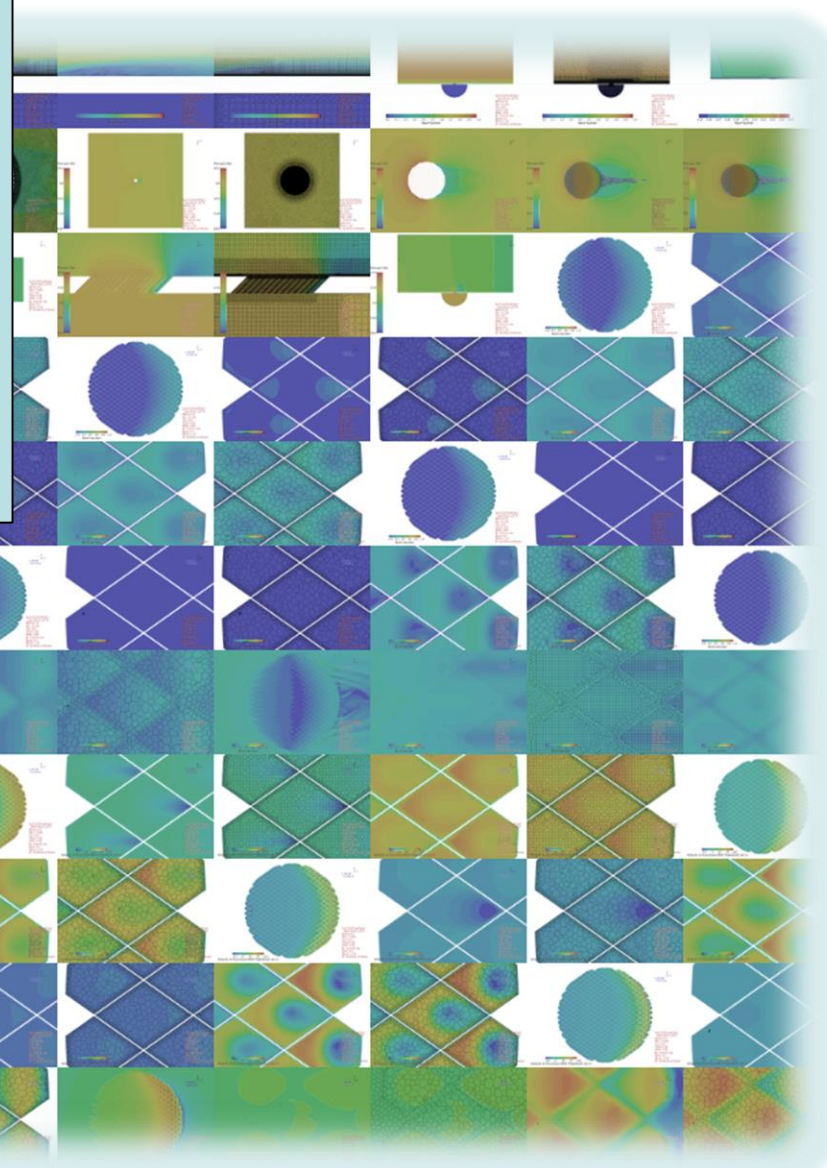


MiniWall Tool for Analyzing CFD and Wind Tunnel Large Data Sets

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Outline

- Motivation
- Main Image Table
- Multi-Image Window
- Single-Image Window
- Demonstration
- Help Window
- Configuration Files
- Summary & Conclusions

Motivation

Motivation

- Visualize large data sets
- Make comparisons between different “runs”
- Extract knowledge and understanding



2002
7x7

Inspired by NASA Ames NAS computer system hyperwall created in 2002

- Scalable concurrent visualization of Typhoon Morakot from different perspectives at the same time (left)
- Visualize large simulations (right)



2008
8x16





Motivation (continued)

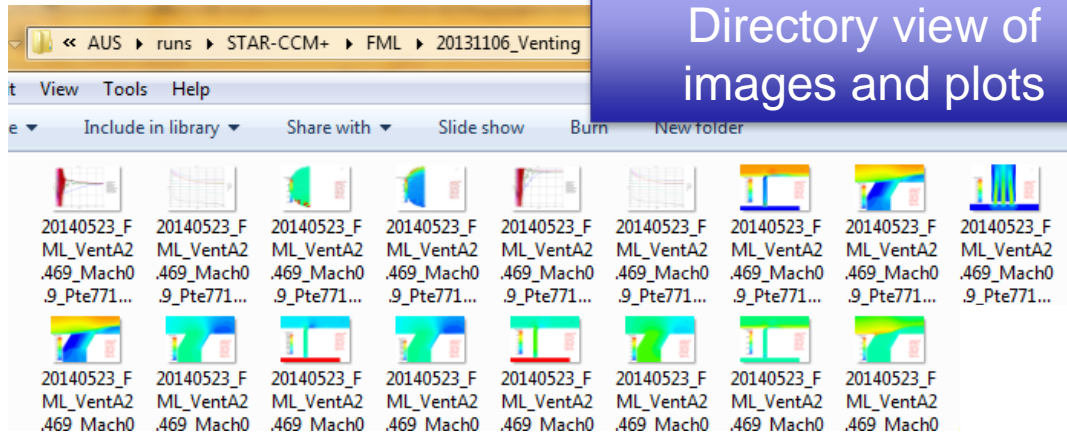
- CFD and Wind Tunnel tests typically have large run matrices
- Wanted to extract knowledge and understanding from gobs of data
- Needed a better way to view results buried in a bunch of folders

Configuration	Angle of Side Slip Attack	Angle	Mach	Altitude	Priority
Baseline-aircraft	-4	0	0.72	45	High
Baseline-aircraft	0	0	0.72	45	High
Baseline-aircraft	2	0	0.72	45	High
Baseline-aircraft	4	0	0.72	45	High
Baseline-aircraft	8	0	0.72	45	High
Baseline-aircraft	12	0	0.72	45	High
Baseline-aircraft	0	5	0.25	0	Med
Baseline-aircraft	4	0	0.25	0	Med
Baseline-aircraft	6	0	0.25	0	Med
Baseline-aircraft	8	0	0.25	0	Med
Baseline-aircraft	12	0	0.25	0	Med
Baseline-aircraft	0	5	0.25	0	Low
Baseline-aircraft	6	5	0.25	0	Low
Baseline-aircraft	0	10	0.25	0	Low
Baseline-aircraft	6	10	0.25	0	Low
Baseline-aircraft	0	15	0.25	0	Low
Baseline-aircraft	6	15	0.25	0	Low
Modified-aircraft	-4	0	0.78	45	High
Modified-aircraft	-2	0	0.78	45	High
Modified-aircraft	0	0	0.78	45	High
Modified-aircraft	2	0	0.78	45	High
Modified-aircraft	4	0	0.78	45	High
Modified-aircraft	6	0	0.78	45	High
Modified-aircraft	8	0	0.78	45	High
Modified-aircraft	10	0	0.78	45	High
Modified-aircraft	12	0	0.78	45	High

Full Run Matrix

Run Matrix Summary

Count of Mach	Column Labels	-4	-2	0	2	4	6	8	10	12	Grand Total
0.72		1		1	1			1		1	5
0.78		3	3	3	5	3	3	3	3	3	29
0.82		1		1	1			1		1	5
0.91					1						1
0.25				11		11					22
Grand Total		5	3	16	8	3	14	5	3	5	62

