OpenVDB Course:

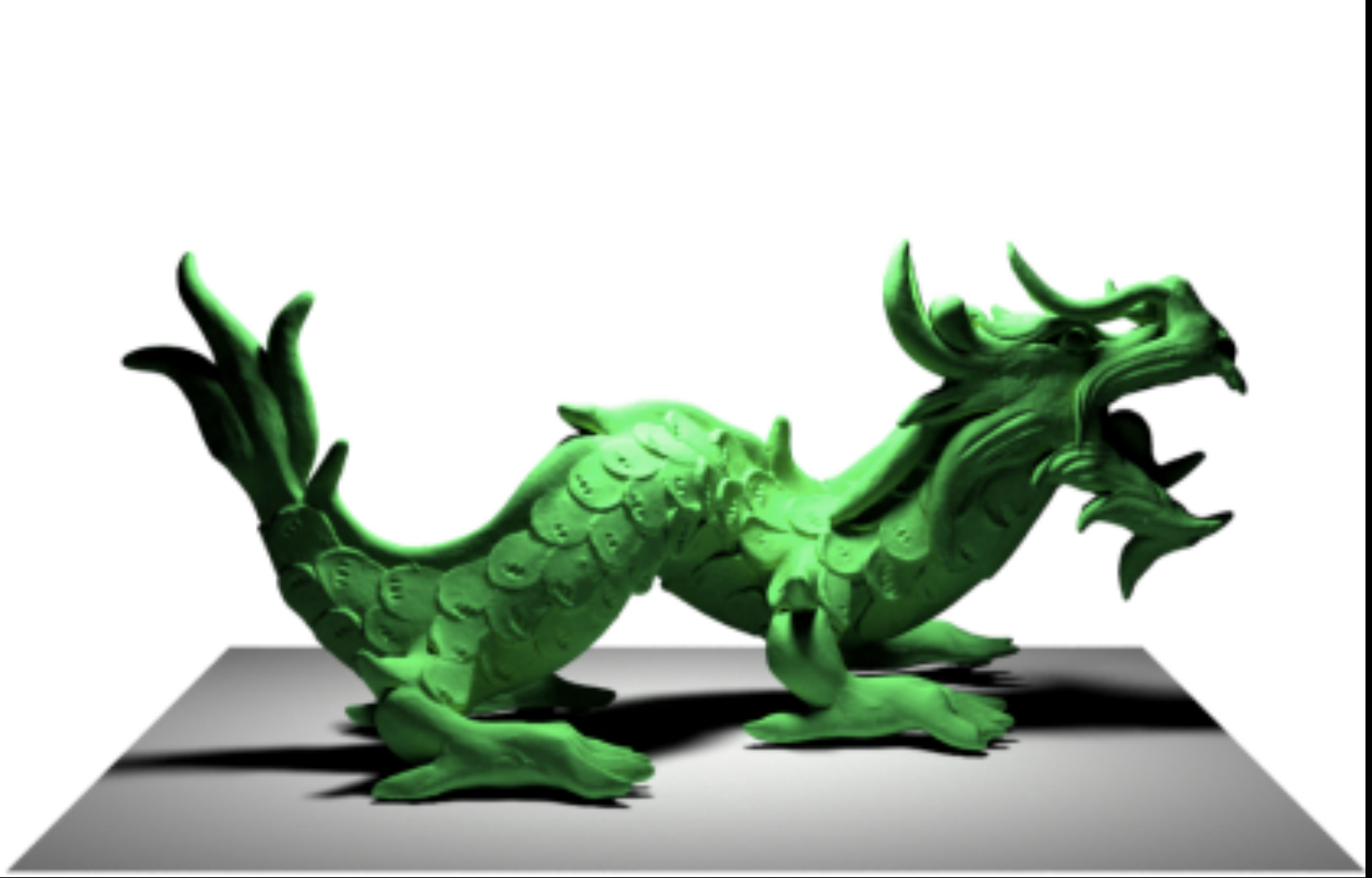
Advanced Applications of OpenVDB in Production

double negative visual effects
dan bailey (dan@dneg.com)

