

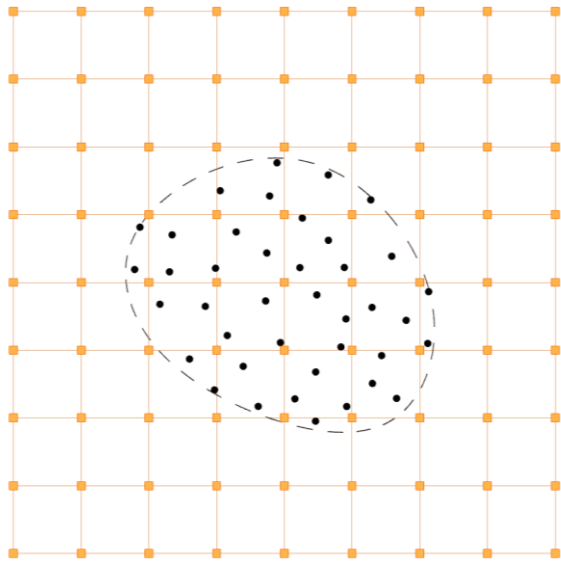
# Bifrost Workshop

## Lesson 7

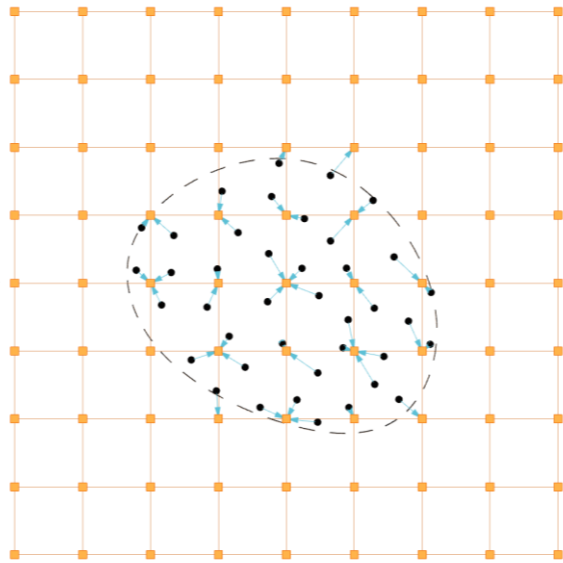
### Simulation Part III

- MPM Sand
- MPM Snow
- MPM Cloth

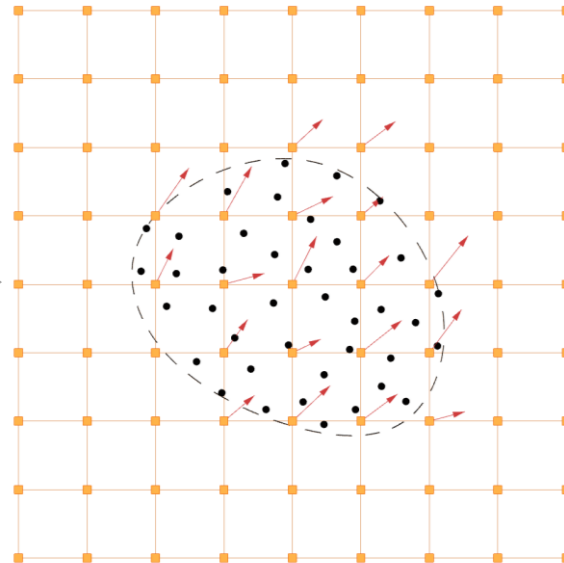
# Material Point Method (MPM)



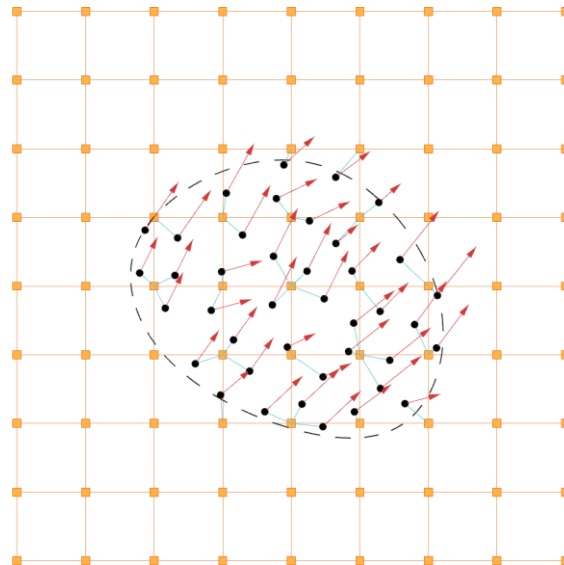
Material points + Voxel grid



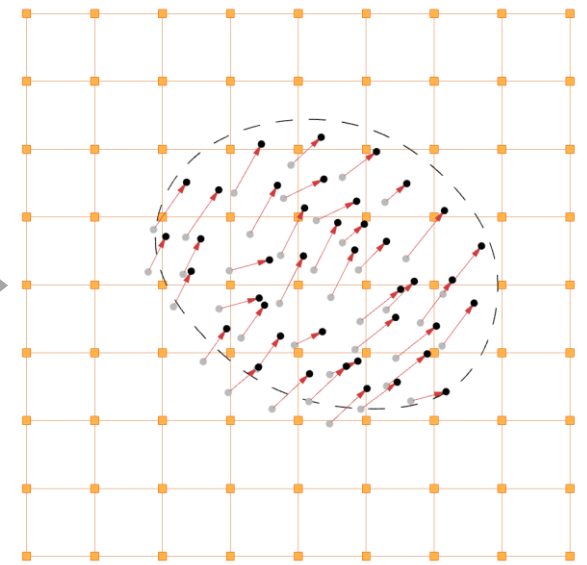
Material point properties are projected to the grid points



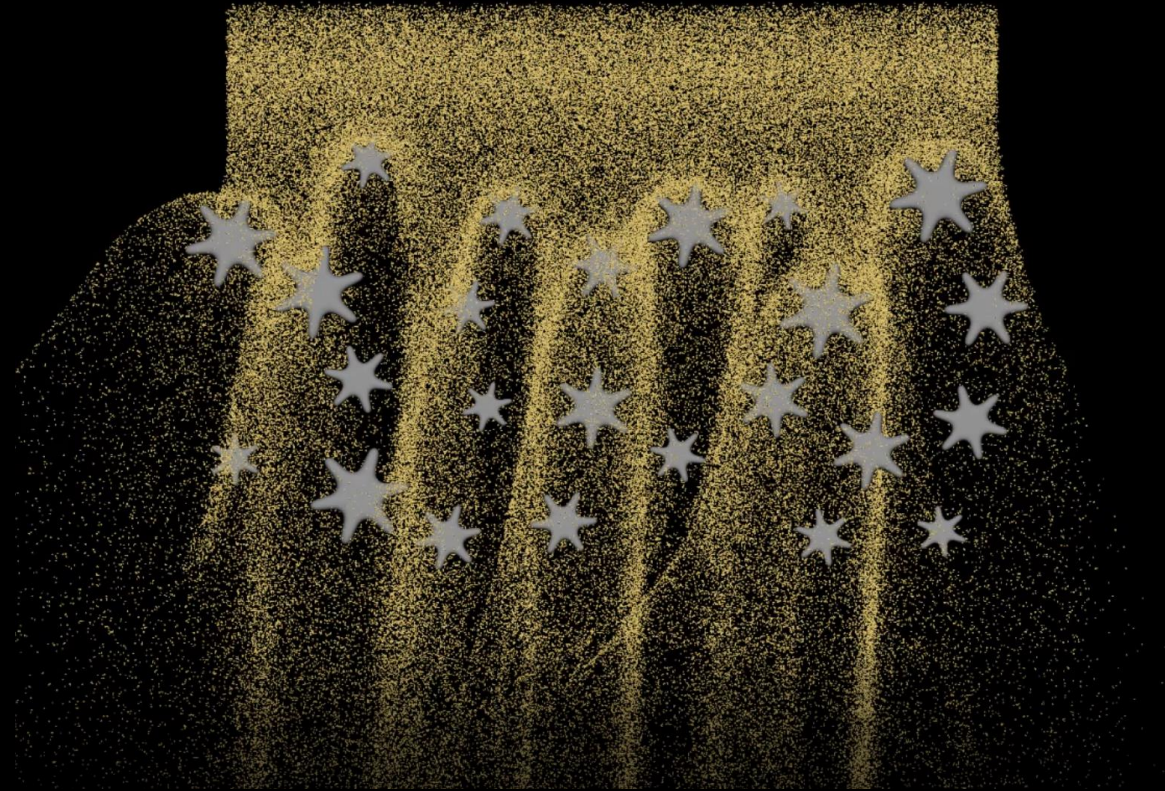
Motion vectors  
are calculated on  
the grid points



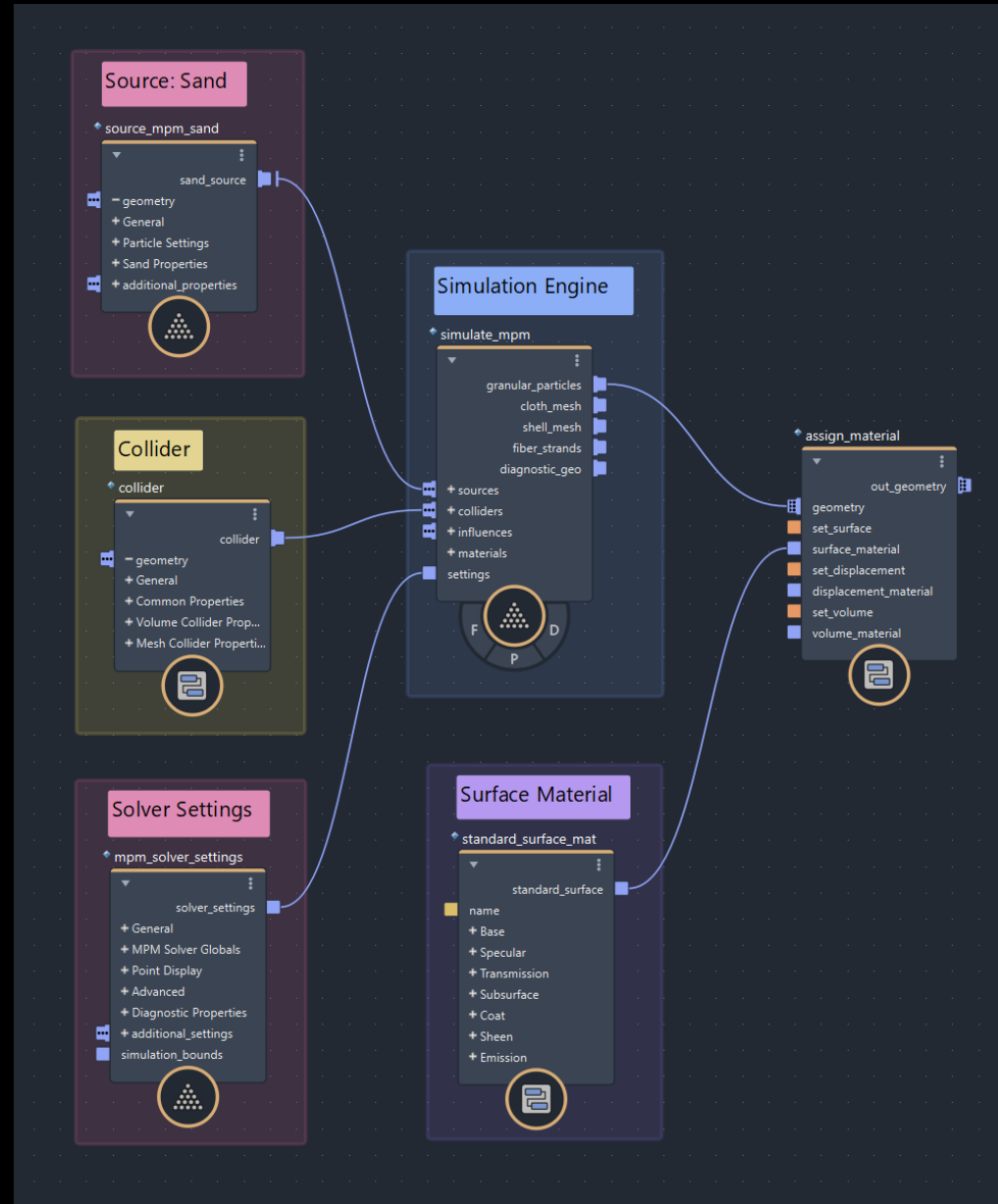
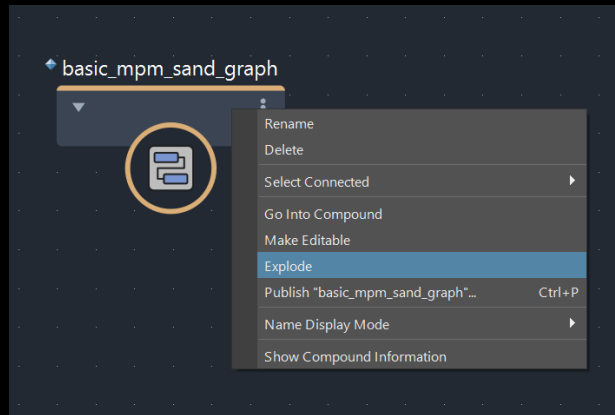
The updated motion vectors are interpolated back to the material points



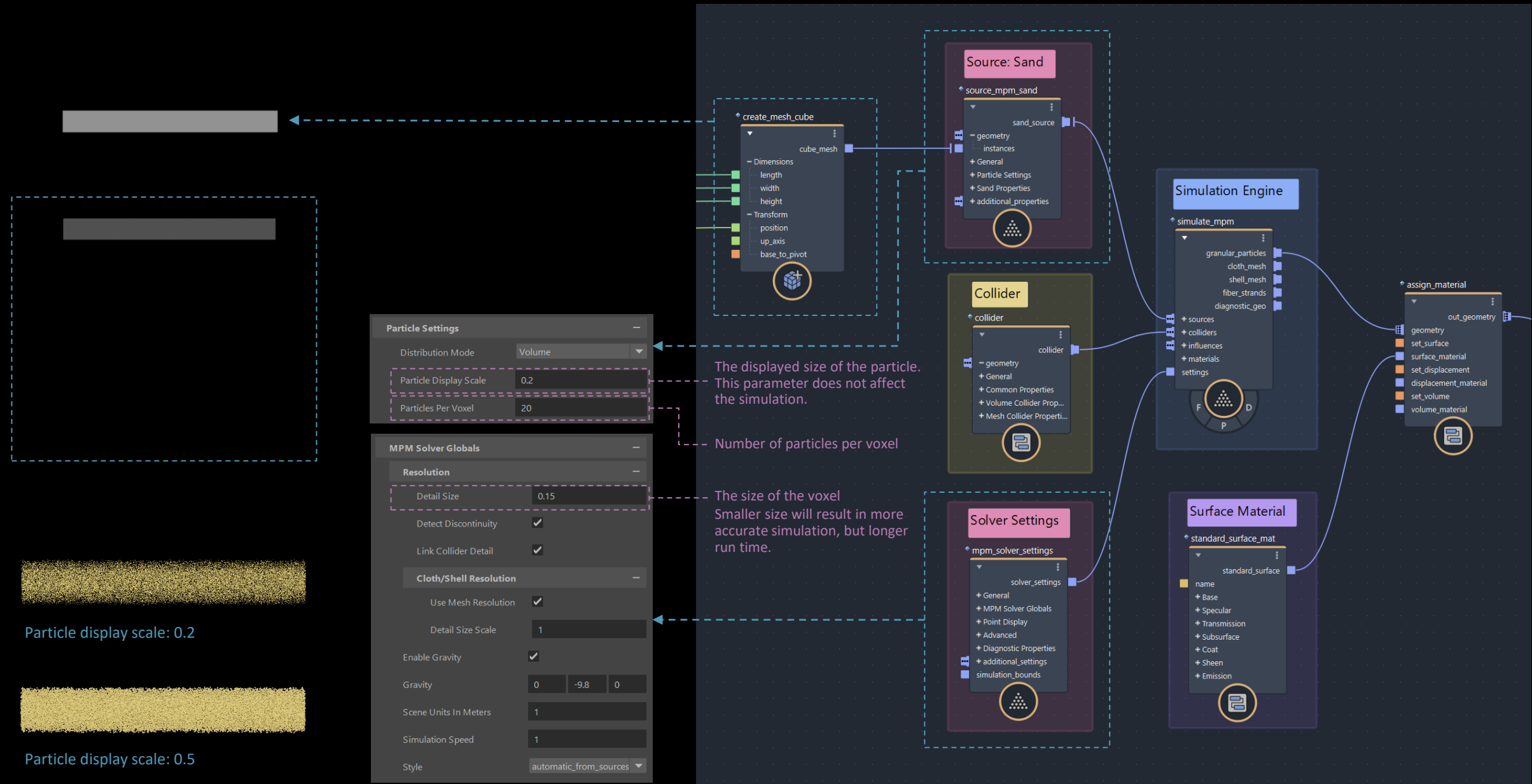
Update the properties of material points



