OAK RIDGE National Laboratory

Advanced User Interface Capabilities

Robert A. Lefebvre

SCALE Users' Group 2020

Reactor and Nuclear Systems Division

Oak Ridge National Laboratory, USA

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

Summary

This tutorial will review the **data plotting** and **geometry visualization** capabilities in the Fulcrum user interface. This tutorial will help you become familiar with Fulcrum's **2D plot**, and **2D and 3D geometry visualization** features.

You will learn how to identify **plottable data items**, **compose** and **export plot** and **plot data** for SCALE plot formats (SDF, Ampx MG/CE, PLT, F71, PTP, SPF, ORIGEN Gamma data, etc.) and **visualize**, **navigate**, **cut**, **hide**, and **export** the **geometry** and **spatial data** (fission-, dose-map, etc.) overlays in 2D and 3D.

No prior experience with SCALE is required. Attendees can follow along using 6.3.0-beta.

User Notice

This tutorial is intended to train users in the advanced functionality of the Fulcrum data and geometry plotting capabilities.

It is not intended to train users in the use of the SCALE code system's cross section processing, criticality safety, depletion, shielding, sensitivity and uncertainty, or source term computational modules.

Schedules and contact information for specific tutorials and training courses can be found at https://www.ornl.gov/scale/scale-training

Outline

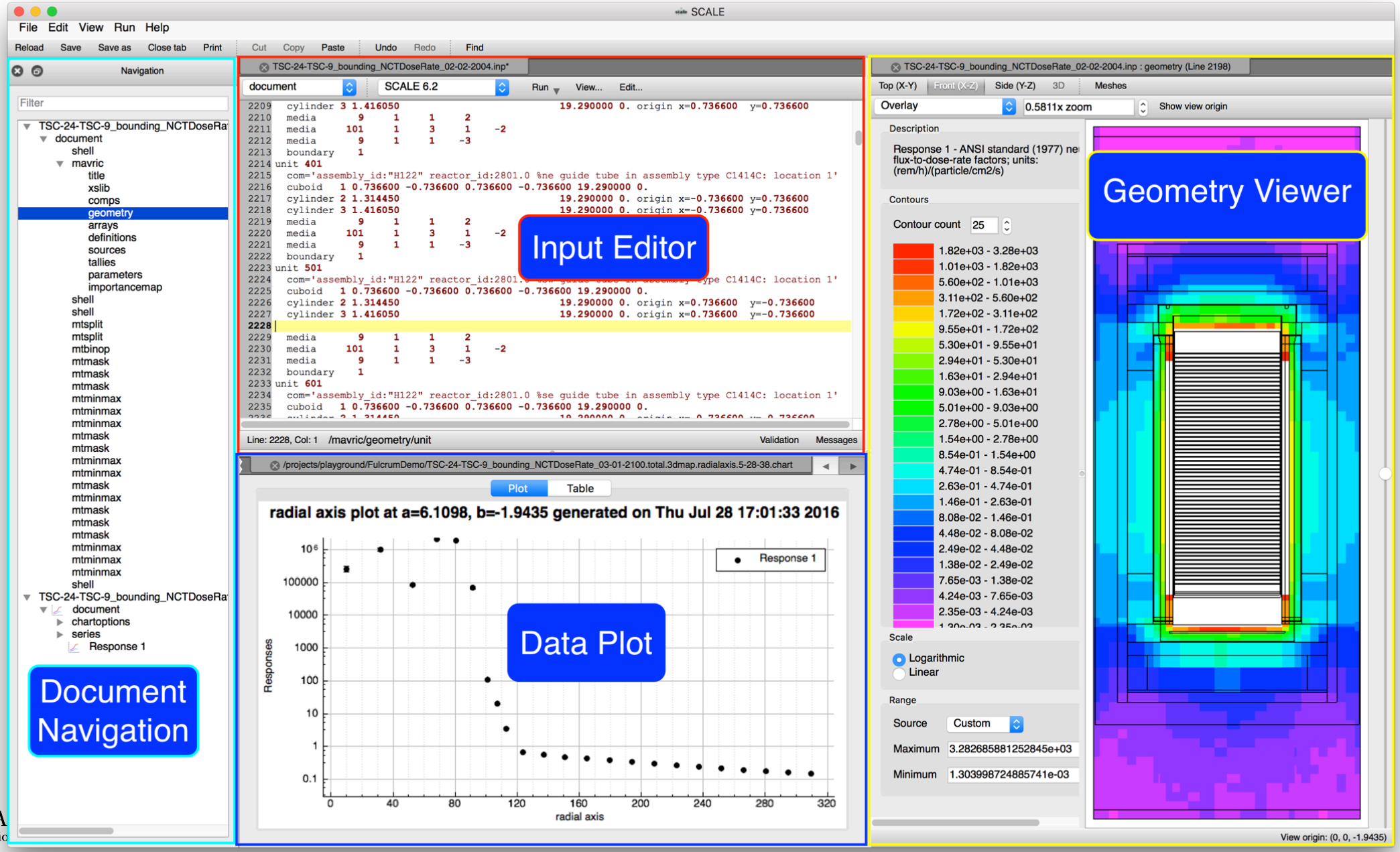
- Vision
- Fulcrum Component Overview
- Plotting Overview
- Plot Controls
- 2D Plots
  - AMPX Cross Section Data (MG, CE) plots
  - Covariance data plots
  - ORIGEN Gamma data
  - Sensitivity Data File (SDF) plots
  - ORIGEN F71 Plot
  - OPUS PLT
  - MAVRIC ChartPlot plots
  - Scale Plot Format (SPF) plots
  - KENO PTP Results plots
- Plot saving
  - PDF, PNG, SPF
- Geometry Visualization
  - Activation and Layout
  - 2D Controls
  - 3D Controls
  - Spatial data plotting

Fulcrum Mission Statement

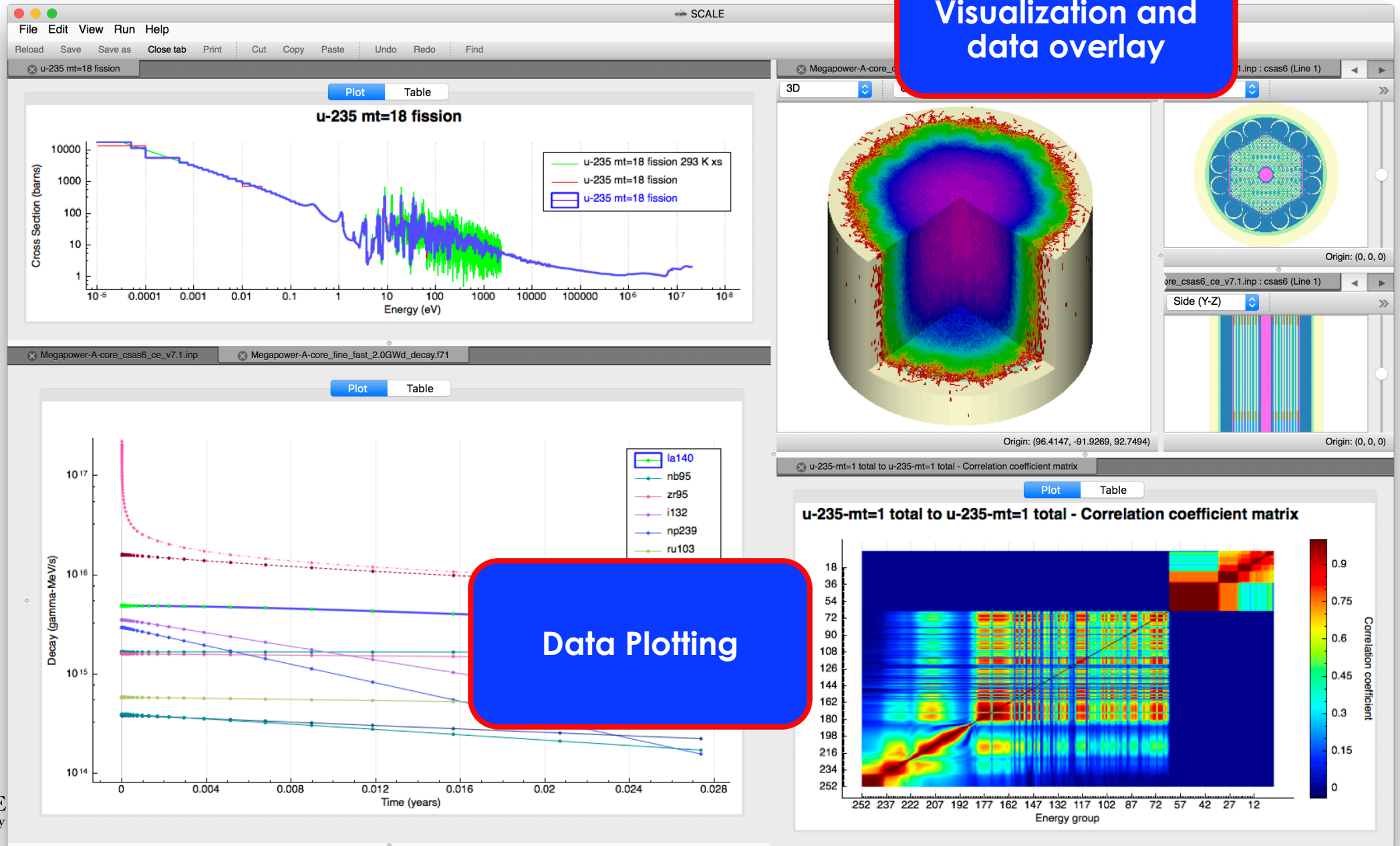
Provide a cross-platform graphical user interface (GUI) designed to facilitate problem creation, modification, navigation, validation, and visualization, as well as output and data file interaction as needed by new and experienced users.



Fulcrum Components Overview



Fulcrum Components Discussed

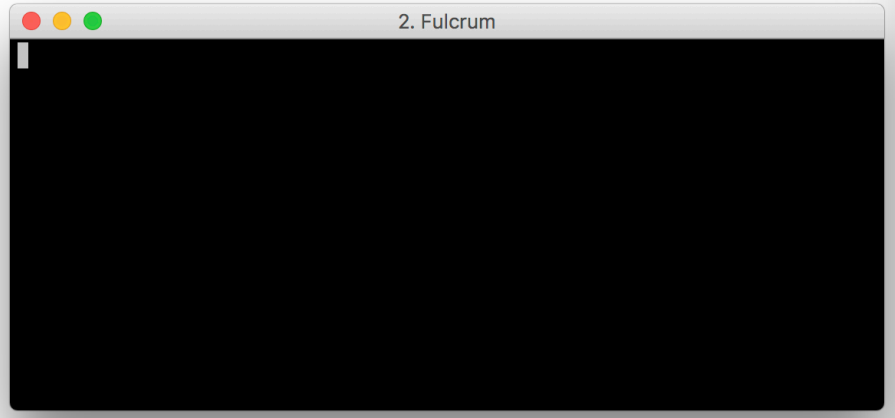


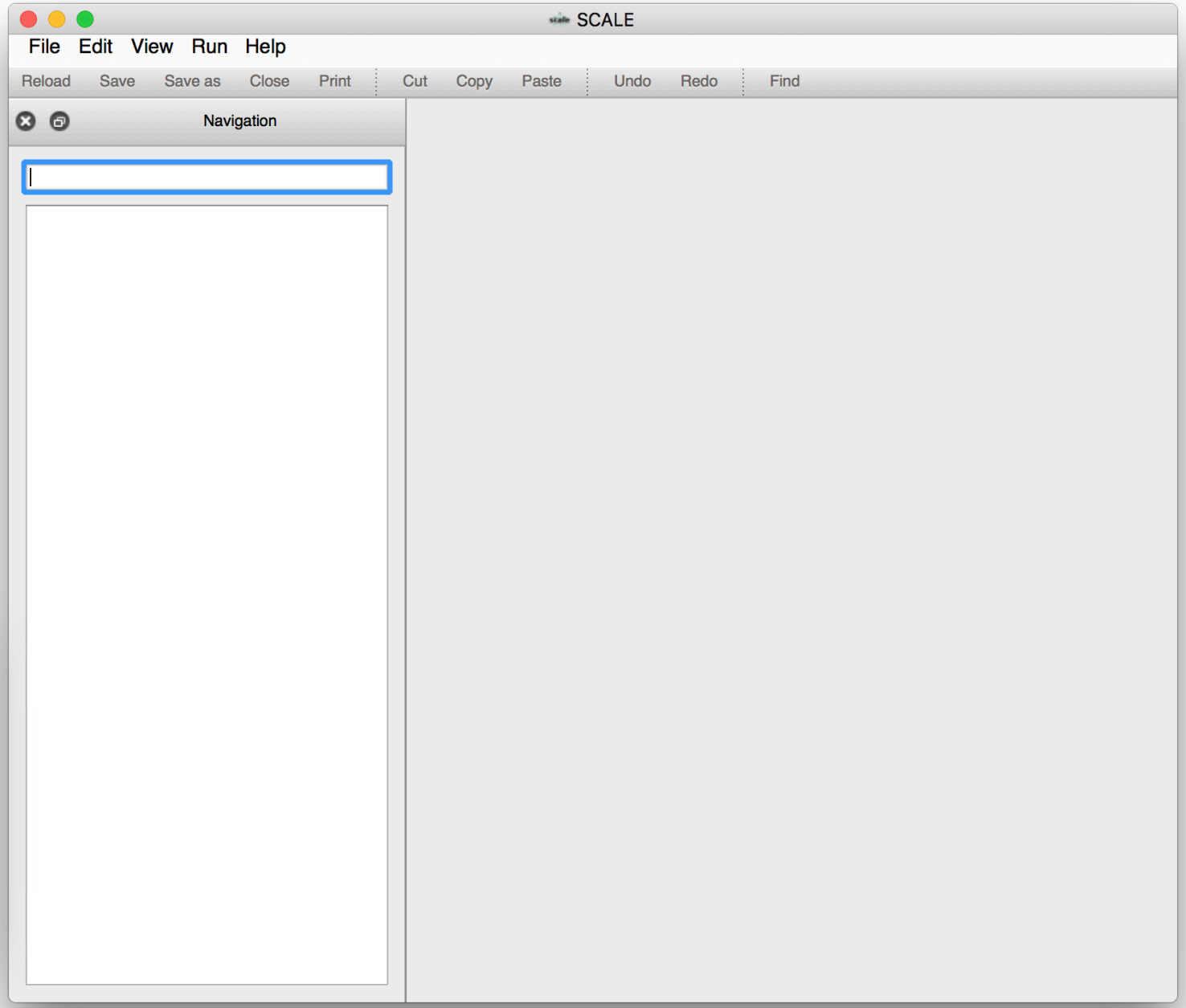
Tutorial Requirements

- Have SCALE 6.3 beta installed
- SCALE Data installed
- Have **Advanced_User_Interface** training pack downloaded
  - includes input and data files

Fulcrum Startup Screen

- **Start Fulcrum**
- Little to look at
- Lean and mean
- Always has a terminal/CMD window in the background that contains log messages





OAK RIDGE National Laboratory

Data Plotting

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

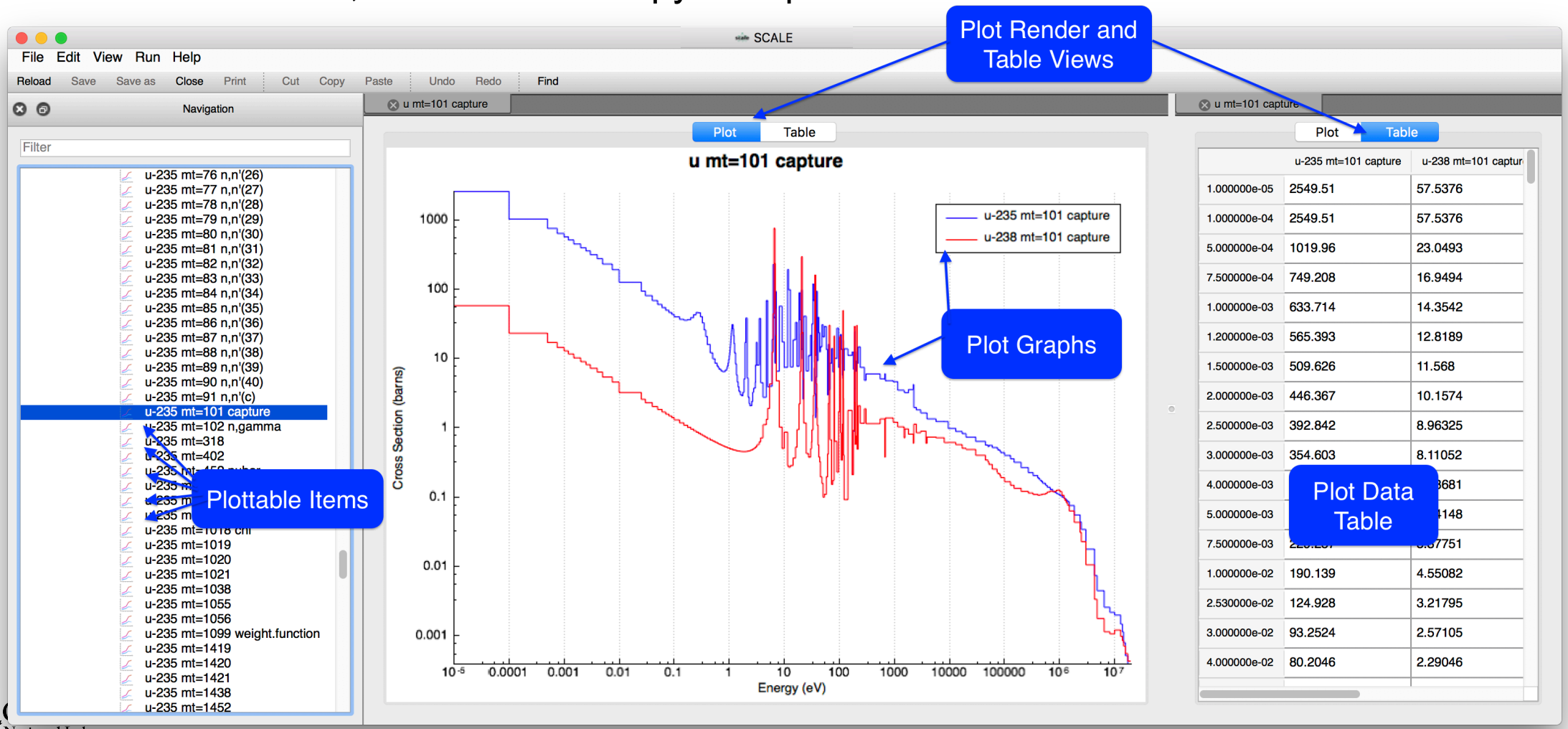
U.S. DEPARTMENT OF ENERGY

Data Plotting Overview

- Plot Controls
- AMPX Cross Section Data
- Covariance Data
- ORIGEN Gamma Data
- ORIGEN Isotope Concentration Data (F71)
- F71 Special Plot Controls (PlotOpus)
- Sensitivity Data Files (SDF)
- Result Plots (KENO PTP, MAVRIC ChartPlot, Opus PLT, etc.)

General Plot Overview

- Interactive and configurable plot rendering
- Plot data **table** displays graph data.
  - Allows column, row and table copy-to-clipboard.

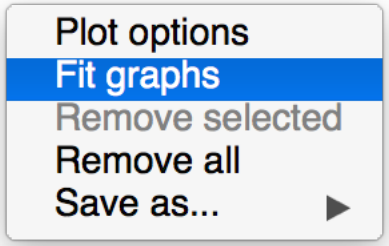


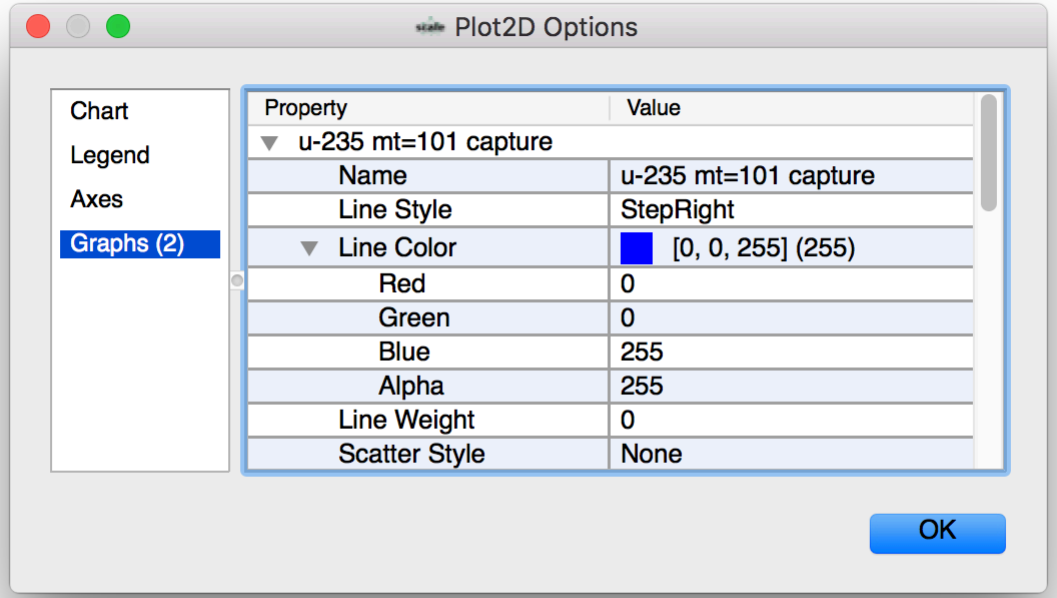
Plot Controls

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/trackpad scroll** action
  - Zoom in by scrolling up
  - Zoom out by scrolling down
- **Panning** is performed via a **left-click and drag**
  - Pan right by left-click and dragging left
  - Pan up by left clicking and dragging down
- Plot **Legend** can be dragged to 9 positions via **left-click and drag**
- Plot **attributes** (color, style, etc.) can be changed via context menu **Plot options**
- **Reset** to original extents via context menu **Fit graphs**

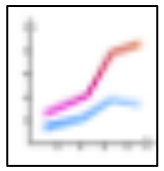
- **Save** Plot as
  PDF (includes scalable vector graphics SVG)
  PNG and JPG image format
  Interactive Scale Plot Format (SPF)



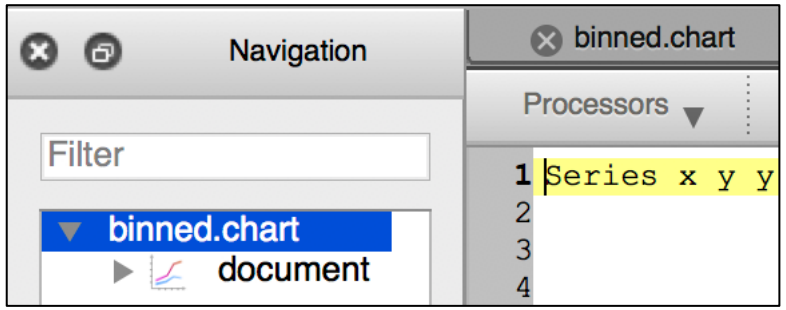


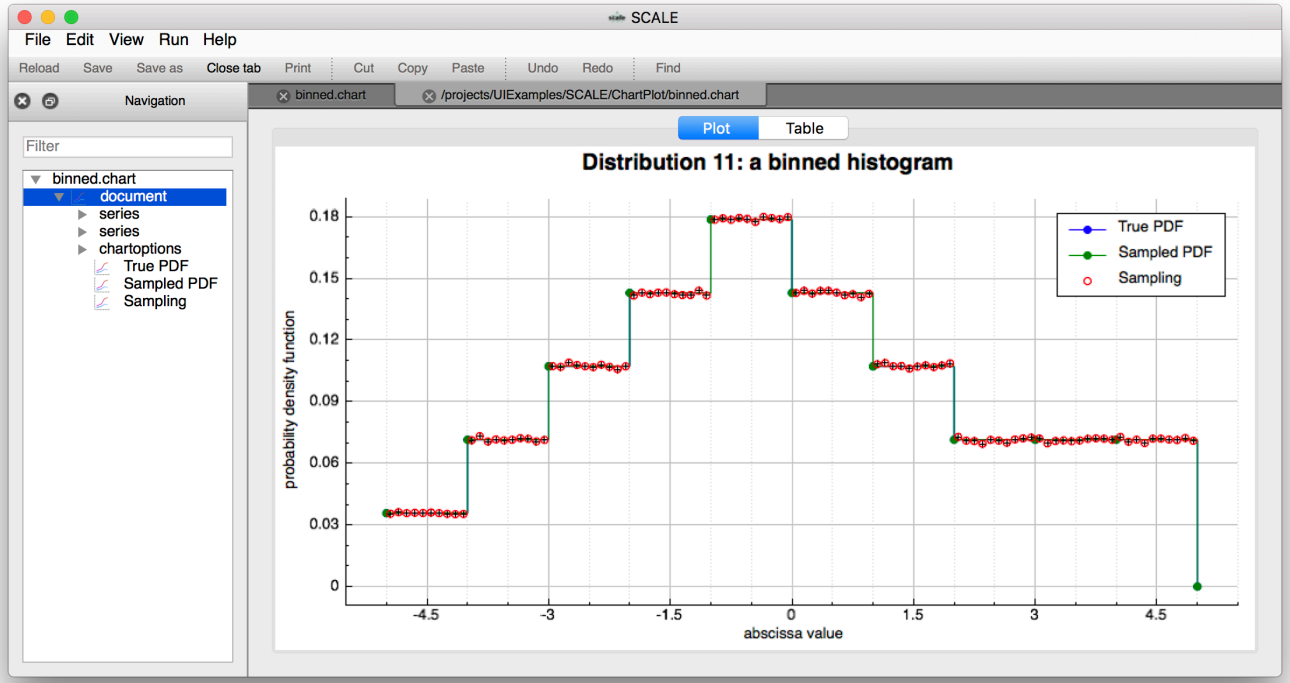
Plot Controls | Hands On

- Click **File > Open file…** and open **Advanced_User_Interface/ChartPlot/ binned.chart**
- Observe the **binned.chart** file become visible in the **Navigation panel** and a new **binned.chart** text editor tab
- Note the **Navigation** panel's Plottable icon



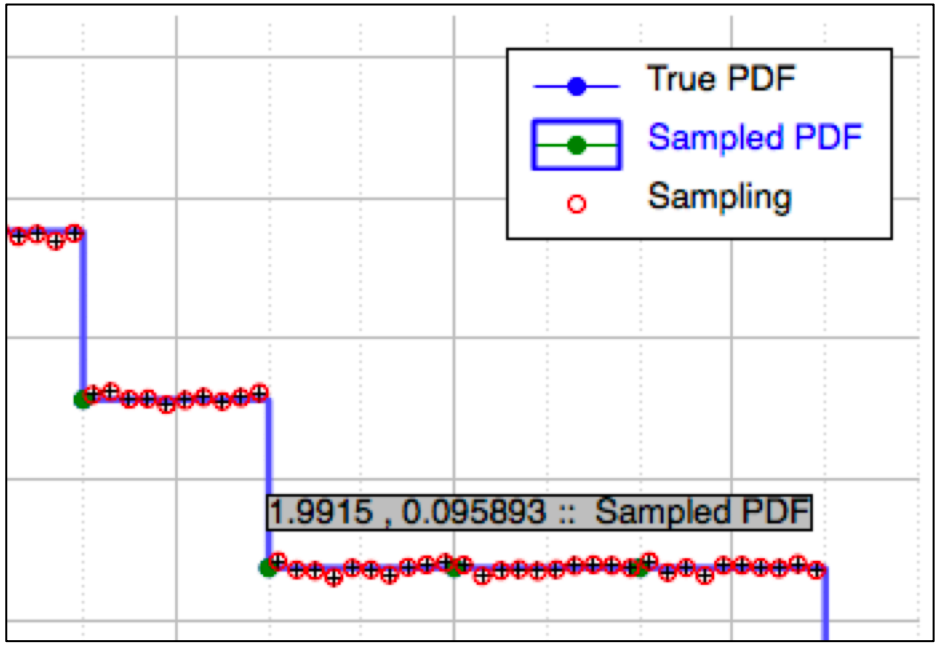
- Double left-click the **binned.chart > document** plottable item to plot the entire document





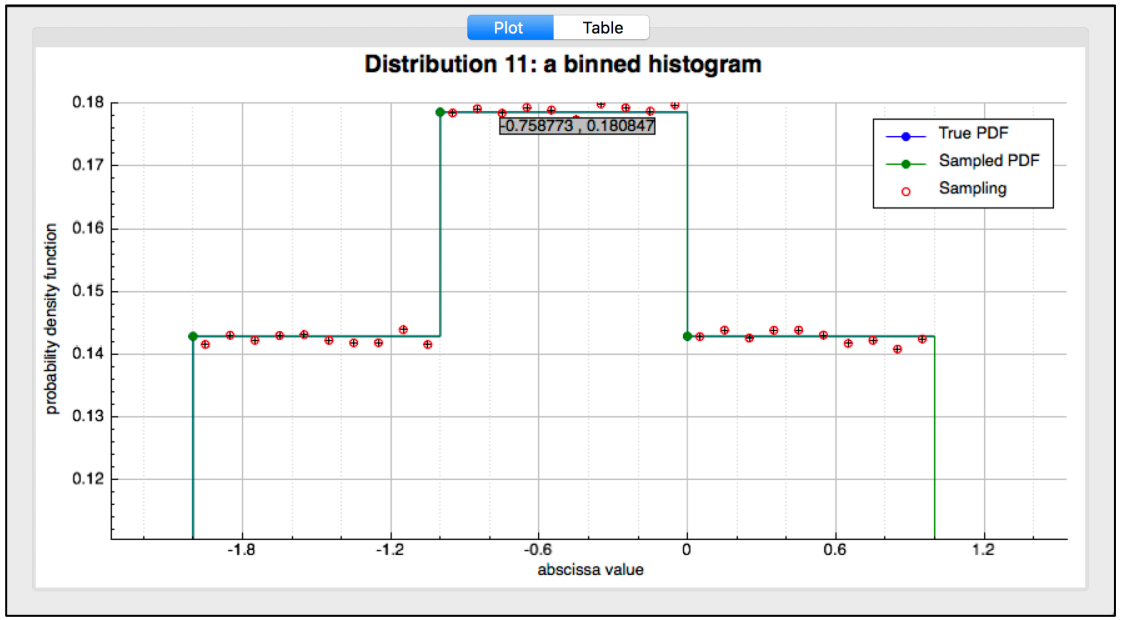
Plot Controls | Hands On Graph Selection

- Select the **green Sampled PDF** graph via a left-click on the green line
- Observe the selected graph turn **blue**, the **Legend** graph entry text color become **blue** with line style emphasized via a **blue box**, and the cursor location include the graph name **Sampled PDF**
- Alternatively, a graph selection can be made in the **Legend** via a left-click of the graph name
- Deselection is accomplished by a left-click in an empty plot location

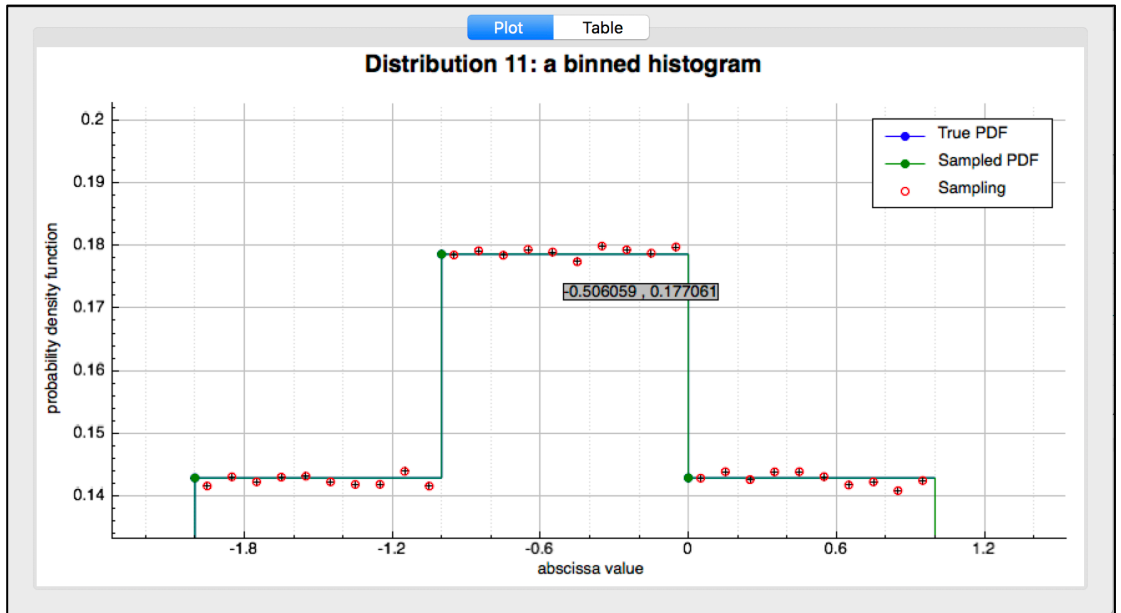


Plot Controls | Hands On Zooming and Panning

- **Zoom in** to the graph peak via **scrolling up**

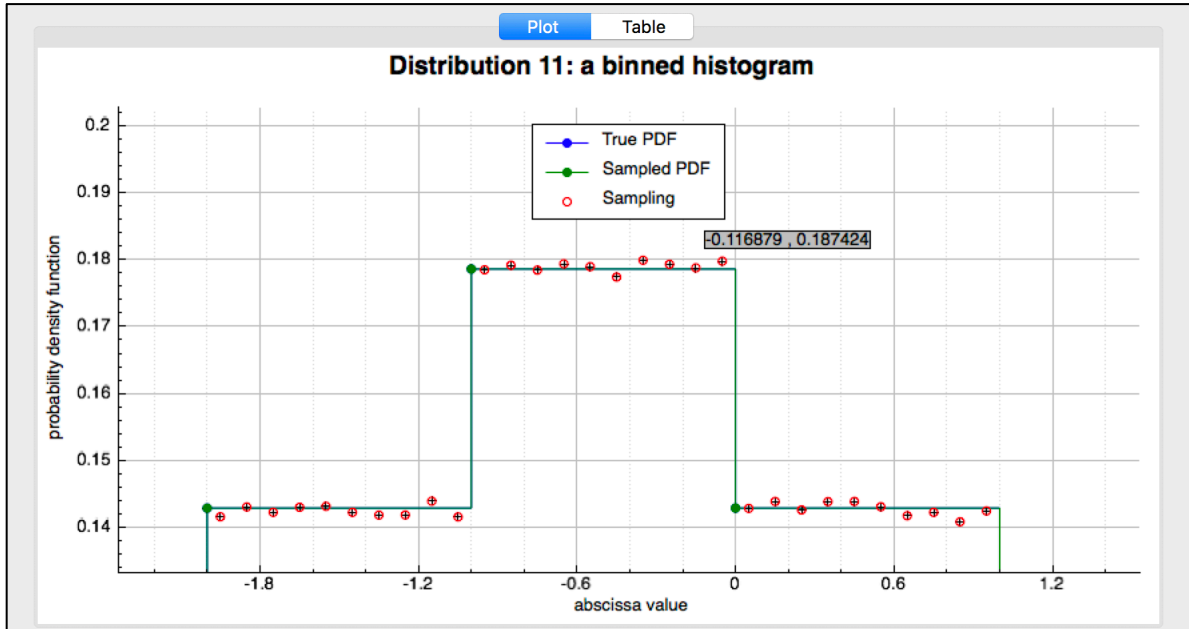


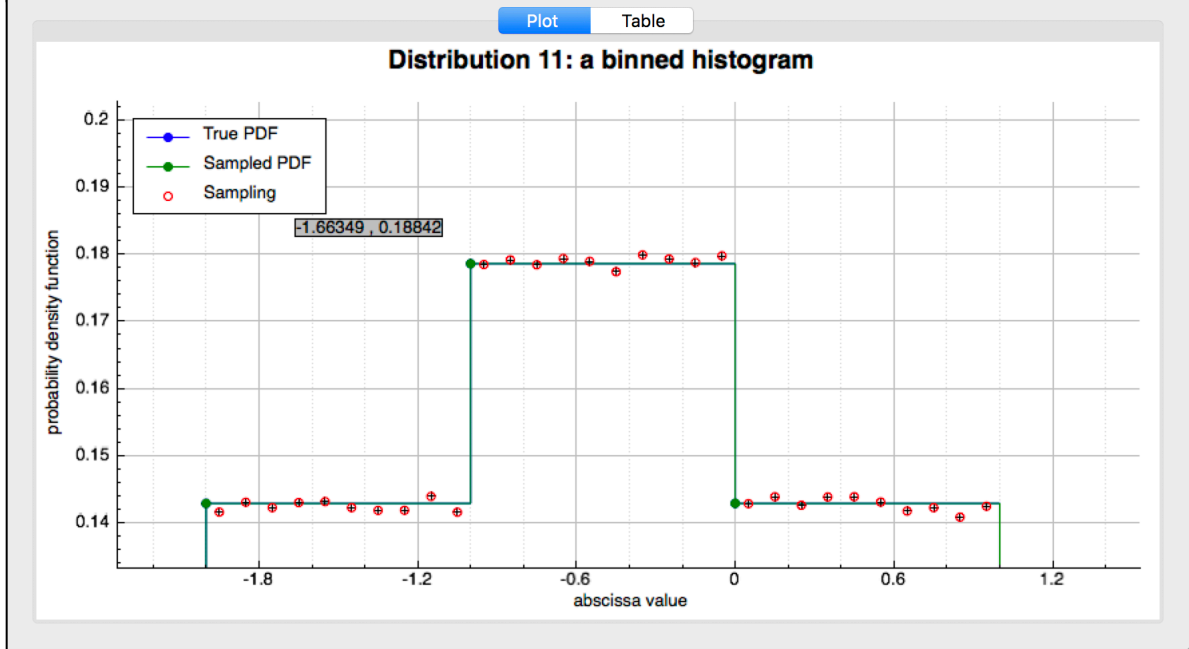
- **Pan down** via **left-click** and **drag down**



Plot Controls | Hands On Legend Position

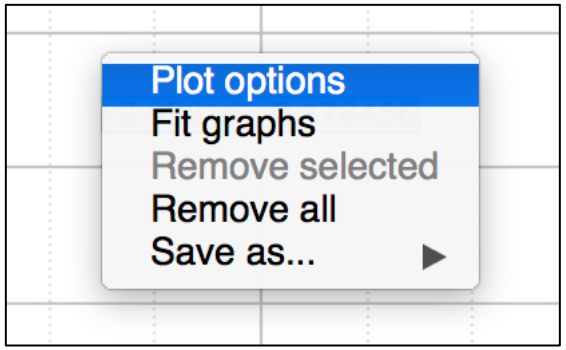
- The **Legend** can be positioned in 9 locations the default is upper-right corner
- Left-click and drag the **Legend** to the upper-left corner
- Observe the **Legend** snap from the upper-right corner to the upper-center to the upper-left corner

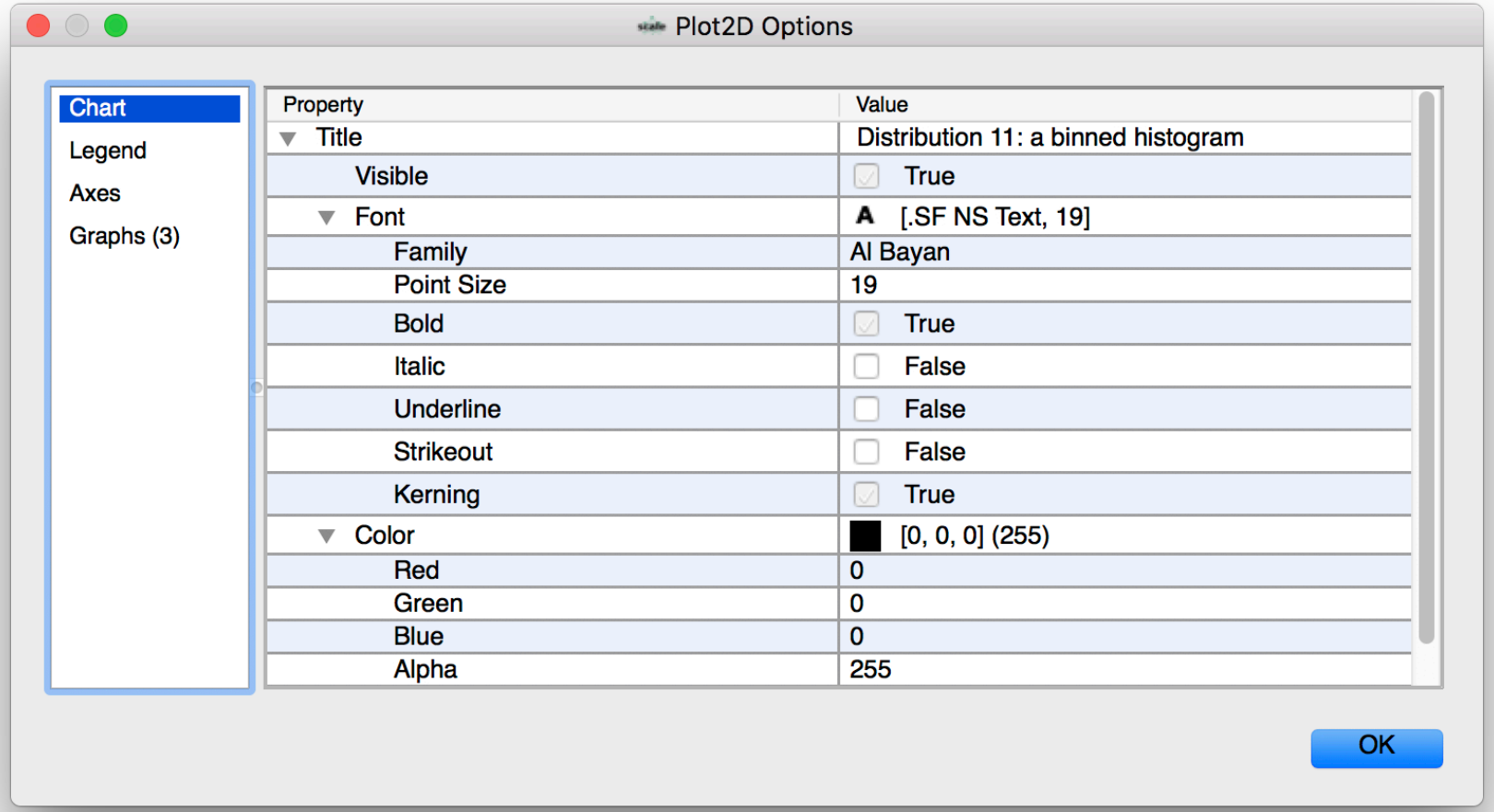




Plot Controls | Hands On Plot Options

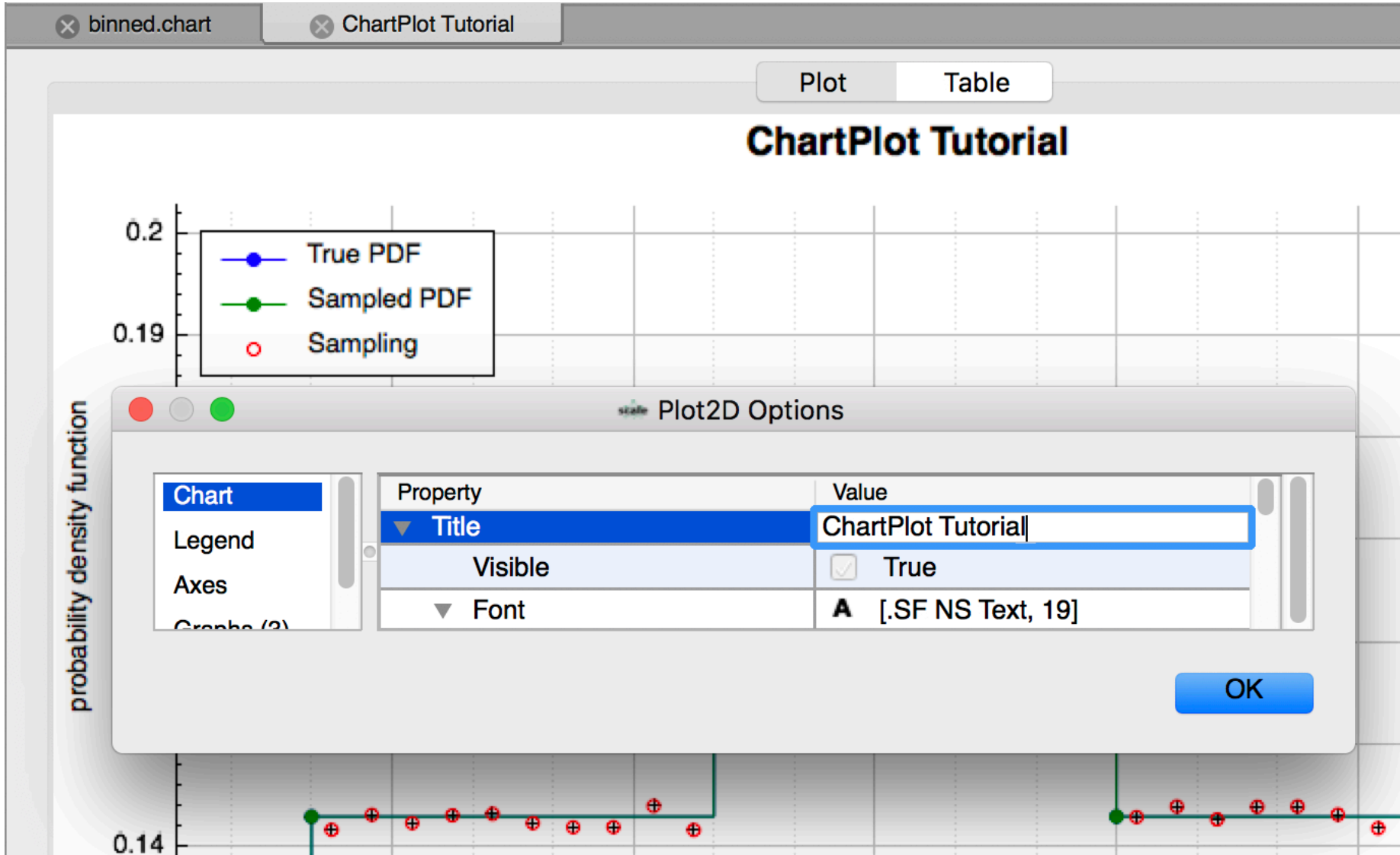
- **Right-click** on the Plot and select **Plot options**
- **Chart** allows changing the plot title's
  - text,
  - font,
  - color, and
  - visibility





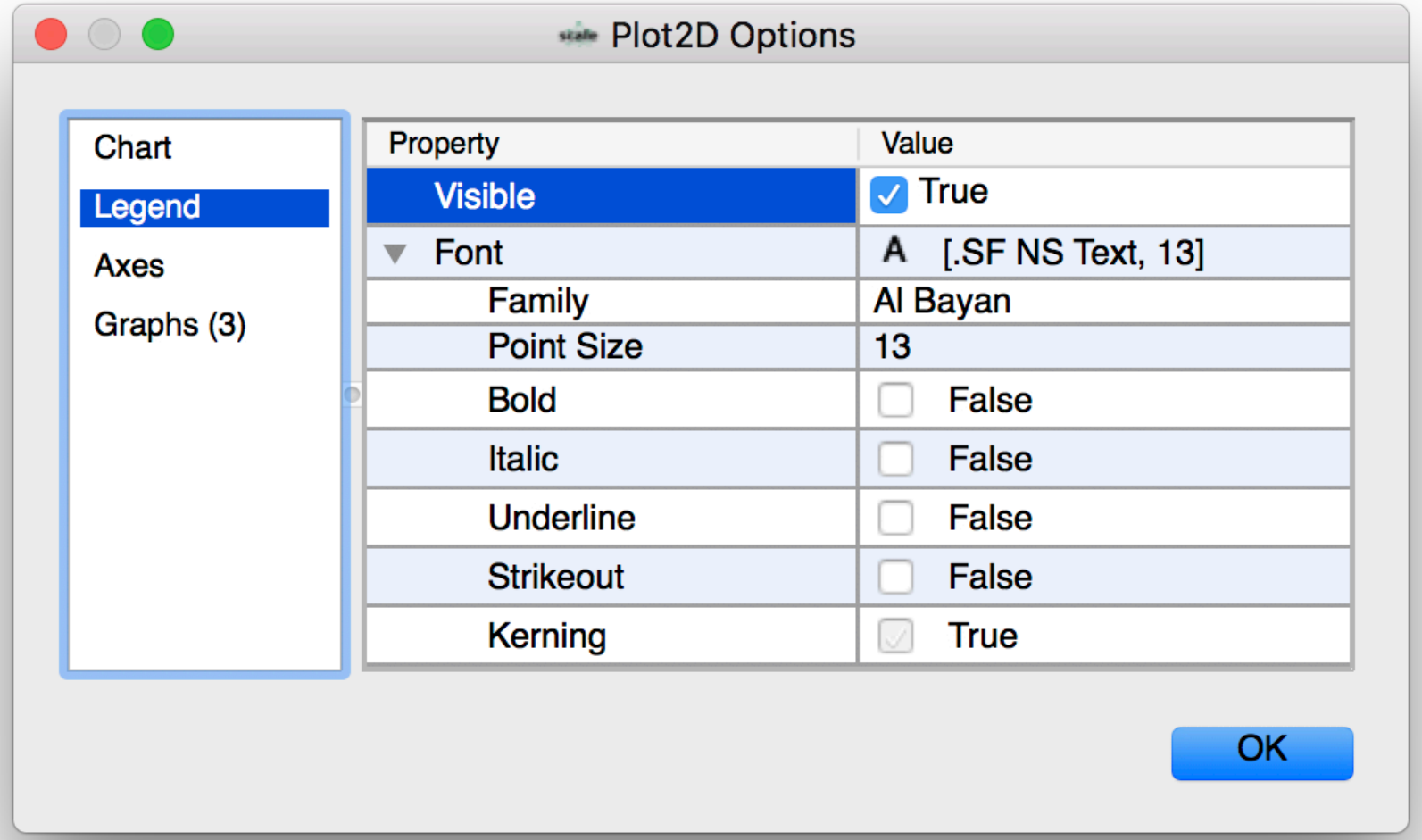
Plot Controls : Plot Options Chart Changes

- In the **Title Value** column remove the existing title and enter **ChartPlot Tutorial**
- Observe the **Plot Tab title** and **Plot Title** update



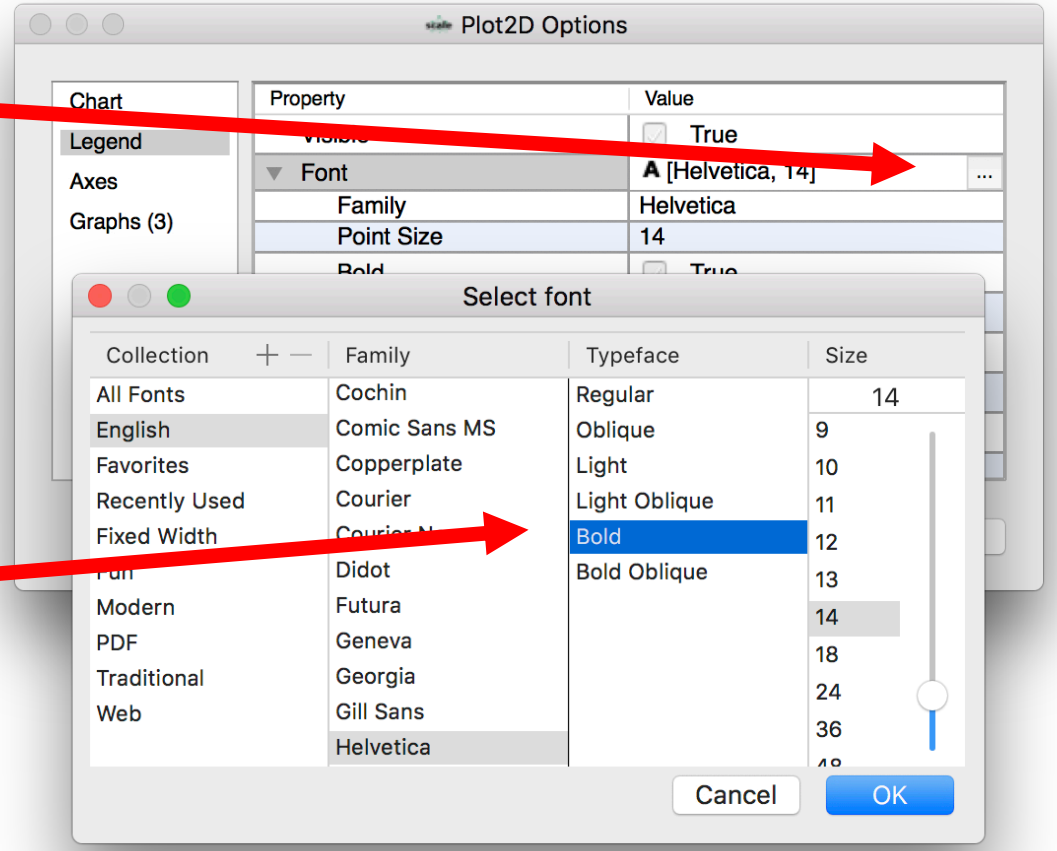
Plot Controls : Plot Options Legend

- **Legend** allows changing the legend's font and visibility



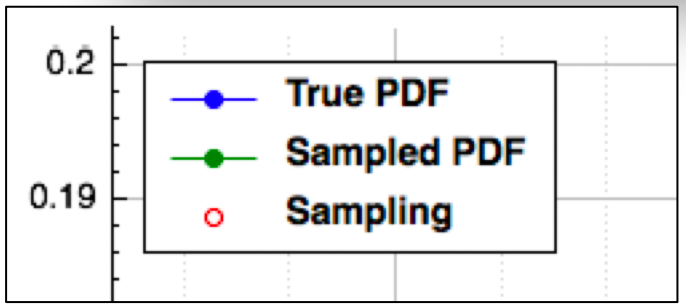
Plot Controls : Plot Options Legend Changes

- Click the **Font** editor ellipsis **…**
  - Note the ellipsis button will appear when the Value column field is selected
  - Platform-specific (Windows, Mac, Linux) Font chooser may appear different than illustrated



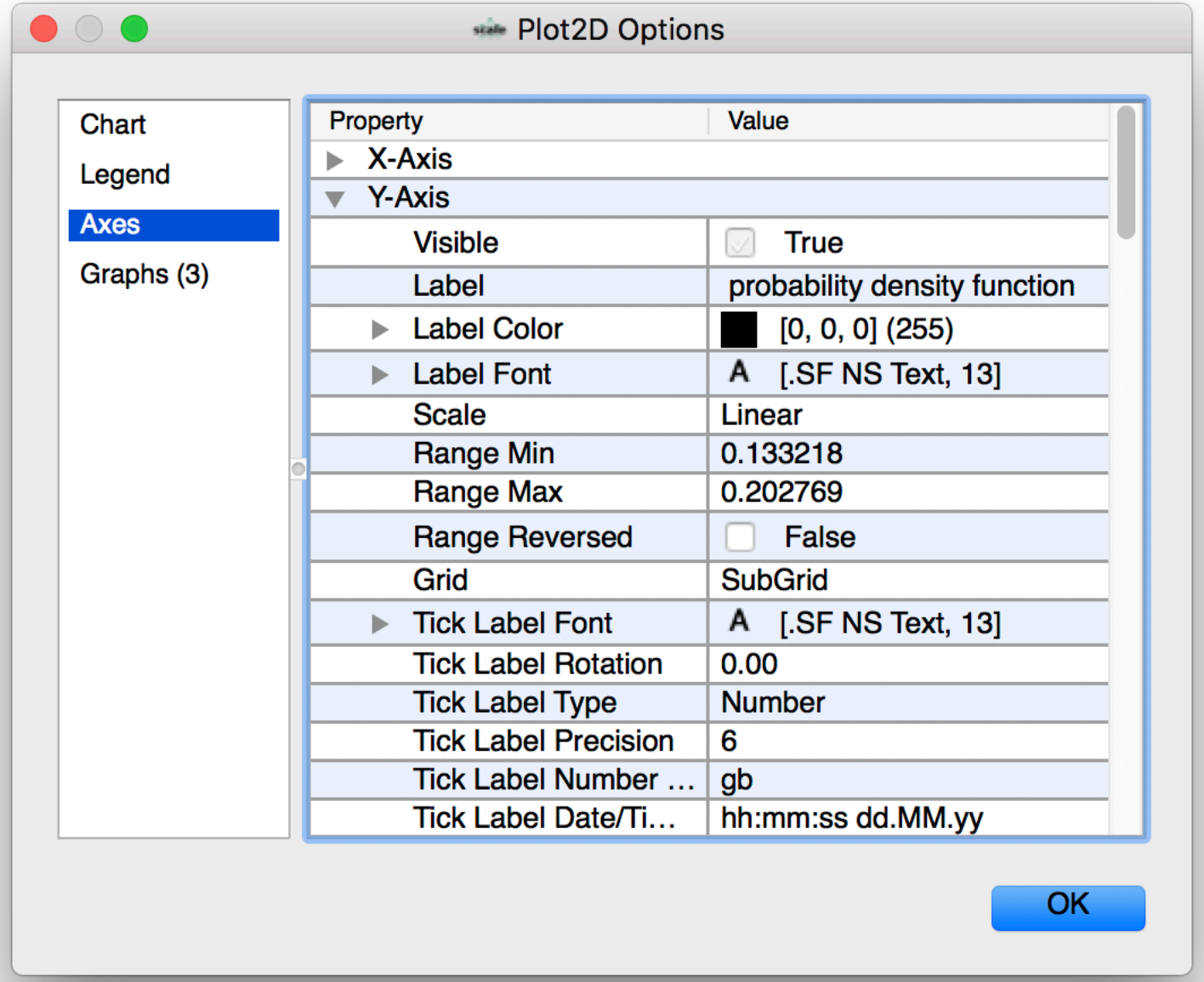
- Change the **Typeface** to be **Bold**
- Click **OK** to close the **Font** editor

- Observe the **Legend** items become **Bold**



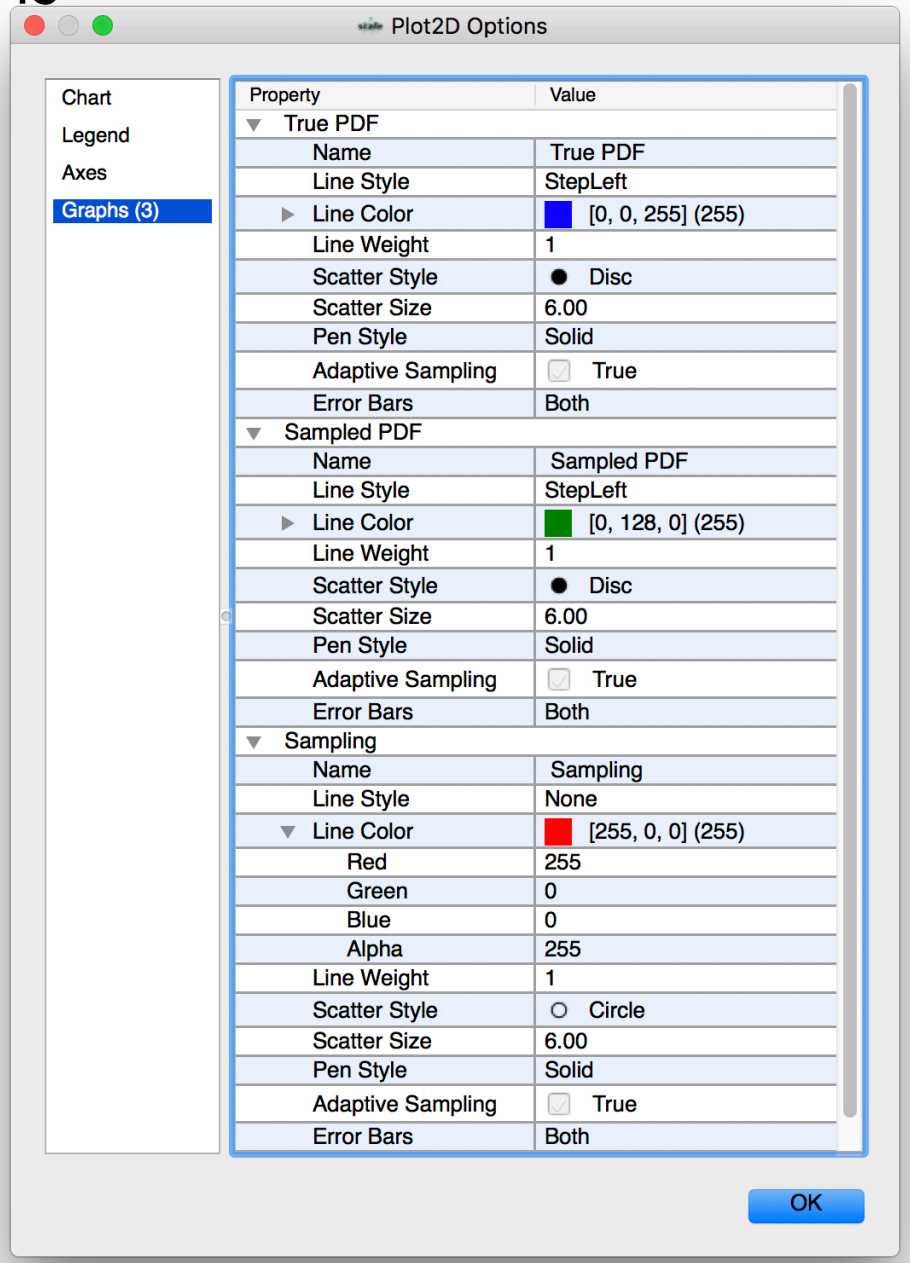
Plot Controls : Plot Options Axes

- **Axes** allows changing axis
  - visibility,
  - label text,
  - text font and color,
  - Scale (linear or log),
  - range,
  - grid,
  - tick label font and attributes (rotation, precision, etc.)



Plot Controls : Plot Options Graphs

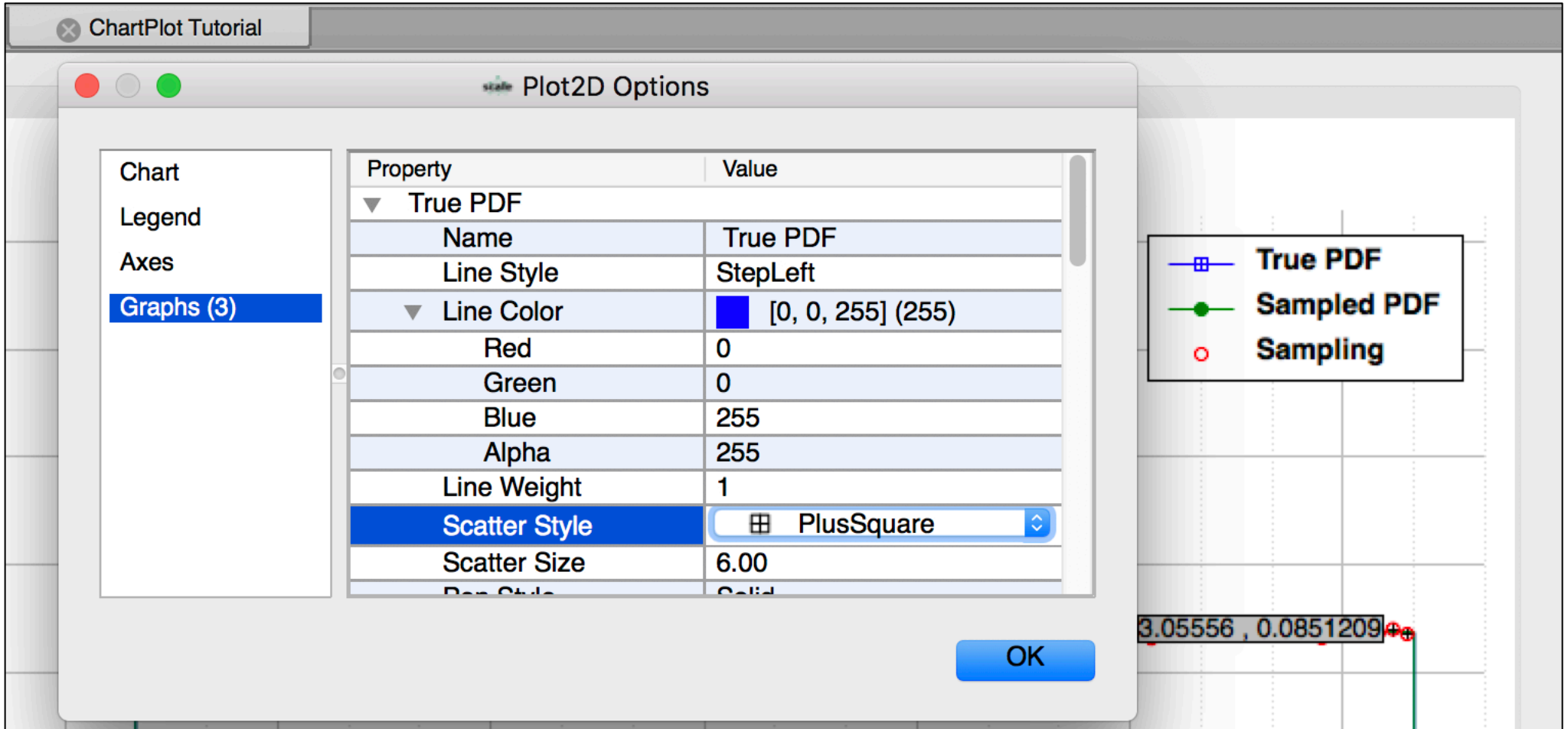
- **Graphs** allows changing
  - graph name,
  - line style, color, and weight,
  - scatter style, and size,
  - pen style,
  - adaptive sampling*,
  - errors bars.



