

COMSOL Multiphysics[®], COMSOL Compiler[™] a COMSOL Server[™]



Martin Kožíšek
Produktový manažer
HUMUSOFT



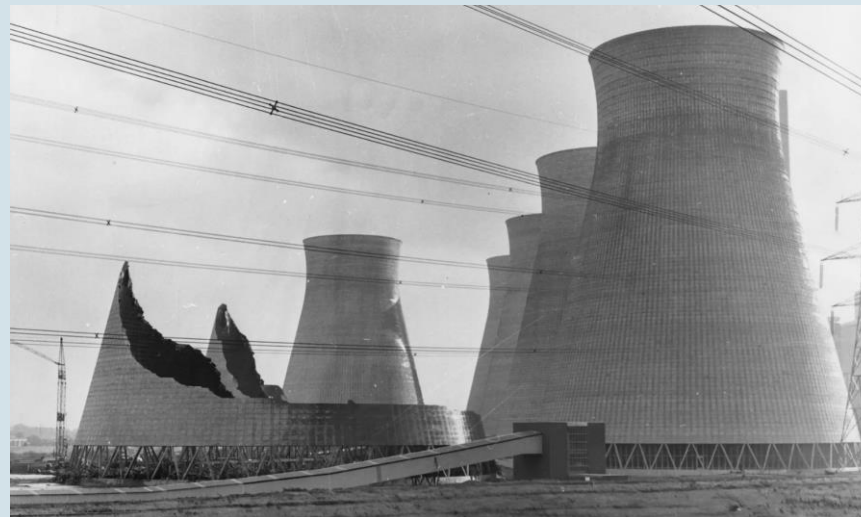
Matouš Lorenc
Aplikační inženýr
HUMUSOFT

Příklad fyzikálního děje

- Elektrárna Ferrybridge
- Inženýrská katastrofa 1.11.1965
- Výpočtáři neuvažovali rozložení věží při výpočtech aeroelasticity
- 28.7.2019 řízený odstřel věží



zdroj videa řízeného odstřelu 28.7.2019: youtube.com

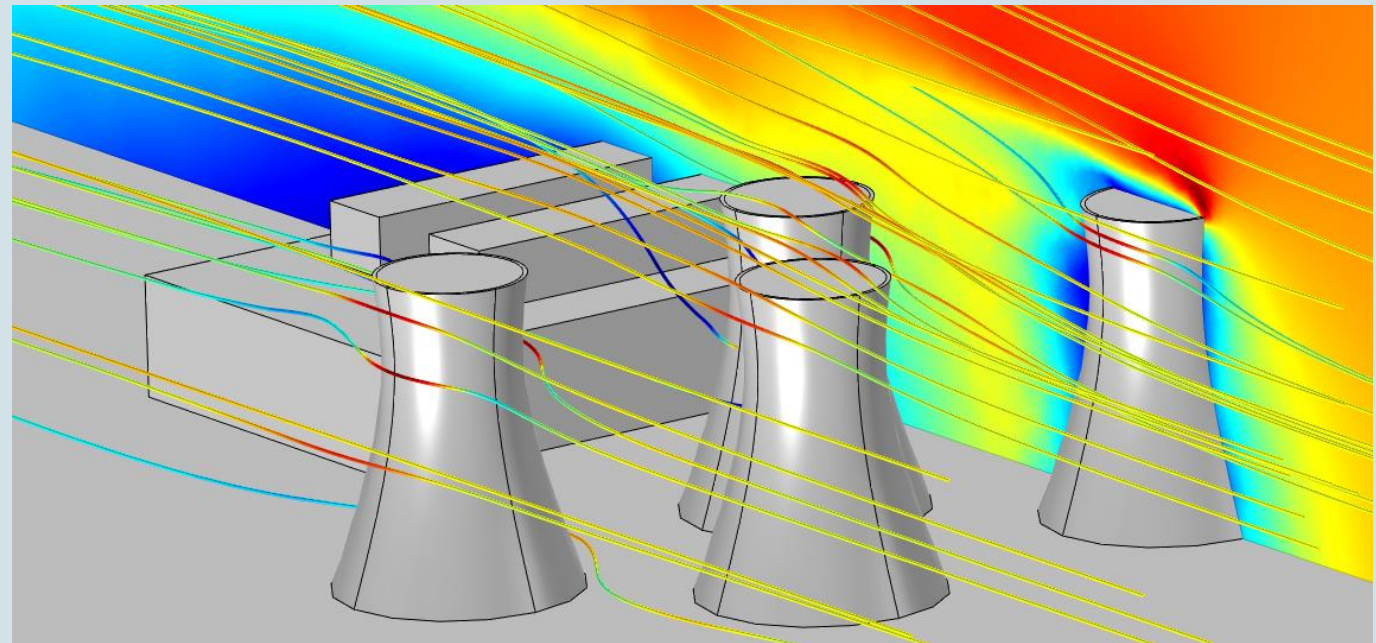
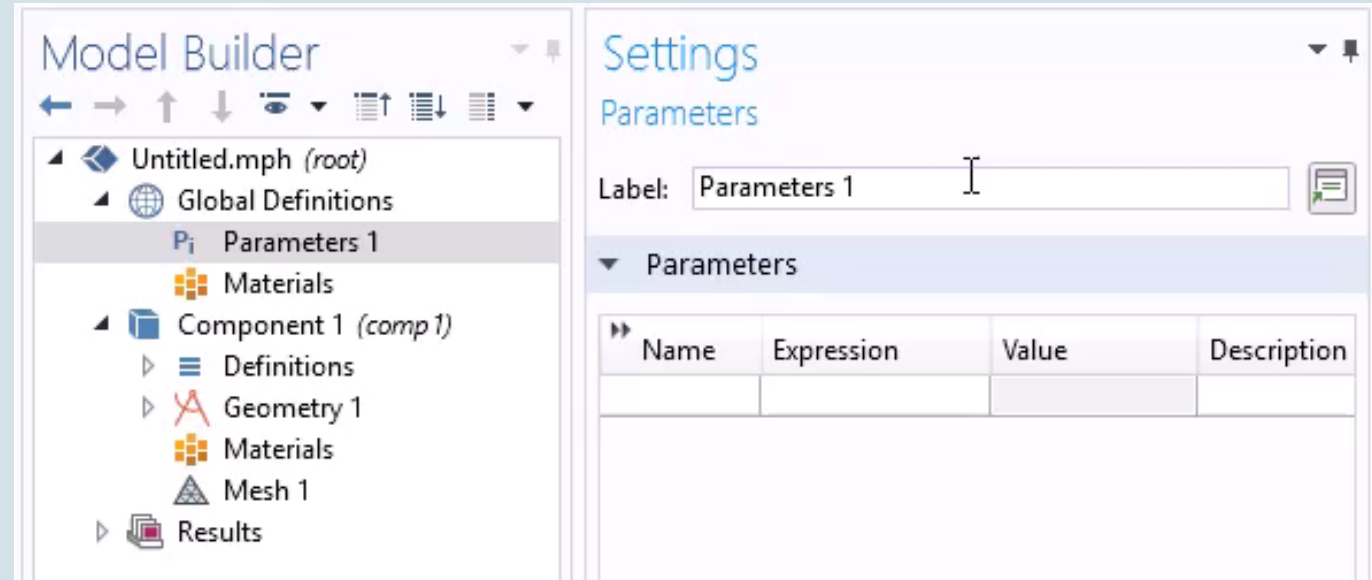


