Beyond **Polygons**, **Voxels** & **Rasterization**

Nejc Lešek CTO, Lightmass Dynamics

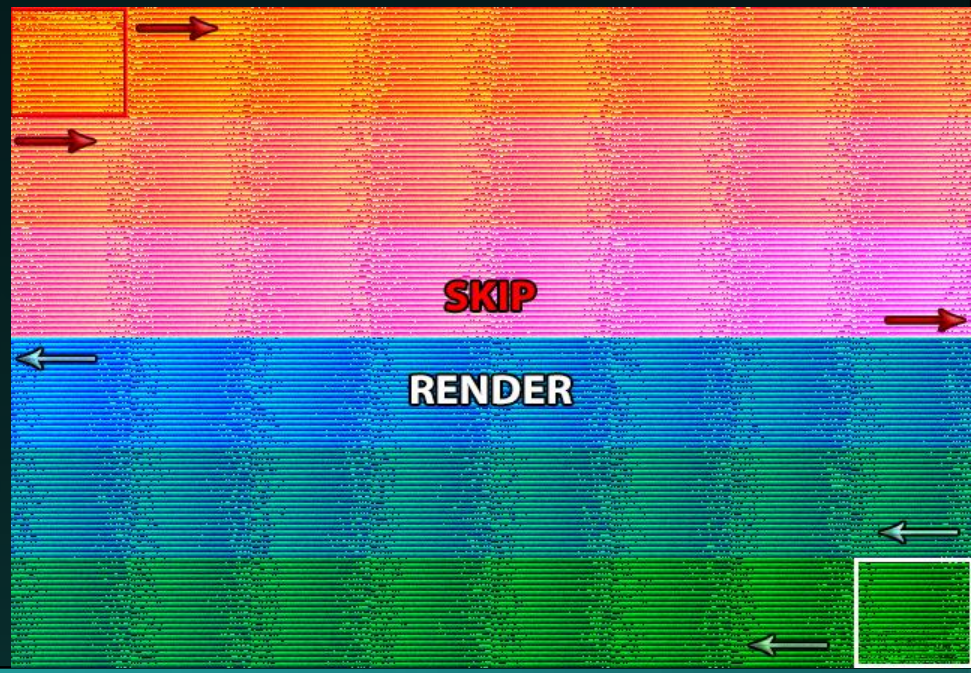

VIDEO: https://vimeo.com/323361180

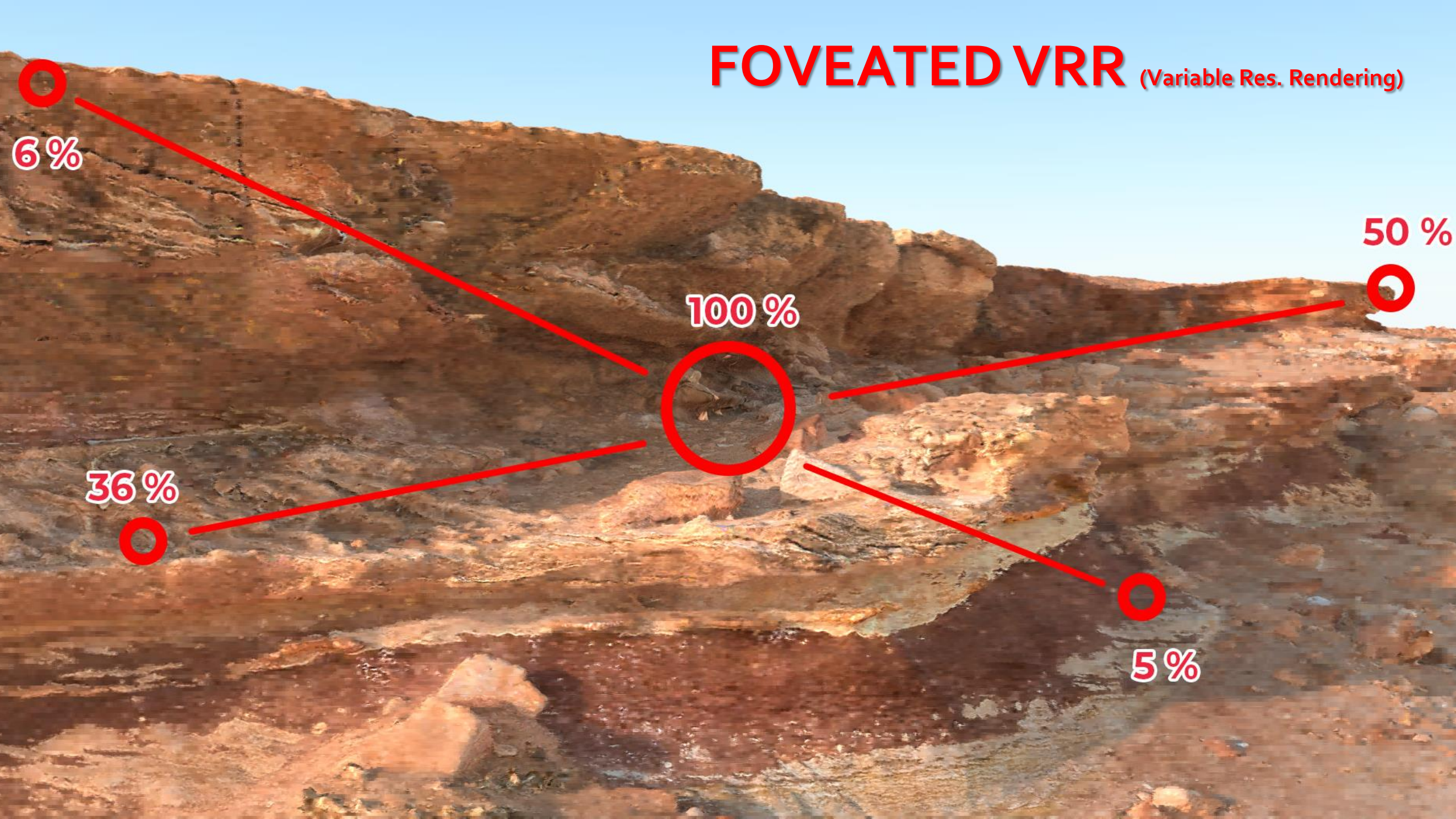
Minimum Requirements

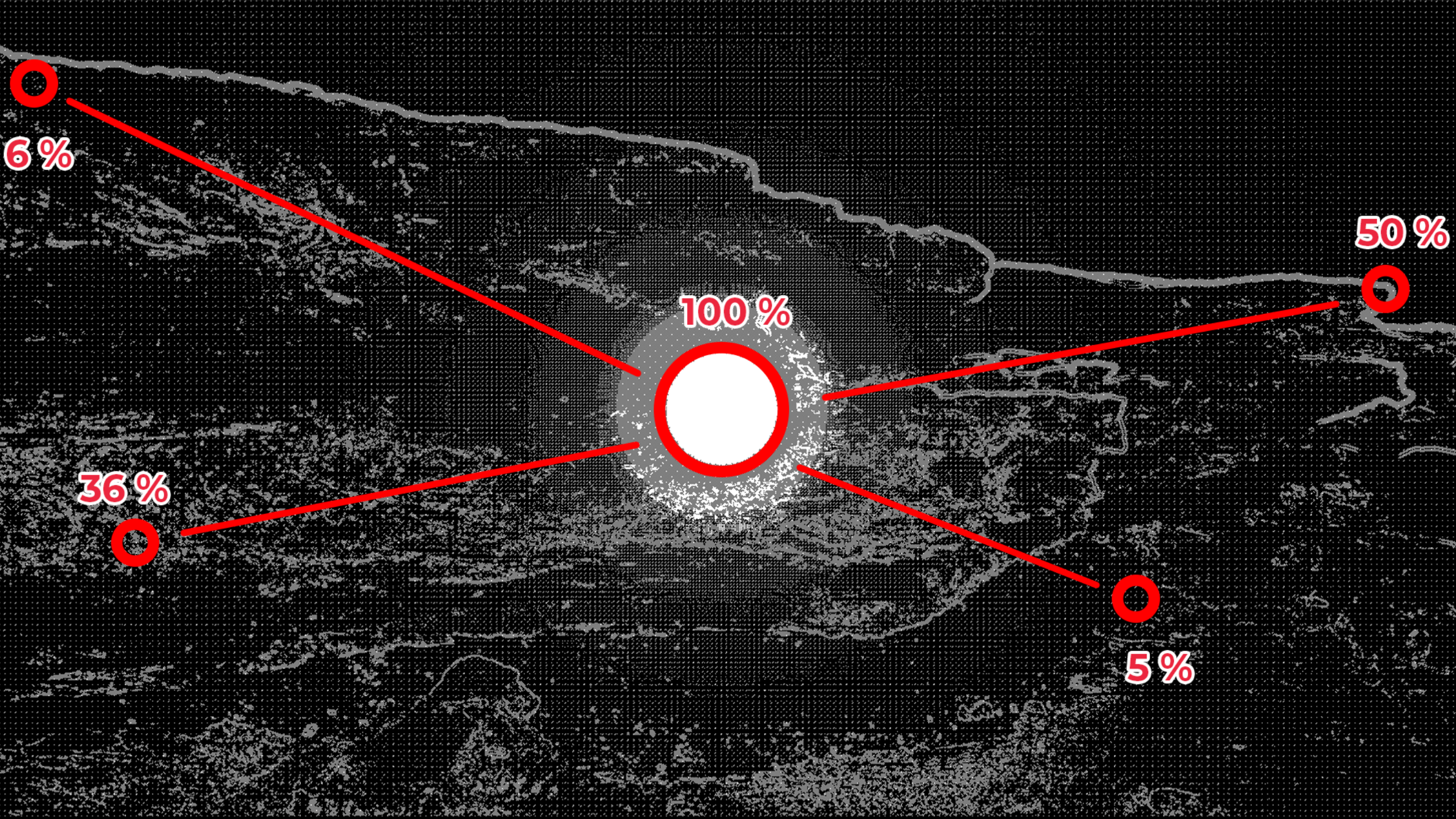
- Variable rate rendering
- Always grouping similar work items
- No rasterization
- Real-time rates (50 ms or less per frame)

DNR (Deconstruction Rendering)

- Groups similar work items
- Enables efficient implementation of:
  - **Variable rate** rendering
  - **Foveated** rendering
  - **Checkerboard** rendering
  - **Any analytic** or **random** pattern




