Light Field Photography (and Video)

Ryan Overbeck

Google

SIGGRAPH 2019

A System for Acquiring, Processing, and Rendering Panoramic Light Field Stills for Virtual Reality

Ryan Overbeck, Daniel Erickson, Daniel Evangelakos, Matt Pharr, and Paul Debevec

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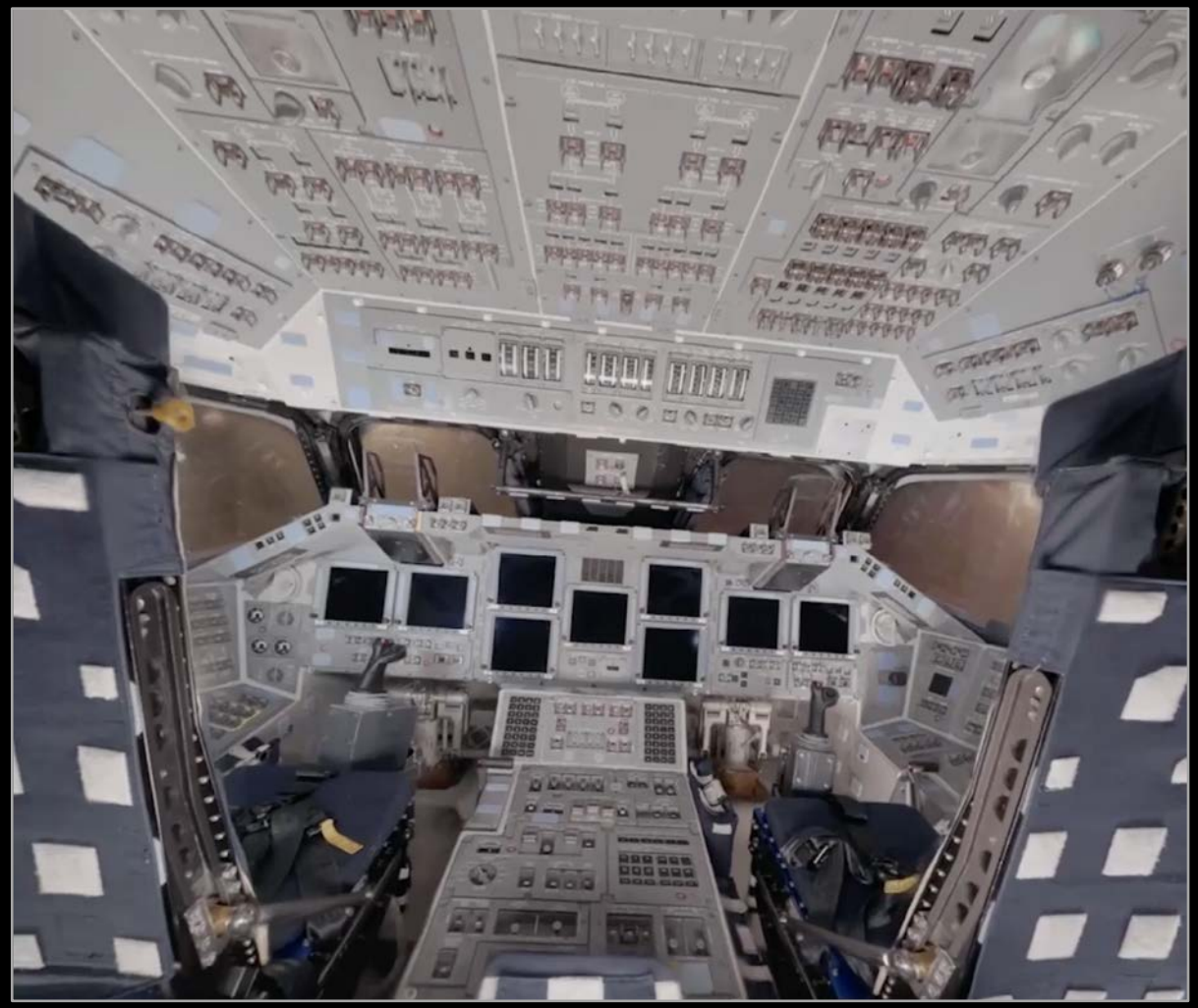
Immersive Photography

- **Photogrammetry**
  - 6 DOF

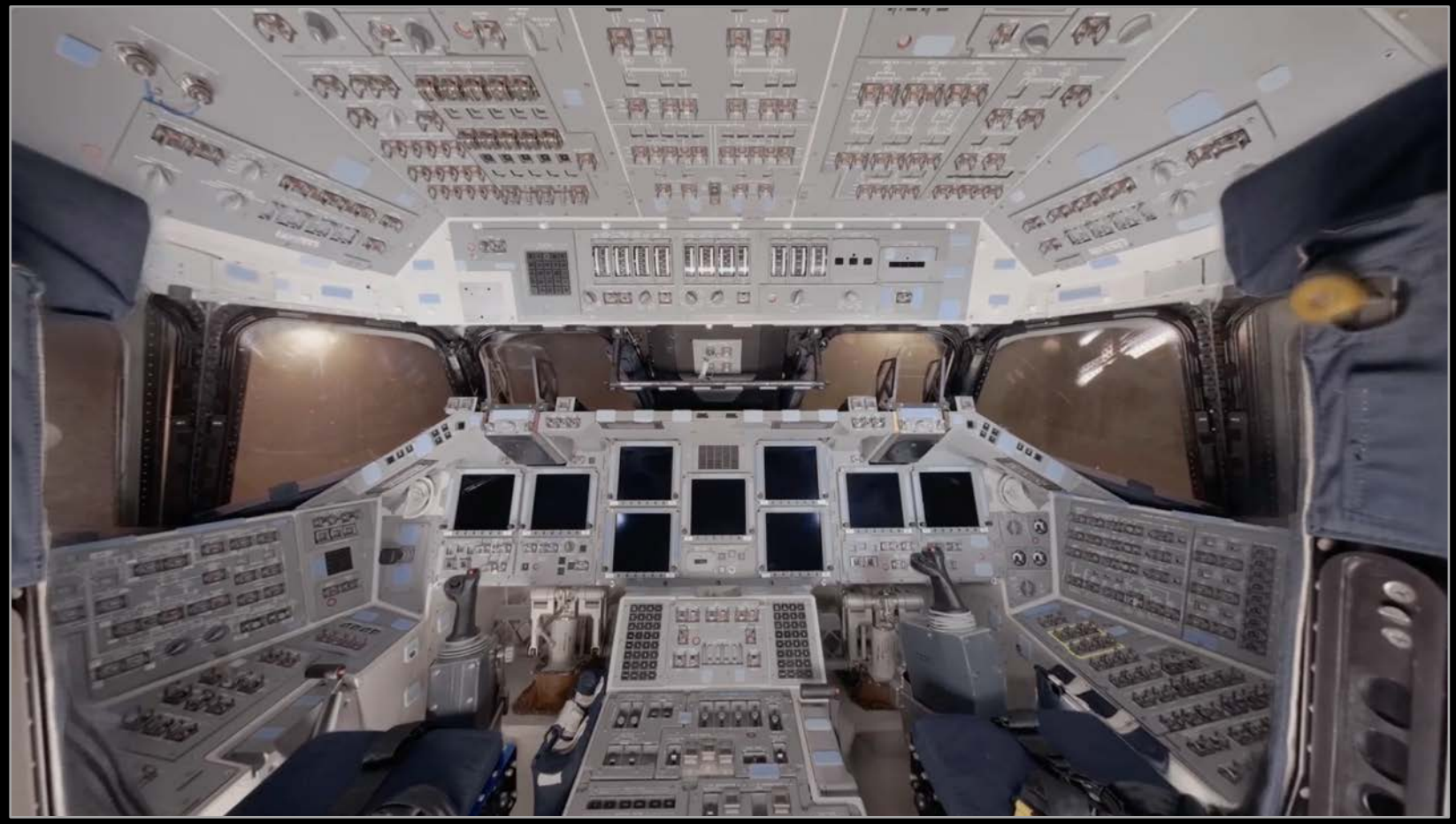
Immersive Photography

- Photogrammetry
  - 6 DOF
- **Stereo Panoramas**
  - Photo-Realism

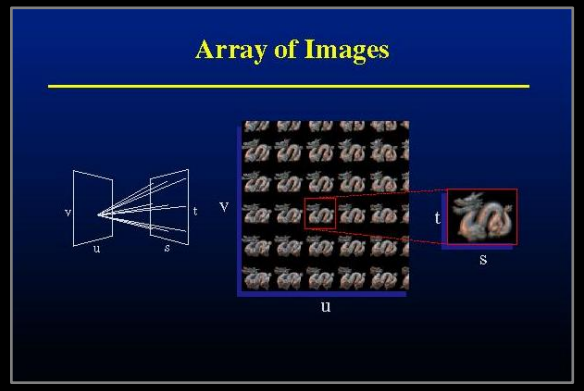


Immersive Photography

- Photogrammetry
  - 6 DOF
- Stereo Panoramas
  - Photo-Realism
- **Light Fields**
  - 6DOF
  - Photo-Realism

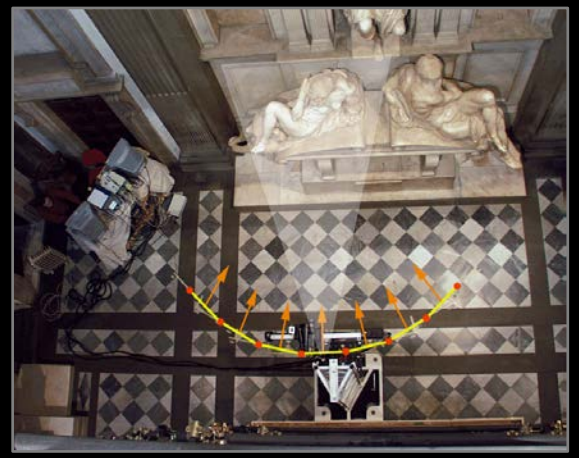


Marc Levoy and Pat Hanrahan. Light Field Rendering. SIGGRAPH 1996



Steven J. Gortler et al. *The Lumigraph.* SIGGRAPH 1996

Levoy et al. The digital Michelangelo project: 3D scanning of large statues. SIGGRAPH 2000. (Light Field of "Night")



otoy

Debevec et al. *Spherical light field environment capture for virtual reality using a motorized pan/tilt head and offset camera.* SIGGRAPH 2015 Posters

