Acoustic radiation of a gearbox

Actran Student Edition Tutorial

Workshop description

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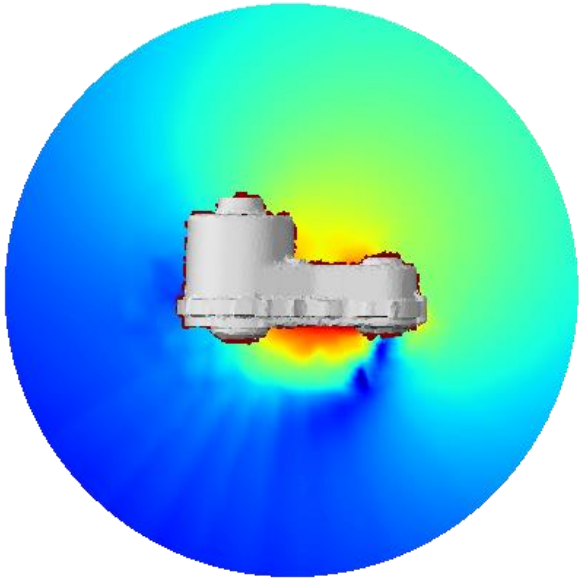
Introduction

- This workshop introduces the computation of the sound radiated in free field by a vibrating gearbox using Actran

- The objectives of this workshop are the following :
  - Explain how to create an Actran model to compute the acoustic radiation based on available vibrating structure data
  - Get introduced to the BC Mesh boundary condition

- Software version
  - Actran 2022 Student Edition



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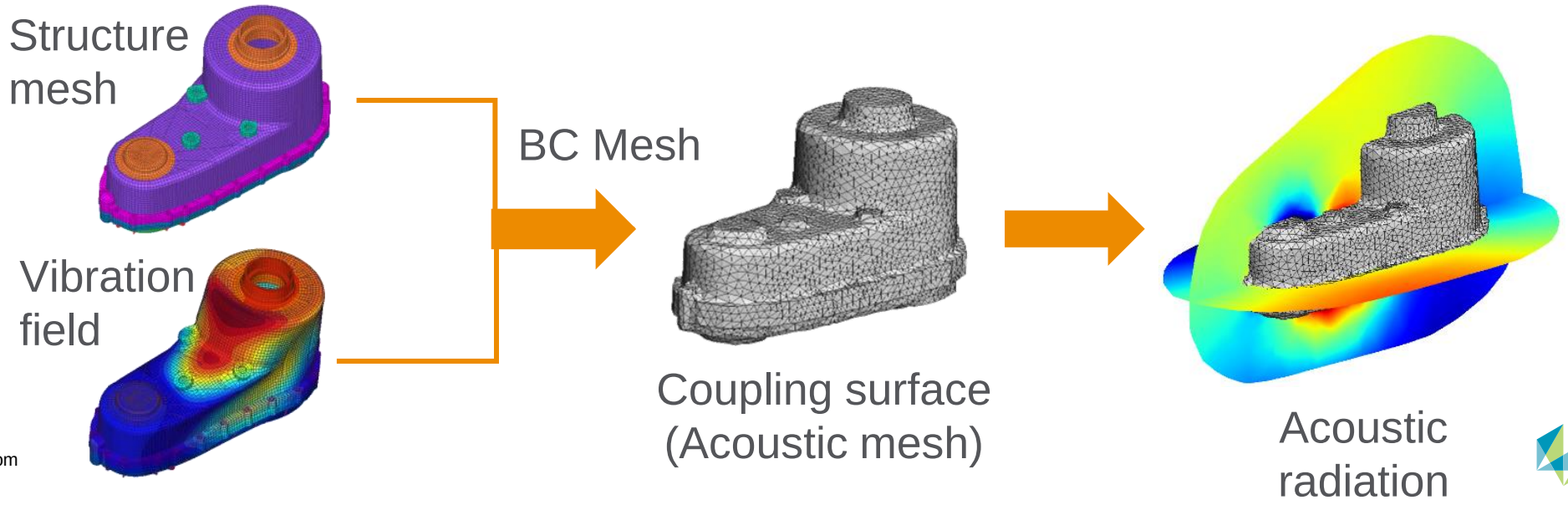
Actran BC Mesh boundary condition

- The BC Mesh boundary condition allows to:
  1. Read the frequency-dependent structure vibrations previously computed with a structure code (Actran, Nastran, Abaqus,…)
  2. Map the vibration field onto the acoustic mesh
     - Weak coupling → no retroaction of the fluid on the structure
     - Valid for light fluid in free field
  3. Compute the acoustic propagation



Workshop strategy

Gearbox vibrations previously computed on a **fine** mesh

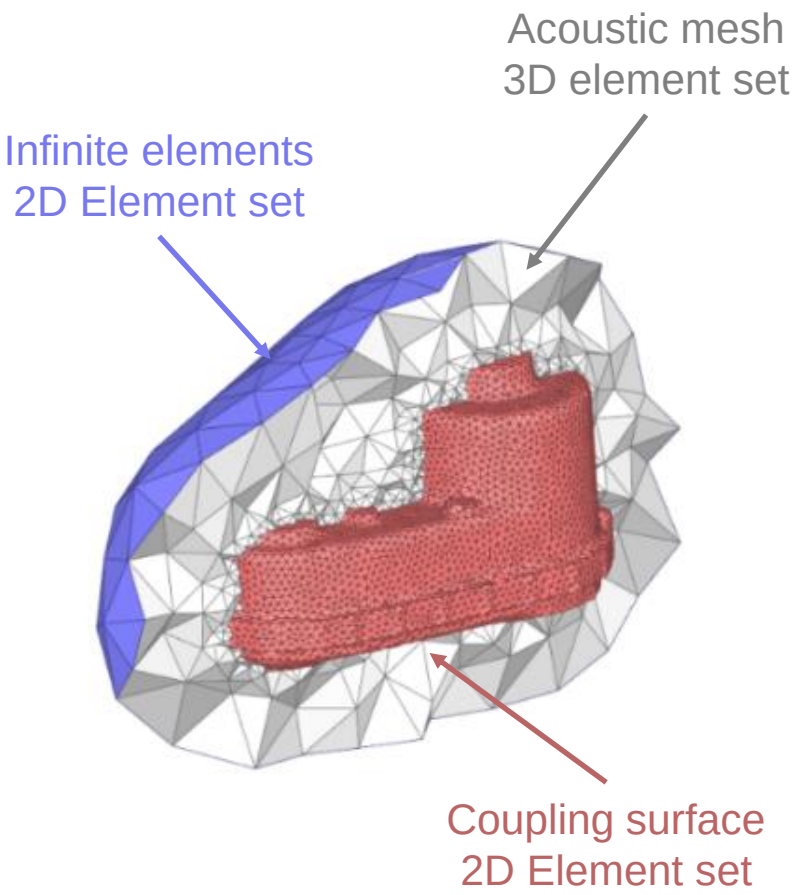
- A **coarser wrap surface** mesh around the structure mesh is imported and used as a *coupling surface*

Vibration pattern must be **mapped** on the acoustic mesh

- Creation of a *BC Mesh boundary conditions* supported by the *coupling surface*

The gearbox radiates in **free-field**

- A *finite fluid* and an *infinite fluid component* are defined



Workshop pre-processing

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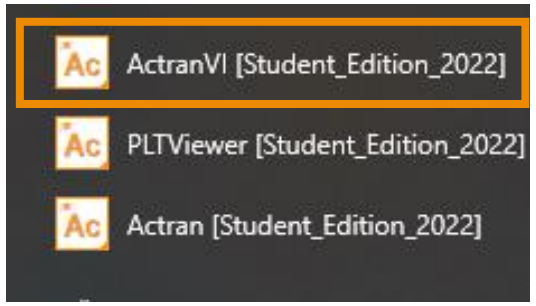
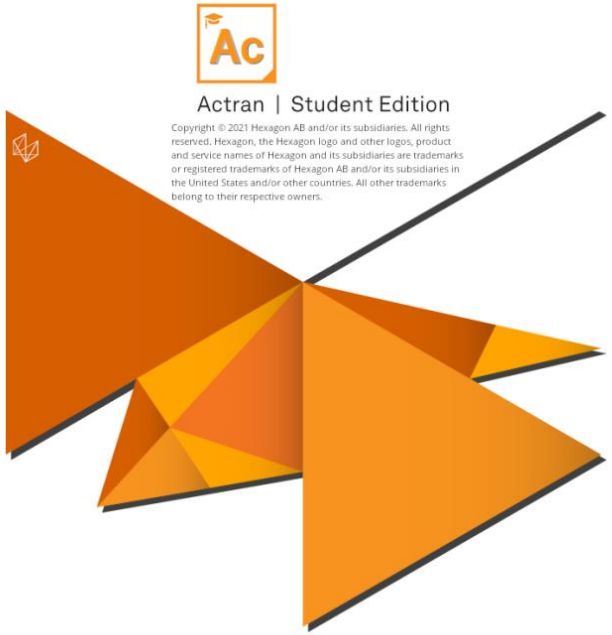
Start ActranVI

- Start ActranVI:
  - Shortcut is available through the Windows Start Menu



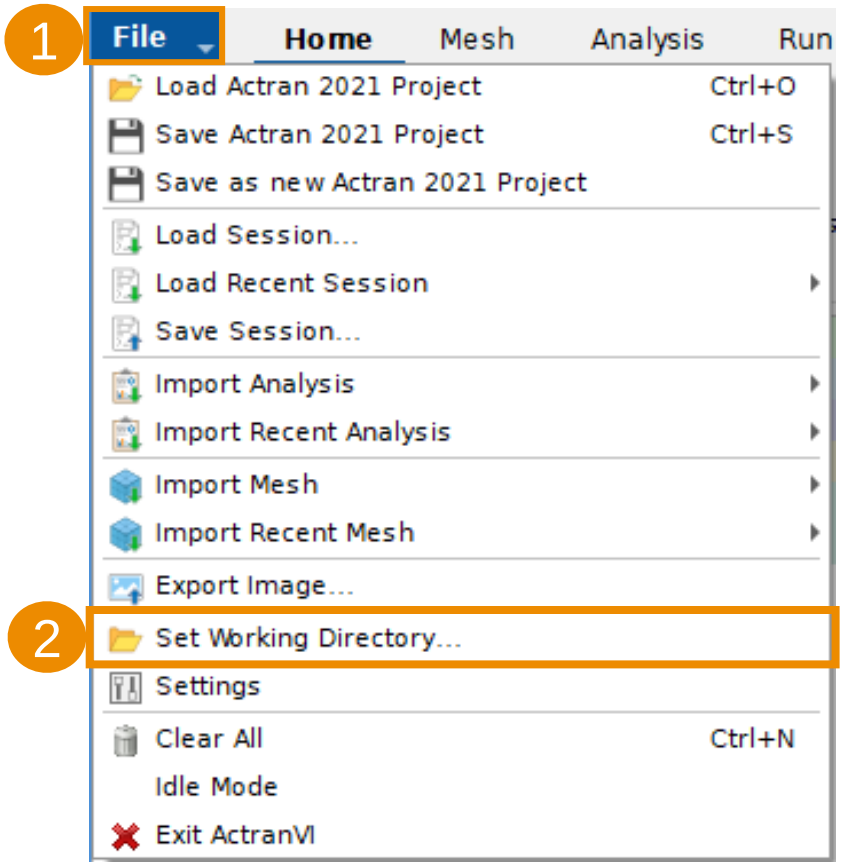
(Windows Start Menu)