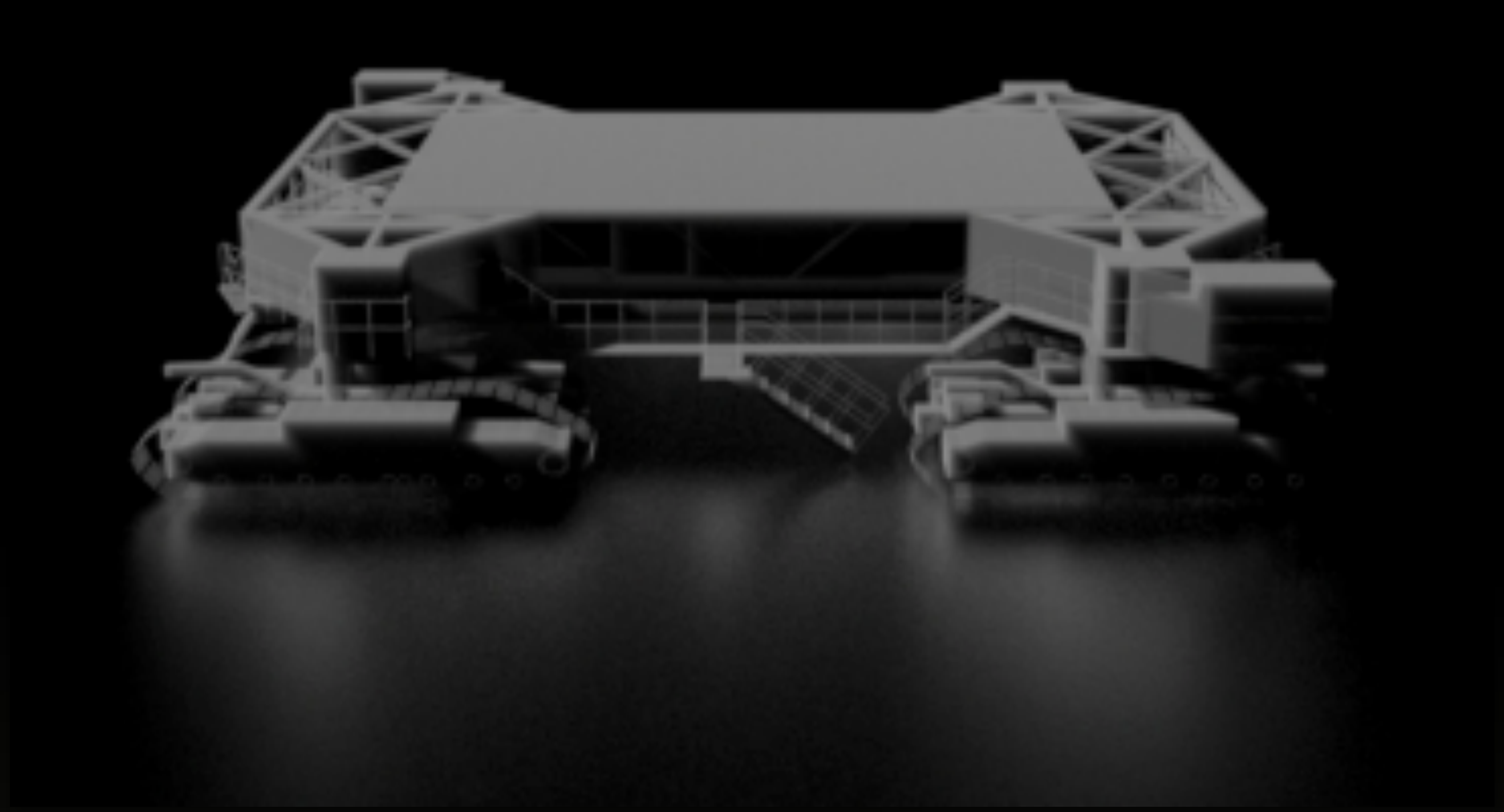
OpenVDB

OpenVDB Uses

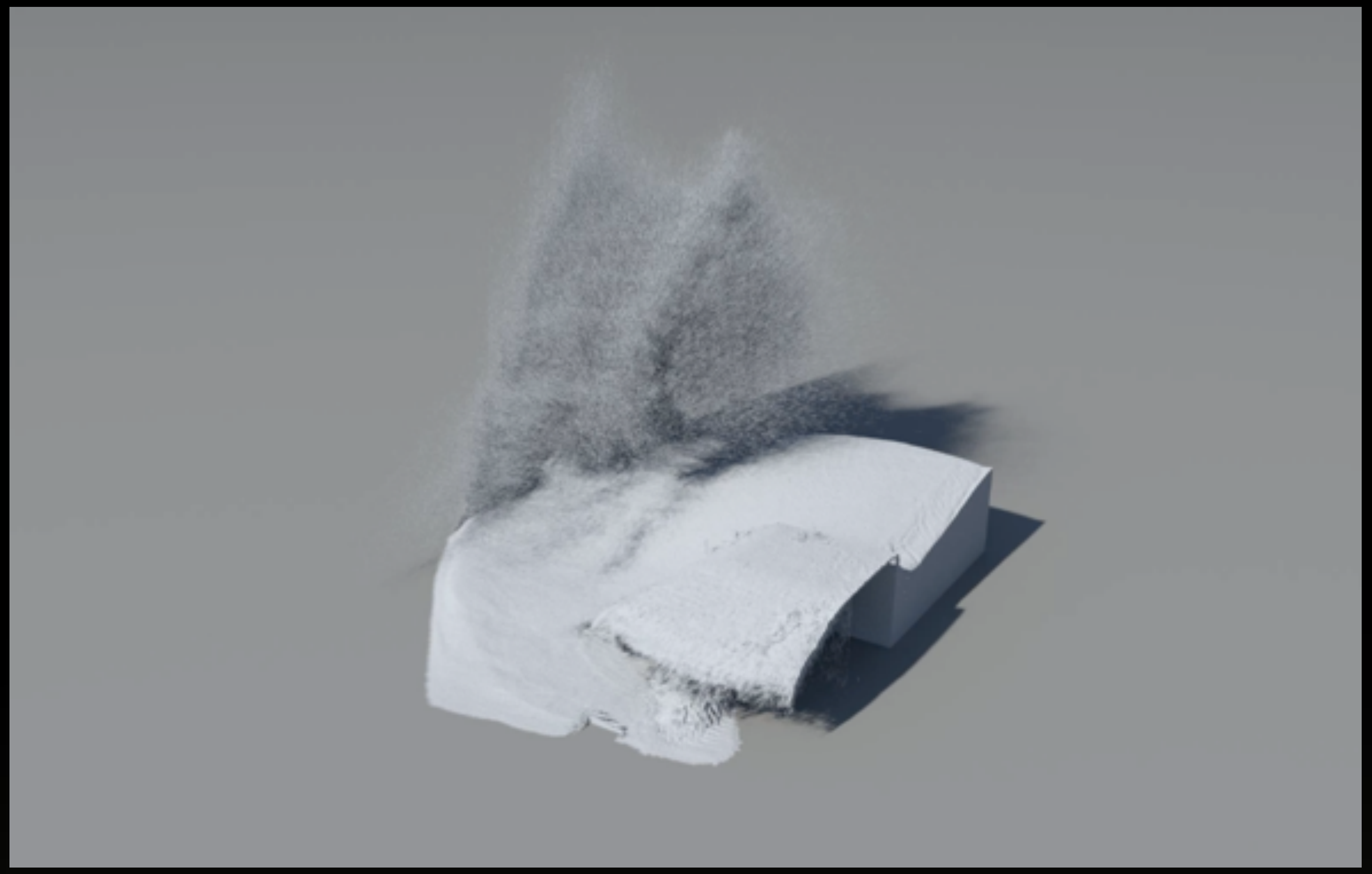
double negative visual effects



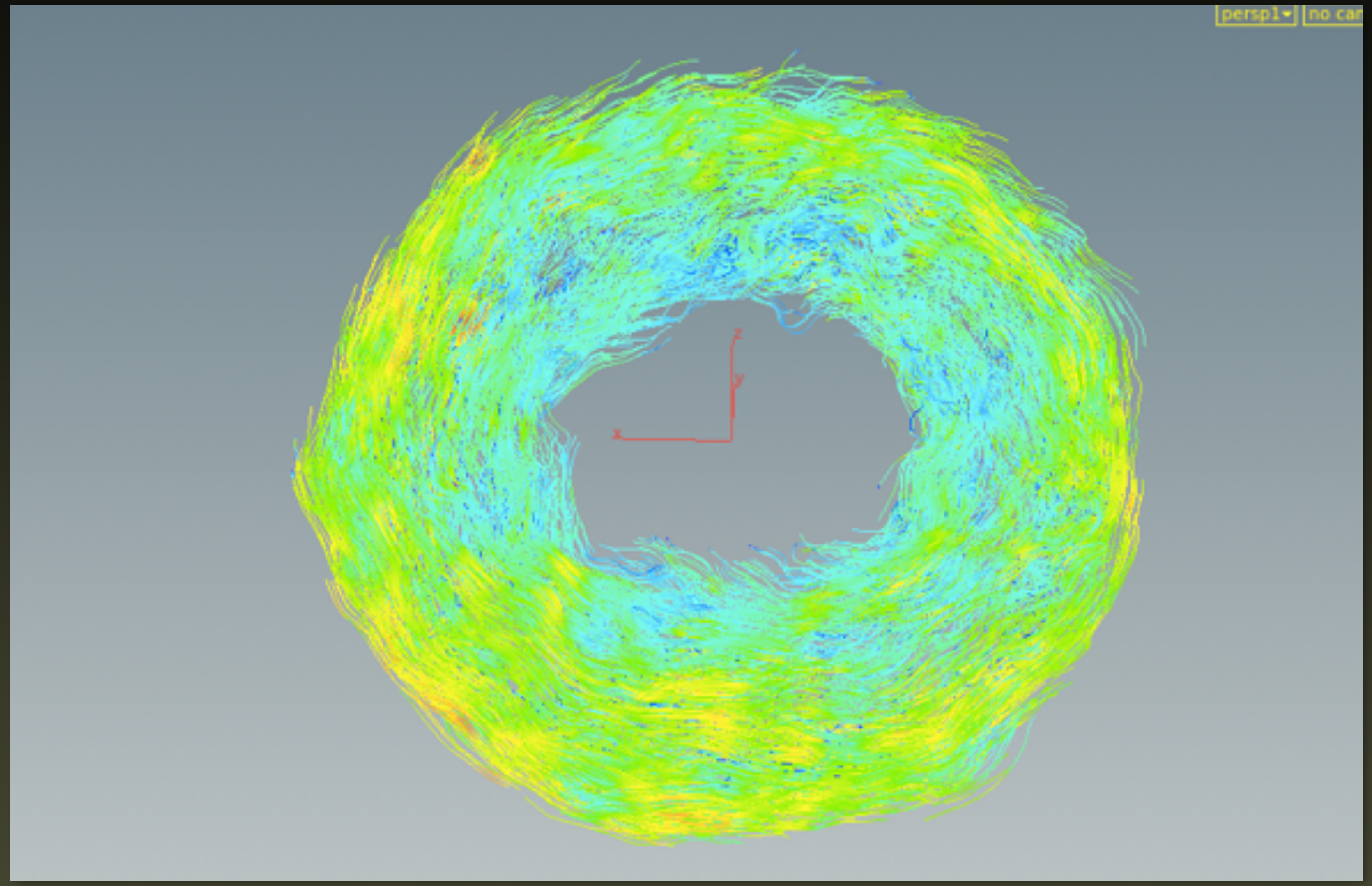
Level Set



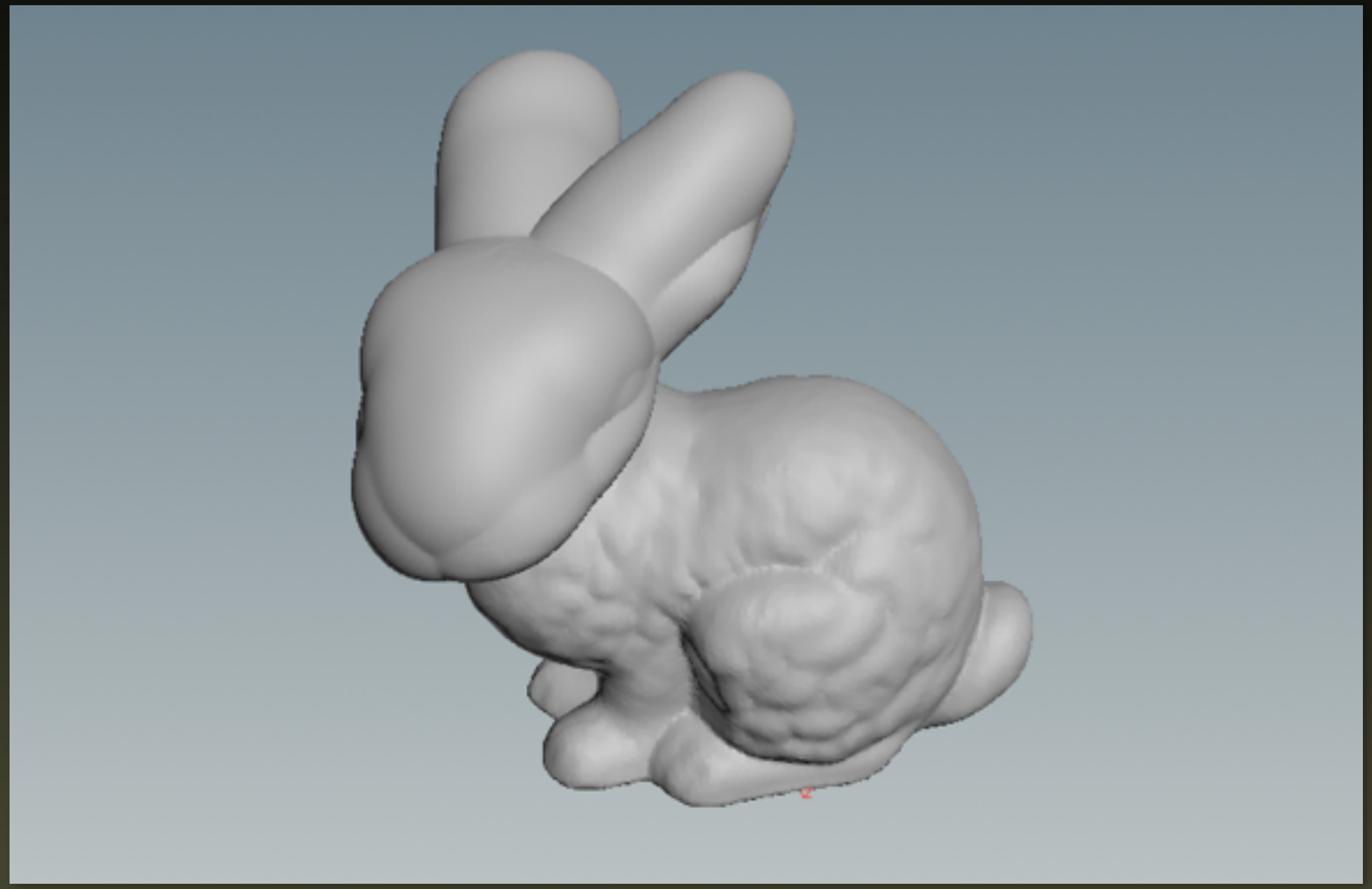
Fog Volume



Points (New)



Vector Field



Alpha Mask

Attributes

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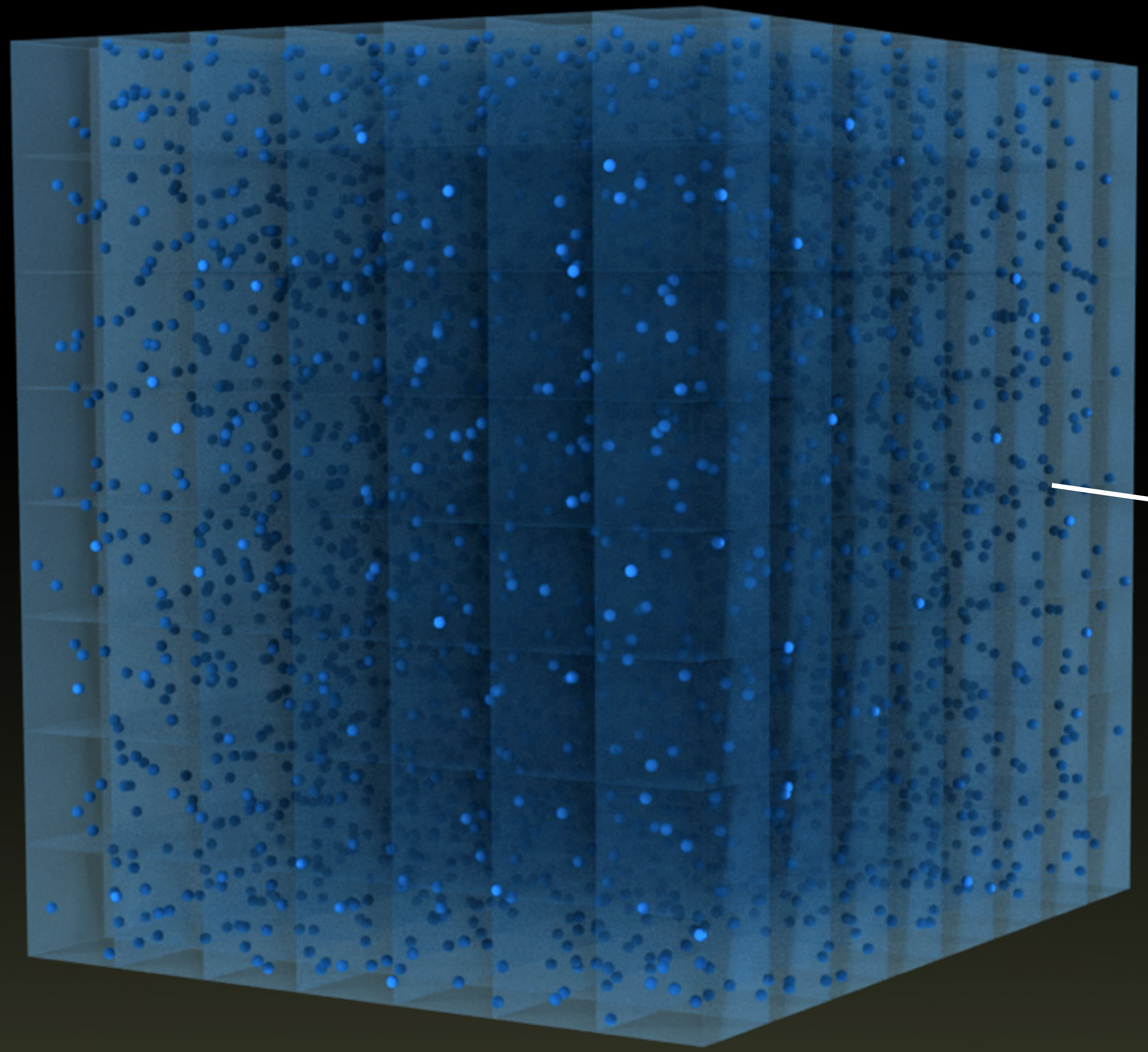
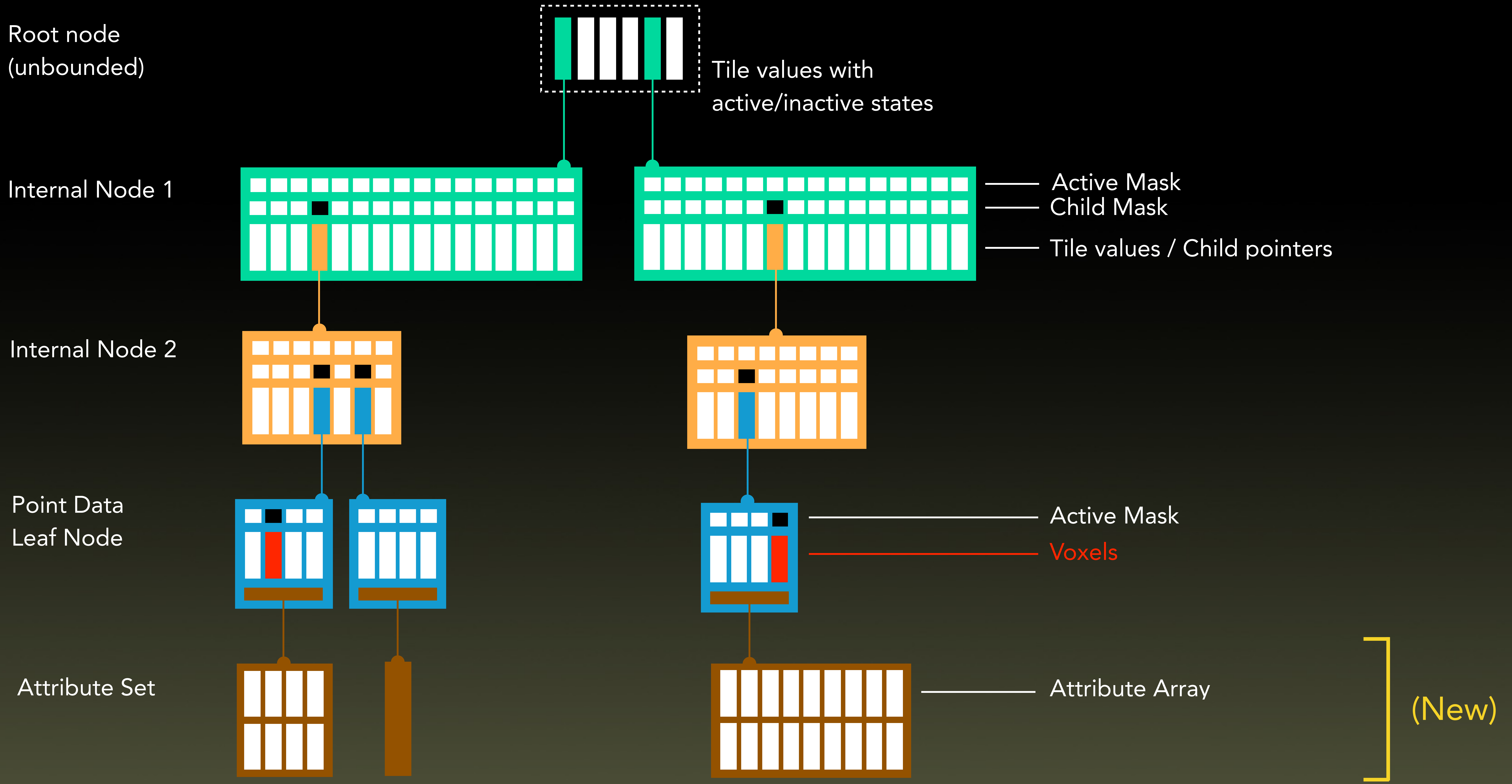
- OpenVDB extended with new Attribute API
- AttributeArray.h and AttributeSet.h

