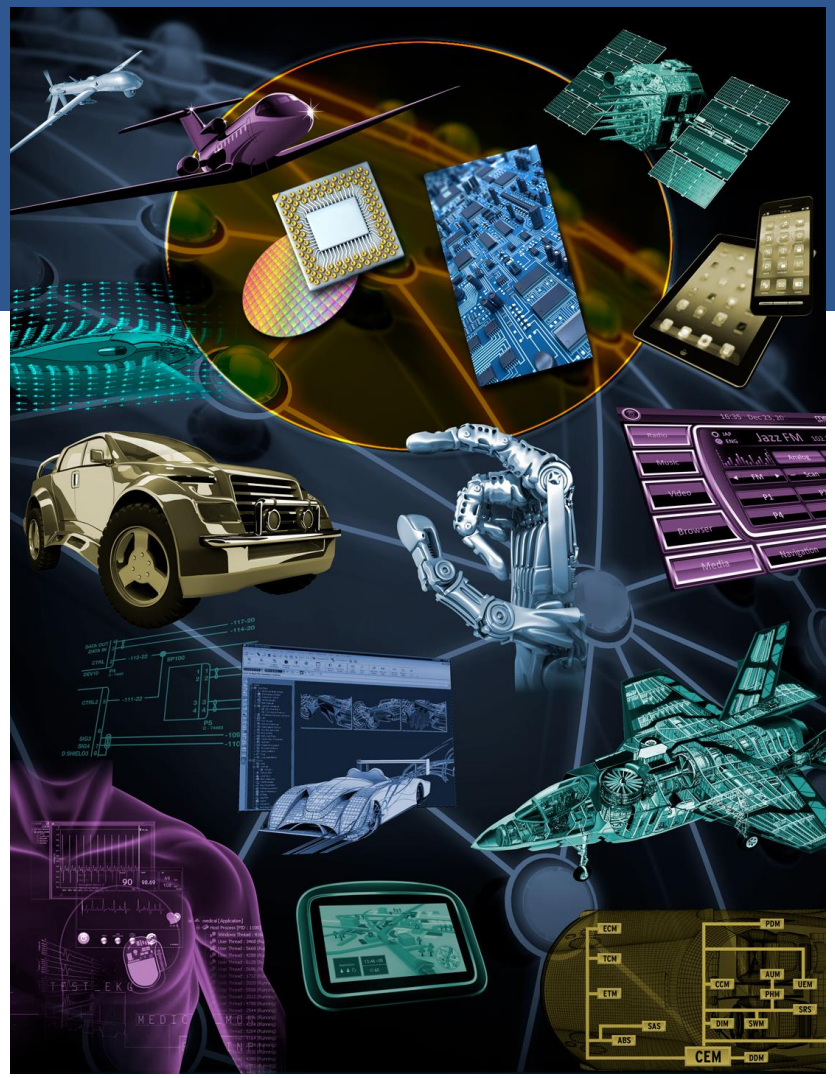

FloTHERM v12.0 New Functionality

Jeff Kim

Sr. Corporate Application Engineer

Mechanical Analysis Division/GSS

January 2018

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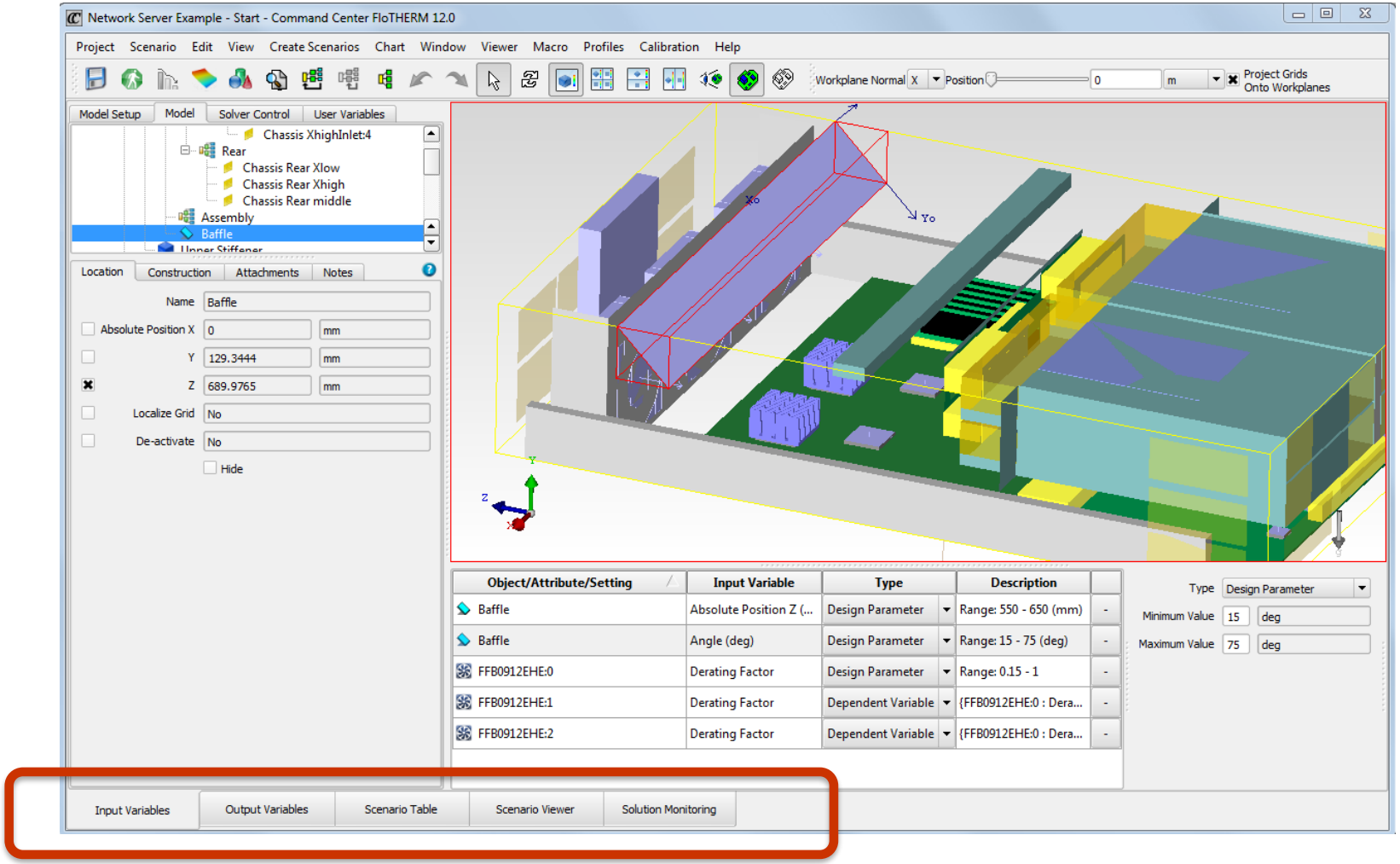
A Siemens Business

COMMAND CENTER OVERVIEW

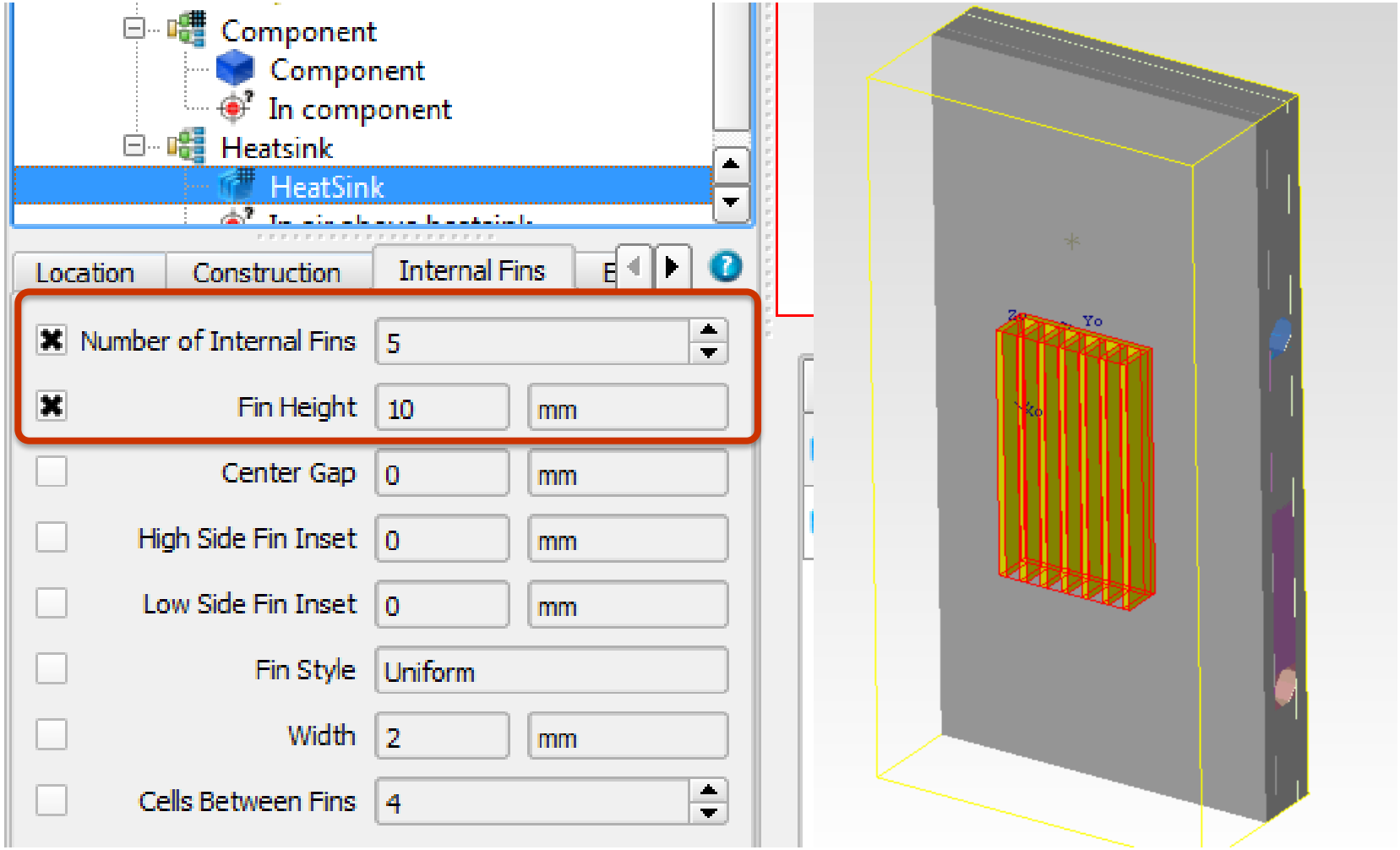
FloTHERM v12.0
New and Improved Command Center

