trajectories and geographical coordinate grids. A second paragraph states that the model pages are kept concise and feature a navigation bar at the top of each page, with a "Help" link in the bottom right corner providing context-sensitive help pages.

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.

The model pages have deliberately been kept as concise as possible. A navigation bar is figured at the top of each SPENVIS page. The [Help](#) link in the bottom right hand corner of this bar points to context sensitive help pages, which in turn contain their own navigation system, including access to guidelines on model usage and background information on the space environment.

Done Open Notebook

# SPENVIS

## Orbit definition



http://www.spenvis.oma.be - Orbit generator: Parameters for segment 1 - Mozilla Firefox

**SPENVIS Project: TOKYO**  
Orbit generator  
Parameters for segment 1

UP

Output  
Help

Segment title:

Orbit type: heliosynchronous

Orbit start: calendar date

01 Jan 2008 00 : 00 : 00

Representative trajectory duration [days]: 4

Altitude [km]: 800

Local time of ascending node [hr]: 0

Output resolution

1.	60.0	s below	20000.0	km
2.	240.0	s below	80000.0	km
3.	3600.0	s elsewhere		

<< Back   Next >>

Done   Open Notebook

# SPENVIS

## Orbit definition

http://www.spENVIS.oma.be - Orbit generator: Parameters for segment 1 - Mozilla Firefox

**SPENVIS Project: TOKYO**  
Orbit generator  
Parameters for segment 1

UP

Output  
Help

Segment title:

Orbit type: heliosynchronous

Orbit start: calendar date

18 : 00 : 00 : 00

Orbit duration [days]: 4

815

810

805

800

795

Altitude (km)

Ascending node [hr]: 0

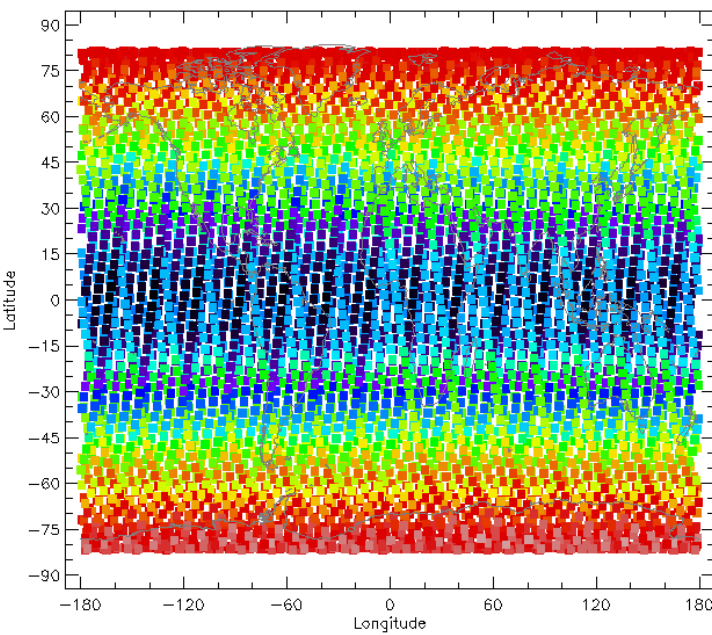
Output resolution

Below 20000.0 km

Below 80000.0 km

elsewhere

Back Next >>



Done

Open Notebook

# SPENVIS

## Radiation environment - Trapped p and e<sup>-</sup>





http://www.spenvis.oma.be - Radiation sources and effects: Trapped radiation model parameters - Mozilla Fir...

