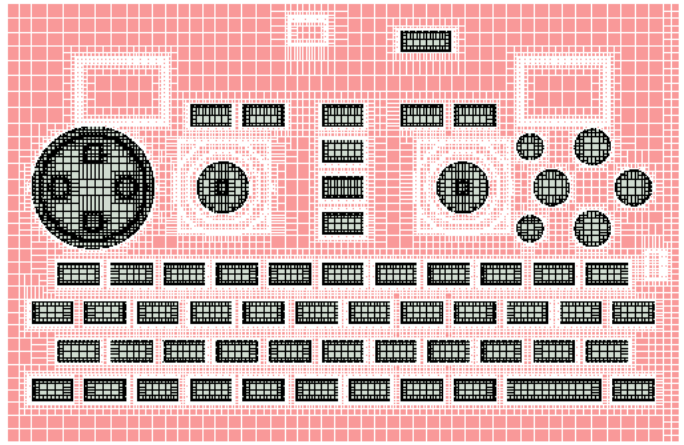
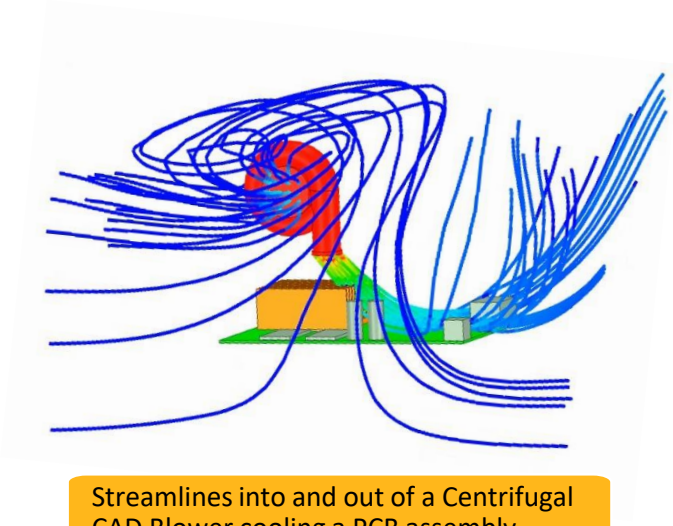
Release 2022 R1 Highlights
Thermal Integrity

2022 R1 Icepak Updates

Icepak 2022 R1 Highlights



- **Reduced Order Modeling (ROM)**
  - Redhawk CTM 2-Way & New Delphi Network Creation
- **Blower Modeling**
- **ECAD Import -** Wirebond & IDX
- **Maxwell 2D** – Icepak EM Loss Coupling

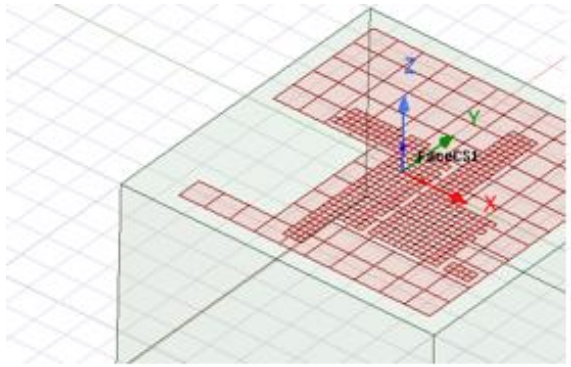


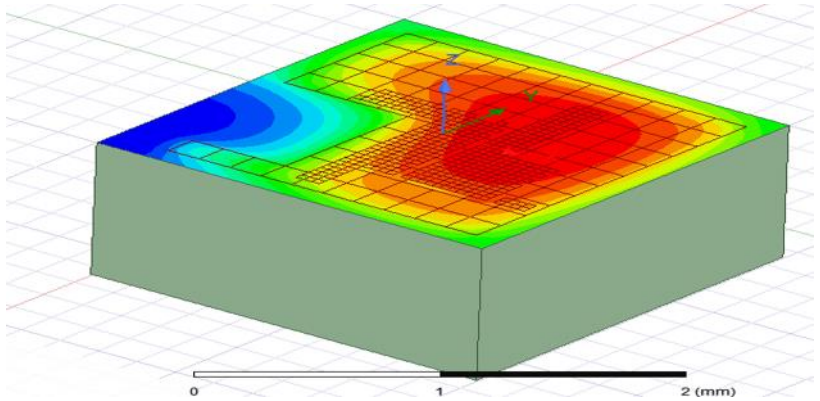
Streamlines into and out of a Centrifugal CAD Blower cooling a PCB assembly

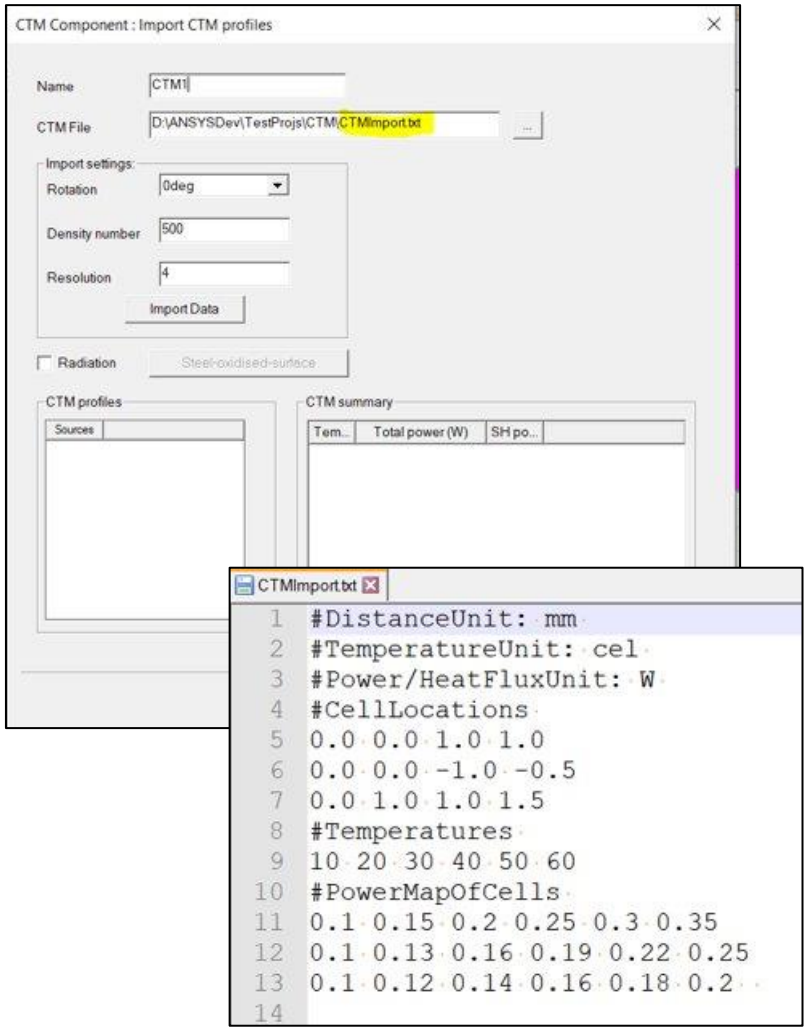
- **Mesher Enhancements –** 2.5D Improvements
- **User Experience**
  - Streamlines & Validation Enhancements
  - Improved Error messaging & troubleshooting
- **Migration**
  - Improve speed of TZR conversion
  - Network Schematic enhancements
  - Toolkit enhancements
    - PCB, Package parameterization

RedHawk CTM Two-Way Workflow

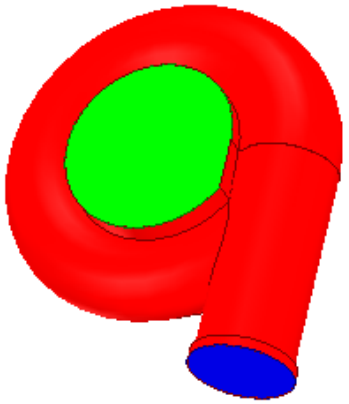
- **Chip Thermal Model (CTM) two-way co-simulation**
  - Chip-aware system design (2021R2)
  - System-aware chip design (2022R1)
  - Auto-export temperatures to RedHawk after simulation
    - Defaults to export folder specified under Design Settings
    - Binary format
  - CTM import using a 3rd party text file
    - CTM native component created
    - No temperature data export

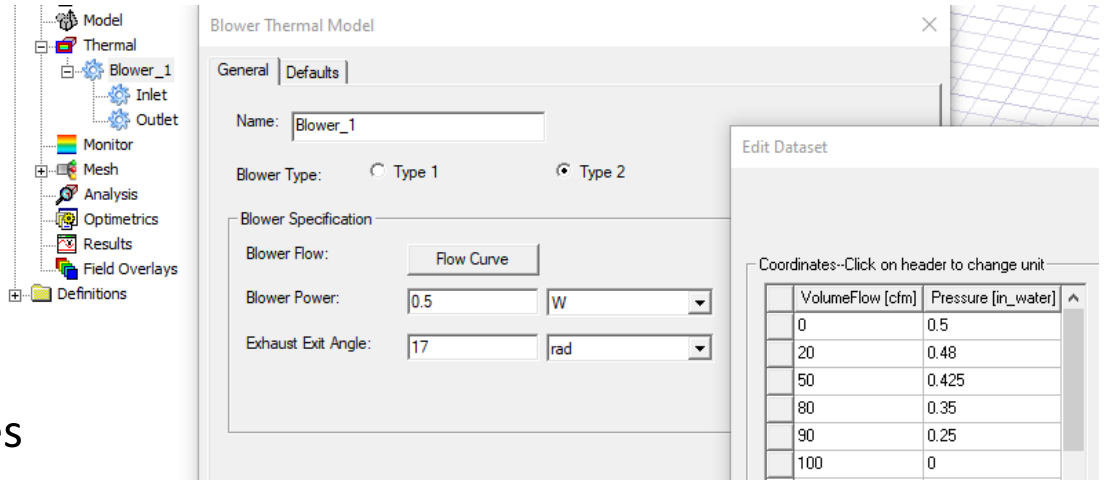




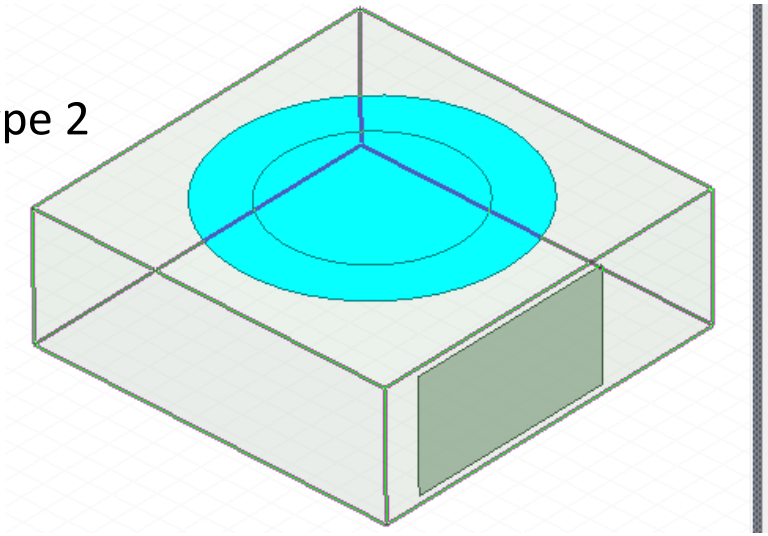


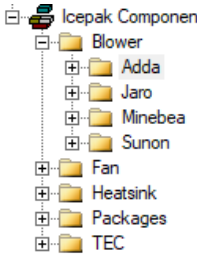
Blower Modeling

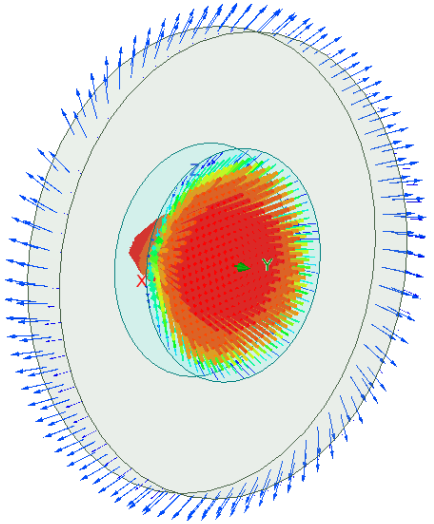




- Generalized Blower boundary
  - Impellers (type 1)
  - Centrifugal blowers (type 2)
  - Single and dual inlets for all geometries
- Blower toolkit
  - Geometry and BC for rectangular and cylindrical geometries
- Vendor Component Library
  - Adda, Jaro, Minebea, Sunon
- Blower Assignment
  - Polygonal approximation allowed for type 1
  - Multiple co-planar inlet faces allowed for type 2
  - Ability to toggle inlet/outlet faces
- Blower Specifications
  - Blower flow curve
  - Fan blade/exit angle
  - RPM (type 1)
  - Blower Power

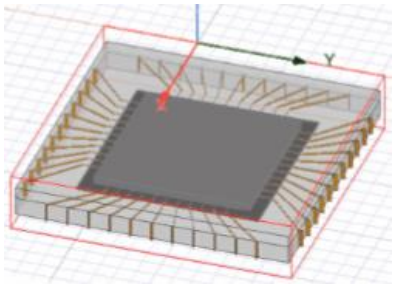




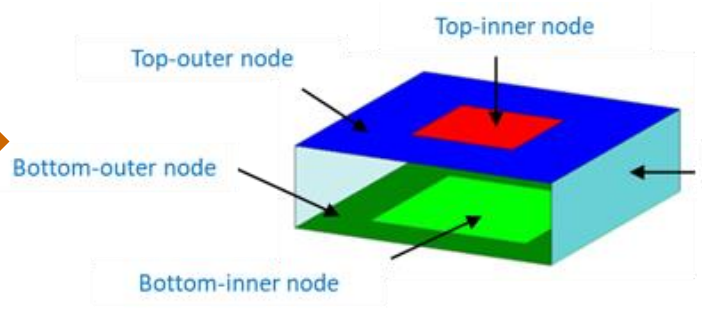


Reduced Order Modeling - Delphi Network Creation*

- Steady-state Delphi network creation for QFP packages



Detailed Package CFD Model



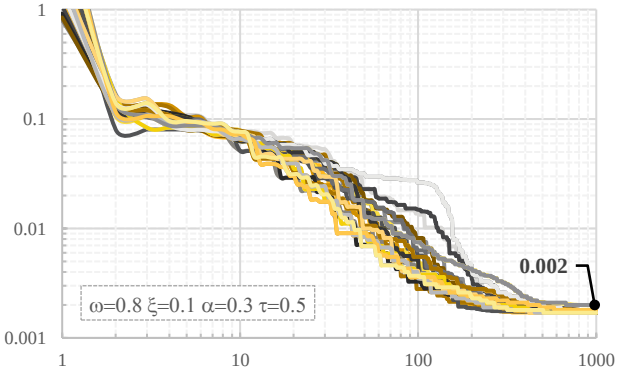
DELPHI's Black-box thermal model

Sides node

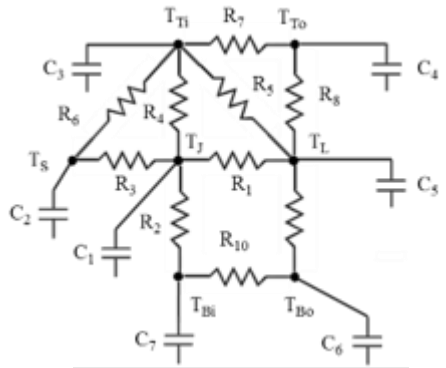
Delphi boundary condition setup

$$\begin{bmatrix} Case & \overline{h}_{TOP} & \overline{h}_{BOTTOM} & \overline{h}_{SIDES} & \overline{h}_{LEADS} \\ 1 & 5 & 1 & 5 & 1 \\ 2 & 15 & 1 & 15 & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 48 & 10 & 1000 & 10 & 100000 \end{bmatrix}$$

