



FLAIR - Intervention planner

Motivation

This tool allows for calculating the dose incurred due to interventions in an activated area, taking into account not only working a specific places but also the traversal of activated zones in order to reach the actual workplaces.

For this purpose workflows can be designed which consist of:

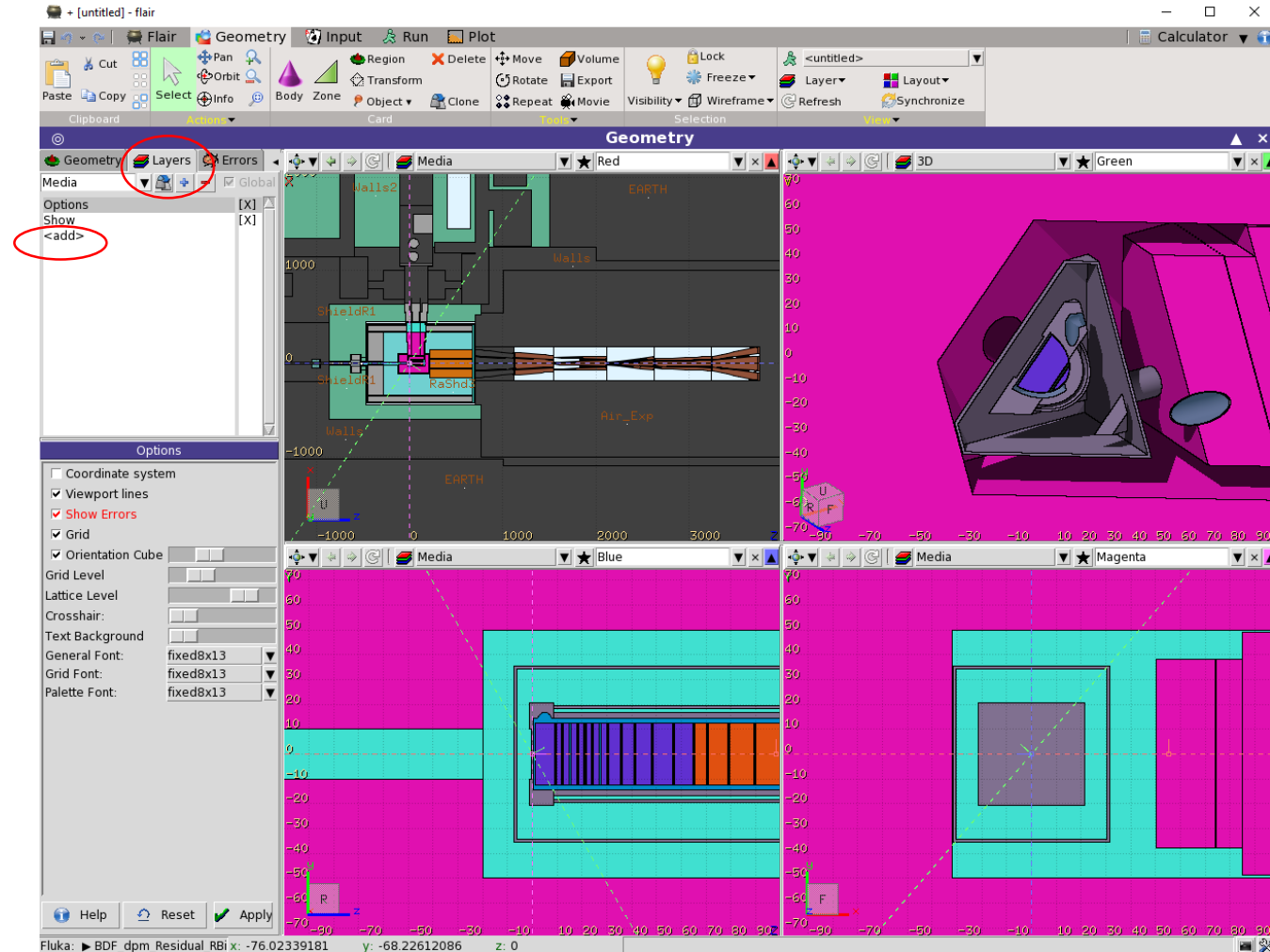
- trajectories
- work places
- times for traversal as well as activities

To run this tool you need to start FLAIR on the cluster via the command “**flair3-beta**”

Planning & optimizing an intervention

In the geometry editor:

- Go to “layers”
 - Select <add> and add a USERBIN
- NOTE: Only Cartesian USRBINS are currently supported