**SPENVIS Project: TOKYO**  
Radiation sources and effects  
Trapped radiation: Model parameters

UP      Output  
Help

### Trapped radiation models

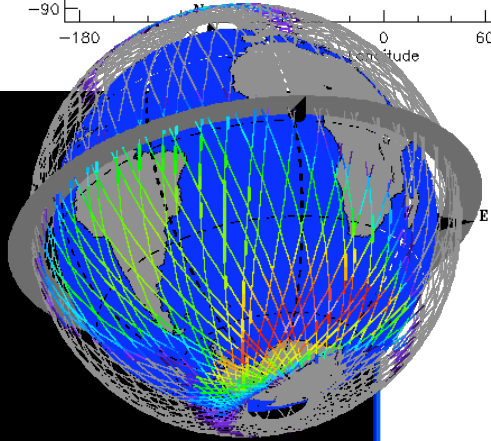
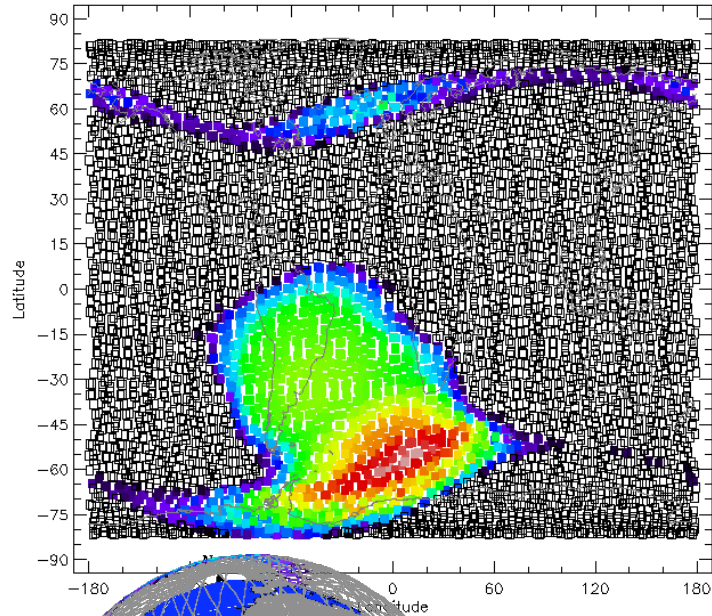
Proton model: AP-8	Electron model: AE-8
Model version: solar maximum	Model version: solar maximum
	include local time variation
	Confidence level: 50.000%
Model developed by: 	Model developed by: 

Reset   Run   Combined Run

Done      Open Notebook

# SPENVIS

## Radiation environment - Trapped p and e<sup>-</sup>



Resources and effects: Trapped radiation model parameters - Mozilla Fir...