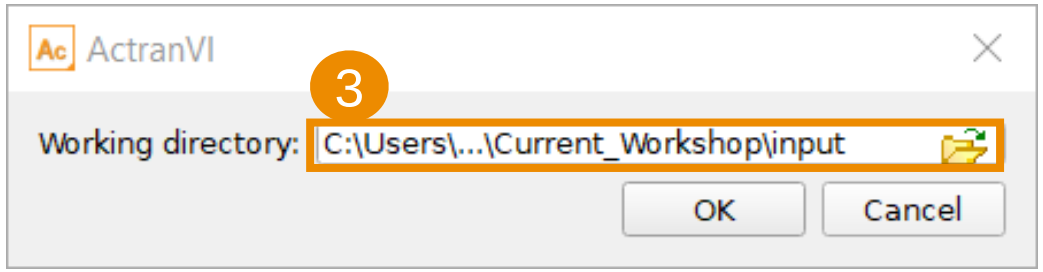
Set the working directory

Select the workshop input directory as the working directory

- The working directory is the project directory where all ActranVI related files are output

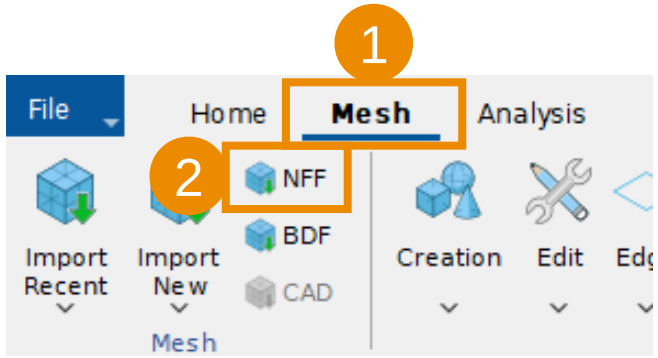


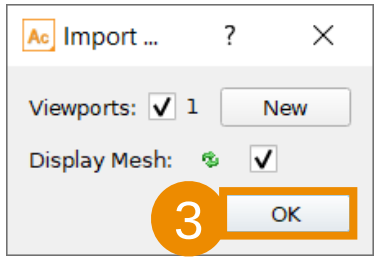
The working directory path should not contain any space or special character