- The tabbed approach is retained:
  - Input Variables – Define what model parameters can vary
  - Output Variables – Define what key results need to be captured
  - Scenario Table – Tabular view of all simulations.
  - **Scenario Viewer** – Graphical view of all simulations.
  - Solution Monitoring – Track the progress of each solution



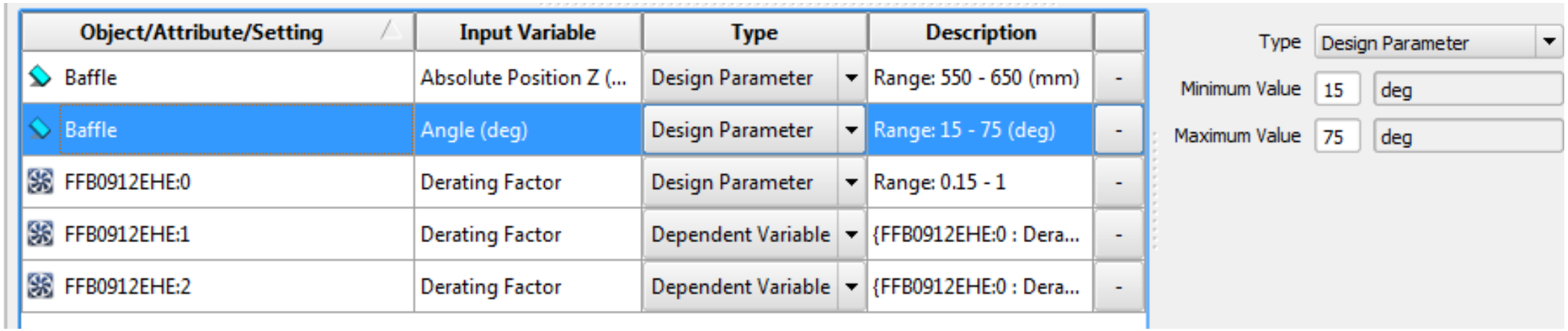
FloTHERM v12.0
Command Center - Input Variables

- Input Variables is a **read-only** view of the **baseline model**
- All inputs are found in the same location as the baseline model.
- Input Variables are nominated from property sheets.
- **Multiple selections** supported.
- **Find tool** is supported



FloTHERM v12.0
Command Center Input Variables

- Nominated Input Variables appear in a table, from which they can be further defined
- Types:
  - **Default**: Manual definition of values for all scenarios
  - **Design Parameter**: Assign a numerical range. Used for optimization and model calibration tasks.
  - **Dependent Variable**: Specify a relationship with other Input Variables.

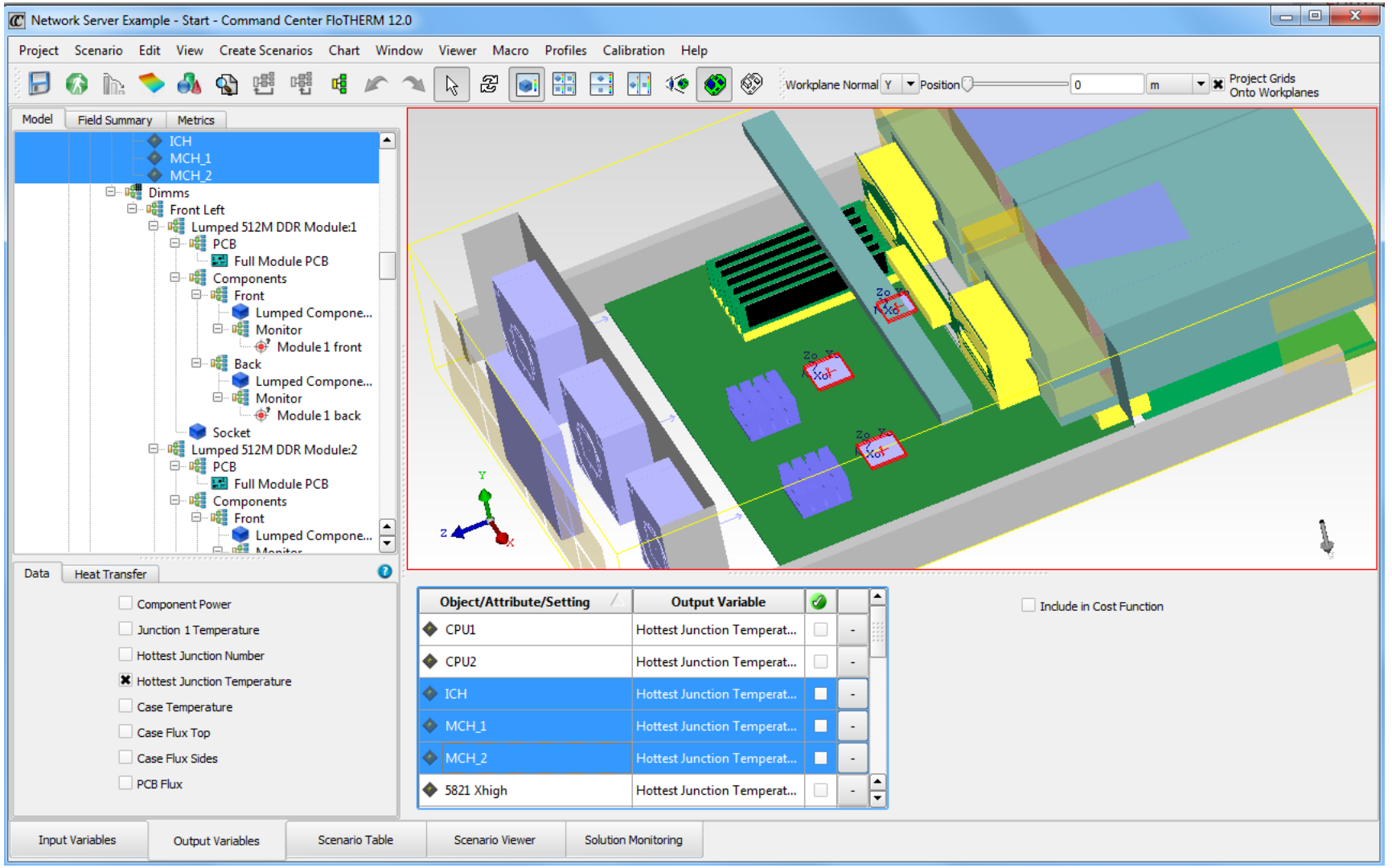


Object/Attribute/Setting	Input Variable	Type	Description	
Baffle	Absolute Position Z (...	Design Parameter	Range: 550 - 650 (mm)	-
Baffle	Angle (deg)	Design Parameter	Range: 15 - 75 (deg)	-
FFB0912EHE:0	Derating Factor	Design Parameter	Range: 0.15 - 1	-
FFB0912EHE:1	Derating Factor	Dependent Variable	{FFB0912EHE:0 : Dera...	-
FFB0912EHE:2	Derating Factor	Dependent Variable	{FFB0912EHE:0 : Dera...	-

FloTHERM v12.0
Command Center Output Variables

- Output Variables is another read-only view of the baseline model
- All inputs are found in the **same location** as the baseline model.
- Output Variables are nominated from property sheets and then appear in a table.
- **Multiple selections** supported.
- **Find tool** is supported.

- Find All MPs and track Temperature!



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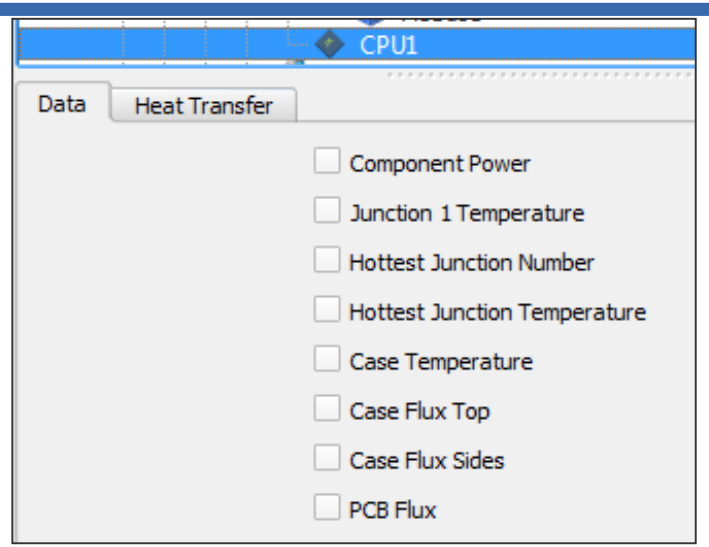
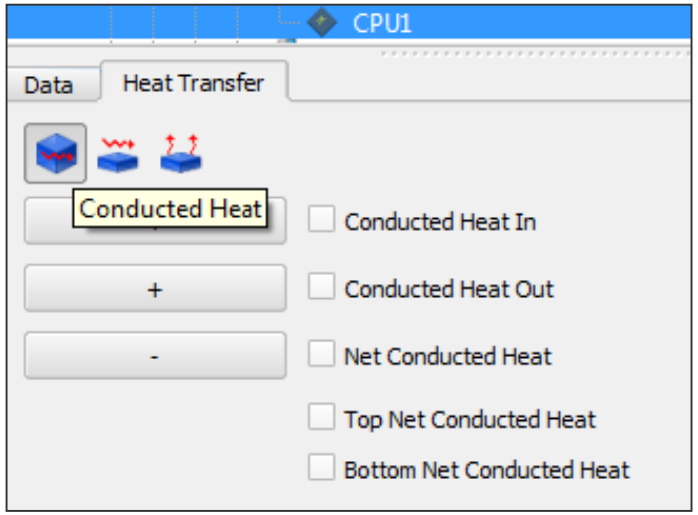
FloTHERM v12.0
Command Center Output Variables

- Tabbed Property Sheets with Output Variable type filters utilized.
  - **Data**: Object specific data
  - **Heat Transfer**: Conduction, convection, radiation heat flux results
  - **Temperature**: Surface temperatures and face based temperature results
  - **Fluid Flow**: Volume flow, mass flow and pressure drop results.
  - **Region Data**: Min, Max, Mean results





FloTHERM v12.0
Command Center Scenario Table

- Scenario Table display the input and output variable values for each defined scenario, as well as the solution status for each.
- Scenarios can be modified directly from the table cells.
- **Full copy/paste operation supported** between the Scenario Table and Spreadsheet tools.
- Solution Progress bar built in.