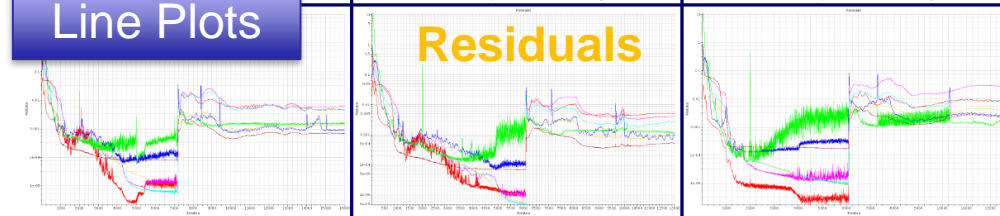
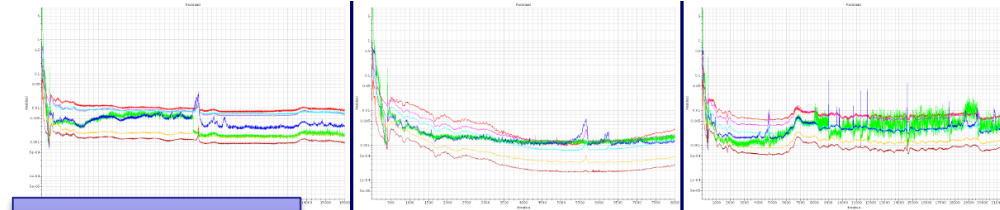
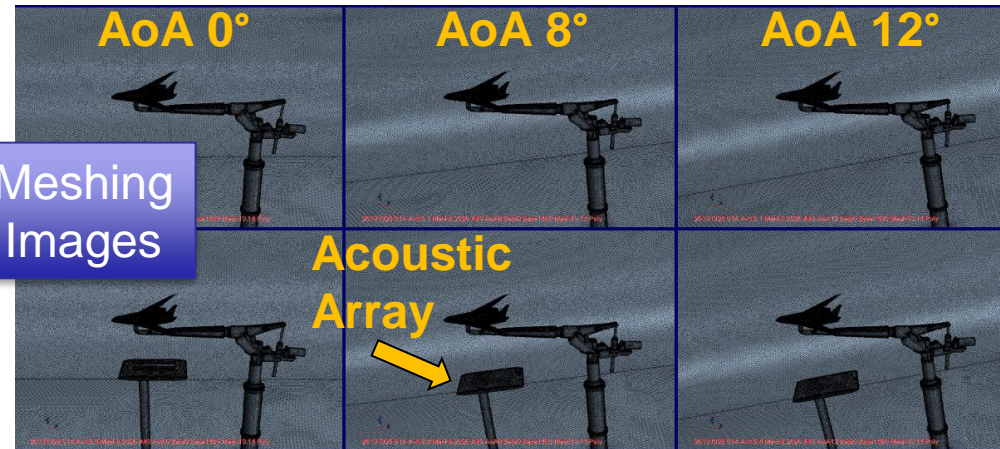


Directory view of images and plots

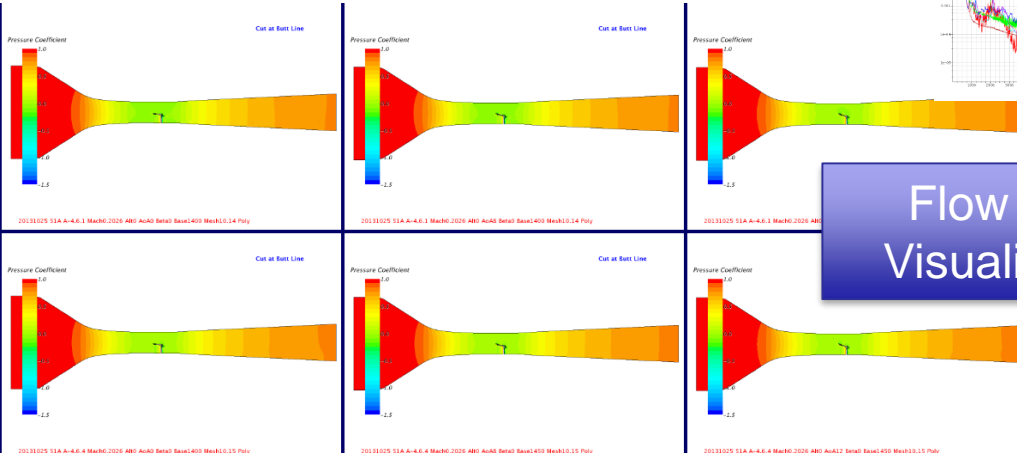
Motivation (continued)

The MiniWall

- Provides for easy and interactive data exploration (slice & dice)
- Allows many images to be displayed simultaneously
- Displays results in the natural context of the test – i.e. Mach versus AoA
- Allows drilling down into the data
- Share the data with others and enable them to explore the data



Pressure in 40'x80' NASA Wind Tunnel





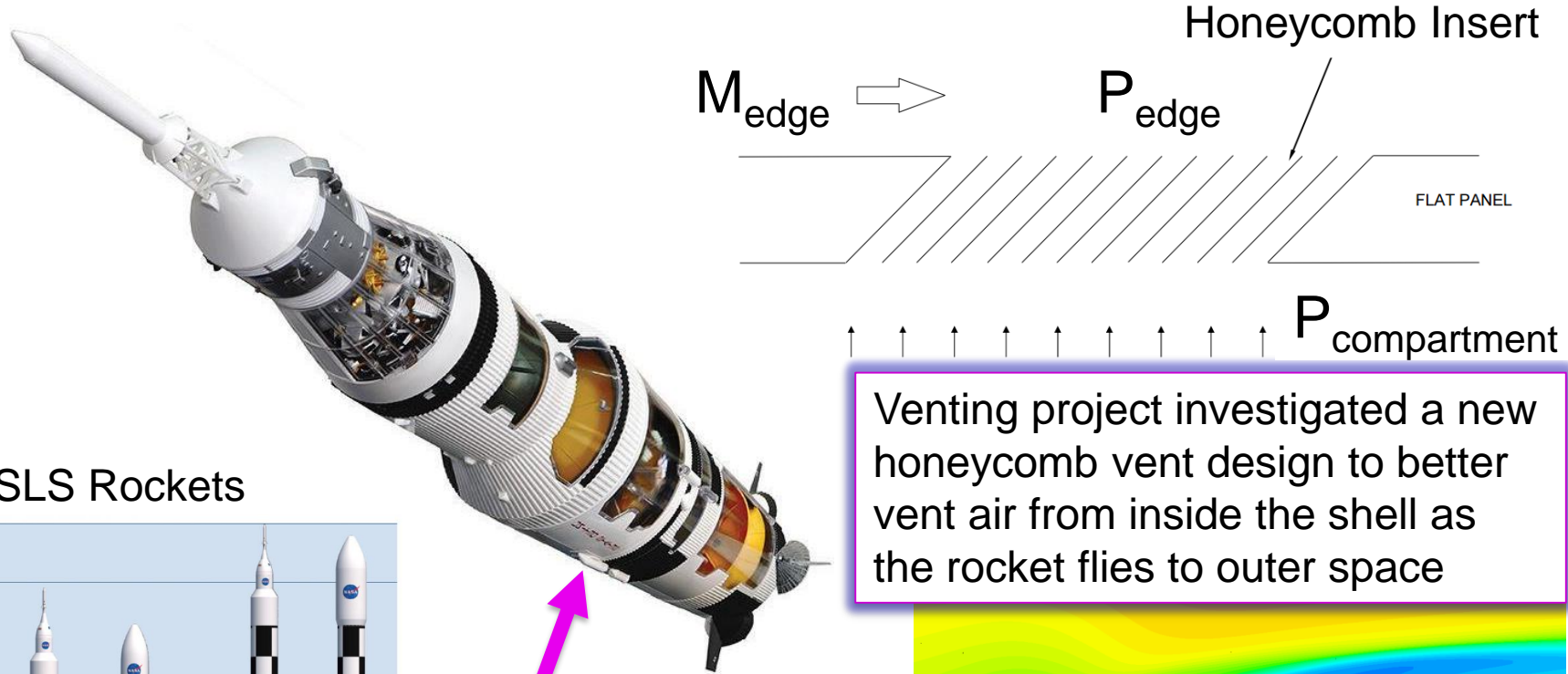
Software History

- Originally written in 2006 by John Melton in Microsoft's ActiveX and JavaScript software. Only ran on Windows computers.
- Paul Stremel rewrote it several years later using JavaScript. This enabled MiniWall to run many different kinds of computers and devices.
- Michael Schuh rewrote it in 2016 to use JavaScript objects and added several new features. Started serving up the pages using webserver nginx and https.



