



# GLOVE

## A visualization framework for massive CFD data



Performance  
improvements with  
parallel framework



Support for  
desktop and  
VR environments



Excellent usability  
based on intuitive  
user interface



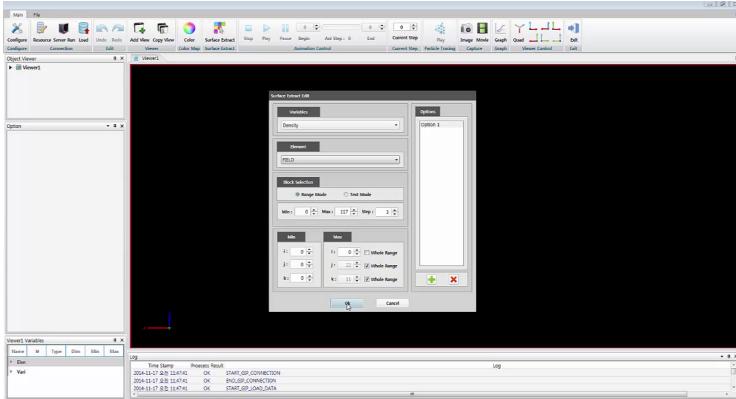
Various features  
for visualization and  
data analysis

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# Goals of GLOVE

- GLOVE is a framework for massive scientific data visualization in high performance computing environments.
- GLOVE aims for interactive visualization of tera-scale dataset.



