How to map a 2D-3D hybrid model in turbomachinery

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Introducing mapping

The 2D-3D hybrid mapping allows you to map thermal results from a source model to a target model with different mesh types.

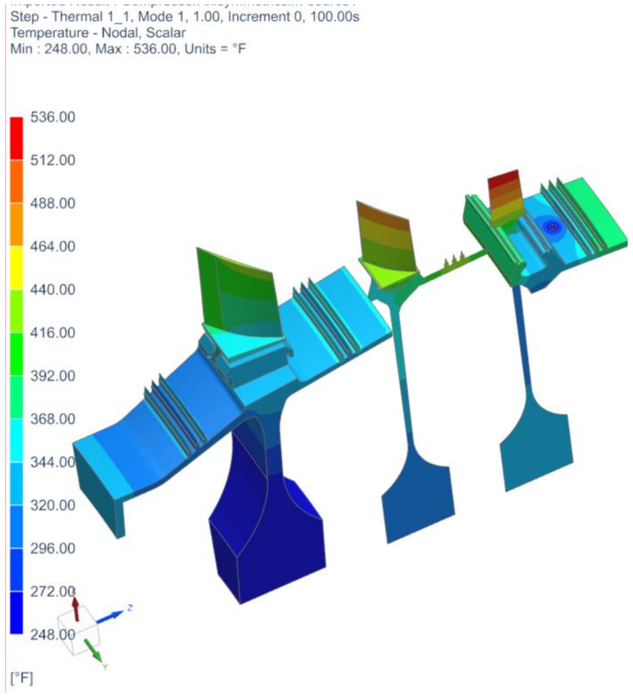
Both the source model and the target model can have different element configurations such as:

- 2D axisymmetric elements
- 3D elements
- Combination of 2D axisymmetric and 3D elements

Mapped results are written in a *[simulation_name]-[solution_name].bun* file.

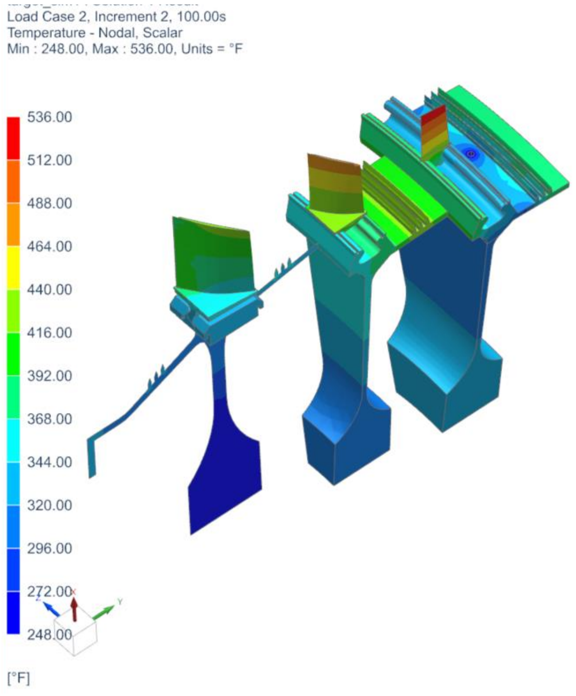
A *[simulation_name]-[solution_name].map* file is used by the solution file to retrieve the regions where mapping is defined in the source and target models.

Thermal Solution



Source

Structural Solution



Target

The source and target solutions can be in the same or separate Simulation file.

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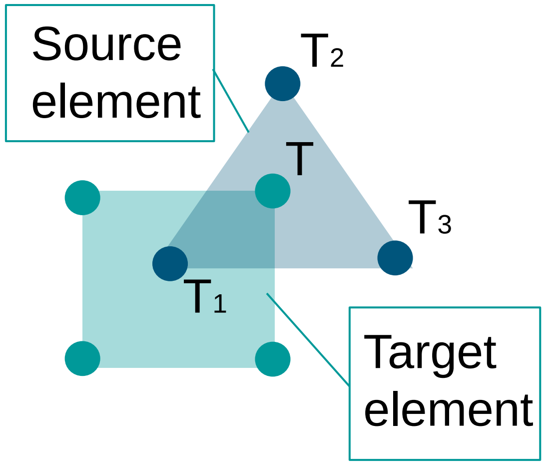
Mapping from 3D source to 3D target and 2D source to 2D target elements

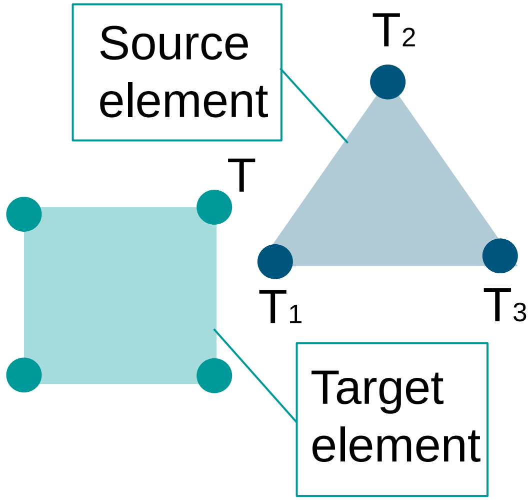
The software uses the proximity method, if 3D source elements is mapped to 3D target elements, and 2D source elements to 2D target elements.

