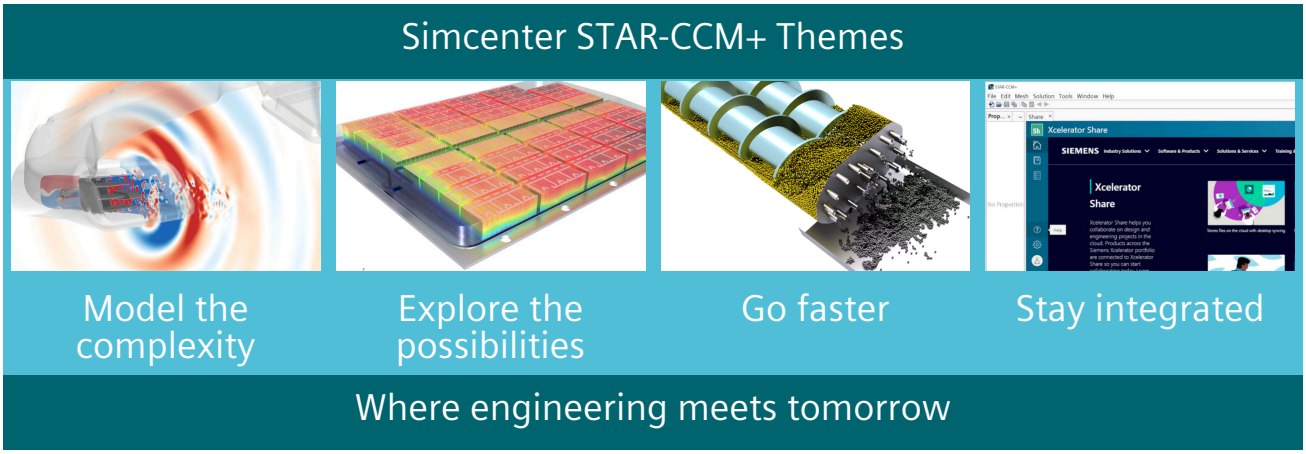
SIEMENS
Ingenuity for life
Version
2021.3
Siemens Digital Industries Software
Simcenter STAR-CCM+
New features and enhancements
Engineer Innovation
www.siemens.com/simcenterccm

New Features and Enhancements in Simcenter STAR-CCM+ 2021.3



Top new features and enhancements for this release are:

- Improved battery electro-thermal analysis workflow
- Meshfree DEM[1]
- Anisotropic near wall meshing
- Parallel core advancing layer mesher
- CGNS workflow improvements
- Lighthill wave model
- Eigenvalue analysis for normal modes in solid mechanics[1]
- Circumferentially averaged profile plots[1]
- Xcelerator Share
- Smaller .simh files through compression[1]

1 Posted on IdeaStorm originally—now moved to Simcenter STAR-CCM+ Community Ideas
A total of 22 new features and enhancements from customer suggestions in this version.

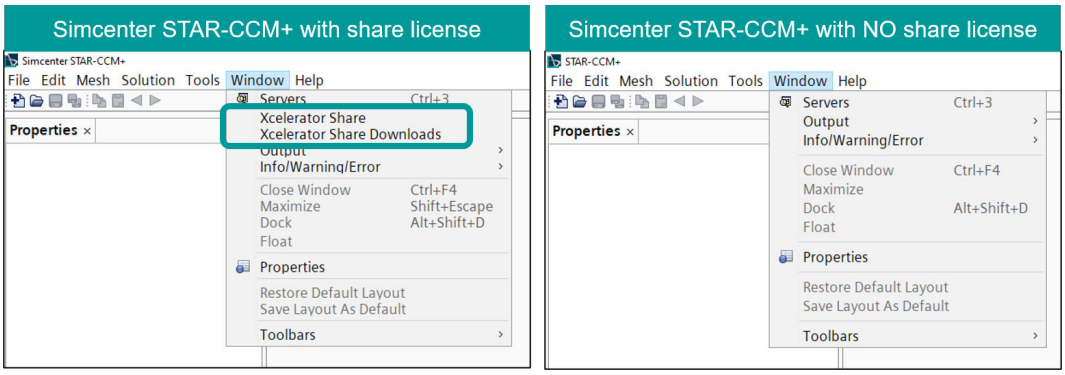
Enhancements to Simcenter STAR-CCM+ 2021.3 are presented by category:

Platform
CAD Integration
Geometry
Mesh
CAE Integration
Physics
Design Exploration
Data Analysis
Application Specific Tools
User Guide

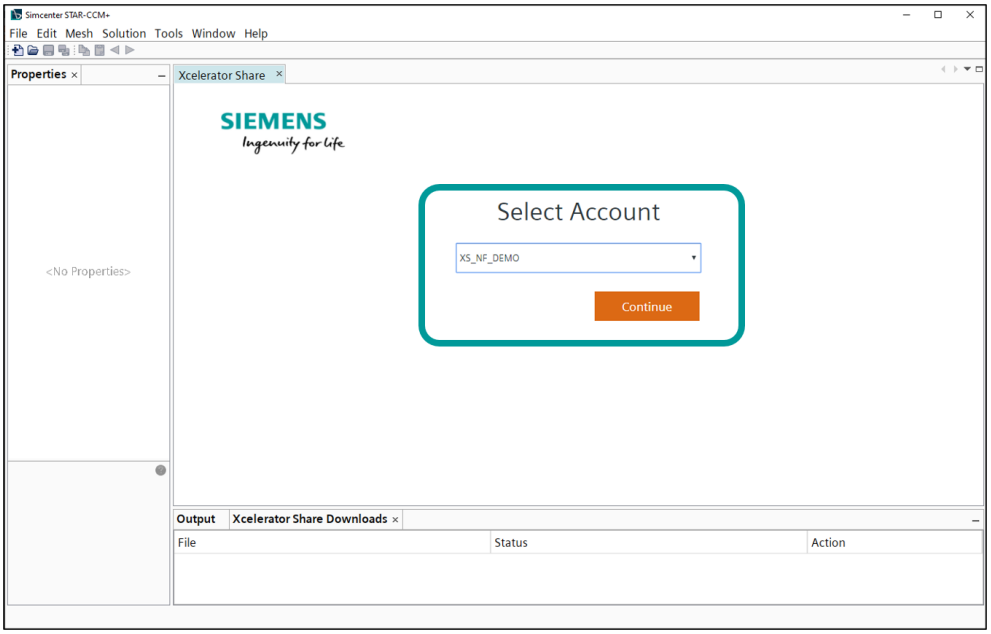
Platform

Xcelerator Share

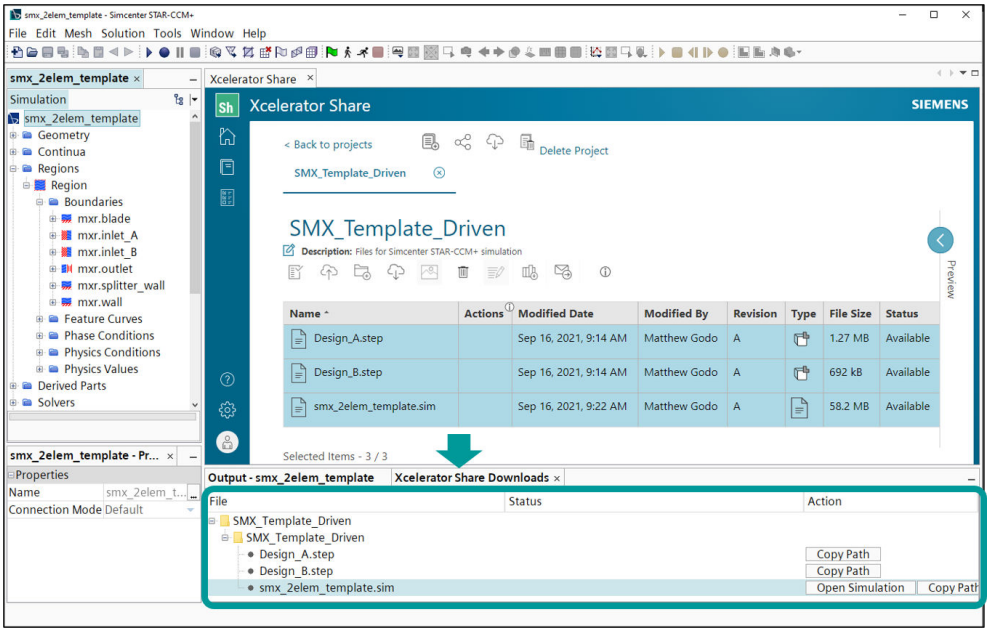
- **Overview**
  - Xcelerator Share is a collaboration platform accessible within Simcenter STAR-CCM+ via an embedded browser
    - Exposure of Xcelerator Share within the Simcenter STAR-CCM+ user interface requires a license
    - To obtain a license, contact your Siemens Digital Industries Software account manager



  - To log into the collaborative platform, you require an Xcelerator Share account, which is created directly by your organization

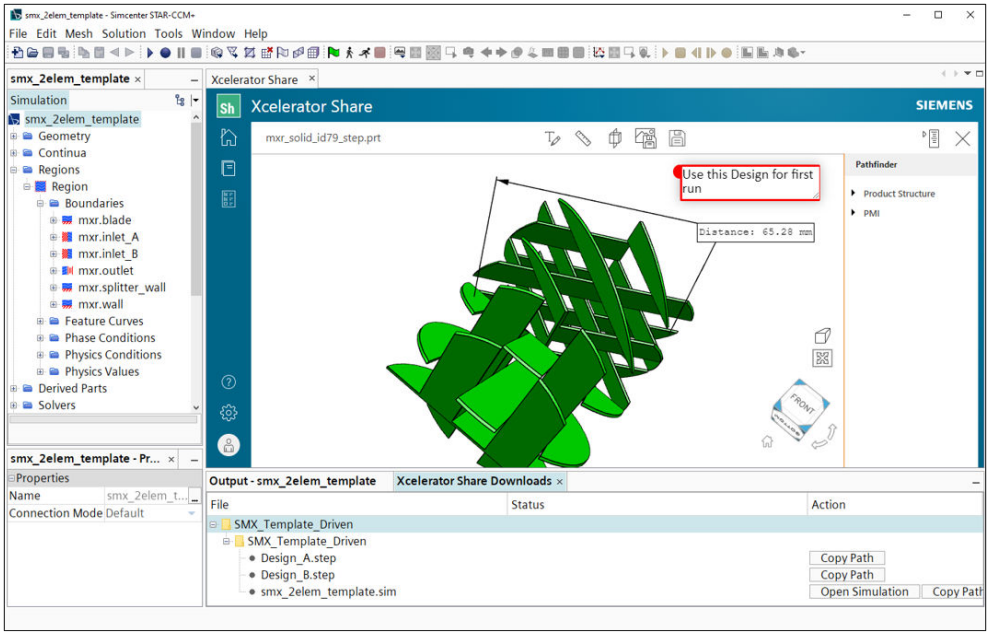


- **Basic capabilities**
  - Create projects and folders to manage and organize content for collaborators
  - Share projects with either internal or external collaborators
    - Access levels can be set on a per-project basis to address security concerns
  - File Upload to Cloud/Download to local resources
    - Files can be uploaded to either:
      - Xcelerator Share account home folder
      - Projects and/or folders within projects
    - Files selected for download are compressed and unarchived when download is complete
    - Download status is displayed in the Xcelerator Share Downloads window



  - View and markup for CAD files
    - CAD files can be selected from any project and viewed interactively

- Tools are available to add text annotations, obtain dimensions and add markups



  - Working with downloaded files
    - Downloaded Simcenter STAR-CCM+ .sim files are opened via the **Open Simulation** button in the Downloads window
    - For CAD content, a **Copy Path** button places the fully resolved file location and name in the paste buffer
      - Provides a consistent workflow to add CAD files wherever they are needed in your simulation efforts

Deployment

- **Certified operating systems (OS)**
  - RHEL 7.9, Amazon Linux 2, HPE Cray OS (supported)
- **Retired operating systems**
  - CentOS 7.4
- **Scheduled operating systems support changes for Simcenter STAR-CCM+ 2022.1**
  - Adding: RHEL/Rocky 8.4, OpenSUSE Leap 15.3 SLES 15 SP3, Cloud Linux 8
  - Adding: Windows 10 21H1, 21H2
  - Retiring: CentOS/RHEL 7.7, 8.0, 8.1, CentOS 8.2, openSUSE Leap 15, 15.1, SLES 12 SP3, SP4, 15, 15 SP1
  - Retiring: Windows 10 1903, 1909, 20H1, Server 2012
- **Retired Message Passing Interface (MPI) versions**
  - Platform MPI 9.1.4.4 (LINUX and Windows)
- **Scheduled Message Passing Interface versions for Simcenter STAR-CCM+ 2022.1**
  - Adding: Intel 2021.2 (Windows)
  - Retiring: Intel MPI 2019.7 (LINUX)

CAD Integration

CAD-Clients

- **Updates**
  - *Support for Siemens NX Version 1980 is added in the Simcenter STAR-CCM+ 2021.2 B release

CAD Clients	Version
Siemens NX/Simcenter 3D	Windows up to NX 1980* **Linux NX 12 to 1953**
Inventor 2021	**Windows 2021**

Key: **New** No change

CAD-Exchange

- **Updates**
  - *Support for Siemens NX Version 1980 is added in the Simcenter STAR-CCM+ 2021.2 B release

Siemens CAD Reader	Version
Siemens NX	Up to NX 1980*

HOOPS CAD Reader	Version
Siemens NX	Up to NX 1926
CATIA V5	**Up to V5-R2020**
Inventor	Up to 2021
ACIS	Up to 2020

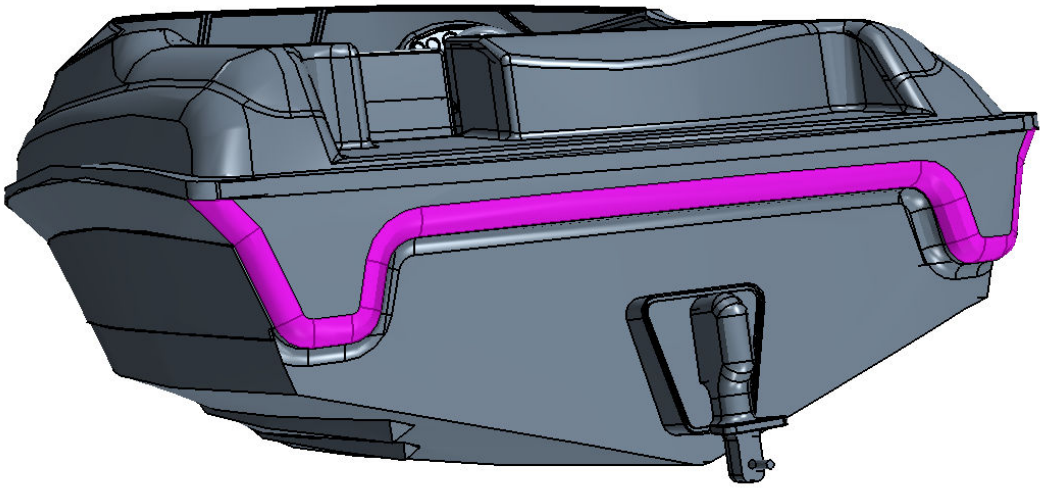
Key: **New** No change

Geometry

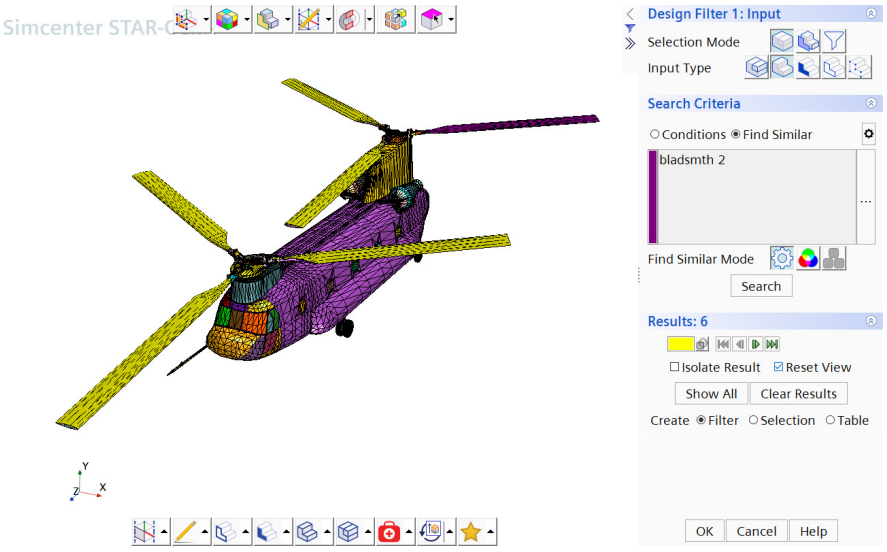
3D-CAD

- **Export 3D-CAD model D2854, D898, D2750, D5376, D5500, D4321**
  - Easily collaborate on geometry preparation by transfering entire 3D-CAD model between .sim files
    - Export Parametric CAD option is added on the 3D-CAD Model node in the simulation tree
    - Creates CAD file and a separate java file with all the features from 3D-CAD
    - Suppress, Rollback, failed features not exported
- **Move face**
  - Parameterize imported geometry for design study
    - Move a collection of faces in a linear, angular, or radial direction
    - Use Overflow Behavior options to define output behavior for overlapping faces
- **Face selection**
  - Improved productivity through a faster selection of complex or multiple faces for geometry preparation

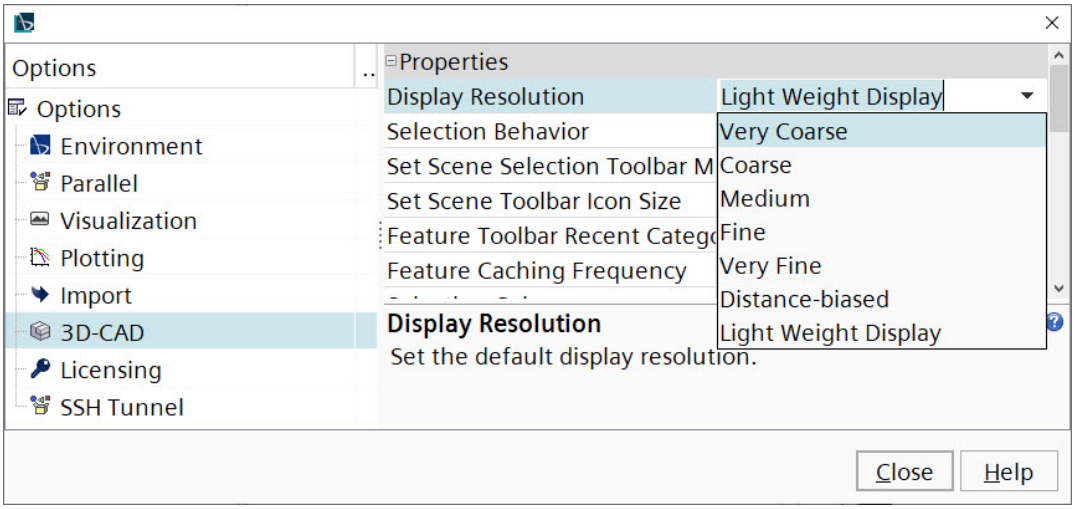
- Select interior face to easily select faces from holes, pockets, and ribs for defeature faces operation
- Tangent face selection by holding the shift key to select continuous fillets