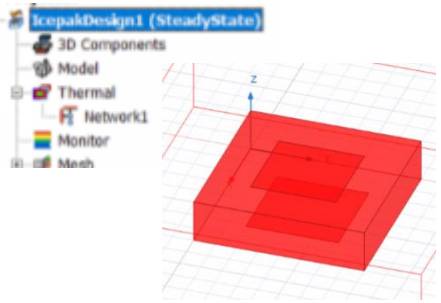
Parametric setups with training BCs



Delphi Optimizer



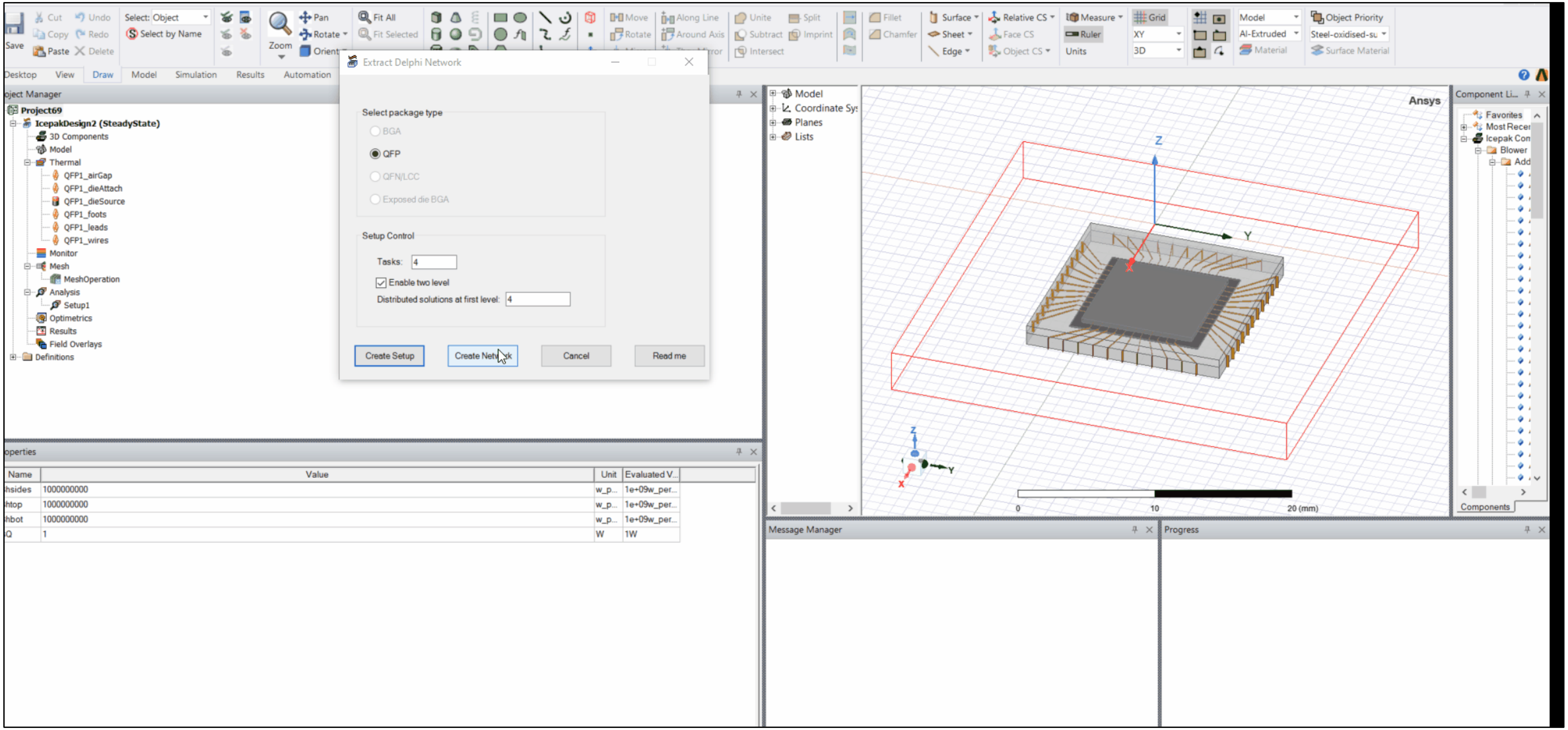
Delphi Network



Icepak Design

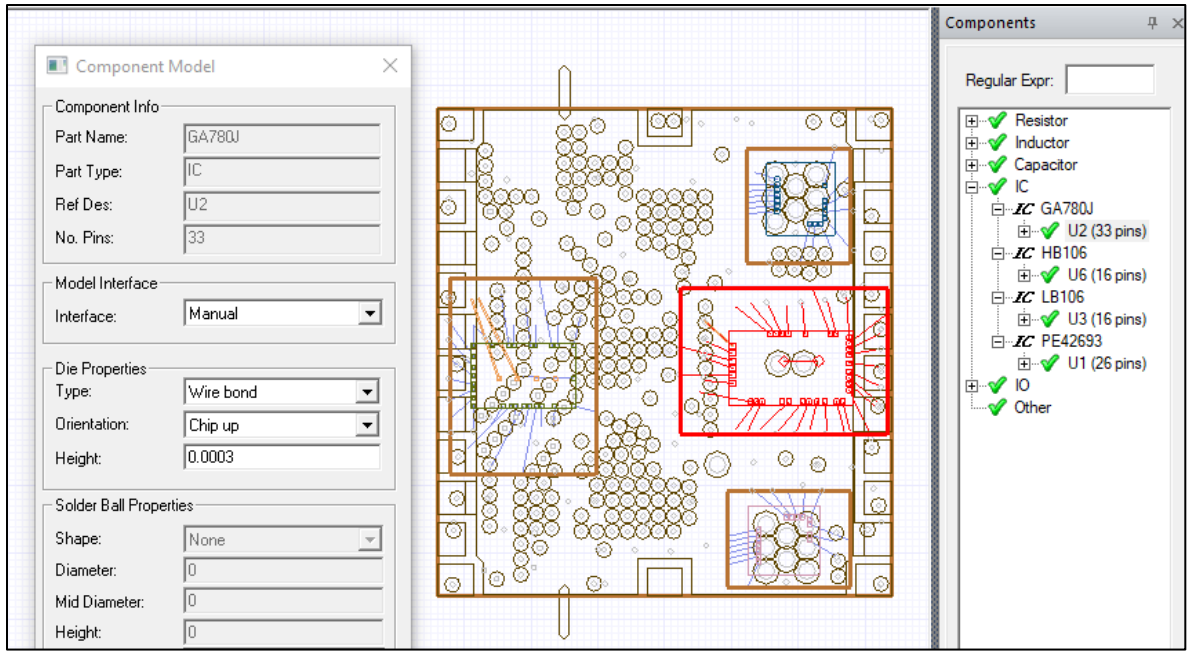
* Requires Feature Flag

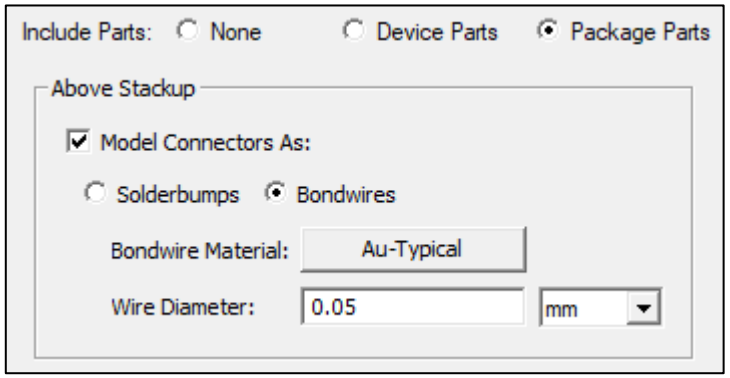
Automated Delphi Network Creation Workflow in AEDT



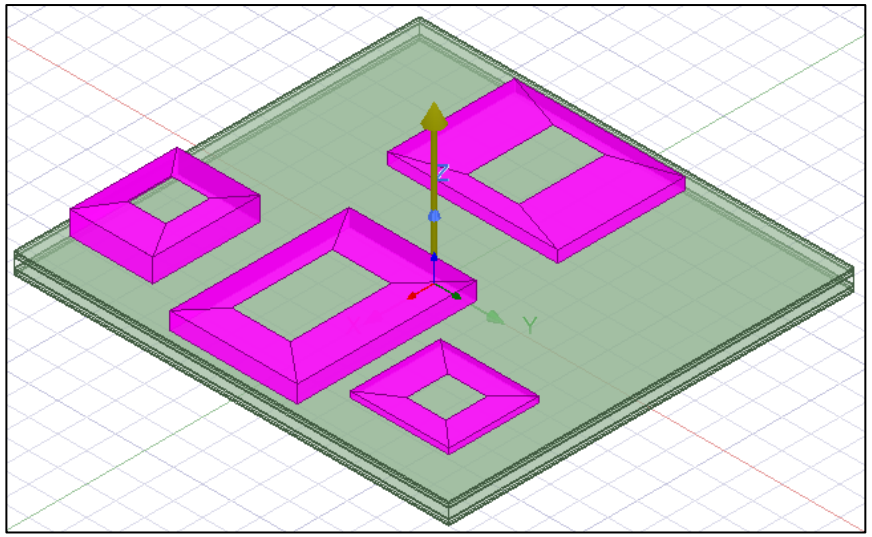
ECAD - Bondwire Import

- **Bondwire Import with PCB Component**
  - Bondwires attached to components with die properties
    - Material and wire diameter input options
    - Modeled as sheets with shell conduction plate BC



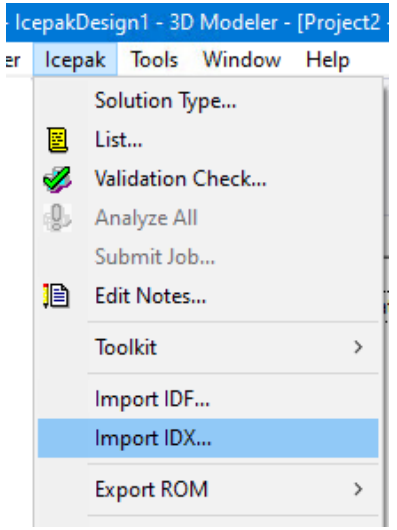


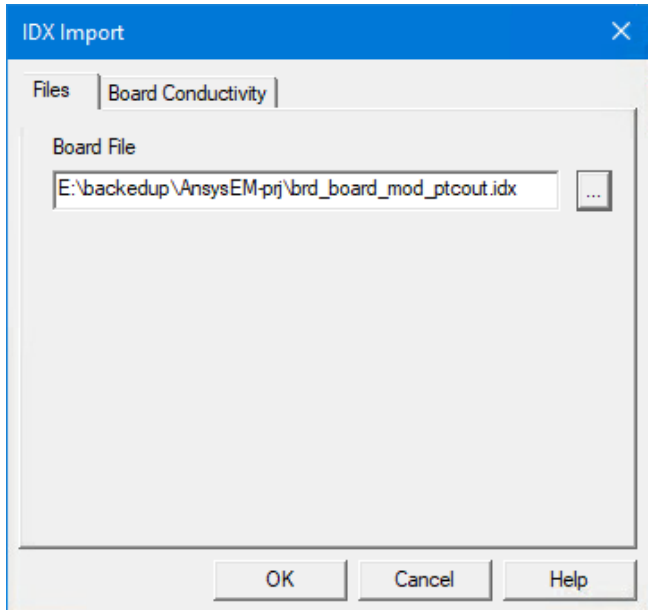
Cross-section View

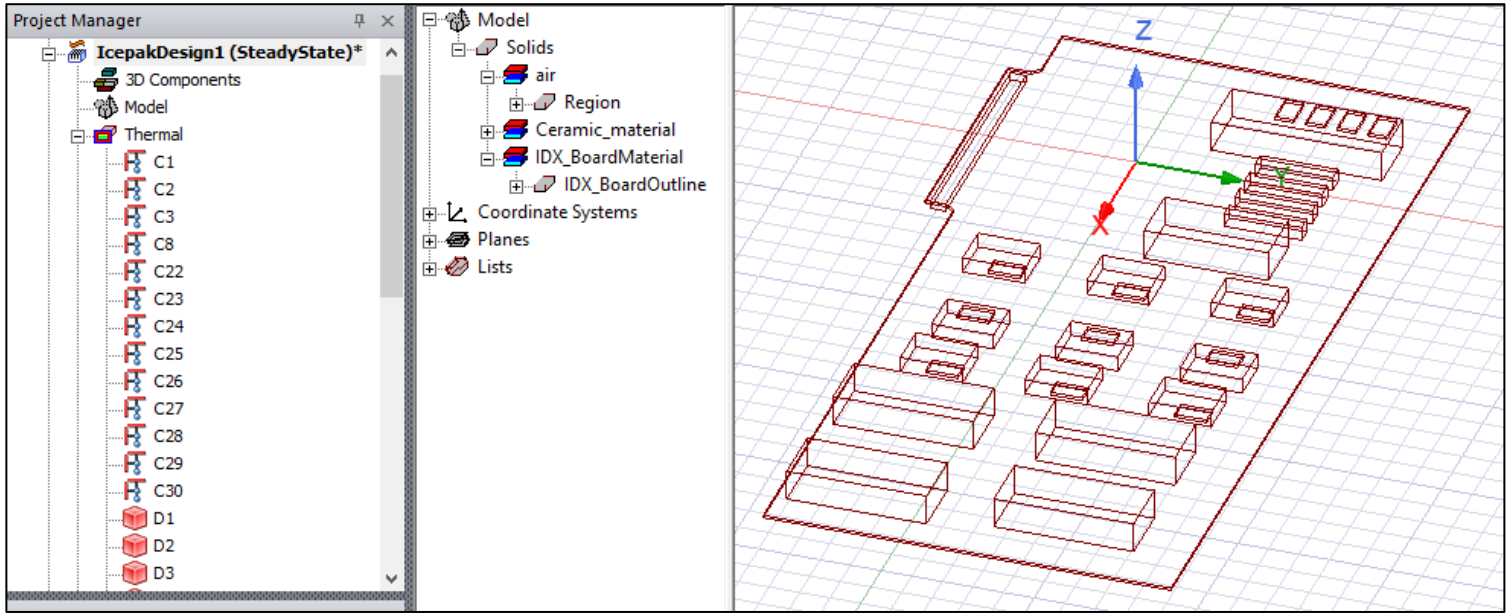


ECAD - IDX Import

- **IDX Import – XML based format consisting of ECAD and MCAD data**
  - Support geometry and boundary condition import (MCAD)
    - Like IDF import in Icepak AEDT
  - Limitations
    - ECAD data import not supported
    - Filters, Modeling options, Cutouts not supported

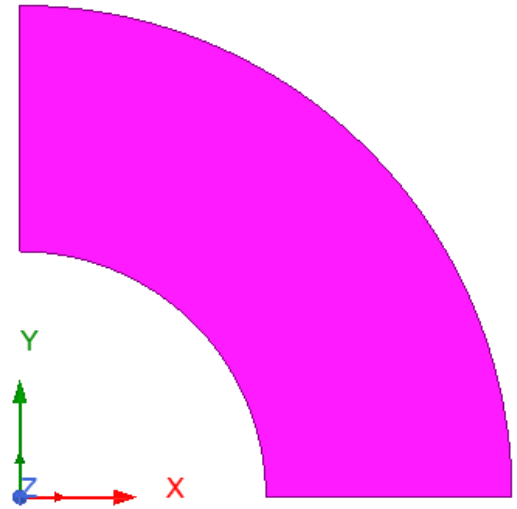




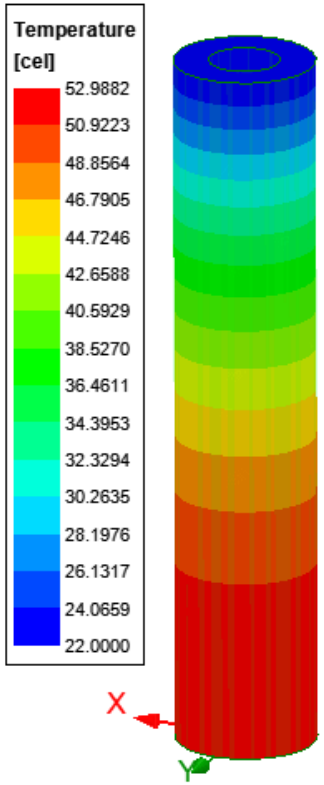


Maxwell 2D – Icepak EM Loss Coupling

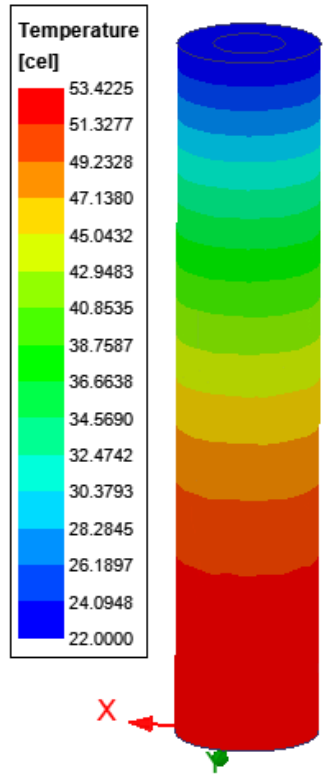
- Support EM Loss Import from Maxwell 2D
  - Extruded geometries of 2D representations
    - Support both +ve and –ve extrusions in XY
    - Can be partial geometries
  - Coupling projects 3D mesh points onto 2D geometry
  - Limitations
    - Extrusions need to be along Z axis
    - Losses not conservative



Maxwell 2D Geometry



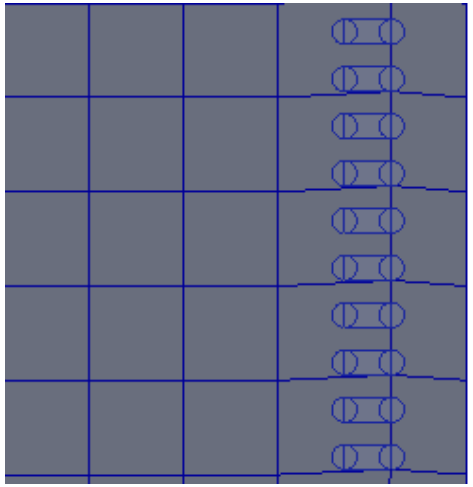
Maxwell 2D Coupling



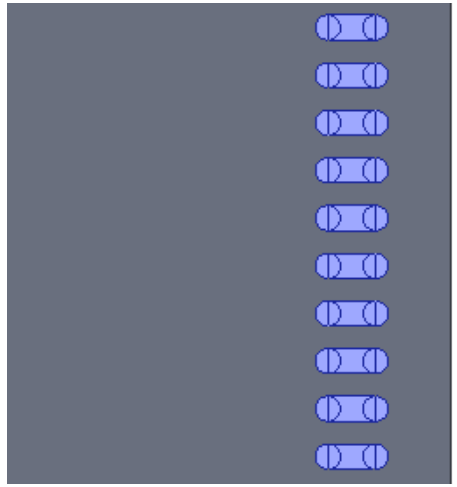
Maxwell 3D Coupling

Meshing Enhancements - 2.5D Meshing

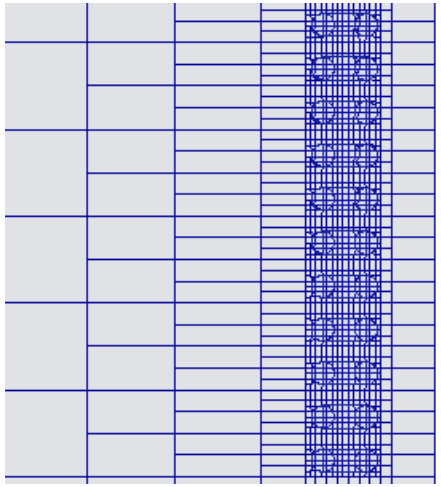
- Capturing Thin Objects in 2.5D Meshing
  - Refinement around 2D sheets parallel to the 2.5D meshing plane
    - Create additional refinement and multi-level around 2D sheets
  - Further mesh optimization using 2.5D mesh sub-blocking in following slide



2021R2: 2D Sheets not meshed



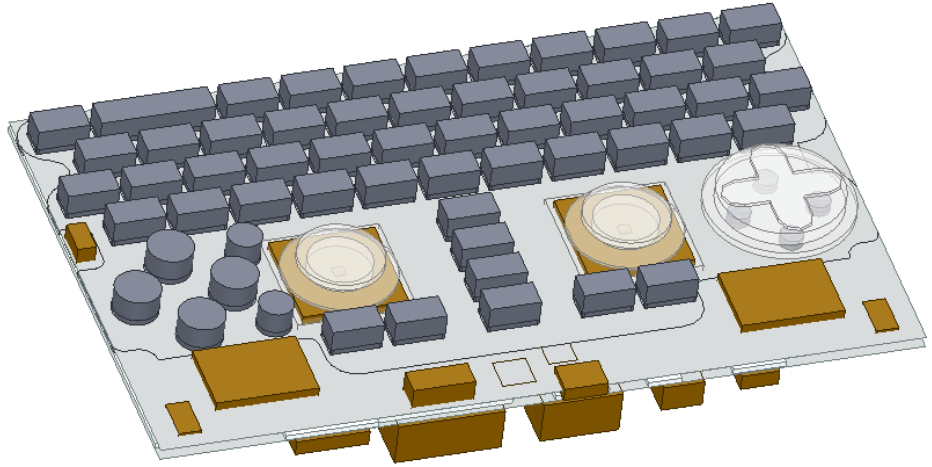
2D Sheets parallel to 2.5D meshing plane



