GPU TECHNOLOGY CONFERENCE

NVIDIA

ADVANCED SKIN SHADING WITH FACEWORKS

Nathan Reed — NVIDIA

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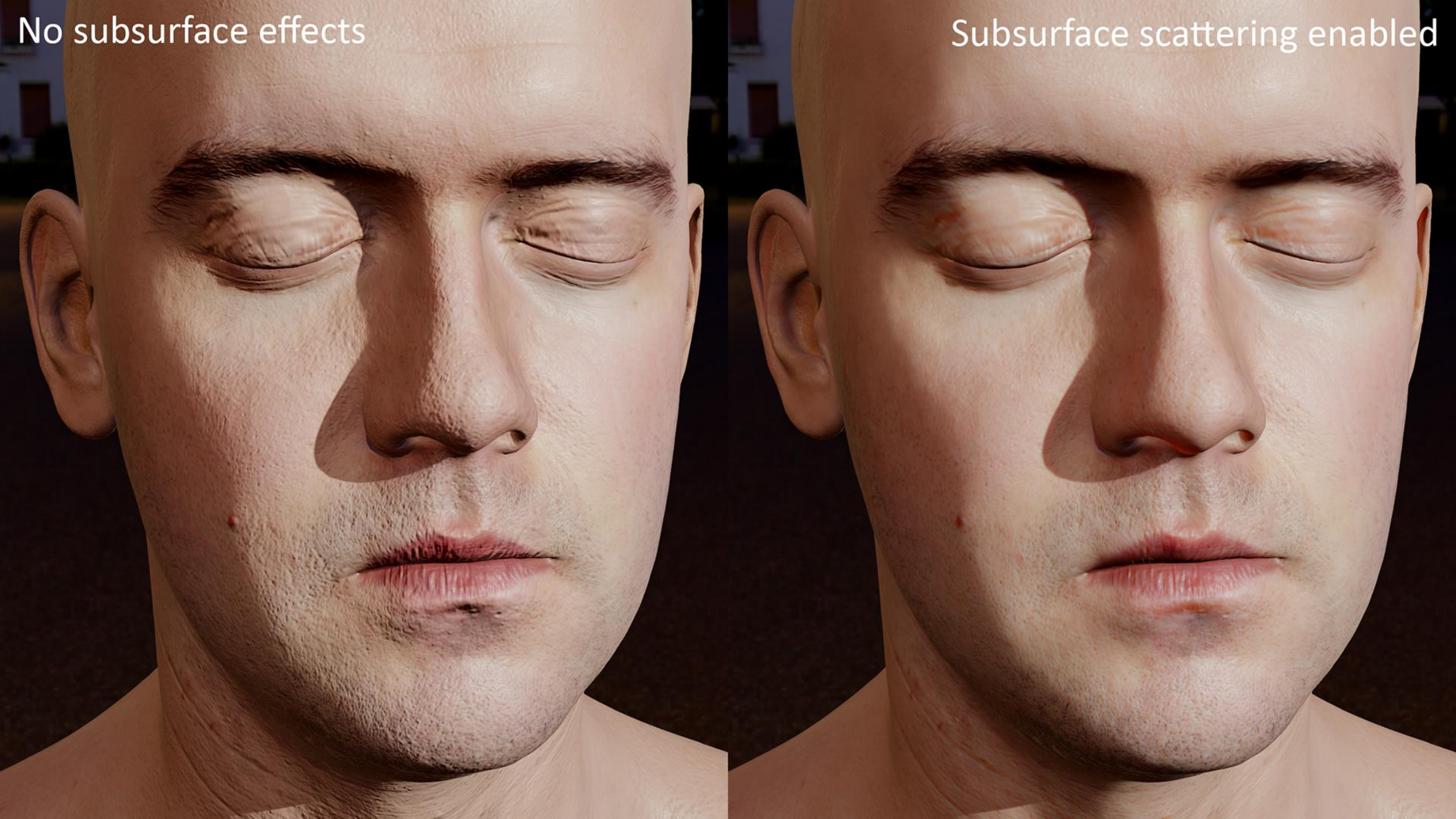
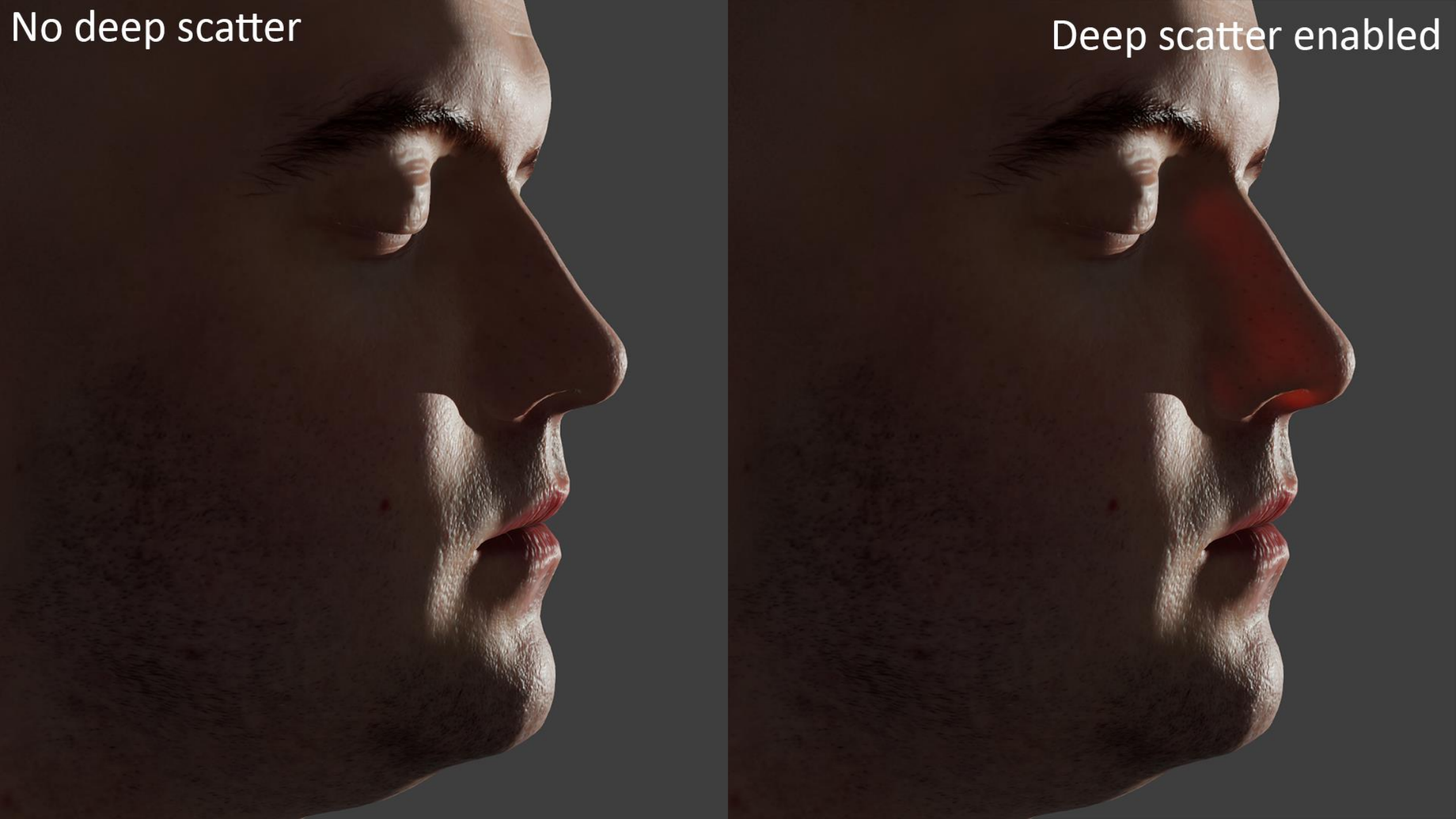
DIGITAL IRA

