Post-processing and advanced visualisation

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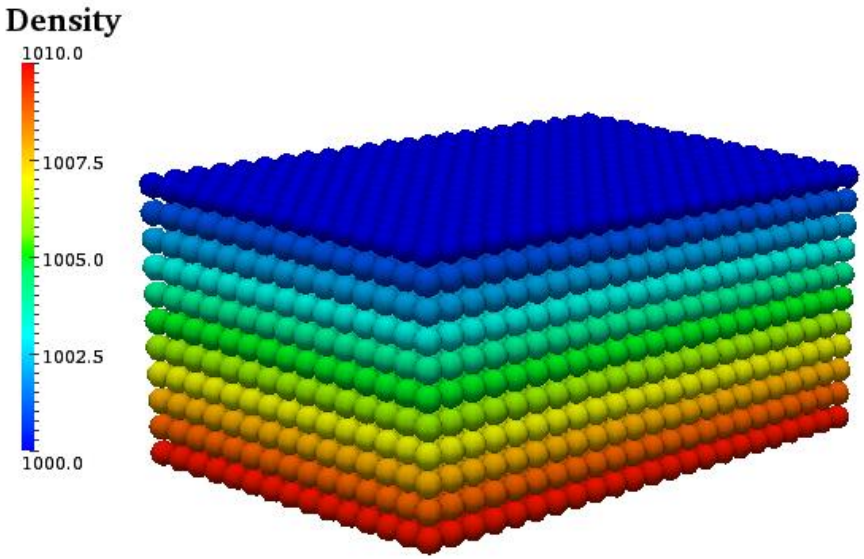
SPAIN

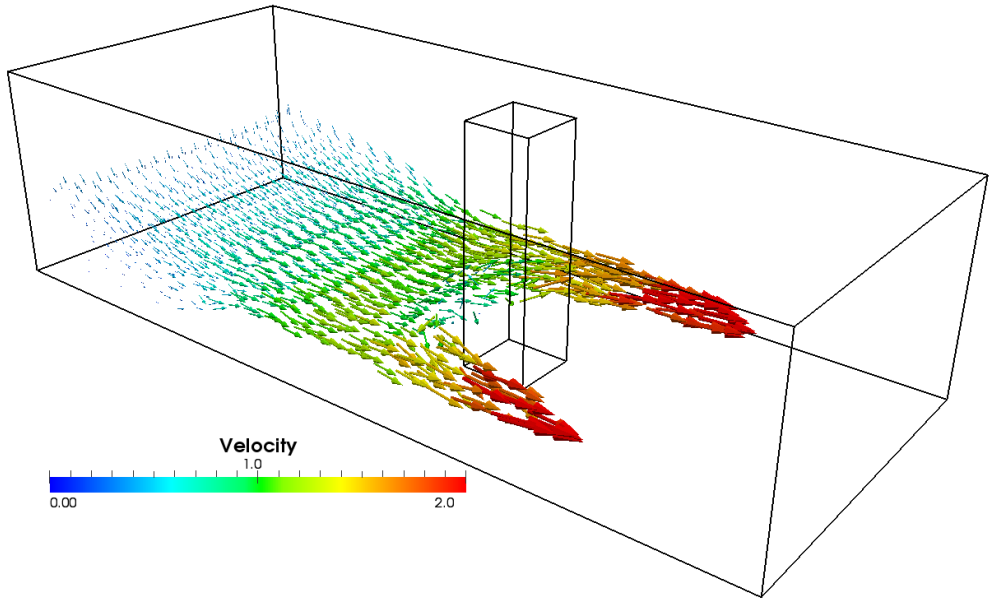
Outline of Presentation

- Post-processing tools
  - PartVTK, PartVTKOut
  - MeasureTool
  - BoundaryVTK, IsoSurface
  - ComputeForces, FloatingInfo
  - TracerVTK
  - MeasureBoxes
- VisualSPHysics

PartVTK

PartVTK is used to convert the binary output from DualSPHysics into different formats (mainly VTK, but also CSV, ASCII…) with the selected magnitudes.



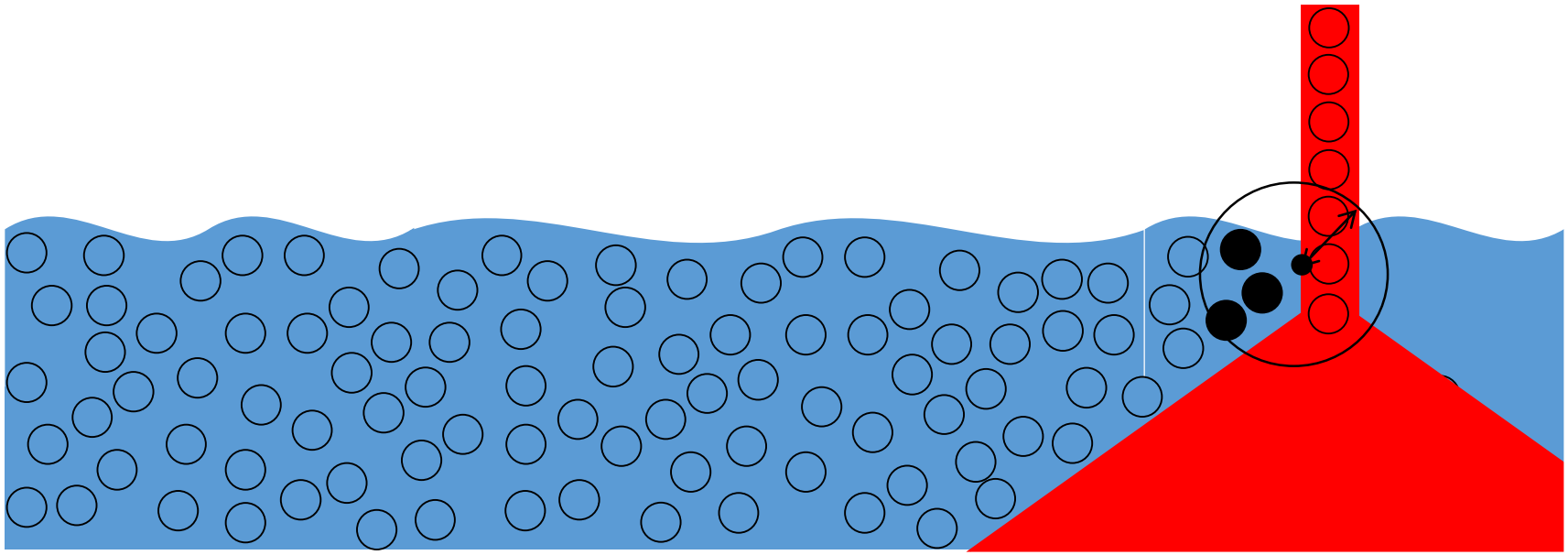


HOW TO NUMERICALLY COMPUTE PRESSURE

DualSPHysics

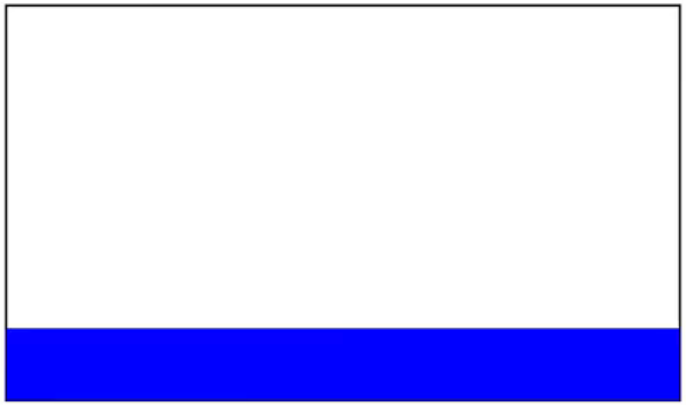
1) For a given location
2) We compute numerical PRESSURE
   using PRESSURE values of neighbouring fluid particles

$$\boldsymbol{P}_a = \frac{\sum_b \boldsymbol{P}_b W_{ab}}{\sum_b W_{ab}}$$

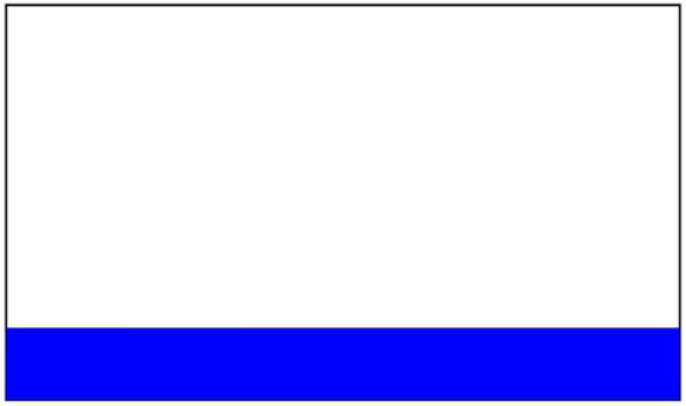


MeasureTool

Compute Pressure in CASESLOSHING



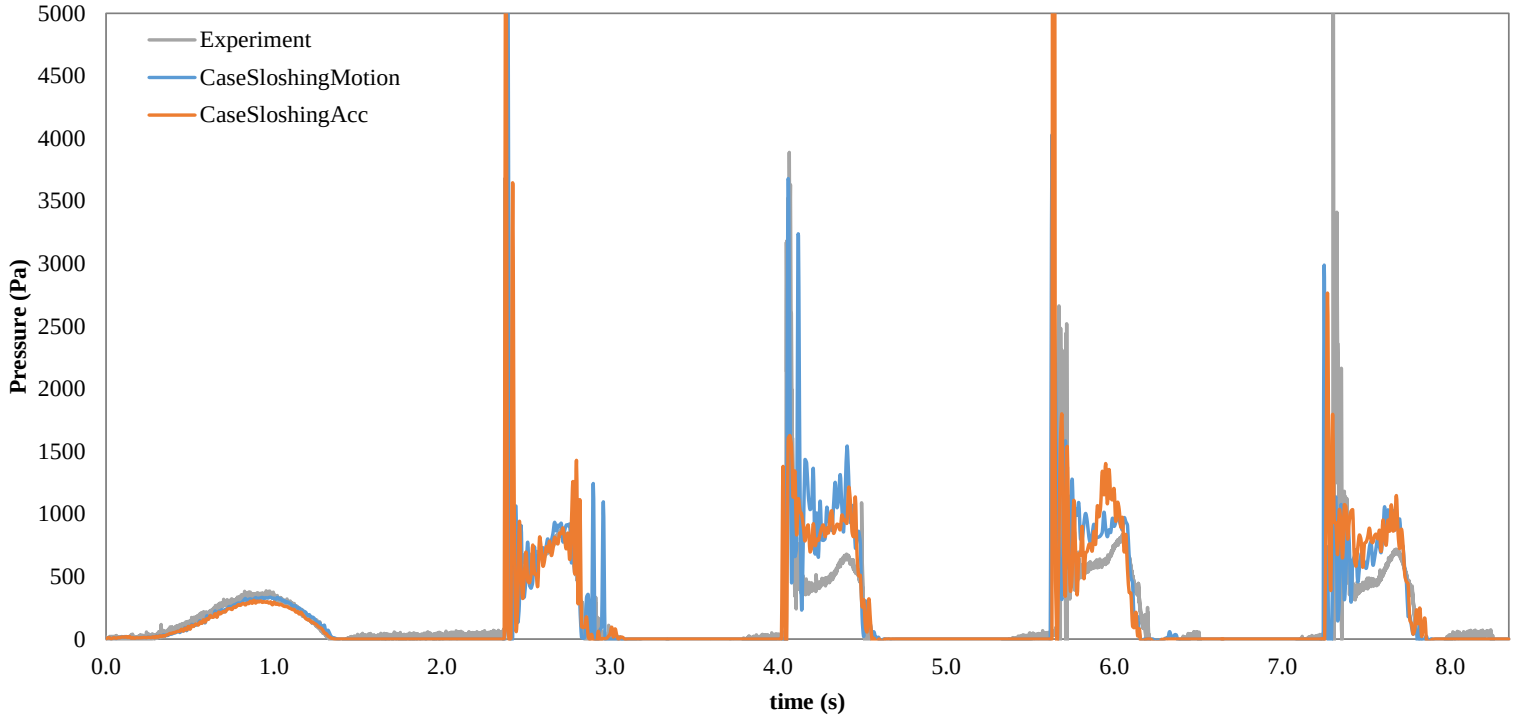
Time: 0 s



Post-processing

MeasureTool

Compute Pressure in CASESLOSHING



MeasureTool

COMPUTING PRESSURE IS A BAD IDEA

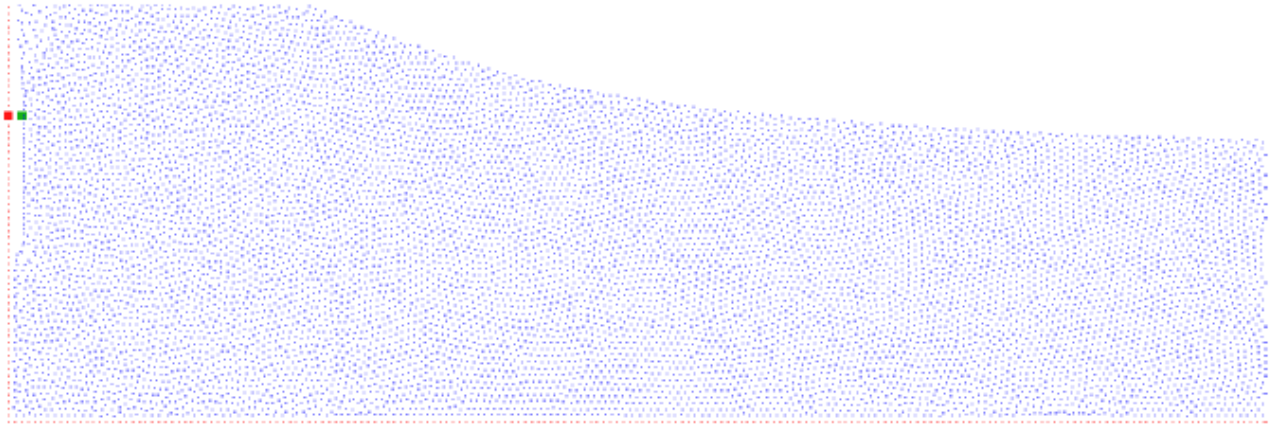
DBC=> GAP BOUNDARY-FLUID (1.5*h)

DBC=> UNPHYSICAL VALUES OF PRESSURE IN THE BOUNDARIES

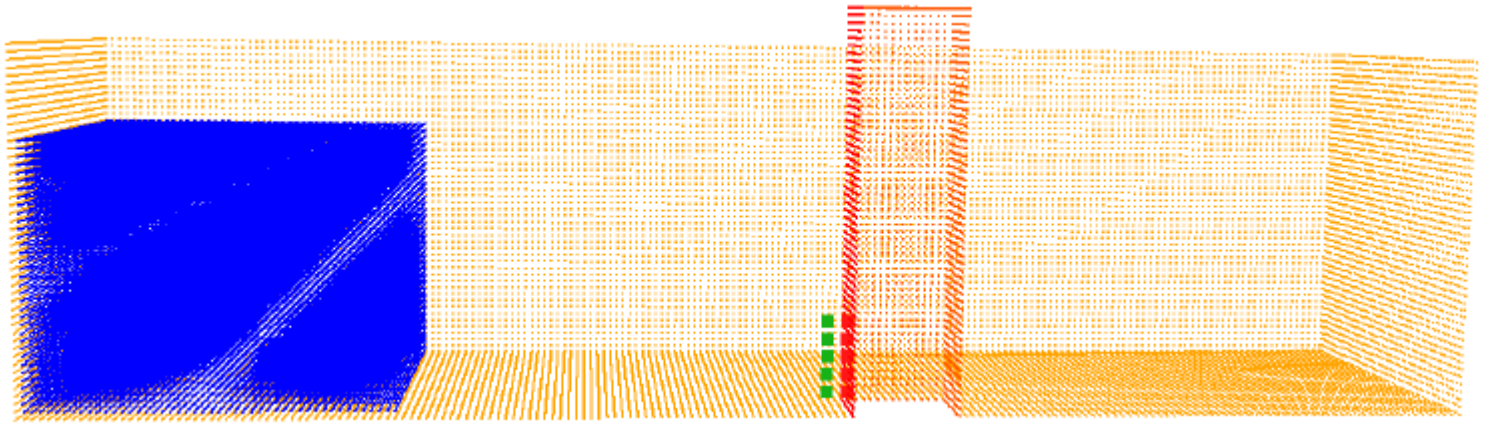
Post-processing

MeasureTool

CASESLOSHING



CASEDAMBREAK



Post-processing

MeasureTool

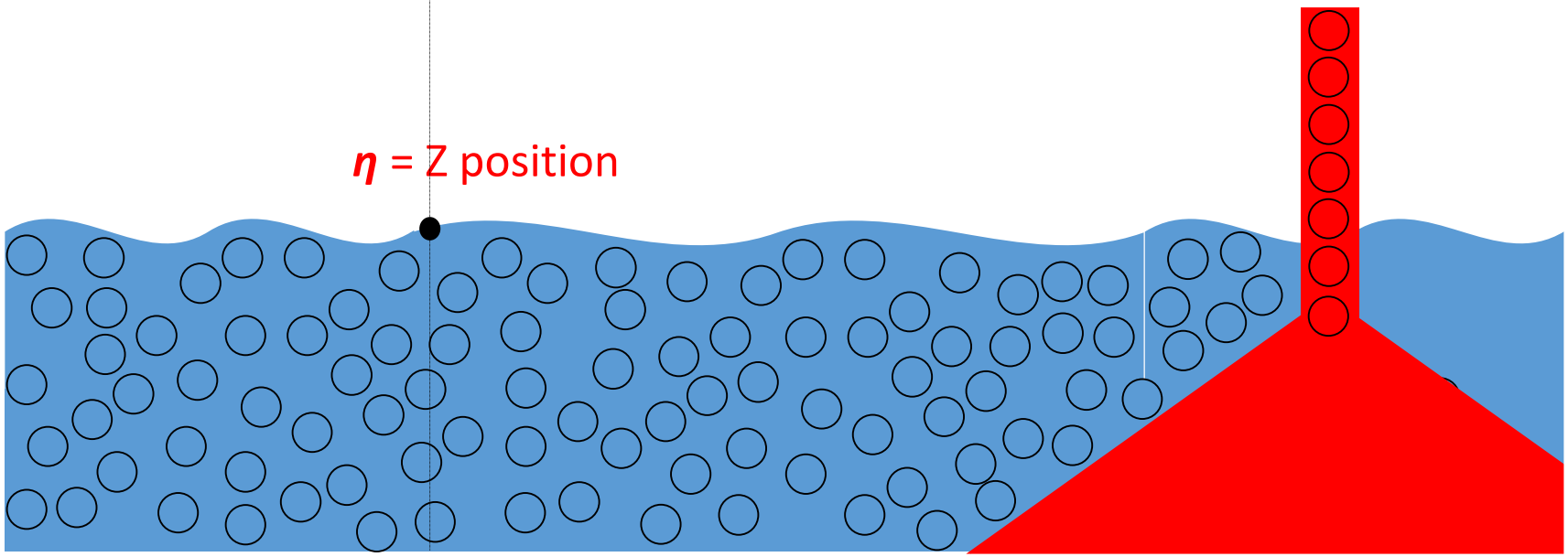
Compute free-surface elevation in CASEWAVEGENERATION

