What's New in Ansys 2025R1 Fluent Webinar

Adam Kroll– DRD's Fluids Team Lead

March 4, 2025

Agenda

- Fluent Native GPU Solver
- Fluent User Experience
    - Desktop Interface
    - Web Interface
- Fluent Meshing
- Fluent CPU Solver Physics Improvements

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Mission Statement

DRD Technology helps engineering teams accelerate product development. With in-house expertise spanning the entire range of physics, we ensure customers succeed when using Ansys simulation tools for virtual prototyping and design verification.
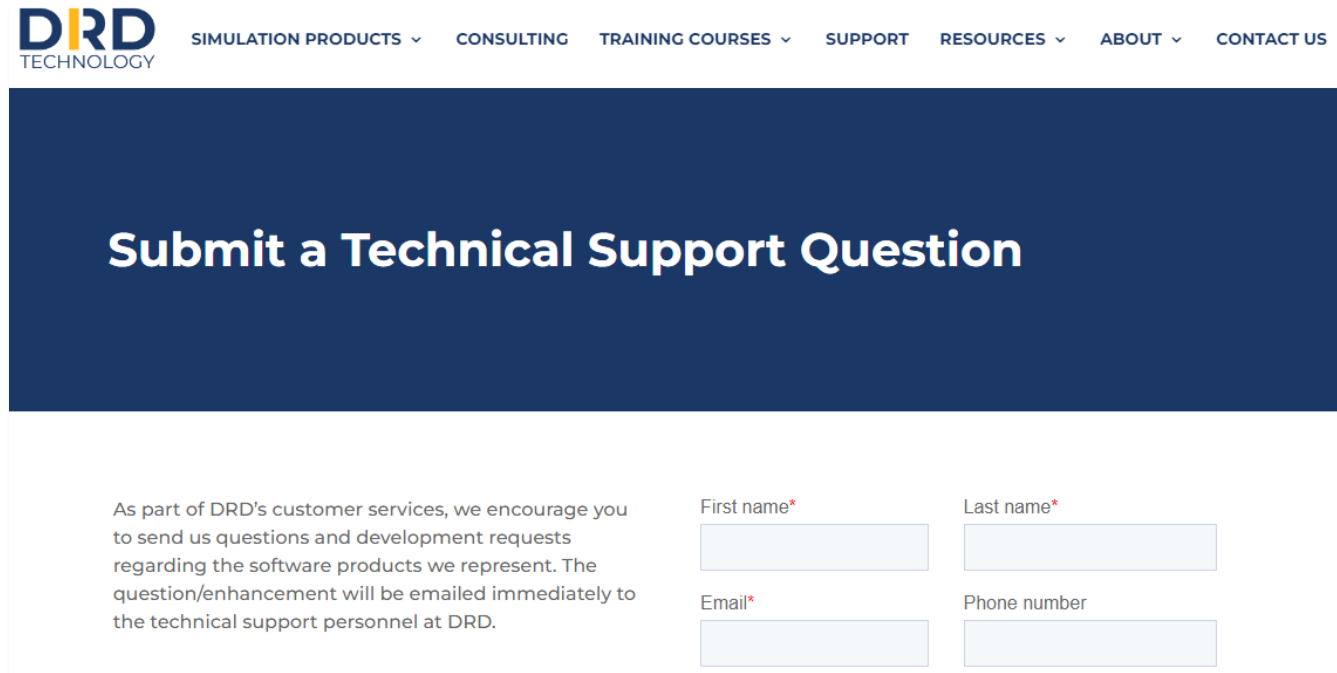

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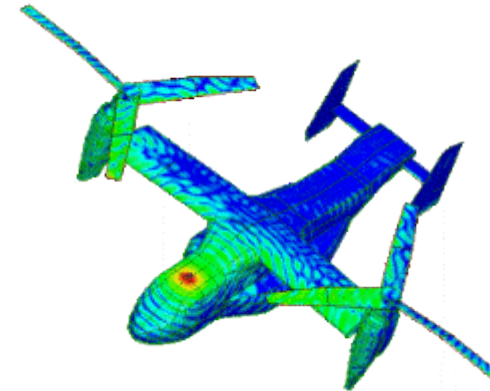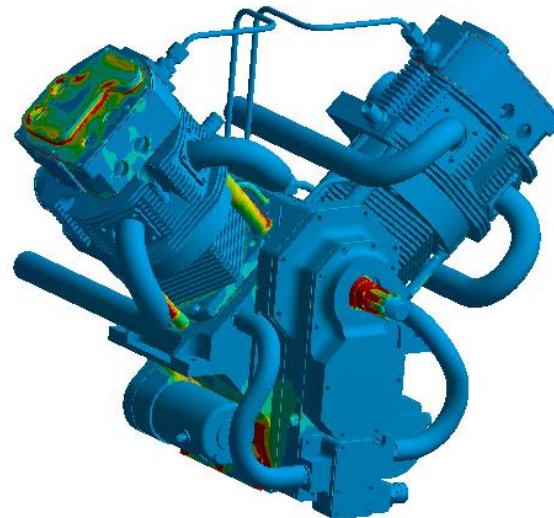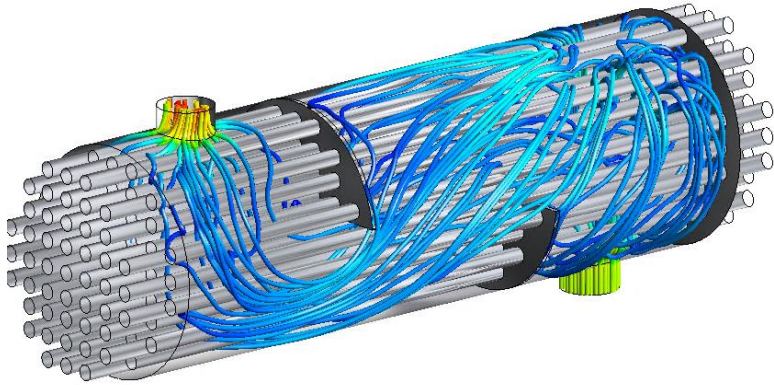
CERTIFIED ELITE CHANNEL PARTNER

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Technical Support Contact Coordinates

<u>Support:</u>
(918) 743-3013 x1
support@drd.com

Or through our website at
www.drd.com

For more than five years, I have worked closely with DRD Technology to execute tactical and strategic initiatives here at EaglePicher due to our unprecedented growth. We've been very happy with DRD and will continue to work with them as our business partner for using Ansys tools effectively and efficiently.

- *Doug Austin*
Director of Research and Development

EaglePicher™
Technologies, LLC

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Fluent Native GPU Solver

GPU Solver Performance

NVIDIA GPU Benchmarks on DrivAer 50M, Segregated
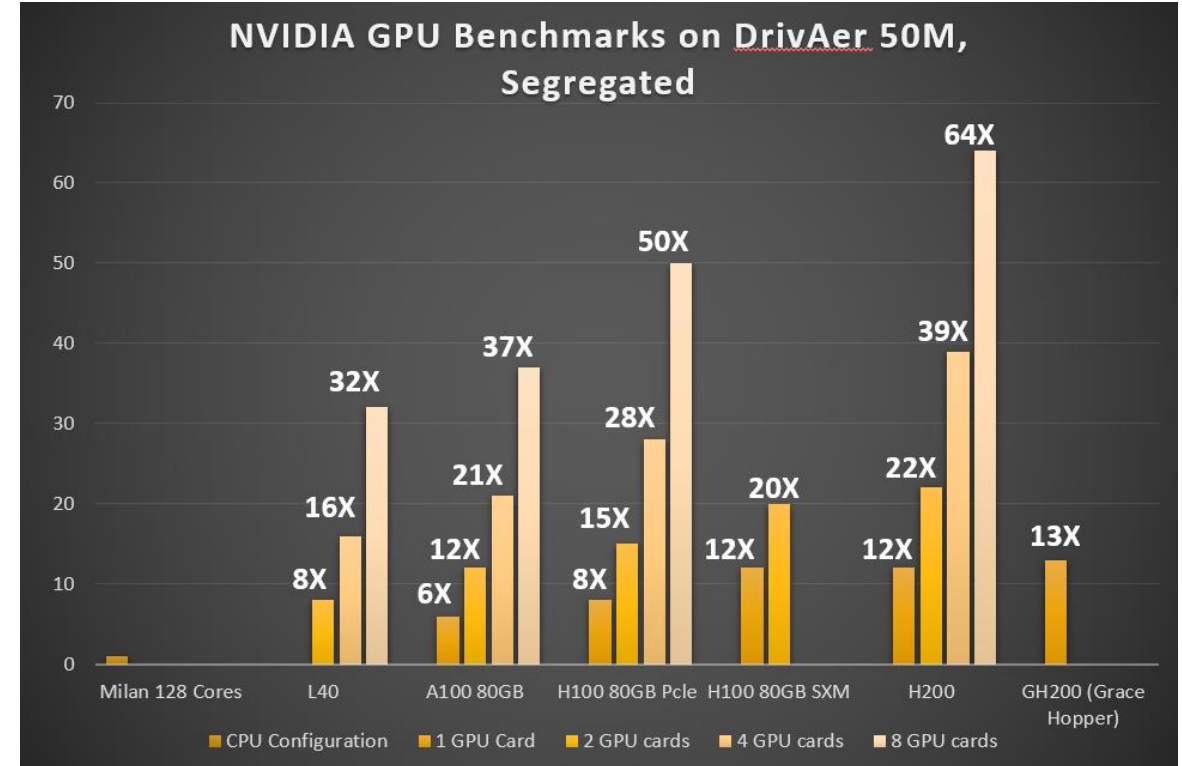
Multi-GPU CFD Solver: Release Timeline

β releases with support for :

- Single/multi-GPU (shared / distributed memory)
- Steady & transient simulations
- Incompressible & subsonic compressible flows
- All mesh types
- Ideal Gas and Materials with variable properties
- Turbulence: standard k-e, SST, GEKO, RKE, SBES
- Solid conduction and CHT
- Porous media
- Transient scale-resolving simulations
- Non-conformal mesh interfaces
- Moving walls & Moving Reference Frame
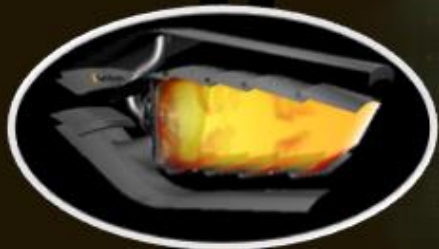- Windows and Linux
- ...

First full releases :

- Various numerics improvements
- Enhanced RANS
- Enhanced LES numerics
- Species transport
- Non-stiff reacting flows
- Compressible flows
- Sliding meshes
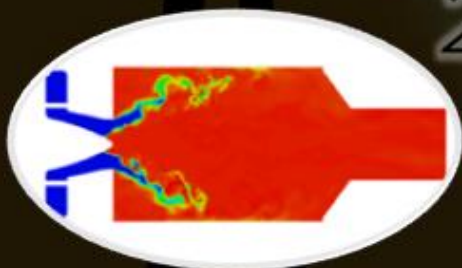- Improved UX and launcher enhancement
- ...

2022/R1
2022/R2
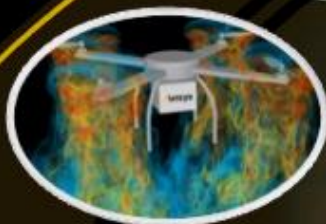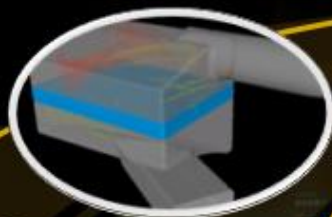
2023/R1
2023/R2

2024/R1

2024/R2

Advanced physics and models :

- Coupled solver
- Lagrangian particles
- Reacting flows
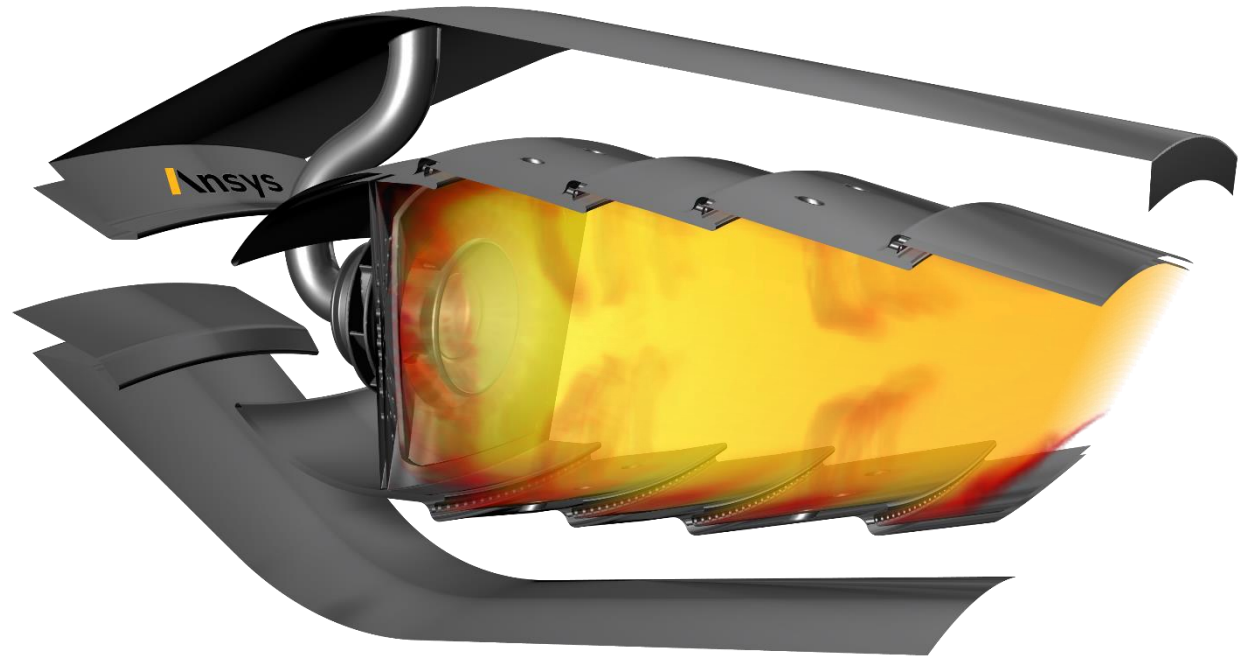- Acoustics
- ...

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Surface-to-Surface (S2S) Radiation Model

- S2S model now supported with GPU
  - Simplified workflow on GPU compared to CPU
    - No need to calculate the view factors explicitly:
      - Enable the radiation model
      - Define the emissivity on the various surfaces
      - Initialize and calculate the solution
  - Support for Periodic BC together with radiation
    - ÃŪËŽŪ ÃŠĔ ĘŪŌąŪËŽŪ ÃŠ

Radiation Heat Flux
[W/m^2]
-650   -325   0   325   650

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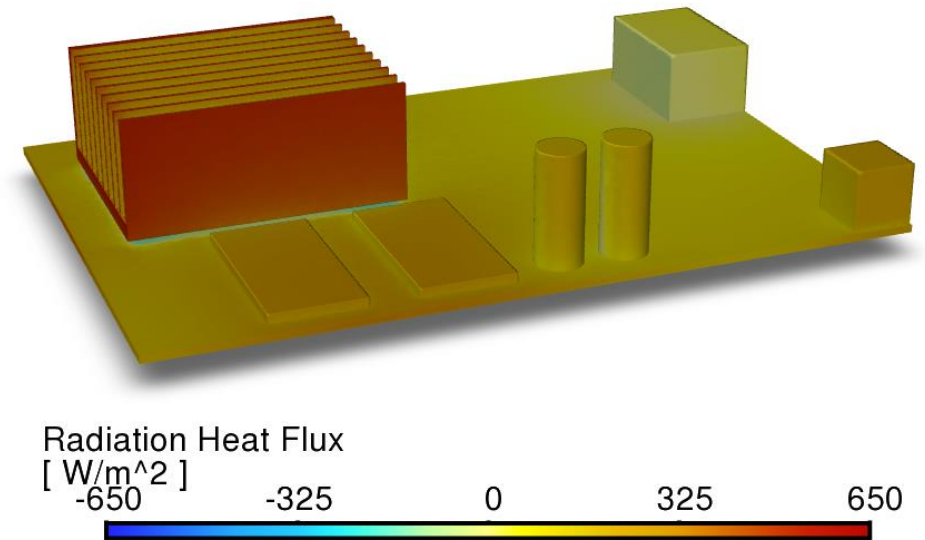
Flamelet Generated Manifold (FGM)

- Support for adiabatic FGM
  - Assumes adiabatic flame temperature
  - Pre-tabulated detailed chemistry
  - Four transport variables:
    - Mixture fraction [f]
    - Variance of mixture fraction [f"]
    - Progress Variable [C]
    - Variance of progress variable [C"]

- Non-adiabatic FGM (Beta)
  - One additional transport equation
    - Total (sensible + combustion) enthalpy
  - Supported Wall Boundary Conditions
    - Heat flux and adiabatic
    - Specified temperature
    - Coupled walls
  - Support for Discrete Ordinates (DO) radiation and Discrete Phase Model (DPM) coupling
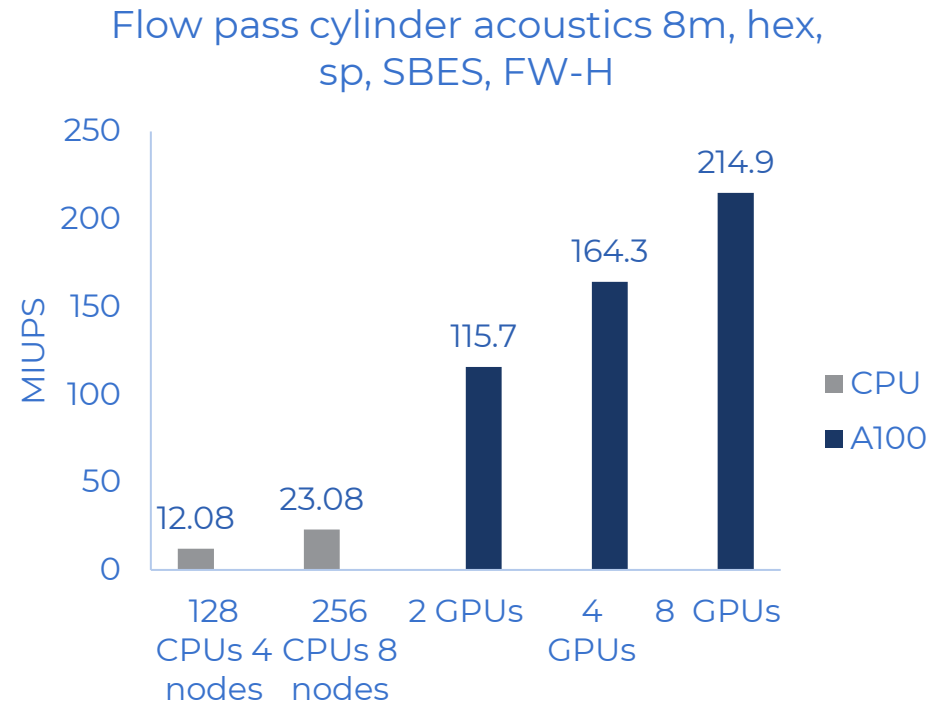 - Conjugate Heat Transfer (CHT) is not yet supported
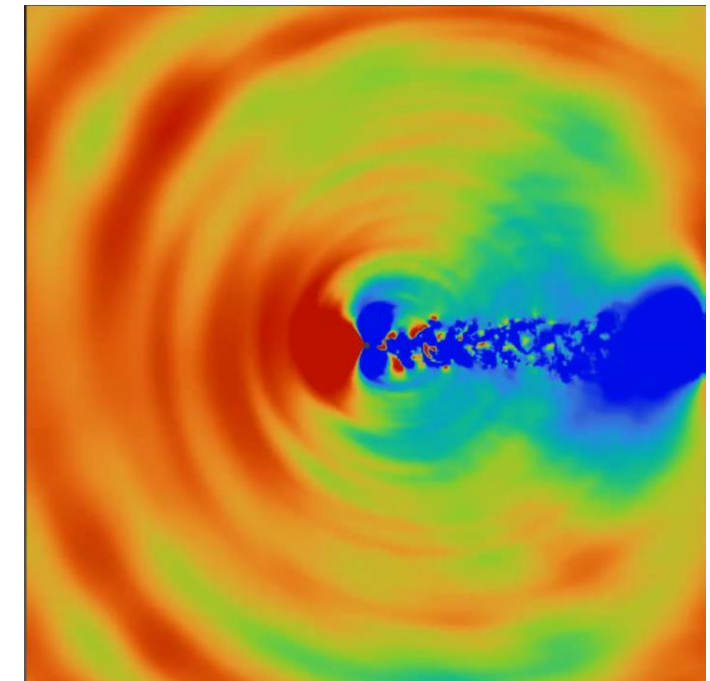
Ffowcs Williams & Hawkings (FWH) (Acoustics)