### SPENVIS Project: TOKYO

Radiation sources and effects  
Trapped radiation: Model parameters

Output  
Help

#### Trapped radiation models

Electron model: AE-8

Model version: solar maximum

include local time variation

Confidence level: 50.000%

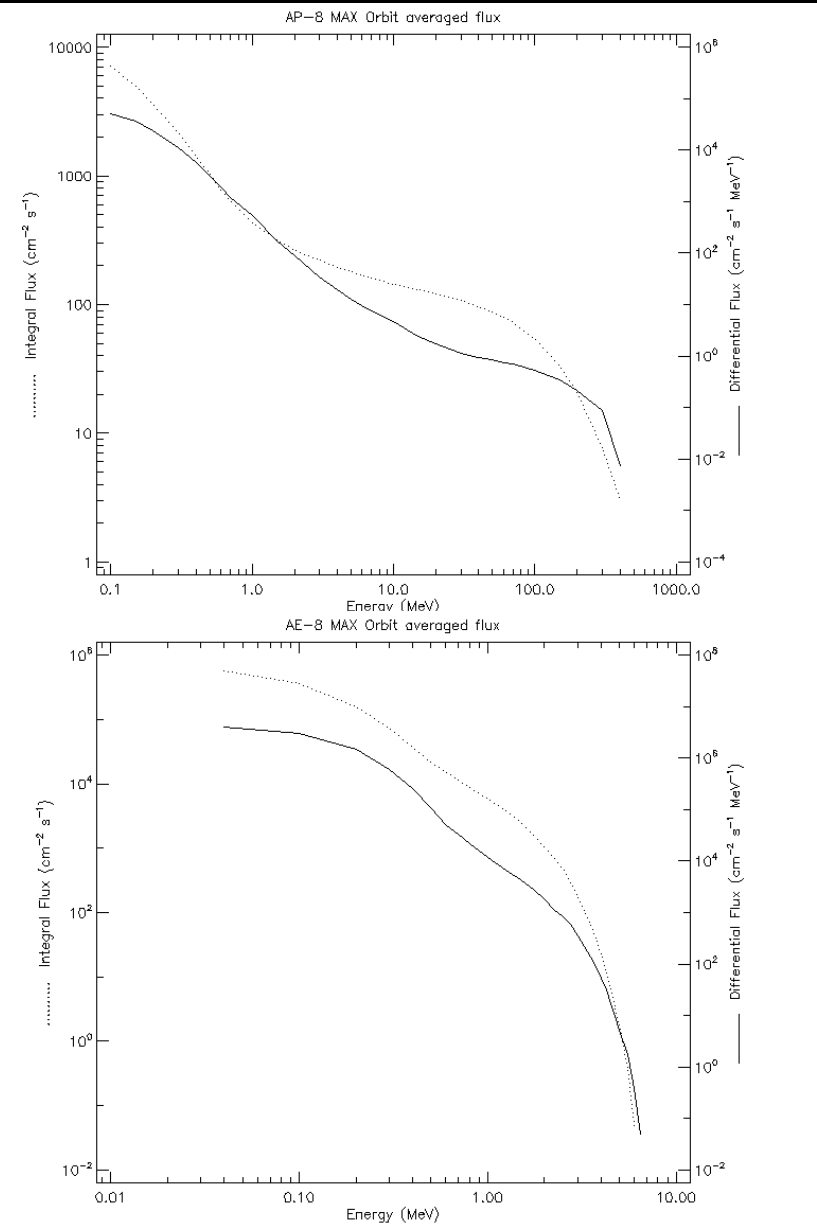
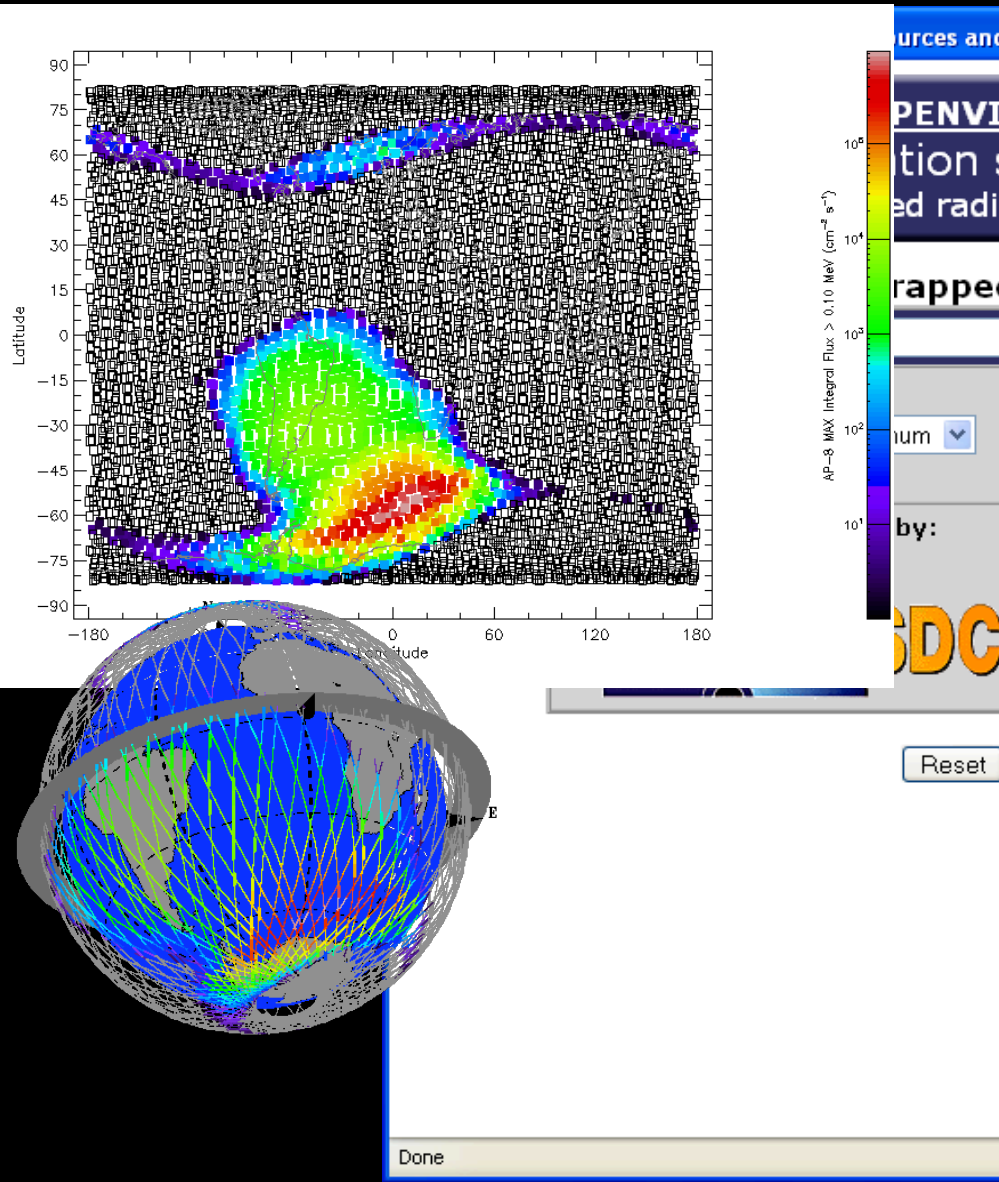
Model developed by:

Reset Run Combined Run

Done Open Notebook

# SPENVIS

## Radiation environment - Trapped p and e<sup>-</sup>



# SPENVIS

## Radiation environment - Solar protons



http://www.spenvis.oma.be - Radiation sources and effects: Solar proton model parameters - Mozilla Firefox

**SPENVIS Project: TOKYO**  
Radiation sources and effects  
Solar proton models: Parameters

UP

Output  
Help

Solar proton model: ESP total fluence

Prediction period: automatic


Offset in solar cycle: automatic

Confidence level [%]: 95.0

Geomagnetic shielding: apply for quiet magnetosphere

Reset Run Combined Run

Model developed by



Done Open Notebook

# SPENVIS

## Radiation environment - Solar protons



http://www.spennis.oma.be - Radiation sources and effects: Solar proton model parameters - Mozilla Firefox