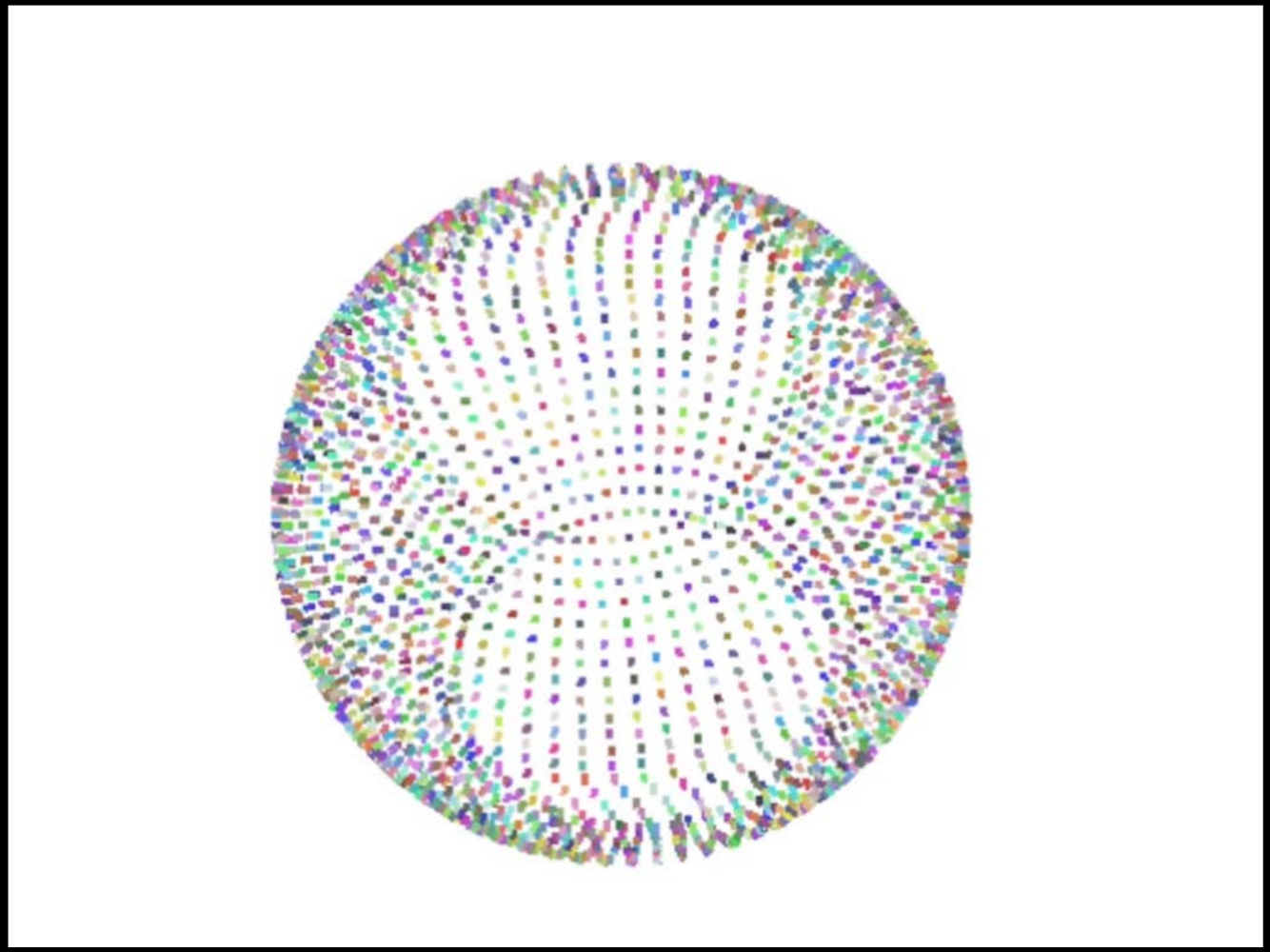
LYTRO

T Milliron et al. Hallelu*jah: The World's First Lytro VR Experience.* SIGGRAPH 2017 VR Village

The System

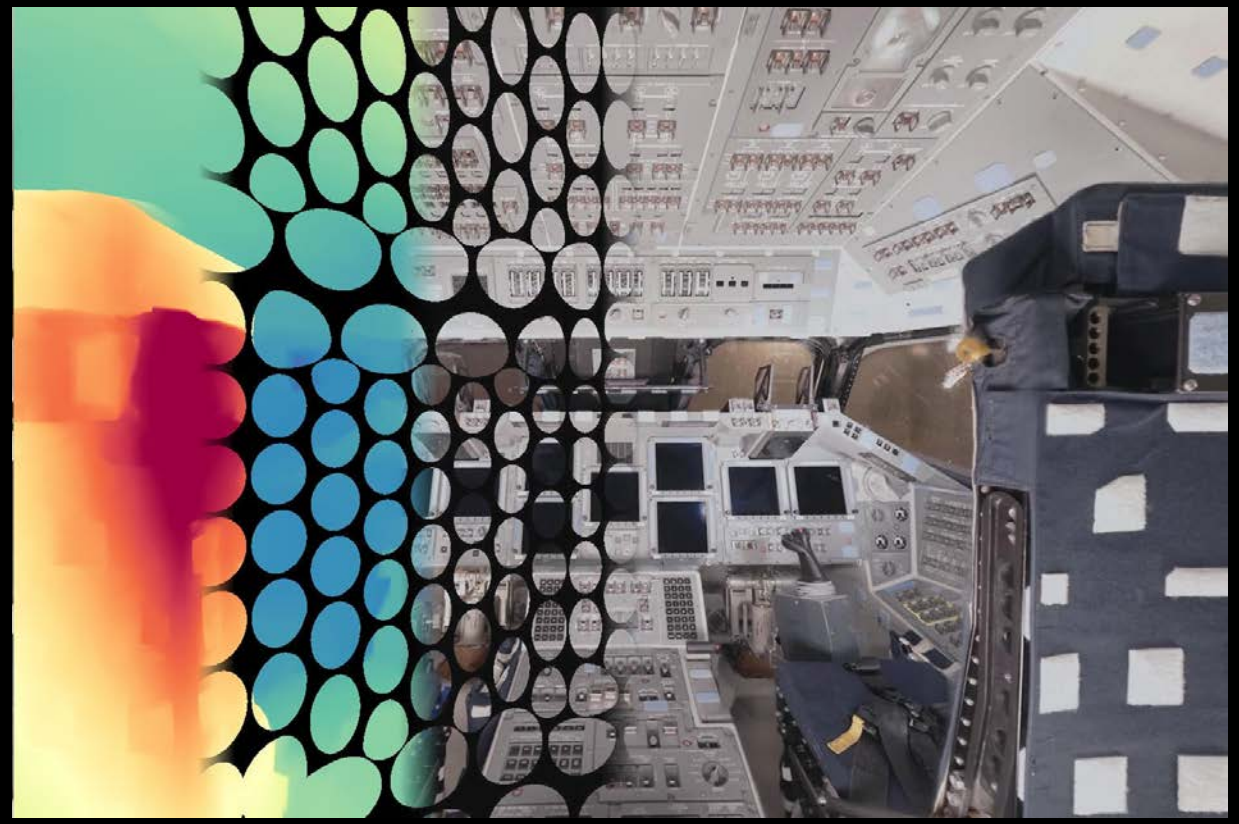
- Acquire

- Acquire
- Process
  - Calibrate

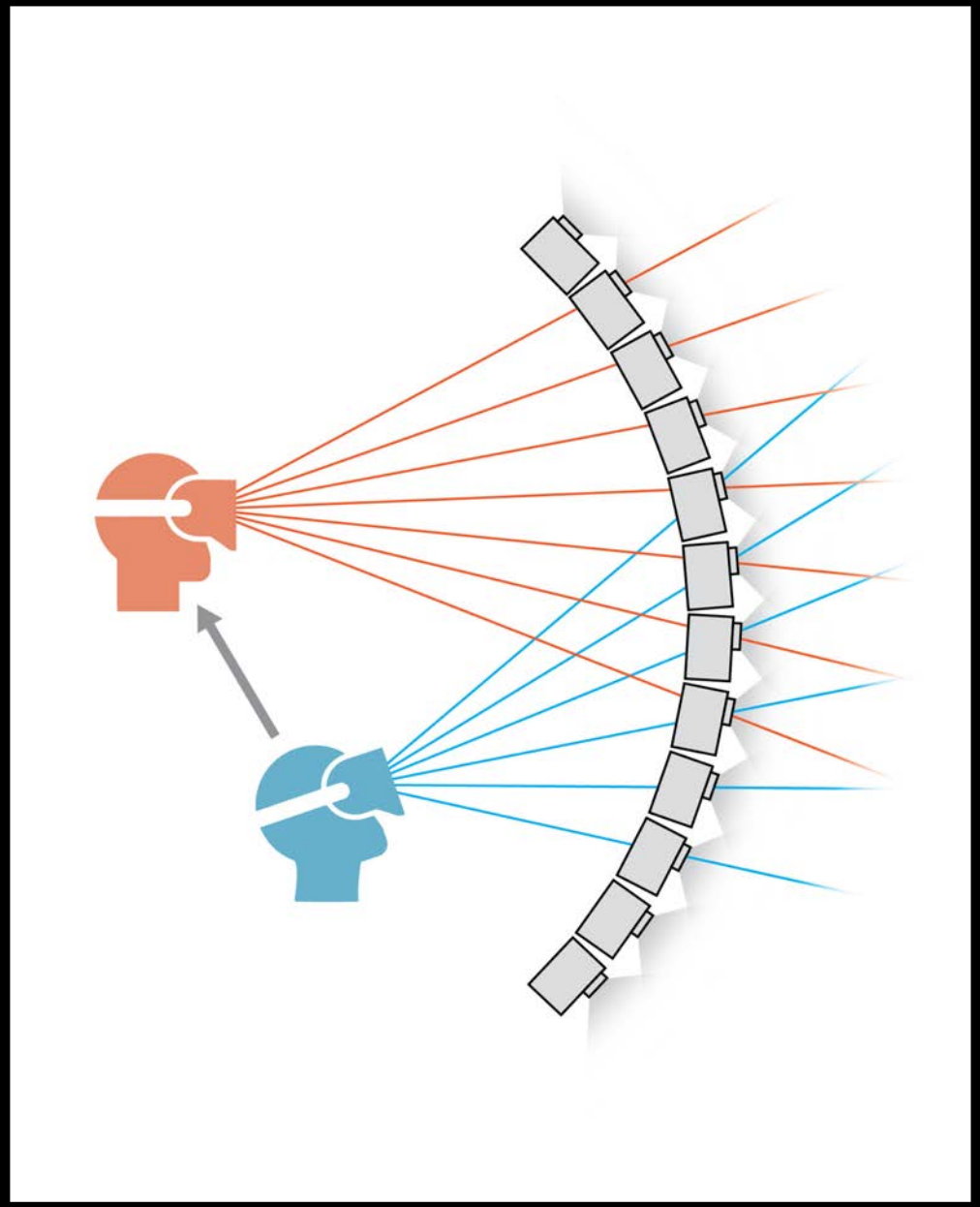


- Acquire
- Process
  - Calibrate
  - Geometry
  - Prefilter
  - Compress

- Acquire
- Process
  - Calibrate
  - Geometry
  - Prefilter
  - Compress
- Render