* adaptive sampling – conducts intelligent sampling of the data points providing significant speed up when many data points are involved. Default is on.

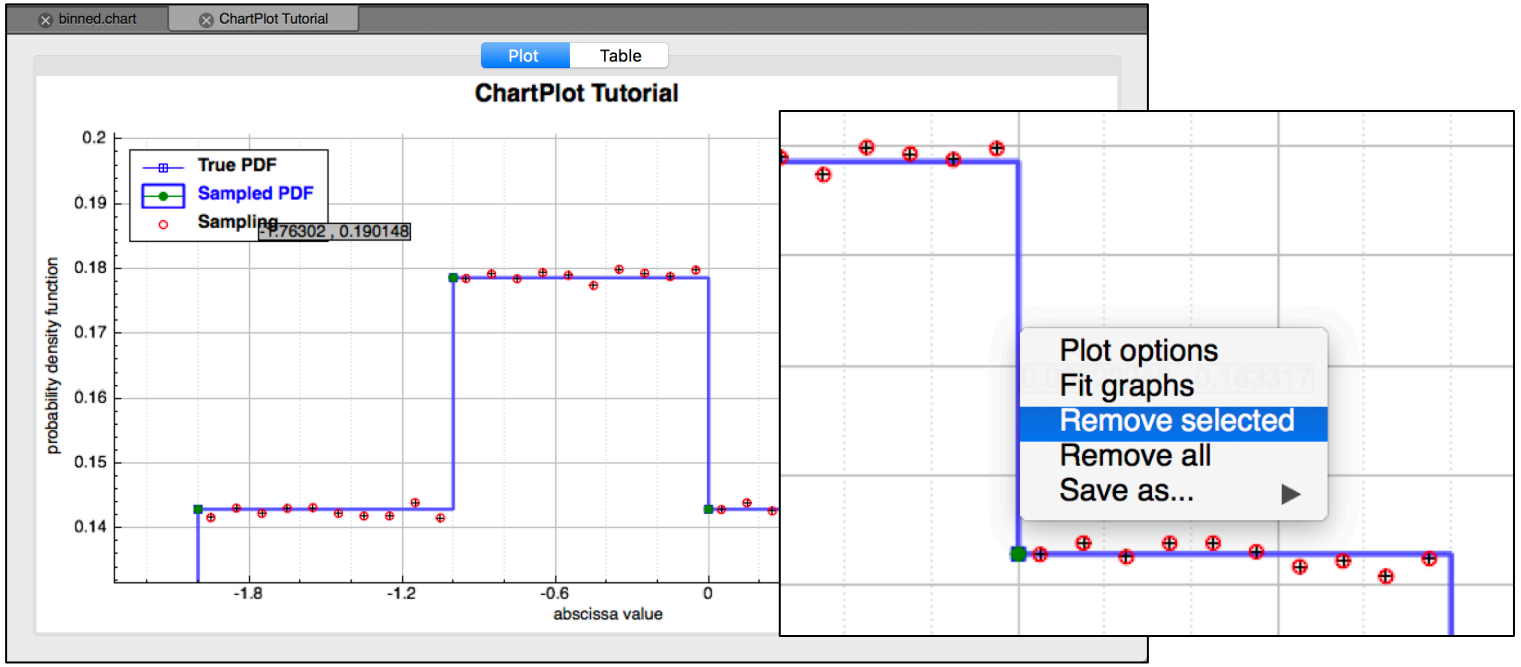
Plot Controls : Plot Options Graph Changes

- Change the **True PDF Scatter Style** to **PlusSquare**
- Observe the **True PDF Legend** entry style update
- Click **OK** to close the **Options** dialog

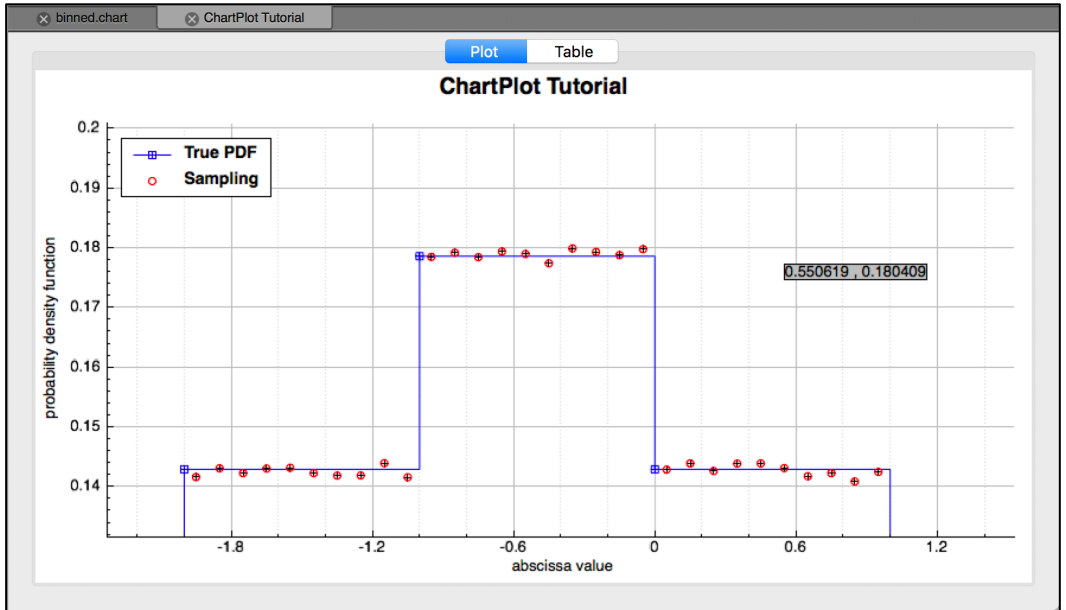


Plot Controls : Graph Removal

- Select the **Sampled PDF** graph via left-click the graph in the plot or in the **Legend**
- Right-Click anywhere in the plot and select **Remove selected**

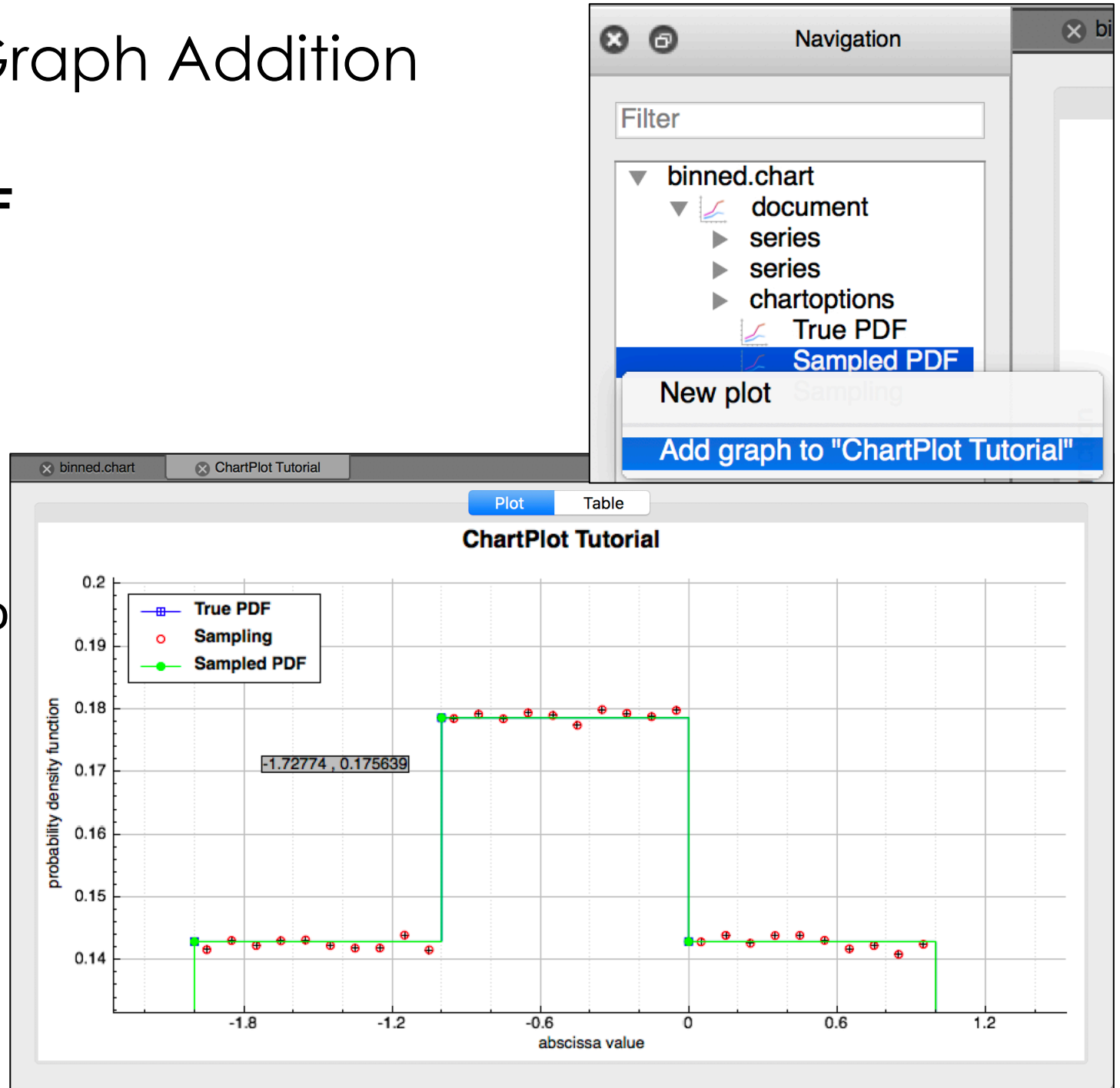


- Observe the **Sampled PDF** is removed from the plot and **Legend**



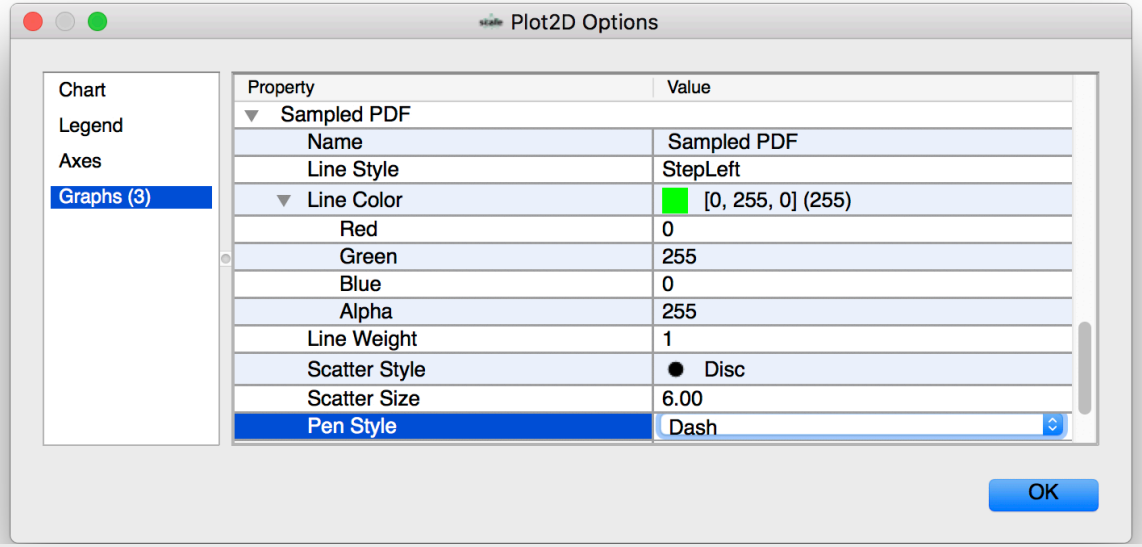
Plot Controls : Graph Addition

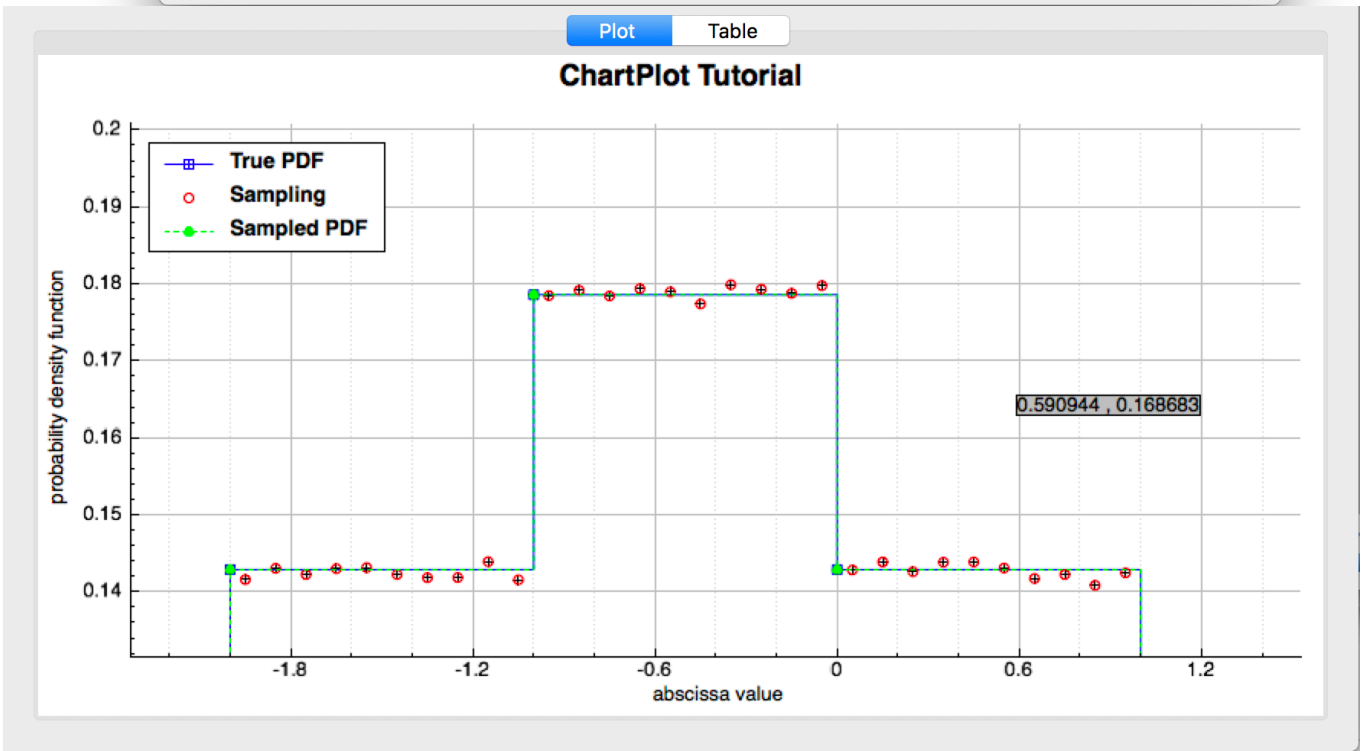
- In the **Navigation** panel right-click the **Sampled PDF**
- select **Add graph to "ChartPlot Tutorial"**
- Observe the **Sampled PDF** is added to the Plot and Legend
- Plot graphs can be added to any plot that has **matching axis names**



Plot Controls : Plot Options Graph Pen Style

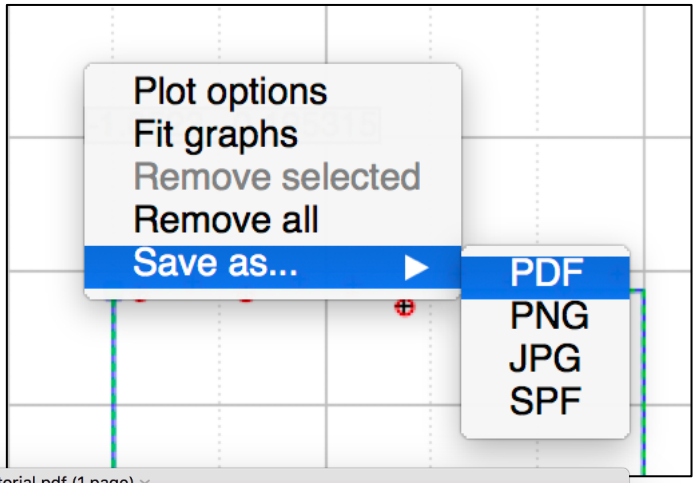
- Right-click the plot and select **Plot Options**
- Update the **Sampled PDF Pen Style** to be **Dashed**
- Click **OK**
- Observe the update in the plot legend and plot, and the improved visibility of **True PDF**

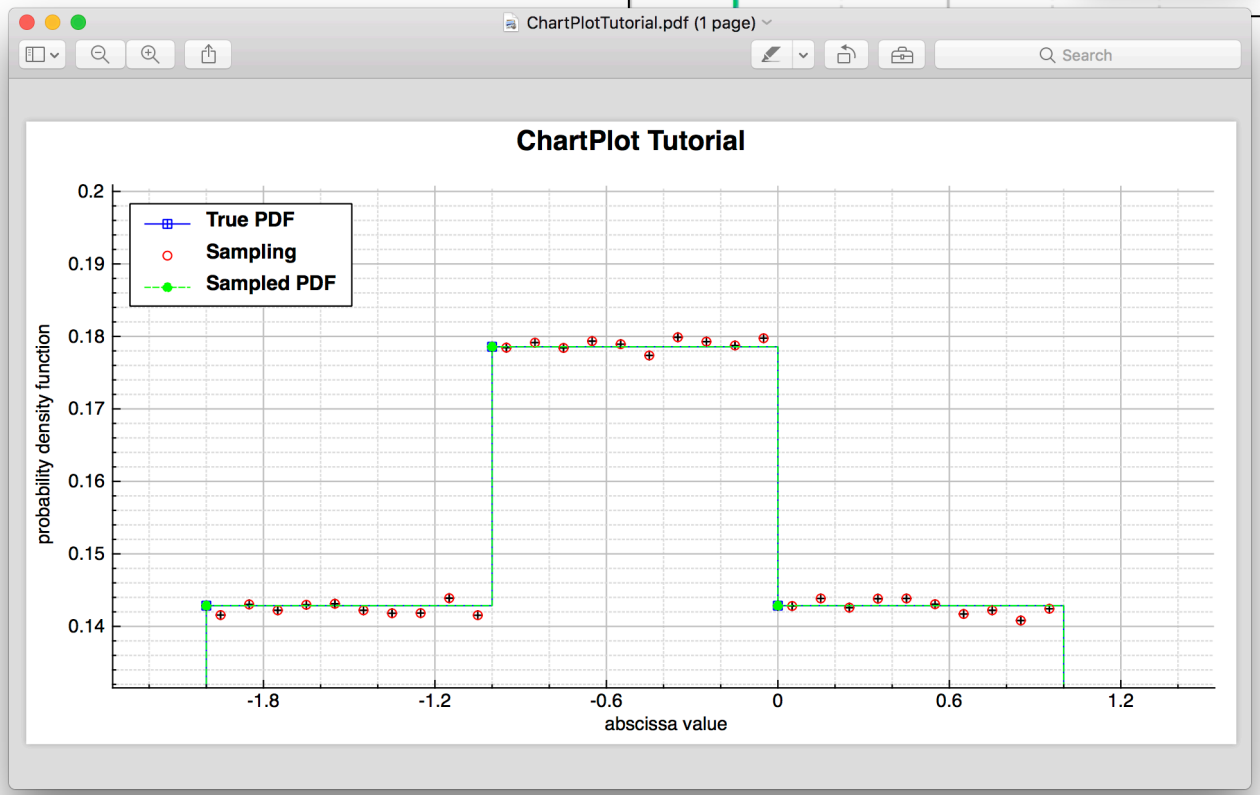




Plot Controls : Save As PDF

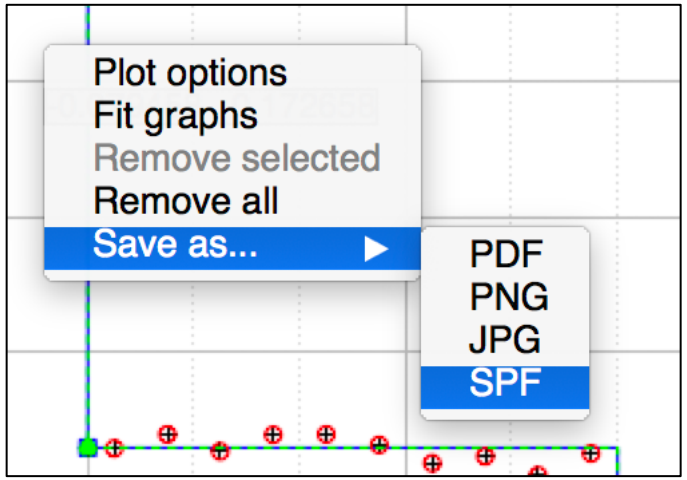
- Save as PDF uses Scalar Vector Graphics (SVG) to improve incorporation into reports
- Right-click the plot and select **Save as… > PDF**
- Save as **ChartPlotTutorial.pdf**
- Open in your PDF viewer and observe report-ready figure

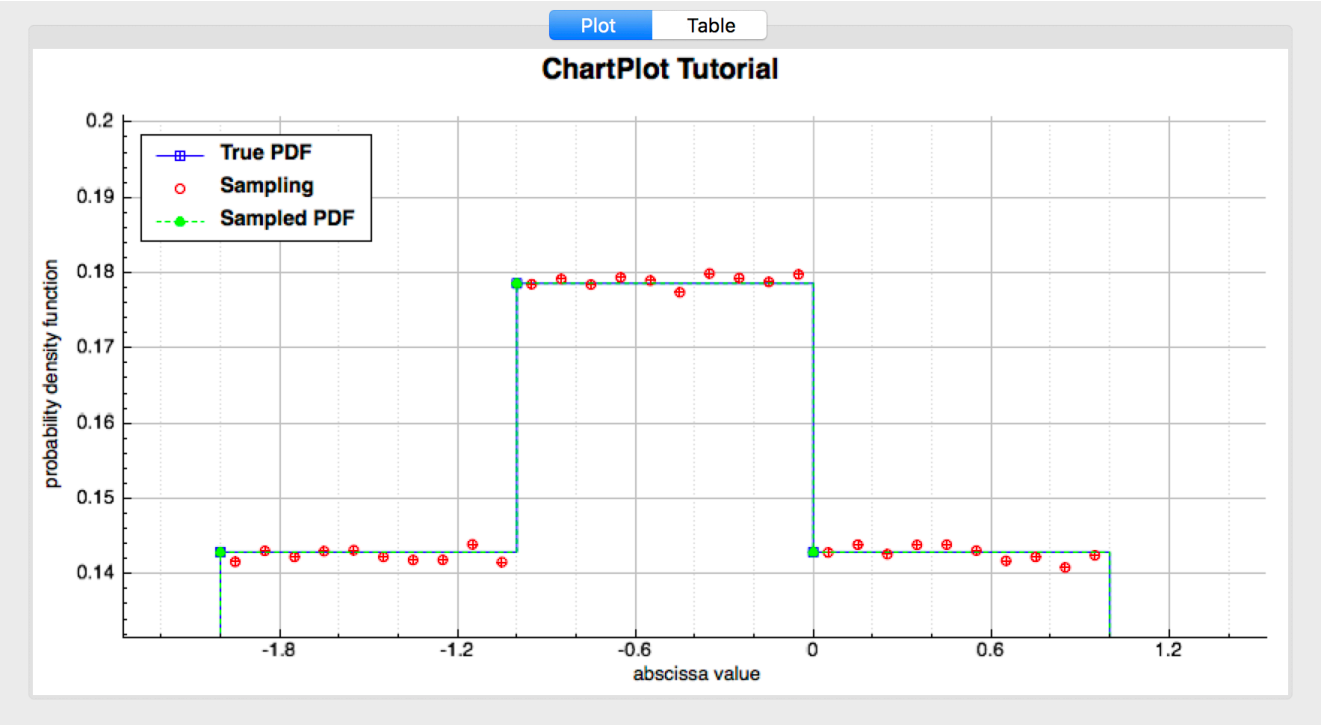




Plot Controls : Save As SPF

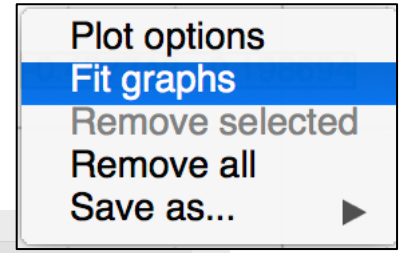
- Save as SPF preserves range and all data (outside zoom) for collaboration
- Right-click the plot and select **Save as… > SPF**
- Save as **ChartPlotTutorial.spf**
- Open the **SPF** file via **File > Open file…** and select **ChartPlotTutorial.spf**
- Observe the **ChartPlotTutorial.spf** available in the **Navigation** panel
- Double left-click the **ChartPlotTutorial.spf > document** plottable item
- Observe the new plot

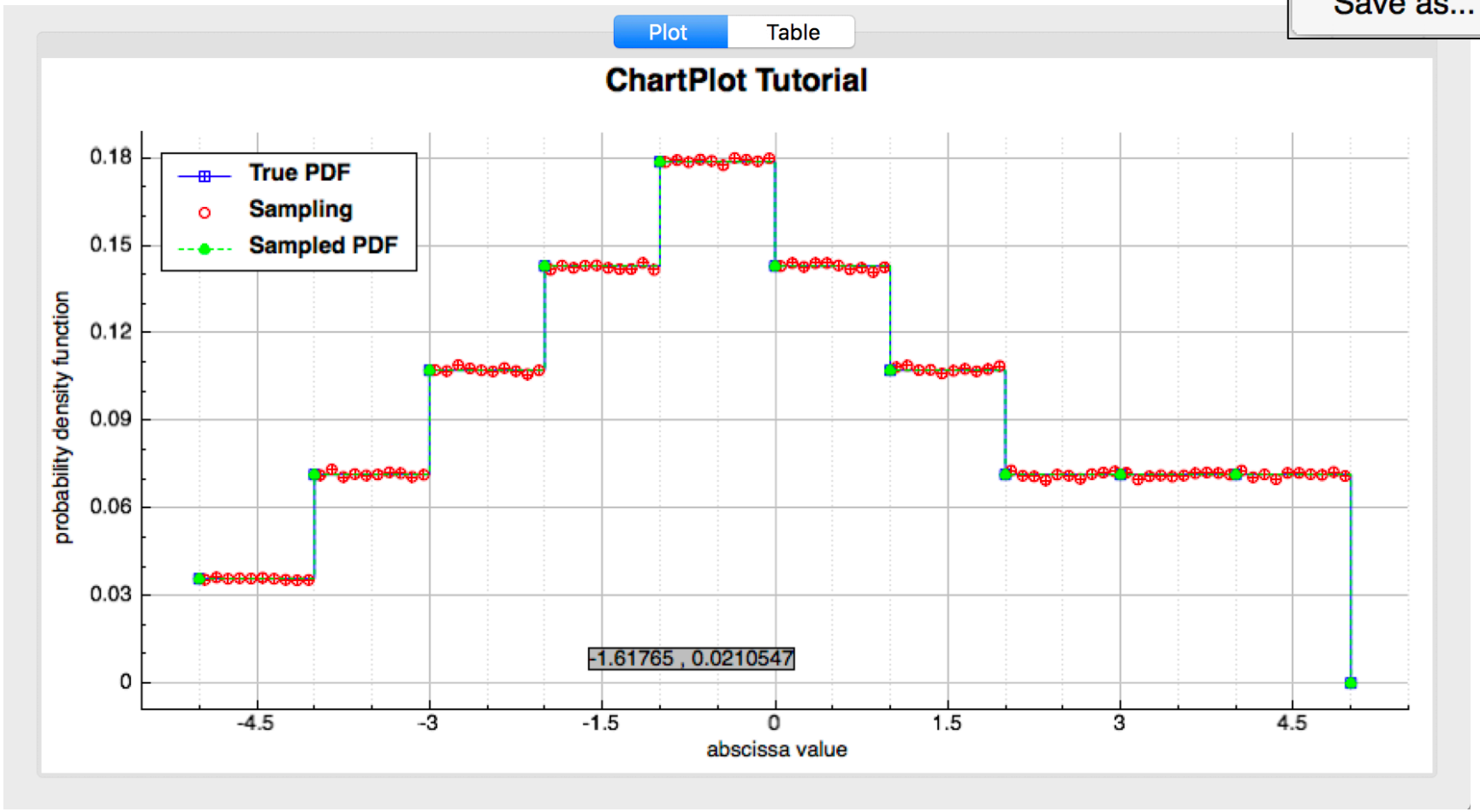




Plot Controls : Fit graphs

- Right-click on the plot and select **Fit graphs** to zoom out to the extents of the graph data
- Useful for quickly identifying the data extents and features



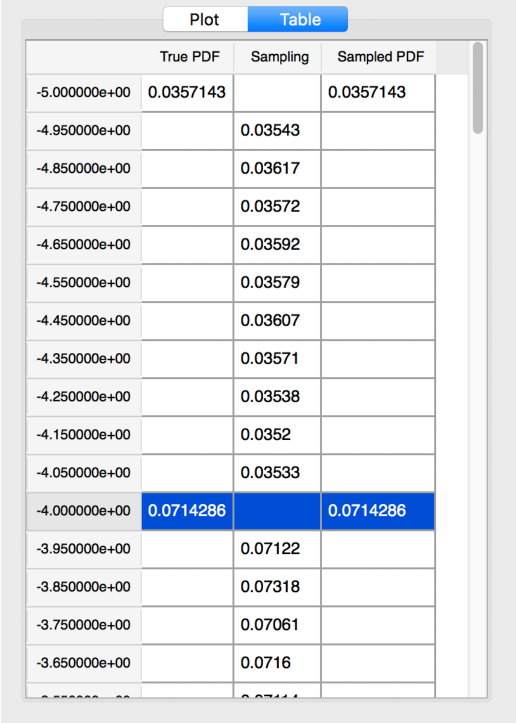


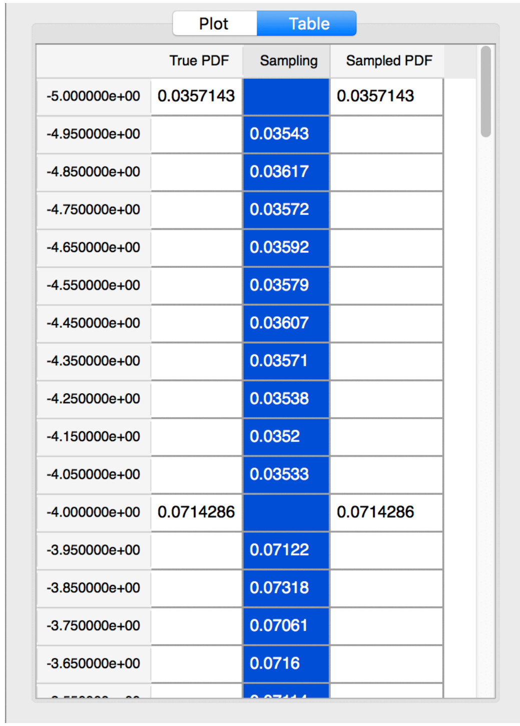
Plot Controls : Plot Options Mentionables

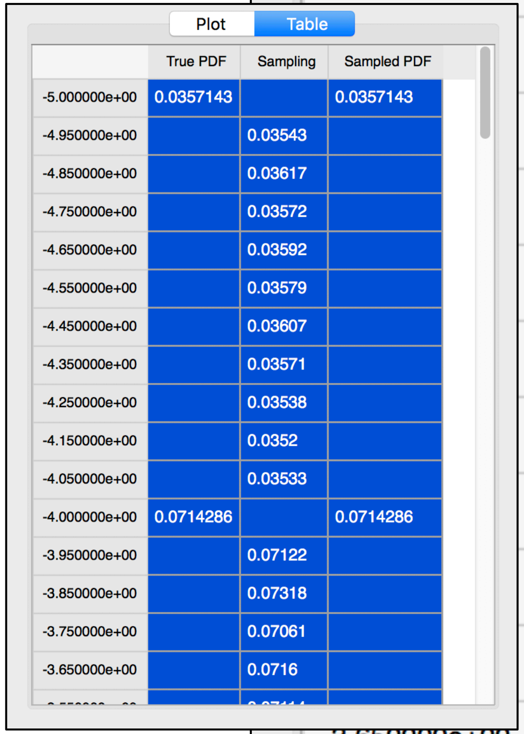
- When the plot is of bars the **Bars** menu allows changing bar graph name
- When the plot is a color/heat map the **Color Map** menu allows changing color map graph name and color gradient

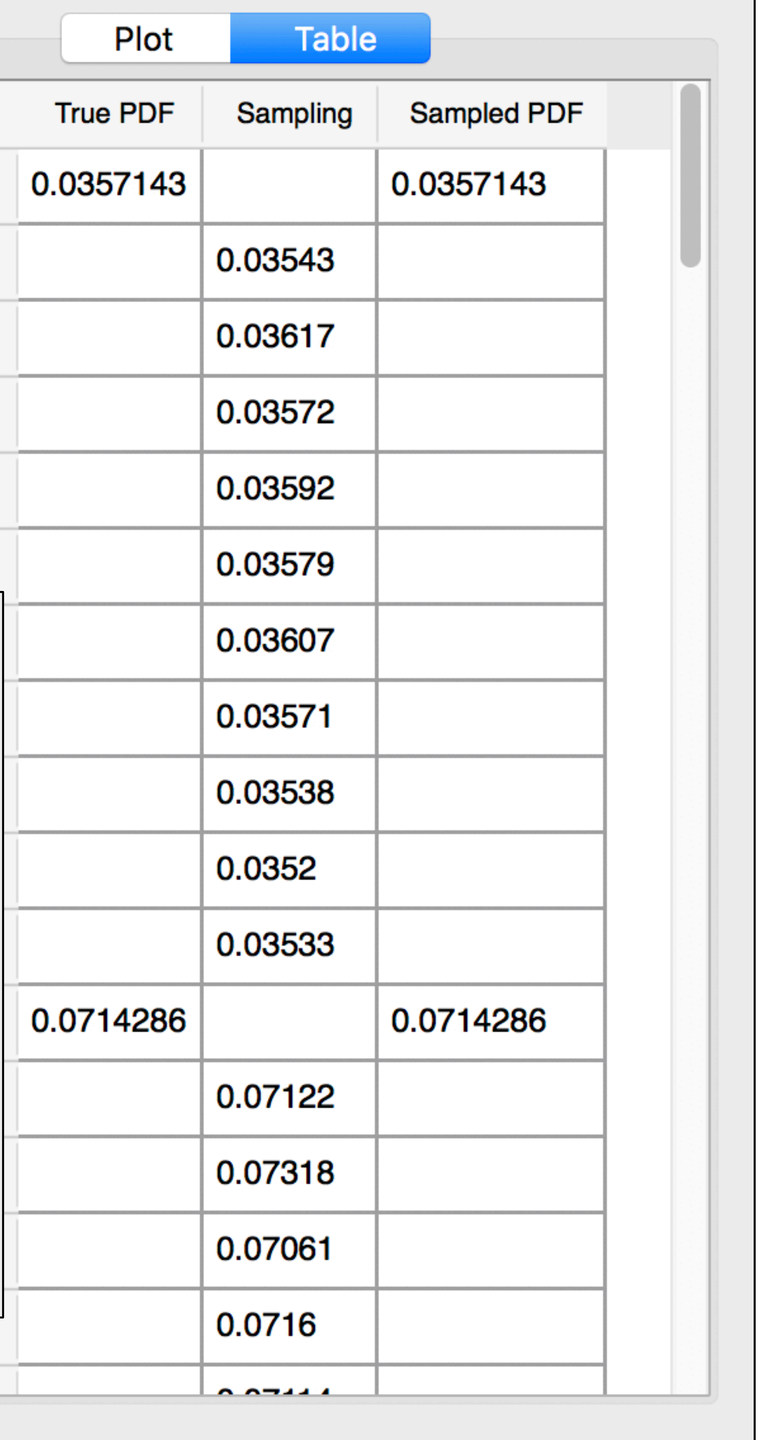
Plot Table

- To see graph data select the **Table** plot tab
- Row, Column, and Table selections allow easy copy-and-paste into Excel, etc.









OAK RIDGE National Laboratory

Plotting | Review

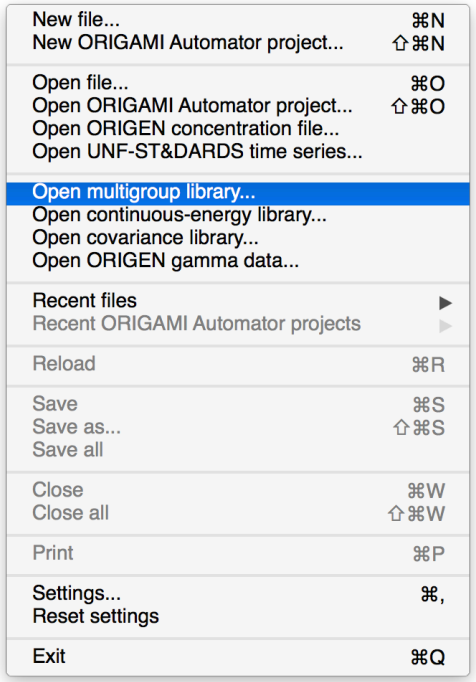
- You are now practiced in
  - Graph **selection**, **removal**, and **addition**
  - Graph **zooming** via mouse/trackpad scrolling
  - Graph **panning** via left-click and dragging
  - Graph **Legend** position adjustment via left-click and dragging
  - Graph data **table** acquisition
  - Plot **attributes** (color, style, etc.) via context menu **Plot options**
  - **Reset** to original extents via context menu **Fit graphs**

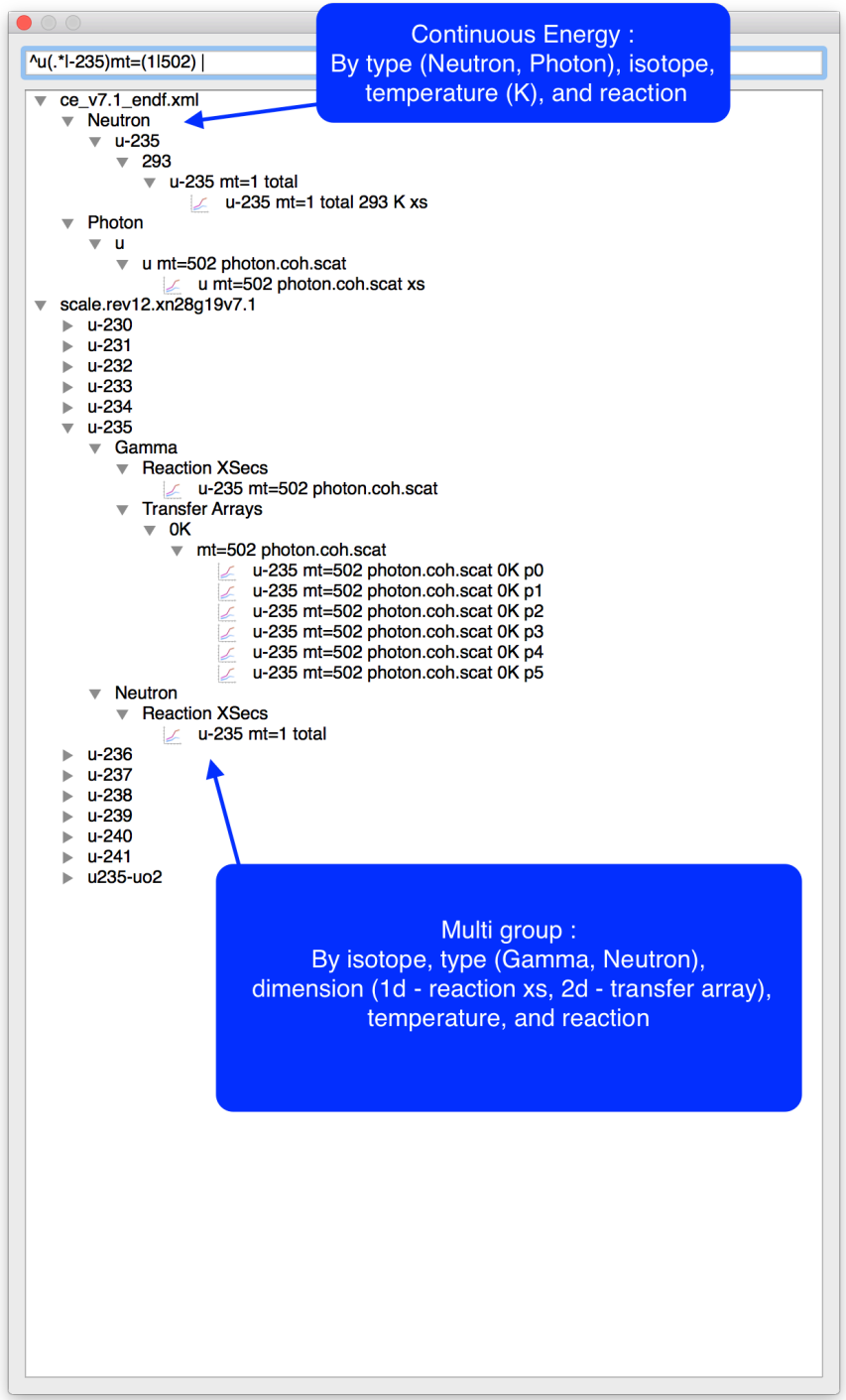
- **Questions?**
- Close all open documents via **File > Close All**
- Close all tabs via **right-clicking** any tab and selecting **Close all tabs**

AMPX Cross Section Data

AMPX Cross Section Data is available in multigroup (MG) and continuous-energy form and is located at ${SCALE}/data. Because the files do not have a unique extension, the user must load them specifically by type.

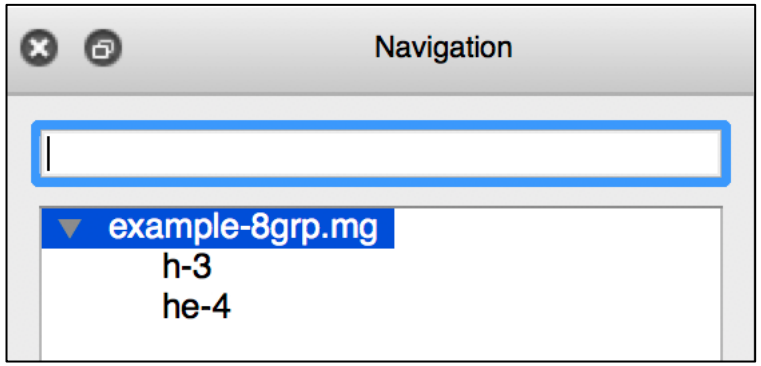
- Load MG XS data via **File>Open multigroup library…**
- Load CE XS data via **File>Open continuous-energy library...**
- CE XS data are displayed hierarchically
  - by Neutron or Photon, Isotope, Temperature (K), and Reaction.
- MG XS data are displayed hierarchically
  - By Isotope, Neutron or Gamma, Reaction XS or transfer array.



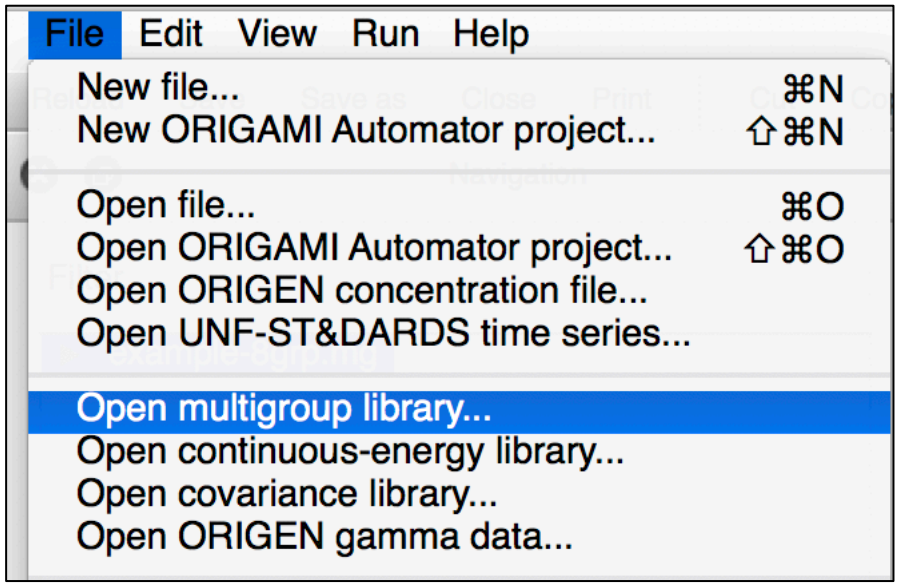


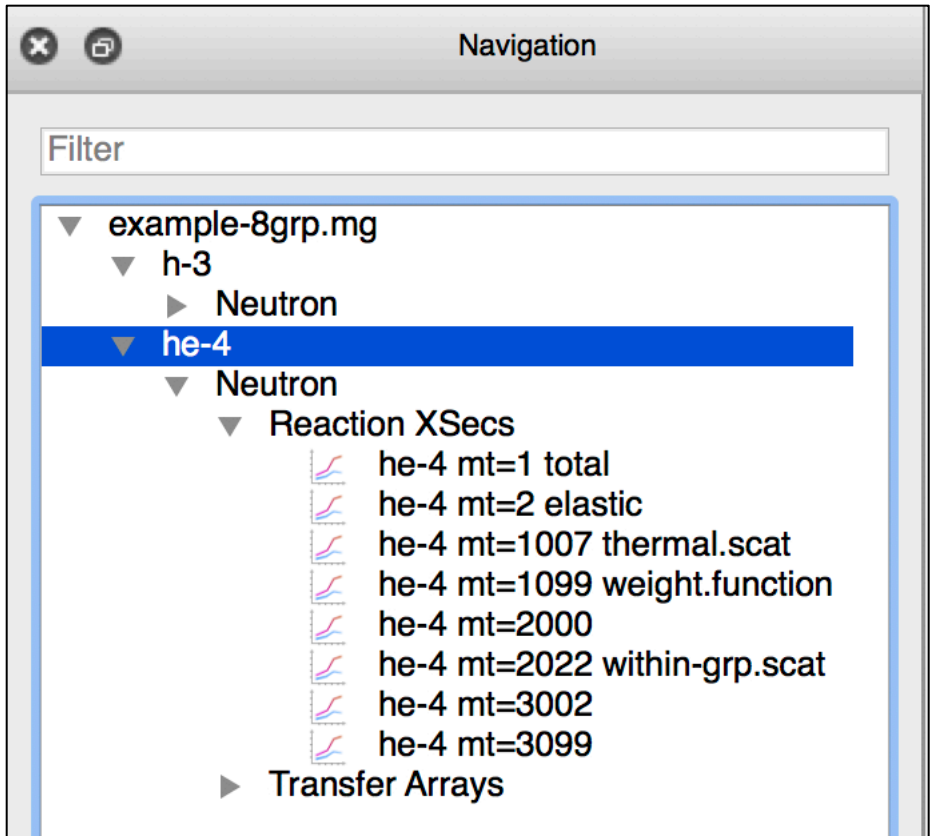
AMPX XS | Hands On

- Click **File > Open multigroup library…** and open **Advanced_User_Interface/AmpxMG/example-8grp.mg**
- Observe the **example-8grp.mg** file become visible in the **Navigation panel**



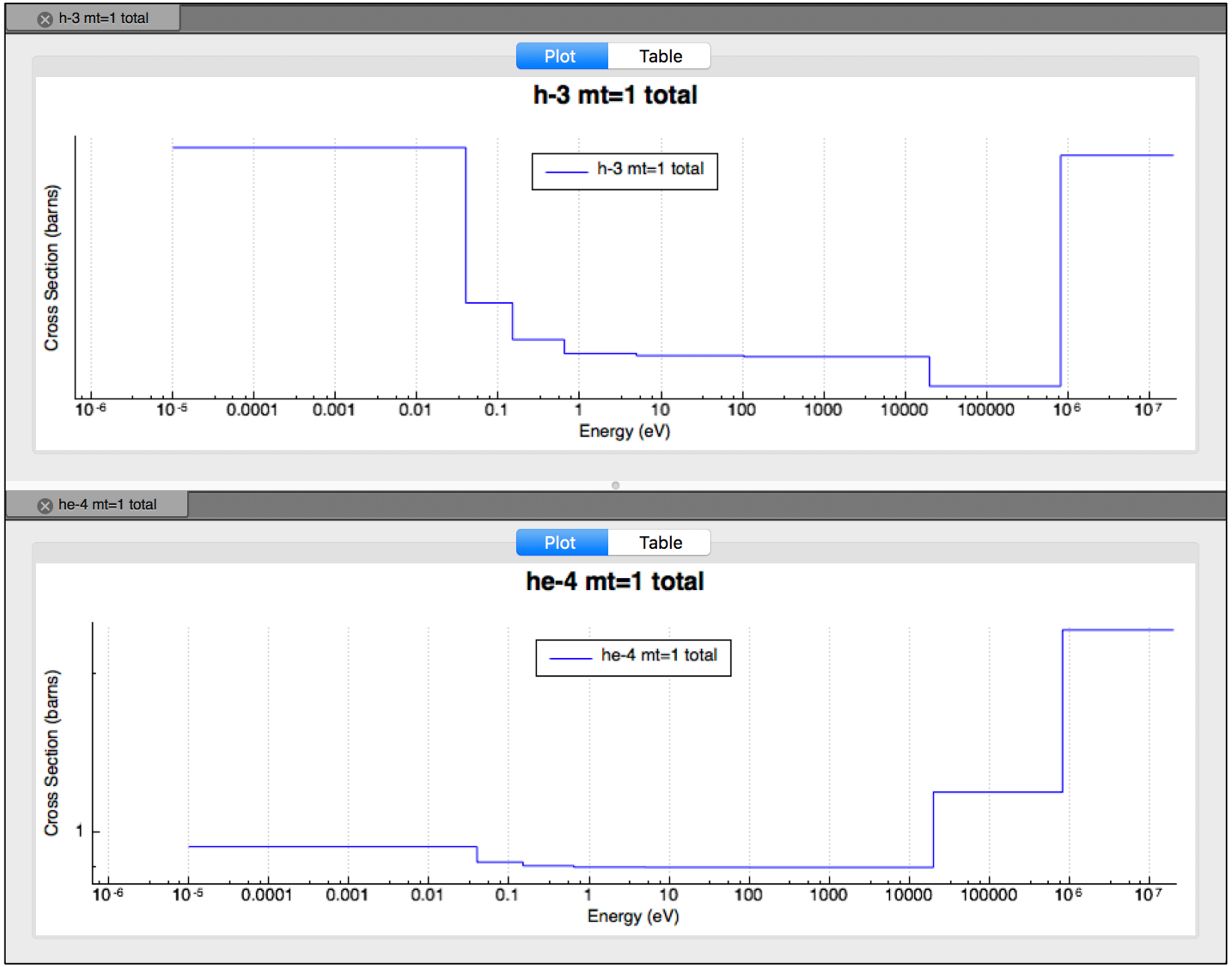
- Double left-click each (**h-3**, **he-4**) to load individual data sets into Fulcrum
  - Because MG libraries can be large Fulcrum in 6.3 (beta 12+) no longer loads all data





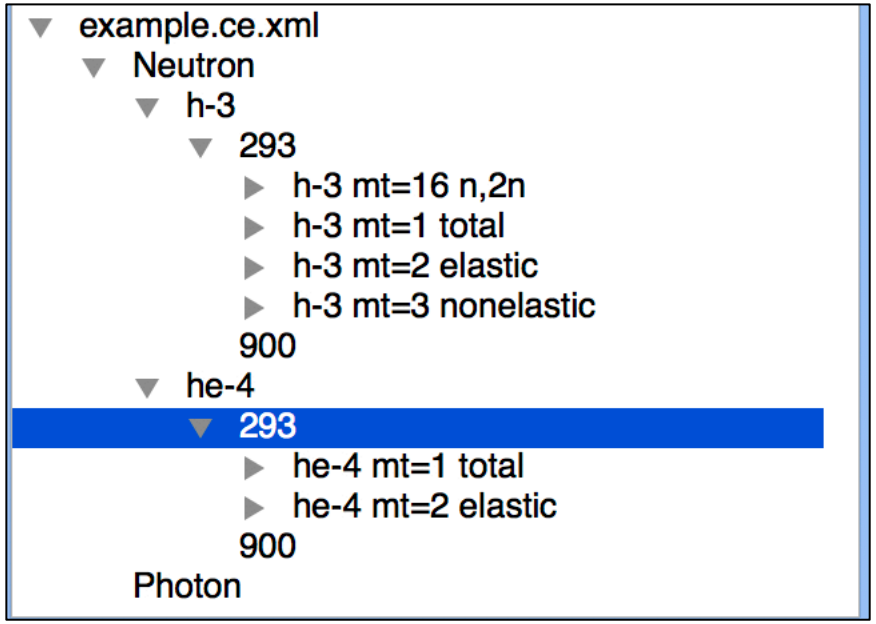
AMPX XS | MG Hands On

- Plot **h-3 mt=1 total** and the **he-3 mt=1 total** on **separate** plots
- Split the Fulcrum workspace by dragging the **he-4 mt=1 total tab** and dropping it at the **bottom-center** (on top of 'Energy (ev)' axis label) of the plot
- Change the **Legend** position to not overlap the data



AMPX XS | Hands On

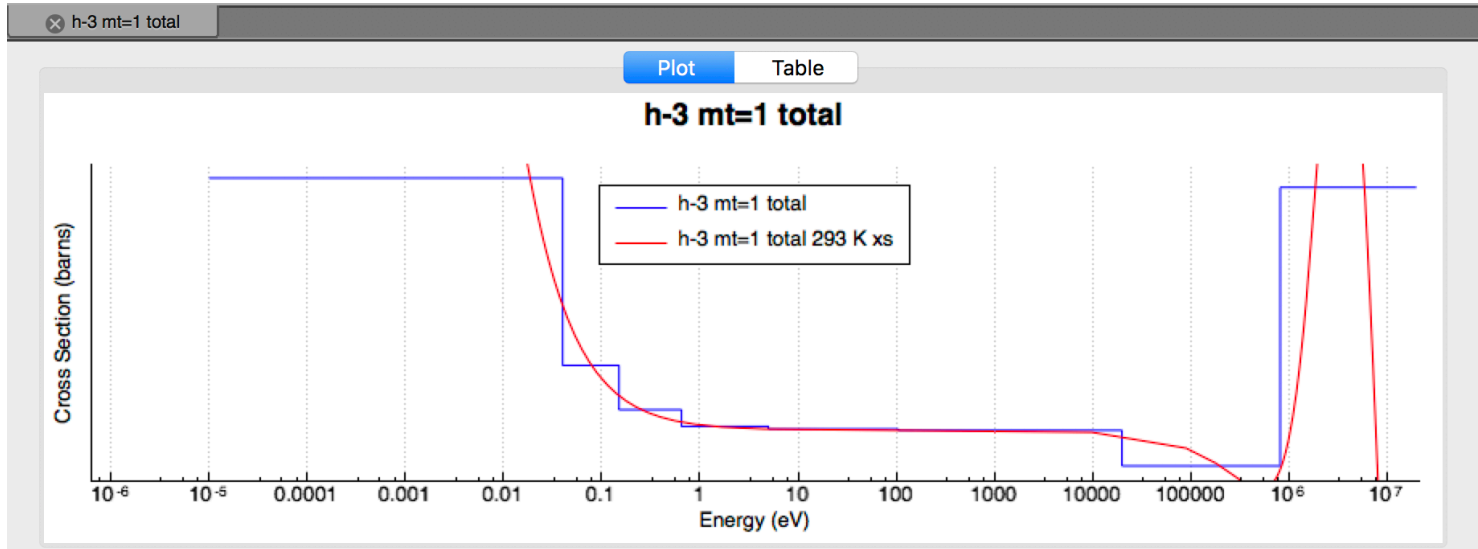
- Click **File > Open continuous-energy library…** and open **Advanced_User_Interface/AmpxCE/example.ce.xml**
- Observe the **example-ce.xml** file become visible in the **Navigation panel**
- Expand the **Neutron** and subsequent **h-3** and **he-3 Navigation** item and observe their available temperatures
- Double left-click each **293** (**h-3**, **he-4**) to load individual temperature data sets into Fulcrum
  - Because CE libraries are large Fulcrum doesn't load all temperature data automatically
- Observe the **nuclide reaction** listed in the **Navigation** panel

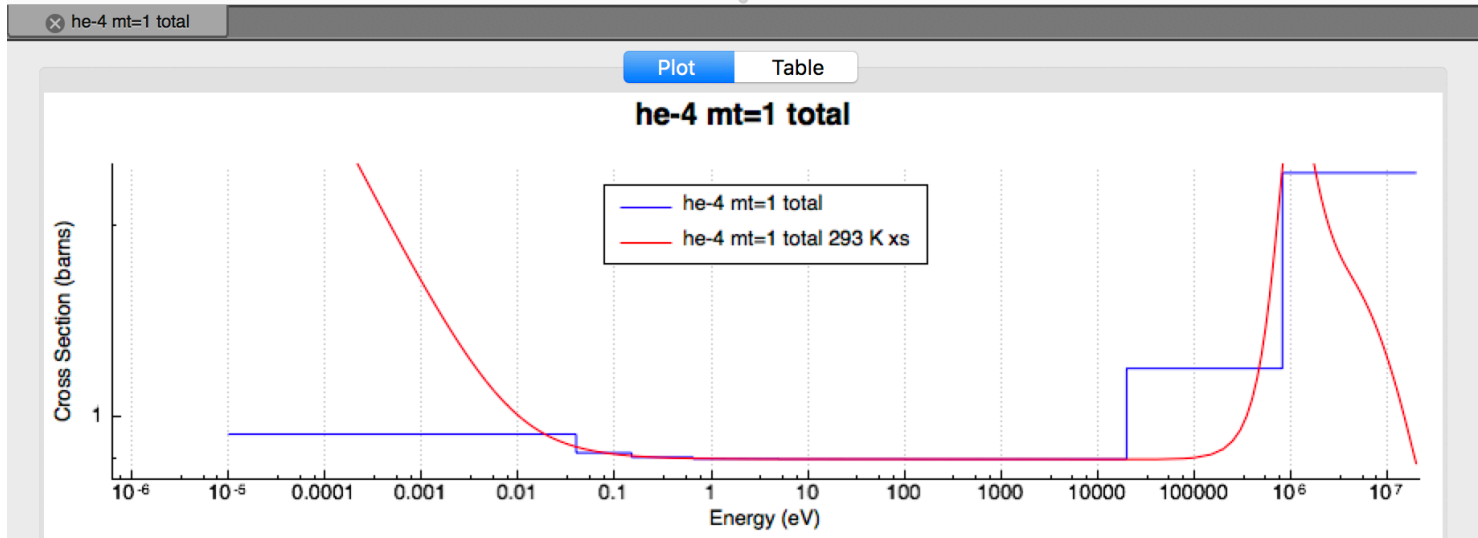


AMPX XS | Hands On

- Expand the **h-3 mt=1 total** and add the **h-3 mt=1 total 293 k xs** to the existing **h-3 mt=1 total** multigroup plot

- Expand the **he-4 mt=1 total** and add the **he-4 mt=1 total 293 k xs** to the existing **he-4 mt=1 total** multigroup plot
- Observe the comparison of the MG and CE cross sections
- **Questions?**
- **Close all files and tabs**

