

From van Karman to Magnus with COMSOL Multiphysics

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Month/Year

Univerza v Ljubljani



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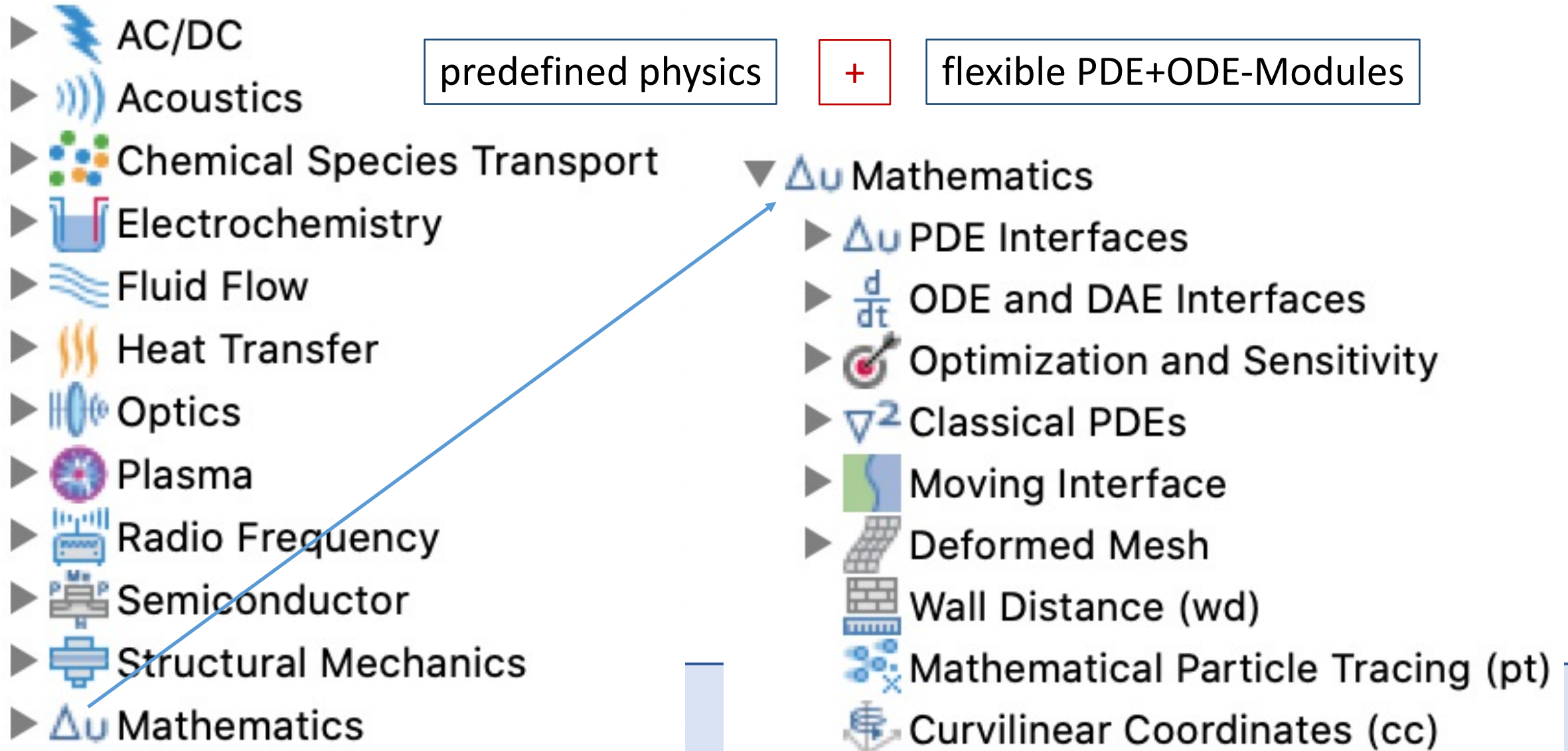
COMSOL Multiphysics

- multi physics → tightly coupled PDEs
e.g.: fluid structure interaction, heat or electrical/magnetic

COMSOL Multiphysics

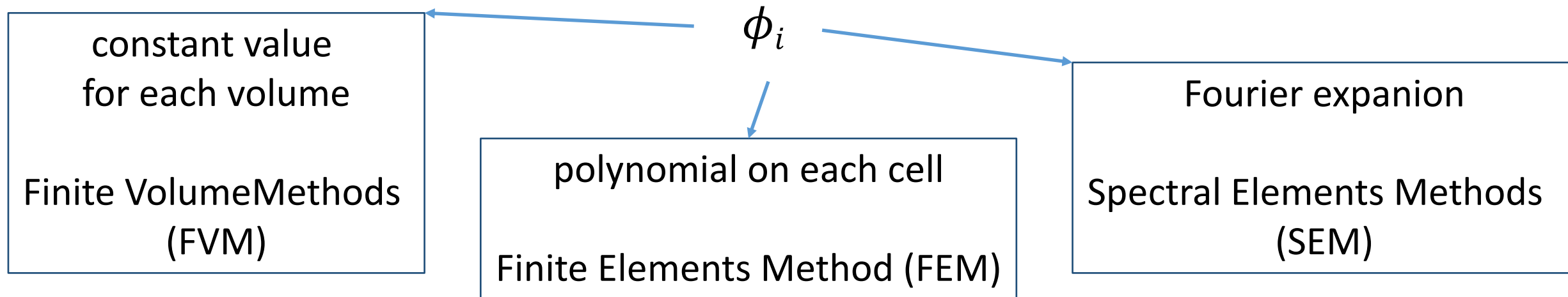
- multi physics → tightly coupled PDEs
e.g.: fluid structure interaction, heat or electrical/magnetic
- COMSOL:
FEM for all types of physics

ANSYS: coupling FVM–FEM
Fluent, cfx ... FVM
Mechanical ... FEM



Why FEM ?