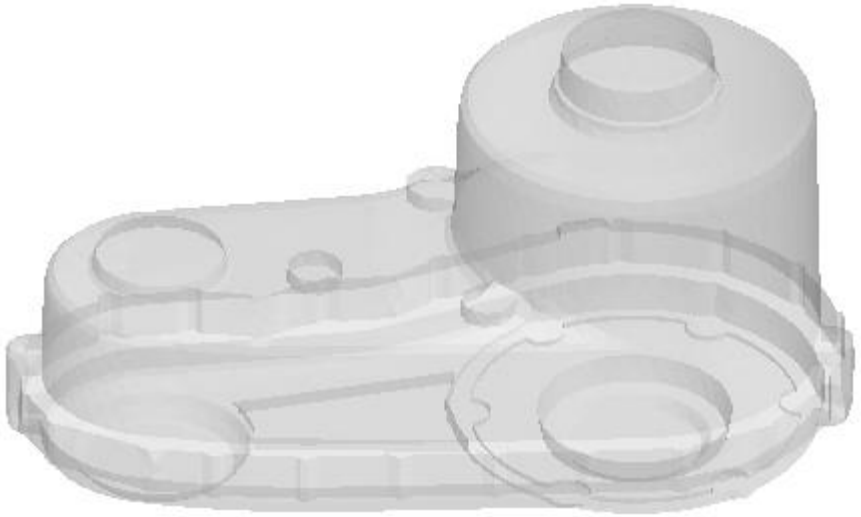


Import the mesh

Import the coupling surface mesh *Coupling_Surface.nff*





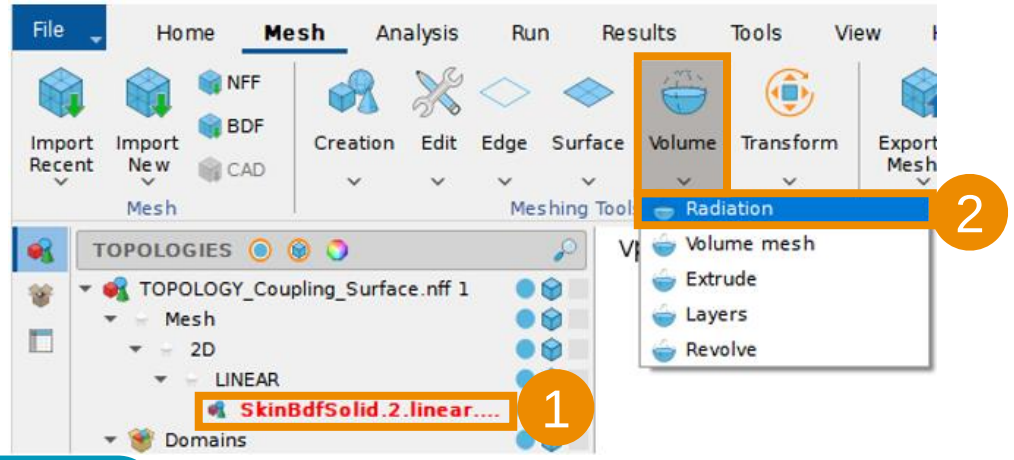


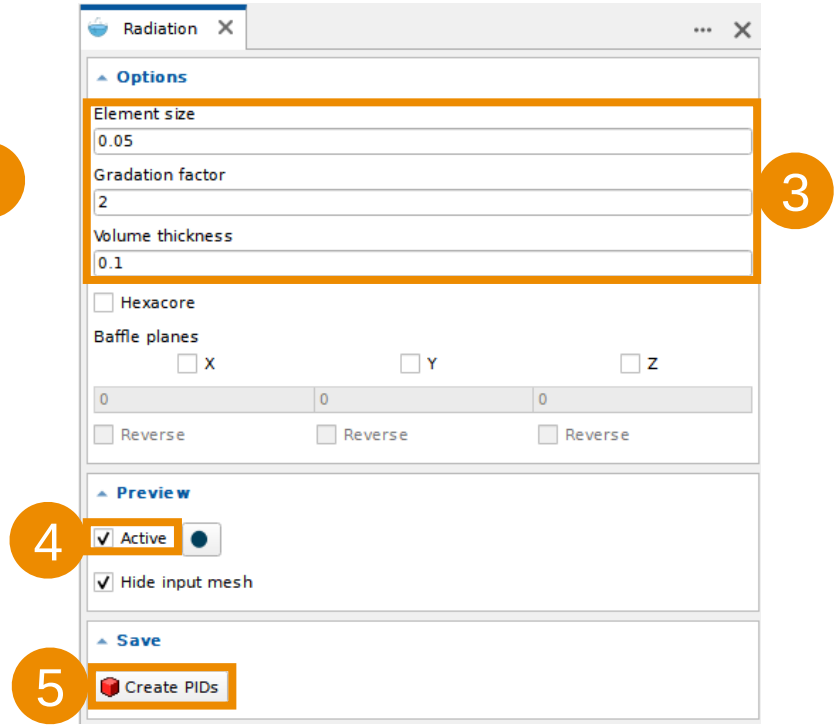
Create the radiation mesh

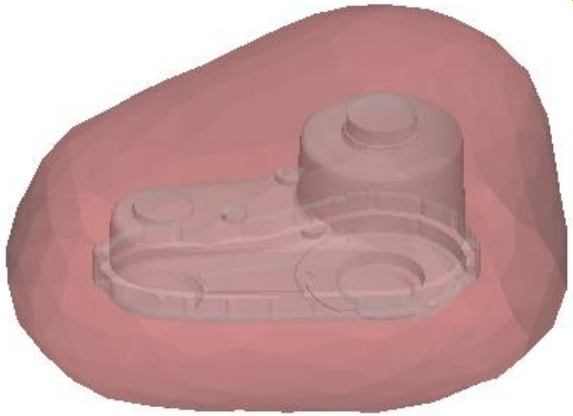
Select the coupling surface mesh

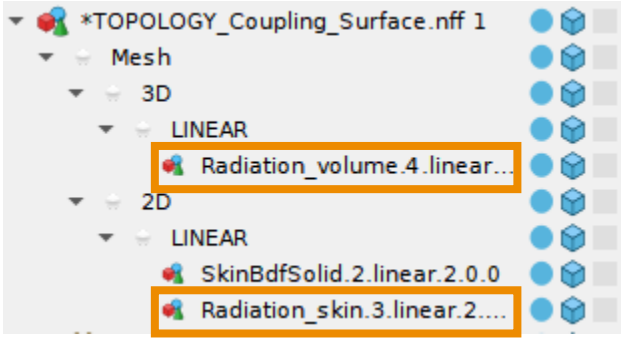
Select the radiation meshing tool

Display the mesh

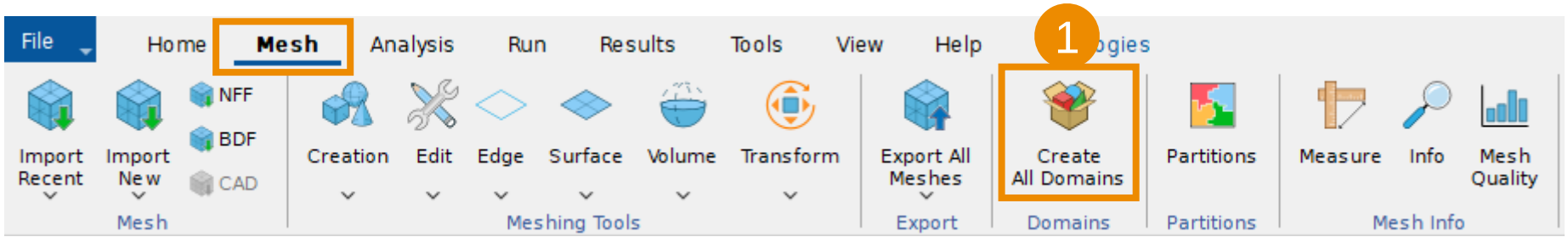






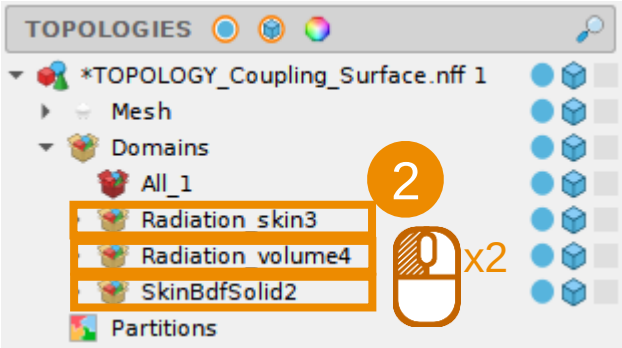


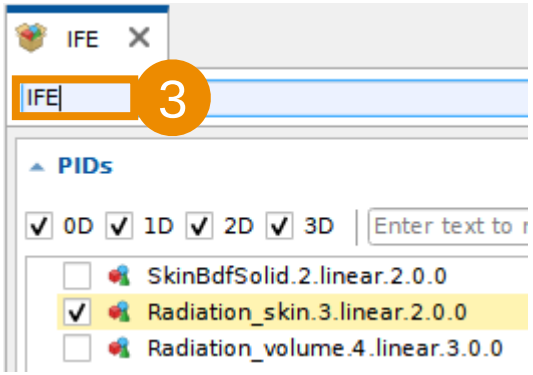
Create the domain



Auto create domain

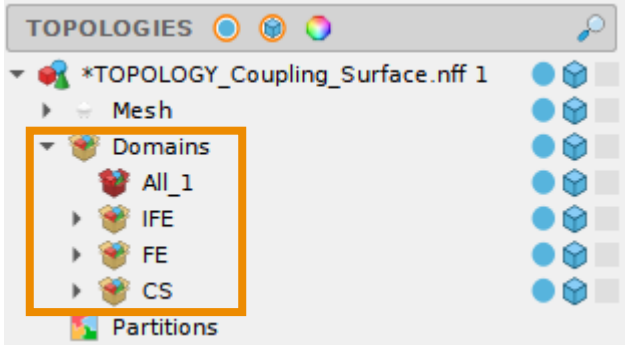
- Automatic domain creation based on PIDs
- One domain per PID





Rename domains

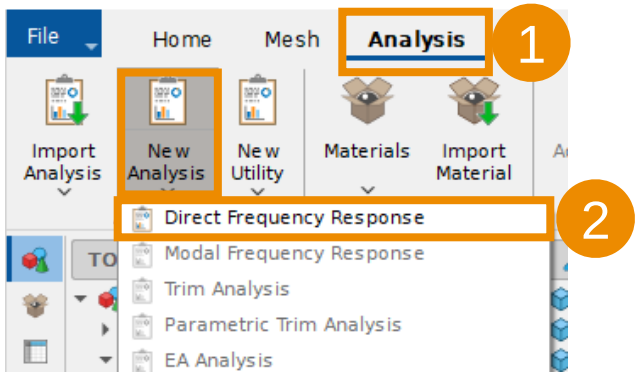
- Radiation_skin3 → IFE
- Radition_volume4 → FE
- SkinBdfSolid2 → CS

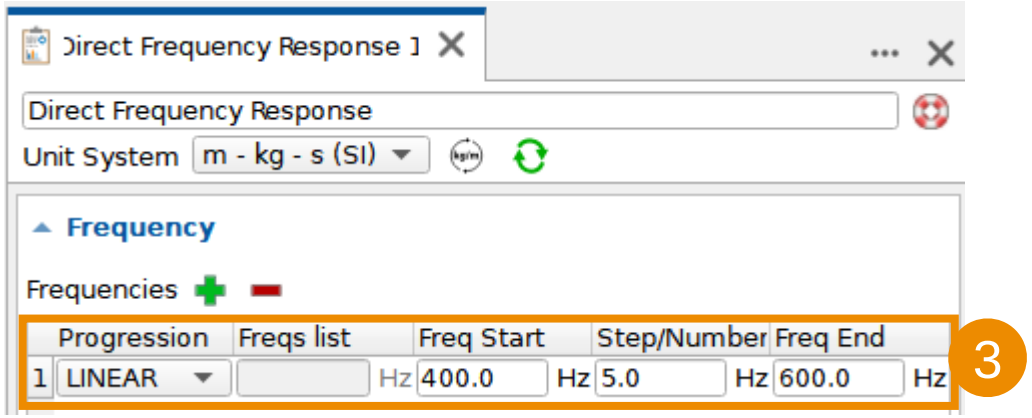


Create the Direct Frequency Response Analysis

Add a *Direct Frequency Response* analysis (DFR)

- Set the frequency range and the step





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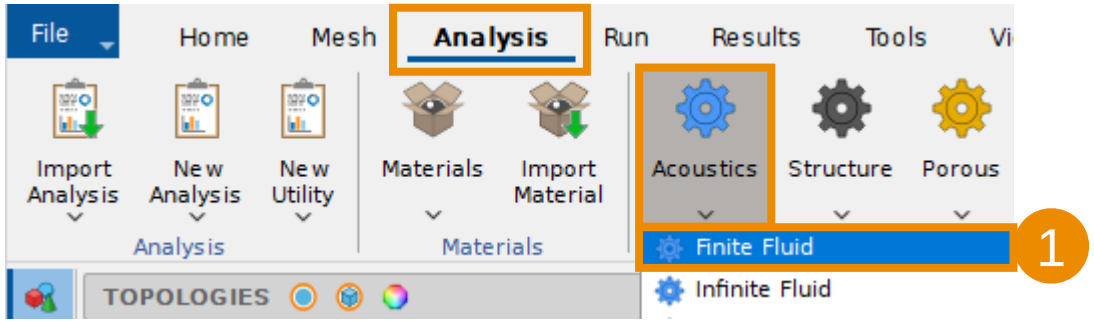
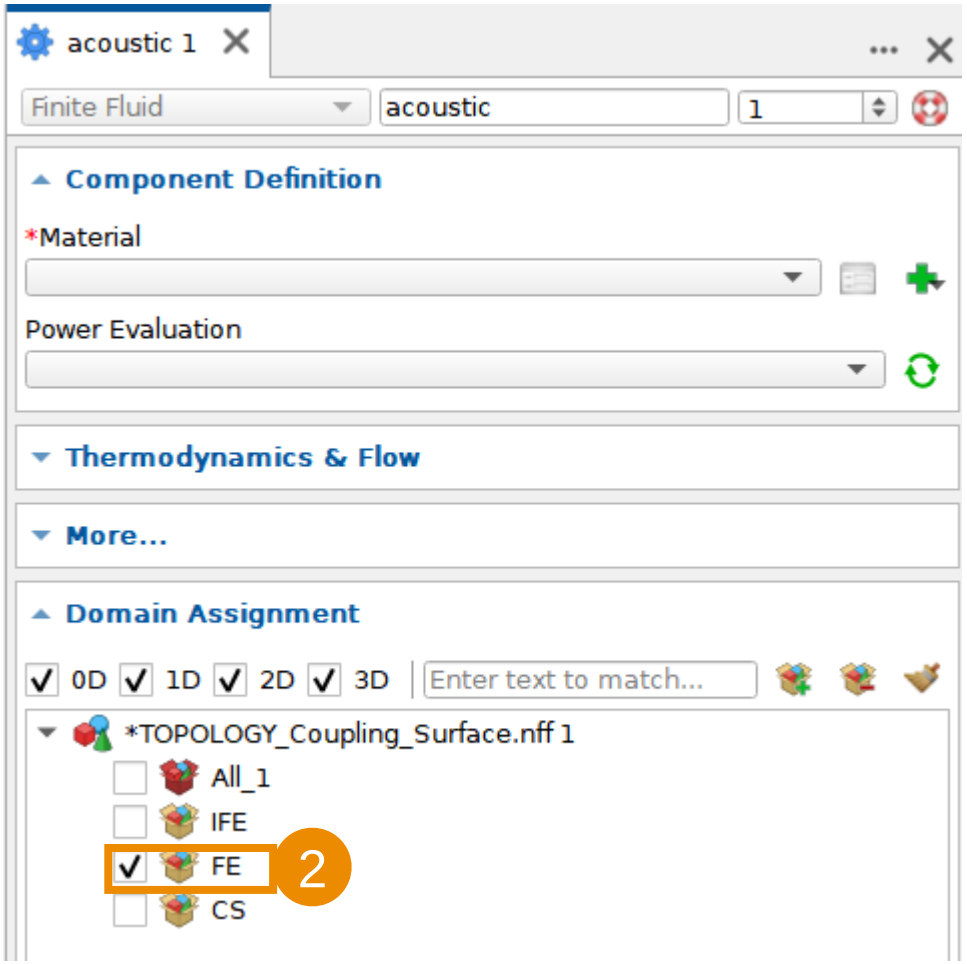
Create a Finite Fluid component (1)