FOVEATED VRR (Variable Res. Rendering)
6 %
100 %
50 %
36 %
5 %

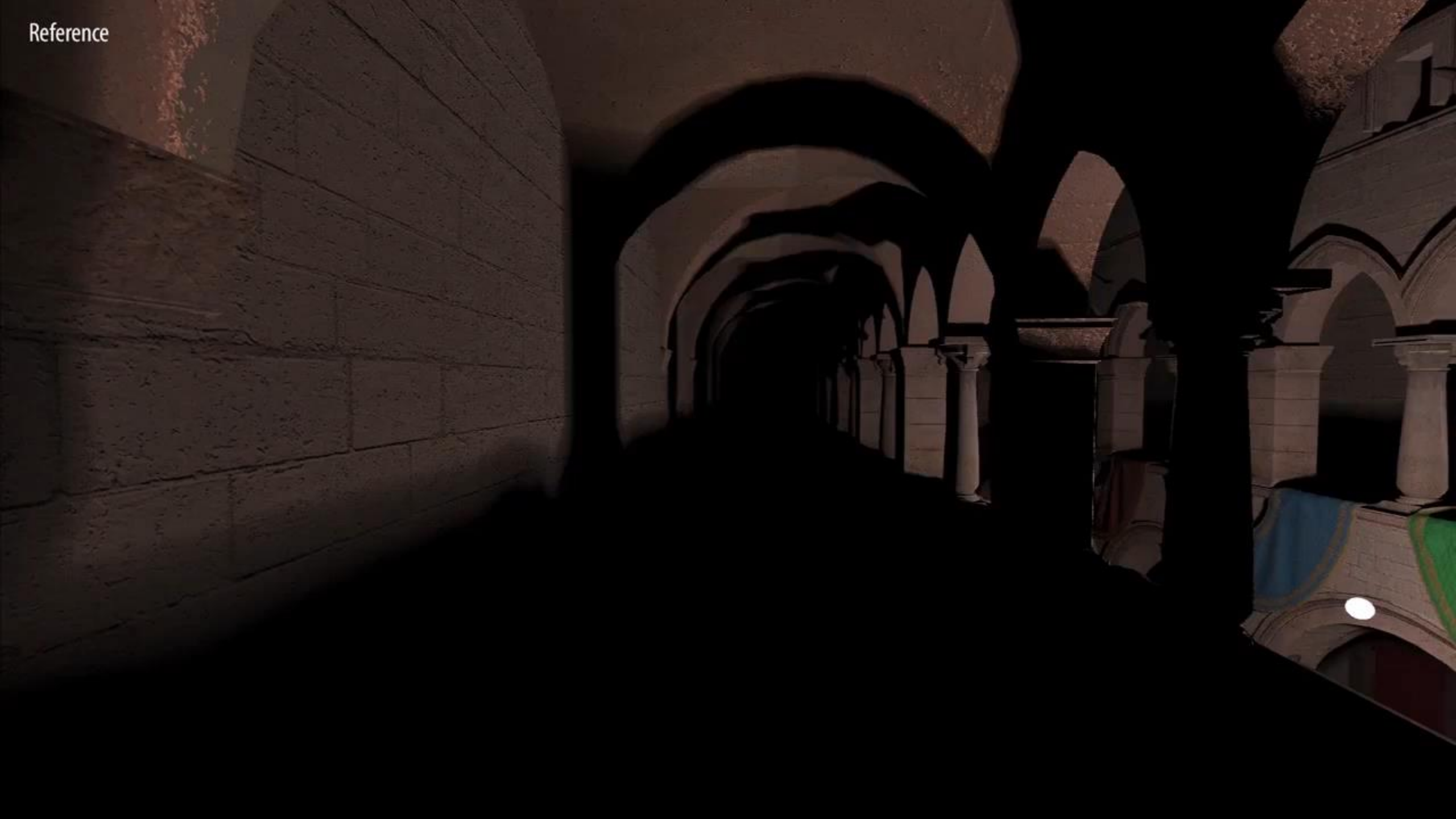

6 %
100 %
50 %
36 %
5 %

Smart Geometry (SMG)

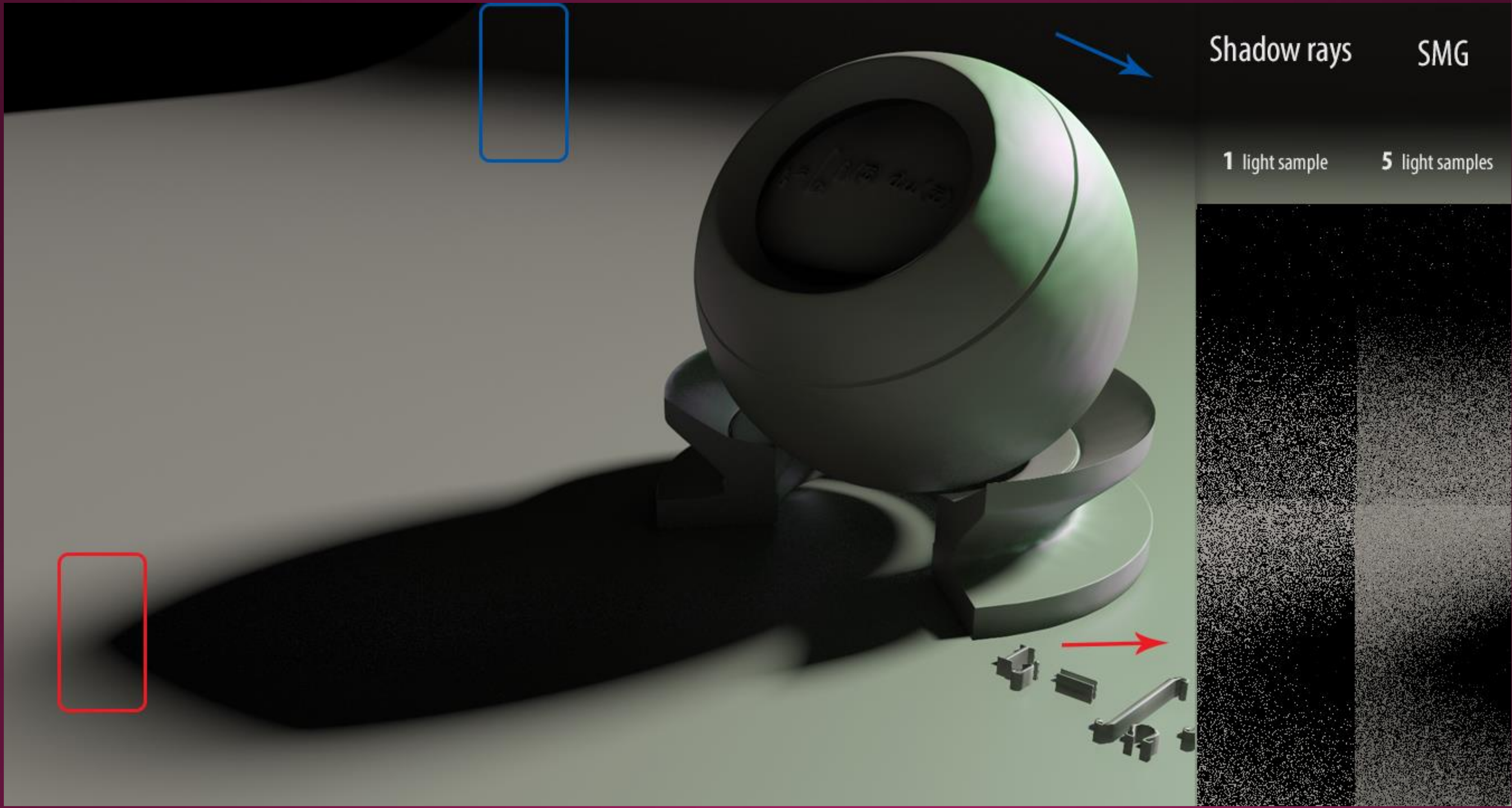
- Attaching neural networks to geometric primitives

- Main concepts:
  - **Simple**, **small** and **shallow** networks
  - **Millions** of **NN** working together
  - **Real-time** training and inference

TIP: as NN input, find scene properties that can be mostly represented with a continuous function.