# MPM Sand

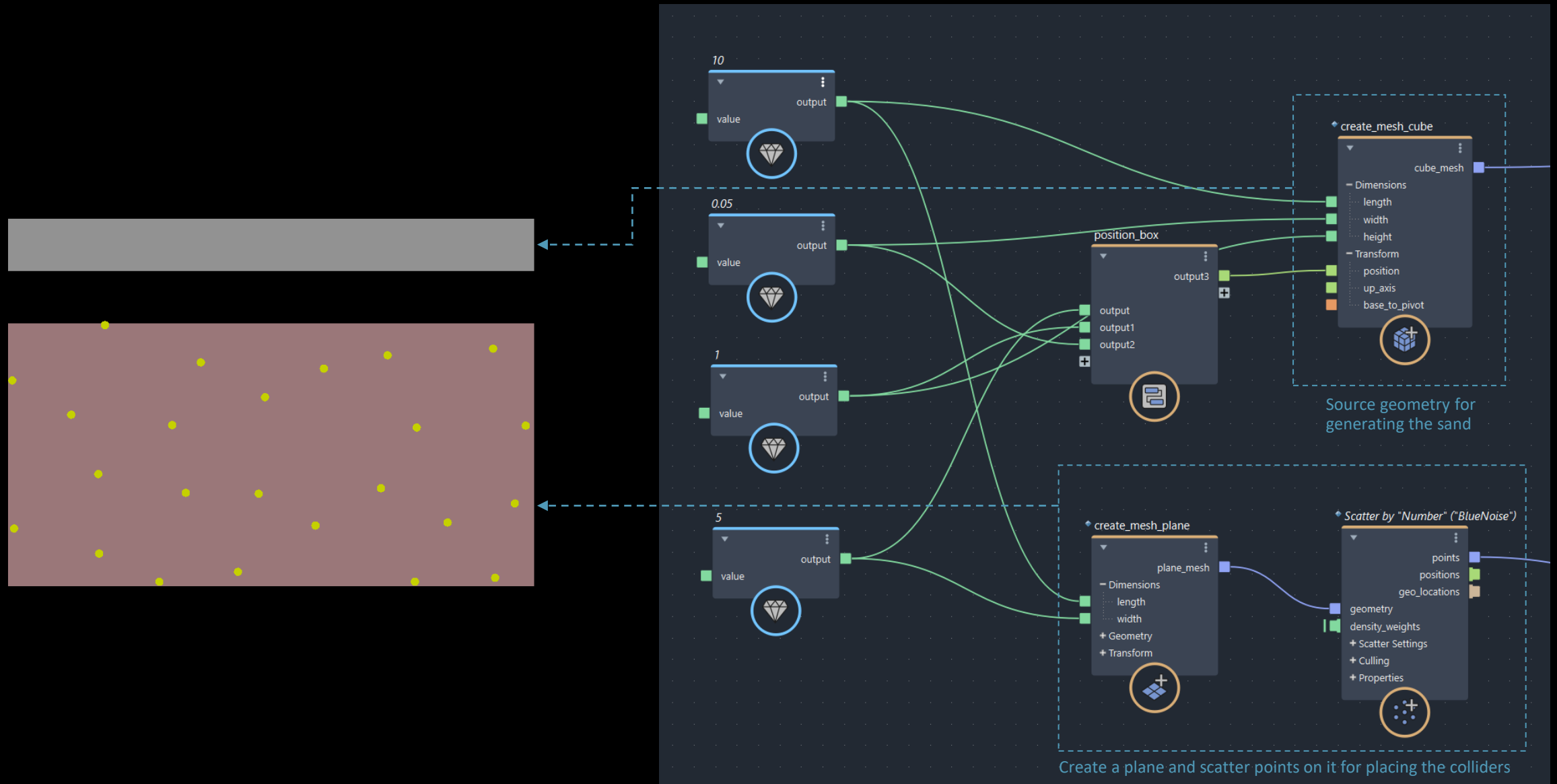


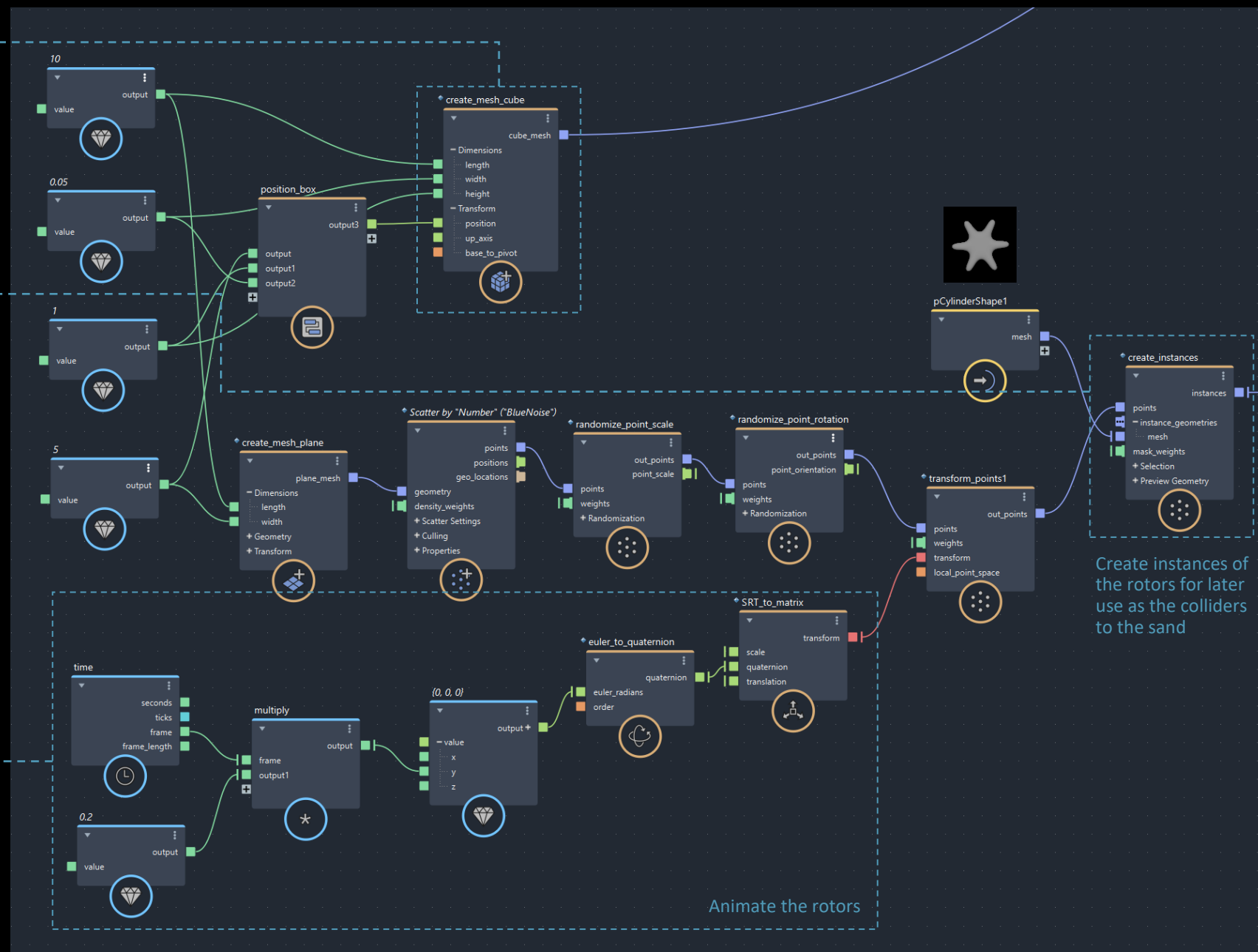
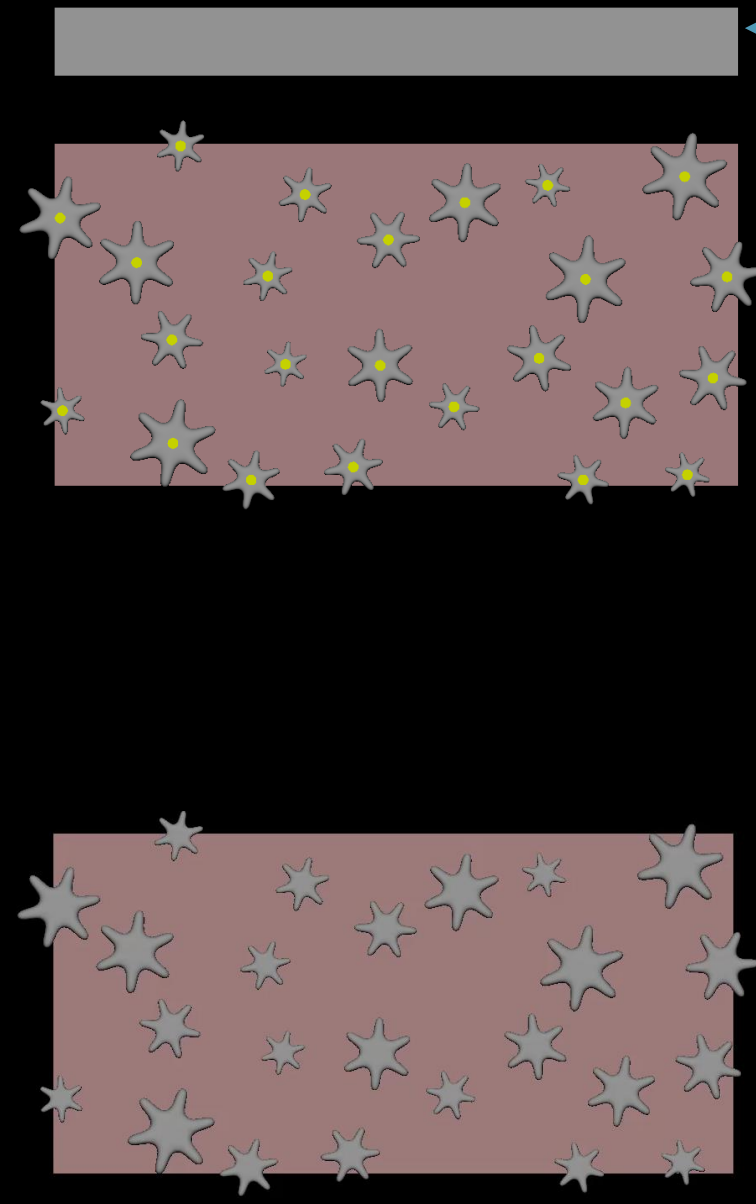
# MPM Sand



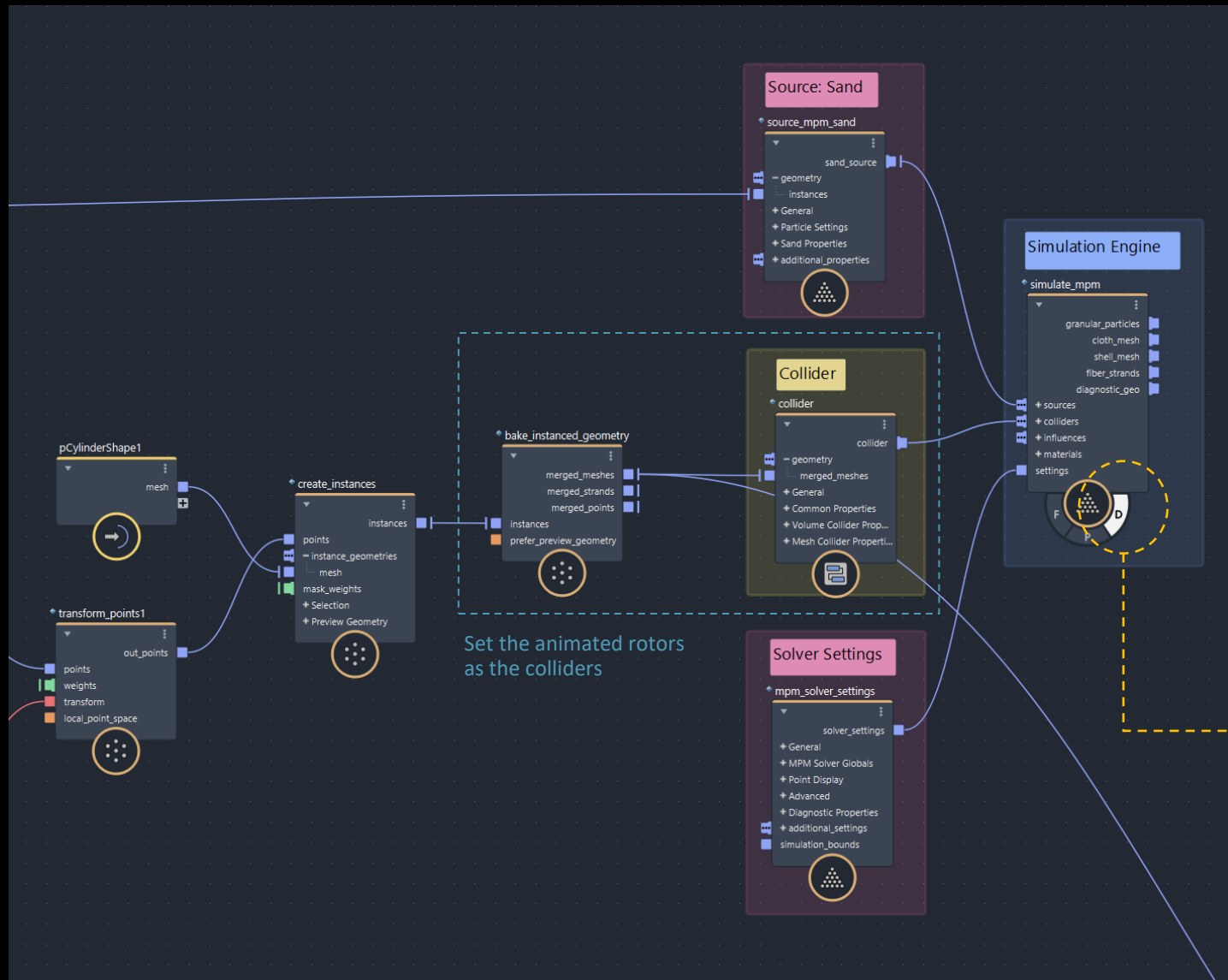
Particle display scale: 0.2

Particle display scale: 0.5



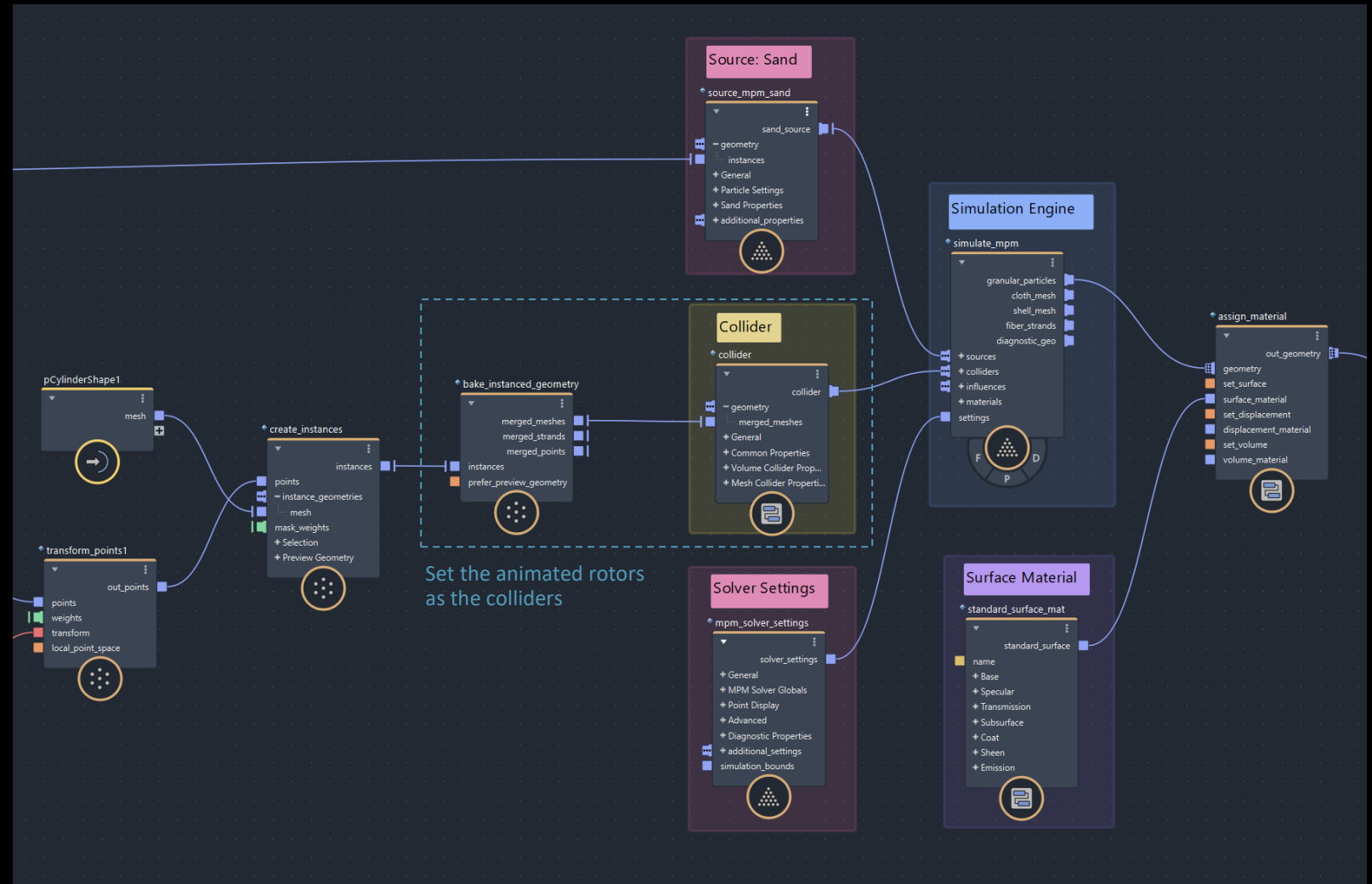
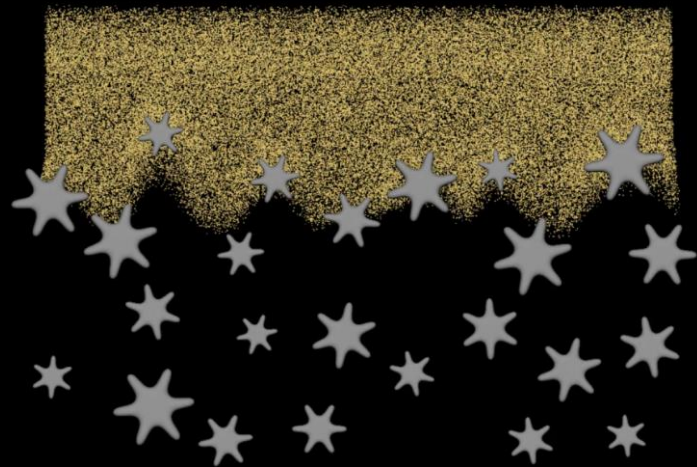






