Imaging Fluid Dynamics for Art

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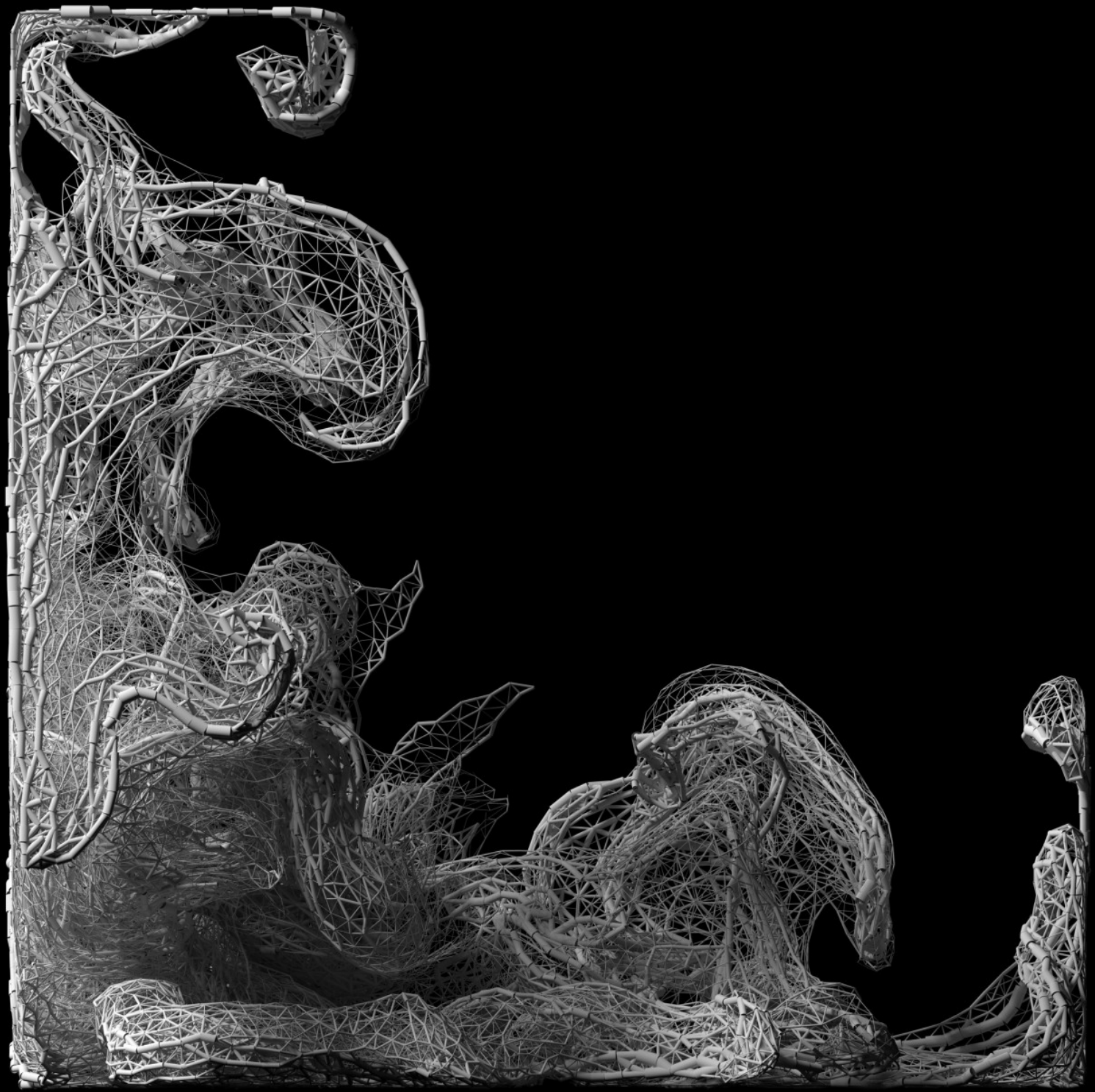
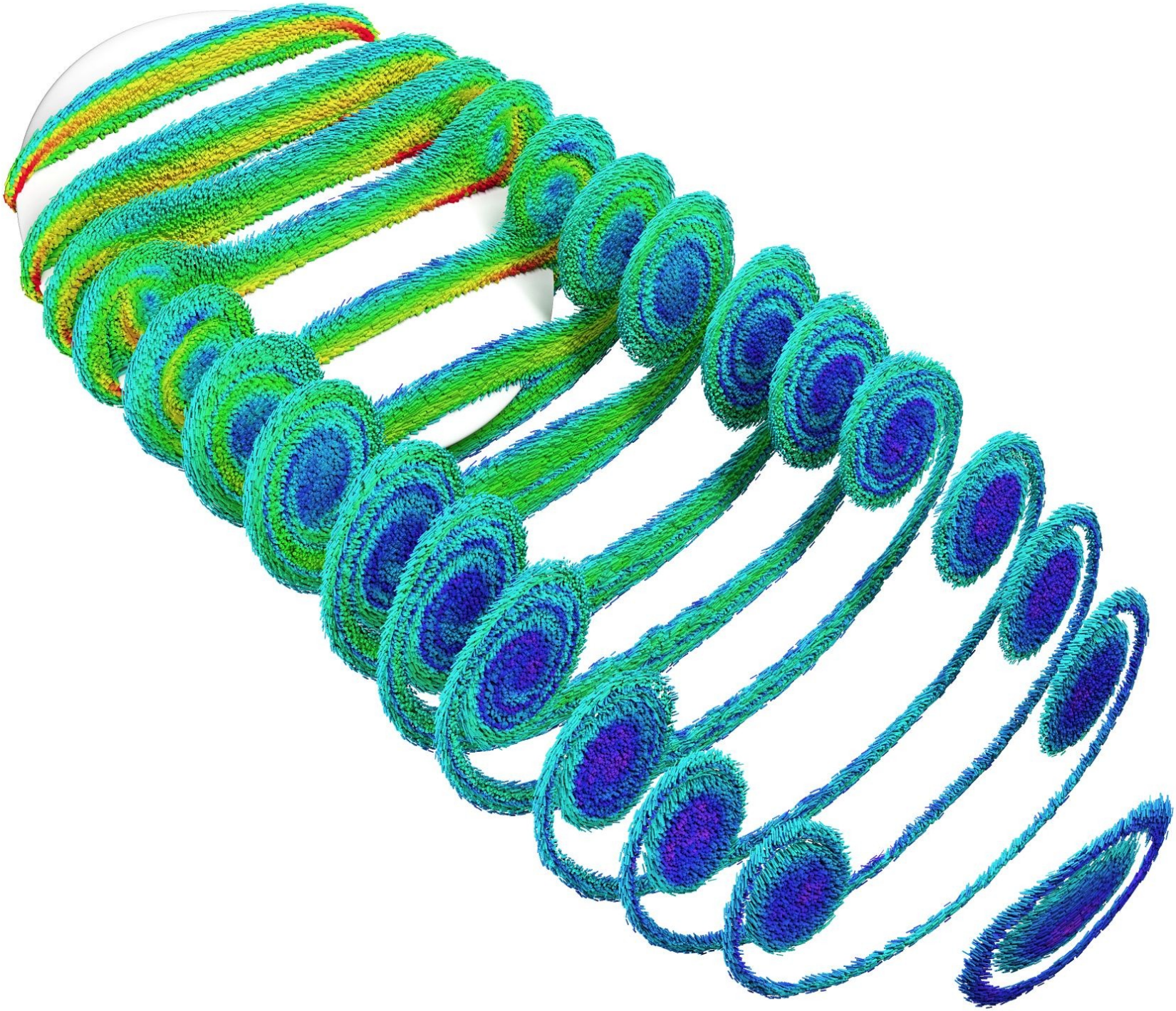
7th International RADIANCE Workshop
Design and Art session, 14h30





Vortex wake behind a circular disc, Copyright 2007 Mark J. Stock

Outline

- 5 min - Intro (burned)
- 8 min – Modeling fluids
- 4 min - Converting data
- 3 min - Rendering
- 5 min - Display
- 5 min - Discussion

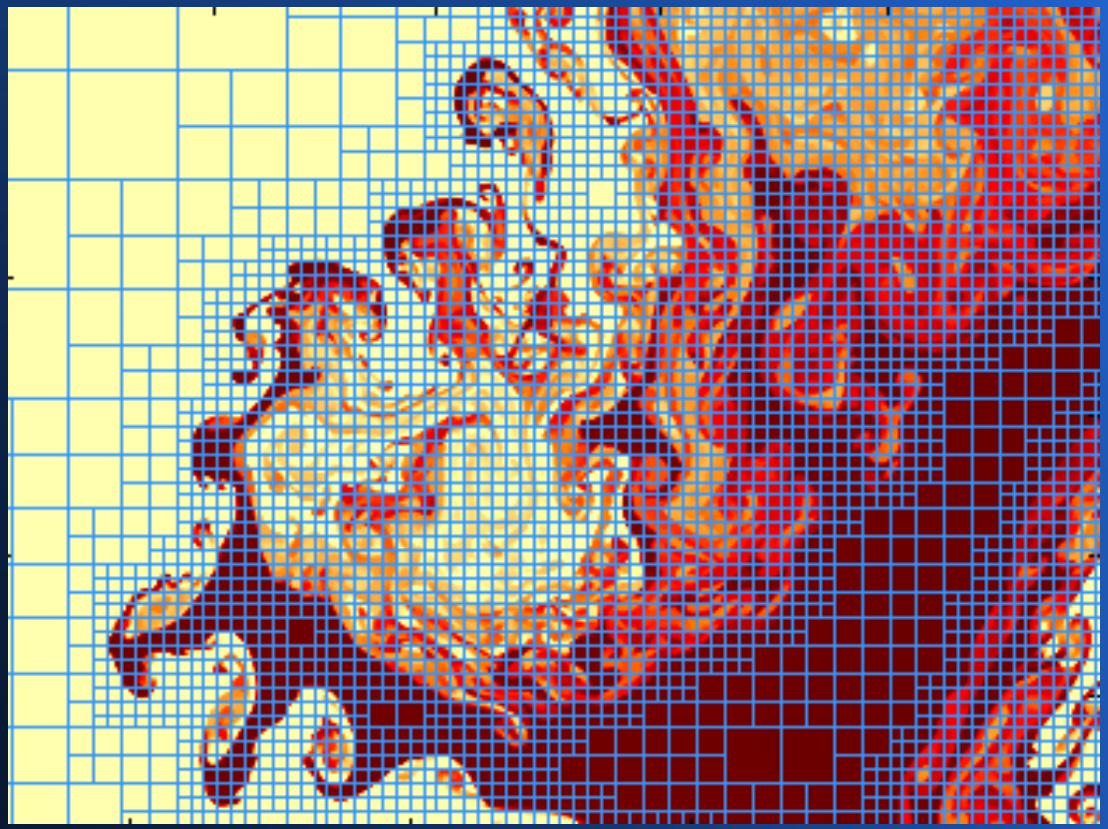
Modeling Fluids

“CFD”