- Tech demo
- Collaboration with Dr. Paul Debevec at USC
- Lots of other inspiring work on skin & eyes
  - [Penner10], [Jimenez12], [Jimenez13]

THE FACEWORKS API

- Middleware lib
- Integrate advanced skin shading in your game engine
- Goal: enable quality that matches Digital Ira
- This is a preview!


No subsurface effects
Subsurface scattering enabled


No deep scatter
Deep scatter enabled


No subsurface effects
SSS & deep scatter enabled

FEATURES

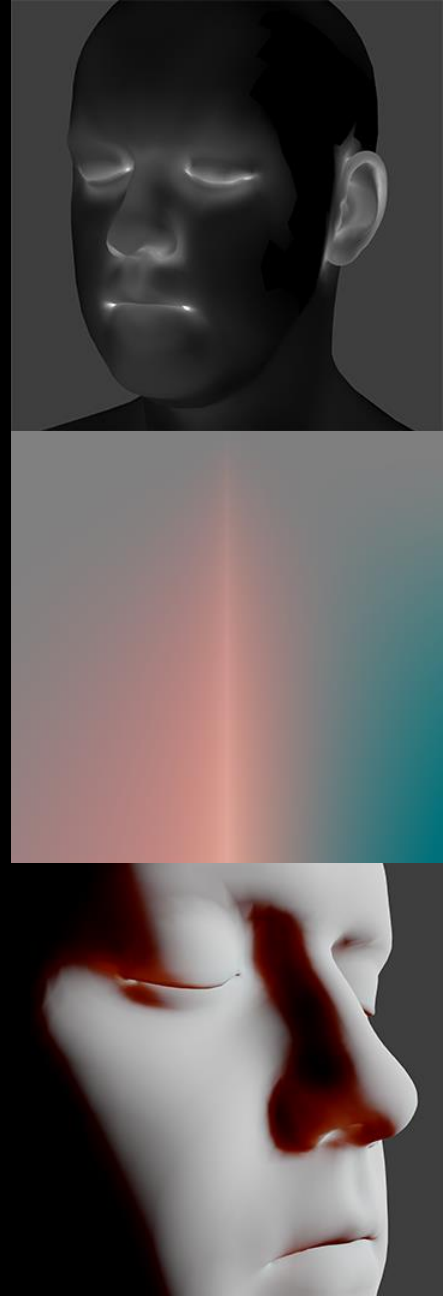
- Subsurface scattering (SSS)
  - One-pass solution based on [Penner10]
  - Both direct and ambient light
- Deep scatter
  - Based on thickness from shadow map [Green07]
  - Direct light only, so far
- D3D11 only, so far

SSS COMPONENTS

- Geometric curvature
- Normal maps
- Shadow edges
- Ambient

SSS 1/4: GEOMETRIC CURVATURE

- Precompute curvature per vertex (1 float)
  - Use bind pose of mesh
- Precompute a LUT (lookup texture)
  - For a given range of curvatures
  - Based on diffusion profile [d'Eon07]
- In PS, sample LUT based on curvature & N·L



SSS 2/4: NORMAL MAPS

- In PS, sample the normal map twice
  - Once as usual
  - Once with higher mip level
- Precompute mesh UV scale
- Combine lighting from both normals & curvature

SSS 3/4: SHADOWS

- Wide shadow filter
  - PCF, VSM, ESM, etc.
  - Not contact hardening – want consistent filter radius
- Precompute a LUT
  - Sharpens shadows
  - Adds red glow in shadowed area
- In PS, sample LUT based on shadow result

SSS 4/4: AMBIENT

- In PS, generate 3 normal vectors
  - Combine blurred & unblurred normals
- Eval ambient light for each normal
- Combine 3 lighting values

DEEP SCATTER

- Estimate thickness from shadow map
  - Helper functions for standard depth maps
  - Inward normal offset to fix silhouette edge issues
  - Poisson disk filter
- Apply falloff function using thickness & N·L
- Multiply by texture for veins, bones etc.

RECAP

Precomputed

- Per-vertex curvature
- Per-mesh UV scale
- Curvature LUT
- Shadow LUT

Pixel Shader

- Interpolate curvature
- Sample normal twice
- Wide shadow filter
- Eval ambient 3 times
- Estimate thickness

