Liquid for a Shattered Wine Glass

This page provides a tutorial for simulating a liquid for a baked fragmented wine glass using Chaos Phoenix.

Overview

This is an Entry Level tutorial which requires no previous knowledge of Phoenix. A basic understanding of 3ds Max would be helpful but is not a prerequisite for being able to follow along.

The instructions on this page guide you through the process of setting up an exploding Wine Glass simulation. The main takeaway of this tutorial is an understanding of how Surface Tension and the Steps per Frame parameters affect the movement of the liquid. The explosive effect is achieved through the use of a native Max Wind Force, which is the main driver of the simulation. Additional velocities are sourced into the simulation from the baked Rigid Body simulation of the wine glass and the Phoenix Turbulence force.

This simulation requires **Phoenix 4.20 Official Release** and **V-Ray 5, Update 2.3 Official Release** for **3ds Max 2018** at least. You can download official Phoenix and V-Ray from https://download.chaos.com. If you notice a major difference between the results shown here and the behavior of your setup, please reach us using the Support Form.

The **Download** button below provides you with an archive containing the start and end scenes.

Download Project Files

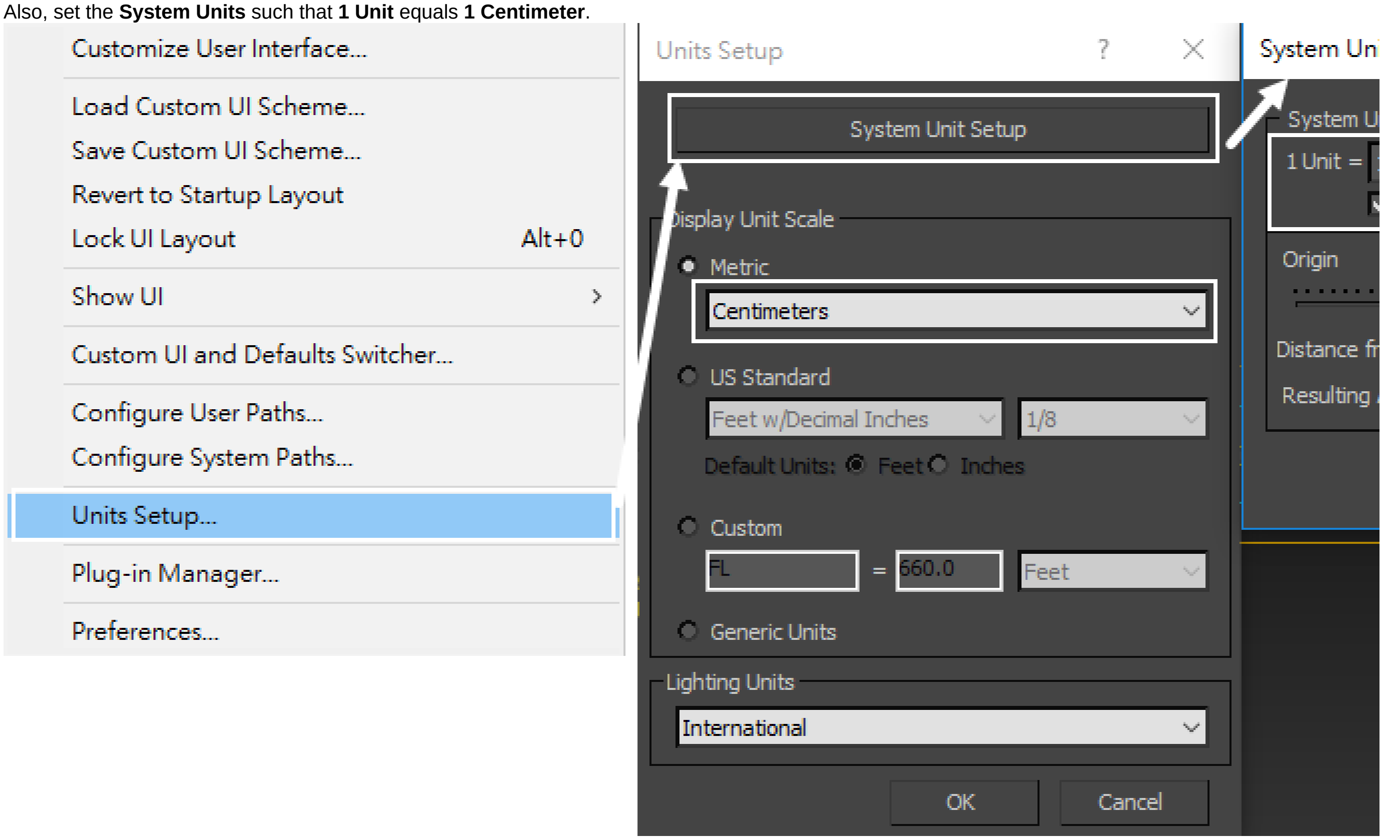
System Units Setup

Scale is crucial for the behavior of any simulation. The real-world **size of the Simulator** in **units** is important for the simulation dynamics. Large-scale simulations appear to move more slowly, while mid-to-small scale simulations have lots of vigorous movement. When you create your Simulator, you must check the **Grid** rollout where the real-world extents of the Simulator are shown. If the size of the Simulator in the scene cannot be changed, you can cheat the solver into working as if the scale is larger or smaller by changing the **Scene Scale** option in the **Grid** rollout.

The Phoenix solver is not affected by how you choose to view the Display Unit Scale - it is just a matter of convenience.

Go to **Customize Units Setup** and set Display Unit Scale to **Metric Centimeters**.

Also, set the **System Units** such that **1 Unit** equals **1 Centimeter**.



Display Unit Scale: ● Metric: Centimeters

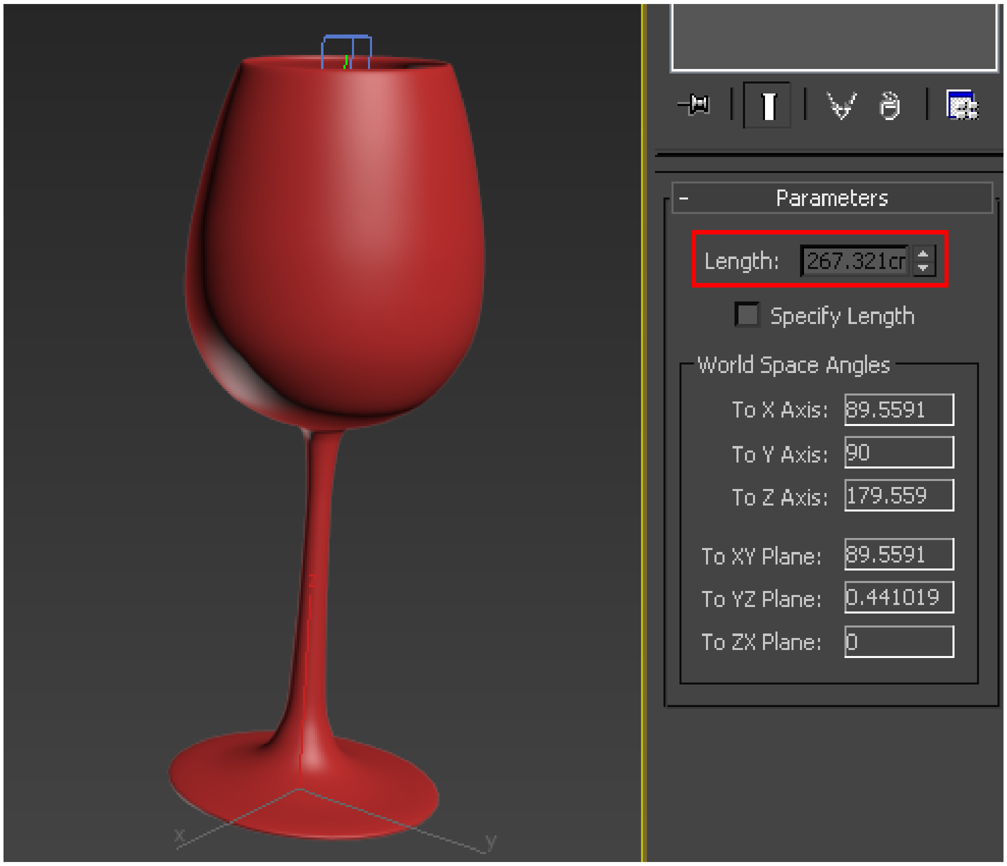
Lighting Units: International

Scene Setup

he height of the wine glass is about 260 cm instead of the usual 18 - 25 cm.

Slower movement of the large scale fluid allows for easier fine-tuning of the liquid motion with respect to the glass shards. It also provides more control over the shape of the simulation.

The **Distance tool** can be used to easily check the size of an object.



Parameters

Length: 267.321cr

□ Specify Length

World Space Angles

To X Axis: 89.5591

To Y Axis: 90

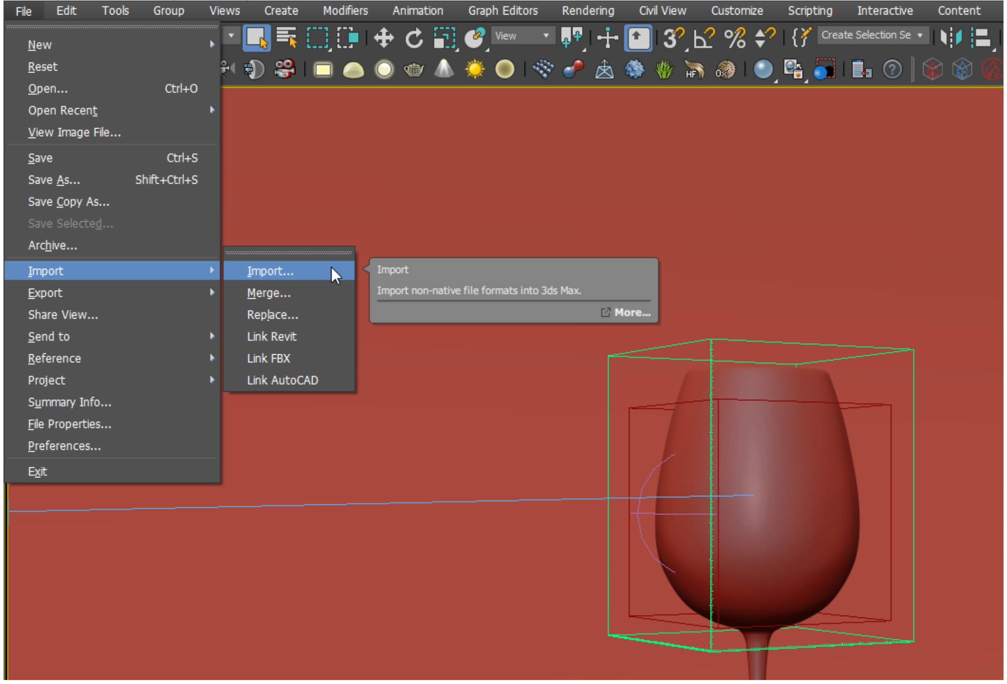
To Z Axis: 179.559

To XY Plane: 89.5591

To YZ Plane: 0.441019

To ZX Plane: 0

The Rigid Body simulation with the shattered wineglass is baked and cached in Alembic. To import Alembic cache in Max, go to **File** **Import** **Import** **Alembic**.

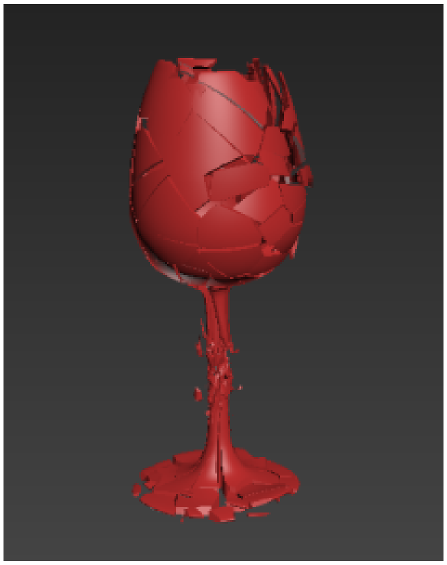


Import

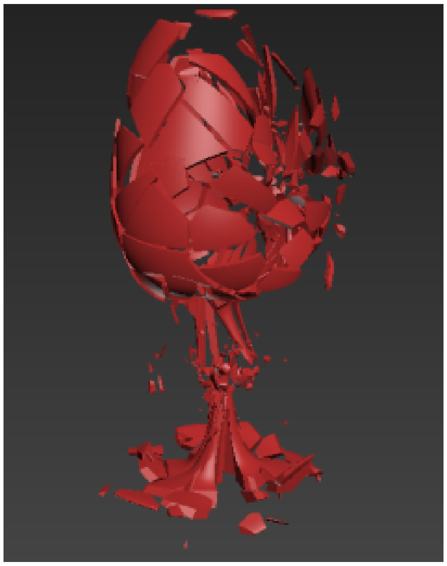
Import non-native file formats into 3ds Max.