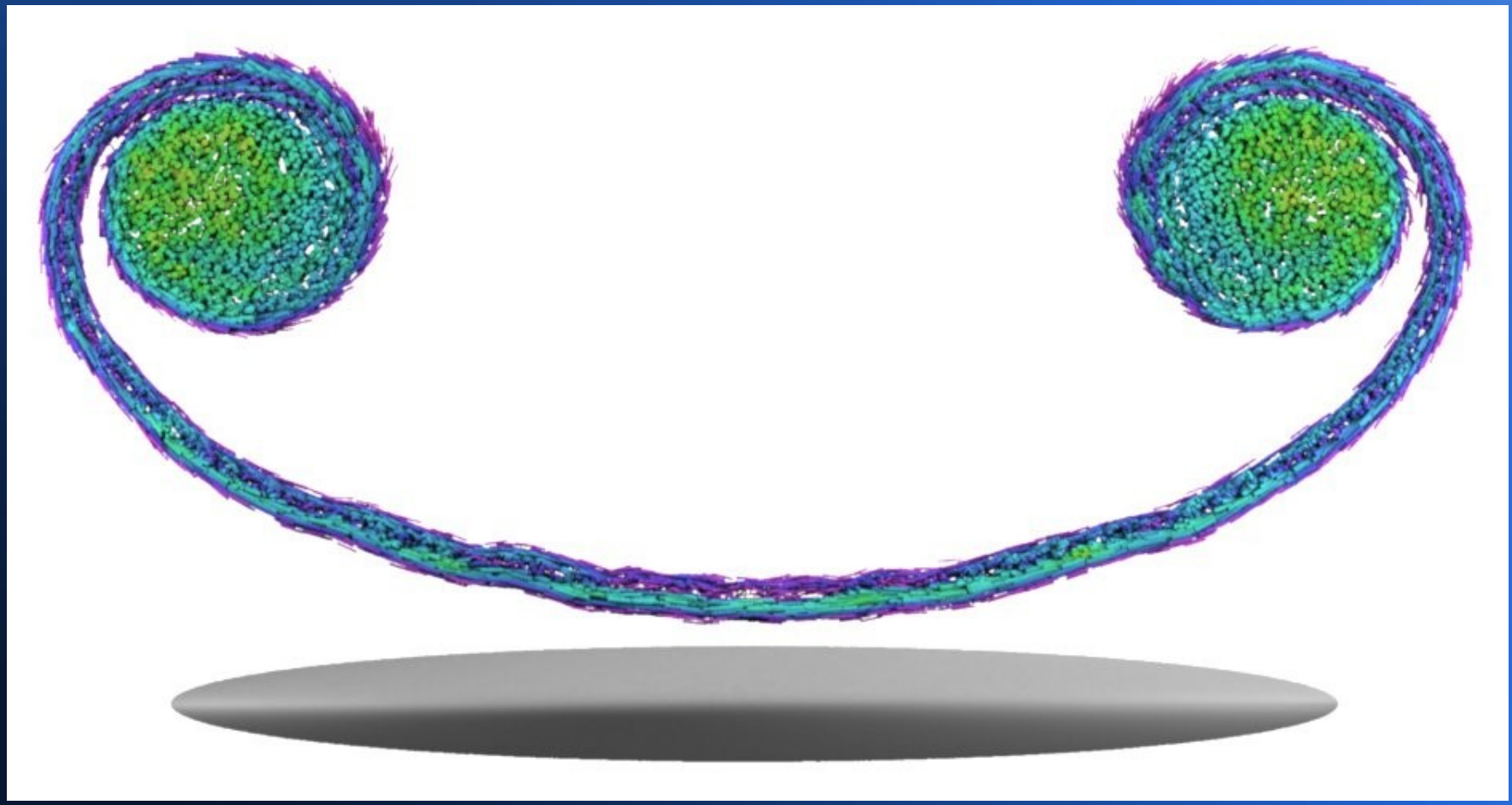
- Computational fluid dynamics

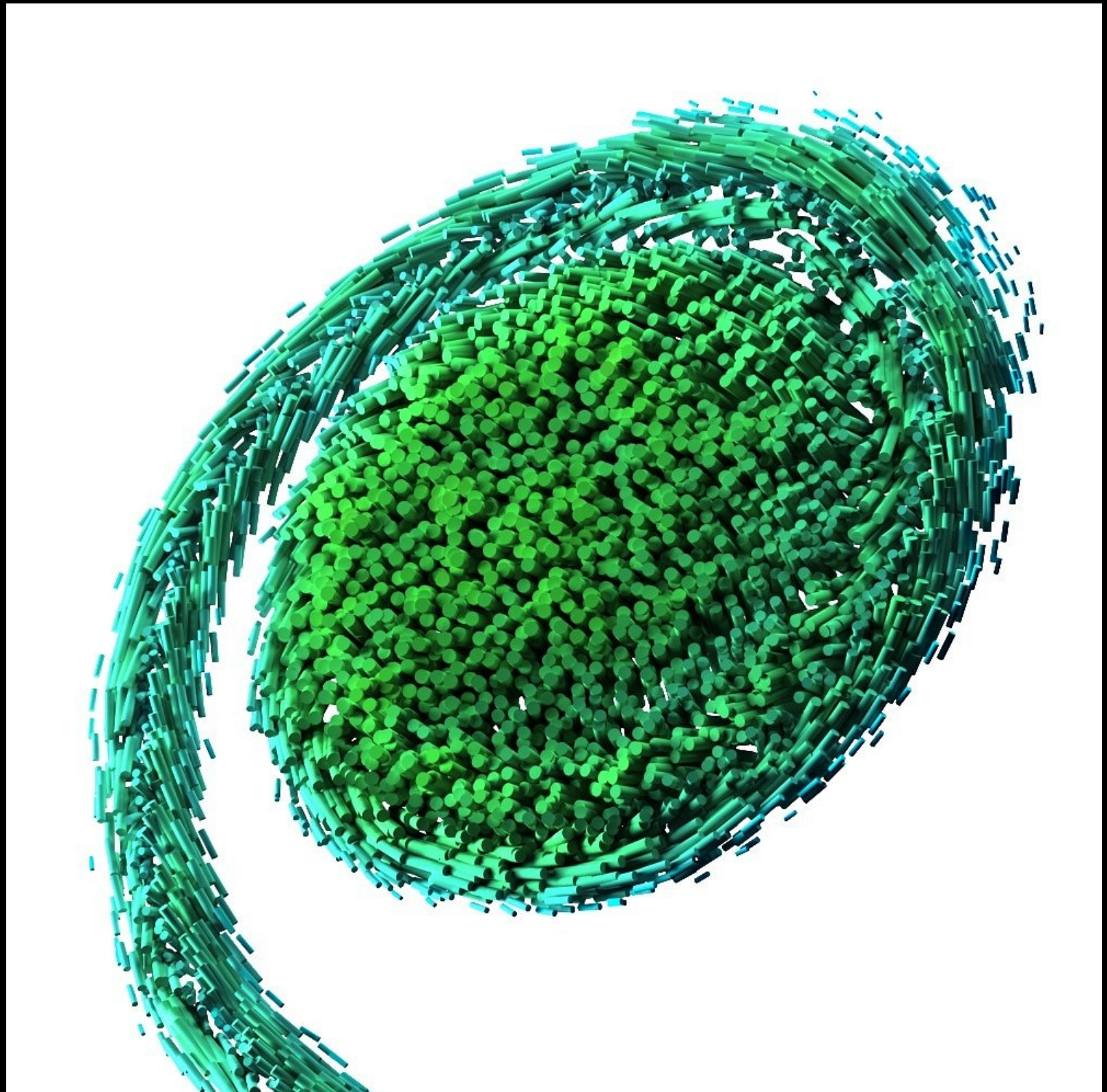
“CFD”

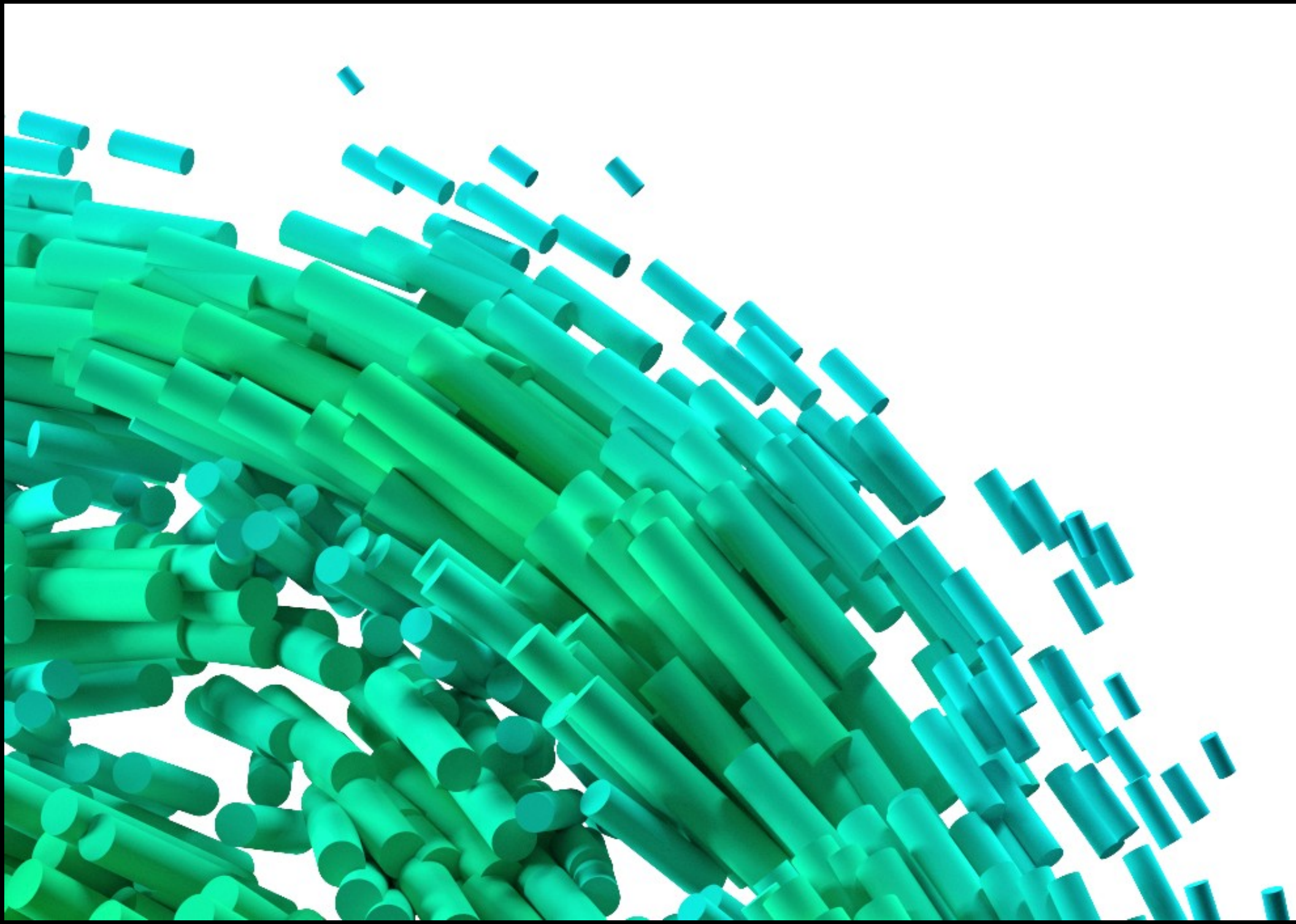
- ~~Computational~~ colorful fluid dynamics