Inputs

Controls

Outputs

	Base Project	Design 1	Design 2	Design 3	
HeatSink : Internal Fin Height (mm)	10	11	14	13	2
HeatSink : Number of Internal Fins	5	9	8	12	1
Solution Status	Steady State Co...	Solving	Solving	Queuing (1)	(
Store Results?	Full	History Only	History Only	History Only	H
Initialize From	-1	Base Project	Base Project	Base Project	B
Water Outlet : Temperature (°C)	21.40496	-	-	-	-
In component : Temperature (°C)	25.15781	-	-	-	-
In air above heatsink : Temperature (°C)	23.1108	-	-	-	-

FloTHERM v12.0
Command Center Scenario Table

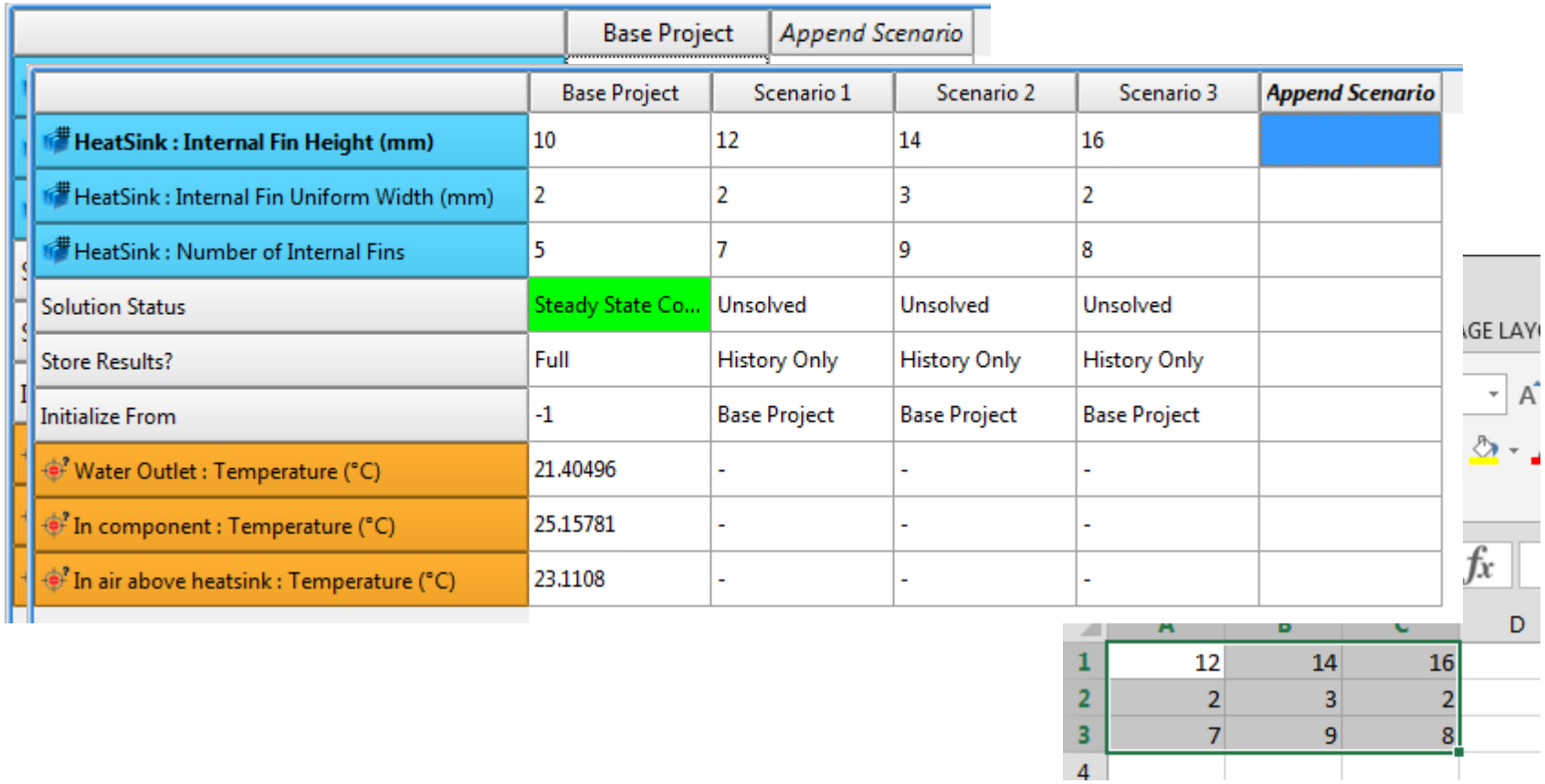
- Append Scenario column, directly enter data to create new scenarios:
- New scenario will take values from adjacent cell if unspecified

	Base Project	*Append Scenario*
HeatSink : Internal Fin Height (mm)	10	12
HeatSink : Internal Fin Uniform Width (mm)	2	
HeatSink : Number of Internal Fins	5	
Solution Status	Steady State Co...	
Store Results?	Full	
Initialize From	-1	
Water Outlet : Temperature (°C)	21.40496	
In component : Temperature (°C)	25.15781	
In air above heatsink : Temperature (°C)	23.1108	

	Base Project	Scenario 1	Appen
HeatSink : Internal Fin Height (mm)	10	12	
HeatSink : Internal Fin Uniform Width (mm)	2 →	2	
HeatSink : Number of Internal Fins	5 →	5	
Solution Status	Steady State Co...	Unsolved	
Store Results?	Full	History Only	
Initialize From	-1	Base Project	
Water Outlet : Temperature (°C)	21.40496	-	
In component : Temperature (°C)	25.15781	-	
In air above heatsink : Temperature (°C)	23.1108	-	

FloTHERM v12.0
Command Center Scenario Table

- Append Scenario column, paste data from external sources to create new scenarios:



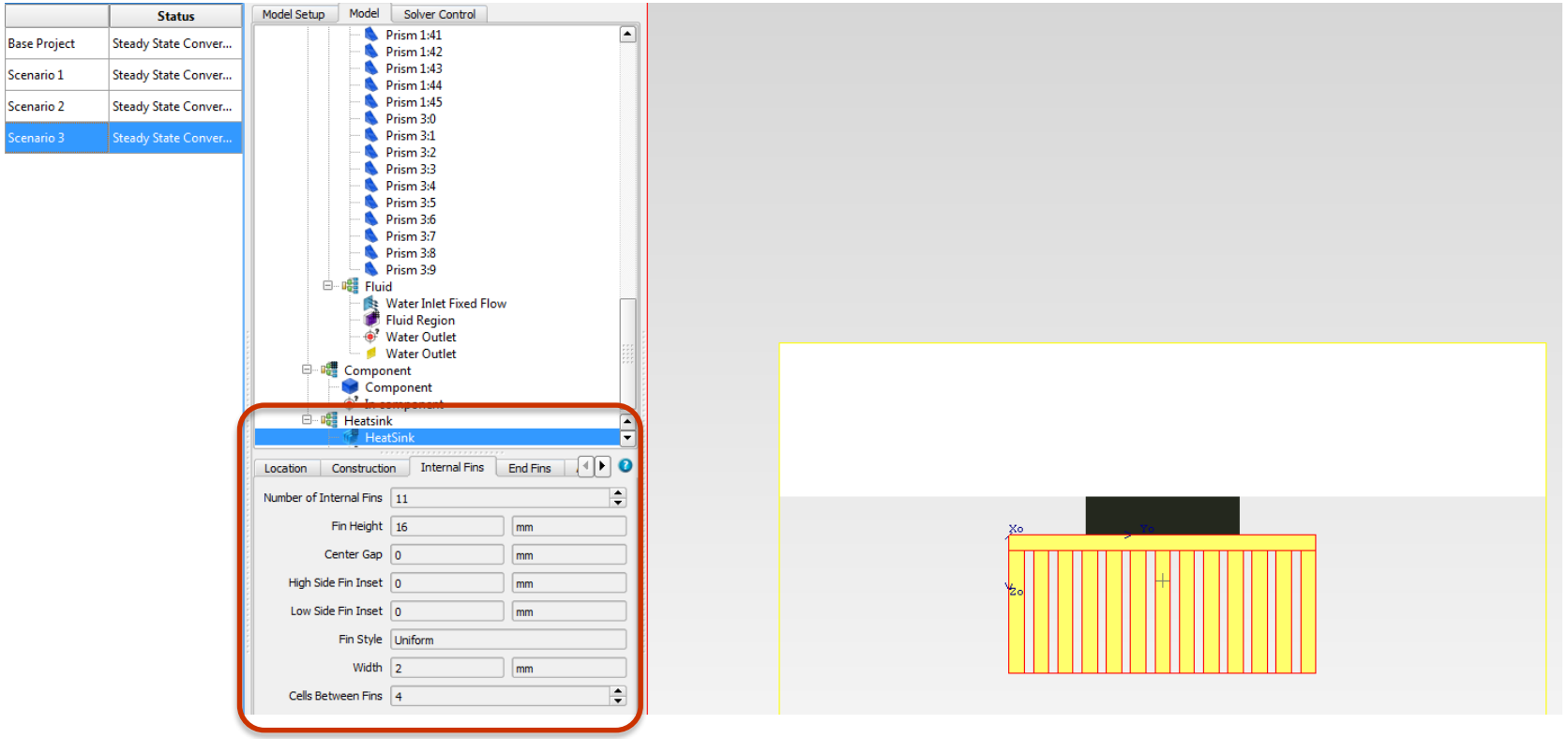
	Base Project	Append Scenario

	Base Project	Scenario 1	Scenario 2	Scenario 3	Append Scenario
HeatSink : Internal Fin Height (mm)	10	12	14	16	
HeatSink : Internal Fin Uniform Width (mm)	2	2	3	2	
HeatSink : Number of Internal Fins	5	7	9	8	
Solution Status	Steady State Co...	Unsolved	Unsolved	Unsolved	
Store Results?	Full	History Only	History Only	History Only	
Initialize From	-1	Base Project	Base Project	Base Project	
Water Outlet : Temperature (°C)	21.40496	-	-	-	
In component : Temperature (°C)	25.15781	-	-	-	
In air above heatsink : Temperature (°C)	23.1108	-	-	-	

	A	B	C	D
1	12	14	16	
2	2	3	2	
3	7	9	8	
4				

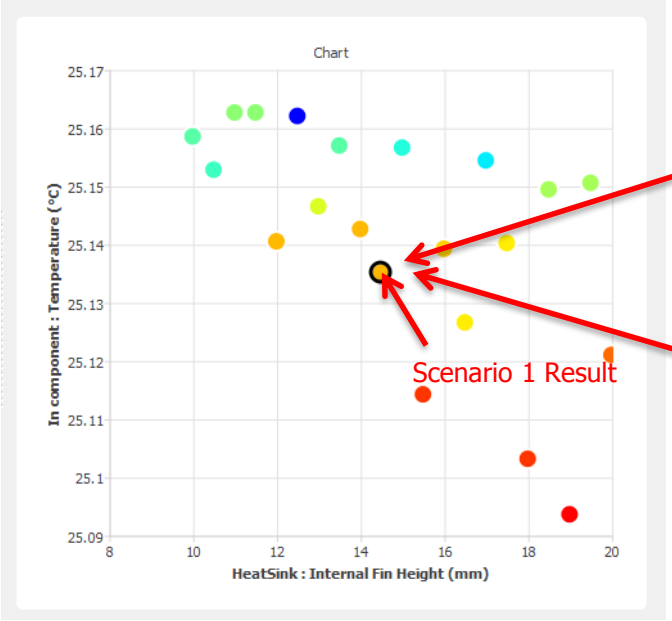
FloTHERM v12.0
Command Center Scenario Viewer

- Model tree and display for each scenario is available for each defined scenario, allowing easy visual inspection of the models, including the grid distribution.