HOW TO NUMERICALLY COMPUTE FREE-SURFACE ELEVATION

1) For a given (X,Y) position
2) We compute numerical MASS at different Z positions using MASS values of neighbouring fluid particles

$$\boldsymbol{m}_a = \sum_b \boldsymbol{m}_b W_{ab}$$

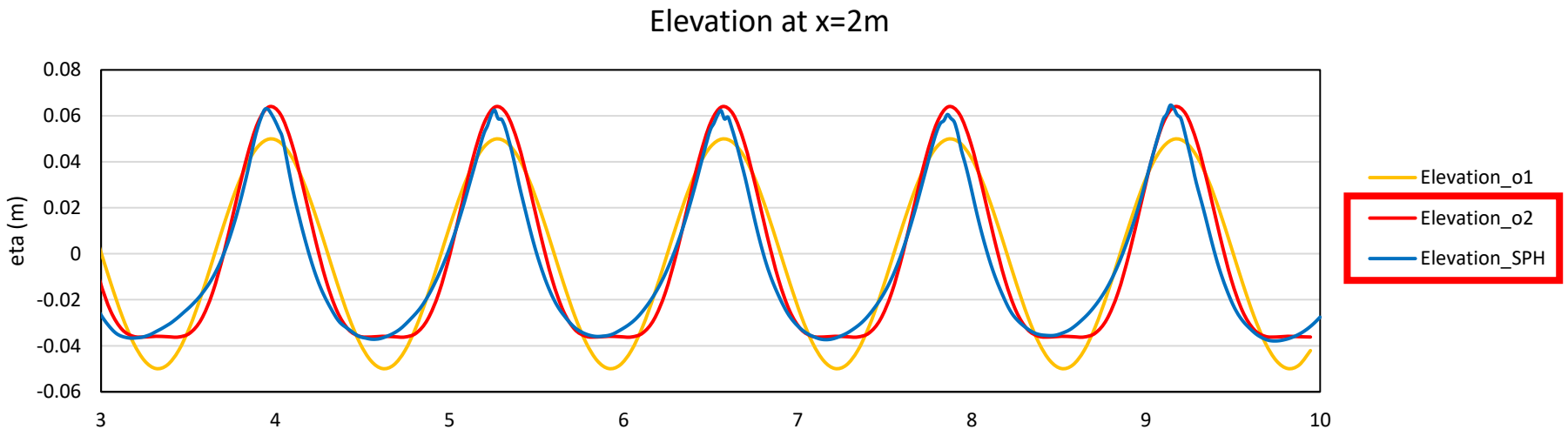
3) We will choose as wave elevation: the Z value for which $\boldsymbol{m}=0.5*\boldsymbol{m}_{reference}$



Post-processing

MeasureTool

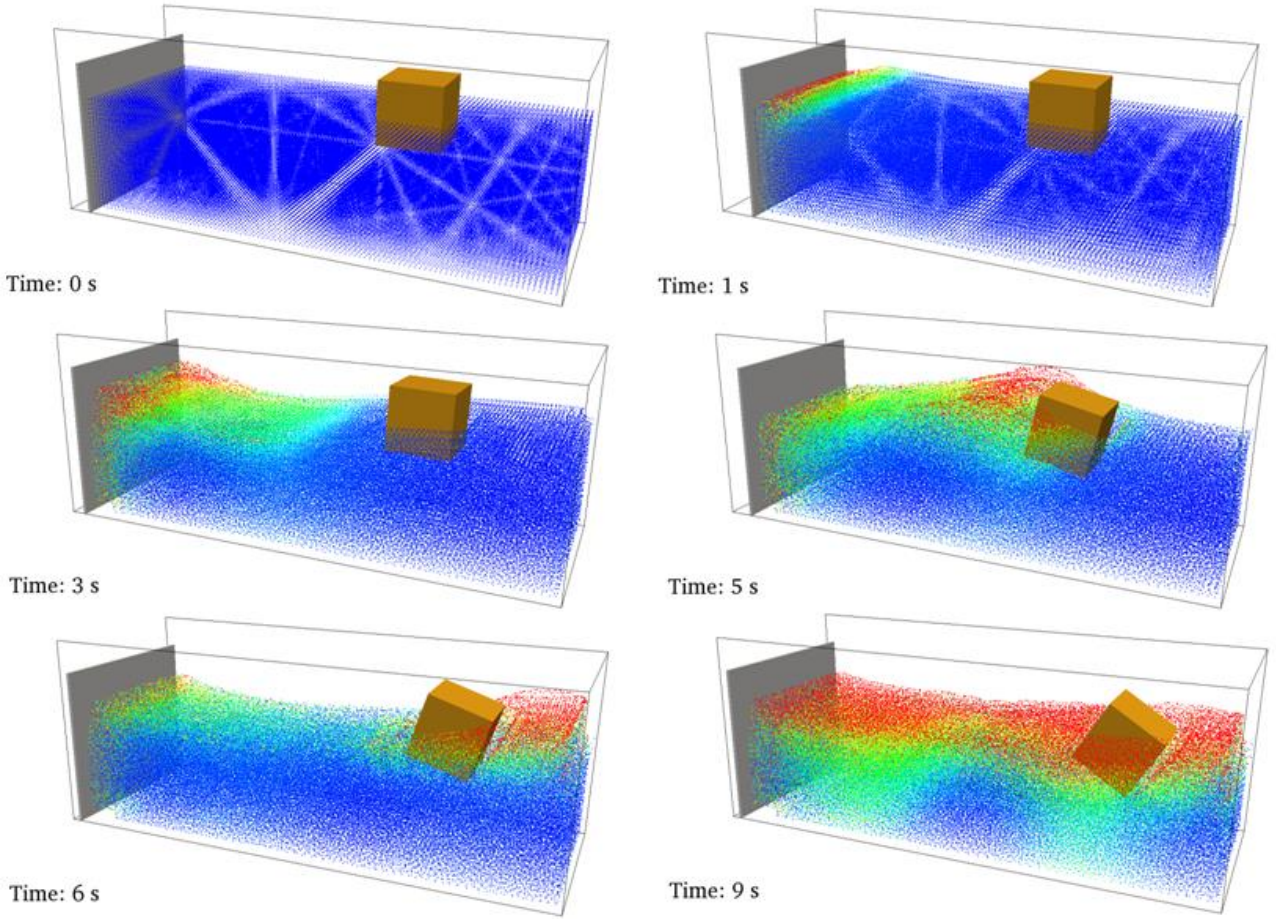
Compute free-surface elevation in CASEWAVEGENERATION



BoundaryVTK

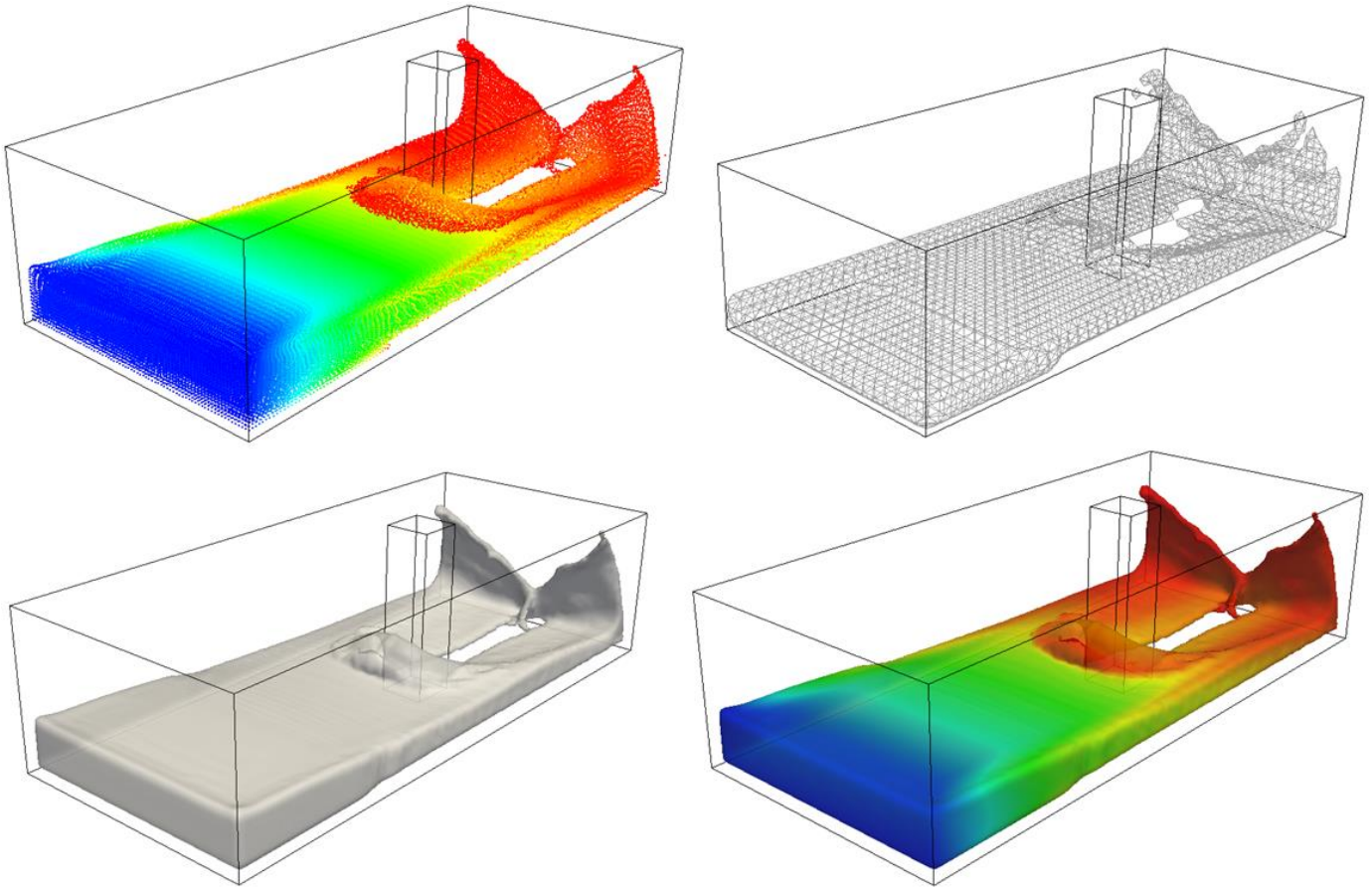
CASEFLOATING

BoundaryVTK generates files that represent the movement of the different boundaries particles (moving and floating objects).



IsoSurface

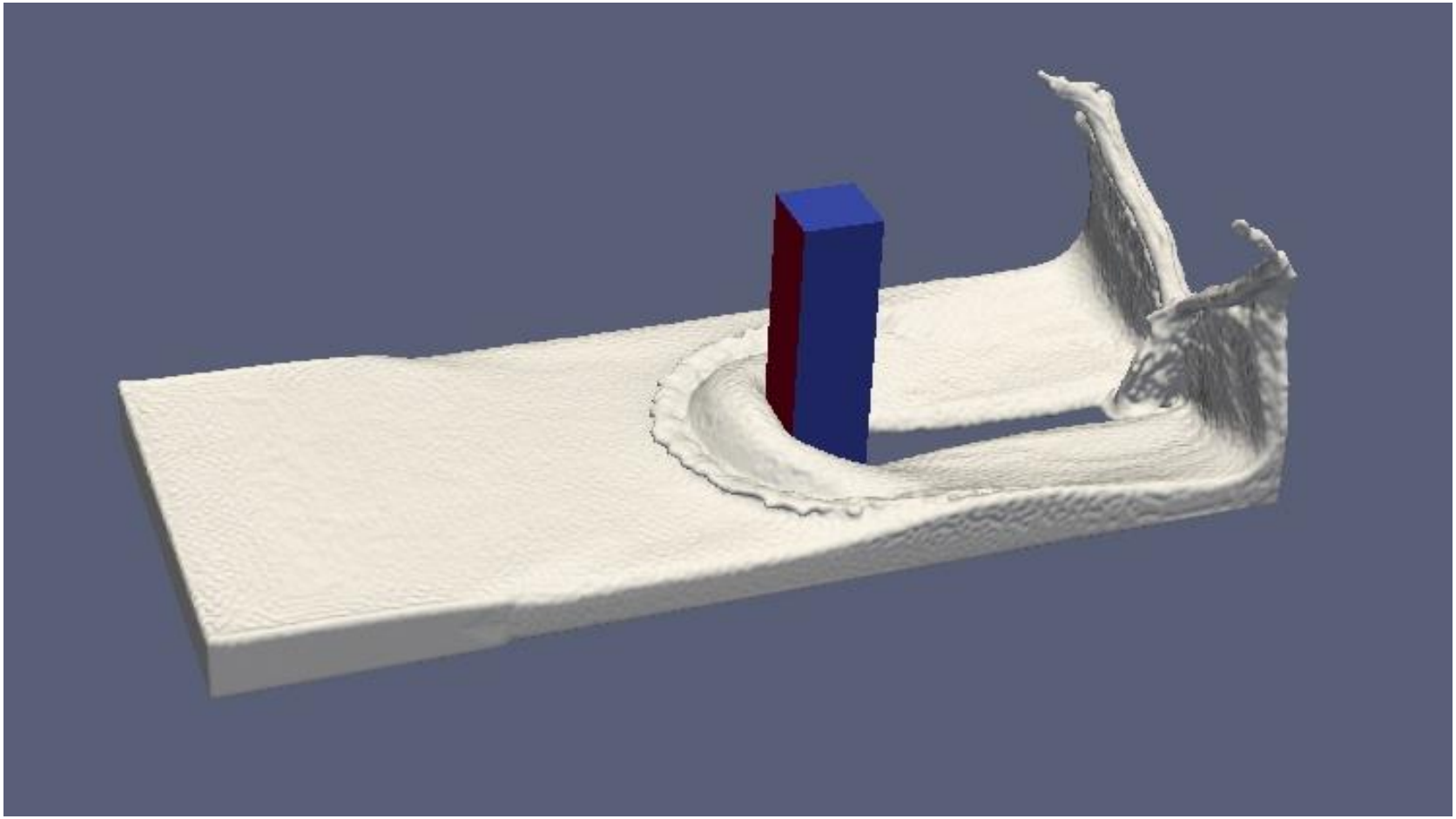
This tool **generates** the **isosurface** of the fluid to improve the visualization.



When the number of particles grow to large numbers the single particle visualization is no longer a choice.

IsoSurface

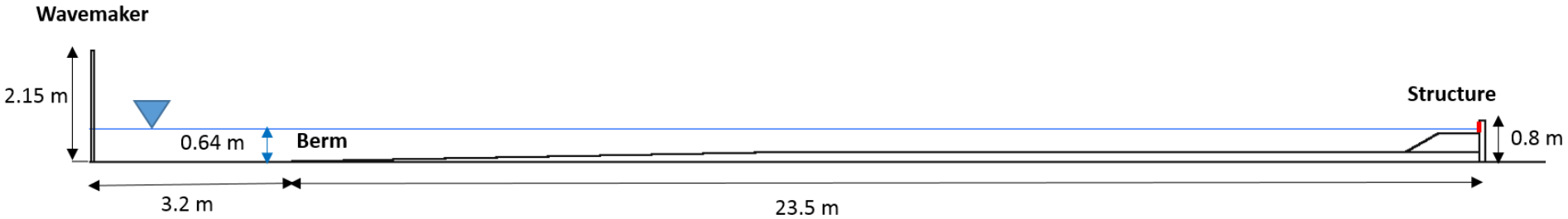
This tool **generates** the **isosurface** of the fluid to improve the visualization.

