Interactive 3D: Displays, Devices, and Applications

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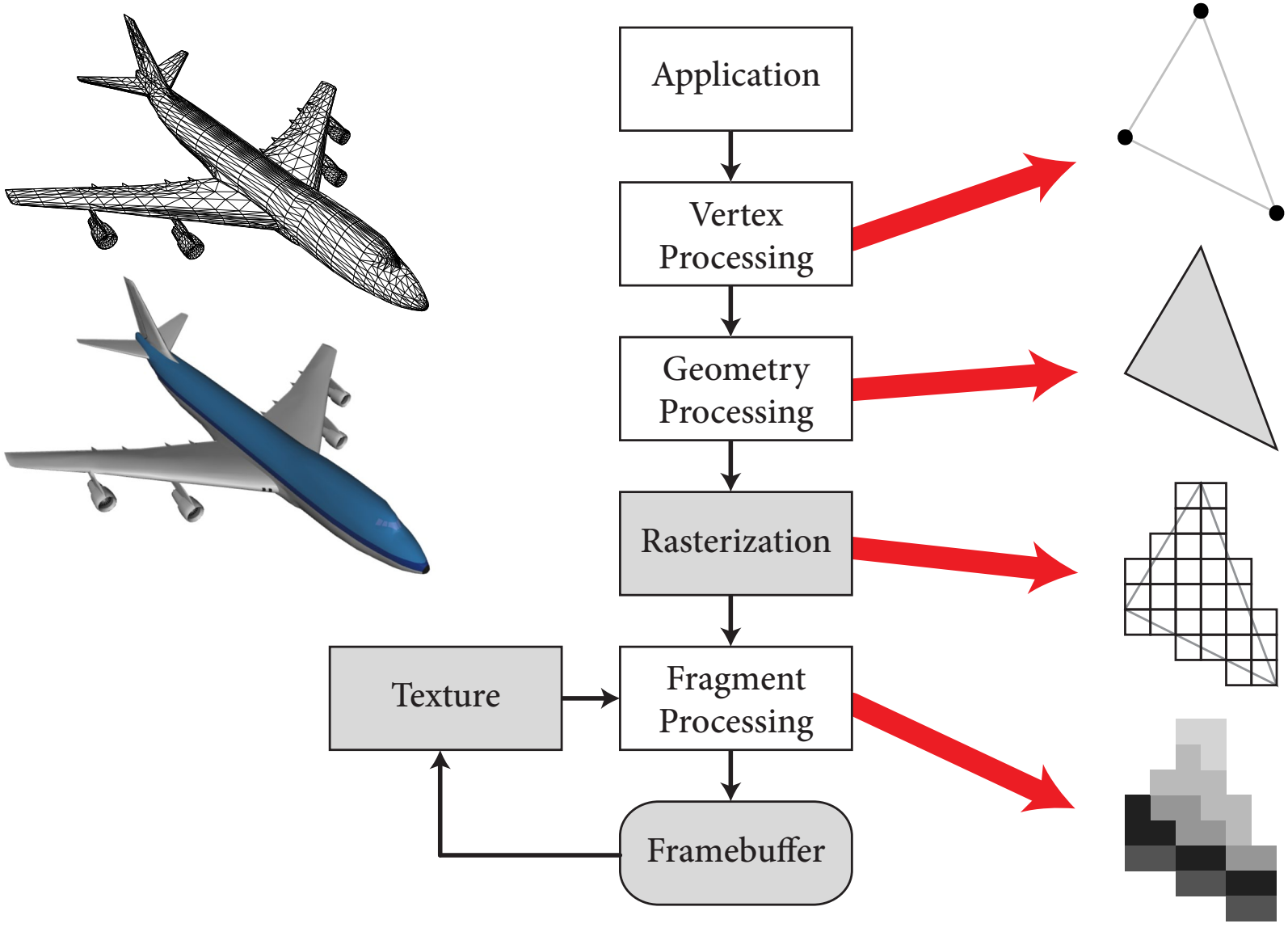
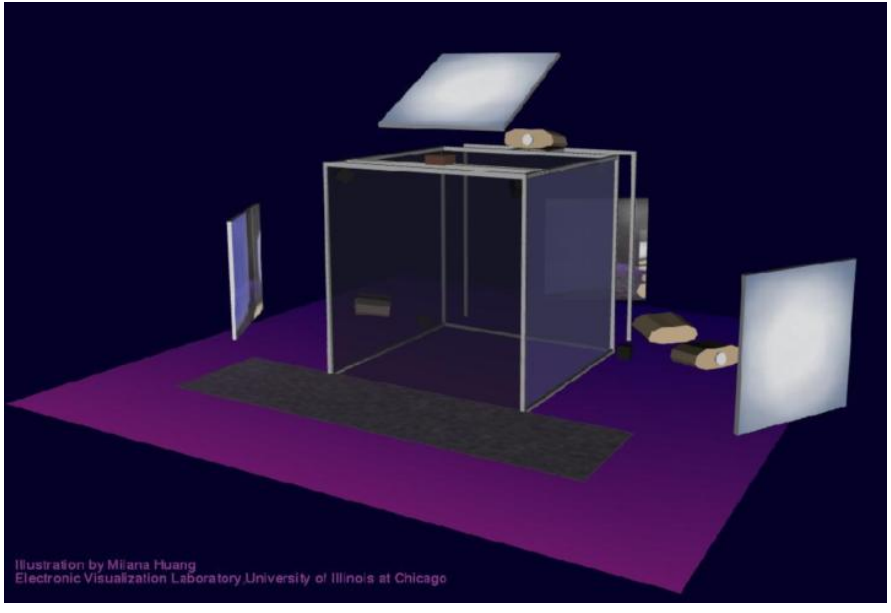
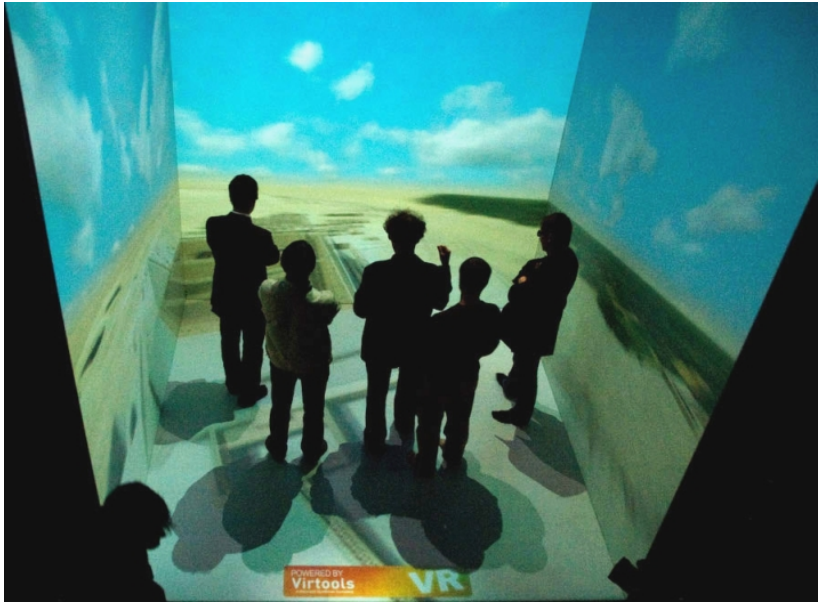
The over-arching theme of our work is to…

- take scientific data
- and off-the-shelf technology,
- modify / enhance / break it,
- apply real-time GPU techniques,
- and bring it to a wide audience.


