

COMSOL Multiphysics® 6.1.



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Twenty minutes never enough!

- Watch our full 3 hours webinar about news in version 6.1.
- <https://youtube.com/@Humusoft>



Novinky v
COMSOL Multiphysics® 6.1
Martin Kožíšek, Radko Kozakovič a Matouš Lorenc

0:00 / 2:35:44 • 1) Postprocessing a tvorba geometrie

Nová verze COMSOL Multiphysics 6.1. - Ukázka novinek!

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Na online semináři jsme 26. 1. 2023 představili ukázky z nové verze COMSOL Multiphysics 6.1. U nejzajímavějších novinek jsme se snažili ukázat, jak je lze použít v praxi. Prošli jsme:

- 1) 0:00:00 Postprocessing a tvorba geometrie
- 2) 0:18:50 Tvorba, oprava a import sítí
- 3) 0:36:50 - Zrychlení řešičů
- 4) 0:39:15 - AC/DC Module
- 5) 0:57:00 - RF Module (vč. simulace elektrostatického výboje a úderu blesku)
- 6) 1:10:10 - Acoustics Module
- 7) 1:21:00 - Proudění tekutin

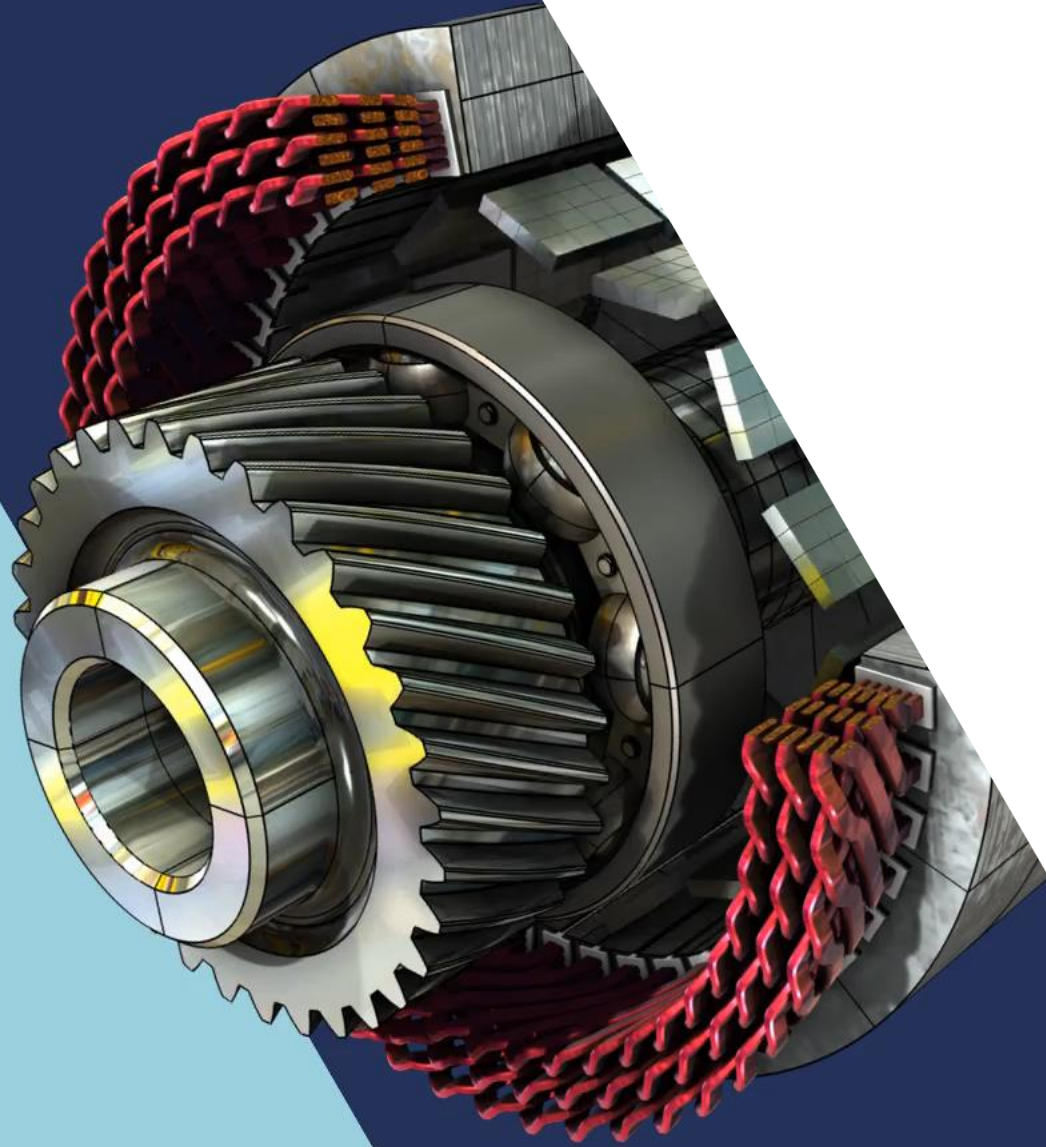
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Building and using AI models responsibly Q&A | DIS212H
Microsoft Developer

<https://youtu.be/vLAcvkxwqyY>



Visualization, Geometry, and Meshing News in 6.1

Visualization with Direct Shadows

Improves depth perception by simulating shadows

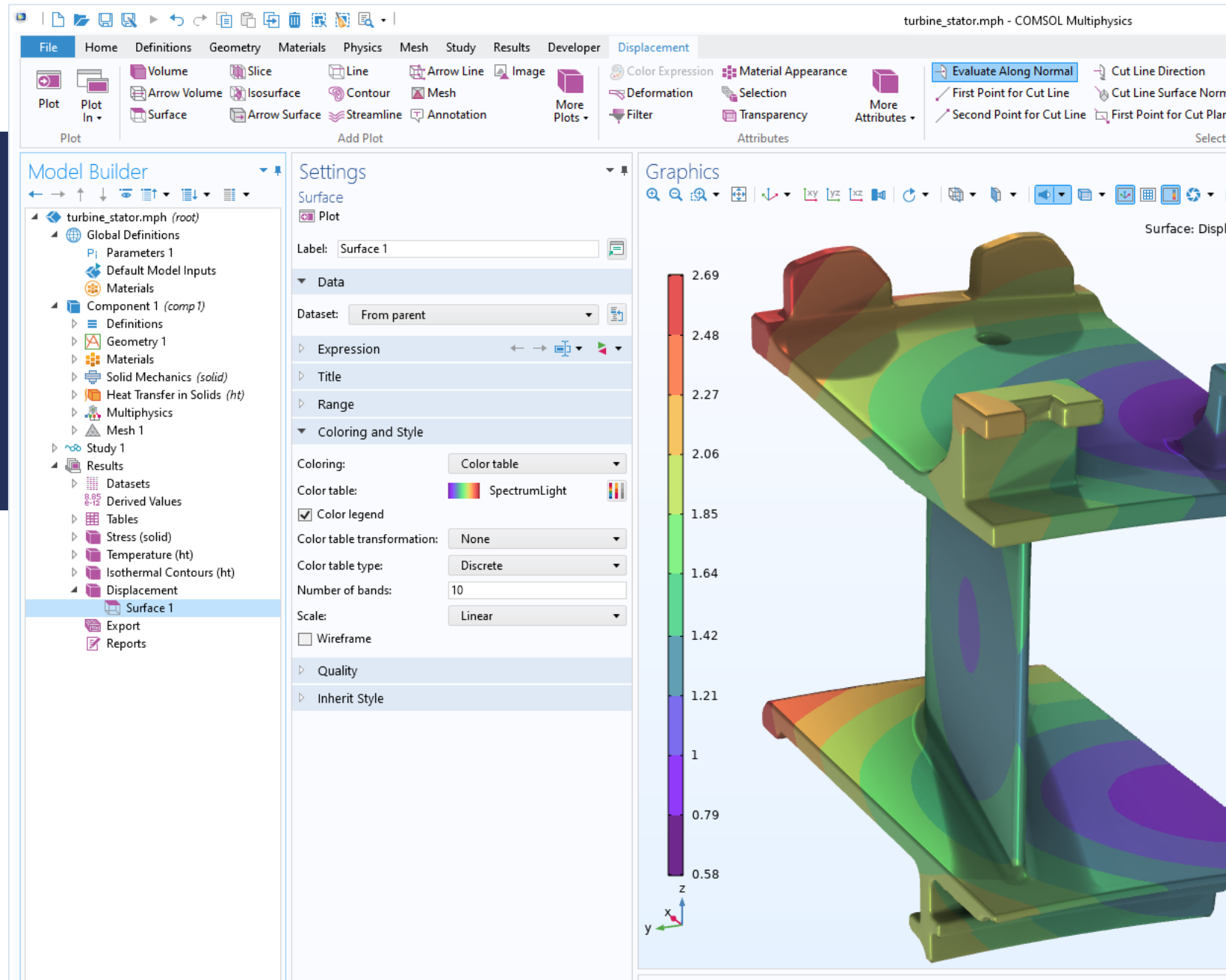
The screenshot displays the COMSOL Multiphysics software interface. The top menu bar includes File, Home, Definitions, Geometry, Materials, Physics, Mesh, Study, Results, Developer, and View 1 - front. The ribbon contains icons for Reset to Default, Directional Light, Point Light, Spotlight, Headlight, Clip Plane, Clip Box, Clip Sphere, Clip Cylinder, and Hide. The Model Builder tree on the left shows the hierarchy: Aston-Martin.mph (root) > Global Definitions > Parameters 1 > Materials > Component 1 (comp1) > Definitions > Selections > Boundary System 1 (sys1) > View 1 - front. The Settings panel on the right is expanded to the Light settings, showing the following options:

