Blender for OpenFOAM Users

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Finnish OpenFOAM User Day 2024

About Blender

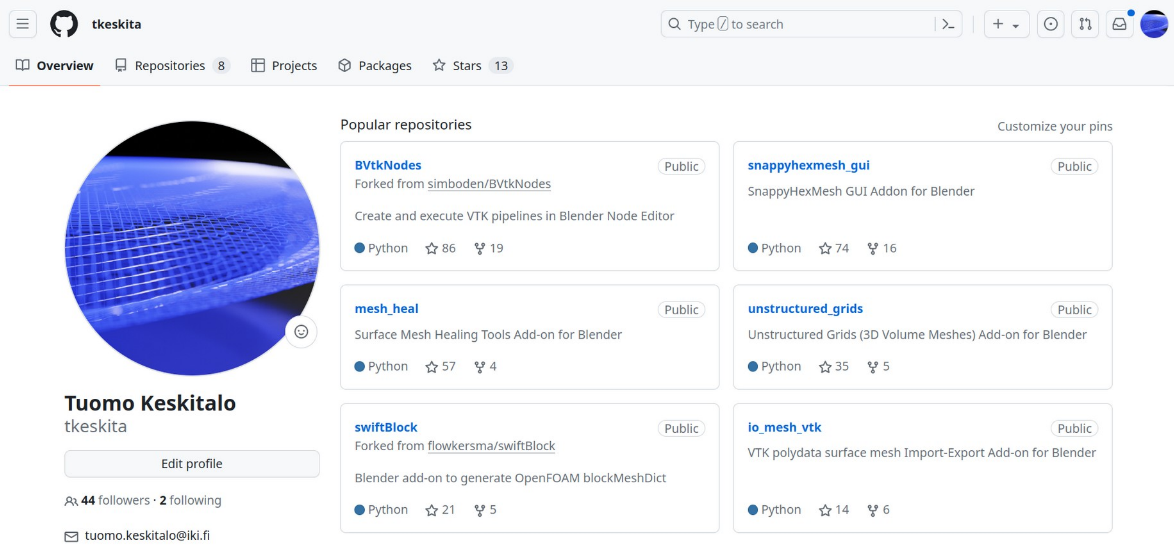
- Blender is a free and open-source 3D polygon surface modelling, animation and rendering software (GPL license)
- Best known for animation films, 3D models for games and 3D printing
- Pros for OpenFOAM users include
  - 3D viewport for visualization of surfaces
  - 3D polygon surface modelling capabilities
  - Python API for creation of custom operators and GUI elements for creating add-on tools
- Cons for OpenFOAM users include
  - Steep learning curve for effective use (modes, shading, ways to select things, keymaps)
  - Rapid development pace causes video tutorials to be outdated quickly
  - ~~Weird user interface~~ (not any more since version 2.80. Docs are also OK)
- Use latest LTS version of Blender to avoid incompatibility issues
- See my tutorial videos: Blender for OpenFOAM users

Blender mesh modelling

- Polygon surface mesh modelling
  → only surfaces of volumes are modelled
- Supports precision modelling (coordinates are single precision floats)
- For all curved shapes, you need to choose number of discretization points
- Operations apply on selection (of vertices, edges or faces)
- Destructive mesh modelling: Geometry/topology changes are permanent. However, there is undo to go back to the previous mesh.
- Allows versatile editing of CAD surface mesh models (e.g. STL / OBJ)
- See tutorial videos for examples

Blender add-ons for OF users

- I maintain and develop several Blender add-ons on my free time: https://github.com/tkeskita
  - Various people have contributed, I authored a few of them
- All add-ons include docs, see links in github



Popular repositories

BVtkNodes Public
Forked from simboden/BVtkNodes
Create and execute VTK pipelines in Blender Node Editor
Python ☆ 86 19

snappyhexmesh_gui Public
SnappyHexMesh GUI Addon for Blender
Python ☆ 74 16

mesh_heal Public
Surface Mesh Healing Tools Add-on for Blender
Python ☆ 57 4

unstructured_grids Public
Unstructured Grids (3D Volume Meshes) Add-on for Blender
Python ☆ 35 5

swiftBlock Public
Forked from flowkersma/swiftBlock
Blender add-on to generate OpenFOAM blockMeshDict
Python ☆ 21 5

io_mesh_vtk Public
VTK polydata surface mesh Import-Export Add-on for Blender
Python ☆ 14 6

Tuomo Keskitalo
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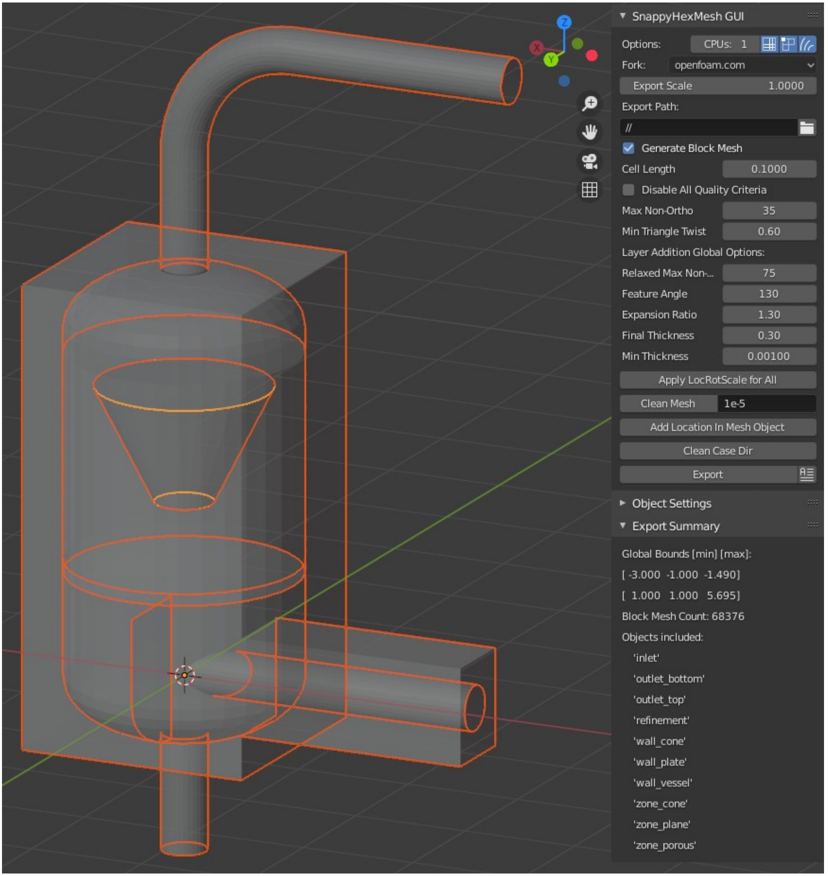
SnappyHexMesh-GUI add-on

