Fluid Simulation in Computer Graphics

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Exercise 2

Assignment 1

- Density estimation:
  We pass the sets of fluid and boundary particles seperately
  - Density is computed, by considering the union of both sets
  - Return density values of two separate sets for fluid and boundary particles

- Unit tests
  - empty point set
  - single point set
  - average of point density values

Assignment 2

b)

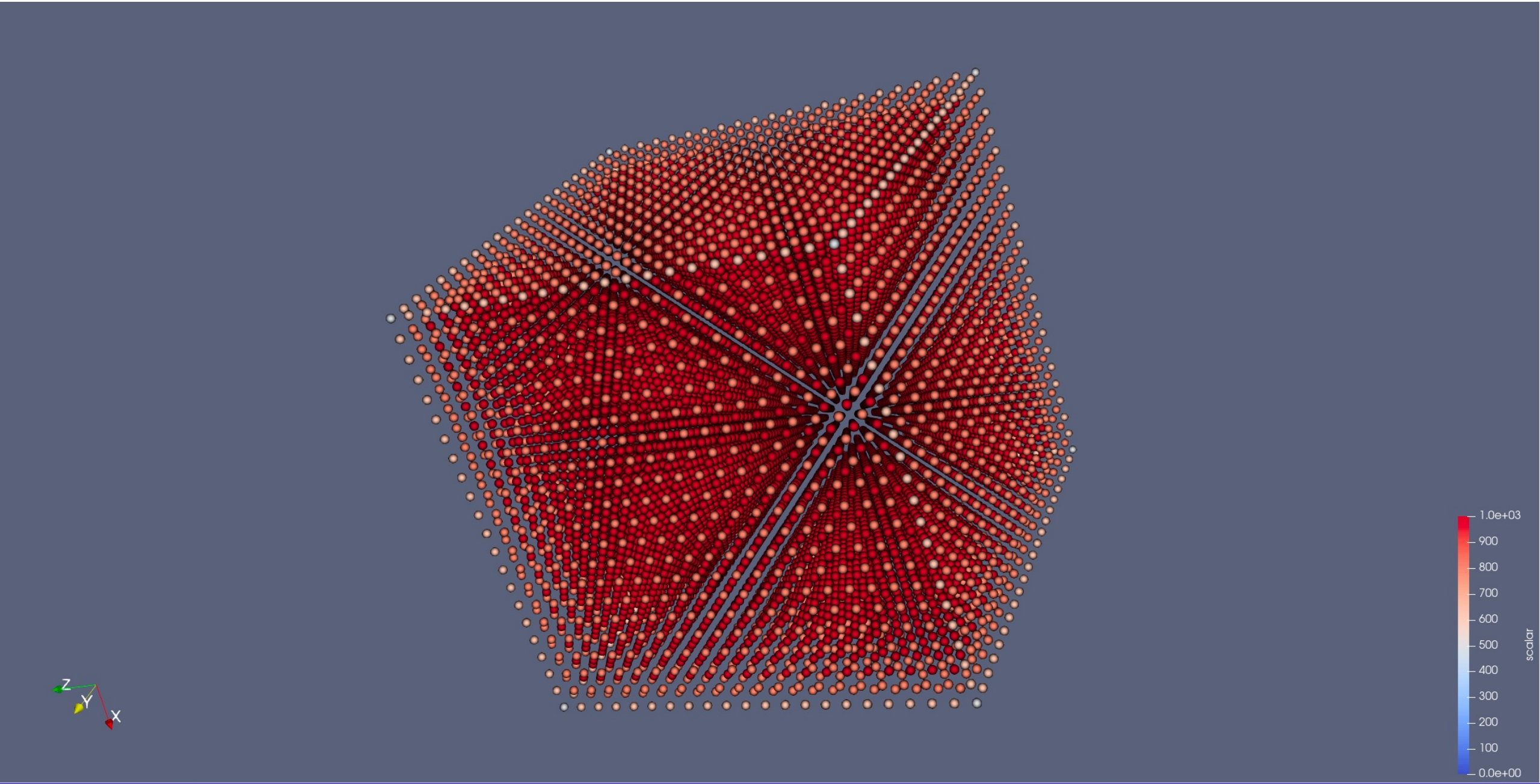
- Problem: Randomly uniformly sampled particles in 3D is not trivial
  - Solution: Grid sampling of particles
  - Pass the coordinates of the box corners
  - Pass amount of expected number of particles
    - The grid may require more particles for uniformity, in that case we correct the amount of particles

- Unit tests
  - particle sampling
    - all particles should be inside the box
    - box should be filled with particles
    - all particles in a neighborhood should have the same average distance
  - build neighborhood
    - particle should have itself as a neighbor
    - computation of correct neighbors

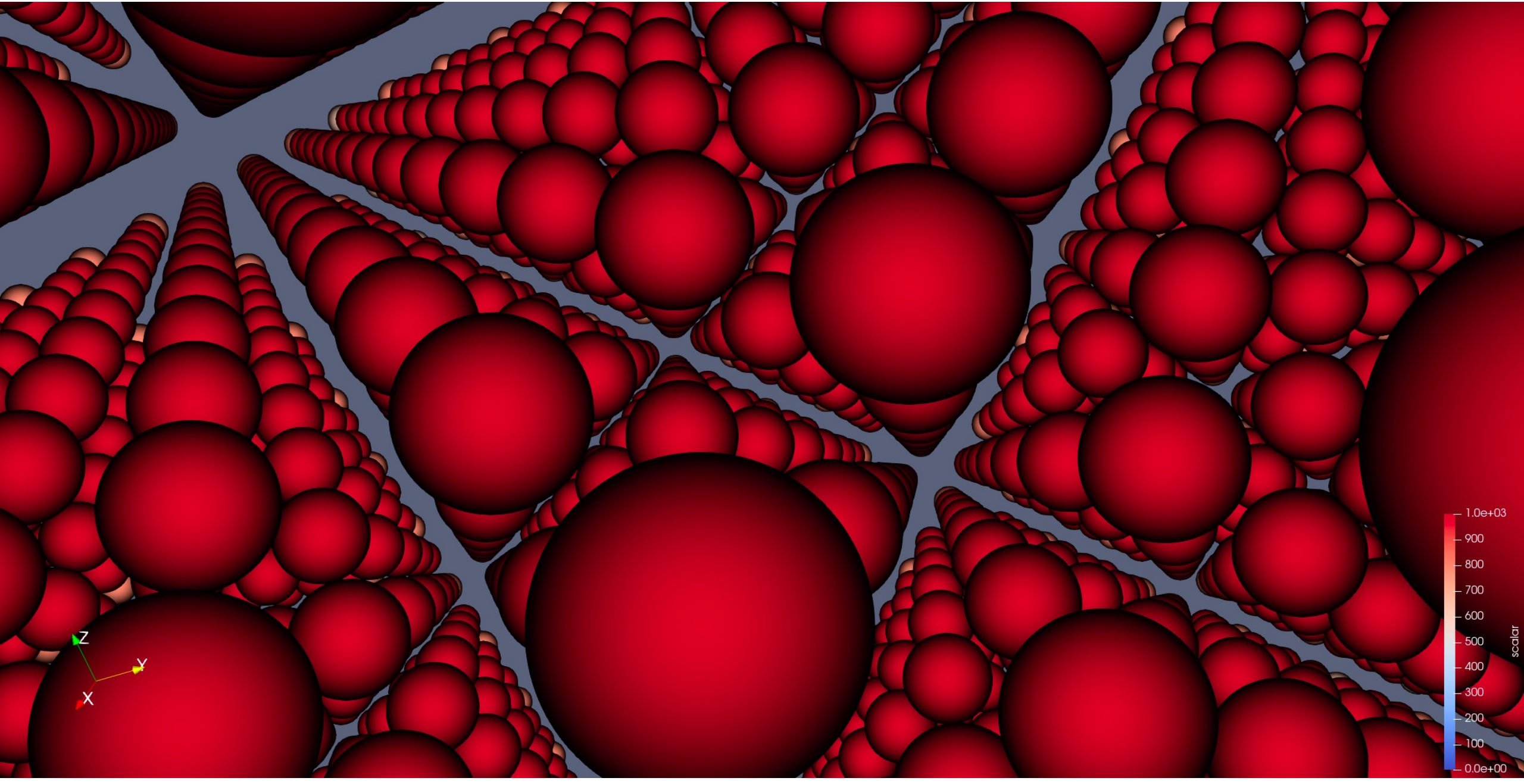
c)

- density estimation for internal fluid particles (surrounded by other particles) returns approximately the rest density
- edge particles have a lower density, compared to the rest density
- corner particles have the lowest density, compared to the rest density
  - reason: Density estimation is impacted by the amount of neighbors, since the density of fluid particles depends on the mass of ist neighbors within the compact support h