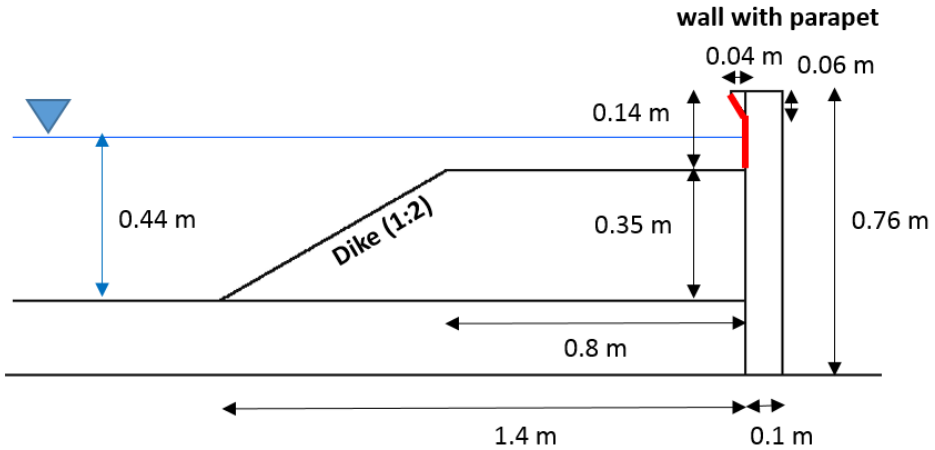


Post-processing

COMPUTING PRESSURE IS A BAD IDEA
COMPUTING FORCE IS BRILLIANT

ComputeForces





EXERTED ON A FIXED VERTICAL WALL

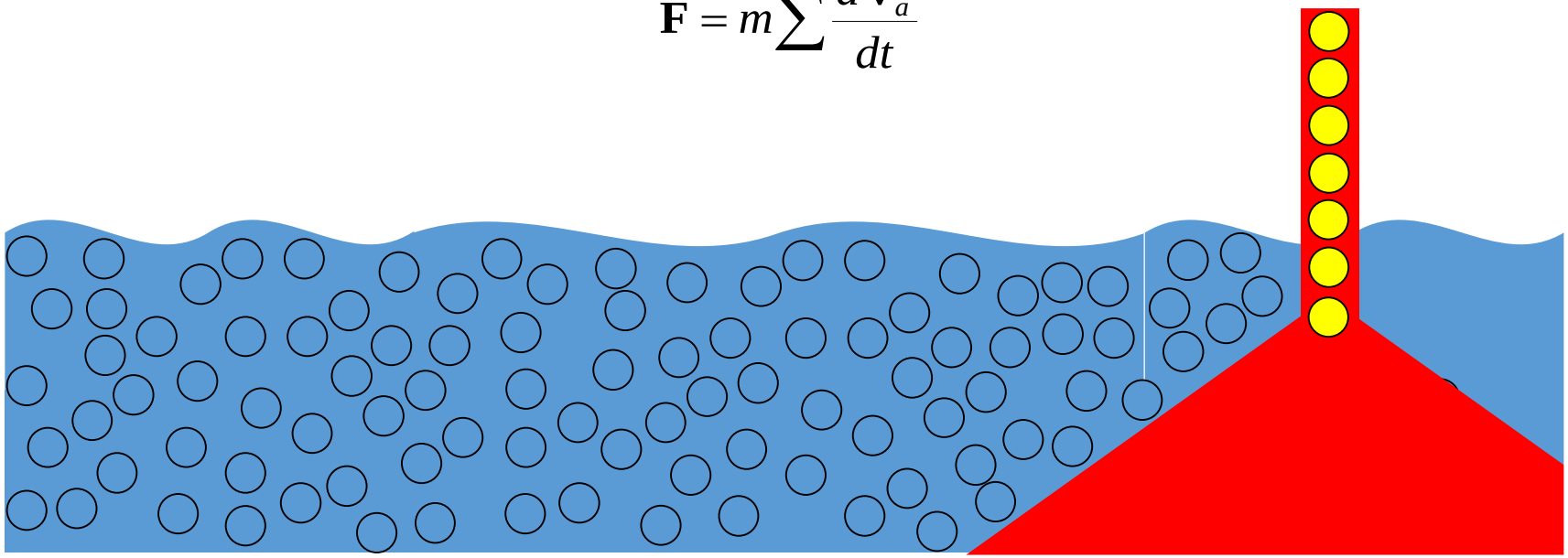
HOW TO NUMERICALLY COMPUTE FORCES

1) For a range of boundary particles
2) We compute numerical ACCELERATION of those boundary particles solving the particle interactions with fluid neighbouring particles

$$\frac{d\mathbf{v}_a}{dt} = -\sum_b m_b \left(\frac{P_b}{\rho_b^2} + \frac{P_a}{\rho_a^2} + \Pi_{ab} \right) \nabla_a W_{ab} + \mathbf{g}$$

3) We do the summation of ACCELERATION values of those boundary particles

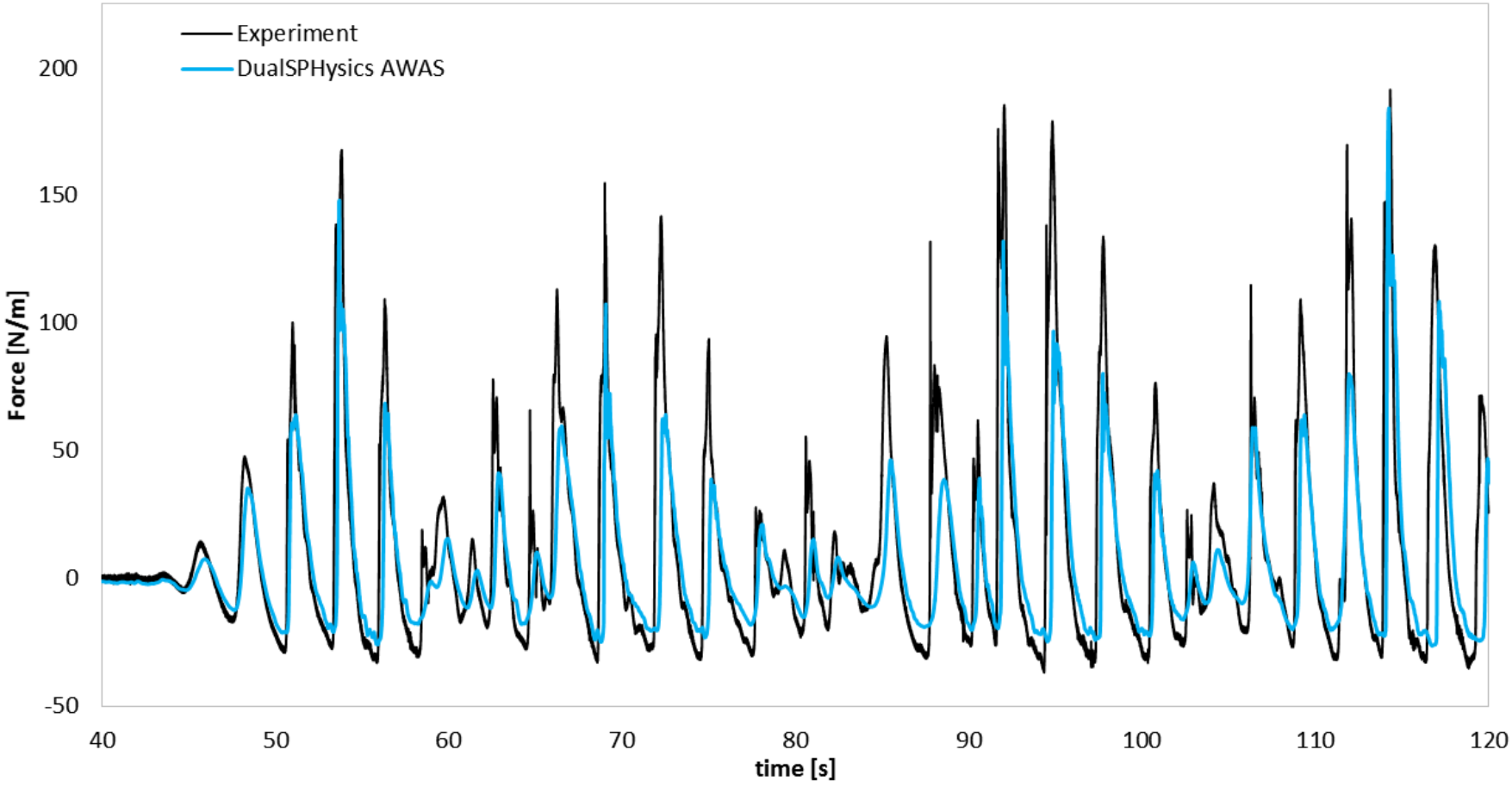
$$\mathbf{F} = m \sum \frac{d\mathbf{v}_a}{dt}$$



