OpenVDB at DWA

DreamWorks Animation

Jeff Budsberg
Head of FX

Talk Overview

- Introduction
- Applications
  - Clouds
  - Liquids
  - Advection
  - Fluids
  - Volume deformation
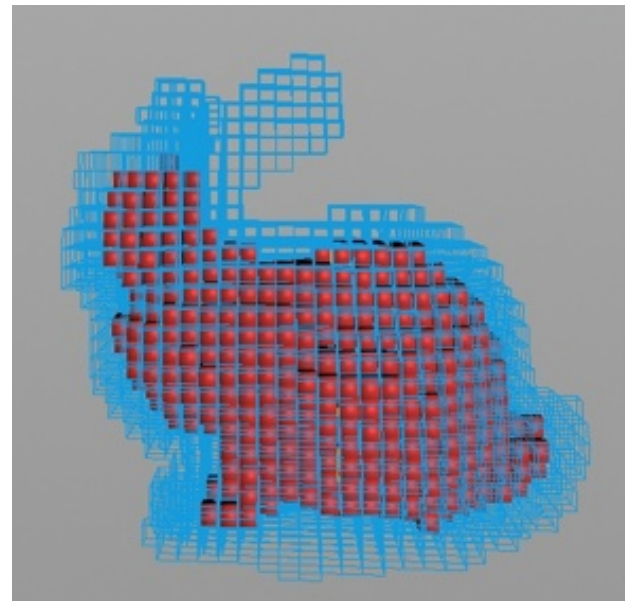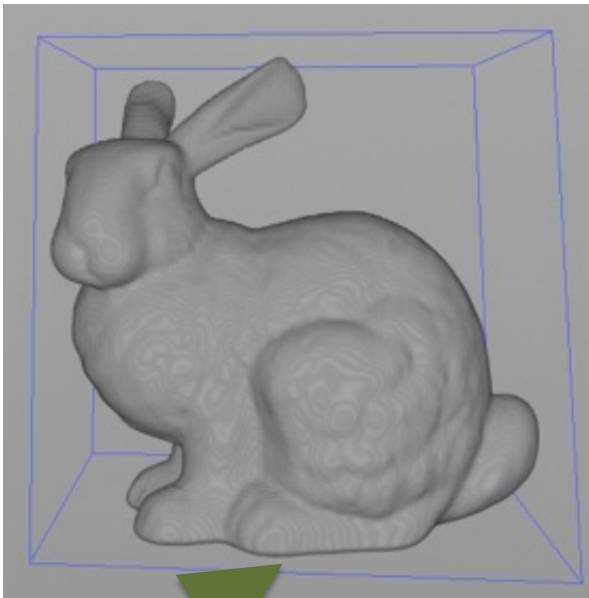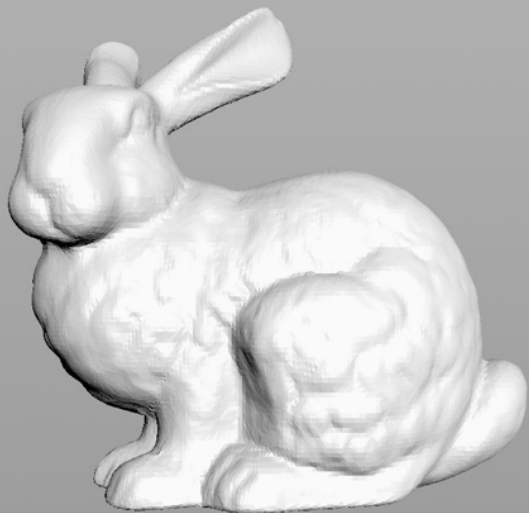 - Fracture + RBD
  - Visualization

+ new tools!

+ tips & tricks!

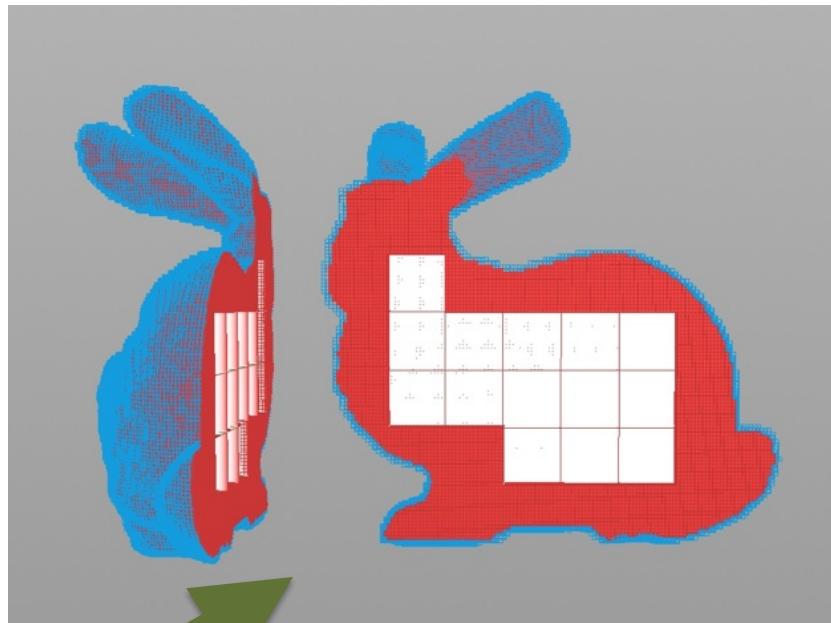DREAMWORKS
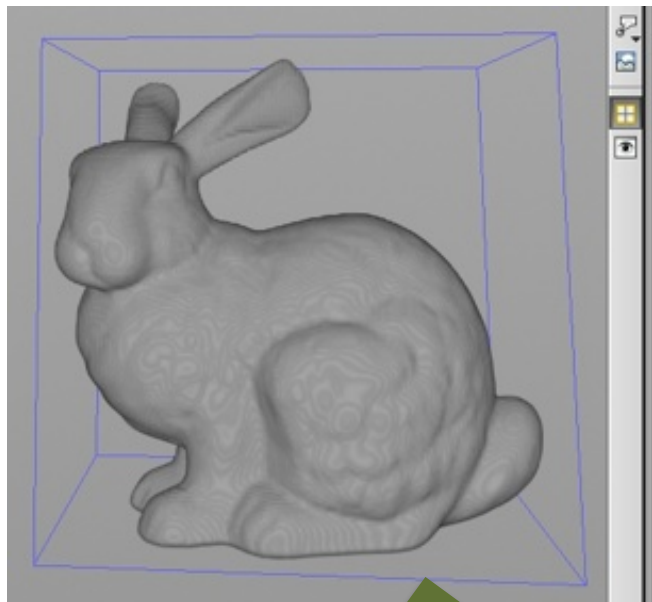the dream is everything

Introduction

- Powerful library
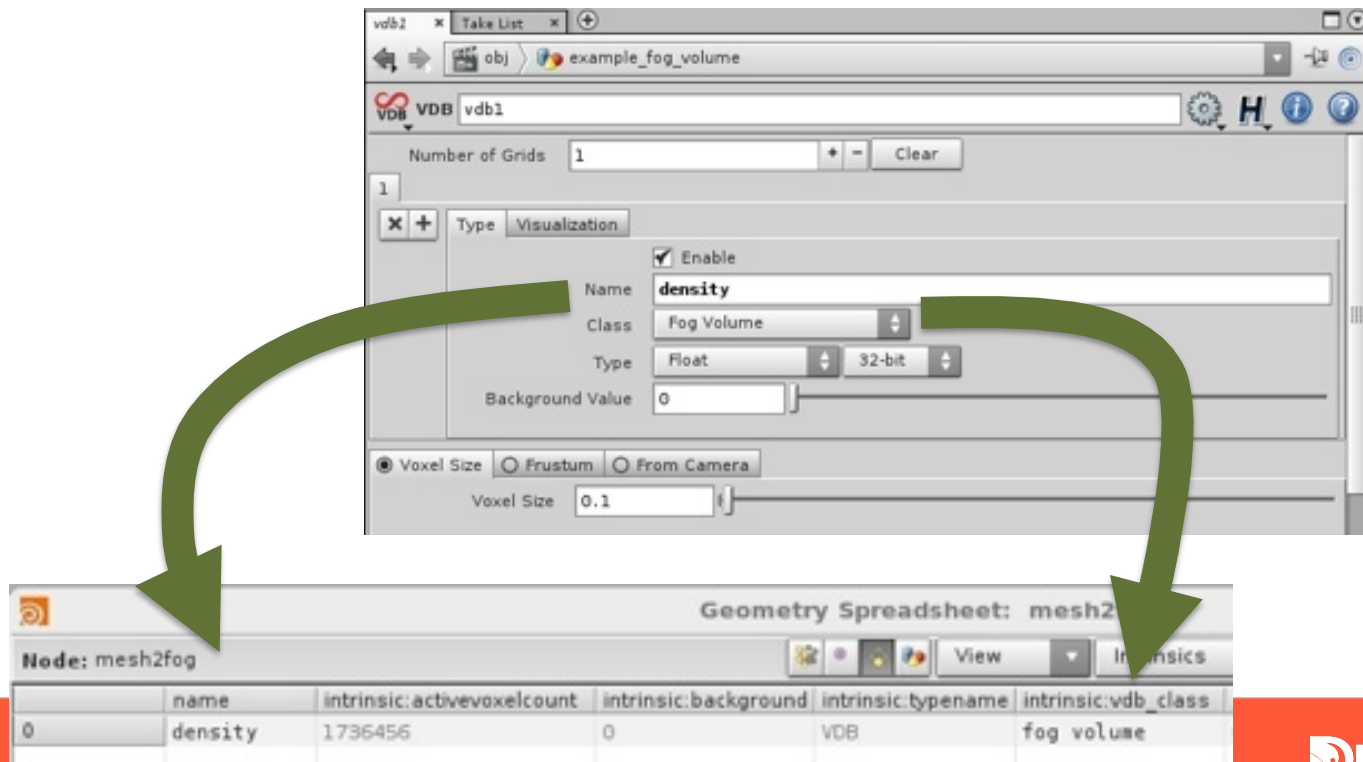
- Collection of flexible tools
  - Third-party
  - OpenVDB
  - Production

Volume Creation

Volume Creation

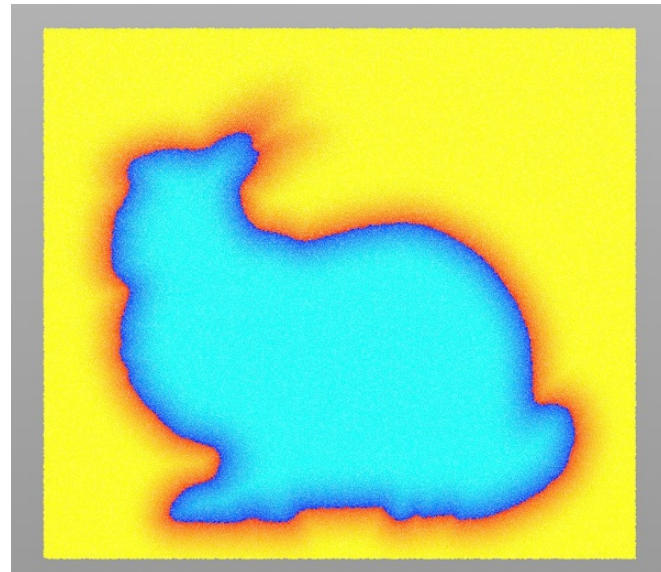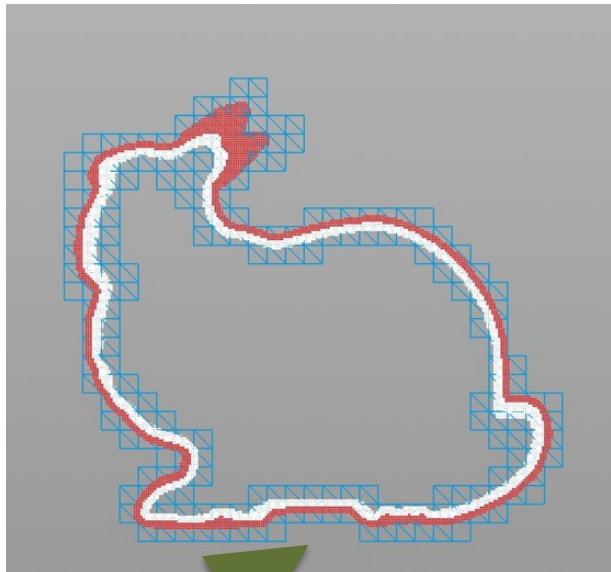# Volume Creation

Level Sets
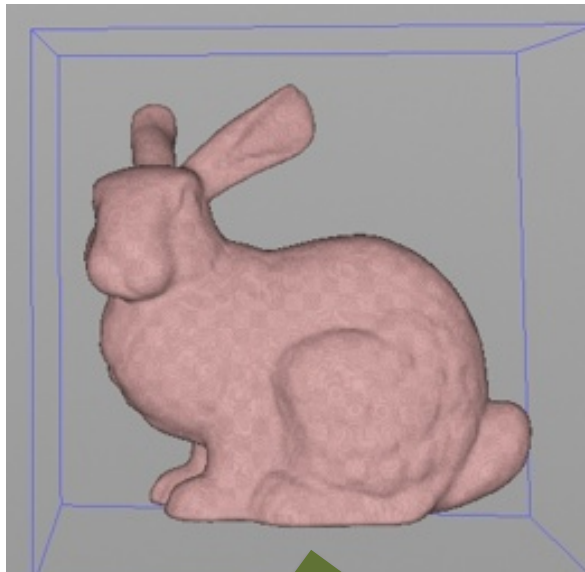
Arbitrary Grids
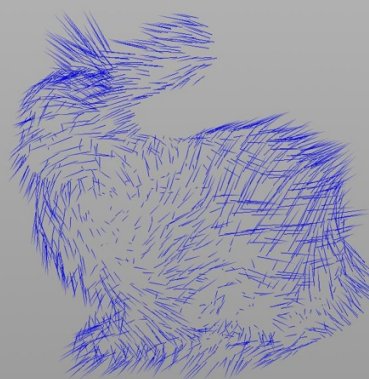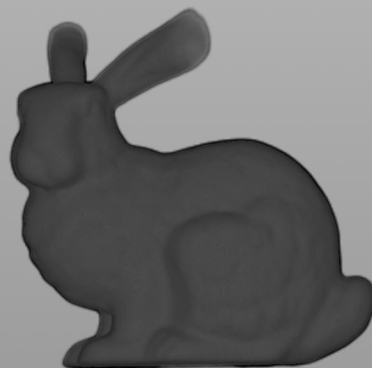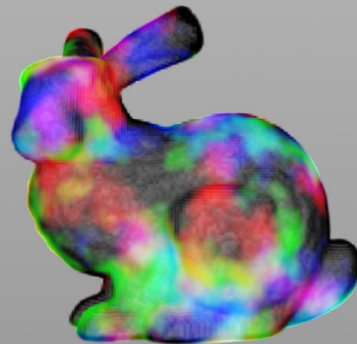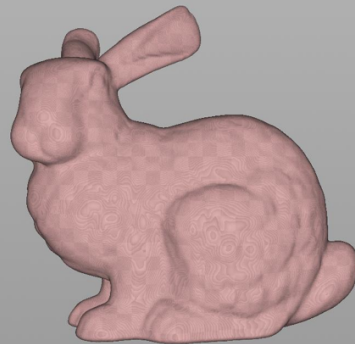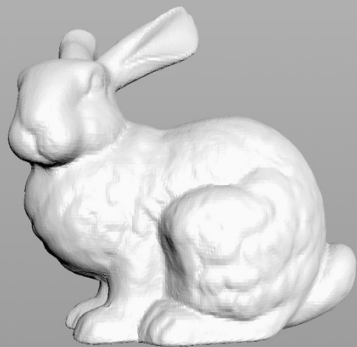
Level Sets
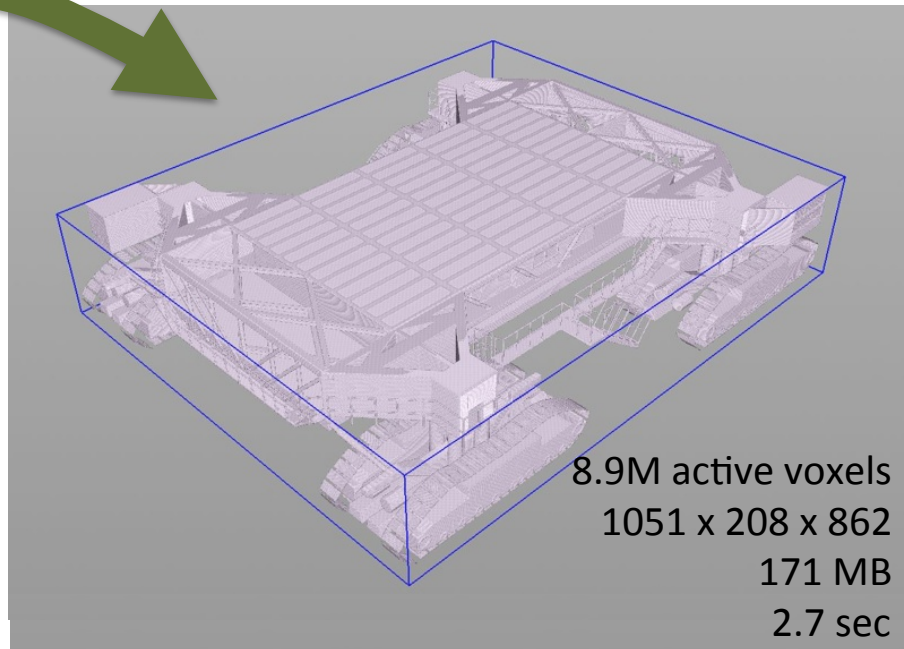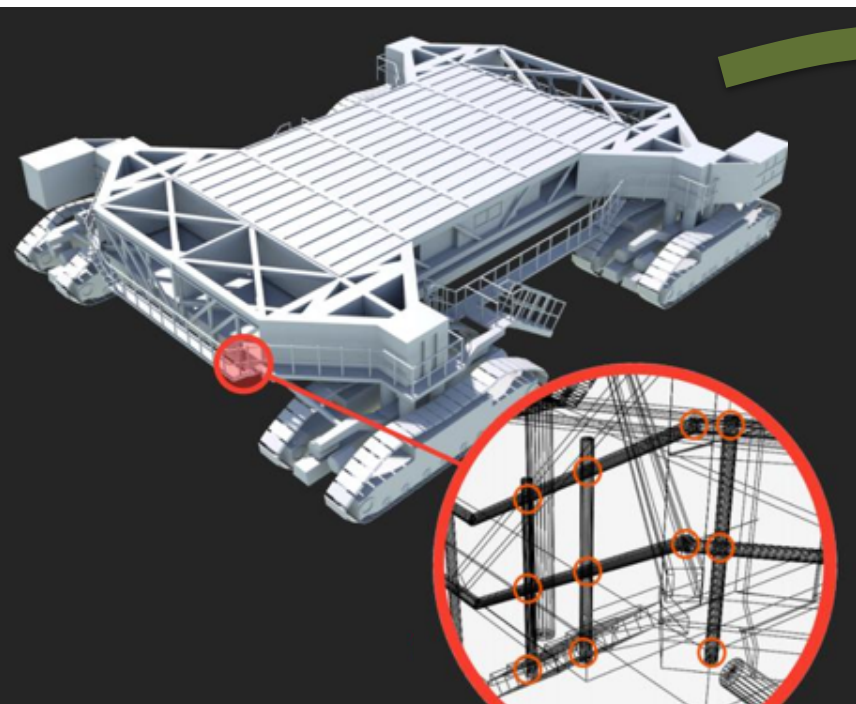
8.9M active voxels
1051 x 208 x 862
171 MB
2.7 sec