Application
Vertex Processing
Geometry Processing
Rasterization
Texture
Fragment Processing
Framebuffer

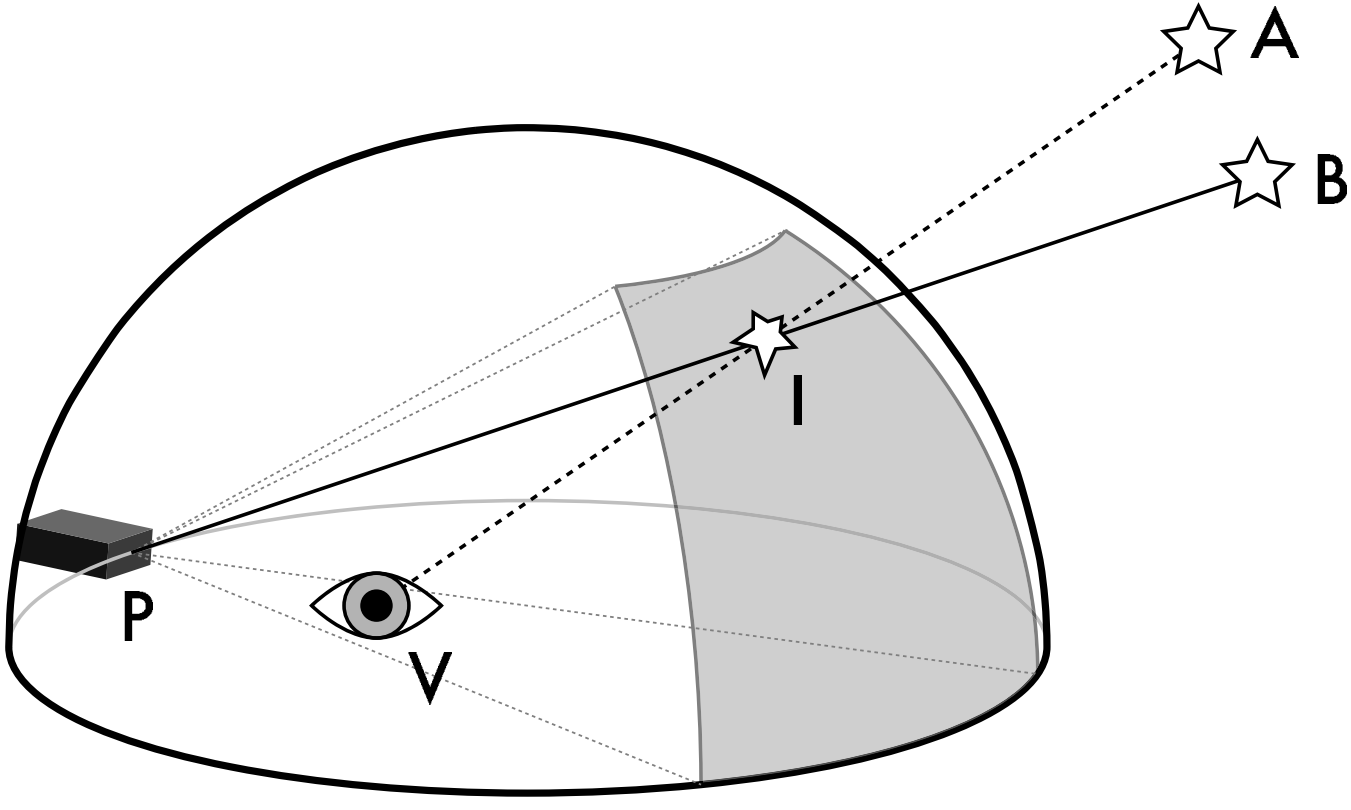




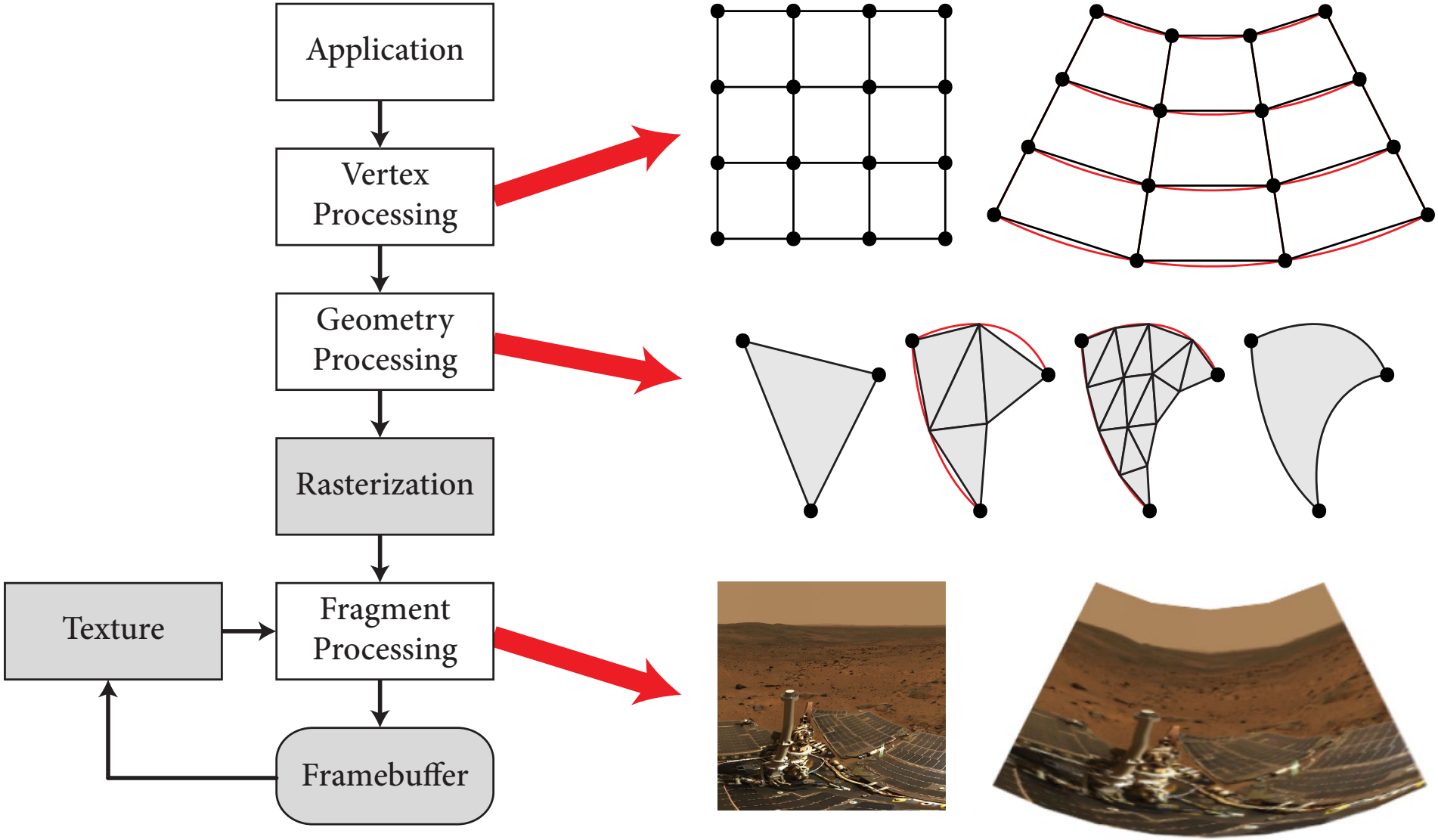
The CAVE Virtual Reality System (1992)

