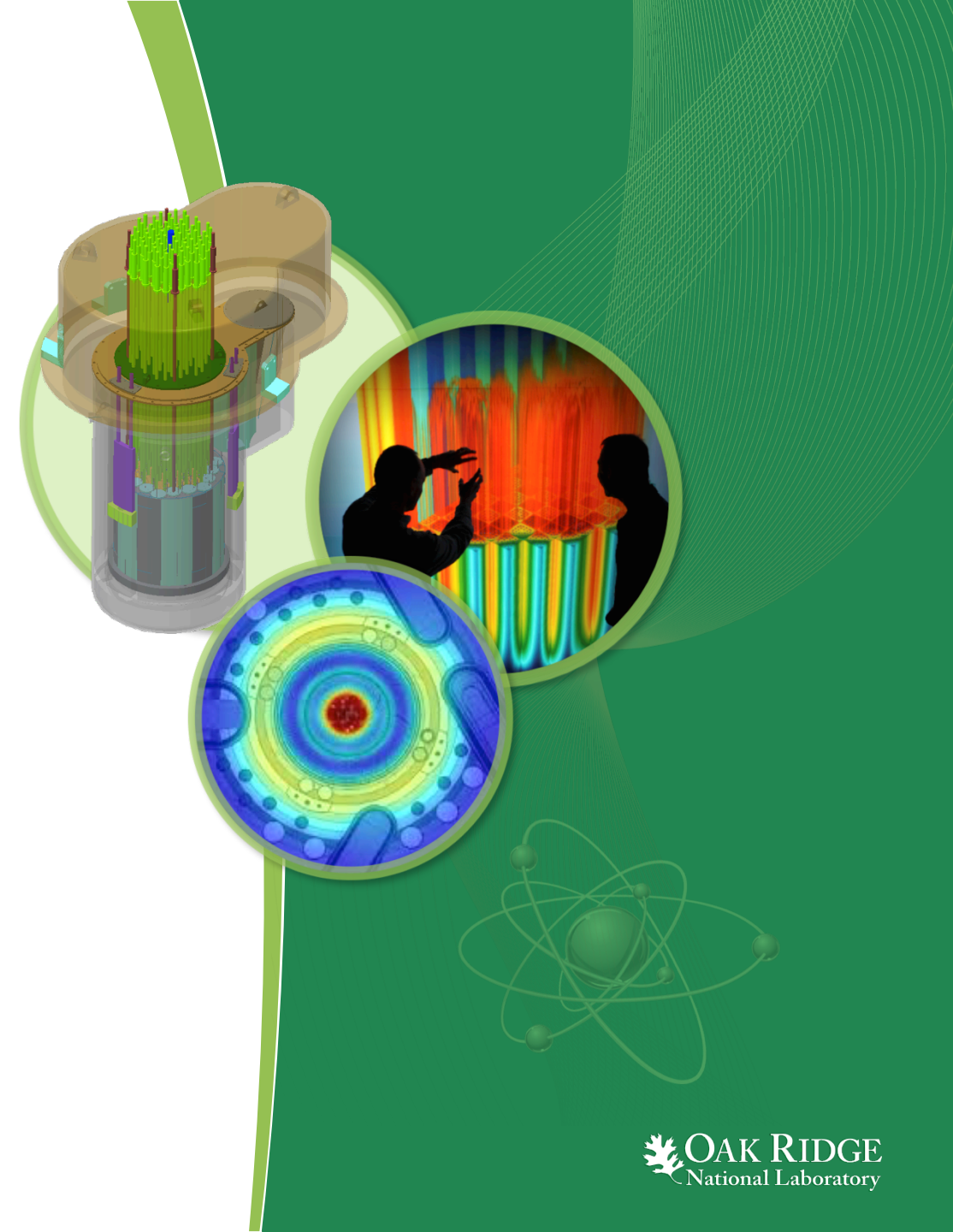


# Fulcrum: Integrated Graphical User Interface in SCALE

## Capability Overview

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# Presentation Outline

- Mission Statement
- Component Overview
- Input Editor
- Data Plotting
- Geometry Visualization

# Fulcrum Mission Statement

Provide a cross-platform graphical user interface (GUI) designed to facilitate problem creation, modification, navigation, validation, and visualization, as well as output and data file interaction as needed by new and experienced users.



# Fulcrum Component Overview

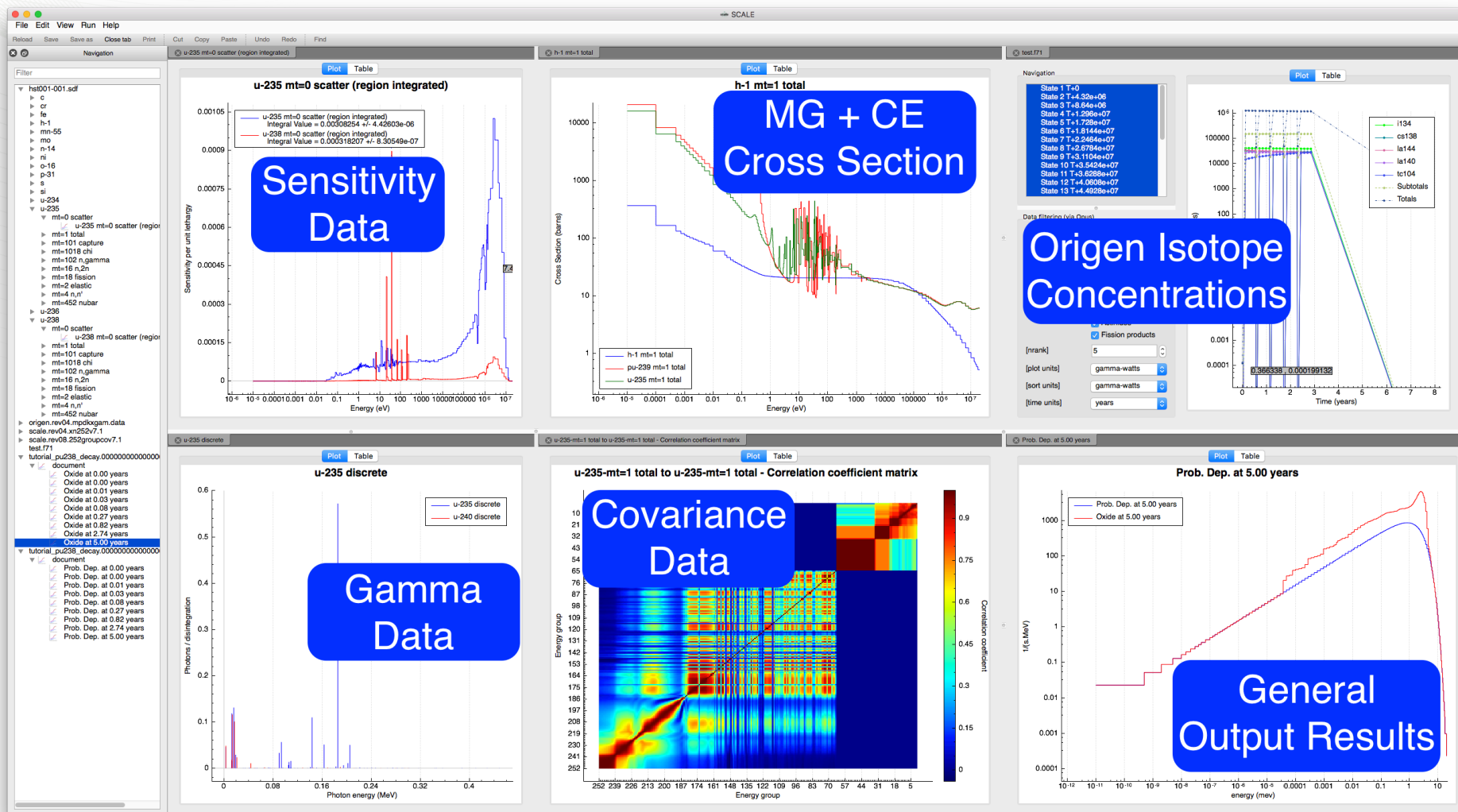
The screenshot displays the SCALE software interface with several key components highlighted:

- Input Editor:** A central window showing a list of geometric objects and their properties. The selected line is 2228: `2228 | cylinder 3 1.416050 19.290000 0. origin x=0.736600 y=0.736600`.
- Document Navigation:** A sidebar on the left showing a tree view of the document structure, including 'TSC-24-TSC-9\_bounding\_NCTDoseRate', 'document', 'shell', 'mavric', and 'geometry'.
- Data Plot:** A plot titled 'radial axis plot at a=6.1098, b=-1.9435 generated on Thu Jul 28 17:01:33 2016'. The y-axis is 'Responses' (log scale, 0.1 to 10^5) and the x-axis is 'radial axis' (0 to 320). A single data series 'Response 1' is plotted as black dots.
- Geometry Viewer:** A 3D visualization of the reactor geometry, showing a central core with a color-coded response distribution. A legend on the left shows response ranges from 1.82e+03 to 2.35e-03.

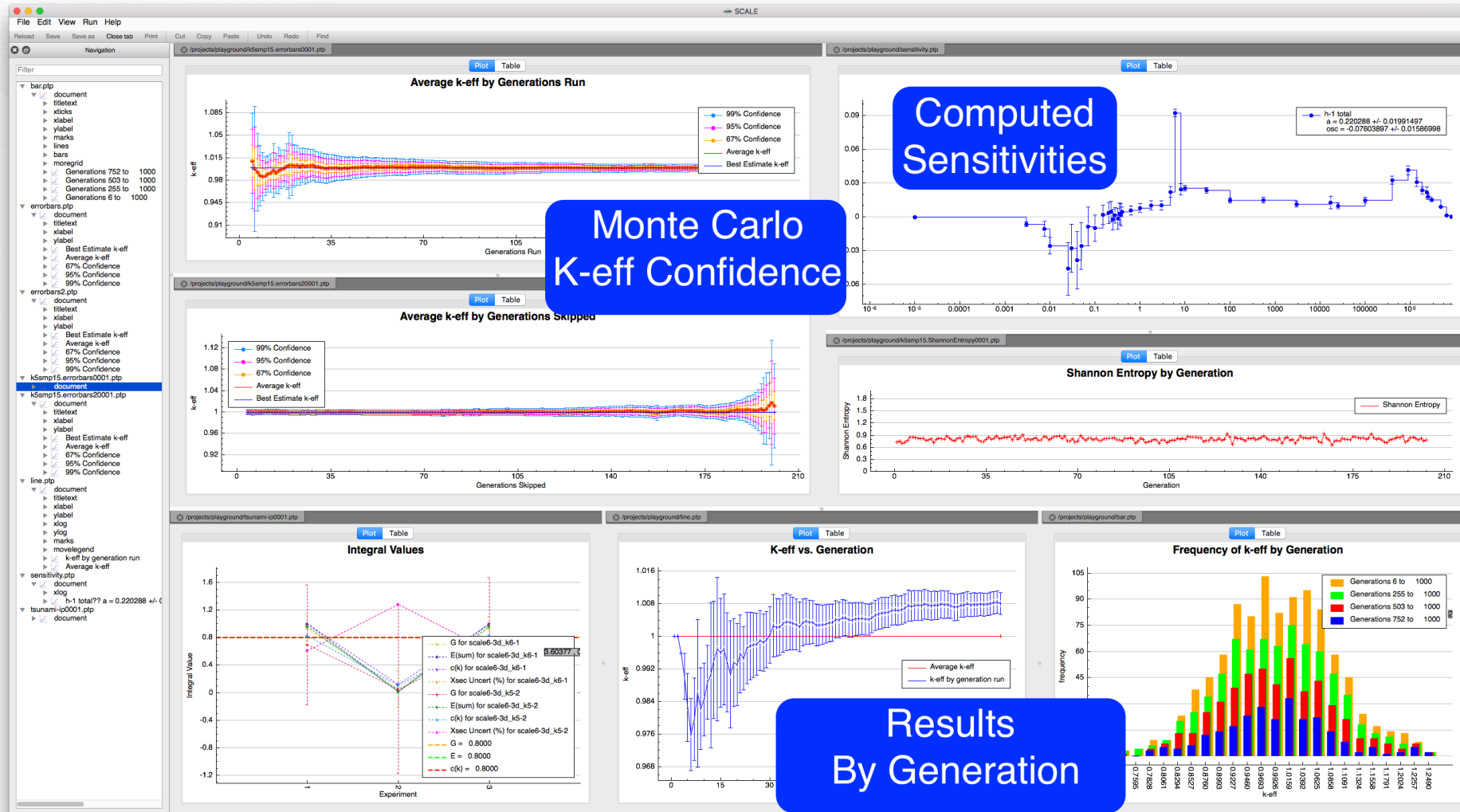
# Fulcrum Plot Data

- Supports Most Major SCALE Data Formats

- Export to Image (supports scalar vector graphics)