- Release of hybrid GPU (flow) / CPU (sound signal) solution
- Similar workflow as with CPU solver
  - Requires export of asd and ard files

Re=$0.9 \cdot 10^5$, M=0.2
FW-H integration surface:
internal zone and wall

1 Nvidia® A100 GPU ~ 640 CPU cores Intel® Xeon® Gold 6242

Flow pass cylinder acoustics 8m, hex, sp, SBES, FW-H

MIUPS

12.08 — 128 CPUs 4 nodes
23.08 — 256 CPUs 8 nodes
115.7 — 2 GPUs
164.3 — 4 GPUs
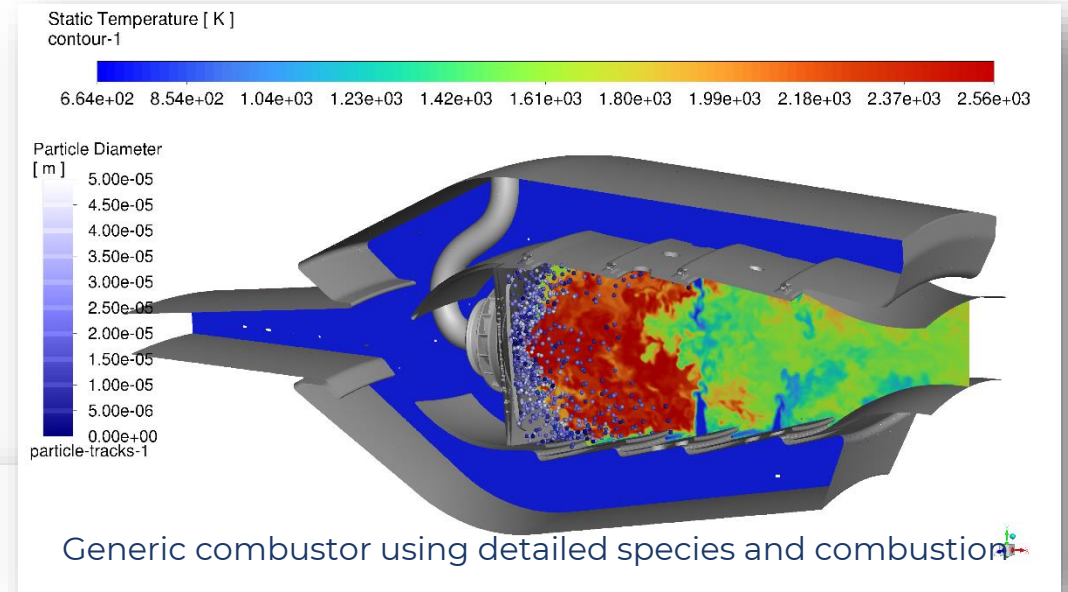214.9 — 8 GPUs

CPU
A100

dp/dt, far-field BC

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Discrete Phase Model:
Two-Way Coupling for Mass-Transfer

- Sources for detailed species transport equations

- Mass transfer from particles to coupled gas phase supports single-component evaporating / boiling particles


Generic combustor using detailed species and combustion

Modified Premix Flame Test
- pdf Table generated at 300 K Fuel/Oxidizer temperature
- Case inlet at 700K for non-adiabatic effects
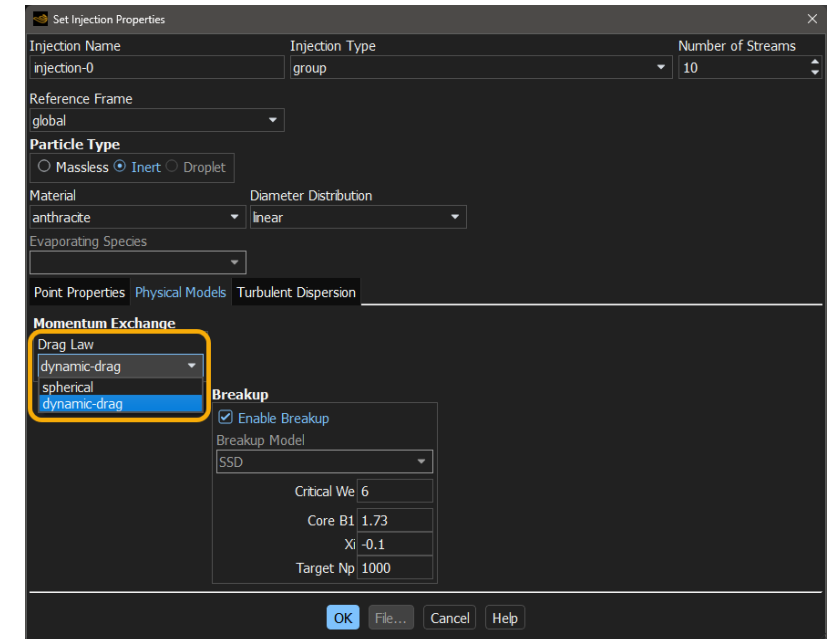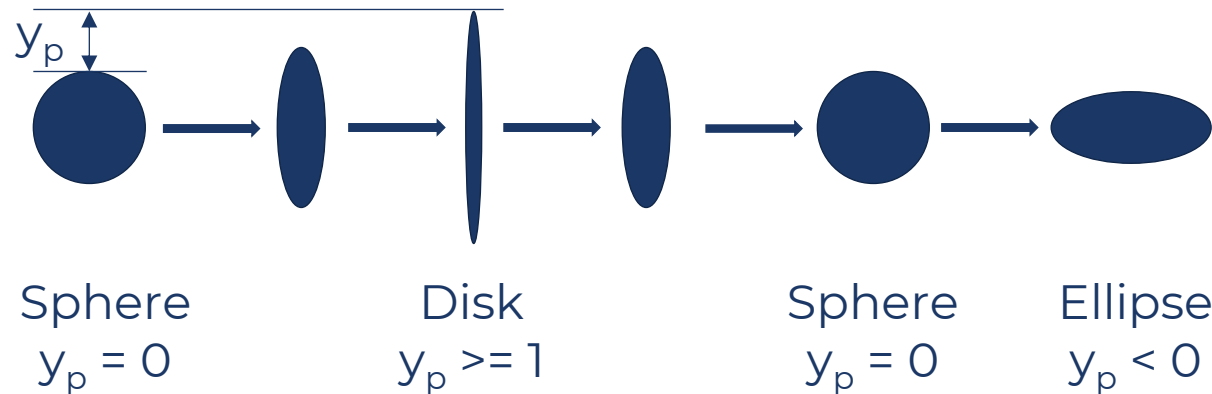- 1% mixture fraction + 6.25 mass% droplets injected at inlet
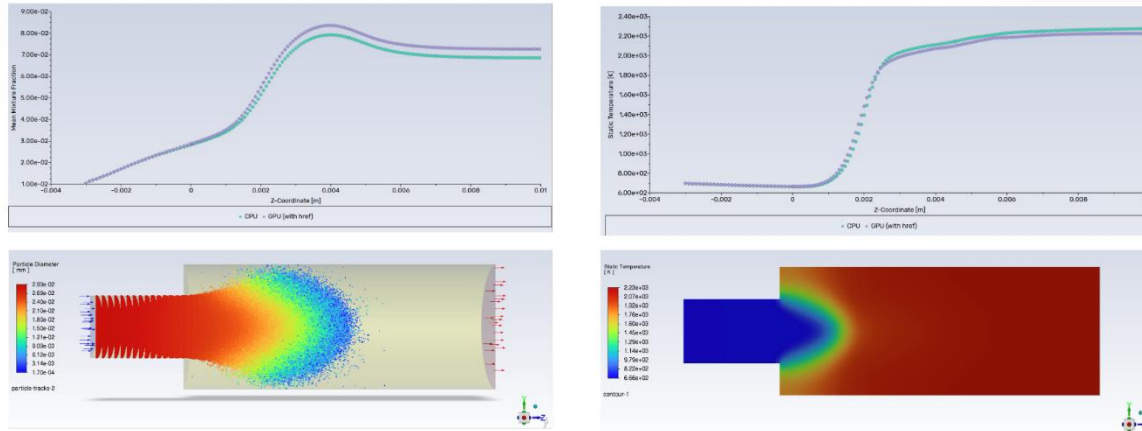
Discrete Phase Model: Dynamic Drag Law

- Solving equation for particle distortion assuming a damped spring-mass system

- New drag option available for particles undergoing droplet breakup
  - Injection specific
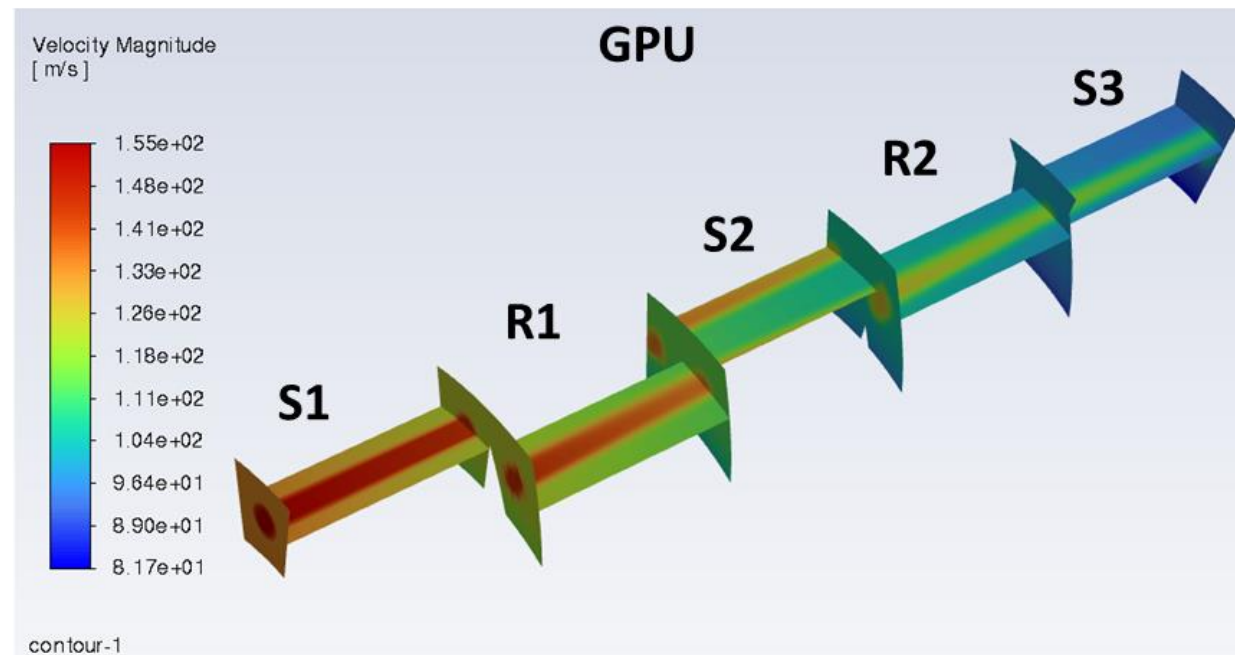 - Scales drag coefficient as function of the particle distortion, y_p
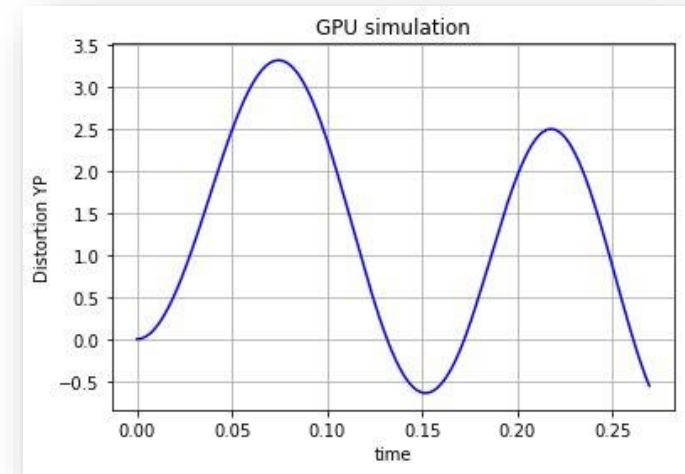
$$y_p(t) = We_c + e^{-t/t_d}\left[(y_{p,0} - We_c)\cos(\omega t) + \frac{1}{\omega}\left(\frac{dy_{p,0}}{dt} + \frac{y_{p,0} - We_c}{t_d}\right)\sin(\omega t)\right]$$

Sphere
$y_p = 0$

Disk
$y_p >= 1$

Sphere
$y_p = 0$
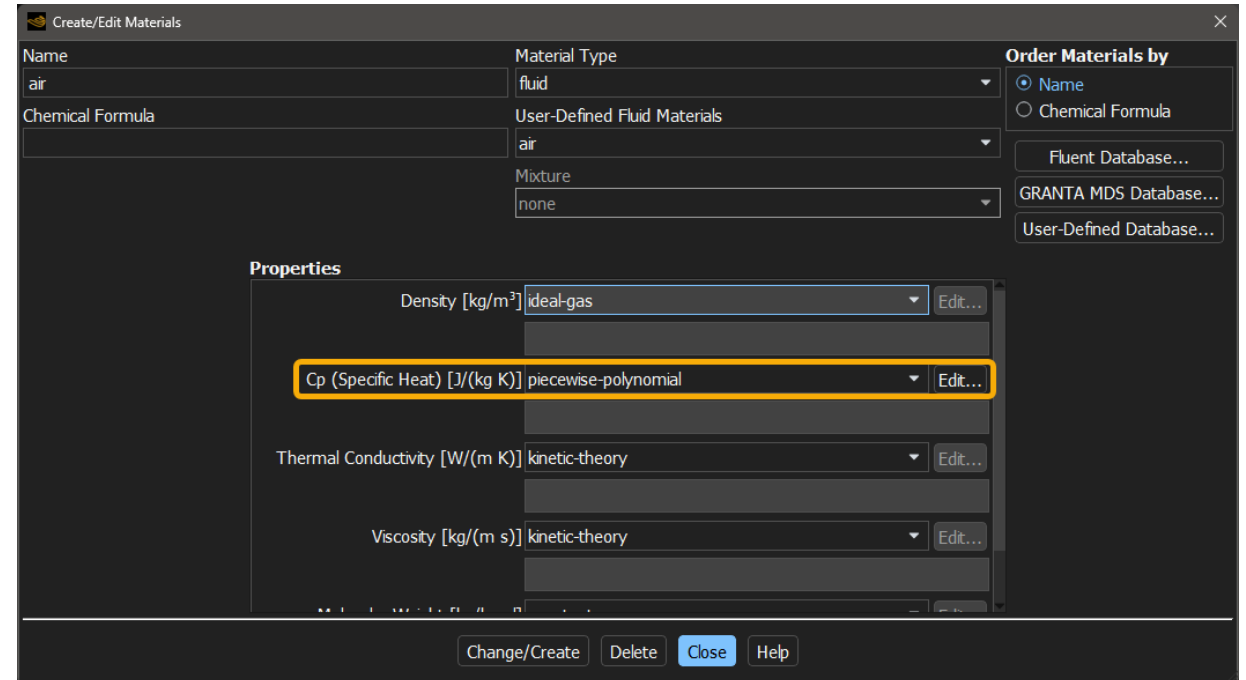
Ellipse
$y_p < 0$

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Turbomachinery

- Periodic repeat option now supported with GPU
  - Pitch change and other turbo interface models will be supported in a future release

Material Properties: Specific Heat

- Specific heat capacity can now depend on temperature when using the compressible ideal gas density formulation

# Material Properties: Compressible Liquid

Water Hammer

Pipe flow with steady state profiles is suddenly closed at one end, which produces water hammer effect.

- Density is assumed as a function of pressure alone using Tait's law

- Allows both compression and expansion

- Useful from physical and numerical perspective

- Current Limitations:
  - Supported only for single phase flows
 - Potentially less stable with second order time
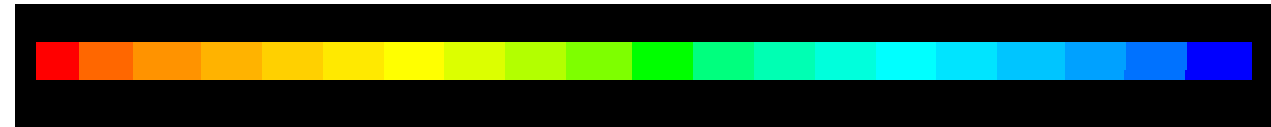
CPU vs GPU comparison
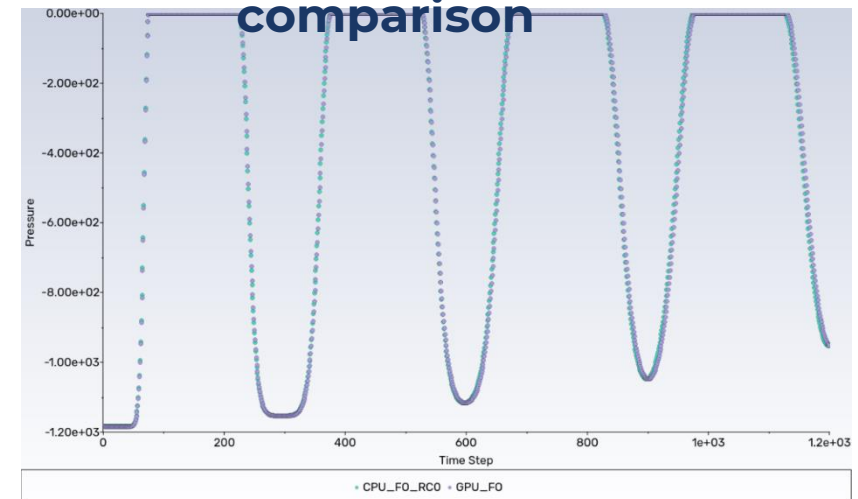
Area weighted average pressure at the outlet

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Expanded Expression Support

- Run time monitoring of quantities of interest defined as expressions and create plots

- Support for flow variables (u, v, w, P, T) and mathematical operators like sin, cos, exp, sqrt
  - Examples:
    ```
    sqrt(u^2 + v^2+w^2)
    Time*Sum(T, ['fluid']) * 2 [kg/(m^3*s)]
    AreaAve(u^2+v^2+w^2,['pressure-outlet 7'])
    ```

