HIDRA Experiment Planning Suite

User Guide for Proposal Writing

Instrument: HIDRA, beamport HB2B, HFIR, ORNL

Date: 2026-07-06

Contents

1. Introduction

What is HIDRA?

HIDRA (High-Intensity Diffractometer for Residual stress Analysis) is a neutron diffraction instrument located at beamport HB2B of the High Flux Isotope Reactor (HFIR), Oak Ridge National Laboratory. It is optimised for non-destructive residual stress measurement in engineering components using the neutron diffraction technique. Neutrons penetrate deep into metallic and ceramic materials, making HIDRA uniquely suited to measuring internal stresses in thick samples and at locations well below the surface.

Planning a User Proposal

User proposals for HIDRA beam time are submitted through the ORNL Neutron Sciences User Program. General information on the proposal process, deadlines, and required documentation can be found at:

https://neutrons.ornl.gov/users

A beam time proposal must include a statement of research and an estimate of required measurement time. This guide shows how to use the HIDRA Planning Suite to determine whether your experiment is feasible and how long it will take — before you submit your proposal.

What This Guide Covers

Tool	What it answers
Count Time Estimator	How long do I need to count per point for this material and gauge volume?
Mapping Planning	If I scan a grid of points across my sample, how long will the total scan take?

2. Physical Background

Two physical models underpin the planning suite. Understanding them at a high level helps you interpret the charts and numbers the tool produces.

Peak Height Scaling Law

The measured diffraction peak height (counts above background) scales approximately with the product of gauge volume and counting time:

$$H = a \cdot (V \cdot t)^b$$

where H is peak height in counts, V is gauge volume in mm^3, t is exposure time in seconds, and a and b are calibration coefficients determined from reference measurements. Rearranging gives the required surface exposure time:

$$t_0 = (H\_target / a)^{(1/b)} / V$$

Lambert-Beer Neutron Attenuation

Neutrons are exponentially attenuated as they travel through material. This means that a gauge volume buried deep inside a sample requires a proportionally longer exposure time than a surface measurement:

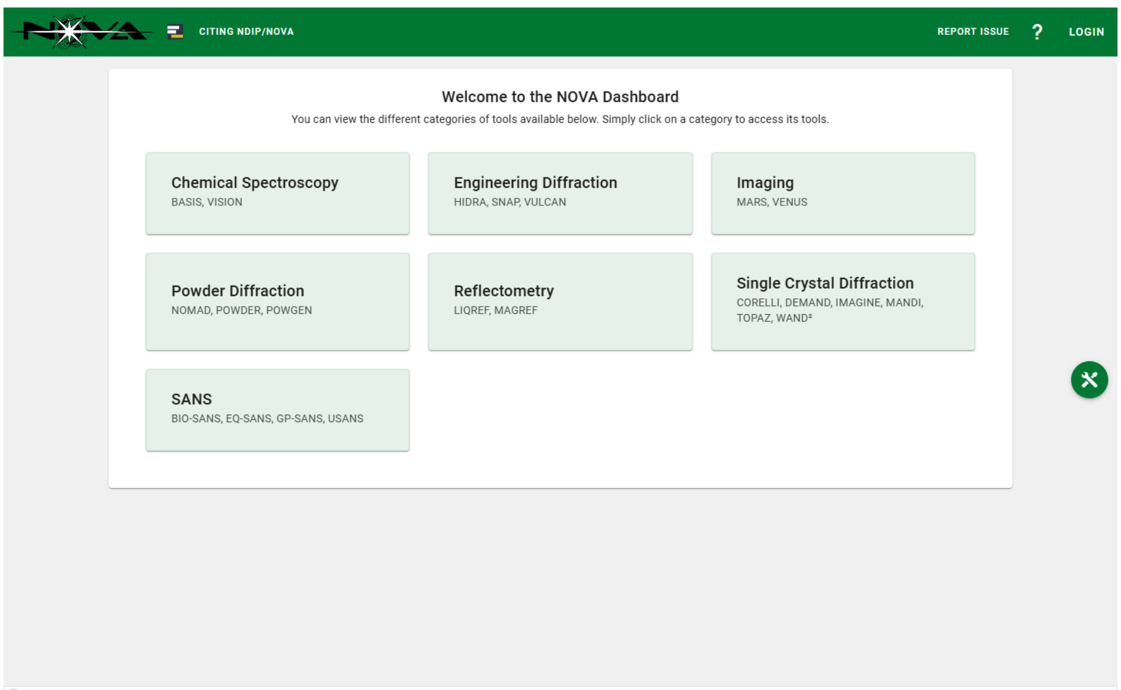
$$t\_required(x) = t_0 \cdot \exp(\Sigma \cdot x)$$

where Σ is the macroscopic attenuation coefficient (mm^{-1}) and x is the total neutron path length through the material (mm). Σ depends on the material composition and the neutron wavelength — the planning tool computes it automatically from the material library.

3. Accessing the Planning Suite

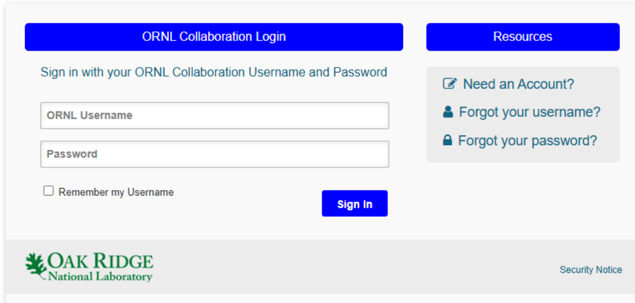
The planning suite runs online on ORNL's Neutron Data Interpretation Platform (NDIP) — no installation is required. Open the NOVA dashboard in your web browser:

https://ndip.ornl.gov/nova/



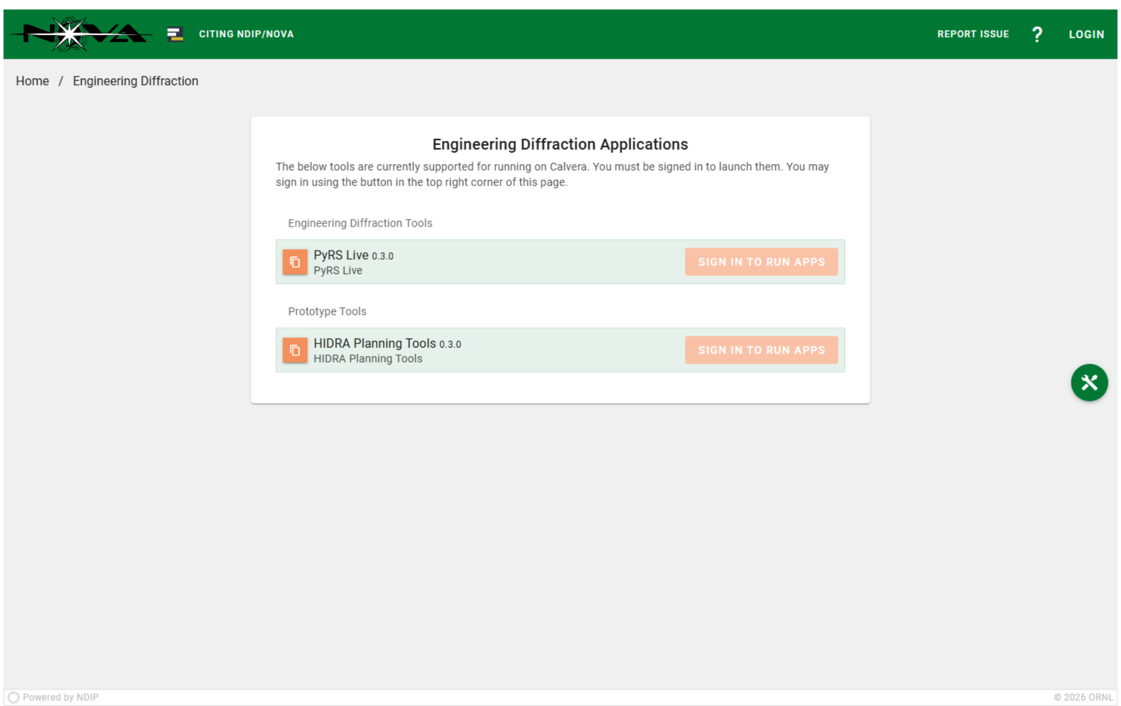
The NOVA dashboard at ndip.ornl.gov/nova. Click LOGIN (top right) to sign in, then open the Engineering Diffraction category.

Click LOGIN in the top-right corner and sign in with your ORNL credentials (UCAMS/XCAMS username and password).



The ORNL Collaboration Login page. External users can request an account via the "Need an Account?" link.

After signing in, open the Engineering Diffraction category and launch HIDRA Planning Tools from the tool list.



The Engineering Diffraction tool list. Launch HIDRA Planning Tools from here (the launch button activates once you are signed in).

The tool can also be launched directly via:

https://ndip.ornl.gov/?tool_id=nova-hidra-planning-tools-prototype

Once the tool starts, the planning suite opens in your browser with the Count Time Estimator tab active.

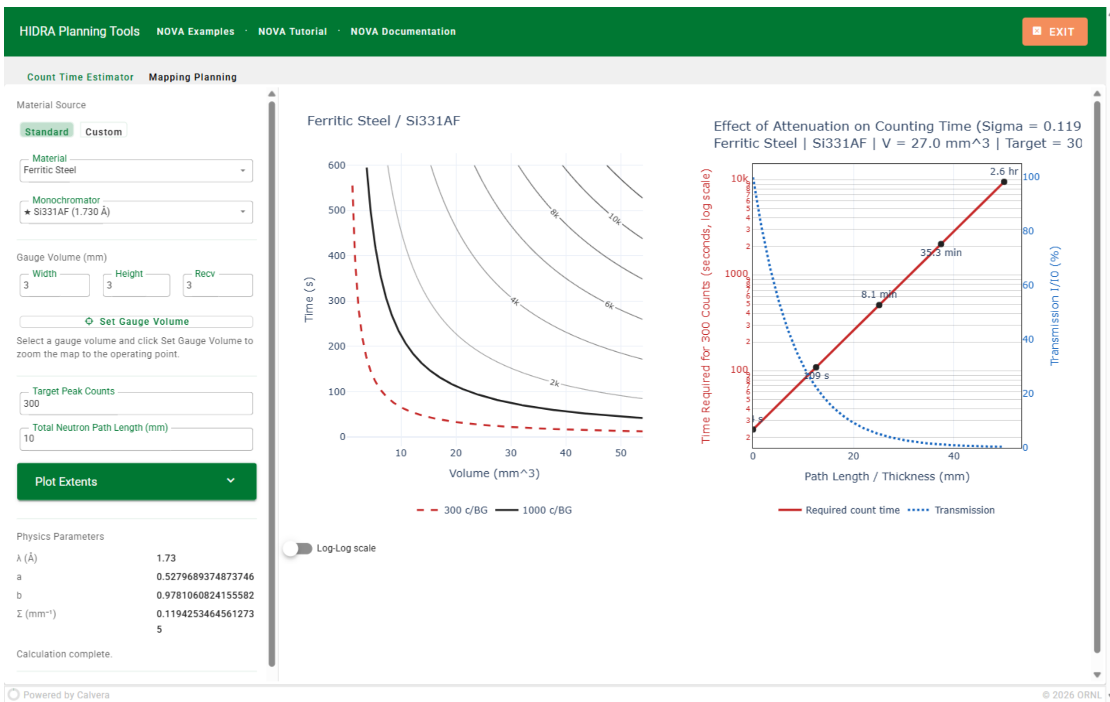


Figure 1. The HIDRA Planning Suite on first launch. The Count Time Estimator tab is active by default.

4. Count Time Estimator

The Count Time Estimator answers the fundamental planning question: "For my material and gauge volume, how long do I need to count per measurement point?"

4.1 Sidebar Controls

Control	Description
Material Source (Standard / Custom)	Standard uses the built-in calibration database. Custom accepts a user-supplied composition and a single reference measurement.
Material	Standard mode lists the six calibration-backed materials: Aluminum, Austenitic Steel, Copper, Ferritic Steel, Inconel 718, Nickel. (70Cu30Ni is in the library but has no calibration data, so measure it via Custom mode.)
Monochromator	Standard mode offers the calibration-backed settings for the chosen material (from Si331AF, Si400, Si422, Si511). A ★ star marks the recommended setting. Custom mode exposes all defined wavelengths (Si220, Si311, Si331AF, Si400, Si422, Si511).
Incident Width / Height / Receiving Width (mm)	The three slit dimensions that define the gauge volume.

	Gauge volume (mm^3) = Width × Height × Receiving Width.
Set Gauge Volume	Locks in the gauge volume and draws a crosshair annotation on the count-time map at your chosen point.
Target Peak Height (counts)	The desired number of counts above background (default 300). Both plots update when changed.
Attenuation Plot Max Path (mm)	X-axis extent of the attenuation curve plot (default 50 mm).

4.2 Selecting a Material

Ensure Material Source is set to Standard. Click the Material dropdown and select the material you plan to measure.