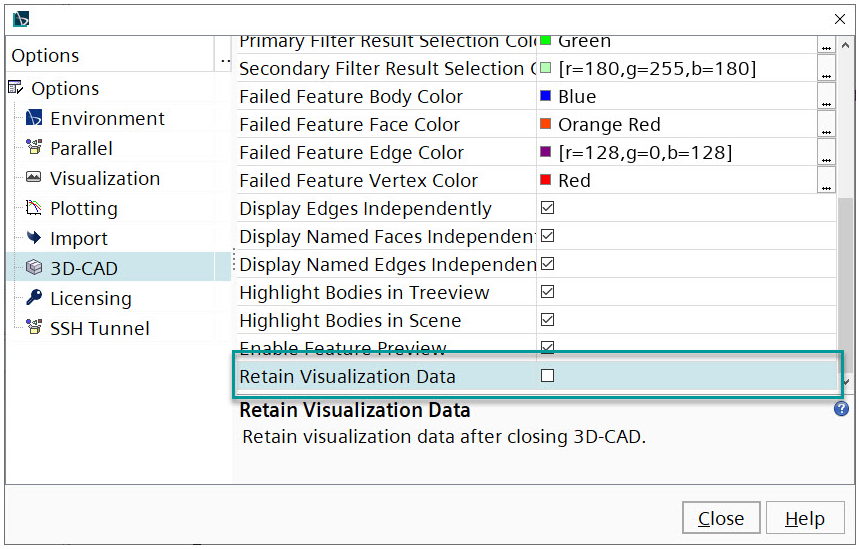
- **Support tessellated geometries in 3D-CAD**
  - Faster geometry organization for tessellation imported into 3D-CAD
    - Import facet data format as stl, JT Tessellation, and dbs files
    - Use the search tool, section cut, and explode view to organize geometry
    - Easily distinguish between facet bodies and sheets in the tree through different icons
    - Transfer facet data as mesh part for further mesh pipeline operation



- **Light weight display**
  - Faster interaction and visualization with low tessellation representation
    - Recommended to use for assemblies of 10 000 bodies or more
    - Global option, off by default
    - Import and feature execution time have seen up to 2x speedup

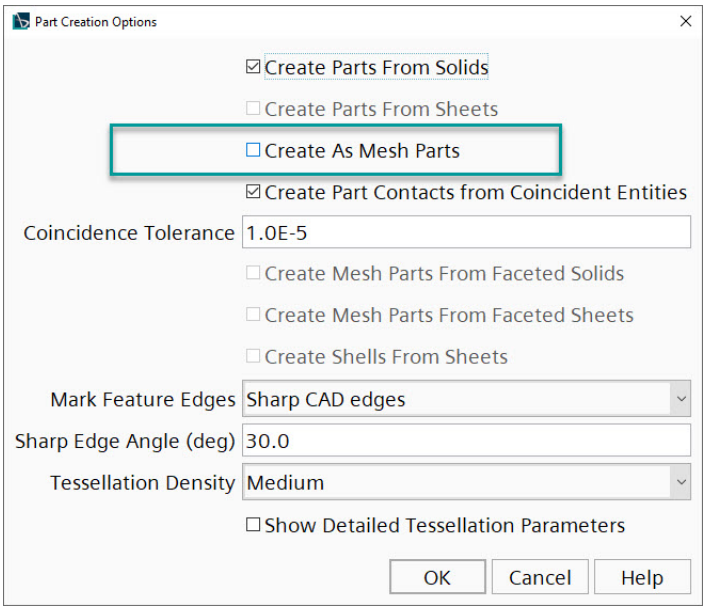


- **Unite/Subtract diagnostic tools**
  - Quickly locate the possible source of errors for unite operation failures
    - Failure location highlighted when selecting the failed feature
    - All possible failures are highligthed
    - Global option to change highlight color
- **Retain visualization data**
  - Faster access to 3D-CAD model in an existing .sim file through global option to retain visualization data
    - Avoid tessellation when opening a 3D-CAD model
    - Increased file size compared to the original CAD due to storing tessellation for visualization



- **Face normal - Extend edge**
  - Faster method to close gap between sheet bodies
  - Use the existing edge to move the face in the normal direction
- **Refit - Repair Faces**
  - Remove invalidities in the imported geometry for a better success rate of downstream operations like unite, sew, etc.
- **Transfer CAD as Mesh parts**

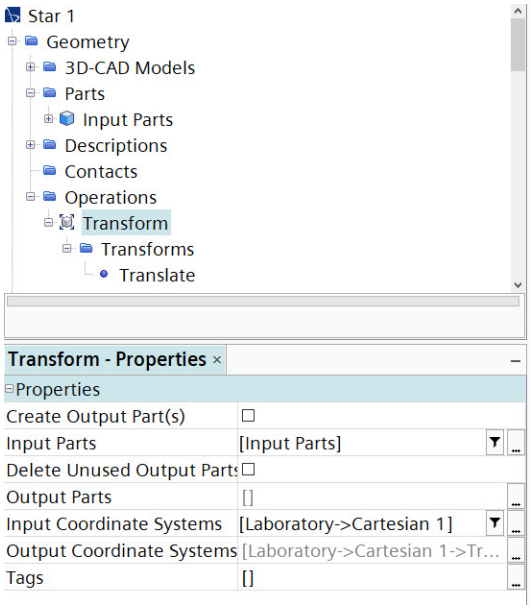
- Faster method to transfer data from 3D-CAD to parts since the tesselation data is lighter compared to the CAD
  - Transfer CAD data as mesh part for further mesh pipeline operation
  - CAD associativity is not maintained with the parts



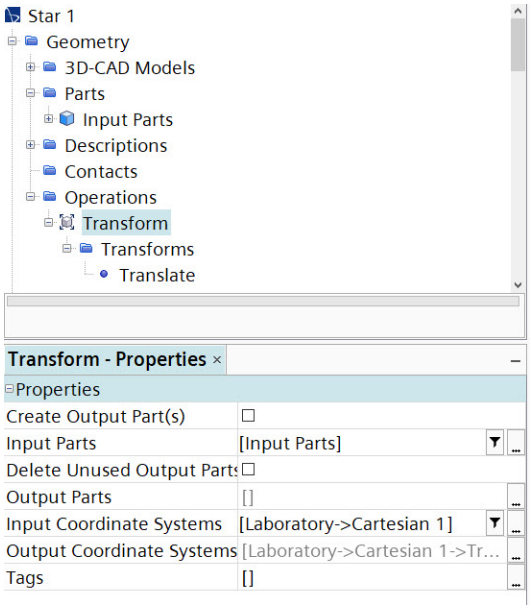
- **Expression support in panel**
  - Easier assignment of parameters in all 3D-CAD feature panels for design studies
    - Convert coordinate system into a single field to assign a vector
    - Parameters created from the panel are highlighted in green
    - Tool-tip to indicate the current values for expression fields
- **Additional 3D-CAD features**
  - Triad to control orientation for rotate, revolve, extend solid, and move face features
  - Create axis with origin and direction option
  - Tolerance option in shell, thicken, and extend solid features
  - Allow imprint option in subtract feature
  - Tolerance option to control find similar feature output in the search tool

Parts

- **Transform coordinate system D3056**
  - Improved automated template workflow by allowing coordinate system to be transformed with parts
    - Always creates a new coordinate system
    - Newly created coordinate system is located under the parent coordinate node



- **Offset operation - Parts based shells**
  - Create offset surface around shell parts
    - Option to include the source part with contact to the output shell



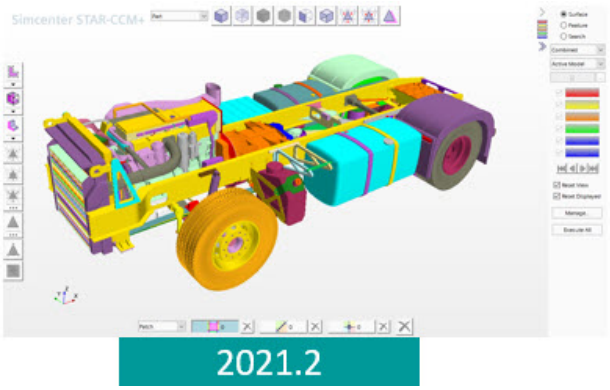
- **Retain descriptions after deleting parts**
  - Improved automated template workflow by retaining the description when all parts are deleted

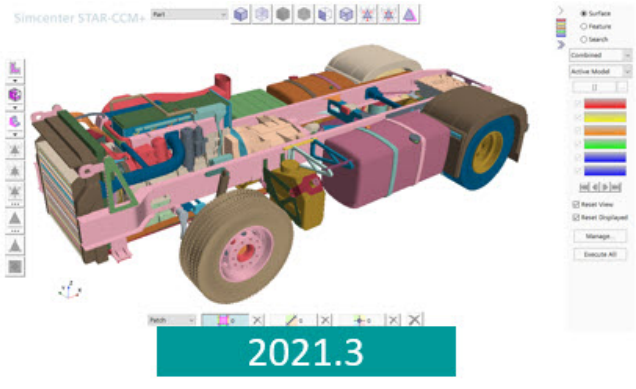
Mesh

Surface Repair

- **Improved visual effectiveness through better Scene defaults**
  - New palette colors automatically applied for:
    - Color by distinguishing part, patch, part surface, etc
    - Assign color while creating part and part surface

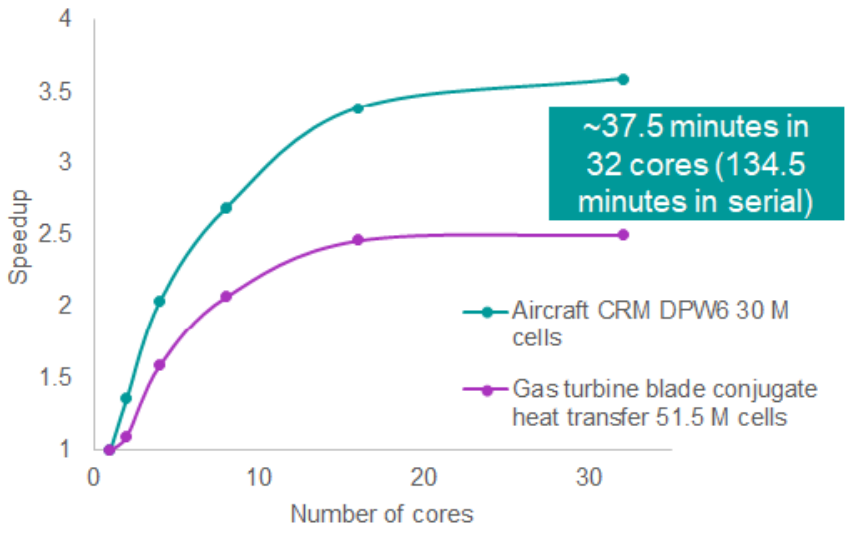
- Color for source and target in feature panel





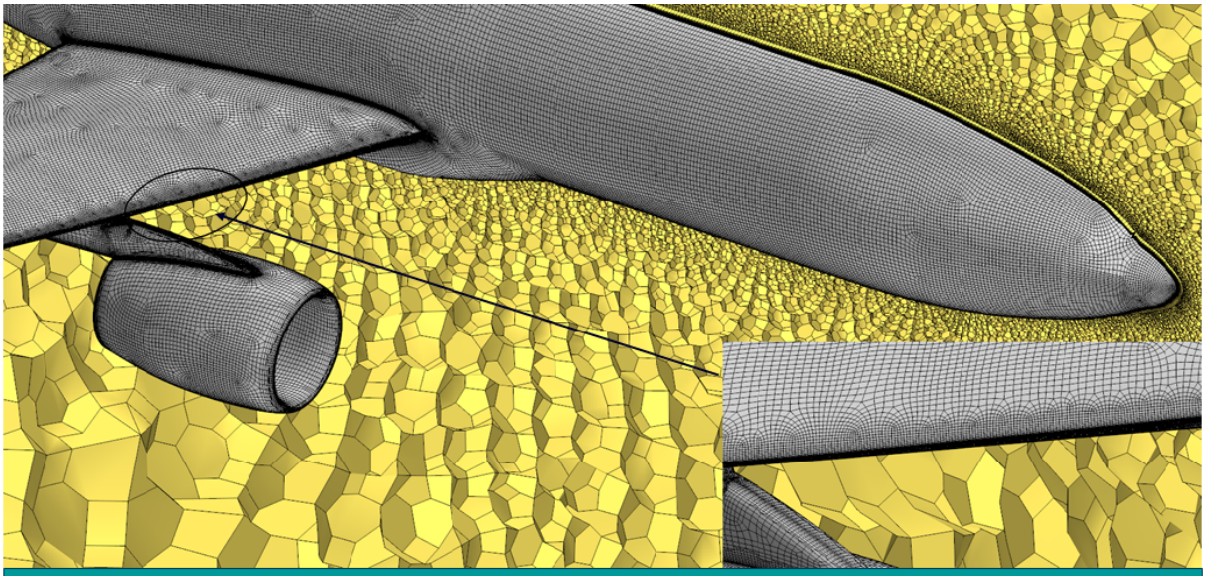
Volume Mesh

- **Parallel core advancing layer mesher**
  - Faster generation of polyhedral meshes with advancing layer mesher
    - Core mesh generation is now parallelized
    - Consistent mesh across different core counts
    - Up to 3.6x faster for 32 cores (case-dependent)

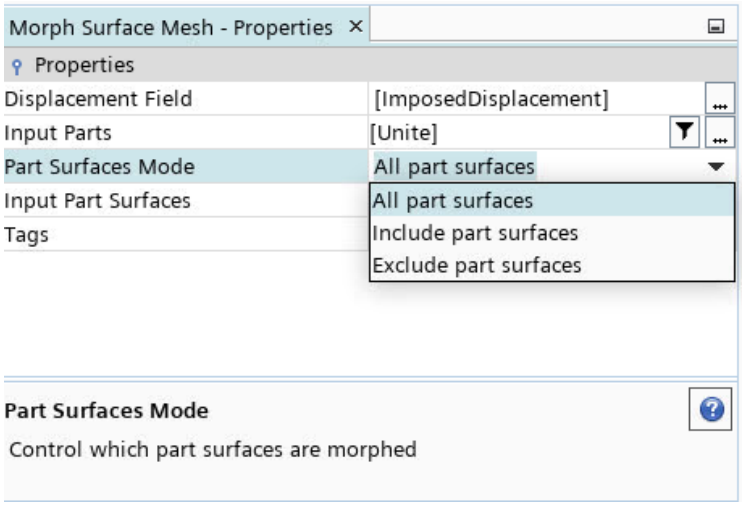


Average cell count difference serial up to np=160 for 24 industrial cases < 0.1%

- **Anisotropic near wall meshing**
  - Increased simulation throughput through fast and efficient anisotropic meshing
    - Efficient mesh distribution to capture high curvature geometry
    - Faster mesh generation and lower memory usage through reduced overall mesh count
  - Anisotropic meshing is enabled through intuitive custom curve controls
  - Available for advancing layer mesher with polyhedral or tetrahedral cells
  - Applications: Fixed & rotary wing aircraft, propeller blades, wind turbines



- **Select part surfaces in morph surface mesh operation**
  - Robust mesh deformation through improved assignment of part surfaces
    - Previously the entire part was used for morphing which could lead to undesired displacements at adjacent boundaries that were not supposed to deform
    - Now individual part surfaces can be included or excluded from the morph surface mesh operation
    - Applications: Shape optimization studies

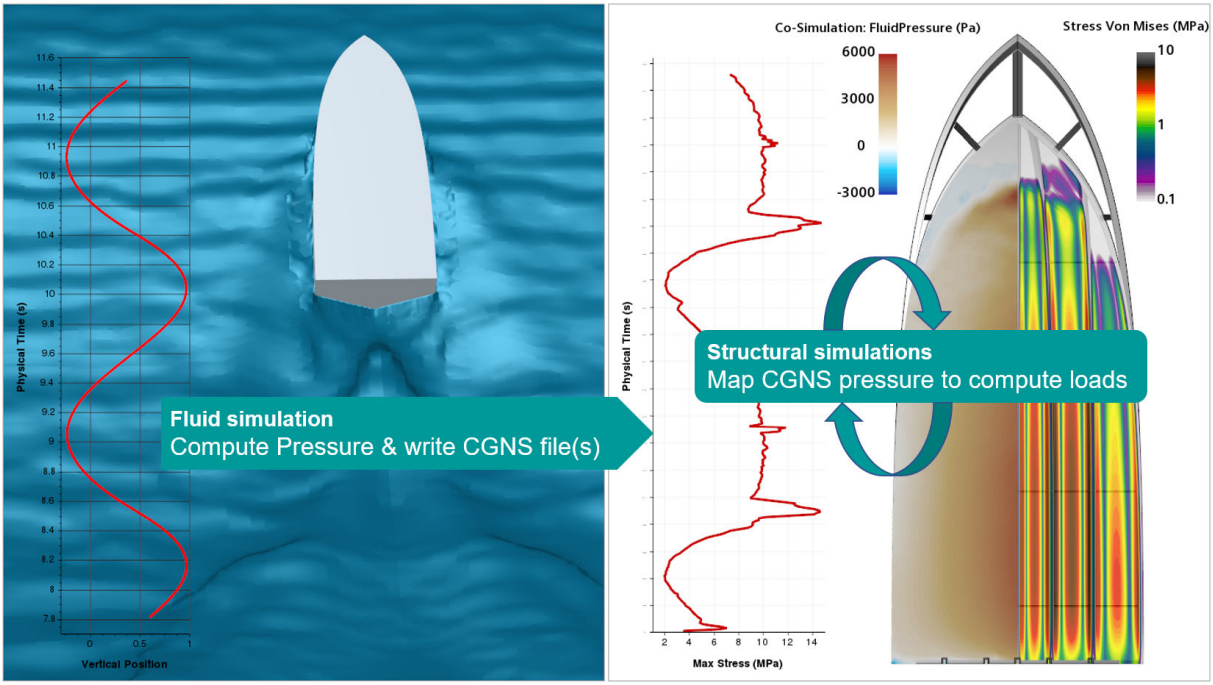


  - **Directed mesher performance improvements**
    - Faster mesh generation for serial directed mesher
      - Up to 3x faster (case-dependent)

CAE Integration

- CGNS Workflow improvements
  - Increased co-simulation productivity through CGNS workflow enhancements

- Fluid and structural teams can work independently
  - Fluid team generates the CGNS data source(s)
  - Structural team leverages an automated and robust CGNS workflow to generate structural results



- Key improvements
  - New Map after Import option
  - A Default Data Mapper is created on import
  - Mapping from CGNS to native regions is automatic
  - Time interpolation is now possible when mapping
  - Surface or Volume parts (but not both) can be selected

Physics

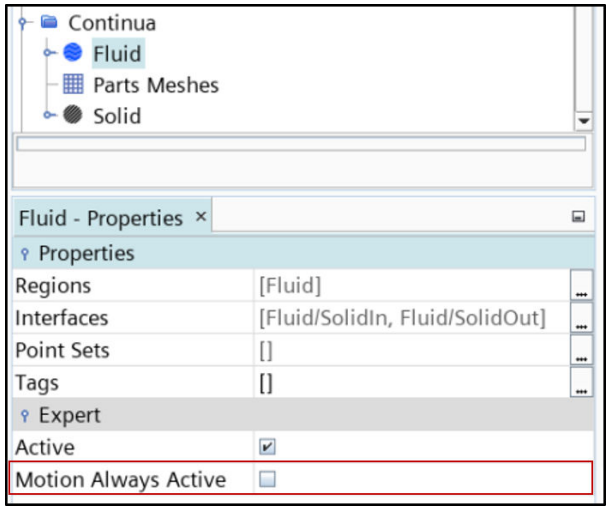
CFD
Multiphase Flow
Computational Rheology
Computational Solid Mechanics
Electromagnetics and Electrochemistry
Aeroacoustics
Motion, Mesh Adaption, and Mapping