- Moving reference frames can be customized with expressions
  - Time-dependent expressions for rotational speed, axis origin, direction and translational velocities
  - No spatially varying expressions
  - Ability to mix and match inputs between expressions and constants
  - Example:
    ```
    3.0*sin(2.0*PI*t/1[s])*1[rad s^-1]
    ```
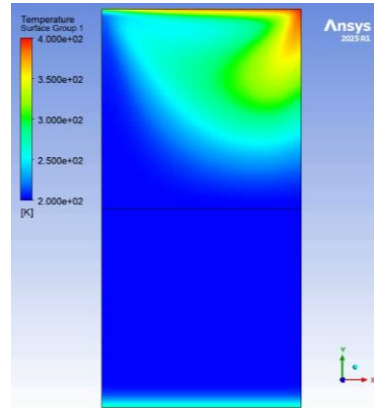
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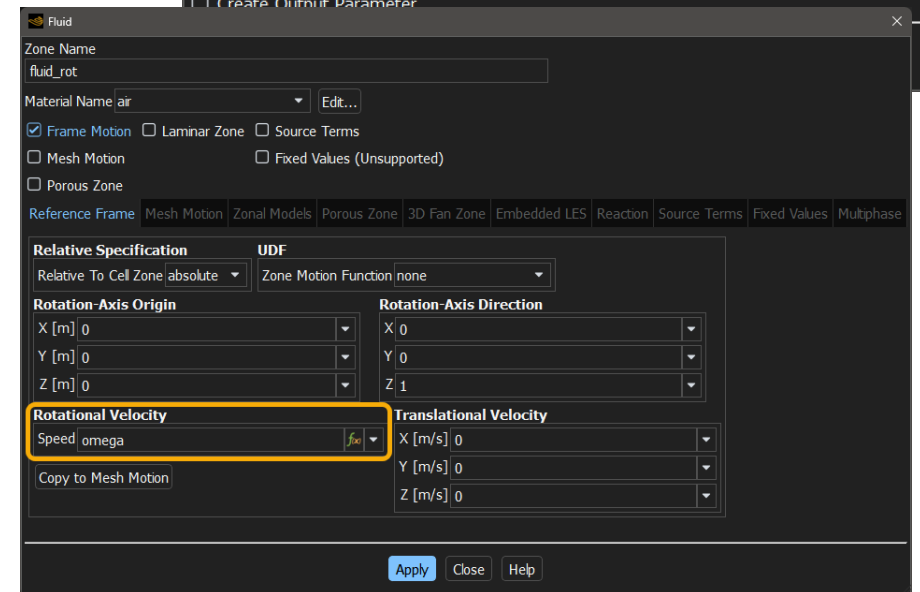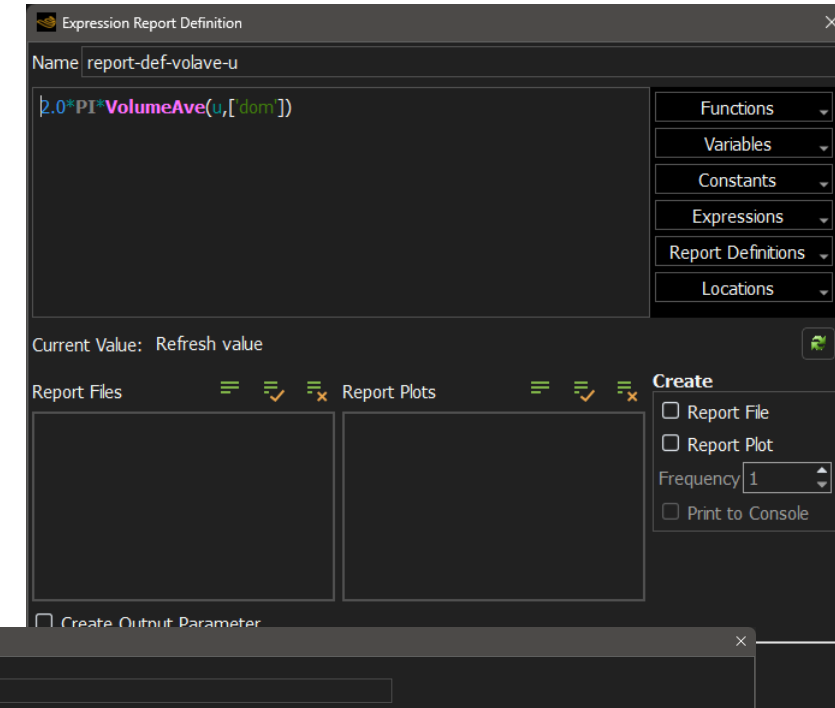
Transient Numerics
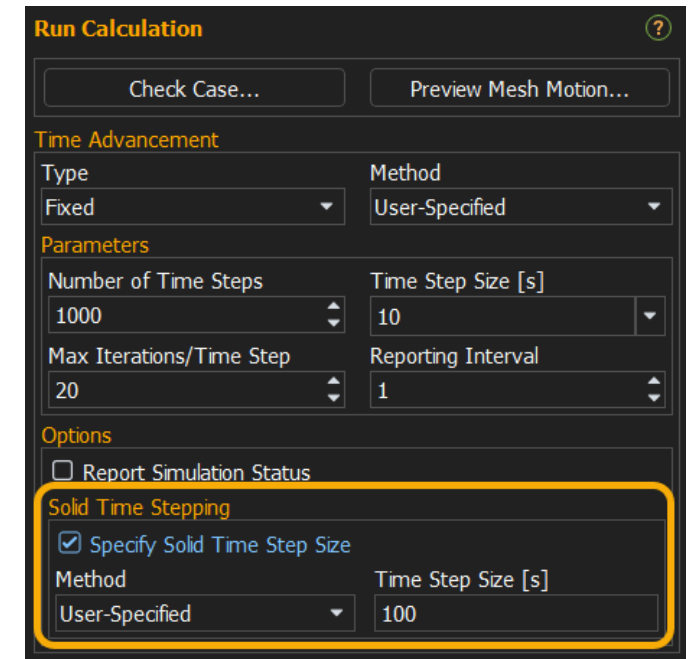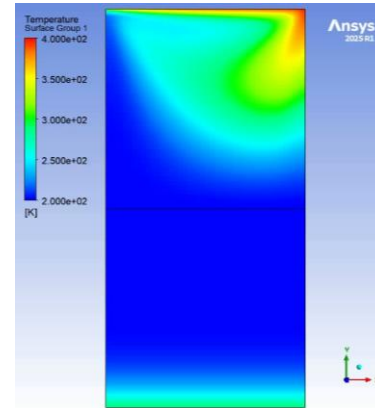
- Solid time-stepping
  - Independent timestep for CHT solids
    - Reduces calculation time when only final state is of interest
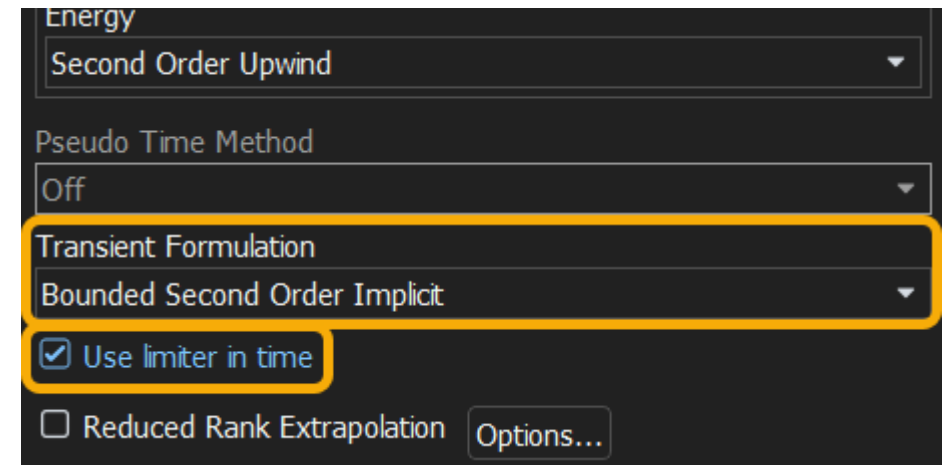
$$dt_f = dt_s = 10 \qquad dt_f = 10, dt_s = 100$$

- Bounded Second Order now available for Transient Formulation
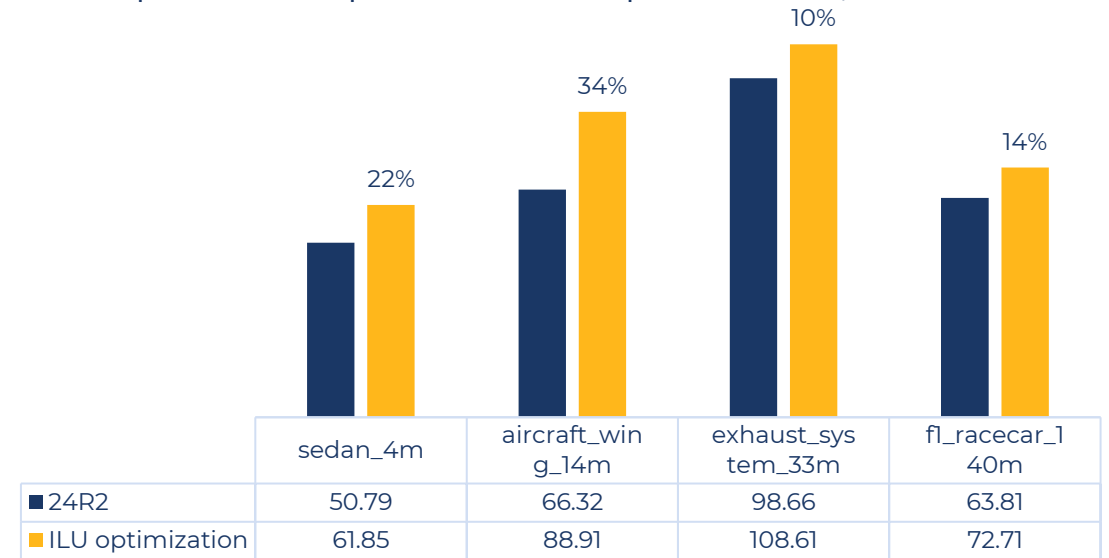 - Improves stability for large time step size
  - Limiter-in-time for second order transient schemes (GPU only)
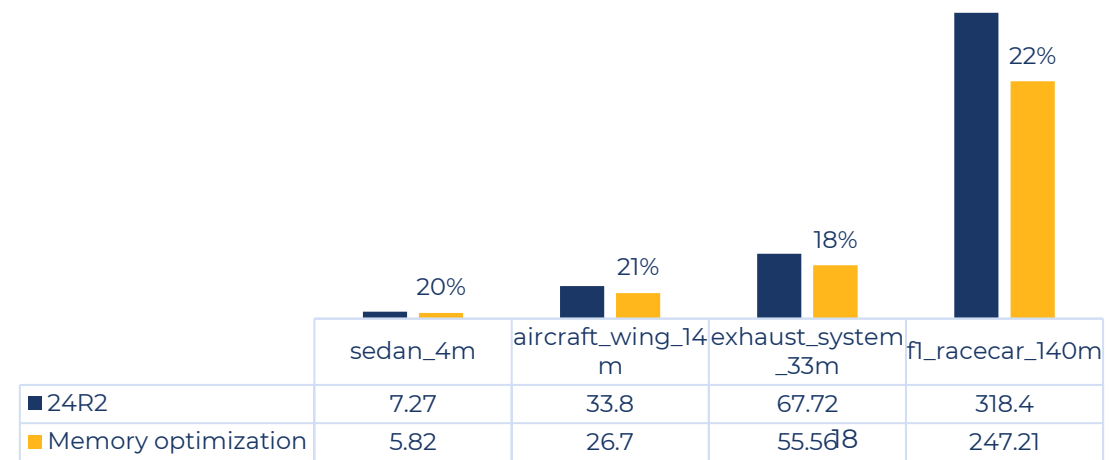   - Improves boundedness for energy

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Coupled Solver Improved Performance

- Optimizations provide improved performance and reduced memory for the coupled GPU solver

- Calculation time reduces by up to 30%

- Memory consumption decreases by up to
  - 20% in single precision
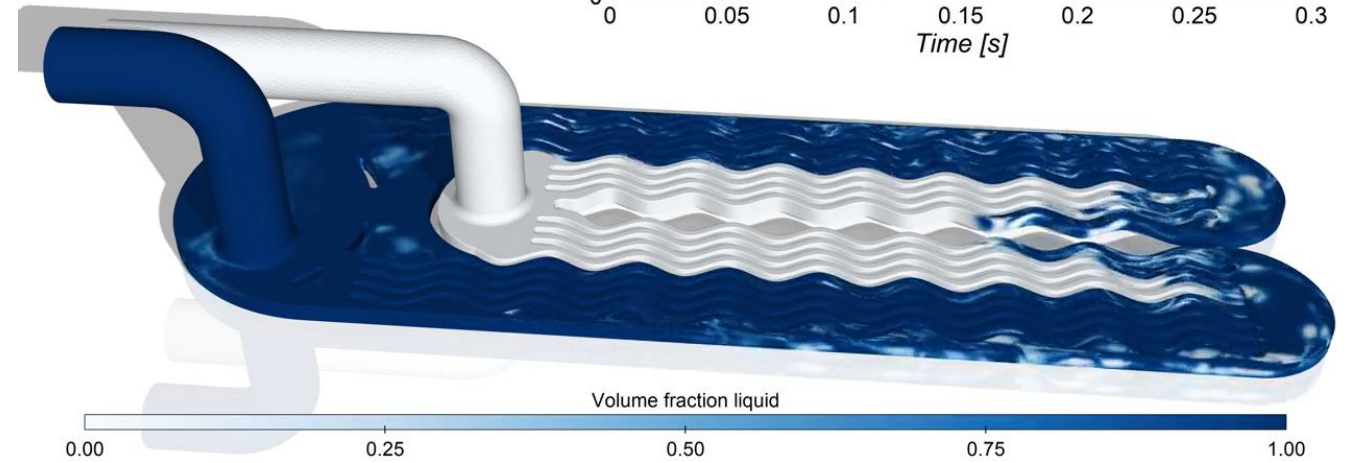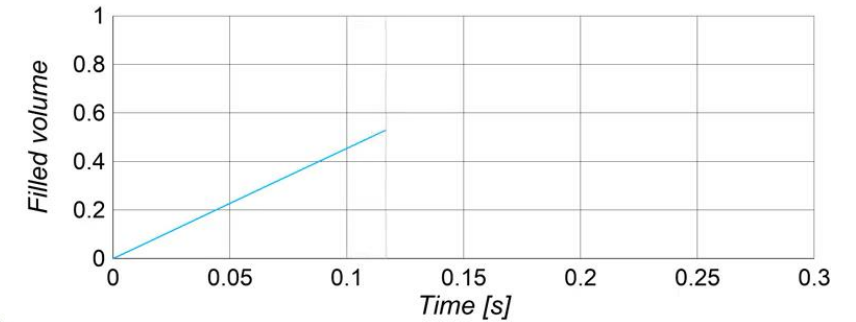 - 25% in double precision

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Coupled solver performance optimization, MIUPS

	sedan_4m	aircraft_win g_14m	exhaust_sys tem_33m	f1_racecar_1 40m
■ 24R2	50.79	66.32	98.66	63.81
■ ILU optimization	61.85	88.91	108.61	72.71

Memory usage (GB) optimization of single precision

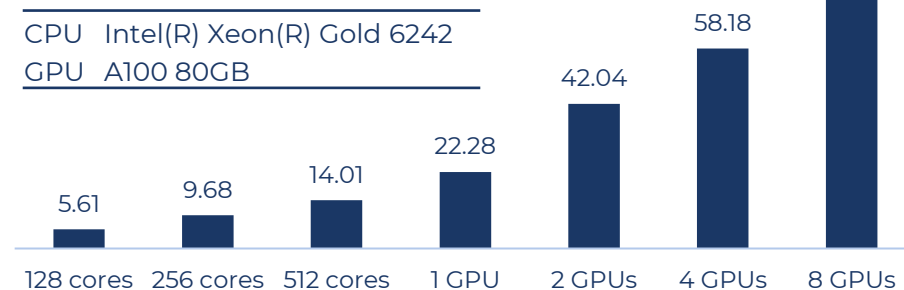|	sedan_4m	aircraft_wing_14 m	exhaust_system _33m	f1_racecar_140m
■ 24R2	7.27	33.8	67.72	318.4
■ Memory optimization	5.82	26.7	55.58	247.21

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Volume of Fluid (VOF) (Beta)

- VoF method now available on GPU
  - Excellent performance and scalability, with 2 x A100 GPU's ~10x faster than 128 CPU cores
  - Most calculations on GPU can use single precision, while CPU requires double precision
    - Reduces memory cost of GPU by a factor of 2 and improves speed up to 40%
  - GPU solver often works with higher URFs compared to CPU solver
   - Reduces required number of iterations

Volume fraction liquid

Capillary filling, VOF + surface tension
1M poly, double precision, MIUPS

| CPU | Intel(R) Xeon(R) Gold 6242 |
| GPU | A100 80GB |

| 128 cores	256 cores	512 cores	1 GPU	2 GPUs	4 GPUs	8 GPUs
5.61	9.68	14.01	22.28	42.04	58.18	73.68

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VOF (Beta) Limitations

- Support for sliding meshes, laminar flow and RANS models

- Limitations of initial beta release:
  - Only isothermal calculations (energy equation must be disabled)
  - Constant material properties
  - Not compatible with other models like
    - Species transport
    - Discrete Phase Model (DPM)
    - Large Eddy Simulation (LES)
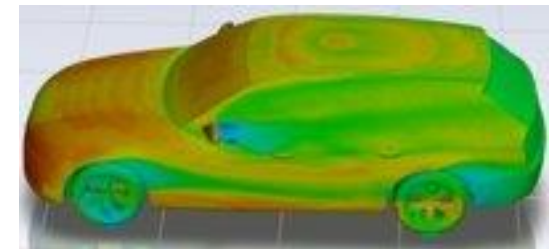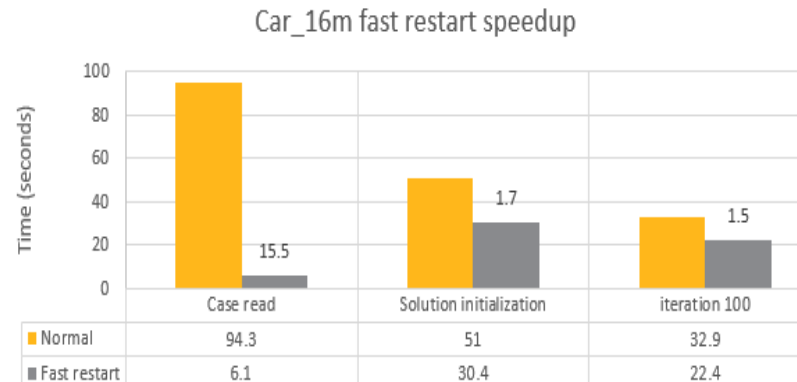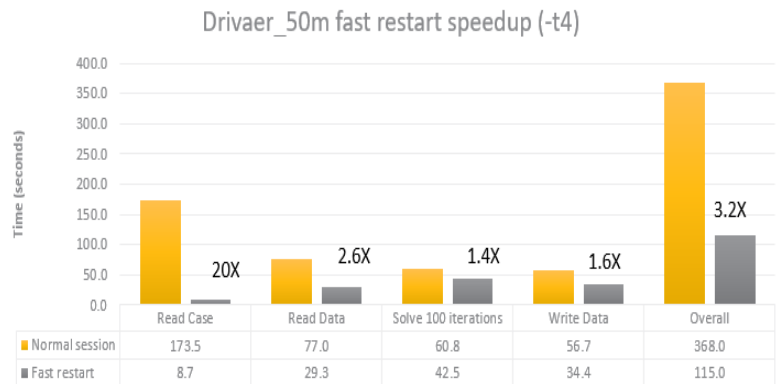 - Only implicit VOF with Compressive scheme