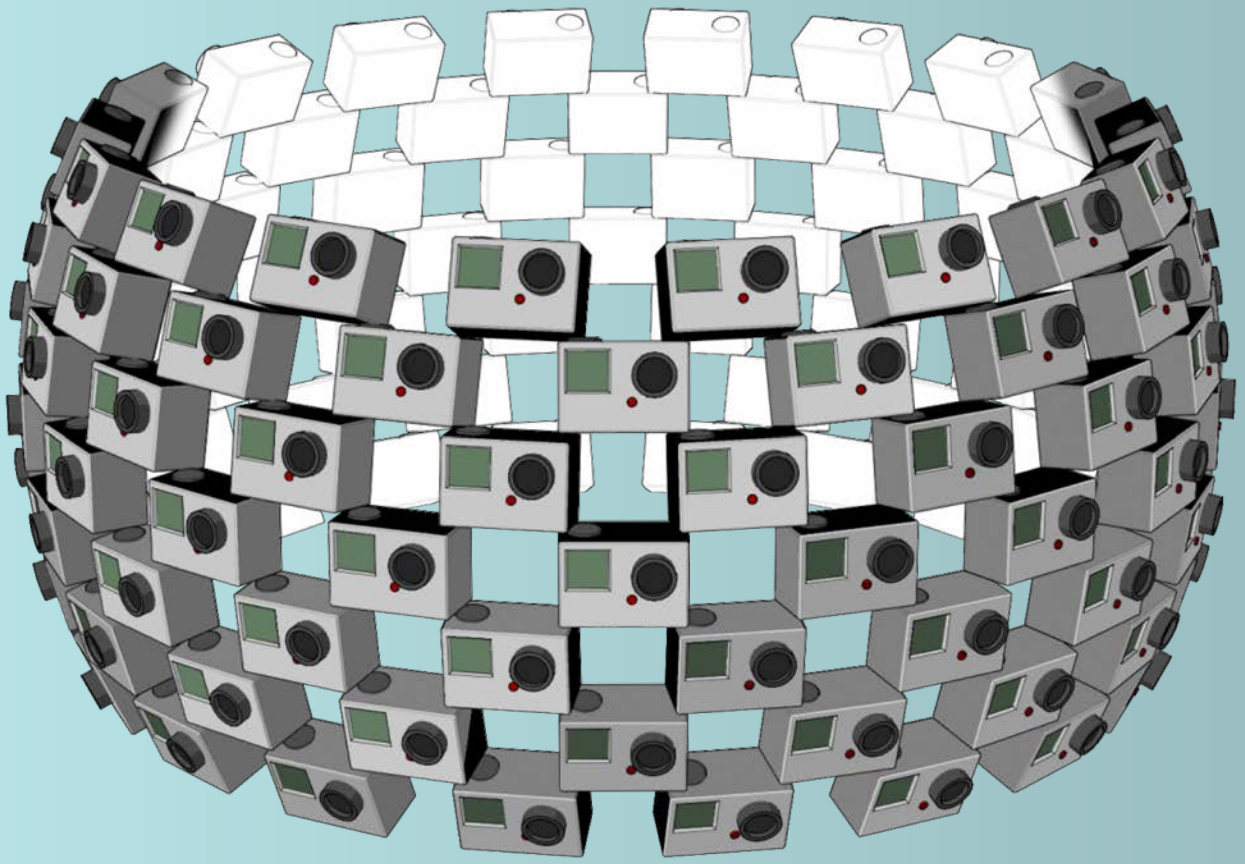


- Acquire
- Render
- Prefilter
- Compress



Light Field

- Acquire sparse images on surface.
- Render views inside surface.



18 x 7 fisheye cylindrical/spherical camera array

(>1Gpixel/frame at 4K each camera)

light field video playback with panoramic stereo and full parallax

(from Stanford SCIEN Workshop on Light Field Imaging, 2/12/2015)

JUMP Odyssey 360 Stereo Camera

Jump: Virtual Reality Video
Anderson et al, SIGGRAPH Asia 2016


16xGoPro rig (5x speed)
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Light Field Portraiture

- GoProx16 rig


2X DSLR


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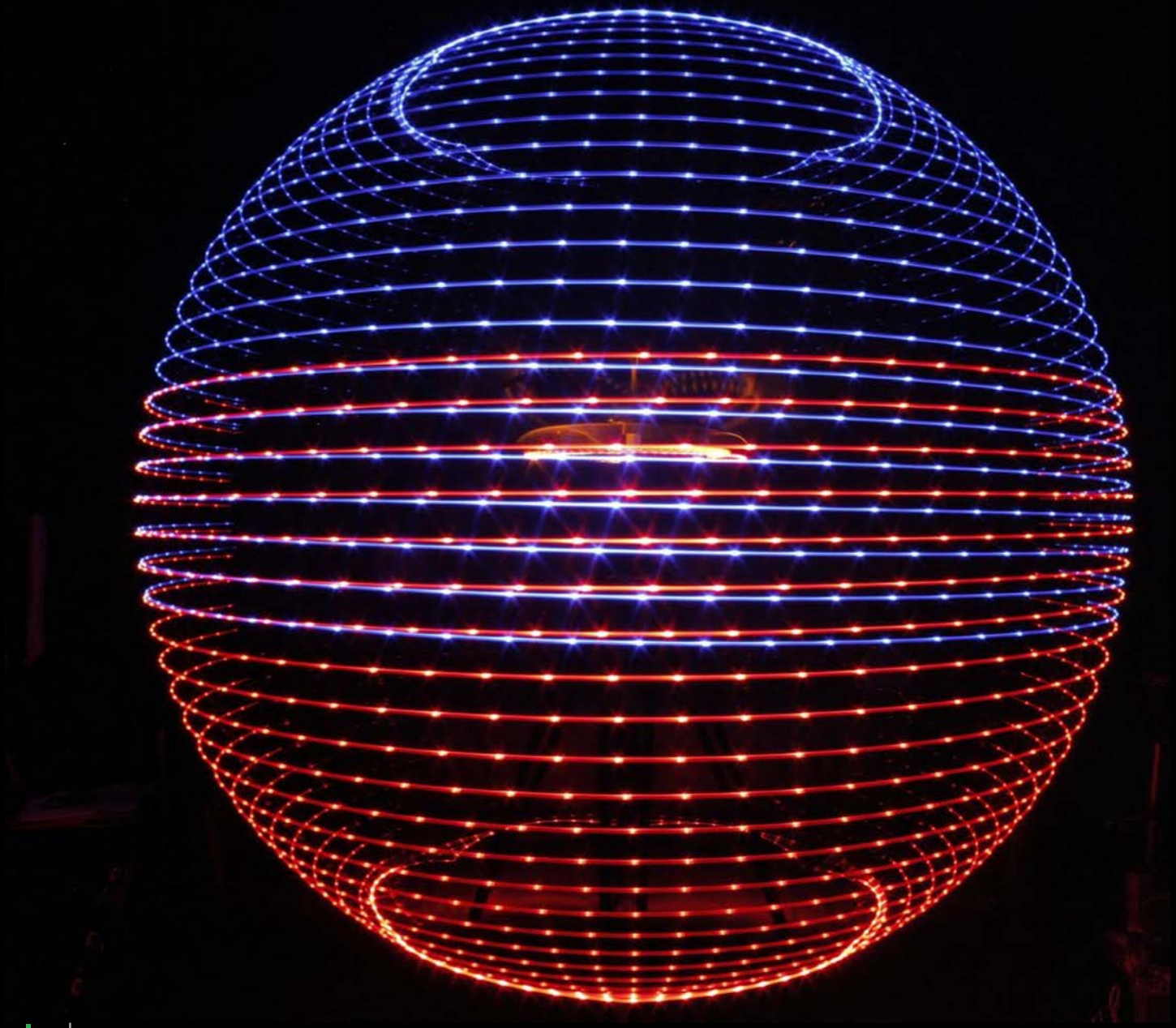



2xDSLR rig (5x speed)