CFD

Flow

- **PISO with face flux updates at each corrector step**
  - Up to 1.15x overall solution speedup for LES gas turbine combustion and in-cylinder simulations due to algorithmic changes in the PISO solver

- **Segregated solver speedup for constant value species**
  - Improved efficiency of combustion solutions by not solving the species field when constant
    - Up to 1.3x overall speedup for in-cylinder simulations
  - The new algorithm skips unnecessary calculations in the Segregated Species Solver when the species solution is trivial, for example when:
    - There is no convection or diffusion
    - There is no evaporation or dilution
  - Speedup is proportional to the number of species
- **Coupled species compatibility with non-reflecting boundary condition**
  - Accurate representation of hot gases in turbine blade aerodynamics by accounting for coupled species in the non-reflecting boundary condition
  - Improved convergence in multi-component turbine simulations when using non-reflecting boundary condition
- **User specified motion activation with Activate/Deactivate workflows**
  - Improved user experience in multi-timescale simulations with motion thanks to Motion Always Active option
    - Choose if motion is to be activated in an inactive continuum
    - Previously motion was always activated for active and inactive continua



Note: Caution needs to be taken when motion is activated in inactive continua as use of large time-steps might induce errors

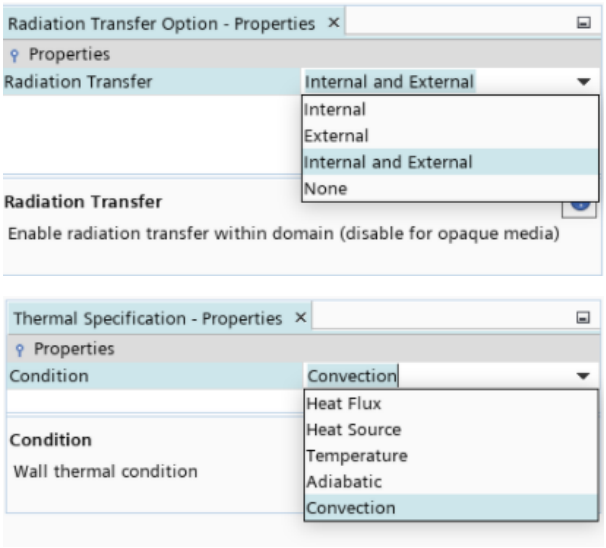
- **Expression input for under-relaxation factor (URF) and CFL ramps D5532**
  - Improved flexibility for templating and design exploration studies by allowing expression inputs for URF and CFL ramps, and turbulent viscosity solver URF
  - Reduced need for scripting and easier use of Simulation Operations with global parameters
  - Allows the use of design exploration for optimum setup in terms of speed and robustness

Energy

- **New external radiation workflow**
  - More intuitive and less error-prone setup of simulations with external radiation thanks to consolidated workflow
    - A region-based option can now activate external radiation on all boundaries of the region

- Minimizes risks of incorrect setups, for instance where boundaries are left out by mistake

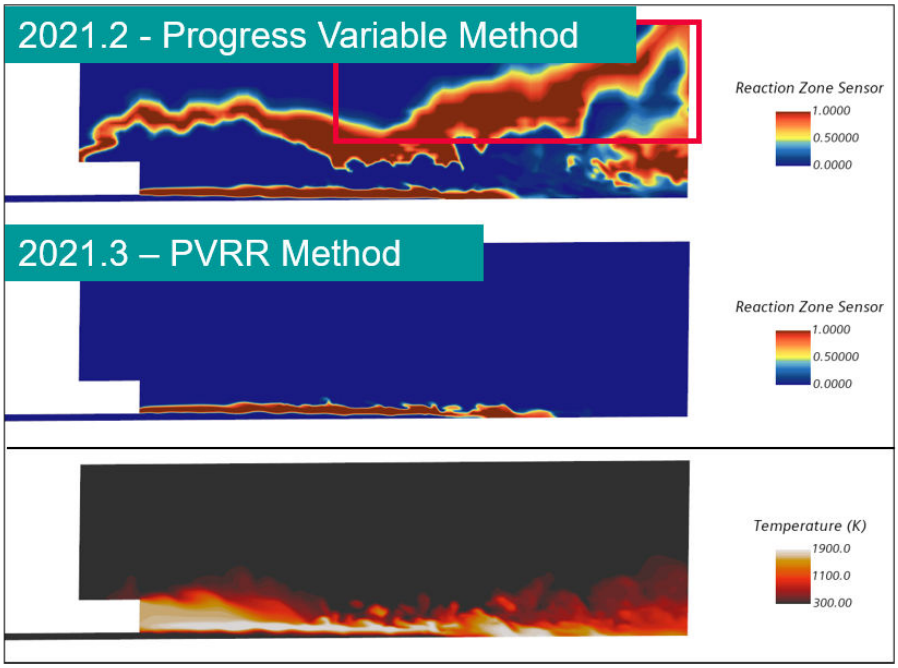
- Wall thermal condition Environment merged into Convection
  - The Thermal Resistance option is now activated by the Convection condition
  - External radiation can now be enforced in addition to other thermal boundary conditions
- Surface Orientation option has been retired, Radiation Transfer option now offers choice for making a region radiate only internally, or only externally, or both (dual)
  - Dual sided option was previously not available



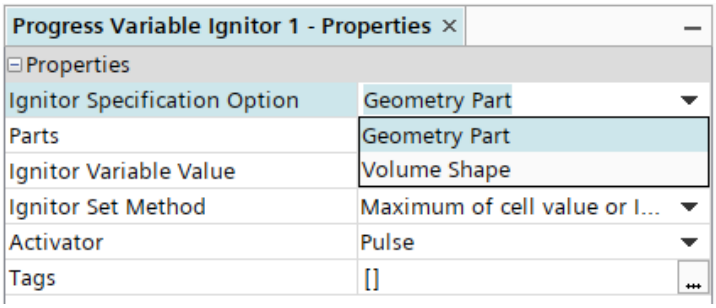
- **Radiation contribution per part D3663**
  - More meaningful post-processing of radiative results with Surface-to-Surface, by allowing more granularity in visualizing radiation fields
    - New workflow allows to filter radiation contribution that is generated only from a subset of sources or reaching only a subset of targets
    - The source and target selection is Parts-based
  - Useful for identifying root-cause of thermal hotspots due to radiation and for designing preventive thermal screens

Reacting Flows

- **Improved reaction zone sensor for Flamelet Generated Manifold (FGM) with Thickened Flame Model (TFM)**
  - Improved accuracy of FGM-TFM simulations with new Progress Variable Reaction Rate (PVRR) definition for reaction zone sensor
    - TFM active only around the flame front
    - Avoid changing mixing outside of flame region
    - Complements already available Progress Variable and User Defined options for reaction zone sensor



- **Flamelet table interpolation optimization**
  - Faster turnaround time for flamelet simulations with table interpolation improvement
    - Up to 1.3x speedup
    - Applicable to all flamelet models
- **Ignitor definition from geometry parts** D2846
  - Reduced set-up time through easier ignitor definition using any geometry Part as input
    - Previously, only simple Volume Shapes (Block, Cone, Cylinder, Sphere), could be used as inputs
    - Applicable to any reacting flow simulation that requires an ignitor



  - Flexible ignitor positions with geometry operations
    - Ignitor positions can be configured to follow geometric changes for example during design space exploration
- **Coagulation source scaling for Soot Moments and Soot Sectional models**
  - Improved soot particle size distribution through possibility to scale coagulation source term
    - Complimentary option to existing Surface-growth, Nucleation, and Oxidation Scales
- **Progress Variable field function in temporary storage for Complex Chemistry with Turbulent Flame Closure (CC-TFC)**
  - Clearer post-processing options with move of Progress Variable field function in temporary storage
    - Recommended practice to use other CC-TFC reaction product mass fractions to monitor simulation

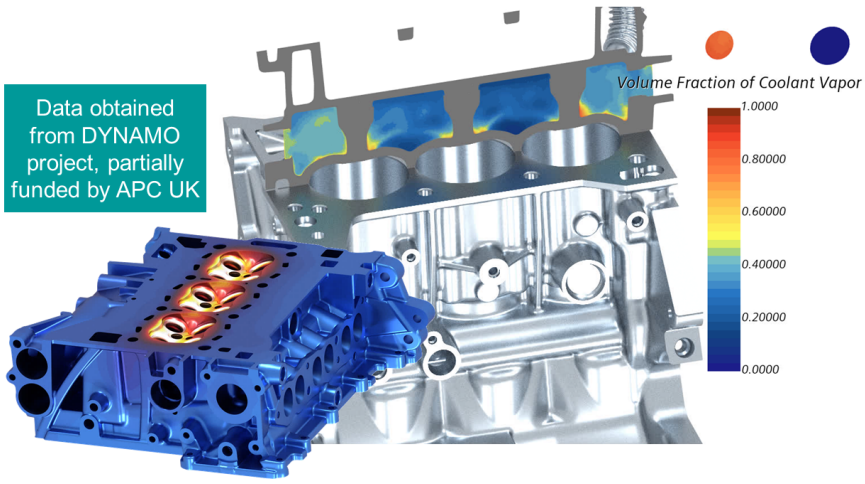
Multiphase Flow

Volume of Fluid (VOF)

- **Transition Manager for resolved VOF-Lagrangian (LMP) transition model**
  - Improved ease of use for hybrid multiphase provided through a new manager for VOF to LMP transition
    - Previously all criteria had to be contained in a single field function
  - Manage multiple criteria for transition based on
    - Blob diameter (predefined)
    - Blob shape (predefined)
    - User criteria (arbitrary field function)
  - On creating a resolved VOF-LMP phase interaction, two criteria are generated automatically
    - Blob diameter (default range 1e-6m to 1e-3m)
    - Blob shape (Sphericity > 0.7, Inertia Tensor Eigenvalue Ratio > 0.8)
    - These can be changed, deleted, or added to

Mixture Multiphase (MMP)

- **Wall/bulk boiling for MMP**
  - More accurate boiling simulations
    - Include more of the physics of boiling with a comprehensive family of sub-models to capture all relevant phenomena
    - More accurate than correlation based models such as Rohsenow which work well for some applications but not others
  - Reduced computational cost compared to Eulerian Multiphase (EMP) for appropriate cases
    - Previously wall/bulk boiling models only available for EMP
    - Allows you to use cheaper MMP model for boiling
  - Unal sub-model for wall bubble departure diameter suitable for wide range of system pressure levels including low pressure applications



Two-Phase Thermodynamic Equilibrium Model

- **Improvements to Drift Flux Model**
  - Improved stability provided by additional controls for the Drift Flux model

        - Under-Relaxation Factor (URF) - Explicit under-relaxation of drift flux sources
        - Max Acceleration Change - Maximum acceleration magnitude change per iteration due to drift flux

Eulerian Multiphase (EMP)

- **Adaptive time-step providers for EMP**
    - Improved ease of use with additional time-step providers reduce solution time for certain categories of simulations
        - You no longer need to determine a time-step size that will be stable and maintain accuracy throughout a transient run
            - Allows larger mean time-step to be run
            - Three new providers:
                * Smoothed Convective CFL

                  As previously available outside of EMP
                * LSI Smoothed Convective CFL

                  Available when ADIS scheme selected

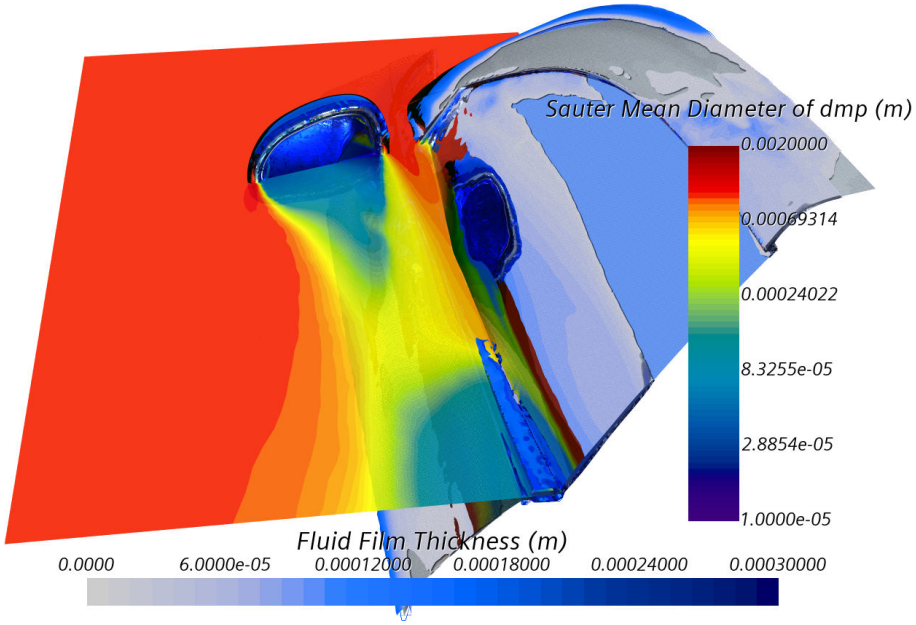
                  Only considers CFL in vicinity of the free surface
                * Free Surface

                  As previously available for VOF
- **Source smoothing for Fluid Film stripping into Eulerian Multiphase (EMP)**
    - Improved stability and reduced computational expense
        - Previously mass stripped from Fluid Film only added to near wall cell
            - Could overload cell in case of thin prism layers and lead to limiting of stripped mass
            - Mitigation was a small time-step size to avoid associated instability
        - Now mass can be spread over several cells with source smoothing approach
            - Analogous to using larger cell for Fluid Film stripping
                * Typically minimum cost in terms of accuracy as mesh density is aimed at other physics
    - Improved ease of use
        - Avoids need to design mesh specifically for Fluid Film stripping
            - Mesh can be designed for continuous fluid with low y+ without impacting stripping
- **Compatibility of EMP Phase Coupled Energy and Fluid Film**
    - Model heat transfer between Fluid Film phases and EMP phases
        - Basic compatibility of Phase Coupled Energy with Fluid Film is provided
        - Includes transfer of energy via Fluid Film impingement and stripping
    - Limitation:
        - Phase interaction models between the Fluid Film and EMP phases including energy transfer (such as evaporation) not supported

Dispersed Multiphase (DMP)

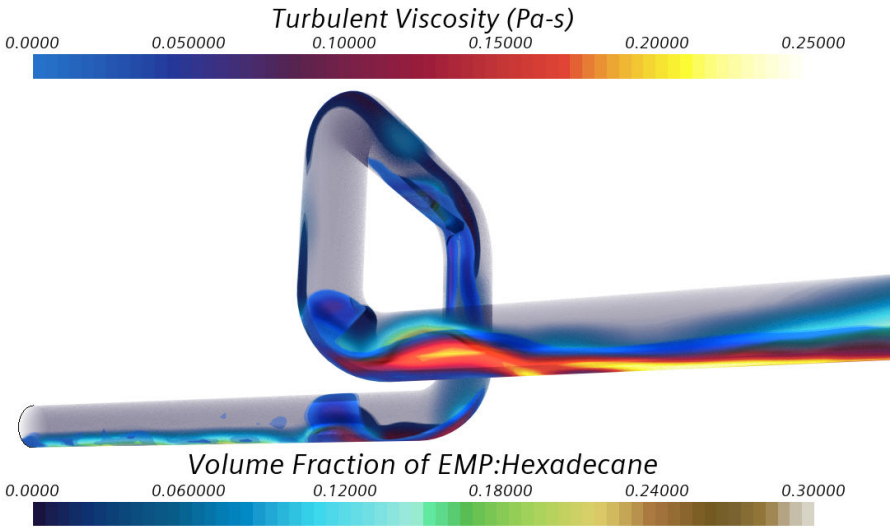
- **S-Gamma population balance model for DMP**
    - Accurately predicts droplet/bubble size distributions for dispersed phases
        - Includes physics such as breakup and coalescence
    - Reduced computational cost compared to MMP and EMP approaches
        - DMP is a lightweight model for low volume fractions
        - Easily added to a single phase modeling strategy

    - Available with the Coupled Solver
    - Can be carried out as post-processing step
  - Benefits applications such as vehicle water management and aircraft icing



Fluid Film

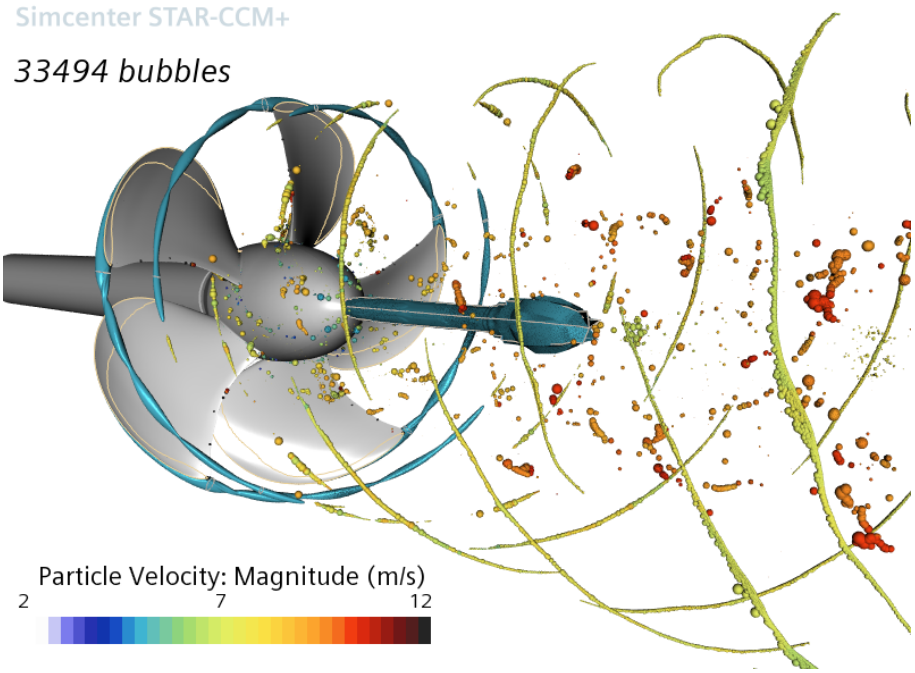
- **Turbulence for Fluid Film**
  - Improved accuracy for industrial problems with Fluid Film
    - For many applications the film can be in the turbulent regime
    - Particularly relevant for thick films
    - Previously Fluid Film could only be modeled as Laminar
  - Turbulent viscosity is modeled algebraically, there are three options:
    - Cioncolini model - suited to annular flows
    - Mudawwar model - suited to heated films
    - Field Function



- **Fluid Film solver options for PISO**
  - Reduced computational expense when using Fluid Film with PISO
    - Fluid Film update frequency now has options that are more efficient for PISO
    - No need to update Fluid Film during every PISO corrector step/iteration
    - Three options provided:
      - First and Last Iteration
      - Last Iteration
      - Every Iteration - Previous behavior and approach used for SIMPLE

Lagrangian Multiphase (LMP)