zdroj: wikipedia.com



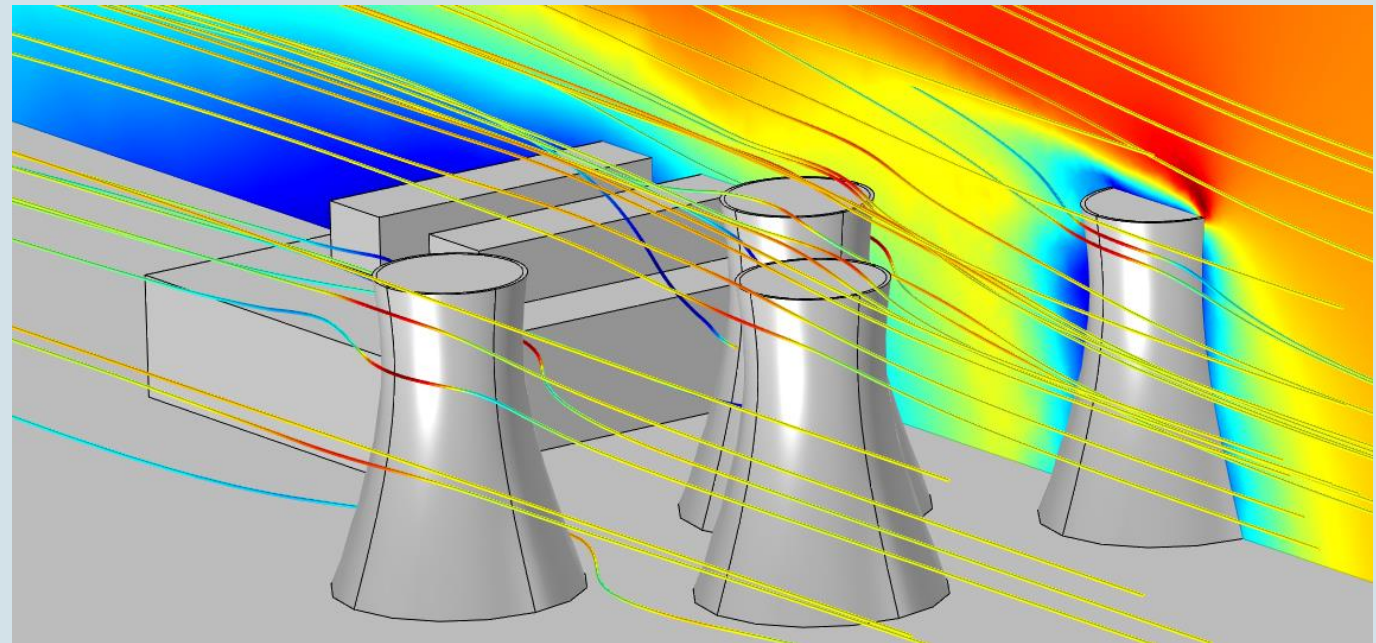
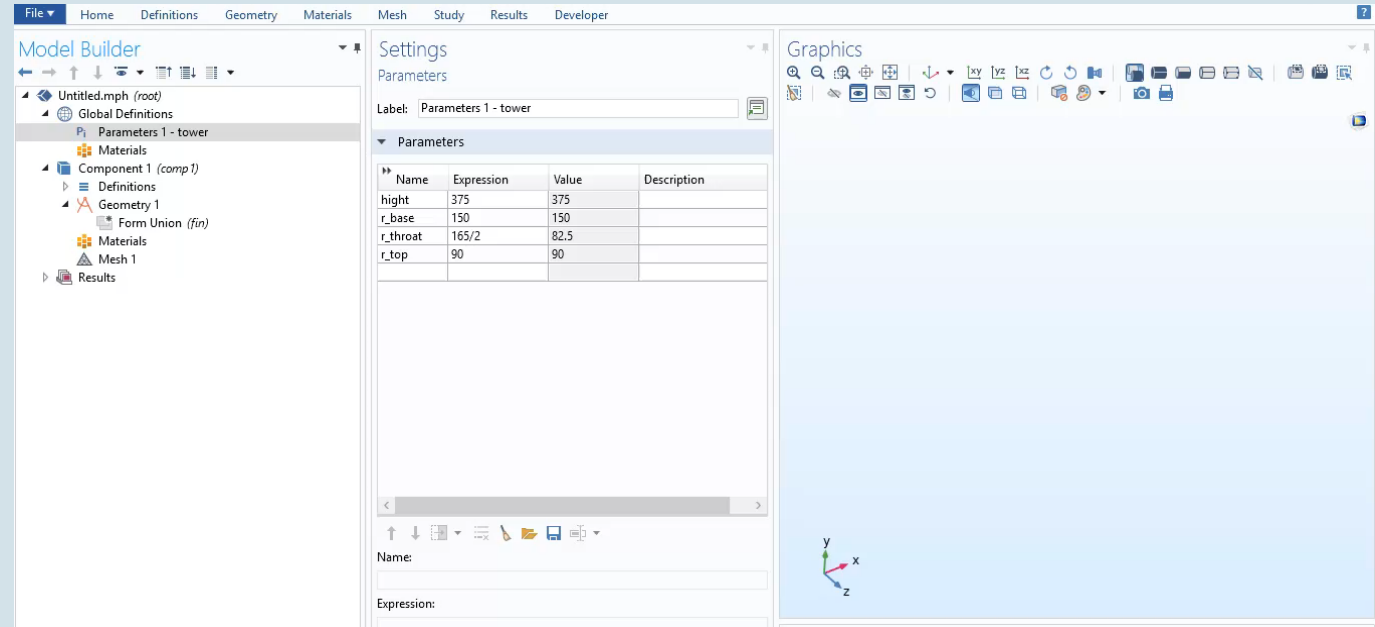
COMSOL Multiphysics®

- Definice parametrů



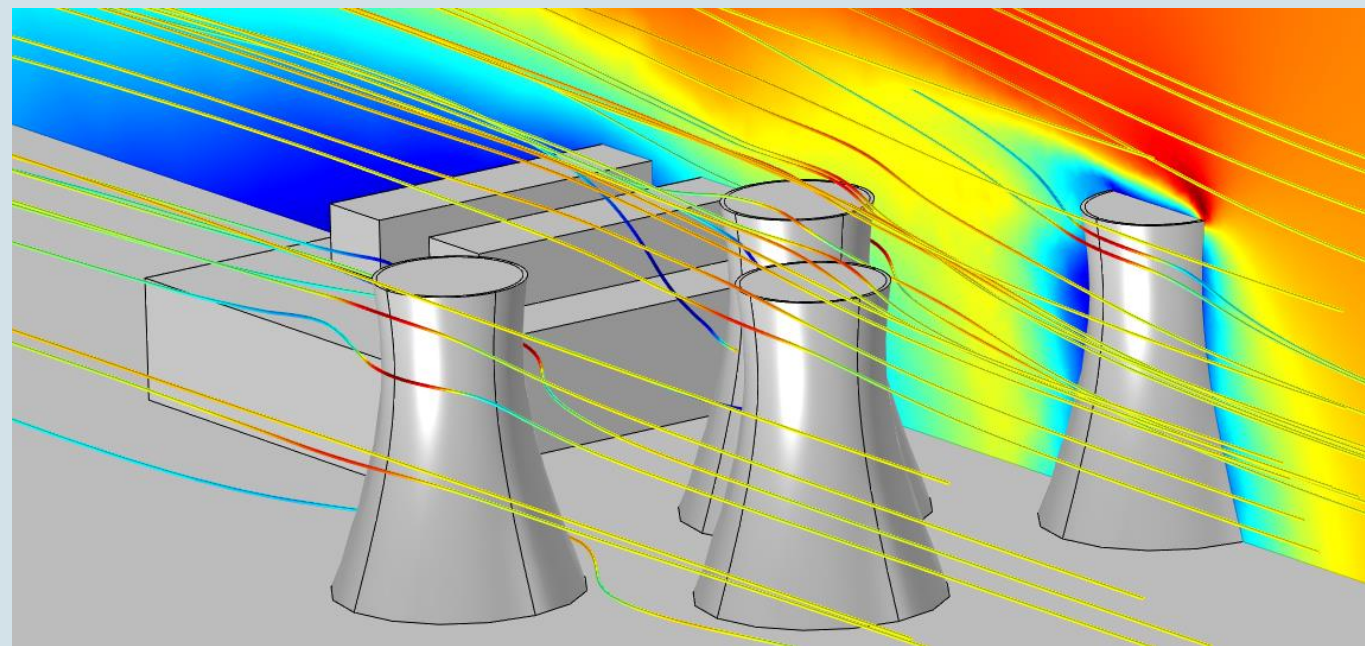
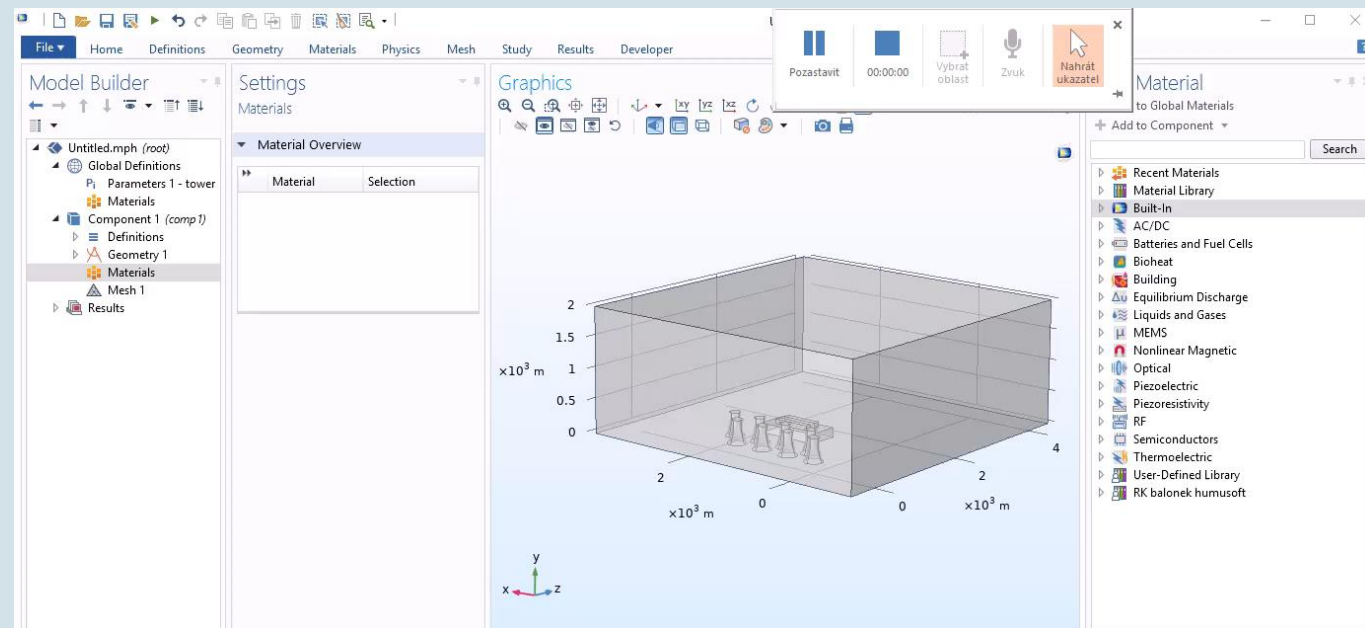
COMSOL Multiphysics®