Post-processing

ComputeForces

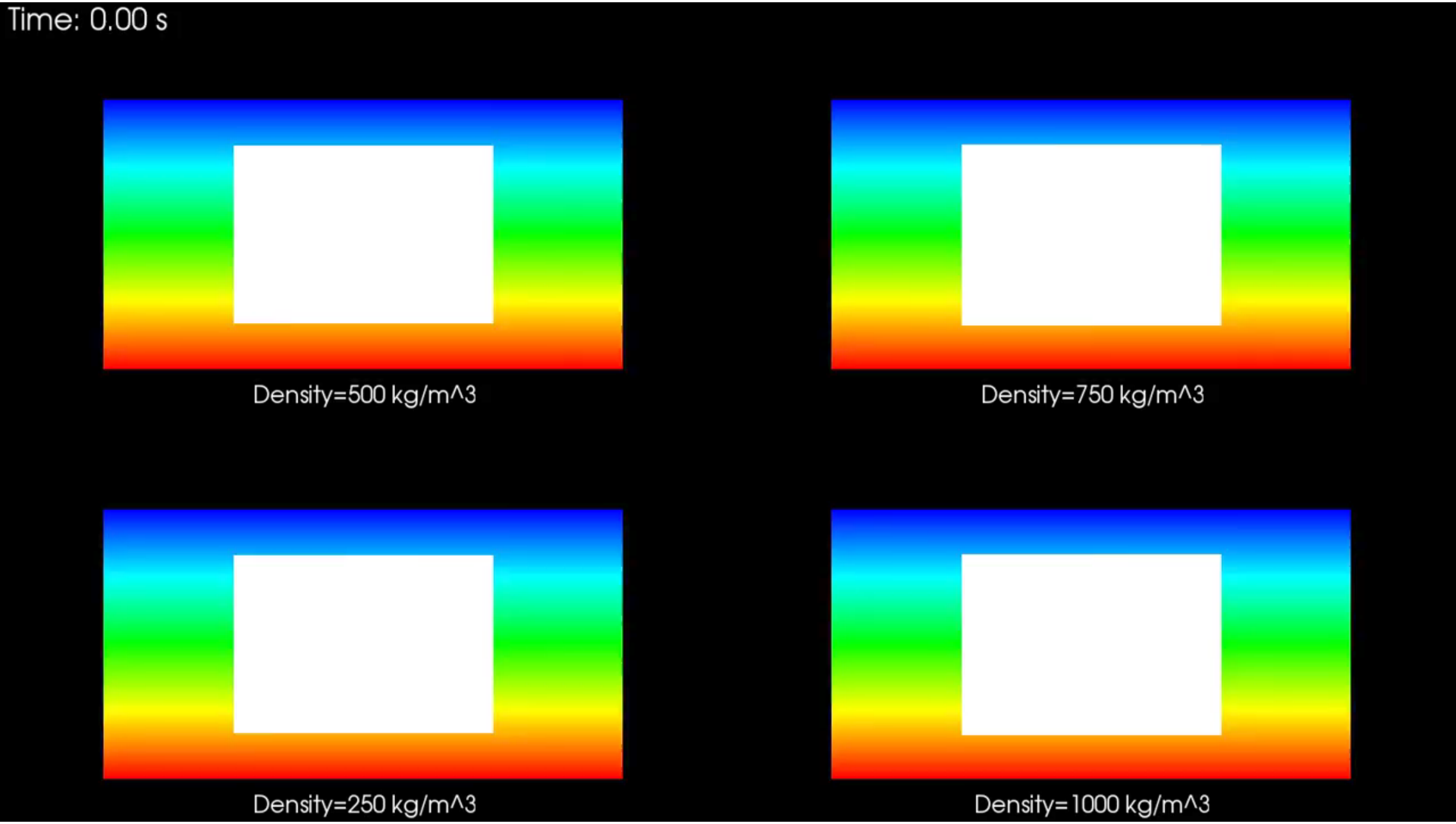
EXERTED ON A FIXED VERTICAL WALL



Post-processing

ComputeForces

EXPERIENCED BY FLOATINGS

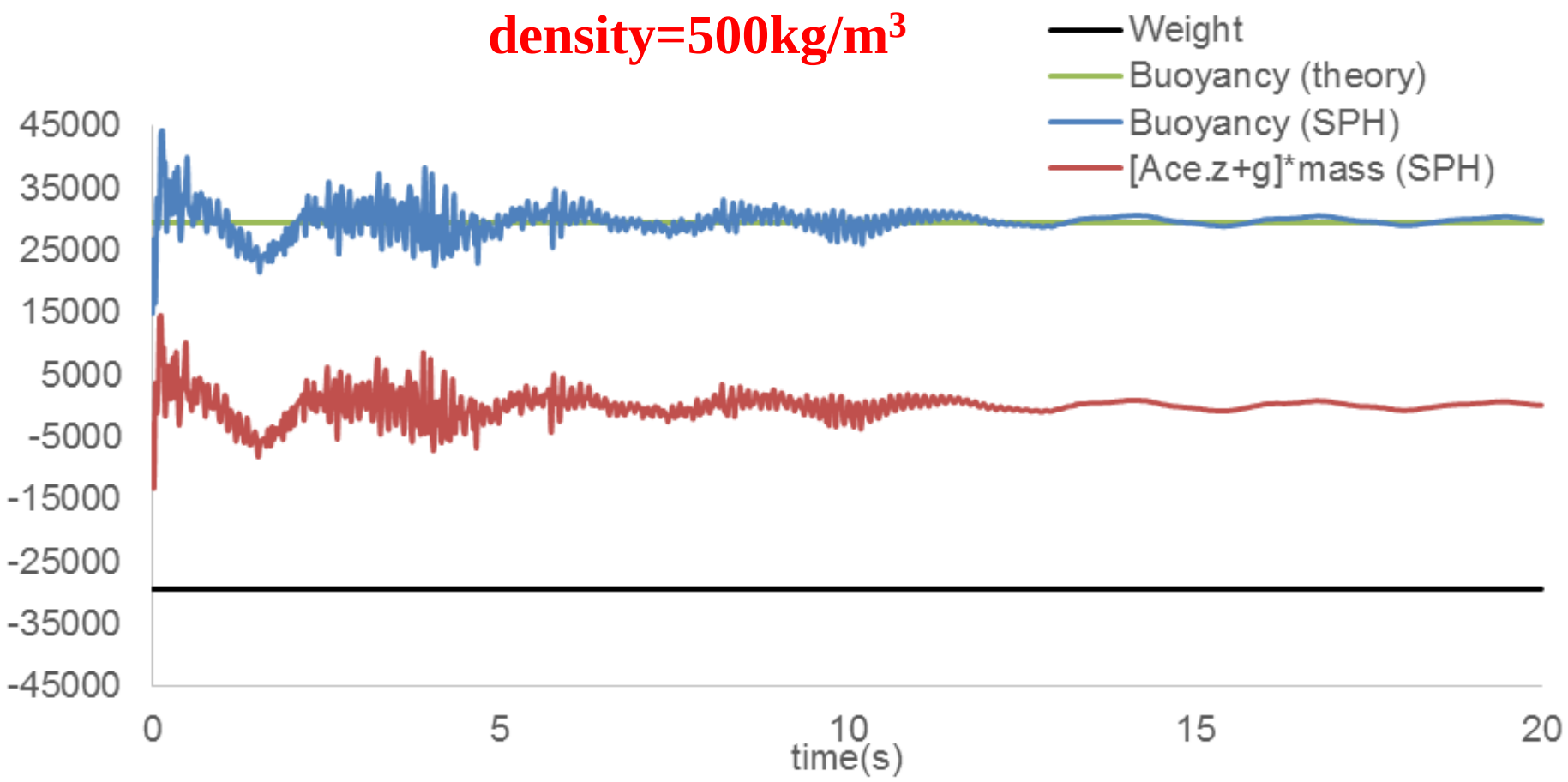


Post-processing

ComputeForces

EXPERIENCED BY FLOATINGS

density=500kg/m^3



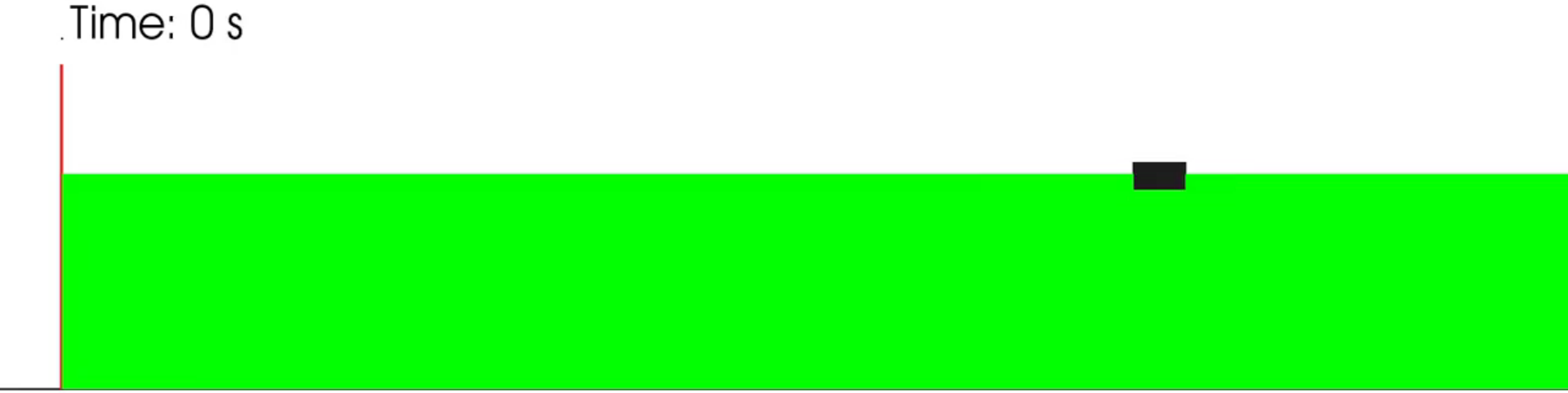
Post-processing

FloatingInfo

3D motions: **heave, surge and sway**
3D rotations: **roll, pitch and yaw**

CASEFLOATINGWAVESVAL

2D motions: **heave, surge**
2D rotations: **roll**

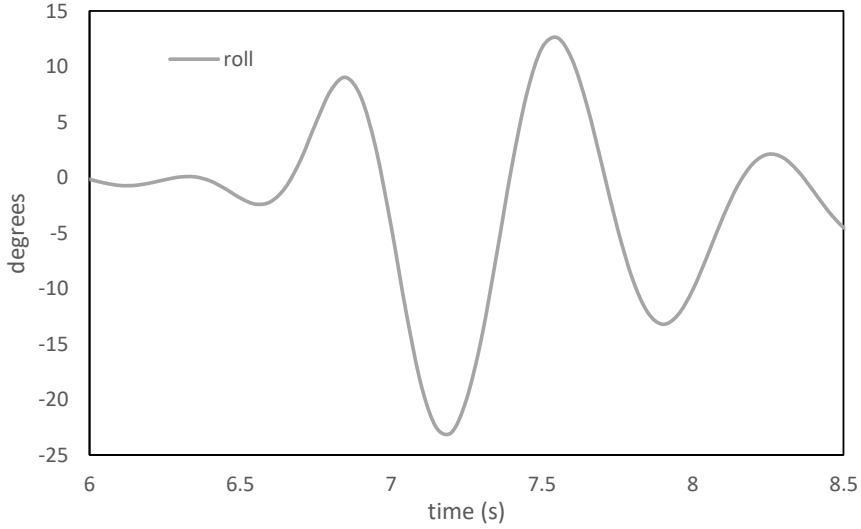


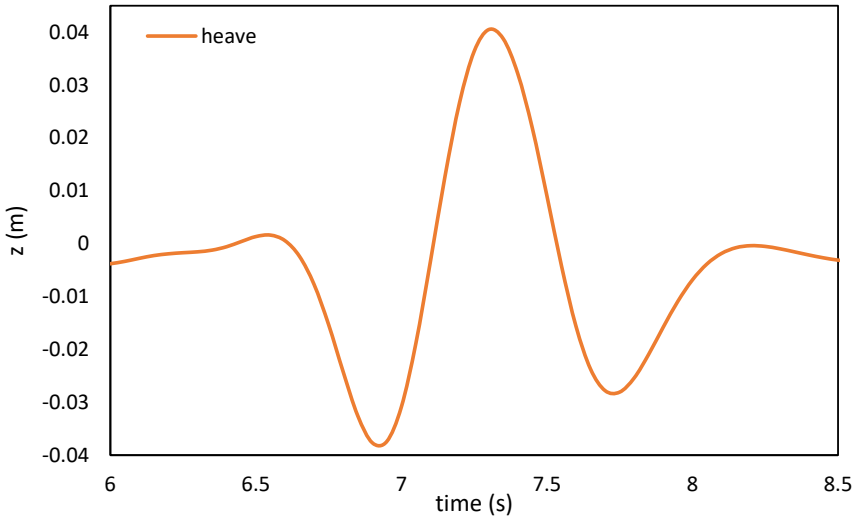
Post-processing

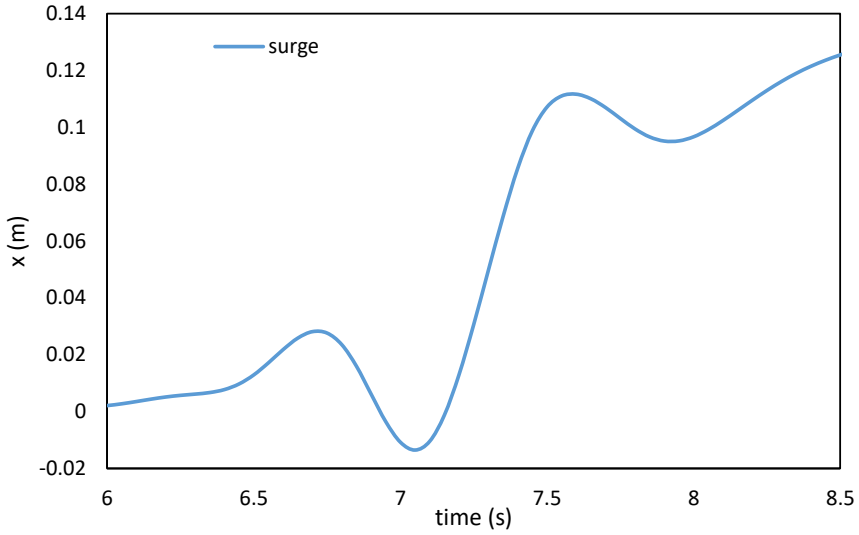
FloatingInfo

CASEFLOATINGWAVESVAL

2D motions: **heave, surge**
2D rotations: **roll**

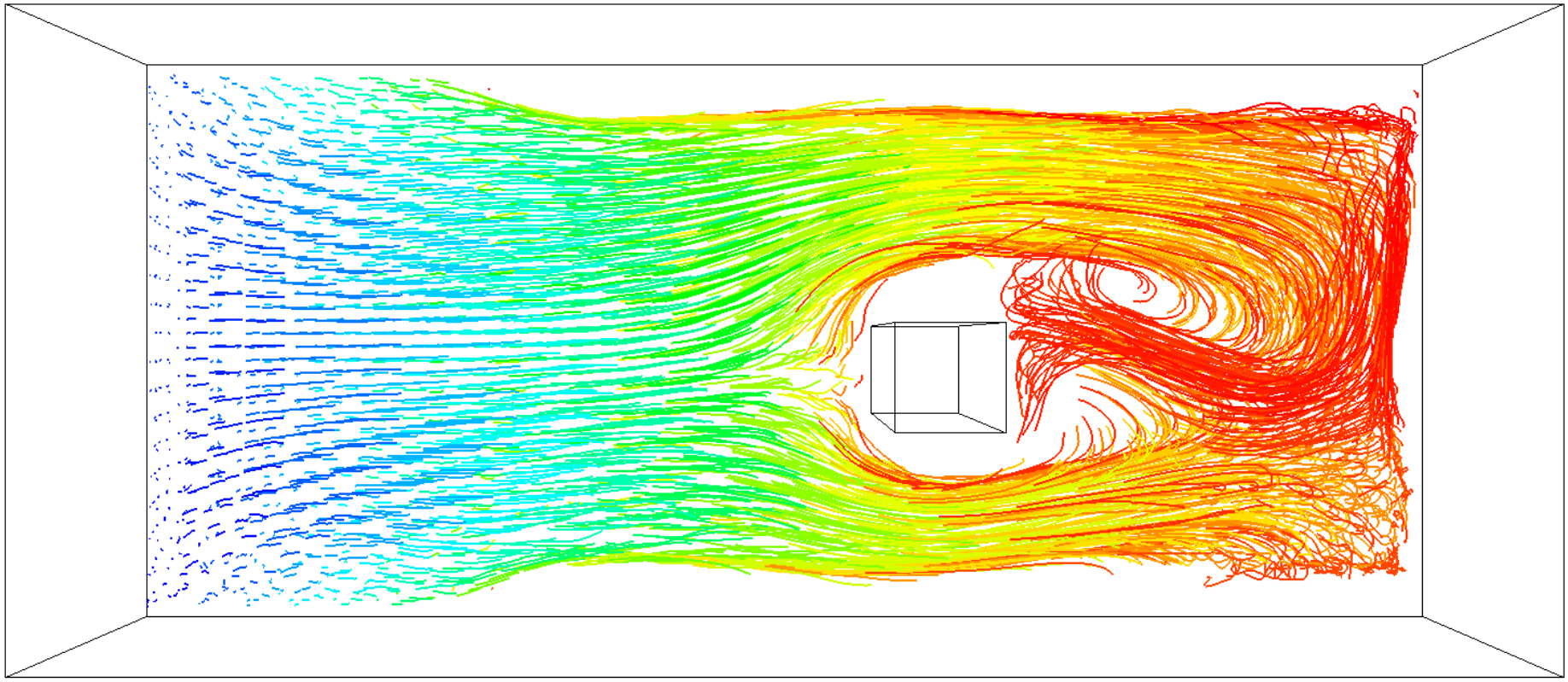






TracerVTK

This tool plots the trajectory of a set of selected particles to show clearly how these particles have moved in very complex geometries.



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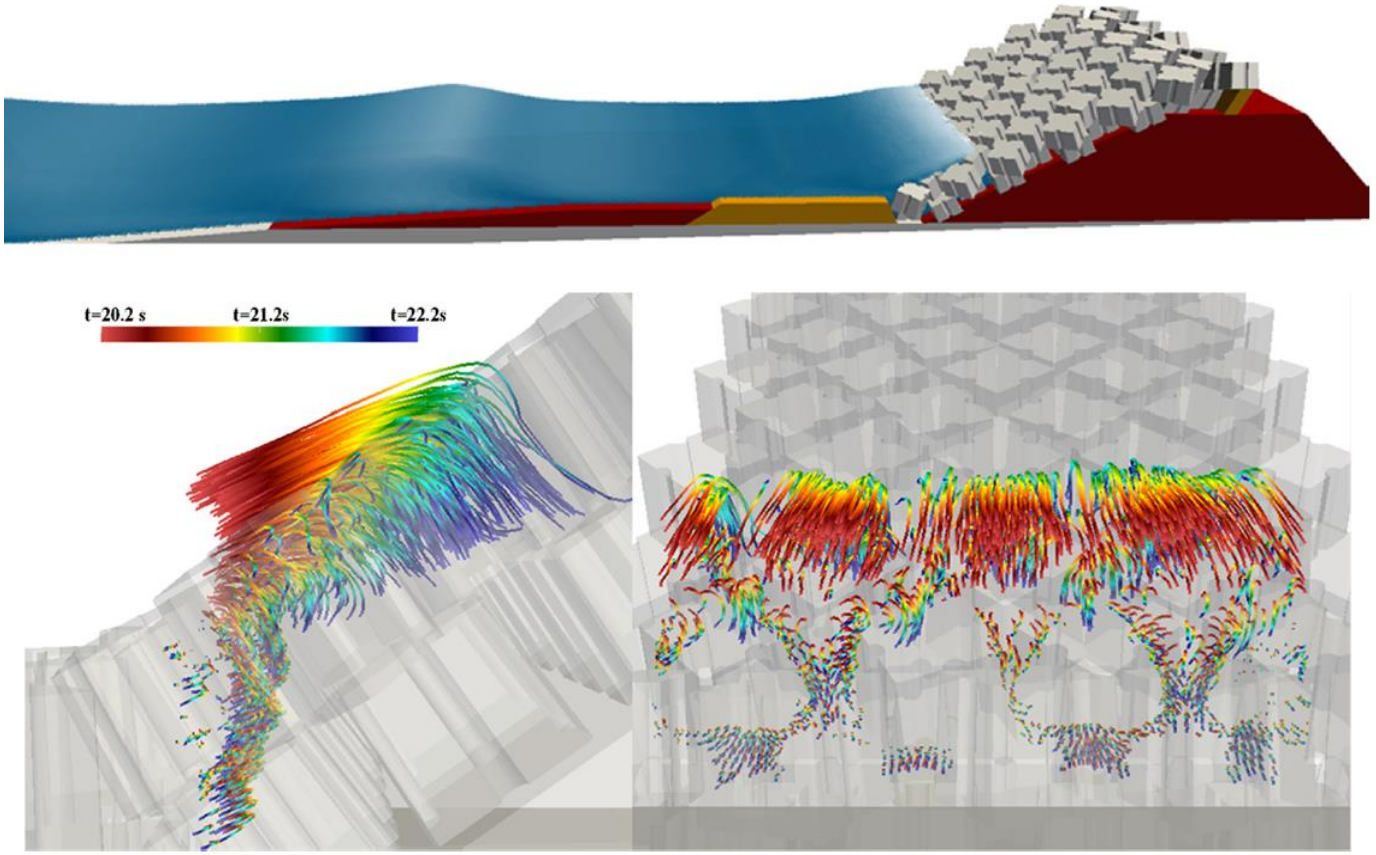
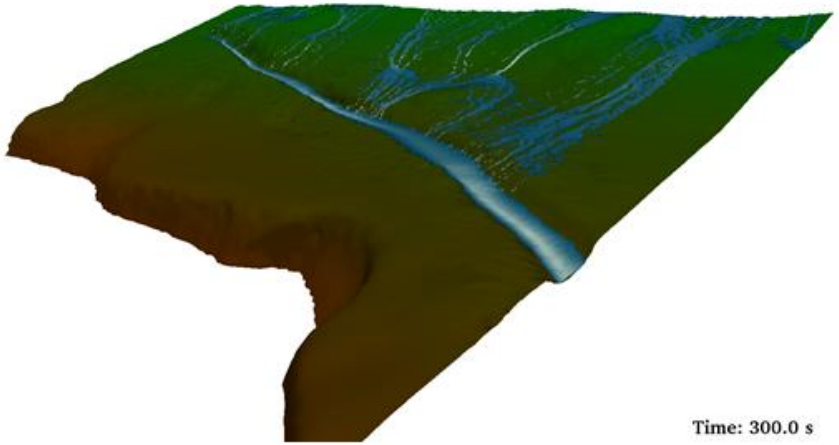


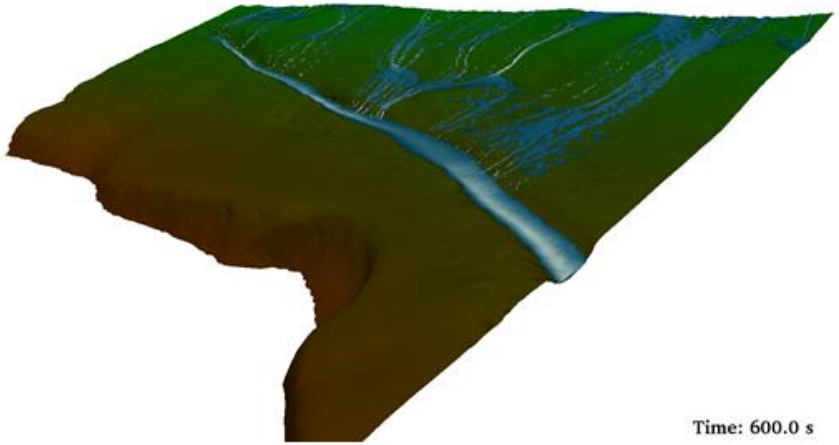
MeasureBoxes

This program calculates the volume and velocity of fluid in any volume of the simulation. The volume can be defined by triangles.

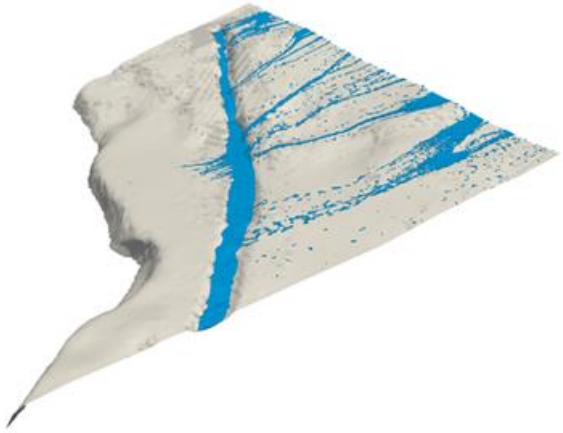
It calculates the amount of fluid that enters or leaves any of the defined volumes.

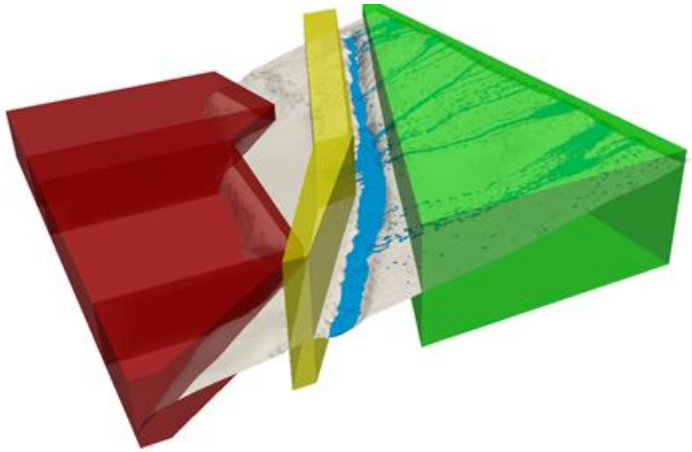


Time: 300.0 s



Time: 600.0 s





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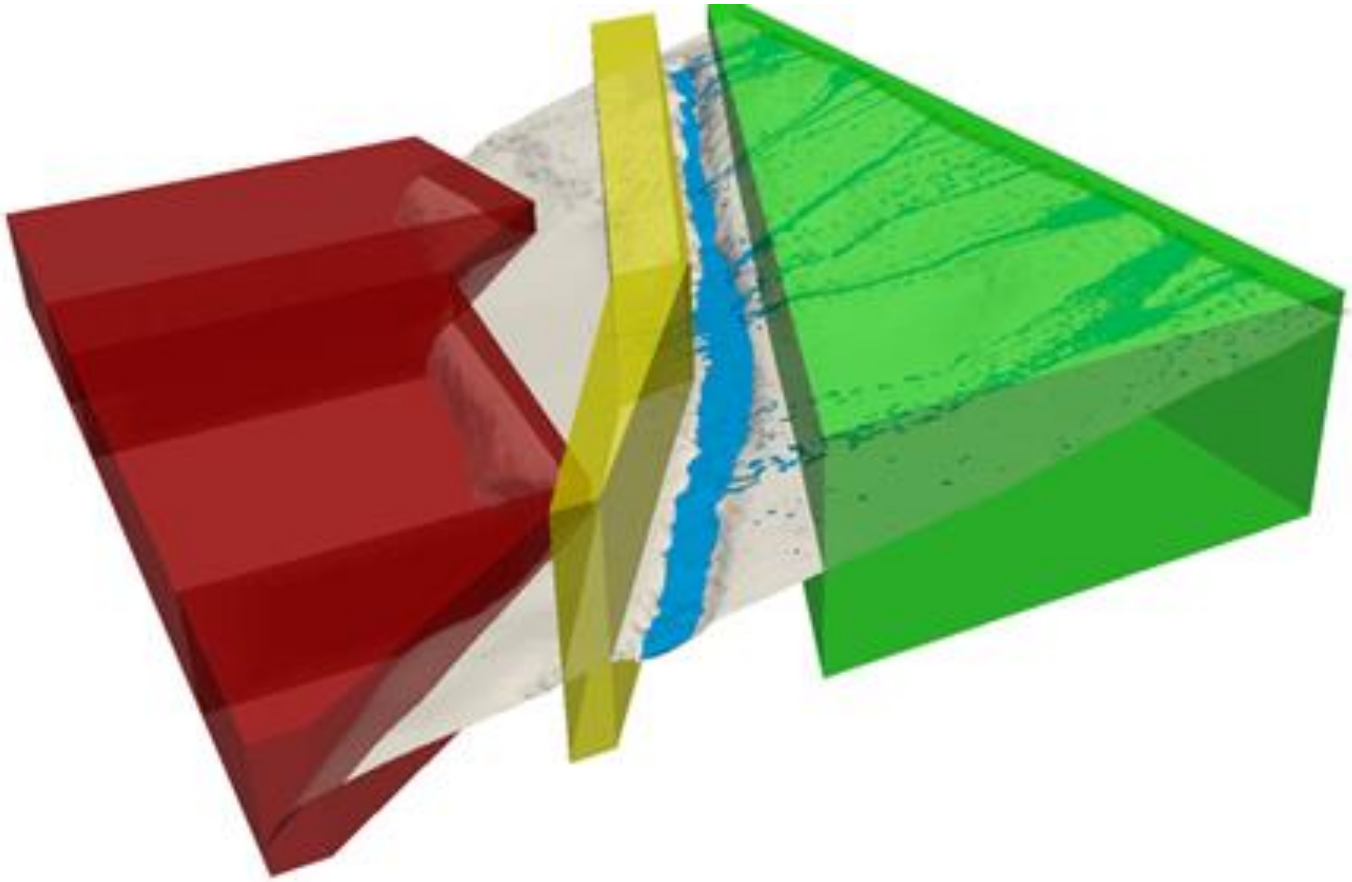