The target node is inside the source element



The temperature is interpolated using the nodal temperatures of all nodes of the associated source element, including mid-side nodes for parabolic elements.

The target node is outside the source element

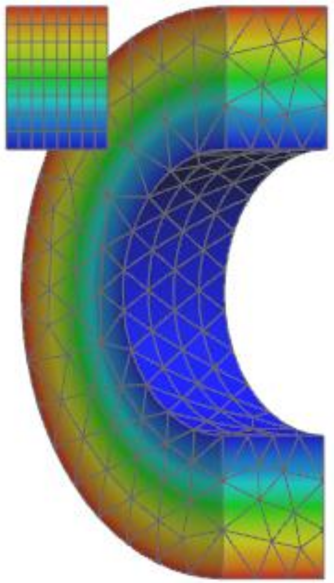


The temperature is extrapolated using the nodal temperatures of all nodes of the associated source element, including mid-side nodes for parabolic elements.

Mapping 2D axisymmetric source elements to 3D target elements

The software rotates each target node around the source axisymmetric axis so that the rotated position is in the source axisymmetric plane.

Then, it uses the proximity method to interpolate or extrapolate the nodal temperatures of the containing or closest source element to the rotated target position.

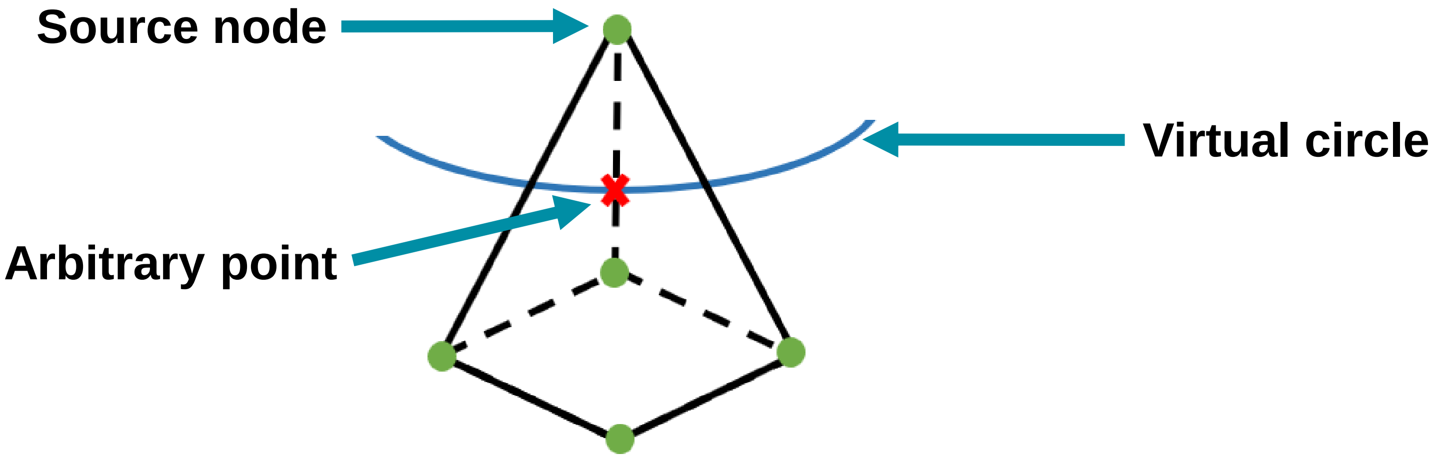


2D axisymmetric to 3D elements temperature mapping

Mapping 3D source elements to 2D axisymmetric target elements

The software uses the circumferential averaging method, where it:

- Rotates the target node around the symmetry axis to create a virtual circle.
- Interpolates the thermal results of the nodes of each source element to an arbitrary point of the intersection arc.
- Associates the average of the interpolated values to the target node.