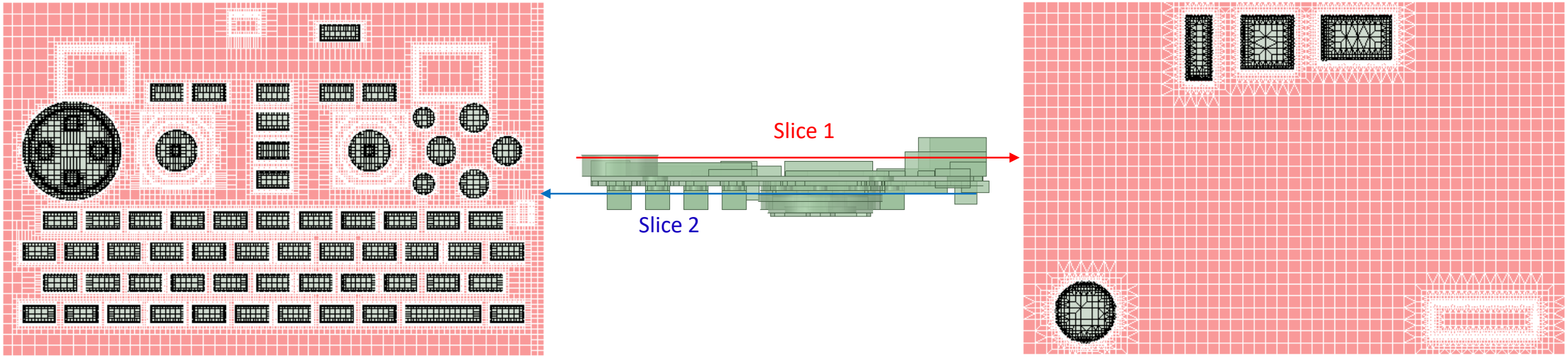
2022R1: 2D Sheets meshed

Meshing Enhancements - 2.5D Meshing*

- Domain Sub-blocking for 2.5D Meshing
  - Prevent refinement from being imprinted throughout extrusion
    - Domain split according to in-plane geometry features
    - Uses non-conformal interface to couple different meshing blocks
  - **Reduced mesh counts and improved performance (~50%)**



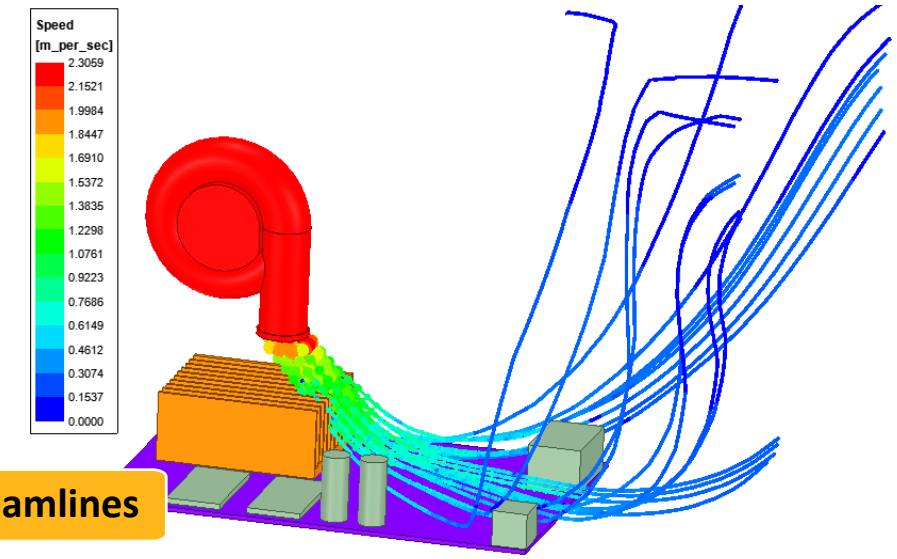
Keyboard model mesh count:
2021R2: **2.35M**
2022R1: **1.38M**



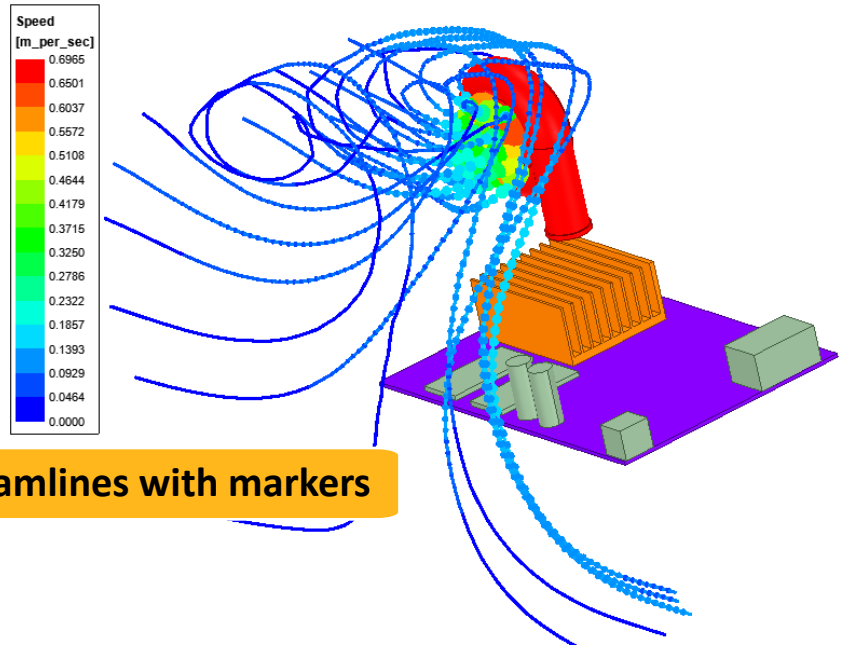
* Requires Feature Flag

Fluid Flow Streamlines*

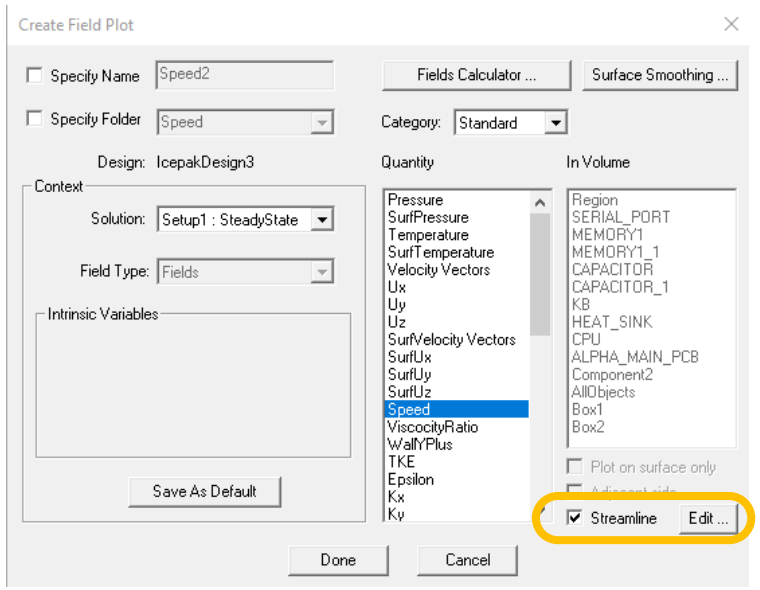
- Steady-state and transient particle traces
  - Forward and reverse direction
  - Uniform and mesh node seeding with skip option
    - Color by variable
    - Standard AEDT line and marker options
  - Animations are not supported yet

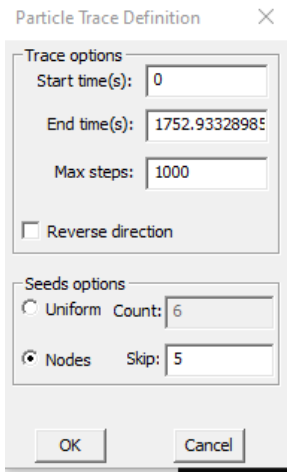


Forward streamlines



Reverse streamlines with markers

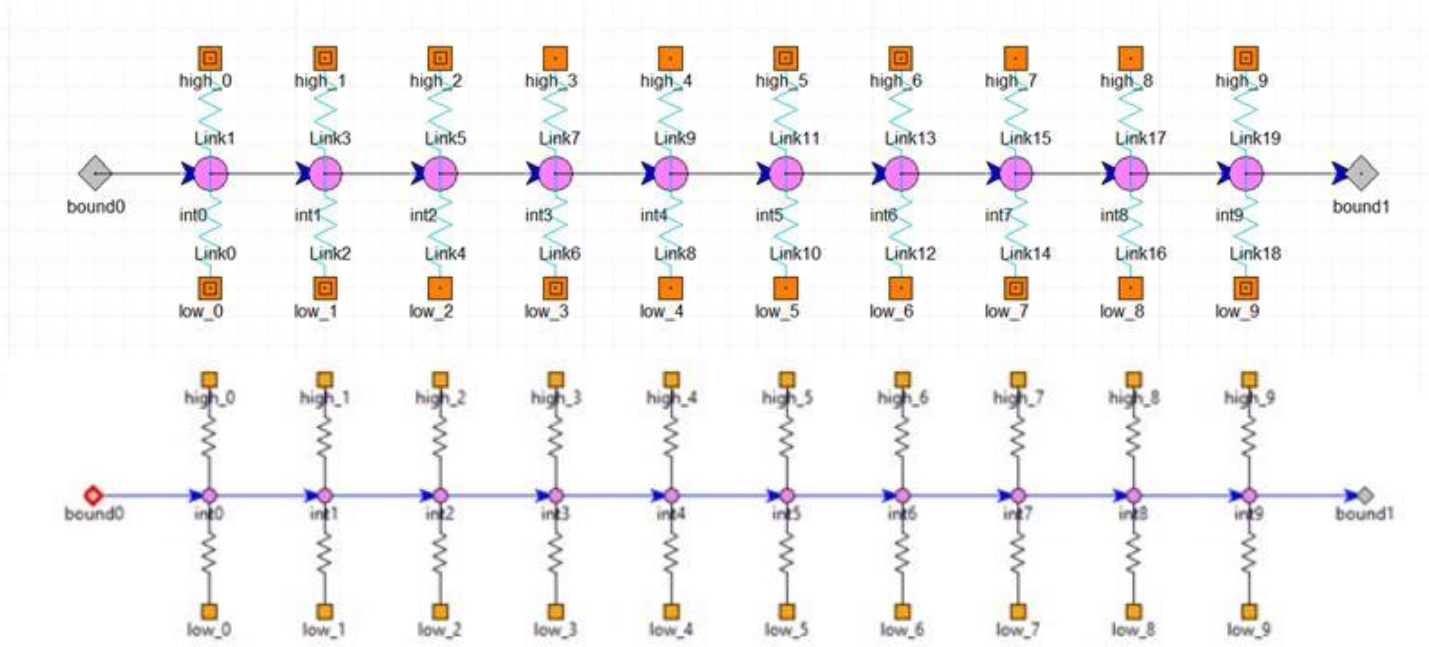




* Requires Feature Flag

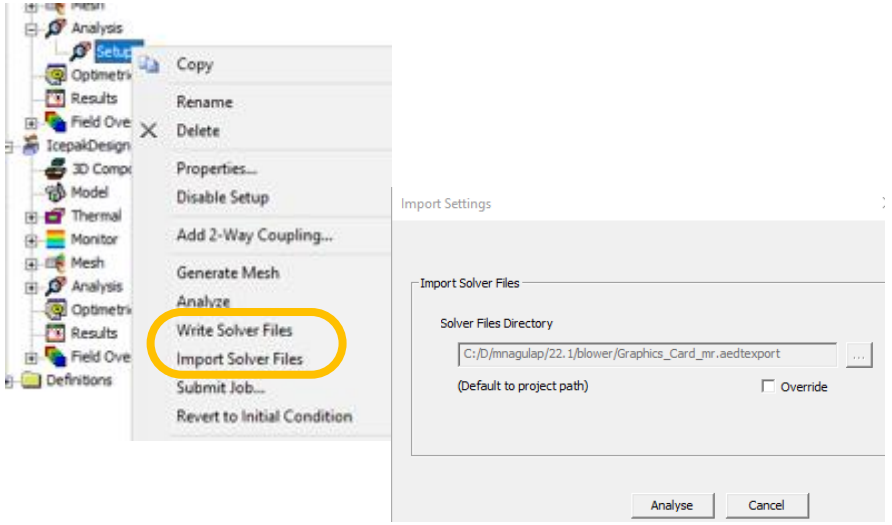
Network Schematic Enhancements

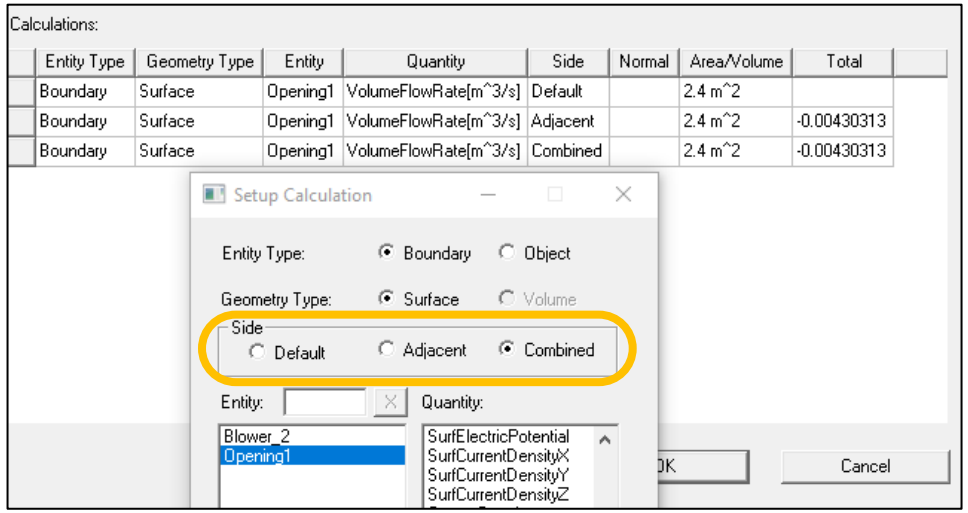
- Network circuit schematic enhancements
  - Simplified node representations
    - Similar ‘look-and-feel’ to Icepak Classic
    - Symbols
    - Color scheme
    - Links connect to nodes directly at centers
  - Icepak Classic network import
    - Networks with non-angled links imported
    - Angled links still imported using page ports



Miscellaneous Enhancements

- Solver File Export / Import
  - Write Solver Files option
  - Import Solver Files option*
- Fields Summary
  - Combined side option for surface quantities
  - Algebraic sum of Default and Adjacent side values
  - Single option to report:
    - Non-zero values at all 1-sided surfaces
    - Ensure heat balance at 2-sided surfaces
- TZR File Import Speed Improvement
  - Synchronization & Validation*
  - Speed-ups up to 70x observed





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Toolkits Development

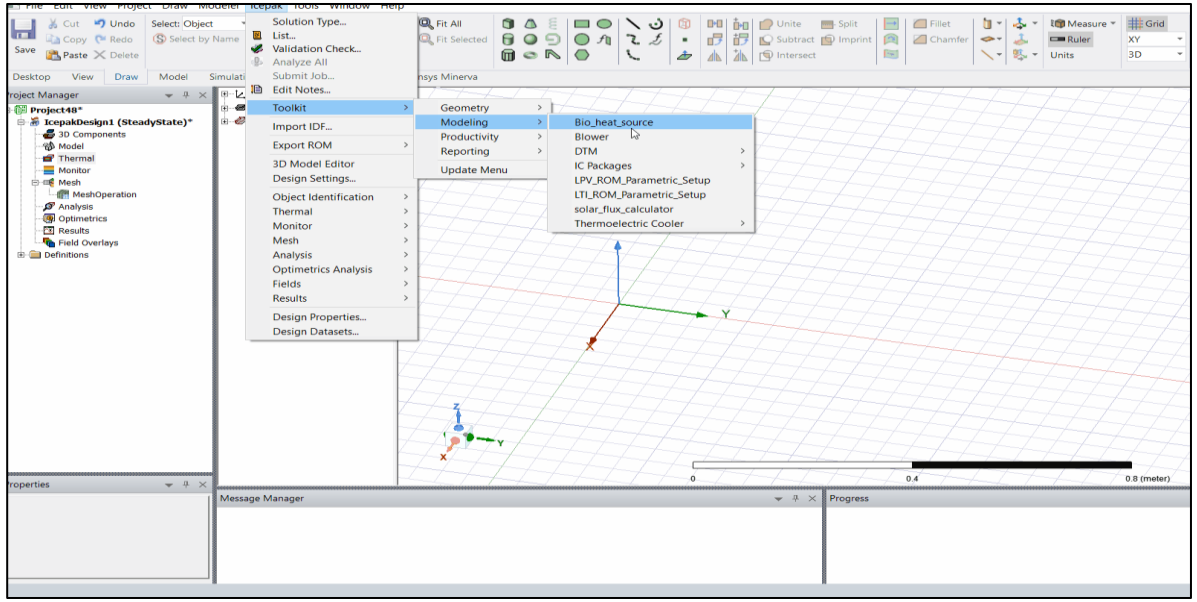
New Toolkits (10)

- Geometry Approximations(6)
- Blower
- Extract Delphi Network
- Contour File Export
- Cut Plane

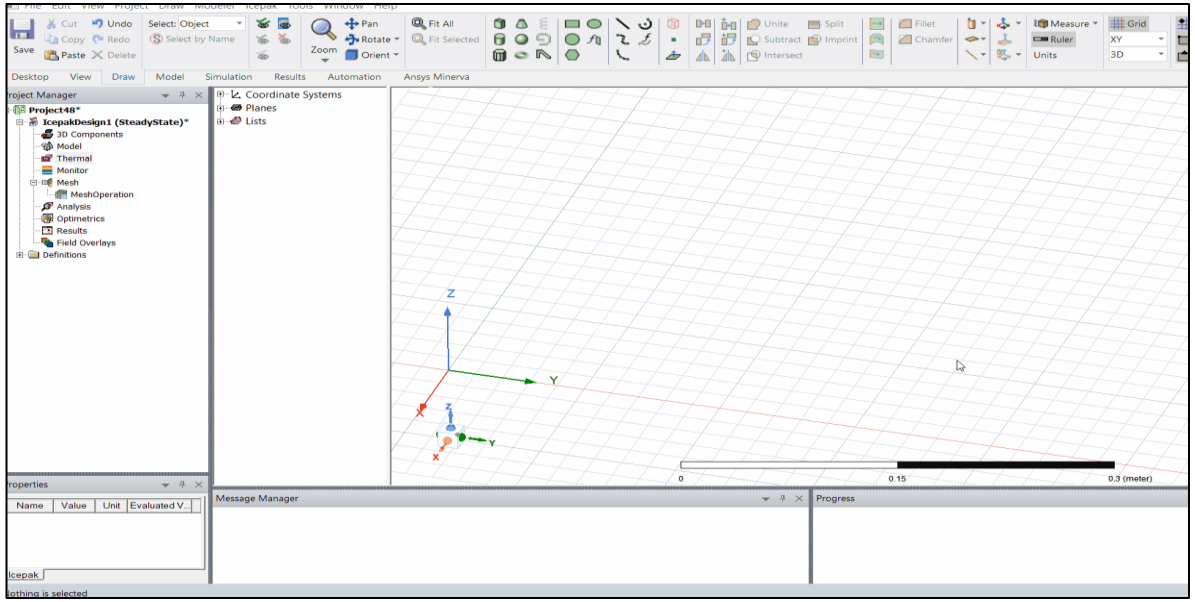
Enhancements (5)