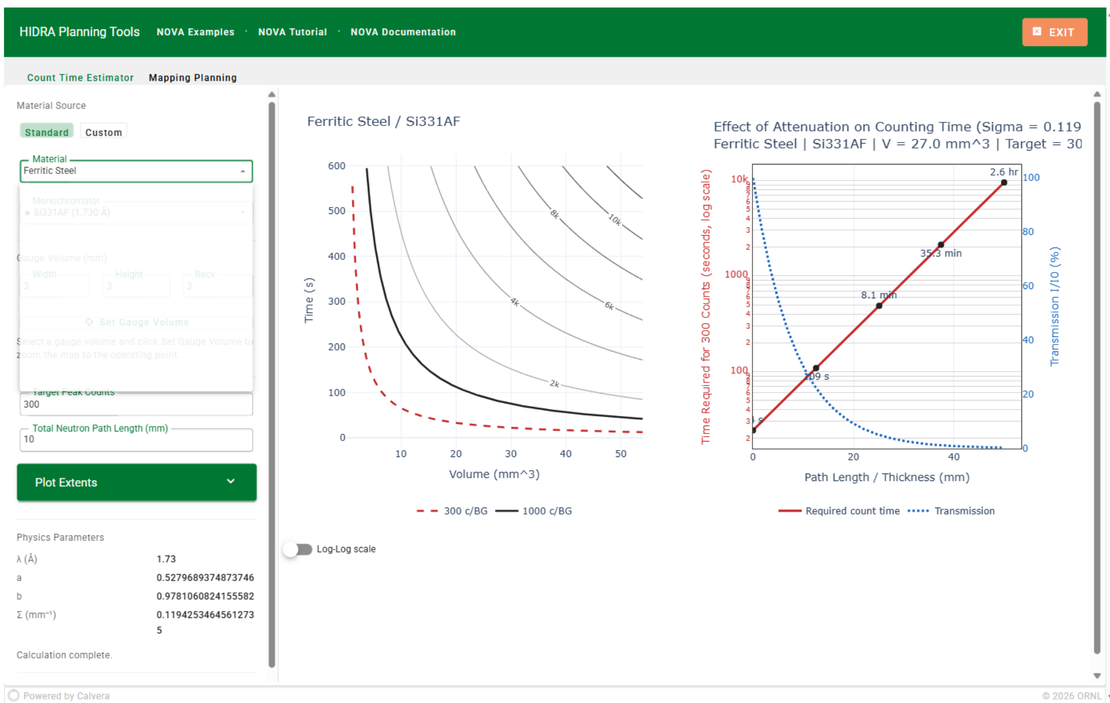


Figure 2. The Material dropdown open, showing the built-in material library. Click a material to select it.

4.3 Preferred Monochromator (★)

After selecting a material, the Monochromator dropdown automatically marks one setting with a ★ star and defaults to it. The recommendation is based on Bragg's law: the starred monochromator places the material's standard residual-stress reflection closest to 2θ = 90°, which minimises geometric strain errors and maximises measurement accuracy.

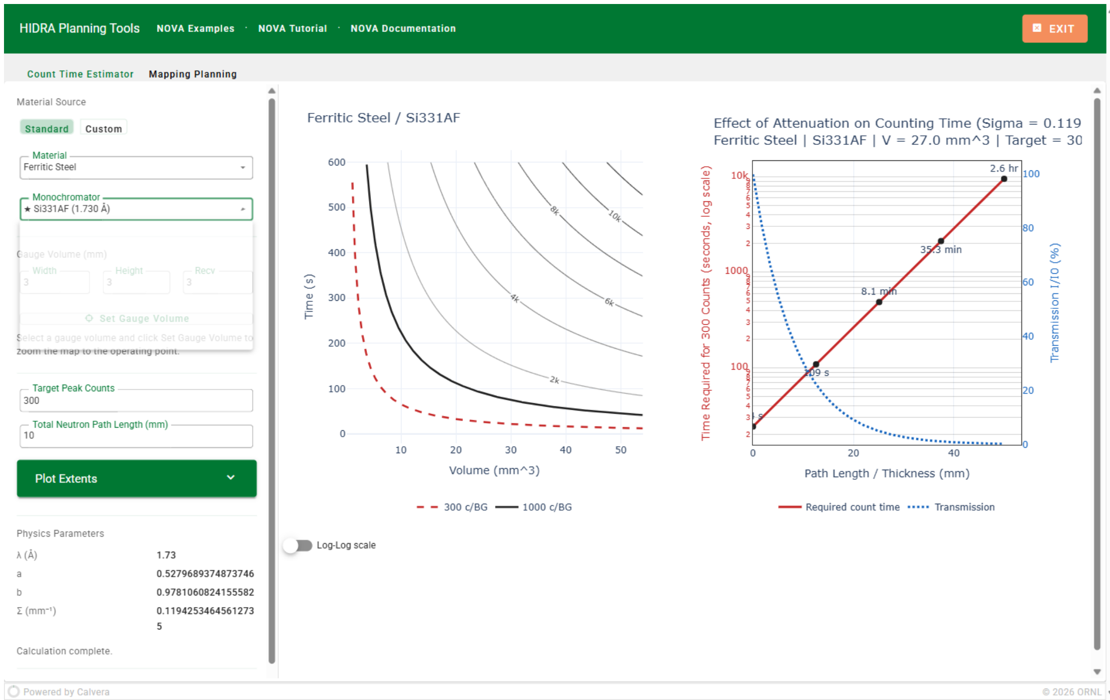


Figure 3. The Monochromator dropdown with the ★ recommended setting highlighted. For Ferritic Steel, Si331AF is preferred.

Material	★ Preferred Mono	Standard Reflection	2θ (approx.)
Ferritic Steel	Si331AF	BCC (211)	~95°
Austenitic Steel	Si422	FCC (311)	~91°
Aluminum	Si331AF	FCC (311)	~90°
Nickel	Si422	FCC (311)	~93°
Copper	Si422	FCC (311)	~90°
Inconel 718	Si422	FCC (311)	~91°

4.4 Setting the Gauge Volume

Enter the slit dimensions in mm. The gauge volume (V) is the product of the three values. Larger gauge volumes give shorter count times but reduce spatial resolution.

For proposal planning, start with a gauge volume that gives roughly 3–5 mm spatial resolution in the measurement direction: for example, 2×2×2 mm (V = 8 mm^3) for high resolution, or 3×3×3 mm (V = 27 mm^3) for moderate resolution with shorter times.

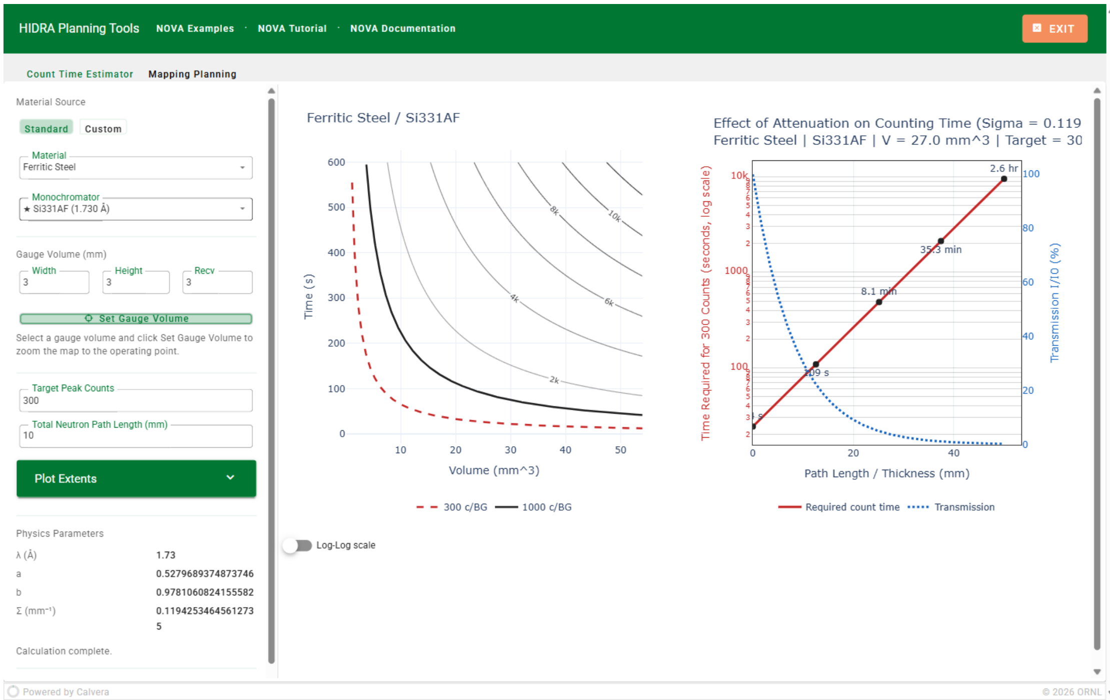


Figure 4. Gauge volume inputs set to 3×3×3 mm (V = 27 mm^3). Enter your planned slit dimensions here.

Click Set Gauge Volume to lock in your choice. A crosshair annotation appears on the count-time map at your gauge volume, and the sidebar shows the estimated exposure time.

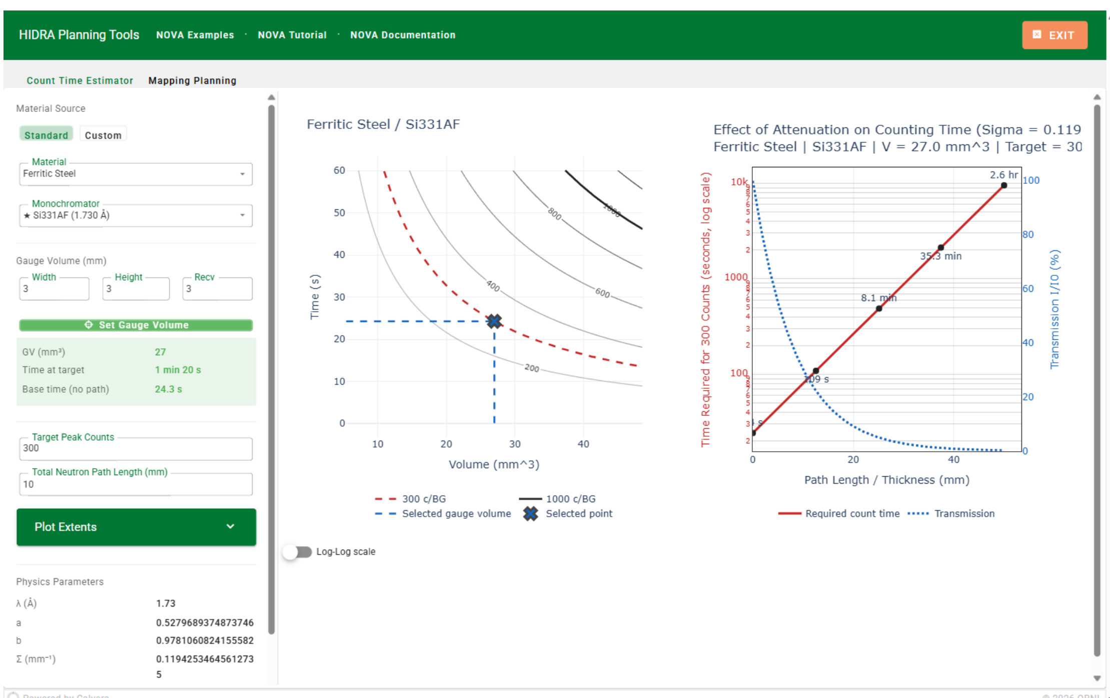


Figure 5. After clicking Set Gauge Volume, the count-time map shows a crosshair at the selected gauge volume with the required exposure time.

4.5 Reading the Count Time Map

The left plot is the Count Time Estimate Map: a contour plot of expected peak height as a function of gauge volume (horizontal axis) and exposure time (vertical axis). Two contour lines are drawn: your target count (dotted) and 1000 counts (solid).

To find your required exposure time: follow the vertical dotted crosshair upward until it meets the target-count contour line. The horizontal crosshair shows the required time. Any point above and to the right of the target contour achieves your goal.

