# Collaborative Engineering with STAR-CCM+

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Mechanical Engineering

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# Collaborative Engineering with STAR-CCM+

1. Importance of Collaboration
2. Examples of Multi-User programs
3. STAR-CCM+ Client-Server Architecture
4. Using Collaboration Mode in STAR-CCM+
5. STAR-CCM+ Multi-User Capabilities
6. Best Practices for Collaboration
7. Multi-User Testing on CFD Models
8. Potential Improvements
9. Example Set-Up

# Importance

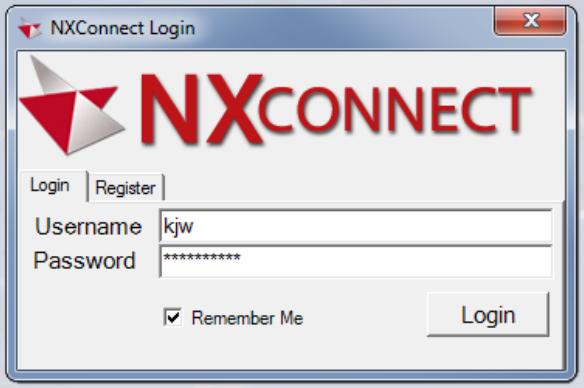
1. Time
2. Knowledge
3. Revision

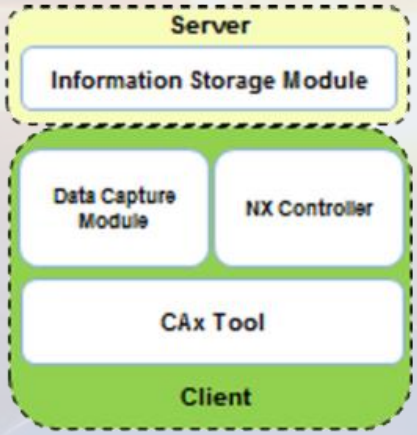
# Collaboration

# Motivation

## NXConnect

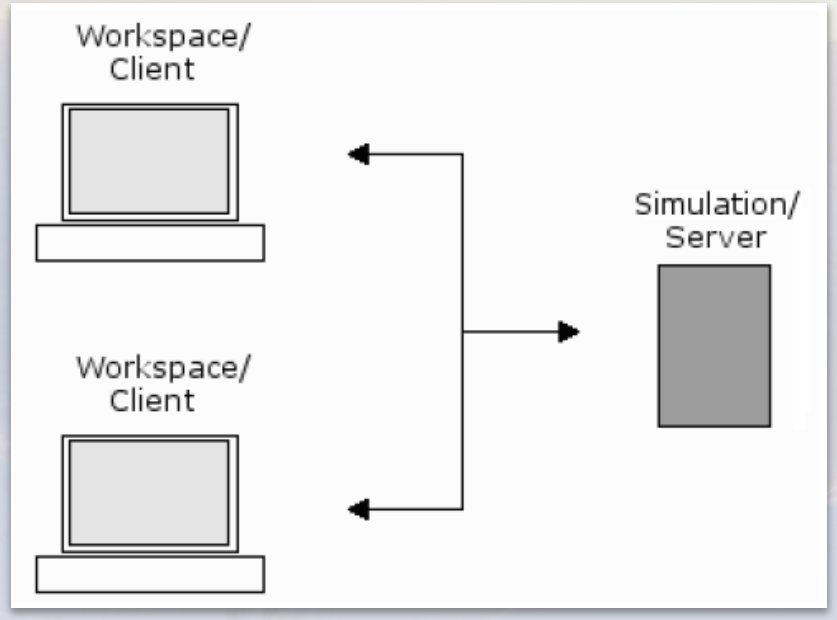
- Multi-User CAD
- Thick Client – Thin Server
- Developed at Brigham Young University
- $\frac{1}{n}$ design time for n users




eDesign

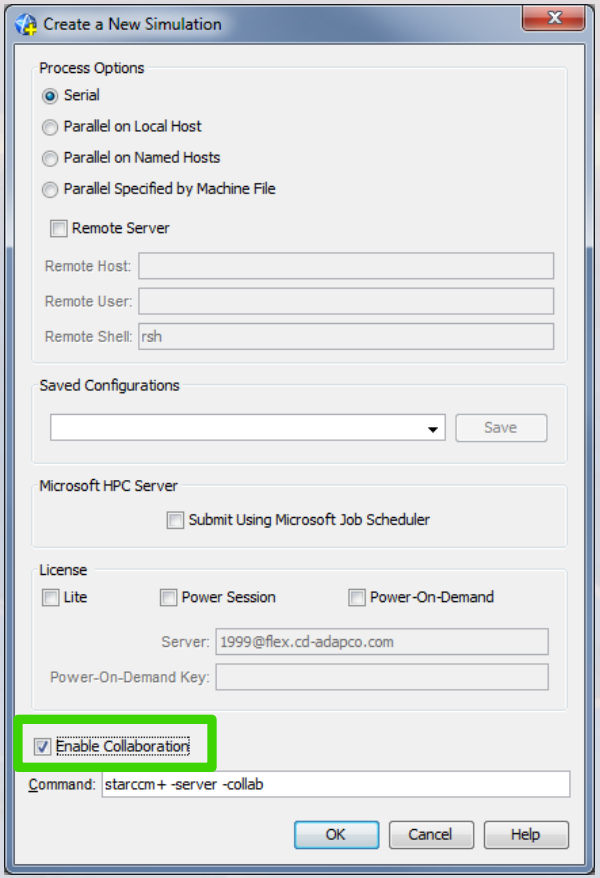
# Client-Server Architecture

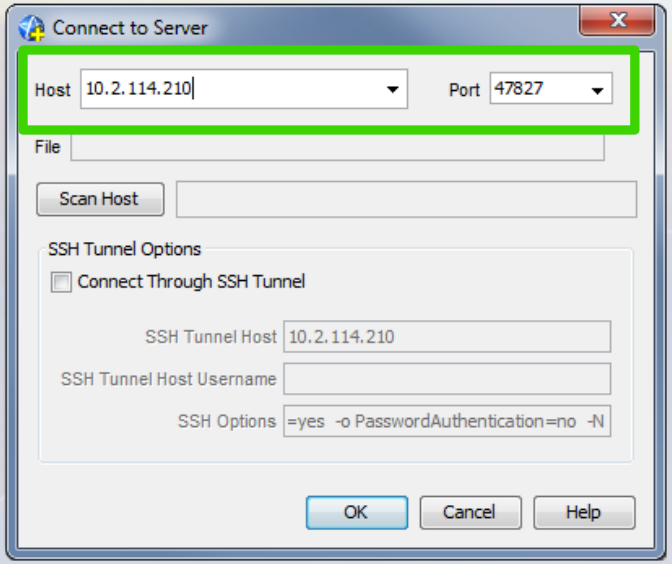



**Client** – Where the user can set up simulations, input commands, and manipulate views for analysis. Generally the GUI workspace

