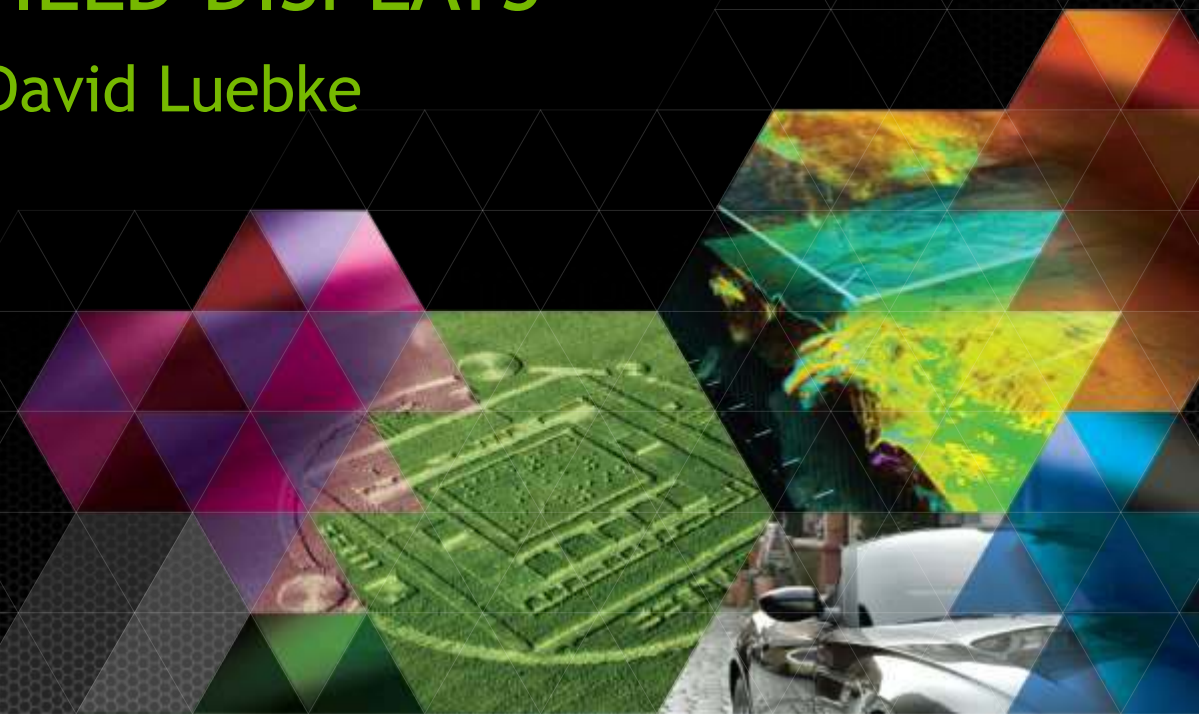


NEAR-EYE LIGHT FIELD DISPLAYS

Douglas Lanman and David Luebke
NVIDIA Research







5DT HMD 800



Cybermind



NMS nVisor SX60



Rockwell Collins SimEye



Sensics piSight



Sensics xSight



Sensics zSight



Virtual Realities VR2000



Sony HMZ-T1



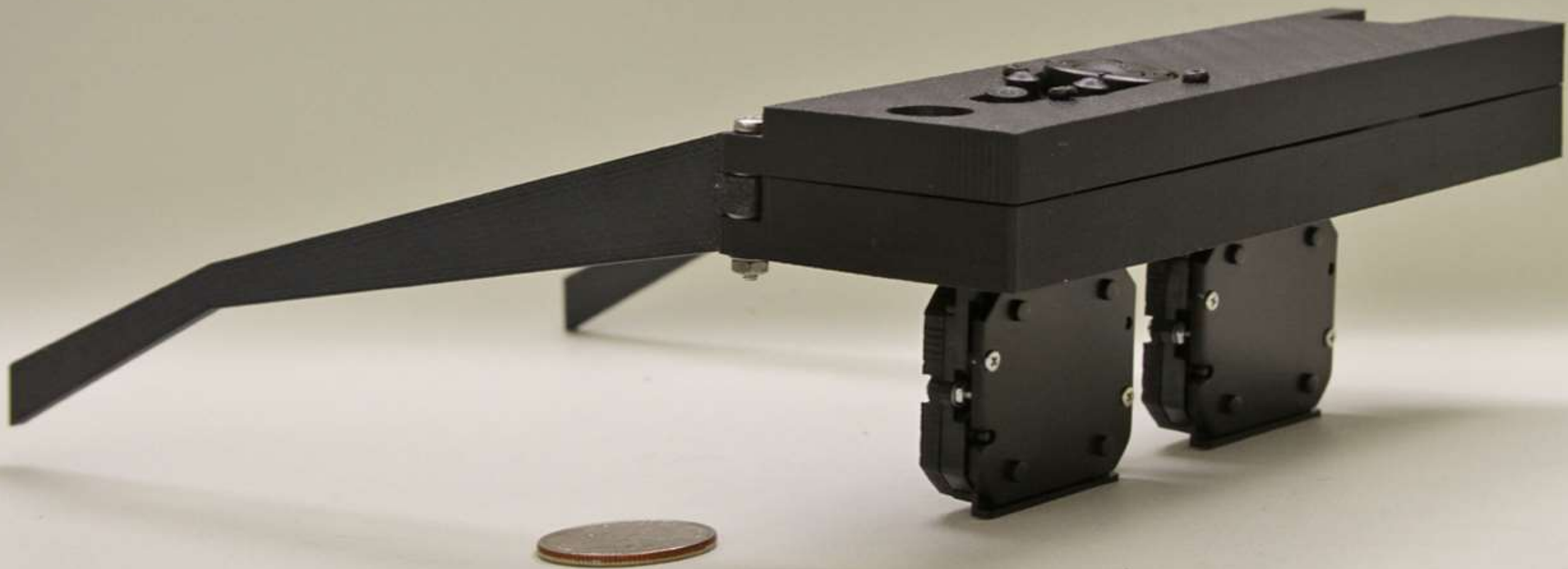
Carl Zeiss Cinemizer



Silicon Micro Display ST1080



Oculus Rift



Electronics Enclosure