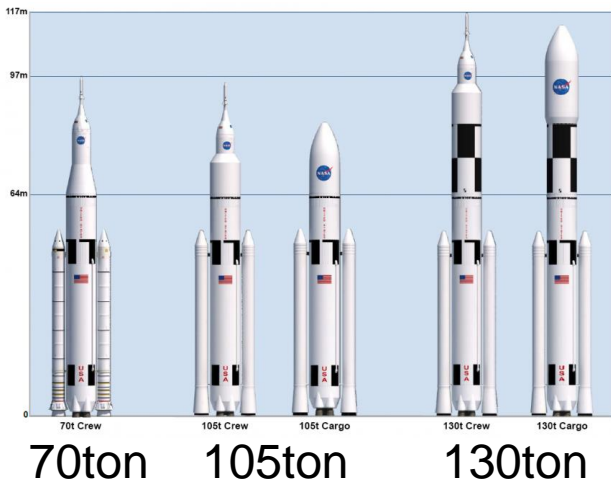
SLS Venting Project

- The images in the paper and demonstration are from the NASA Space Launch System (SLS) venting project

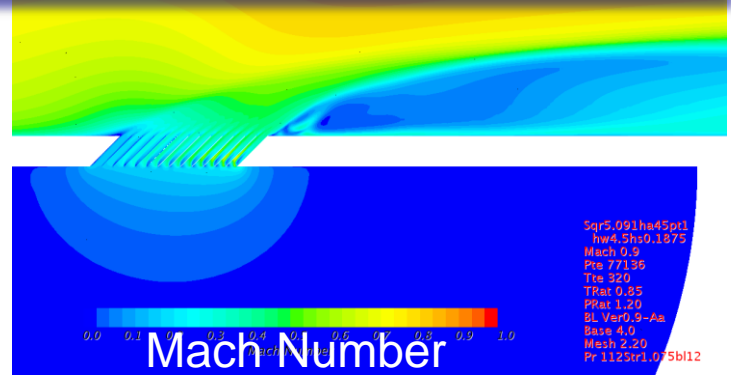


Venting project investigated a new honeycomb vent design to better vent air from inside the shell as the rocket flies to outer space

NASA SLS Rockets



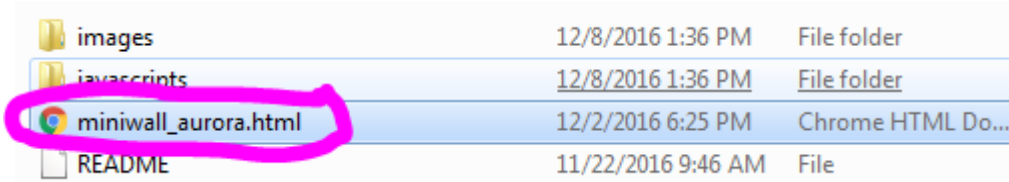
Apollo Saturn V Cutaway showing air space between internal components and shell



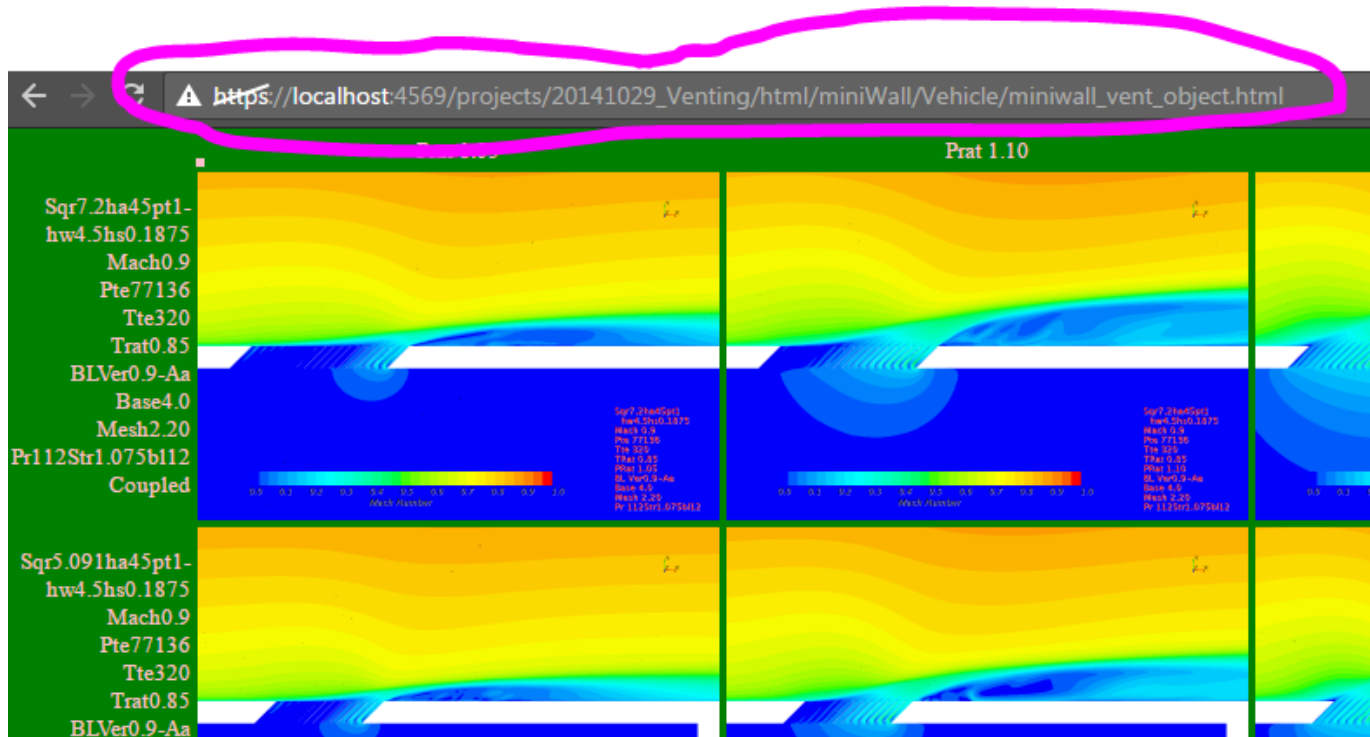
How to View a MiniWall

- MiniWall can be opened from a local html file or URL

- File



- URL example, the MiniWall below is being served by an HTTP server through an SSH tunnel. The page requires a user name and password to be accessed.