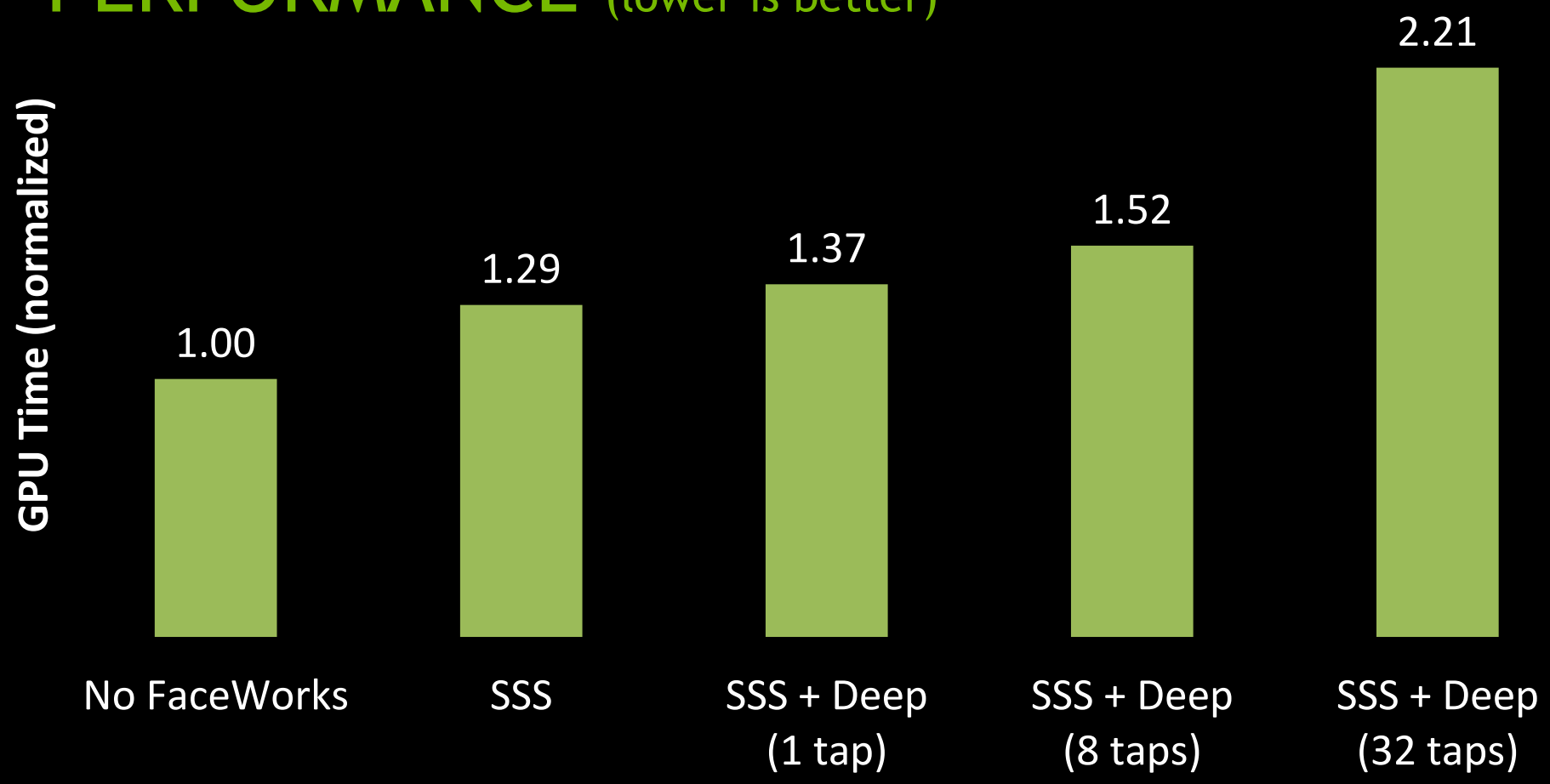
INTEGRATION

- C API & .dll, link into your engine & tools
  - Precompute data
  - Set graphics state per draw
- HLSL API, #include into your shaders
  - Evaluate lighting in PS

INTEGRATION

- Look up bind points using shader reflection
- Create context object
- Per draw: fill out config struct, set state

PERFORMANCE (lower is better)



FUTURE WORK

- Ambient-light deep scatter
- Specular model for skin
  - Including occlusion
- Eye rendering
- Customizable diffusion profiles
- Support more APIs/platforms
  - OpenGL, Mobile, Consoles

BACKUP SLIDES

INTEGRATION WALKTHROUGH

- C API & .dll, link into your engine & tools
  - Precompute data
  - Set graphics state per draw
- HLSL API, #include into your shaders
  - Evaluate lighting in PS

INTEGRATION WALKTHROUGH

- In tools:
  - Precompute curvature & UV scale for each model
  - Look up bind points for constant buffers etc. in shaders
  - Generate curvature & shadow LUTs
    - Can also just be done once and checked in

INTEGRATION WALKTHROUGH

- In engine:
  - Create a context
  - Fill out config struct
  - Set state before draw call

INTEGRATION WALKTHROUGH

- In pixel shader:
  - Get mip level for blurred normal
  - Sample normal twice
  - Evaluate direct light
  - Evaluate shadow
  - Get 3 normals for ambient
  - Evaluate ambient light
  - Estimate thickness
  - Evaluate deep scatter

FEEDING THE RENDERER

- Need high-quality models and textures for good results!
  - LPS head: 18K tris (before tess), 4K textures
- Normal map should not be softened
  - Need strong bumps for specular
  - The shader will soften the diffuse
- Head scans are great, if within your means

EXTRA GOODIES IN THE SAMPLE APP

- Physically-based shading
  - Blinn-Phong NDF, Schlick-Smith visibility, Schlick Fresnel
  - 2-lobe specular [Jimenez13]
- IBL with preconvolved cubemaps [Lagarde11]
- Filmic tonemapping [Hable10]
- Adaptive tessellation
  - More polygons where curvature is high

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REFERENCES

- d'Eon & Luebke, "Advanced Techniques for Realistic Real-Time Skin Rendering", GPU Gems 3 (2007)
- Green, "Real-Time Approximations to Subsurface Scattering", GPU Gems 3 (2007)
- Hable, "Uncharted 2 HDR Lighting", GDC 2010
- Jimenez et al, "Separable Subsurface Scattering and Photorealistic Eyes Rendering", SIGGRAPH 2012
- Jimenez & von der Pahlen, "Next-Generation Character Rendering", GDC 2013
- Lagarde, "Adopting a physically based shading model", blog post (2011)
- Penner, "Pre-Integrated Skin Shading", SIGGRAPH 2010