Scientific Visualization at NVIDIA

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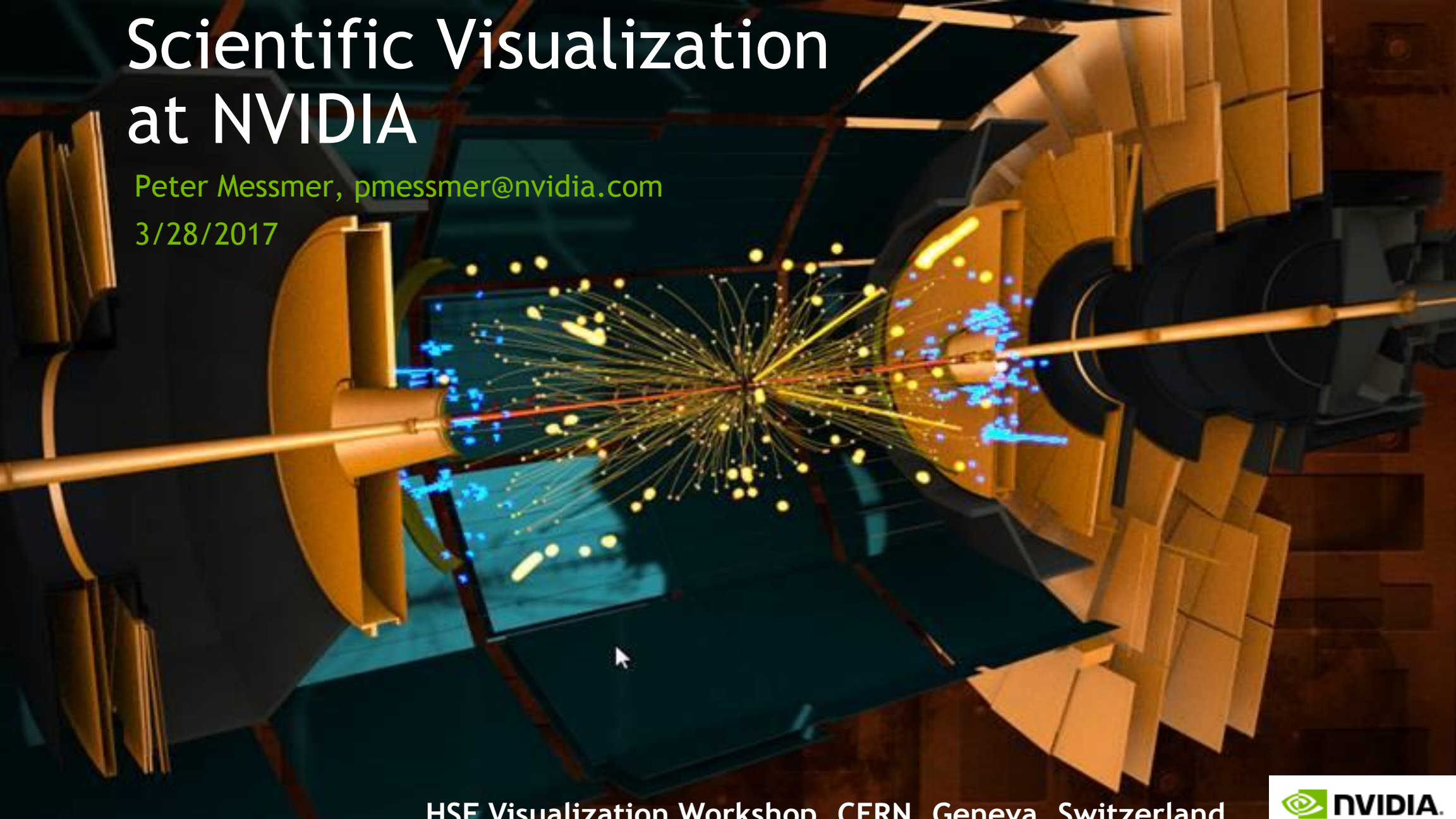
3/28/2017



HSF Visualization Workshop, CERN, Geneva, Switzerland

NVIDIA

Some graphics features on Pascal P100 GPUs

OPENGL

HW accelerated rasterization

OpenGL 4.5

EGL context management

X based remoting solutions

CUDA interop

NVCODEC

Video de-/encoder

H.264, H.265, HEVC (up to 8k)

Lossy/Lossless compression

Separate silicon, async execution

Commercial remoting solutions

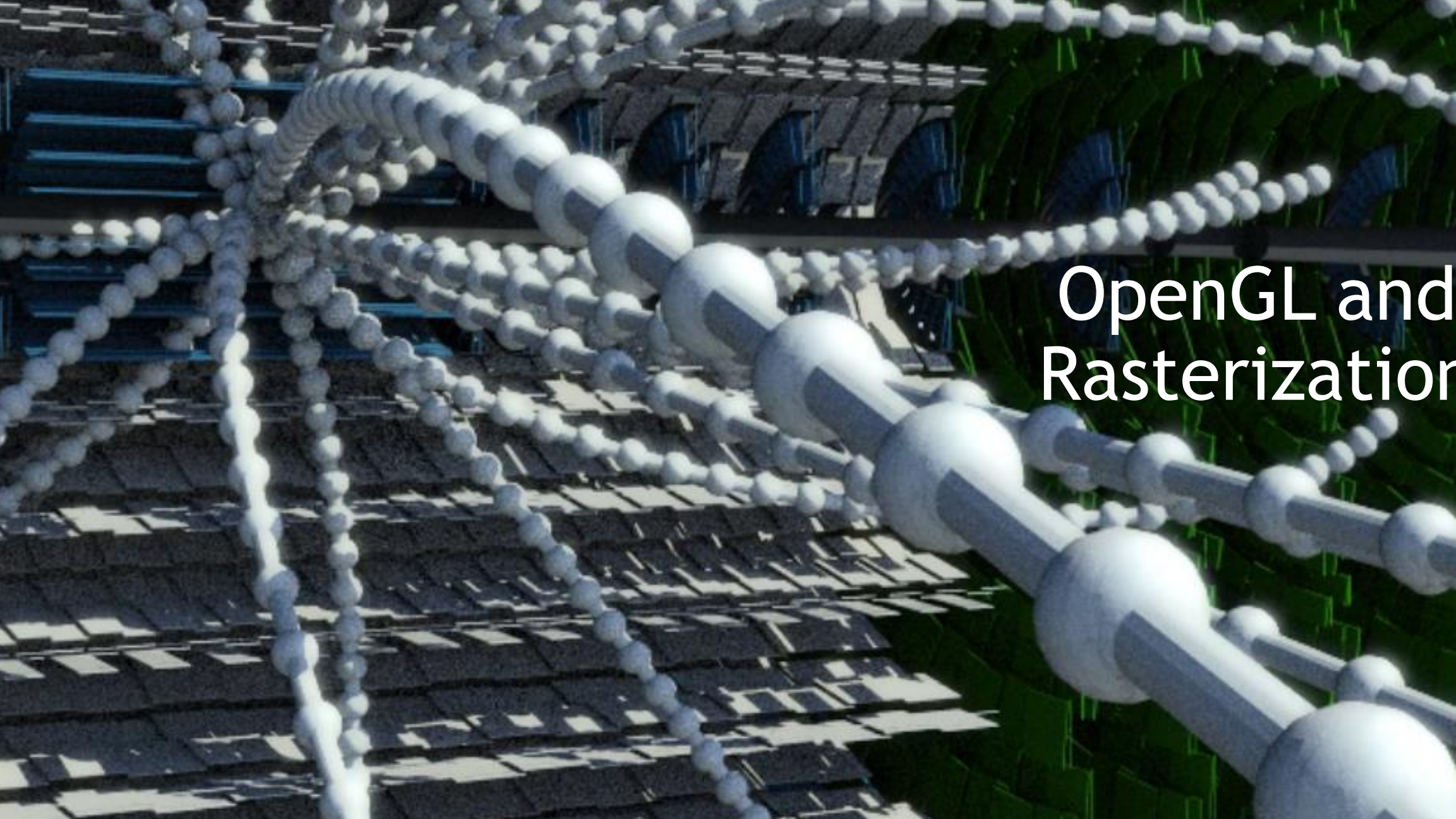
eDCV
desktop cloud visualization

ADVANCED RENDERING

IndeX volume renderer (ParaView plugin)