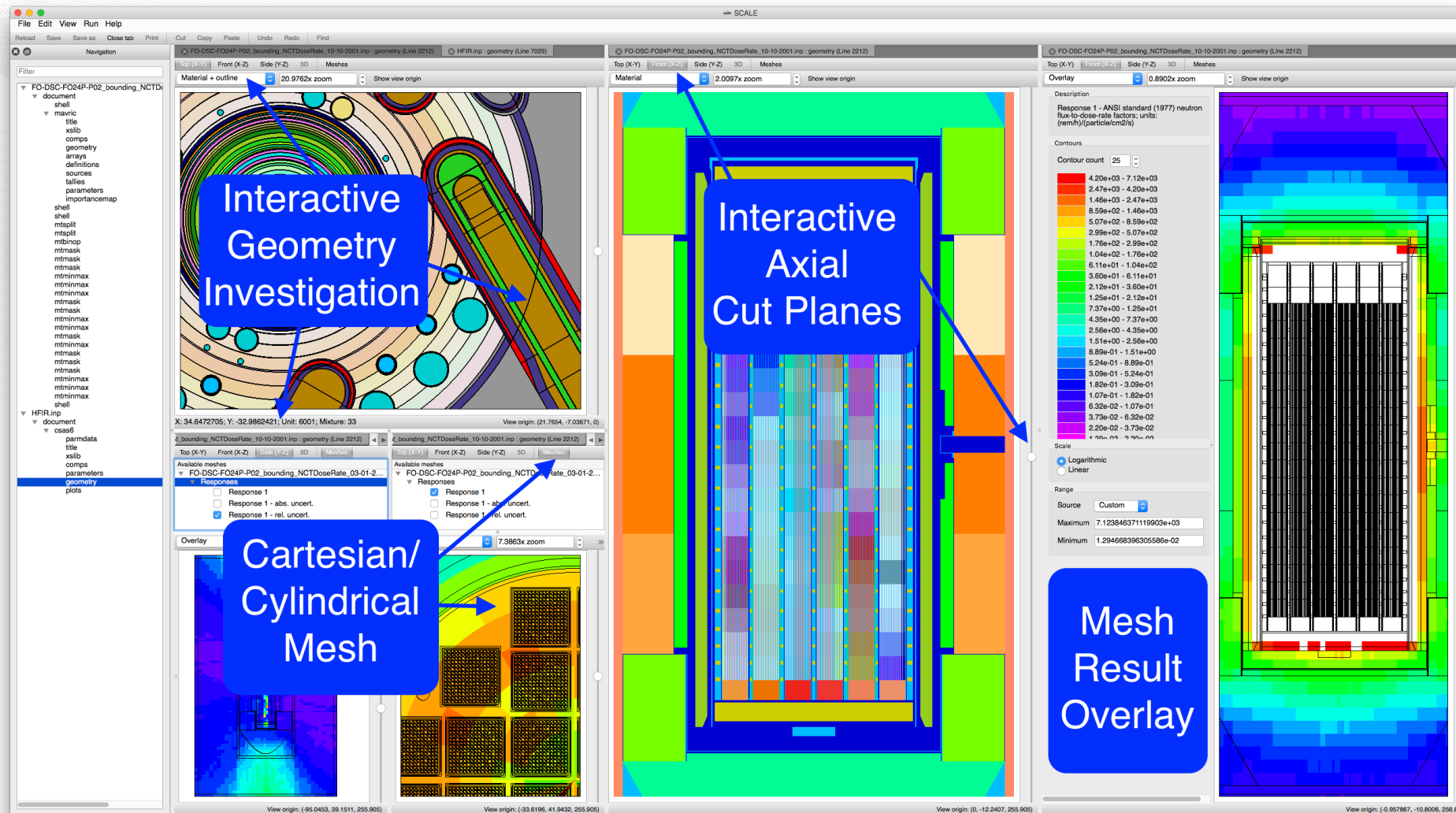


# Fulcrum General Output Result Plots



# Fulcrum Geometry Visualization

- Interactive Geometry Visualization
- Support for Most Mesh Data\*



\*Currently Support: 3dmap, Mesh Importance Map, Mesh Source Map, and Denovo Flux File

# Component Summary

- Input editor facilitates problem creation, modification, navigation, validation, execution and output file viewing in a consistent, platform independent manner.
- Data plotting facilitates a fast, interactive means of interrogating input and output data.
  - Supports most SCALE data formats.
- Geometry viewer facilitates a fast, interactive means of interrogating SCALE Geometry.
- Fulcrum provides a modular workspace with splitting and drag-and-drop configurable layout.



# Fulcrum Input Editor Components

The screenshot displays the Fulcrum Input Editor interface, which is a multi-pane application for editing and executing input files. The main window is titled "SCALE 6.2" and contains a code editor with a list of geometric shapes and their parameters. A secondary window shows the execution output, including a table of results and a list of sources. A third window displays a validation error message. The interface is annotated with several callouts:

- Customizable Execution:** Points to the "Run" button in the top menu bar.
- Document Quick Navigation:** Points to the "document" dropdown menu in the top bar.
- Context Aware Input Autocompletion:** Points to the list of shapes in the left pane.
- Synchronized Input Text Editor:** Points to the main code editor area.
- Cursor Context:** Points to the highlighted line in the code editor.
- Execution Messages:** Points to the output window showing the results of the execution.
- Syntax Highlights:** Points to the highlighted text in the code editor.
- Input Block Highlights:** Points to the highlighted block in the code editor.
- Input Validation:** Points to the validation error message at the bottom.

```
34 global unit 1
35 cylinder 1 8.255 25.40 -25.40
36 cylinder 2 10.795 27.94 -27.94
37 cylinder 3 20.955 27.94 -27.94
38 cylinder 4 13.335 40.64 30.48
39 cylinder 5 13.335 -30.48 -40.64
40 cylinder 6 35.56 45.72 -45.72
41
42 cone - kenovi (configurable) 2.4 -152.4
43 cone
44
45
46
47
48
49
50
51
52
53 end geom
54 dodecahedron - kenovi (configurable)
55 dodecahedron
56 'Defini
57 ellipsoid - kenovi (configurable)
58 hexprism - kenovi (configurable)
59 read def
60 hopper - kenovi (configurable)
61 hopper
62 parallelepiped - kenovi (configurable)
63 end parallelepiped
64 pentagon - kenovi (configurable)
65 dist pentagon
66 plane - kenovi (configurable)
67 plane
68 end xplane
69 yplane
70 zplane
71 grid quadratic - kenovi (configurable)
72 quadratic
73 rhexprism
74 rhomboid - kenovi (configurable)
75 rhomboid
76 ring - kenovi (configurable)
77 ring
78 sphere - kenovi (configurable)
79 sphere
80 end geometry
```

```
43
44
45
46 MAVRIC, part 2, writing the forward discrete ordinates input
47 *****
48
49 constructMacroMaterialRAYS (46 x-bins, 46 y-bins)
50
51 Total numMacros: 23
```

```
Line: 118, Col: 15 /mavric/tallies/meshTally/unit/value Validation Messages
```

```
89 linear 30 0.00e6 1.50e6
90 bounds 0.510e+6 0.512e+6 1.172e6 1.174e6 1.331e6 1.333e6 end
91 end energyBounds
92 end definitions
93
94
95 'Sources Block
96
97 read sources
98 src 1
99 title="one of 5 cobalt-60"
100 useNormConst
101 multiplier=37e9
102 cylinder 8.255 25.40 -25.40
103 photons
104 eDistributionID=1
105 end src
106 end sources
107
108
109 'Tallies Block
110 ' only collect mesh tally information outside the package (in air region)
111 ' multiplier converts responses from rem/hr to mrem/hr
112
113 read tallies
114 meshTally 1
115 photon
116 gridGeometryID=8
117 responseID=5
118 unit=1 region=7
119 energyBoundsID=1
```

```
line:49 column:22 - Validation Error: region value "30" does not exist in set: [.././../cone/id
.././cuboid/id
.././cylinder/id
.././dodecahedron/id
.././ecylinder/id
.././ellipsoid/id
.././hexprism/id
.././hopper/id
.././parallelepiped/id
.././pentagon/id
.././plane/id
.././quadratic/id
.././rhexprism/id
.././rhomboid/id
.././ring/id
.././sphere/id
.././wedge/id
.././xplane/id
.././yplane/id
.././zplane/id]
```

```
Line: 41, Col: 9 /mavric/geometry/global_unit Validation Messages
```

```
Line: 105, Col: 11 /mavric/sources/source/term Validation Messages
```

# Input Autocompletion : Static Text

- Static text autocompetition also facilitates abbreviated input to include the component's description allowing users to discover and/or more quickly recall the necessary input components for their analysis.
- Cursor context allows the autocompletion popup to show what is legal and has not already been specified.