**SPENVIS Project: TOKYO**  
Radiation sources and effects  
Solar proton models: Parameters


UP

Output  
Help

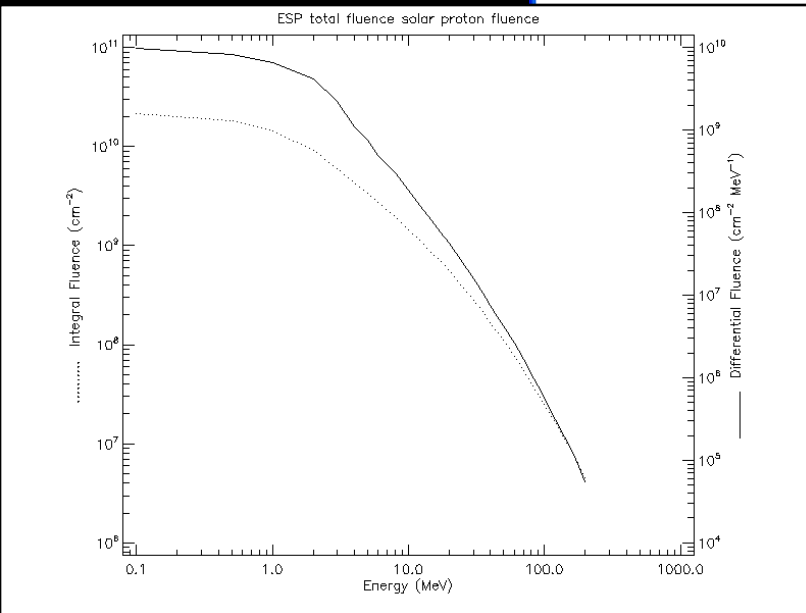
Solar proton model: ESP total fluence  
Prediction period: automatic  
Offset in solar cycle: automatic  
Confidence level [%]: 95.0  
Geomagnetic shielding: apply for quiet magnetosphere

Reset Run Combined Run

Model developed by



Done Open Notebook



# MULASSIS

## Geometry

http://www.spervis.oma.be - Radiation sources and effects: Geometry definition for Multi-Layered Shielding S...

**SPENVIS Project: TOKYO**  
Radiation sources and effects  
Multi-Layered Shielding Simulation: Geometry

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.

**Geometry:** User defined

Layer number	Material Edit	Thickness (unit)		Visualisation colour
Layer 1	Aluminium	2.0	mm	grey
Layer 2	Silicon	0.3	mm	yellow

Do not include the particle tracks in the visualisation of the geometry in Encapsulated PostScript (EPS) format.

Reset   Geometry   Source particles >   Physical models >>   Analysis parameters >>>   Create macro

Model developed by

**QinetiQ**

Done   Open Notebook

# MULASSIS

## Geometry

http://www.spervis.oma.be - Radiation sources and effects: Geometry definition for Multi-Layered Shielding S...

**SPENVIS Project: TOKYO**

Radiation sources and effects  
Multi-Layered Shielding Simulation: Geometry

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.

**Geometry:** User defined

Layer number	Material Edit	Thickness (unit)		Visualisation colour
Layer 1	Aluminium	2.0	mm	grey
Layer 2	Silicon	0.3	mm	yellow

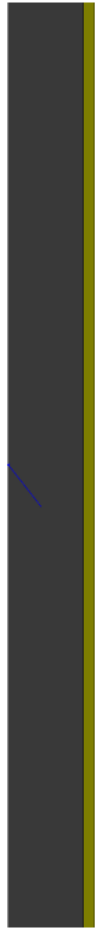
Do not include the particle tracks in the visualisation of the geometry in Encapsulated PostScript (EPS) format.

Reset   Geometry   Source particles >   Physical models >>   Analysis parameters >>>   Create macro

Model developed by

**QinetiQ**

Done   Open Notebook



# MULASSIS

## Particle source

http://www.spennis.oma.be - Radiation sources and effects: Source particles for Multi-Layered Shielding Simu...

**SPENVIS Project: TOKYO**

Radiation sources and effects  
Multi-Layered Shielding Simulation: Source particles

UP

Output  
Help

**Source particle type and spectrum**

Incident particle type: proton

Number of primary particles to simulate: 10,000

Incident energy spectrum: trapped protons

Don't use energy biasing

Interpolation type: linear

Angular distribution: cosine-law (isotropic)

Minimum angle: 0.0 [degrees]

Maximum angle: 90.0 [degrees]

Reset < Geometry Source particles Physical models > Analysis parameters >> Create macro

Done Open Notebook

# MULASSIS

## Particle source

http://www.spennis.oma.be - Radiation sources and effects: Source particles for Multi-Layered Shielding Simu...