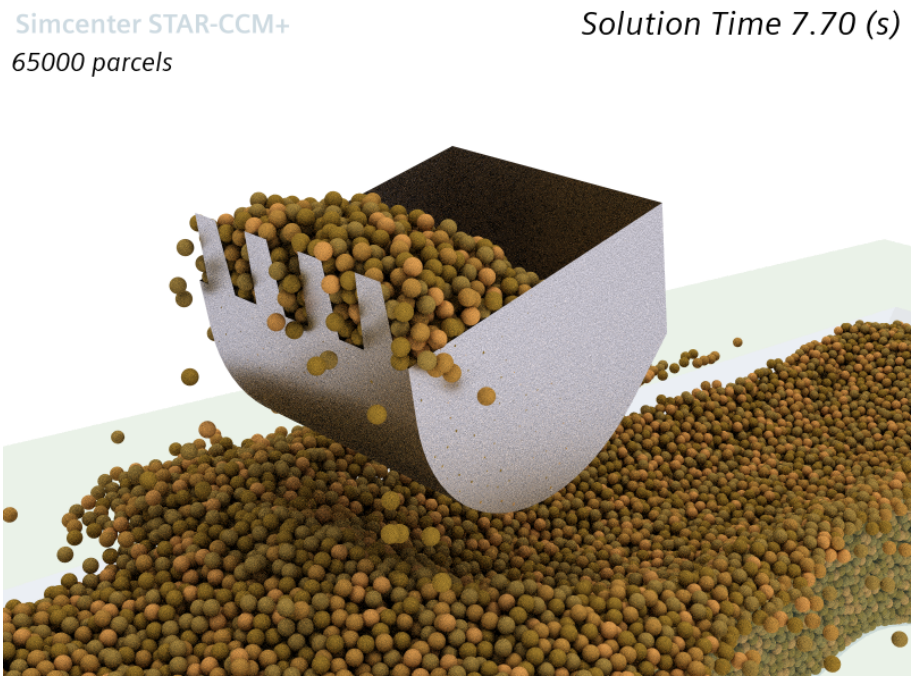
- **Support for bubbles in resolved VOF-Lagrangian transition model D1541**
  - Speed benefits of hybrid multiphase approach available for wider range of applications
    - Formation of bubbles is resolved with VOF
    - Subsequent tracking done with Lagrangian
  - Combines adaptive mesh refinement with cell clustering to balance accuracy and turnaround time
  - Available for single component gas



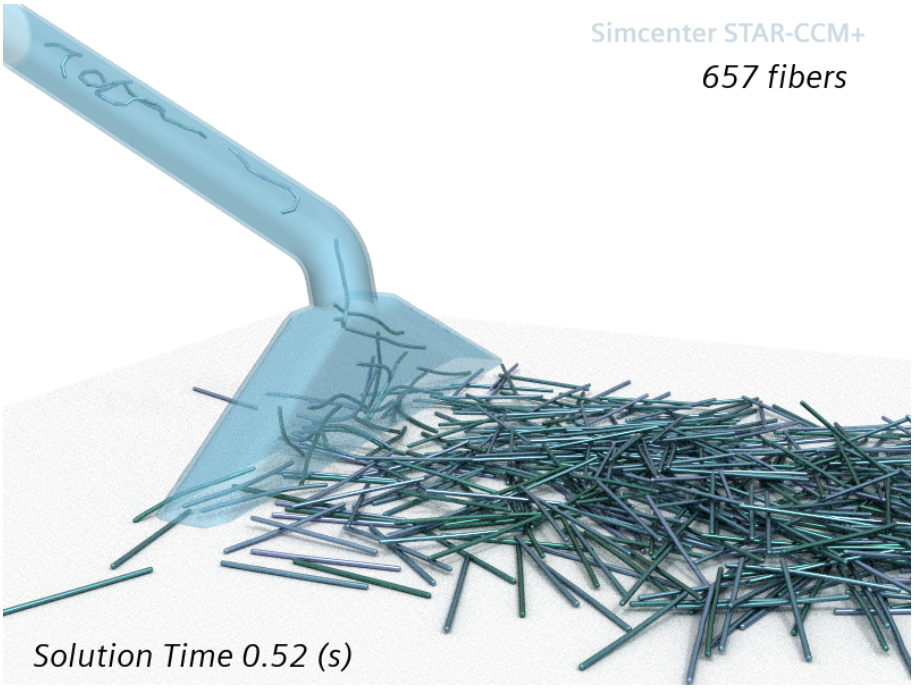
Discrete Element Method (DEM)

- **Meshfree DEM D3651**
  - Improved ease of use with new workflow for simulations where DEM interaction with fluid flow can be neglected
    - No longer requires
      - Volume meshing step
      - Geometry preparation, including enforcing watertight condition
      - Continuous phase fluid models and solvers
      - Overset mesh for complex motion

- Speed-up of DEM computations
  - On average 5x speedup for all applications with moving boundaries
- Reduced time to solution due to improved stability and robustness of DEM simulations
- Application examples in Heavy Equipment industry
  - Soil/rock excavation
  - Dump truck unloading
  - Agricutural machines and attachments
  - Mining and construction equipment



- **Flexible fibers D5039**
  - Improved speed and ease of use for all applications with flexible elongated particles through introduction of new Flexible Fiber model
    - Non-spherical fiber segments – cylinders
    - Optimal solution for bending and axial stiffness of fibers
    - Faster than using Particle Clumps



- **Repeatability of DEM simulations with Random Injector**
  - Helps in interpreting the results of parametric studies or DEM model calibration
- **Injector Orientation Specification option improved**
  - For setting initial orientation of DEM particles, you provide angles in the lab frame
  - No need for adjusting the orientation input to account for the difference between moment of inertia reference frame and lab frame

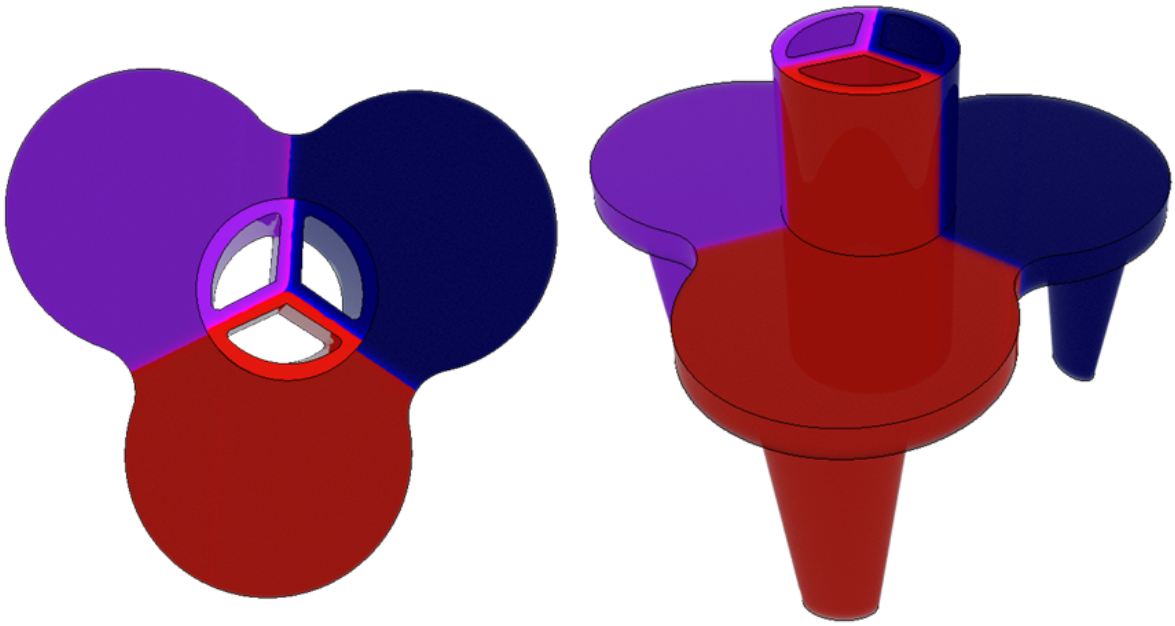
General Multiphase

- **Phase Mass Conservation Error Report D1728**
  - Increased accuracy by ensuring convergence by using a new report type Mass Conservation Error
  - Most useful for transient cases (but can also be used for steady state simulations)
    - Reports mass error for selected phases within a time-step or iteration
  - To monitor the cumulative mass error incured throughout a simulation, use a cumulative monitor of this report
    - Particularly useful in closed systems to identify systematic mass errors before they can accumulate
  - Can be used as the basis for stopping criteria to
    - Avoid uneccessary iterations to reduce computational cost for a given accuracy
    - Ensure convergence to improve accuracy for a given computational cost
  - Applicable to phases of VOF, MMP, EMP, Fluid Film, and DMP

Computational Rheology

- **Viscous Multiphase Solver D4011**
  - Predicts interaction of multiple viscous fluids
    - Model transient or steady state multiphase flow
    - Each phase may have a different rheological model including generalized Newtonian and viscoelastic models

- Predicts phenomena such as encapsulation in co-extrusion
- Provides alternative to morpher to find interface between fluids
- Fluids can wrap around each other, separate, or undergo other topology changes that are impossible with the morpher due to fixed mesh topology



Computational Solid Mechanics

- **Eigenvalue analysis for normal modes D3687**
  - Gain structural performance insights by accessing vibration characteristics of structures with modal analysis
    - Extracts natural vibration mode shapes and frequencies of the structure
    - Allows determination of appropriate time-step to then model transient structural or fluid-structure interaction simulations
  - Reduced use of third-party tools thanks to inbuilt solution
    - Solid Stress Normal Modes optional model
    - Normal Modes accessible as Solution View
  - Support for linear models only: pre-stressing or pre-loading will not affect the model
- **FSI of Hyperelastic materials with contact: linearization of surface load**
  - Reduced time to solution with more efficient pressure linearization algorithm for highly nonlinear materials and applications
    - Relevant for applications with Hyperelastic materials (rubber), mechanical contact, large deformations, or strong fluid-structure coupling
- **Adaptive Time-Step Size - specify value for interval**
  - Enhanced solver controls for improved convergence with ability to specify time-step size on a given interval
- **Mechanical contact (frictionless, rigid obstacles): full linearization**
  - Reduced computational expense for contact simulations with curved, rigid obstacles
- **FSI Coupling Specification options renamed**

- Easier set-up through clearer options in FSI Coupling Specification
  - Solid Deformation was renamed Solid Displacement, and None was renamed Uncoupled
- **Finite Volume Solid Stress is hidden in 2021.3**
  - Planned to be retired in 2022.1

Electromagnetics and Electrochemistry

Electromagnetics

- **Alpha-beta formulation for permanent magnets**
  - Simplification of setup of permanent magnets with temperature-dependent behavior thanks to introduction of alpha-beta formulation
    - Alpha-beta formulation is standard among manufacturers of magnets
    - Removed need to pre-compute or provide magnets' behavior via several B-H curves at different temperatures
- **Ampere-Turn method in Excitation Coil models split into different input conditions**
  - More intuitive setup of current-driven coils and busbars
- **Speedup of 2D simulations of e-machines**
  - Faster simulations and improved convergence in 2D thanks to revised algorithm
    - Current conservation is now enforced with an implicit method that allows for faster computations
    - Previously used explicit method was slow for simulations with high electrical conductivities
    - Range of speedups observed depending on the simulation

Case	Number of processors	Speedup
E-machine 1	1	9.6x
E-machine 2	1	33.2x
	2	26.5x
	8	34.2x
	32	37.8x
E-machine 3	1	7.1x
	5	8.9x
	32	7.9x

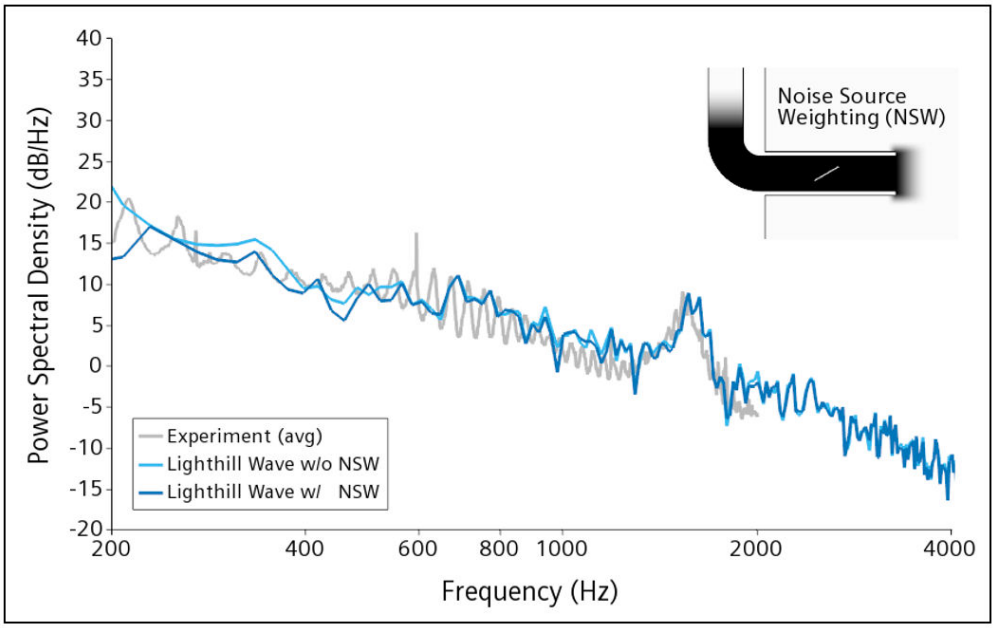
Electrochemistry

- **Electrochemical reactions with charged species**
  - Simplification of corrosion simulations thanks to charged species now able to participate in electrochemical reactions
    - Charged Species model now compatible with Electrochemistry Potential Reacting model
    - By using the Charged Species model, you can run simulations without having to necessarily impose Electrochemistry's dilute assumption (as required when Electrochemical Species model is utilized)
- **Implicit discretization of homogeneous electrochemical reactions in phasic porous media**
  - Improved robustness and reduced computational expense thanks to new implicit discretization
- **New warning message when default unit porosity is used with Electromagnetism model**
  - New message helps preventing wrong setups of phasic porous media

- **Expression support for under-relaxation factor of Electrochemistry Coupled Solver**
  - Improved flexibility for templating and design exploration studies with ability to use global parameters in expression definition

Aeroacoustics

- **Lighthill Wave model**
  - Enhanced ease of use and reduced opportunity for error with new hybrid aeroacoustics modeling approach, targeted at HVAC (Heating, Ventilation, Air Conditioning) systems
  - Simplifies the setup process, removes the need to define noise source regions compared to existing hybrid approach, the Acoustic Wave model
  - Reduced turnaround time with ability to use coarser meshes and fewer inner iterations yet retain accurate predictions compared to best practices with existing hybrid approach using the Acoustic Wave model



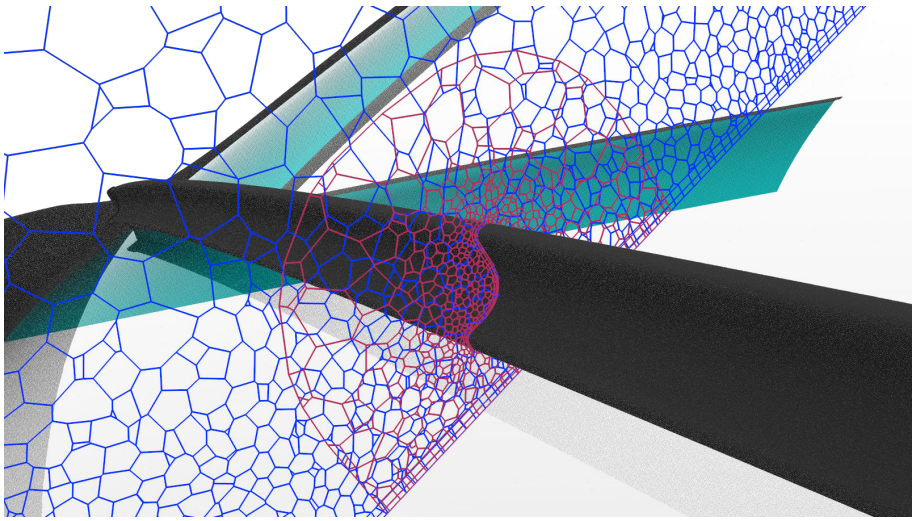
- **Ffowcs-Williams Hawkings (FW-H) data without .csv files**
  - Access FW-H results faster through an embedded workflow
  - No longer requires exporting and re-importing external .csv files as tables: access FW-H results natively, similarly to the monitor data
- **Standard Newmark (temporal scheme in Acoustic Wave solver) retirement in 2022.3**
  - Standard Newmark temporal scheme option of the Acoustic Wave solver has been deprecated starting in Simcenter STAR-CCM+ 2021.3 and is planned to be removed in 2022.3. The recommended practice is to use Newmark Alpha instead.

Motion, Mesh Adaption, and Mapping

- **Optimized interface performance for a large number of contacts**
  - Faster simulations for large number of contacts through automatic multithreading of topology-based interface intersection

        - Solver automatically switches on multithreading for improved concurrency based on number of contacts and available computing resources
            - Activated when the number of contacts is higher than available CPU sockets, for example:
                * Number of contacts = 20; Using 5 nodes with 2 sockets/node, available sockets = 10.
        - Applications: Engine crank case oil splash with several rotating components
        - No changes to user interface

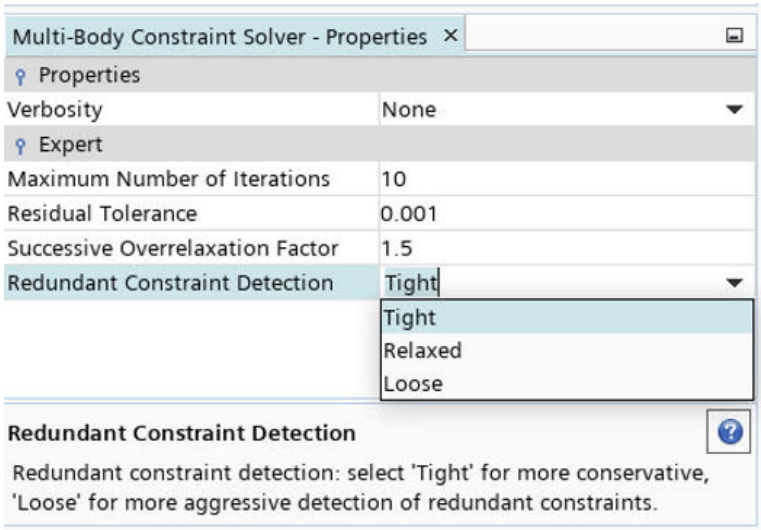
- **Remeshing solver for dynamic fluid body interactions D2286**
    - Robust dynamic fluid body interaction (DFBI) morphing simulations through automatic remeshing
        - Upon encountering invalid mesh solver rolls back to the previous state and remeshes
        - Previously only explicit motions were supported
        - Now DFBI implicit motion cases are supported where body motion within inner iterations of a time-step may create an invalid mesh
            - If body motion within the first inner iteration of a time-step creates invalid mesh, then solver is rolled back to the beginning of time-step and remeshing is done
            - If body motion within a later inner iteration of a time-step creates invalid mesh, then solver is rolled back to the previous inner iteration, the 6-DOF solver is frozen to let other flow physics converge, and remeshing is done at the next time-step
        - Applications: Electric machines, marine sink, and trim
- **Remeshing solver for user-defined vertex motion**
    - Efficiently model remeshing for User-Defined Vertex Motion cases for predefined configurations
    - Applications: Vane pumps, piston cooling
- **Improved robustness for overset shell cases**
    - Improved reliability of windscreen wiper simulations with overset shell regions through enhanced overset donor search
        - Helpful when the near-wall cell in the background region is much smaller than that in the overset region
        - Applications: Wiper water management where fluid-film is modeled via shell region and the background mesh has refinement zones to facilitate hybrid fluid-film to VOF transition, for example near A-pillar