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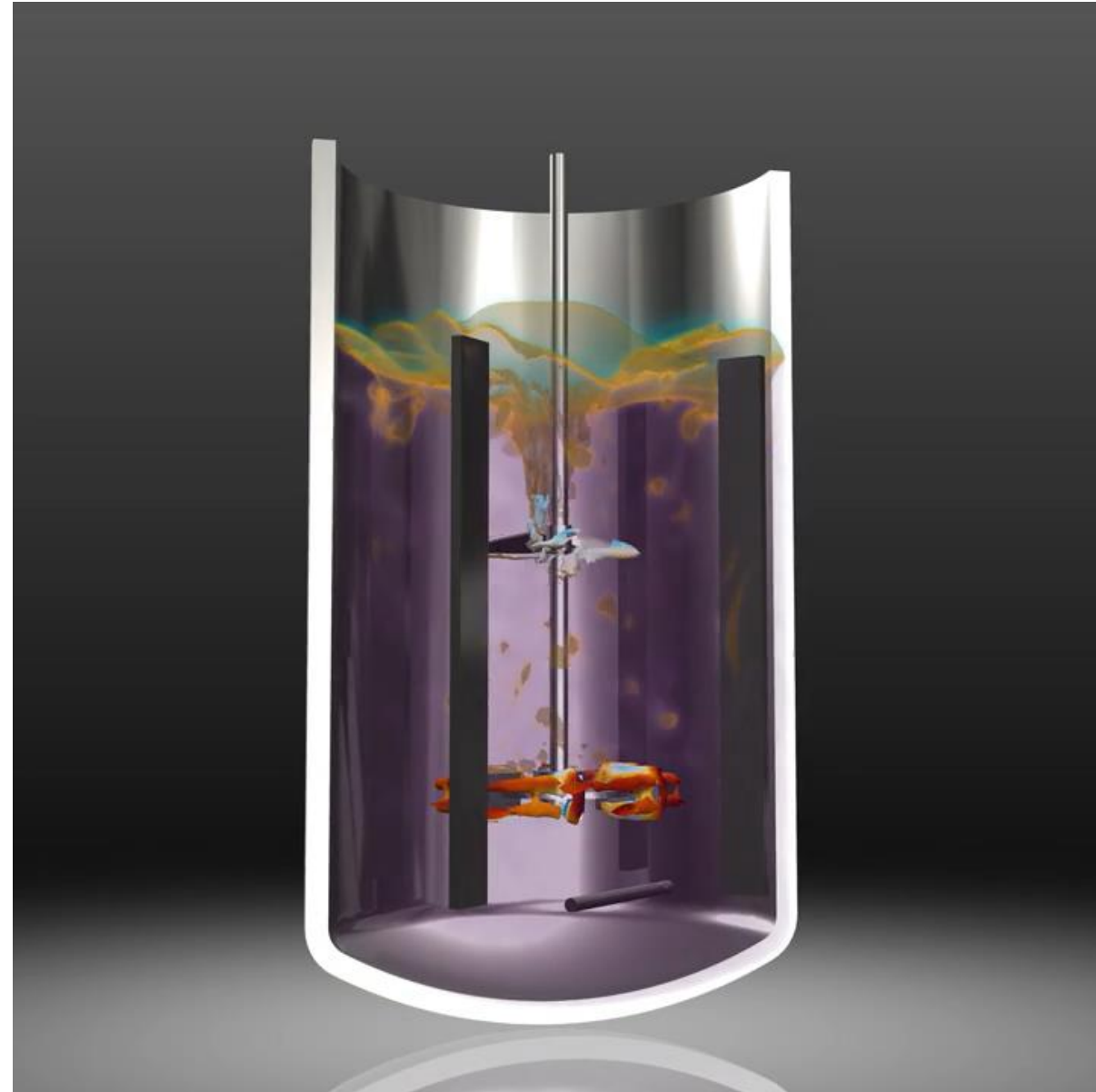
VOF (Beta) Other

- Surface tension for VOF
  - Continuum surface force model with constant surface tension coefficient
  - Optional boundary-zone-based wall adhesion

- Modified Body Force Weighted

- From Neighboring Cell
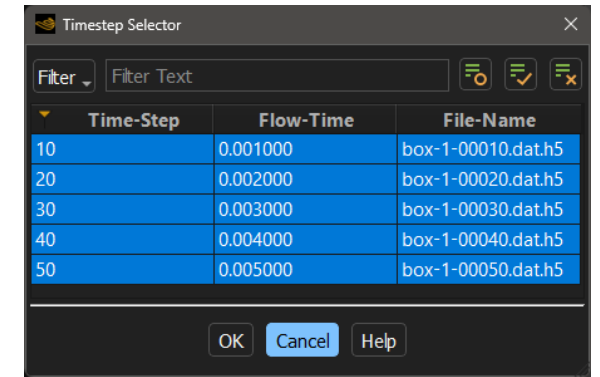 - Volume Fraction
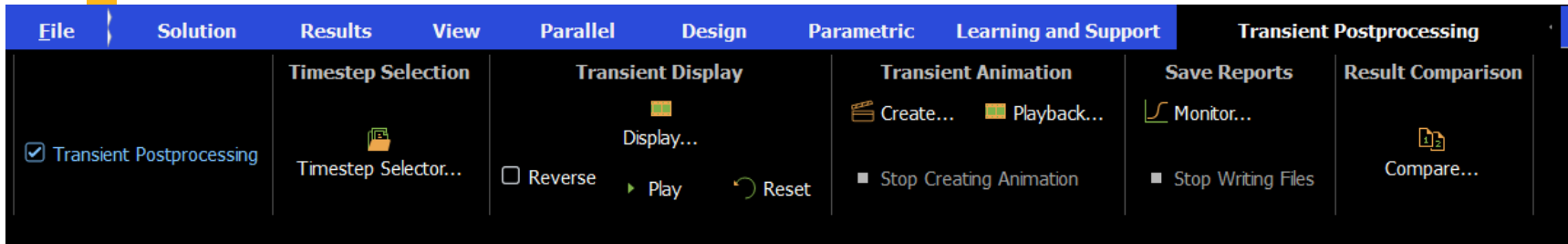 - Pressure

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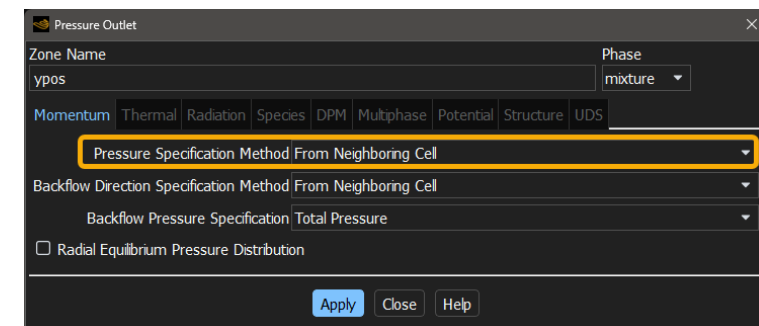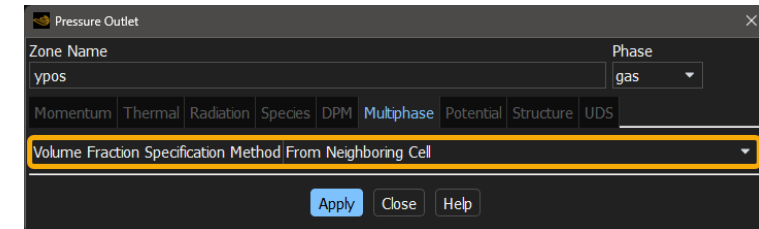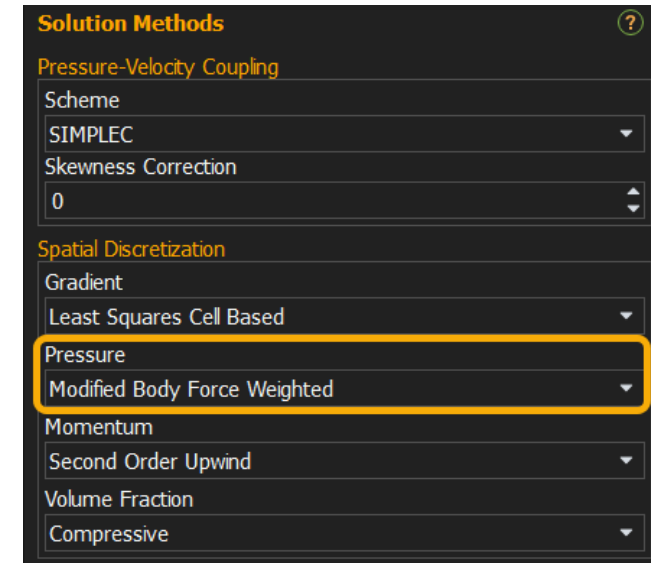
Fast Restart/Native GPU Post-Processing (Beta)

- Reduce the case/data loading time when restart the GPU solver calculation and enabling native GPU post-processing
  - Command line option: `-lite`
  - Unsupported objects like iso-surfaces are disabled
- Work for both first-time and restart runs
- Once saved with lite, cas/dat can only be read in this mode

Drivaer_50m fast restart speedup (-t4)

	Read Case	Read Data	Solve 100 iterations	Write Data	Overall
Normal session	173.5	77.0	60.8	56.7	368.0
Fast restart	8.7	29.3	42.5	34.4	115.0

Speedup: 20X, 2.6X, 1.4X, 1.6X, 3.2X

Car_16m fast restart speedup

	Case read	Solution initialization	iteration 100
Normal	94.3	51	32.9
Fast restart	6.1	30.4	22.4

Speedup: 15.5, 1.7, 1.5

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Fluent User Experience: Desktop Interface

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Transient Post-Processing

- Transient post-processing of multiple time steps within Fluent
  - Only for static meshes in the first release, recommended for small cases
    - First release can only read the full Fluent *.dat* files, which requires more time compared to reduced data sets in CFD Post or EnSight
- Read the last dat file of a sequence to access all previous steps with the Timestep Selector
- Create transient animations after the calculation is finished


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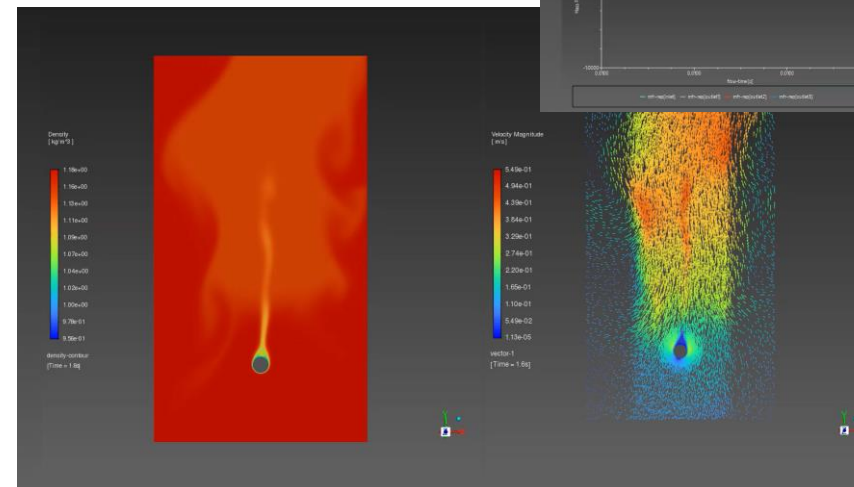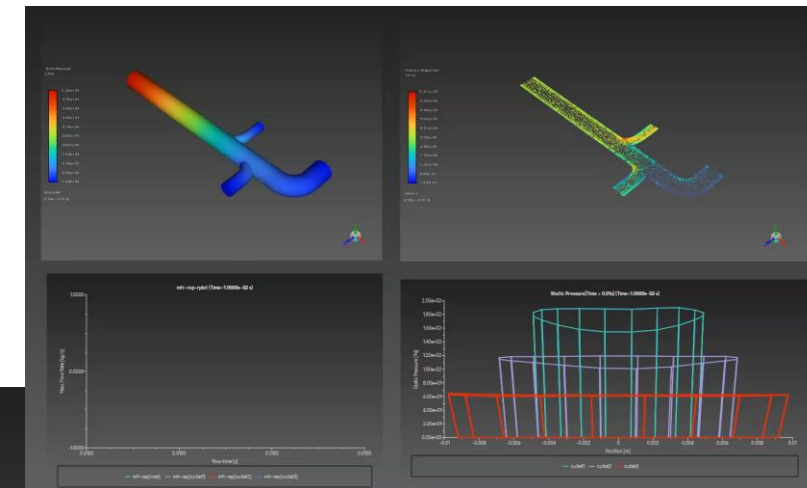
Clipping Plane

- Clipping plane available in context menu of a graphics window
  - Visual clip only, not stored in an object
    - Use clip surface objects for persistent clips
  - Limited to one active clipping plane
 - Interactive handle to change position/orientation
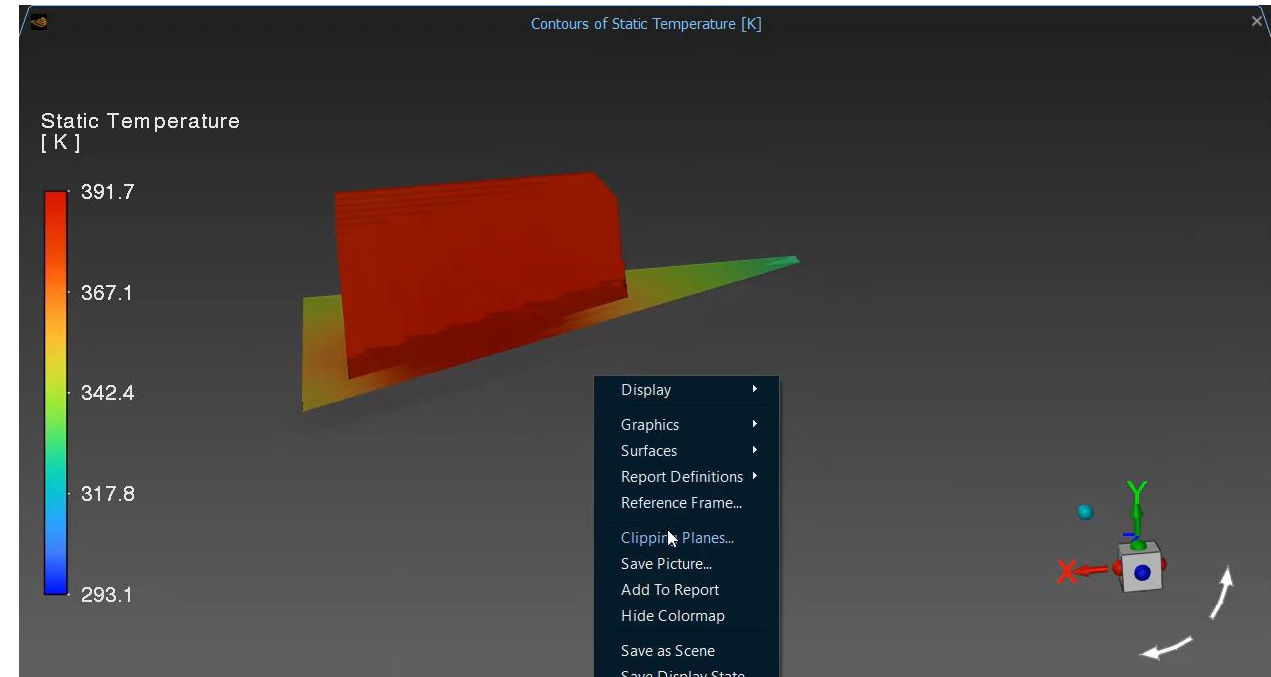
Non-Conformal Interfaces

- New Matching option for 1-to-1 interfaces
  - Forces zero area non-overlapping boundaries
    - Cannot pair interface boundary participating in matching interface in another 1-to-1 interface

- Cell zone pairing for 1-to-1 interfaces
  - Allows interface creation by selecting cell zones
    - All boundaries of selected cell zones (of type wall and interface) participate in auto pairing
    - Can mix and match face and cell zones

- NCI exclusion list
  - Allows to specify boundary pairs not to be paired by auto pairing (TUI and GUI)
    - `/define/mesh-interfaces/auto-options/set-exclusion-pairs`

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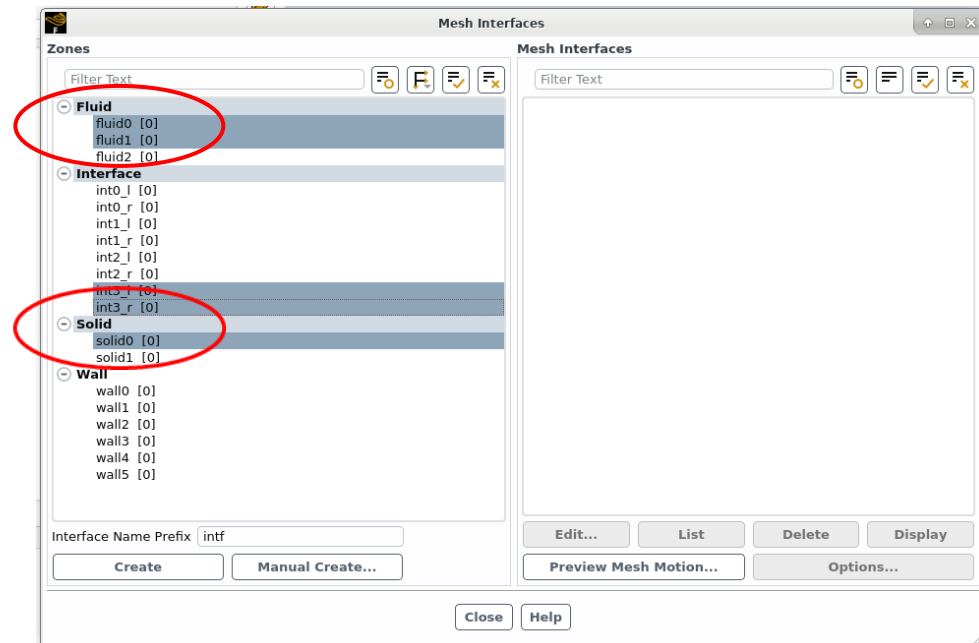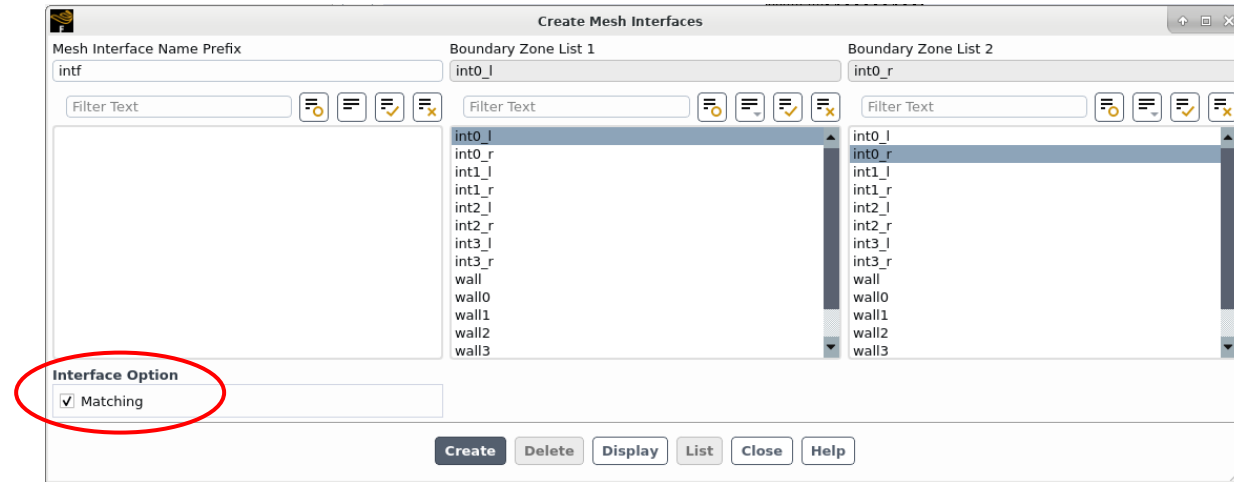
Parametric Workflow