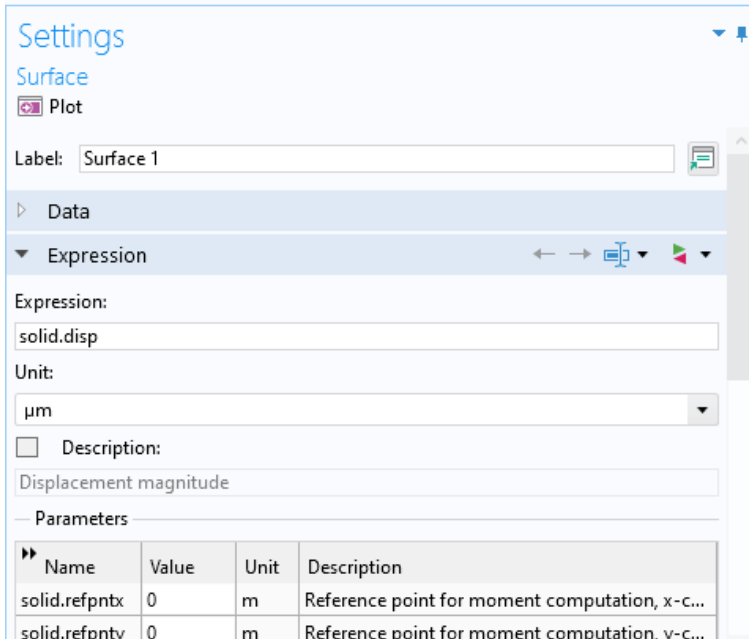
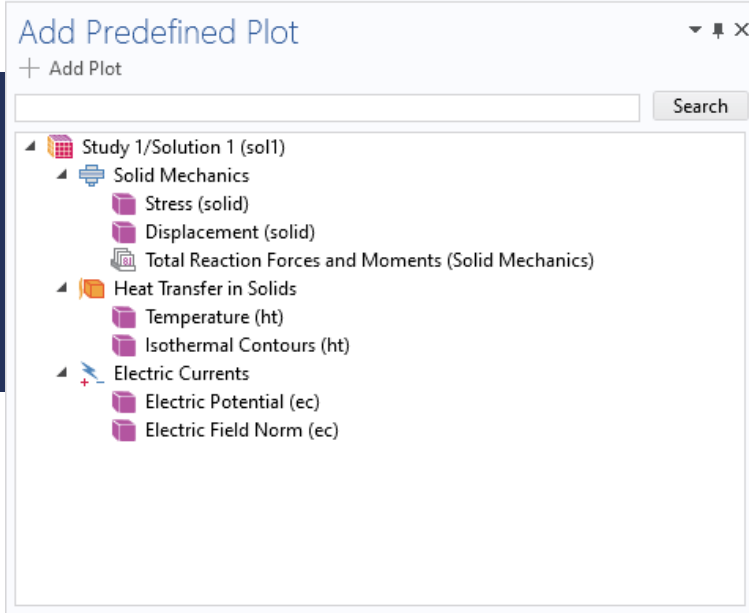
- Show grid
- Mesh rendering
- Show axis orientation
- Show axis units
- Lock camera
- Lock rotation center
- Light
 - Ambient occlusion
 - Radius type: Relative
 - Fraction of scene bounding box: 0.4
 - Shadow strength: 1
 - Shadow tightness: 1
 - Quality preset: Medium quality
 - Direct shadows
 - Shadow softness: 0.5
 - Shadow strength: 0.5
 - Quality preset: Low quality
 - Bias settings: Default
- Environment
- Transparency
- Colors
 - Show selection colors
 - Show material color and texture
- Clipping

The Graphics window on the right shows a 3D rendering of a blue Aston Martin sports car. The car is rendered with a blue mesh and is casting a shadow on the ground. The shadow is rendered with a soft, semi-transparent appearance, demonstrating the effect of the Direct Shadows setting. The bottom status bar shows Messages, Progress, Log, and Table tabs.

Discrete Color Legend

New discrete color table type is available for all plots that use color tables. This can make it easier to interpret visualizations of field variations.





Predefined Plots

- Plot group templates stored in the model but not added to the *Results* section
- Selected from the ribbon or the model tree
- Opens in its own desktop window
- Managed by physics interfaces

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Application Builder Model Manager Component 1 Add Component Parameters Variables Functions Parameter Case Import Build All Add Material Select Physics Interface Add Physics Build Mesh Mesh 1 Compute Select Study Add Study Select Plot Group Add Plot Group Add Predefined Plot Windows Reset Desktop

Model Builder

- Untitled.mph (root)
 - Global Definitions
 - Parameters 1
 - Materials
 - Component 1 (comp 1)
 - Definitions
 - Boundary System 1 (sys 1)
 - View 1
 - Geometry 1
 - Import 1 (imp 1)
 - Form Union (fin)
 - Materials
 - Mesh 1
 - Results

Settings

Import

Build Selected Build All Objects

Label: Import 1

Source: COMSOL Multiphysics file

Filename: \\hay\ARCHIVE\USERS\kozisek\PROFILE\Desktop\Unt

Browse Import

Include result from virtual operations

Selections of Resulting Entities

Resulting objects selection

Show in physics: Domain selection

Color: None

Individual object selections

Show in physics: Domain selection

Cumulative selection

Contribute to: None New

Assigned Attributes

Construction geometry

Graphics

→ imp1 | 53

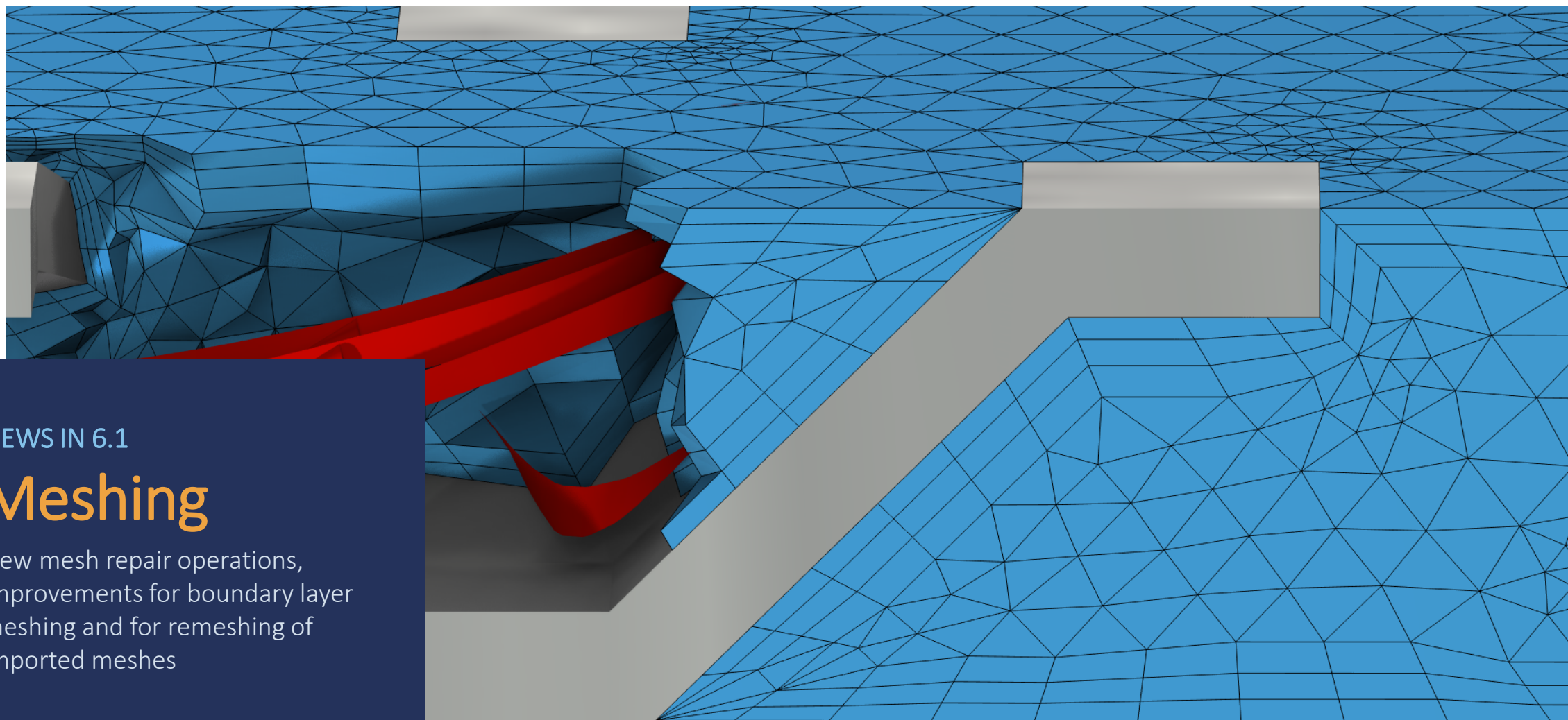
The 3D model shows a mechanical assembly with a base plate and a vertical plate. Dimensions are provided in meters (m):

- Base plate: 80m x 60m x 20m
- Vertical plate: 80m x 60m x 20m
- Vertical plate offset: 20m from the right edge
- Vertical plate height: 100m
- Vertical plate thickness: 20m

Coordinate system: x (right), y (front), z (up)

Messages Progress Log Table

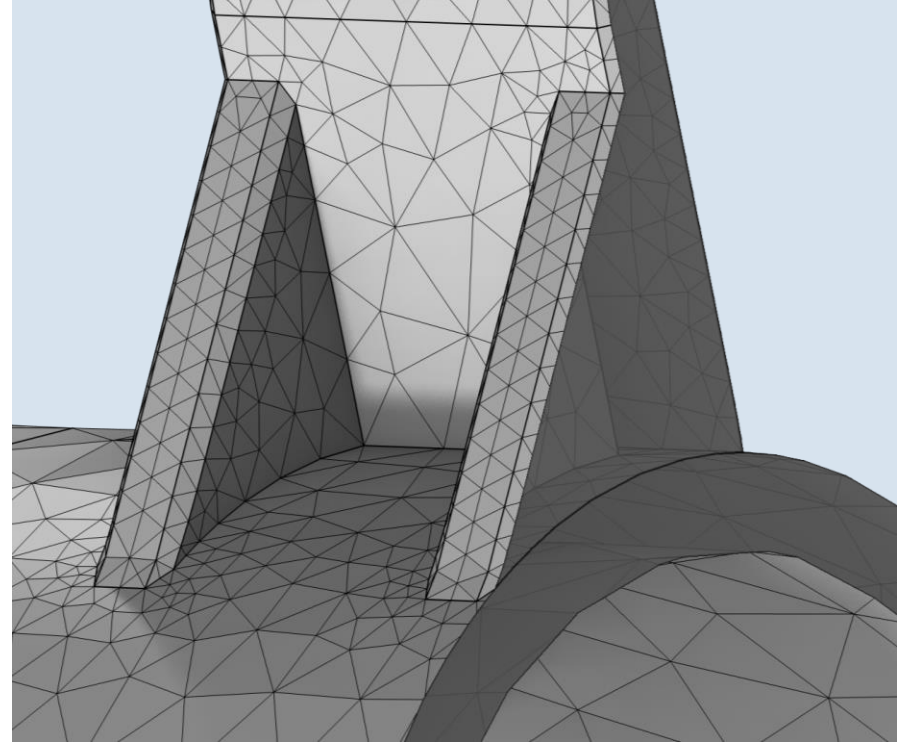
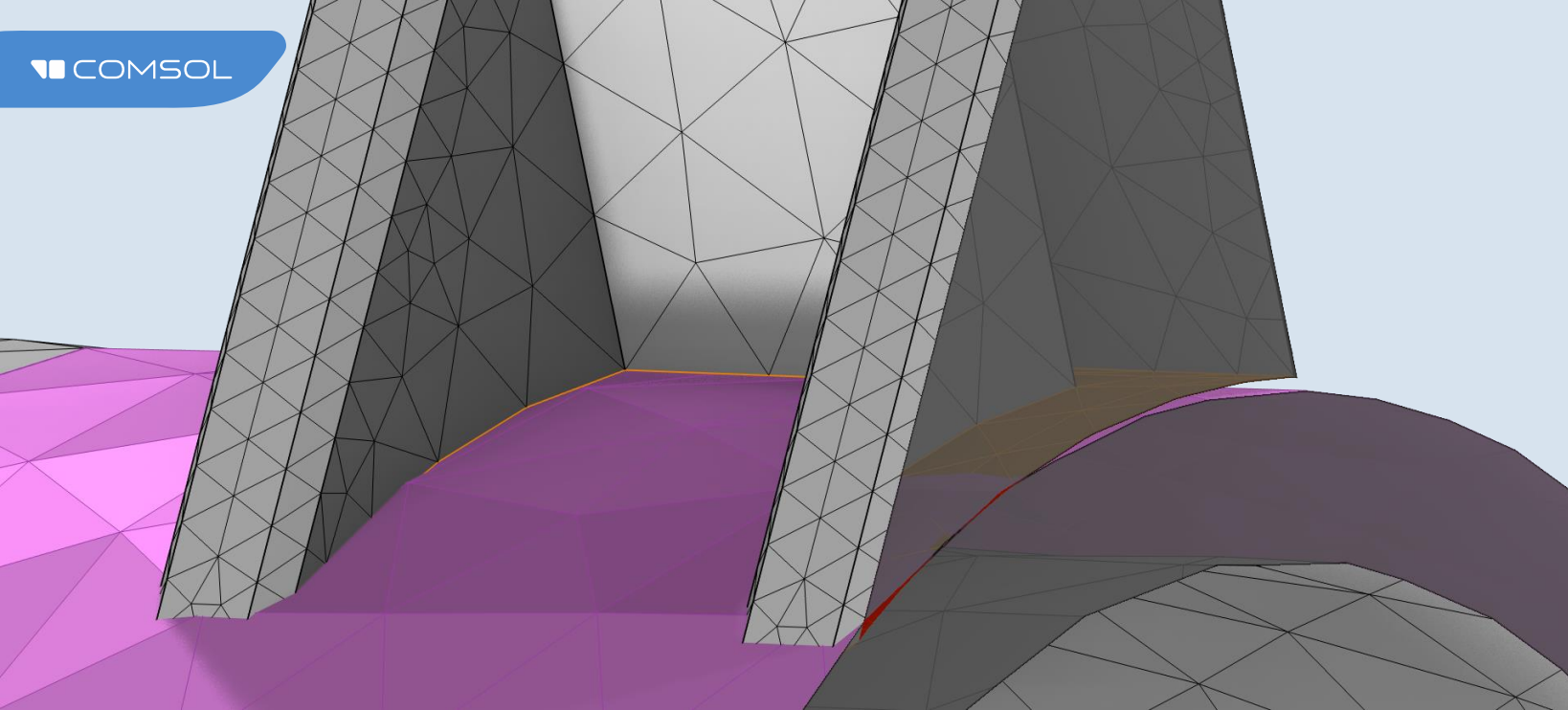
[Jan 21, 2023, 5:38 PM] Finalized geometry is disconnected and has 2 components.