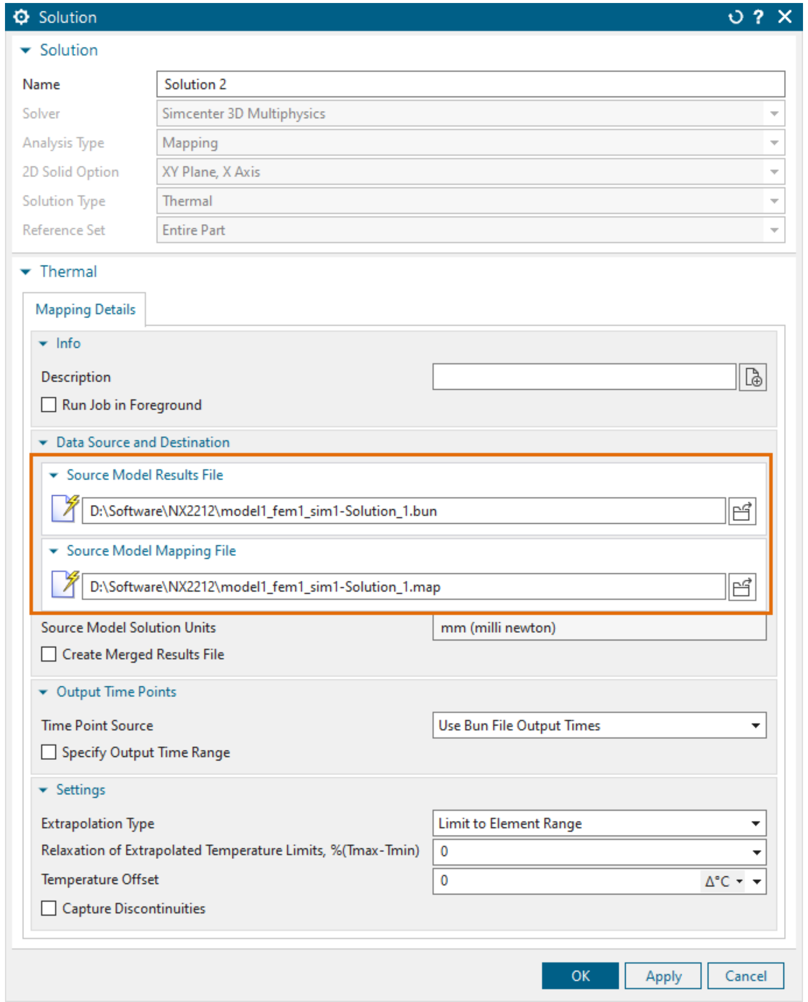


A 3D source element

Creating a target solution

To conduct a 2D-3D mapping solution, you must have:

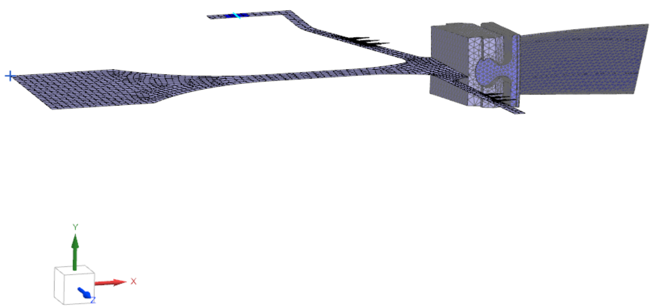
- The target solution with **Mapping** analysis type.
- The bun file generated from the source solution that contains the mapped results.
- The mapping file that is used by the target solution to retrieve the regions where mapping is defined in the source model.



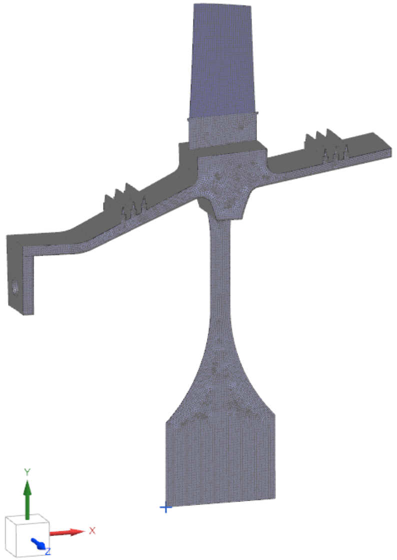
Aligning target and source models automatically

To automatically align the source model to the target model with different 2D-3D hybrid meshes, the solver uses one of the following options:

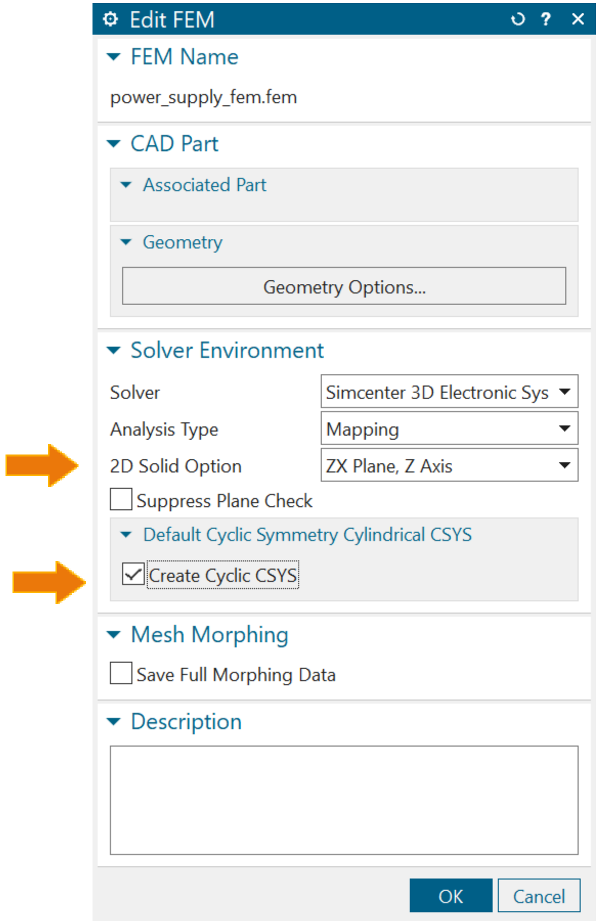
- The **2D Solid Option** of both models.
- The cyclic symmetry cylindrical coordinate system in the source model and the **2D Solid Option** of the target model.