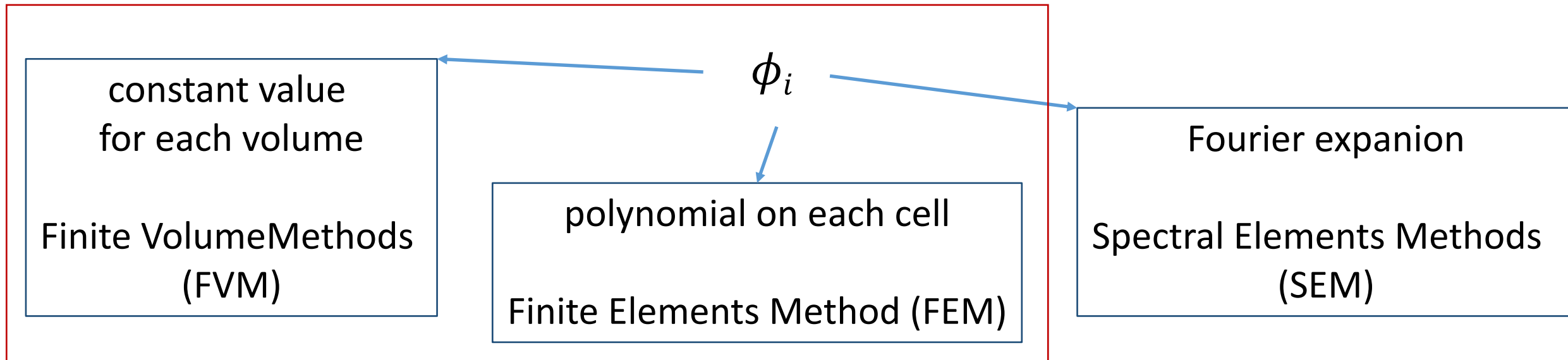
$$P(\partial_x, \partial_t)u = F, u_0 = f, Bu = g, \text{ assumption : } u \approx u = \sum u_i \phi_i$$



mathematical model & governing equations —> precision

Why FEM ?

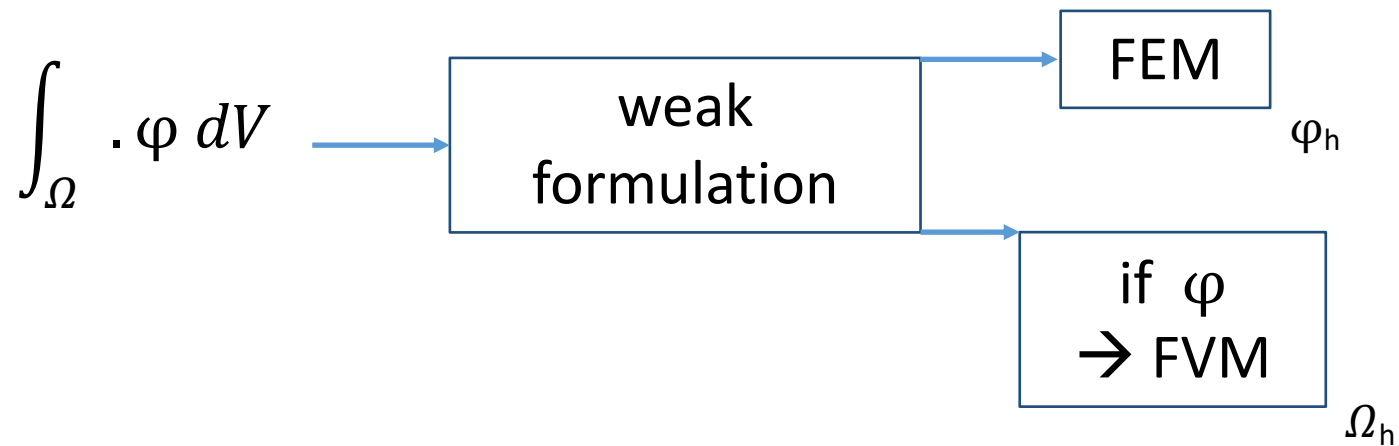
$$P(\partial_x, \partial_t)u = F, u_0 = f, Bu = g, \text{ assumption : } u \approx u = \sum u_i \phi_i$$



mathematical model & governing equations —> precision

$$\partial_t u + \partial_x \Gamma = F \quad \text{in } \Omega$$

u ... conserved quantity
 Γ ... flux, Ω ... volume

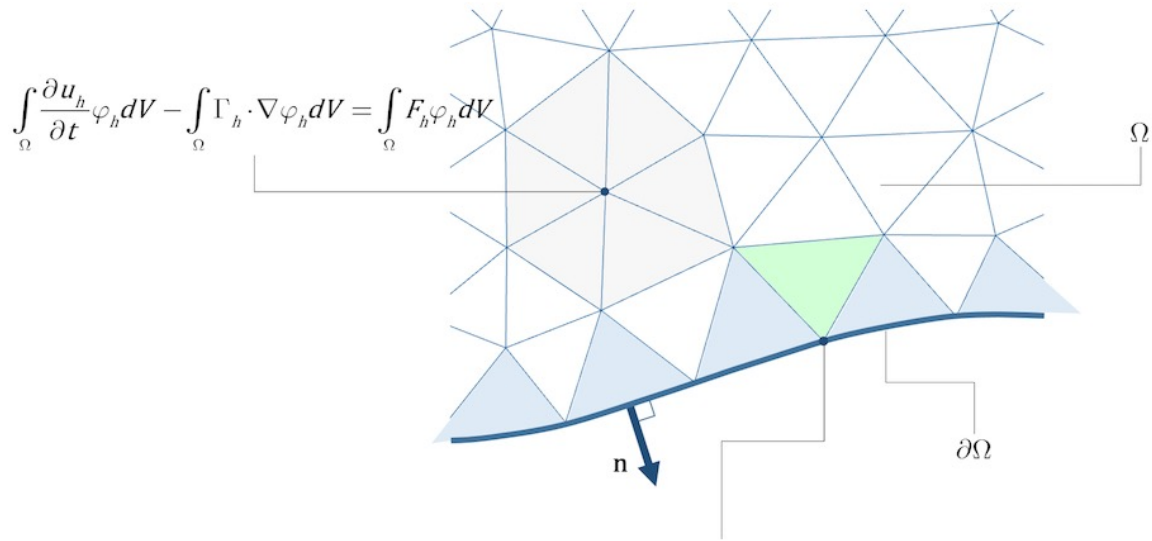


see <https://www.comsol.de/blogs/fem-vs-fvm/>

Conservation Law: The sum of all drawbacks stays constant.