Electronic Visualization Lab, University of Illinois at Chicago


Elumens Visiondome 5 (2001)



A spherical display requires a spherical renderer.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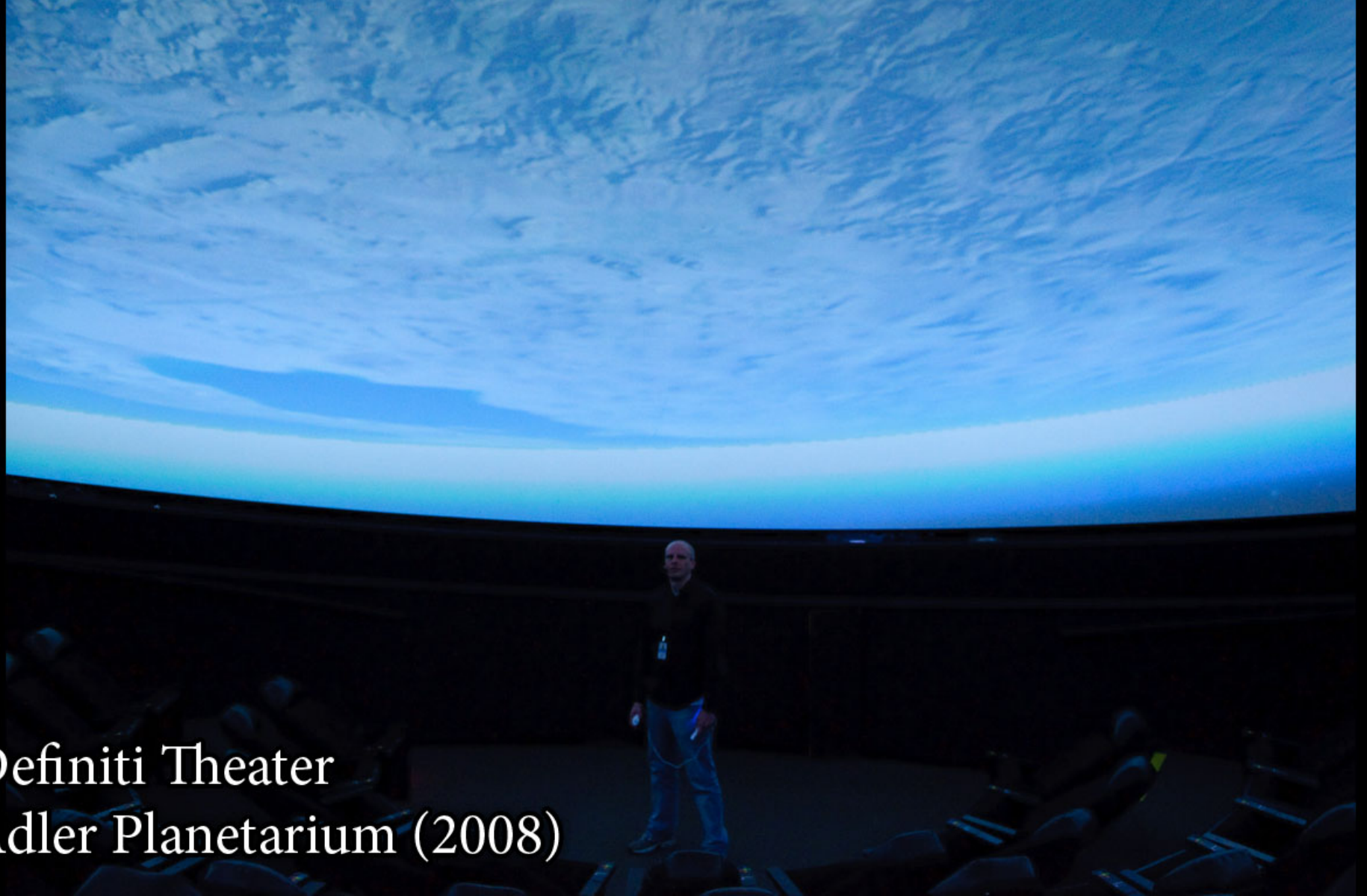
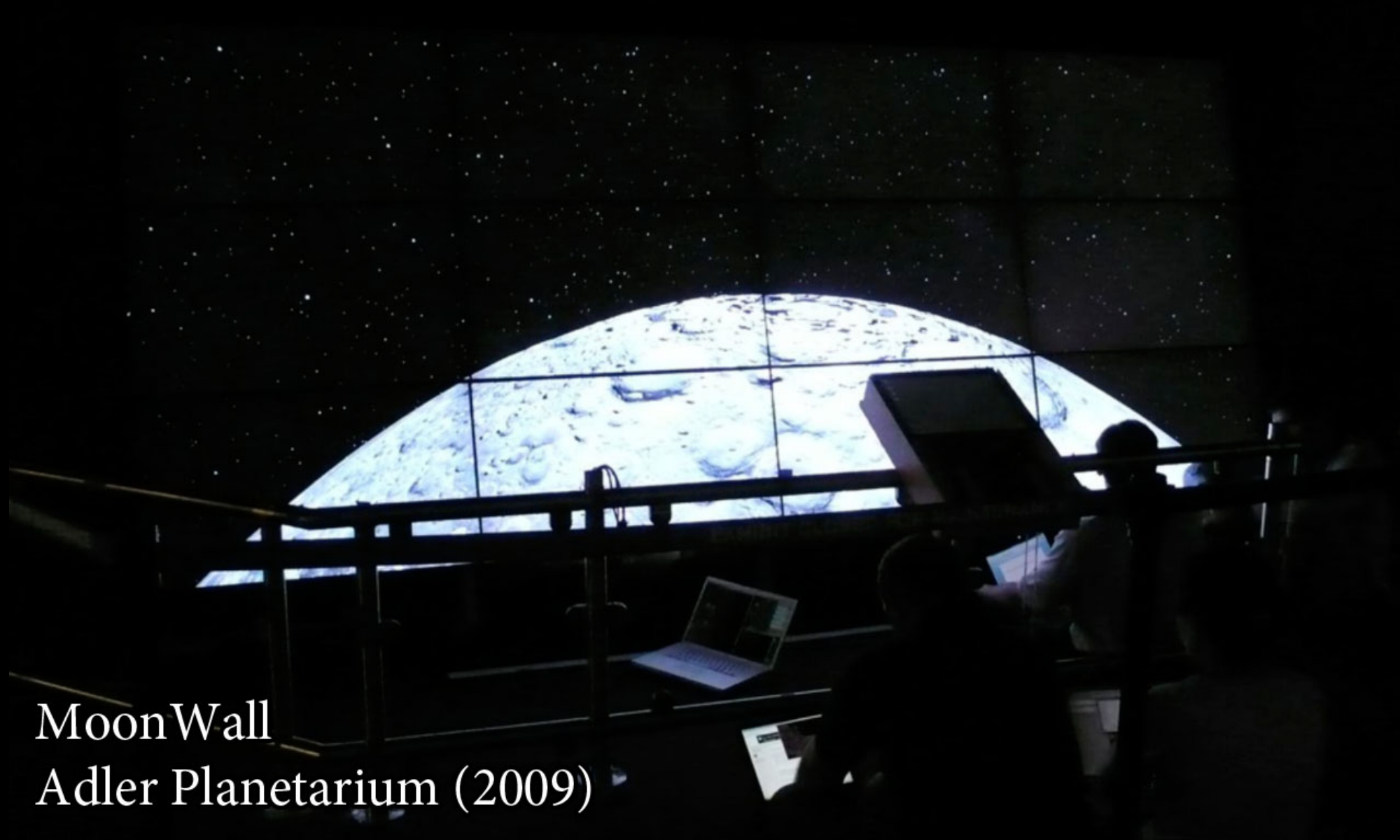
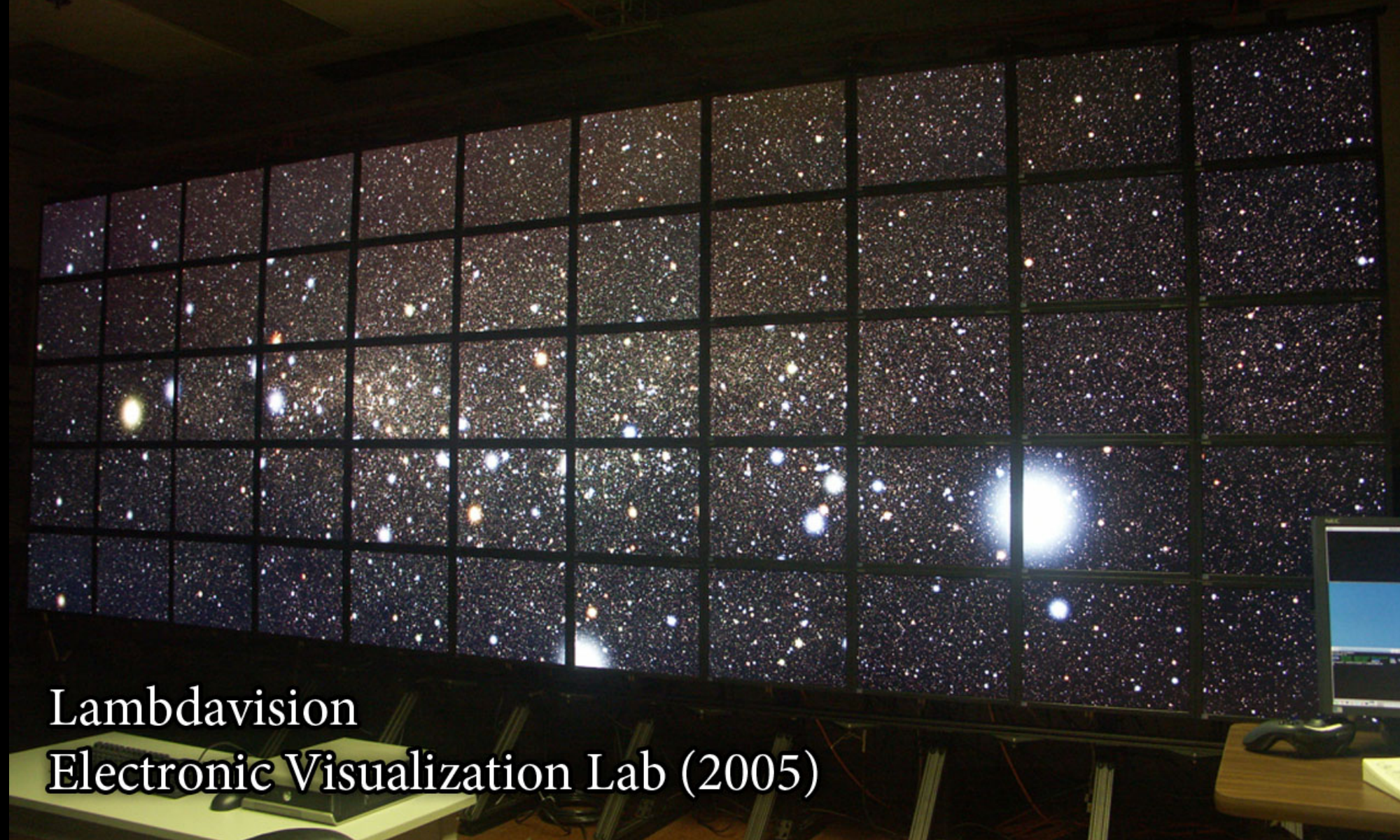
Fragment Processing
Framebuffer