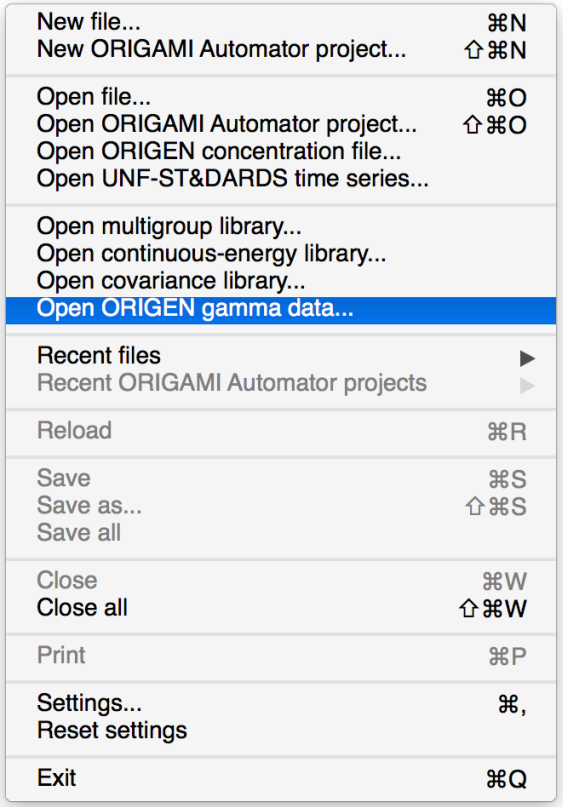


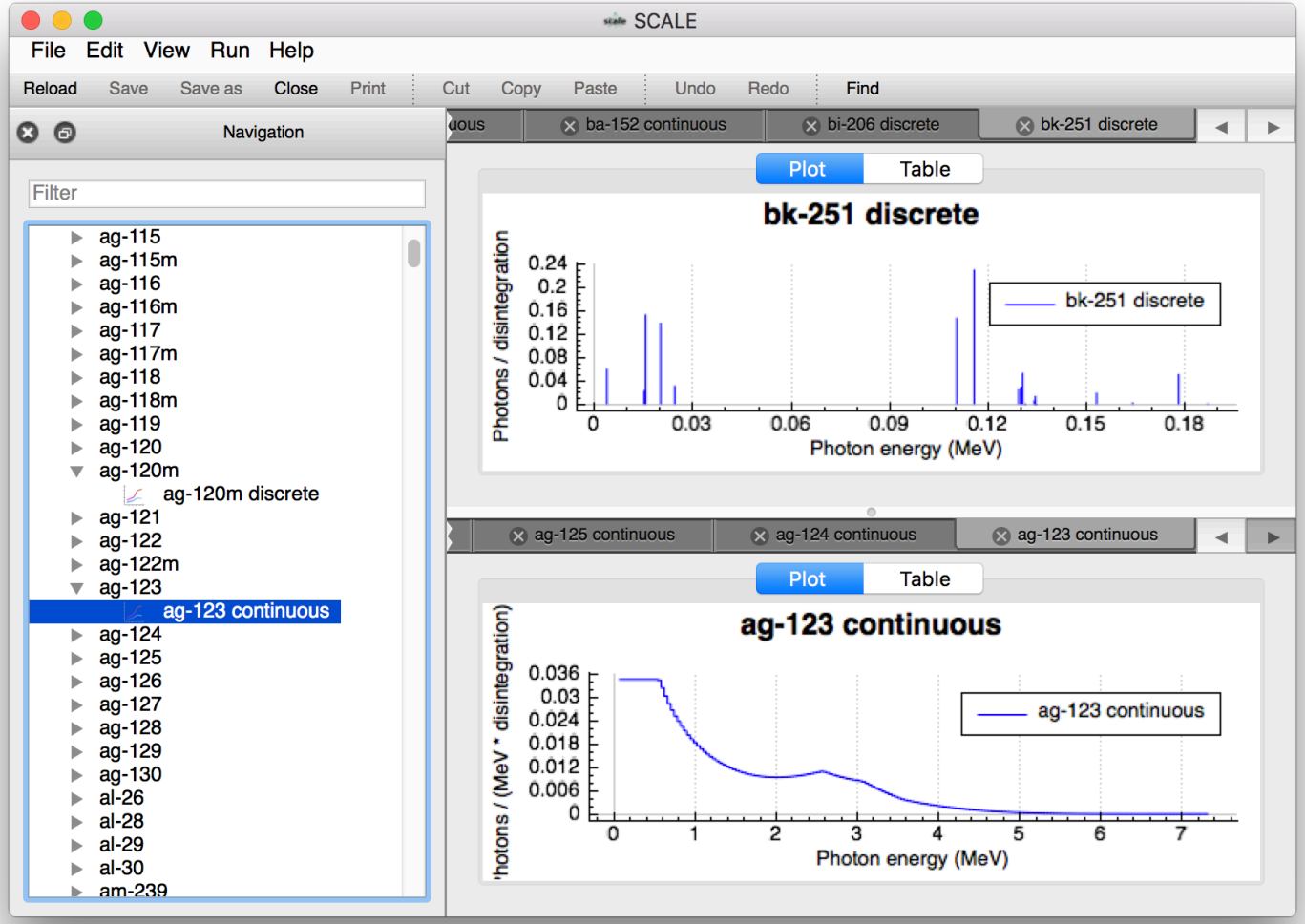


ORIGEN Gamma Data

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…**

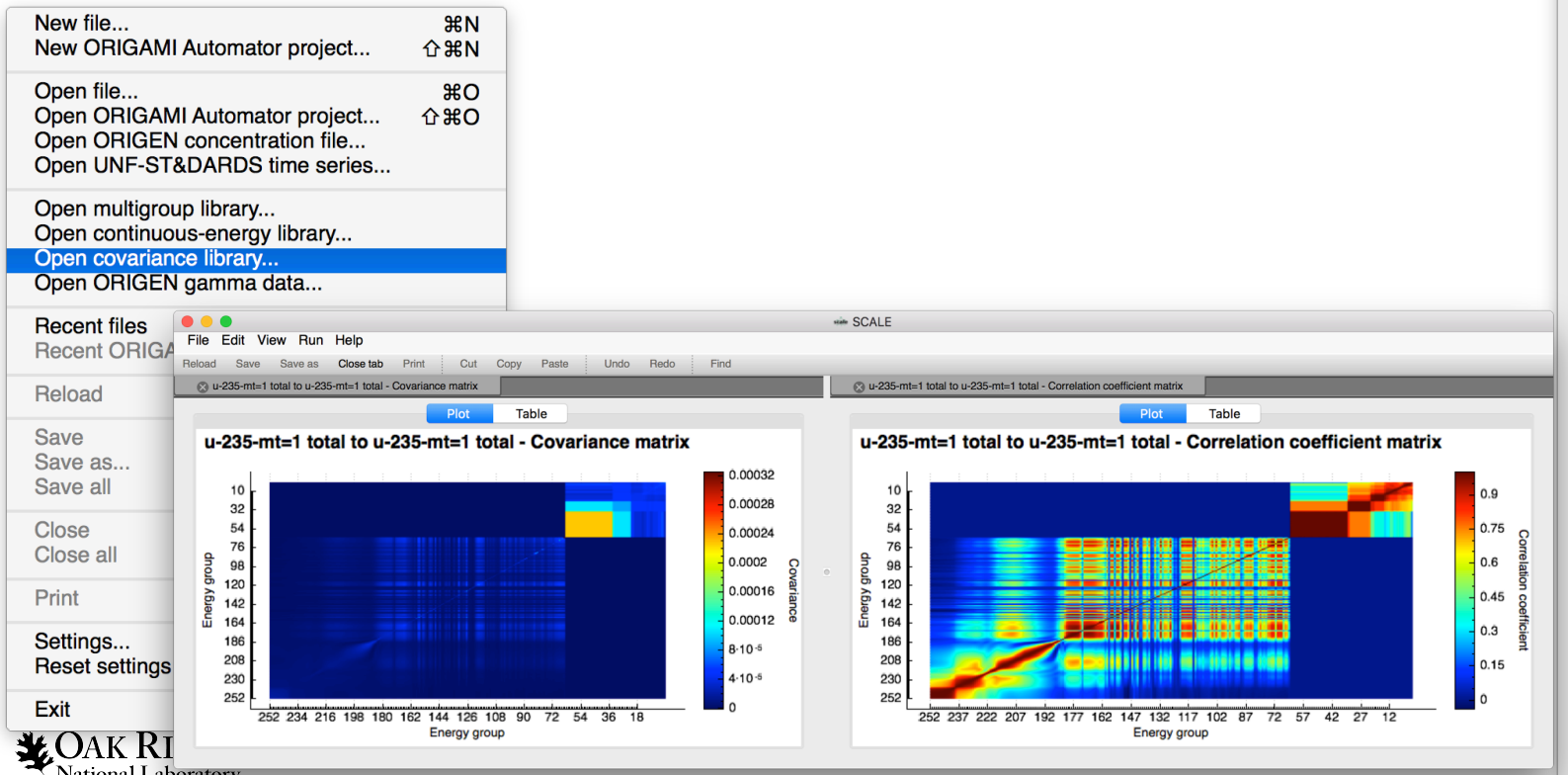


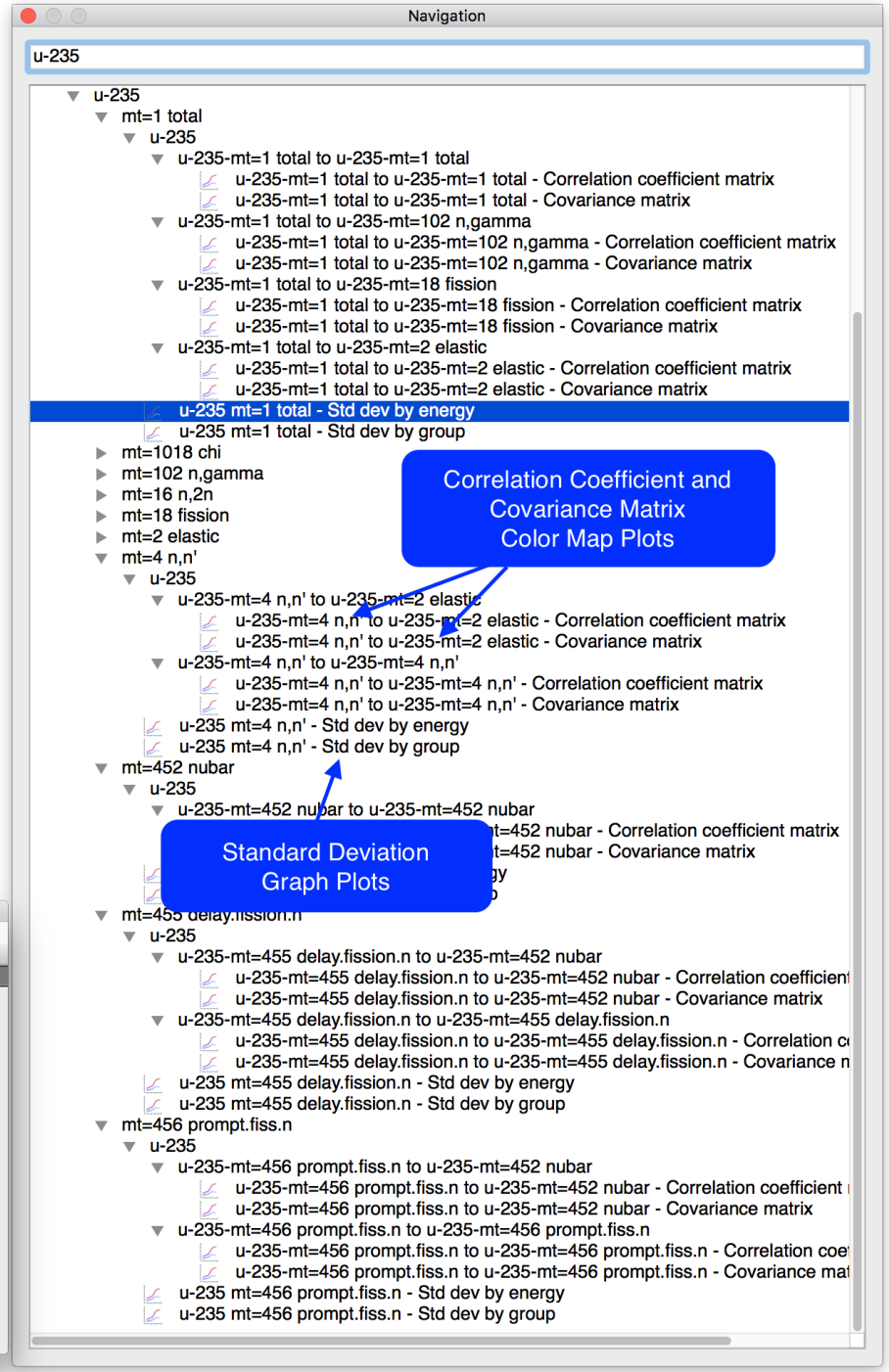


Covariance Data

Covariance Data is available in SCALE/data. Because the files do not have a unique extension, the user must load them specifically using **File > Open covariance library….**

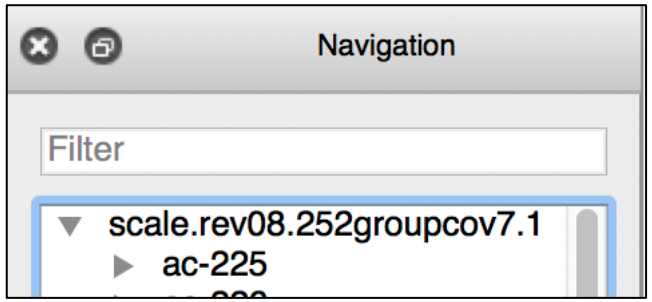
- Correlation coefficient matrix color map plots
- Covariance matrix color map plots
- Isotope Reaction Standard Deviation by energy or group graph plots



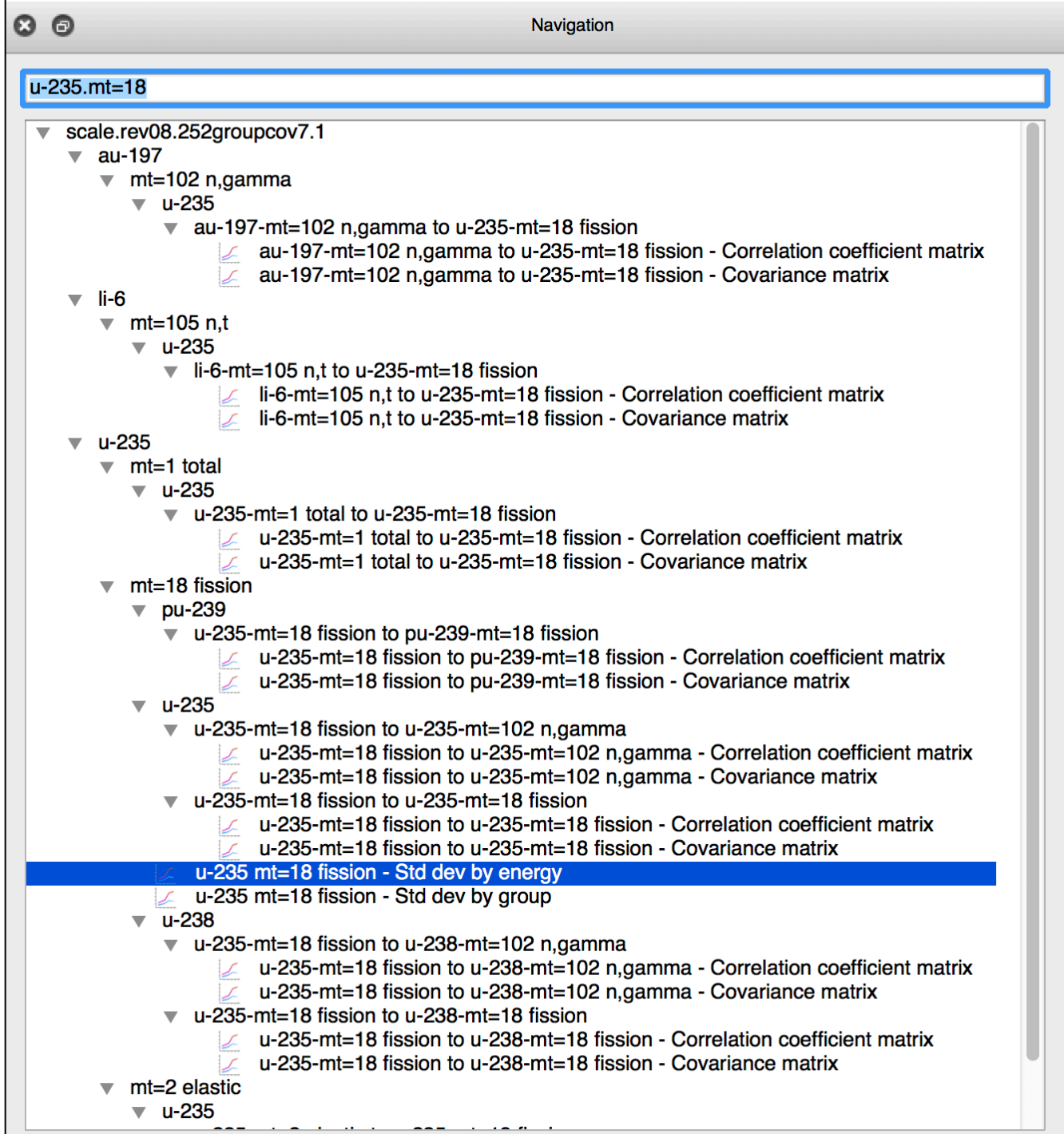


Covariance | Hands On

- Use **File > Open Covariance Library…** to open the **SCALE/data/scale.rev??.252groupcov7.1**
- Observe the **252groupcov7.1** display in the **Navigation** panel
- In the **Navigation** panel's **Filter** field enter **u-235.mt=18**
  - Note the period (**.**) indicates a match of anything and finds item labels with either a space or hyphen

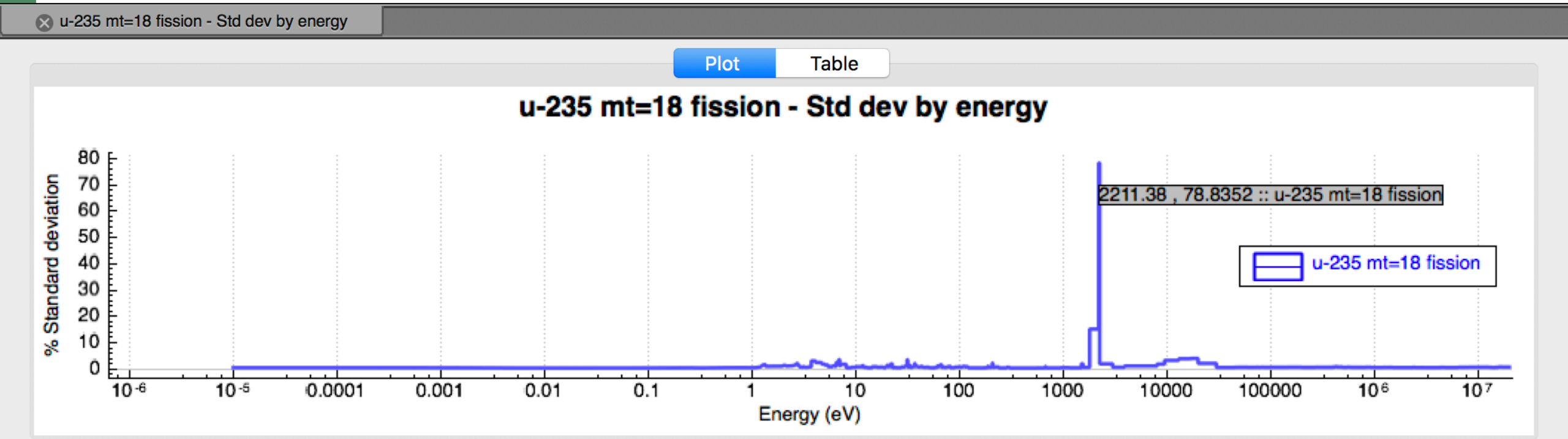


- Observe all matches presented



Covariance | Hands On Std Dev

- Plot the **u-235 mt=18 fission – Std dev by energy**
- Observe the **~78% std-dev @ ~2.2 keV**

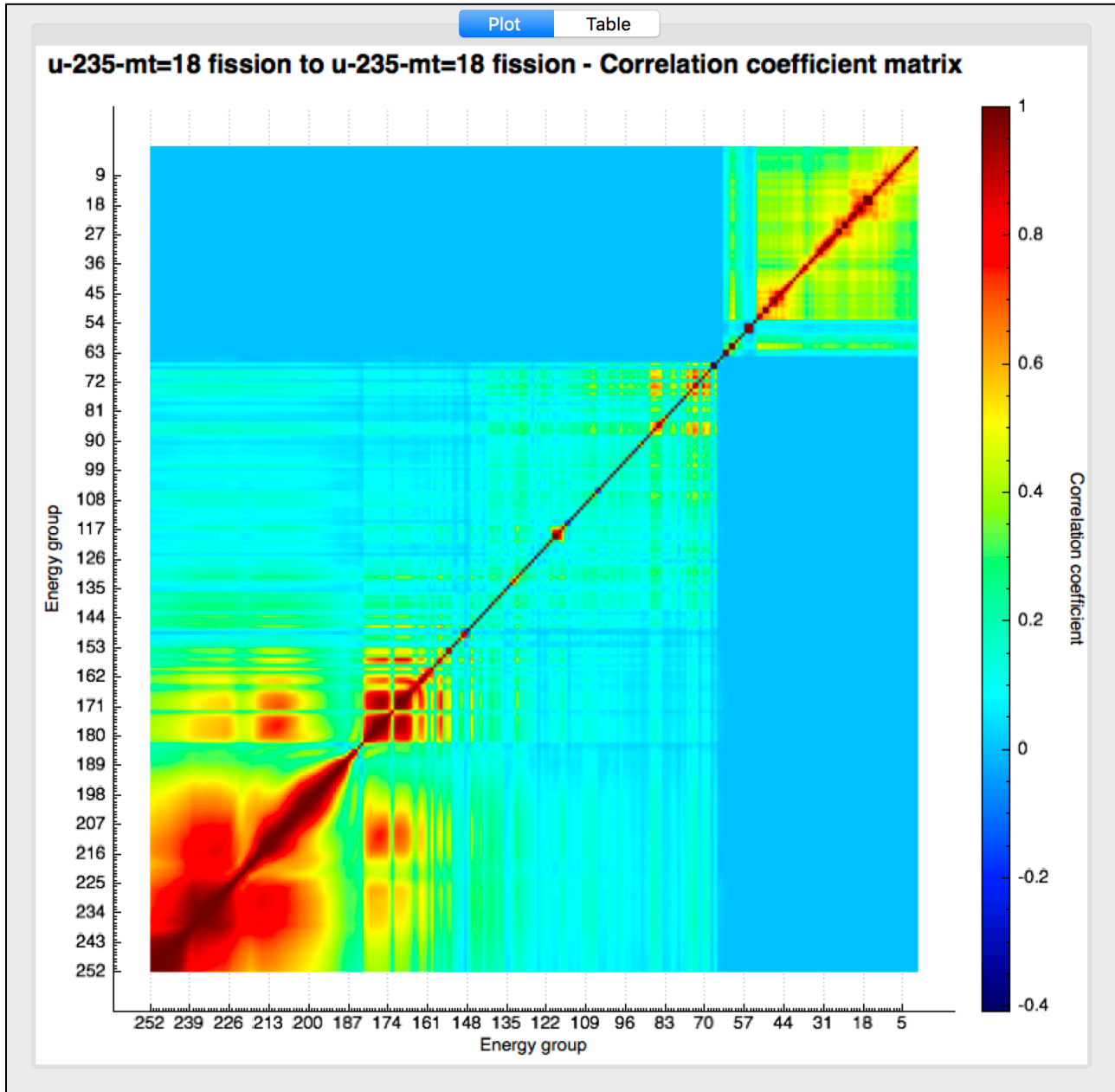


Covariance | Hands On Correlation Coefficient Matrix

- Plot the **u-235-mt=18 fission to u-235-mt=18 fission – Correlation coefficient matrix**

- **Close all files and tabs**

- Remove the **Filter u-235.mt=18 fission**
  - If you forget subsequent file content may not be displayed because it doesn't match the filter

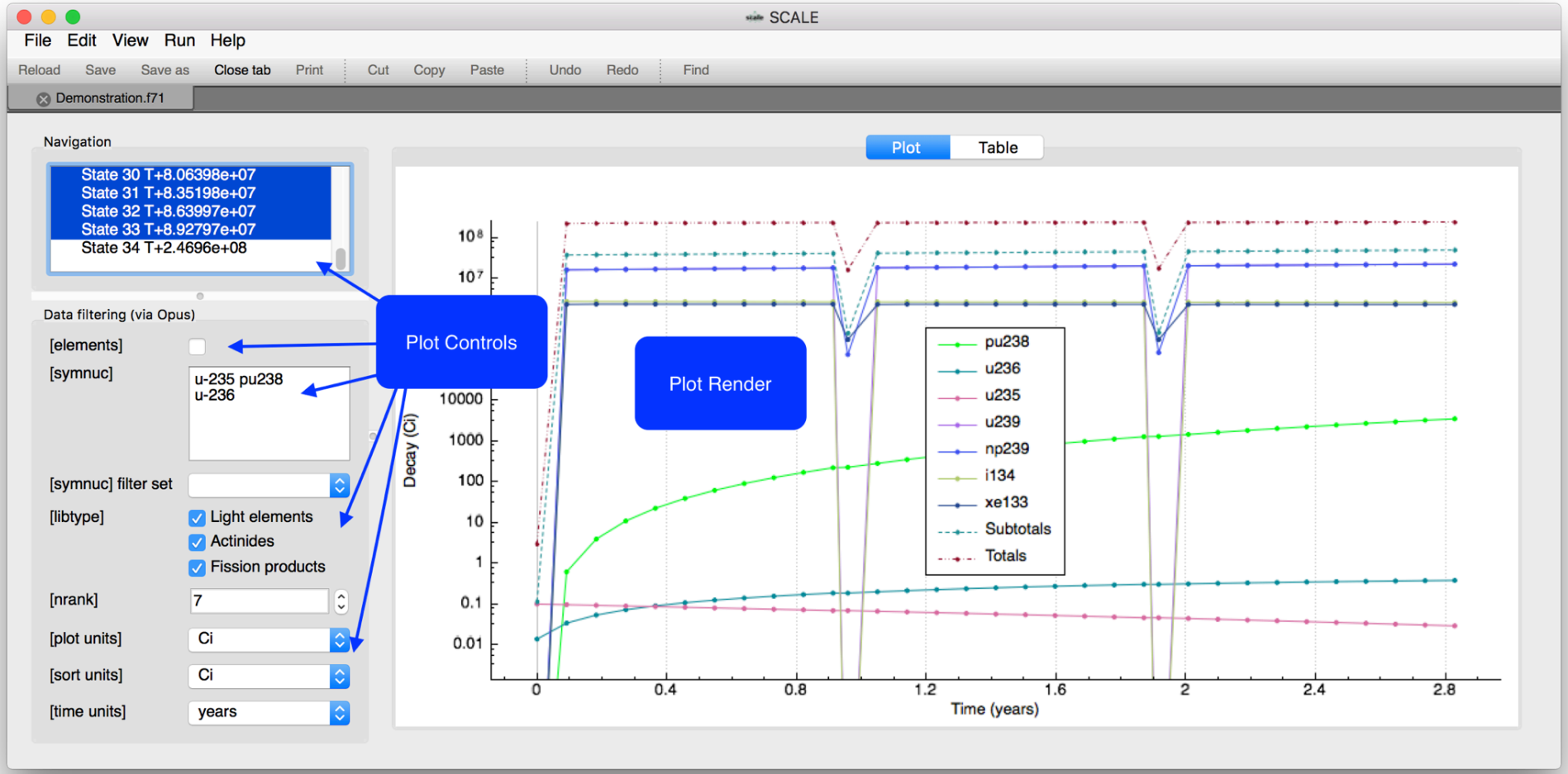


OAK RIDGE National Laboratory

ORIGEN Isotope Concentration Data (F71)

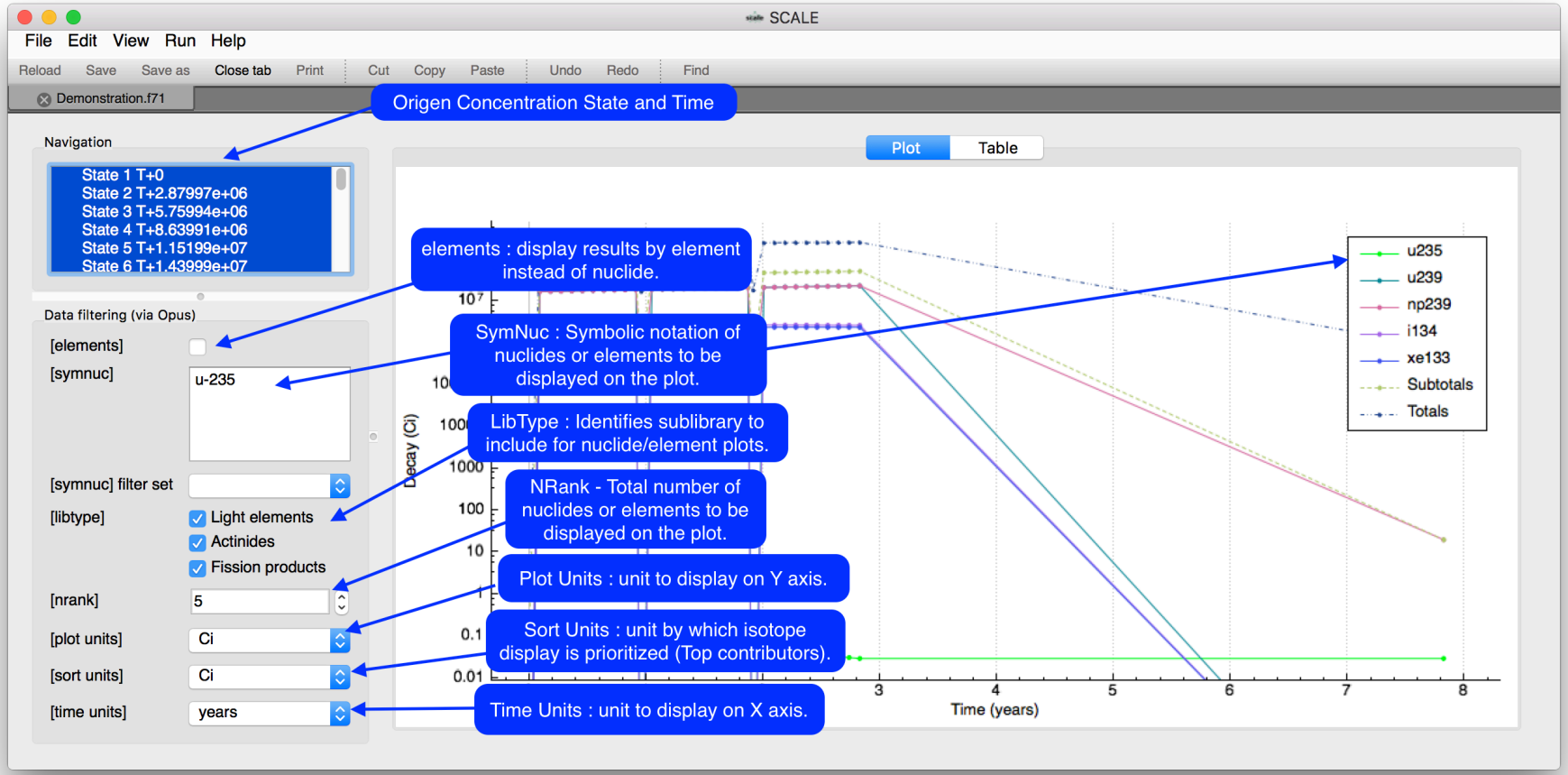
Origen concentration data contains results from depletion, decay, and activation calculations. The plot capabilities are centered about the expected Fulcrum interactive plot controls with the addition of a more familiar PlotOPUS -style set of controls.

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



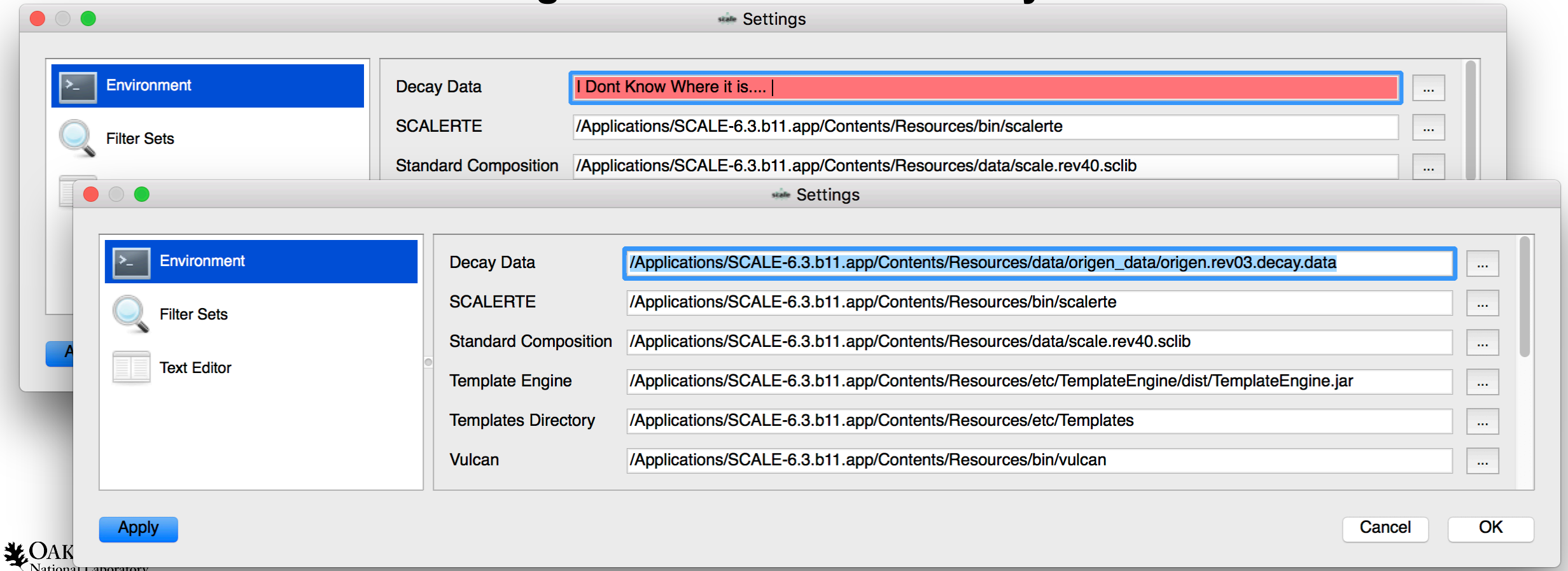
ORIGEN F71 Special Plot Controls (PlotOPUS)

- **Navigation** allows selection of state information at a given time point
- **[Elements]** allows display of results by element instead of nuclide
- **[SymNuc]** allows specifying nuclides or elements to include in the plot
- **[Libtype]** allows display of nuclides or elements contained in the light elements, actinides, and fission product isotope sets
- **[Nrank]** allows limiting the display of the top contributors
- **Time**, **Plot**, and **Sort Units** allows changing the X and Y axis and the nuclides or elements displayed based on contribution



ORIGEN F71 Plotting | !! Requirement !!

- The F71 plotting requires the **ORIGEN decay data** which is located in the SCALE DATA directory (**data/origen_data/origen.rev??.decay.data**)
- When plotting an F71 **without** the decay data a **blank plot** is presented
- Fix this via the **File > Settings > Environment > Decay Data**

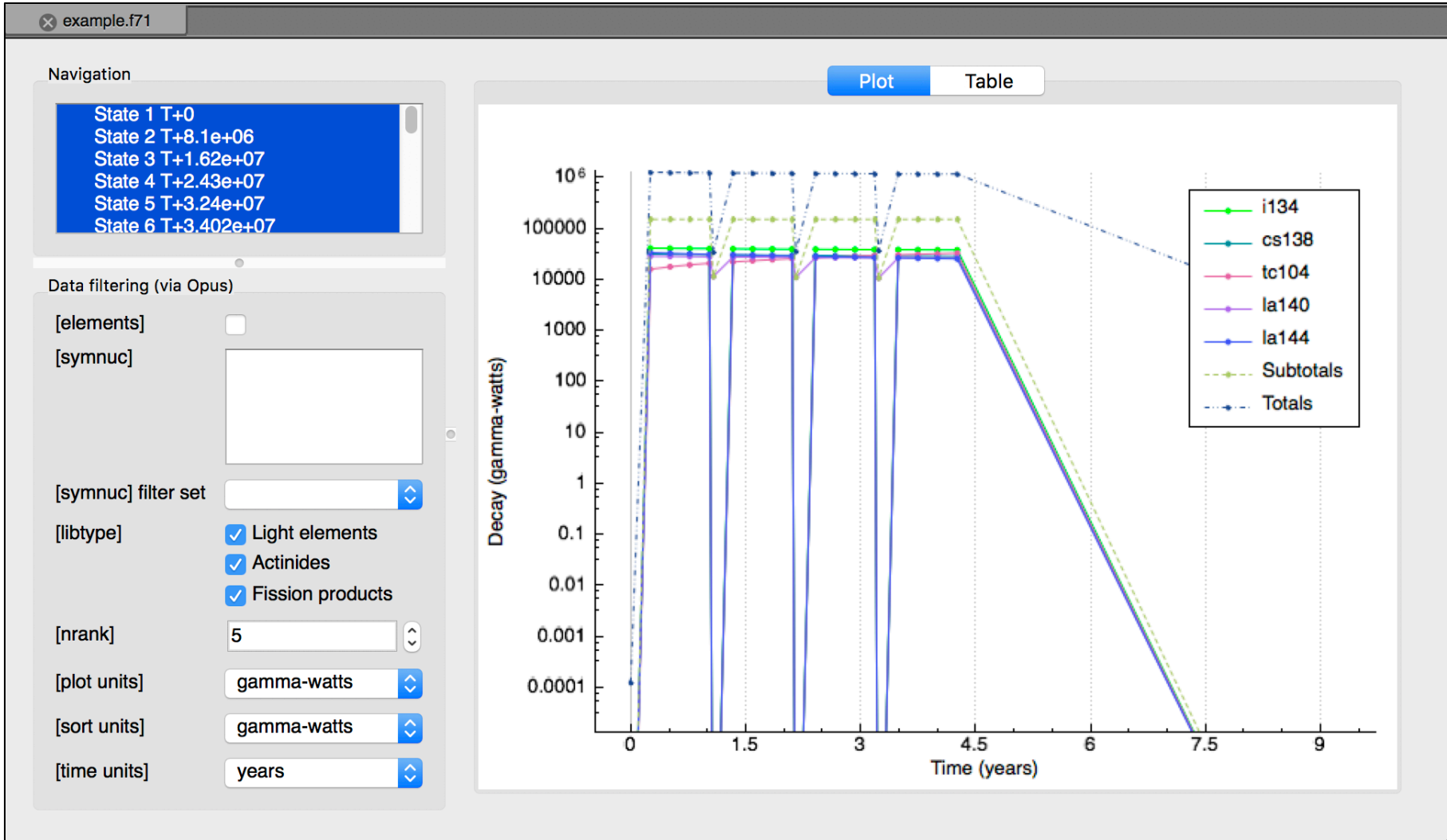


ORIGEN F71 | Hands On Initial Plot

- Use **File > Open file…** and open the **Advanced_User_Interface/OrigenF71/example.f71**

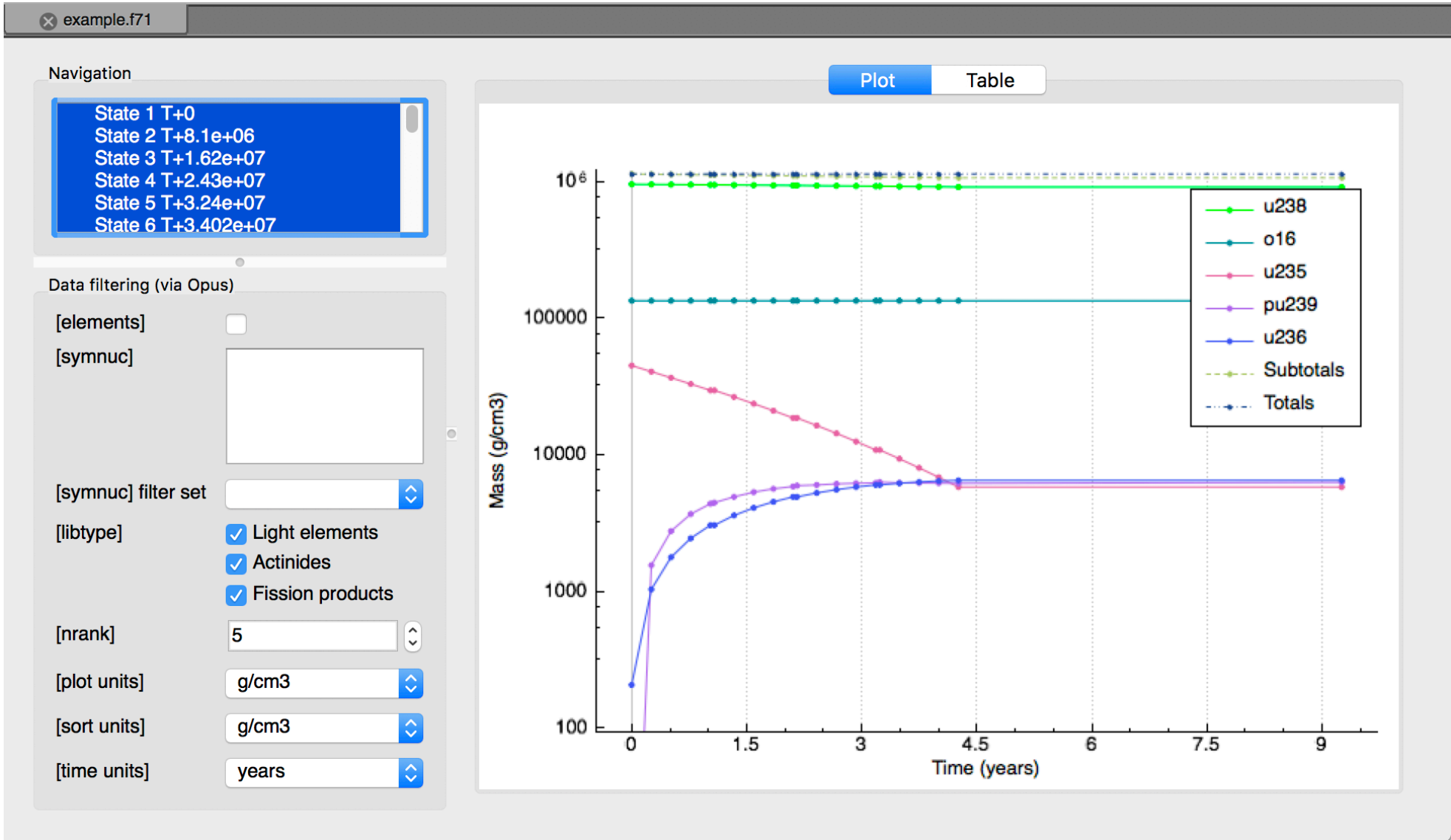
- Observe the **Navigation State** set are all default selected and plot the multicycle irradiation and decay times

- Observe the default plot **Data filtering**



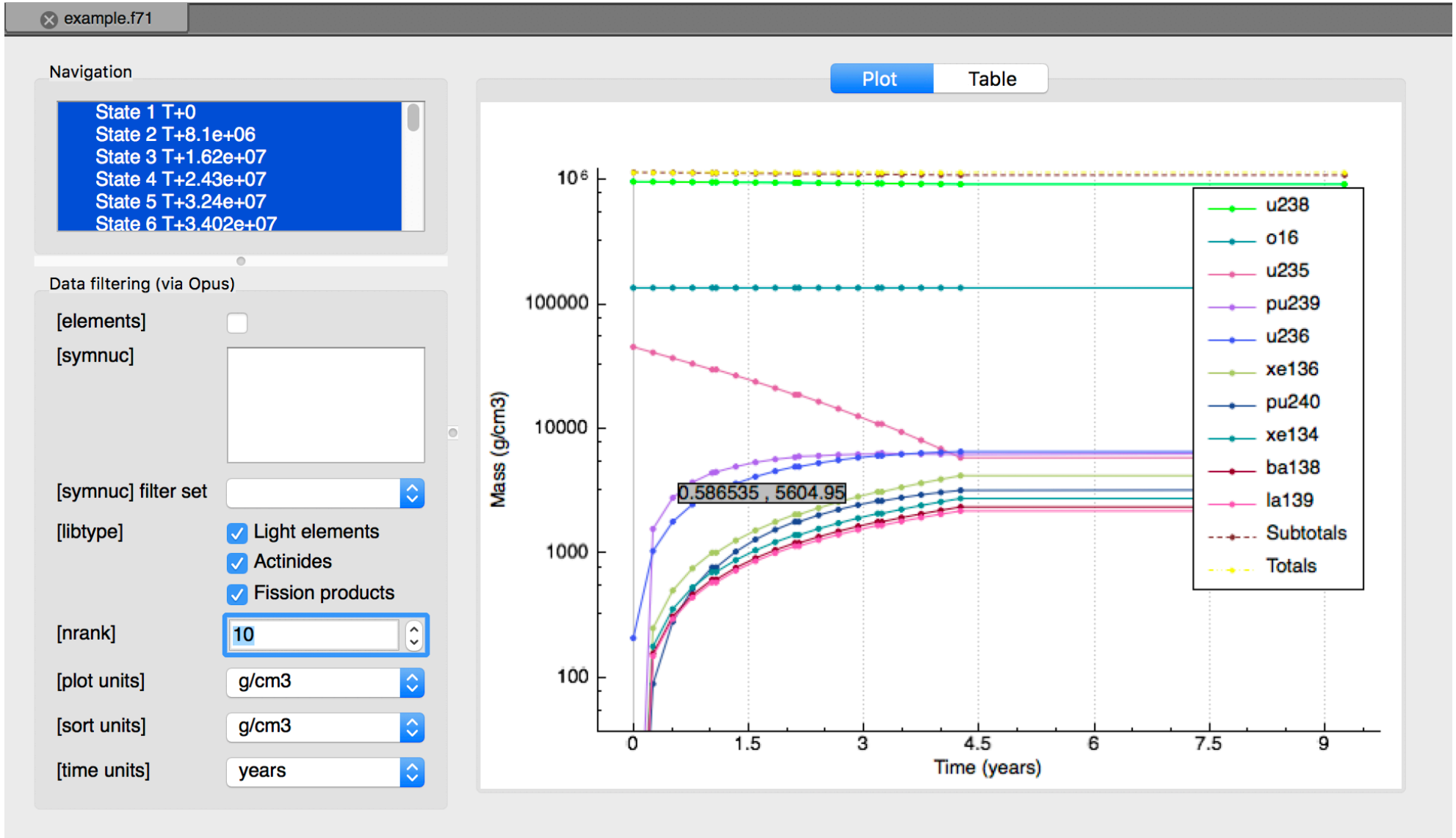
ORIGEN F71 | Hands On Units

- Update the **Plot** and **Sort** Units to be **g/cm3**



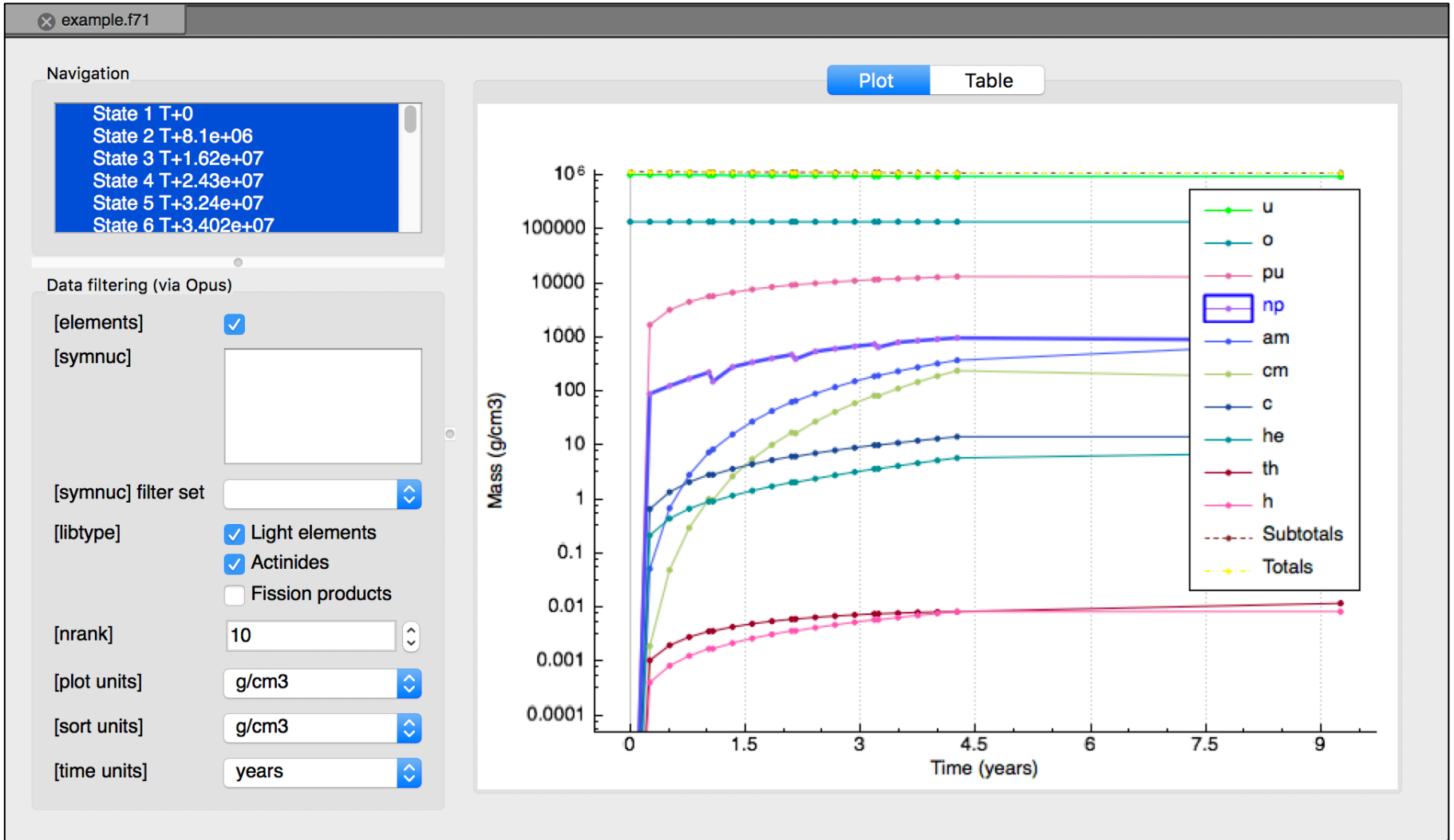
ORIGEN F71 | Hands On NRank

- Update the **Nrank** to **10** to illustrate additional **Mass (g/cm3)** contributors



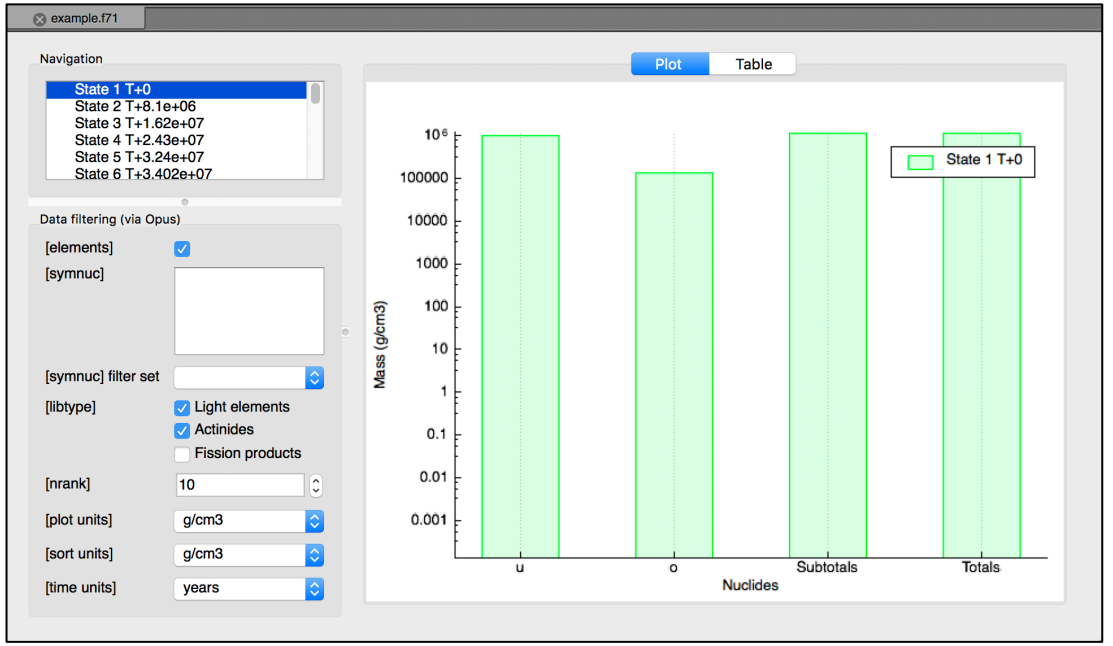
ORIGEN F71 | Hands On Elements and LibType

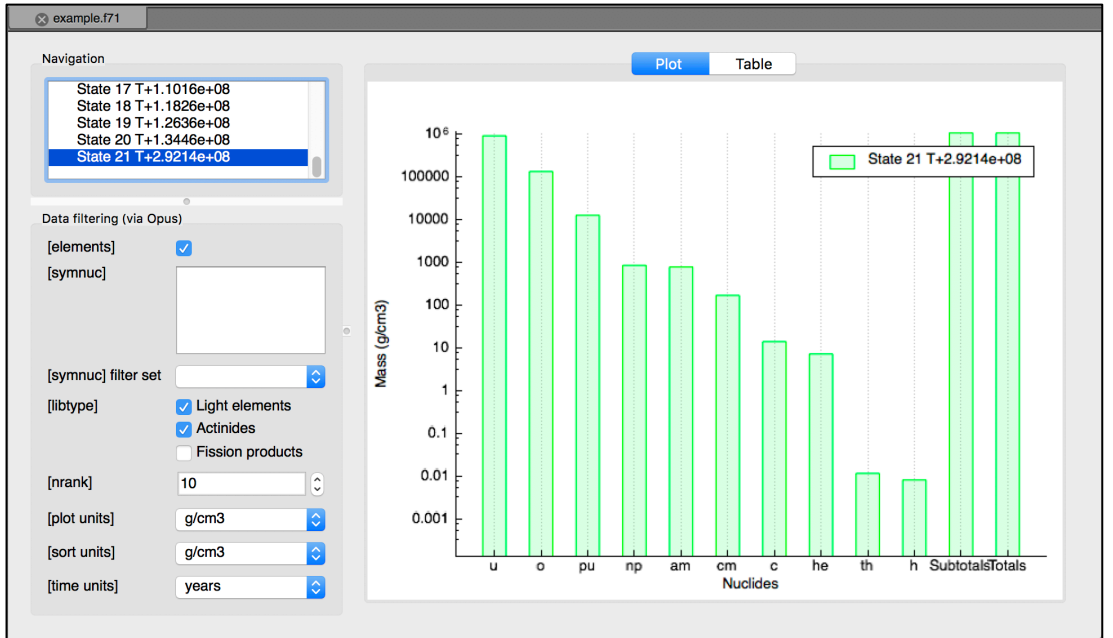
- Check the **Elements checkbox** to consolidate isotopes
- Uncheck the **Fission Products checkbox**
- Select neptunium (**np**)



ORIGEN F71 | Hands On Single State Navigation

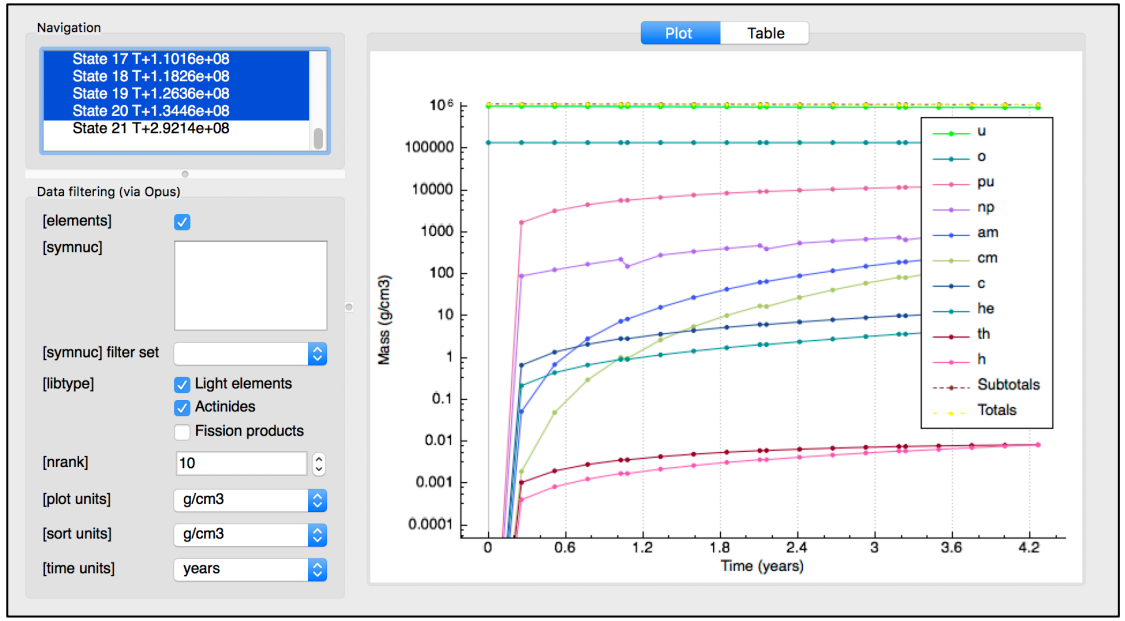
- Single **State** selection displays a bar plot of **Filtered** quantity
- Select **State 1 T+0**
- Note at T=0 it is a **uo2** system with only **U** and **O**
- Use the **Arrow keys** to navigate the **State** history from **T+0** to **T+2.92e+8**
- Observe the evolution of the isotope inventory over time

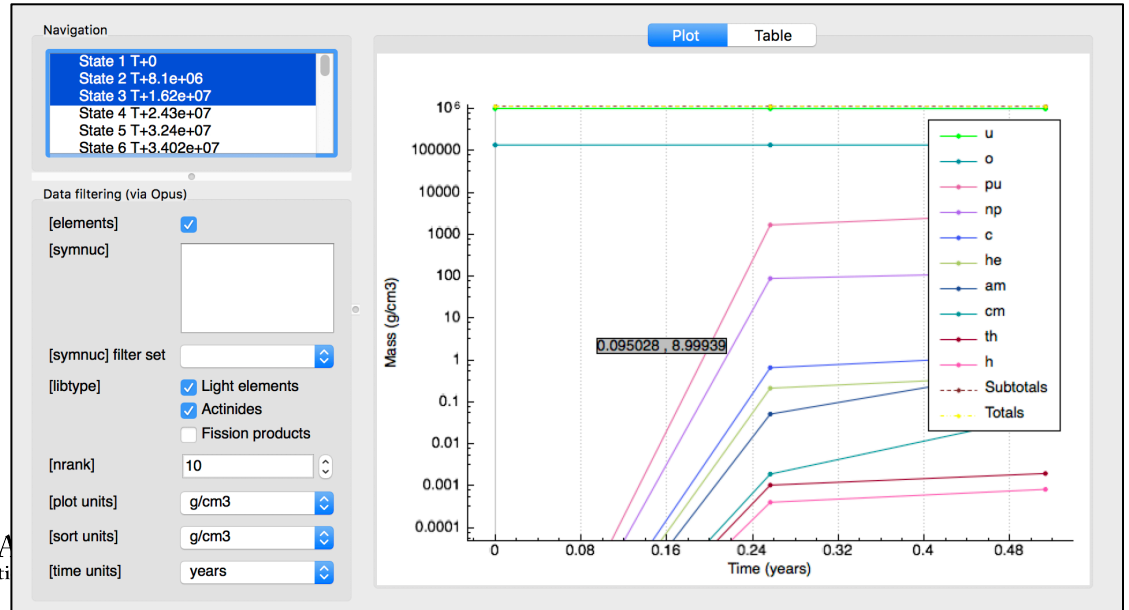


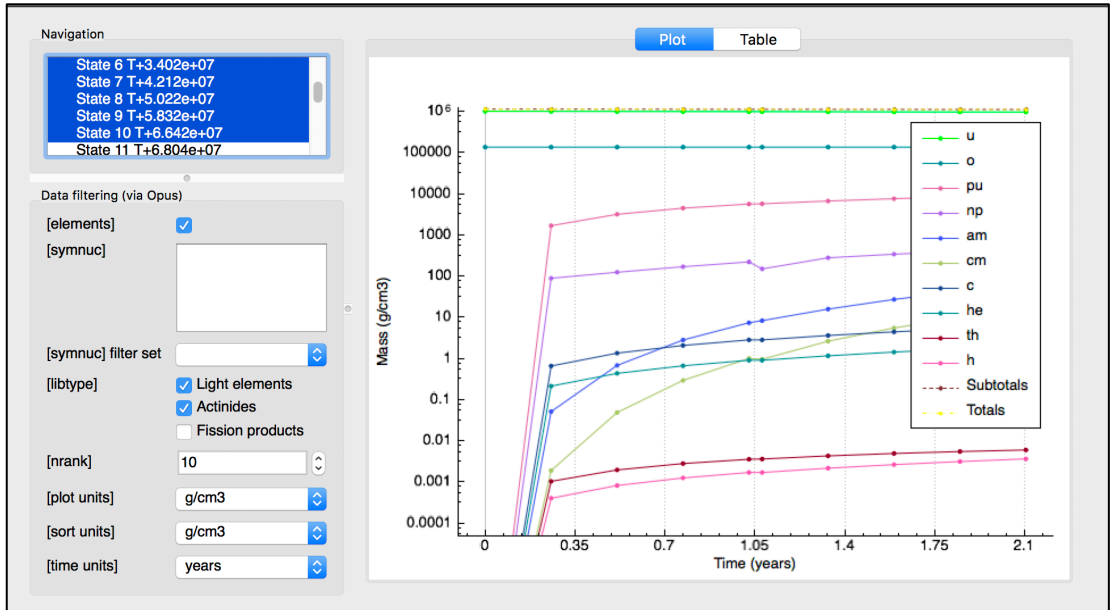


ORIGEN F71 | Hands On Multi State Navigation

- Multi-**State** selection
  displays time series plot of **Filtered** quantity
- Select **State 1 T+0**
- Press the **shift key and arrow down**
  to select multiple **State** sets
- Observe the data update and assorted elements build in over time

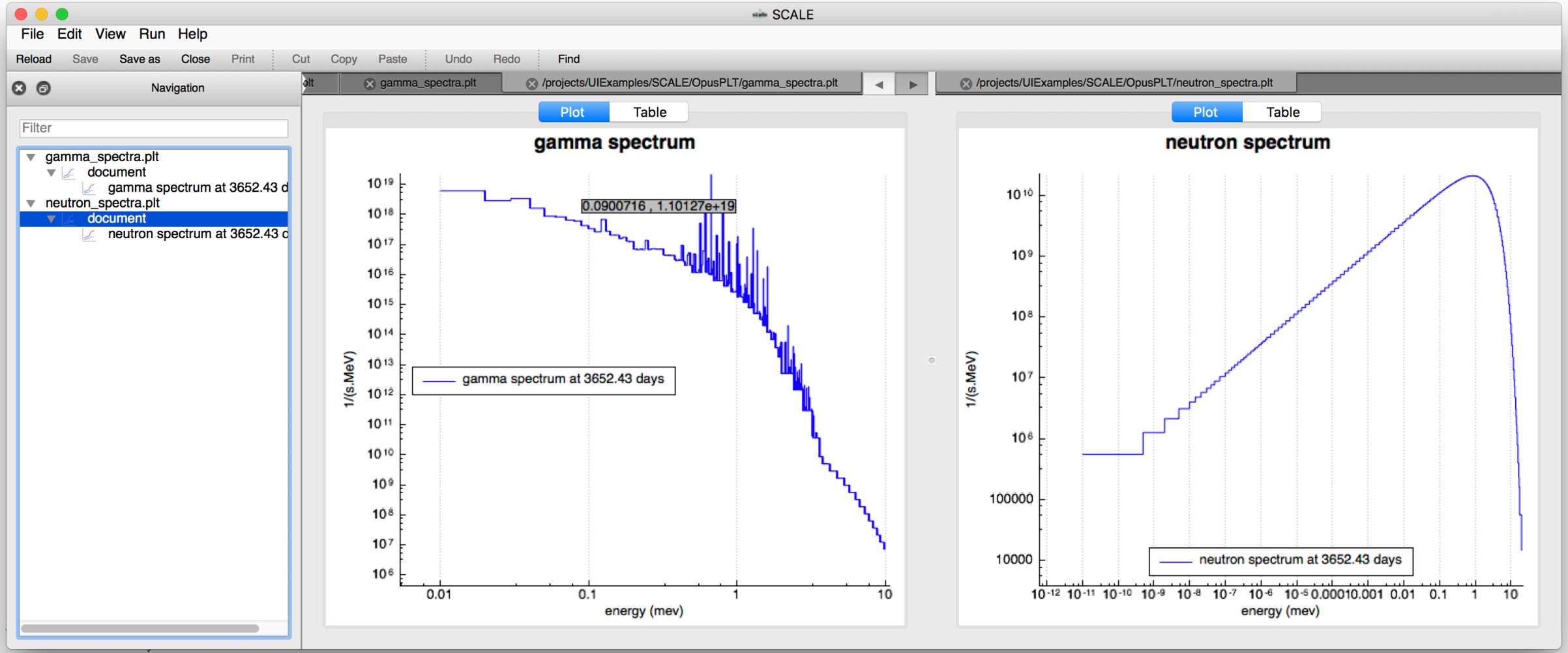






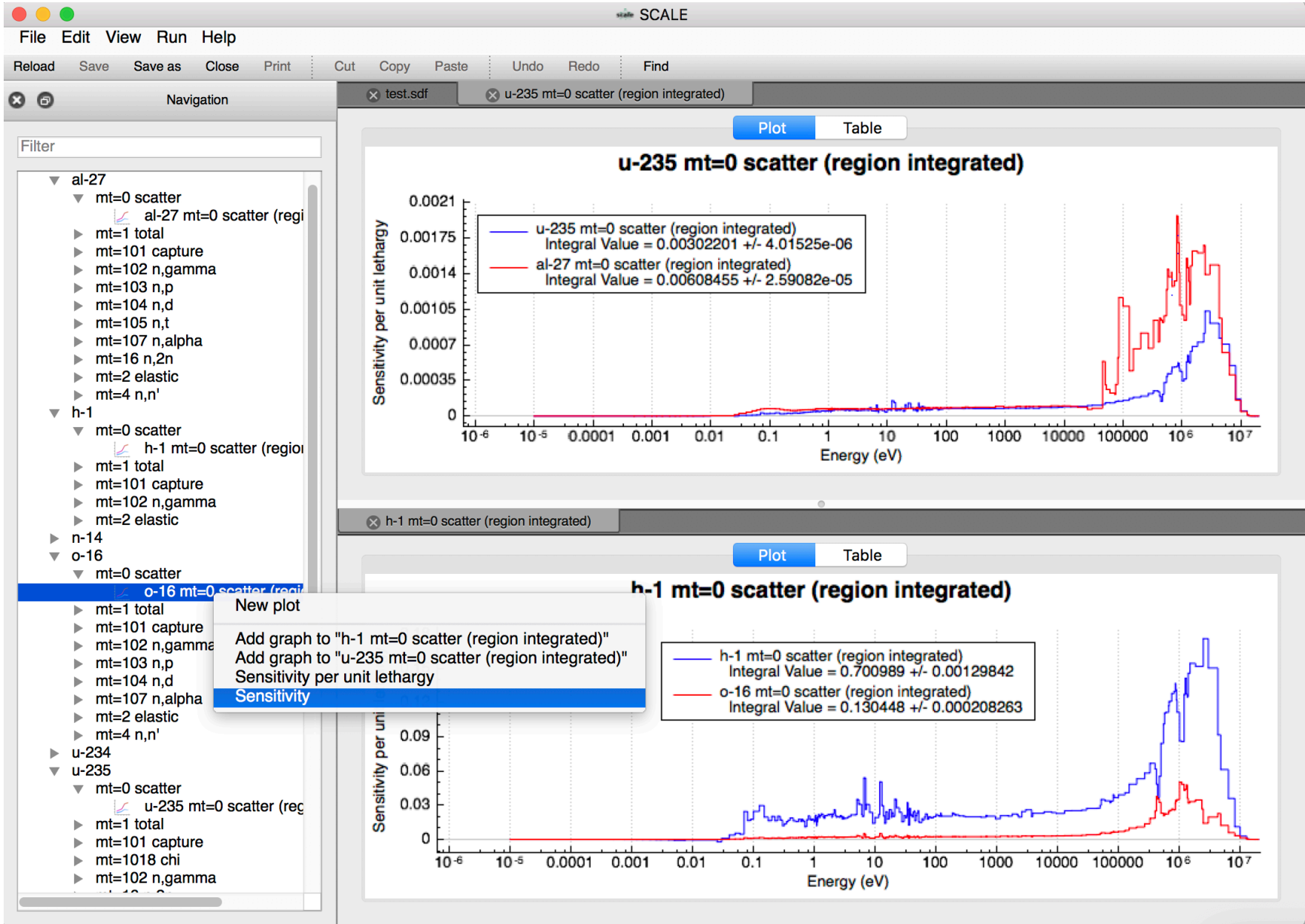
OPUS PLT

The OPUS provides an ORIGEN postprocessing capability that results in PLT files that can illustrate nuclide or element quantities (superseded by ORIGEN F71 capability on prior slides) and **neutron** or **photon spectra (Not yet available in the F71 Viewer)**