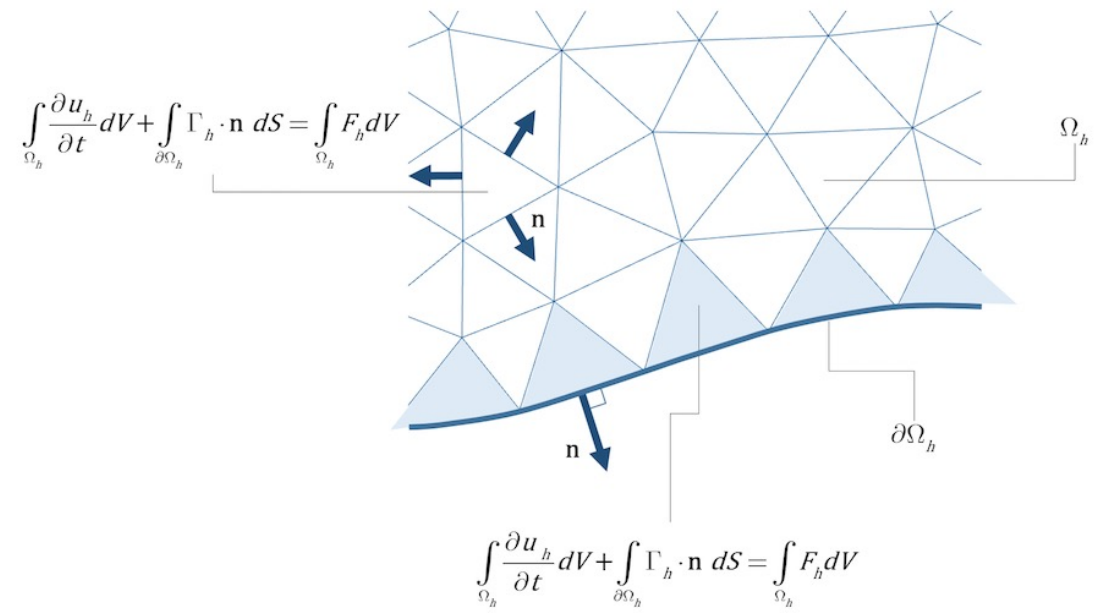
FEM and FVM

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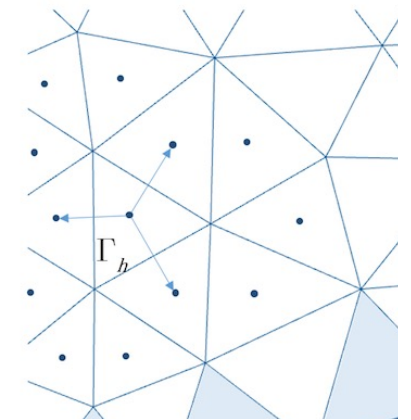
$$\int_{\Omega} \frac{\partial u_h}{\partial t} \varphi_h dV - \int_{\Omega} \Gamma_h \cdot \nabla \varphi_h dV + \int_{\partial\Omega} \Gamma_h \cdot \mathbf{n} \varphi_h dS = \int_{\Omega} F_h \varphi_h dV$$

FEM



$$\int_{\Omega_h} \frac{\partial u_h}{\partial t} dV + \int_{\partial\Omega_h} \Gamma_h \cdot \mathbf{n} dS = \int_{\Omega_h} F_h dV$$

FVM



Conservation Law: The sum of all drawbacks stays constant.

FEM:

higher order → straight forward
→ adaptive mesh refinement

unphysical oscillation

conservation:
globally satisfied

locally:

with continuous functions not satisfied
COMSOL → discontinuous Galerkin (DG)

FVM:

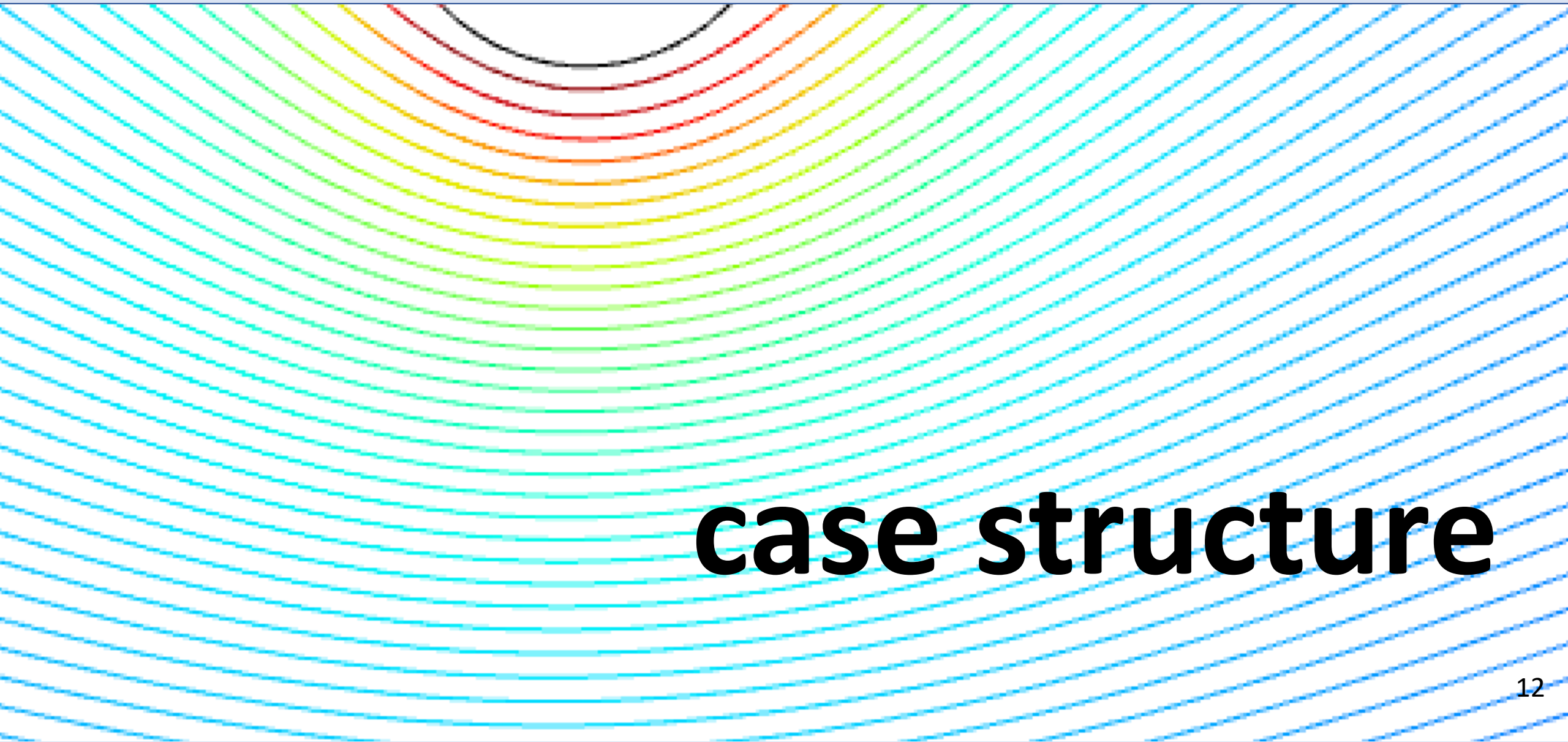
higher order:
method becomes less local

high numerical diffusion

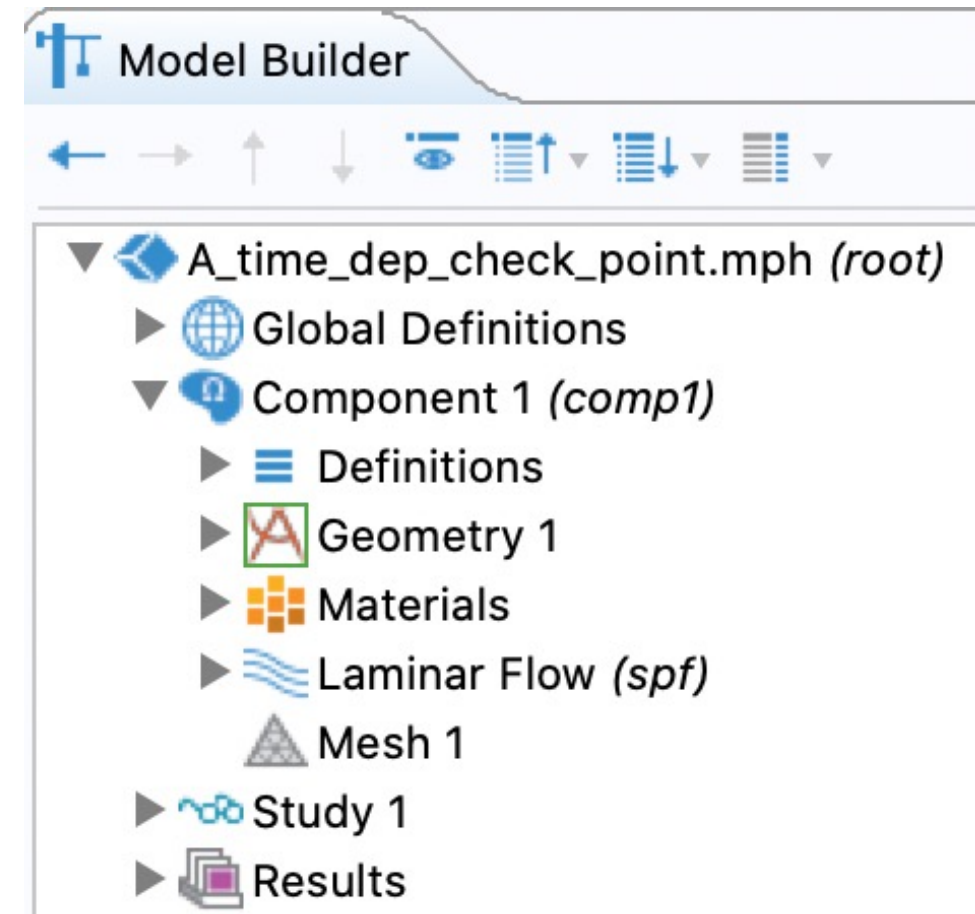
conservation:

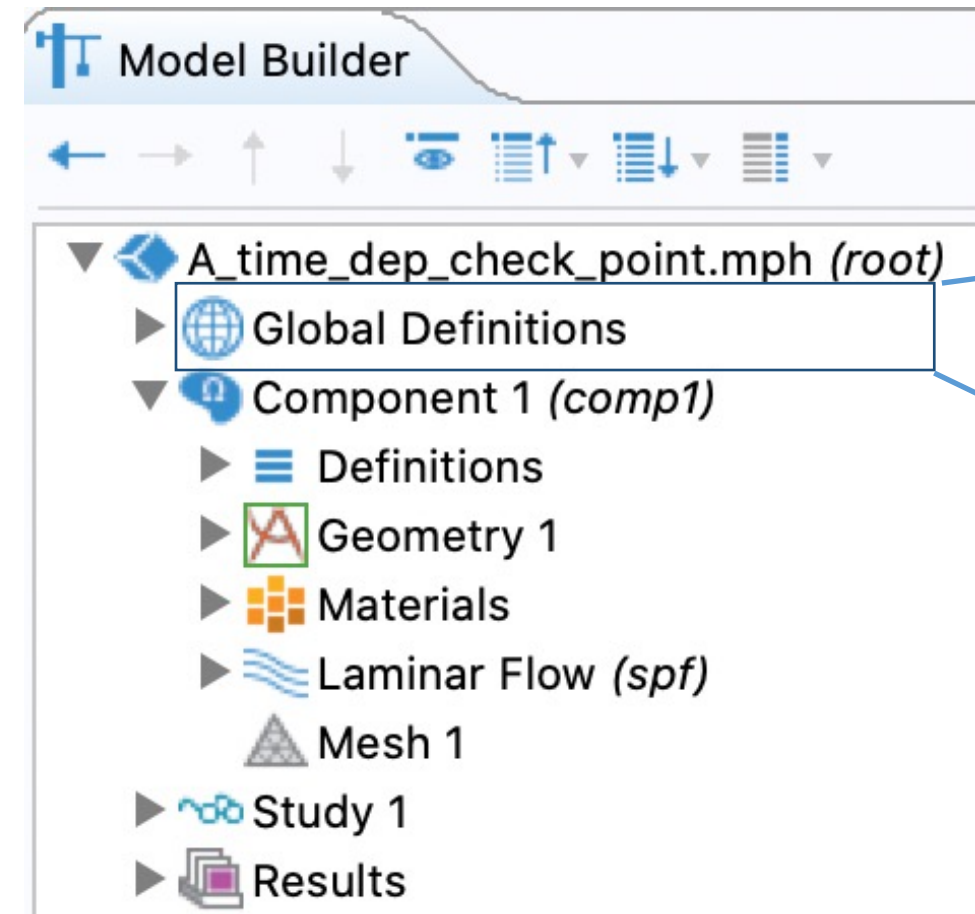
by default locally satisfied

Conservation Law: The sum of all drawbacks stays constant.