More...

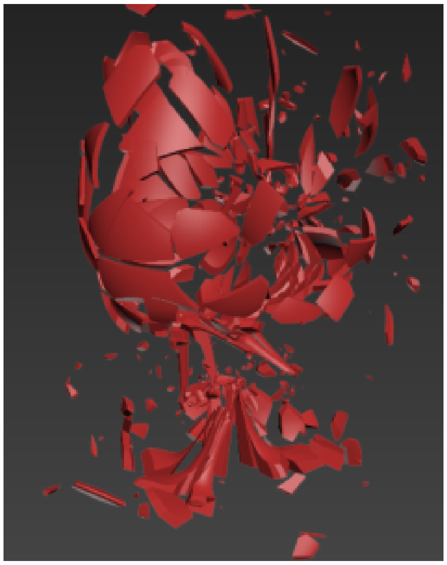
Frame 1



Frame 2

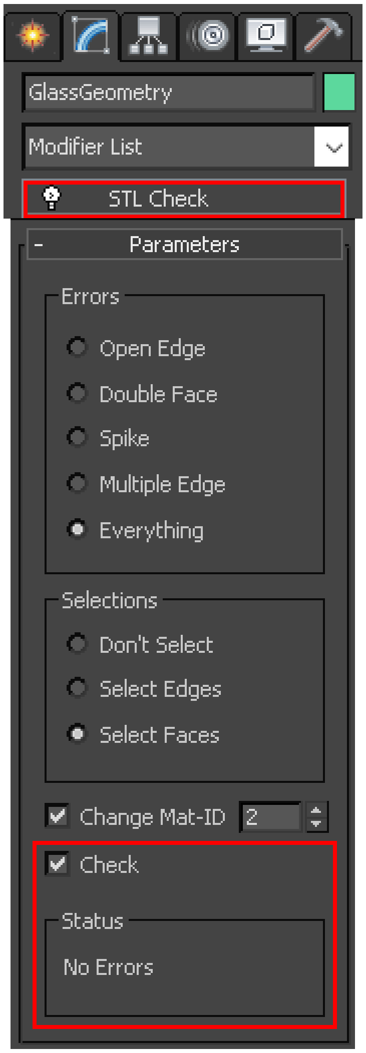


Frame 5



Frame 10

Note that Phoenix works best with closed geometry. You may check it with 3dsMax **STL Check** modifier. Geometry with a hole or other errors might cause problems when simulating.



GlassGeometry

Modifier List

STL Check

Parameters

Errors

○ Open Edge
○ Double Face
○ Spike
○ Multiple Edge
● Everything

Selections

○ Don't Select
○ Select Edges
● Select Faces

☑ Change Mat-ID 2

☑ Check

Status

No Errors

Forces

Phoenix allows you to preview the forces in your scene which eliminates the process of constant tweaking and simulating. You can preview any Max native force as well as all the forces that ship with Phoenix.

To see the effect of a force on your container, enable **Forces** from the **Preview** tab of your Simulator.

> ⚠ Note that when Auto Range is Enabled, the Min and Max values of the incoming velocities are displayed. This could be incredibly useful when setting up the Magnitude of your forces or troubleshooting your simulation. If the Max value was along the lines of 5000, you would naturally expect your simulation to 'explode'. Take note of those values when tweaking the Force Fields.

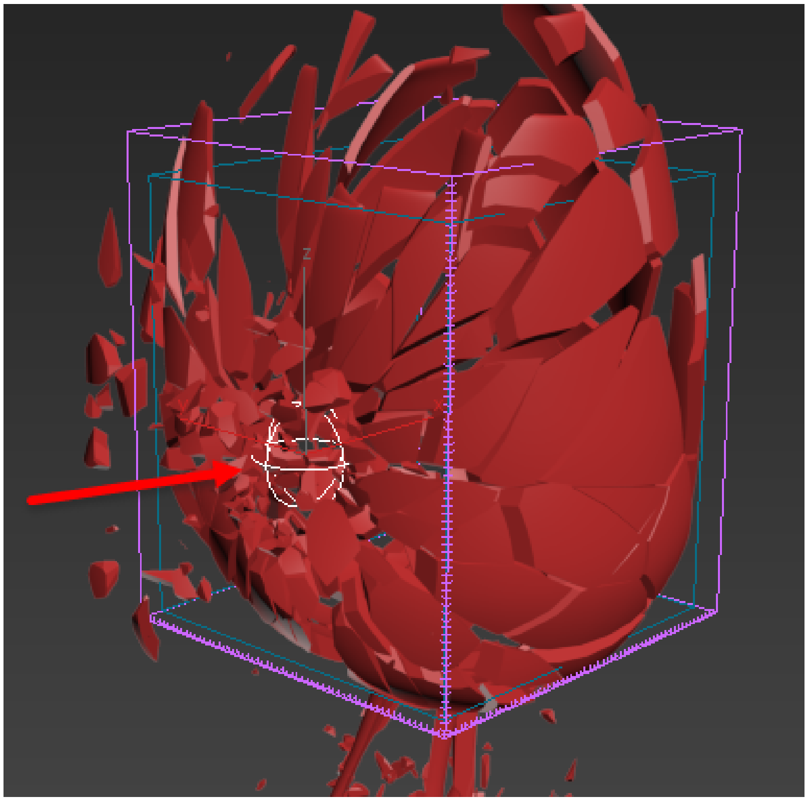
The desired explosive effect of the liquid is achieved through a standard 3ds Max **Wind** Force combined with **Phoenix Turbulence**.

To create the Wind Force go to **Create panel Space Warps Forces**.

Depending on the placement, the look of the simulation will vary dramatically. Experiment to find a desirable result. In this tutorial the position of the force is at the center of the glass. The **exact position** of the **Wind** force in the scene is **[-58, 0, 195]**.

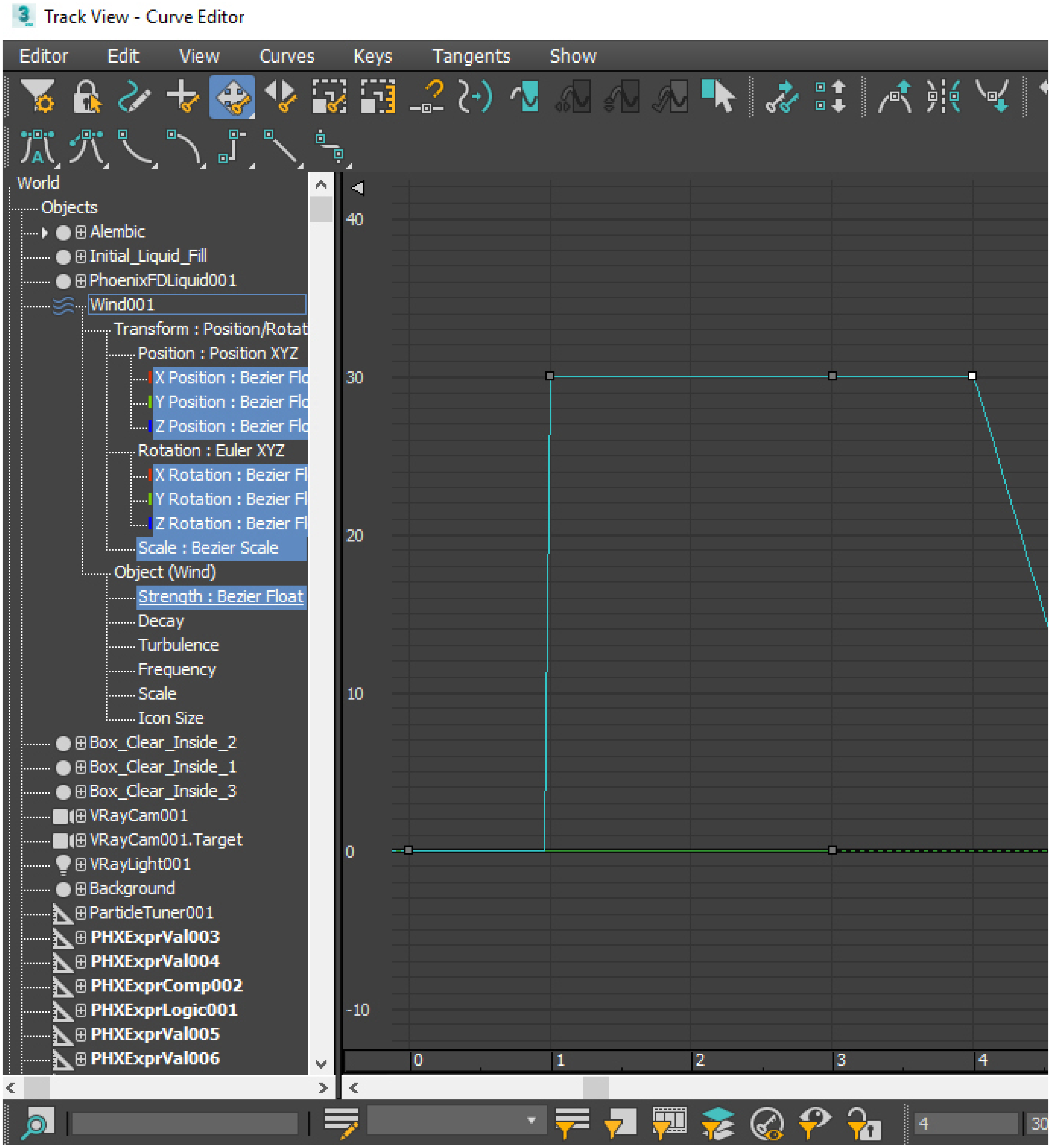
Change its type to **Spherical**. This will cause the force to affect the liquid in all directions.

Set the **Strength** to **30.0**.



Animate the Wind **Strength** to emulate the impact when the glass shatters with the following **keyframes**:

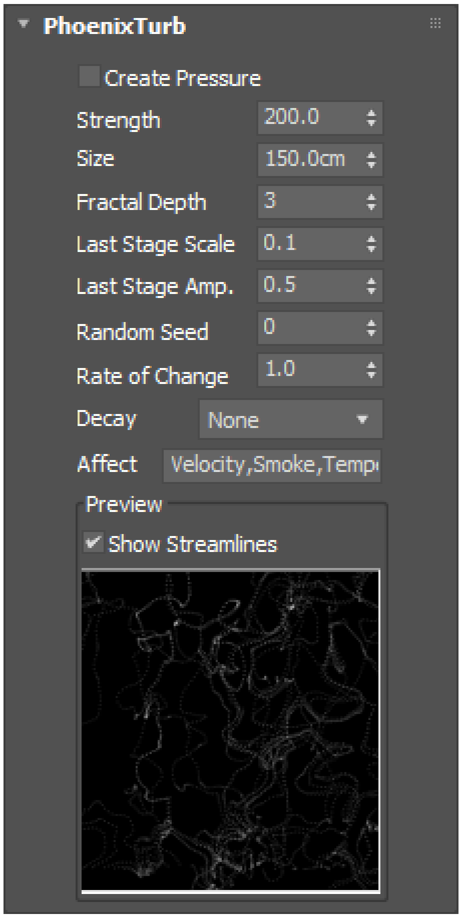
Frame **0**: set to **0**;
Frame **1**: set to **30**;
Frame **4**: set to **30**;
Frame **5**: set to **0**.



To create the Phoenix Turbulence go to **Create panel**
Helpers Phoenix FD PHXTurbulence.

Set the **Strength** to **200.0**.

Set the **Size** to **150.0**.