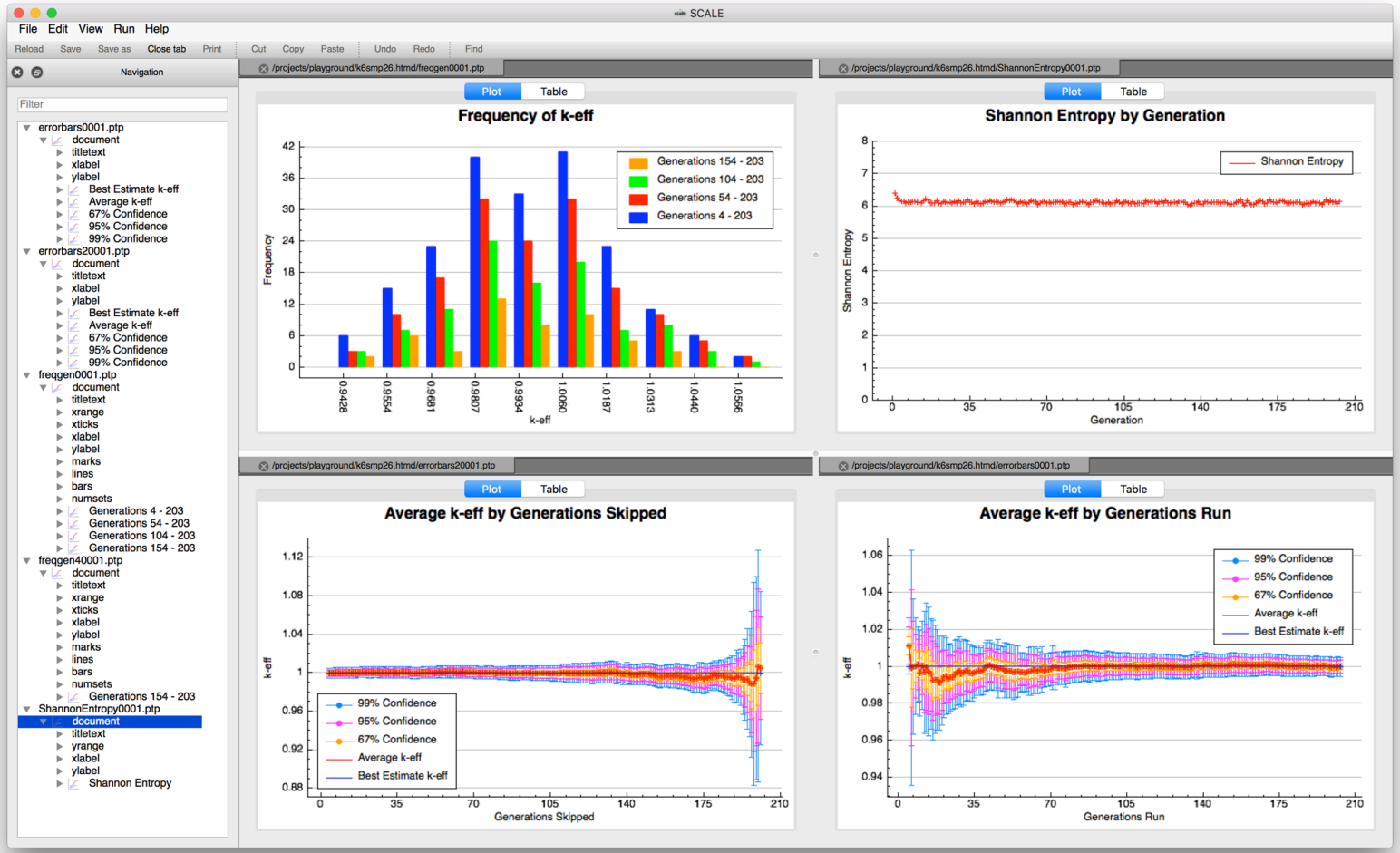
Sensitivity Data File (SDF)

- Sensitivity of k-eff to cross section data
- Sensitivity per unit lethargy
- Sensitivity of k-eff and reaction rates to energy-dependent cross section data for each reaction of each nuclide in a system model



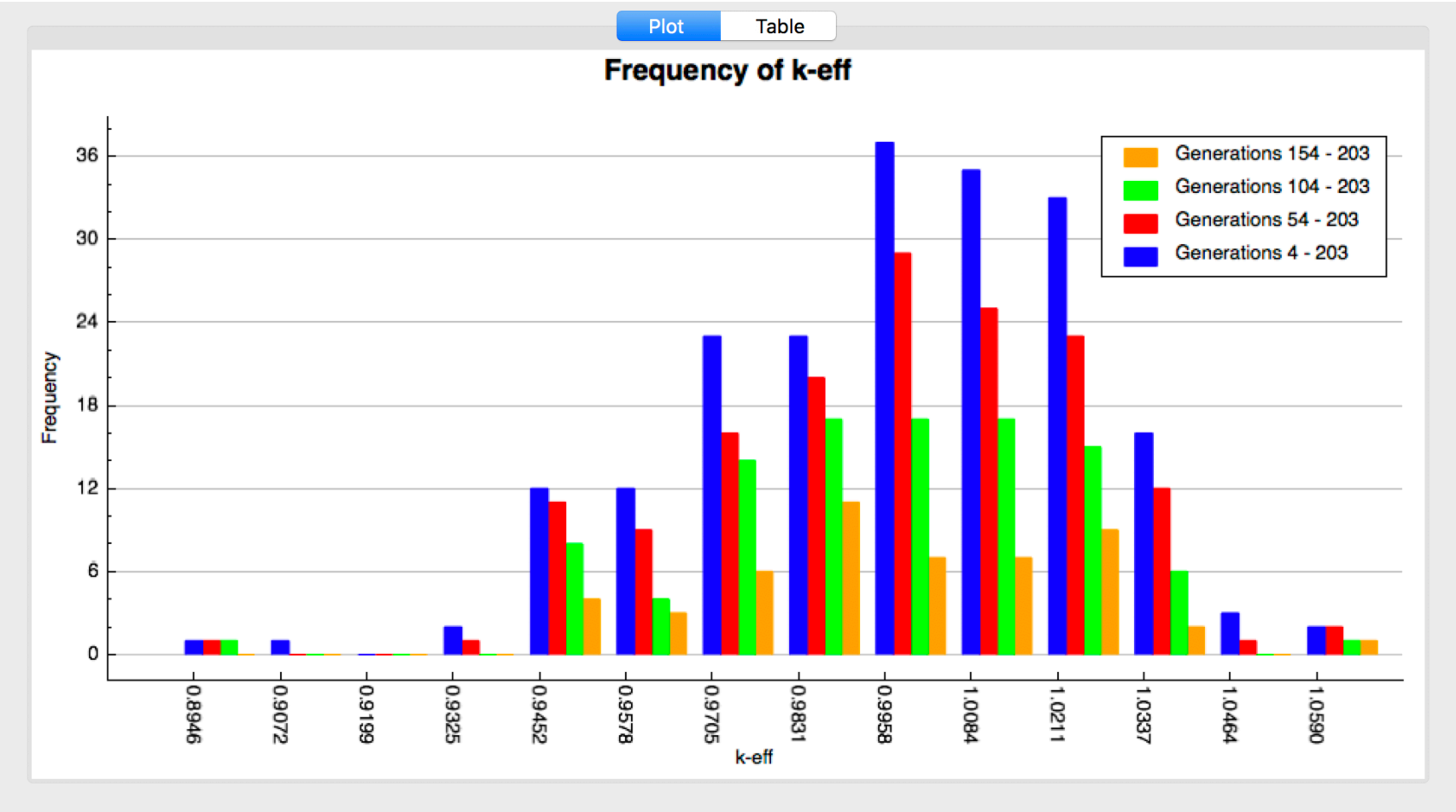
Result Plots

- 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
- Etc.



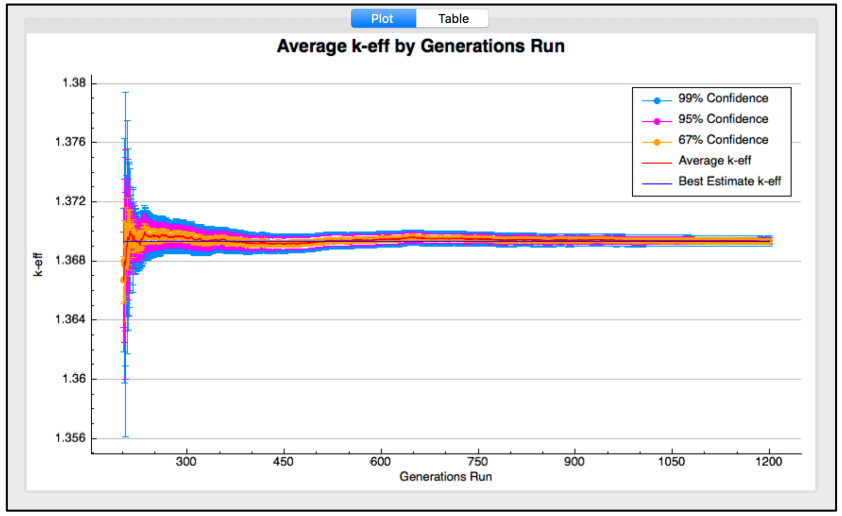
Result Plots | Hands On K-eff Frequency by Generation

- Use **File > Open…** and open **Advanced_User_Interface/PTP/ frequency_by_generations.ptp**
- Double left-click the **document** plottable item
- Observe the frequency of k-eff by generation plotted

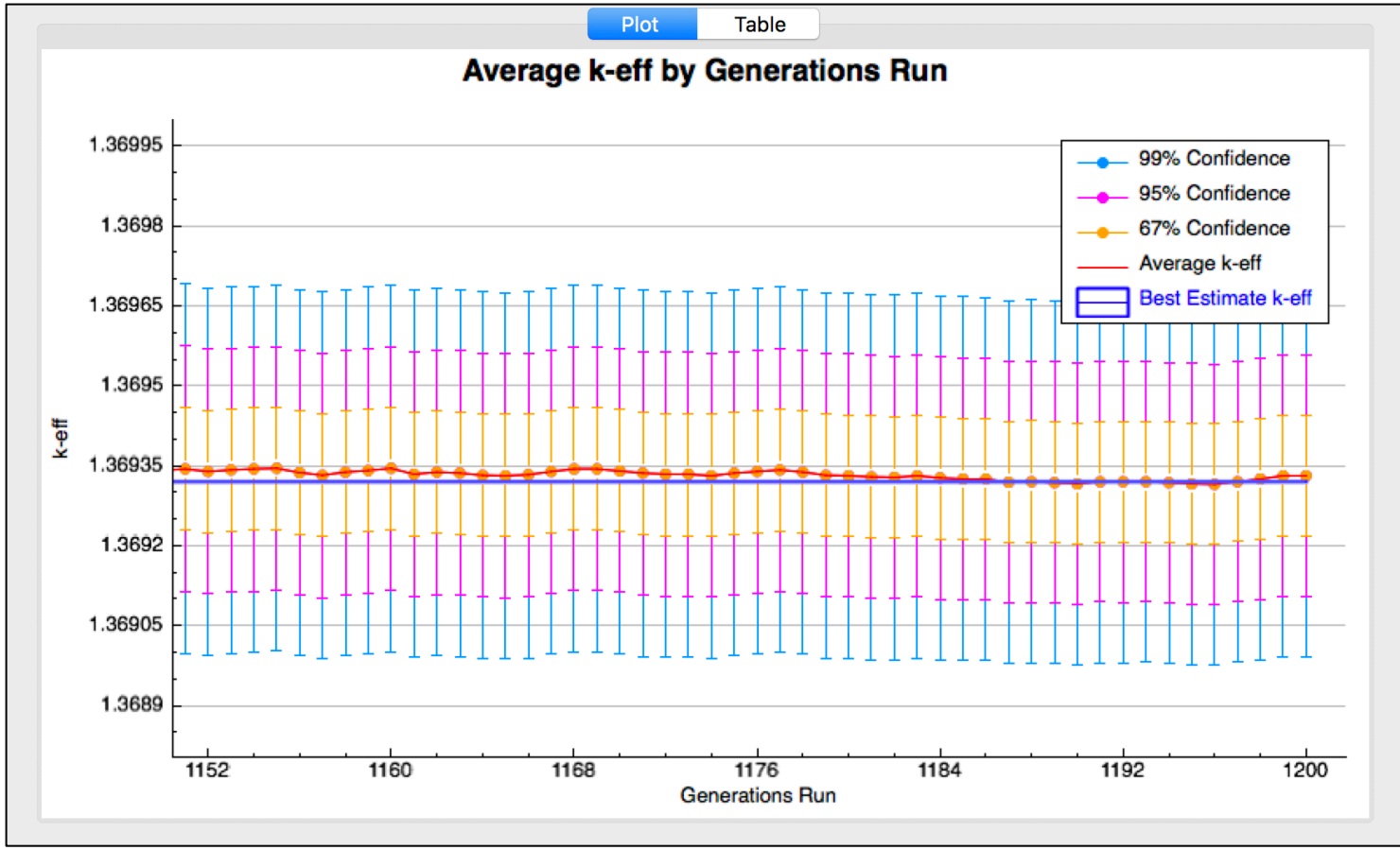


Result Plots | Hands On Average K-eff by Generation

- Use **File > Open…** and open **Advanced_User_Interface/PTP/average_keff_by_generation_run.ptp**
- Double left-click the **document** plottable item
- Observe the frequency of k-eff by generation plotted



- Zoom into last 200 generations and observe the **Average** and **Best Estimate**



Plot Review

- You are now practiced in
  - ChartPlot data
  - AMPX XS data
  - Covariance data
  - ORIGEN F71 data and the F71Viewer (PlotOpus) controls
  - KENO Result data (PTP)
- You are aware of
  - Sensitivity Data Files
  - OPUS PLT
  - ORIGEN Gamma Data
- **Questions?**
- Close all open documents via **File > Close All**
- Close all tabs via **right-clicking** any tab and selecting **Close all tabs** for each tab group

OAK RIDGE National Laboratory

Geometry Visualization

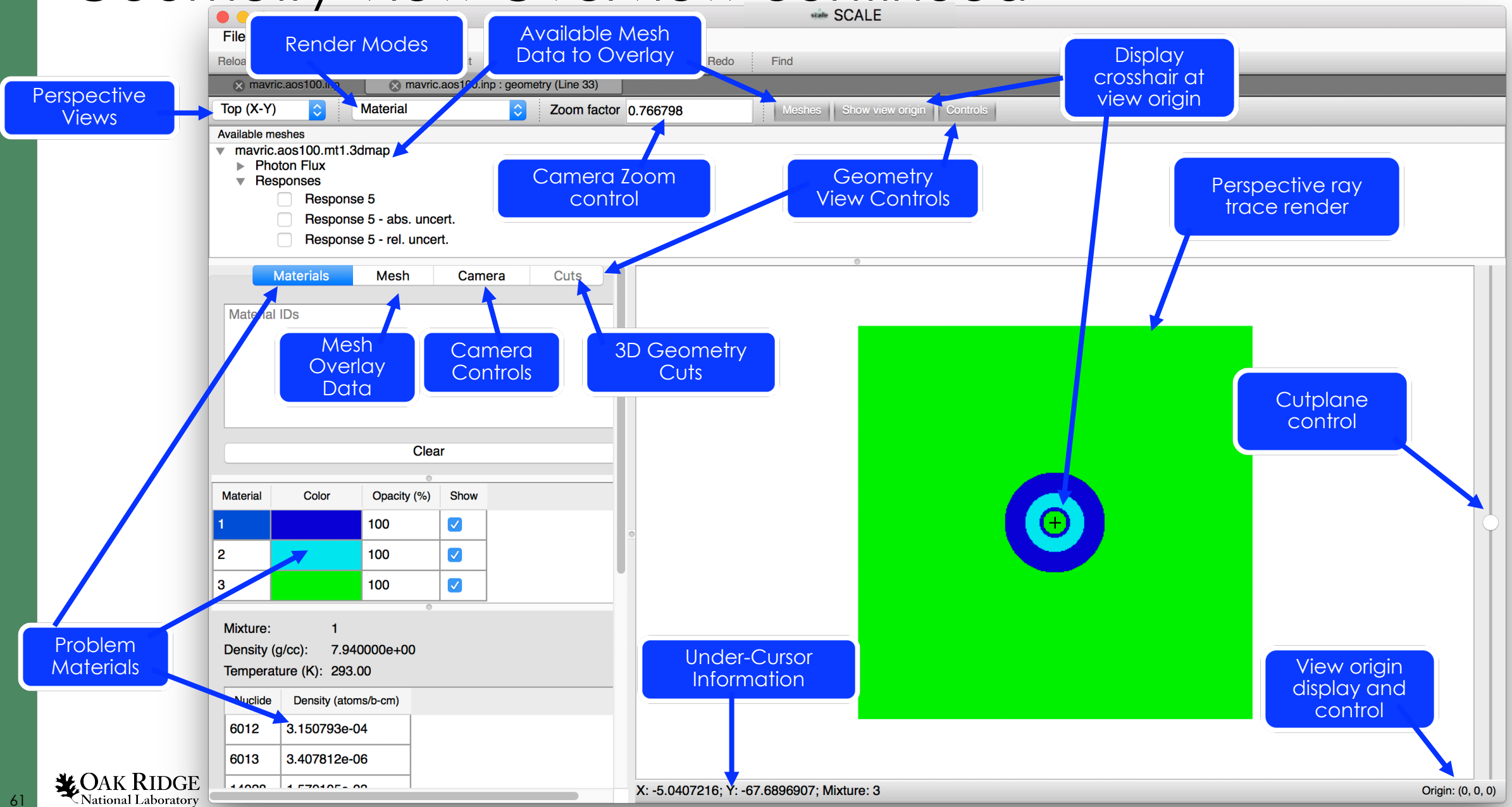
ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

Geometry Visualization Overview

- Geometry Viewer Layout
- 2D Viewer Controls
- Perspective Views
- Render Modes
- Mesh Overlay
- 3D Viewer Controls

Geometry View Overview continued

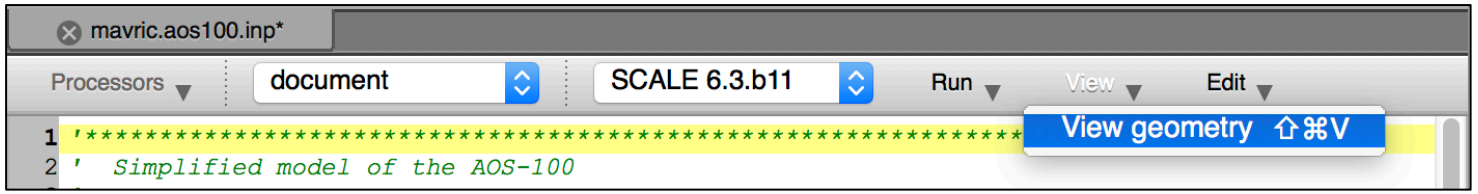


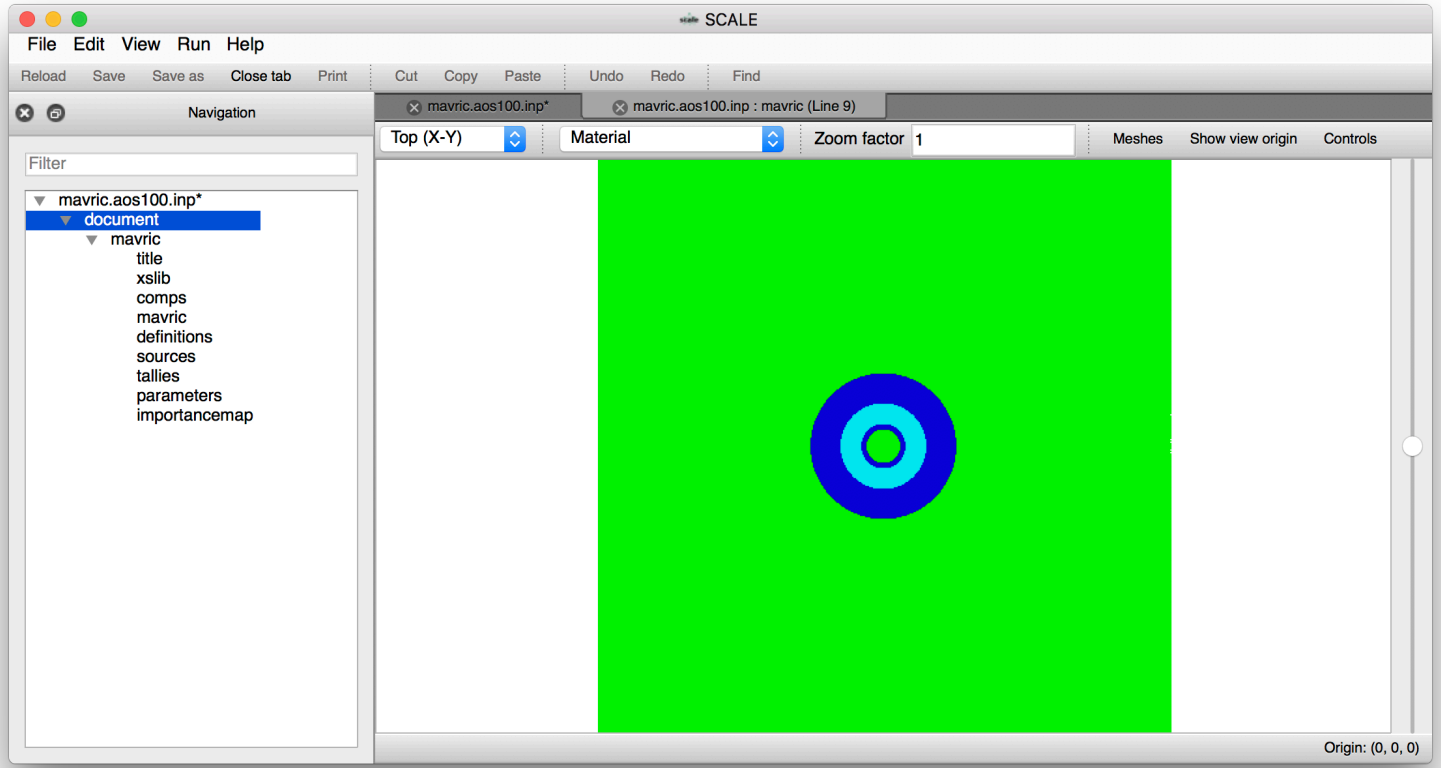
Geometry Viewer Overview

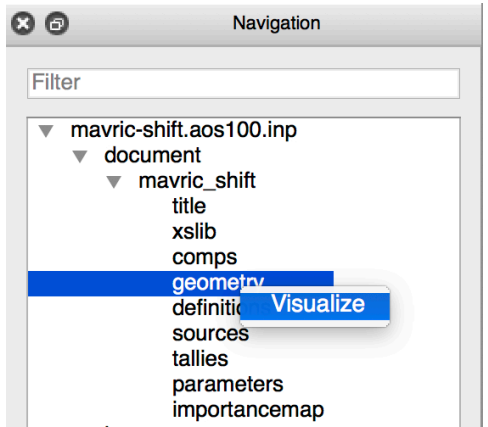
- **Perspective Views** provide 2D axis-aligned and 3D geometry renderings
- **Available Meshes to Overlay** allows combining geometry rendering with mesh-based results
- **Render Modes** – toggle between different **material**, **outline**, and **mesh overlay** render modes
- **Show view origin** – highlights exact point at center of the view with a crosshair
- Under-Cursor Information – shows **position**, and **Mixture** under cursor
- **View origin** – **displays** and provides **control** of the origin of the view
- **Cutplane controller** – interactively manipulates the elevation of the 2D view plane
- Context Menu (via right click) – allows changing color and saving images

Geometry Visualization Activation

- From within the text editor, click **View** or click **View > View geometry**
- Alternatively, from within the **Navigation panel** left click **document>sequence** and right click **geometry** and select **Visualize**

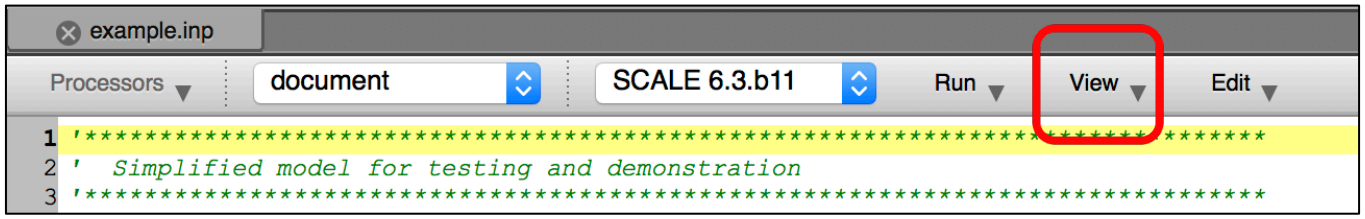


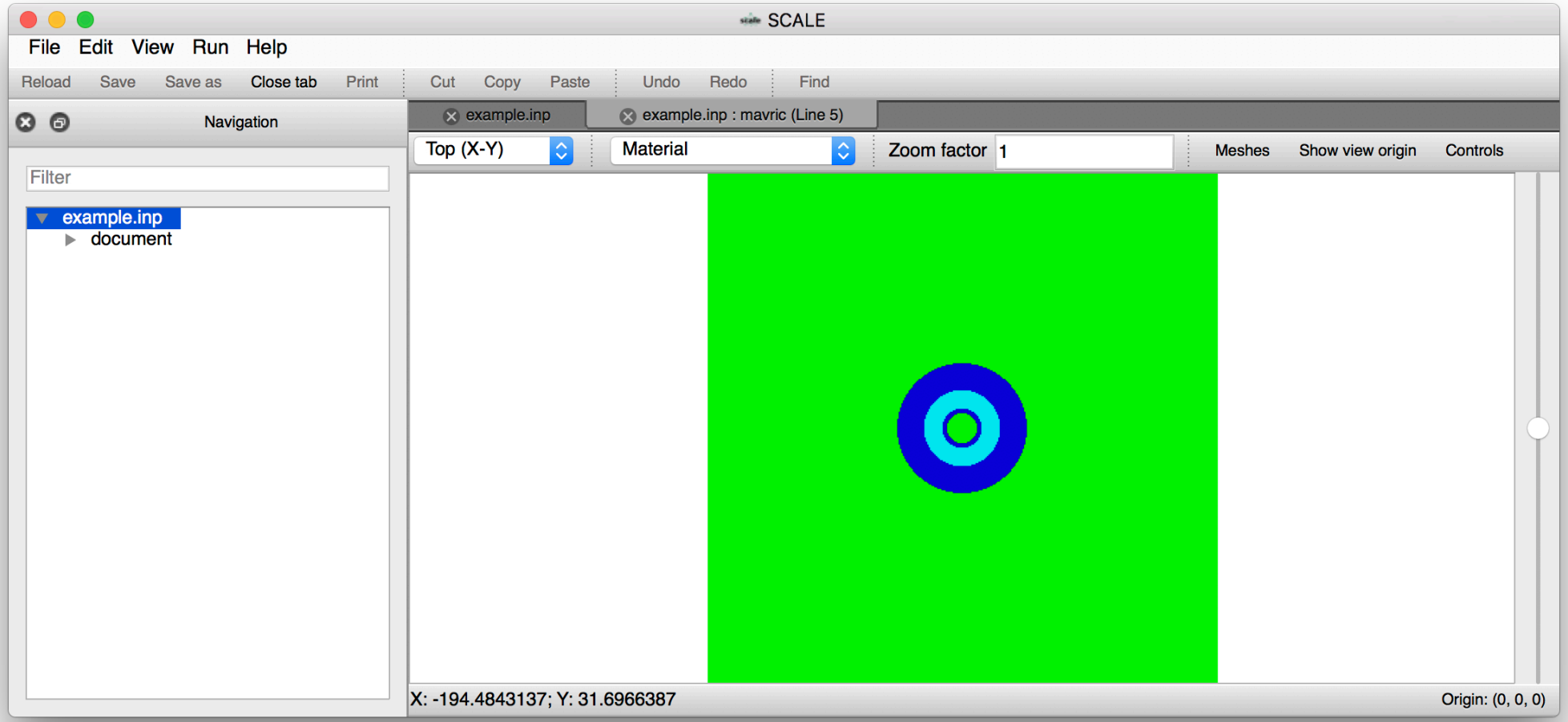




Geometry Visualization | Get Started!

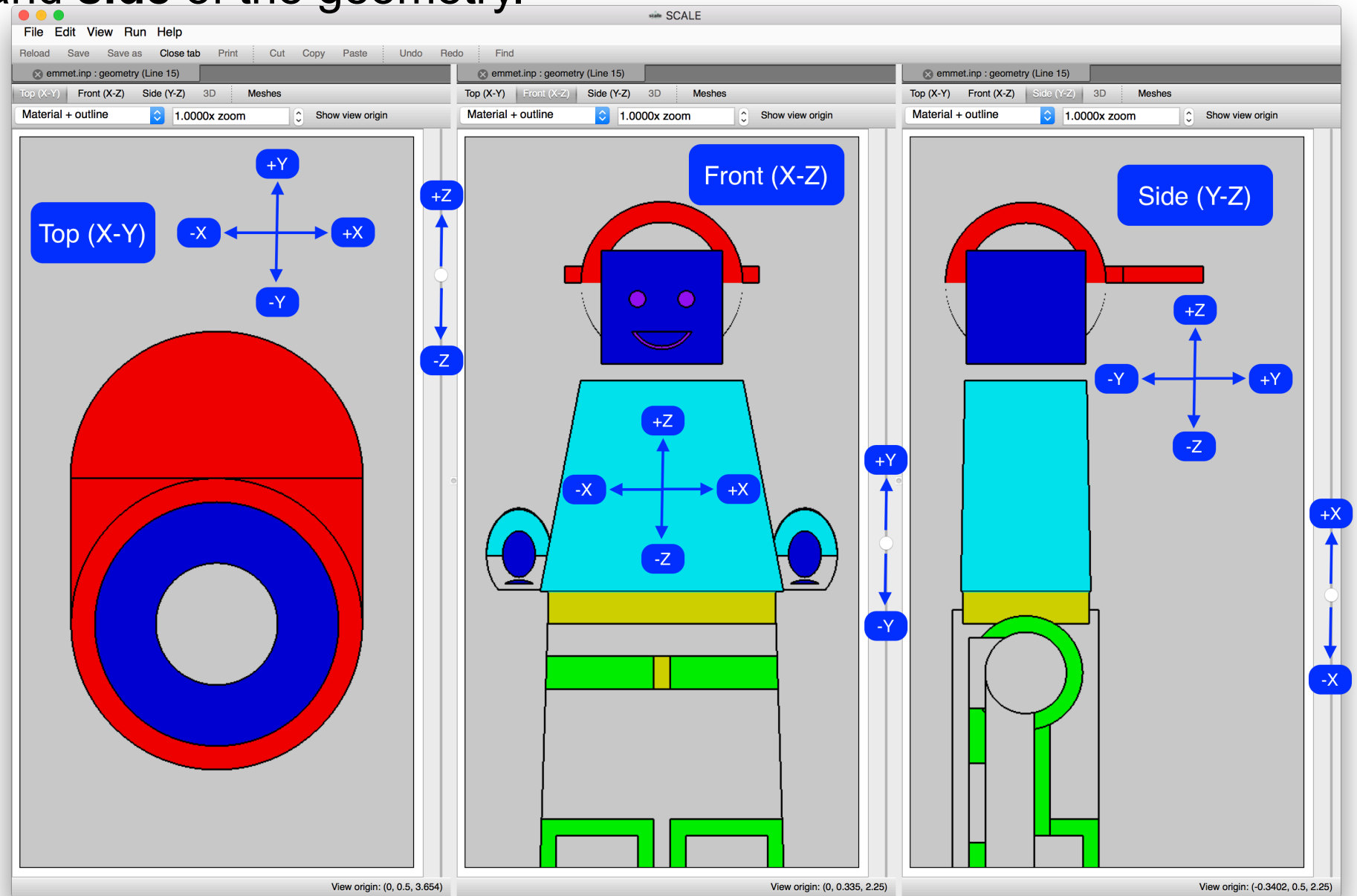
- Using **File > Open…** open **Advanced_User_Interface/Input/example.inp** and click **View**





2D Perspective Views

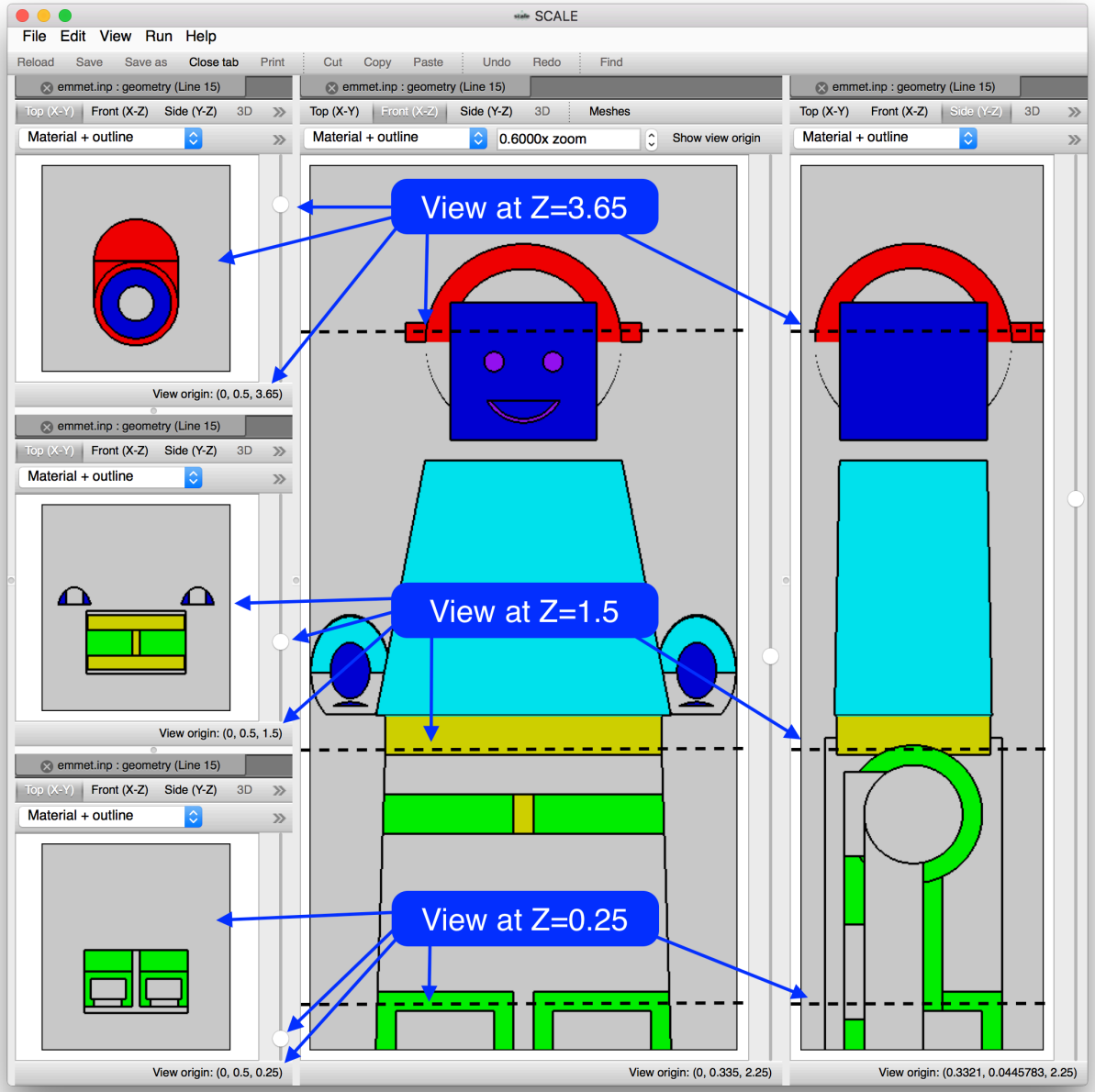
- 2D Perspective views provide standard orthographic model projections of the **top**, **front**, and **side** of the geometry.



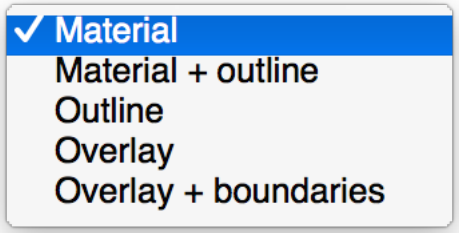
2D Perspective Views : Elevation Control

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.

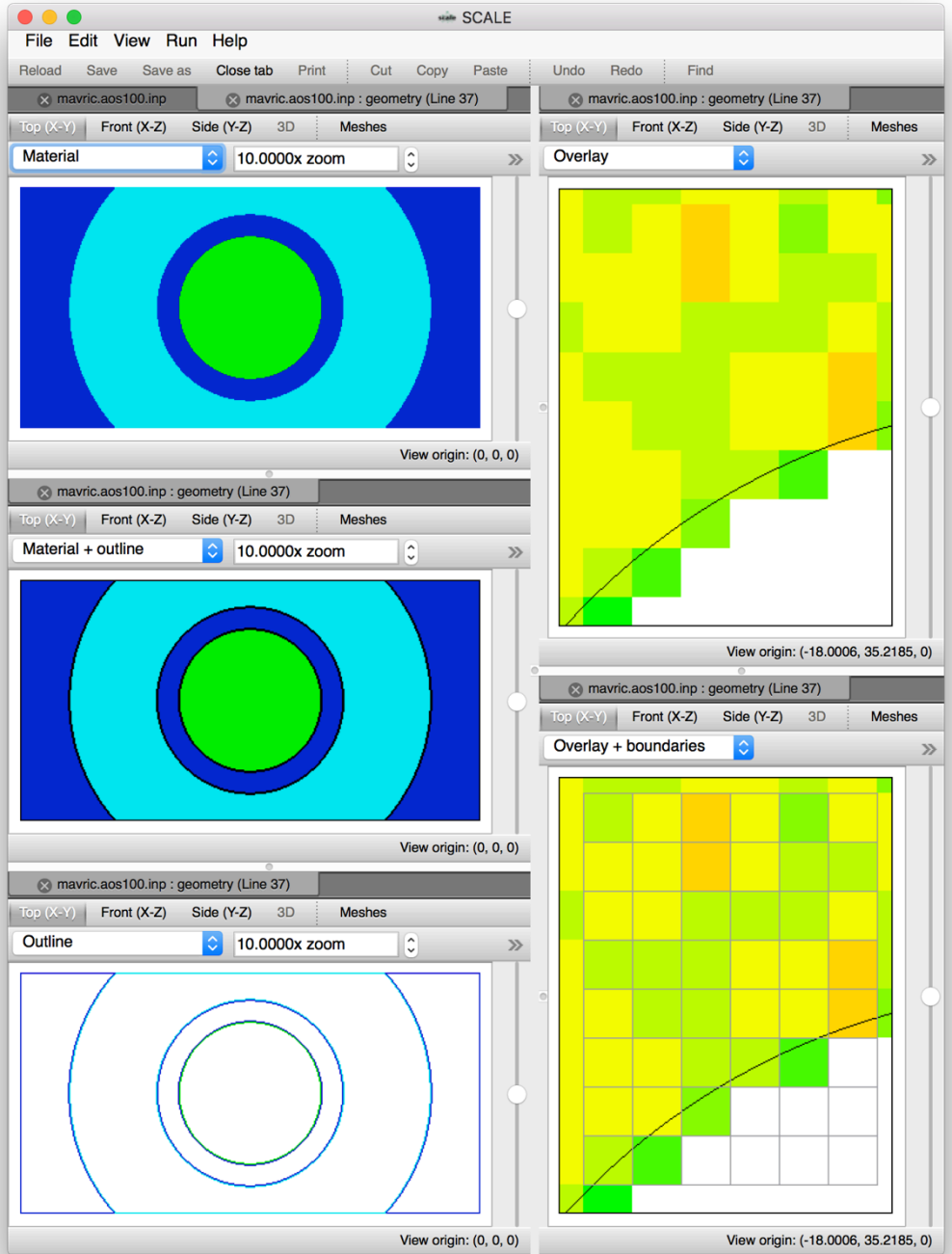


Render Modes



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

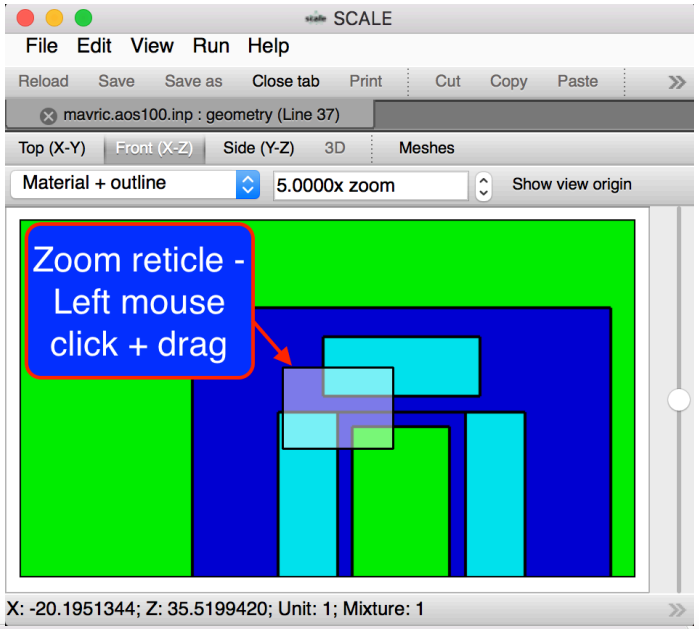


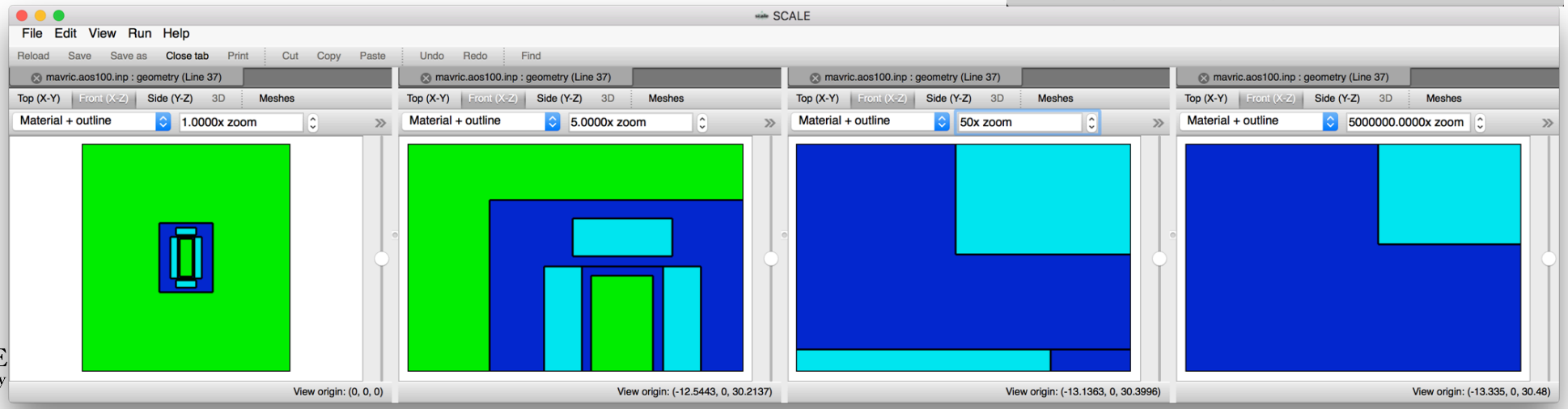
OAK RIDGE National Laboratory

Geometry Magnification (Zoom)

Ray traced geometry rendering allows for significant magnification.

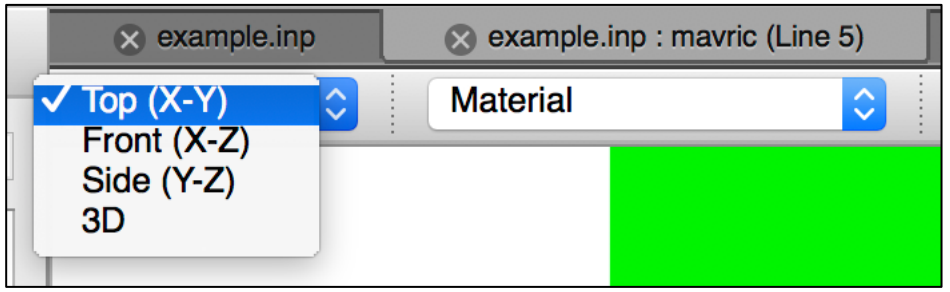
- Specify a zoom value.
- Visually specified via a user-drawn zoom reticle.
  - **Left click and drag down and to the right.**



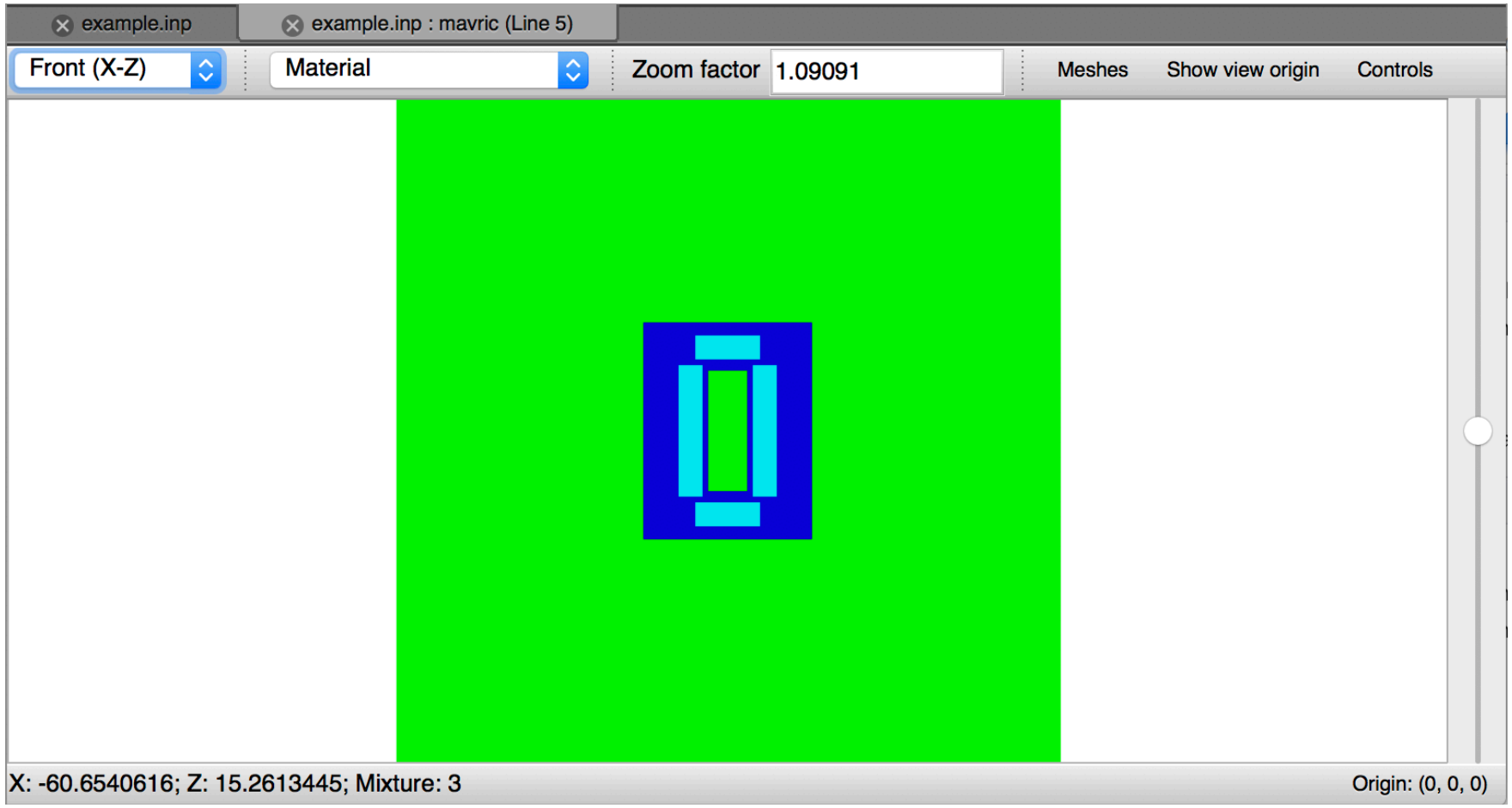


Geometry Visualization | Hands On with 2D Views

- Click the perspective dropdown and select **Front (X-Z)**

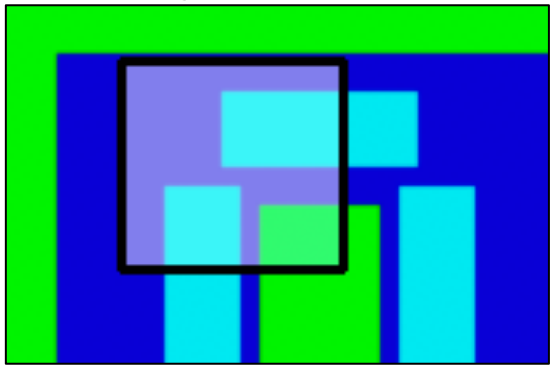


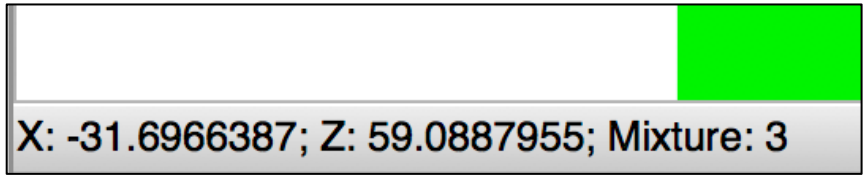
- Observe the new rendering of the **X-Z** cut at **Origin: (0,0,0)**



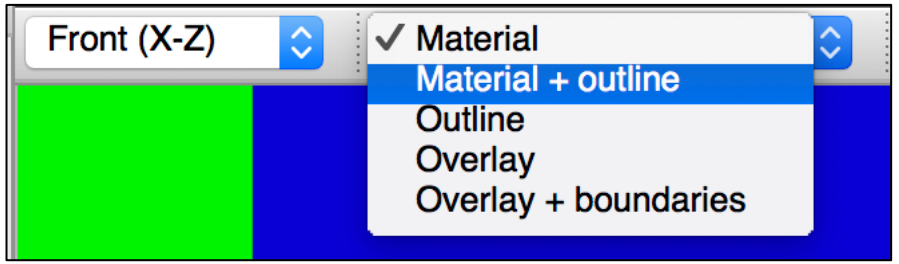
Geometry Visualization | Hands On with 2D Views

- Mouse over the model rendering and observe information under the cursor displayed in the lower-left of the rendering
- Perform a zoom by left-click and drag as depicted

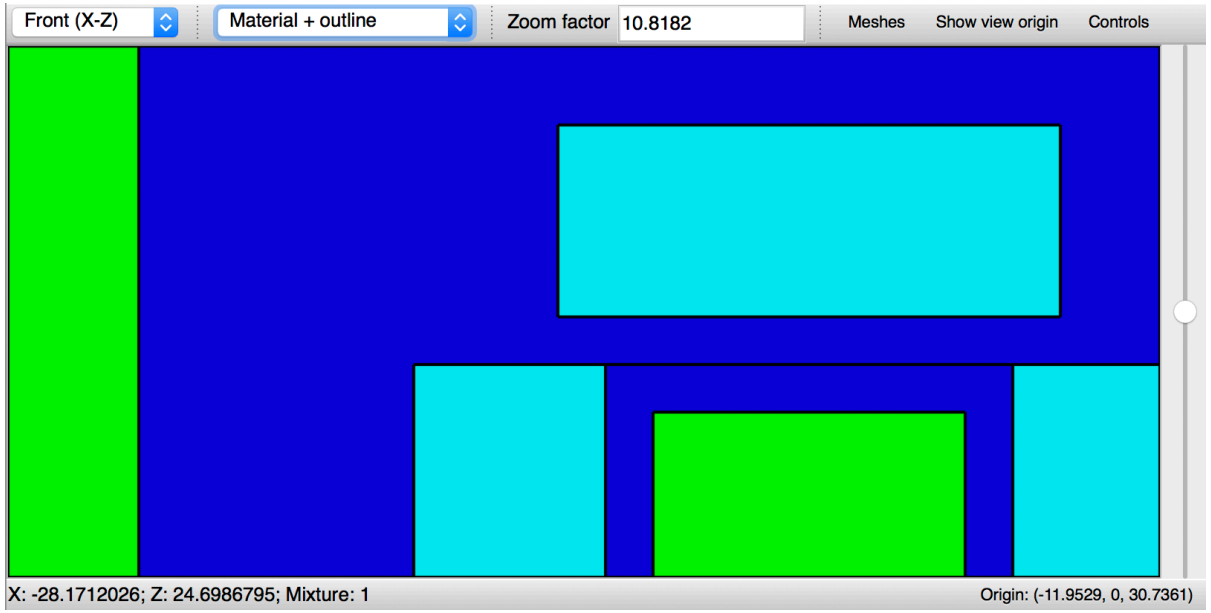




- Update the **Render mode** to **Material + Outline**



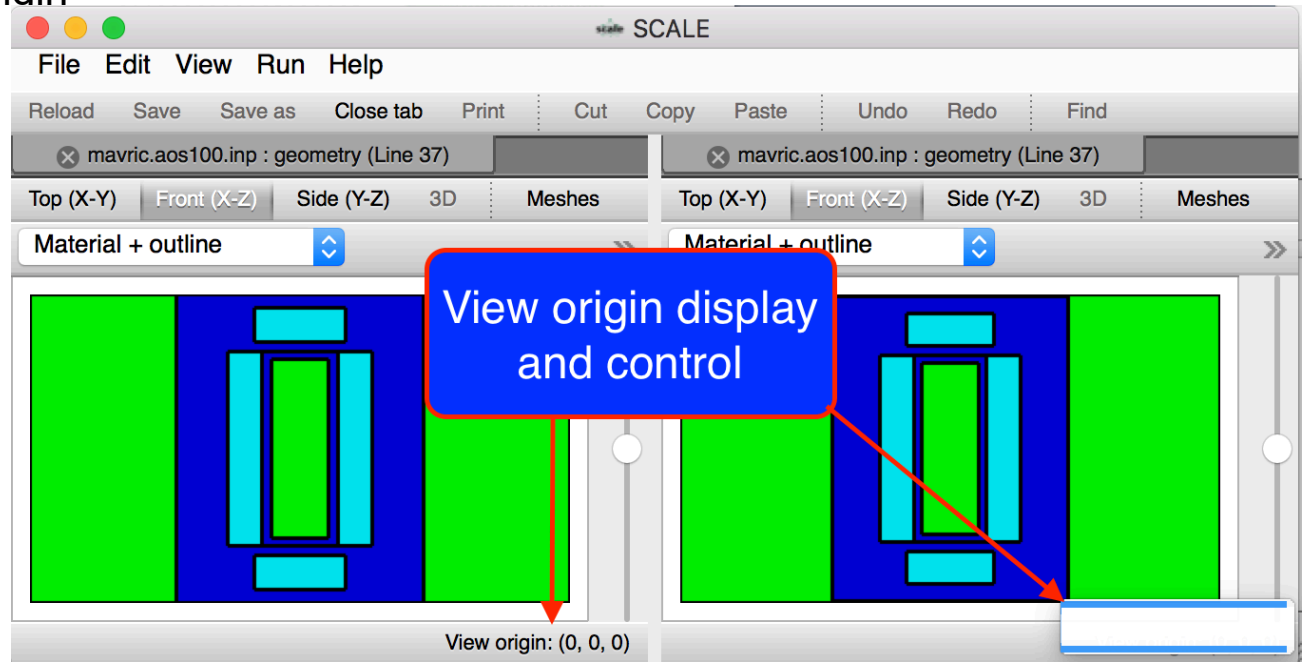
- Observe the new view **Origin, Zoom factor,** and geometry region **outline**



Geometry View | Origin Display and Control

Often when geometry errors are encountered, an X, Y, Z position is included in the error message. The ability to quickly navigate to this location and inspect the geometry is facilitated by the view origin control

- Left-click the **View origin display** will activate X, Y, Z entry
- 3 Modes of **Origin** input
  - **Single value** : Updates the view plane elevation (axis intersect – **same as slider control** but more precise)
  - **Two values** : Updates the view plane 2D origin (**pans** the image)
    - Top (X-Y) – sets the X and Y coordinates of the origin
    - Front (X-Z) – sets the X and Z coordinates of the origin
    - Side (Y-Z) – sets the Y and Z coordinates of the origin
  - **Three values** :
    Updates the view plane **elevation** and the view plane 2D **origin**
- Double left-click centers the view origin at the point clicked
  - Useful when combined with the **Show View Origin**
- Shift and left-click **pans**

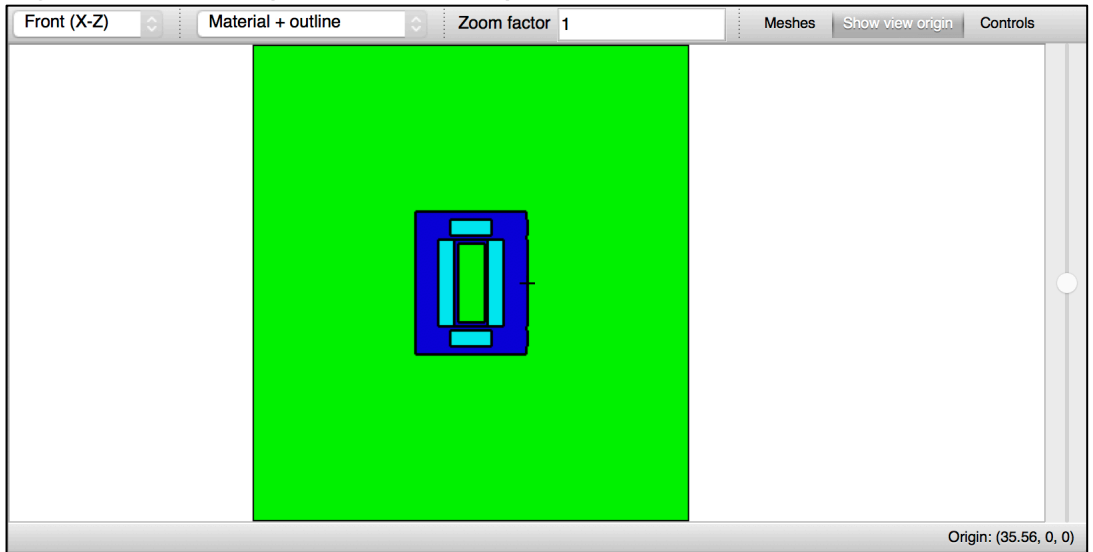


Geometry View | Hands On 2D Controls

- Click **Show View Origin**

- Perform a view **pan** by clicking the **Origin** label (lower-right corner) and entering 2 values (-12, 32) and pressing the **return/enter** key

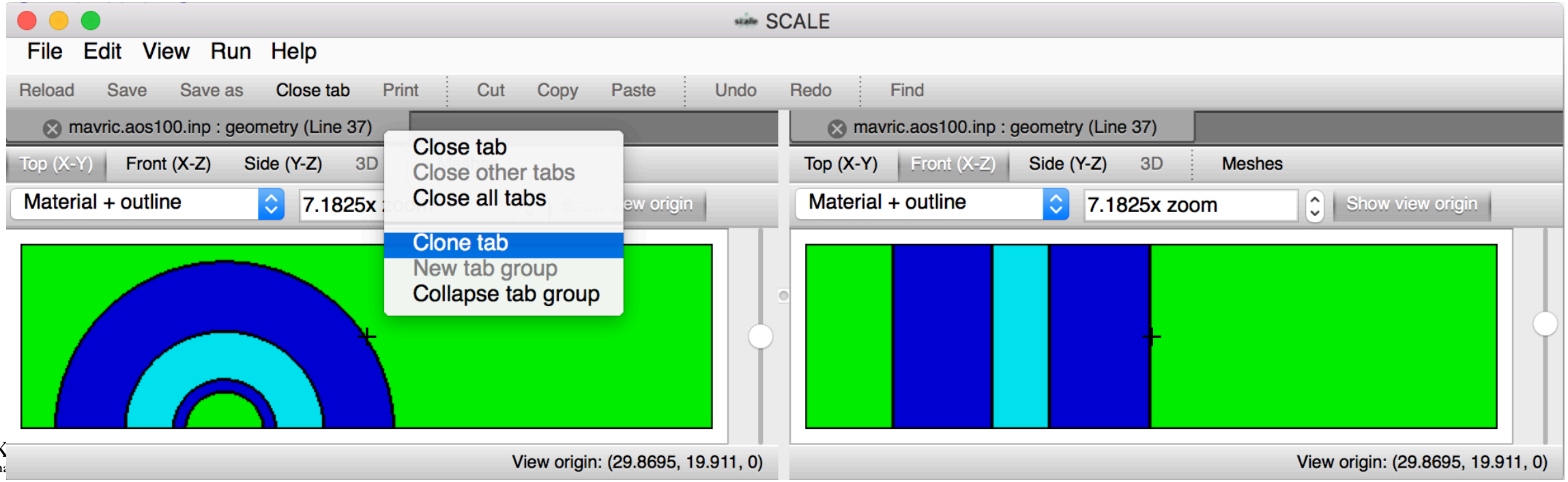
- Perform a X-Z **elevation** change (change in Y-intersect) by entering a single value (-8)
- Play with the **elevation slider**
  - Sliding up increases **Y-intersect**, down decreases **Y-intersect**
- Perform an **elevation and origin** change by entering 3 values (35.56, 0, 0)
  - Places the view origin at the edge of the outermost cylinder for this example problem
- **Zoom out** by
  - **Enter 1.0** in the **Zoom Factor** field or
  - Left-click and dragging up and to the left and releasing



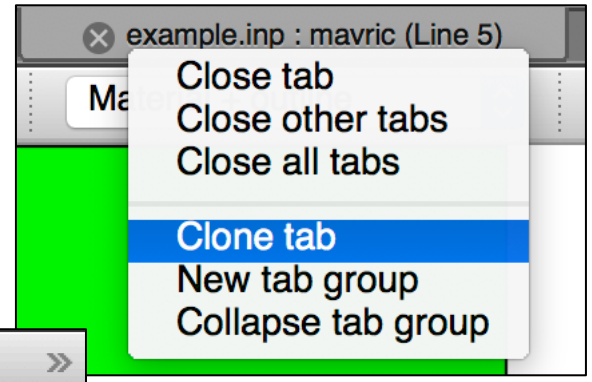
Geometry View Origin Preserved Across View Plane

The geometry viewer is often used for geometry verification and debugging. Both typically involve known locations – X, Y, Z of lost particle, etc.