Reference

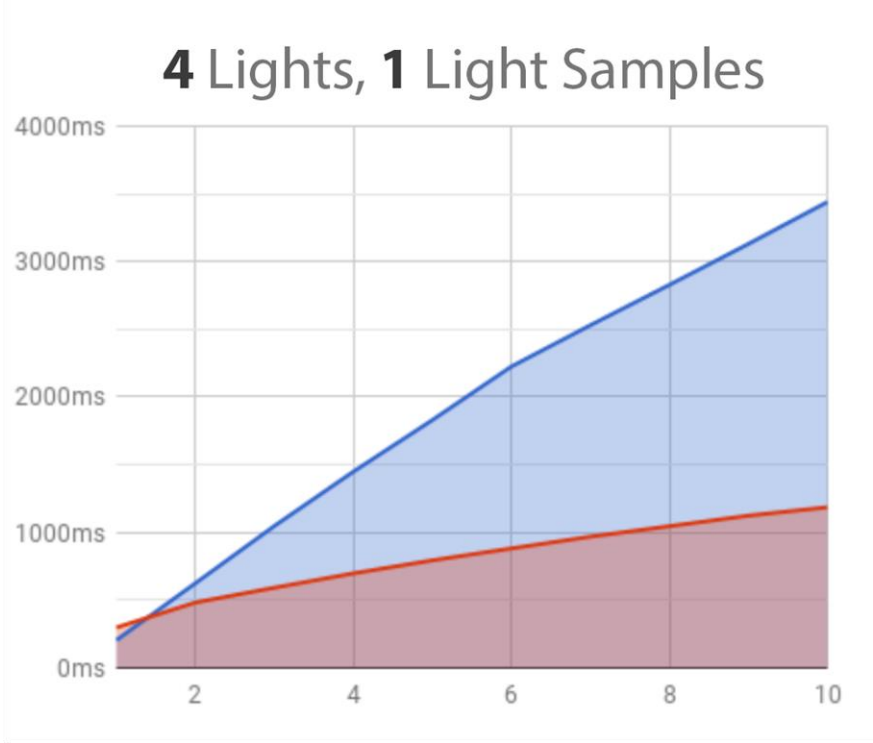
SMG: SHADOW RAYS

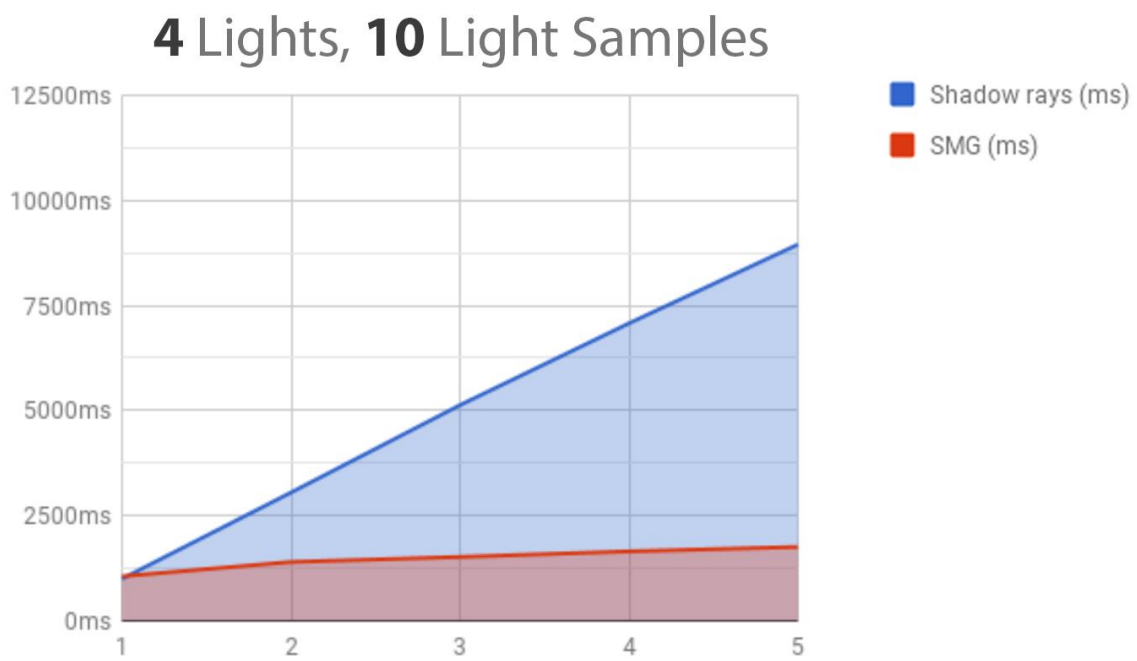


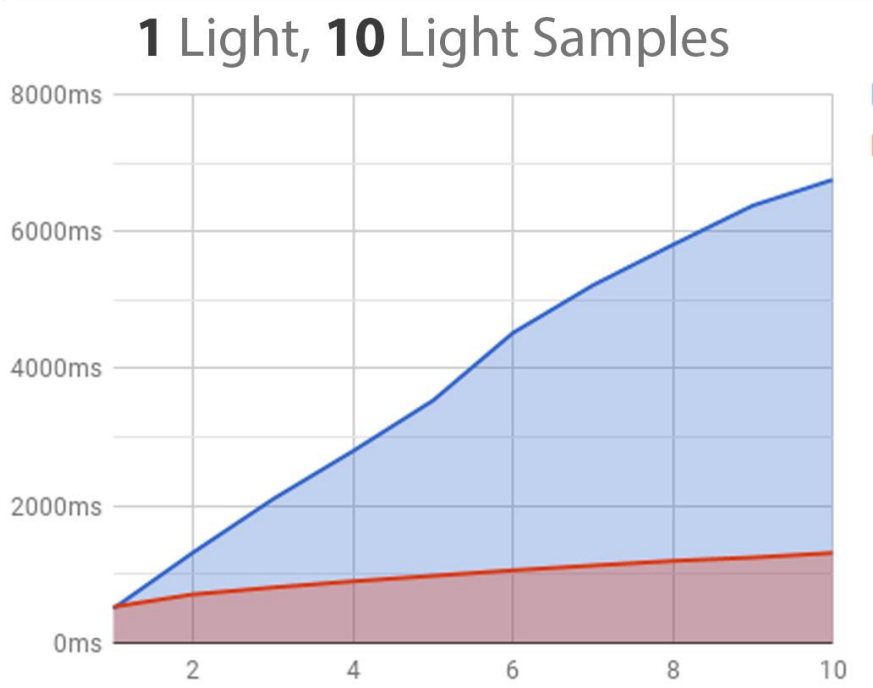
SMG: SHADOW RAYS

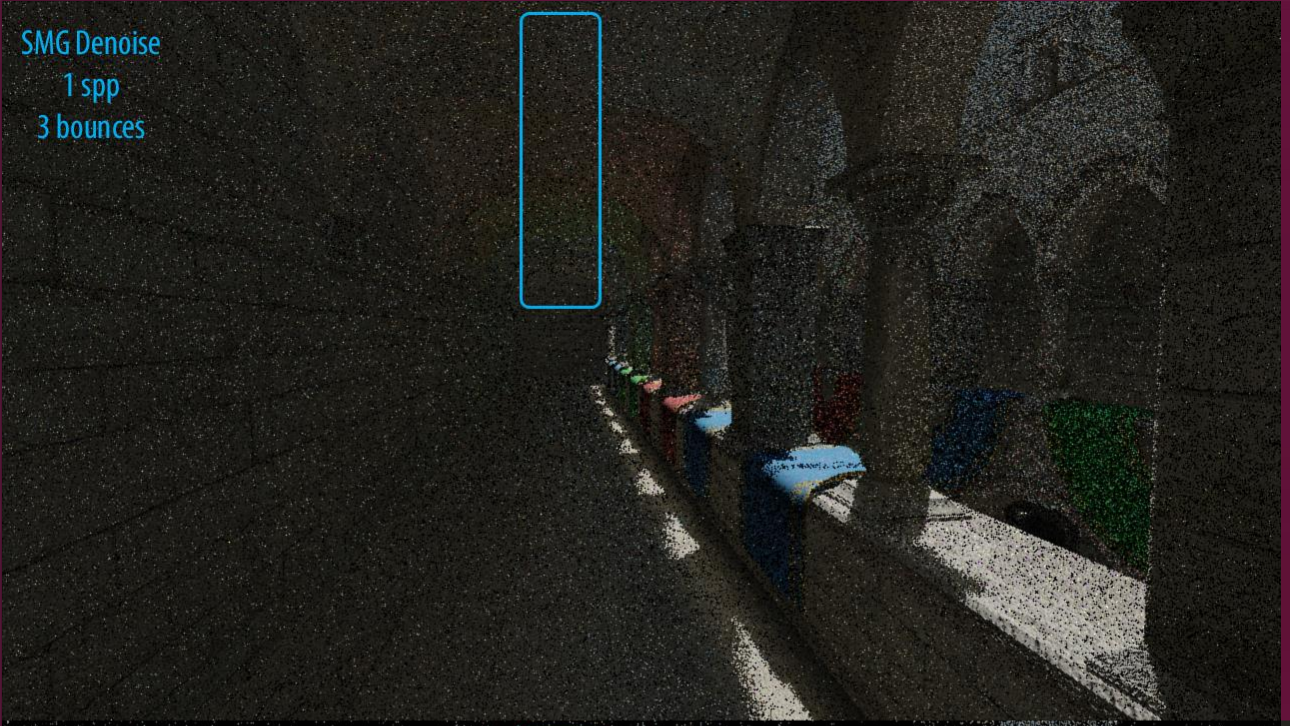
Performance impact
BVH vs. **SMG**

BVH – Linear
SMG – Sublinear





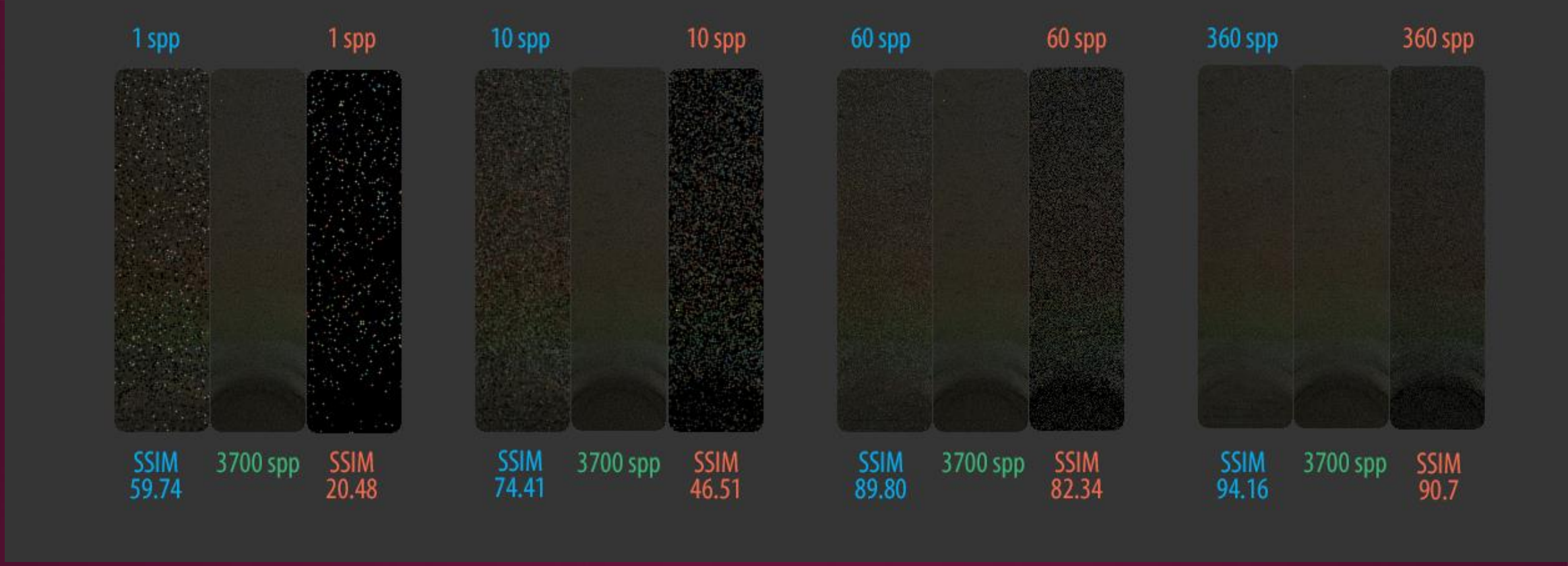




SMG: DENOISE

- Spatial denoise
- NN approximate energy at surface

SMG: DENOISE



GOOD FOR:

- Static scenes
- Can compliment lightmaps;
  by vectorizing soft shadow regions.

BAD FOR:

- Dynamic scenes
- Very small primitives

SMG: LIGHT TRANSPORT

A viable high performance substitute for:

- Bidirectional PT
- Metropolis light transport

Finds up to **70% more paths** than **unidirectional** path **tracing**.

PGNR (Path Guided Neural Rendering)

PGNR (Path Guided Neural Rendering)

- DNN autoencoder denoise, but…

- Very **sparse** secondary ray **sampling**
- **Full** resolution **primary rays**
- **Variable** DNN **depth**
- Scene data & NN organized into voxels