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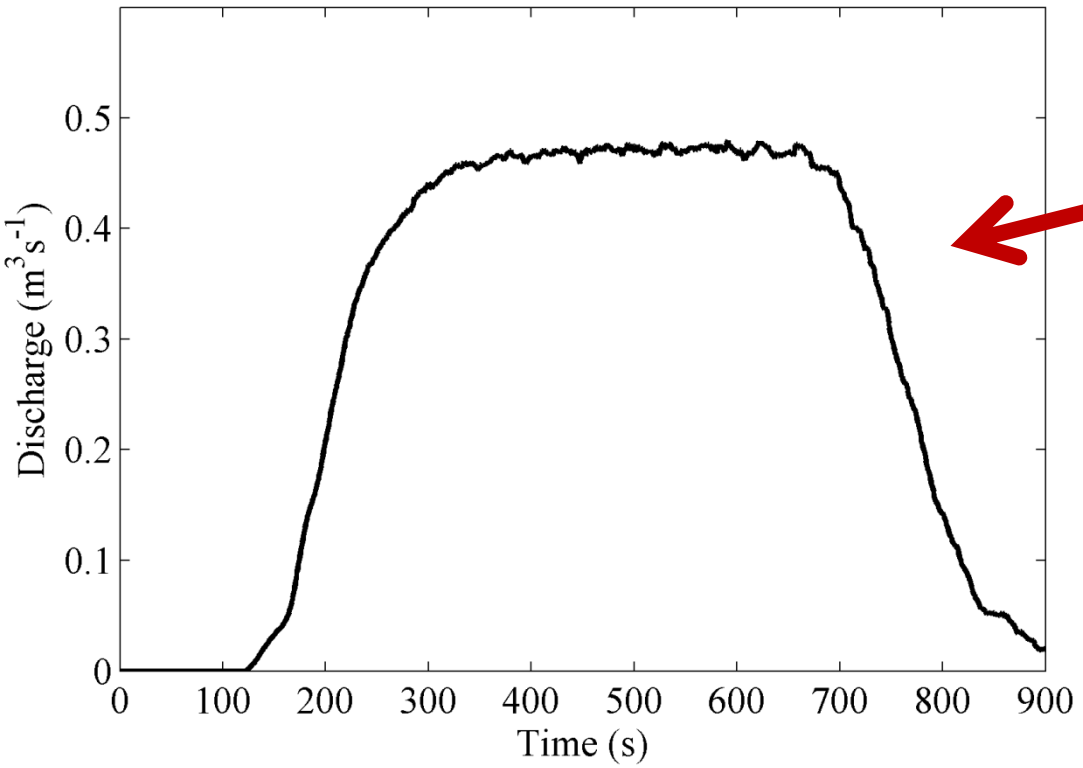
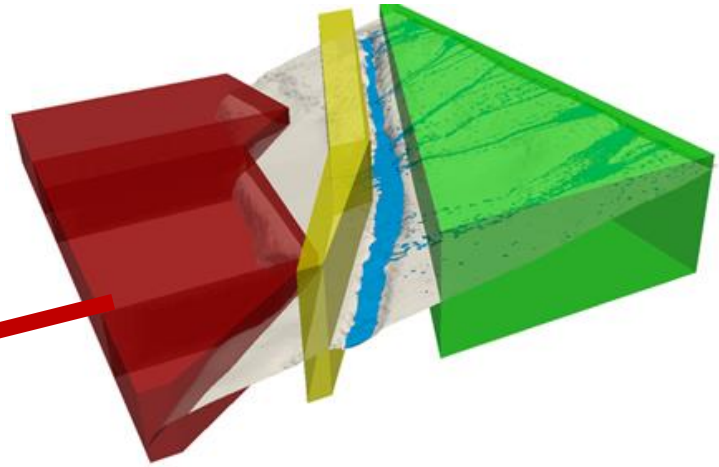
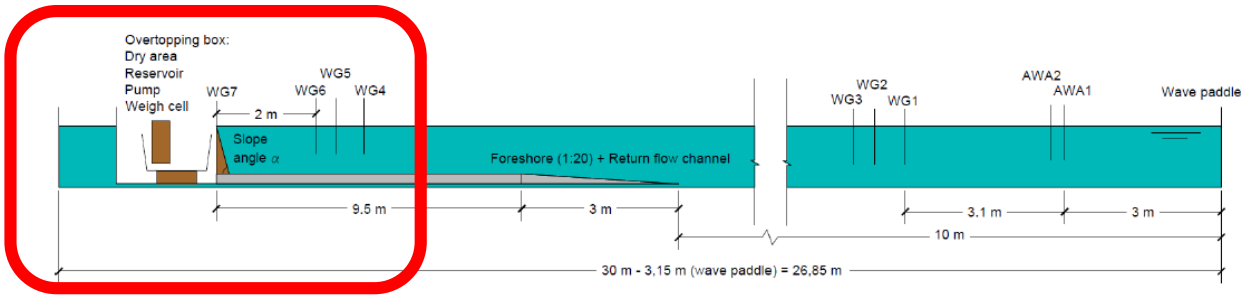


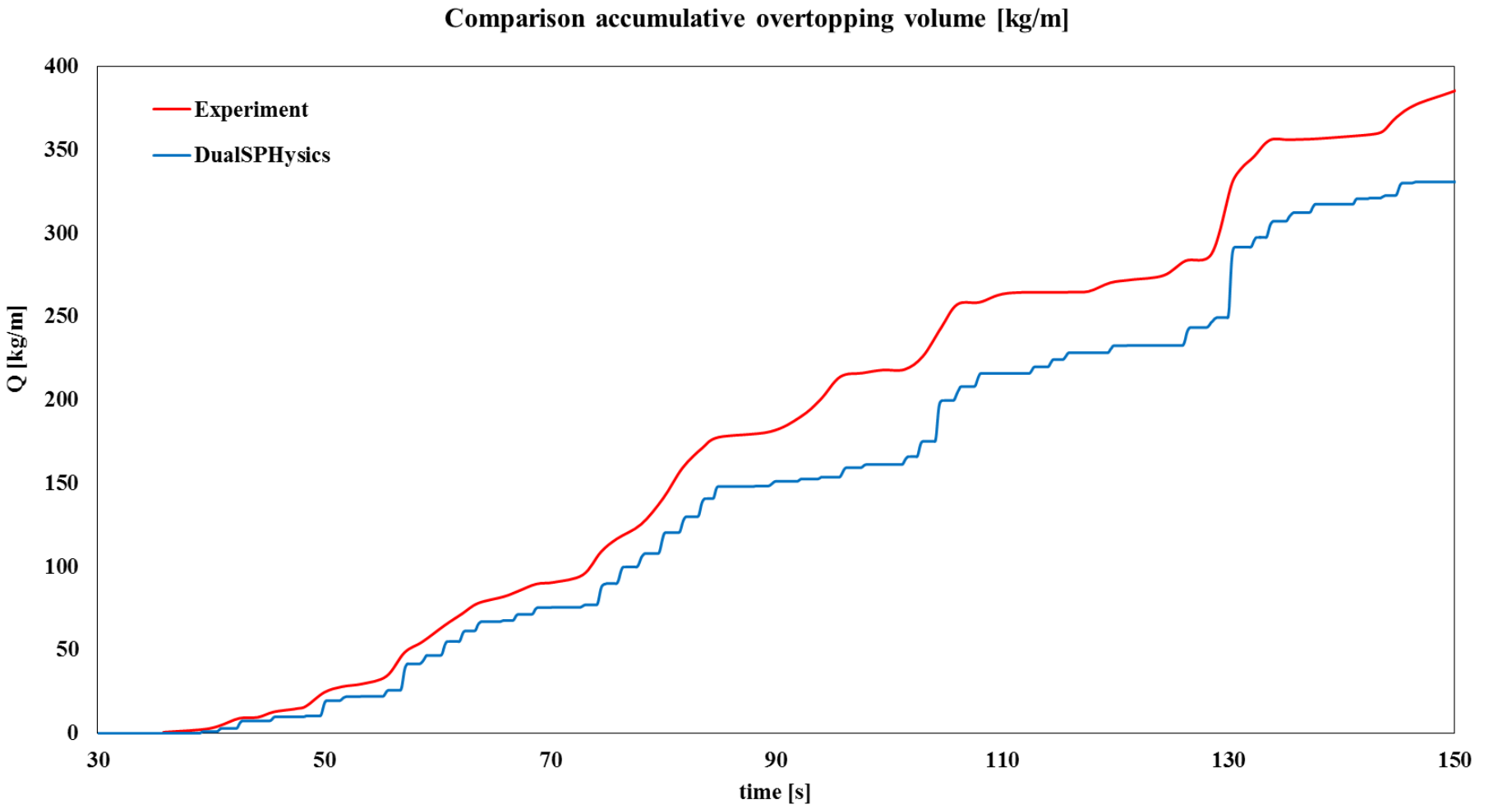


Post-processing

OVERTOPPING!!!

MeasureBoxes





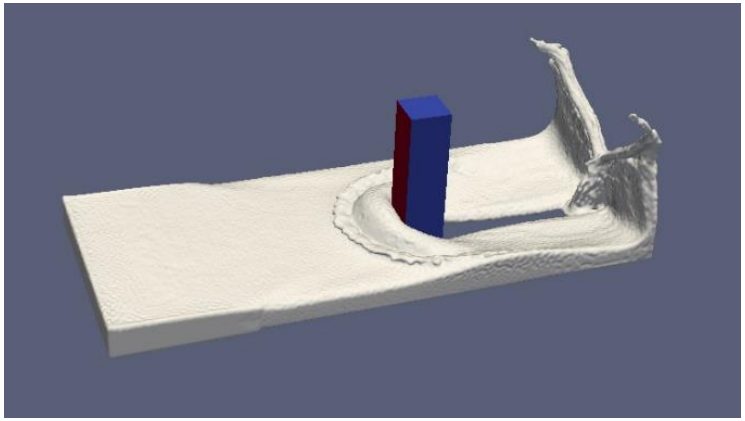
Outline of Presentation

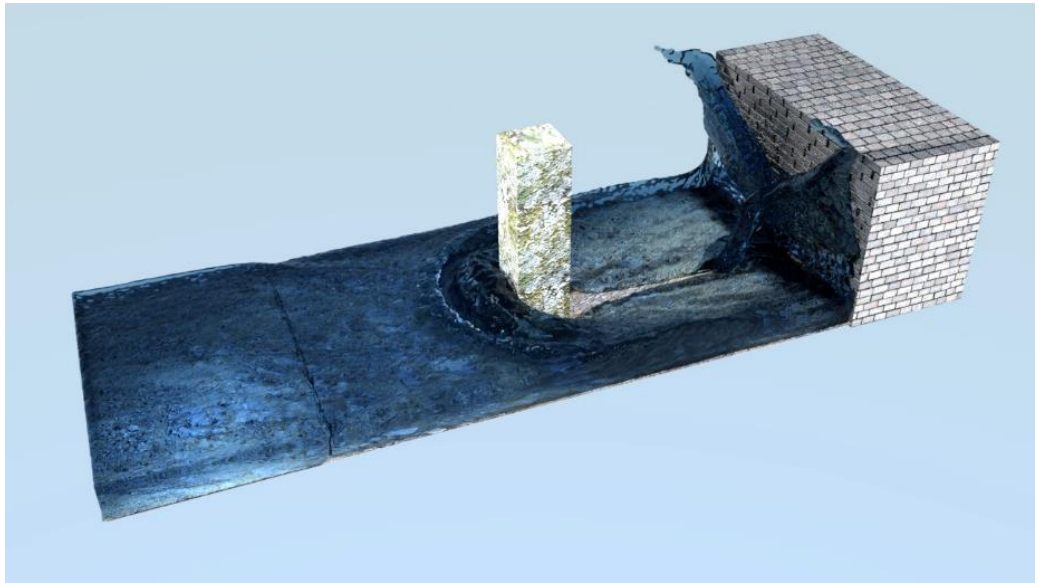
- Post-processing tools
  - PartVTK, PartVTKOut
  - MeasureTool
  - BoundaryVTK, IsoSurface
  - ComputeForces, FloatingInfo
  - TracerVTK
  - MeasureBoxes

- VisualSPHysics: **new !!!**

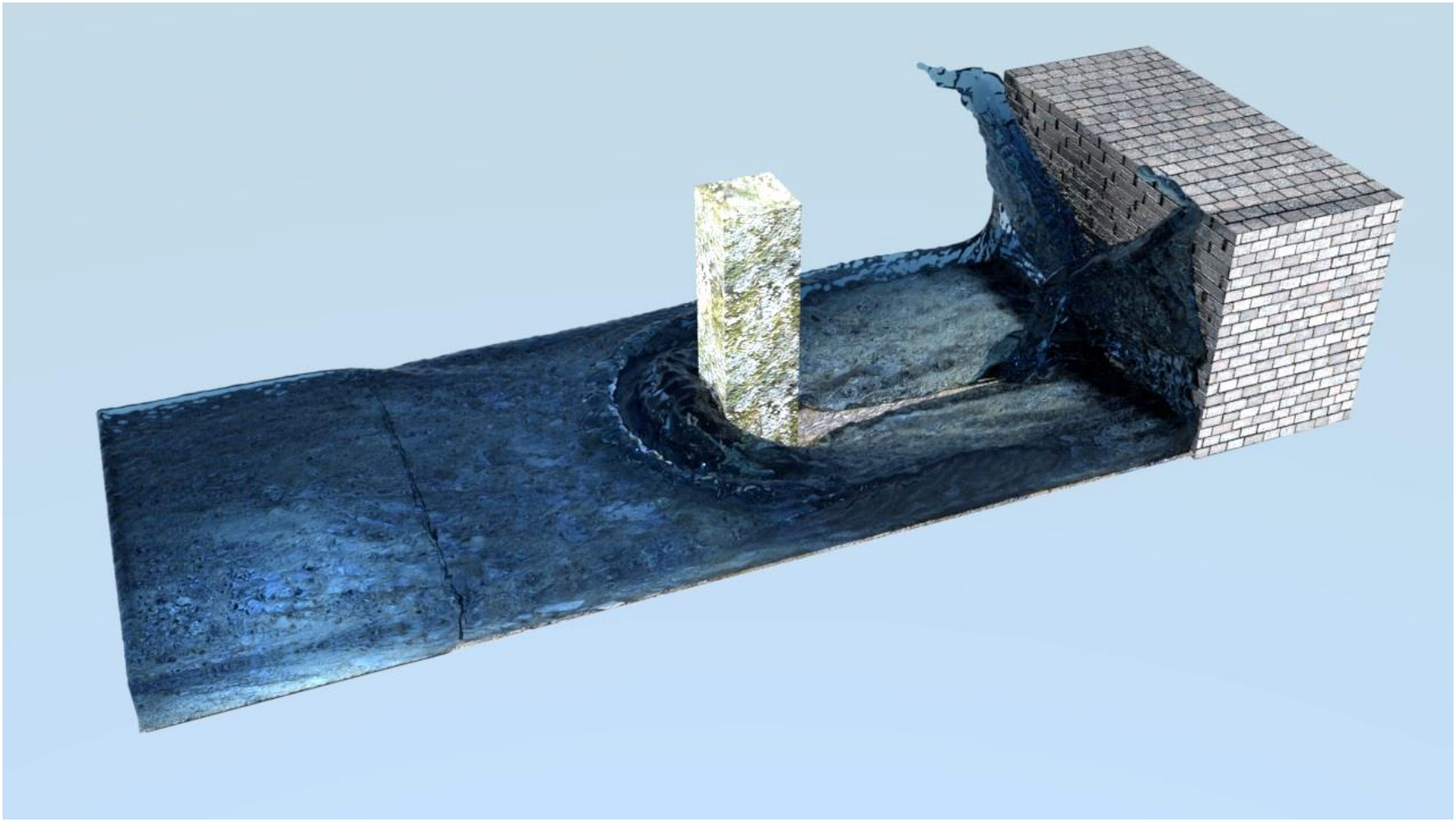
VisualSPHysics

- **Visualization** is an **important tool** to communicate scientific results.
- Scientific SPH animations usually present poor visual realism.
- Scientists are -usually- not 3D artists.
- Suitable tools to easily produce high quality animations are needed.



