Algorithmic Modeling and Radiance Rendering

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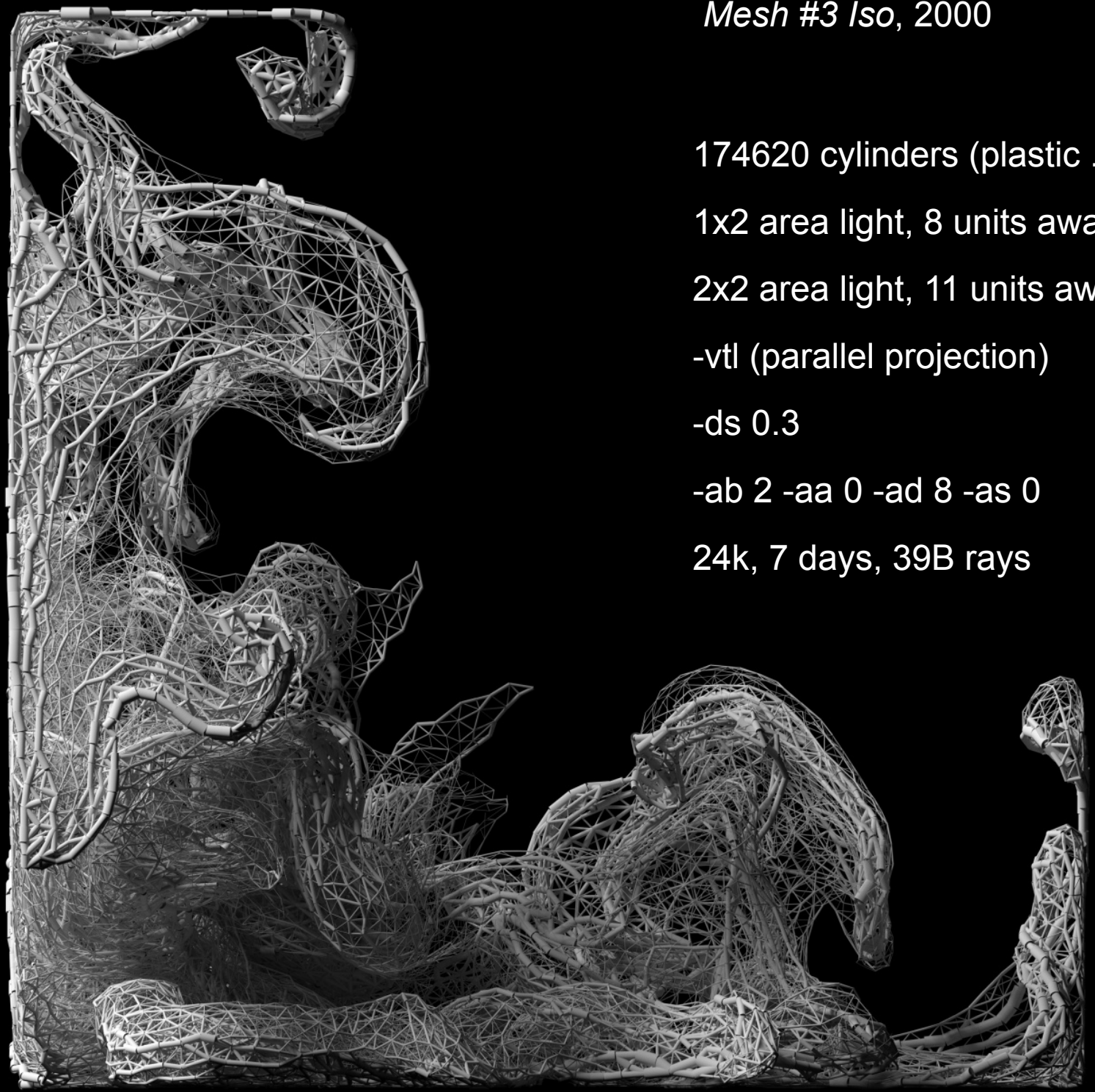
Untitled, 2000



Mesh #3 Iso, 2000

174620 cylinders (plastic .6 .6 .6 .0 .0)

1x2 area light, 8 units away

2x2 area light, 11 units away

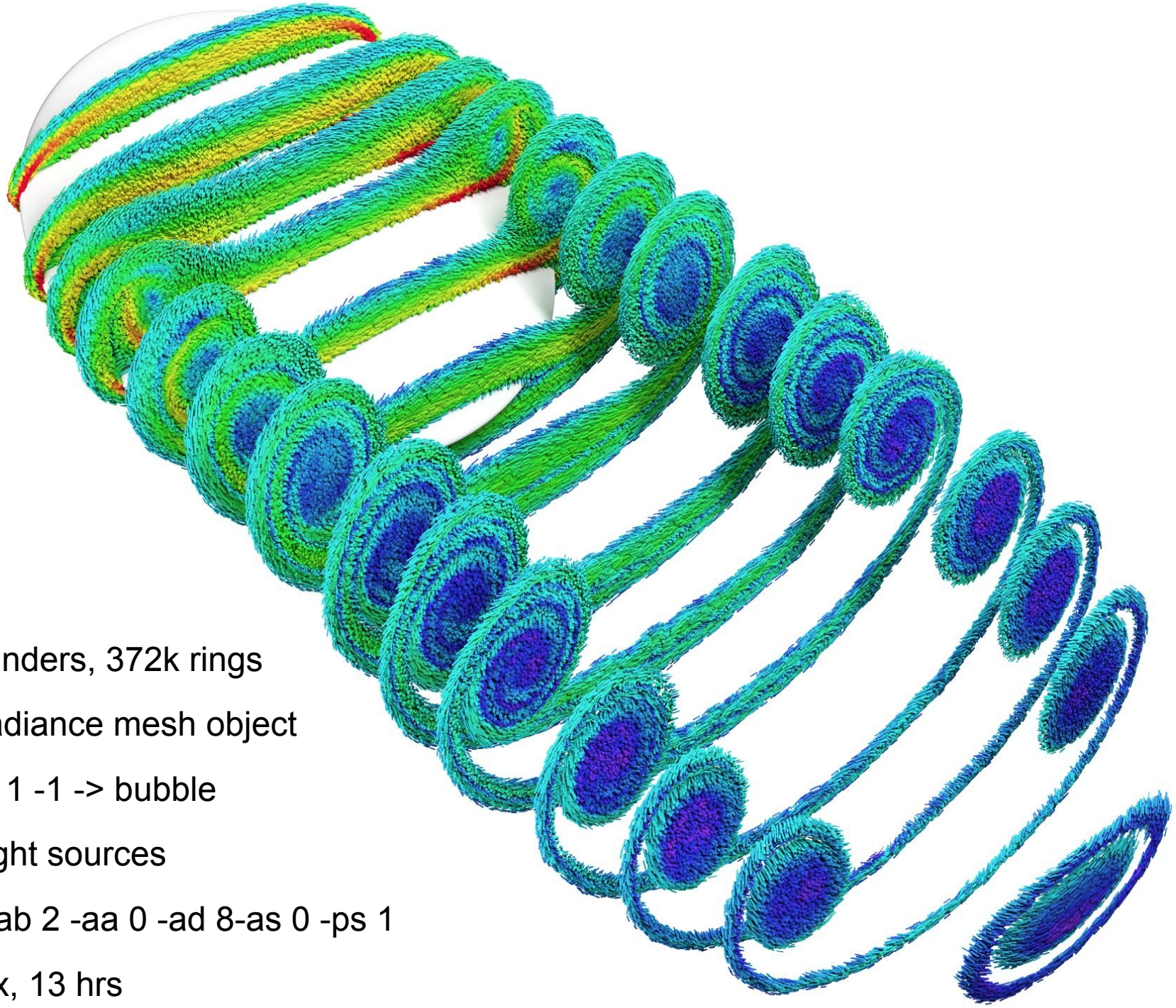
-vtl (parallel projection)

-ds 0.3

-ab 2 -aa 0 -ad 8 -as 0

24k, 7 days, 39B rays

Image for a publication, 2005



186k cylinders, 372k rings

disc is radiance mesh object

glow 1 1 1 -1 -> bubble

3 area light sources

-ds 0.2 -ab 2 -aa 0 -ad 8-as 0 -ps 1

14400 px, 13 hrs

Outline

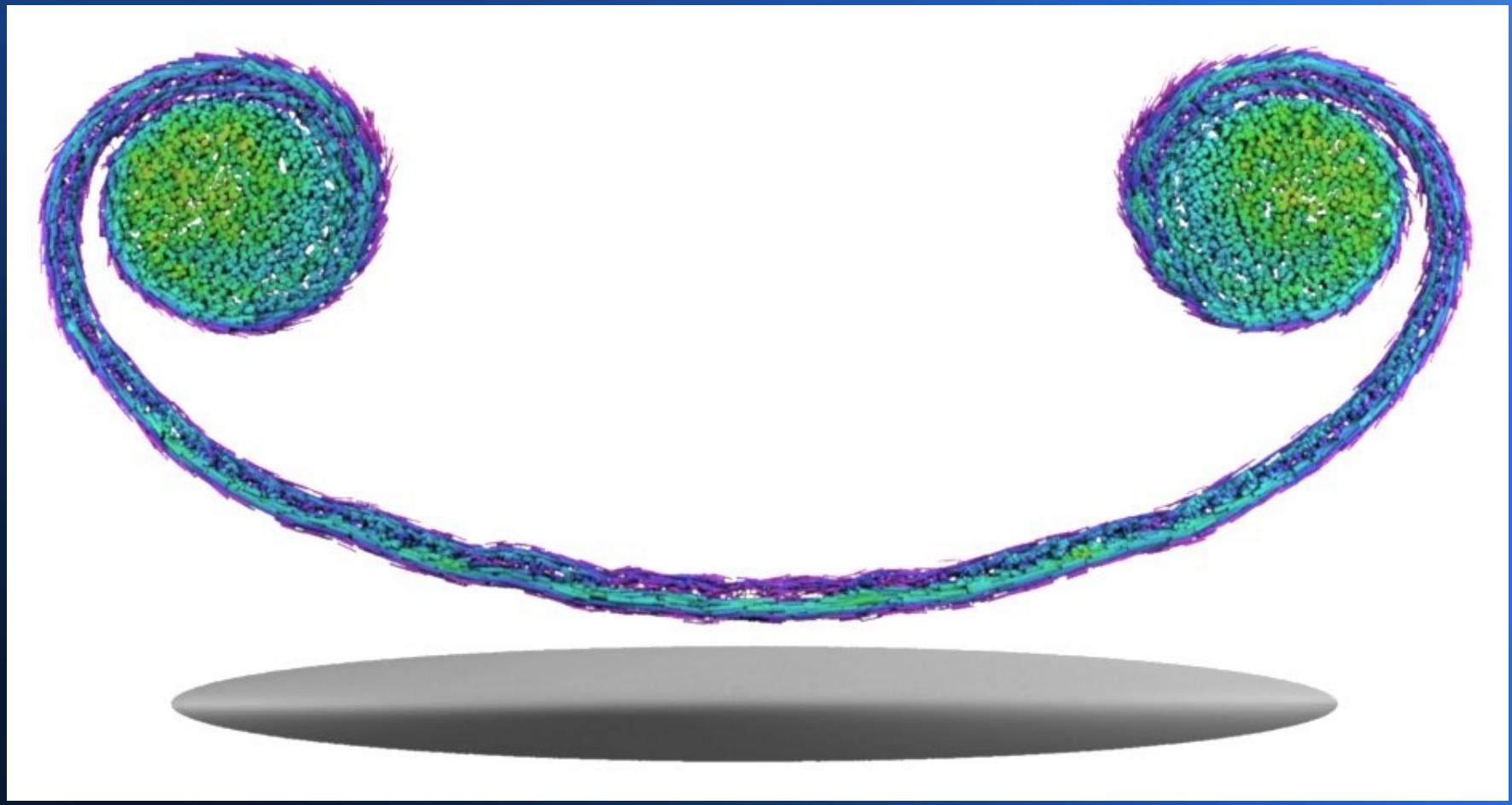
- Intro (burned)
- Modeling
- Geometry manipulation
- Rendering
- Discussion

