

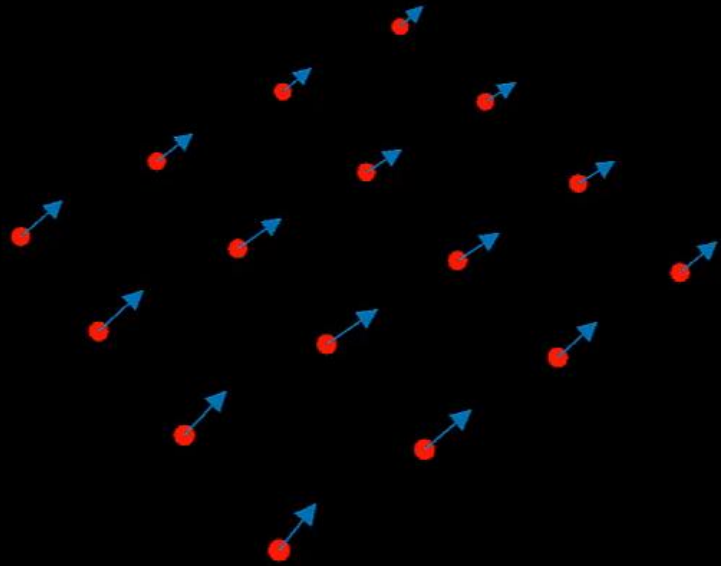
# Bifrost Workshop

## Lesson 5

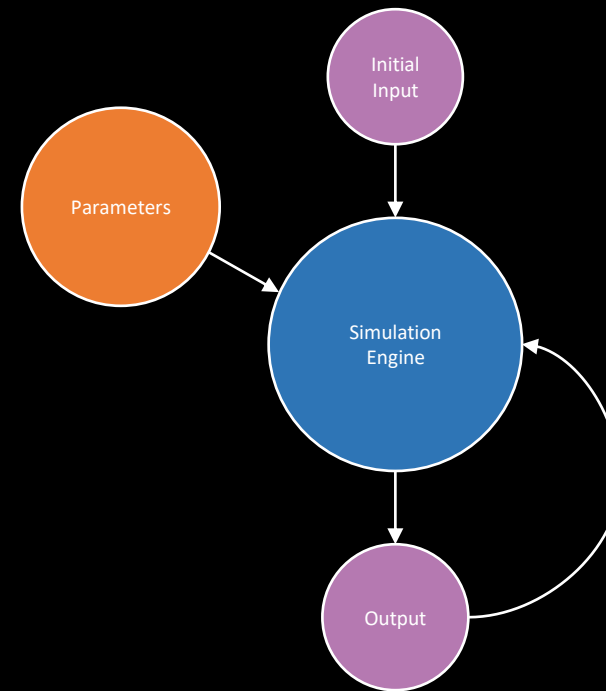
### Simulation Basics

- Particles
- Aero: smoke
- Aero: fire

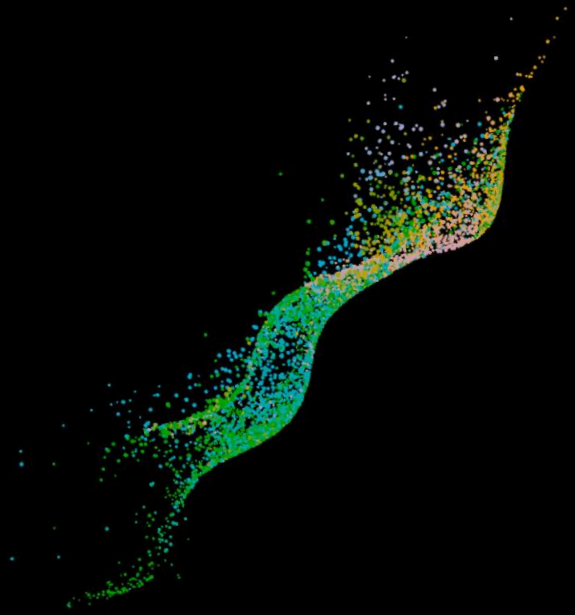
## What is a simulation?



Simulation is the imitation a real-world process over time. It predicts the behavior of the system using a mathematical model with a set of parameters. The output of one step will become the input of the next step.



## Types of Simulations



Particles

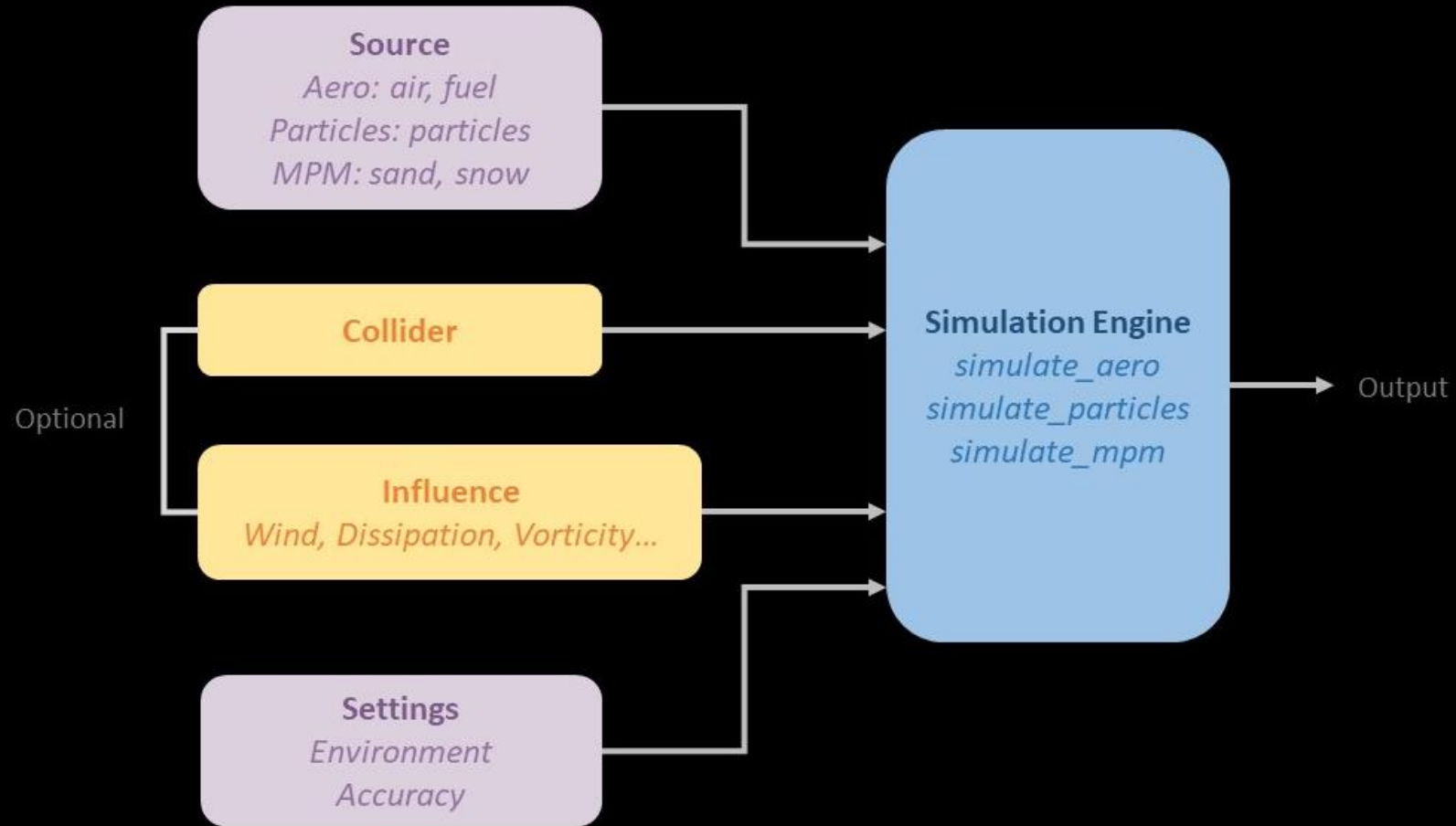


Aero

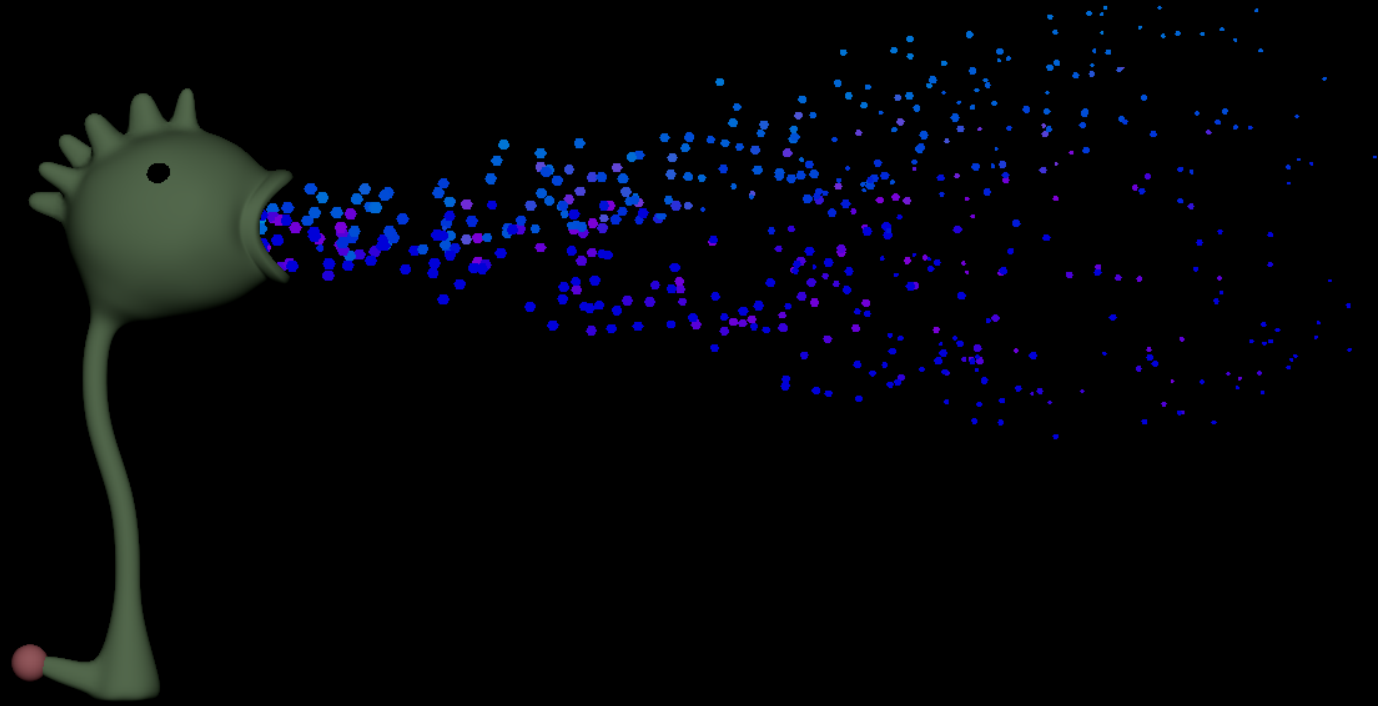


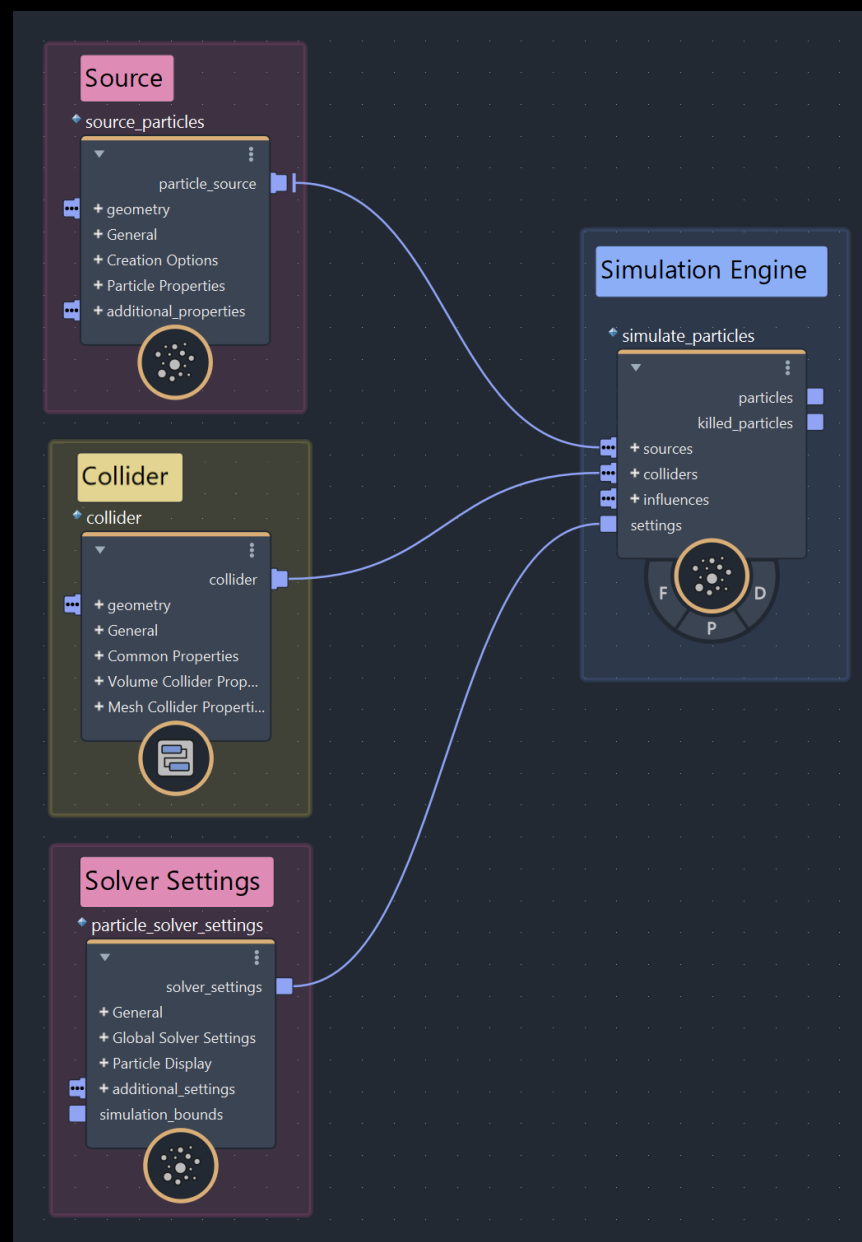
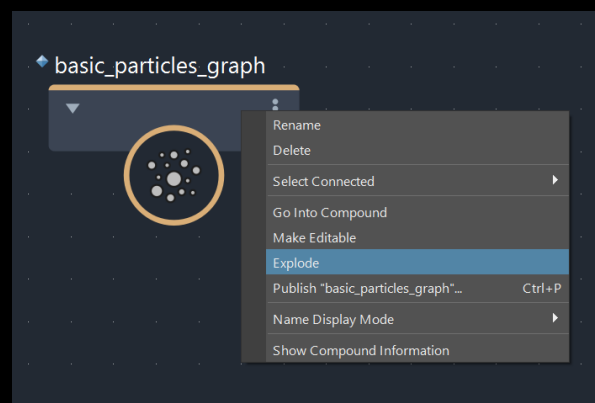
MPM (Material Particle Method)

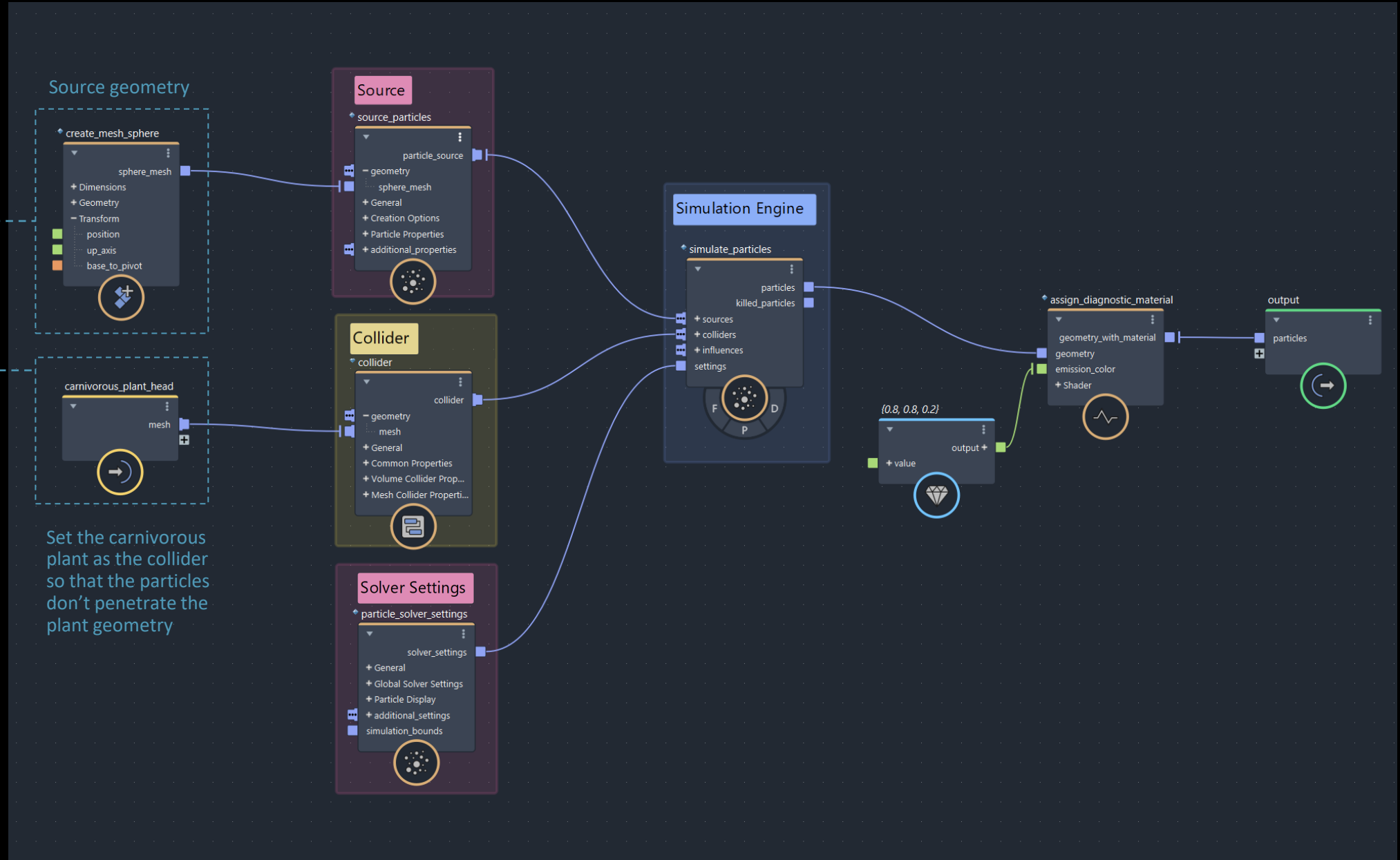
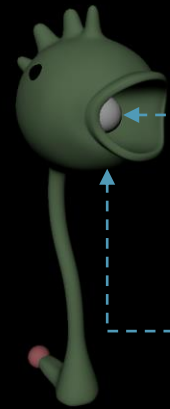
## Main Components of a Simulation Graph