Source



Target



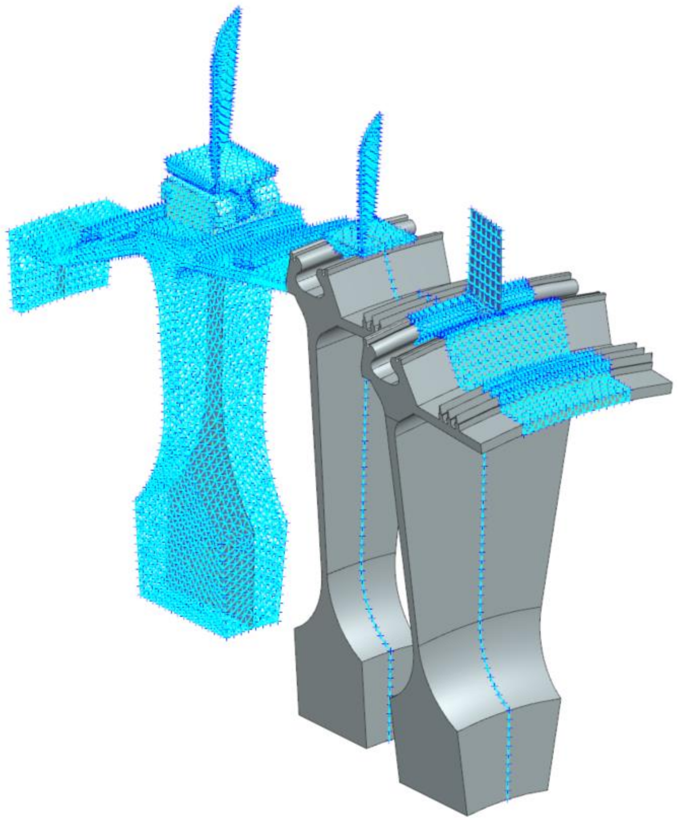
The thermal solver ignores any rotation specified in the **Source Model Mapping** simulation object.

Aligning target and source models manually

To manually align the source model to the target model, you can use the **Source Model Mapping** command, which allows you to align the target model to any mesh selected as an XML file.

The alignment tools allow users to define the rotation, translation and scaling operations to align the source model onto the target model.

The software aligns the source model's coordinates with those of the target model, altering the position of the source model while keeping the target model intact.



Source (in blue) and target models with not congruent geometries after alignment

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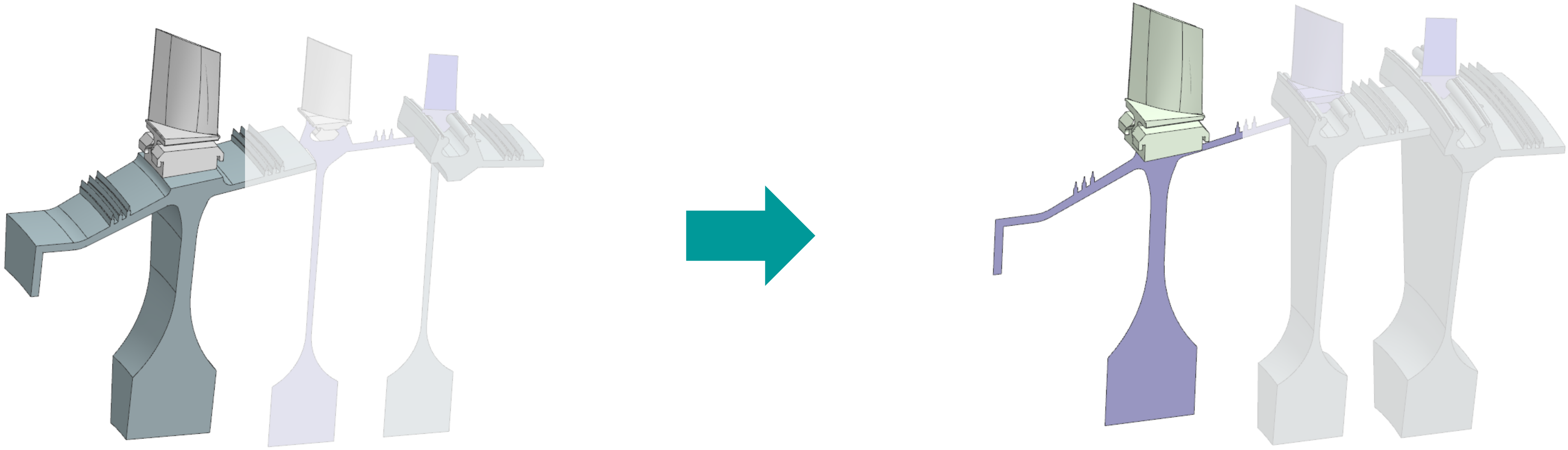
Source and target model geometry

In this example, the axisymmetric mapping analysis, contains source and target models with mix of 2D and 3D entities.