- **DFBI multi-body: Six degree of freedom in body coordinate system**

- Easily define motion for DFBI multi-bodies through six degree of freedom specification in body coordinate system
  - Previously a new coordinate system had to be defined and managed at the position of the body coordinate system
  - It is now possible to select the DFBI body's coordinate system to define the motion

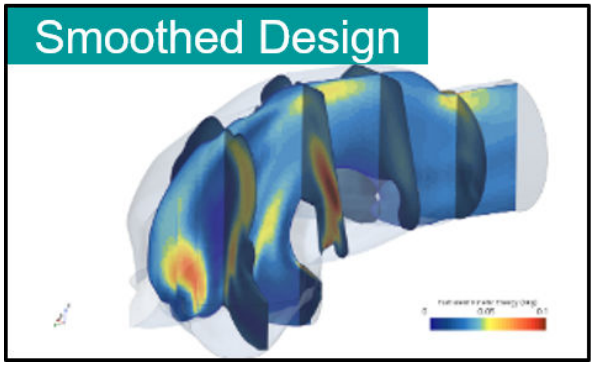
- **DFBI multi-body: Redundant constraint detection**
  - Improved robustness of DFBI multi-body systems through automatic detection and removal of redundant constraints
    - Redundant equations arise due to various joints and constraints contributing to the same constraint equations
    - Redundant constraint detection option removes unnecessary constraint equations and makes the solution more robust
      - The default setting of "Tight" removes constraints that are close to redundancy
      - For intermittent redundancies, very large constraint deviations occuring through the course of the simulation can be resolved through "Relaxed" or "Loose" settings
    - Example: Automotive car door hinged by two revolute joints. Mathematically the second joint is not needed and will therefore be removed from the system

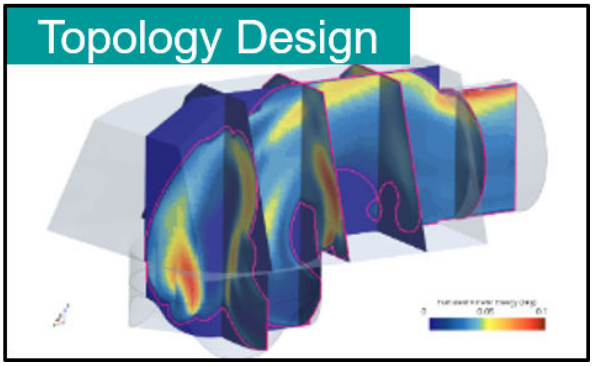


Design Exploration

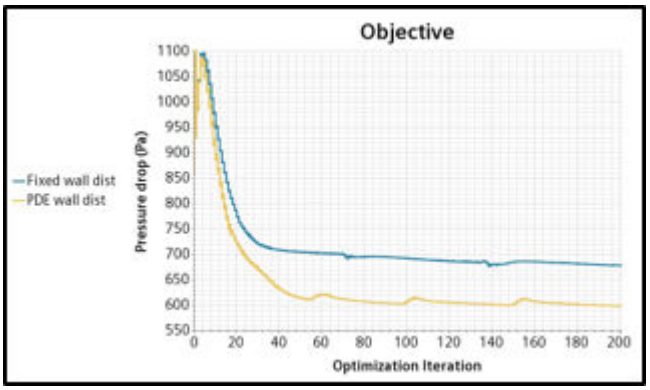
Adjoint

- **Topology Optimization turbulence treatment - wall distance on interface**
  - Improved final design thanks to an improved optimization process
    - The wall distance is captured from the fluid-solid interface as opposed to the envelop boundaries
    - The PDE wall distance is used to calculate the wall distance from the material indicator
    - Physical quantities are calculated more accurately and a better correlation with the smoothed validation results is observed





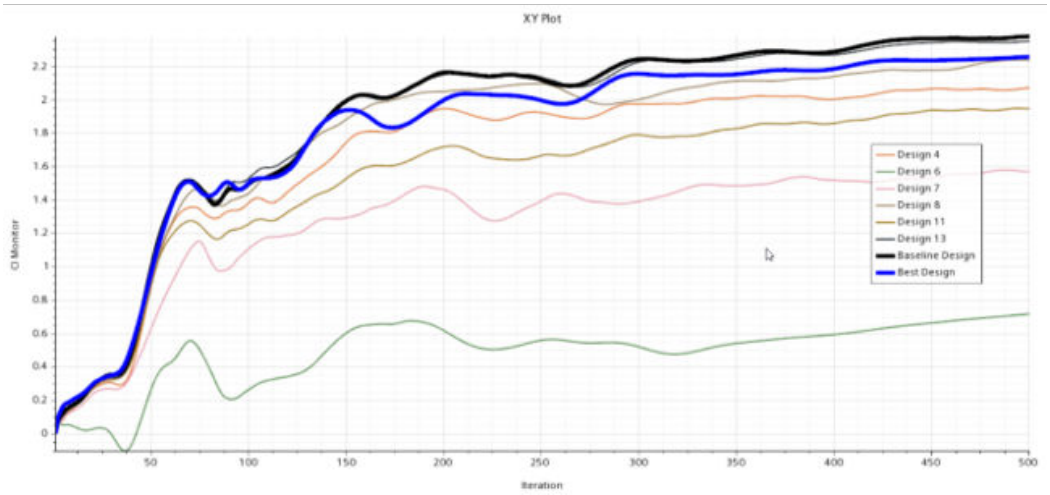
- Objectives are further optimized



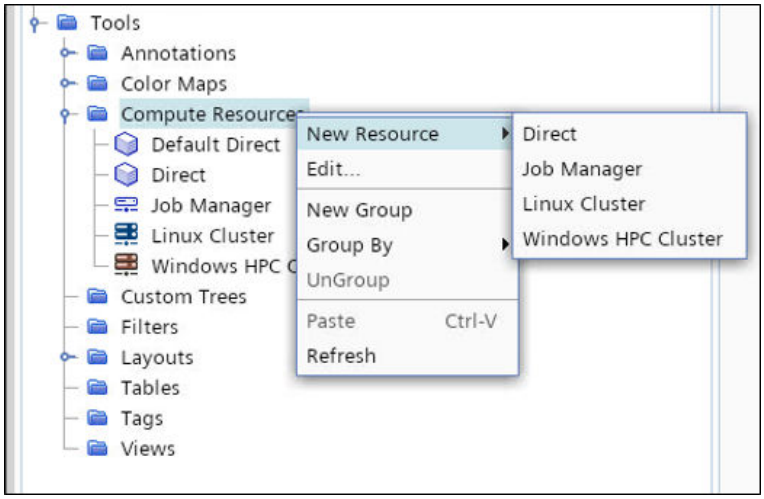
- **Support for local coordinate systems in adjoint cost functions**
  - Improved usability of adjoint workflows thanks to support of the differentiation of vector and position field functions in local Cartesian, cylindrical, and spherical coordinate systems

Design Manager

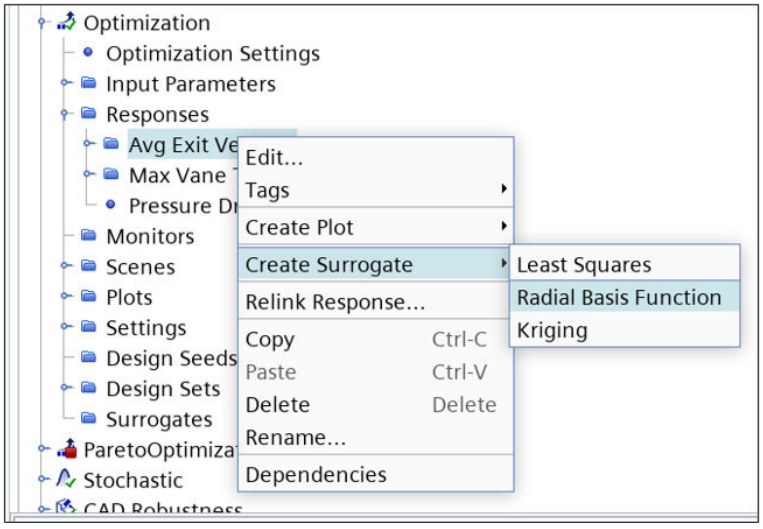
- **Understand time-dependend trends for Design Manager studies through comparison of transient (monitor) data sources**
  - Advanced Multiphysics simulation efforts are increasingly run to study time-dependent performance indicators, e.g.
    - Underhood vehicle thermal management
    - In-cylinder combustion
    - External aerodynamics
  - Monitor data sources can now be stored and compared directly within Design Manager
    - Selectively store monitor as part of a Design Manager project
    - Comparative plots can use Design Sets to show
      - Specific designs, Baseline and/or Best Design (see image below)



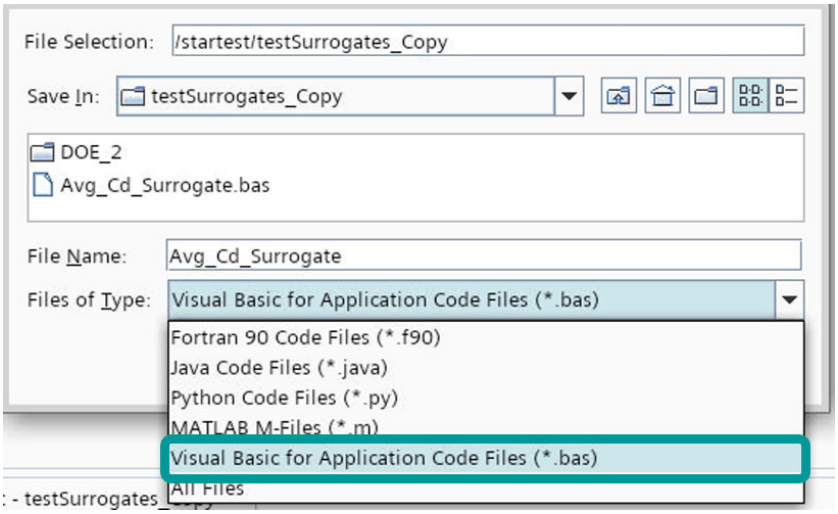
- **Reuse compute resources configurations across multiple studies**
  - Set up your compute resources once and reuse the configuration for subsequent studies
  - Compute resources are now located in within Tools



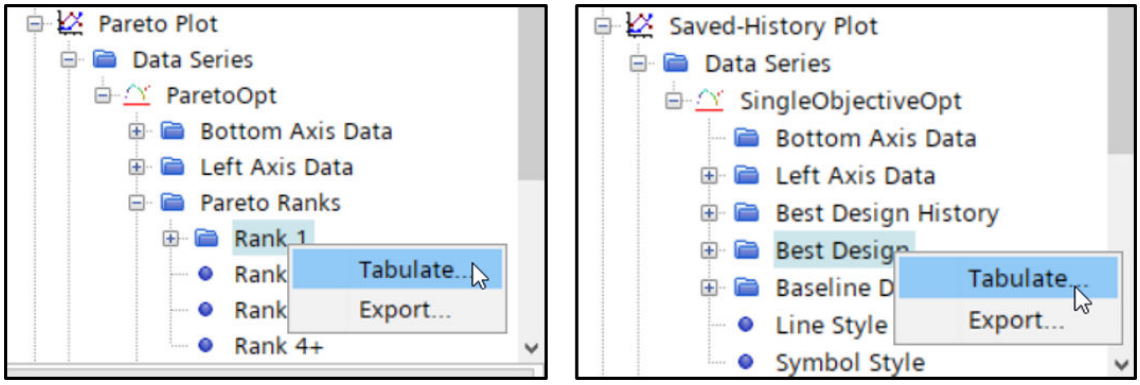
- **Quicker Surrogate creation through new shortcut workflow**
  - Quicker, more consistent Design Manager surrogate study setup



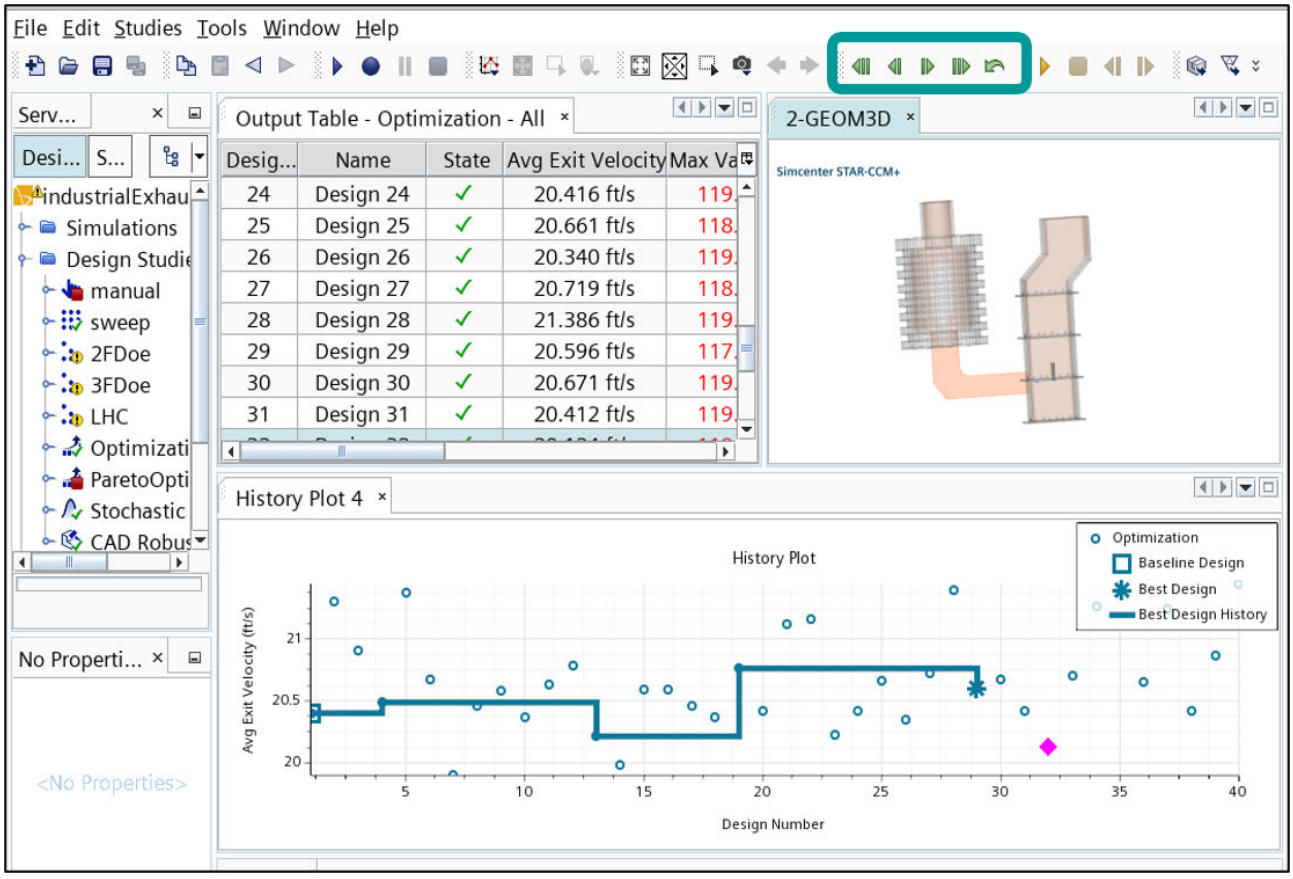
- **Enhance knowledge extraction for surrogate modeling efforts in MS Excel with Visual Basic code export**
  - Gain further insight through compatible data exports to common engineering tools



- **Enable collaborative review of Design Studies outside of Simcenter STAR-CCM+ via extension of Tabulate and Export for all Design Manager plot types**
  - Expand the scope of quantitative interrogation for all Design Manager plots

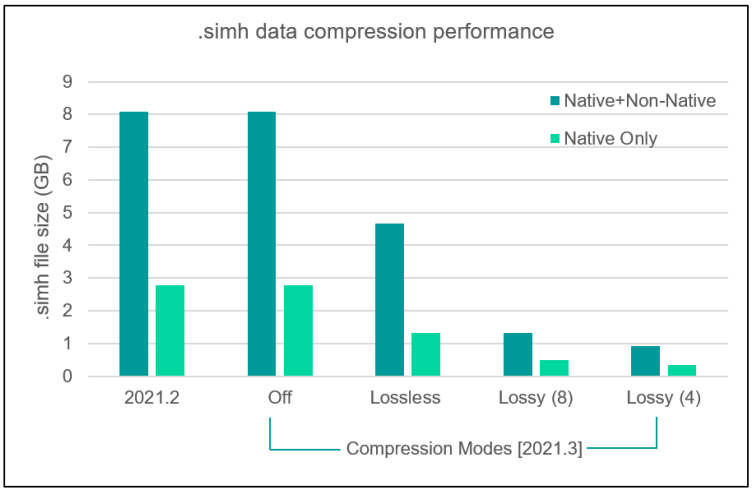


- **Improve productivity through automated scrolling to target row(s) in Design Study tables**
  - Holding down the green left/right arrows enables continuous navigation through designs
    - In previous versions, the arrow keys needed to be repeatedly pressed to navigate designs

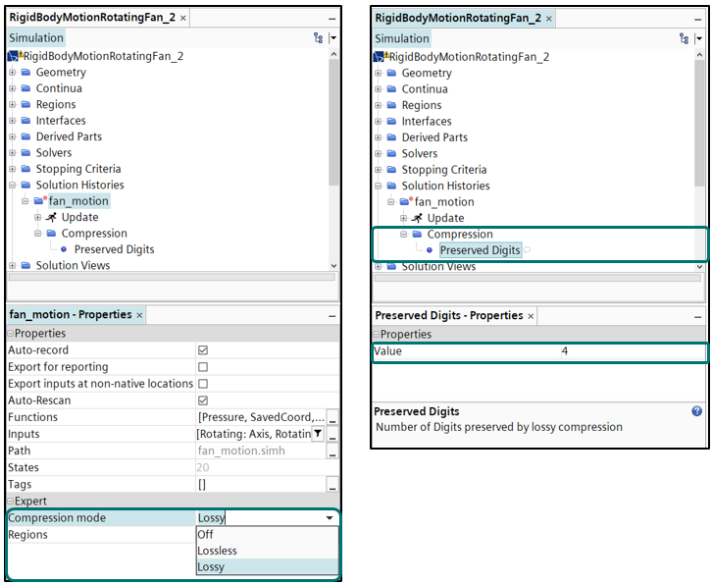


Data Analysis

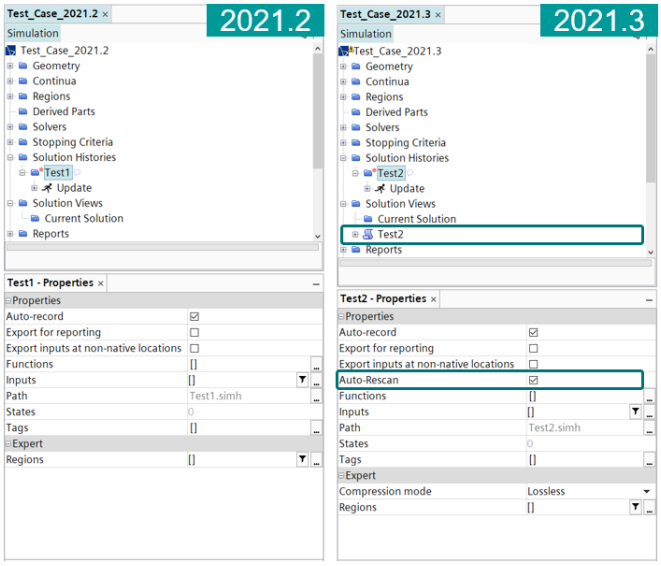
- **Smaller .simh files through compression D3007, D3417**
  - Enhanced productivity through compressed .simh file export
    - Example: .simh file size reduction in 2021.3 for a transient model consisting of 17M cells exporting 26 field functions on 12 Parts in Inputs
      - Lossless: ~2x smaller
      - Lossy: Up to 8x smaller
      - Applicable to both native and non-native locations