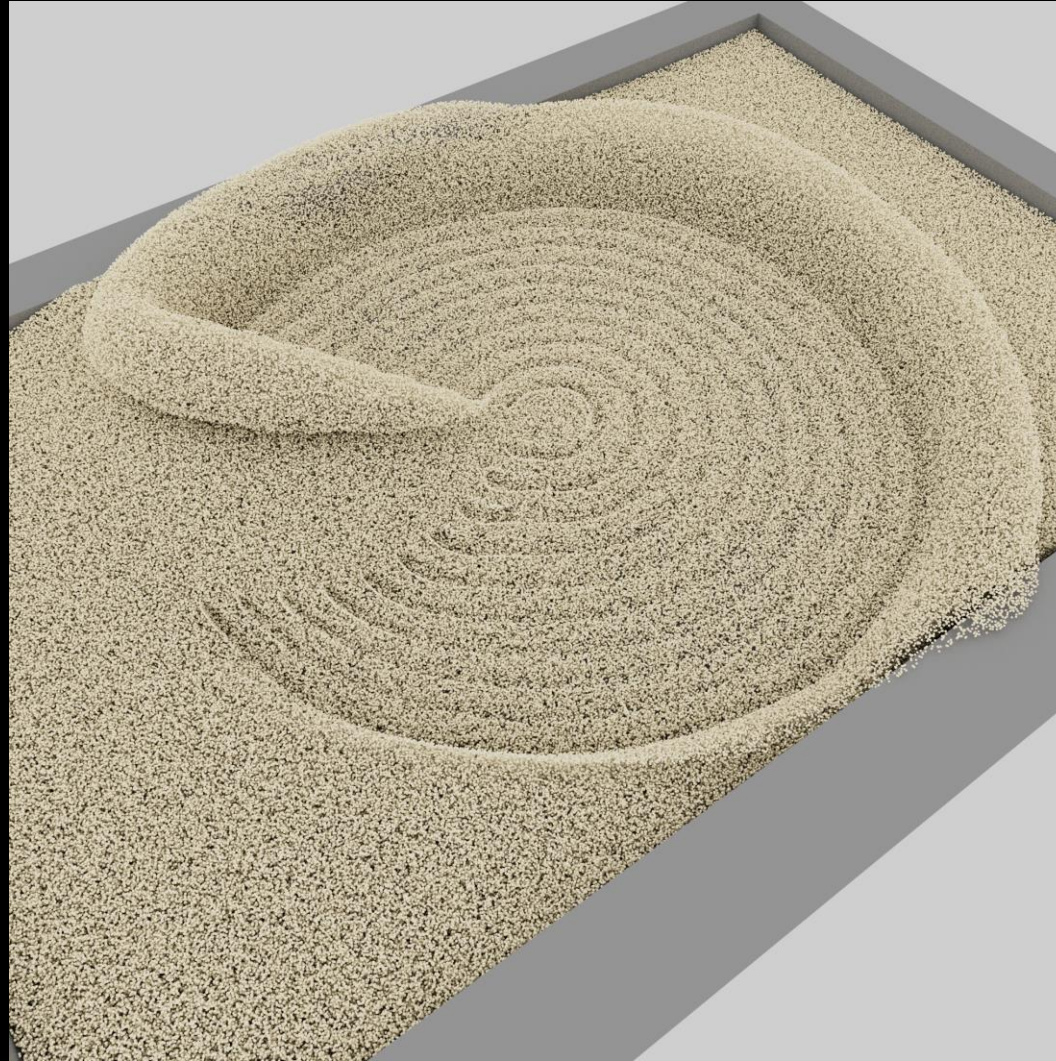
Turn on the diagnostic view of "simulate\_mpm" to check if the simulation runs correctly before assigning materials.



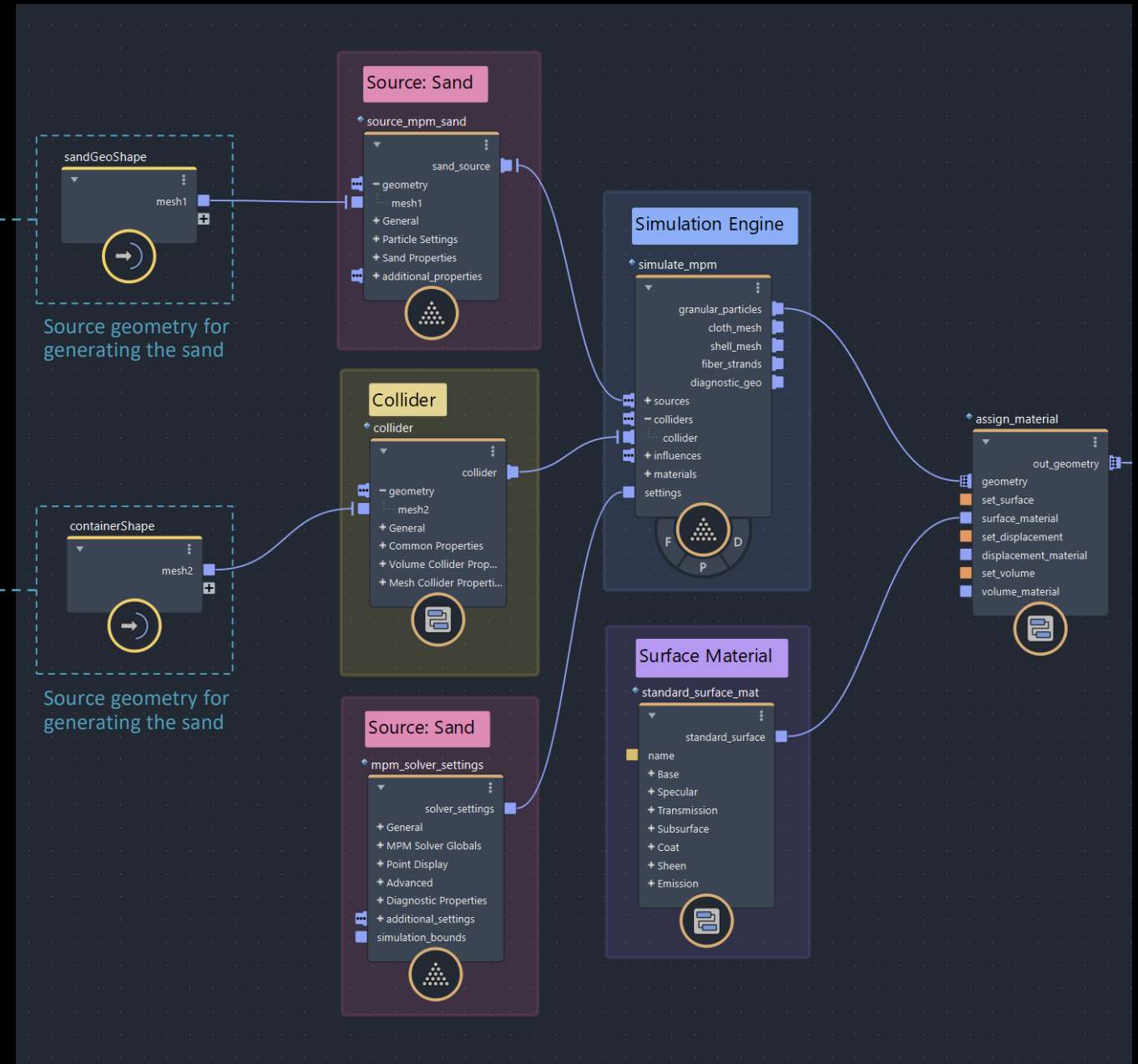
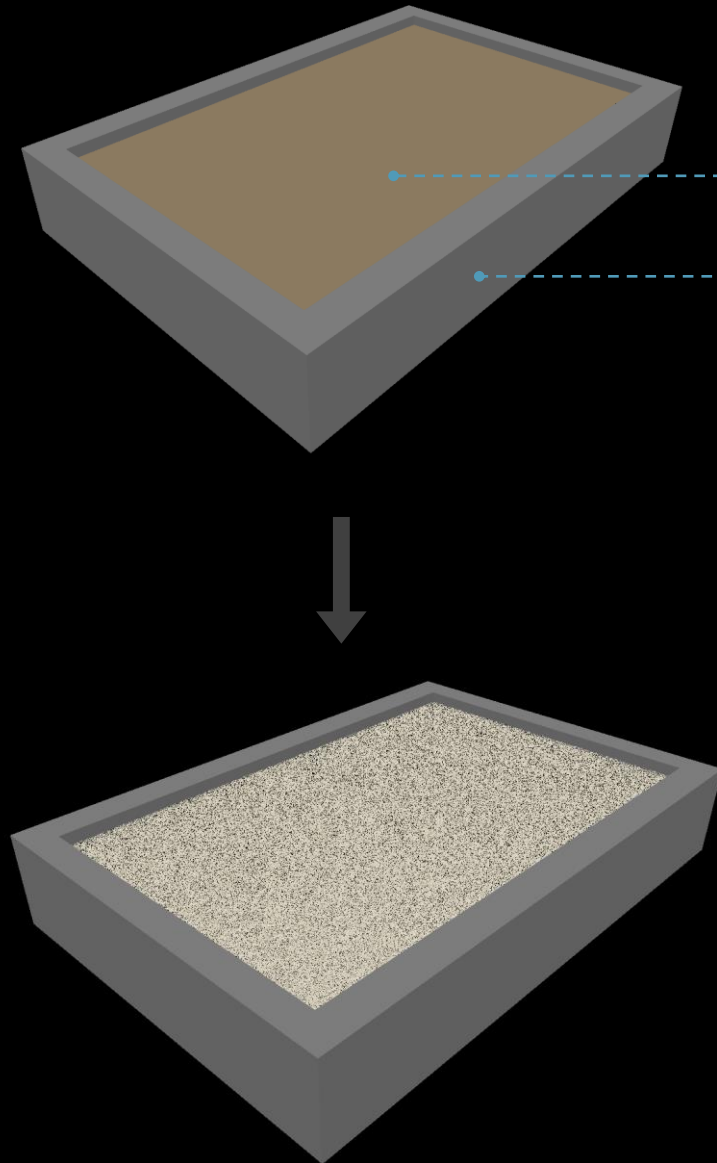




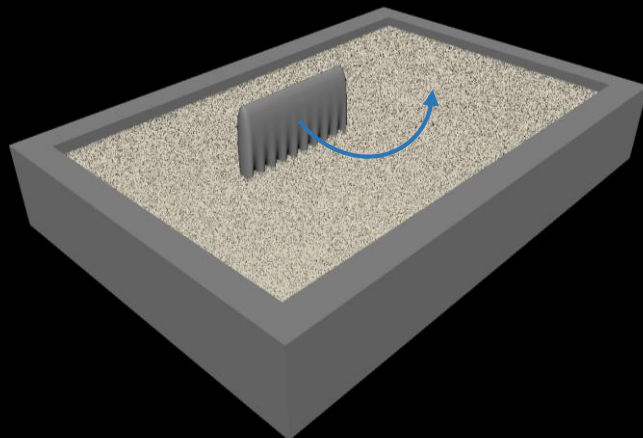
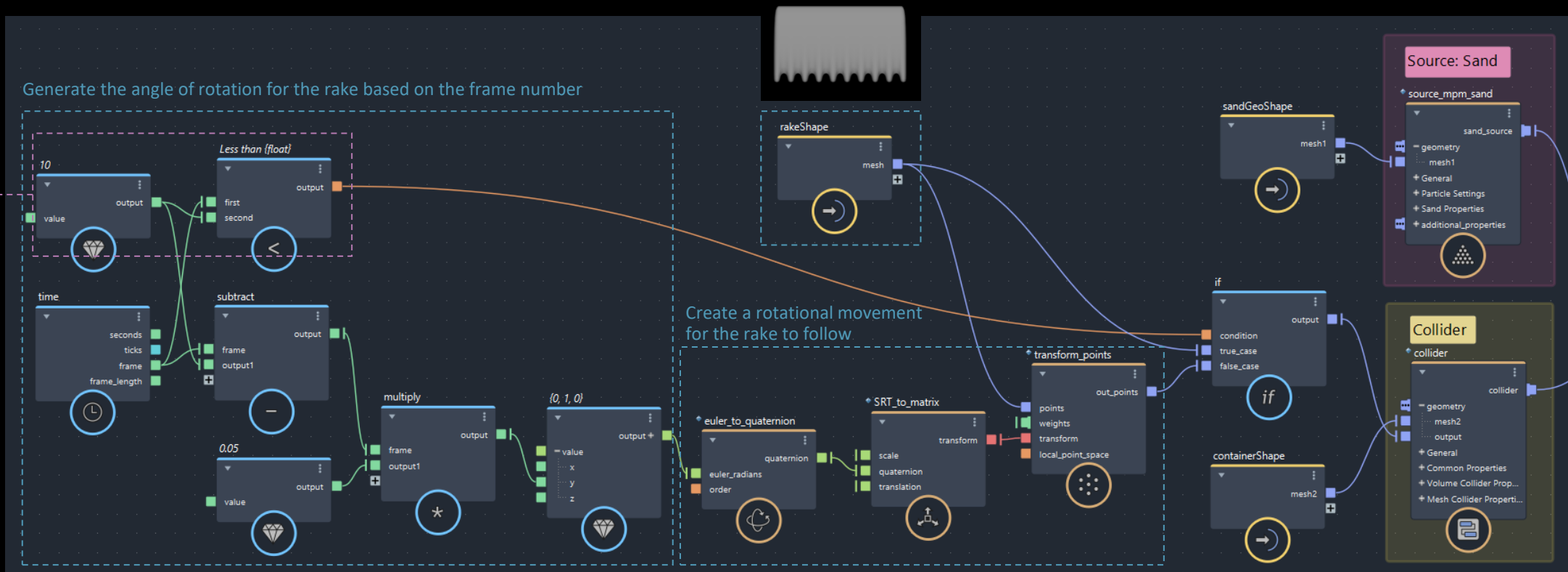
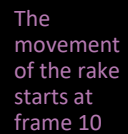
MPM Sand



# MPM Sand



## MPM Sand





# MPM Sand

The degree to which the sand preserves its volume vs. its shape.