- Parametric Report in PPT format
  - Based on the DP results objects
  - DP-specific images and comparisons of DPs
  - Exported content defined after the parametric run to keep the size of the report manageable
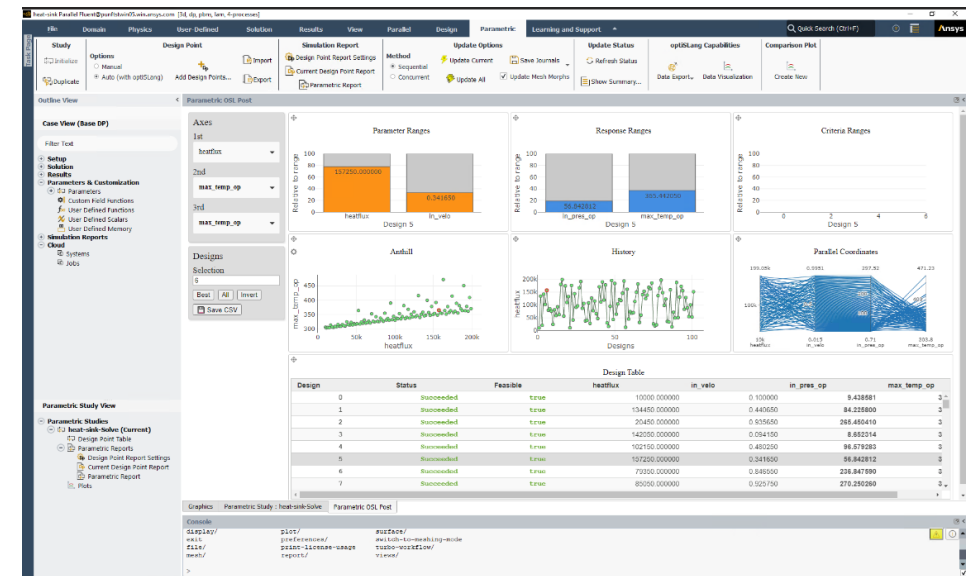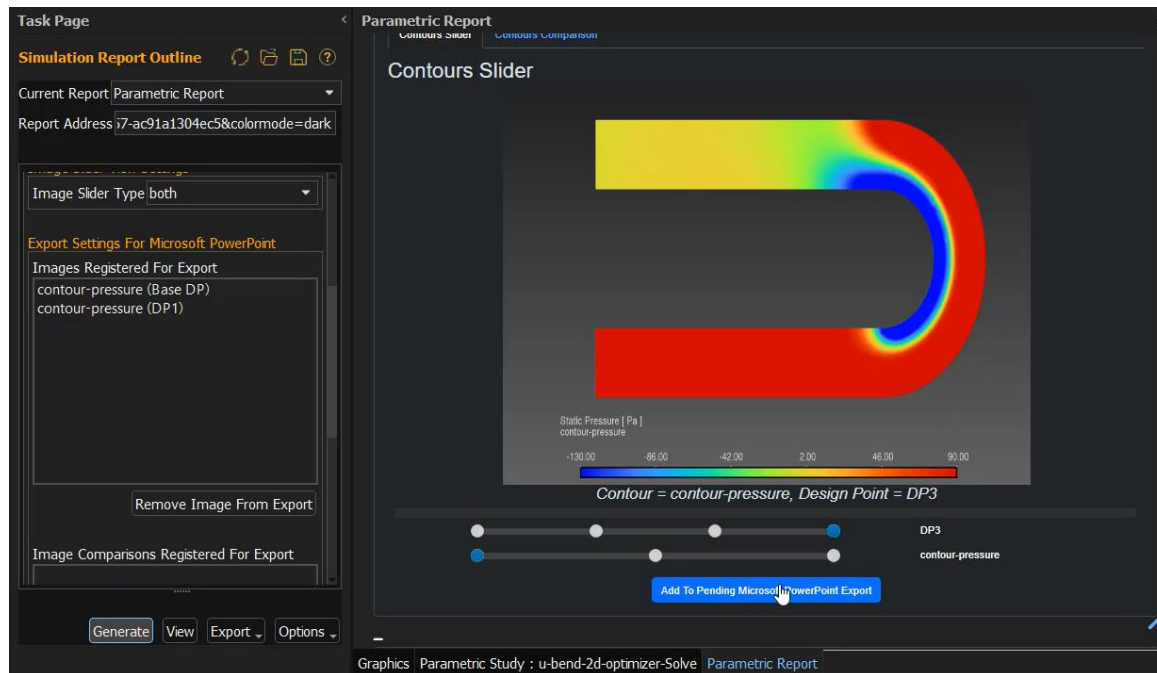
User Interface Performance

- Performance is dramatically improved for cases with many zones
  - Test cases show UI operations are 3x to 500x faster
  - Overall setup time reduced by 4x to 15x
 - 1-to-1 auto-pairing for Non-Conformal Interfaces:

Cores	Boundaries	Interfaces	24R1 [mins]	24R2 [mins]	25R1 [mins]	Speedup 24R1 > 25R1
128	332	660	97	32	16	6x
64	127	369	71	14	7	10x

  - Performance also improved for 1-to-1 interface deletion

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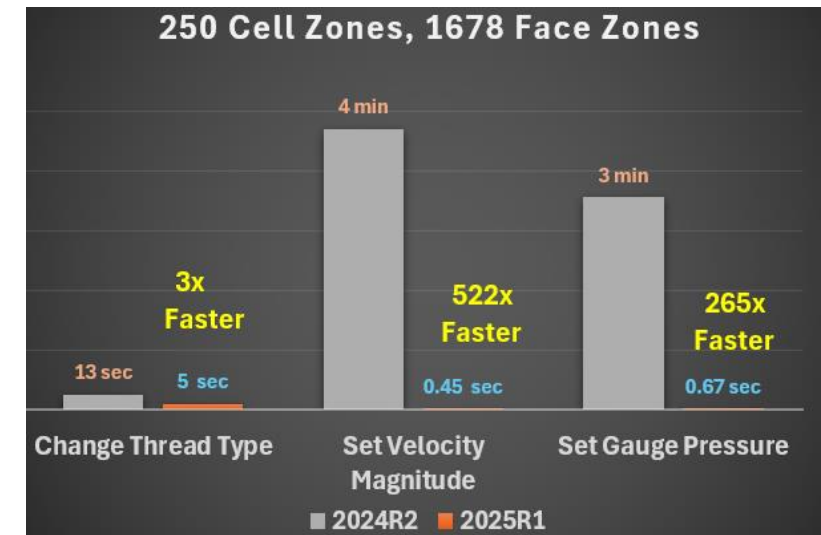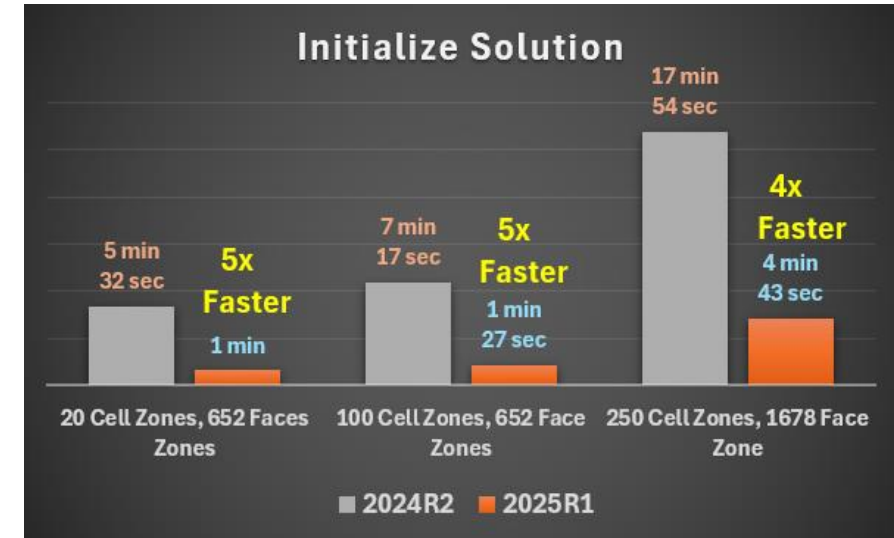
Graphics Performance

- New preference to improve performance of rendering large surfaces with millions of triangles
  - Large surfaces are splits into multiple shells of 160k facets
  - Need to redisplay after setting the preference
  - Applies to both Meshing and Solve modes

- Improved interactivity: more responsive panning, zooming, and rotating
  - Best for low number of zones with high facet count
  - Example case: 1 zone, 150M faces
    - Rotate: FPS 0-1 (24R2) vs 55-65 (25R1)
    - Zoom: FPS 0-1 (24R2) vs 15-25 (25R1)
    - Pan: FPS 0-1(24R2) vs 55-65 (25R1)
    - Initial mesh display time: 760s (24R2) vs 350s (25R1)
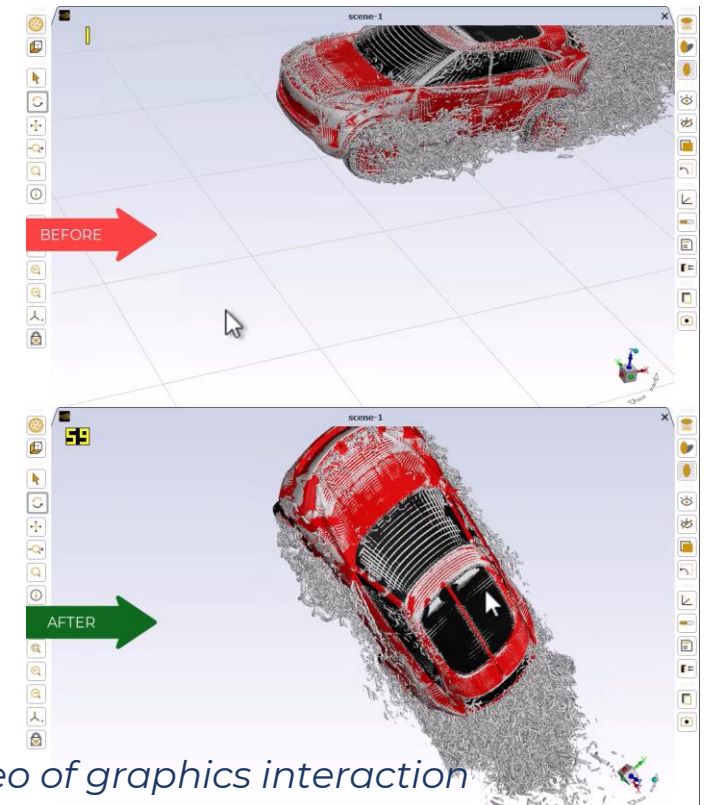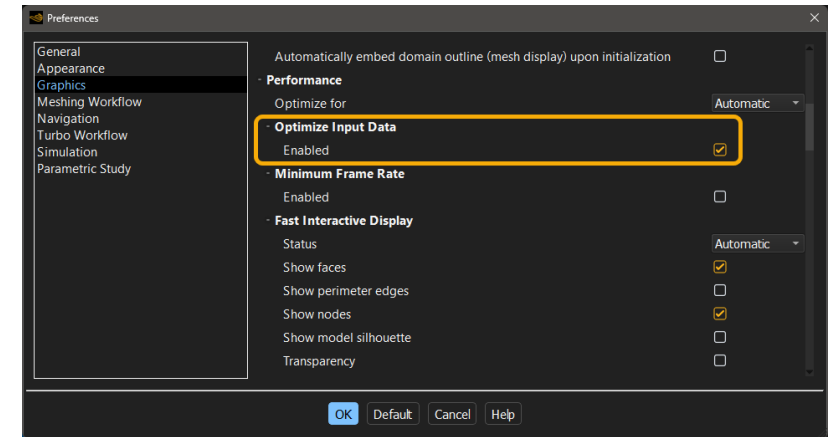
Video of graphics interaction

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Fluent User Experience:
# Web Interface

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Fluent Web Interface

WHAT IS IT?: A single workflow interface from meshing (β) to solving to post-processing available directly in a web browser

WHO IS IT FOR?: Available to any Fluent user of any license type.

WHAT CAN IT DO?:

- Mesh (β), physics setup solve and post-process within a single interface

- Monitor simulation results in real-time, before the problem has been solved

- Available to connect with batch as well as interactive Fluent sessions

- Collaborate with colleagues on the same project at the same time

- Modernized UI/UX with a familiar look and feel to Fluent desktop

- While not all models are available for setup, additional models are included with each release

DRD
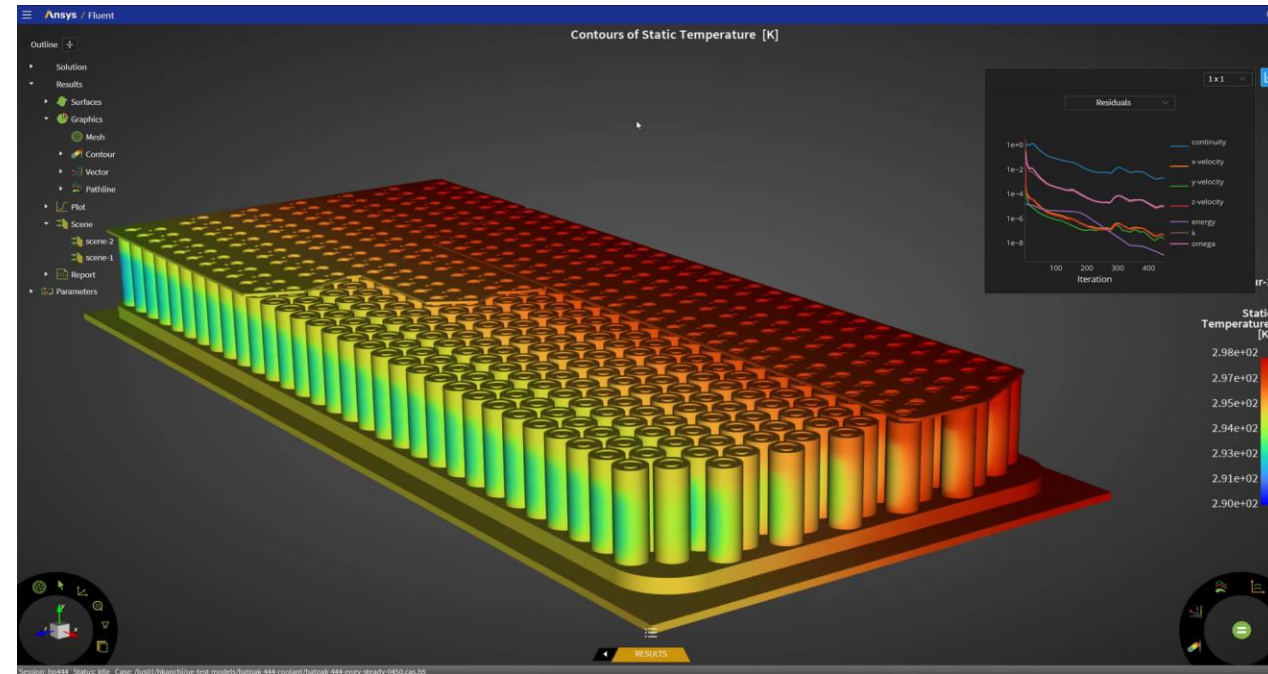
Additional Physics (Beta)

- Eddy dissipation, finite rate

- Partially premixed combustion with FGM

- Volume of fluids multiphase method (excluding mass transfer and reactions)

- Discrete phase model and particle post-processing

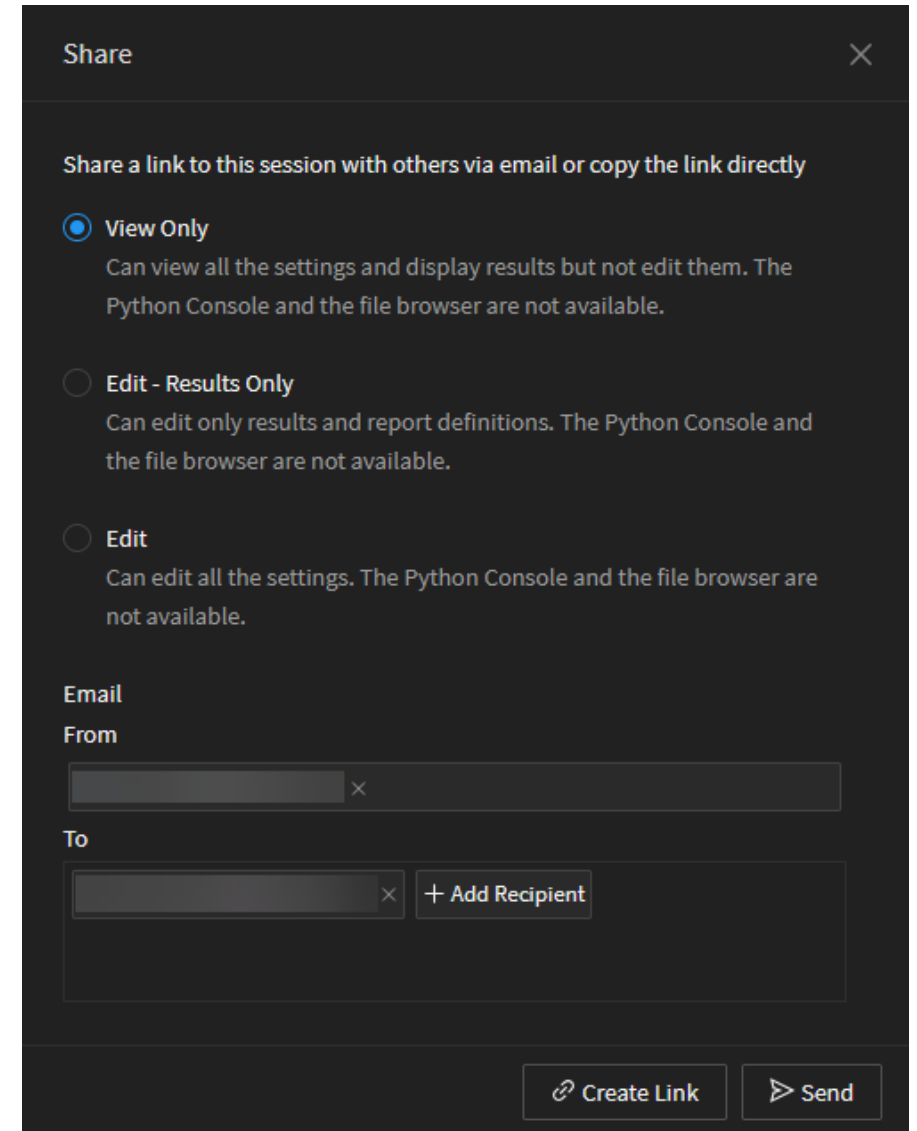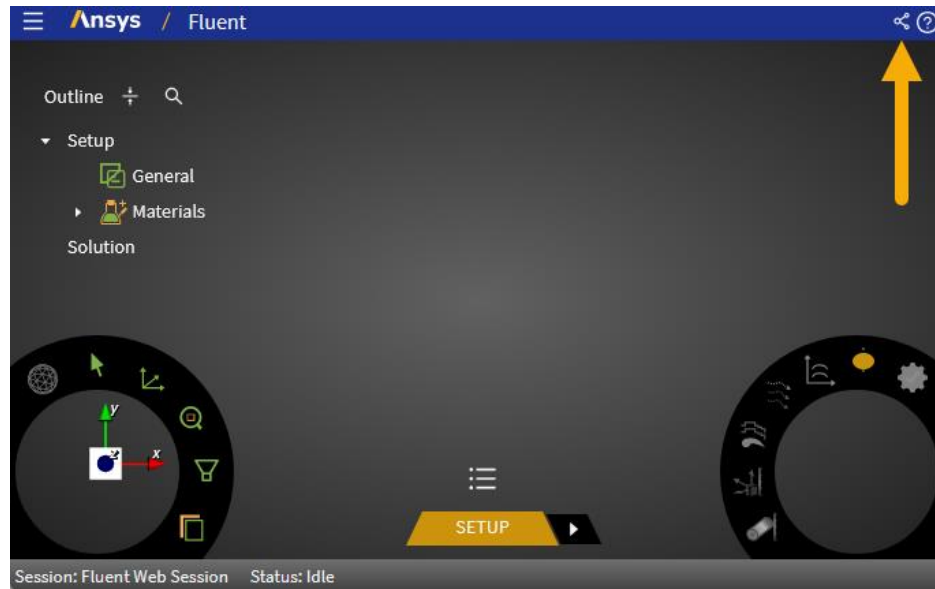- Adjoint solver, shape optimization, parameterize and explore (parametric mesh morphing)
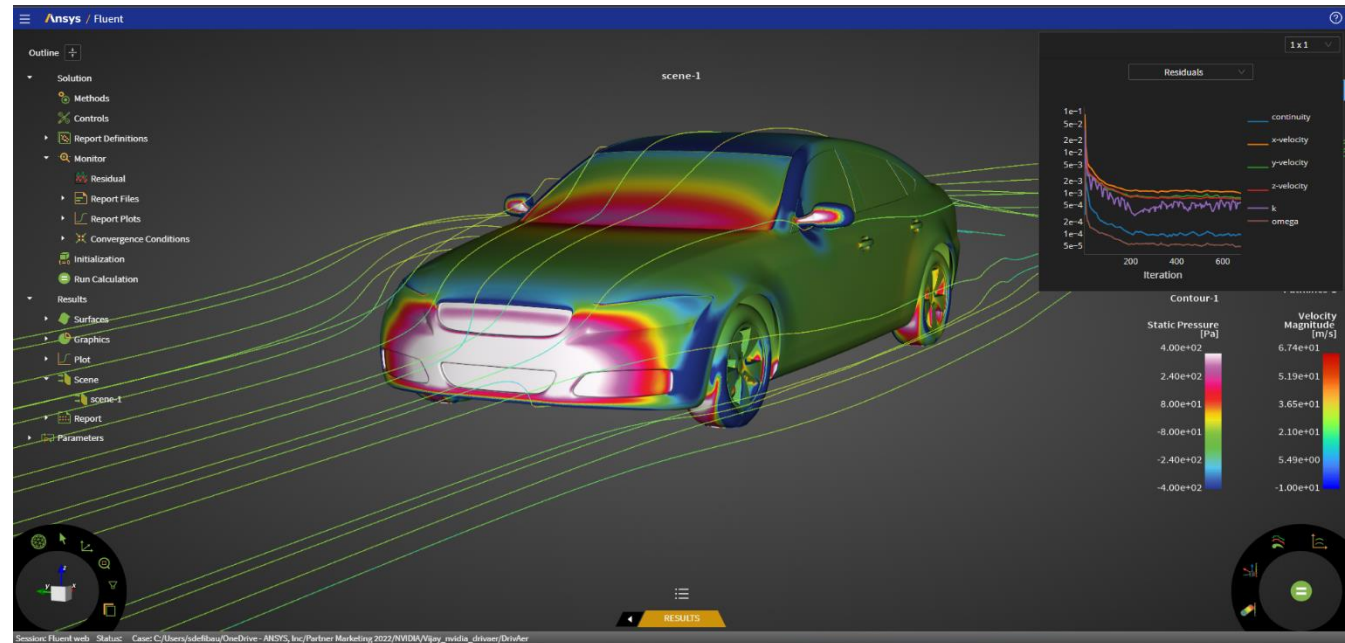
Fluent Meshing Watertight Workflow (Beta)