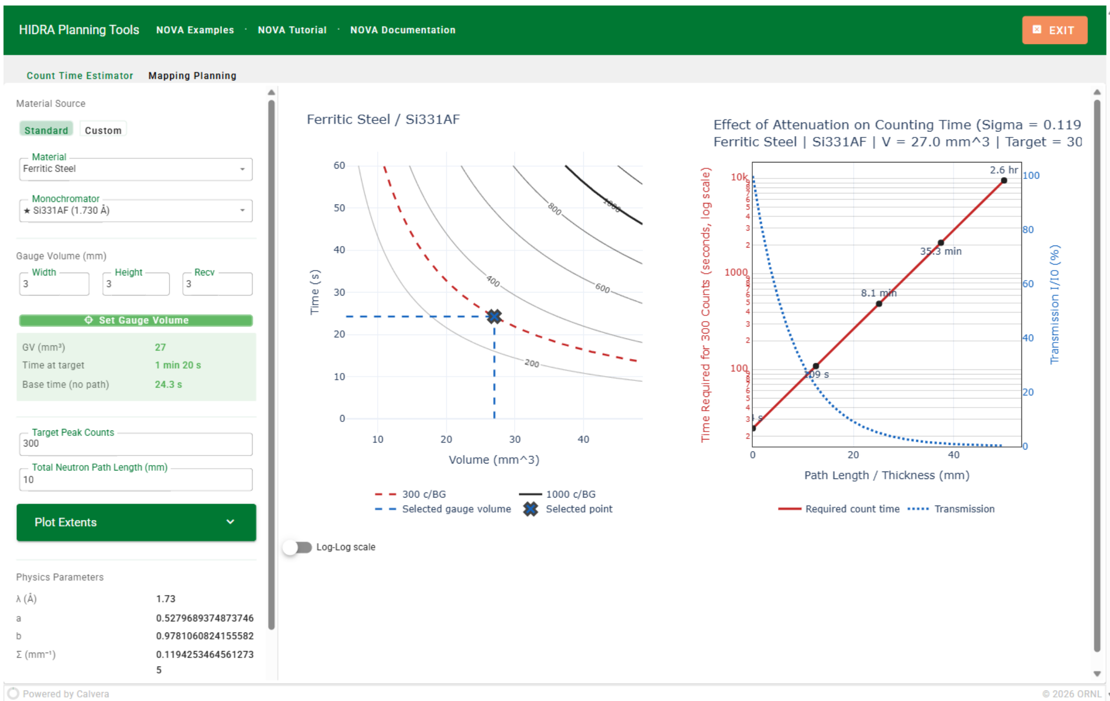


Figure 6. The Count Time Estimate Map. The crosshair marks the required exposure time (~24 s) at 27 mm³ gauge volume for Ferritic Steel / Si331AF with a target of 300 counts.

4.6 Checking Attenuation Effects

The right plot is the Attenuation Count Time curve. The red line (log scale, left axis) shows how the required exposure time grows exponentially as the measurement point moves deeper into the sample. The blue dotted line (right axis) shows transmission I/I_0 — the fraction of neutrons surviving to reach the gauge volume.

Use this plot to scale the surface count time for your deepest measurement point. For example: if the count time map shows 24 s at the surface, and the attenuation curve shows that 25 mm depth requires 3× more time, plan for approximately 72 s per point at that depth.

Figure 7. The Attenuation Count Time curve for Ferritic Steel / Si331AF. Required time grows exponentially with sample depth.

4.7 Physics Parameters

Below the gauge volume controls, the sidebar shows read-only Physics Parameters: the neutron wavelength λ (Å), calibration coefficients a and b, and the macroscopic attenuation coefficient Σ (mm^{-1}). Record these values for your proposal.

Figure 8. The Physics Parameters section showing Σ, t_0, λ, a, and b.

4.8 Standard vs Custom Mode

If your material is not in the library, switch to Custom mode at the top of the sidebar. Enter the alloy name, composition (e.g. Fe:90, Cr:8, Ni:2), density in g/cm^3, and one reference measurement (observed peak height, gauge volume, and exposure time). The tool anchors the count-rate model to that single known point.

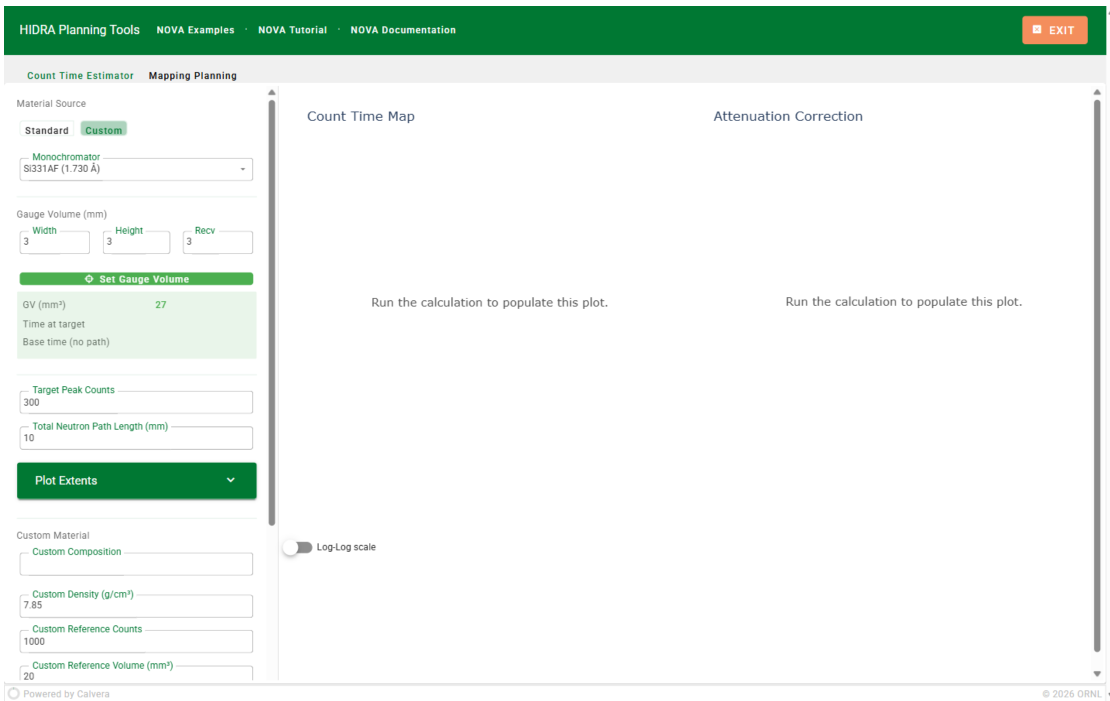


Figure 9. Custom material mode with fields for composition, density, and a single reference measurement.

Situation	**Use**
Your material is in the built-in library	Standard mode
Custom alloy with no calibration data, but you have one reference measurement	Custom mode
Quickly testing different gauge volumes or target counts	Either mode

4.9 Transferring Values to the Mapping Planner

Once you are satisfied with the Count Time Estimator results, click Use these values in the Mapping Planner at the bottom of the sidebar. This transfers t_0, Σ, and the gauge volume dimensions to the Mapping Planning tab in one click — no manual re-entry needed.

Figure 10. The transfer button at the bottom of the Count Time Estimator sidebar.

4.10 Worked Example — Aluminum vs Steel

It is tempting to assume a low-attenuation material is always quick to measure. Comparing Aluminum and Ferritic Steel at the same gauge volume (3×3×3 mm = 27 mm^3), target (300 counts), and preferred monochromator (Si331AF) shows why you must read both numbers — the surface count time t_0 and the attenuation coefficient Σ — together.

Material	Σ (mm^{-1})	t_0 surface (s)	t at 10 mm depth (s)	Increase with depth
Ferritic Steel	0.119	~24	~80	~3.3× (strong attenuation)
Aluminum	0.010	~137	~152	~1.1× (weak attenuation)

Aluminum is a weak neutron scatterer, so its surface count time is long (~137 s versus ~24 s for steel). But aluminum barely attenuates neutrons ($\Sigma \approx 0.01$ mm^{-1}), so measuring 10 mm deep adds only about 11 %. Steel is the opposite: it scatters strongly (short surface time) yet attenuates hard, so the same 10 mm of depth more than triples the required time. The practical lesson for proposal planning: a low Σ does not guarantee a cheap experiment, and a short surface time can still balloon deep inside a strongly attenuating sample. Read t_0 from the Physics Parameters panel and the depth scaling from the attenuation curve before committing to a measurement plan.

4.11 Worked Example — Custom Alloy (No Calibration Data)

Suppose you plan to measure a low-alloy steel that is not in the built-in library — for example Fe 90, Cr 8, Ni 2 (wt%) at a density of 7.9 g/cm^3 — and you have a single reference measurement from a previous experiment: 1000 counts from a 20 mm^3 gauge volume in 180 s. Switch Material Source to Custom (see Figure 9) and enter:

Custom field	Value
Composition	Fe:90, Cr:8, Ni:2
Density (g/cm^3)	7.9
Reference counts	1000
Reference volume (mm^3)	20
Reference time (s)	180

The tool anchors the count-rate model to that single point (it fixes the power-law exponent b = 1 and solves for the coefficient a from your reference). For a 27 mm^3 gauge volume and a 300-count target it then reports approximately:

Quantity	Value
Σ (attenuation coefficient)	~0.116 mm^{-1} (1.16 cm^{-1})
t_0 (surface count time)	~40 s
t at 10 mm depth	~128 s

Because this alloy is iron-dominated, its Σ is close to ferritic steel's, and the depth scaling behaves similarly. Custom mode lets you sanity-check feasibility for any alloy as long as you can supply a composition, a density, and one reference measurement.

5. Mapping Planning — Box / Plate Geometry

The Mapping Planning tool simulates a full residual-stress mapping scan on a sample. For each measurement point it computes how much material the incident and diffracted beams must traverse, applies the Lambert-Beer attenuation correction, and classifies each gauge volume location as Fully Buried, Partially Buried, or Outside the sample.

5.1 Sidebar Inputs

Input	Default	Description
Sample type	Cuboid	Cuboid (enter L×W×T mm and centre) or Upload STL for 3D geometry.
Measurement points	Grid builder	Regular grid (one start:stop:step spec string per axis) or Upload CSV (columns: x, y, z).
Gauge Volume (Inc. Width / Height / Rec. Width)	Copied from CTE	Set by the transfer button; can also be entered manually.
Q direction (Q_x, Q_y, Q_z)	(1, 0, 0)	Measurement direction in sample coordinates. Normalised automatically.
2θ angle (°)	90°	Angle between incident and diffracted beams. 90° is standard for HIDRA.
Scattering plane rotation (°)	90°	Rotates the scattering plane around Q. Use to control which sample face the beams pass through.
Base count time t_0 (s)	—	From the Count Time Estimator (transferred automatically).
Attenuation Σ (cm^{-1})	—	From the Count Time Estimator (transferred automatically). Note: the

		Mapping tab uses cm^{-1}; the CTE displays mm^{-1}. The transfer converts automatically.

5.2 Worked Example — Through-Thickness Depth Profile

Scenario: a 100×100 mm steel plate, 10 mm thick, in which we want to profile residual strain through the thickness. We place a single column of measurement points along the thickness direction (Y) and leave X and Z fixed at the centre of the plate. This is the clearest way to see two things at once: how the required count time grows with depth, and how the burial status changes as points approach and pass the sample surface.

Step 1: Transfer values from the Count Time Estimator.

After completing the Count Time Estimator for Ferritic Steel, click Use these values in the Mapping Planner. The Mapping Planning tab opens with t_0, Σ, and gauge volume already filled in.

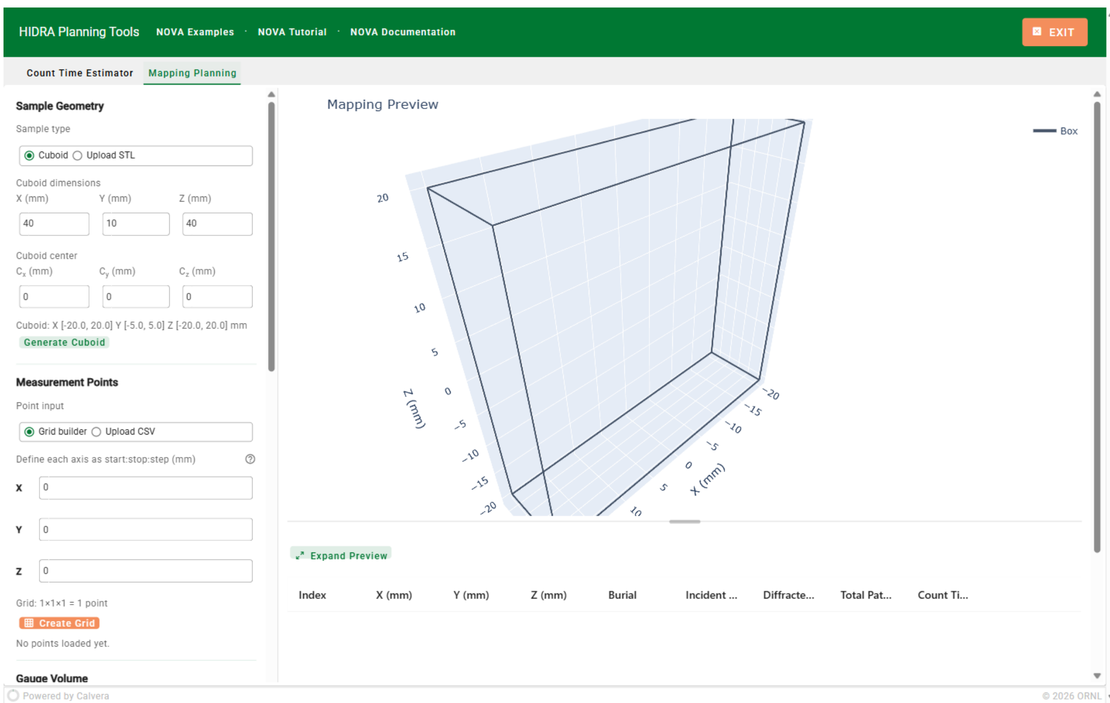


Figure 11. The Mapping Planning tab after transfer from the Count Time Estimator. Count time parameters are pre-filled.