NEWS IN 6.1

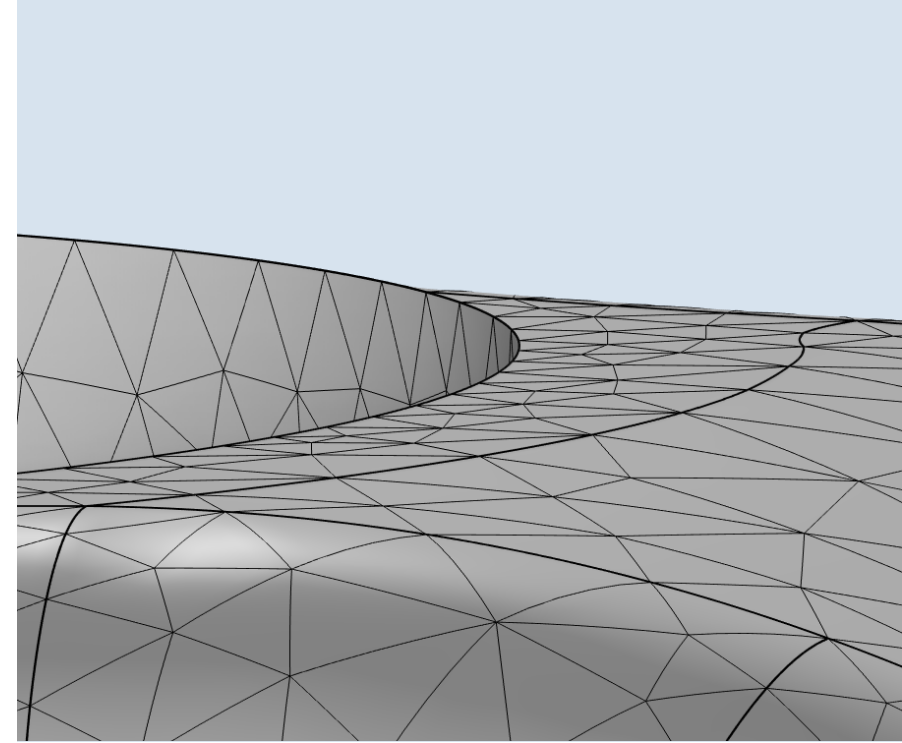
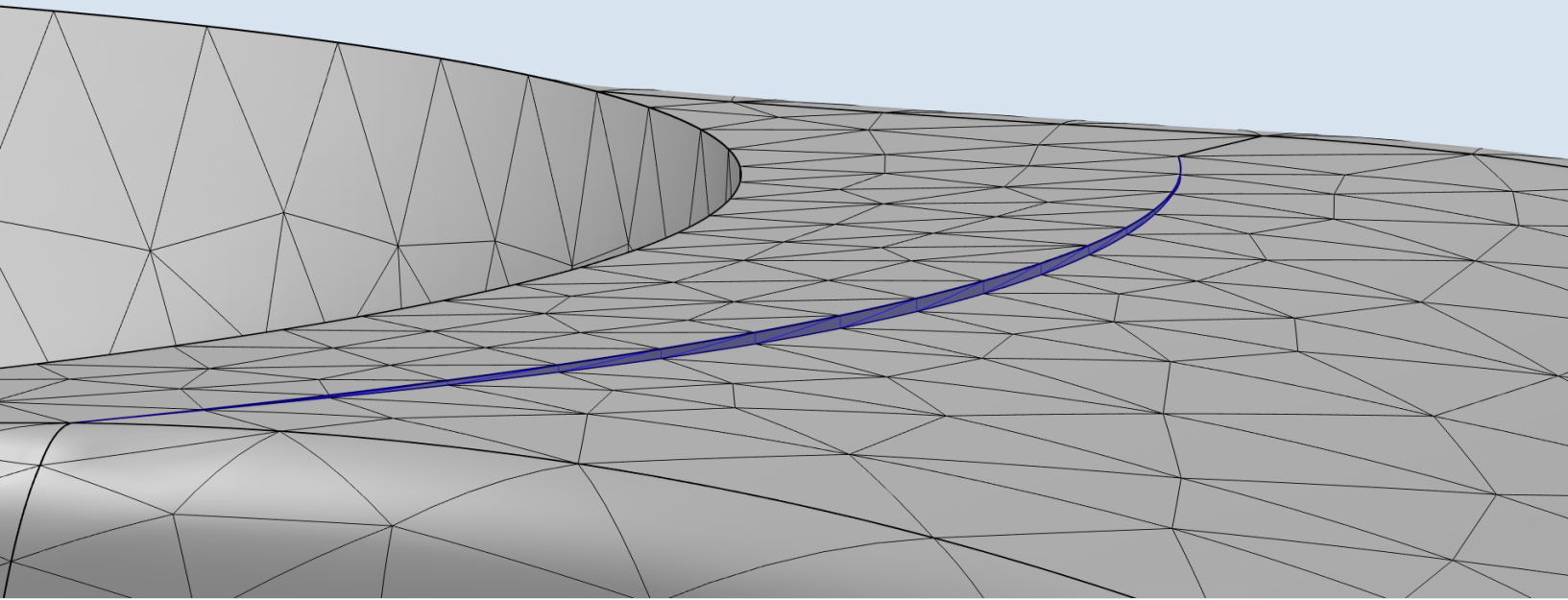
Meshing

New mesh repair operations,
improvements for boundary layer
meshing and for remeshing of
imported meshes



Repairing Meshes

- Provides an alternative to geometry repair for misaligned CAD models
- Merge of nearby faces, edges, or vertices in meshes for easier meshing