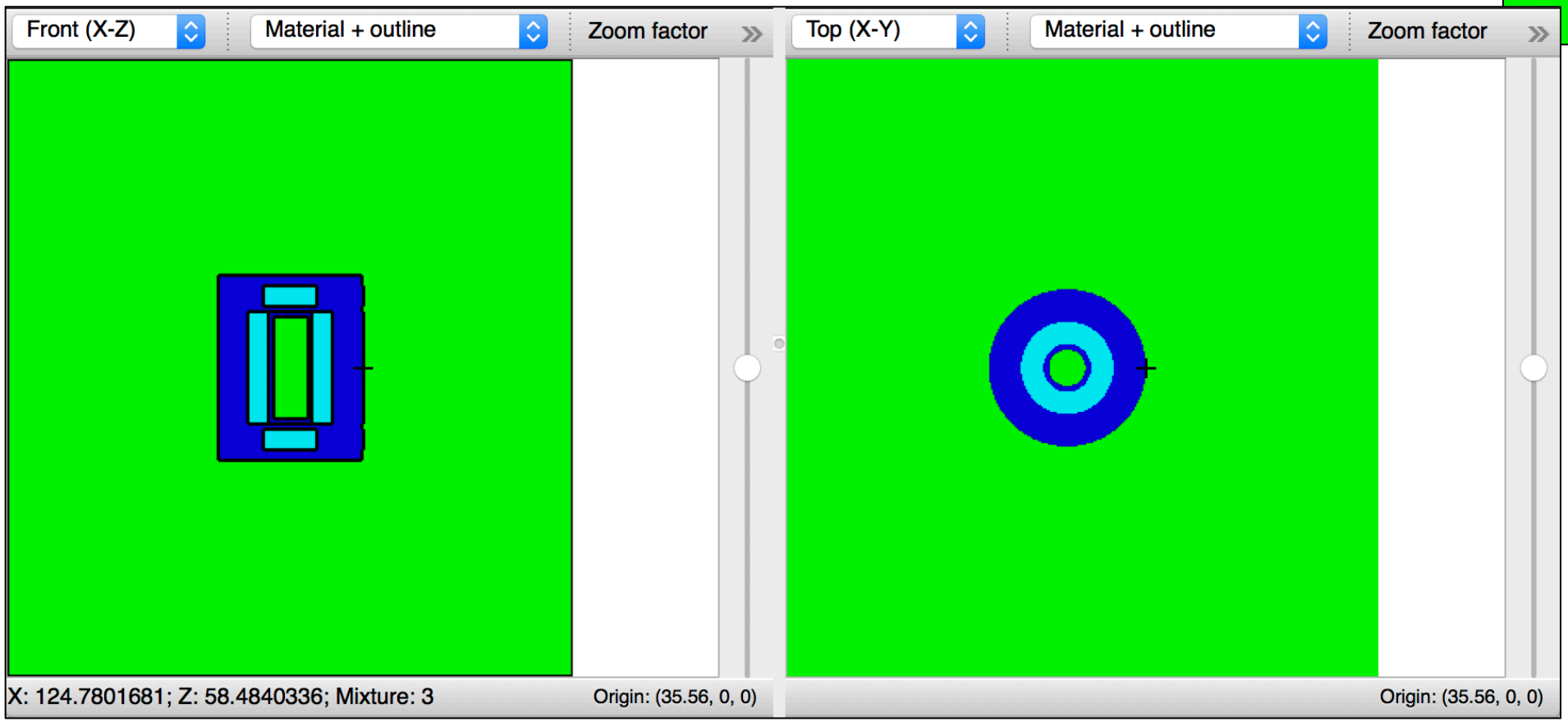
- View origin is preserved during view plane changes (Top to Front, etc.)
  - Facilitates quickly identifying locations where initial view plane is epsilon (1e-15) off a tangent surface
- Cloneable geometry viewer with subsequent view plane change allows quick visual comparison of location



Geometry View | Hands On 2D Clone



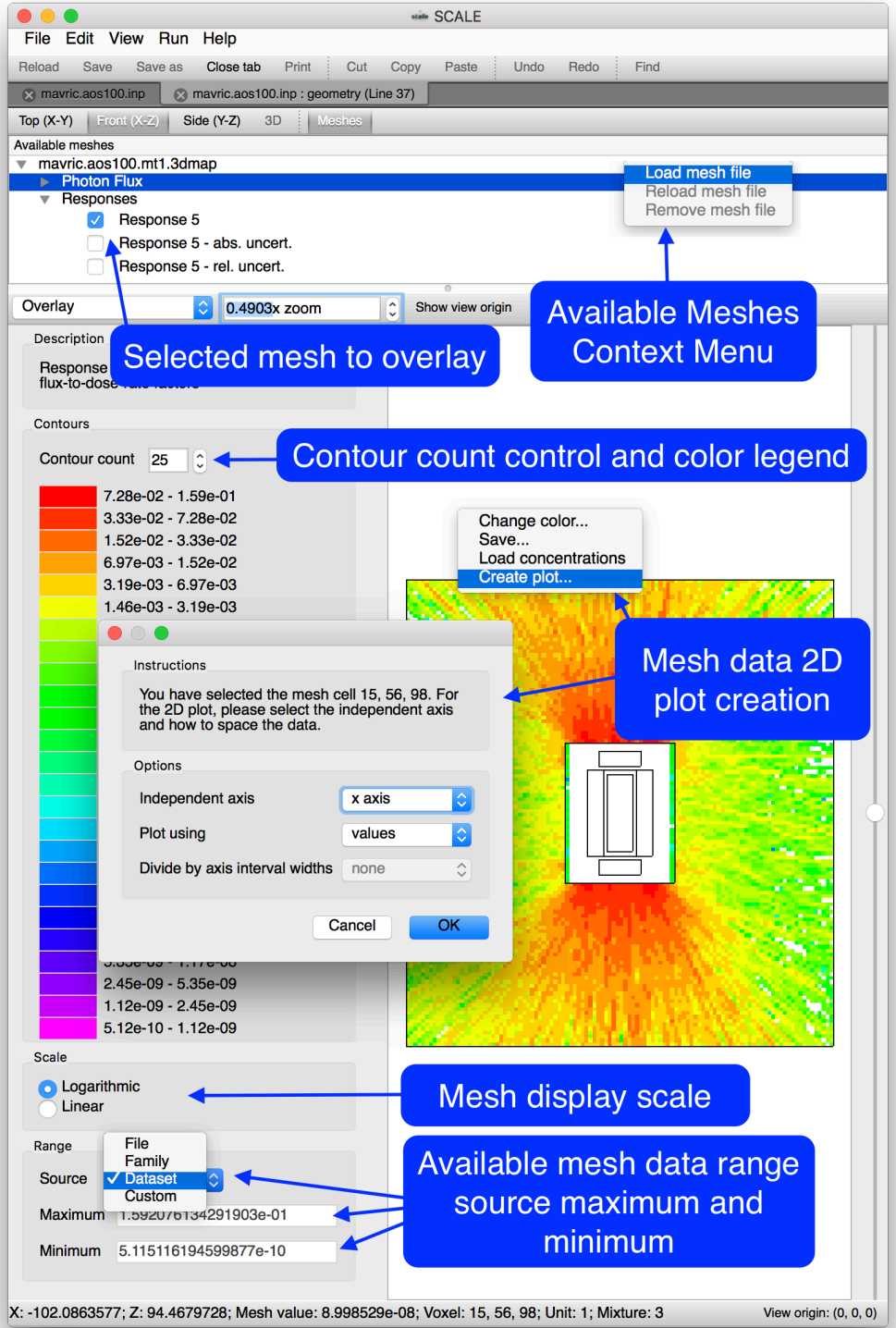
- Right-click the **example.inp : mavric (Line 5)** geometry tab and select **Clone tab**
- In the new tab change the perspective to **Top (X-Y)**



- **Close the Top (X-Y) tab**

Mesh Overlay Overview

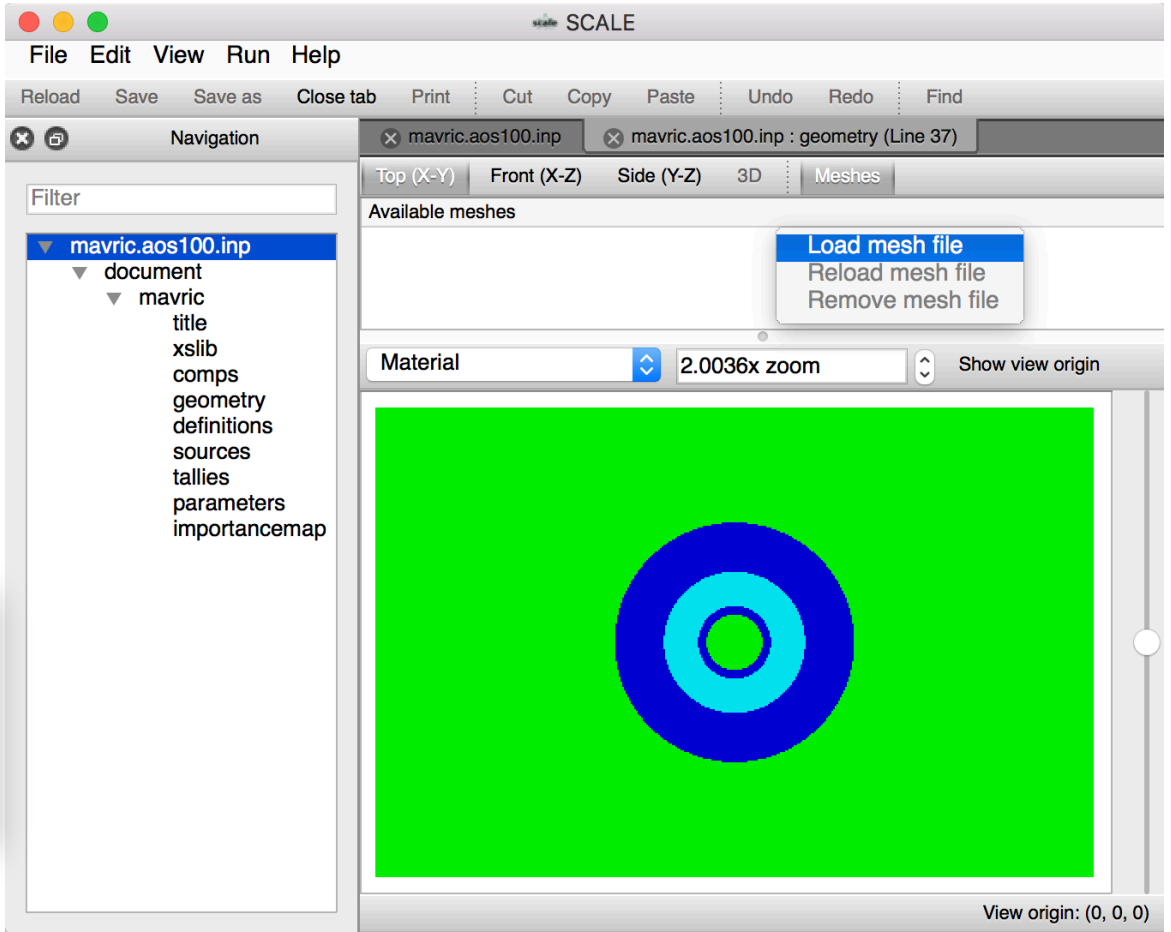
- Loading Mesh Data
- Render Modes
- Contours and color legend
- Scale – Log and Linear
- Range – File, Family, Dataset, or Custom
- Position, Mesh value, Mesh Voxel, Unit, and Mixture under Cursor
- Context Menu
- 2D Plot creation

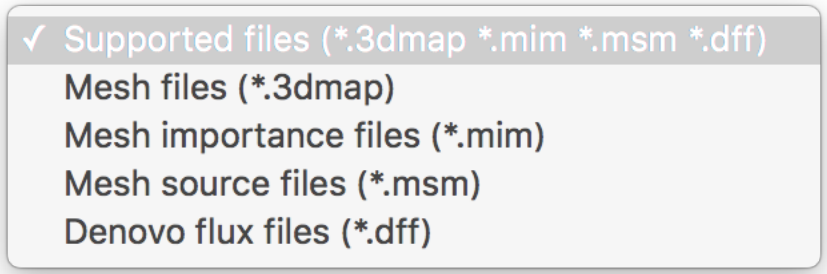


Mesh Overlay | Loading Mesh Data

With the **Available meshes** window open, a context menu is available via **right-click**. This context menu will allow **loading** new, and **removing** or **reloading** existing mesh files

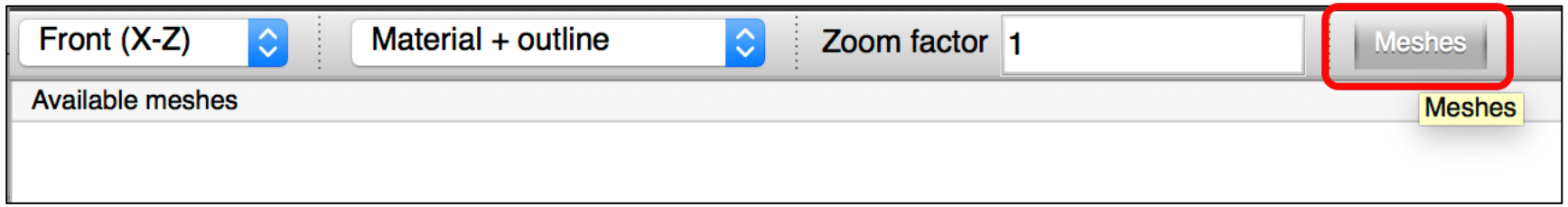
- Right-click in **Available meshes** to access the **Load mesh file** dialog. Select the mesh to load
- Most of SCALE's major mesh formats are supported



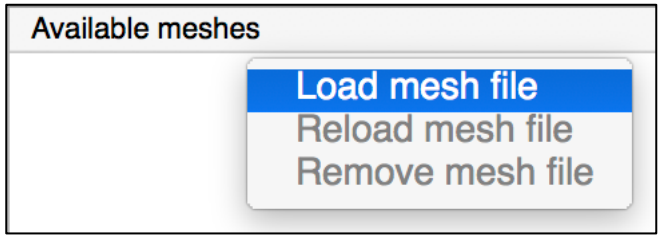


Mesh Overlay | Hands On Loading Mesh Data

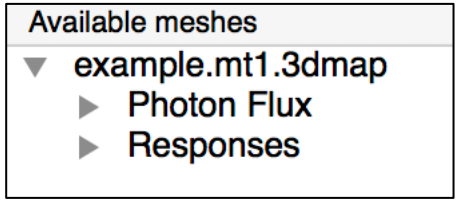
- Click the Geometry View's **Meshes** panel button and observe the **Available meshes**



- Right-click inside the **Available meshes** panel and select **Load mesh file**

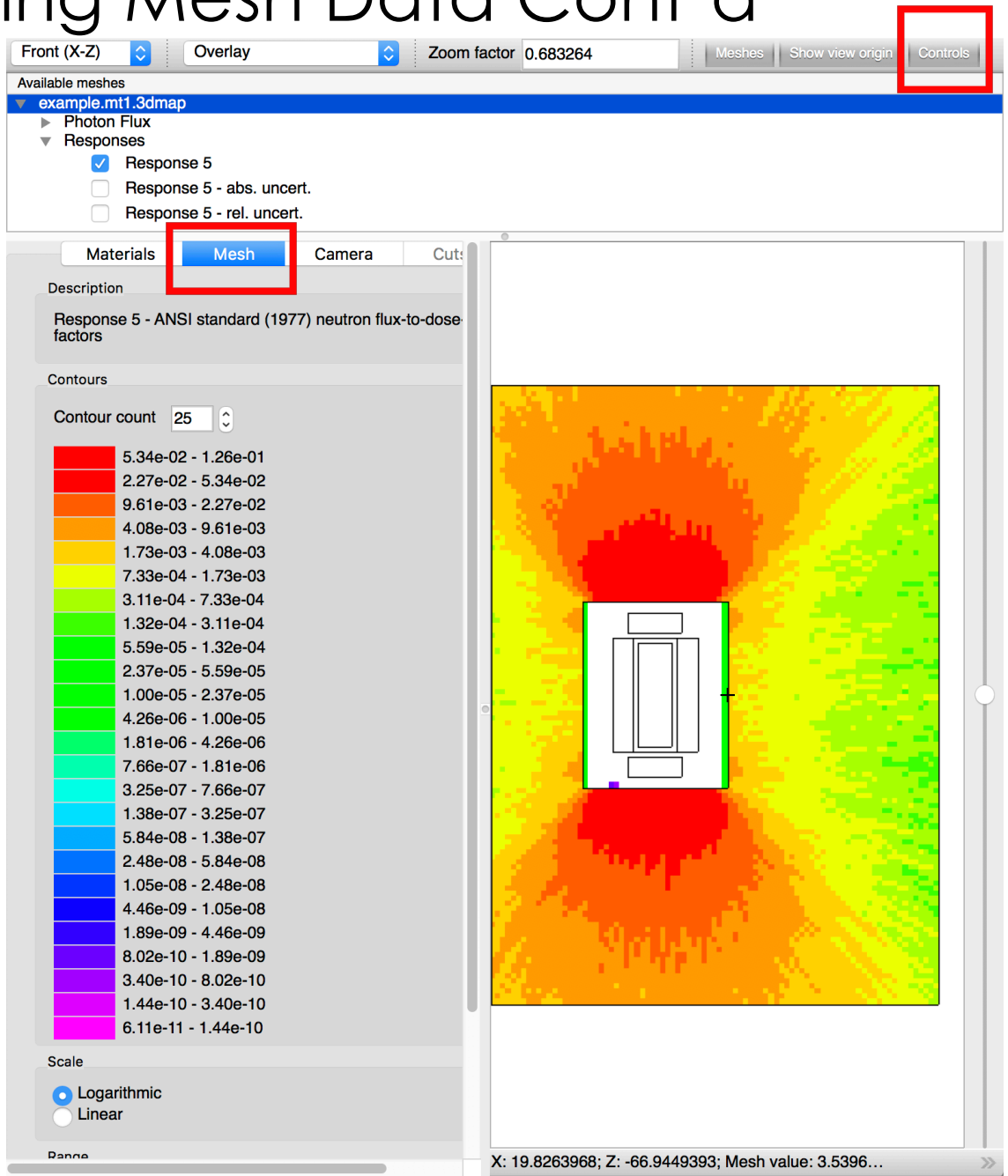


- Open the **Advanced_User_Interface/Input/example.mt1.3dmap**
- Observe the available data sets for plotting



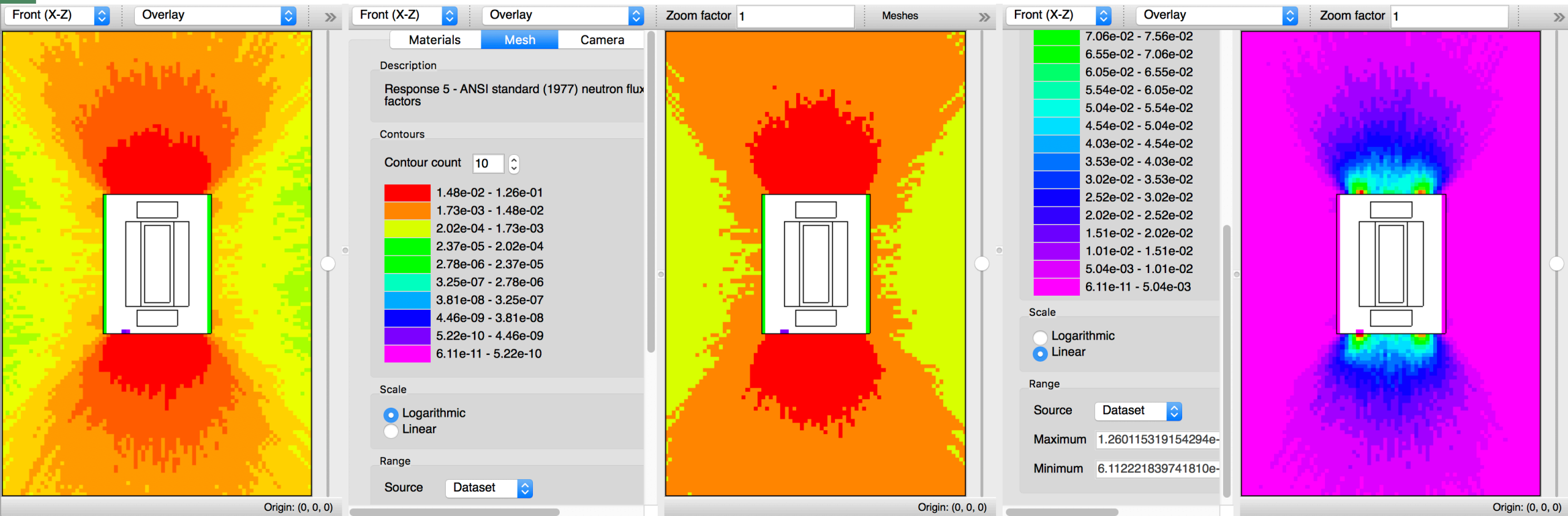
Mesh Overlay : Hands On Loading Mesh Data Cont'd

- Expand **Responses** and select **Response 5**
- Change the render mode to **Overlay**
- Click the **Controls** panel button
- select the **Mesh** tab
- Mouse over the data rendering and observe the display of the cursor position (**X-Z**), **mesh voxel**, and **mesh value**



Mesh Overlay | Contours, Color Legend, and Scale

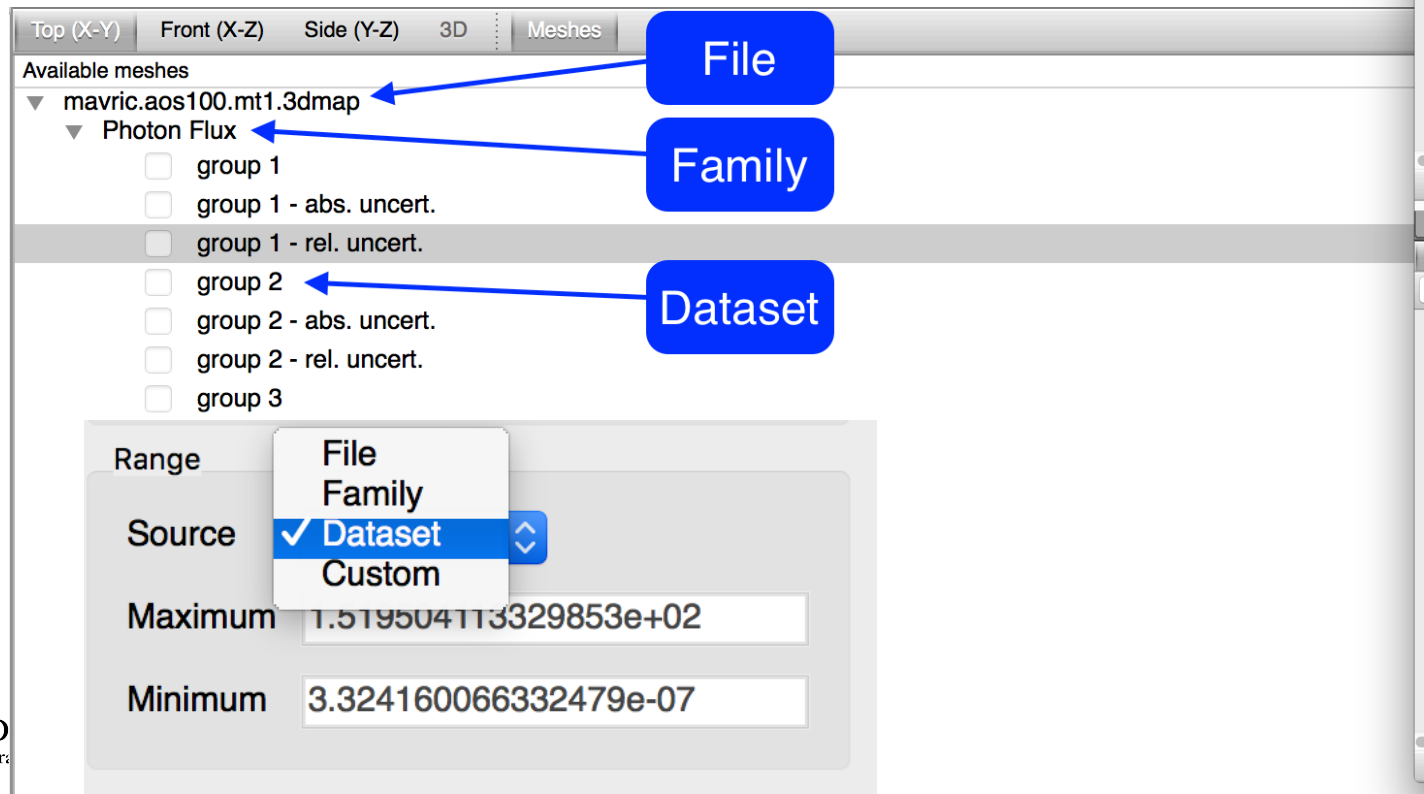
- Controls influenced by MAVRIC's MeshView plot program
- Allows changing contour count from 25 to 2 enhancing data contrast
- Can improve print quality for printouts
- Linear and logarithmic scale data display

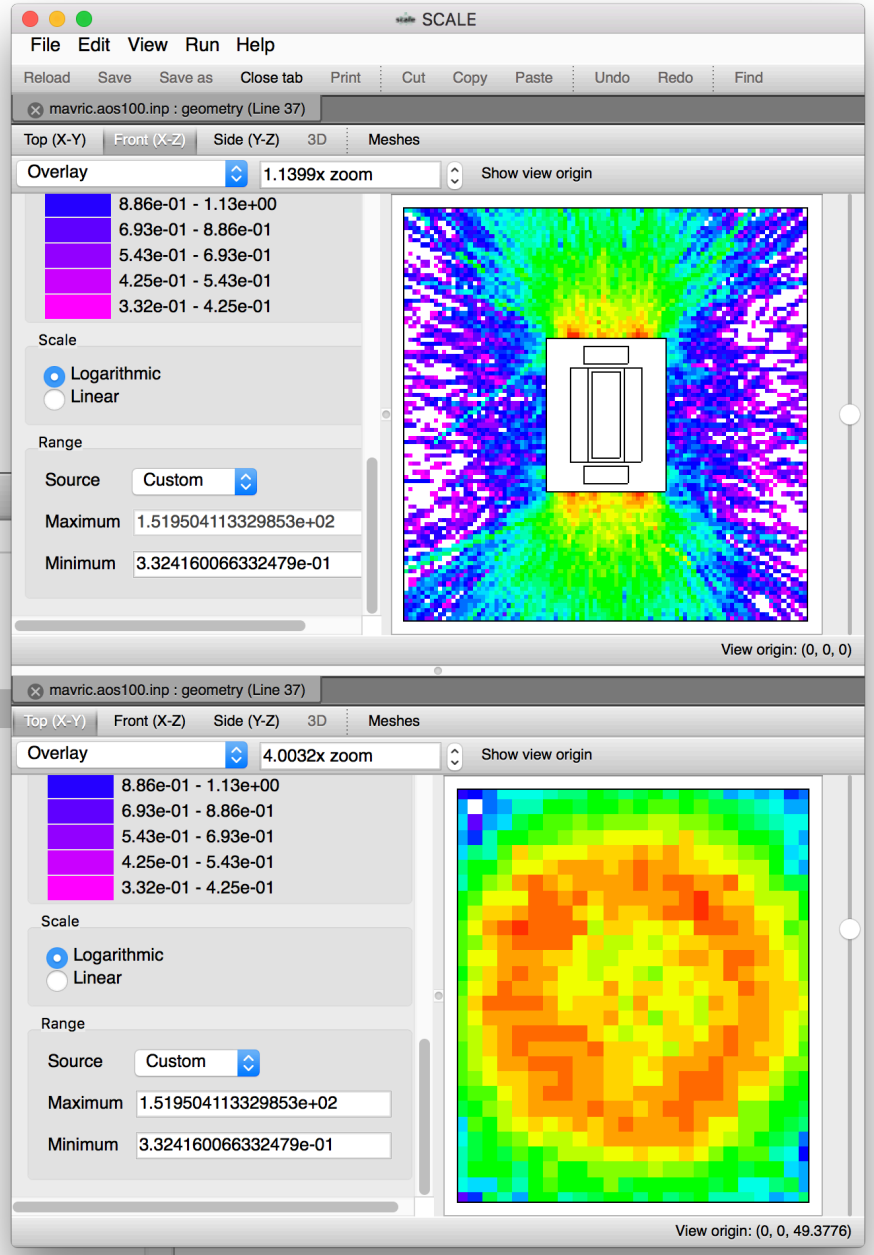


Mesh Overlay | Data Ranges

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

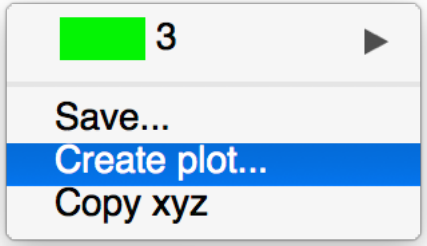
- The file indicates the entire mesh file context.
- The family range provides context to a selected dataset.
- Custom allows down-selection.



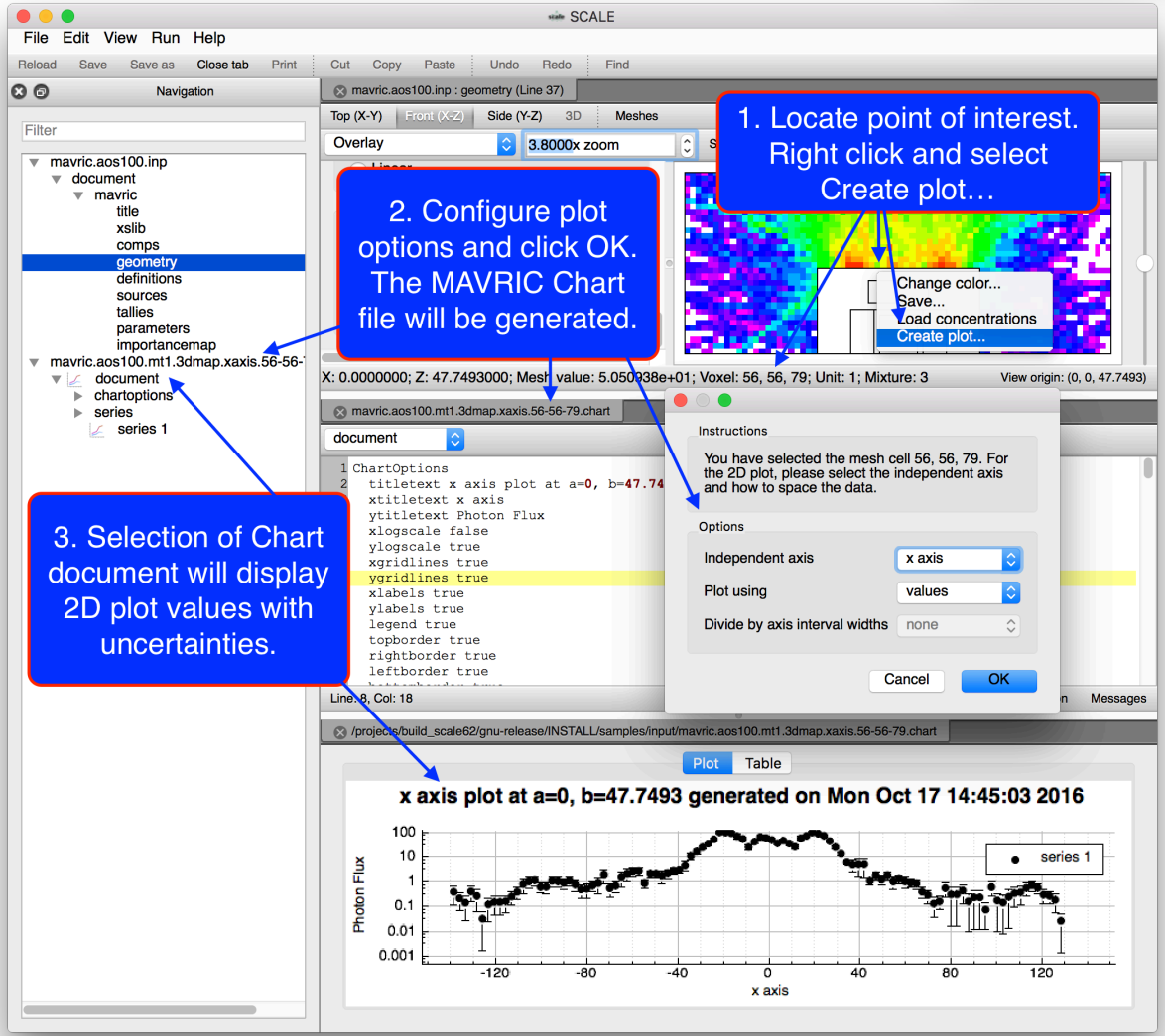


Mesh Overlay | Integrated 2D Plot Creation

- 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.

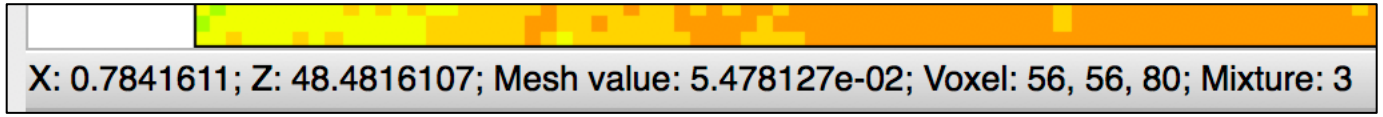


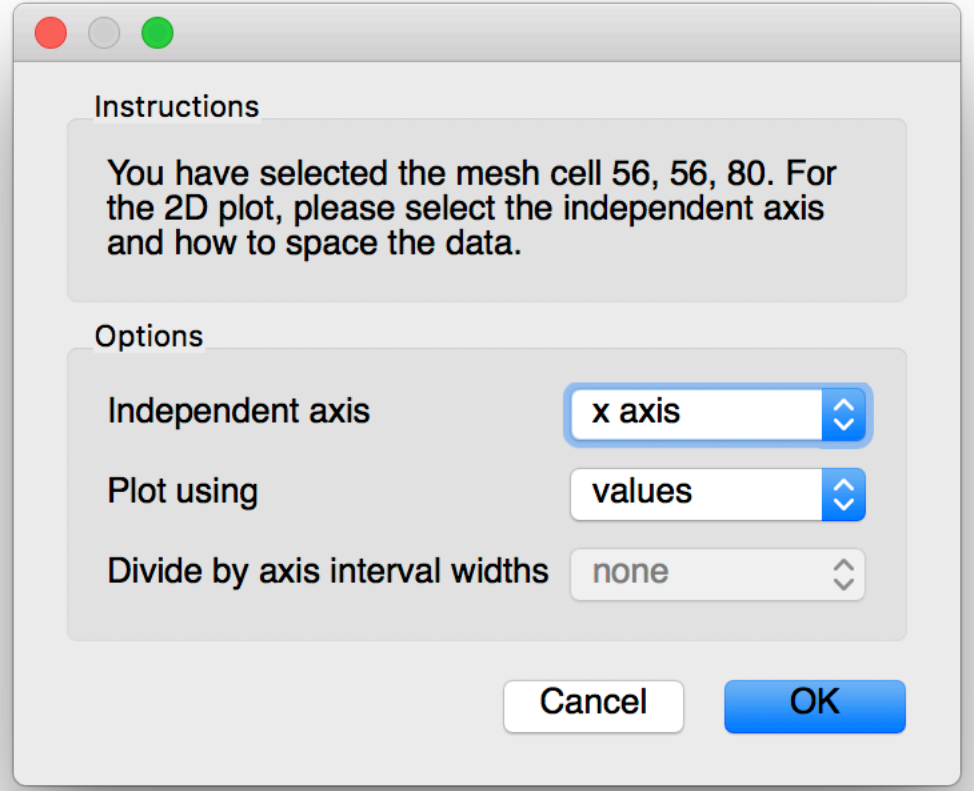
- Plot options include
  - Independent axis
    - Cartesian X,Y, and Z
    - Cylindrical Radial, Theta, and Z
    - Group when group-wise data is available
  - Plot using values or indices
  - When data is group-wise axis interval widths can optionally be divided linearly or logarithmically

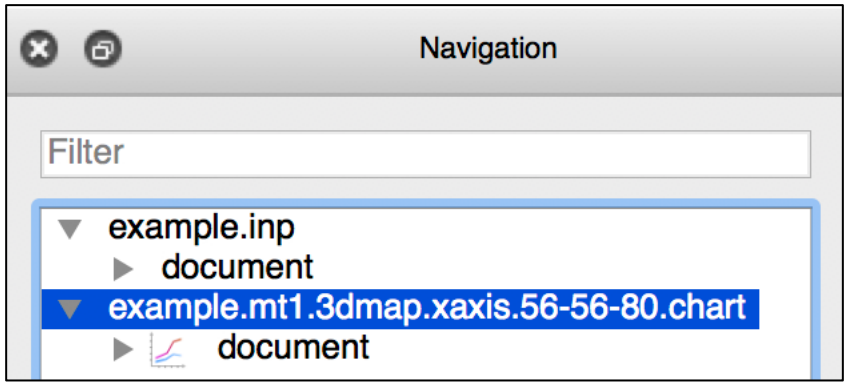


Mesh Overlay | Hands On Interactive 2D Plots

- Using the cursor find **Voxel 56, 56, 80**
- **Right-click** and select **Create Plot …**
- Select defaults
  - Plot mesh **values** along the **x axis**
- Click **OK**
- Observe **chart** file generated and available in the **Navigation** panel

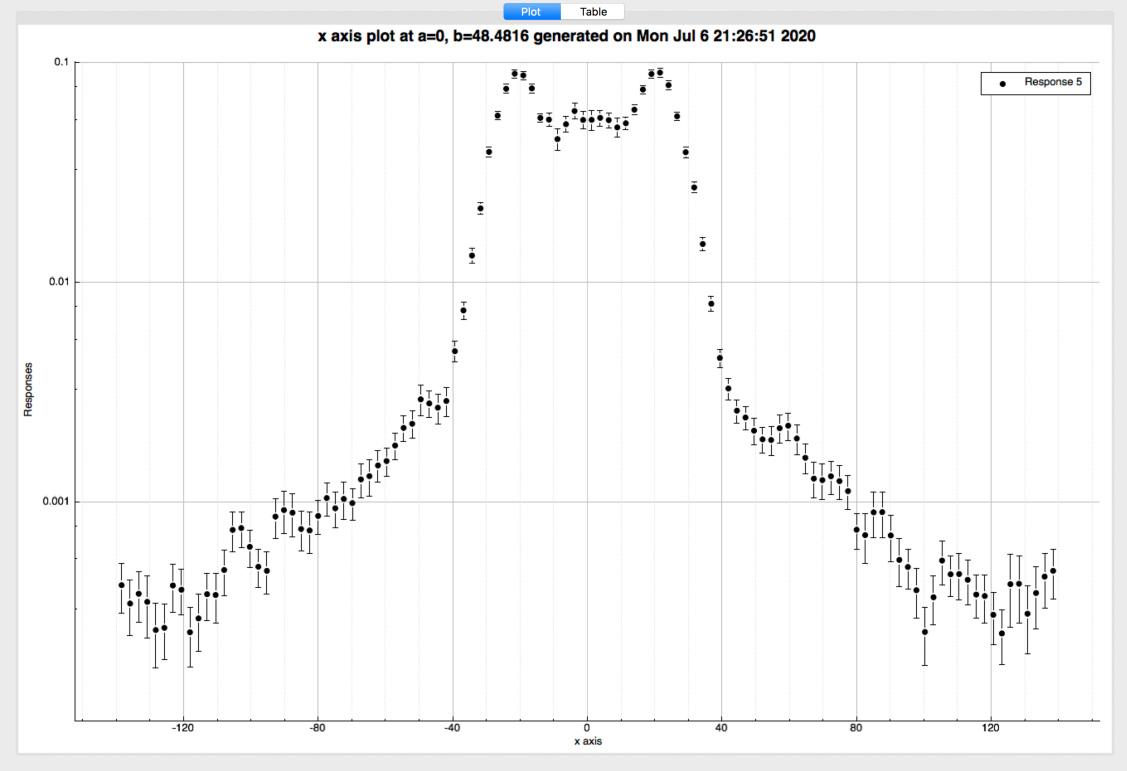






Mesh Overlay | Hands On Interactive 2D Plots

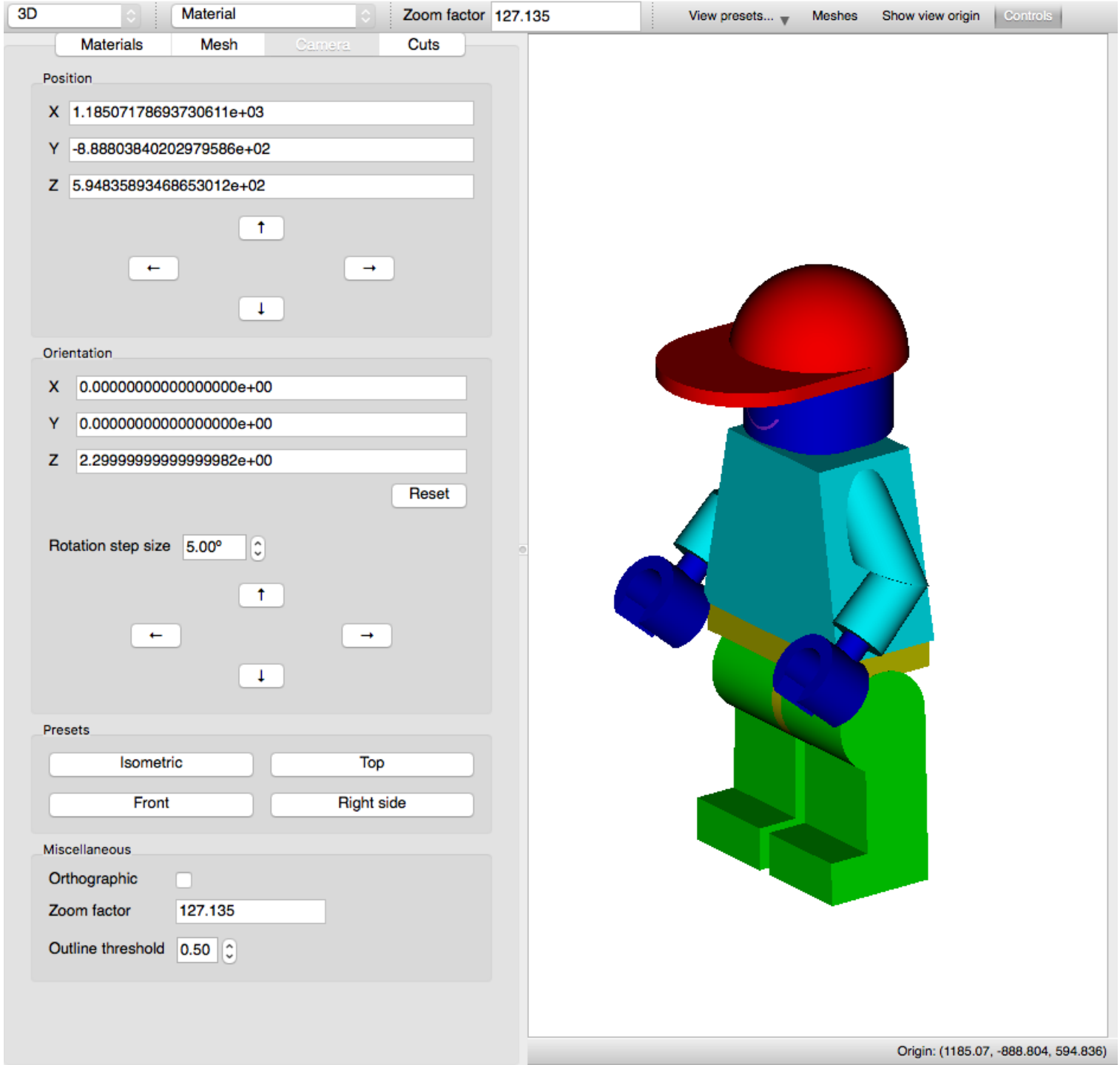
- Double left-click the **example*chart > document** to plot the data



- Observe the **data** and the **high** and **low uncertainties**
  - **Remember the Table view allows copy-and-paste of the data**
- **Close** the Chart tab and file and select the previously opened Geometry tab

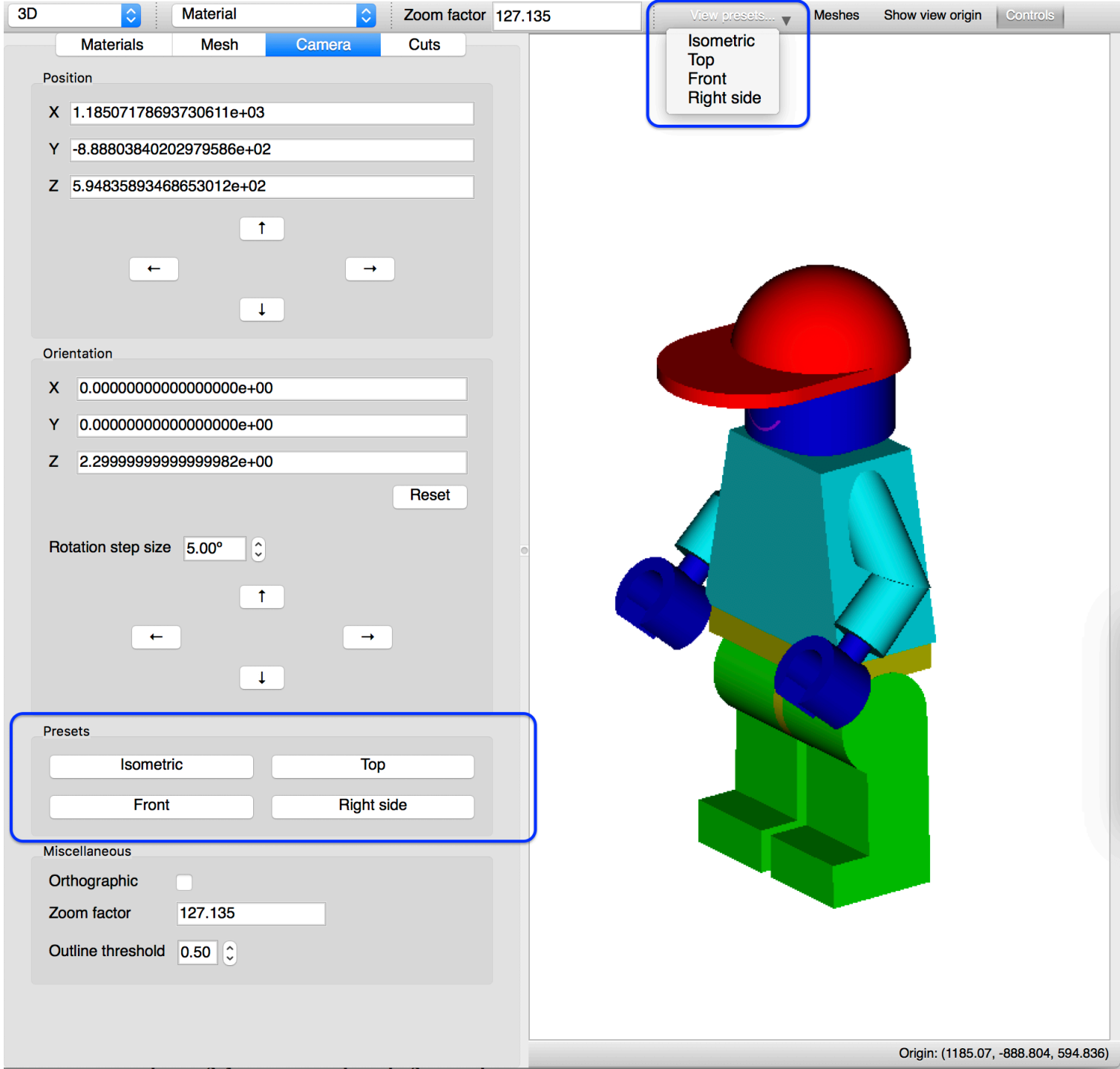
3D Overview

- **Camera**
  - **Presets**
  - **Panning**
  - **Zooming**
  - **Rotation**
- **Rendering modes**
- **Display metadata**
- **Material controls**
  - **Filter material table**
- **Geometry Cuts**



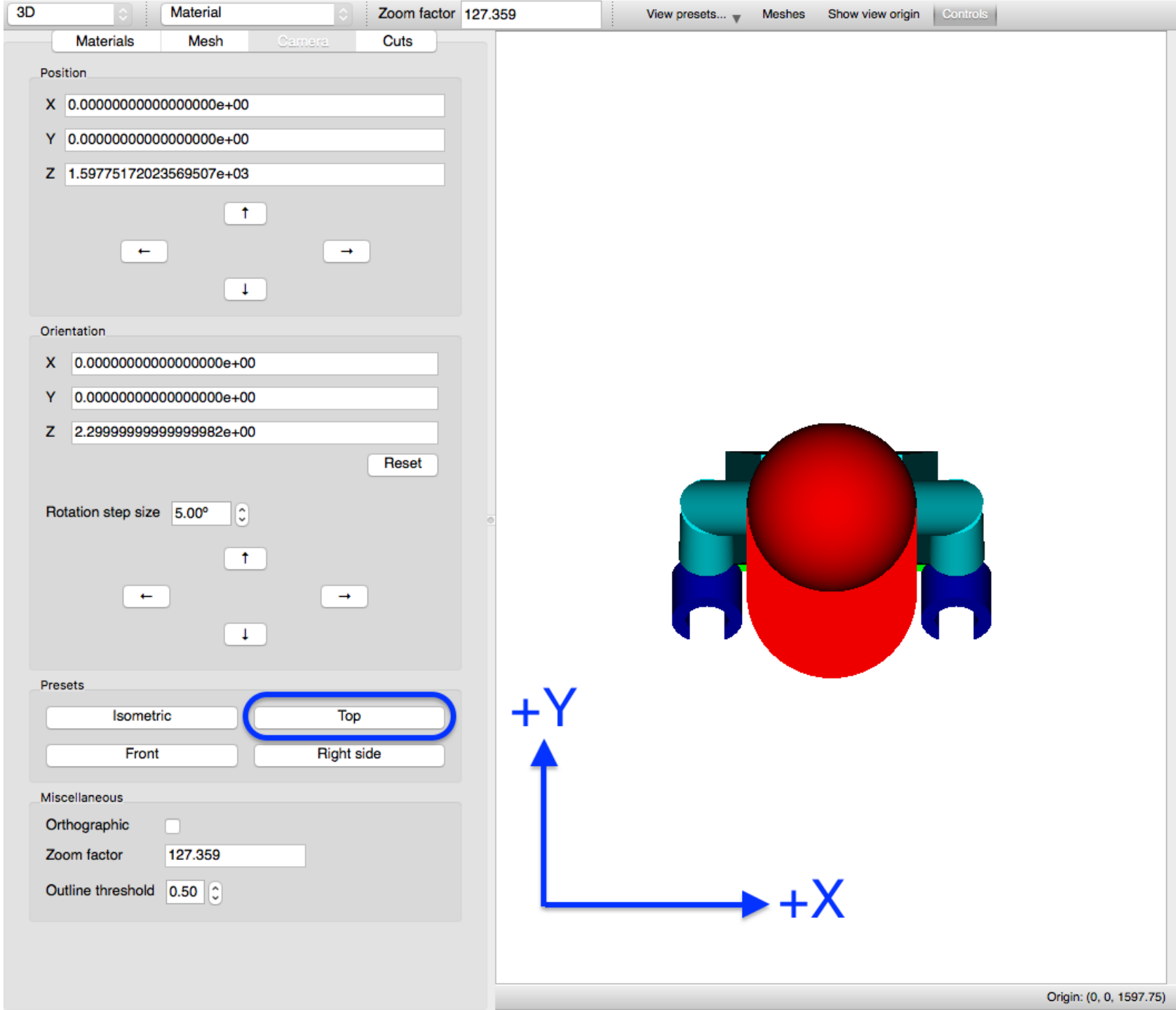
Camera presets

- **Top**: camera is in +Z looking into –Z
- **Front**: camera is in –Y looking into +Y
- **Right side**: camera is in +X looking into –X
- **Isometric**: camera is above and in front +X,-Y,+Z



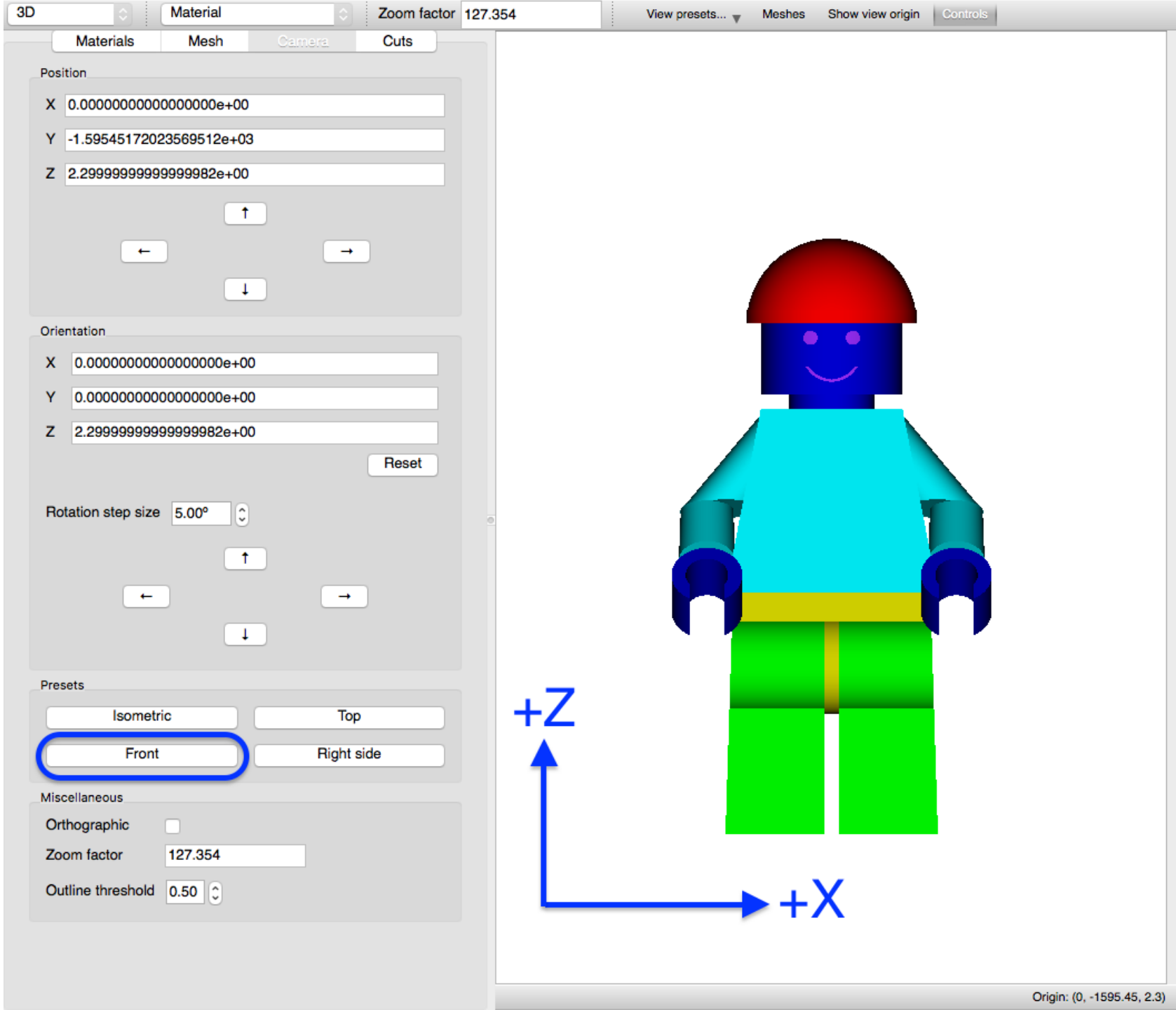
Camera presets:

- **Top**: camera is in +Z looking into –Z
- Front: camera is in –Y looking into +Y
- Right side: camera is in +X looking into –X
- Isometric: camera is above and in front



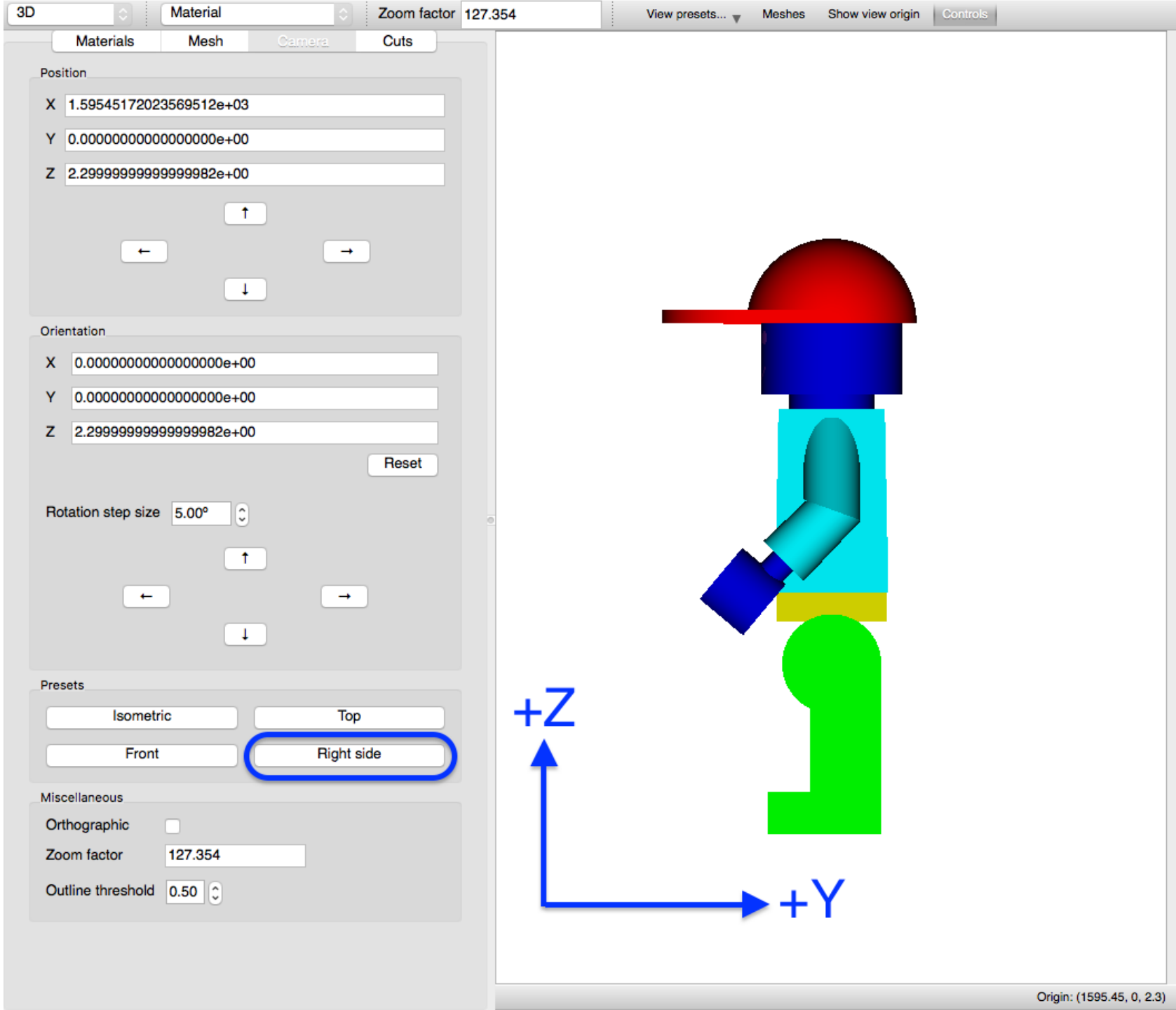
Camera presets:

- Top: camera is in +Z looking into –Z
- **Front:** camera is in –Y looking into +Y
- Right side: camera is in +X looking into –X
- Isometric: camera is above and in front



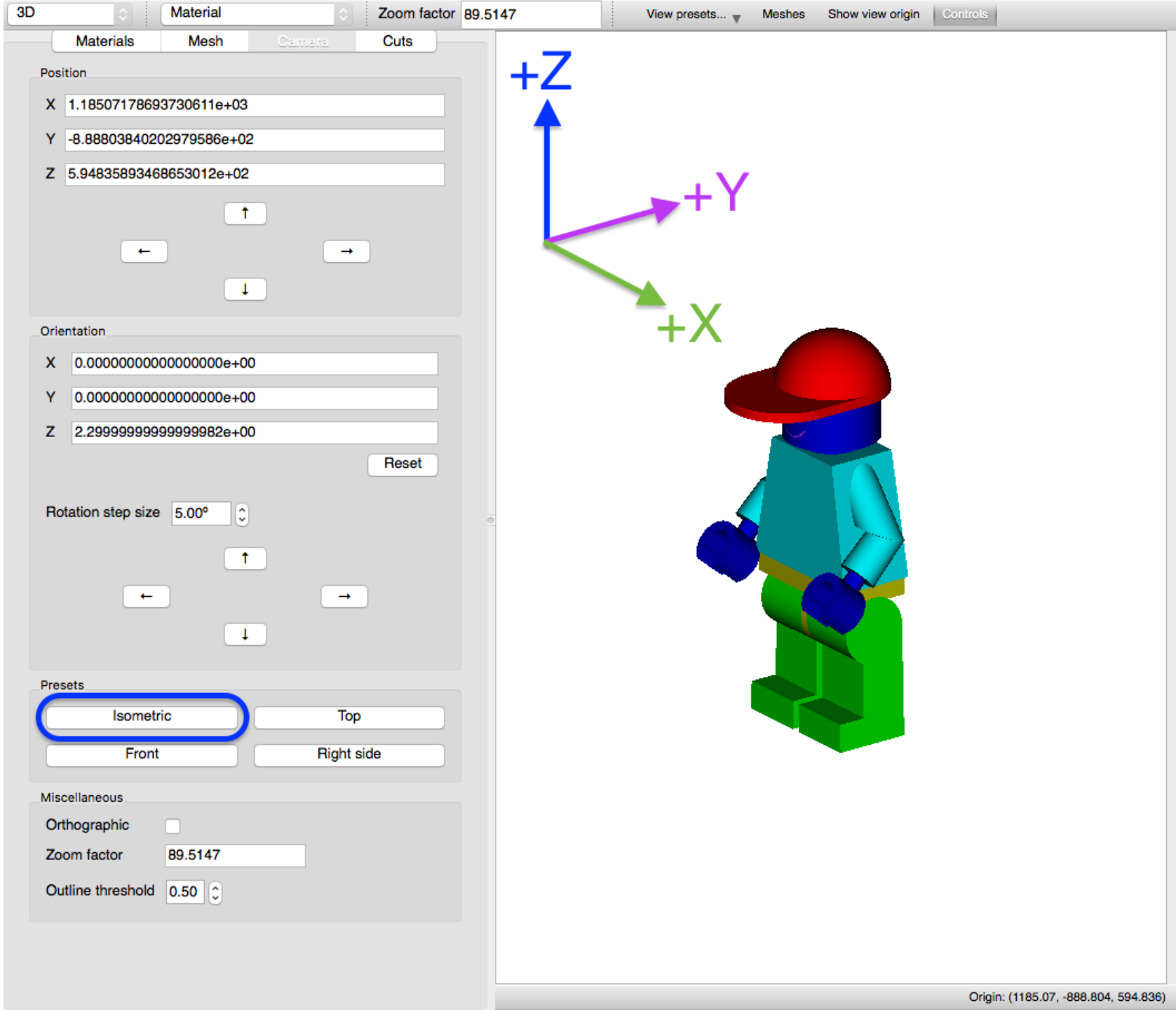
Camera presets:

- Top: camera is in +Z looking into –Z
- Front: camera is in –Y looking into +Y
- **Right side**: camera is in +X looking into –X
- Isometric: camera is above and in front



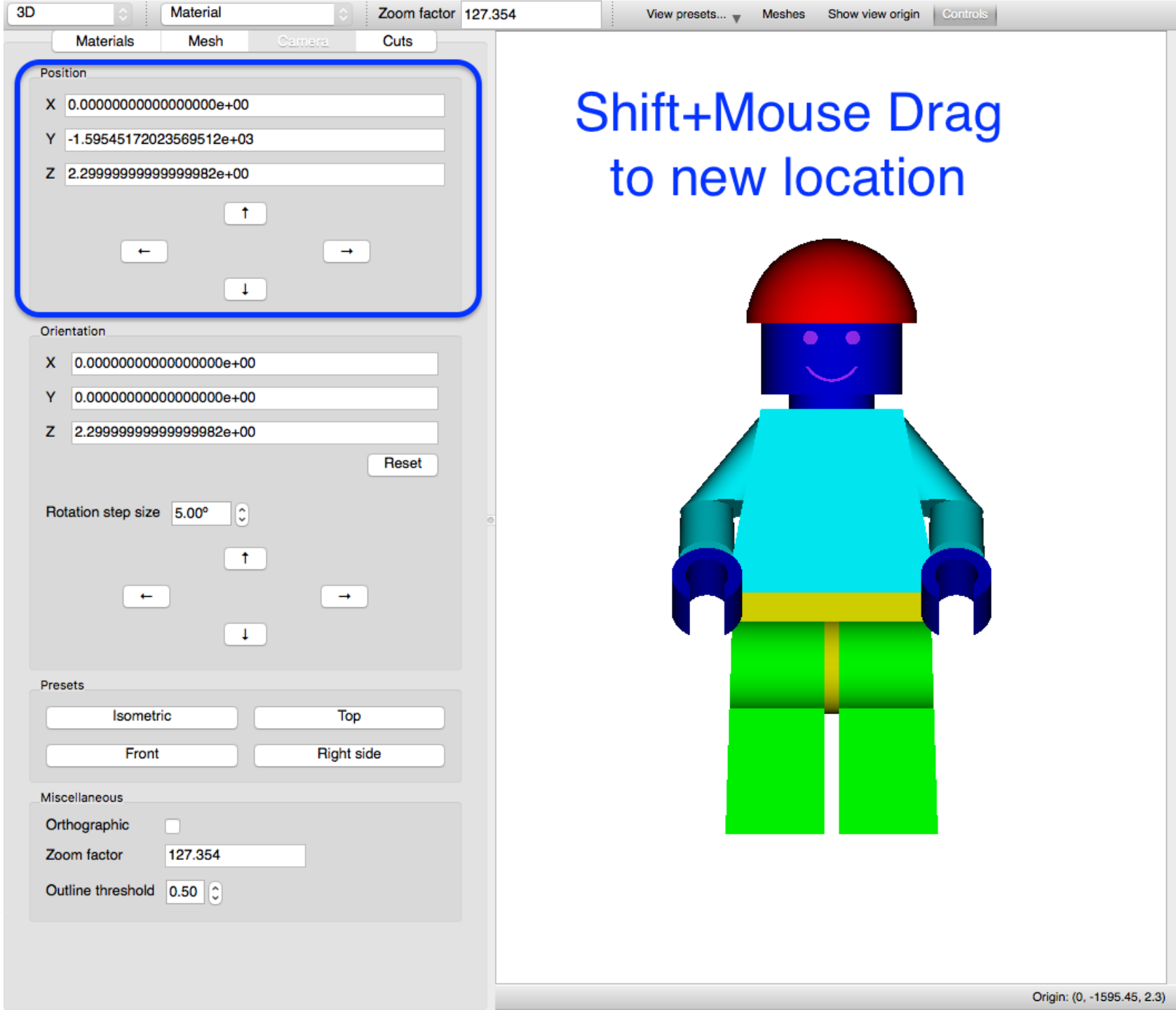
Camera presets:

- Top: camera is in +Z looking into –Z
- Front: camera is in –Y looking into +Y
- Right side: camera is in +X looking into –X
- **Isometric**: camera is above and in front



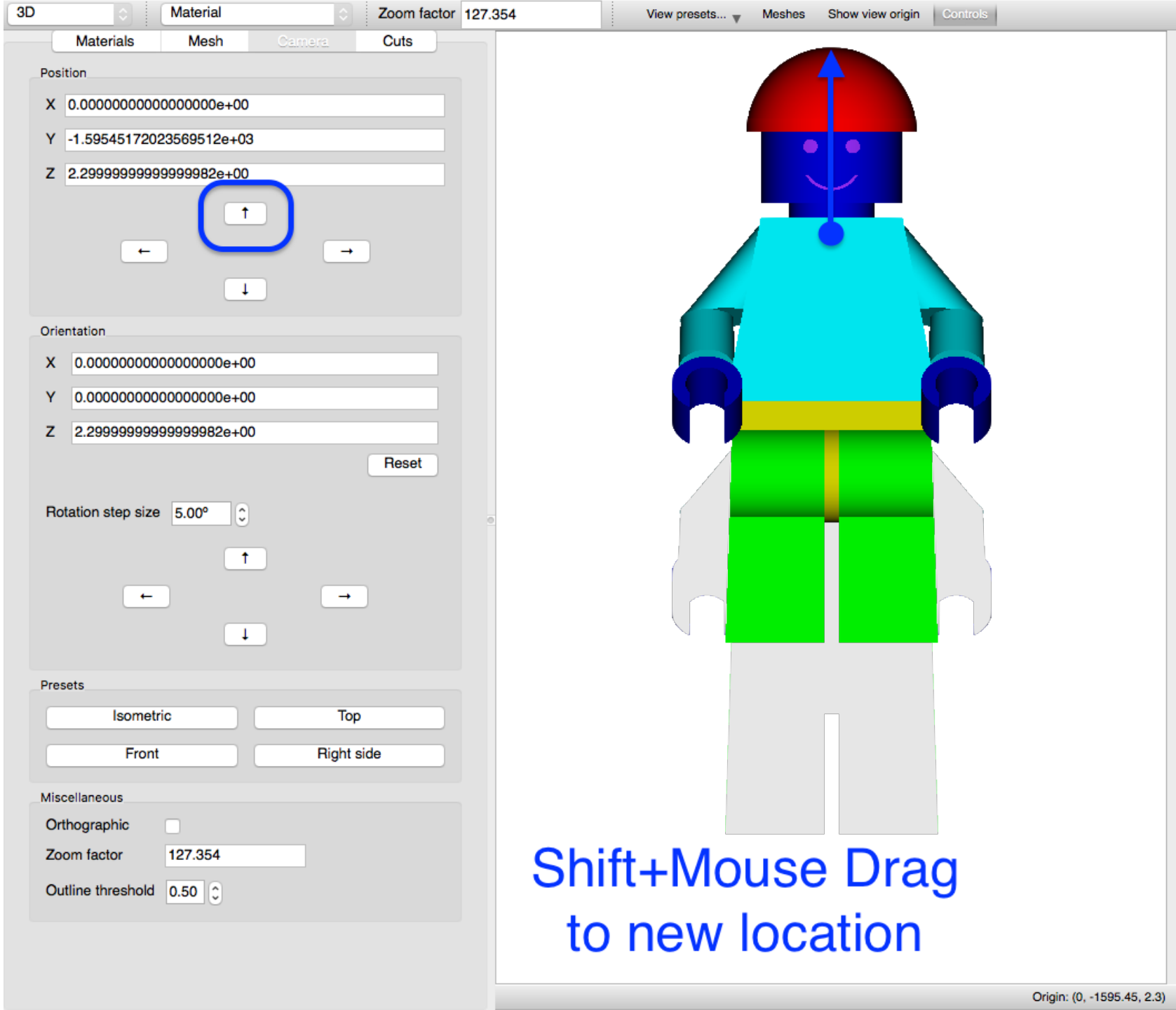
Camera Panning

- **Position** fields allow absolute camera positioning
- **Up** arrow moves model up by moving camera down
- **Down** arrow moves model down by moving camera up
- **Left** arrow moves model left by moving camera right
- **Right** arrow moves model right by moving camera left
- **Double-click** at a point pans to re-center at click point



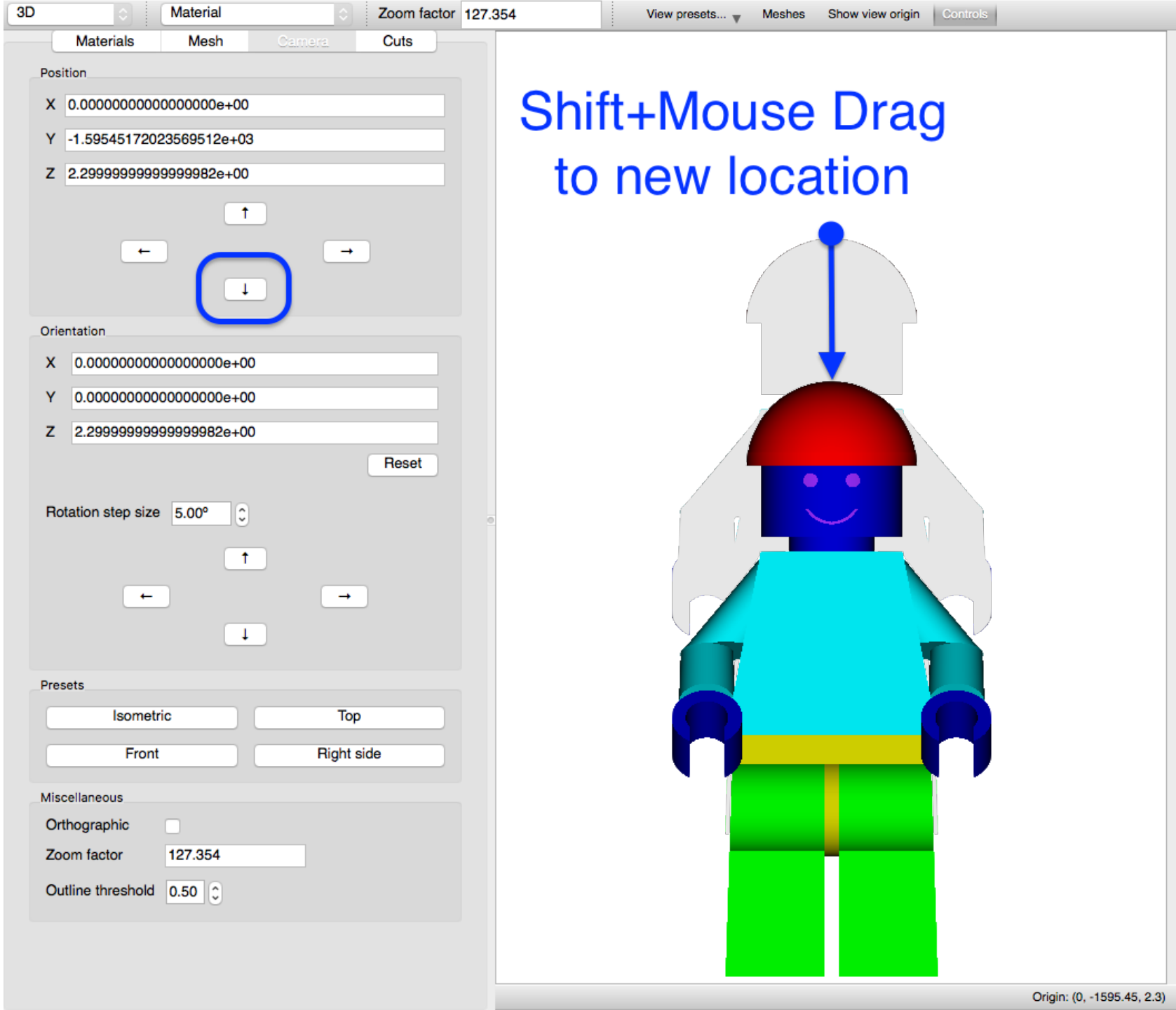
Camera Panning:

- **Up** arrow moves model up by moving camera down
- Down arrow moves model down by moving camera up
- Left arrow moves model left by moving camera right
- Right arrow moves model right by moving camera left
- Double-click at a point pans to re-center at click point



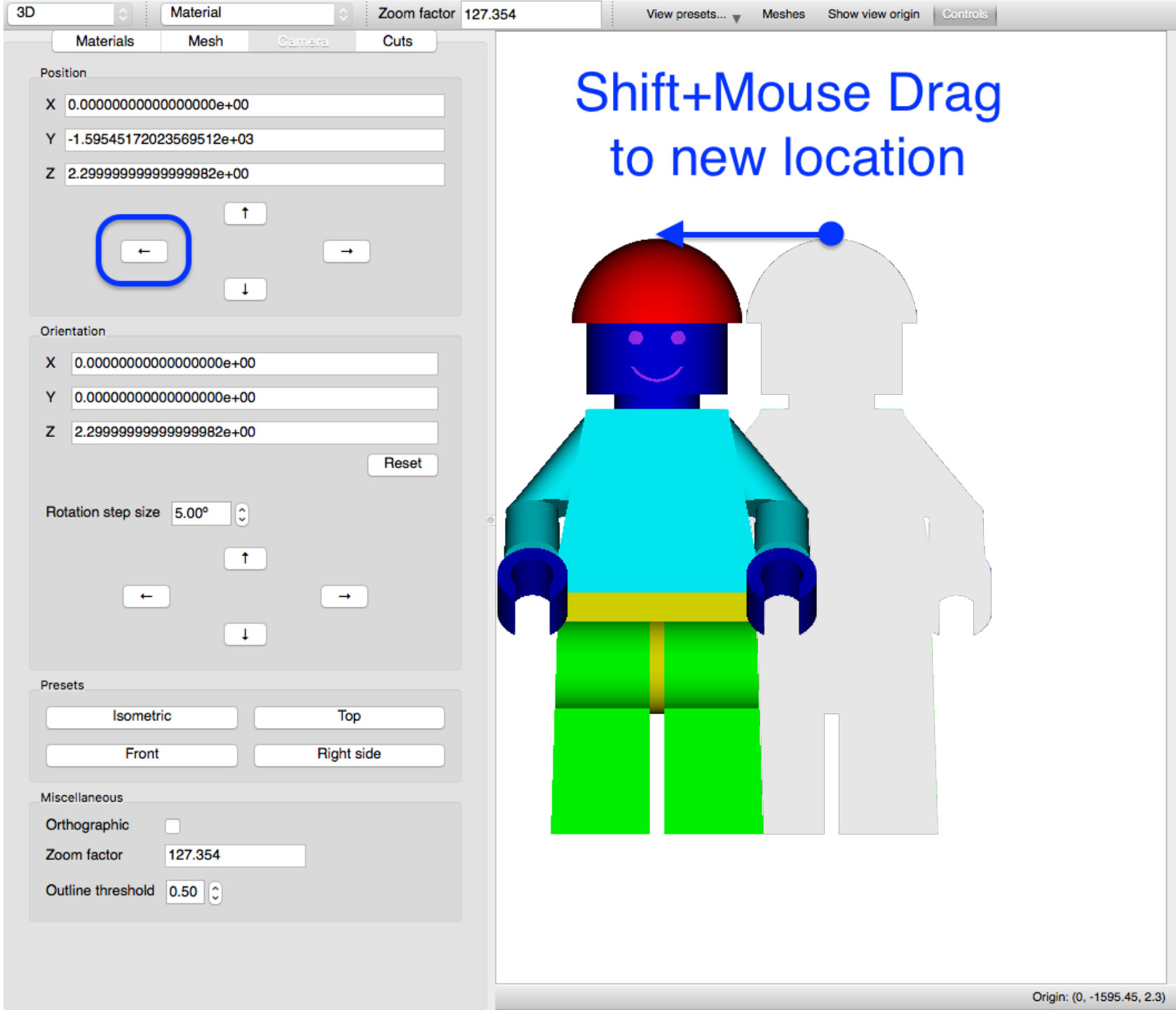
Camera Panning:

- Up arrow moves model up by moving camera down
- **Down** arrow moves model down by moving camera up
- Left arrow moves model left by moving camera right
- Right arrow moves model right by moving camera left
- Double-click at a point pans to re-center at click point



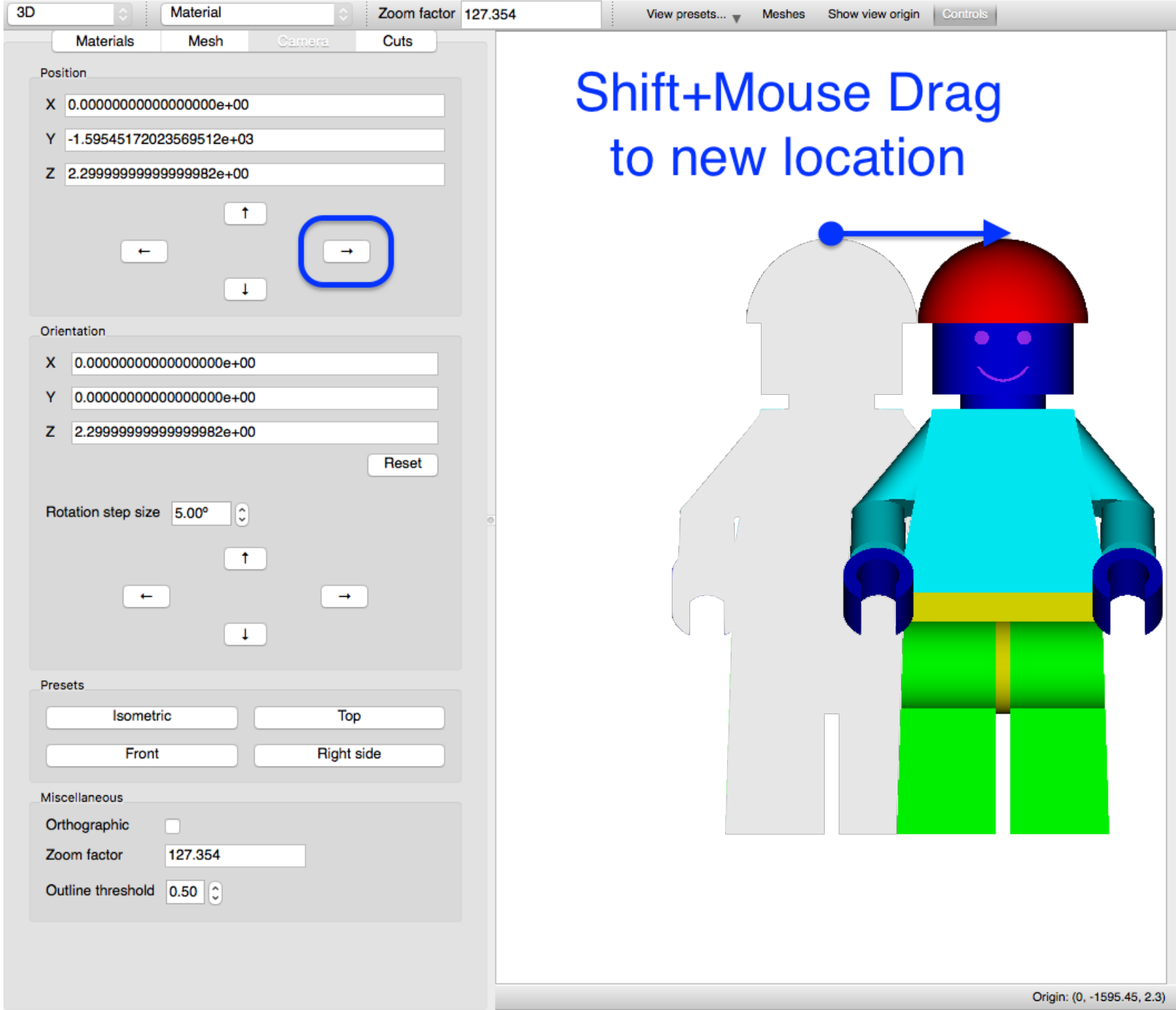
Camera Panning:

- Up arrow moves model up by moving camera down
- Down arrow moves model down by moving camera up
- **Left** arrow moves model left by moving camera right
- Right arrow moves model right by moving camera left
- Double-click at a point pans to re-center at click point



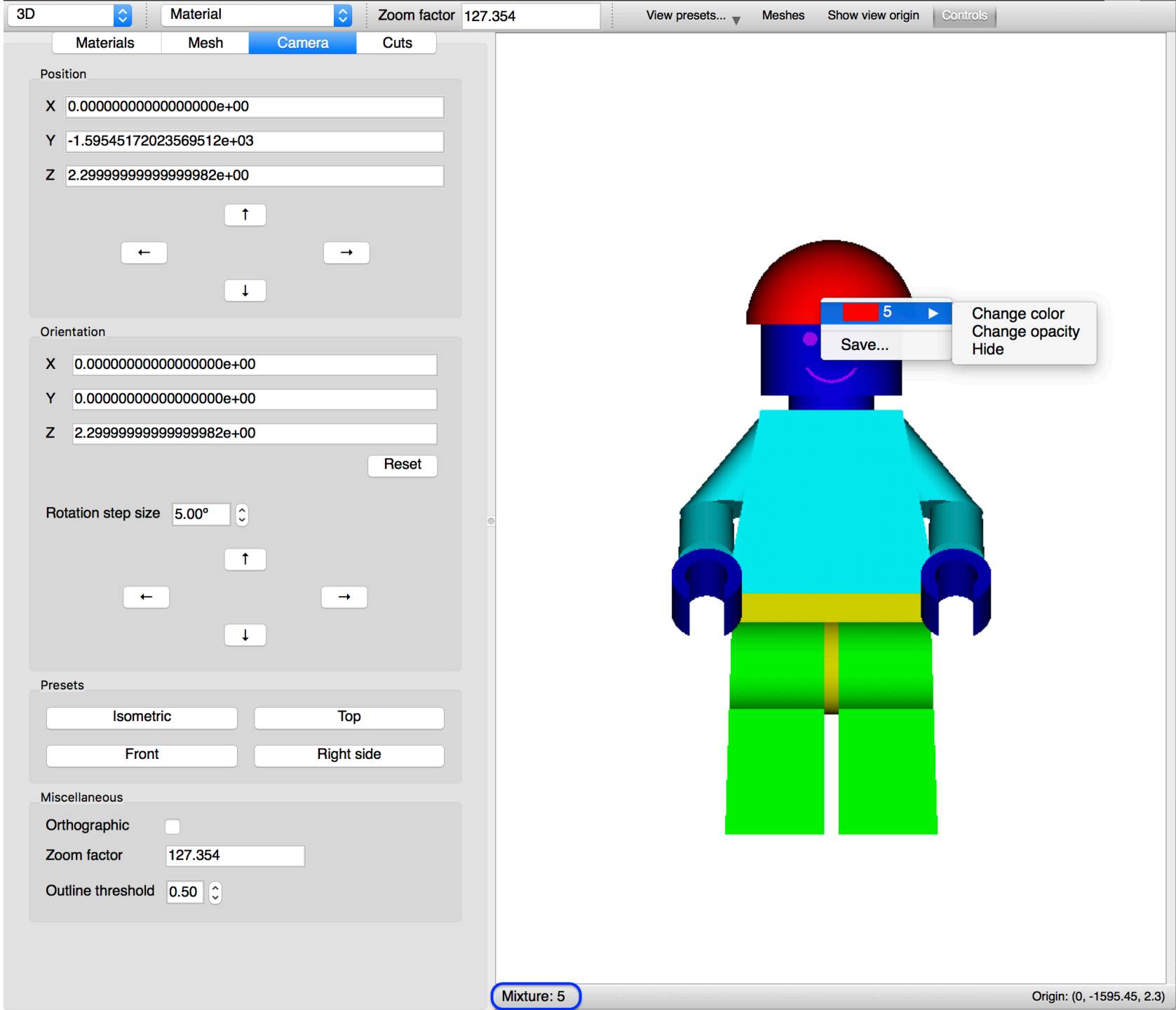
Camera Panning:

- Up arrow moves model up by moving camera down
- Down arrow moves model down by moving camera up
- Left arrow moves model left by moving camera right
- **Right** arrow moves model right by moving camera left
- Double-click at a point pans to re-center at click point



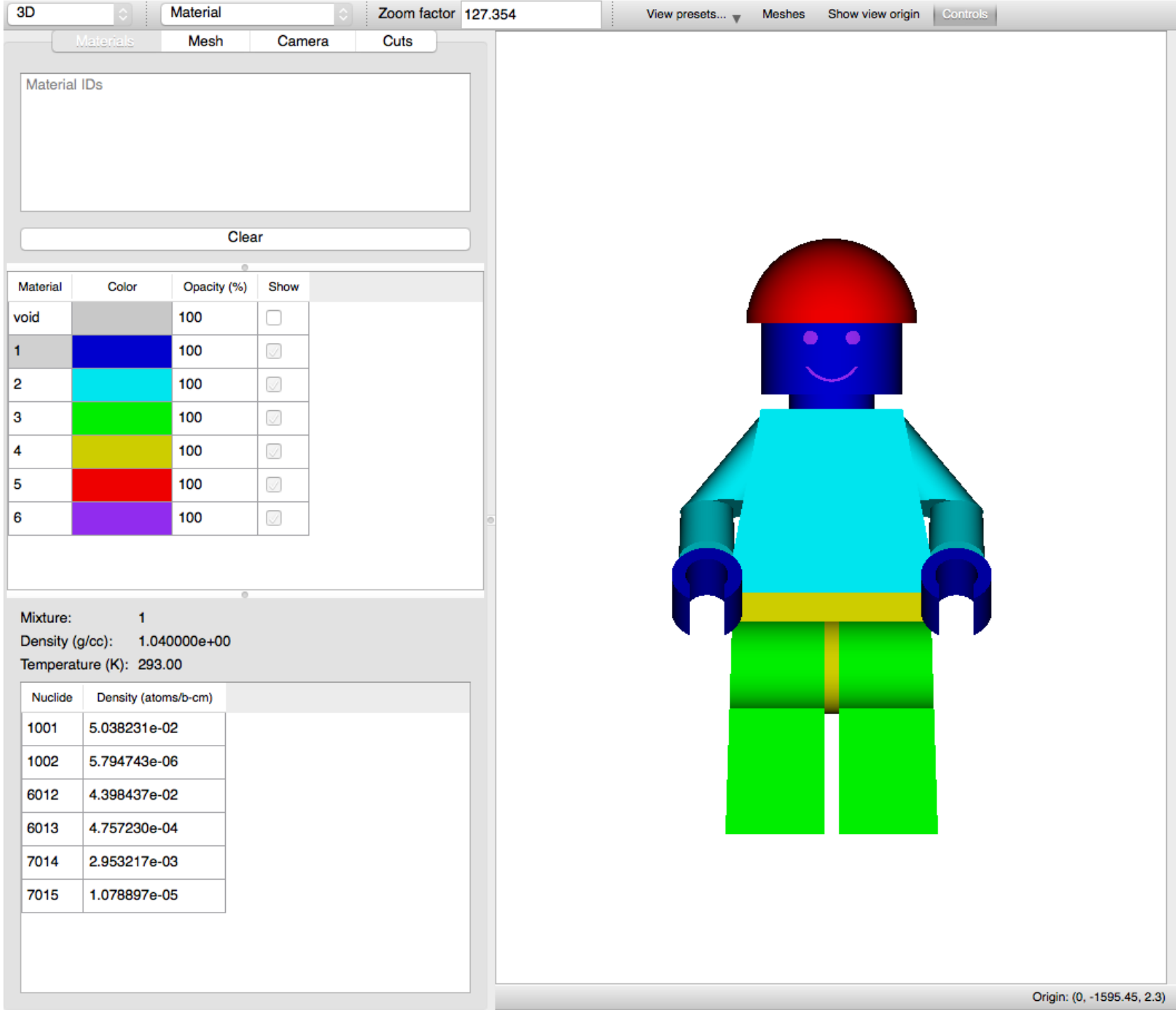
Display metadata

- Mousing-over pixels reports the material under the cursor
- The user can also right-click on a pixel with material information and control
  - **visibility**,
  - **opacity**,
  - and **color**
  - for **one or more** materials under the given pixel.

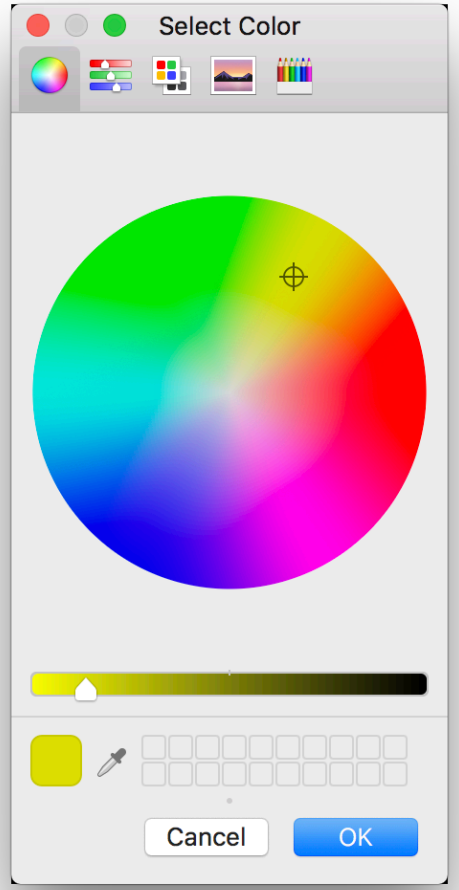


Materials Controls

- A table containing the full listing of known materials in the model.
- Table allows controlling
  - **visibility**,
  - **opacity**,
  - and **color**
  - for **all** material in the model.
- Mixture information changes as a function of selected material



Materials Controls: Color



3D | Material | Zoom factor 127.354 | View presets... | Meshes | Show view origin | Controls

Materials | Mesh | Camera | Cuts

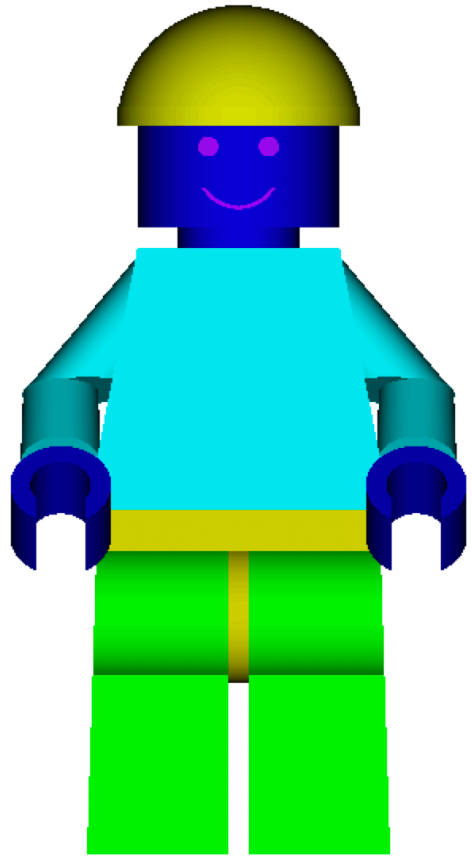
Material IDs

Clear

Material	Color	Opacity (%)	Show
void		100	☐
1		100	☑
2		100	☑
3		100	☑
4		100	☑
5		100	☑
6		100	☑

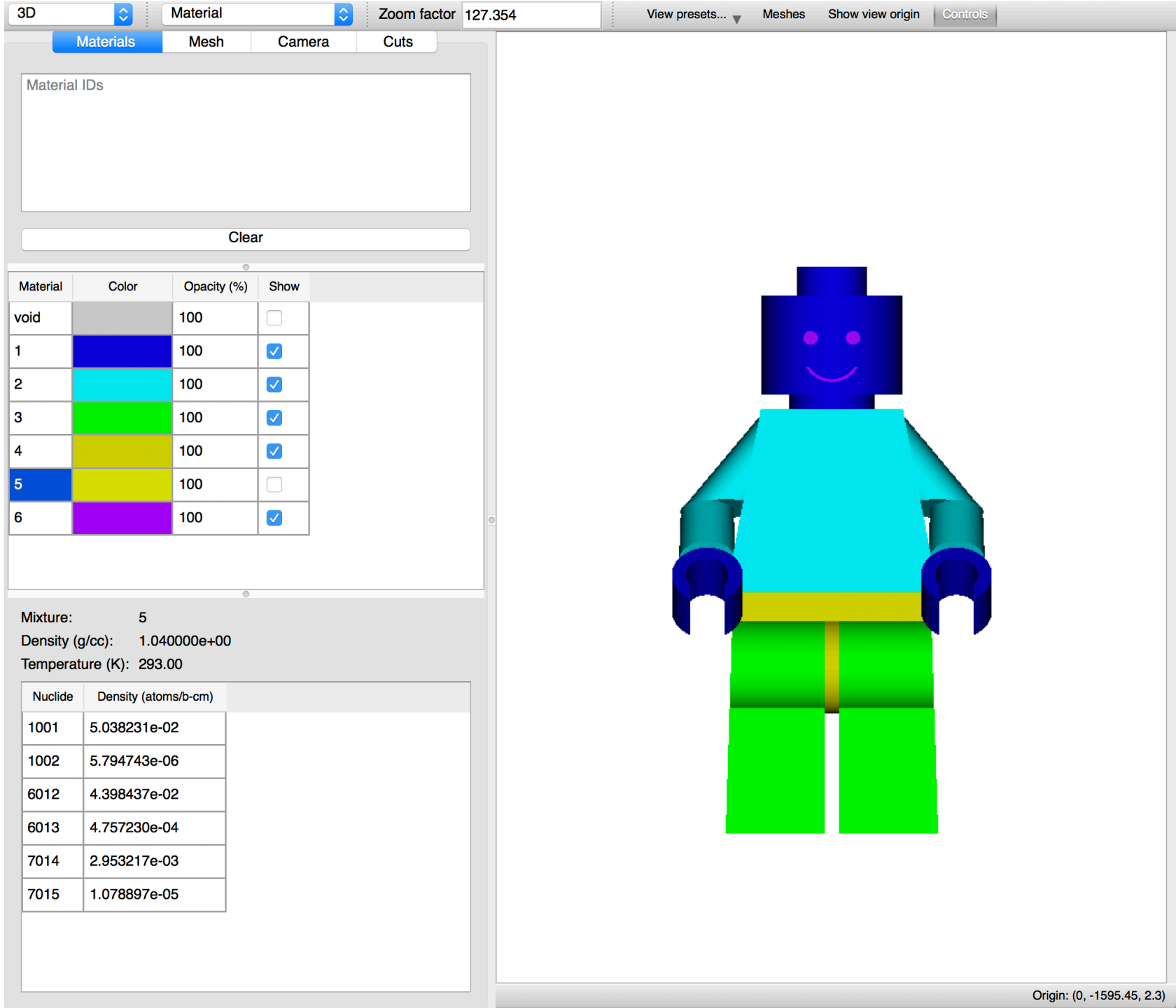
Mixture: 5
Density (g/cc): 1.040000e+00
Temperature (K): 293.00

Nuclide	Density (atoms/b-cm)
1001	5.038231e-02
1002	5.794743e-06
6012	4.398437e-02
6013	4.757230e-04
7014	2.953217e-03
7015	1.078897e-05

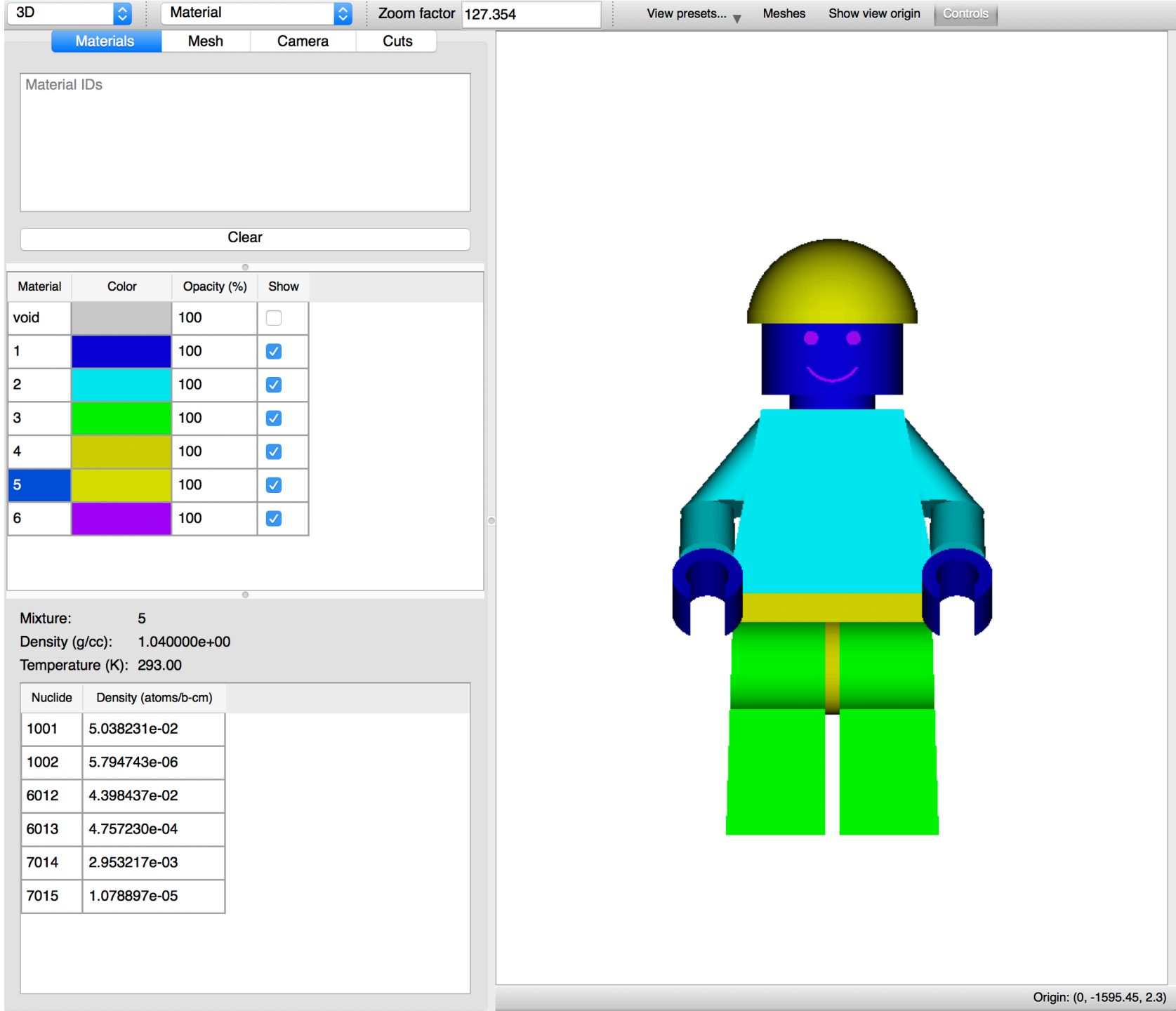


Origin: (0, -1595.45, 2.3)

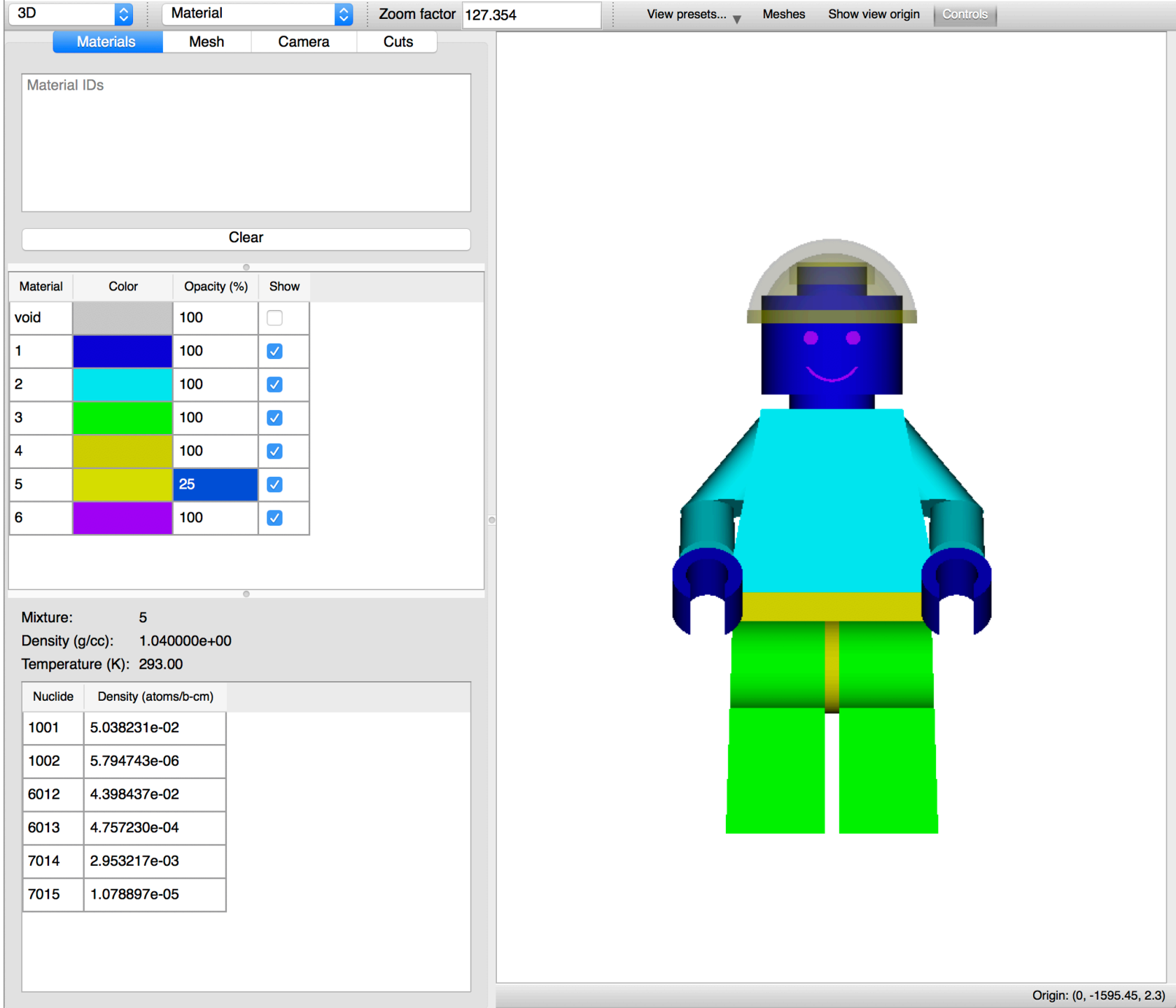
Materials Controls: Visibility



Materials Controls: Visibility

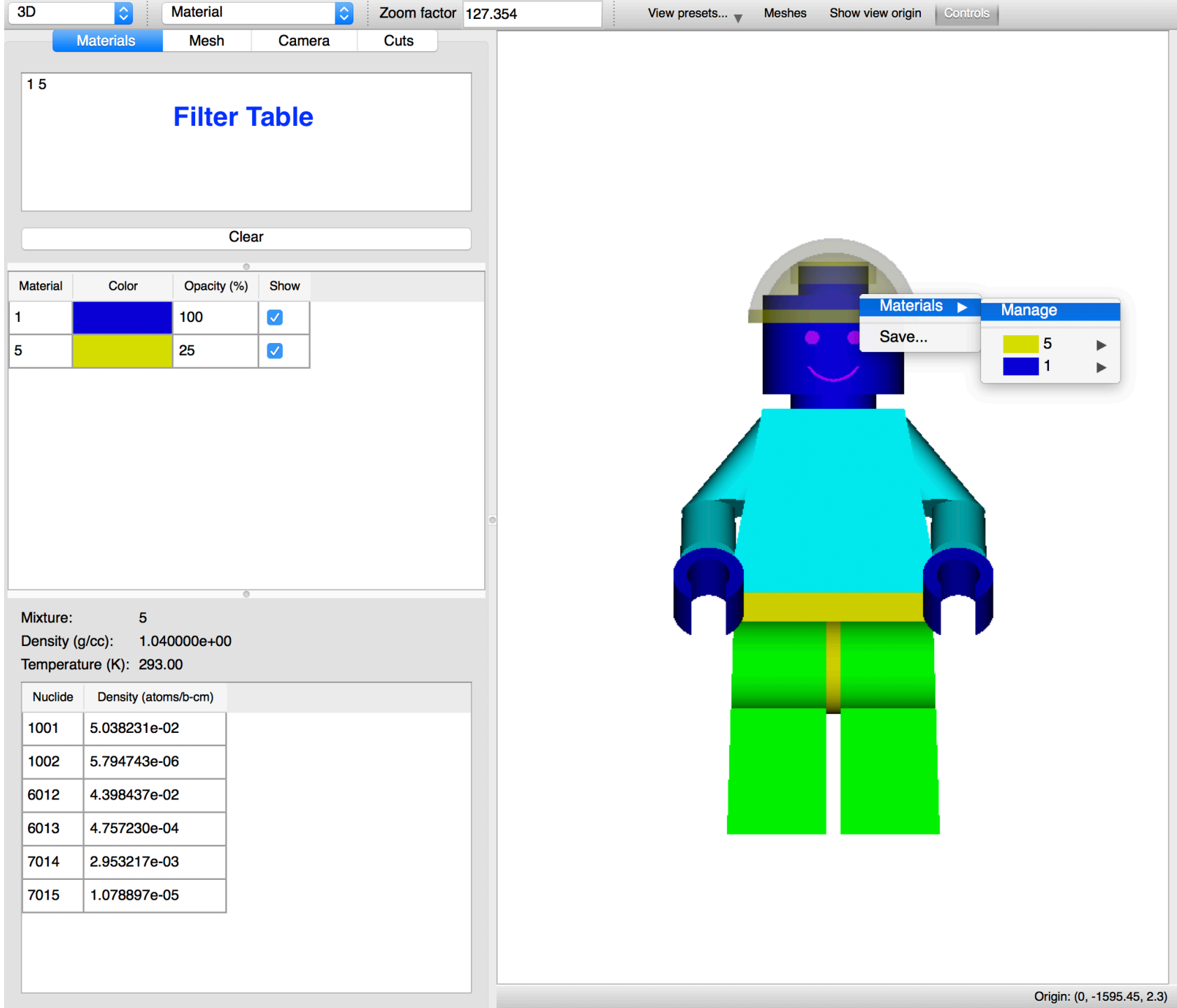


Materials Controls: Opacity



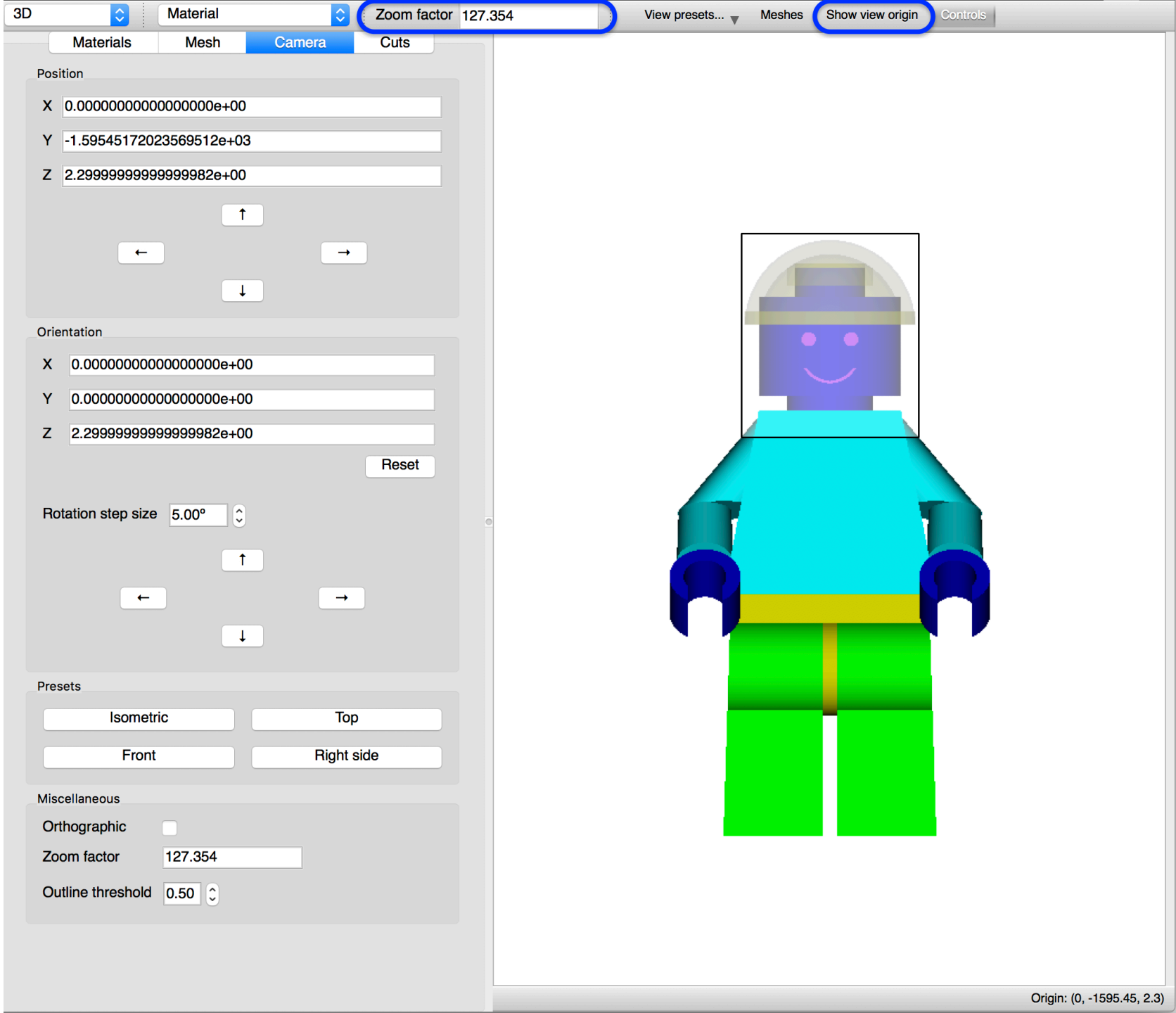
Material Filter

- Users can type material identifiers (numbers) to filter material table rows.
- Same filtering capability conducted by right-clicking a pixel with multiple materials and selecting **'Manage'**



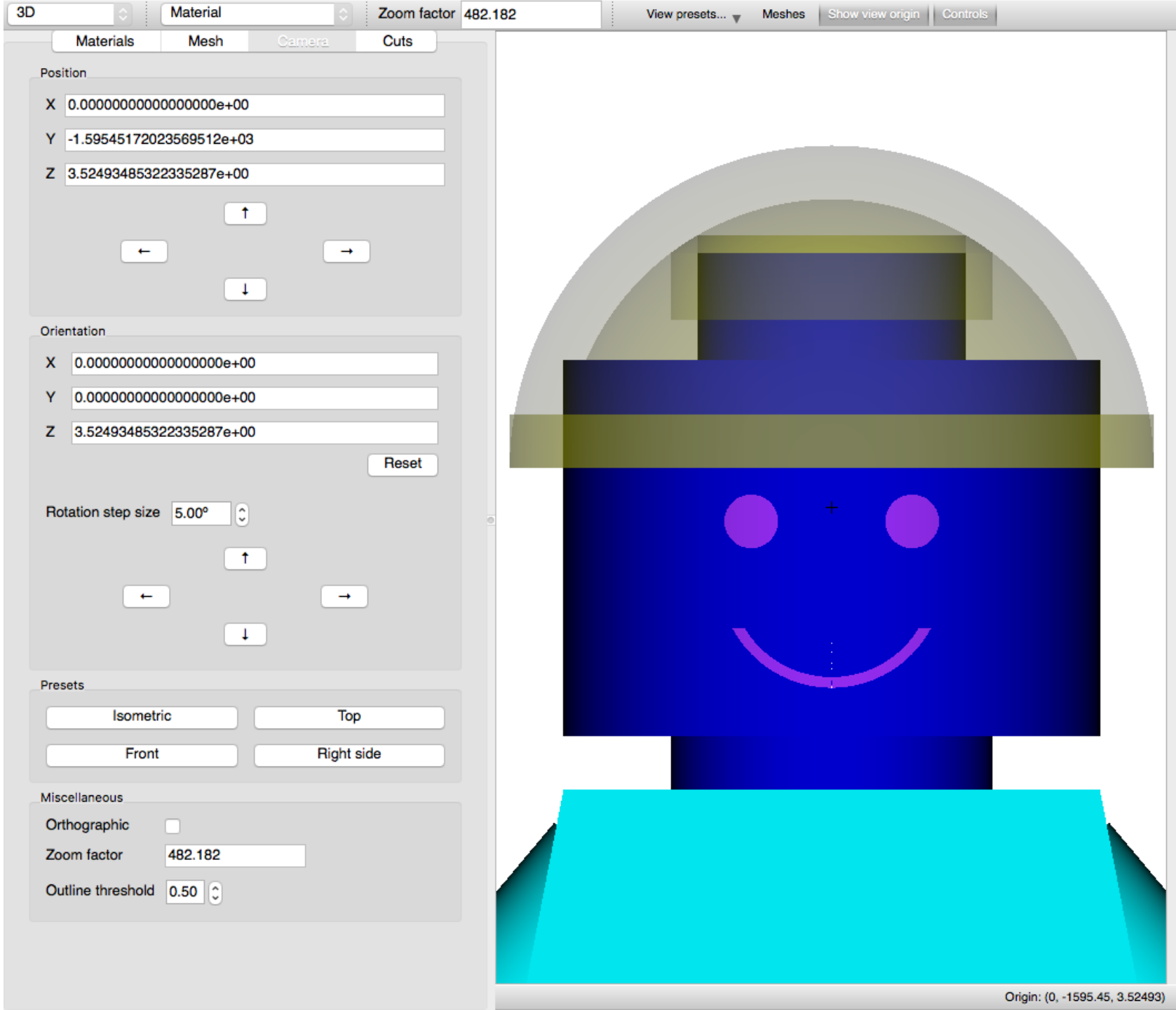
Zooming

- Rectangle (or lasso) zoom is implemented just as it is in the 2D view
  - Click upper-left and drag to lower-right
- Quick zoom is implemented via a **Zoom factor** text field, allowing the user to enter a zoom (multiplication) factor.
  - **Show view origin** can assist in zoom factor focus



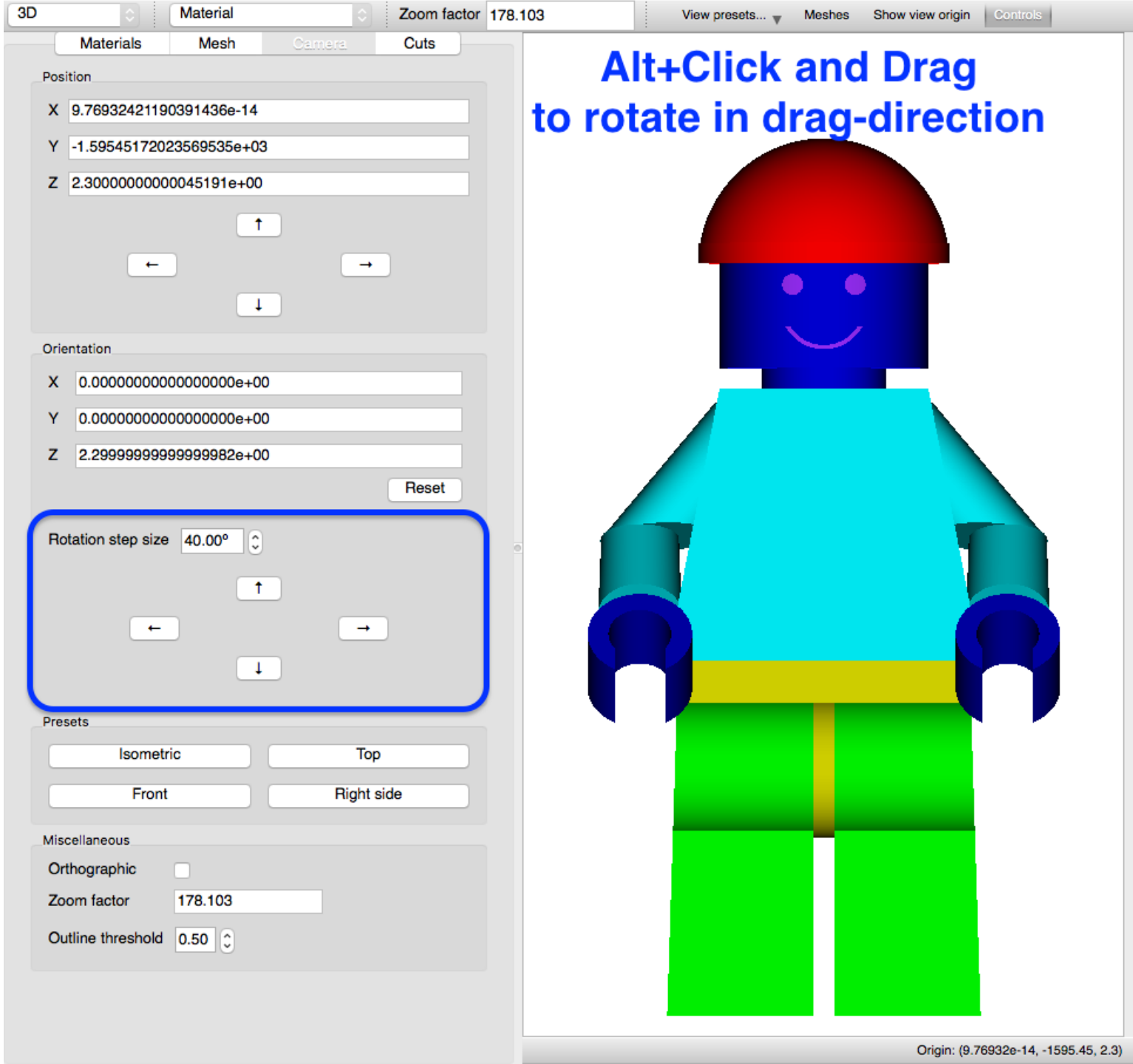
Zooming

- Rectangle (or lasso) zoom is implemented just as it is in the 2D view
  - Click upper-left and drag to lower-right
- Quick zoom is implemented via a **Zoom factor** text field, allowing the user to enter a zoom (multiplication) factor.
  - **Show view origin** can assist in zoom factor focus



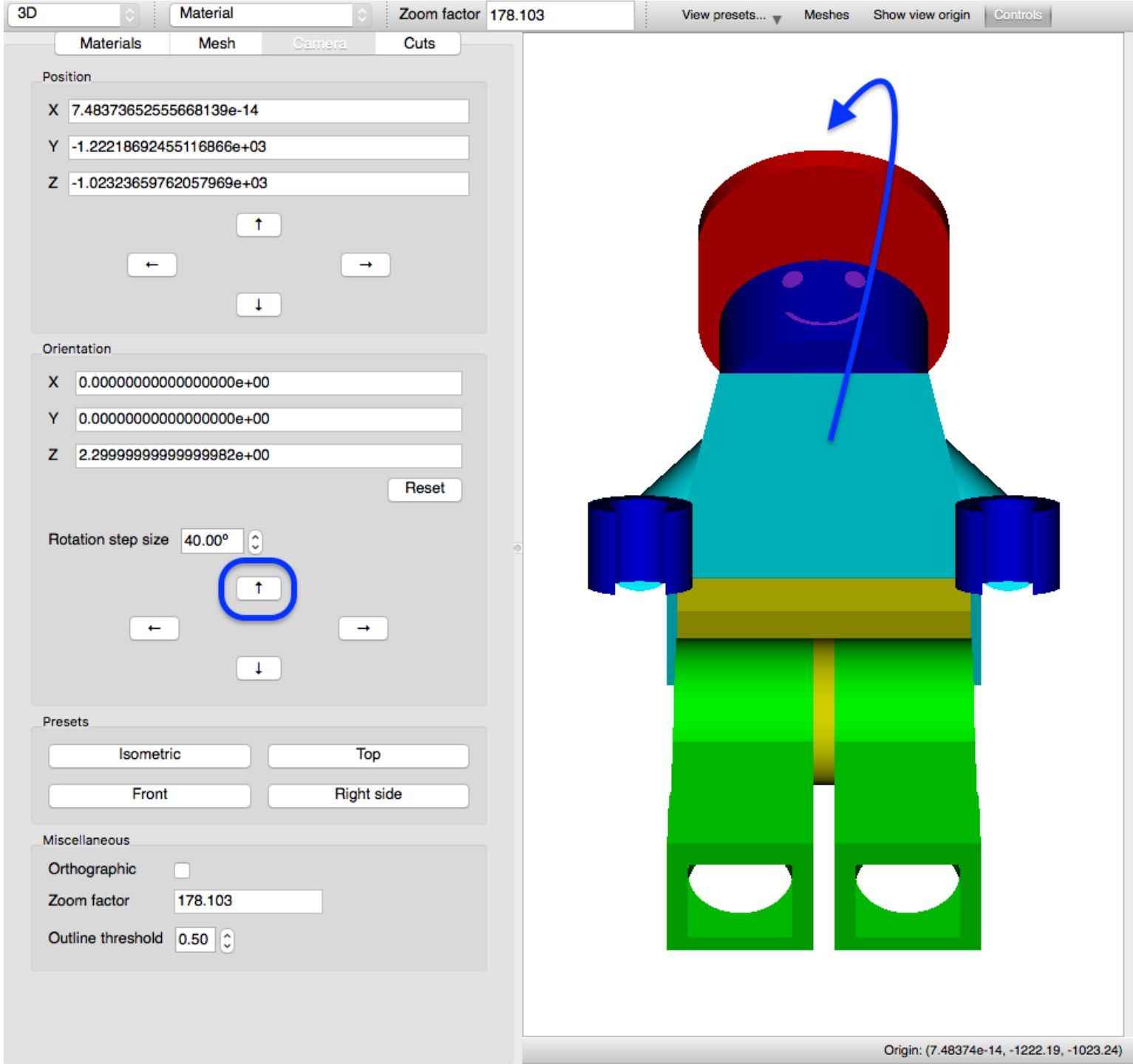
Camera Rotation

- **Rotation step size** input field allows specifying explicit rotation.
- Up arrow rotates model up by rotating camera down
- Down arrow rotates model down by rotating camera up
- Left arrow rotates model left by rotating camera right
- Right arrow rotates model right by rotating camera left
- Arbitrary rotation is achieved by **Alt+click-and-drag**