Step 2: Enter the plate dimensions.

Under Sample Geometry, confirm Cuboid is selected. Enter 100 mm for X (length), 10 mm for Y (the thickness we will profile), and 100 mm for Z (width). Leave the centre at (0, 0, 0), so the plate spans Y = −5 mm to +5 mm through its thickness.

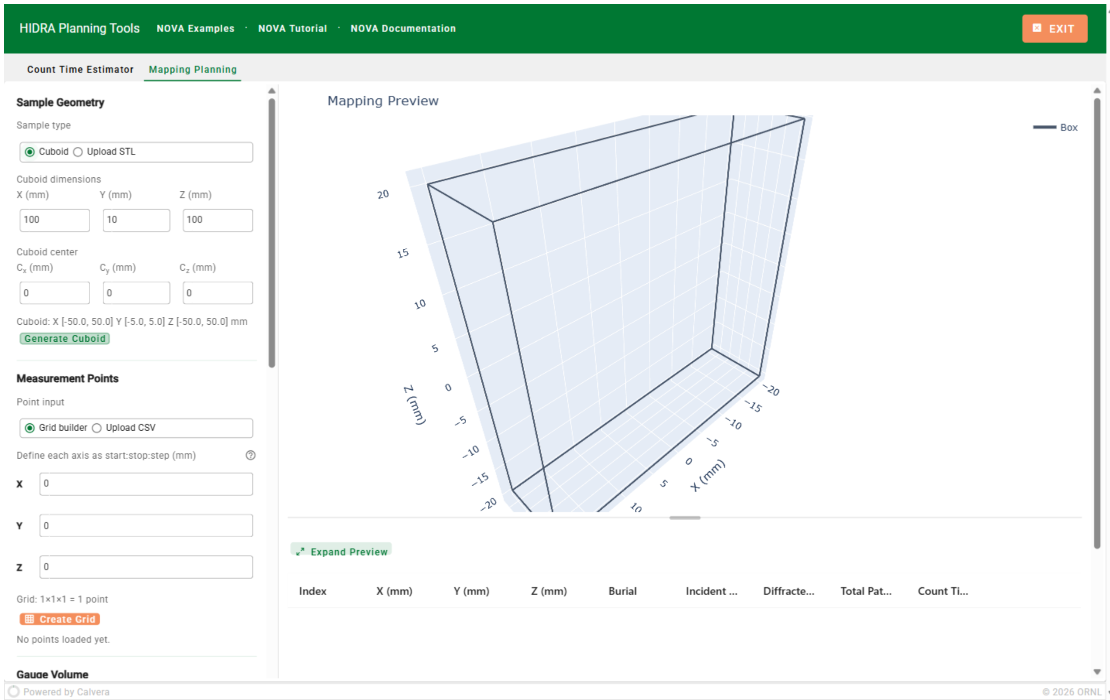


Figure 12. Cuboid geometry inputs: a 100×100 mm plate 10 mm thick (Y), centred at the origin.

Step 3: Build the through-thickness measurement line.

Under Measurement Points, select Grid builder. Each axis is defined by a single start:stop:step string in millimetres, so an entire line of points is typed into one field. Use a single point in X and Z (just 0) and step through the thickness in Y. Deliberately run Y past the far surface (to +8 mm) so the last points fall outside the 10 mm-thick plate:

Axis	Spec	Expands to
X	0	0 (single point)
Y	-5:8:2	−5, −3, −1, 1, 3, 5, 7 mm
Z	0	0 (single point)

The start:stop:step notation includes the stop value when it lands on a step, so -5:8:2 produces 7 points from −5 to 7 mm. Click Create Grid to generate the point array. (Section 5.4 shows how to mix spacings and list explicit points along one axis.)

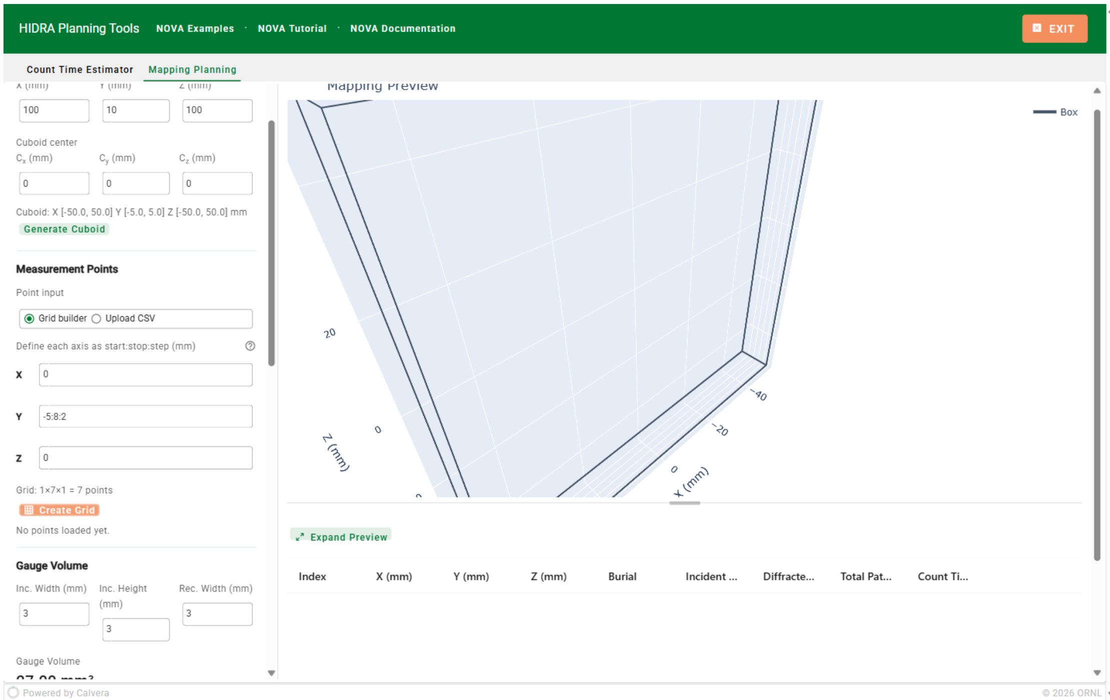


Figure 13. Grid builder inputs for a single through-thickness column, using the start:stop:step syntax: X = 0, Y = -5:8:2, Z = 0.

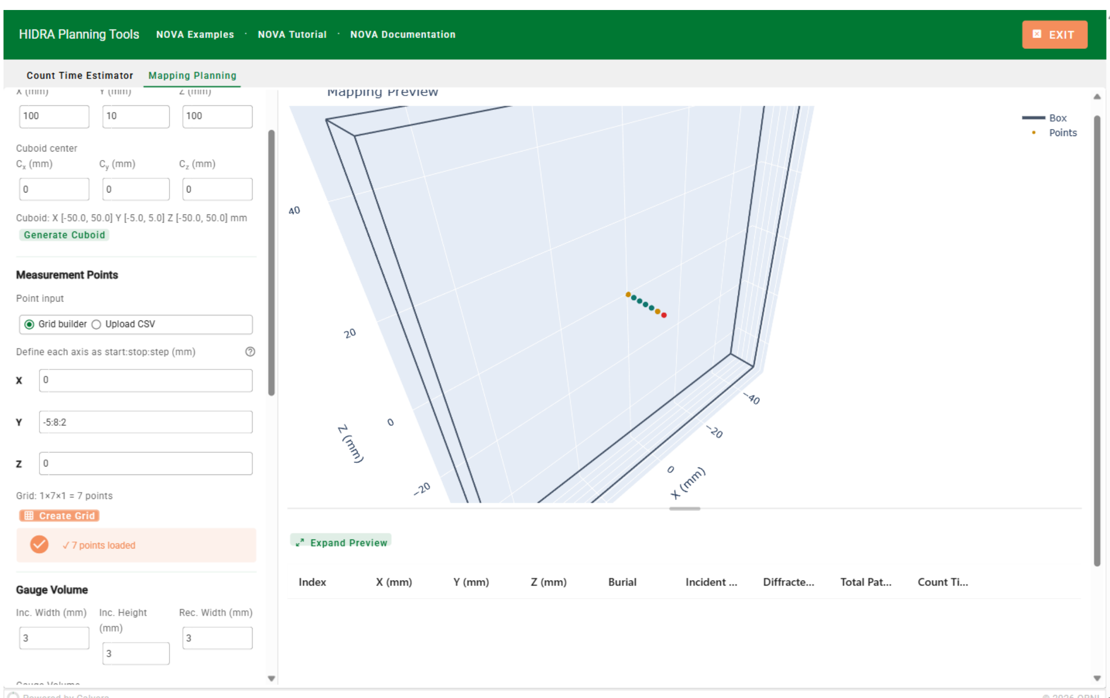


Figure 14. 3D preview showing the plate and the column of measurement points running through (and just past) its thickness.

Step 4: Set the diffraction geometry.

Under Diffraction Geometry, set Q = (0, 1, 0) so the measurement direction points through the thickness, and keep 2θ = 90° and rotation = 90°. With Q along the thin axis, the incident and diffracted beams both reach each point through the same face of the plate, so the total beam path — and therefore the count time — grows with depth below that surface.

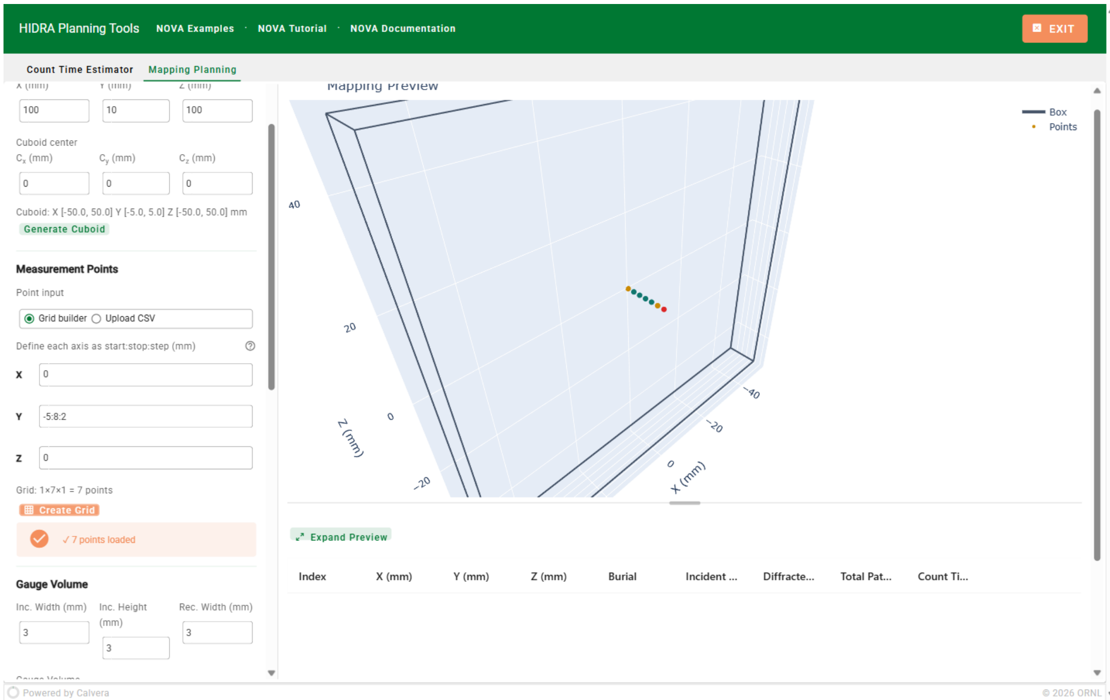


Figure 15. Diffraction Geometry inputs with Q = (0, 1, 0) (through-thickness), 2θ = 90°, and rotation = 90°.

Step 5: Confirm count time parameters.

Under Count Time Parameters, t_0 and Σ should already be filled from the transfer. The sidebar shows the equivalent Σ in mm^{-1} below the input field.