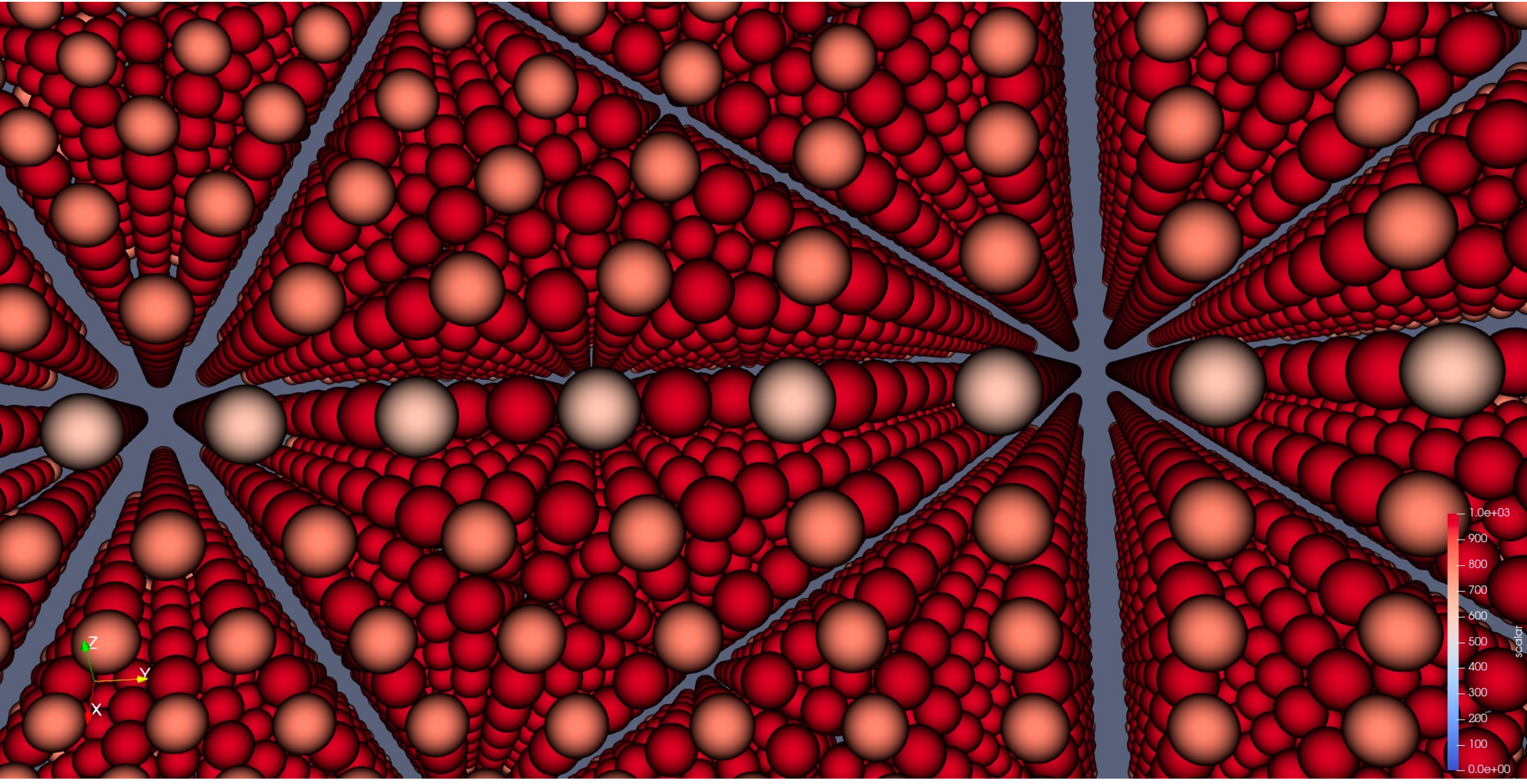
- fluid particle cube



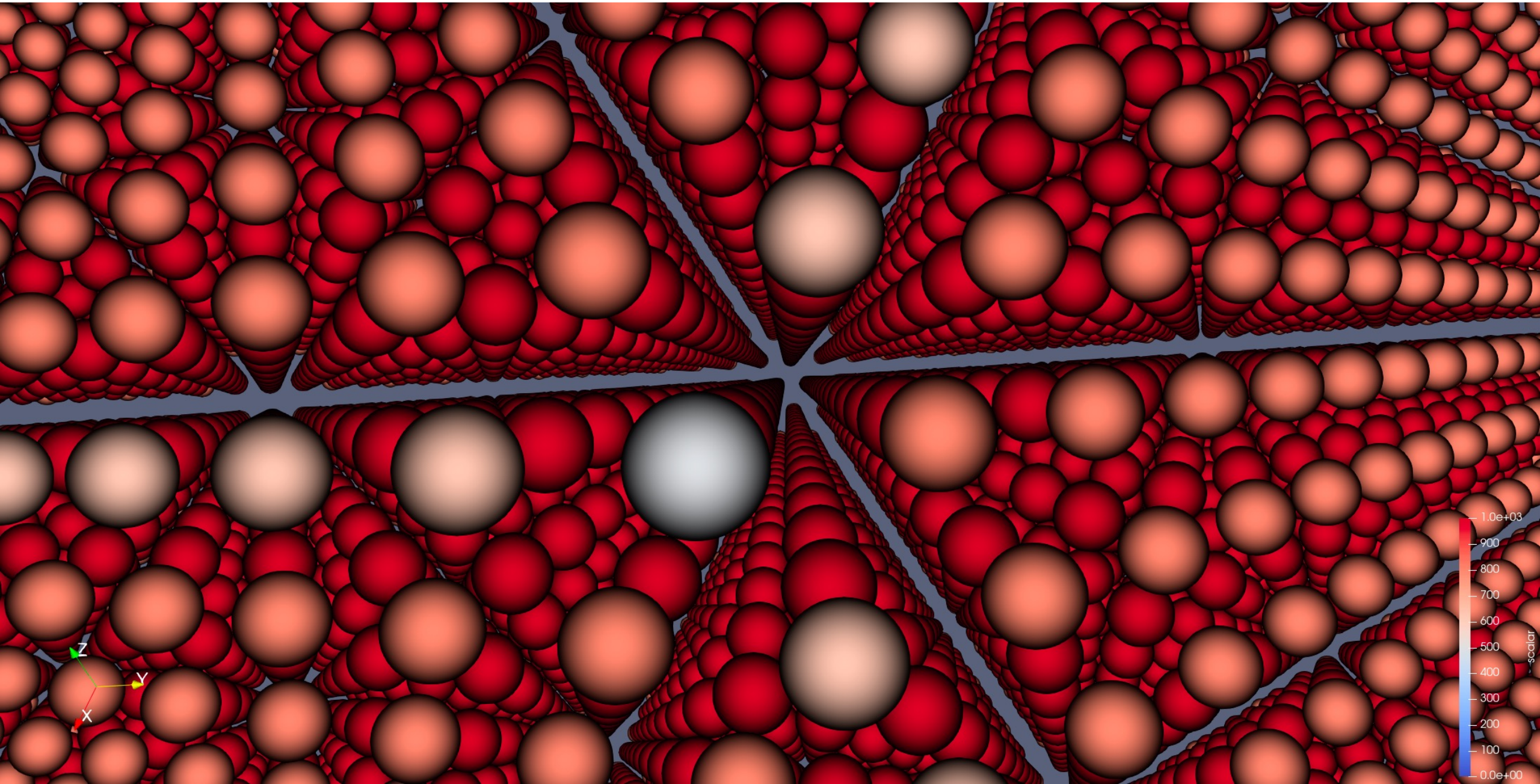
- internal particles: particles completely surrounded by other particles



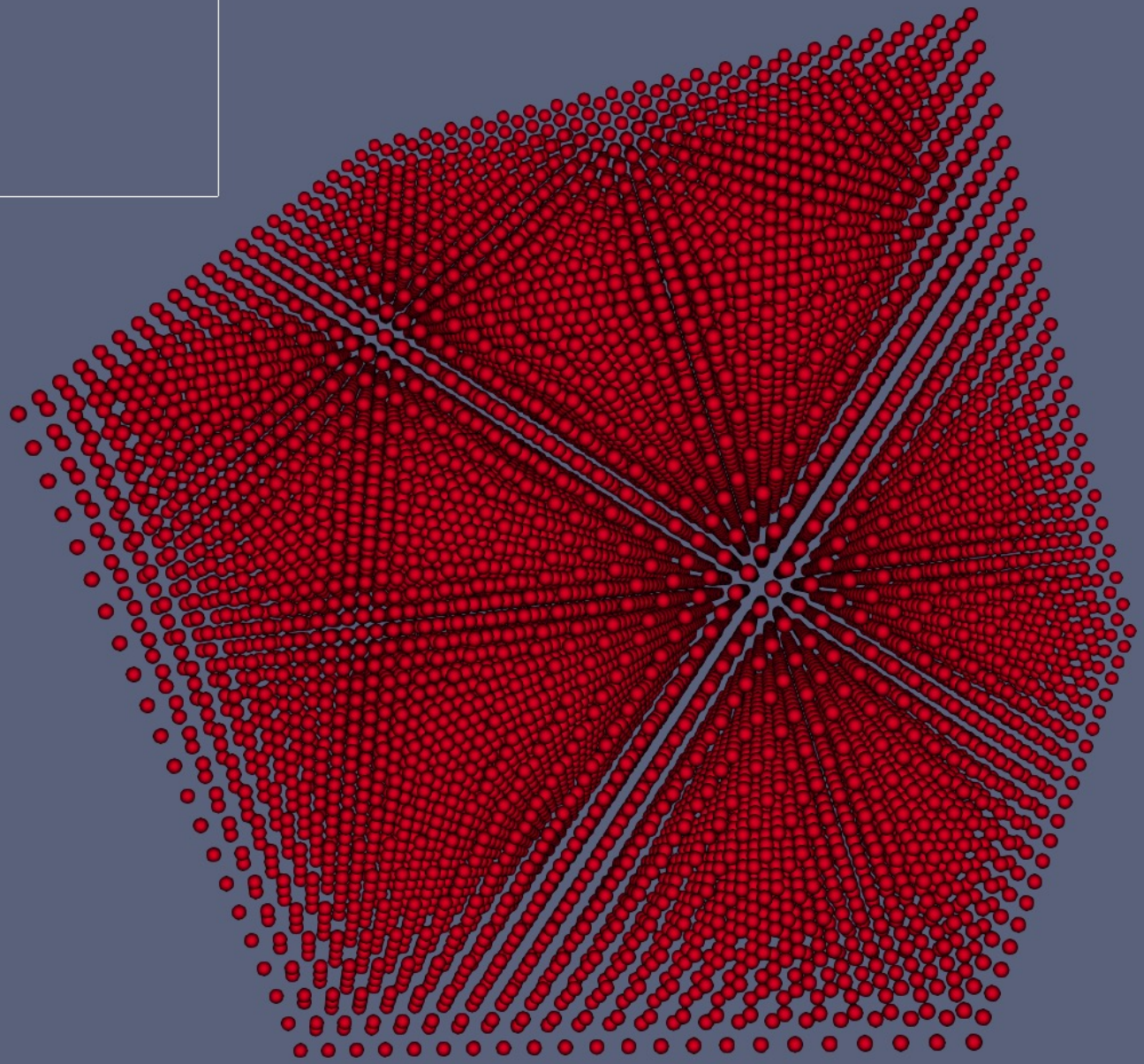
- edge particles: particles depicting the edge of the fluid cube