**Server** – Executes the commands set up by the user.

# Using Collaboration Mode



# STAR-CCM+ Multi-User Capabilities

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# Multi-User Capabilities

## Geometry

| | Yes | No |
|---|---|---|
| Combine Parts | X | |
| Combine Surfaces | X | |
| Surface Repair | | X |
| Splitting Surfaces | *(see notes) | |
| 3D CAD Models | *(see notes) | |
| Create part | X | |
| Composite Parts | X | |
| Boolean Operations | X | |
| Retesselate Parts | X | |
| Apply Tags/Filters | X | |

SURFACE REPAIR

- 2 Users cannot use surface repair mode at the same time
  - "WARNING: Already editing surface, shutting down repair session"
  - The client that gets closed will often have errors in the scene that was used

# Multi-User Capabilities

## Geometry

| | Yes | No |
|---|---|---|
| Combine Parts | X | |
| Combine Surfaces | X | |
| Surface Repair | | X |
| Splitting Surfaces | *(see notes) | |
| 3D CAD Models | *(see notes) | |
| Create part | X | |
| Composite Parts | X | |
| Boolean Operations | X | |
| Retesselate Parts | X | |
| Apply Tags/Filters | X | |

SPLITTING SURFACES

- Can be done with multiple clients, but with some issues*
  - While splitting by patch, the scene only highlights the part surface in the client which selected it and the part surface number will not be removed from the edit window
  - User 1 and User 2 can select the same surface to be split by angle, but the operation done last will split a different surface

# Multi-User Capabilities

## Geometry

| | Yes | No |
|---|---|---|
| Combine Parts | X | |
| Combine Surfaces | X | |
| Surface Repair | | X |
| Splitting Surfaces | *(see notes) | |
| 3D CAD Models | *(see notes) | |
| Create part | X | |
| Composite Parts | X | |
| Boolean Operations | X | |
| Retesselate Parts | X | |
| Apply Tags/Filters | X | |

3D CAD MODELS

- Can be used by both clients simultaneously*
  - Different operations can be performed simultaneously
  - 1 scene is shared by all users
  - Operations open at the same time will be combined, not overwritten
- If features are being edited by user 1, only those listed below that operation can be edited simultaneously by user 2

# Multi-User Capabilities

## Meshing

| | Yes | No |
|---|---|---|
| Create Mesh Continua | X | |
| Assign Mesh Values | X | |
| Customize Surface Mesh | X | |
| Generate Surface Mesh | | X |
| Generate Volume Mesh | | X |
| Contact Prevention | X | |

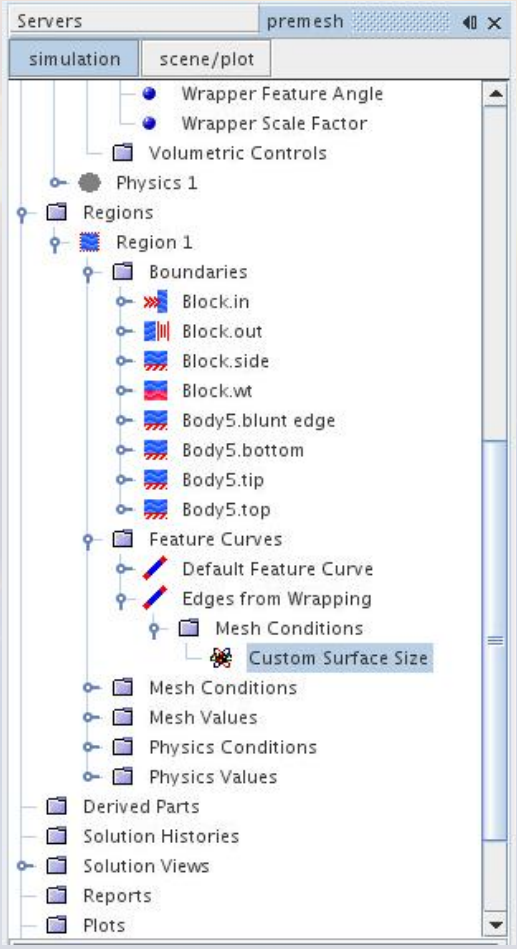
WHILE GENERATING MESH

- No new operations can be performed
- Only values in the properties window can be edited

# Multi-User Capabilities

## Region

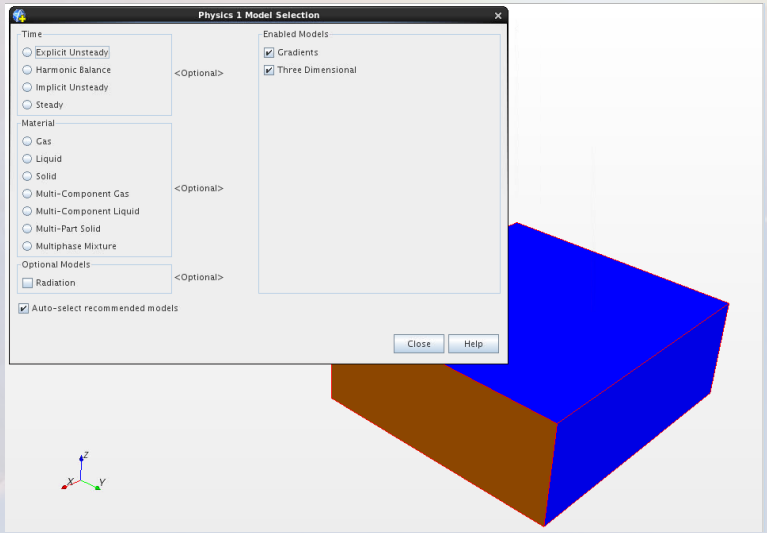
| | Yes | No |
|---|---|---|
| Assign Parts to Regions | X | |
| Defining Boundaries | X | |
| Specify Applied Continua | X | |
| Edit Boundary Mesh Values | X | |
| Splitting Feature Curves | X | |
| Edit Feature Curve Mesh Size | X | |
| Create Interface | X | |