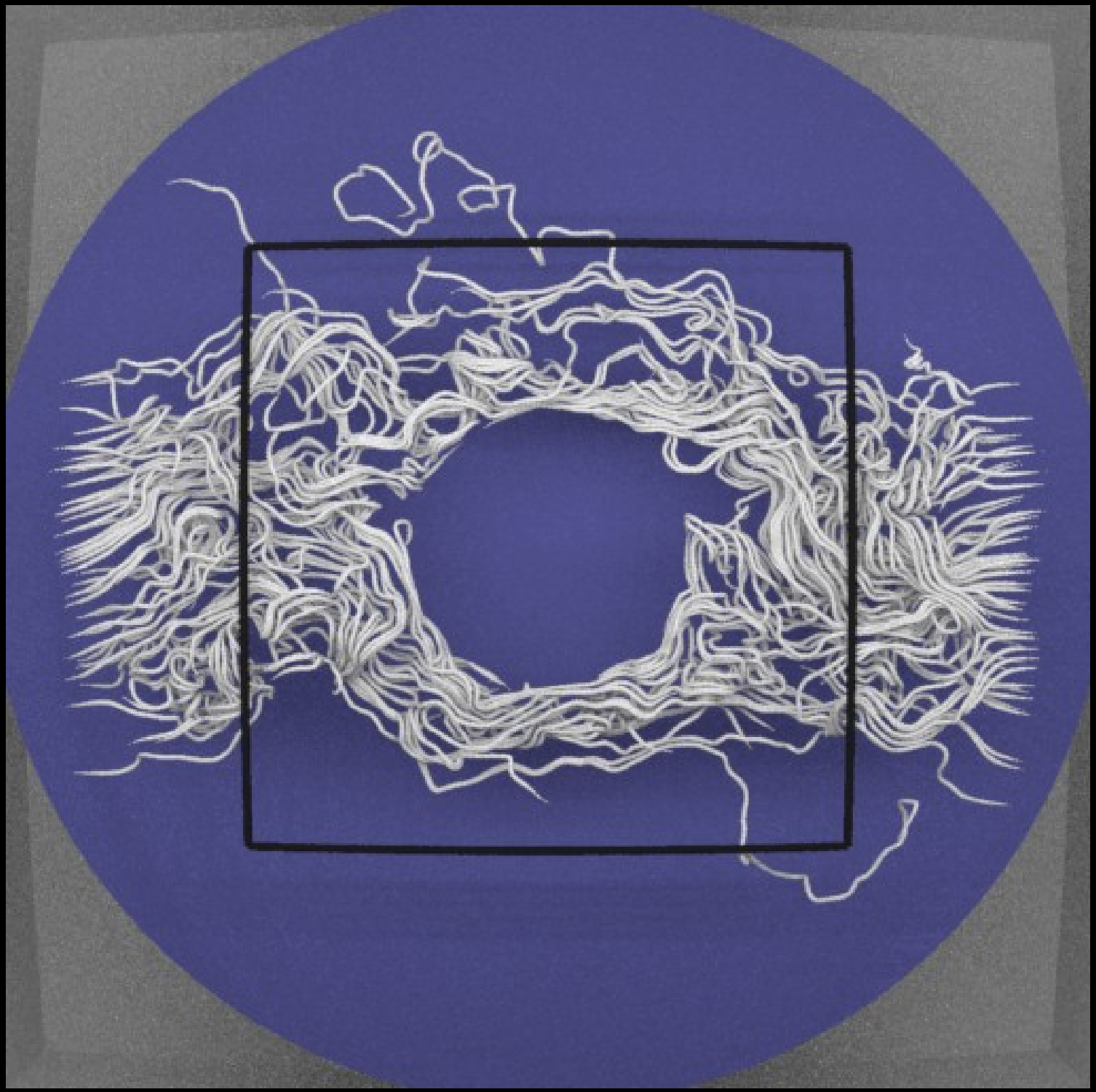


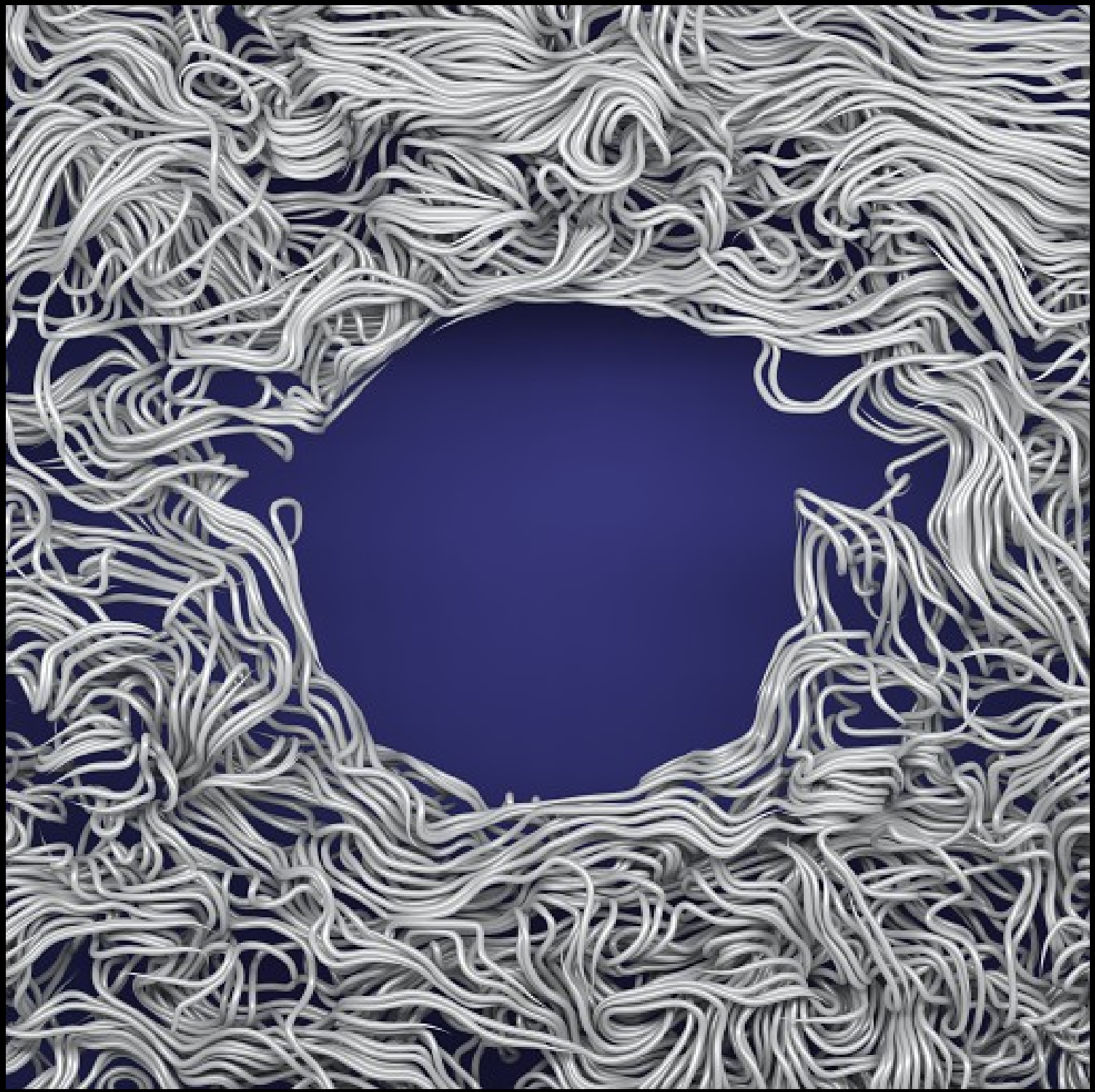
3D Vortex particle dynamics

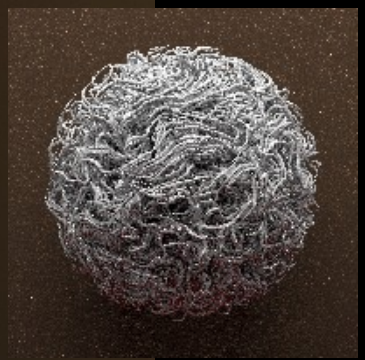




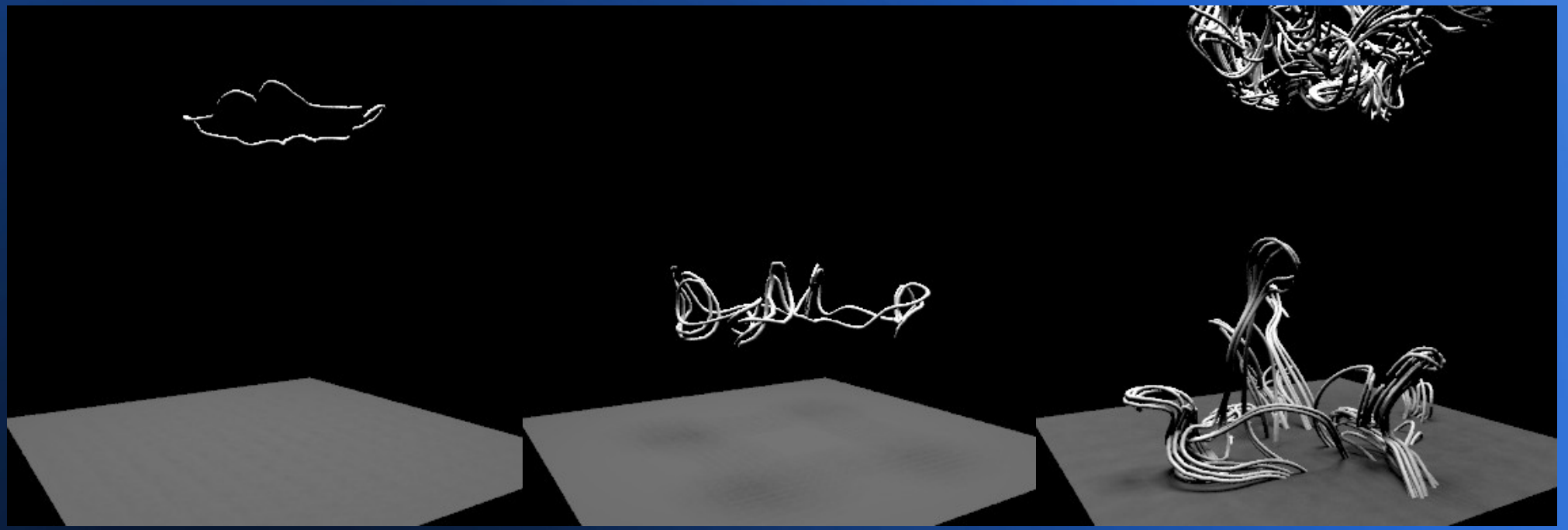


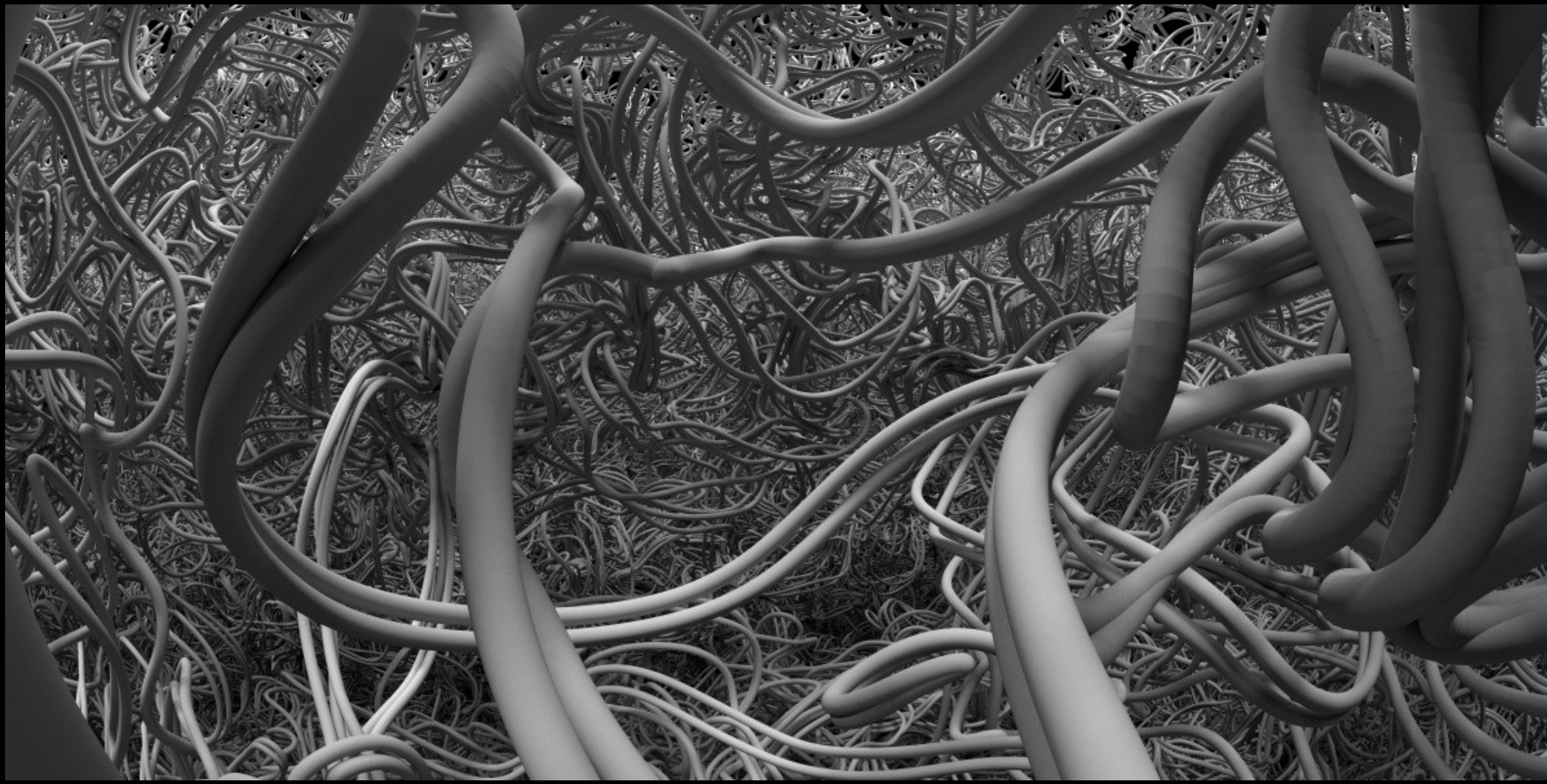