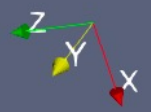


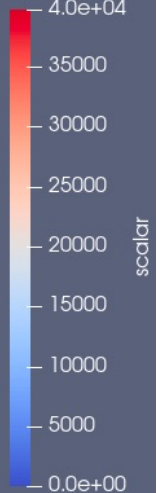
- corner particles: particles depicting the corner of the cube



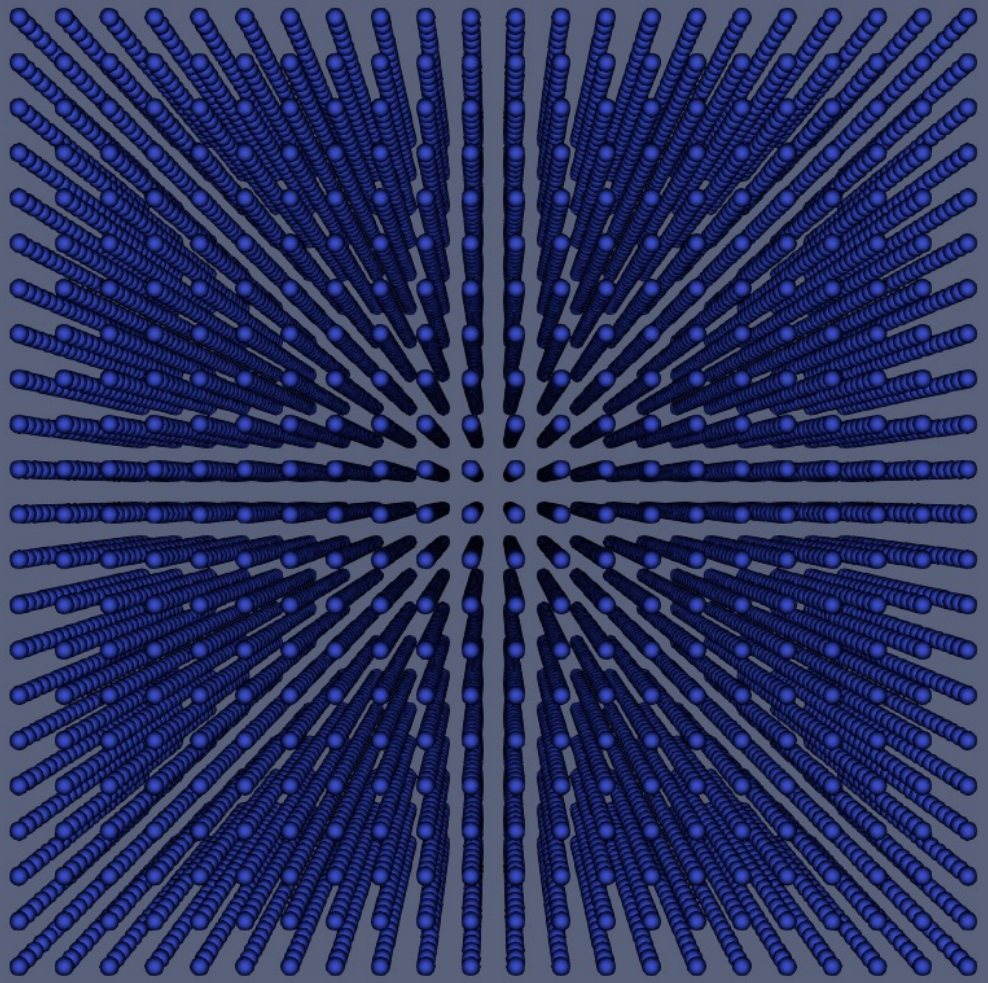
10 000 particles
0.2 ETA

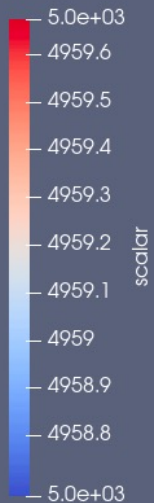




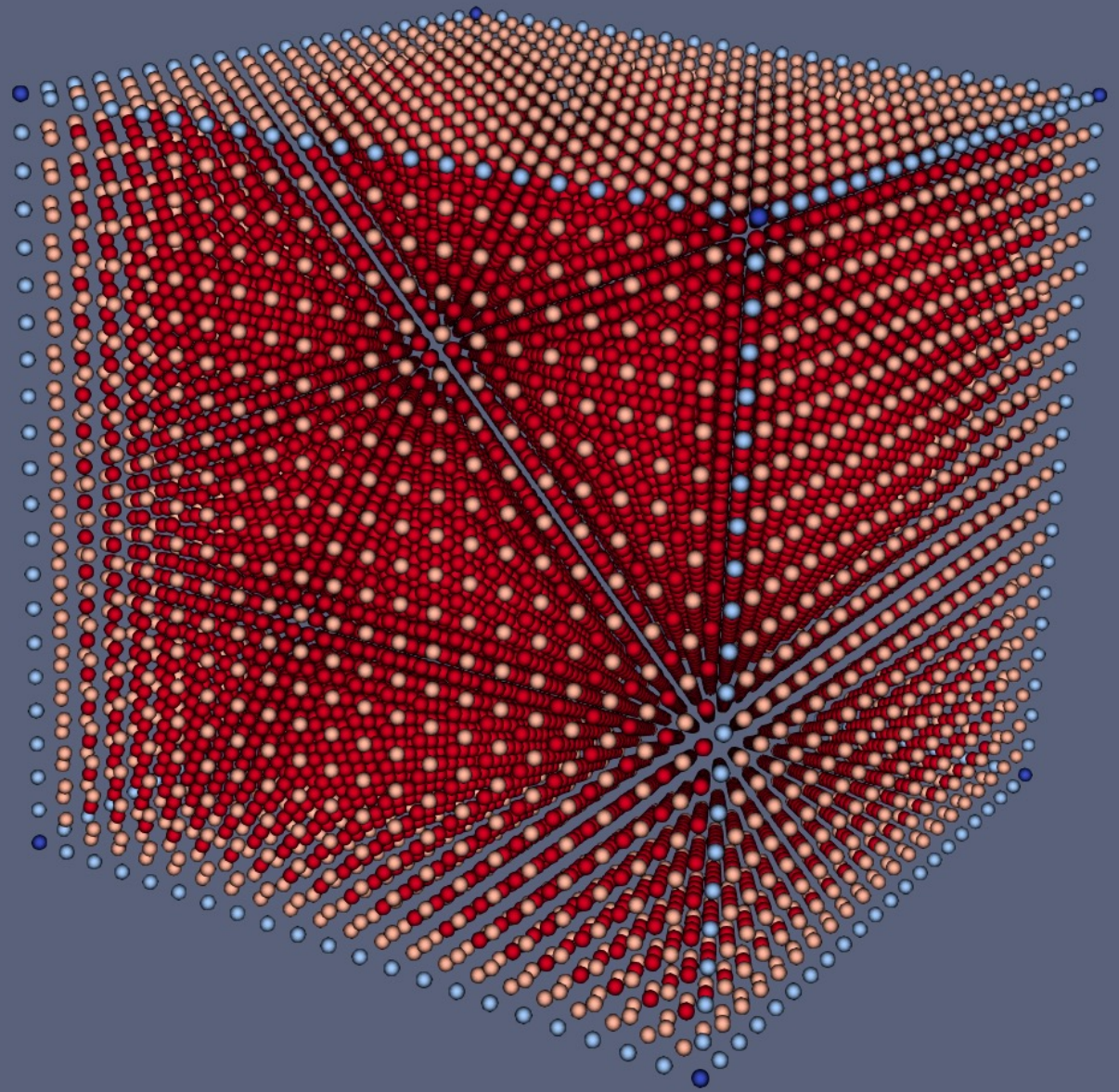