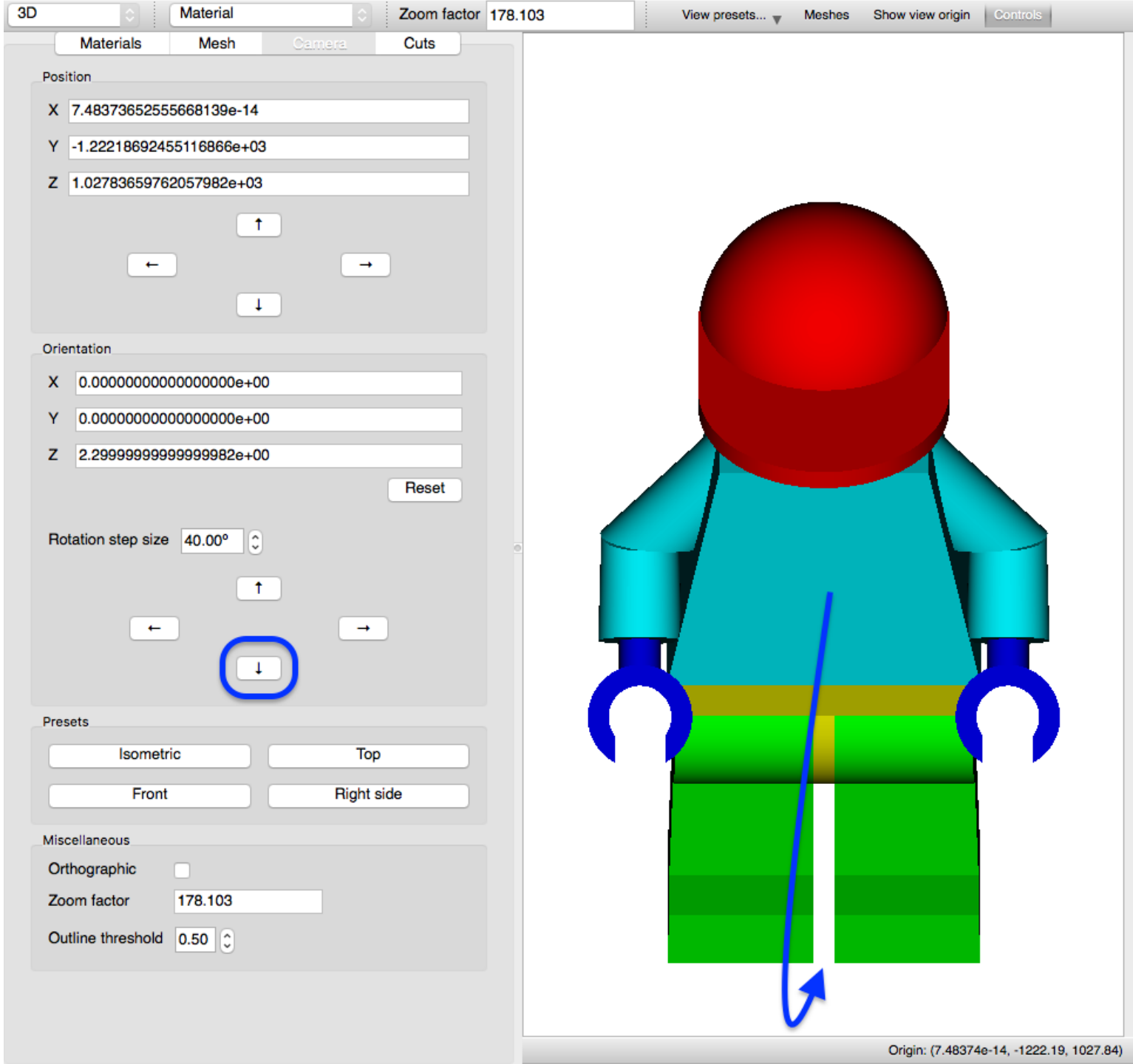
Camera Rotation: Up

- **Rotation step size** input field allows specifying explicit rotation.
- **Up arrow rotates model up** by rotating camera down
- Down arrow rotates model down by rotating camera up
- Left arrow rotates model left by rotating camera right
- Right arrow rotates model right by rotating camera left
- Arbitrary rotation is achieved by **Alt+click-and-drag**



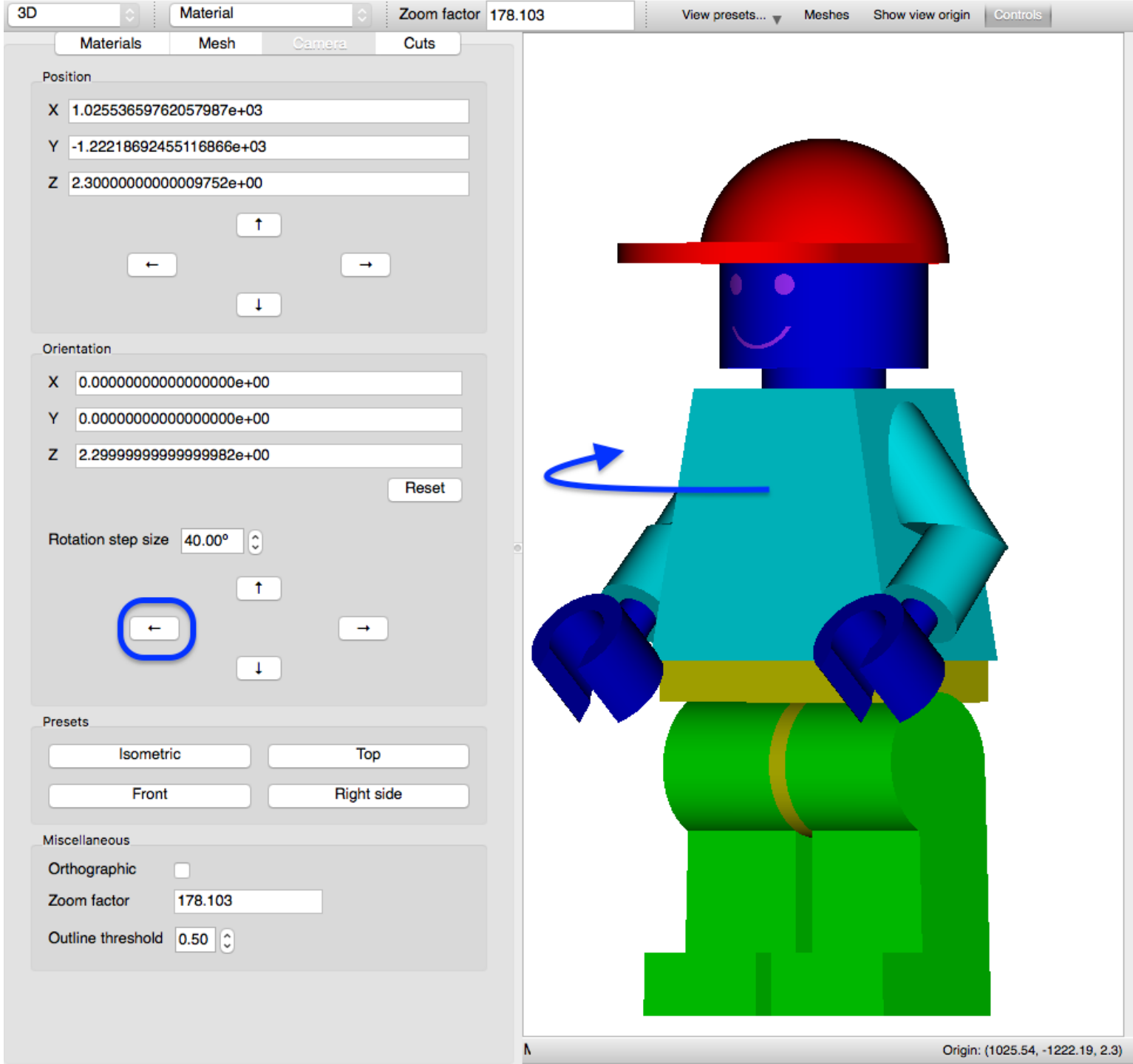
Camera Rotation: Down

- **Rotation step size** input field allows specifying explicit rotation.
- Up arrow rotates model up by rotating camera down
- **Down arrow rotates model down** by rotating camera up
- Left arrow rotates model left by rotating camera right
- Right arrow rotates model right by rotating camera left
- Arbitrary rotation is achieved by **Alt+click-and-drag**



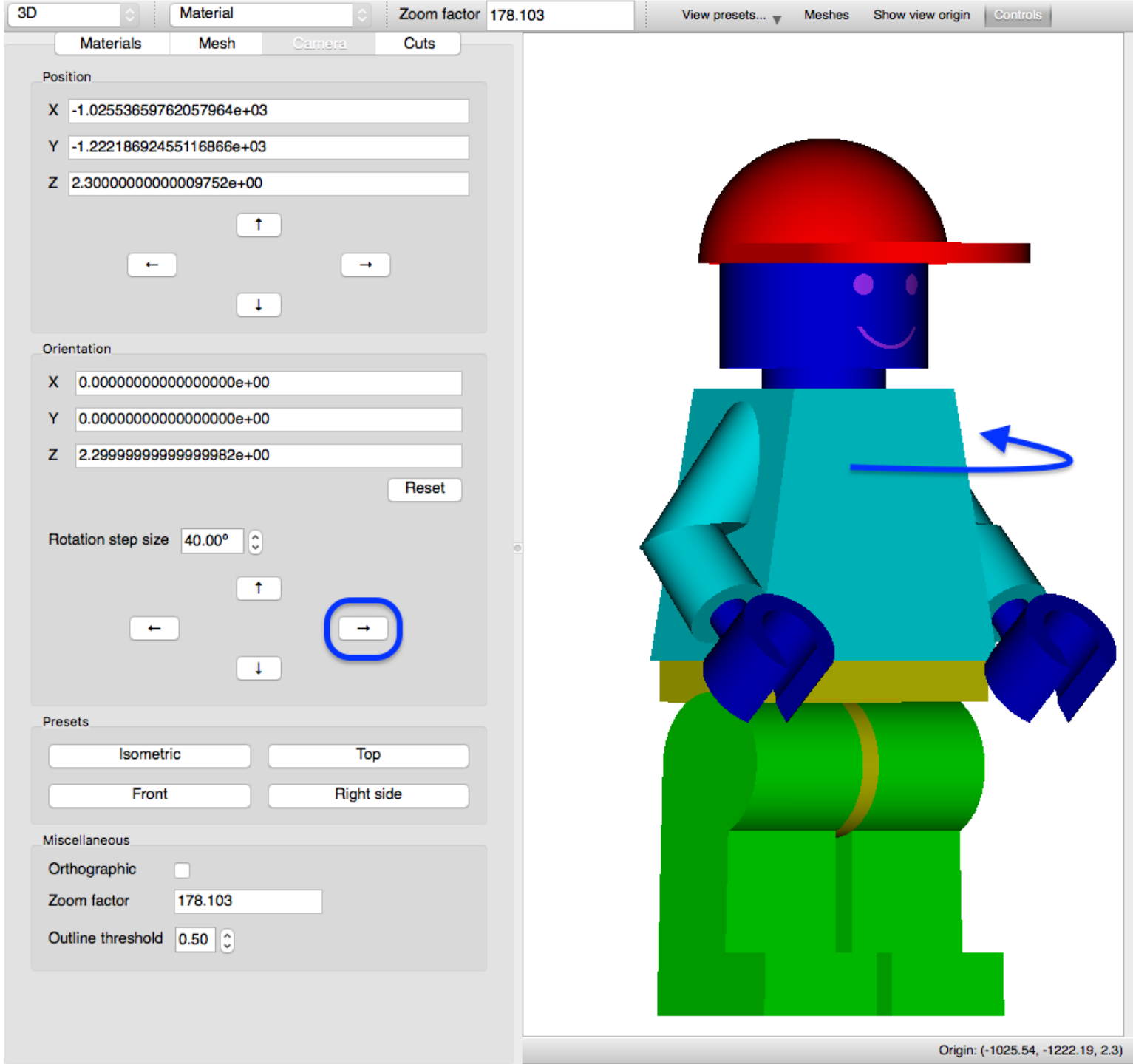
Camera Rotation: Left

- **Rotation step size** input field allows specifying explicit rotation.
- Up arrow rotates model up by rotating camera down
- Down arrow rotates model down by rotating camera up
- **Left arrow rotates model left** by rotating camera right
- Right arrow rotates model right by rotating camera left
- Arbitrary rotation is achieved by **Alt+click-and-drag**



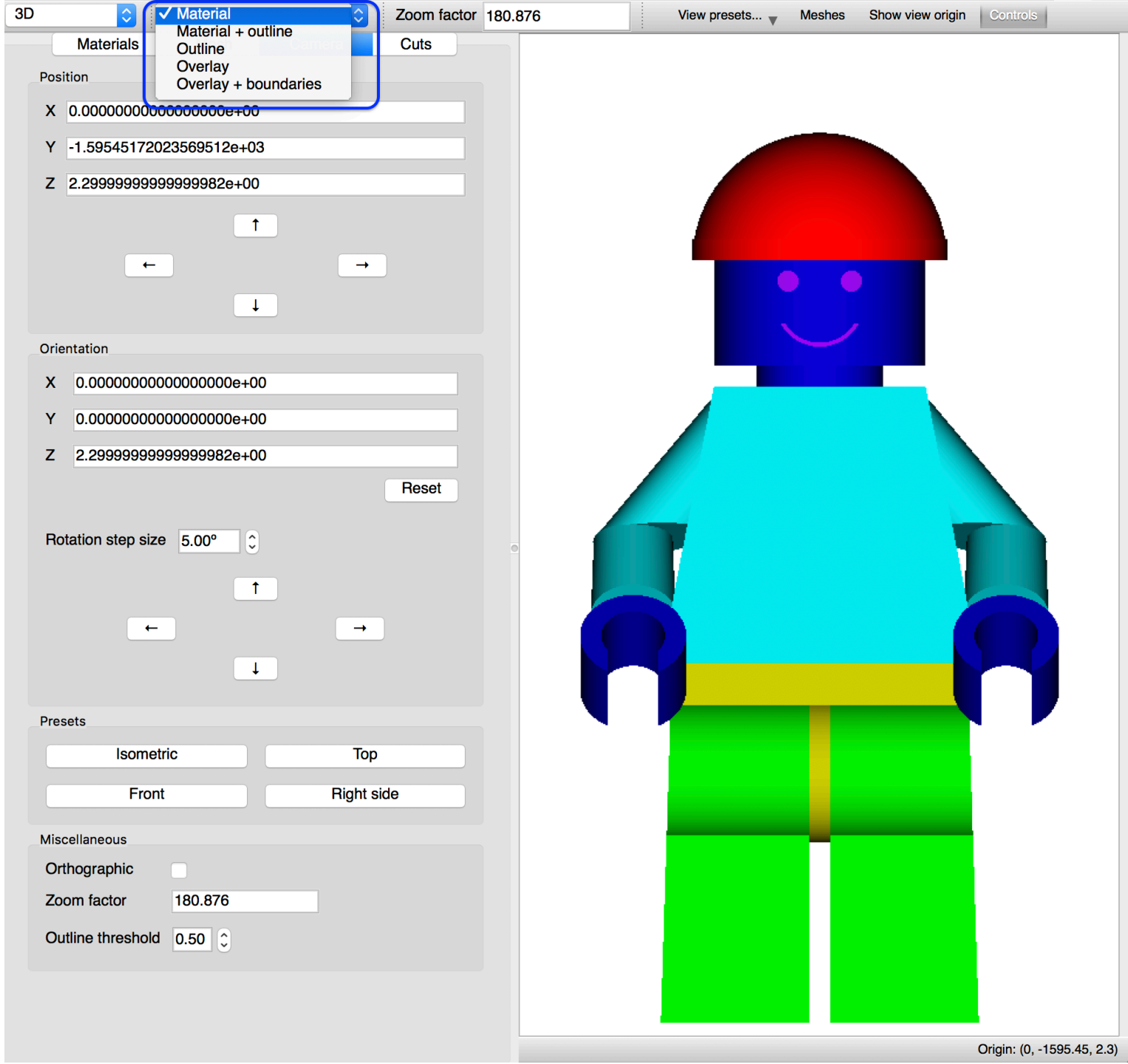
Camera Rotation: Right

- **Rotation step size** input field allows specifying explicit rotation.
- Up arrow rotates model up by rotating camera down
- Down arrow rotates model down by rotating camera up
- Left arrow rotates model left by rotating camera right
- **Right arrow rotates model right** by rotating camera left
- Arbitrary rotation is achieved by **Alt+click-and-drag**



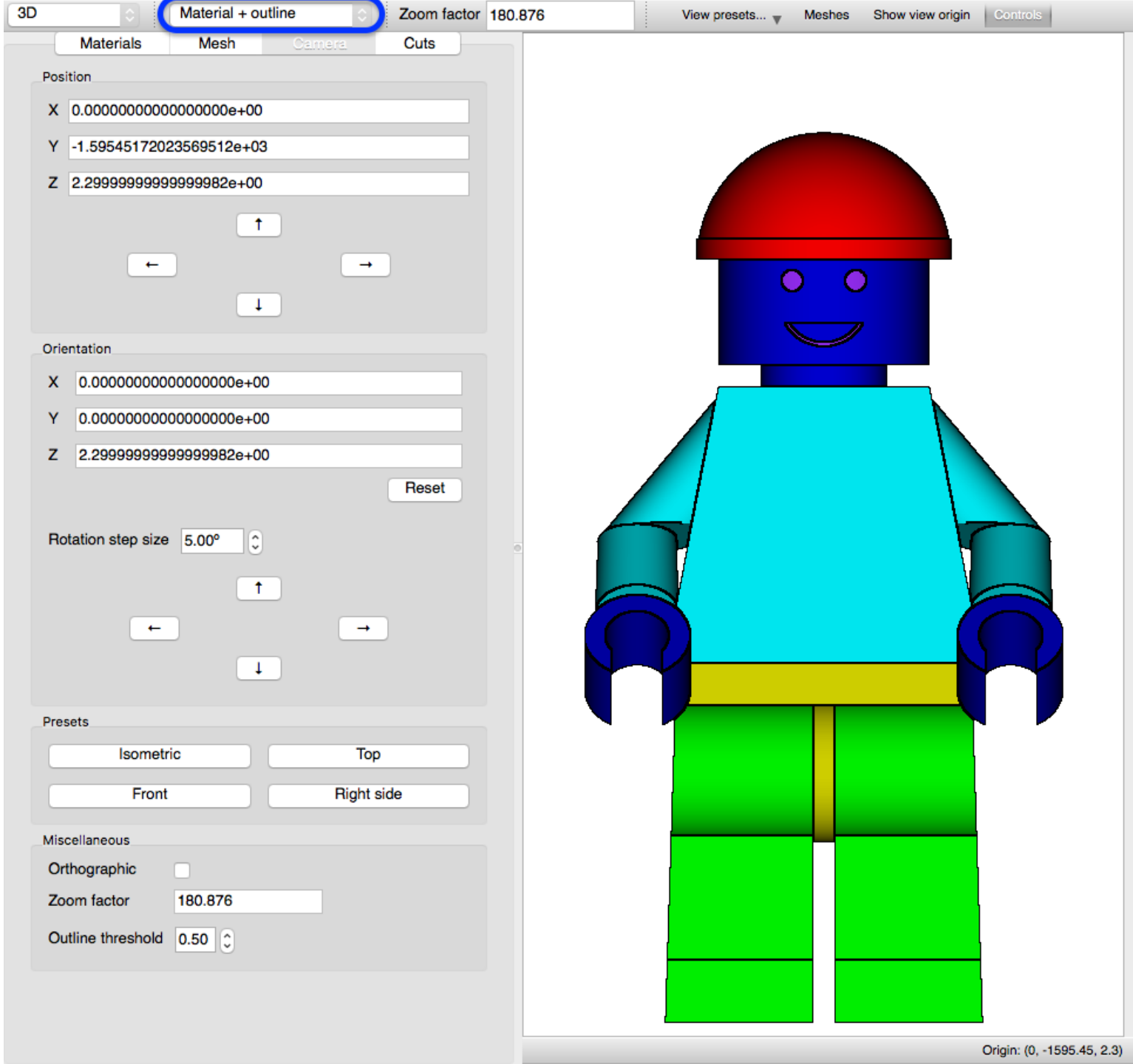
Rendering modes

- **Material** renders only material colors, shaded according to surface normal
- **Material+Outline** renders same as **Material** with the addition of black outlines at boundaries
- **Outline** renders only material boundaries using Material colors
- Mesh data **Overlay** and **Overlay+boundaries** capabilities do data point sampling on first interacted geometry surfaces



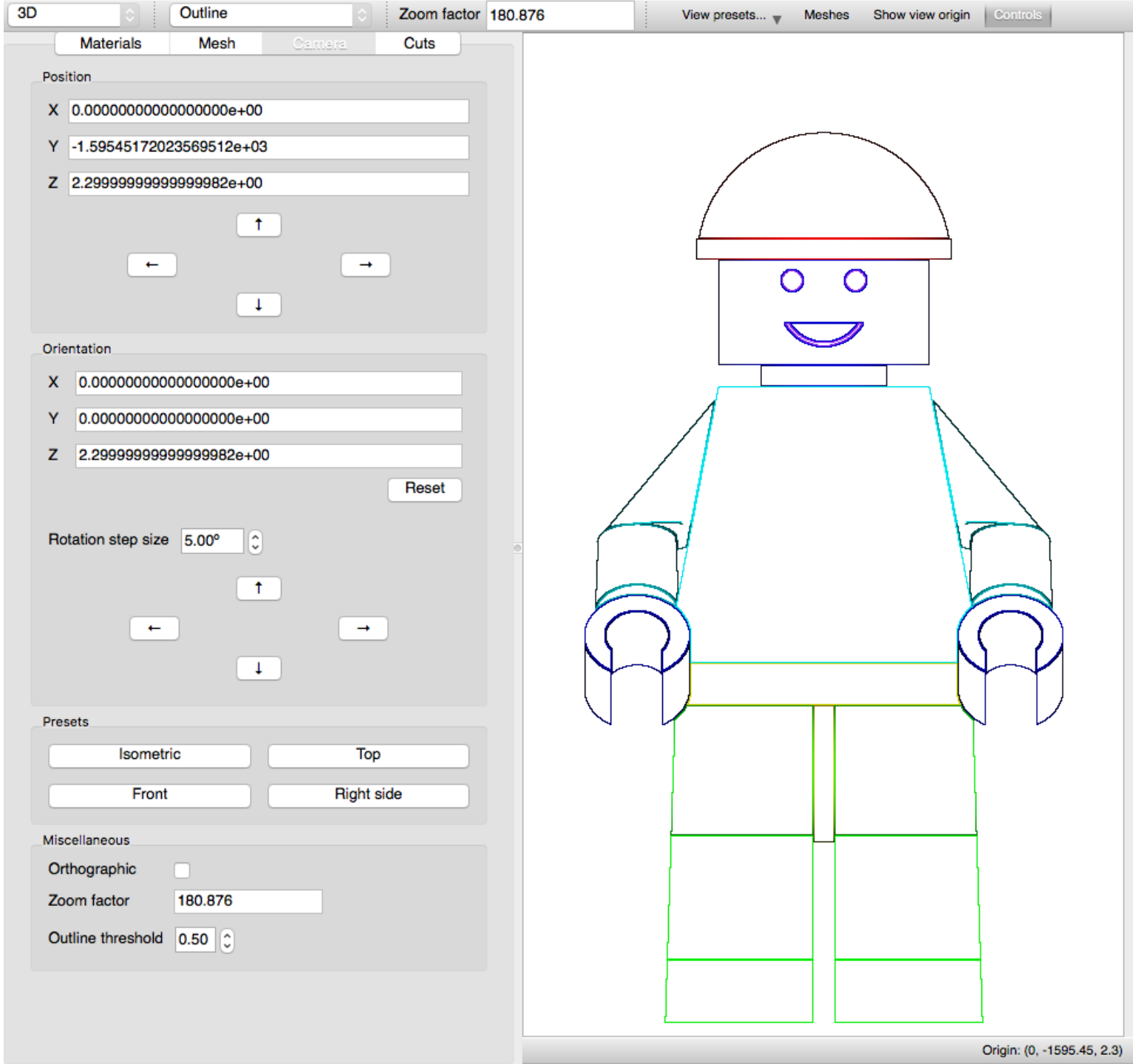
Rendering modes: Material + outline

- renders same as **Material** with the addition of black outlines at boundaries



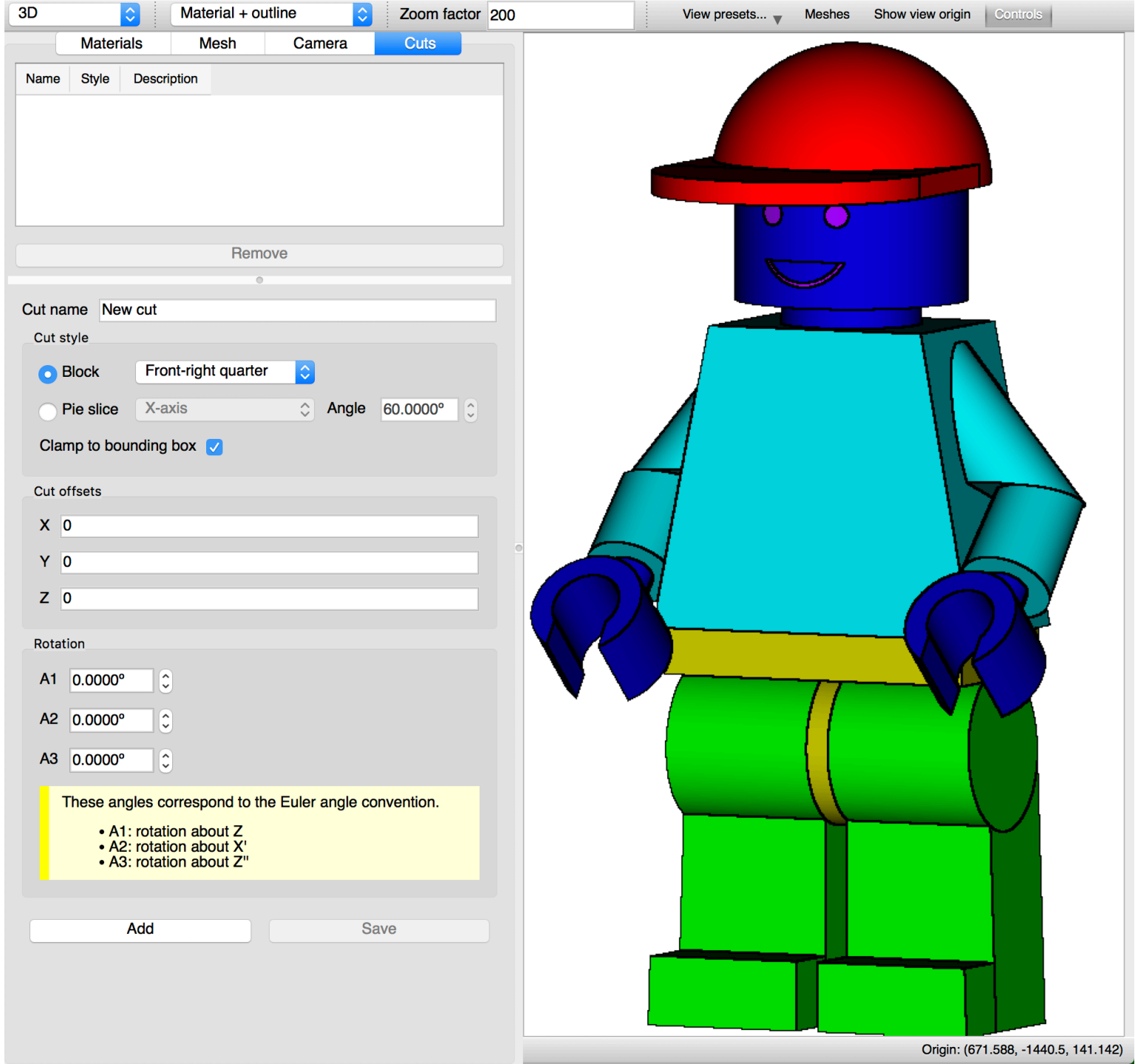
Rendering modes: Outline

- renders only material boundaries using Material colors



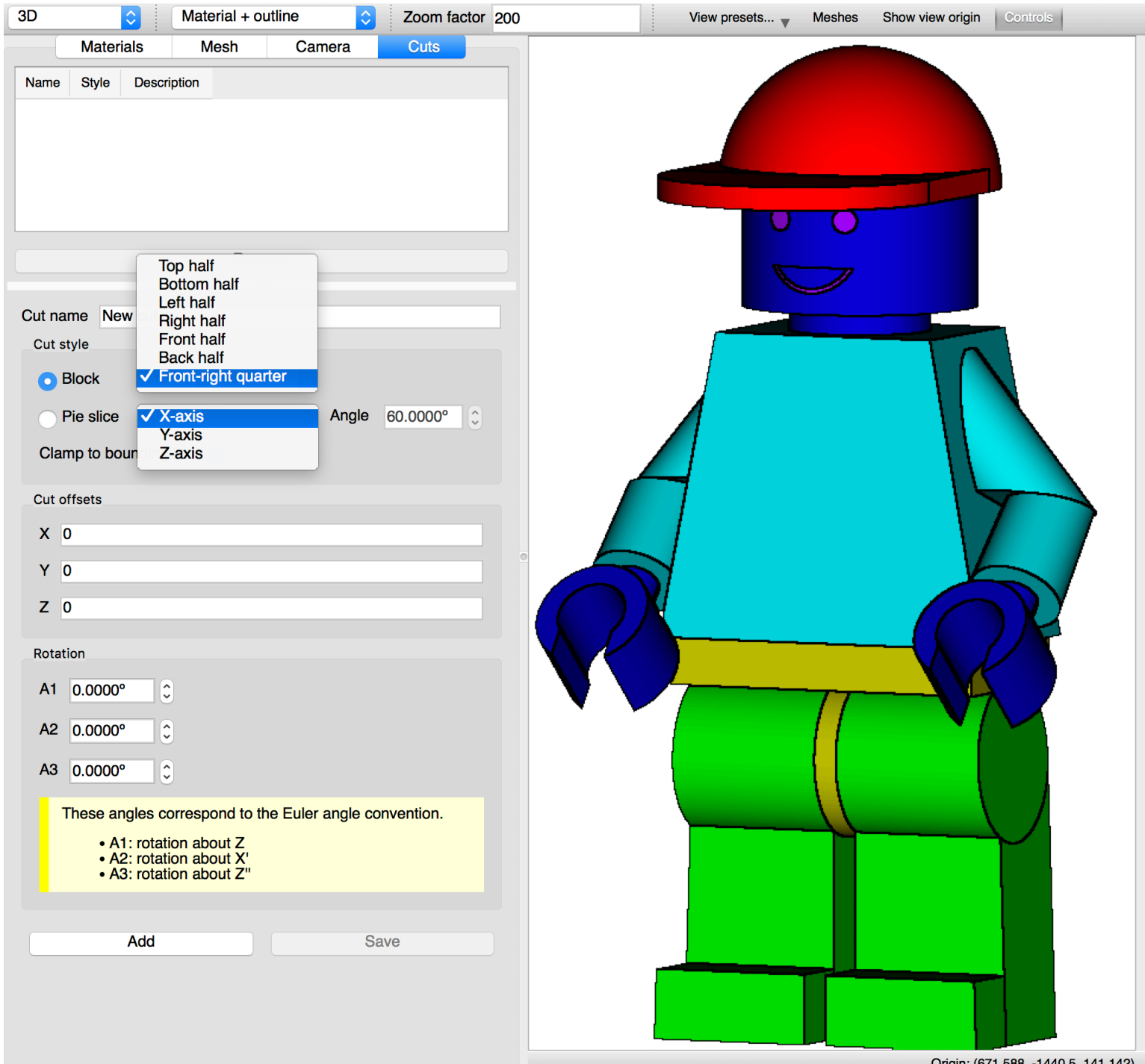
Model Cutting

- **Named Block** and **Pie slice** model cut styles
- Boundary box cut **clamping**
- **Cut offsets** allow for moving the origin of the cut
- **Rotation** uses Euler-X convention to rotate cuts to desired angles
- Ability to **remove** and **edit/save** existing cuts



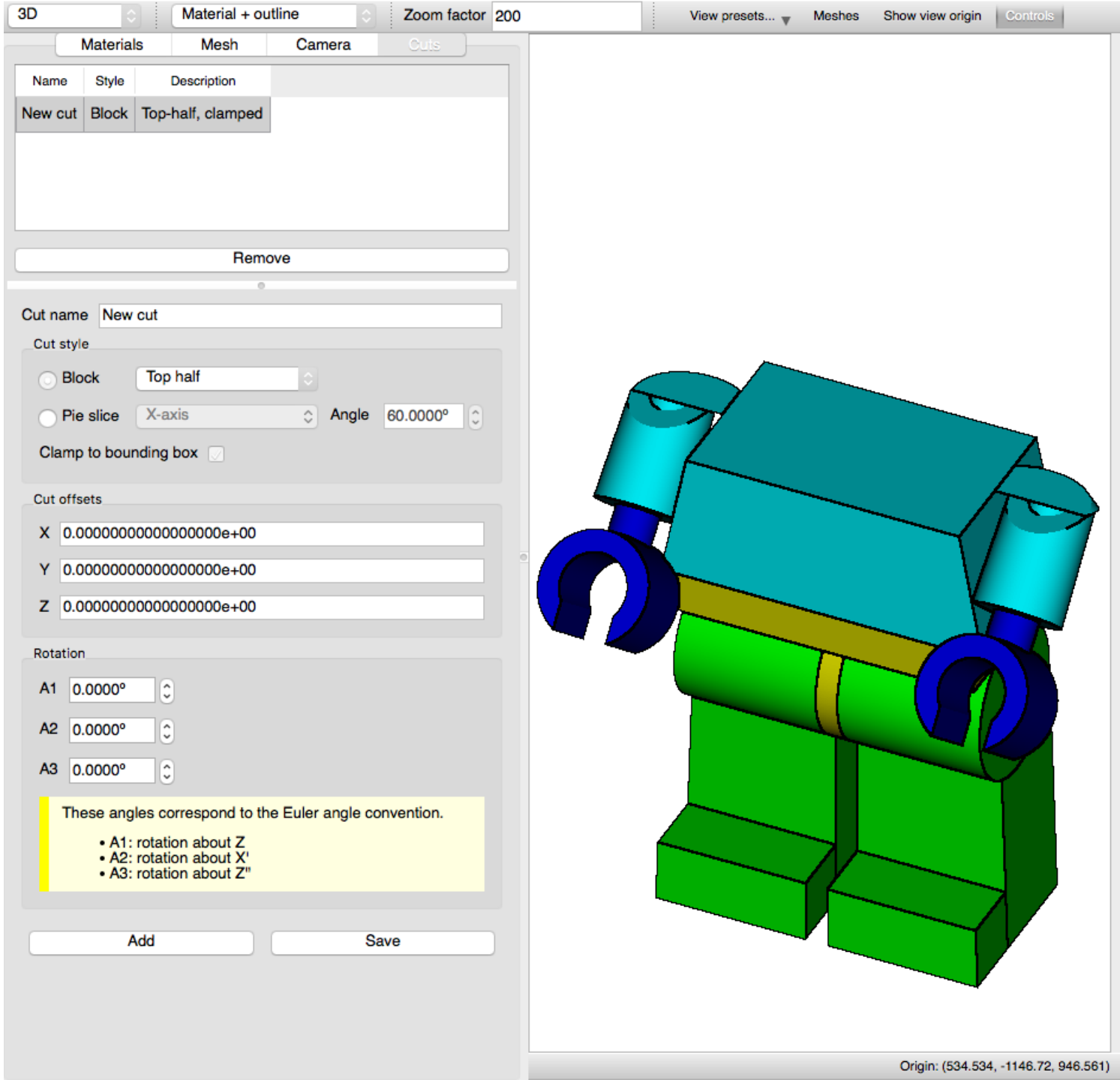
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



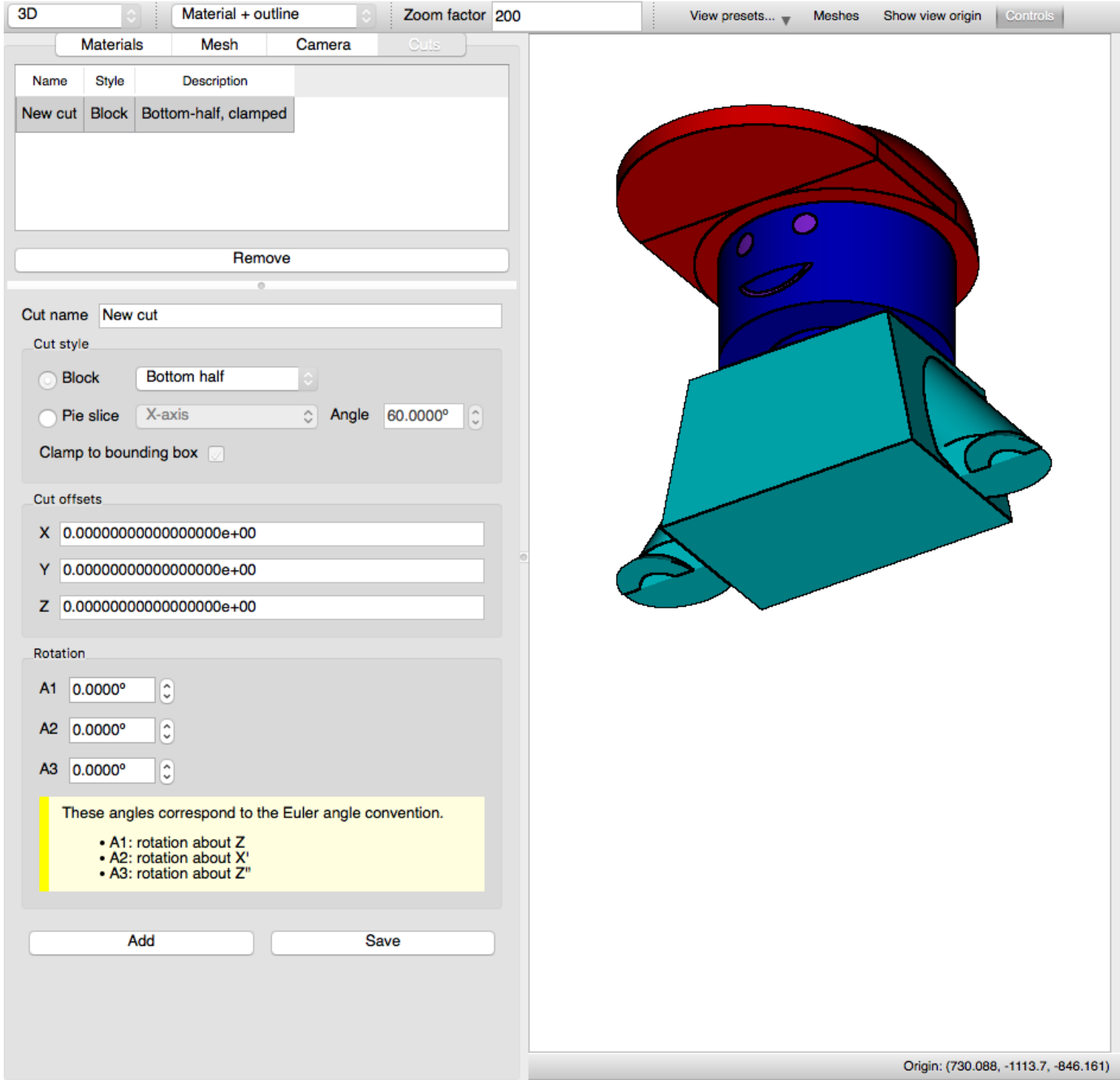
Model Cutting: Cut Styles

- **Block**
  - **Top half (+Z)**
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



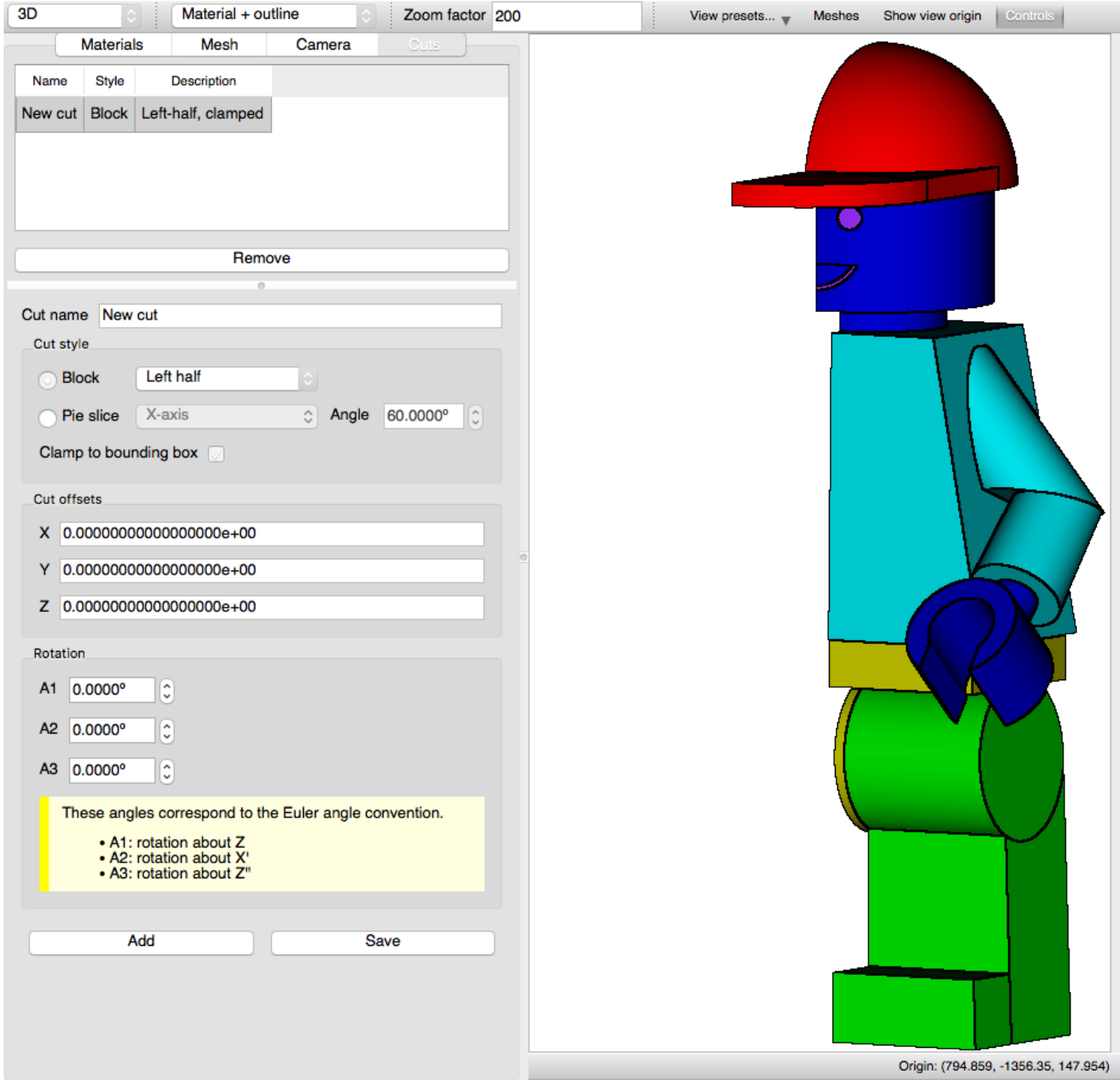
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - **Bottom half (-Z)**
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



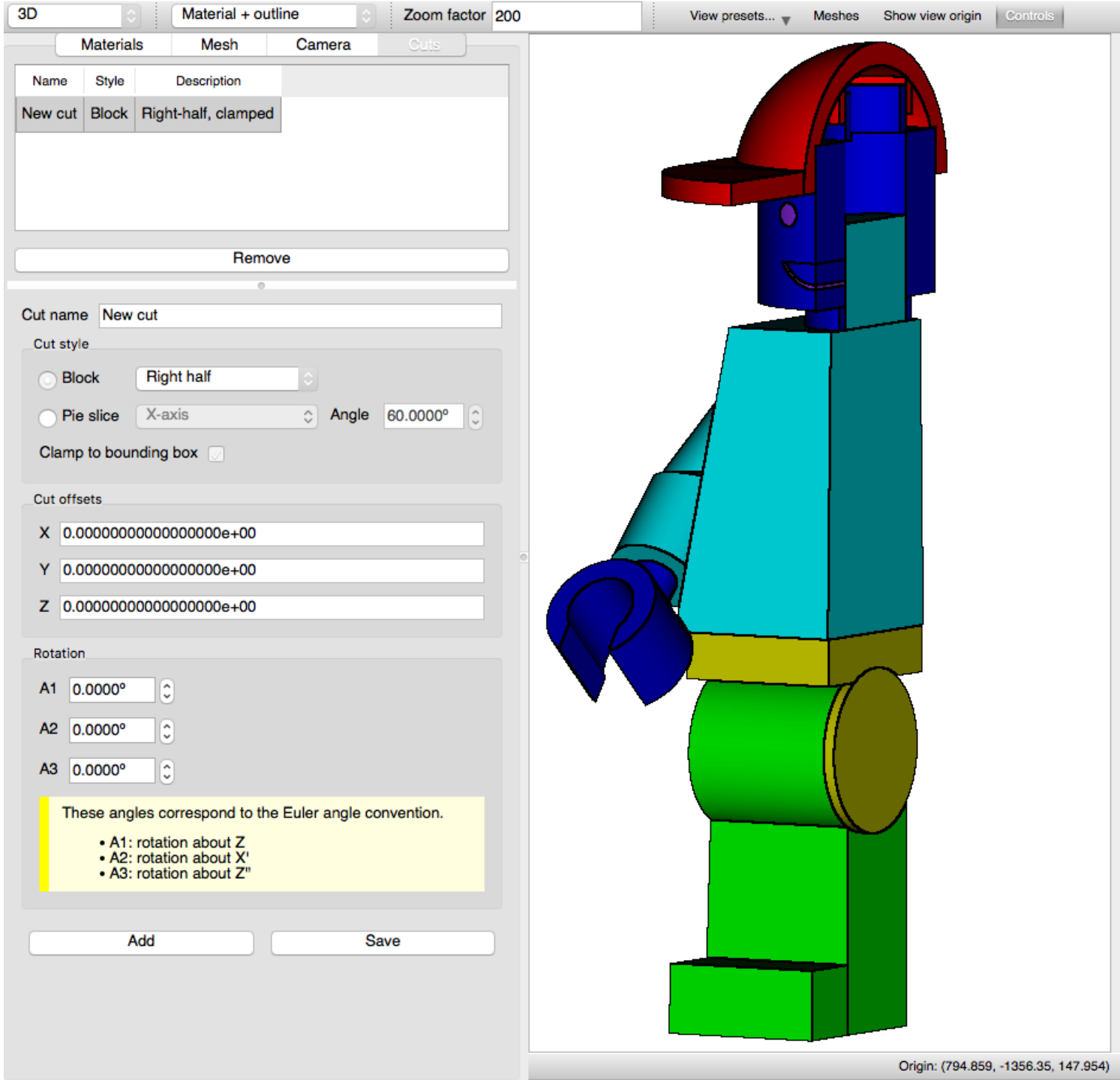
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - **Left half (-X)**
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



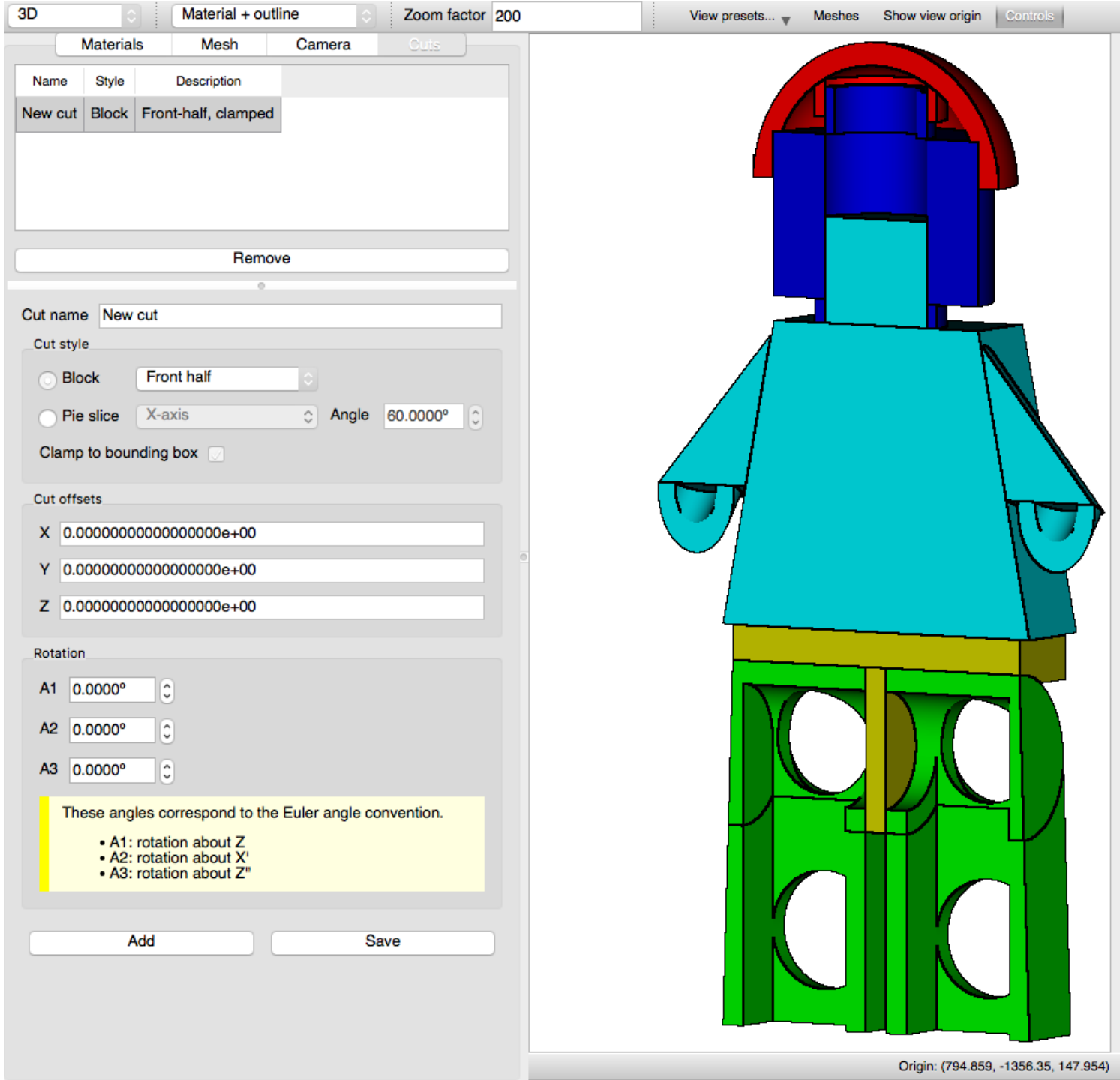
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - **Right half (+X)**
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



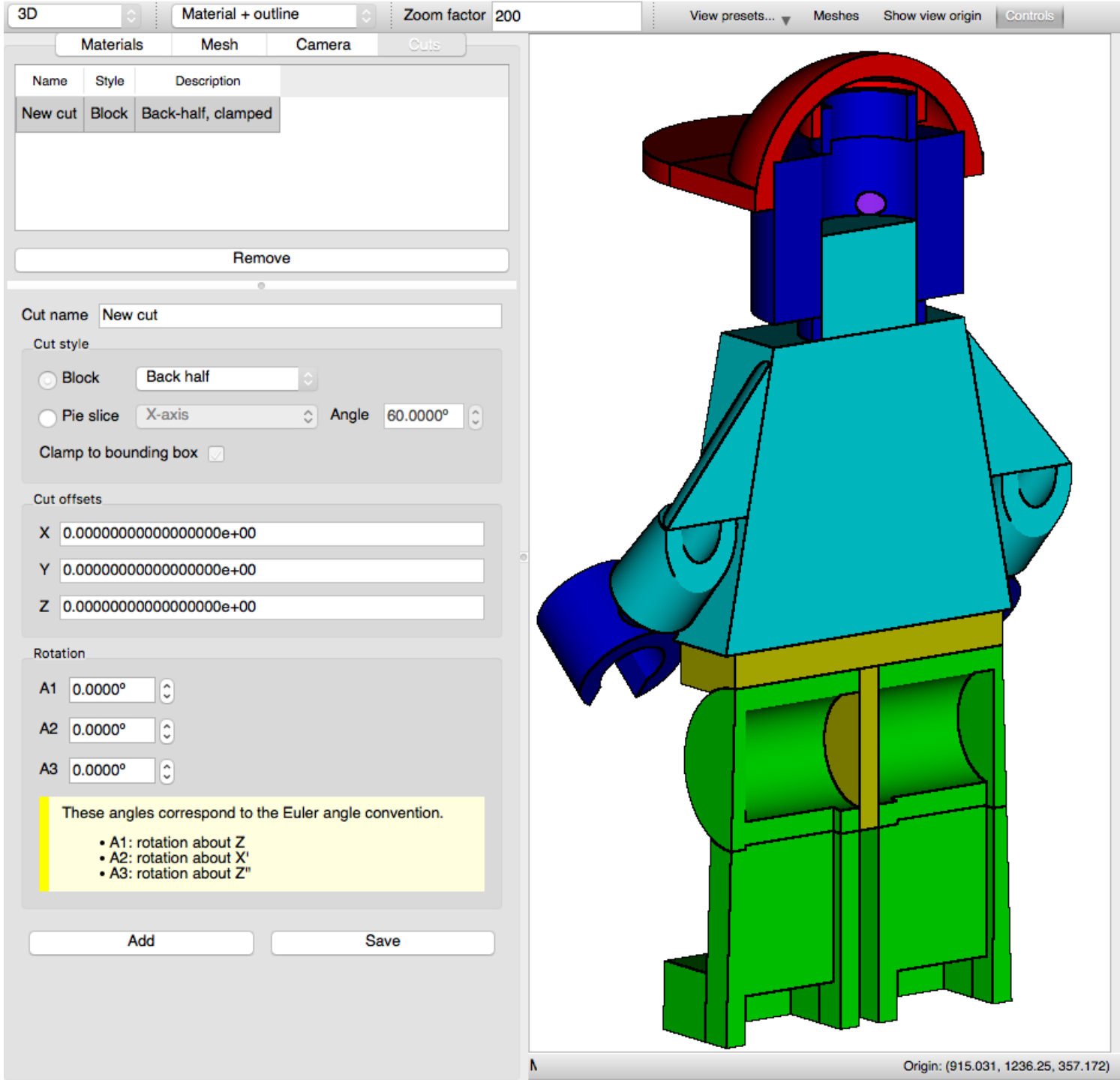
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - **Front half (-Y)**
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



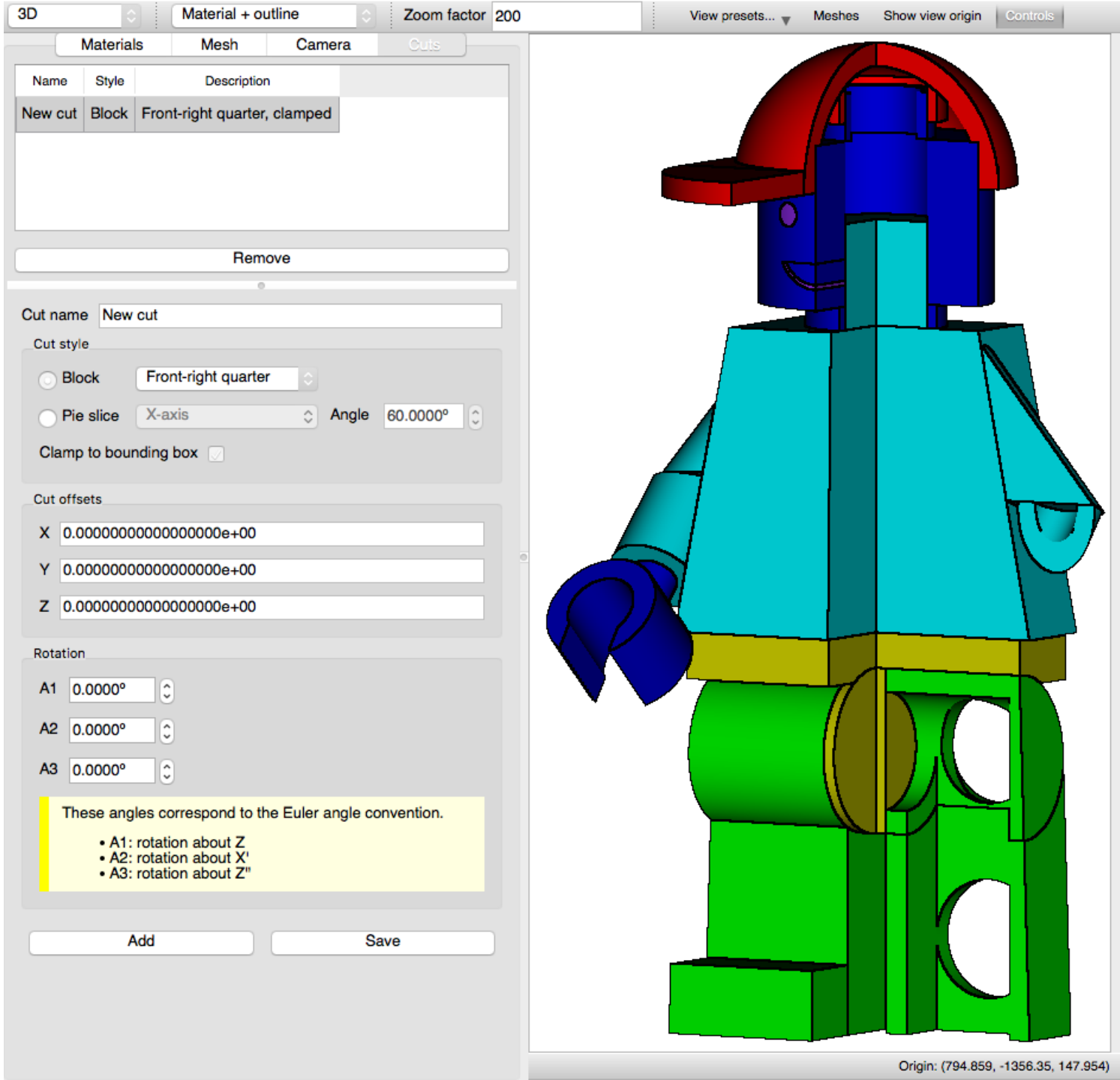
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - **Back half (+Y)**
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



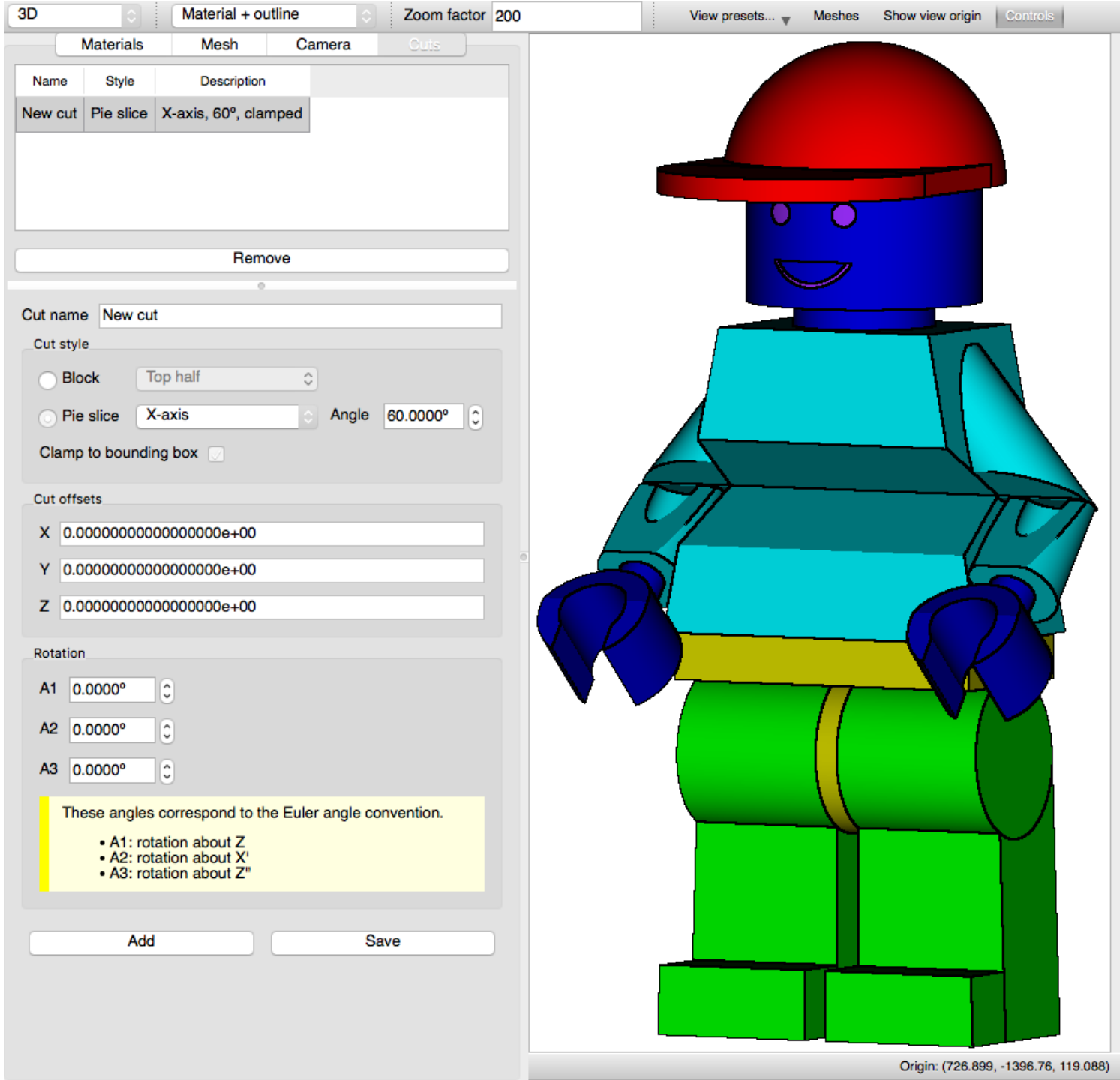
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - **Front-right quarter (-Y,+X)**
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



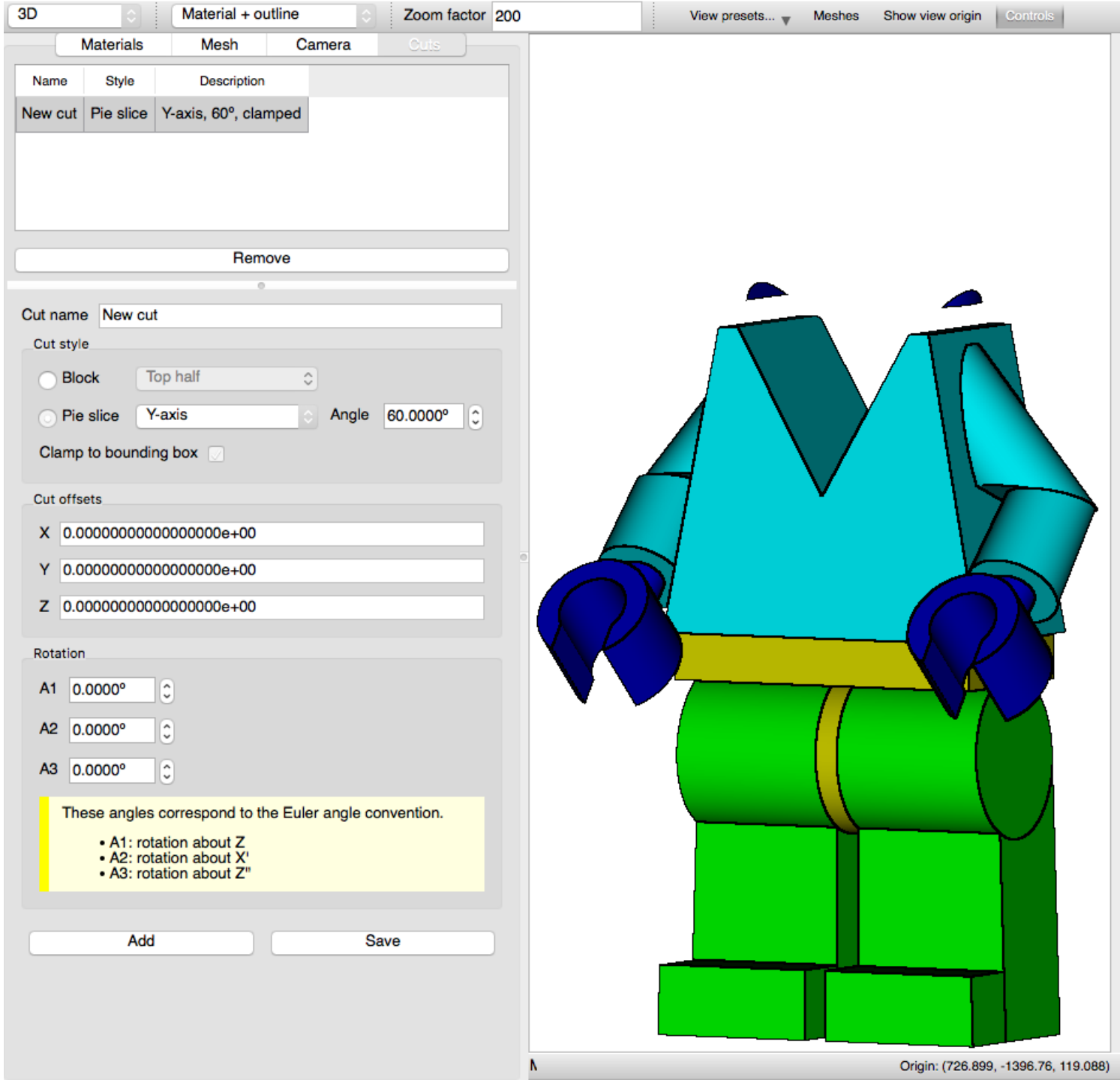
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - **<u>X axis (opening in –Y)</u>**
  - Y axis (opening in –Z)
  - Z axis (opening in -Y)