Left-Eye Display

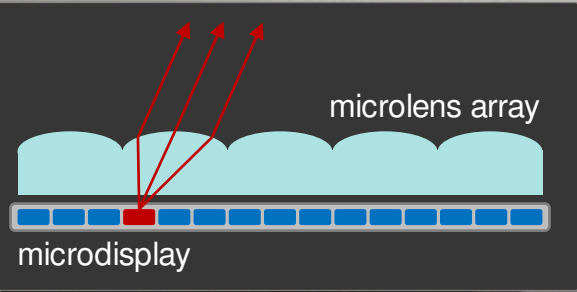
Right-Eye Display

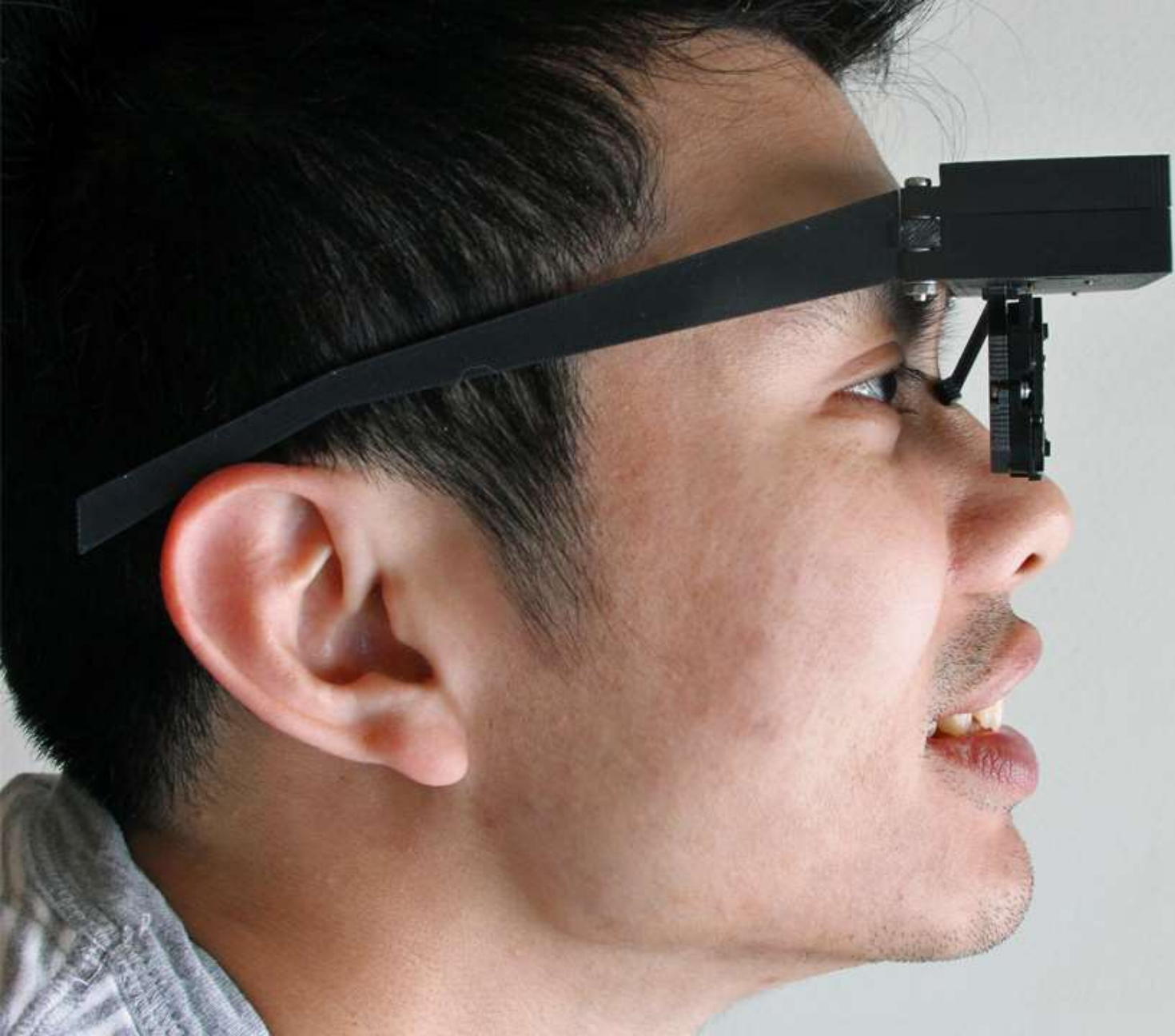
Electronics Enclosure



Left-Eye Display

Right-Eye Display





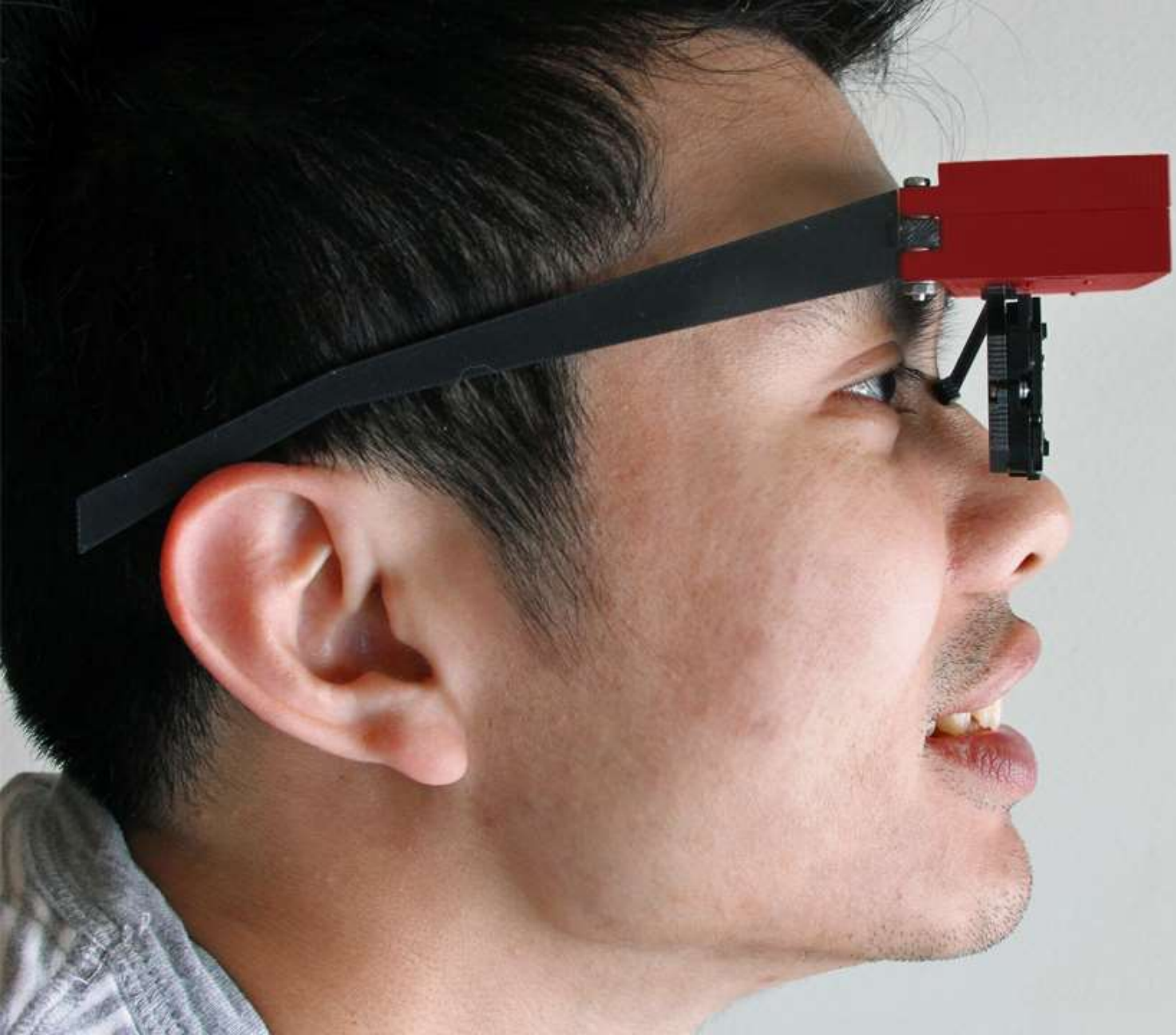


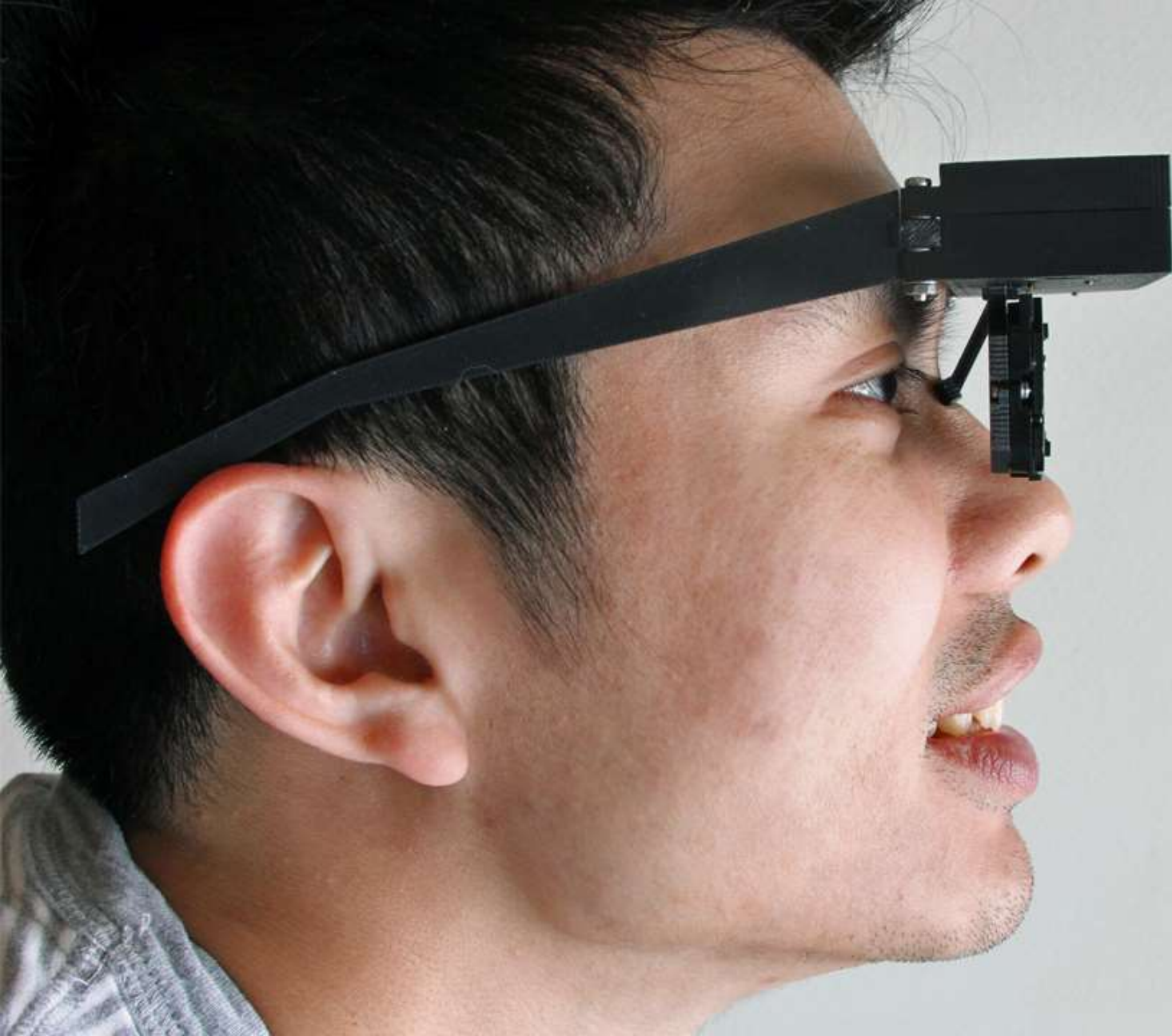




Image Shown on Microdisplay



Perceived Image (Close-Up Camera)



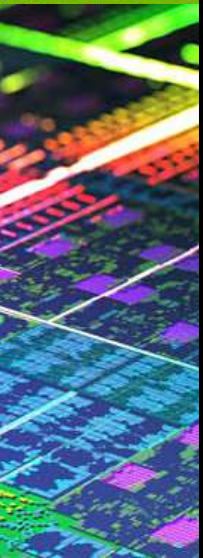
Benefits

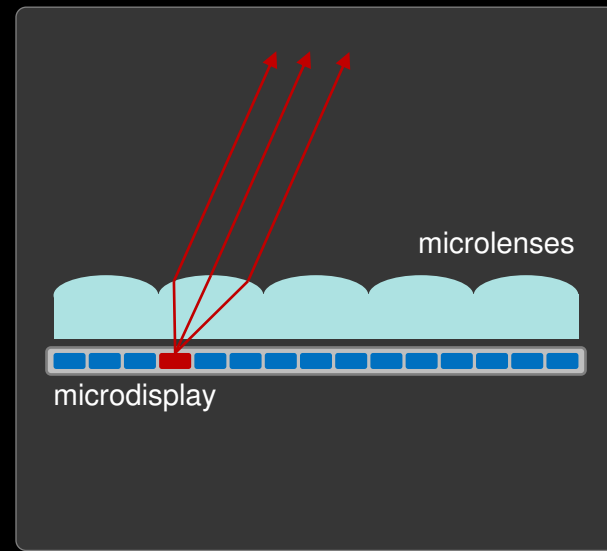