- Definice parametrů
- Tvorba/import geometrie



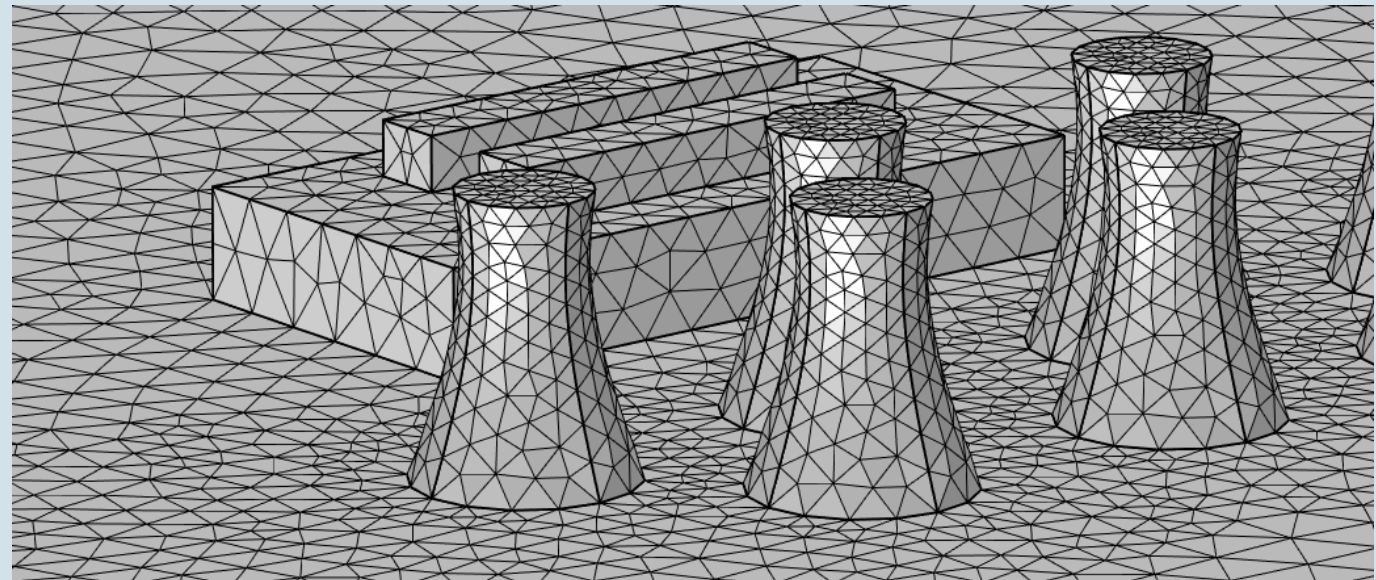
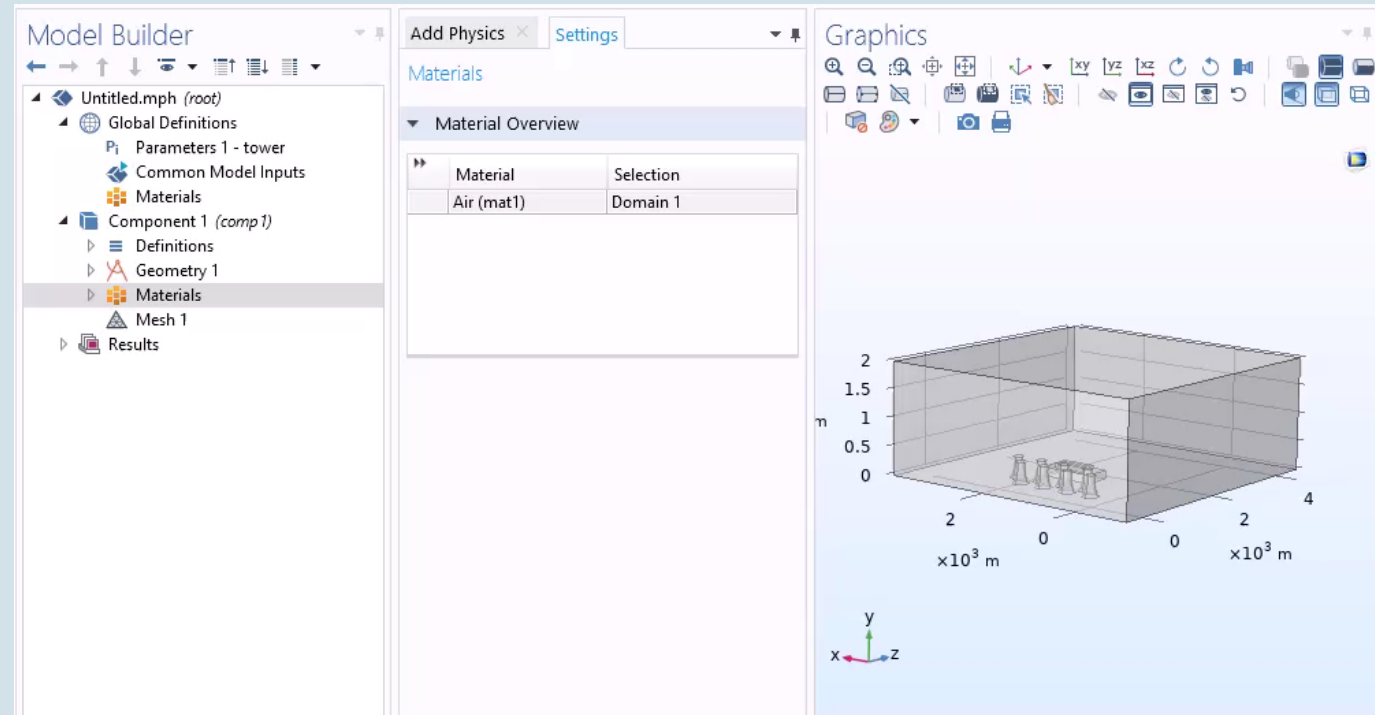
COMSOL Multiphysics®