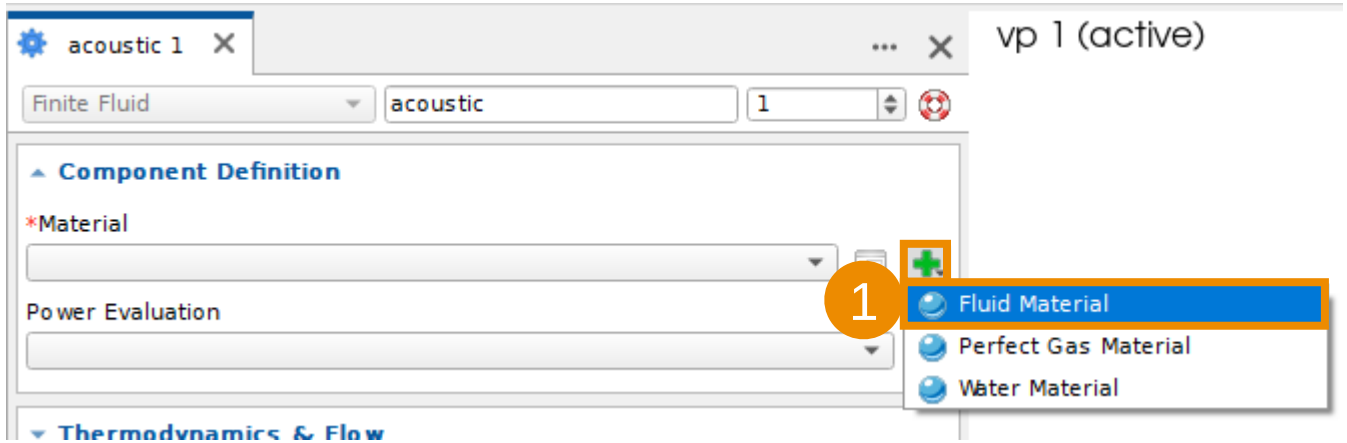
Add a Finite Fluid component

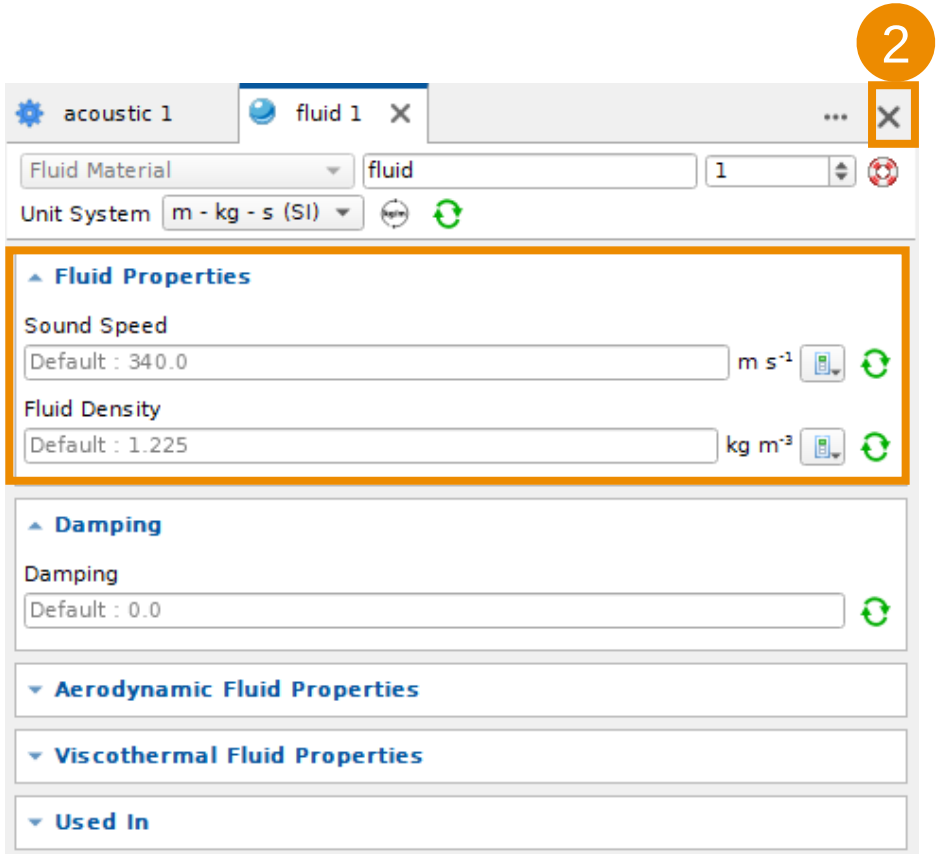
Set up the Finite Fluid component domain

Create a Finite Fluid component (2)

Define a material for air

- Add a Fluid Material
- Leave the default values:
  - $c = 340\ m/s$
  - $\rho = 1.225\ kg/m^3$





Close all property windows

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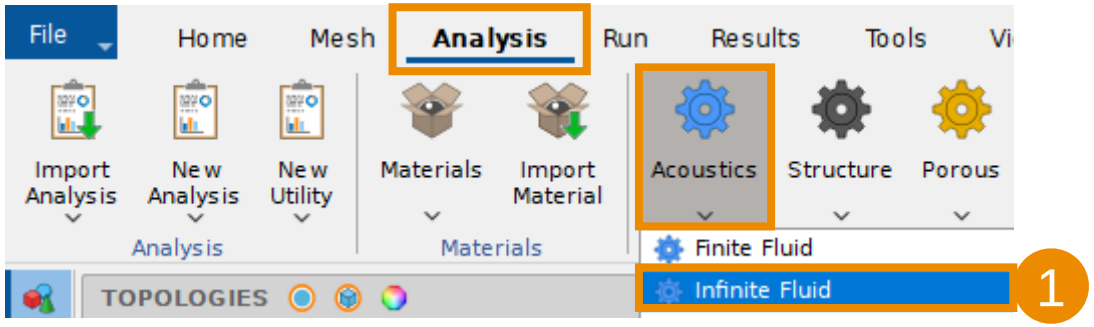
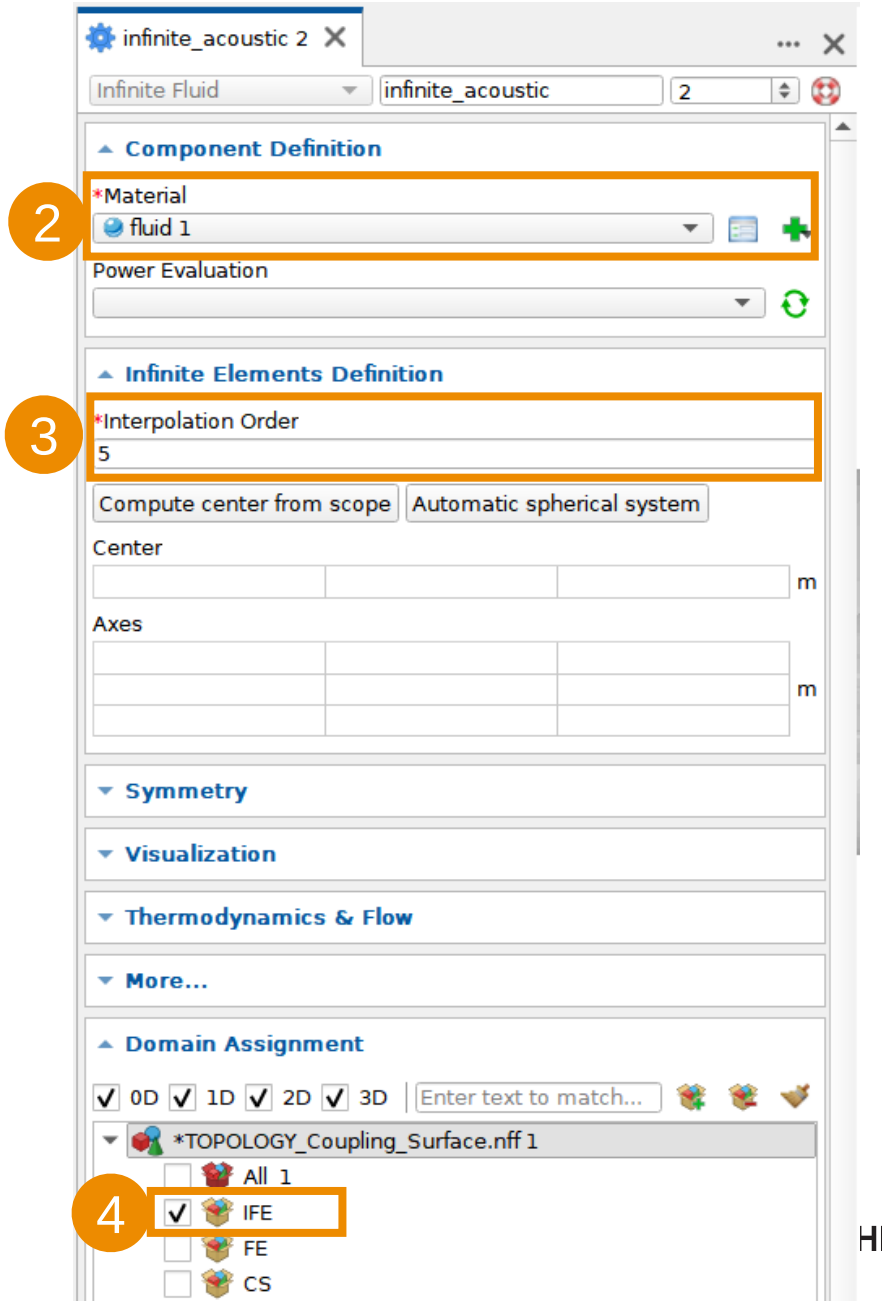
Create the Infinite Fluid component (1)





Add an *Infinite Fluid component*

Set up the *Infinite Fluid component* properties

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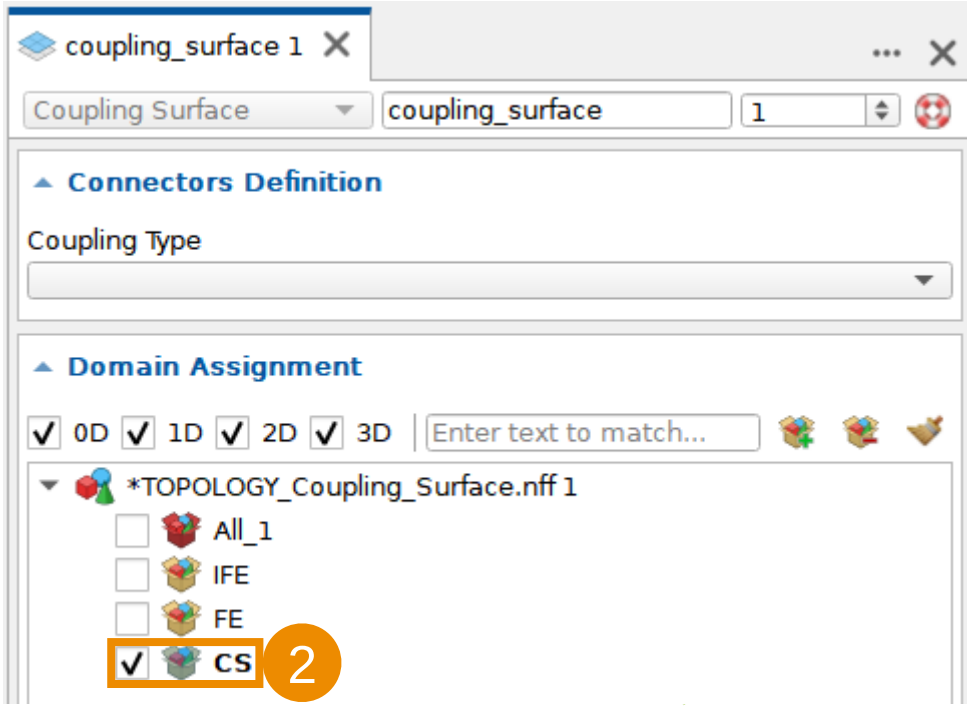
Create the Coupling Surface