OptiX raytracing framework

Iray raytracing solution


OpenGL and
Rasterization

Modern OpenGL for HPC Viz

Mandatory to access advanced rendering features

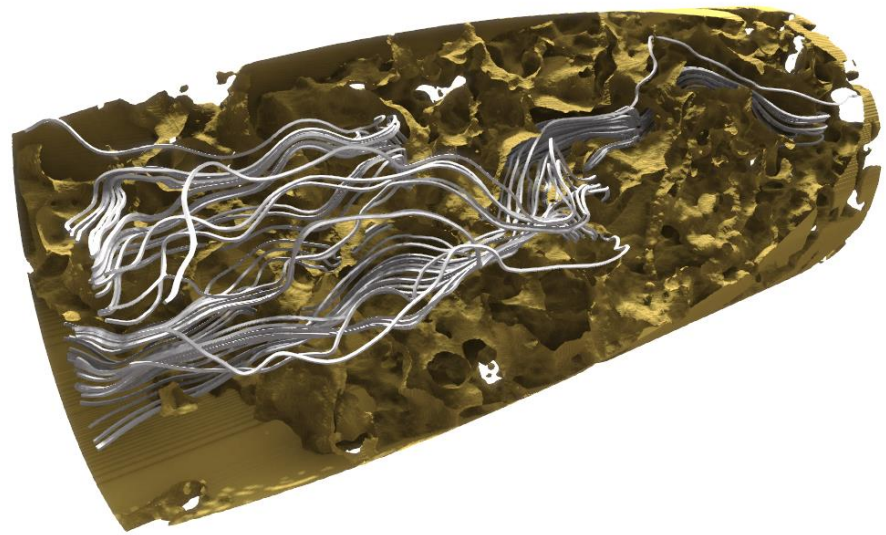
Many SciVis packages are stuck with old standards

Time to revisit rendering pipeline

E.g. Kitware's VTK supports now OpenGL 3.2

Enables advanced shaders (AO, VXGI, ..)

GPU hardware support



Data courtesy Florida Intl University & TACC

Pick a toolchain that supports new levels of OpenGL

OpenGL Rendering Performance

glmark2

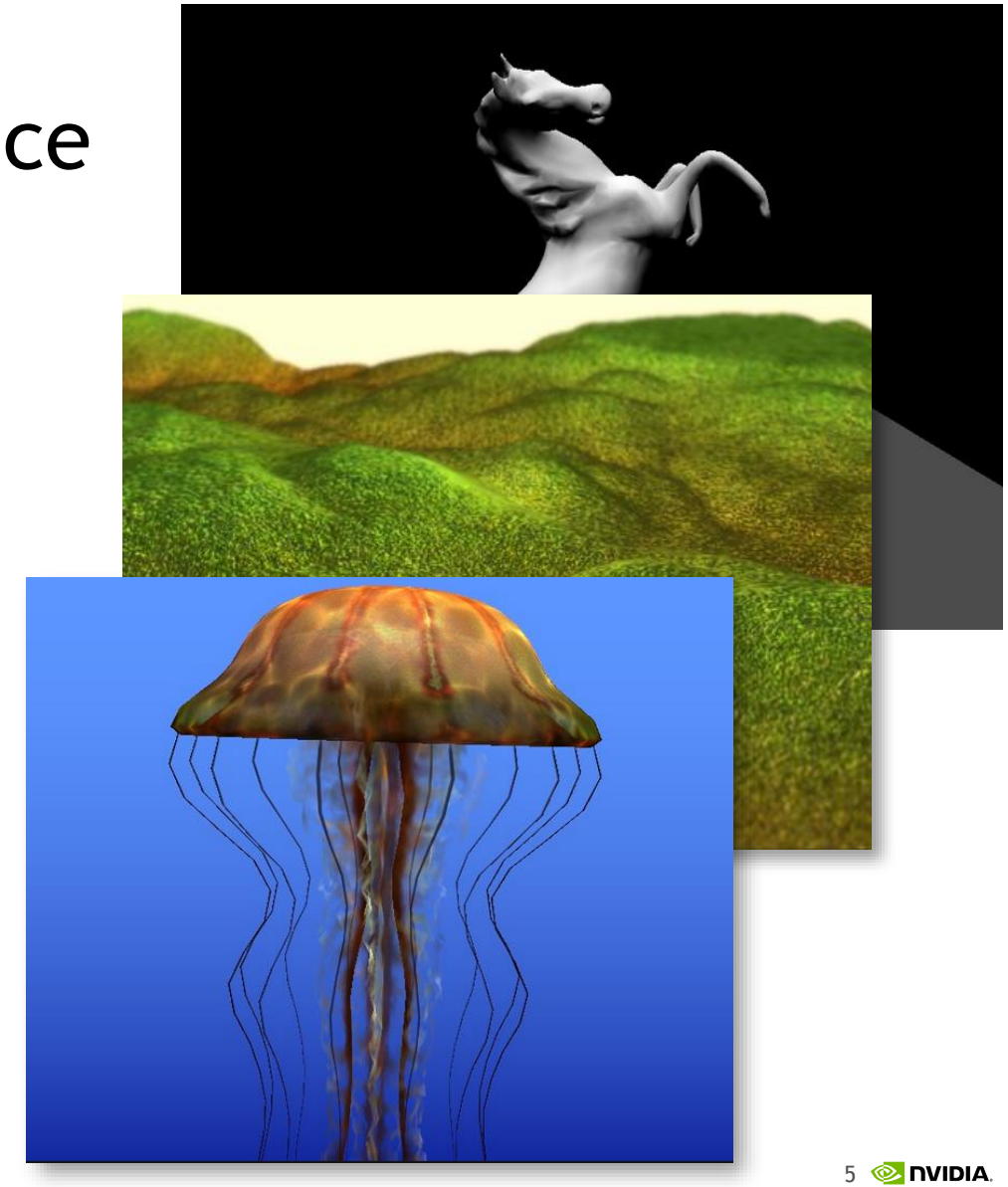
Range of rendering workloads

Established OpenGL performance benchmark

Easy to setup, run

Score (higher is better)

x86 + P100 (PCIe):	26636	
Power8 + P100 (Nvlink):	29987	(+13%)