cam 1 HDR images


cam 2 HDR images

30-90 seconds
People + Outdoors

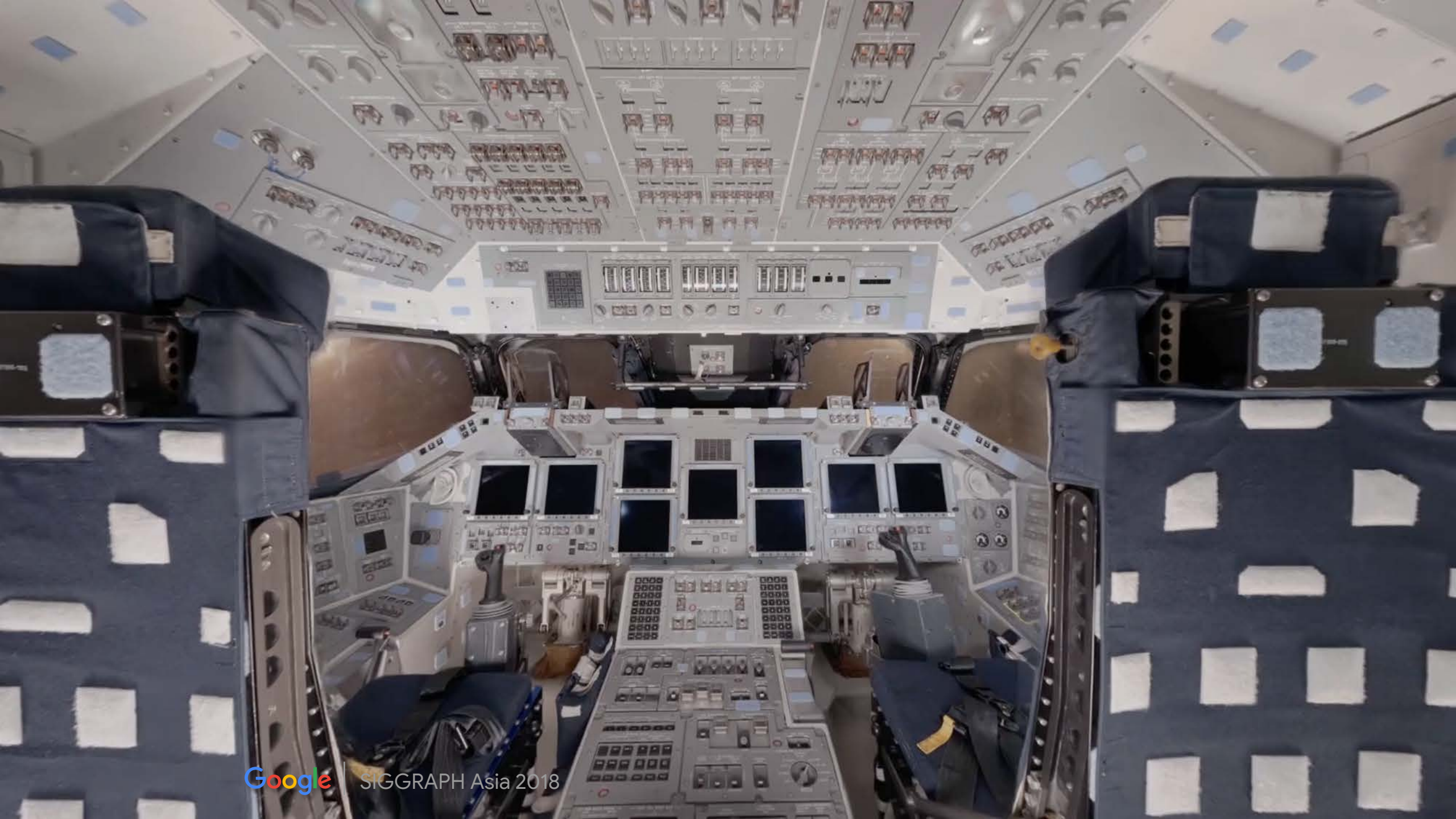
10-40 minutes
Highest Quality Pixels

- Acquire
- **Render**
- Prefilter
- Compress

Quality

Speed

Stereo views @90 Hz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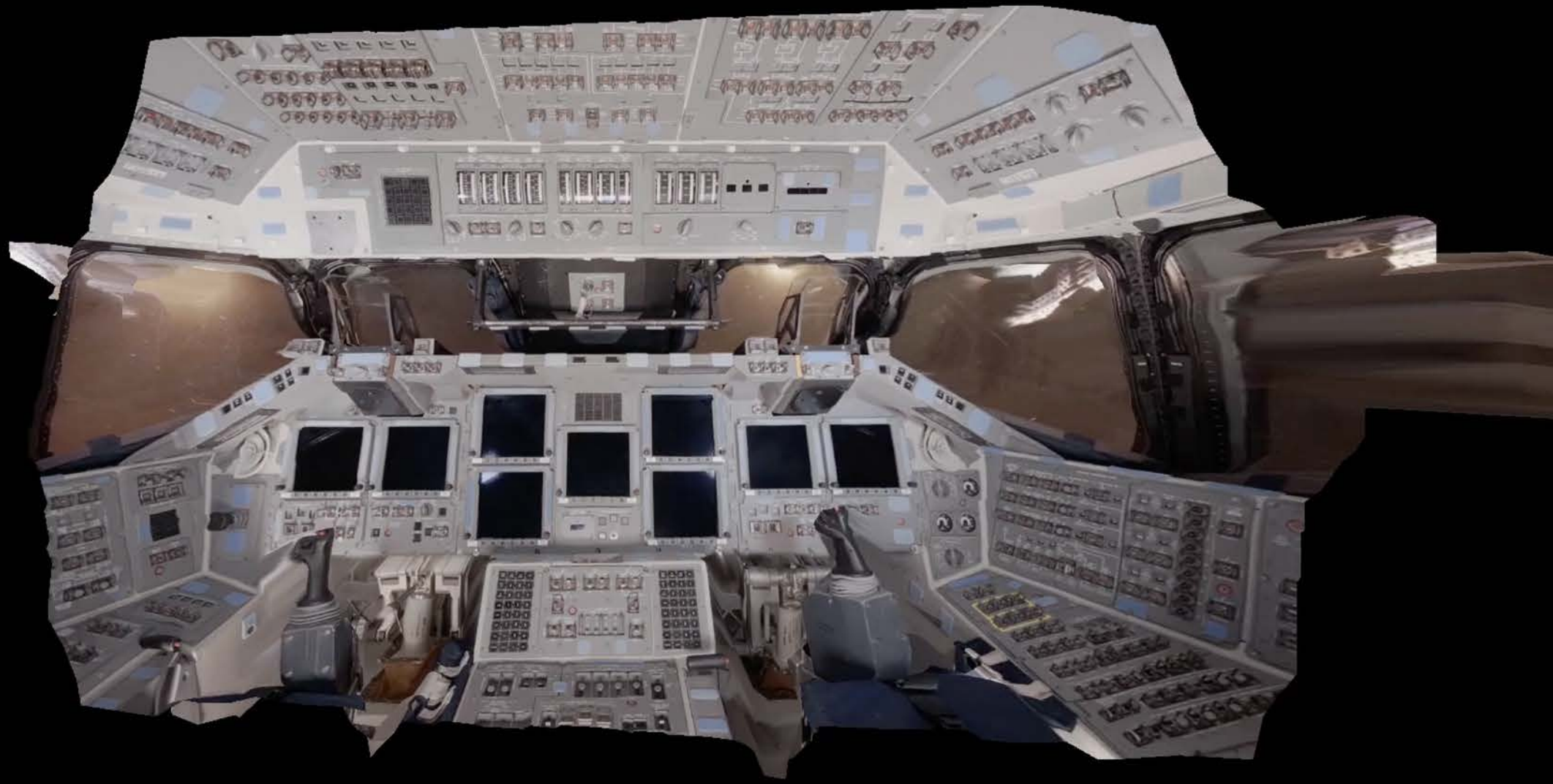
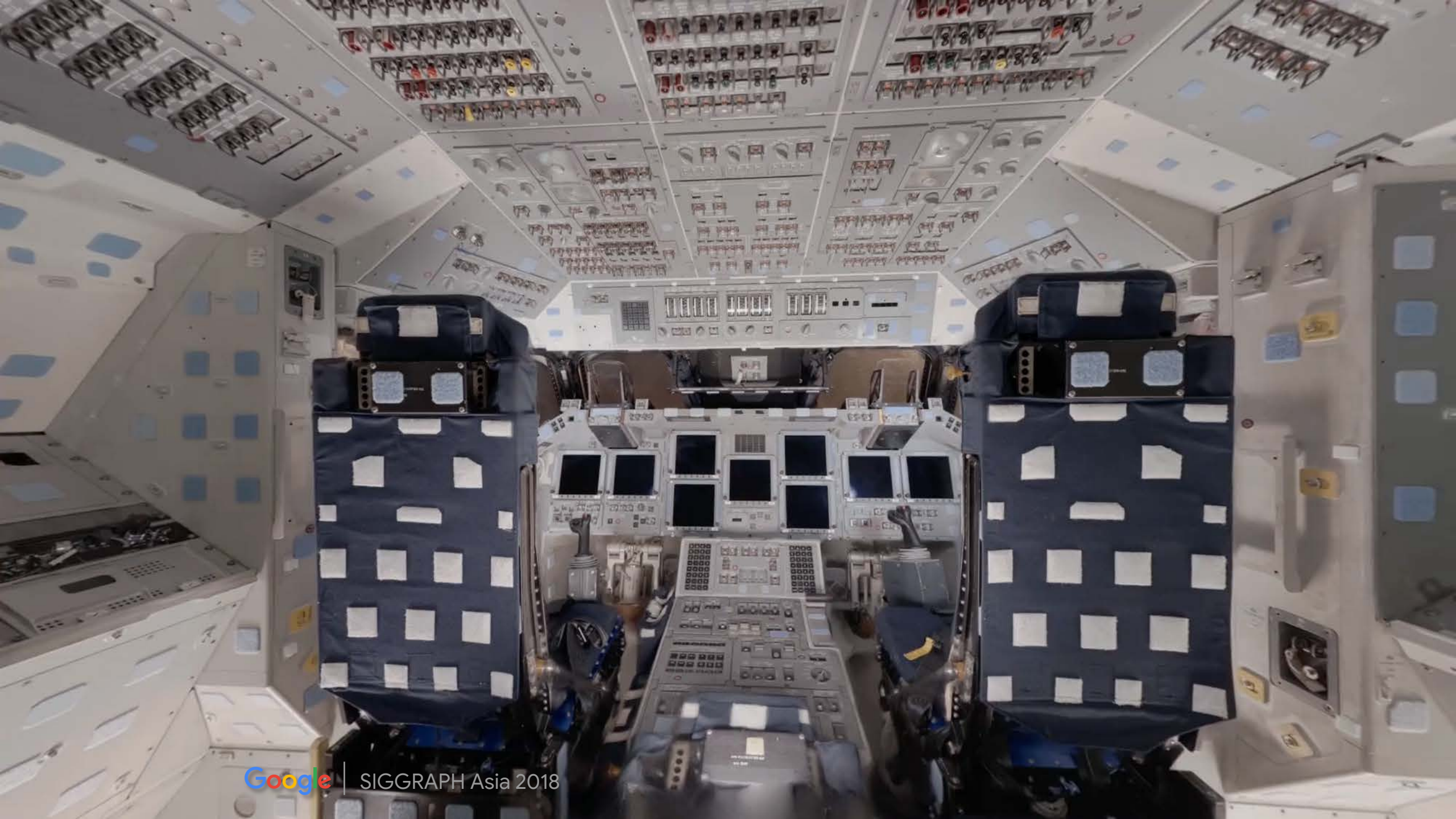
SIGGRAPH Asia 2018




Google
SIGGRAPH Asia 2018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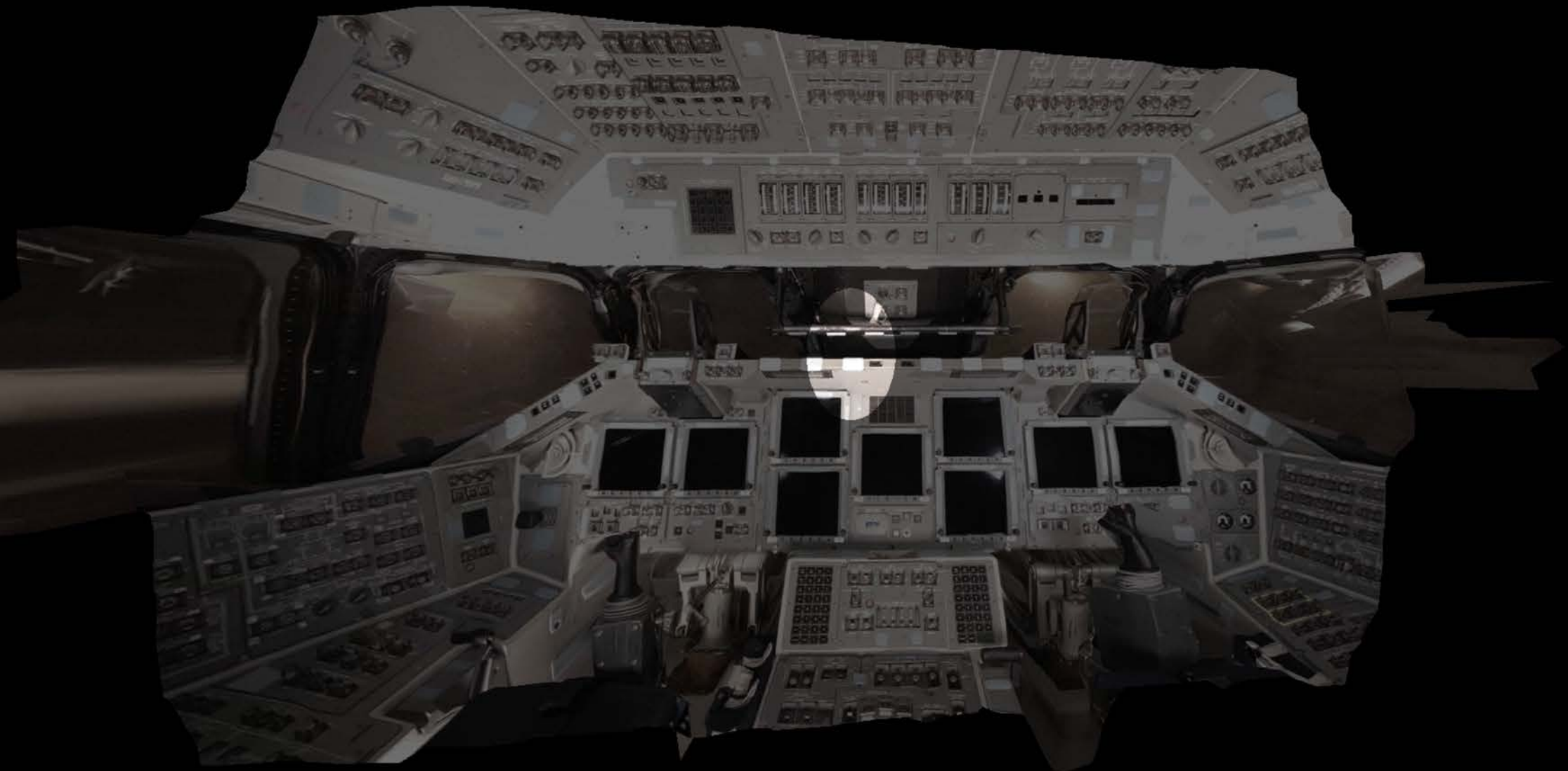