Access Autocomplete via  
\* CTRL+SPACE Keys, or,  
\* Edit...>Autocomplete

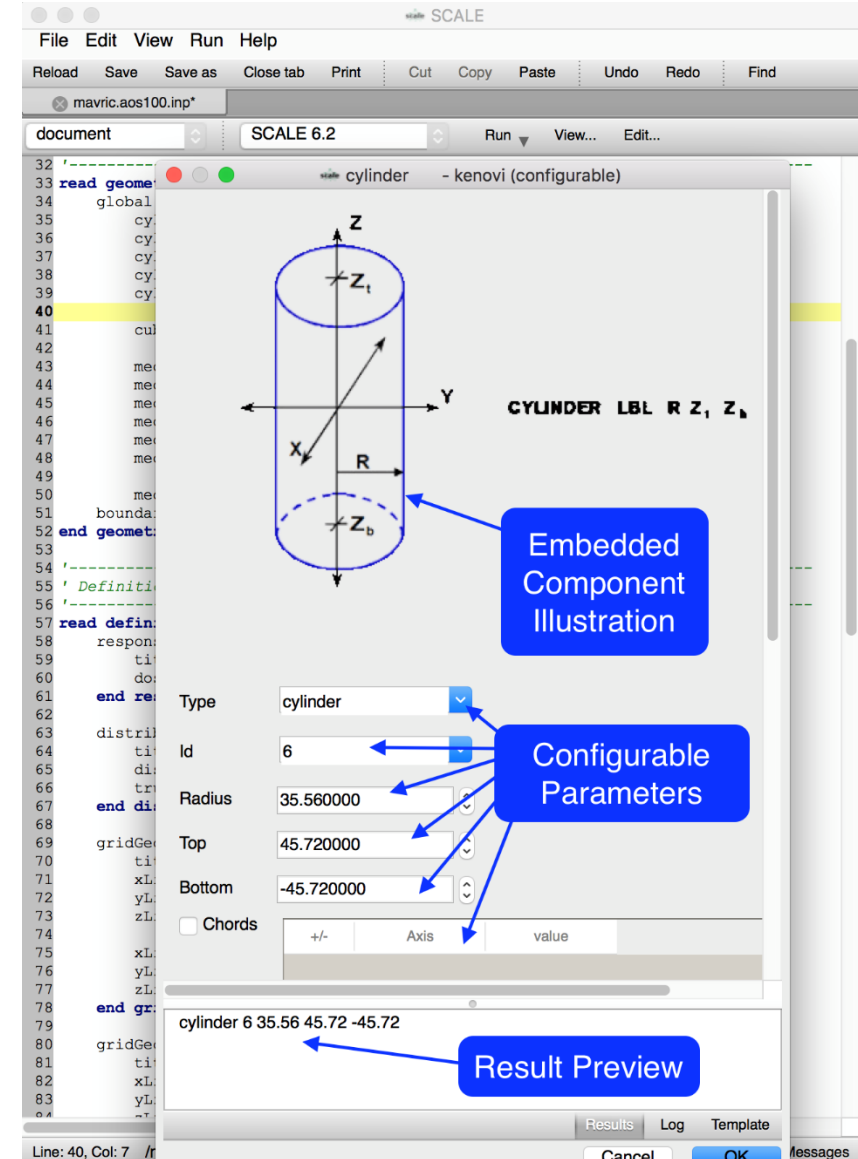
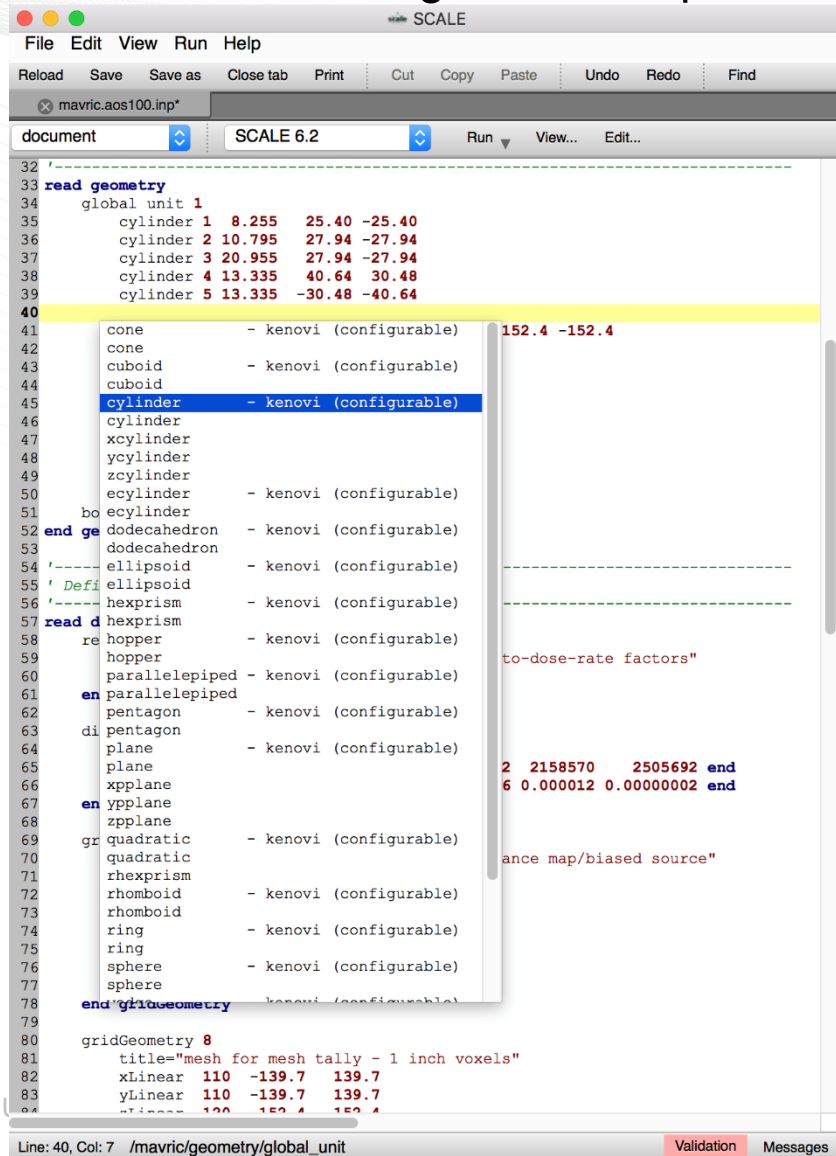
```
File Edit View Run Help
Reload Save Save as Close tab Print Cut Copy Paste Undo Redo Find
csas6_7.inp*
document SCALE 6.2 Run View... Edit...
24 uranium 10 den=18.76 1 293 92235 93.2 92238 5.6 92234 1.0 92236 0.2 end
25 uranium 11 den=18.76 1 293 92235 93.2 92238 5.6 92234 1.0 92236 0.2 end
26 uranium 12 den=18.76 1 293 92235 93.2 92238 5.6 92234 1.0 92236 0.2 end
27 uranium 13 den=18.76 1 293 92235 93.2 92238 5.6 92234 1.0 92236 0.2 end
28 uranium 14 den=18.76 1 293 92235 93.2 92238 5.6 92234 1.0 92236 0.2 end
29 end comp
30 read param
31 pgm=yes plt=yes
32 end param
33 read geom
34 global unit 1
35 *** one through t wta
36 'one top piece wth
37 cuboid 10 2p6.3 wtl
38 'two middle pie sig
39 cuboid 20 2p6.3 msh
40 'three bottom pie ttl
41 cuboid 30 4p6.3 dbh
42 *** four is item dbl
43 cylinder 40 4.55 gen
44 *** five is item npg
45 cylinder 50 5.76 nsk
46 *** six is item 4 res
47 cylinder 60 4.55 nbk
48 *** seven and eig xnb
49 'seven
50 cuboid 70 2p3. xfb
51 'eight
52 cylinder 80 4.57 beg
53 *** nine is item nb8
54 cylinder 90 4.55 nl8
55 *** ten is item 7 nqd
56 cylinder 100 5.7 ngp
57 *** eleven is ite pnm
58 cylinder 110 4.5 cxm
59 *12 through 14 is cep
60 'twelve
61 cylinder 120 5.7 fni
62 'thirteen
63 cuboid 130 4p6.3 dbx
64 'fourteen
65 sphere 140 6. flx
66 *** fifteen is th fdn
67 'fifteen
68 cuboid 150 4p2 ptb
69 media 1 1 +10
70 media 2 1 +20 -10
71 media 3
72 media 4
73 media 5
74 media 6
75 media 7
76 media 8
77 media 9
78 media 10
79 media 11
80 media 12
81 media 13
82 media 14
83 media 0
84 -110 -120 -130 -140 vol=31432.726088316
Line: 31, Col: 19 /csas6/parameters Validation Messages
```

Parameters with descriptions

# Input Autocompletion : Configurable Text

- Allows user to configure values prior to inserting into input.

Access Autocomplete via  
\* CTRL+SPACE Keys, or,  
\* Edit...>Autocomplete



# Input Autocompletion : Configurable Text

- Configurable autocompletion allows entire input creation.
- Results preview facilitates learning input syntax.
- Attributes can be labeled even when the actual input attribute may not have a label.
- Attributes can have a drop-down listing the available or common values to specify.

Access Autocomplete via  
\* CTRL+SPACE Keys, or,  
\* Edit...>Autocomplete

The screenshot displays the SCALE software interface. At the top, there is a menu bar with 'File', 'Edit', 'View', 'Run', and 'Help'. Below the menu bar, there are options for 'Reload', 'Save', 'Save as', 'Close tab', 'Print', 'Cut', 'Copy', 'Paste', and 'Undo'. The main window shows a configuration form for 'origami' with the following fields:

Field	Value
Title	this-is-my-title
Fuel Type	w17x17
Uranium (MTU)	1.0
Enrichment (Wt%U235)	4.5
Burnup (MWd/MTU)	40000
Cycles	3
Number of Burnup Interpolations per Cycle	4
Cooling Time (days)	1825
Power History - Percent Up	95
Power History - Average Power (MW/MTU)	40
Moderator Density (g/cc)	0.7332

A blue button labeled 'Results Preview' is positioned above a text area containing the following configuration code:

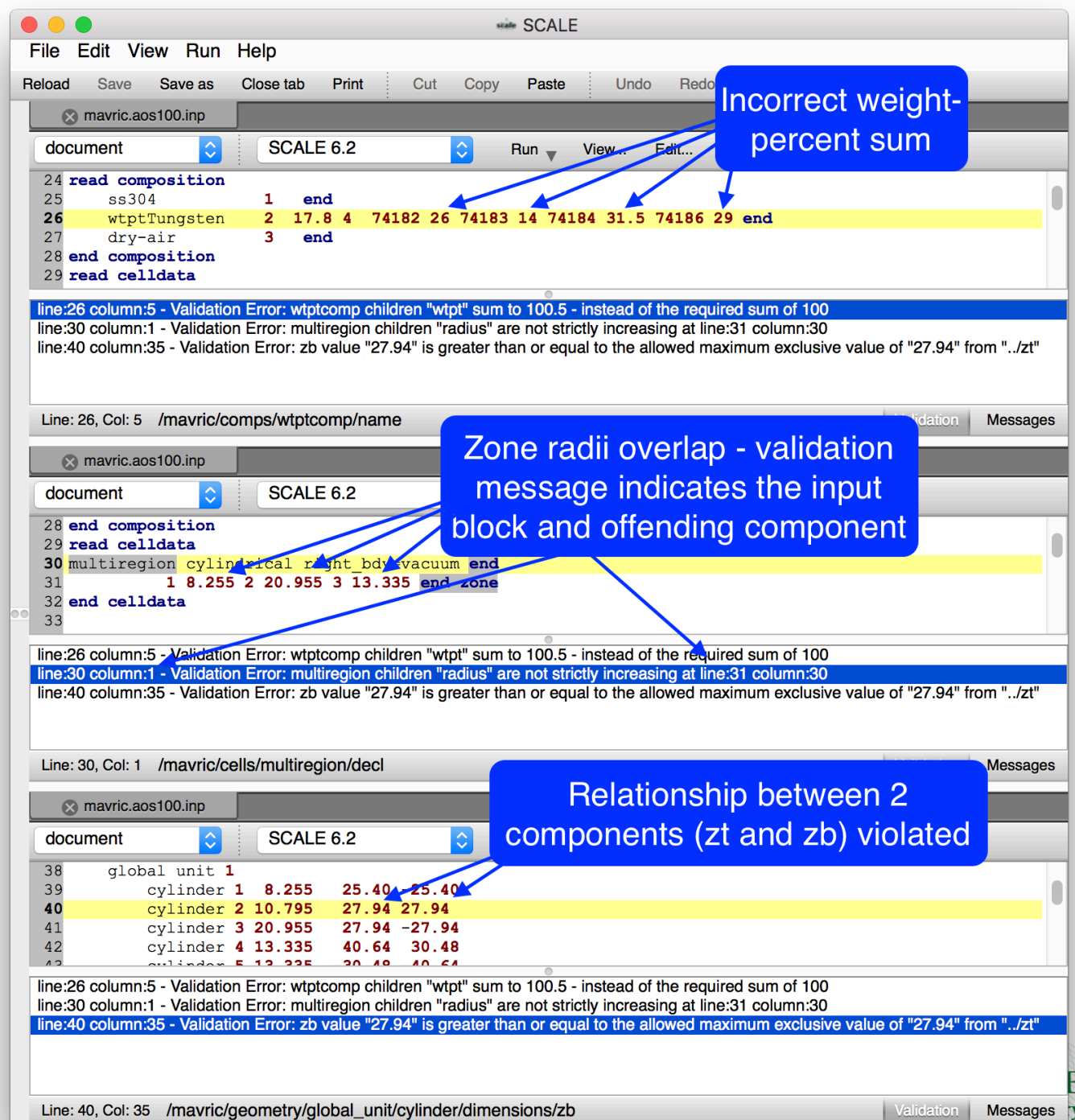
```
=origami
title="this-is-my-title"
options{ mtu=1.0 ft71=all}
libs=[ "w17x17" ]
fuelcomp{
  uox(fuel){ enrich=4.5 }
  mix(1){ comps=[ fuel=100 ] }
}
modz=[ 0.7332 ]
pz=[ 1.0 ]
hist[
  cycle{ power=40 burn=333.33 nlib=4 down=16.67 }
  cycle{ power=40 burn=333.33 nlib=4 down=16.67 }
  cycle{ power=40 burn=333.33 nlib=4 down=0 }
  cycle{ down=1825 }
]
end
```

At the bottom of the window, there are buttons for 'Results', 'Log', 'Template', 'Cancel', and 'OK'. The status bar at the very bottom shows 'Line: 1, Col: 1', 'Validation', and 'Messages'.