Environment

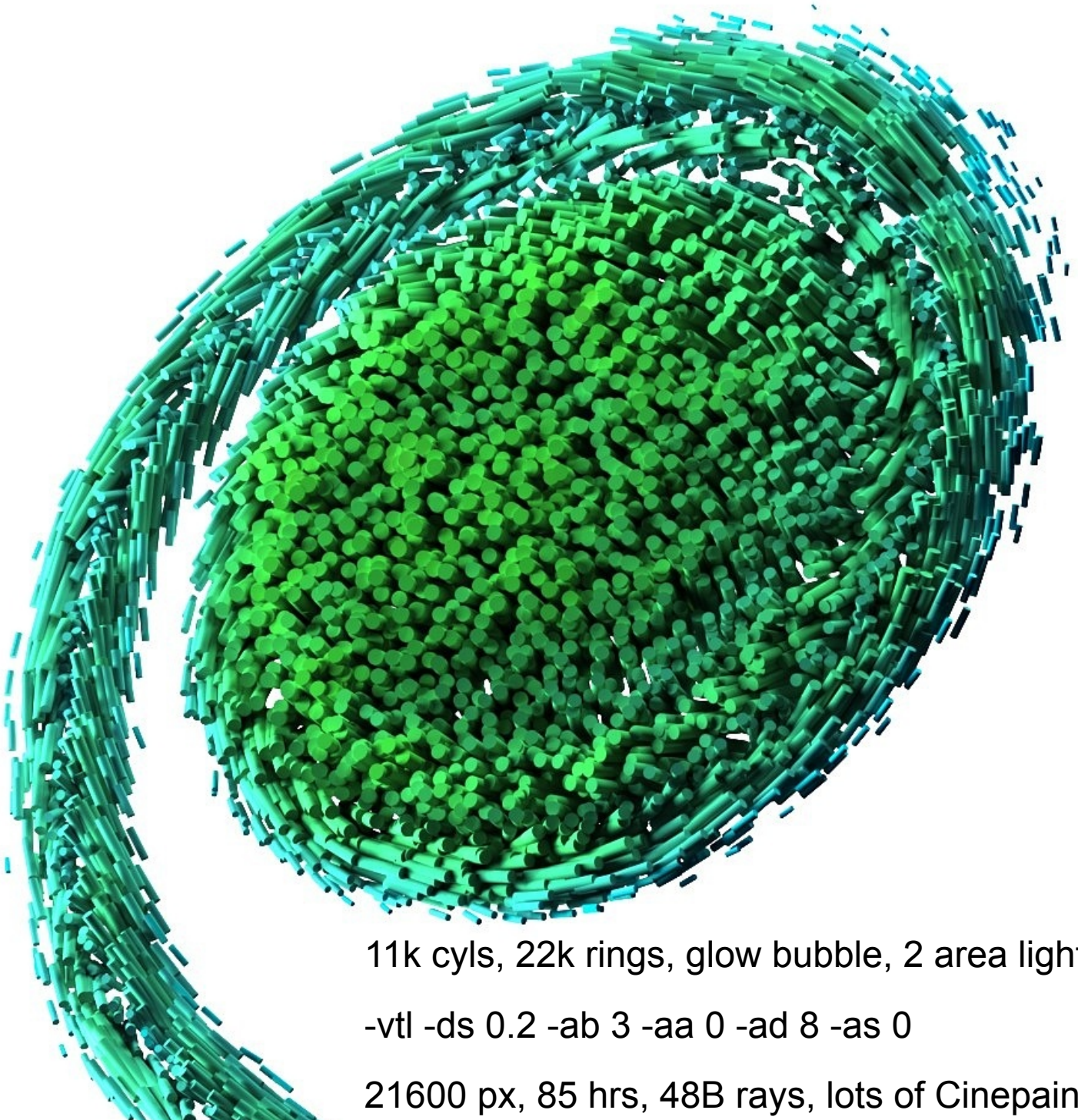
- Fedora 8 64-bit Linux
- Quad-core Phenom
- 8 GB RAM
- >1 TB RAID