3D Vortex tube dynamics

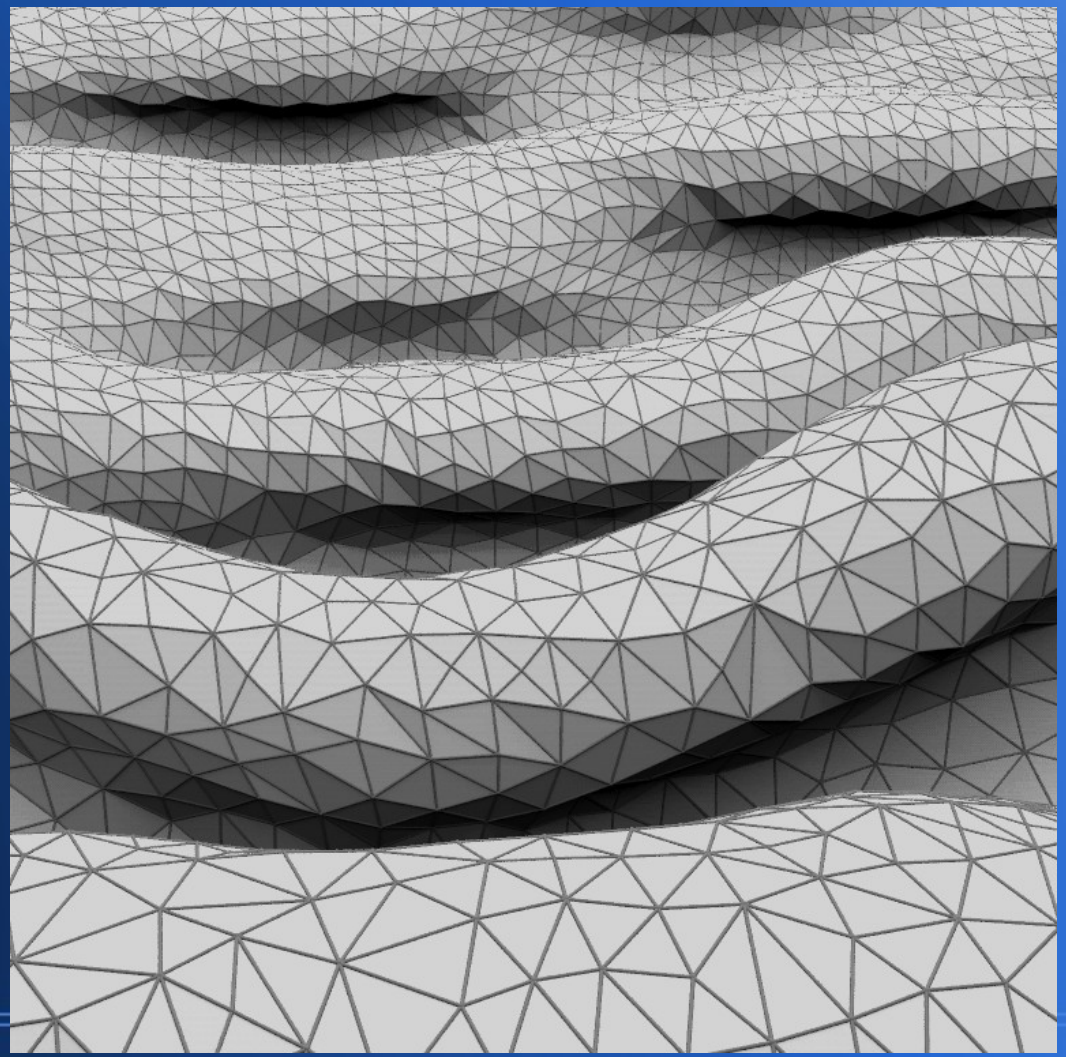


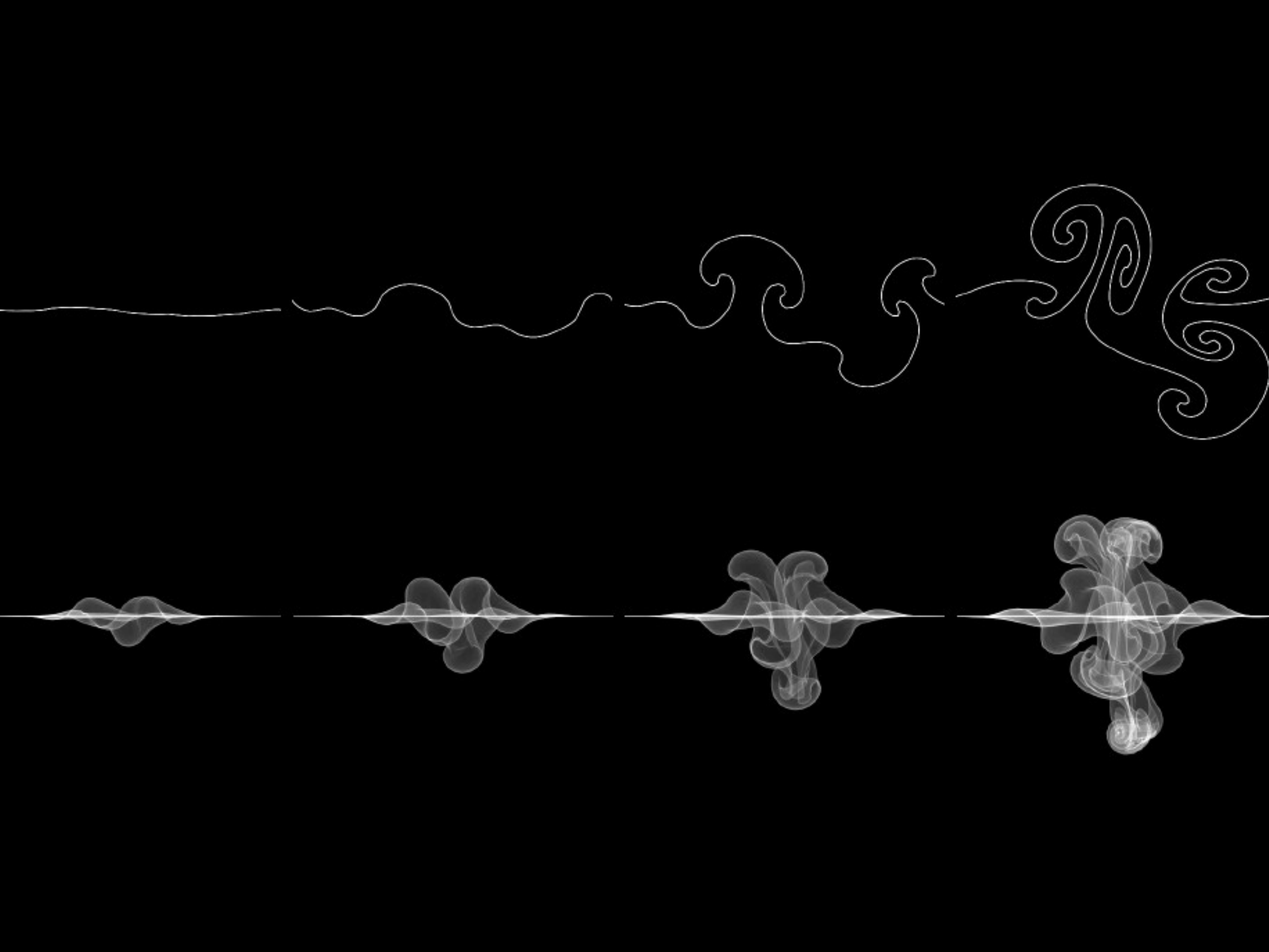


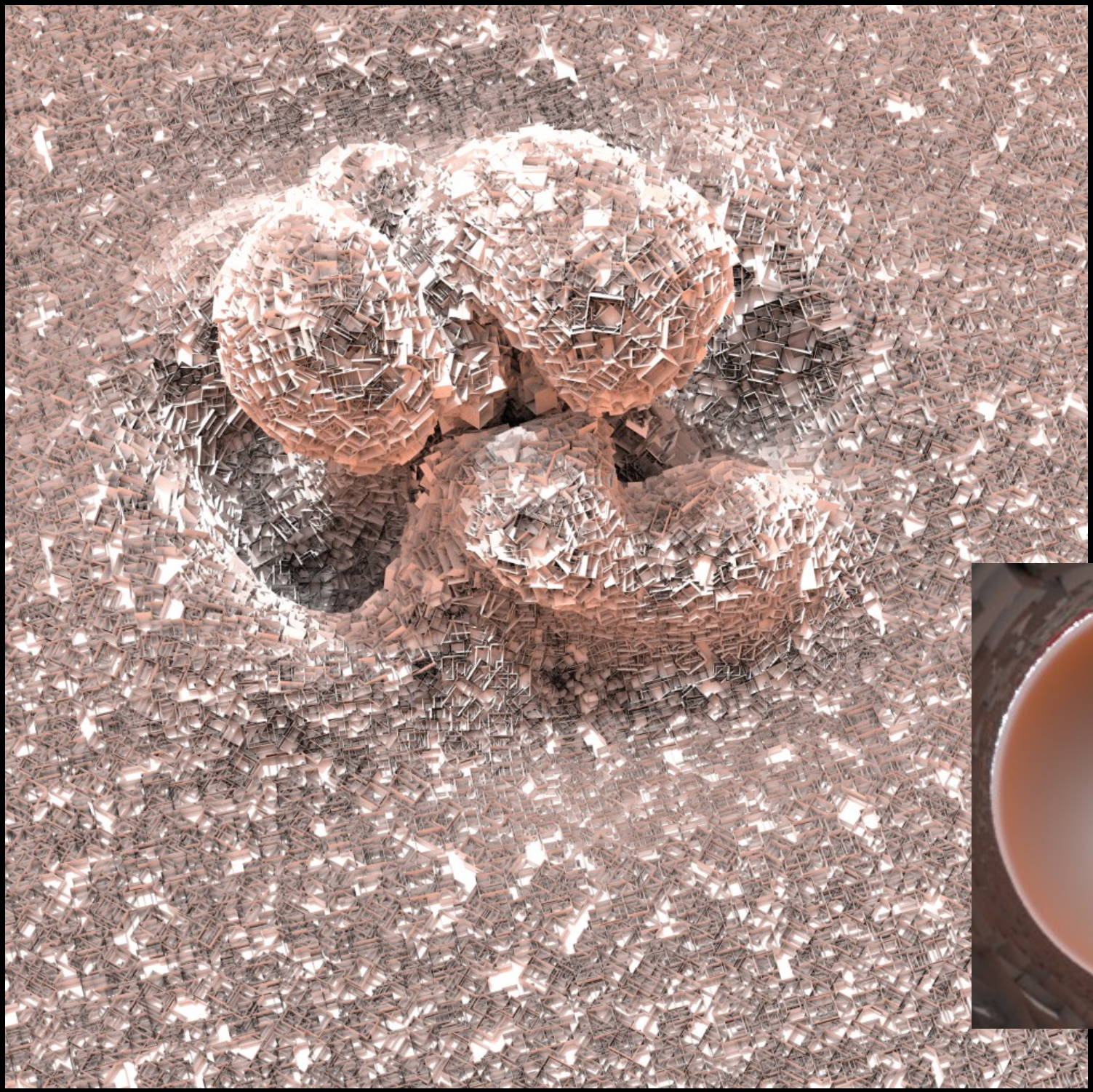
-vta -vh 176 -vv 88 -ab 1 -aa 0 -ad 16 -as 0 -x 24000 -y 12000