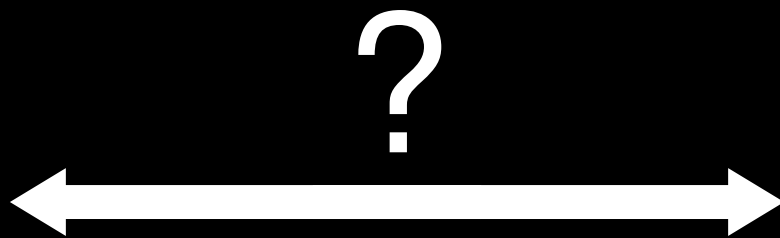
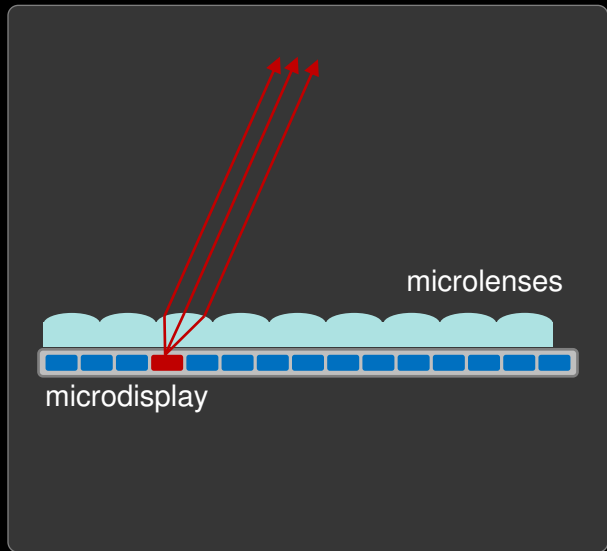
- **thin**
- **lightweight**
- **immersive** (wide fields of view)
- **comfortable**
- addresses accommodation-convergence conflict
- approximates retinal defocus cues
- no need for corrective eyewear

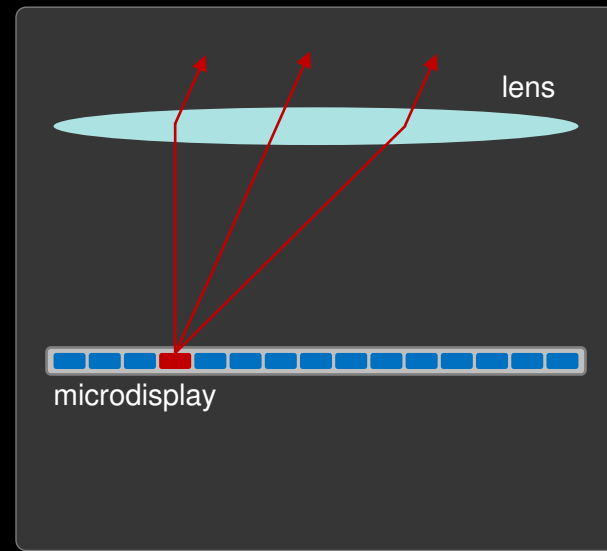
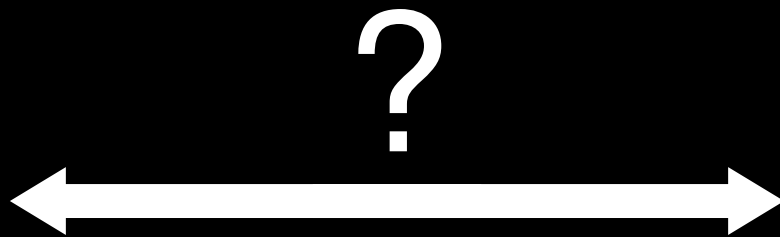
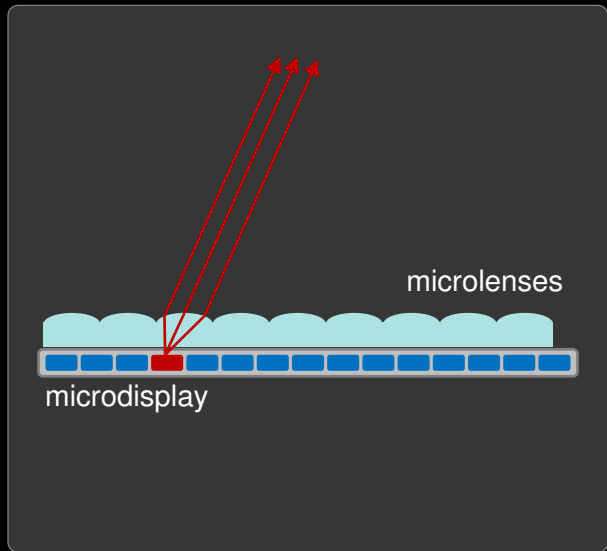
Limitations