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Volume Manipulation
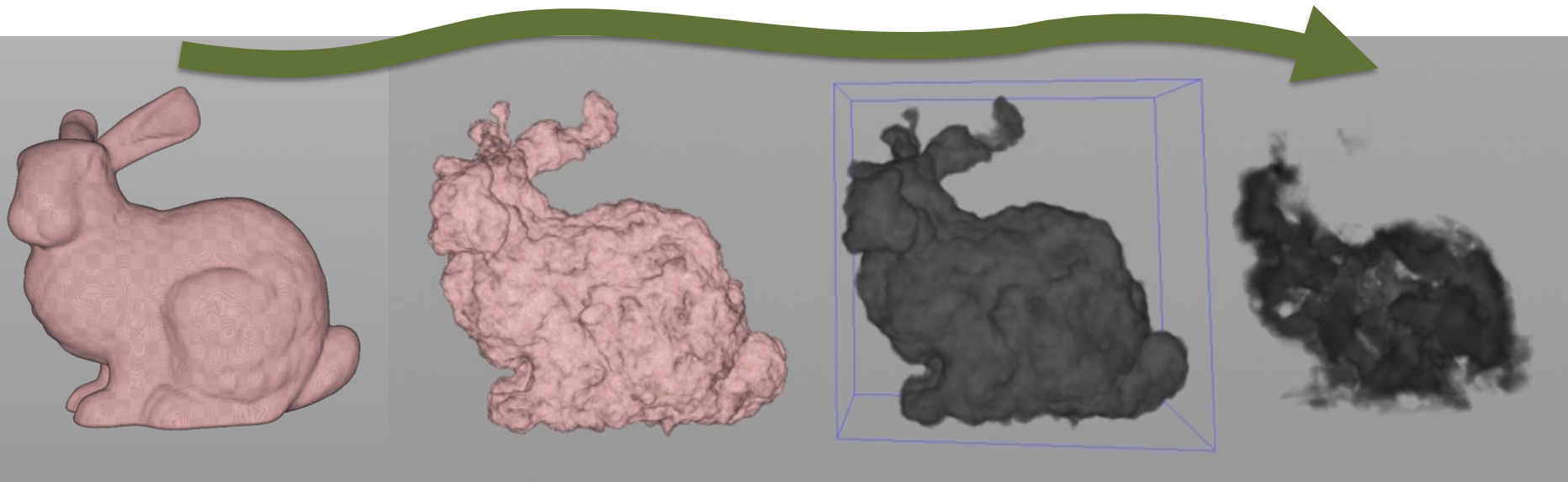
Φ += noise(CPT)

Φ •= noise(P)

Combining Grids
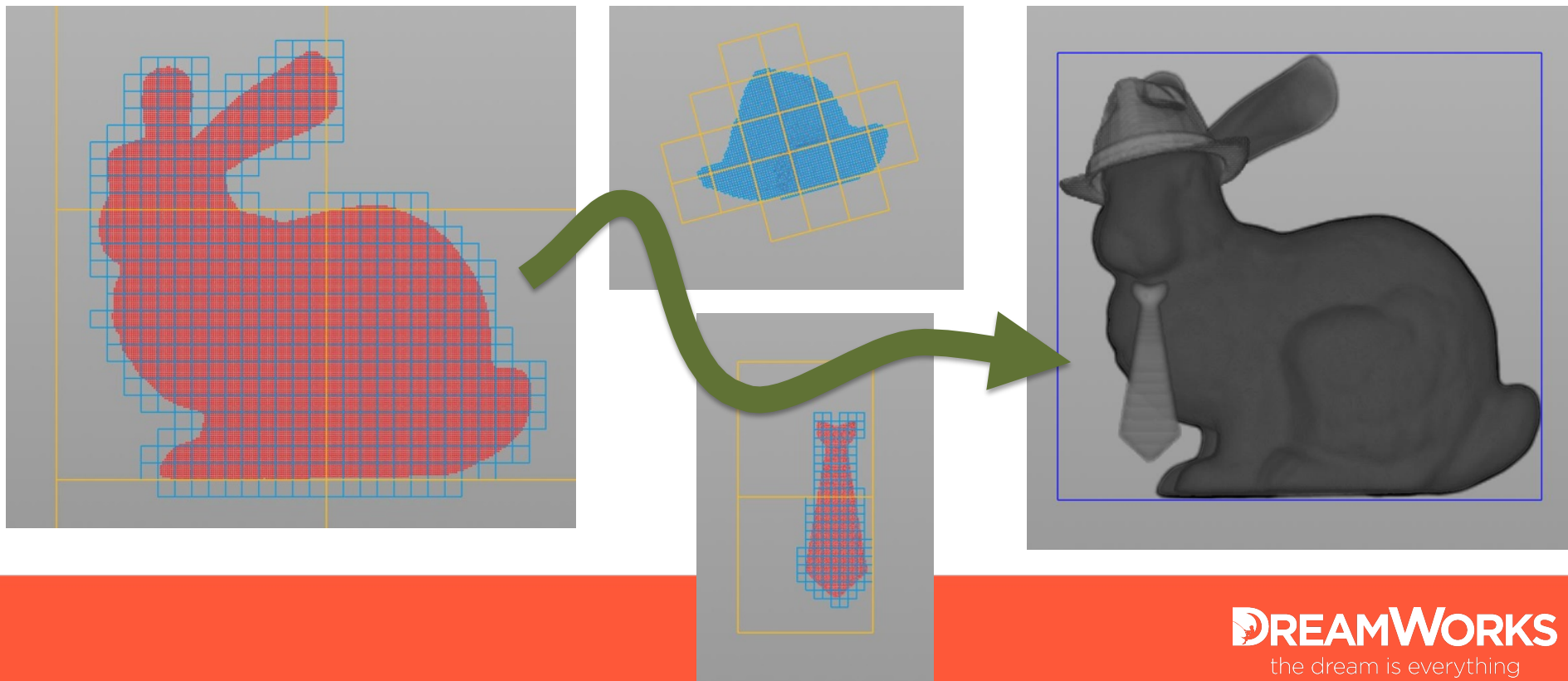
Combining Grids

Clouds

Miller, B., Museth, K., Penney, D. and Bin Zafar, N. Cloud modeling and rendering for Puss in Boots.   Siggraph Talk, 2012

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Clouds

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Cloud Modeling

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Frustum Buffers

Frustum Buffers

ortho/frustum visual comparison (same number of voxels)

Frustum Buffers

ortho/frustum visual comparison (same number of voxels)

Raster Primitives

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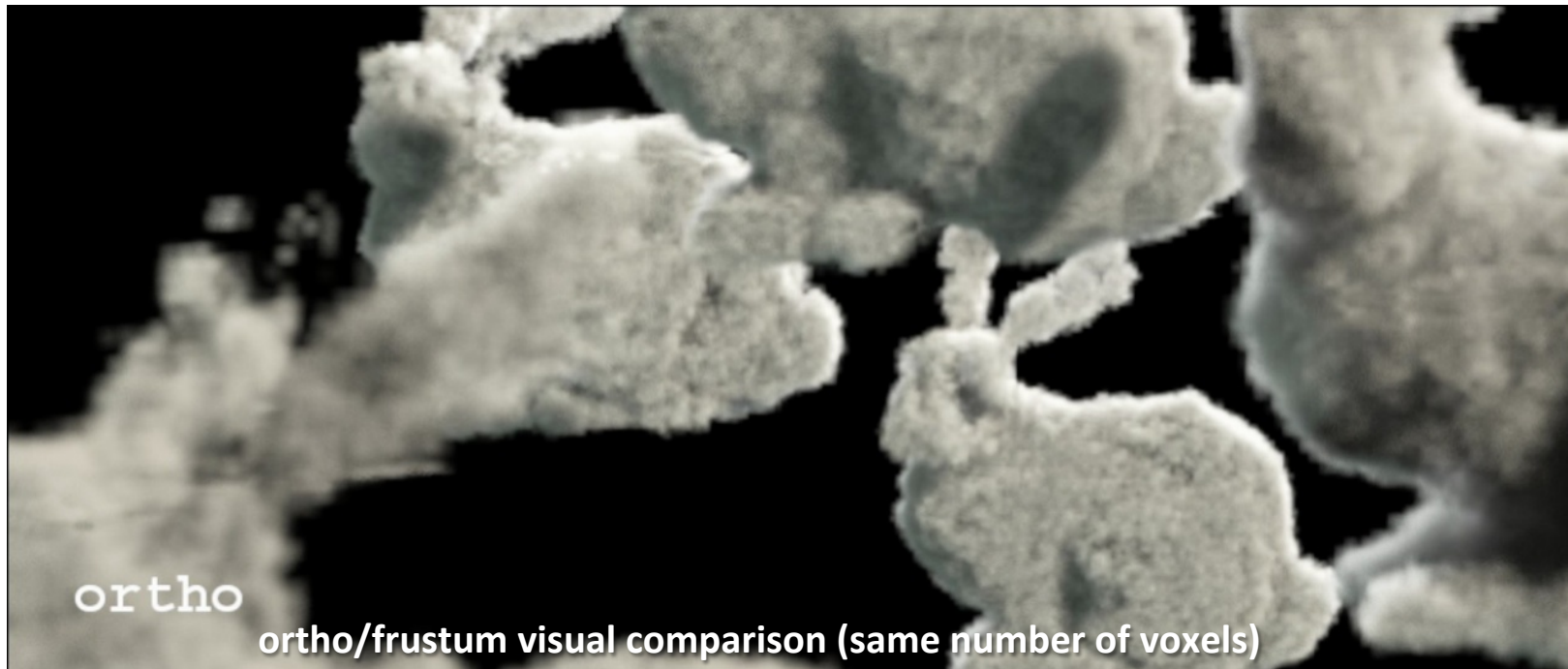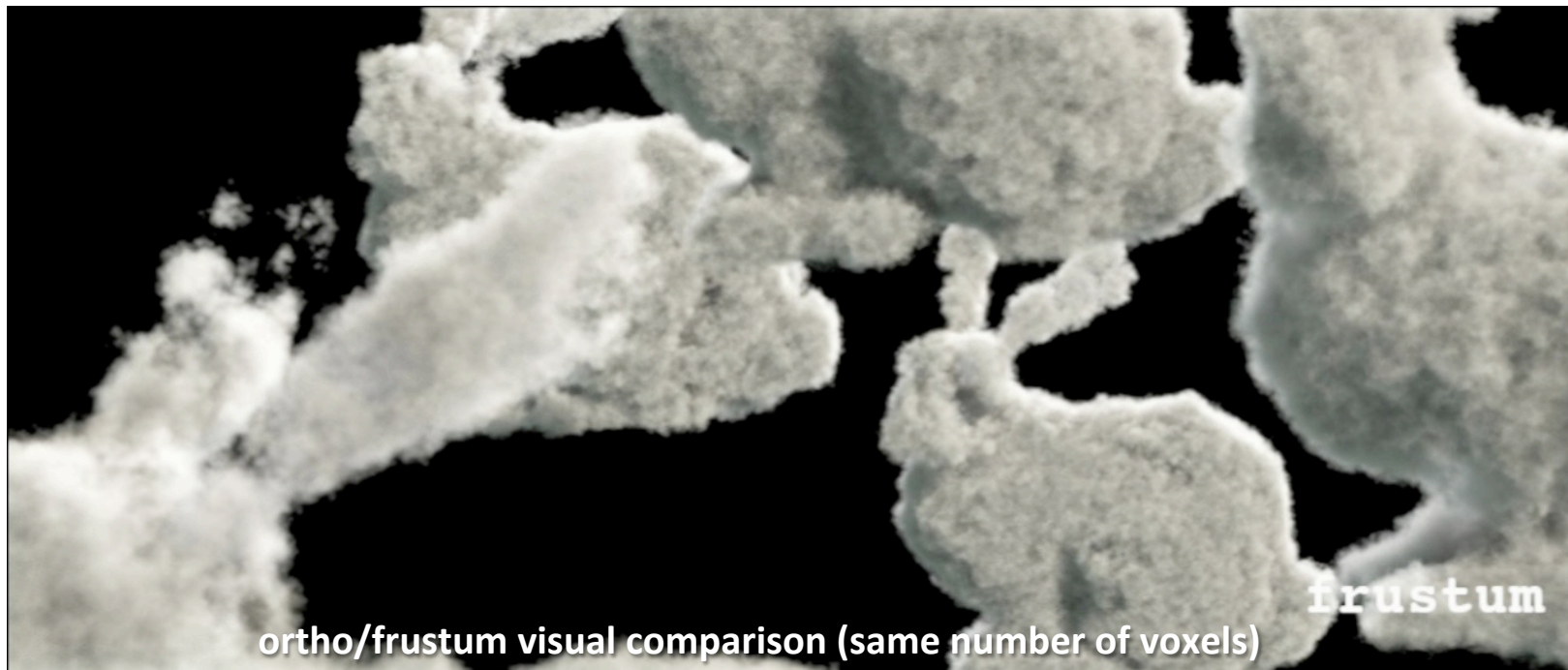
Raster Primitives
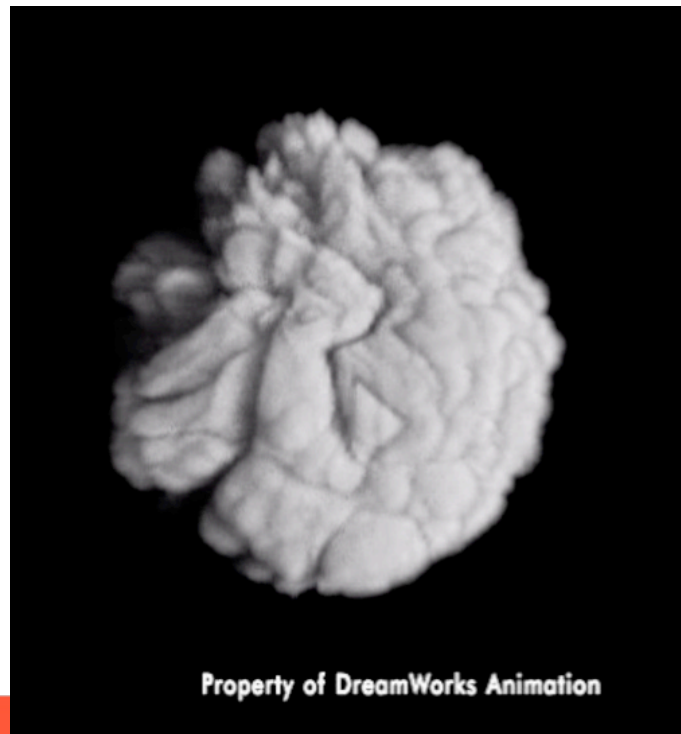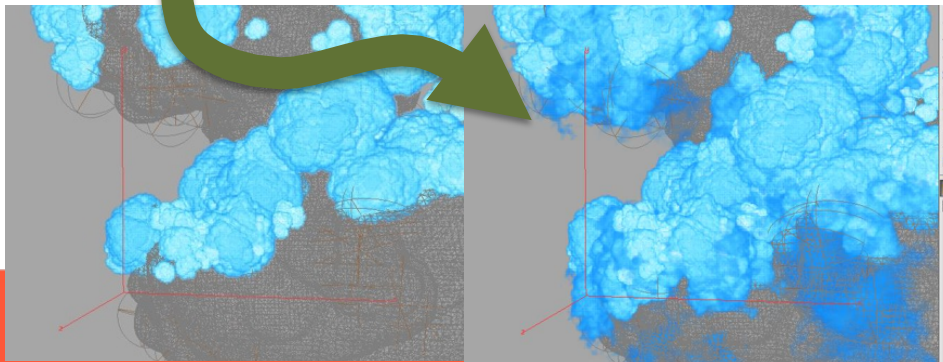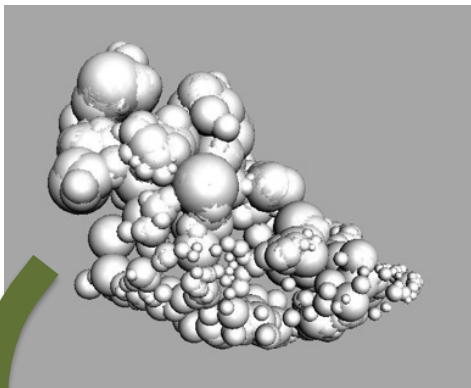
Raster Primitives

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Liquids

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Budsberg, J., Losure, M., Museth, K., Baer, M. Liquids in The Croods. DigiPro, 2013
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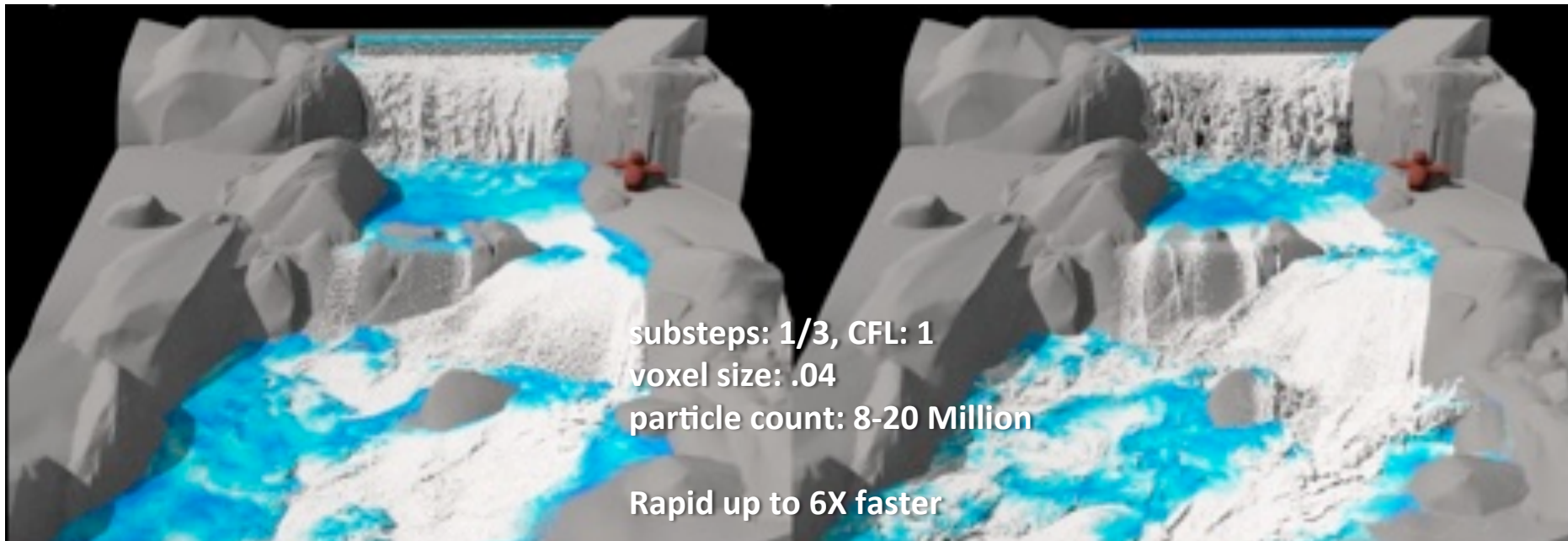Losure, M. Surreal Night Swimming in Home. Siggraph Dailies, 2015
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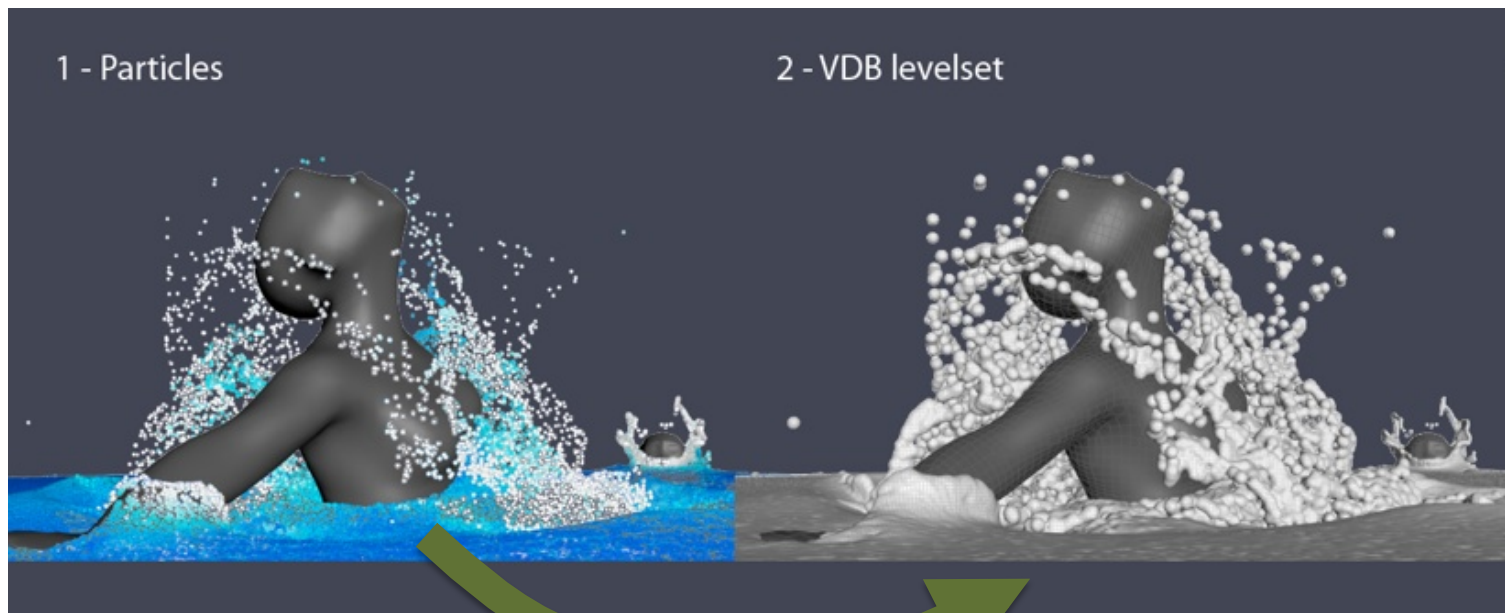
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Solvers