# Multi-User Capabilities

## Boundary Conditions

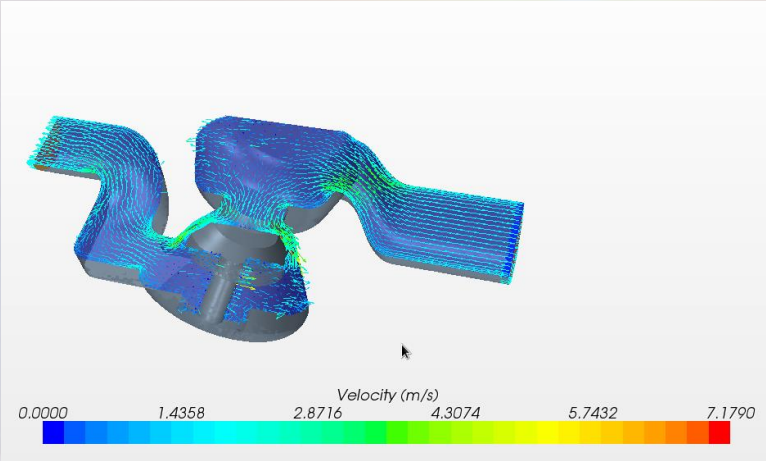
| | Yes | No |
|---|---|---|
| Create Physics Continua | X | |
| Define Initial Conditions | X | |
| Define Boundary conditions | X | |
| Setting Boundary Type | X | |
| Edit Boundary Mesh Values | X | |
| Edit Boundary Physics Values | X | |



# Multi-User Capabilities

## Post Processing

| | Yes | No |
|---|---|---|
| Create Scenes | X | |
| Create Reports, Monitors, and Plots | X | |
| Visualize Report Solutions in Scenes | X | |
| Select Convergence Criteria | X | |
| Create Derived Parts | X | |



# Using Macros

- Macros can be created and saved by each client
  - The macro for each client will be different
  - Macros are saved from client rather than server
- Macros set up in a collaborative simulation cannot be played if operations not yet executed are called.

# Best Practices

## Viewing Scenes

Highlighted Parts

- Selected part is highlighted for each client
- Have only the working scene open in each client

Split Surfaces

- Surfaces hidden in a scene can be seen when that surface is split (only specific named surface is hidden)
- Each user should include only the necessary parts in a scene, rather than hiding other parts

# Best Practices

## Surfaces

Surface Repair

- Avoid opening surface repair mode when it is in use by another user
- Use Boolean operations (unite, intersect, merge) for other surface repair
  - Parts must be closed and manifold

Splitting Surfaces

- User 1 cannot split a surface that is currently open in surface repair mode by User 2
  - False split surfaces will appear in the tree, but will not correspond to any geometry
  - Surface Repair mode will be closed for User 2

# Multi-User Testing

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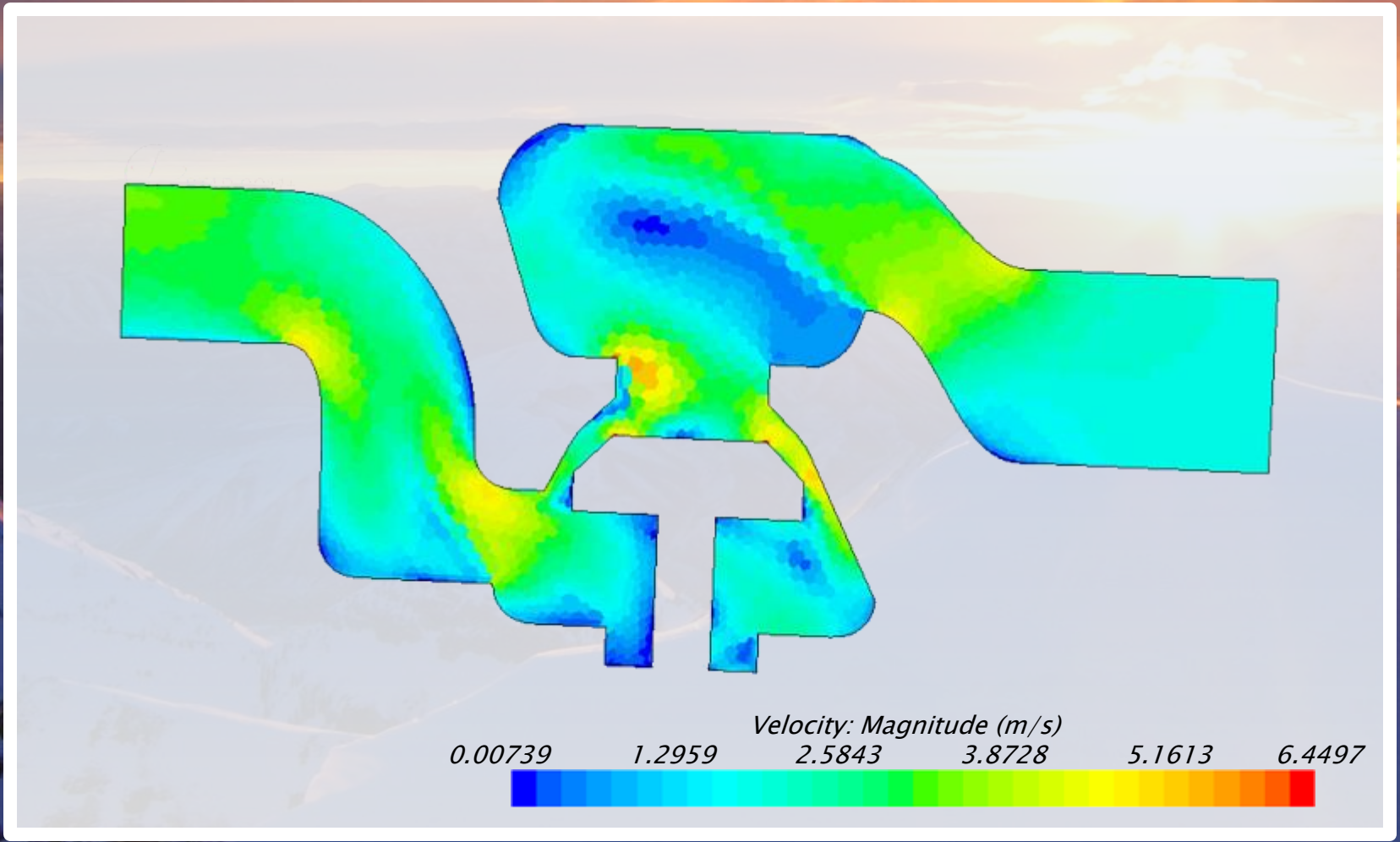
# Control Valve Model