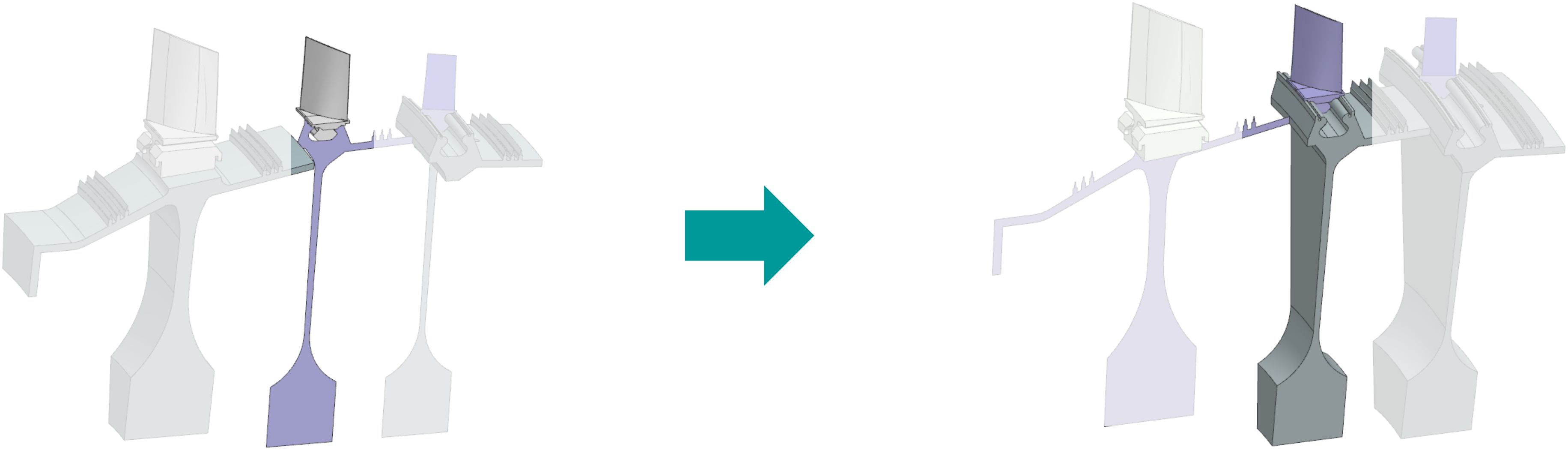


Source   Target

- 3D to 2D disk where circumferentially averaged temperatures will be mapped.

Source and target model geometry

In this example, the axisymmetric mapping analysis, contains source and target models with mix of 2D and 3D entities.



Source Target

- 2D to 3D, where 2D temperatures will be swept onto 3D bodies.

Source and target model geometry

In this example, the axisymmetric mapping analysis, contains source and target models with mix of 2D and 3D entities.

Source   Target

- Mix of 2D/3D bodies to a 3D body, where the 3D portions of source and target are of different sector sizes.

Axisymmetric mapping constraints

You can map temperature results from *a region* in the source model to a corresponding region in the target model to reduce mapping time by eliminating unnecessary calculations on very large models.

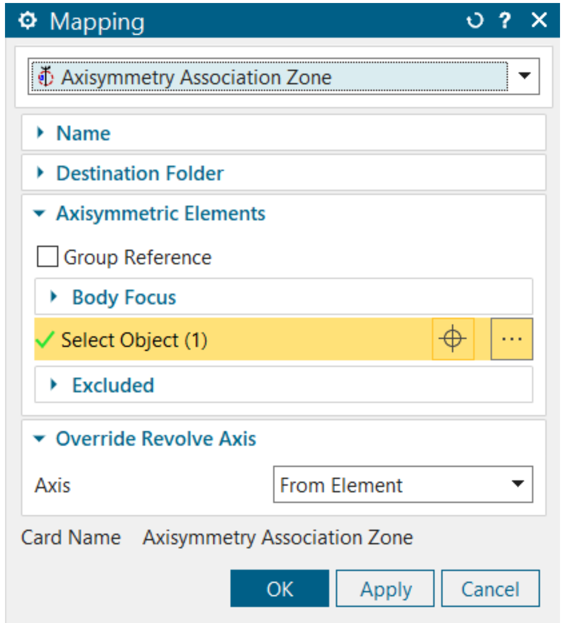
The mapping process associates a specific element in the source model to each target node or element which is based on the closest distance criteria and controlled by the zone associations.

- The *source model* must be a non-axisymmetric thermal model which may include both non-axisymmetric and axisymmetric meshes.
- The *target model* is a model that contains a solution with **Analysis Type** set to **Mapping**.