DWA Rapid

Houdini 13 FLIP

substeps: 1/3, CFL: 1
voxel size: .04
particle count: 8-20 Million

Rapid up to 6X faster

# Particle to Level Set
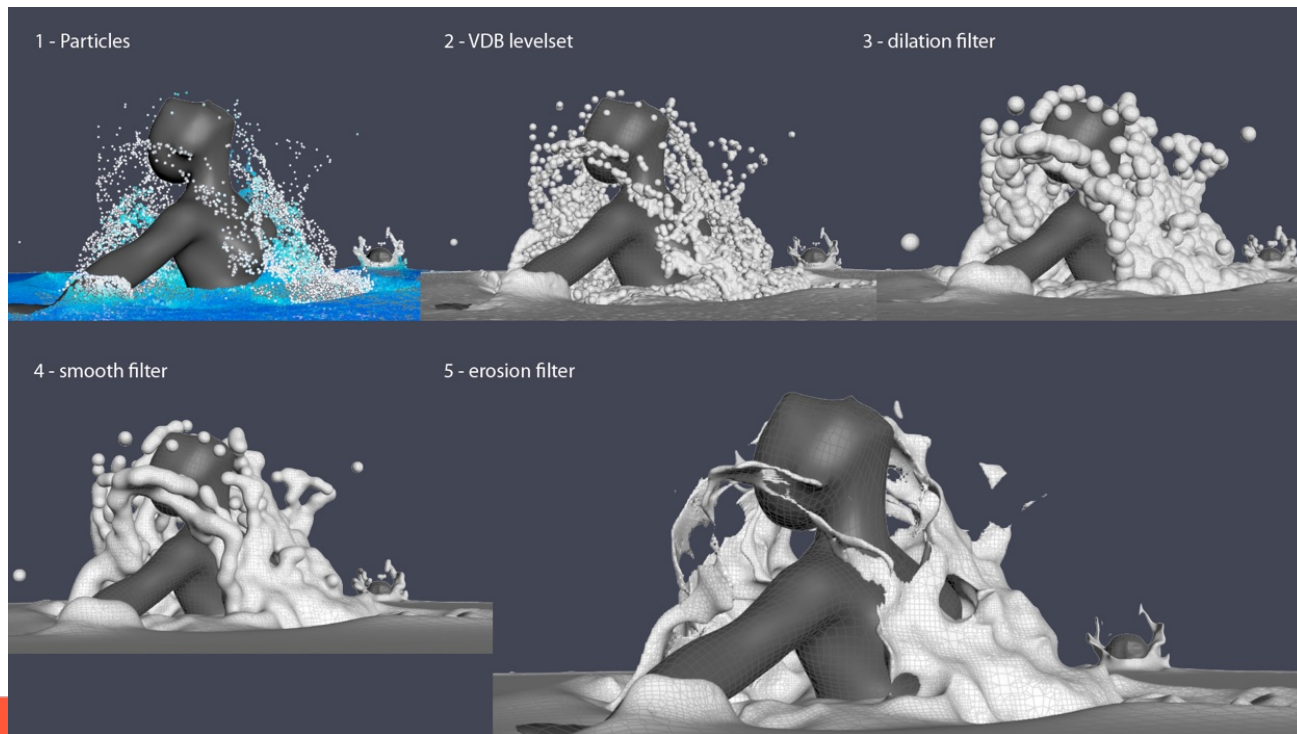

1 - Particles   2 - VDB levelset

Budsberg, J., Losure, M., Museth, K., Baer, M. Liquids in The Croods. DigiPro, 2013

Particle to Level Set

- Artists want control
  - Remove artifacts / holes
  - Accentuate sharp features
  - Smooth flat areas

  - And make it fast!

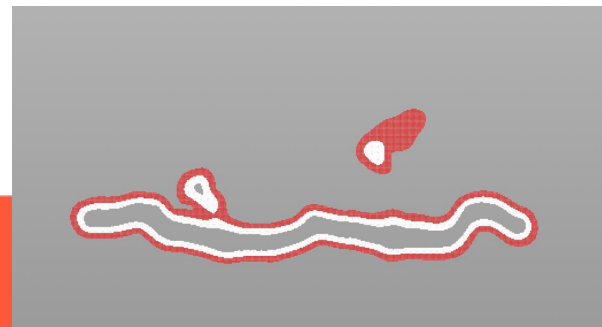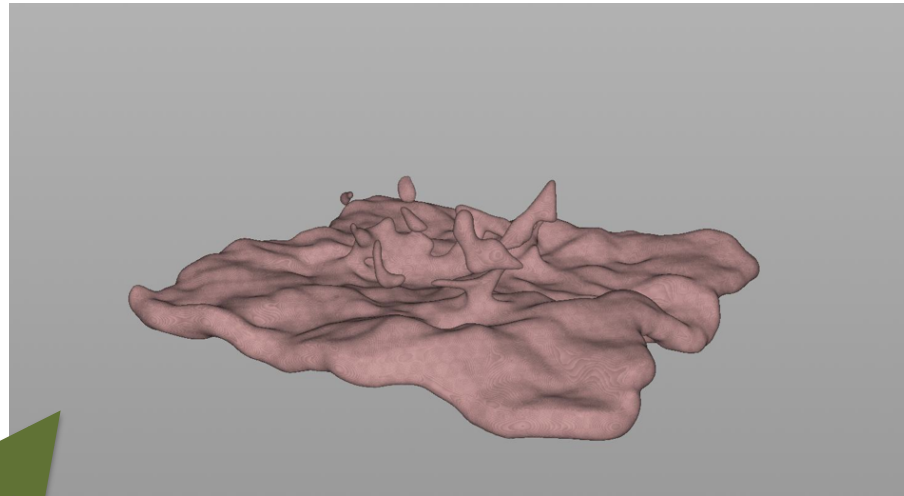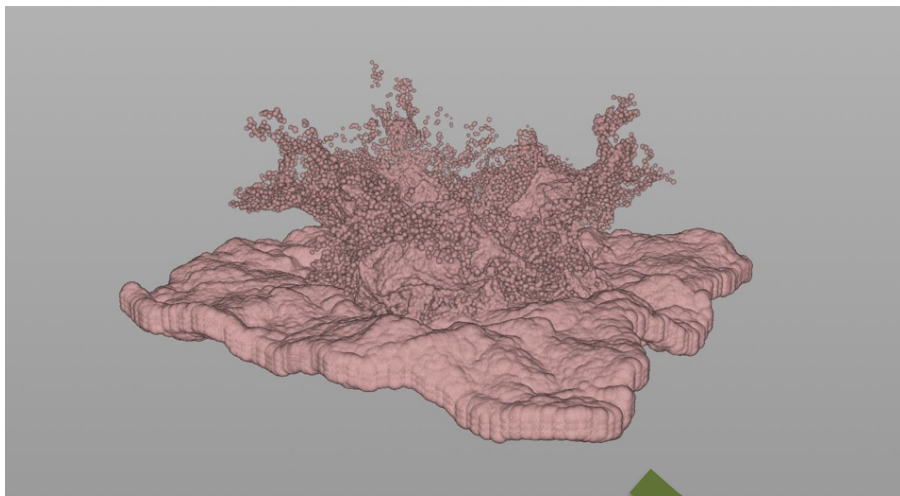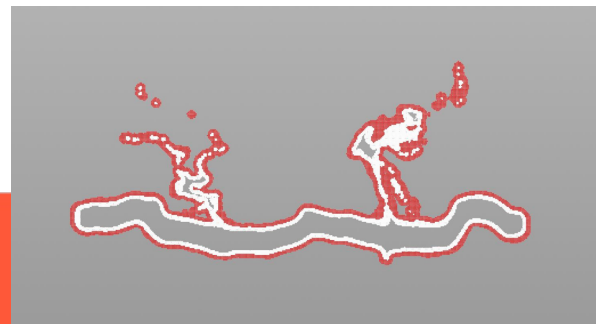Budsberg, J., Losure, M., Museth, K., Baer, M. Liquids in The Croods. DigiPro, 2013

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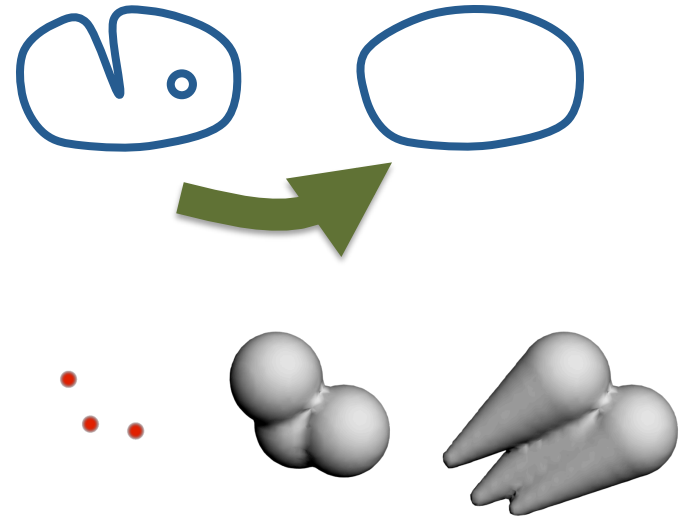
LS Filtering / Morphological Ops
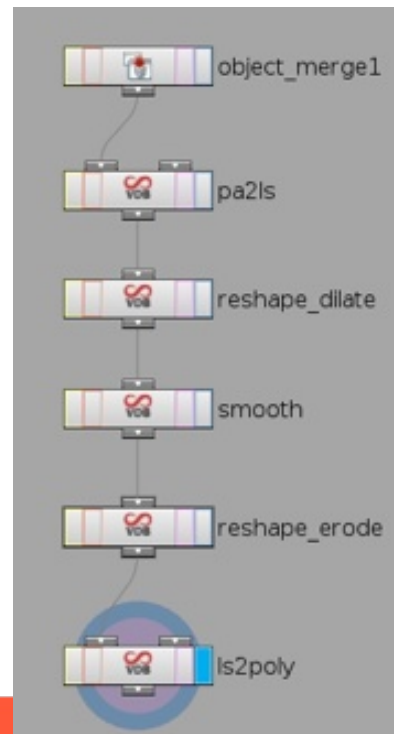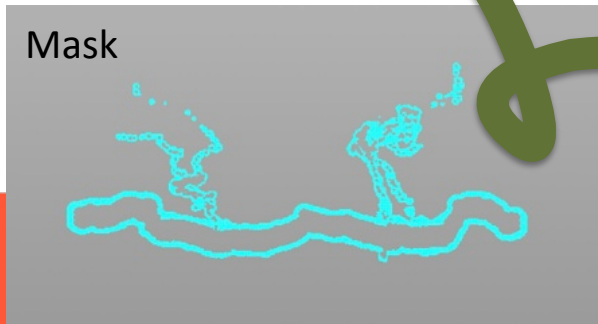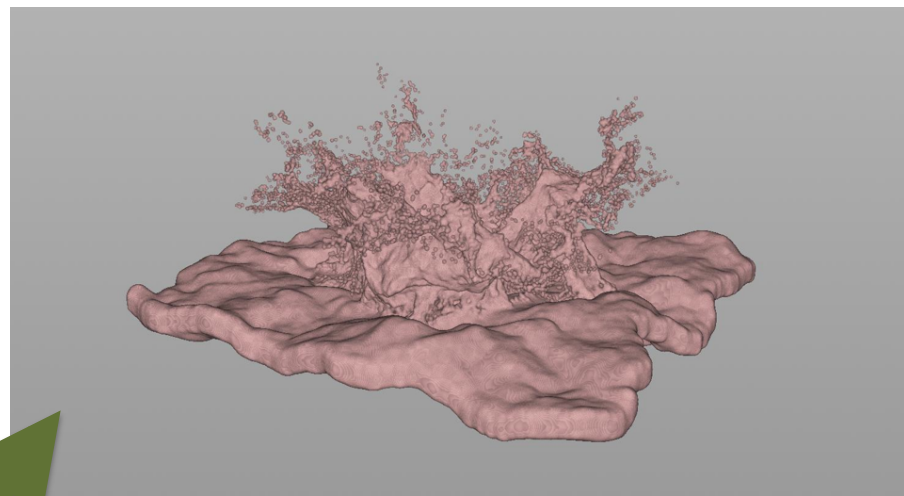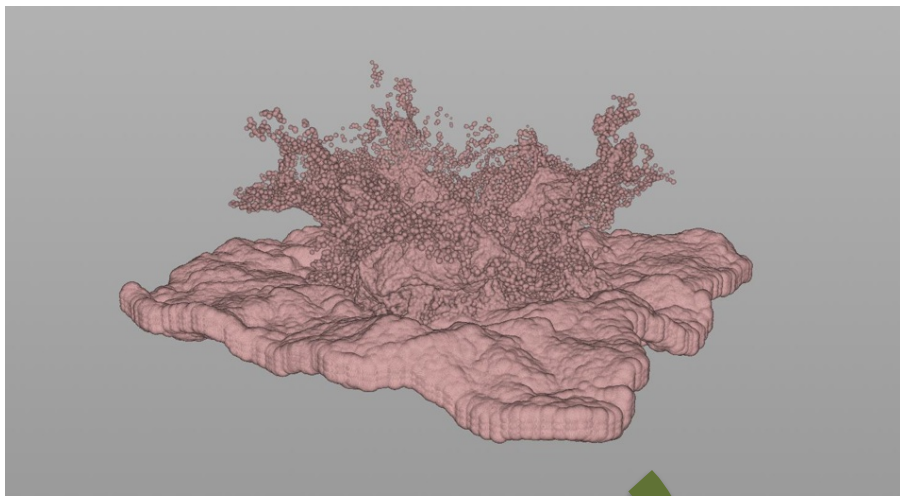

Budsberg, J., Losure, M., Museth, K., Baer, M. Liquids in The Croods. DigiPro, 2013

LS Filtering

LS Filtering

Mask

LS Filtering / Morphological Ops

Smooth

Blur

Dilate

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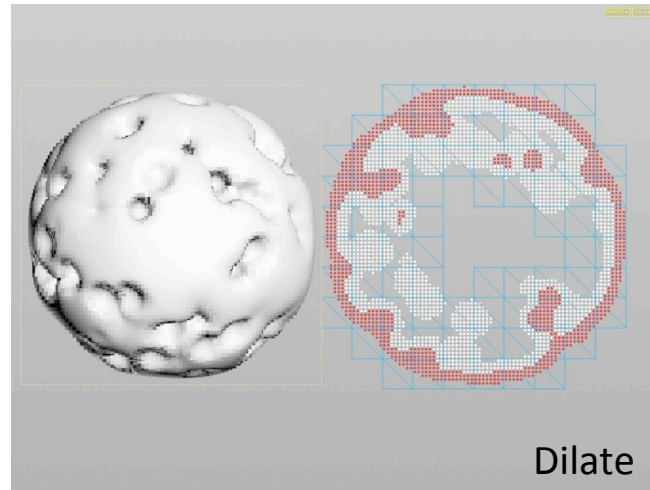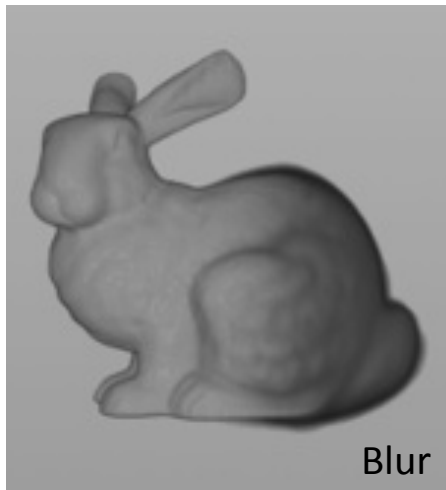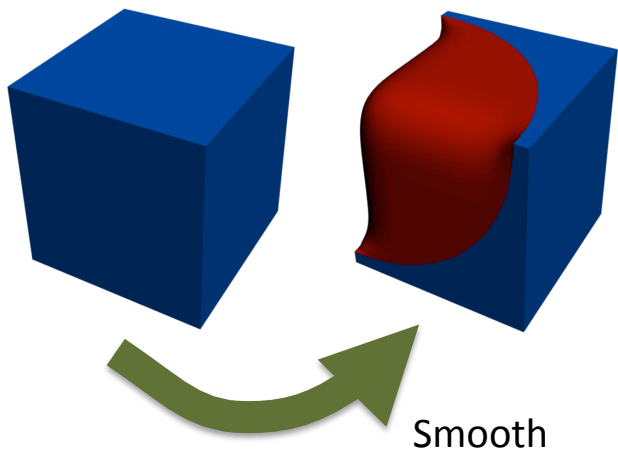
LS Filtering / Morphological Ops