- Variable support for Packages and PCB
- PCB
- DTM Monitor Support
- Dataset support for Power Budget
- Power density support for Bio-Heat Source

Blower Modeling - Toolkits

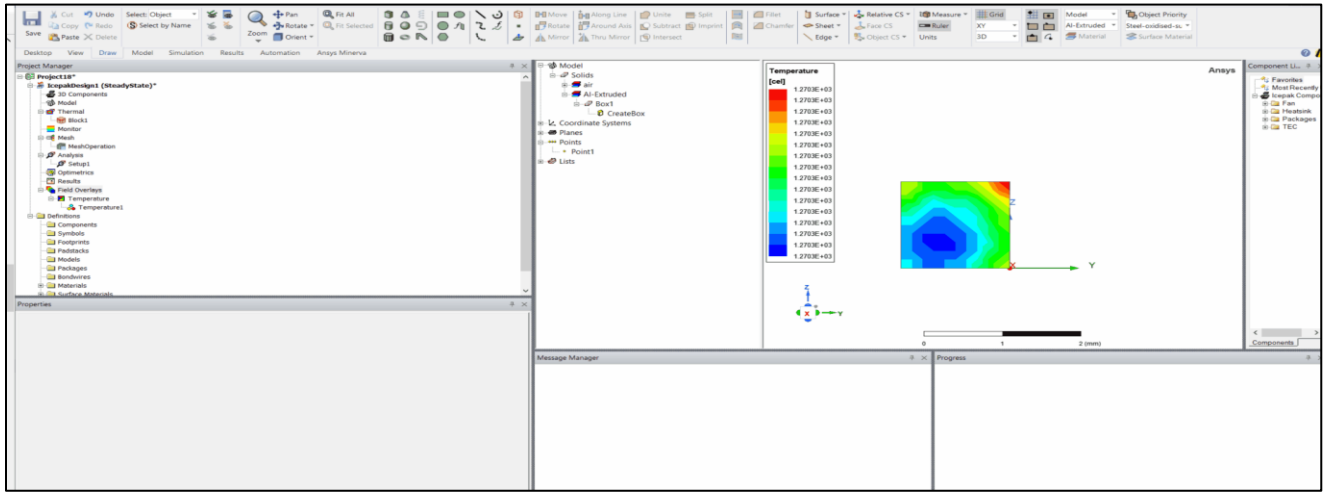


Type 1 Blowers

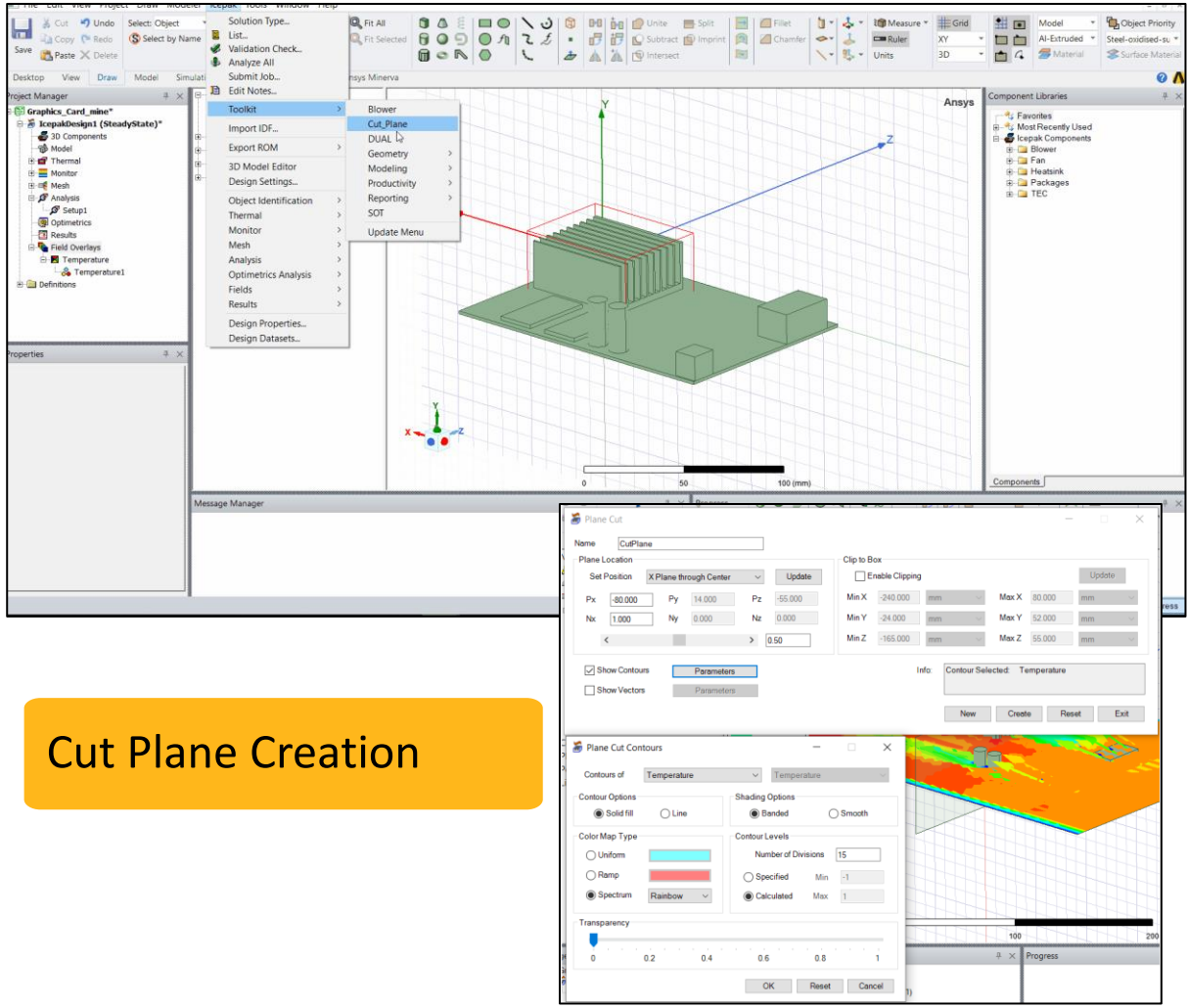


Type 2 Blowers

Post Processing Toolkits

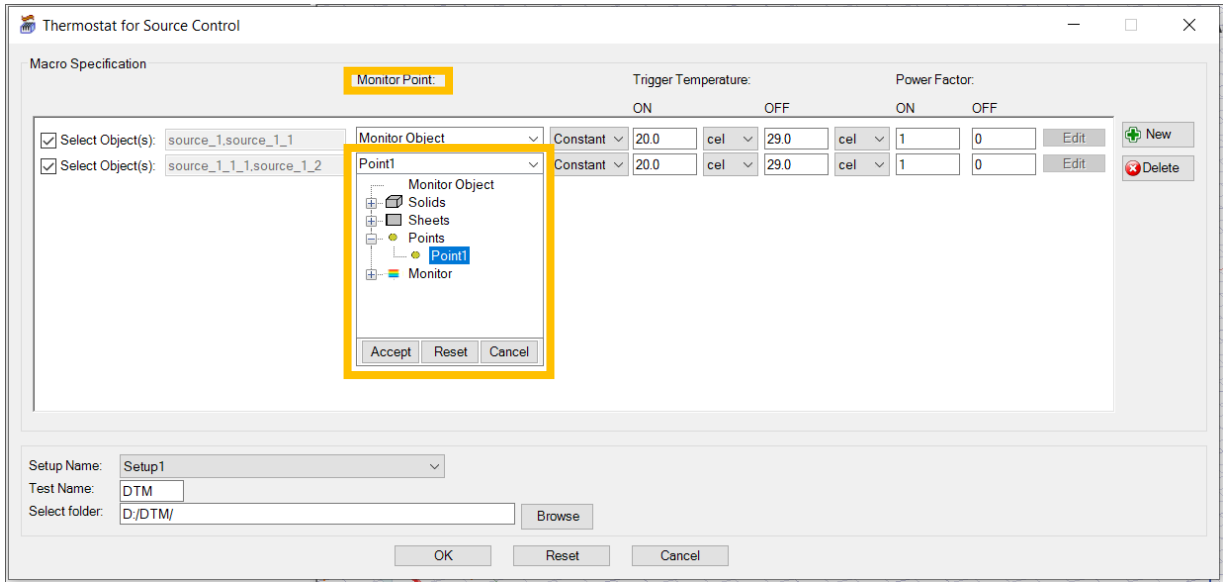


Field Plot ASCII Export

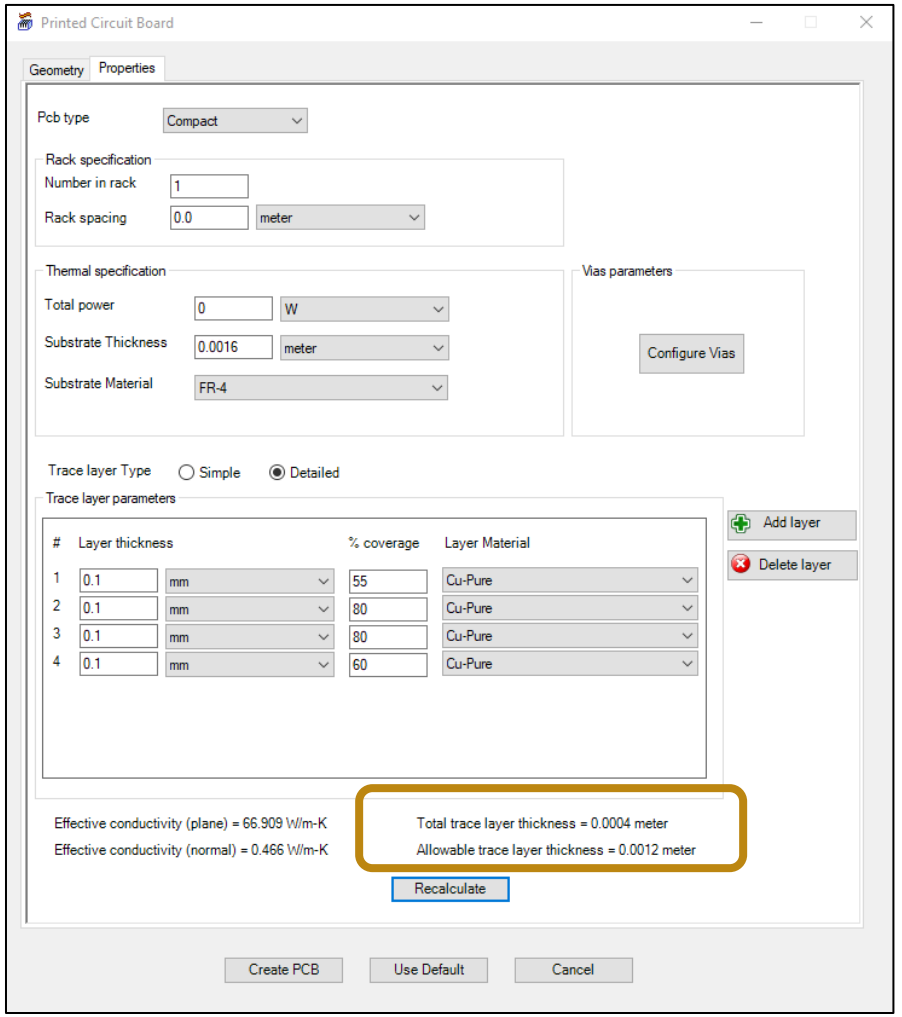


Cut Plane Creation

Other Toolkit Enhancements



DTM Monitor Support

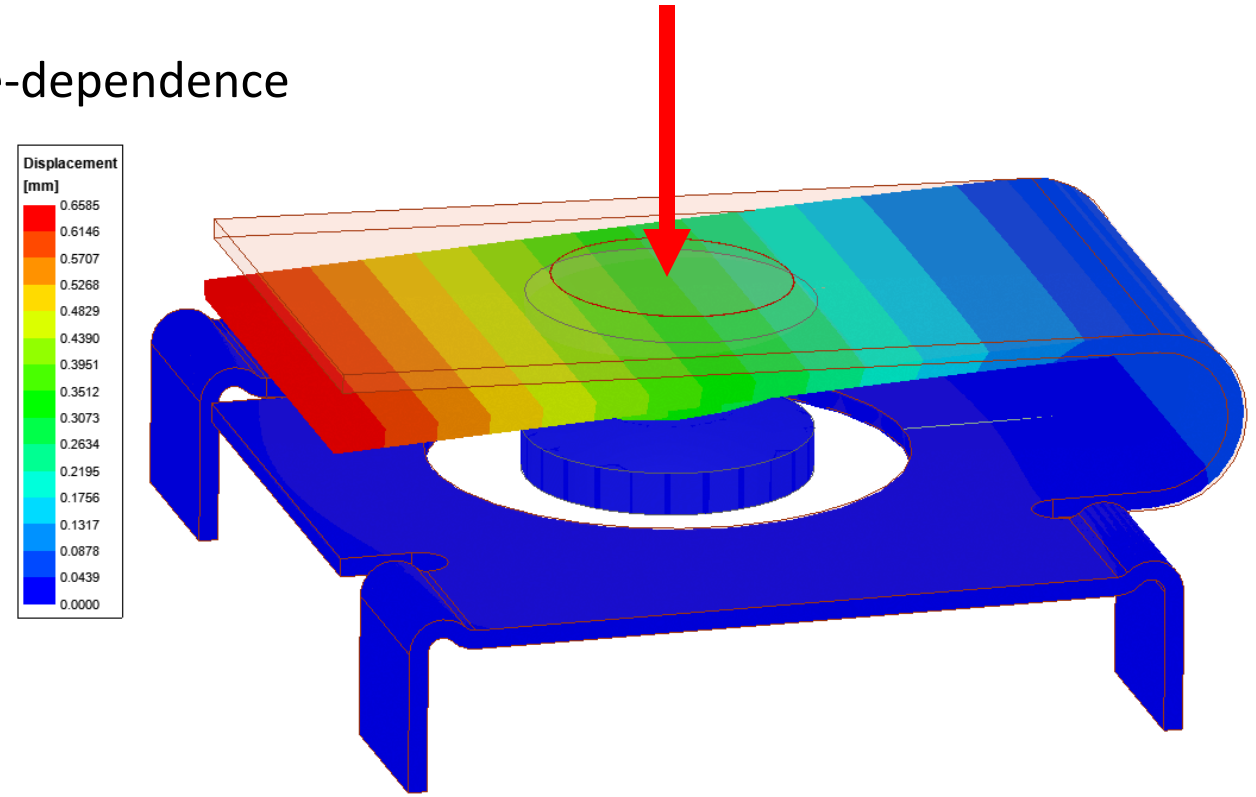


PCB

2022 R1 Mechanical in AEDT Update

Mechanical 2022R1 Highlights

- Coupling
  - Maxwell 2D – Thermal EM Loss Coupling
- Materials
  - General expression support for temperature-dependence
- Structural - Beta
  - Boundaries
    - Displacement
    - Pressure/Force
  - Coupling
    - Mechanical Thermal-Structural Link
    - EM Force – Structural Coupling
- Meshing - Beta
  - Thermal Slider bar Meshing
- Reporting
  - Fields Summary



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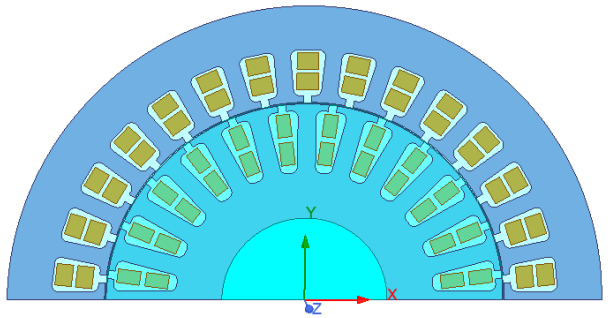
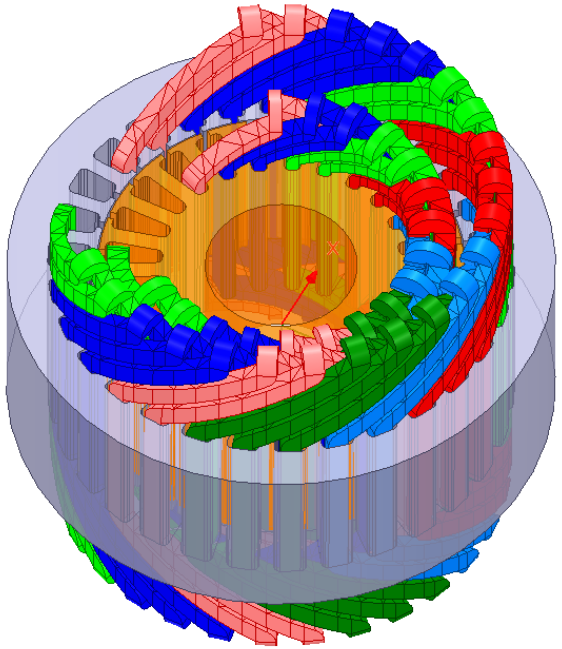