- Now store and share .simh files more efficiently
  - Compression mode option added under Expert property
  - Applicable to Surface data only
  - Options to export Lossless and Lossy compression
    * Lossless compression mode as default
    * Specify number of preserved digits under Lossy mode



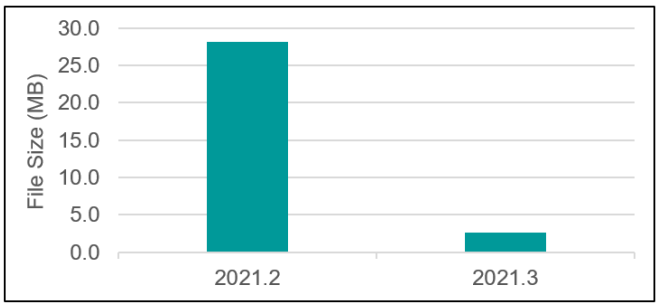
- **Faster .simh setup and usage**
  - Quicker .simh data access through paired Solution Views creation
    - Automatic creation of Solution Views
      - Node named after .simh file
      - Corresponding representation added within Representations node



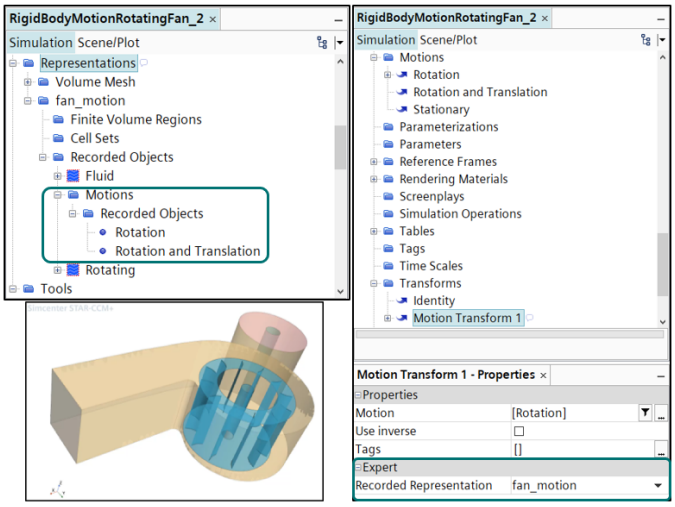
  - Improve productivity when working with .simh through Auto-Rescan
    - Reduced number of mouse clicks
    - Checkbox option to automatically sync all states in file
      * Default option is active on .simh creation

- No need to manually rescan data on .simh export

- **Automatic recording of Motions in .simh file D1383, D4164, D5570**
  - Efficiently create Motion animations within a Scene through recorded Motion data in .simh
    - Generate ~10x smaller .simh file compared to previous releases

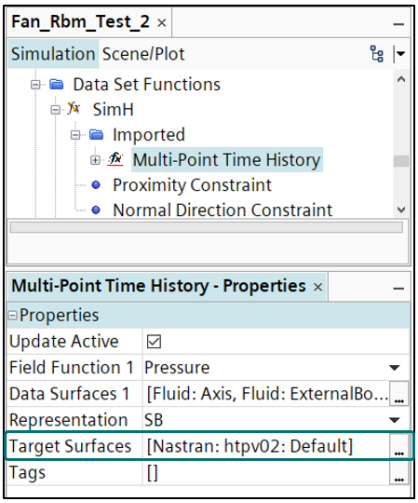


    - Automatic export of all defined Motions to .simh file
      - No change in .simh export or import workflow



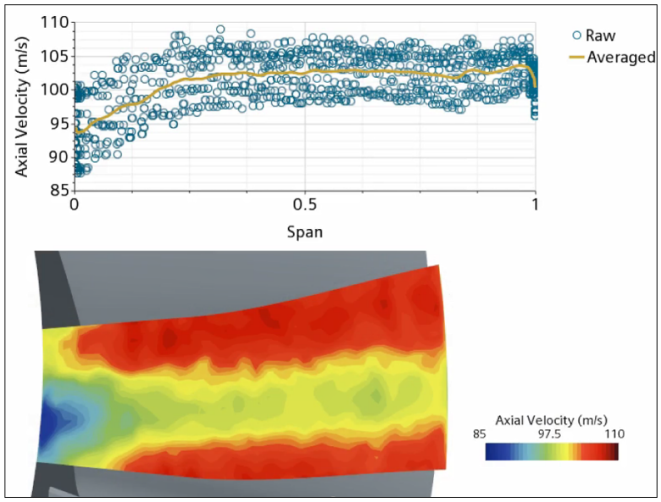
    - Recorded Representation option added under Motion Transform
    - Control specification of the Motion being recorded

- **More adaptable File-based coupling using .simh**
  - Effectively collaborate with other analysis tools through the integration of Simcenter STAR-CCM+ .simh and Data Set Functions
    - Map .simh data onto imported CAE model and export in .mat file
    - Target Surfaces allows selection of surfaces from imported CAE model

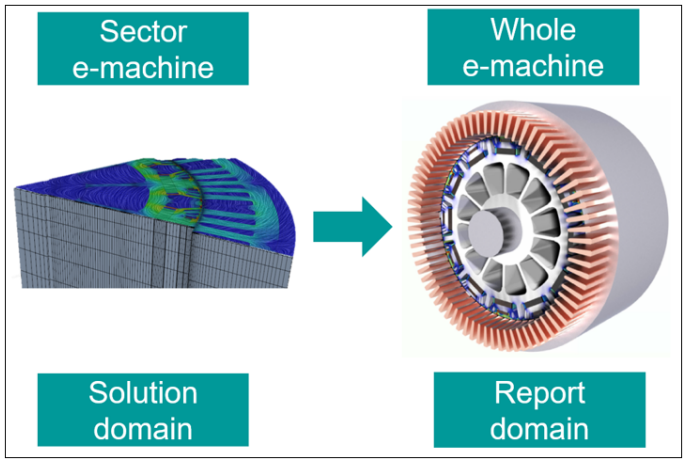


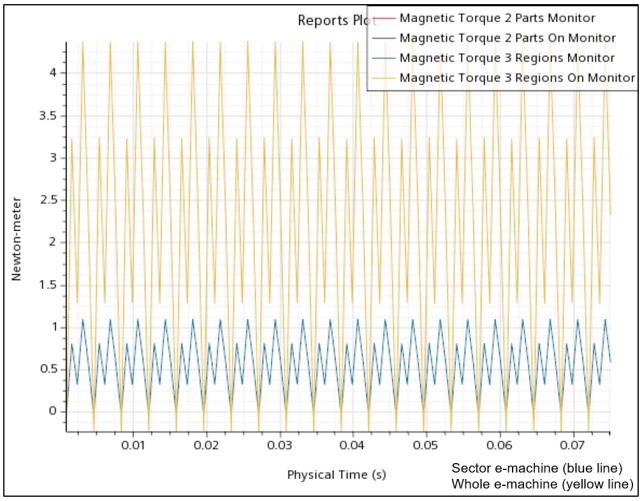
  - Removes previous limitation of both surfaces to be from chosen representation

- **Circumferentially averaged profile plot D3418**
  - Faster comprehension of flow solution data for design analysis using Average Profile part



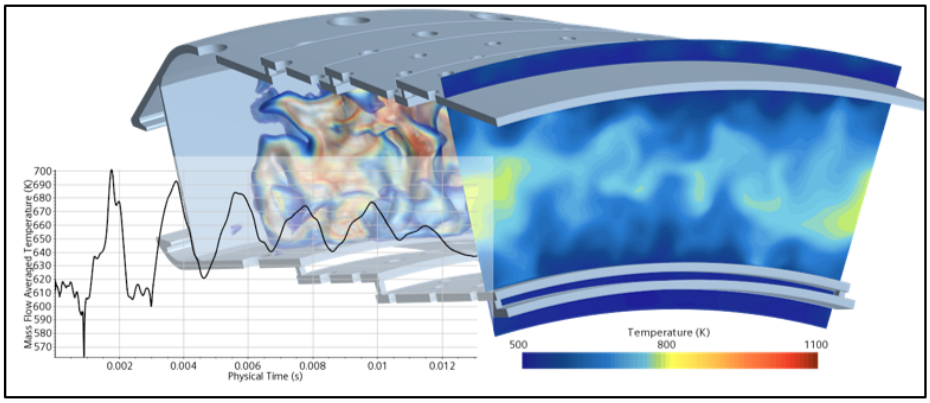
    - Simplified plotting of circumferentially averaged flow compared to previous releases
    - Automatic plotting of raw and averaged data on same axis
    - Removes the need for writing custom field functions
    - Improved performance compared to legacy field function method
      - Faster computation
      - Reduced memory usage
  - Flexible binning strategies
    - Able to automatically resolve underlying mesh
    - Optional setting to set a number of constant size bins
- **Whole e-machine report with Idealizations**
  - Easily gain insight in to whole e-machine performance with only a sector model solution using Idealizations

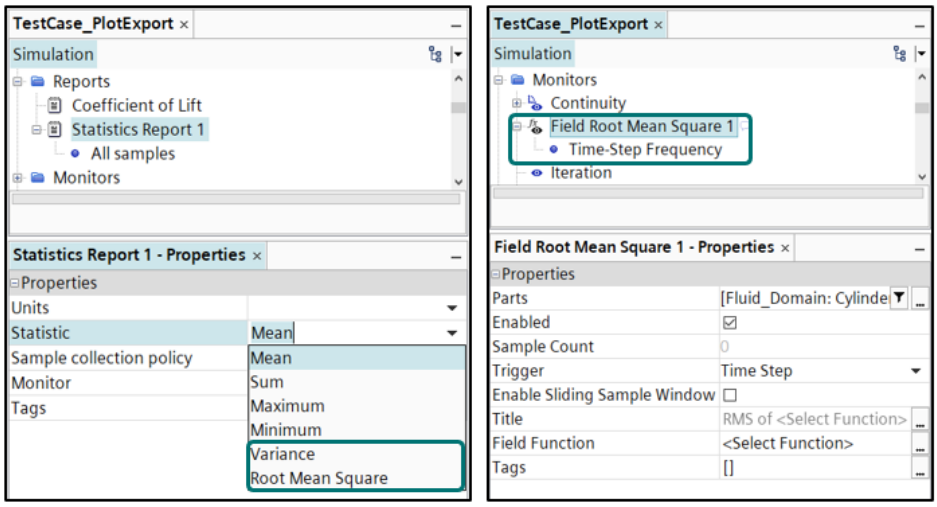




  - Automatically converts from sector to whole e-machine quantities for Magnetic Force and Magnetic Torque reports
    - Checkbox option to enable Idealization added to properties panel
    - Compatible with periodic interfaces only
  - Eliminates the need for dozens of mouse clicks, extra reports, and manual bookkeeping

- **Expanded quantitative transient data analysis D922, D5200**
  - Quickly gather insights on variability in simulation data of interest





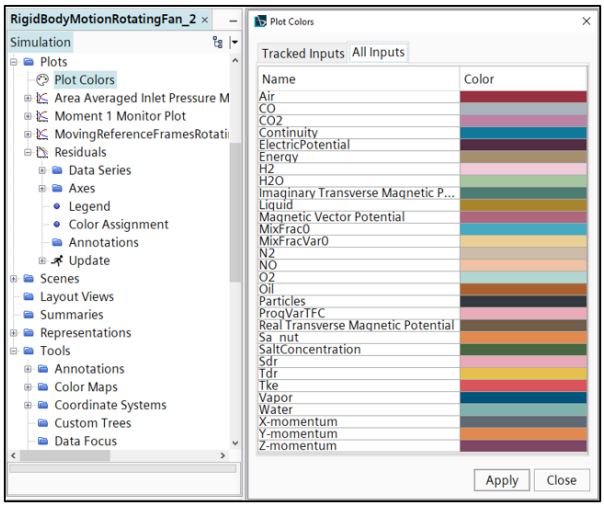
- Use Variance of outlet Temperature monitor to deduce uniformity
- Use Root Mean Square of pressure to assess combustion stability

◦ Easily compute Root Mean Square of a Field Function for selected Parts

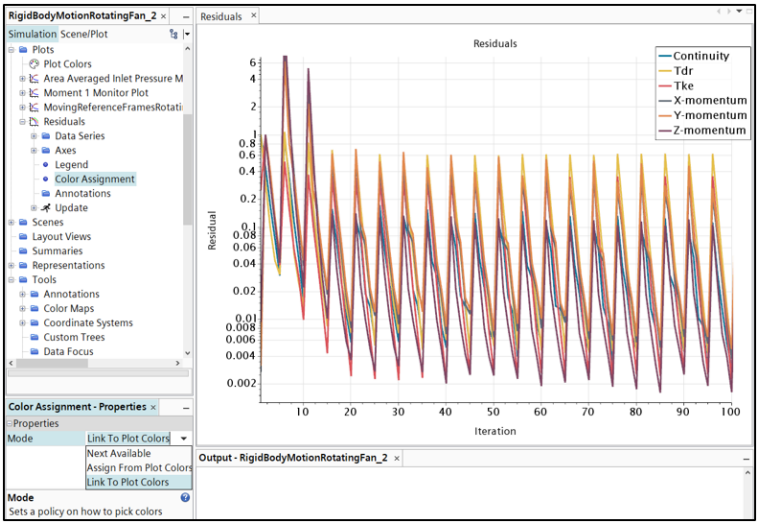
- Trigger types include
  - Iteration, Time Step, Delta Time, Update Event
- Support for Sliding Sample
- Avoid writing complicated macros

- **Easier customization of Plot Colors D1234, D3251**

◦ Easily compare residual plots between simulations through consistent plot colors assignment

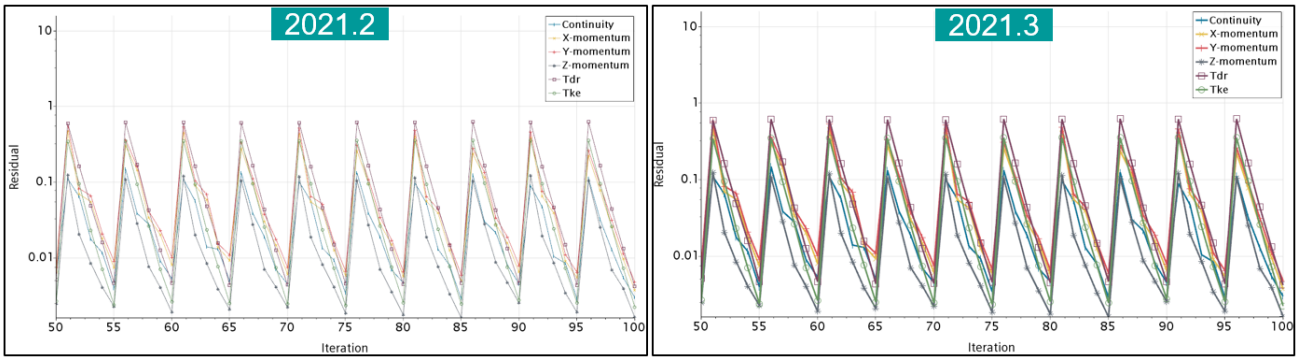


- Set and maintain colors tied to specific Inputs
  - Avoid different colors being used for data series due to model selection
  - Specify Color Assignment policy
  - Copy and paste palettes between different simulations



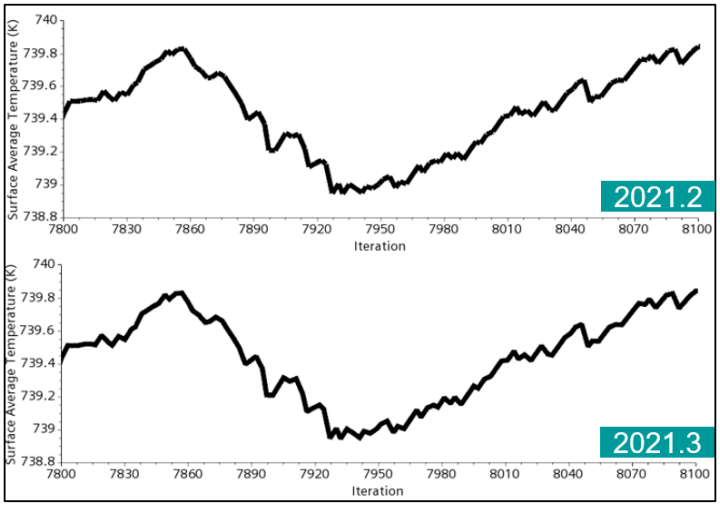
- Default sequence of data series colors under 'All Inputs'
  - New plot default color palette set to Siemens color

- **Enhanced Line and Symbol rendering in Plots**
  - Improved out of the box readability of Plots through updated default setup



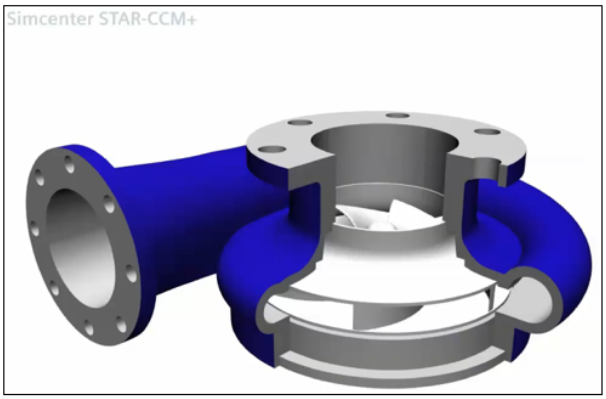
  - Allows for easier identification of datasets
  - New Plots and Plotted Objects use increased Line and Symbol Style sizes
    - Restored plots use existing Style sizes
    - Applies to both Simulation and Design Manager projects

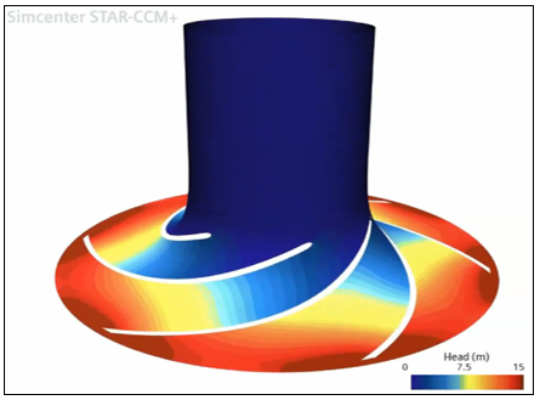
- **Improved rendering of thick Lines in Plots**
  - Achieve improved visual comprehension of Plots with thick Lines