PhoenixTurb

□ Create Pressure

Strength 200.0

Size 150.0cm

Fractal Depth 3

Last Stage Scale 0.1

Last Stage Amp. 0.5

Random Seed 0

Rate of Change 1.0

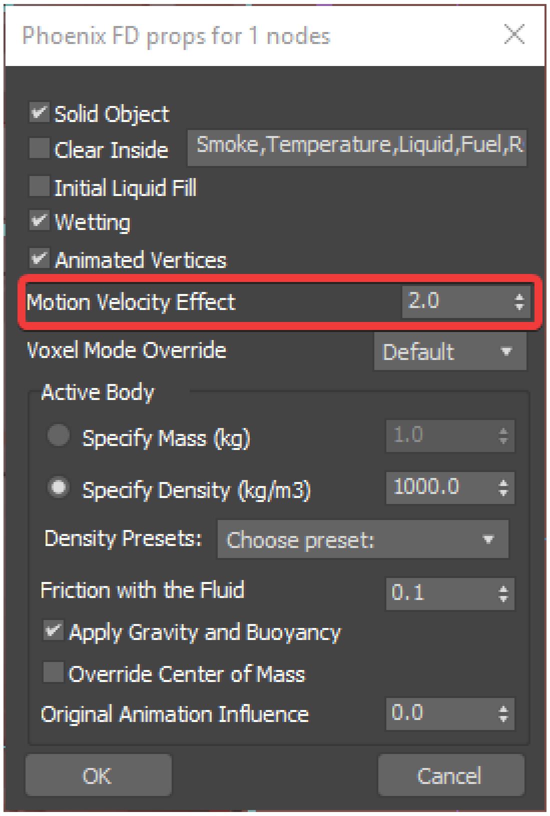
Decay None

Affect Velocity,Smoke,Temp

Preview

☑ Show Streamlines

With the help of the Wind force, the glass will push the liquid to burst and scatter. You can control the interaction strength between the glass and the liquid by adjusting the **Motion Velocity Effect**, located in the **Phoenix Per-Node Properties**. Higher values will cause the simulation to act as if the liquid is moving at a higher velocity, creating a bigger and more dramatic burst. For this tutorial, we will set its value of **2.0**.


Phoenix FD props for 1 nodes

☑ Solid Object

□ Clear Inside — Smoke,Temperature,Liquid,Fuel,R

□ Initial Liquid Fill

☑ Wetting

☑ Animated Vertices

Motion Velocity Effect: 2.0

Voxel Mode Override: Default

Active Body

○ Specify Mass (kg): 1.0

● Specify Density (kg/m3): 1000.0

Density Presets: Choose preset:

Friction with the Fluid: 0.1

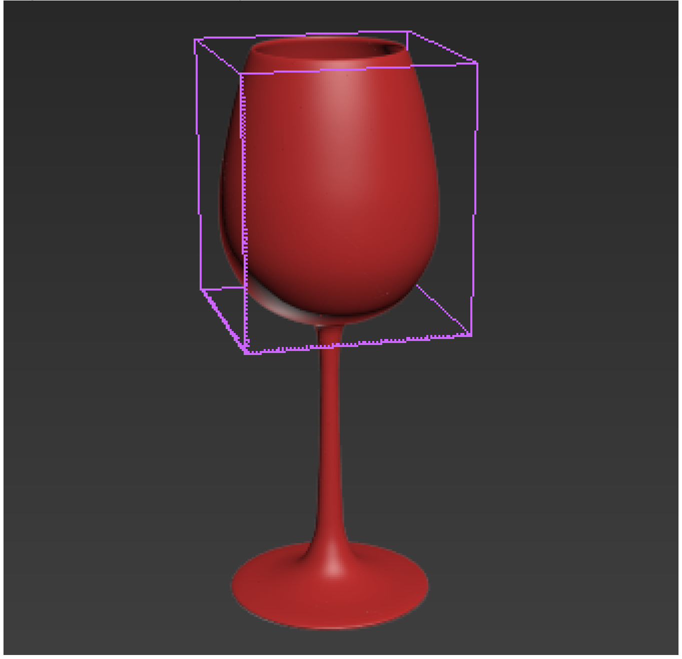
☑ Apply Gravity and Buoyancy

□ Override Center of Mass

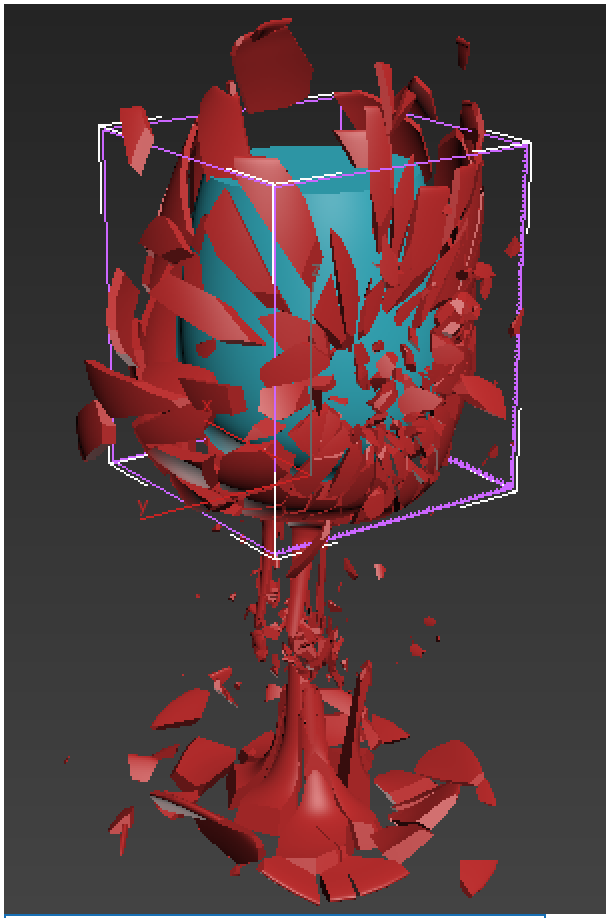
Original Animation Influence: 0.0

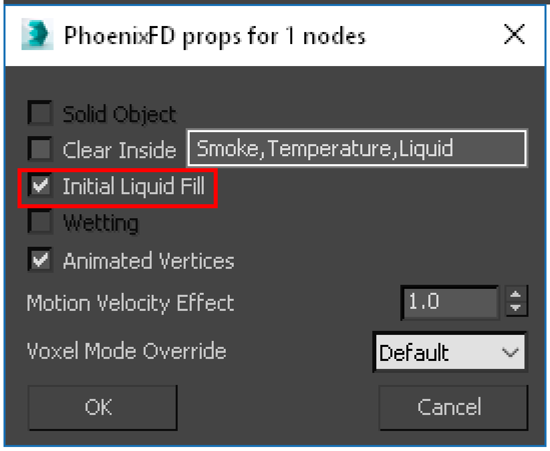
Container Properties

Create a Phoenix Liquid Simulator and set grid dimensions,
so it encompasses the bowl of the glass.



In the image below, the blue geometry in the inside of the glass is used for the initial filled state of the liquid. For more information on creating this, see the Using Initial Liquid Fill with Containers tutorial. Right click to access its Chaos Phoenix Per-Node Properties and make sure **Initial Liquid Fill** is **enabled**.





PhoenixFD props for 1 nodes

□ Solid Object

□ Clear Inside Smoke,Temperature,Liquid

☑ Initial Liquid Fill

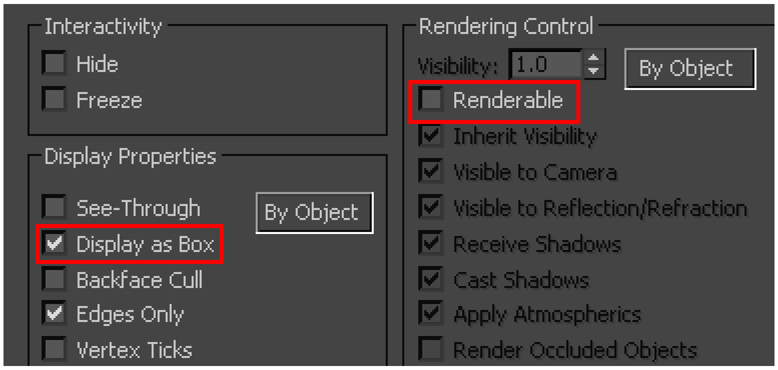
□ Wetting

☑ Animated Vertices

Motion Velocity Effect 1.0

Voxel Mode Override Default

This piece of geometry will not need to be rendered or displayed in the viewport. Access its Object Properties from the quad menu and enable Display as Box and disable Renderable.



□ Hide

□ Freeze

□ See-Through

☑ Display as Box

□ Backface Cull

☑ Edges Only

□ Vertex Ticks

Visibility: 1.0

□ Renderable

☑ Inherit Visibility

☑ Visible to Camera

☑ Visible to Reflection/Refraction

☑ Receive Shadows

☑ Cast Shadows

☑ Apply Atmospherics

□ Render Occluded Objects

The **Simulator Grid** parameters are tweaked as follows:

The **Scene Scale** is set to **1.0**.

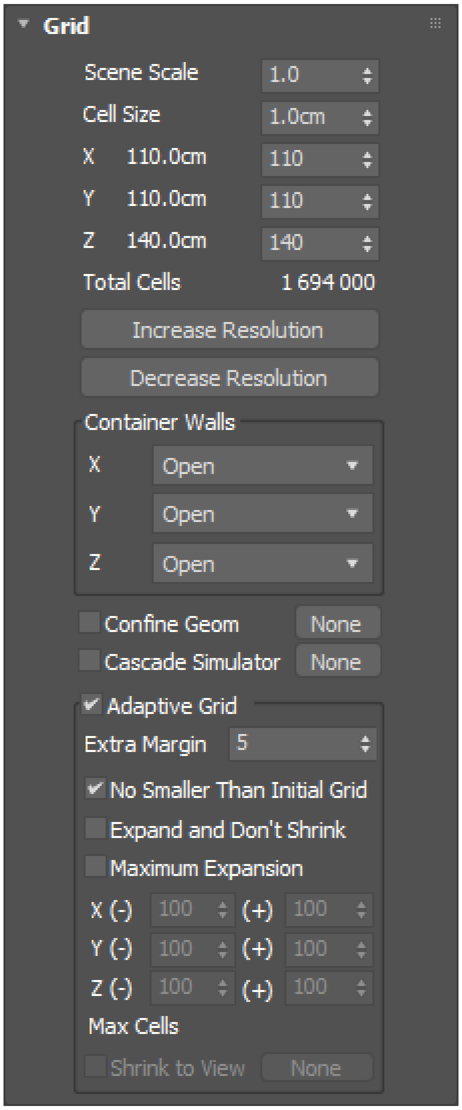
The **Cell Size** is set to **1.0 cm**.

The **X/Y/Z Size** of the Simulator is set to **110/110/140** as a starting point.

The **Adaptive Grid** is **enabled**. This tells Phoenix to track the Liquid and increase the size of the simulator when the particles get close to the boundary.

The **Extra Margin** is set to **5**.

The **Expand and Don't Shrink** is **disabled**.



Grid

Scene Scale 1.0

Cell Size 1.0cm

X 110.0cm 110

Y 110.0cm 110

Z 140.0cm 140

Total Cells 1 694 000

Increase Resolution

Decrease Resolution

Container Walls

X Open

Y Open

Z Open

□ Confine Geom None

□ Cascade Simulator None

☑ Adaptive Grid

Extra Margin 5

☑ No Smaller Than Initial Grid

□ Expand and Don't Shrink

□ Maximum Expansion

X (-) 100 (+) 100

Y (-) 100 (+) 100

Z (-) 100 (+) 100

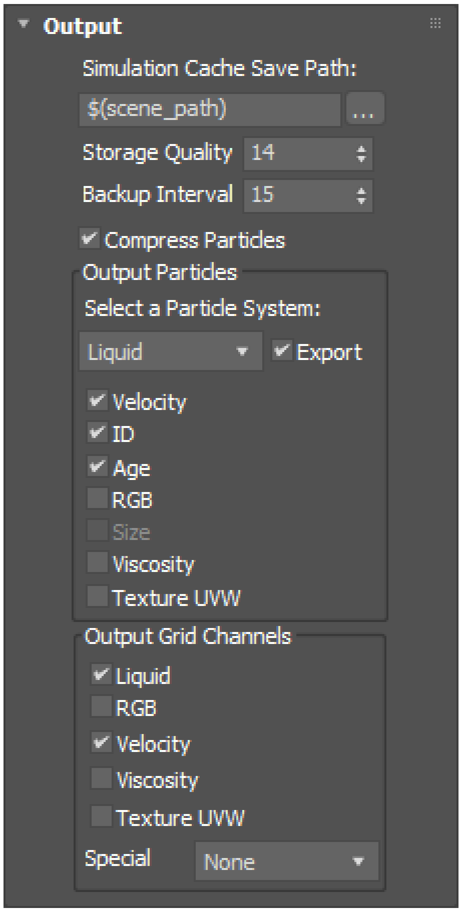
Max Cells

□ Shrink to View None

⚠ Increasing the resolution of the grid can sometimes alter the shape and behavior of the simulation. Remember that higher resolution does not necessarily mean more realistic simulations. It depends on the project. Sometimes the resolution is too high, and there are too many details, or the look is not what the director is asking for. You have to find a good balance.