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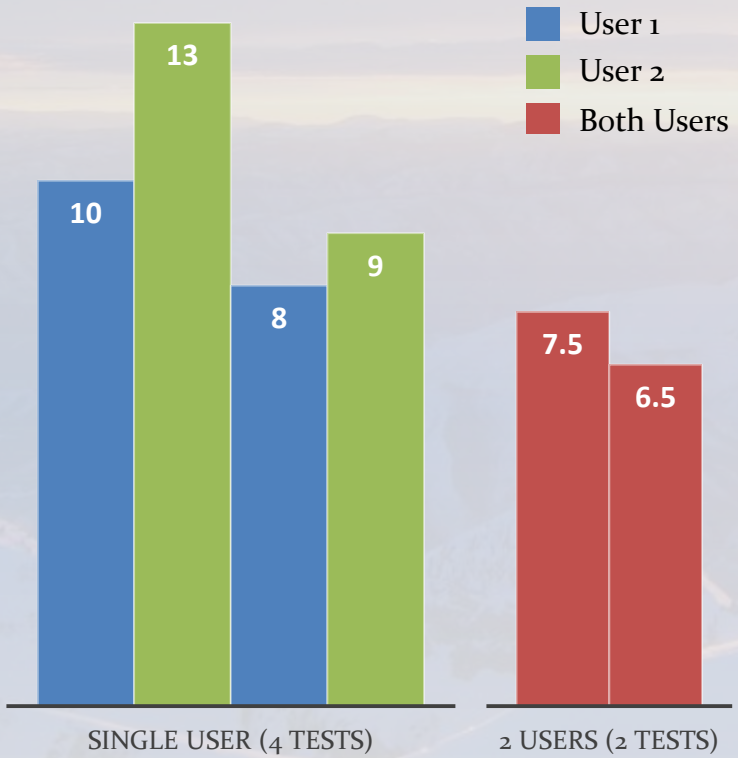
# Control Valve Model



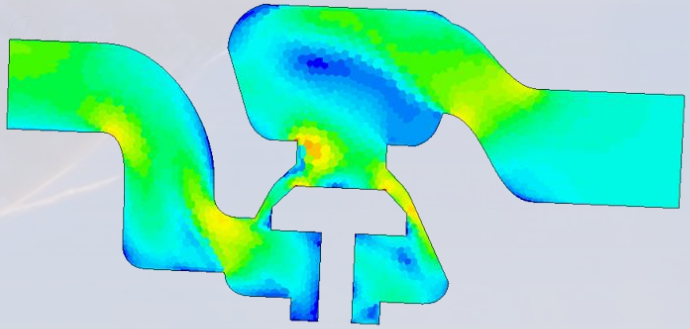

Model Set-Up Time (minutes)

**Time Reduction**

Average: 30 %

**Model**

460,124 Cells



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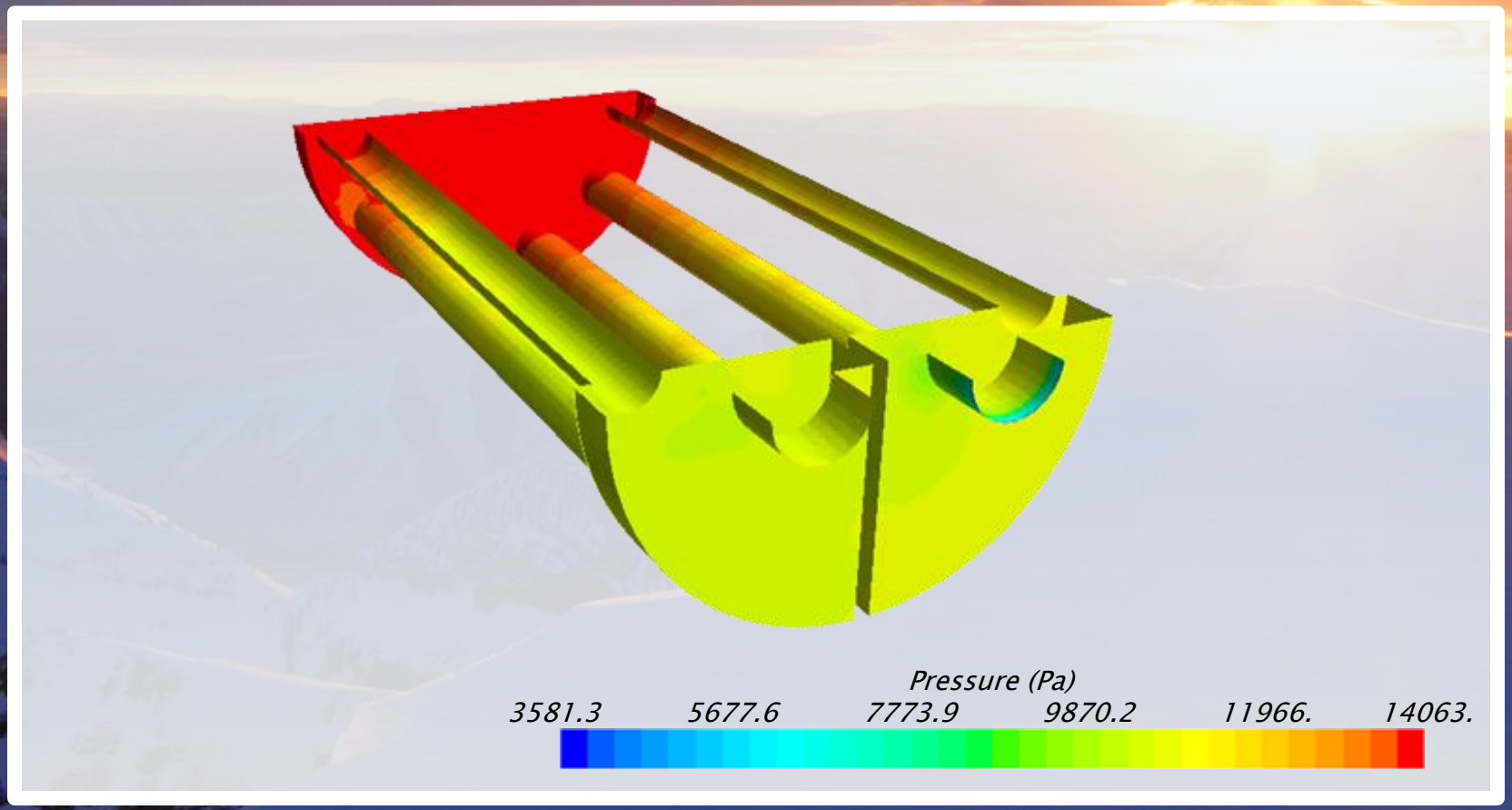
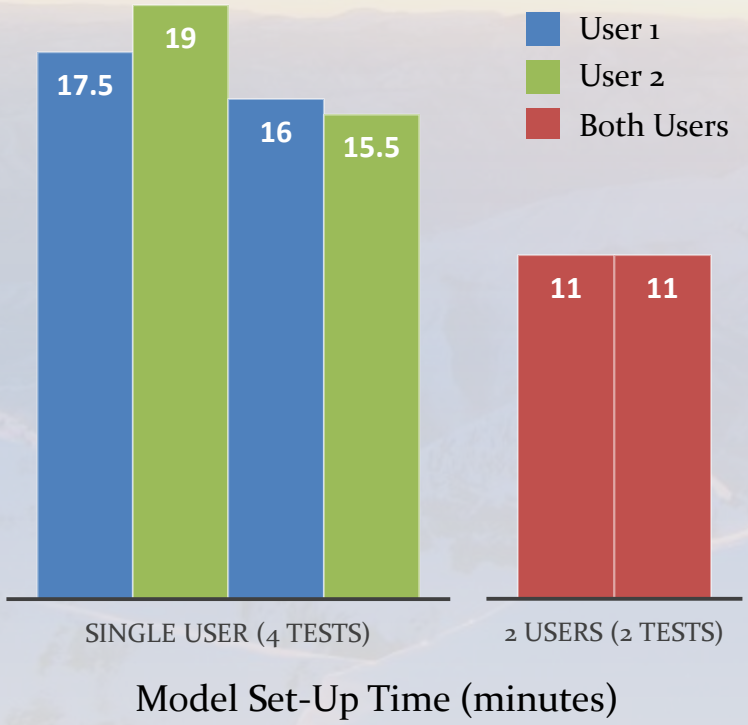
# Multi-Region Heat Exchanger Model



