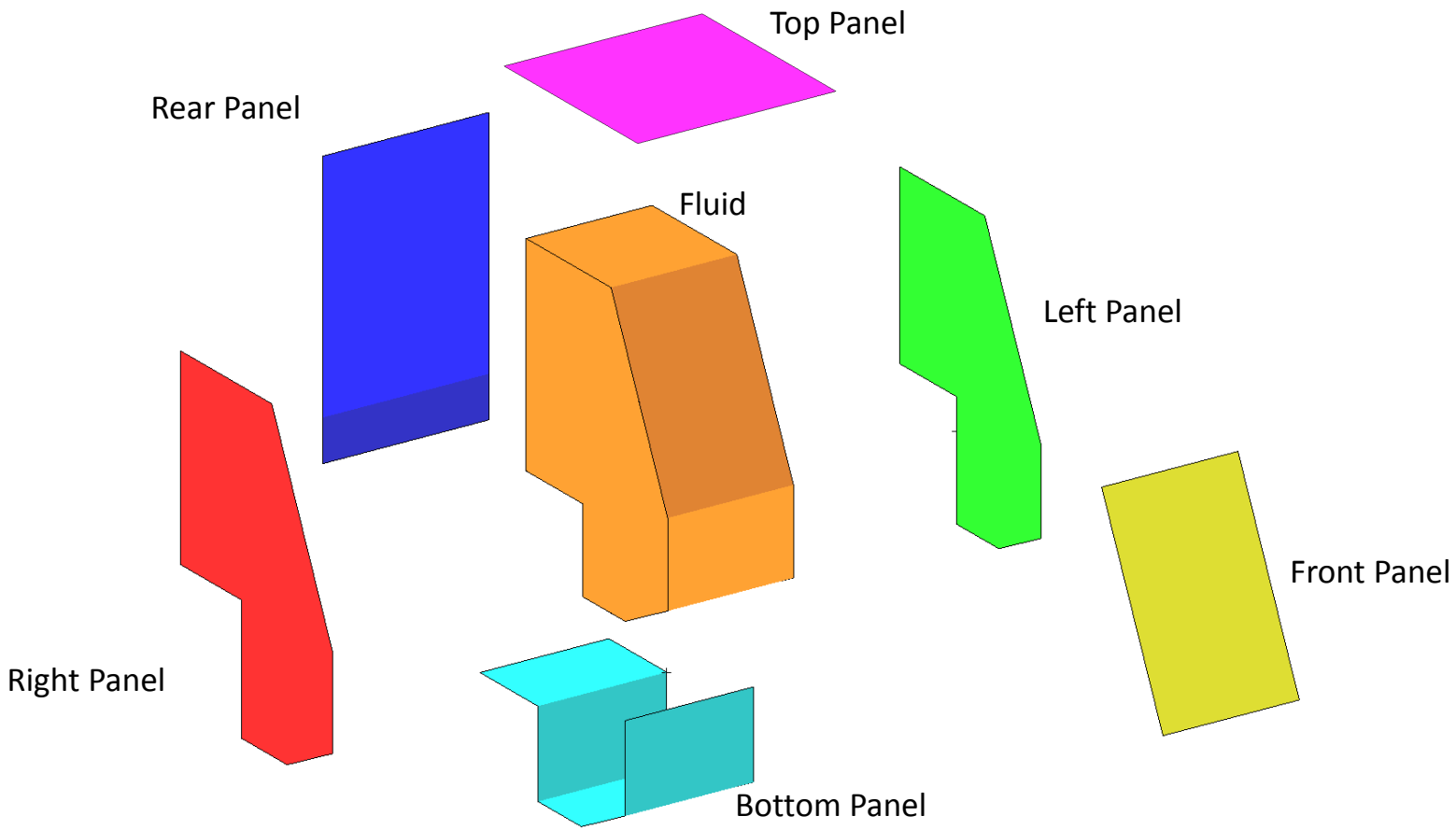
Workshop - Use the HDF5 Explorer to Create Plots

AN MSC NASTRAN HDF5 EXPLORER TUTORIAL

Questions? Email: christian@ the-engineering-lab.com

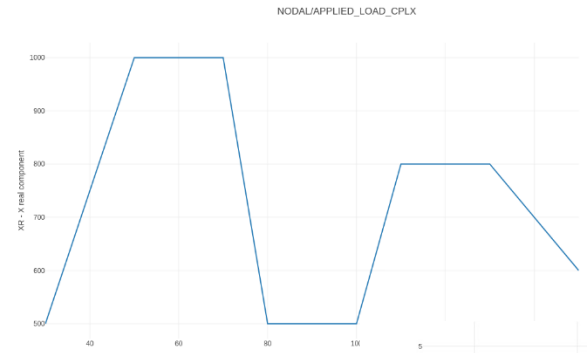
Goal

The following finite element model is considered.

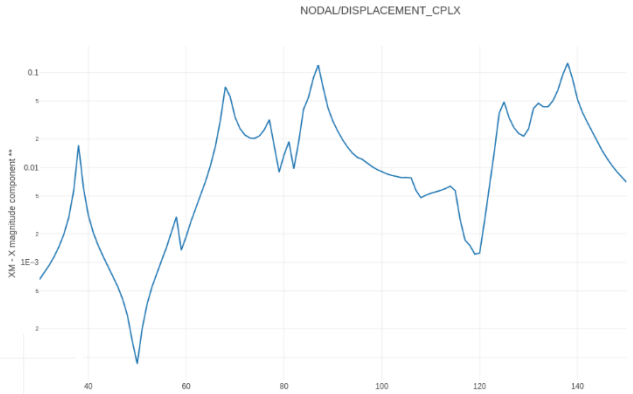


Goal

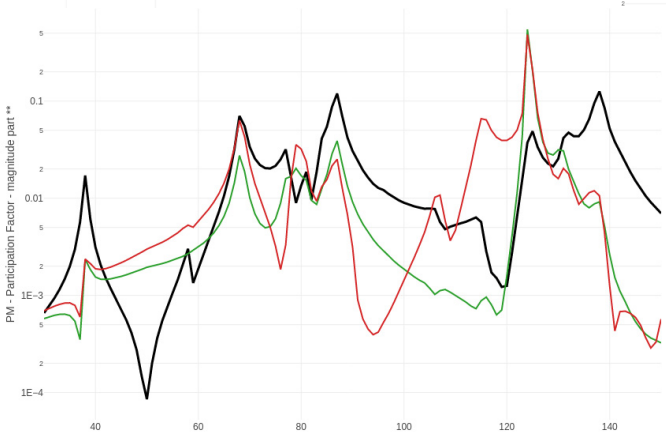
The goal is to produce the following plots



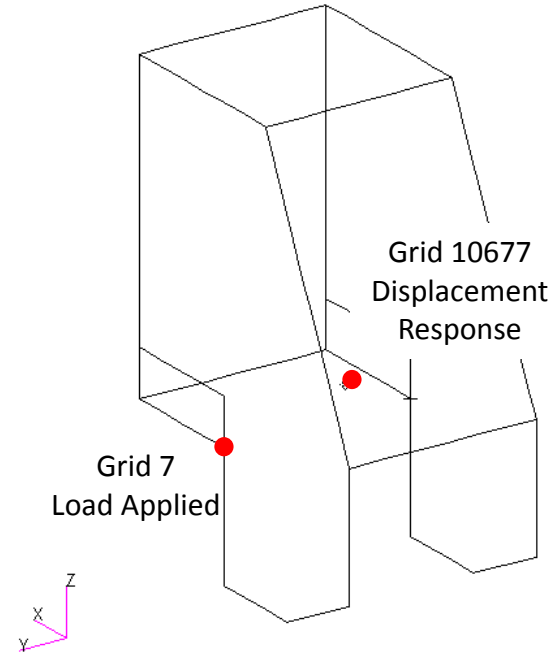
Applied Loading at Grid 7



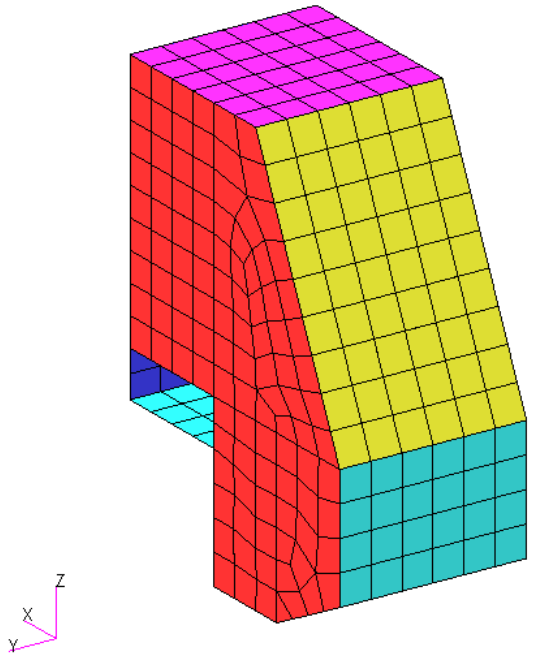
Displacements at Grid 10677



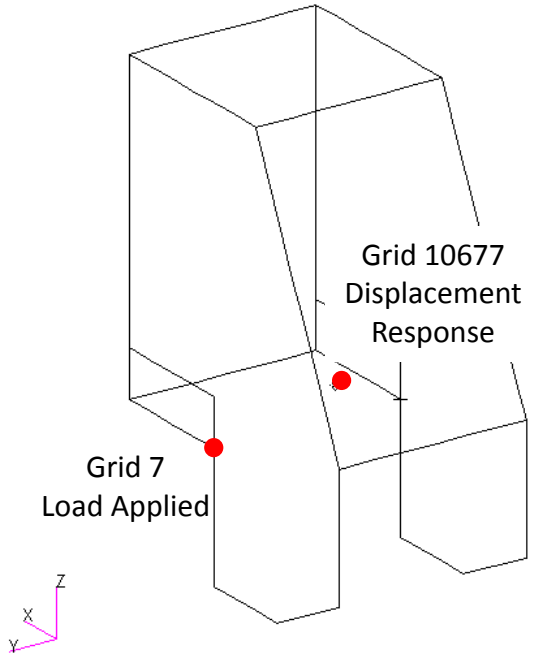
Mode Participation Factors at Grid 10677