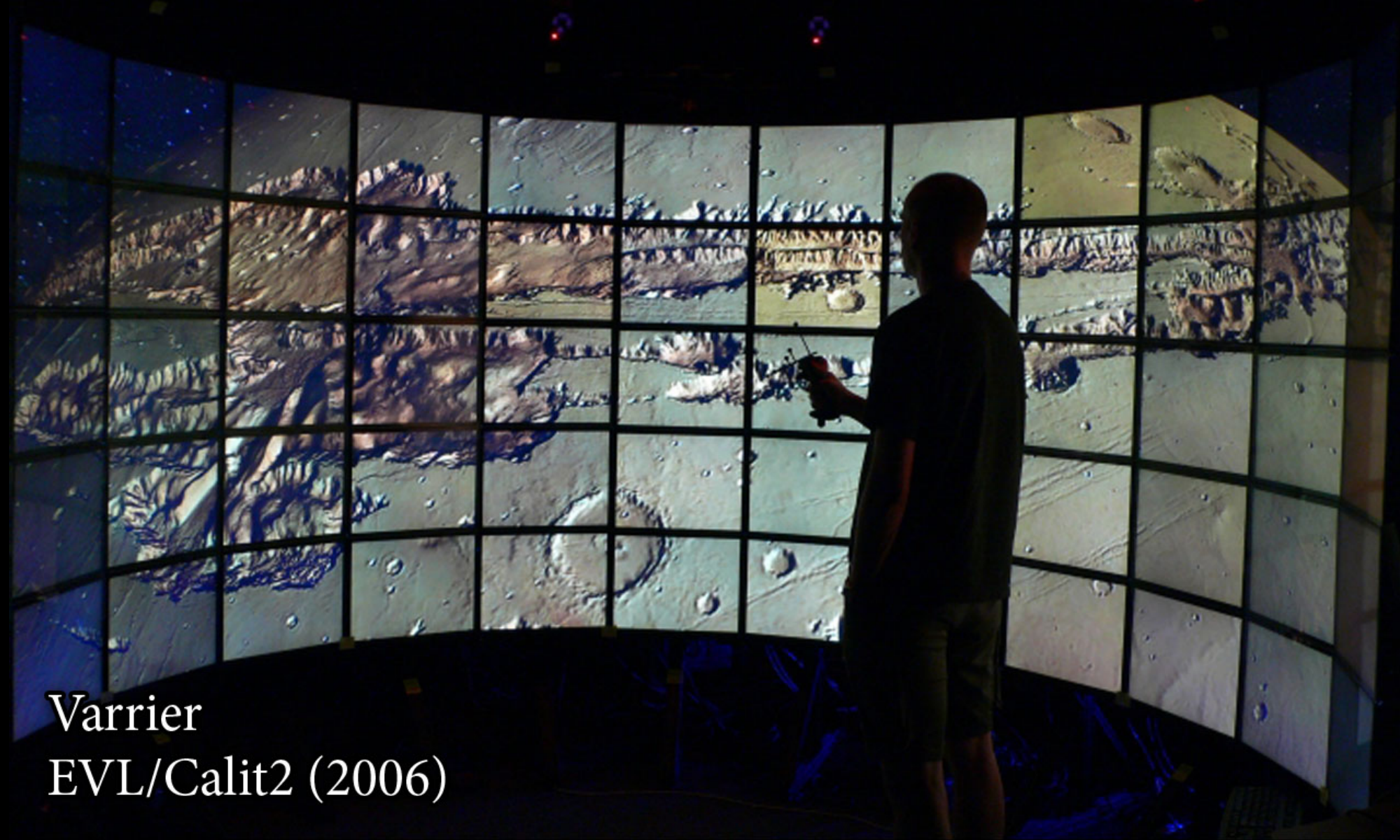


Definiti Theater
Adler Planetarium (2008)