# Multi-Region Heat Exchanger Model



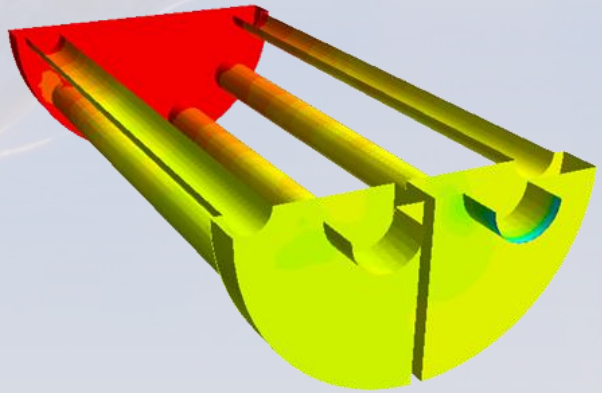

Model Set-Up Time (minutes)

**Time Reduction**

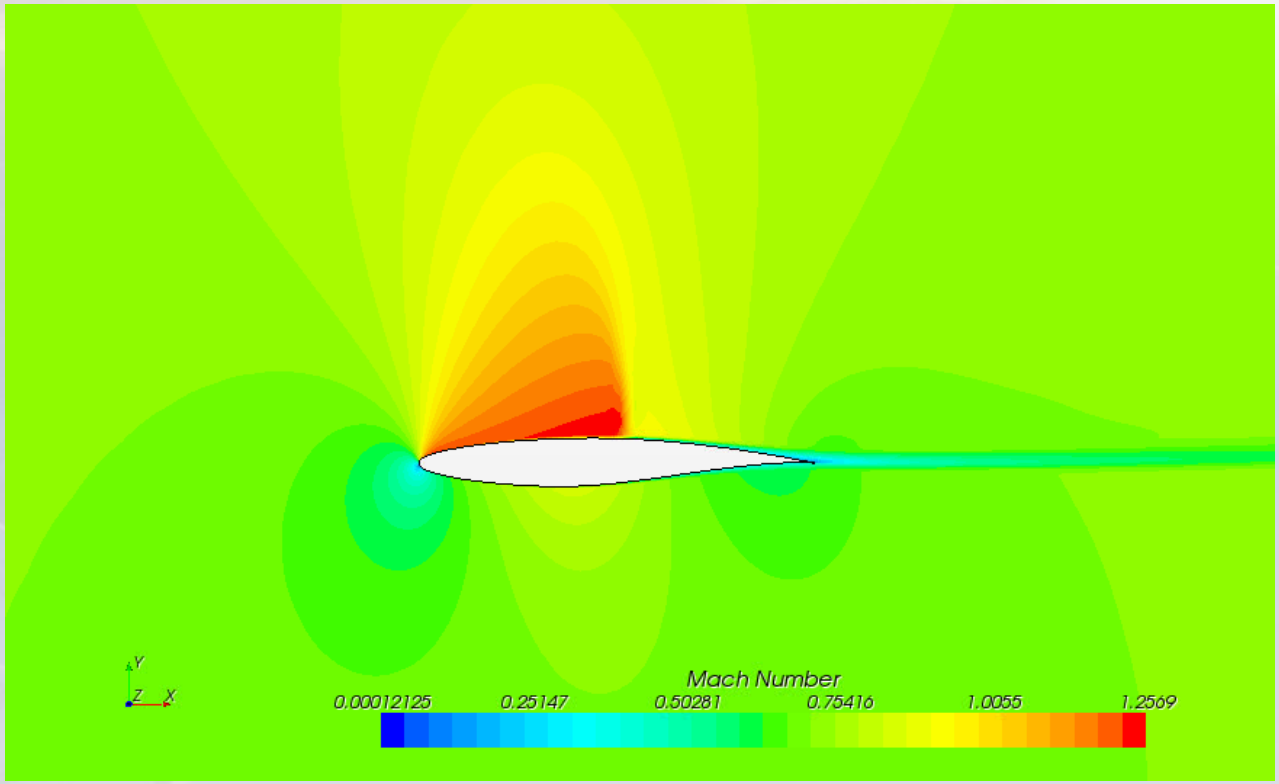
Average: 35 %

**Model**

600,000 Cells



# Transonic Flow: RAE2822 Airfoil Model

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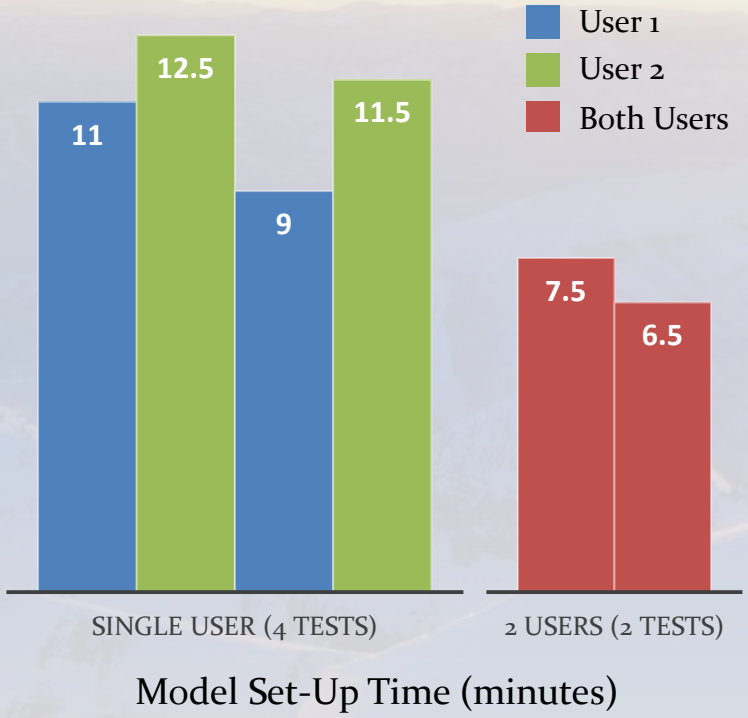