Planning & optimizing an intervention

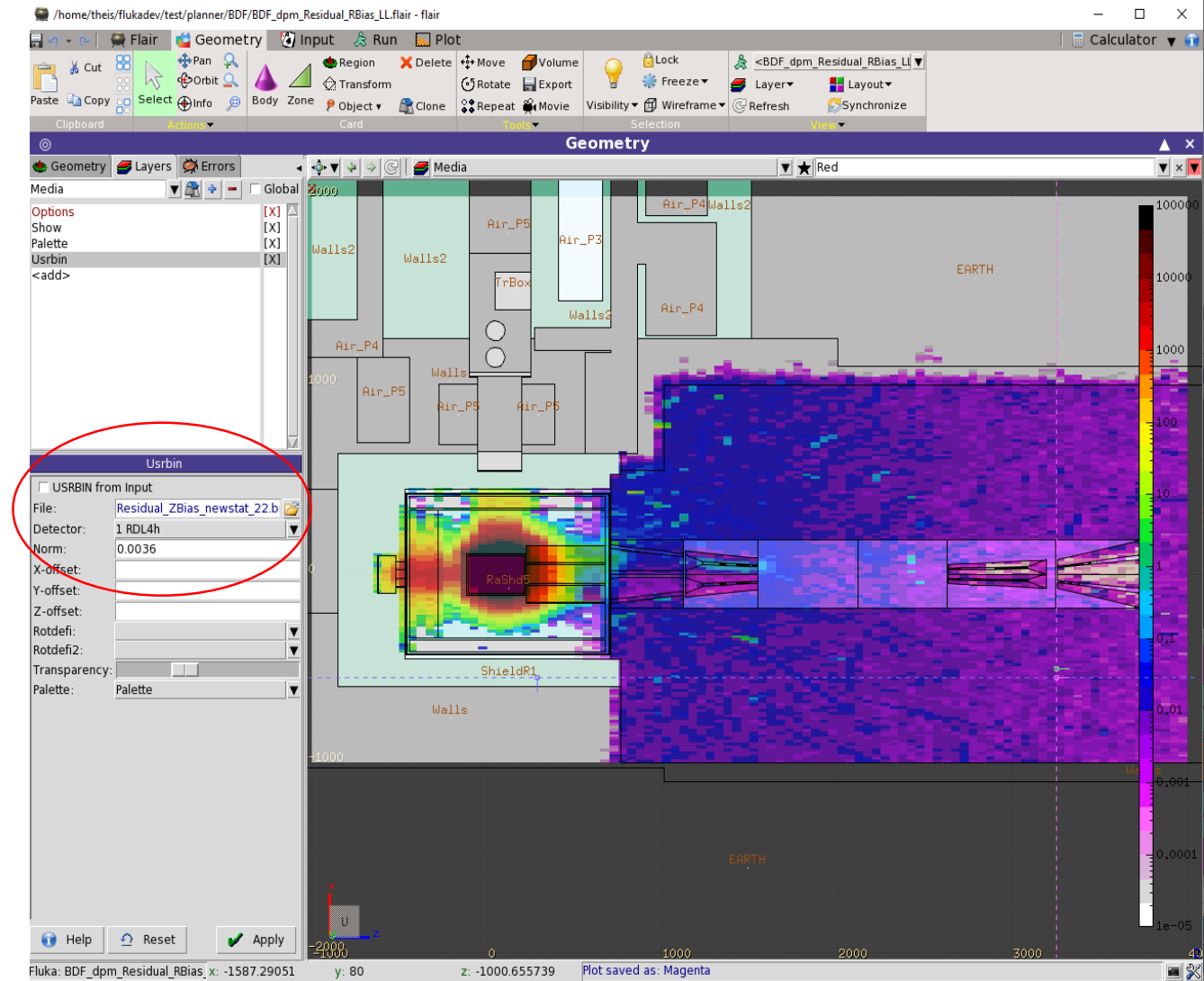
In the geometry editor:

- In the USRBIN options select a file containing the residual dose rate data or use an existing scoring

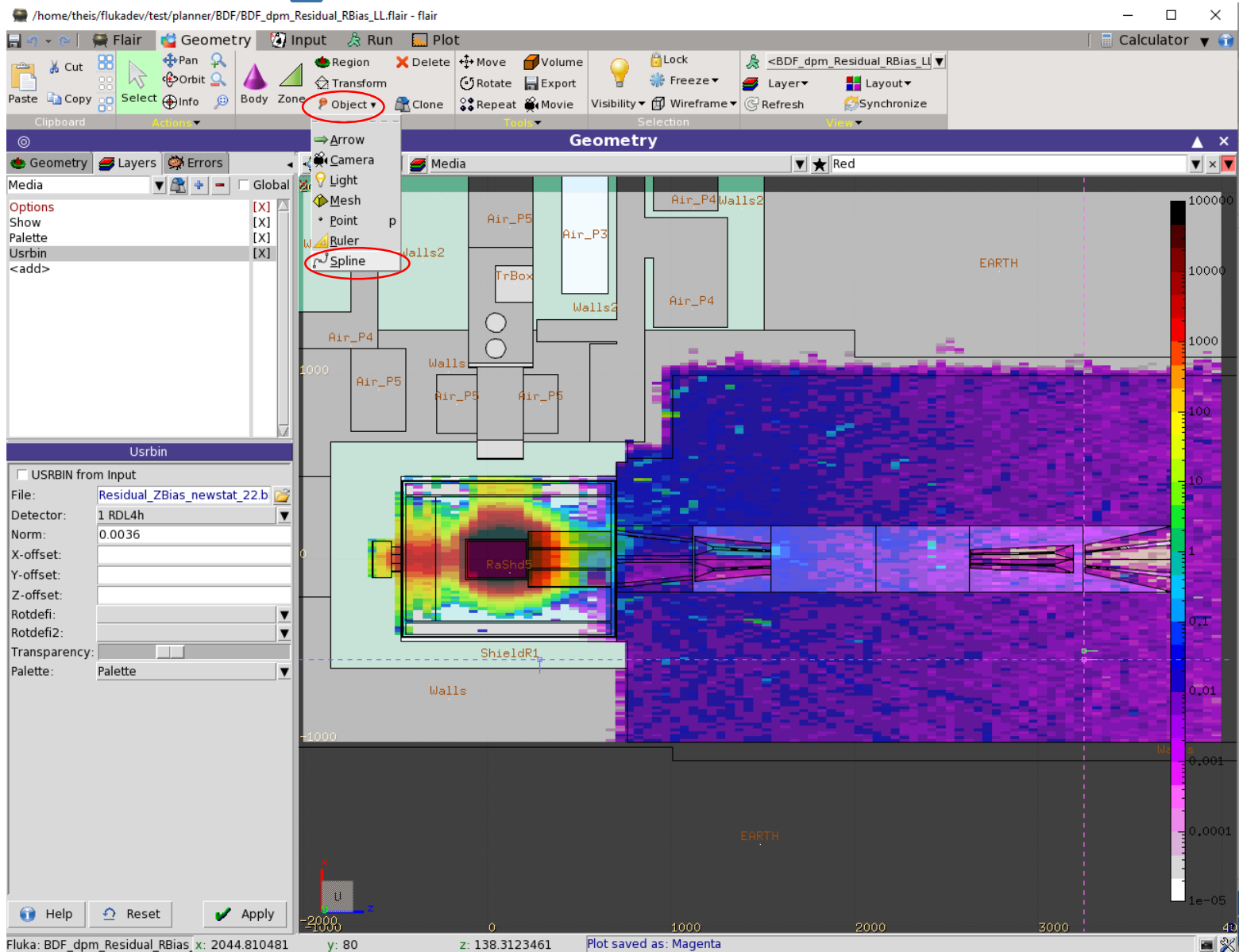
!!ATTENTION!!