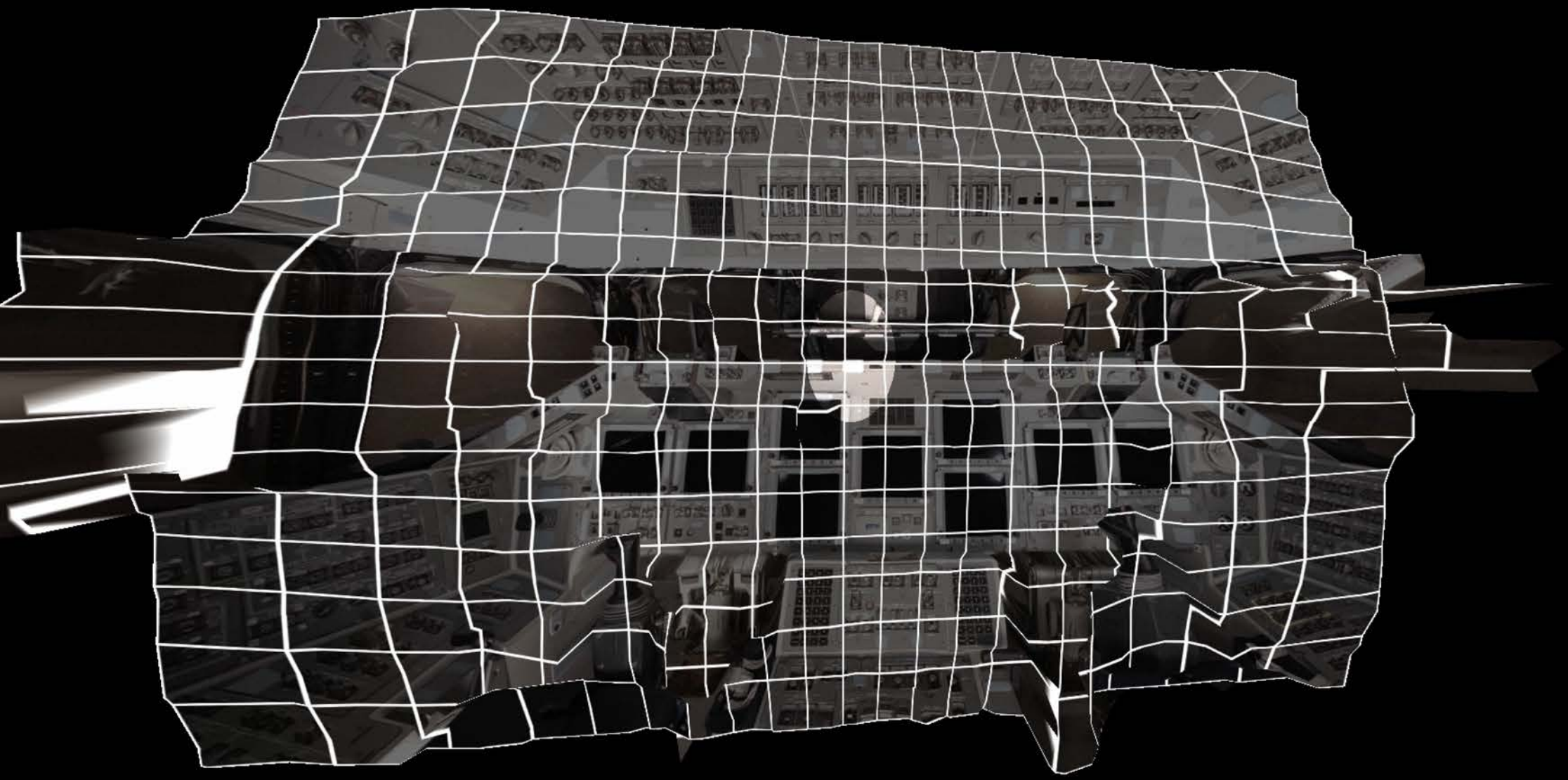

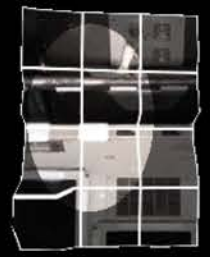


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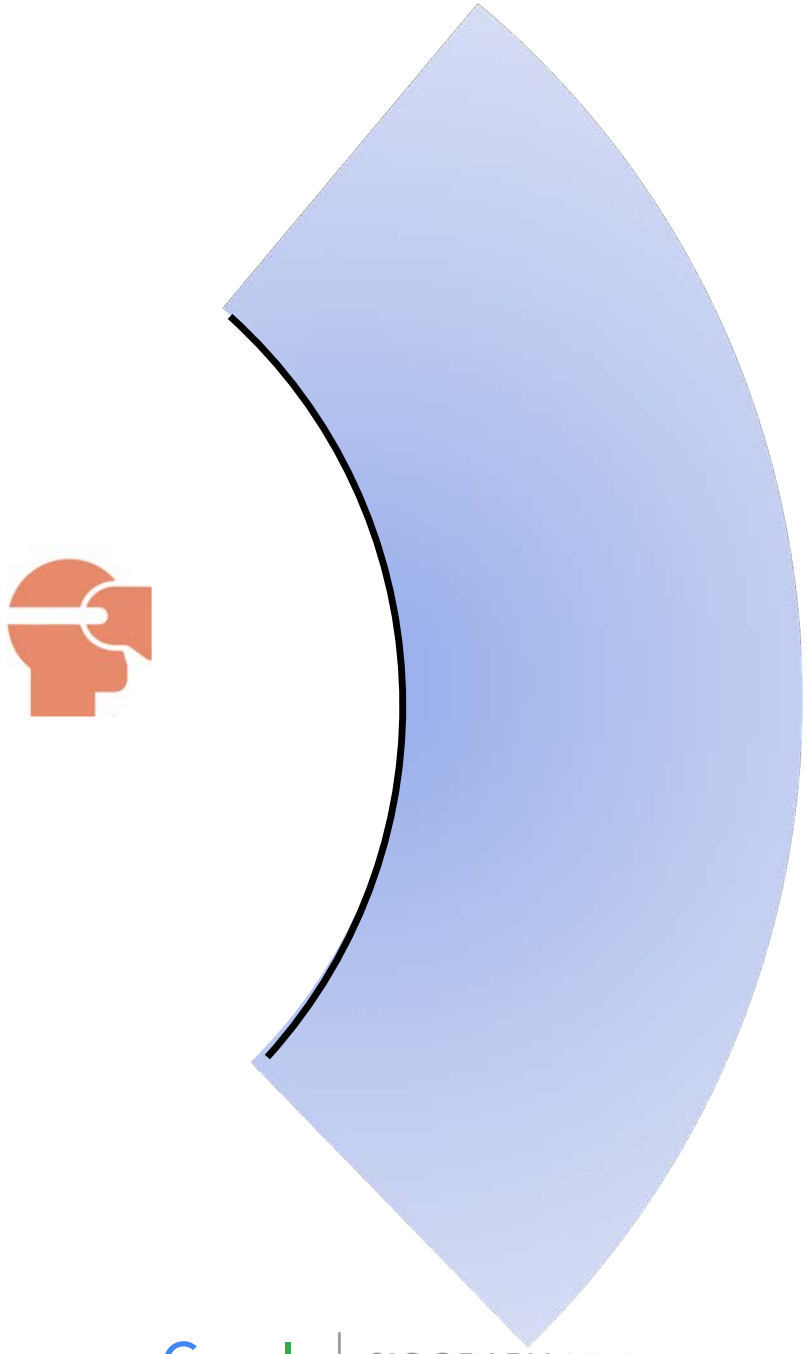