VDB Points Leaf Node



Points located within a Leaf Node are owned by that Leaf along with all of their attributes

VDB Points Data Structure



Point Data Class Structure

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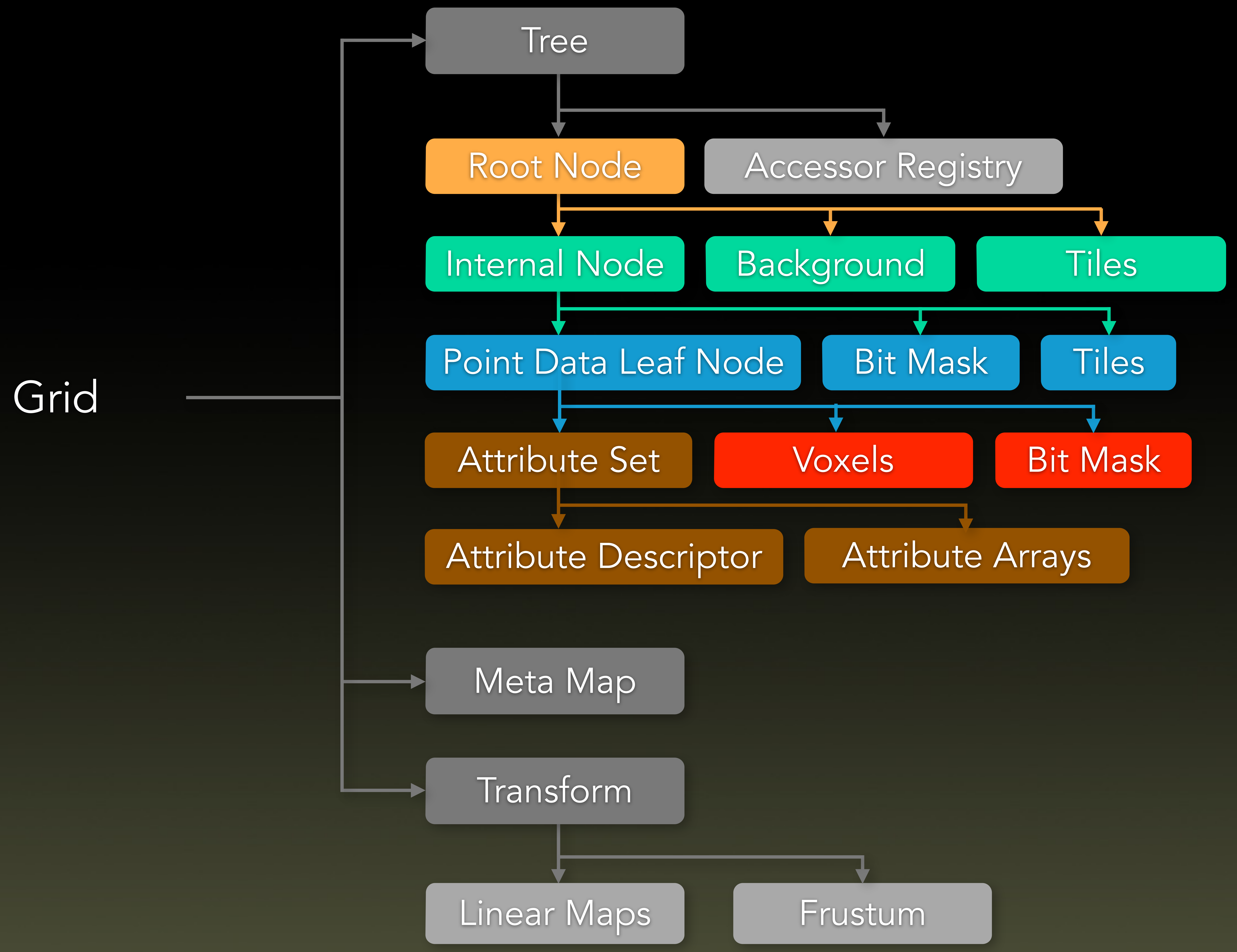
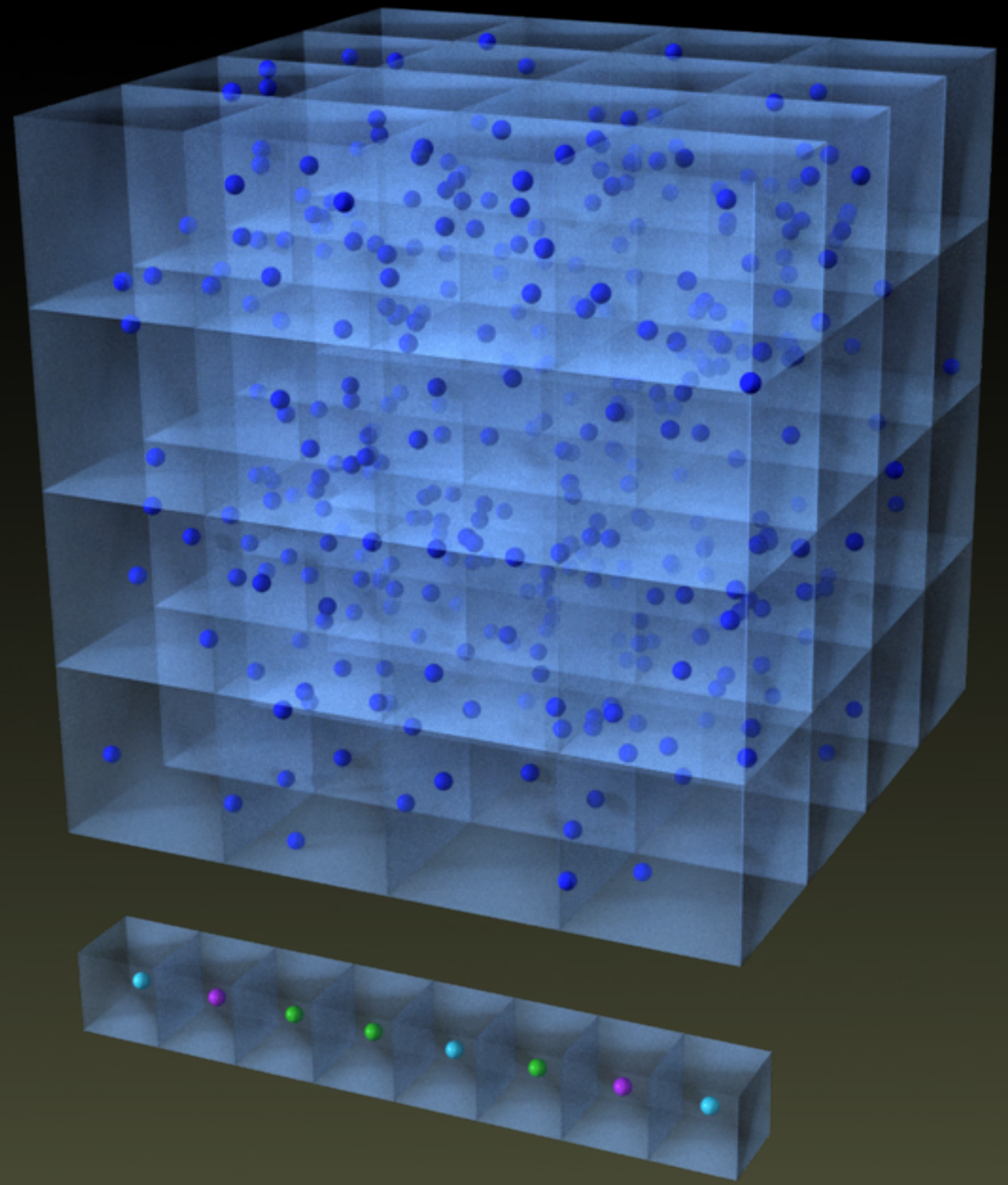


Dynamic Attribute Arrays

Leaf Nodes can store different attributes (from each other)

However, not typically supported by tools



OpenVDB

Motivation

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	Convenience	Performance	Memory	I/O	Distribution
Spatial Organisation	✓			✓	✓
Greater Compression			✓	✓	
Data Locality		✓			
VDB Topology and Tools	✓				

OpenVDB

In-Memory Compression

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Attribute Compression

(Not Available for Native Houdini Points)

(x, y, z) => (w)

3 x 32-bits 16-bits

Uniform Value Compression

(Available for Native Houdini Points)

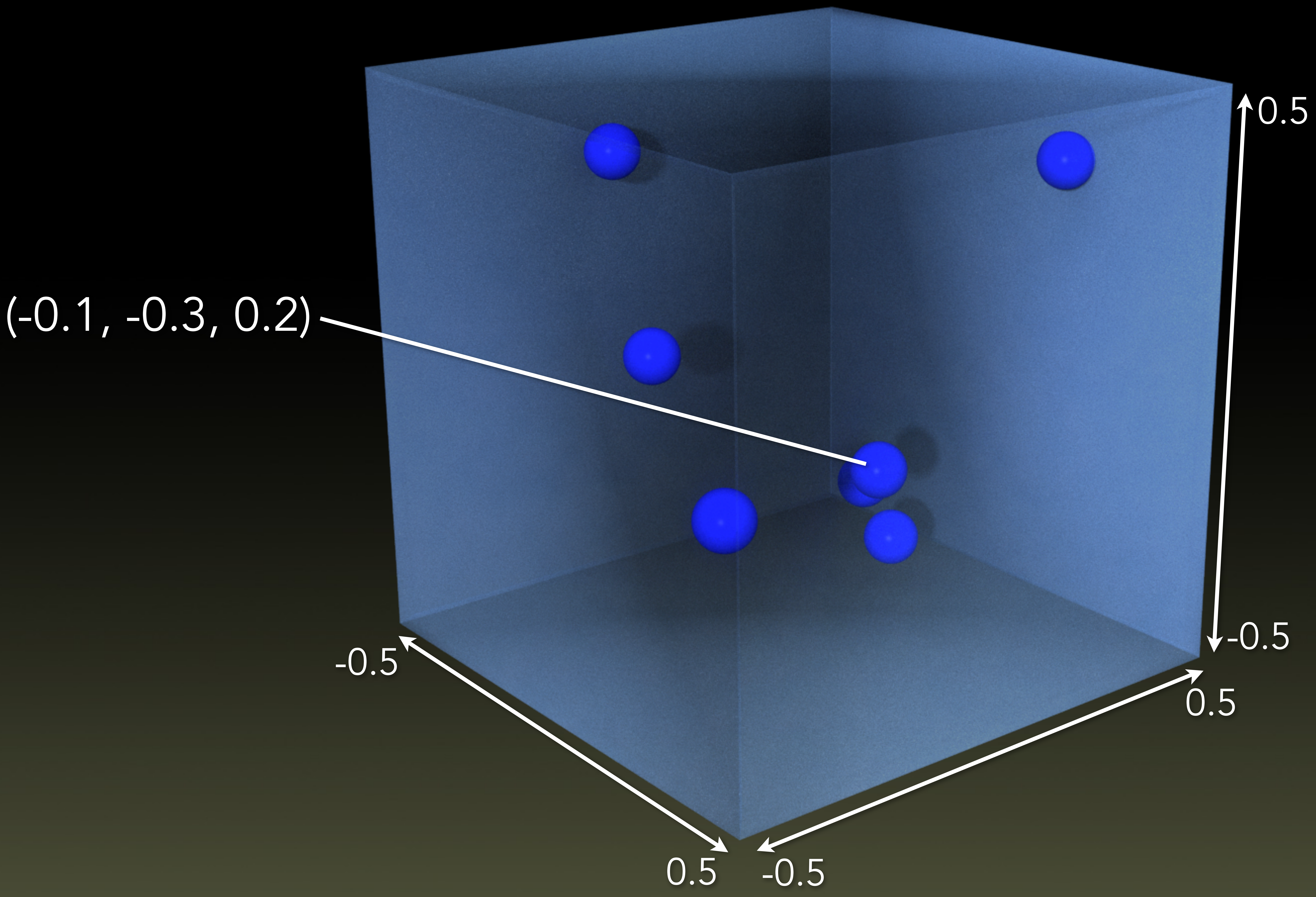
[1, 1, 1, 1, 1, 1, ...] => [1]