Modeling

3D Vortex particle dynamics



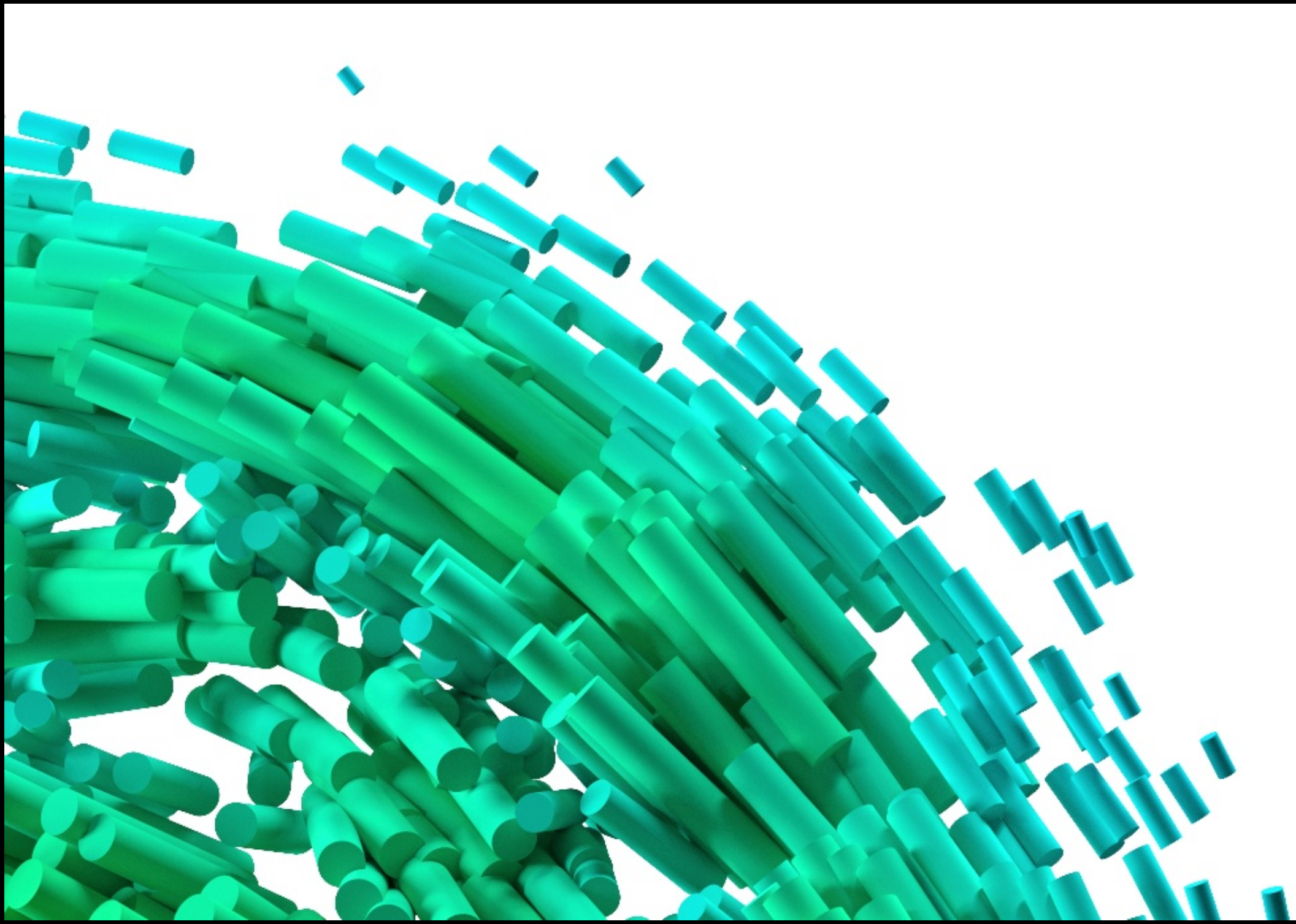
Green Tendril, 2005

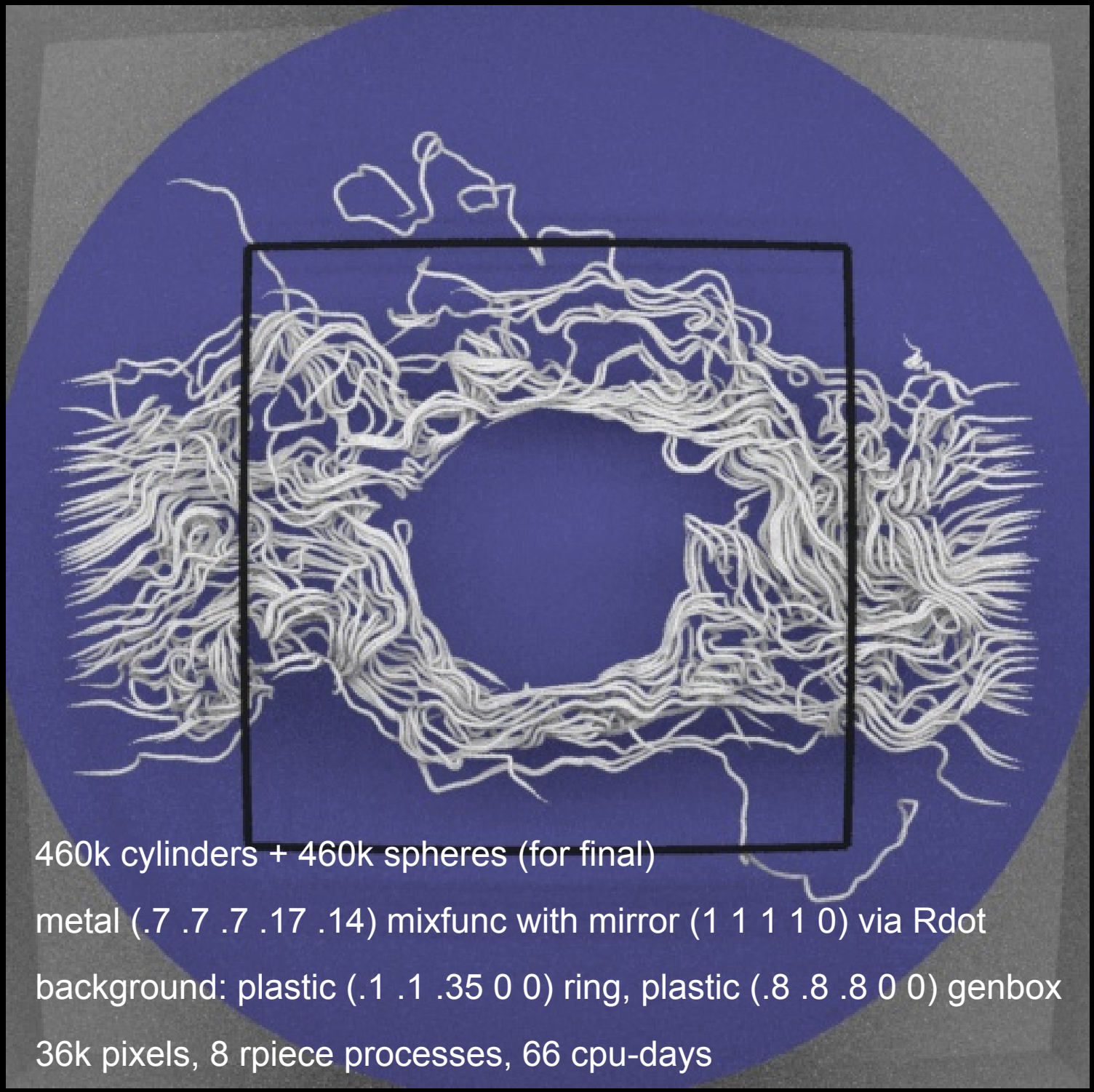


11k cyls, 22k rings, glow bubble, 2 area lights

-vtl -ds 0.2 -ab 3 -aa 0 -ad 8 -as 0

21600 px, 85 hrs, 48B rays, lots of Cinepaint



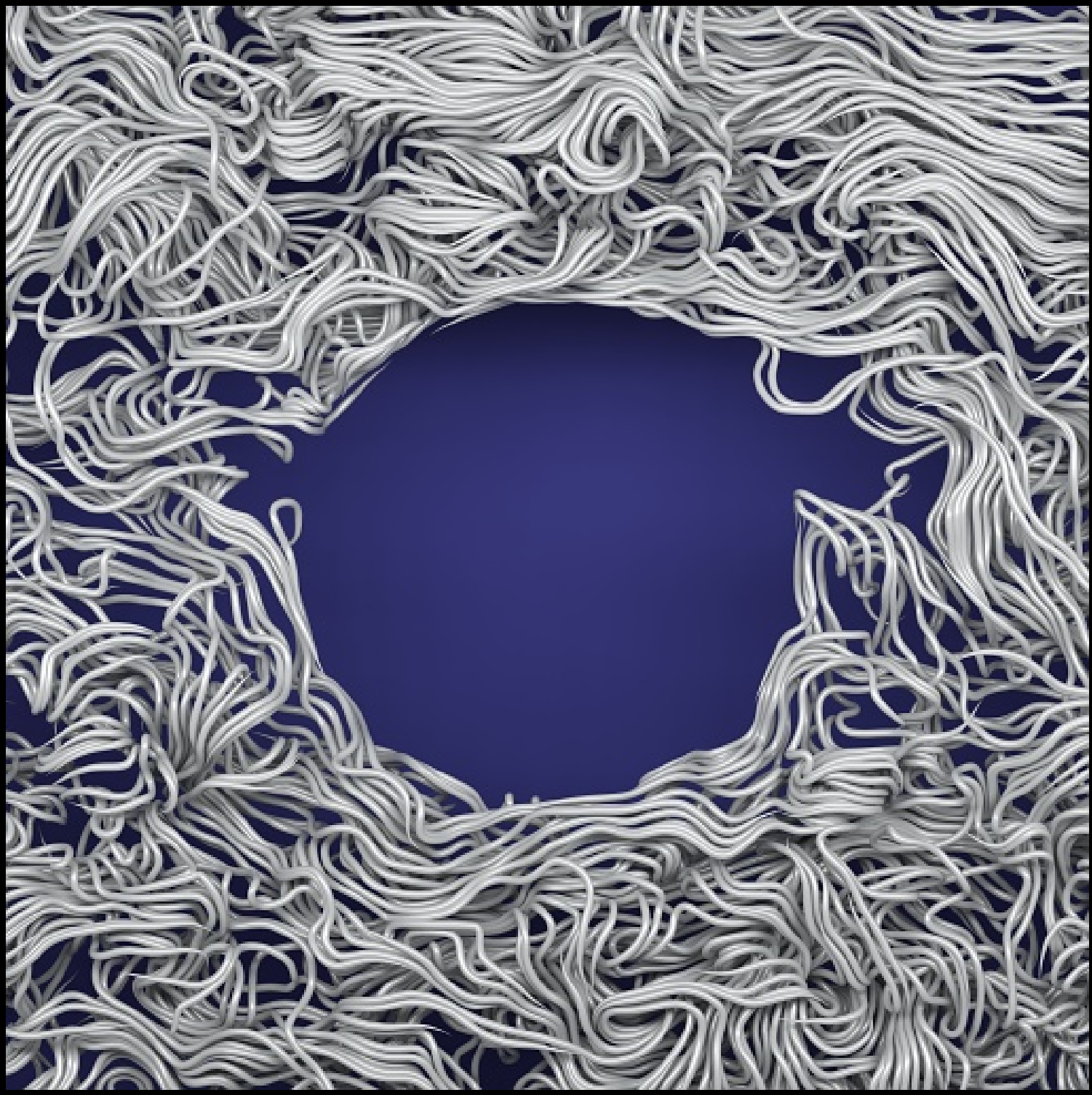


460k cylinders + 460k spheres (for final)

metal (.7 .7 .7 .17 .14) mixfunc with mirror (1 1 1 1 0) via Rdot

background: plastic (.1 .1 .35 0 0) ring, plastic (.8 .8 .8 0 0) genbox

36k pixels, 8 rpiece processes, 66 cpu-days



Extruded Simplices B, 2005

Dynamo, 2006

1.2M primitives (cylinder, sphere, cone)

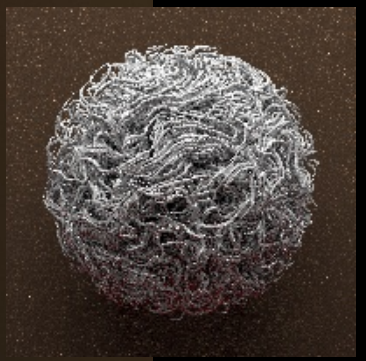
tubes and room are plastic (.6 .6 .6 0 0)

Background is plastic (.075 .048 .028 0 0)