- **reduced spatial resolution**
- high-resolution or tiled microdisplays
- careful microlens array selection
- **requires larger microdisplays**
- **requires user calibration**

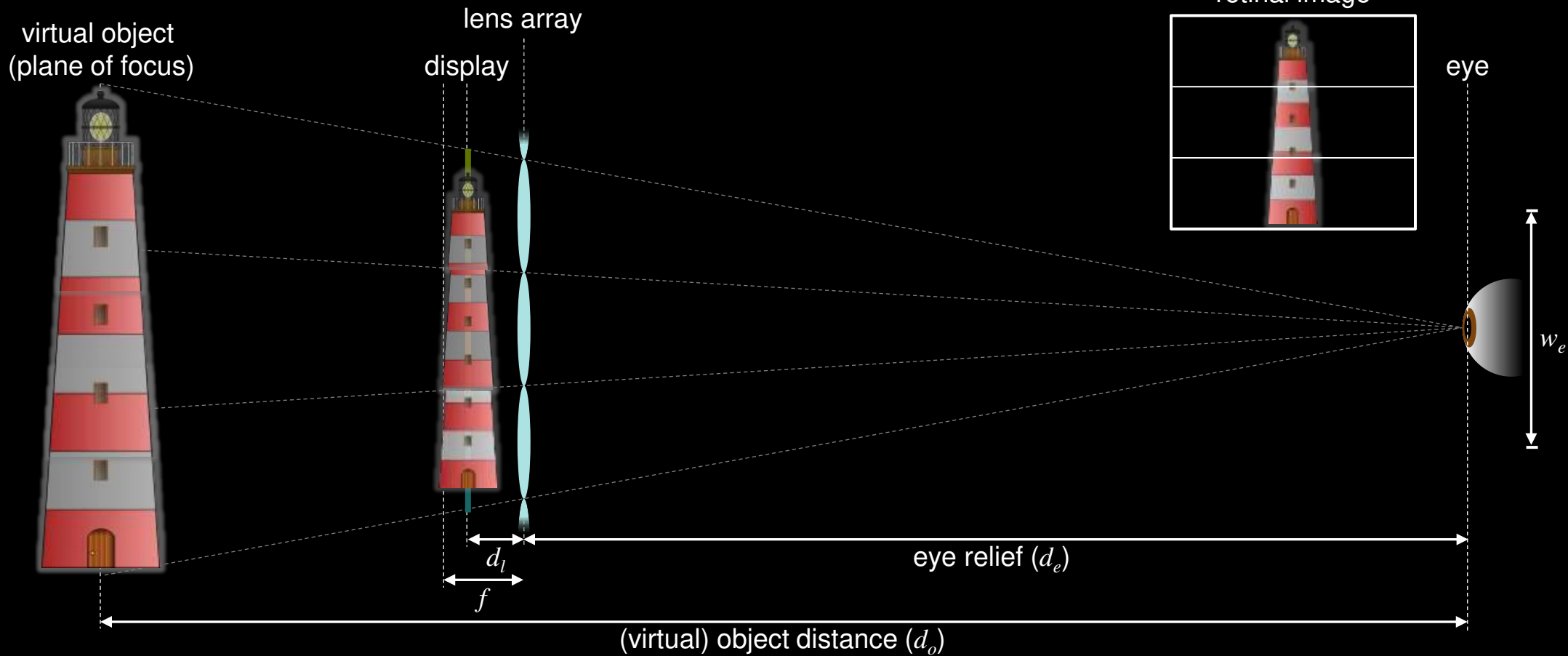
Designing Near-Eye Light Field Displays



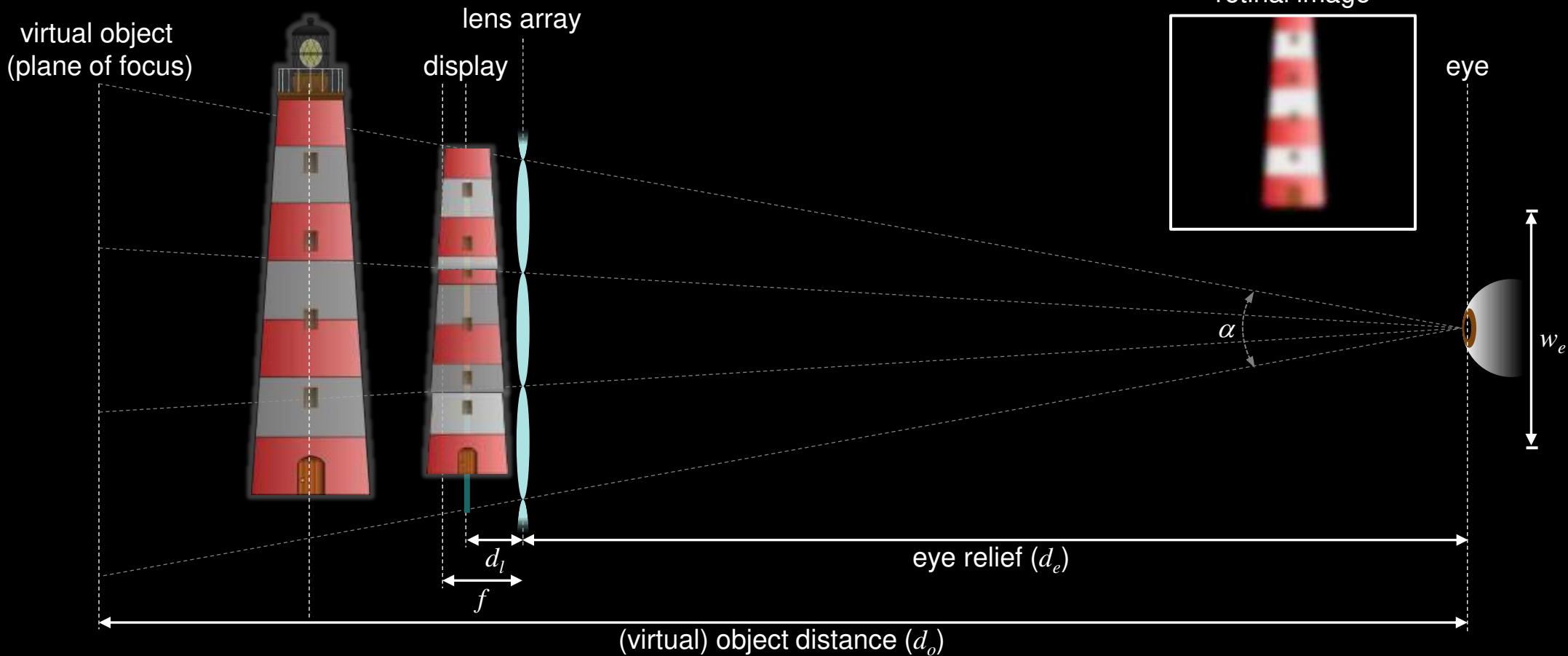