- Definice parametrů
- Tvorba/import geometrie
- Knihovna materiálů



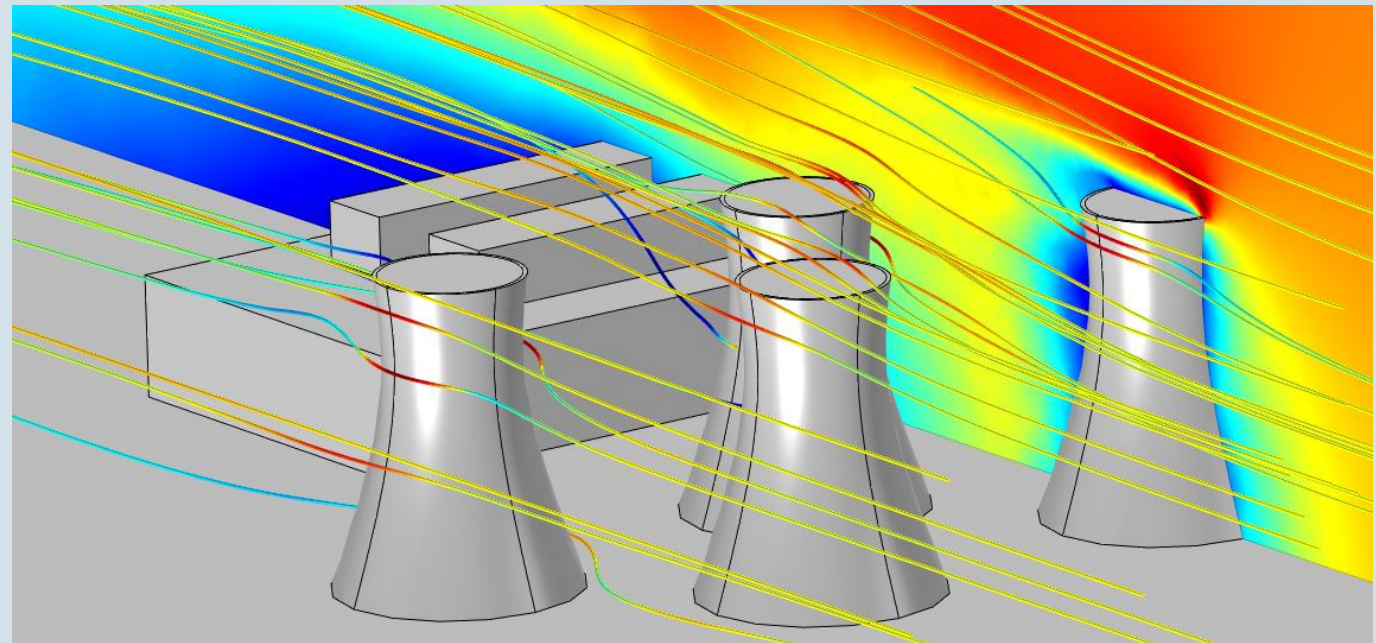
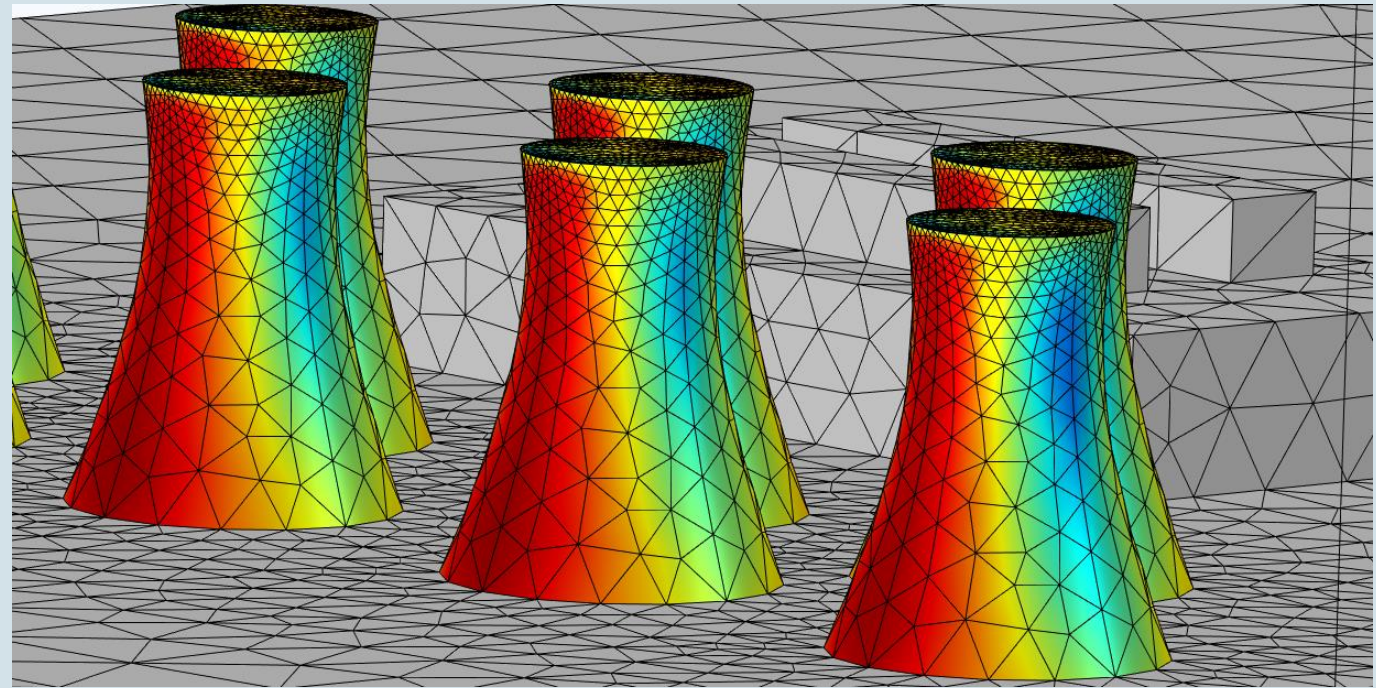
COMSOL Multiphysics®

- Definice parametrů
- Tvorba/import geometrie
- Knihovna materiálů
- Okrajové a počáteční podmínky
- Síťování výpočetní oblasti



COMSOL Multiphysics®

- Definice parametrů
- Tvorba/import geometrie
- Knihovna materiálů
- Okrajové a počáteční podmínky
- Sítování výpočetní oblasti
- Výpočet simulace fyzikálního děje
- Zpracování výsledků