# Input Validation : Value Errors

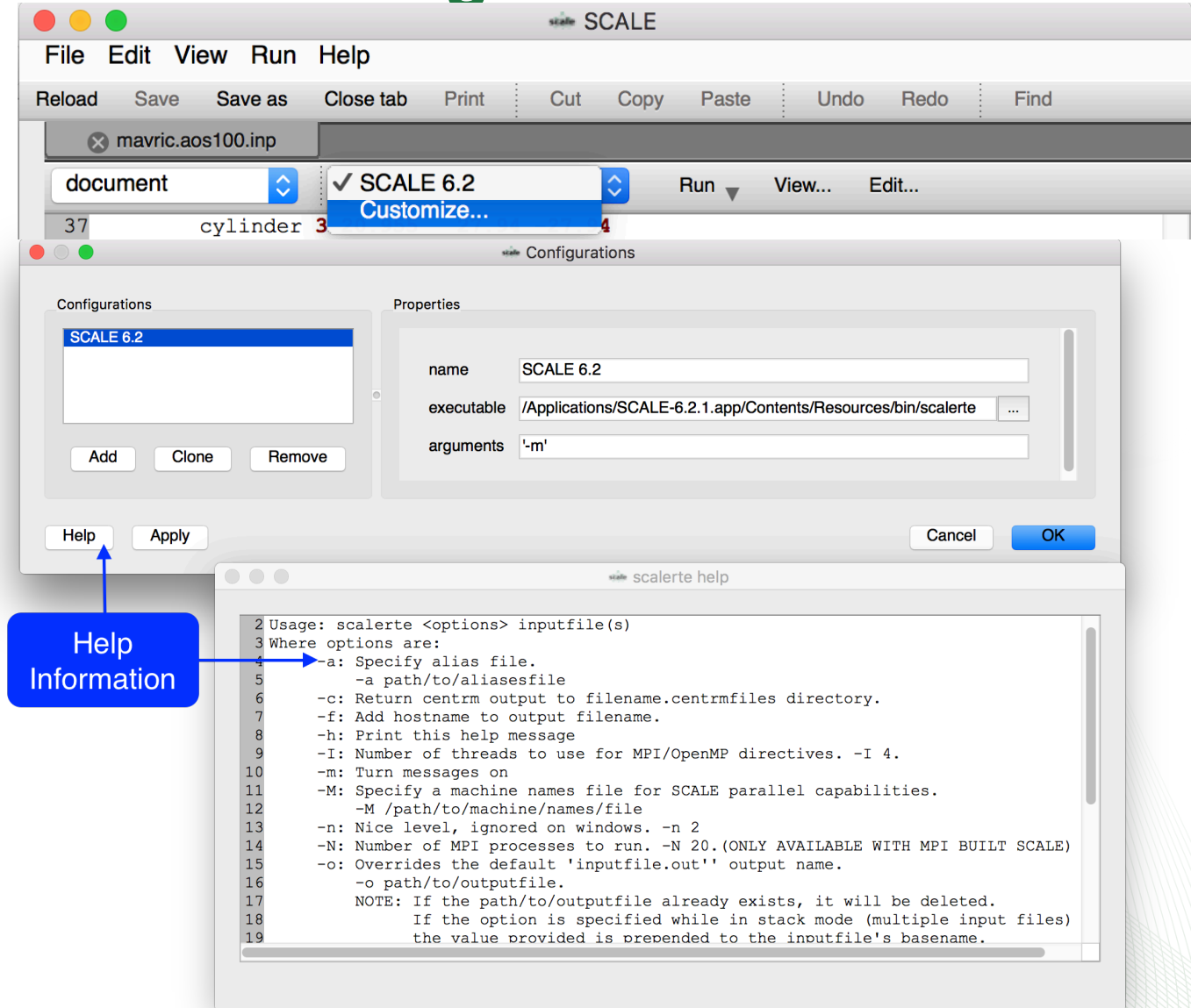
Value constraint errors can be hard to find. Input validation provides immediate feedback on the following.

- Simple value ranges
  - E.g.,  $0.0 < x \leq 100$
- More complex
  - Expected value sums
  - Expected value function (increasing, decreasing, etc.)
  - Component relationship
    - E.g.,  $X > Y$



# Input Execution : Customized Configurations

- Add new
- Clone existing
- Remove existing
- Modify existing
- Show executable help
- Provide additional arguments



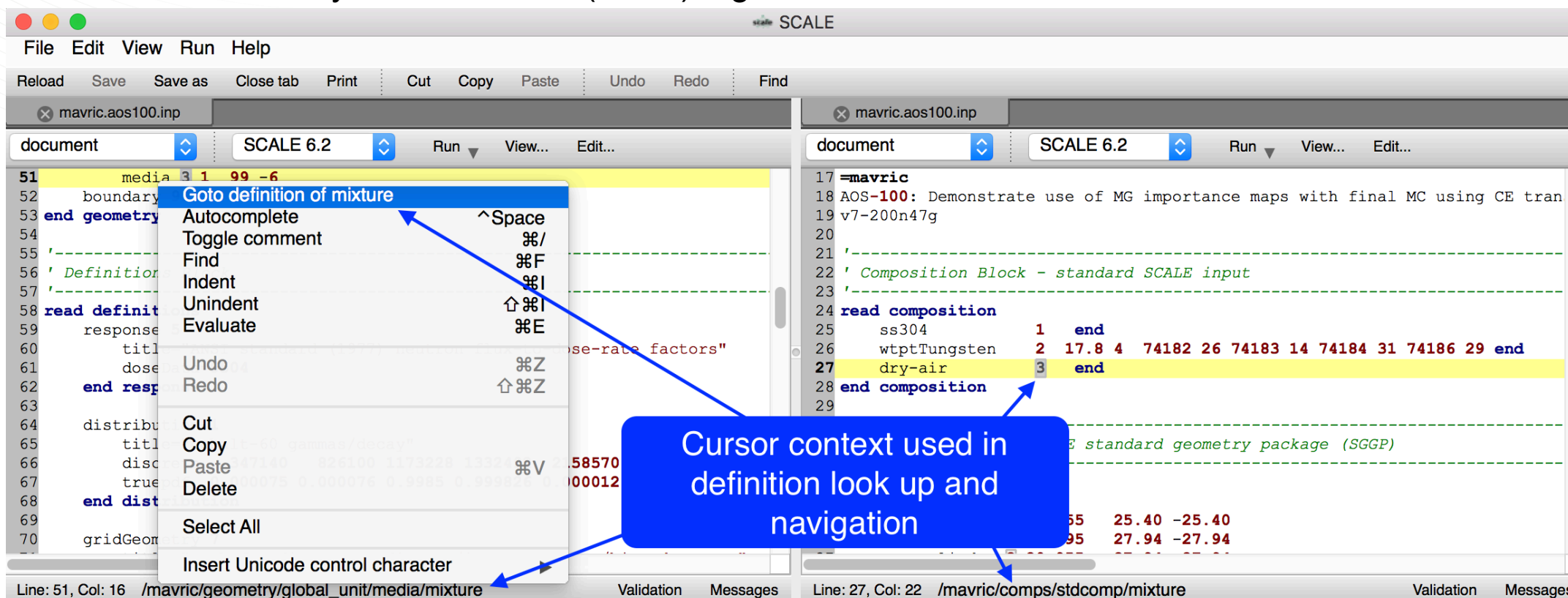
# Miscellaneous Features

- Column select/edit
  - via ALT+left click+mouse drag key and mouse combo
- Go to definition – allows quick navigation to input components definition via a right click popup context menu.
  - E.g., anywhere an identifier is used to reference another input component.
- Math evaluator
  - Ability to evaluate selected text as a math expression – replaces selection with expression's result.
- Comment toggle
  - Ability to comment/uncomment selected lines
- Indent/unindent
  - Ability to indent/unindent selected lines
- Auto saves – automatic backup to *inputname.fulcrum.autosave*.
  - File exists only while there are unsaved document changes

# Miscellaneous : Go To Definition

The 'Go To Definition' feature (available via right clicking an input component) is intended to facilitate the user in quickly navigating to the component being referenced. New users can discover input component relationships. Experienced users can have their navigation accelerated, especially in larger inputs.

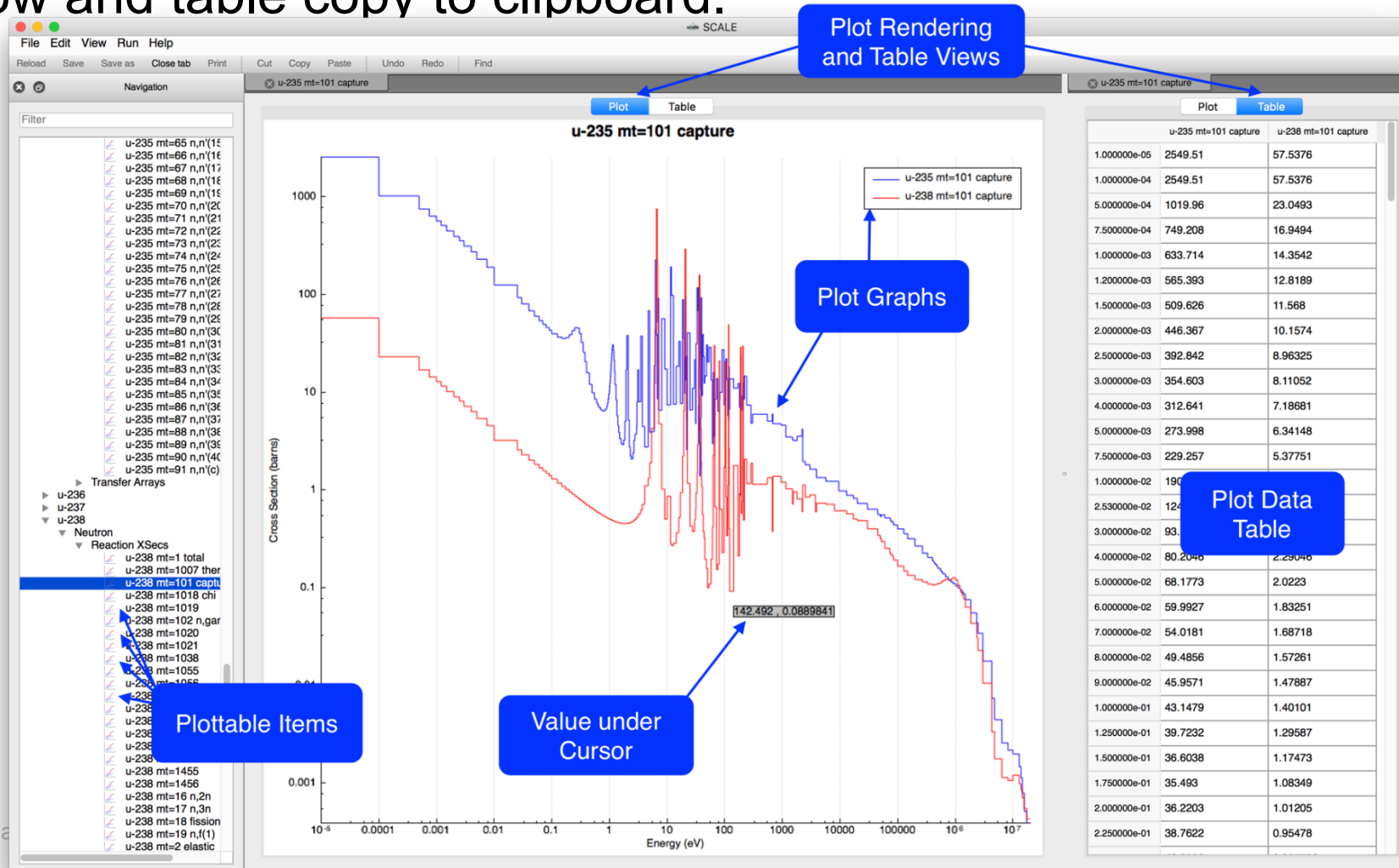
- Referenced mixture identifier – goes to the mixture's definition.
- Referenced Geometry unit identifiers (holes) – goes to the unit definition.