In FLUKA the canonical time unit is in seconds and integration is done in this time unit!!

If you want to convert from pSv to uSv, then your normalization factor must be $1E-6$. The conversion of the dose rate from s^{-1} to h^{-1} is done automatically in the reporting

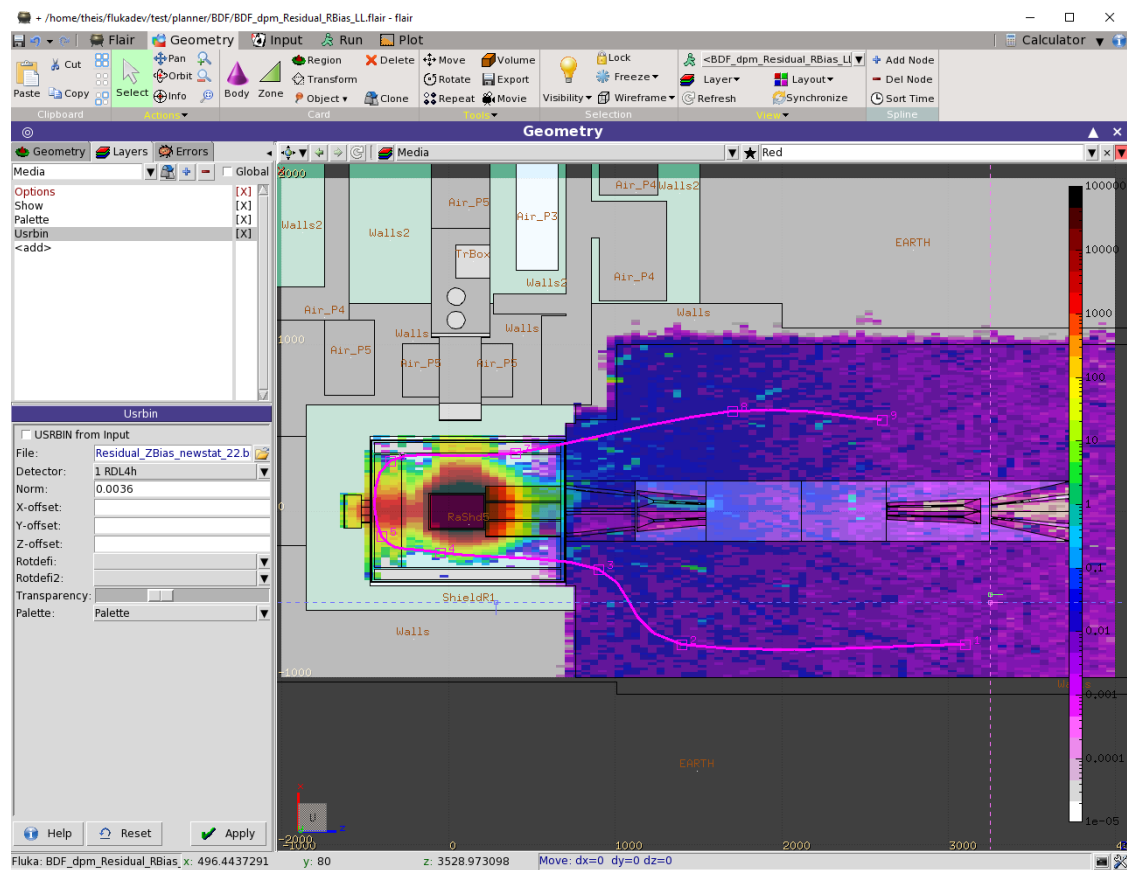


Creating an intervention workflow



- Select the menu “Object” -> “Spline”
- Select a viewpoint and use the left mouse button to define nodes of a spline
- Each node is consecutively numbered and can be edited at a later stage
- Use the right mouse button to finish the workflow
- In addition to the graphical representation a corresponding card is automatically created and saved in the input file