- Generates a ready-to-run Snappy case folder structure from surface objects
- Usage:
  - Import surfaces from CAD (STL or OBJ)
  - Setup Snappy parameters in GUI
  - Export
  - Run script in terminal: **./run**
    (runs blockMesh, surfaceFeatureExtract, snappyHexMesh, checkMesh)
- Key to efficient meshing with Snappy is iterative Snappy workflow



Options: CPUs: 1

Fork: openfoam.com

Export Scale 1.0000

Export Path: //

☑ Generate Block Mesh

Cell Length 0.1000

□ Disable All Quality Criteria

Max Non-Ortho 35

Min Triangle Twist 0.60

Layer Addition Global Options:

Relaxed Max Non-... 75

Feature Angle 130

Expansion Ratio 1.30

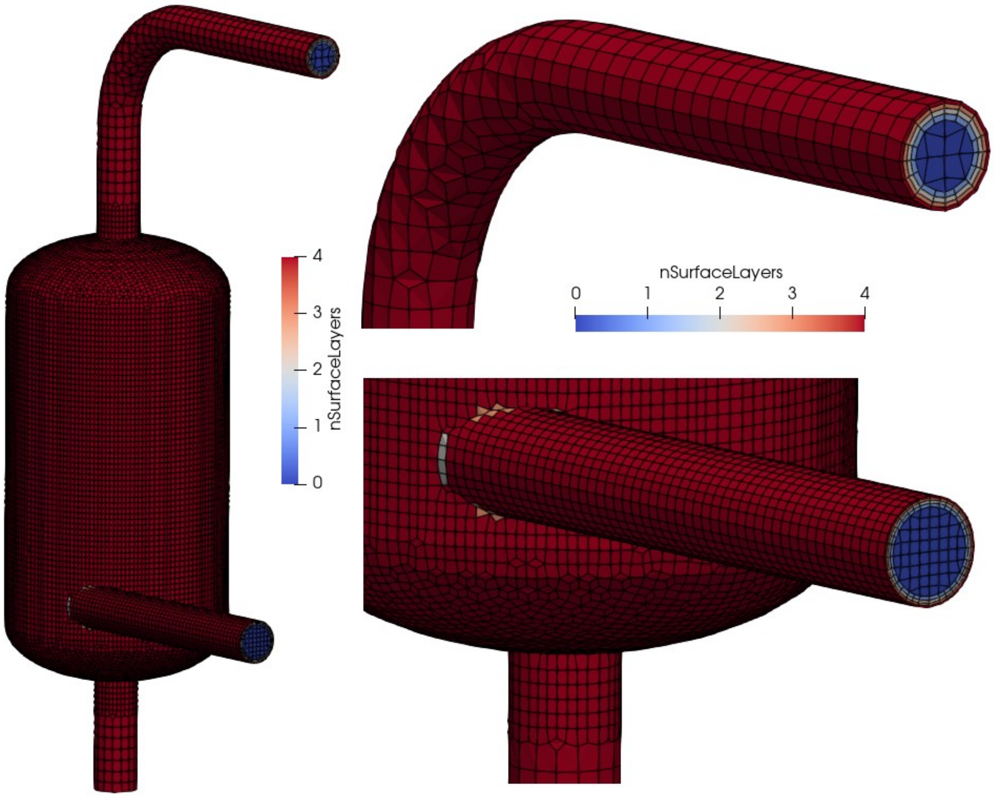
Final Thickness 0.30

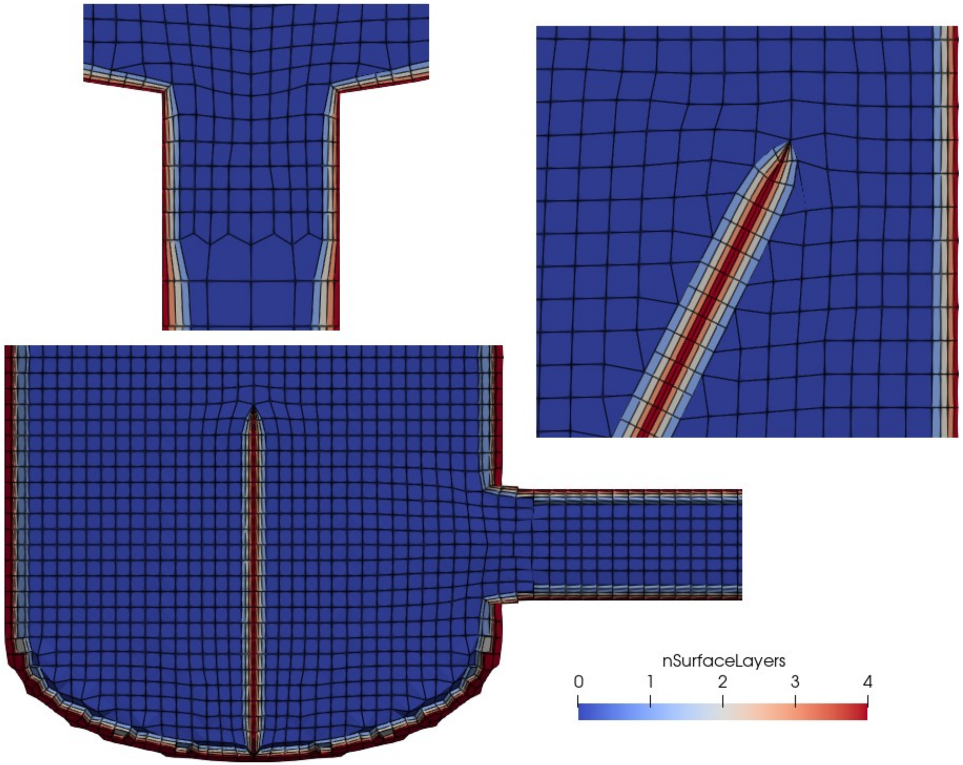
Min Thickness 0.00100

Clean Mesh 1e-5

```
Global Bounds [min] [max]:
[ -3.000  -1.000  -1.490]
[  1.000   1.000   5.695]
Block Mesh Count: 68376
Objects included:
   'inlet'
   'outlet_bottom'
   'outlet_top'
   'refinement'
   'wall_cone'
   'wall_plate'
   'wall_vessel'
   'zone_cone'
   'zone_plane'
   'zone_porous'
```