In the Output rollout, enable the **Velocity** channel in the Output Grid Channels section. This will allow the final mesh to include Motion Blur.

In this tutorial will be shown how to set a simple expression with Particle Tuner, which will help optimizing the simulation process. For this setup the **Age** channel in the Output Particle Channels section must be **enabled**.



Output

Simulation Cache Save Path:

$(scene_path) ...

Storage Quality 14

Backup Interval 15

☑ Compress Particles

Output Particles

Select a Particle System:

Liquid ☑ Export

☑ Velocity

☑ ID

☑ Age

□ RGB

□ Size

□ Viscosity

□ Texture UVW

Output Grid Channels

☑ Liquid

□ RGB

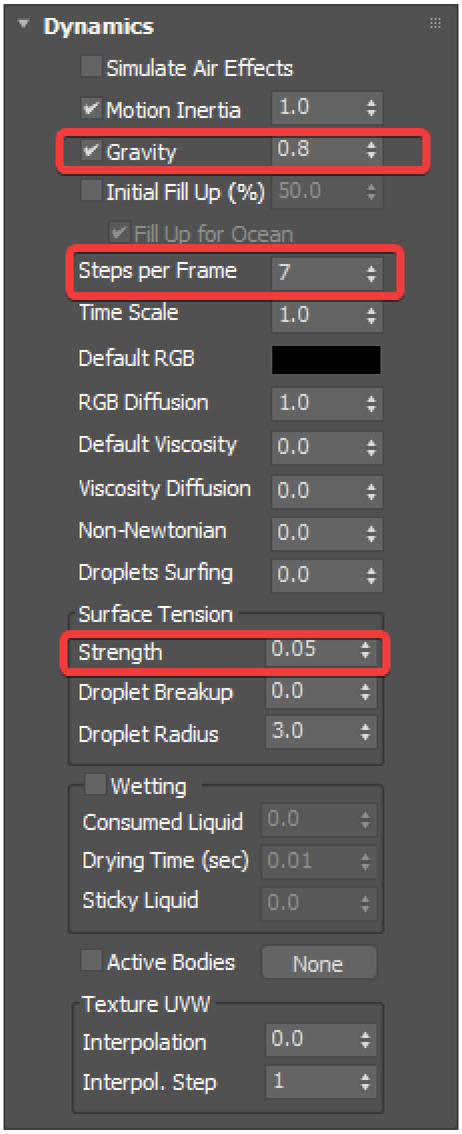
☑ Velocity

□ Viscosity

□ Texture UVW

Special None

The quality of the liquid's mesh depends on the Dynamics settings. In this setup the **Gravity** is set to **0.8**, the **Steps Per Frame** to **7**, Surface Tension **Strength** to **0.05**.



Dynamics

☐ Simulate Air Effects

☑ Motion Inertia 1.0

☑ Gravity 0.8

☐ Initial Fill Up (%) 50.0

☑ Fill Up for Ocean

Steps per Frame 7

Time Scale 1.0

Default RGB ■

RGB Diffusion 1.0

Default Viscosity 0.0

Viscosity Diffusion 0.0

Non-Newtonian 0.0

Droplets Surfing 0.0

Surface Tension

Strength 0.05

Droplet Breakup 0.0

Droplet Radius 3.0

☐ Wetting

Consumed Liquid 0.0

Drying Time (sec) 0.01

Sticky Liquid 0.0

☐ Active Bodies None

Texture UVW

Interpolation 0.0

Interpol. Step 1

First, let's look at **Steps Per Frame (SPF)**.

One of the most important parameters of the simulator, with significant impact on quality and performance. To understand how to use it, keep in mind that the simulation is a sequential process and happens step by step. **It produces good results if each simulation step introduces small changes**, but it's also a trade-off between performance and detail, as described below.

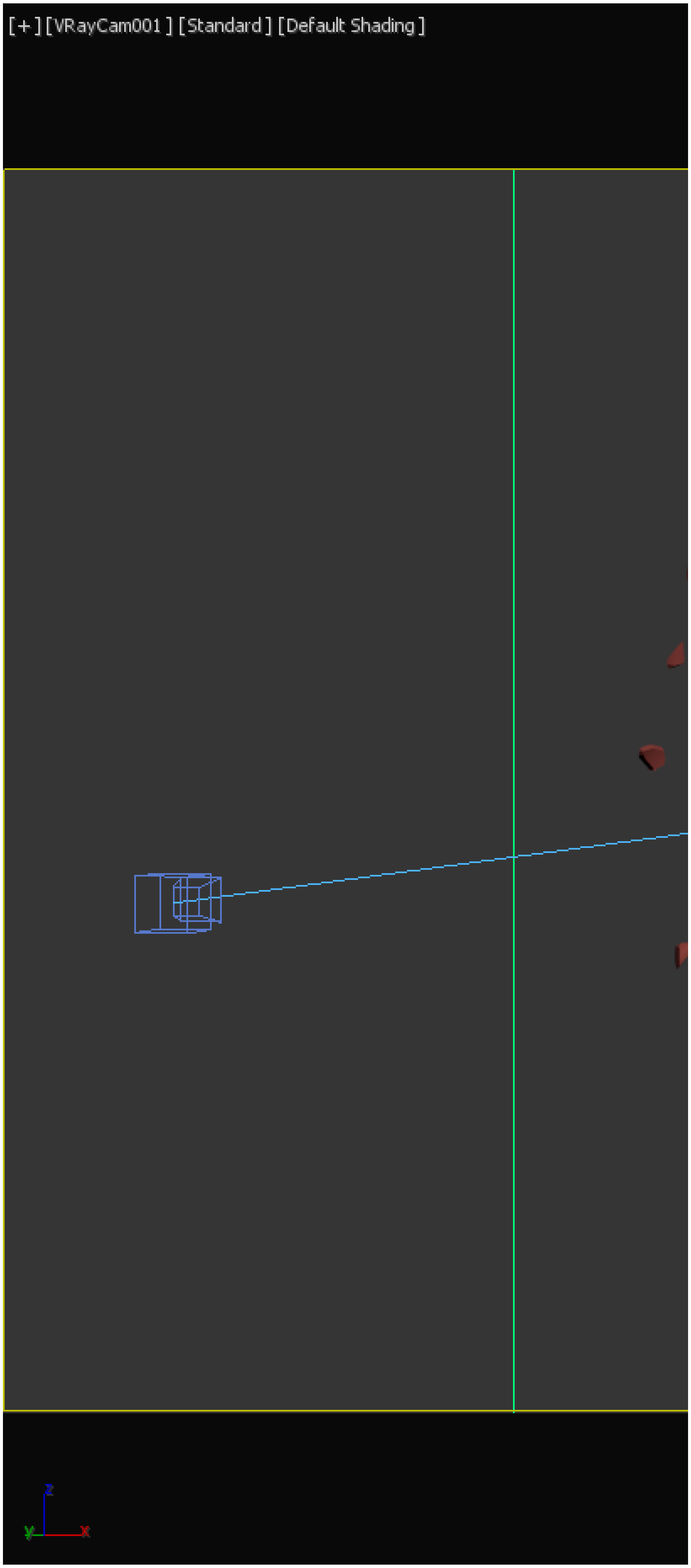
For example let's take an object that is hitting the liquid surface with high speed. If at the first step the object is far away from the water and at the second step, the object is already deep under the water - the result won't look good. You have to introduce intermediate steps until the changes of each step get small enough. The **Steps Per Frame** option creates these steps within each frame. A value of 1 means that there are no intermediate steps and each step is exported into the cache file. A value of 2 means that there is one intermediate step, i.e. each second step is exported to the cache file while the intermediate steps are just calculated, but not exported.

Signs that the **Steps Per Frame** need to be increased are:

- Liquid simulations have too many single liquid particles.
- Liquid simulations are torn and chaotic.
- Liquid simulations of streams have steps or other periodical artifacts.
- Fire/Smoke simulations have artifacts that produce a grainy appearance.

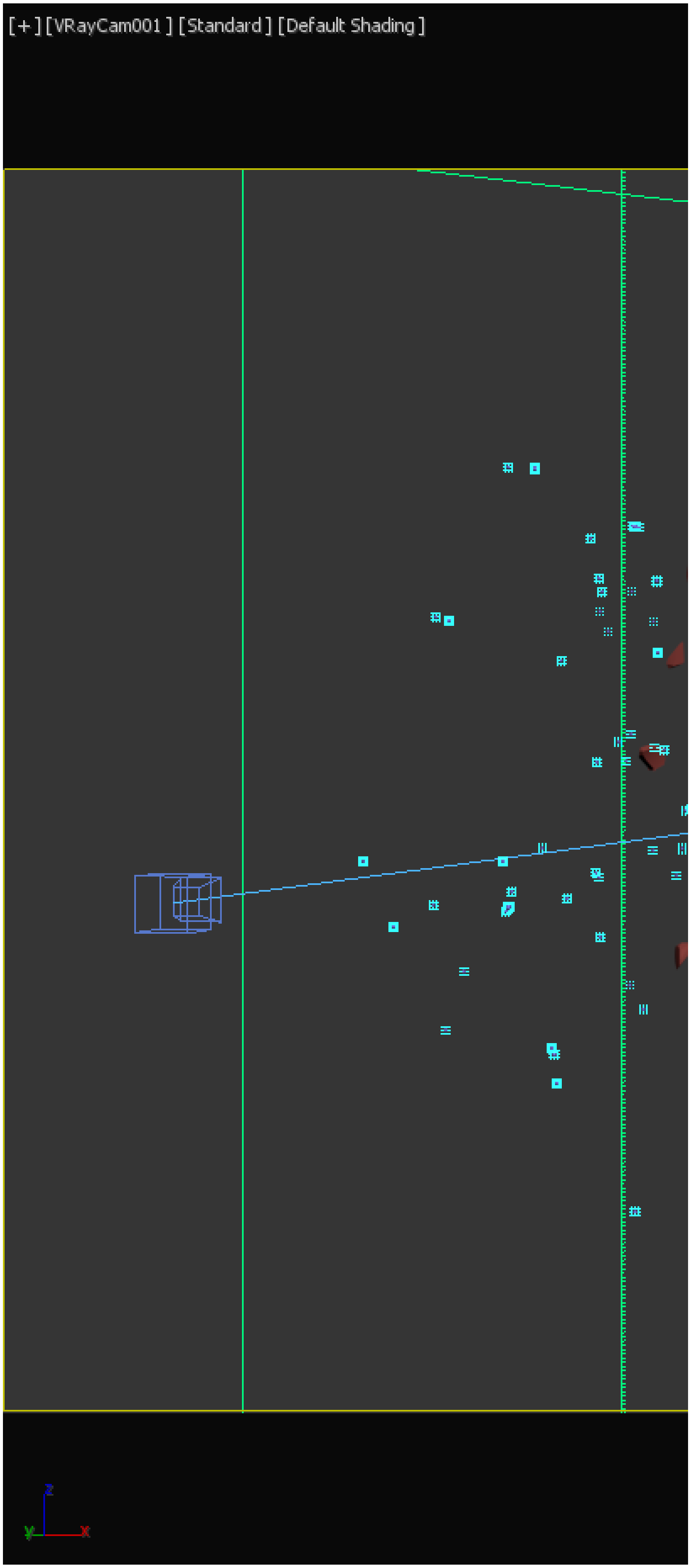
More often than not, those issues will be caused by the simulation moving too quickly (e.g. the emission from the source is very strong or the objects in the scene are moving very fast). In such cases you should use a higher **SPF**.