GLOVE Remote User Interface



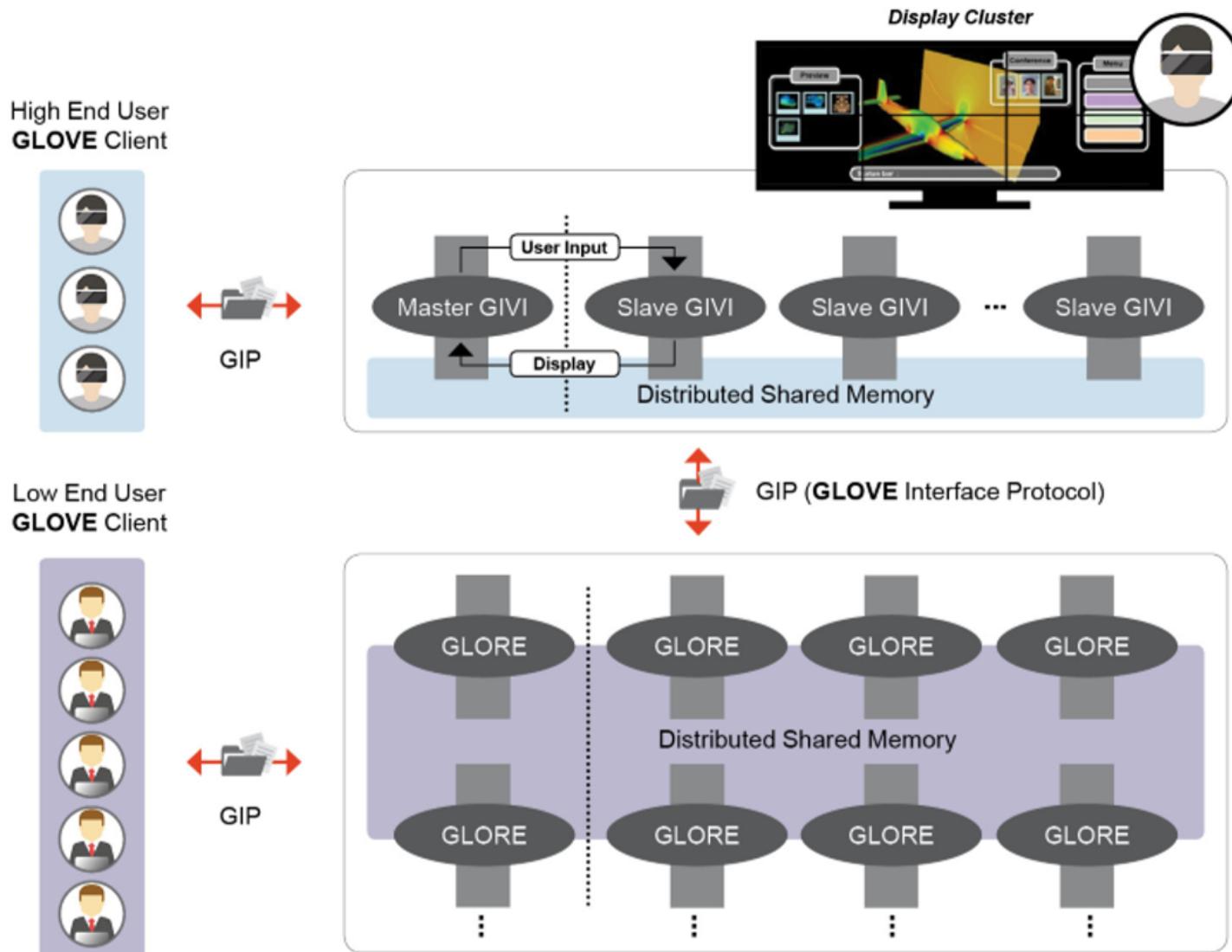
Display Cluster for Tiled Display

GLOVE VR User Interface

Interconnection network

Computing Cluster for Parallel Visualization

# GLOVE Architecture



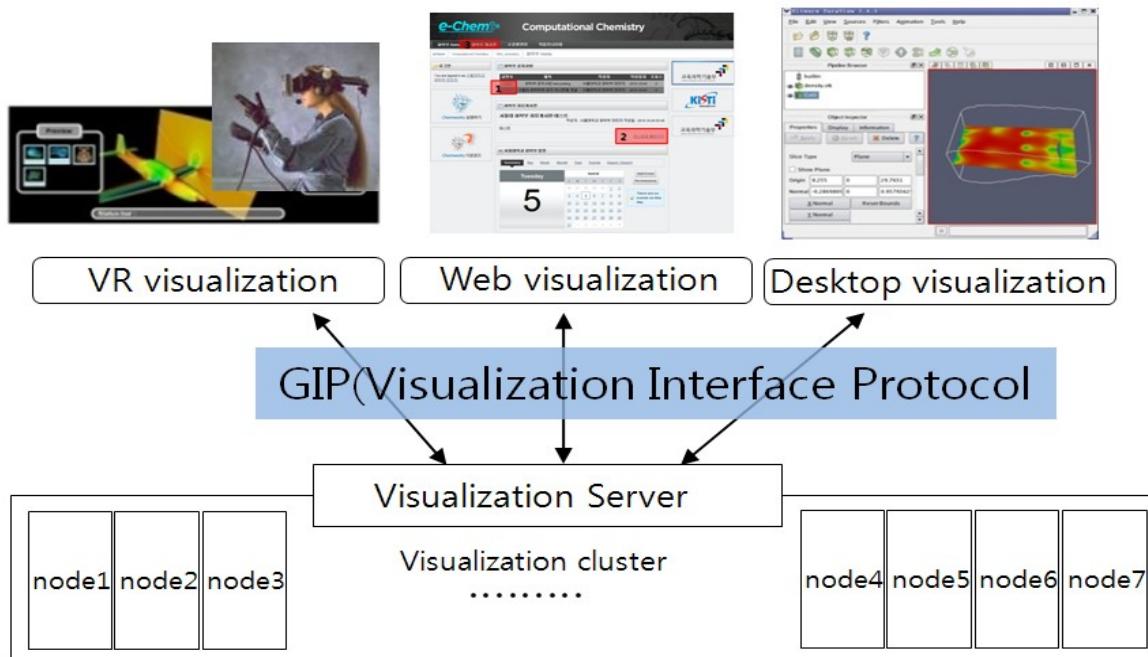
GLORE : GLOve Visualization Server

GIVI : GLOVE Integrated Visualization Interface

GIP : GLOVE Interface Protocol

# Features of GLOVE

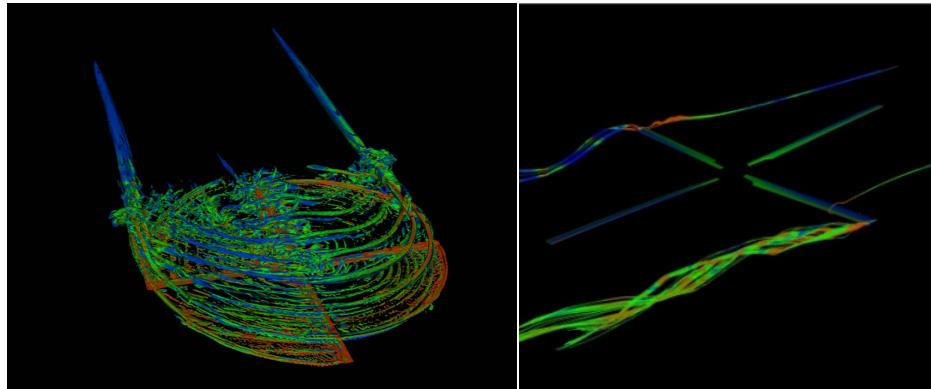
- Support of multiple clients at the same time
- Effective load distribution and load balancing
- Customized rendering and user interface
- Support of various 3D environment including tiled display.



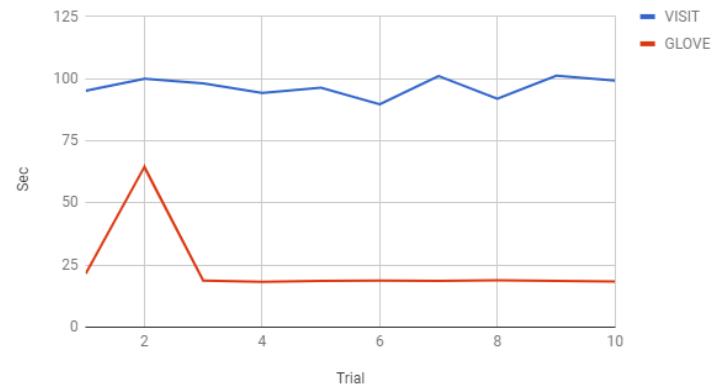
# Performance test

## ■ Data set and experimental environment

Total # of points	size / time step	# of time steps	Total size
135M	12.64GB	98	1.21TB
Total number of nodes		64	
CPU		Xeon X5450 3.0 GHz	
Memory size / node	32GB	Total memory size	2TB