# Transonic Flow: RAE2822 Airfoil Model

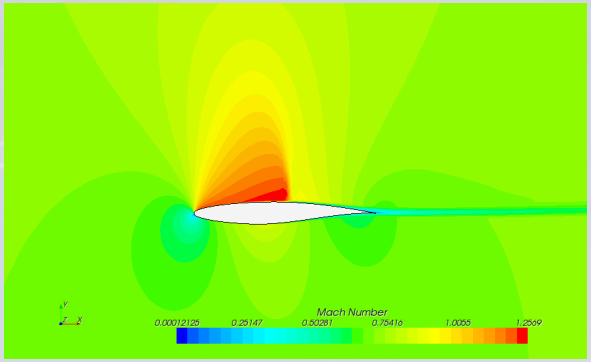



**Time Reduction**

Average: 36 %

**2-D Model**

24,576 Cells

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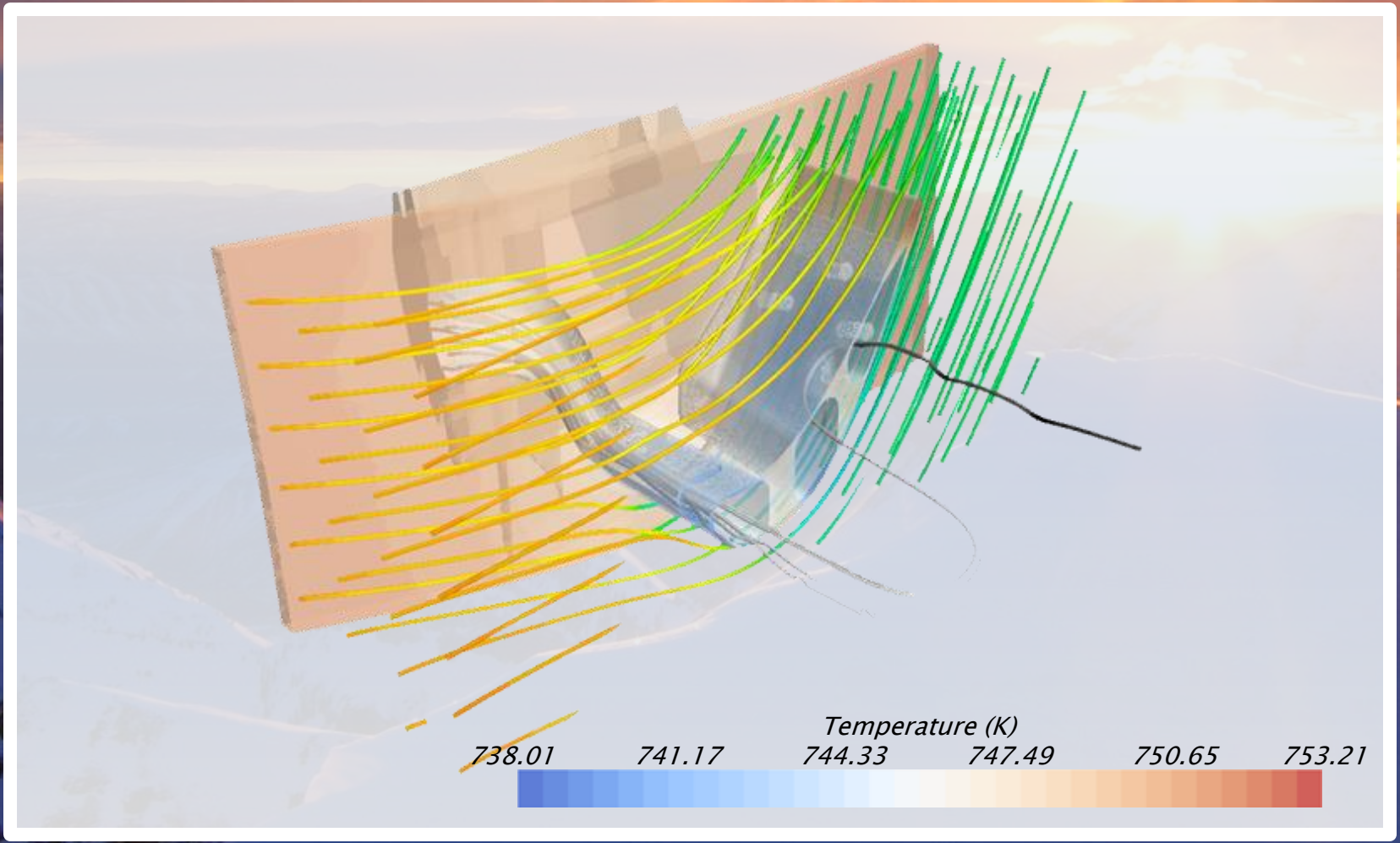
# Cooled Turbine Model