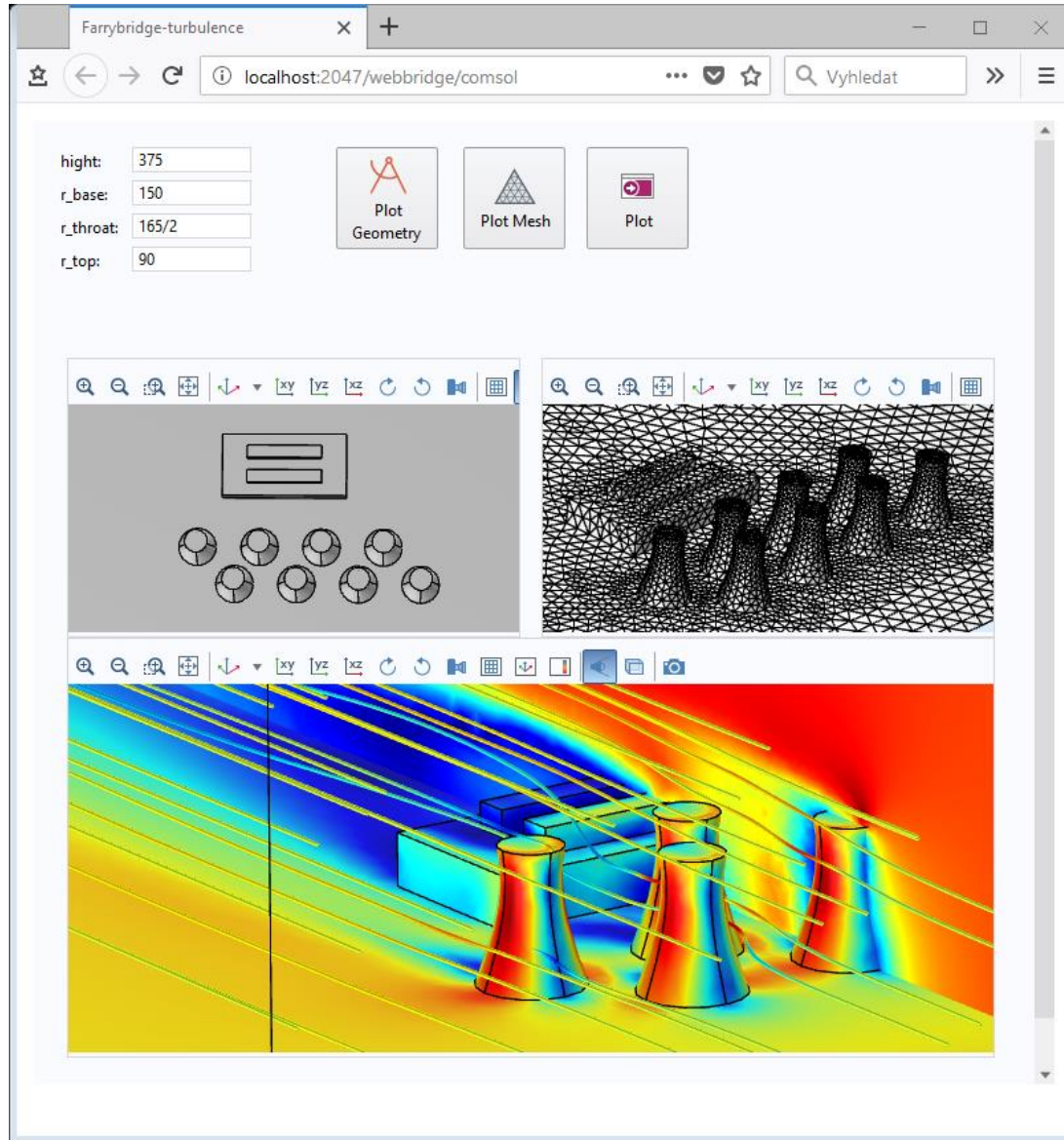


COMSOL Multiphysics®

- Definice parametrů
- Tvorba/import geometrie
- Knihovna materiálů
- Okrajové a počáteční podmínky
- Síťování výpočetní oblasti
- Výpočet simulace fyzikálního děje
- Zpracování výsledků
- Tvorba aplikace

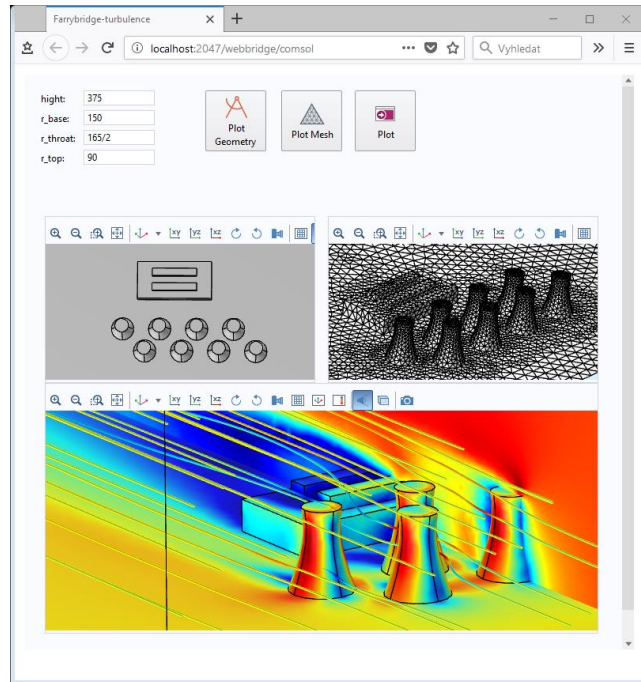
The screenshot displays the COMSOL Multiphysics software interface for a simulation titled "farrybridge-turbulence.mph". The interface is divided into several main sections:

- Model Builder:** A tree view on the left showing the model structure, including Global Definitions, Component 1 (comp1), Study 1, and Results. The "Velocity (spf)" result is selected.
- Settings:** A central panel for configuring the selected result. It includes options for Data set (Study 1/Solution 1 (sol1)), Title, Plot Settings (View: Automatic, Show hidden entities, Propagate hiding to lower dimensions, Plot data set edges), Color Legend (Show legends, Show maximum and minimum values, Show units, Position: Right, Text color: Black), Number Format, and Window Settings.
- 3D Plot:** A 3D visualization of the velocity field (spf) around a complex geometry. The plot shows a color gradient from yellow (low velocity) to red (high velocity). The axes are labeled with 10^3 m. A coordinate system (x, y, z) is visible in the bottom left of the plot area.
- Message Log:** A window at the bottom right showing the simulation progress and log, including messages such as "Finalized geometry has 1 domain, 29 boundaries, 64 edges, and 48 vertices" and "Solution time (Study 1): 2207 s. (36 minutes, 47 seconds)".



COMSOL Server™

- Sdílení aplikace přes webové rozhraní
- Server běží u vás na počítači
- Komu vygenerujete heslo, ten může ovládat aplikace
- Aplikace pro mobilní telefony



COMSOL Compiler™

- Aplikace kompilovaná s RunTime knihovnamí COMSOL Multiphysics
- Vytvoří stand-alone program pro simulaci dané úlohy
- Vygenerujete licenční soubor
- Prodáte program pro výpočet obtékání elektrárny

COMPILE and DISTRIBUTE multiple apps
with COMSOL Compiler™

RUN simulation apps
on any machine



Equation

Show equation assuming:
Study 1, Time Dependent

$$e_a \frac{\partial^2 \mathbf{u}}{\partial t^2} + d_a \frac{\partial \mathbf{u}}{\partial t} + \nabla \cdot \Gamma = f$$

$$\mathbf{u} = [u_1, u_2]^T$$

$$\nabla = \left[\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right]$$

Conservative Flux

-u1x	x
-u1y	y
-u1z	z

Γ

0	x
0	y
0	z

Source Term

f

(alpha-u1)*(u1-1)*u1-u2
epsilon*(beta*u1-gamma*u2-delta)

Damping or Mass Coefficient

1	0
0	1

Mass Coefficient

0	0
0	0

Mathematics

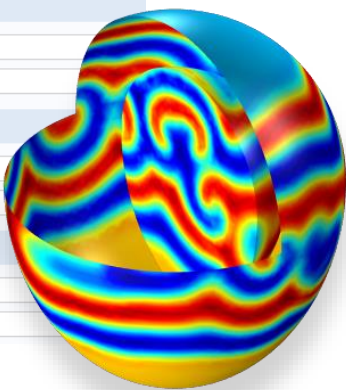
- PDE Interfaces
- ODE and DAE Interfaces
- Optimization and Sensitivity
- Classical PDEs
- Moving Interface
- Deformed Mesh
- Wall Distance (wd)
- Mathematical Particle Tracing (pt)
- Curvilinear Coordinates (cc)

Show equation assuming:

$0 = \int_{\Omega} \text{weak} \partial v$

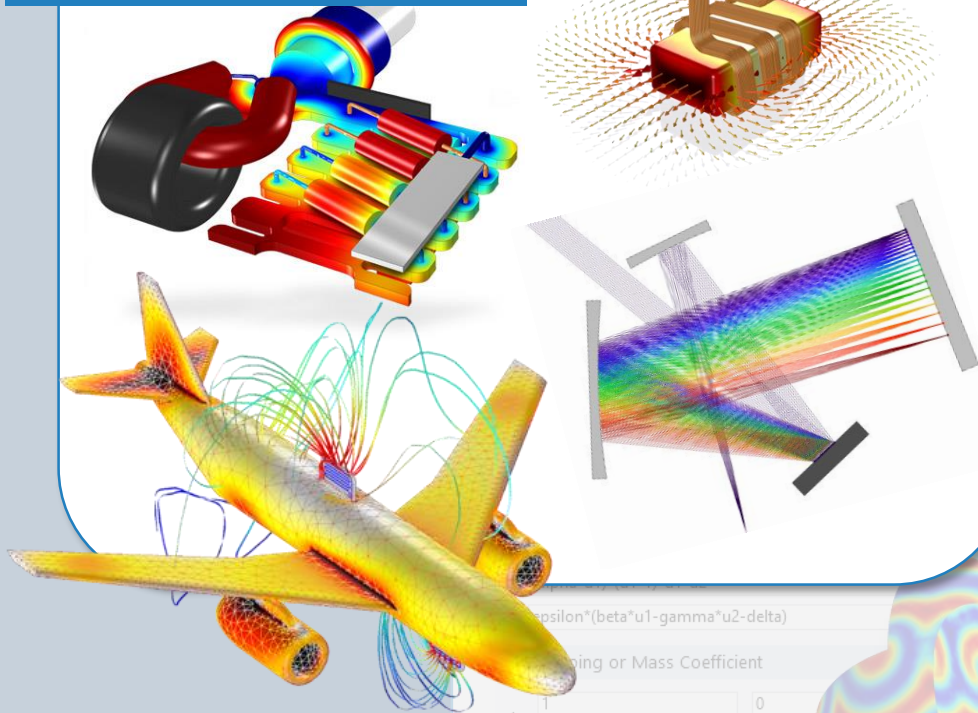
Weak Expressions

weak -test(ux)*ux-test(uy)*uy-test(uz)*uz+1[m^-2]*test(u)