Add a Coupling Surface

Assign the domain *CS*



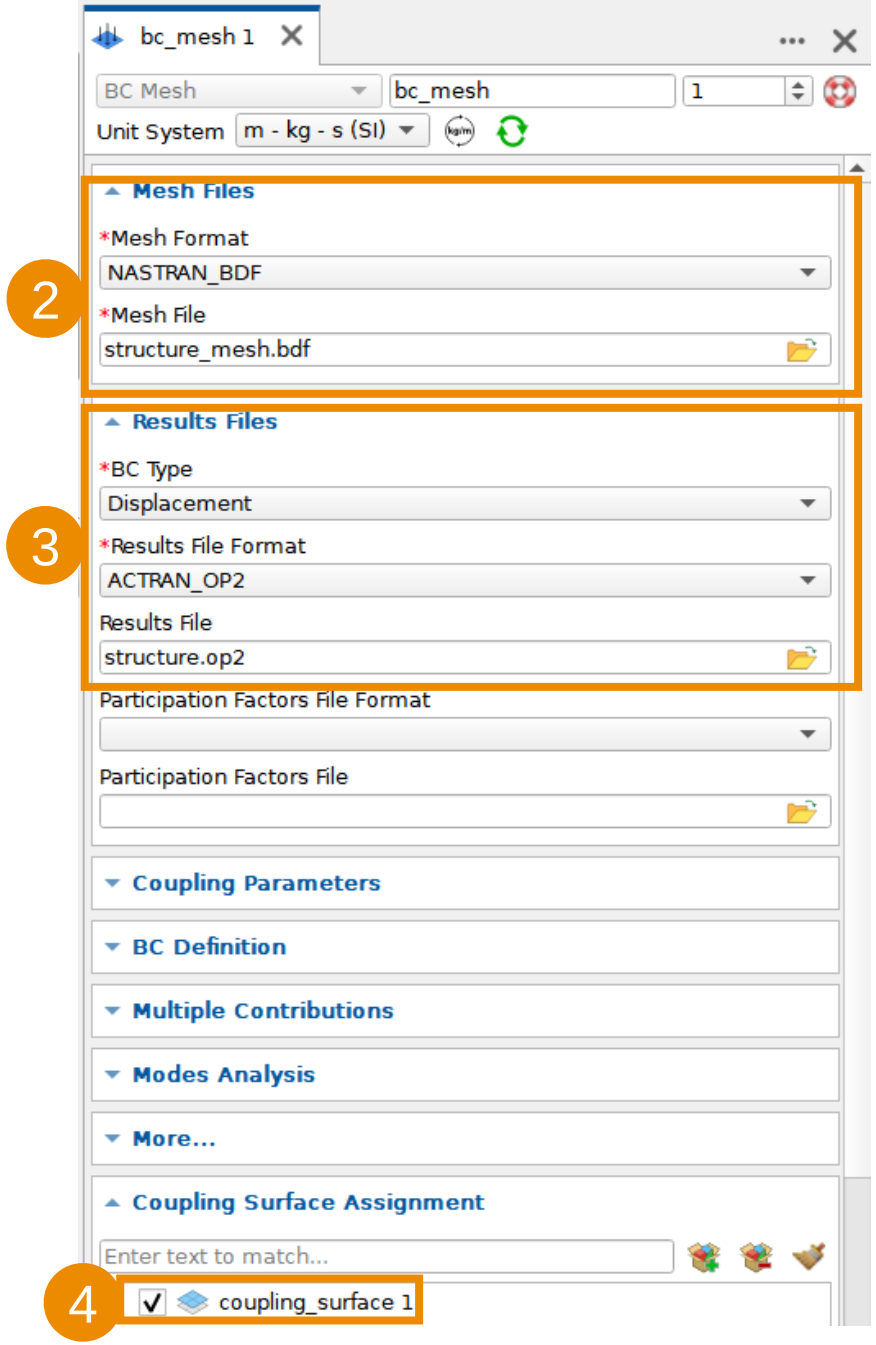
Create the BCMesh

Add a BC Mesh boundary condition

Set up the BCMesh properties

- Mesh file: *structure_mesh.bdf*
- Results File: *structure.op2*

This condition will be used to map the vibration data onto the acoustic mesh

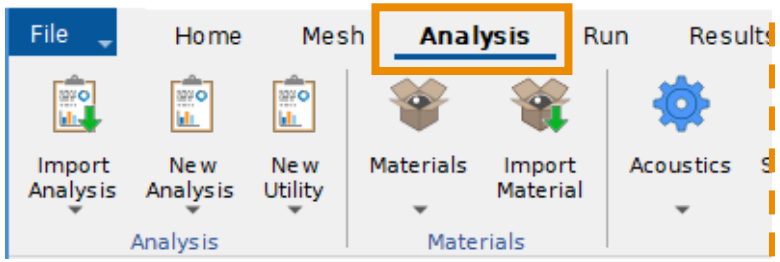


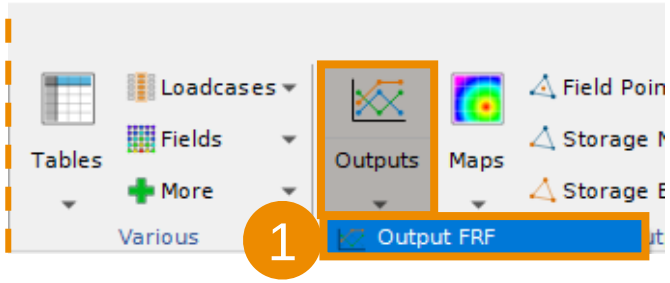
Post-processing parameters – FRF

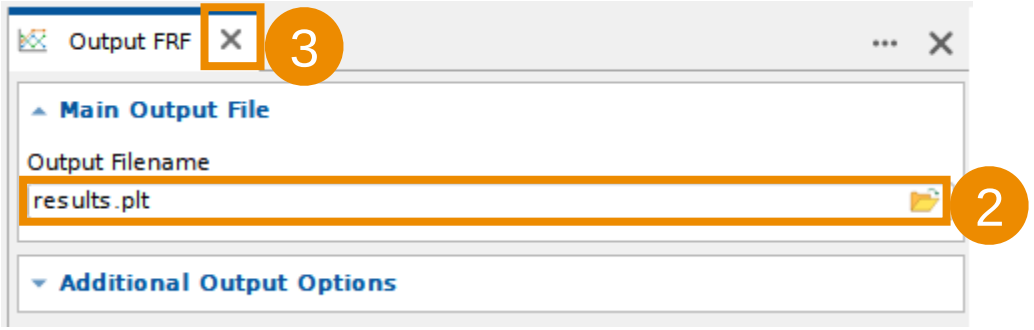
Create an output FRF post-processing parameter

Specify the name of the output file *results.plt*

Close the property window







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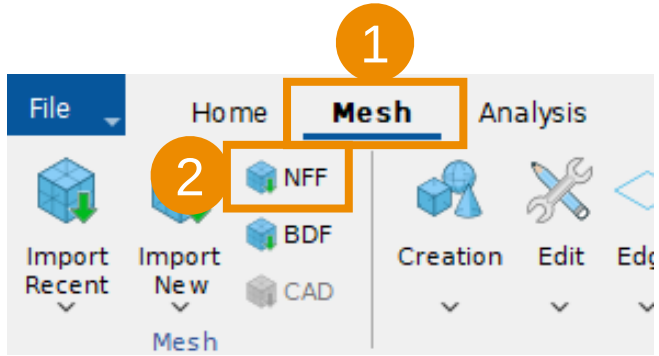
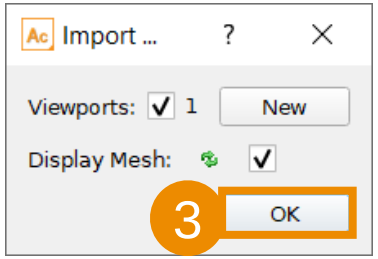
Post-processing parameters – FRF

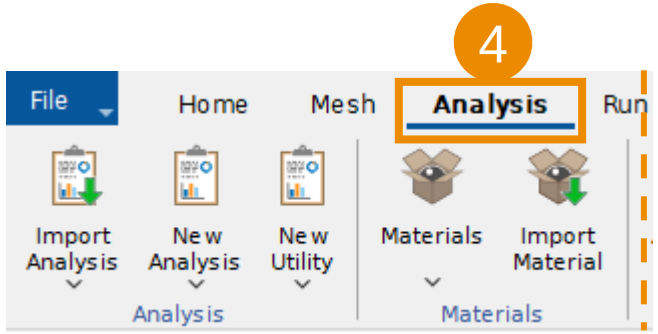
Import microphones mesh

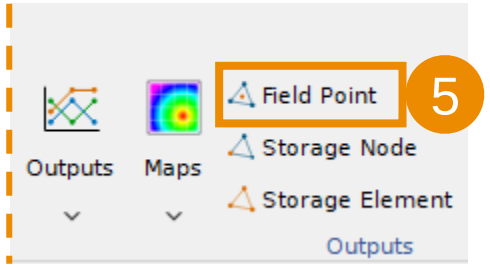
Import the microphones mesh *directivity.nff*