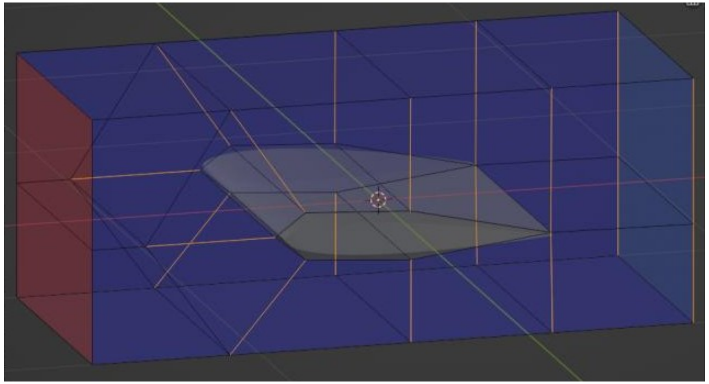
Boundary layers with SnappyHexMesh

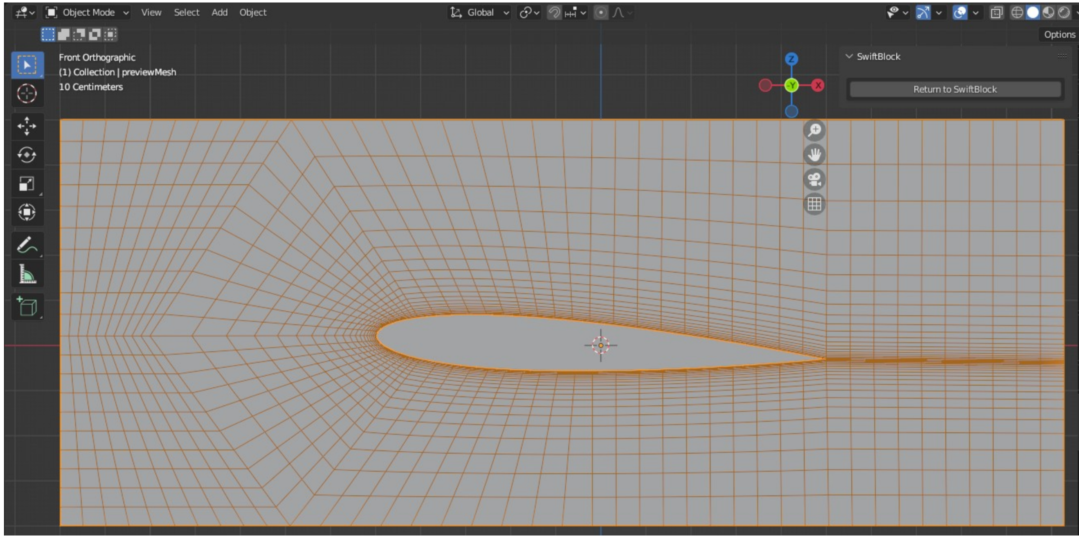




SwiftBlock add-on

- GUI for blockMesh for creation of structured block meshes
  - controlled grading for boundary layers
  - snapping to surfaces