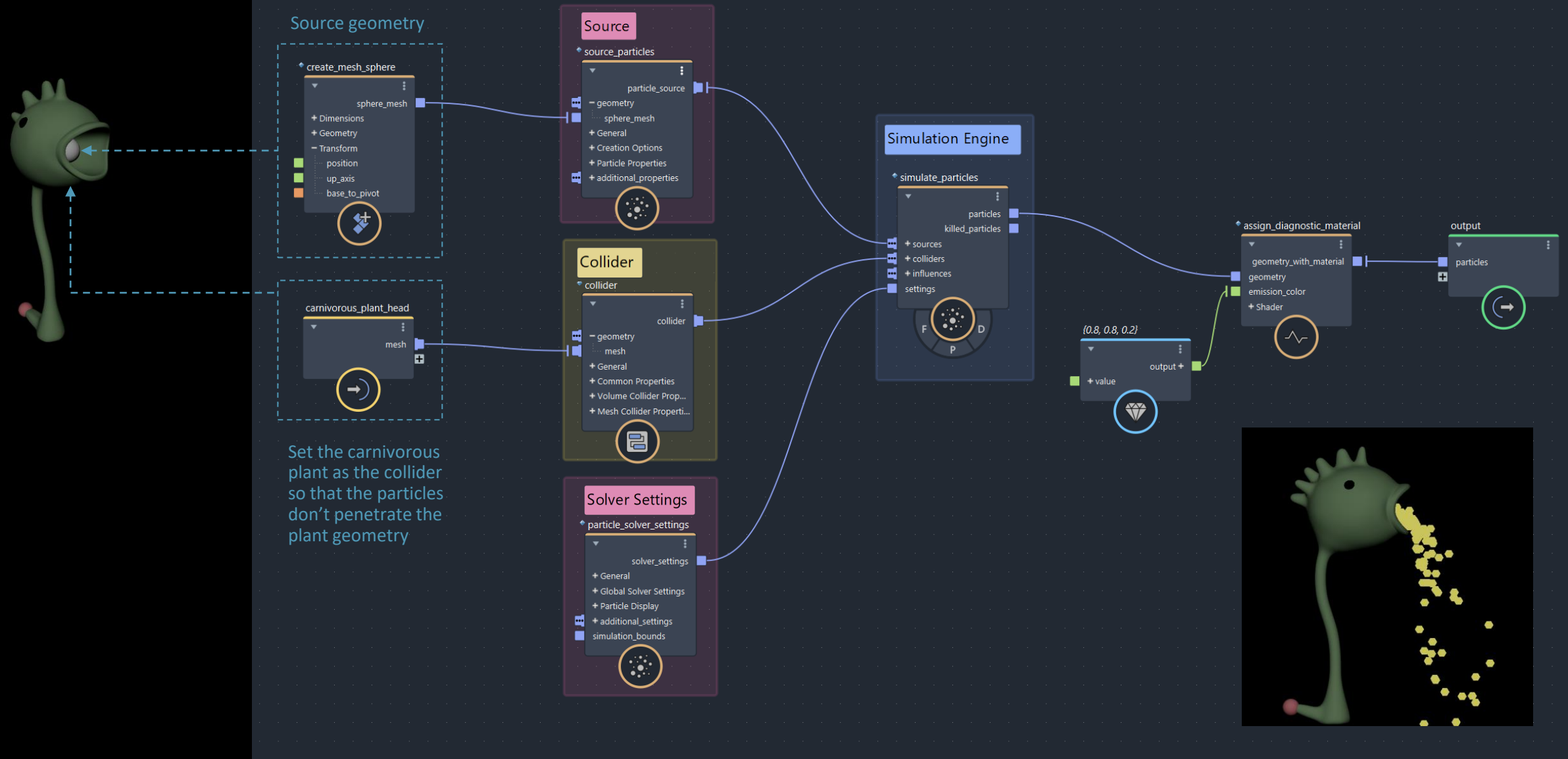


## Particle Simulation











# Particle Simulation

## Adjust Parameters

**source\_particles**  
Type: source\_particles

**General**

- Enable: ☒
- Start Frame: 1
- Use End Frame: ☐
- End Frame: 24

**Creation Options**

- Distribution: Surface
- Volume Detail Size: 0.3
- Rate: 2
- Rate Mode: Count
- Passthrough Points: ☐

**Particle Properties**

- Speed: 2
- Direction: 0, 0, 1
- Normal Speed: 0
- Spread: 0.2
- Inherit Velocity: 0
- Bounciness: 0.5
- Live Forever: ☐
- Age Limit: 10
- Size: 0.05

**Node Network:**

- create\_mesh\_sphere** (Source) → **source\_particles** (Source)
- carnivorous\_plant\_head** (Geometry) → **collider** (Collider)
- source\_particles** → **simulate\_particles** (Simulation Engine)
- collider** → **simulate\_particles**
- simulate\_particles** → **assign\_diagnostic\_material** (Material)
- assign\_diagnostic\_material** → **output** (Output)
- simulate\_particles** → **Solver Settings** (Solver Settings)

**Simulation Engine Settings:**

- simulate\_particles: particles, killed\_particles
- + sources
- + colliders
- + influences
- settings: F, D, P

**Solver Settings:**

- particle\_solver\_settings: solver\_settings
- + General
- + Global Solver Settings
- + Particle Display
- + additional\_settings
- simulation\_bounds

**Assign Diagnostic Material Settings:**

- assign\_diagnostic\_material: geometry\_with\_material, geometry, emission\_color, + Shader

**Output Settings:**

- output: particles

**Particle Properties Explanations:**

- Speed: Initial speed of the particles
- Direction: Set the direction of the emission to be along z axis
- Normal Speed: Speed along normal direction of the source geometry
- Spread: 0: along the defined direction, 0.5: randomly perturb the defined direction to a spread of 180 degree
- Age Limit: Lifespan of the particles in seconds
- Size: Particle size

**3D Preview:** A green creature head (carnivorous\_plant\_head) is shown emitting a cloud of yellow particles (output) against a black background.

# Particle Simulation

## Adjust Parameters

**particle\_solver\_settings**  
Type: particle\_solver\_settings

**General**

- Use Master Start Frame: ☐
- Master Start Frame: 1
- Label Point Id: ☒

**Global Solver Settings**

- Gravity: ☒
- Gravity Vector: 0, 0, 0
- Substeps: 1
- Simulation Speed: 1

**Collision Options**

- Self Collisions: ☐
- Spin On Collision: ☐
- Collision Spin: 0.3
- Viscosity: 0
- Store Self Collisions: ☐
- Store Surface Collisions: ☐

**Particle Display**

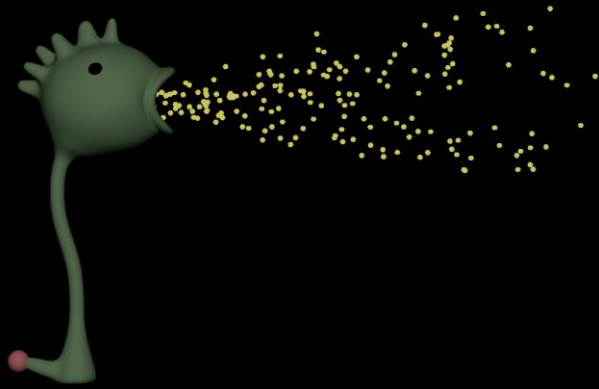
- Shape: Sphere
- Numeric Property: point\_position
- Face Camera: ☐
- Simulation Bounds: ☐

**Diagram Components:**

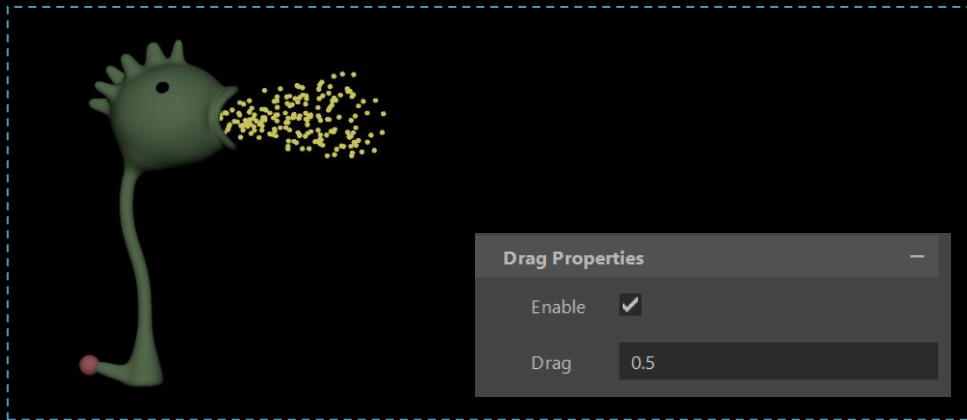
- Source:** create\_mesh\_sphere (sphere\_mesh) → source\_particles (particle\_source)
- Collider:** carnivorous\_plant\_head (mesh) → collider (collider)
- Simulation Engine:** simulate\_particles (particles, killed\_particles, sources, colliders, influences, settings)
- Solver Settings:** particle\_solver\_settings (solver\_settings)
- Output:** assign\_diagnostic\_material (geometry\_with\_material, emission\_color, Shader) → output (particles)

**Annotations:**

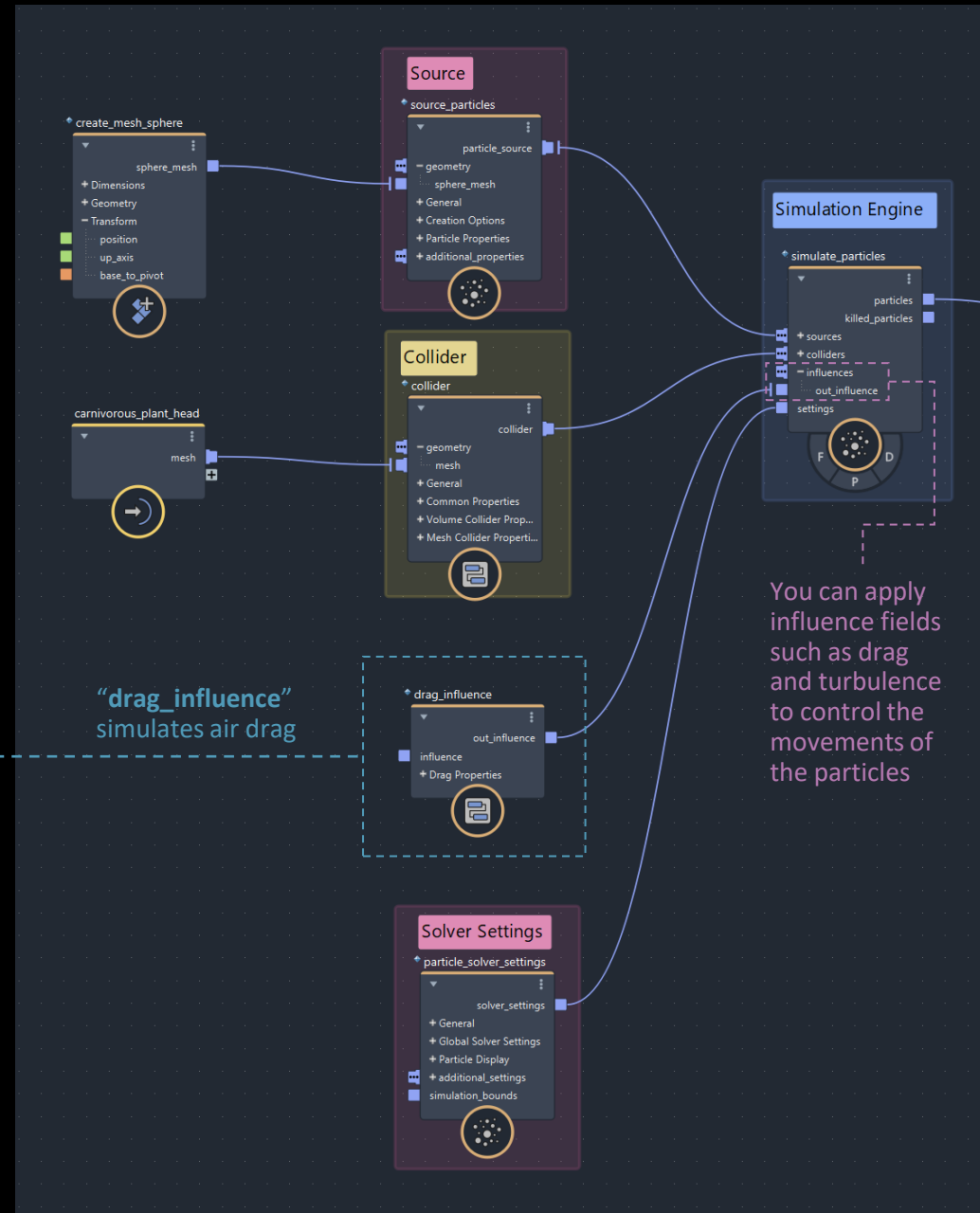
- Turn off the gravity to prevent the particles from falling to the ground (points to Gravity Vector field).
- The fluid's resistance to deformation (points to Viscosity field).