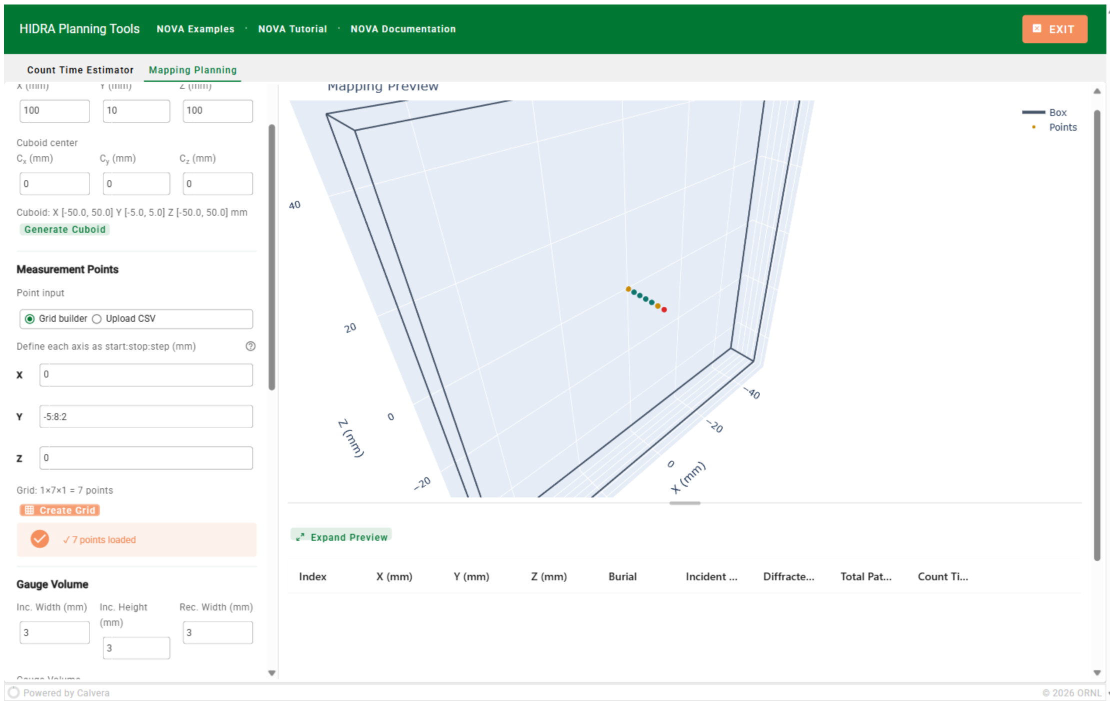


Figure 16. Count Time Parameters pre-filled from the Count Time Estimator.

Step 6: Run the simulation.

Click Run Simulation. The tool computes beam paths and burial status for every point in the grid. Computation time depends on the number of points and the geometry.

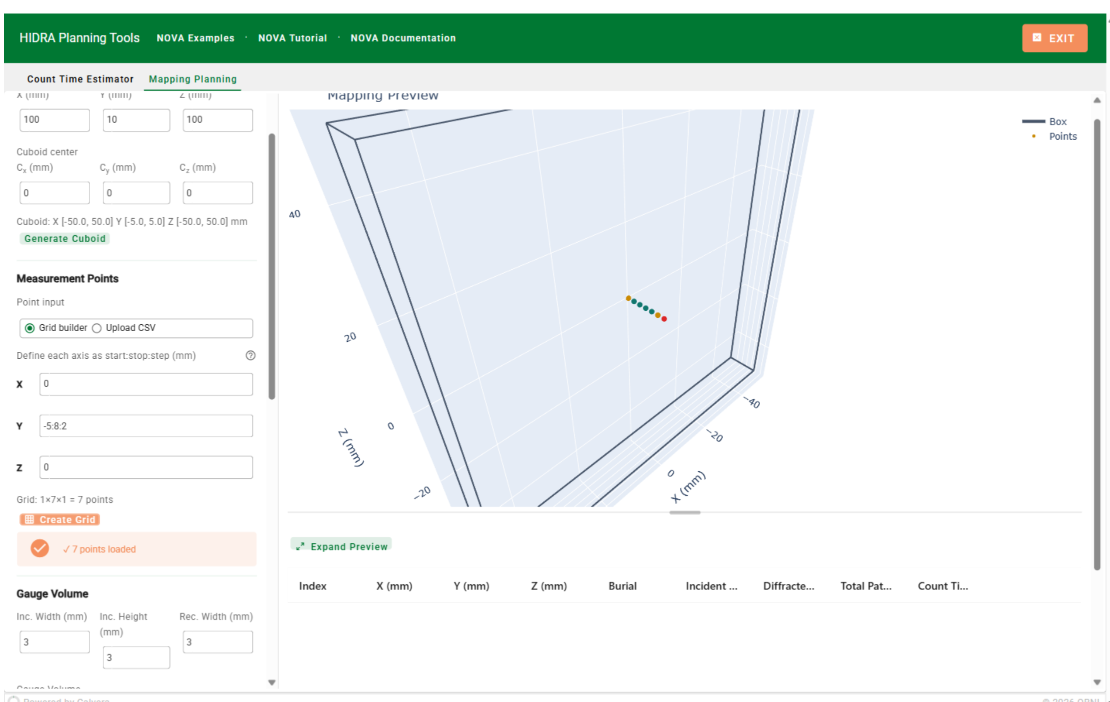


Figure 17. The Run Simulation button.

5.3 Interpreting the Results

Burial Status Visualization

After the simulation, the 3D figure shows measurement points colored by burial status:

Color	Status	Meaning
Teal	Fully Buried	All 8 corners of the gauge volume are inside the sample. Count time is computed.
Amber	Partially Buried	Some corners are outside. Excluded from the total scan time.
Red	Outside	All corners are outside the sample. Excluded from the total scan time.

Because the column runs from one surface to just past the other, this single scan shows all three statuses. The points at Y = −5 mm and Y = +5 mm sit on the surfaces, so their gauge volumes straddle the edge and register as Partially Buried; the point at Y = +7 mm is beyond the plate and registers as Outside; the four interior points are Fully Buried and are the only ones that contribute to the total scan time.

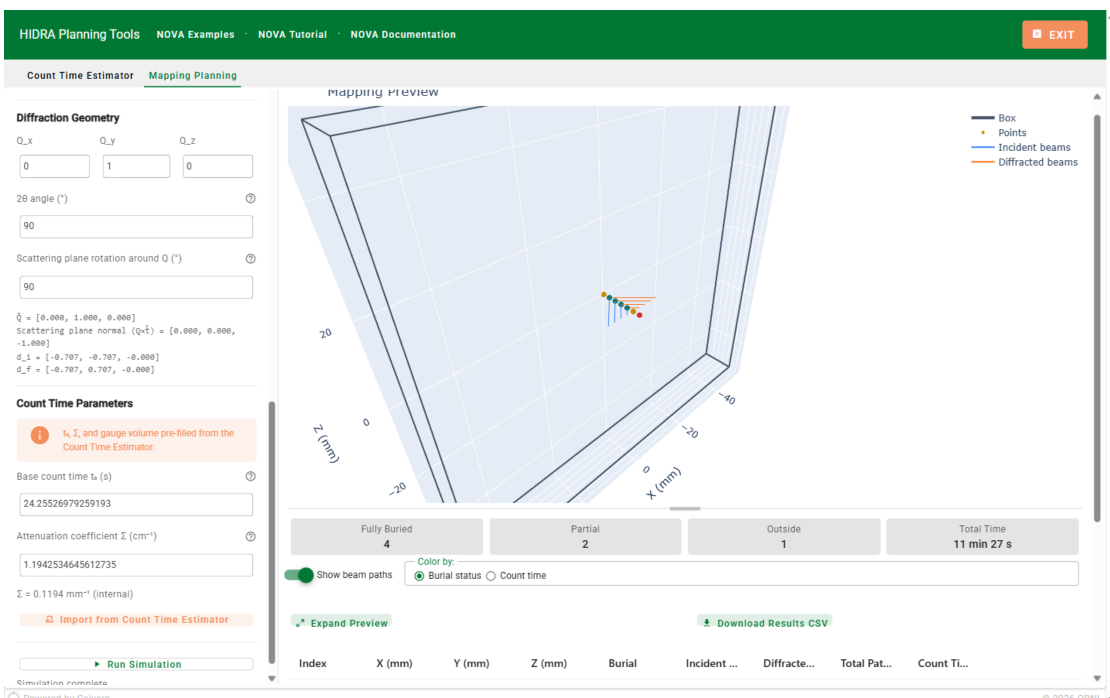


Figure 18. Simulation results colored by burial status along the through-thickness column: teal = fully buried (interior), amber = partially buried (at the surfaces), red = outside (beyond the far face).

Count Time Visualization

Toggle Color by to Count time to see how the required exposure time varies through the thickness. With Q along the thin axis, both beams exit the same face, so a point deeper below that face has a longer total beam path and needs more time. The four fully-buried points span almost an 8× range in count time:

Point Y (mm)	Status	Total beam path (mm)	Count time (s)
−5	Partially Buried	—	— (excluded)
−3	Fully Buried	22.6	≈ 362
−1	Fully Buried	17.0	≈ 184
1	Fully Buried	11.3	≈ 94
3	Fully Buried	5.7	≈ 48
5	Partially Buried	—	— (excluded)
7	Outside	—	— (excluded)

The total scan time reported in the metrics strip (≈ 11 min 27 s here) is the sum over the fully-buried points only. The deepest fully-buried point needs roughly 6 minutes on its own — a direct, visual reminder that depth, not just the number of points, drives the cost of a through-thickness profile.

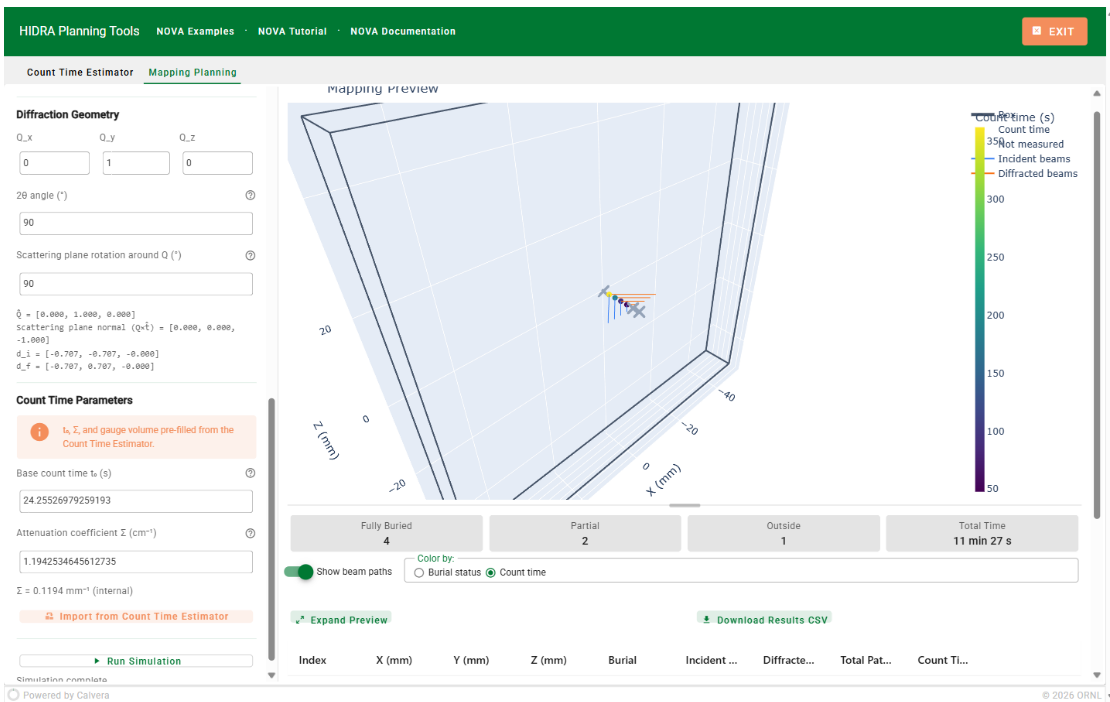


Figure 19. Simulation results colored by count time (Viridis scale). The point deepest below the measurement face is darkest (longest exposure); points nearer the face are lighter.

Beam Paths

Enable Show beam paths to draw the incident and diffracted beam trajectories for each fully-buried measurement point. This is useful for visualising how the beams enter and exit the sample, and for checking that beams do not pass through unexpected features.

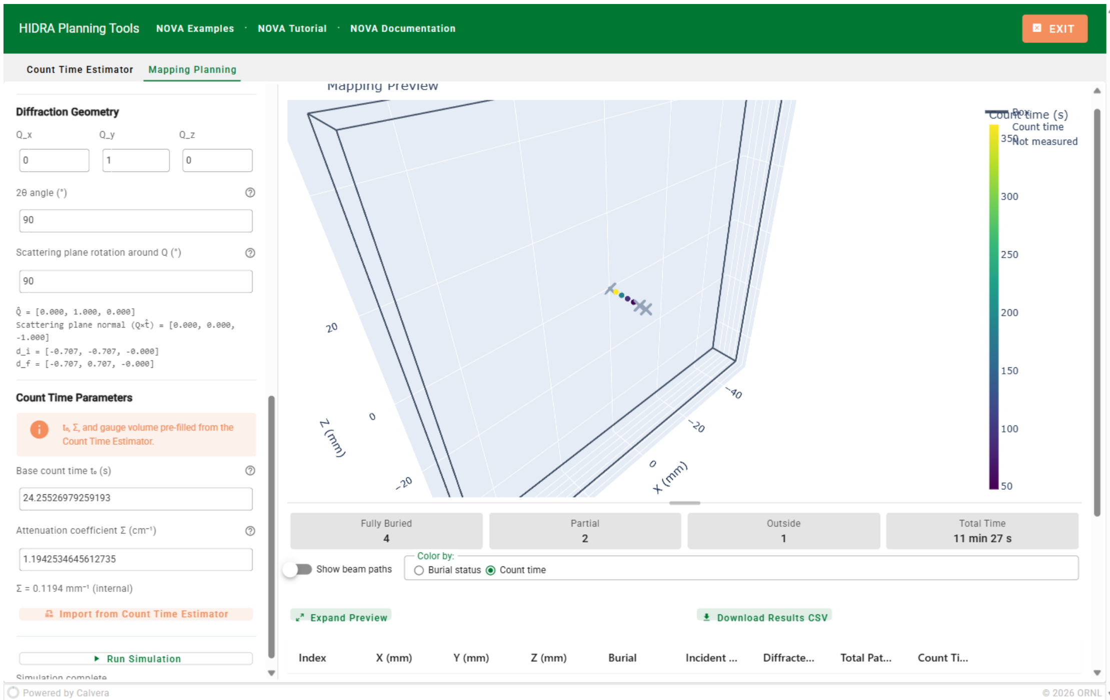


Figure 20. Show Beam Paths enabled. Each line shows the full beam trajectory through the sample for one measurement point.