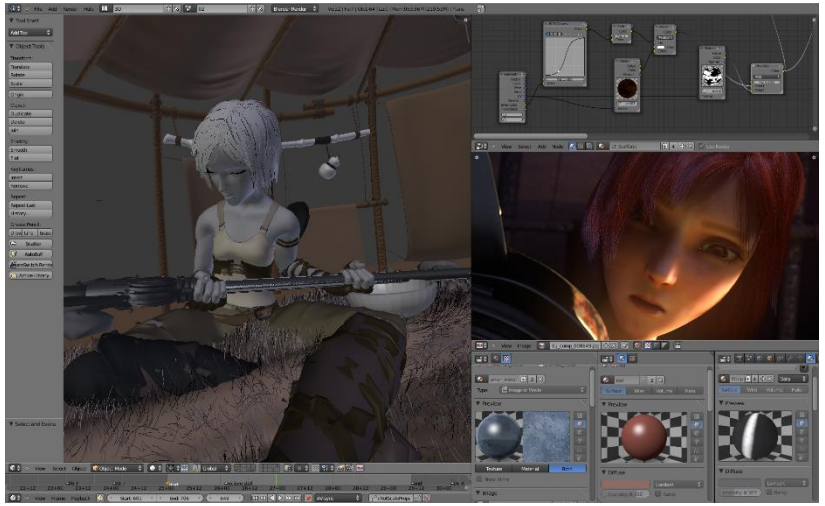


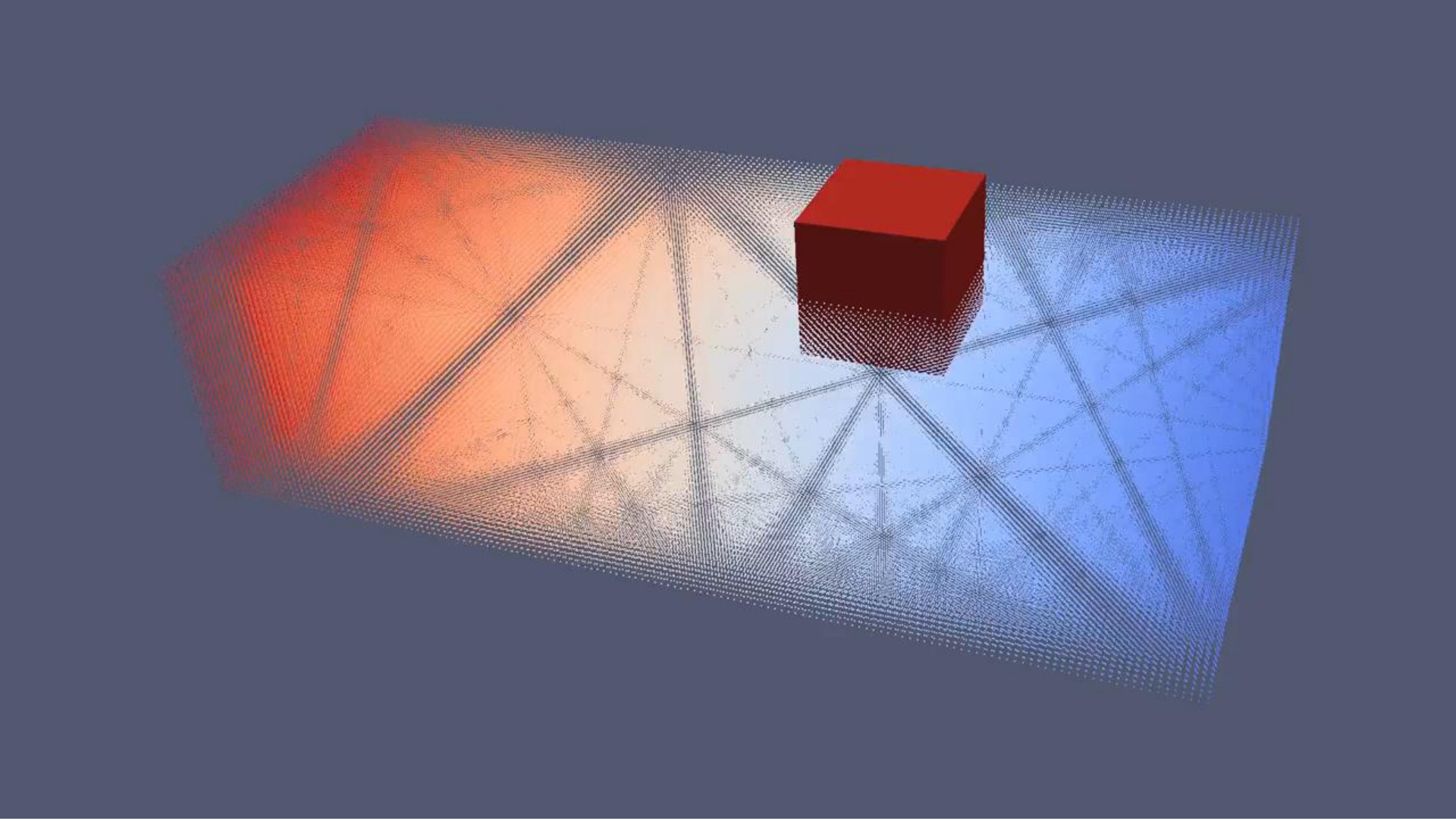
VisualSPHysics



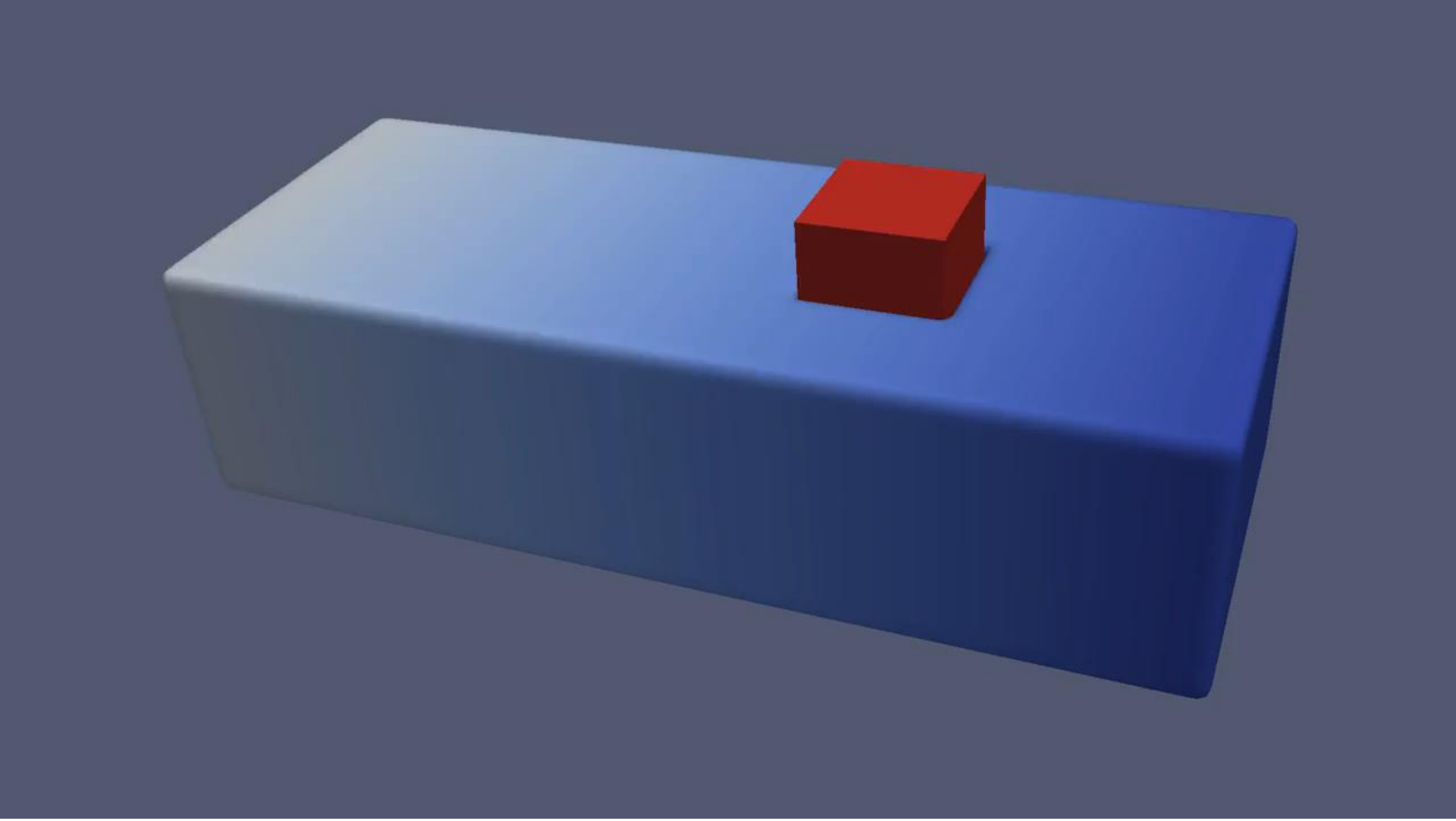
BLENDER

- Popular 3D graphics software used for creating animated films, visual effects, art, 3D printed models, interactive 3D applications and video games.
- Includes a path-tracing render engine (Cycles) that physically simulate light to offer realistic results.

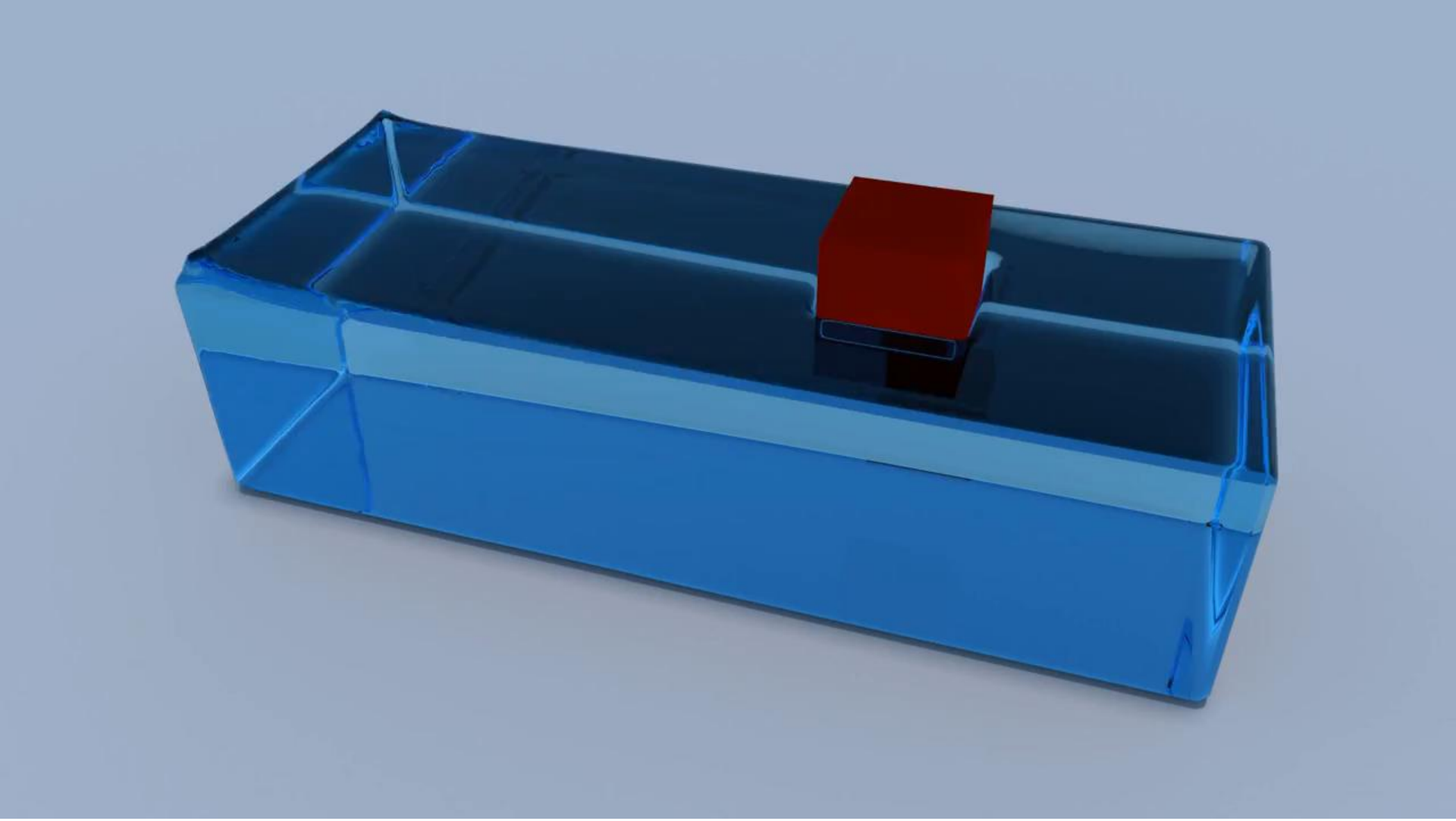




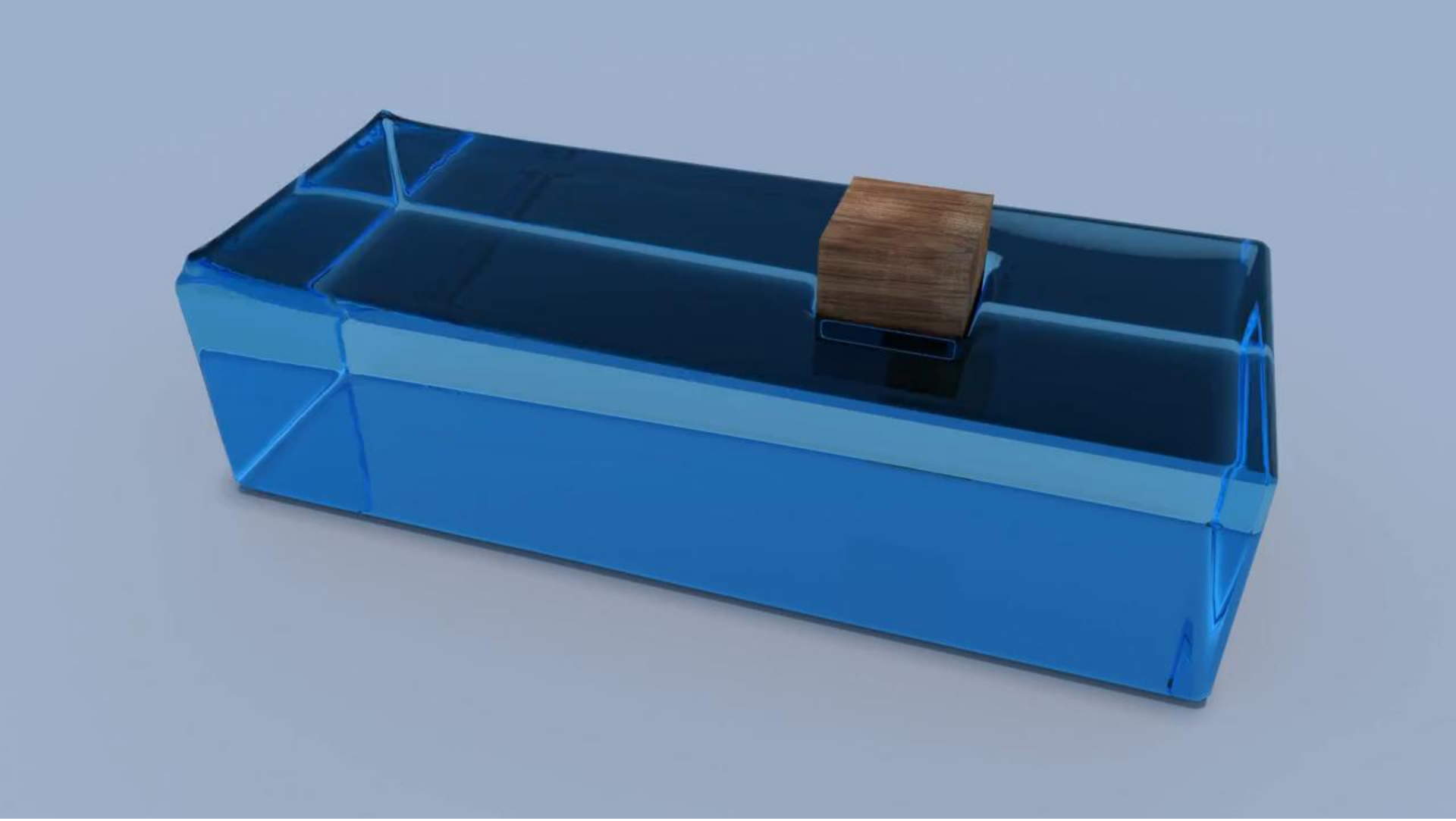
Visualization Features (Particles)



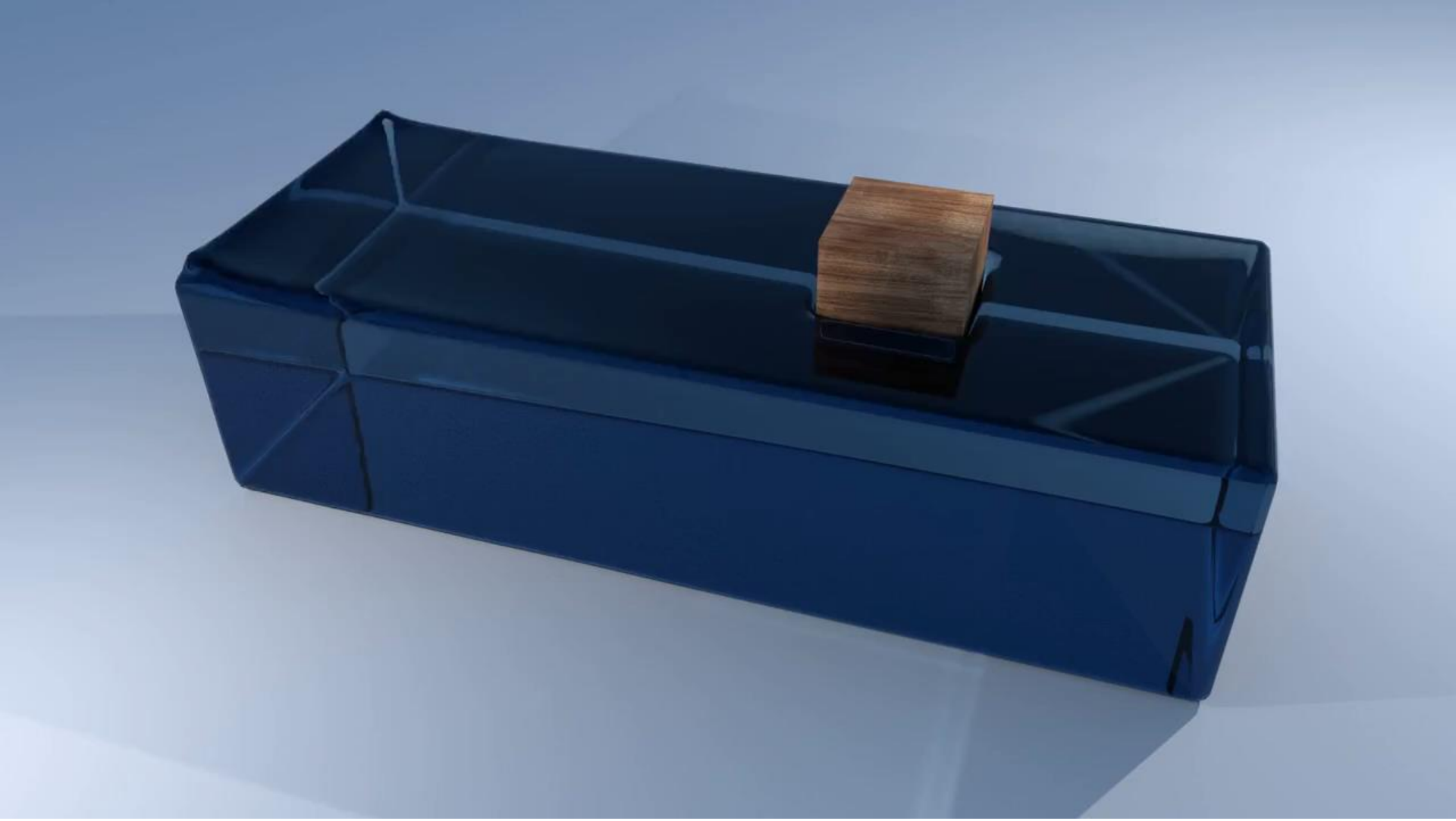
Visualization Features (Isosurface)