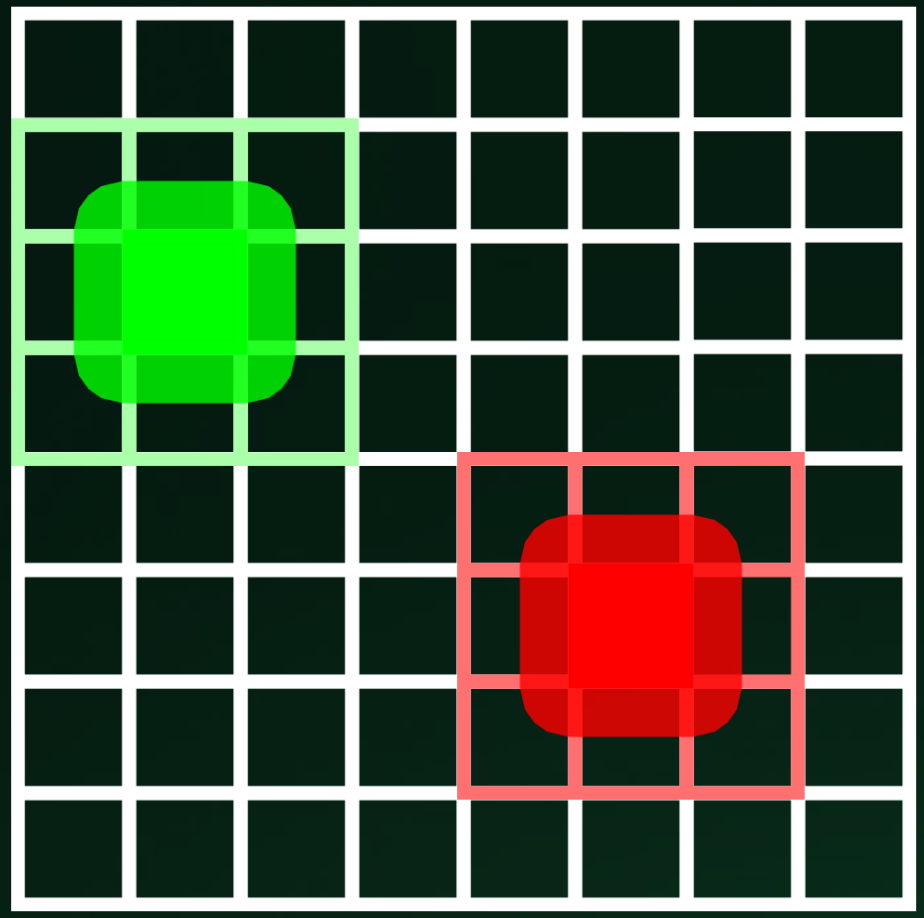
PGNR: Voxelized autoencoders

GPU 1

GPU 2

...

GPU N

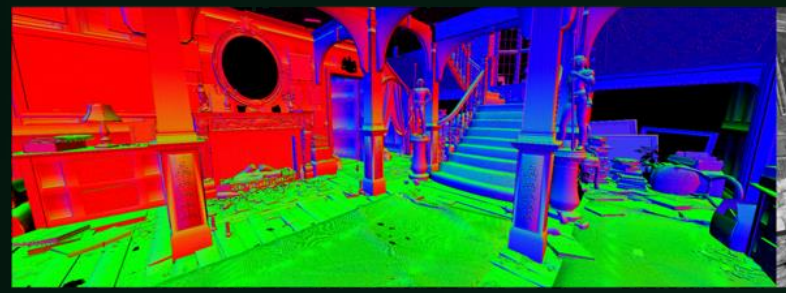


- Offline voxel data interpolation
- A bit of overfitting is welcome
- Each voxel can be processed by a different GPU, training scales linearly!

PGNR (Path Guided Neural Rendering)

