The NVIDIA cutting-edge VR technologies in Funhouse
VRWORKS GRAPHICS

For Game and Application developers

**MULTIRES SHADING**
Increase performance via an innovative new way to render for VR

**VR SLI**
Scale performance with multiple GPUs

**LENS MATCHED SHADING**
Render to a surface that more closely approximates the lens corrected image and avoid rendering many pixels that would be discarded

**SINGLE PASS STEREO**
Project both right-eye and left-eye views of geometry by drawing the geometry only once
Scale performance across multiple GPUs

GPU affinity masking & Broadcasting

Frame 1 (Left eye)

Frame 1 (Right eye)
VR SLI

GPU Affinity Masking

Left eye rendering

Shadow maps, GPU physics, etc.

Right eye rendering
VR SLI

Broadcasting

Render scene once

Left eye

Right eye
VR SLI

Cross-GPU data transfer via PCI Express
Multi-Projection
Multi-Projection

A hardware feature on NVIDIA GPUs

Fast viewport broadcast, which makes MRS, LMS & SPS possible
Multi-res Shading
Multi-res Shading

VR headset optics (Distortion and counter-distortion)
Multi-res Shading

VR headset optics (Distortion and counter-distortion)
Multi-res Shading

An innovative new way to render for VR
New features on Pascal GPU

- Lens-Matched Shading
- Single Pass Stereo
Lens-Matched Shading
Lens-Matched Shading

More closely approximate the lens corrected image
Lens-Matched Shading

A new hardware feature on Pascal GPU: Modified W

\[ w' = w + Ax + By \]

SV_POSITION table:

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>W</th>
</tr>
</thead>
</table>

- Modified W equation
- Clipping: \( \text{abs}(xyz) \leq w', z \geq 0 \)
- Perspective Divide: \( xyz \neq w' \)
- Viewport Transform
- Rasterization
Lens-Matched Shading

\[ w' = w + Ax + By \]
Lens-Matched Shading

Subdivide the screen into 4 viewports
Lens-Matched Shading

Projection Configuration

- Set the coefficients to the Modified W equation
  - WarpLeft
  - WarpRight
  - WarpUp
  - WarpDown

- Set the size of the octagon
  - SizeLeft
  - SizeRight
  - SizeUp
  - SizeDown
Single Pass Stereo
Single Pass Stereo

Another new hardware feature on Pascal GPU

Draw geometry only once, then simultaneously project both right-eye and left-eye views of the geometry with a single GPU

Render scene once
Single Pass Stereo

Not only reduce CPU overhead

- Draw(…)
- Input Assembler
- Vertex Shader
- Cull, Clip, Viewport
- Geometry Shader
- Tessellation Shaders
- Rasterizer
- Pixel Shader
- Output Merger
Single Pass Stereo

The views of the eyes in VR

- The eye vectors are parallel
- Transform a world space point to the clip spaces of the eyes
  - Only the X coord is different
Single Pass Stereo

Implementation

- Output 2 sets of coords from the last geom processing shader stage
  - The clip space coords for the left eye (SV_POSITION)
  - The clip space X coord for the right eye (NV_X_RIGHT)
Single Pass Stereo

Implementation

- Output a viewport mask to identify which viewports correspond to which eye
  - NV_VIEWPORT_MASK
  - UINT, higher 16 bits for the right view, lower 16 bits for the left view

```
NV_VIEWPORT_MASK
[ 31 : 16 ] [ 15 : 0 ]
```

```
0 0 ... 1 0
```

```
0x00020001
```

```
0 0 ... 0 1
```
Single Pass Stereo

Stereo Layouts

Side-By-Side Layout

Render Target Array (RTA) Layout
VRWORKS GRAPHICS

For Game and Application developers

**MULTIRES SHADING**
Increase performance via an innovative new way to render for VR

**VR SLI**
Scale performance with multiple GPUs

**LENS MATCHED SHADING**
Render to a surface that more closely approximates the lens corrected image and avoid rendering many pixels that would be discarded

**SINGLE PASS STEREO**
Project both right-eye and left-eye views of geometry by drawing the geometry only once
Questions?
youngy@nvidia.com

http://developer.nvidia.com/vrworks