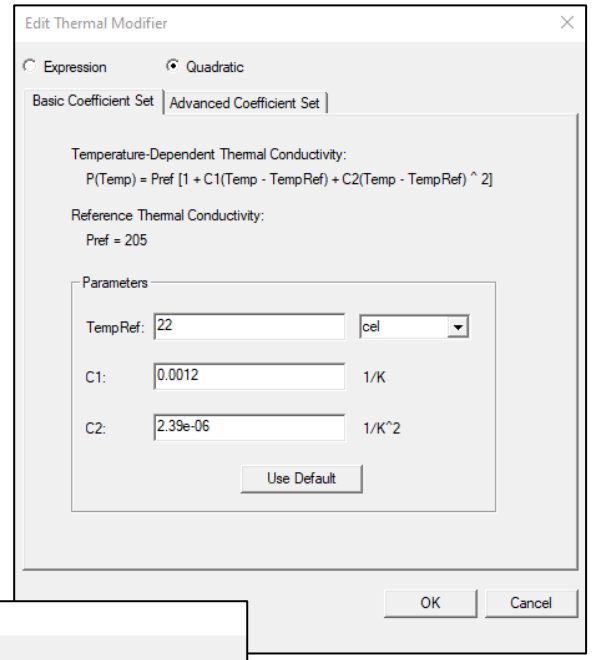
Maxwell 2D Geometry

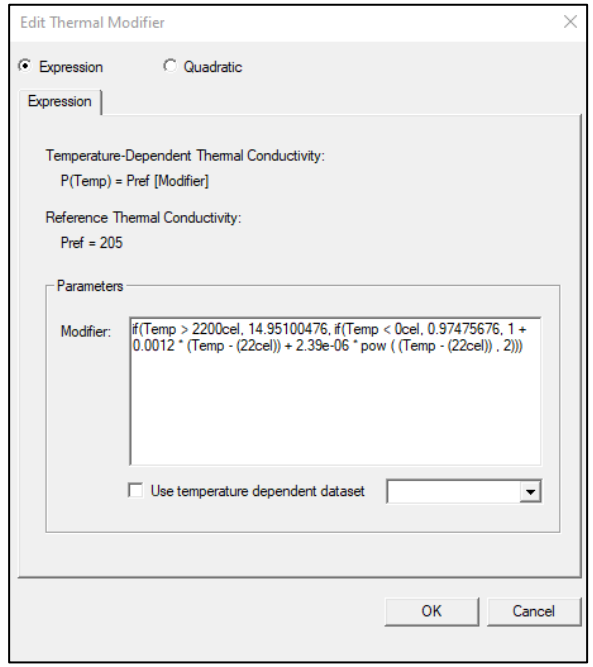


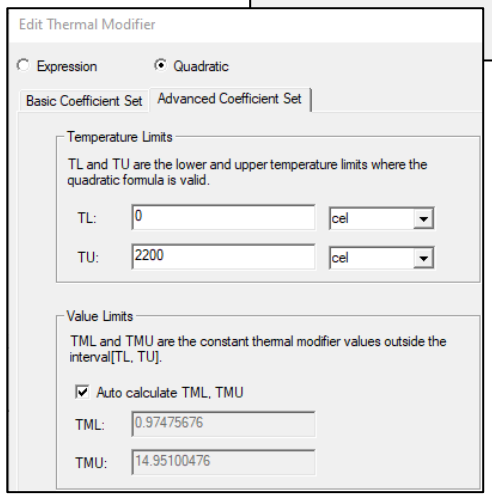
Thermal 3D Geometry

Temperature-Dependent Materials

- Temperature Dependent Materials
  - General expression support
  - Quadratic expressions
    - Advanced coefficient support
  - Converted to datasets for solver
  - Thermal & Structural





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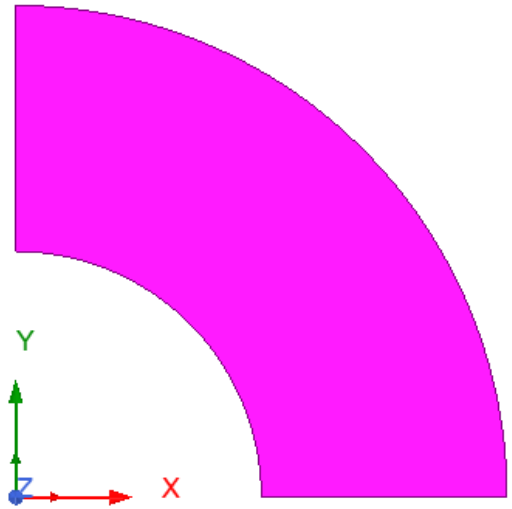
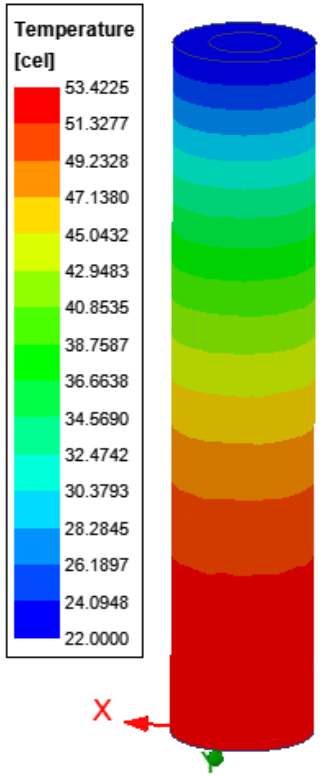
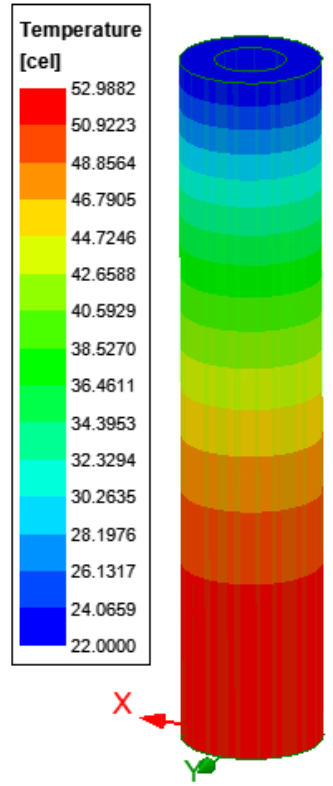
Maxwell 2D – Thermal EM Loss Coupling



Maxwell 2D Geometry



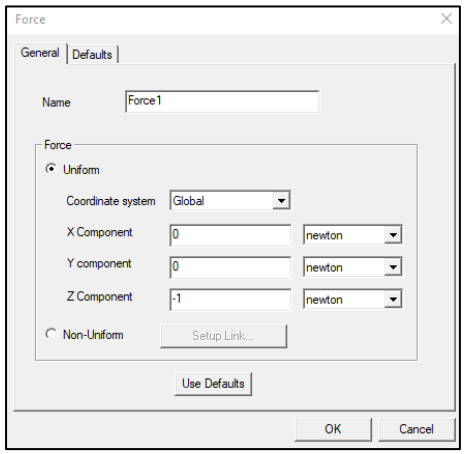
Maxwell 3D Coupling

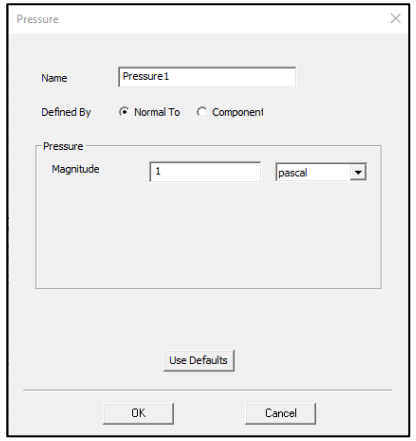


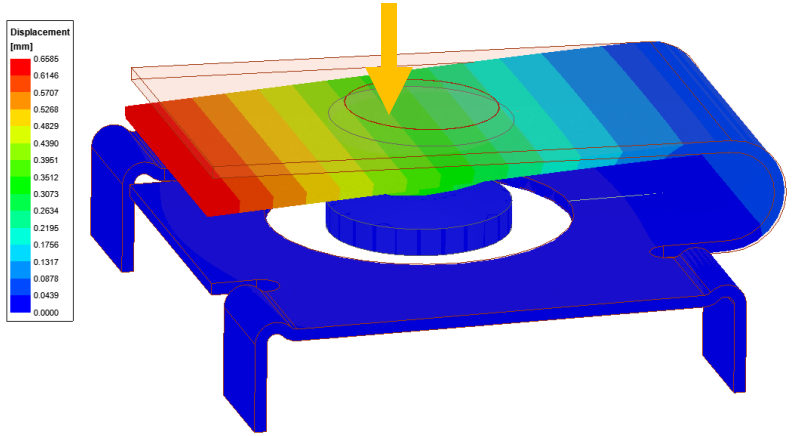
Maxwell 2D Coupling

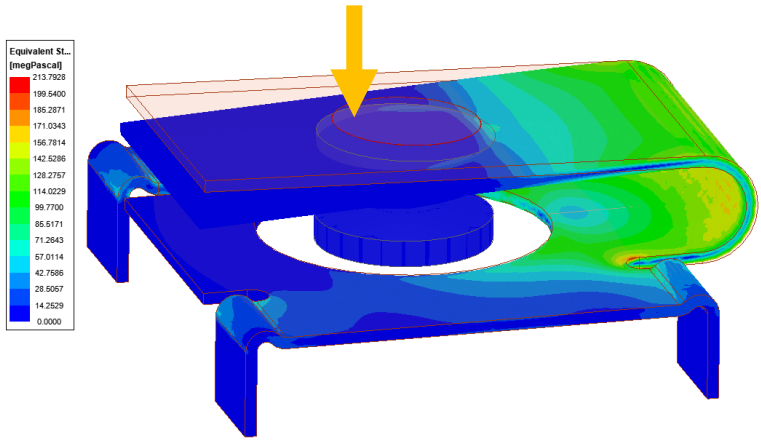
Mechanical Structural - Pressure/Force Excitations

- Force Excitation
  - Face and Object assignment
  - Uniform and Non-uniform Force options
    - Uniform (face): X, Y, Z components
    - Non-uniform via Setup Link to HFSS/Maxwell
- Pressure Excitation
  - Face assignment
  - Normal To or Component options
    - Normal To: Magnitude
    - Component: X, Y, Z components
  - Support curved faces





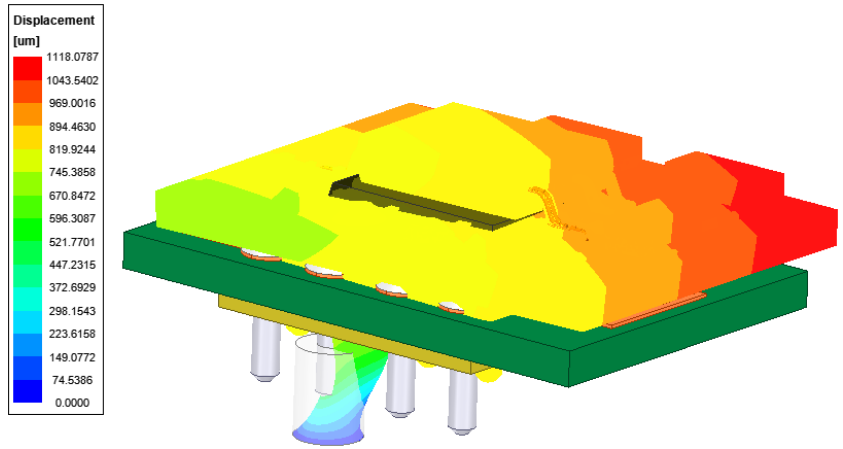


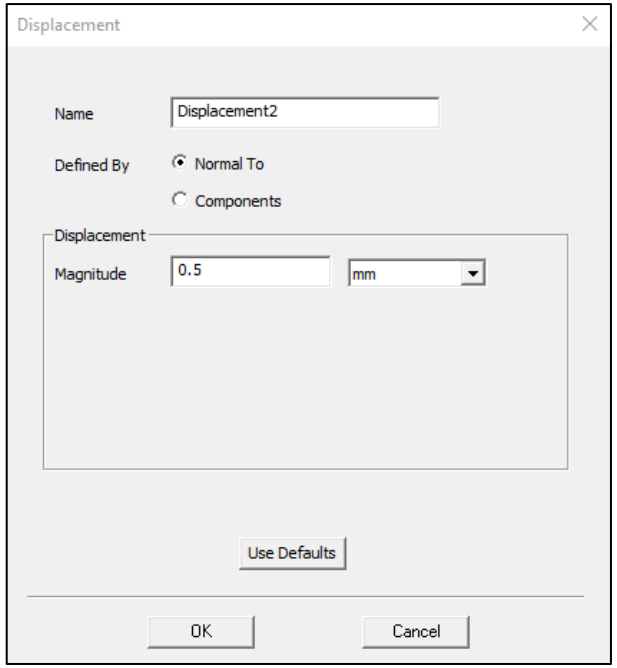


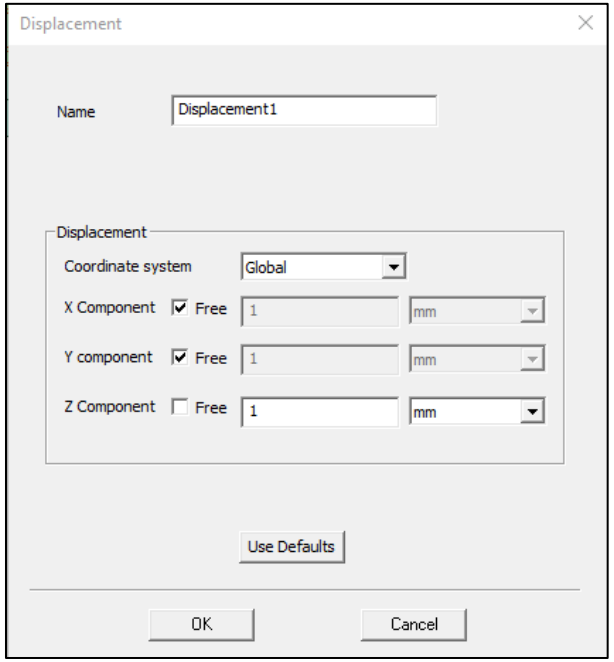
Assembly under 1N vertical force

Structural - Displacement Excitation

- Displacement Excitation
  - Assignment: Faces and Edges
  - Normal To (faces)
    - Magnitude
  - Components (faces and edges)
    - X, Y, Z components
    - Each component can be fixed magnitude or free



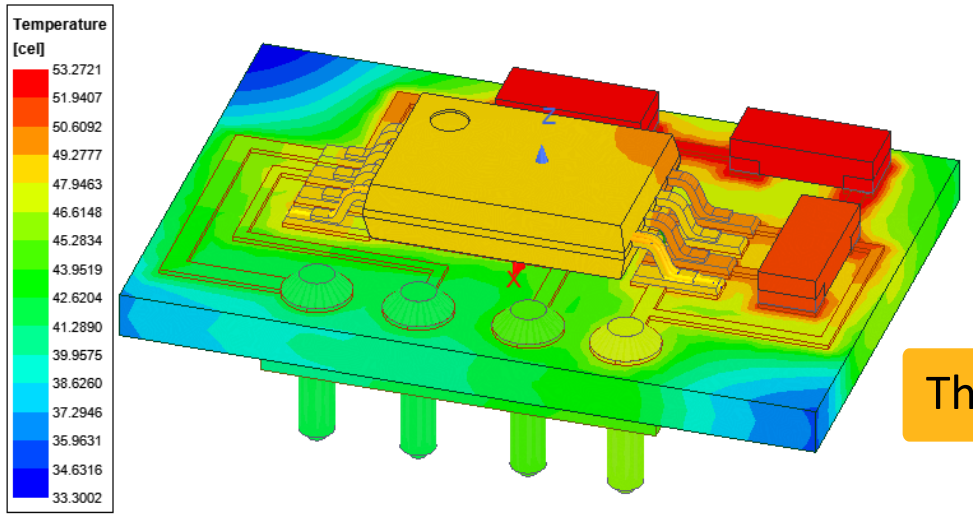




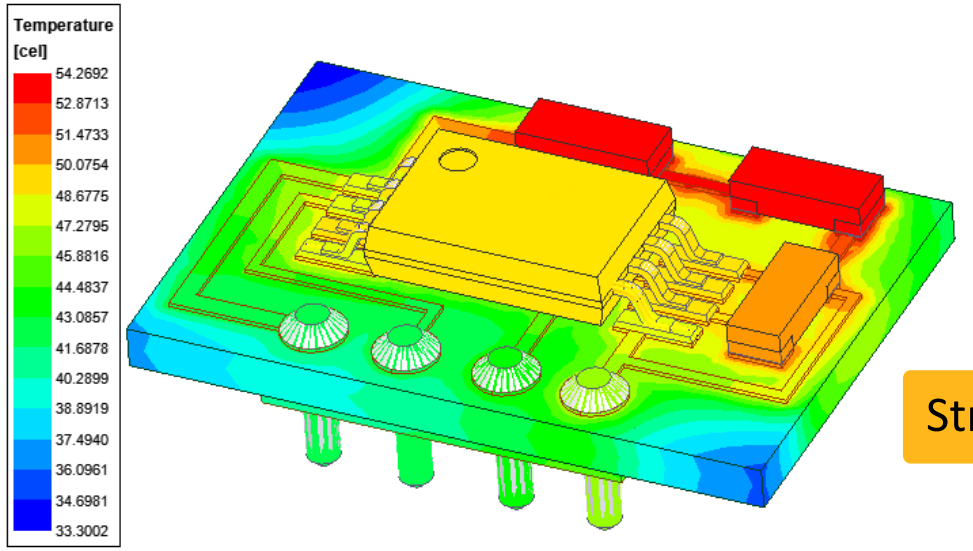
PCB Assembly with Y, Z displacements along edge

Thermal Stress Analysis - Link to Mechanical Thermal

- Coupled Thermal Stress Analysis
  - Linked to Thermal design
    - Thermal condition excitation
  - Temperatures imported for objects
    - System Coupling mapper
  - Temperature field plots



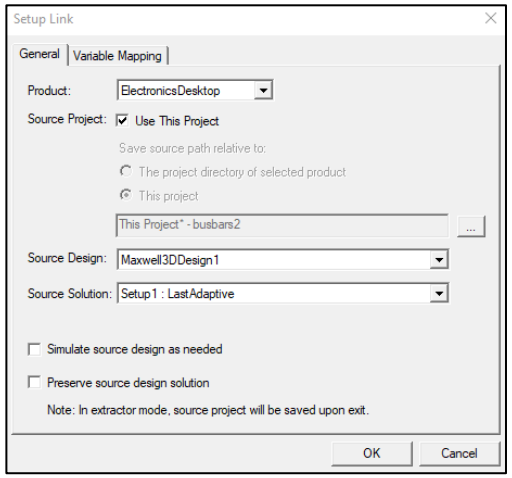
Thermal

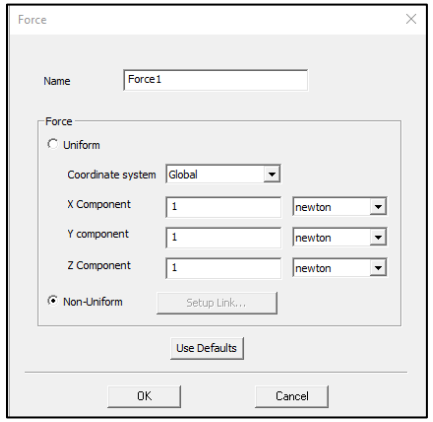


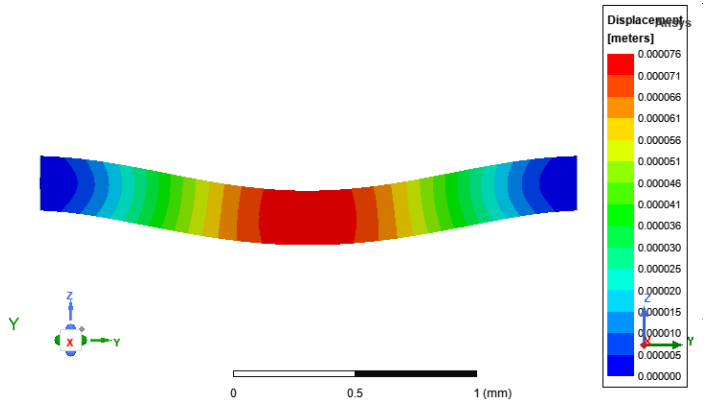
Structural

EM Force – Structural Coupling

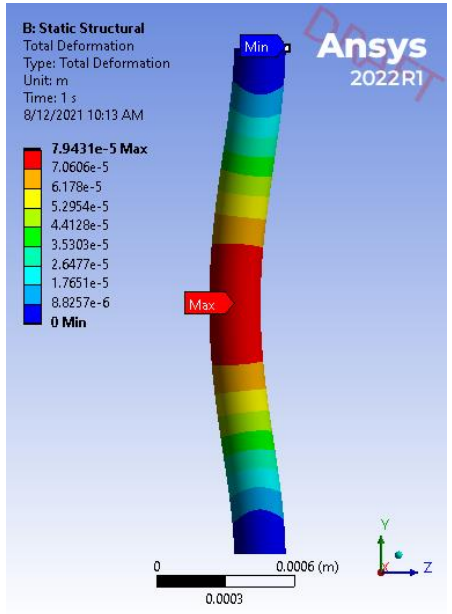
- Coupled EM Force - Structural Analysis
  - Linked to Maxwell 3D
    - Surface and Volume assignment
  - Linked to HFSS
    - Surface assignment
  - Assignment: Faces and Objects
  - 1-way coupling support







