HEXAGON

Introduction to Actran

Actran Student Edition Tutorial

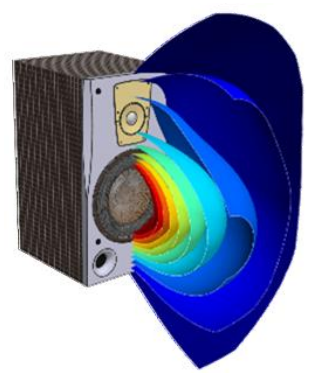
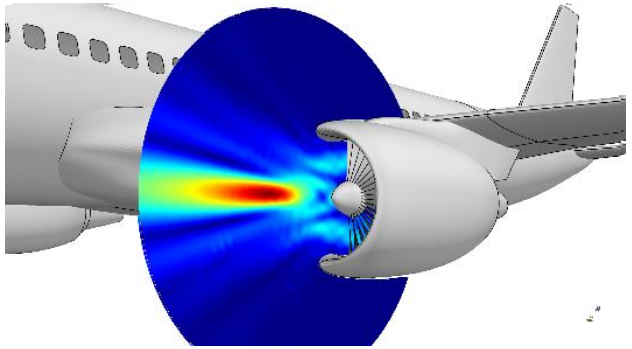
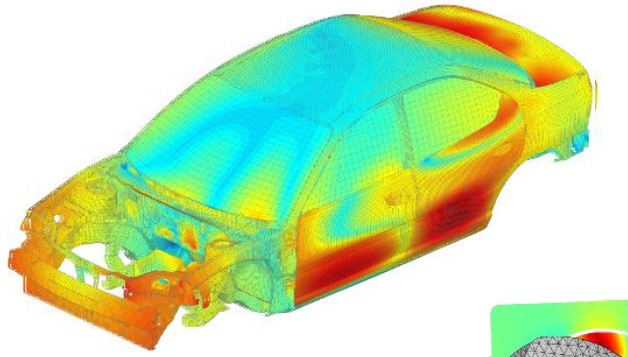
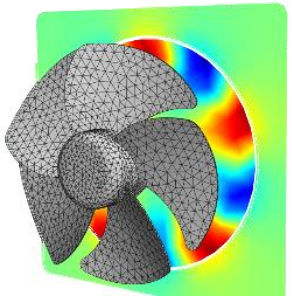
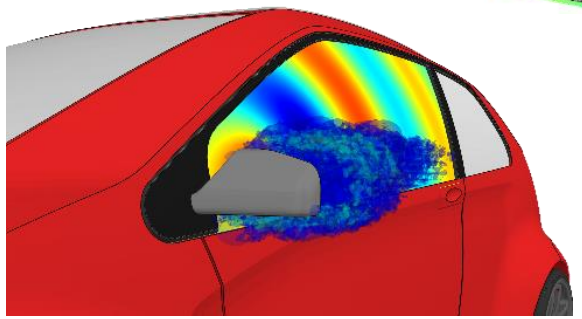
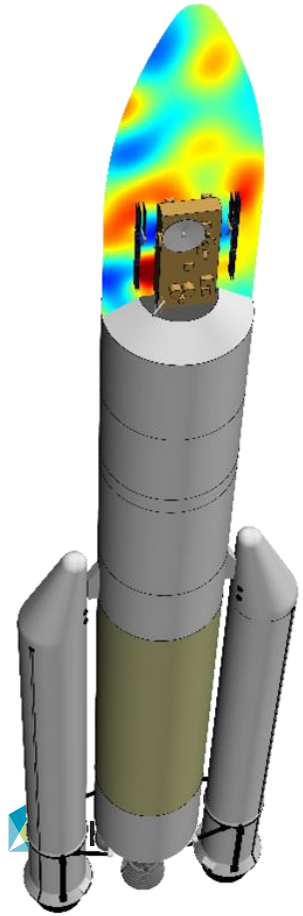
What is Actran?

HEXAGON

What is Actran?

- Actran is an acoustic simulation software package:
  - Based on **Finite Element Method**
  - Able to solve **vibro-acoustic** and **aero-acoustic problems**
  - With efficient implementation and highly scalable solver

- Actran is:
  - Extensively used by engineers around the world for **various applications**
  - **Validated** against experiments
  - Supported by a team of **acoustic simulation experts**

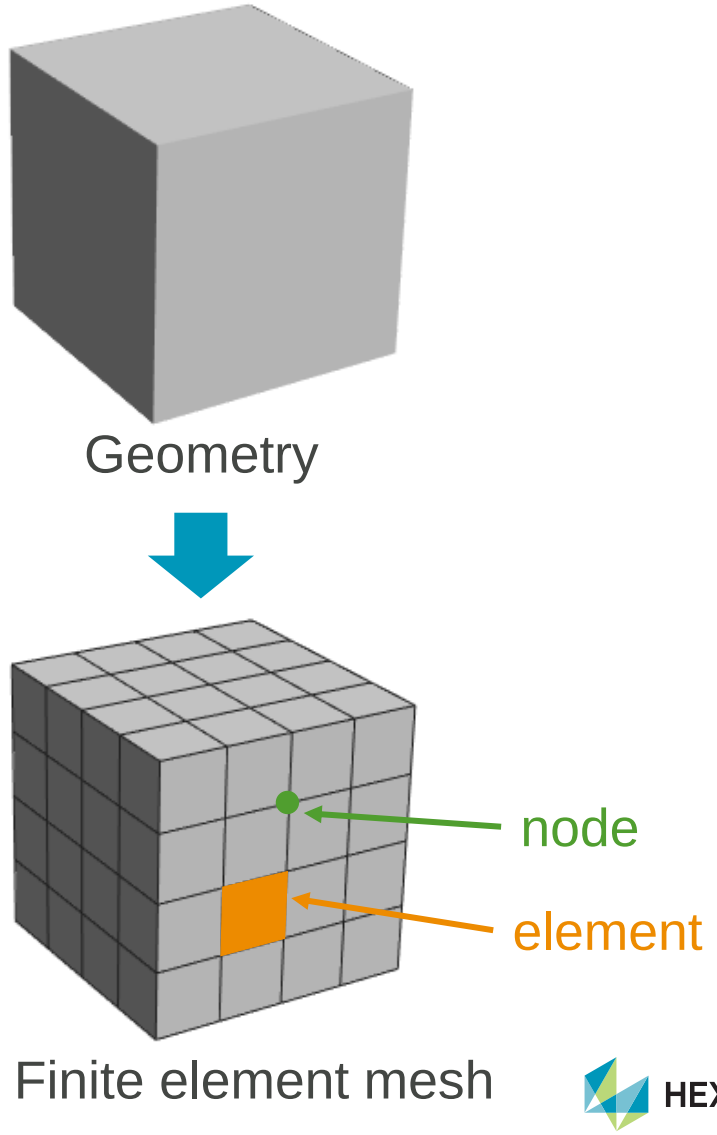







Actran is a solver

HEXAGON

Finite element basics

- Actran is based on the finite element method
- Discretization of complex geometry in nodes and elements → finite element mesh
- Resolution of the system for all nodes according to the relationships between each node



HEXAGON

Direct Frequency Response

- The vast majority of configurations are modelled using a **Direct Frequency Response** (DFR) analysis

- It computes:
  - the **response** of an **acoustic system**
  - to an **excitation** at the **specified frequencies**
  - for all finite element nodes

- The following equation system is solved by Actran:

$$(\mathbf{K} + i\omega\mathbf{C} - \omega^2\mathbf{M})\mathbf{x}(\omega) = \mathbf{F}(\omega)$$