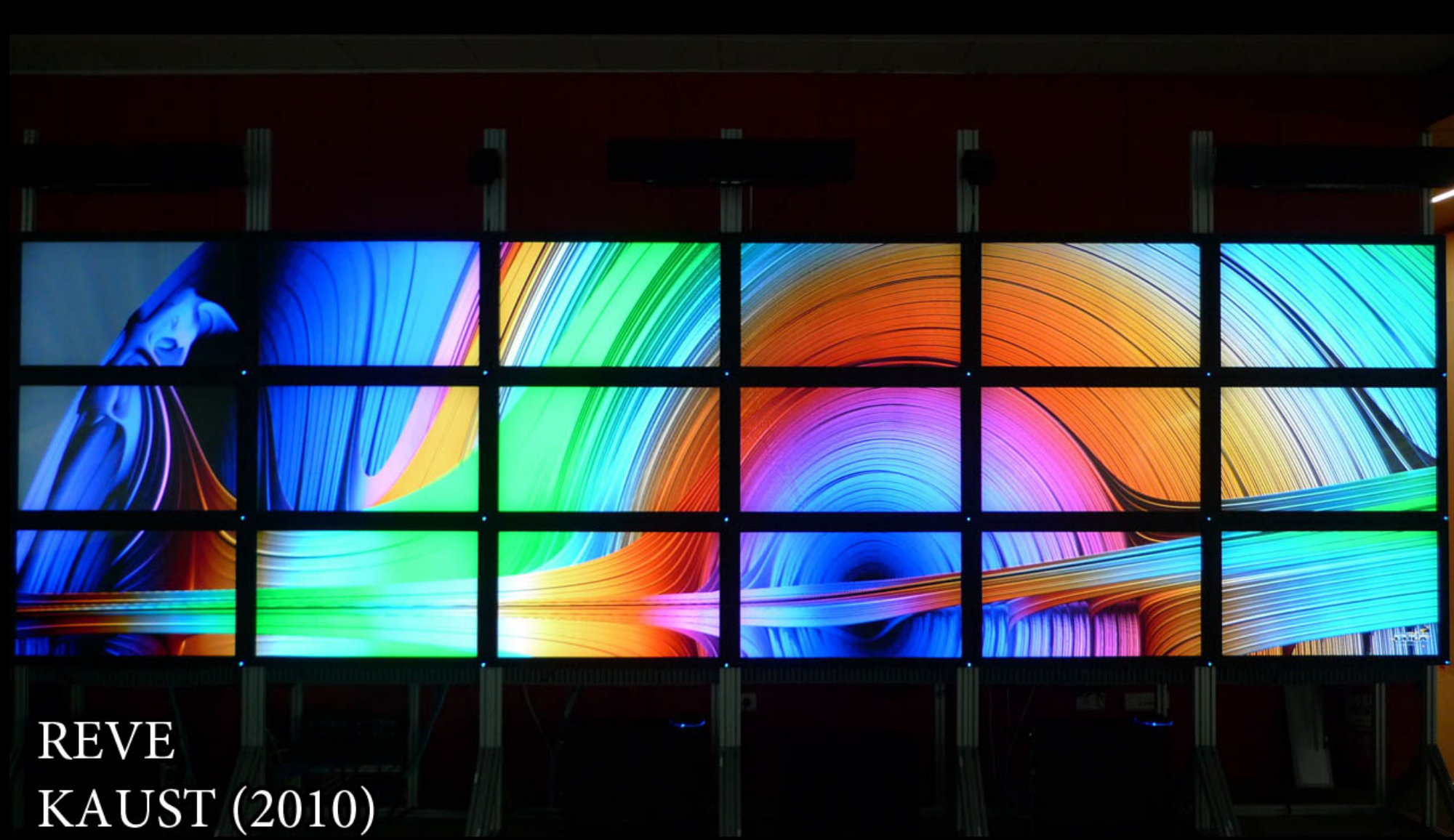


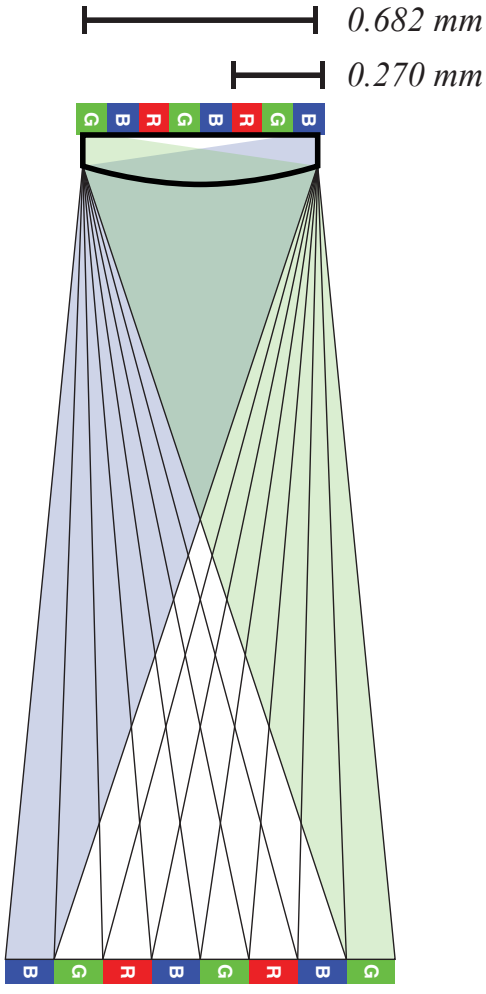
MoonWall
Adler Planetarium (2009)

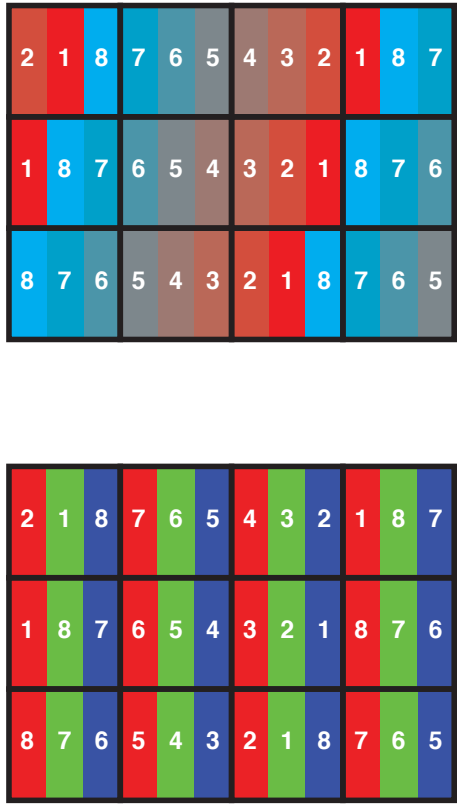

Lambdavision
Electronic Visualization Lab (2005)