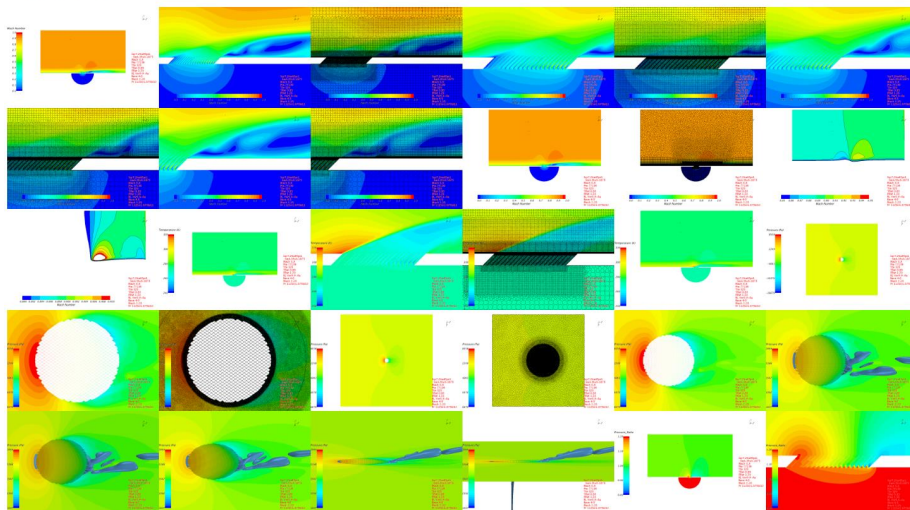


Three Main Views

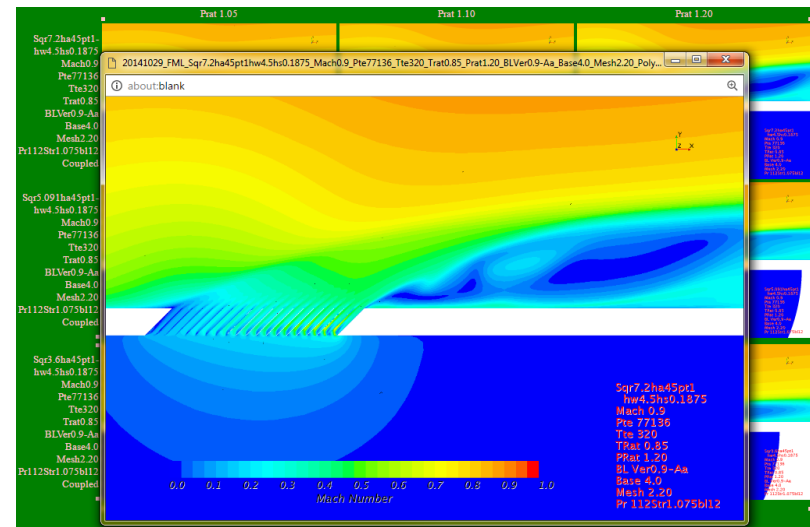
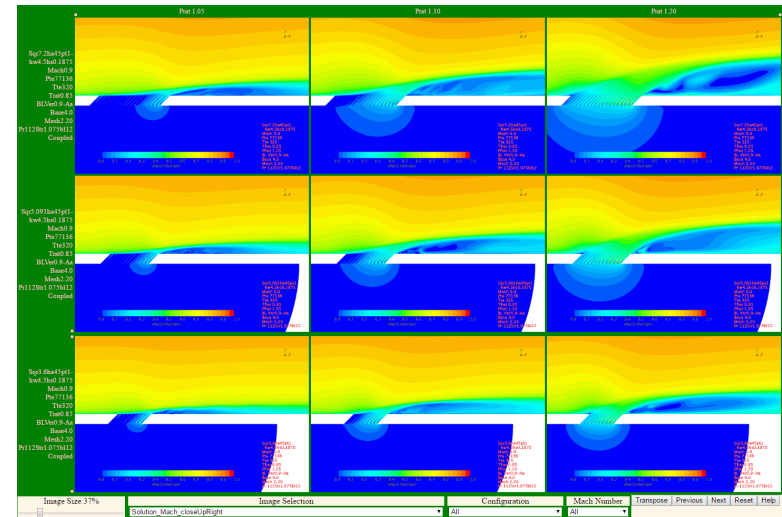
Main Image Table

Multi-image Window

20141029_FML_Sqr7.2ha45pt1hw4.5hs0.1875_Mach0.9_Pte77136_Tte320_Trat0.85_Pratt1.20_BLVer0.9-Aa_Base4.0_Mesh2.20_Poly_Pr112Str1.075bl12_Coupled - 20%



Single-image Window



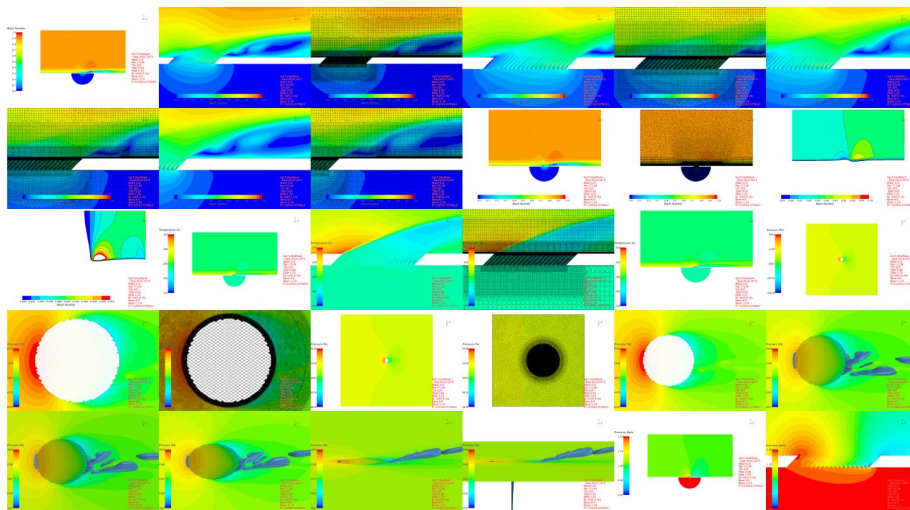


Three Main Views

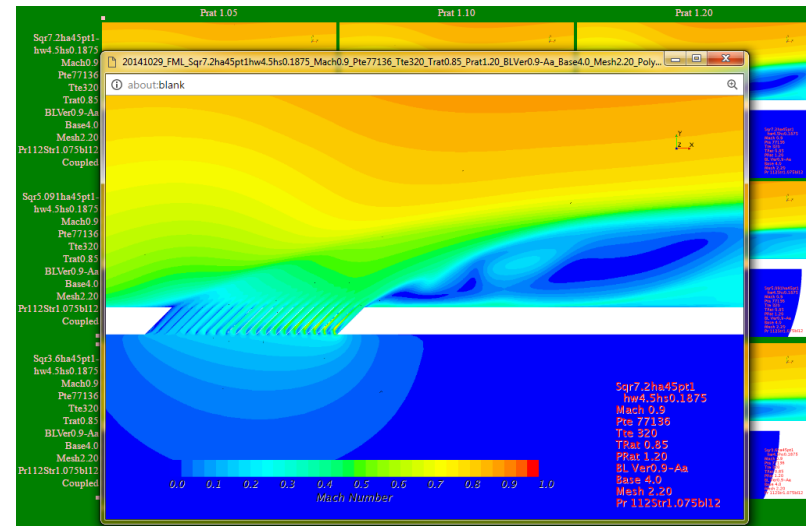
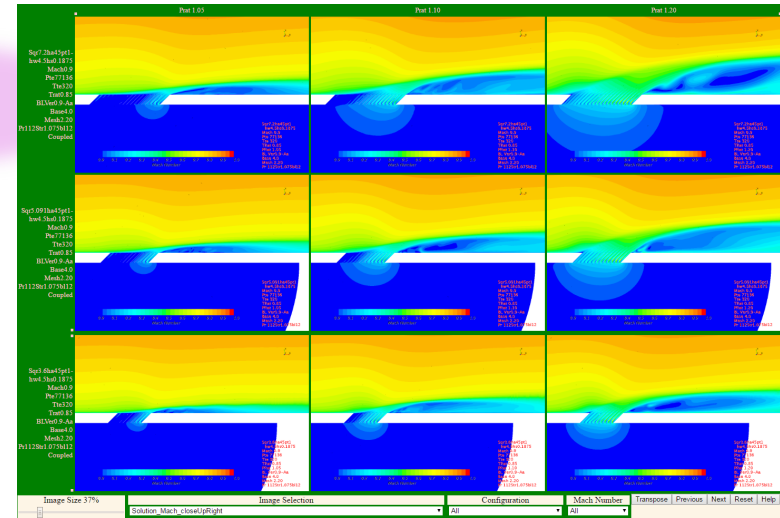
Main Image Table

Multi-image Window

20141029_FML_Sqr7.2ha45pt1hw4.5hs0.1875_Mach0.9_Pte77136_Tte320_Trat0.85_Pratt1.20_BLVer0.9-Aa_Base4.0_Mesh2.20_Poly_Pr112Str1.075bl12_Coupled - 20%