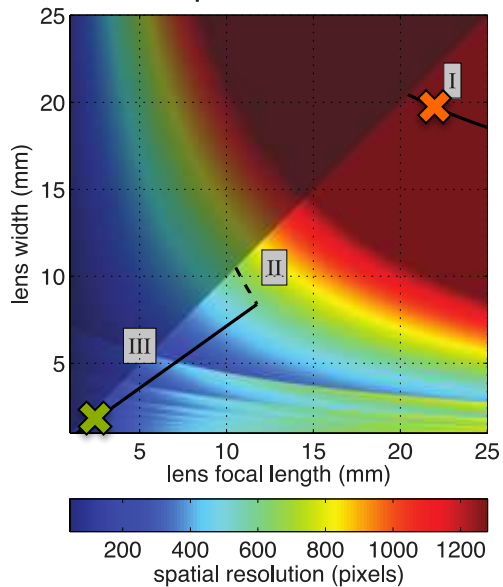
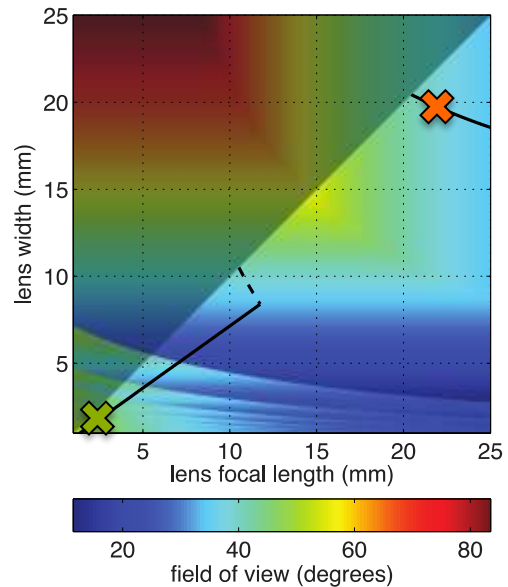
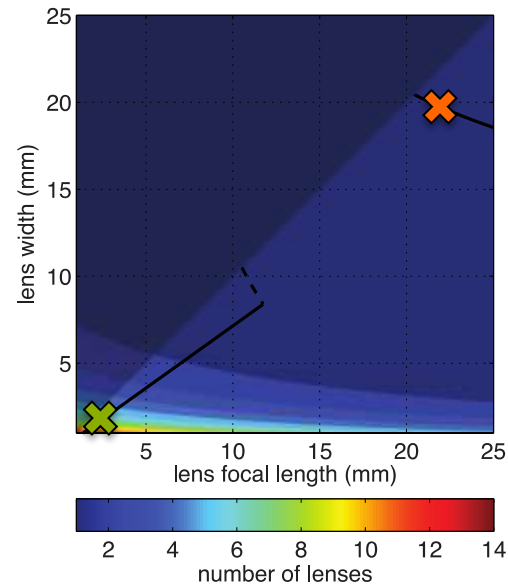
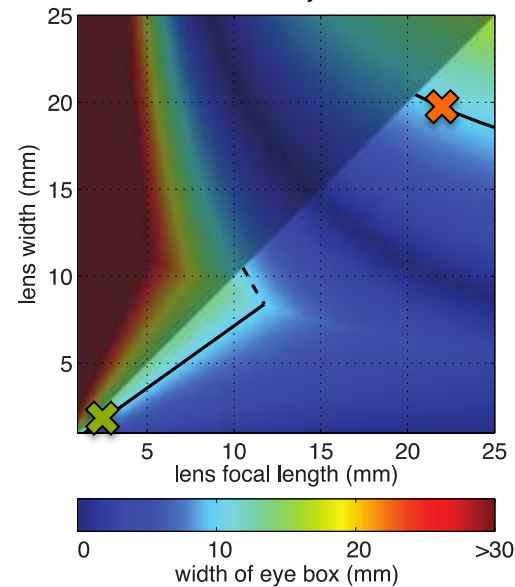
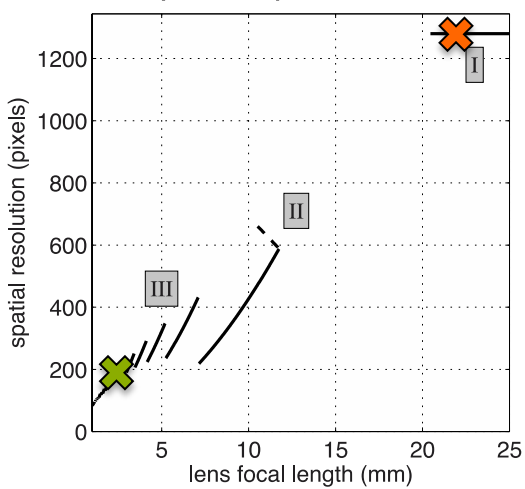
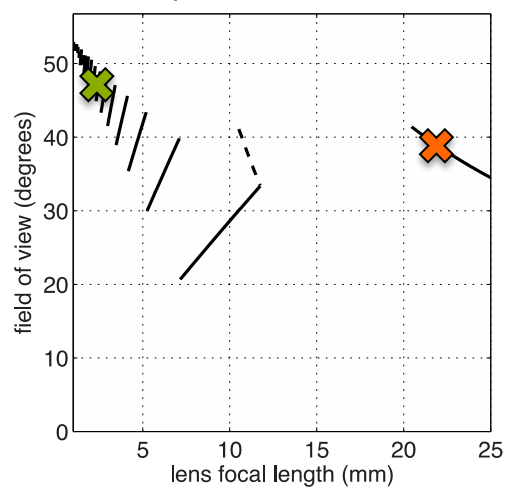
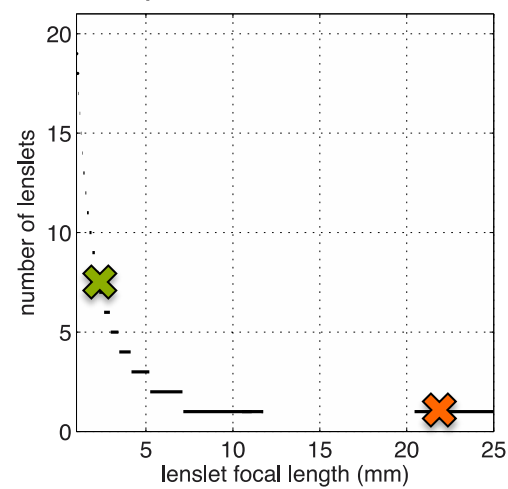
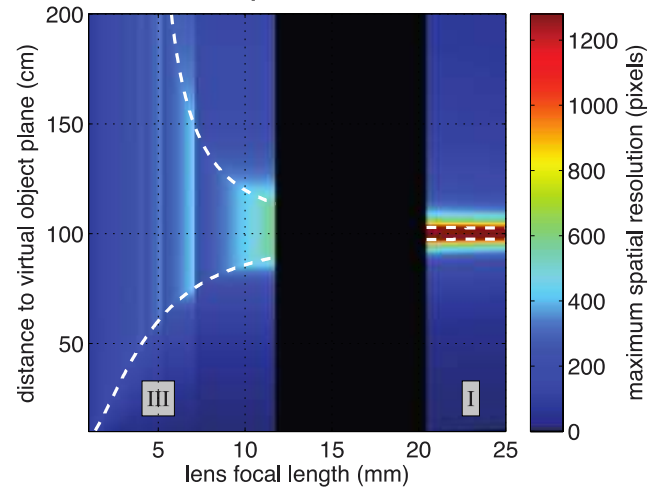