FloTHERM v12.0
Command Center – Selection Linking

- Selections are retained throughout Command Center:
  - Scenario selection linking between Scenario Table, Scenario Viewer, Solution Monitoring tabs, and Charts.
  - Object selection linking between Scenario Viewer, Input Variables, and Output Variable tabs, and the Project Manager



	Base Project	Scenario 1	Scenario 2
HeatSink : Internal Fin Height (mm)	10	14	16
HeatSink : Internal Fin Uniform Width (mm)	2	2	2
HeatSink : Number of Internal Fins	5	7	8
Solution Status	Steady State Co...	Steady State Co...	Steady State Co...
Store Results?	Full	History Only	History Only
Initialize From	-1	Base Project	Base Project
Water Outlet : Temperature (°C)	21.40496	21.40537	21.40336
In component : Temperature (°C)	25.15781	25.16143	25.15057
In air above heatsink : Temperature (°C)	23.1108	23.11257	23.08619

Scenario Table

	Solution Status
Base Project	Steady State Converged
Scenario 1	Steady State Converged
Scenario 2	Steady State Converged
Scenario 3	Steady State Converged
Scenario 4	Steady State Converged

Scenario Viewer & Solution Monitoring List

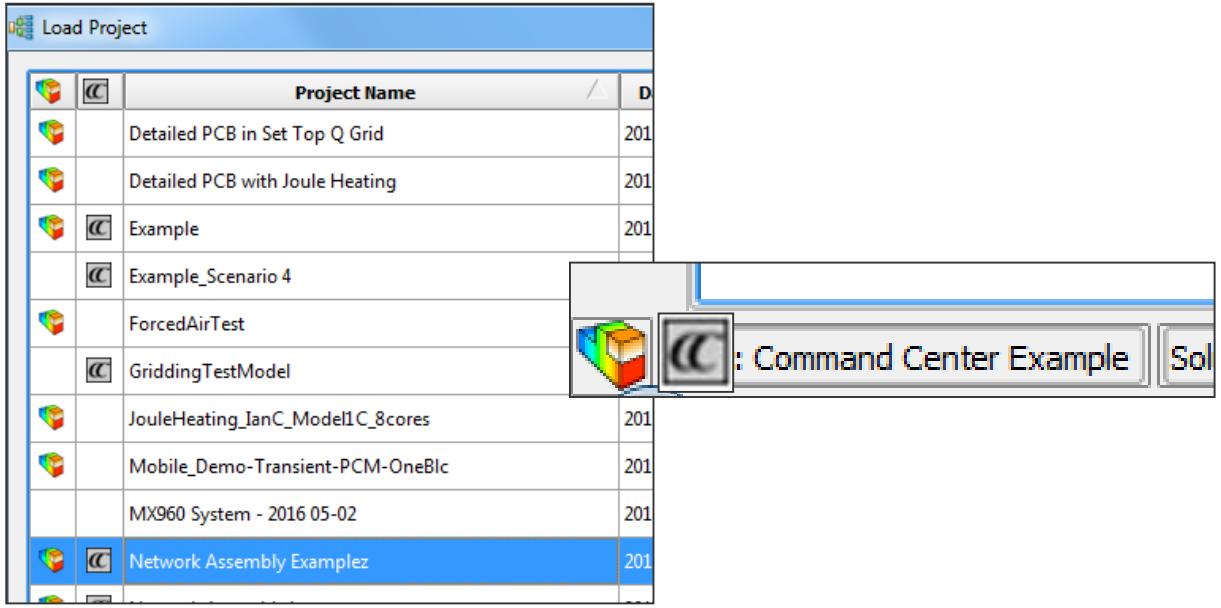
COMMAND CENTER TOOLS

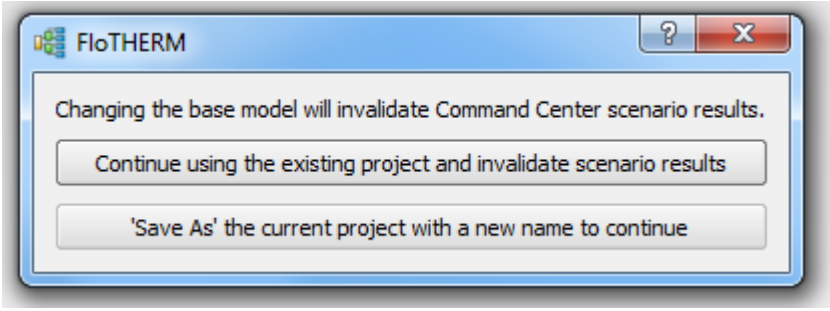
FloTHERM v12.0
Command Center Awareness

- Presence of Command Center setup is now indicated in the Load Project dialog.
- An icon will appear if at least one input variable or Output Variable has been defined.

- Project Manager status bar will indicate if Input Variables are defined in Command Center

- A change to the base model that would invalidate scenario results prompts the user to save as new project





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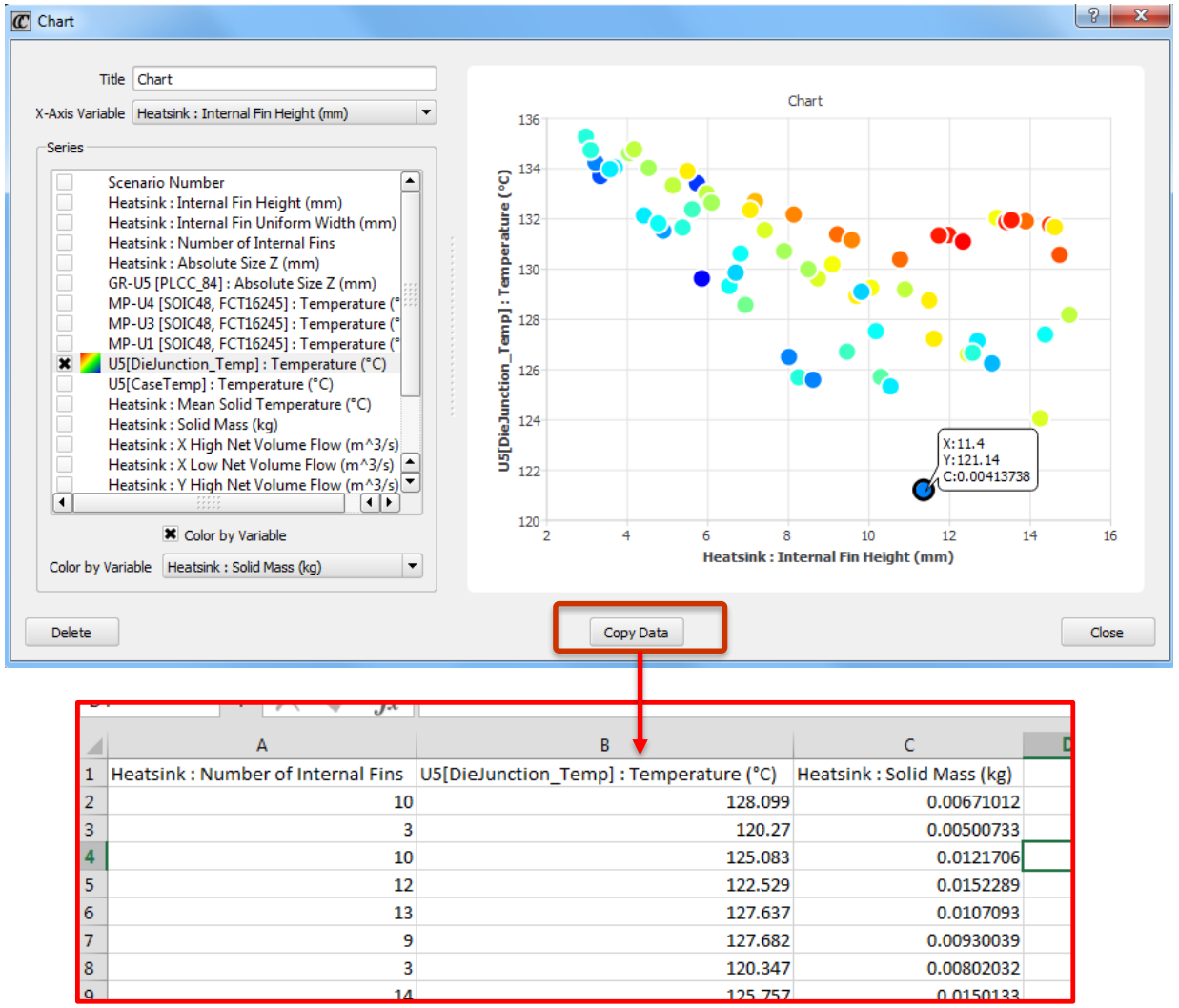
FloTHERM v12.0
Command Center – Charts

- XY Scatter Charting Tool
- Chart Point – Scenario selection linking
- Double click to annotate or remove annotation
- Colour chart points uniformly or by another variable