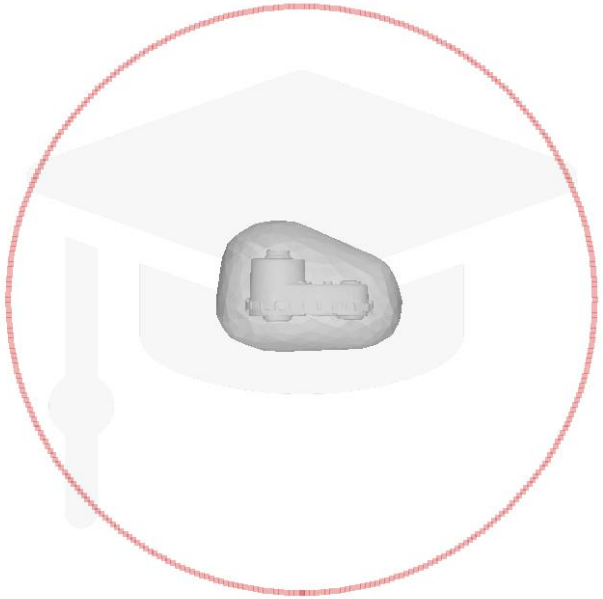
Create the field points

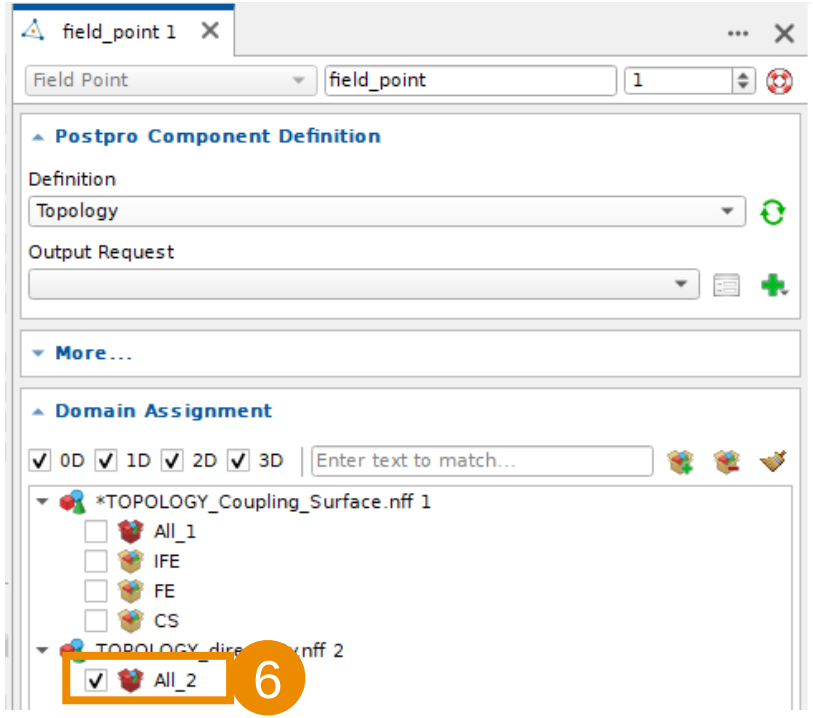








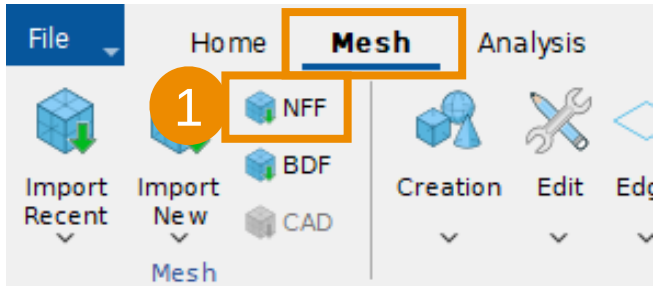


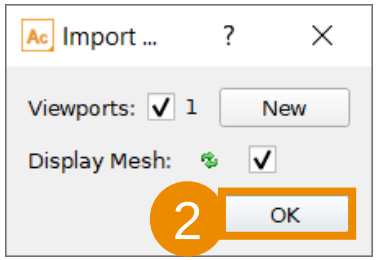


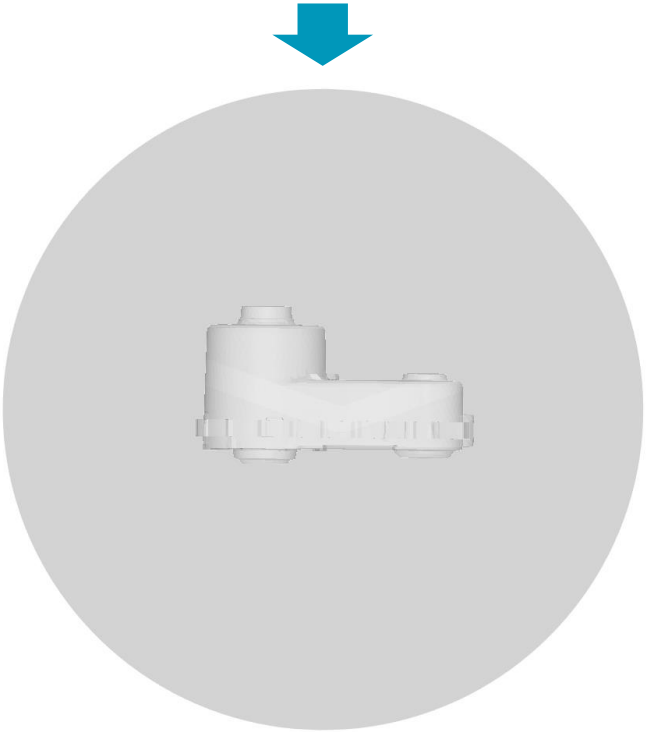
Post-processing parameters – Maps

Import mesh

Import the map mesh
field_mesh.nff







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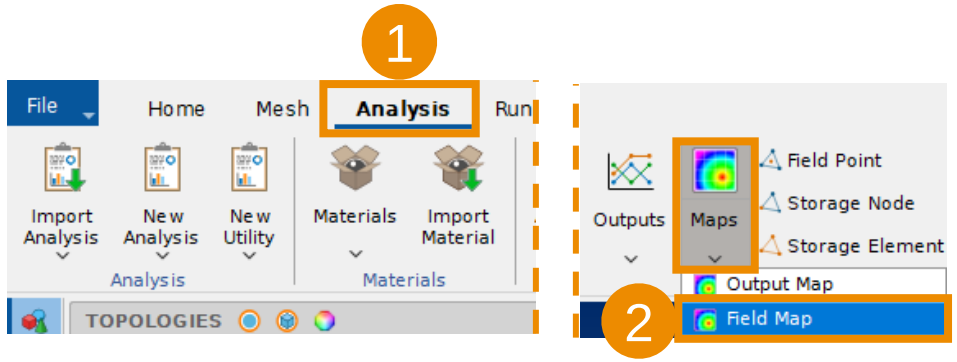
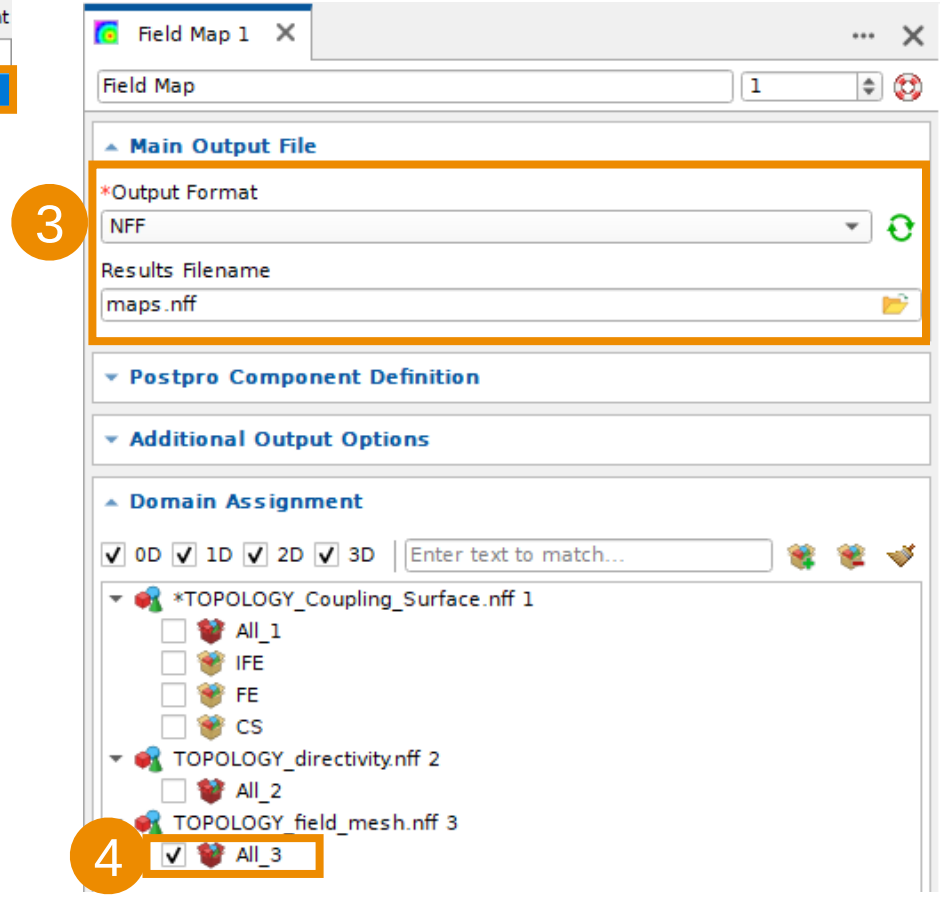
Post-processing parameters – Maps

Add a Field Map

Save the field map under the name maps.nff



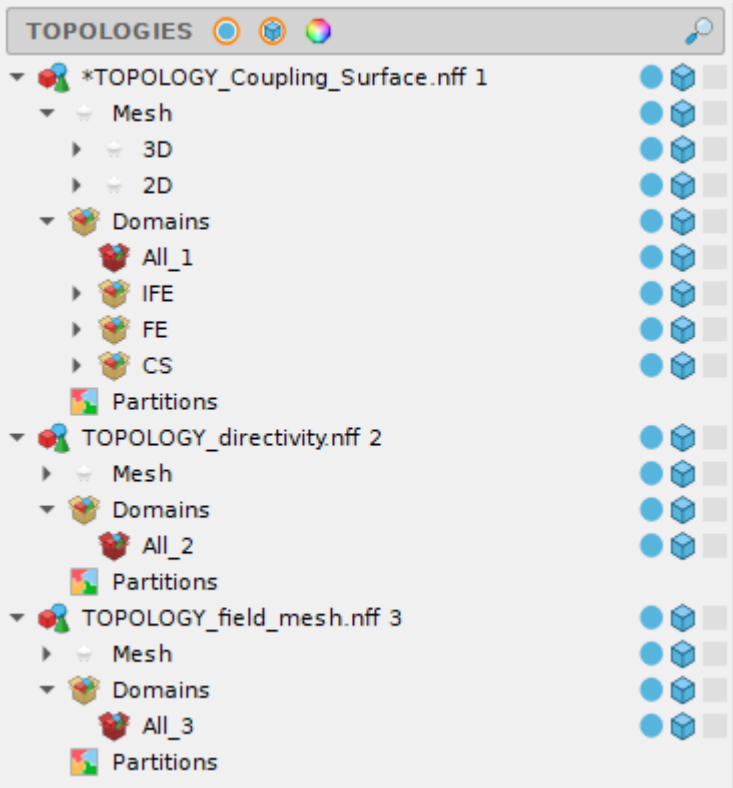


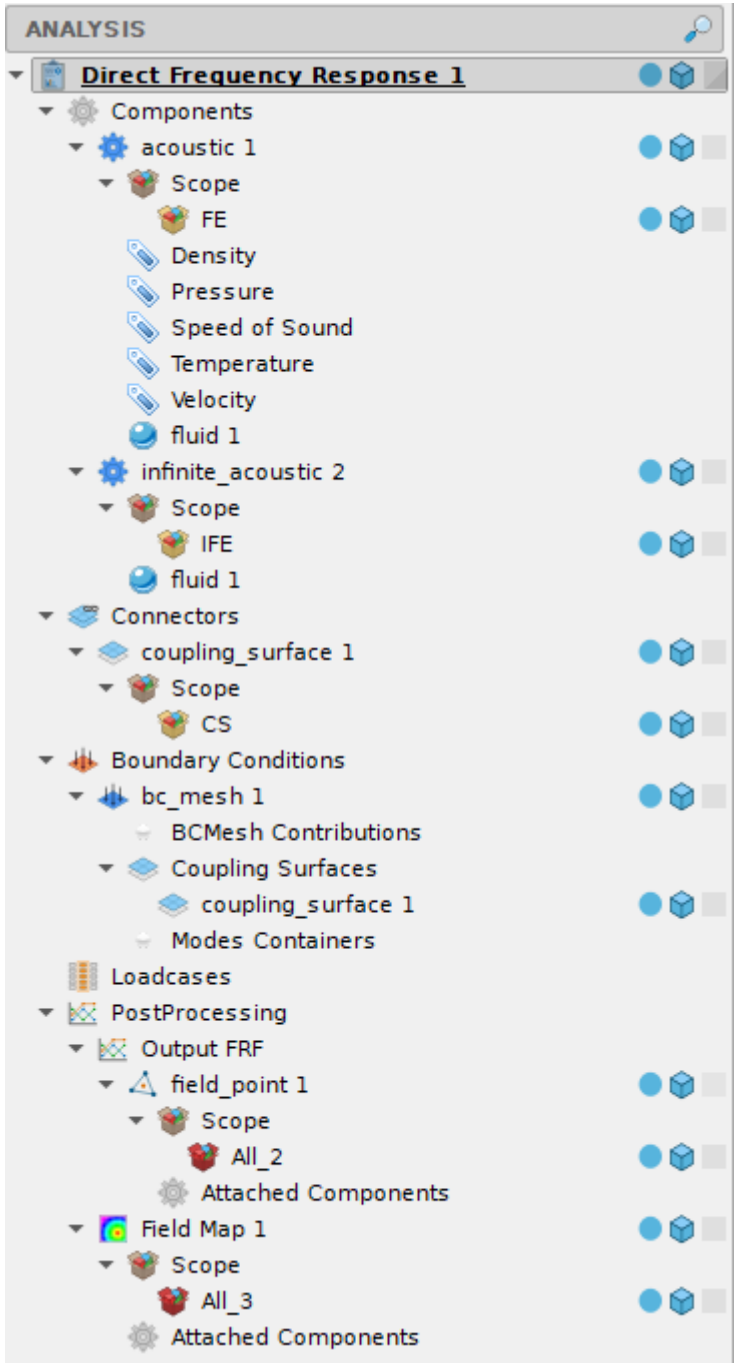
Check the analysis

The *Analysis* setup is now complete

All the parts of the *Analysis* are available and editable on the data tree panel