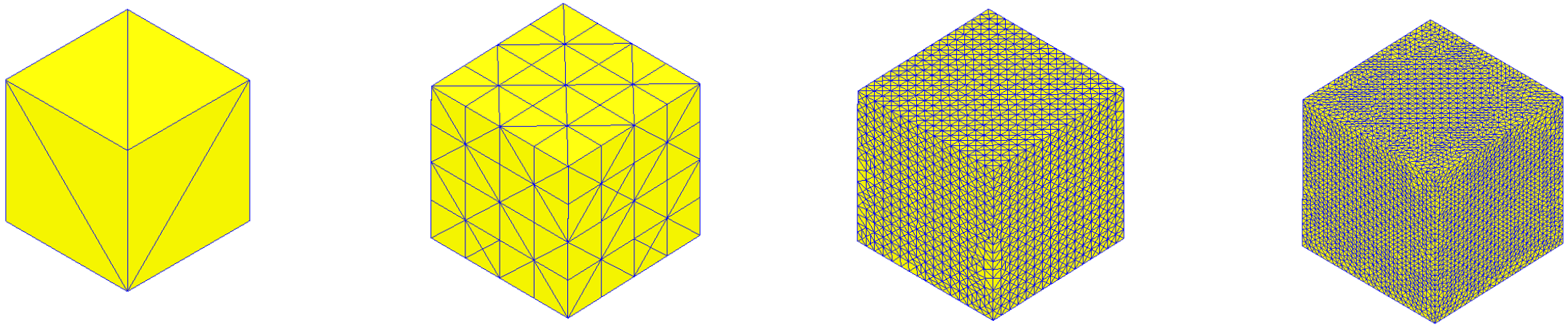
AEDT



Workbench

Automated Slider-bar Meshing – Mechanical Thermal [Beta]

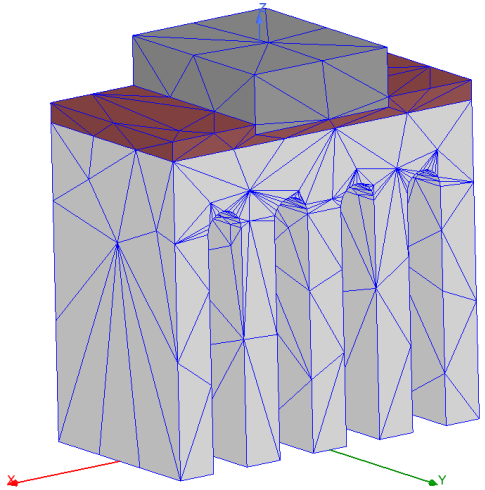
- Automated refinement based on slider position
  - Length-based refinement inside and on surfaces of all objects
  - Refinement tailored to curvilinear and rectilinear geometries
- Restrict the need for user-defined mesh operations
- **Improved solution accuracy**



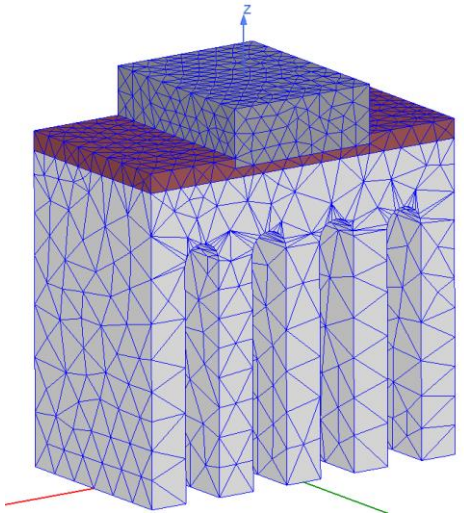
2021R2 (All slider positions)

2022R1 Auto refinement

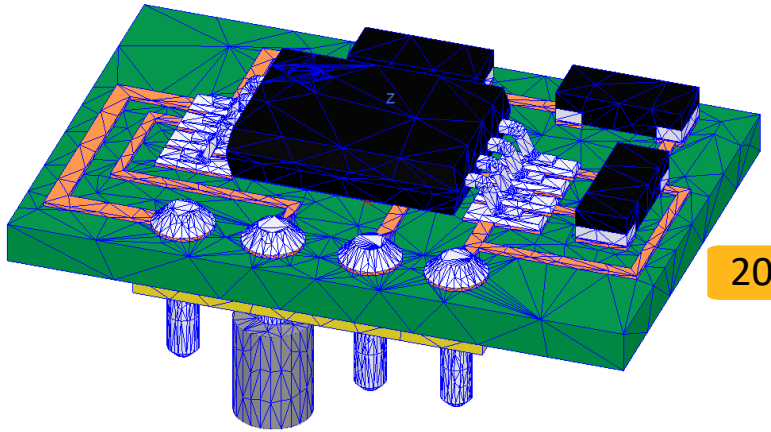
Automated Slider-bar Meshing – Mechanical Thermal [Beta]



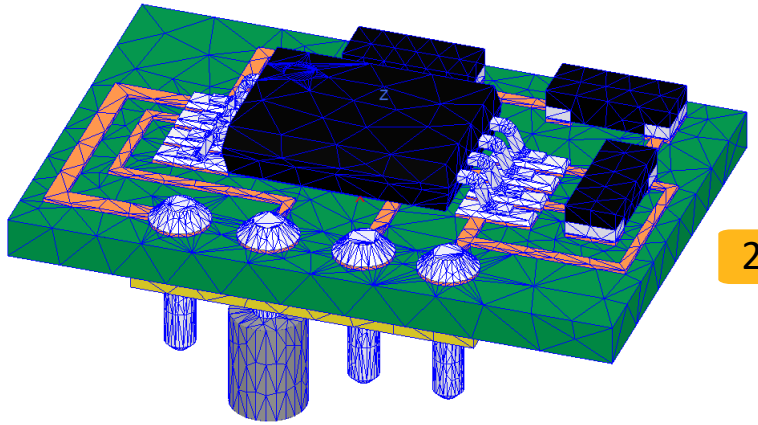
2021R2 (Count: 2k)



2022R1 (Count 11k)



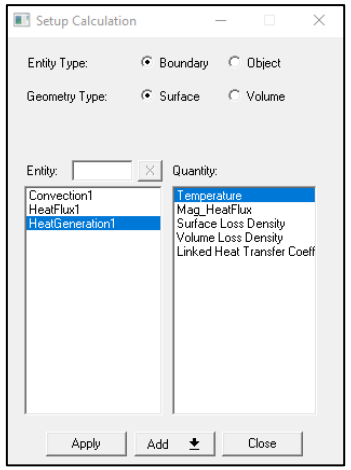
2021R2 (Count: 13k)

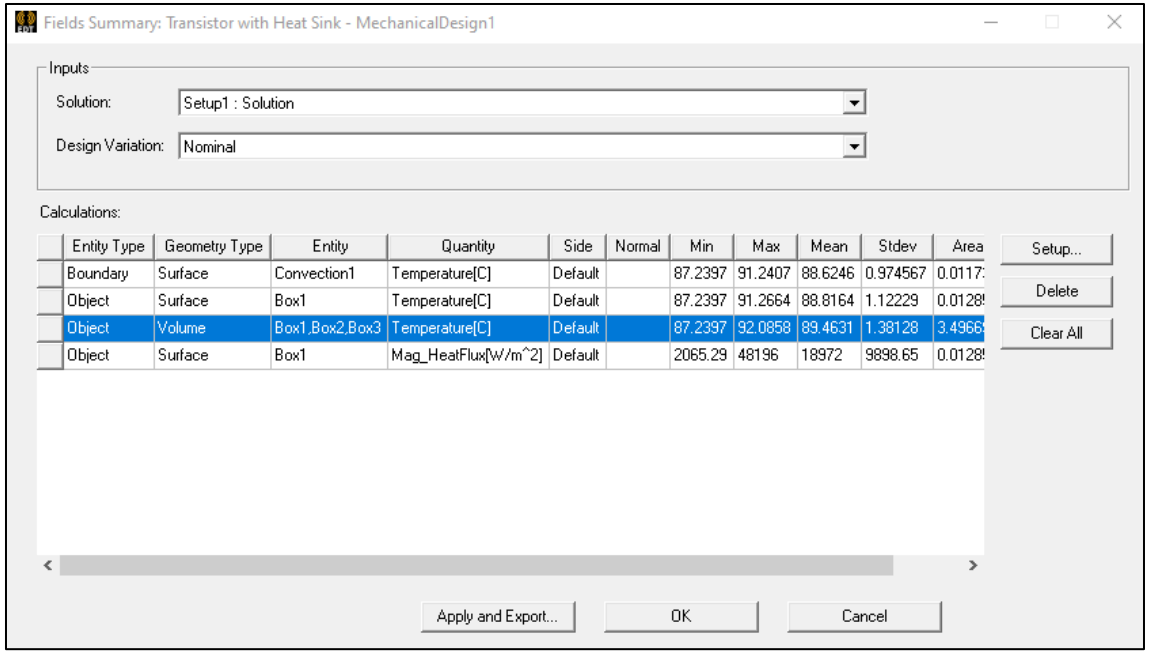


2022R1 (Count 14k)

Fields Summary

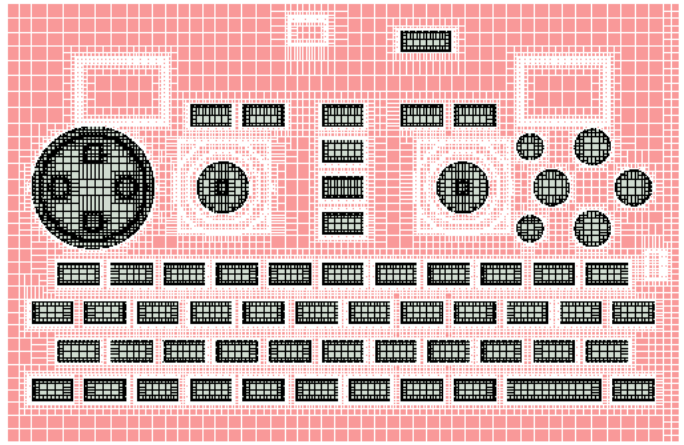
- User-friendly report calculation capability
  - Supports all Fields Calculator variables
  - Boundary and Object selection
  - Surface and Volume calculations
  - Min, Max, Mean, Standard Deviation, Total**
  - Multi-select and multiple calculations
  - Export to CSV format



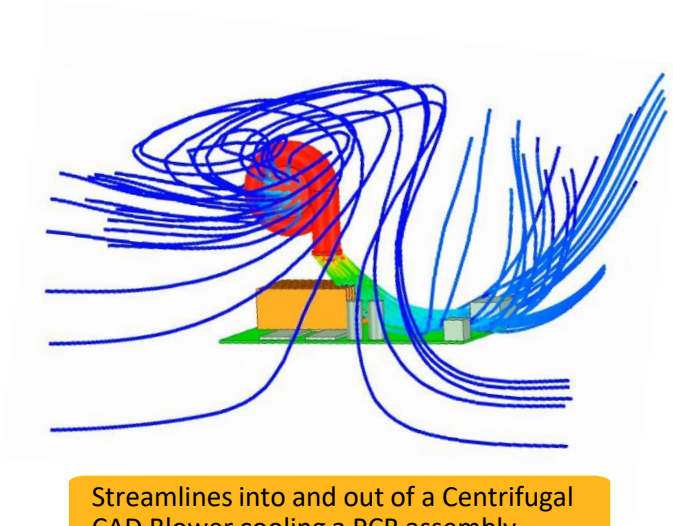


** Total and Heat Flow Rate available for Objects, but not boundaries

Icepak 2022 R1 Highlights



- **Reduced Order Modeling (ROM)**
  - Redhawk CTM 2-Way & New Delphi Network Creation
- **Blower Modeling**
- **ECAD Import -** Wirebond & IDX
- **Maxwell 2D** – Icepak EM Loss Coupling

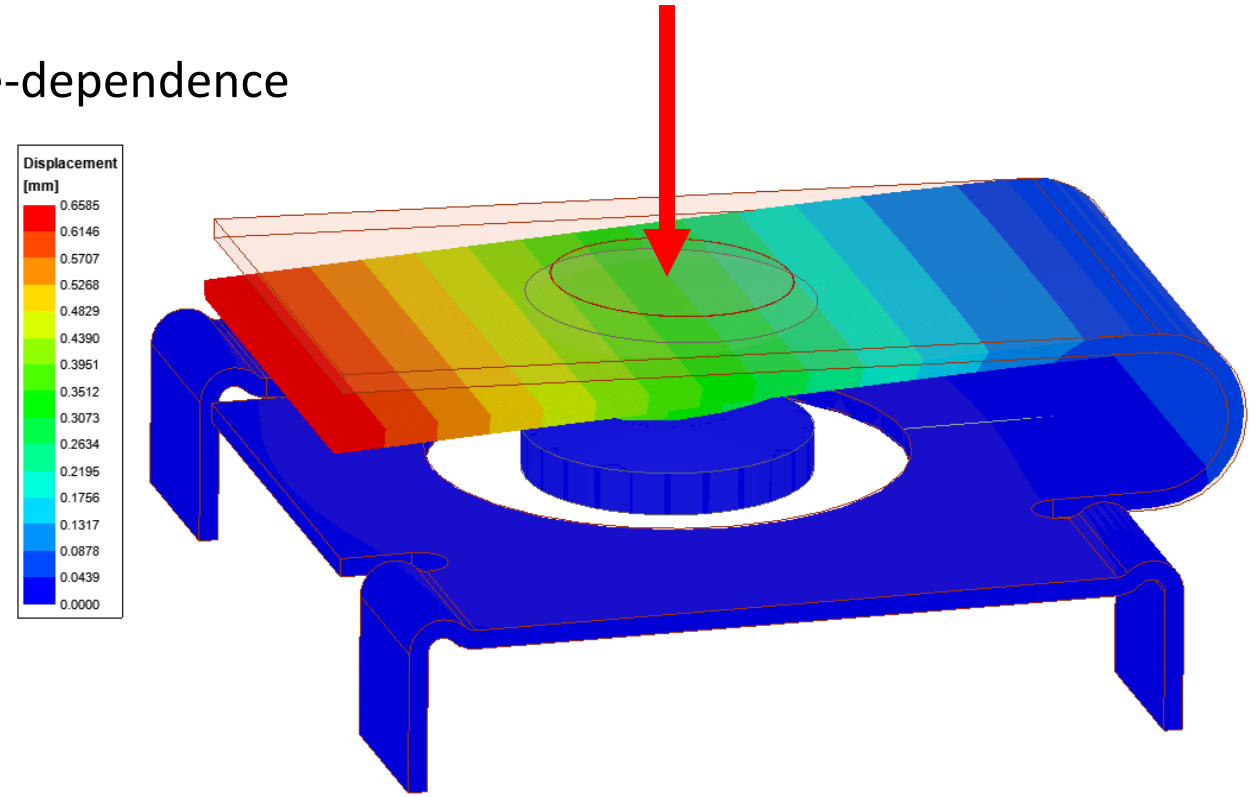


Streamlines into and out of a Centrifugal CAD Blower cooling a PCB assembly

- **Mesher Enhancements –** 2.5D Improvements
- **User Experience**
  - Streamlines & Validation Enhancements
  - Improved Error messaging & troubleshooting
- **Migration**
  - Improve speed of TZR conversion
  - Network Schematic enhancements
  - Toolkit enhancements
    - PCB, Package parameterization

Mechanical 2022R1 Highlights

- Coupling
  - Maxwell 2D – Thermal EM Loss Coupling
- Materials
  - General expression support for temperature-dependence
- Structural - Beta
  - Boundaries
    - Displacement
    - Pressure/Force
  - Coupling
    - Mechanical Thermal-Structural Link
    - EM Force – Structural Coupling
- Meshing - Beta
  - Thermal Slider bar Meshing
- Reporting
  - Fields Summary




Ansys

APPENDIX

Validation - Error Messages and Handling

- HDM Error Message Handling
  - Detailed error messages printed in message window and HDM aborted
  - Cause of errors and suggested solutions documented
- Boundary Condition Validation
  - Improved error handling
  - Cause of errors and suggested solutions documented

Error Message	Cause of Error	Possible Solution
Unknown planes:	A 2D sheet primitive object has a plane other than xy,xz, or yz	Contact Ansys support for assistance
Incorrect polygon vert count	A polygon object has less than 3 vertices, or the specified number of vertices does not match the actual number	Check polygon shape definition for repeated vertices. If no repeated vertices are defined, submit a defect tolcepak Dev
Domain is not present, error in input file	The air region is not correctly identified by the geometry engine.	Contact Ansys support for assistance
Failed to triangulate objectObject_Name. Polygon vertices may be collapsed due to min gap settings	The polygon shape “Object_Name” cannot be converted into a triangulatedsurface for meshing.	Check the vertices of the polygon to see if any two ofthem are too close to each other, If so, considermerging them to one point.
External mesh "file name" cannot be reused. Please check if it is a valid mesh file.	The reuse mesh file named "file name" cannot be located or opened.	Check if the correct mesh file has been selected in the reuse mesh operation.
Polyhedron is not supported in Icepak. Reuse mesh cell type must be hex, prism, pyramid or tet.	The reuse mesh contains polyhedral cells, which are not supported by Icepak.	When meshing in fluent, avoid using polyhedral cells.
External mesh's bounding box must match the object's box. The local coordinate system of the object might be wrong	The reuse mesh's bounding box does not match that of the geometry	Check if the correct mesh file has been selected in the reuse mesh operation. Check if the reuse meshconforms well with the geometry.
Element count (total_count, nx, ny ,nz) is higher than the max_elements specified	For cartesianmesher, the mesh count of the initial background mesh is larger than the maximum element count specified in the UI.	Use larger max elementsize, orincrease the "Maxelements" located in the "Options" tab of mesh controlpanel.
CART3D/CART2D HANGING NODE FAILED for assembly (meshregion) name.	3D/2D multi-level meshing is not successful in the mesh region.	Use non-isotropic transition of 3D MLM.