System Unknown Load

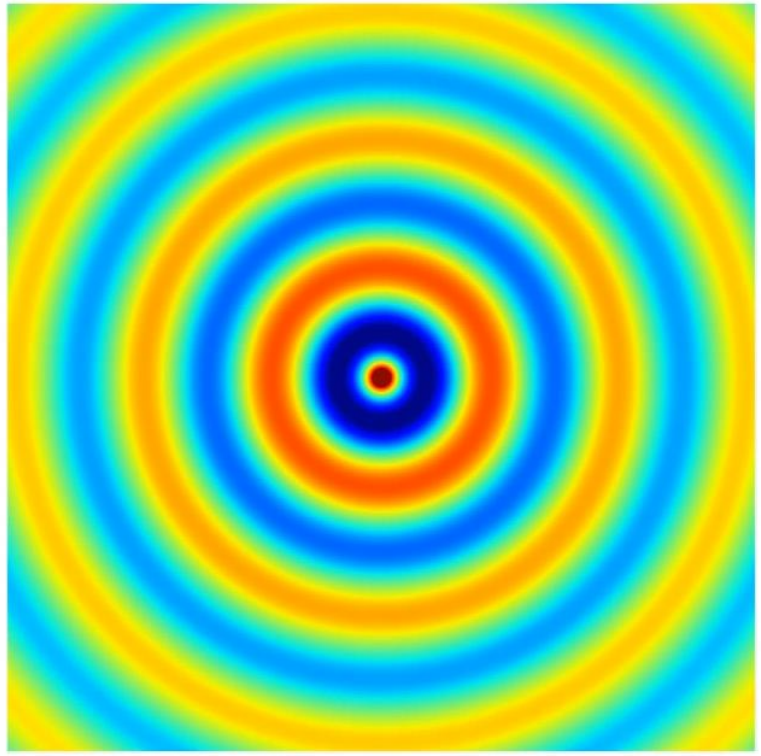
with
- Pulsation $\omega = 2\pi f$
- stiffness matrix **K**
- damping matrix **C**
- mass matrix **M**

HEXAGON

Frequency response results (1)

- A Direct Frequency Response computes the response of an acoustic system **to an excitation at specified frequencies**
- The solution computed by a Direct Frequency Response at 1000Hz corresponds to the acoustic propagation of one or several excitations pulsating at 1000Hz
- Results are output in **frequency domain** (real and imaginary part)

- Example: frequency response of a monopole pulsating at 1000Hz (slow phase animation)

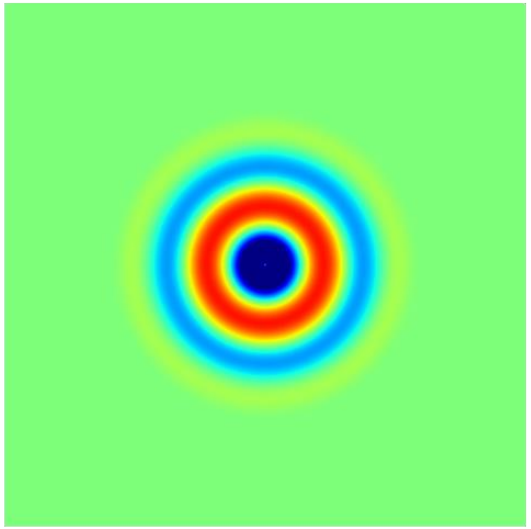


Frequency response results (2)

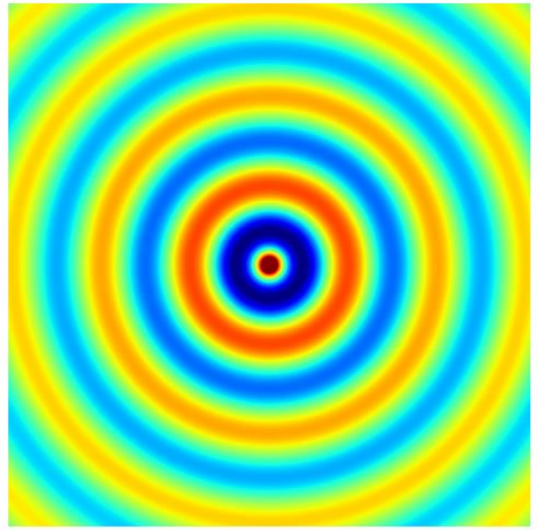
- Direct Frequency Response provides a **harmonic response** in frequency domain

- For a monopole pulsating at 1000Hz:
  - Equivalent to a source pulsating harmonically for an infinite amount of time
  - Effect of the monopole pulsation is fully propagated through space (no transition as for time domain simulation)

- **Time domain** simulation of a monopole pulsating at 1000Hz:



Pressure at t=1.8e-3s
(1.8 pulsations)

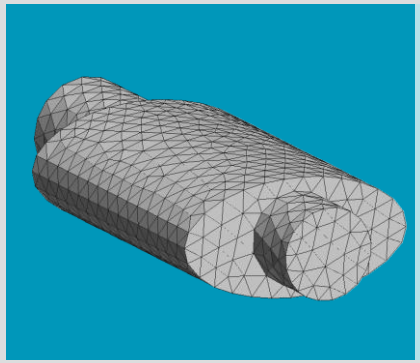


Pressure at t=0.02s
(20 pulsations)

Solution on the computation domain is equivalent to DFR results with phase=0

Actran concepts overview

Actran Analysis

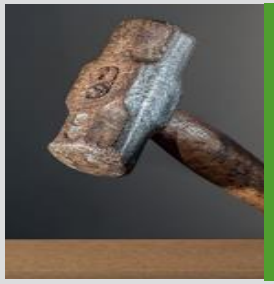


Element Sets
Group of finite element (based on mesh creation)

Materials
Describes the physical properties of a component

Analysis parameters
Any other parameter which influence the computation of the model (analysis frequencies, outputs, solver,…)

Domains
Collection of element sets (organized for the Actran analysis)



Boundary conditions
Characterizes a known restriction or an excitation on the finite elements

$$\Delta p - \frac{1}{c^2}\frac{\partial^2 p}{\partial t^2} = 0$$

$$\underline{\underline{\sigma}} = \underline{\underline{c}}^E \underline{\underline{\varepsilon}} - \underline{\underline{e}}\vec{E}$$

$$\vec{D} = \underline{\underline{e}}\underline{\underline{\varepsilon}} + \underline{\underline{\varepsilon}}^S \vec{E}$$

Components
Physical model & numerical formulation applied on a domain of finite elements

$$Zx = B$$

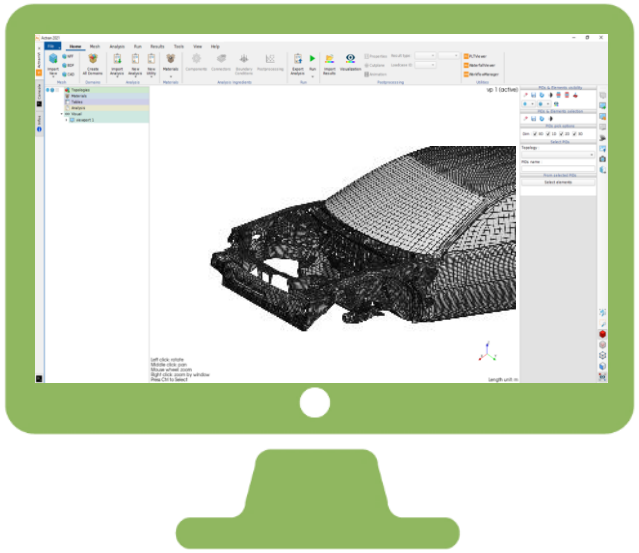
HEXAGON

Actran Graphical User Interface

HEXAGON

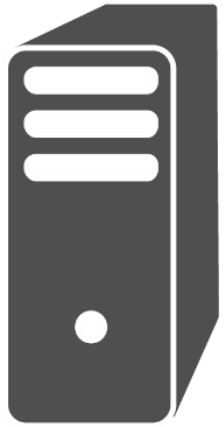
Actran is supported by a Graphical User Interface (GUI)