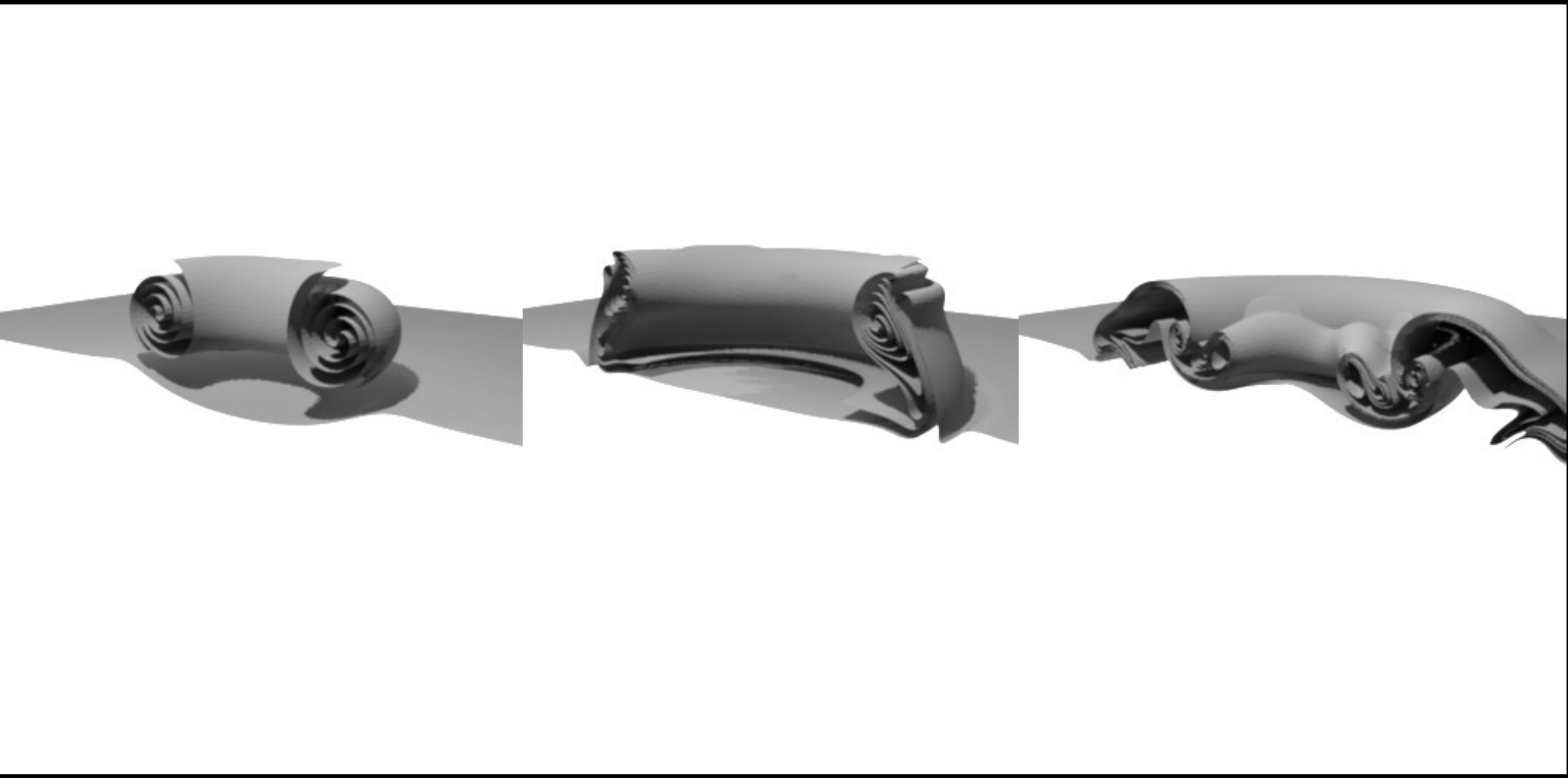
3D Vortex sheet dynamics

- Ph.D. research
- Triangle mesh
- Shear layers





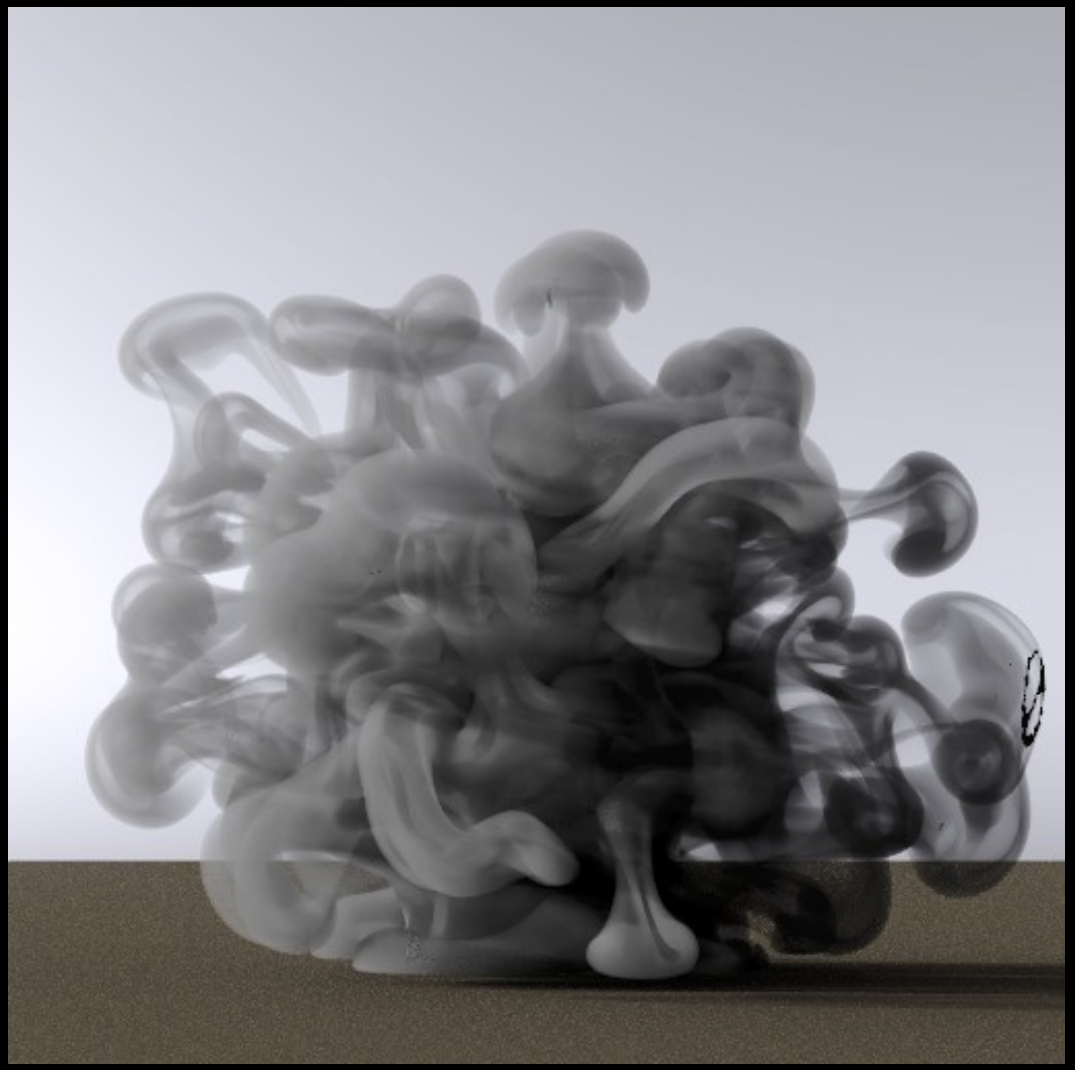




-ds 0.1 -dj 0.7 -ab 2 -u -aa 0 -ad 16 -as 0 -x 4096 -y 4096

730619 triangles, obj2mesh

-ab 2 -aa 0 -ad 8

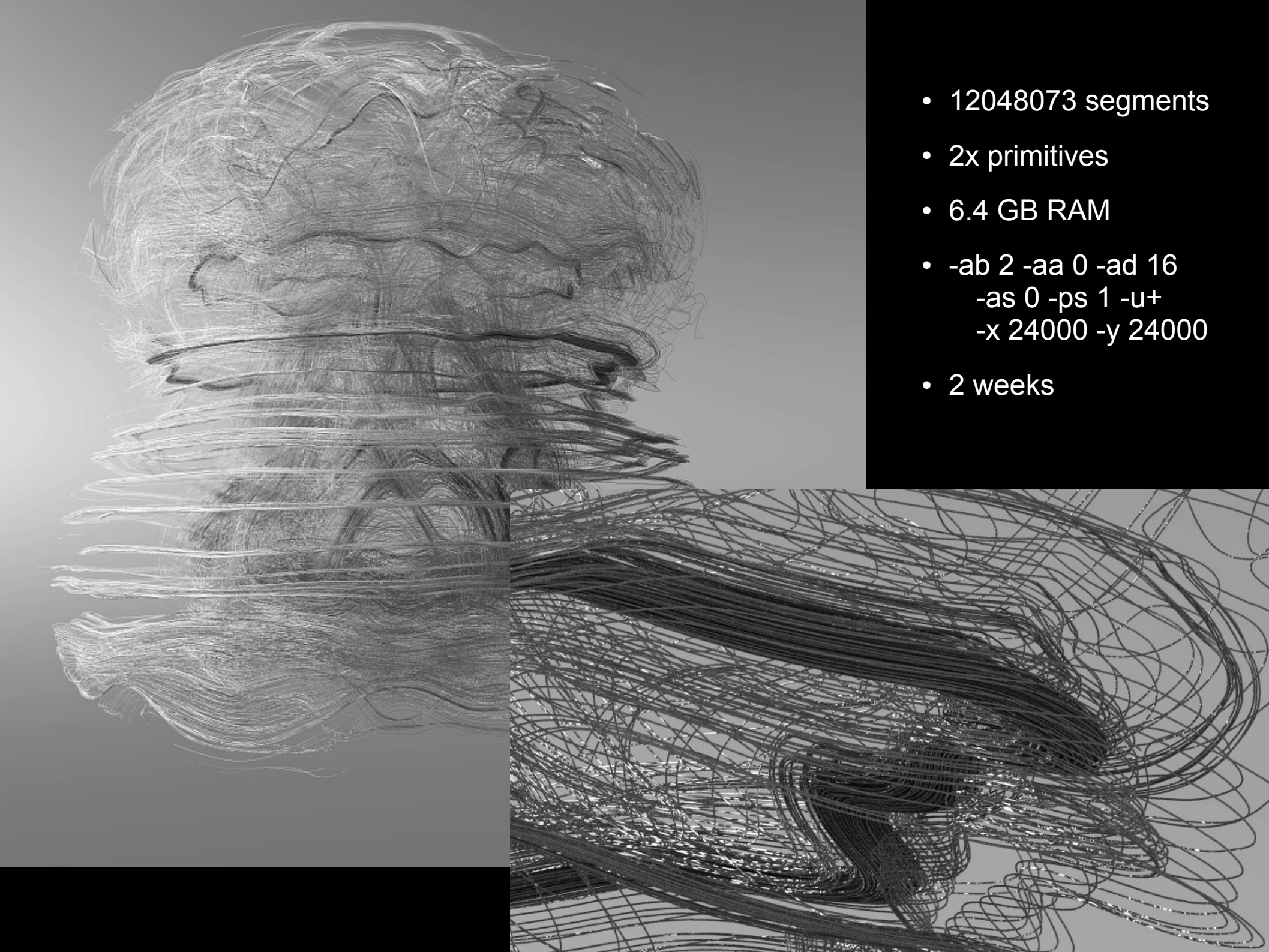


void mist def 2 sun sky 0 7 30 30 30 0.5 0.5 0.5 0.1

-ms 0.0003 -ab 1 -aa 0 -ad 8

tracefield

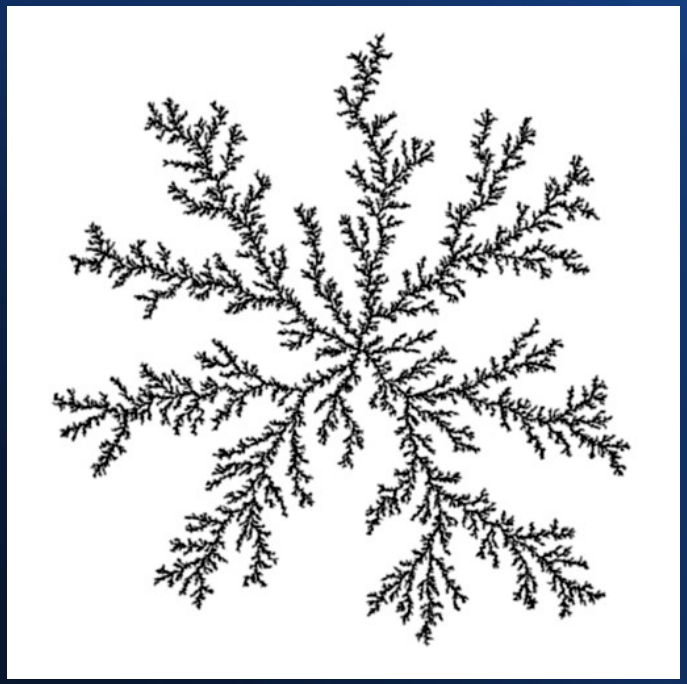
- 3D raster → 3D vector (→ 2D raster)

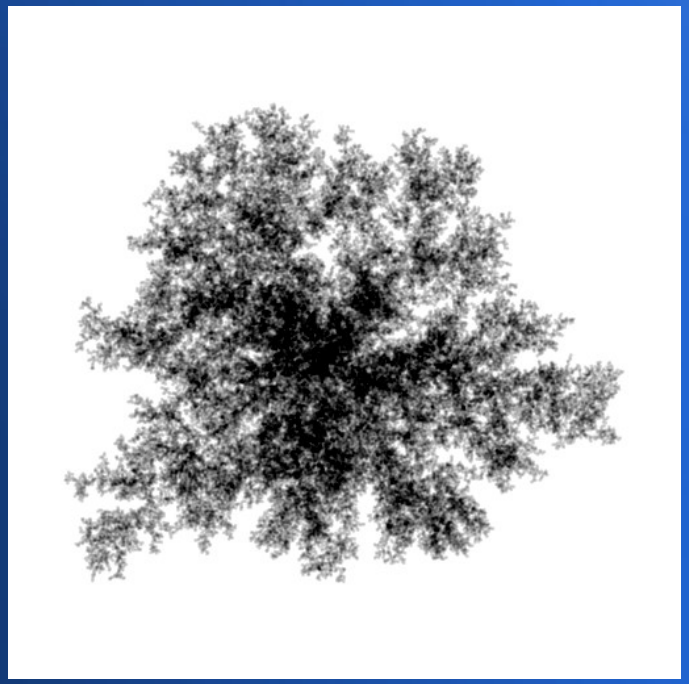


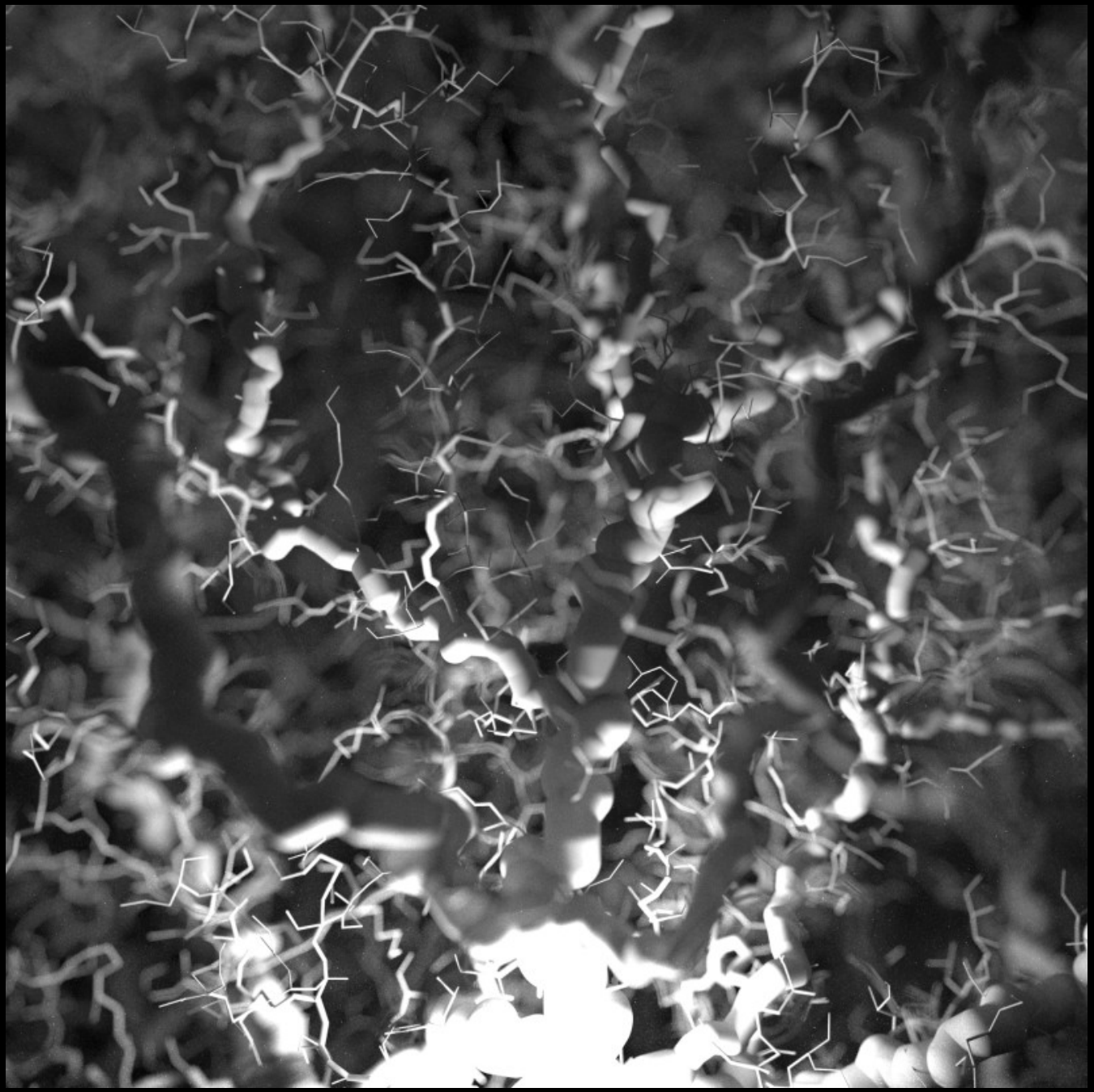
- 12048073 segments
- 2x primitives
- 6.4 GB RAM
- -ab 2 -aa 0 -ad 16
  -as 0 -ps 1 -u+
  -x 24000 -y 24000
- 2 weeks