Check if the data tree is identical to the one shown



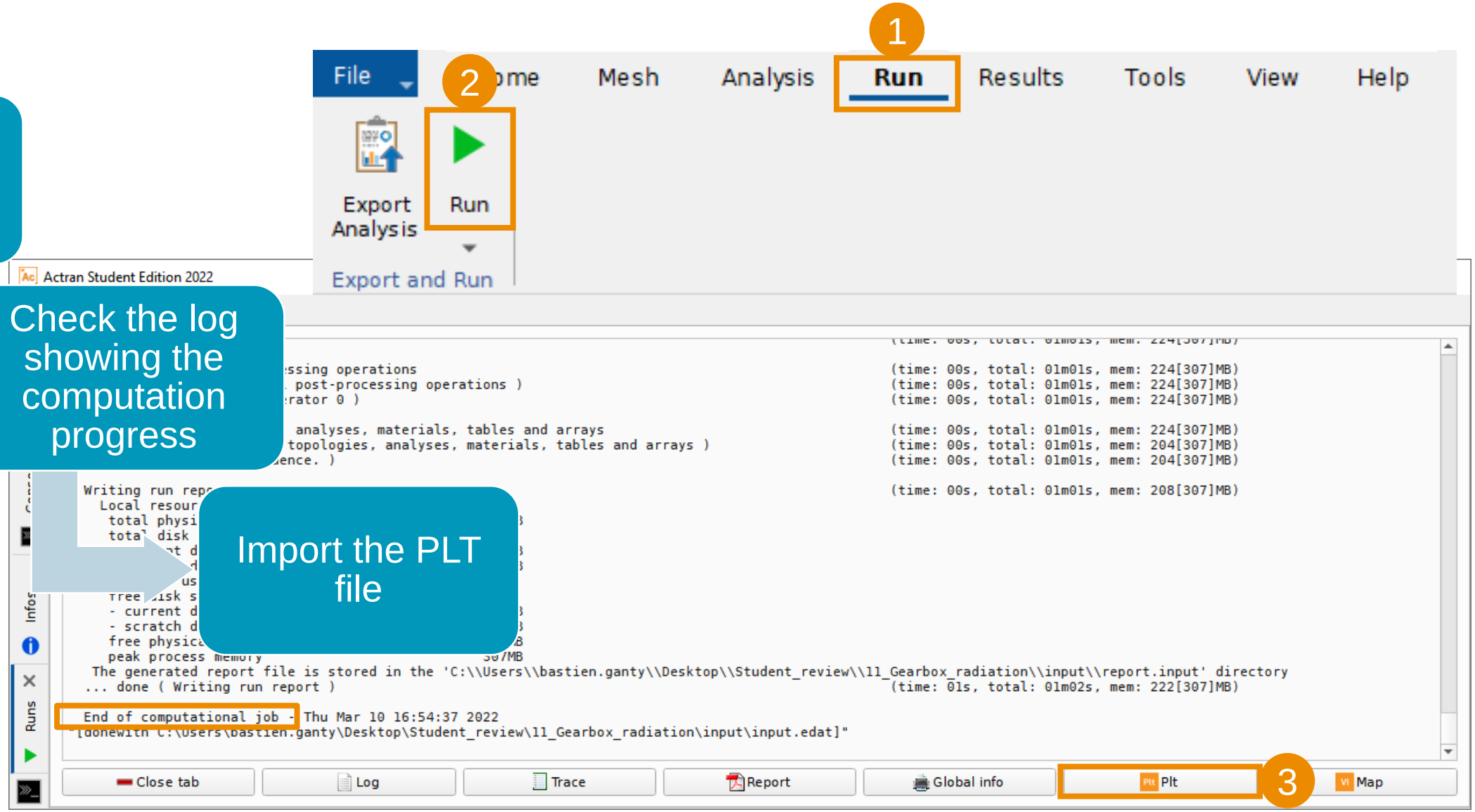


Launch the analysis in ActranVI

Launch the computation

Check the log showing the computation progress

Import the PLT file

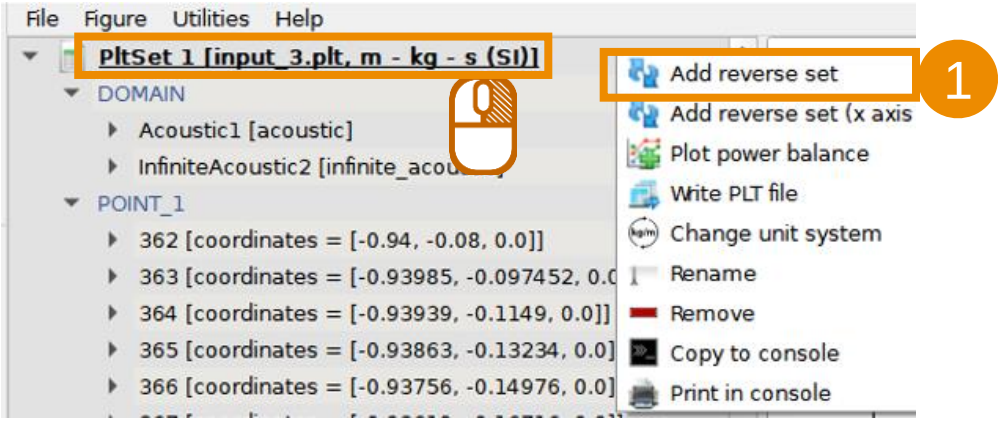


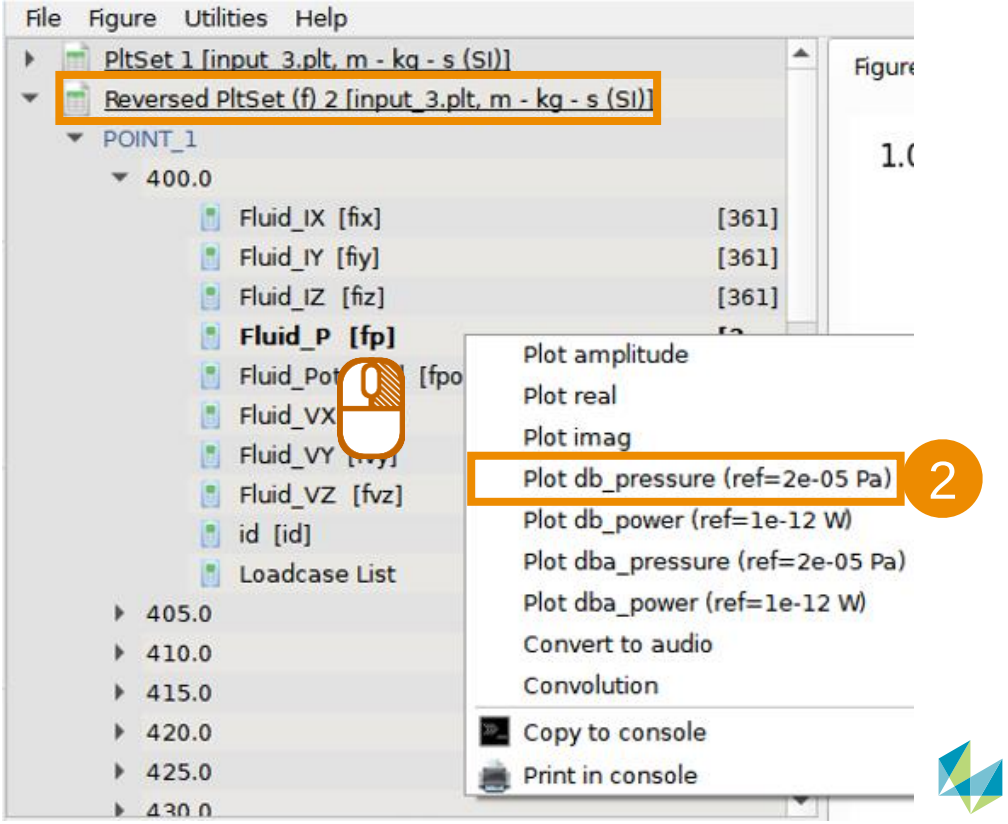
Post-processing

Plot the directivity

Add reverse set

Plot the pressure at 400Hz





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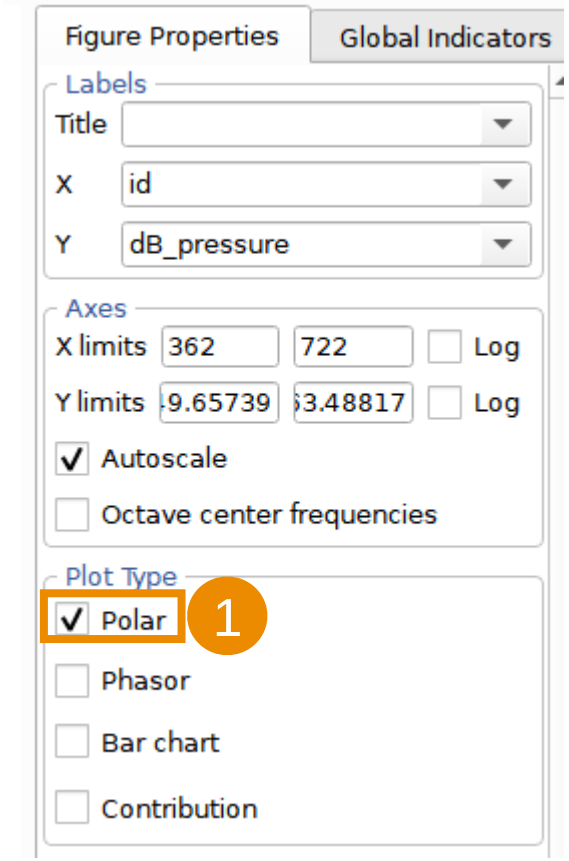
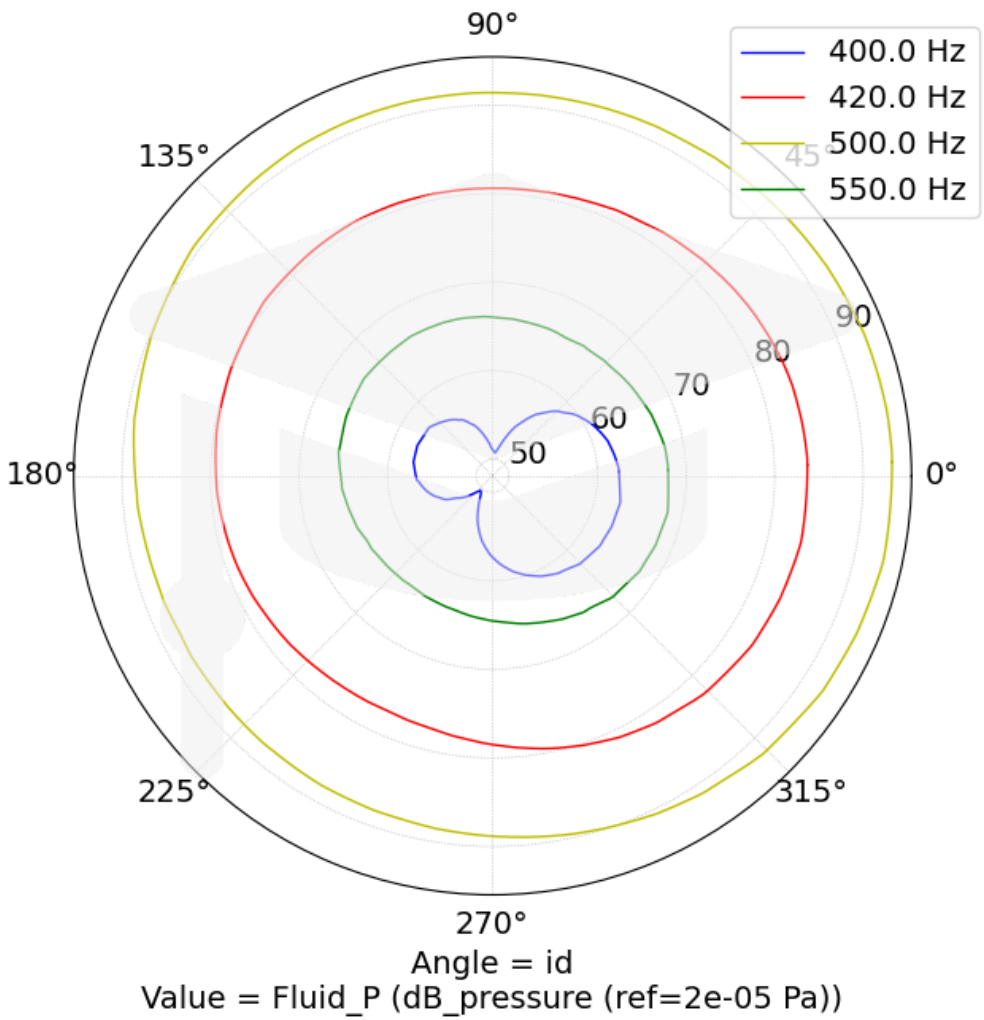
Plot the directivity





Active the polar plot

Plot the dB pressure at 420, 500 and 550 Hz as well

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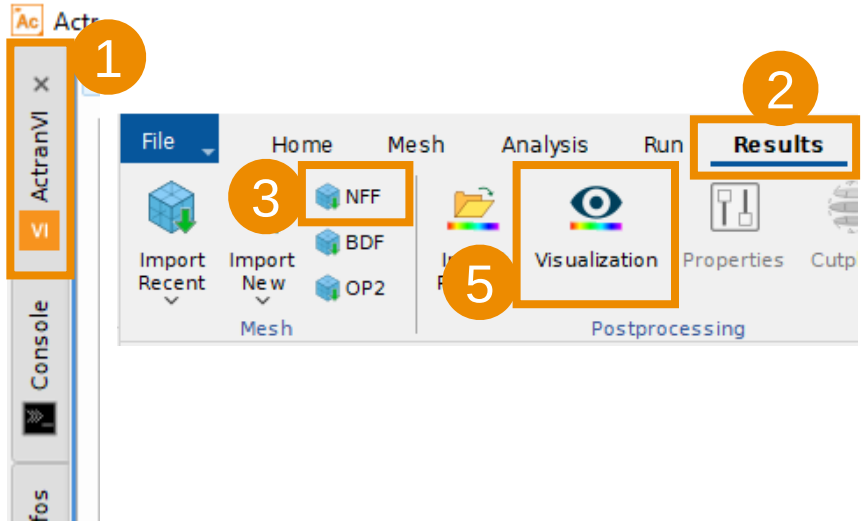
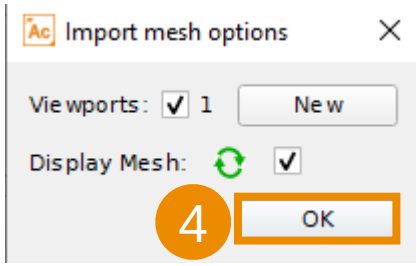
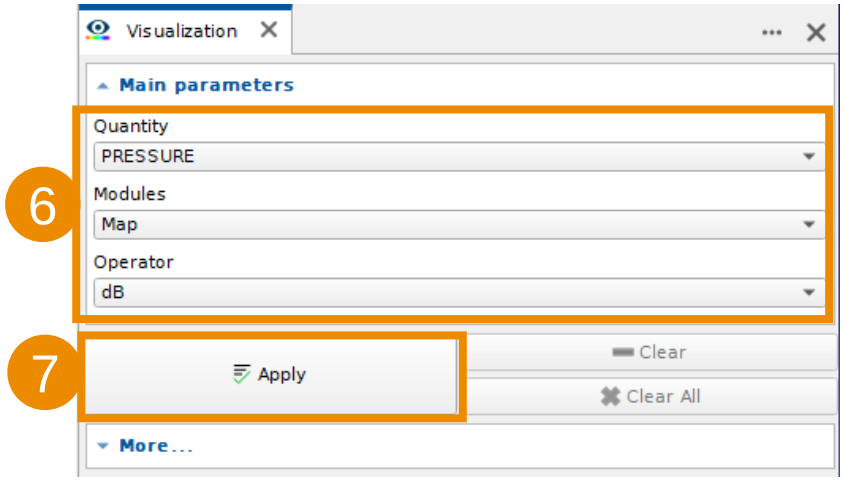
Visualize the output field map (1)

Import the results







Go back to ActranVI → Import the folder *maps.nff* → Visualize the pressure in dB