# General Plot Overview

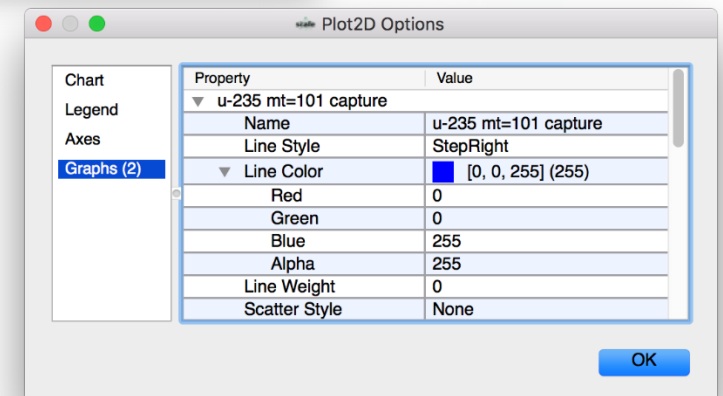
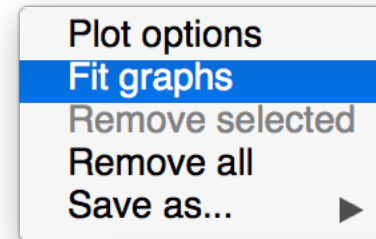
- Interactive and configurable plot rendering
- Plot data table displays graph data.
  - allows row and table copy to clipboard.



# Plot Controls

Fulcrum plots consist of graph, bars, or color maps, which can be manipulated as follows.

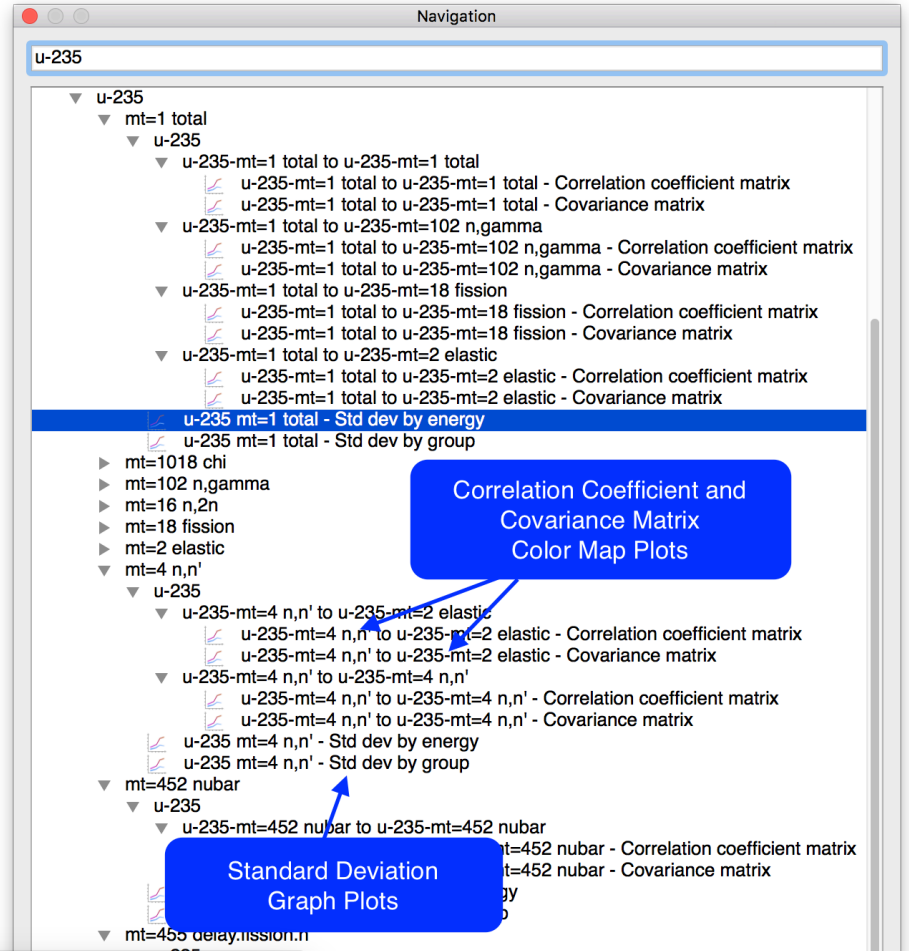
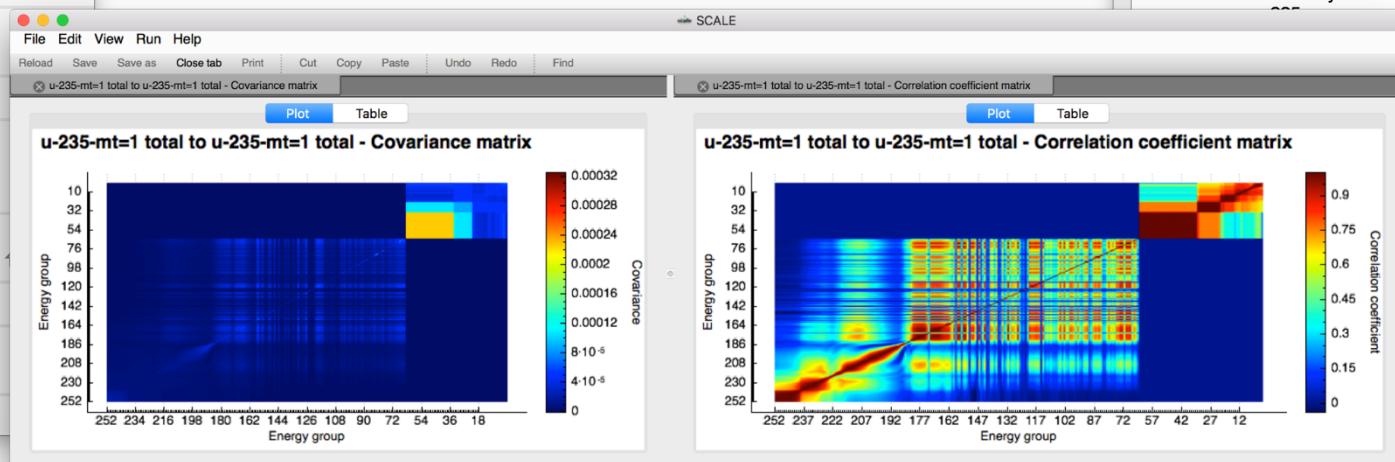
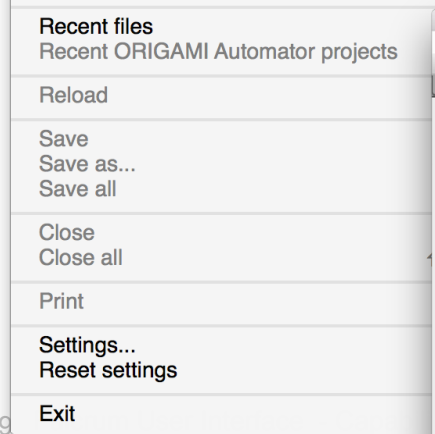
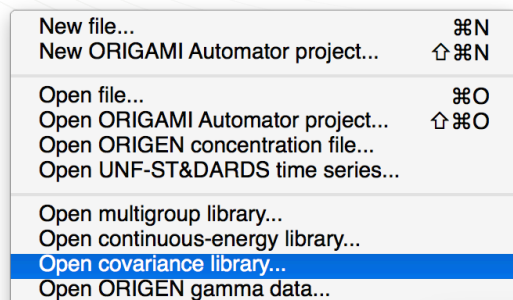
- Select graph via left click in plot or legend.
  - Remove selection via context menu 'Remove selected'
- Zooming is performed via the mouse scroll action.
  - Zoom in by scrolling up.
  - Zoom out by scrolling down.
- Reset to original via context menu Fit graphs.
- Panning is performed via a click and drag.
  - Pan right by left clicking and dragging left.
  - Pan up by left clicking and dragging down.
- Save Plot as
  - **PDF (includes scalable vector graphics - SVG),**
  - PNG and JPG image format
  - **Interactive Scale Plot Format (SPF)**
- Plot attributes (color, style, etc.) can be changed via context menu Plot options.
- Plot Legend can be drug to 9 cardinal positions via left-click and drag.



# Covariance Data

Covariance Data is available at SCALE/data. Because the files do not have a unique extension, the user must load them specifically by type.

- Correlation coefficient matrix color map plots
- Covariance matrix color map plots
- Isotope Reaction Standard Deviation by energy or group graph plots

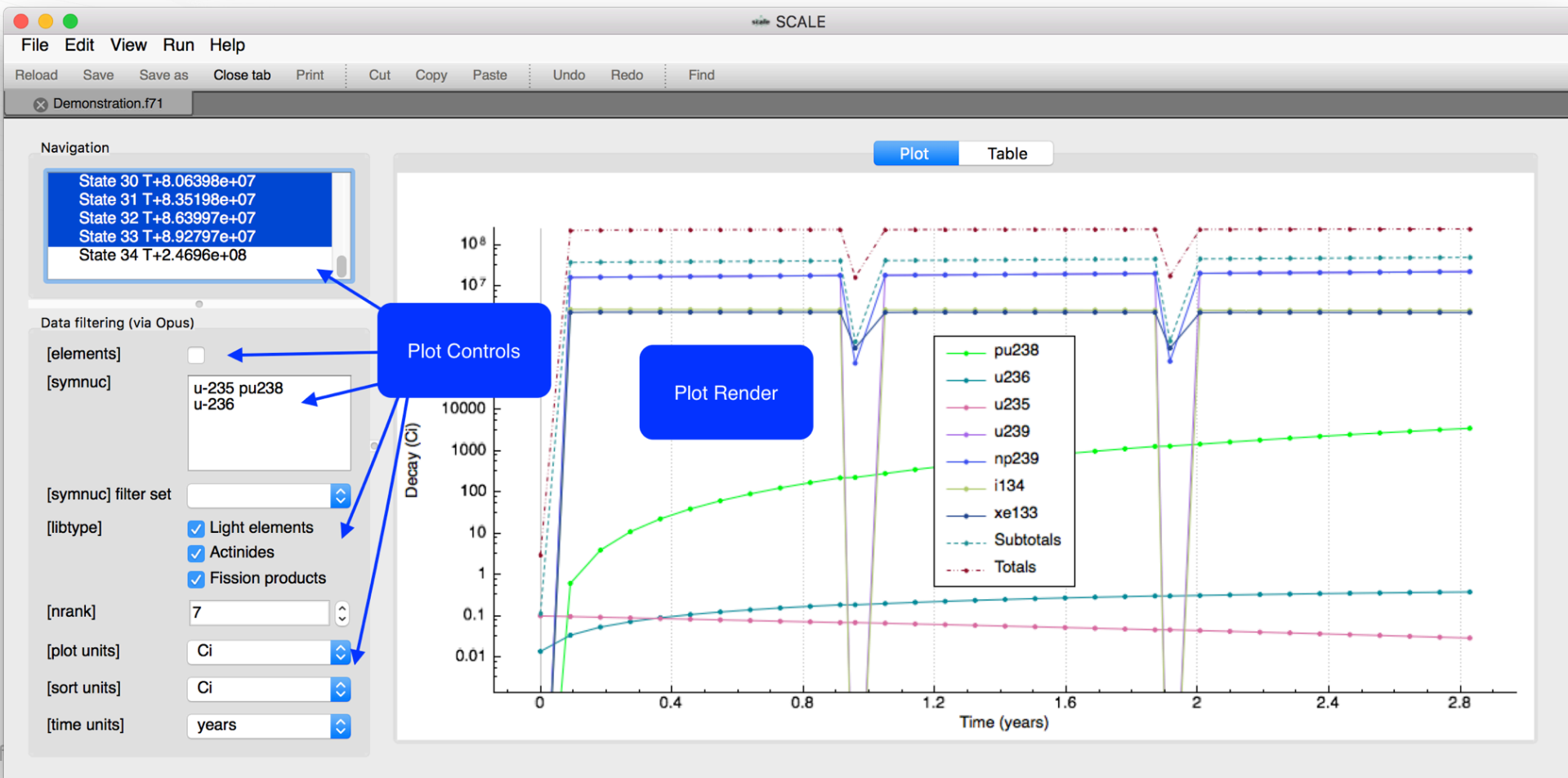


delay.fission.n to u-235-mt=452 nubar  
 it=455 delay.fission.n to u-235-mt=452 nubar - Correlation coefficient  
 it=455 delay.fission.n to u-235-mt=452 nubar - Covariance matrix  
 delay.fission.n to u-235-mt=455 delay.fission.n  
 it=455 delay.fission.n to u-235-mt=455 delay.fission.n - Correlation coefficient  
 it=455 delay.fission.n to u-235-mt=455 delay.fission.n - Covariance matrix  
 delay.fission.n - Std dev by energy  
 delay.fission.n - Std dev by group  
 prompt.fiss.n to u-235-mt=452 nubar  
 it=456 prompt.fiss.n to u-235-mt=452 nubar - Correlation coefficient  
 it=456 prompt.fiss.n to u-235-mt=452 nubar - Covariance matrix  
 prompt.fiss.n to u-235-mt=456 prompt.fiss.n  
 it=456 prompt.fiss.n to u-235-mt=456 prompt.fiss.n - Correlation coefficient  
 it=456 prompt.fiss.n to u-235-mt=456 prompt.fiss.n - Covariance matrix  
 prompt.fiss.n - Std dev by energy  
 prompt.fiss.n - Std dev by group

# ORIGEN Isotope Concentration Data (F71)

Origen concentration data contains results from depletion, decay, and activation calculations. The plot capabilities are centered about the expected Fulcrum interactive plot with the addition of a more familiar PlotOPUS style set of controls.