Single-image Window

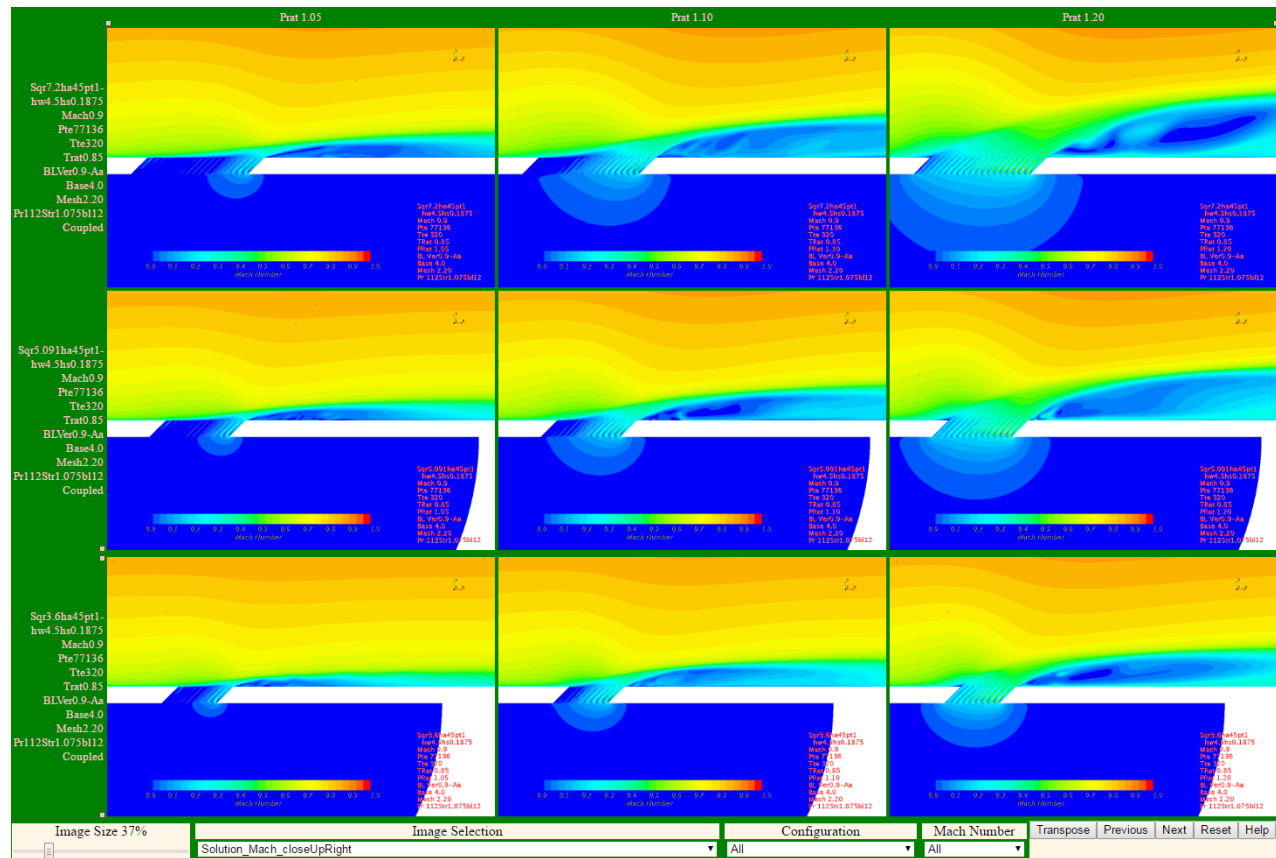


Main-Image Table

- User first sees the Main-Image Table
- CFD simulations of a honeycomb vent design analyzed for the Space Launch System (SLS) rocket

Pressure Ratio

Geometry
(Different vent
diameters)



Main-Image Table Controls

- Controls are located at the bottom of the screen
- Also controlled by the mouse and keyboard

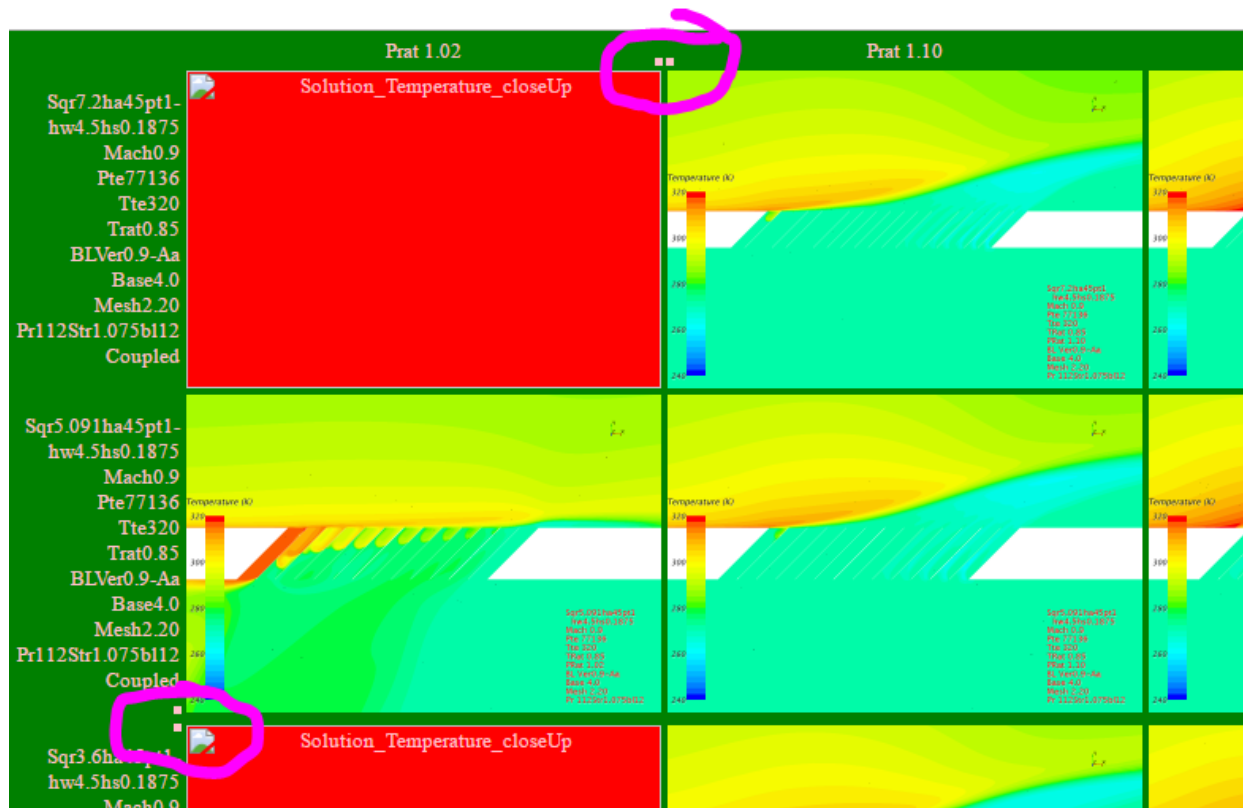
The screenshot displays a grid of simulation results for Mach number close-up views. The grid is organized by Prandtl number (Prat) and configuration. The bottom of the screen features a control table with the following data:

Image Selection	Configuration	Mach Number
Sqr5.091ha45pt1-hw4.5hs0.1875-Mach0.9-Prte77136-Tte320-Trat0.85-BLVer0.9-Aa-Base4.0-Mesh2.20-Pr112Str1.075b112-Coupled	All	All
Sqr5.091ha45pt1-hw4.5hs0.1875-Mach0.9-Prte77136-Tte320-Trat0.85-BLVer0.9-Aa-Base4.0-Mesh2.21-Pr112Str1.075b112-Coupled	Sqr3.6ha45pt1hw4.5hs0.1875 Sqr5.091ha45pt1hw4.5hs0.1875 Sqr7.2ha45pt1hw4.5hs0.1875	All 0.9 1.4

Arrows in the image point from the 'Image Selection', 'Configuration', and 'Mach Number' columns of the table to the corresponding image in the grid above.