Model Set-up | Computation



ActranVI

Input
*.edat

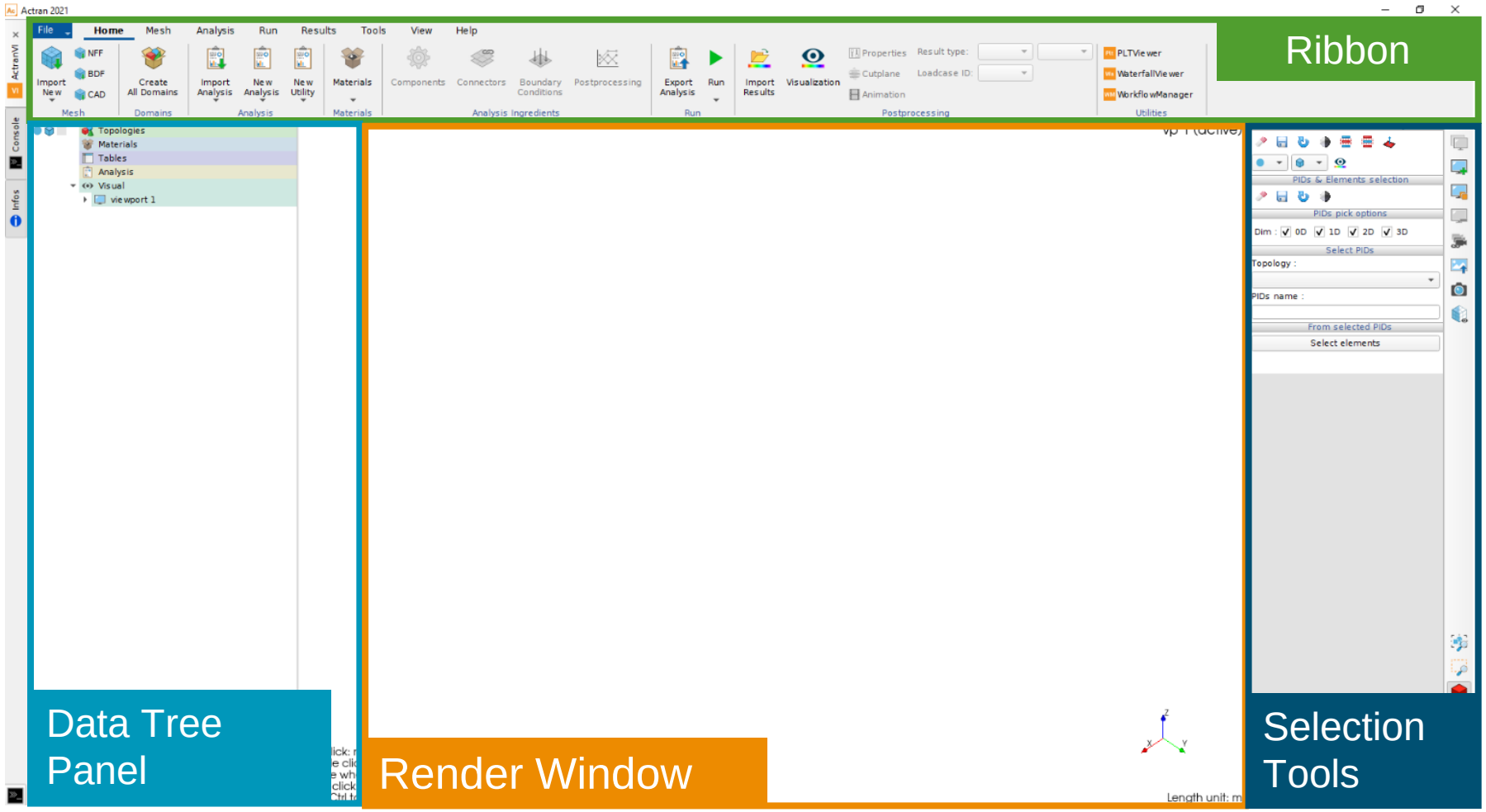


Ac Actran

Solver

HEXAGON

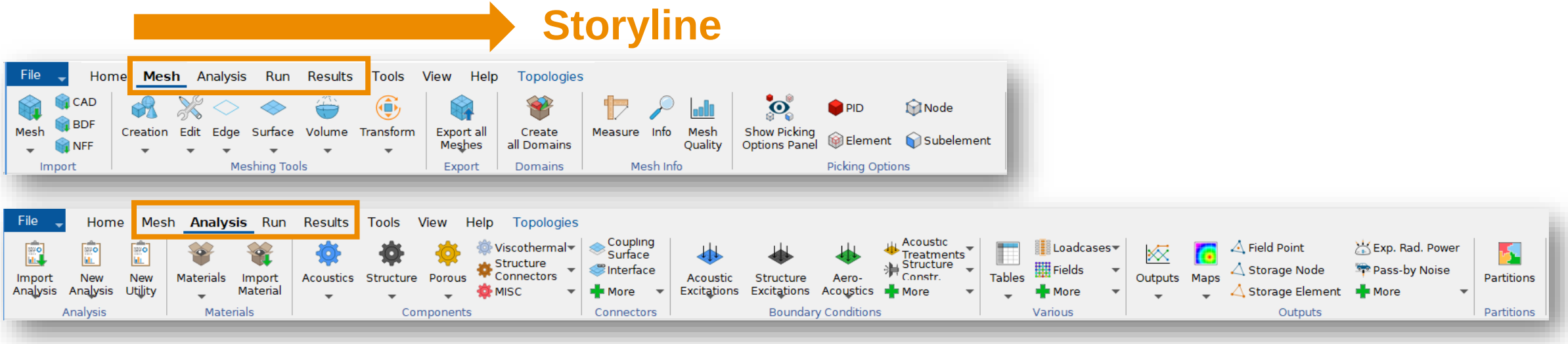
ActranVI overview



HEXAGON

Ribbon

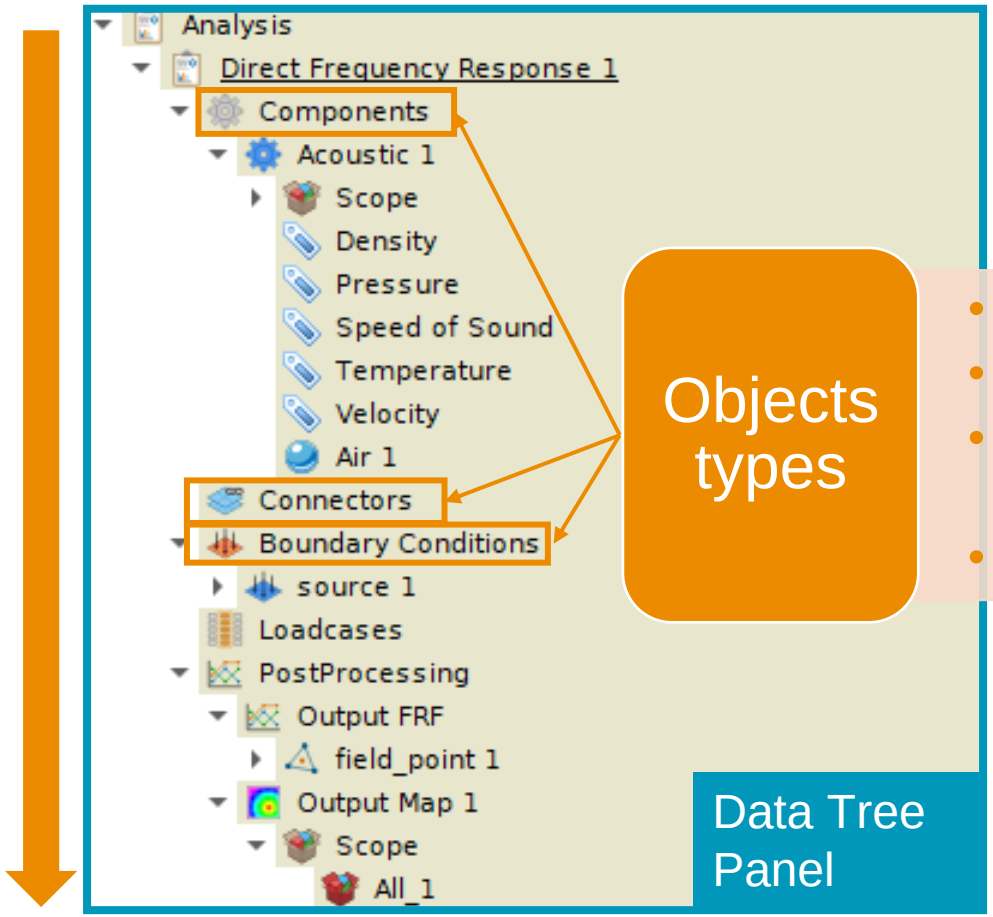
- **Complete** and **organized** layout
- **Guided analysis set-up** and **post-processing** operations using **ribbon storytelling**