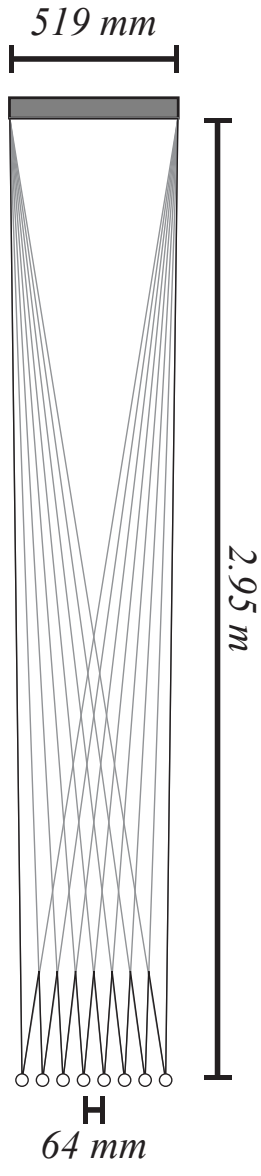


Varrier
EVL/Calit2 (2006)


REVE
KAUST (2010)


0.682 mm
0.270 mm
G B R G B R G B
B G R B G R B G


2 1 8 7 6 5 4 3 2 1 8 7
1 8 7 6 5 4 3 2 1 8 7 6
8 7 6 5 4 3 2 1 8 7 6 5
2 1 8 7 6 5 4 3 2 1 8 7
1 8 7 6 5 4 3 2 1 8 7 6
8 7 6 5 4 3 2 1 8 7 6 5

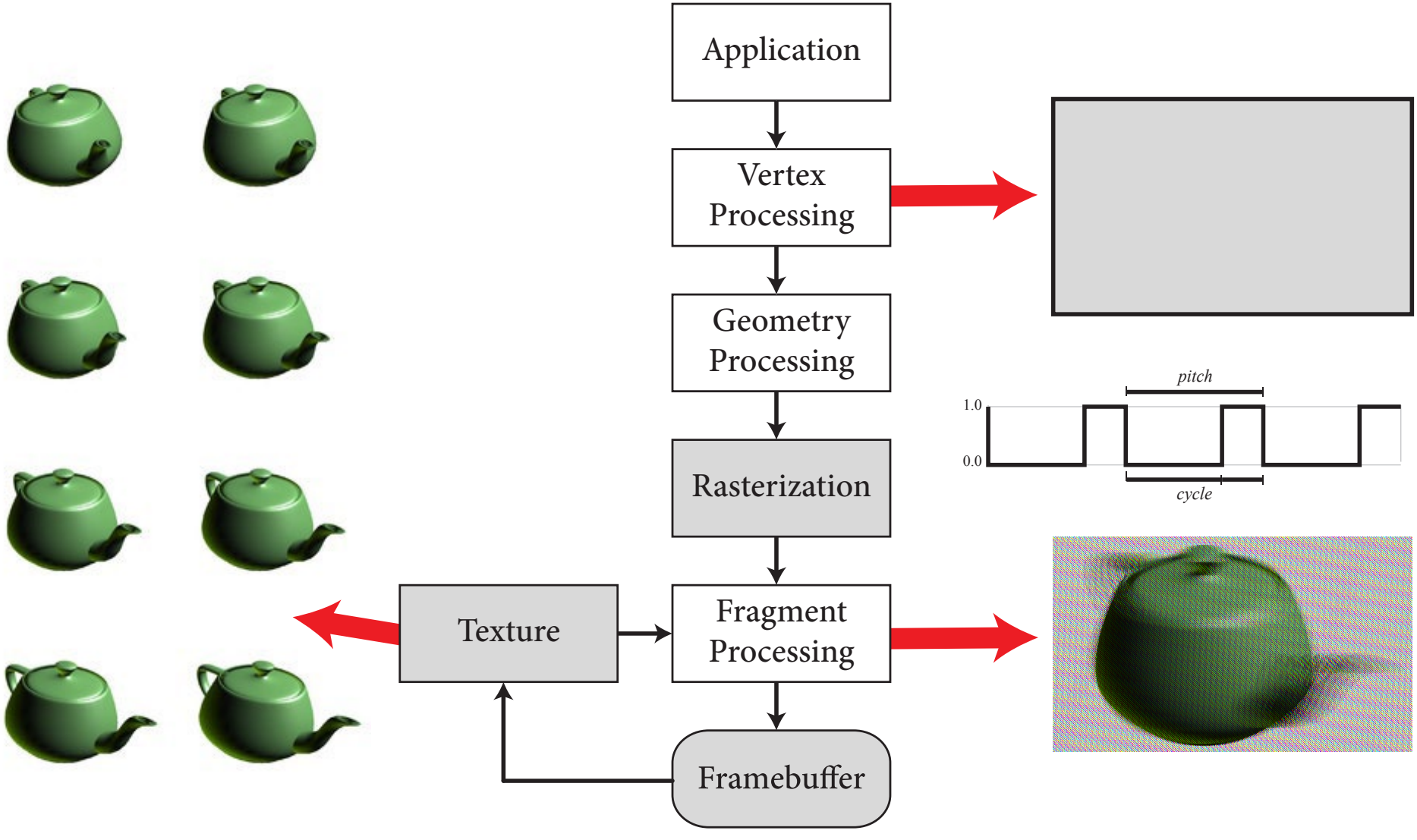

519 mm
2.95 m
H
64 mm

GPU Autostereo Interleaving

The interleaving process is prohibitively expensive, and usually relegated to an *offline* process.

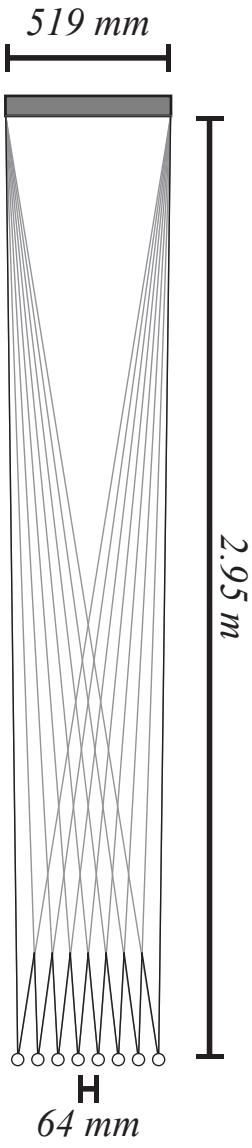
But the programmable GPU revolutionizes autostereo, making real-time possible. [IEEE VR 2007, ACM VRST 2010]

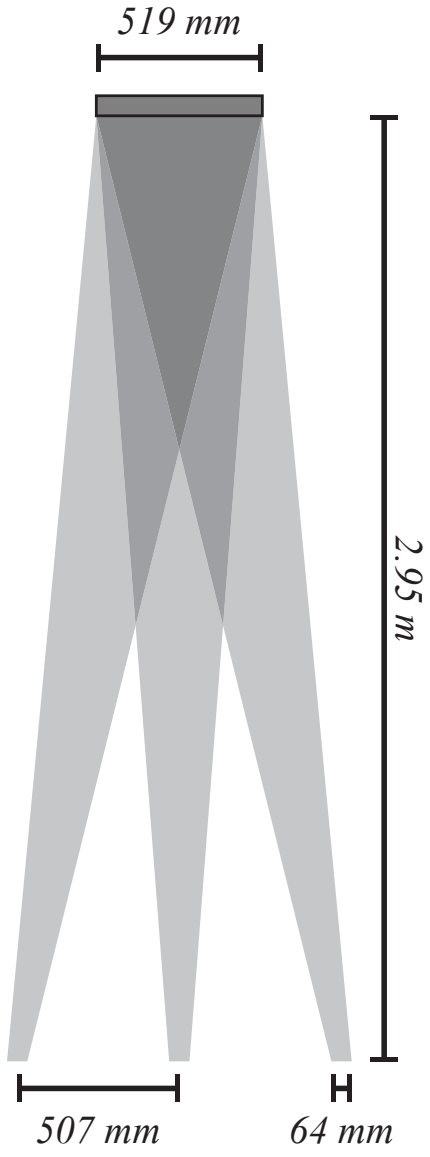
- Interleaver Vertex Shader
- Interleaver Fragment Shader