Details of the structural model

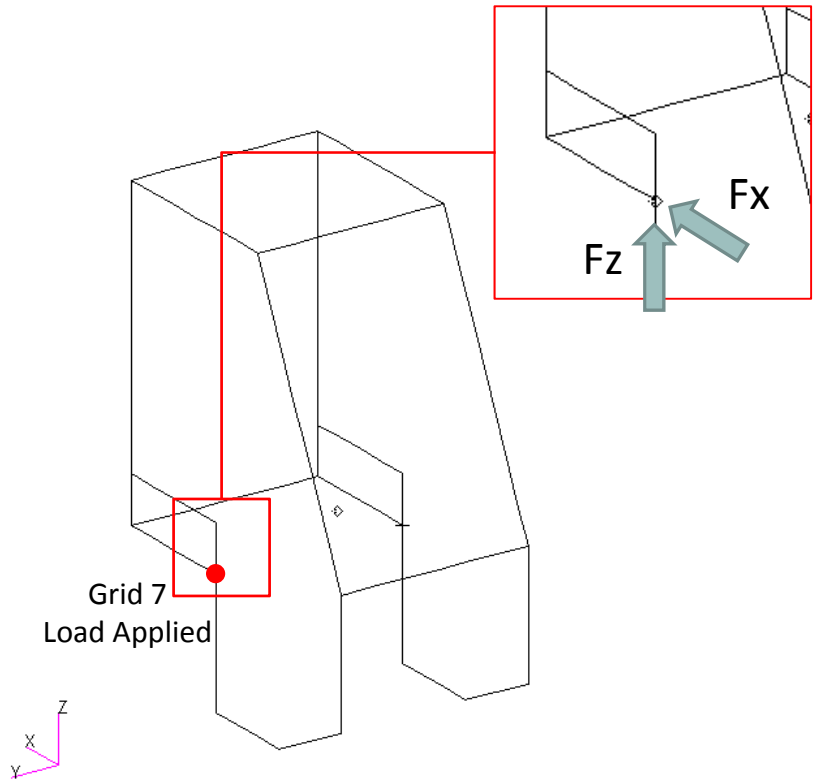


Mesh

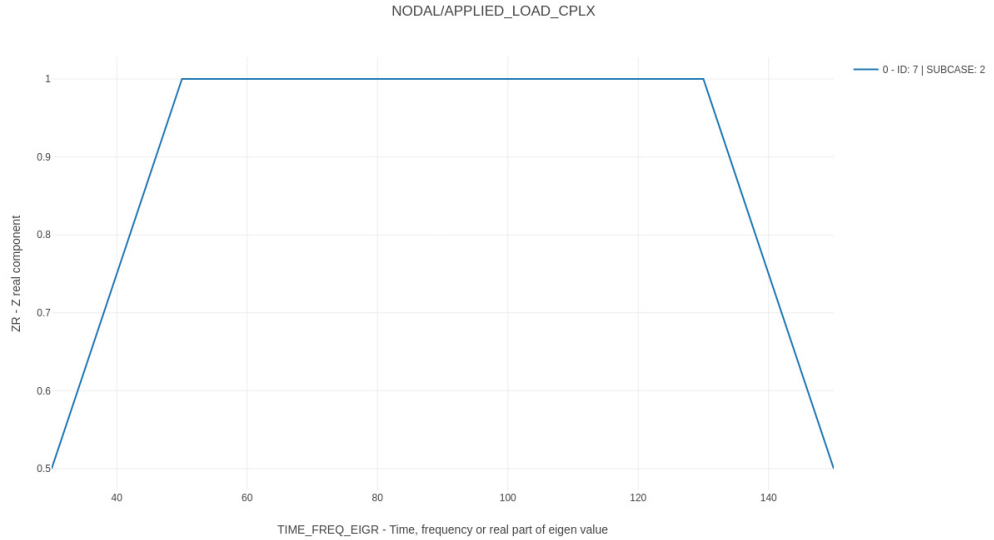


Wireframe

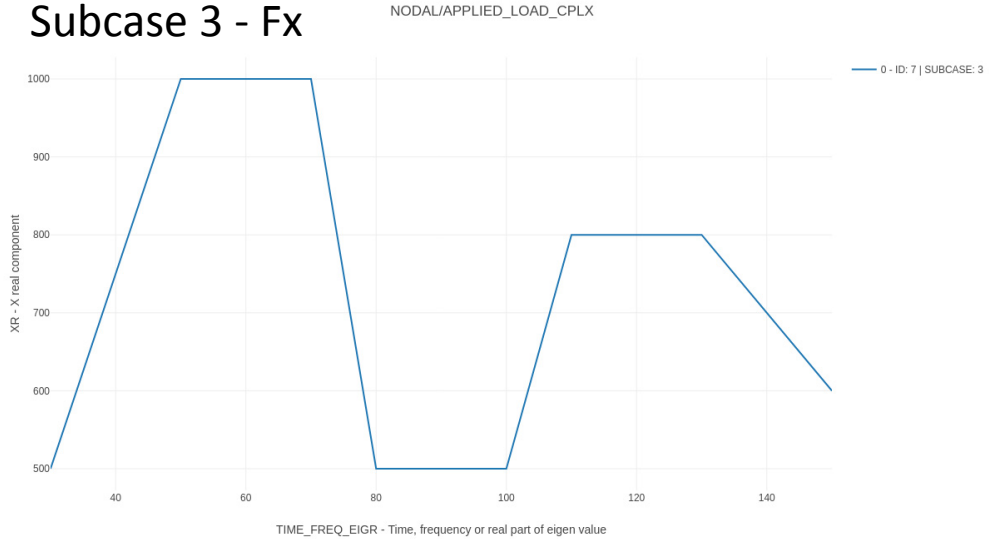
Details of the structural model
Loading



Subcase 2 - Fz



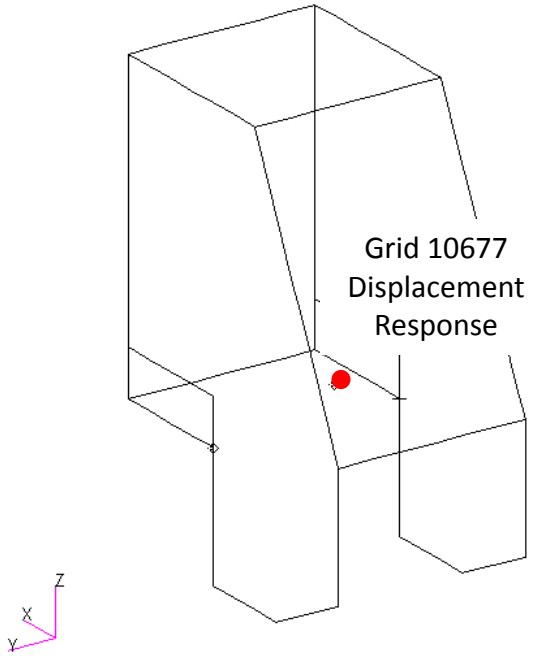
Subcase 3 - Fx



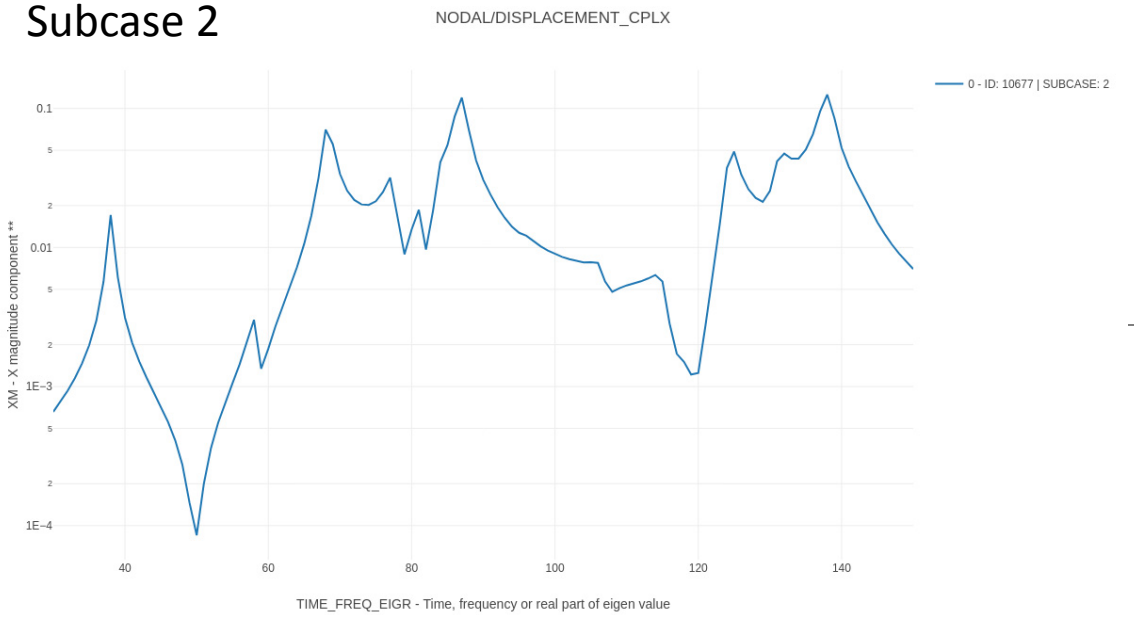
Details of the structural model

Response

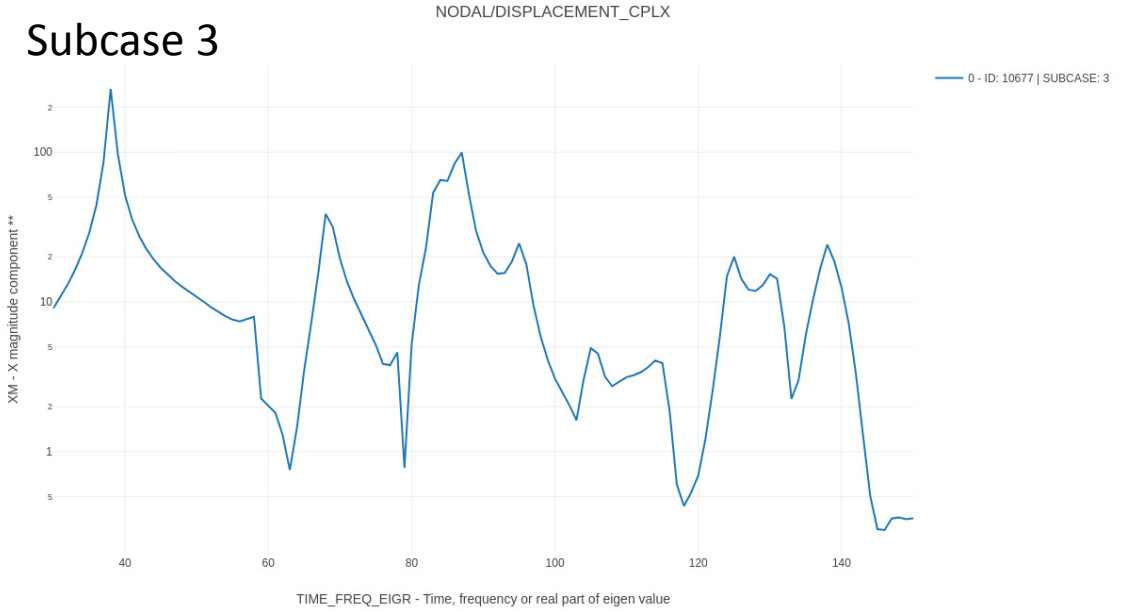
Displacement at Grid 10677



Subcase 2



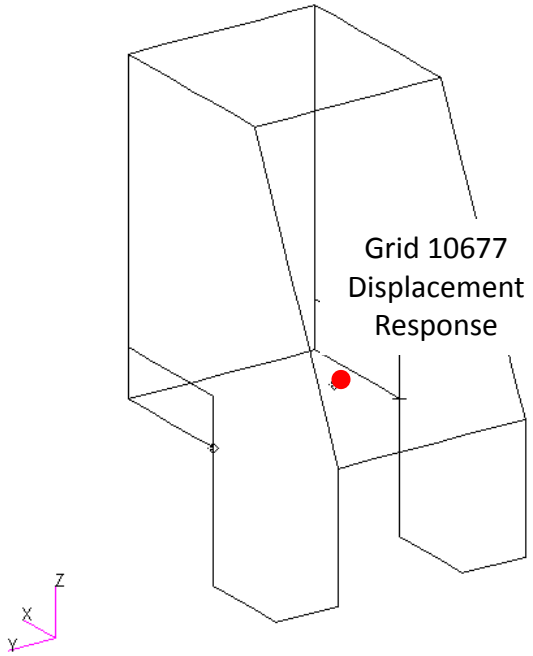
Subcase 3



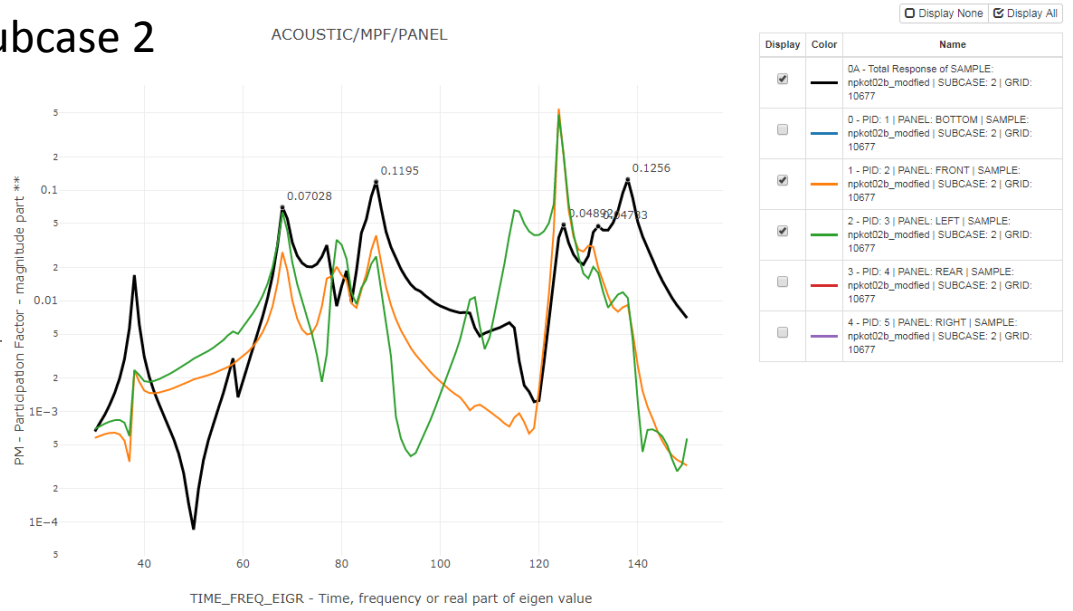
Details of the structural model

Response

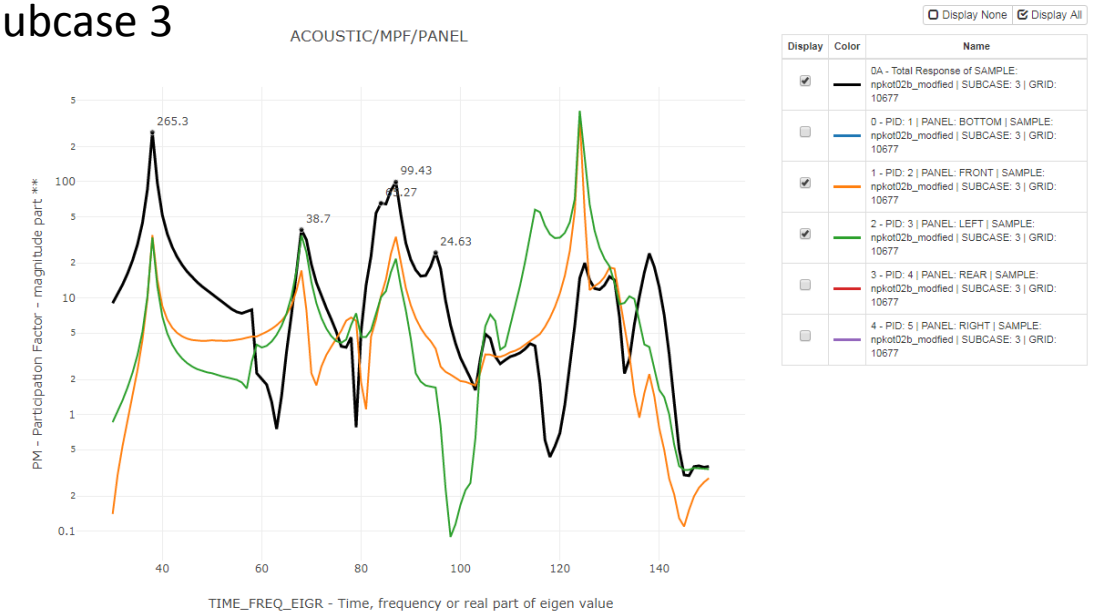
Mode Participation Factors, Panel, at Grid 10677



Subcase 2



Subcase 3



Goal

It should be noted that the plots can be manually created as follows.

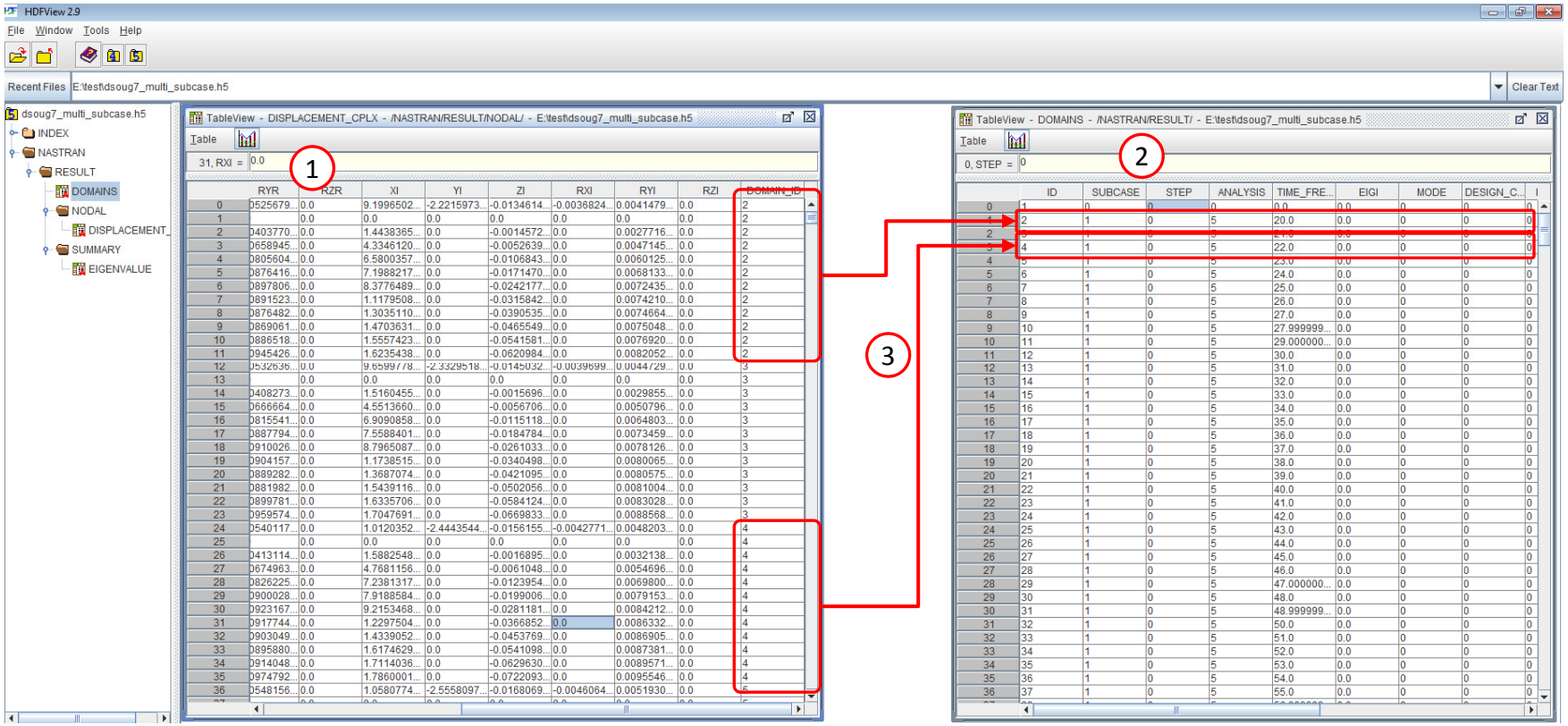
The data necessary to create the plots is located in 2 different datasets, Dataset A and B. Dataset A contains the displacement values and Dataset B contains the corresponding Subcase and Frequency values. The 2 datasets must be paired.

1. Open Dataset A: NASTRAN/RESULT/NODAL/DISPLCACEMENT_CPLX
2. Open Dataset B: NASTRAN/RESULT/DOMAINS
3. Pair each line in Dataset A with the corresponding line in Dataset B

The paired data can be used to create a plot.

If Mode Participation Factor plots are to be created, the necessary data is located in 3 separate datasets.

This process can be done with the HDFView desktop program, Excel or other tools, but is tedious for large amounts of data.



Goal

The HDF5 Explorer performs this process and creates plots automatically.

Nastran SOL 200 Web App - HDF5 Explorer | Acquire Dataset | Plots Browser | Combine Plots | Last Plot Added | Connection | Home

Acquire Dataset

Session ID: 65357 HDF5

Select Dataset

- ACOUSTIC/MPF/PANEL
- ACOUSTIC/PRESSURE_CPLX
- NODAL/APPLIED_LOAD_CPLX
- NODAL/DISPLACEMENT_CPLX
- NODAL/GRID_WEIGHT
- SUMMARY/EIGENVALUE

Specify Entities

10677,11217

Grid identifier (ID)

Examples: 10677, 11217, etc.

Auto Execute

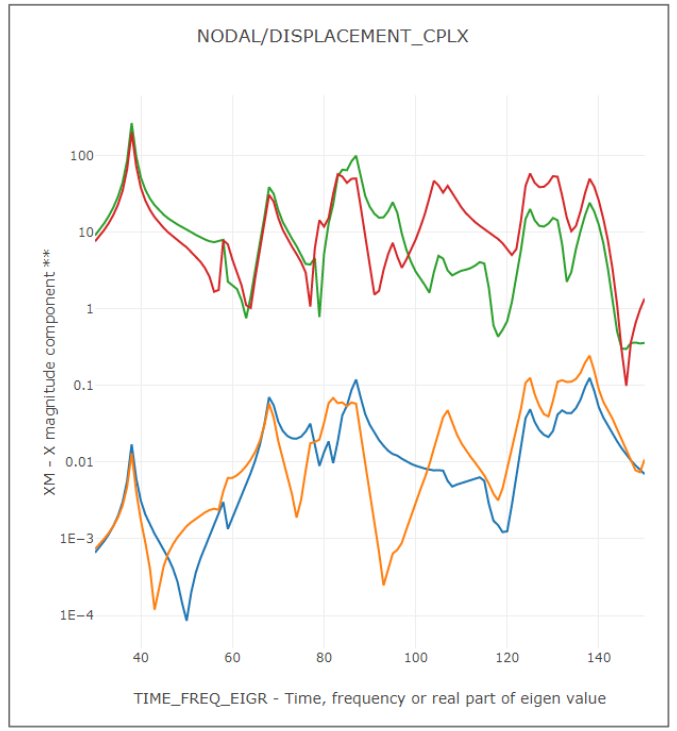
Acquire Dataset

Acquisition complete and successful

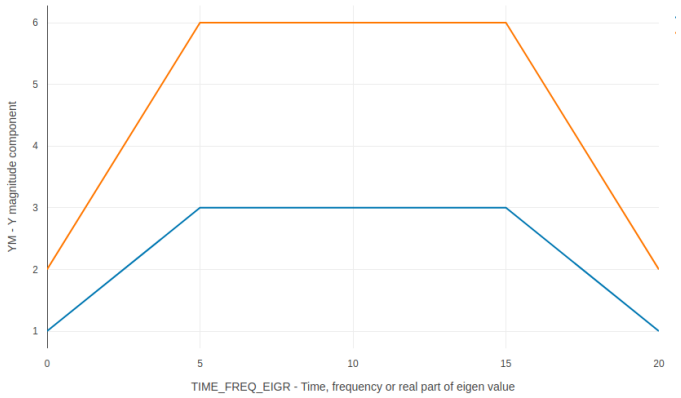
Acquired Dataset — Create Plot | Reset Filters | Download CSV

NODAL/DISPLACEMENT_CPLX - 10677,11217

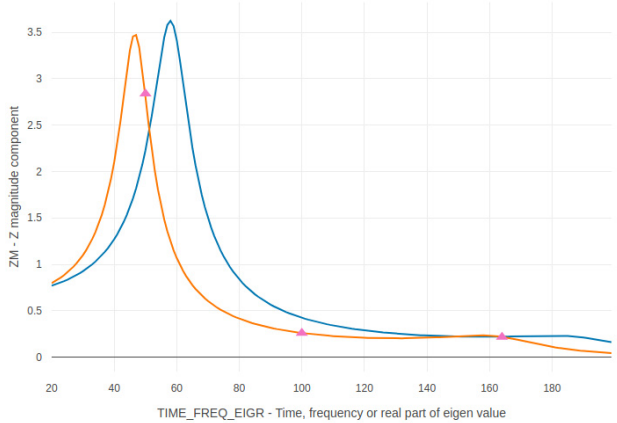
ZP	RXP	RYP	RZP	SAMPLE	DOMAIN_ID	SUBCASE	STEP	ANALYSIS	TIME_FREQ_EIGR
hase component **	RX phase component **	RY phase component **	RZ phase component **	Name of H5 File**	Domain identifier	Subcase number	Step number	Analysis type	Time, frequency or real part of eigen value
				npkot02b_		2 3	0	5	30 31 32 33
	0	0	0	npkot02b_modfied	123	3	0	5	30
	0	0	0	npkot02b_modfied	124	3	0	5	31
	0	0	0	npkot02b_modfied	125	3	0	5	32
	0	0	0	npkot02b_modfied	126	3	0	5	33
	0	0	0	npkot02b_modfied	127	3	0	5	34
	0	0	0	npkot02b_modfied	128	3	0	5	35
	0	0	0	npkot02b_modfied	129	3	0	5	36
	0	0	0	npkot02b_modfied	130	3	0	5	37



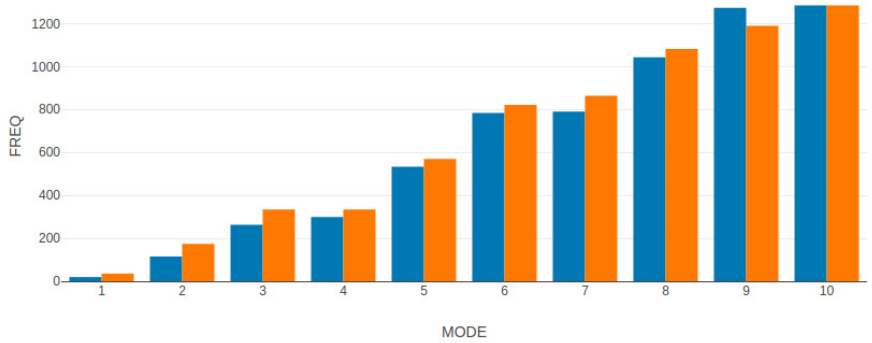
Example plots created by the HDF5 Explorer



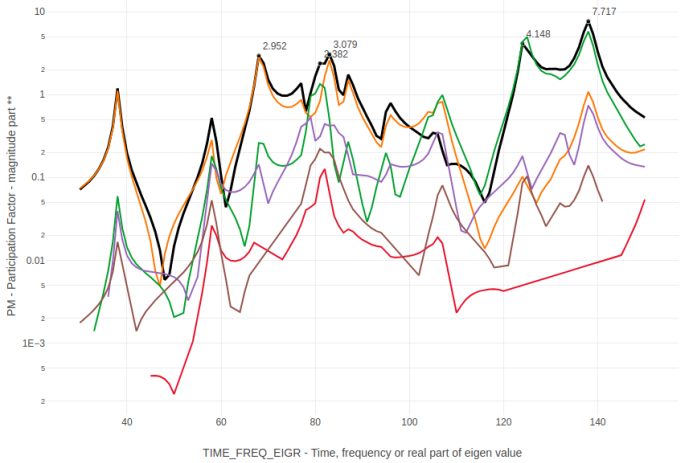
Applied Loading
Frequency Response Analysis



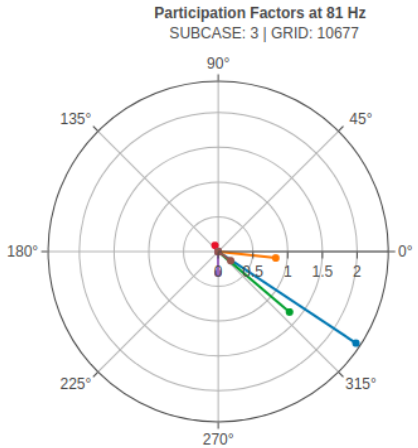
Acceleration vs. Forcing Frequency
Frequency Response Analysis