- Interactive cutting planes

- Mesh diagnostics, cell clusters

- Wildcards, improvements for large models

- FM-style shortcuts

- Desktop preferences

- Display options

- Some options require Fluent Meshing to run with graphics support and do not work when running in batch without graphics
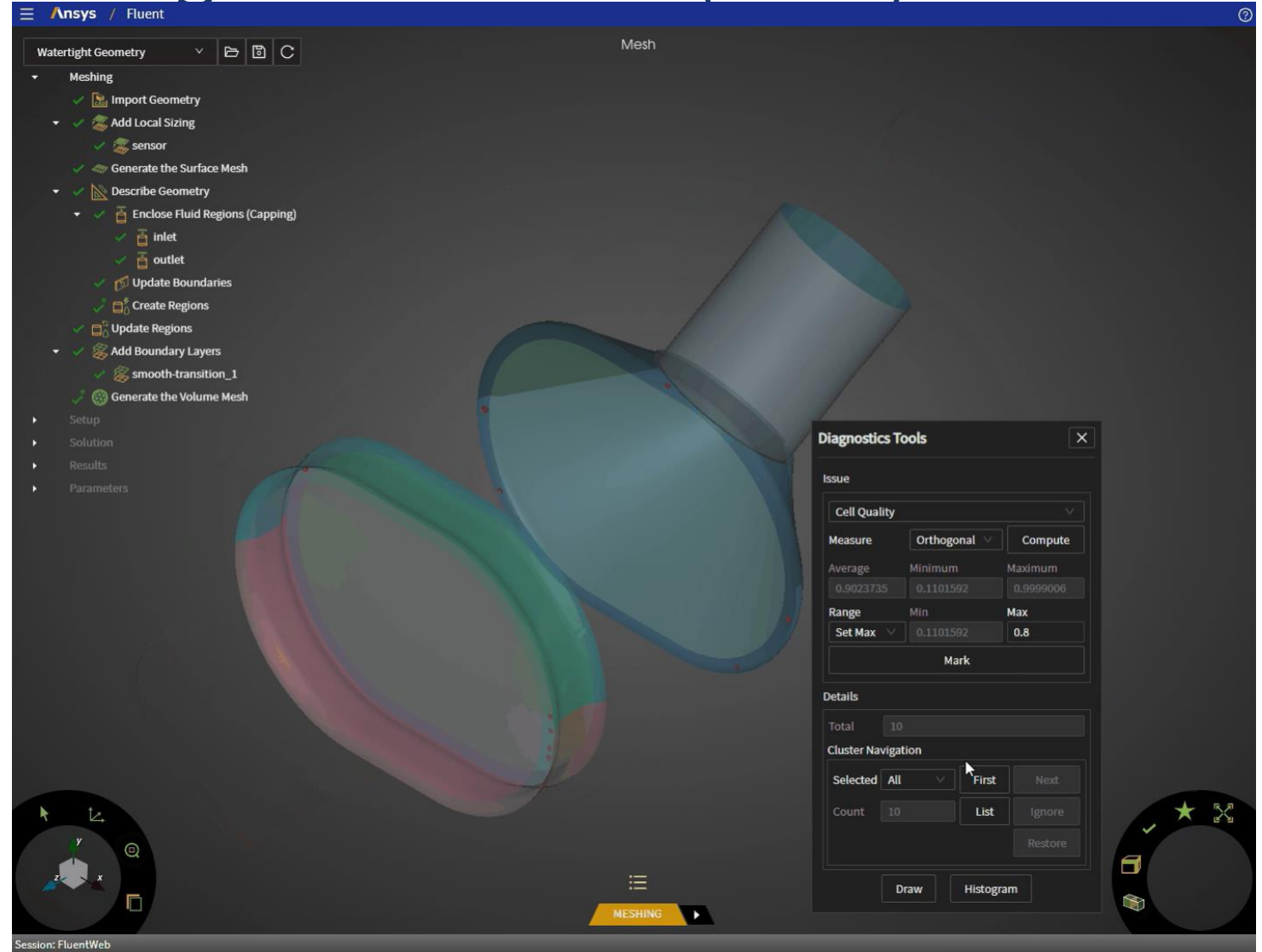
Shareable Links with Permissions

- View only, results edition only, or full access
- Accessed from web interface share icon in the upper right corner
  - Links remain active for the current session
 - Creating a link does *not* require an email

Share

Share a link to this session with others via email or copy the link directly

- ⦿ **View Only**
  Can view all the settings and display results but not edit them. The Python Console and the file browser are not available.

- ◯ **Edit - Results Only**
  Can edit only results and report definitions. The Python Console and the file browser are not available.

- ◯ **Edit**
  Can edit all the settings. The Python Console and the file browser are not available.

Email
From

To

＋ Add Recipient

🔗 Create Link   ▷ Send

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Post-Processing & Animations

Animate particle tracks and pathlines
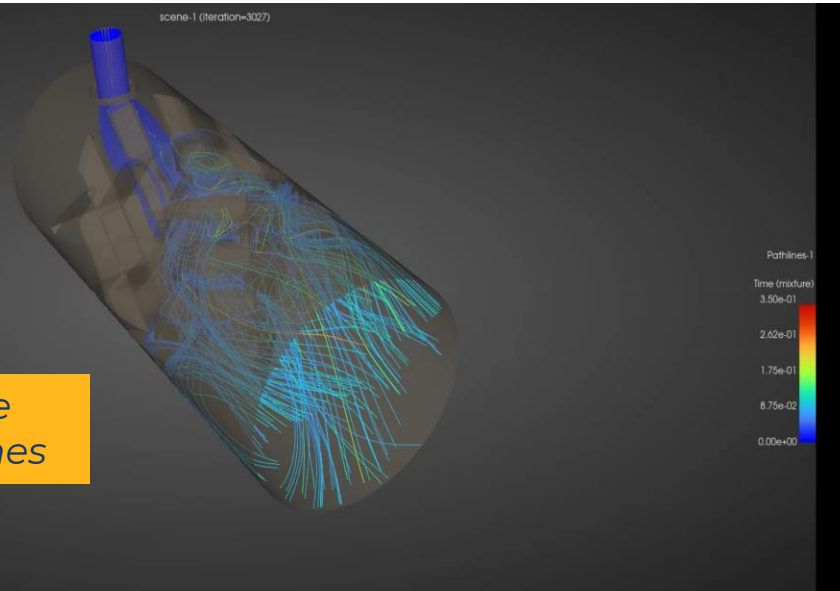
Interactive plane definition
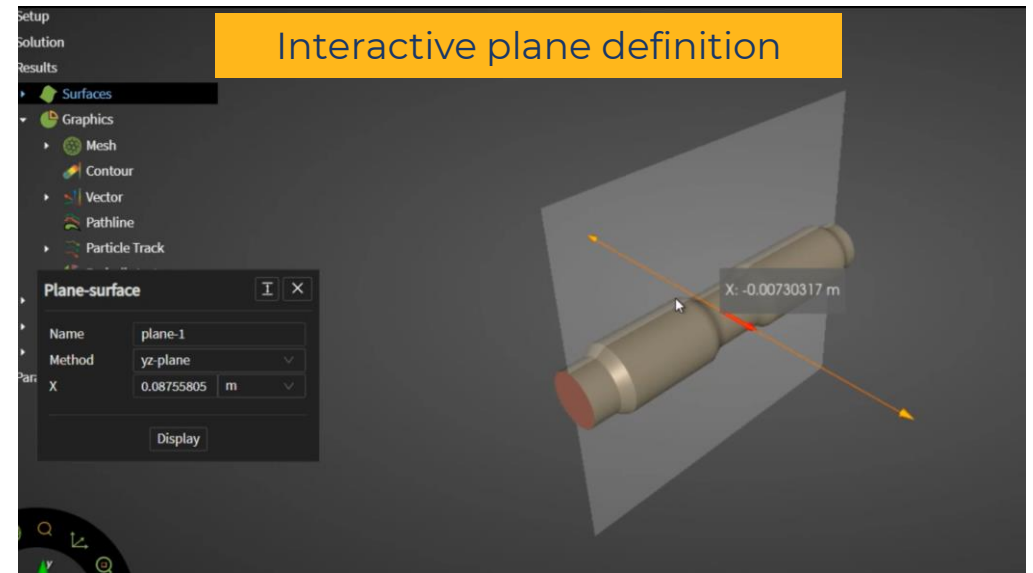
Periodic instancing
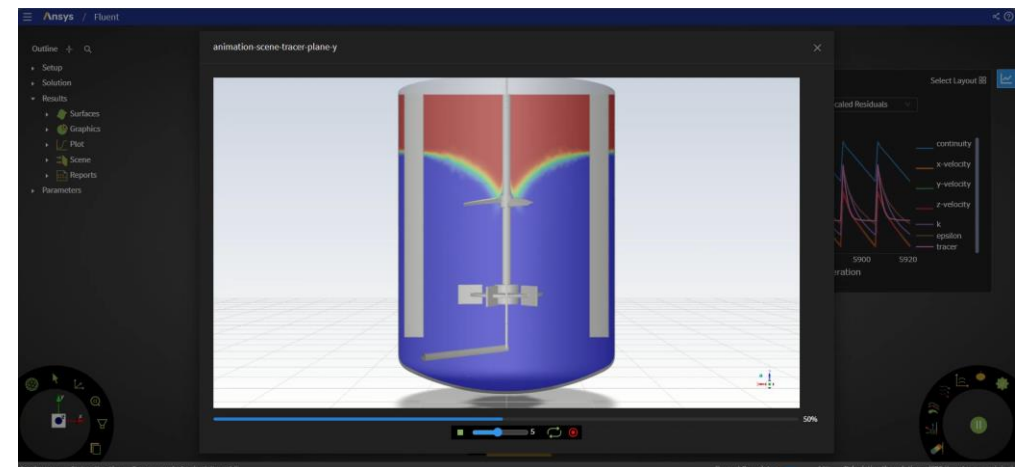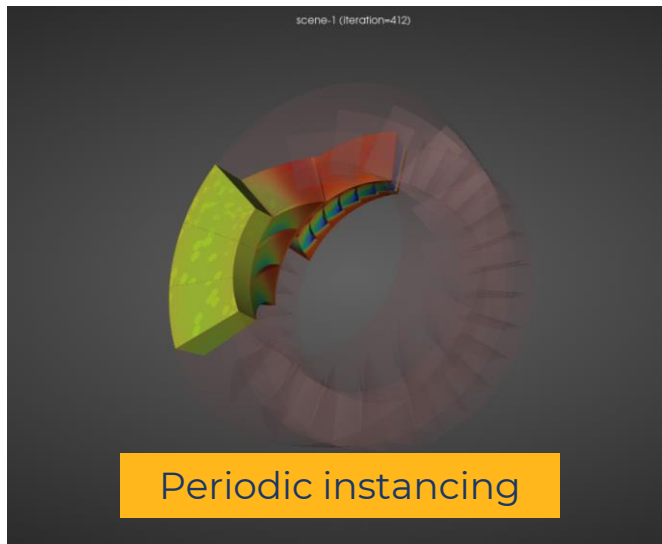
Animation playback while the calculation is running

Manager Panels

- Introduction of manager panels to edit multiple objects simultaneously
- Available for almost all grouped objects in the Outline tree
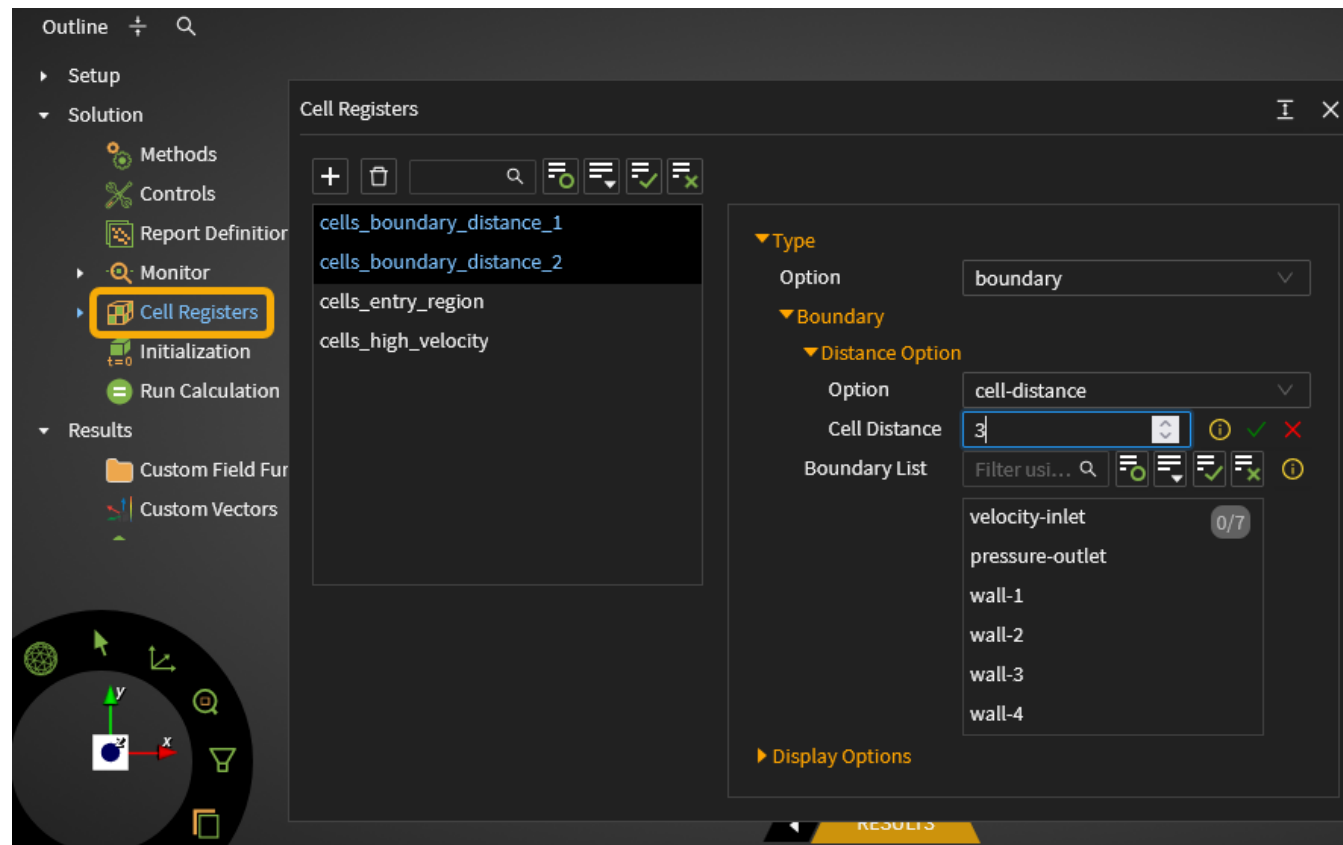
Notification of Invalid or Incomplete Settings