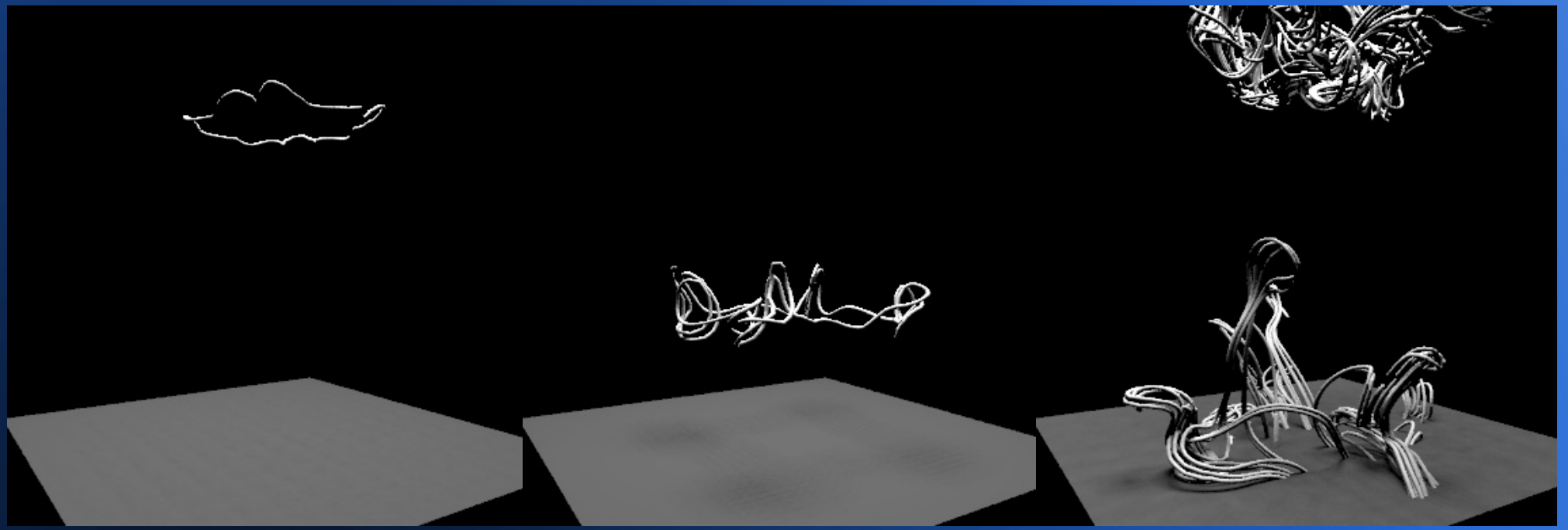
Incandescent area light source overhead

-vtl -ds 0.1 -ab 3 -aa 0 -ad 8 -as 0 -ps 1 -u+

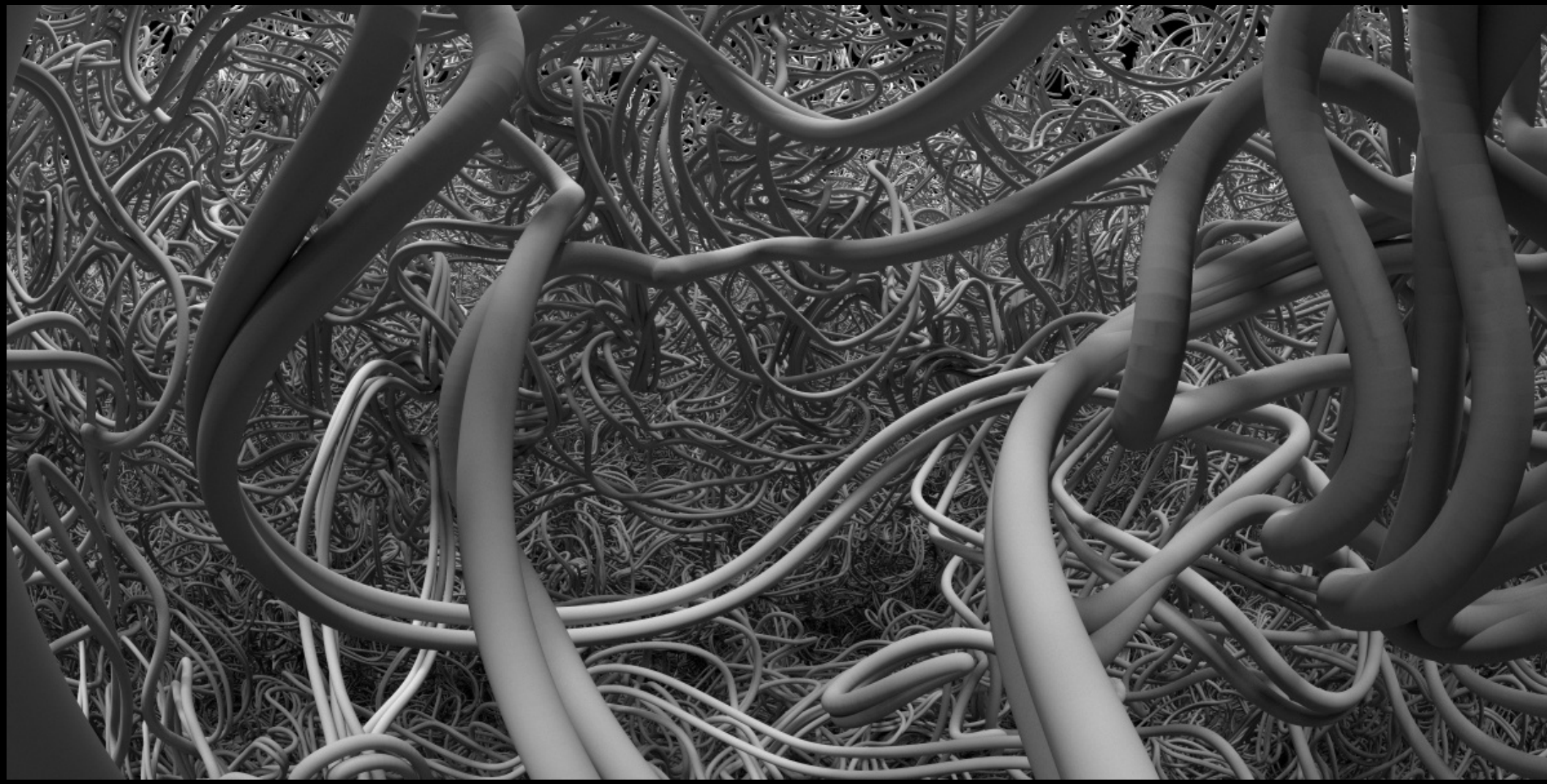
36k pixels, 8 rpiece jobs, 38 CPU-days



3D Vortex tube dynamics



Turbulence Infinite, 2003



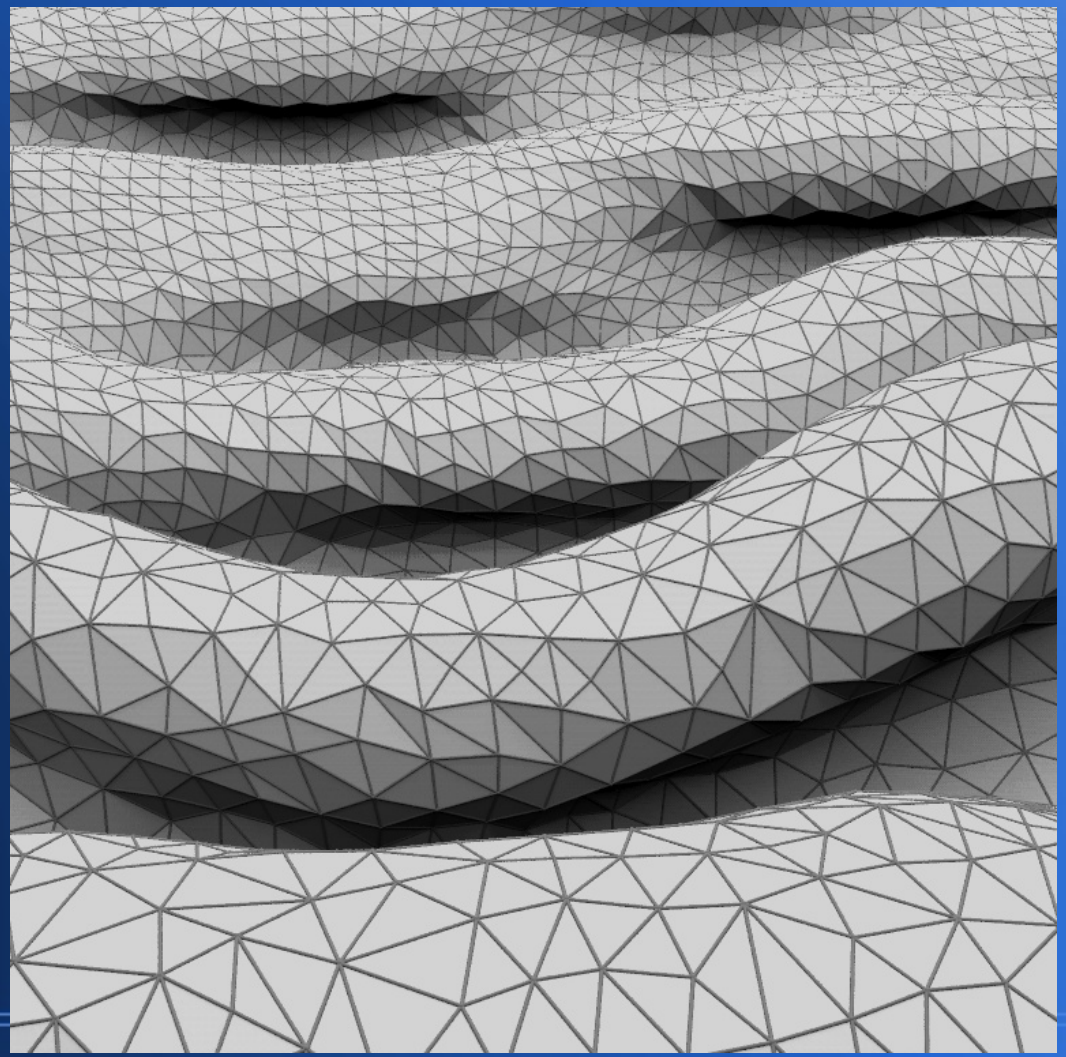
42k cylinders + 42k spheres in static octree, instanced 45 times, plastic (.4 .4 .4 0 .01)

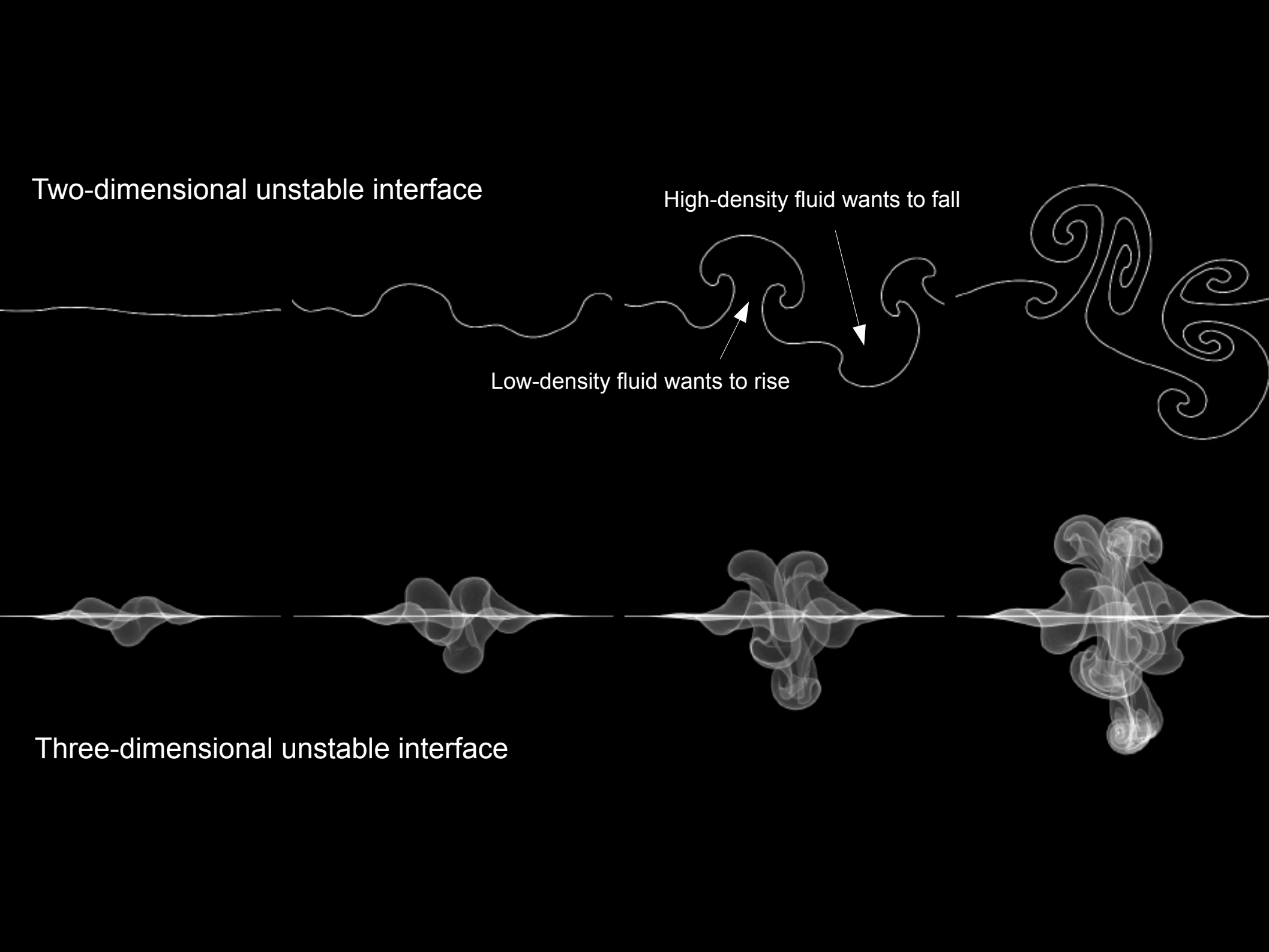
One overhead light, plastic (.6 .6 .6 0 0) floor, mirror (1 1 1) walls

-vta -vh 176 -vv 88 -ab 1 -aa 0 -ad 16 -as 0 24k x 12k, 2 days

3D Vortex sheet dynamics

- Ph.D. research
- Tracking a moving triangle mesh
- Allows infinite stretching and recoalescence




Two-dimensional unstable interface
High-density fluid wants to fall
Low-density fluid wants to rise
Three-dimensional unstable interface

Open House, 2006

39k triangle mesh,
395k polygons,
all plastic (.7 .7 .7 0 0)