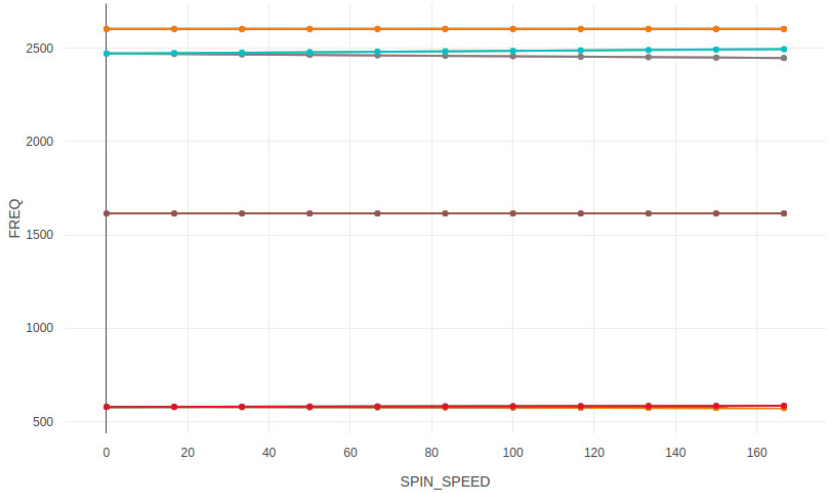
Natural Frequency vs. Mode Number
Normal Modes Analysis



Mode Participation Factors (MPF)
Frequency Response Analysis



Polar Plots (MPF Only)
Frequency Response Analysis

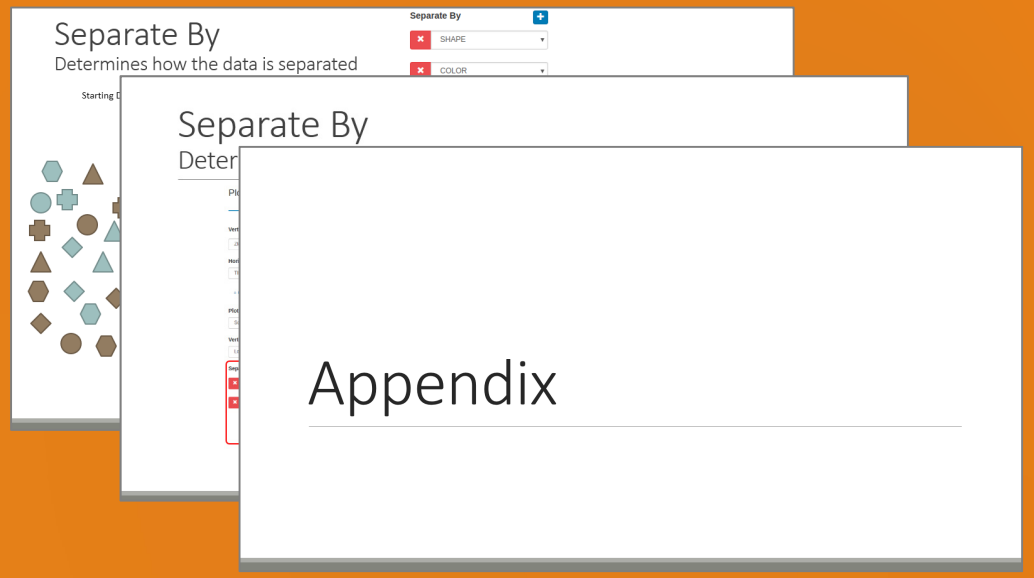


Campbell Diagrams
Rotordynamic Analysis

More Information Available in the Appendix

The Appendix includes information regarding the following:

- Separate By - Determines how the data is separated
- Filters - Control grid ID and Subcases to display



Contact me

- Nastran SOL 200 training
- Nastran SOL 200 questions
- Structural or mechanical optimization questions
- Access to the SOL 200 Web App

christian@ the-engineering-lab.com

Tutorial

PART A - AUTOMATIC PLOTS

SOL 200 Web App Capabilities

The Post-processor Web App and HDF5 Explorer are free to MSC Nastran users.

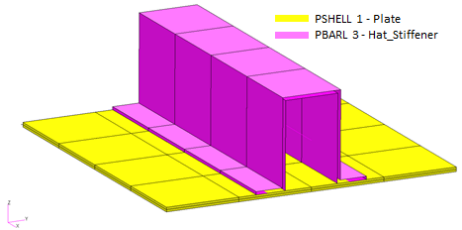
Compatibility

- Google Chrome, Mozilla Firefox or Microsoft Edge
- Windows and Red Hat Linux
- Installable on a company laptop, workstation or server. All data remains within your company.

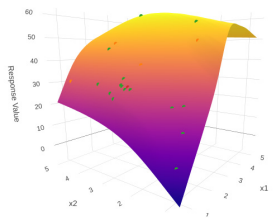
Benefits

- REAL TIME error detection. 200+ error validations.
- REALT TIME creation of bulk data entries.
- Web browser accessible
- Free Post-processor web apps
- +80 tutorials

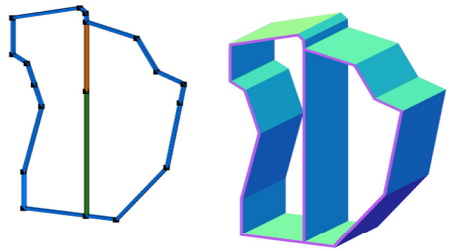
Web Apps



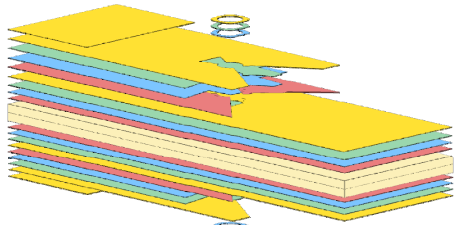
Web Apps for MSC Nastran SOL 200
Pre/post for MSC Nastran SOL 200. Support for size, topology, topometry, topography, multi-model optimization.



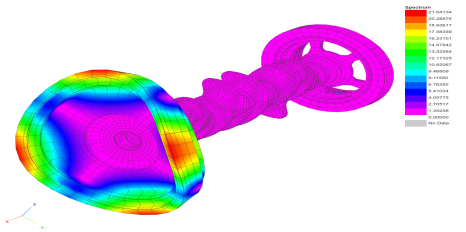
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



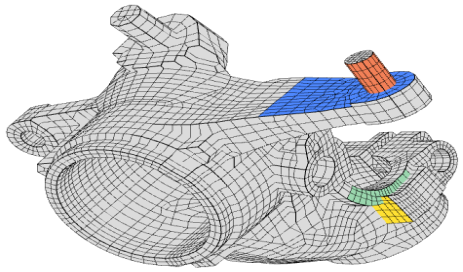
PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically



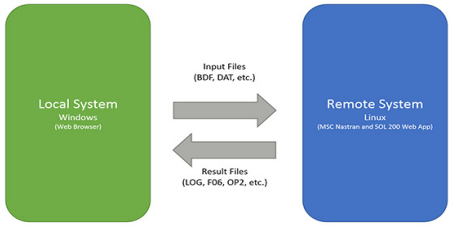
Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries



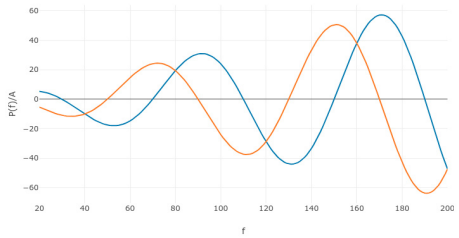
Post-processor Web App
View MSC Nastran results in a web browser on Windows and Linux



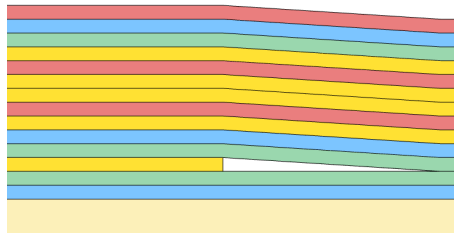
Shape Optimization Web App
Use a web application to configure and perform shape optimization.



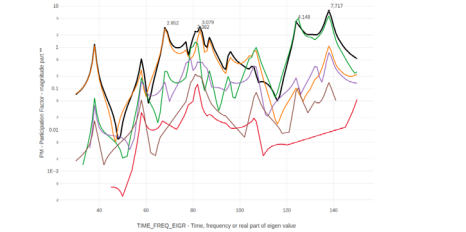
Remote Execution Web App
Run MSC Nastran jobs on remote Linux or Windows systems available on the local network



Dynamic Loads Web App
Generate RLOAD1, RLOAD2 and DLOAD entries graphically



Stacking Sequence Web App
Optimize the stacking sequence of composite laminate plies

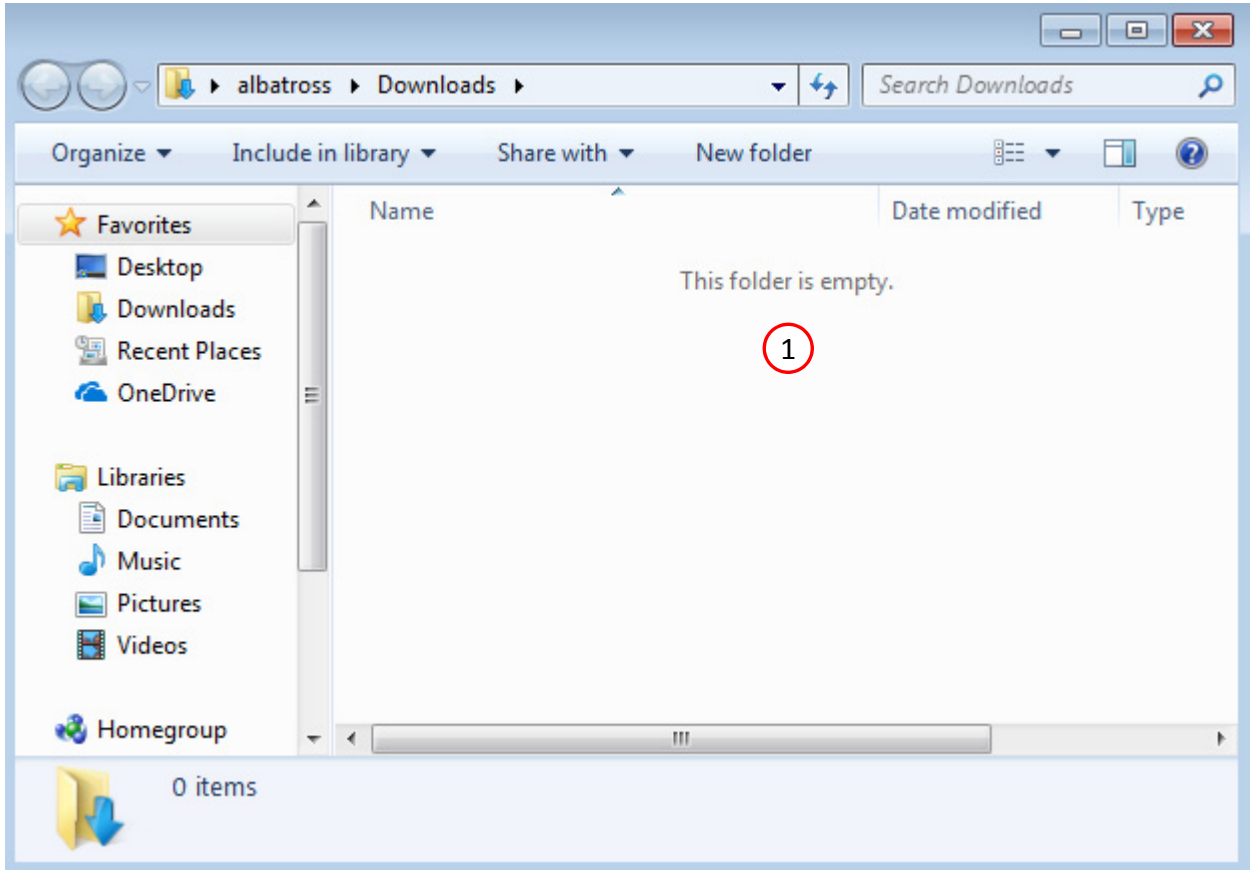


HDF5 Explorer Web App
Create graphs (XY plots) using data from the H5 file

Before Starting

1. Ensure the Downloads directory is empty in order to prevent confusion with other files

- Throughout this workshop, you will be working with multiple file types and directories such as:
  - .bdf/.dat
  - nastran_working_directory
  - .f06, .log, .pch, .h5, etc.
- To minimize confusion with files and folders, it is encouraged to start with a clean directory.



Go to the User's Guide

1. Click on the indicated link

- The necessary BDF files for this tutorial are available in the Tutorials section of the User's Guide.

Obtain Starting Files

1. Find the indicated example
2. Click Link
3. The starting file has been downloaded

- When starting the procedure, all the necessary BDF files must be collected together.

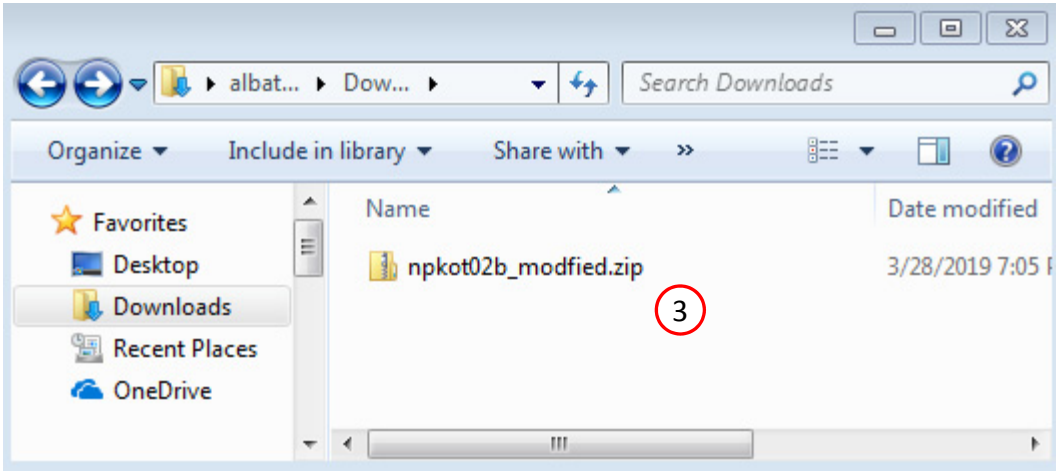
1

Use the HDF5 Explorer to Create Plots Link

Starting with MSC Nastran 2016, results can be outputted to the HDF5 file type. This tutorial introduces the HDF5 Explorer and the following concepts:

- Acquiring datasets from the HDF5 file (.h5)
- Creating plots
  - Applied Loading vs. Frequency
  - Displacement vs. Frequency
  - Mode Participation Factors vs. Frequency
  - Natural Frequency vs. Mode Number
- Exporting data to CSV

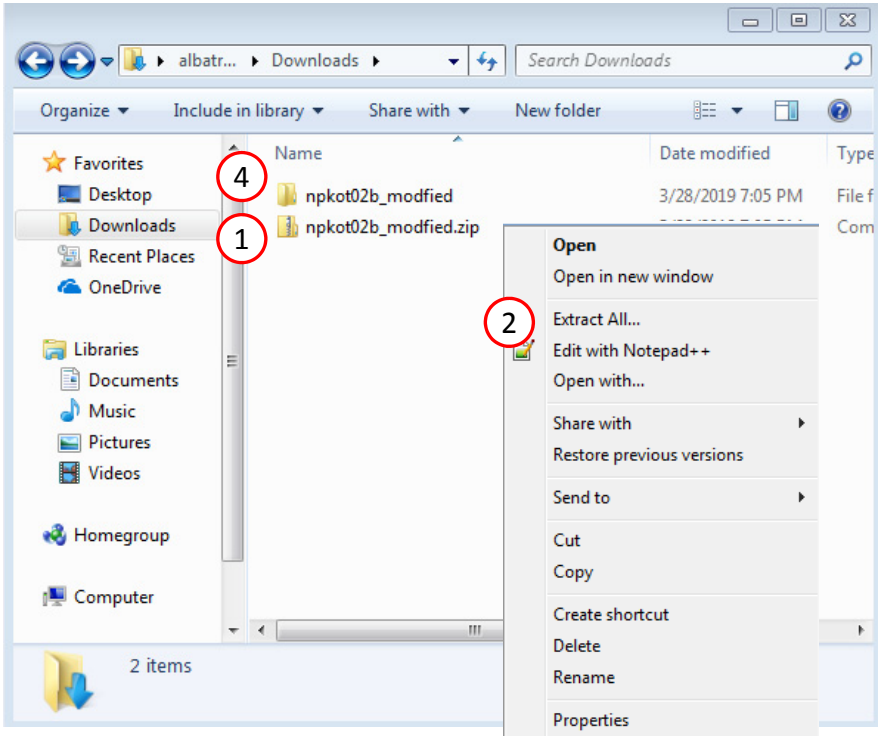
Starting Files: Link 2

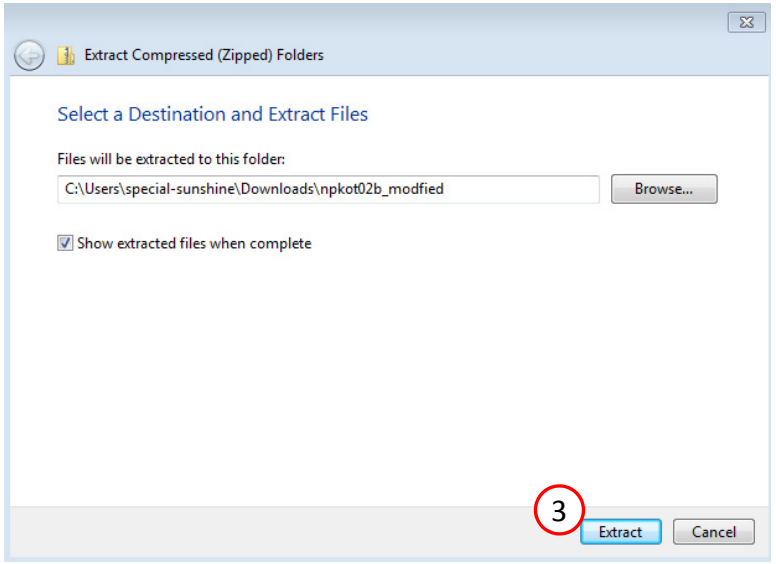


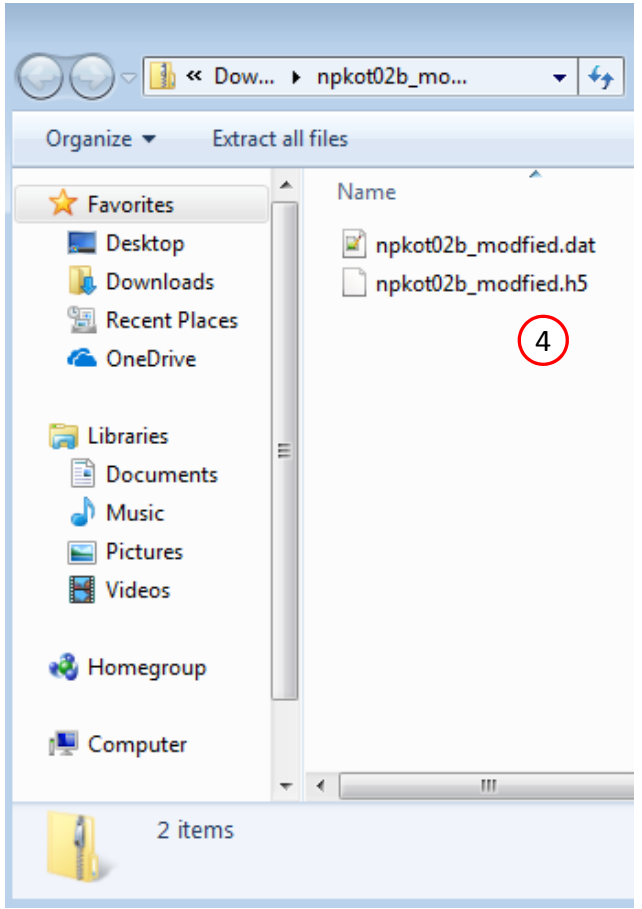
Obtain Starting Files

1. Right click on the zip file
2. Select Extract All…
3. Click Extract
4. The starting files are now available in a folder

- This example is using a previously created design model. The design model is a model that has been converted to SOL 200 and contains bulk data entries describing the optimization problem statement, e.g. variables, objective and constraints.