DLA

- Diffusion-limited aggregation
- Not a CFD technique







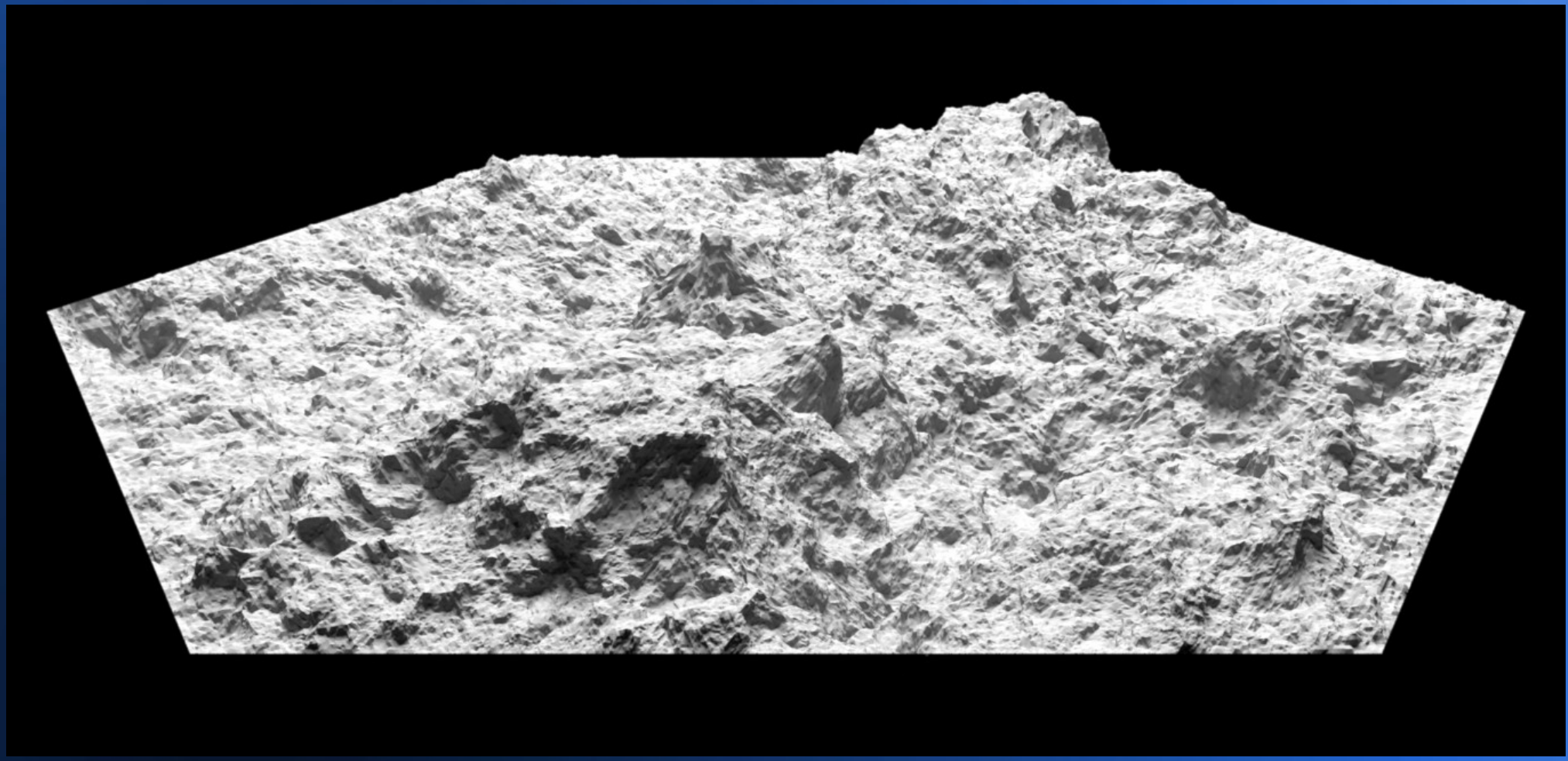
- vwrays -fd -vf vf2 -x 28800 -y 28800 | rcalc -id6 -e 'a:5.0;d:100.0' -e `vwright i < vf2` -e 'theta=2*PI*rand(2*recno-1);r=0.5*a*sqrt(rand(2*recno))' -e 'r1=r*cos(theta);r2=r*sin(theta)' -e 'dx=r1*ihx+r2*ivx;dy=r1*ihy+r2*ivy;dz=r1*ihz+r2*ivz' -e '$1=ipx+dx;$2=ipy+dy;$3=ipz+dz' -e '$4=$4-dx/d;$5=$5-dy/d;$6=$6-dz/d' -od | rtrace -fdc -x 28800 -y 28800 -ab 2 -aa 0 -ad 4 -as 0 -dj 0.7 image11.oct > img31.pic

Converting Data

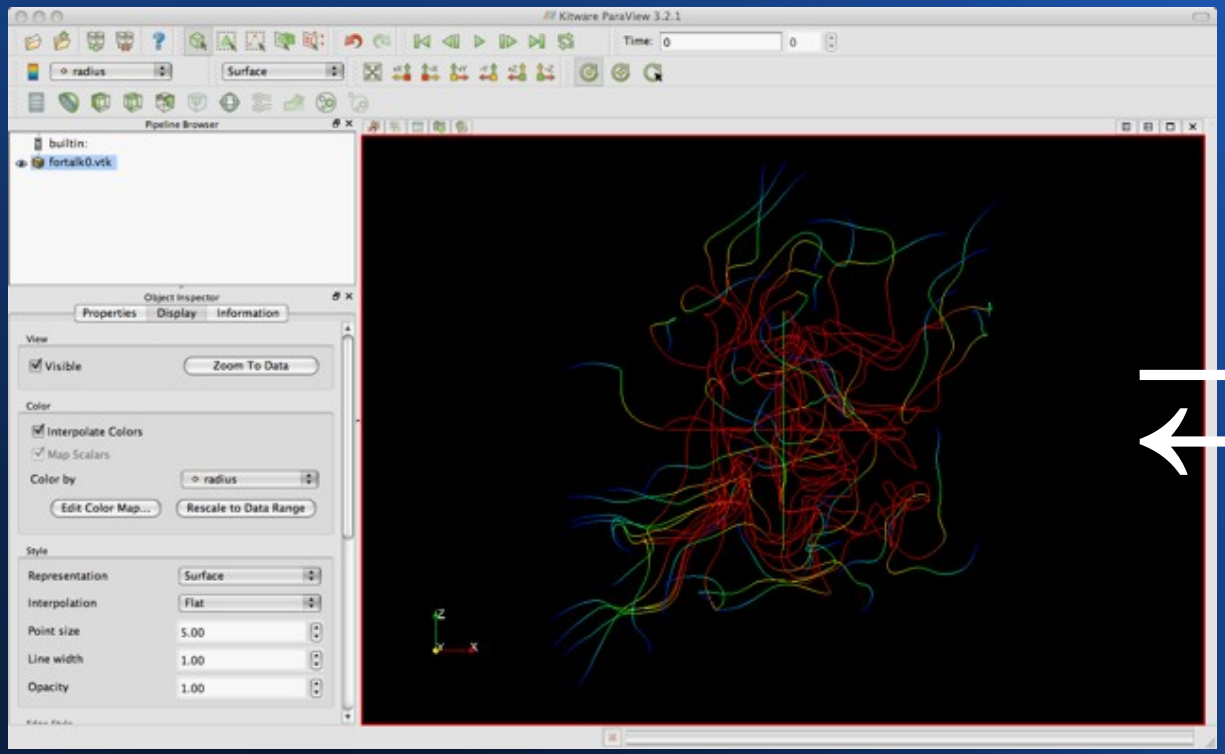
Converting data

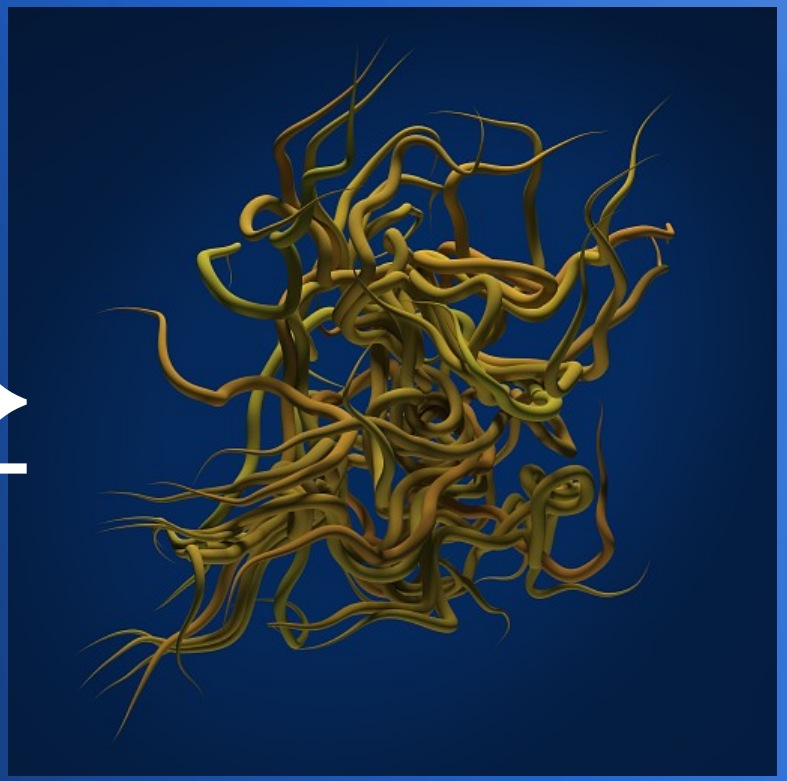
- Direct dump to .rad or .obj or .b3d
- Rocktools – 3D tri mesh
- Stickkit – 3D network
- makeMistCubes – from 3D scalar field

Rocktools



Stickkit





Reads .rad cylinders, cones, and spheres, too!

makeMistCubes

- 3D scalar field in
- 228204 mist cubes out

Handling large models

Problem: oconv dislikes overlapping geom

Handling large models

- Problem: oconv dislikes overlapping geom
  - 100k primitives w/ overlap – 10M w/o
  - Even with “-n 80”
  - Even with 8 GB RAM

Handling large models

- Problem: oconv dislikes overlapping geom
  - 100k primitives w/ overlap – 10M w/o
  - Even with “-n 80”
  - Even with 8 GB RAM
- Solution: recursively split geometry
  - oconv, instance separately

Rendering

Rendering large frames

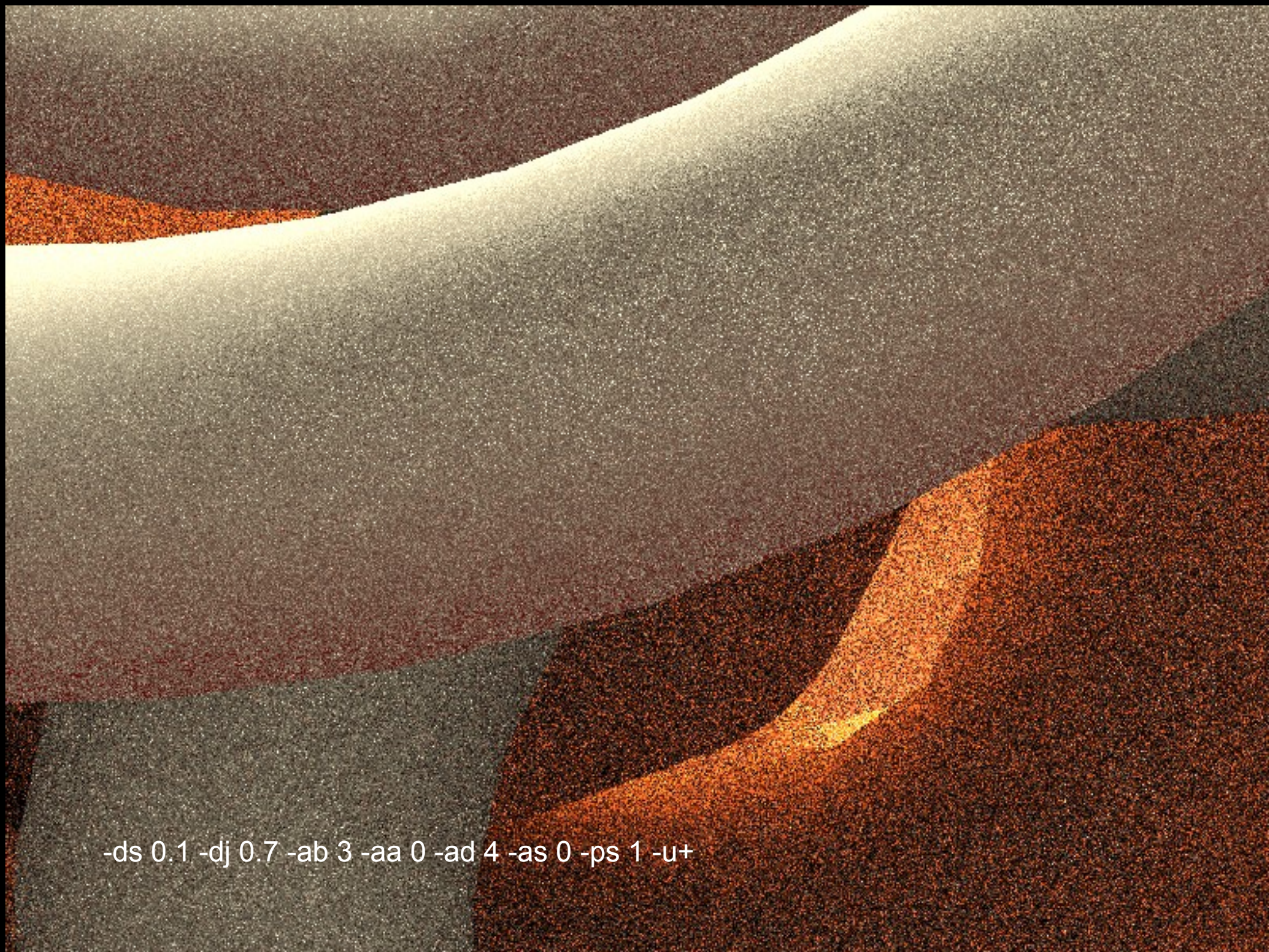
- 1 frame at 24000 to 50000 pixel res
- 7250 frames at 1080p
- Quad-core machines are great
- Play with compile options (gain 2-20%)