Stream Compression

=> =>

(Available for Native Houdini Points in Houdini 14 but only for disk compression)

Position Storage



Floating-point

Exponent

10110111

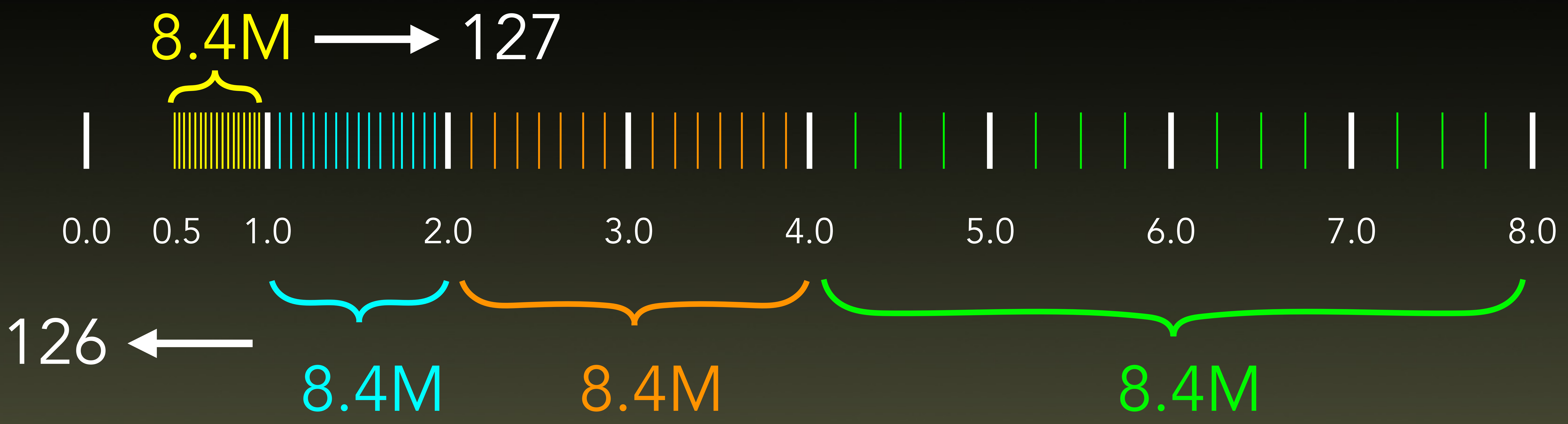
8 bits

Mantissa

010101110101010101010101010

24 bits

$$\boxed{1.\{mantissa\} \times 2^{\{exponent\}}}$$



Quantisation

Encoding

32-bit floating-point → (int) round(x * 2^{16f} + 0.5f) → 16-bit integer

Decoding

16-bit integer → float(x) / 2^{16f} → 32-bit floating-point

Position Compression

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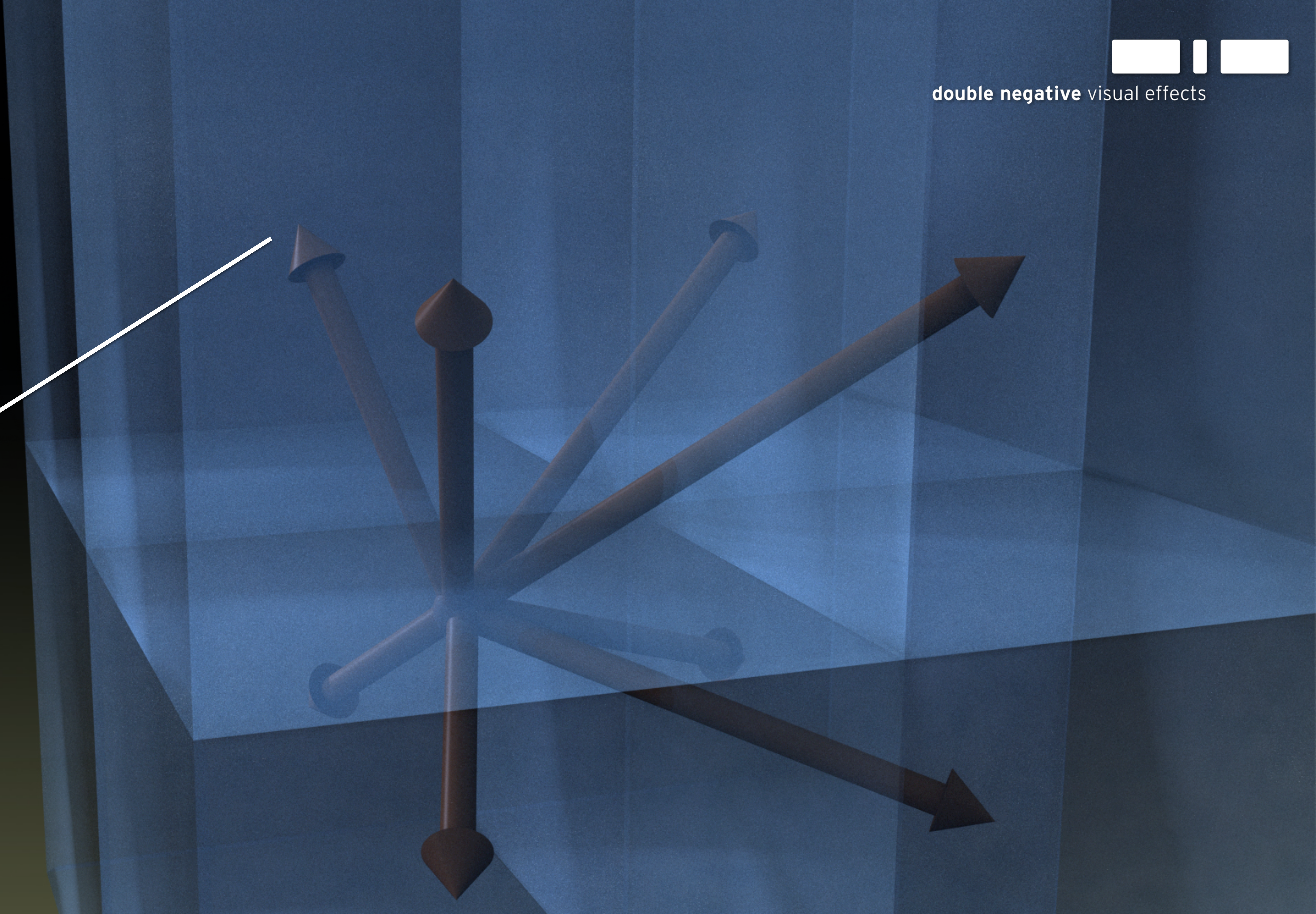
Float Array	No Quantisation	16-bit Quantisation	8-bit Quantisation
Memory: 1.92GB	Memory: 1.95GB	Memory: 1.02GB	Memory: 568MB

OpenVDB



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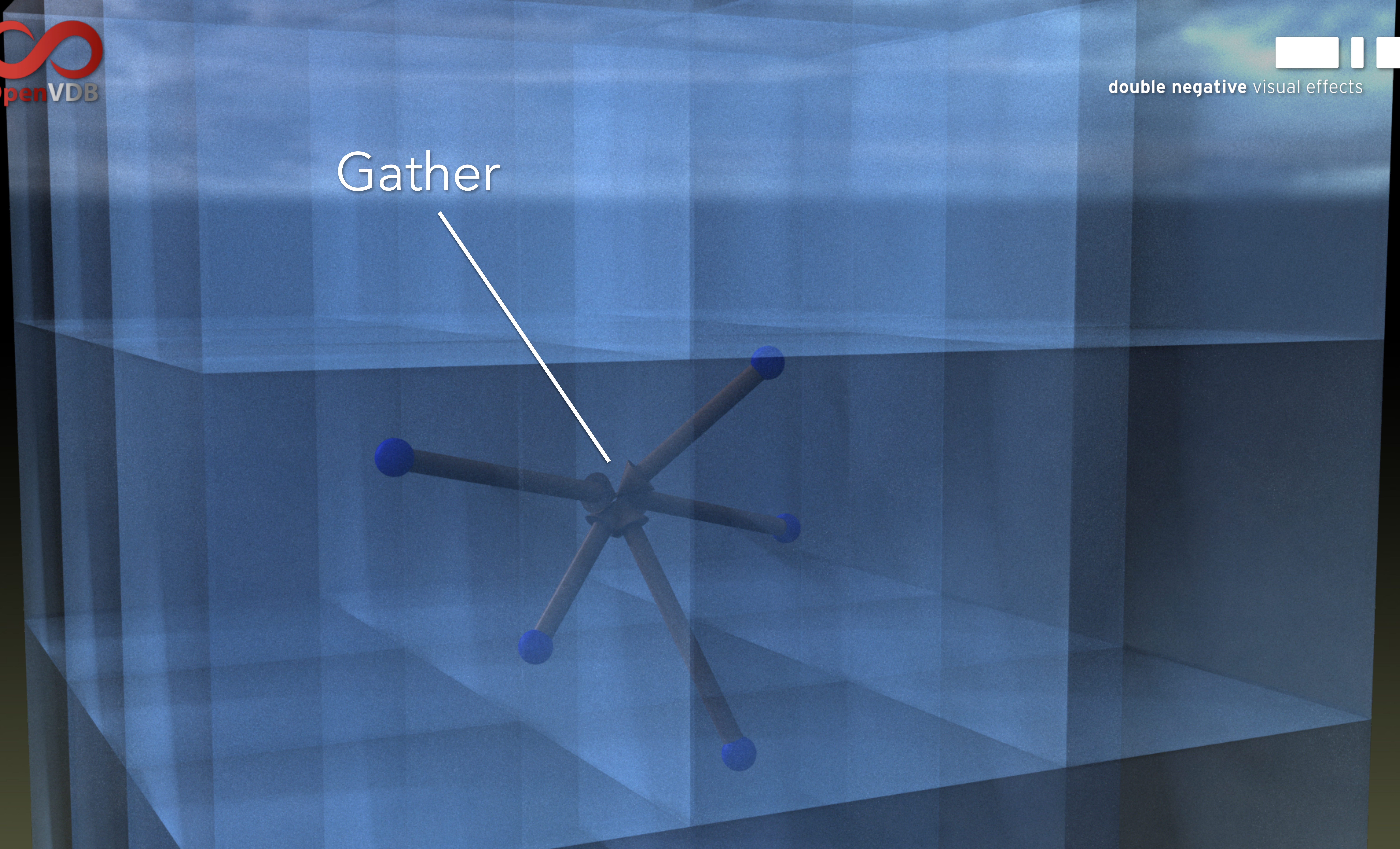
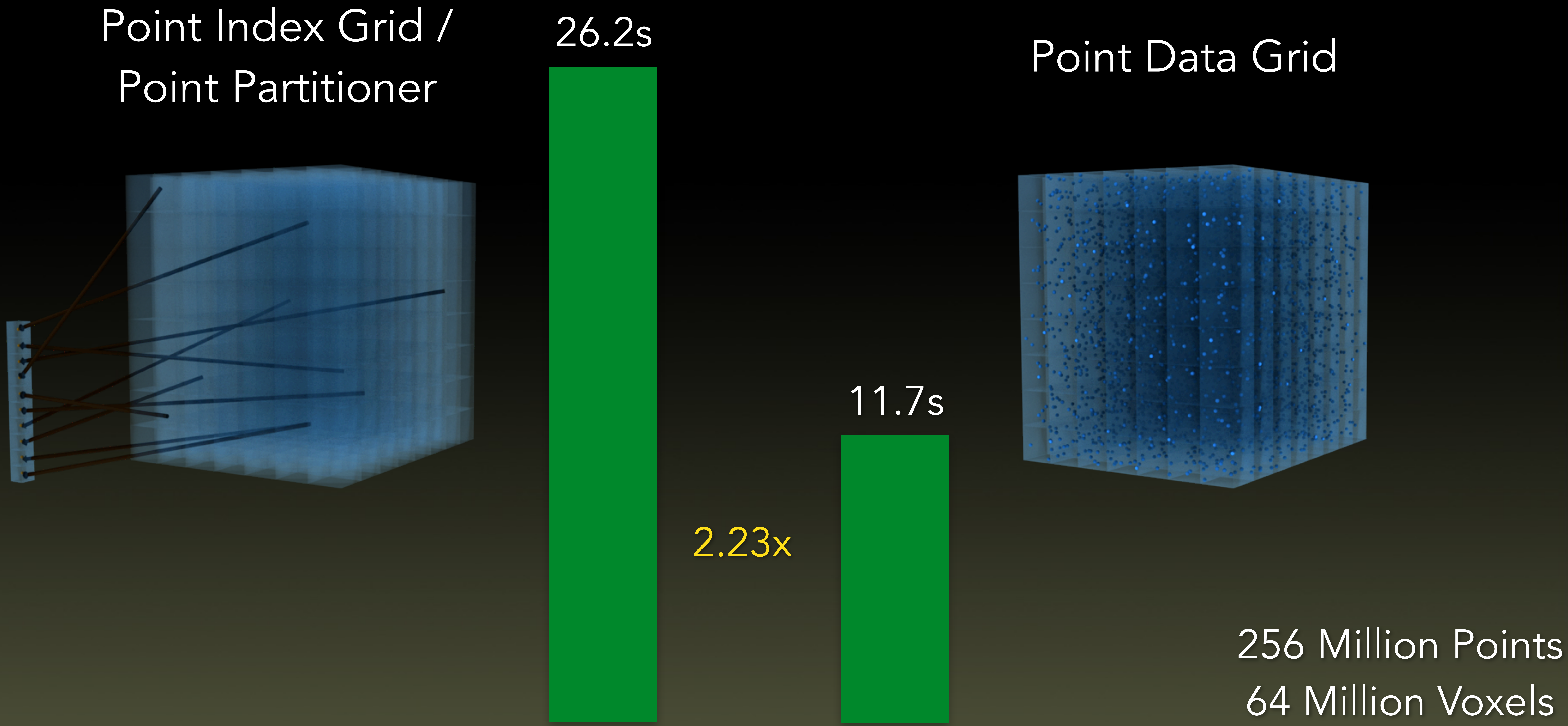