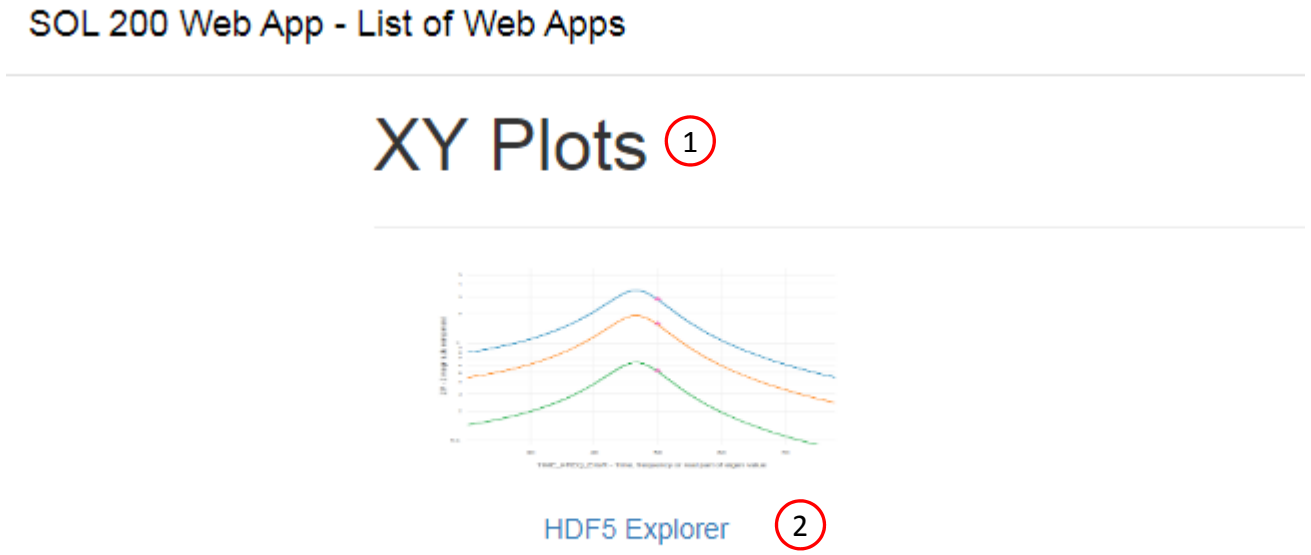


Beams Viewer and PBMSECT Web App

1. Navigate to the homepage
2. Click on the indicated link

Open the HDF5 Explorer

1. Search for section XY Plots
2. Click the icon titled HDF5 Explorer

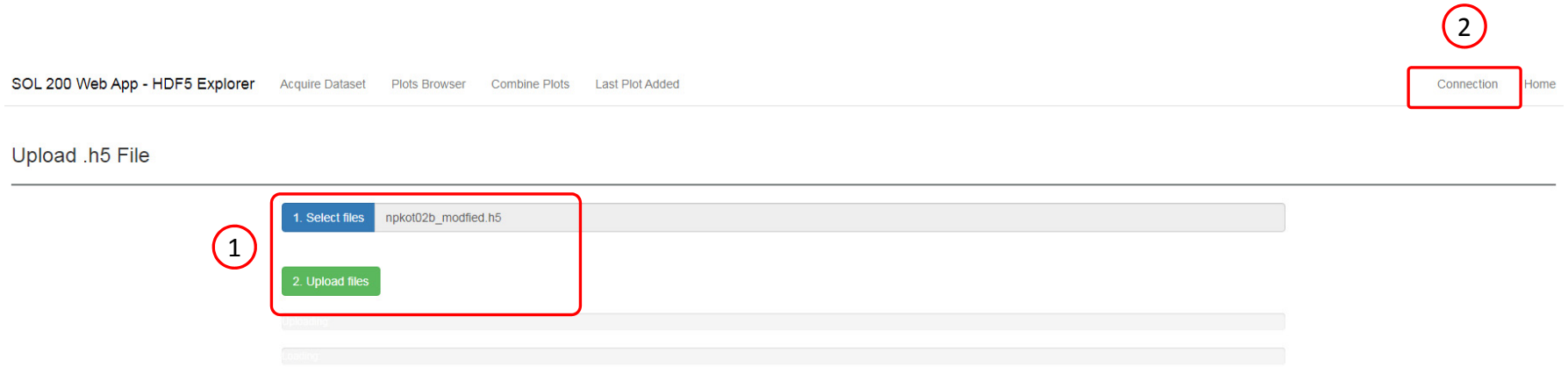


Starting Options

The data contained in the H5 file must be extracted and sent to the web browser. There are 2 methods to do this.

1. Option 1 – Directly upload the H5 file
   - Recommended for H5 files less than 10 gigabytes (GB)
2. Option 2 – Download a portable desktop application to emit the data contained in the H5 file
   - Recommended for H5 files greater than 10GB

Part A of this workshop demonstrates option 2.
Part B of this workshop demonstrates option 1.

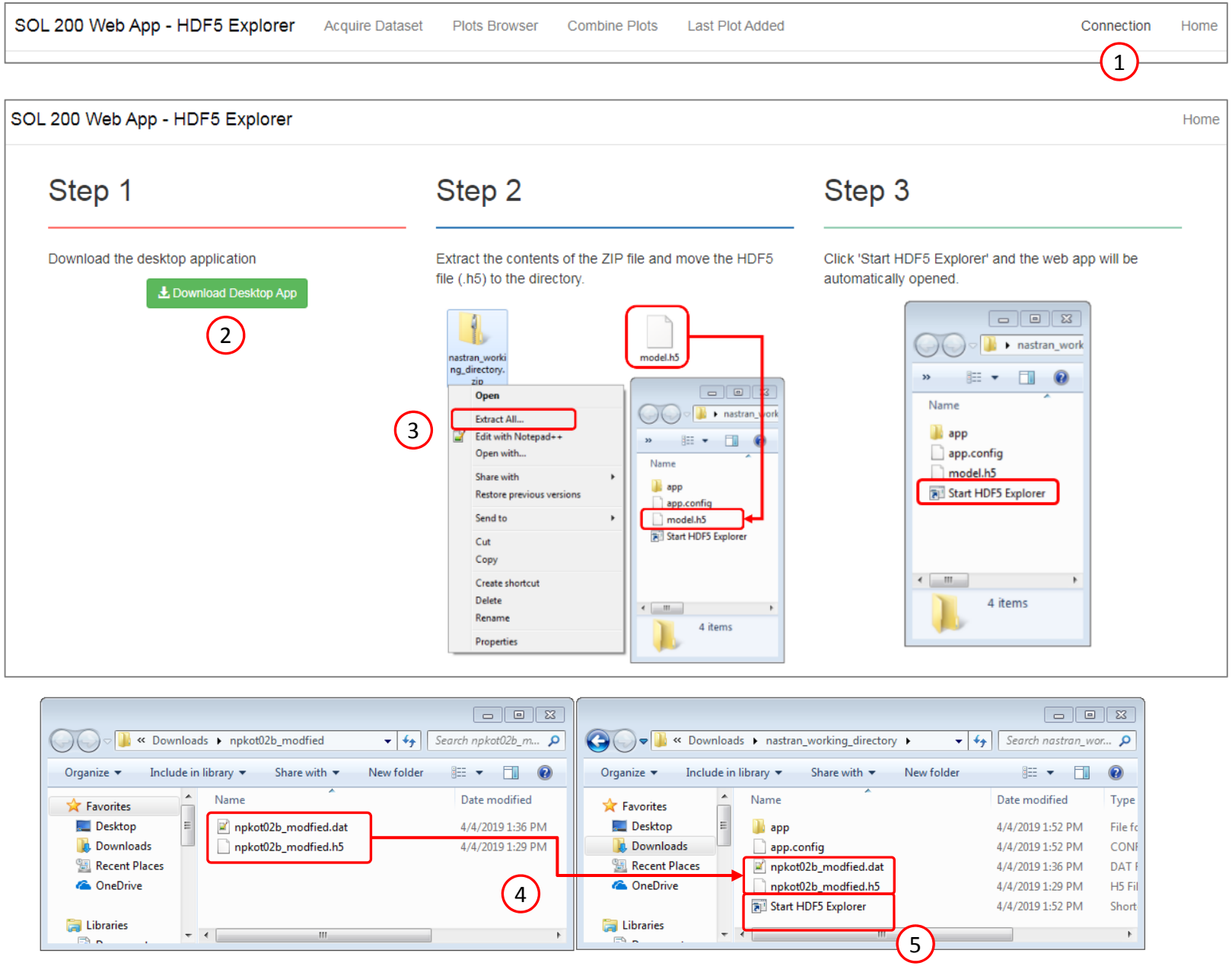


Open the HDF5 Explorer

Follow the instructions on the page to download and configure the desktop application. This application is used to start the HDF5 Explorer

1. Click Connection
2. Download the desktop application
3. Extract the contents of the ZIP file
4. Move the files from folder A to folder B
    1. Folder A - npkot02b_modified
    2. Folder B - nastran_working_directory
5. Click ‘Start HDF5 Explorer’ and the web app will be automatically opened

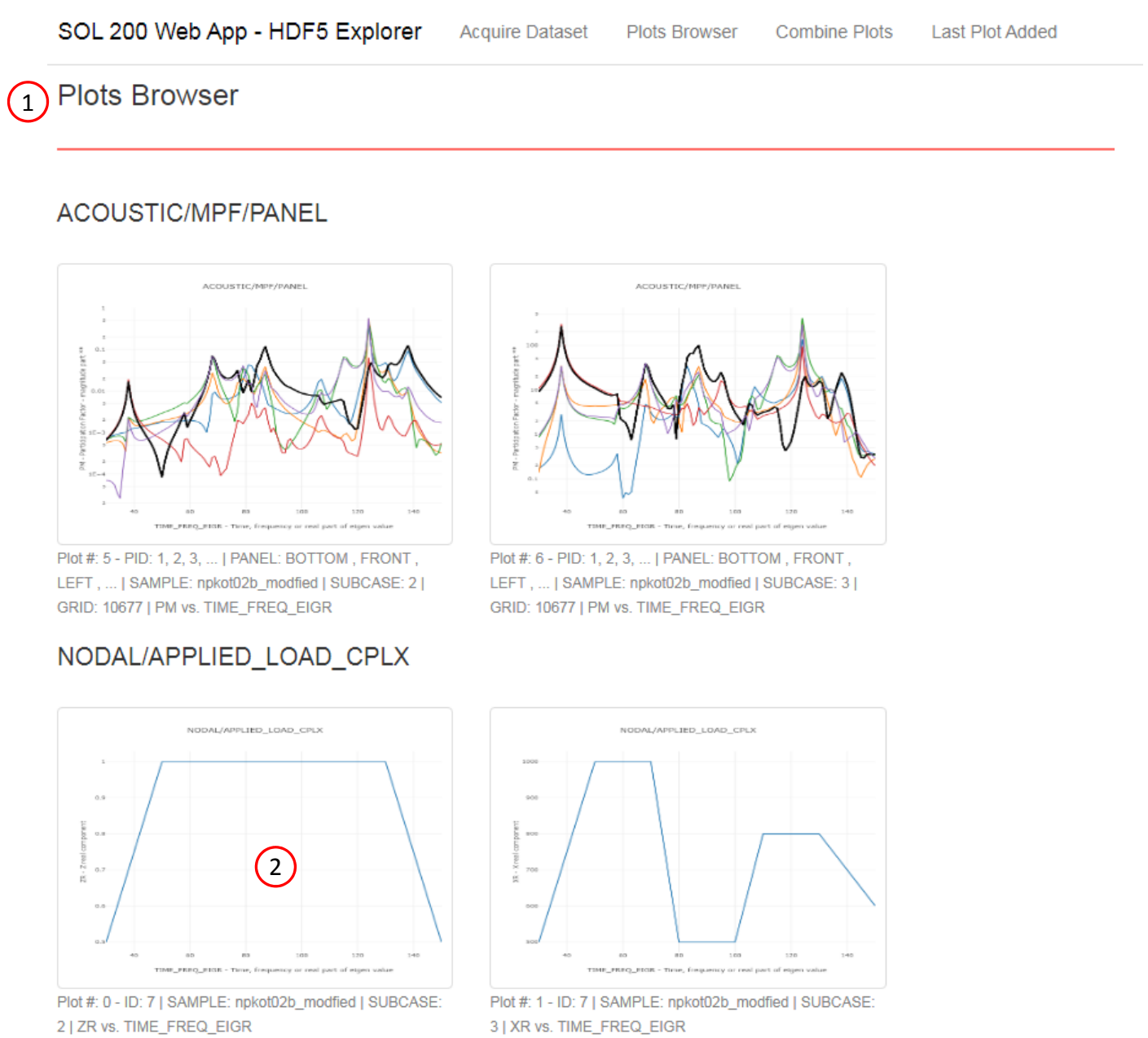
- It is critical to have all the following files and folders together: .h5, app, app.config, Start HDF5 Explorer. The DAT/BDF file is optional, but it is recommended to also include this file.



Plots Browser

1. The HDF5 Explorer when started will automatically create plots. All the plots created are listed in the Plots Browser.
2. Click on the indicated image.

- When the BDF file is together with the H5 file, the HDF5 Explorer will scan the BDF file for specific settings that determine an XY plot should automatically generated. These settings are detailed in the following pages.



Plot

1. After clicking a plot in the Plots Browser, the app navigates to the actual plot.
    - In this example, a Applied Loading vs. Frequency plot has been created.

- When the HDF5 Explorer is first started, plots are automatically created. The decision logic regarding the creation of plots is discussed on the next page.

How are plots automatically created?

A plot is created if the following conditions are met.

1. The H5 file contains one of the listed datasets in the table.

Example:

1. A Normal Modes (SOL 103) analysis was performed and the H5 file contains the dataset SUMMARY/EIGENVALUE.
2. This configuration will lead to the creation of a Frequency vs. Mode plot.

Dataset	Case Control Command
NODAL/APPLIED_LOAD	OLOAD
NODAL/APPLIED_LOAD_CPLX	OLOAD
NODAL/SPC_FORCE	SPCF
NODAL/SPC_FORCE_CPLX	SPCF
ACOUSTIC/MPF/FLUID_MODAL	PFMODE
ACOUSTIC/MPF/PANEL	PFPANEL
ACOUSTIC/MPF/PANEL_MODAL	PFPANEL
ACOUSTIC/MPF/STRUCTURE_MODAL	PFMODE
ACOUSTIC/MPF/STRUCTURE_PANEL	PFPANEL
SUMMARY/EIGENVALUE	

The dataset is written to the H5 file if the corresponding case control commands existed in the BDF or DAT file.

How are plots automatically created?

Multiple plots are created if the following conditions are met.

1. The H5 file contains one of the listed datasets in the table.
2. The BDF exists AND has an XYPLOT or XYPUNCH command.

Example:

1. The H5 file contains the dataset NODAL/DISPLACEMENT_CPLX.
2. The BDF file contains these case control commands.
   - XYPLOT DISP /6(T2RM,T2IP)
   - XYPLOT DISP /11(T2RM,T2IP)

This configuration will lead to the creation of 4 plots. Plot 1 will be for GRID 6, T2RM component. Plot 2 will be for GRID 6, T2IP component. Plots 3 and 4 are similarly created for GRID 11.

Dataset	Case Control Command
NODAL/ACCELERATION	ACCELERATION
NODAL/ACCELERATION_CPLX	ACCELERATION
NODAL/ACCELERATION_TRANS	ACCELERATION
NODAL/ACCELERATION_TRANS_CPLX	ACCELERATION
NODAL/DISPLACEMENT	DISPLACEMENT
NODAL/DISPLACEMENT_CPLX	DISPLACEMENT
NODAL/DISPLACEMENT_TRANS	DISPLACEMENT
NODAL/DISPLACEMENT_TRANS_CPLX	DISPLACEMENT
NODAL/VELOCITY	VELOCITY
NODAL/VELOCITY_CPLX	VELOCITY
NODAL/VELOCITY_TRANS	VELOCITY
NODAL/VELOCITY_TRANS_CPLX	VELOCITY
ACOUSTIC/PRESSURE	PRESSURE
ACOUSTIC/PRESSURE_CPLX	PRESSURE
NODAL/RESPONSE_SPECTRUM/ACCELERATION_CPLX	ACCELERATION
NODAL/RESPONSE_SPECTRUM/DISPLACEMENT_CPLX	DISPLACEMENT
NODAL/RESPONSE_SPECTRUM/VELOCITY_CPLX	VELOCITY

The dataset is written to the H5 file if the corresponding case control commands existed in the BDF or DAT file.

How are plots automatically created?

Multiple plots are created if the following conditions are met.

1. The H5 file contains one of the listed datasets in the table.
2. The design_model.bdf or app.config file exists AND has a "$ useHdf5" line. This line is automatically managed by the web app and does not need to be manually added or edited.

Example:

1. The H5 file contains the dataset NODAL/ACCELERATION_CPLX
2. The design_model.bdf or app.config contains these lines

```
$ useHdf5@[NODAL/ACCELERATION,
1001, YM, 12]

$ useHdf5@[NODAL/ACCELERATION,
1001, ZM, 13]
```

One plot is created for each line that exists. For the lines shown above, a total of 2 plots are created.