HEXAGON

Actran analysis: data tree panel nodes

Direct Frequency Response Analysis parameters and objects

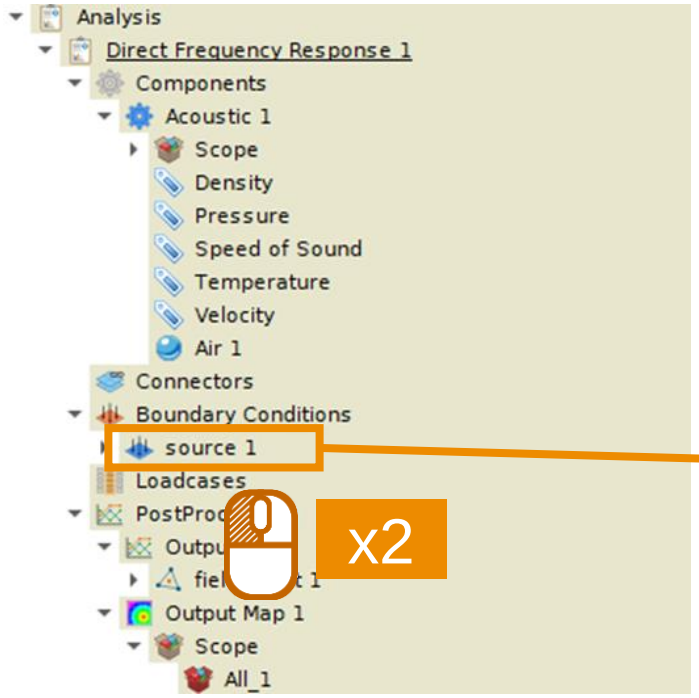


Objects types

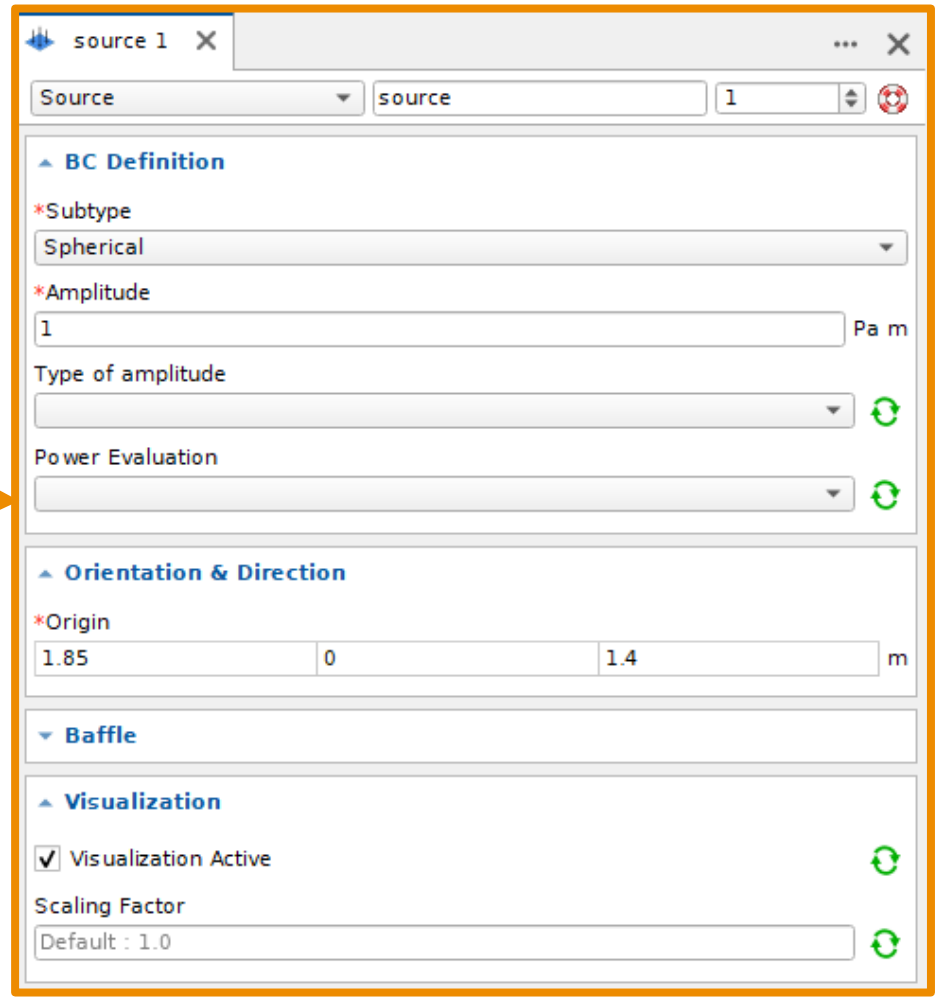
- *Components*
- *Connectors*
- *Boundary Conditions*
- …

HEXAGON

Actran analysis: edit objects properties



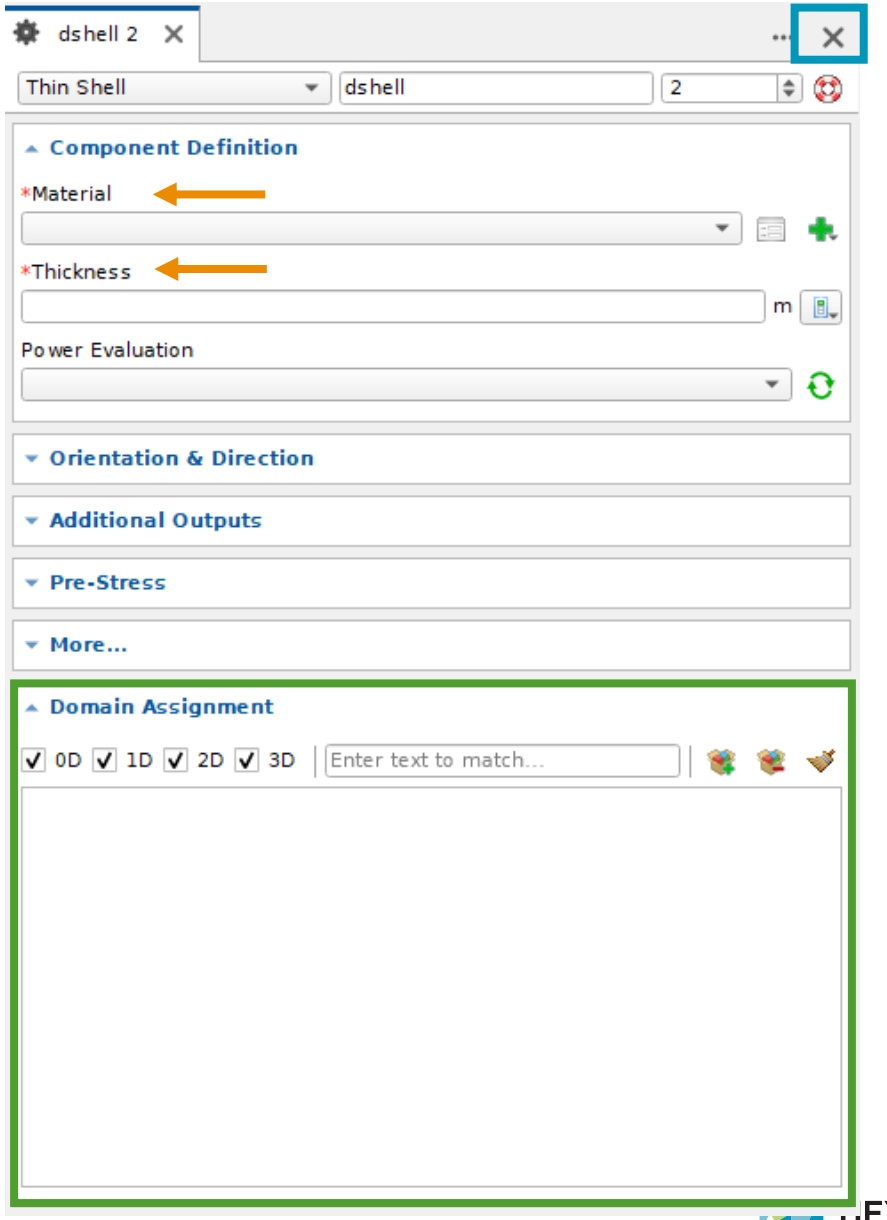
Double-click on a tree node to open the object properties window



HEXAGON

ActranVI properties window

- Only parameters with * are mandatory
- Assigning a domain is always mandatory
- You can close or open any properties window anytime: input parameters will be taken into account