Gather

Gather Rasterisation Performance



In-House Dynamo Liquid Solver

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Houdini

OpenVDB

Dynamo

Dynamo Nodes

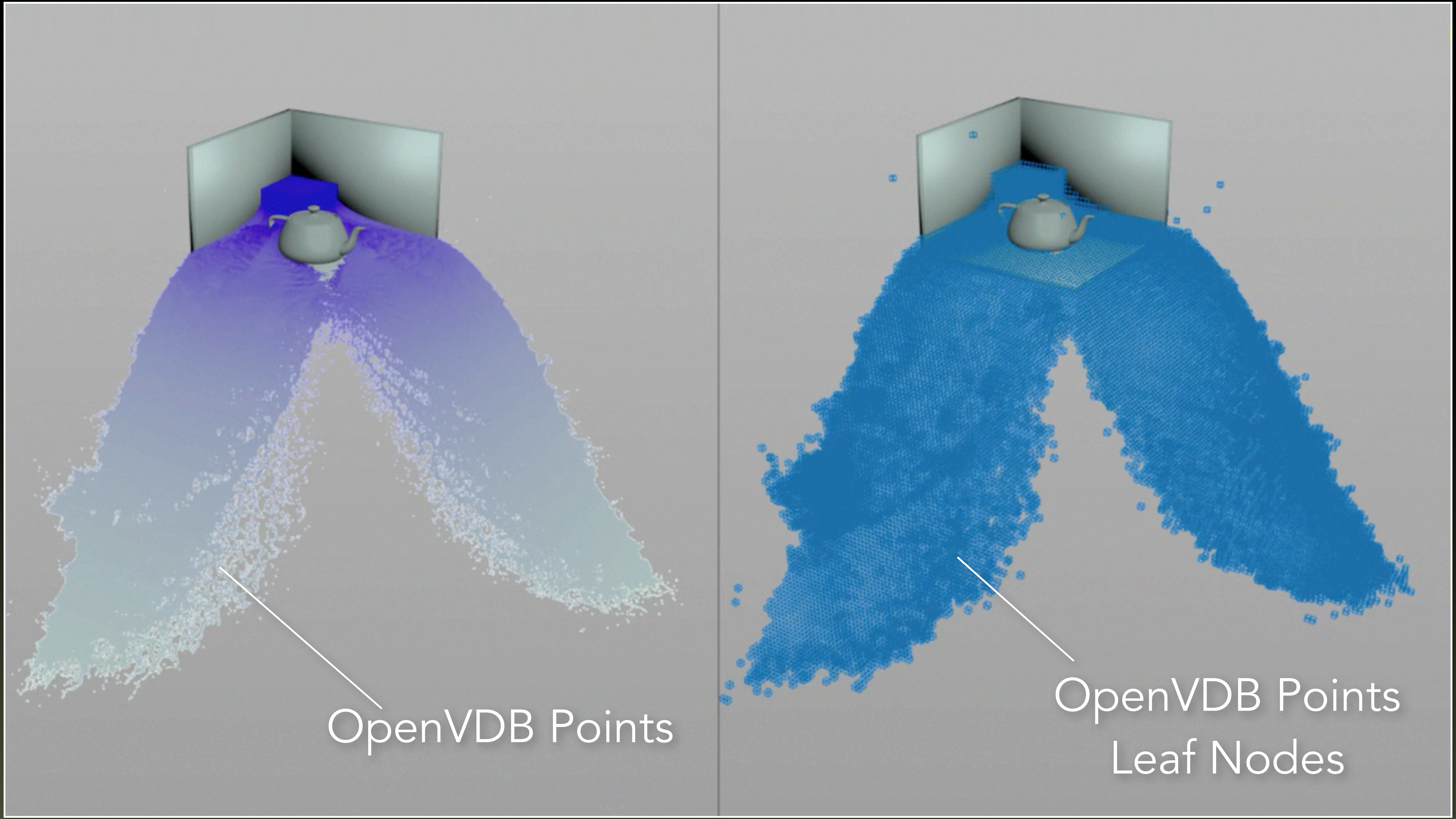
Dynamo
Data Model

Dynamo Distribution

OpenVDB
OpenVDB Points

Large Data Sets All Stored using OpenVDB

Dynamo Sparse Solve



Houdini Integration

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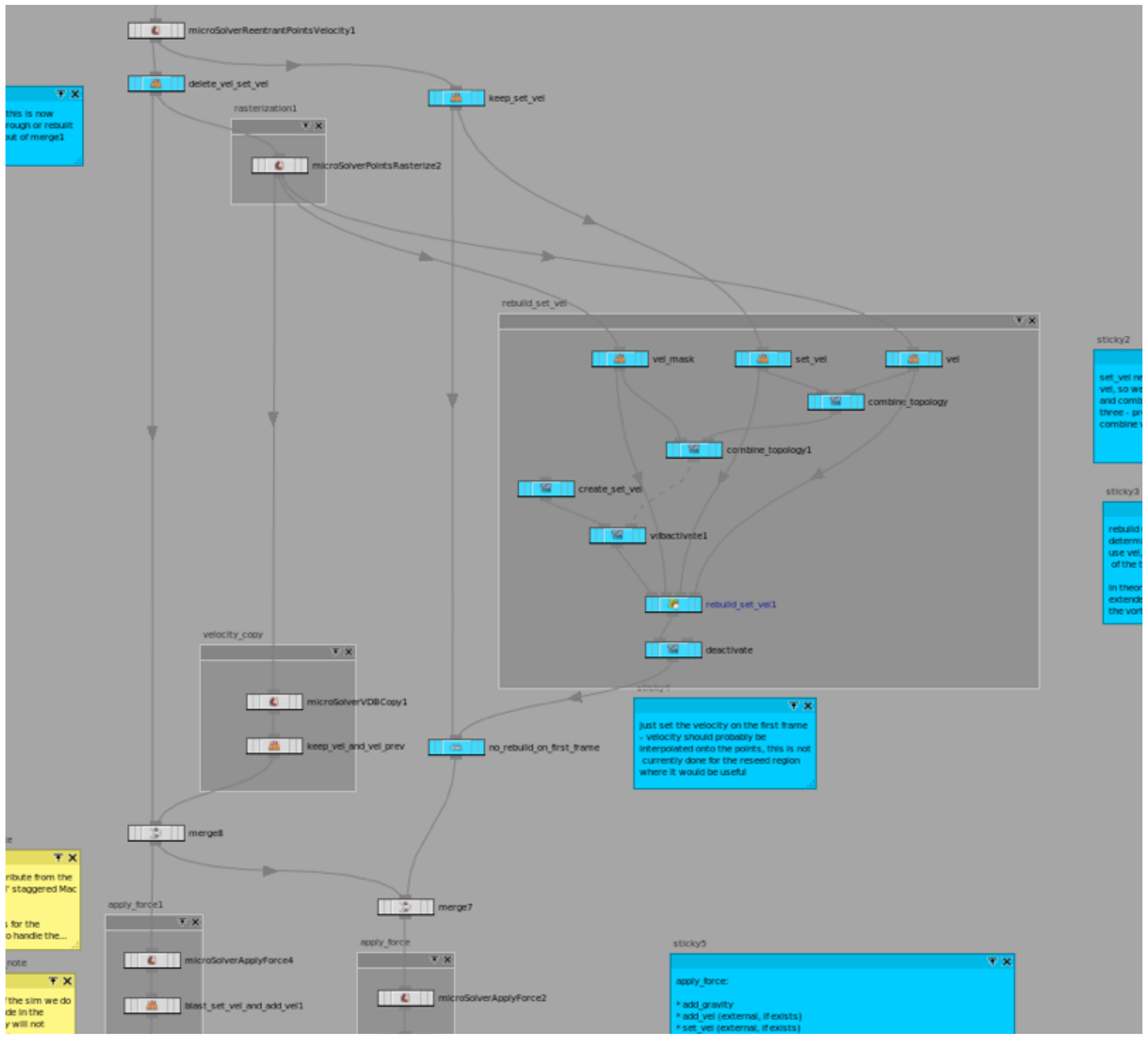
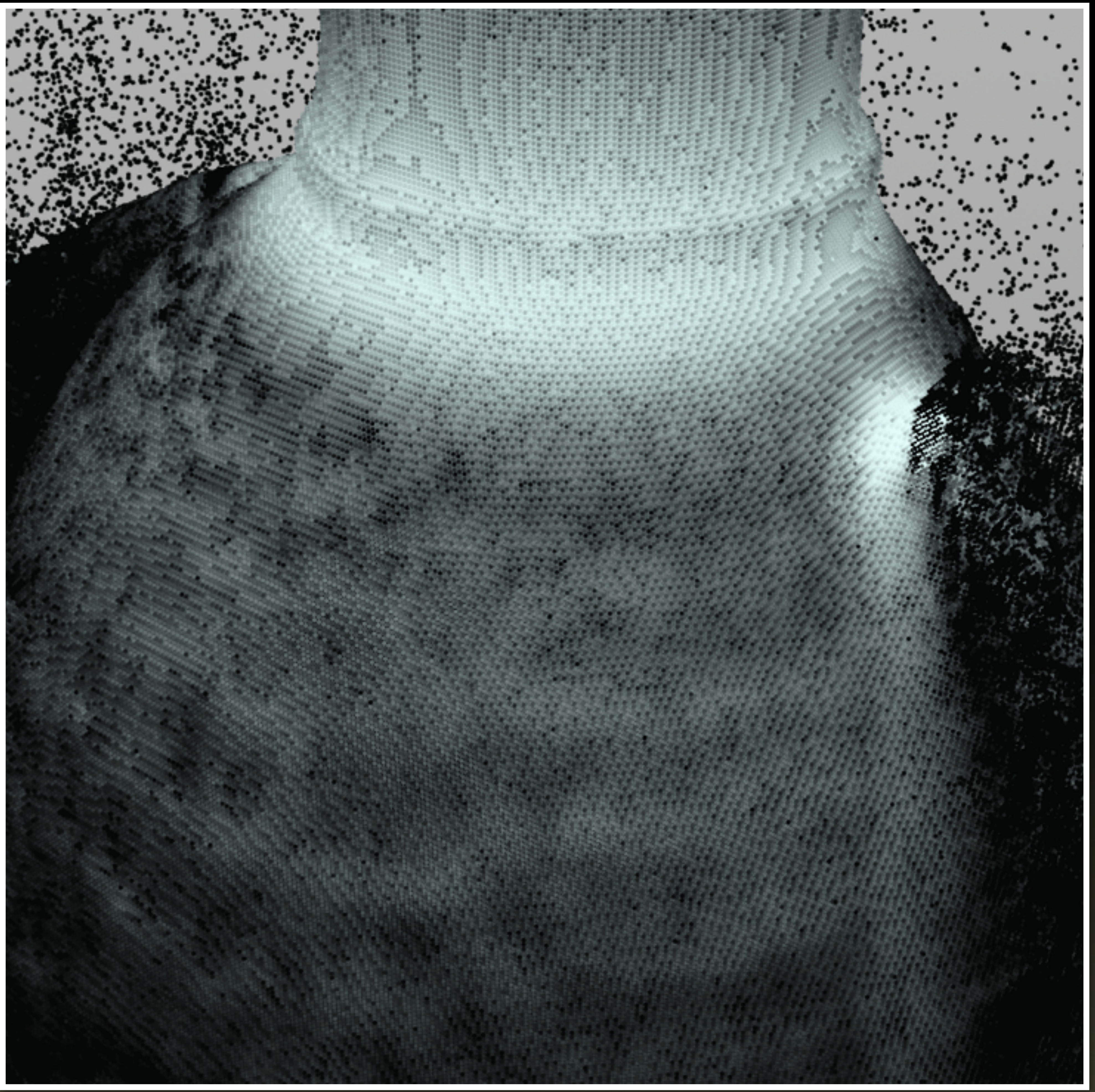