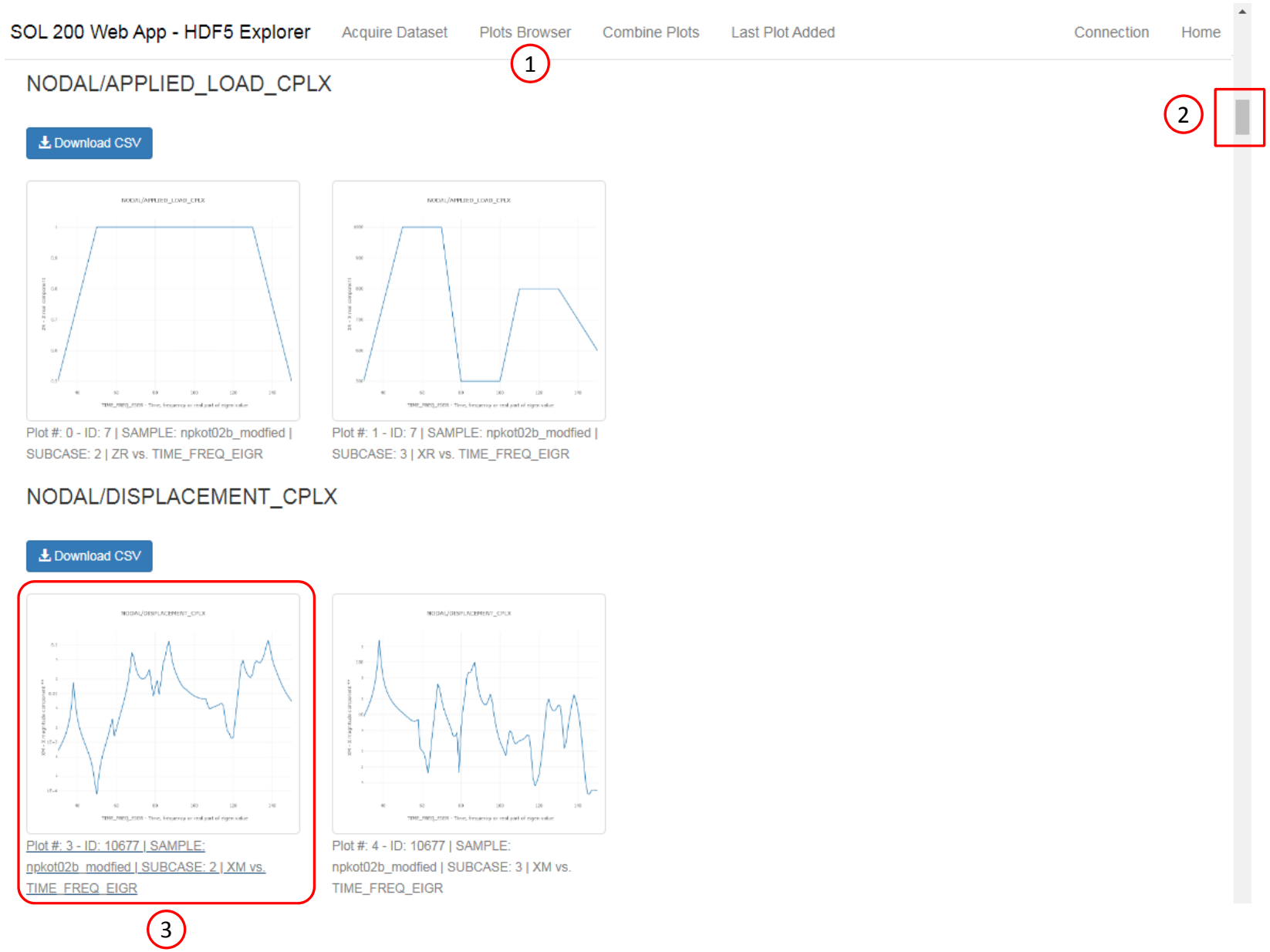
Dataset	Case Control Command
NODAL/ACCELERATION	ACCELERATION
NODAL/ACCELERATION_CPLX	ACCELERATION
NODAL/ACCELERATION_TRANS	ACCELERATION
NODAL/ACCELERATION_TRANS_CPLX	ACCELERATION
NODAL/DISPLACEMENT	DISPLACEMENT
NODAL/DISPLACEMENT_CPLX	DISPLACEMENT
NODAL/DISPLACEMENT_TRANS	DISPLACEMENT
NODAL/DISPLACEMENT_TRANS_CPLX	DISPLACEMENT
NODAL/VELOCITY	VELOCITY
NODAL/VELOCITY_CPLX	VELOCITY
NODAL/VELOCITY_TRANS	VELOCITY
NODAL/VELOCITY_TRANS_CPLX	VELOCITY
ACOUSTIC/PRESSURE	PRESSURE
ACOUSTIC/PRESSURE_CPLX	PRESSURE
NODAL/RESPONSE_SPECTRUM/ACCELERATION_CPLX	ACCELERATION
NODAL/RESPONSE_SPECTRUM/DISPLACEMENT_CPLX	DISPLACEMENT
NODAL/RESPONSE_SPECTRUM/VELOCITY_CPLX	VELOCITY

The dataset is written to the H5 file if the corresponding case control commands existed in the BDF or DAT file.

View Plot

1. Click Plots Browser
2. Use the vertical scroll bar to find the indicate section titled NODAL/DISPLACEMENT_CPLX
3. Click the indicated image

- The Plots Browser displays image previews of each plot.
- To modify a plot, click any of the displayed images.



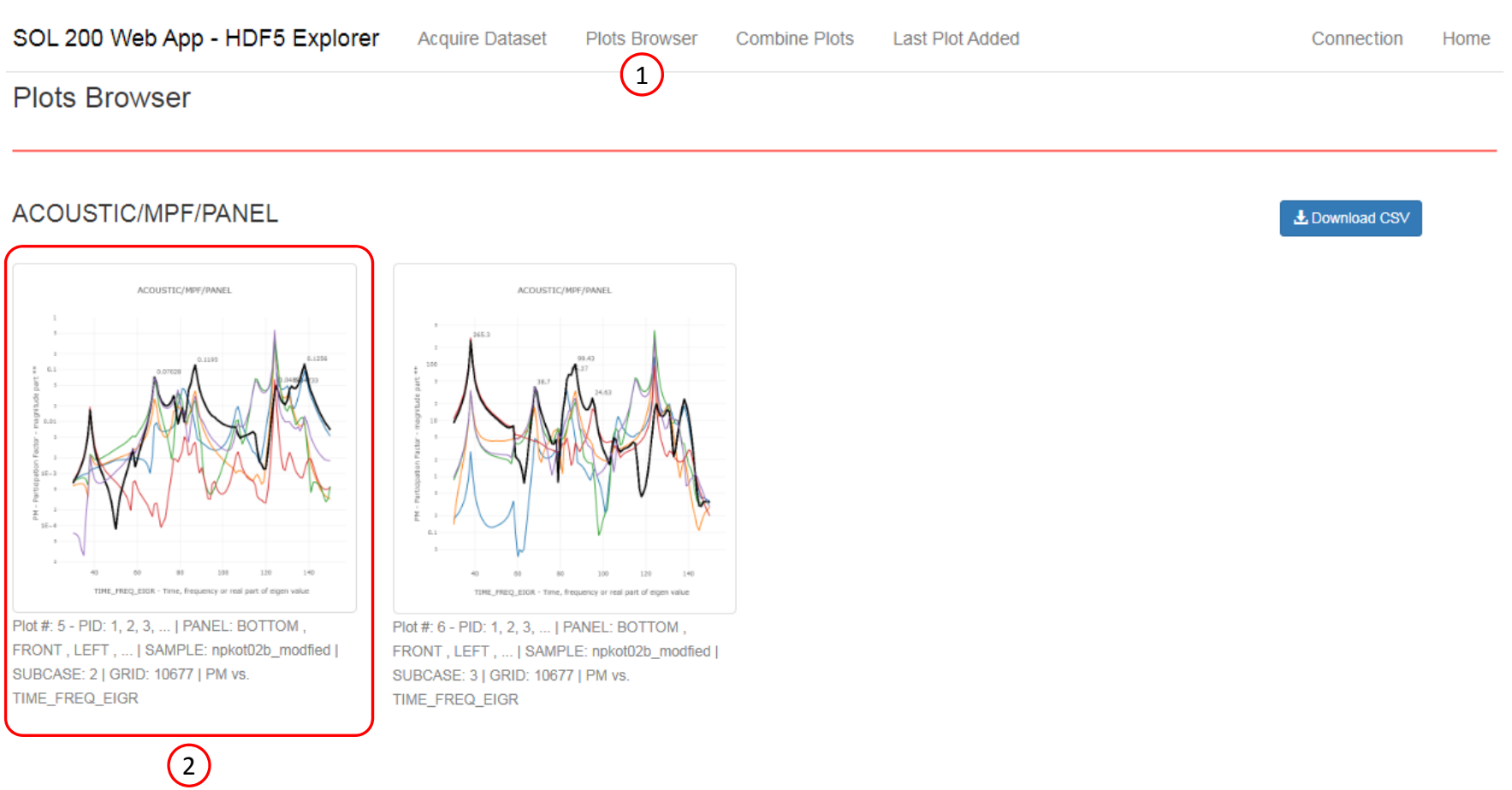
View Plot

1. The corresponding plot is displayed and can be modified

Plots Browser

1. Click Plots Browser
2. Click on the indicated image

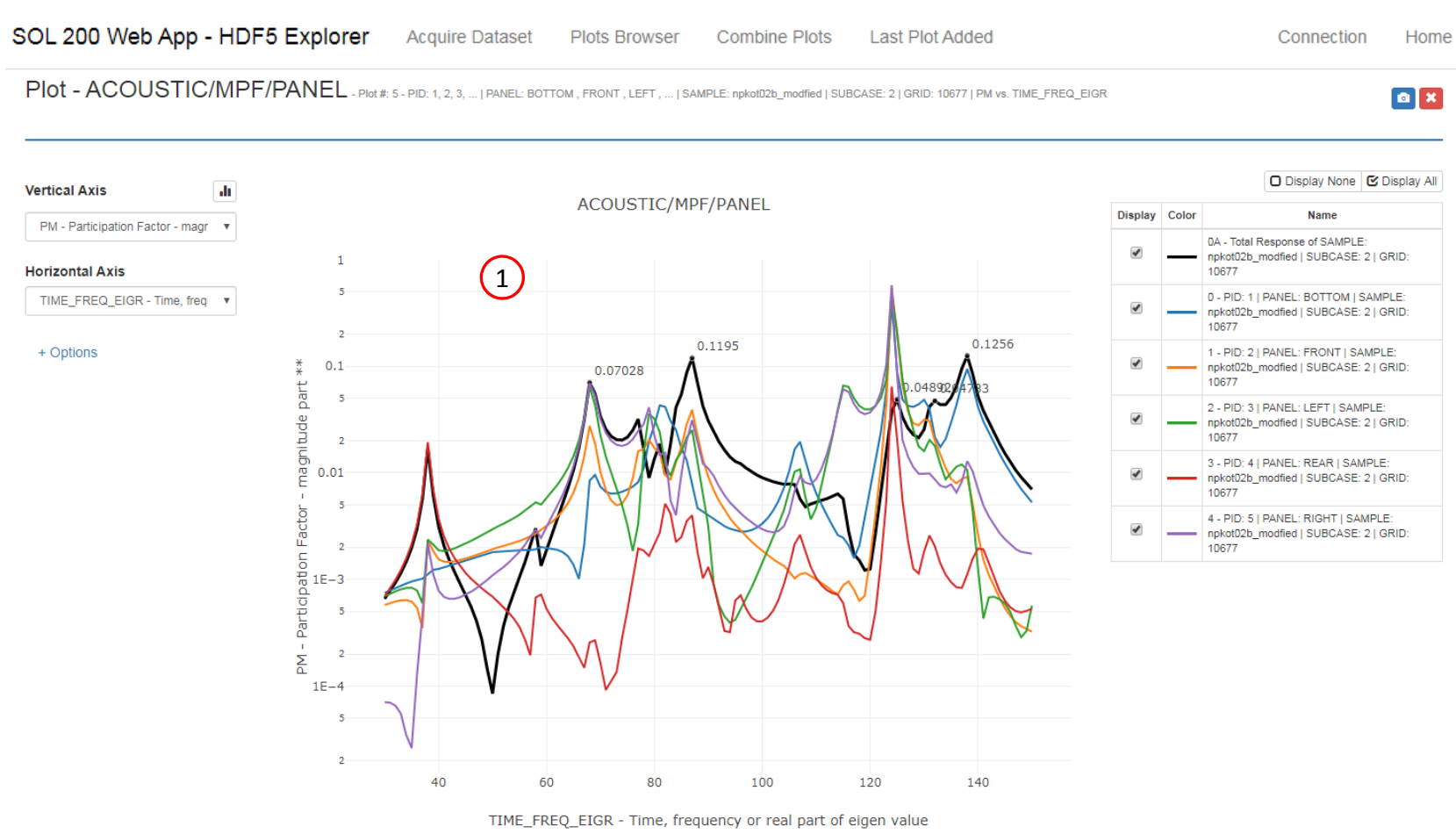
- In the event dozens of plots have been created, the Navigation on the right side bar can be used to jump to different locations in the app.
- The Plots Browser contains image previews/thumbnails of the plots that have been created. Clicking on any of the plots scrolls the page to the actual plot.



Mode Participation Factor Plots

1. The page navigates to the Mode Participation Factor Plot

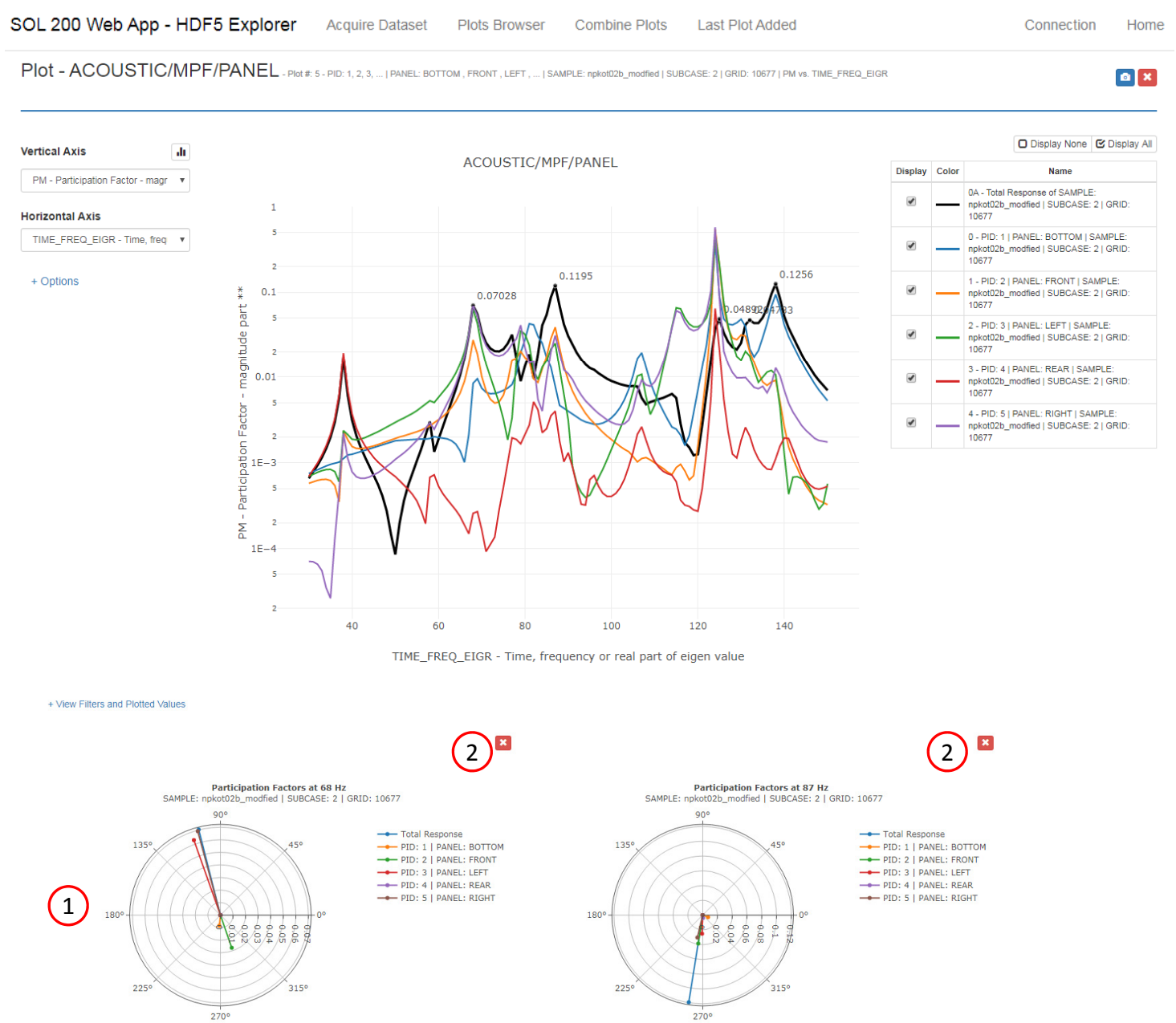
- The app is capable of producing both mode participation factor plots and polar plots.



Mode Participation Factor Plots

1. The Polar Plots for the top peaks are shown
2. Delete every Polar Plot

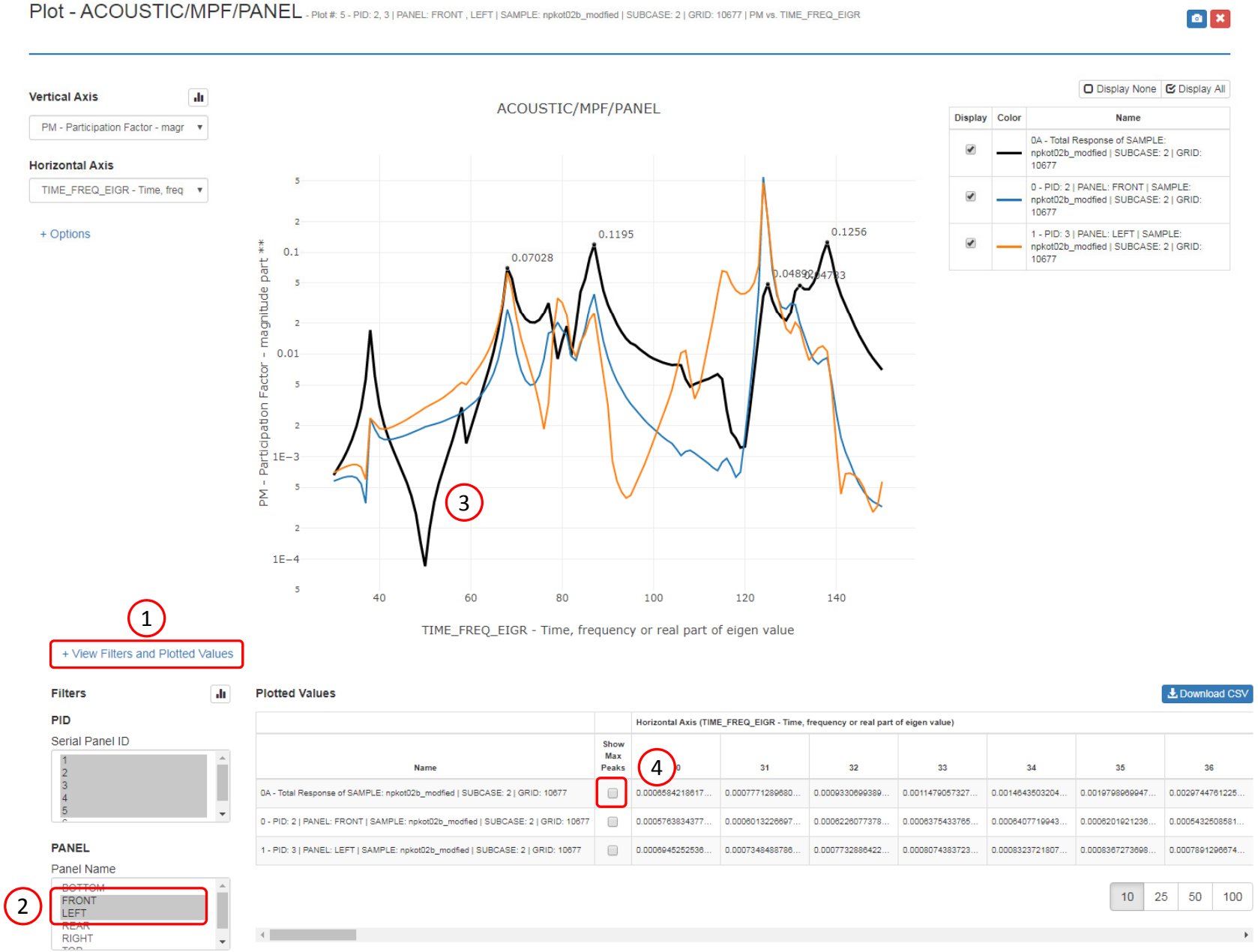
- When the app is first started, polar plots are created for the top 5 peaks. If a point is clicked on the mode participation factor plot, a polar plot for that point is automatically created.



Filter the Plot and Display Peak Values

The data plotted can be controlled as follows. Plots for only panels FRONT and LEFT will be displayed.