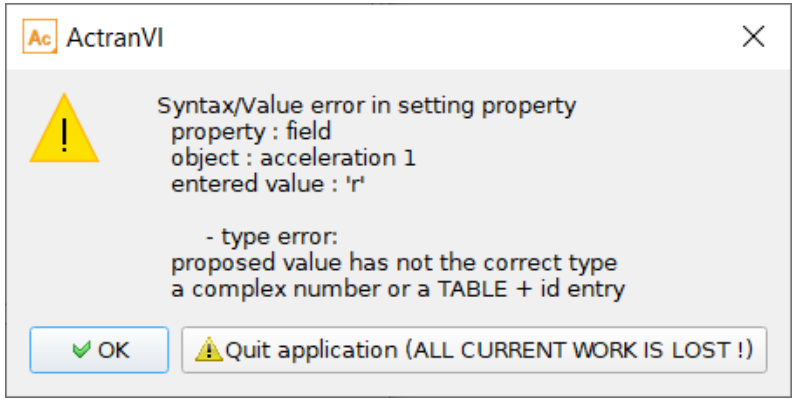


Errors in ActranVI

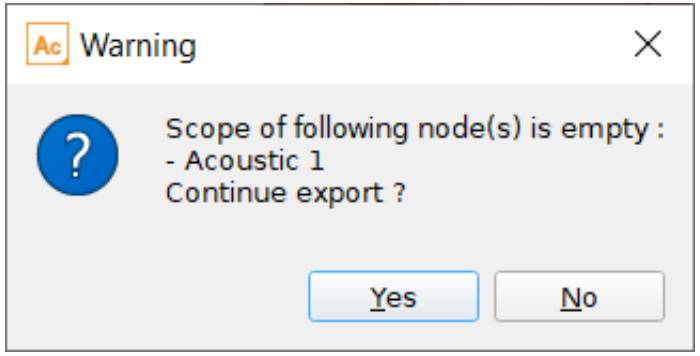
- You may come across error messages when pre-processing, running or post-processing a model
- **Read carefully** the error message and try to analyze what happens:
  - Is it a Warning or a Fatal message?
  - Can I find where the error is and correct it?

Examples

- Analysis pre-processing:



- Analysis export :