Troubleshooting Documentation

Icepak Help

Icepak Troubleshooting - Boundary Conditions

Error Message	Cause	Guidance
Interior Opening "OpeningName" cannot have a Velocity specification.	Velocity is specified on an internal opening.	Switch the opening inlet type to Pressure.
Heat Transfer Coefficient specification for Stationary wall "WallName" will be ignored as it is internal to the domain.	A stationary wall with heat transfer coefficient specified is on the interior of the computational domain.	Switch the external condition to Heat Flux.
This design has power specified but does not have any wall or flow boundaries. The solution might not converge.	A design has a power specification but does not have a wall or flow boundary condition assigned.	Create an external wall boundary or appropriate flow boundaries.

You are here: Icepak Help > Icepak Troubleshooting > Icepak Troubleshooting Meshing

Icepak Help

Icepak Troubleshooting - Meshing

Error Message	Cause	Guidance
Unknown planes	A 2D sheet primitive object has a plane other than xy, xz, or yz.	Contact Ansys support for assistance.
Incorrect polygon vert count	A polygon object has less than 3 vertices, or the specified number of vertices does not match the actual number.	Check the polygon shape definition for repeated vertices. If no repeated vertices are defined, contact Ansys support for assistance.
Domain is not present, error in input file	The air region is not correctly identified by the geometry engine.	Contact Ansys support for assistance.
External mesh "file name" cannot be reused. Please check if it is a valid mesh file.	The reuse mesh file named "file name" cannot be located or opened.	Check if the correct mesh file has been selected in the reuse mesh operation.
Polyhedron is not supported in Icepak. Reuse mesh cell type must be hex, prism, pyramid or tet.	The reuse mesh contains polyhedral cells, which are not supported by Icepak.	When meshing in Fluent, avoid using polyhedral cells.
External mesh's bounding box must match the object's box. The local coordinate system of the object might be wrong.	The reused mesh's bounding box does not match that of the geometry.	Check if the correct mesh file has been selected in the reuse mesh operation. Also, check if the reuse mesh conforms well with the geometry.
Failed to triangulate object "object name". Polygon vertices may be collapsed due to min gap settings.	The polygon shape "object name" cannot be converted into a triangulated surface for meshing.	Check the vertices of the polygon to see overlapped vertices or self-intersection. If so, correct the geometry.
CART3D/CART2D HangingNode FAILED for assembly (mesh region) "assembly name".	3D/2D multilevel meshing is not successful for the mesh region "assembly name".	Use non-isotropic transition of 3D MLM.

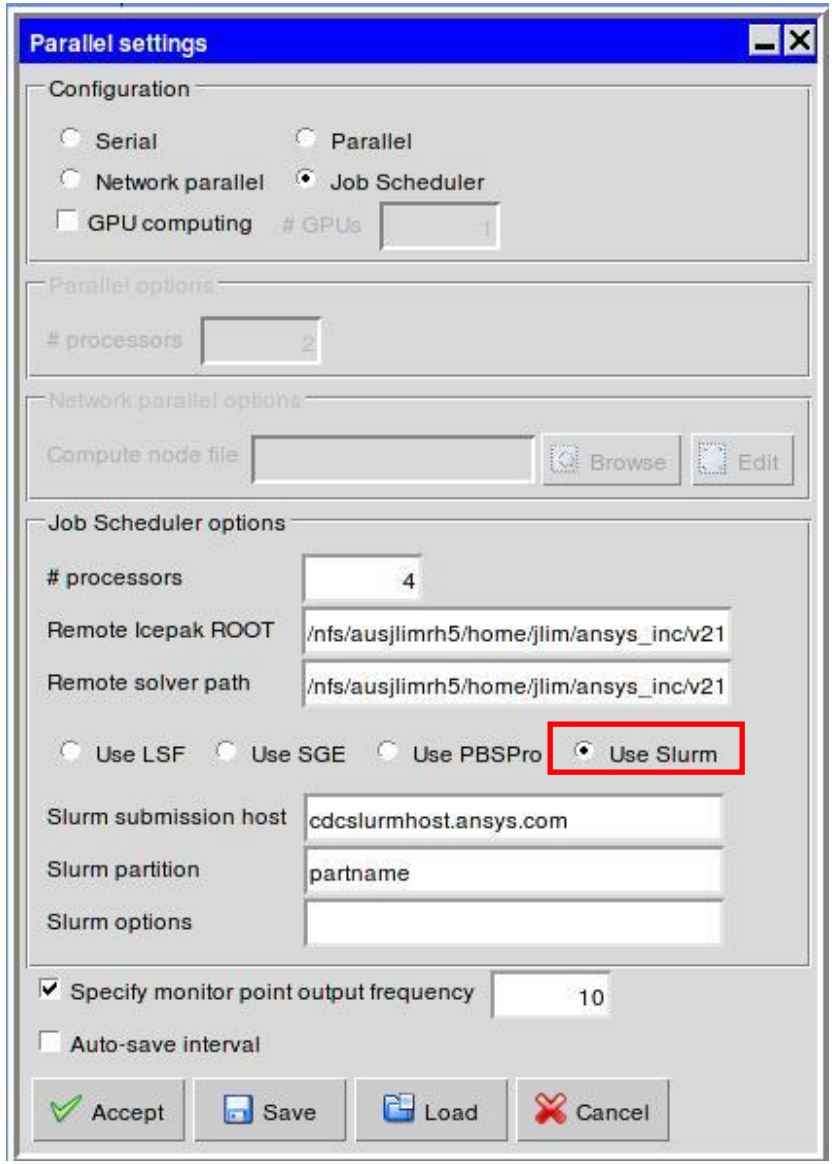
Classic Icepak 2022 R1 Update

Classic Icepak 2022R1 Summary

- Scheduler enhancements
  - Slurm support
  - Switch to FLUENT scheduler syntax
- Modeling
  - Transient junction temperature
  - DO solar irradiation model on flow boundary
- Meshing
  - Size function for 2d objects in 2.5D
  - Auto 2D Layer-by-Layer Mesh Separately (BETA)
  - Handle 2D object on mesh separately/mesh reuse objects (BETA)
- Miscellaneous
  - Network node names in Temperature Limits dialog
  - Option to merge ECXML file
  - Use CAD z-axis as flow direction for CAD fan

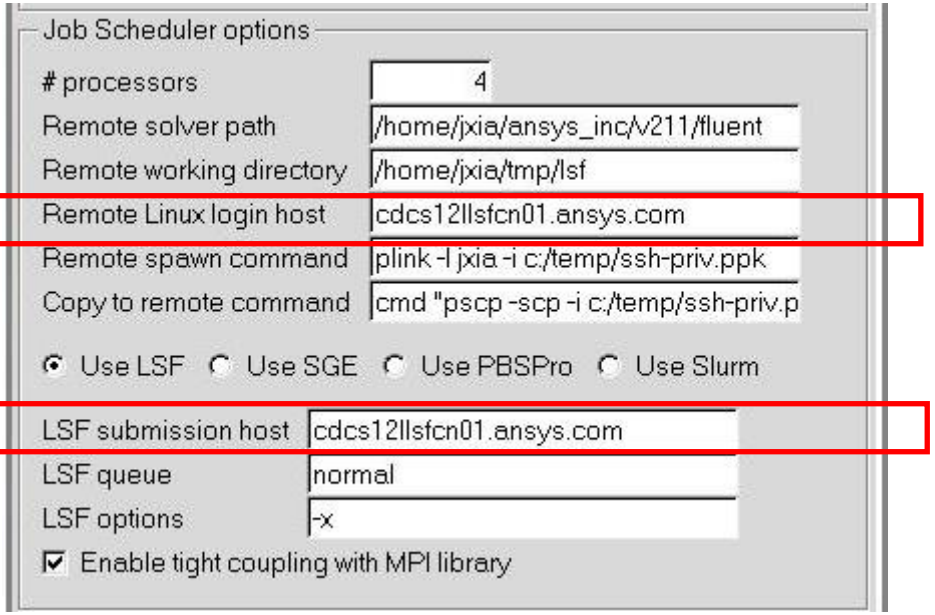
Scheduler Enhancements

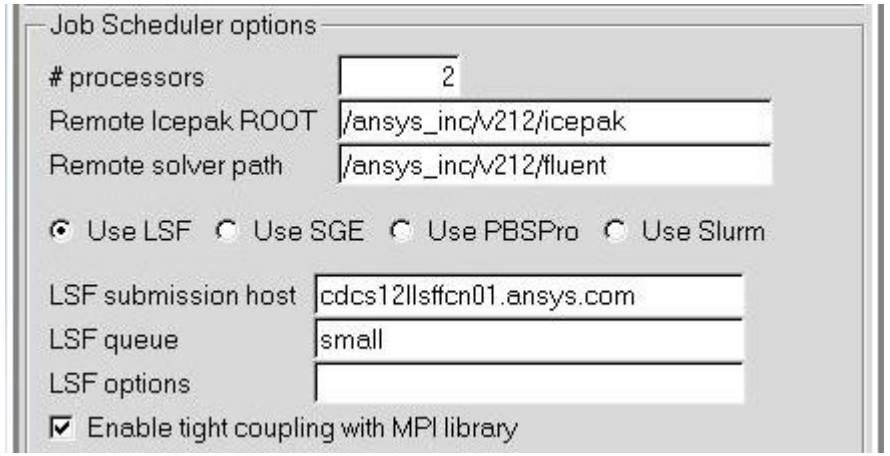
- Slurm scheduler support
  - Remote Linux from windows
  - Native on Linux
- FLUENT command line syntax switched to "–scheduler_{*param*}=<*options*>" format
  - fluent 3ddp -t4 … -node0=<*Remote Linux Login Host*> -scheduler=<*lsf, sge, pbs, slurm*> -scheduler_headnode=<*Submission host*> ….



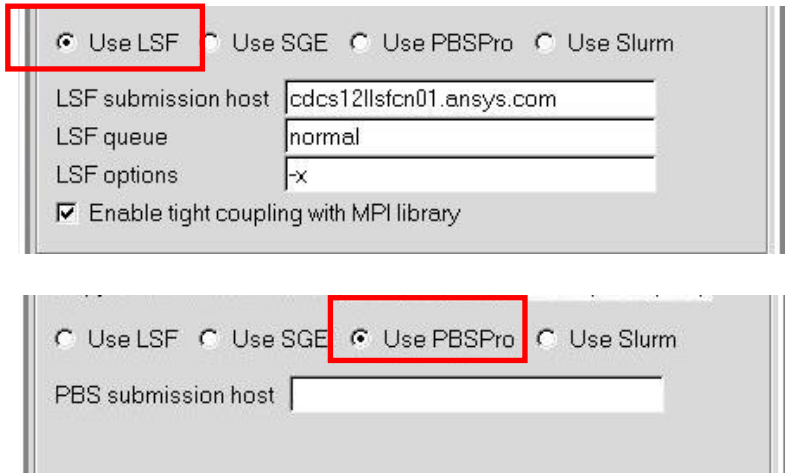
Scheduler Enhancements (Cont'd)

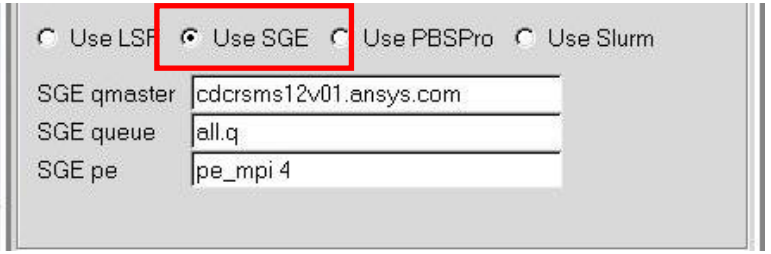
- Distinction between "Remote Linux login host" vs "Submission host"
  - **Remote Linux login host** – Remote Linux desktop/server for login using user's credentials
  - **Submission host** – Cluster head node where scheduler is started
  - If "Submission host" is empty or "localhost", cluster head node assumed to be login host

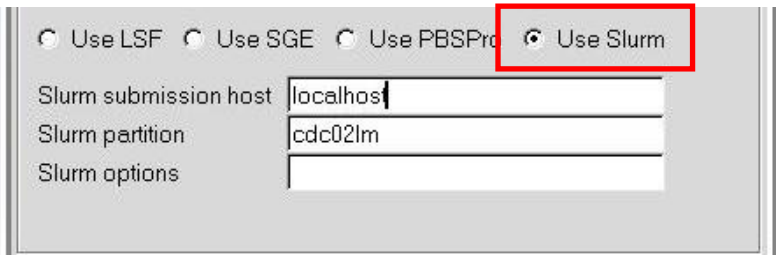




Submission host on native Linux from current workingmachine





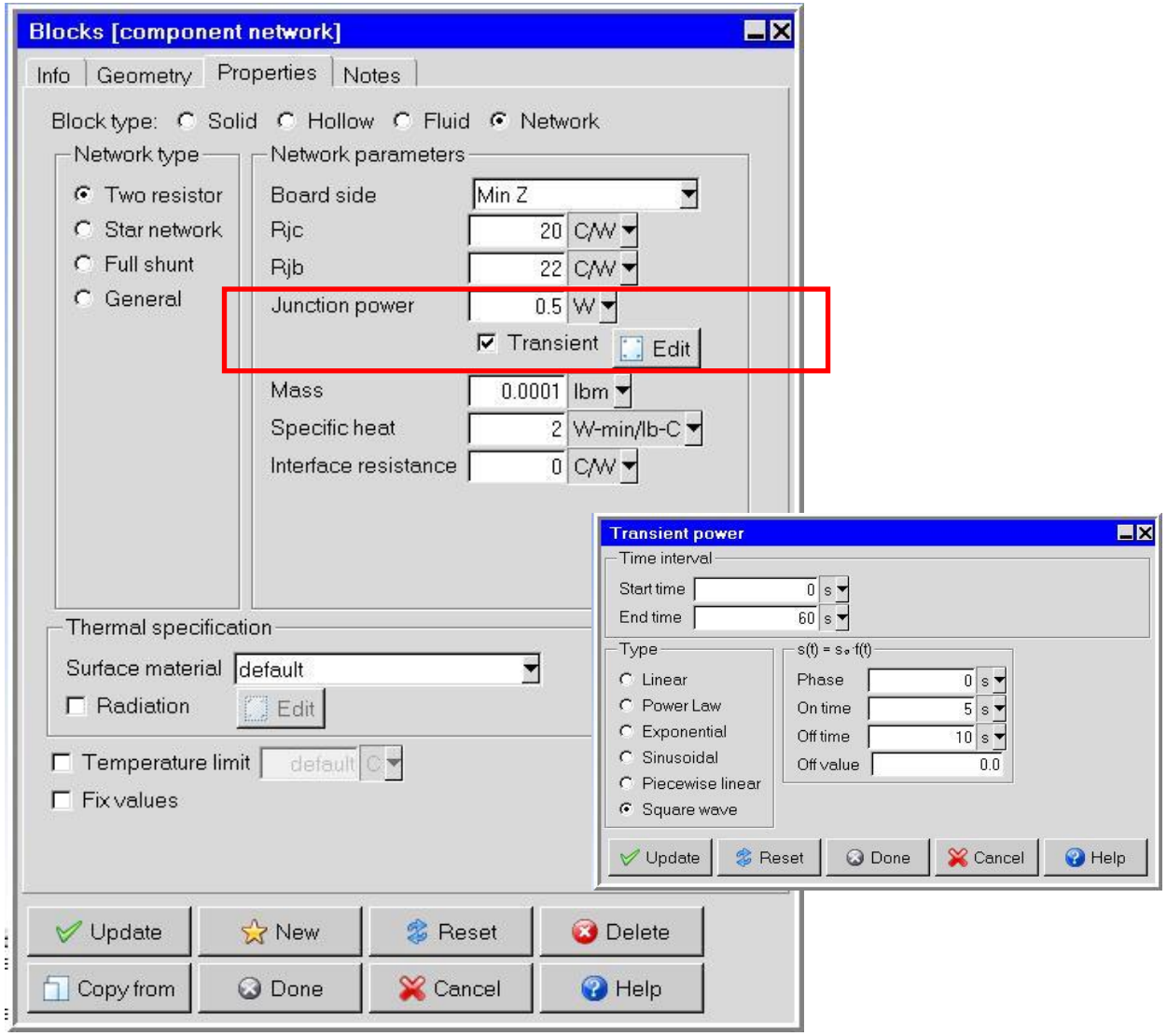


Submission host for respective schedulers when using Remote Linux from Windows

Modeling

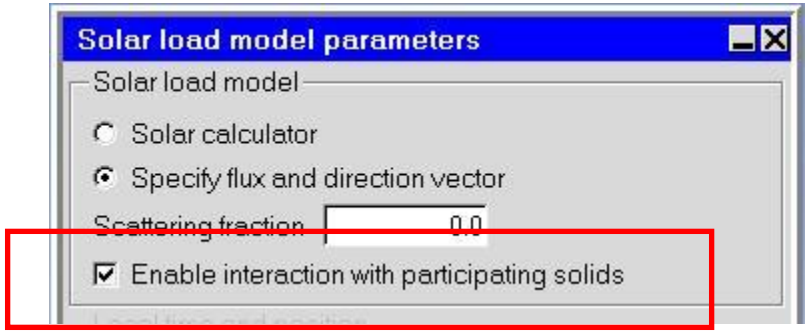
- Transient junction power
  - *Two resistor, Star network* and *Full shunt*
  - Save, Load, View updated in *Transient Viewer*