- When the settings of an object are either invalid or incomplete, a warning message inside the panel indicate what must be corrected
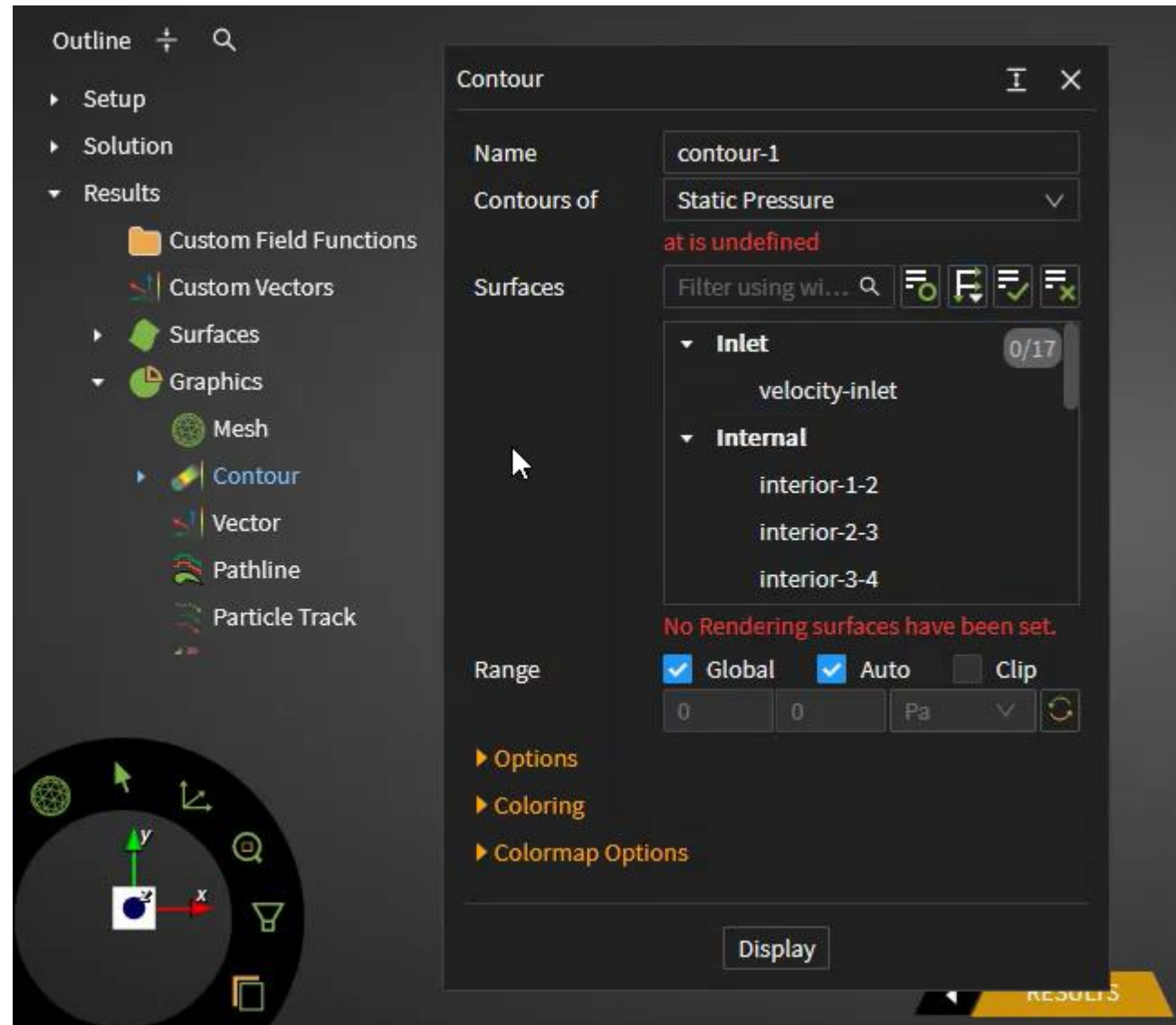
Fluent Meshing

Thin Meshing

- New capability to create layered mesh inside thin regions
  - Algorithm can automatically transition to unstructured mesh in locally-bulky regions
  - Conformal connection with all other volume fill methods supported

- Thin Meshing controls are similar to Multizone controls
  - Selection of parameters (number of layers, biasing, etc)
  - Selection of regions
  - Selection of source and target faces
  - Advanced options

- Stacked Plates option
  - For models with stacked planar plates aligned in Global X, Y ,Z the "Stacked Plates" option can be used for semi-automatic assignment of source and target faces based on selection of one or a few key seed sources

Thin volume meshing with boundary layers in bulk region
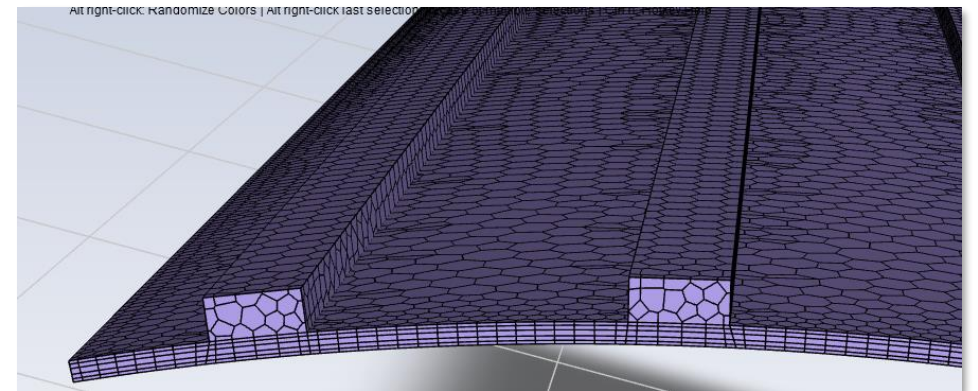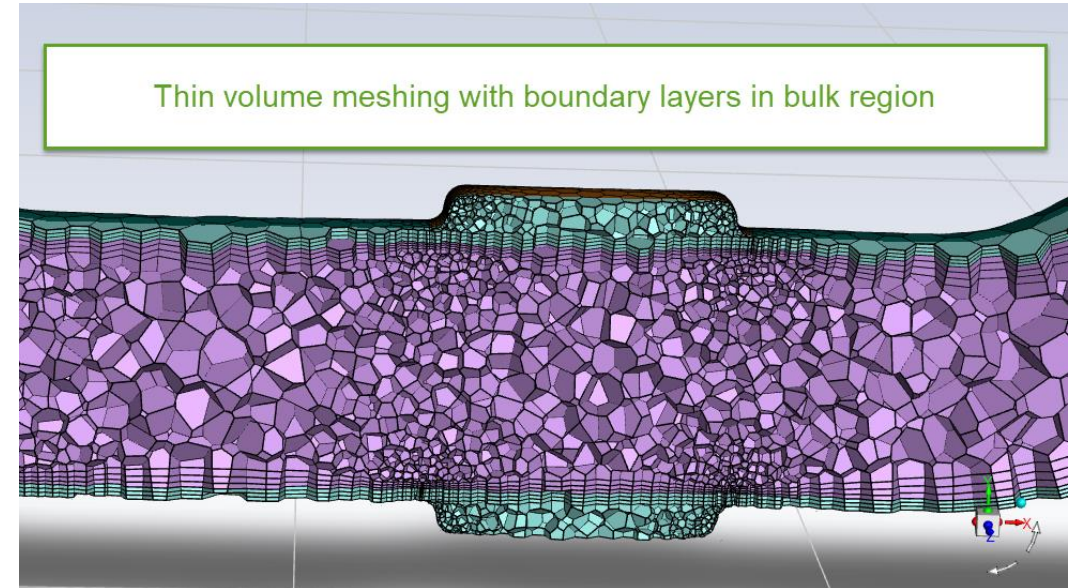
Auto-Thin Meshing (Beta)

- Automatically detect and configure thin mesh regions and source/target selections
  - Targeted use cases: Solid thin plates and decomposed thin fluid regions
  - Cannot be used together with Stacked Plates
  - Additional option to specify a target cell size within the thin gap in addition to the min number of intervals
  - Separates faces automatically if needed
 - Limited to serial meshing for the thin regions
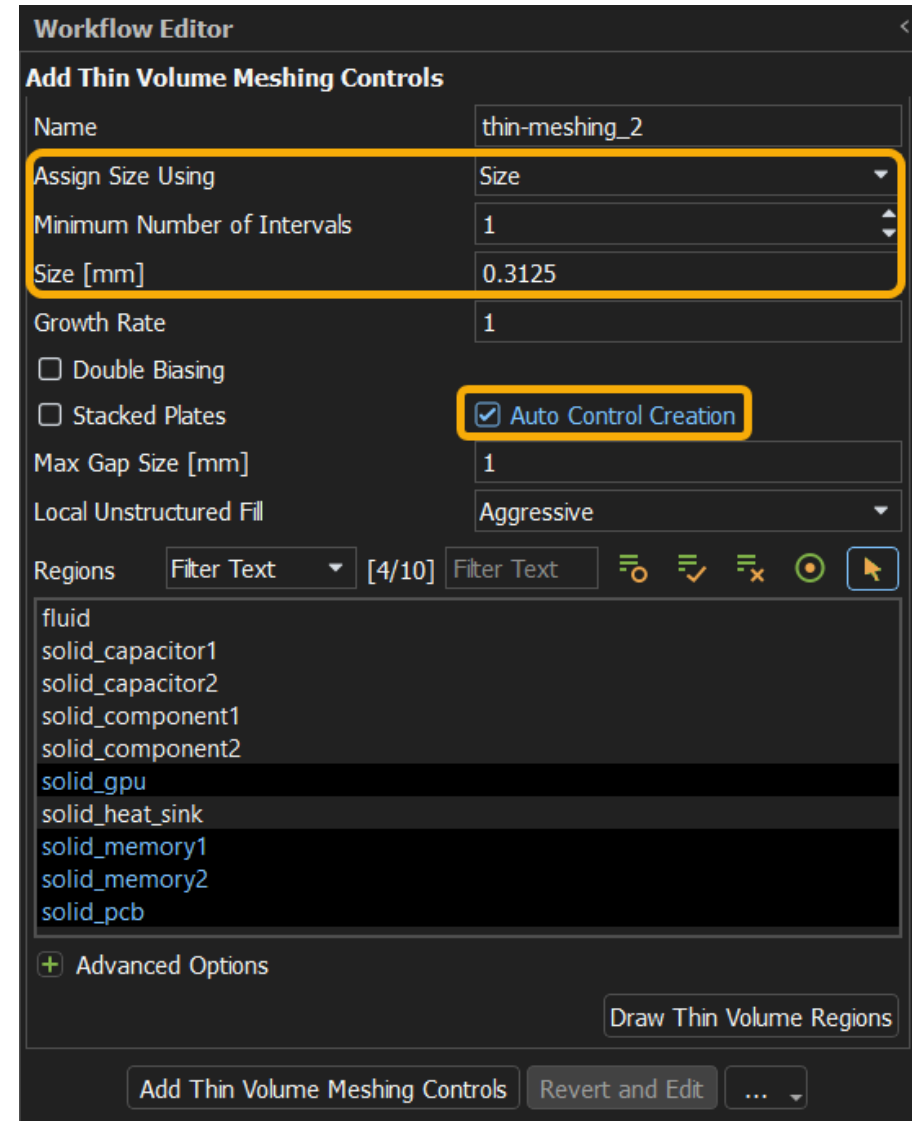
Boundary Layer Usability

- The list of available zones/labels is filtered automatically to show only items without boundary layer definition
  - Release for WTM, beta for FTM
  - Simplifies setup for complex models

Filtered automatically for next BL definition
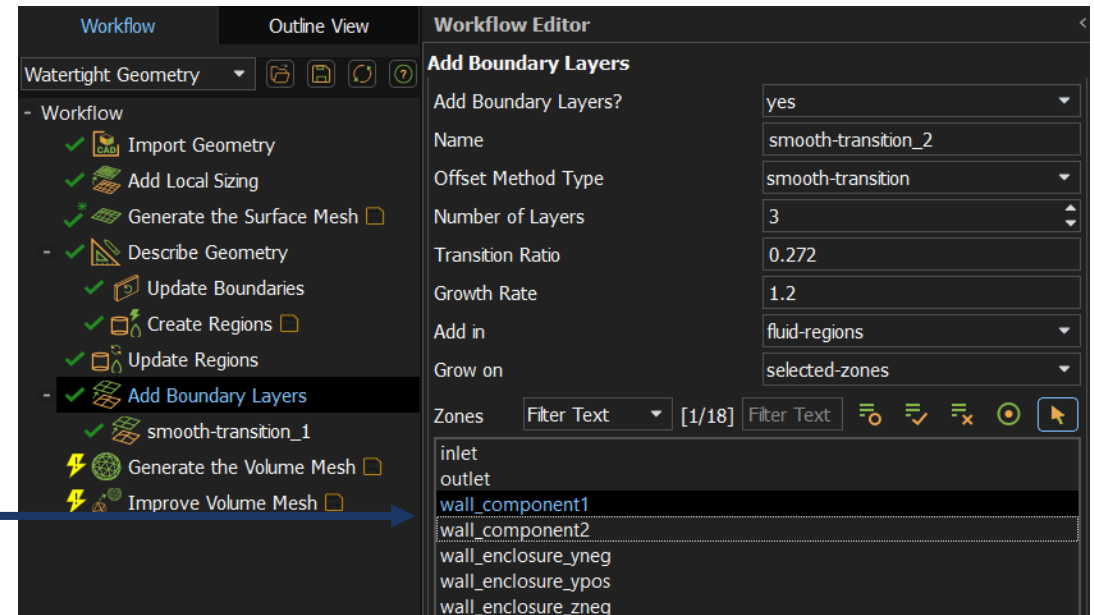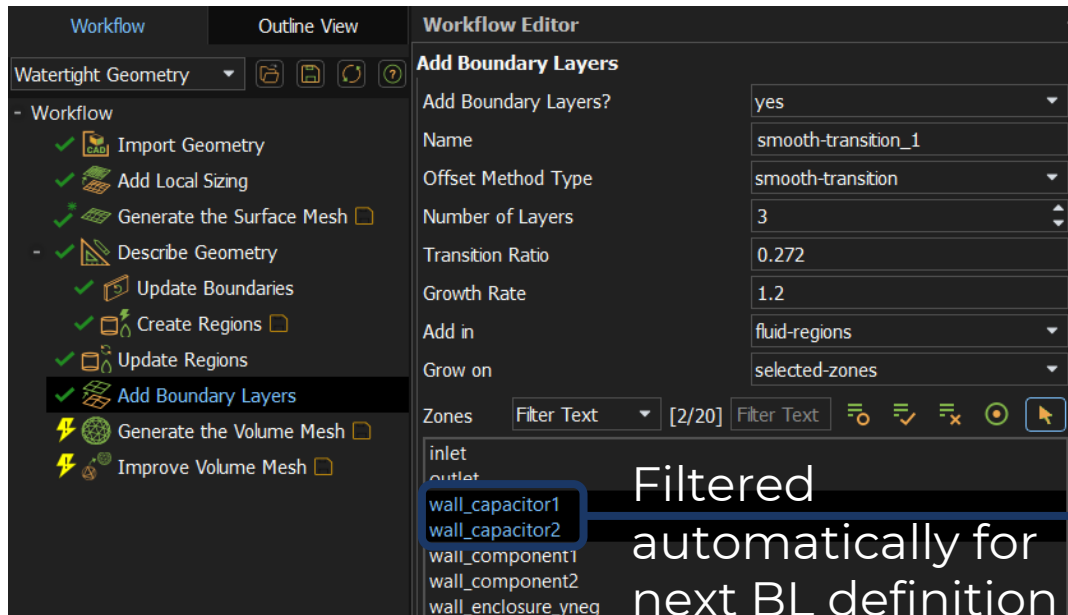
Fault-Tolerant: Modular Wrapping

- For very large model it is more efficient to simplify sub-assemblies before meshing the full model
  - Sub-assemblies are skin-wrapped
    - Tasks updated accordingly (Generate volume mesh removed…)
    - Faster as no remesh nor improve operations done
    - Easier manipulation/inspection
  - Resulting sub-assemblies are imported into a new workflow for global wrap and volume mesh
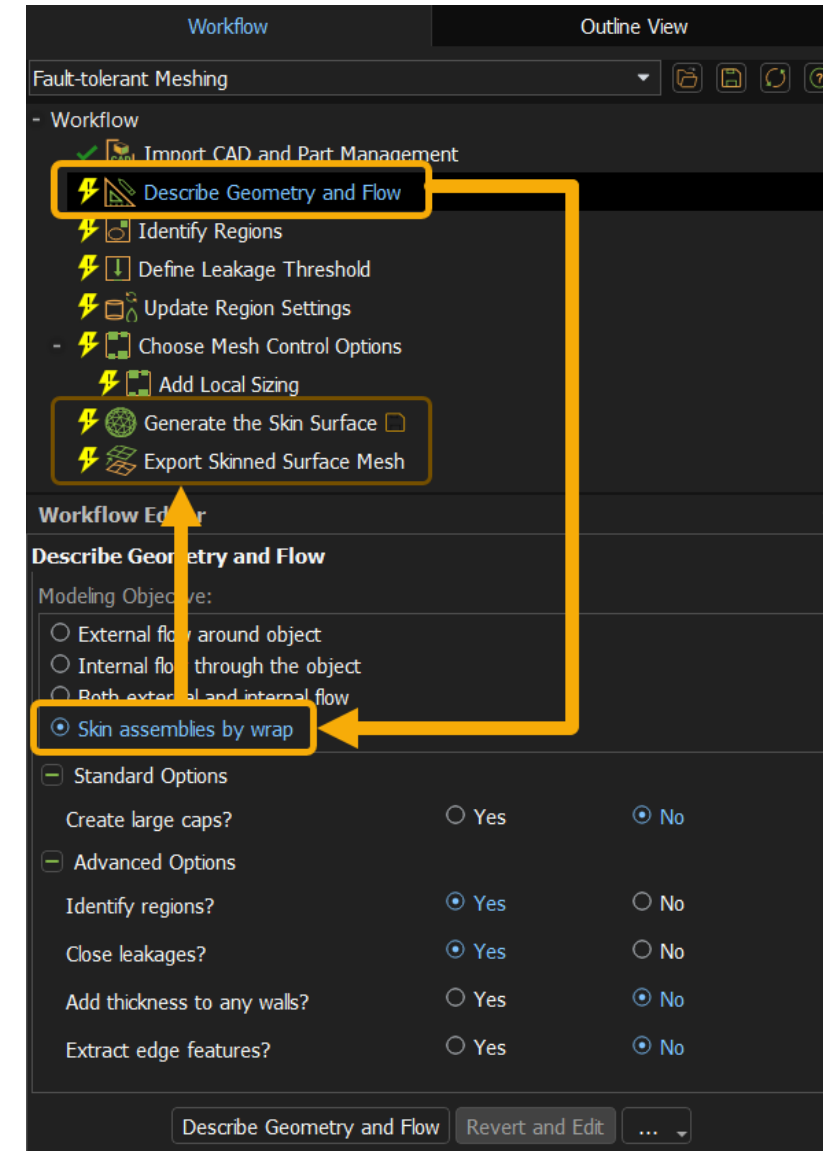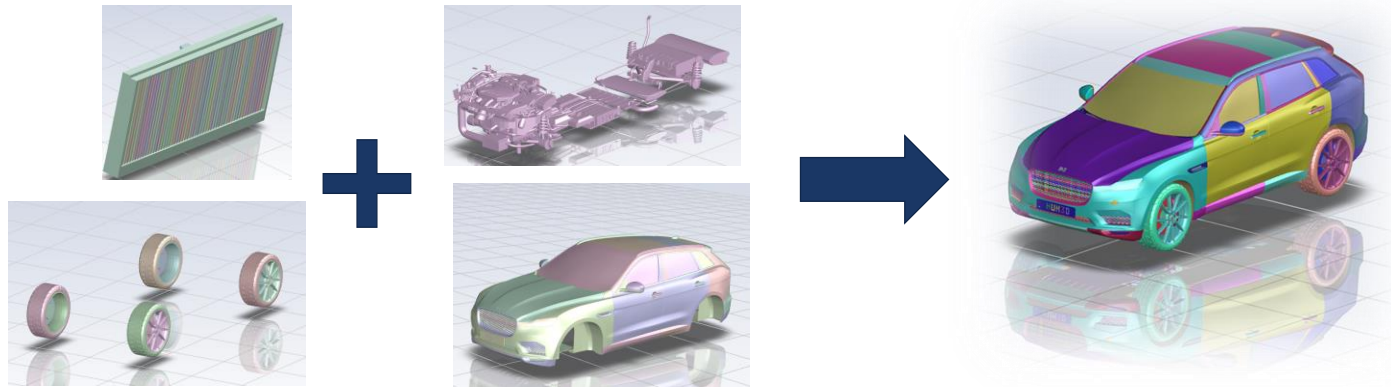
March 4, 2025