LS Smooth   Smooth

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Adaptive meshing

~1.1M polys

~177K polys
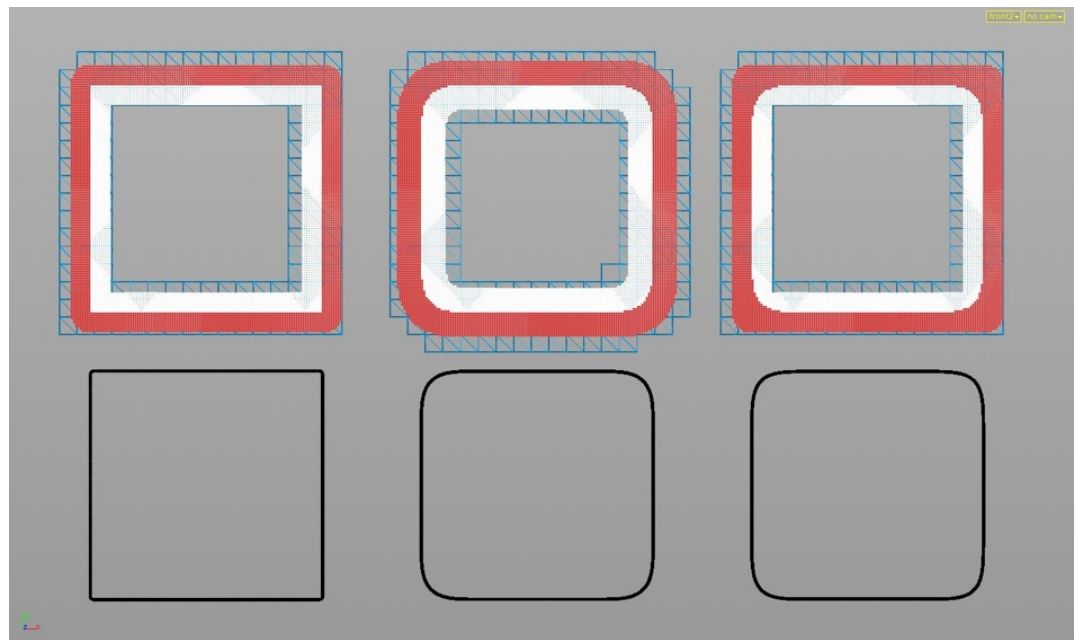
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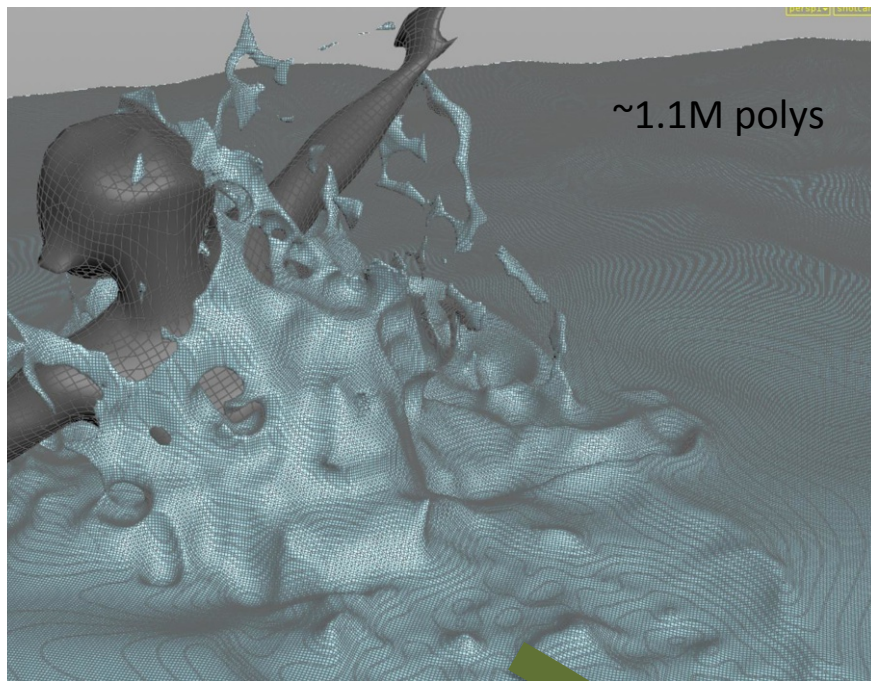
Masked Meshing
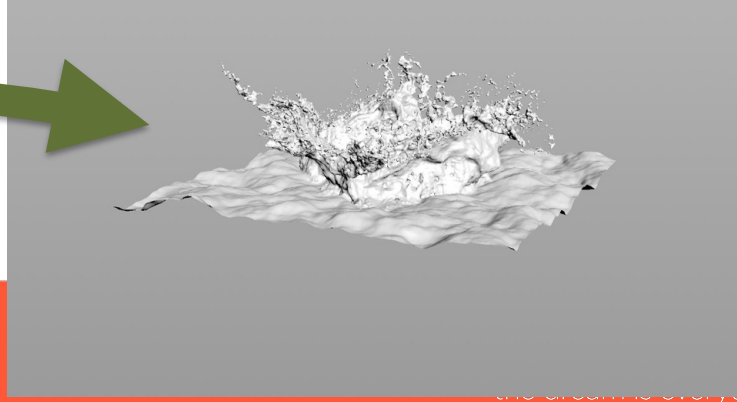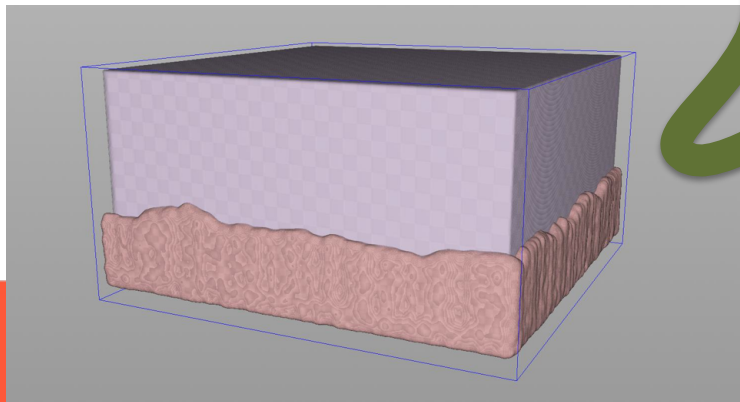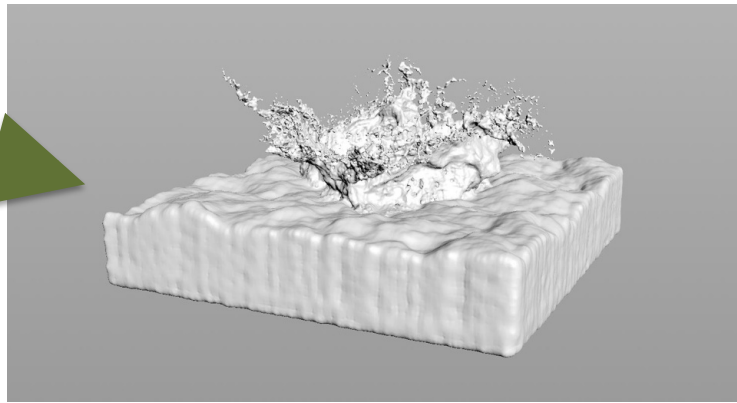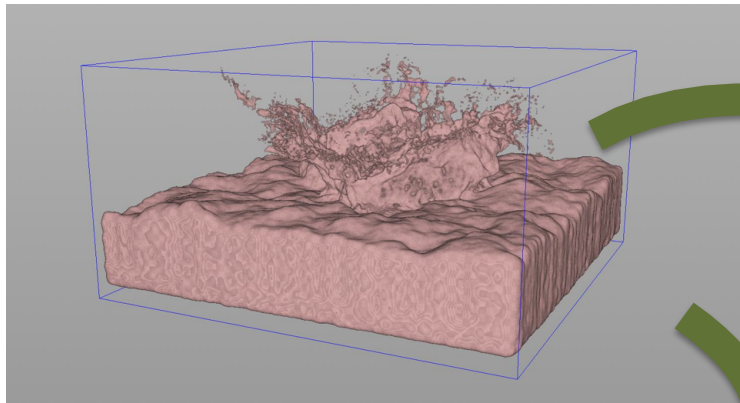
Simplification Masks
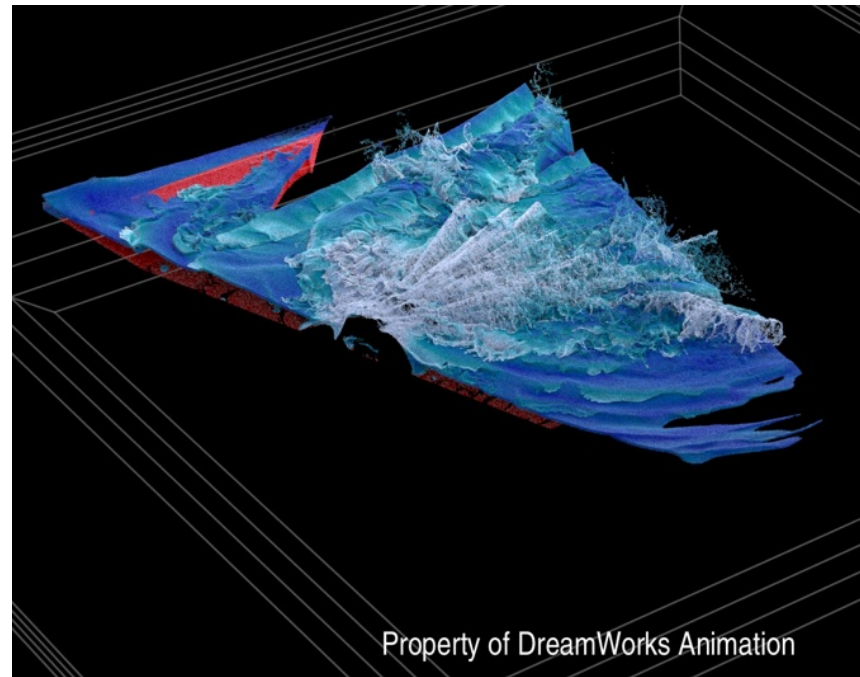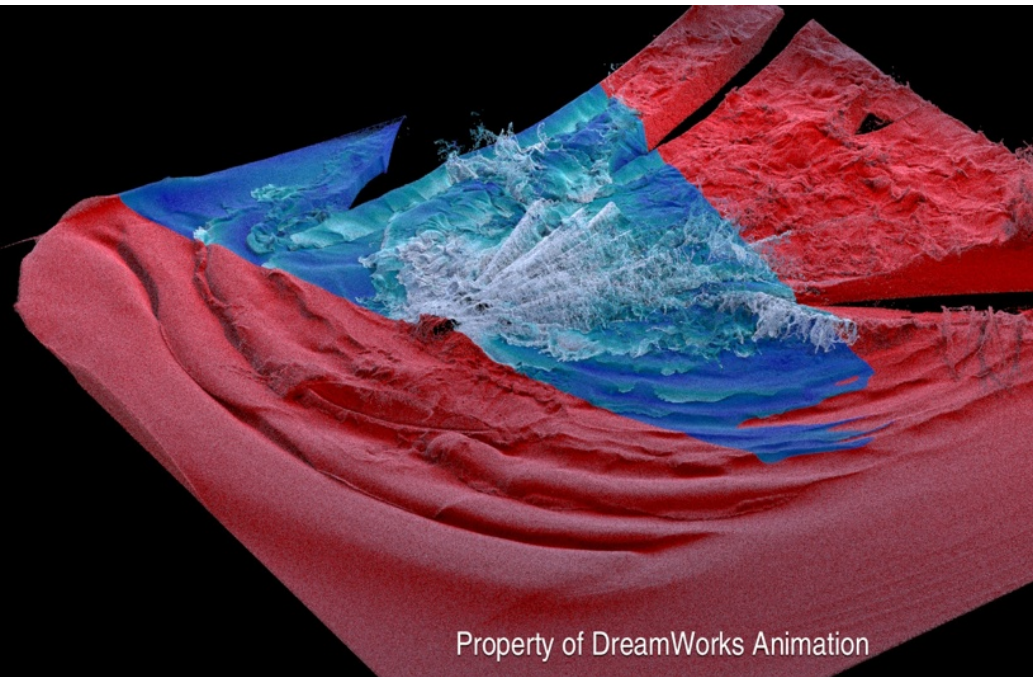
Van Opstal, B., Janin, L., Museth, K. Large Scale Simulation and Surfacing of Water and Ice in How to Train Your Dragon 2, Siggraph Talk, 2014

Simplification Masks
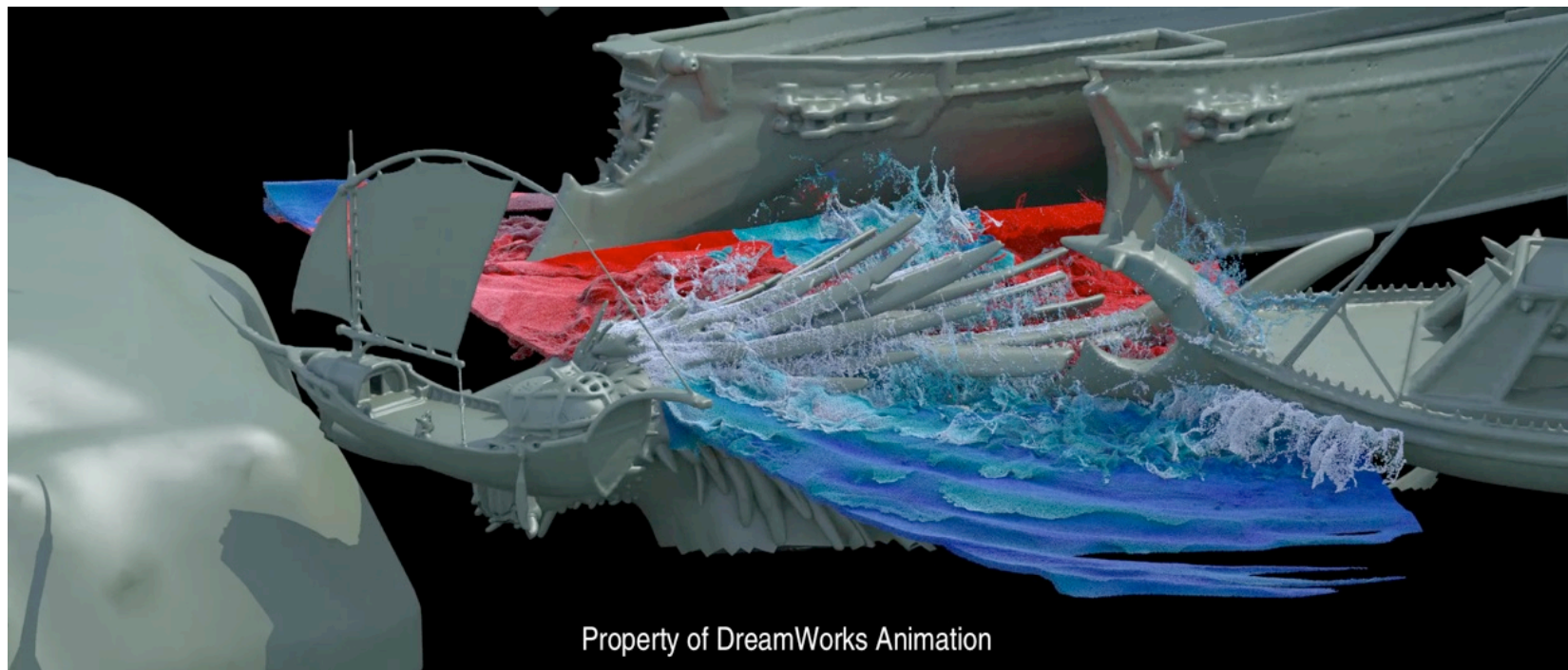
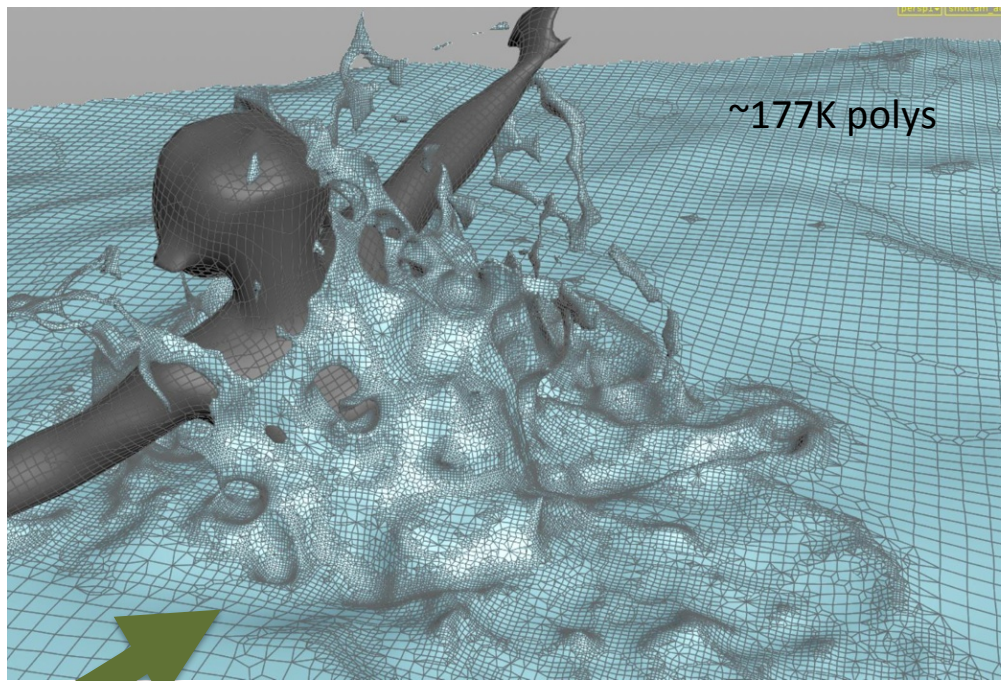Property of DreamWorks Animation

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Simplification Masks

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Distributed Filtering
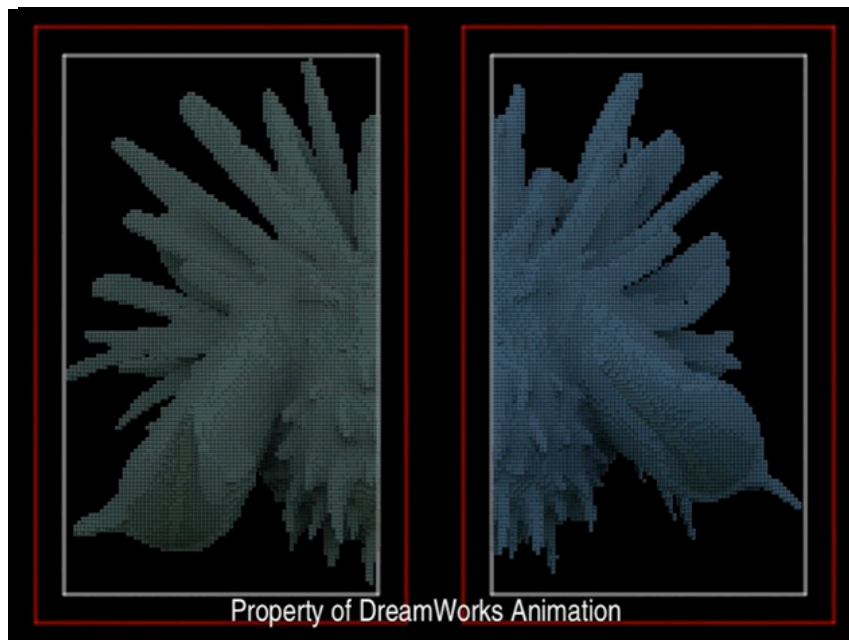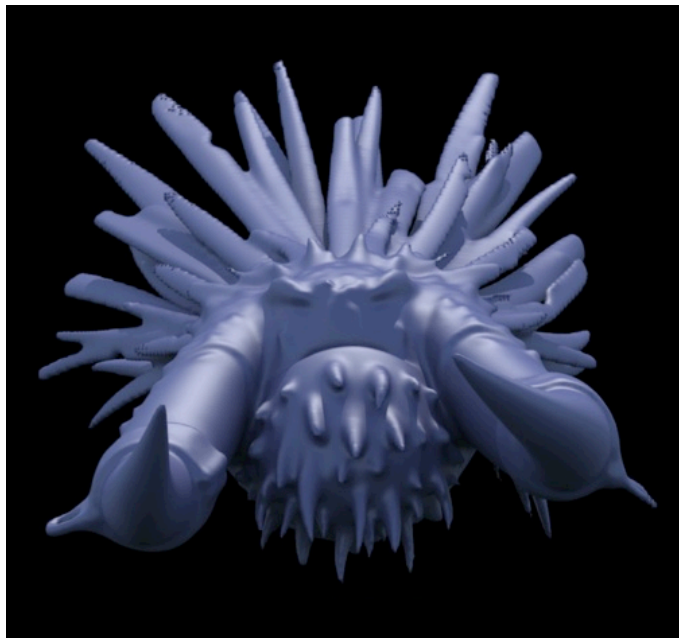
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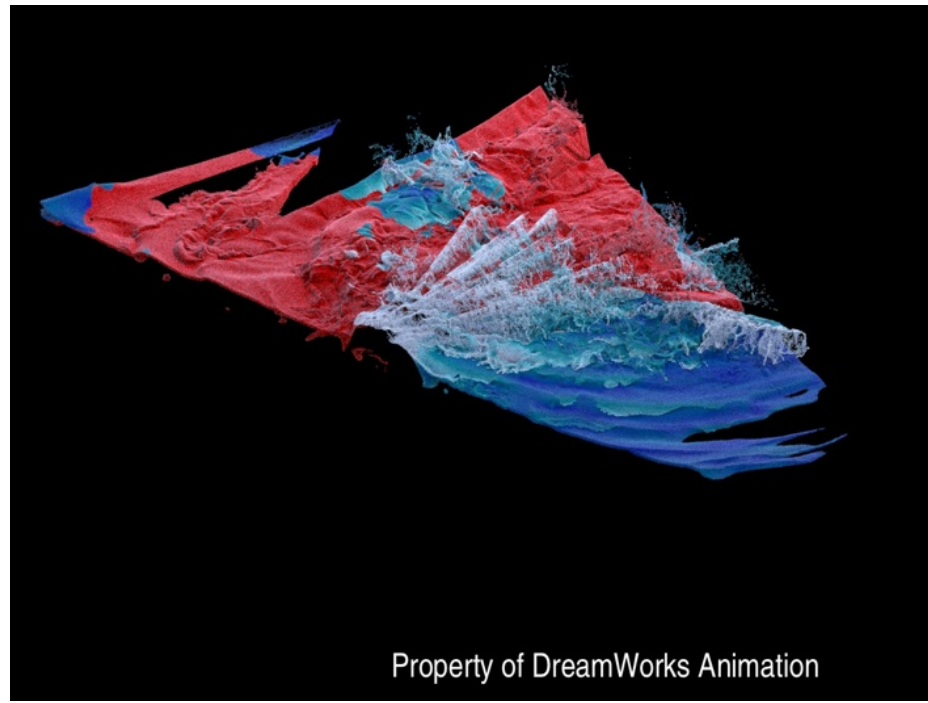
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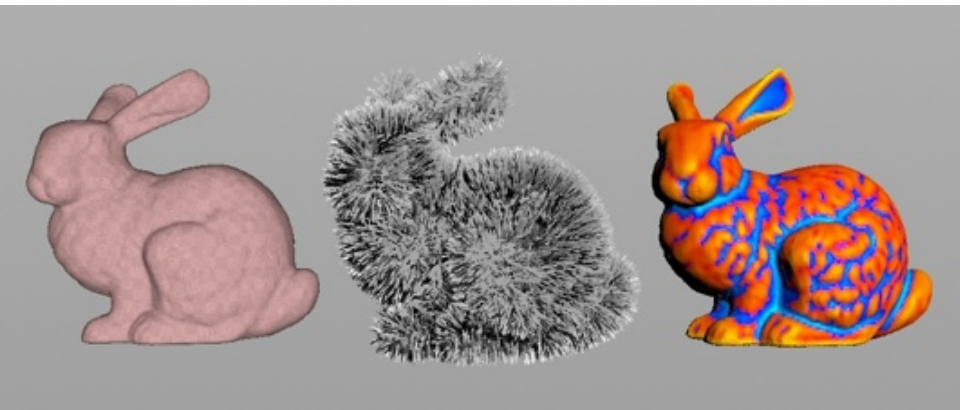
Grid Analysis