OpenSceneGraph

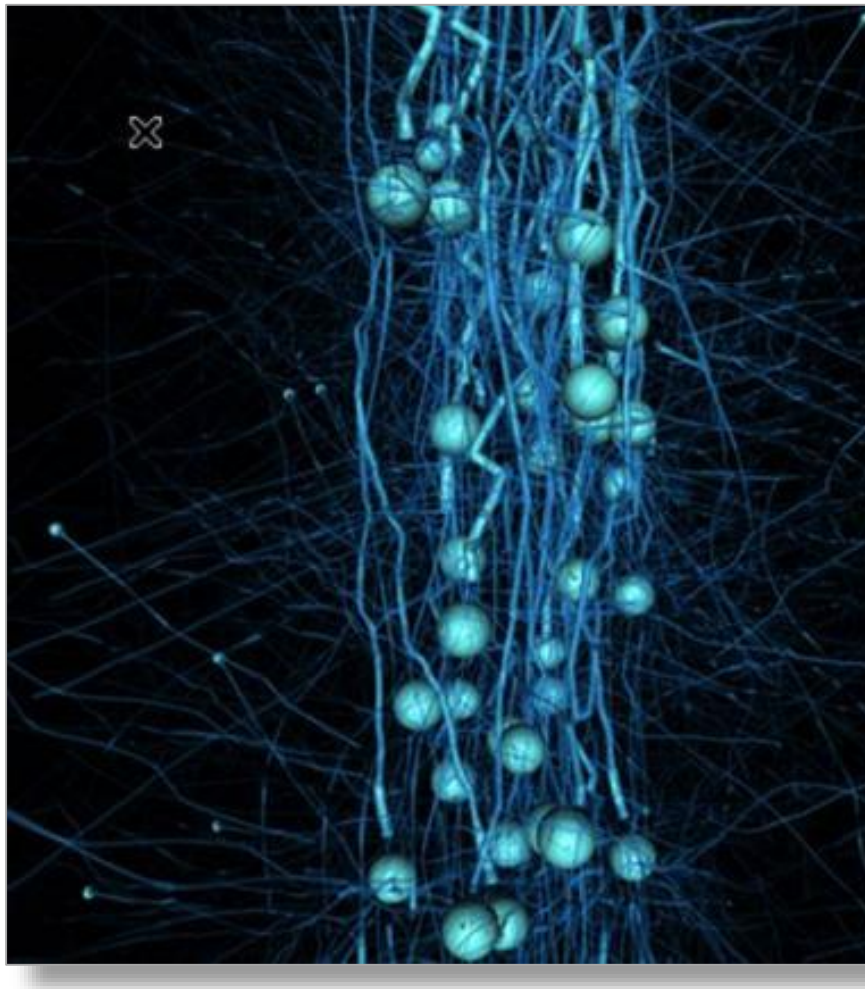
One possible scene graph API

Widely supported, C++ and Python API

Support for latest OpenGL extensions

Readily available readers

WebGL version: OSG.JS



Entertainment Tools for Scientific Visualization

A new dimension of exploration using OpenGL

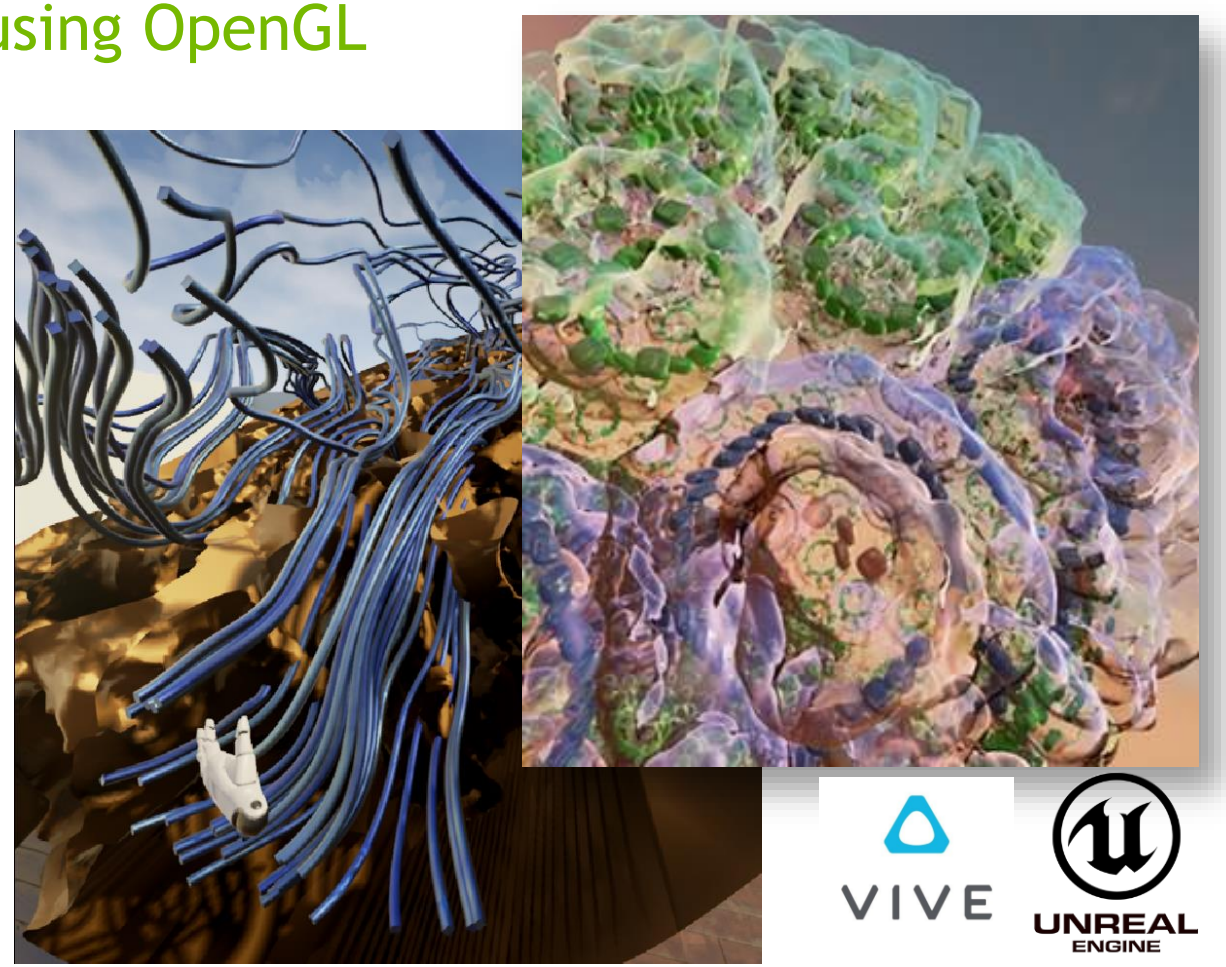
High quality rendering, portability, maintenance etc on mission-critical path

Support for range of displays

Unreal Engine in browser

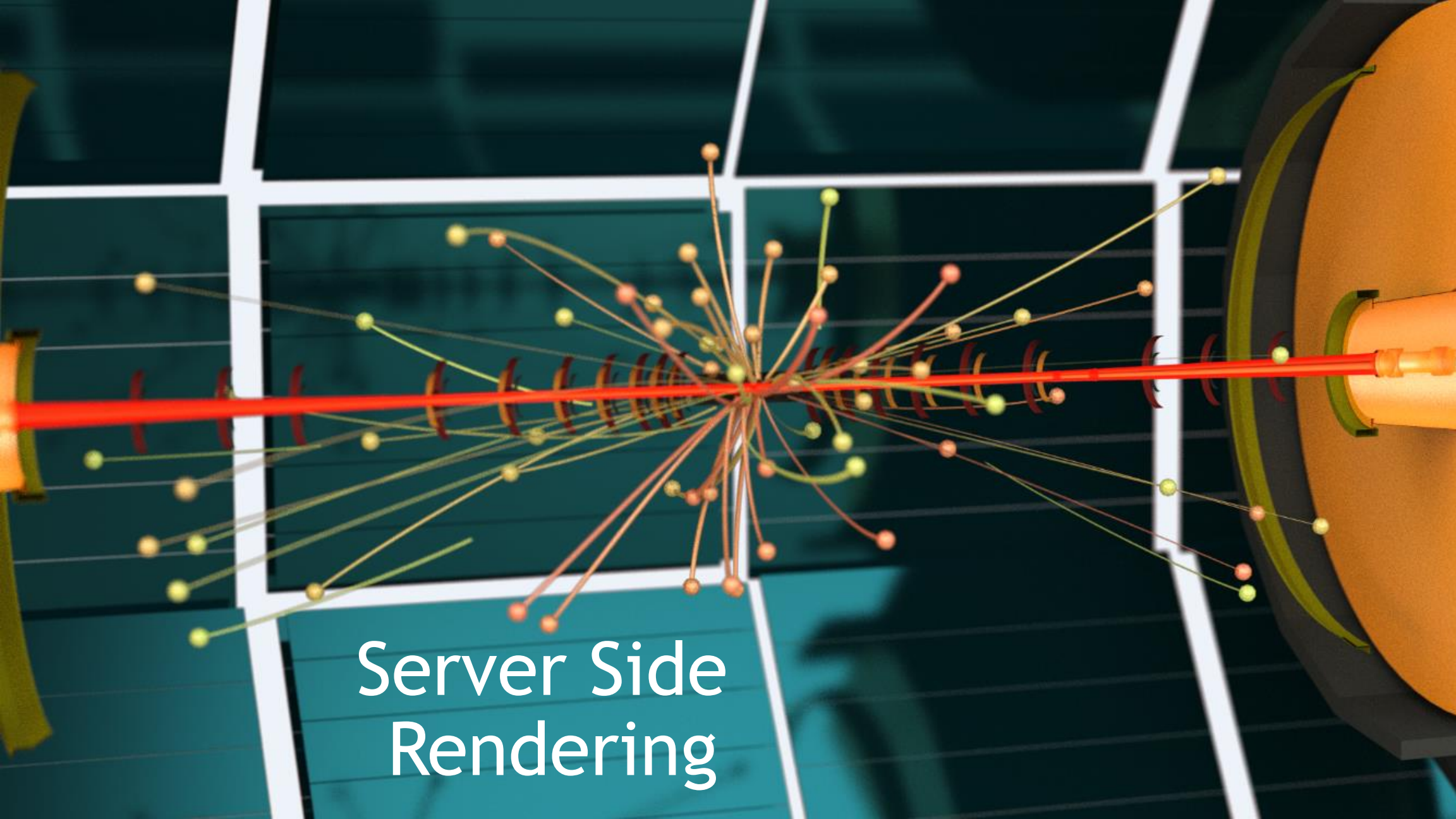
First class support for VR:

Orientation + Navigation = Exploration



VIVE

UNREAL ENGINE


Server Side
Rendering

Typical HPC Environment

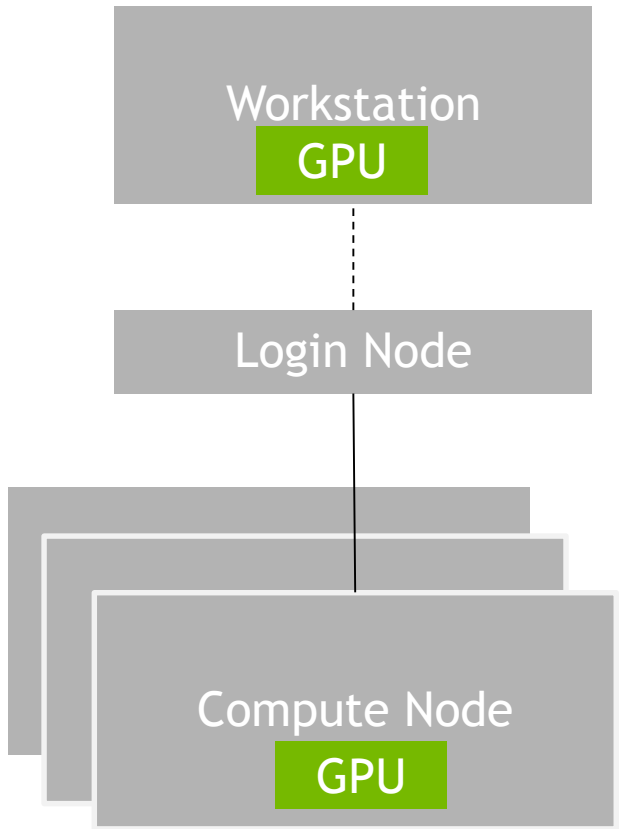
Workstation on scientist's desk

Remote HPC center

Compute nodes not directly accessible

Output from compute nodes:

- File transfer
- X forwarding
- Remote rendering



Remote Rendering

Know your latencies

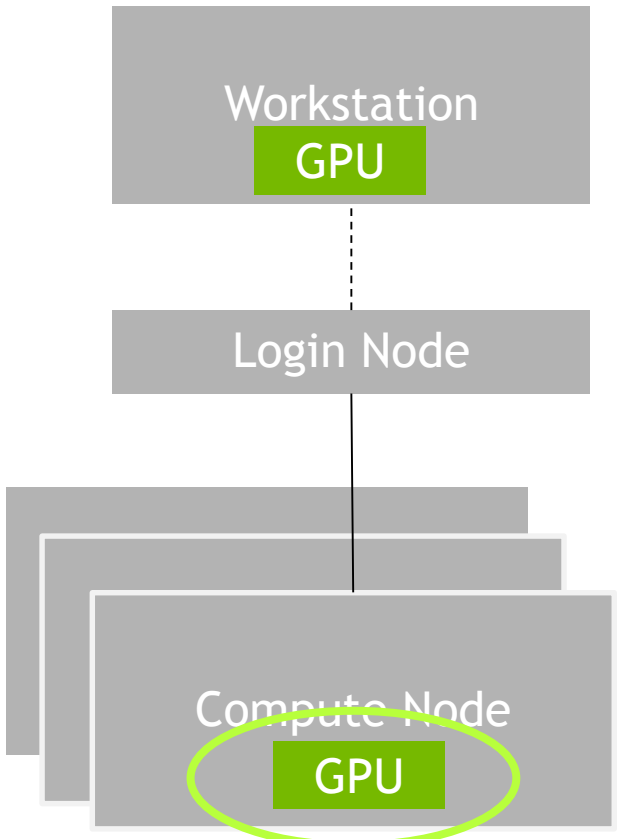
Use compute node's GPU for rendering

Capture renderings and ship pixel data to user

Compression is key

Requires running X server on compute node*

* Requirements will change with EGL



In-Situ Visualization in the Cloud

Supercomputer on demand

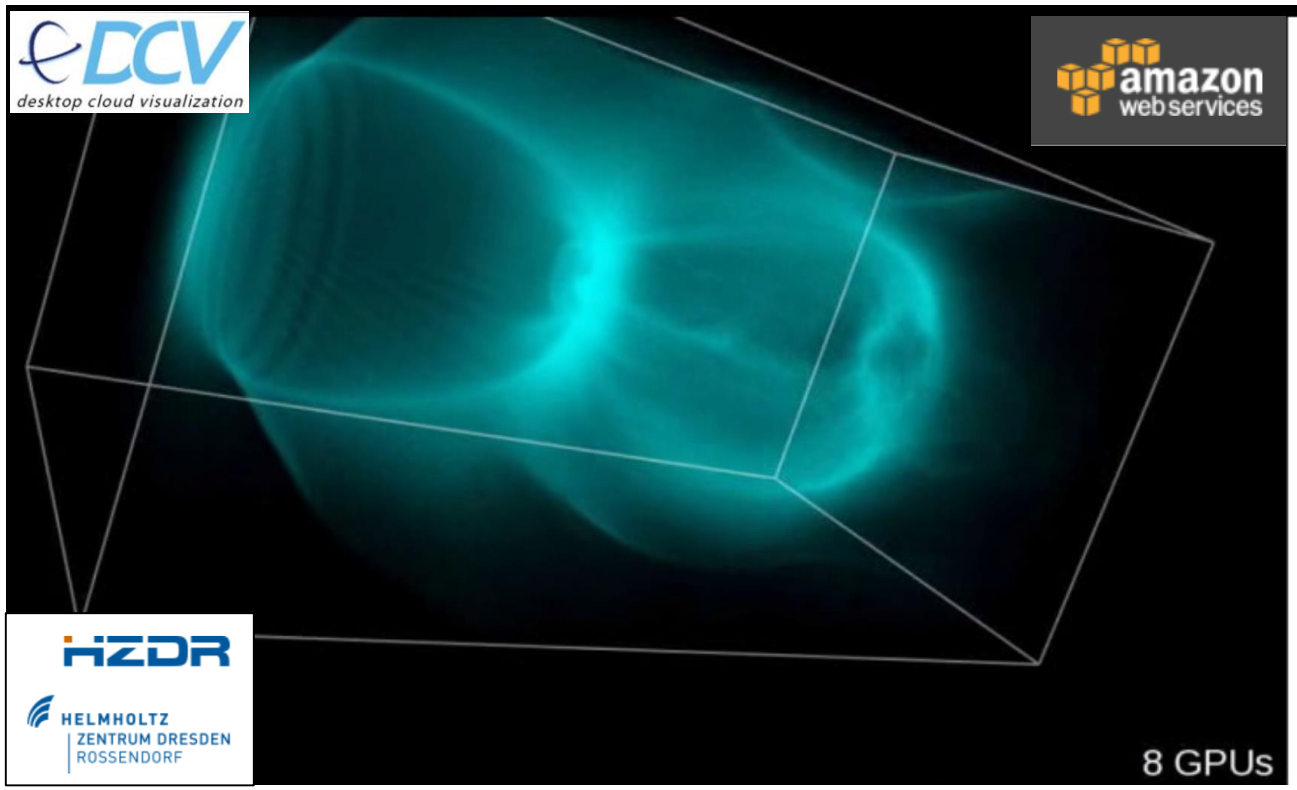
Compute & Vis in Cloud

P2 instance of Amazon EC2

4xK80, compute and vis

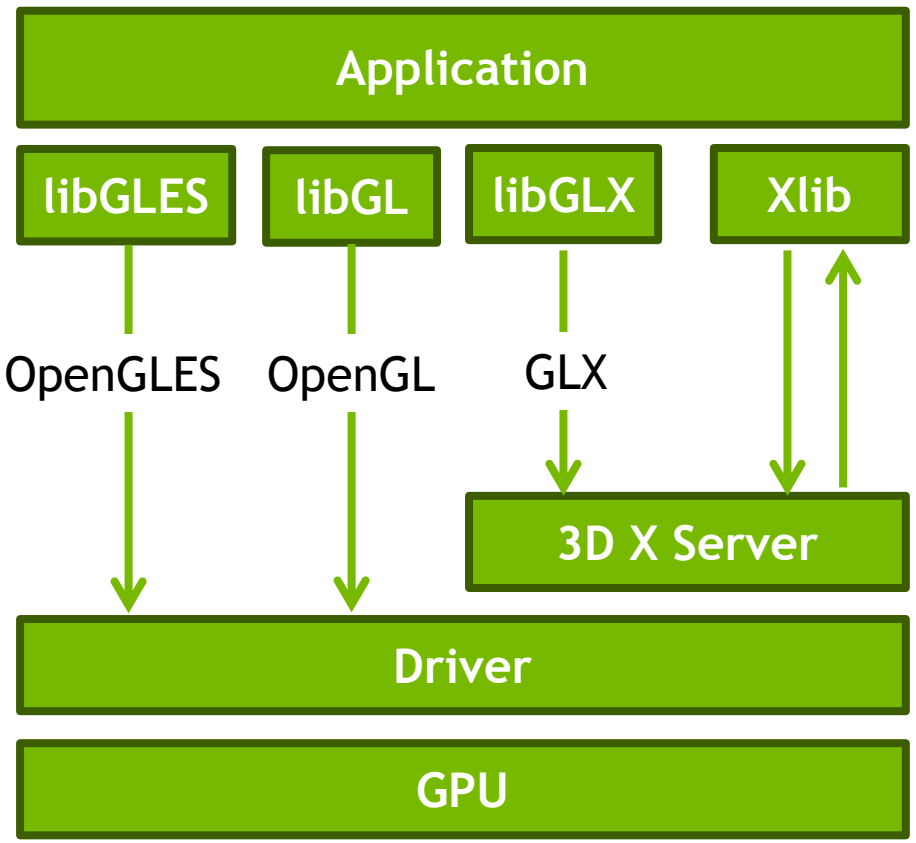
NICE DCV for hardware accelerated streaming