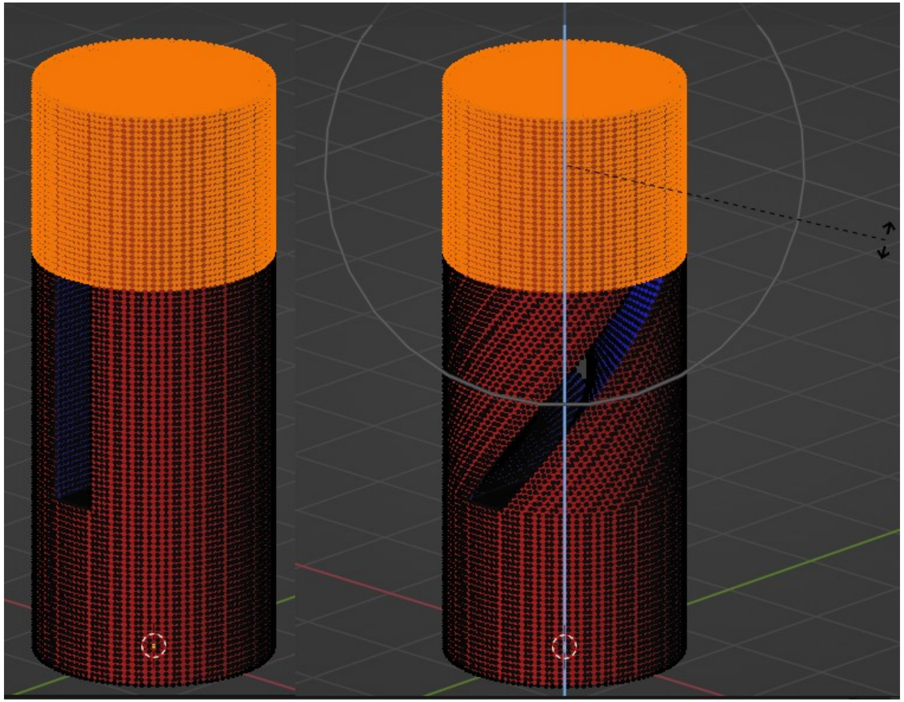




PS. If you want Python interface to blockMesh, try Classy Blocks

Unstructured Grids add-on

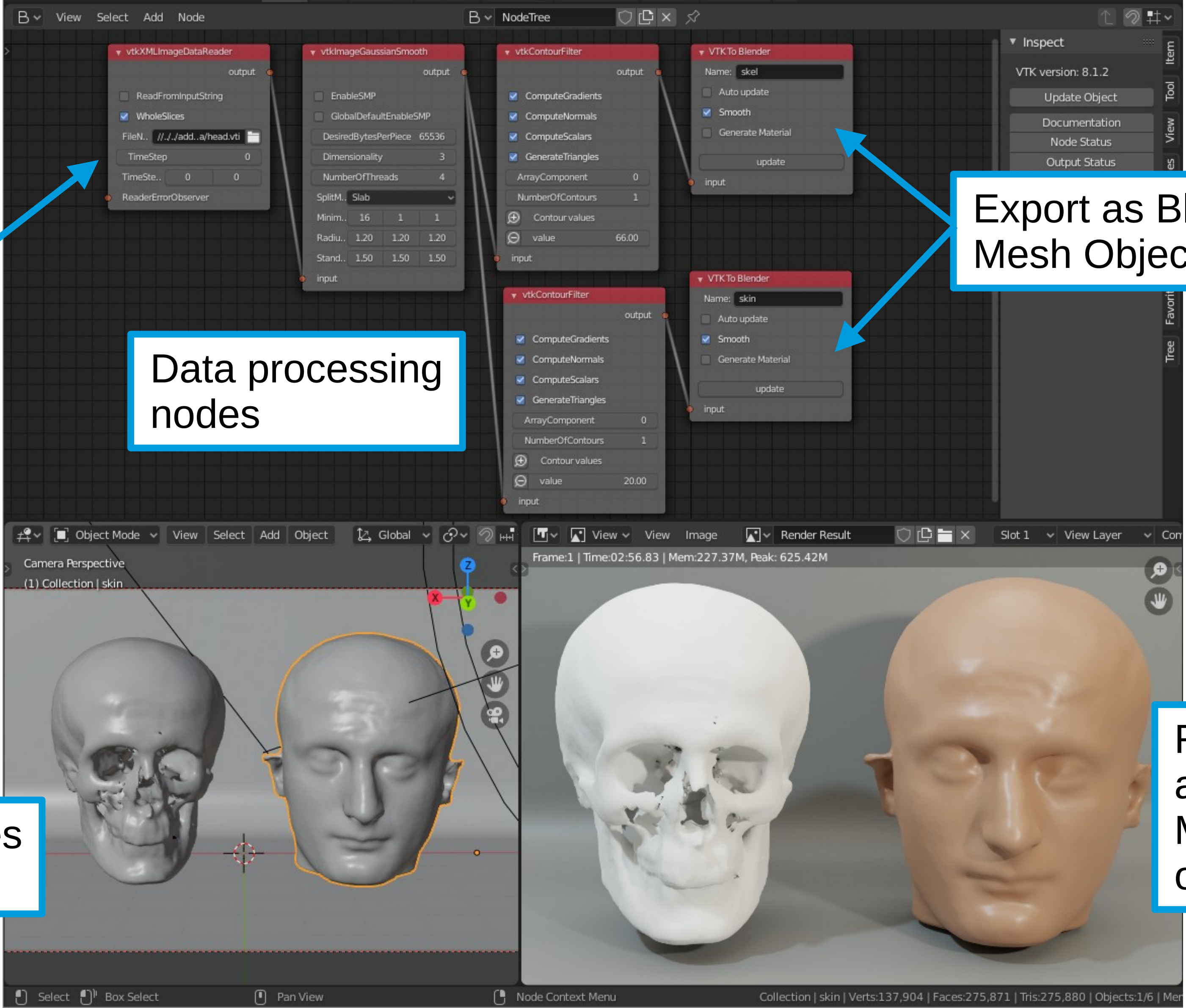
- Editing of OpenFOAM polyMesh in Blender
  - Import and export of polyMesh
  - Extrusion of new cells and boundary layers
  - Editing of patches
  - Editing of face and cell zones
- Note: Python cell data model → slow for big meshes



Example: Rotate selected vertices with Proportional Editing in Blender

BVTKNodes

- Wraps the Visualization Toolkit (VTK) library for scientific visualization in Blender
  - Simply put, turns Blender into Paraview with photorealistic rendering features
- VTK pipeline is presented as nodes in Blender
- Consider to use only if you **really** need photorealistic rendering of your results
  - Warning: It takes a lot of time to learn all necessary rendering related topics and settings



vtkXMLImageDataReader
output
□ ReadFromInputString
☑ WholeSlices
FileN.. //../../add..a/head.vti
TimeStep 0
TimeSte.. 0 0
ReaderErrorObserver

vtkImageGaussianSmooth
output
□ EnableSMP
□ GlobalDefaultEnableSMP
DesiredBytesPerPiece 65536
Dimensionality 3
NumberOfThreads 4
SplitM.. Slab
Minim.. 16 1 1
Radiu.. 1.20 1.20 1.20
Stand.. 1.50 1.50 1.50
input

vtkContourFilter
output
☑ ComputeGradients
☑ ComputeNormals
☑ ComputeScalars
☑ GenerateTriangles
ArrayComponent 0
NumberOfContours 1
Contour values
value 66.00
input

vtkContourFilter
output
☑ ComputeGradients
☑ ComputeNormals
☑ ComputeScalars
☑ GenerateTriangles
ArrayComponent 0
NumberOfContours 1
Contour values
value 20.00
input

VTK To Blender
Name: skel
□ Auto update
☑ Smooth
□ Generate Material
update
input

VTK To Blender
Name: skin
□ Auto update
☑ Smooth
□ Generate Material
update
input

VTK version: 8.1.2
Update Object
Documentation
Node Status
Output Status

Frame:1 | Time:02:56.83 | Mem:227.37M, Peak: 625.42M

Collection | skin | Verts:137,904 | Faces:275,871 | Tris:275,880 | Objects:1/6 | Mer