gradient   curvature   velocity   vorticity
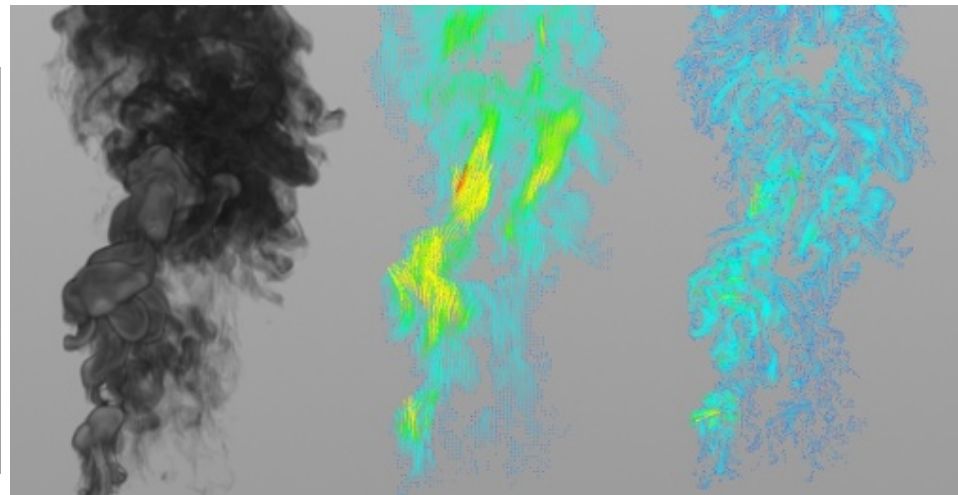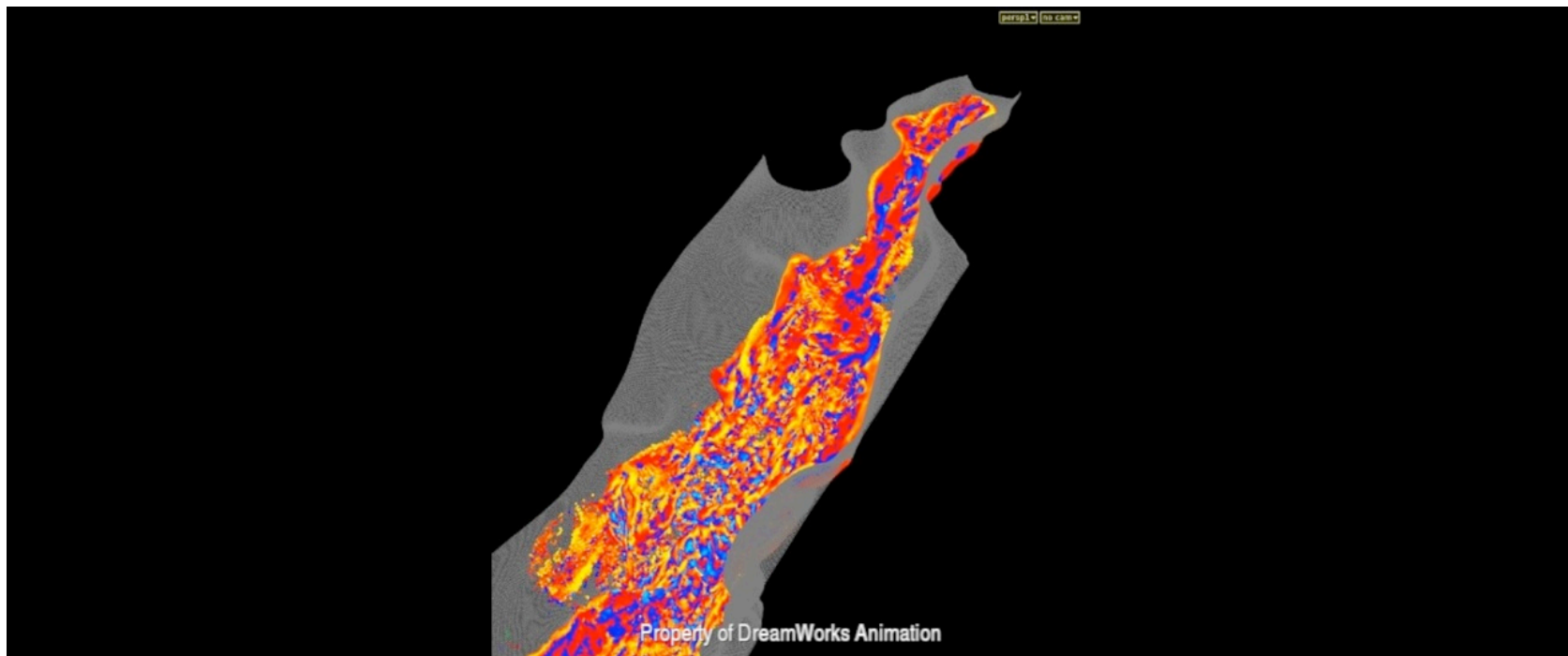
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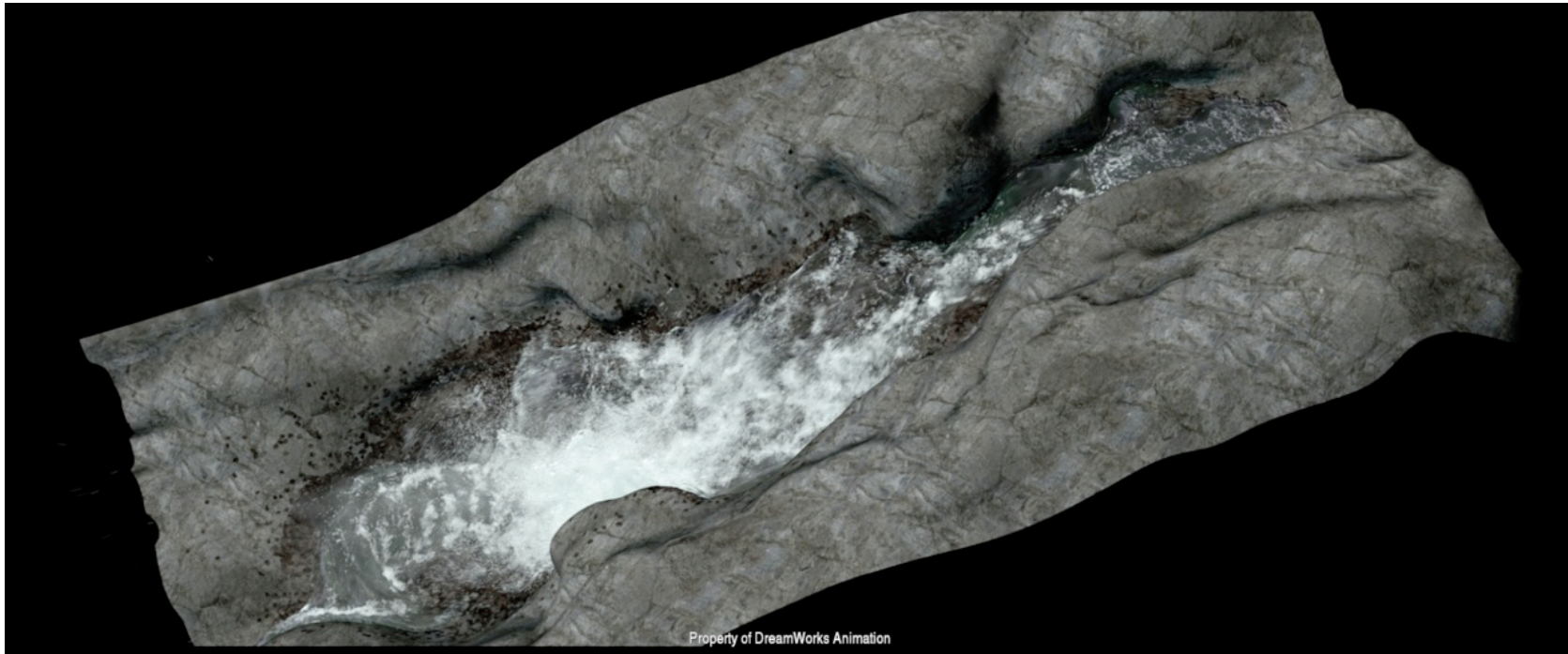
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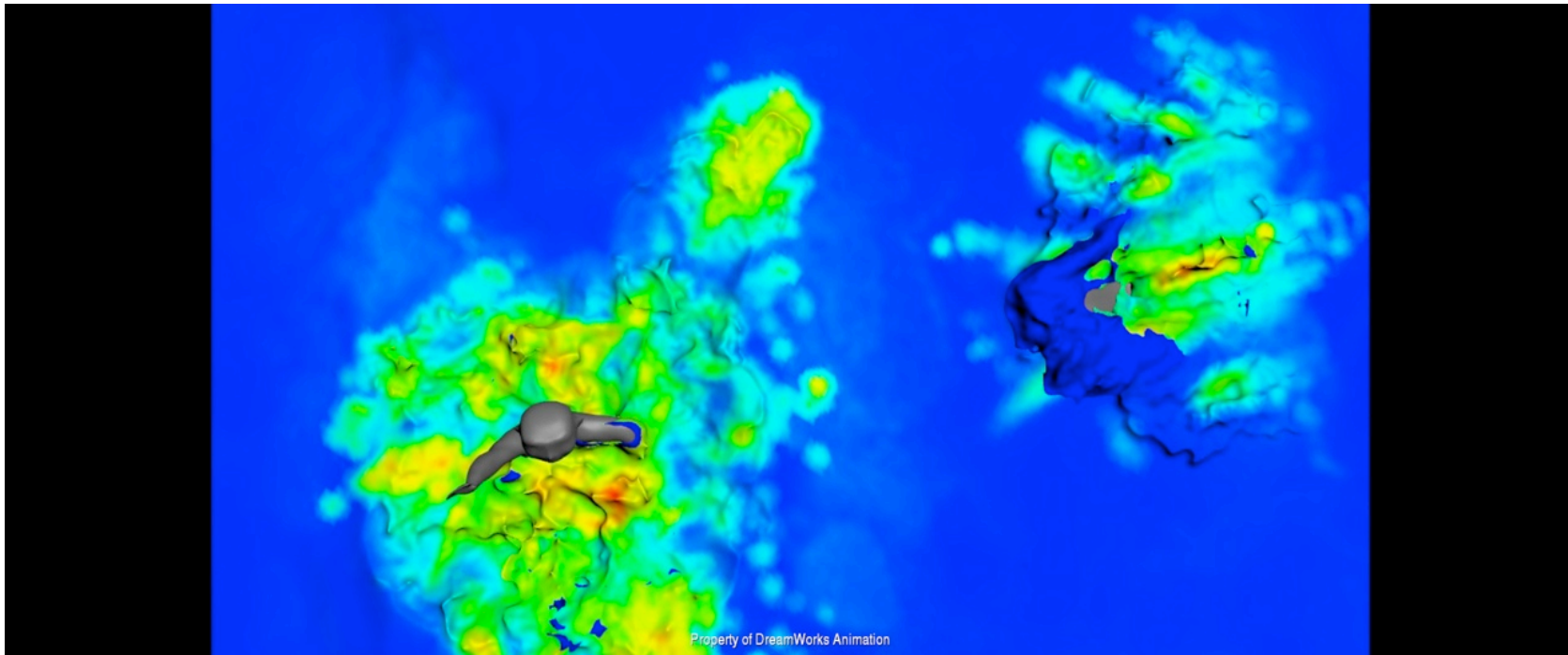
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Secondary Elements

Secondary Elements

Losure, M. Surreal Night Swimming in Home. Siggraph Dailies, 2015

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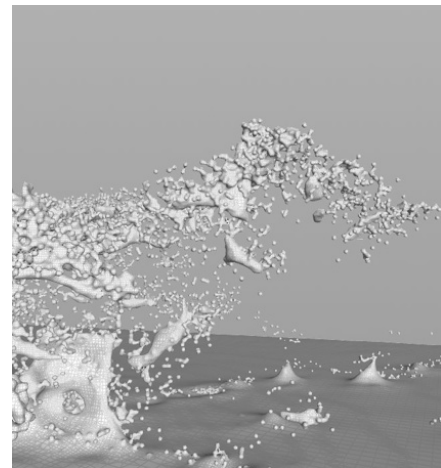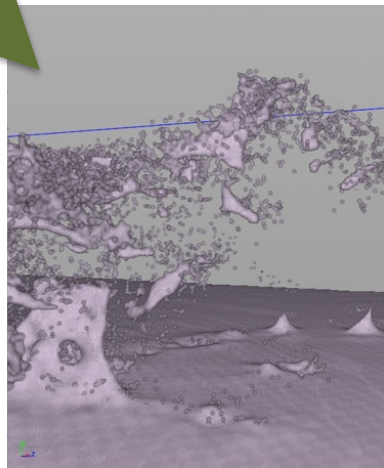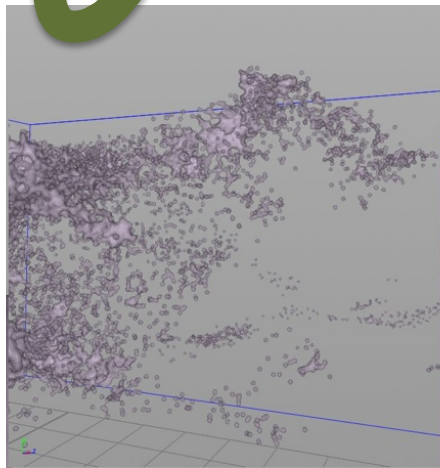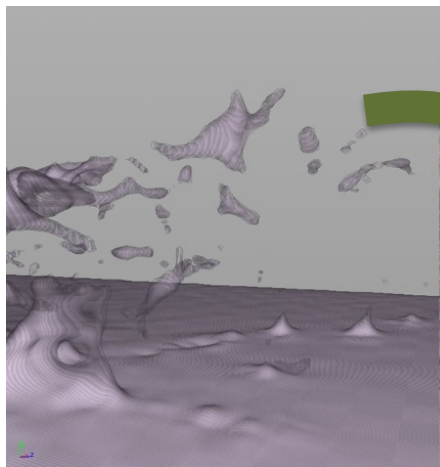
Secondary Elements
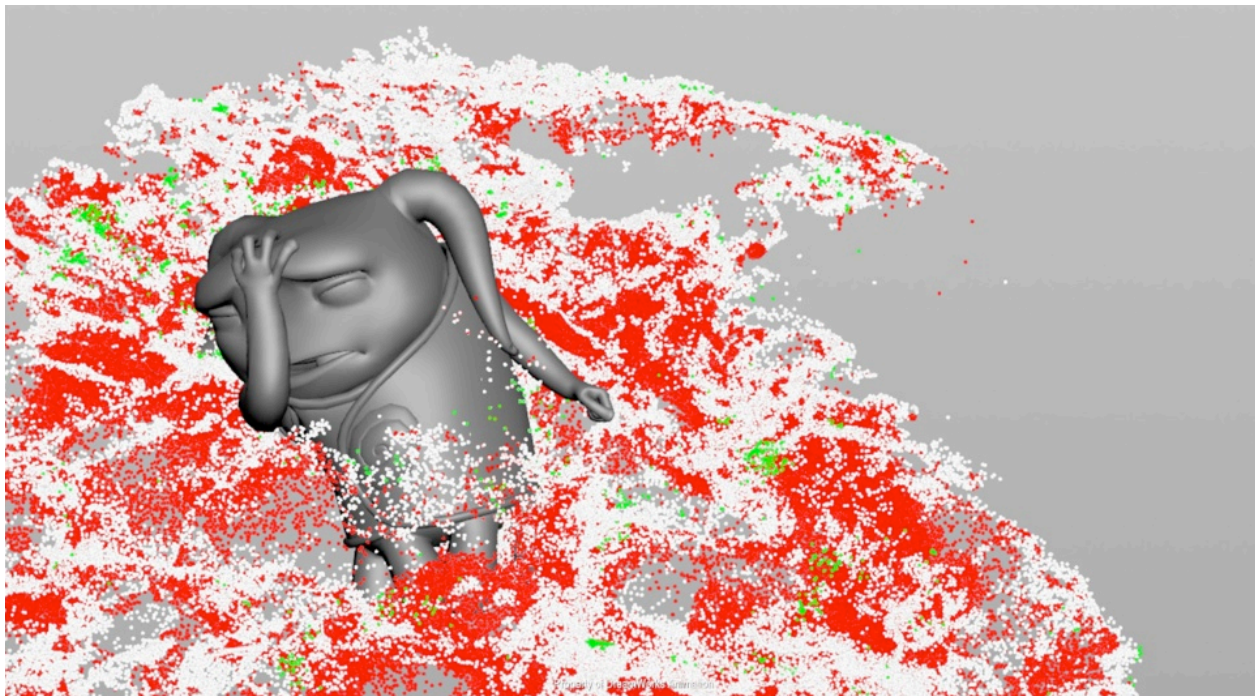
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Secondary Elements