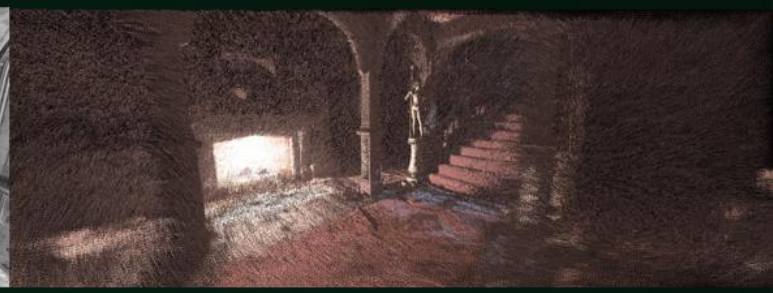
Autoencoder inputs

Normals 3D

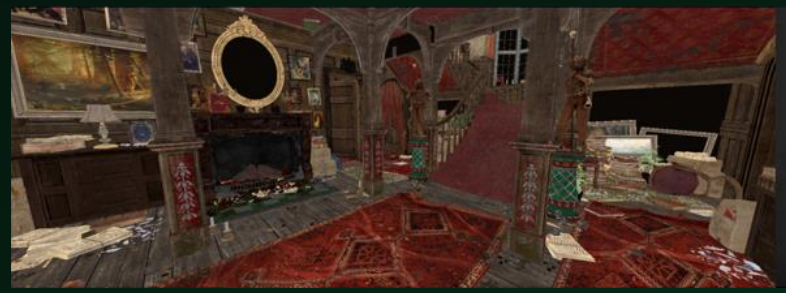


Roughness 1D

Adaptive temporal reprojection



Albedo 3D

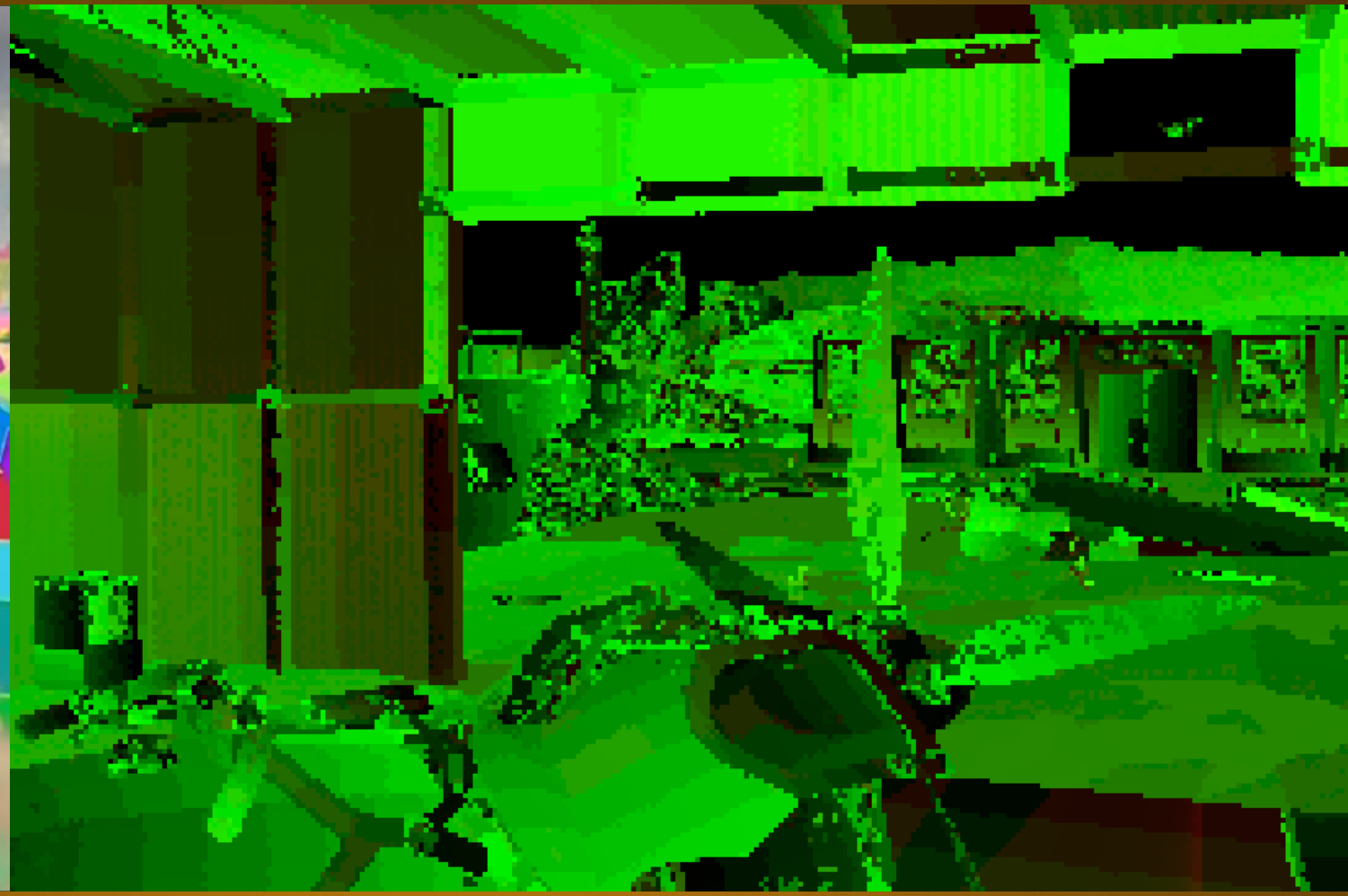


Depth 1D

Direct Light 1D

PGNR

DSRVT (Deep Super Resolution Virtual Texturing)



Rage, Megatextures | Id Software

DSRVT (Deep Super Resolution Virtual Texturing)

- Provides Virtual Texturing benefits:
  - Memory management (use only what you need / can see)
  - Effectevly unlimited texture resolution

- Super Resolution:
  - Adds extra details when we run out of higher res. textures

  OR

  - Reduces shipped texture size by x4

INPUT

1024 x 1024

OUTPUT

2048 x 2048

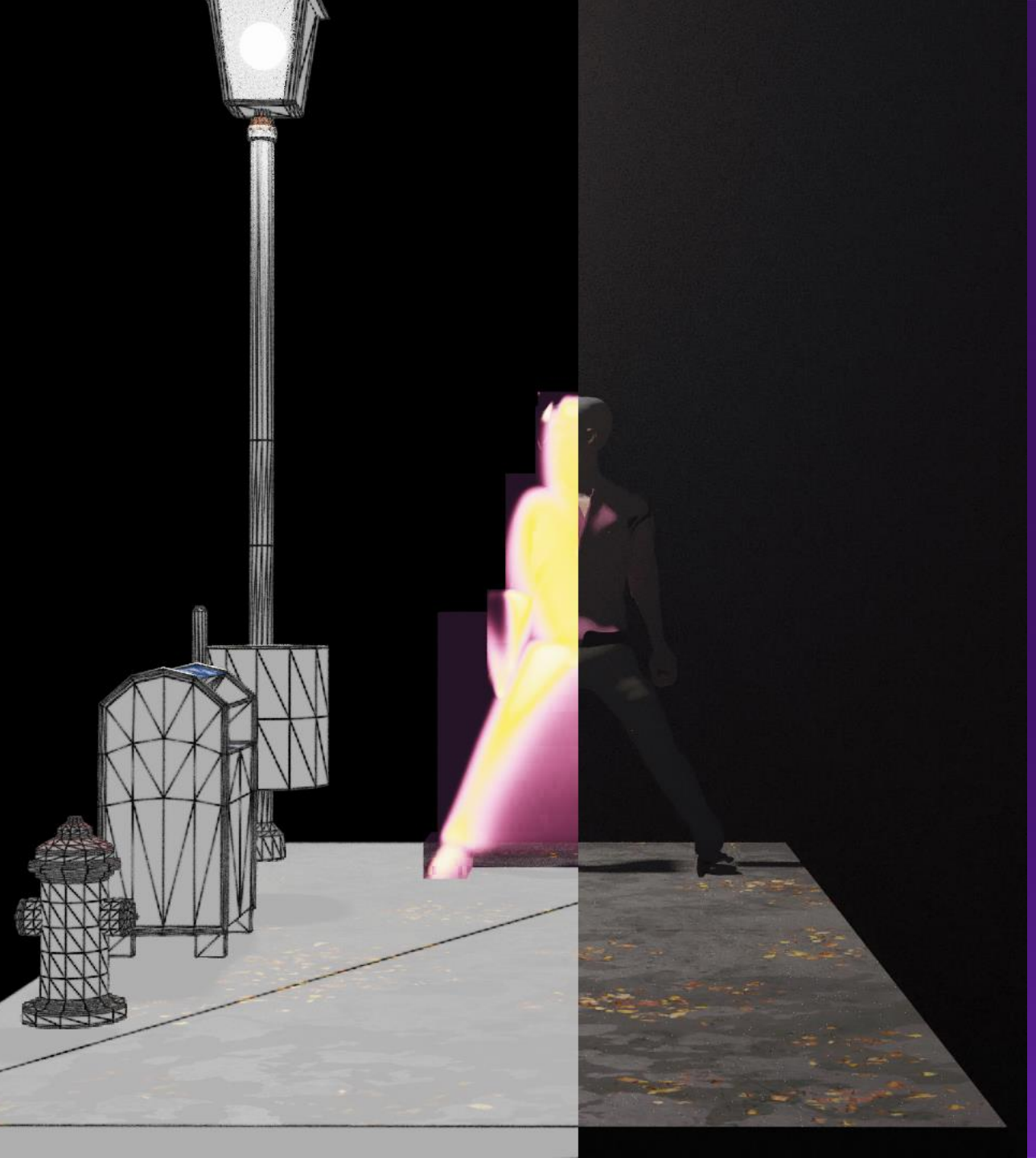
QNM

Quantum neural models

QNM (Quantum Neural Models)

- Defines volumetric object with properties

- Uses **neural primitives**
- Uses **Tensor** Pipeline
- **Potential to unify** physics, animation, geometry and materials