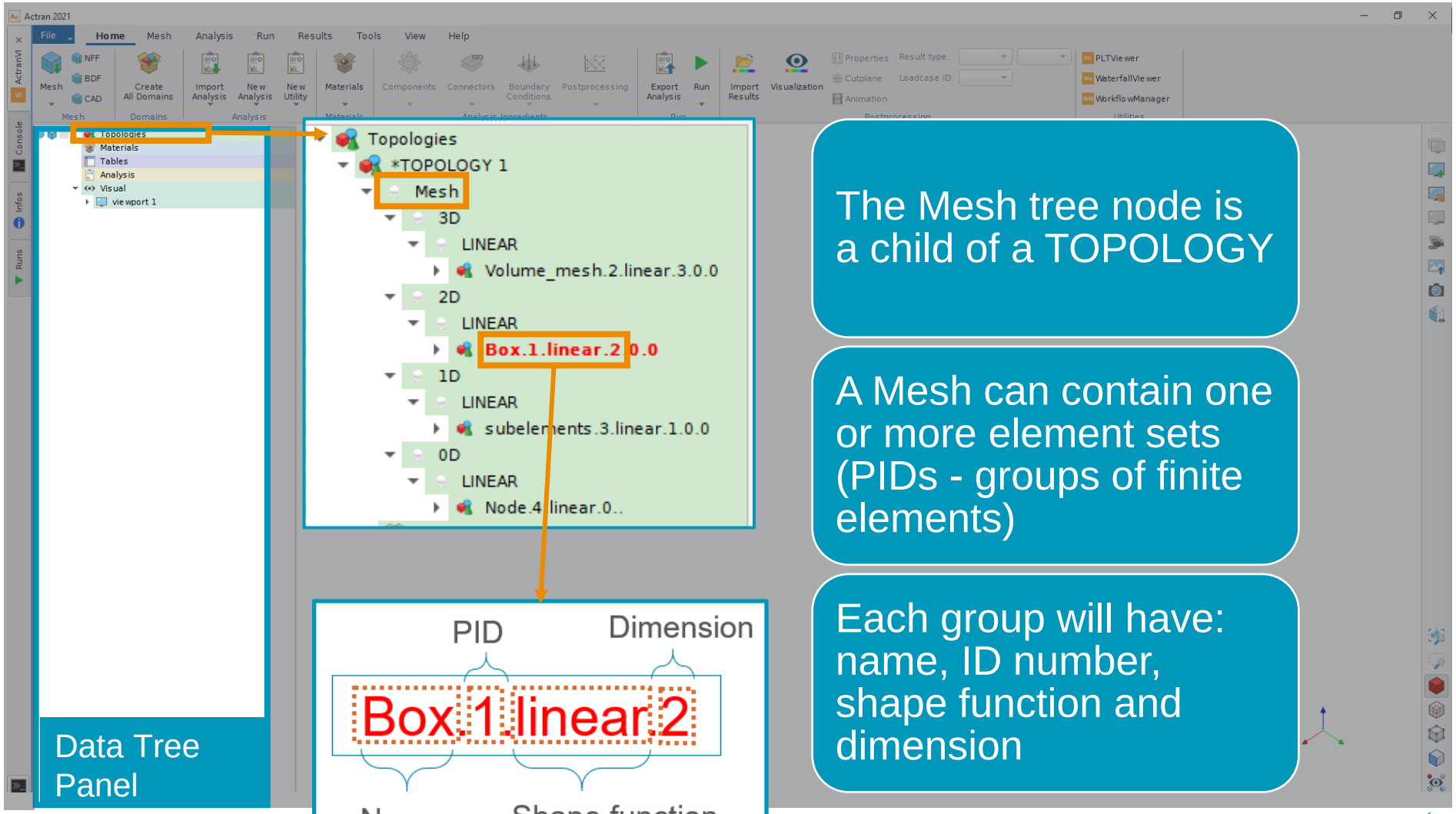


HEXAGON

Meshing in ActranVI

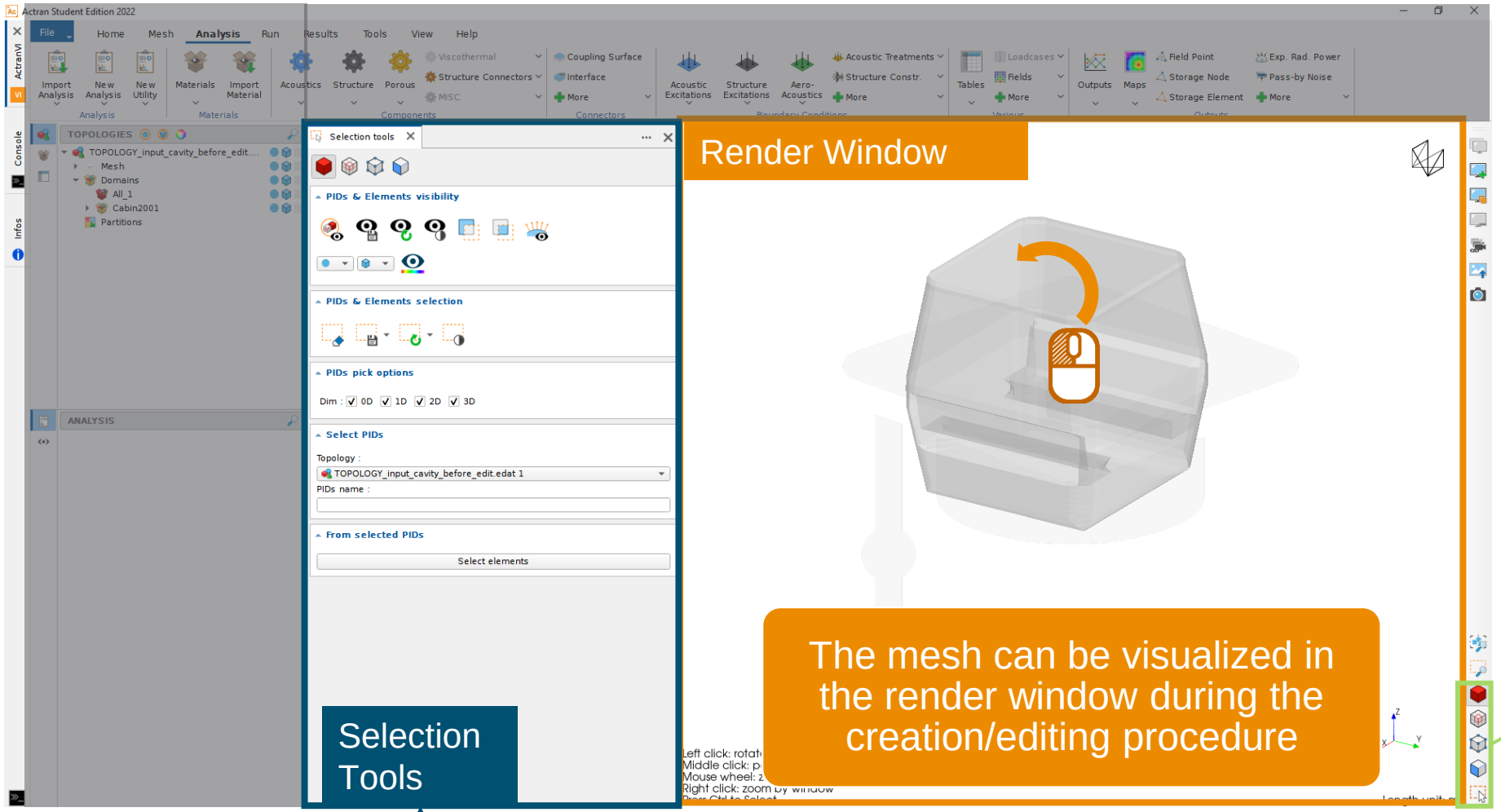
HEXAGON

Meshing overview: data tree panel



HEXAGON

Meshing overview: visualization and selection



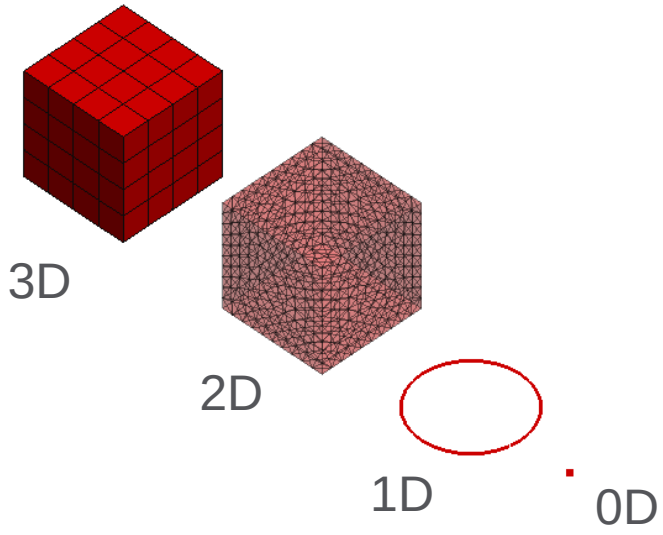
The mesh can be visualized in the render window during the creation/editing procedure

Selection and visualization tools can be used for mesh editing, analysis and improvement

Selection modes

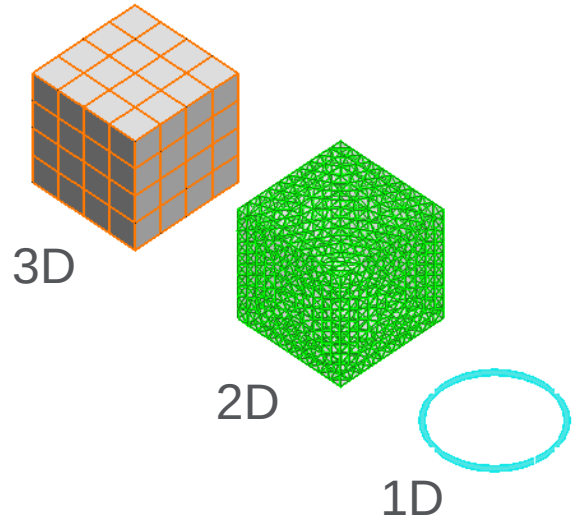
- PID
- Element
- Node
- Sub-element
- Expand selection tools