**0:** no volume preservation & highest resistance against shape change

**1:** no shape preservation & acts like liquid

How much the sand resists sliding against itself for a given amount of compression

How much the sand tends to stick together

**0:** completely dry sand

**higher value:** sand clumps together more

| Sand Properties     |     |
|---------------------|-----|
| Mass Density        | 500 |
| Viscosity           | 0   |
| Volume Preservation | 0.5 |
| Vibration Speed     | 50  |
| Friction            | 1   |
| Cohesion            | 1   |



Friction: 0.1 Cohesion: 0



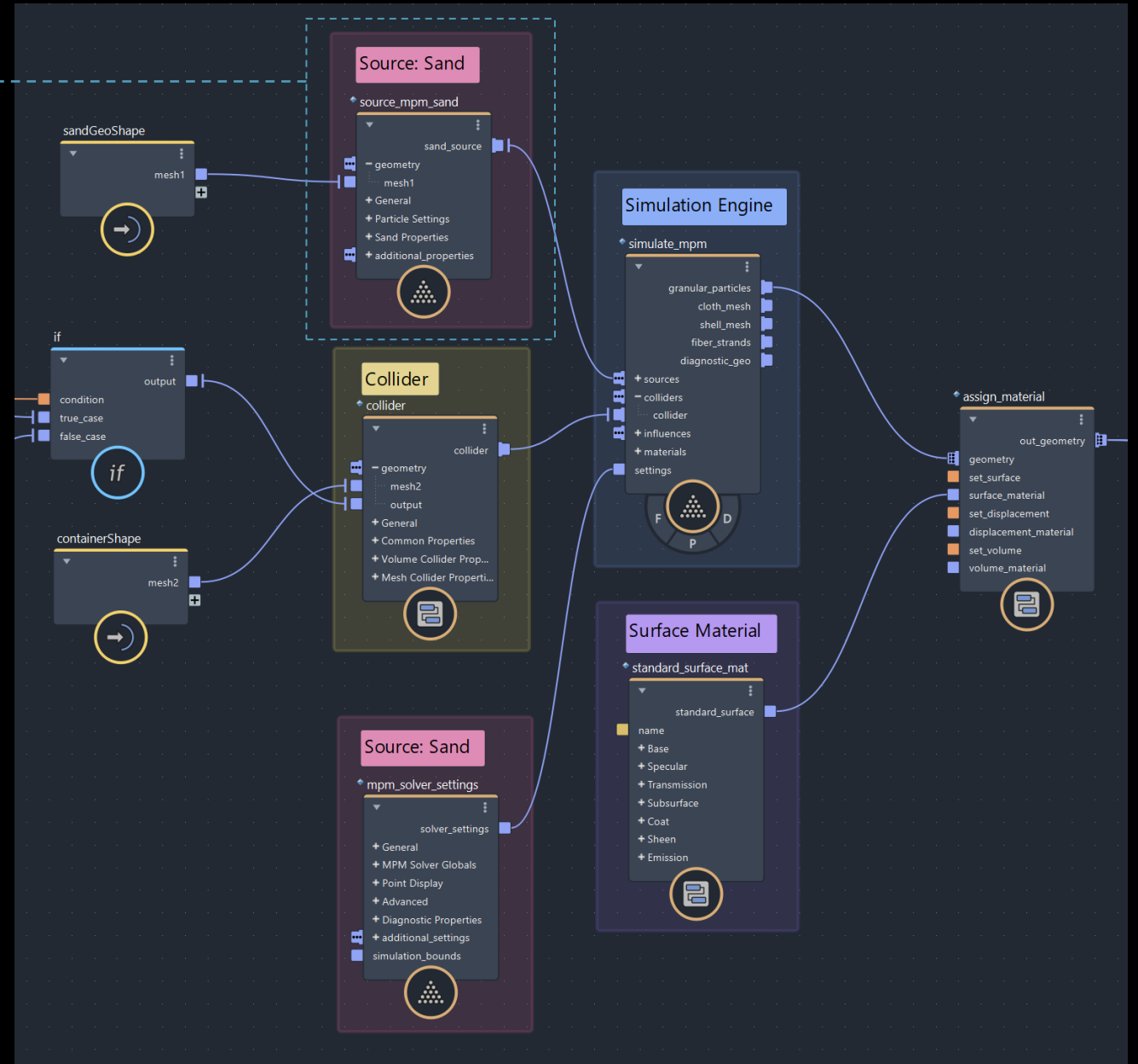
Friction: 1 Cohesion: 0



Friction: 1 Cohesion: 1



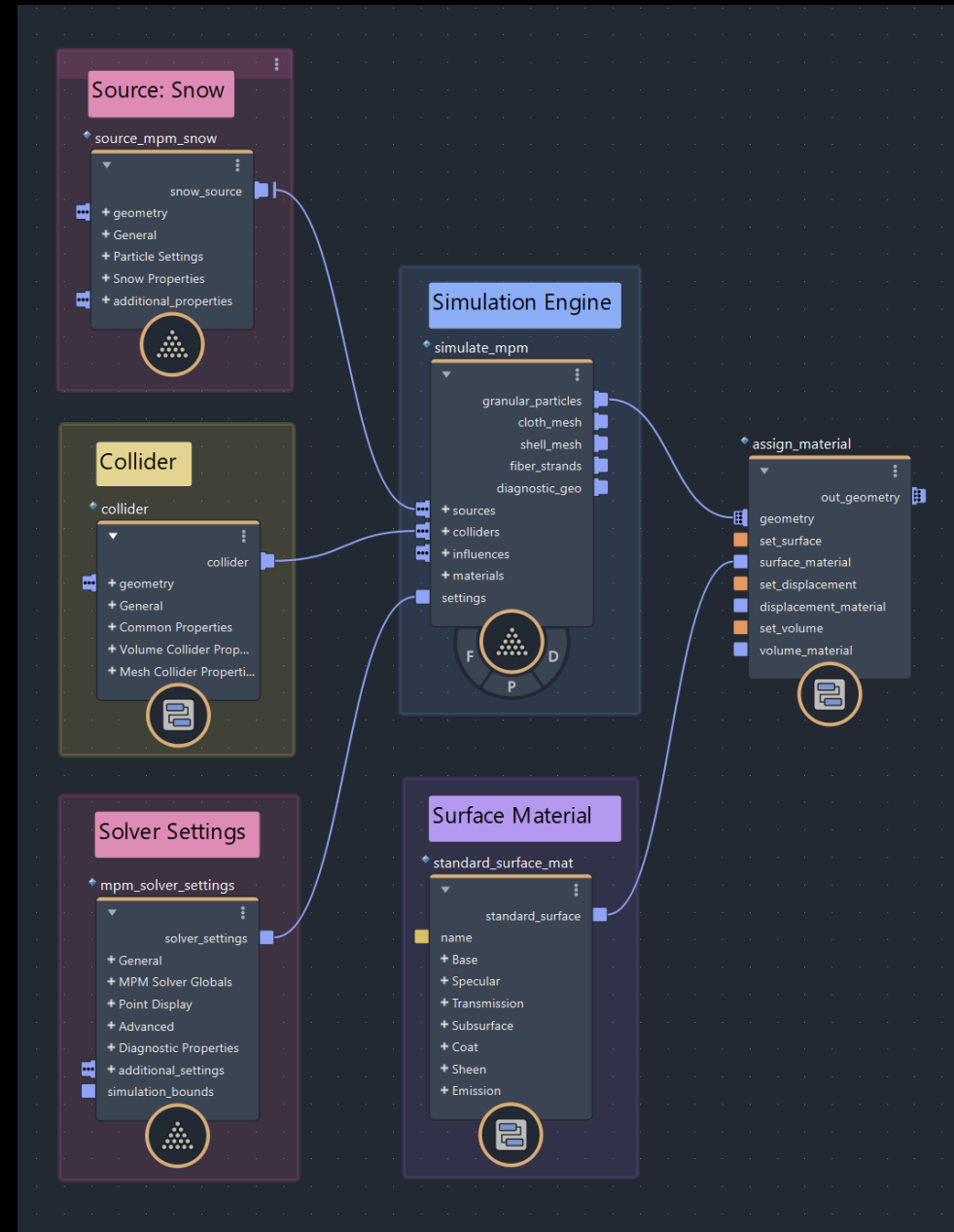
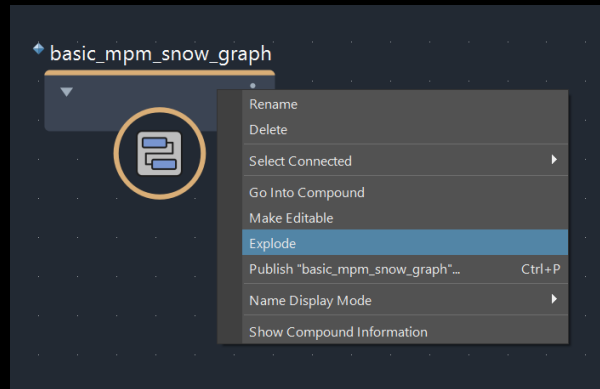
Friction: 1 Cohesion: 10



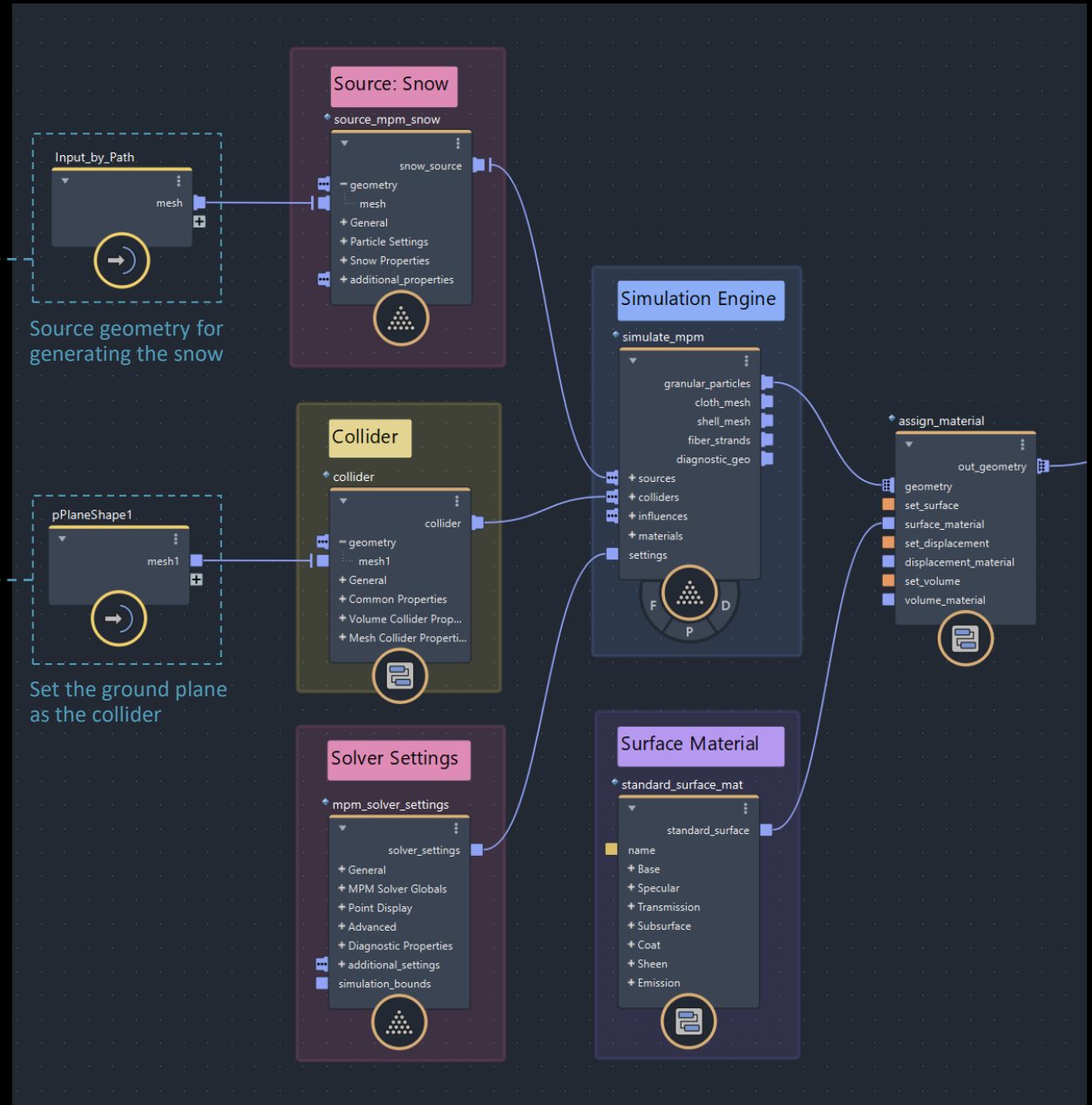
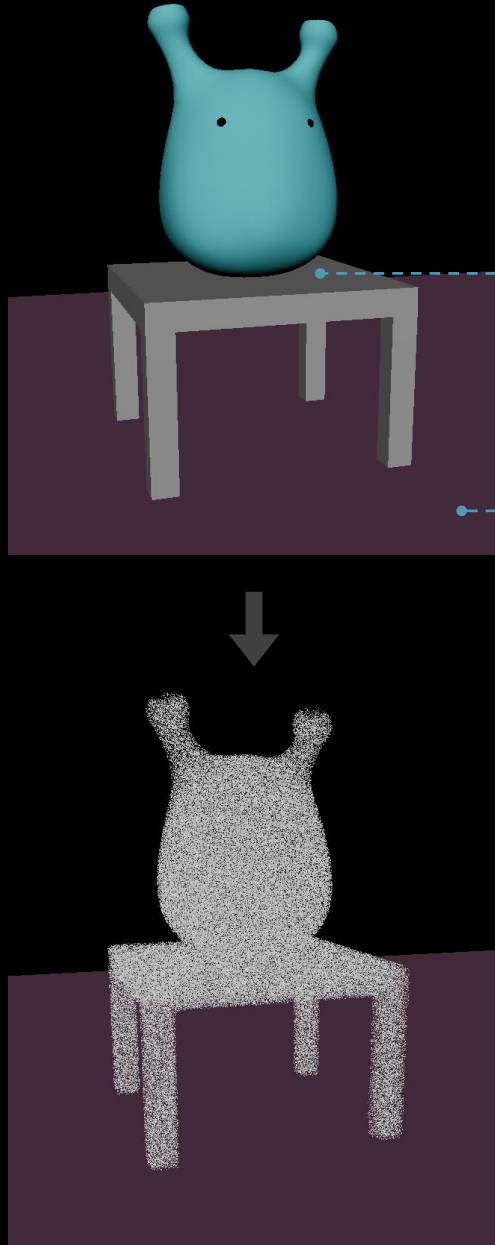