QNM

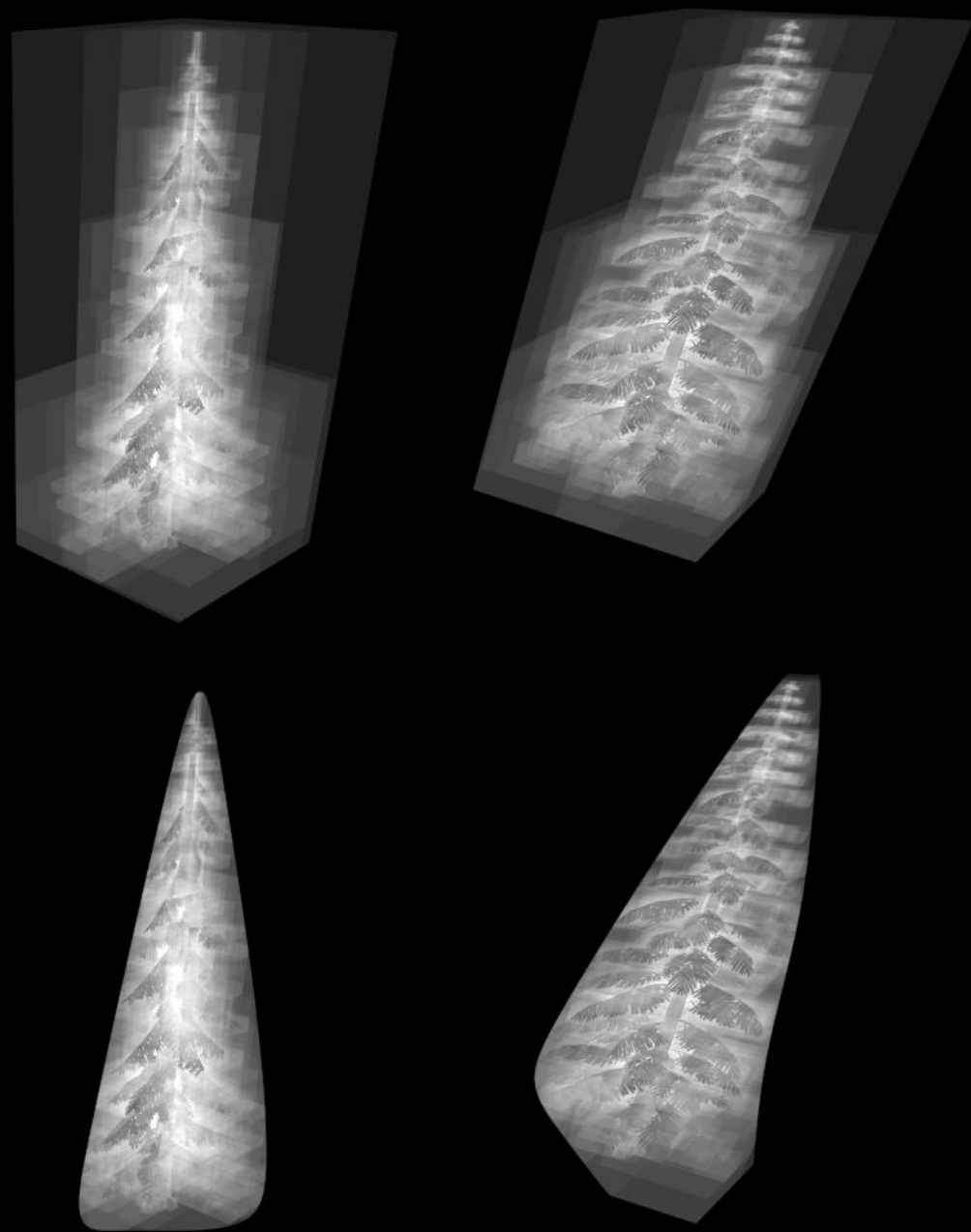
Animation **guided** by **NN inputs**

QNM model size: **~5 KB**
QNM primitives: **9**

Polygonal model size: **~1 MB**
(vertices, normals, texture coordinates)

Polygonal primitives (triangles): **31 415**

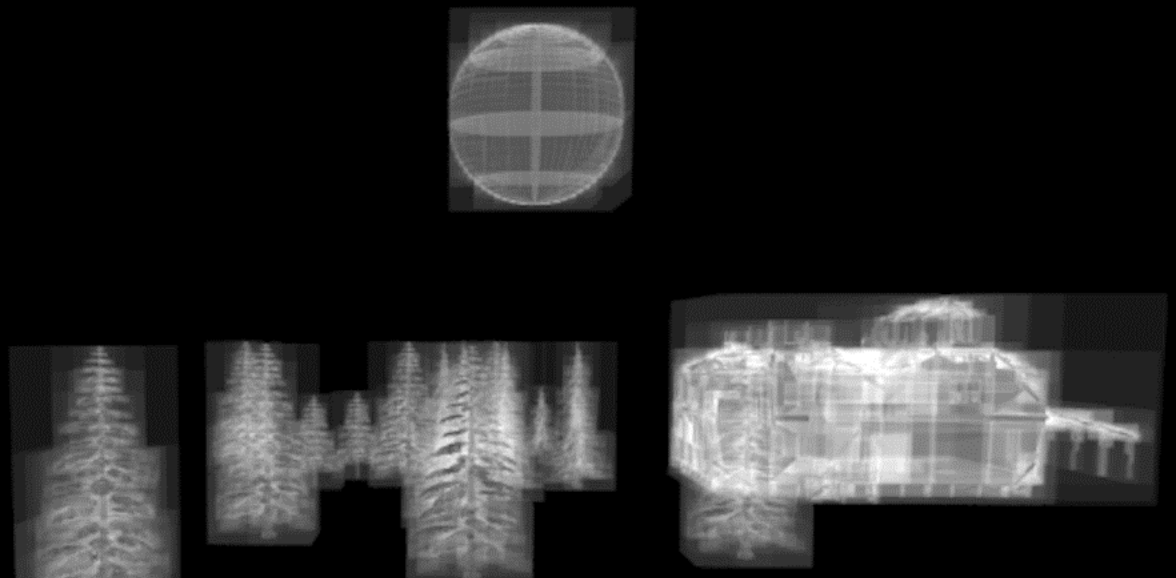
BVH
acceleration structure



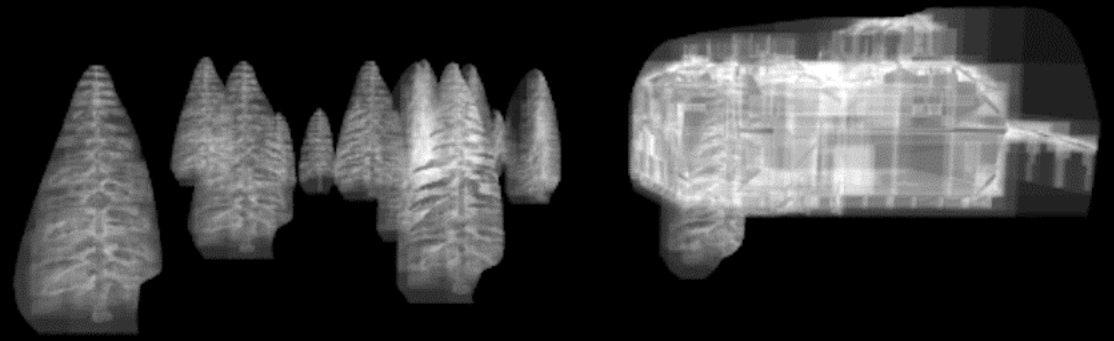
QNBVH
acceleration structure

***20-40% reduction** in ray-box **intersection** tests*

BVH



QNBVH



Questions

Thank you!

Email: nejc@lightmass-dynamics.com
Twitter: @nejclesek