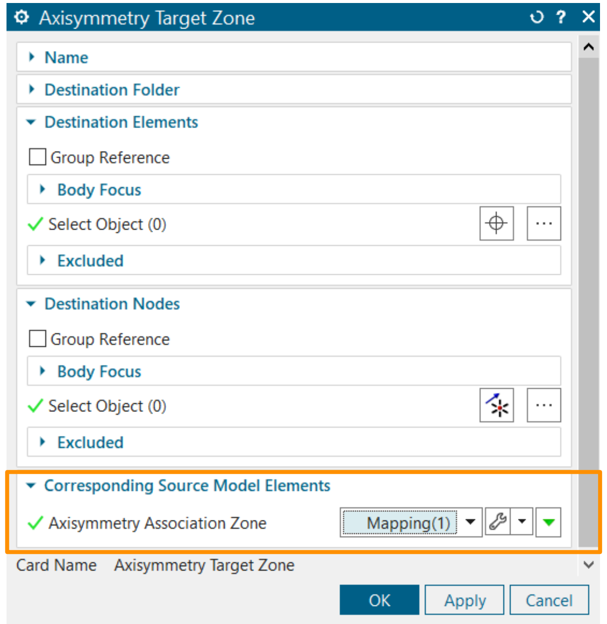
When you solve the target mapping solution, the software generates a *[simulation_name]-[solution_name].bun* file with the mapped thermal results on its mesh. The solution file uses a *[simulation_name]-[solution_name].map* file to retrieve the regions where mapping is defined in the source solution.

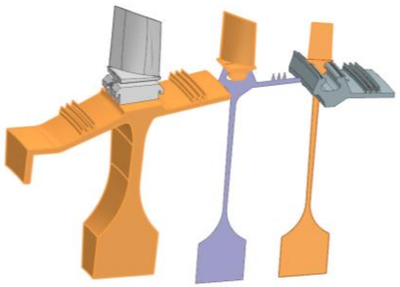
Axisymmetric mapping constraints

Axisymmetric Association Zone

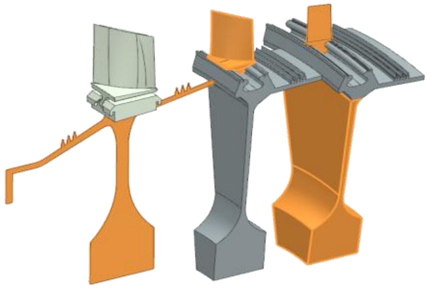


Axisymmetric Target Zone





Source model



Target model

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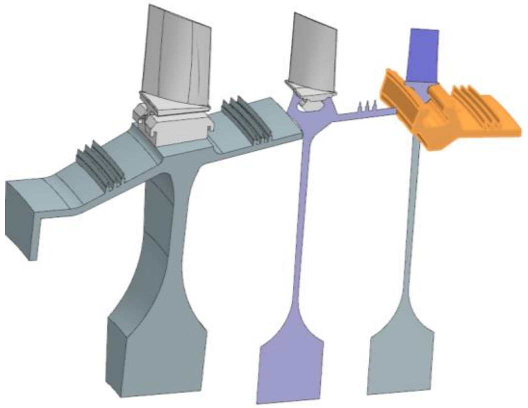
Rotational periodicity mapping constraints

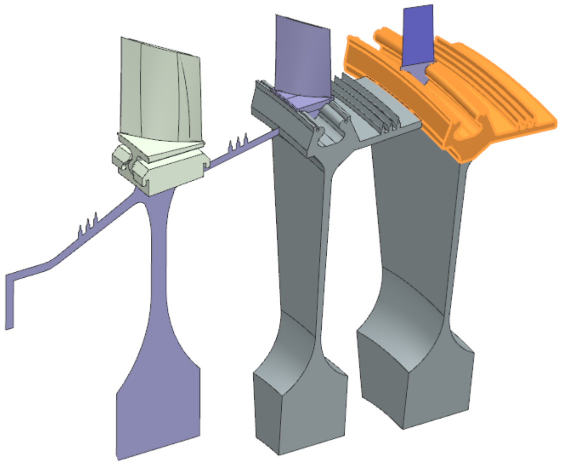
If you have different 3D segment sizes between source and target that have periodic temperatures, use the **Rotational Periodicity Association Zone** and matching **Rotational Periodicity Target Zone** constraints.

If circumferential offsets are required on individual rotational periodicity zones, those can be added in the target constraint **to circumferentially align the model.**

Several mapping constraints of different types can be combined in the same solution.