# MPM Snow



# MPM Snow



# MPM Snow

Particle Settings

Distribution Mode

Volume

Particle Display Scale

0.2

Particles Per Voxel

16

Passthrough Points

Passthrough Properties

Geometry Volume Conversion

Resolution Mode

Relative

Geo Volume Mode

Solid

Use Solver Detail Size

☒

Geo Detail Size

0.05

Geo Volume Offset

0

Min Hole Radius

0

Optimal Adaptivity

☐

Display Diagnostic

☐

MPM Solver Globals

Resolution

Detail Size

0.07

Detect Discontinuity

☒

Link Collider Detail

☒

Cloth/Shell Resolution

Use Mesh Resolution

☒

Detail Size Scale

1

Enable Gravity

☒

Gravity

0

-9.8

0

Scene Units In Meters

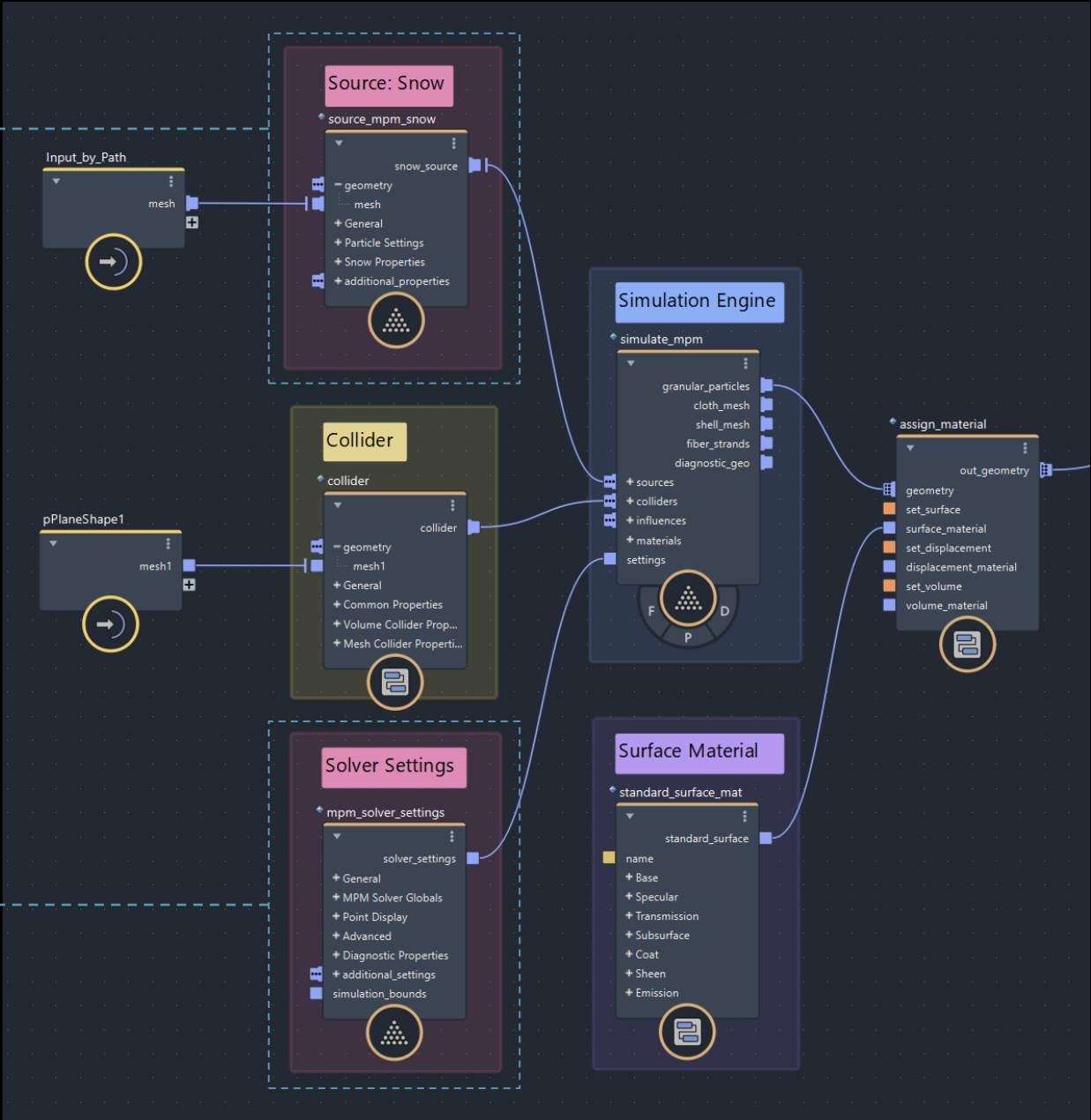
1

Simulation Speed

1

Style

automatic\_from\_sources



# MPM Snow

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

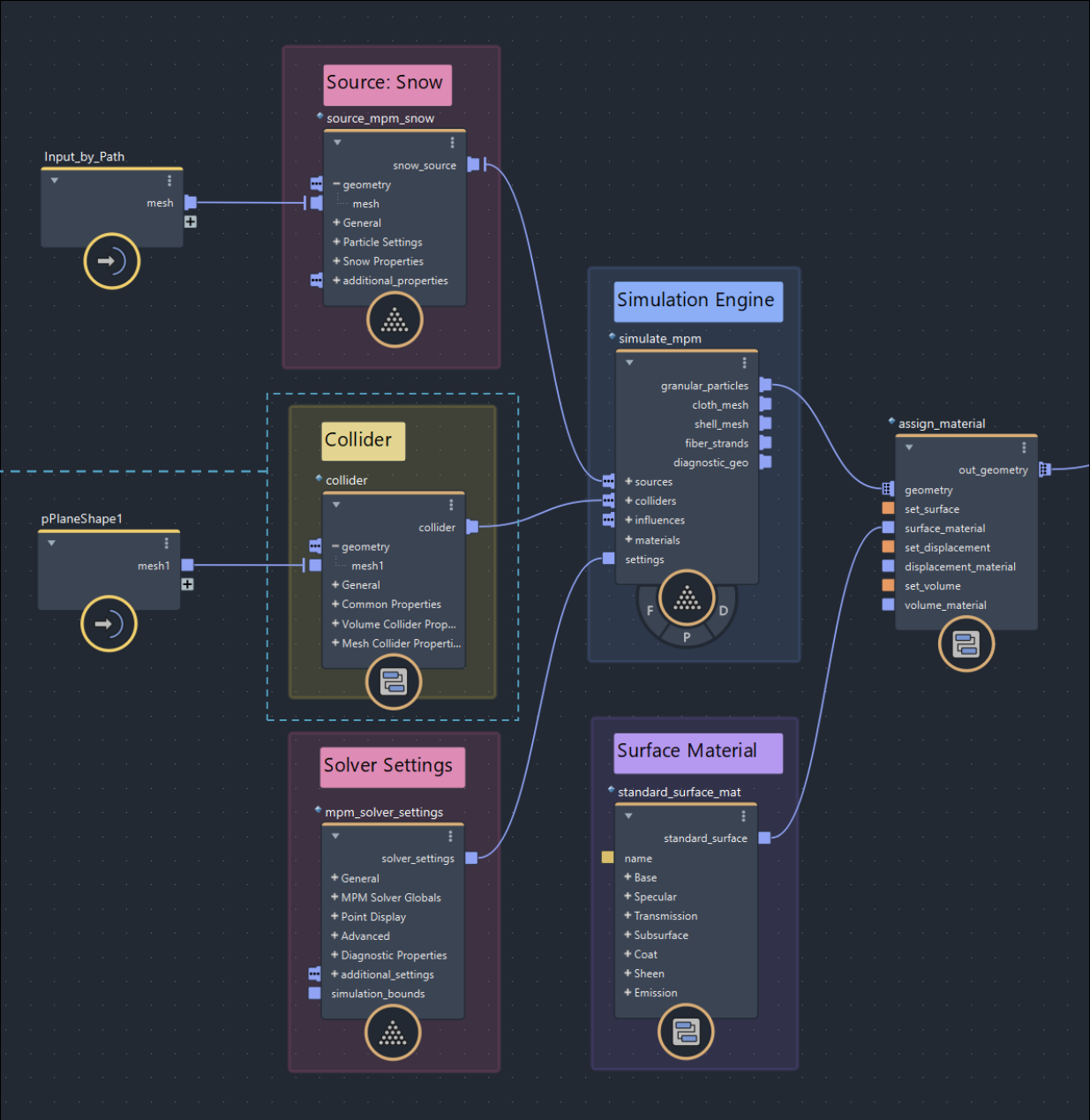
Roughness

0

Stickiness

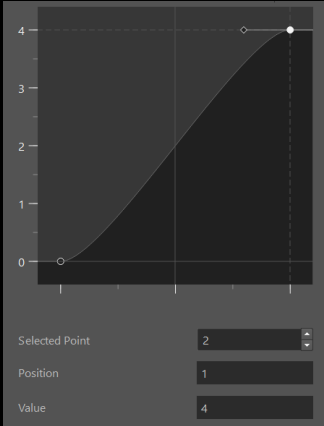
1.5

Increasing the stickiness to prevent the snow from spreading too much on the surface of the collider



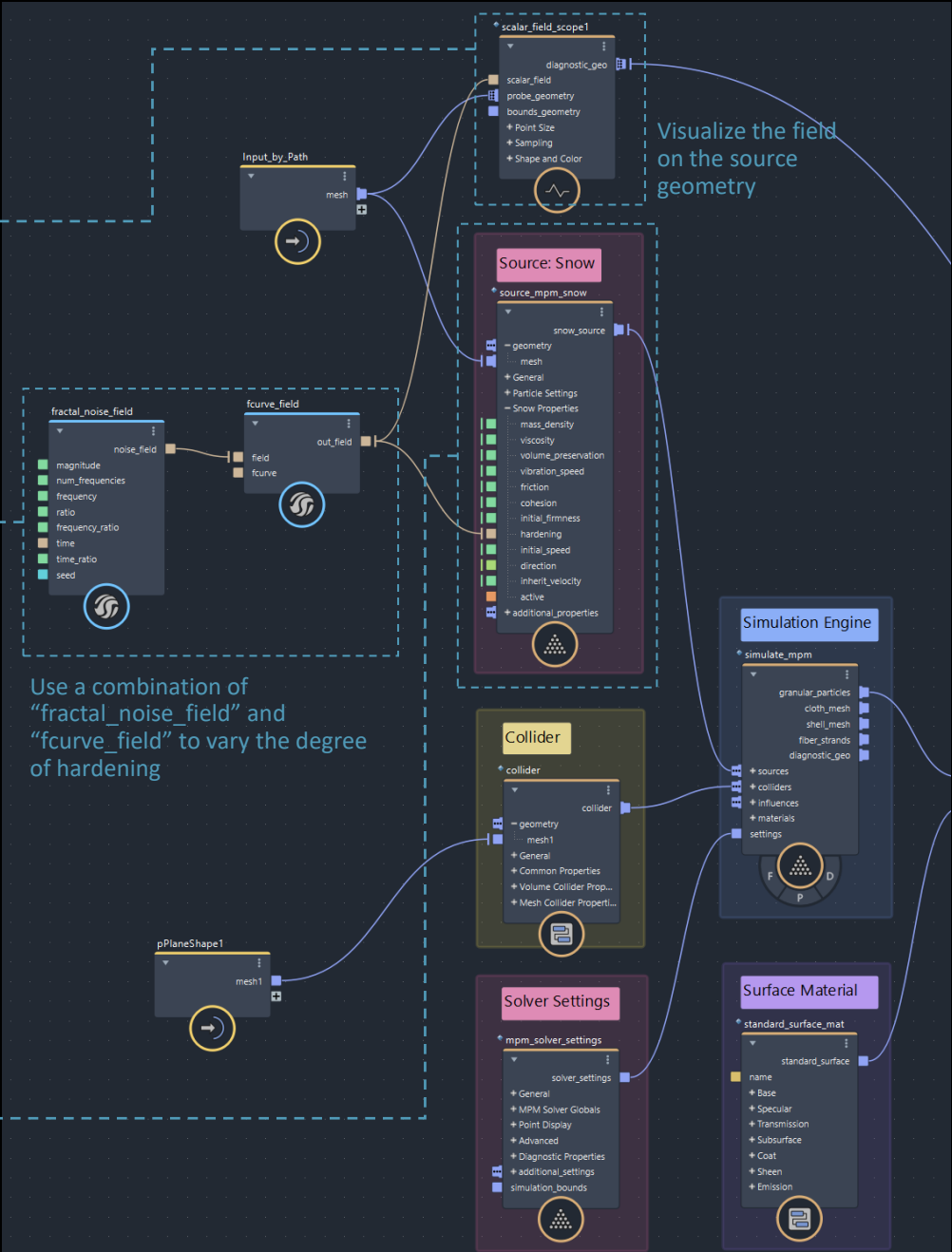
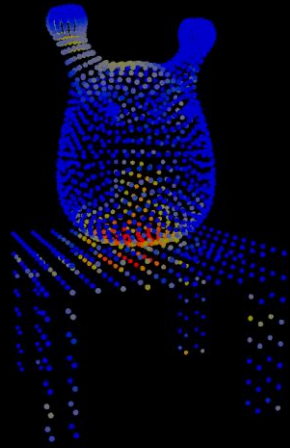
# MPM Snow

|                 |       |
|-----------------|-------|
| Magnitude       | 1     |
| Num Frequencies | 2     |
| Frequency       | 0.316 |
| Ratio           | 0.5   |
| Frequency Ratio | 0.5   |
| Time            |       |
| Time Ratio      | 1.5   |
| Seed            | 0     |

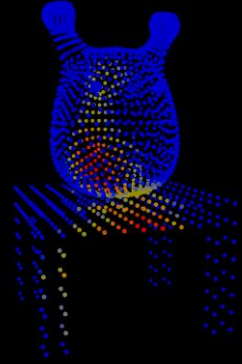


| Snow Properties     |                       |
|---------------------|-----------------------|
| Mass Density        | 250                   |
| Viscosity           | 0.0001                |
| Volume Preservation | 0.5                   |
| Vibration Speed     | 50                    |
| Friction            | 1                     |
| Cohesion            | 5                     |
| Initial Firmness    | 1                     |
| Hardening           | curve_field.out_field |

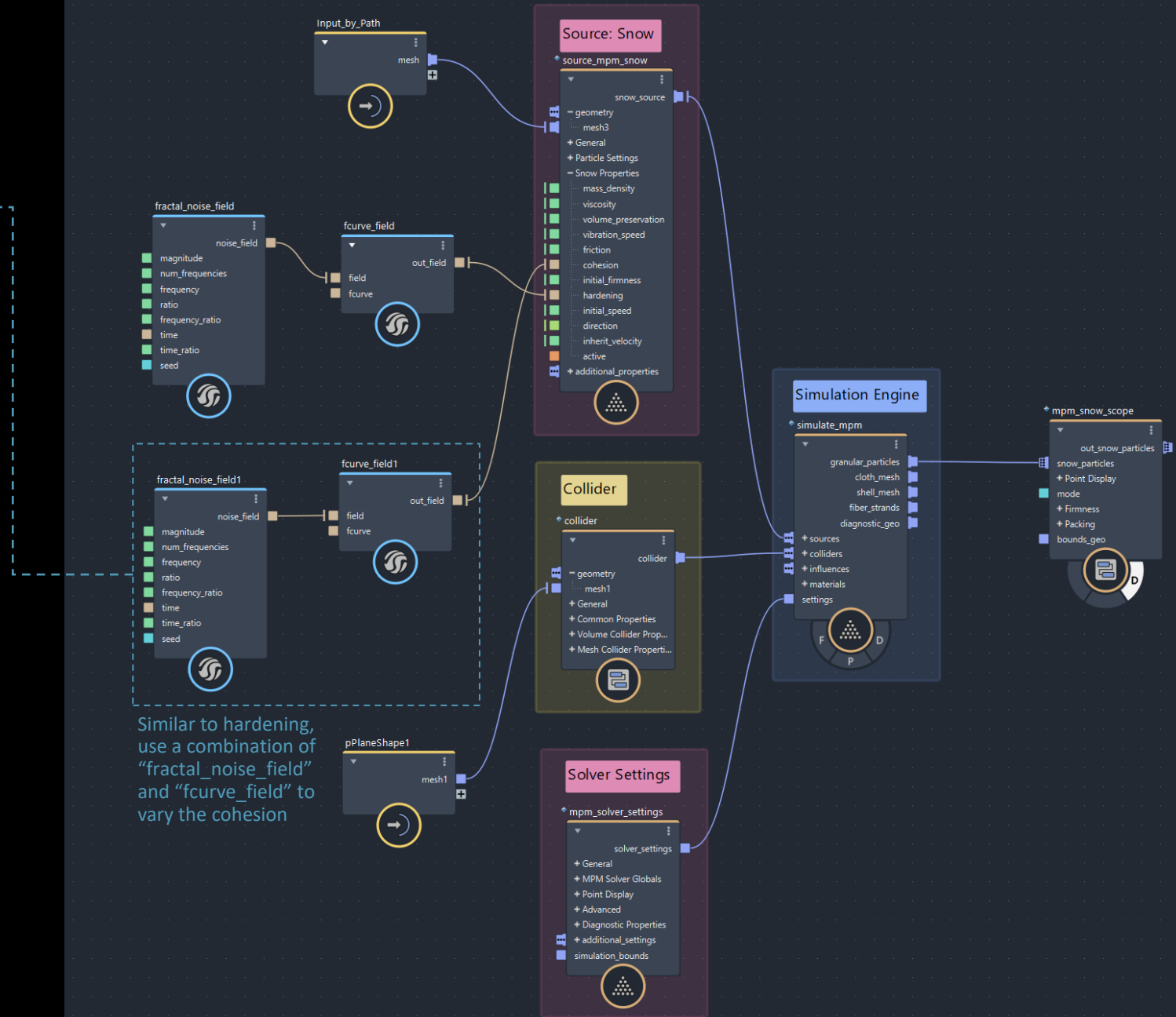
Hardening controls how fast the firmness changes upon packing/unpacking. A higher value means that the snow becomes firmer faster when being packed and becomes looser faster when being unpacked.



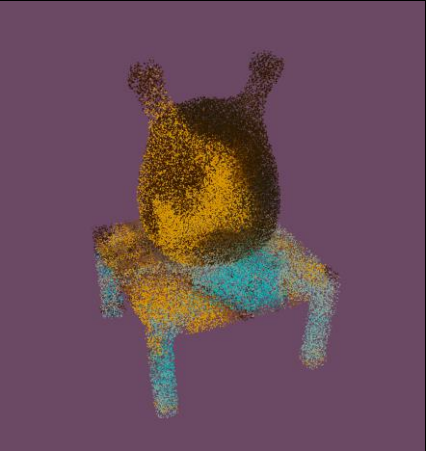
# MPM Snow



|                 |        |
|-----------------|--------|
| Magnitude       | 1      |
| Num Frequencies | 3      |
| Frequency       | 0.1402 |
| Ratio           | 0.5    |
| Frequency Ratio | 0.5    |
| Time            |        |
| Time Ratio      | 1.5    |
| Seed            | 3      |