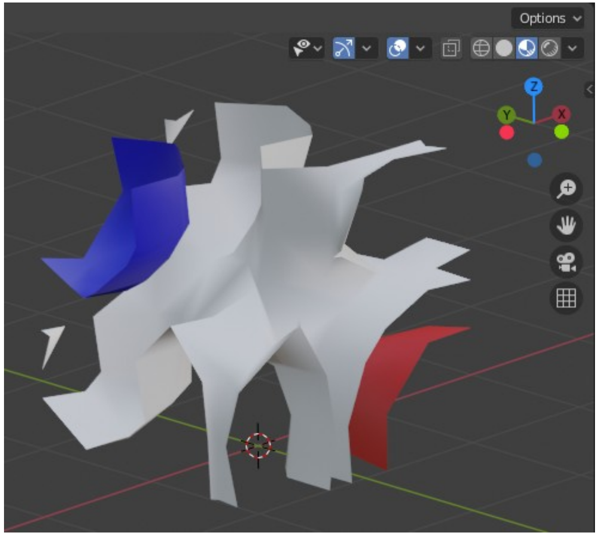
Reader node

Data processing nodes

Export as Blender Mesh Objects

Result Meshes in Blender

Rendering after applying Materials to objects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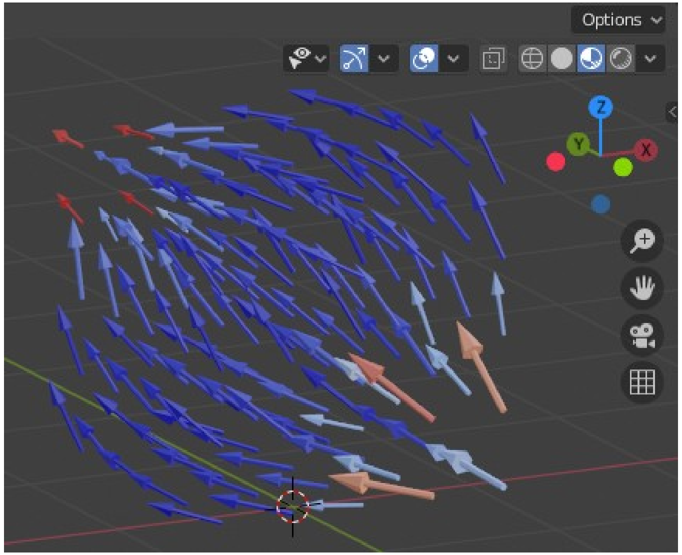