Rotational Periodicity Association Zone



Rotational Periodicity Target Zone

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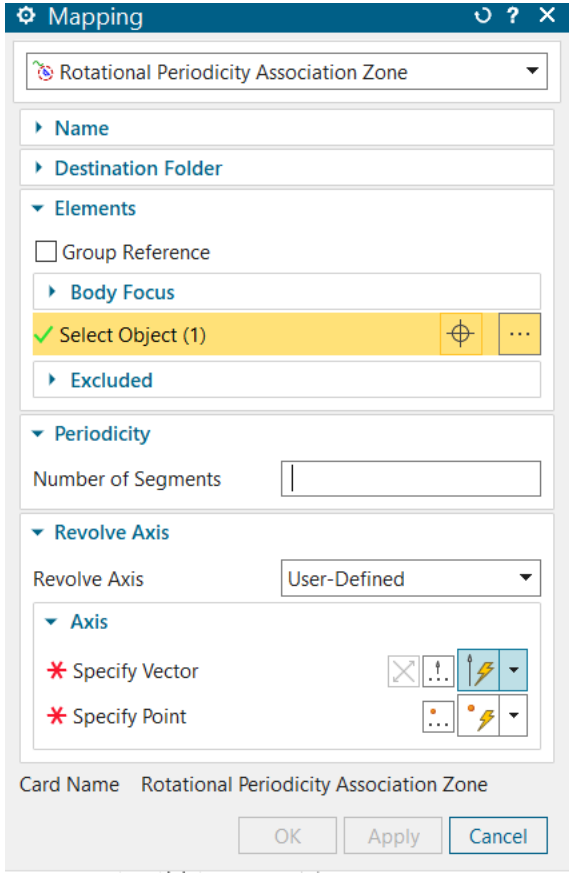
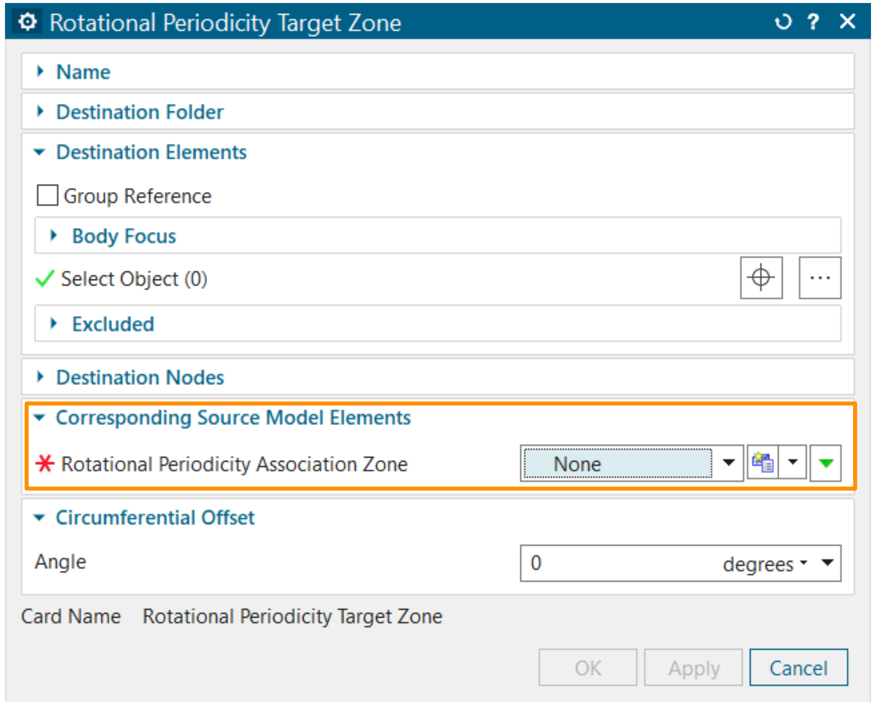
Rotational periodicity mapping constraints

Rotational Periodicity Association Zone



Rotational Periodicity Target Zone



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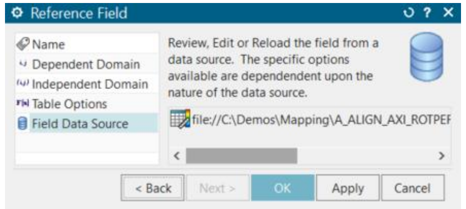
Mapping constraints in a 2D-3D hybrid model

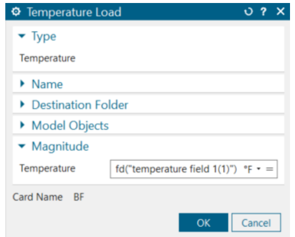
Case	Mapping scenario			Constraint		Commets
	Source model/Result	Target model	Description	Source model solution	Target model solution	
1	2D	2D	The source and target model contain axisymmetric elements.	The **Thermal Association Zone** type of **Mapping** constraint	**Thermal Target Zone**	Use separate zones to limit mapping regions, either for axisymmetric or thermal zones.
				The **Axisymmetry Association Zone** type of **Mapping** constraint	**Axisymmetry Target Zone**	
2	3D	2D	The results from the source model, which contains 3D elements are mapped with circumferential averaging to the target model, which contains 2D axisymmetric elements.	The **Axisymmetry Association Zone** type of **Mapping** constraint.	**Axisymmetry Target Zone**	Use separate zones to limit mapping regions.
3	2D	3D	The results from the source model, which contains 2D axisymmetric elements are mapped with expansion to the target model, which contains 3D elements.	The **Axisymmetry Association Zone** type of **Mapping** constraint.	**Axisymmetry Target Zone**	Use separate zones to limit mapping regions.
4	3D	3D	The source and target models have the same number of cyclic symmetric 3D segments.	The **Thermal Association Zone** type of **Mapping** constraint.	**Thermal Target Zone**	Separate mapping into different zones, if required.
				The **Axisymmetry Association Zone** type of **Mapping** constraint.	**Axisymmetry Target Zone**	
5	2D/3D	2D/3D	The source and target models have the same number of cyclic symmetric 3D components.	The **Axisymmetry Association Zone** type of **Mapping** constraint.	**Axisymmetry Target Zone**	Map 2D and 3D regions in separate zones when the regions are in contact.
6	3D	3D	The source and target models have different number of cyclic symmetric 3D segments.	The **Rotational Periodicity Association Zone** type of **Mapping** constraint	**Rotational Periodicity Target Zone**	
7	2D/3D	2D/3D	The 2D axisymmetric component in the source model is mapped to the 3D component in the target model.	The **Axisymmetry Association Zone** type of **Mapping** constraint	**Axisymmetry Target Zone**	Use axisymmetry association zone where you map 2D/3D to 2D/3D.
			The 3D component in the source is mapped to the 3D component in the target with different number of segments.	The **Rotational Periodicity Association Zone** type of **Mapping** constraint	**Rotational Periodicity Target Zone**	Use rotational periodicity where you have 3D to 3D with different segment numbers.