SOP "Micro-Solvers"



Pressure Visualisation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Dynamo FLIP Liquid Simulation
1 Billion Points +

Distribution Scaling

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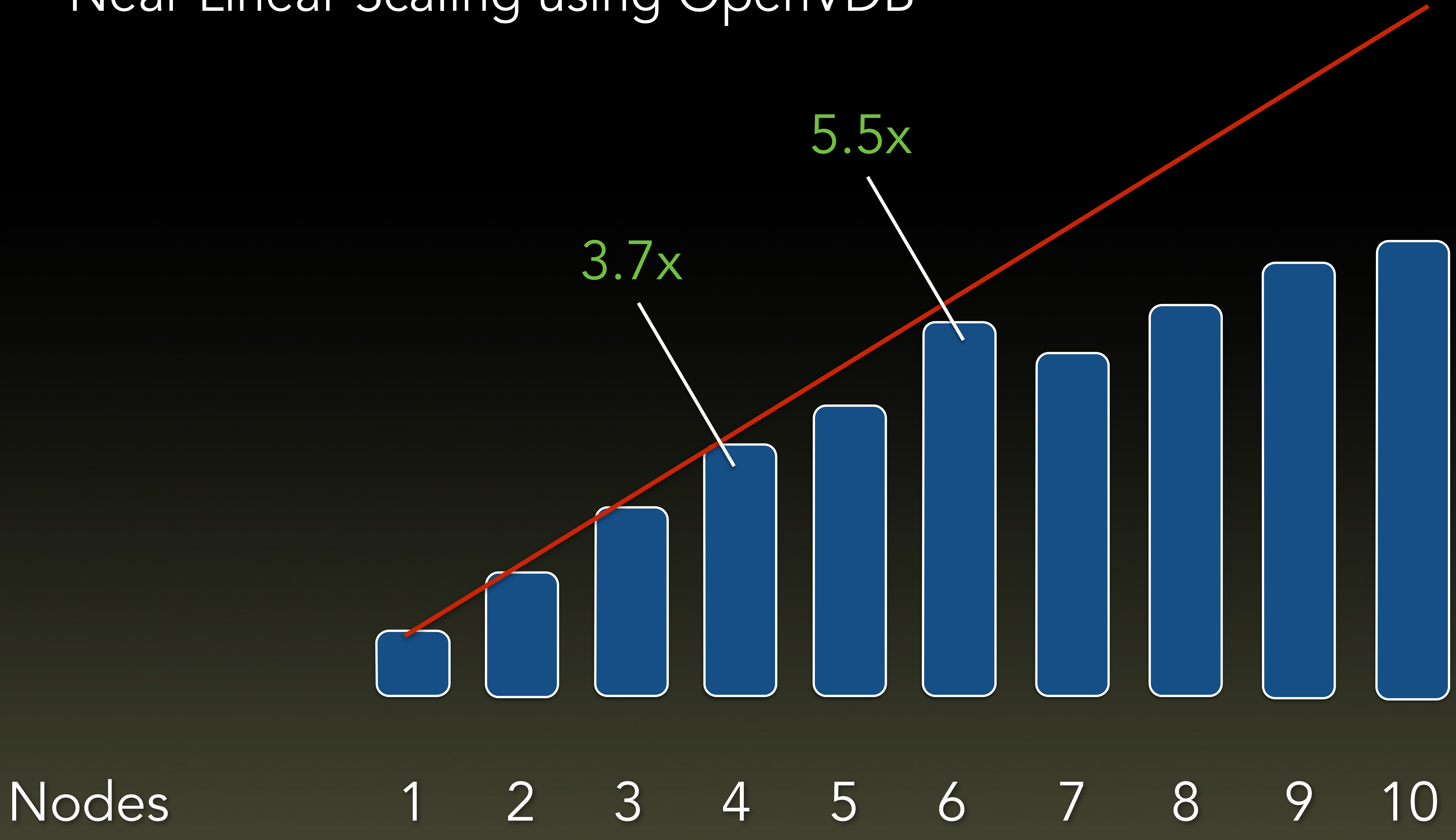
Near-Linear Scaling using OpenVDB



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Point Count: 1 billion

Peak Memory: 60GB

Performance: 10-15 mins/frame

Nodes: 1 machine

Render Time: 1 hour/frame

Memory: 11.0 GB

Clarisse Integration

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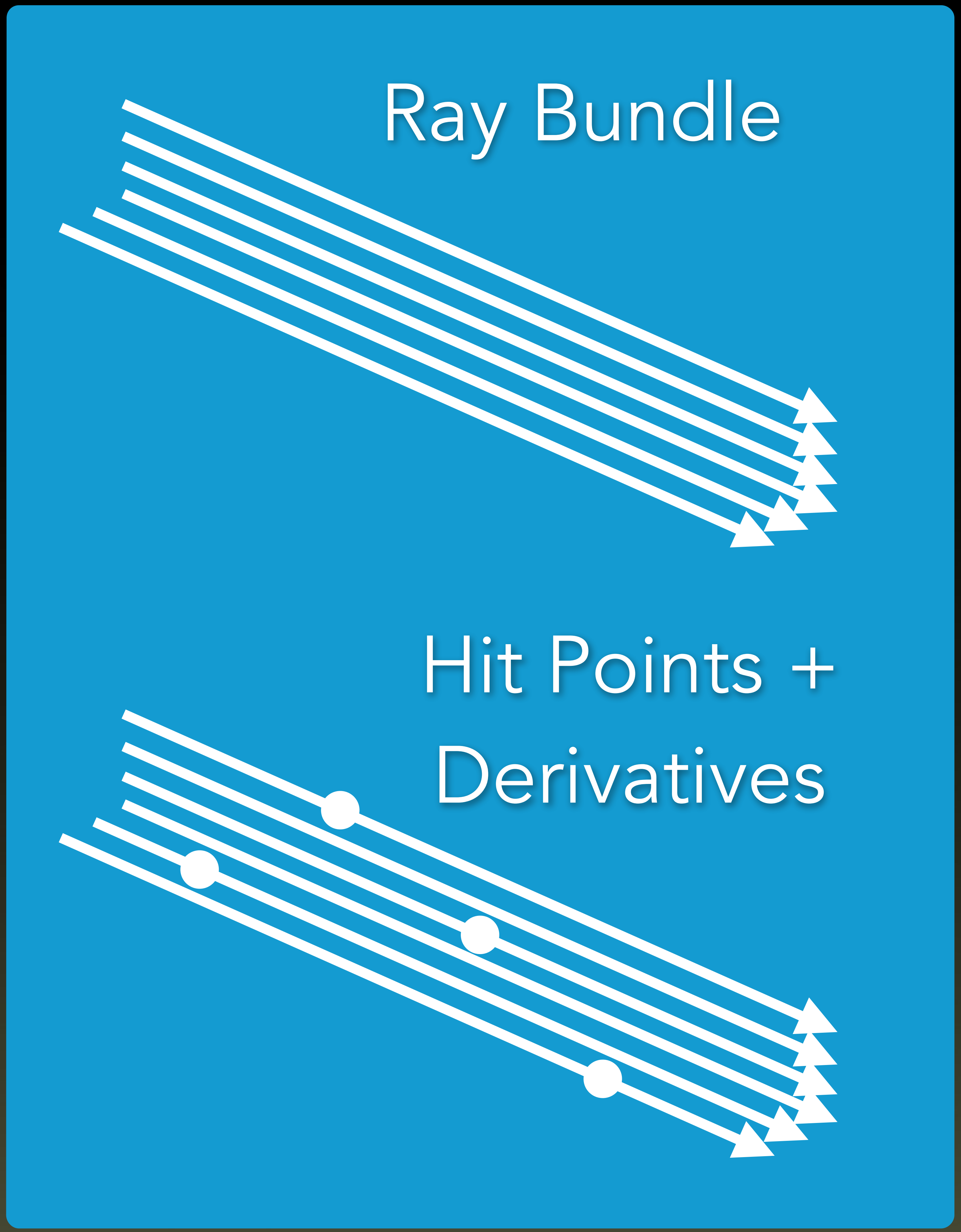
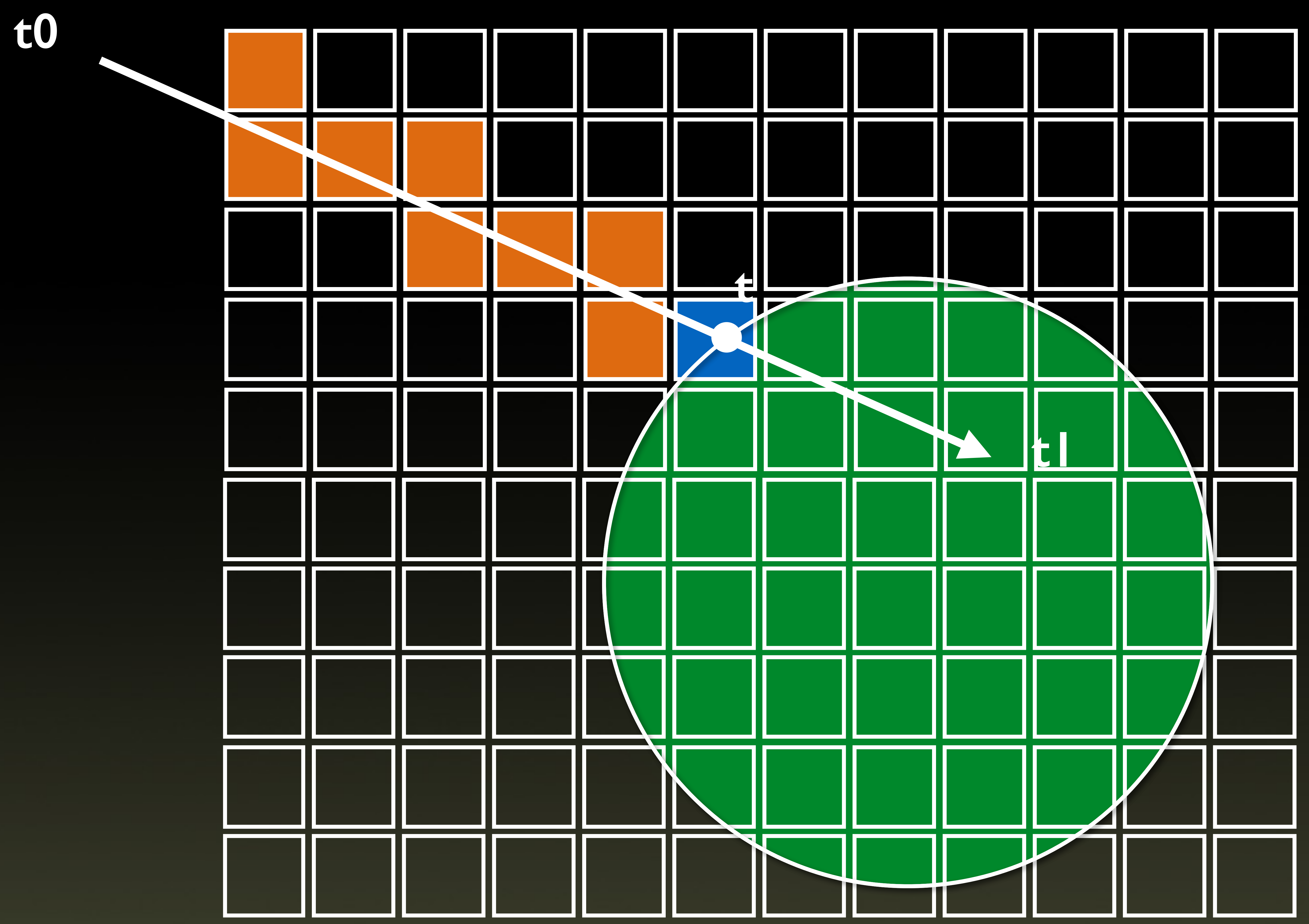
clarisse iFX