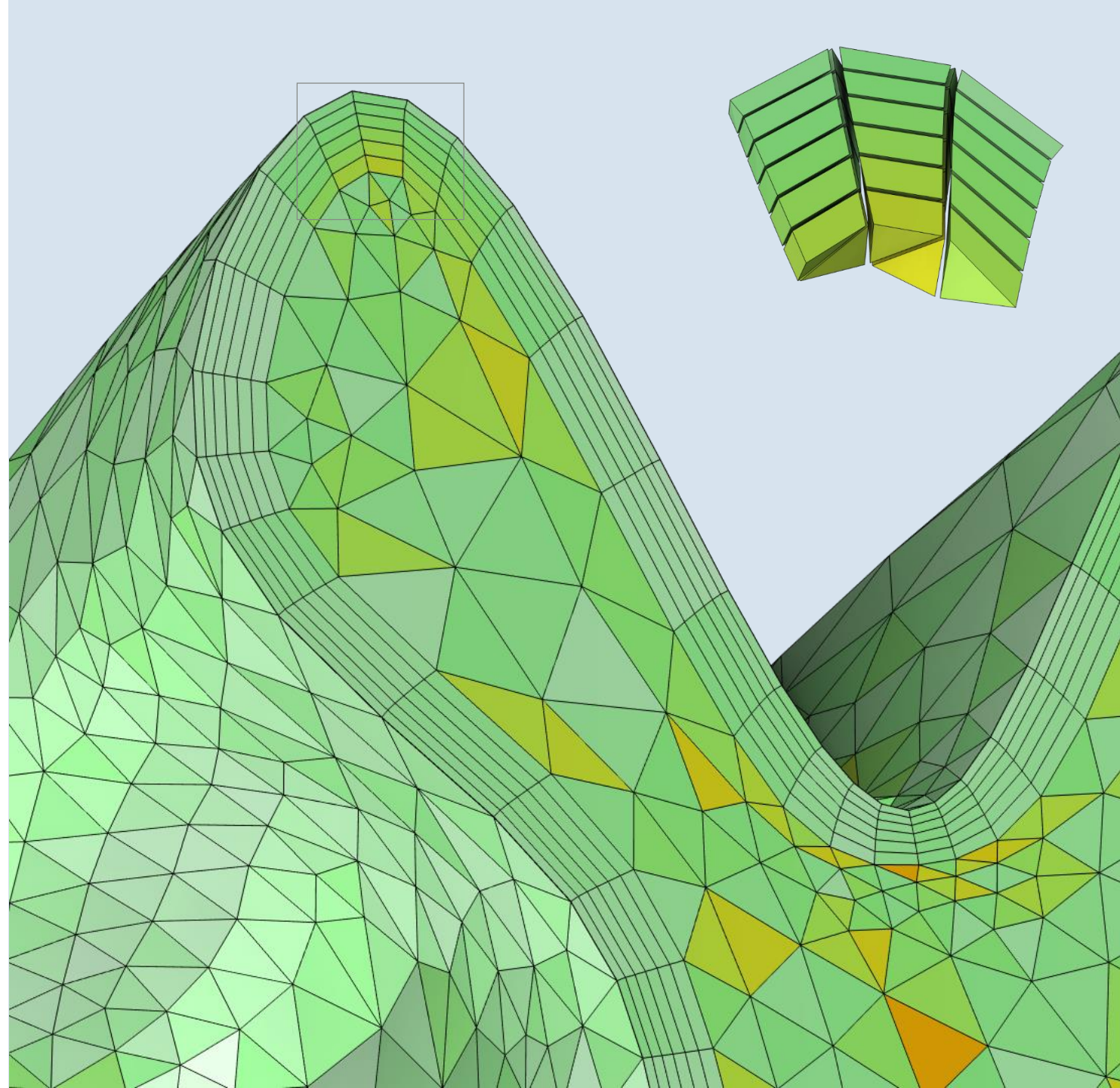


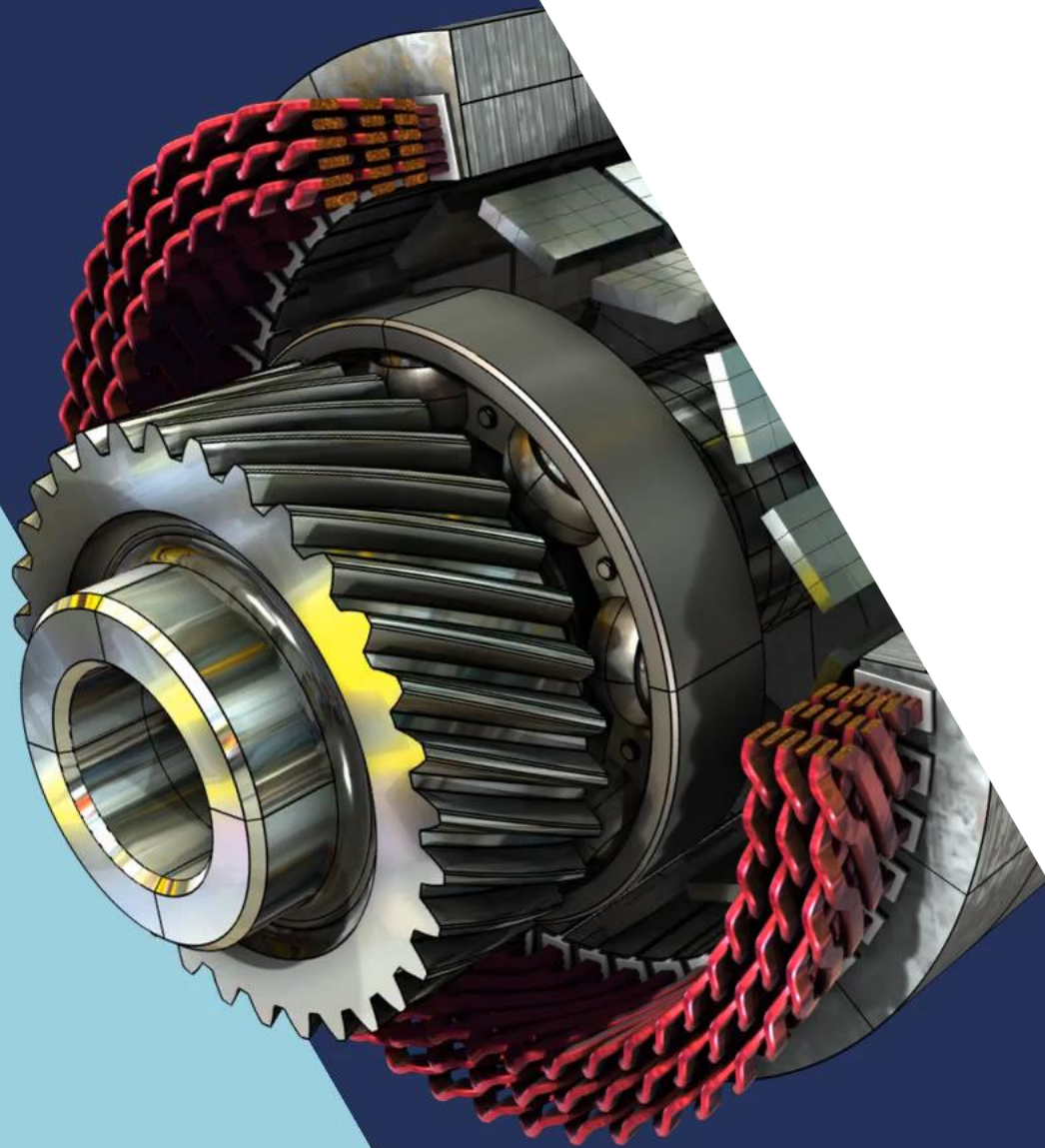
Collapse Entities in Meshes

- New operation to remove small edges and faces in meshes by collapsing them
- Finds and collapses entities smaller than an automatically determined entity size
- Simplifies remeshing of imported meshes

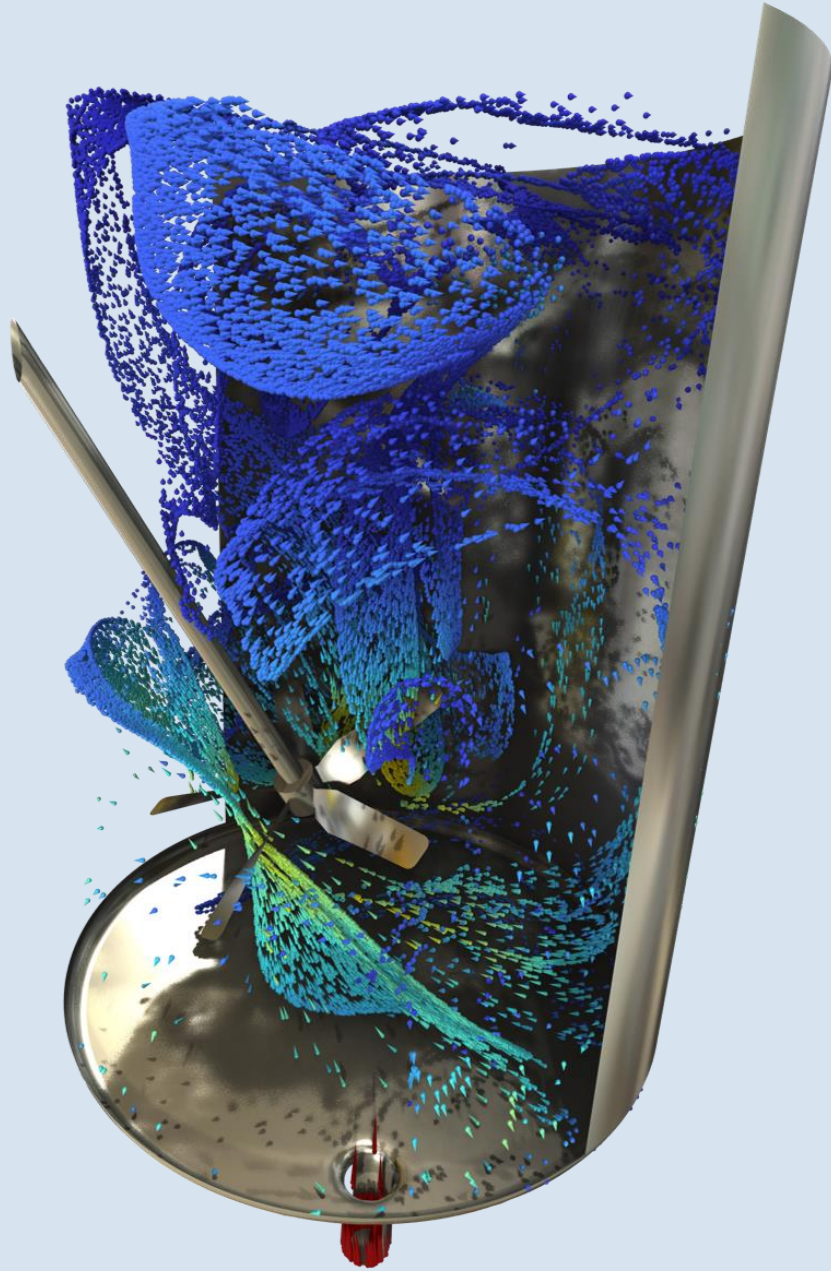
Boundary Layer Meshing Improvements

- Automatic adjustment of element directions away from the wall, especially useful for concave- and convex-shaped boundaries
- Improves the quality, which speeds up convergence and increases accuracy
- Option to turn off the adjustment, resulting in constant directions through all layers





Solver Performance in 6.1



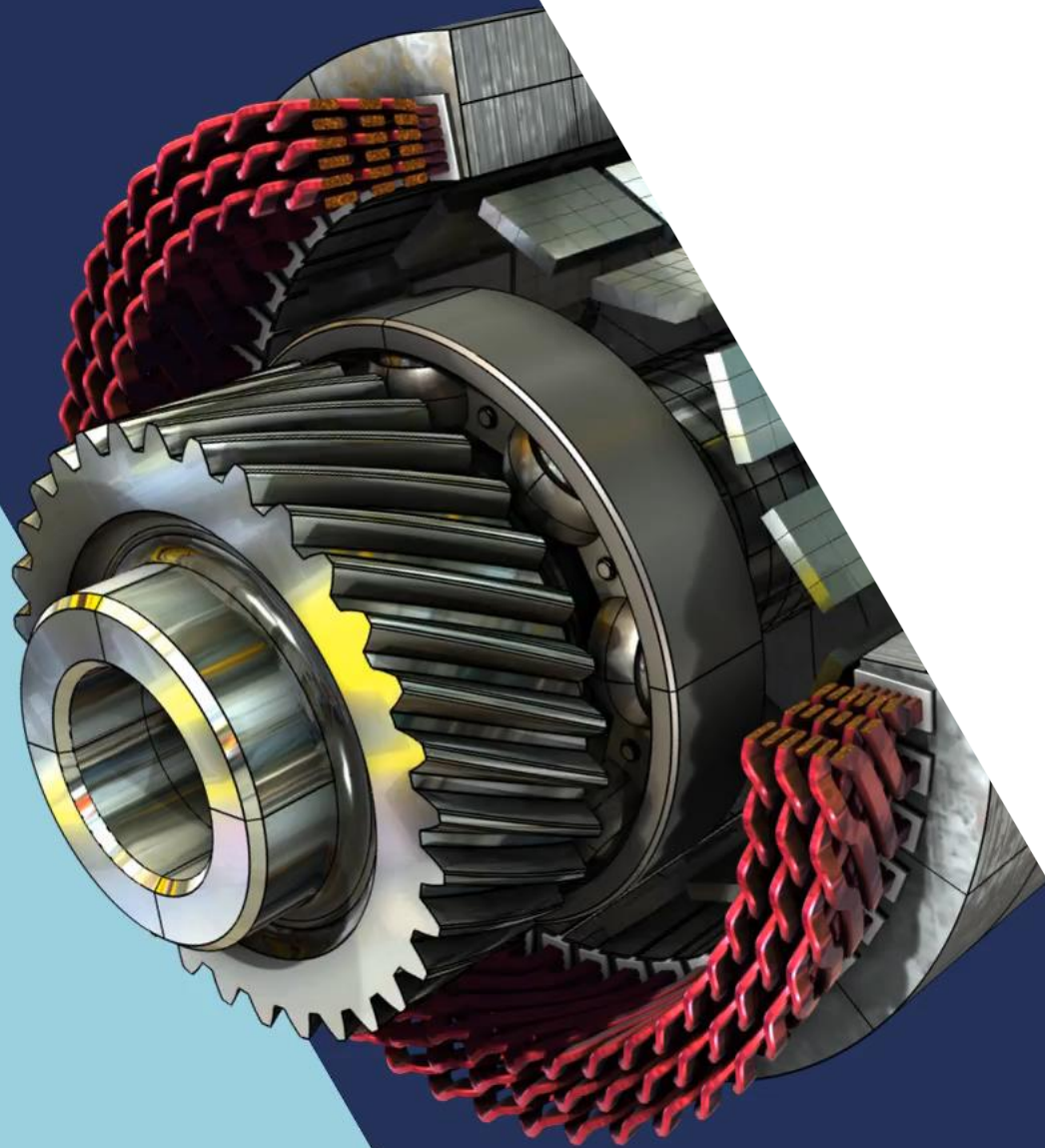
Solvers

Solver Performance

- Up to 30% faster solvers for CFD
- Elastic–acoustic waves: 40% faster and larger models, > 2 billion DOFs