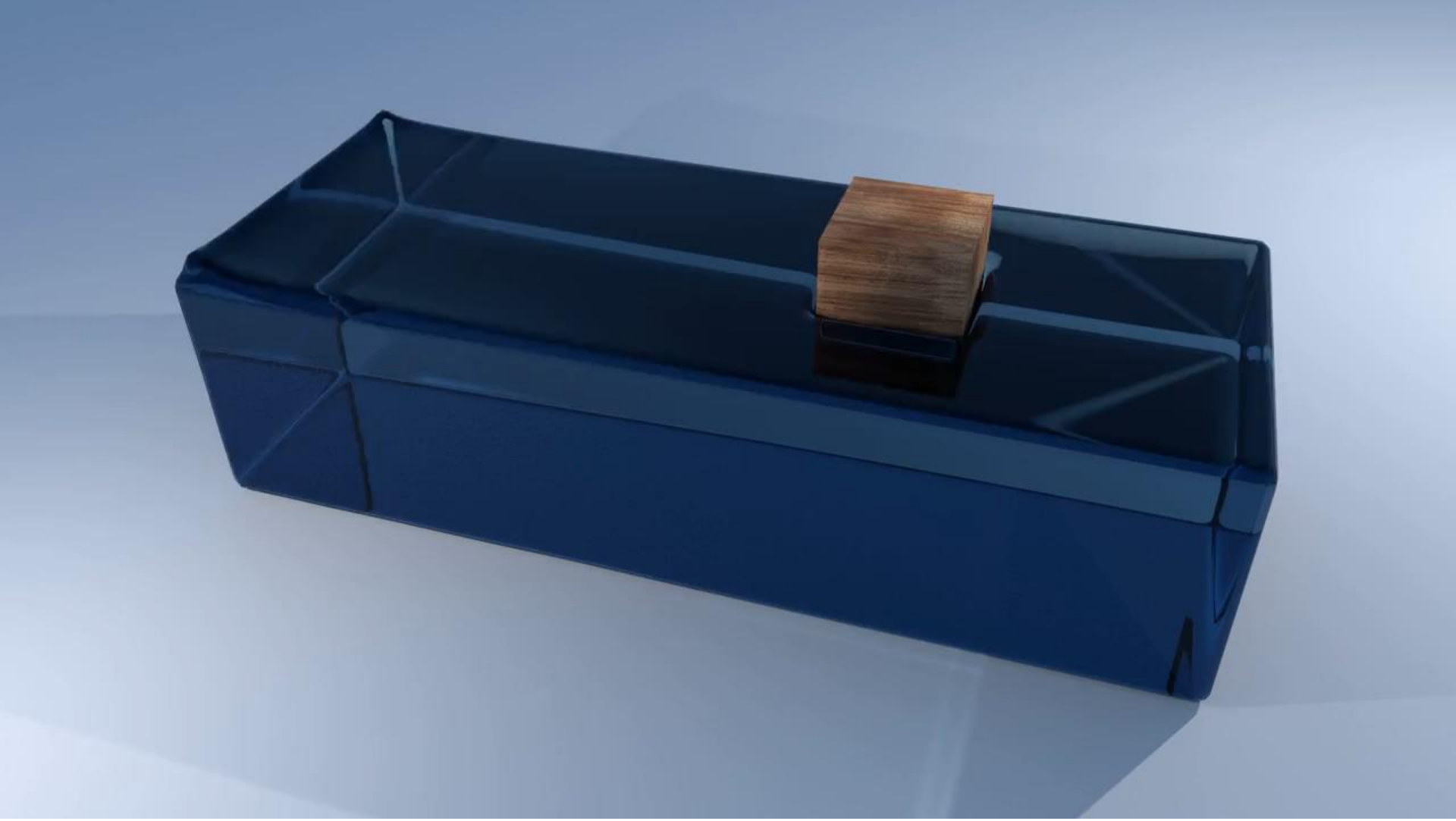
Visualization Features (Blender Import)



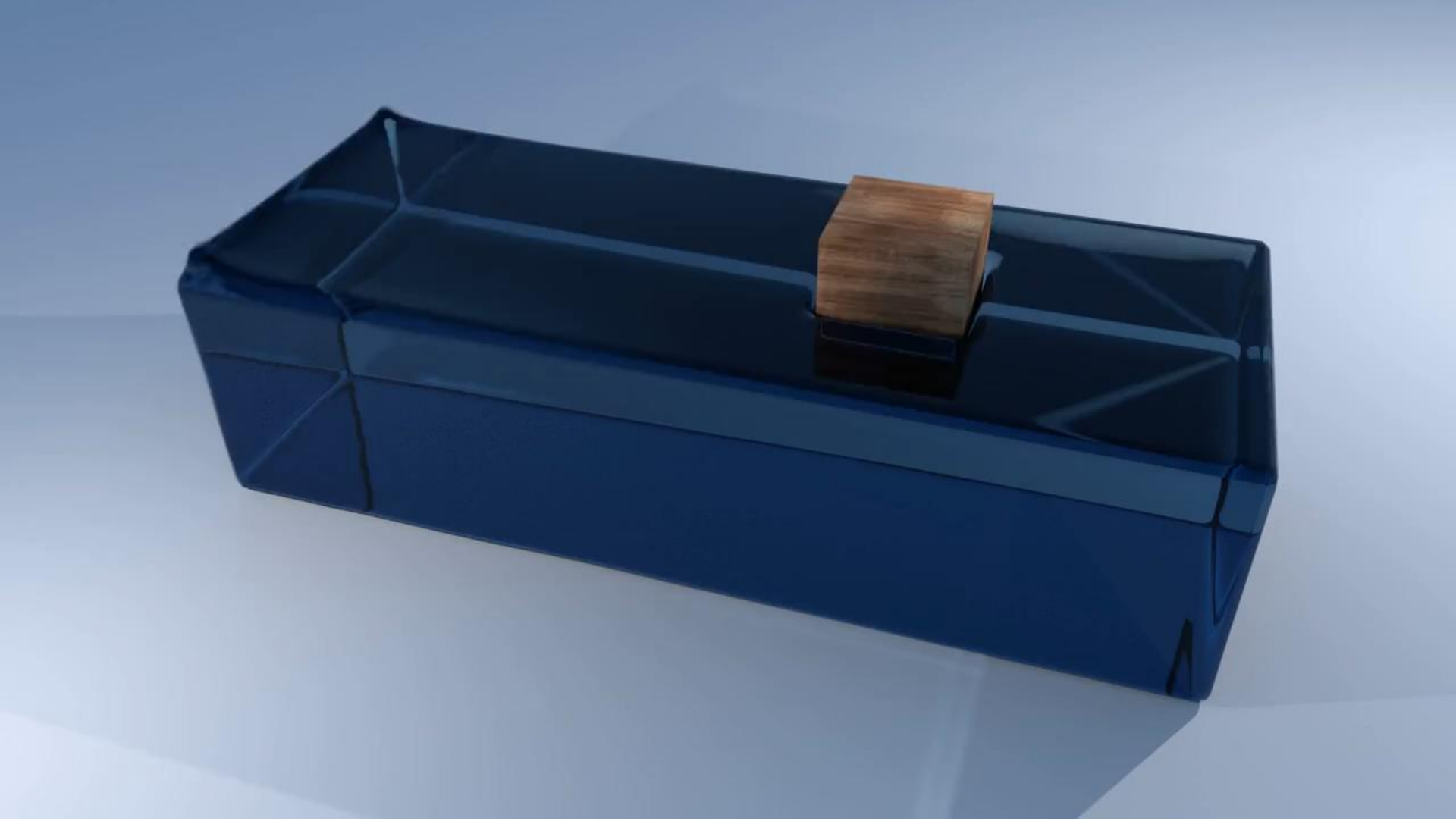
Visualization Features (Texturing)



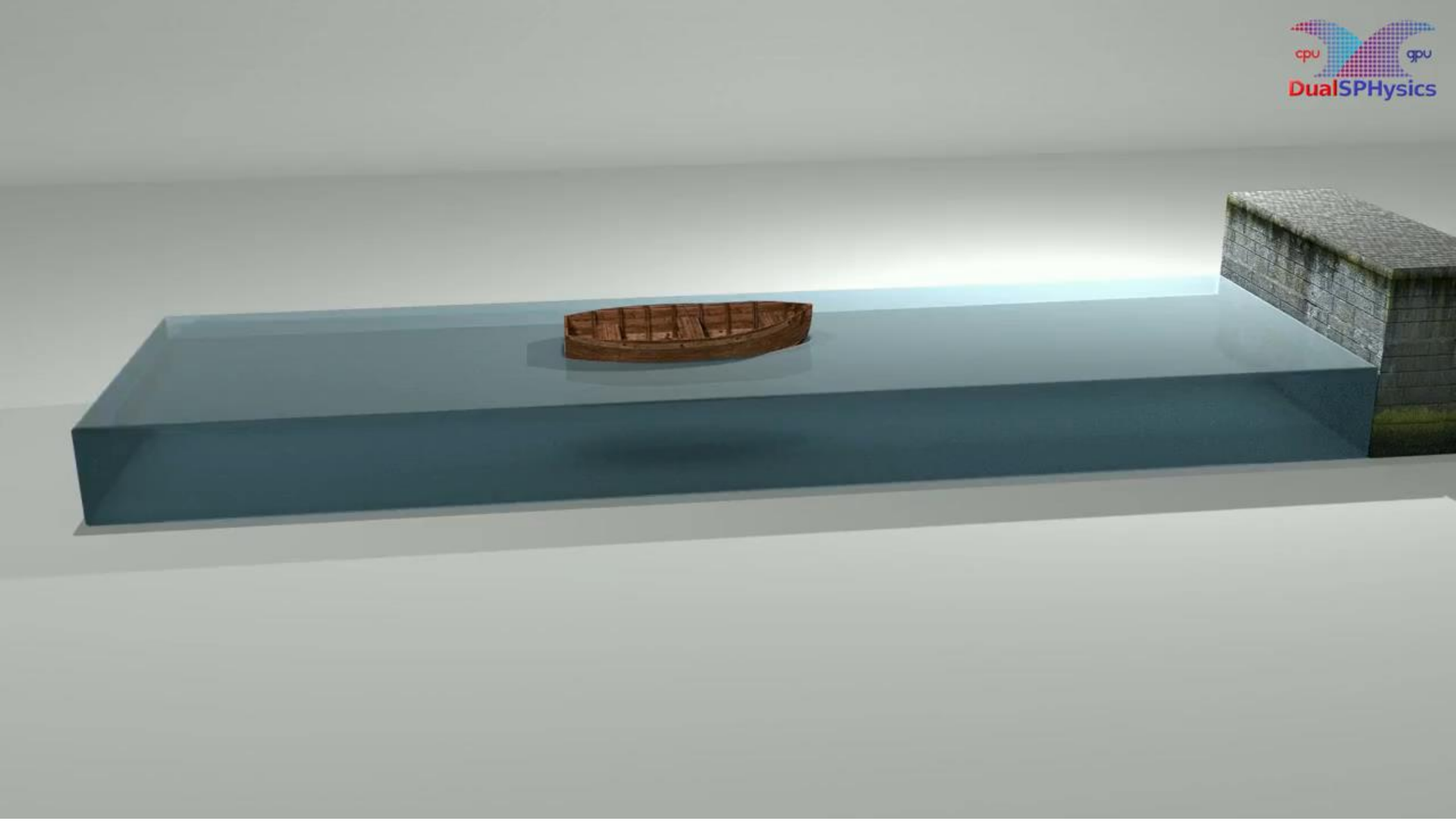
Visualization Features
(Improved materials and Lighting)



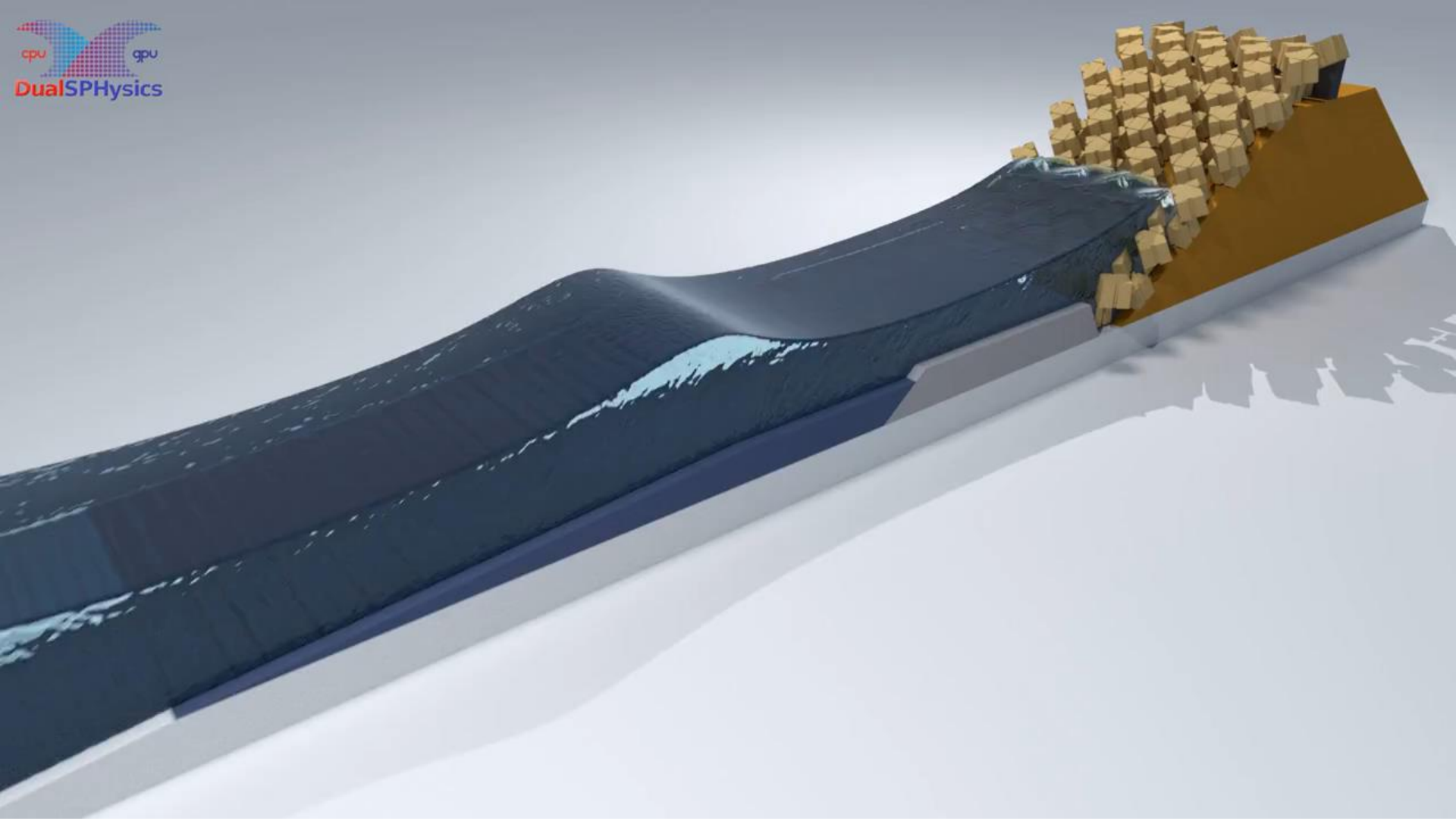
Visualization Features (Foam)



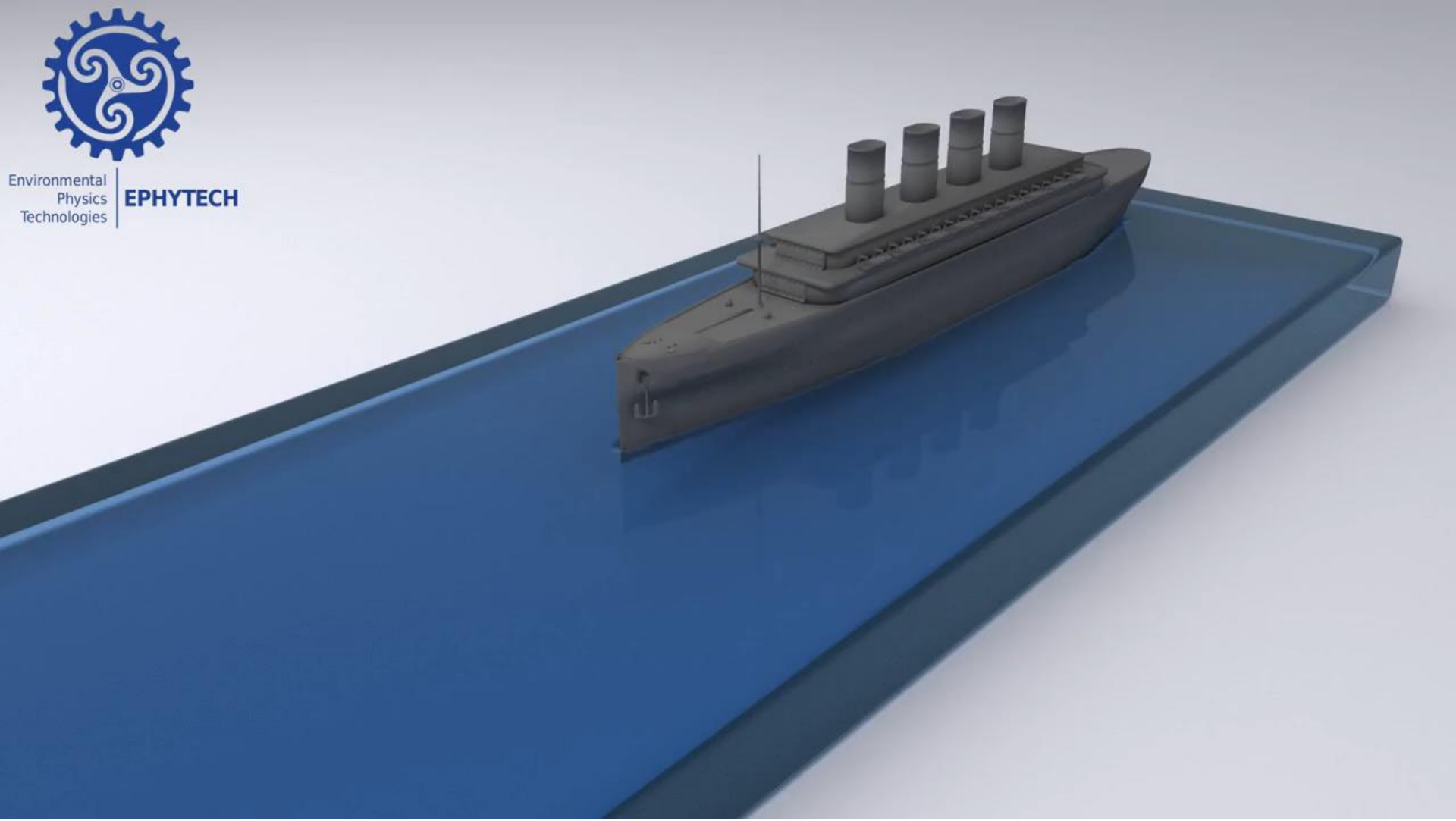
Visualization Features (Motion Blur)