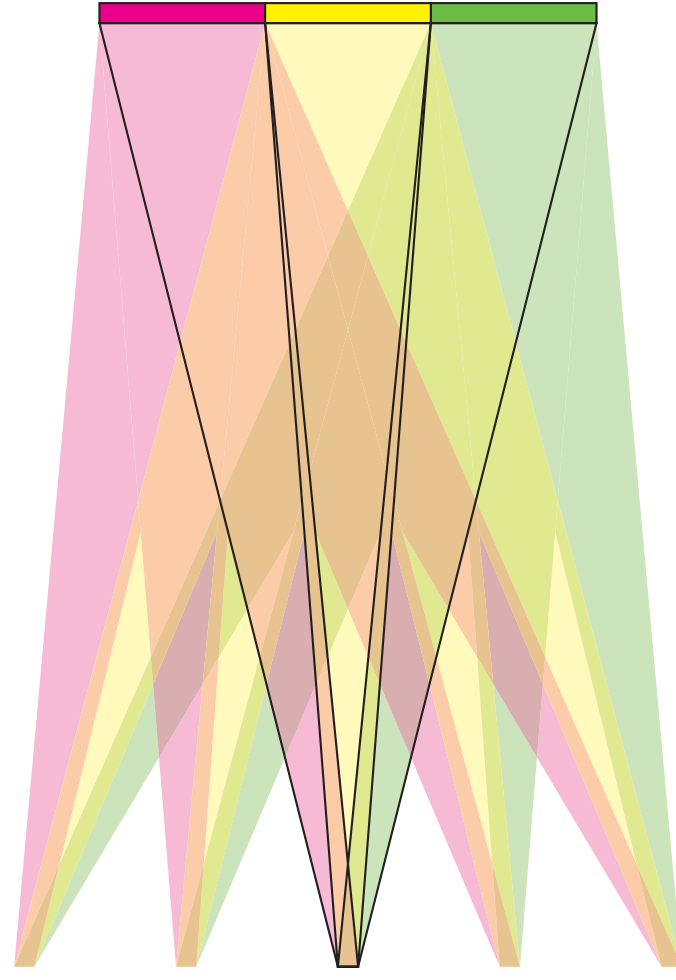

Application
Vertex Processing
Geometry Processing
Rasterization
Fragment Processing
Framebuffer
Texture
pitch
1.0
0.0
cycle

Projection scale and repetition

Setting each channel to a different solid color
and letting the projected image fall upon a white card.


519 mm
2.95 m
H
64 mm


519 mm
2.95 m
507 mm
H
64 mm



To the classroom. . .

Moving from the lab, to the planetarium, to the museum, and finally to the classroom, new and original technologies are still a driving force.

- Video Game Design
- Interactive Computer Graphics

“Plants vs. Zombies” Popcap

“Flight Control” Firemint

TacTile Multi-user Multi-touch Table – EVL / CCT (2009)

The 3D Graphics Classroom

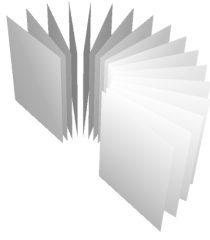
A course on 3D graphics must emphasize…

- Mathematics
- Source code
- *3D Graphics*

Given the opportunity to create a new LSU course from scratch, I sought the perfect tool to help me, and settled upon the iPad.

iPad presentation software features

	Keynote	Safari	PDF Viewer	OmniGraffle	*Custom*
VGA Output	●		○	●	●
3D		○			●
Mathematics			●		●
Typesetting			●		●
Video	○	●			○
Pan & Zoom			●	●	●
Authoring	●			●	
Speaker Notes					●
Pointer	●				●

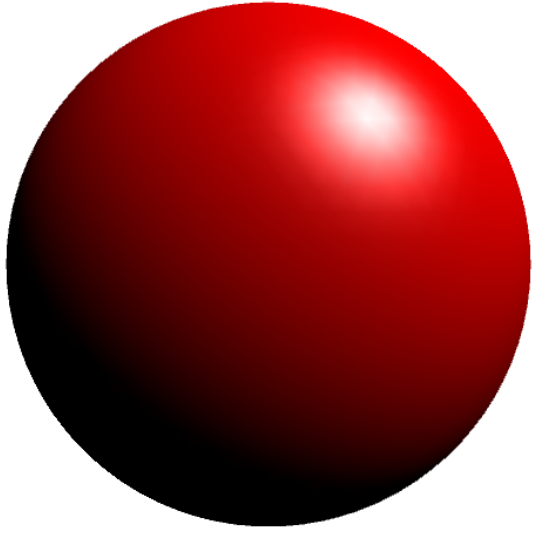


DOCSPIN

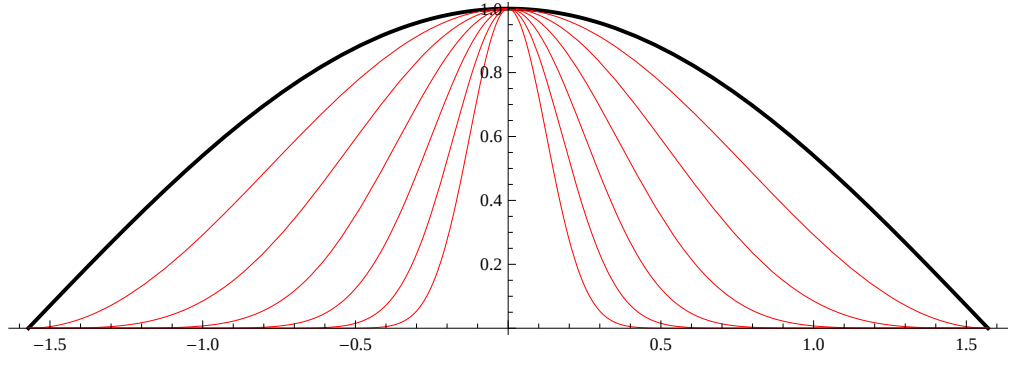
- A native Cocoa application for iOS
- Written in Objective C
- Renders PDF overlaid with OpenGL ES