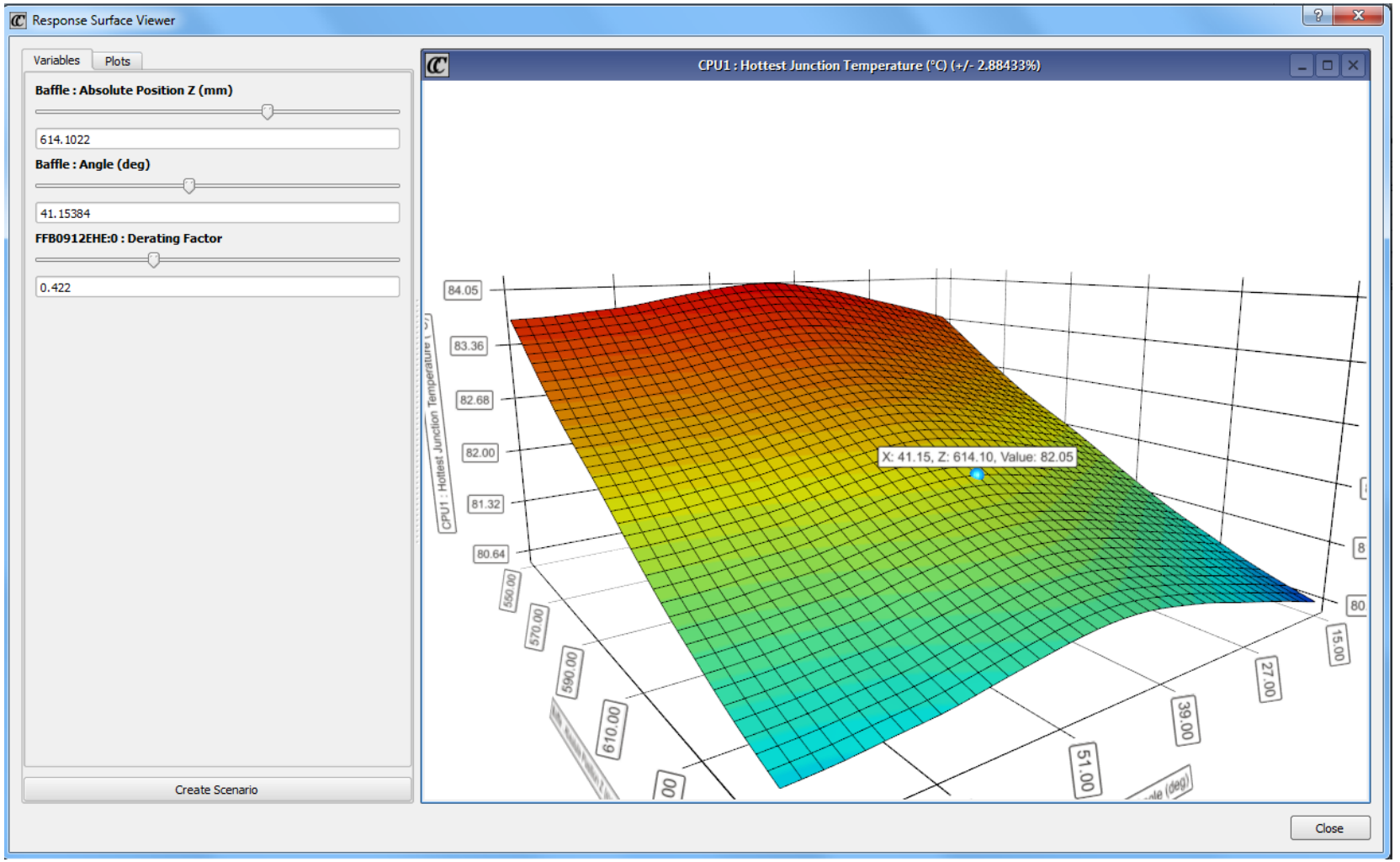
- **Copy/Paste chart data** into spreadsheet applications



	A	B	C
1	Heatsink : Number of Internal Fins	U5[DieJunction_Temp] : Temperature (°C)	Heatsink : Solid Mass (kg)
2	10	128.099	0.00671012
3	3	120.27	0.00500733
4	10	125.083	0.0121706
5	12	122.529	0.0152289
6	13	127.637	0.0107093
7	9	127.682	0.00930039
8	3	120.347	0.00802032
9	14	125.757	0.0150133

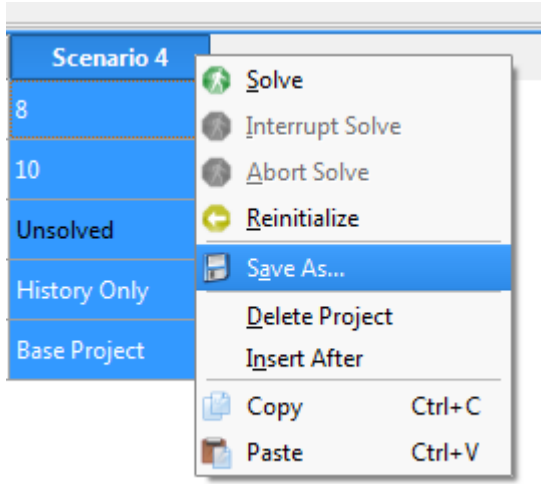
FloTHERM v12.0
Command Center – Response Surfaces

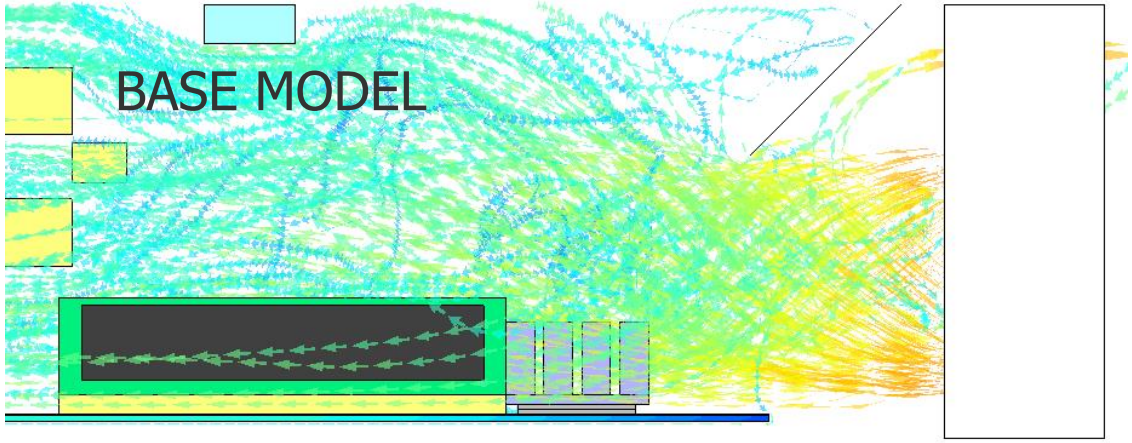
- 3D Plot Type
- Click Surface to annotate and update slider bar values
- Then use **'Create Scenario'** command to easily create new models for any point of interest.

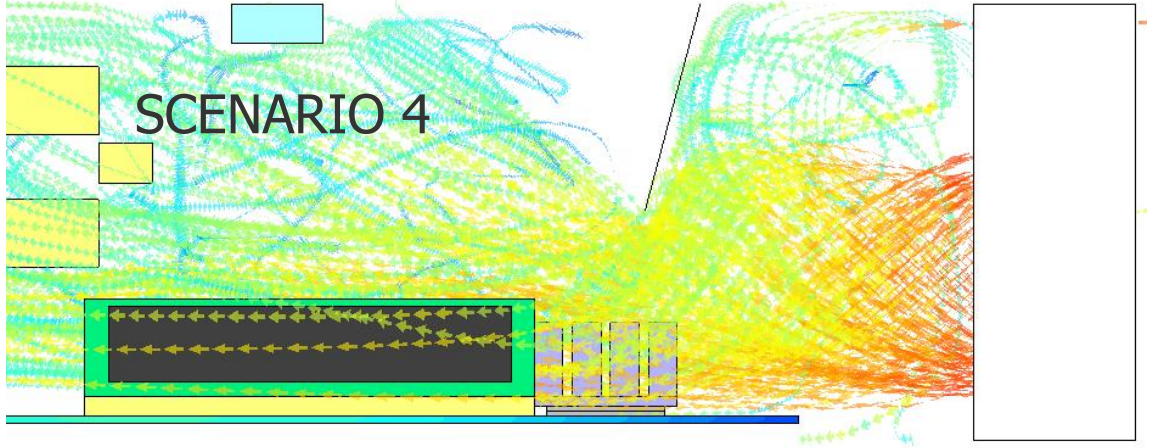


FloTHERM v12.0
Command Center Scenario Table

- Scenario controls as per previous versions, with two extensions
- The 'Save As…' command will now copy:
  - Visual Editor state
    into the new project to save time for subsequent post-processing.
  - All Input Variables
  - All Output Variables

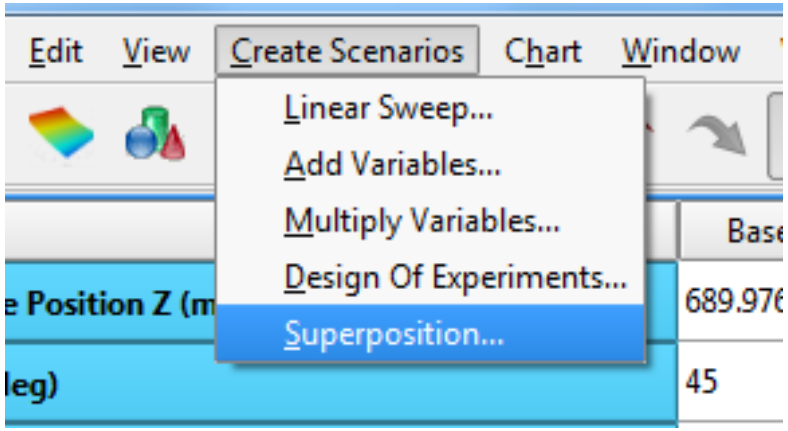


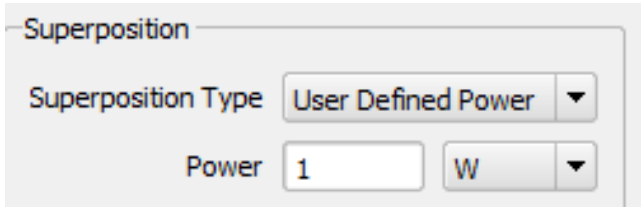


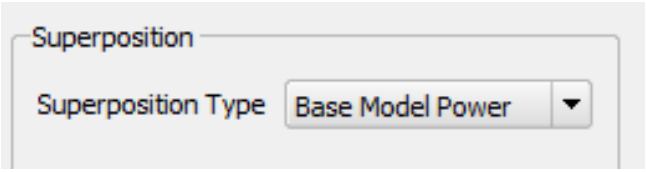


FloTHERM v12.0
Command Center – Scenario Creation Tools

- Create Scenarios menu containing various tools to create scenarios.
  - As in previous versions:
    - **Linear Sweep**
    - Add/Multiply Variables
    - Design of Experiments
  - And new in v12: **Superposition**
    - One scenario is created per total power input variable, and only one component is powered per scenario.
    - Powers are User Defined, or taken from the base model.
    - Greatly reducing the user interaction required to set up these analyses.