Keep in mind that **higher Steps Per Frame decreases the performance** in a linear way, i.e. if you increase the SPF twice, your simulation will go twice as slow. However, the quality does not have a linear relation to the SPF. Each simulation step kills fine details, and thus for maximum detail **i t's best to use the lowest possible SPF** that runs without any of the issues mentioned above. For additional information, please refer to Phoenix Explained.



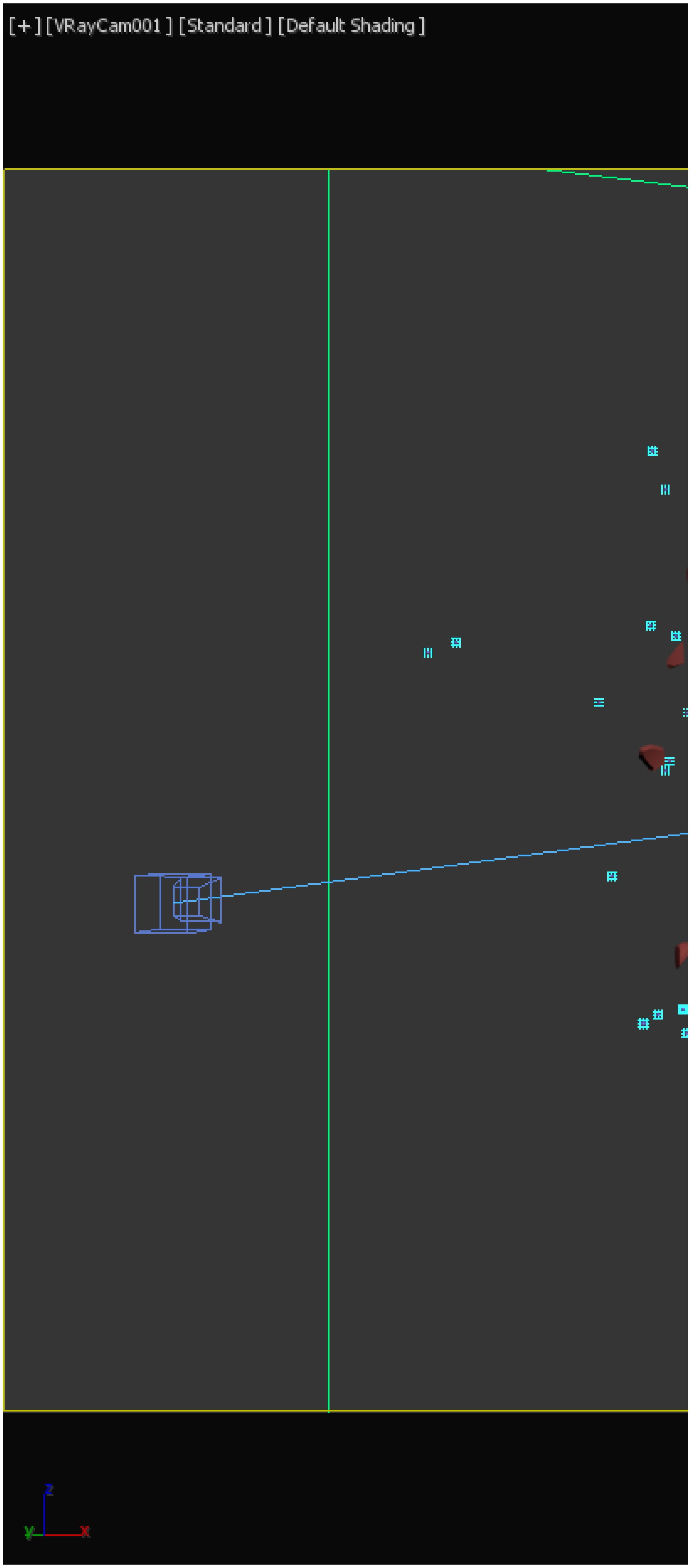
[+] [VRayCam001] [Standard] [Default Shading]

Steps Per Frame = 1


[+] [VRayCam001] [Standard] [Default Shading]
z
y
x

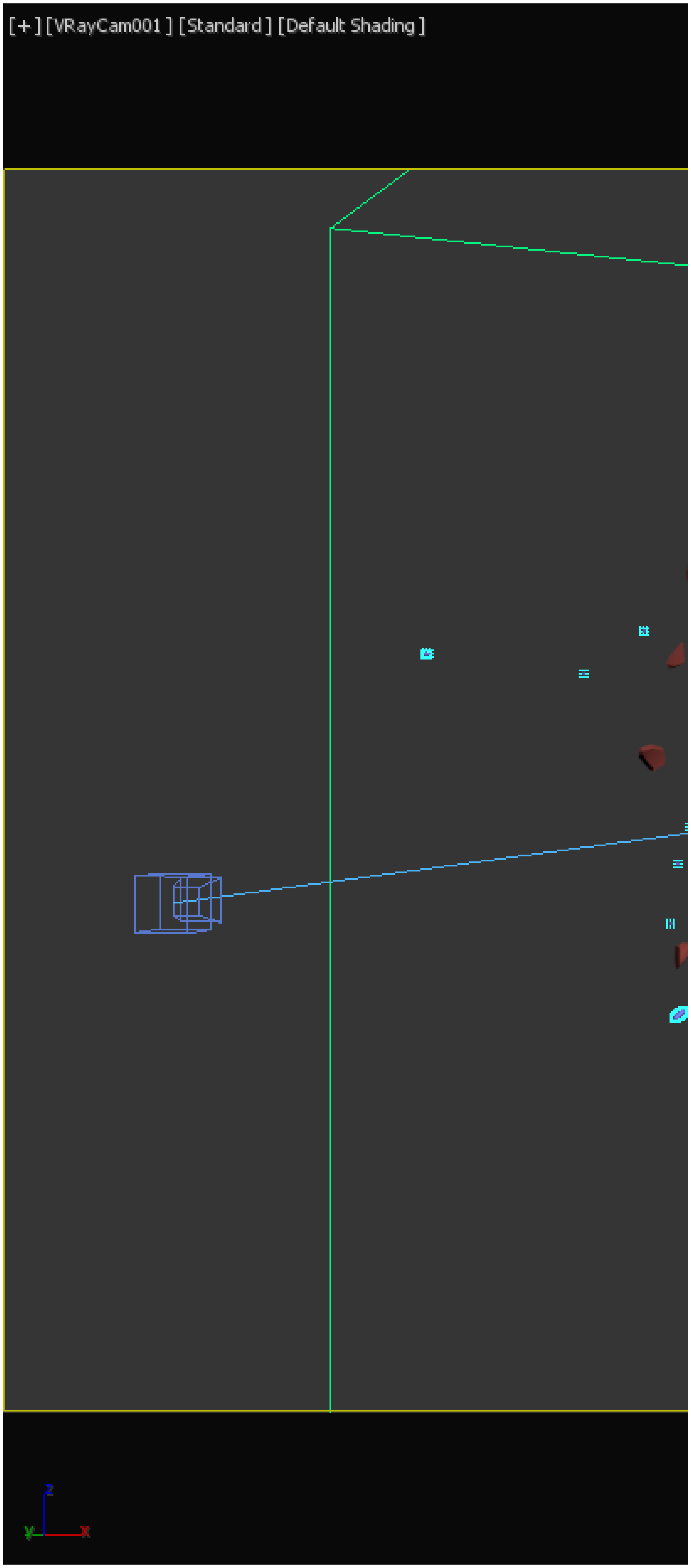
Steps Per Frame = 15

Next is the **Surface Tension Strength**. This parameter plays an important role in small-scale liquid simulations because an accurate simulation of surface tension indicates the small scale to the audience. Lower **Strength** values will cause the liquid to easily break apart into individual liquid particles, while higher values will make it harder for the liquid surface to split and will hold the liquid particles together.



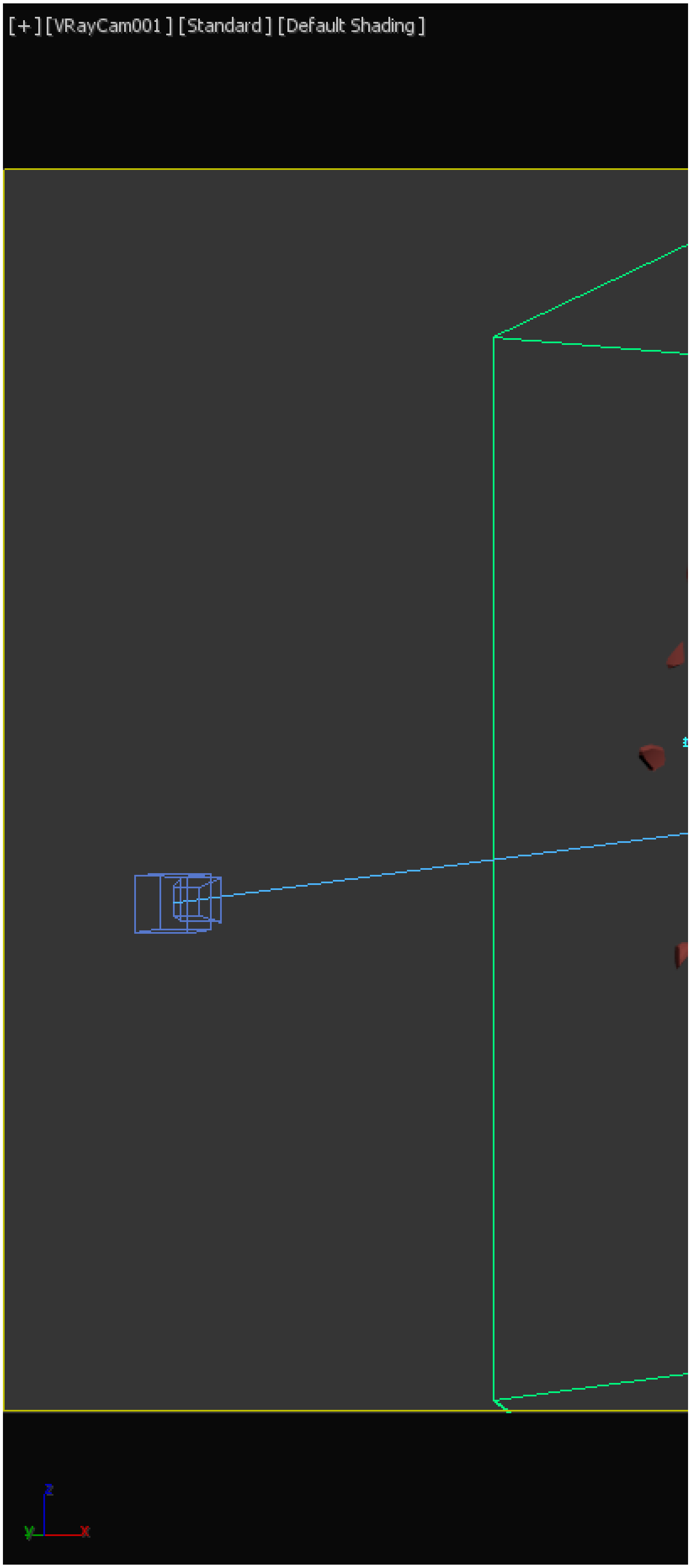
[+] [VRayCam001] [Standard] [Default Shading]

Strength = 0.0



[+] [VRayCam001] [Standard] [Default Shading]

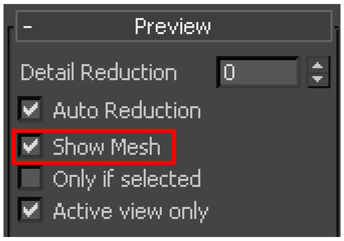
Strength = 0.2



[+] [VRayCam001] [Standard] [Default Shading]
z
y
x

Strength = 0.5

To preview the liquid as a mesh, simply enable the **Show Mesh** option in the Preview rollout. When enabled, shows the implicit surface as a mesh. This mode overrides the Voxel Preview mode.