Custom skycolor.cal

-ab 3 -aa 0 -ad 8 -ps 1 -u

-vta -vh 18.75

36k pixels, 25 days

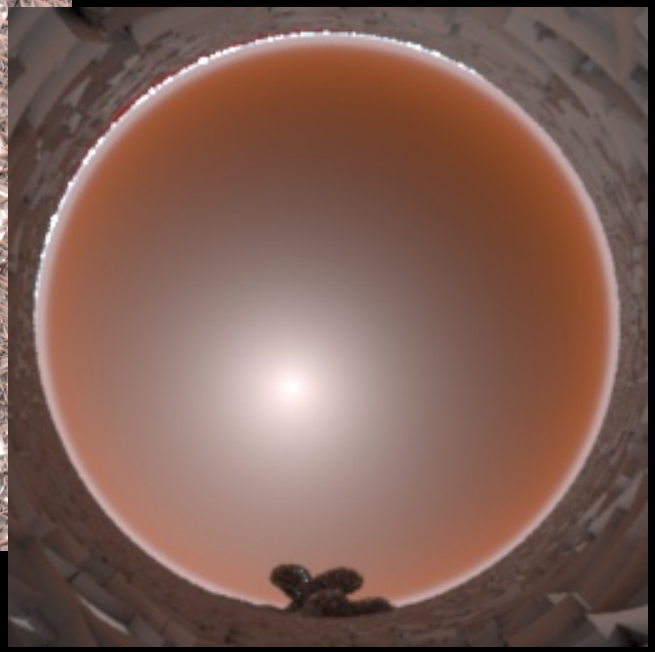


Image sequence from dissertation, 2006

Radiance triangle mesh, plastic (.2 .2 .2 0 0), antimatter half-domain

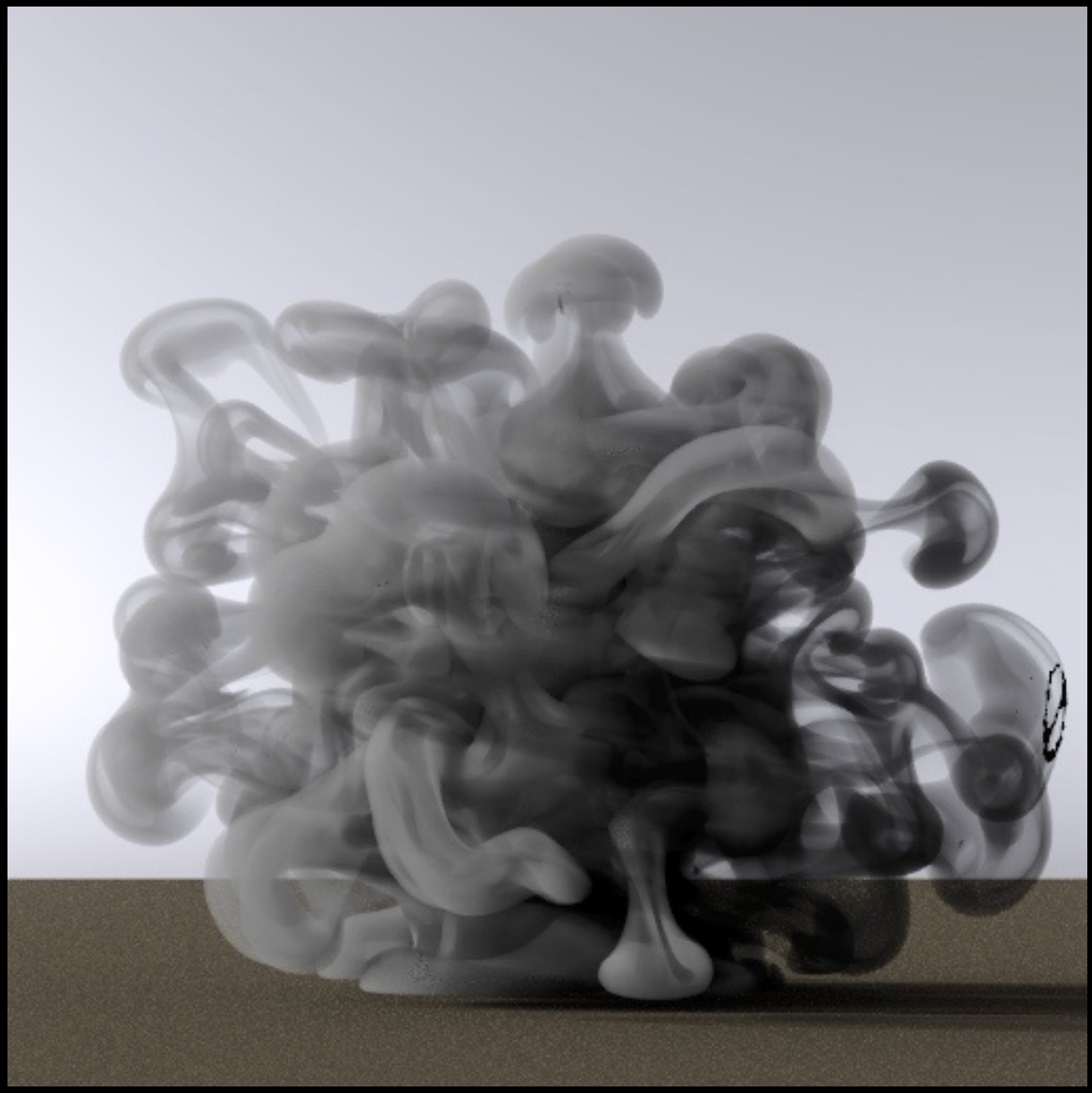
One ring light, glow (1 1 1 0) background ring, glow (1 1 1 0) fill light

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

730619 element Radiance tri mesh

Standard gensky (both scenes)

-ab 2 -aa 0 -ad 8

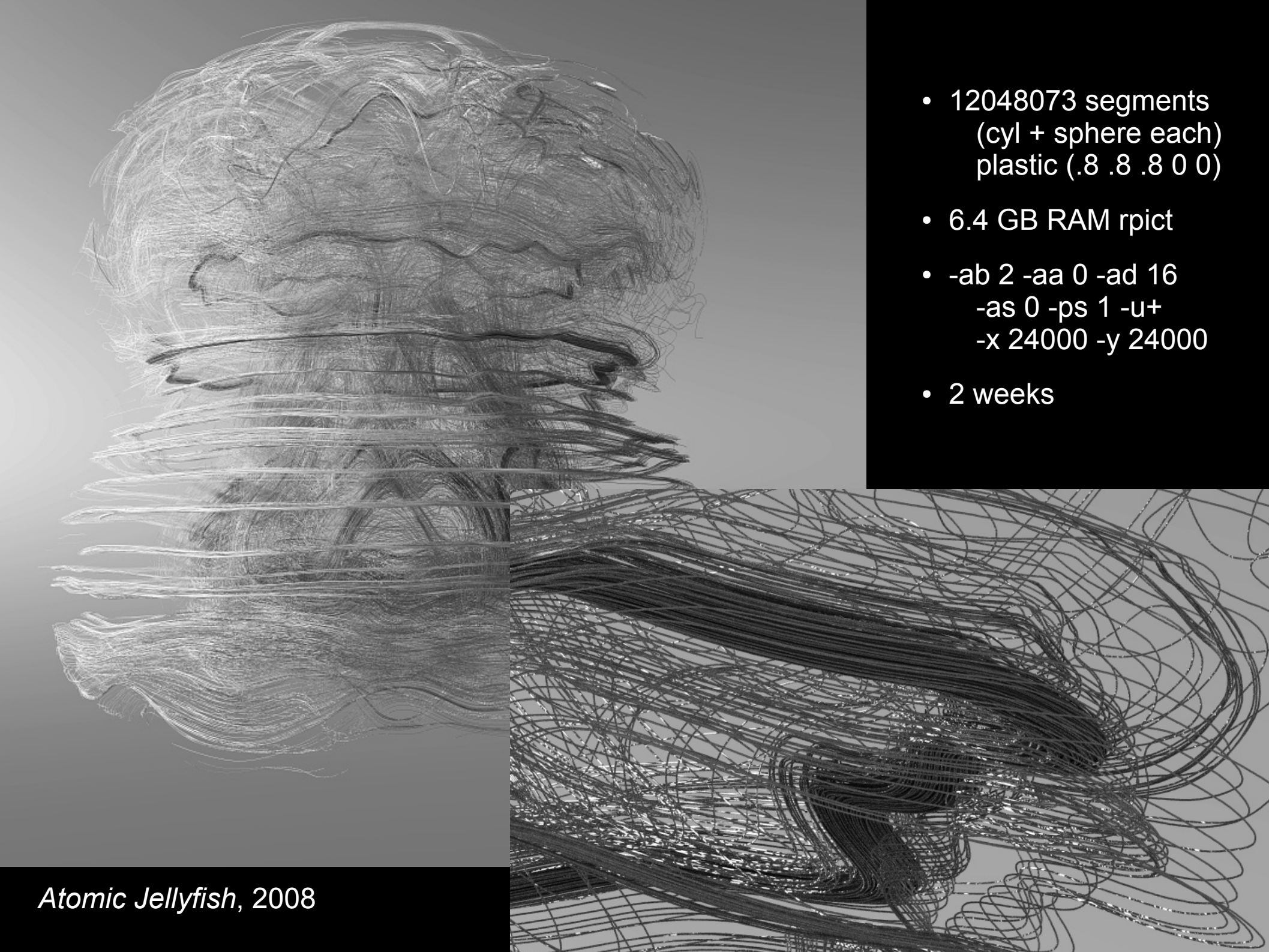


void mist def 2 sun sky 0 7 30 30 30 0.5 0.5 0.5 0.1

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

tracefield

- 3D raster → 3D vector (→ 2D raster)