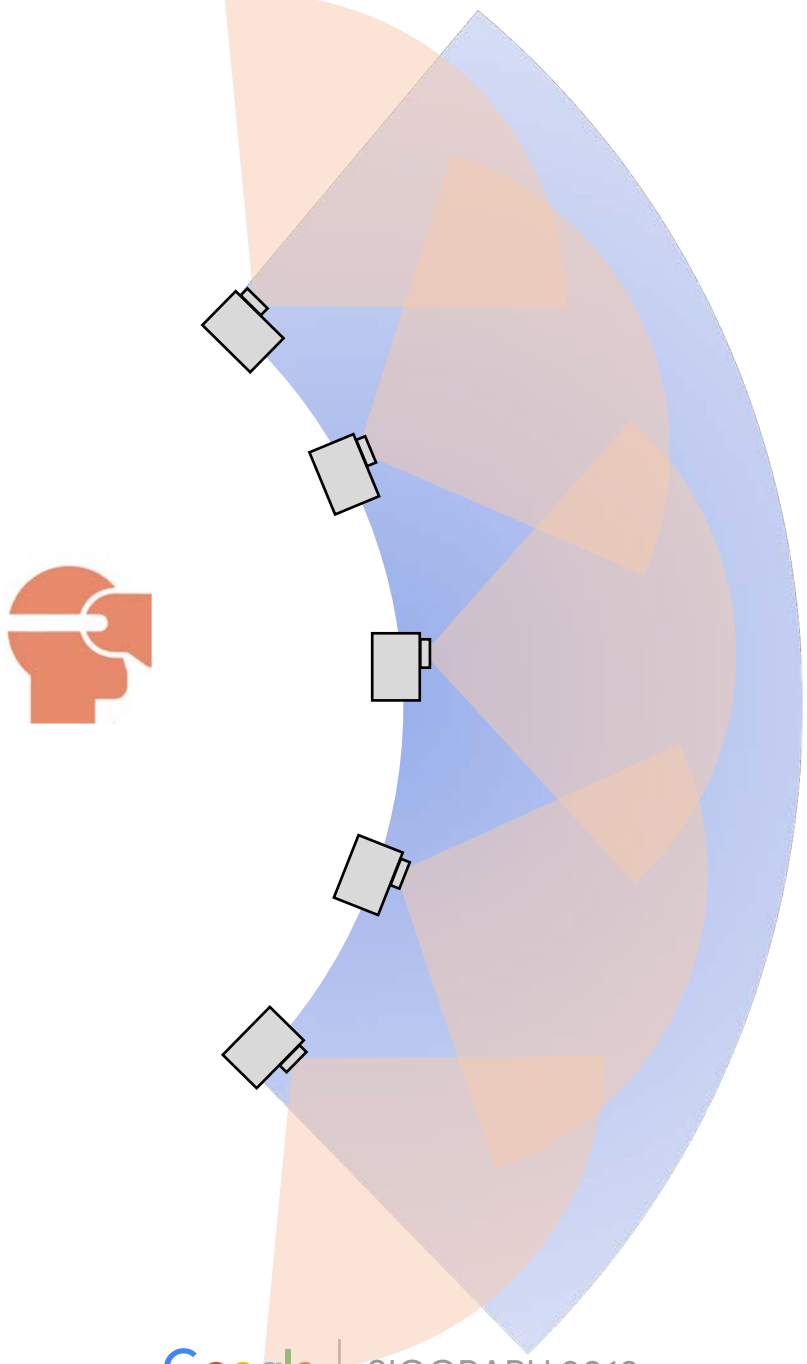
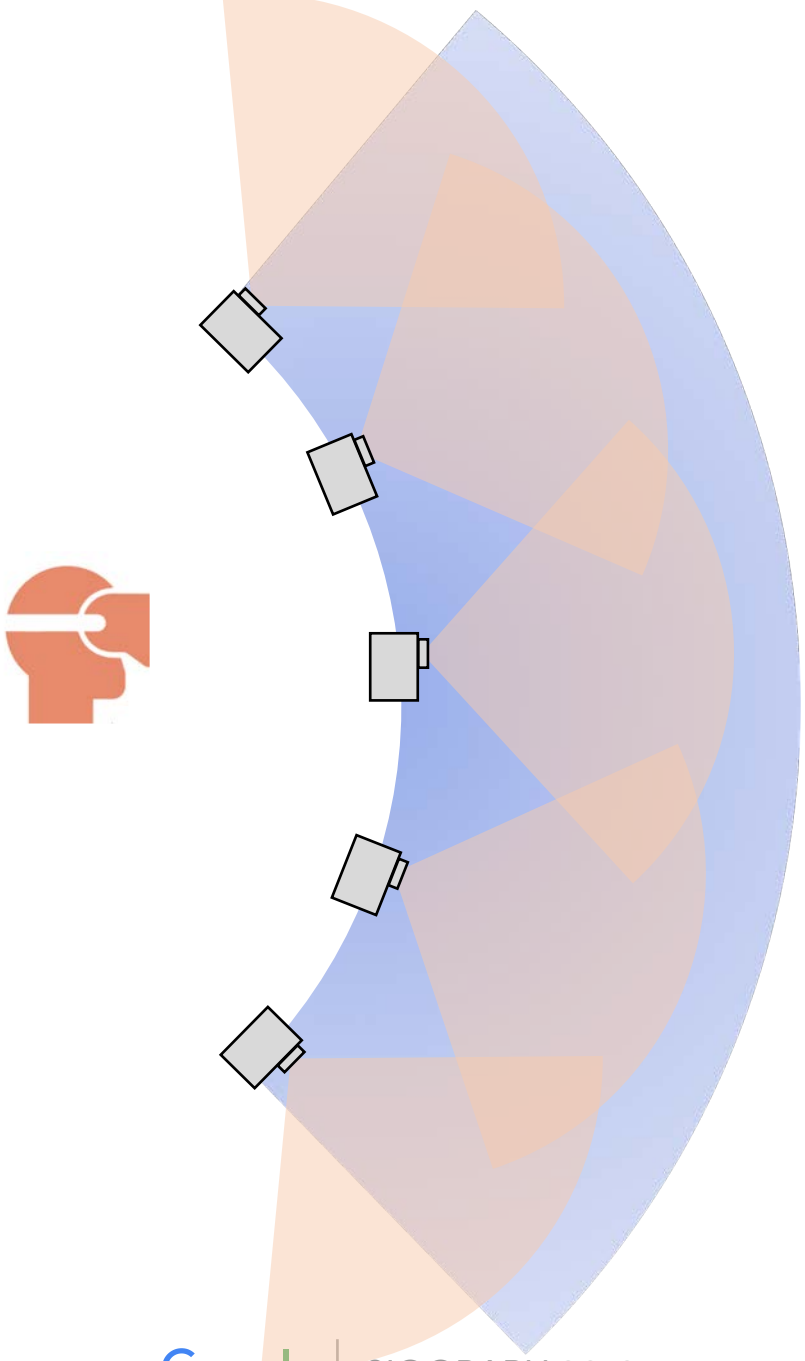
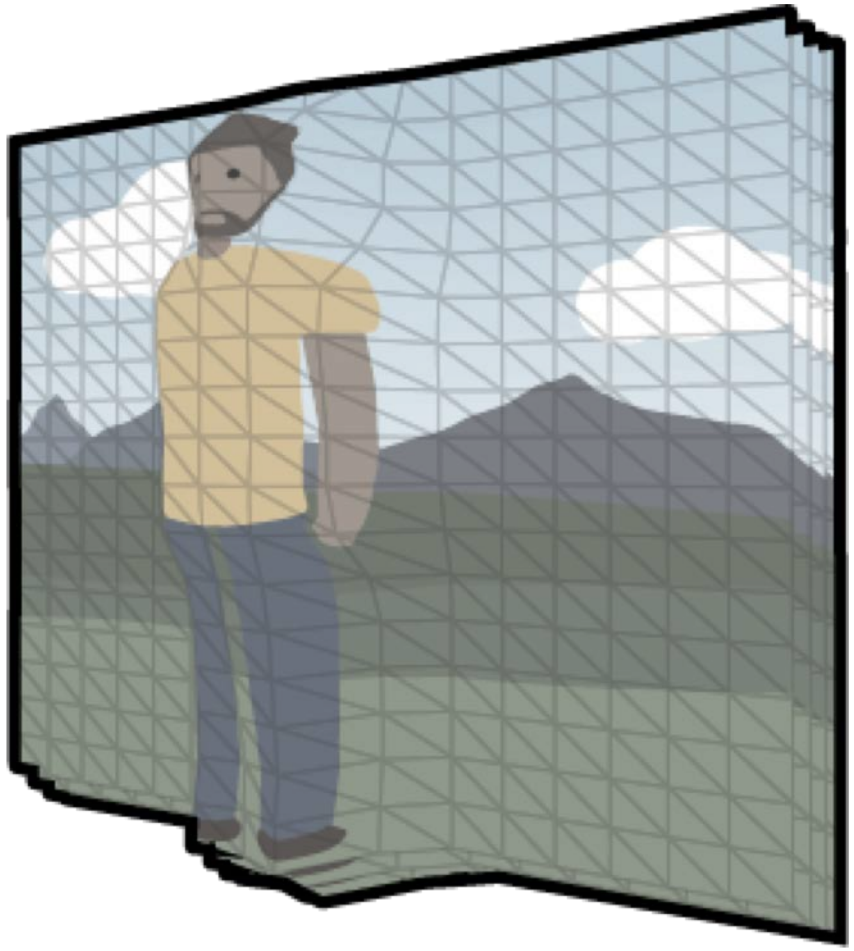
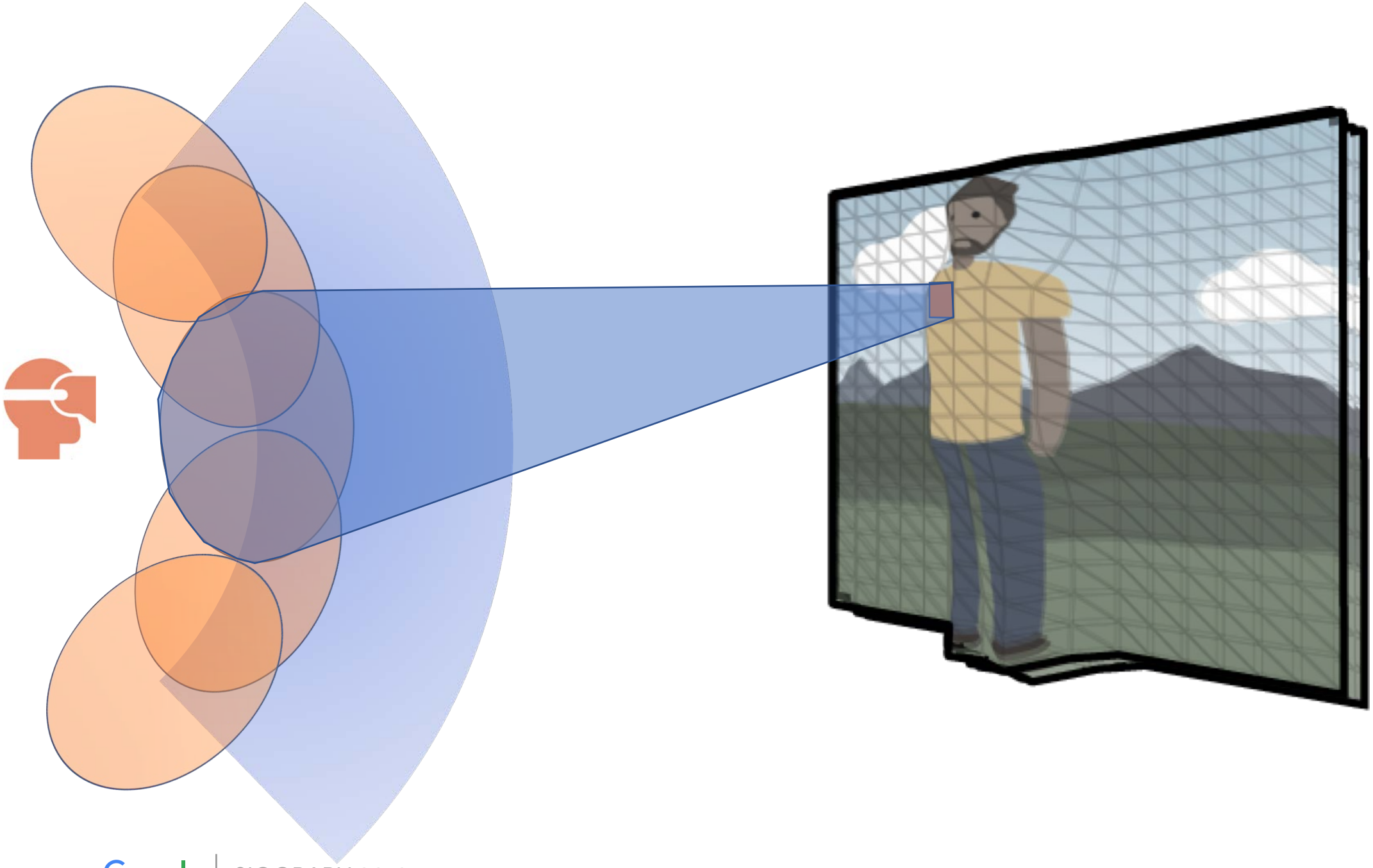
- Acquire
- Render
- **Prefilter**
- Compress