Boat simulation



Waves interacting with a breakwater



Animation of a ship

Office simulation

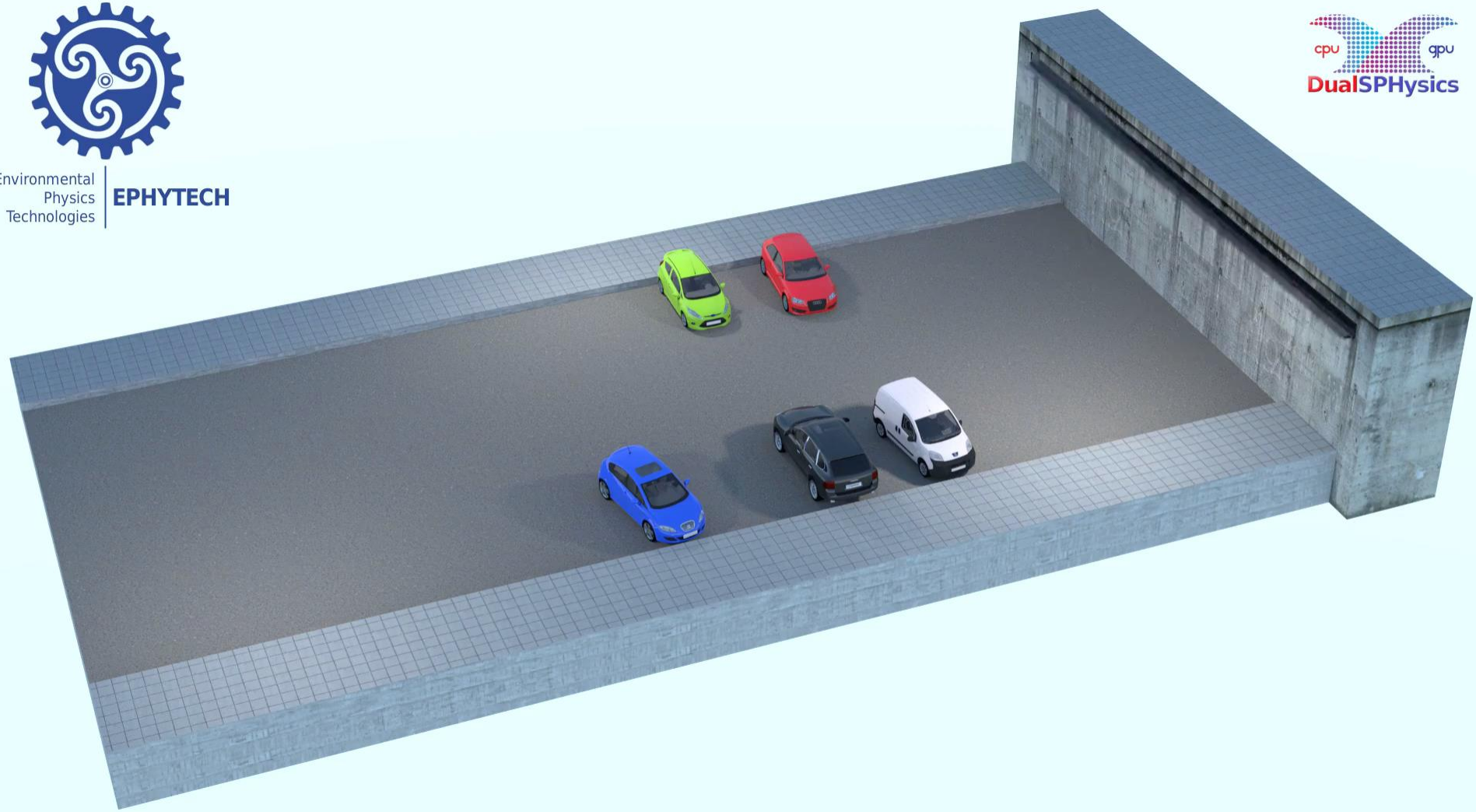
Environmental Physics Technologies | EPHYTECH

Tyre simulation

Simulation of a natural creek

Environmental Physics Technologies | EPHYTECH

DualSPHysics



Urban flood

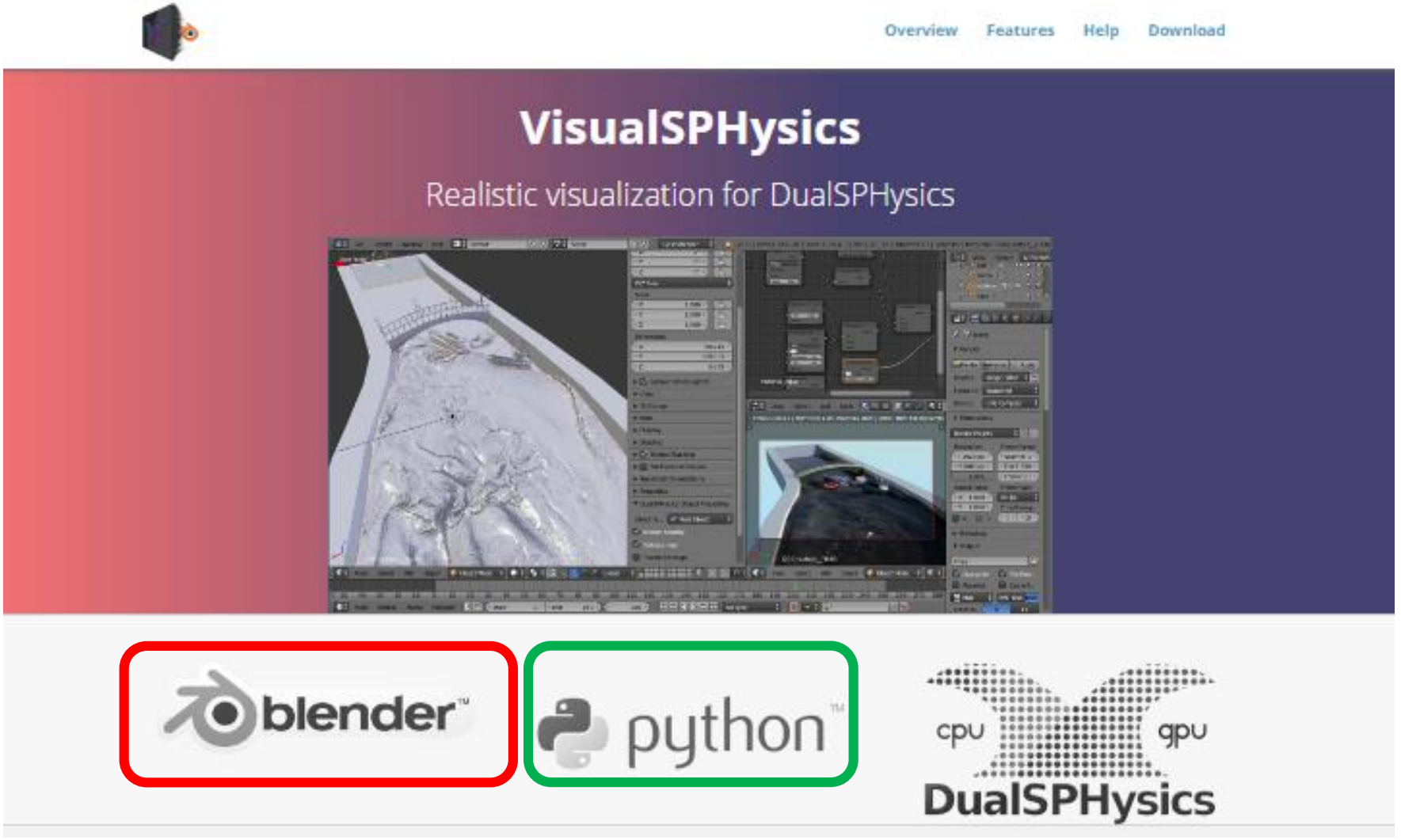

Environmental
Physics
Technologies
EPHYTECH
cpu
gpu
DualSPHysics

Urban flood

VisualSPHysics

Realistic visualization for DualSPHysics

Orlando García-Feal



VisualSPHysics

Realistic visualization for DualSPHysics

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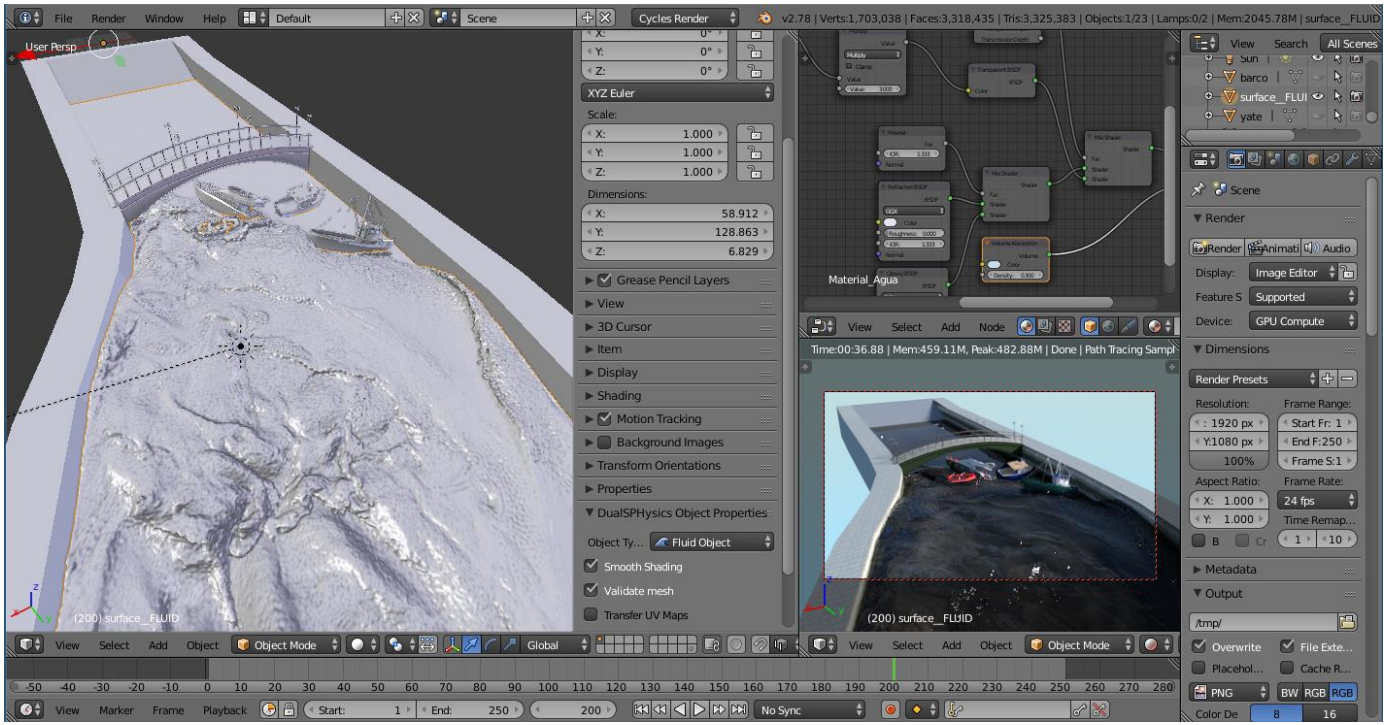
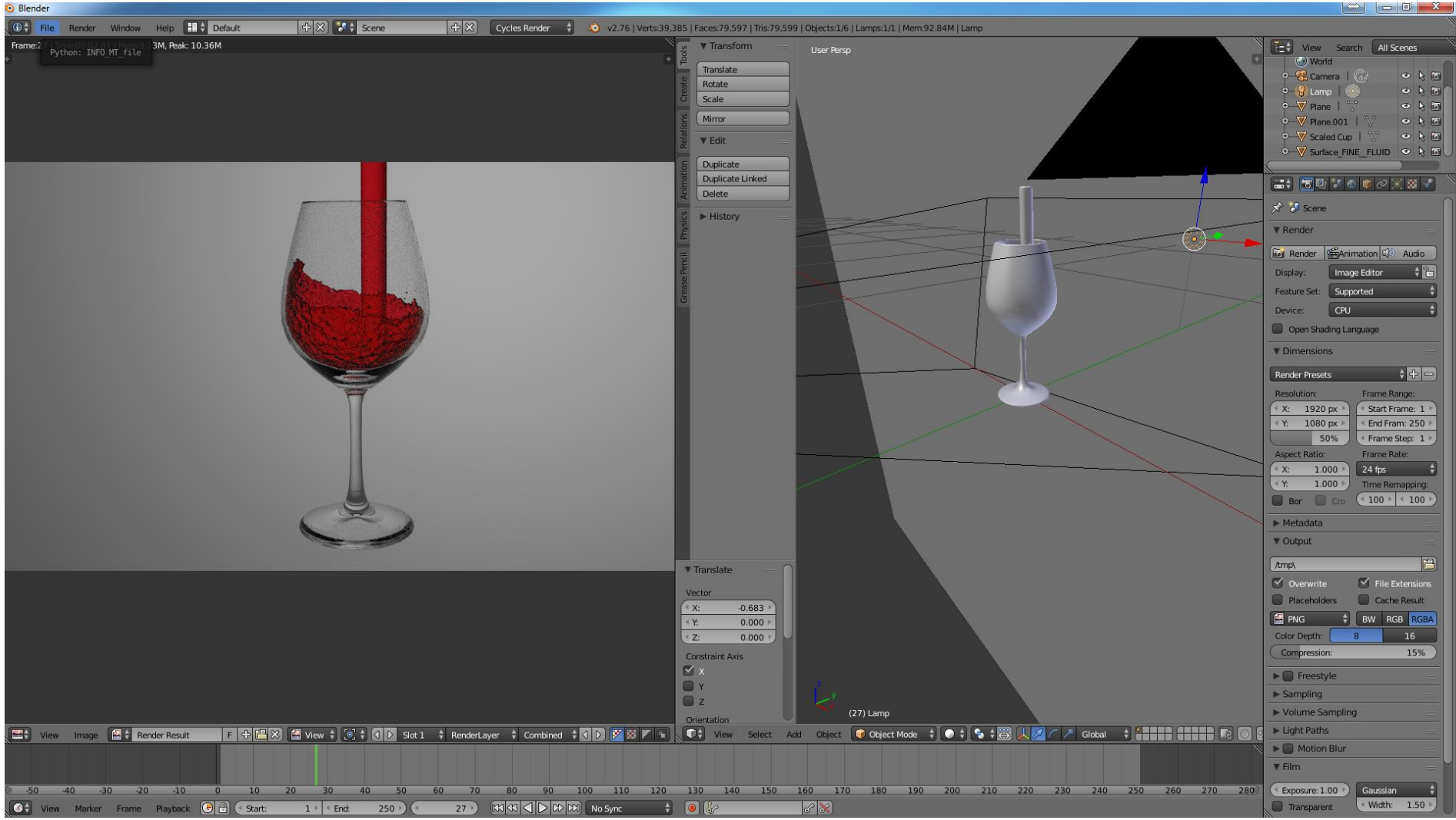
Modular: Distributed as a Blender add-on. Simple to install.
Integrated: Use all the Blender tools for your simulations.
Customizable: Easy customizable with Python.



Let us try VisualSPHysics



STEPS in VisualSPHysics

- Install Blender (https://www.blender.org/)
- Download VisualSPHysics (beta-version for Windows)
- Open Blender and go to File -> User Preferences -> Add-ons
  Click on "Install from file..."
  Select the downloaded ZIP file of VisualSPHysics
  Enable the checkbox with "Object: VisualSPHysics Blender Addon"
  Click on "Save User Settings" button and close the preferences window.
- *Engine to use for rendering*: Cycles Render
- Remove initial box: right click & R (or SUPR)
- IMPORT Stl:
  - We select “scaled_cup.stl”
- FLUID: SHIFT + A → Mesh → DualSPHysics Object
  - Object Type: Fluid Object
  - Activate “Smooth Shading”
  - Activate “Validate mesh”
  - Select “Surface_0000.vtk”
- BACKGROUND: SHIFT + A → Mesh → Plane
  - “R” (rotate), “X” (rotation in X axis), “90” (90 degrees)
  - Move the plan backwards (green arrow)
  - “S” (scale), “10” (x10)
- MOVE LIGHT: Outliner: Scene: Lamp
  - Move light close to the cup

- DEFINE MATERIALS
  - Split windows (\\\ and move to display new window)
  - Editor Type (cube icon) → Node editor
  - Outliner: Scene: Scaled Cup
    - Tools (left), Shading: Smooth
    - Node editor: New
      - Remove “Diffuse BSDF”
      - SHIFT + A → Shader → Glass BSDF
      - Connect BSDF to Surface
  - Outliner: Scene: Surface_FLUID
    - Node editor: New
      - Remove “Diffuse BSDF”
      - SHIFT + A → Shader → Glass BSDF
      - Connect BSDF to Surface
      - IOR: 1.333
      - Color: red
  - Outliner: Scene: Lamp
    - Node editor: Use Nodes
      - Strength: 50
- Viewport Shading (circle icon) → Rendered
- CAMERA
  - Click “+” and drag to the left for new options
  - Activate “Lock Camera to View”
  - View → Cameras → Activate camera
  - Move to choose frame
- RENDER

Visualisation in Paraview loading VTK files

Visualisation in Blender

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Thank you

Acknowledgements

- DualSPHysics team: all developers and contributors
- Orlando García Feal

Website

Free open-source **DualSPHysics** code:

http://www.dual.sphysics.org