1. Click +View Filters and Plotted Values
2. For the PANEL Filter, select only panels FRONT and LEFT
   - The CTRL and SHIFT key conventions can be used. To select or deselect specific options, hold the CTRL key and click. To select or deselect continuous options, hold the SHIFT key and click.
3. The plot is updated to show only the Total Response and panels FRONT and LEFT
4. As an option, the max peak values can be displayed by marking the checkbox in the column titled “Show Max Peaks”

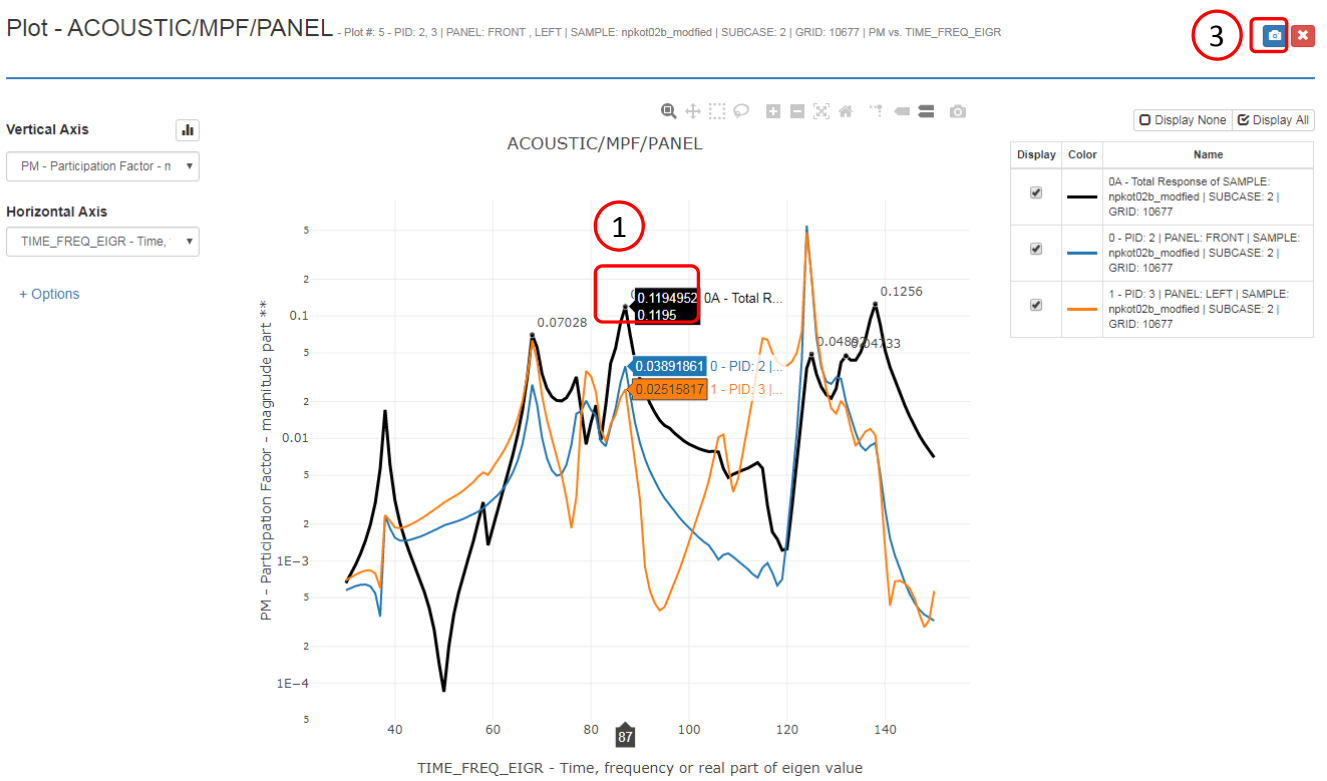


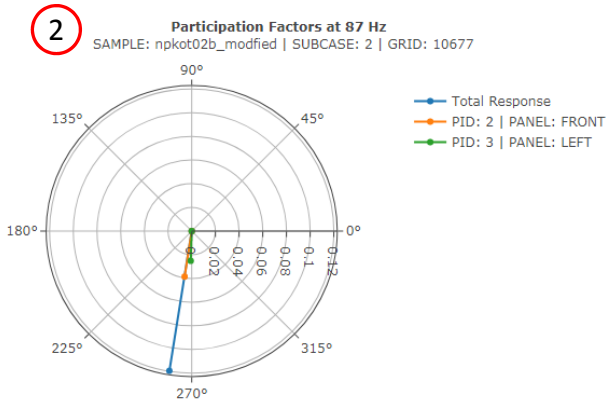
Create a Polar Plot

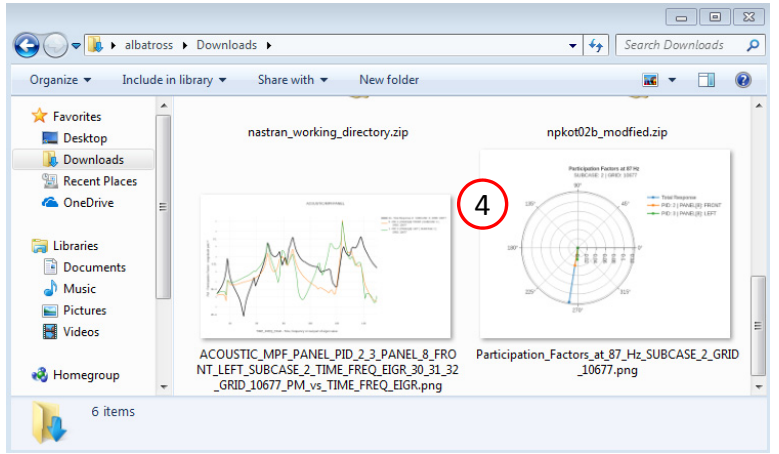
A new polar plot is created as follows.

1. Click any point on the plot
2. Scroll the page down until the new polar plot is visible, a Polar Plot is created for the respective frequency
3. The plots can be downloaded as images by clicking the indicated icon
4. The image files are available on the desktop

- Images can be downloaded for any plot.







Tutorial

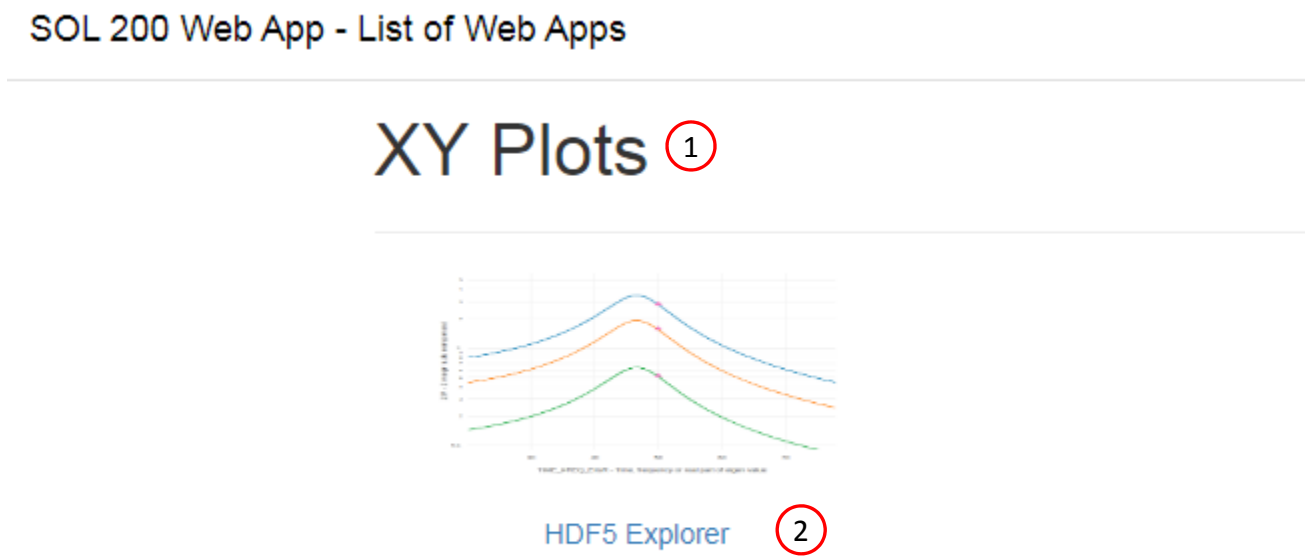
PART B - MANUAL PLOTS

Beams Viewer and PBMSECT Web App

1. Navigate to the homepage
2. Click on the indicated link

Open the HDF5 Explorer

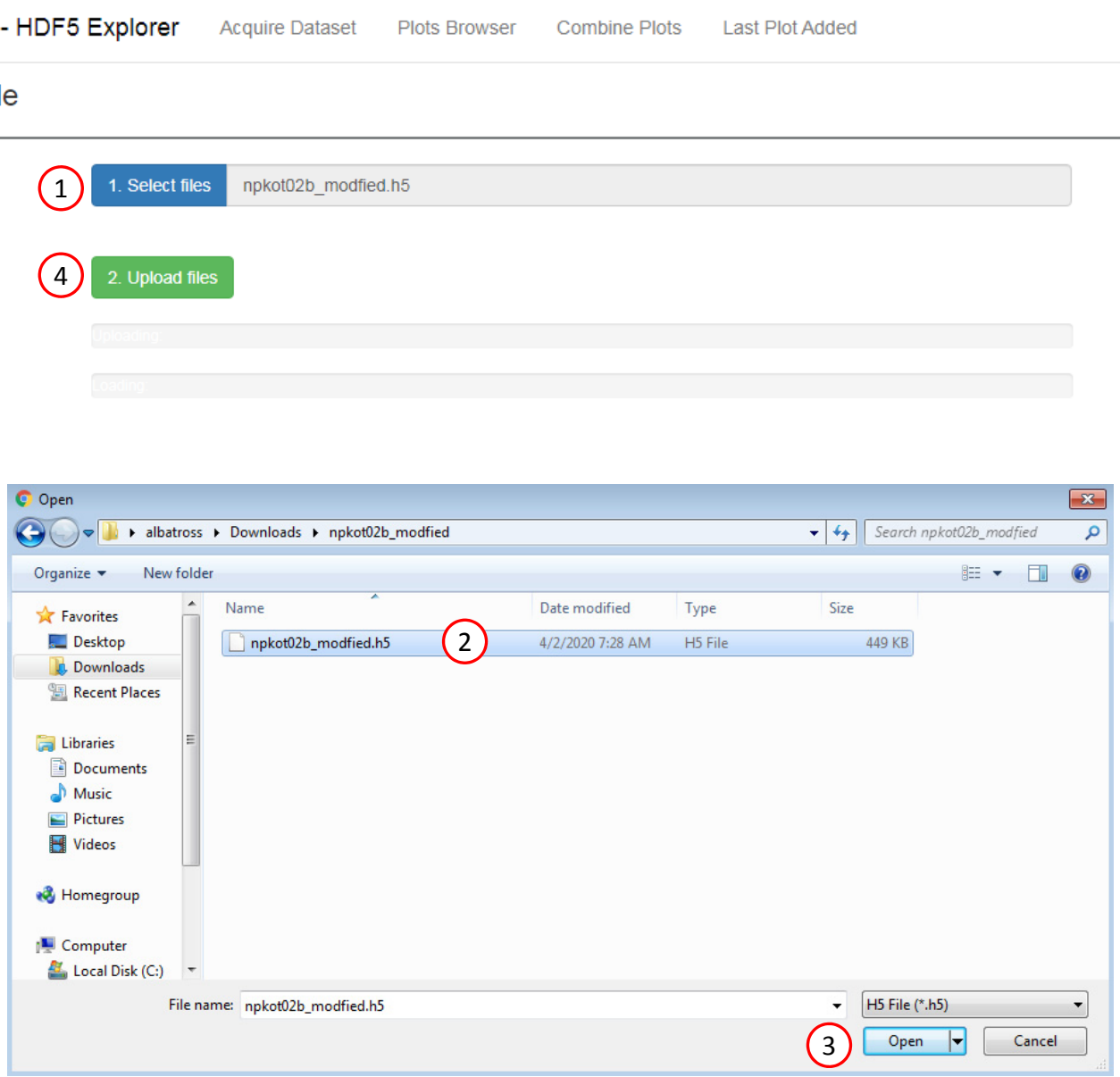
1. Search for section XY Plots
2. Click the icon titled HDF5 Explorer



Upload the H5 file

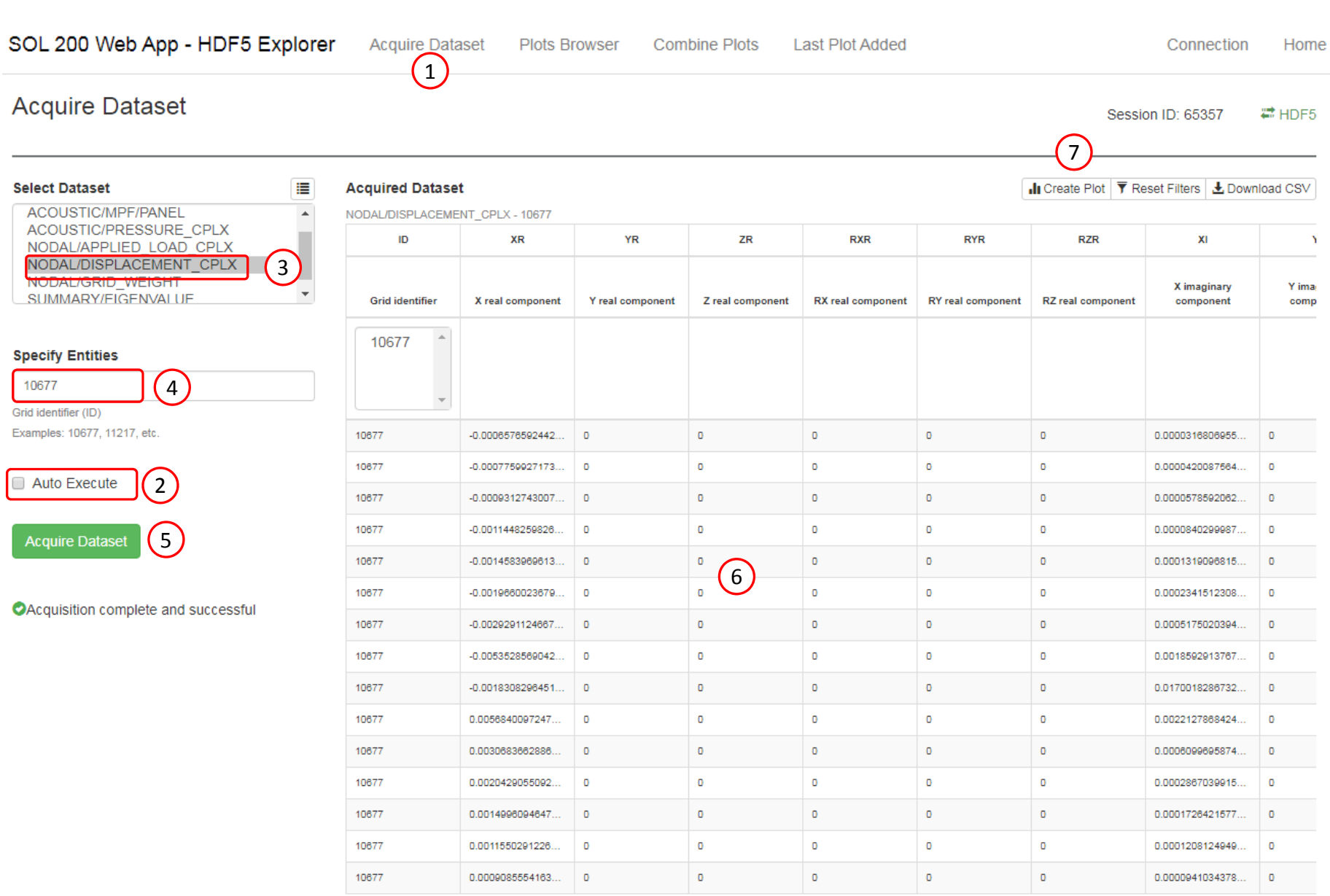
1. Click Select files
2. Select the indicated file
3. Click Open
4. Click Upload files

- There are 2 methods of loading data to the HDF5 Explorer.
  - Method 1 – Directly upload an H5 file as shown on this page.
  - Method 2 – Click Connection in the top right corner, download the ZIP file and continue as shown in Part A of this tutorial.



Manually Acquire a Dataset

1. Click Acquire Dataset
2. Unmark the check box titled Auto Execute
3. Select the dataset named NODAL/DISPLACEMENT_CPLX
4. Specify the following Grid ID: 10677
5. Click Acquire Dataset
6. A new set of data is extracted from the H5 file and displayed in the table
7. Click Create Plot



New Plot

Create Plot was clicked in the previous step. The following is done to inspect the new plot.

1. Click Last Plot Added
2. A plot has been automatically generated for GRID 10677 and for SUBCASEs 1 and 2

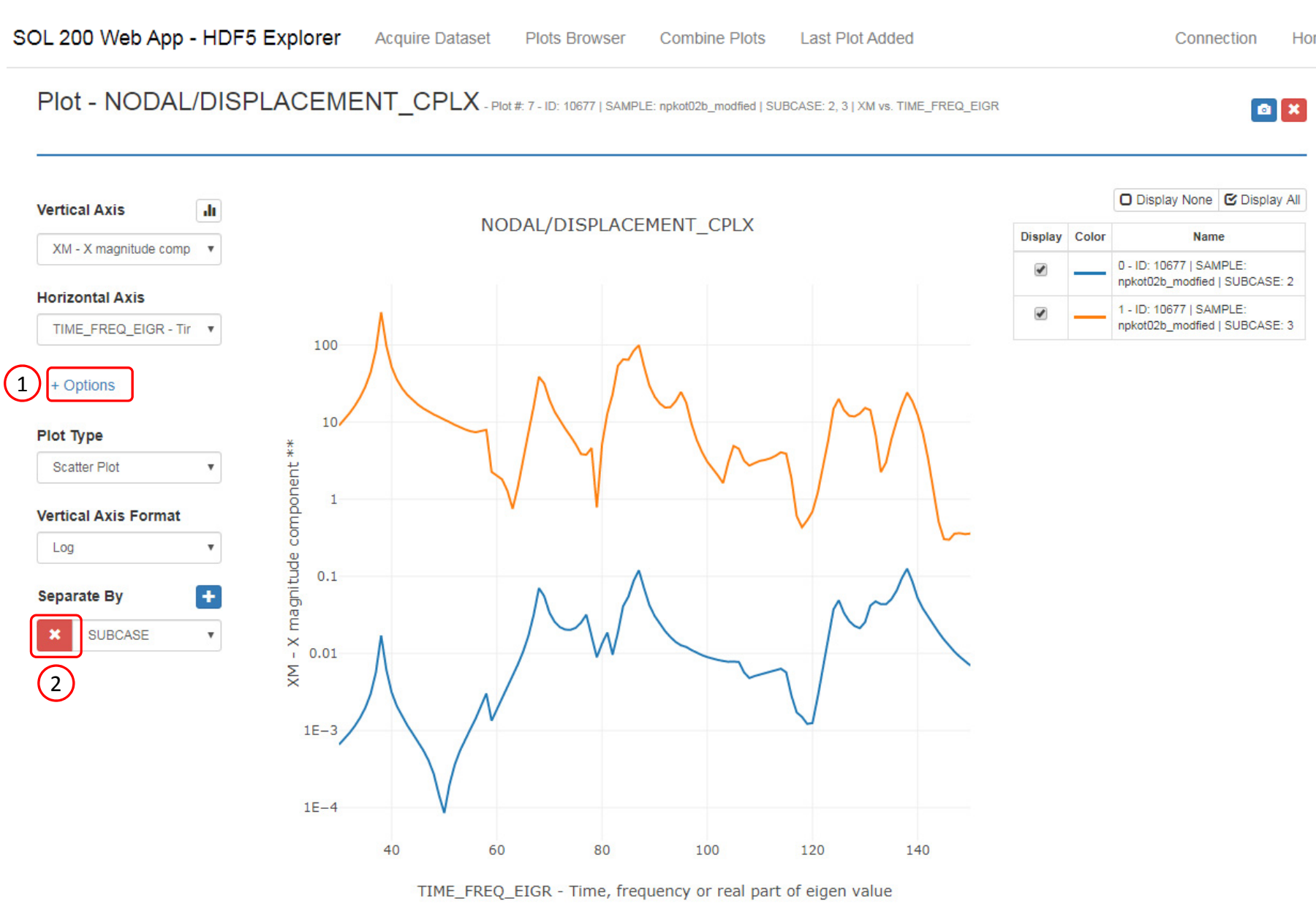
- After *Create Plot* is clicked, a new plot is created and is accessible via the links *Last Plot Added* or *Plots Browser*.

Separate Data for Plotting

Knowledge about separating data is critical to creating plots and is discussed here.