- Easy selection of state information to display.
- Easy display of nuclides or elements by id or category.
- Easily display different units (Decay, Mass, Number).



# ORIGEN Gamma Data

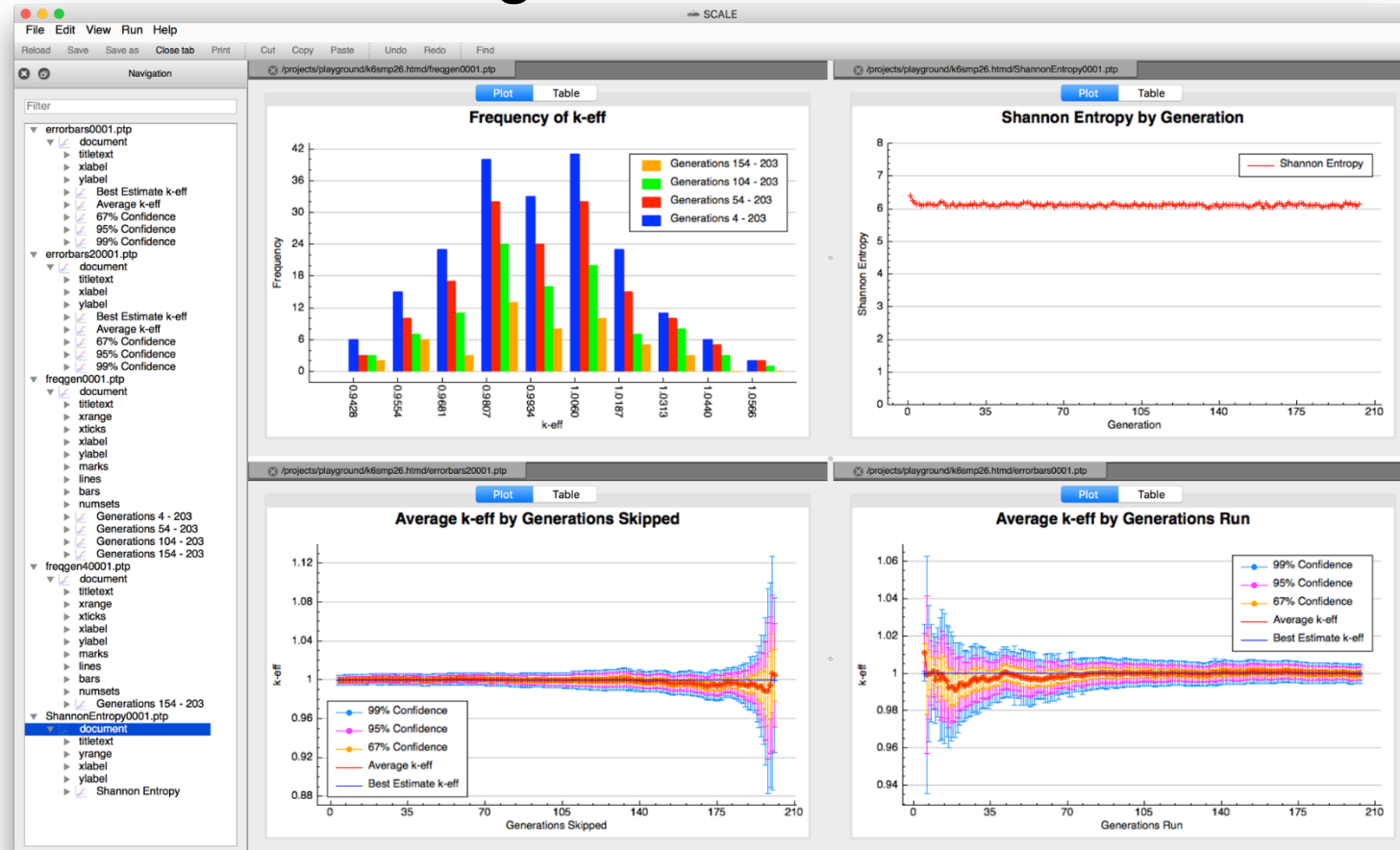
The master photon data library, located at SCALE/data/origen\_data/origen.rev###.mpdkxgam.data, provides both discrete and continuous energy gamma lines.

- Opened via File>Open ORIGEN gamma data...

The screenshot displays the SCALE software interface. The top menu bar includes File, Edit, View, Run, and Help. Below it, a secondary menu bar contains Reload, Save, Save as, Close, Print, Cut, Copy, Paste, Undo, Redo, and Find. A Navigation pane on the left shows a list of gamma data entries, with 'ag-123 continuous' selected. The main window features two plots. The top plot, titled 'bk-251 discrete', shows 'Photons / disintegration' on the y-axis (0 to 0.24) versus 'Photon energy (MeV)' on the x-axis (0 to 0.18). The bottom plot, titled 'ag-123 continuous', shows 'Photons / (MeV \* disintegration)' on the y-axis (0 to 0.036) versus 'Photon energy (MeV)' on the x-axis (0 to 7). A File menu is open in the top right corner, with 'Open ORIGEN gamma data...' highlighted.

# Keno Result Plots

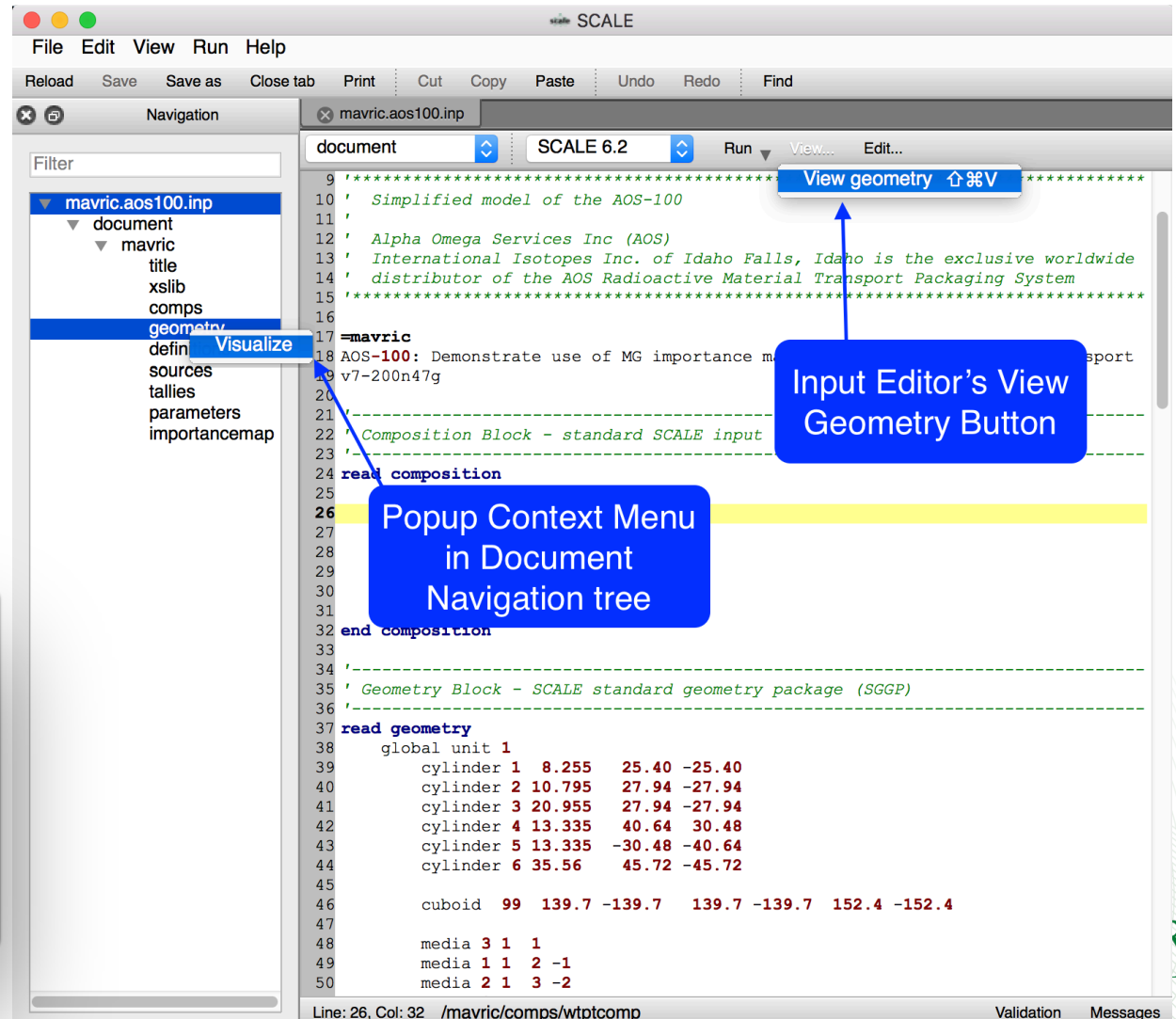
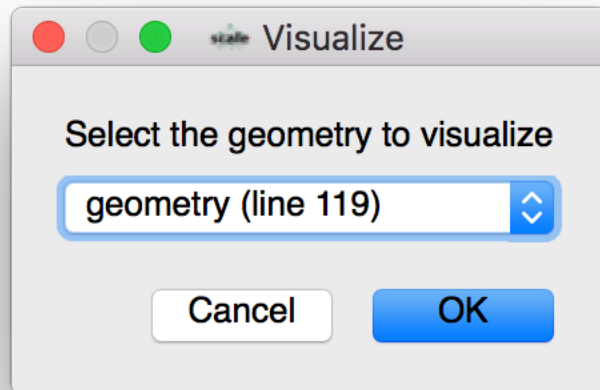
- Plot of average k-effective by generation run
- Plot of average k-effective by generations skipped
- Final edit of fissions, absorptions, and leakage
- Frequency distributions
- Shannon Entropy
- Flux plotting