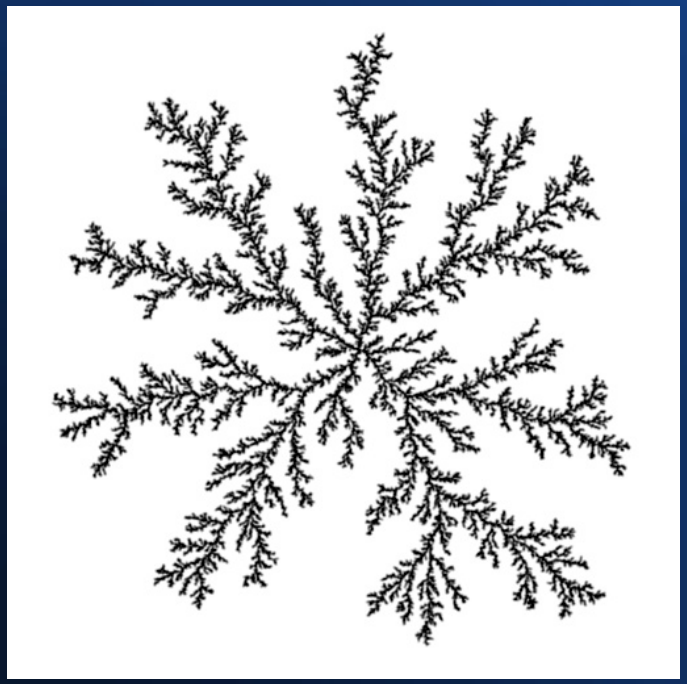


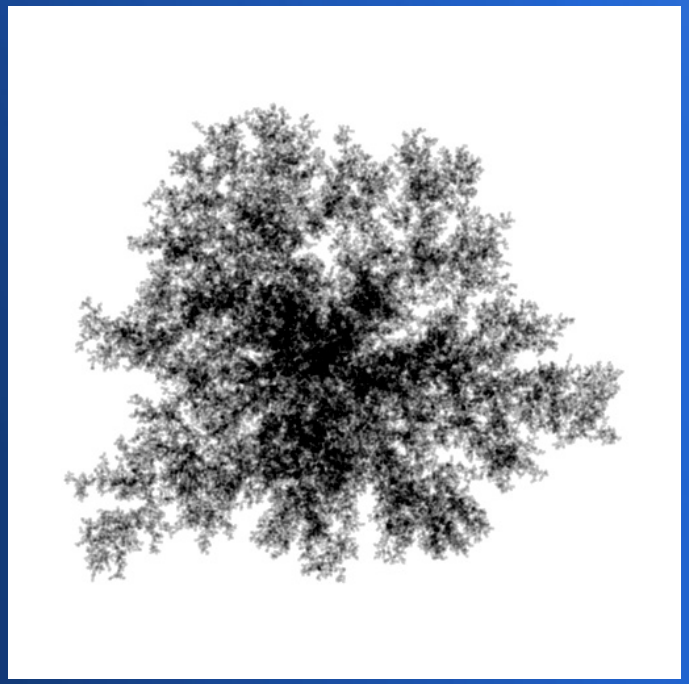
- 12048073 segments
  (cyl + sphere each)
  plastic (.8 .8 .8 0 0)
- 6.4 GB RAM rpict
- -ab 2 -aa 0 -ad 16
  -as 0 -ps 1 -u+
  -x 24000 -y 24000
- 2 weeks

Atomic Jellyfish, 2008

Diffusion-Limited Aggregation

- Not related to fluids





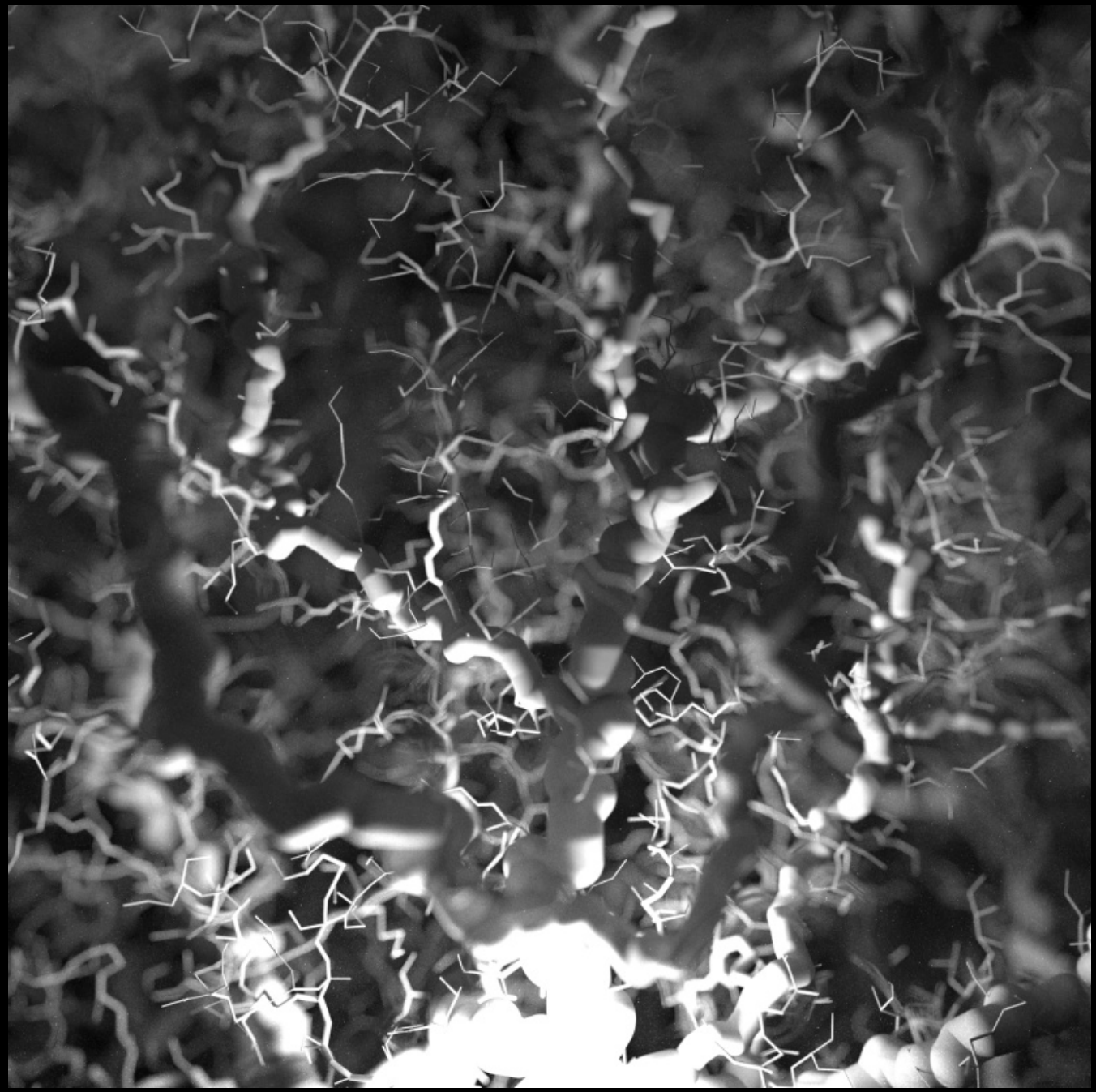
Twigs #23, 2004

464k cylinders,
464k spheres,
plastic (.5 .5 .5)

One ring light

Old-school depth-of-field blur

28.8k px, 4 days



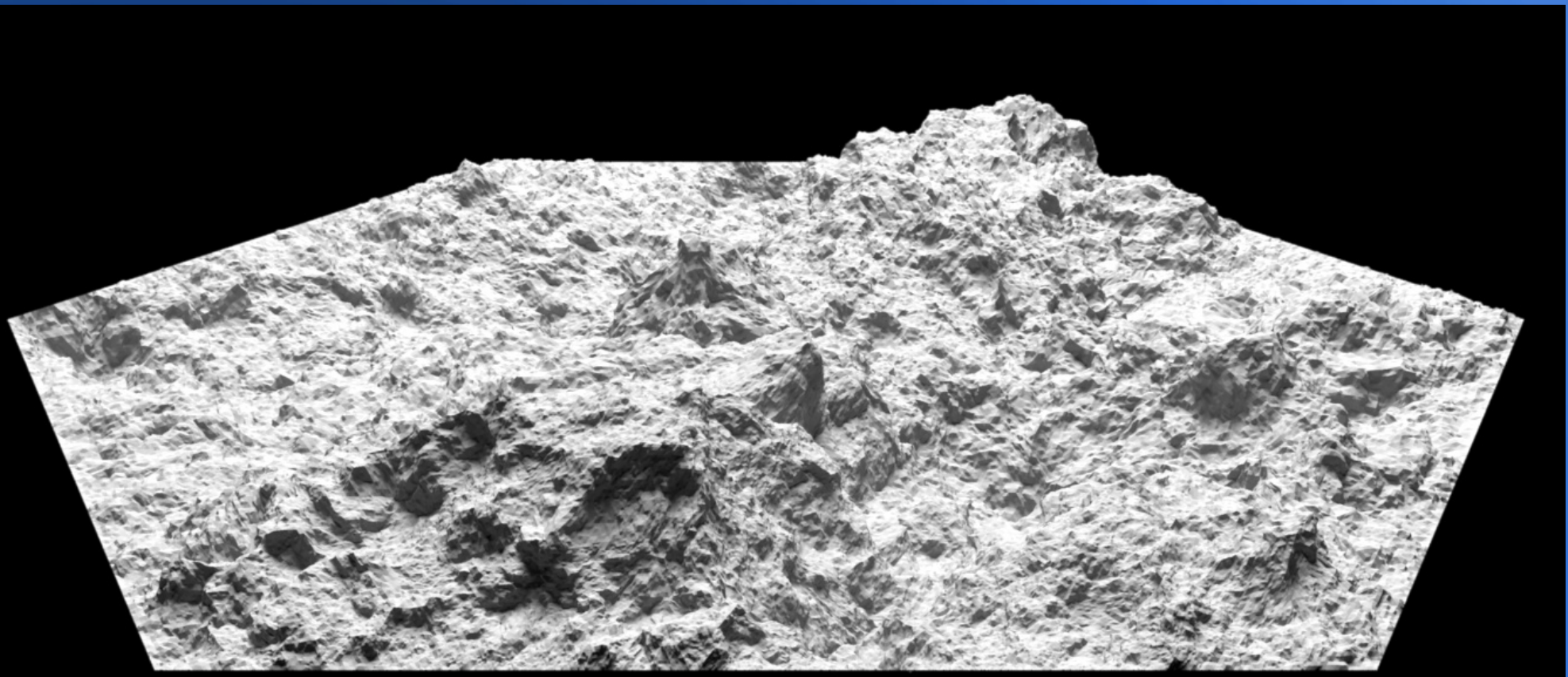
- vwrays -fd -vf vf2 -x 28800 -y 28800 | rcalc -id6 -e 'a:5.0;d:100.0' -e `vwright i < vf2` -e 'theta=2*PI*rand(2*recno-1);r=0.5*a*sqrt(rand(2*recno))' -e 'r1=r*cos(theta);r2=r*sin(theta)' -e 'dx=r1*ihx+r2*ivx;dy=r1*ihy+r2*ivy;dz=r1*ihz+r2*ivz' -e '$1=ipx+dx;$2=ipy+dy;$3=ipz+dz' -e '$4=$4-dx/d;$5=$5-dy/d;$6=$6-dz/d'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