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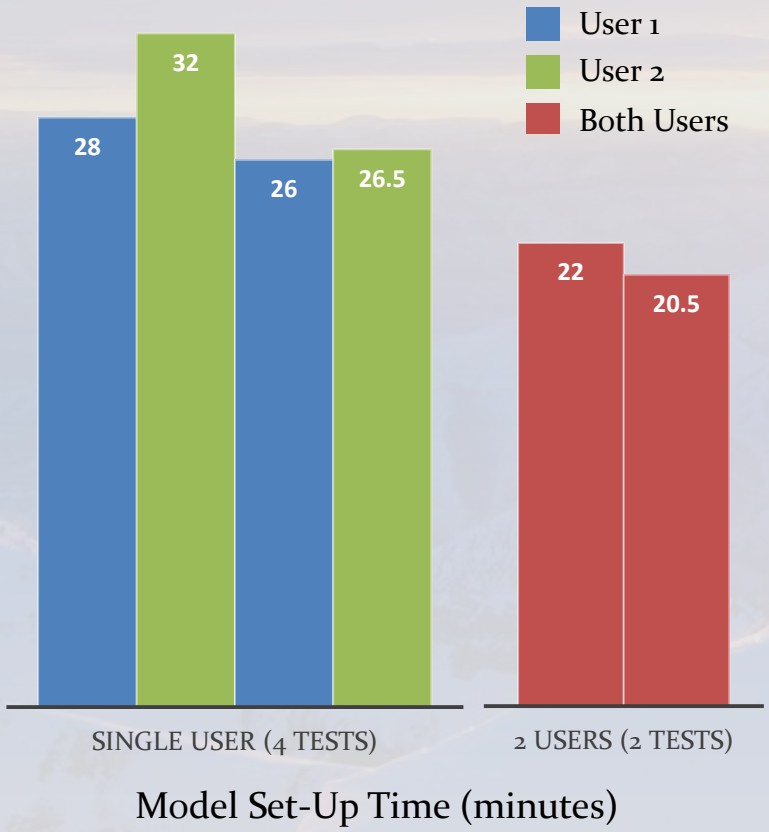
# Cooled Turbine Model



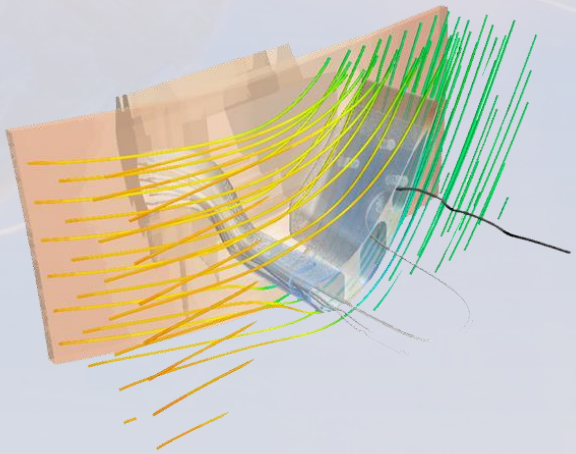

Model Set-Up Time (minutes)