# Activating the Geometry Viewer

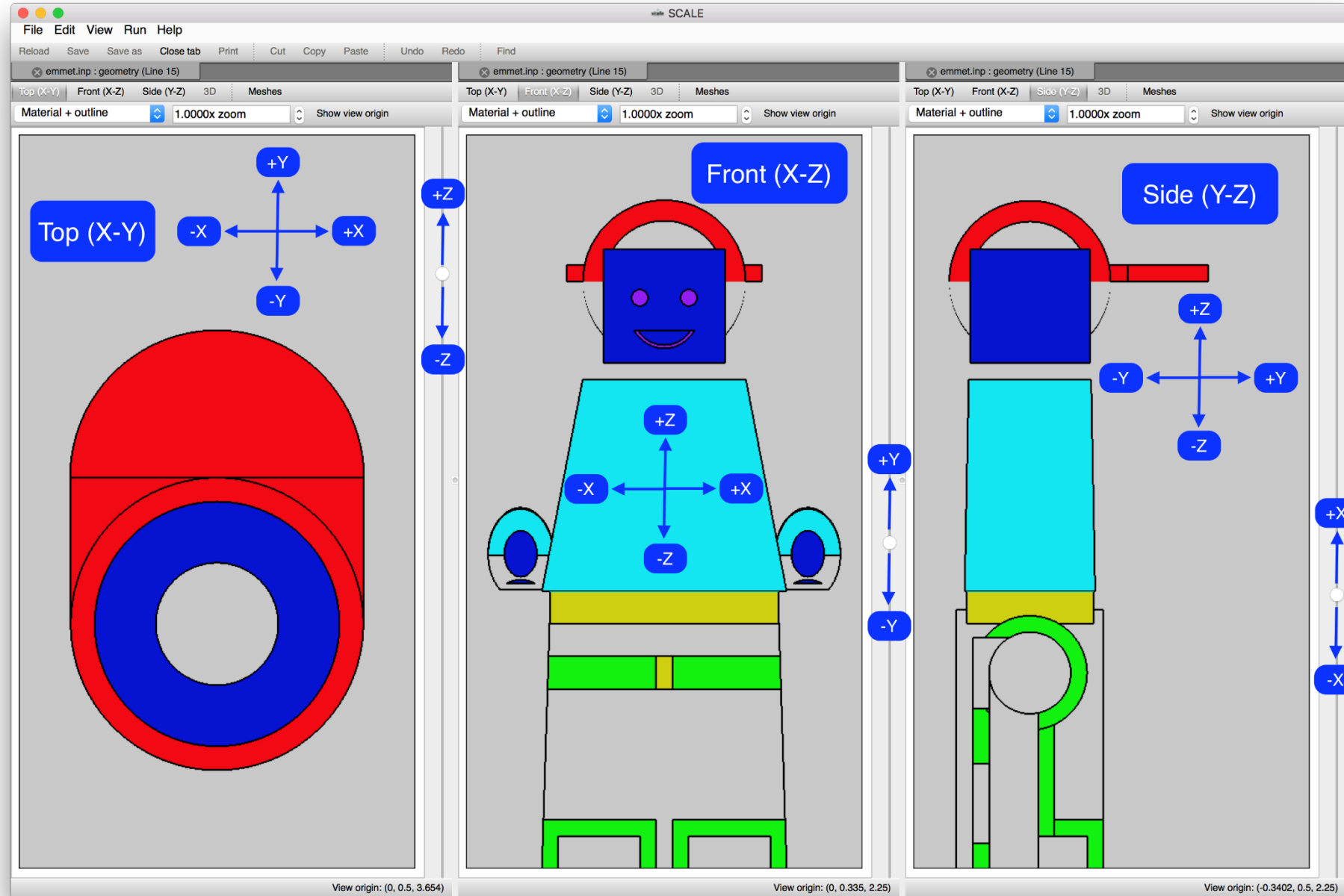
Activating the geometry viewer can be accomplished via the Input Editor's View...>View geometry button or the Document Navigation geometry item's popup context menu.

- If multiple geometry input blocks exist in the document, a selection will be provided.



# Axis Views

- Axis views provide standard orthographic model projections of the top, front, and side of the geometry.

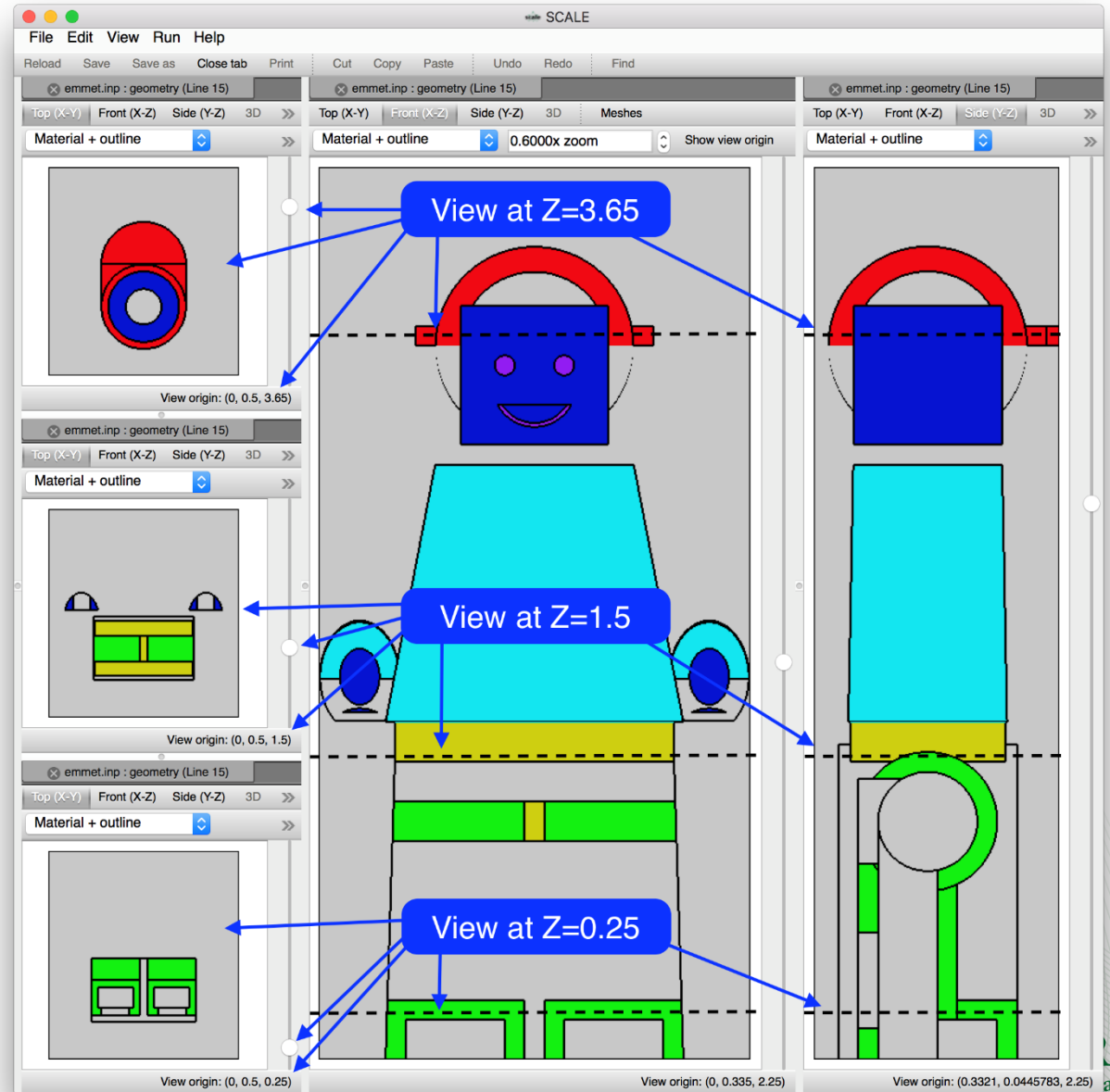




# Axis Views : Elevation Control

View plane elevation is controlled via a slide control on the right side of each geometry view.

- View plane elevation corresponds to view plane control – the higher the slider control, the higher the view plane.
  - Top (X-Y) - raising the slider increases the Z intersect.
  - Front (X-Z) – raising the slider increases the Y intersect.
  - Side (Y-Z) – raising the slider increases the Z intersect.