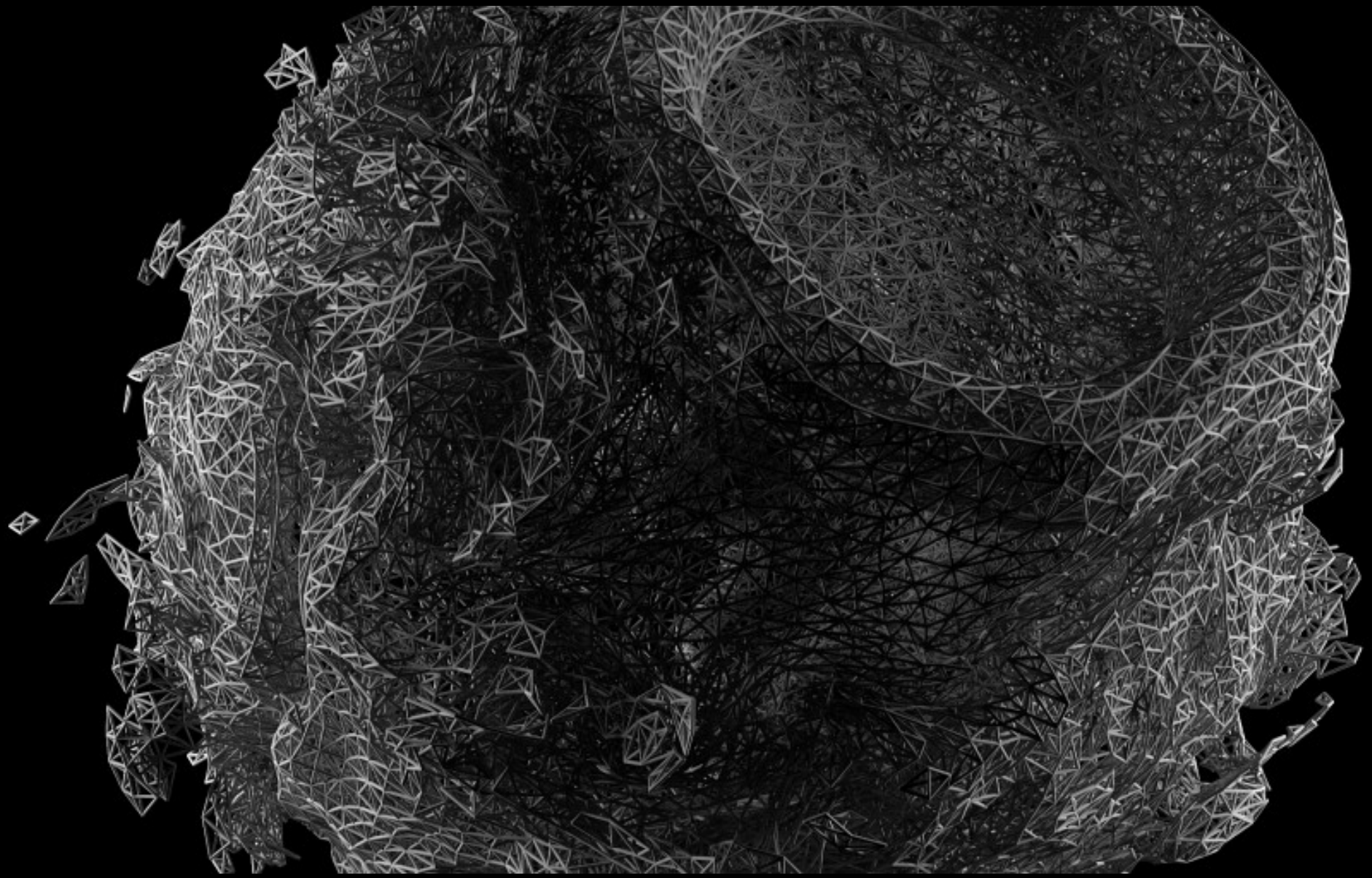
To “-aa 0”

- No amb cache – all oct
- Trivially parallel
- Can weight toward 1st bounce
- *No frame coherence*
- *Noisy, must oversample, but...*

...or not

- *Ambient cache is big*
- *Must share amb file*
- Smooth results
- Reusable results


-ds 0.1 -dj 0.7 -ab 3 -aa 0 -ad 4 -as 0 -ps 1 -u+



7250 frames, -ab 2 -aa 0 -ad 16 -as 0 -ps 1 -dj 0.7 -ds 0.2 -u+ -x 3840 -y 2160

Display Techniques

Display techniques

- 1+ LCD screen
- Lightjet or Inkjet print
- HDR display

Mesh #3 Iso, 2000, Mark Stock - Mozilla Firefox

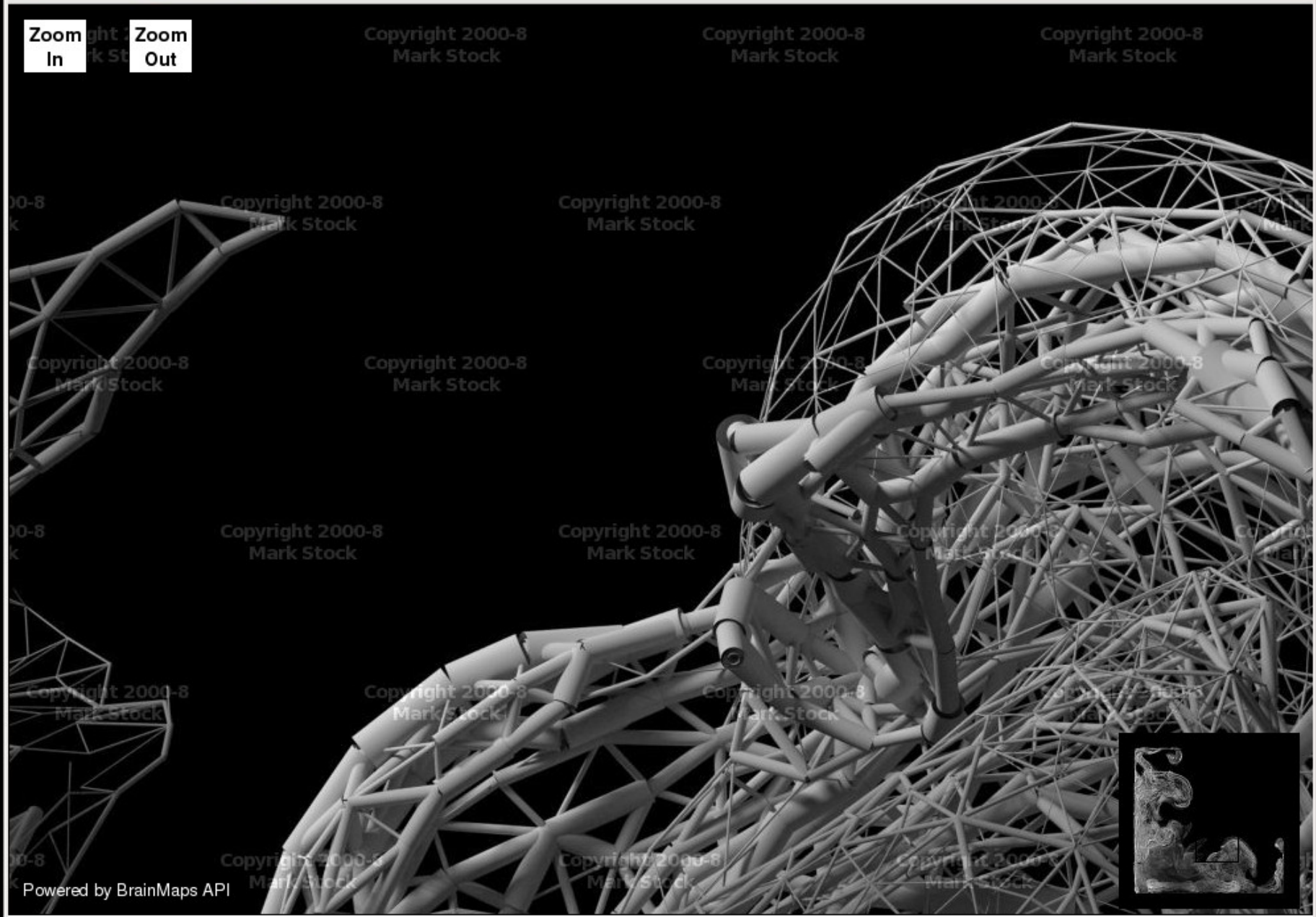
File Edit View History Bookmarks Tools Help