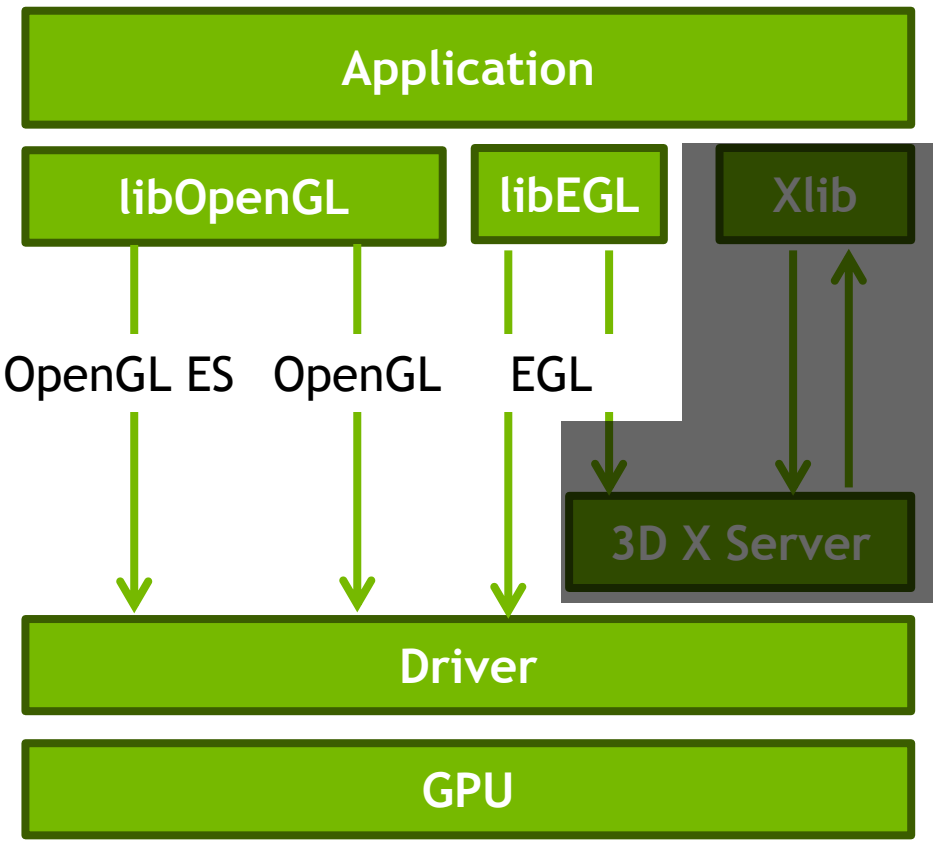
Uses H264 encoders on GPU



Axel Hübl et al., 2016

OpenGL on Headless Servers

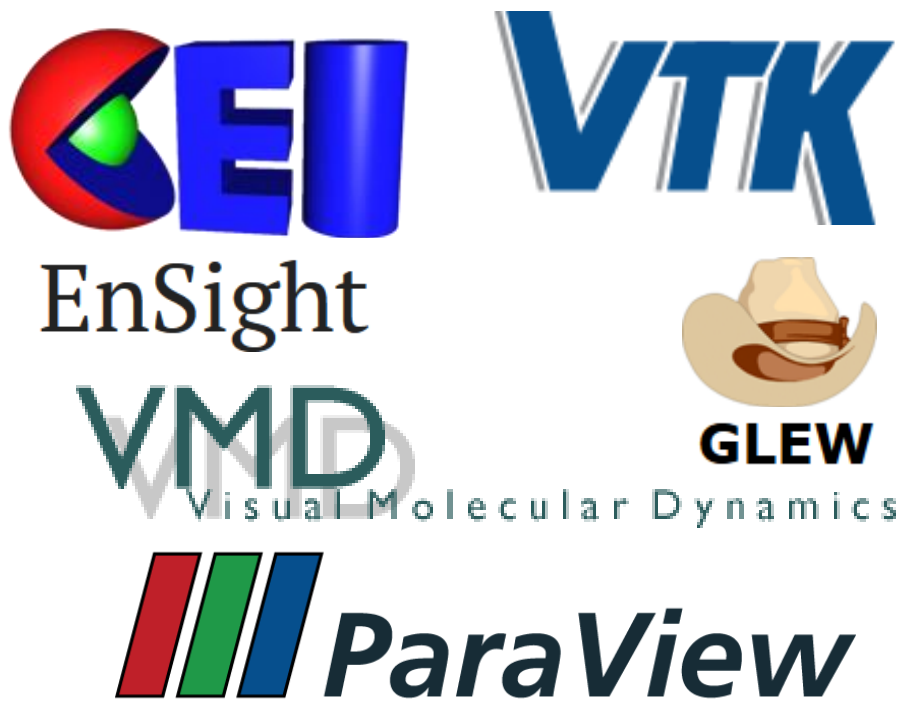




Visualization on GPU Accelerated HPC Systems

Streamlined GPU accelerated off-screen rendering

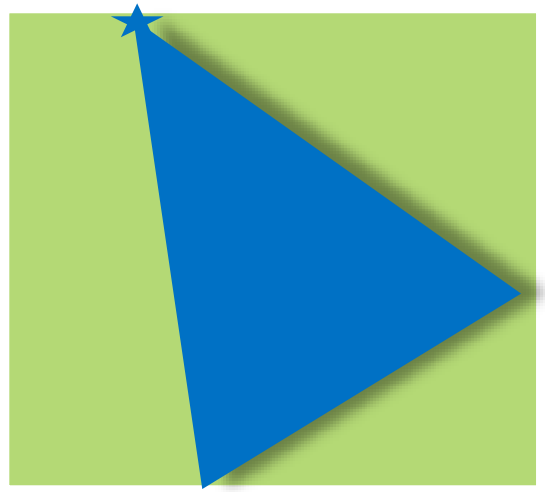
- Prior to EGL: X server required for GPU accelerated rendering
- Desktop OpenGL on EGL announced at SC15
- With EGL: OpenGL without X
- Major enabler for GPU rendering in HPC, incl. Cray systems*
- Quick adoption by vis tool developers
- https://devblogs.nvidia.com/parallelforall/egl-eye-opengl-visualization-without-x-server/
- * Requires driver version 358.7 or newer required, available on Power8/P100 in 375.37