No drag influence, frame = 100



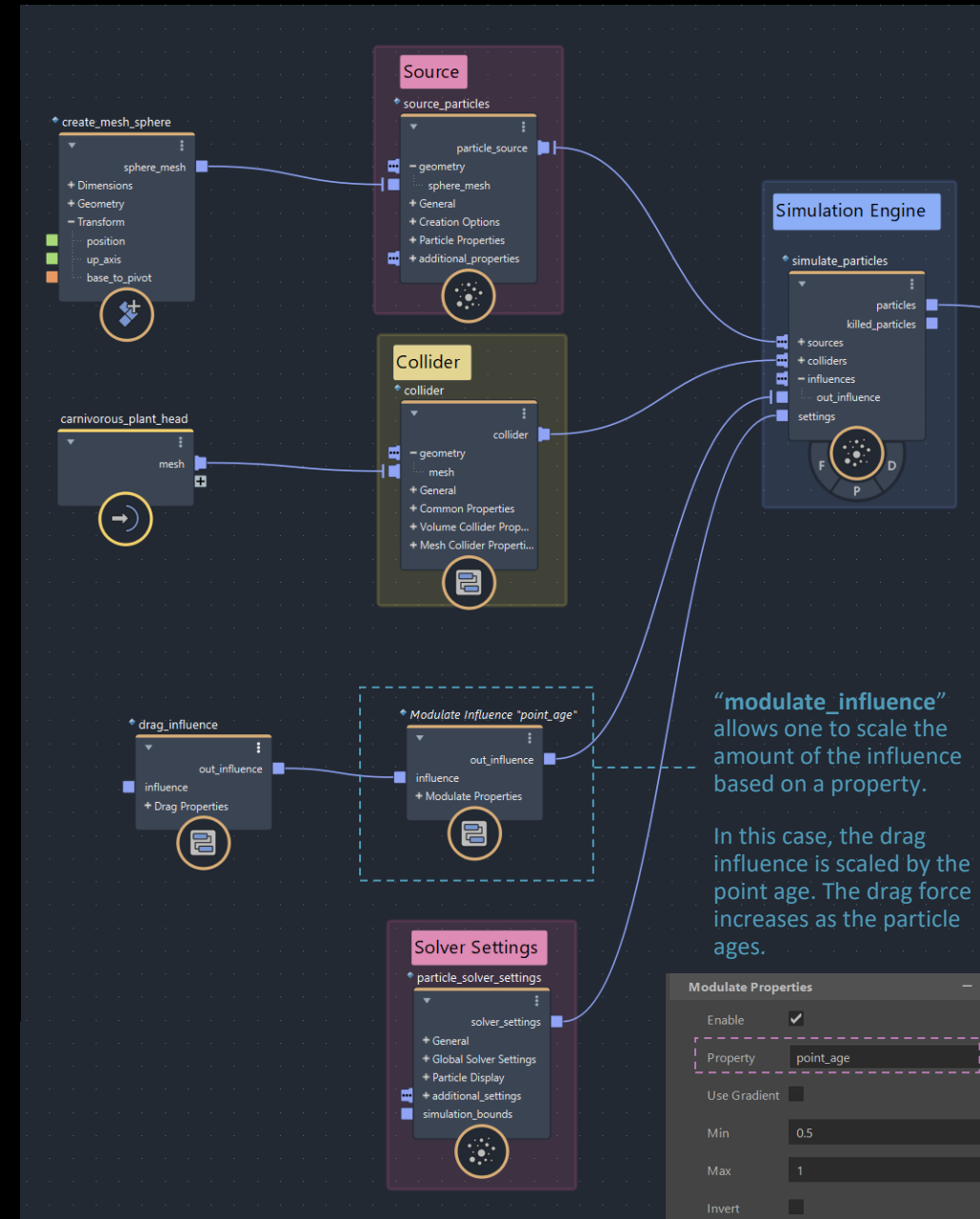
drag influence = 0.5, frame = 100

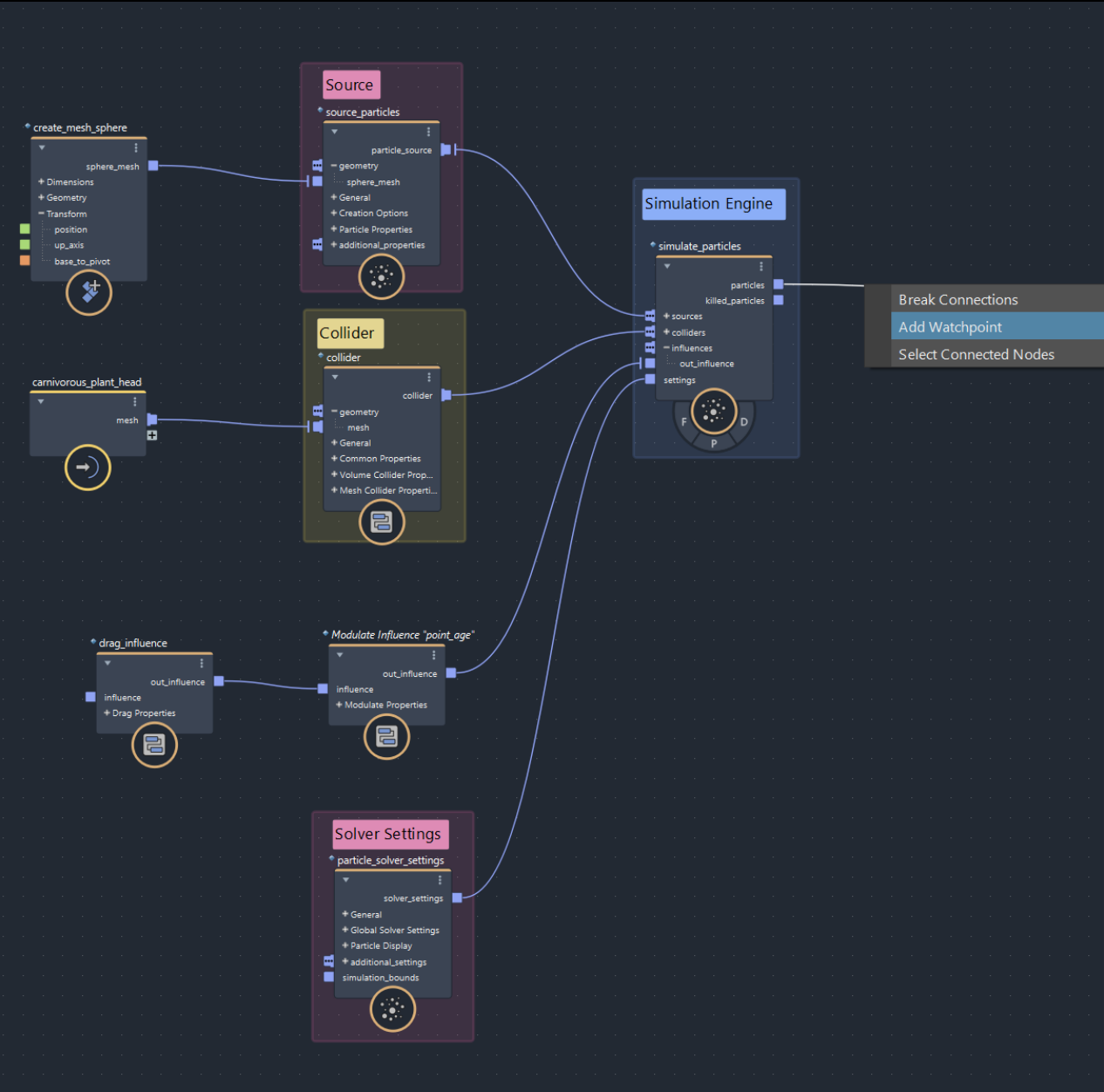


With modulate influence

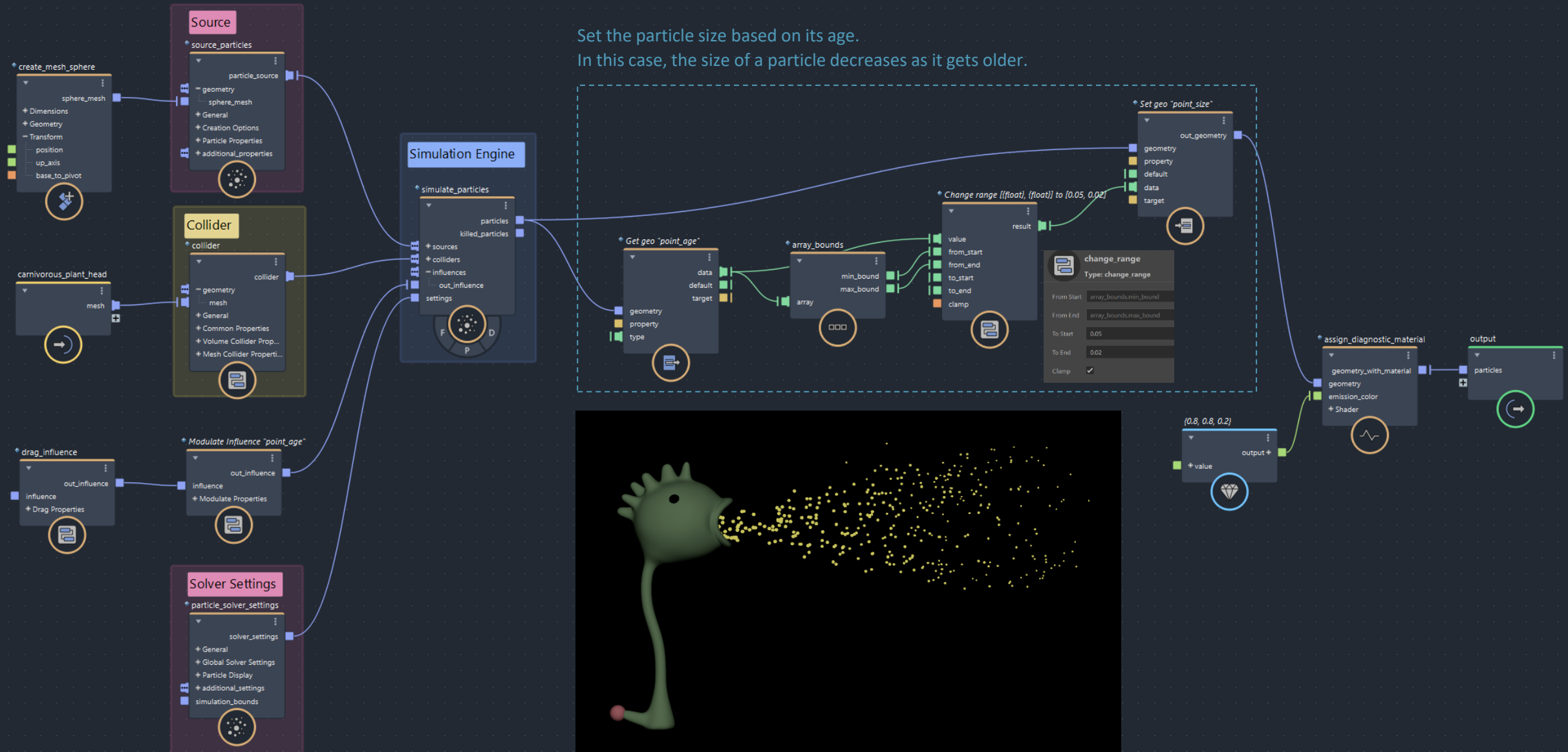


Without modulate influence





property	data	default	depends_on	count	target
point_age	2420 elements array<float>	0	0 element array<string>		point_component
point_bounciness	2420 elements array<float>	0.5	0 element array<string>		point_component
point_component				2420	
point_id	2420 elements array<long>	0	0 element array<string>		point_component
point_position	2420 elements array<Math::float3>	{0f, 0f, 0f}	0 element array<string>		point_component
point_size	2420 elements array<float>	0.05	0 element array<string>		point_component
point_velocity	2420 elements array<Math::float3>	{0f, 0f, 0f}	0 element array<string>		point_component
render_settings					