Magnifier Array

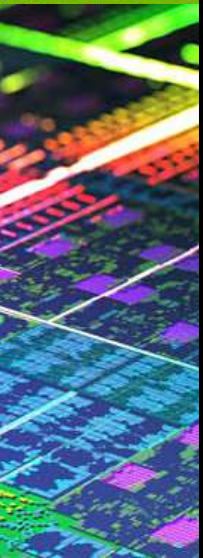


Magnifier Array: Light Field Synthesis



Spatial Resolution**Field of View****Number of Lenses****Width of Eye Box****Optimized Spatial Resolution****Optimized Field of View****Optimized Number of Lenses****Depth of Field**

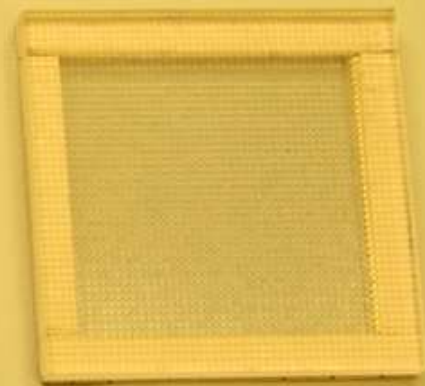
LVT Film-based Prototype

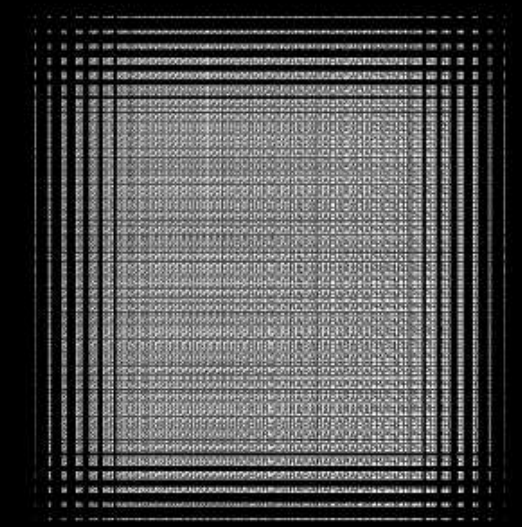
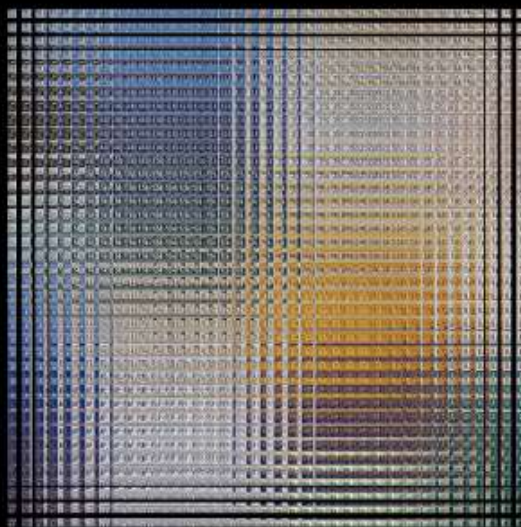
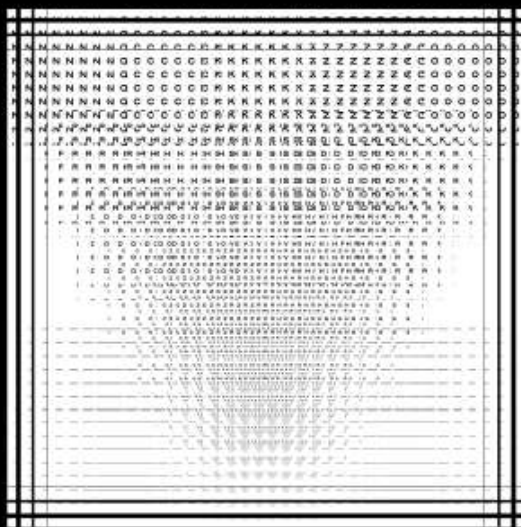
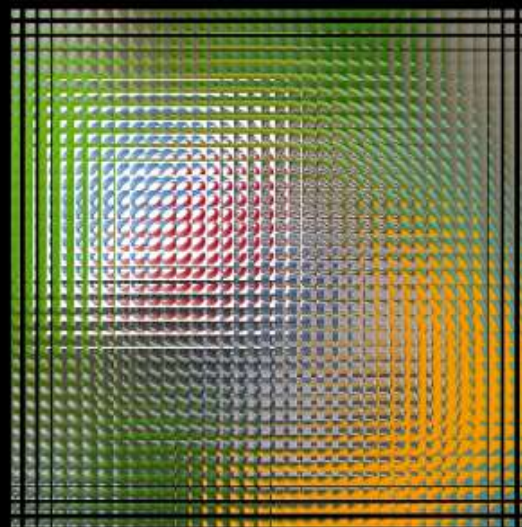
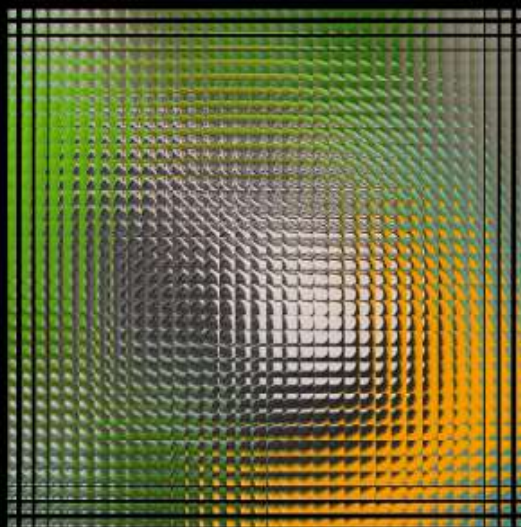
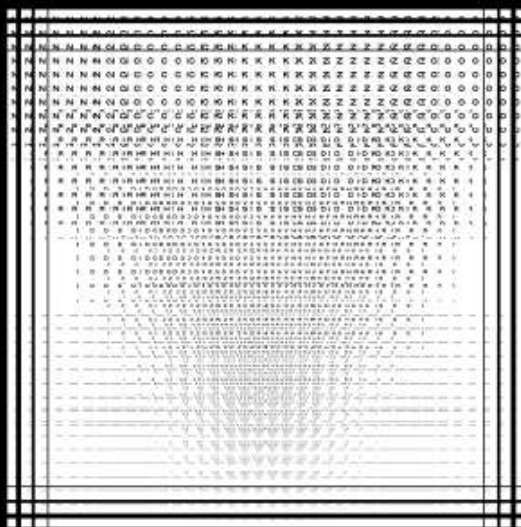