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Vector Fields

$$F(x, y, z) = \hat{y}x - \hat{x}y$$

Vector Fields

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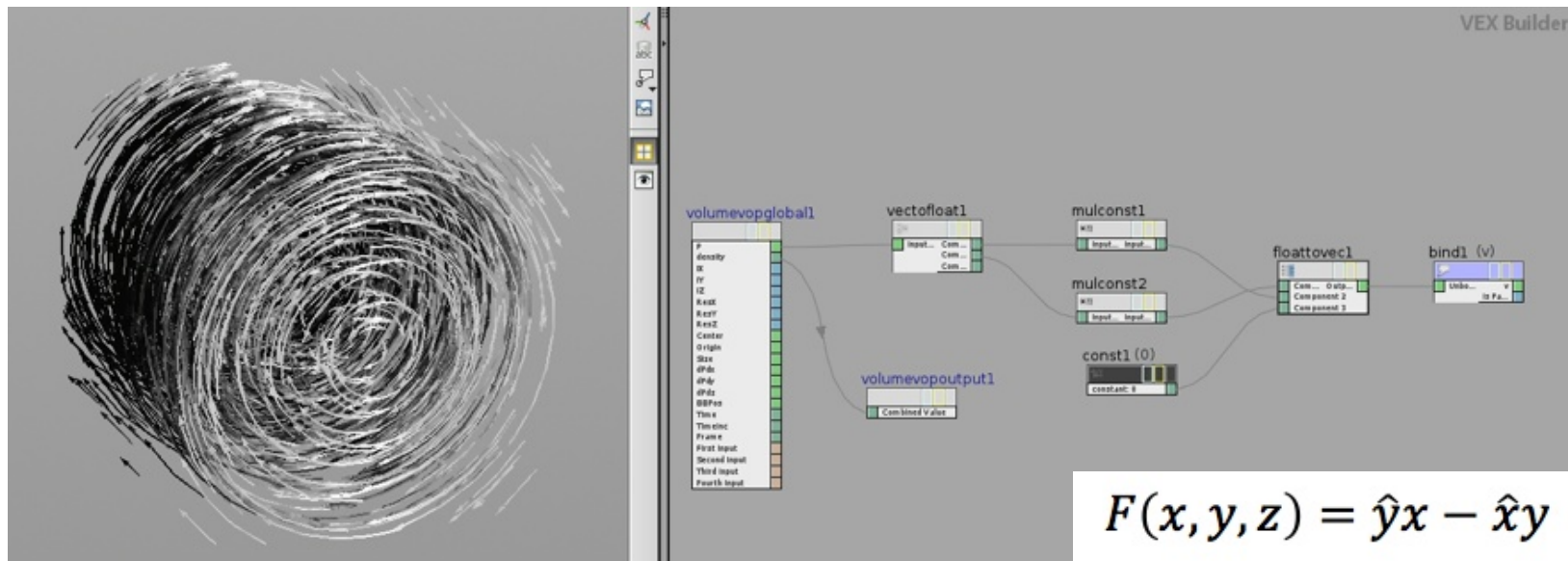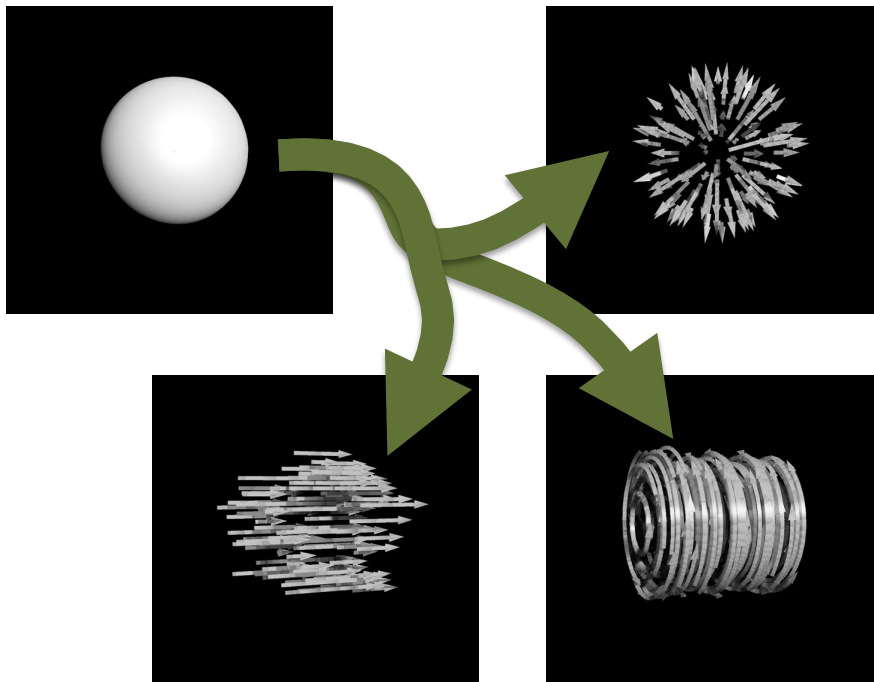
Vector Fields

Flow fields

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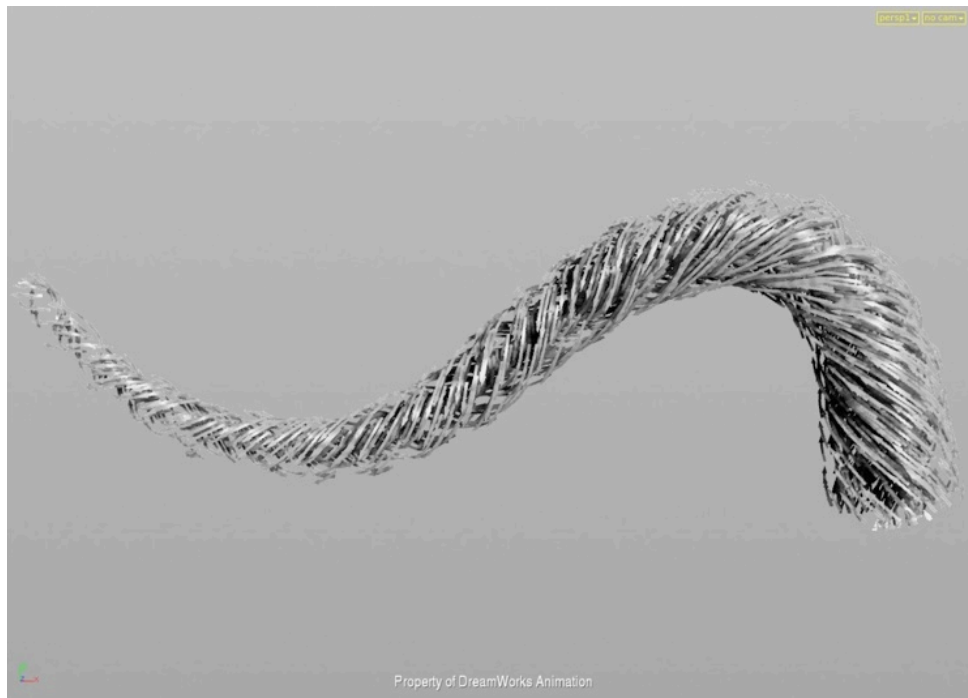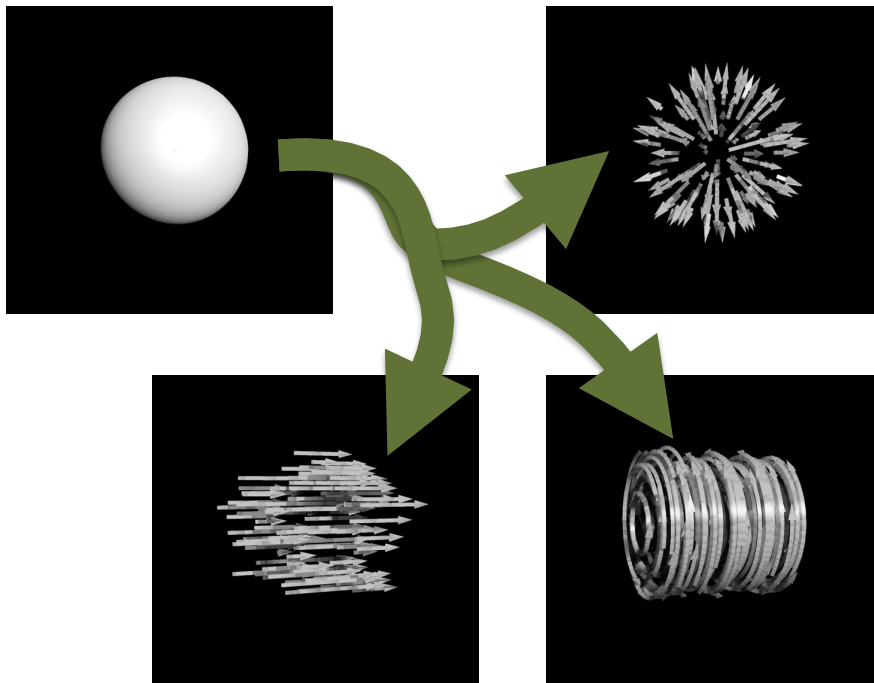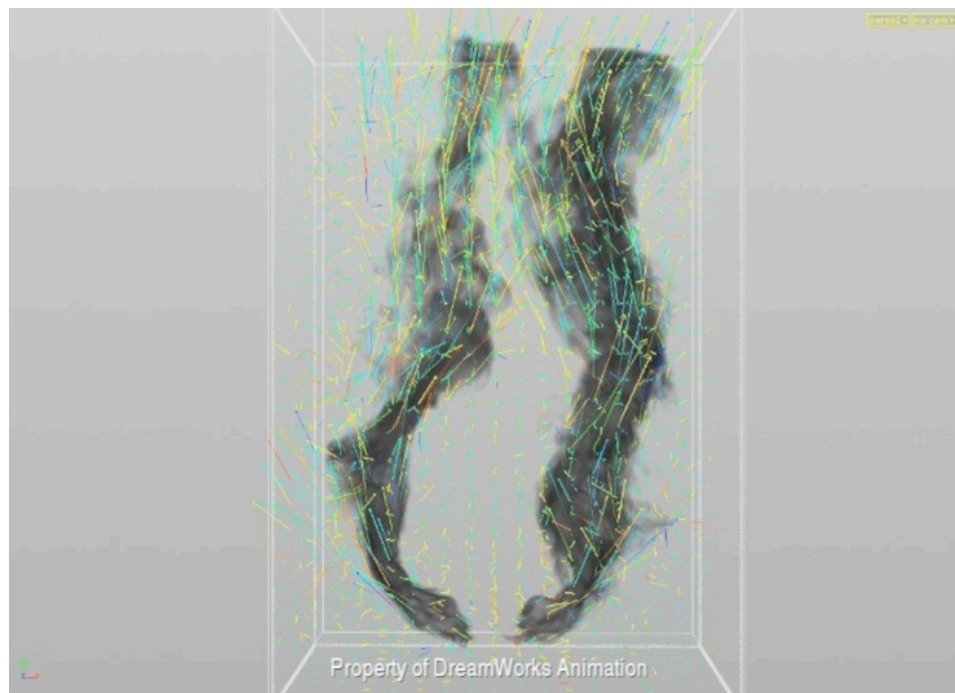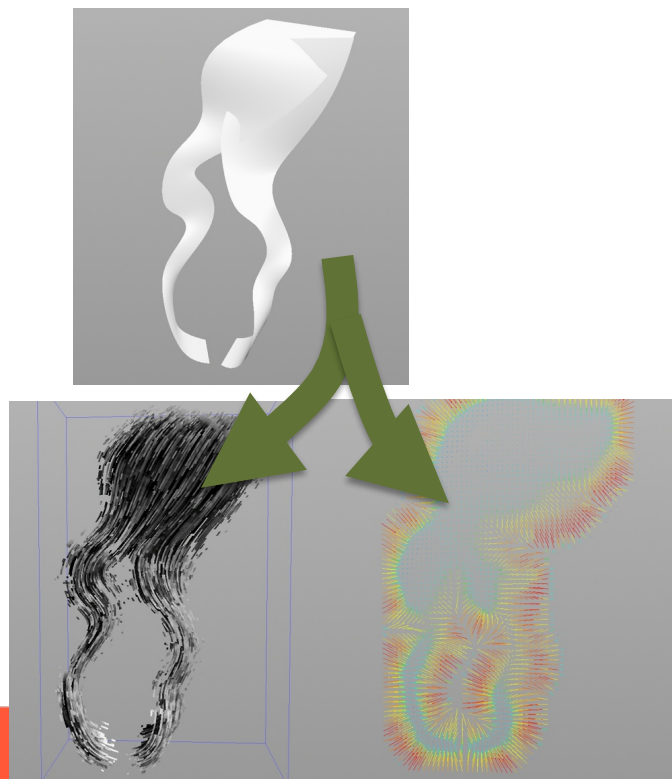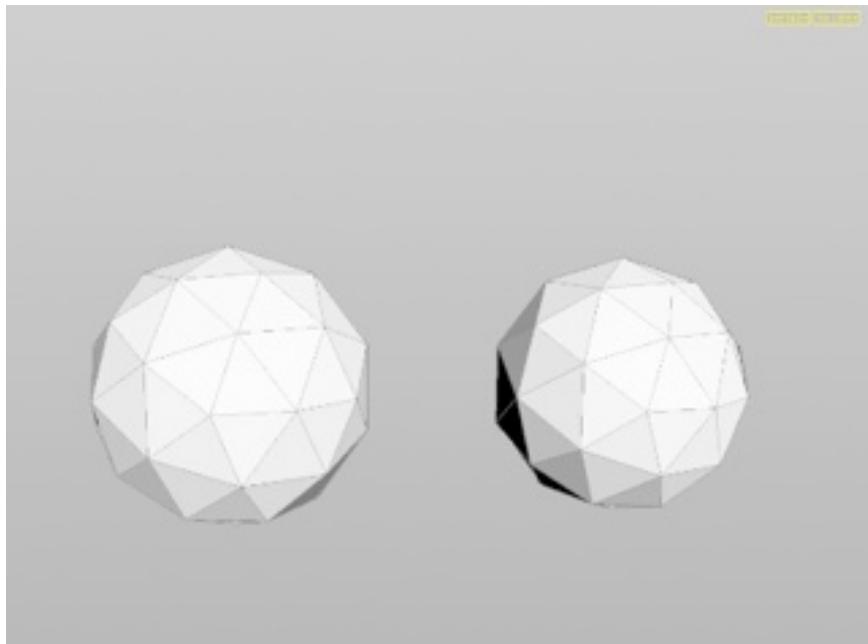
Advection

Forward Euler   Runge-Kutta 4ᵗʰ order   Level Set
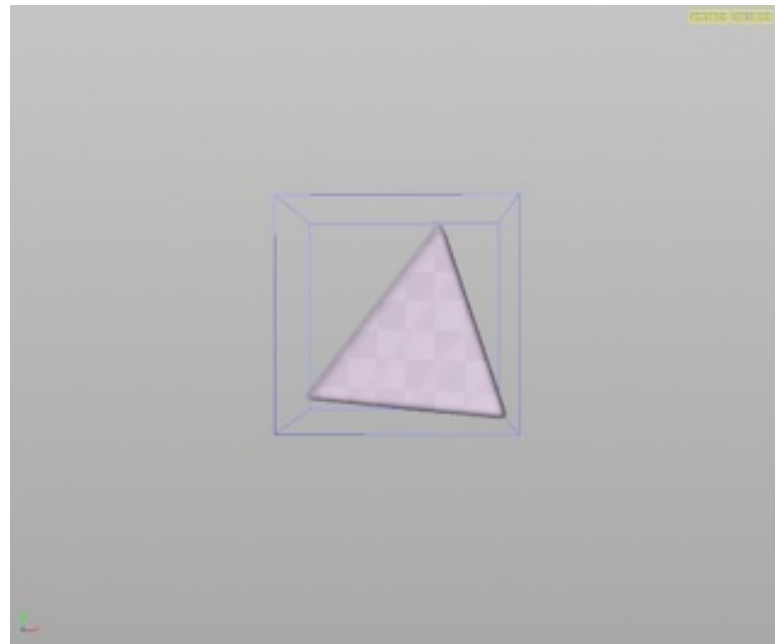
Constrained Advection

Constrained Advection

Constrained Advection

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Flow fields

Property of DreamWorks Animation

Lipton, D., Museth, K., Sutherland, B. Jack's Frost: Controllable Magic Frost Sim. for Rise of The Guardians. Siggraph 2013
Ghoniem, A. and Museth, K. Hair growth by means of sparse volumetric modeling and advection. Siggraph 2013

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Fluid Simulation

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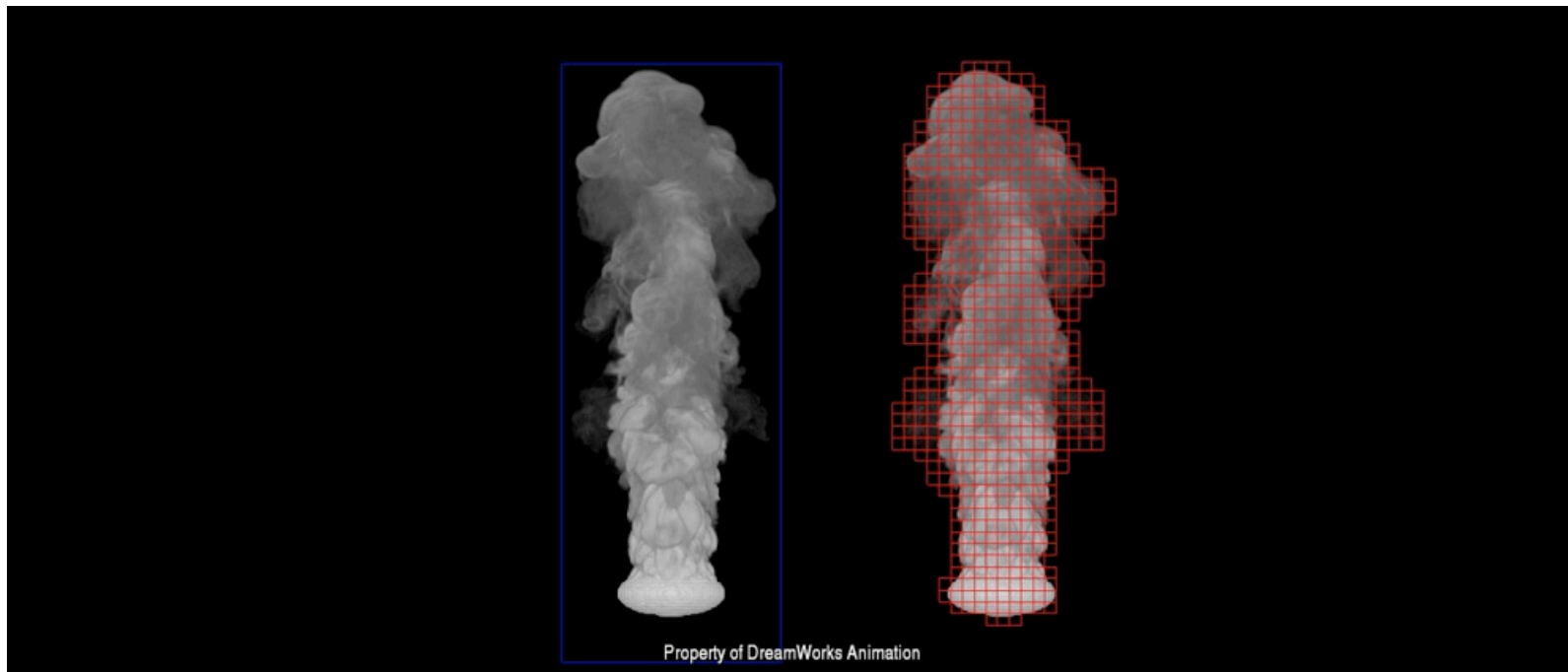
Henderson, R. Scalable Fluid Simulation in Linear Time on Shared Memory Multiprocessors. DigiPro, 2012

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Fluid Simulation

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Lee, F. Snow in How To Train Your Dragong 2. Siggraph Dailies, 2015
Mayer, Jason. Pyro in The Croods. Siggraph Dailies, 2013.