– Preview

Detail Reduction 0

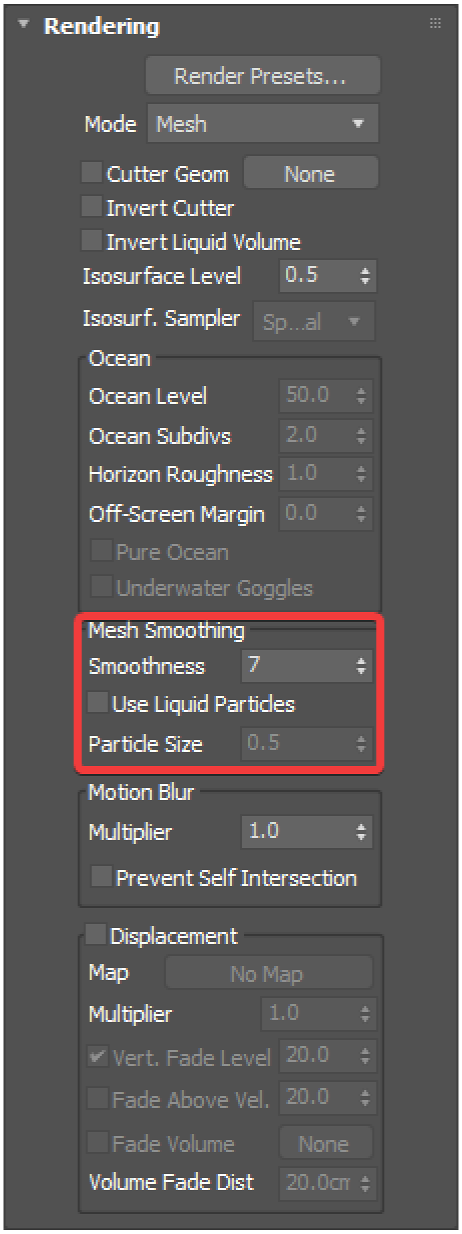
☑ Auto Reduction

☑ Show Mesh

□ Only if selected

☑ Active view only

By default, Phoenix uses a grid-based method for creating the mesh rather than a particle-based one. As a result, the mesh may appear jagged in places. These artifacts can be reduced by adjusting the **Smoothness** parameter in the Rendering rollout.



Rendering

Render Presets...

Mode: Mesh

□ Cutter Geom: None

□ Invert Cutter

□ Invert Liquid Volume

Isosurface Level: 0.5

Isosurf. Sampler: Sp...al

Ocean

Ocean Level: 50.0

Ocean Subdivs: 2.0

Horizon Roughness: 1.0

Off-Screen Margin: 0.0

□ Pure Ocean

□ Underwater Goggles

Mesh Smoothing

Smoothness: 7

□ Use Liquid Particles

Particle Size: 0.5

Motion Blur

Multiplier: 1.0

□ Prevent Self Intersection

□ Displacement

Map: No Map

Multiplier: 1.0

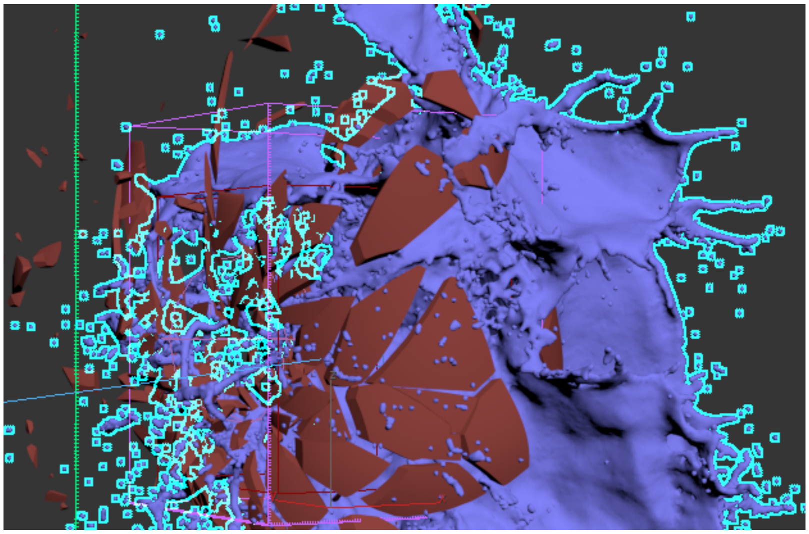
☑ Vert. Fade Level: 20.0

□ Fade Above Vel.: 20.0

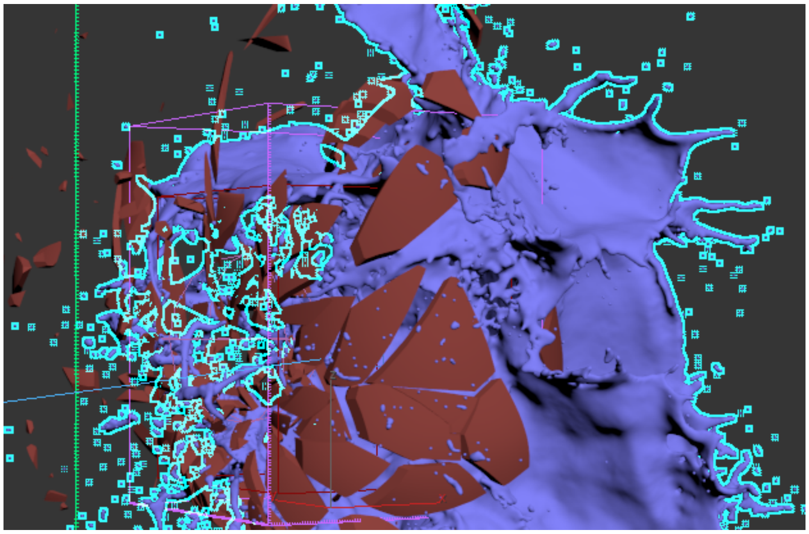
□ Fade Volume: None

Volume Fade Dist: 20.0cm

The example images show the simulation with different **Smoothness** values.



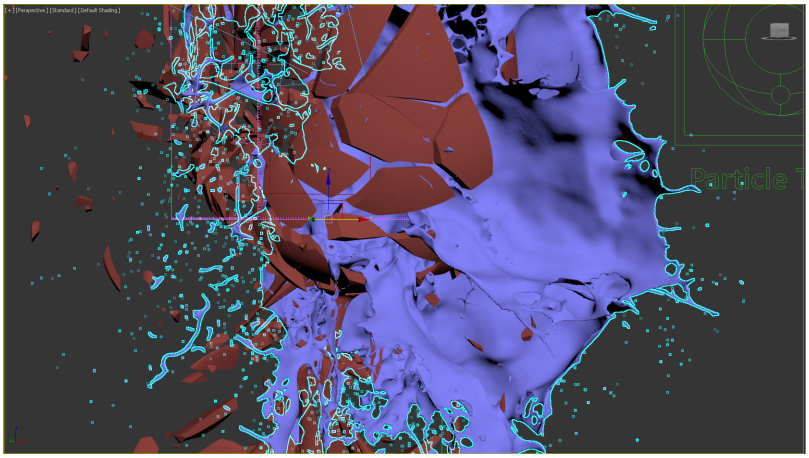
Smoothness = 0



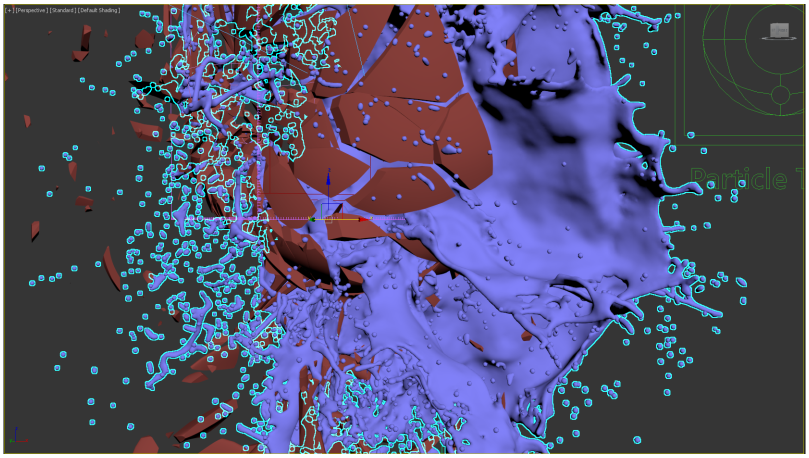
Smoothness = 100

Phoenix also offers a particle-based method for creating the liquid mesh that can be enabled through the **Use Liquid Particles** option. The resulting mesh will become thinner depending on the specified **Particle Size**.

We will leave **Use Liquid Particles disabled** for our scene.



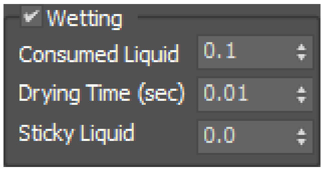
Particle Size = 0.2



Particle Size = 1.0

Wetting can be used to make liquids stick to the collision geometry in your scene. By default, all solid objects are affected but the option to disable the **Wetting** effect for a certain body can be found on the Phoenix Properties for that geometry.

Enable **Wetting**. Set the **Consumed Liquid** to **0.1** and the **Sticky Liquid** to **0**.



☑ Wetting

Consumed Liquid 0.1

Drying Time (sec) 0.01

Sticky Liquid 0.0

Particle Tuner

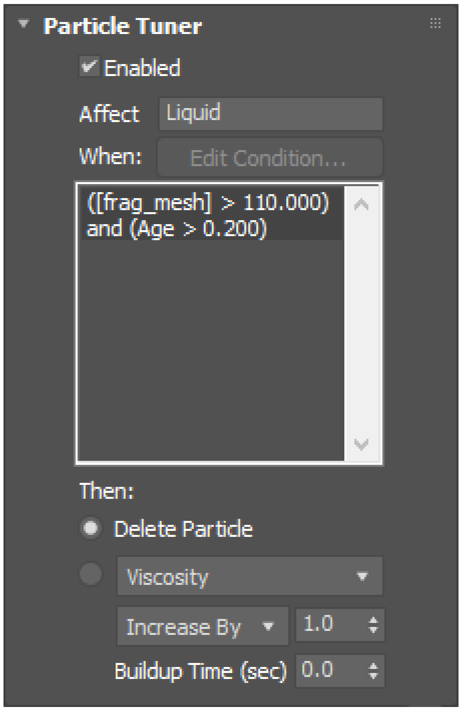
The Particle Tuner uses expression operators to directly affect the particles of the Phoenix Simulator. It goes through all particles in the simulation and changes the values of these that pass a certain condition.

While creating turbulent liquid simulations it could happen that a particle or two are moving way too fast. In combination with the Adaptive grid this could lead to an increased simulation time.

In this tutorial the Particle Tuner is added for deleting the particles that are far away from the glass and are only increasing the simulator's Adaptive Grid size.

The **Particle Tuner expression tree** is created as follows:

- If the **Distance to** the "frag_mesh" mesh is **Greater Than 110** and If the **Age** is **Greater Than 0.200**.
- Then **Delete Particle**.



Particle Tuner

☑ Enabled

Affect: Liquid

When: Edit Condition...