Fault-Tolerant: Prime Wrapper (Beta)

- An alternate wrapper is available as beta for the modular wrapping approach
  - Speed-up of mesh generation
  - Faceting will be different
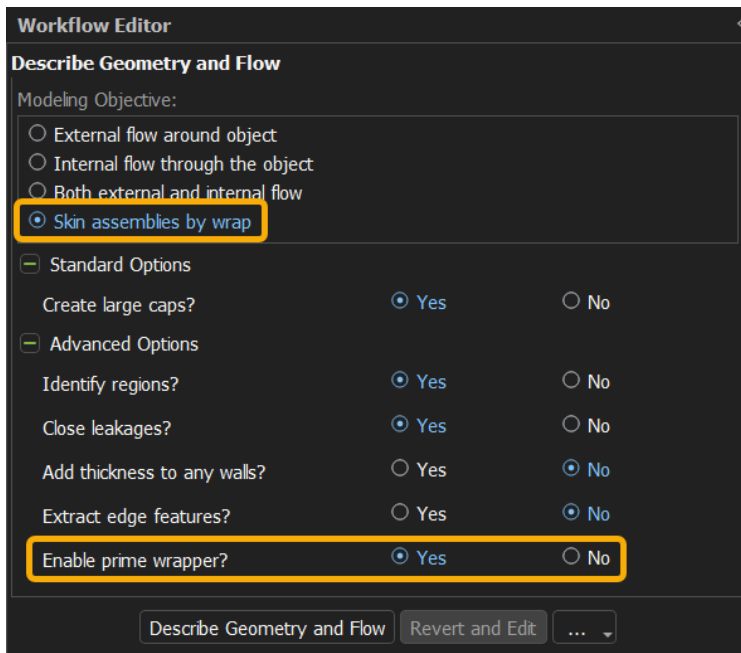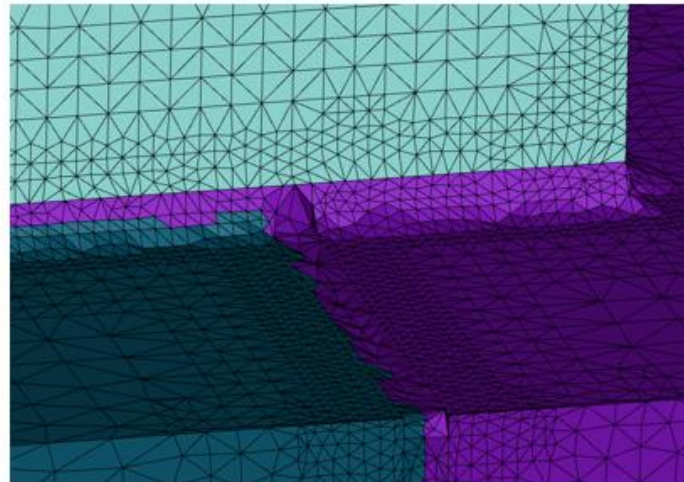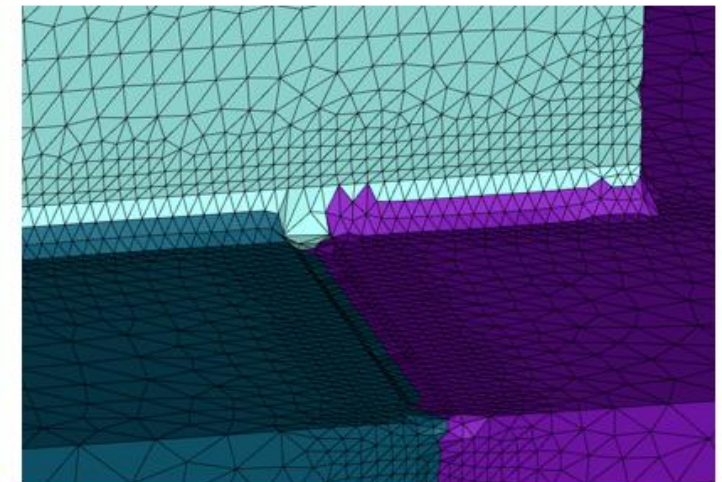
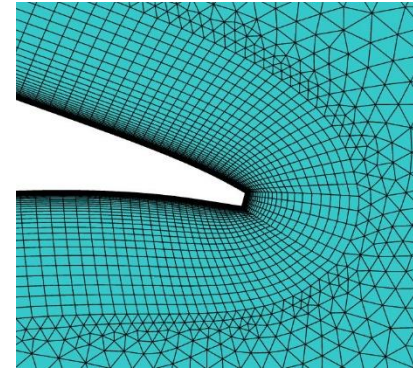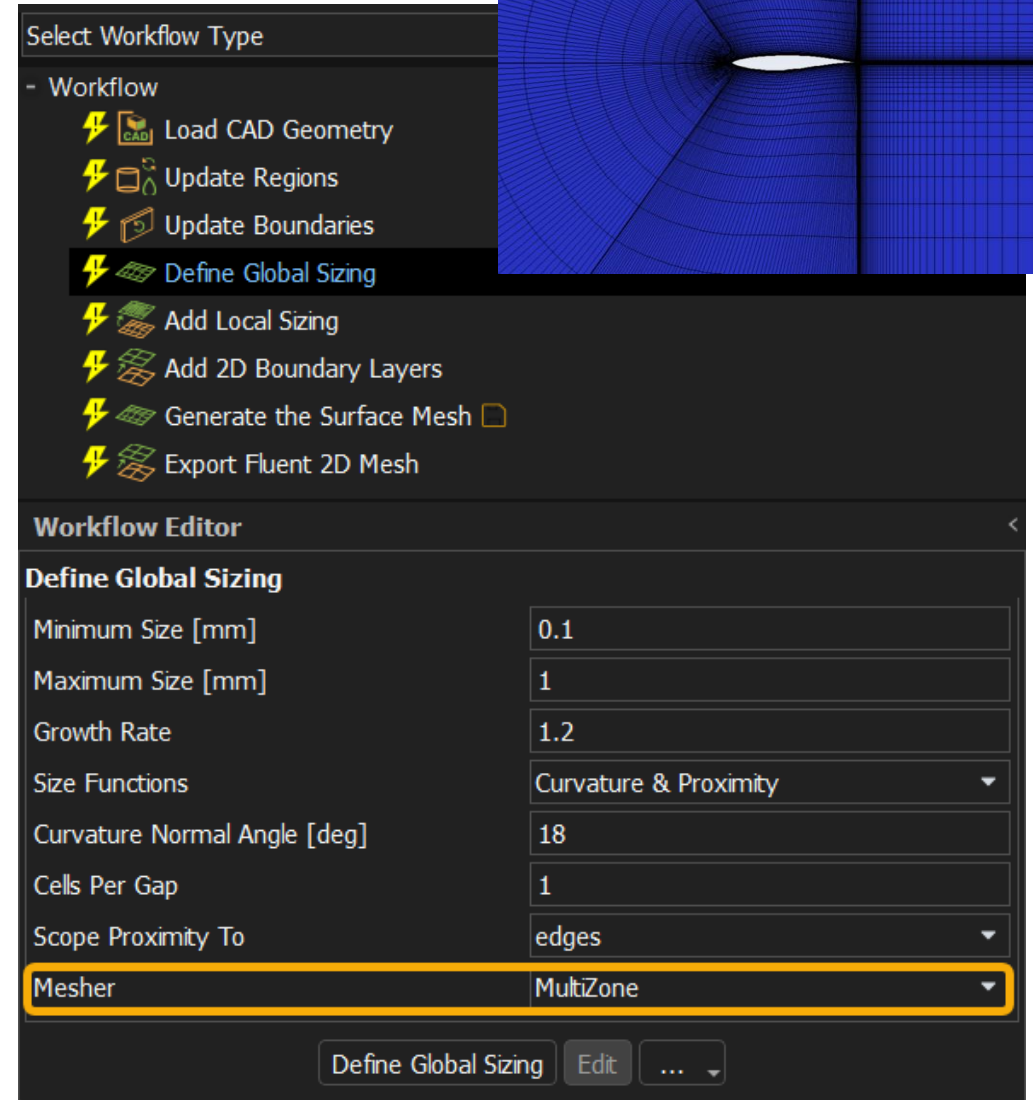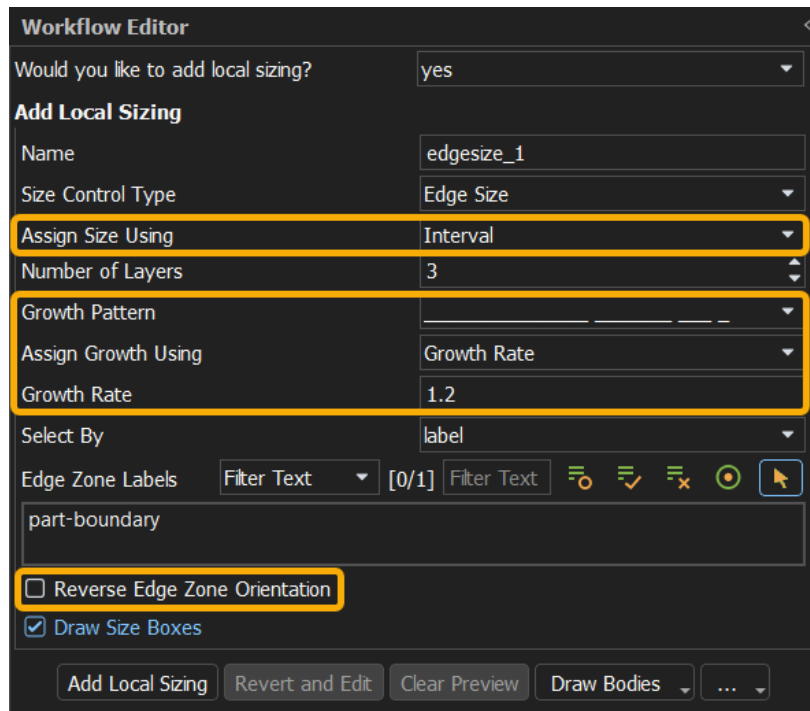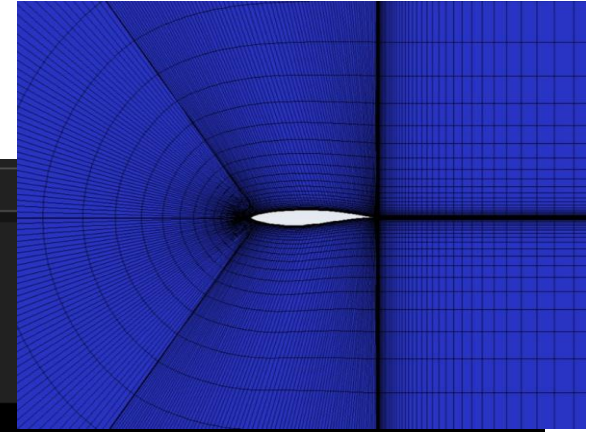# 2D Meshing: Boundary Layers

- Various improvements for smoother boundary layers
  - Normal smoothing
  - Shrinkage

- Introduction of Last Ratio method
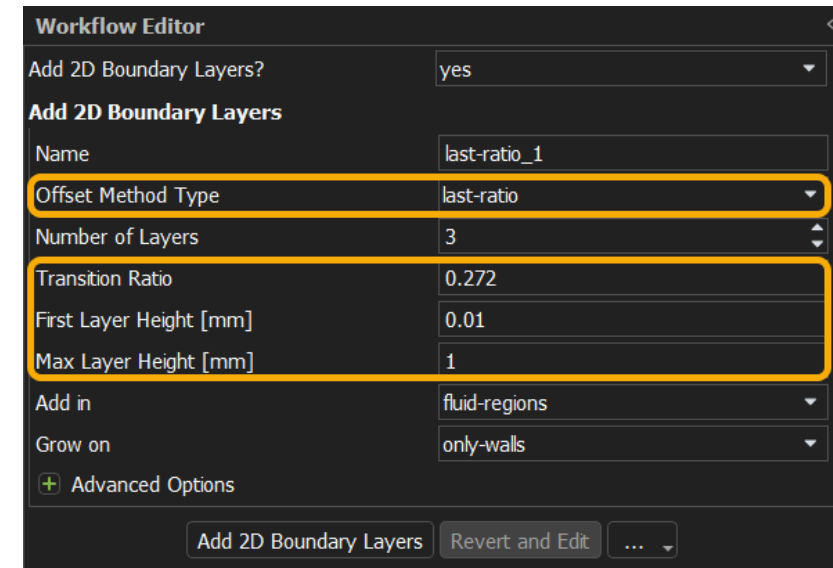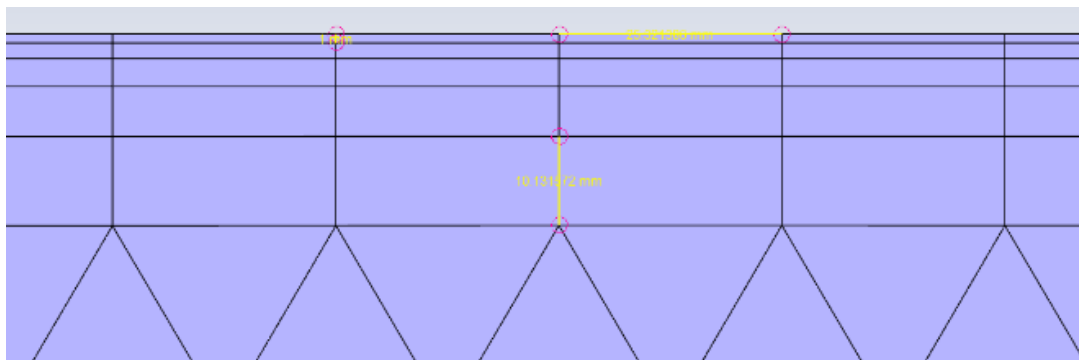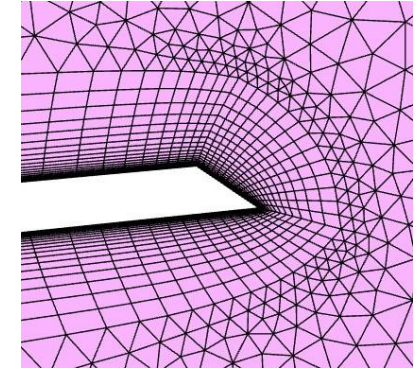
2D Meshing: Mapped Quad (Beta)

- 2D MultiZone allows generation of quad mesh
  - Used for the full domain
- Local edge sizing options with biasing


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Fluent CPU Solver Physics Improvements

Polyhedral Unstructured Mesh Adaption (PUMA)

- 2D polyhedra support
  - Hanging node conversion to polyhedral by default when reading older case file
    - Can be disabled using `/file/convert-hanging-nodes-during-read?`
- 2D PUMA
  - Default adaption method
    - Can be changed to legacy hanging node adaption using `/mesh/adapt/set/method`
- Refinement levels from Fluent Meshing imported during I/O and mode transfer when reading Rapid Octree meshes
  - Allows for more intuitive PUMA adaption and better mesh quality in Fluent

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Dynamic Remeshing

- Previously released Geometry Reconstruction extended to dynamic mesh remeshing
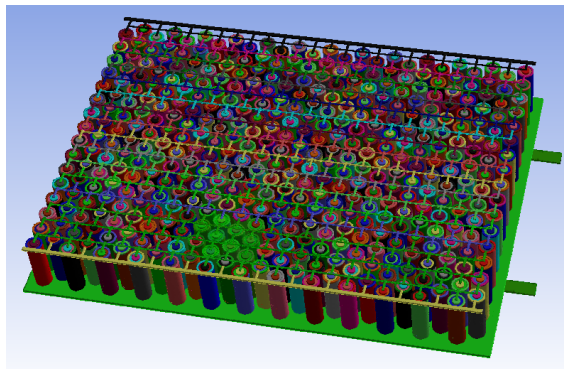 - Nodes are projected onto the smooth reconstructed surface
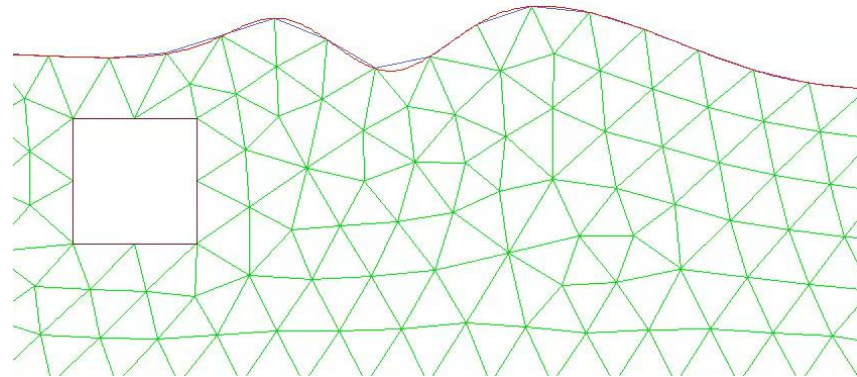
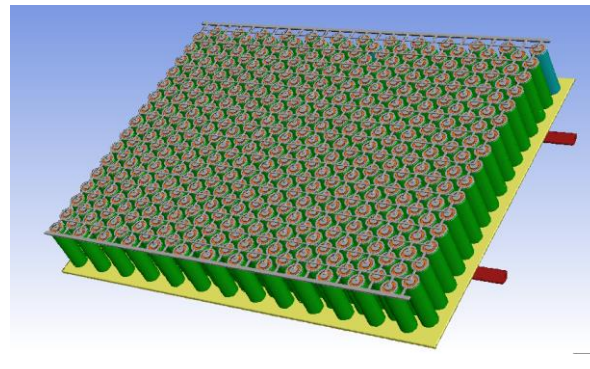# Battery Model: Variable-Based Connection

- Variable-based connection replaces zone-based connection to mitigate bottlenecks for connecting a large number of zones
  - Requires a single zone for all modules, tabs, and busbars
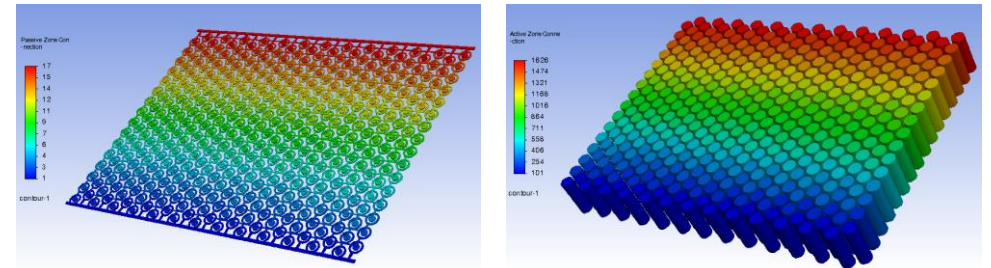
Total cell count: 2,189,189   Battery connection: 16s26p   (416 batteries)

Cell threads: 1682
Face threads: 8343

Cell threads: 6
Face threads: 28

	Old Method	New Method
Case reading	30 min	40s
Data reading	10 min.	7s
Solution initialization	1 min	10s
Running 20 iterations	4 min.	60s
Case writing	3 min.	13s
Data writing	20 s	5s

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More Updates

Wrap Up

The recording and slides for this webinar are in our Technical Resources Library.

If you are not on our mailing list, or are unsure if you are, please let us know at support@drd.com and we can add you!

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TECHNOLOGY

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WHITE PAPER

Six Considerations for Selecting Engineering Simulation

WEBINAR

Full CAD Associativity Between NX and Ansys - (June 22, 2023)

WEBINAR

Full CAD Associativity Between Autodesk Inventor and

WEBINAR

Full CAD Associativity Between Creo Parametric and Ansys - (June 1

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Wrap Up

Wrap Up

Thank you for your attention!

May I address any questions?

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