Streamline Test Results

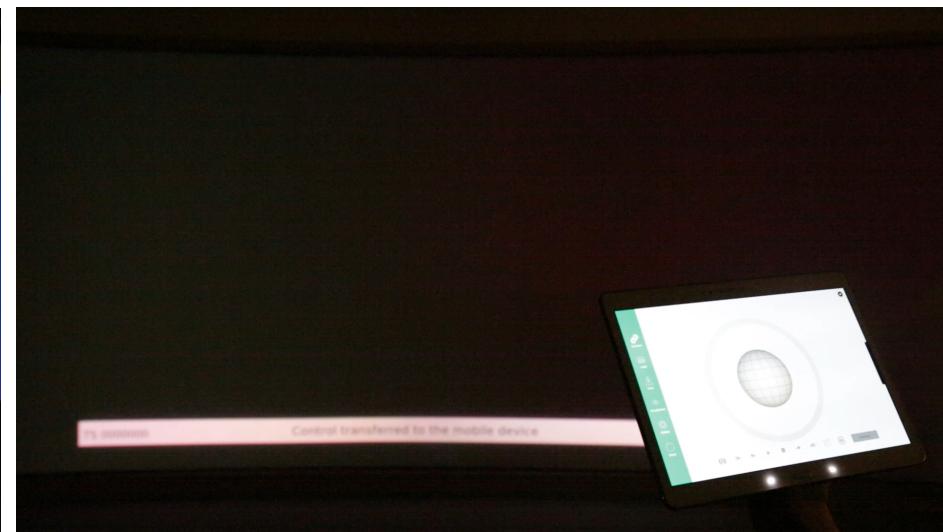


Tool	Ensight (sec)	ParaView (sec)	GLOVE (sec)	Ensight : ParaView : GLOVE
Slice	1.5	1.79	1.80	0.83 : 0.99 : 1
Iso-surface	4.8	10.11	2.12	2.26 : 4.76 : 1
Animation	307	274	2.12	144.8 : 129.2 : 1

	Streamline	Pathline
GLOVE	71.02	85.12
Ensight	79.74	3906.91
Ensight/GLOVE	1.12	45.90

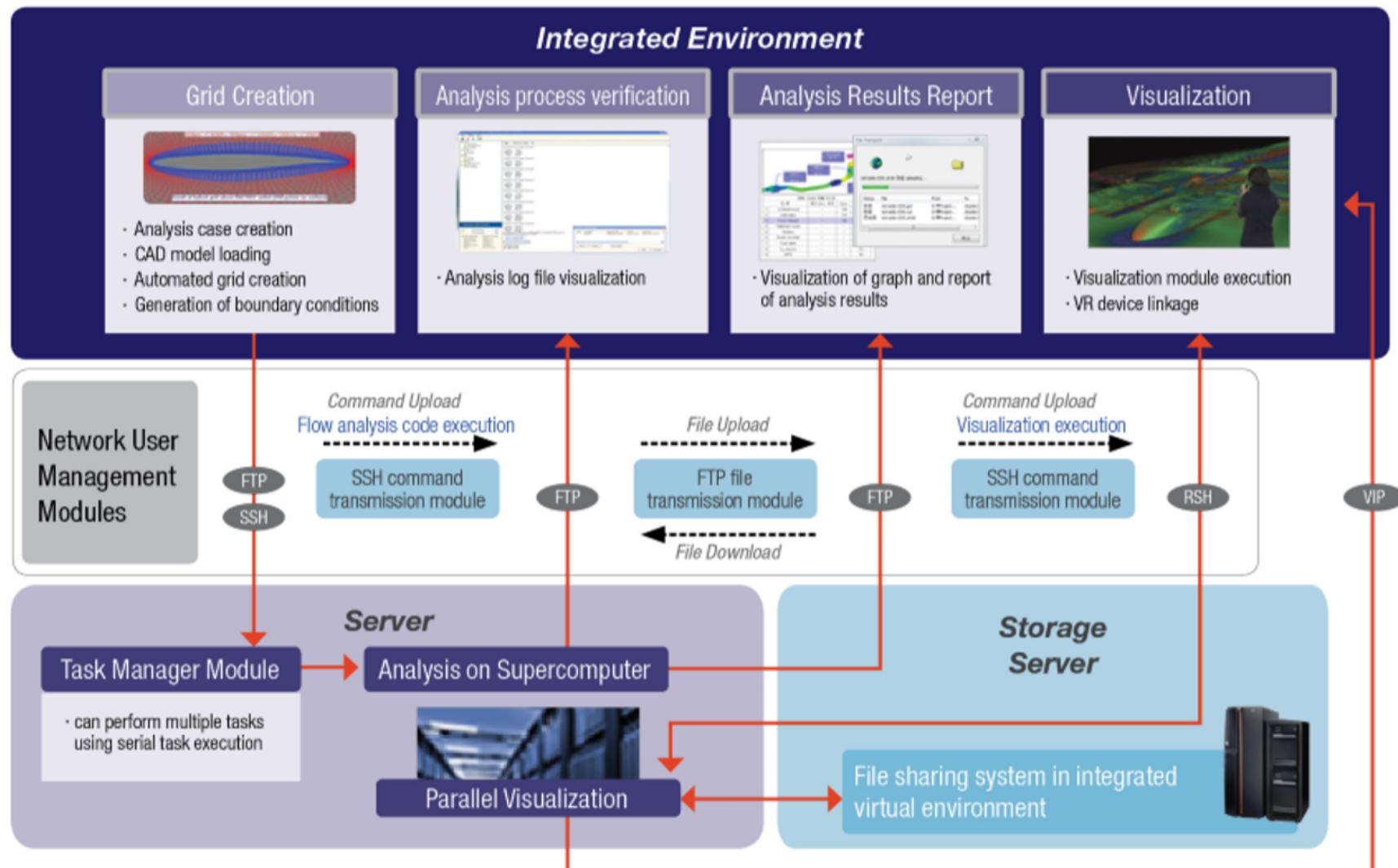
# 3D visualization

- GIVI for high-end users supports various types of display environments (including high-resolution tiled display, immersive VR environments, etc.)
- GIVI for low-end users supports a 3D monitor and a 3D mouse
- GIVI supports various types of 3D input devices (IS-900, smart phone, haptic device, etc.)