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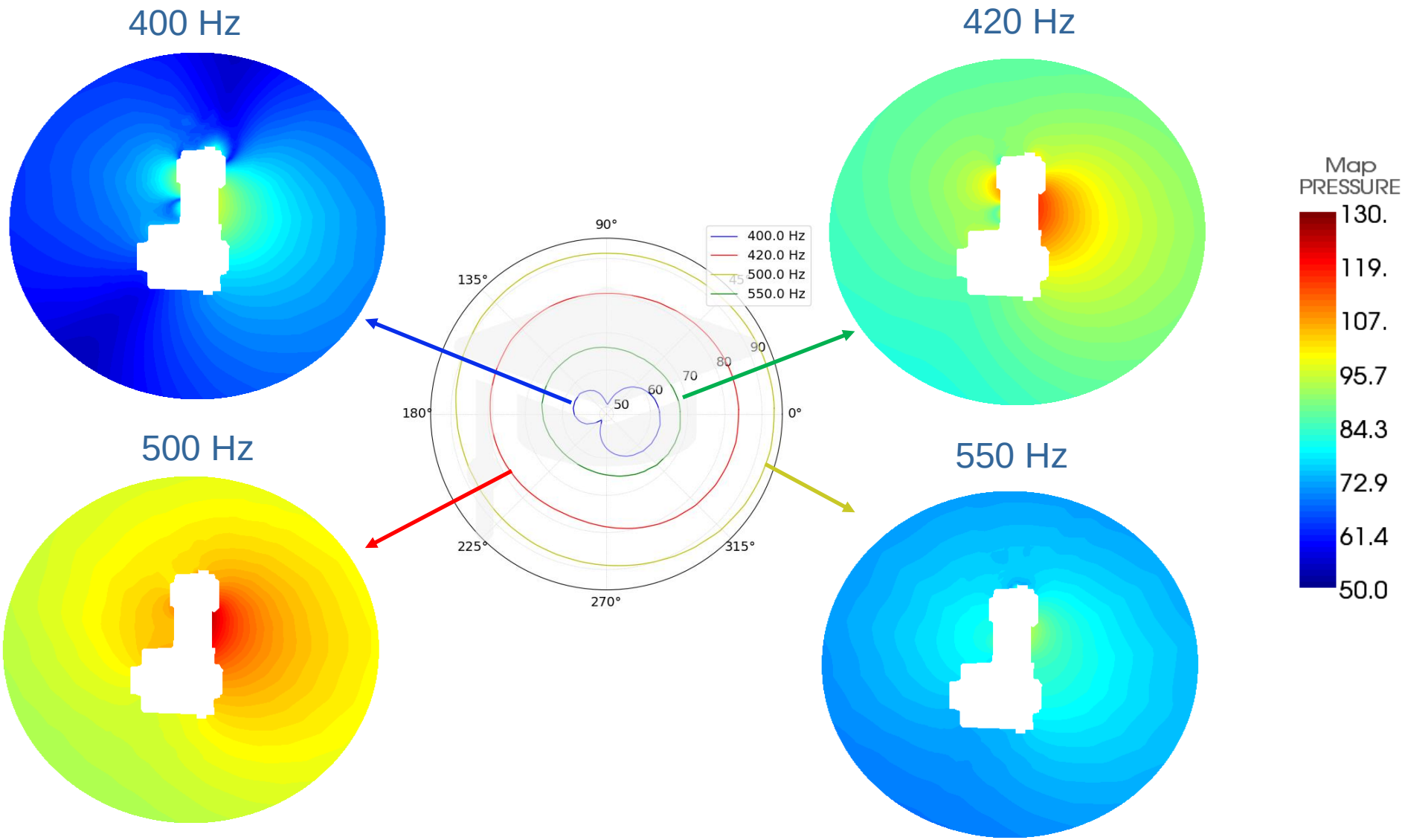
Visualize the output field map (2)



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Conclusions

Conclusions

- Acoustic propagation of a gearbox in free-field conditions was studied, based on a pre-computed vibrating structure

- The model involved:
  - A coupling surface whose mesh was generated inside ActranVI
  - A BC Mesh boundary condition supported by the coupling surface
  - Finite Fluid component for the near field
  - Infinite Fluid component for the far field
  - Field points for directivity plots and field maps

- The results highlighted a high directivity in the radiation pattern

- Going further:
  - Study the propagation and directivity in other directions
  - Add a sound barrier (e.g. cover)
  - Account for the floor (semi-free field) and its absorption

HEXAGON