Main-Image Table Controls

- Columns and rows can be hidden by clicking on the column or row title
- The “u” key unhides all hidden columns and rows
- Clicking on pink squares unhides a hidden column or row



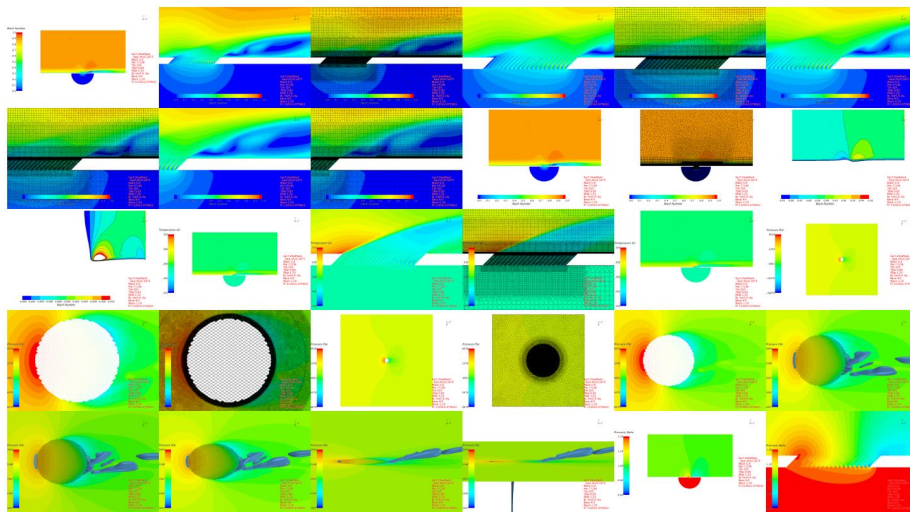


Three Main Views

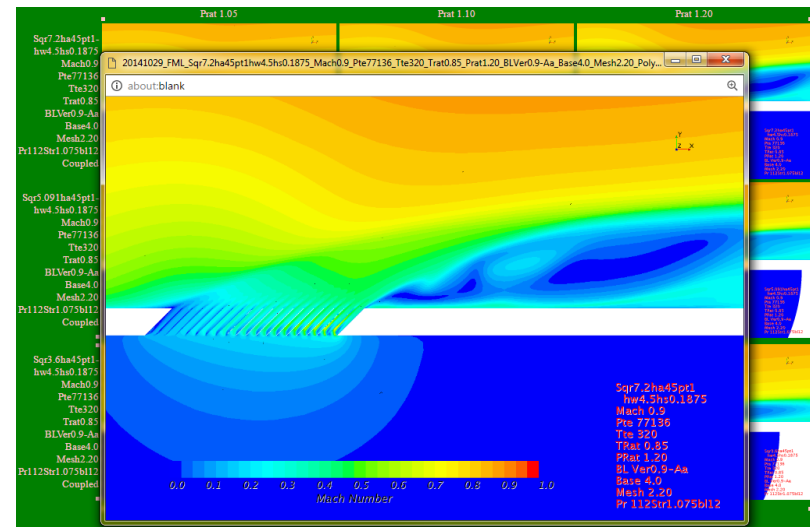
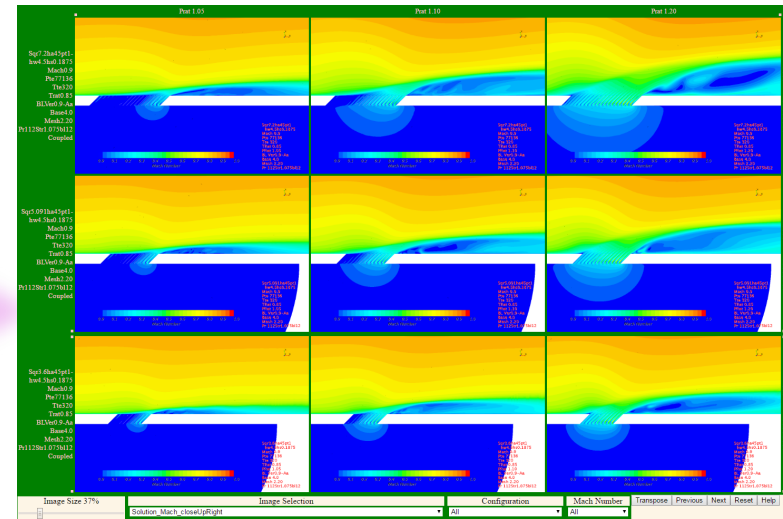
Main Image Table

Multi-image Window

20141029_FML_Sqr7.2ha45pt1hw4.5hs0.1875_Mach0.9_Pte77136_Tie320_Trat0.85_Pratt1.20_BLVer0.9-Aa_Base4.0_Mesh2.20_Poly_Pr112Str1.075bl12_Coupled - 20%