Results Table

Below the 3D figure, a table lists every measurement point with its burial status, incident path length (mm), diffracted path length (mm), total path length (mm), and required count time (s). A summary row shows the total scan time for all fully-buried points.

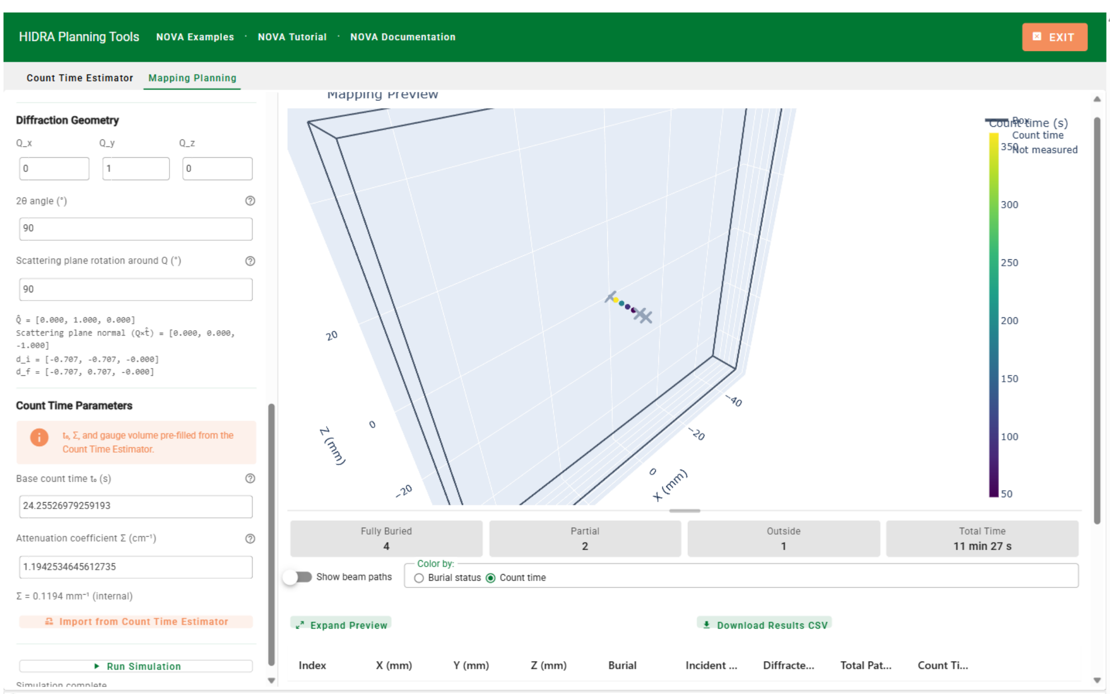


Figure 21. The results table showing per-point burial status and count times.

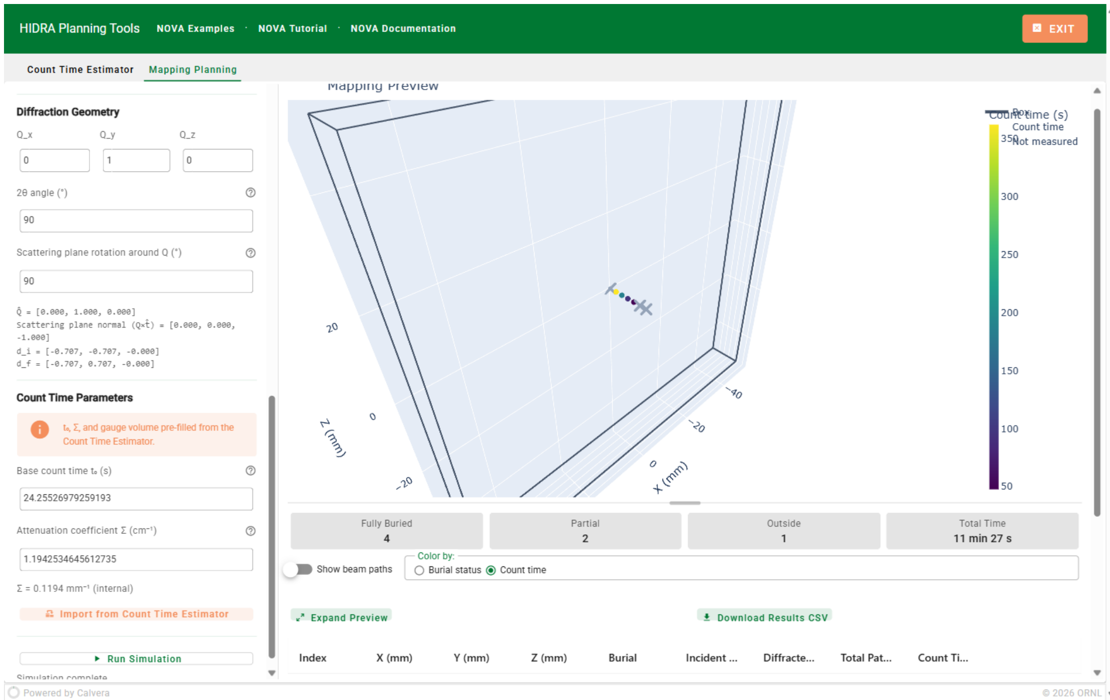


Figure 22. The Download Results CSV button to export the full results table.

5.4 Advanced Grid Specifications — Mixed Spacing and Explicit Points

Each axis field accepts more than a single start:stop:step range. Two extensions let you concentrate measurement points exactly where they matter:

- Chain several ranges with commas to vary the spacing along one axis. The segments are concatenated and any duplicated boundary point is removed automatically.
- List explicit coordinates by separating bare numbers with commas — the points are placed exactly where you type them.

As an example, the following grid keeps a fine 0.5 mm spacing through the centre of the plate while using coarser 1 mm steps toward the edges, samples two depths, and measures three discrete positions across the width:

Axis	Spec	Expands to
X	-20:-11:1,-10:10:0.5,11:20:1	coarse 1 mm at the edges, fine 0.5 mm through −10..10 mm (61 points)
Y	0,3	two depths: 0 and 3 mm
Z	-10,0,10	three explicit positions: −10, 0, 10 mm

This produces 61 × 2 × 3 = 366 measurement points, all inside the 100 × 10 × 100 mm plate. The comma-chained X axis is the key idea: -10:10:0.5 gives the dense central sampling where the strain gradient is steepest, while -20:-11:1 and 11:20:1 fill in the flanks more coarsely — so you spend beam time where it counts without over-sampling the edges. Ranges include the stop value when it lands on a step, overlapping boundary points are de-duplicated, and the whole specification is parsed only when you press Create Grid, so partially typed strings never raise an error.

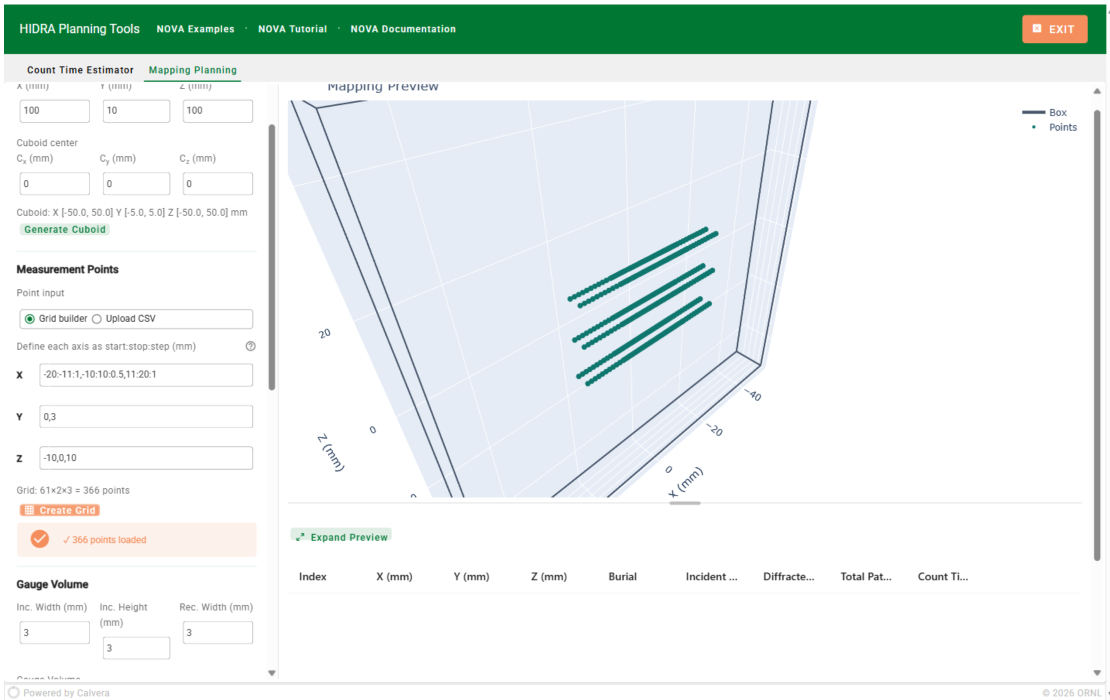


Figure 23. Advanced grid specification. The X axis chains three ranges (-20:-11:1, -10:10:0.5, 11:20:1) for mixed spacing, while Y = 0,3 and Z = -10,0,10 list explicit positions. The 3D preview shows the resulting 366-point grid — dense through the centre, coarser at the edges.

6. Mapping Planning — Custom STL Geometry (Coffee Cup Example)

If your sample has a complex 3D shape — such as a pressure vessel, turbine blade, or weld fitting — you can upload an STL file instead of using an idealised cuboid. The tool correctly handles hollow geometries: neutron path lengths include the total material thickness through all walls the beam passes, not just the nearest surface.

6.1 Loading an STL File

Under Sample Geometry, select Upload STL. A file selector appears.

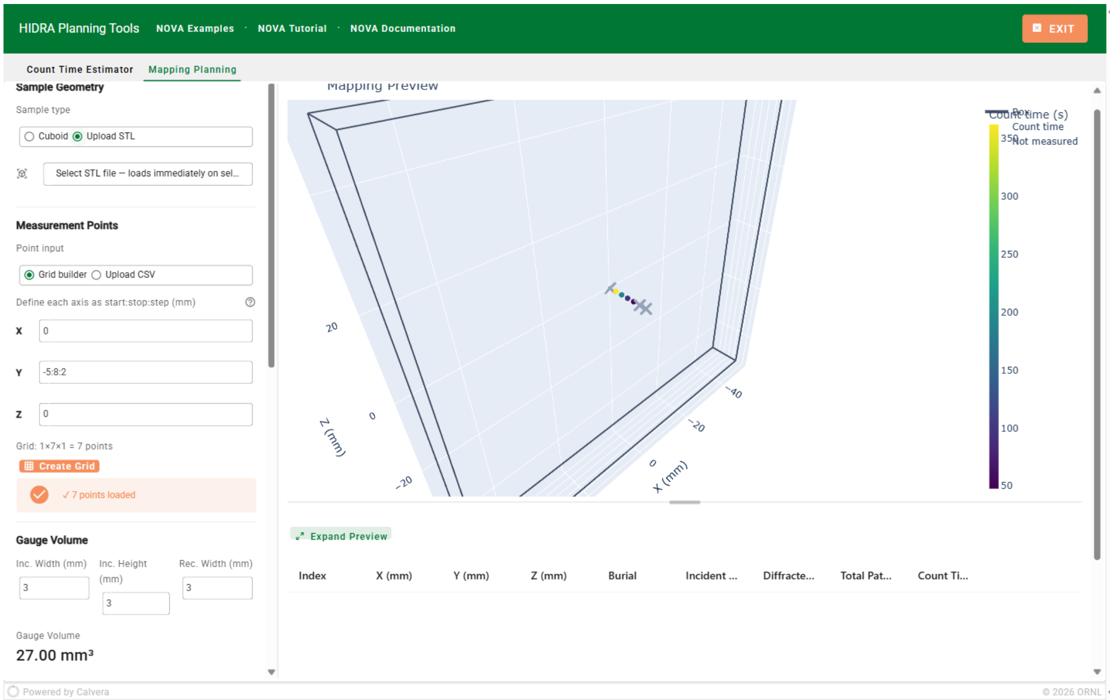


Figure 24. The Upload STL option selected in the Sample Geometry section.