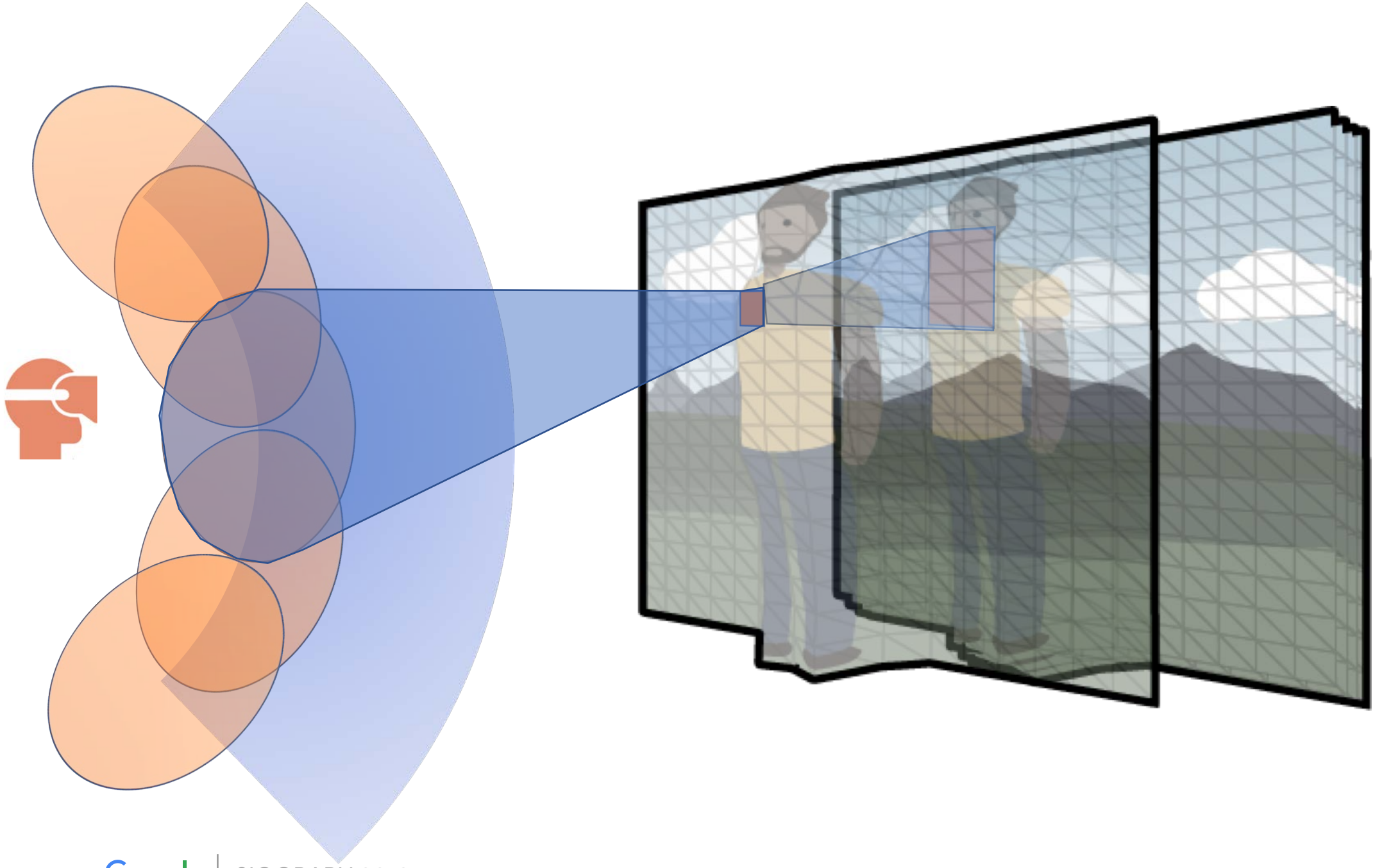













Without Prefilter


With Prefilter


Low Res Geometry
Without Prefilter


Low Res Geometry
With Prefilter


With Prefilter

- Acquire
- Render
- Prefilter
- Compress

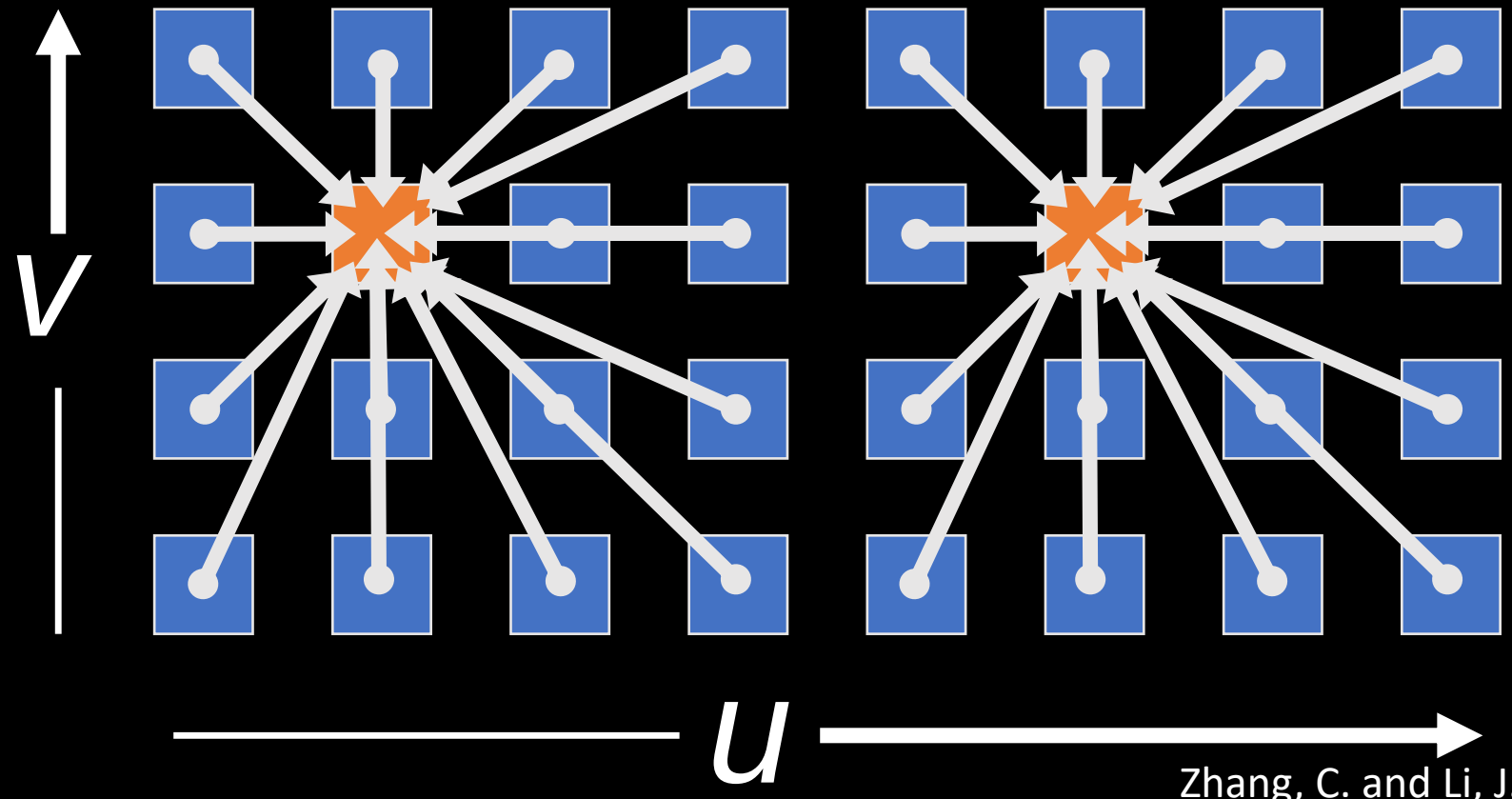
~1000-2000 Images X 1280x1024 X RGB

= ~4-8GB Uncompressed

IDEA: Use Video Compression

We need random access to tiles

Motion Compensated Prediction (MCP) for Light Fields



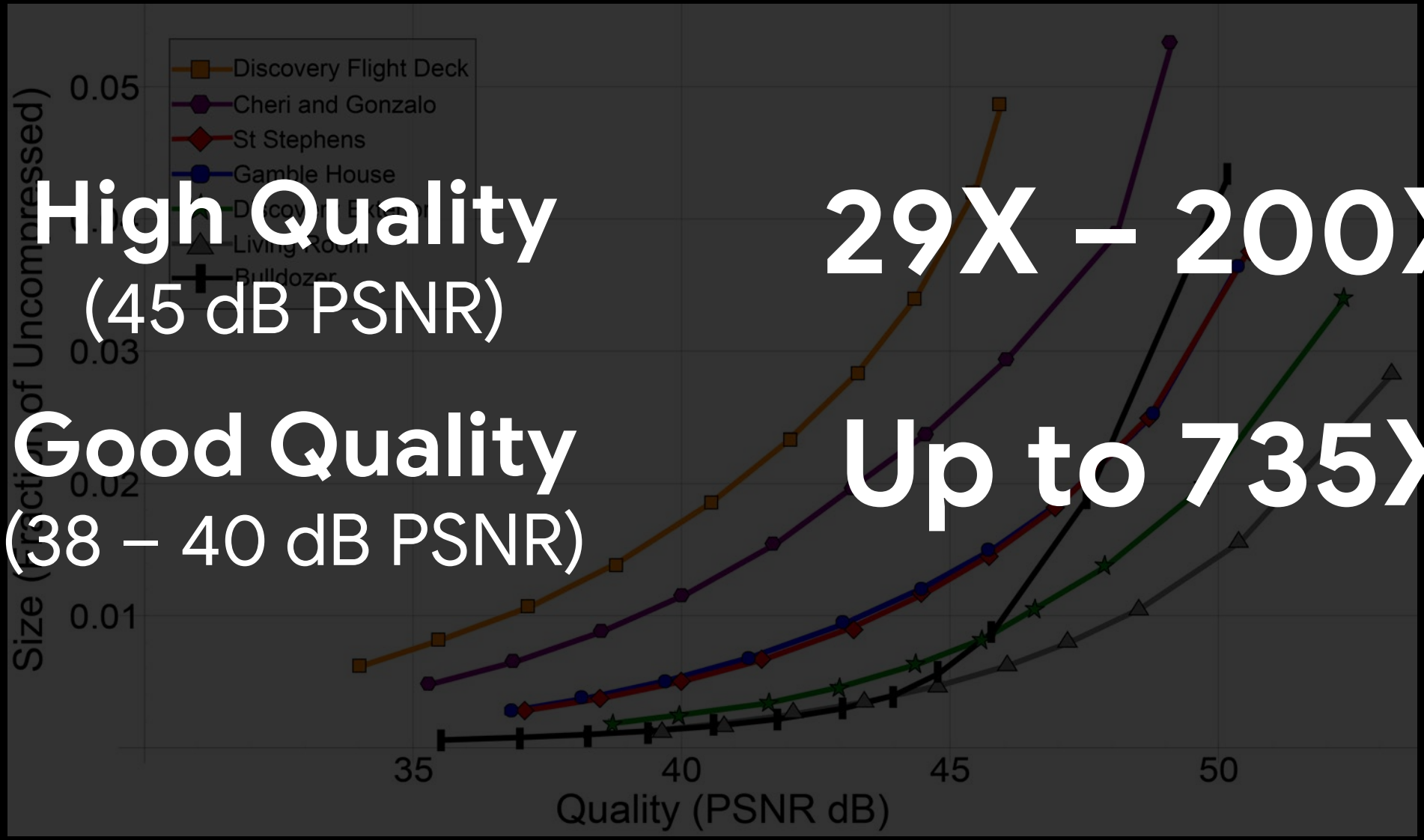
Zhang, C. and Li, J., 2000. Compression of lumigraph with multiple reference frame (MRF) prediction and just-in-time rendering.