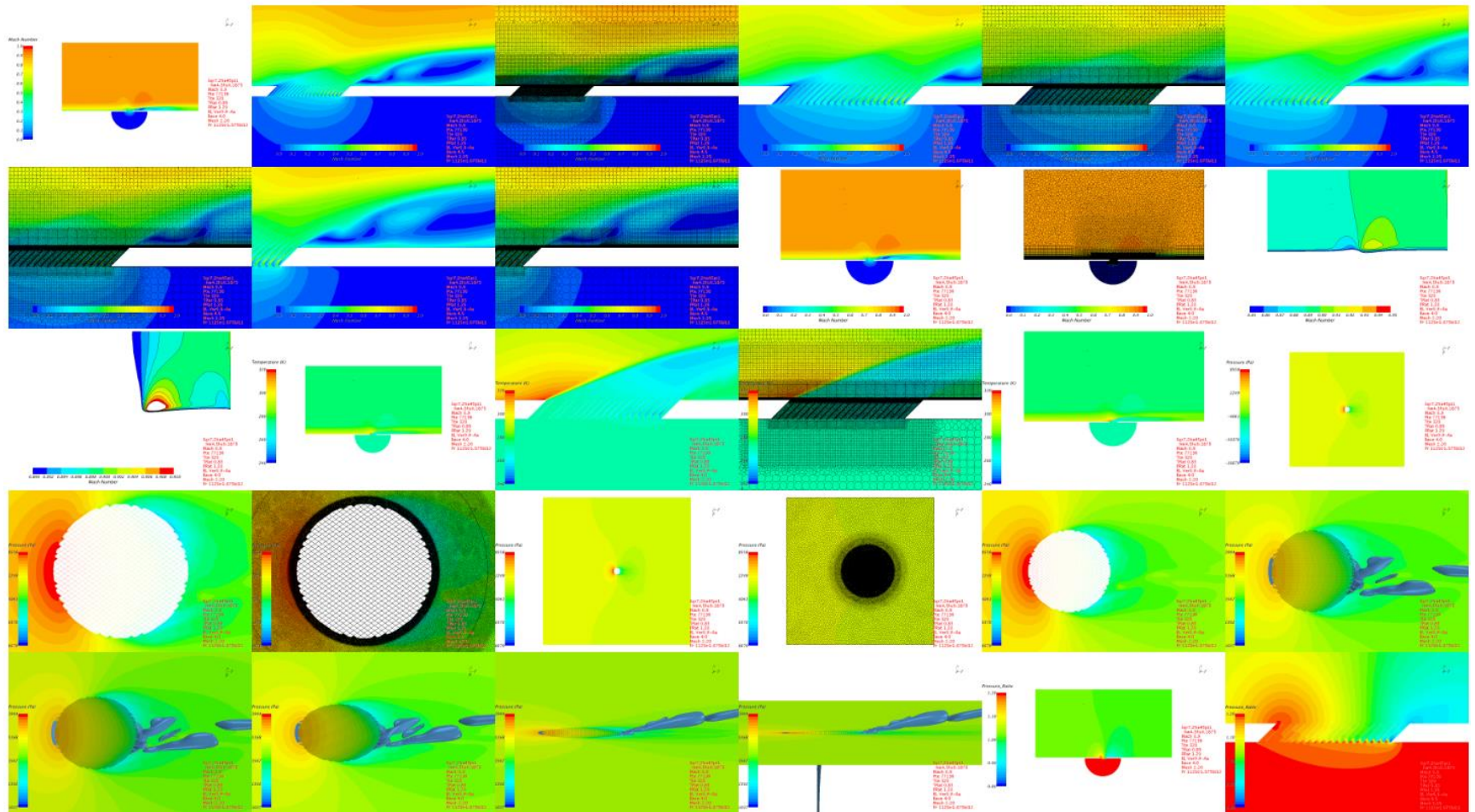
Single-image Window

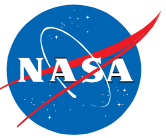


Multi-Image Window

- Shows all available images for a data set in main image table

20141029_FML_Sqr7.2ha45pt1hw4.5hs0.1875_Mach0.9_Pte77136_Tte320_Trat0.85_Prnt1.20_BLVer0.9-Aa_Base4.0_Mesh2.20_Poly_Pr112Str1.075bl12_Coupled - 20%



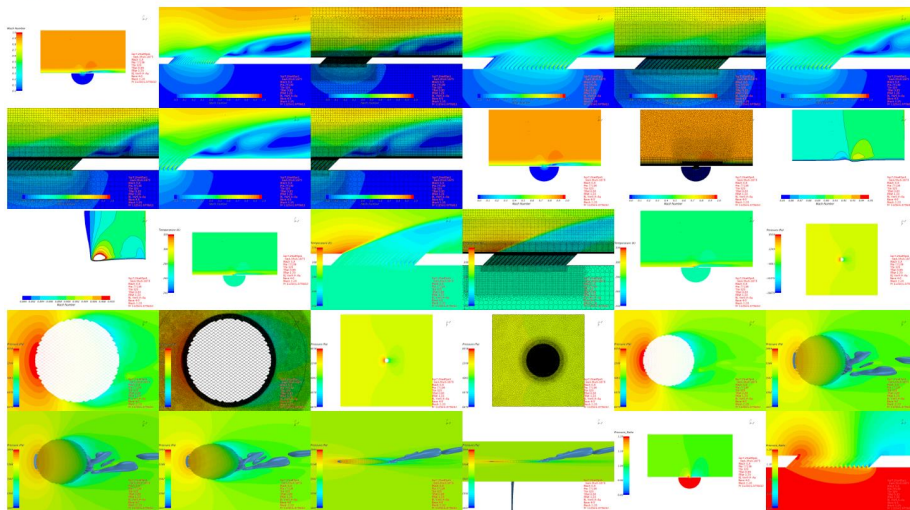


Three Main Views

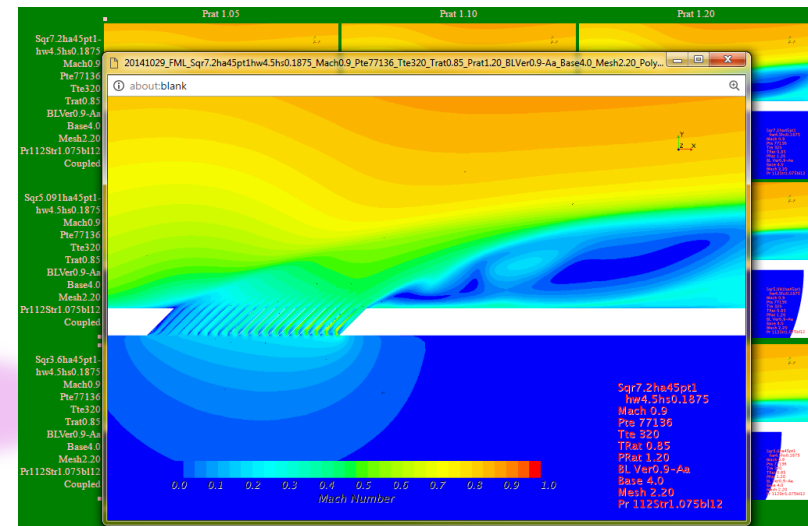
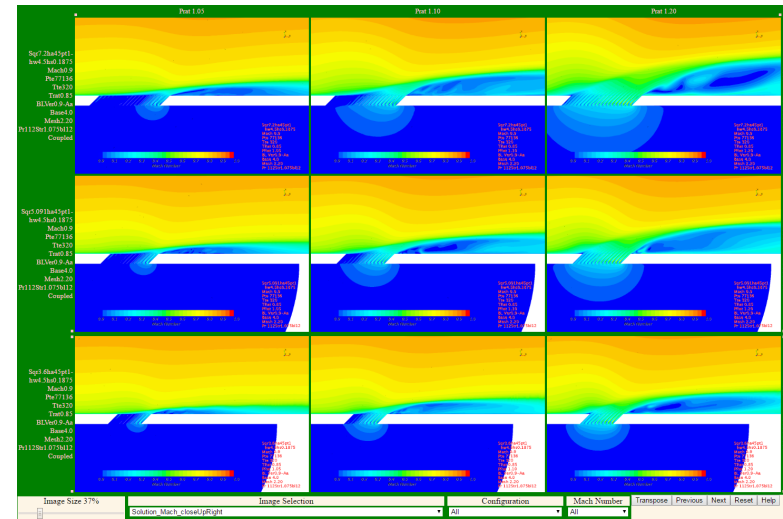
Main Image Table

Multi-image Window

20141029_FML_Sqr7.2ha45pt1hw4.5hs0.1875_Mach0.9_Pte77136_Tte320_Trat0.85_Pratt1.20_BLVer0.9-Aa_Base4.0_Mesh2.20_Poly_Pr112Str1.075bl12_Coupled - 20%