Converting Geometry

Converting geometry

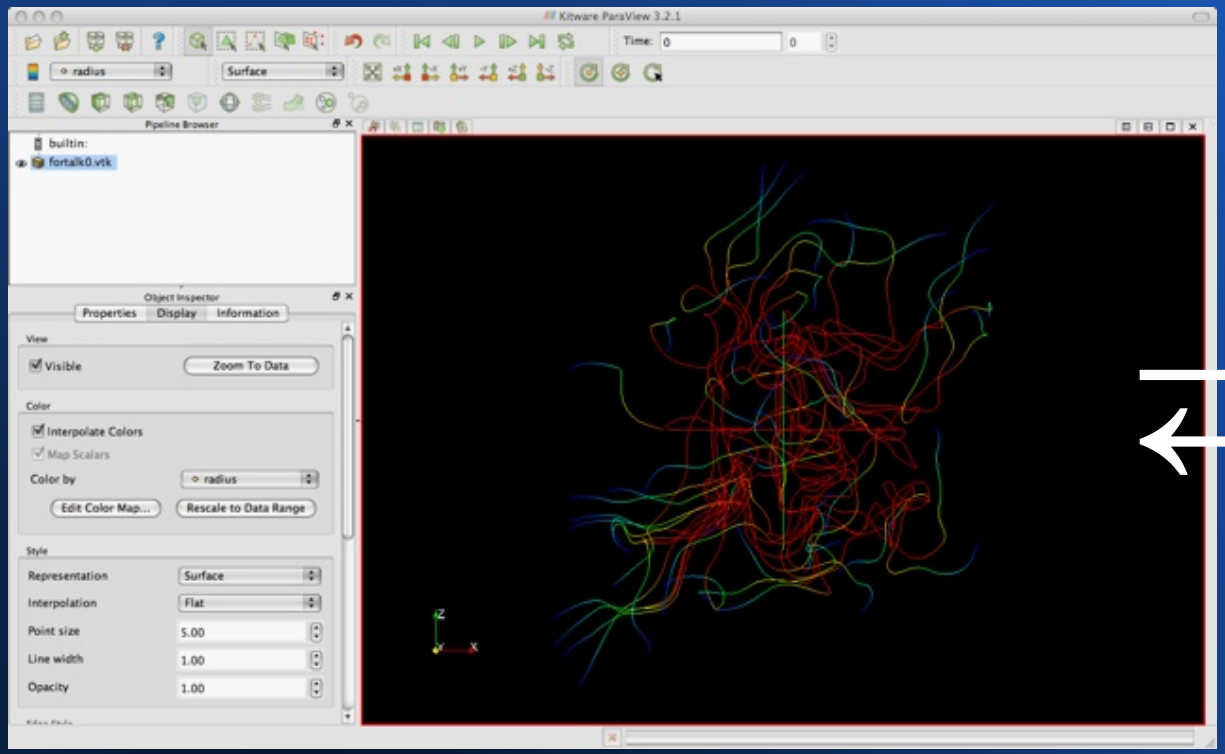
- Direct dump to .rad or .obj or .b3d
- Rocktools – 3D tri mesh
- Stickkit – 3D network
- makeMistCubes – from 3D scalar field

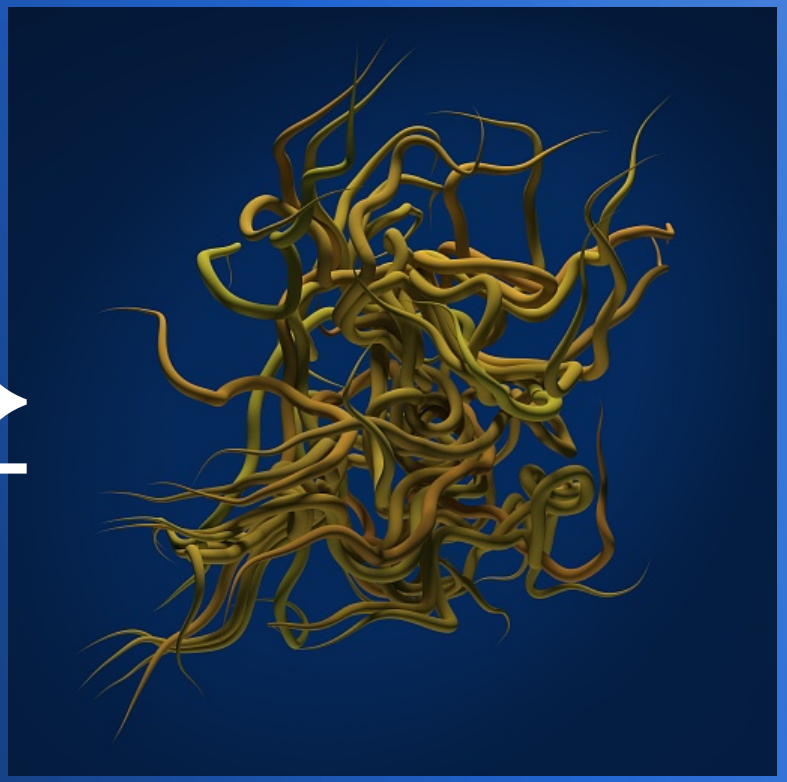
Rocktools



538k triangles (plastic .2 .2 .2 0 0); large area light; -ds 0.1 -ab 3; 4k x 2k, 5 hrs

Stickkit





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

makeMistCubes

3D density field is input

228k cubes (each 6 polys)

Extinction coeff varies in 1000 levels

-ma .96 .96 .96 -mg .2 -ms .01

-ab 2 -aa 0 -ad 16 -as 0 -ps 1

Standard gensky

4k px, 26 hrs

Handling large models

Problem: oconv dislikes overlapping geom

Handling large models

- Problem: oconv dislikes overlapping geom
  - oconv 100k primitives in memory with overlap but >10M without
  - Even with “-n 80”
  - Even with 8 GB RAM

Handling large models

Solution: recursively split geometry

- oconv each separately
- instance each separately

Perpetuity?, 2008; >20M triangles?, plastic 0.03 and 0.8

Rendering

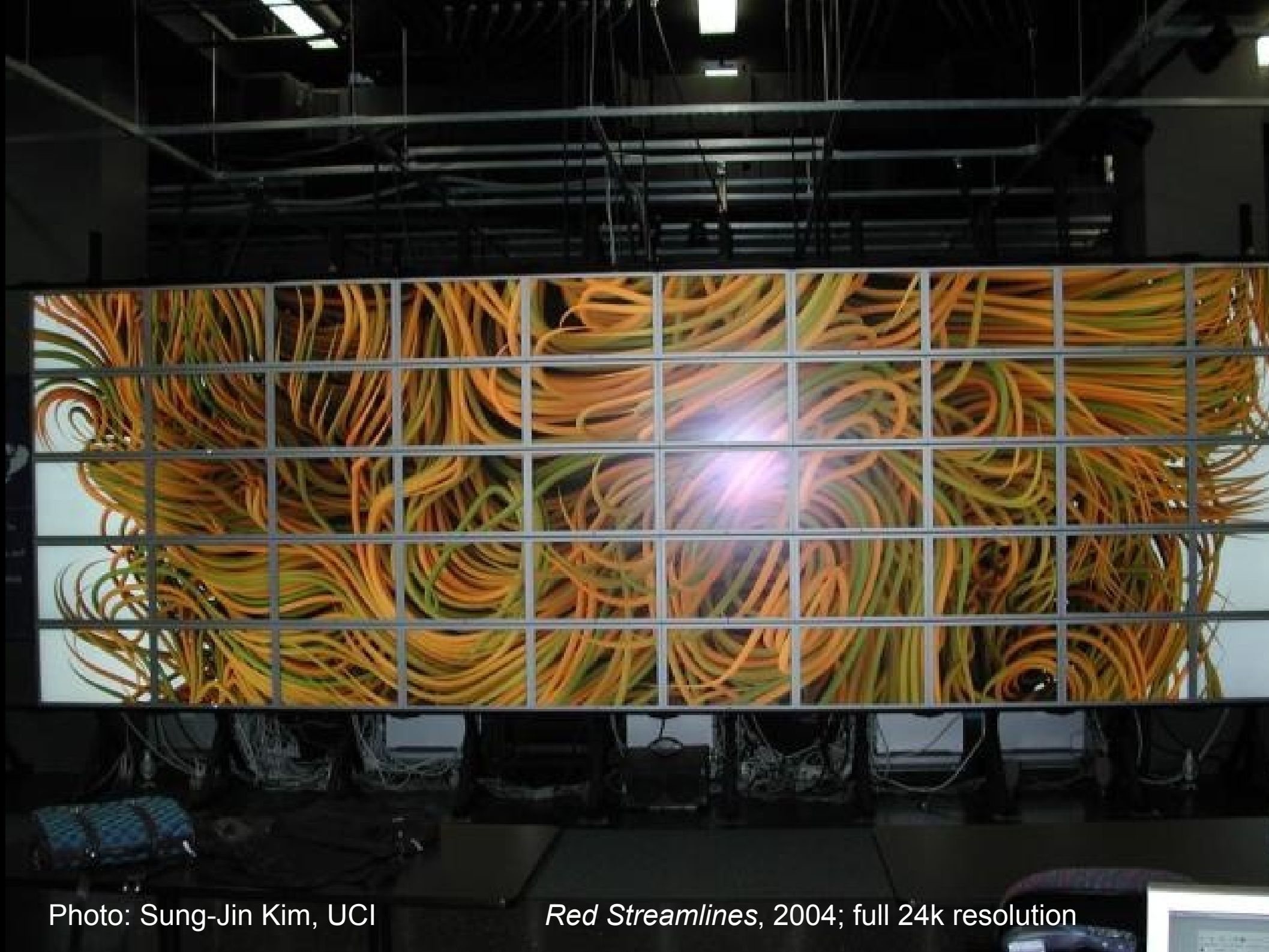


Photo: Sung-Jin Kim, UCI

Red Streamlines, 2004; full 24k resolution

Rendering large frames

- single frame at 24000^2 to 57600^2 pixels
- 7250 frames at 3840 x 2160
- rpiece for single frames, scripts for series
- compile-time optimization gains 2-20% speed
  (`-O2 -funroll-loops -ffast-math`)

To “-aa 0”