Uncertainty Quantification (UQ)

- Use experimental data for calibrating input uncertainty
- Multidimensional interpolation functions based on Gaussian process regression (Kriging)

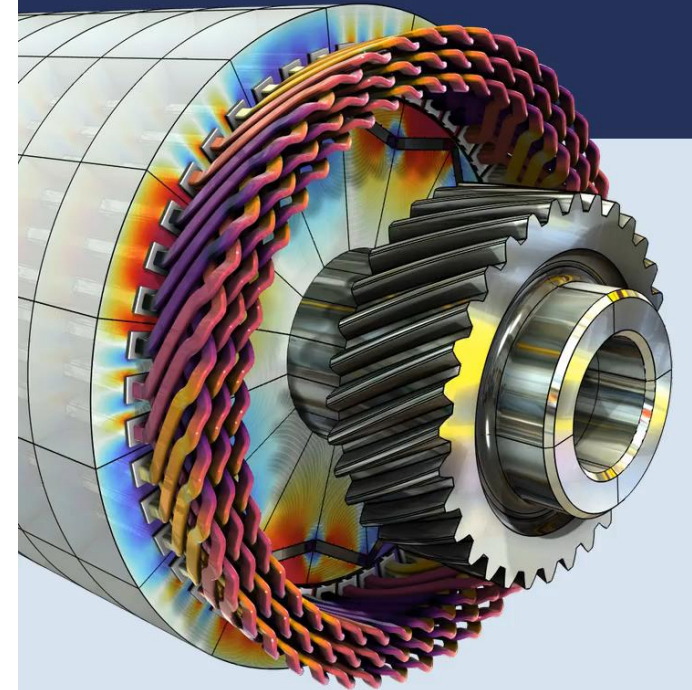


AC/DC Module 6.1

AC/DC MODULE

Electrical Machines

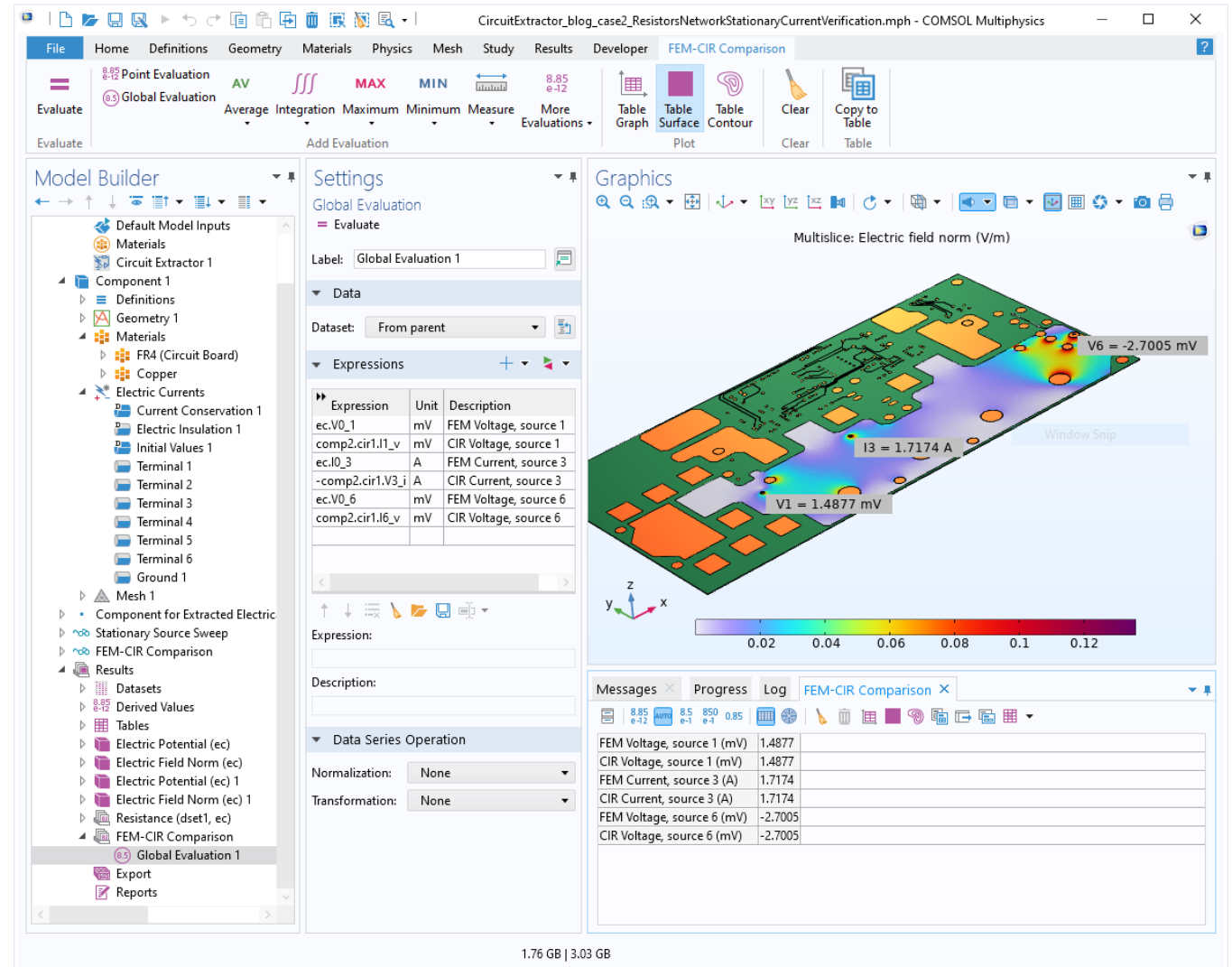
- *Magnet domain feature*
 - Magnetization direction
 - Interior insulation boundaries
 - Magnet arrays
- *Winding Layout feature*
 - Specify winding pattern, 2D
- Coil wire cross section from *Slot Filling Factor*
- Improved *Sector Symmetry*
- New and enhanced examples and tutorial models



AC/DC MODULE

Circuit Extraction

- *Circuit Extractor* add-in
- Lumped matrix output from source sweep studies
 - EC, ES, and ESBE (stationary)
 - MEF and MFCO (stationary and frequency domain)
- *Passive Conductor* feature for *Magnetic Fields, Currents Only*
- Enhanced postprocessing



AC/DC MODULE

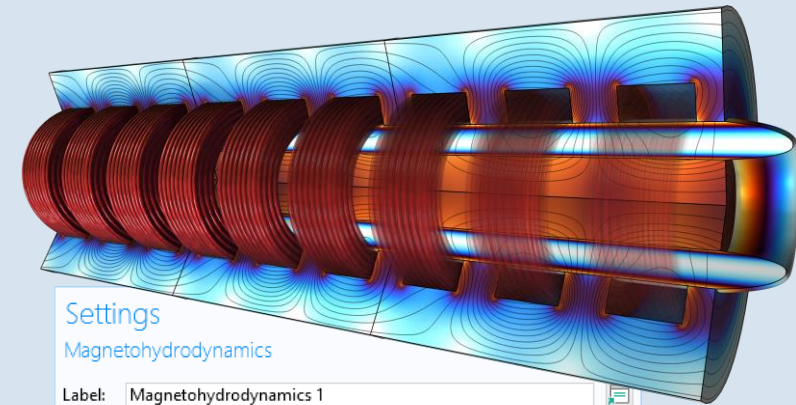
Magnetohydrodynamics

New *Magnetohydrodynamics* multiphysics interface

- Interaction between electromagnetics and fluid flow
- Conserves electrical currents
- New *Liquid Metal* material library

Extended *Magnetic and Electric Fields* interface

- Transient study is now available
- Supports both gauged and ungauged formulations
- Efficient iterative solver with hybrid preconditioners