Creating an intervention workflow



Graphical representation

```

:spline spline
      Xc: -800.0      Yc: 80.0      Zc: 3100.0
      option: Spline  anchor: 0      color: 0
      tension:      # segments:

# node(s): 9
node:1.t: 0.0      x: 0.0      y: 0.0      z: 0.0
node:2.t: 1.0      x: -1.1368683772161603e-13 y: 0.0      z: -1700.0
node:3.t: 2.0      x: 450.0      y: 0.0      z: -2200.0
node:4.t: 3.0      x: 550.0      y: 0.0      z: -3150.0
node:5.t: 4.0      x: 650.0      y: 0.0      z: -3500.0
node:6.t: 5.0      x: 1100.0      y: 0.0      z: -3450.0
node:7.t: 6.0      x: 1150.0      y: 0.0      z: -2700.0
node:8.t: 7.0      x: 1400.0      y: 0.0      z: -1400.0
node:9.t: 8.0      x: 1350.0      y: 0.0      z: -500.0
  
```

Parametrization via cards which are pre-created via the graphical editor

Creating an intervention workflow

The image shows a text editor window displaying a spline definition. The text is as follows:

```
:spline spline
Xc: -800.0 Yc: 80.0 Zc: 3100.0
option: Spline anchor: 0 color: 0
tension: # segments:
# node(s): 9
node:1.t: 0.0 x: 0.0 y: 0.0 z: 0.0
node:2.t: 1.0 x: -1.1368683772161603e-13 y: 0.0 z: -1700.0
node:3.t: 2.0 x: 450.0 y: 0.0 z: -2200.0
node:4.t: 3.0 x: 550.0 y: 0.0 z: -3150.0
node:5.t: 4.0 x: 650.0 y: 0.0 z: -3500.0
node:6.t: 5.0 x: 1100.0 y: 0.0 z: -3450.0
node:7.t: 6.0 x: 1150.0 y: 0.0 z: -2700.0
node:8.t: 7.0 x: 1400.0 y: 0.0 z: -1400.0
node:9.t: 8.0 x: 1350.0 y: 0.0 z: -500.0
```

Callouts point to various parts of the text:

- Name**: Points to the word `spline`.
- Origin**: Points to the coordinates `Xc: -800.0 Yc: 80.0 Zc: 3100.0`.
- Number of nodes**: Points to `# node(s): 9`.
- Absolute time* when the worker will reach this node**: Points to the `.t:` values for each node.
- Position of the node**: Points to the `x:`, `y:`, and `z:` coordinates for a node.

All parameters can be edited in the text editor but positions can also be changed interactively in the geometry editor

* default unit is seconds

Creating an intervention workflow

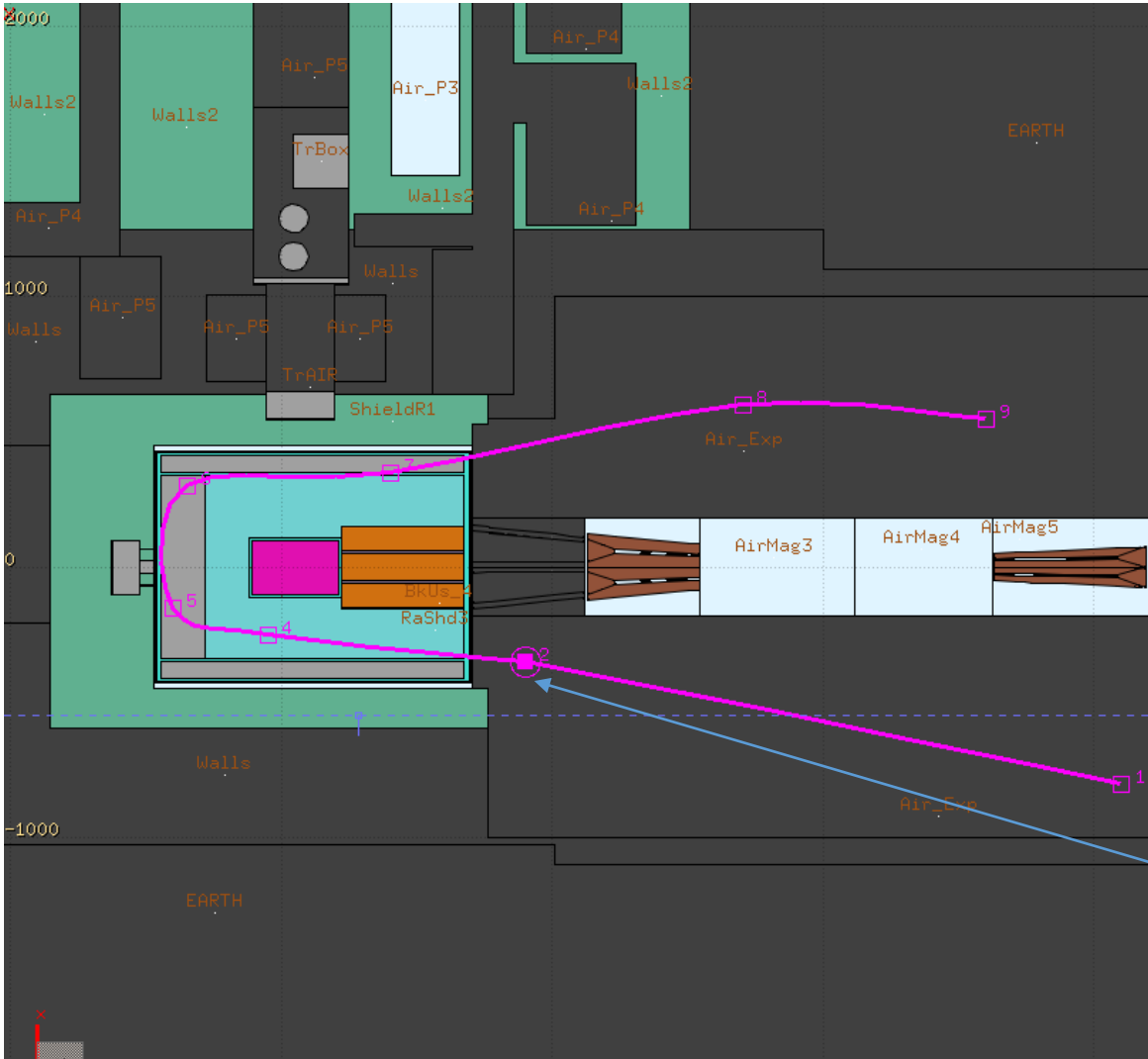
```
:spline spline
  Xc: -800.0      Yc: 80.0      Zc: 3100.0
  option: Spline ▼ anchor: 0      color: 0
  tension:      # segments:

# node(s): 9 ▼
node:1.t: 0.0      x: 0.0      y: 0.0      z: 0.0
node:2.t: 1.0      x: -1.1368683772161603e-13 y: 0.0      z: -1700.0
node:3.t: 2.0      x: 450.0      y: 0.0      z: -2200.0
node:4.t: 3.0      x: 550.0      y: 0.0      z: -3150.0
node:5.t: 4.0      x: 650.0      y: 0.0      z: -3500.0
node:6.t: 5.0      x: 1100.0      y: 0.0      z: -3450.0
node:7.t: 6.0      x: 1150.0      y: 0.0      z: -2700.0
node:8.t: 7.0      x: 1400.0      y: 0.0      z: -1400.0
node:9.t: 8.0      x: 1350.0      y: 0.0      z: -500.0
```