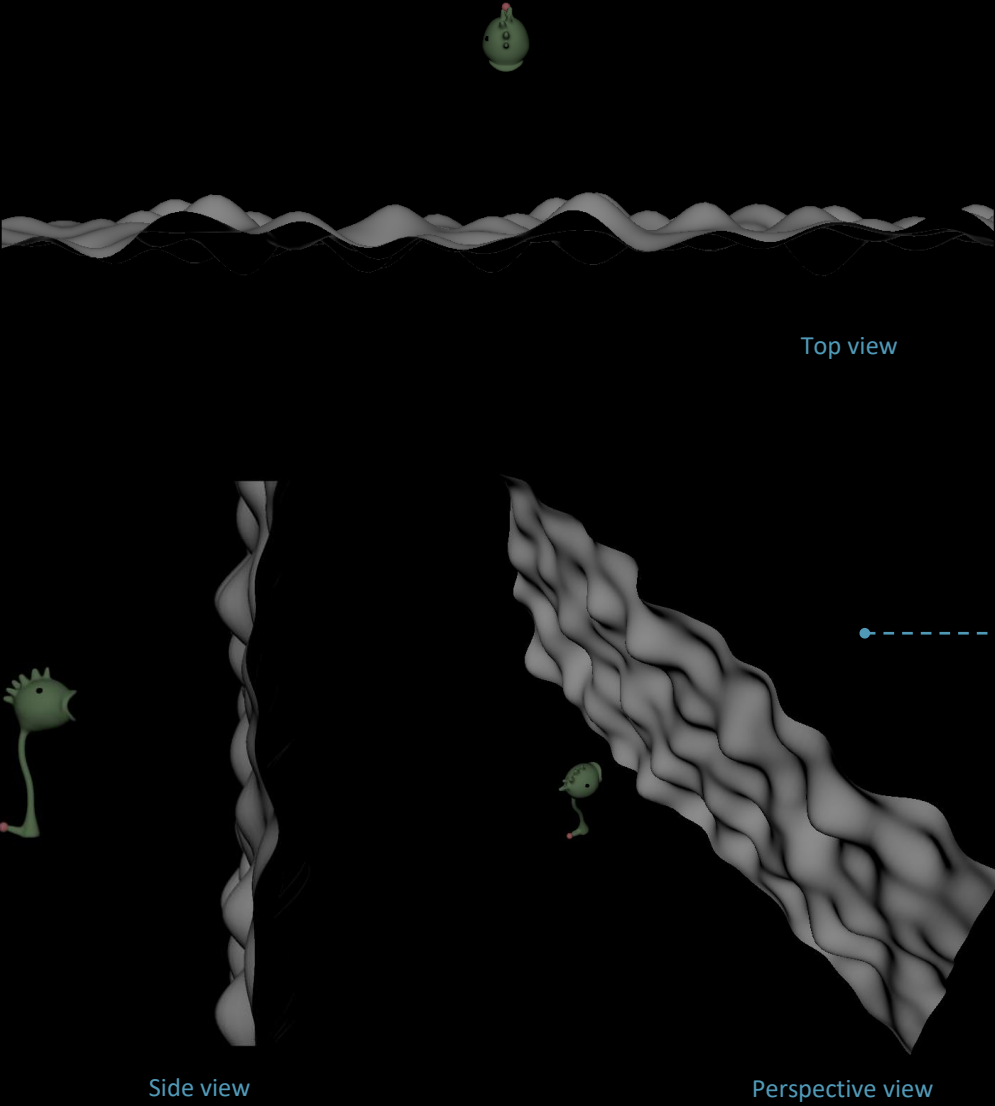
# Particle Simulation

## Modify Property Values

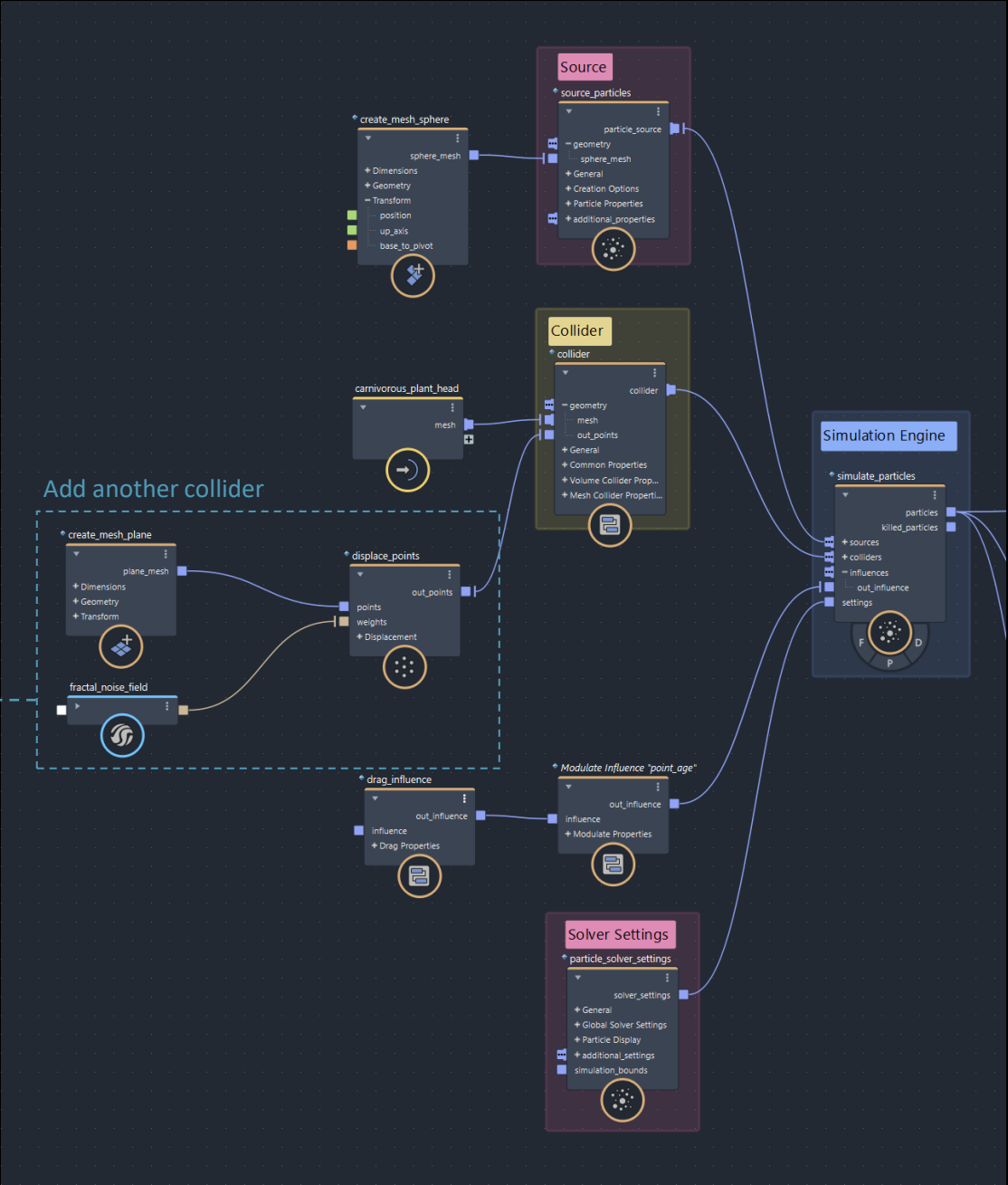




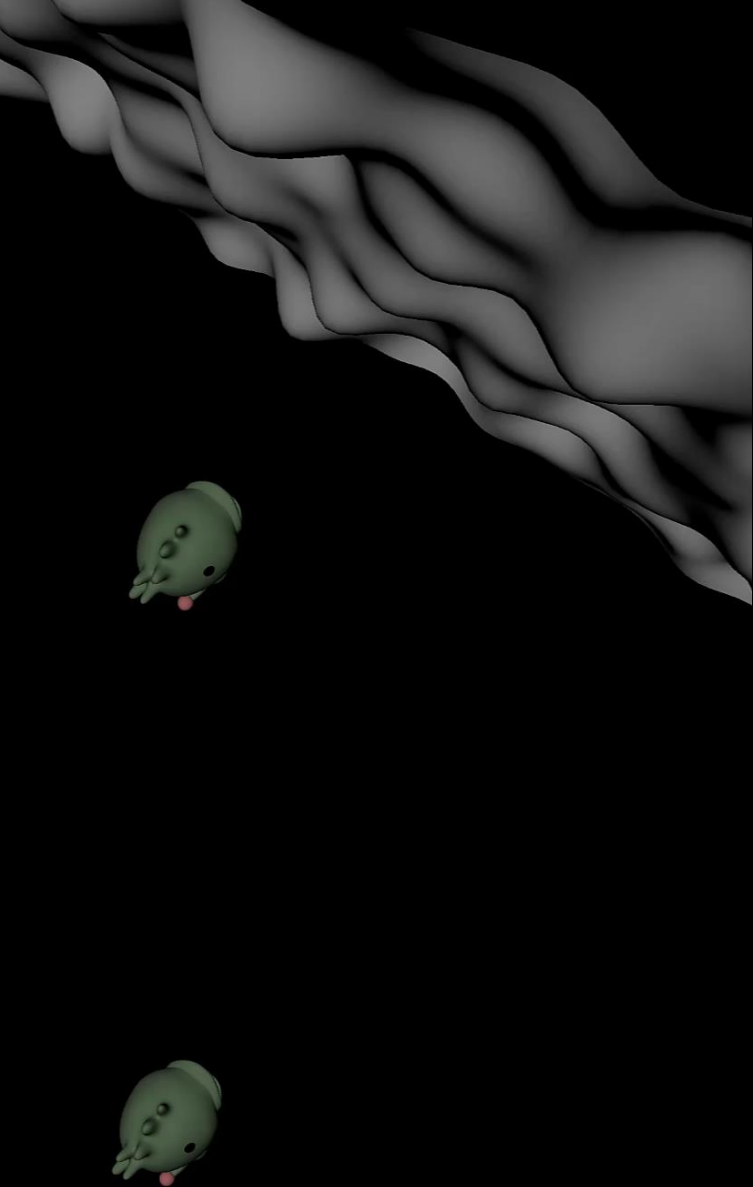
# Particle Simulation



# Collider Settings



# Particle Simulation



Common Properties

Detail Size

0.05

Offset

0

Inherit Velocity

1

Volume Collider Properties

Resolution Mode

Relative

Geo Mode

Solid

Min Hole Radius

0

Optimal Adaptivity

Display Diagnostic

Mesh Collider Properties

Bounciness

0

Friction

0.5

Roughness

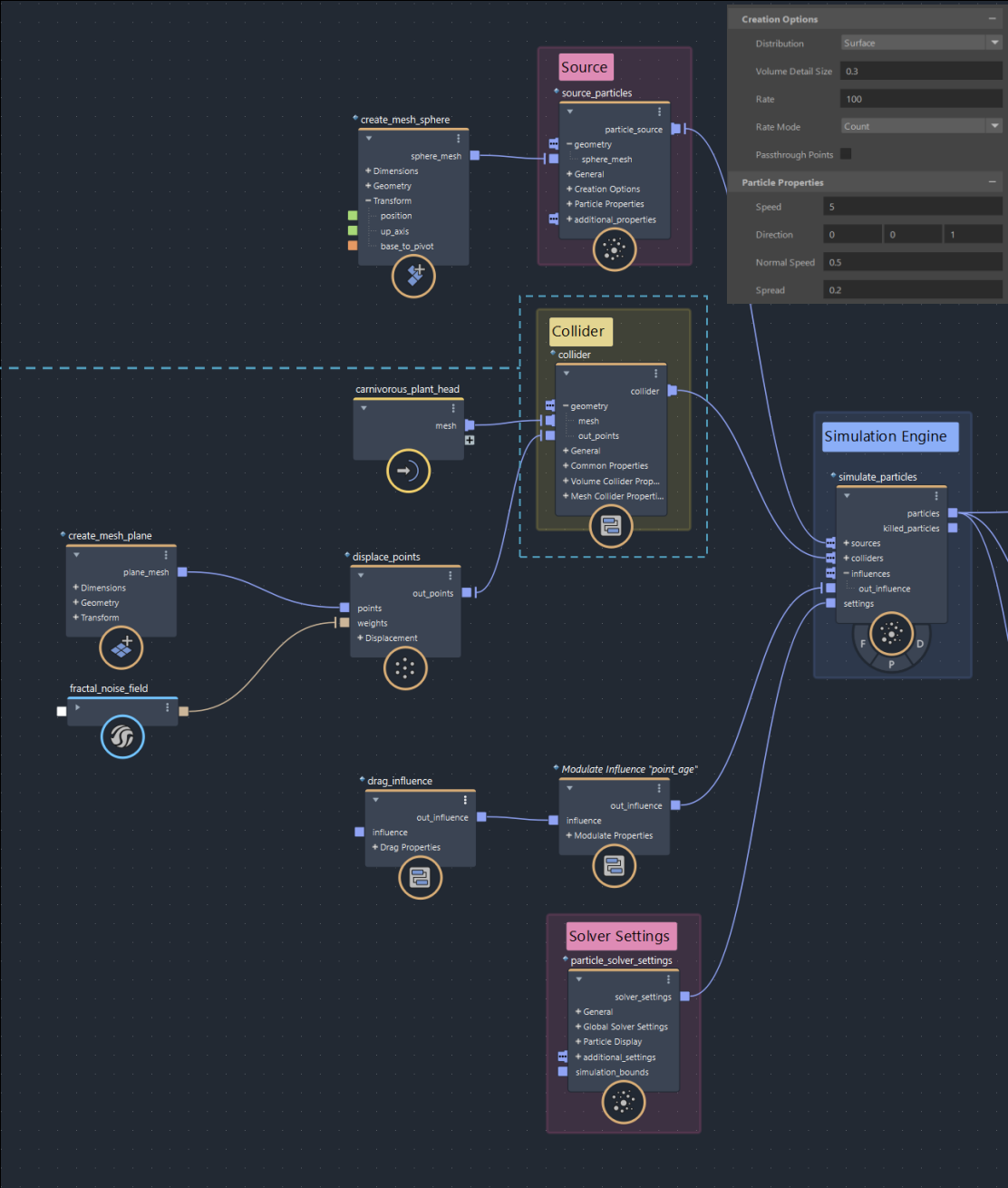
0

Stickiness

0.2

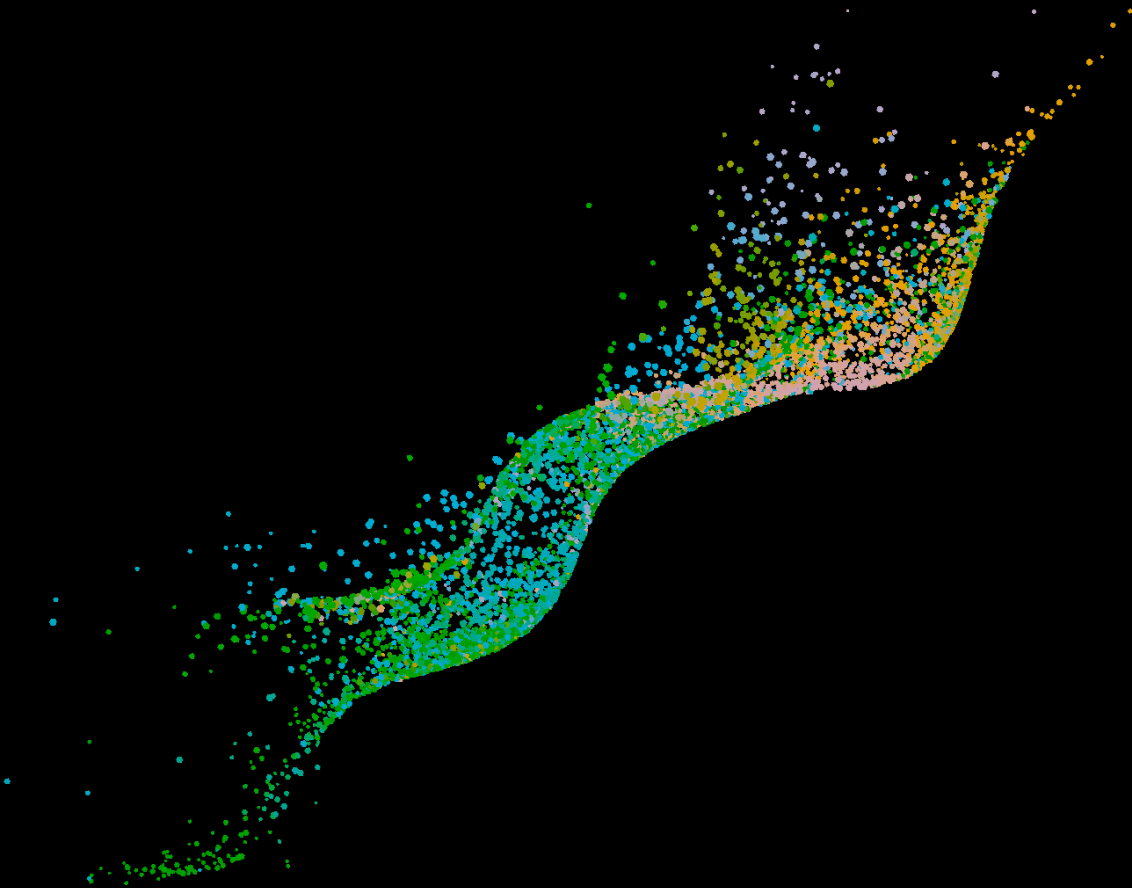
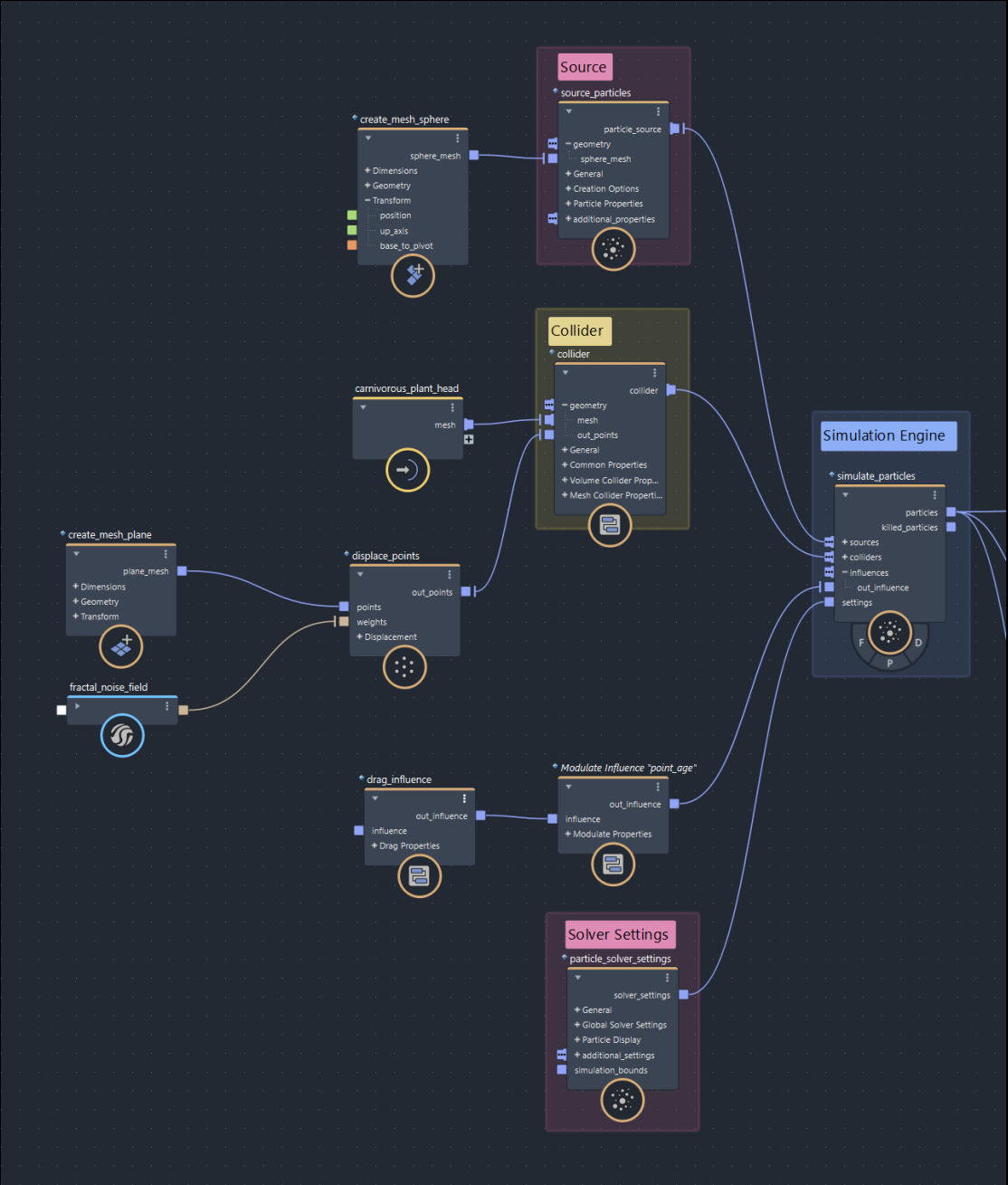
Collider Settings

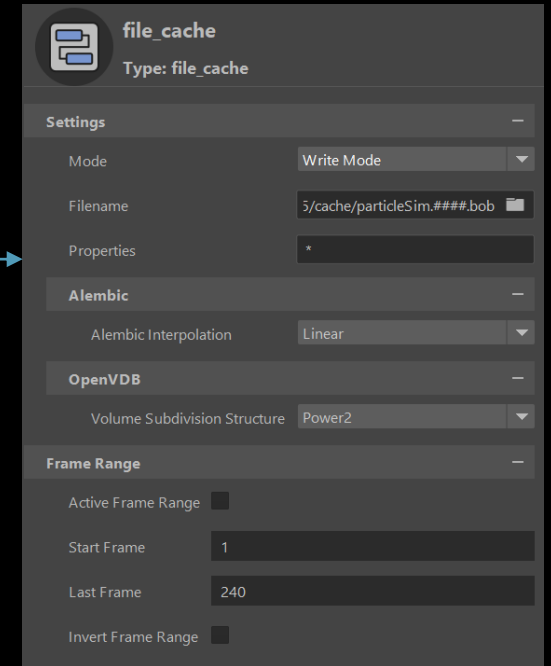
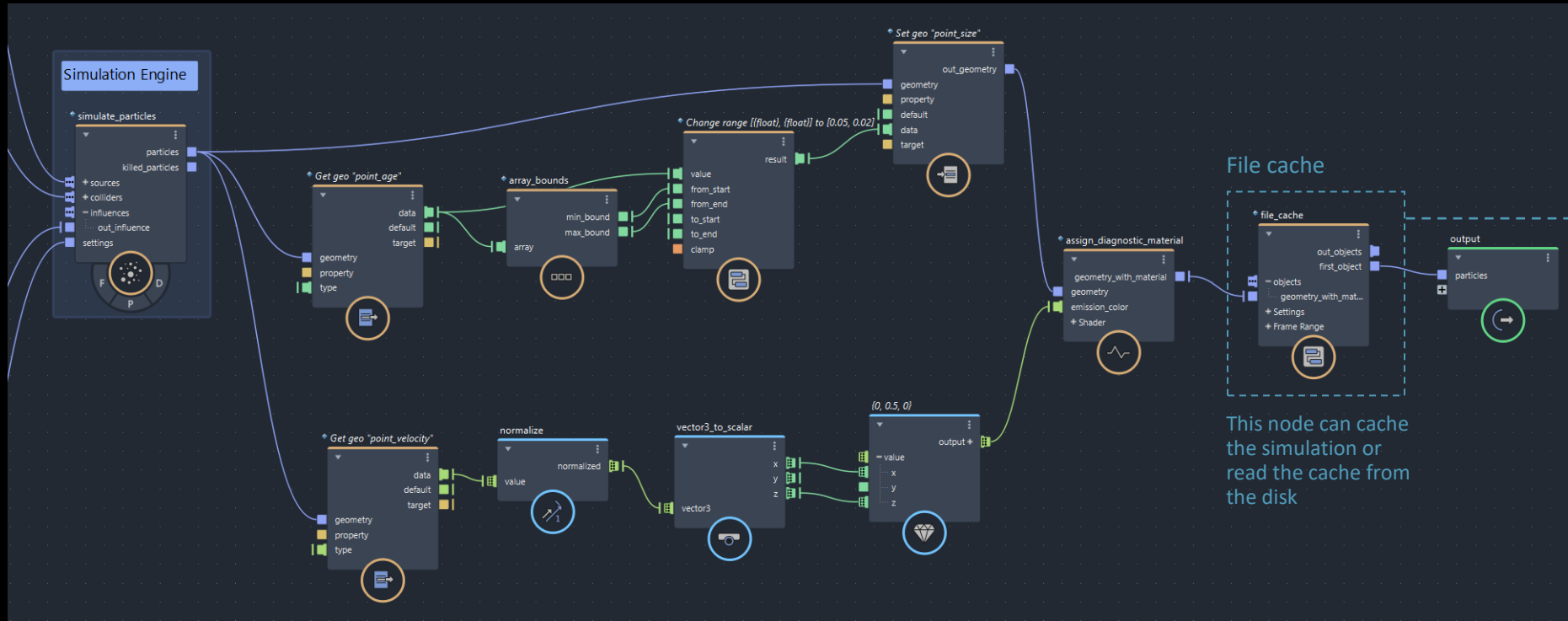
# Collider Settings



# Particle Simulation

# Collider Settings

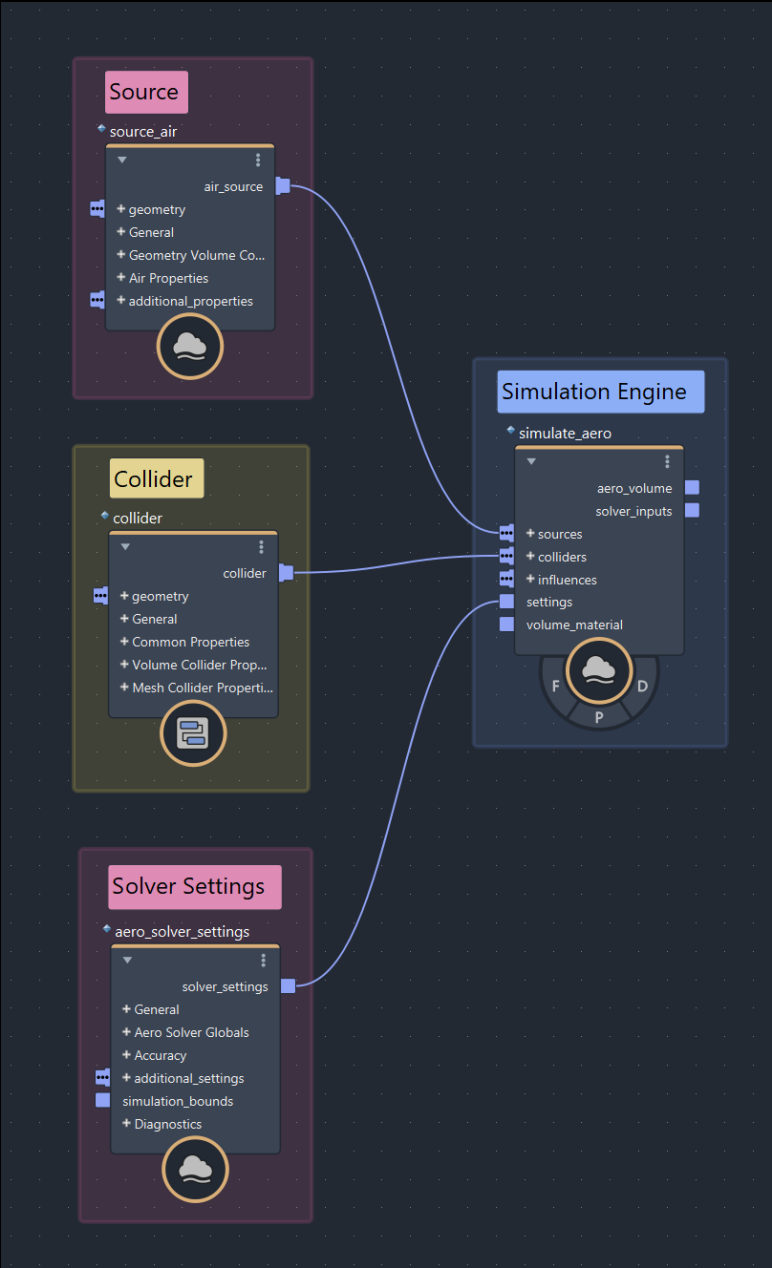
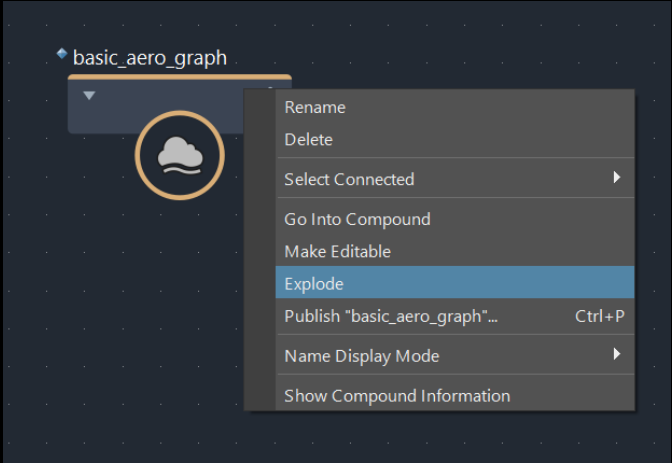


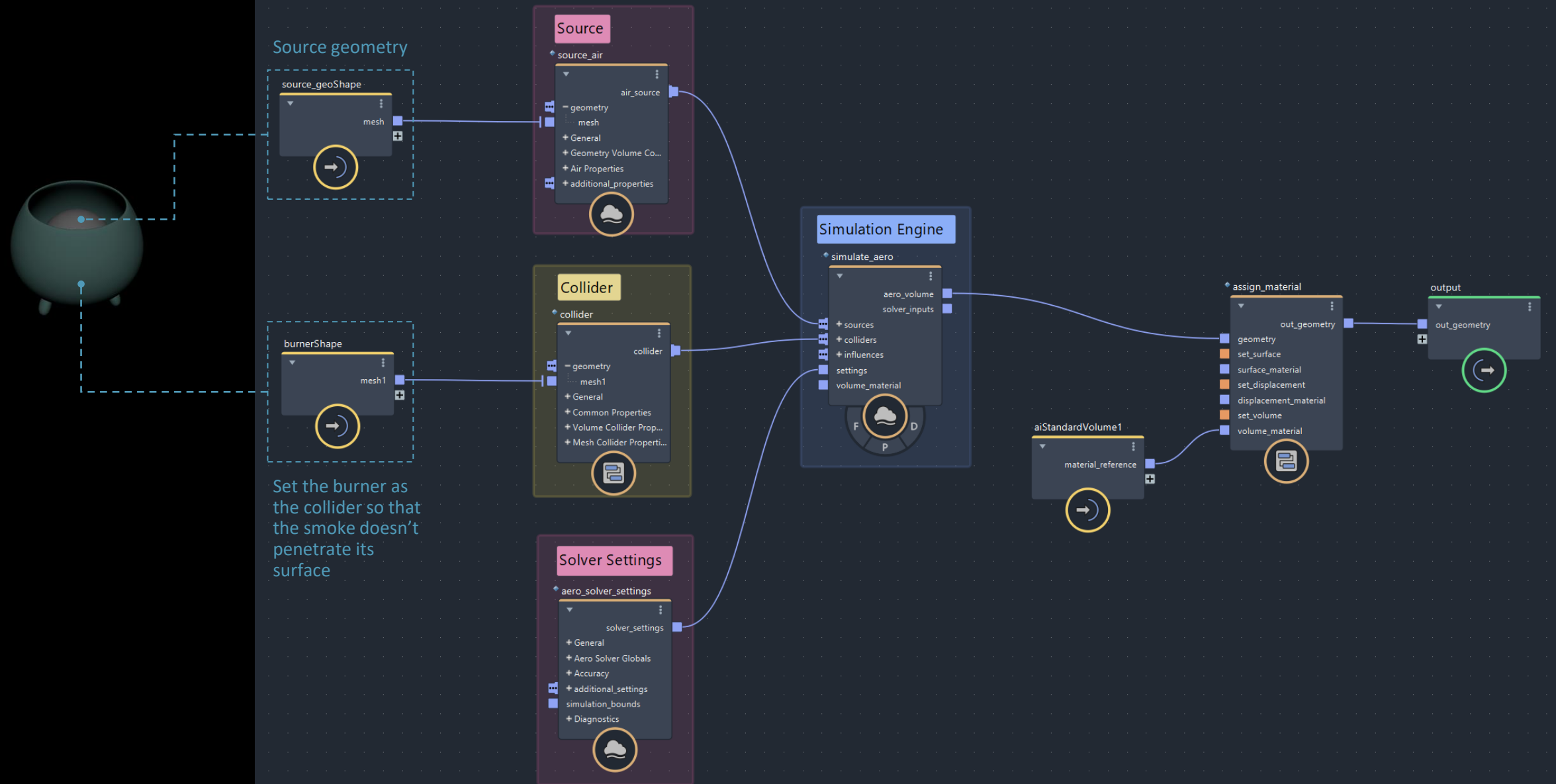


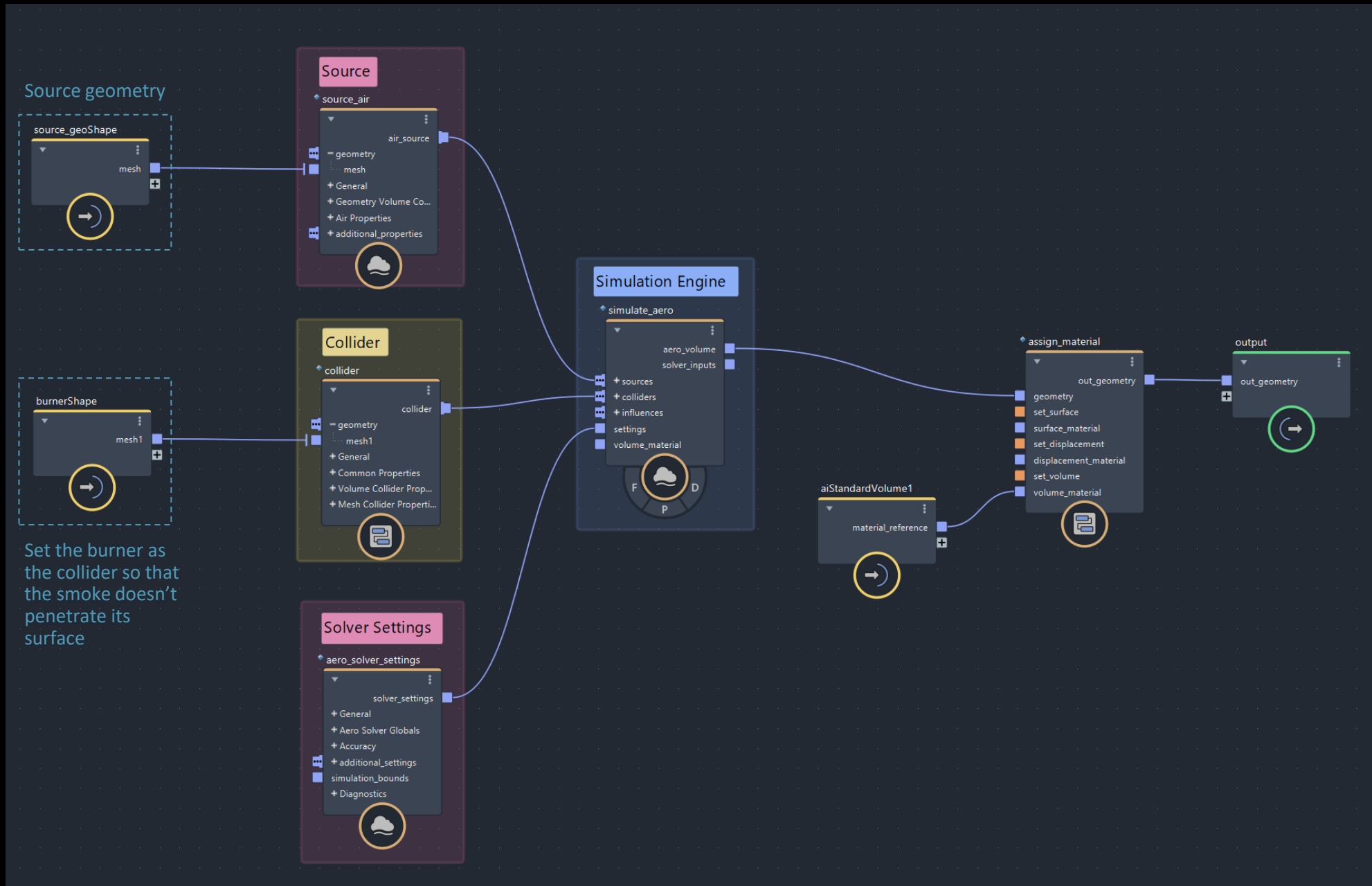
## Name

- particleSim.0000.bob
- particleSim.0001.bob
- particleSim.0002.bob
- particleSim.0003.bob
- particleSim.0004.bob
- particleSim.0005.bob
- particleSim.0006.bob
- particleSim.0007.bob
- particleSim.0008.bob
- particleSim.0009.bob
- particleSim.0010.bob