1. Click Options
2. Click the x to delete the Subcase separator

- In the event the plots do not appear correct, the reader is encouraged to modify the Separate By options.
- Refer to the Appendix for additional comments regarding the *Separate By* option

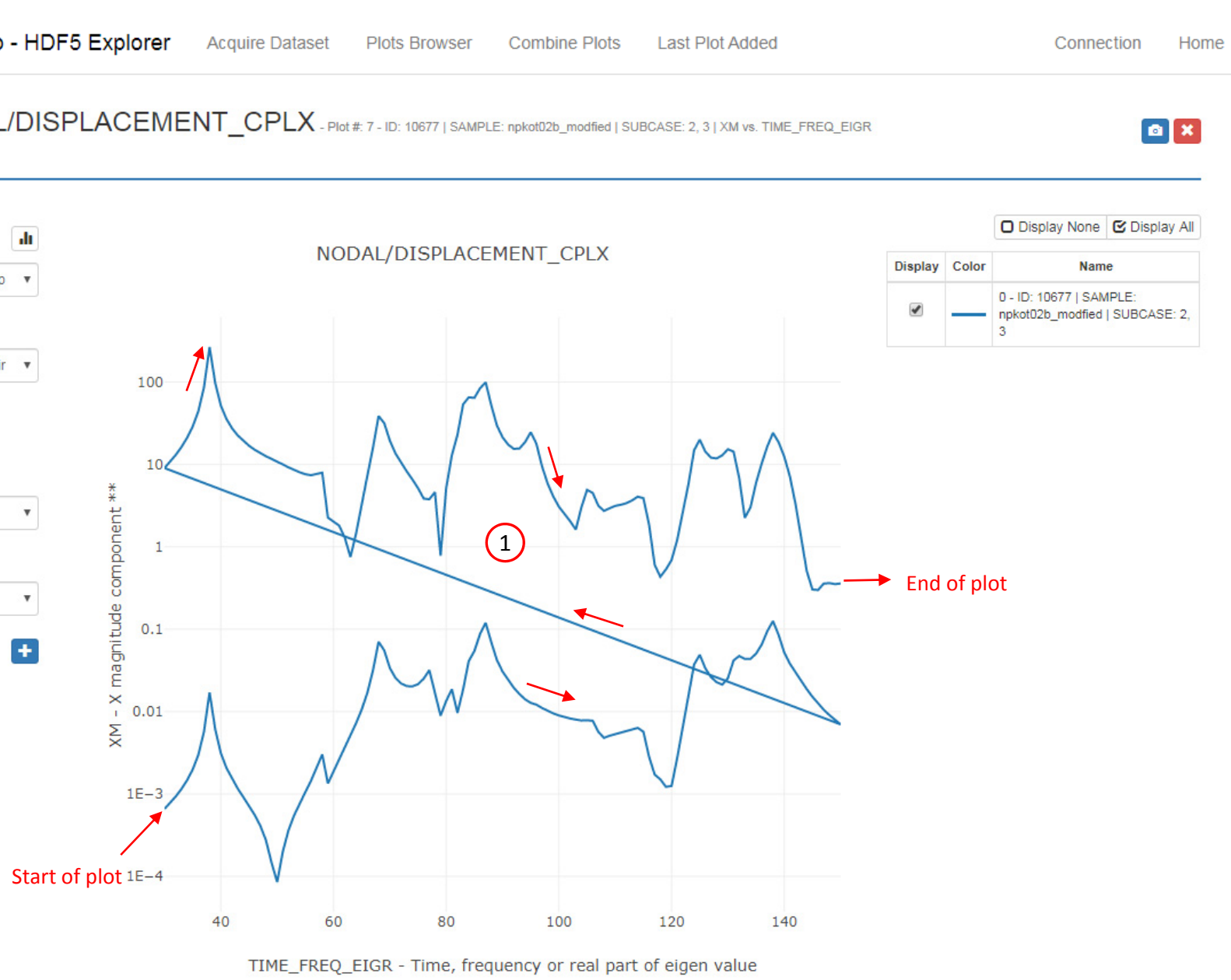


Separate Data for Plotting

1. The data is no longer separated and is one continuous plot. The plot will appear to loop.

To correct this behavior, separation criteria must be defined.

- The example shown is one case where the plot appears incorrect. The solution is to add criteria for Separate By.
- Refer to the Appendix for additional comments regarding the *Separate By* option

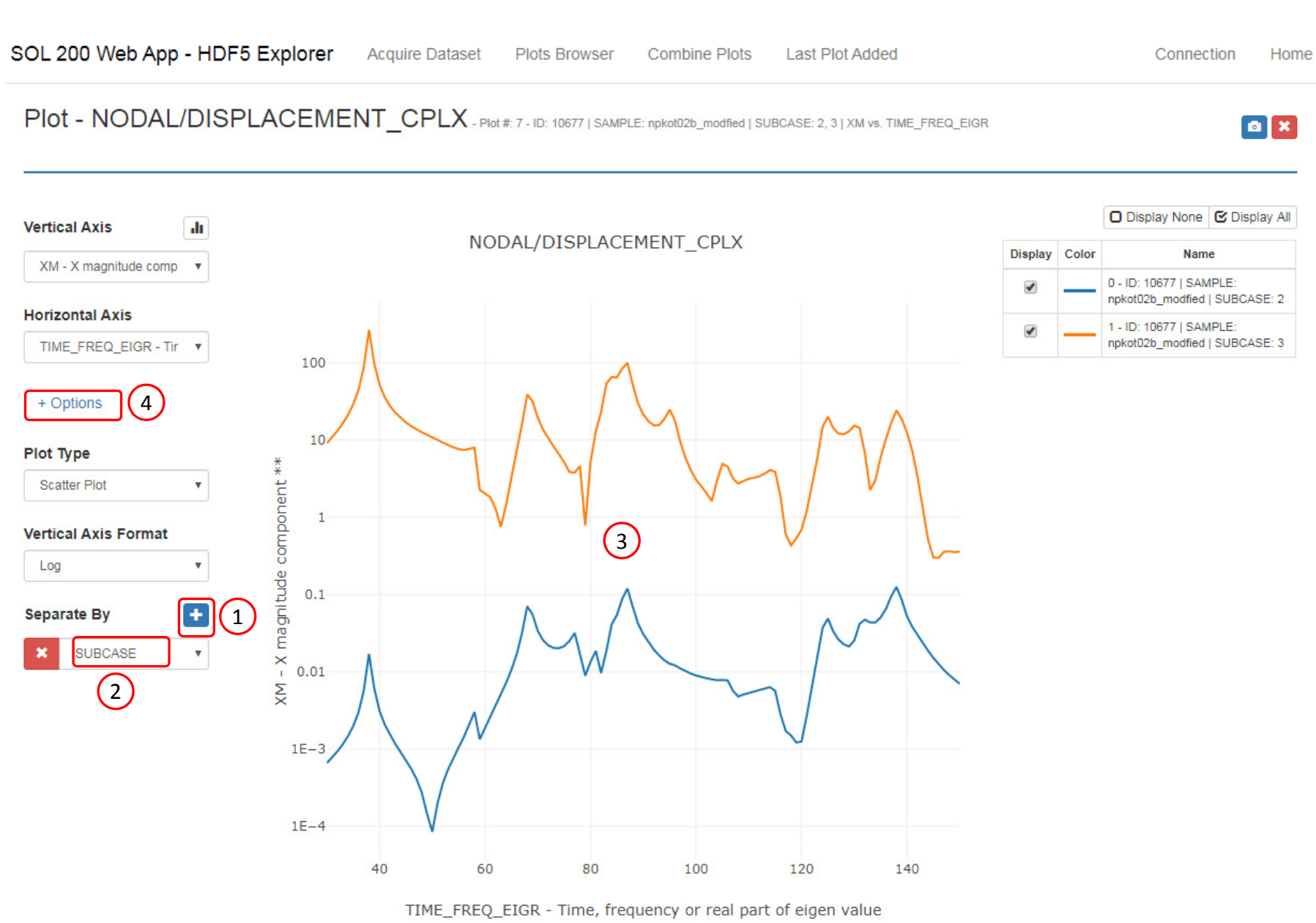


Separate Data for Plotting

The data is separated by Subcases as follows:

1. Click the plus [+] icon
2. Select Subcase
3. The plot is updated, but now the plots are separated by Subcase
4. Click +Options to hide the section

- After a new option for Separate By is created and set, the plot appears correct.
- Refer to the Appendix for additional comments regarding the *Separate By* option

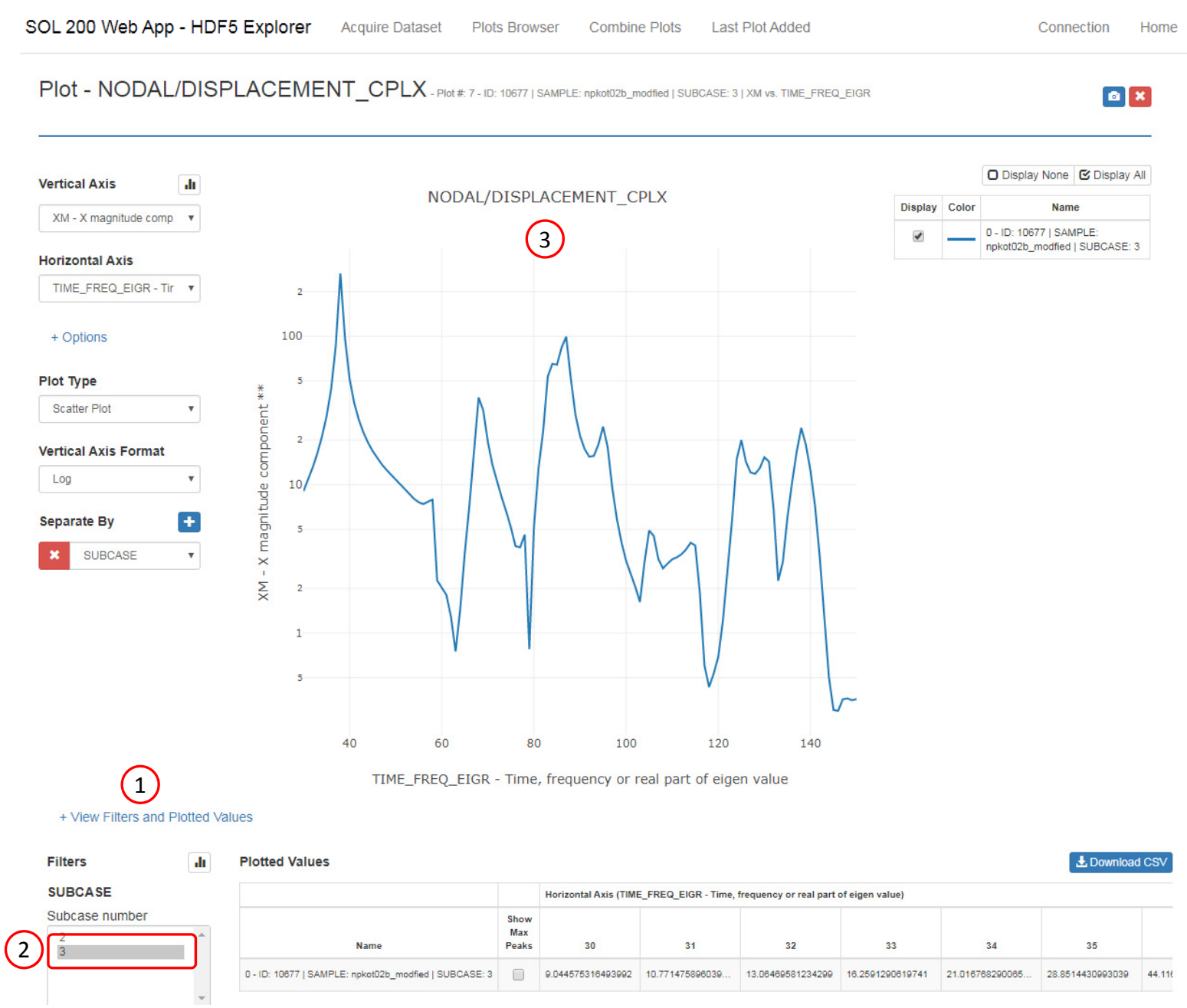


Filter Plots

Currently, plots for both Subcase 2 and 3 are plotted. A plot for only Subcase 3 can be displayed as follows.

1. Click +View Filters and Plotted Values
2. Select only Subcase 3
3. The plot is automatically regenerated and shows values for Subcase 3

- The filters are used to limit the data that is displayed in the plot and table titled Plotted Values.



Tutorial

PART B - CSV DOWNLOAD AND ADDITIONAL CAPABILITIES

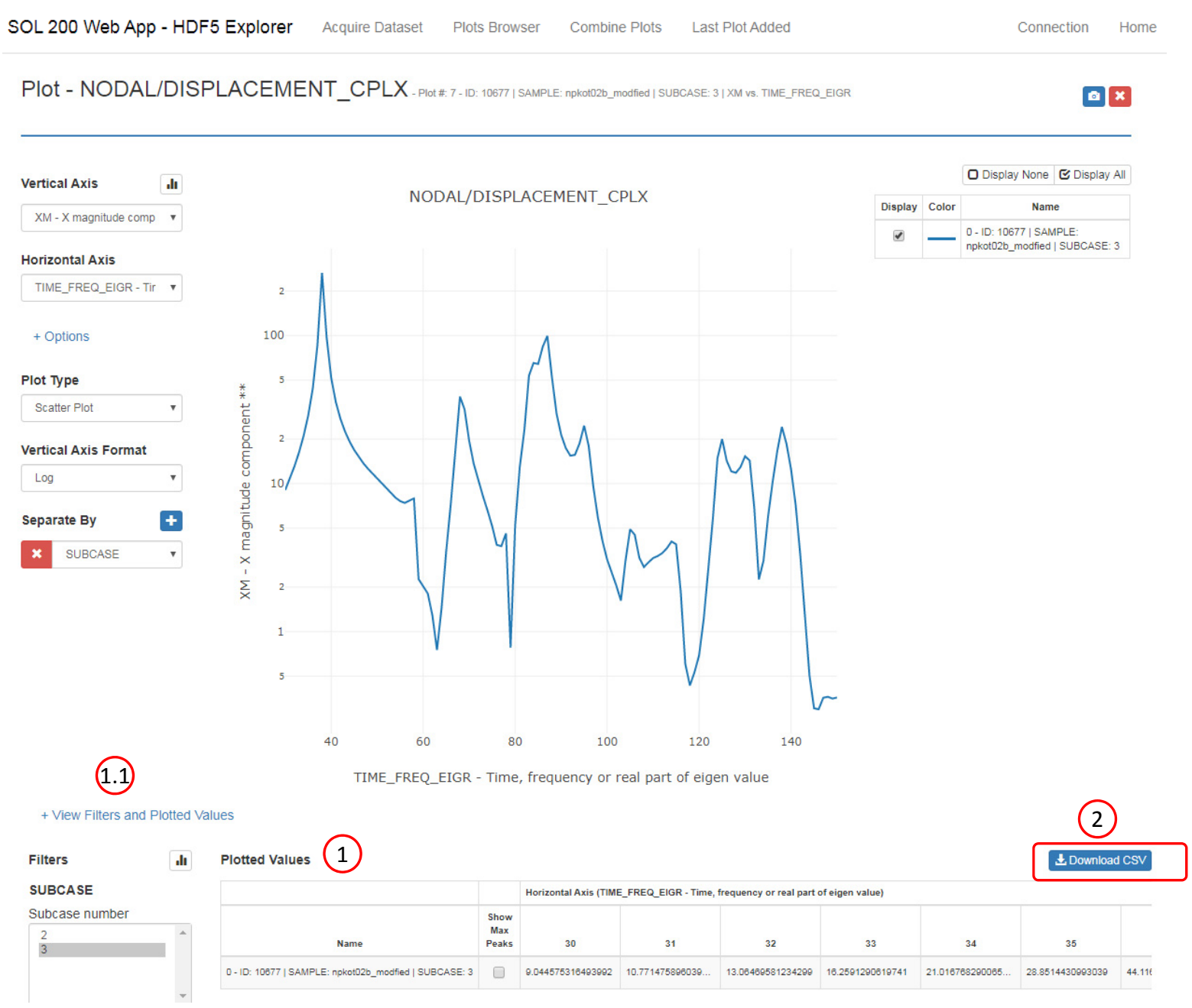
CSV Download of Plotted Values

Each plot has a corresponding table with plotted values and can be downloaded to a CSV file as follows:

1. A table of plotted values is displayed
    1. If the table is not visible, click + View Filters and Plotted Values
2. Click Download CSV

A .csv file has been downloaded to the desktop and can be opened in Excel.

- When using the HDF5 Explorer, multiple tables may be discovered. Each step has an option to download a CSV file.



Filter Acquire Dataset and Download CSV

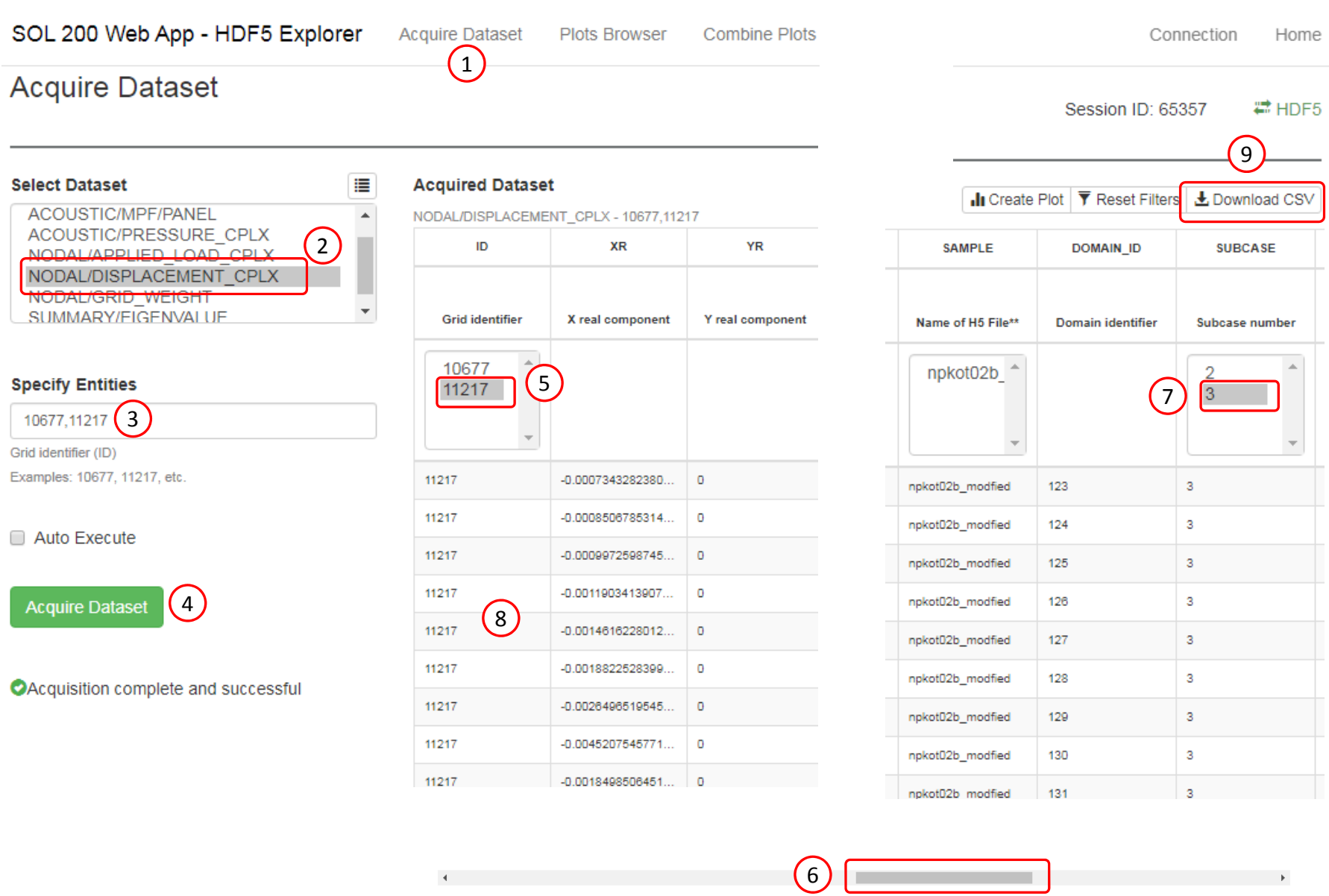
Manually extract DISPLACEMENT data for Grids 10677 and 11217

1. Click Acquire Dataset
2. Select the dataset named NODAL/DISPLACEMENT_CPLX
3. Specify the following Grid IDs: 10677, 11217
4. Click Acquire Dataset

The acquired dataset can be filtered to only display certain values. The following steps filter the data to only show data for Grid 11217 and Subcase 3

5. Select Grid 11217 in the ID column
6. Use the horizontal scroll bar to display the SUBCASE column
7. Select Subcase 3 in the SUBCASE column
8. The data in the table is now only for Grid 11217 and Subcase 3
9. Click Download CSV

A .csv file has been downloaded to the desktop and can be opened in Excel.