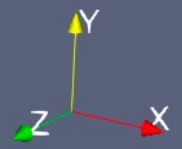
10 000 particles
0.4 ETA

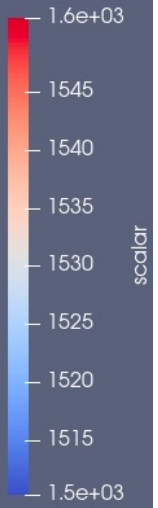




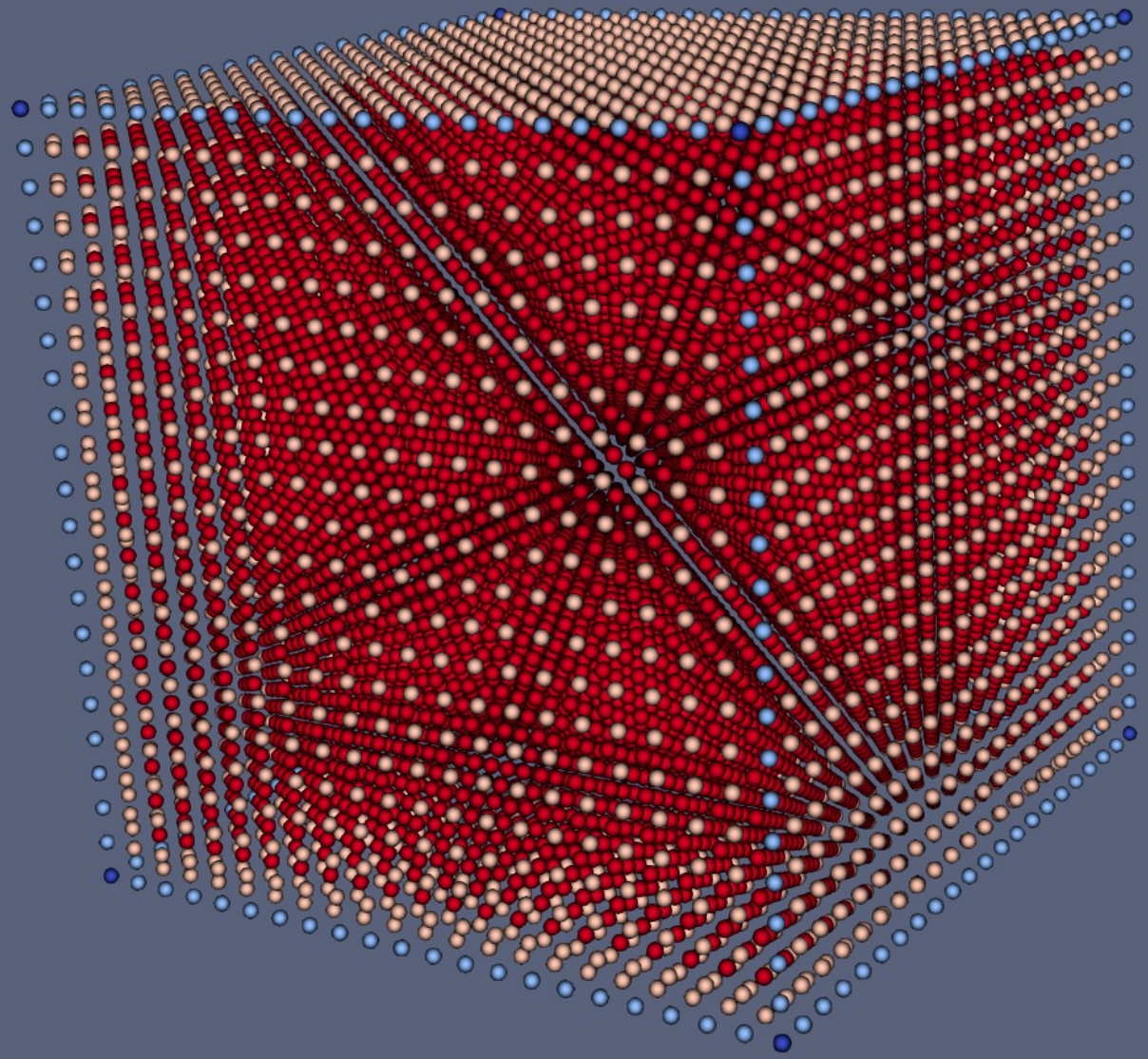
10 000 particles
0.8 ETA



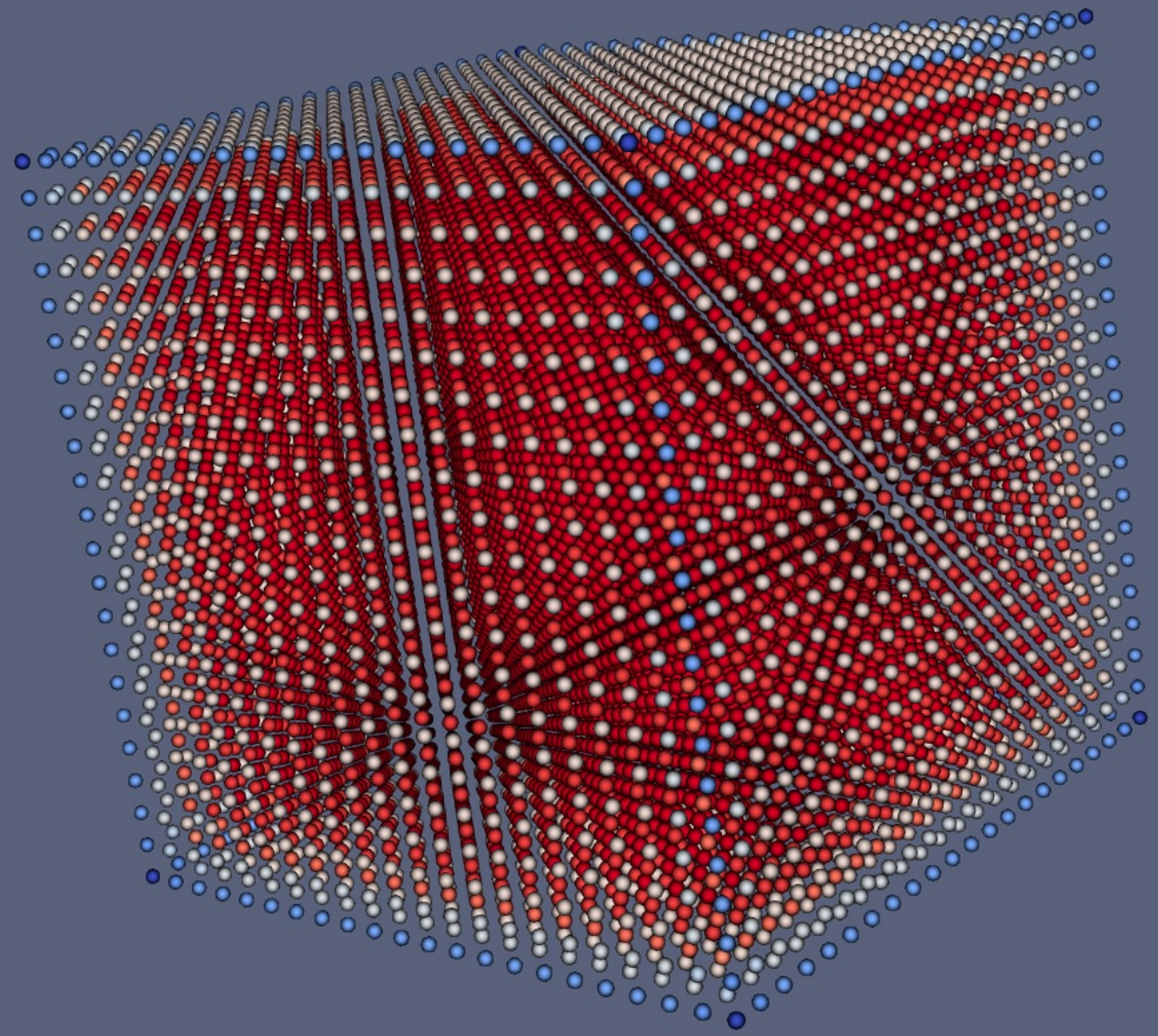


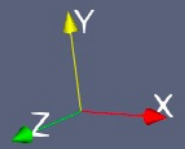