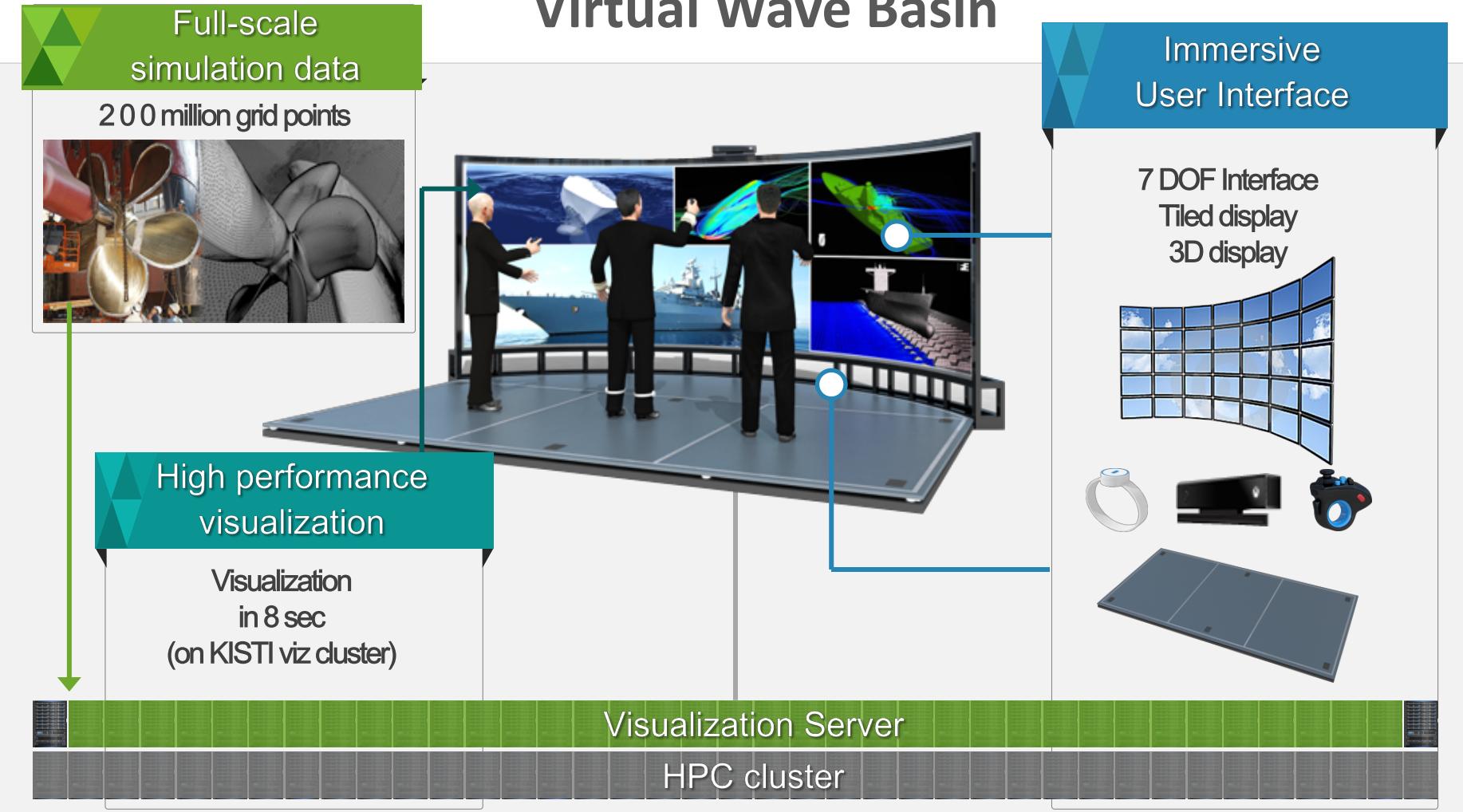
# Applications of GLOVE

## Virtual Wind Tunnel

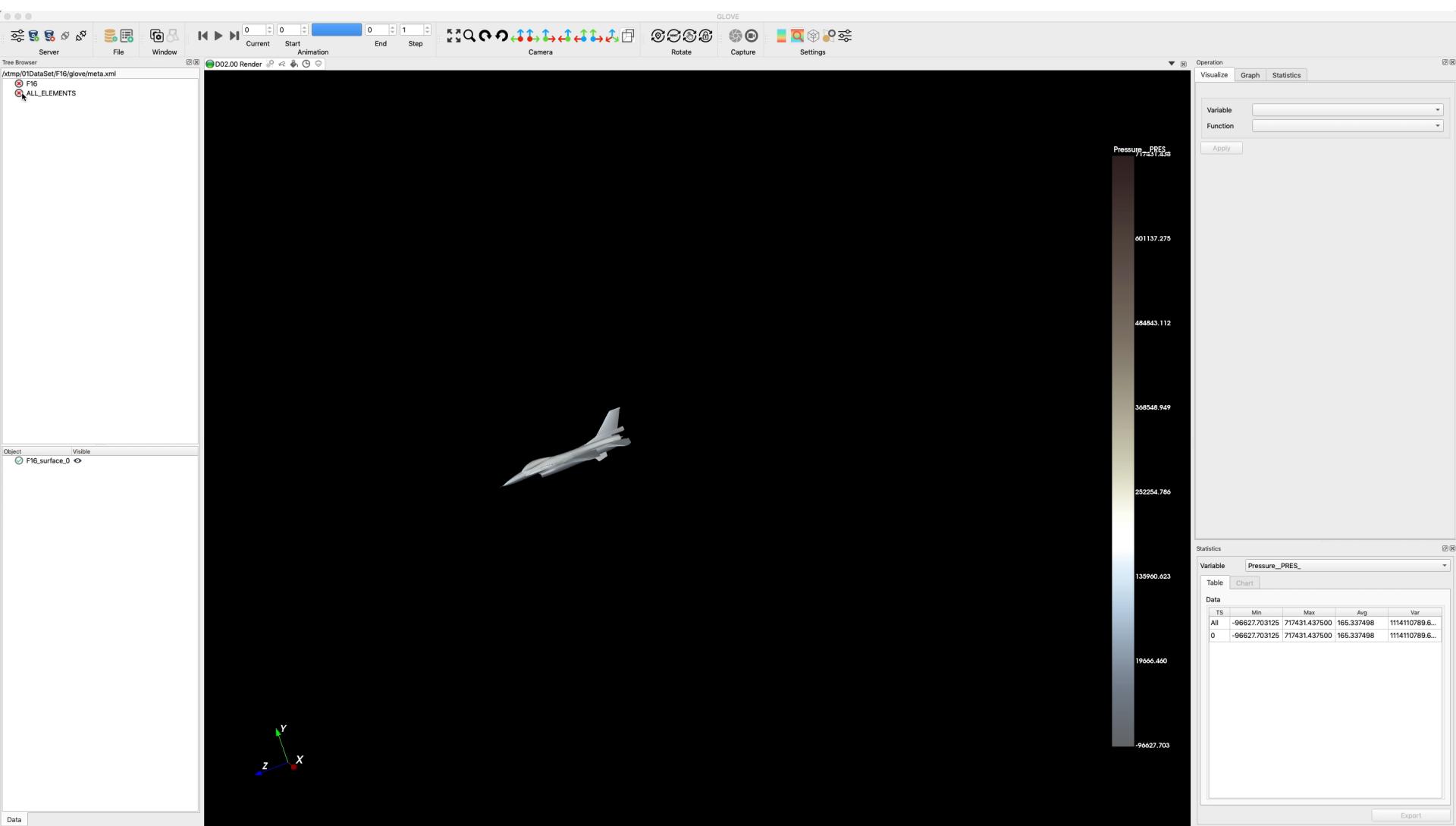