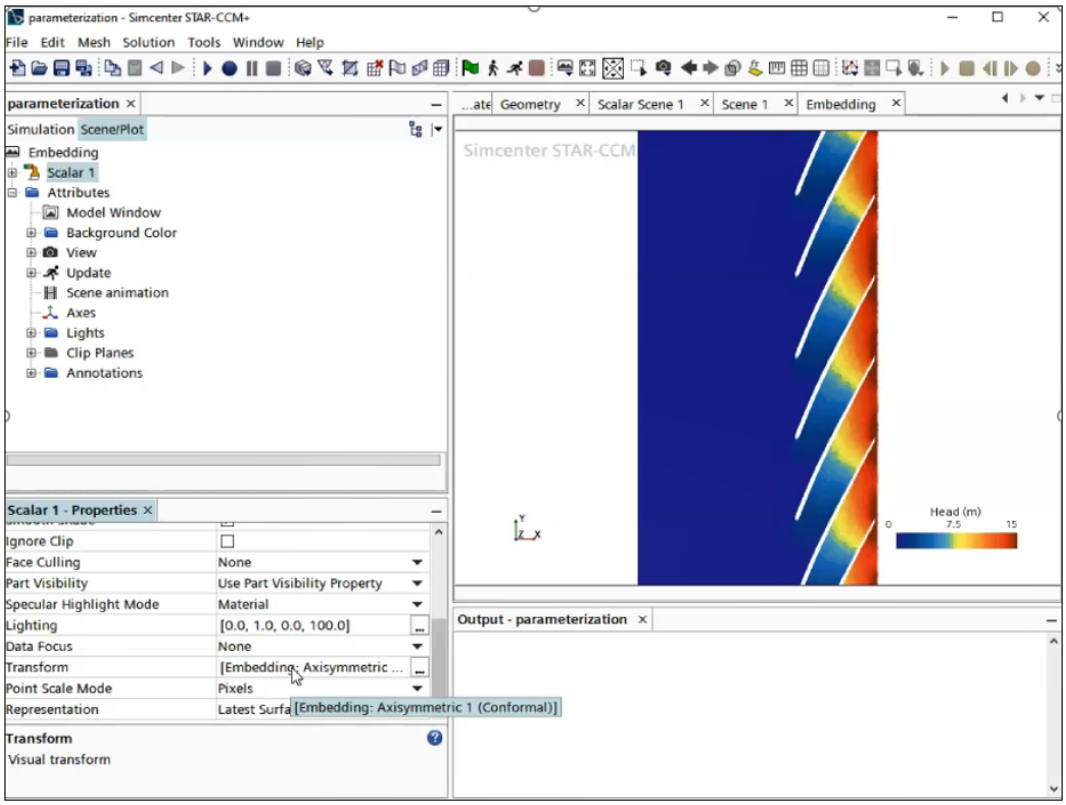
- Avoid misinterpretation of data
- Smoother appearance of thick Lines using updated framework
  - Removes gaps at sharp angles
  - Avoids overlap of consecutive line segments
- Complies with requirements of WebGL

- **Axisymmetric parameterization expanded geometry coverage D3418**
  - Allows flow path parameterization of turbomachinery geometries containing additional geometric features



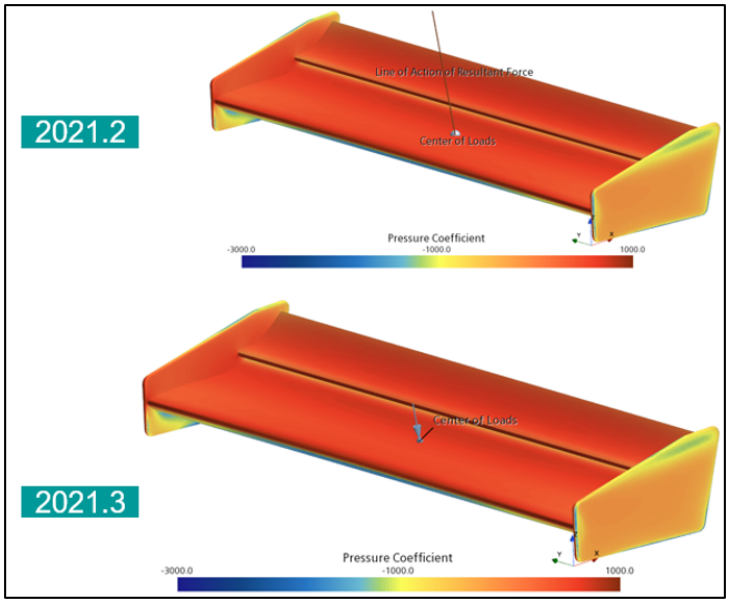


  - Full machine 360° models
  - Multiple leakage channels on the hub and/or shroud
  - Endwall contouring
  - Compatible with other features that rely on axisymmetric parameterization
    - Profile average
    - Surface average
    - Conformal and isometric embedding
- **Planar embedding view reset**
  - Simplifies visualization workflow and eliminates the need for manually determining appropriate view



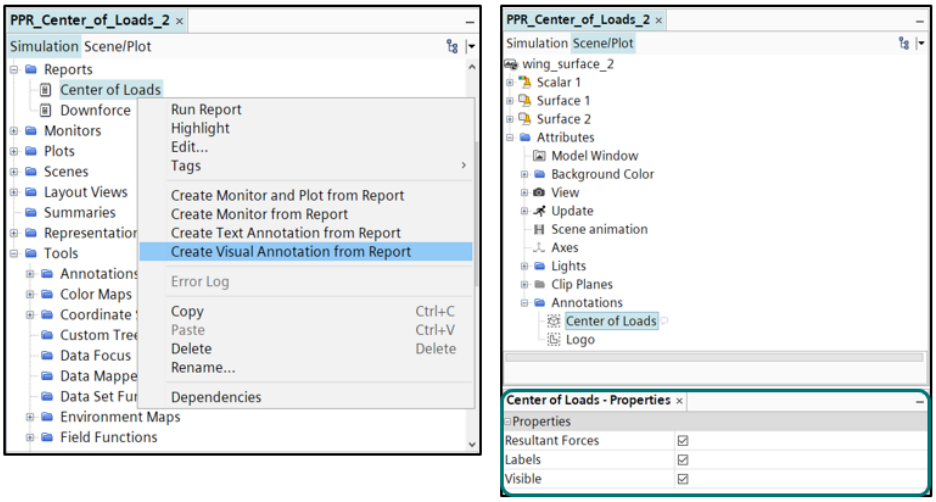
- Automatically positions the scene view to the appropriate location when conformal or isometric embedding transformations are applied
- View is reset when all embedding transformations are removed

- **Visually interpret report output in a Scene D3116**
  - Easily locate Center of Loads through Visual Annotation



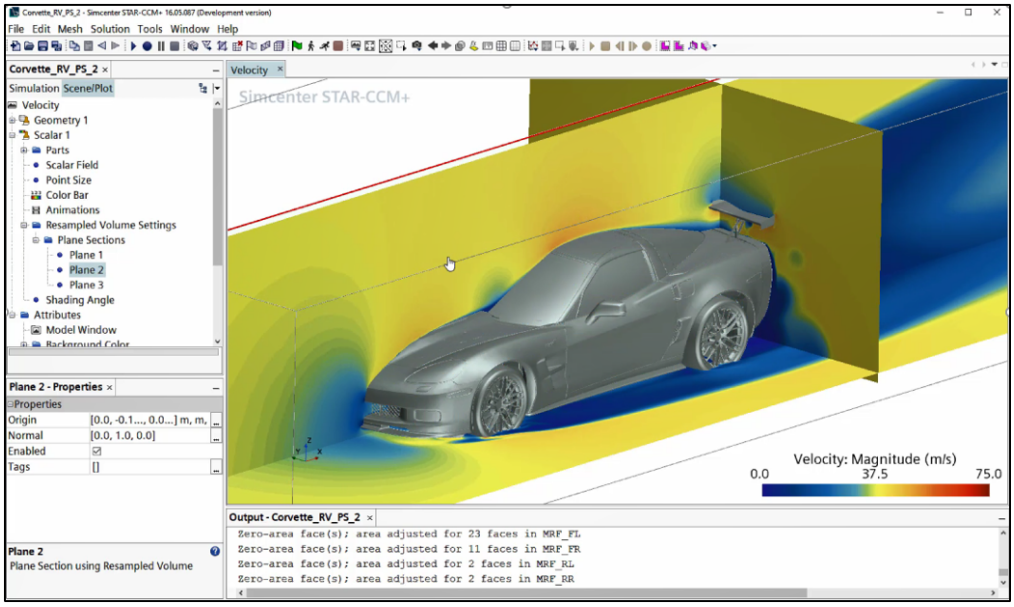
- Communicate critical results to stakeholders for faster decision-making
- Robust workflow encapsulates qualitative presentation of complex calculation
- Ability to drag-and-drop annotation in Scene

  - Generate geometry aware annotation automatically

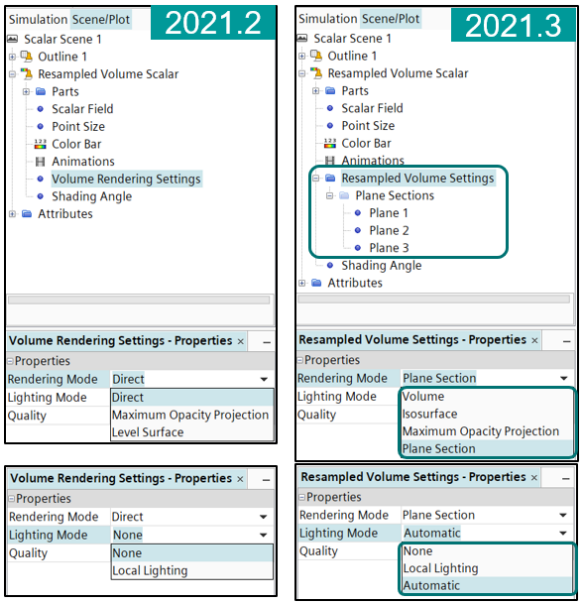


- Location of Center of Loads shown as a sphere
- Direction of Force vector shown as 3D glyph
- Customizable annotation display options

- **Faster Plane Sections creation and display D4428**
  - Assess flow features for faster decision making using downsampled data



  - Interactively reveal complex flow phenomena on large datasets
  - Resampled Volume is used for downsampling

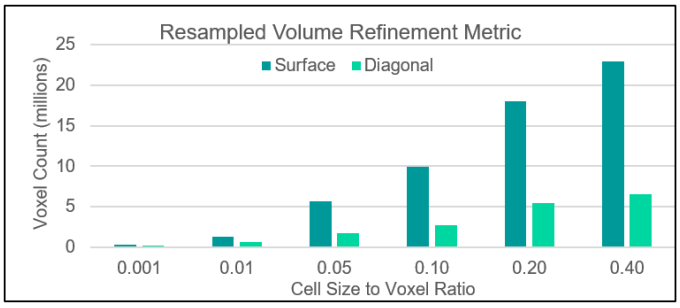


- New Plane Section Rendering mode enabled under Resampled Volume Settings
- Customize up to three Plane Sections
- Modify Plane Sections interactively in-scene
- Screenplay support for animation
- Qualitative assessment only

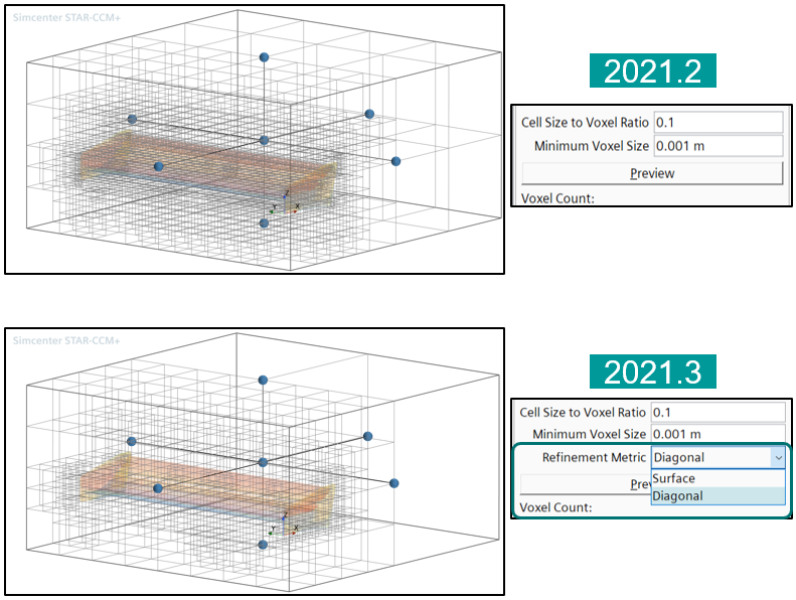
  - Recommendation: Use GPU/OpenGL rendering only

- **Efficient Resampled Volume refinement strategy**

  - Generate smaller Resampled Volumes out of the box through Diagonal Refinement Metric

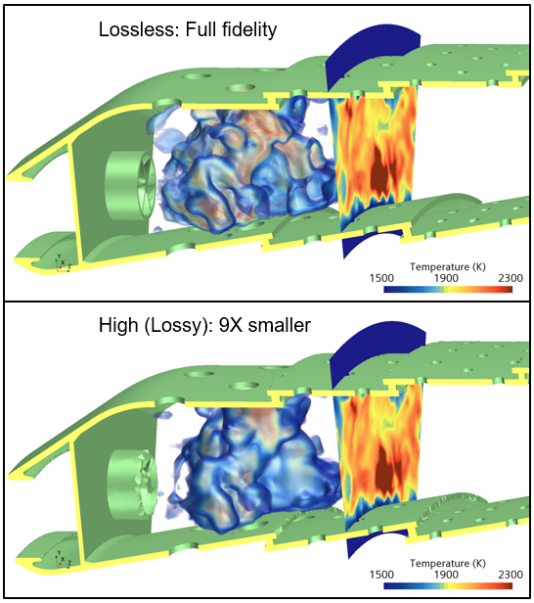


- Reduced rate of Voxel Count rise with increasing Cell-to-Voxel Ratio
- User selectable Refinement Metric options

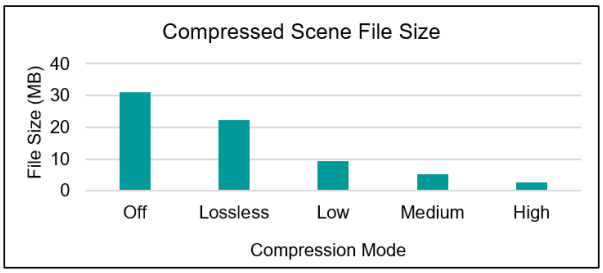


- Surface method used in previous releases
- Diagonal method set as new default
  * Less aggressive refinement of prism layers

- **Pragmatic file size reduction for Scene files D2413, D5527**
  - Enhanced productivity through reduced level of detail for Scene file export

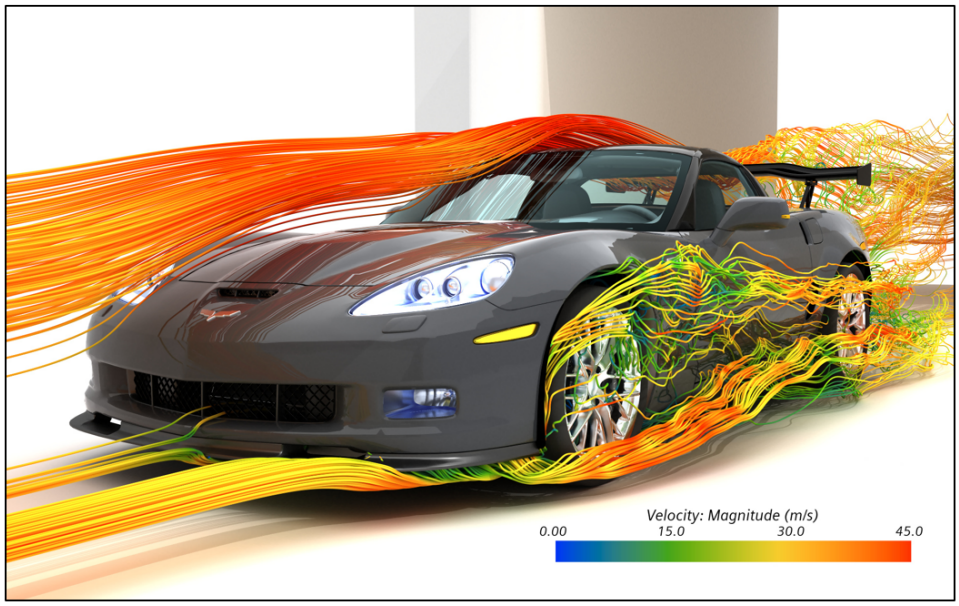


  - Smaller Scene file requires less disk space
  - Requires less rendering resources
  - Easier to share with collaborators



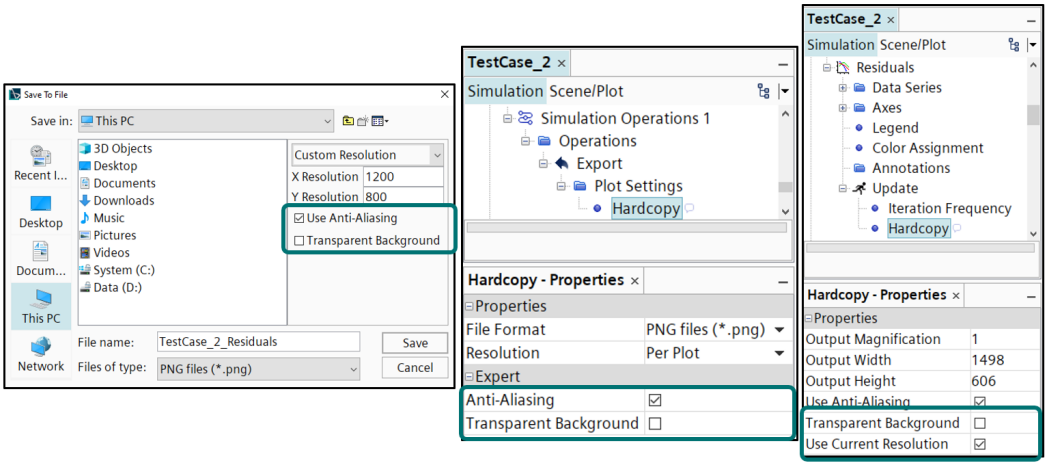
- Lossy Compression mode option added
  - Applicable to Surface and Resampled Volume data

- **Enhanced photo-realistic rendering using Clearcoat**
  - Create realistic rendering of materials through Clearcoat



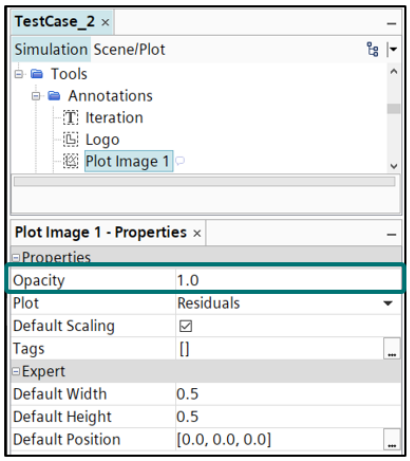
  - Allows for more realistic depiction of paint surfaces
  - Specify 'Clearcoat IOR' value for simulating glossiness
    - Applicable to Matte and Metallic materials
    - Value ranges between 1 and infinity

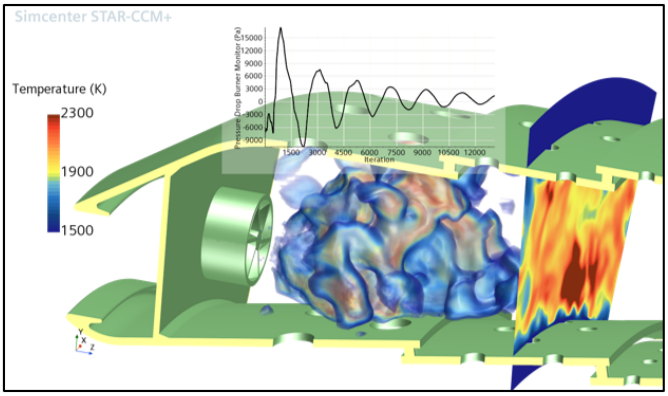
- **Harmonized hardcopying and export setup for Scenes and Plots D3251**
  - Increased ease of setup for hardcopying and exporting of Plots