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Volume Stamping

Volume Stamping

Property of DreamWorks Animation

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Volume Stamping

Volume Stamping

original: 130   retimed: 180.62
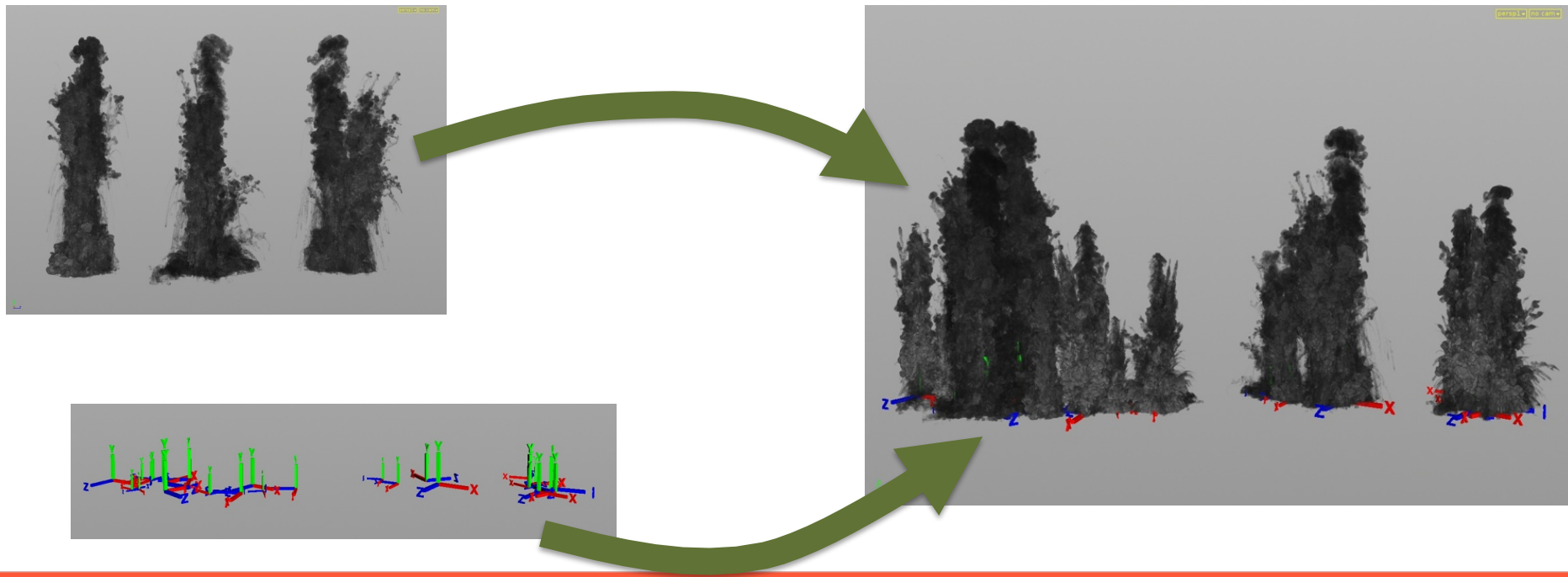
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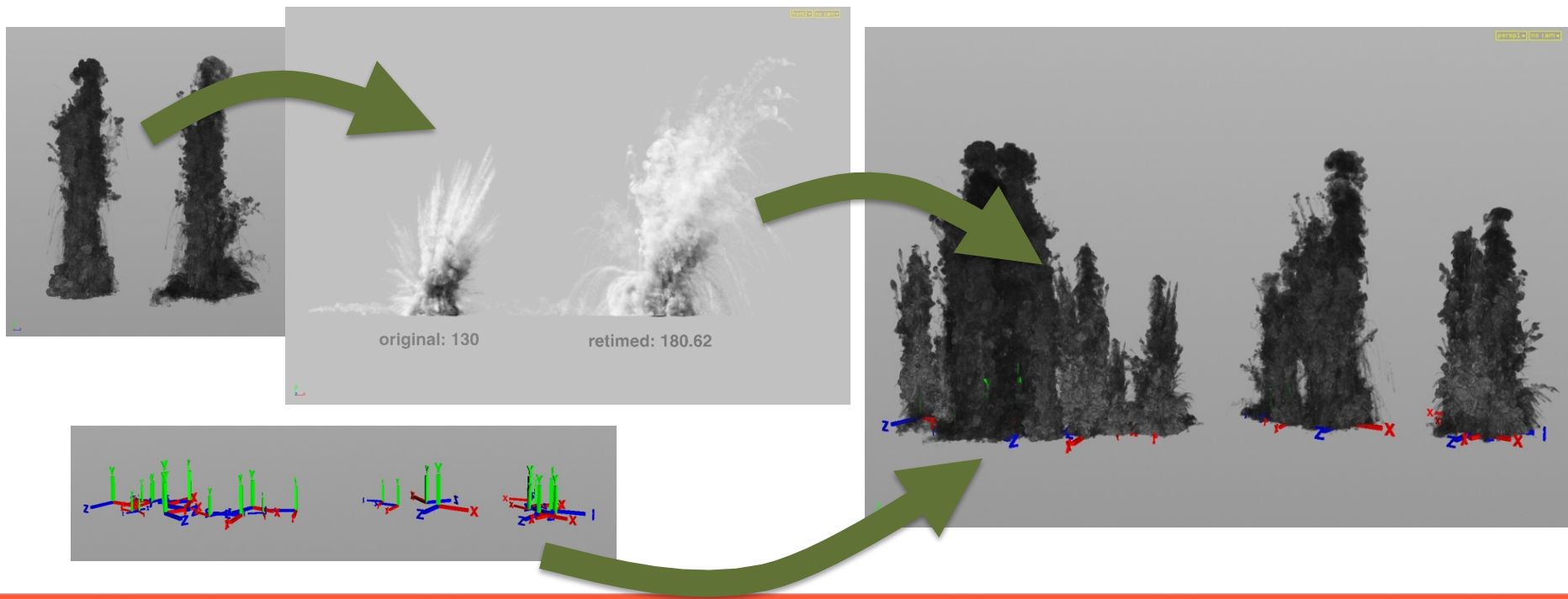
Volume deformation
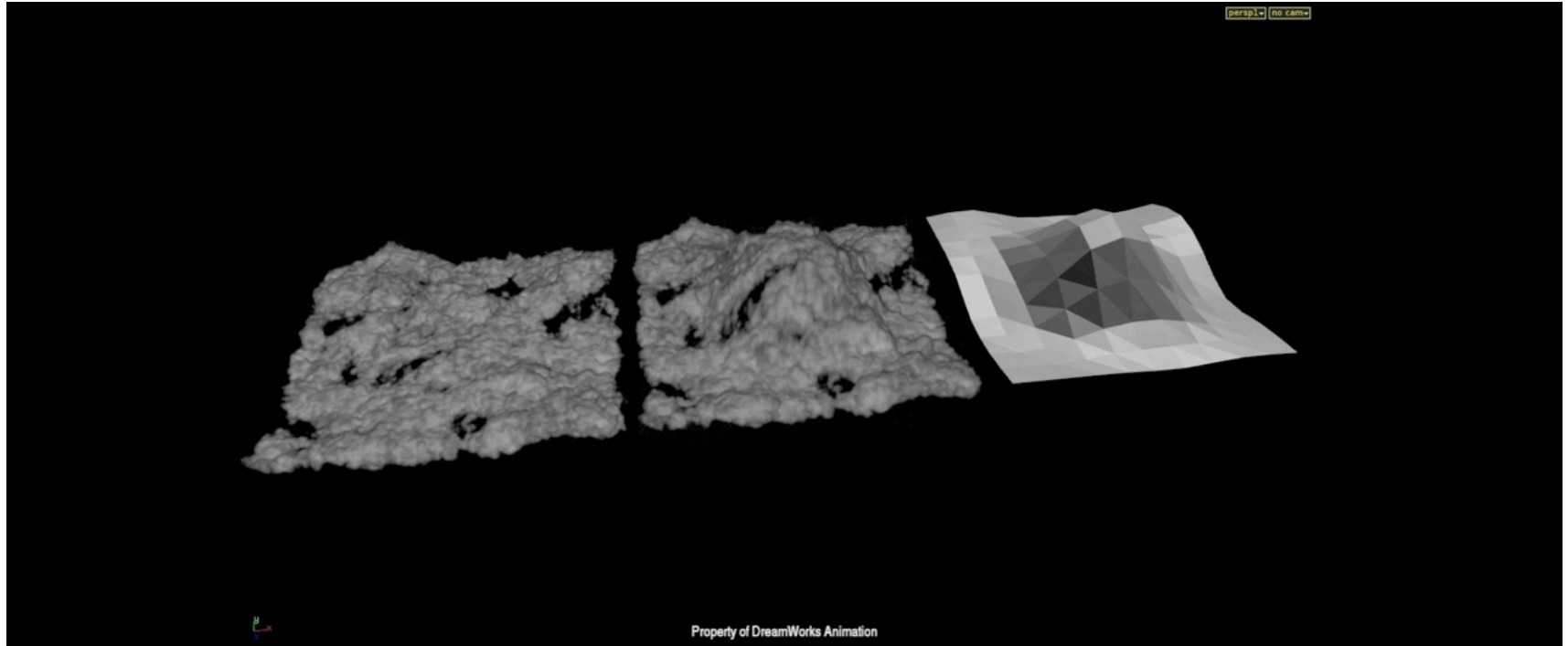
Volume deformation

Property of DreamWorks Animation

Volume deformation

Volume deformation

Property of DreamWorks Animation

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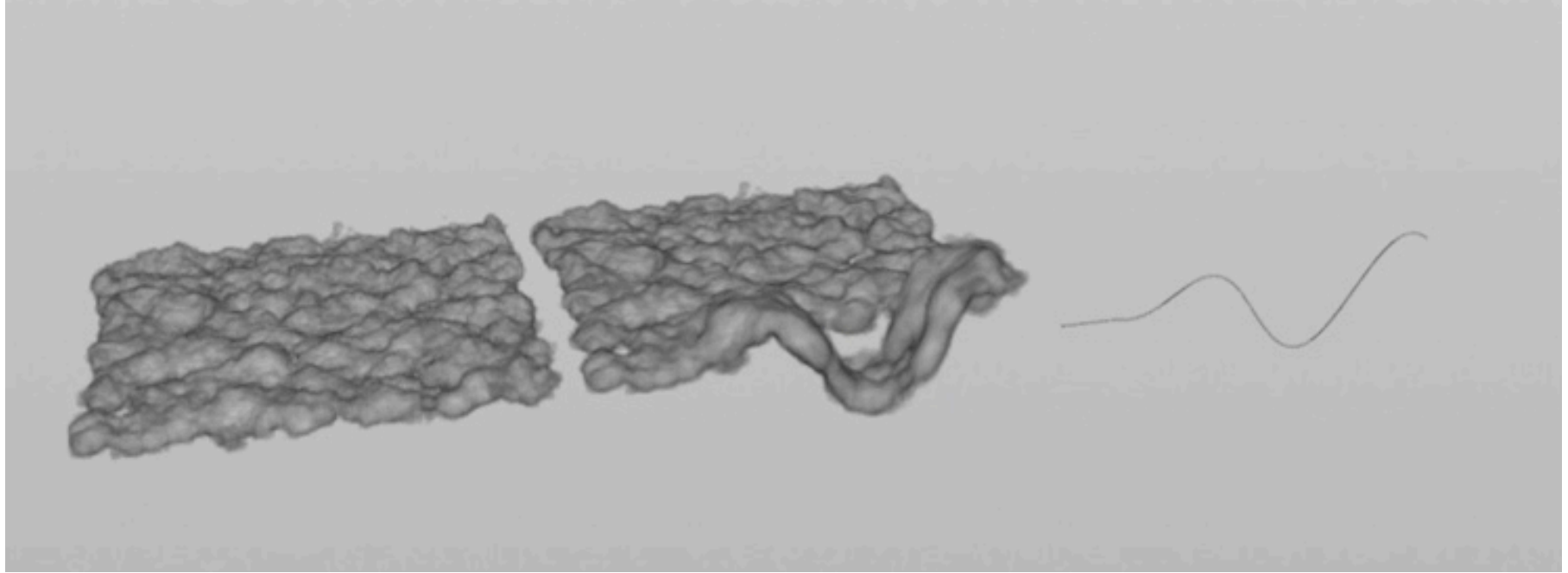
Volume Fracture

Desire better-looking fractures

- Art-directed shapes
- Organic
- Concave
- Interlocking

Alden, M., Melich, G. and Museth, K. Efficient and seamless volumetric fracture.
Siggraph Talk, 2012

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Volume Fracture

Proxy Generation

Decomposing yields degenerate initial RBD state!

Budsberg, J., Bin Zafar, N., Alden, M. Elastic and Plastic Deformations with Rigid Body Dynamics.   Siggraph Talk, 2014
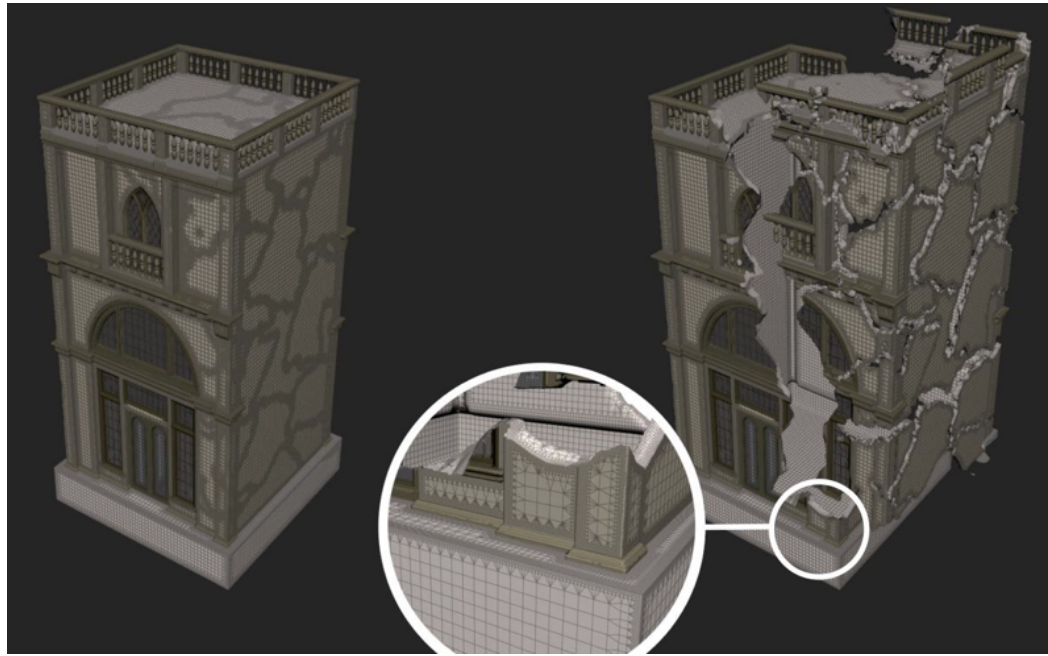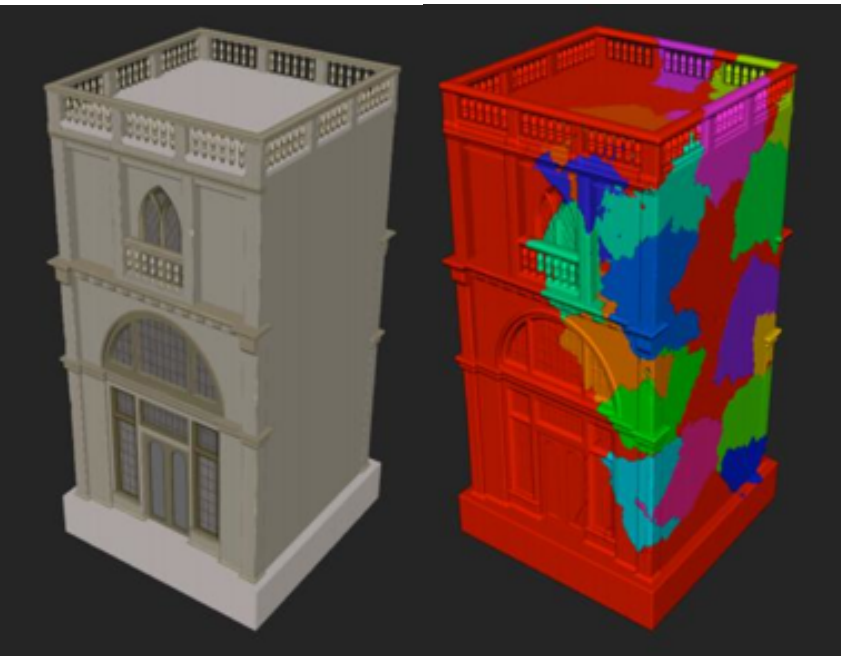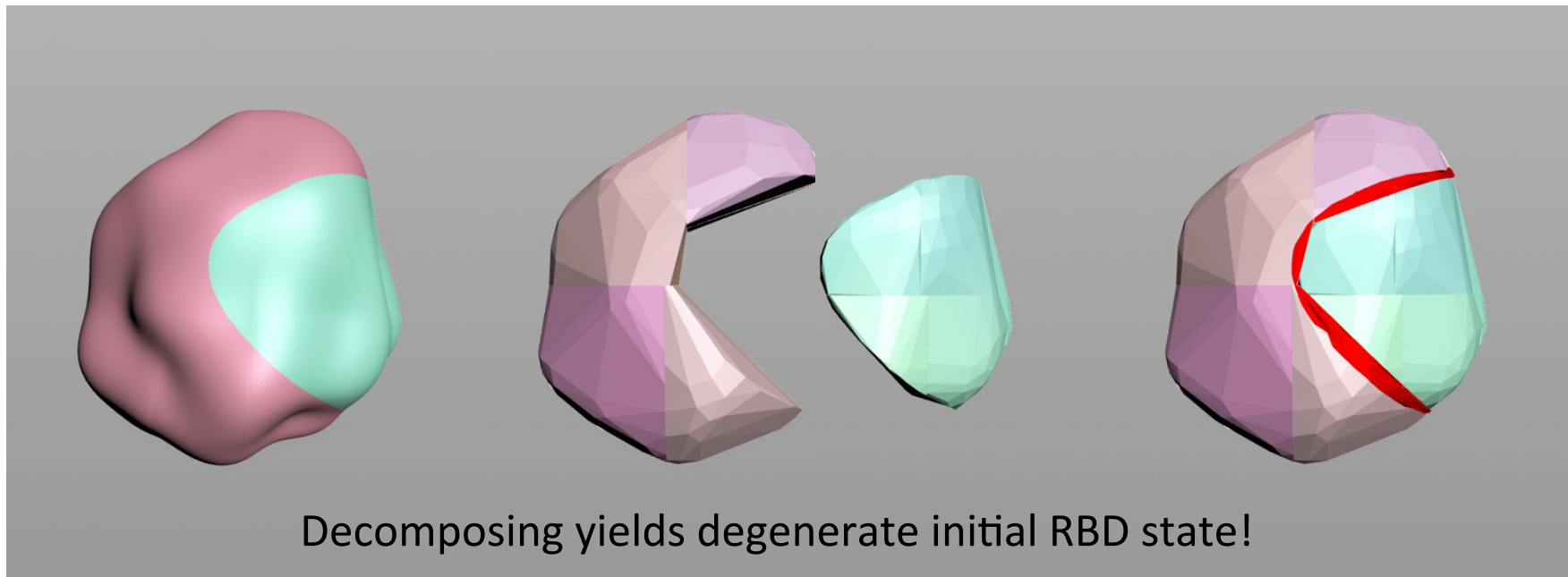
Proxy Generation