**Time Reduction**

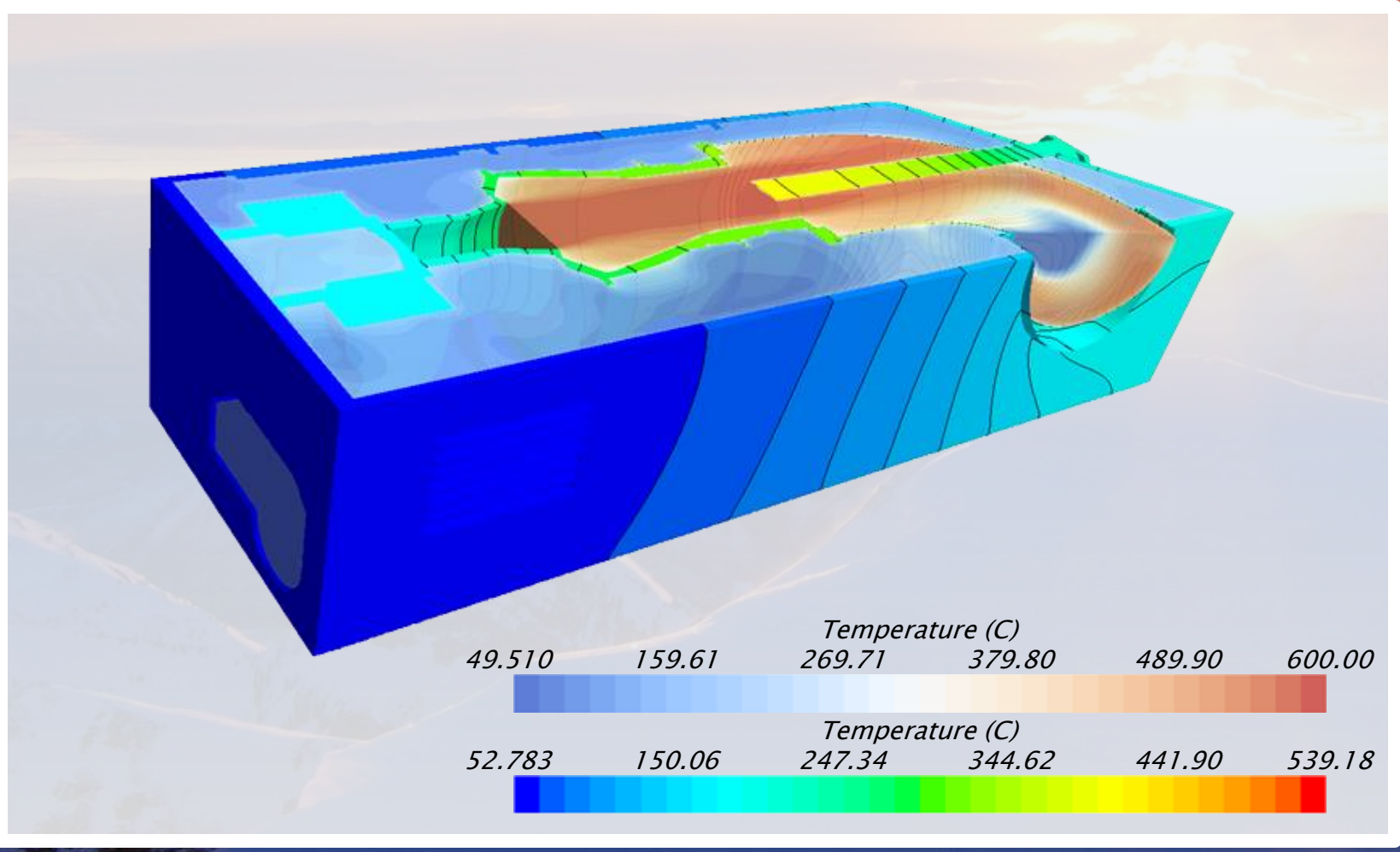
Average: 24.4 %

**Model**

5.2 M Cells



# Crescendo Model

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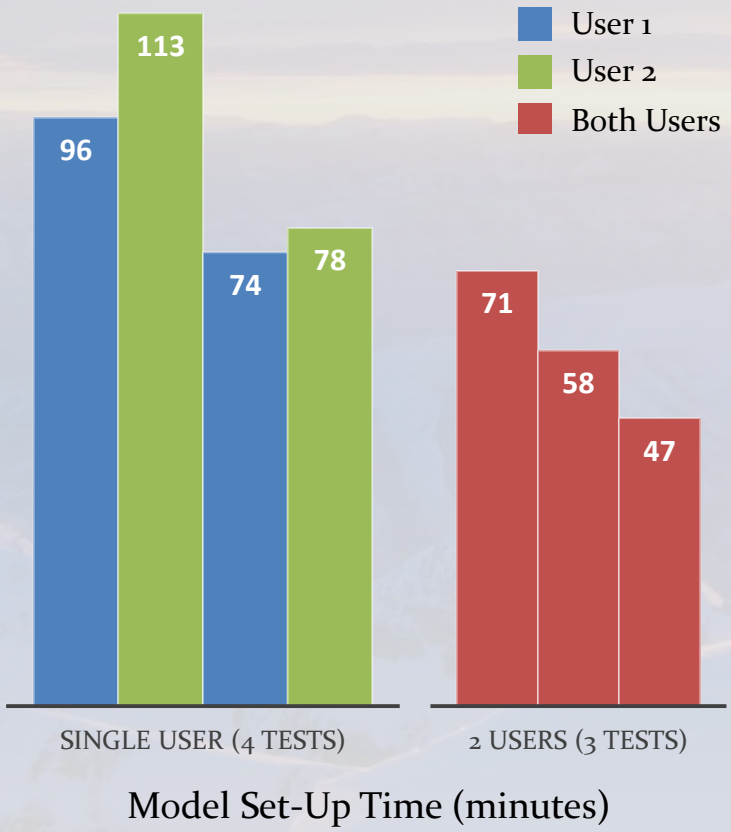
# Crescendo Model



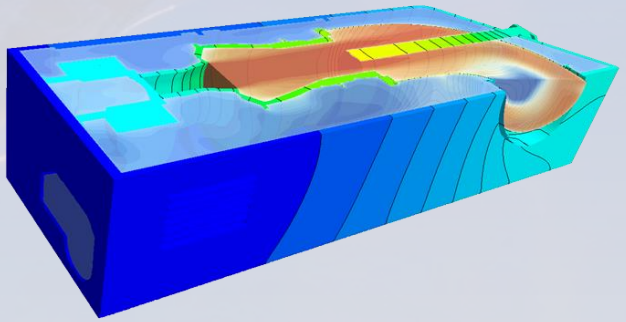

Model Set-Up Time (minutes)

**Time Reduction**

Average: 35 %

**Model**

1.85 M Cells



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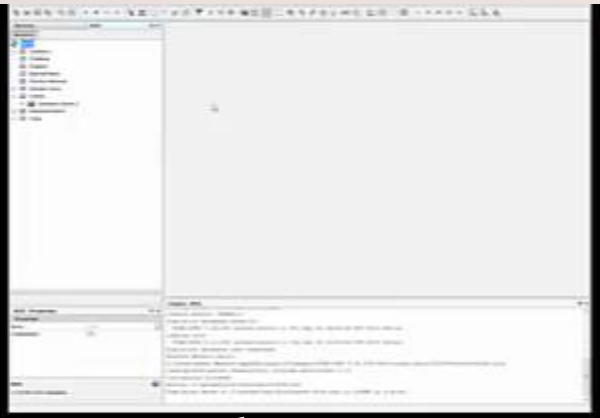
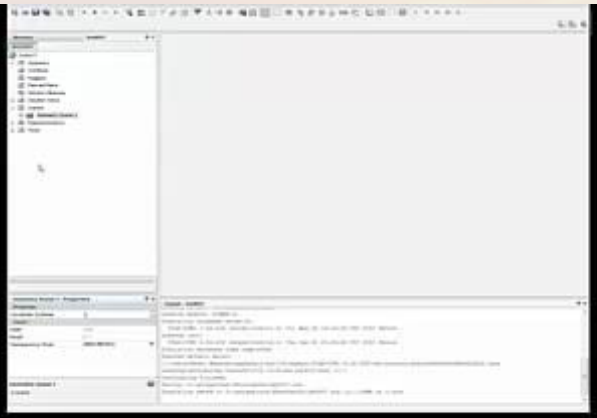
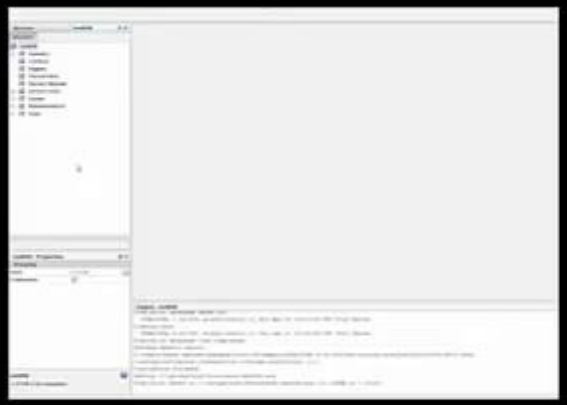
# Set-Up Example



Single User 1



Single User 2



Collaborative

# Improvements

Mesh Generation

- Only values can be changed while the mesh is being generated. No new operations can be executed
- Possible Improvements – Enable other non mesh based operations during mesh generation (post processing setup, continua setup, new shape part creation)

Surface Repair

- Only one user can use surface repair at a time. All other non mesh based operations can still be done while surface is being repaired.
- Possible Improvements – Enable surface repair for different users when used on different parts

Macros

- Macros will only log processes done by one client
- Possible Improvements – Record macros on server so that all commands are logged and can be re-executed

# Thank You


- Dr. Steve Gorrell, Dr. Greg Jensen, and Dr. Chia-Chi Teng from my graduate committee
- Ryan Packer for working as User 2
- Deryl Snyder, Lisa Mesaros, Chris Penny, Prashanth Shankara, Aaron Bird, and Jeff Smith from CD-adapco