Intersection Testing



Tracing Rays - DDA for Level Sets



Intersections:
9 voxels

Tracing Rays - DDA for Points

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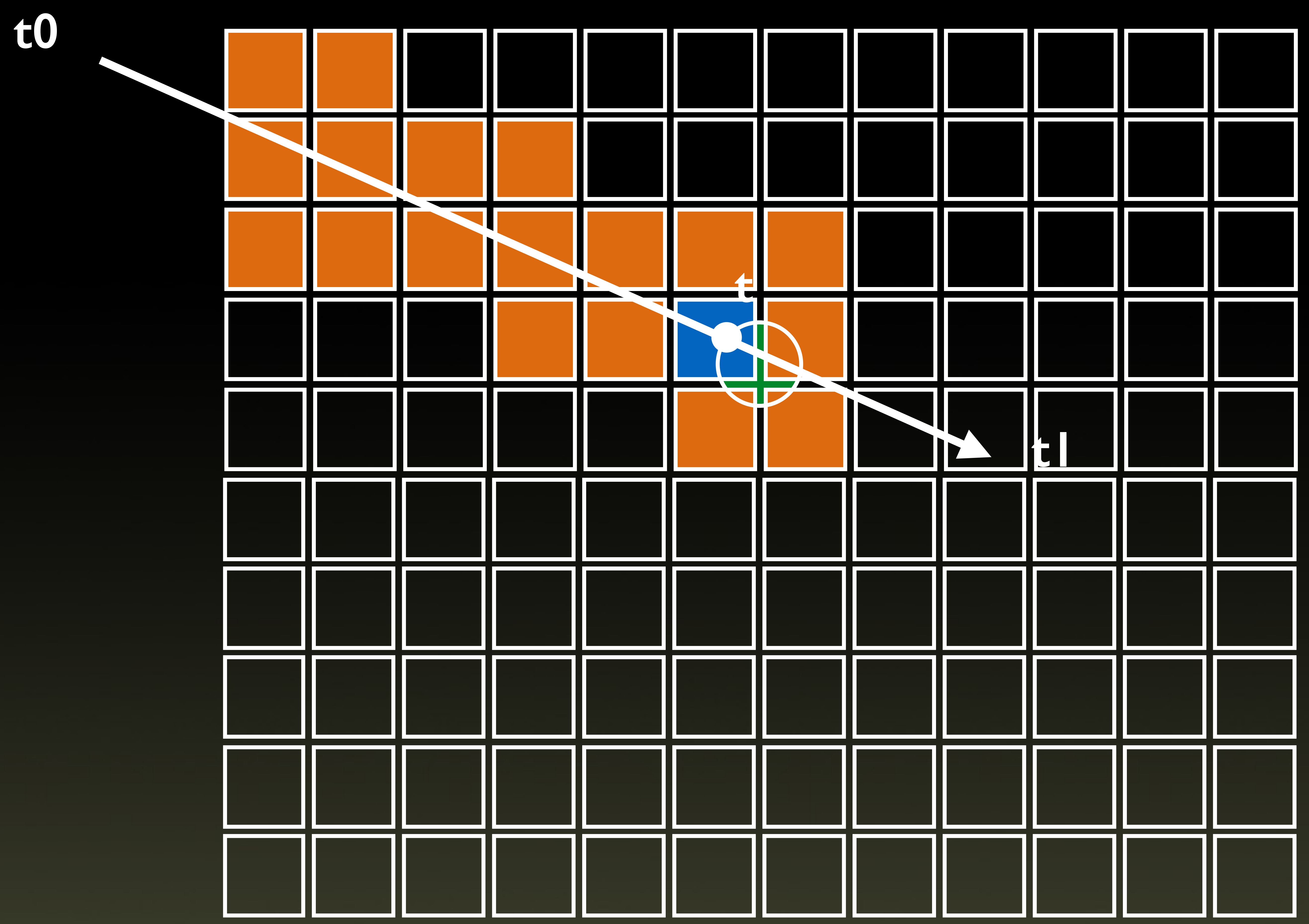

Intersections:
19 voxels

More Intersections
due to Point Radius!

6 Billion Points (position only)
Memory Usage: 17.84GB

Tracing Rays - Motion Blur

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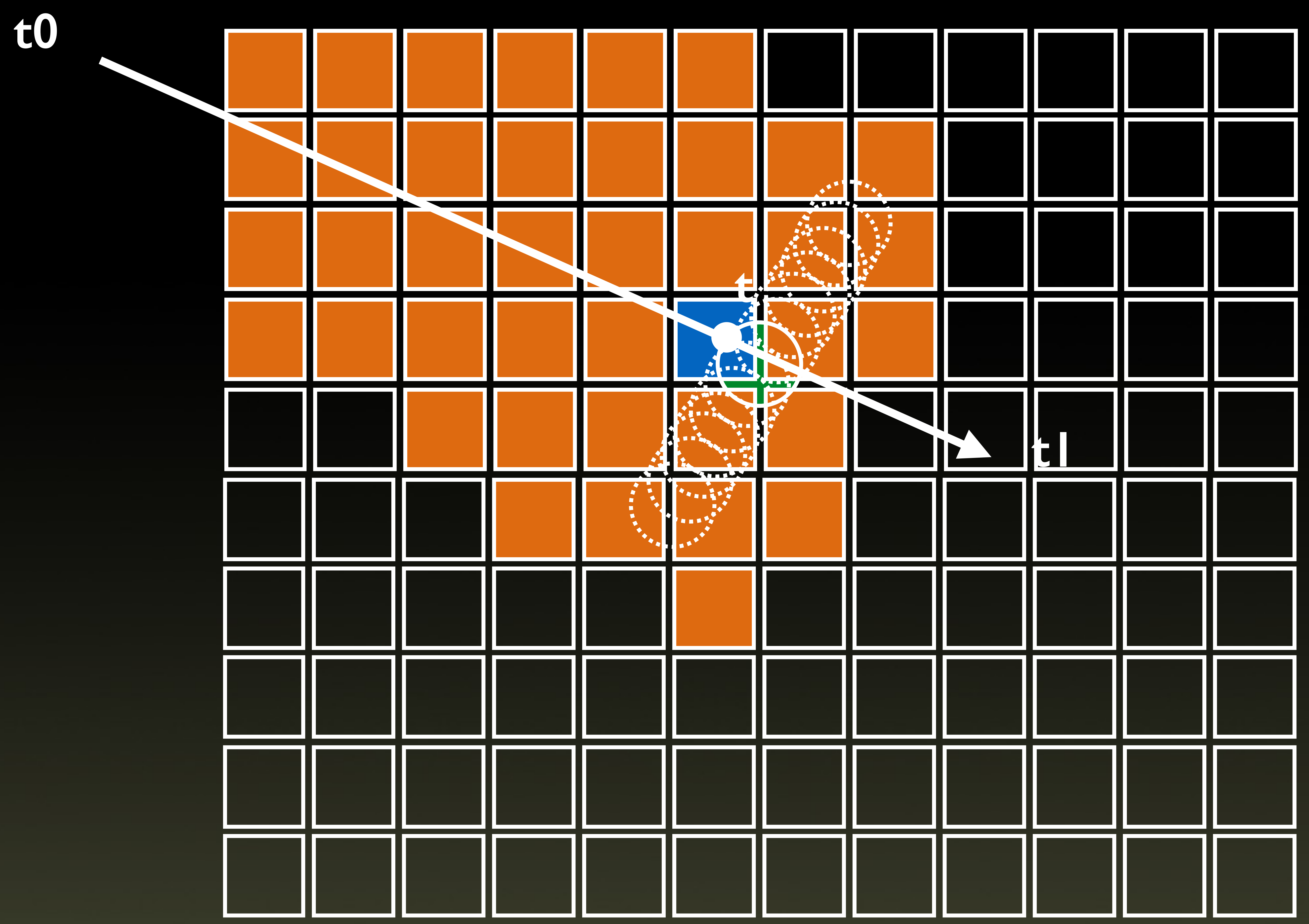

Intersections:

40 voxels

Even More Intersections to Introduce Motion Blur!