Meshing overview: selection modes



PID

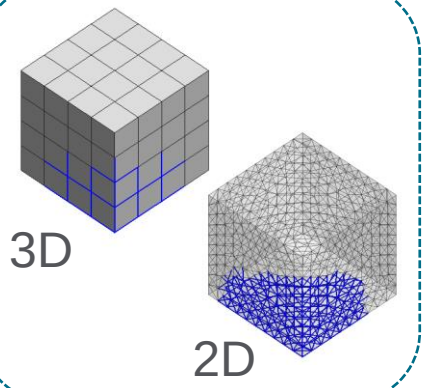
Element

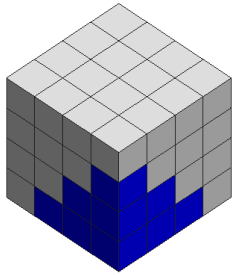


Selection modes

Edges

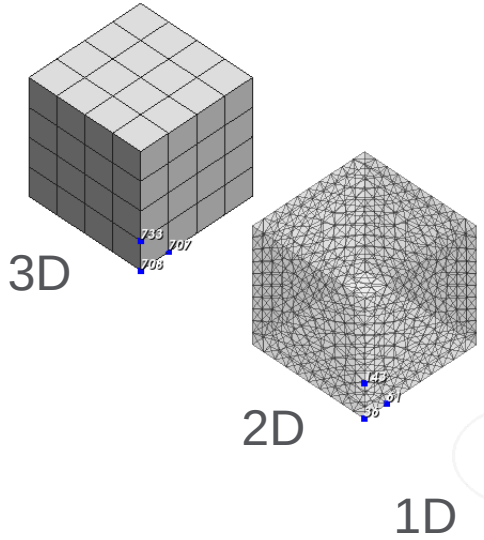
Surfaces





Sub-element

Node

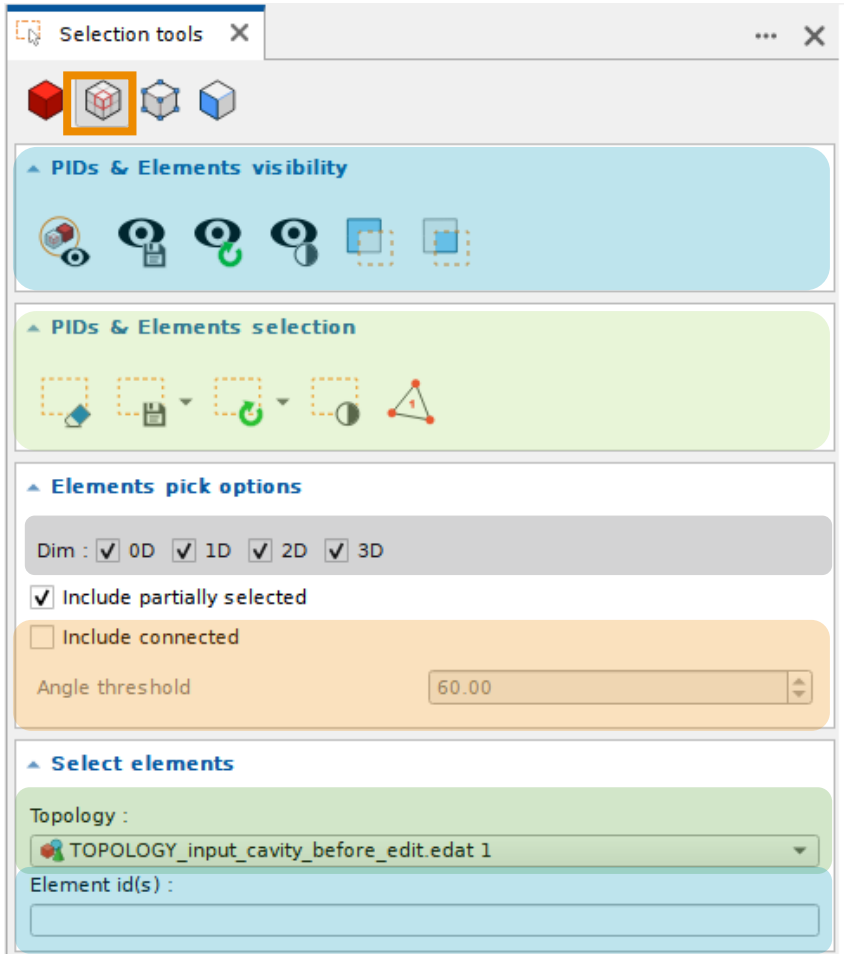


ActranVI meshing overview – Element picking options panel

Show/hide options for specific selections

Activate mesh dimensions to be selected

Set specific topologies to be active for selection



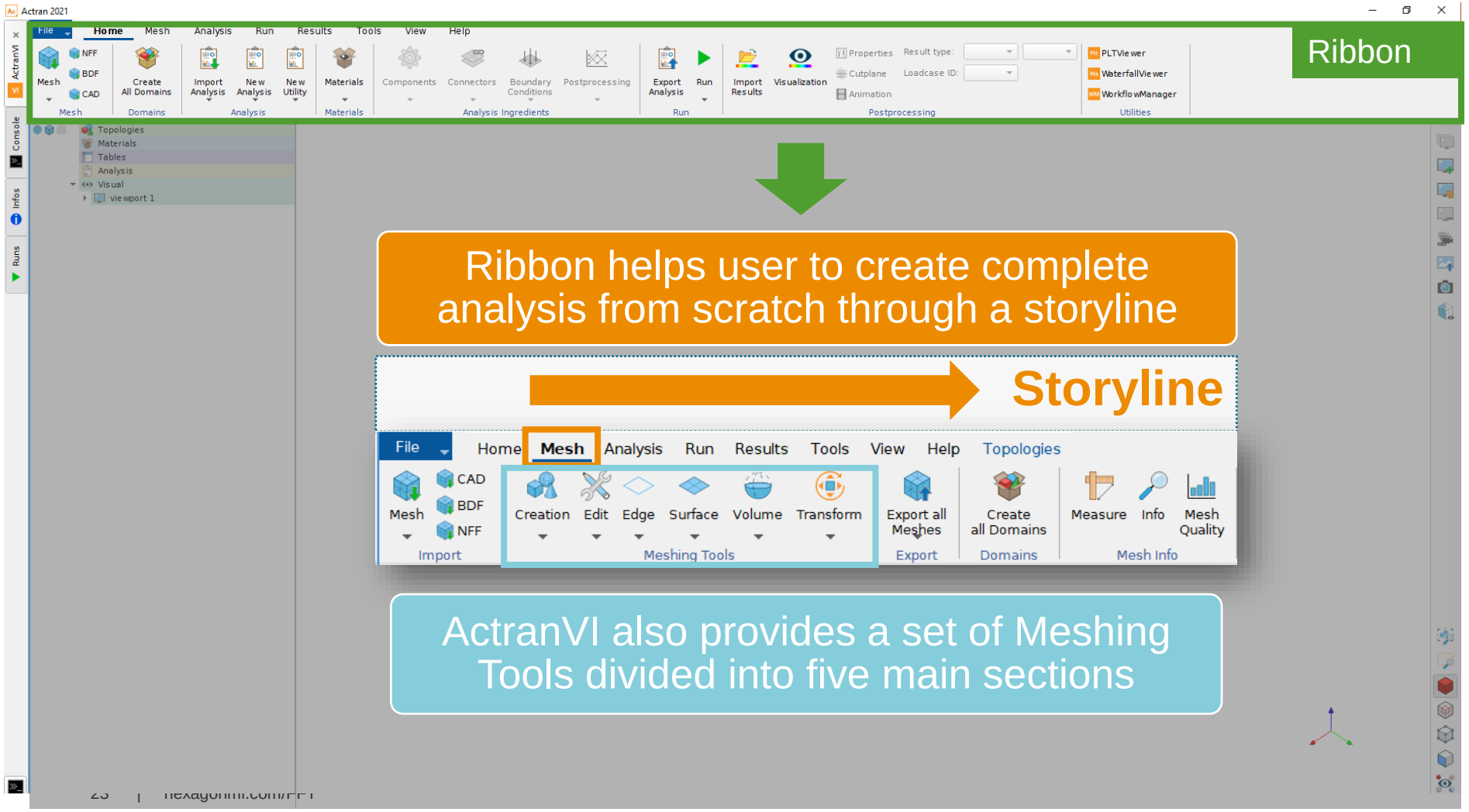
Save/Edit specific selections

Include connected parts based on a threshold angle

Select mesh element by ID(s)

HEXAGON

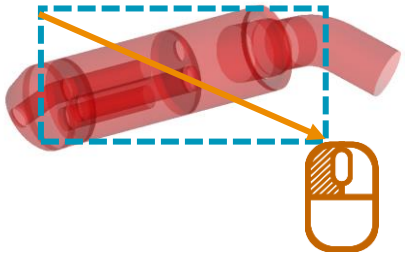
ActranVI meshing overview – Meshing tools