**Absolute:** the voxel size of the emitter is in world-space unite

**Relative:** the voxel size is proportional to the size of the bounding box of the emitter

**Shell:** voxelizes the mesh as a thin shell

**Solid:** voxelizes the mesh as a solid

**Geo Detail Size:** the size of the smallest resolvable detail in the voxelized emitter

**Fluid Detail Size:** the size of the smallest resolvable detail in the smoke

**Rate:** adds and blends a source at a time-dependent rate

General

Enable Air Source

☒

Start Frame

1

Use End Frame

☐

End Frame

1

Resolution Mode

Absolute

Geometry Volume Conversion

Geo Volume Mode

Shell

Use Fluid Detail Size

☐

Geo Detail Size

0.05

Geo Volume Offset

0

Min Hole Radius

0

Optimal Adaptivity

☐

Display Diagnostic

☐

Air Properties

Fluid Detail Size

0.05

Fog Density

2

Fog Density Mode

rate

Temperature

250

Temperature Mode

rate

Initial Speed

0

Initial Speed Direction

0

0

0

Speed Mode

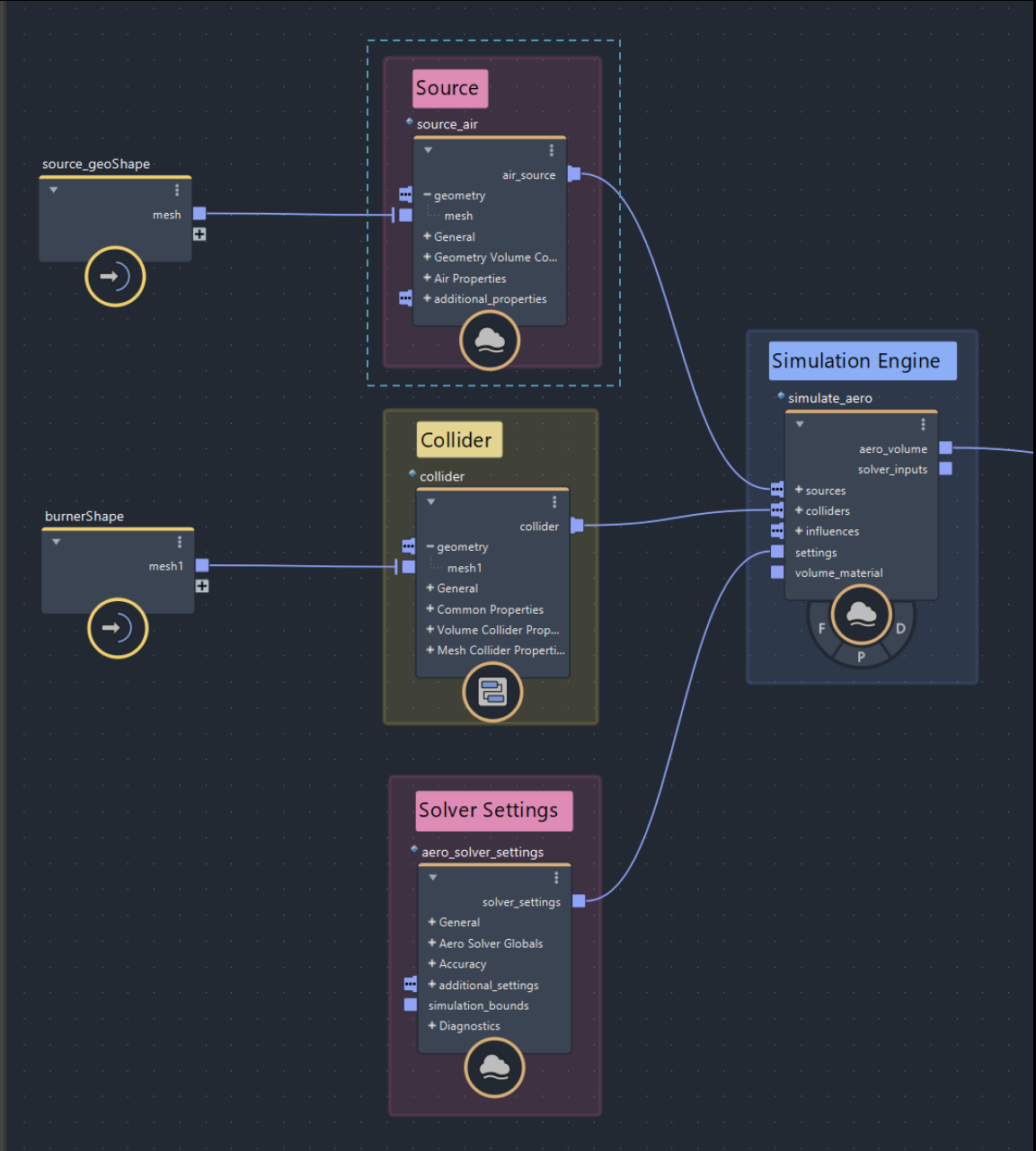
rate

Inherit Velocity

1

Trail Smoothness

2



# Aero Simulation - Smoke

## Adjust Parameters

General

Enable Variation

☒

Property

fog\_density

Multiplier

1

Layer Mode

Replace

Random Variation

Randomize Value

☒

Min

0.2

Max

1

Bias

0

Animated

☒

Seed

0

Specify the property that you want to vary

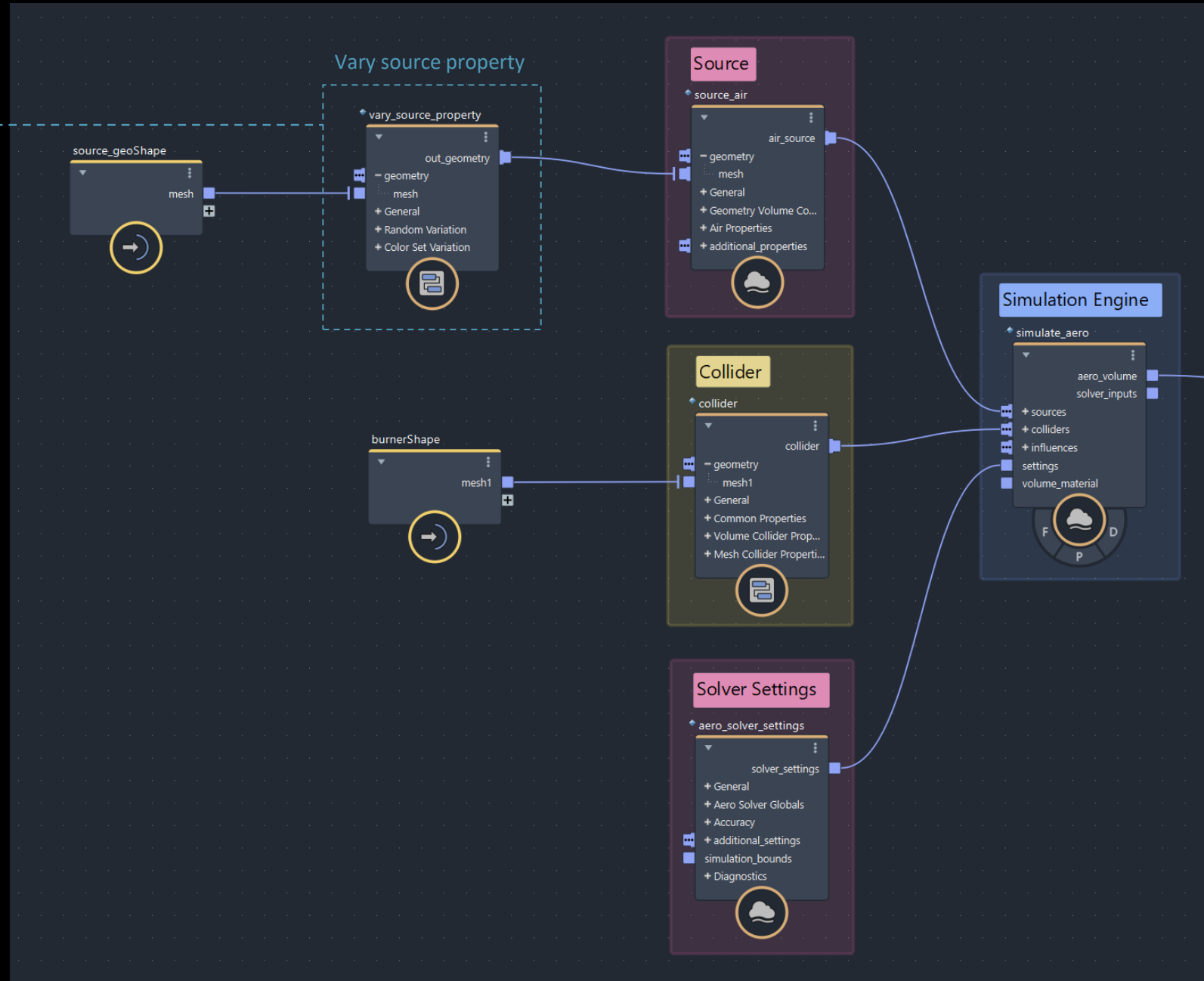
The range of the values for the specified property. In this case, the fog density emitted using the specified mode will vary between 0.2 and 1.

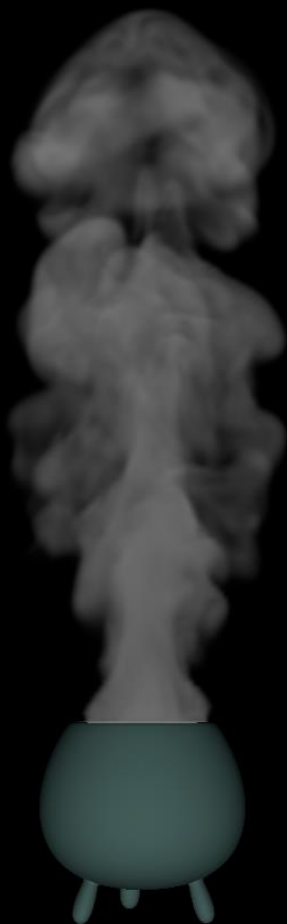


## Without varying fog density

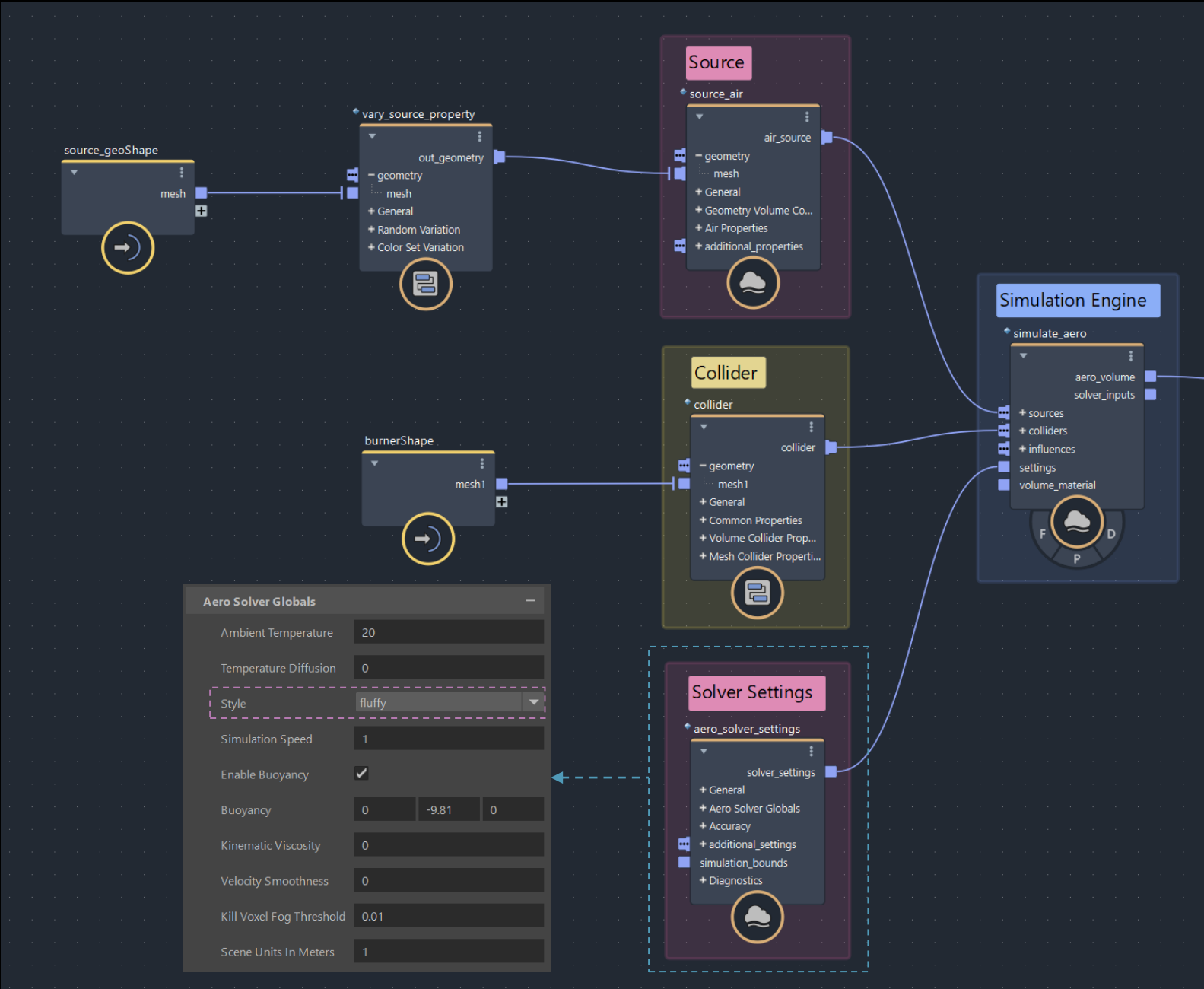


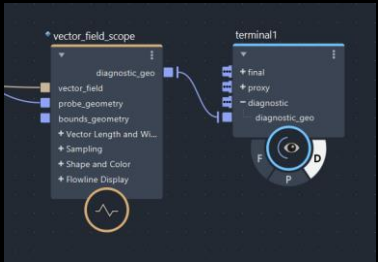
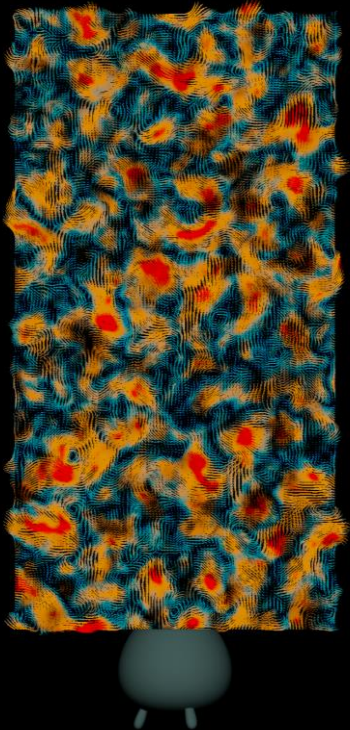
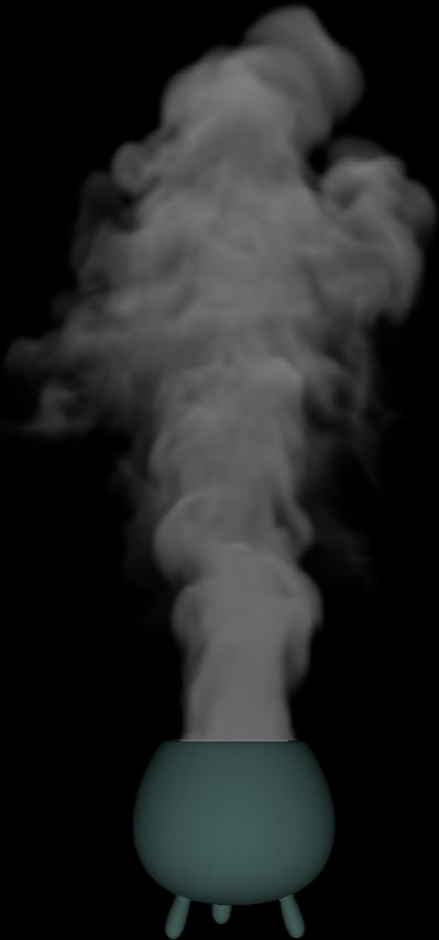
### With varying fog density





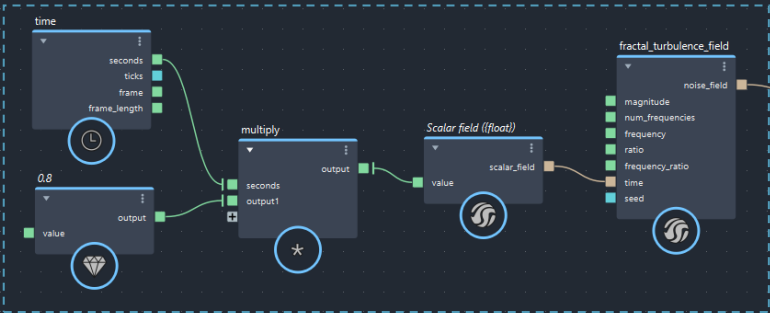
Change the style to “fluffy” for a more dynamic appearance