- By default the worker is moving between different nodes and the velocity is calculated based on the different times of arrival that have been specified
- In order to model a **workplace** where the worker is remaining for a **period of time to do some work two consecutive nodes** need to be defined with a **different time but an identical position**.
- The identical position can also be defined in the geometry editor by selecting a node and dropping it on its subsequent or previous neighbor. Such a **“workplace”** will be **symbolized with a circle** around the node.

* default unit is seconds

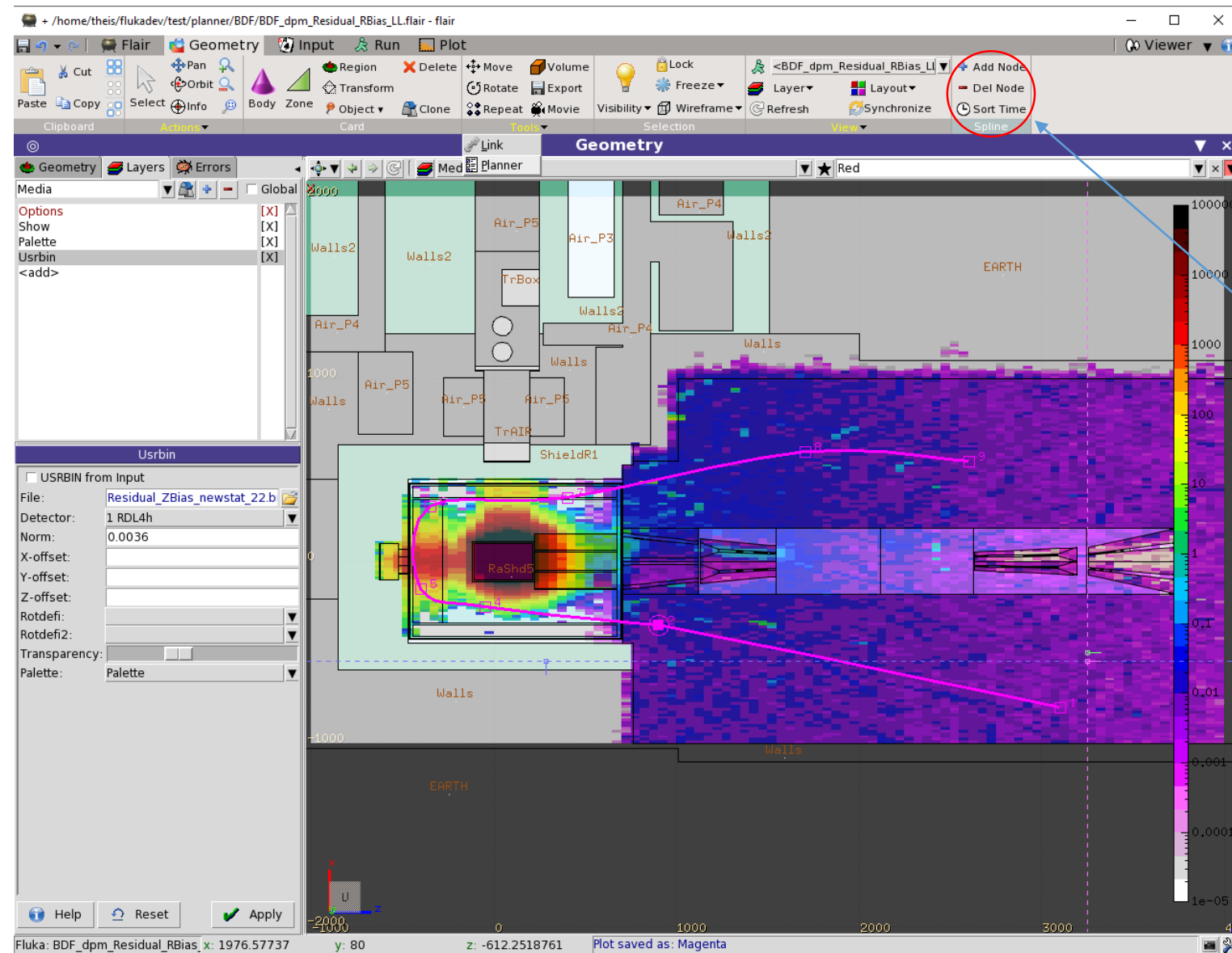