Settings
Magnetohydrodynamics

Label: Magnetohydrodynamics 1

Name: mhd1

Domain Selection

Equation

Show equation assuming:
Study 1, Time Dependent

$\mathbf{F} = \mathbf{J} \times \mathbf{B}$

$\mathbf{J} = \sigma(\mathbf{E} + \mathbf{u} \times \mathbf{B})$

Coupled Interfaces

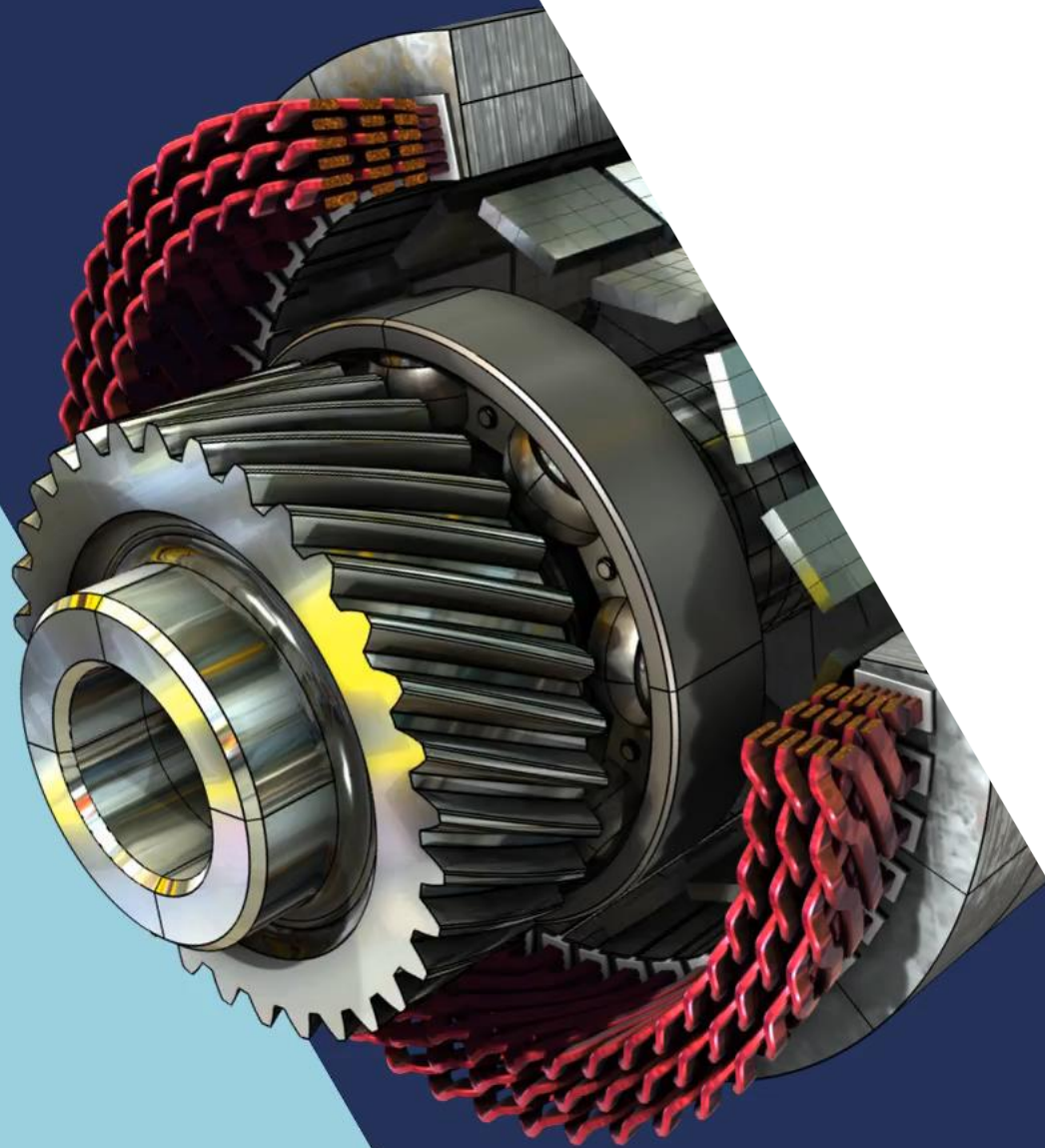
Electromagnetic:
Magnetic and Electric Fields (mef)

Fluid flow:
Laminar Flow (spf)

Coupling Settings

Include Lorentz force

Include electromotive force



RF Module 6.1

RF MODULE

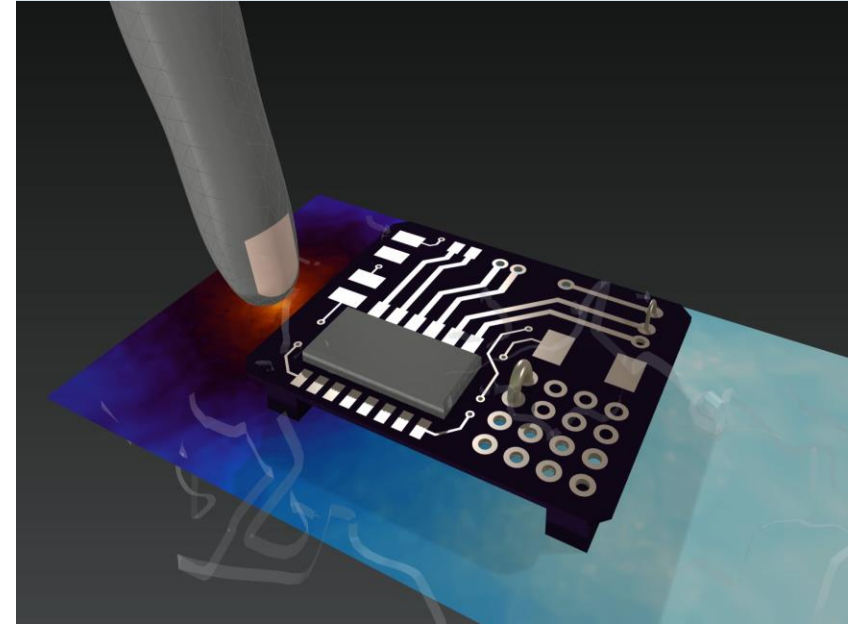
Lightning and Electrostatic Discharge (ESD)

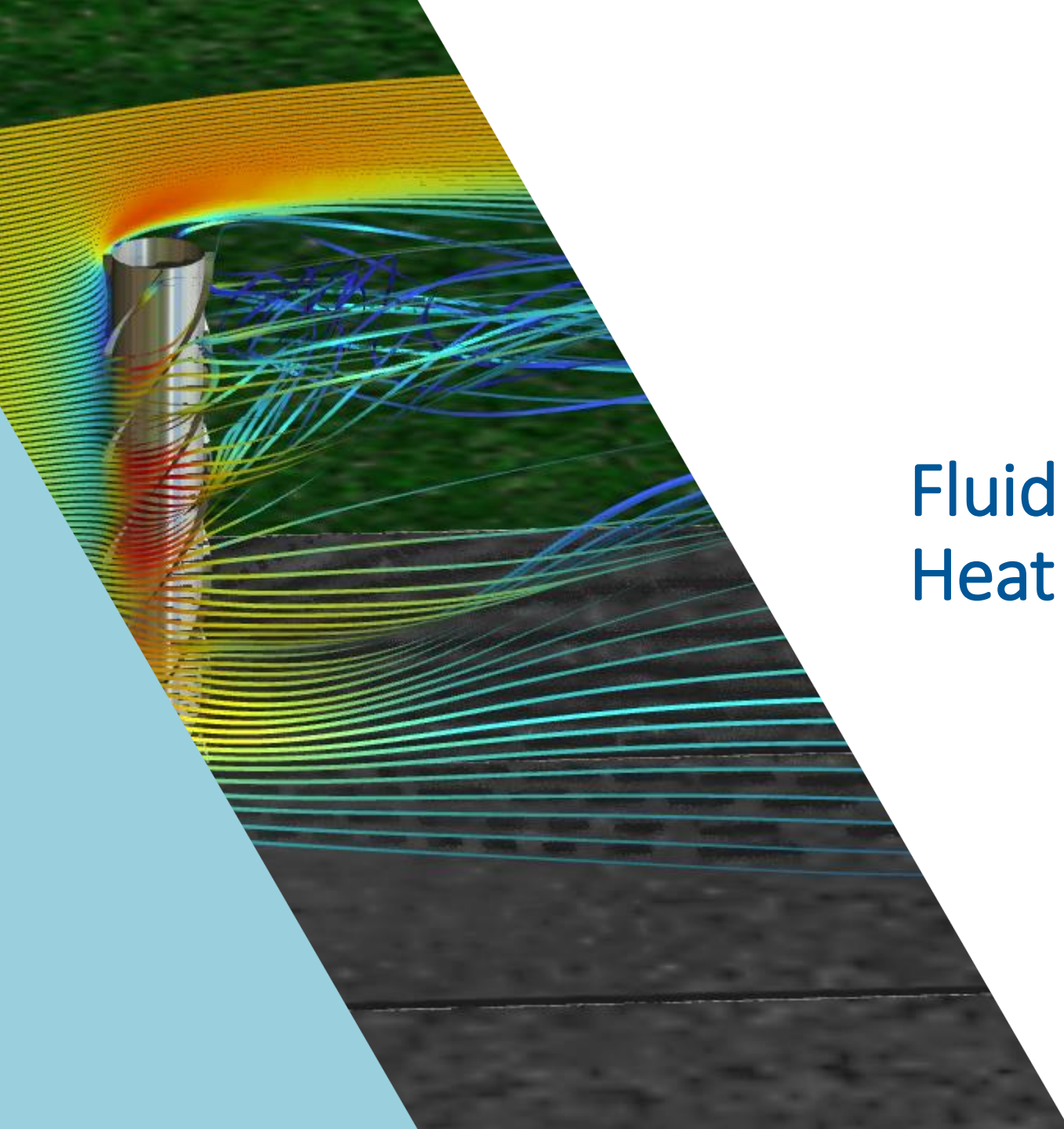
Predefined adjustable ESD models

- Human body
- Extended human body
- Machine
- Charged device

Pulses for electrostatic discharge and lightning

- Transient lumped port
- Transient edge current
- Fully parameterized to customize the pulse shape





Fluid Flow & Heat Transfer in 6.1.

Detached Eddy Simulation (DES)

- Combines the accuracy of LES* with the performance of RANS** models by using less dense mesh with RANS close to the walls
- Gives high accuracy at relatively low computational cost for flows around bluff bodies or with separation from sharp edges

*LES = Large eddy simulation

**RANS = Reynolds-averaged Navier–Stokes (turbulence models)

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

- Toolbar:** Contains icons for File, Home, Definitions, Geometry, Materials, Physics, Mesh, Study, Results, and Developer. Below these are icons for Application Builder, Model Manager, Component 1, Add Component, Parameters, Variables, Functions, Parameter Case, Build All, Import, LiveLink, Add Material, DES RBVM, Spalart-Allmaras, Add Physics, Build Mesh, Mesh 1, Compute, Study 2, Add Study, Velocity (spf), and Add Plot Group.
- Model Builder:** Shows a hierarchical tree of the model structure:
 - bump.mph (root)
 - Global Definitions
 - Parameters 1
 - Materials
 - Component 1 (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - DES RBVM, Spalart-Allmaras (spf)
 - Fluid Properties 1
 - Initial Values 1
 - Wall 1
 - Wall 2
 - Inlet 1
 - Outlet 1
 - Laplace Equation (lpeq)
 - Laplace Equation 1
 - Zero Flux 1
 - Initial Values 1
 - Flux/Source 1
 - Dirichlet Boundary Condition 1
 - Mesh 1
 - Study 1
 - Step 1: Stationary
 - Solver Configurations
 - Solution 1 (sol1)
 - Study 2
 - Step 1: Wall Distance Initialization
 - Step 2: Time Dependent
 - Solver Configurations
 - Results
 - Datasets
 - Derived Values
 - Tables
 - Velocity (spf)
 - Pressure (spf)
 - Wall Resolution (spf)
 - Cp at z=0
 - Export
 - Reports

Settings

LES RBVM

Label: DES RBVM, Spalart-Allmaras

Name: spf

Domain Selection

Equation

Physical Model

Turbulence

Turbulence model type:

Detached Eddy Simulation

LES model:

RBVM

Turbulence model:

Spalart-Allmaras

Wall treatment:

Automatic

Turbulence model parameters

Edit DES model parameters

C_μ 0.09 1

Spalart-Allmaras parameters:

C_{b1} 0.1355 1

C_{b2} 0.622 1

C_{v1} 7.1 1

$\sigma_{\bar{v}}$ 2/3 1

C_{w2} 0.3 1

C_{w3} 2 1

K_v 0.41 1

B 5.2 1

C_{DES} 1 1

Consistent Stabilization

Discretization

Dependent Variables

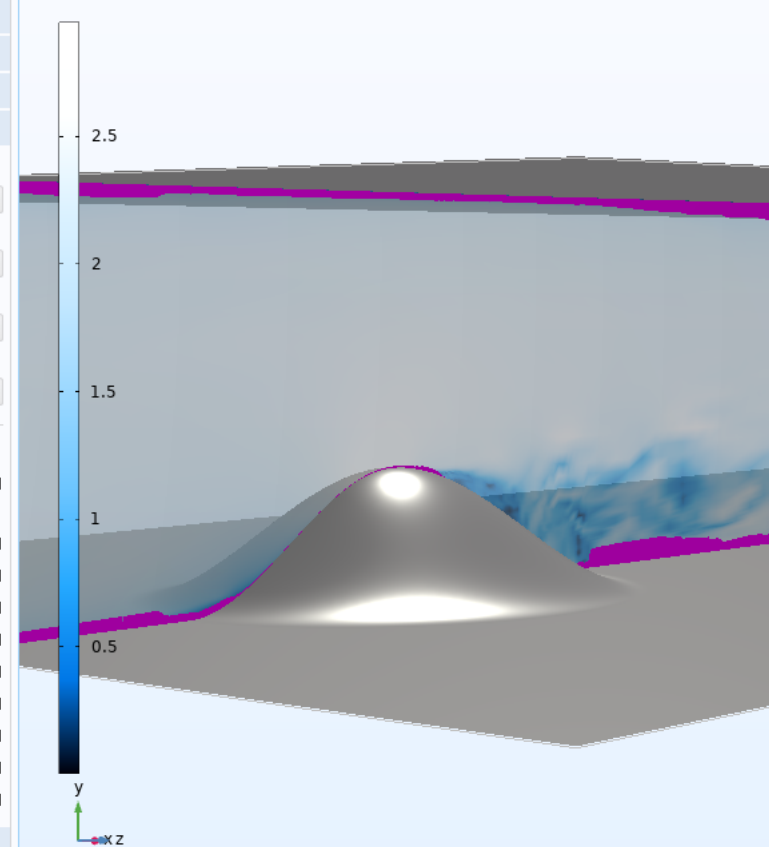
Graphics

Flow Field X

Time=19.99 s

Slice: Velocity magn

m/s



Messages x Progress Log Table 1 x

Realistic Inlets for LES

- Random velocity fluctuations in space and time
- Based on a truncated energy spectrum for homogeneous isotropic turbulence
- Includes time correlation
- Specify k and ε , or intensity and length scale, and the number of Fourier modes

les_3d_hill.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Application Builder Model Manager Component 1 Add Component Parameters Functions Parameter Case Import Build All Add Material LES RBVM Add Physics Build Mesh Mesh 1 Compute Study 2: Time dependent LES solution Add Study Instantaneous streamlines

Workspace Model Definitions Geometry Materials Physics Mesh Study

Model Builder

- les_3d_hill.mph (root)
 - Global Definitions
 - Parameters 1
 - Materials
 - Component 1 (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Laplace's Equation (lpeq)
 - Laplace's Equation 1
 - Zero Flux 1
 - Initial Values 1
 - Flux/Source 1
 - Dirichlet Boundary Condition 1
 - LES RBVM (spf)
 - Fluid Properties 1
 - Initial Values 1
 - Wall 1
 - Wall 2
 - Inlet 1
 - Outlet 1
- Mesher
 - Meshes
- Study 1: Stationary potential flow solution
- Study 2: Time dependent LES solution
- Study 3: Time-averaged LES solution
- Results
 - Datasets
 - Views
 - Derived Values
 - Tables
 - Cp contours on the hill
 - Non-dimensional vorticity flux
 - Velocity vectors at z=0
 - Velocity vectors at x=3.69H
 - Instantaneous streamlines
 - Export
 - Reports

Settings

Inlet

Label: Inlet 1

Boundary Selection

Selection: Manual

Override and Contribution

Equation

Boundary Condition

Velocity

Velocity

Normal inflow velocity

Velocity field

U_0 $U^* \text{abs}(y/(3.2^*H))^{(1/7)} \text{abs}(1-(y/(3.2^*H)))^{(1/7)}/0.7$ m/s

Include synthetic turbulence

Turbulence Conditions

Specify turbulent length scale and intensity

Specify turbulence variables

Turbulent intensity:

I_T Low (0.01)

Turbulence length scale:

L_T User defined

L_{Tin} m

Number of Fourier modes:

N 600

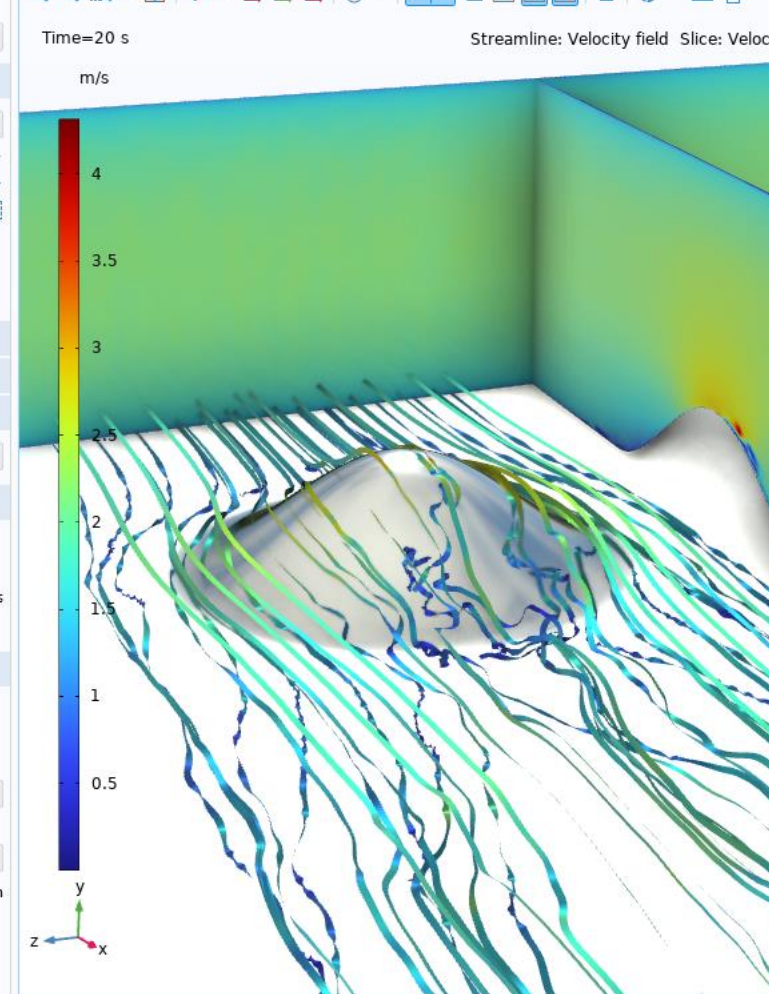
Use random seed

Random seed:

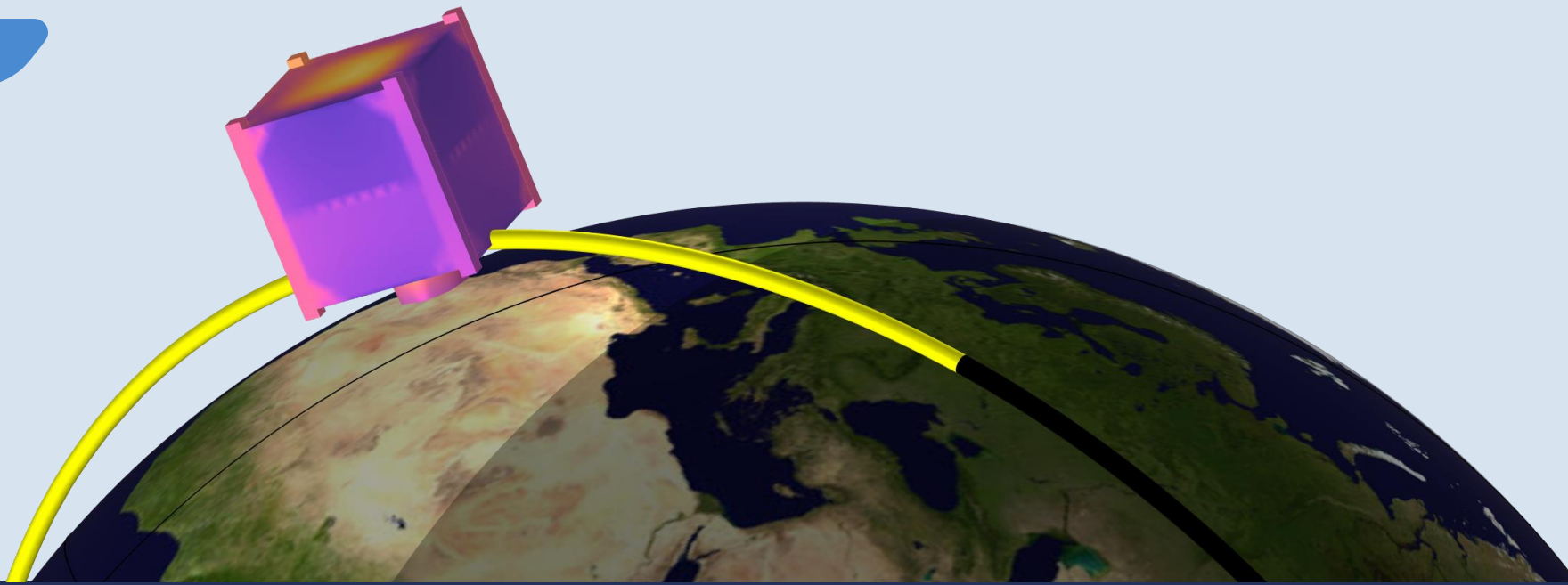
r 113013 1

Graphics Velocity Field X

Time=20 s Streamline: Velocity field Slice: Velocity



Messages Progress Log Table



The Orbital Thermal Loads Interface Computes Environmental Radiative Loads and Thermal Radiation