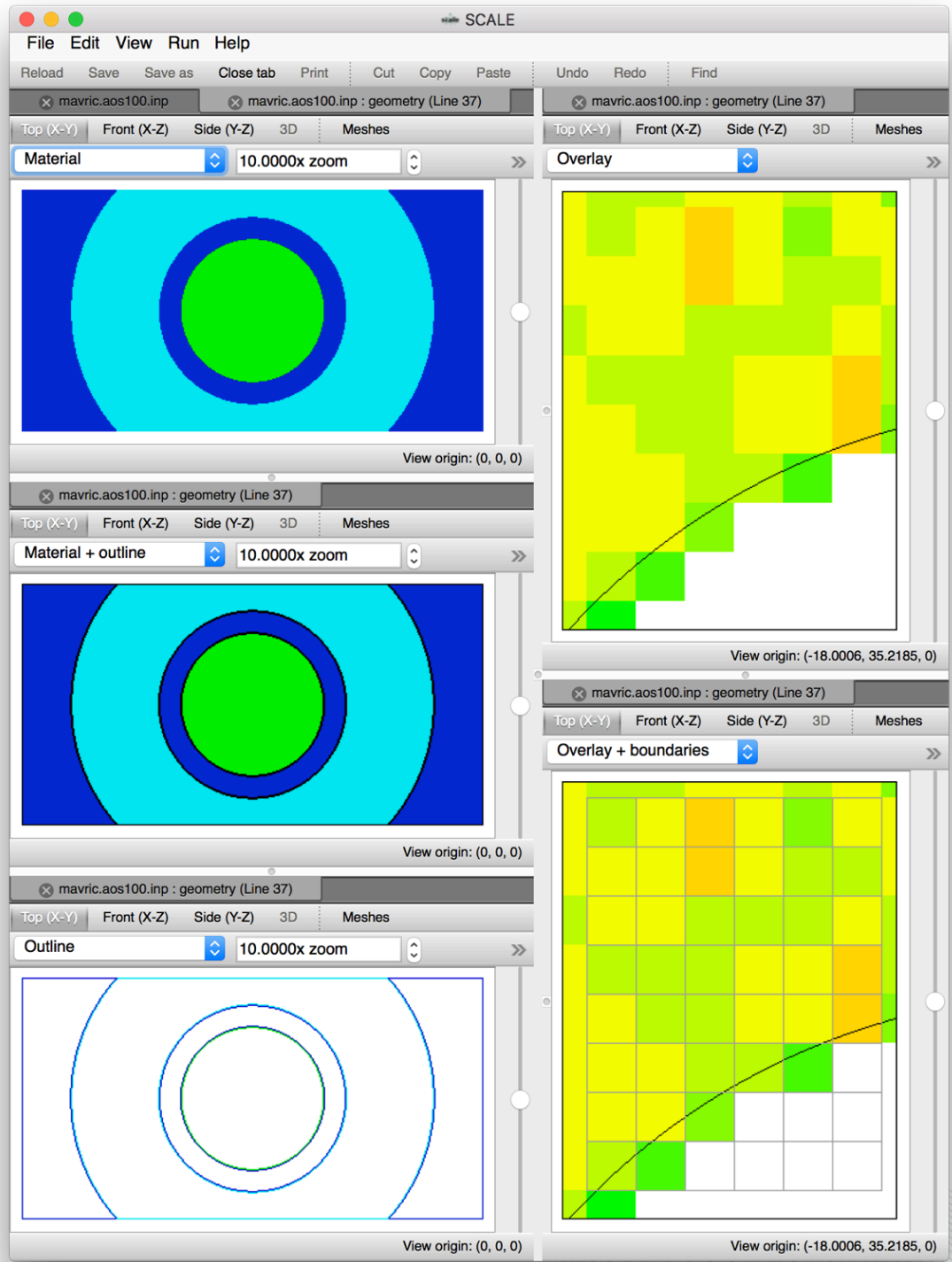


- ✓ Material
- Material + outline
- Outline
- Overlay
- Overlay + boundaries

# Render Modes

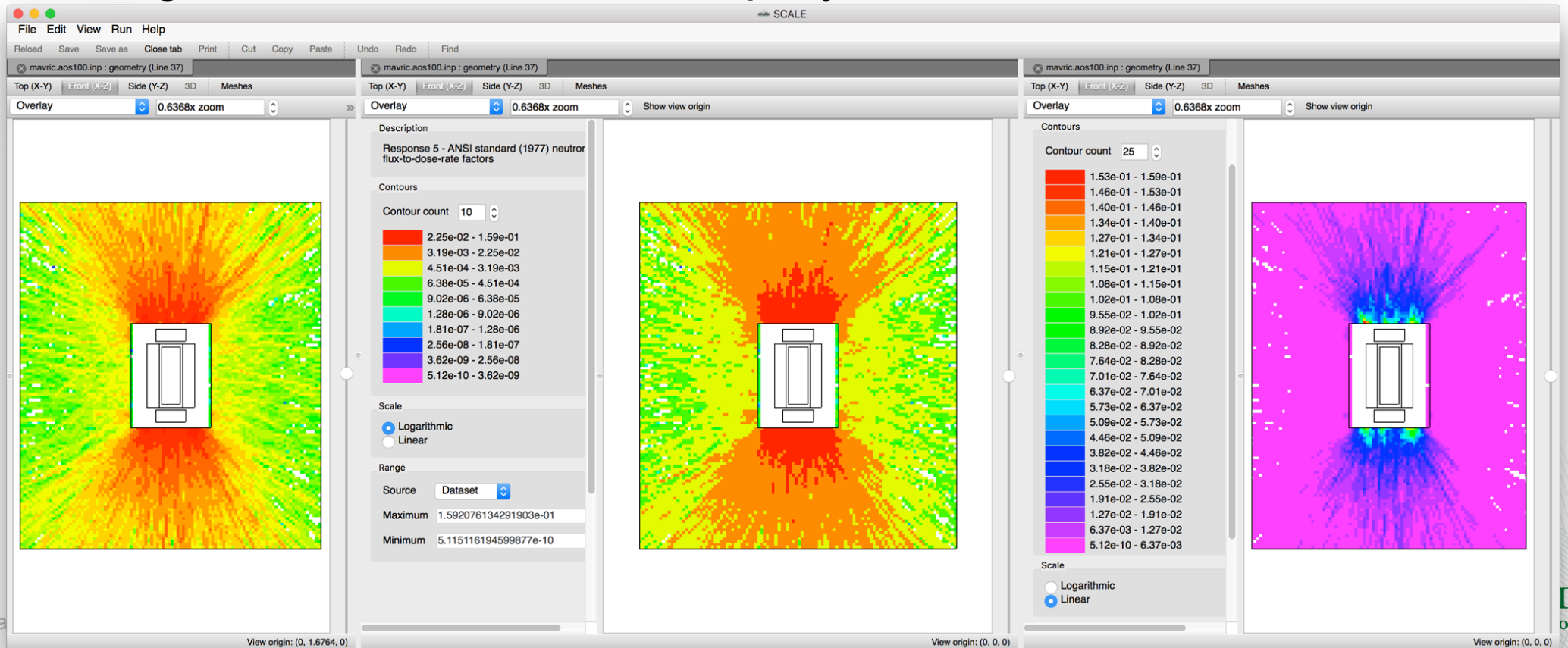
Render modes control the information displayed.

- Material displays only the materials/mixtures.
  - Can hide geometry region outlines that are the same material.
- Material + outline displays the material and the region outlines.
  - Displays region outline in black.
  - Useful for contrasting geometry regions.
- Outline displays only geometry region outlines.
  - Displays region outline in material color.
- Overlay displays geometry region outline and mesh data results.
- Overlay + boundaries displays geometry region outline, mesh boundaries\*, and mesh data results



# Mesh Contours, Color Legend, and Scale

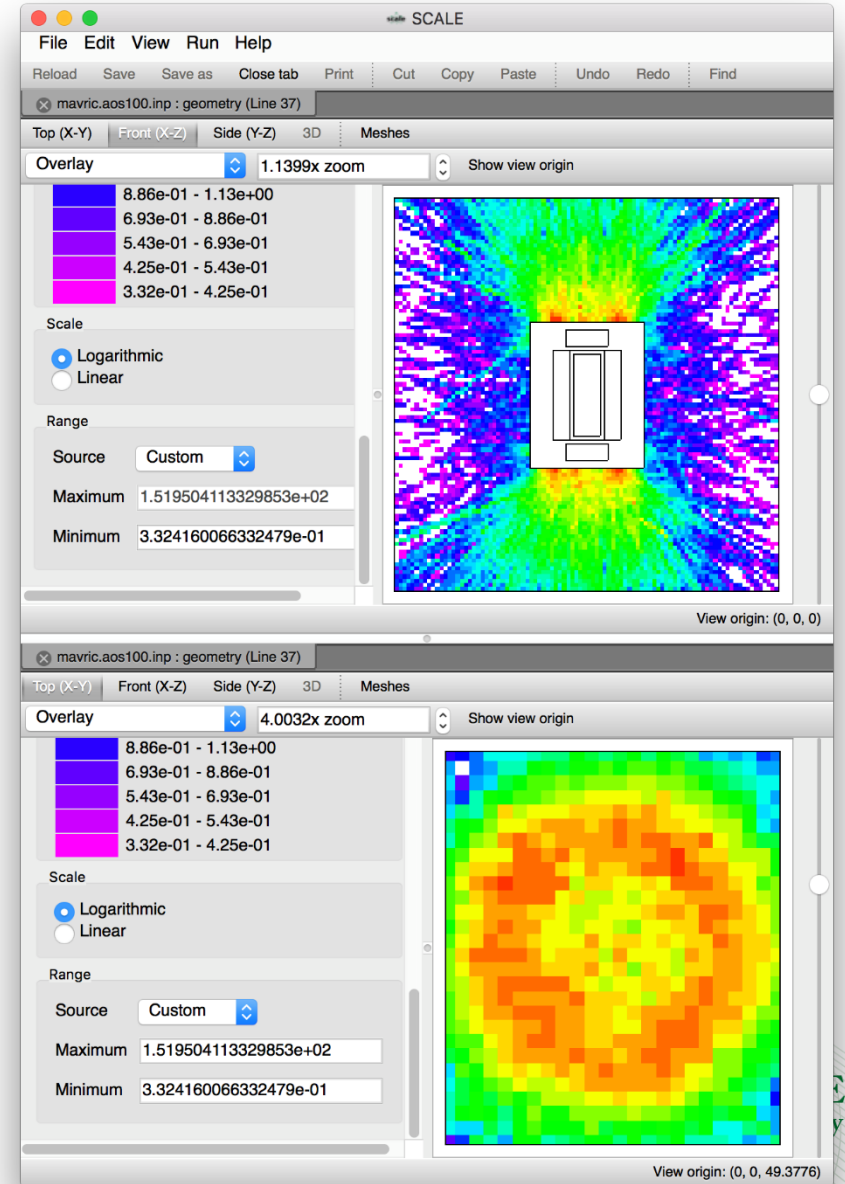
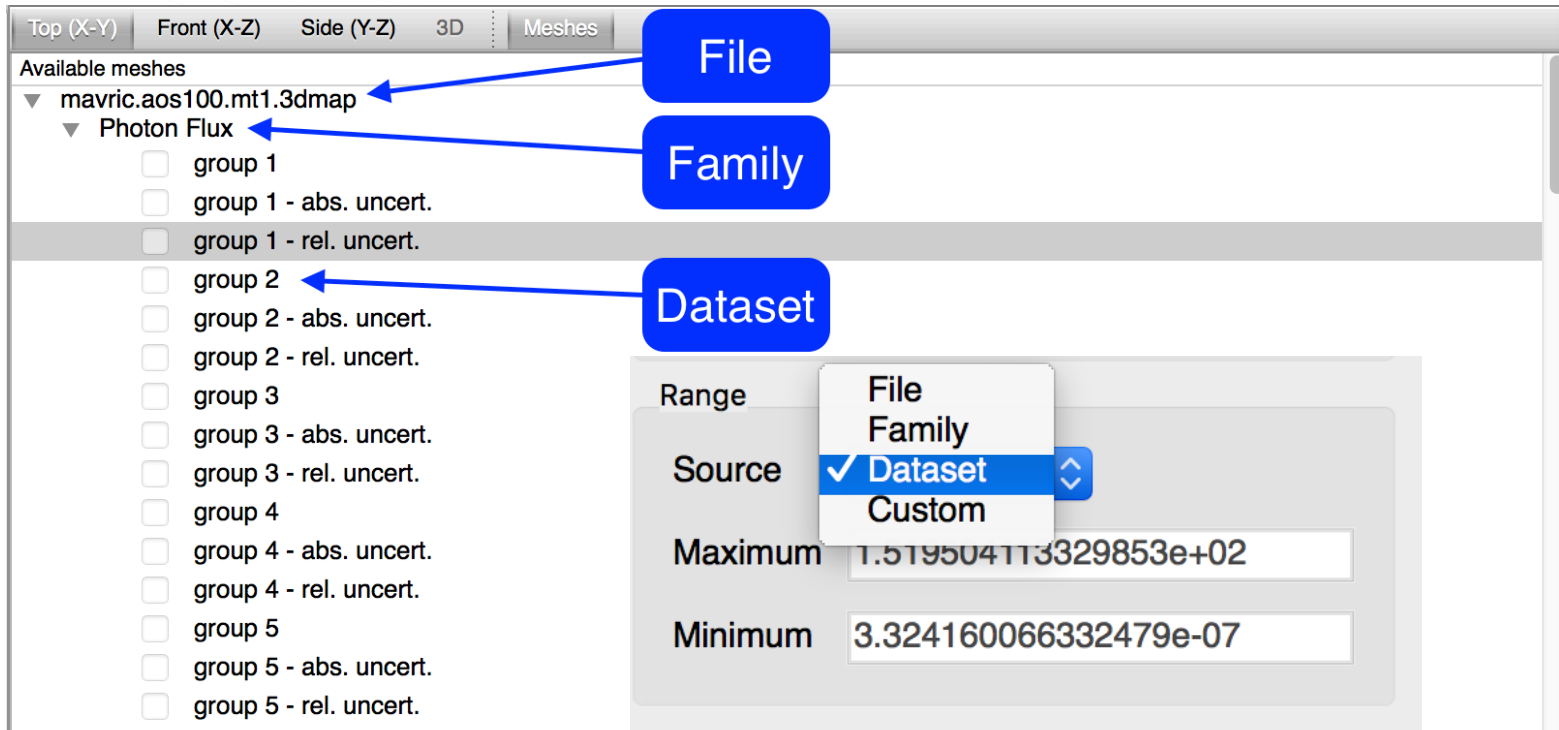
- Controls influenced by MAVRIC's MeshView plot program.
- Allows changing contour count from 25 to 2 enhancing data contrast.
- Can improve print quality for black and white printouts.
- Linear and logarithmic scale data display.



# Mesh Overlay : Data Ranges

The overlaid dataset's data range can be selected as the file, family, dataset or as custom user-specified.

- The file indicates the entire mesh file context.
- The family range provides context to a selected dataset.
- Custom allows down-selection.



# Mesh Overlay : Integrated 2D Plot Creation

Mesh data can be further investigated via the integrated 2D plot creation capability. 2D Plot creation is available via the Create plot popup context menu.

- Plot options include
  - Independent axis
    - Cartesian X,Y, and Z.
    - Cylindrical Radial, Theta, and Z.
    - Group when group-wise data is available.
  - Plot using values or indices.
  - When data is group-wise axis interval widths can optionally be divided linearly or logarithmically.

The screenshot illustrates the workflow for creating a 2D plot from mesh data in the SCALE software. The interface is divided into several panels:

- Navigation Panel:** Shows a tree view of the project files, including 'mavric.aos100.inp' and 'mavric.aos100.mt1.3dmap.xaxis.56-56-79.chart'.
- 3D View:** Displays a 3D mesh of a building structure. A context menu is open over the mesh, with the 'Create plot...' option selected.
- Configuration Dialog:** A dialog box titled 'Instructions' is shown, providing options for the plot. The 'Independent axis' is set to 'x axis', and 'Plot using' is set to 'values'. The 'Divide by axis interval widths' is set to 'none'.
- 2D Plot:** The resulting plot is titled 'x axis plot at a=0, b=47.7493 generated on Mon Oct 17 14:45:03 2016'. The y-axis is labeled 'Photon Flux' (logarithmic scale from 0.001 to 100) and the x-axis is labeled 'x axis' (linear scale from -120 to 120). The plot shows a single data series with error bars.

Three numbered callouts provide additional instructions:

1. Locate point of interest. Right click and select Create plot...
2. Configure plot options and click OK. The MAVRIC Chart file will be generated.
3. Selection of Chart document will display 2D plot values with uncertainties.

# Presentation Summary

- Fulcrum Mission Statement
- Fulcrum Component Overview
- Fulcrum Input Editor
- Fulcrum Data Plotting
- Fulcrum Geometry Visualization
- Questions?