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Proxy Generation

Robust
- Concave features, holes, self-intersections
- Proxy always inside

Fast
- Takes full advantage of multi-threaded hardware

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Elastic Deformation

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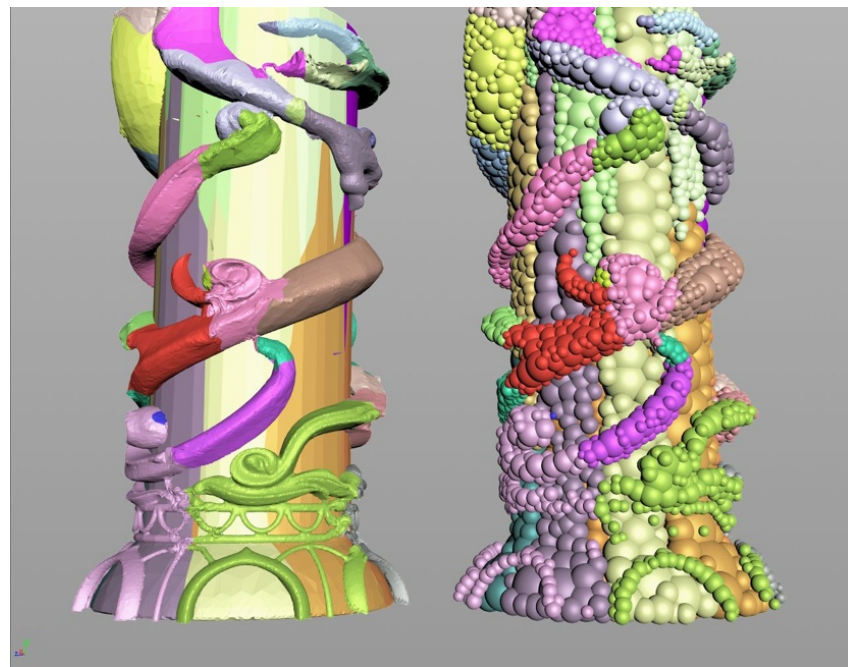
Elastic Deformation

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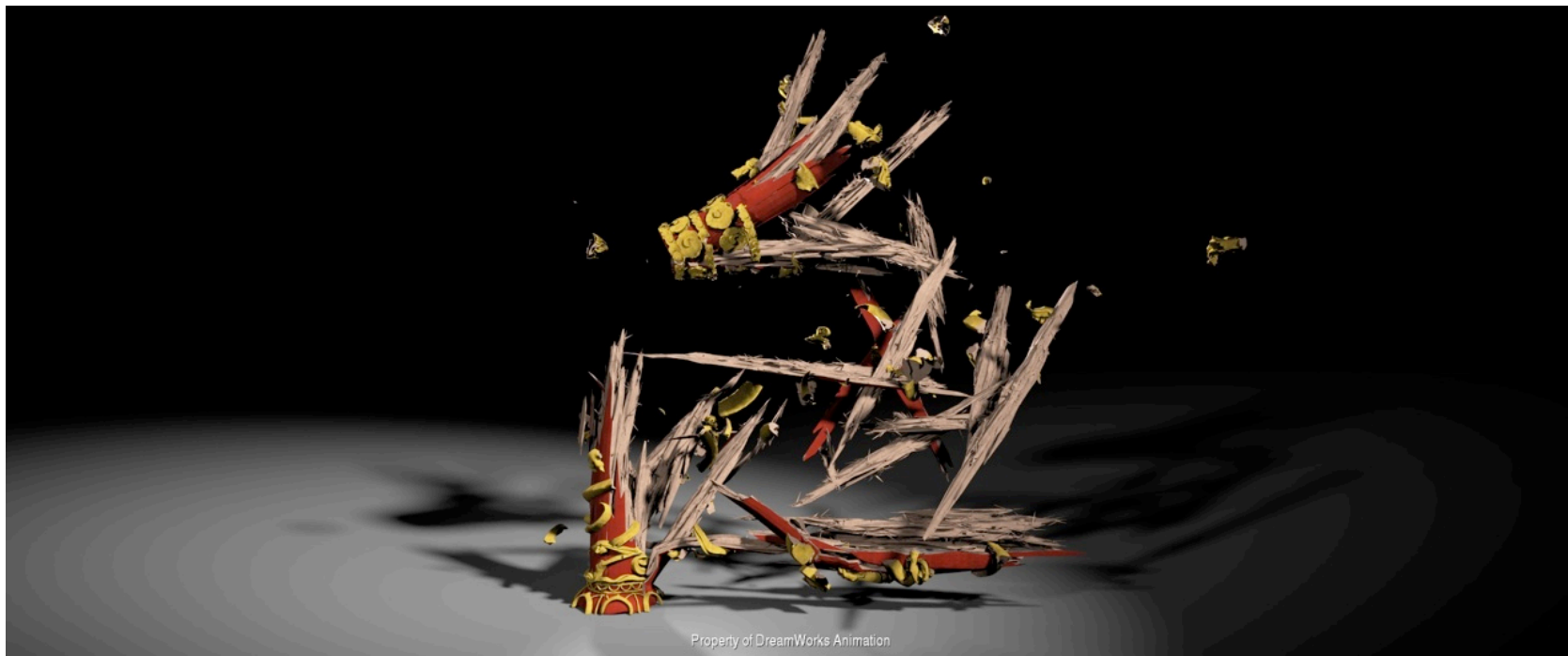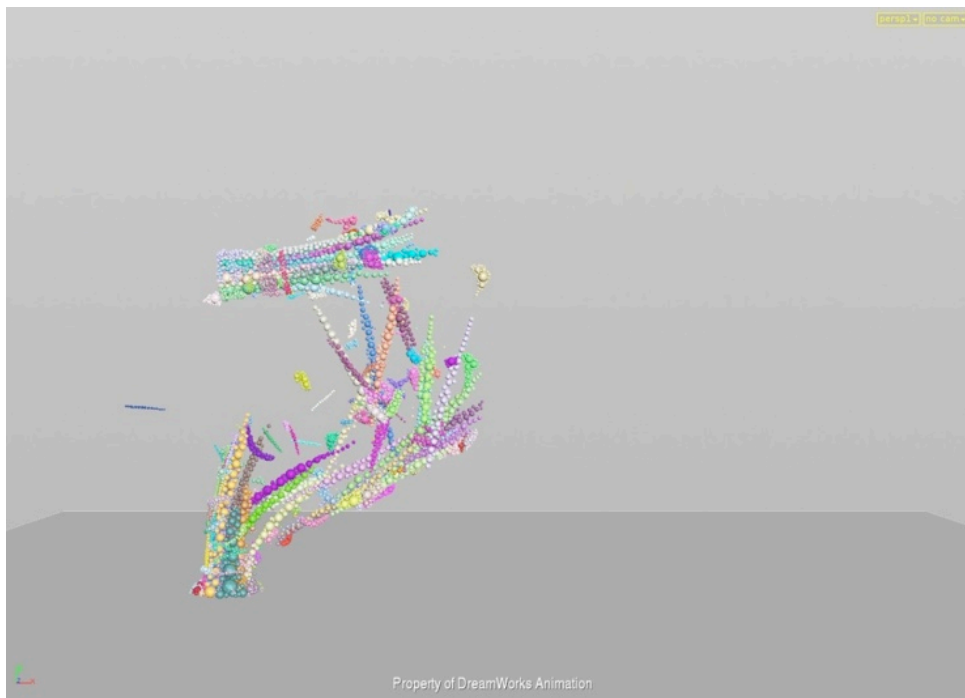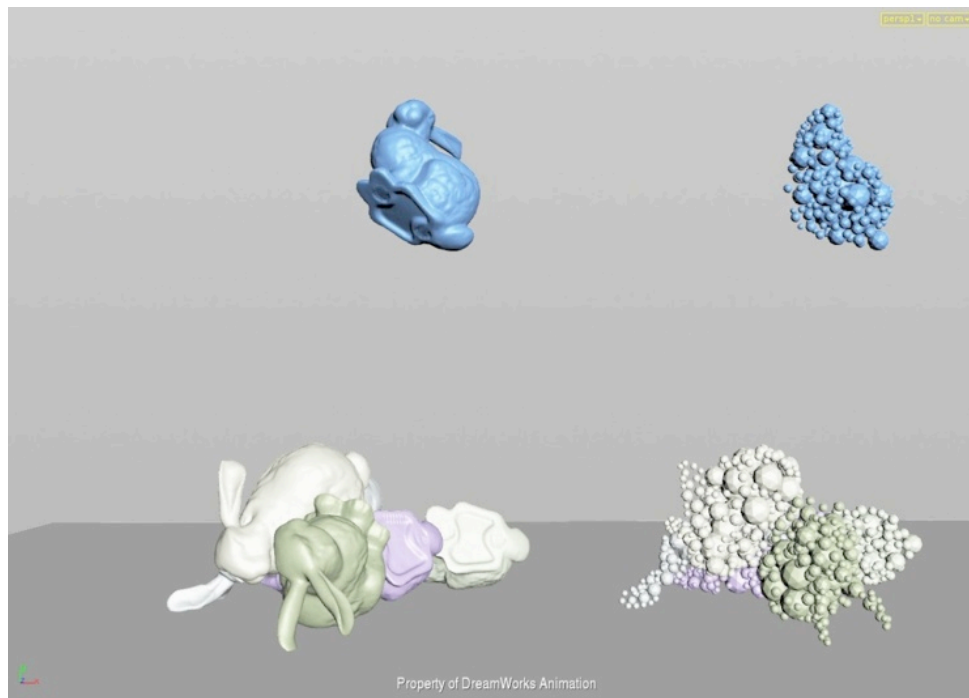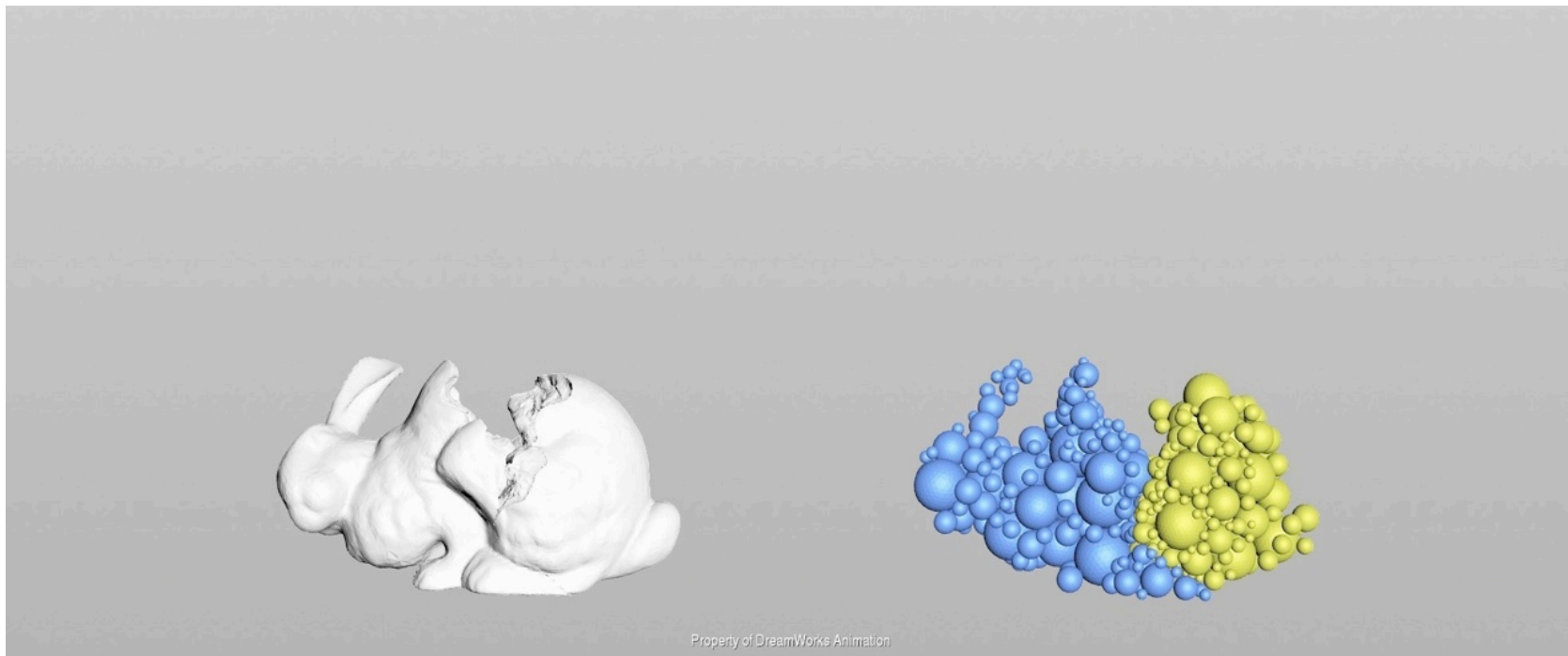the dream is everything

Collisions

Many options!

- Watertight polygonal
- Level set
- Spheres

Collisions

Many options!
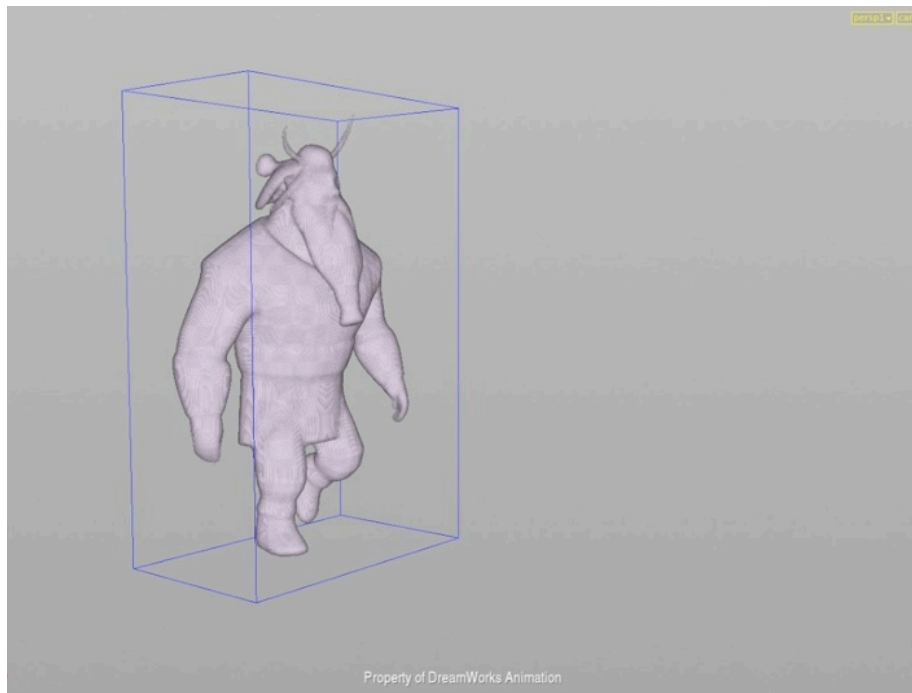
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Collisions

Many options!

- Watertight polygonal
- Level set
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Visualization

Matthews, M. Amorphous: An OpenGL Sparse Volume Renderer. ACM Siggraph Talks, 2012

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Visualization

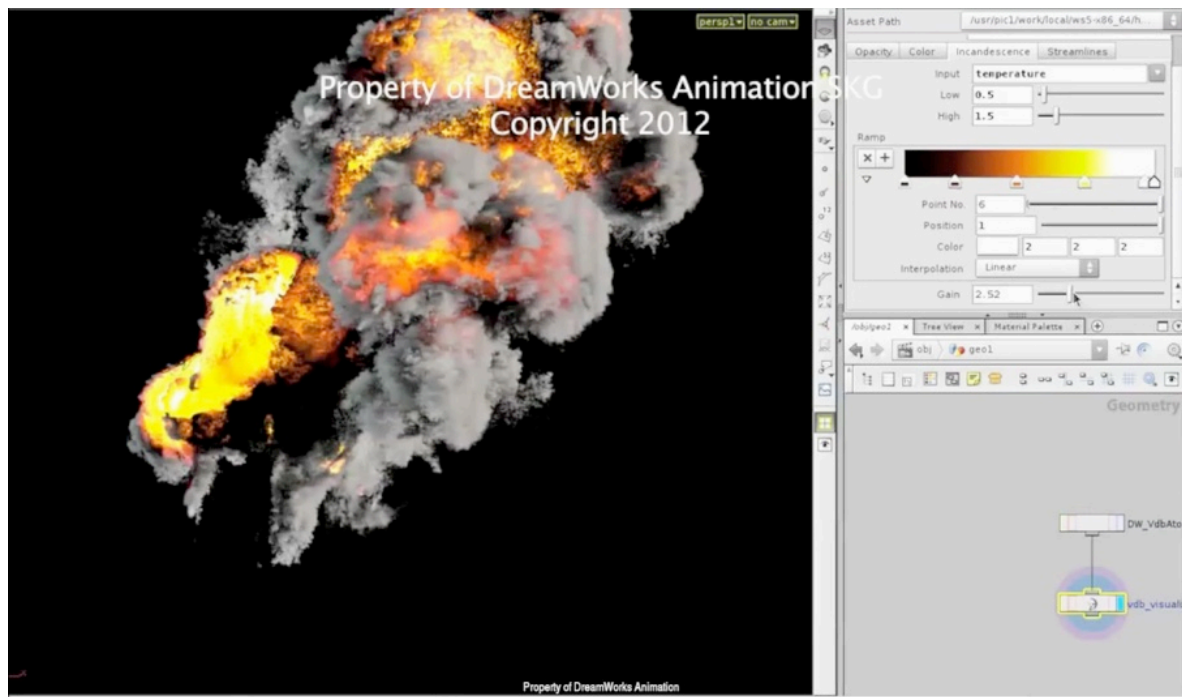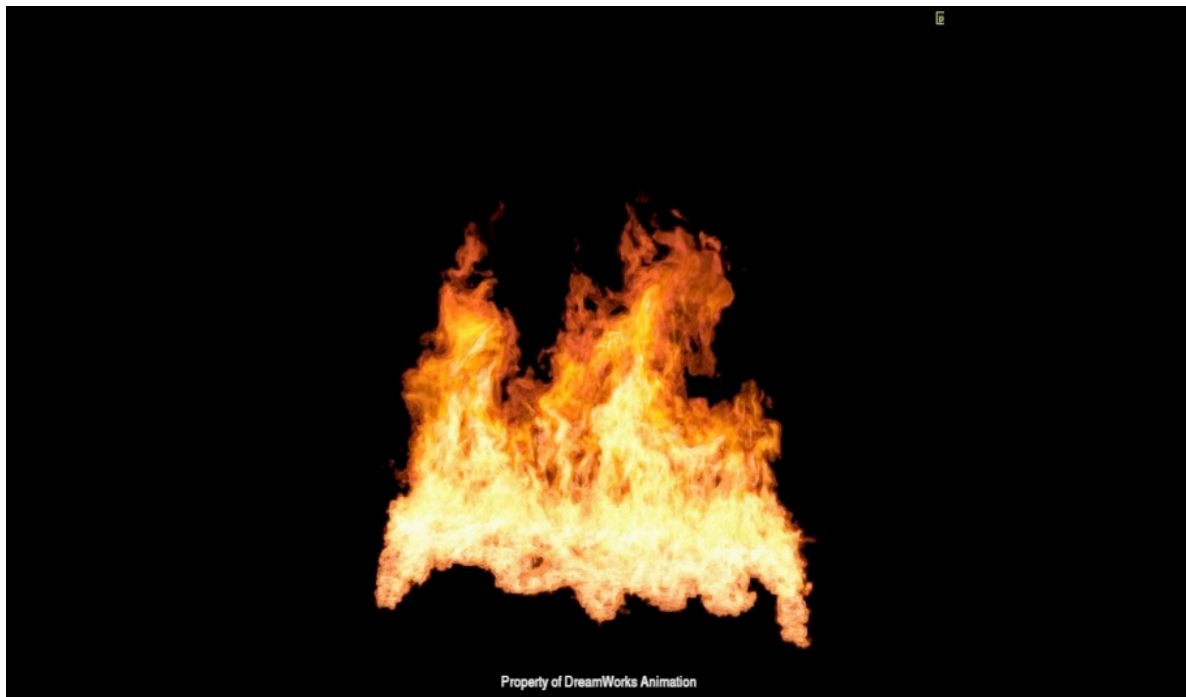

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Conclusion

- Tons of applications
- Modular toolset
- Fast & efficient operations on huge datasets
- Easy to make new tools

Thanks!

FX R+D
- Ken Museth
- Mihai Alden
- David Hill
- Peter Cucka

Michael Losure
Baptiste Van Opstal
Mark Matthews

Questions?

Forget to ask something?
www.openvdb.org/forum