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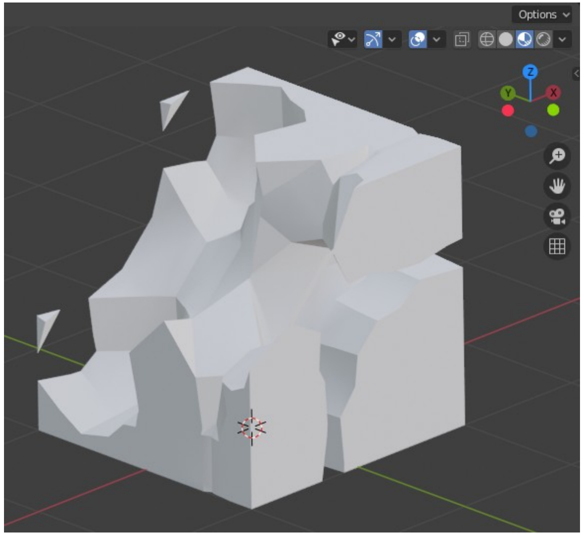
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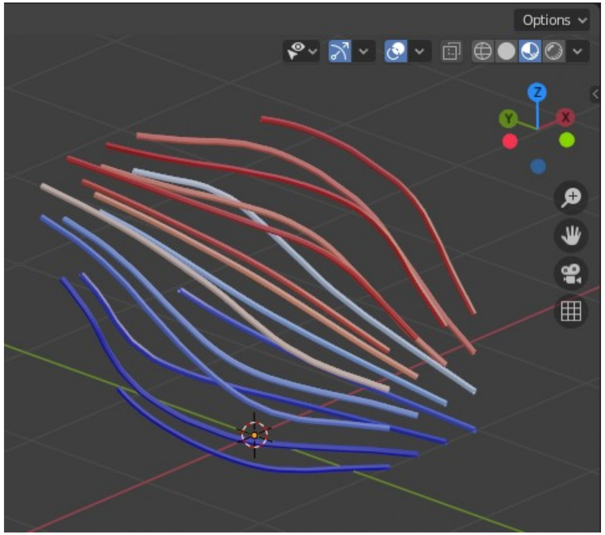
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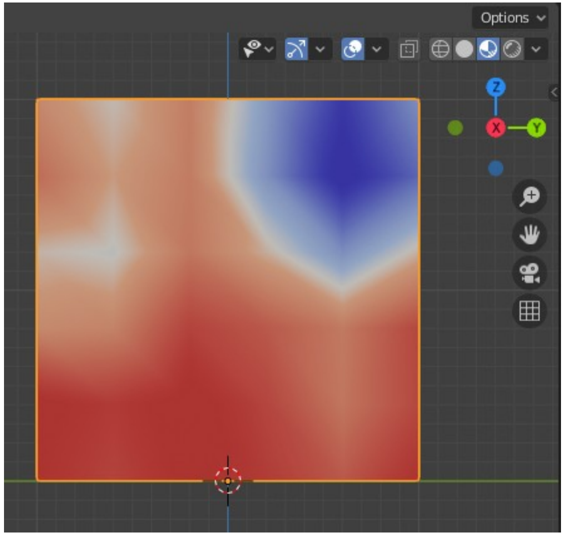