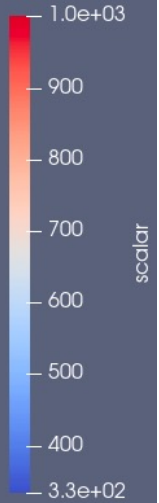
10 000 particles
1.0 ETA



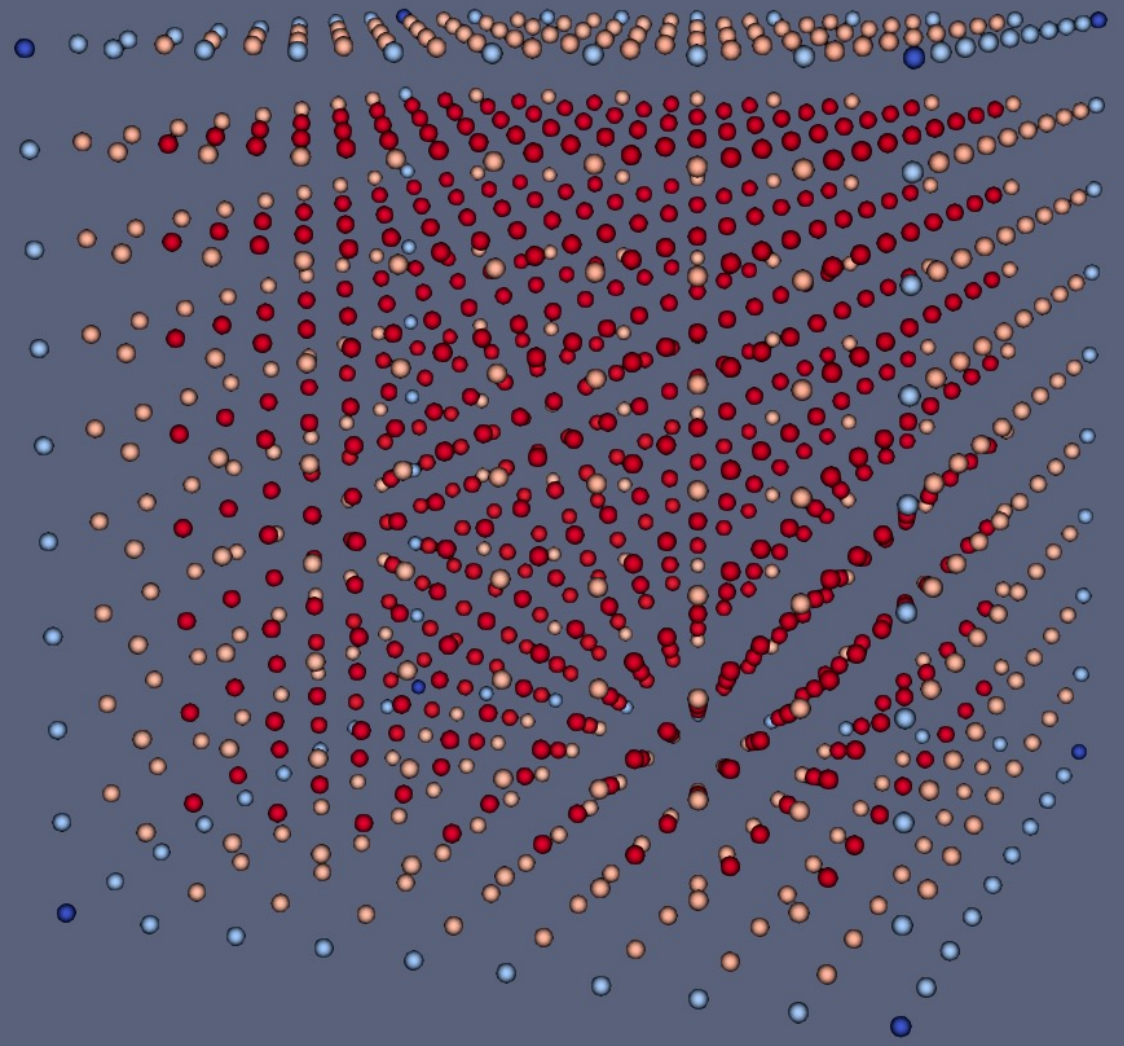
10 000 particles
1.8 ETA

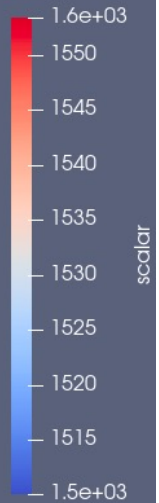




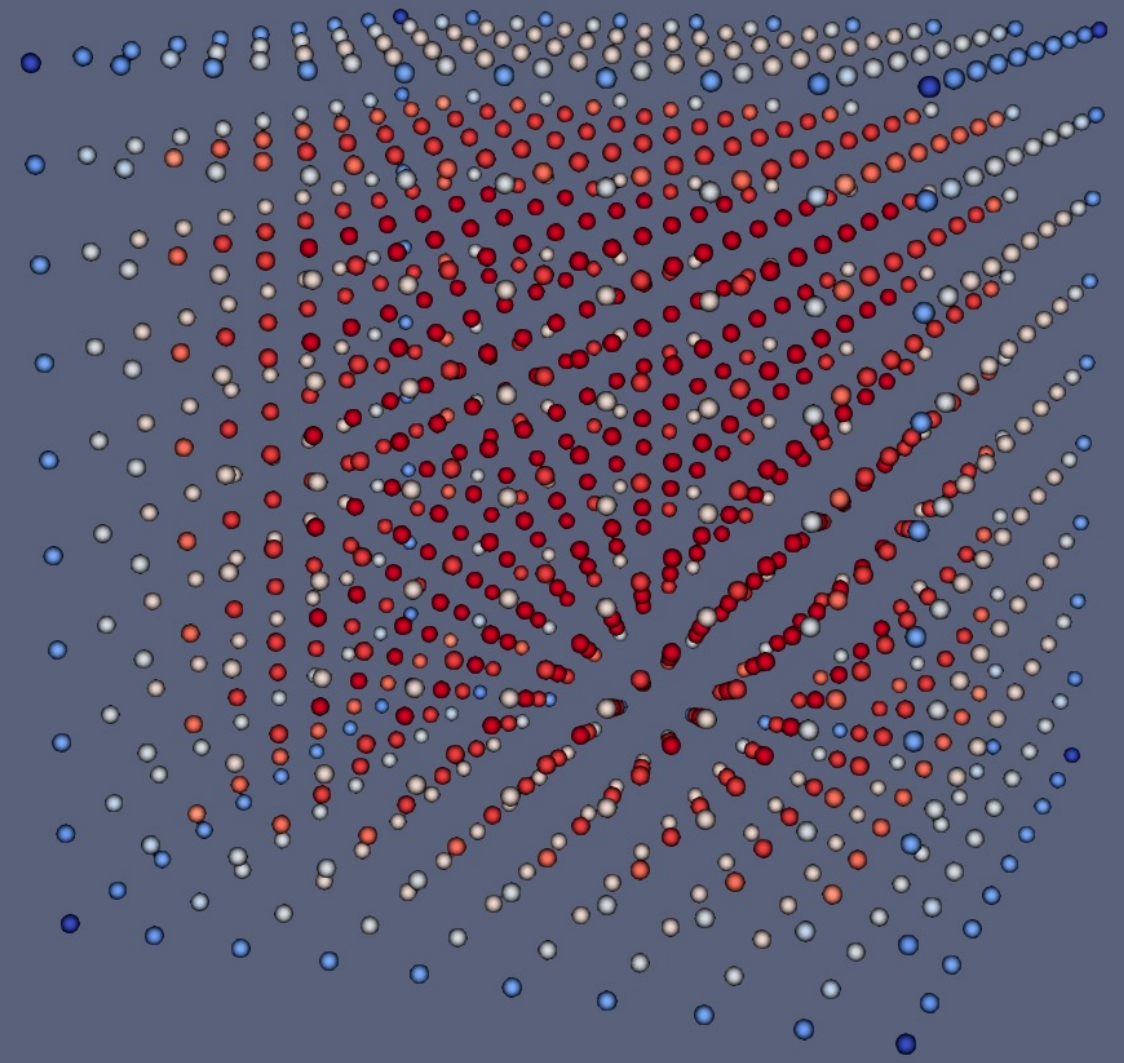


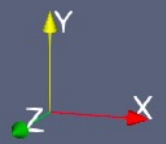
1 000 particles
0.6 ETA