**SPENVIS Project: TOKYO**  
Radiation sources and effects  
Multi-Layered Shielding Simulation: Source particles

UP

Output  
Help

**Source particle type and spectrum**

Incident particle type:

Number of primary particles to simulate:

Incident energy spectrum:

energy biasing

Interpolation type:

Angular distribution:

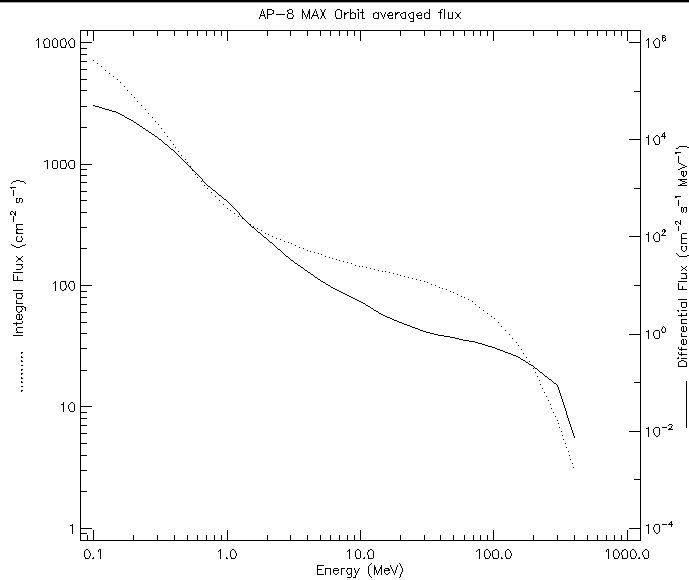
Minimum angle:  [degrees]

Maximum angle:  [degrees]

Source particles   Physical models >   Analysis parameters >>   Create macro

Done

Open Notebook



http://www.spennis.oma.be - Radiation sources and effects: Physical models for Multi-Layered Shielding Simu... [-] [x]

**SPENVIS Project: TOKYO** Output

Radiation sources and effects Help

Multi-Layered Shielding Simulation: Physical models

### Physical models and production cut-offs

Simulation conditions: Standard EM  processes

No hadron  nuclear interactions

Default cut unit: mm

Default global cut: 0.1

Particle dependent global cut

Region dependent cuts: Number of regions: 0

Reset << Geometry < Source particles Physical models Analysis parameters > Create macro

Done Open Notebook

# MULASSIS

## Analysis



http://www.spenvis.oma.be - Radiation sources and effects: Analysis parameters for Multi-Layered Shielding ...

**SPENVIS Project: TOKYO**

Radiation sources and effects  
Multi-Layered Shielding Simulation: Analysis parameters

Analysis type: Total ionizing dose

Energy deposition / TID

Output units: rad

Select layers for energy deposition/total ionising dose analysis:  
1  2

Reset <<< Geometry << Source particles < Physical models Analysis parameters Create macro

Done Open Notebook

# MULASSIS

## Macro generation - Run



http://www.spennis.oma.be - Radiation sources and effects: Inputs for Multi-Layered Shielding Simulation - M...

**SPENVIS Project: TOKYO**

▲ UP

Radiation sources and effects  
Multi-Layered Shielding Simulation: Macro file

Output  
Help

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.

<<<< Geometry <<< Source particles << Physical models < Analysis parameters Run

Done

Open Notebook

# MULASSIS

## Macro generation - Run



http://www.spennis.oma.be - Radiation sources and effects: Inputs for Multi-Layered Shielding Simulation - M...

http://www.spennis.oma.be - Mozilla Firefox

```
# SPENVIS generated macrofile for MULASSIS
/geometry/layer/delete 0
/geometry/layer/shape slab
/geometry/layer/add 0 Aluminium 2 2.000E+00 mm
/geometry/layer/add 1 Silicon 8 3.000E-01 mm
# =====
# Spennis particle source
# Project: TOKYO
# title:
# Particle: proton
# Mission Segment: 1 365.0 Days
# =====
/analysis/file spennis
/analysis/normalise 5.635E+10 cm2
/analysis/dose/add 2
/analysis/dose/unit rad
/geometry/update
/phys/cuts/global/default 1.000E-01 mm
/phys/scenario em
/gps/particle proton
/gps/ene/type arb
/gps/hist/type arb
/gps/ene/min 1.000E-01 MeV
/gps/ene/max 4.000E+02 MeV
/gps/hist/point 1.000E-01 5.029E+04
/gps/hist/point 1.500E-01 3.560E+04
/gps/hist/point 2.000E-01 2.357E+04
/gps/hist/point 3.000E-01 1.096E+04
/gps/hist/point 4.000E-01 5.743E+03
/gps/hist/point 5.000E-01 3.085E+03
/gps/hist/point 6.000E-01 1.889E+03
/gps/hist/point 7.000E-01 1.202E+03
/gps/hist/point 1.000E+00 5.282E+02
/gps/hist/point 1.500E+00 1.681E+02
/gps/hist/point 2.000E+00 8.729E+01
/gps/hist/point 3.000E+00 3.425E+01
/gps/hist/point 4.000E+00 1.964E+01
/gps/hist/point 5.000E+00 1.250E+01
/gps/hist/point 6.000E+00 9.580E+00
/gps/hist/point 7.000E+00 7.611E+00
/gps/hist/point 1.000E+01 4.704E+00
```