Options
Z
X
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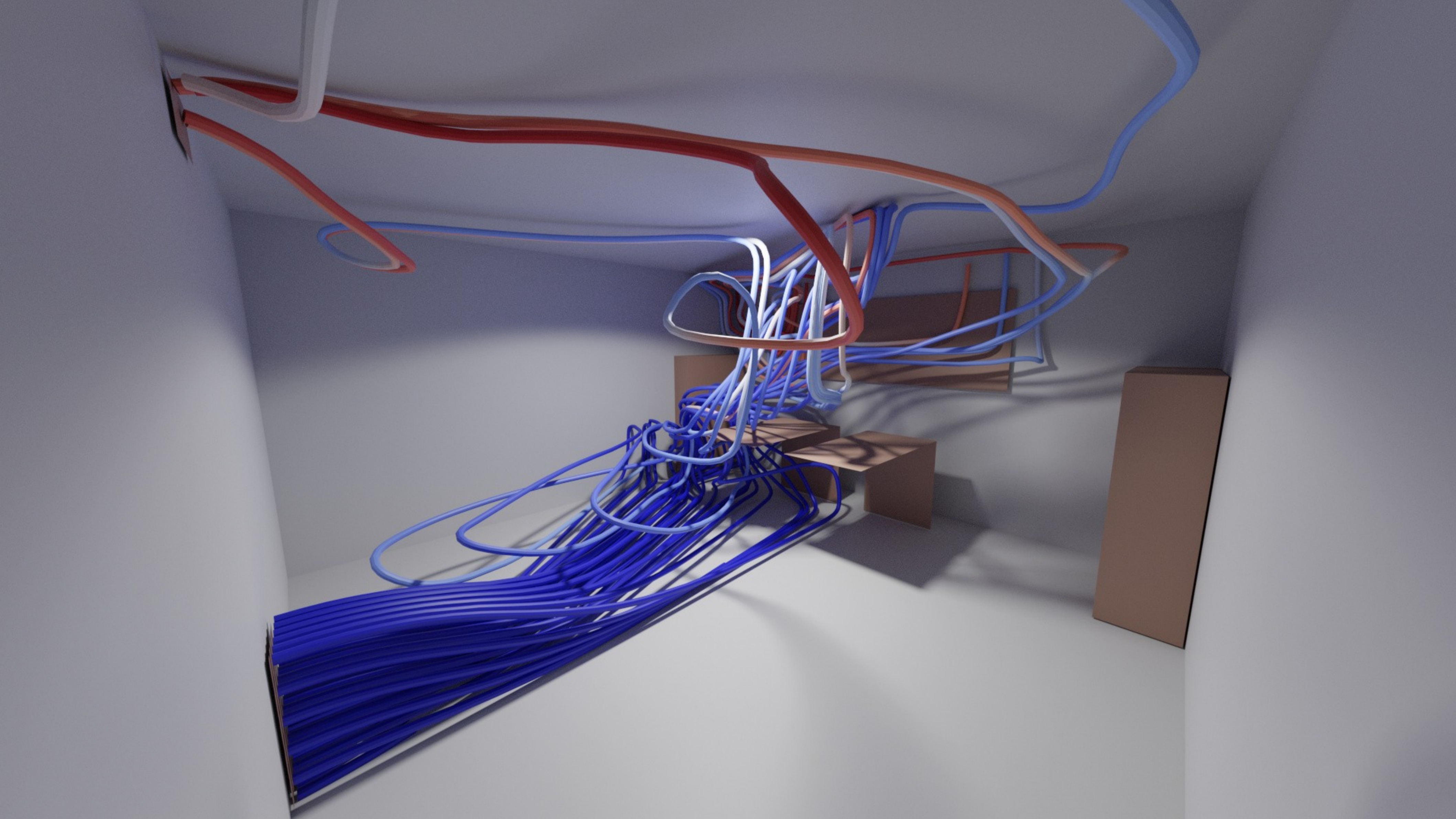
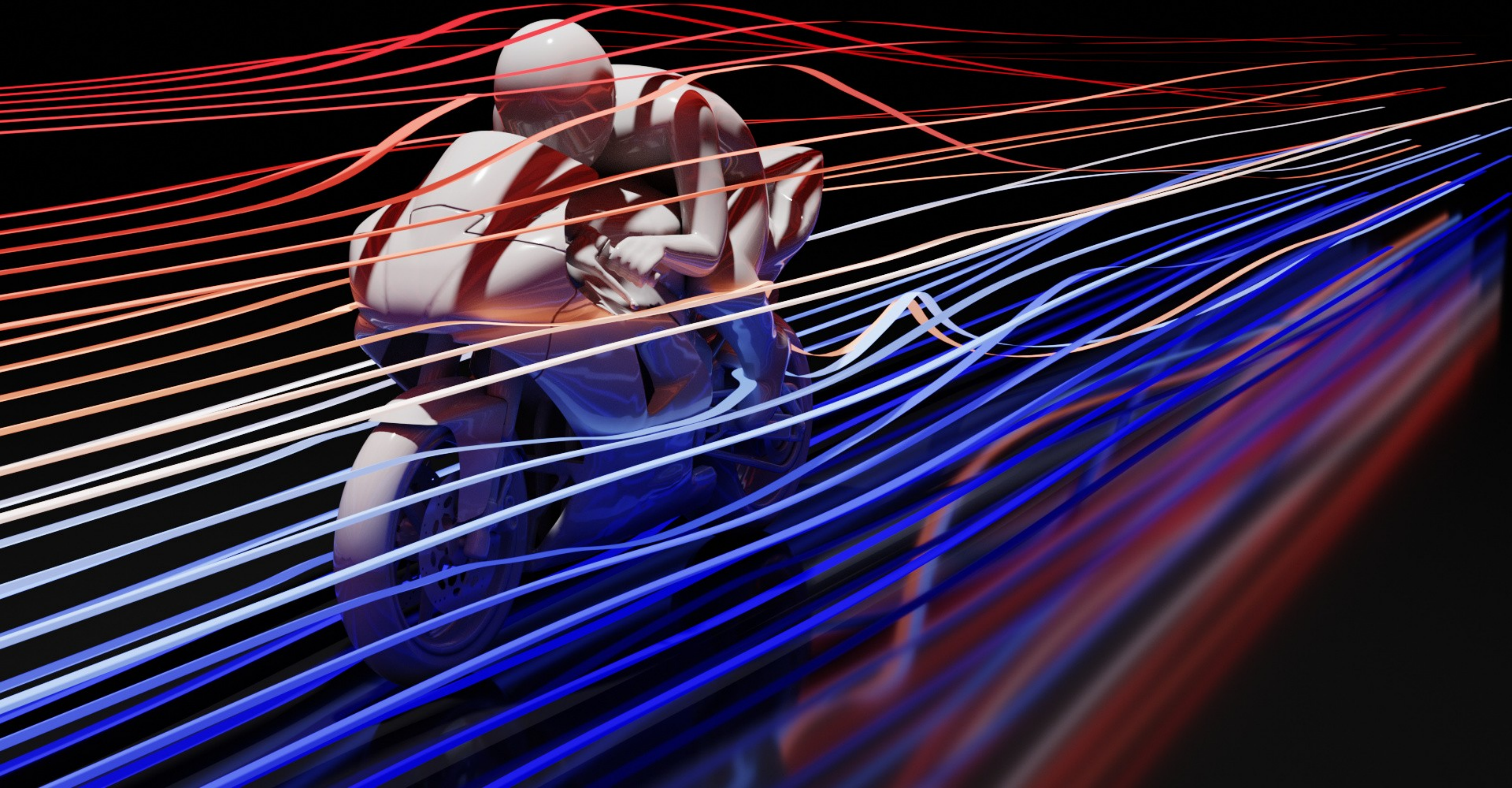
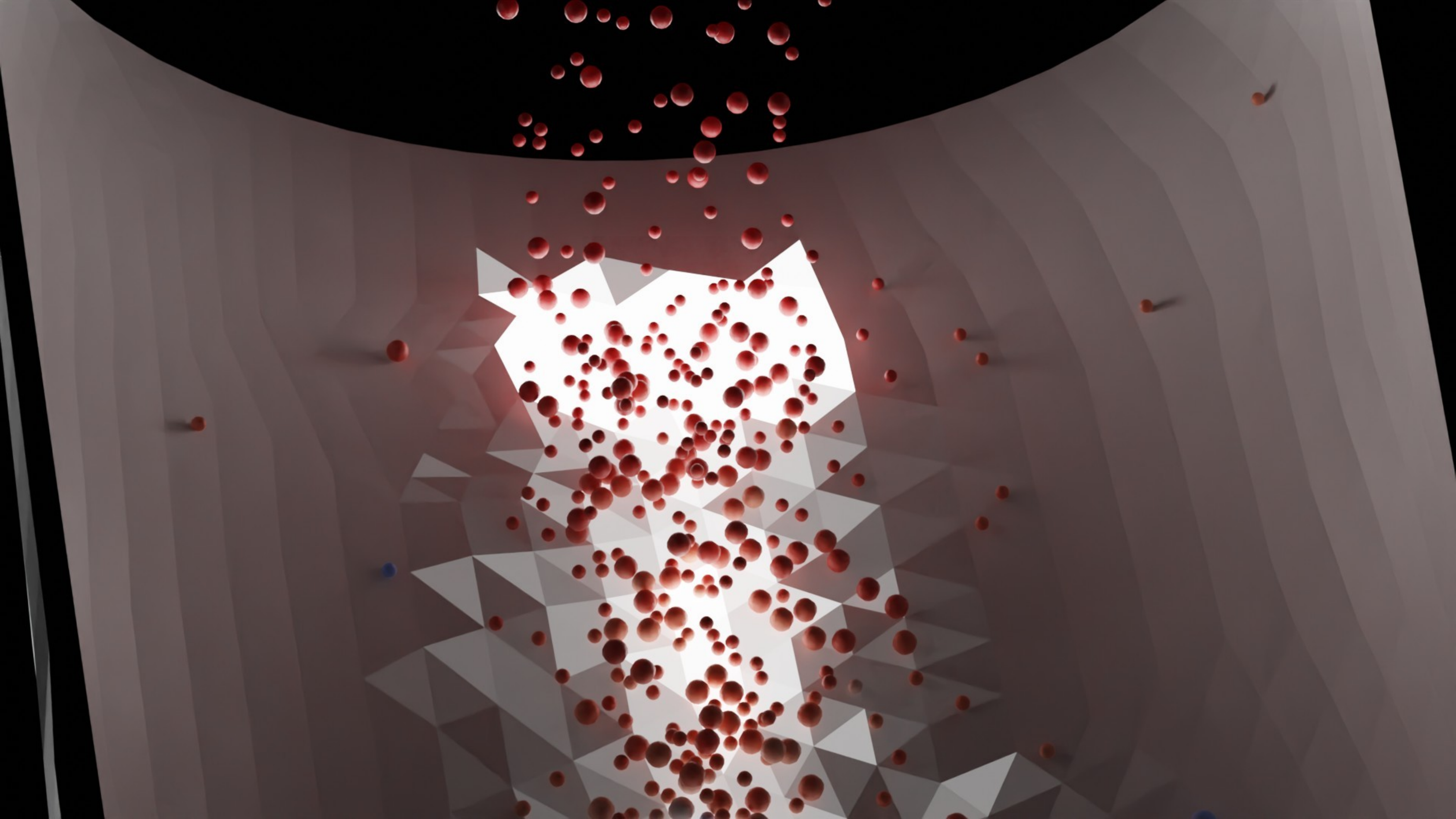
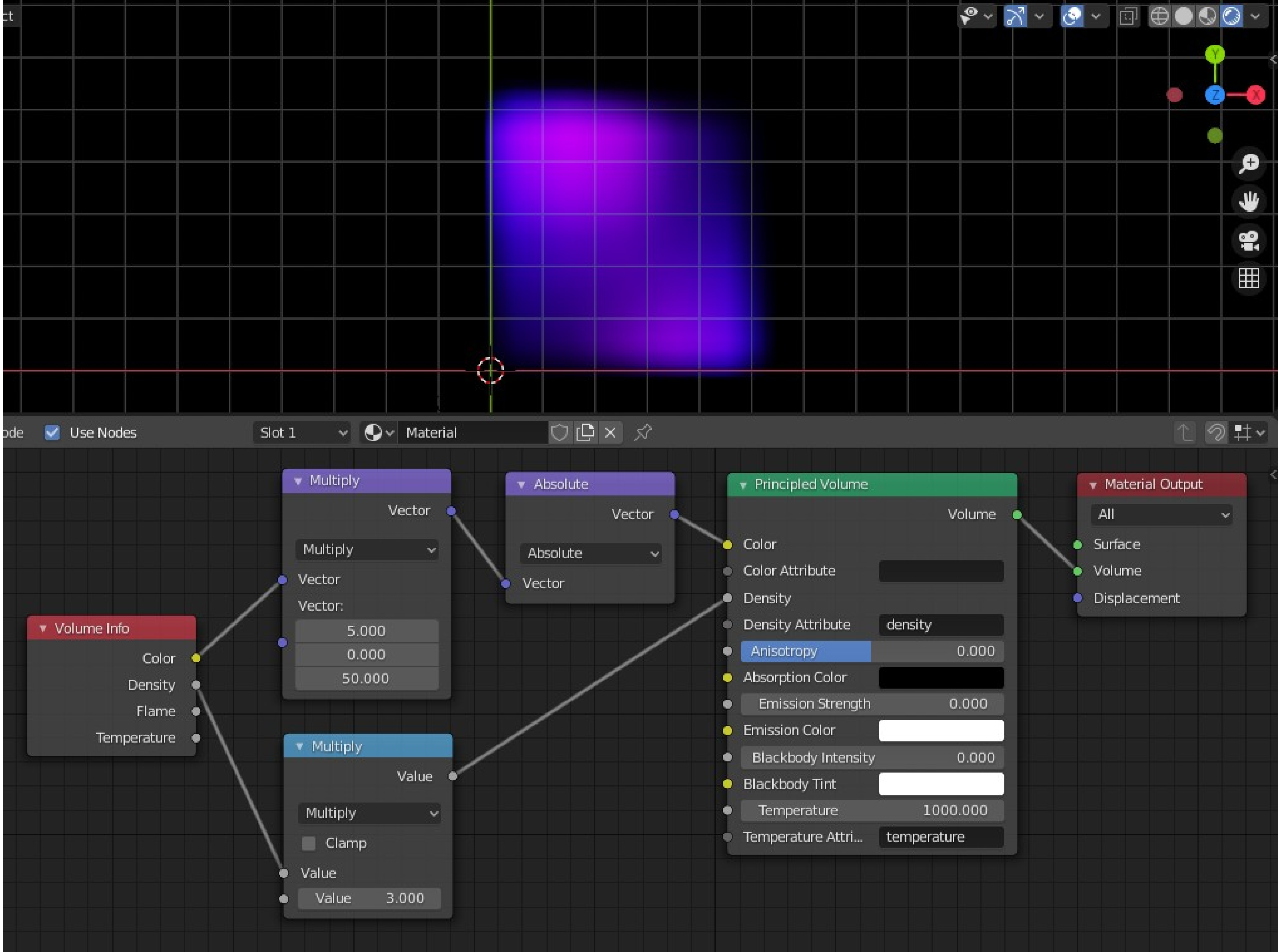