([frag_mesh] > 110.000) and (Age > 0.200)

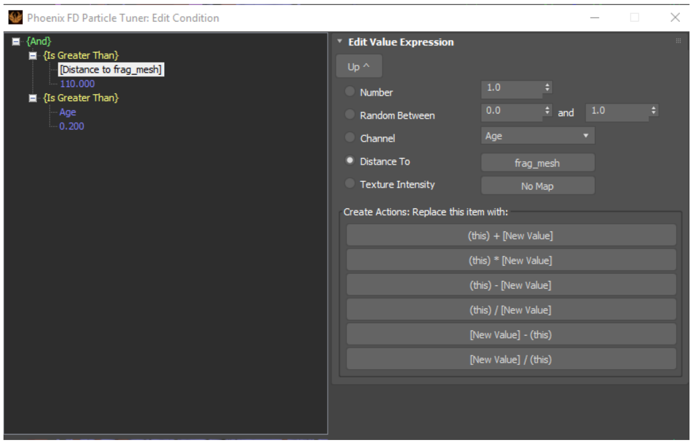
Then:

● Delete Particle

○ Viscosity

Increase By: 1.0

Buildup Time (sec): 0.0



Phoenix FD Particle Tuner: Edit Condition

```
{And}
  {Is Greater Than}
    [Distance to frag_mesh]
    110.000
  {Is Greater Than}
    Age
    0.200
```

Edit Value Expression

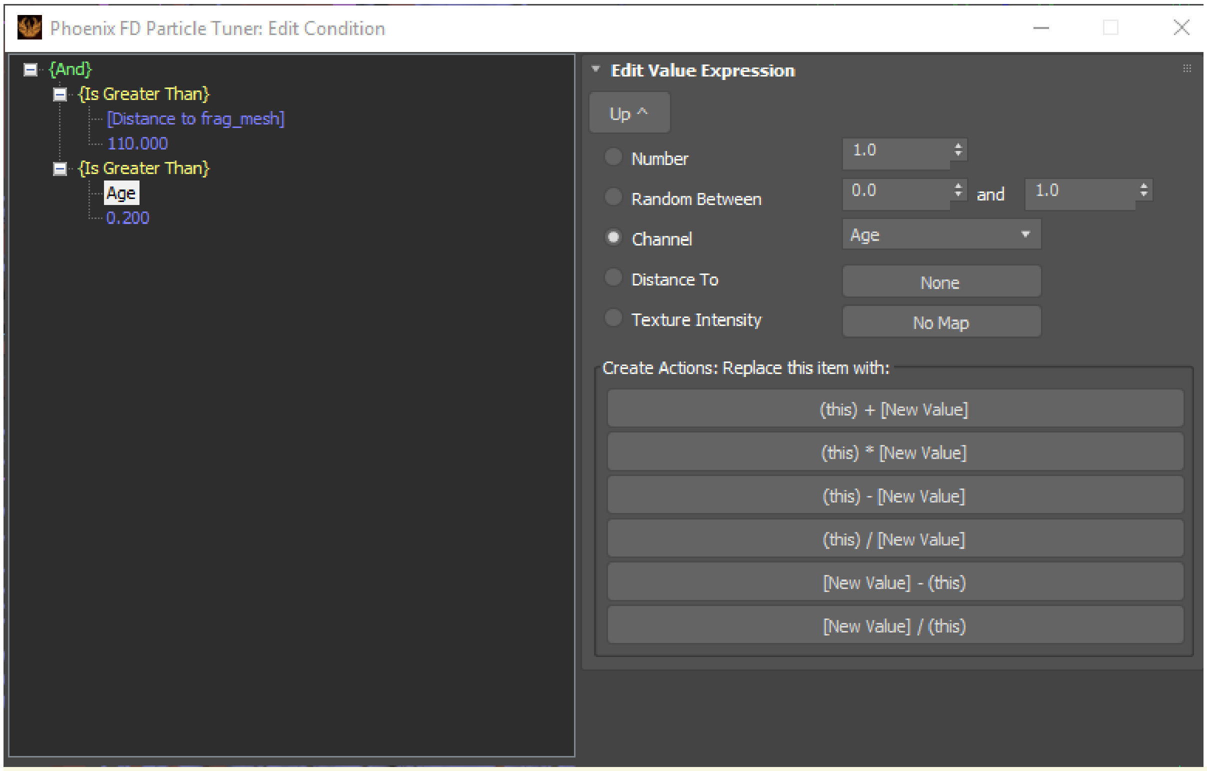
○ Number: 1.0

○ Random Between: 0.0 and 1.0

○ Channel: Age

● Distance To: frag_mesh

○ Texture Intensity: No Map



Phoenix FD Particle Tuner: Edit Condition

```
{And}
  {Is Greater Than}
    [Distance to frag_mesh]
    110.000
  {Is Greater Than}
    Age
    0.200
```

Edit Value Expression

○ Number 1.0

○ Random Between 0.0 and 1.0

● Channel Age

○ Distance To None

○ Texture Intensity No Map

Create Actions: Replace this item with:

When using the Age channel as a condition in the Particle Tuner - make sure that the Age checkbox for the affected particle group is enabled in the Output rollout of the simulator.
It is very important to pick the correct mesh for the distance expression. In this case "frag_mesh" mesh should be selected, because this is the existing one in the scene after the 2nd frame of the animation.

Materials

Glass Material

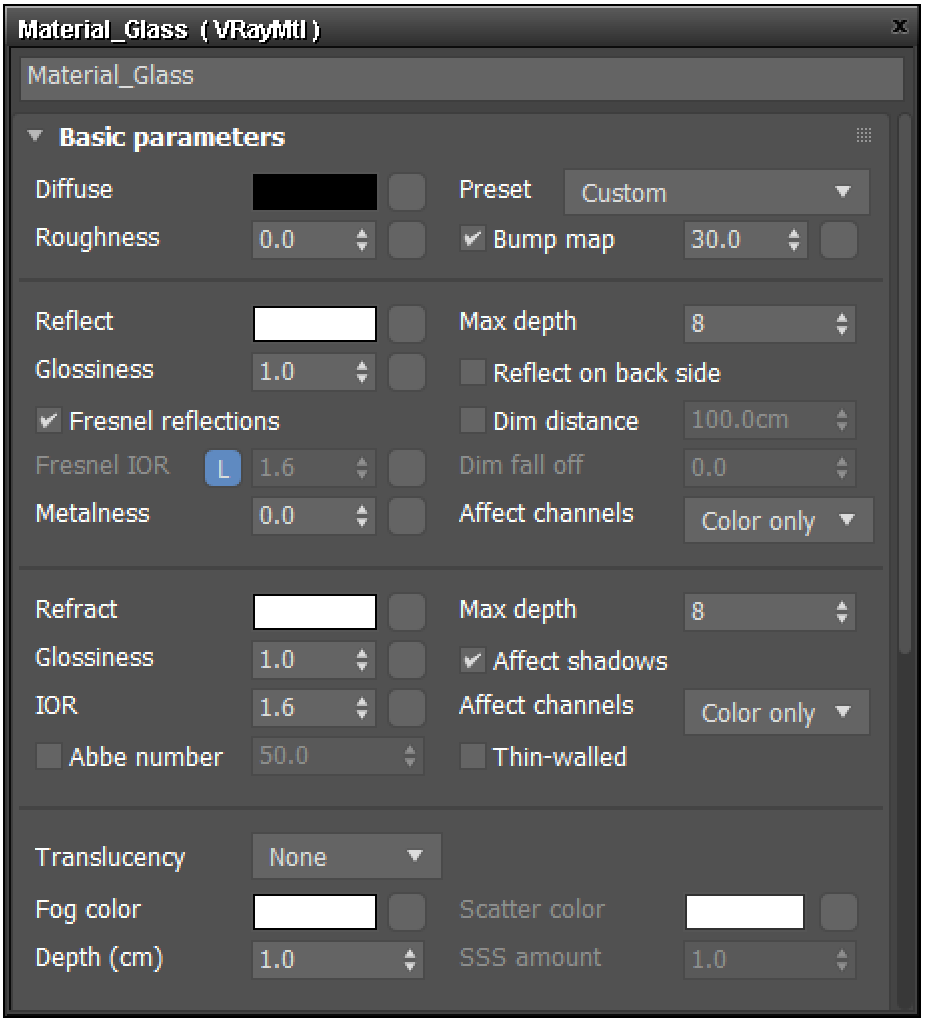
To create a realistic glass material:

Set the **Diffuse** color to **RGB [0, 0, 0]**.

Set the **Reflect** and **Refract** colors to **RGB [255, 255, 255]**.

Set the **IOR** to **1.6**.

Set the **Refraction** and **Reflection Max depth** to **8**.



Material_Glass (VRayMtl)

Material_Glass

Basic parameters

Diffuse ■ Preset Custom

Roughness 0.0 ☑ Bump map 30.0

Reflect □ Max depth 8

Glossiness 1.0 □ Reflect on back side

☑ Fresnel reflections □ Dim distance 100.0cm

Fresnel IOR L 1.6 Dim fall off 0.0

Metalness 0.0 Affect channels Color only

Refract □ Max depth 8

Glossiness 1.0 ☑ Affect shadows

IOR 1.6 Affect channels Color only

□ Abbe number 50.0 □ Thin-walled

Translucency None

Fog color □ Scatter color □

Depth (cm) 1.0 SSS amount 1.0

Wine Material

To create a realistic red wine material:

Set the **Diffuse** color to **RGB [0, 0, 0]**.

Set the **Reflect** and **Refract** colors to **RGB [255, 255, 255]**.

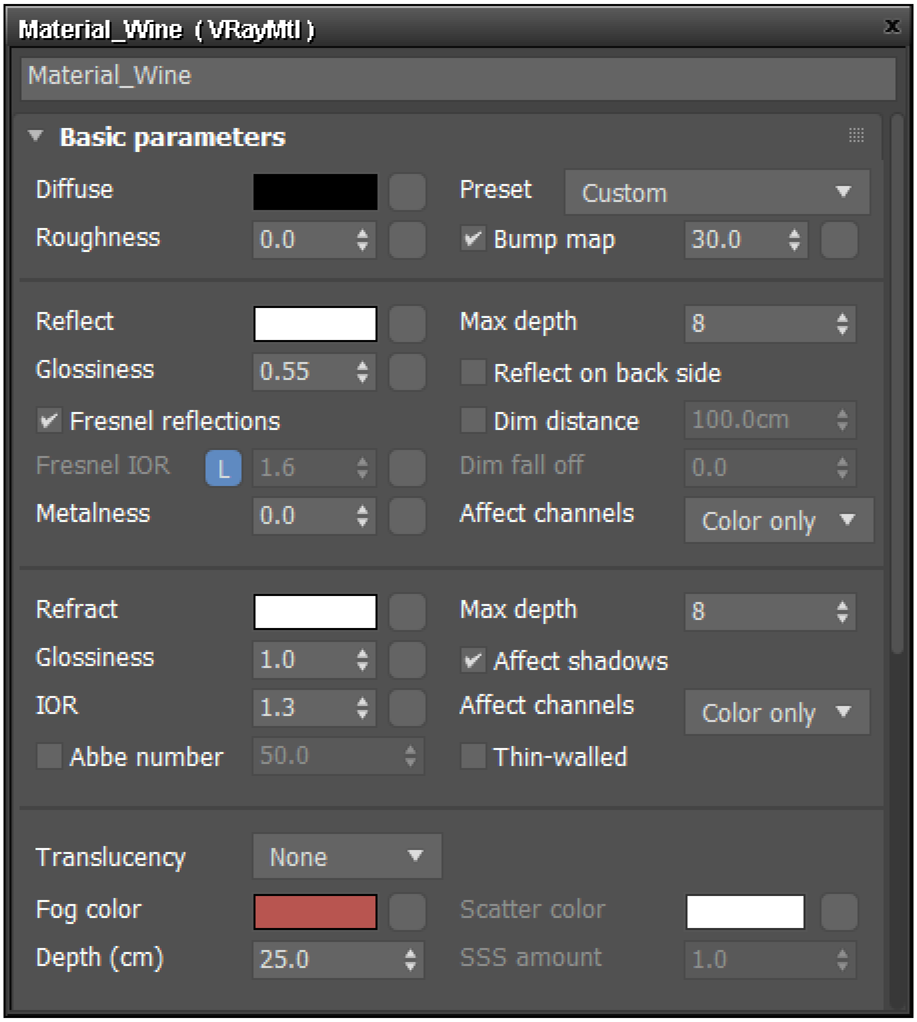
Set the **Glossiness** to **0.55**.

Set the **IOR** to **1.3**.

Set the **Reflection** and **Refraction Max depth** to **8**.

Set the **Fog color** to **RGB [125, 23, 20]**.

Set the **Fog Depth** to **25**.



Material_Wine (VRayMtl)

Material_Wine

Basic parameters

Diffuse	■	Preset	Custom ▼
Roughness	0.0	☑ Bump map	30.0
Reflect	□	Max depth	8
Glossiness	0.55	□ Reflect on back side	
☑ Fresnel reflections		□ Dim distance	100.0cm
Fresnel IOR L	1.6	Dim fall off	0.0
Metalness	0.0	Affect channels	Color only ▼
Refract	□	Max depth	8
Glossiness	1.0	☑ Affect shadows	
IOR	1.3	Affect channels	Color only ▼
□ Abbe number	50.0	□ Thin-walled	
Translucency	None ▼		
Fog color	🟥	Scatter color	□
Depth (cm)	25.0	SSS amount	1.0

Lighting and Camera

The source of illumination in the scene is a single **V-Ray Dome Light**.

Select the **V-Ray Dome Light** and enable **Map**.