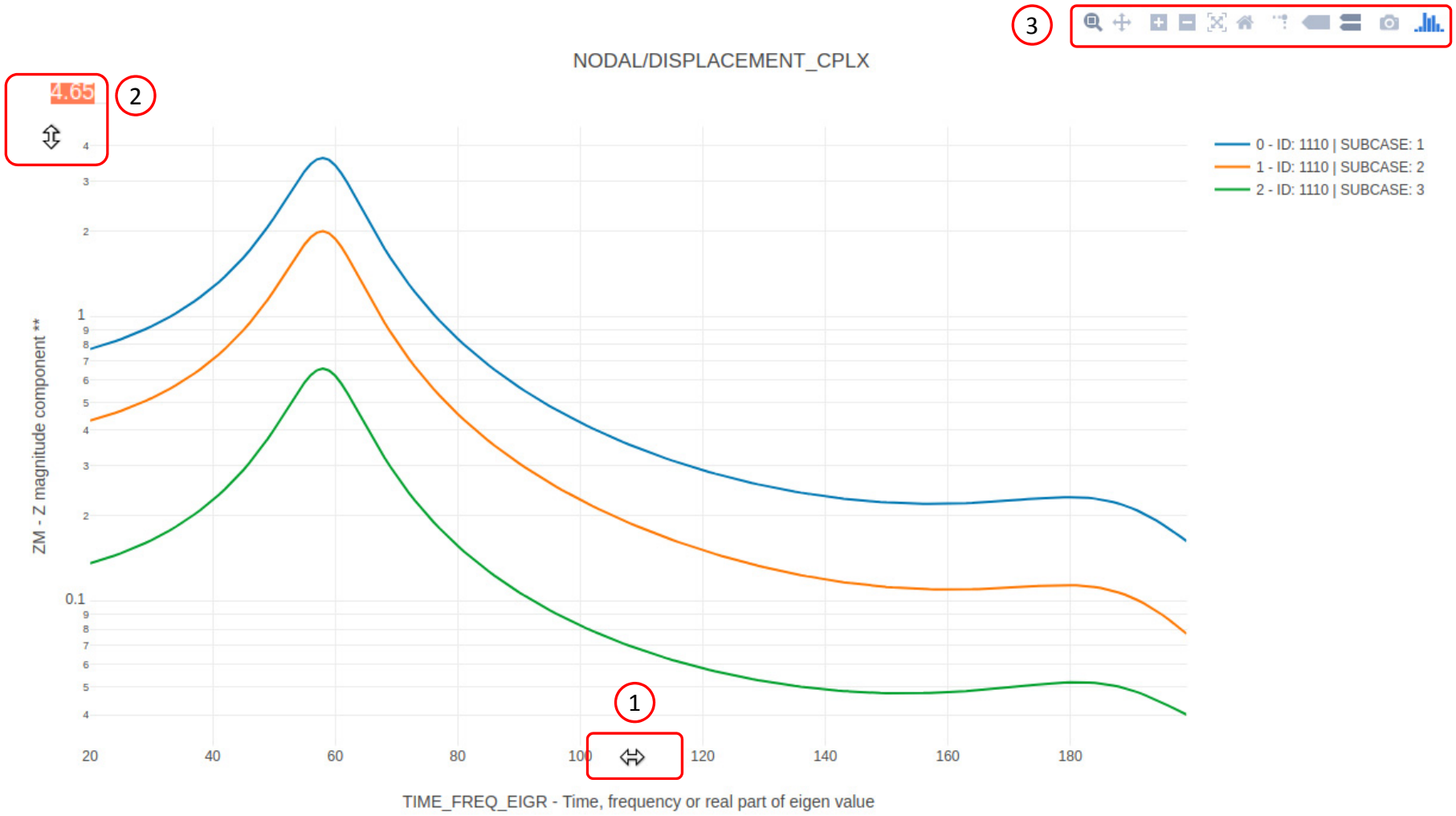
Other Tools

The plot itself has additional options that are worth mentioning.

1. The axis can be translated left/right or up/down. Do the following:
   - Move the mouse cursor to the axis until the cursor changes to a double arrow.
   - Press and hold the left mouse button. The axis can now be translated.

2. The range of axis values can be changed as follows:
   - Move the mouse cursor to the beginning or end of the axis until a double arrow appears
   - Once the double arrow appears, double click the mouse
   - A new box appears and a new value can be specified. In this example the value is 4.65.
   - Change the number and press the Enter Key to update the range of values

3. A bar of tools is also available that allows multiple functions such as panning, zooming in and out, etc. You are encouraged to explore these additional tools.



End of Tutorial

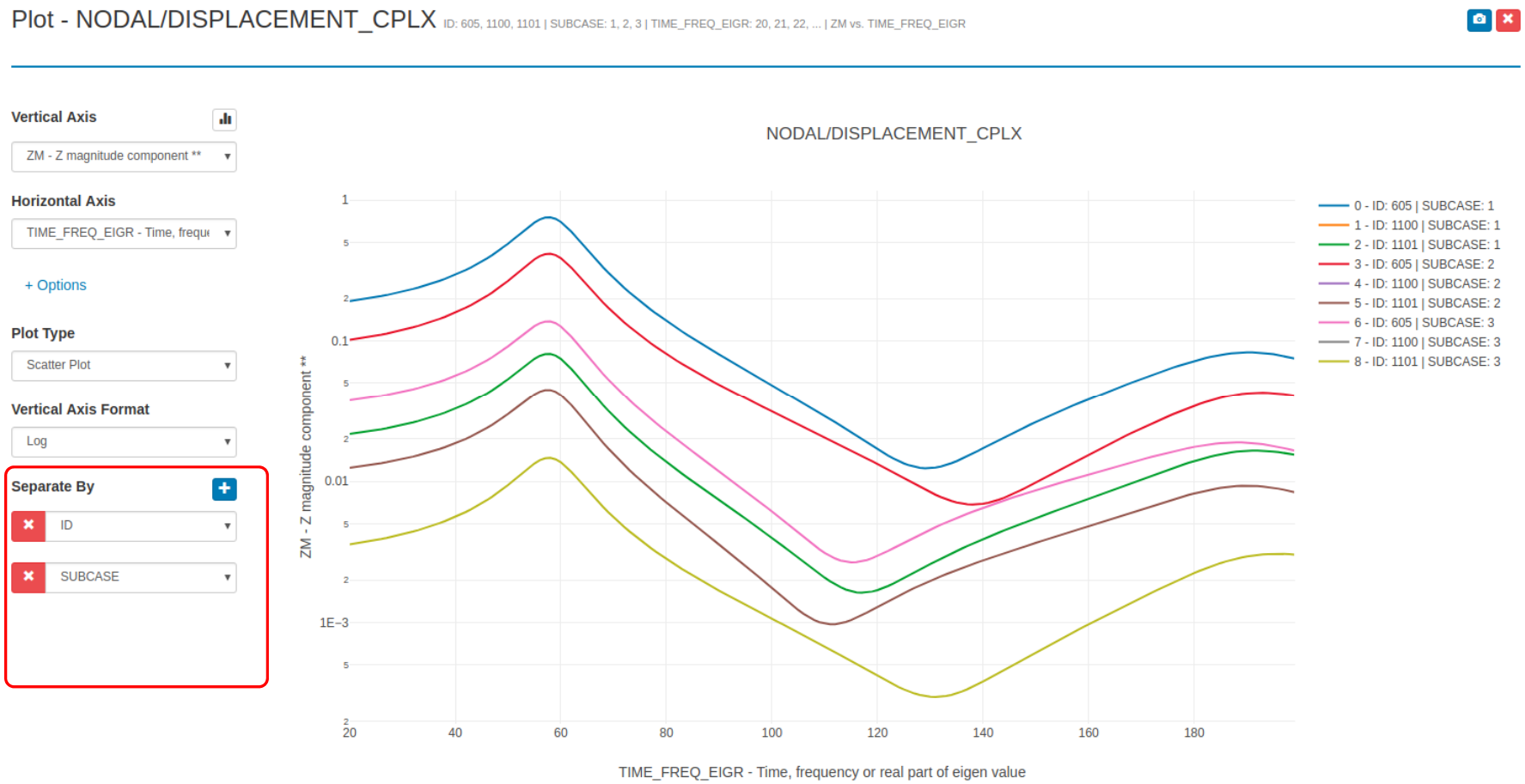
Appendix

Appendix Contents

- Separate By - Determines how the data is separated
- Filters - Control grid ID and Subcases to display

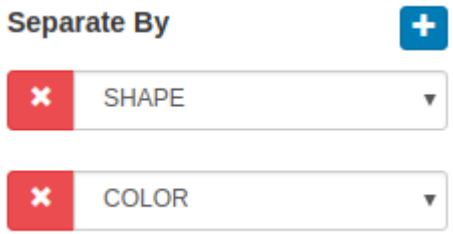
Separate By

Determines how the data is separated



Separate By

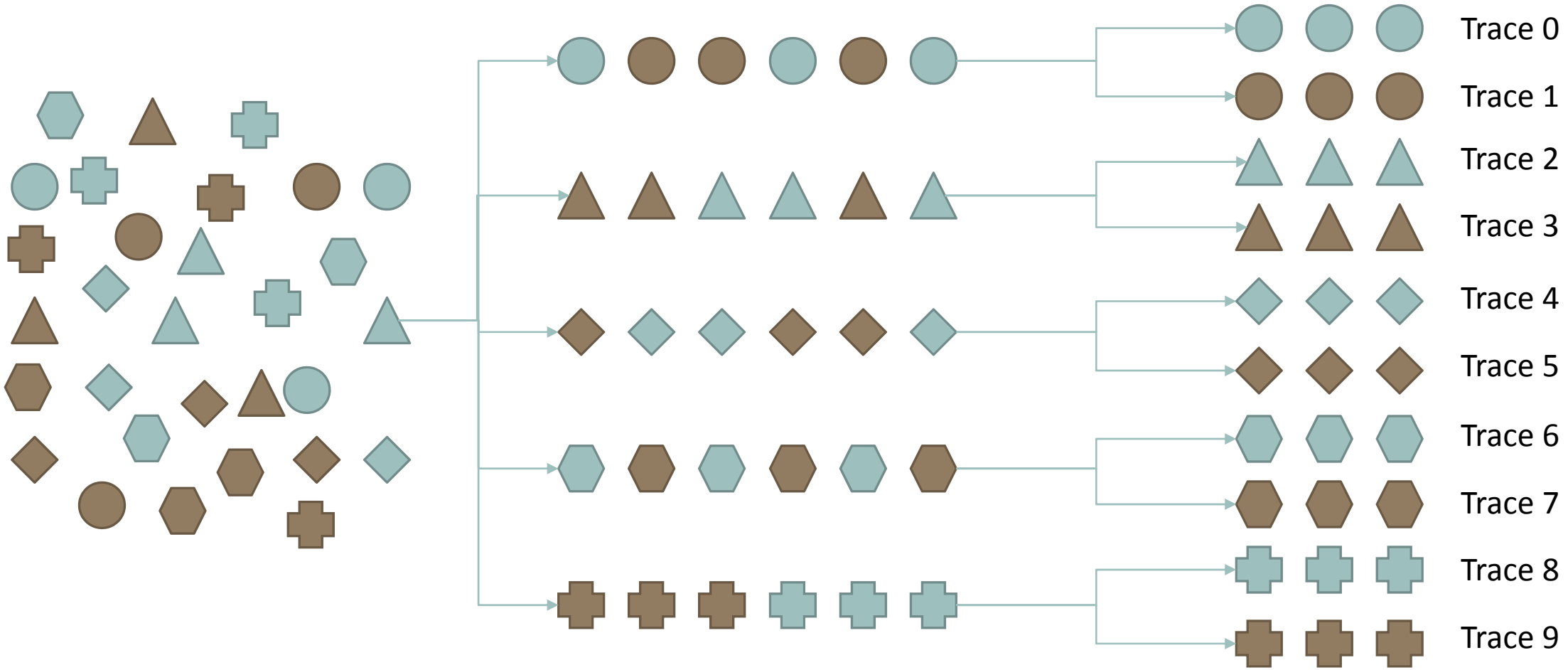
Determines how the data is separated



Starting Dataset

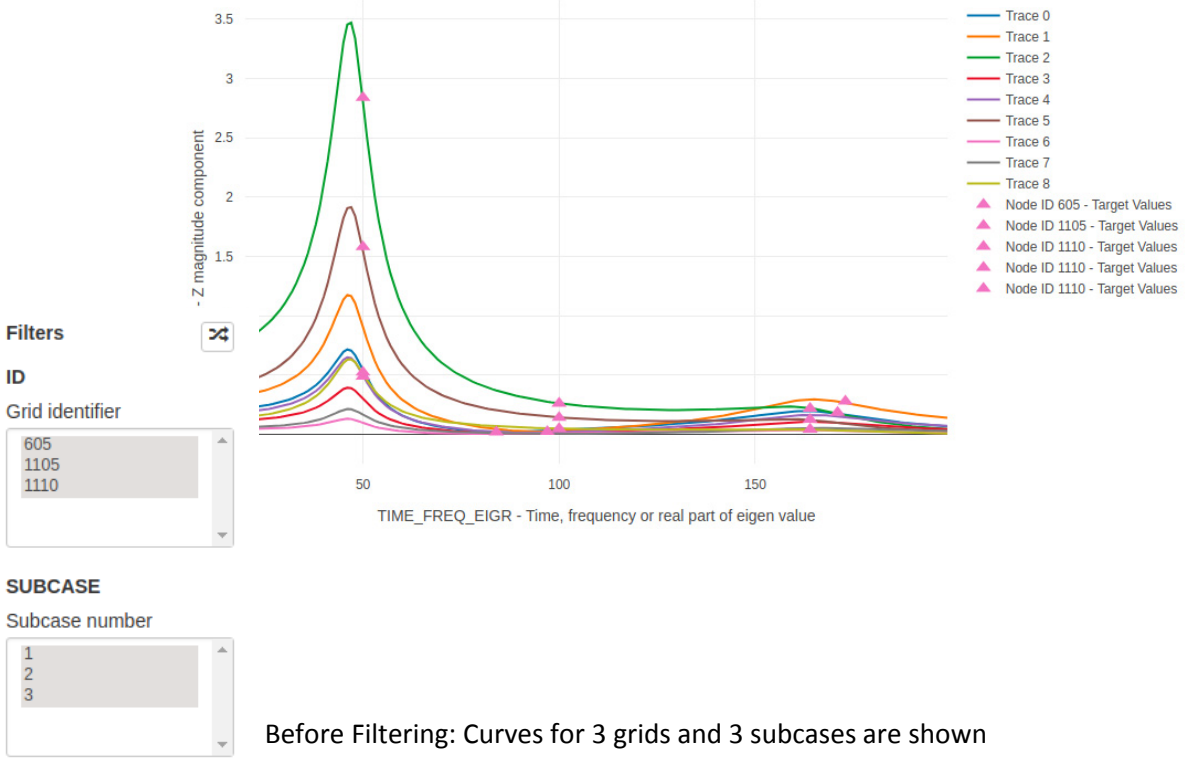
Previous data is separated by shape

Previous data is separated by color
The final separated data is used for plotting

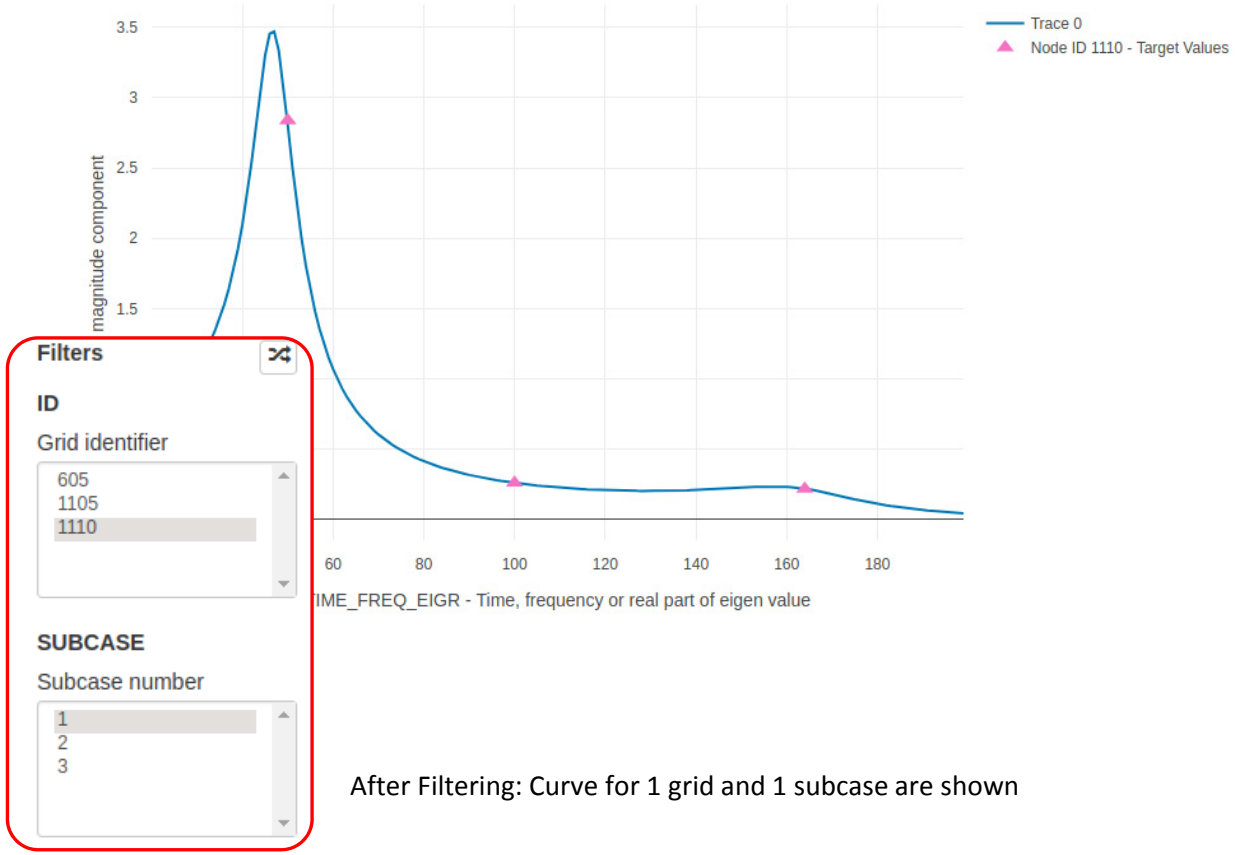


Filters

Control grid ID and Subcases to display



Before Filtering: Curves for 3 grids and 3 subcases are shown



After Filtering: Curve for 1 grid and 1 subcase are shown