Volume Info
Color
Density
Flame
Temperature

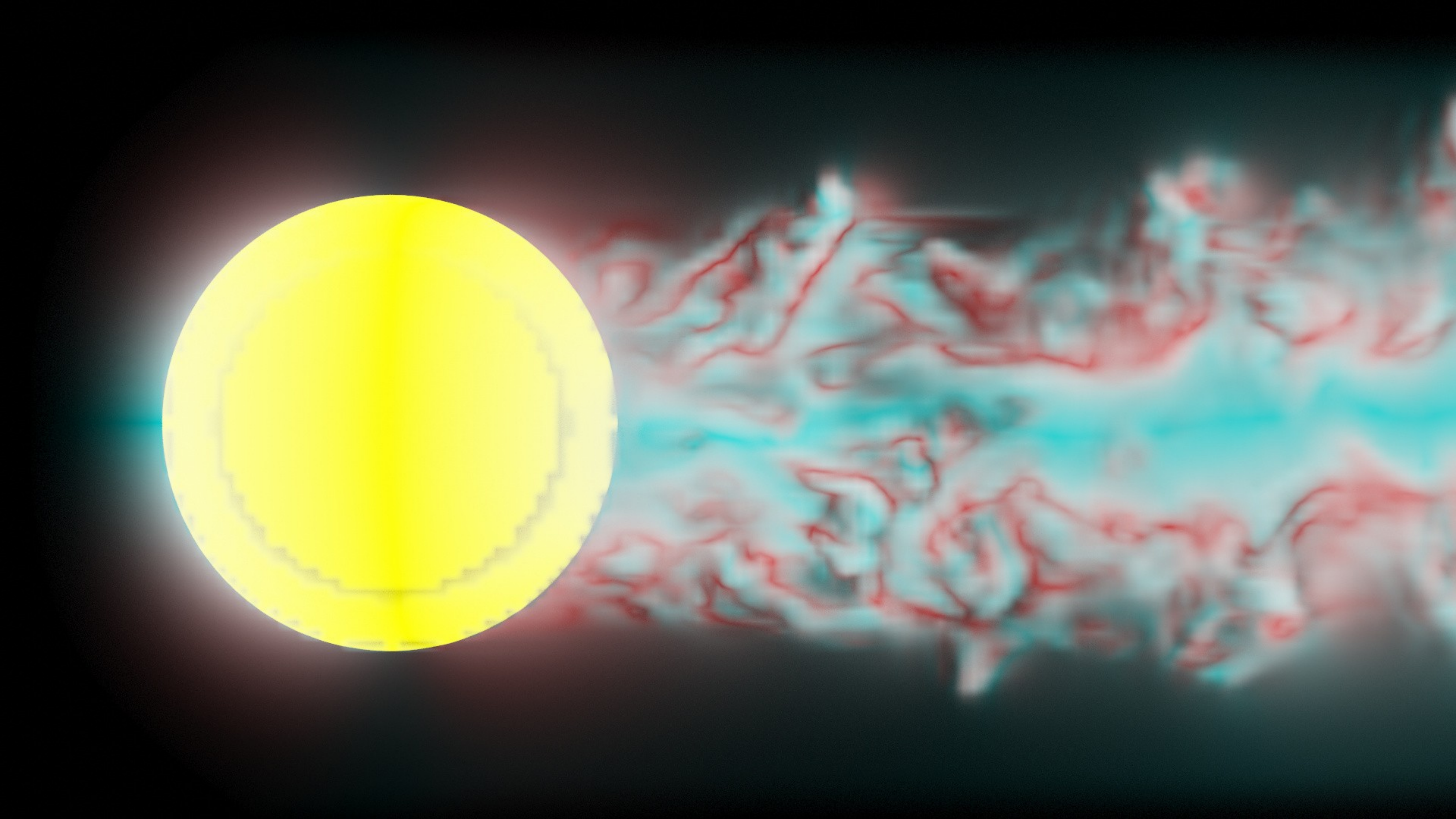
Multiply
Vector
Multiply
Vector
Vector:
5.000
0.000
50.000

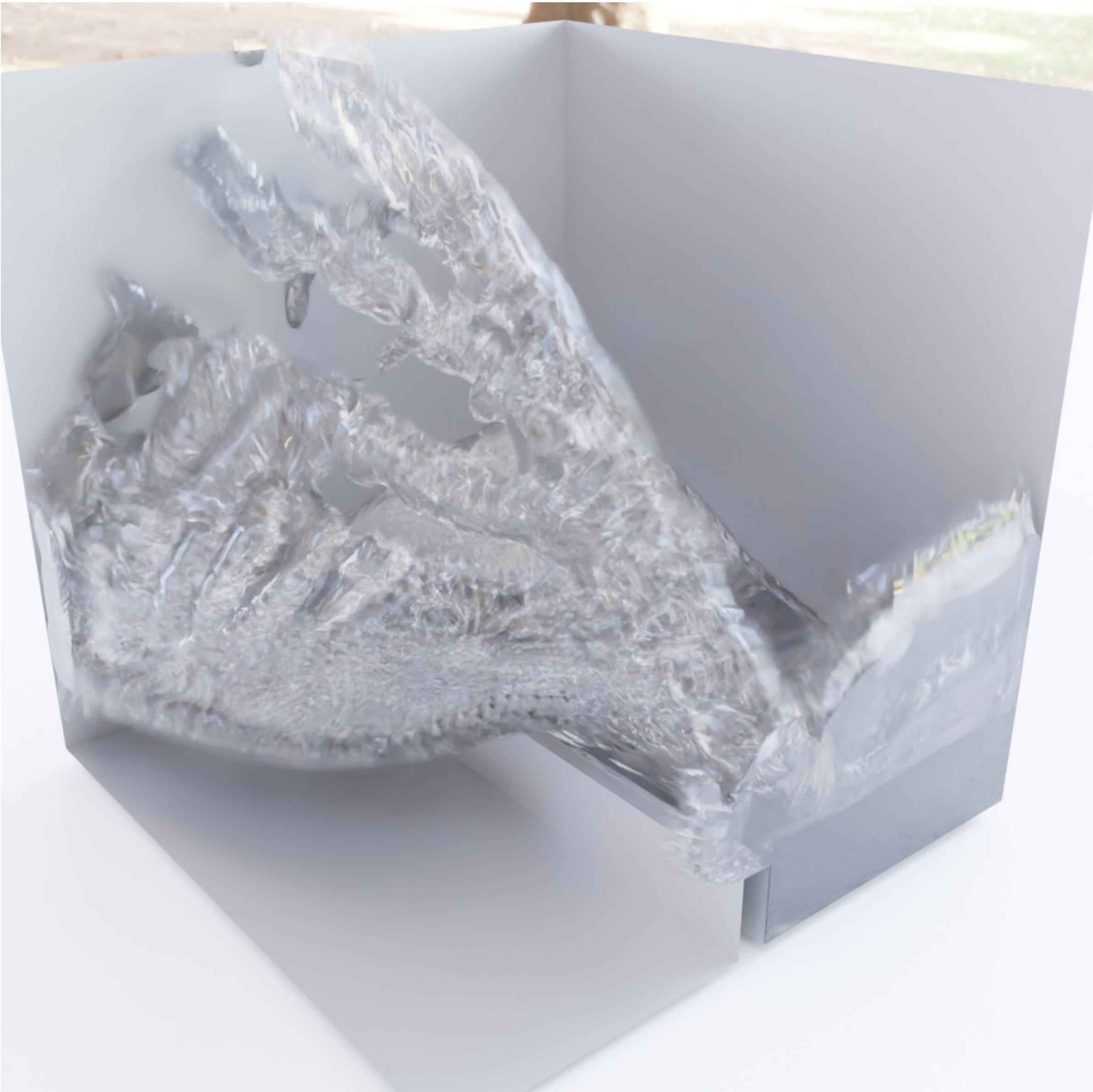
Multiply
Value
Multiply
Clamp
Value
Value 3.000

Absolute
Vector
Absolute
Vector

Principled Volume
Volume
Color
Color Attribute
Density
Density Attribute density
Anisotropy 0.000
Absorption Color
Emission Strength 0.000
Emission Color
Blackbody Intensity 0.000
Blackbody Tint
Temperature 1000.000
Temperature Attri... temperature

Material Output
All
Surface
Volume
Displacement





Links to videos

- Tutorial videos
- Blender mesh modelling time lapse
- BVTKNodes visualizations (from BVTKNodes gallery)
  - 3D dam break
  - Water wave – net interaction
  - Chute DEM simulation
  - Volumetric vortex visualization
  - 2D 4-phase dam break
  - Isosurface value animation