BVH Structure

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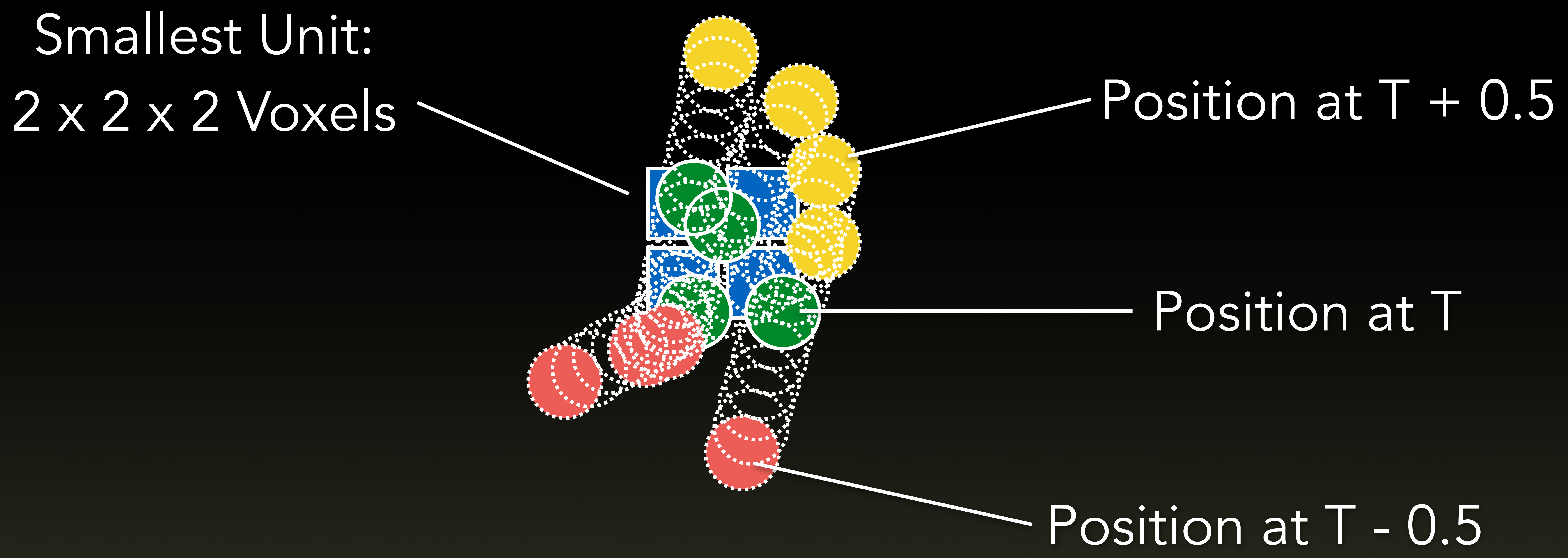
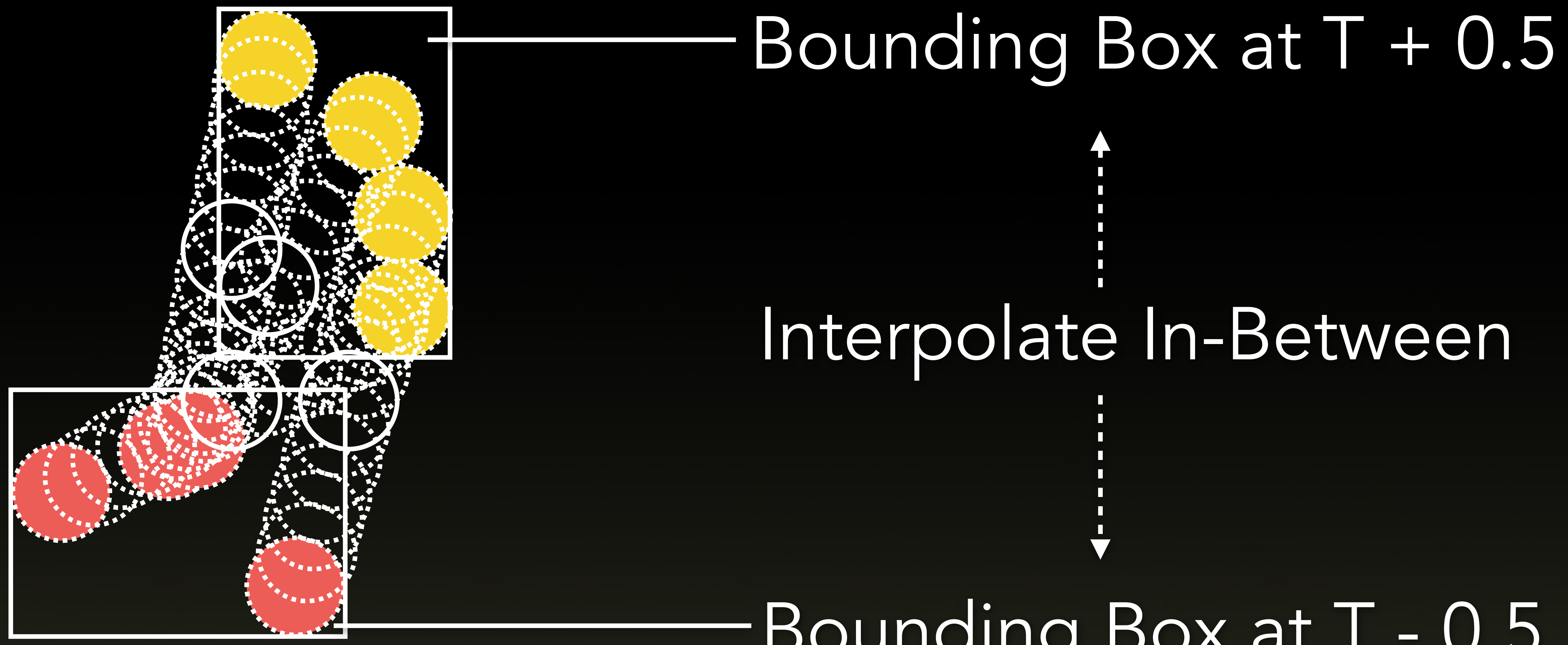
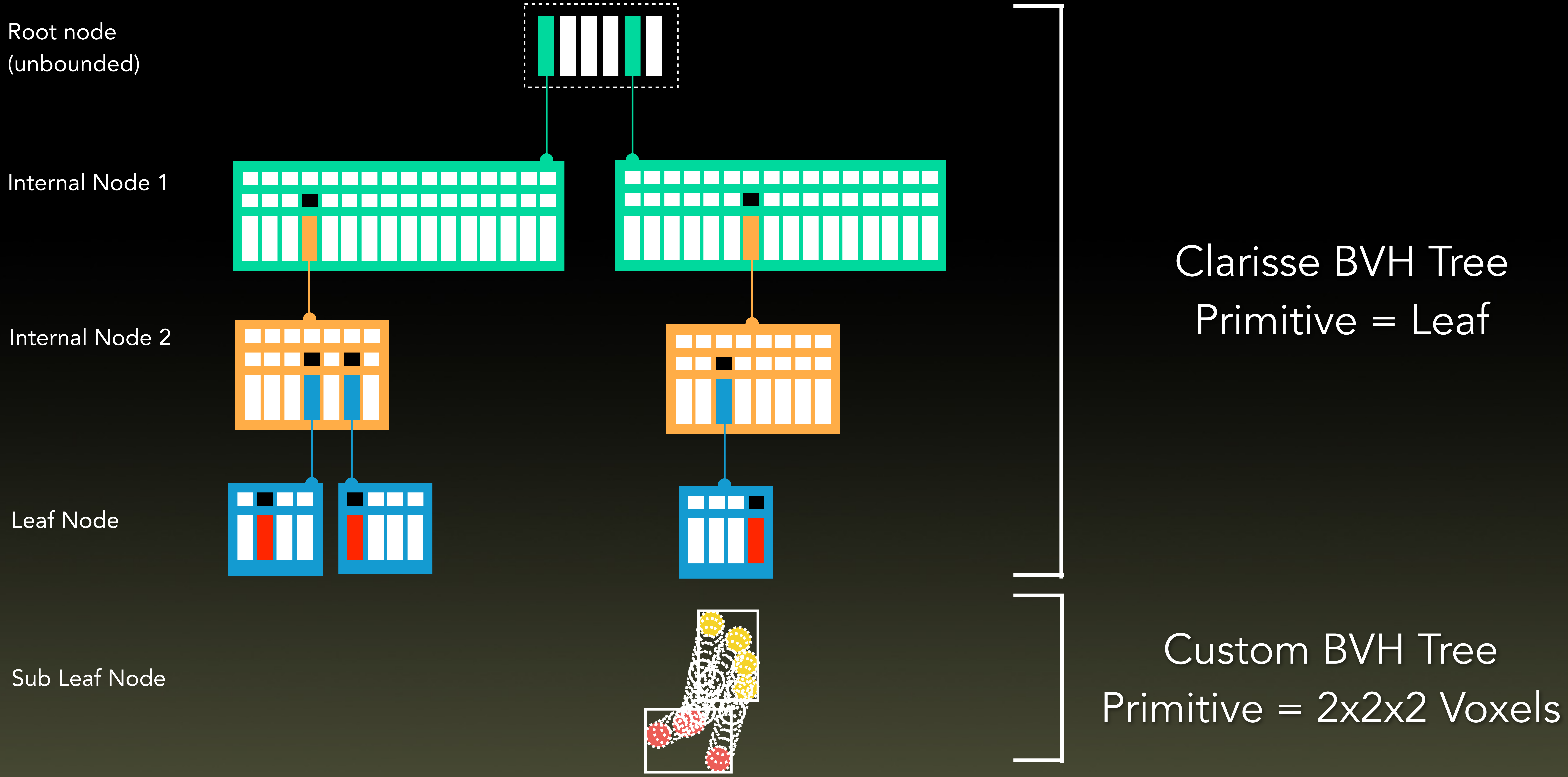


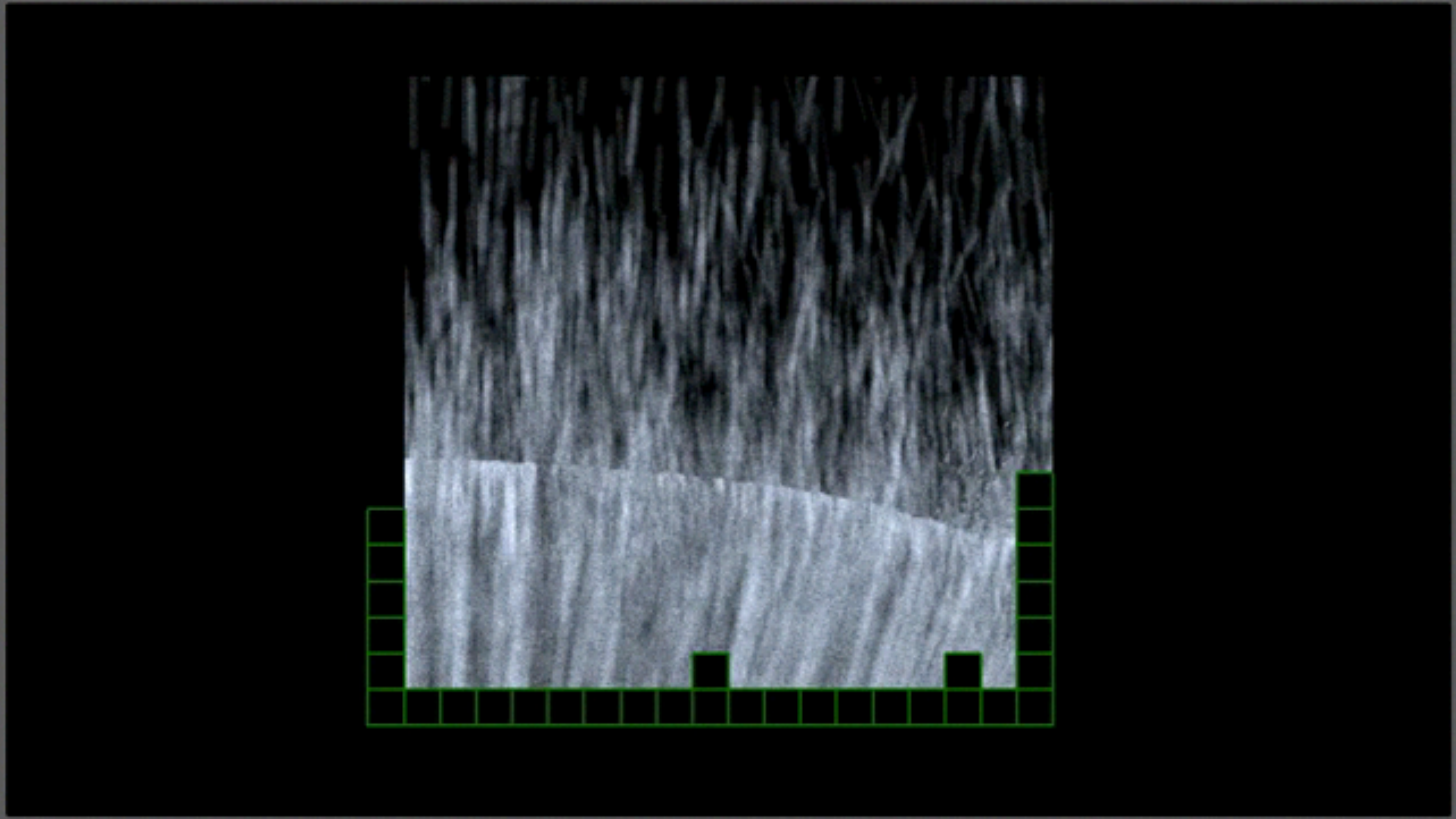
BVH Structure



BVH Structure



Interactive Speed Raytracing 1 Billion Points in Clarisse!



Memory Footprint:
10.4GB (VDB Points)
20% (VDB Grid)
6.4MB (BVH Tree)

Position (16-bit)
Velocity (32-bit + 16-bit)

720p with 6 anti-alias samples
Renders in 200s

Optimum Voxel Size

Voxel Size: 0.25	Voxel Size: 0.05	Voxel Size: 0.01
Leaves: 583	Leaves: 17,200	Leaves: 789,000
Memory: 956 MB	Memory: 999 MB	Memory: 2,829 MB

Slow Performance ← Low Memory, Fast Performance → High Memory

OpenVDB

Open-Source

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openvdb::points::initialize()

OpenVDB API

AttributeArray
PointDataLeaf
Serialisation
AttributeSet
PointConversion

Houdini 13+

OpenVDB Houdini

OpenVDB Points SOP
Viewport Visualisation

Due to be announced on OpenVDB mailing list very soon!

Email me for more information (dan@dneg.com)