Creating an intervention workflow



:spline ¹ spline		X ¹	Y ¹	Z ¹
option:	Spline ▾	-800.0	80.0	3100.0
tension:			anchor: 0	color: 0
# segments:				
# node(s):	9 ▾			
node:1.t:	0.0	x: 0.0	y: 0.0	z: 0.0
node:2.t:	600.0	x: 450.0	y: 0.0	z: -2200.0
node:3.t:	1800.0	x: 450.0	y: 0.0	z: -2200.0
node:4.t:	3600	x: 550.0	y: 0.0	z: -3150.0
node:5.t:	3800	x: 650.0	y: 0.0	z: -3500.0
node:6.t:	4000	x: 1100.0	y: 0.0	z: -3450.0
node:7.t:	4200	x: 1150.0	y: 0.0	z: -2700.0
node:8.t:	4400	x: 1400.0	y: 0.0	z: -1400.0
node:9.t:	4600	x: 1350.0	y: 0.0	z: -500.0

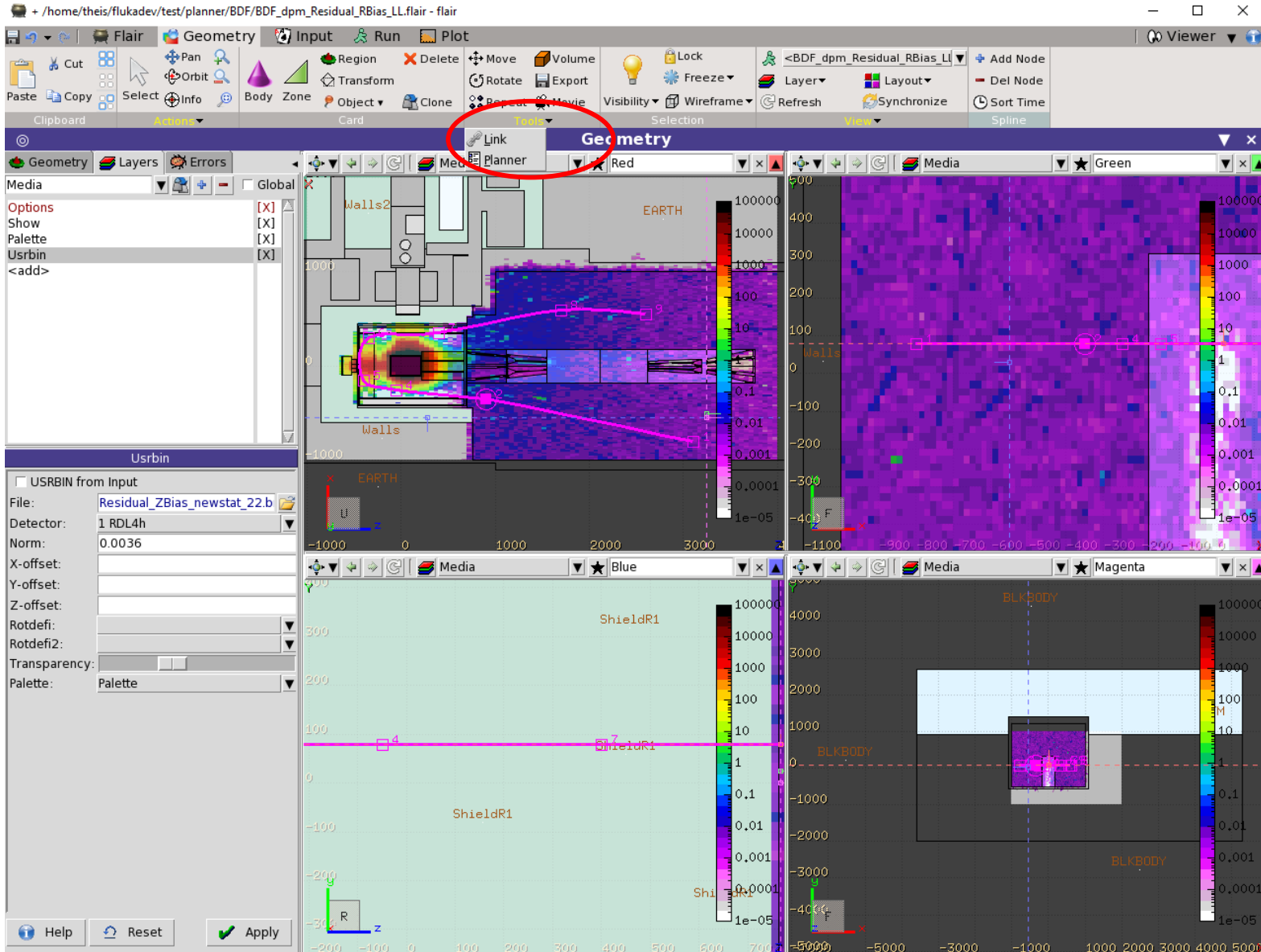
Workplace for
(1800 – 600) =
1200 seconds