OpenGL not limited to Rendering Tasks

Interop goes both ways, esp with EGL

CUDA->OpenGL typically one-way only

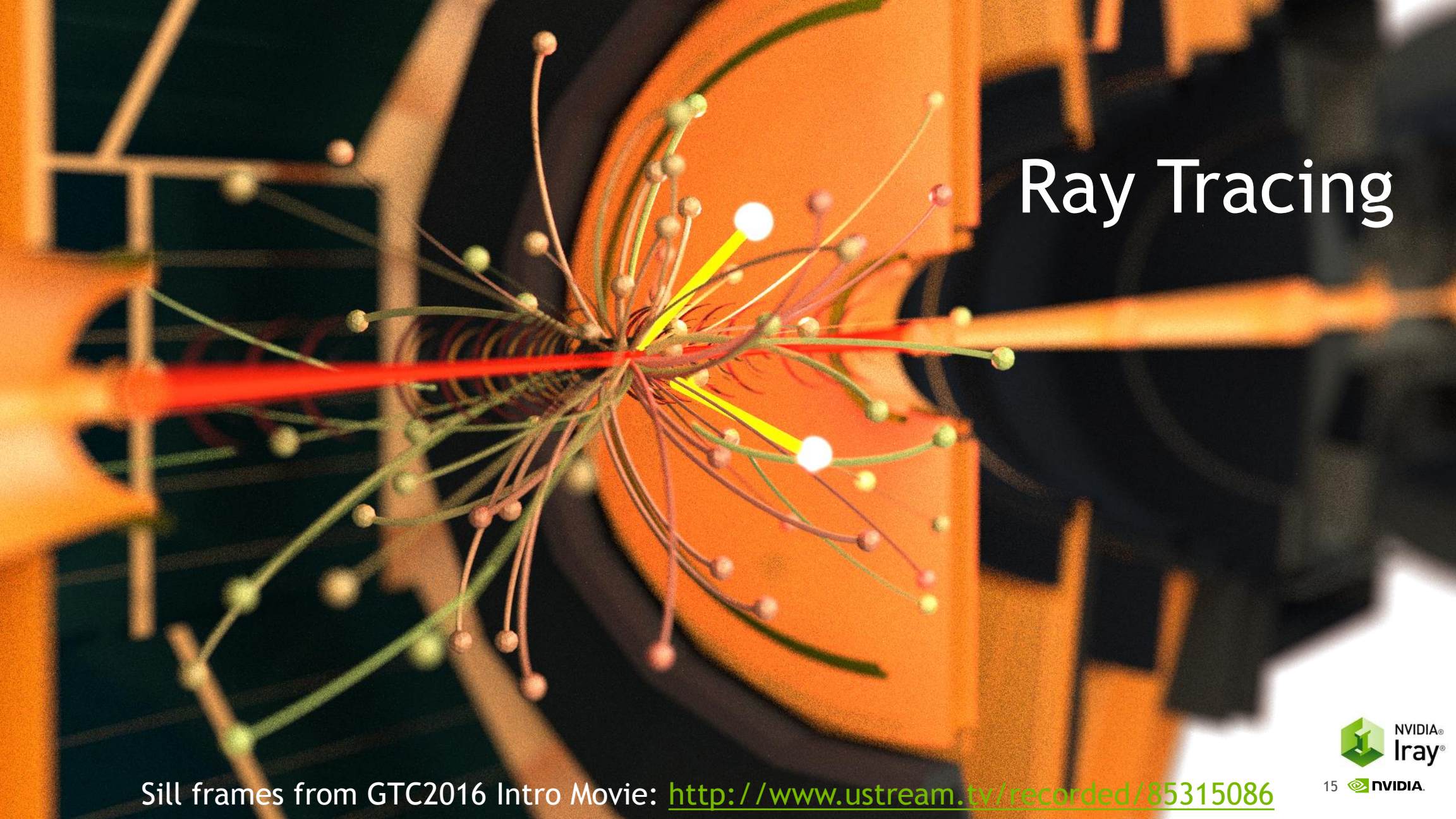


EGL enables lighter weight access to OpenGL

- No X server needed

Potential use of OpenGL for rasterization-like problems?

- Determine covered “pixels”
- 3D ordering/occlusion via Z-buffer



Ray Tracing

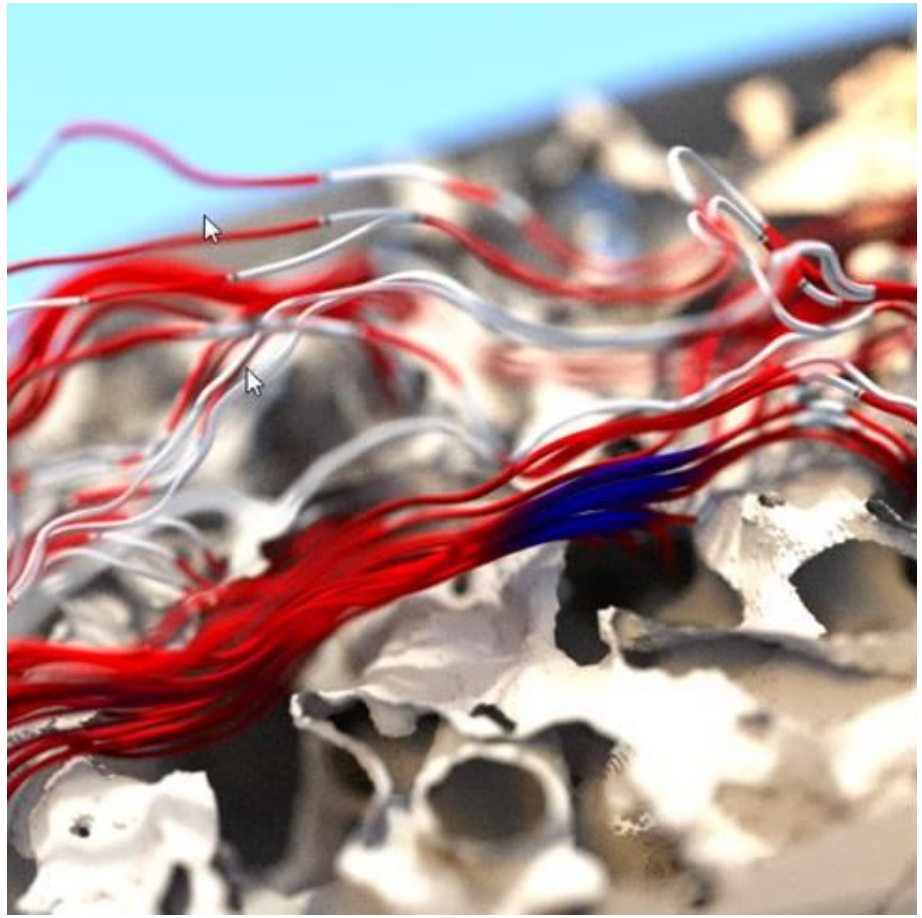
Sill frames from GTC2016 Intro Movie: http://www.ustream.tv/recorded/85315086

NVIDIA® Iray®

Telling a Better Story, Visually

Advanced rendering improves messaging

- Advanced rendering can help visual message, e.g. guiding the eye via depth of field
- Particularly useful for complex visualizations
- NVIDIA's Ray-Tracing solutions
  - Iray – plugin for Maya, Cinema4D, ..
  - OptiX – Ray-Tracing Framework
- Post-processing of ParaView files



GPU Accelerated Ray-Tracing Solutions

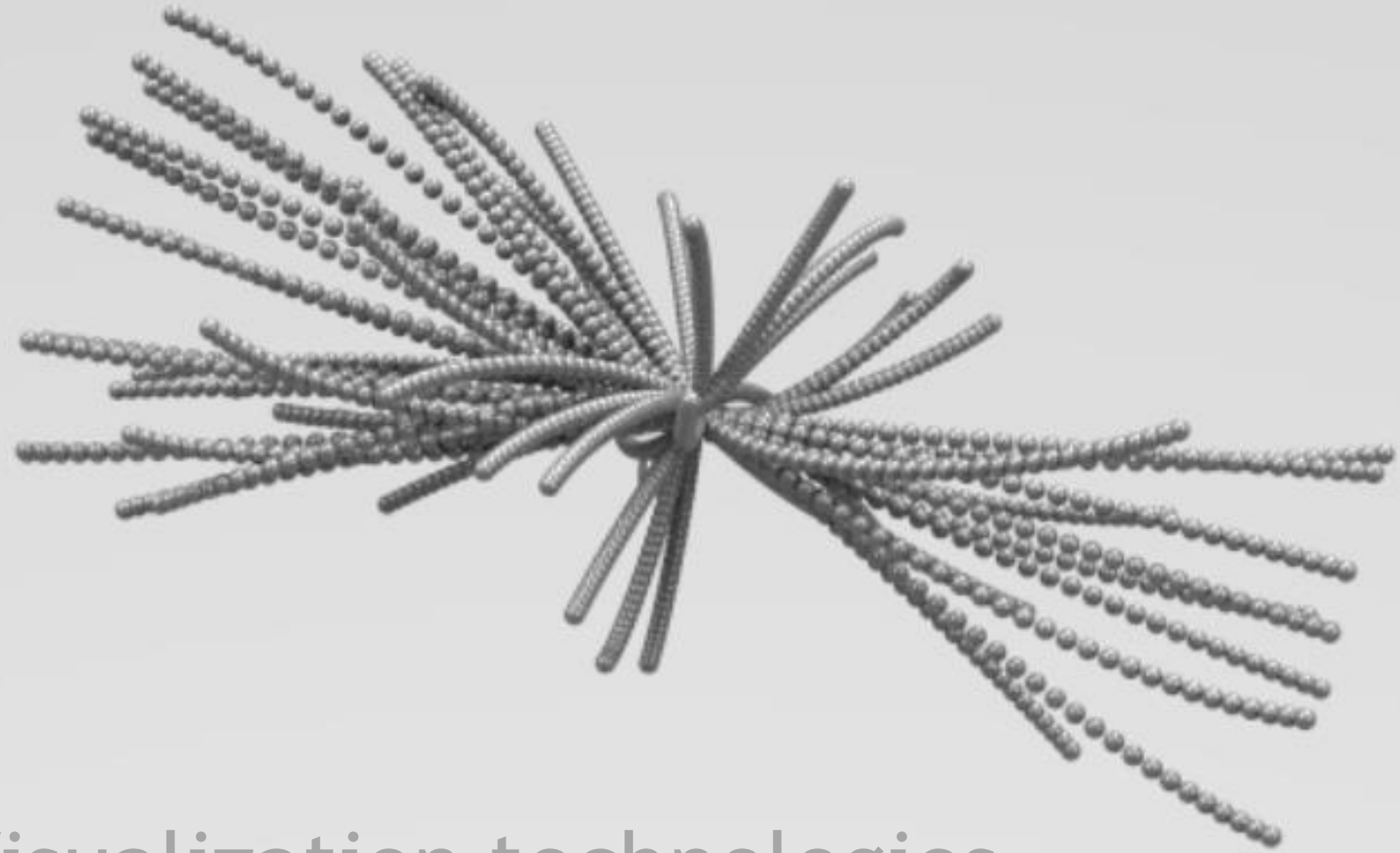
OptiX Ray Tracing Engine

- SDK
- Ultimate flexibility
- Fast mesh collisions
- https://developer.nvidia.com/optix