# MPM Snow



mpm\_snow\_scope

Type: mpm\_snow\_scope

Snow Particles

simulate\_mpm.granular\_particles

Point Display

Size Scale

1

Shape

Sphere

Shadows

0.5

Mode

packing

Firmness

Firmness Start

0

Firmness End

1

Firmness Start Color

1

0.5423

0

Firmness End Color

0

0.715

1

Packing

Unpacking Color

1

0.5423

0

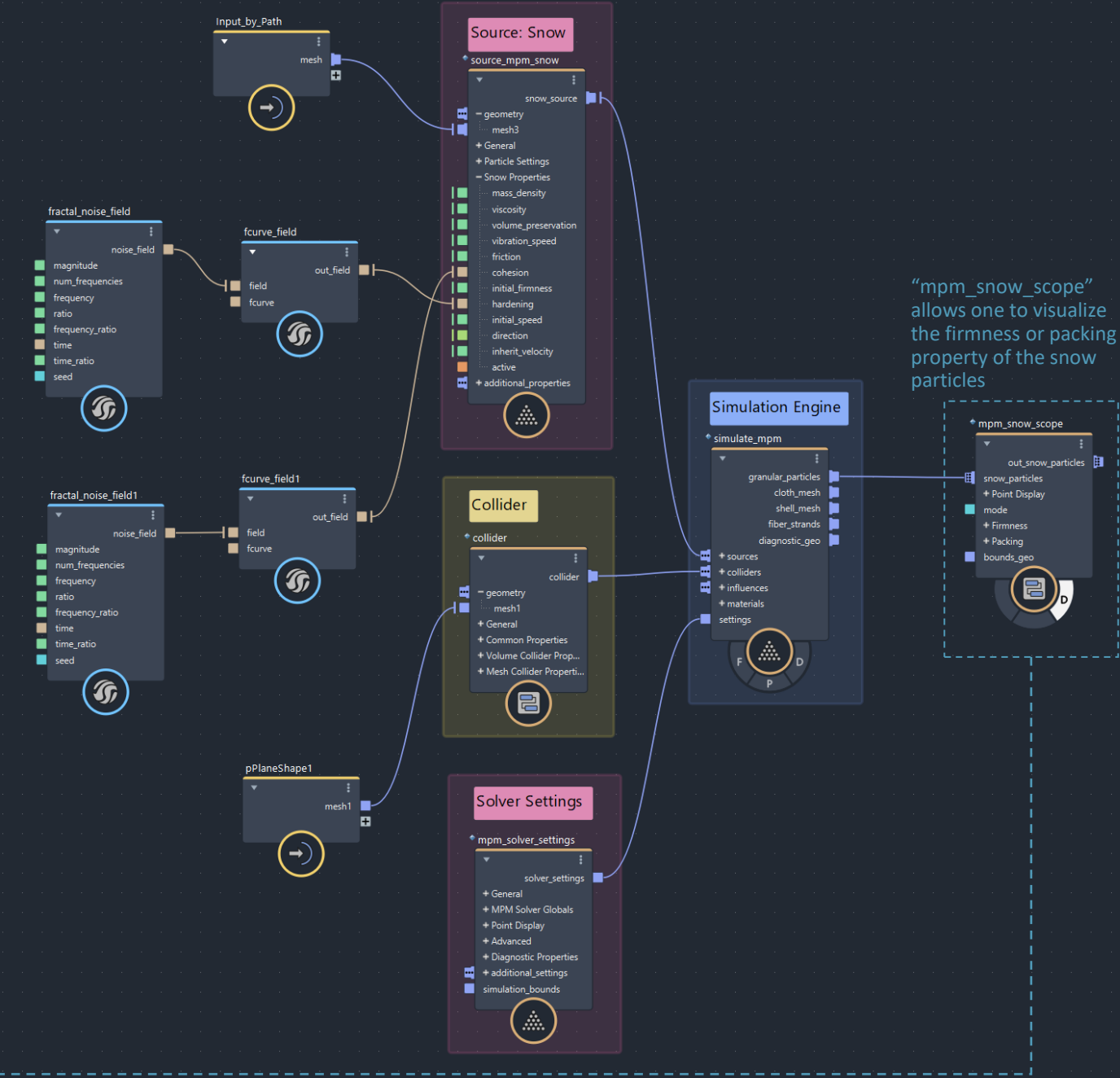
Packing Color

0

0.715

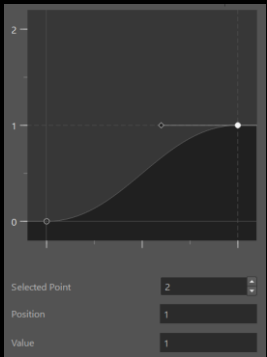
1

Bounds Geo

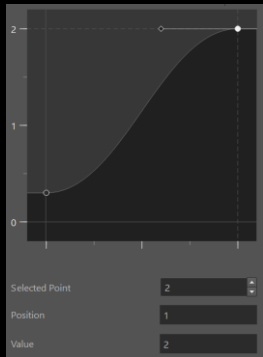




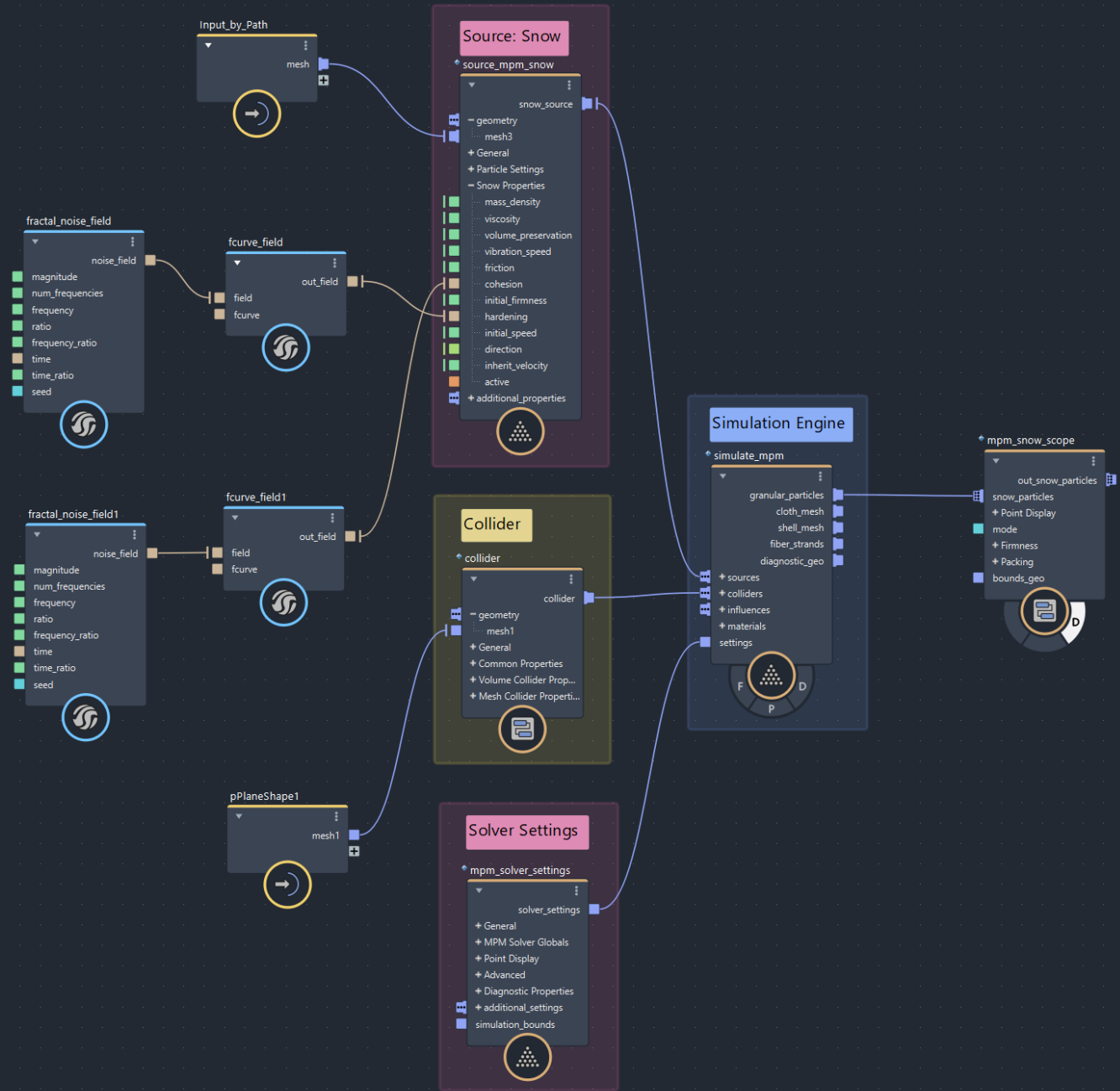
# MPM Snow



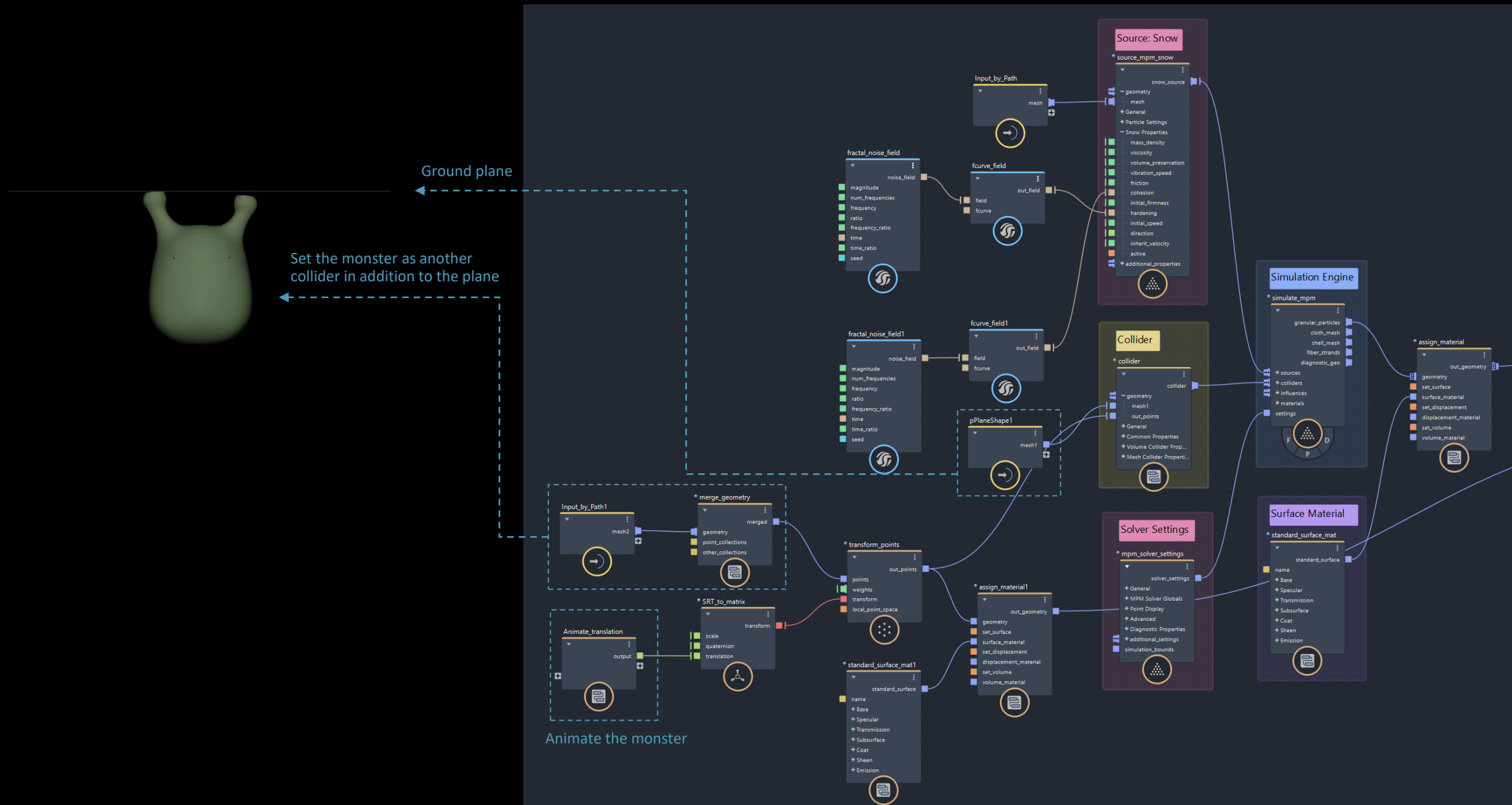
Cohesion range: 0 - 1



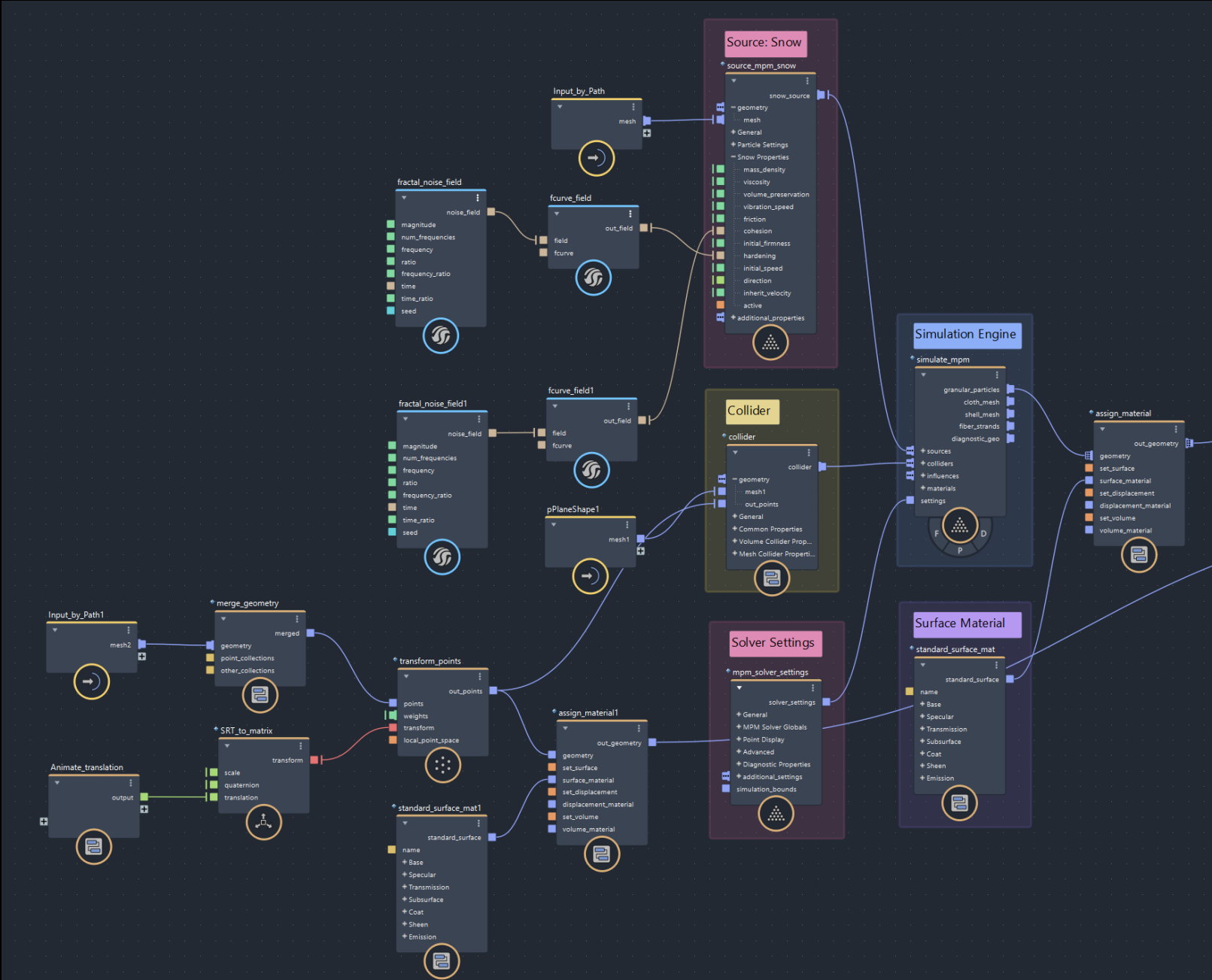
Cohesion range: 0.3 - 2



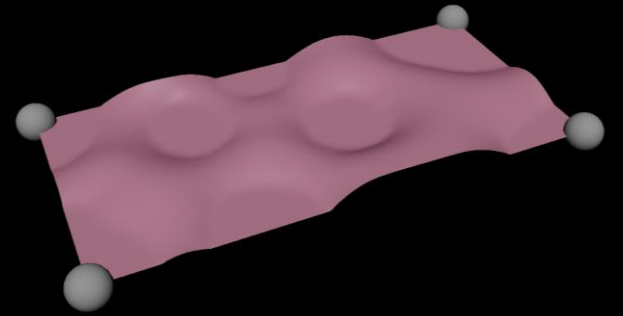
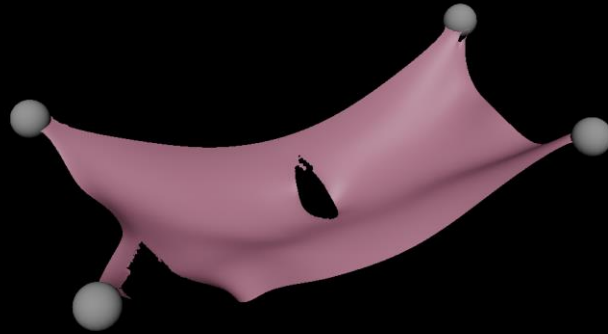
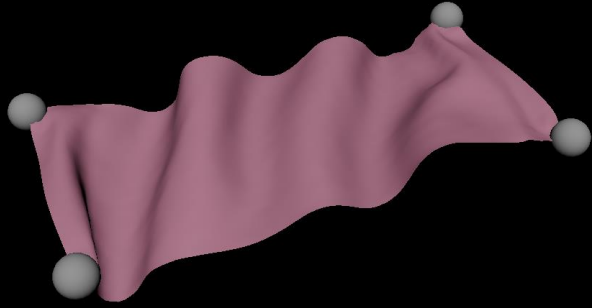
# MPM Snow

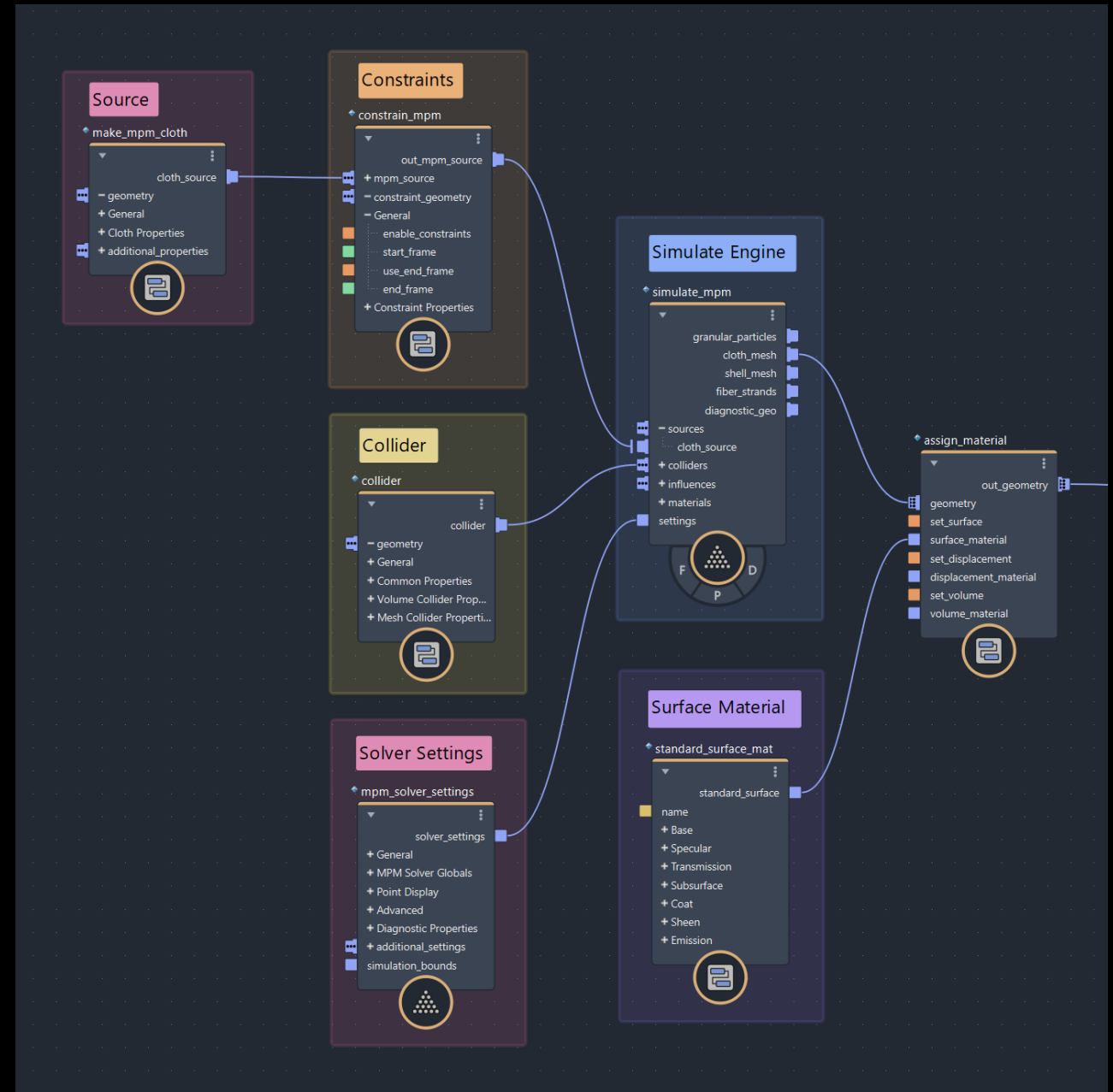
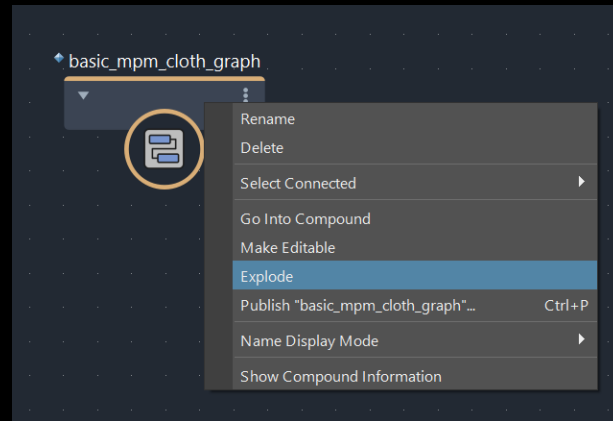