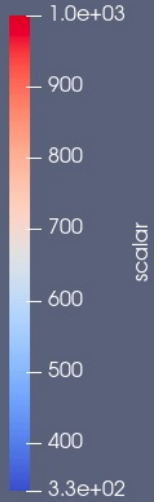


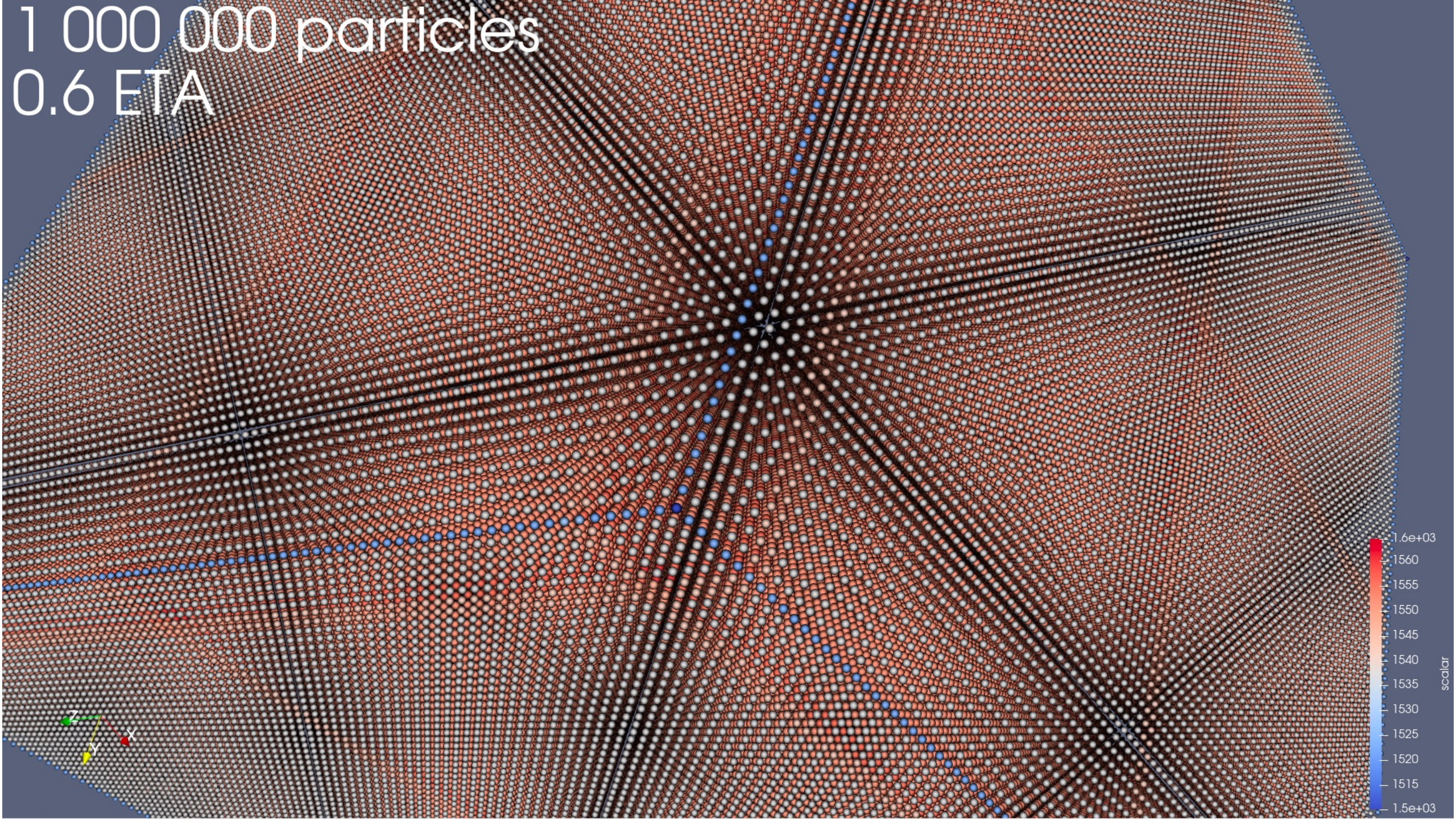


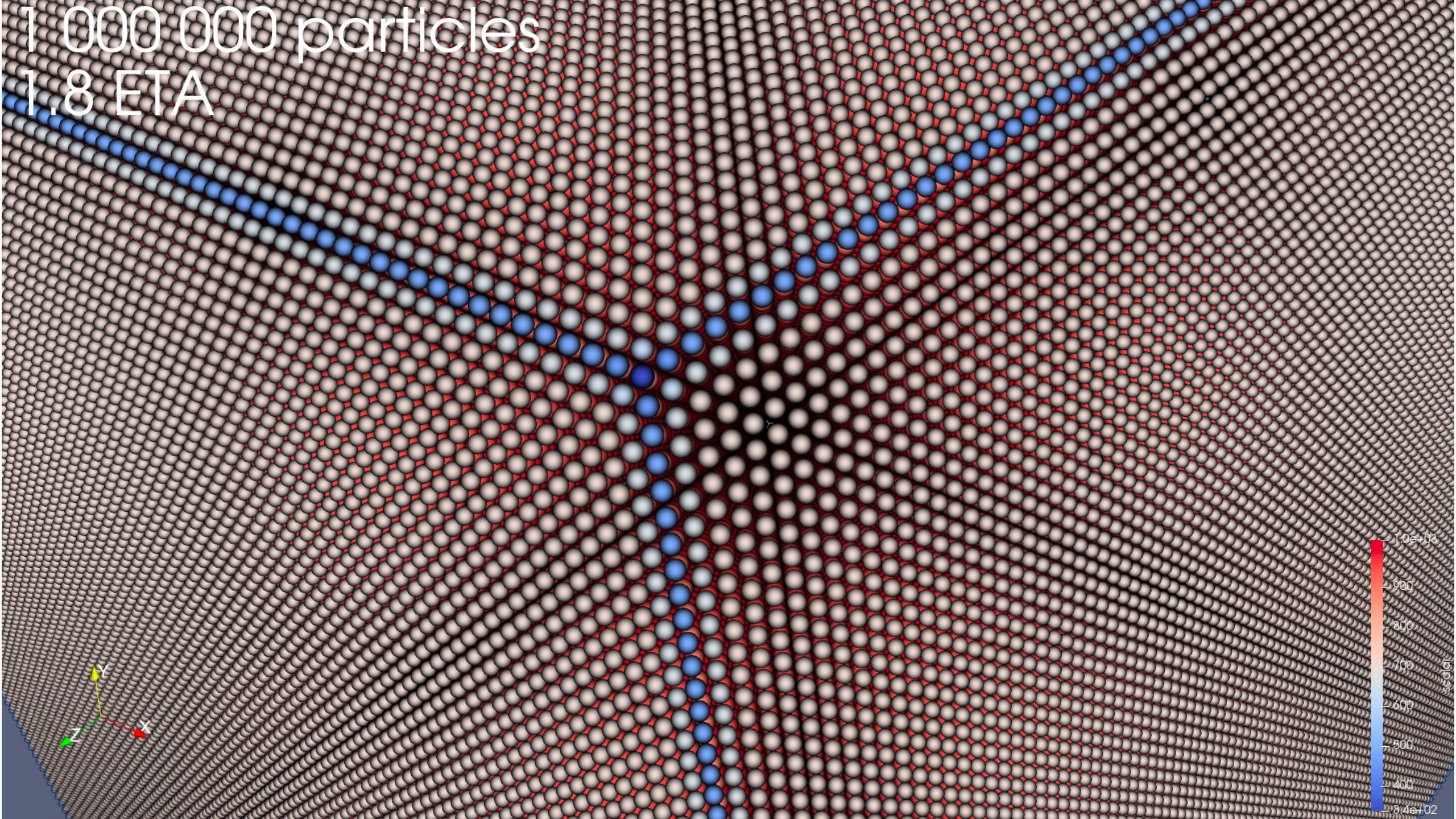
1 000 particles
1.8 ETA







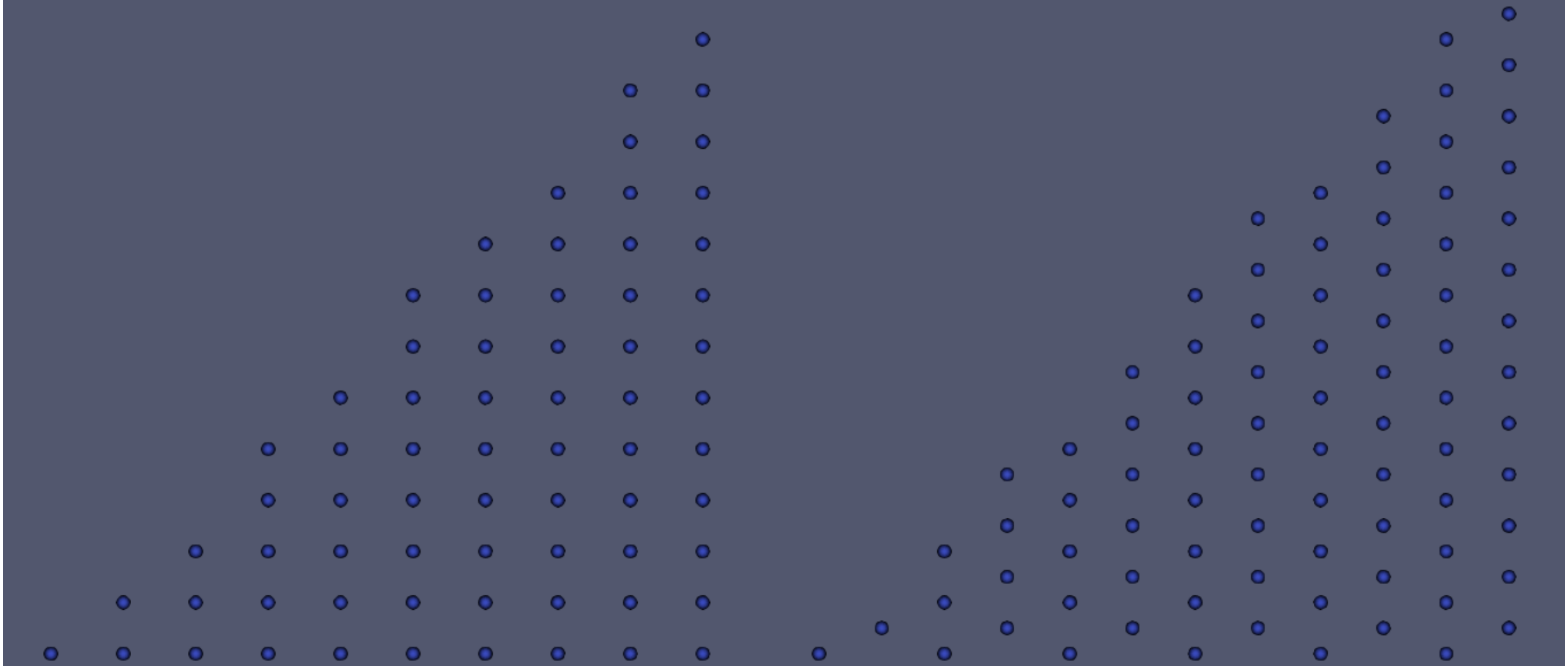

1 000 000 particles
0.6 ETA
Z
X
Y
1.6e+03
1560
1555
1550
1545
1540
1535
1530
1525
1520
1515
1.5e+03
scalar