Vlastní PDR / ODR

Elektromagnetismus



Mathematics

- FE Interfaces
- FE and DAE Interfaces
- Optimization and Sensitivity
- Classical PDEs
- Moving Interface
- Preformed Mesh
- Ball Distance (wd)
- Mathematical Particle Tracing (pt)
- Curvilinear Coordinates (cc)

Equation assuming:

$\int_{\Omega} \text{weak } \partial \nu$

Weak Expressions

Weak -test(ux)*ux-test(uy)*uy-test(uz)*uz+1[m^-2]*test(u)

$\epsilon \text{epsilon}^*(\beta \text{beta}^* u_1 - \gamma \gamma^* u_2 - \delta \delta)$

Scaling or Mass Coefficient

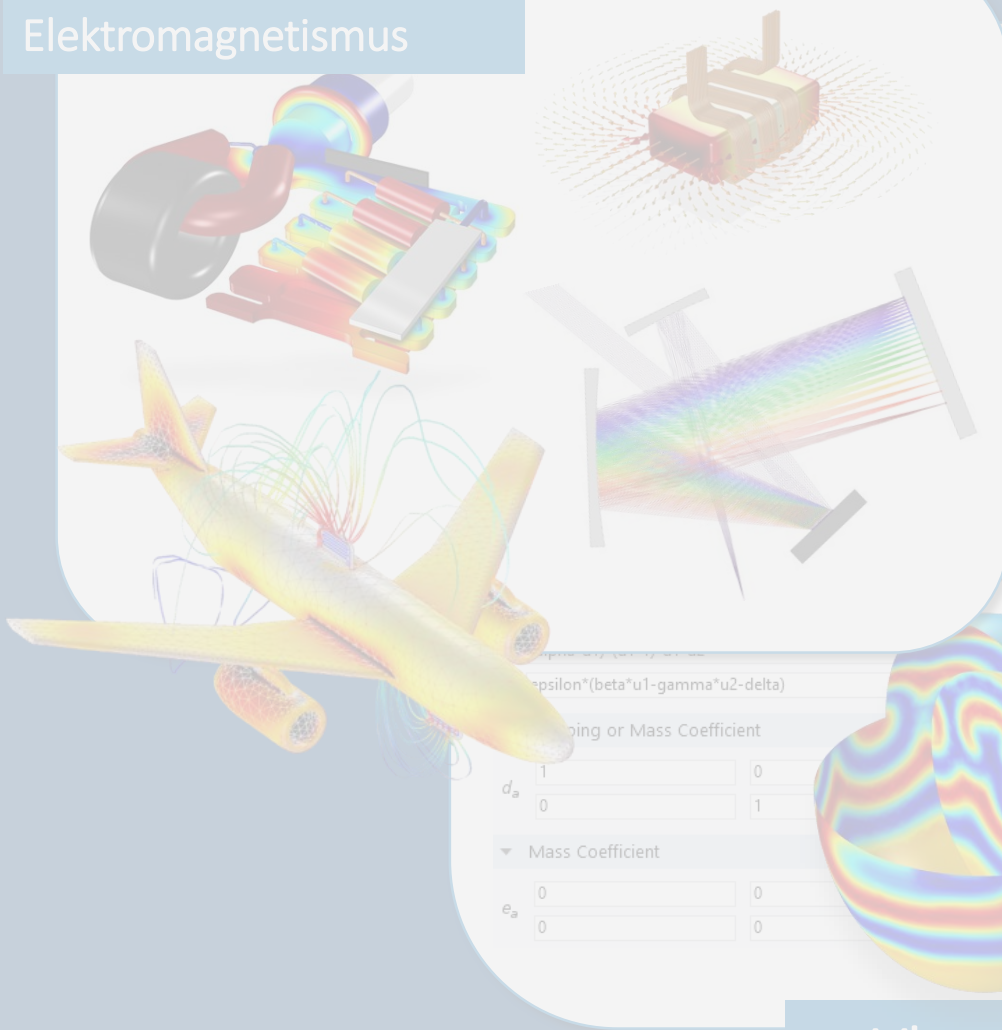
d_a	1	0
	0	1

Mass Coefficient

e_a	0	0
	0	0

Vlastní PDR / ODR

Elektromagnetismus



$\epsilonpsilon(\beta \cdot u_1 - \gamma \cdot u_2 - \delta)$

Spring or Mass Coefficient

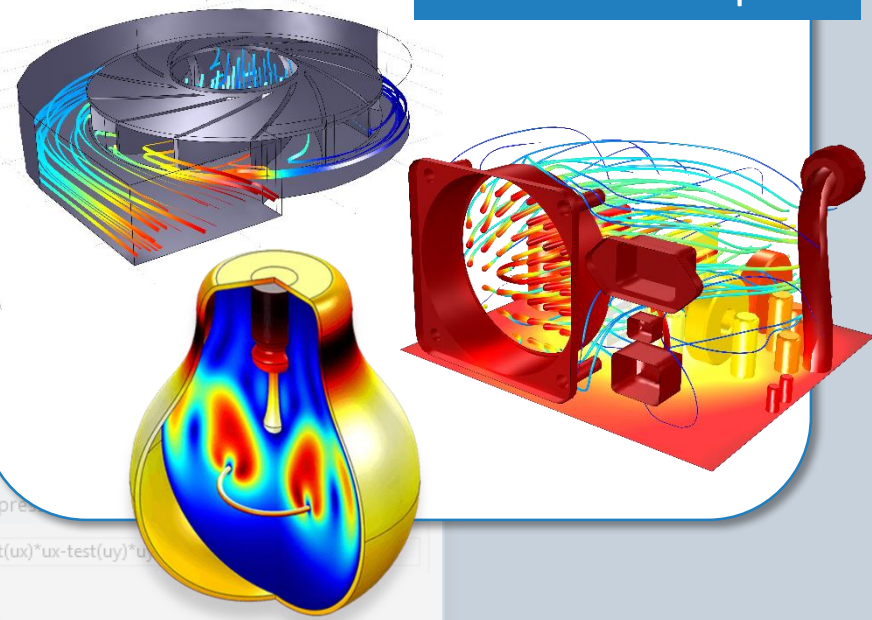
d_a	1	0
	0	1

Mass Coefficient

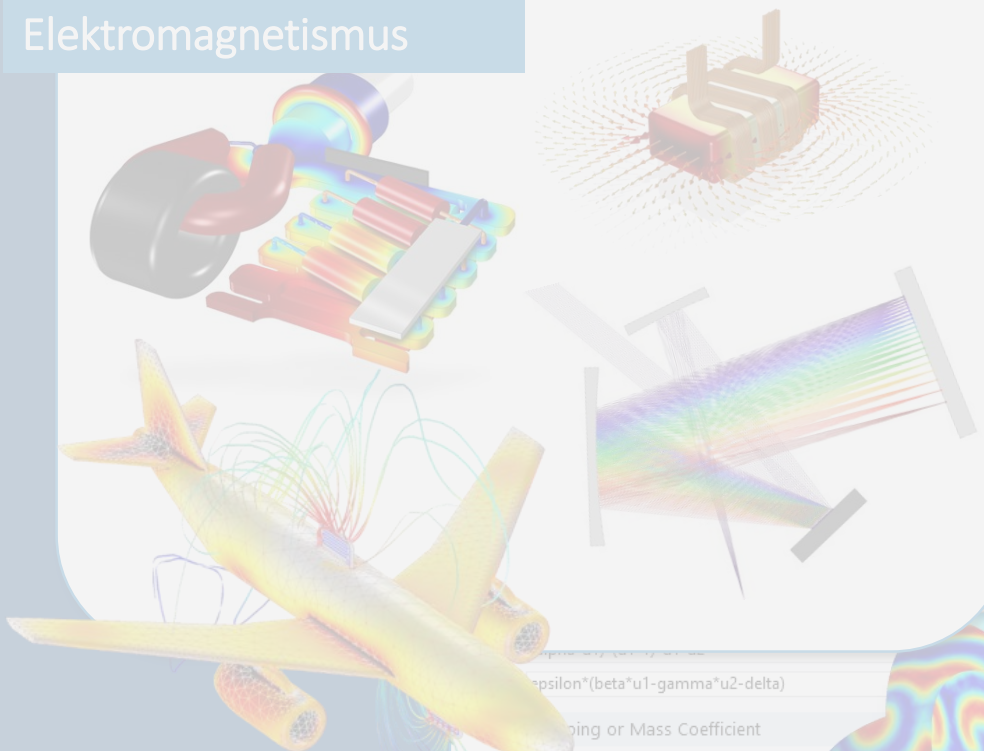
e_a	0	0
	0	0

Vlastní PDR / ODR

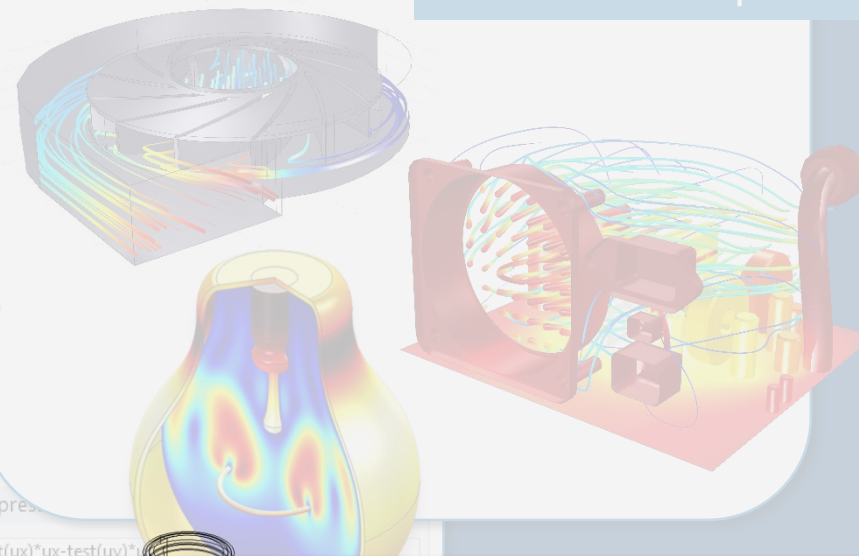
Proudění a teplo



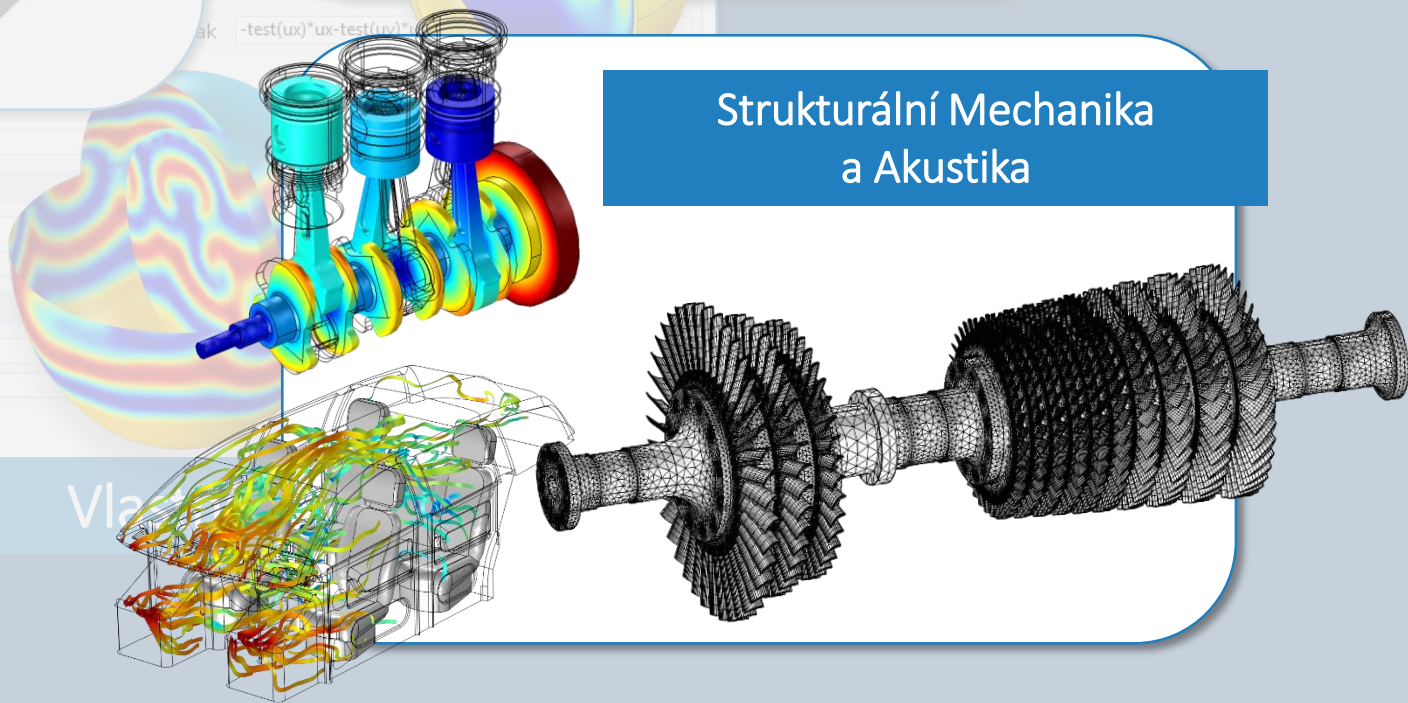