# Applications of GLOVE

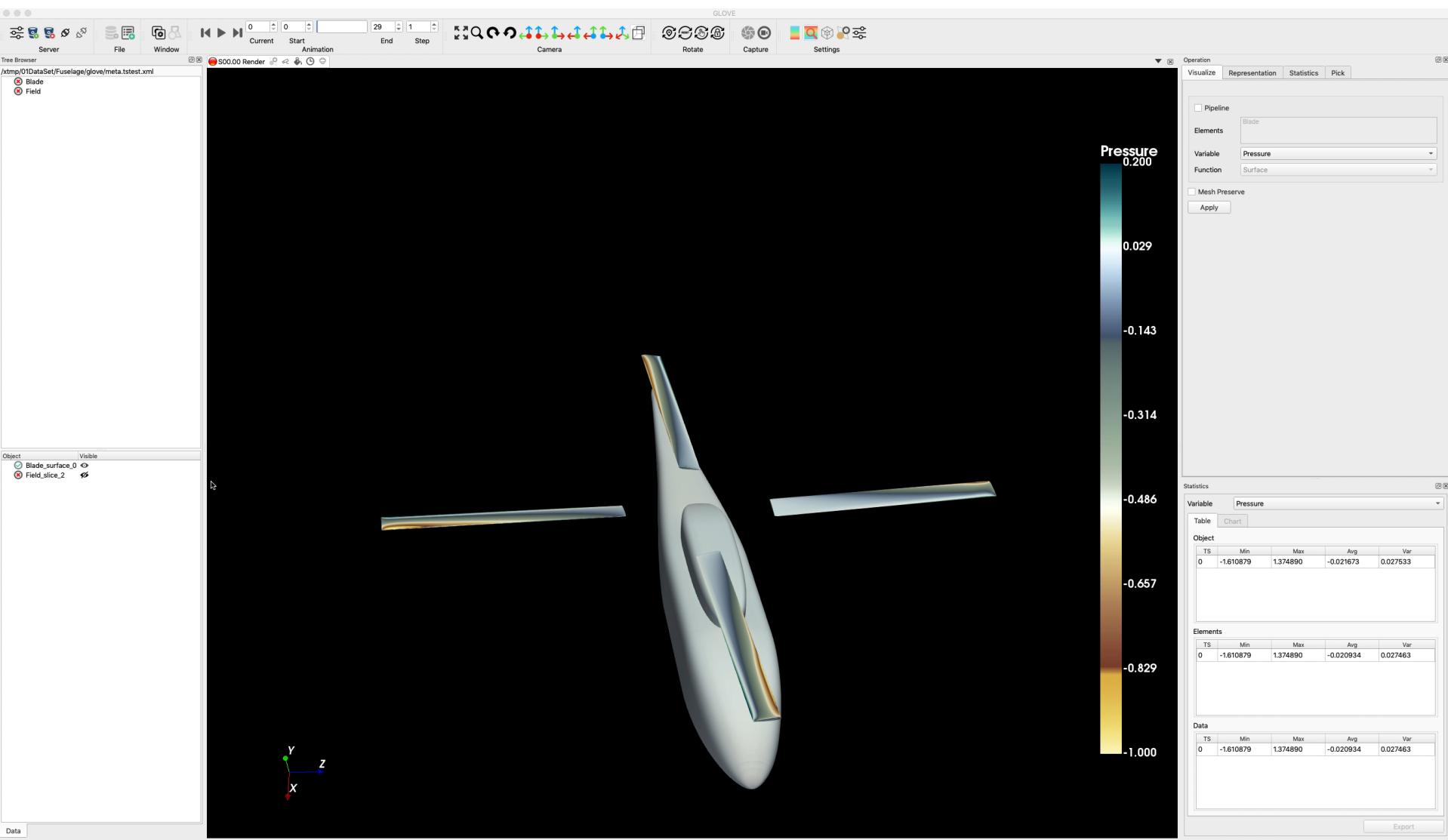
## Immersive Visualization System for Virtual Wave Basin