Click the file input and select your STL file. The geometry loads and appears in the 3D scene immediately.

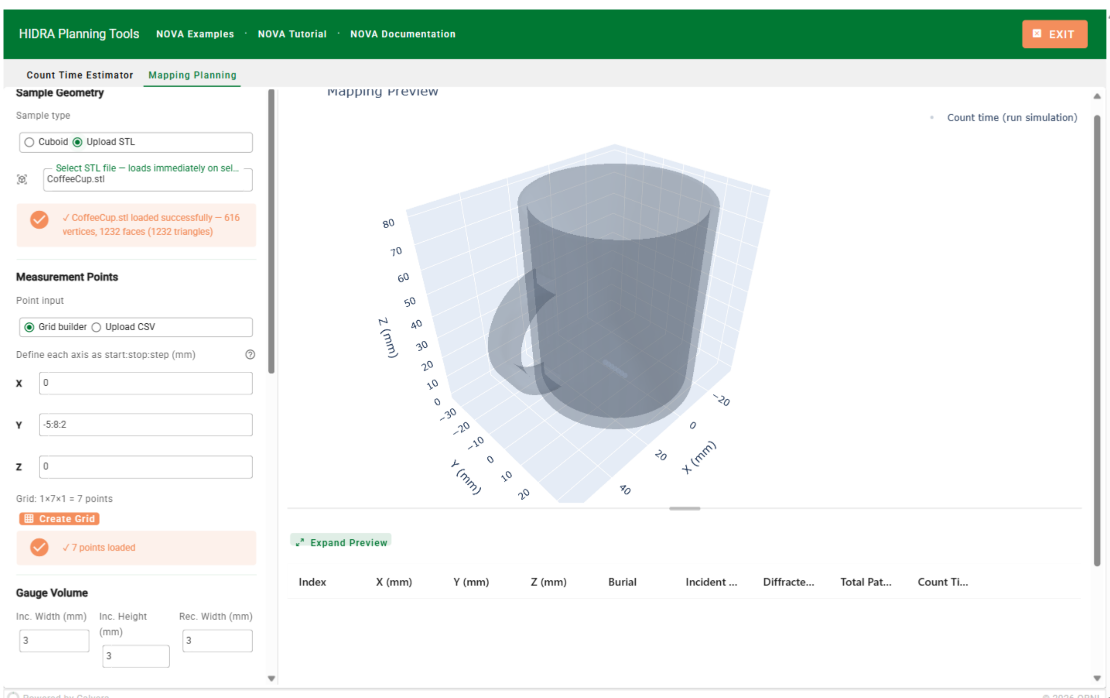


Figure 25. A coffee cup STL loaded in the 3D view. The tool displays the geometry while awaiting measurement points.

STL requirements:

- • The file must be a watertight (closed) mesh. Open shells give incorrect burial status and path-length results.
- • STL coordinates must be in mm to match the measurement point CSV.
- • Export from CAD software with mm units selected.

6.2 Loading Measurement Points from CSV

Under Measurement Points, select Upload CSV. Upload a CSV file with columns x, y, z (any case). The 148-point coffeecup_scan_points.csv in the repository is provided as a worked example.

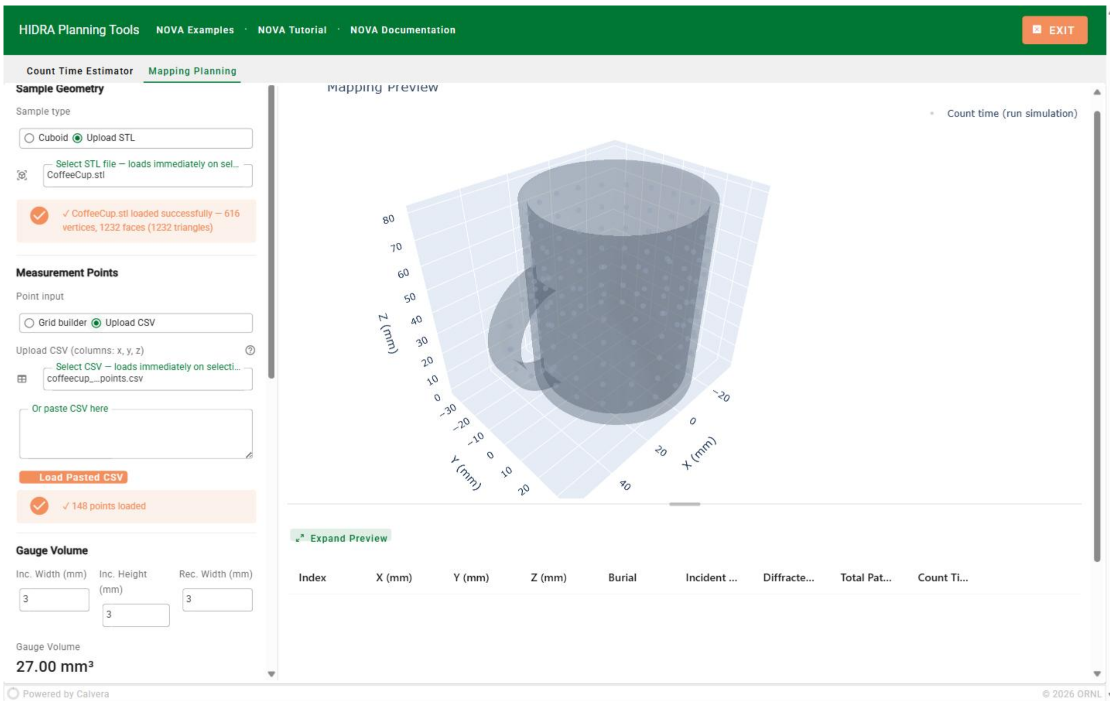


Figure 26. The coffee cup geometry with 148 measurement points loaded from a CSV file.

6.3 Running the Simulation and Interpreting Results

Click Run Simulation.

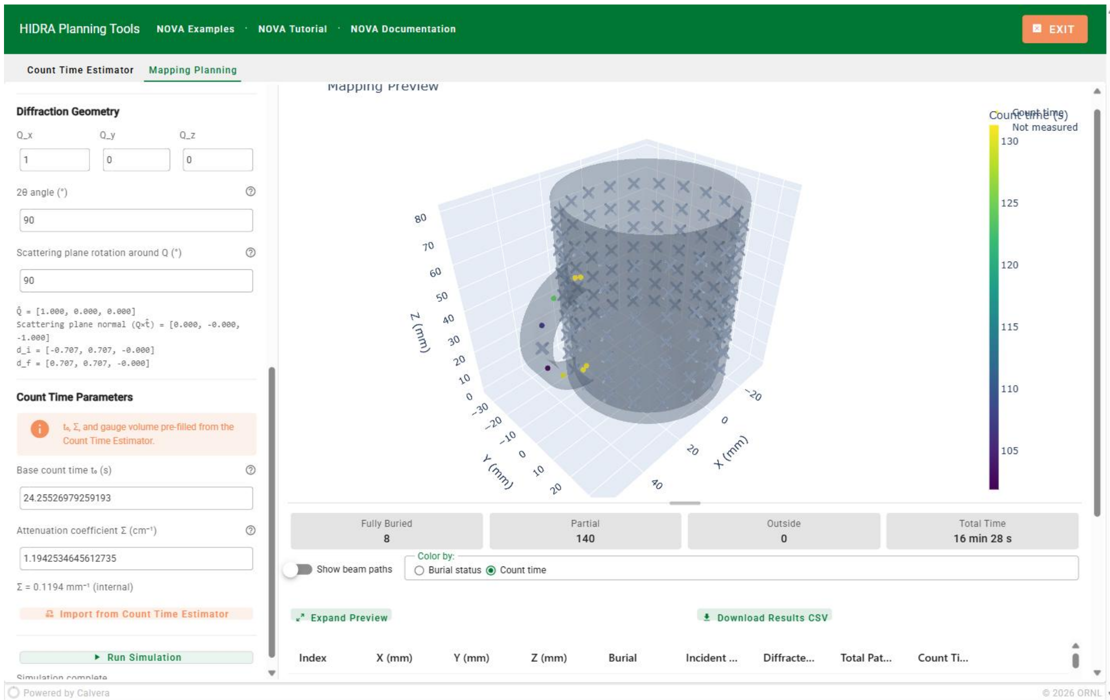


Figure 27. Coffee cup simulation results colored by burial status. Points inside the cup walls are fully buried; points in the hollow interior register as outside or partially buried.

Enable Show Beam Paths to see how each beam traverses the cup walls and air gap inside.

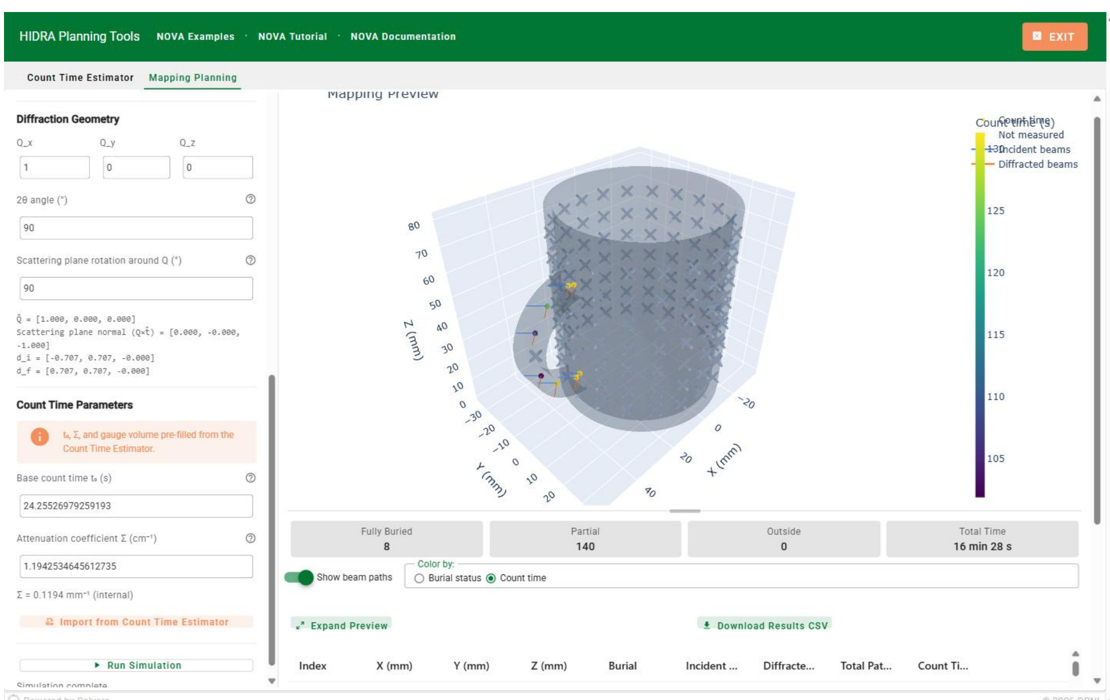


Figure 28. Coffee cup simulation with beam paths. Each beam passes through both walls of the cup. The total path length sums all material the beam traverses — cup wall in, air gap, cup wall out.

For hollow geometries, the tool sums all material chord lengths. If the cup wall is t mm thick on each side, a horizontal beam through the centre has a total material path length of 2t — not just t for the nearest wall. This is the correct physics.

6.4 Point Selection — Inspecting Individual Beam Paths

After the simulation, click any row in the results table to select that measurement point. The 3D figure switches from the overview beam-path display to a detailed view of that single point's beam geometry, including the physical spread of the beams.

The detail view shows two beam volumes:

Beam	Shape	Description
Incident	Prism (constant cross-section)	Defined by the incident slit dimensions (Width × Height). The cross-section is fixed from source through the gauge volume.
Diffracted	Frustum (expanding cone)	Starts at the receiving-slit dimensions at the gauge volume and expands linearly to the 300 × 300 mm detector face at approximately 1 m. This spread represents the actual solid angle accepted by the detector.

This visualization is particularly valuable for identifying potential detector shadowing — cases where the expanding diffracted beam cone intersects a feature of the sample (such as a protruding handle, weld bead, or attachment) before reaching the detector. If the frustum visibly passes through a structural feature, the attenuation calculation already accounts for the material thickness, but the geometry also implies that the detector could receive a partially blocked or attenuated diffraction signal.

It is worth inspecting which beam — incident or diffracted — carries the long path, because the two have different consequences. A long incident path attenuates the beam before it reaches the gauge volume; a long diffracted path attenuates the signal on its way out and can also be shadowed by a feature standing between the gauge volume and the detector. The coffee cup, with Q along X, gives a clean mirror pair of examples that both involve the handle.

Long diffracted path: the point at (10.3, −31.6, 20.0) has a diffracted path of 23.3 mm (incident only 1.7 mm) — the diffracted frustum leaves the gauge volume and passes through the handle on its way to the detector. This is the classic detector-shadowing case.