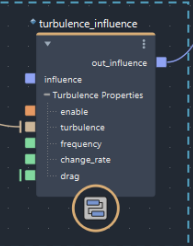
For visualizing a vector field

Connect an animated fractal turbulence field to the turbulence influence and use it to provide the accelerations

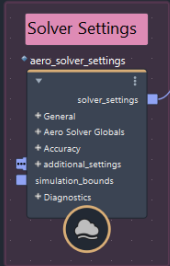


fractal turbulence field	
Type: fractal_turbulence_field	
Magnitude	2
Num Frequencies	3
Frequency	3
Ratio	0.5
Frequency Ratio	0.5
Time	scalar_field.scalar_field
Seed	0

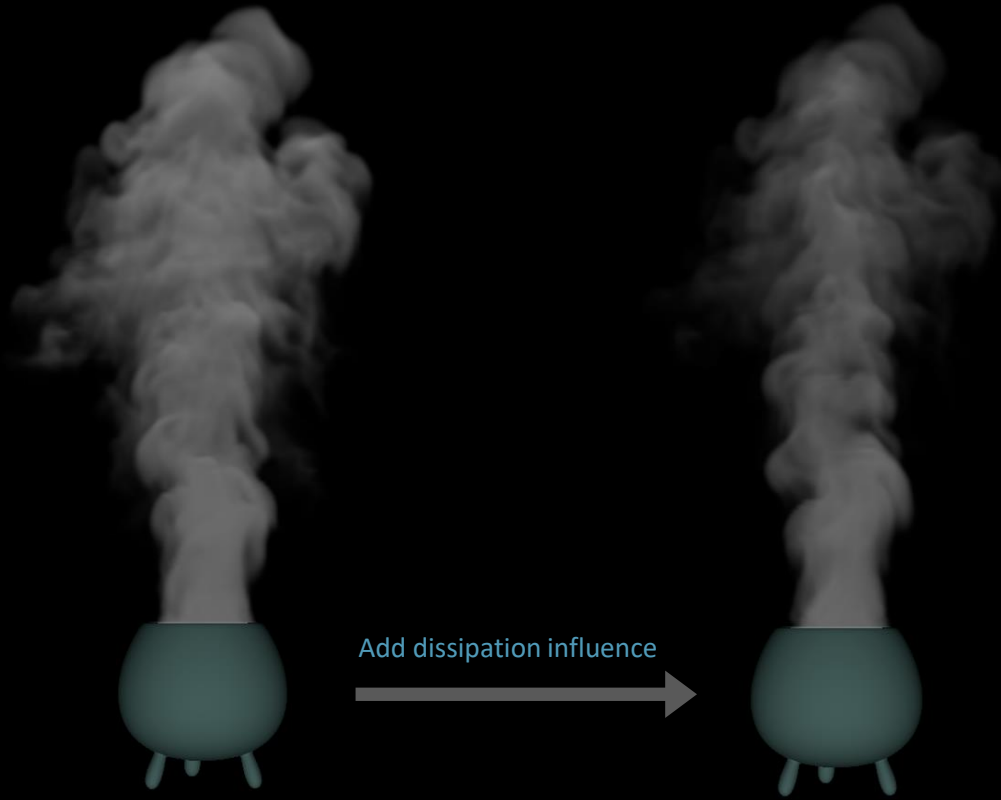
Turbulence influence



turbulence_influence	
Type: turbulence_influence	
Influence	
Turbulence Properties	
Enable	<input checked="" type="checkbox"/>
Turbulence	fractal_turbulence_field.noise_field
Frequency	1
Change Rate	1
Drag	1

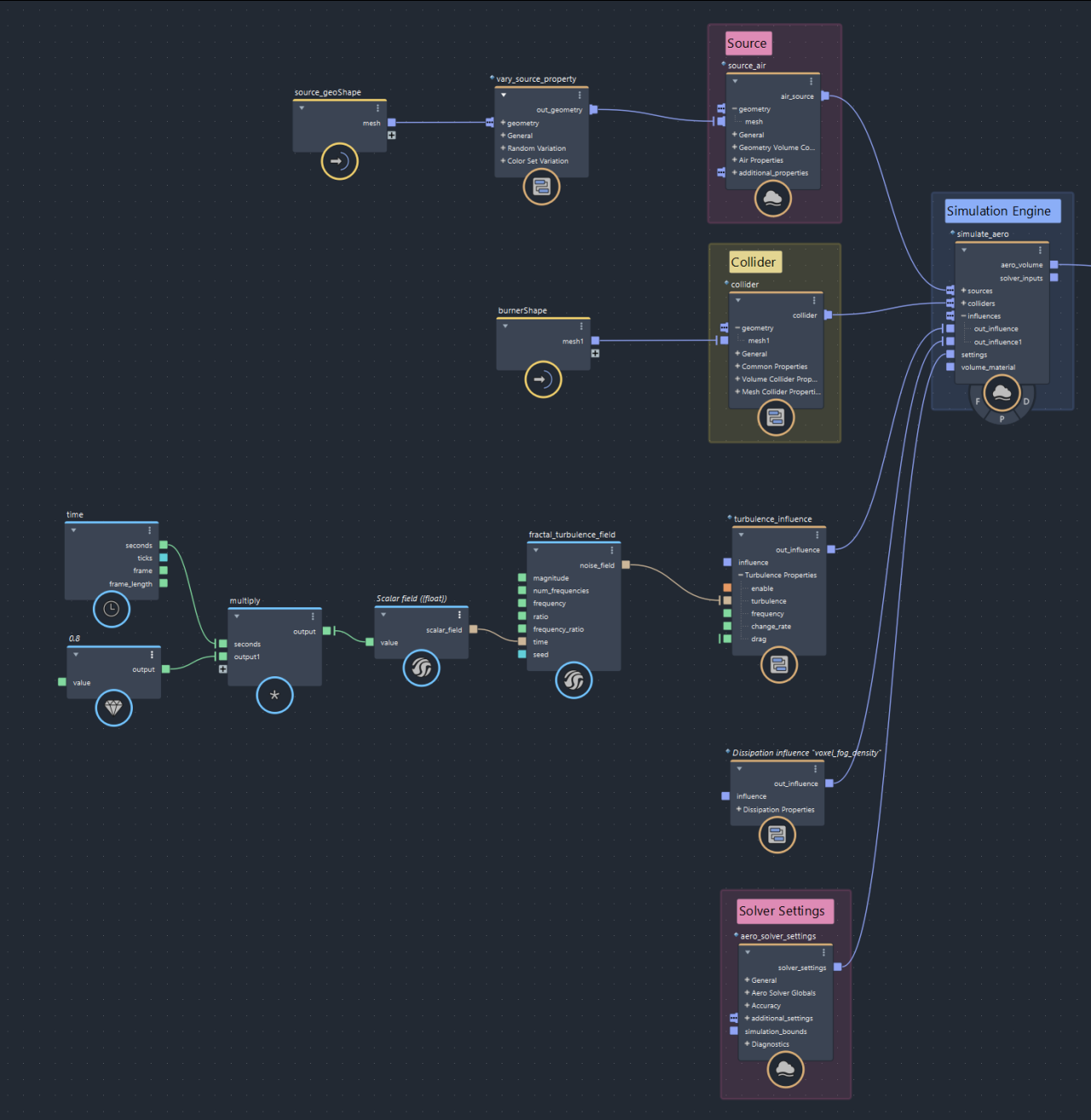


## Aero Simulation - Smoke




## Add dissipation influence

## Add Influences




# Aero Simulation - Smoke

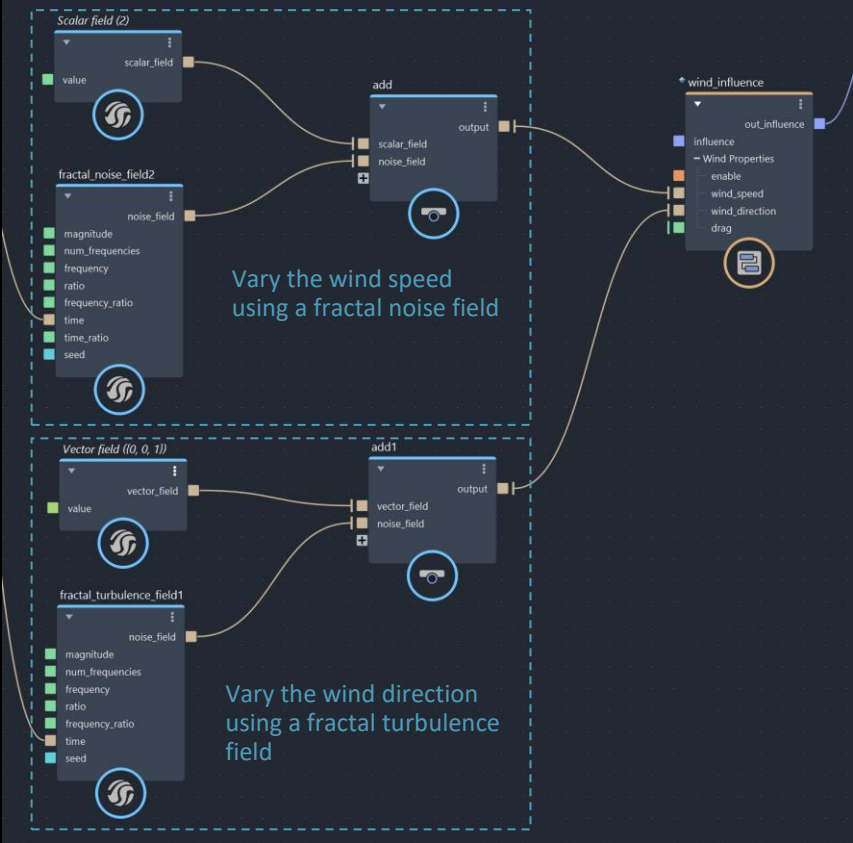


**fractal\_noise\_field2**  
Type: fractal\_noise\_field

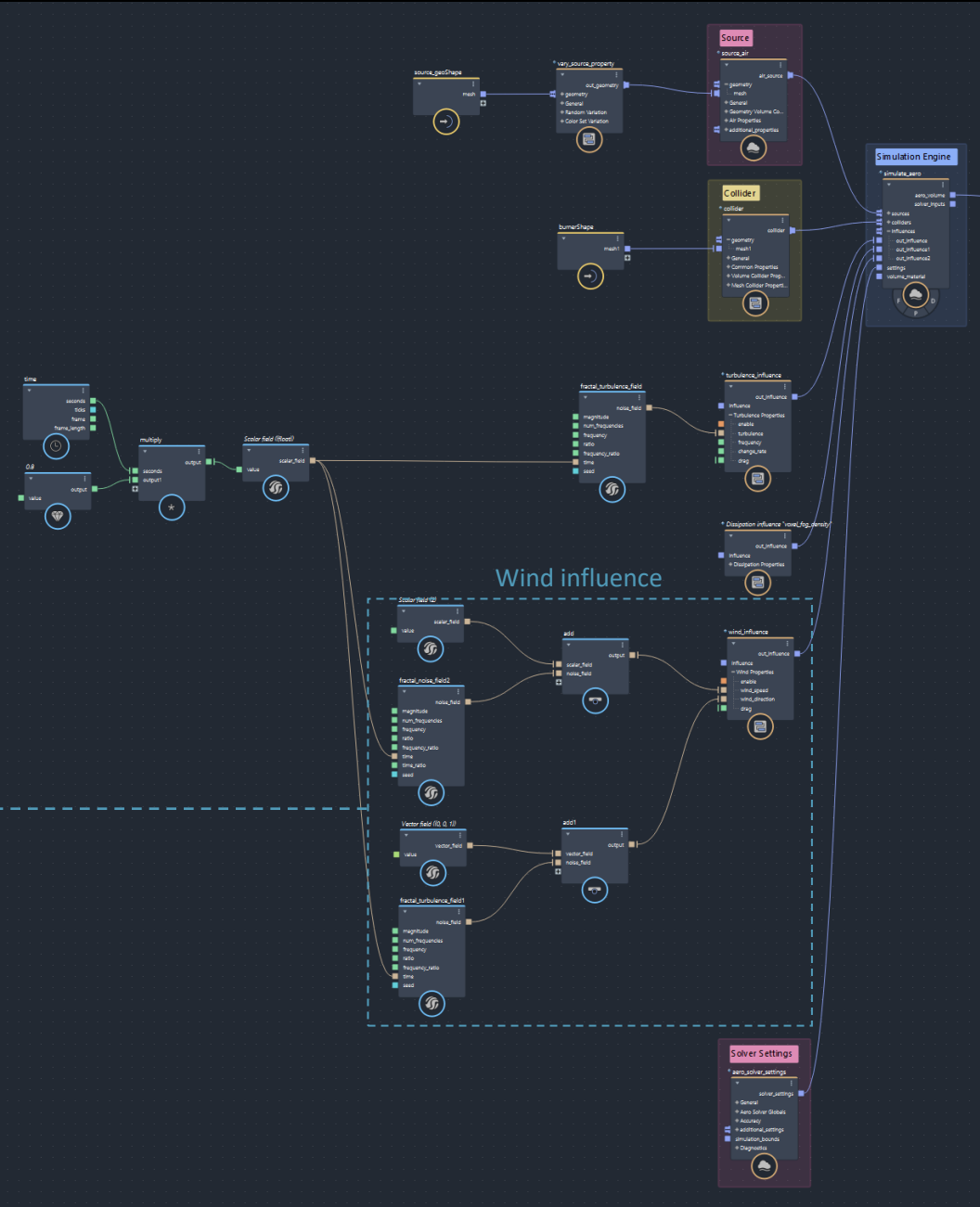
Magnitude	0.3
Num Frequencies	3
Frequency	1
Ratio	0.5
Frequency Ratio	0.5
Time	scalar_field.scalar_field
Time Ratio	1.5
Seed	0

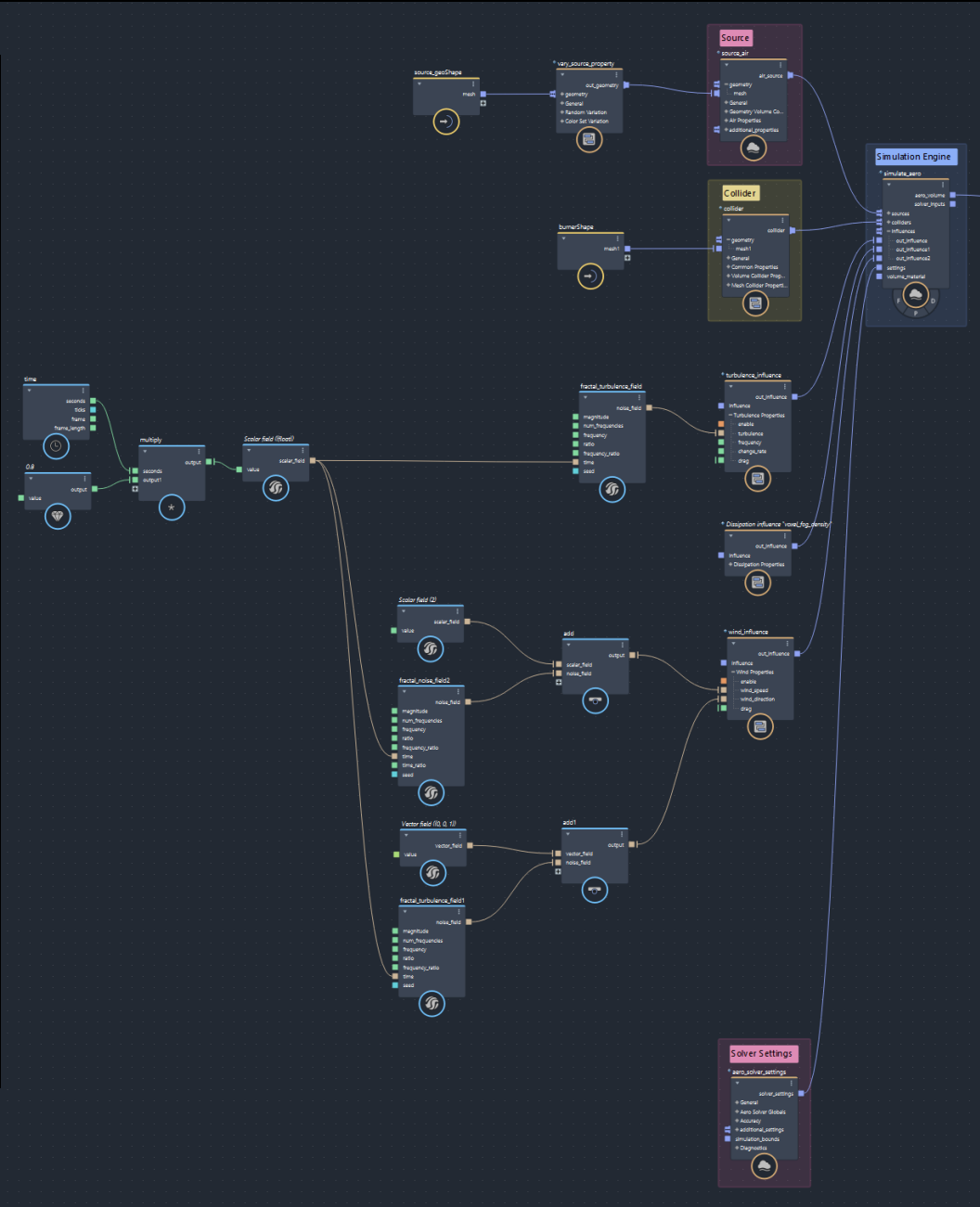
**fractal\_turbulence\_field1**  
Type: fractal\_turbulence\_field

Magnitude	0.3
Num Frequencies	3
Frequency	1
Ratio	0.5
Frequency Ratio	0.5
Time	scalar_field.scalar_field
Seed	0