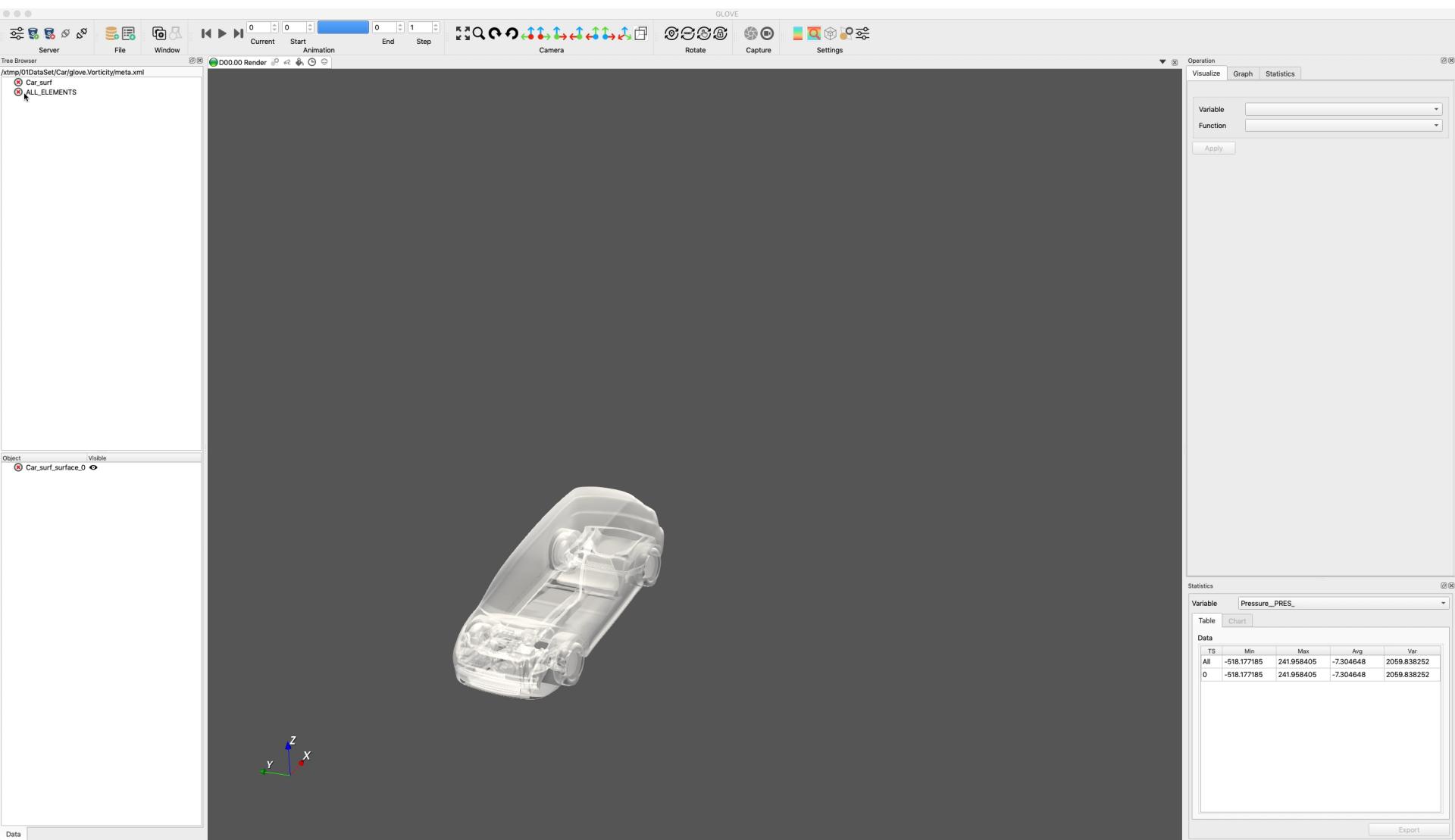
# Demo 1 : Multi-slice user interface



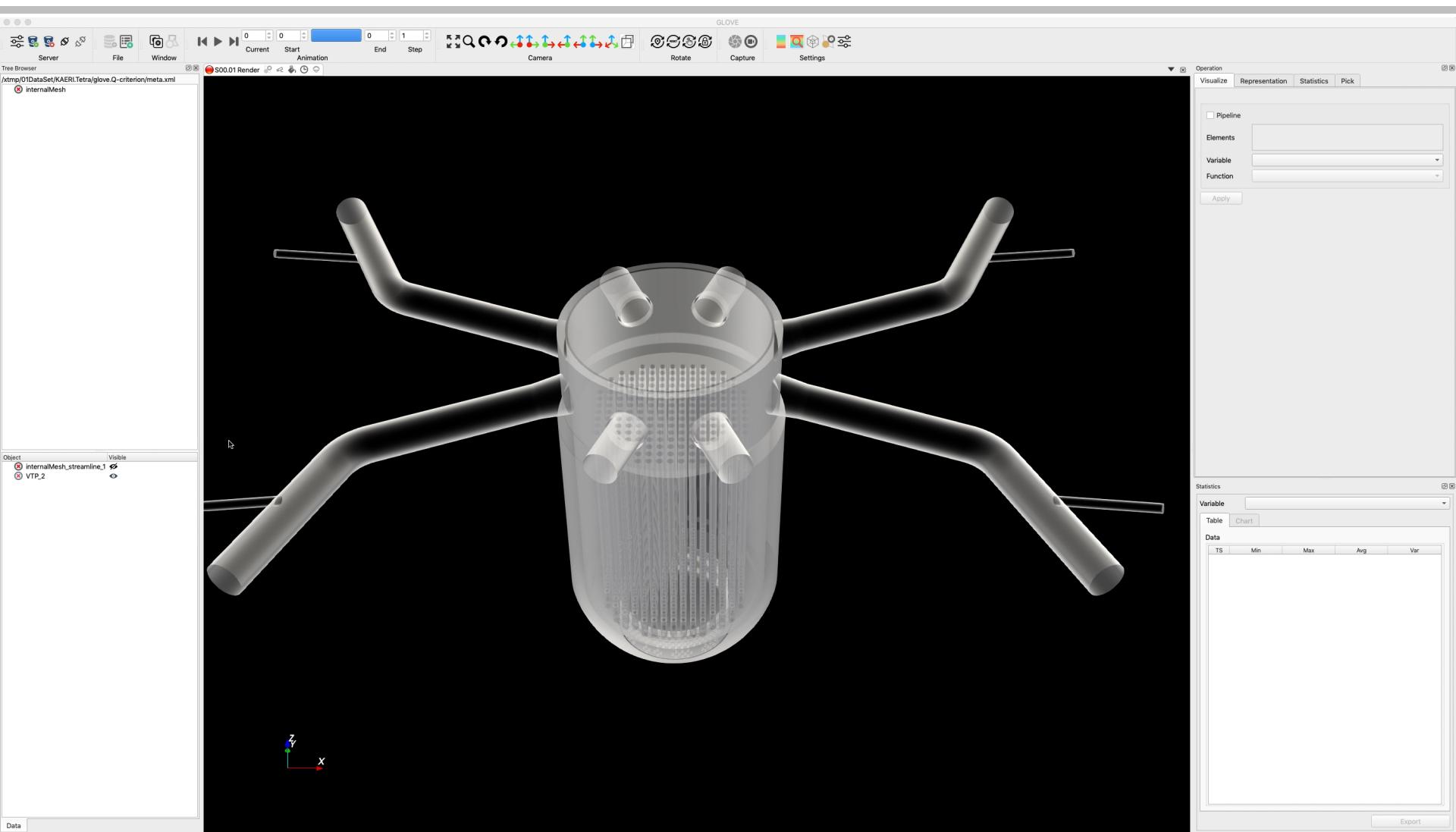
# Demo 2 : Multi-slice animation



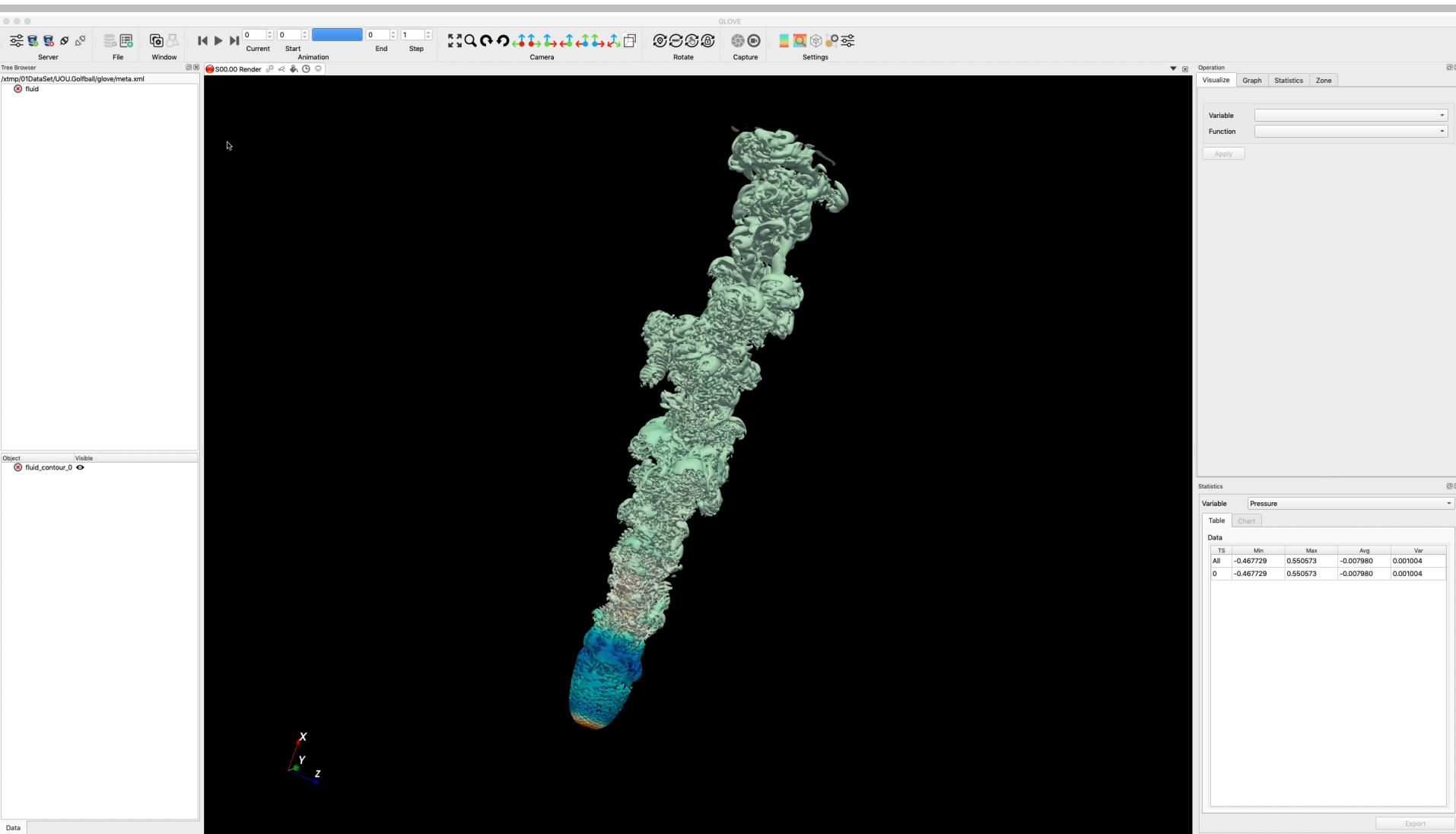
# Demo 3 : Streamline – outer flow



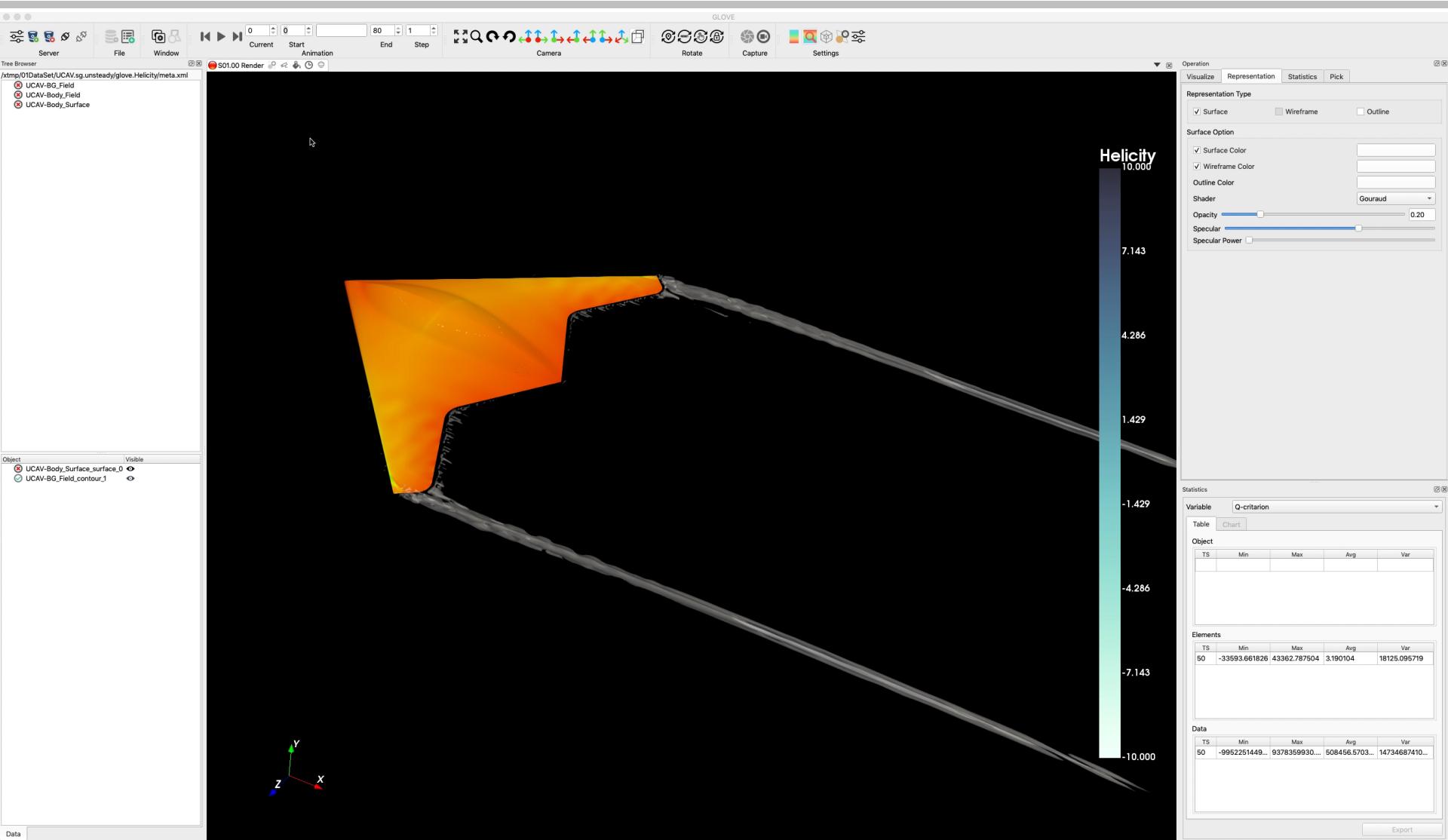
# Demo 4 : Streamline – inner flow



# Demo 5 : Shading



# Demo 6 : Multi time step animation



# Conclusion & Future Work

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- We developed GLOVE which is a real-time visualization framework for tera-scale CFD data
- GLOVE provides optimized performance with advanced HPC technology and customized UI for efficient usability
- Future Plan
  - Parallel and distributed rendering including ray casting.
  - Providing new feature extraction and recommendation for visualization by learning CFD simulation data with AI