**SPENVIS Project: TOKYO**

Radiation sources and effects  
Multi-Layered Shielding Simulation: Macro file

Output  
Help

no commands used as input for the Multi-Layered Shielding Simulation

**analysis tool**  
to run on your local copy of the MULASSIS software.

erver, click the Run button below.

source particles << Physical models < Analysis parameters Run

Open Notebook

Done Open Notebook

# MULASSIS

## Output

http://www.spennis.oma.be - Radiation sources and effects: Results from Multi-Layered Shielding Simulation ...

**SPENVIS Project: TOKYO**

Radiation sources and effects  
Multi-Layered Shielding Simulation: Results

Output  
Help

Tables	Plots
<a href="#">Report file for the multilayered analysis tool</a> <a href="#">Macro file for the multilayered analysis tool</a> <a href="#">Log file for the multilayered analysis tool</a> <a href="#">Output file for the multilayered analysis tool</a>	<a href="#">EPS representation of the geometry</a>

New plots

Total ionizing dose per layer

Plot as: Portable Network Graphics (PNG)

Navigation: <<<<< Geometry <<<< Source particles <<< Physical models << Analysis parameters

Done Open Notebook

# MULASSIS Output



```
http://www.spenvis.oma.be - Mozilla Firefox
File Edit View History Bookmarks Tools Help

-----
MULTI-LAYER SHIELDING SIMULATION SOFTWARE (MULASSIS)
-----

Code Development Information
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MULASSIS has been developed by   : Dr F Lei & Dr P Truscott,
                                QinetiQ Ltd, UK
with the assistance of          : The Geant4 Collaboration
MULASSIS development sponsored by : European Space Agency,
                                Space Environments and
                                Effects Analysis Section

MULASSIS version                : v1.17
File creation date & time       : Tue Feb 12 06:46:42 2008

-----

Material Definition:
-----

There are 3 materials used:
Material: Vacuum   density: 0.000 kg/m3  temperature: 2.73 K  pressure: 0.00 atm
---> Element: Vacuum ( )  Z = 1.0  N = 1.0  A = 1.01 g/mole  ElmMassFraction: 1
Material: Aluminium density: 2.700 g/cm3  temperature: 273.15 K  pressure: 1.00 at
---> Element: Al ( )  Z = 13.0  N = 27.0  A = 26.98 g/mole  ElmMassFraction: 100.00
Material: Silicon  density: 2.329 g/cm3  temperature: 273.15 K  pressure: 1.00 atm
---> Element: Si ( )  Z = 14.0  N = 28.1  A = 28.09 g/mole  ElmMassFraction: 100.00

-----

Geometry Definition:
-----

There are 3 physical volumes used (including the world volume which is PhysVol #1).

PhyVol#  PhyVol Name  Start  Thickness  Material
      2  Layer-1      -1.15 mm  2 mm      Aluminium
```