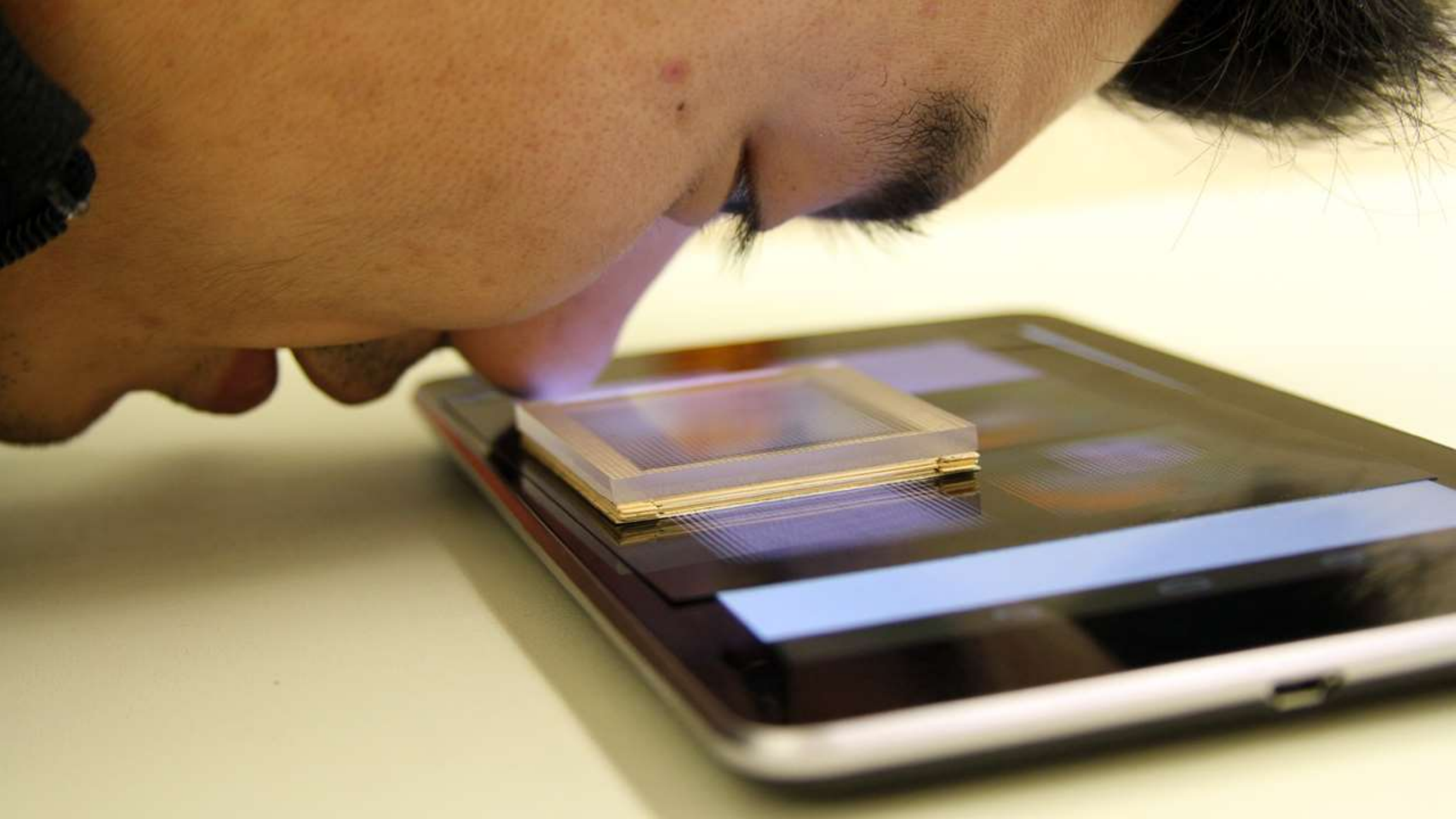


Backlit LVT Film

Microlens Array

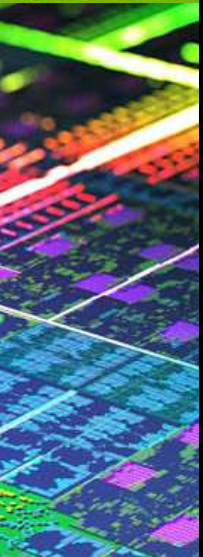


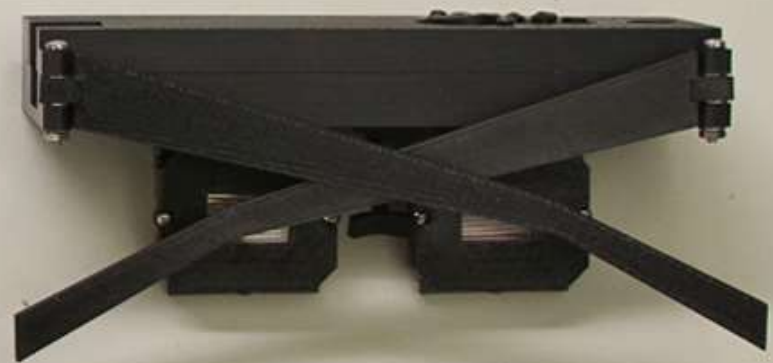