Junction power viewer

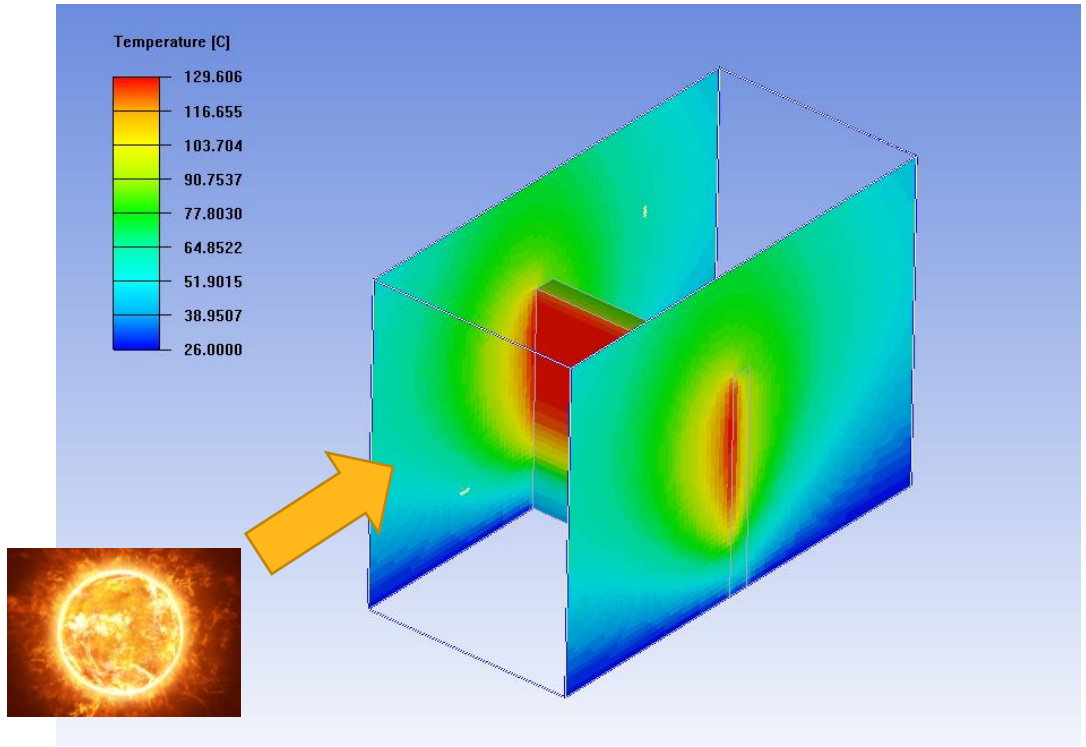


Modeling (Cont'd)

- DO solar irradiation model on flow boundary
  - Solar irradiation applied as DO intensity at inflow/outflow boundaries
  - Turn on when "Enable interaction with participating solids" option is checked
- DO solar model vs Ray-tracing
  - Not the same!
  - Ray-tracing applies solar load as heat flux at incident wall using solar absorptivity and distributes evenly reflected solar load
  - DO model treats solar load by adding solar flux to intensity in given direction
    - RTE solved with full interaction with participating solids and opaque/transparent boundaries
    - Net wall radiation flux $q_{\text{rad}} = \epsilon \int_{\mathbf{s}.\mathbf{n}>0} \boldsymbol{I}(\mathbf{s})\, \mathbf{s}.\mathbf{n}\, d\Omega - n^2 \epsilon \sigma T_w^4$



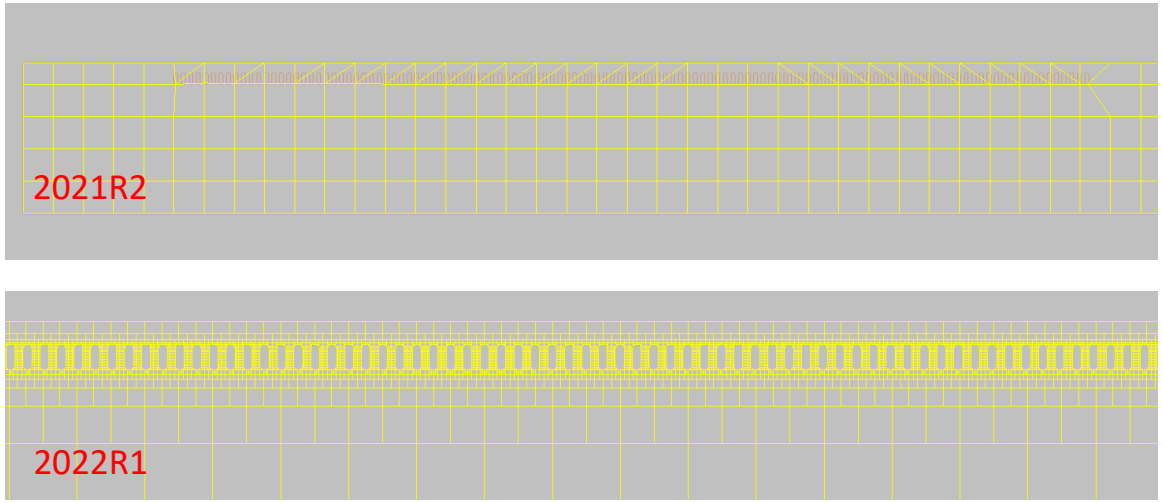
Enabling DO solar model



Solar load on wood block using DO

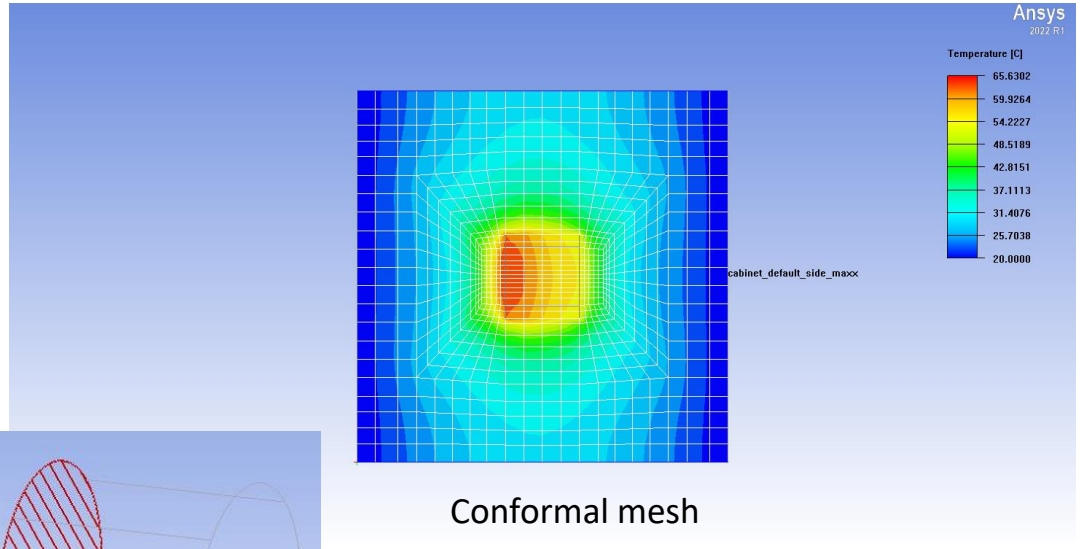
Meshing Enhancements

- Size controls for 2d objects in 2.5D Meshing
  - Level, proximity and curvature size functions

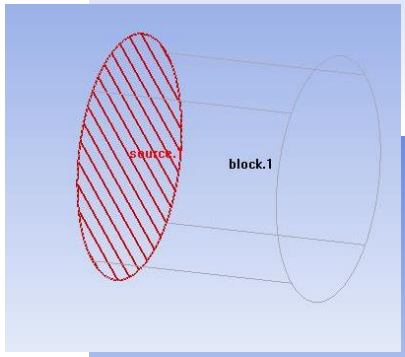


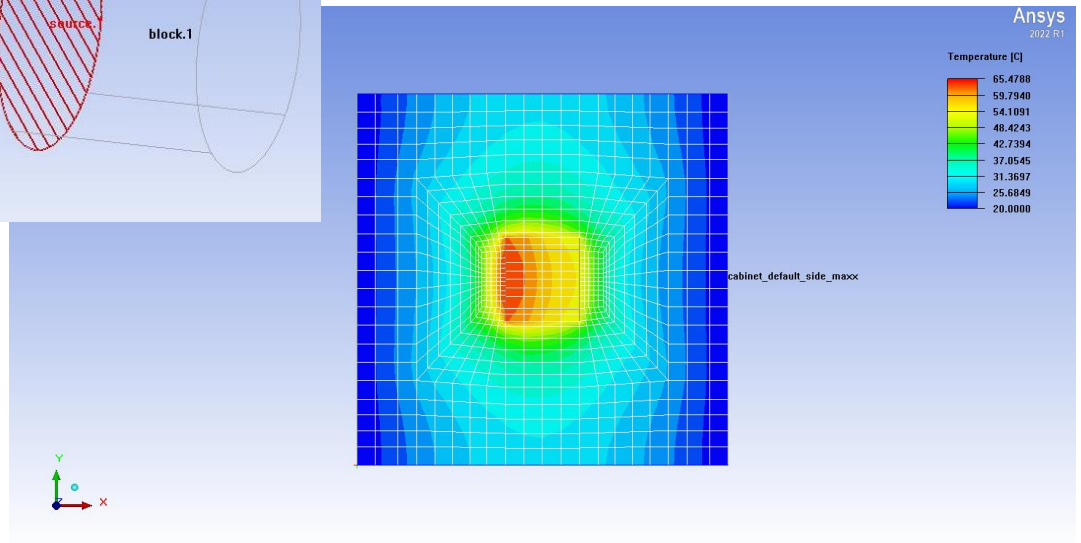
2D pads mesh

- 2D objects on internal couplings (BETA)
  - Allows 2D object on meshed separately object boundary
  - Set ICEPAK_MAKE_INTERNAL_COUPLING_MAP=1



Conformal mesh

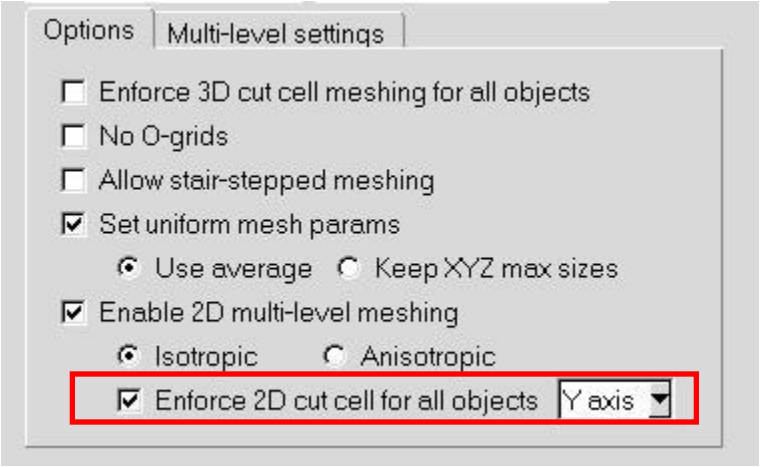


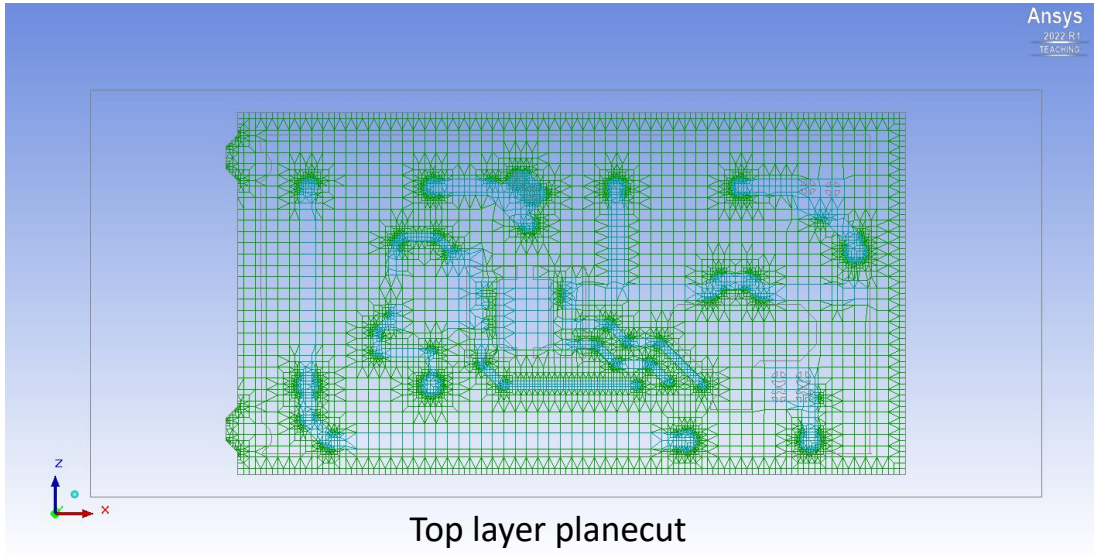


Mesh separately

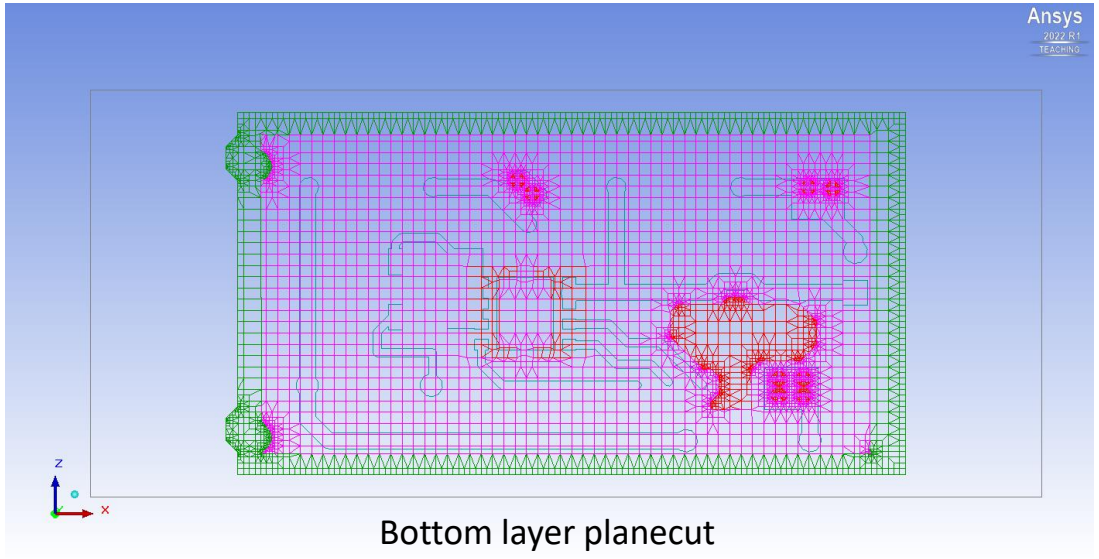
Meshing Enhancements (Cont'd)

- Auto mesh-separately for 2D objects (BETA)
  - Applicable only when 2D direction is specified
  - Objects with common elevation ranges grouped into separate "assembly"
  - Local "assembly" avoids imprinting all outlines to single plane
  - Set ICEPAK_ENABLE_BETA_FEATURES="hdm_2.5d_blocking"





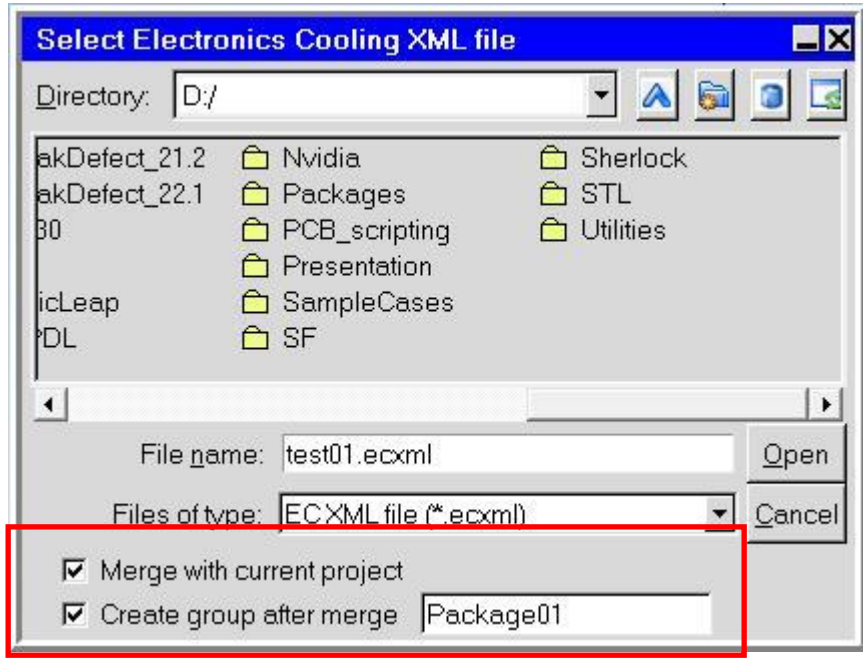
Top layer planecut



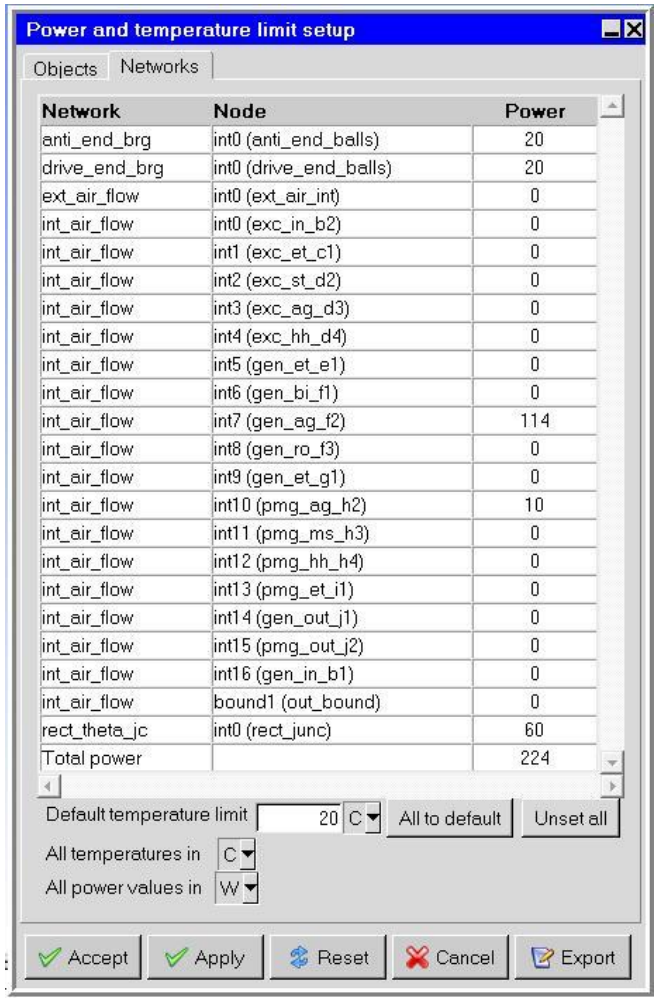
Bottom layer planecut

Miscellaneous

- Network node names in Power/Temp limits setup
  - Format: int*N* (*name*)
- ECXML enhancements
  - Option to merge into current project
  - Group assignment during merge



ECXML merge option



Network node names

Miscellaneous (Cont'd)

- CAD fan flow direction determined by z-axis
  - Decoration updated to show flow direction