### Results from Multi-Layered Shielding Simulation - ...

**Object: TOKYO**  
Results and effects  
Simulation: Results

Output  
Help

#### Plots

PS representation of the geometry

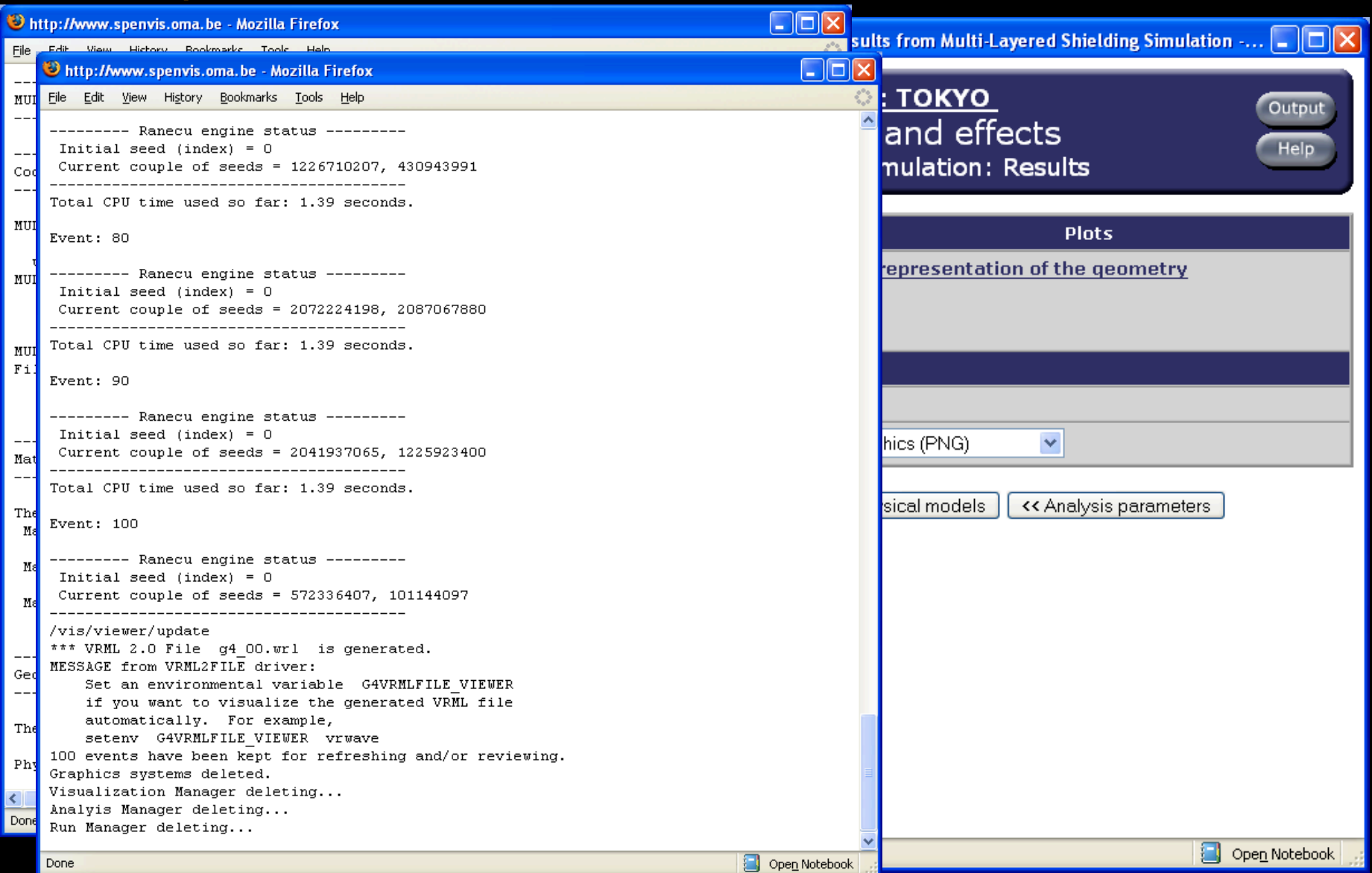
Graphics (PNG)