http://markjstock.com/p03zoom/

Google

Zoom In

Zoom Out



Done

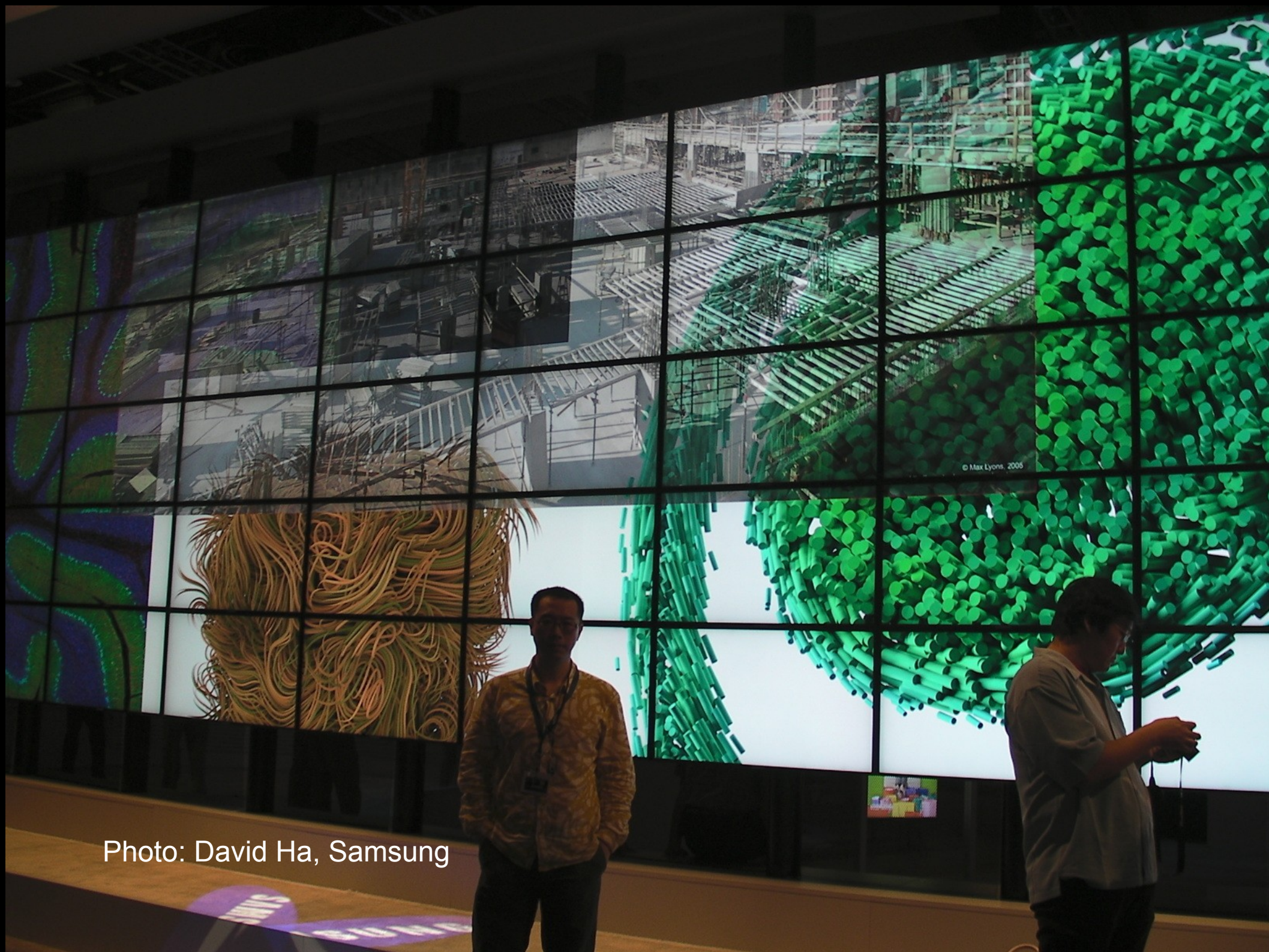


Photo: David Ha, Samsung

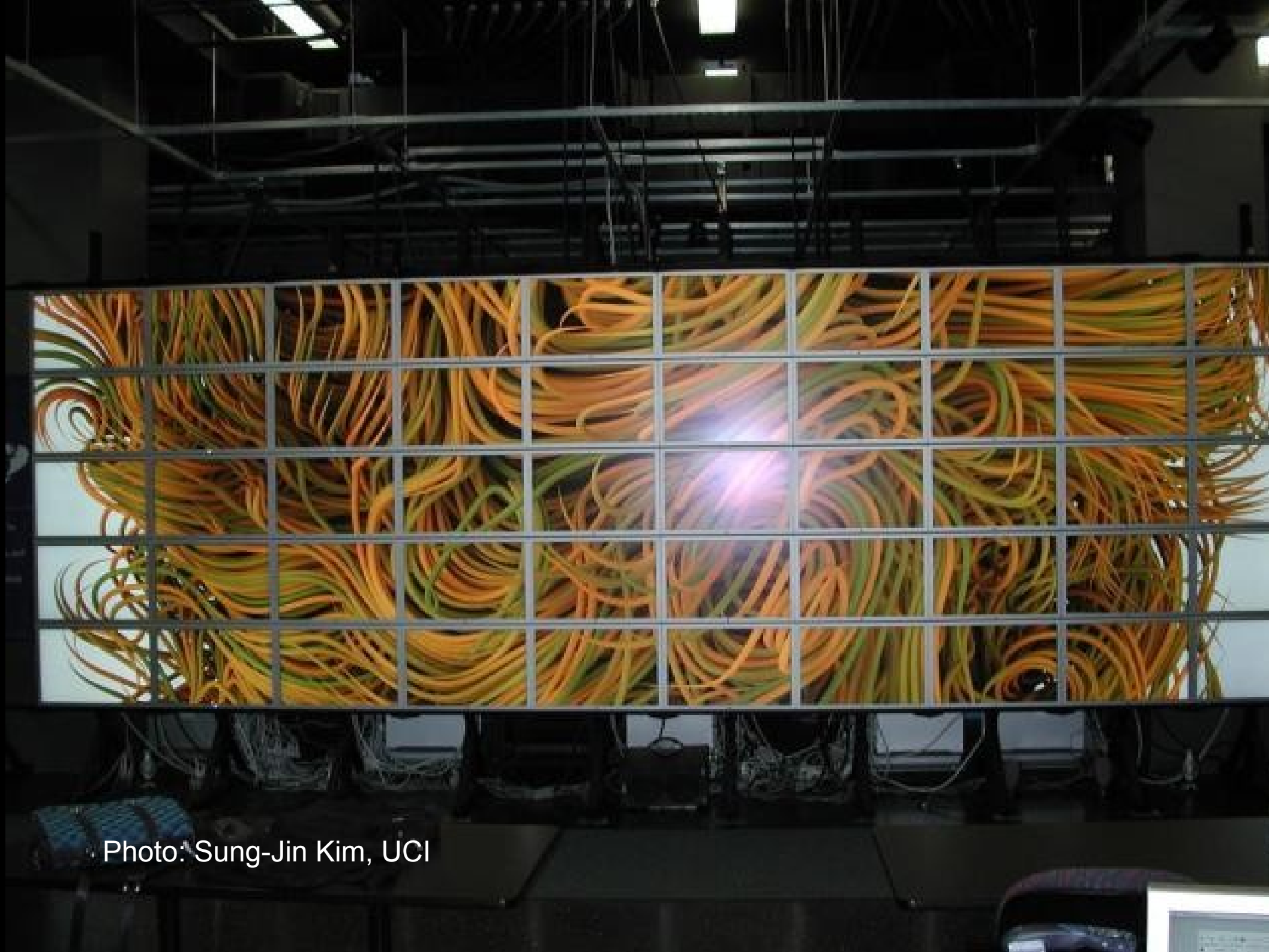
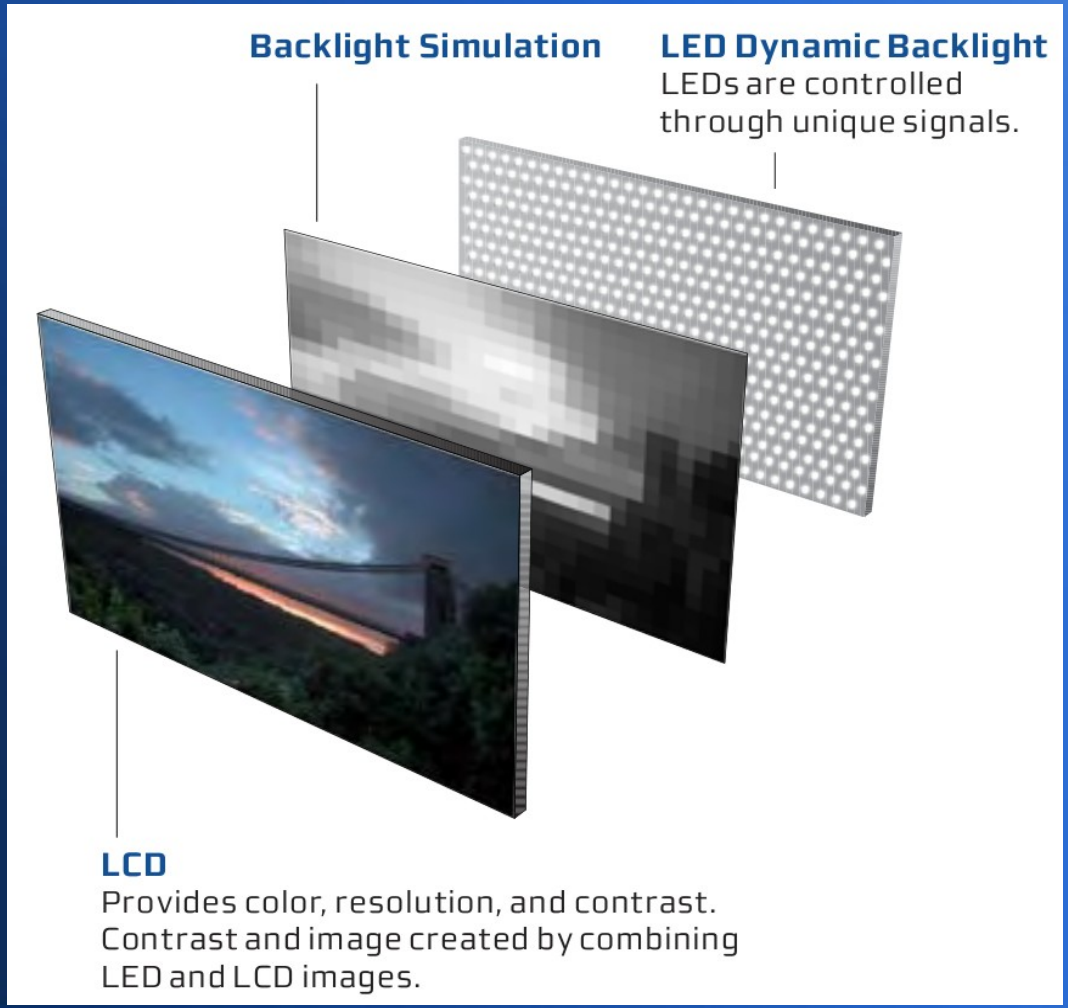


Photo: Sung-Jin Kim, UCI

Display - HDR

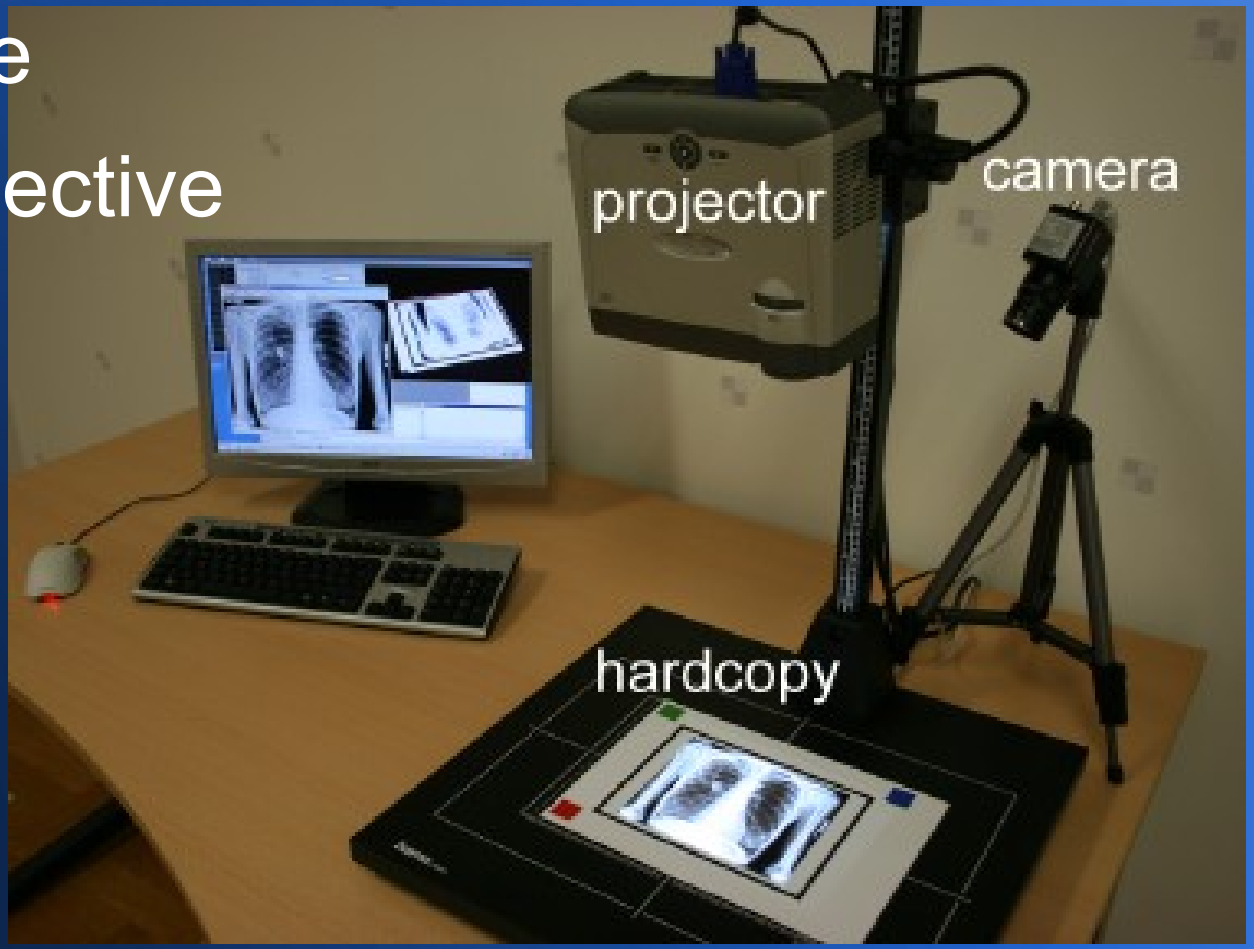
- Dolby/Brightside



Dolby Laboratories, 2008

Display - HDR

- Dolby/Brightside
- Projector + Reflective



Bimber and Iwai, 2008

Superimposing Dynamic Range, Bimber & Iwai, SIGGRAPH, 2008

Display - HDR

- Dolby/Brightside
- Projector + Reflective
- Overlaid transparencies

Display - HDR

- Dolby/Brightside
- Projector + Reflective
- Overlaid transparencies

16bpp

Display - HDR

- Dolby/Brightside
- Projector + Reflective
- Overlaid transparencies

16bpp

Display - HDR

- Dolby/Brightside
- Projector + Reflective
- Overlaid transparencies

16bpp

=

8bpp
Light map

8bpp
Detail map

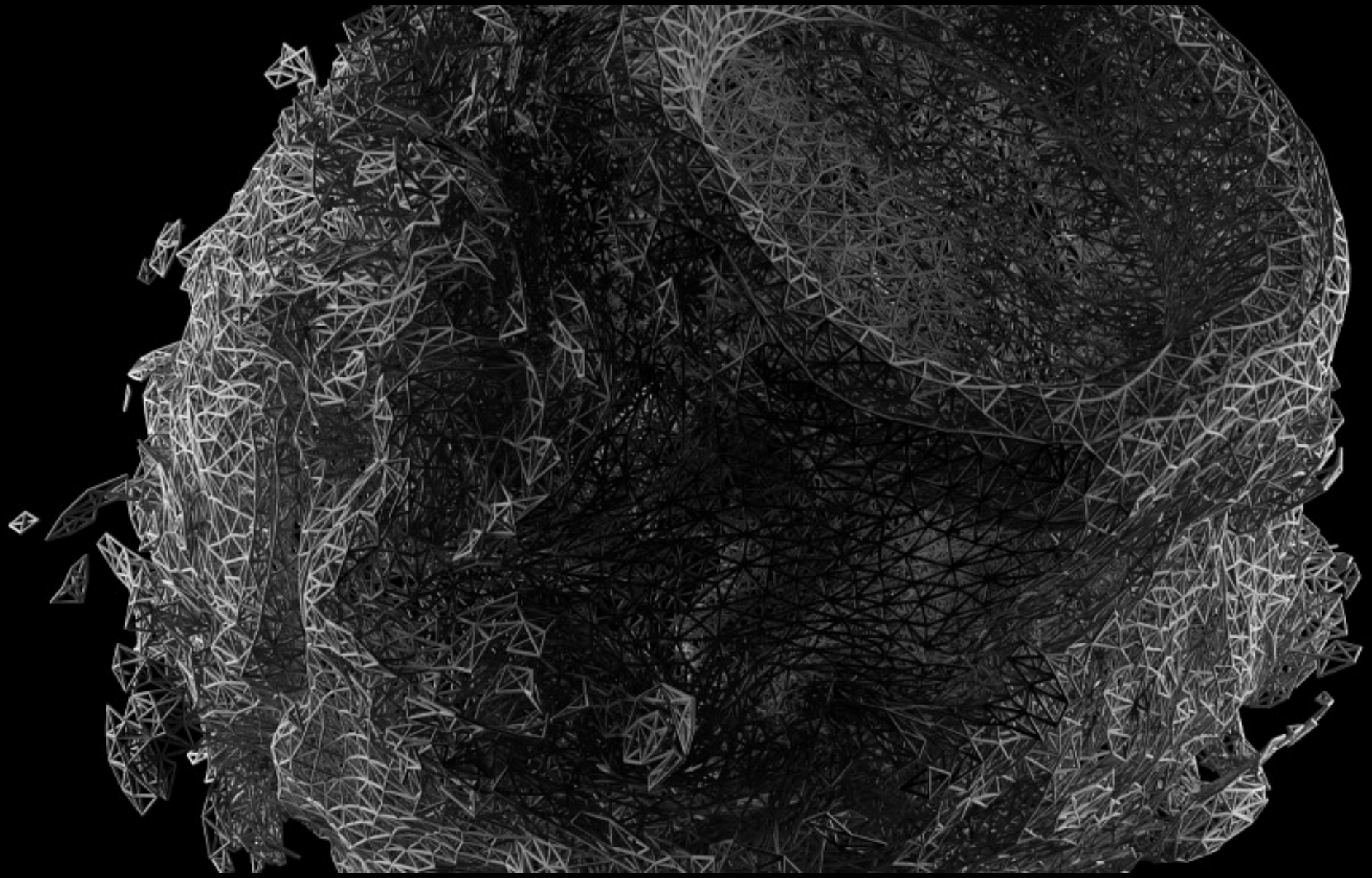
Perpetuity? 2008

Summary

1) Shapes from CFD
2) Triangles / segments
3) Radiance

Summary

1) Shapes from CFD
2) Triangles / segments
3) Radiance
4) ???
5) Profit



Smoke Water Fire, 2007