VP9

+

1. Random access to tiles
2. Unlimited reference images

“Large Scale Tile Decoding”



High Quality
(45 dB PSNR)

29X – 200X*

Good Quality
(38 – 40 dB PSNR)

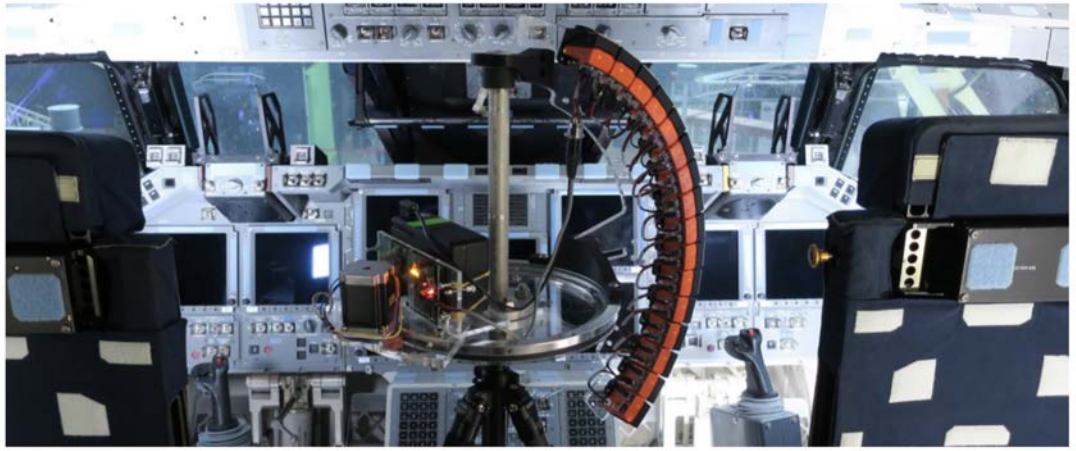
Up to 735X*

* Results on our datasets which are sparser than most light field datasets


Welcome to Light Fields

GOOGLE AR AND VR

Experimenting with Light Fields



Connectivity

MIT Technology Review

VR is still a novelty, but Google's light-field technology could make it serious art

A new VR app lets you explore worlds with surprising depth and detail.

by Rachel Metz March 14, 2018

STEAM STORE COMMUNITY ABOUT SUPPORT

Your Store Games Software Hardware Videos News

All Games > Casual Games > Welcome to Light Fields

Welcome to Light Fields


Saint Stephen’s Church


Airstream Selfie

Light Field Video

Light Field Video

Sparser Cameras
1000s -> 10s

Need better view synthesis

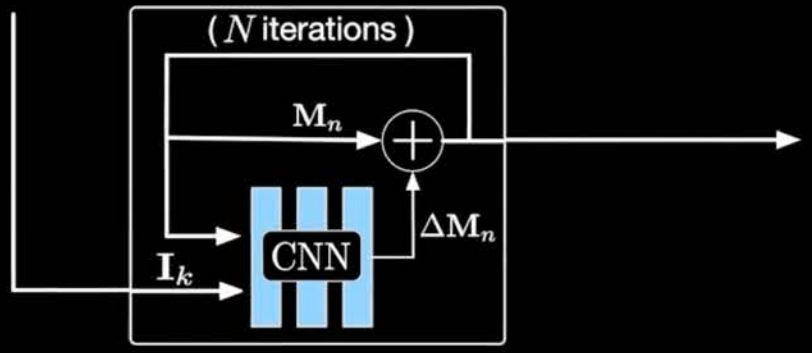
LONG BEACH
CALIFORNIA
June 16-20, 2019

DeepView: View Synthesis with Learned Gradient Descent

John Flynn, Michael Broxton, Paul Debevec, Matthew Duvall, Graham Fyffe, Ryan Overbeck, Noah Snavely, Richard Tucker

Google | SIGGRAPH 2019

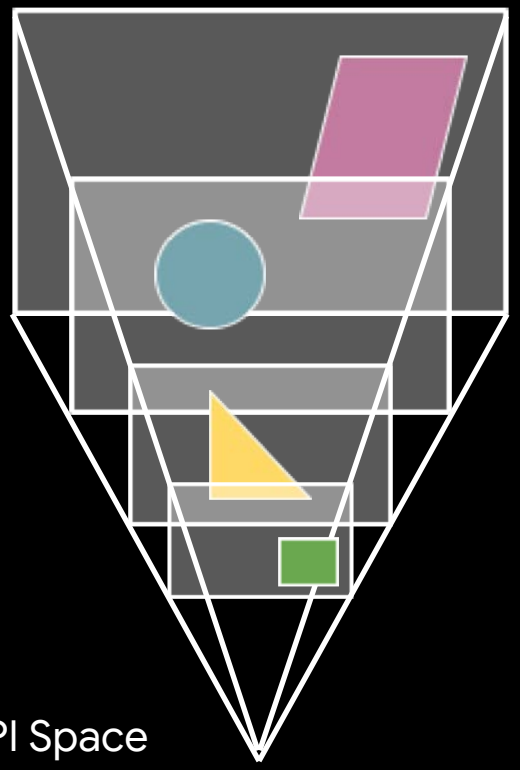
A sparse set of input images from different viewpoints



Learned gradient descent

Network generated multi-plane image

Multiplane Image

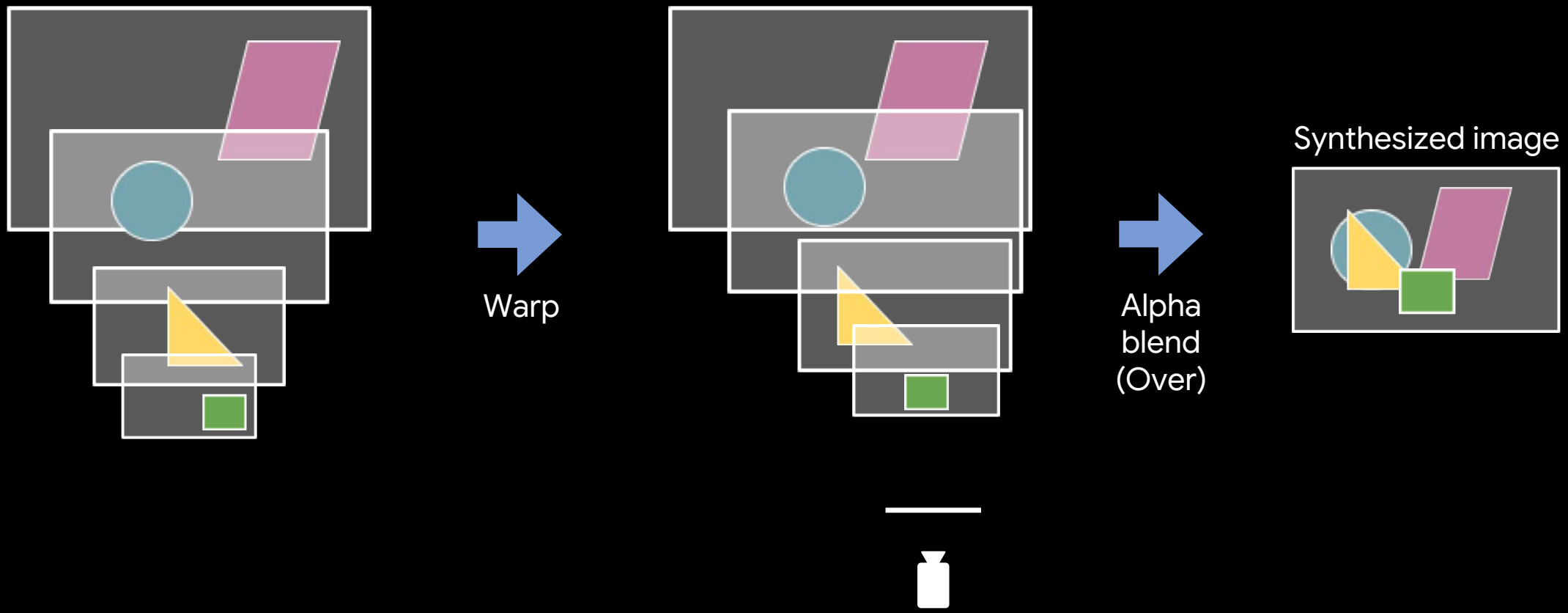


Each plane is at a fixed depth and encoded by an RGBA image

MPI Space

Zhou et al. *Stereo magnification: Learning view synthesis using multiplane images*, SIGGRAPH 2018.

Multiplane Image




EXIT

thrive
SIGGRAPH2019
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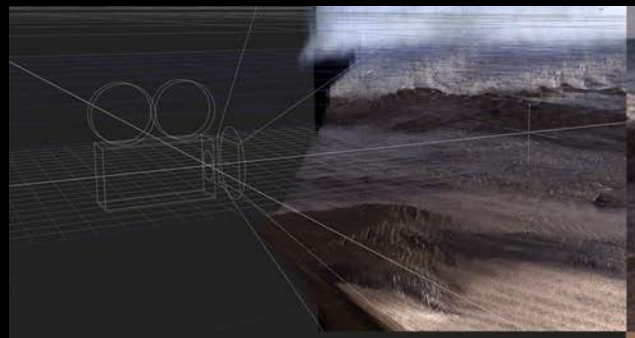
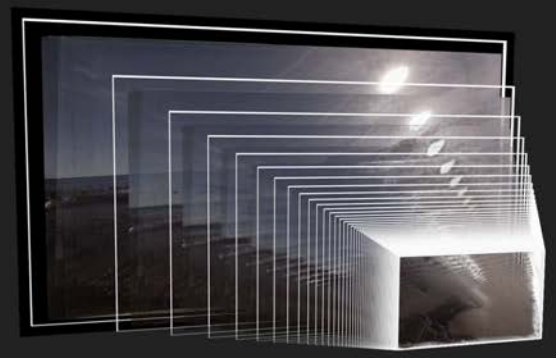
POSTERS



Compositing Light Field Video Using Multiplane Images

Matthew DuVall, John Flynn, Michael Broxton, Paul Debevec

Google, Inc.



VR@50 Light Fields SIGGRAPH 2018

VR@50 Light Fields at
SIGGRAPH 2018
Download at: https://augmentedperception.github.io/deepview/


Thank you!
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