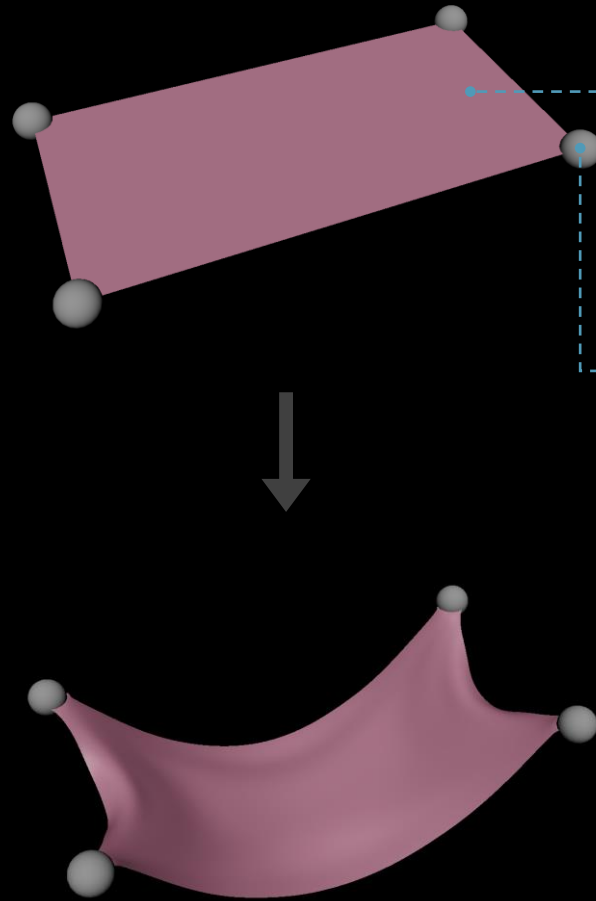
# MPM Snow



## MPM Cloth

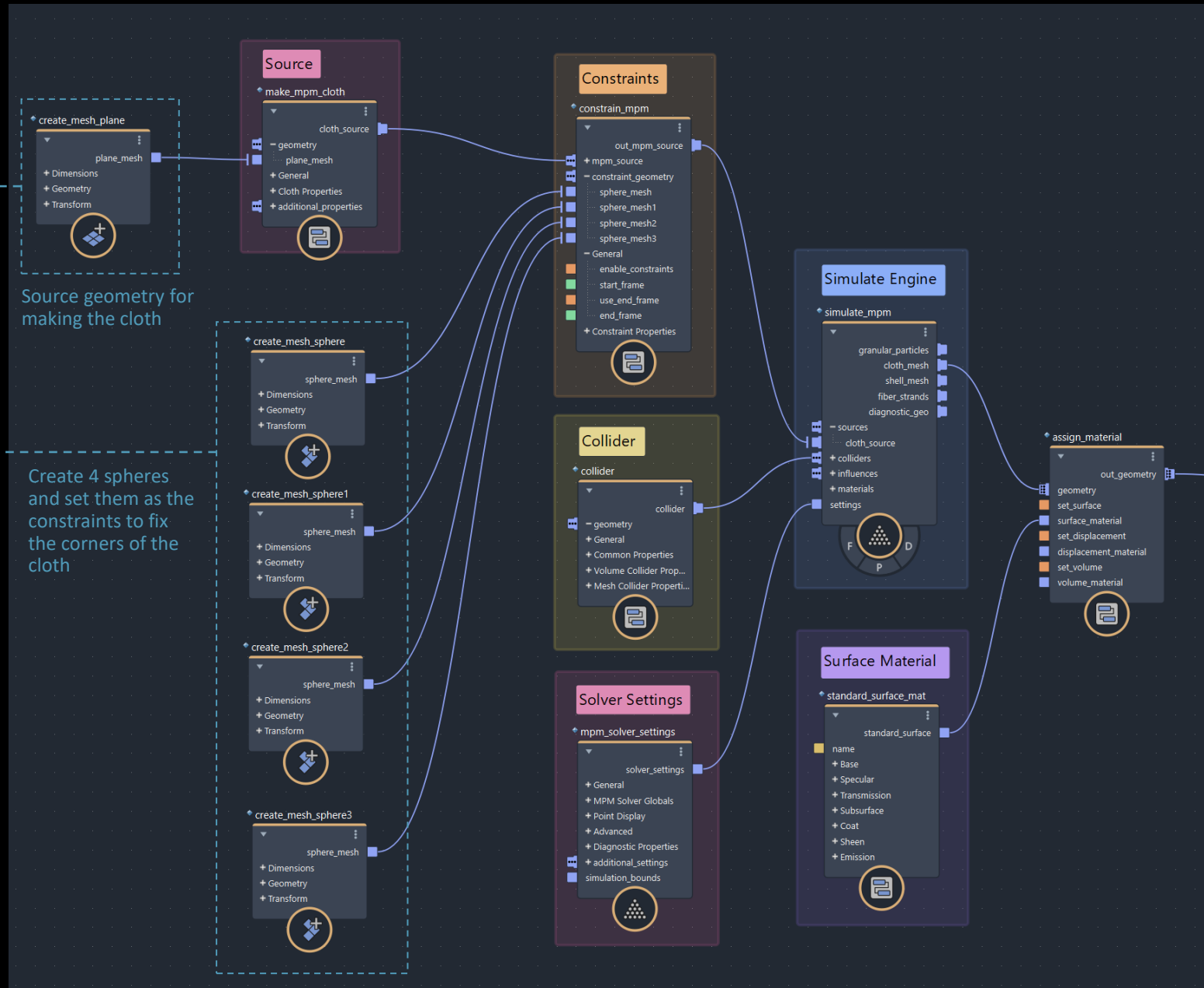






Source geometry for making the cloth

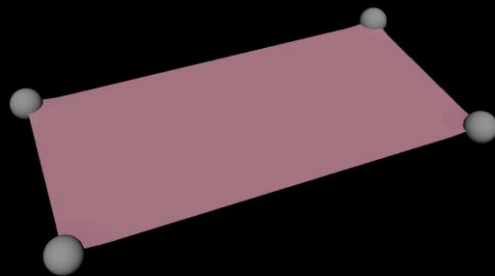
Create 4 spheres and set them as the constraints to fix the corners of the cloth



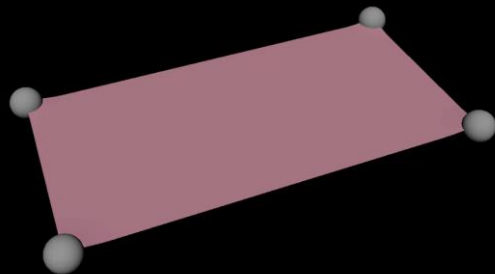
The degree to which the cloth preserves its area vs. its shape.

0: no area preservation & highest resistance against shape change  
1: no shape preservation

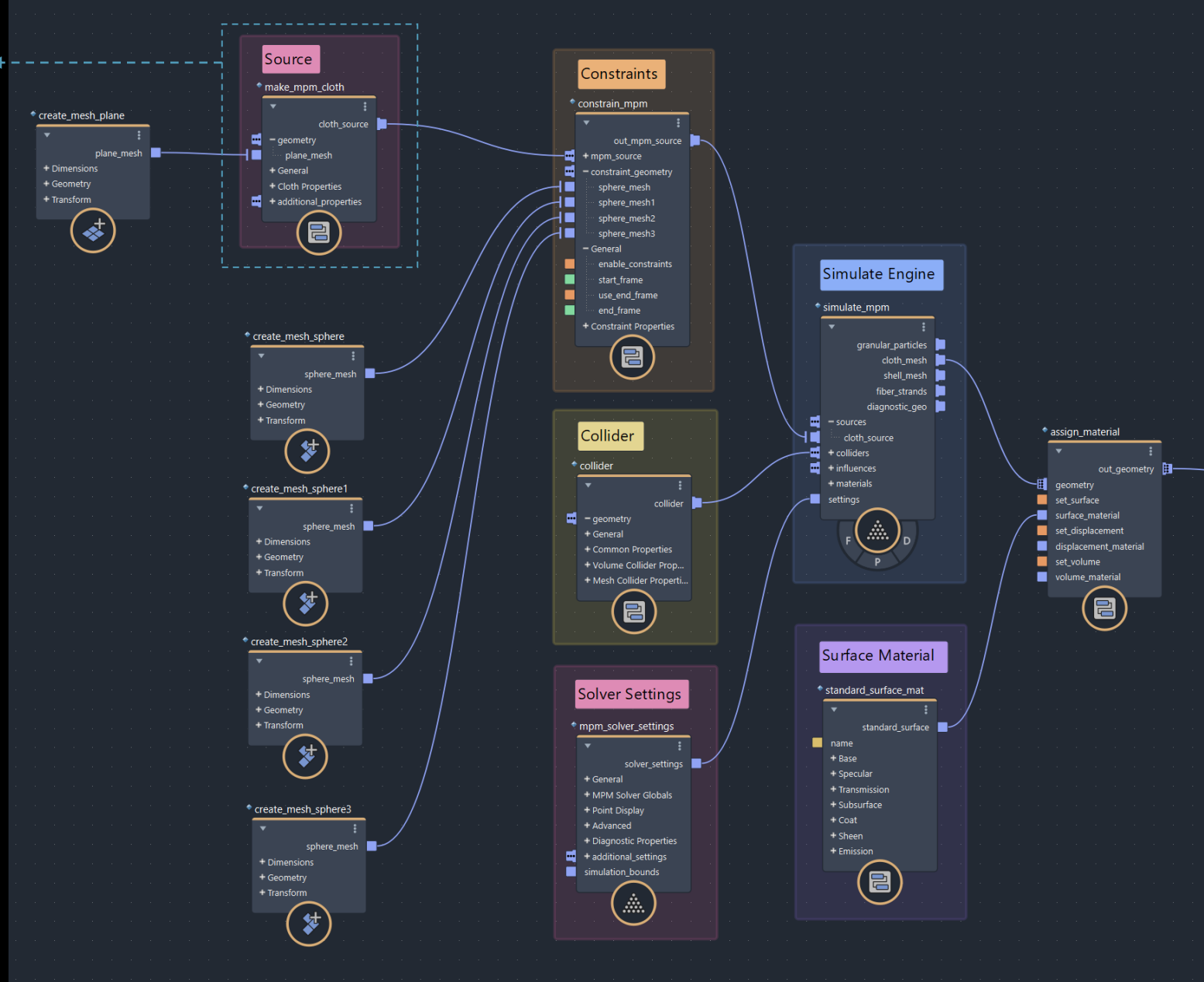
| Cloth Properties    |       |
|---------------------|-------|
| Mass Density        | 100   |
| Viscosity           | 150   |
| Area Preservation   | 0.5   |
| Vibration Speed     | 20    |
| Collision Max Speed | 20    |
| Thickness           | 0.001 |
| Friction            | 0     |
| Initial Speed       | 1     |
| Direction           | 0 0 0 |
| Inherit Velocity    | 0     |