Iray Ray-Tracing Solution

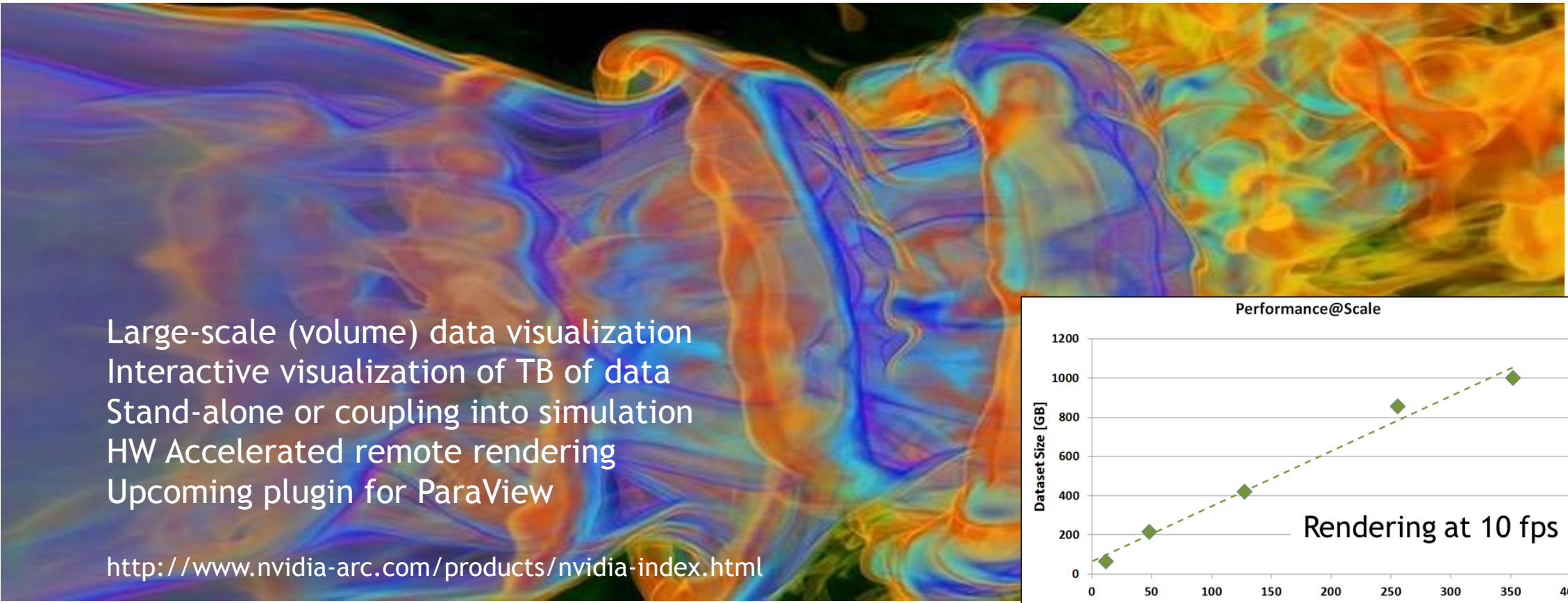
- SDK, mostly accessed as plugin
- Photoreal, real-time, ..
- Physically accurate
- Material Definition Language
- https://developer.nvidia.com/iray-sdk

Email if more questions



Visualization technologies

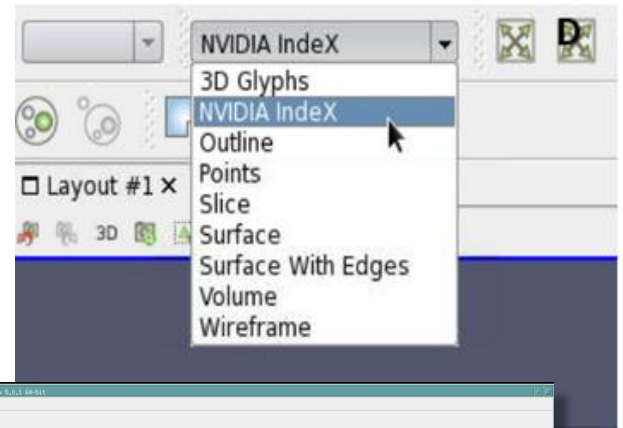
NVIDIA IndeX: Scalable, Interactive Volume Vis



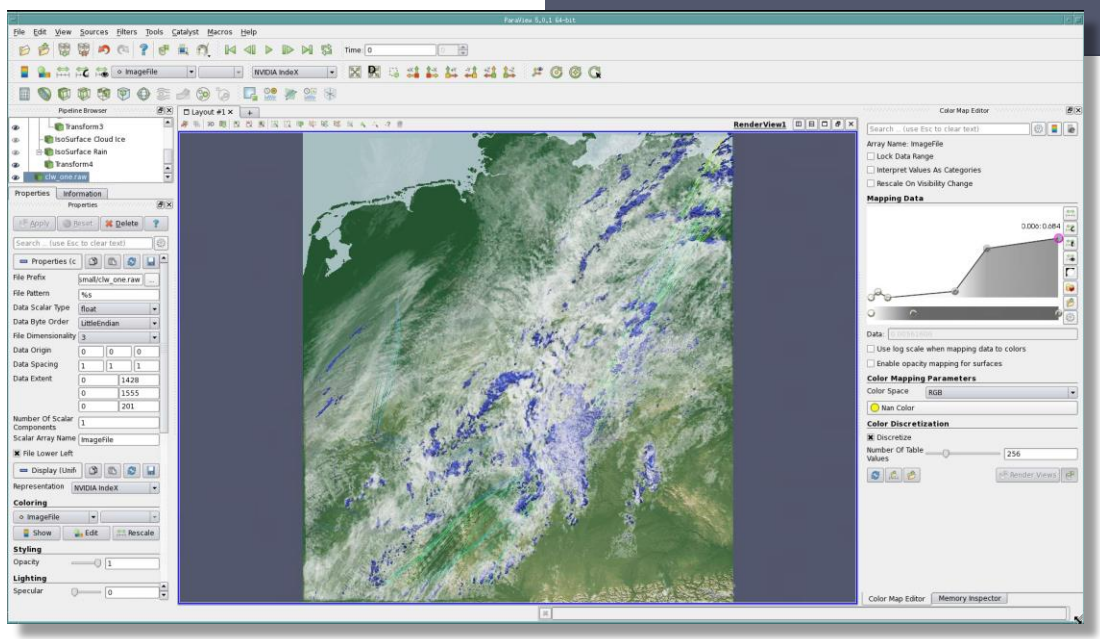
Large-scale (volume) data visualization
Interactive visualization of TB of data
Stand-alone or coupling into simulation
HW Accelerated remote rendering
Upcoming plugin for ParaView

http://www.nvidia-arc.com/products/nvidia-index.html

NVIDIA IndeX for ParaView plugin



- NVIDIA IndeX rendering in ParaView
- Retain ParaView workflows
- Structured and unstructured meshes



Workstation Edition: Free

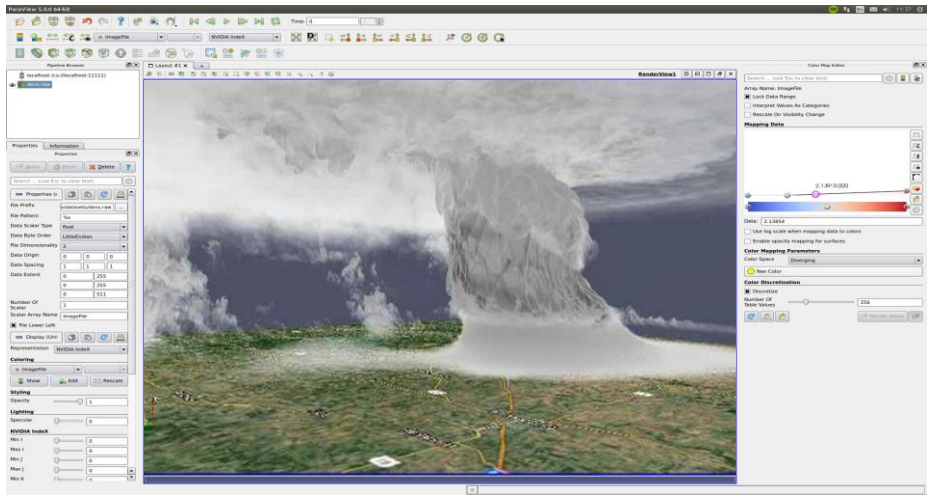
Cluster Edition: For Scalable Performance