Physical models << Analysis parameters

Done

Open Notebook

# MULASSIS Output

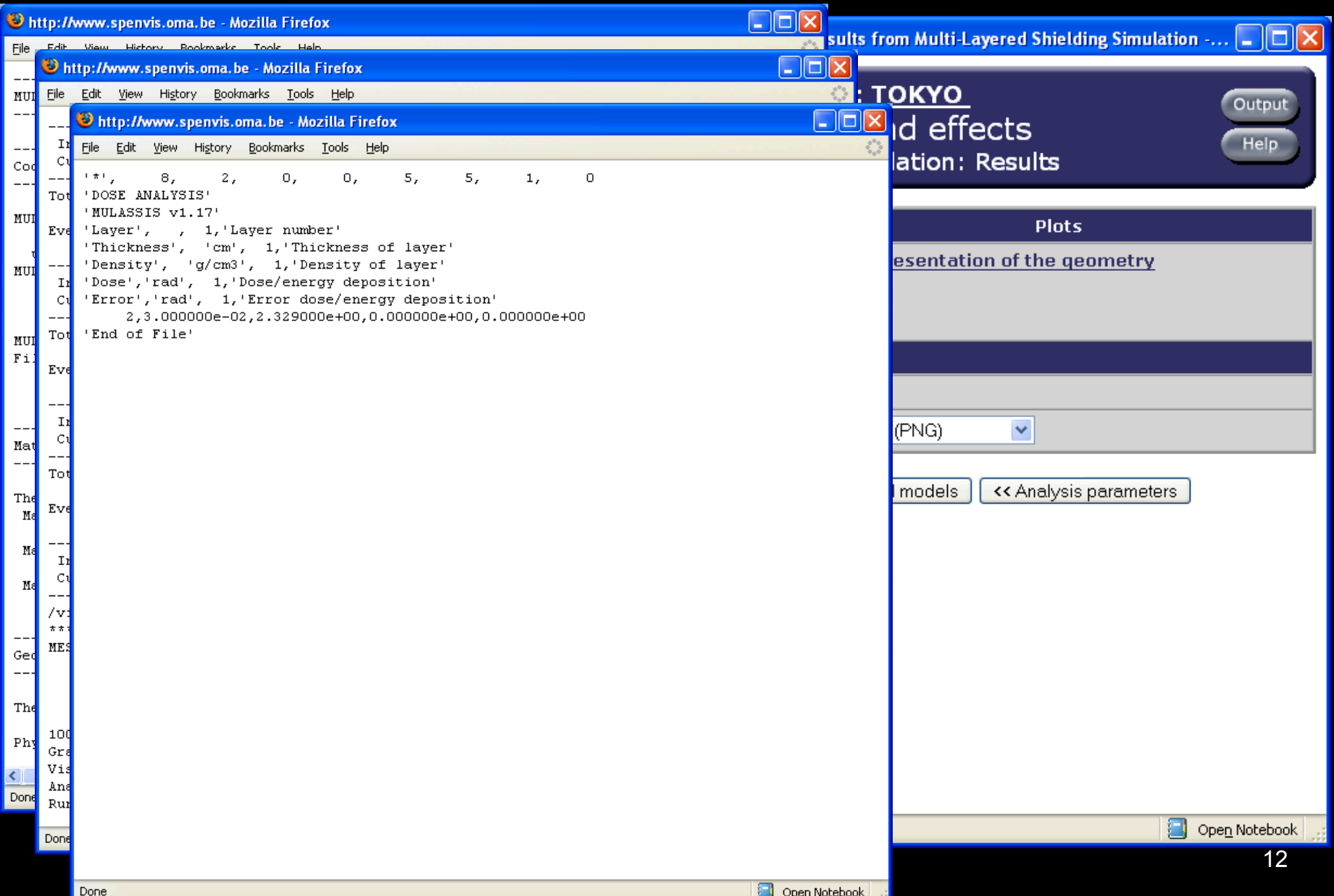


The screenshot displays two overlapping windows. The background window is a Mozilla Firefox browser showing the output of a simulation. The text in the browser window is as follows:

```
----- Ranecu engine status -----  
Initial seed (index) = 0  
Current couple of seeds = 1226710207, 430943991  
-----  
Total CPU time used so far: 1.39 seconds.  
Event: 80  
----- Ranecu engine status -----  
Initial seed (index) = 0  
Current couple of seeds = 2072224198, 2087067880  
-----  
Total CPU time used so far: 1.39 seconds.  
Event: 90  
----- Ranecu engine status -----  
Initial seed (index) = 0  
Current couple of seeds = 2041937065, 1225923400  
-----  
Total CPU time used so far: 1.39 seconds.  
Event: 100  
----- Ranecu engine status -----  
Initial seed (index) = 0  
Current couple of seeds = 572336407, 101144097  
-----  
/vis/viewer/update  
*** VRML 2.0 File g4_00.wrl is generated.  
MESSAGE from VRML2FILE driver:  
Set an environmental variable G4VRMLFILE_VIEWER  
if you want to visualize the generated VRML file  
automatically. For example,  
setenv G4VRMLFILE_VIEWER vrwave  
100 events have been kept for refreshing and/or reviewing.  
Graphics systems deleted.  
Visualization Manager deleting...  
Analysis Manager deleting...  
Run Manager deleting...
```

The foreground window is a web application titled "Results from Multi-Layered Shielding Simulation". It features a dark blue header with the text "TOKYO" and "and effects simulation: Results". Below the header, there are two buttons: "Output" and "Help". The main content area is titled "Plots" and contains a section for "representation of the geometry". At the bottom of the page, there are two buttons: "Physical models" and "<< Analysis parameters".

# MULASSIS Output



The screenshot displays a web browser window with three tabs, all pointing to <http://www.spenvis.oma.be>. The active tab shows the output of a simulation, including a header line with numerical values: `*1, 8, 2, 0, 0, 5, 5, 1, 0`. Below this, the text reads: `'DOSE ANALYSIS'`, `'MULASSIS v1.17'`, and a list of parameters: `'Layer', , 1, 'Layer number'`, `'Thickness', 'cm', 1, 'Thickness of layer'`, `'Density', 'g/cm3', 1, 'Density of layer'`, `'Dose', 'rad', 1, 'Dose/energy deposition'`, and `'Error', 'rad', 1, 'Error dose/energy deposition'`. The output concludes with `2,3.000000e-02,2.329000e+00,0.000000e+00,0.000000e+00` and `'End of File'`.

Overlaid on the right side of the browser is a software interface window titled "Results from Multi-Layered Shielding Simulation". The interface includes a header with "TOKYO" and "nd effects", a "Simulation: Results" section, and a "Plots" section with a link for "resentation of the geometry". There are "Output" and "Help" buttons, a "(PNG)" dropdown menu, and a "<< Analysis parameters" button. The interface also features an "Open Notebook" button at the bottom right.