Area preservation = 0

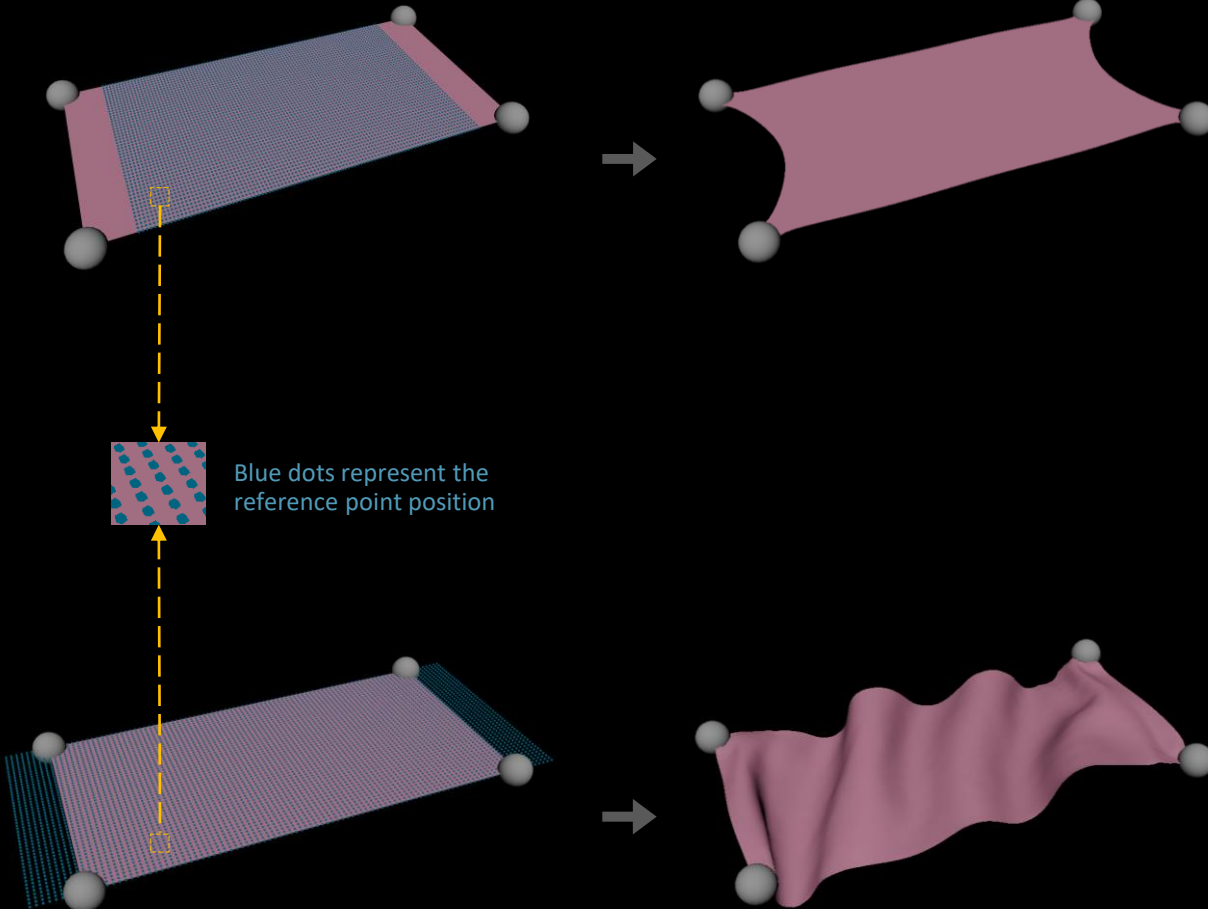


Area preservation = 1



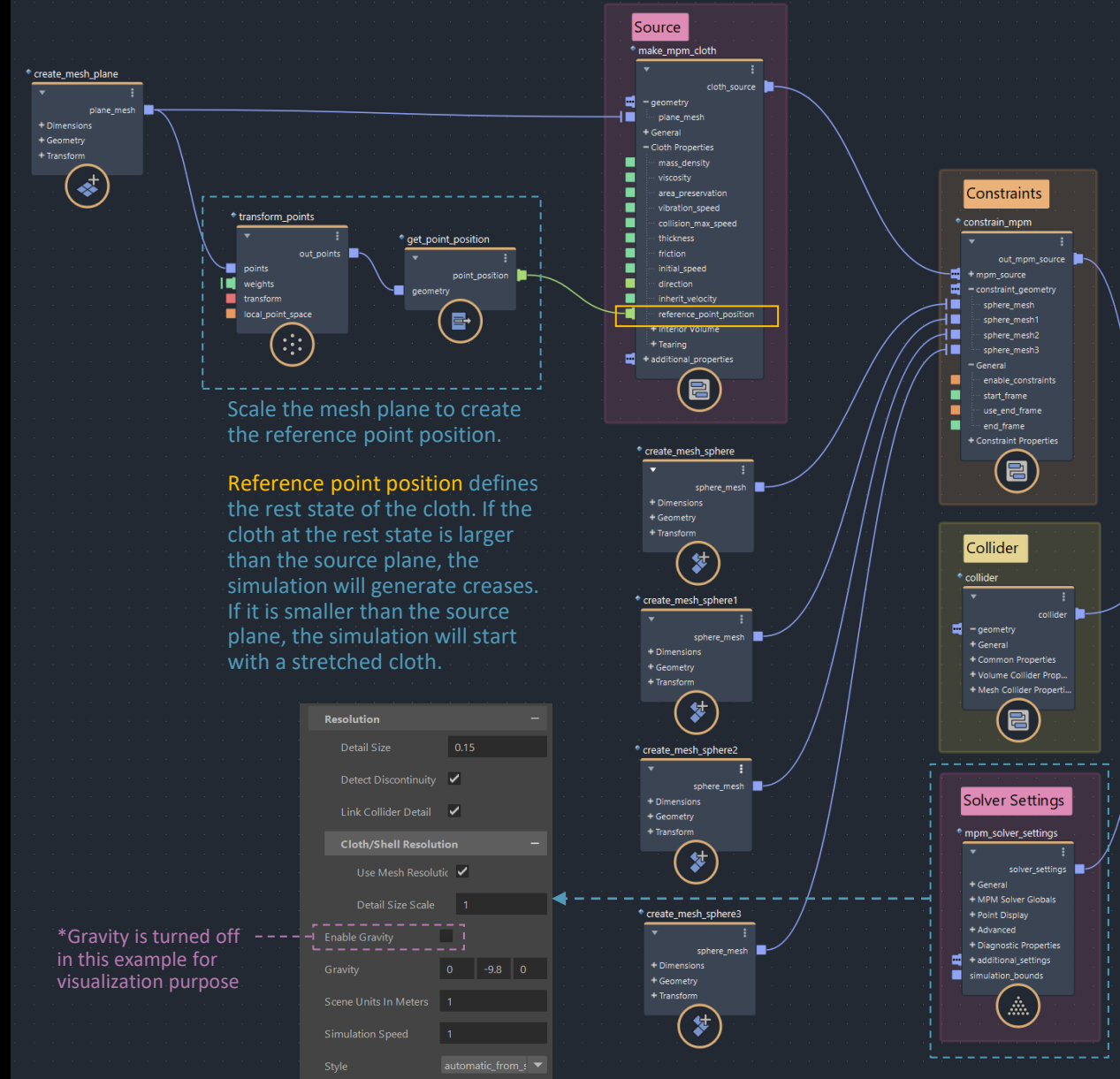


# MPM Cloth

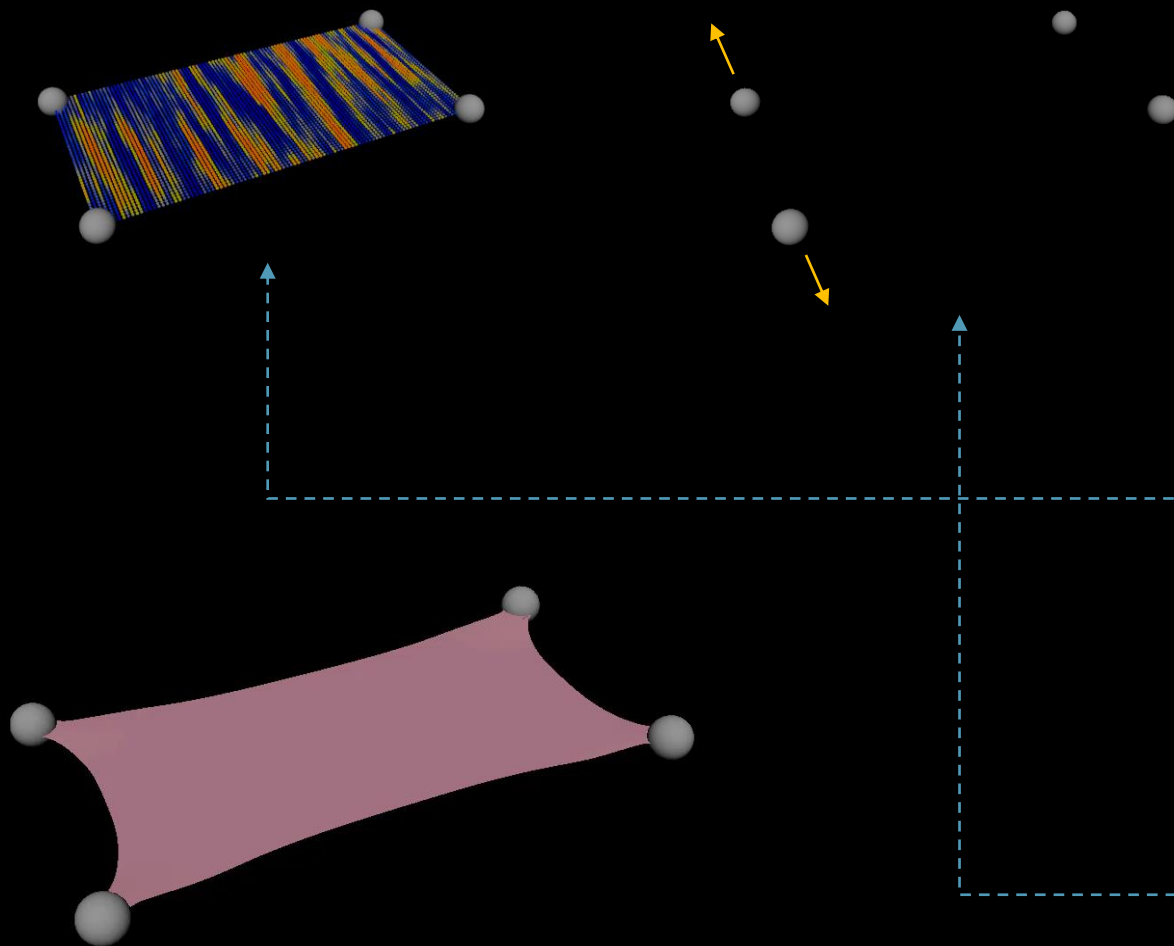


Blue dots represent the reference point position

## Reference point position

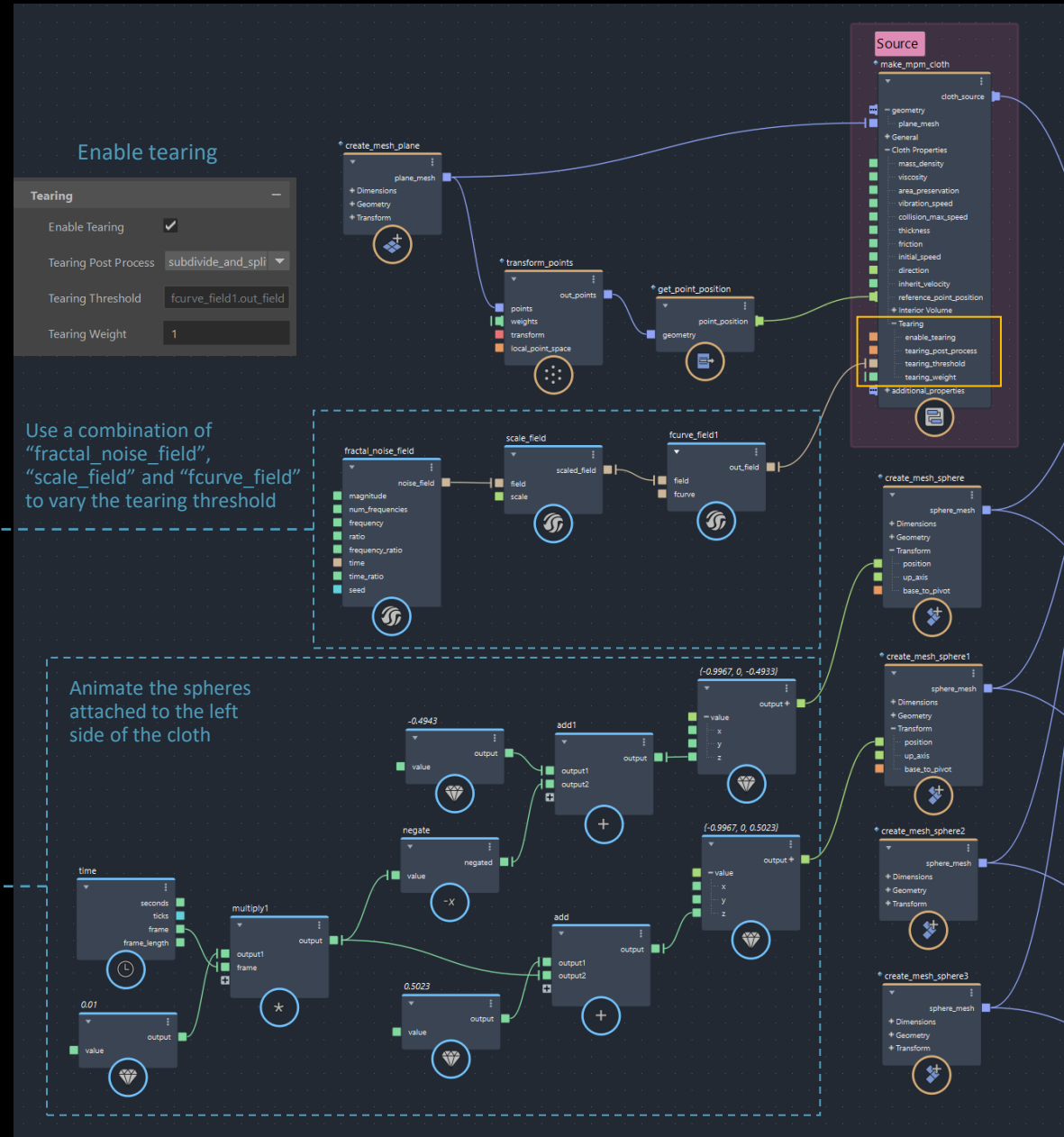


## MPM Cloth



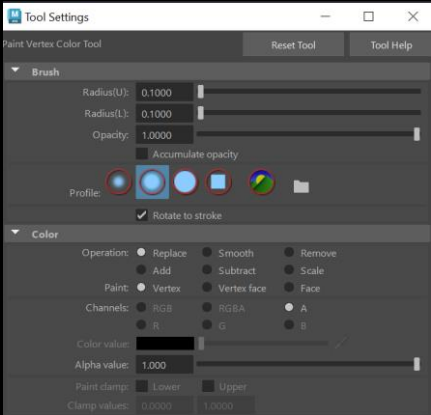
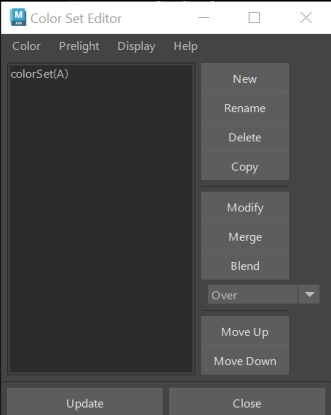
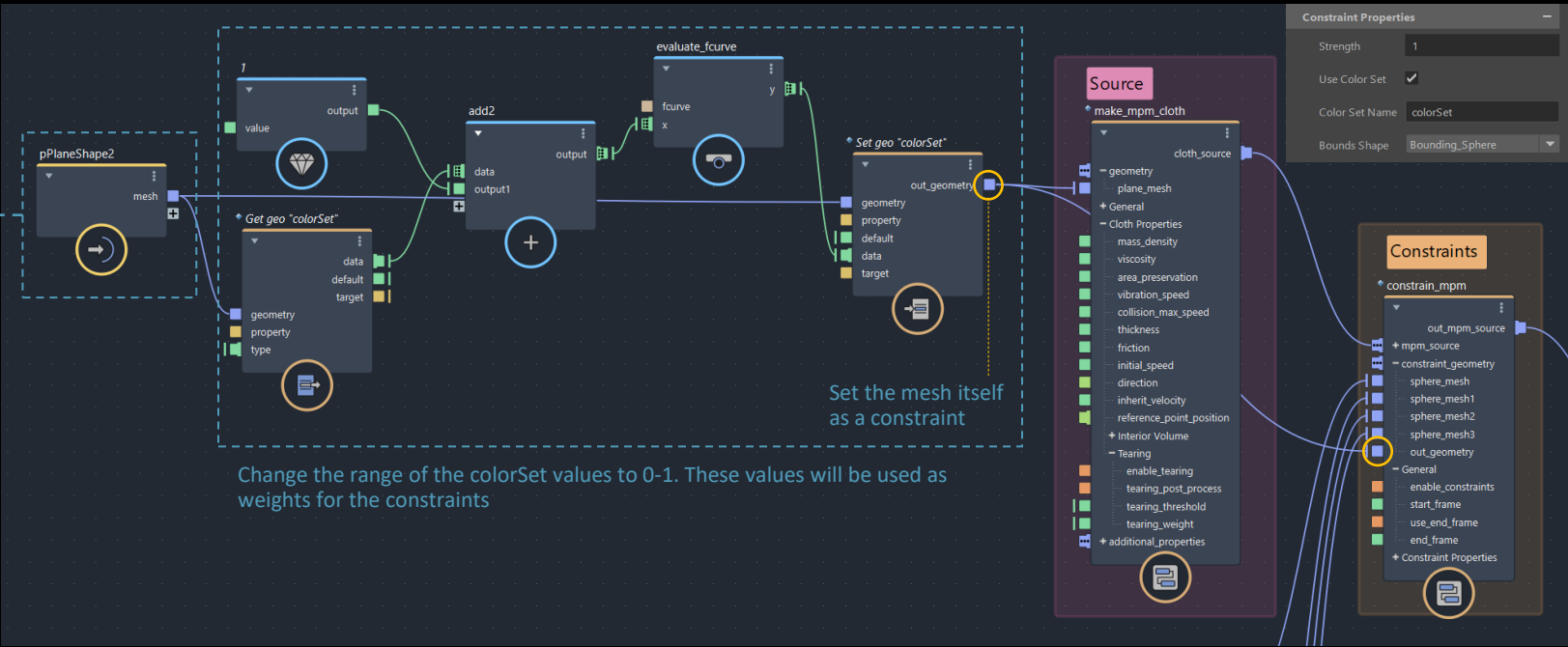
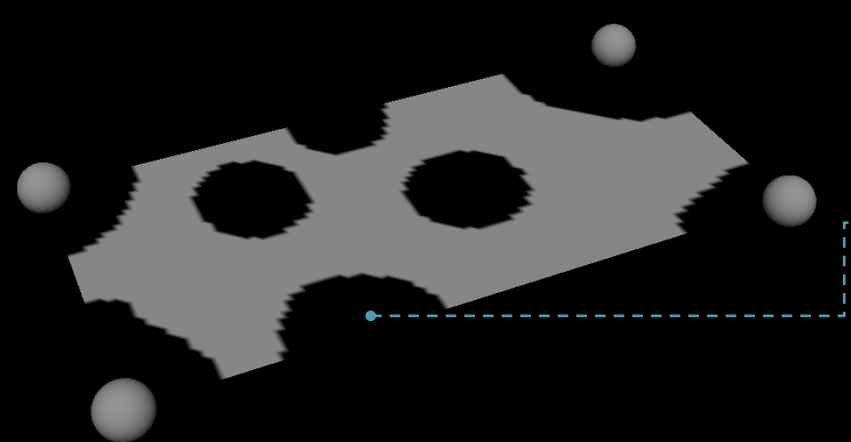
## Tearing animation

## Tearing

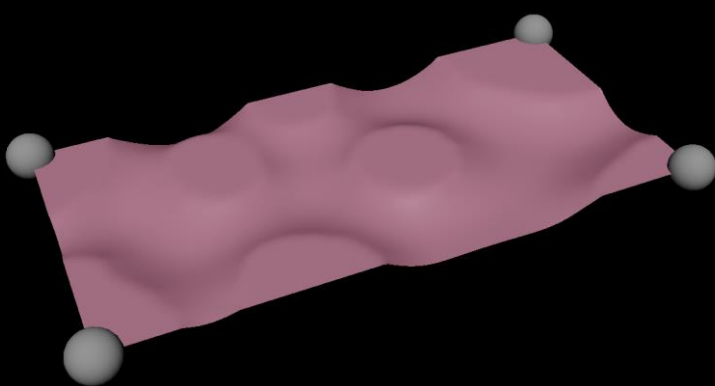


# MPM Cloth

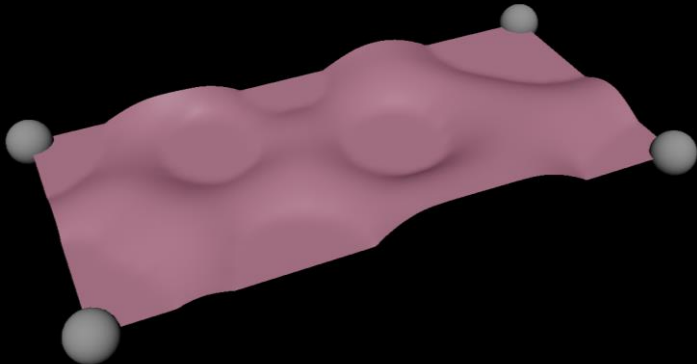
Use ColorSet as weights for constraints



Create a color set and use the paint vertex color tool to color the mesh plane



Gravity = -9.8



Gravity = 9.8