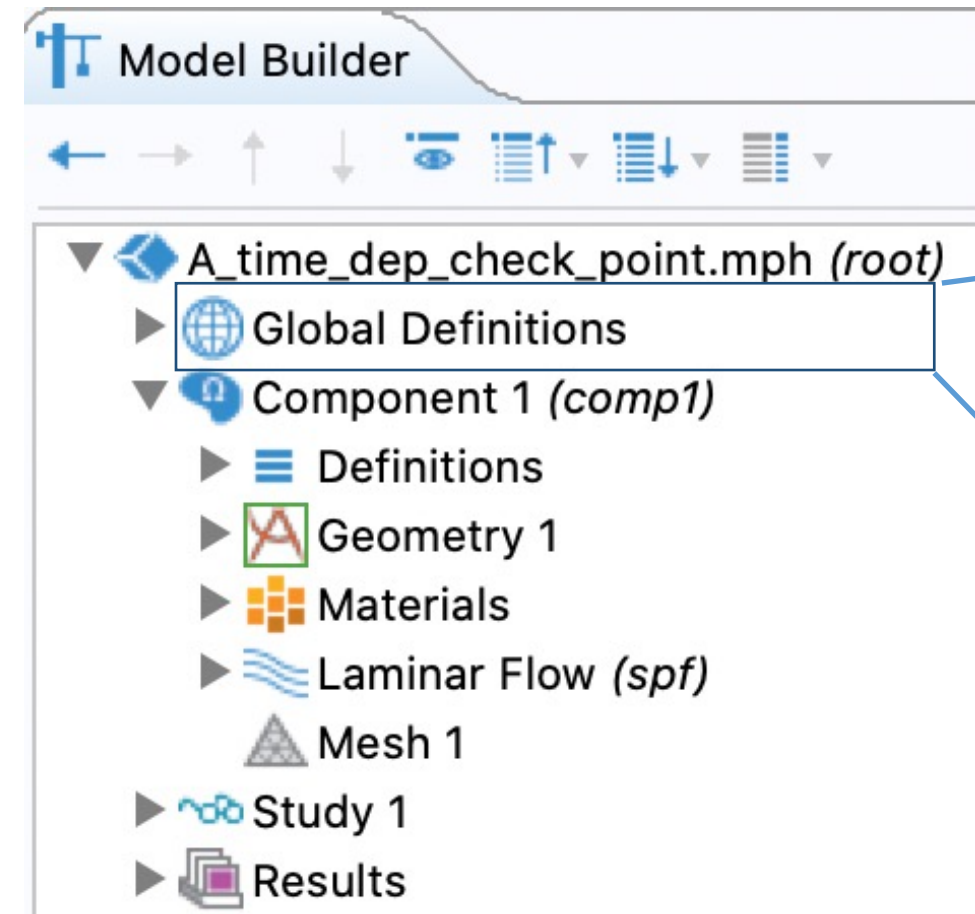
case structure





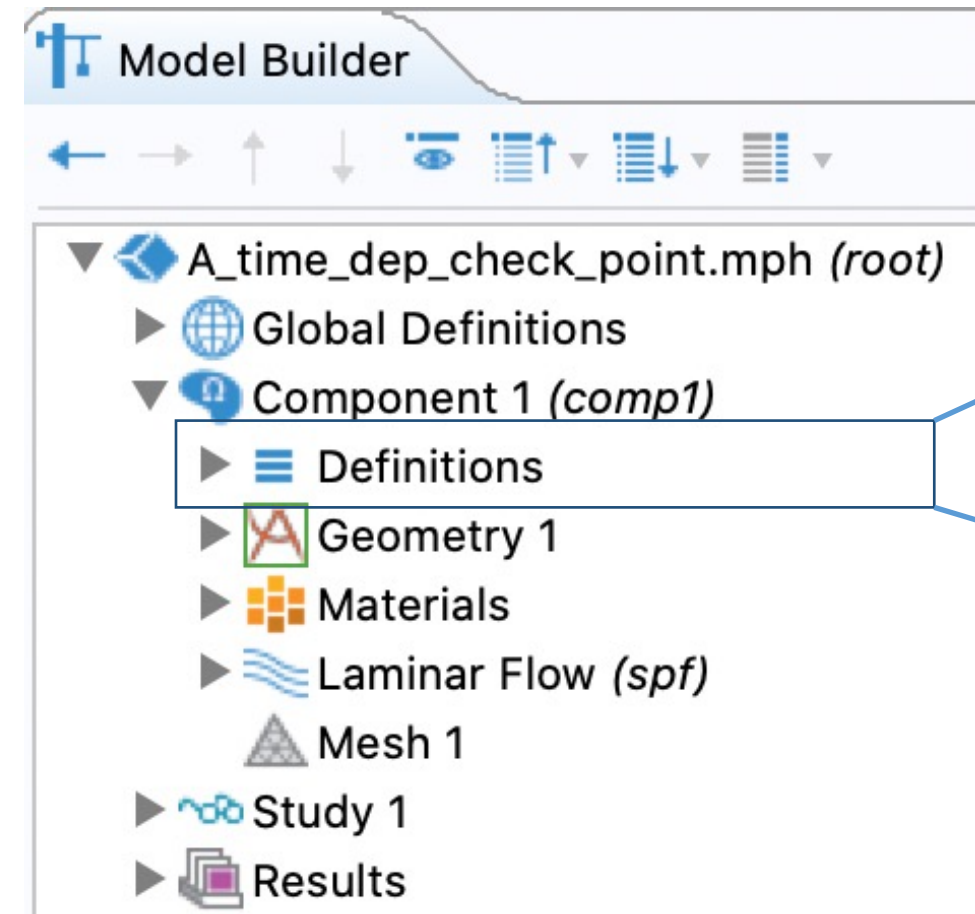
right click on headline

- to see options



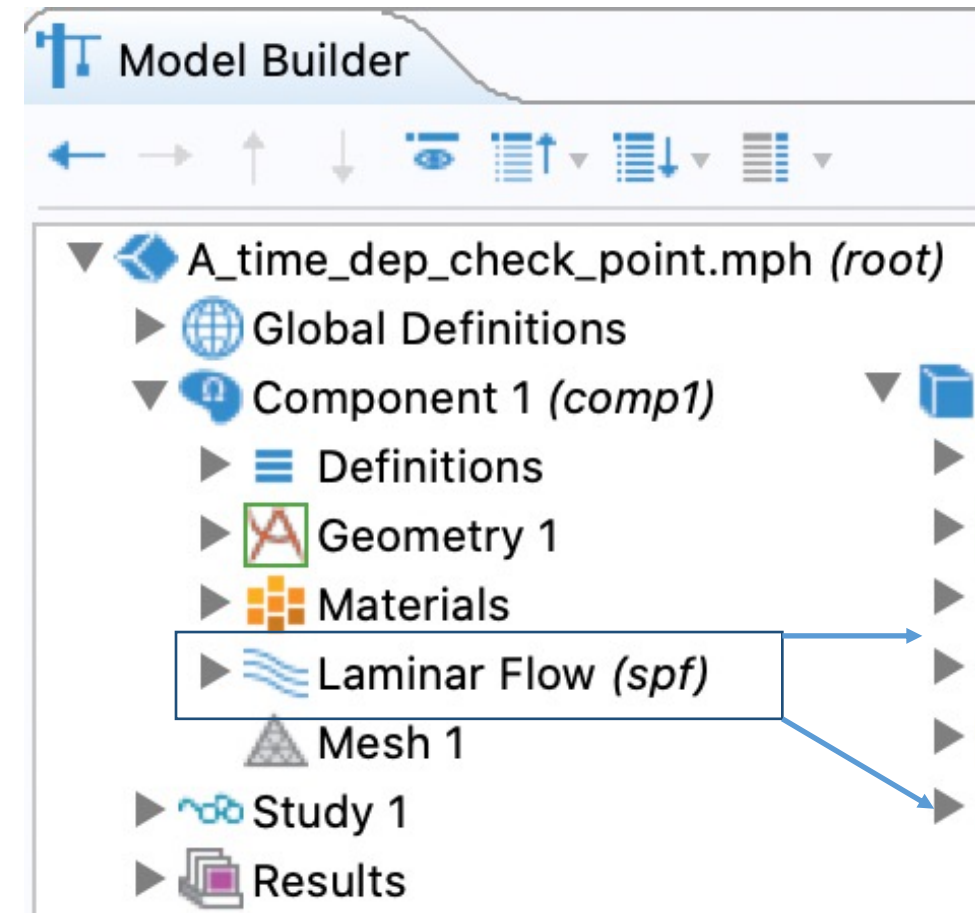