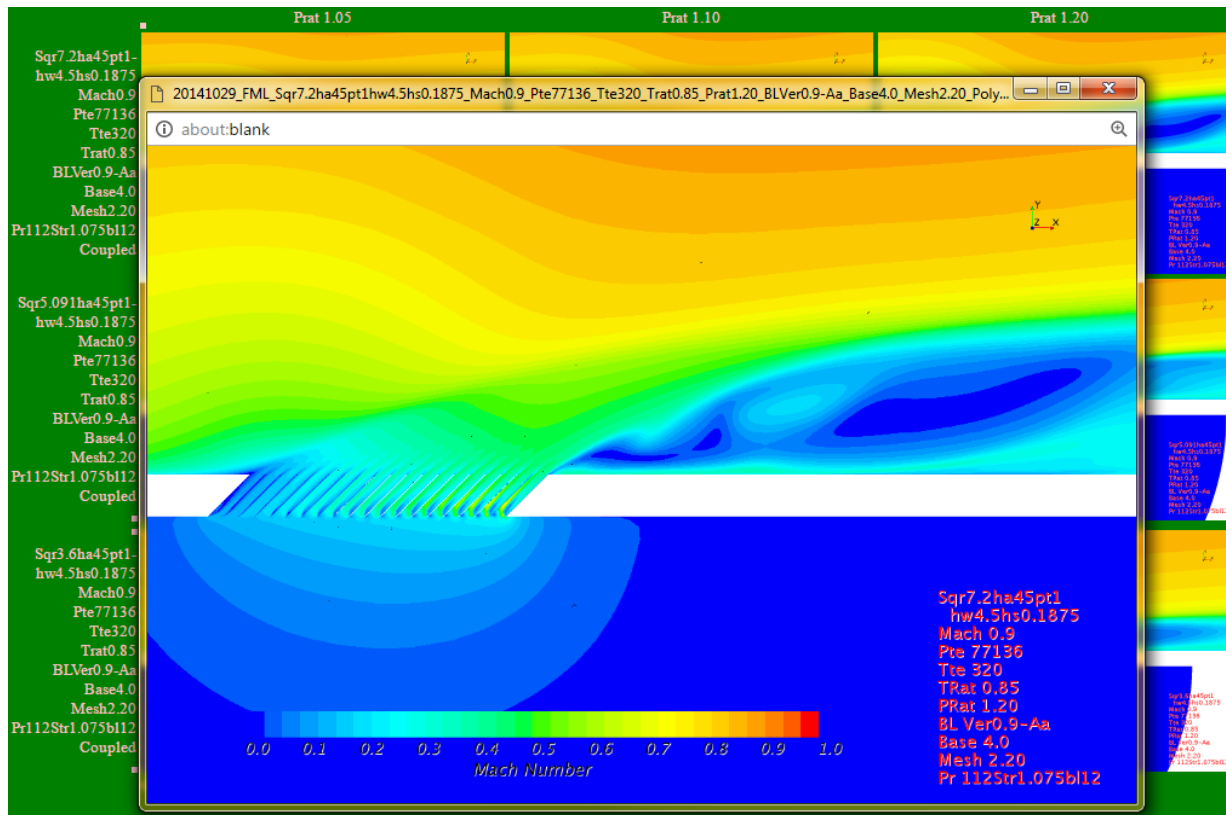


Single-image Window

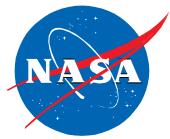


Single-Image Window

- Shows large view of image from main image table or multi-image window
- Use “Shift-left-mouse” click to open an image in a single-image window



Use “h” key for “help”



MiniWall Help

Brief list of keys for controlling the MiniWall behavior

Key and/or Mouse Click

Action

- a Show or hide all of the images that did not load in a multi-image window
- j Next image
- J Reduce the image scale by 1%
- Right-Arrow Next image
- Left-Mouse-Click Next image (only for the clicked image)
- h This help message
- k Previous image
- K Increase the image scale by 1%
- l Link all of the single image windows together so that they all show the same image. Currently false.
- L Link images together in all of the single image windows and the main image window so that they all show the same image. Currently false.
- Ctrl-Left-Mouse-Click Previous image (only for the clicked image)
- Left-Arrow Previous image
- Shift-Left-Mouse-Click Open a new window with the current image. Works in main image table and multi-image windows.
- Shift-Alt-Left-Mouse-Click Open a new multi-image window with all of the images for the image selected
- p Raise all of the single image windows. This will bring them to the top in the order they were opened.
- q Close the current help or single image window
- Q Close all of the single image and help windows
- r For the main table window, reset the images to have the original image size of 40%. For the single image windows, reset the size to 100%
- R Link or unlink all of the single image windows resize events together. Currently false with size undefined%.
- t Transpose the table
- u Unhide all of the hidden rows and columns in the main image table
- Left-Click on row or column title Hide all of the images in the given row or column
- Unhide all of the images in the next or previous row or column. The yellow box is only present when a column or row is hidden.

Multi-Image Window

- Shift-Left-Mouse-Click Open a new single image window with the current image. Works in main image table and multi-image windows.
- Left-Mouse-Click Set the image in the main image table to the selected image by default. If the "l" link single images option is active, then set the images in the single image windows to the selected image. If the "L" link all images option is active, then set the images in the single image windows and the main image window to the selected image.

Configuration – MiniWall.html

- MiniWall.html file is used to make main-image table
- Specifies two JavaScript files used to setup and run the MiniWall
- Has a few configuration parameters

```
1 <HTML>
2 <HEAD>
3   <script src="javascripts/utils_object.js"> </script>
4   <script src="javascripts/setup_vent_object.js"> </script>
5 </SCRIPT>
6 /*
7  * Michael Schuh
8  * NASA Ames Research Center Code AA
9  * Moffett Field, CA 94035
10 *
11 * MiniWall Software
12 * 2016-04-14 Version 2.1 Inspired by the MiniWall created by John Melton in 2006 and reworked by Paul Stremal
13 */
14 // Initial values to select the initial image and scaling of the images.
15 // The first index in a list is "0"
16 initial_image_index = 205;
17 initial_size_in_percent = 25;
18 initial_selected_configuration_index = 0;
19 initial_selected_mach_number_index = 0;
20 miniwall_page_tab_name = "Venting MiniWall";
21 // Tell the utils_object.js tools what type of miniwall controls to use
22 miniwall_type = "venting";
23 </SCRIPT>
24 </HEAD>
25 <BODY onLoad="createObjectTablePage();"> </BODY>
26 </HTML>
```

Loads the
JavaScript files

Sets some initial values

“onLoad” method creates
the Main Image Table

Configuration – Setup_vent_object.html

- Defines lists of data sets, column values, image names, and other control options

```

1 // Miniwall setup parameters
2 var row_data_sets = [];
3 // Mach 0.9
4 row_data_sets.push("Sqr7.2ha45pt1hw4.5hs0.1875:Mach0.9:Pte77136:Tte320:Trat0.85:BLVer0.9-Aa:Base4.0:Mesh2.20:Pr112Str1.075bl12_Coupled");
5 row_data_sets.push("Sqr5.091ha45pt1hw4.5hs0.1875:Mach0.9:Pte77136:Tte320:Trat0.85:BLVer0.9-Aa:Base4.0:Mesh2.20:Pr112Str1.075bl12_Coupled");
6 row_data_sets.push("Sqr5.091ha45pt1hw4.5hs0.1875:Mach0.9:Pte77136:Tte320:Trat0.85:BLVer0.9-Aa:Base4.0:Mesh2.20:Pr112Str1.075bl12_Coupled");
7 // Mach 1.4
8 row_data_sets.push("Sqr7.2ha45pt1hw4.5hs0.1875:Mach1.4:Pte73711:Tte320:Trat0.85:BLVer0.9-Aa:Base4.0:Mesh2.20:Pr112Str1.075bl14_Coupled");
9 row_data_sets.push("Sqr5.091ha45pt1hw4.5hs0.1875:Mach1.4:Pte73711:Tte320:Trat0.85:BLVer0.9-Aa:Base4.0:Mesh2.20:Pr112Str1.075bl14_Coupled");
10 row_data_sets.push("Sqr5.091ha45pt1hw4.5hs0.1875:Mach1.4:Pte73711:Tte320:Trat0.85:BLVer0.9-Aa:Base4.0:Mesh2.20:Pr112Str1.075bl14_Coupled");
11 [lines not shown]
12
13 var column_values = [];
14 column_values.push("1.02");
15 column_values.push("1.05");
16 column_values.push("1.10");
17 column_values.push("1.20");
18 [lines not shown]
19
20 var configuration_basename="20141029_FML"; // configuration name
21 var column_label_prefix="Prat"; // x-axis label (A for AoA, etc.)
22 var image_filename_extension="png";
23
24 var image_extension_names = \
25 [lines not shown]
26 Solution_Mach \
27 Solution_Mach_closeUpRight \
28 Solution_Mach_closeUpRightMesh \
29 Solution_Mach_closeUpTop \
30 Solution_Mach_closeUpTopMesh \
31 [lines not shown]
32 \
33 ";
34
35 var configurations = new Array();
36 configurations.push("All");
37 configurations.push("Sqr3.6ha45pt1hw4.5hs0.1875");
38 configurations.push("Sqr5.091ha45pt1hw4.5hs0.1875");
39 configurations.push("Sqr7.2ha45pt1hw4.5hs0.1875");
40
41 var mach_numbers = new Array();
42 mach_numbers.push("All");
43 mach_numbers.push("0.9");
44 mach_numbers.push("1.4");

```

Main image
table Rows

Main image
table Columns

Image Names

Main image table Configuration
selector values

Main image Mach
Number selector values



Summary & Conclusions

- Easy to work, share, and collaborate on large data sets
- Provides intuitive access to non-experts
- Transforms data into knowledge and understanding
- Enables viewing the data in the natural context of the test
- Runs on many devices
- Data can be served remotely and protected by SSH and passwords
- Can be used with any data that can be displayed in an HTML page
- Investigating the software release process to make the MiniWall available