	Base Project	Scenario 1	Scenario 2	Scenario 3	Scenario 4
U1 [Component] : Conduction Total Power (W)	2	1	0	0	0
U2 [Component] : Conduction Total Power (W)	3	0	1	0	0
U3 [Component] : Conduction Total Power (W)	1.4	0	0	1	0
U4 [Component] : Conduction Total Power (W)	0.33	0	0	0	1

FloTHERM v12.0
Command Center - Automation Support

- Command Center will fully support **FloSCRIPT technology** found in other areas of FloTHERM.
- Every aspect of using Command Center can be scripted:
  - Input/Output Variables, Scenario Definition
  - Solving, Optimization, Calibration
  - Results extraction

- In addition, the scenario file written to 'PDProject' has a new XML format. Easy to read and write.

```
<scenarios>
<input_variables>
<output_variables/>
<design_of_experiments>
    <new_value new_value="sequentialFromBest" property_name="optimizationType"/>
    <new_value new_value="Base Project" property_name="startFrom"/>
    <new_value new_value="10" property_name="maximumNumberOfSteps"/>
    <new_value new_value="0" property_name="criticalCostValue"/>
    <new_value new_value="false" property_name="designExperimentsBeforeOptimizatior
    <new_value new_value="Design" property_name="designName"/>
    <new_value new_value="true" property_name="enableCollisionDetection"/>
    <new_value new_value="1" property_name="numberOfExperimentsToDesign"/>
    <new_value new_value="false" property_name="userDefinedNumberOfExperiments"/>
</design_of_experiments>
```

FloTHERM v12.0
Command Center - General

- **64 bit Support**. Extremely large models and many scenarios no longer pose a problem.

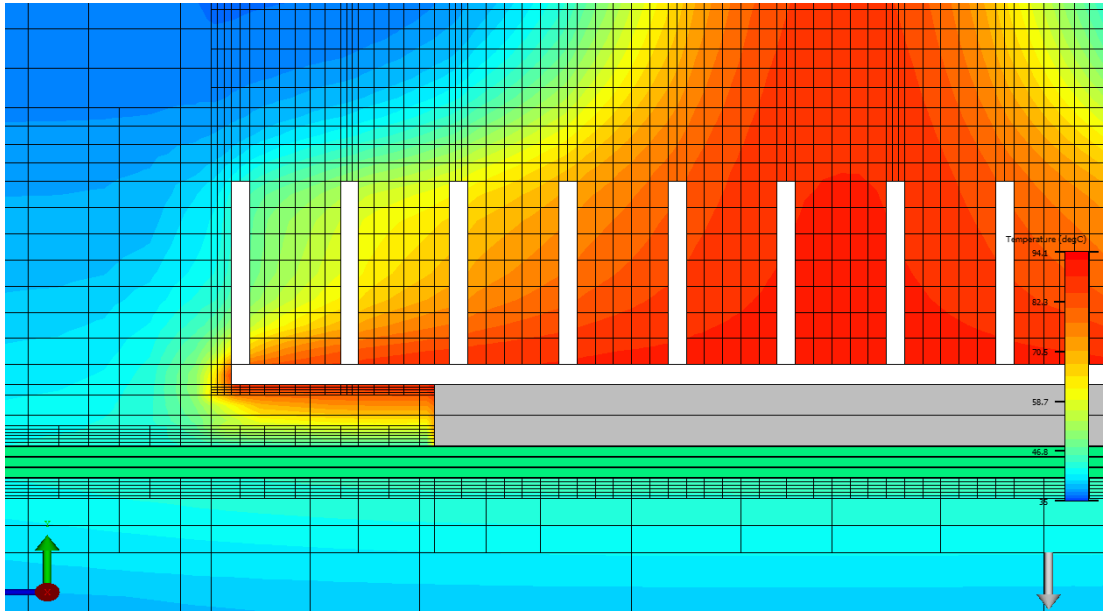
- **Scenario handling is vastly improved**. 50x faster in some cases for larger models with many defined scenarios.

COMPACT COMPONENTS

FloTHERM v12.0
Compact Components - Localized Grid Spaces

- 2-Resistor and 'Area Array' Compact Component SmartParts can now:
  - **Touch a localized grid** space boundary:
  - **Cross a localized grid** space boundary

- Benefit: Gridding is faster and easier than before!

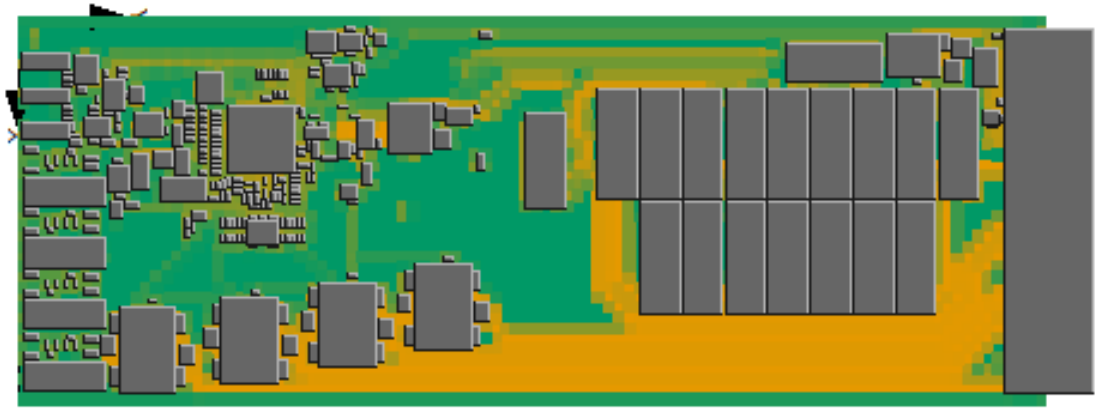


FLOEDA BRIDGE

FloTHERM v12.0
ODB++ Import

FloEDA Bridge - ODB++ Import

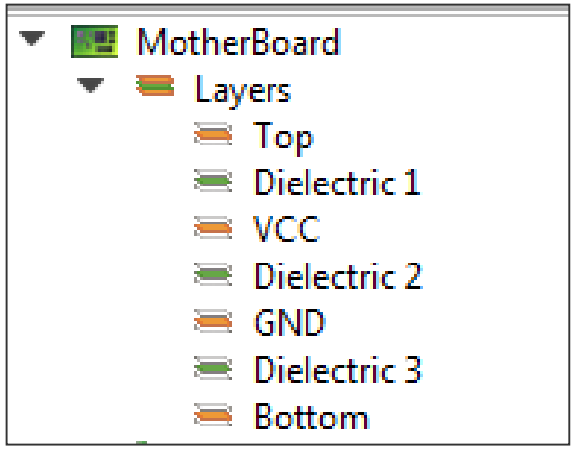
- Offering interfacing options most layout tools, including Xpedition, PADS, and tools from Cadence, Zuken, and Altium.
- Contains
  - Board Outline
  - Component Layout
  - Layer Stack Up
  - Metallic Distribution on all layers.

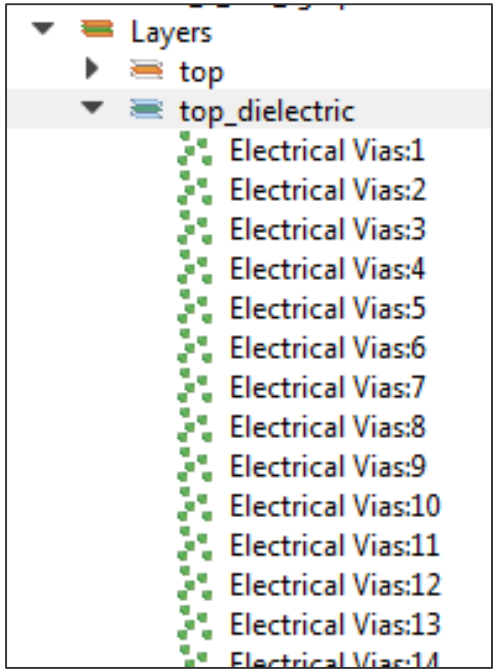


FloTHERM v12.0
Blind and Buried Vias

- Layers can be defined as 'Dielectric' or 'Metallic'
- ODB++ import will automatically create the stack up with appropriate settings for each layer, and assign images for each layer.
- Dielectric layers can be processed in the same way as metallic layers, creating a material map of that layer to user controlled resolution.

- Benefit: The entire board can be mapped, increasing accuracy when conduction into the PCB is critical.