Orbital Modeling

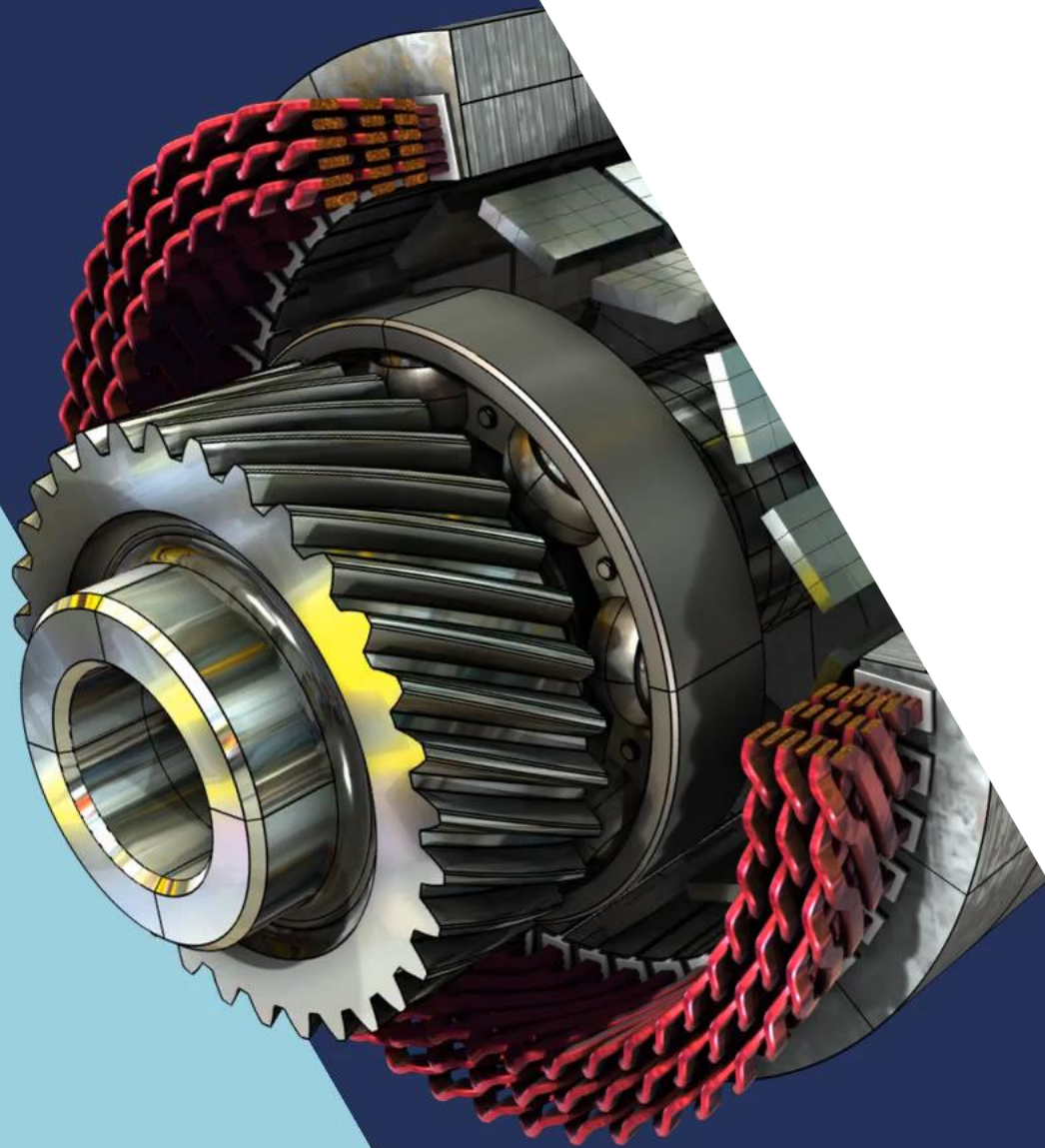
Use the orbital and mission parameters to determine how the satellite is oriented relative to the Sun and Earth.

Radiative Environment

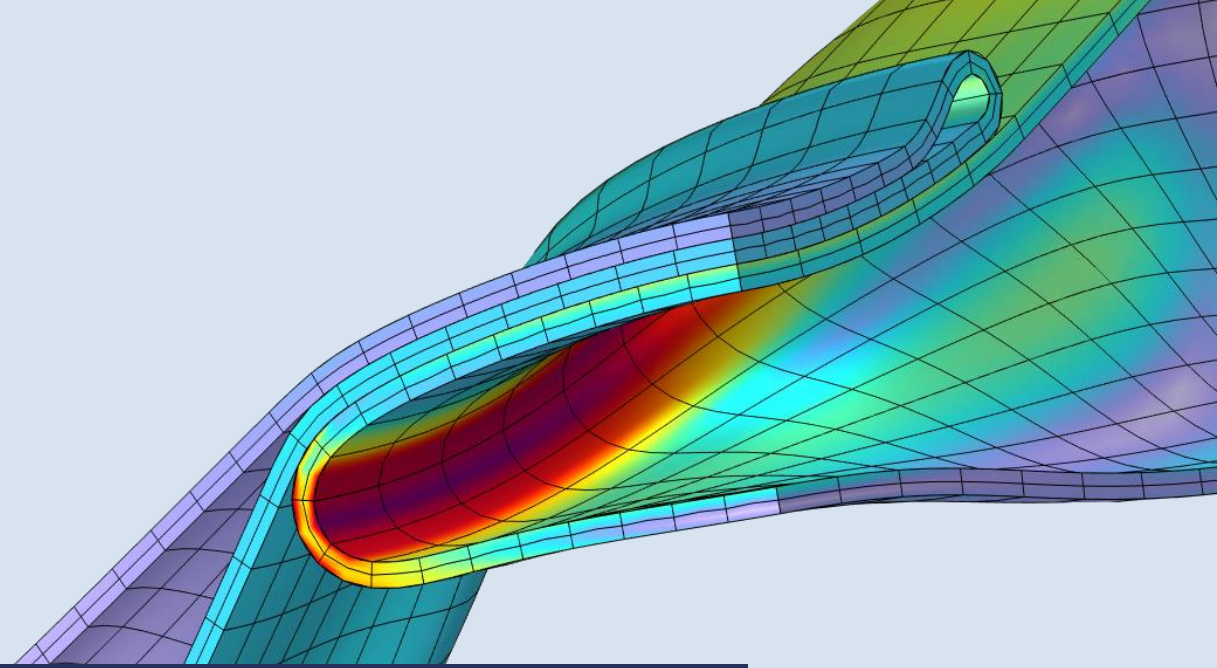
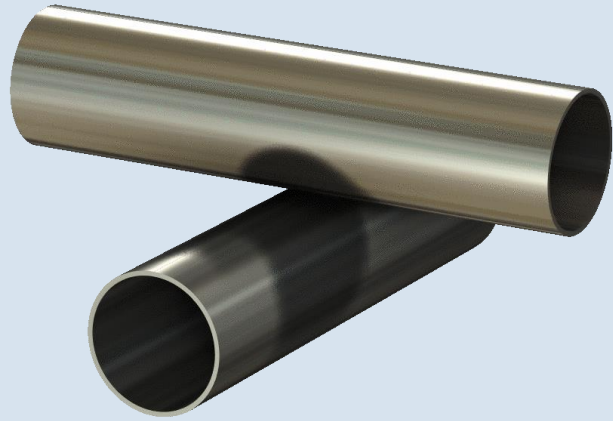
Using the satellite orientation, compute the incident solar, albedo, and Earth infrared (IR) loads.

Temperature Distribution over Time

Once the environmental loads are known, compute the satellite temperature and radiative heat exchange between surfaces and the surrounding space.



Structural Mechanics in 6.1



New Contact Formulations

Nitsche Formulation

More accurate than the penalty method; still no extra degrees of freedom (DOFs).

Faster Search Method

New algorithm for finding the source boundary.

New Formulations

Improved formulations for *Shell*, *Membrane*, and *Layered Shell* interfaces.

Reduced Jacobian improves stability.

Self-Contact

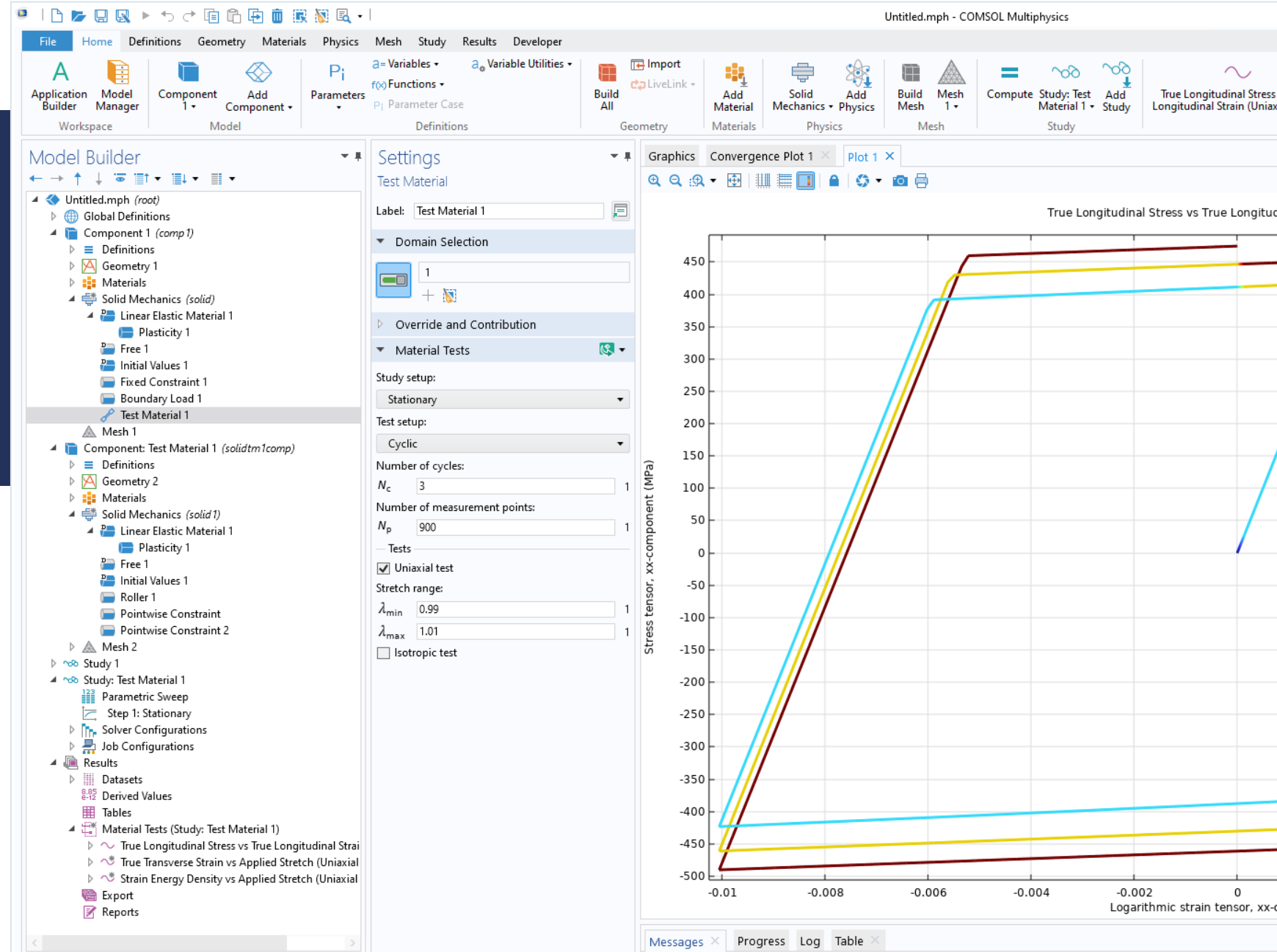
Self-contact is now fully supported.

Numerical Testing of Material Models

The *Test Material* feature provides automatic set up of numerical tests on a single element.

Test scenarios:

- Uniaxial, biaxial, triaxial, shear, isotropic, oedometer
- Monotonic or cyclic
- Stationary or time dependent



Topology Optimization

- The full wheel is modeled
- Sector symmetry imposed
- The wheel rim optimized for stiffness
- Optimization includes milling constraints in the axial direction