globally available

- parameters
- variables
- functions
- materials



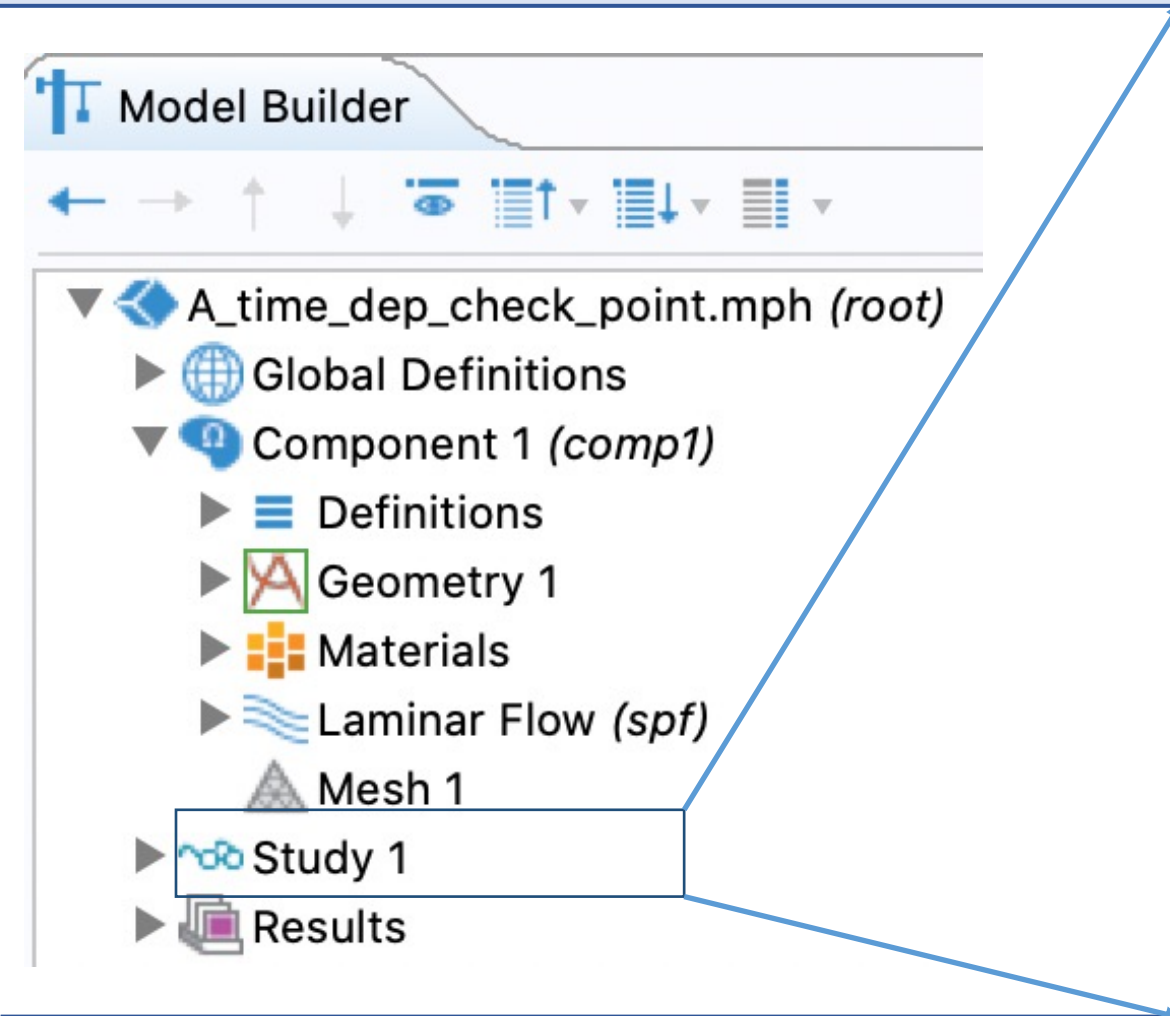
**definitions available
to comp1**

probes, contact areas, ...