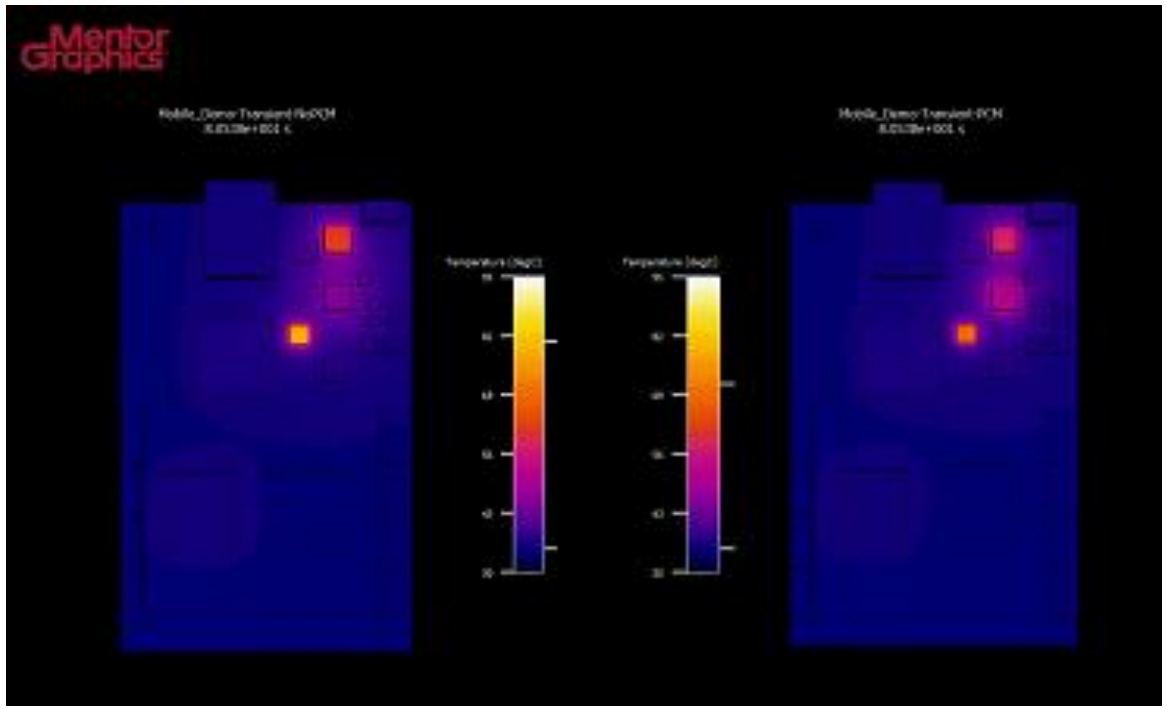


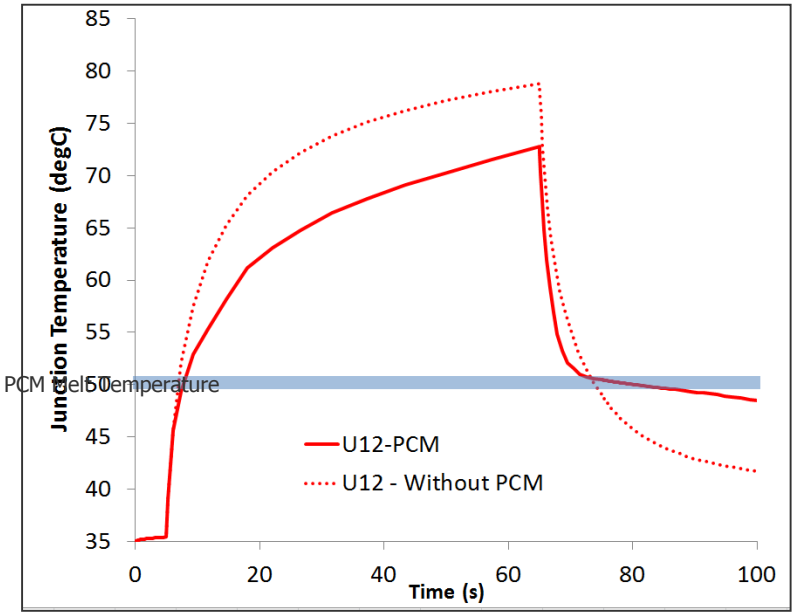


PHASE CHANGE MATERIALS

FloTHERM v12.0
Phase Change Materials

- Determine the impact on temperature transient response for encapsulated PCM applications.



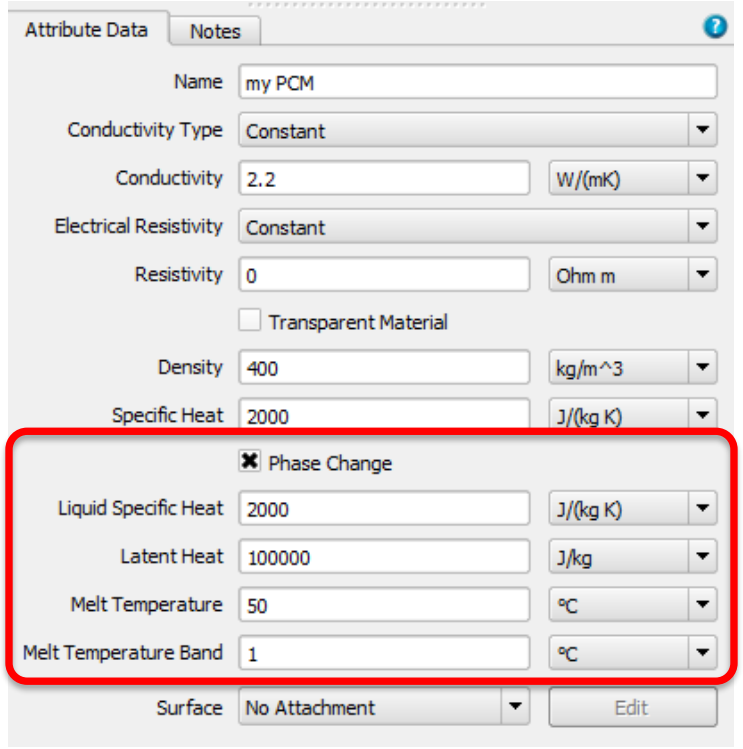


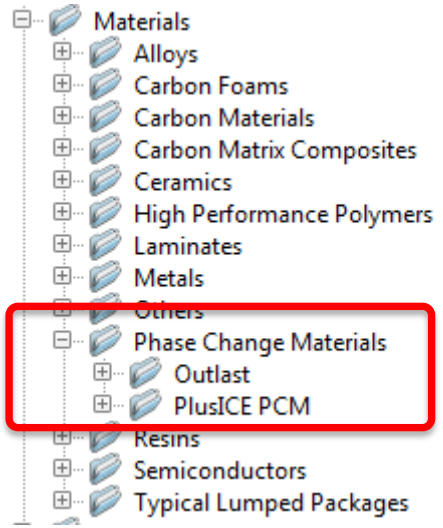
Jeff Kim, FT12 New Func, Jan 2018

FloTHERM v12.0
Phase Change Materials

- For 'Solid' objects, definition of:
  - Melt Temperature and Range
    - T_{melt} defined as the center of temperature band
  - Latent Heat of Fusion
  - Liquid Specific Heat

- **Several vendor materials** provided in library





FloTHERM v12.0
Phase Change Materials – How it works

- Enthalpy is solved for within a PCM to ensure the full extent of the latent heat is accounted for.

- An important consequence of this is that the user does not need to know (or keypoint) the start and end of the melting event. An important advantage over tools that use a Cp=f(T) approach.

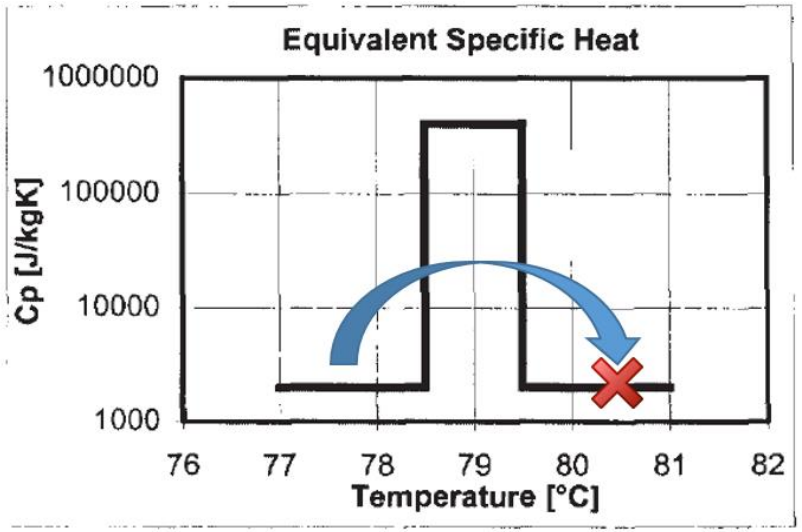
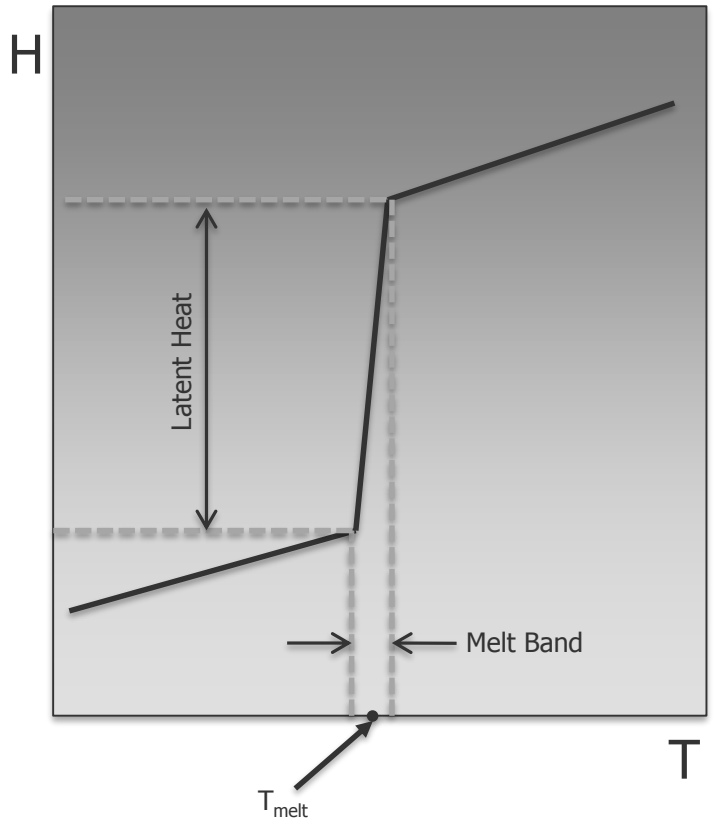


Fig. 3: The Equivalent Specific Heat Used in the Model.

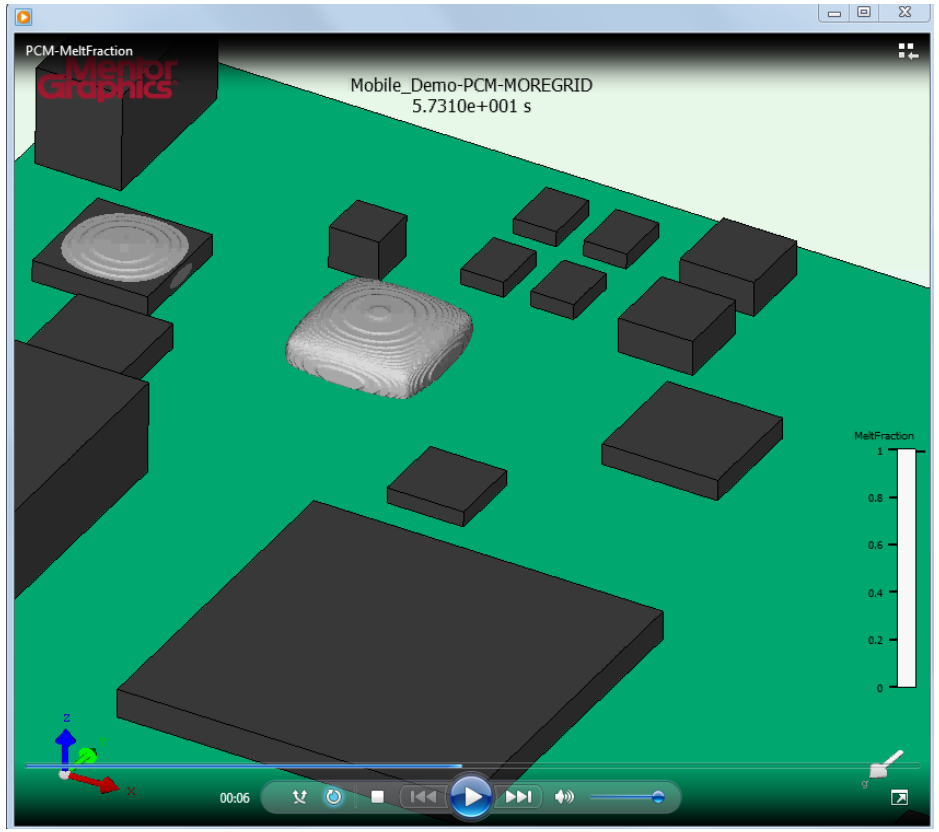


FloTHERM v12.0
Phase Change Materials – Post-Processing

- New Scalar: Melt Fraction
  - **0 indicates completely solid**
  - **1 indicates completely liquid**