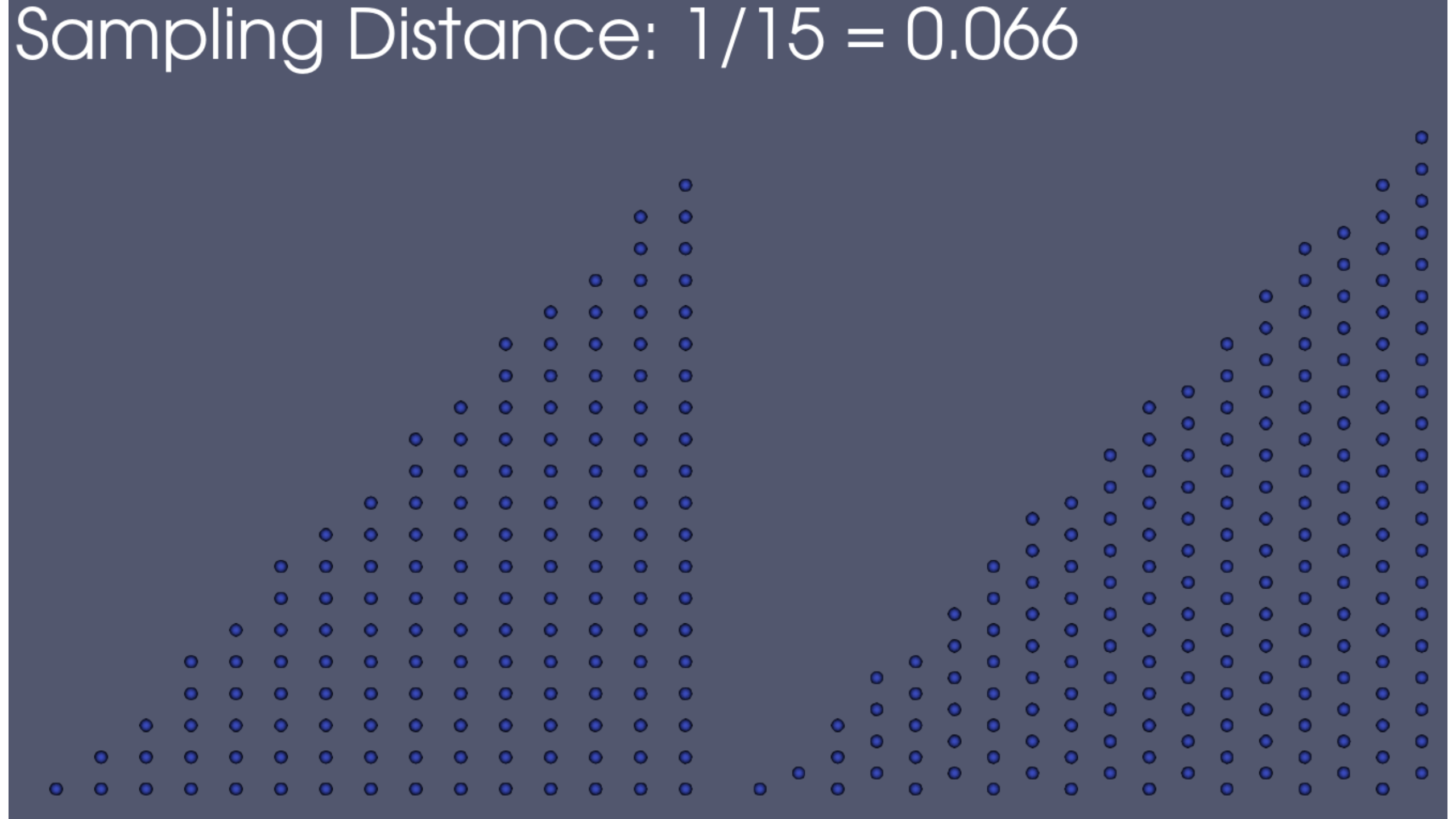

1 000 000 particles
1.8 ETA
Y
Z
X
1.0e+00
900
800
700
600
500
400
8.4e+02

- summarizing the parameter search

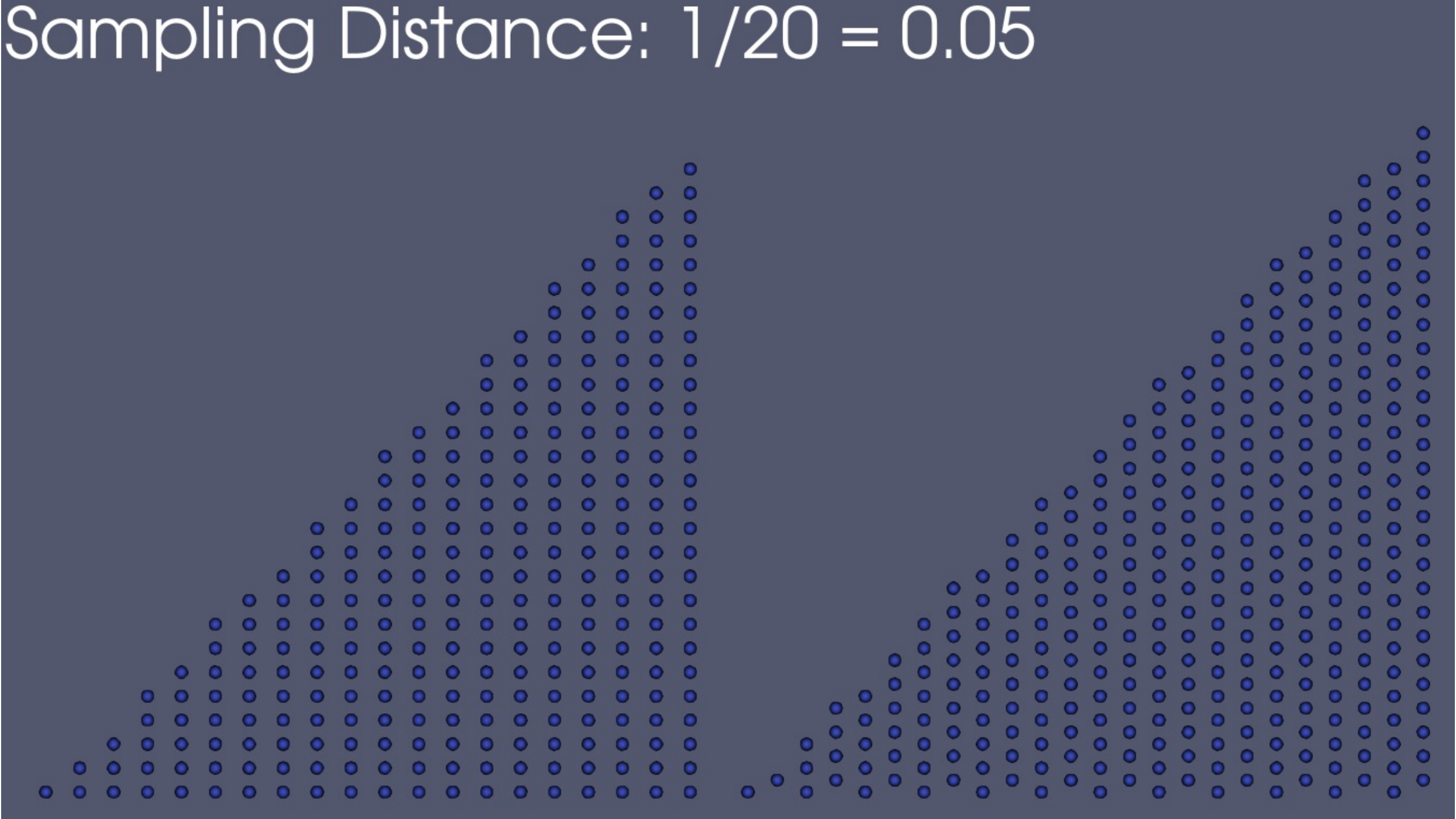
Sampling Distance: 1/10 = 0.1

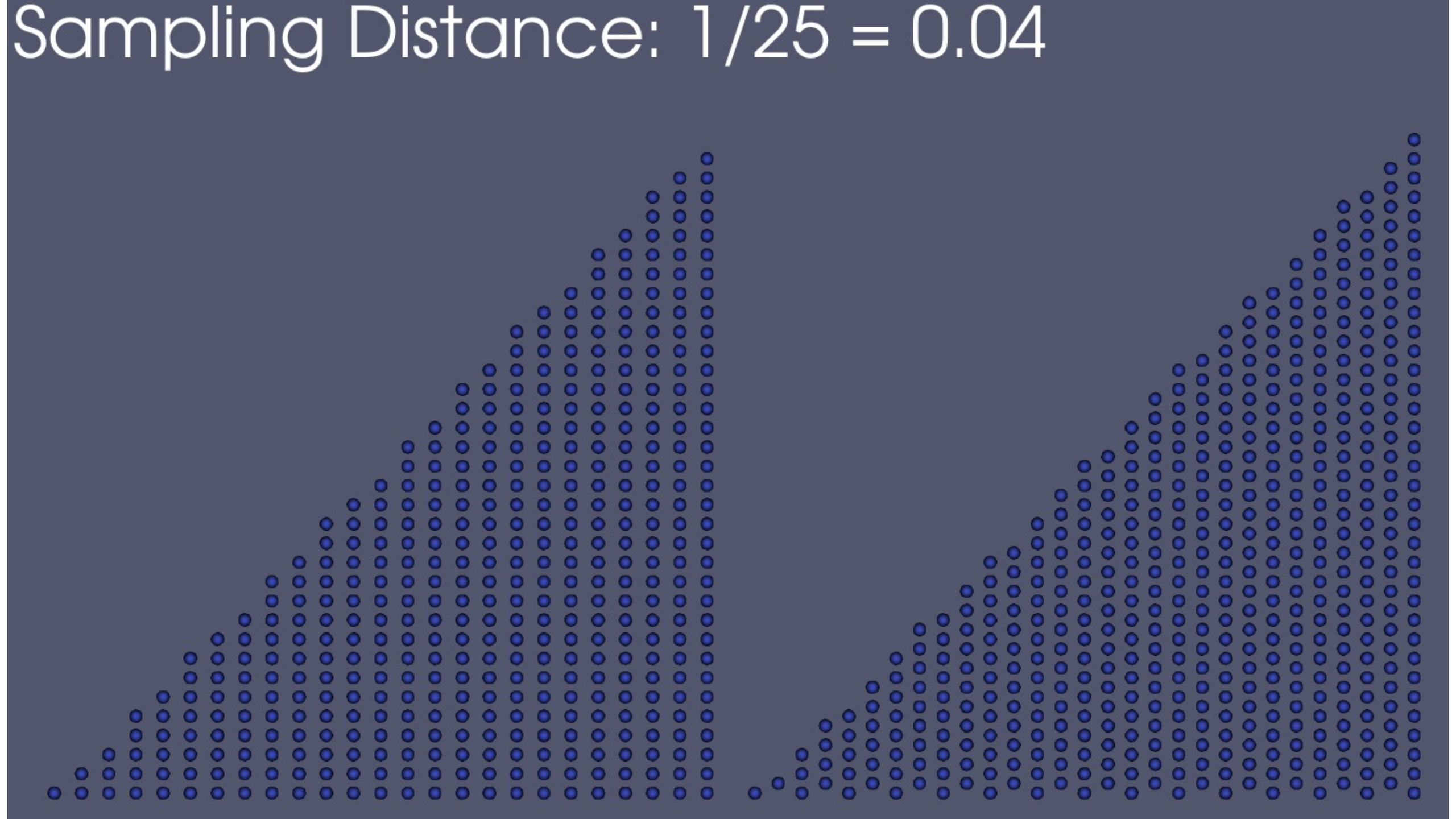
2.2



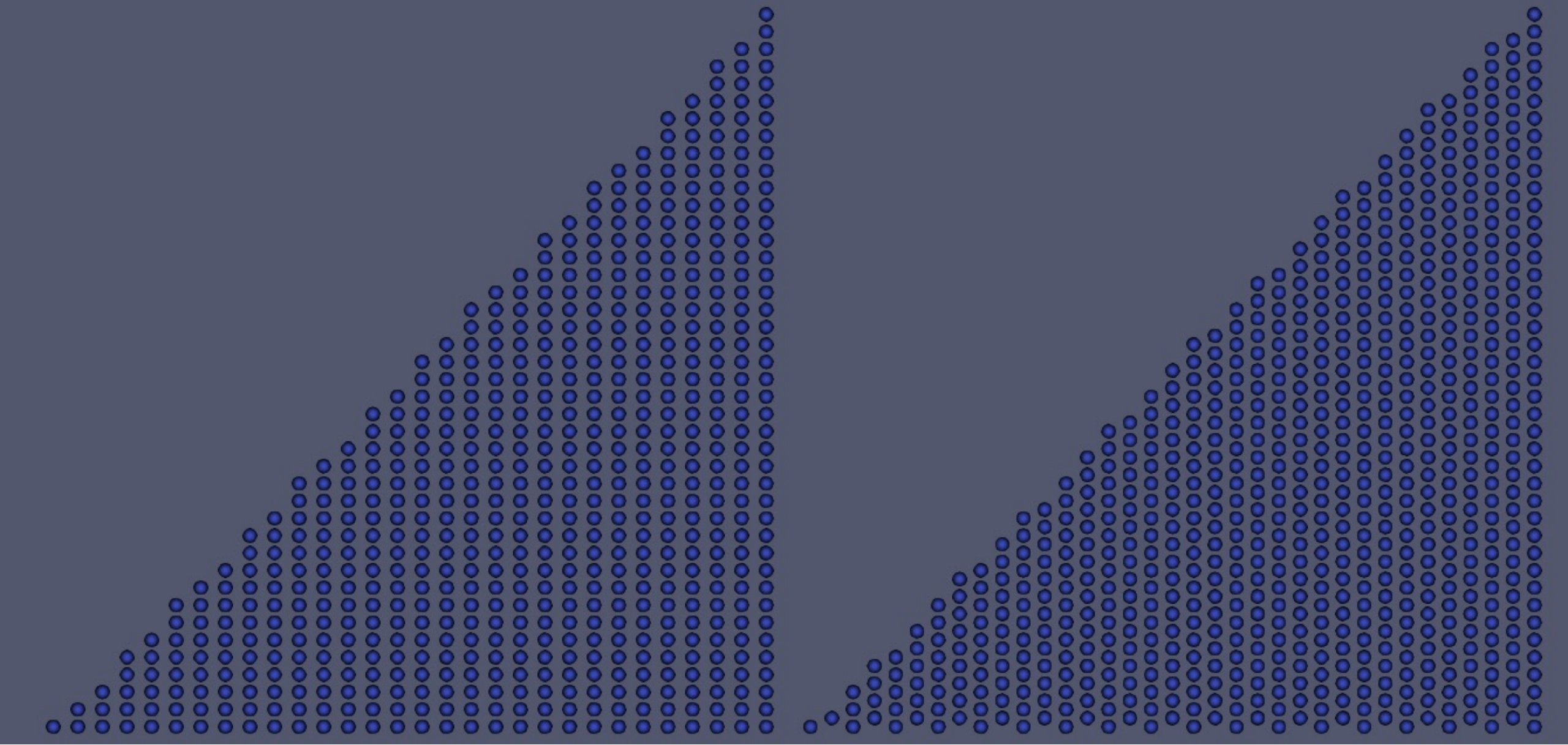

Sampling Distance: 1/15 = 0.066

Sampling Distance: 1/20 = 0.05

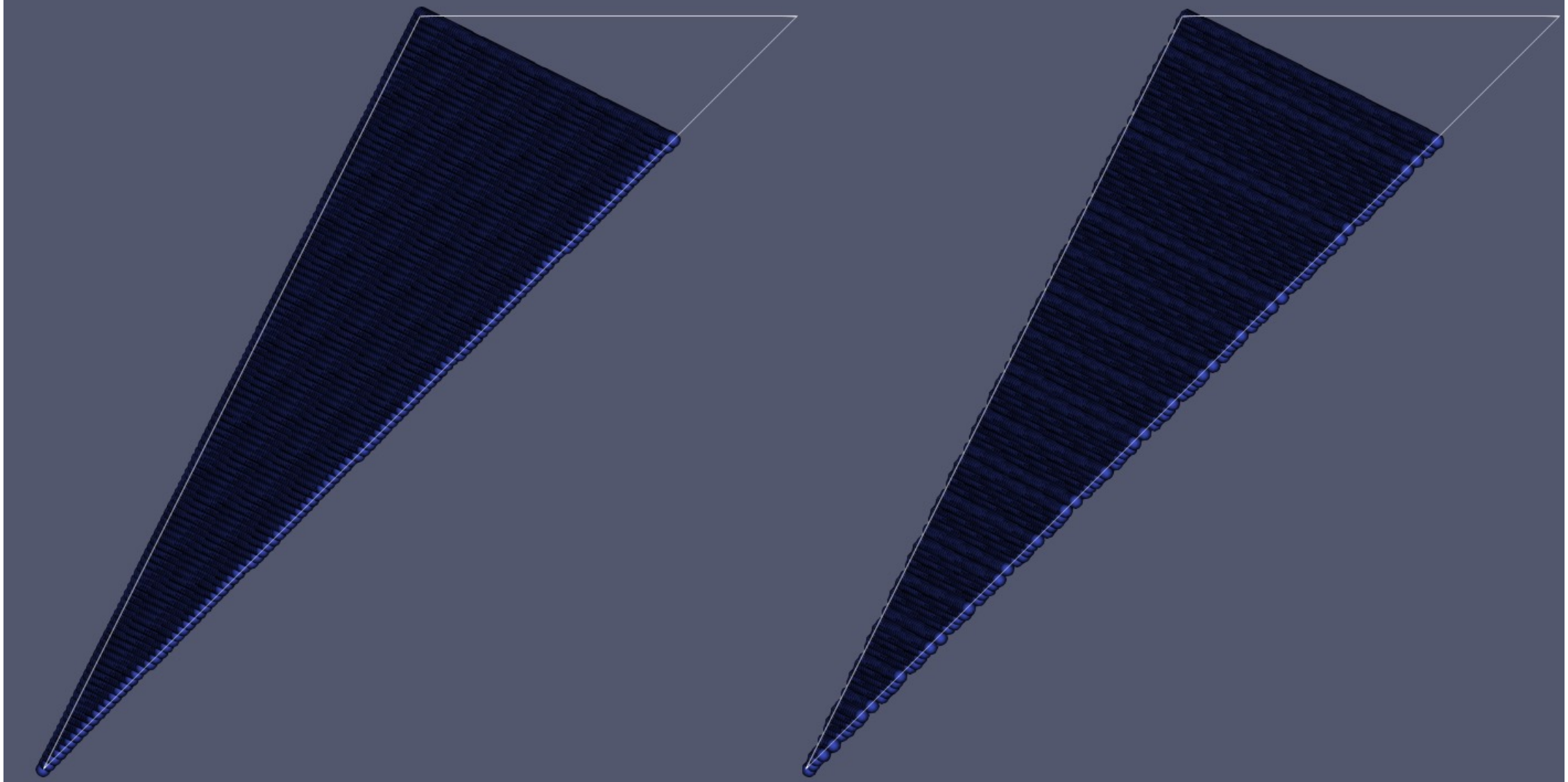



Sampling Distance: 1/25 = 0.04

Sampling Distance: 1/30 = 0.033

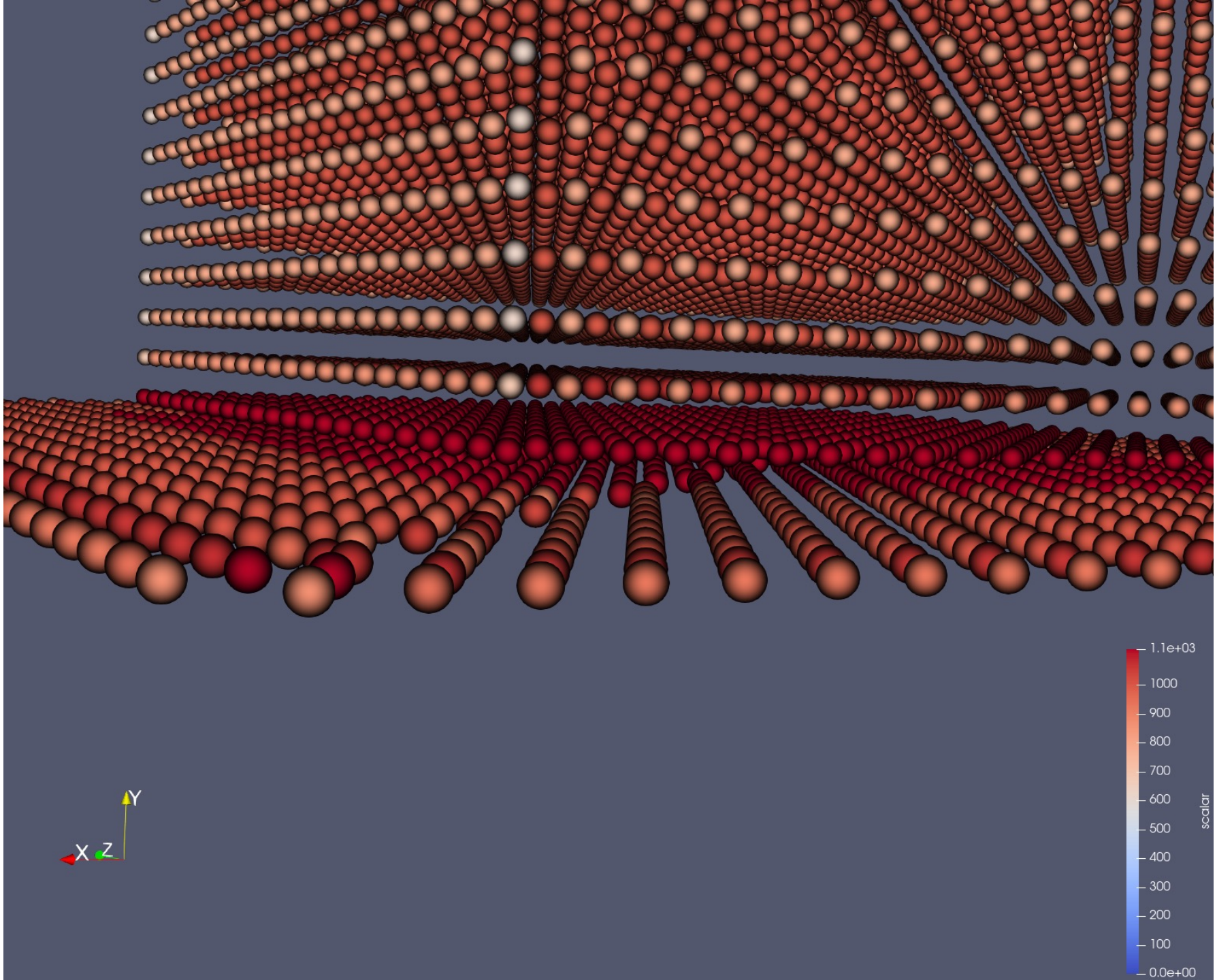


Optuse Triangle
Sampling Distance: 1/100 = 0.01



- triangles with an obtuse angle:
  - choose AB as the longest edge of the triangle
  - then proceed as before in the normal implementation
- triangles with circumscribed sphere smaller than half the particle distance sampling
  - problem: Samples only zero or one particle
  - solution: Adjust the sampling rate to a smaller value

2.3


Y
X
Z
1.1e+03
1000
900
800
700
600
500
400
300
200
100
0.0e+00
scalar

Assignment 3

- we followed the example pseudo code of task 5.
- we implemented a functionality how long the time between to VTK-frames has to be

- dealing with high velocity particles:
  - Incorporation of air friction leading to resistance for the particle velocity

Assignment 4

- We implemented the formulas.

Assignment 5

i. *B = 0, v_f = 0, v_b = 0, epsilon = 0*
ii. *B = 1 000, vf = 0, vb = 0, epsilon = 0*
iii. *B = 1 000, vf = 0, vb = 0, epsilon = 0, with floor sampled underneath*
iv. *B = 1 000, vf = 0.1, vb = 0, epsilon = 0*
v. *B = 1 000, vf = 0.1, vb = 1 000, epsilon = 0*
vi. *B = 1 000, vf = 0, vb = 0, epsilon = 0.5*