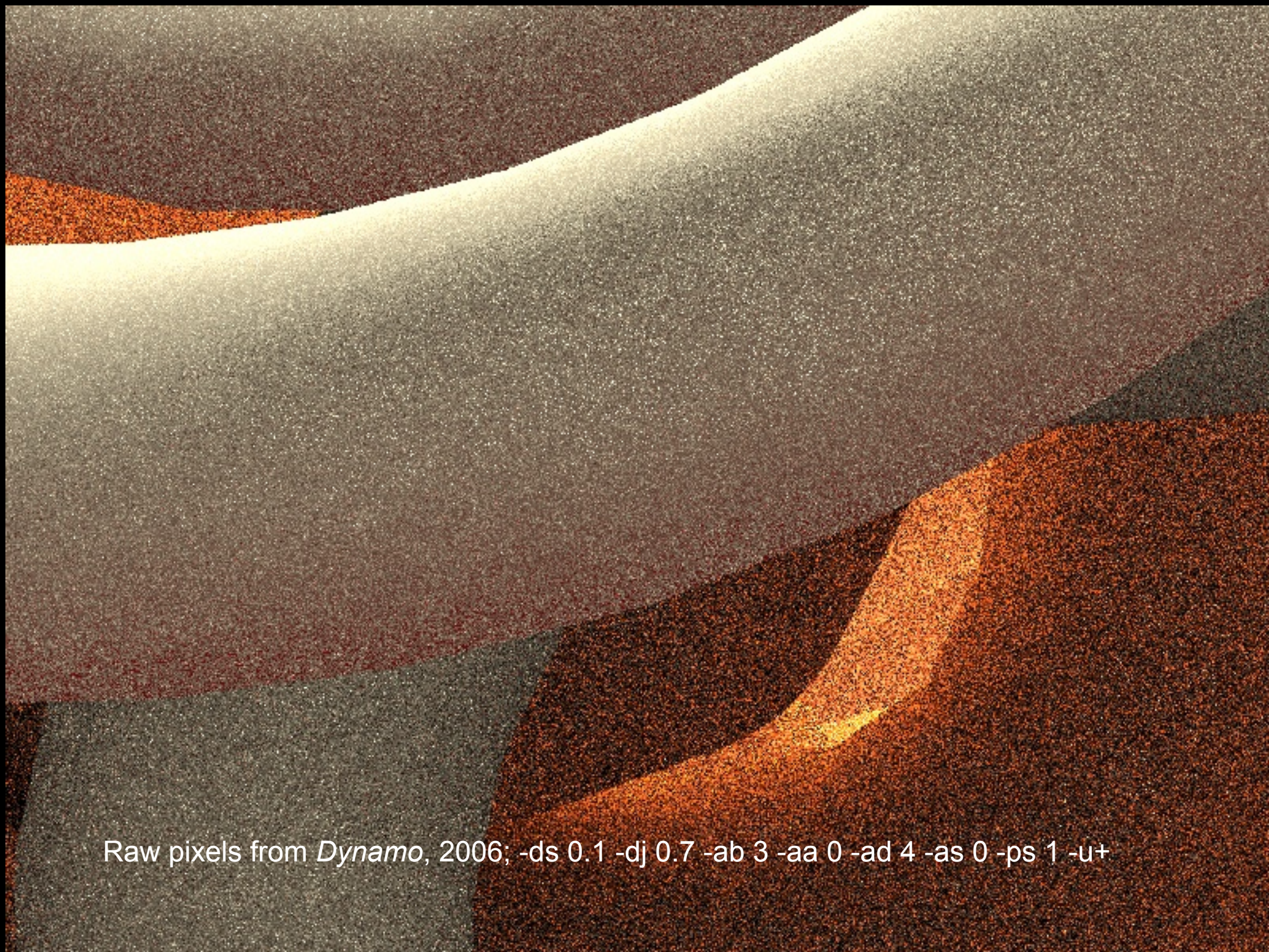
- No amb cache – all oct
- Trivially parallel
- Can weight toward 1st bounce
- *No frame coherence*
- *Noisy, must oversample, but...*

To “-aa 0”

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

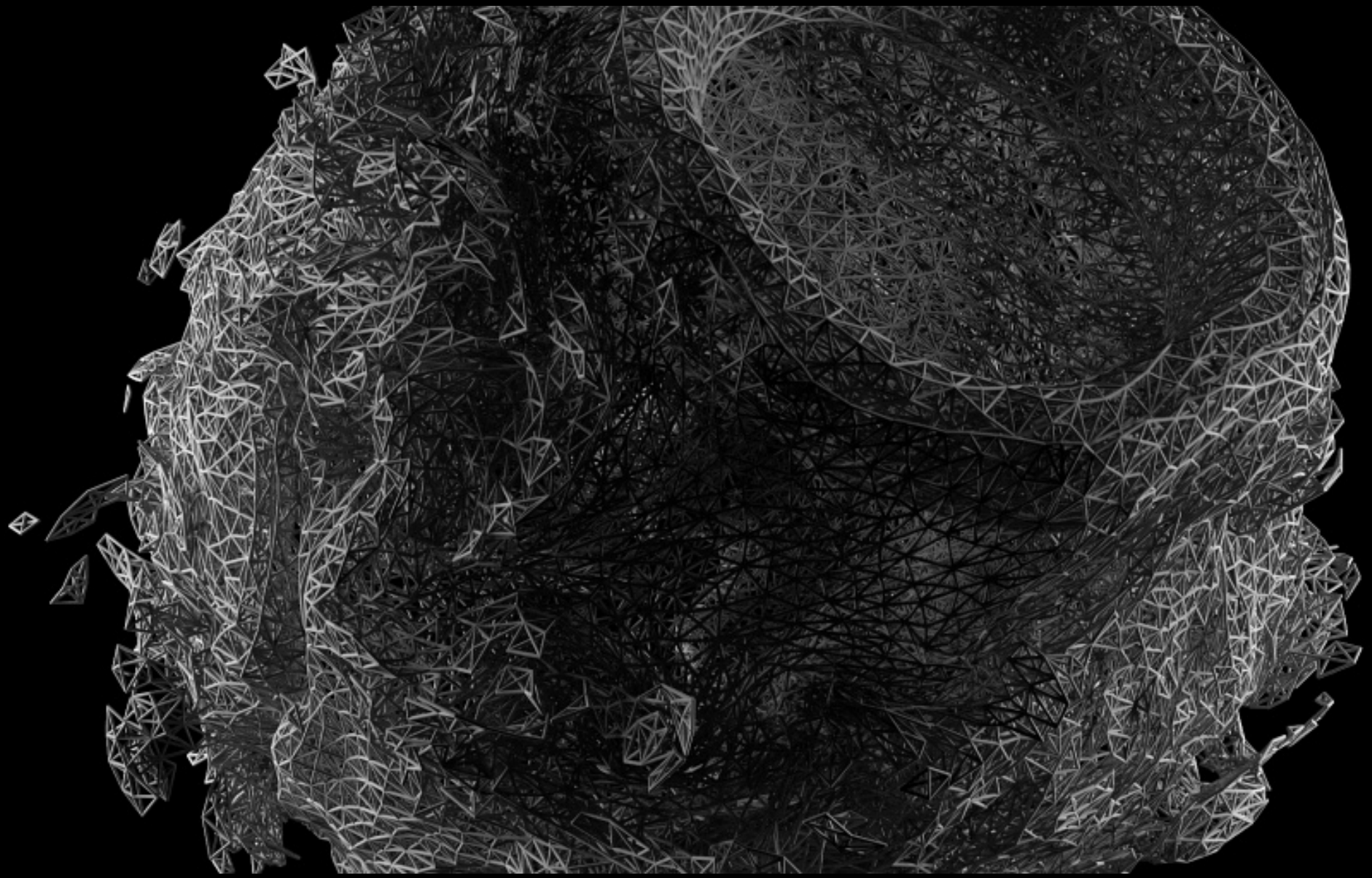
...or not

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



Raw pixels from *Dynamo*, 2006; -ds 0.1 -dj 0.7 -ab 3 -aa 0 -ad 4 -as 0 -ps 1 -u+

Smoke Water Fire, 2007



50k-700k cylinders (plastic .1 .1 .1 0 0), 2 cylinder lights, motion blur via frame averaging

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

Perpetuity?, 2008 -ab 4 -aa 0 -ad 16 -as 8, 55k x 35k, 58B rays, 9 CPU days

Post-processing

```
pfilt -1 -x /4 -y /4 -r 0.7 img01.pic >
  img01q.pic
pfilt -1 -e -5 -x /2 -y /2 img01q.pic |
  ra_ppm |
  pnmtopng > img01e.png
```

Cinepaint (for HDR images)

Gimp (for 8bpp images)

Summary

1) Shapes from algorithms
2) Convert to mesh or cylinder/sphere list
3) Radiance

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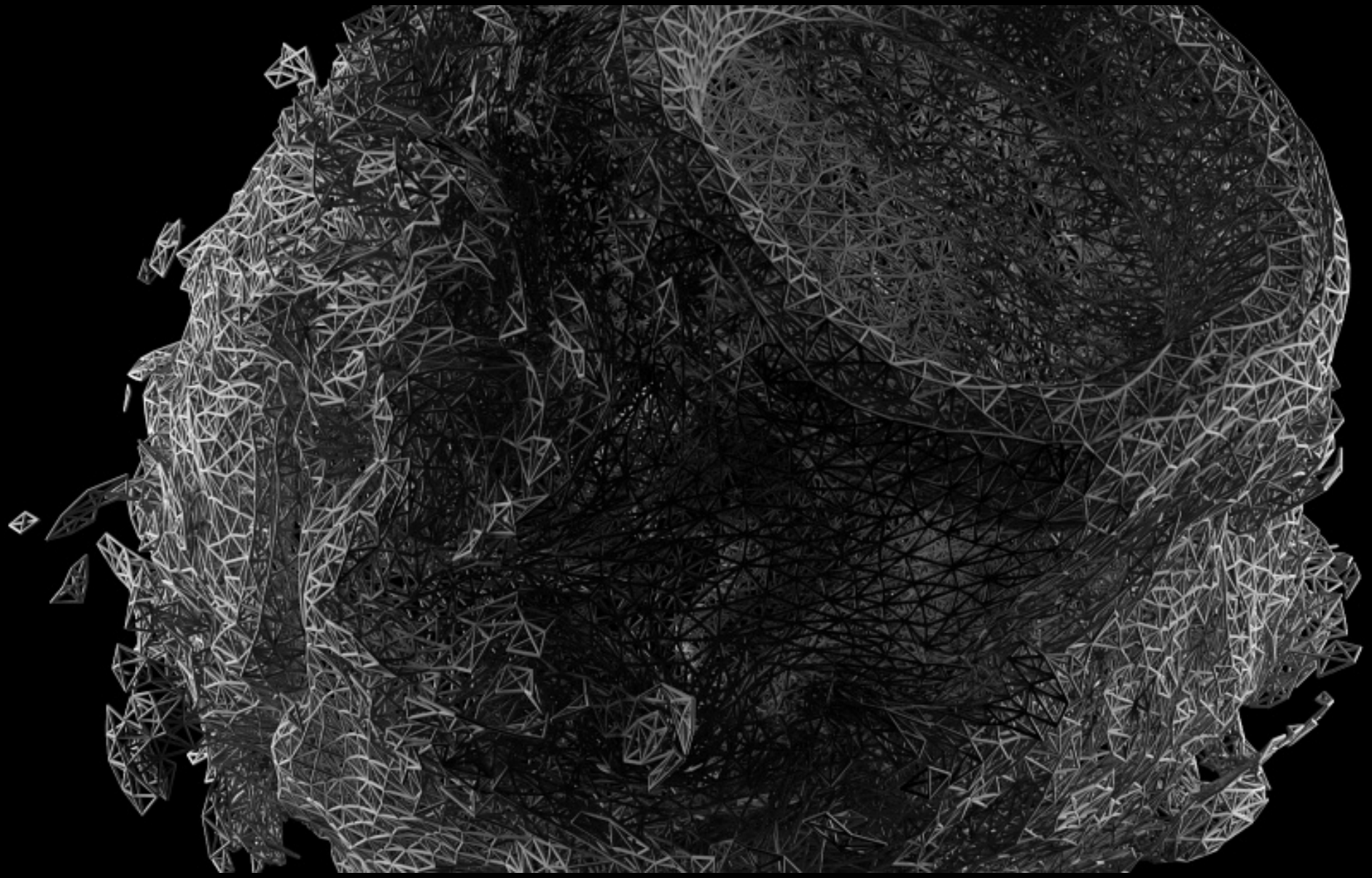
1) Shapes from algorithms
2) Convert to mesh or cylinder/sphere list
3) Radiance
4) ???
5) Profit



Smoke Water Fire, 2007

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