- Isosurface of Melt Fraction = 1 will show the moving melting front in a transient animation

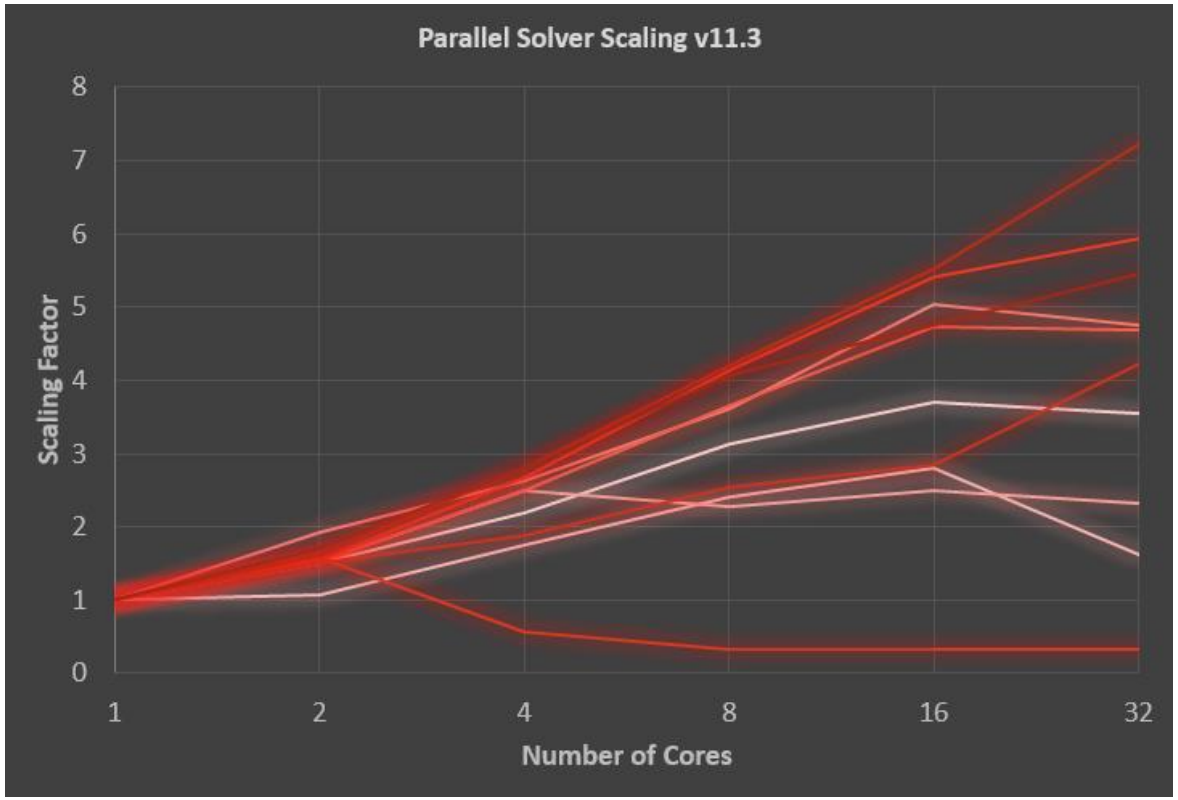
- Melt Fraction is supported for Monitor Points and Region type results.

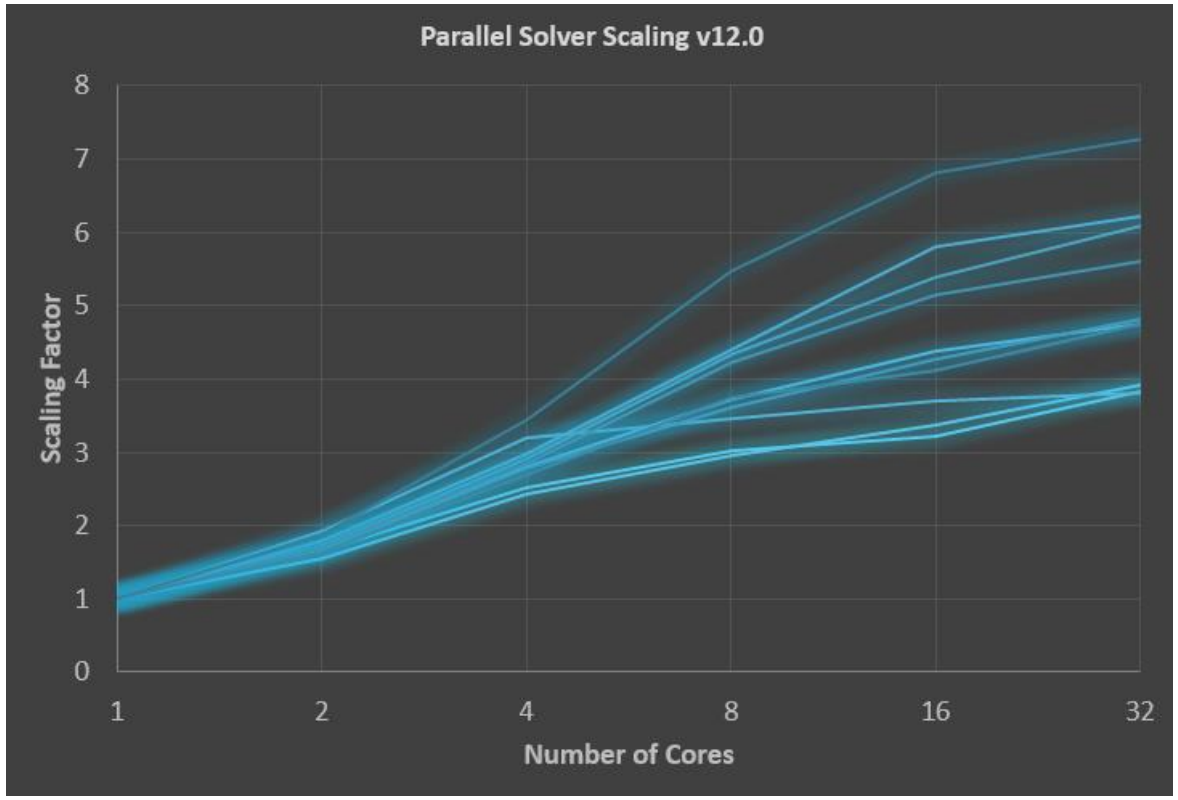


SOLVER

FloTHERM v12.0
Scalability and Stability Improvements

- Parallel Solver aspects re-engineered to offer improved stability and scalability for a broader range of models and cores.

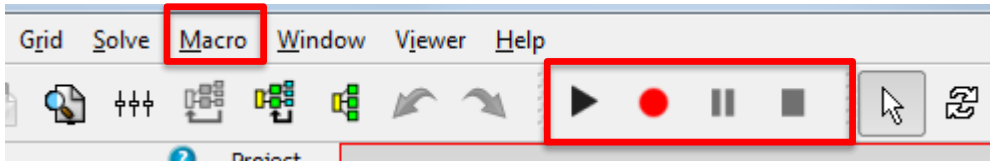




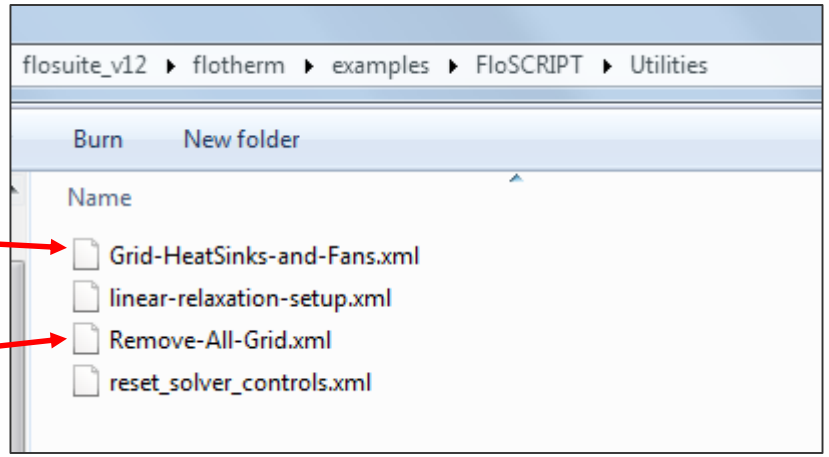
EXTRAS

FloTHERM v12.0
Work Flow Automation

- Macro Recorder
  - Record specific FloSCRIPT commands and save to user defined location. Pause and Stop Recording commands supported.
  - Playback FloSCRIPT included as toolbar icon.



- Edit/Find queries are FloSCRIPT able. Subsequent actions are applied to Found objects
  - Examples:
    - Find all Heat Sinks and Fans, then attach grid constraint.
    - Find all objects with Localized Grid active, then turn off localized grid



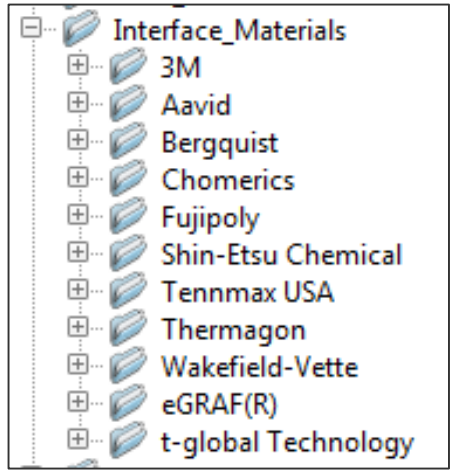
FloTHERM v12.0 Extras

- **Multi-Select of Attributes**
  - Common property sheet used to quickly modify all selections
    - Quickly change Transient attributes attached to Sources
    - Quickly save attributes to a library folder

- **Use Summary columns for fast attribute display.**
  - Click an attribute icon to show the attribute property sheet
  - Click again to cycle through multi-face attributes if present

- **Project Load Speed Up**
  - Large models now load up to 100x faster

- **Updated Thermal Interface Material Library**



FloTHERM v12.0
Operating System Changes

- **FloTHERM v12 is 64-bit only**
  - Supported Operating Systems
    - Windows 7
    - Windows 8 and 8.1
    - Windows 10
    - Windows Server 2008 R2
    - Windows Server 2012
    - Windows Server 2012 R2
    - RHEL 6

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