Editing of an intervention workflow



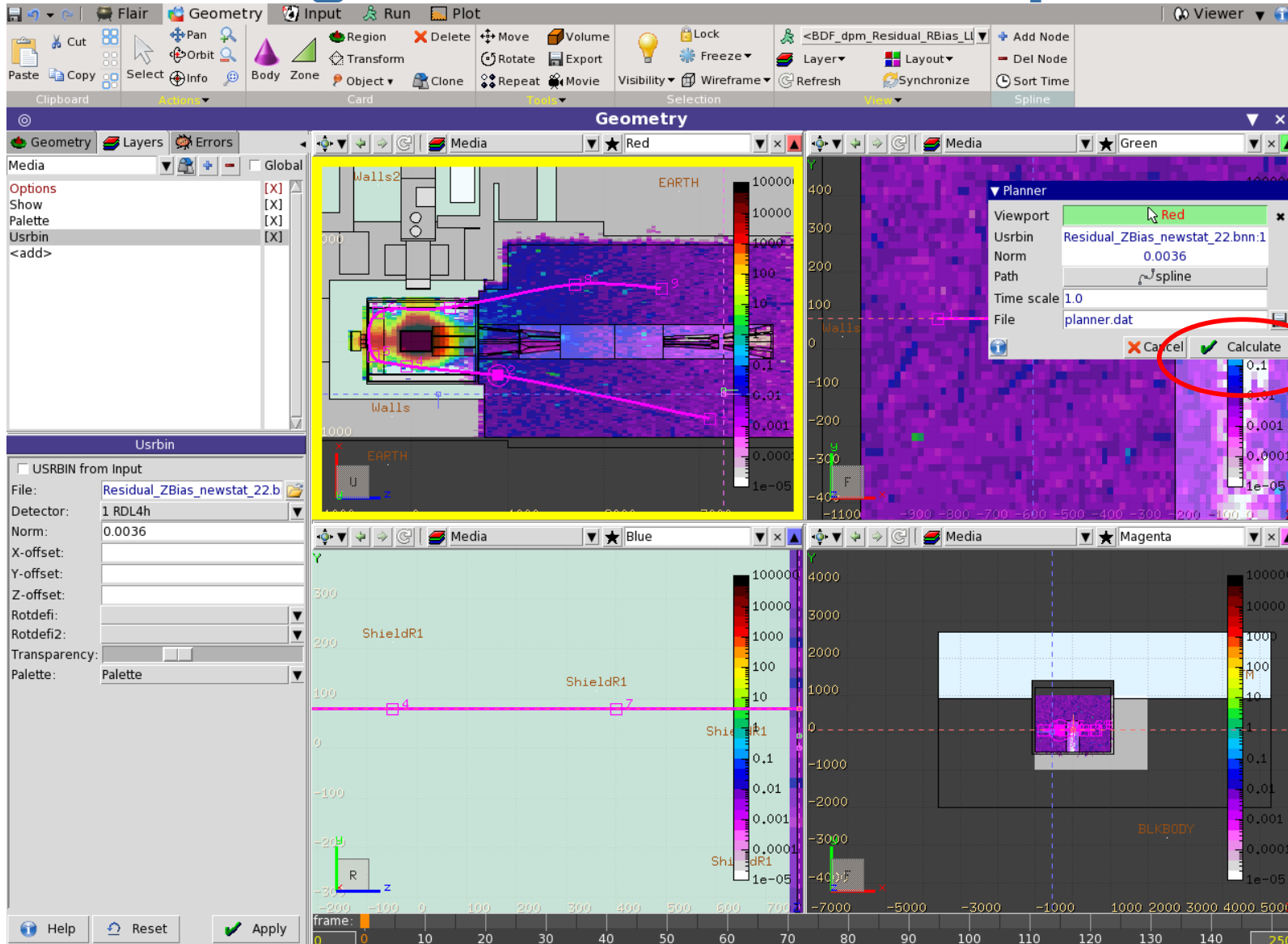
- Nodes can be selected and moved individually
- The whole spline can be selected and displaced as a whole
- New nodes can be added or existing nodes deleted via the “spline” tab in the menu which appears when a spline is selected

Creating an intervention report



- Clicking on the down-arrow in the “Tools” tab will open a context menu
- Select “Planner”