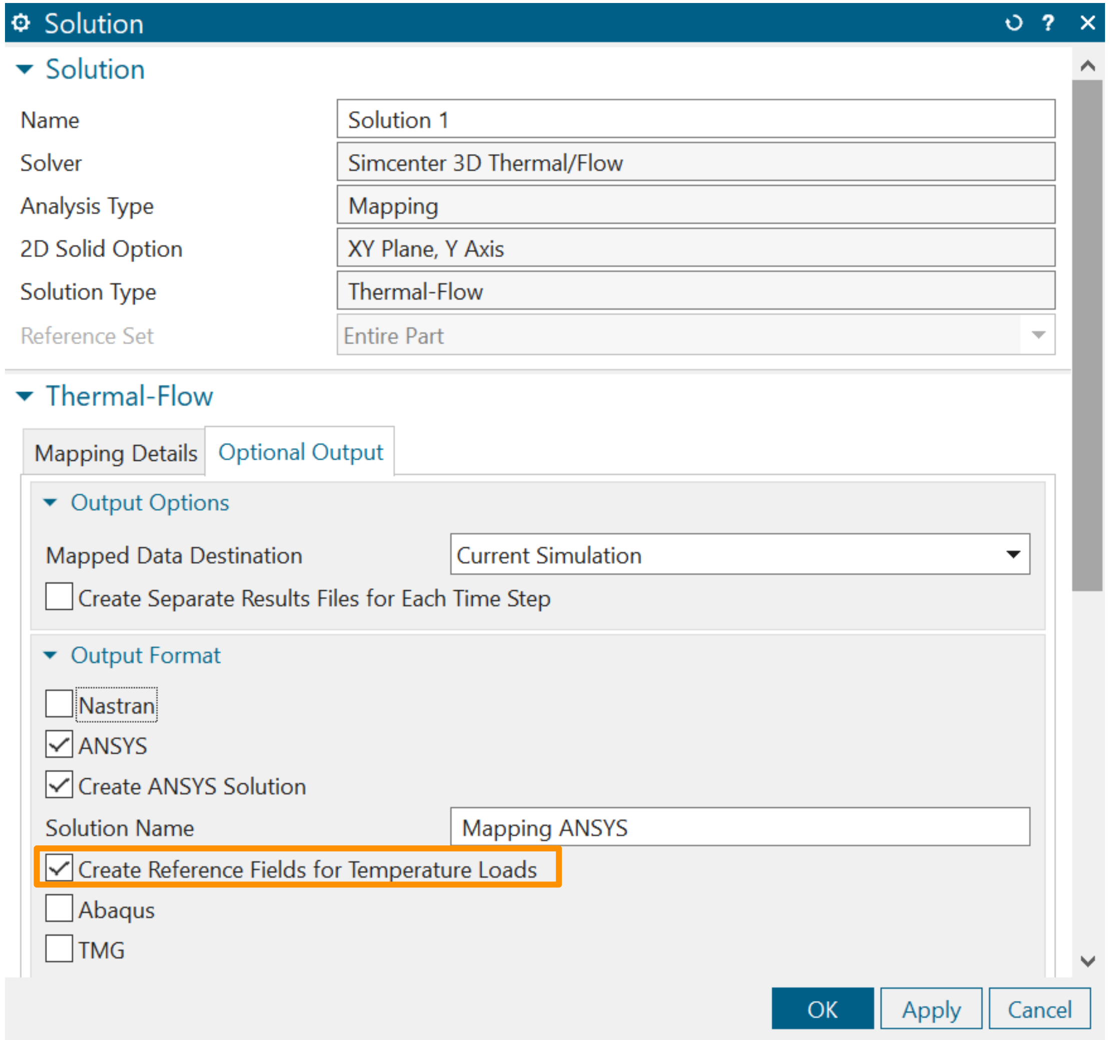
Generating reference fields in ANSYS mapping solutions

You can create reference to bun file to avoid large node-temperature fields in a mapped ANSYS solution, using the **Create Reference Fields for Temperature Loads** option.

This reference field can be used in **Temperature Load**.







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Displaying the number of mapped nodes

After solving the mapping solution, the thermal solver displays the number of mapped nodes in the **<simulation name>-<solution name>.log** file.

You can inspect the log file to identify if any node is missing from the mapping results file.

Example:

```
Number of target nodes to map - 15708
Number of mapped target nodes - 15708
```