- Consistency with Scenes hardcopying workflow
- Antialiasing and Transparent Background options added to
  - Plot export and hardcopy dialog
  - Export Simulation Operation node
- Hardcopy Antialiasing property removed from Plot nodes
- Antialiasing property removed from Tools>Options>Plotting

◦ Improved readability of Plot Image annotation in Scenes





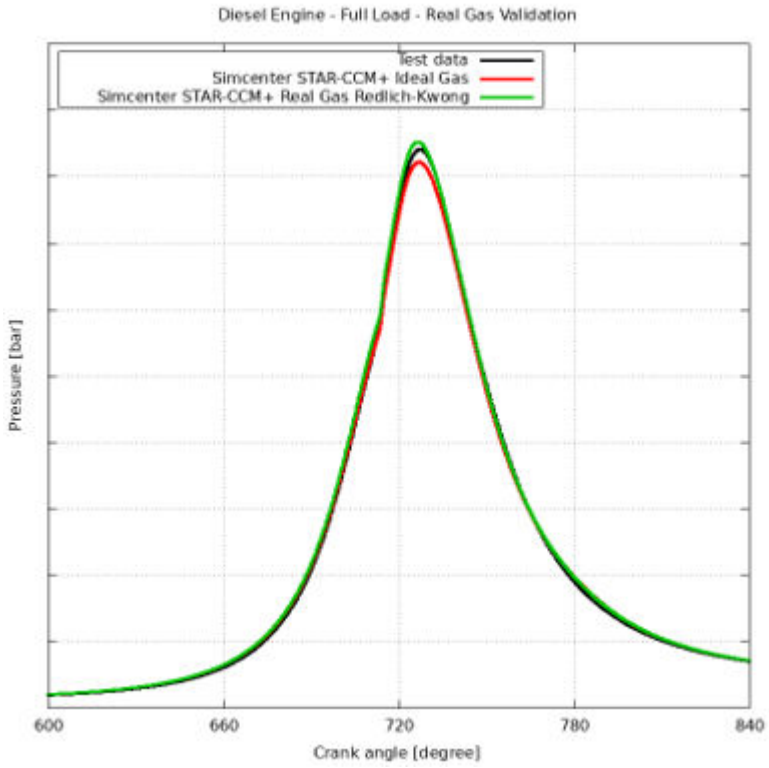
- Control Opacity of Plot Image annotation
  - Default Opacity value of 1

Application Specific Tools

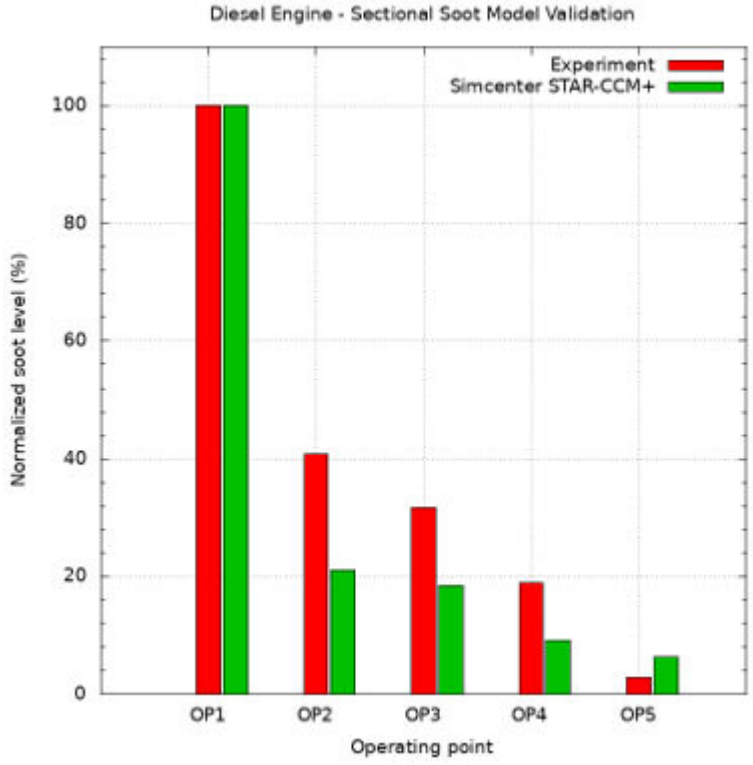
In-cylinder Solution
Electronics Cooling
Batteries
E-Machines

In-cylinder Solution

- **Complex Chemistry combustion model**
  - Accurate ignition and emission prediction through Complex Chemistry combustion model
    - Fast and straightforward setup of all species, reactions, thermodynamics, and transport properties through CHEMKIN (TM) format files import
  - Accurate flame position in turbulent-drived flames through Turbulent Flame Closure
  - Shorter turnaround times using Relax to Chemical Equilibrium in cases where knock or emissions are less important
- **Real Gas model**
  - Higher accuracy for high cylinder pressures through real gas equation of state
  - Redlich-Kwong model is activated by default, other models can be selected in the Simulation tree



- **Soot Sectional Method model**
  - Improved prediction of total soot mass and particle size distribution through soot sectional method
  - Includes nucleartion, condensation, surface growth, and coagulation stages of soot formation, as well as soot oxidation
  - Compatible with ECFM-3Z, ECFM-CLEH, and Complex Chemistry combustion models



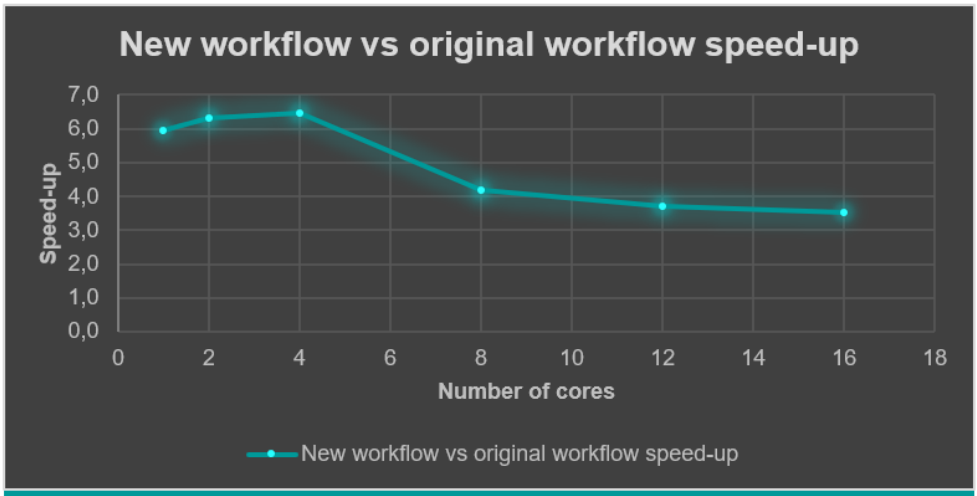
- **Support for carbon-free fuels**
  - Support for any CHON formulation of fuel (including pure hydrogen and ammonia) in the ECFM-3Z and ECFM-CLEH combustion models
    - Hydrogen and ammonia included in the ECFM fuels database
  - Complex chemistry combustion model with Turbulent Flame Closure option, previously compatible with hydrogen as a fuel, is also now compatible with ammonia
- **Multiple injectors can now be defined in a single model**
- **PISO solver selected by default**
  - Inlet/outlet extrusion layers also activated by default, as recommended when using the PISO algorithm
- **Cyclic time printed to the output window during the simulation**
- **"Injector Mass Injected" plot renamed to "Fuel Mass Tracking"**
  - Better representation of what is displayed in the plot, including fuel that is initialized/convected into the model
- **Improved performance through single shell region specified for liquid film model setup**
- **Option to select for which walls the liquid film model will create shells**
  - Previously, all walls were assumed to be relevant for modeling liquid film
  - Allowing direct specification of which walls to include in the model improves performance
- **"Keep Feature Edges" input when creating parts**
  - Allows selective retention of edges, which can result in better meshes with fewer unimportant CAD feature lines preserved
    - Named edges are always preserved

Electronics Cooling

- To aid stability, the default under-relaxation factors for both segregated solid and fluid energy has been changed to 0.9999 and 0.99 respectively

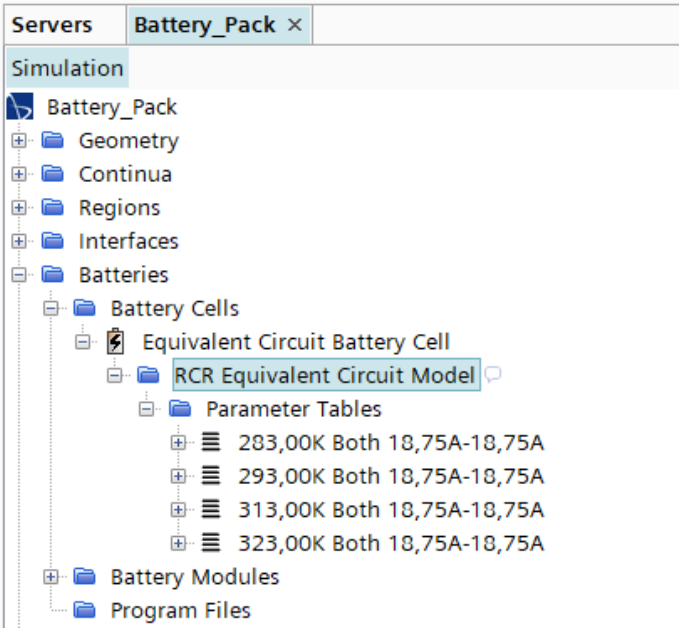
Batteries

- **New Improved Simcenter STAR-CCM+ Batteries workflow**
  - New workflow with significant improvements from the original Simcenter Battery Design Studio-dependent workflow
  - Operating without a Simcenter Battery Design Studio (BDS) input file
    - The input TBM file is no longer required
    - The entire process is fully contained in Simcenter STAR-CCM+ so you do not have to change environments between tasks
  - Leveraging a new RCR 0D model
    - Much faster to compute, up to 10X speed-up compared to the original workflow
    - Significantly lower memory consumption with good scalability, allowing to run thousands of battery cells
    - Significantly higher accuracy than the typical uniform, constant heat source term applied to a cell.
    - Dedicated relevant outputs are provided, including voltage, heat generation, state of charge, and current density



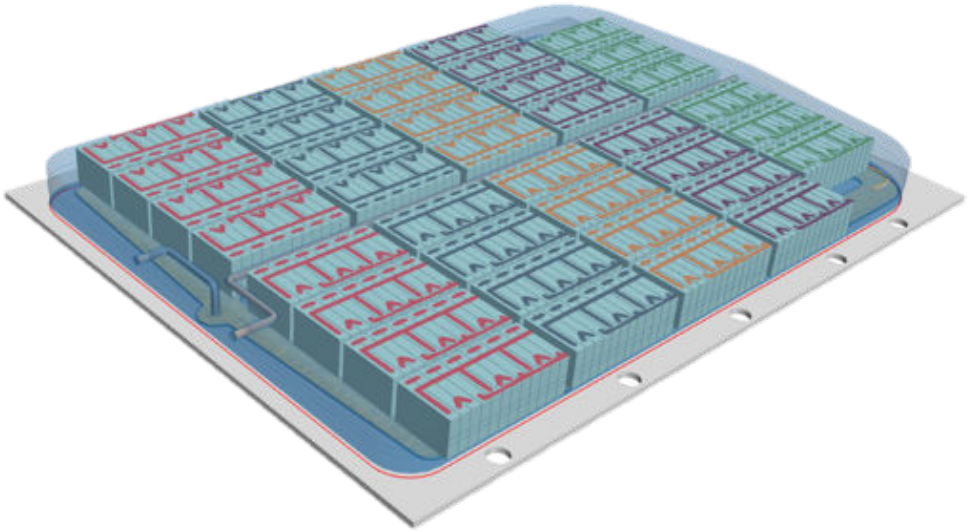
Excellent speed-up for the new workflow, compared to the original workflow.
Case: 48 battery cells + liquid cooling plate
5M cells mesh

- Simplified setup for improved usability and productivity
  - RCR 0D model configuration now available in the Simcenter STAR-CCM+ Batteries node, with two new configuration options
    - Direct import of RCR data to the look-up tables
      * Useful if the model fitting was performed on a 3rd party tool
      * Respect of name convention in the header helps populating the look-up tables automatically
    - Fully automated setup via RCR data extraction from a TBM file
      * Useful if the model fitting was previously performed in Simcenter Battery Design Studio

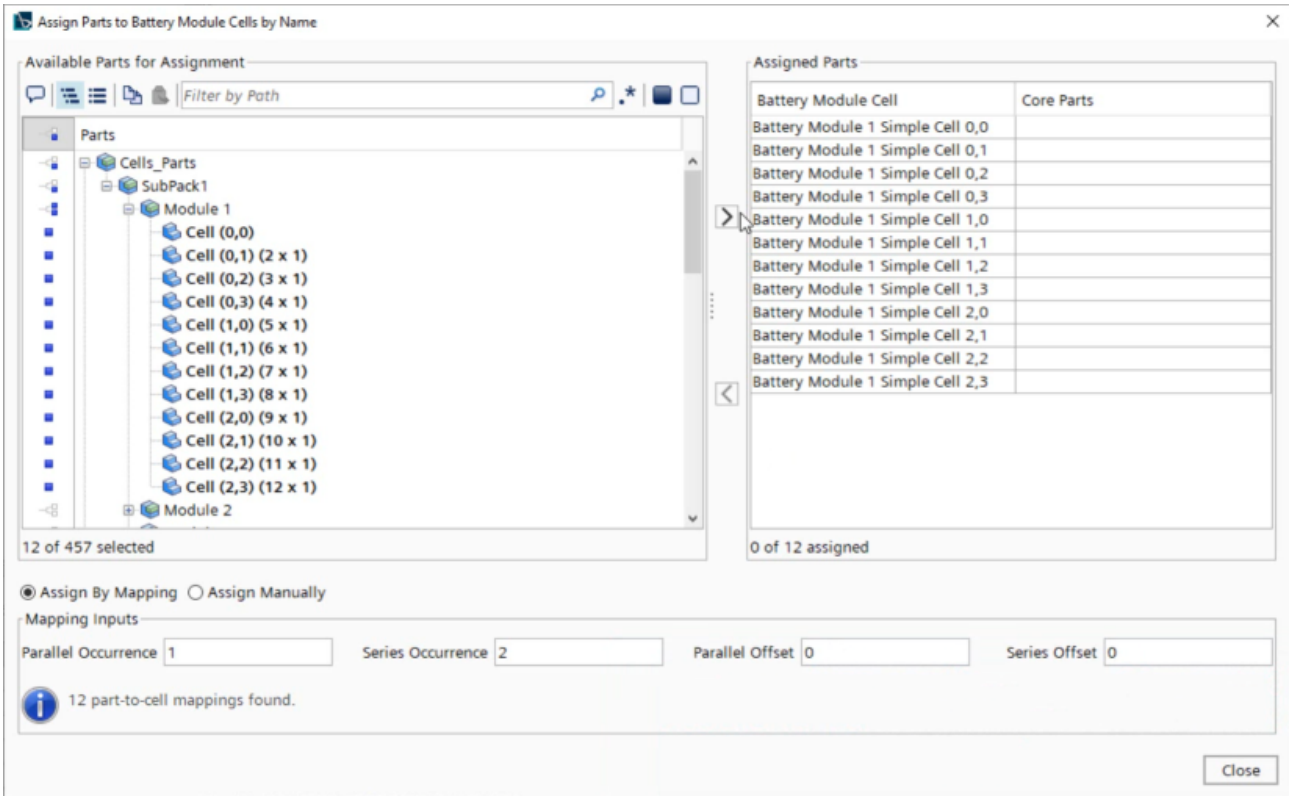


- Supports arbitrary, user designed cells geometries

- Support for import of battery cell geometry gives more flexibility on the cell's shapes
- Simplified interfacing with the rest of the battery packs geometry parts
- Lets you decide how the RCR performance model is assigned to the cell's parts



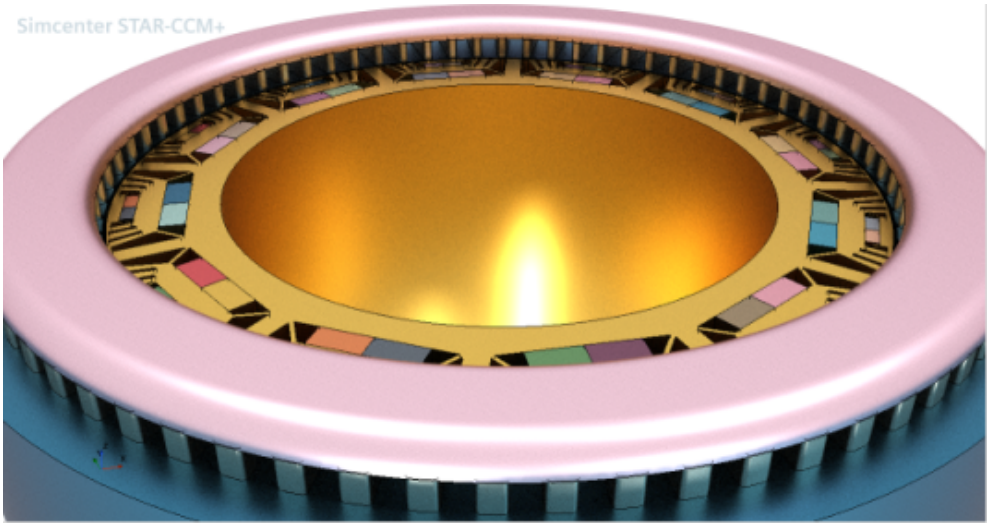
- Fast and flexible battery cell model assignment to geometry parts
  - Dedicated user interface for easy configuration and assignment with two options:
    - A bulk manual assignment, the selected cell's parts are associated to the selected cell's objects in their appearance order
    - Using a mapping technique leveraging the parallel and series indexes in the parts names.



- To access this new workflow, a "Simcenter STAR-CCM+ Batteries add-on" license is required
- Legacy workflow continues to be supported

E-Machines

- **Enhanced E-Machines Performance Workflow**
  - Easier workflow through direct import of e-machine design files from Simcenter SPEED
    - E-machine design geometry is automatically generated in 3D-CAD and exported to Parts
    - E-machine materials data are imported into the parts metadata field
    - A template sim file can be used to setup automatically the full model including the physics



User Guide

- **New Tutorials**
  - Compressible Flow
    - Anisotropic Volume Meshing: Onera M6 Wing
  - Multiphase Flow
    - Mixture Multiphase with Large Scale Interfaces: Gear Lubrication
  - Discrete Element Method
    - Meshfree DEM: Excavator
  - Solid Stress
    - Normal Modes Solver: Wind Turbine Blade
  - Battery
    - Electro-Thermal Modeling: Battery Pack Cooling
- **Modified Tutorials**
  - Gas Turbine Aerodynamics: Post-Processing – added topic for creating a profile average plot
  - Hybrid Multiphase: Fountain – added VOF-Lagrangian transition criteria
  - Hyperelastic Stress Analysis with Adaptive Time-Step: Trileaflet Heart Valve – linearized the pressure boundary condition
  - Ffowcs Williams-Hawkings: Sound Propagation – updated to use the new FW-H receiver table workflow
  - Several other tutorials were updated to conform to the latest user interface and default settings in their respective areas.

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