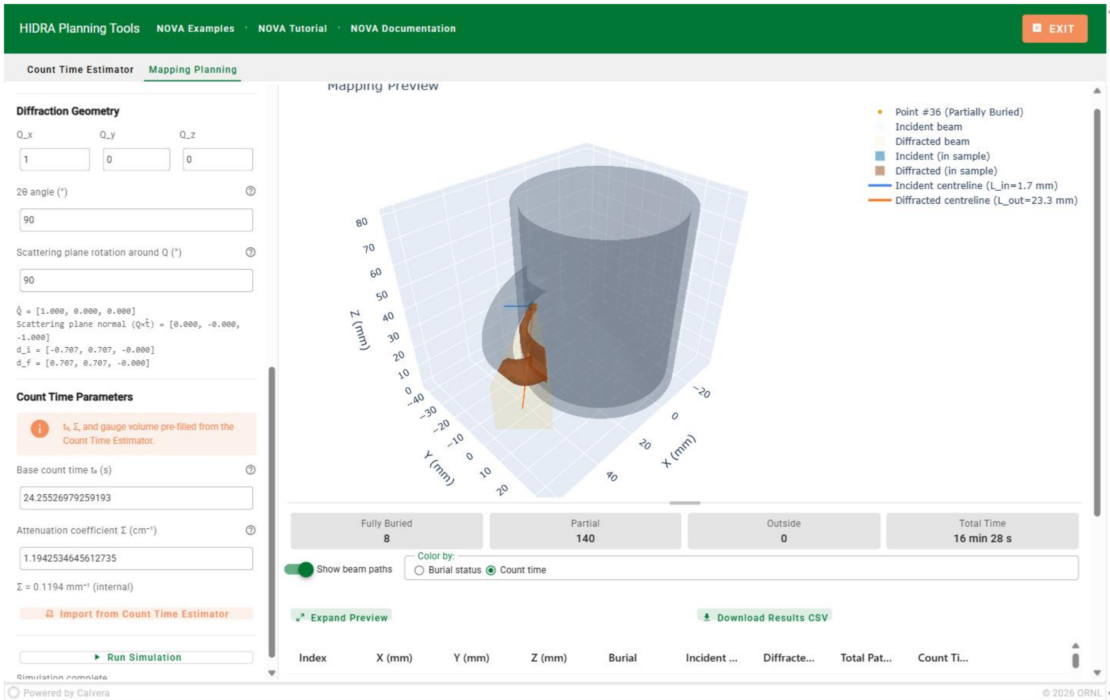


Figure 29. Long diffracted path. Point (10.3, −31.6, 20.0): the incident beam prism (blue) enters a thin wall (1.7 mm), but the diffracted frustum (orange, expanding toward the detector) travels 23.3 mm through the cup handle — the point most affected by handle attenuation and potential detector shadowing.

Long incident path: the mirror point at (10.3, 31.6, 60.0) reverses the situation — the incident beam travels 23.3 mm through the handle to reach the gauge volume, while the diffracted beam exits through only 1.7 mm of wall. Here the concern is incident-beam attenuation upstream of the measurement, not detector shadowing. Comparing the two views makes it obvious, at a glance, which side of the measurement the long path is on.

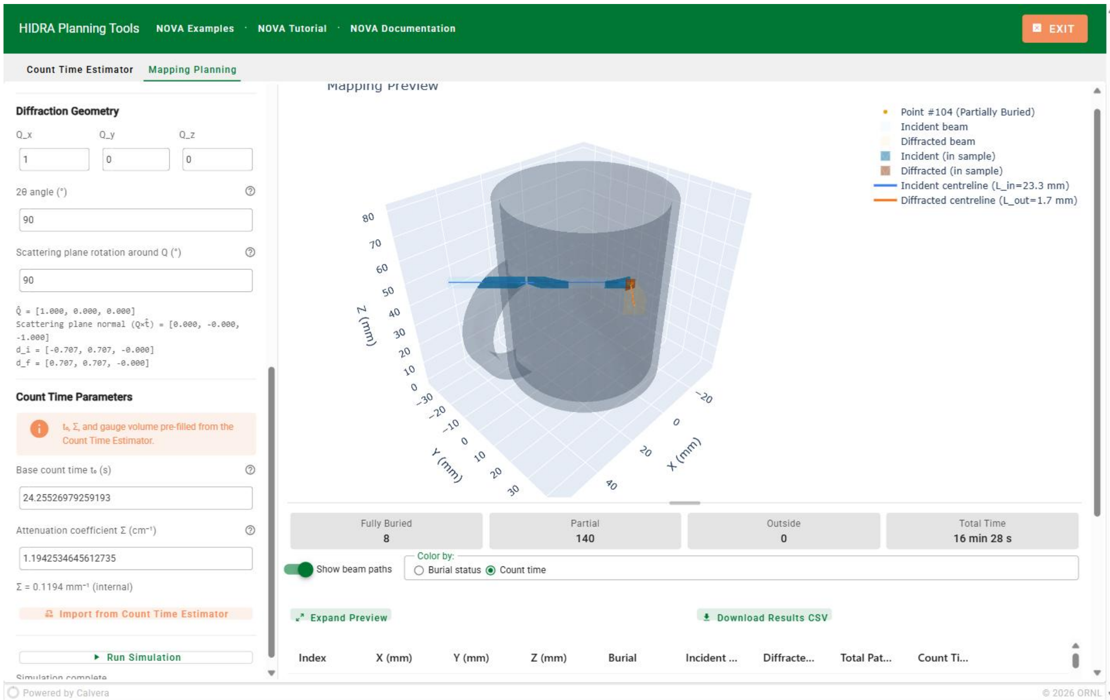


Figure 30. Long incident path. Point (10.3, 31.6, 60.0): the incident beam prism (blue) travels 23.3 mm through the cup handle to reach the gauge volume, while the diffracted frustum (orange) exits through only 1.7 mm of wall — the mirror image of Figure 29.

Changing the Q direction reveals different points as the long-path cases. For example, setting Q = (0, 0, 1) re-orients the beams and makes points on the opposite side of the cup the ones whose beams traverse the handle. Re-running with a few Q directions is a quick way to check that no important measurement point is compromised by an awkward beam path before you commit to a scan plan.

7. Working with the Interactive Plots

Every chart in the planning suite is an interactive Plotly figure, not a static image. A few controls make the figures easier to read and ready to drop straight into a proposal.

7.1 The Plotly Toolbar

Hover over any plot and a small toolbar appears in the top-right corner. The camera icon downloads the figure as a PNG; the Count Time Estimate Map and the Attenuation Count Time curve export at high resolution (1200×800), which is suitable for inclusion in a proposal document. The toolbar also provides zoom, pan, box-zoom, and an autoscale (home) button to reset the view. Note that the count-time plot legends now sit below the plot area rather than overlapping the data.

7.2 Count Time Map — Log-Log Toggle

Below the Count Time Estimate Map is a Log-Log toggle. Switching it on sets both the gauge-volume and exposure-time axes to logarithmic scaling. Use this when you want to compare a very wide range of gauge volumes or count times on a single chart — for example, contrasting a 2×2×2 mm high-resolution scan against a 5×5×5 mm fast survey.

7.3 Mapping 3D Scene Controls

Control	What it does
Color by → Burial status	Colors each point by classification: teal = fully buried, amber = partially buried, red = outside the sample.
Color by → Count time	Colors fully-buried points on a Viridis scale by required exposure time, with a color bar legend (see Figure 19). Useful for spotting which regions dominate the total scan time.
Show beam paths	Draws the incident and diffracted beam trajectories for each point. The drawn stubs extend only ~12 mm beyond the sample surface so the beams stay at the geometry's scale instead of overshadowing it.
Expand Preview	Opens the 3D figure in a large dialog for closer inspection. Close the dialog to return to the normal layout.
Drag / scroll in the scene	Rotate by dragging, zoom with the scroll wheel, and double-click to reset the camera to its default view.

7.4 Selecting a Point from the Results Table

Click any row in the results table to focus that measurement point. The 3D scene switches from the overview to a detailed single-point view showing the incident beam prism and the expanding diffracted frustum, which is ideal for checking potential detector shadowing (see Figure 29). Click a different row to move the focus, and re-run or toggle Show beam paths to return to the overview.

7.5 Exporting Results

Once a mapping simulation has produced results, the Download Results CSV button appears below the 3D scene (it stays hidden until there is something to export). The CSV contains the full per-point table — coordinates, burial status, path lengths, and count times — with numeric values rounded to two decimals, matching the on-screen table.

8. Preparing Your Beam Time Request

Value	Where to find it	What to write in your proposal
t_0 (s)	Count Time Estimator sidebar, Physics Parameters	"The surface count time at our planned gauge volume is X s."
Σ (mm^{-1})	Count Time Estimator sidebar, Physics Parameters	"The macroscopic attenuation coefficient for this material at this wavelength is Σ = X mm^{-1}."
t at maximum depth (s)	Read from the attenuation curve at your deepest point	"At our deepest measurement point (X mm), the required count time is Y s."
Total fully-buried points	Mapping results summary strip	"Our scan plan includes N fully-buried measurement points."
Total scan time (s)	Mapping results summary strip	"Total measurement time for this mapping plan is Y h at the planned gauge volume, plus overhead for sample positioning and alignment."

Figures to download and include in your proposal:

- Count Time Estimate Map — shows required exposure vs gauge volume for your material.
- Attenuation Count Time curve — shows how count time grows with sample depth.
- 3D mapping simulation preview — shows your planned measurement grid on the sample.

Both Plotly figures can be downloaded as 300 dpi PNG files directly from the browser using the camera icon in the plot toolbar.

For general guidance on writing the statement of research and completing the proposal form, see: https://neutrons.ornl.gov/users

Appendix A: Pre-built Material Library

Material	Density (g/cm^3)	Composition (wt%)	★ Preferred Mono
Ferritic Steel	7.85	Fe 98.81, C 0.20, Mn 0.90, P 0.04, S 0.05	Si331AF
Austenitic Steel	7.93	Fe 70.5, Cr 18, Ni 8, Mn 2, Si 1, C 0.08, P 0.045, S 0.03	Si422
Aluminum	2.70	Al 100	Si331AF
Copper	8.96	Cu 100	Si422
Nickel	8.91	Ni 100	Si422
Inconel 718	8.19	Ni 52.5, Cr 19, Fe 18.5, Nb 5.1, Mo 3.05, Ti 0.9, Al 0.5	Si422
70Cu30Ni	8.93	Cu 70, Ni 30	Si422

Standard mode only offers materials that also have calibration data in the count-time database — currently six of the seven listed above: Aluminum, Austenitic Steel, Copper, Ferritic Steel, Inconel 718, and Nickel. 70Cu30Ni is included in the composition library but has no calibration entry, so measure it through Custom mode (supply the composition, density, and one reference measurement).

Appendix B: Monochromator Wavelengths

Setting	λ (Å)	Notes
Si422	1.540	Most commonly used; preferred for austenitic alloys
Si400	1.890	
Si511	1.450	Shortest wavelength — least neutron absorption
Si311	2.270	
Si331AF	1.730	Asymmetric focusing; preferred for ferritic steel and aluminum
Si220	2.600	Longest wavelength — most neutron absorption

The table lists every defined wavelength. Standard mode shows only the calibration-backed subset (Si331AF, Si400, Si422, Si511), filtered per material to those with calibration data for that material. Custom mode offers all six settings.

Appendix C: Gauge Volume Guidance

The gauge volume (V = Width × Height × Receiving Width) determines both the spatial resolution and the required exposure time.

Gauge Volume (mm^3)	Spatial Resolution	Typical t_0 (Ferritic Steel, 300 counts)

8 (2×2×2 mm)	~2 mm	~100 s
27 (3×3×3 mm)	~3 mm	~24 s
64 (4×4×4 mm)	~4 mm	~11 s
125 (5×5×5 mm)	~5 mm	~6 s

For a first proposal, 3×3×3 mm is a reasonable starting point. Discuss with the instrument team if higher spatial resolution is scientifically required.

Appendix D: Glossary

Term	**Definition**
Gauge volume	The small region of the sample simultaneously illuminated by the neutron beam. Its shape is defined by the incident slit (Width × Height) and receiving slit (Receiving Width).
Burial status	Classification of each measurement point: Fully Buried (all 8 gauge-volume corners inside the sample), Partially Buried (some inside), or Outside.
t_0	Base count time: the exposure time needed to reach the target peak height at the sample surface (zero path length through material), at your planned gauge volume.
Σ (sigma)	Macroscopic attenuation coefficient (mm^{-1}). Determines how rapidly the beam is absorbed as it passes through the material.
Lambert-Beer law	The exponential attenuation law: $t = t_0 \cdot \exp(\Sigma \cdot L)$, where L is the total neutron path length through the material.
Power-law peak scaling	The empirical relationship H = a · (V · t)^b between peak height H, gauge volume V, and exposure time t. Coefficients a and b are calibrated from reference measurements.
Count time map	Contour plot of predicted peak height as a function of gauge volume and exposure time. Use it to find the minimum exposure time for your target peak height at your chosen gauge volume.