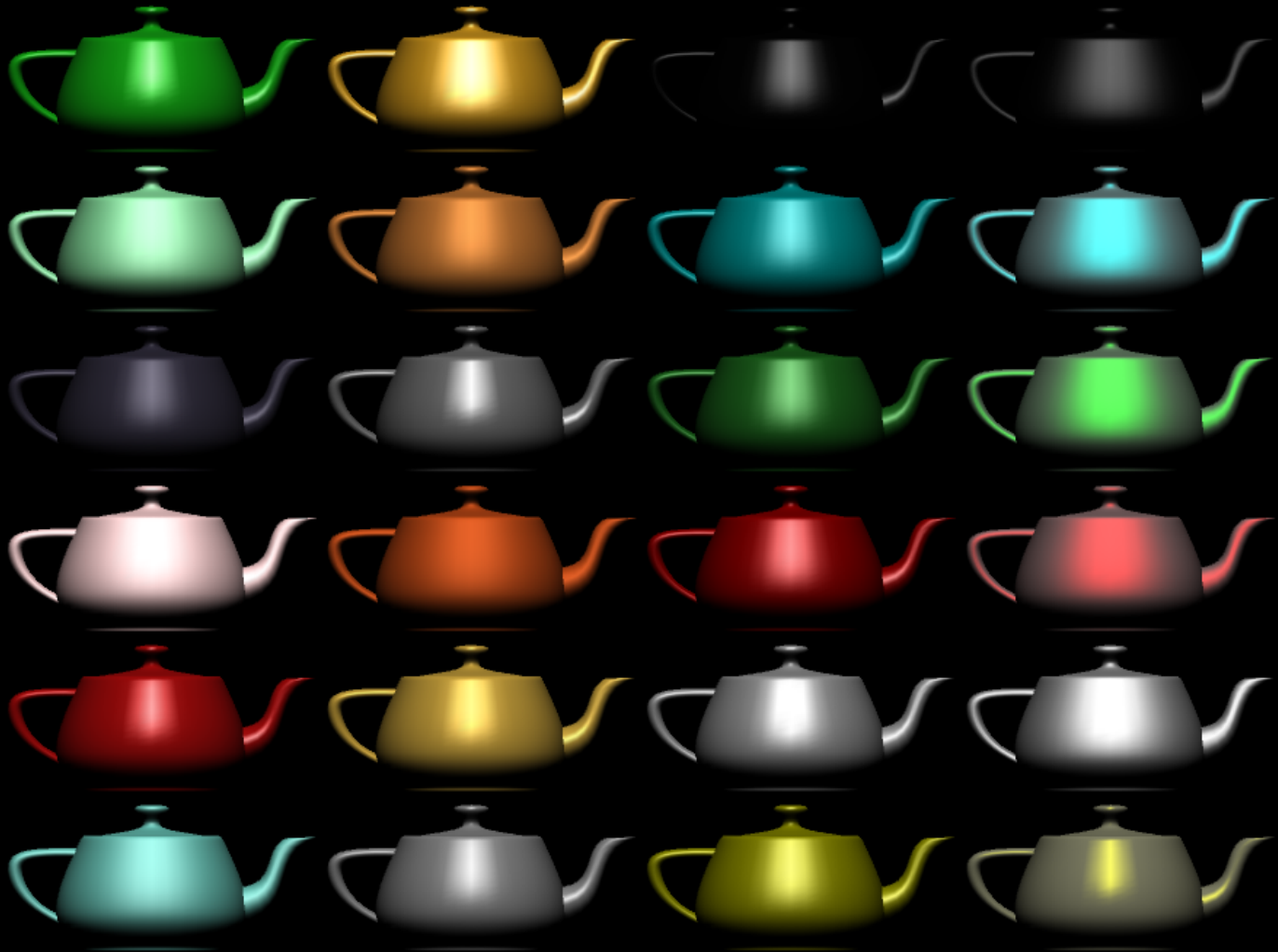
Diffuse plus Specular Illumination

Most materials exhibit both diffuse *and* specular properties, so one usually uses both at the same time.



$$\boldsymbol{c}_d = \boldsymbol{m}_d \left(\boldsymbol{n} \cdot \boldsymbol{l}\right) + \boldsymbol{m}_s \left(\boldsymbol{n} \cdot \boldsymbol{h}\right)^{\alpha}$$





Texture Filtering

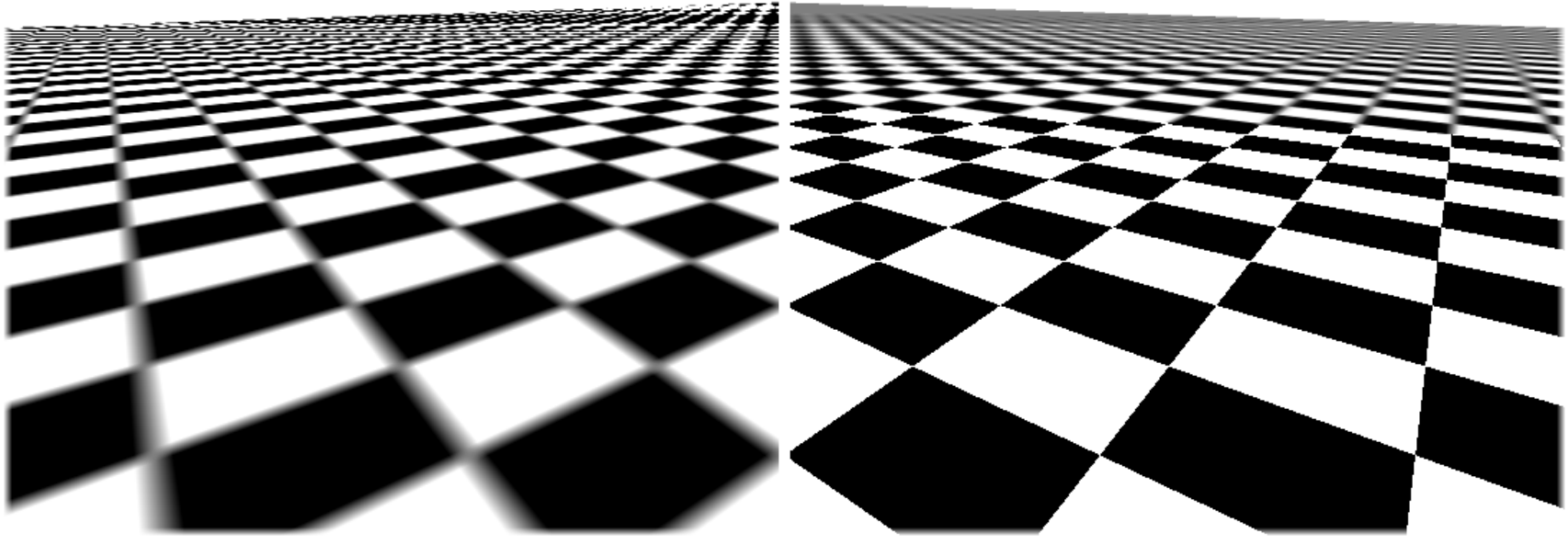
min:
GL_NEAREST

mag:
GL_NEAREST

min:
GL_LINEAR

mag:
GL_LINEAR

Mipmap Texture Filtering



min: GL_LINEAR
mag: GL_LINEAR

min: GL_LINEAR_MIPMAP_LINEAR
mag: GL_NEAREST

Nice Mathematics

$$P = \begin{bmatrix} \frac{2n}{r-l} & 0 & \frac{r+l}{r-l} & 0 \\ 0 & \frac{2n}{t-b} & \frac{t+b}{t-b} & 0 \\ 0 & 0 & -\frac{f+n}{f-n} & -\frac{2fn}{f-n} \\ 0 & 0 & -1 & 0 \end{bmatrix}$$

Thanks to LaTeX

Source Code

Source code listings are crucial in teaching programming. As a long list of tiny text, code does not fit well on slides.

- We need to scroll it.
- We need to zoom in on it.

➠ An example C listing

Powerpoint Presentations

PPT is universal. *Significant* time and energy has been invested in it. We must have backward compatibility.

PDF gets us most of the way.

➠ An example presentation

PDF

A great deal of valuable information is presentable as PDF.

- An object diagram
- A journal paper
- Sheet music
- A detailed diagram

Usage? Authoring?

- Basic page content is standard PDF.
- Hyperlinks and annotations add structure.
- There is *no* on-device authoring feature planned.
- Interactive 3D is native Objective C and OpenGL, in compliance with Apple Developer licensing.

Availability will be Open Source, possibly $0.00 App Store

Interactive 3D: Displays, Devices, and Applications

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