Elektromagnetismus



Proudění a teplo



Strukturální Mechanika a Akustika



Vla

$\epsilon = \epsilon_0 \cdot \epsilon_r$

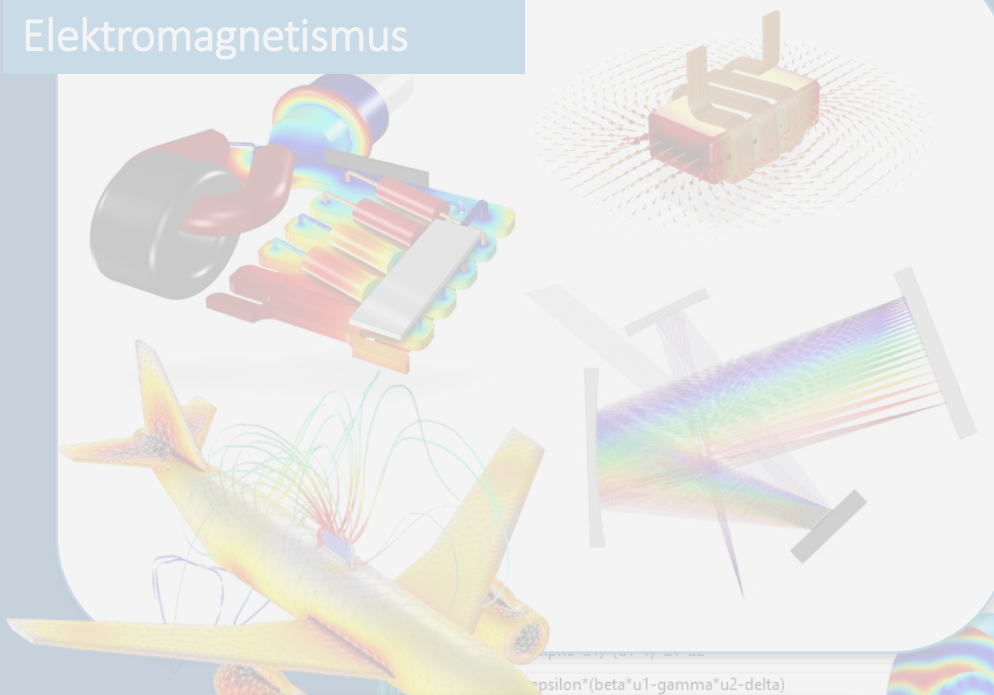
Scaling or Mass Coefficient

d_a	1	0
	0	1

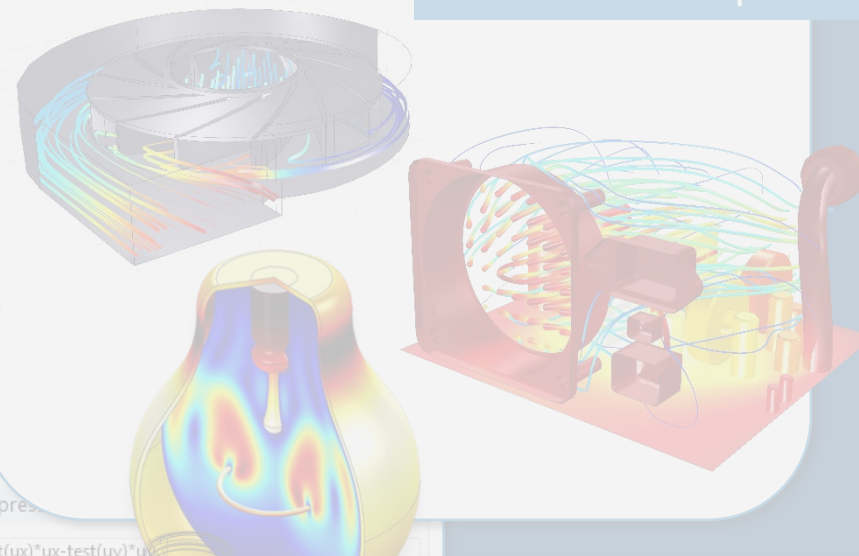
Mass Coefficient

e_a	0	0
	0	0

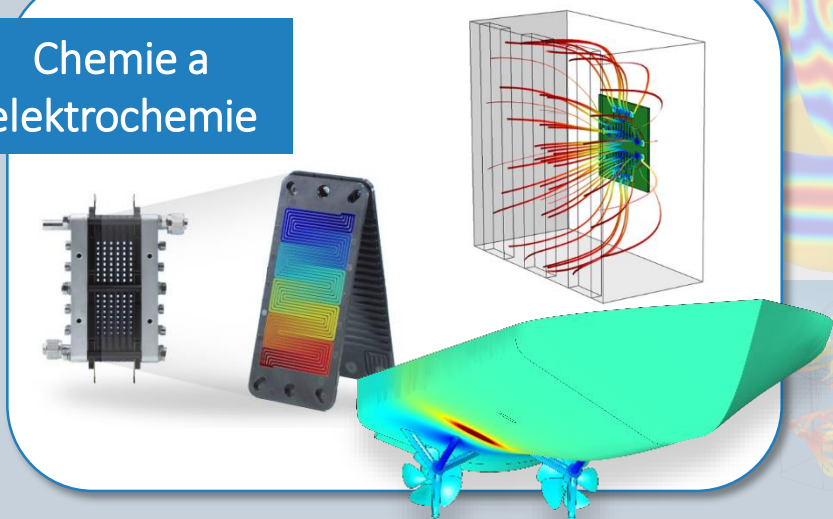
Elektromagnetismus



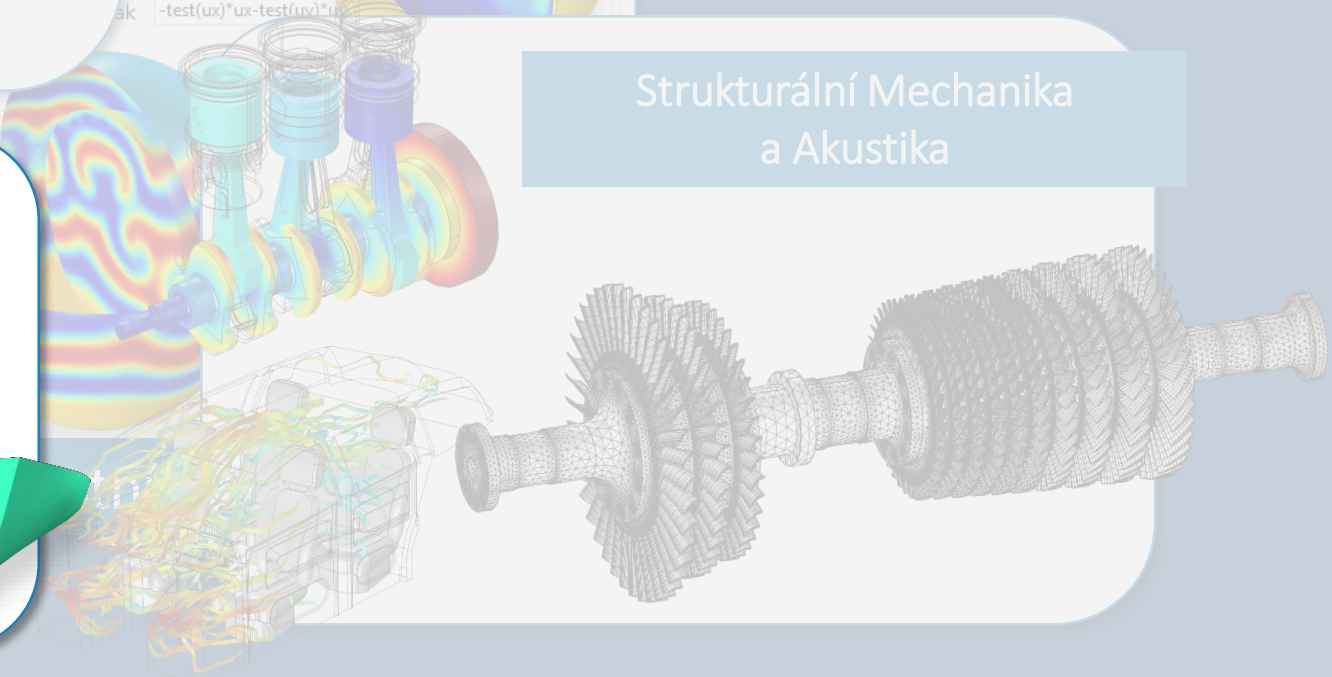
Proudění a teplo



Chemie a elektrochemie



Strukturální Mechanika a Akustika



The COMSOL[®] Software Product Suite

COMSOL MULTIPHYSICS[®]

The platform product. Understand, predict, and optimize physics-based designs and processes with numerical simulation.

DEPLOYMENT PRODUCTS

- COMSOL Compiler™
- COMSOL Server™

Distribute simulation applications created with COMSOL Multiphysics.

ADD-ON PRODUCTS

ELECTROMAGNETICS

- AC/DC Module
- RF Module
- Wave Optics Module
- Ray Optics Module
- Plasma Module
- Semiconductor Module

FLUID & HEAT

- CFD Module
 - Mixer Module
- Subsurface Flow Module
- Pipe Flow Module
- Microfluidics Module
- Molecular Flow Module
- Heat Transfer Module

STRUCTURAL & ACOUSTICS

- Structural Mechanics Module
 - Nonlinear Structural Materials Module
 - Composite Materials Module
 - Geomechanics Module
 - Fatigue Module
 - Multibody Dynamics Module
 - Rotordynamics Module
- MEMS Module
- Acoustics Module

CHEMICAL

- Chemical Reaction Engineering Module
- Batteries & Fuel Cells Module
- Electrodeposition Module
- Corrosion Module
- Electrochemistry Module

MULTIPURPOSE

- Optimization Module
- Material Library
- Particle Tracing Module

INTERFACING

- LiveLink™ for MATLAB®
- LiveLink™ for Excel®
- CAD Import Module
- Design Module
- ECAD Import Module
- LiveLink™ for SOLIDWORKS®
- LiveLink™ for Inventor®
- LiveLink™ for AutoCAD®
- LiveLink™ for Revit®
- LiveLink™ for PTC® Creo® Parametric™
- LiveLink™ for PTC® Pro/ENGINEER®
- LiveLink™ for Solid Edge®
- File Import for CATIA® V5



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