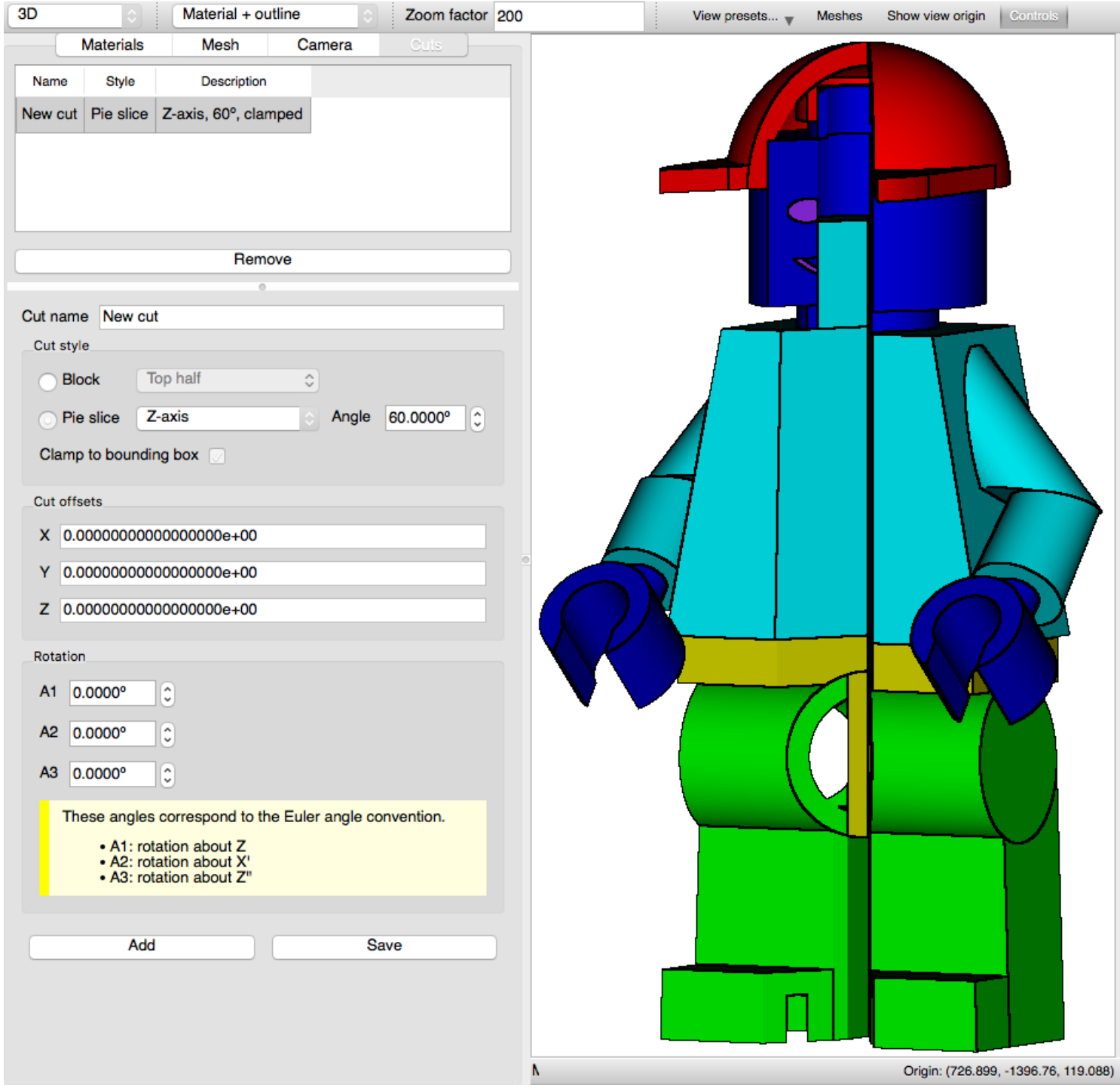
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - **Y axis (opening in –Z)**
  - Z axis (opening in -Y)



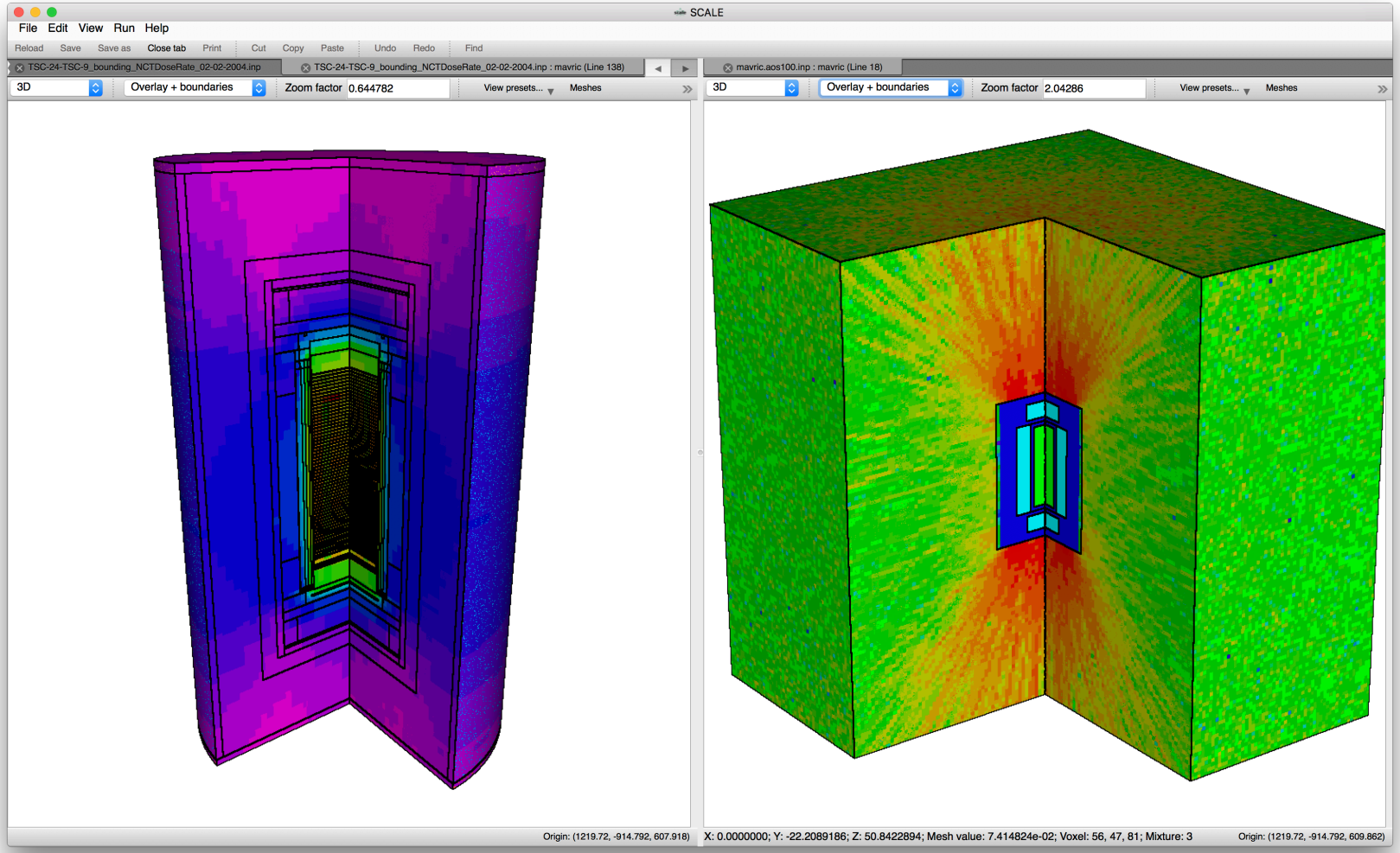
Model Cutting: Cut Styles

- **Block**
  - Top half (+Z)
  - Bottom half (-Z)
  - Left half (-X)
  - Right half (+X)
  - Front half (-Y)
  - Back half (+Y)
  - Front-right quarter (-Y,+X)
- **Pie slice**
  - X axis (opening in –Y)
  - Y axis (opening in –Z)
  - **Z axis (opening in -Y)**



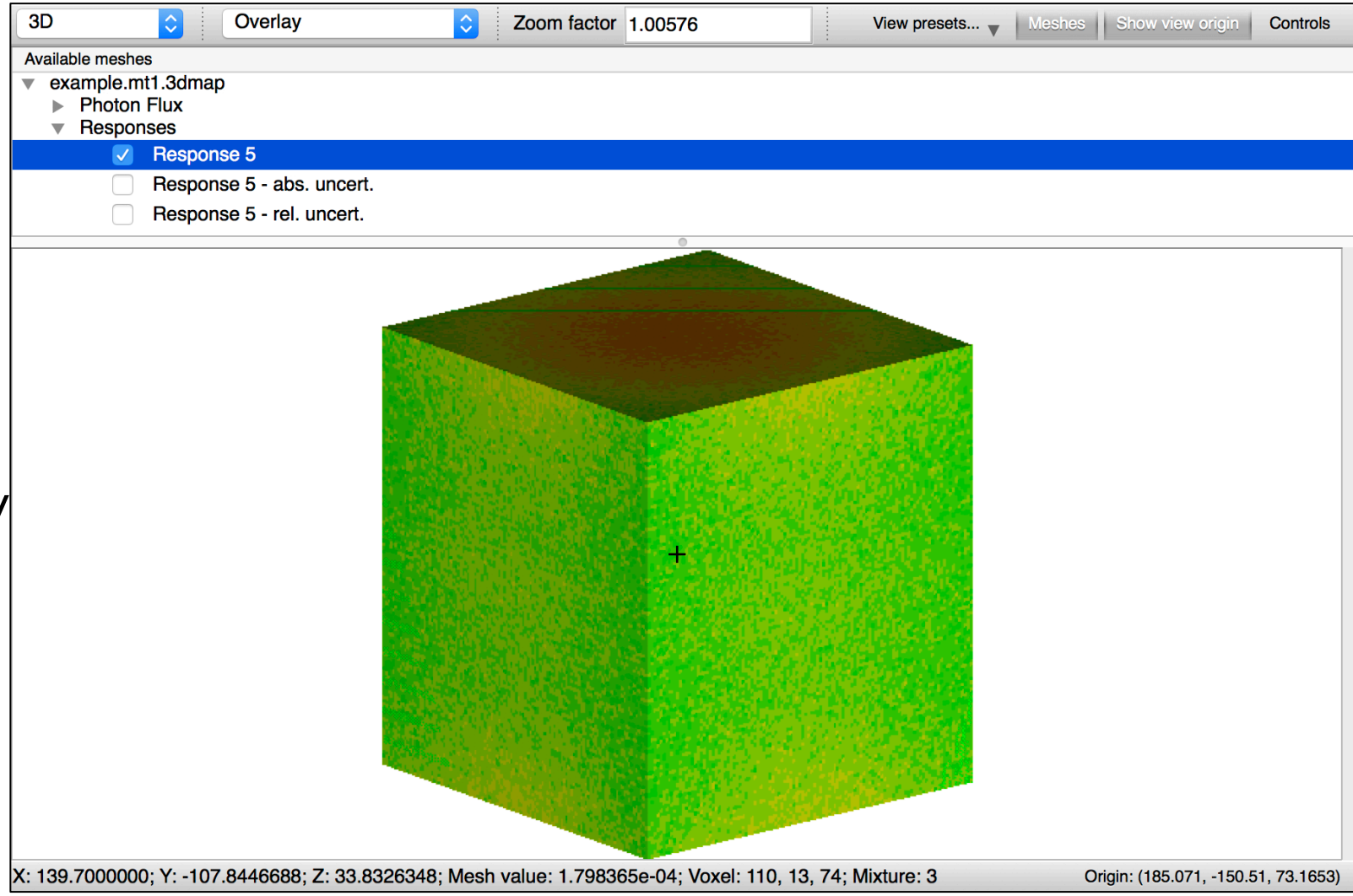
3D Model visualization with mesh overlay

- Available when **mesh** data is **loaded** and selected, and the **render mode** is **Overlay** or **Overlay + Boundaries**



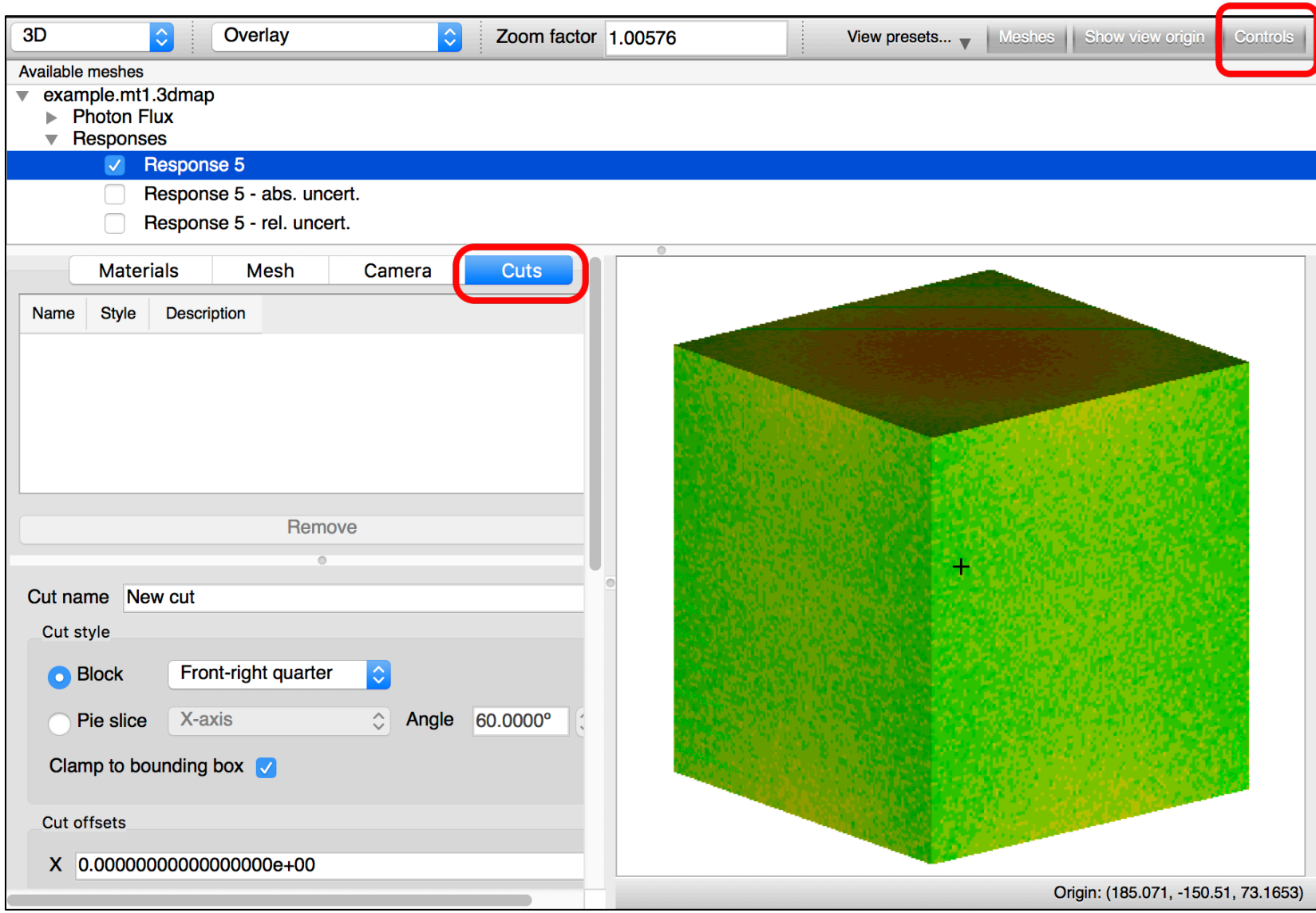
3D Controls | Hands On

- Change the perspective from Front (X-Z) to **3D**
- Depending on your CPU clock speed and core count you may observe a pause while the model is raytraced
- Note the **Origin** is now the Camera not View Plane origin
- Observe mouse-over **surface** information



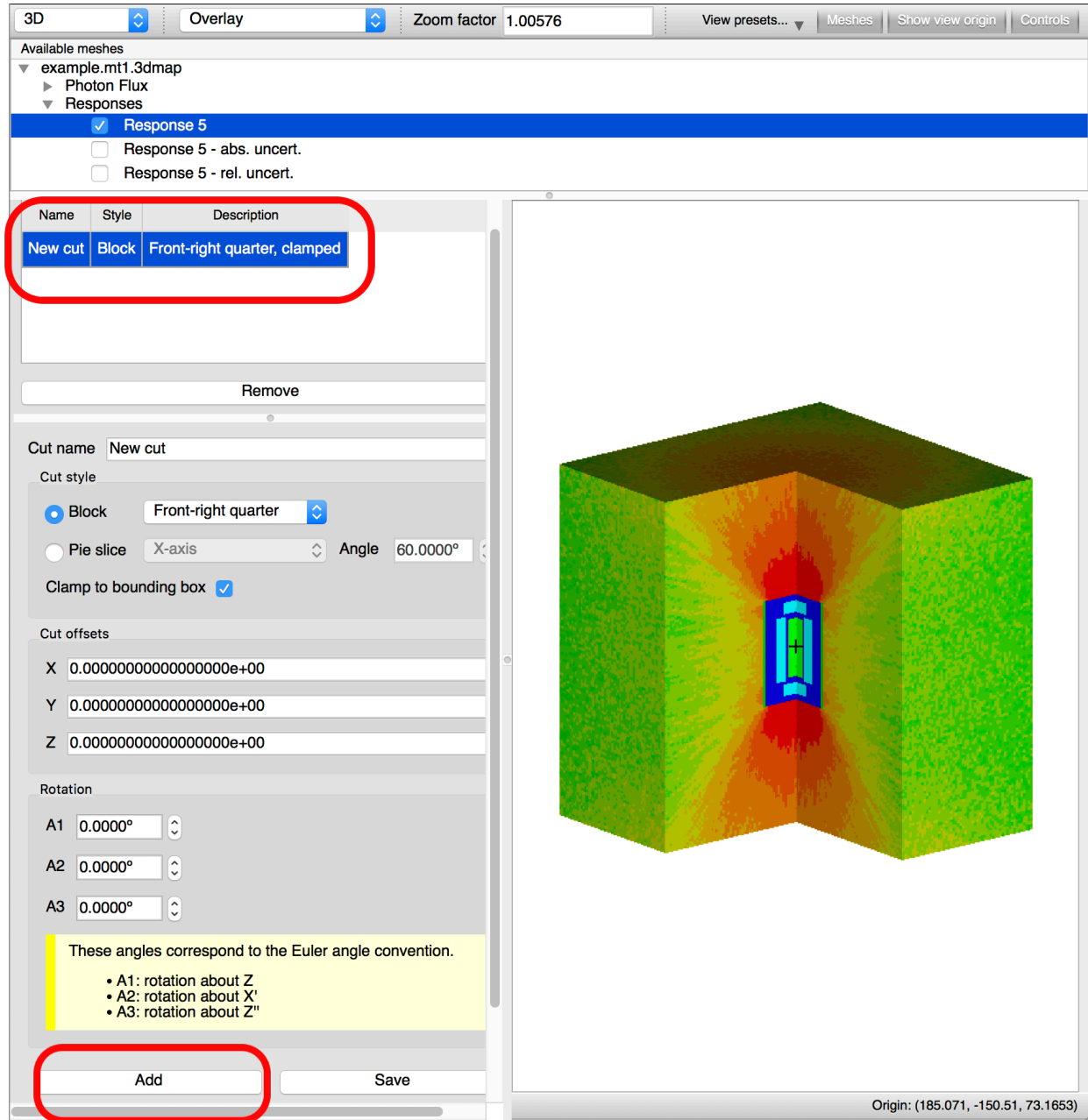
3D Controls | Hands On Model Cut

- Click the **Controls** panel button to display sidebar controls
- Click the **Cuts** tab



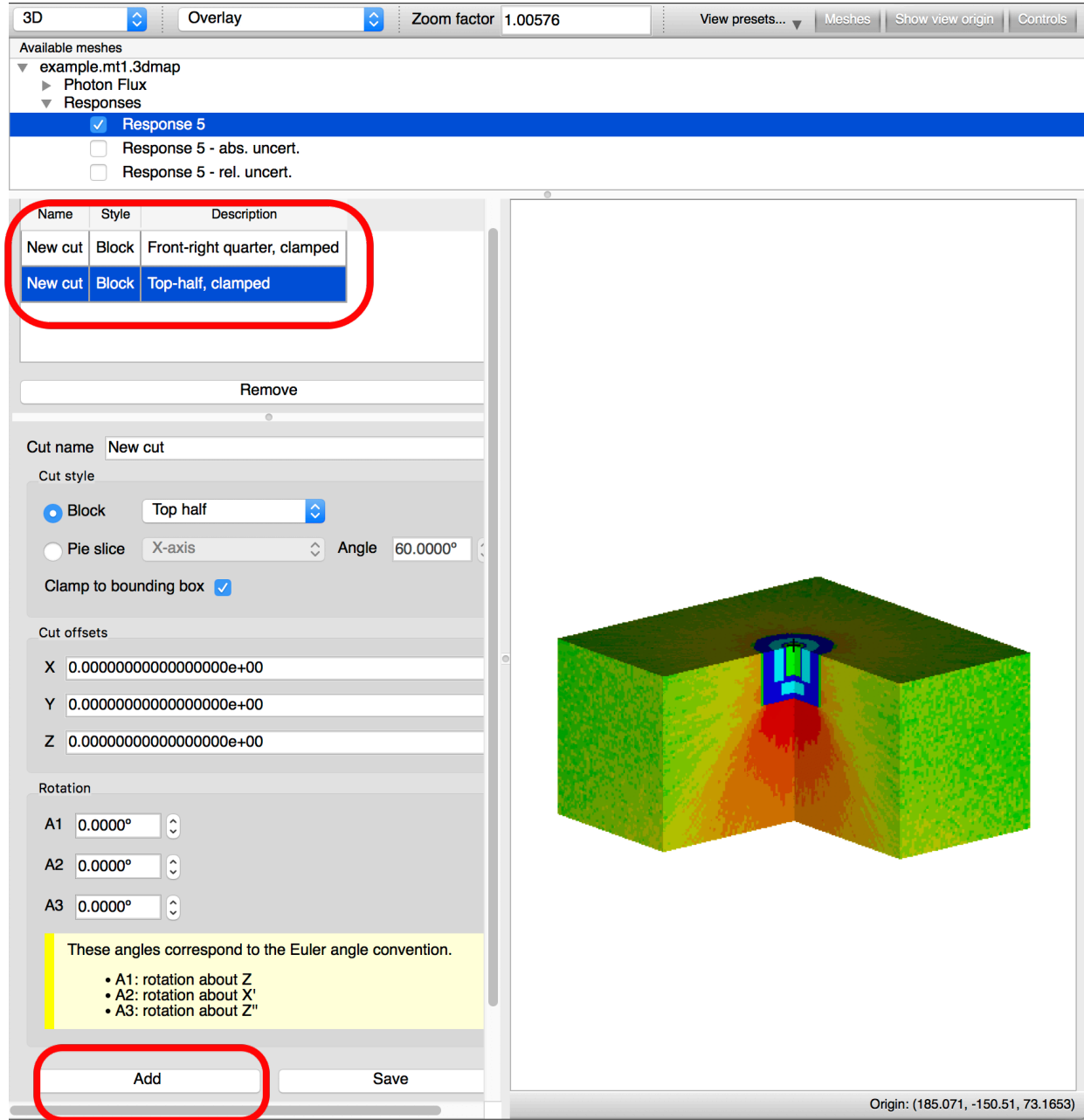
3D Controls | Hands On New Model Cut

- Conduct a default **Front-right quarter Block** cut by clicking the **Add** button
- Observe the **New cut** entry in the cuts table
- Observe the section removed and rendered with new overlay data



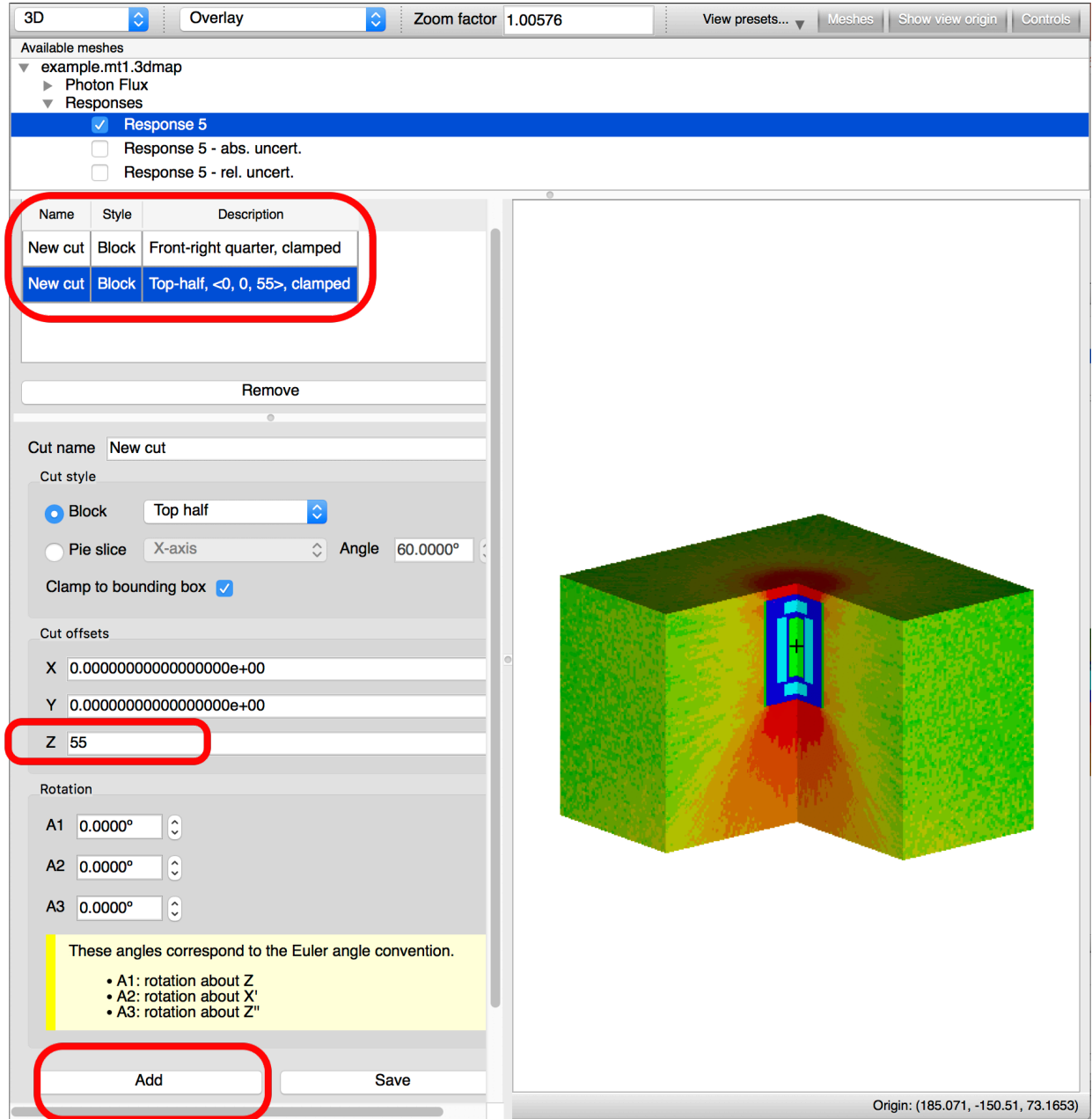
3D Controls | Hands On New Model Cut Cont'd

- Conduct a default **Top half Block** cut by selecting the **Top half Cut style** and clicking the **Add** button
- Observe the **New cut** entry in the cuts table
- Observe the section removed and rendered with new overlay data



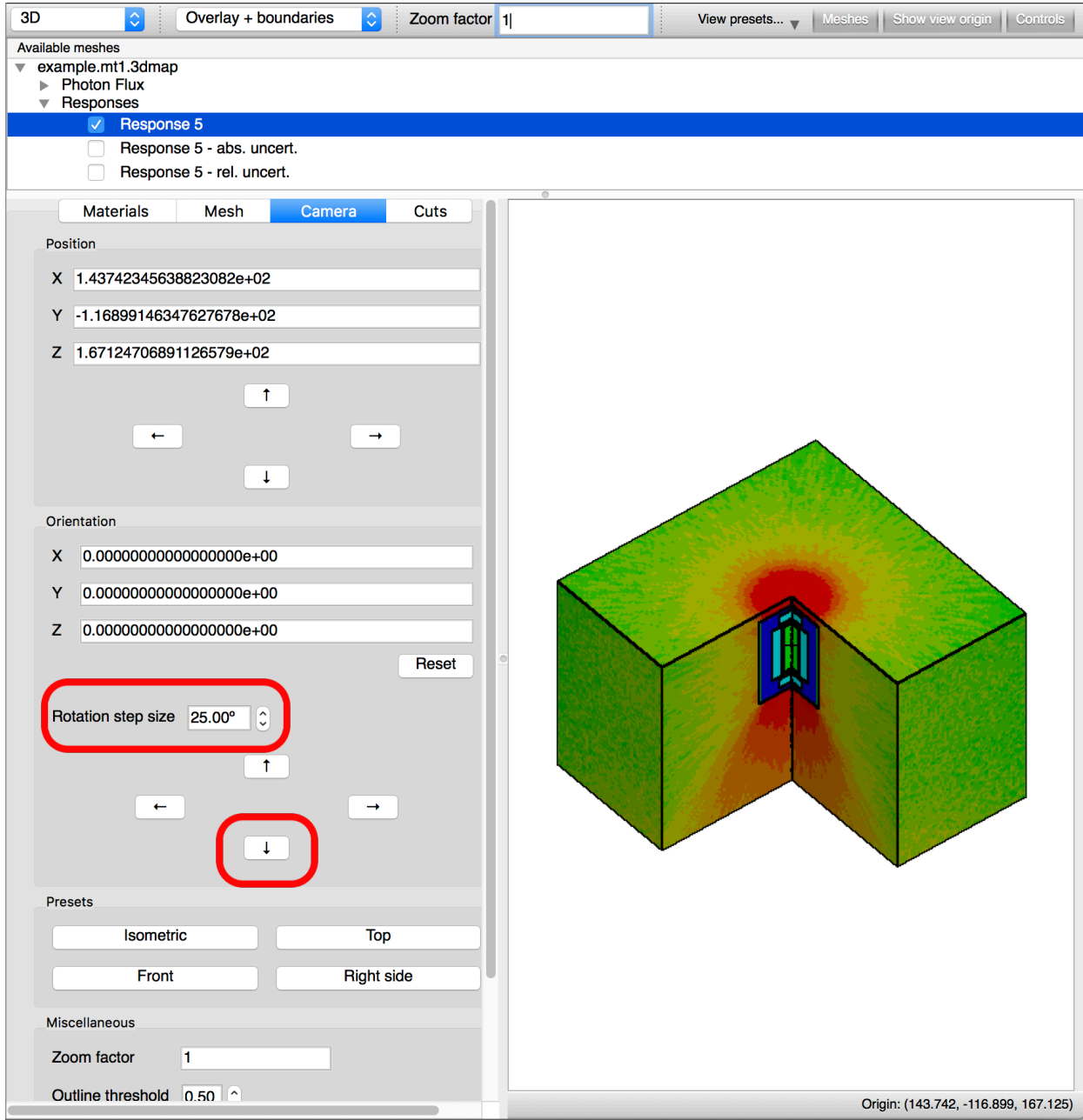
3D Controls | Hands On Updating Existing Model Cut

- Let's edit the **Top-half** cut to remove less model via a **Cut offset** in **Z** of **55**
- Update **Cut offset Z** to be **55**
- Click **Save**
- Observe the cuts table entry **Description** update as well as the additional model and data visible



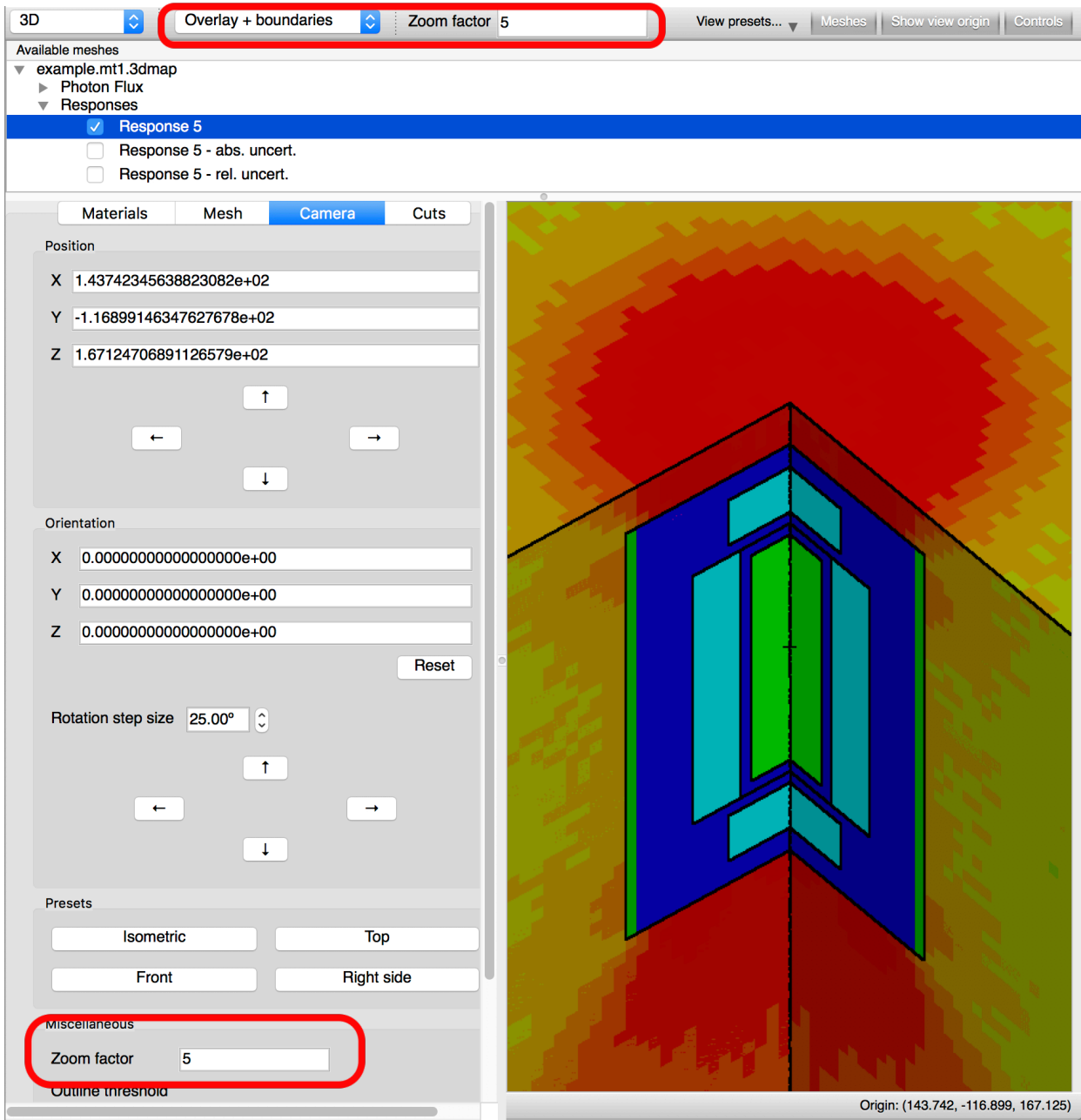
3D Controls | Hands On Camera Controls

- Select the **Camera** controls
- Update **Rotation step size** to be **25**
- Rotate **down** by clicking the **Orientation down** arrow button
- Observe the camera **Position** change
  - Good to remember the camera is moving, not the model



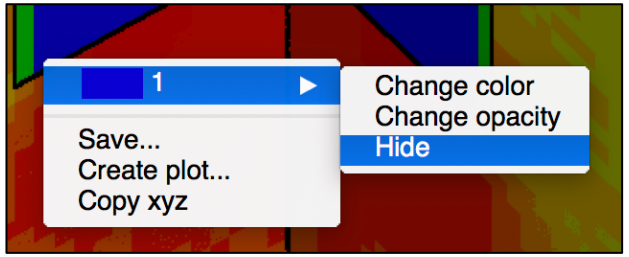
3D Controls | Hands On Camera Controls

- Update the **Zoom** to be **5**
- Update the **Render mode** to be **Overlay + boundaries**
  - In 3D this mode includes rendering boundaries as a function of surface normal

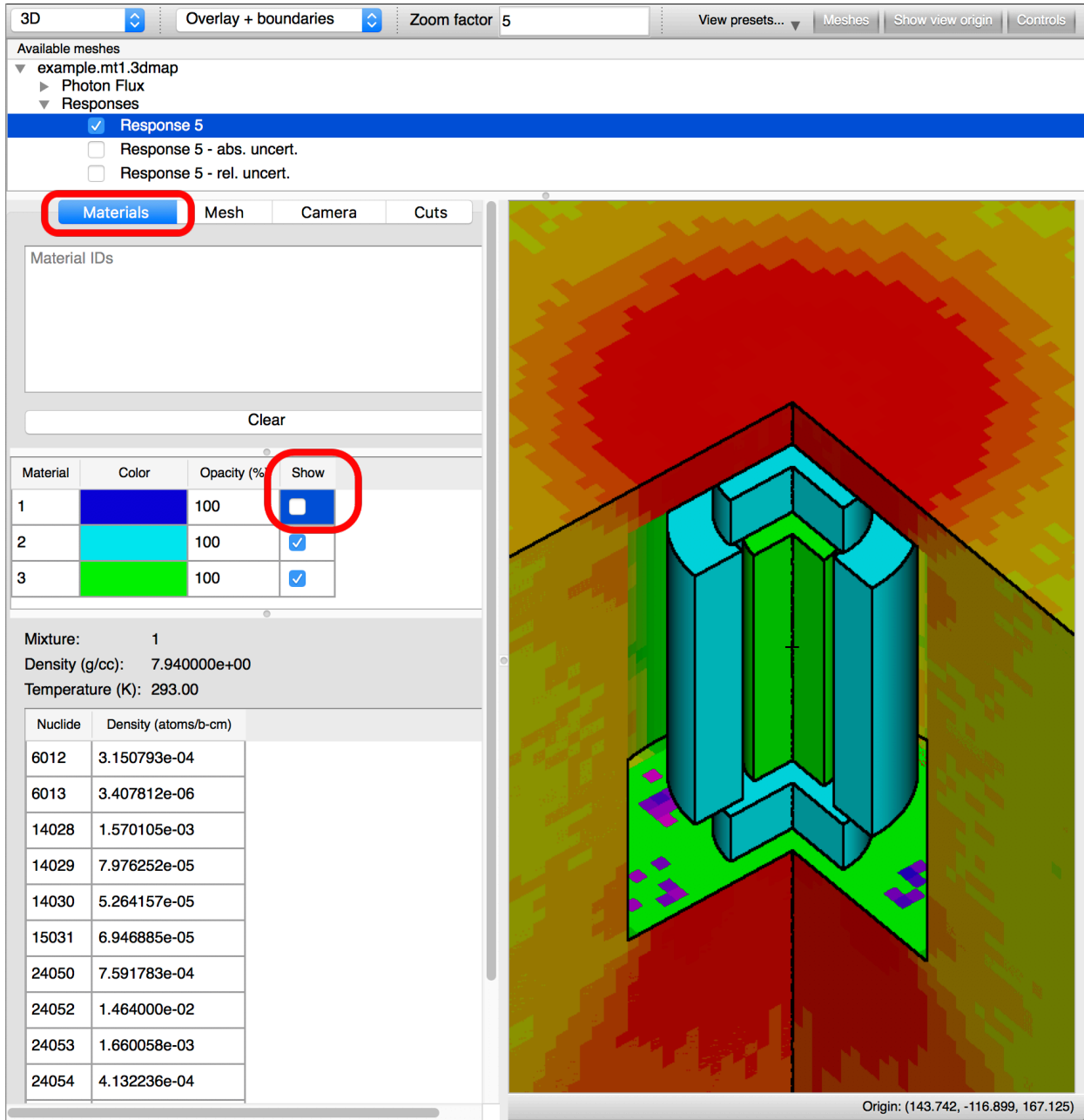


3D Controls | Hands On Material Controls

- Click the **Materials** panel button to display materials controls
- In the **Show** column of the **Material** table deselect material **1**
  - Alternatively, right-click the region and select **Hide**

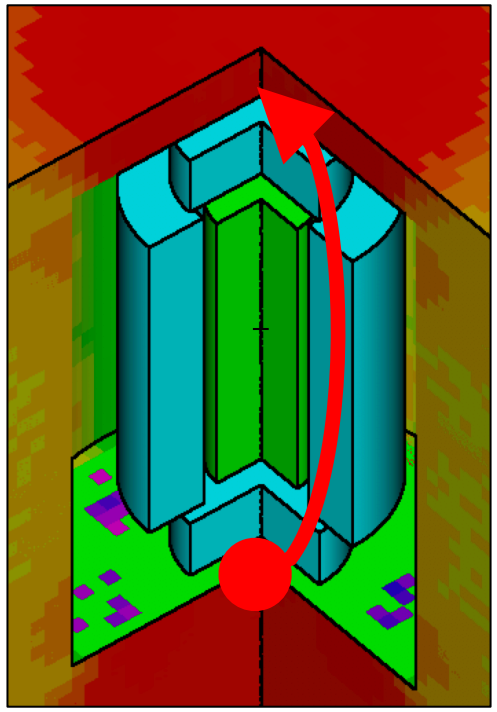


- Observe Material 1 is hidden in the rendering

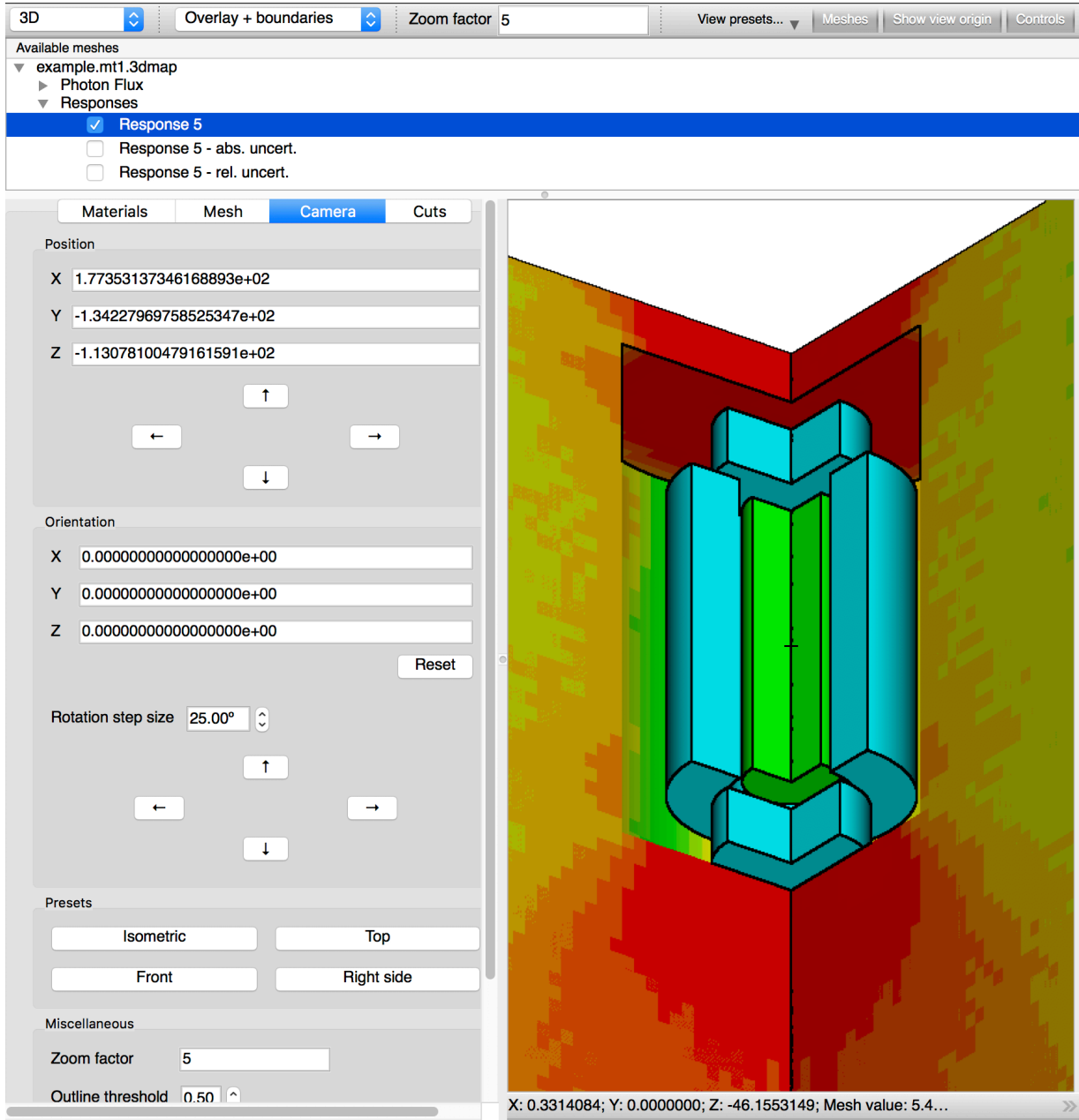


3D Controls | Hands On Arbitrary Rotation

- With the **Alt** (**option** on Mac) key pressed click and **drag up** as depicted

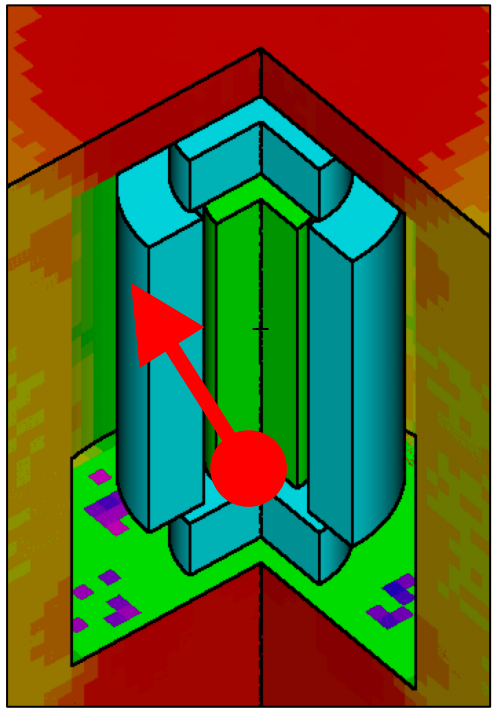


- Perform various rotations to become familiar with control

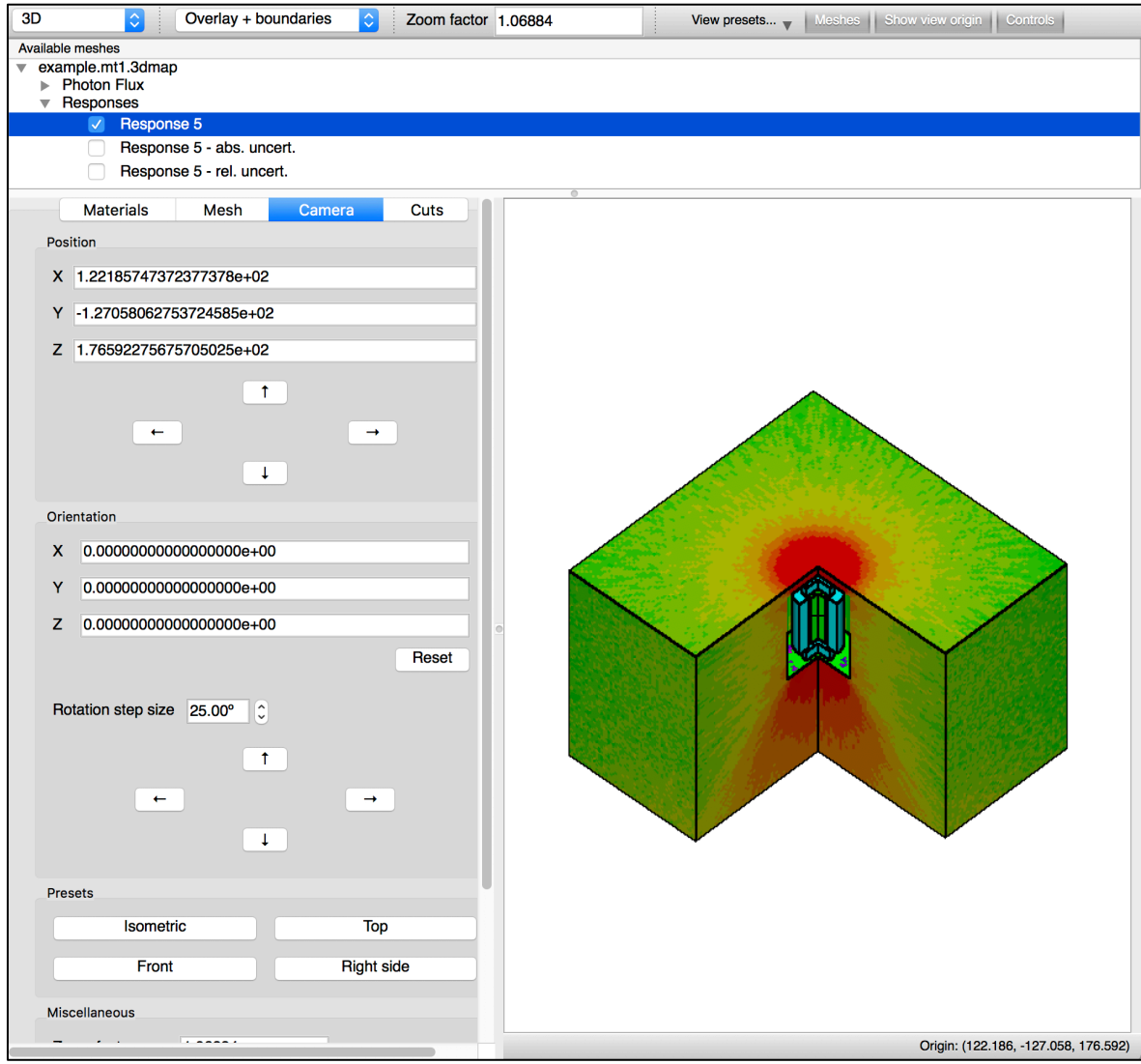


3D Controls | Hands On Fit to Screen

- Too close or far or simply lost in the geometry?
- A Left mouse button press and drag **up and to the left** and release fits the model's extents to the render window

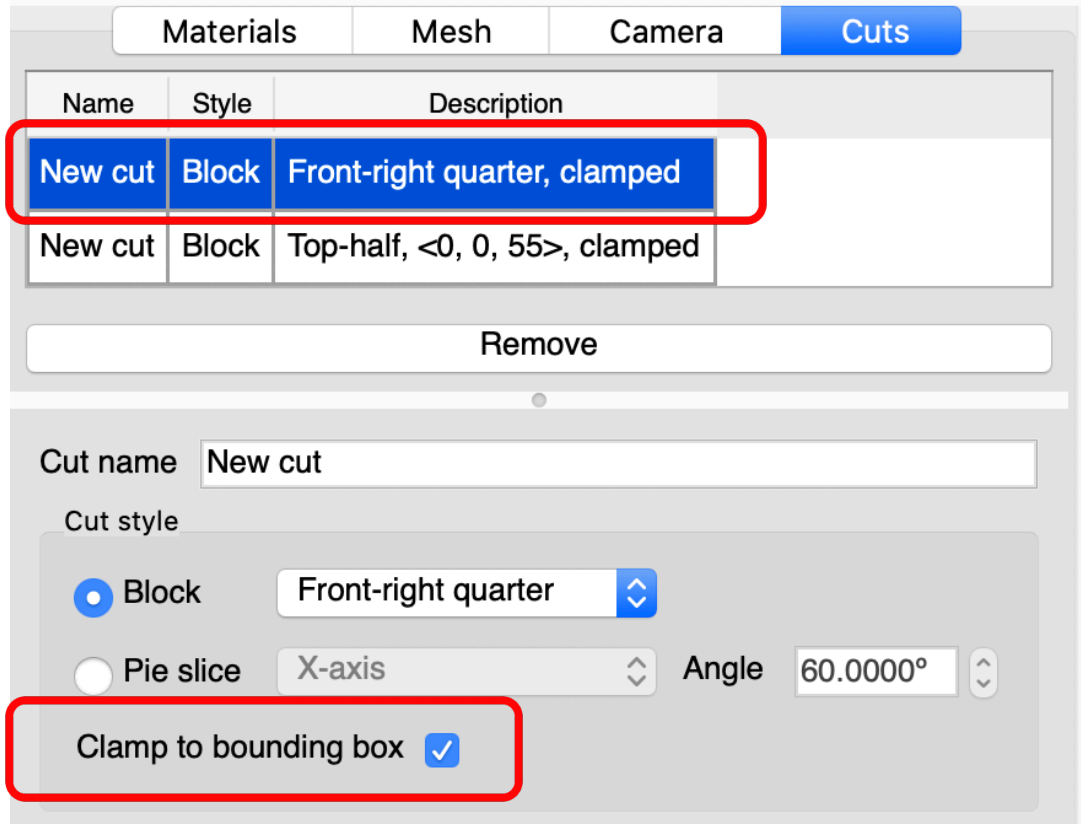


- Zooms out if too close to model
- Zooms in if too far away from the model



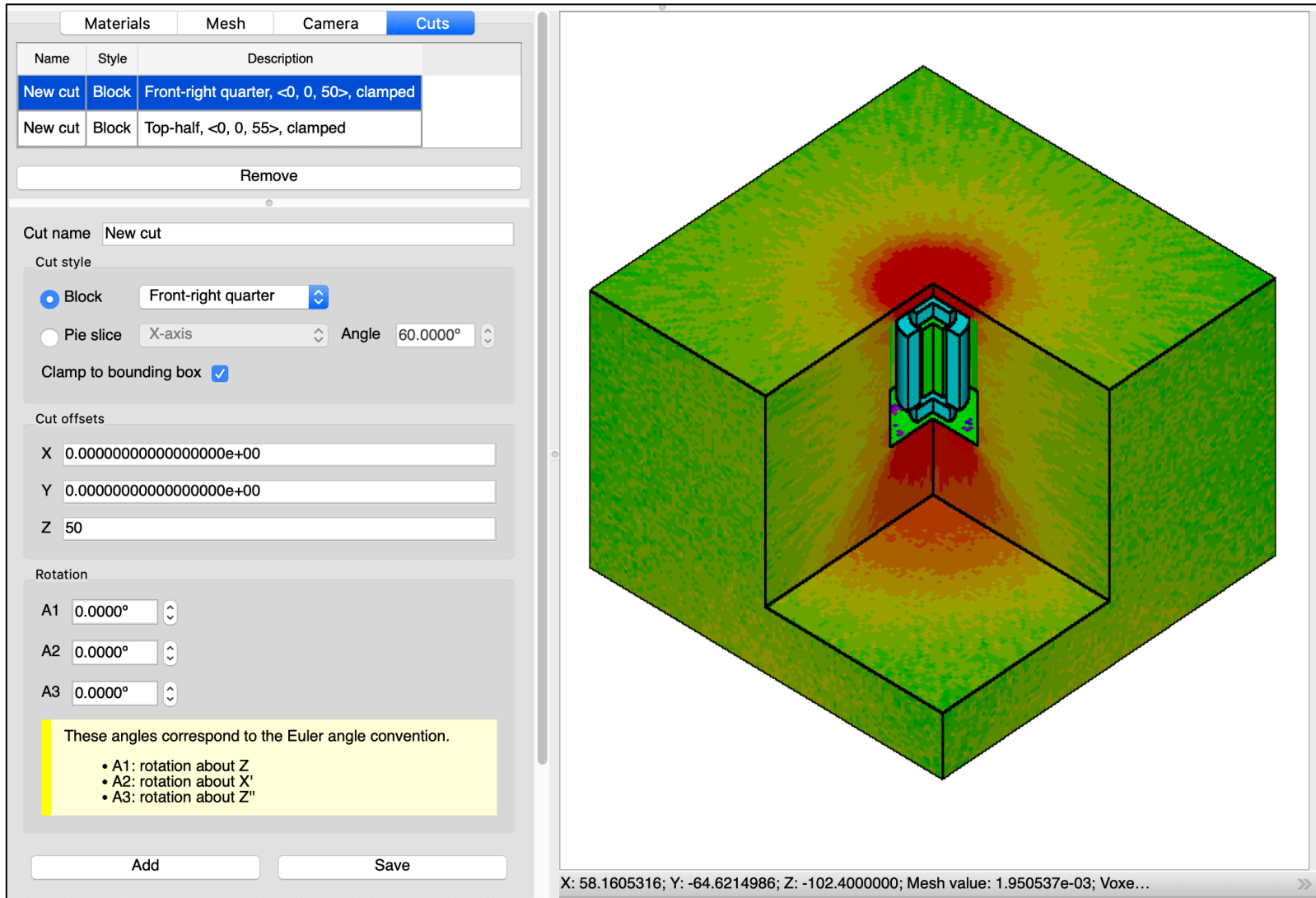
3D Controls | Hands On Cut Clamp to Bounding Box

- Select the **Cuts** tab
- Select the **Front-right quarter** cut
- The **Clamp to bounding box** option updates the 'infinite' cutting surface into a cutting volume
  - E.g., Front-right quarter is defined via 2 planes, **clamp to bounding box** updates the cutting surface to be a cutting box
- Volume is defined prior to application of translation and rotation



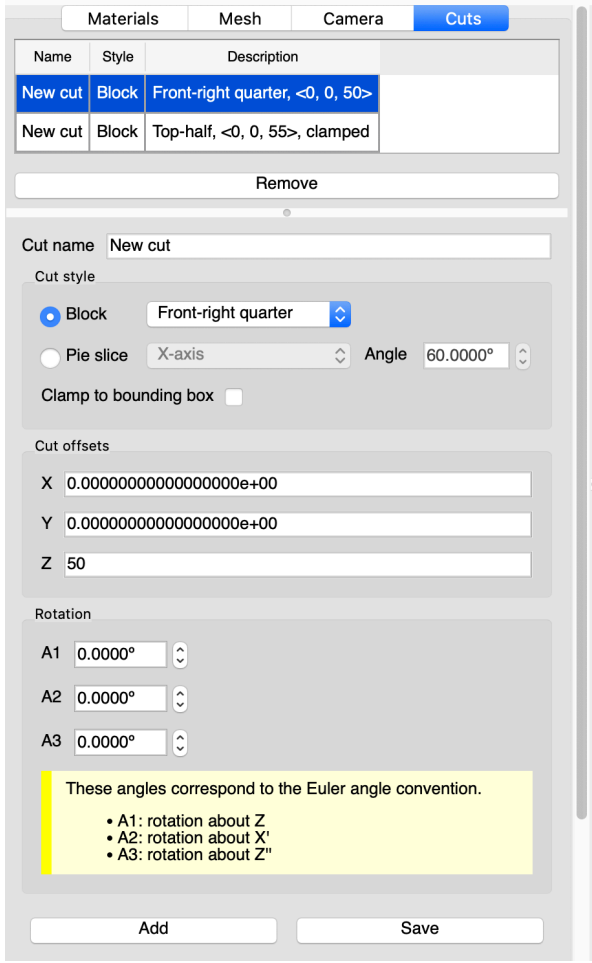
3D Controls | Hands On Cut Clamp to Bounding Box

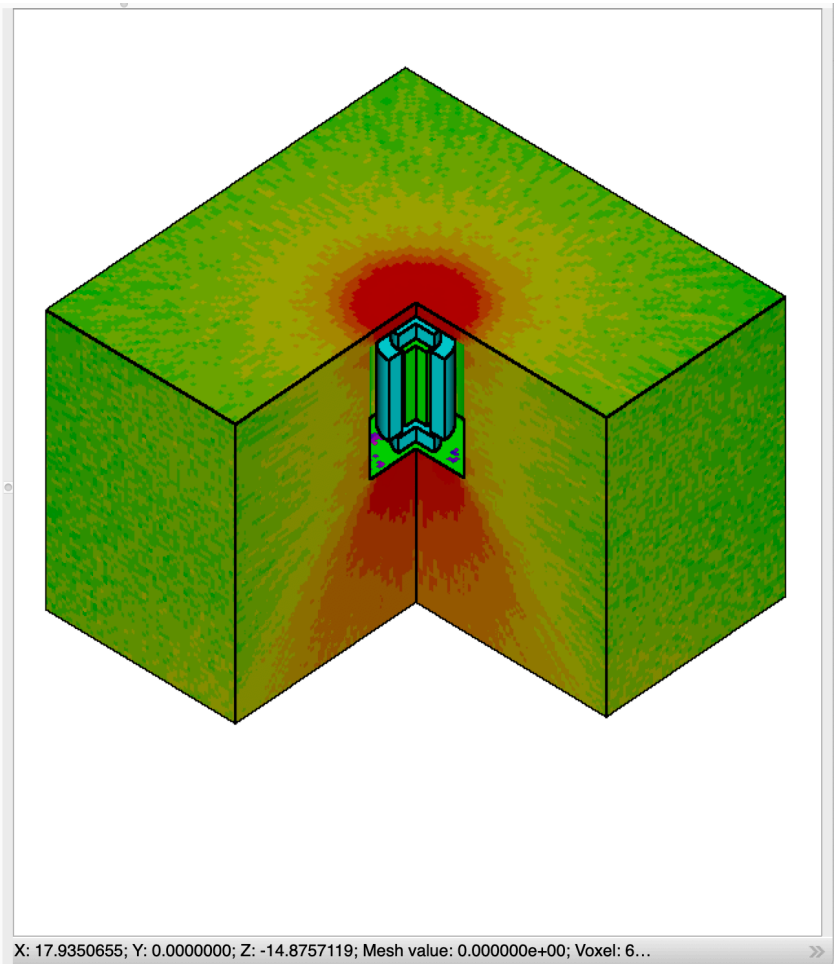
- Update **Cut Offsets** to be **50**
- Click **Save**
- Observe the **Clamped** cut is offset +50 from the lower z extent of -152.4 creating a ‘shelf’ at z=-102.4
  - Mouse over model to see X,Y,Z values



3D Controls | Hands On Cut Clamp to Bounding Box

- Uncheck the **Clamp to Bounding Box**
- Click **Save**
- Observe the cut offset of +50 is ignored as the front-right corner cut is no longer clamped to the bounding box





Geometry Review

- You are now aware and practiced with 2D and 3D Camera controls
- You are aware and practiced with 3D Cut and Material controls
- You are aware and practiced with 2D and 3D mesh data overlay information, controls, and data plotting

- **Questions?**

Advanced User Interface Capabilities Review

- You are now aware and practiced with data plotting
  - Various data formats, options, and controls
- You are now aware and practiced with 2D and 3D geometry visualization
  - Controls, cuts, and data overlay

- Thank you!

Questions?