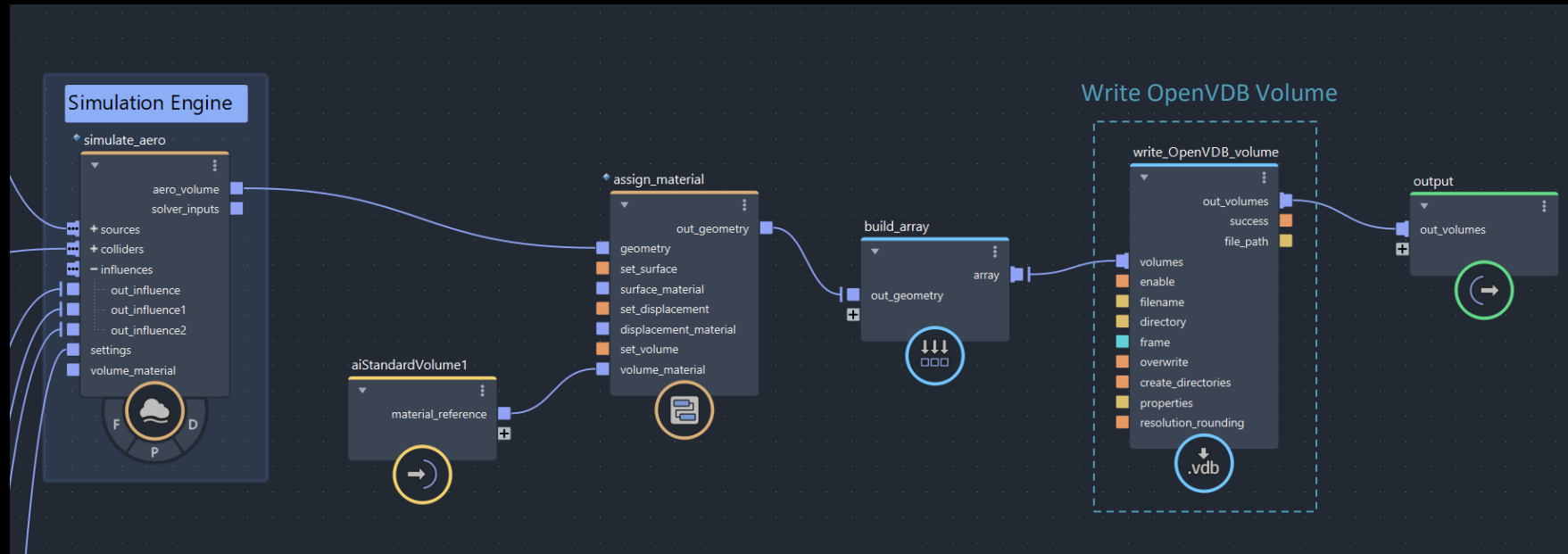


# Add Influences









**write\_OpenVDB\_volume**  
Type: write\_OpenVDB\_volume

Enable ☒

Filename

Directory

Frame

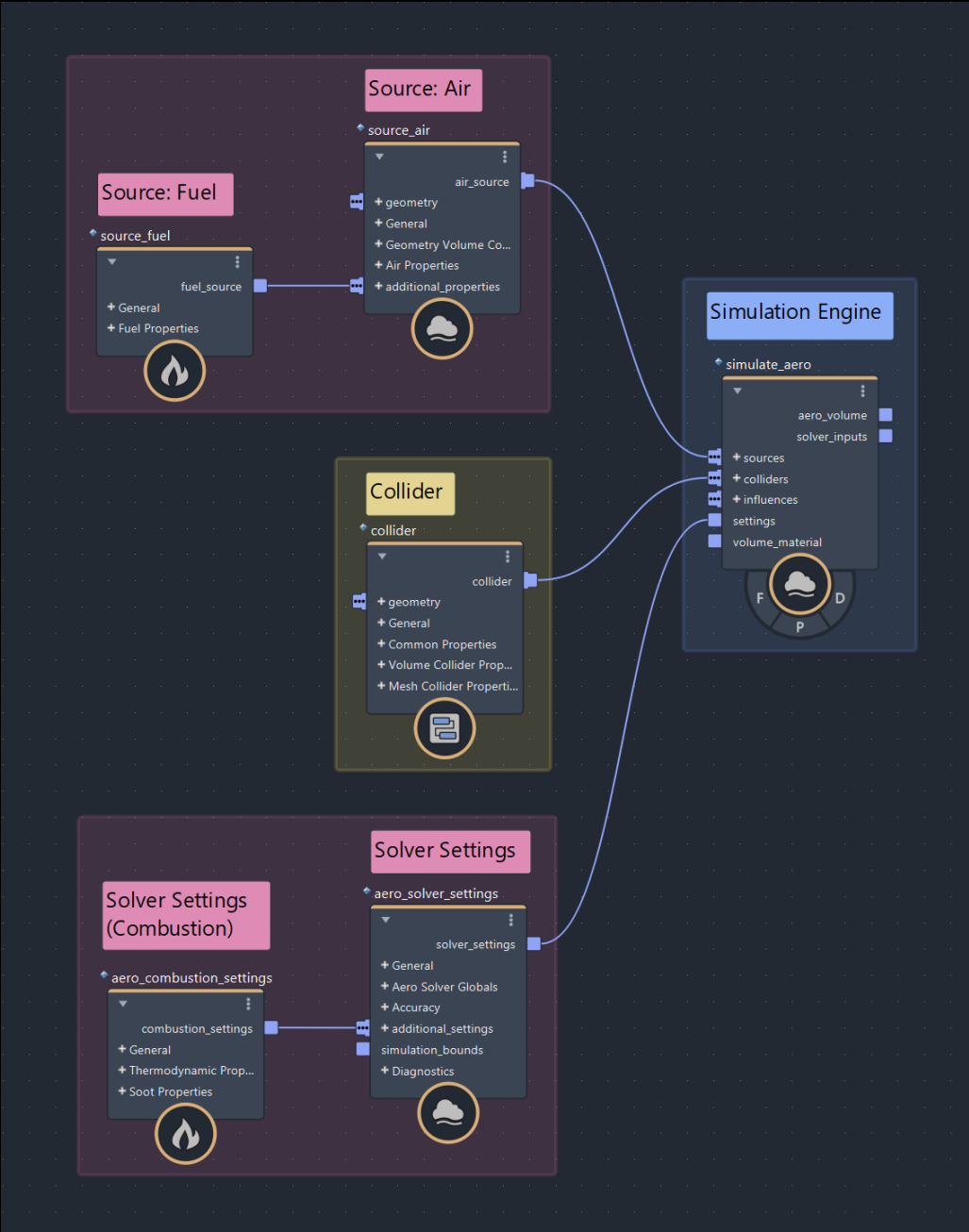
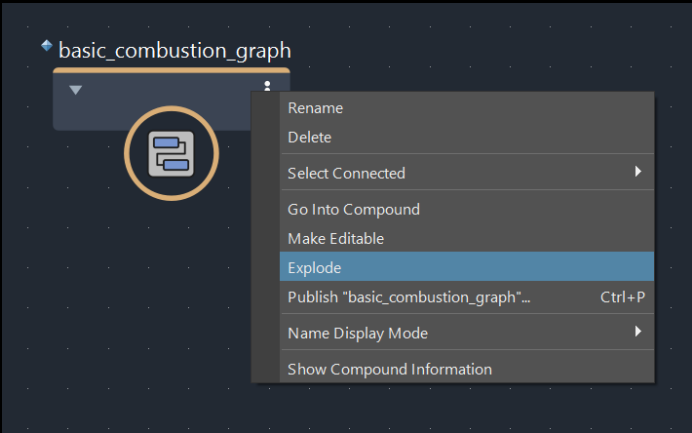
Overwrite ☒

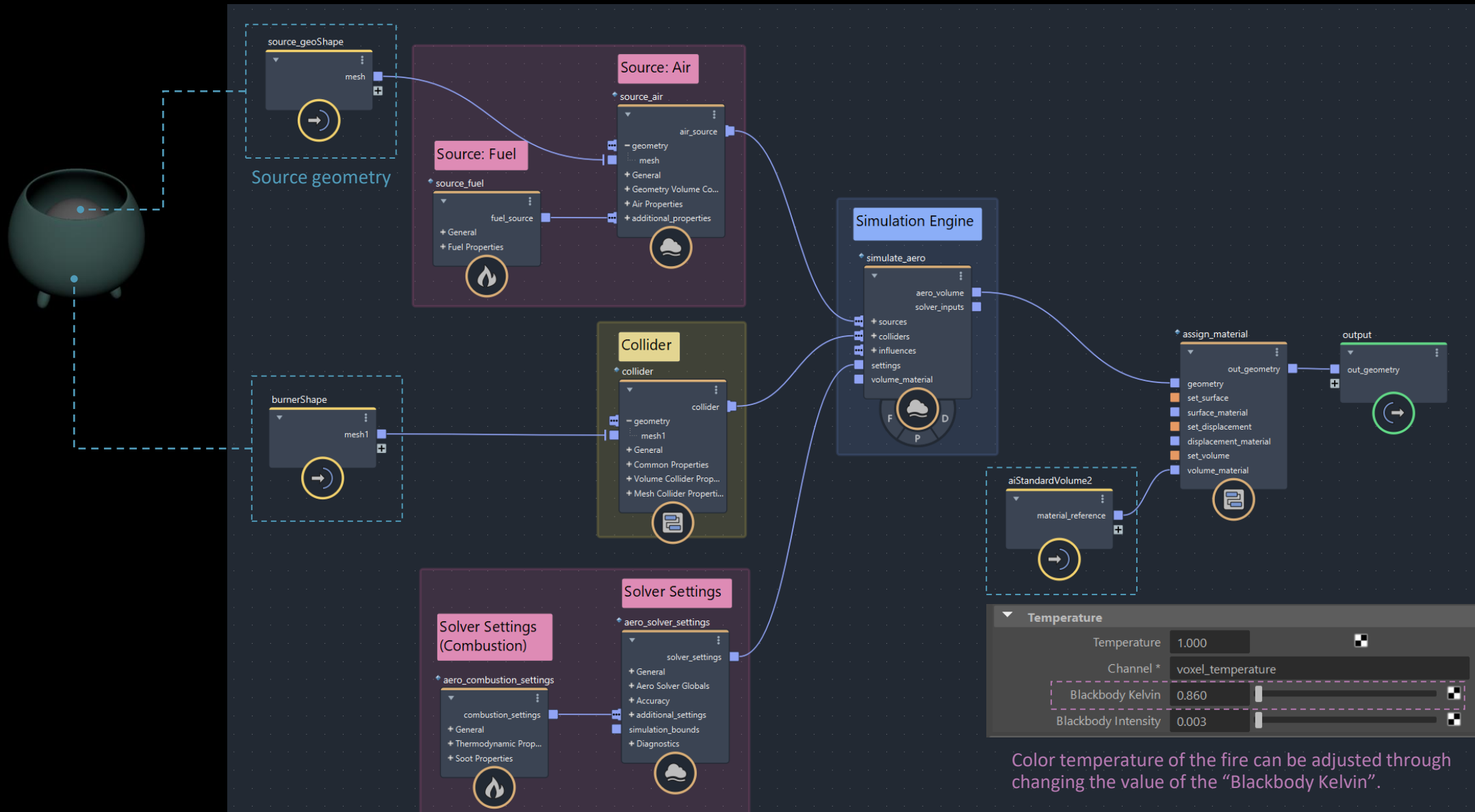
Create Directories ☐

Properties

Resolution Rounding







General

Enable Air Source

☒

Start Frame

1

Use End Frame

☐

End Frame

1

Resolution Mode

Absolute

Geometry Volume Conversion

Geo Volume Mode

Shell

Use Fluid Detail Size

☐

Geo Detail Size

0.05

Geo Volume Offset

0

Min Hole Radius

0

Optimal Adaptivity

☐

Display Diagnostic

☐

Air Properties

Fluid Detail Size

0.05

Fog Density

0

Fog Density Mode

rate

Temperature

580

Temperature Mode

set

Initial Speed

0

Initial Speed Direction

0

0

0

Speed Mode

rate

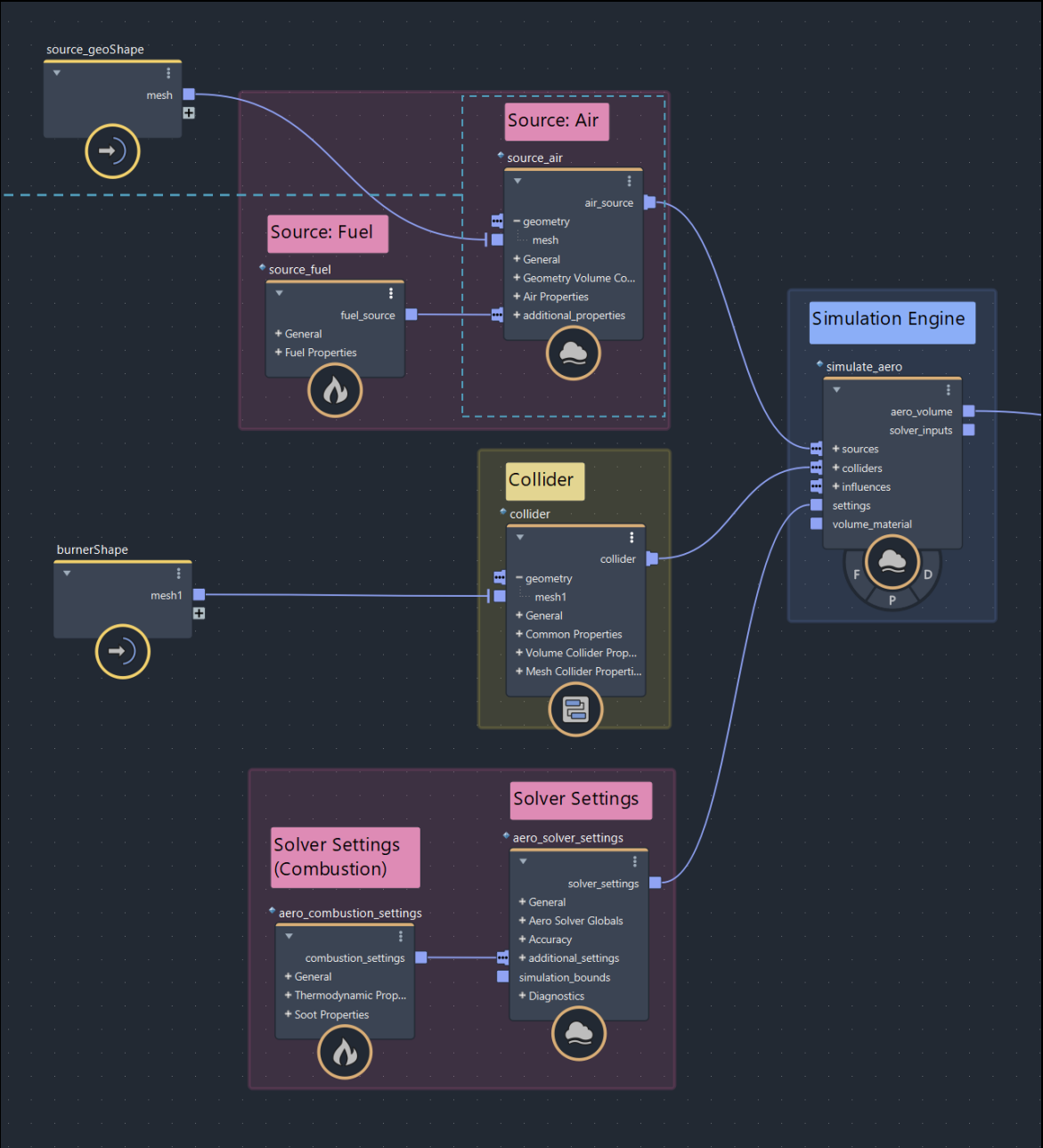
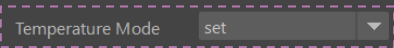
Inherit Velocity

1

Trail Smoothness

2

Use "set" for the temperature mode in a fire simulation to avoid the temperature rapidly rising to unrealistic values.



## Aero Simulation - Fire

## Adjust Parameters

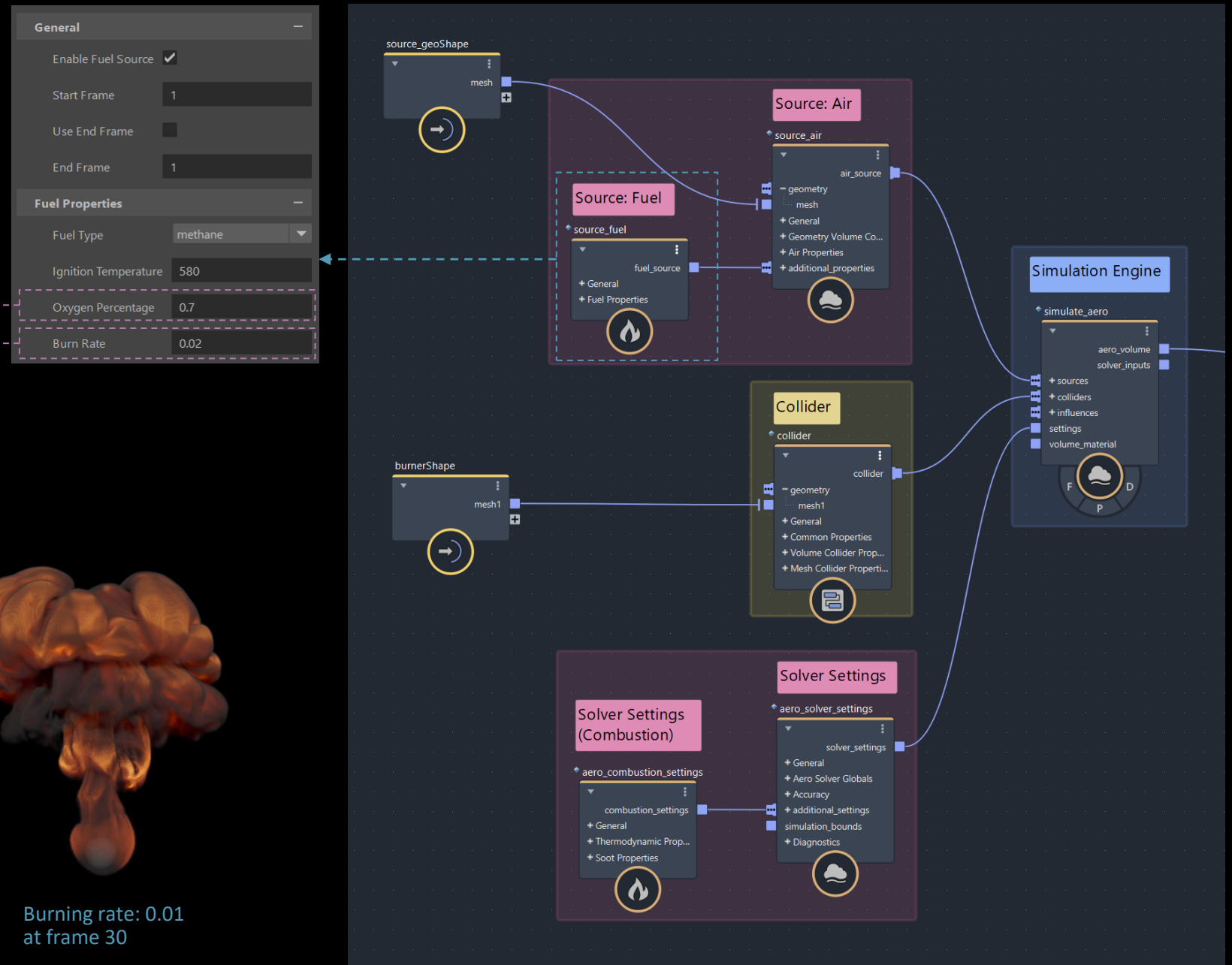
A higher oxygen percentage leads to a more violent explosion, faster flame propagation and higher temperature.

A higher burn rate results in a more violent combustion.