Creating an intervention report



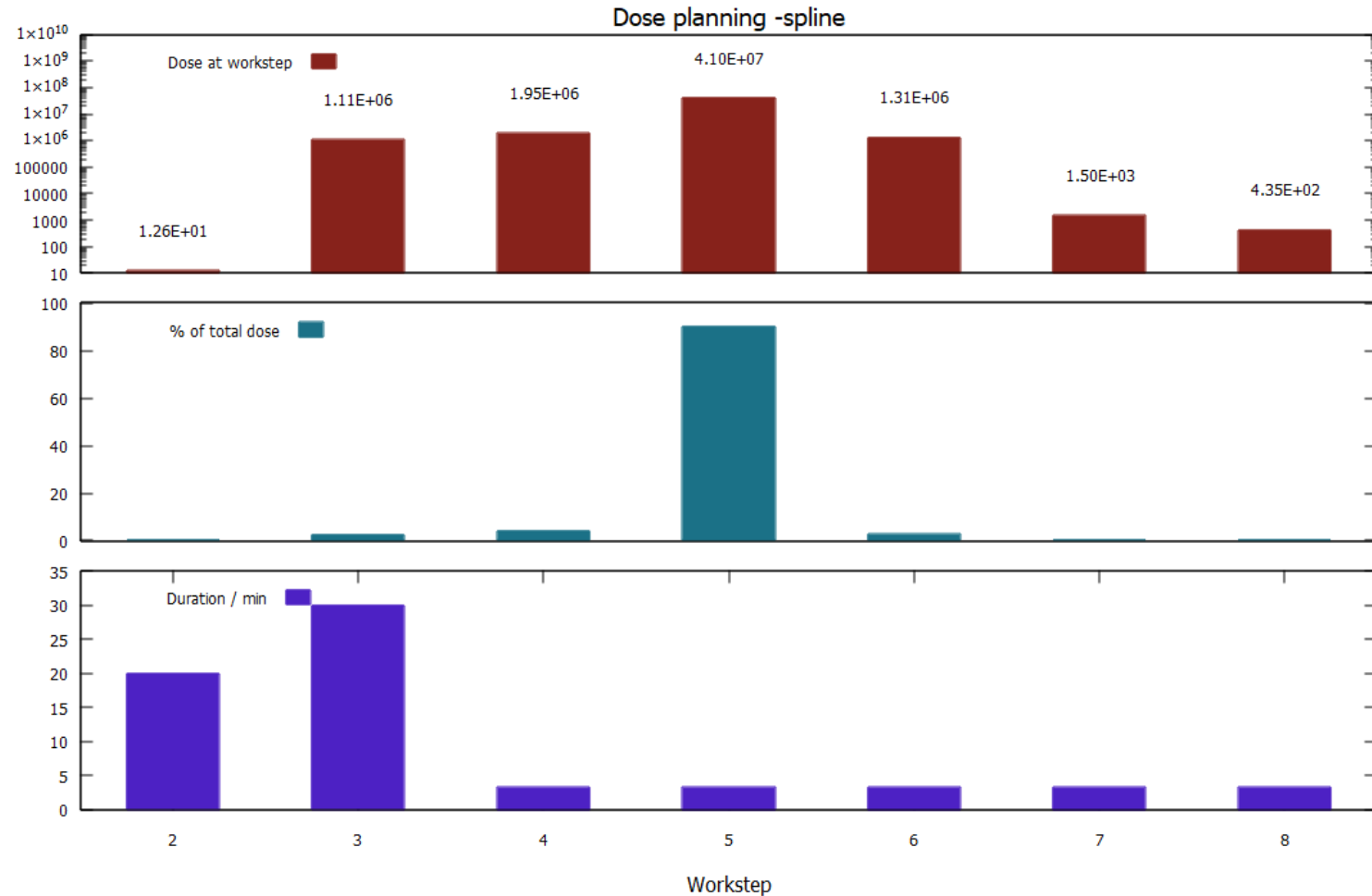
- Select the viewport which will flash in yellow
- Select the path for which the dose report should be calculated and press “Calculate” in the dialog that has opened.

Creating an intervention report

```
#####  
#  
# /\ For graphical representation please load this file in GNUPLOT > 5.0 /\  
#  
#####  
#  
# Planner  
# Report date:      2020-03-12 13-18-58  
# Workflow :       spline  
# Usrbin File:     Residual_ZBias_newstat_22.bnn  
# Name:           RDL4h [1]  
# Norm:           0.0036  
# Nodes:          9  
# Total time:      76.6667 min  
# Total length:    70.4501 m  
# Integral dose:   4.53974e+07  
# Total dose while moving: 4.53974e+07 (100%)  
# Total dose while working: 12.6255 (2.7811e-05%)  
#  
#  
#####  
#  
# I N T E R V E N T I O N   R E P O R T  
#  
#####  
# step   abs. time (s)   Dose           duration (s)   speed (cm/s)  
#-----  
# 1       600.0         1.5426e+03     600.0         3.74  
# 2       1800.0        1.2625e+01     1200.0        0.00  
# 3       3600.0        1.1053e+06     1800.0        0.53  
# 4       3800.0        1.9481e+06     200.0         1.89  
# 5       4000.0        4.1029e+07     200.0         2.41  
# 6       4200.0        1.3119e+06     200.0         3.78  
# 7       4400.0        1.4989e+03     200.0         6.62  
# 8       4600.0        4.3484e+02     200.0         4.51  
#-----
```

- This will create a textual summary report
- The report can be saved and directly loaded in GNUPLOT (version ≥ 5.0 only!!) to obtain a graphical representation

Creating an intervention report



The created GNUPLOT script can be customized easily by the user

Please note that versions prior to GNUPLOT 5 will unfortunately not work

Integral dose: 4.5397e+07
Total dose while moving: 4.5397e+07 (1.0000e+02%)
Total dose while working: 1.2625e+01 (2.7811e-05%)