Learn more: www.nvidia.com/index

Scalable Volume Rendering in ParaView

Plugin enables GPU accelerated volume rendering

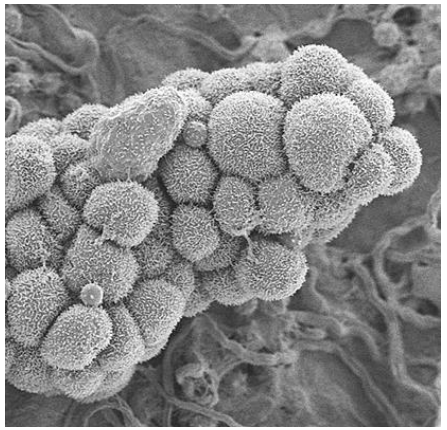
- Index plugin addresses shortcomings in ParaView built-in volume renderer
- Beta version supports
  - 3D structured, scalar grids
  - Single precision float, unsigned short
  - Overlay of opaque ParaView geometries (e.g. streamlines)
- Free plugin, requires commercial IndeX license

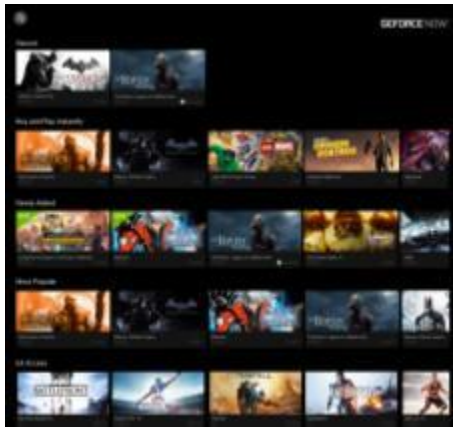


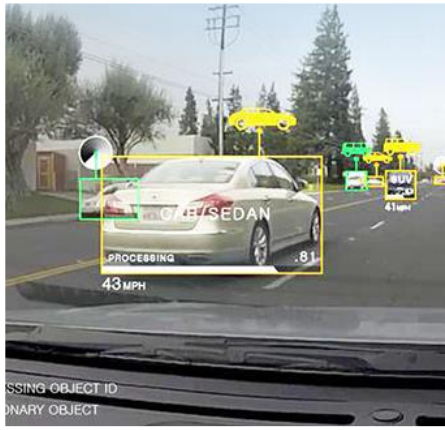
ParaView

- RC at: www.paraview.org

DEEP LEARNING EVERYWHERE







INTERNET & CLOUD

Image Classification
Speech Recognition
Language Translation
Language Processing
Sentiment Analysis
Recommendation

MEDICINE & BIOLOGY

Cancer Cell Detection
Diabetic Grading
Drug Discovery

MEDIA & ENTERTAINMENT

Video Captioning
Video Search
Real Time Translation

SECURITY & DEFENSE

Face Detection
Video Surveillance
Satellite Imagery

AUTONOMOUS MACHINES

Pedestrian Detection
Lane Tracking
Recognize Traffic Sign

All just xGMM

Visualization technologies

Summary

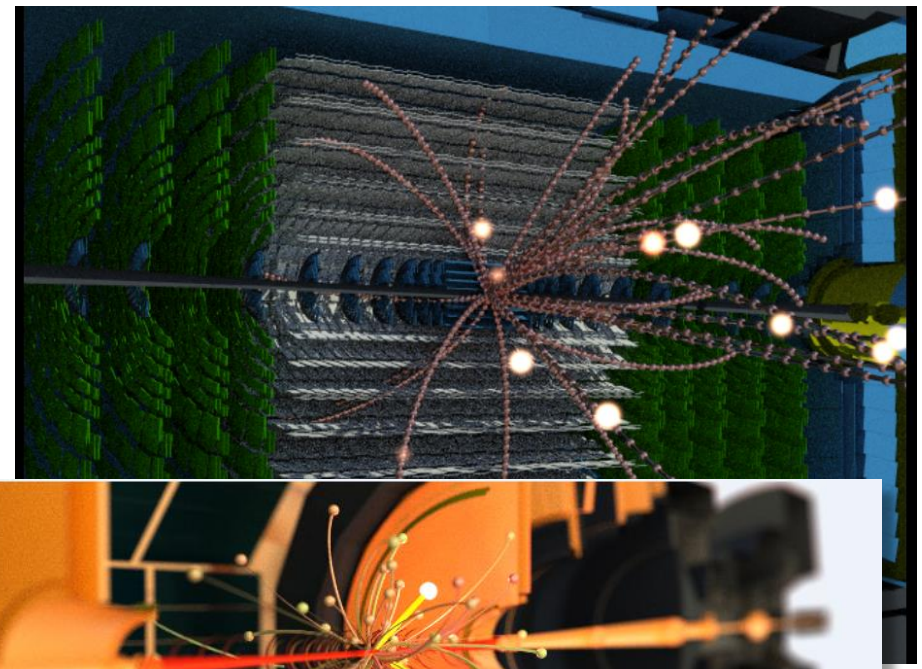
OpenGL: rendering workhorse

Cloud: High performance GPU for everybody

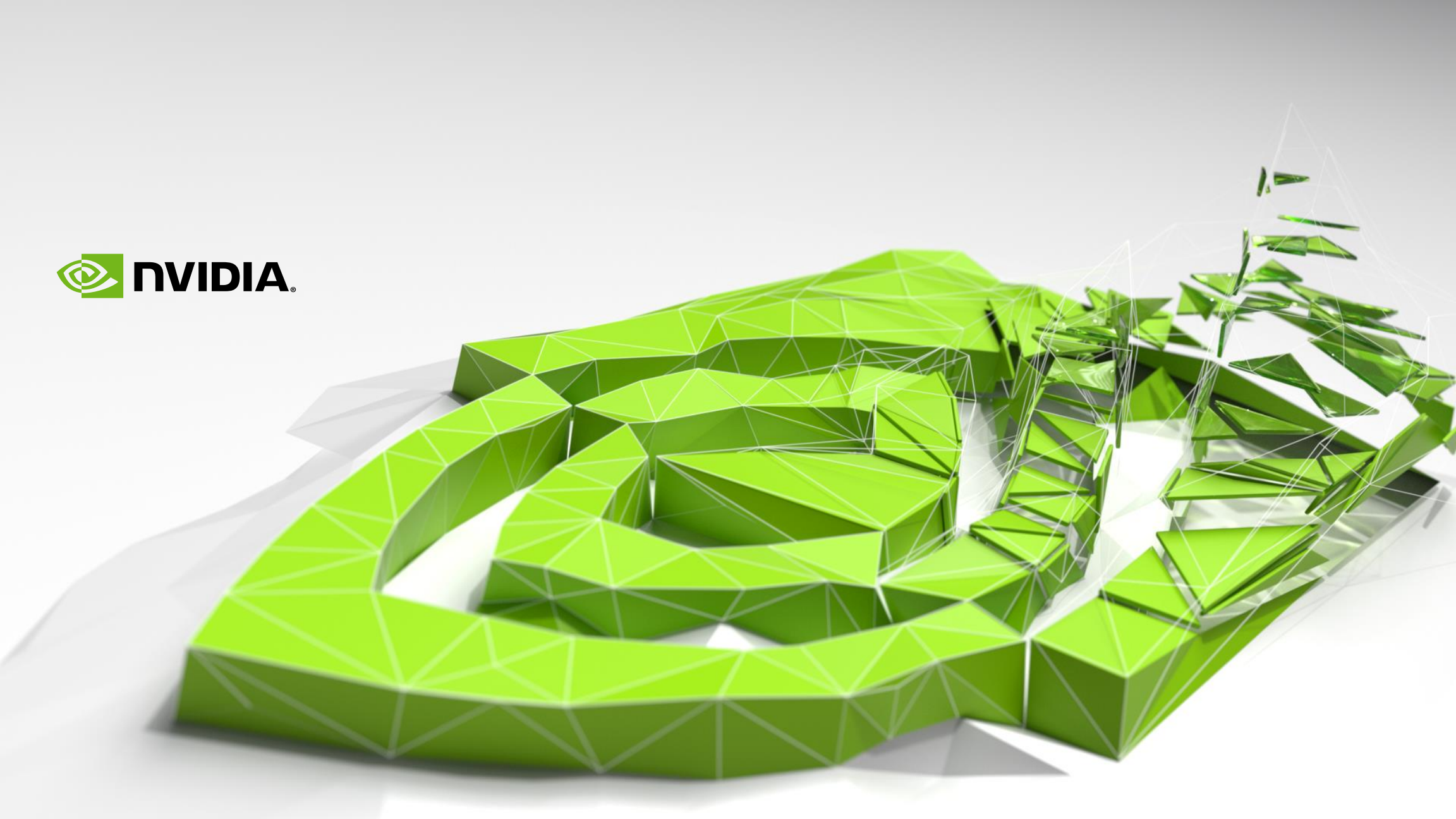
Ray-tracing frameworks

Rendering technologies

Let’s collaborate!



Sill frames from GTC2016 Movie: http://www.ustream.tv/recorded/85315086
Thanks to Felice Pantaleo, Thomas Mc Cauley, Tai Sakuma (CMS)


NVIDIA