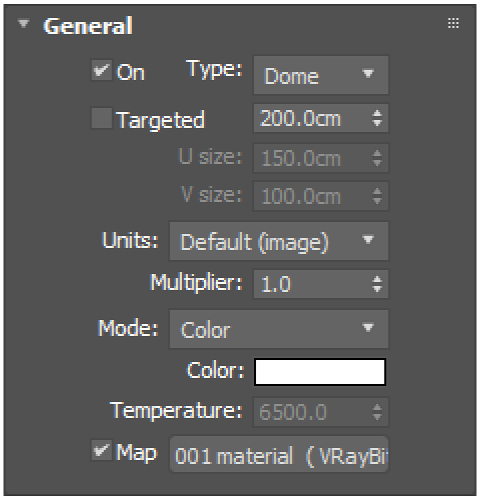
Press on the **Cosmos** icon in the V-Ray toolbar. In the HDRIs section   Studio   choose *Studio 001*. Press the green arrow to Import the HDR map. Chaos Cosmos will plug the selected HDR map in the Texture slot.

The exact **position** of the **V-Ray Light** is XYZ: **[4500, 0, 0]**.

Starting with V-Ray 5, the VRayHDRI map is renamed to VRayBitmap.

Set the **Multiplier** to **1**.

Make the Dome Light **Invisible** in the rendered image from the Options tab.



General

☑ On Type: Dome

□ Targeted 200.0cm

U size: 150.0cm

V size: 100.0cm

Units: Default (image)

Multiplier: 1.0

Mode: Color

Color: □

Temperature: 6500.0

☑ Map 001 material (VRayBi

For this setup a VRayPhysicalCamera is used.

The **Film Gate** is set to **36.0**.

The **Focal Length** is set to **40.0**.

The **Film Speed (ISO)** is set to **100**.

The **F-Number** is set to **2.0**.

The **Shutter Speed** is set to **200**.

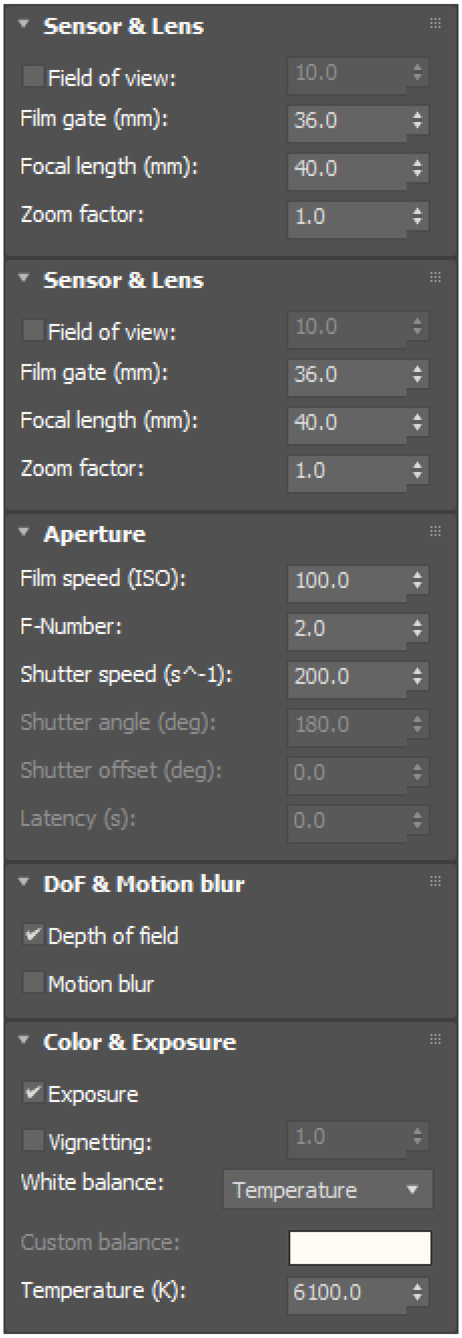
The **Depth of field** is **enabled**.

The **Exposure** is **enabled** and the **Temperature** is set to **6100 K**.

In this tutorial the exact position of the **Camera** is **[-425, -750, 200]**

and of the **Camera Target** is **[-16, -65, 187]**.

The final scene contains a second camera that can be used for closer shots.



Sensor & Lens

□ Field of view: 10.0

Film gate (mm): 36.0

Focal length (mm): 40.0

Zoom factor: 1.0

Sensor & Lens

□ Field of view: 10.0

Film gate (mm): 36.0

Focal length (mm): 40.0

Zoom factor: 1.0

Aperture

Film speed (ISO): 100.0

F-Number: 2.0

Shutter speed (s^-1): 200.0

Shutter angle (deg): 180.0

Shutter offset (deg): 0.0

Latency (s): 0.0

DoF & Motion blur

☑ Depth of field

□ Motion blur

Color & Exposure

☑ Exposure

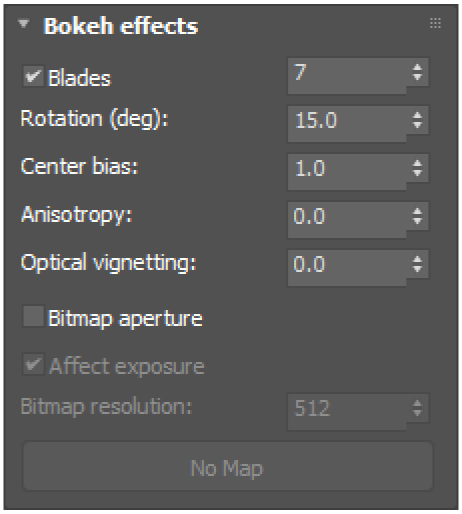
□ Vignetting: 1.0

White balance: Temperature

Custom balance:

Temperature (K): 6100.0

In the **Bokeh effects** section, set the **Blades** to **7**, the **Rotation (deg)** to **15.0**, and the **center bias** to **1.0**. This will add some imperfect details to the lens.


Bokeh effects

☑ Blades 7

Rotation (deg): 15.0

Center bias: 1.0

Anisotropy: 0.0

Optical vignetting: 0.0

☐ Bitmap aperture

☑ Affect exposure

Bitmap resolution: 512

No Map

Render Settings

The **Image Sampler Type** is set to **Bucket**.

The **Max subdivs** are set to **4**.

The **Bucked width** is set to **16.0**.

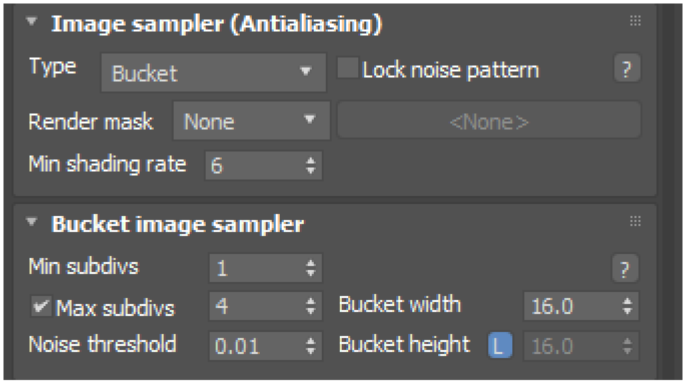


Image sampler (Antialiasing)

Type: Bucket ☐ Lock noise pattern ?

Render mask: None <None>

Min shading rate: 6

Bucket image sampler

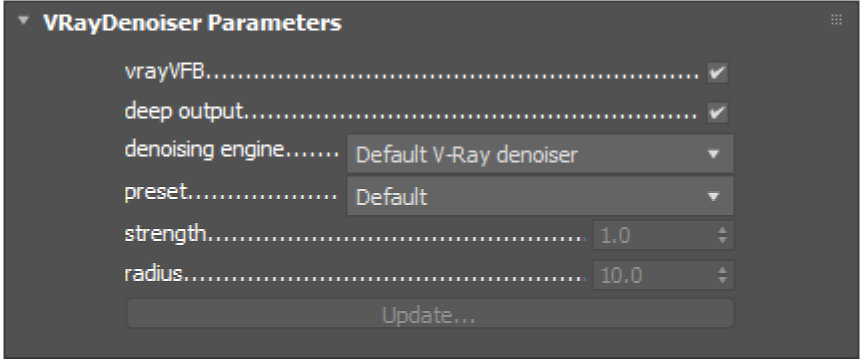
Min subdivs: 1 ?

☑ Max subdivs: 4 Bucket width: 16.0

Noise threshold: 0.01 Bucket height: L 16.0

A **V-Ray Denoiser Render Element** is added to the final image. The Denoiser takes an existing render and applies a denoising operation to it after the image is completely rendered in order to remove the noise in the image.

For this tutorial the **Default** settings of the element are used.


VRayDenoiser Parameters

vrayVFB.......... ☑

deep output.......... ☑

denoising engine....... Default V-Ray denoiser

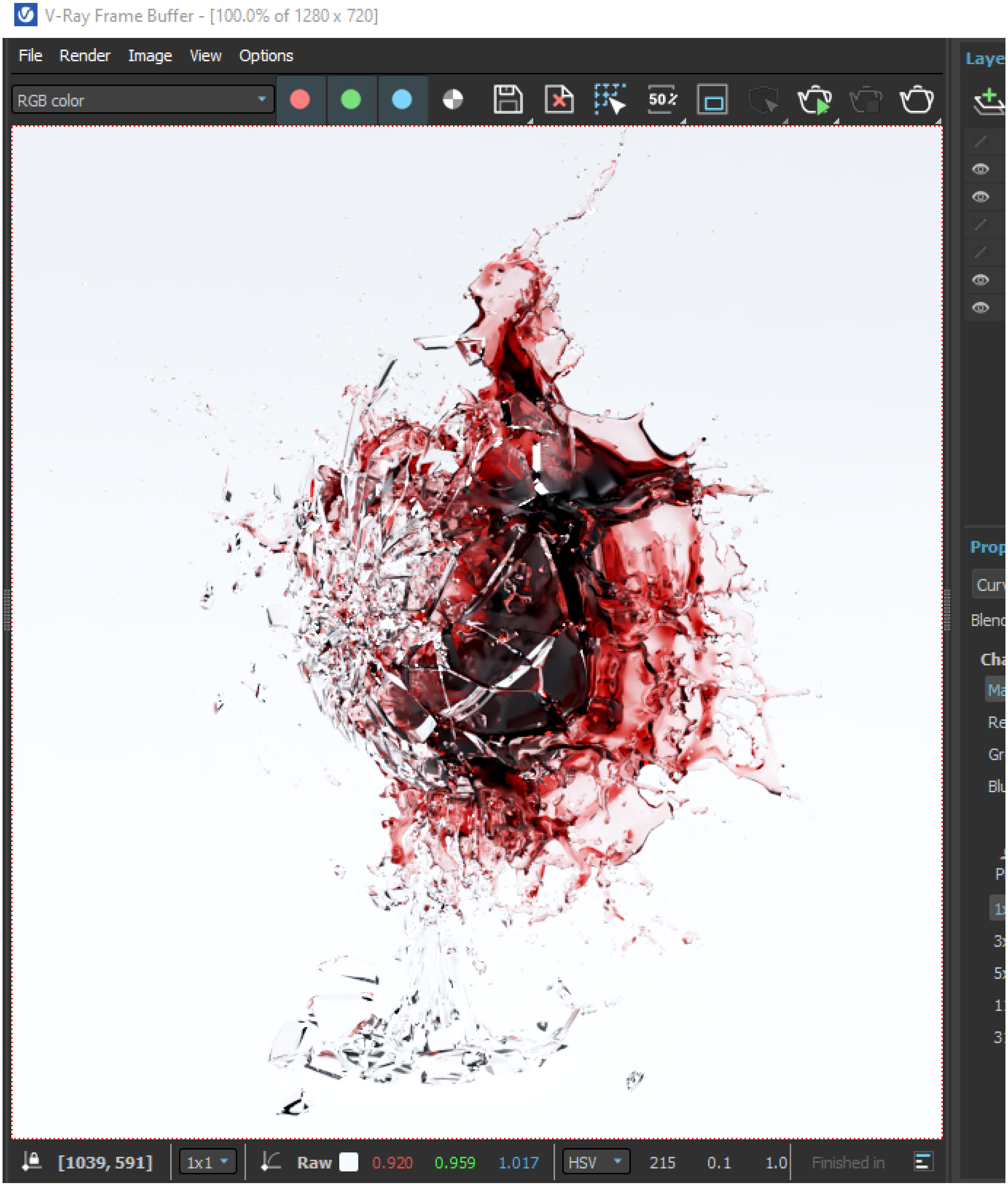
preset.......... Default

strength.......... 1.0

radius.......... 10.0

Update...

The V-Ray Physical Camera offers additional exposure controls, but you can also fine-tune renders using the V-Ray Frame Buffer. In this case the **Curves** setting is used to add more contrast to the image.



Final Results