Burning rate: 0.05  
at frame 30



Burning rate: 0.01  
at frame 30



# Aero Simulation - Fire

Adjust Parameters



Buoyancy = -0.98

Buoyancy = -0.3

A lower buoyancy results in a lower flame height

General

Enable Solver

☒

Use Master Start Frame

☐

Master Start Frame

1

Store Mass Density

☐

Aero Solver Globals

Ambient Temperature

20

Temperature Diffusion

0

Style

fluffy

Simulation Speed

1

Enable Buoyancy

☒

Buoyancy

0-30

Kinematic Viscosity

0

Velocity Smoothness

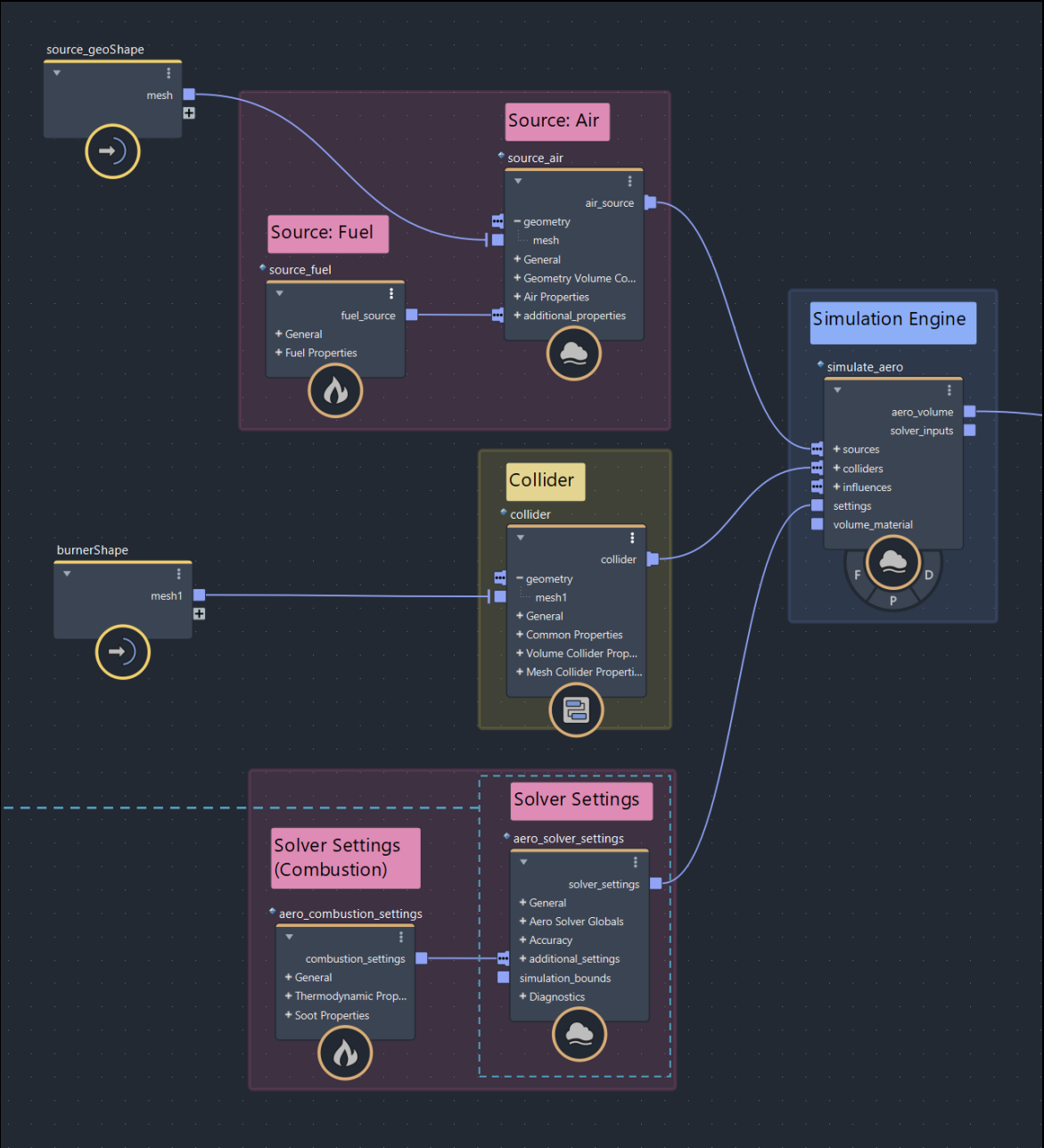
0

Kill Voxel Fog Threshold

0.01

Scene Units In Meters

1



## Aero Simulation - Fire



Expansion scale: 0.5



Expansion scale: 0.1

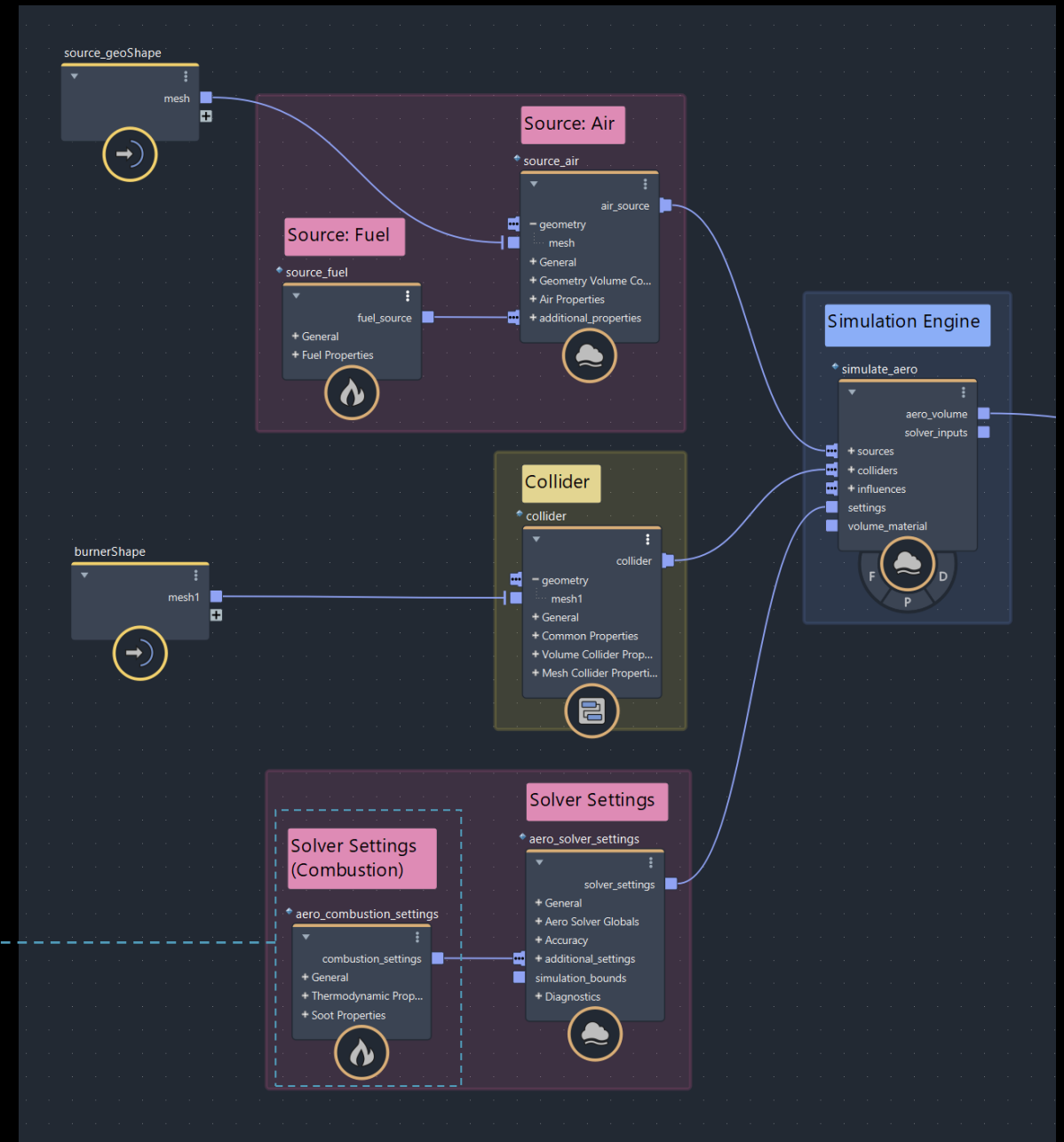
Lower the expansion scale  
to prevent explosion.

Lower the soot formation rate to decrease the amount of soot generated during the simulation

If selected, soot will be oxidized and becomes invisible

Thermodynamic Properties	
Expansion Scale	0.1
Radiative Heating	1
Radiative Cooling	1
Flame Propagation Speed	1
Oxygen Diffusion	1
Soot Properties	
Emit Soot	<input checked="" type="checkbox"/>
Soot Model	physical
Soot Formation Rate	0.2
Lower Formation Limit	0
Upper Formation Limit	1
Oxidize Soot	<input checked="" type="checkbox"/>
Soot Oxidation Rate	2
Lower Oxidation Limit	0
Upper Oxidation Limit	1

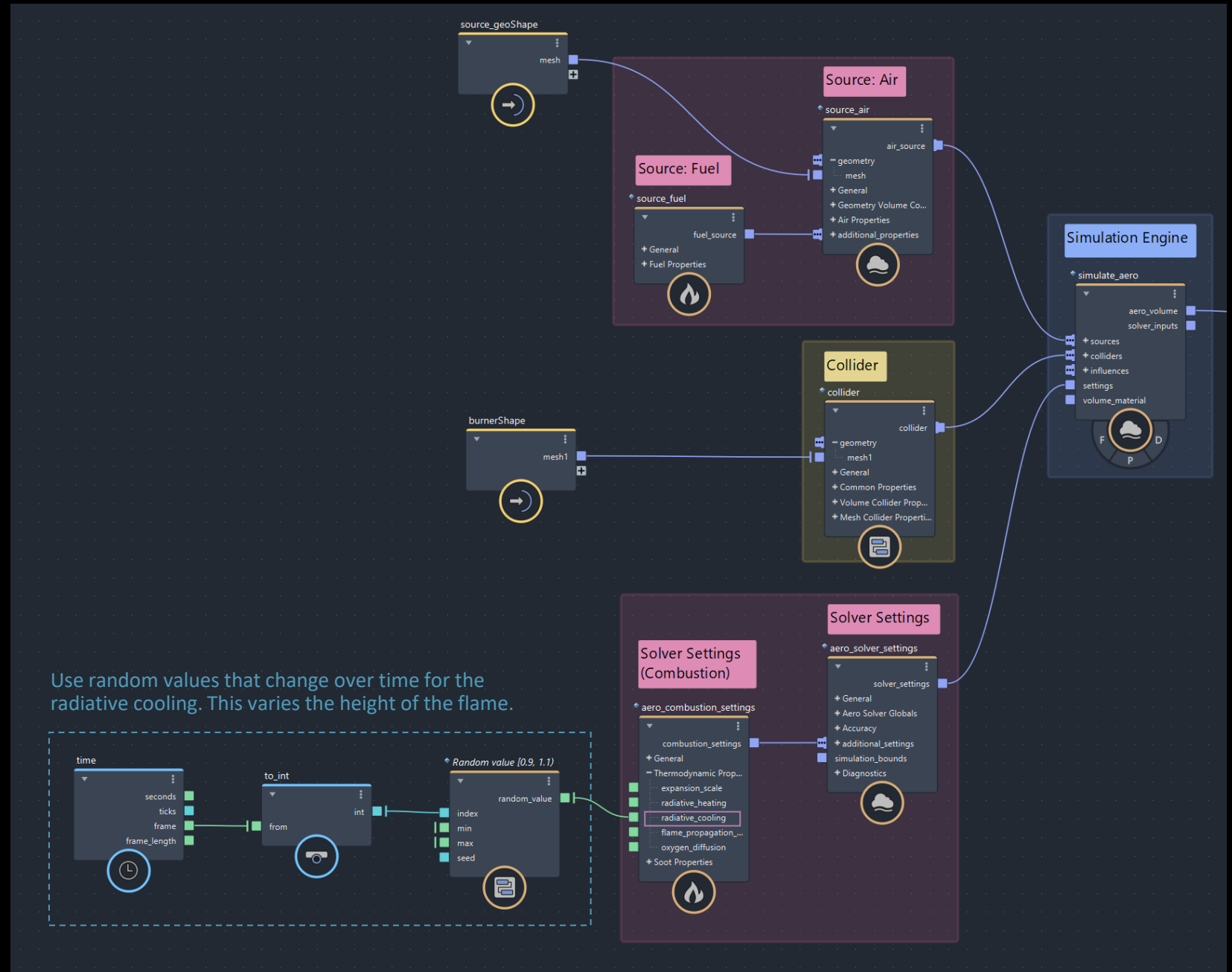
## Adjust Parameters





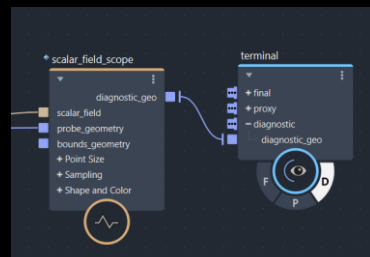
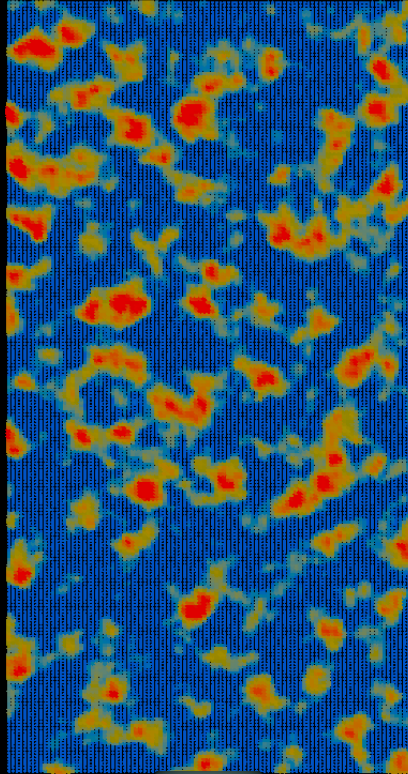
## Aero Simulation - Fire

## Adjust Parameters

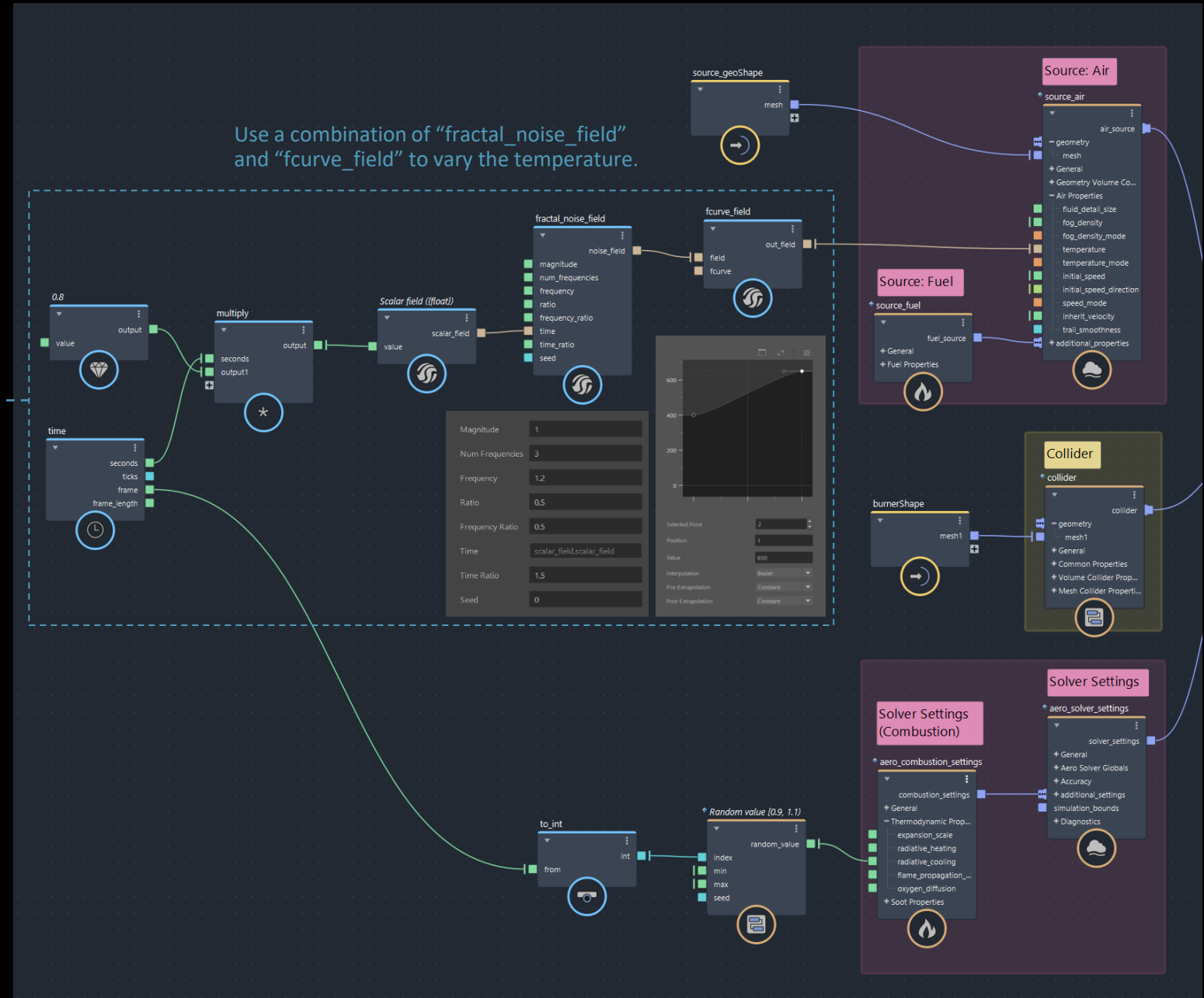


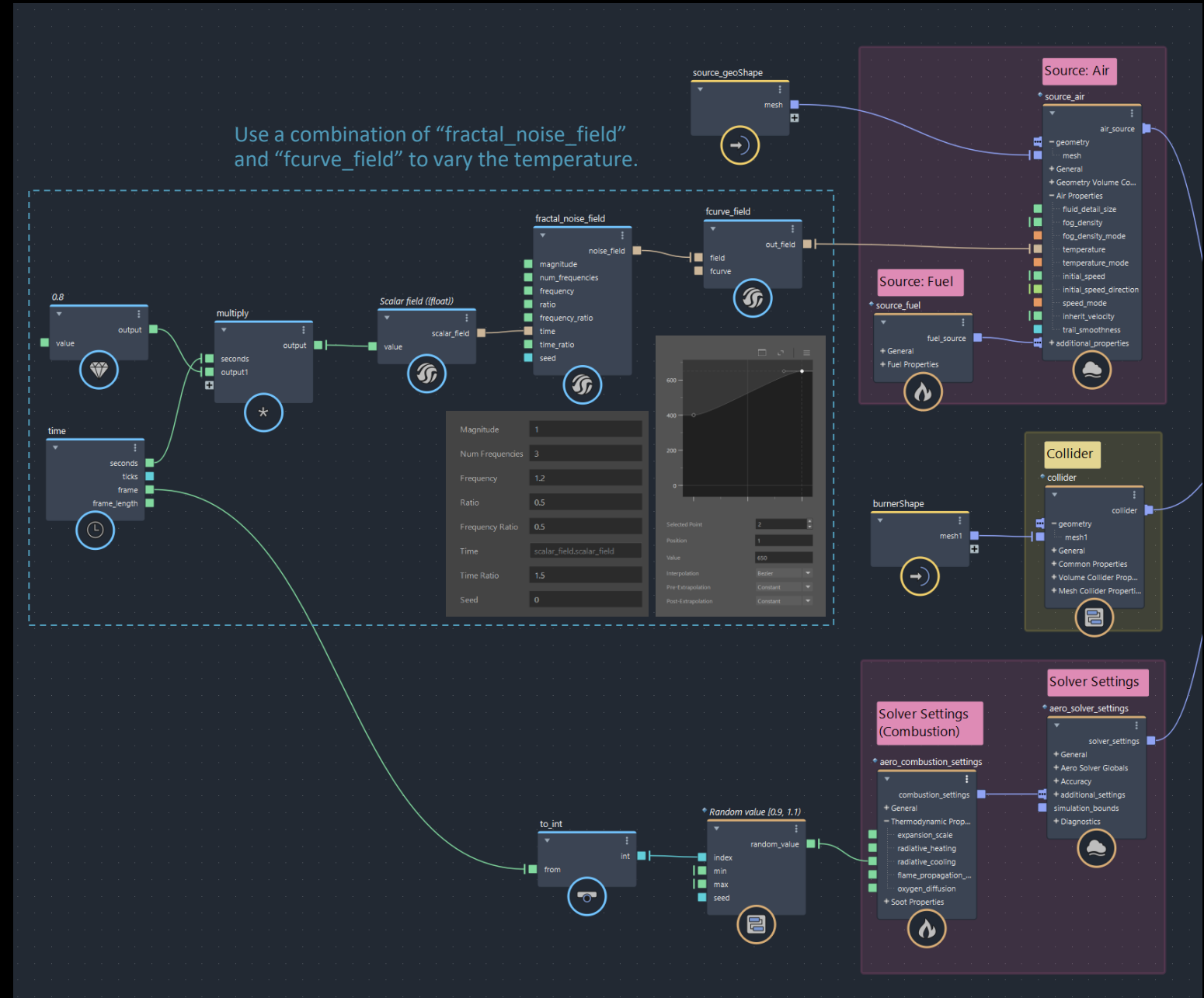
## Aero Simulation - Fire

## Vary source property using fields



For visualizing a scalar field





## Aero Simulation - Fire

## Add Influences