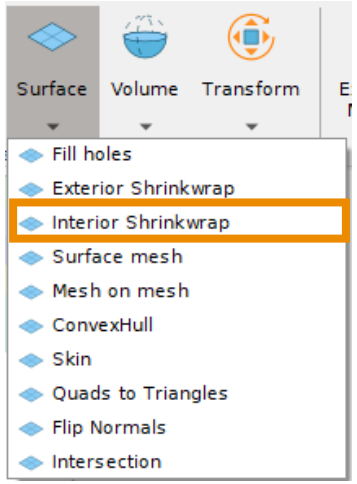
HEXAGON

General meshing procedure

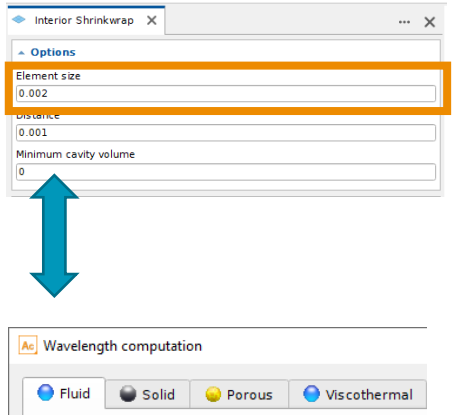
Select PIDs



Choose meshing tool

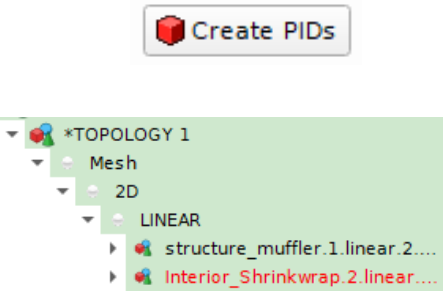


Set Parameters



Preview

Create new PIDs

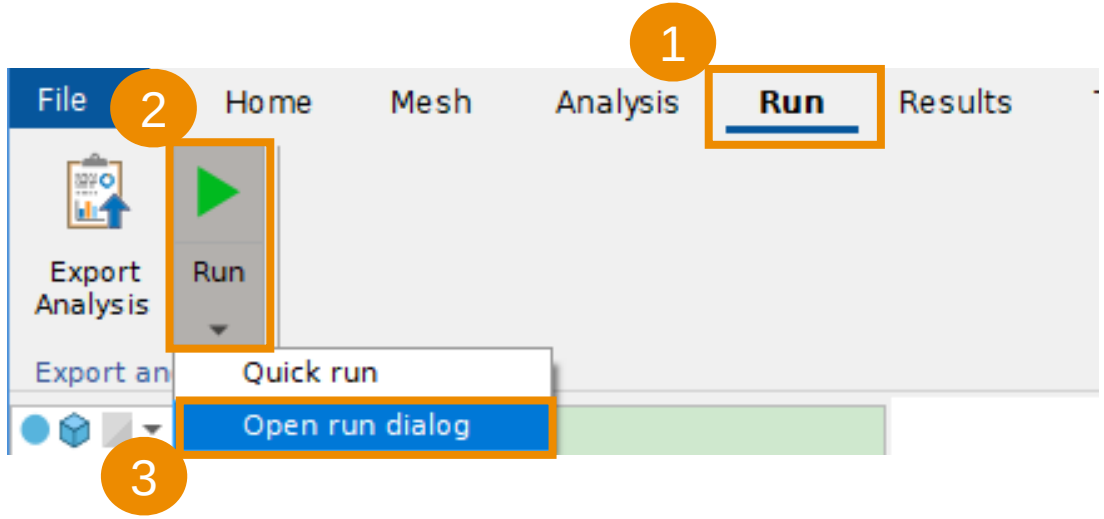


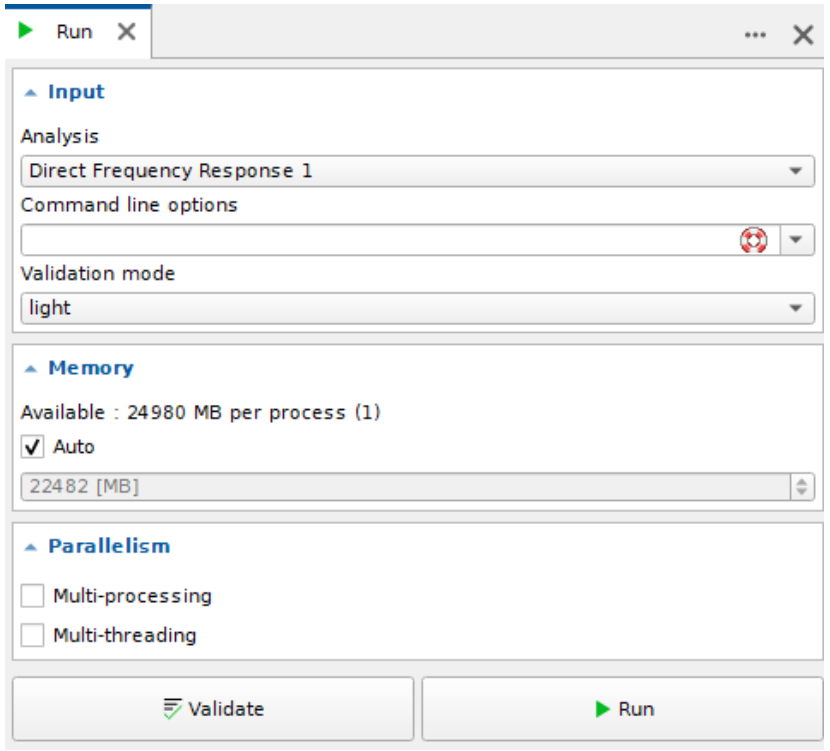
HEXAGON

Actran launch and outputs

HEXAGON

Launch the Actran analysis in ActranVI



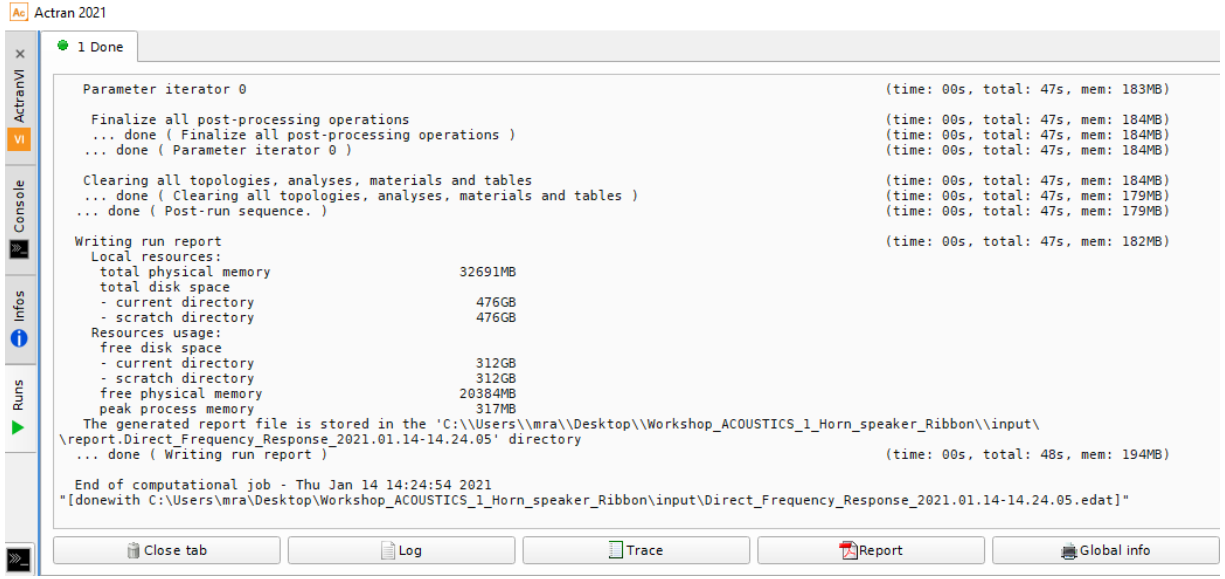


HEXAGON

Information on computation process

- A window pops-up with information related to the different steps of the analysis:
  - The **command line** read by Actran
  - **Real-time information** about different steps involved in the computation
  - **Resource consumptions**
  - The warning or error messages (if any)

- This information can also be retrieved in the *.log file (in the report directory)



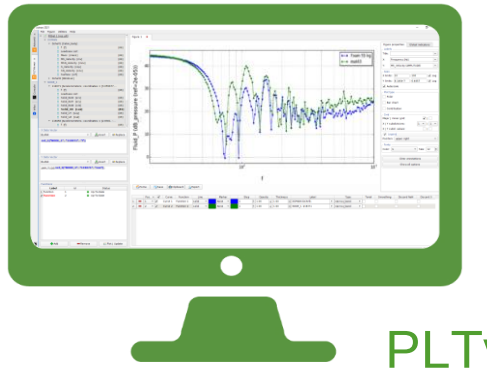
HEXAGON

Actran output : FRF and Maps

Computation | Post-processing

Frequency Response Function (FRF):
results at all the frequencies for a given node

*.plt



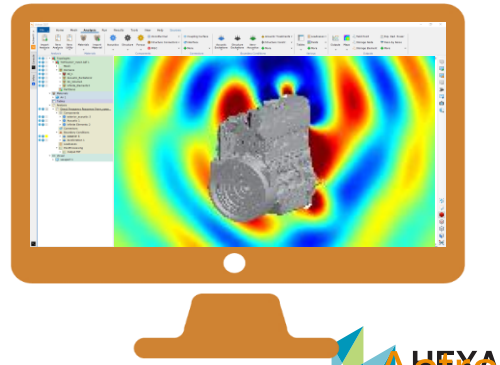
PLTviewer

Ac Actran
Solver

	100Hz	200Hz	300Hz		1000Hz
Node 1	974.74	794.66	523.86	…	507.21
Node 2	770.92	247.10	654.31	…	628.57
Node 3	473.51	875.77	300.71	…	22.66
…	…	…	…	…	…
…	…	…	…	…	…
Node 5877	946.14	147.55	787.7	…	49.2
Node 5878	174.06	498.23	23.63	…	98.28

Maps: results at all the nodes for a given frequency

*.nff



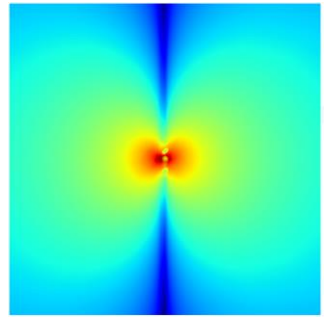
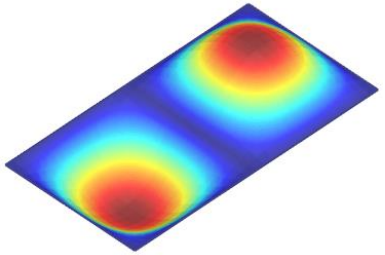
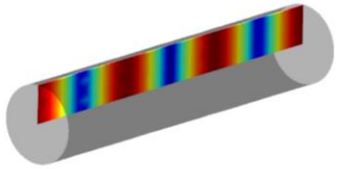
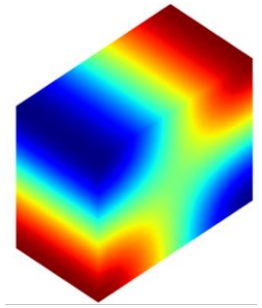
HEXAGON ActranVI

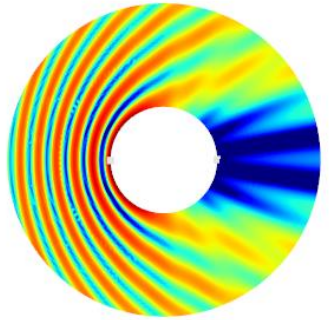
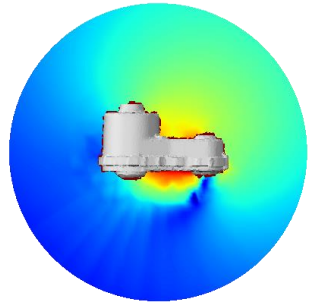
Actran Student Edition workshops

HEXAGON

14 workshops are available

- 01_Monopole_in_free_field
- 02_Dipole_in_free_field
- 03_Plate_modal_extraction
- 04_Plate_forced_response
- 05_Impedance_tube_rigid
- 06_Impedance_tube_absorption
- 07_Cavity_modal_extraction
- 08_Monopole_in_cavity
- 09_Muffler_transmission_loss
- 10_Scattering_cylinder
- 11_Gearbox_radiation
- 12_Baffled_Plate_transmission
- 13_Coupled_plate_cavity_forced_response
- 14_Coupled_plate_cavity_added_damping_foam

HEXAGON