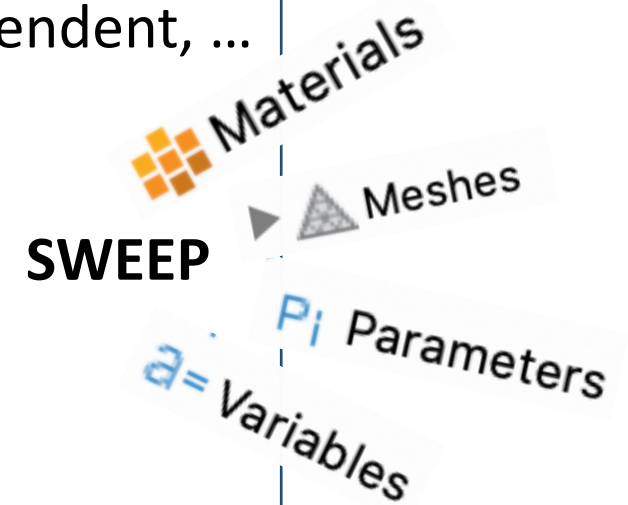
(multi-)physics

respective boundary,
initial conditions, ...



compute

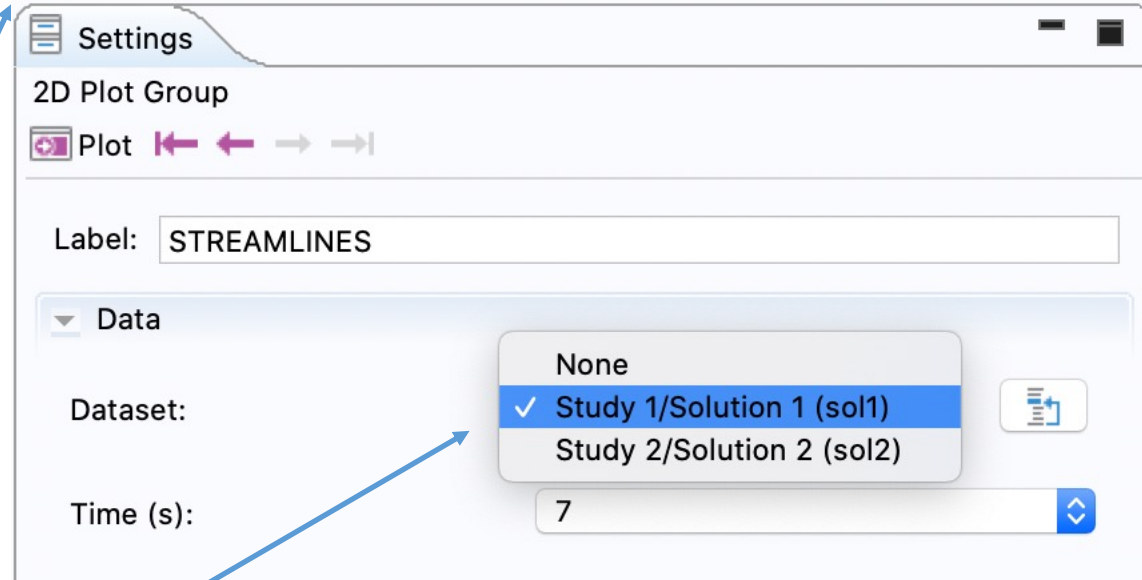
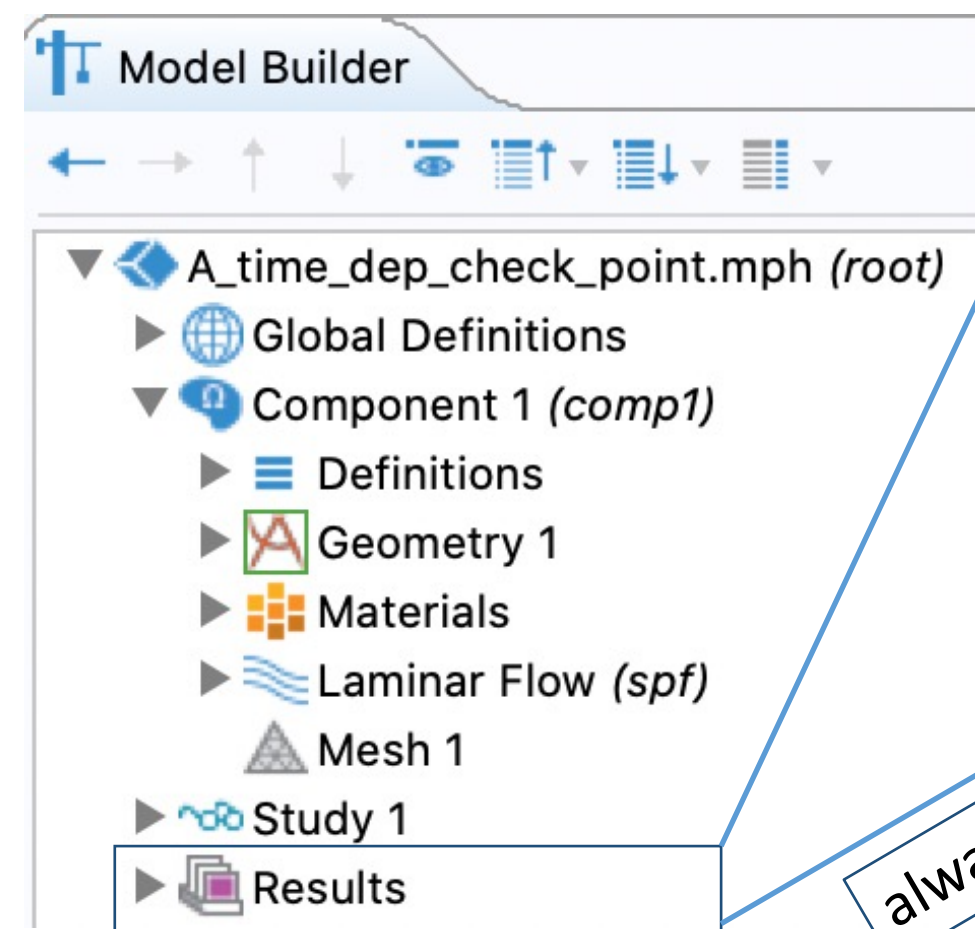
- stationary, time-dependent, ...
- $A = 3, 3.2, 3.4, \dots$
- modify boundary conditions, solver config, ...



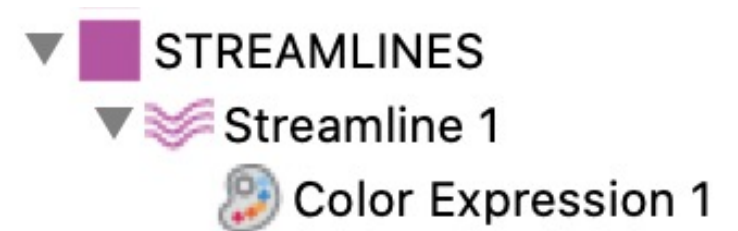
Show Default Solver

Case structure

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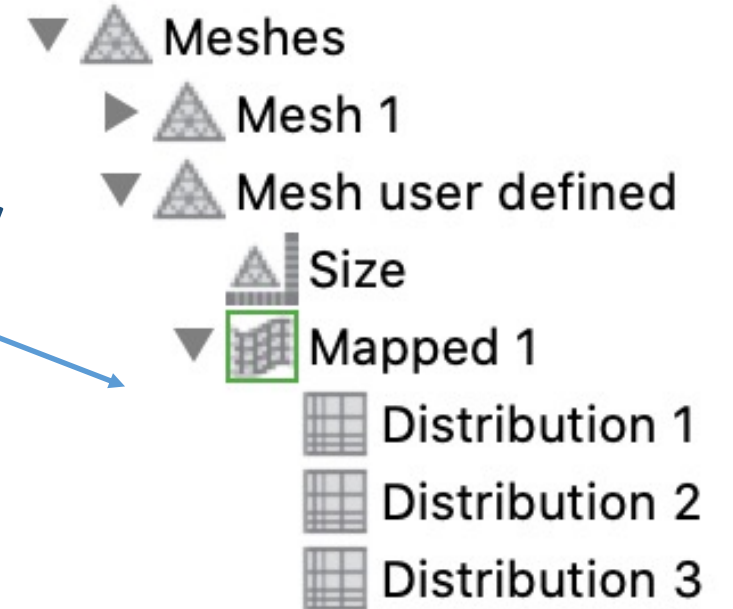


always refer to study



Trees

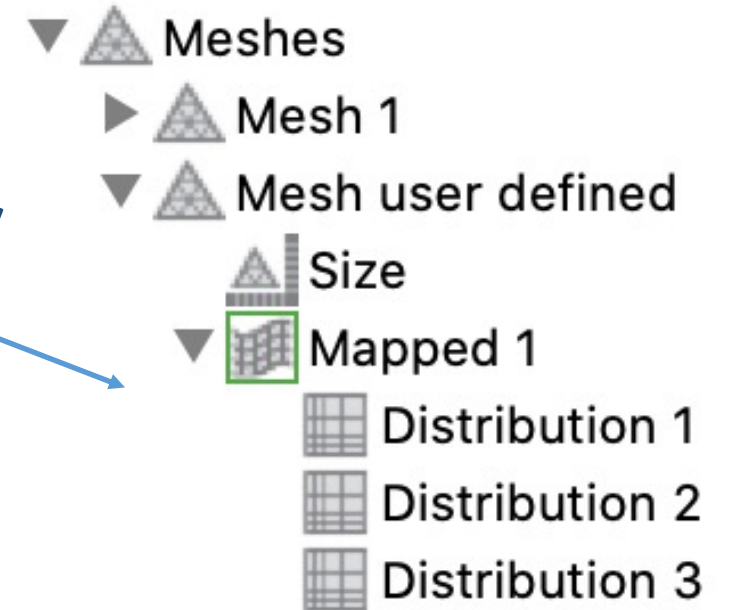
further options → sub - menus



Trees



further options → sub - menus









2D Plot Group 6

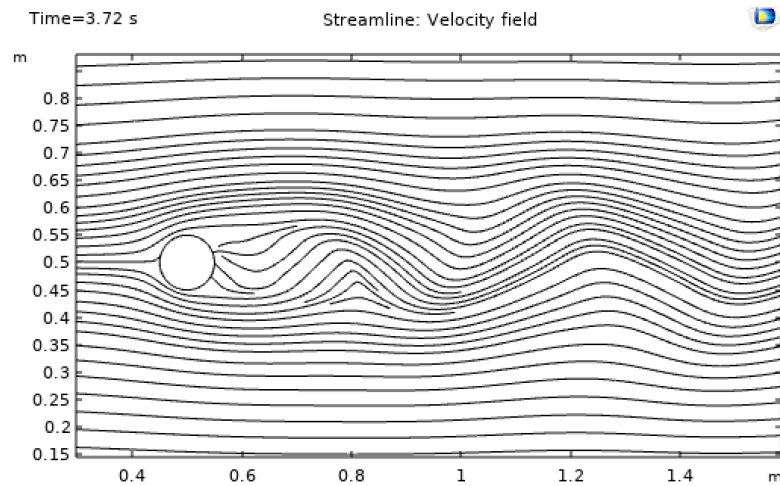


Trees

further options → sub - menus




- ▼  STREAMLINES
- ▼  Streamline 1









- ▼  Meshes
 - ▶  Mesh 1
 - ▼  Mesh user defined
 -  Size
 - ▼  Mapped 1
 -  Distribution 1
 -  Distribution 2
 -  Distribution 3

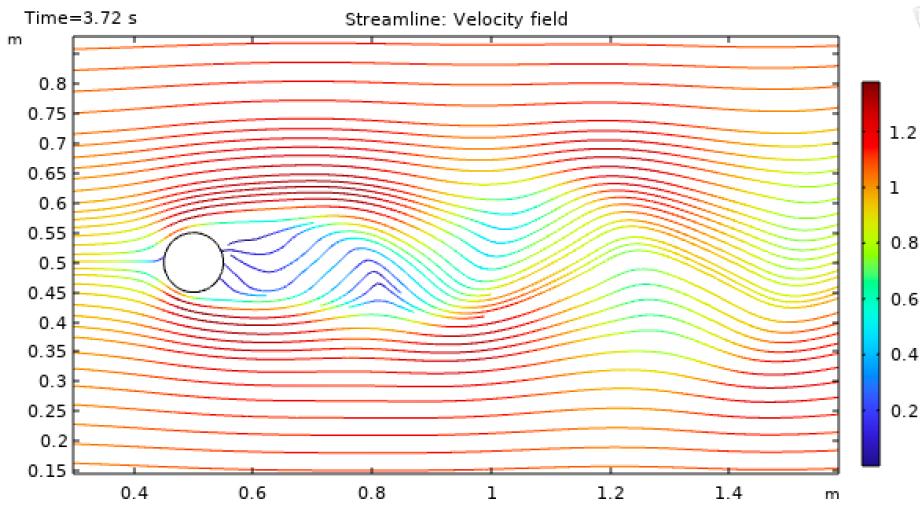


Trees

further options → sub - menus

- ▼  STREAMLINES
- ▼  Streamline 1
-  Color Expression 1

- ▼  Meshes
- ▶  Mesh 1
- ▼  Mesh user defined
-  Size
- ▼  Mapped 1
-  Distribution 1
-  Distribution 2
-  Distribution 3















Case structure

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Trees

further options → sub - menus

- ▼  STREAMLINES
- ▼  Streamline 1
-  Color Expression 1 |
-  Surface - p

- ▼  Meshes
- ▶  Mesh 1
- ▼  Mesh user defined
-  Size
- ▼  Mapped 1
-  Distribution 1
-  Distribution 2
-  Distribution 3