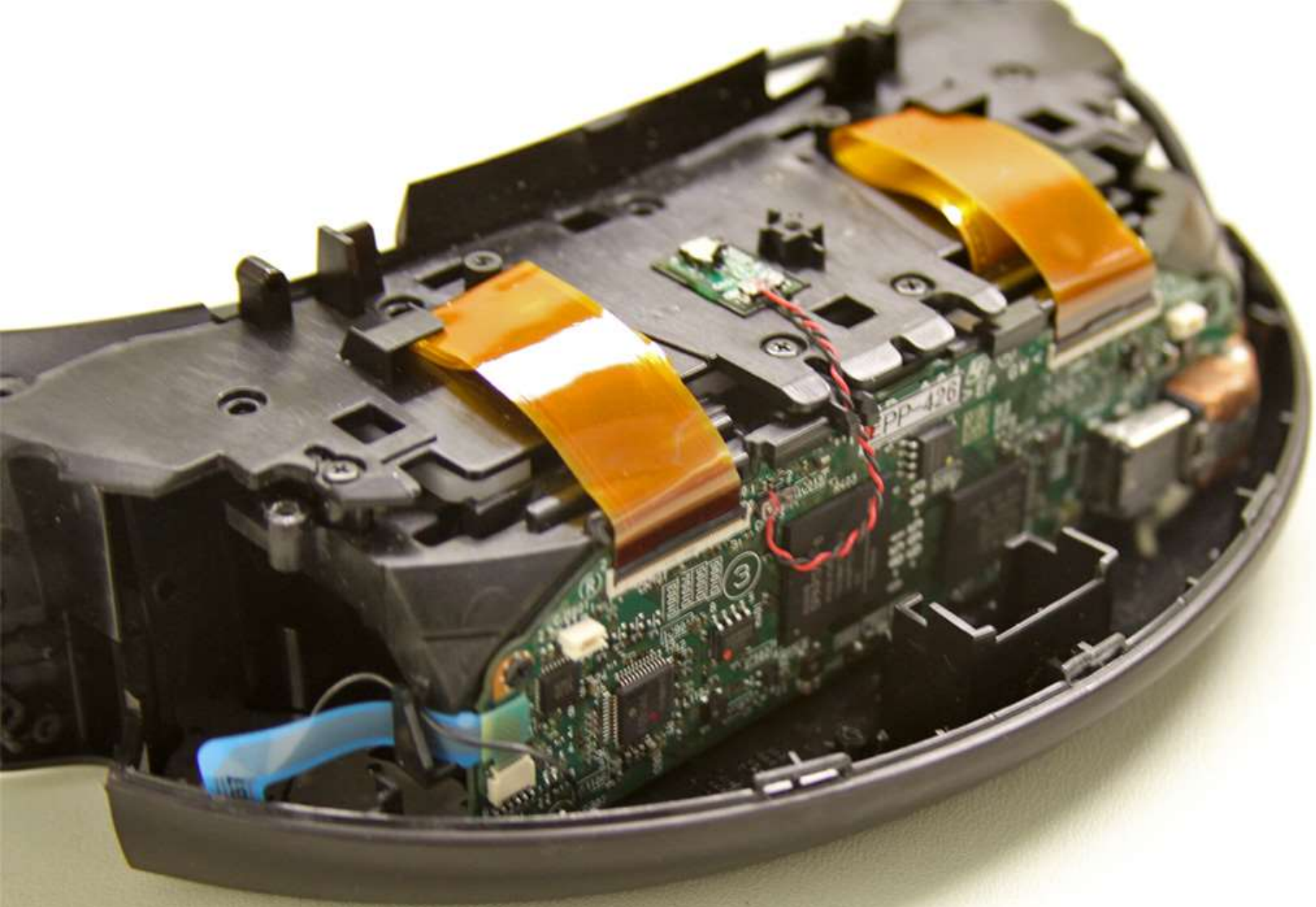


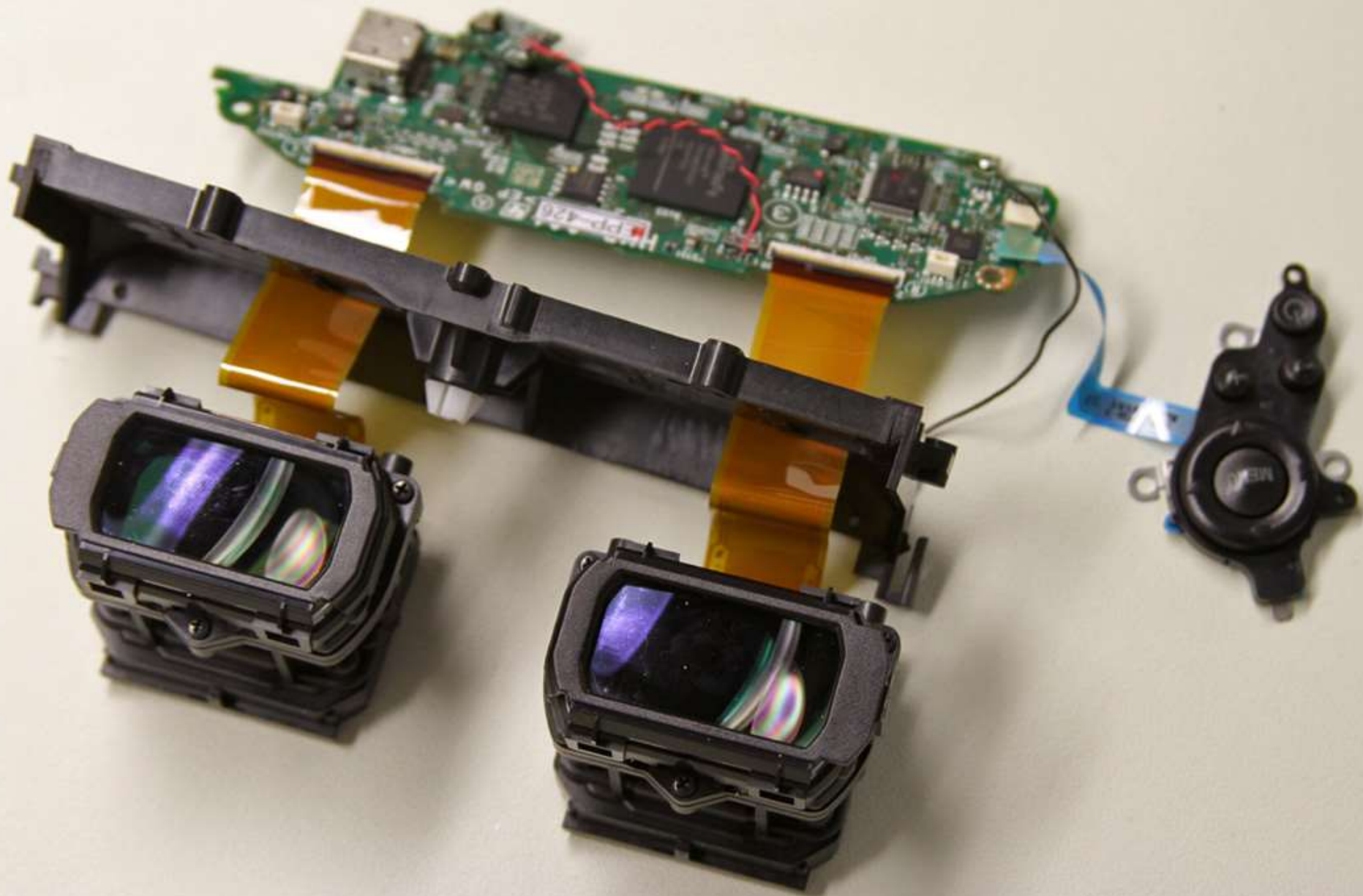


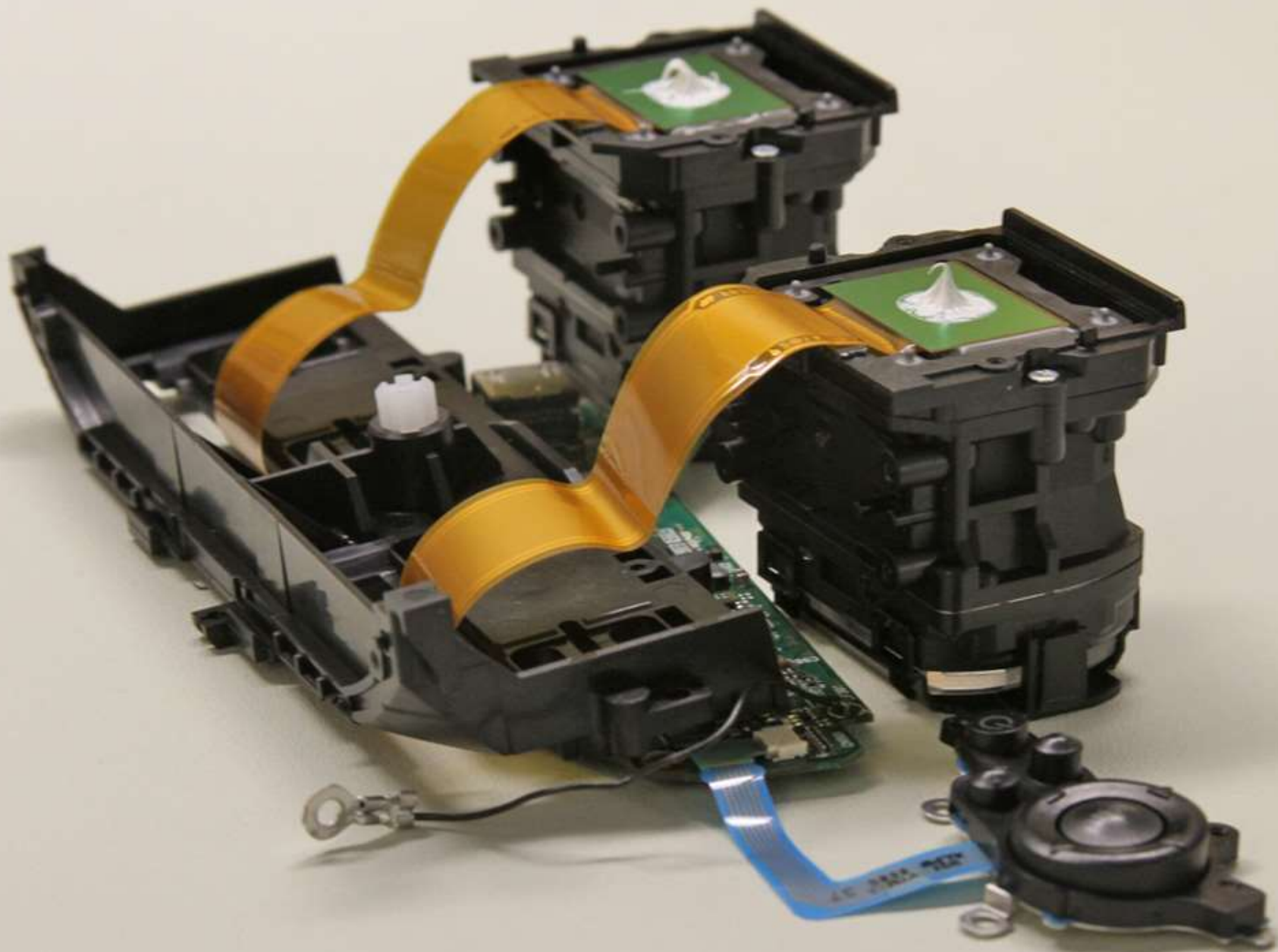
Binocular OLED-based Prototype Hardware Construction



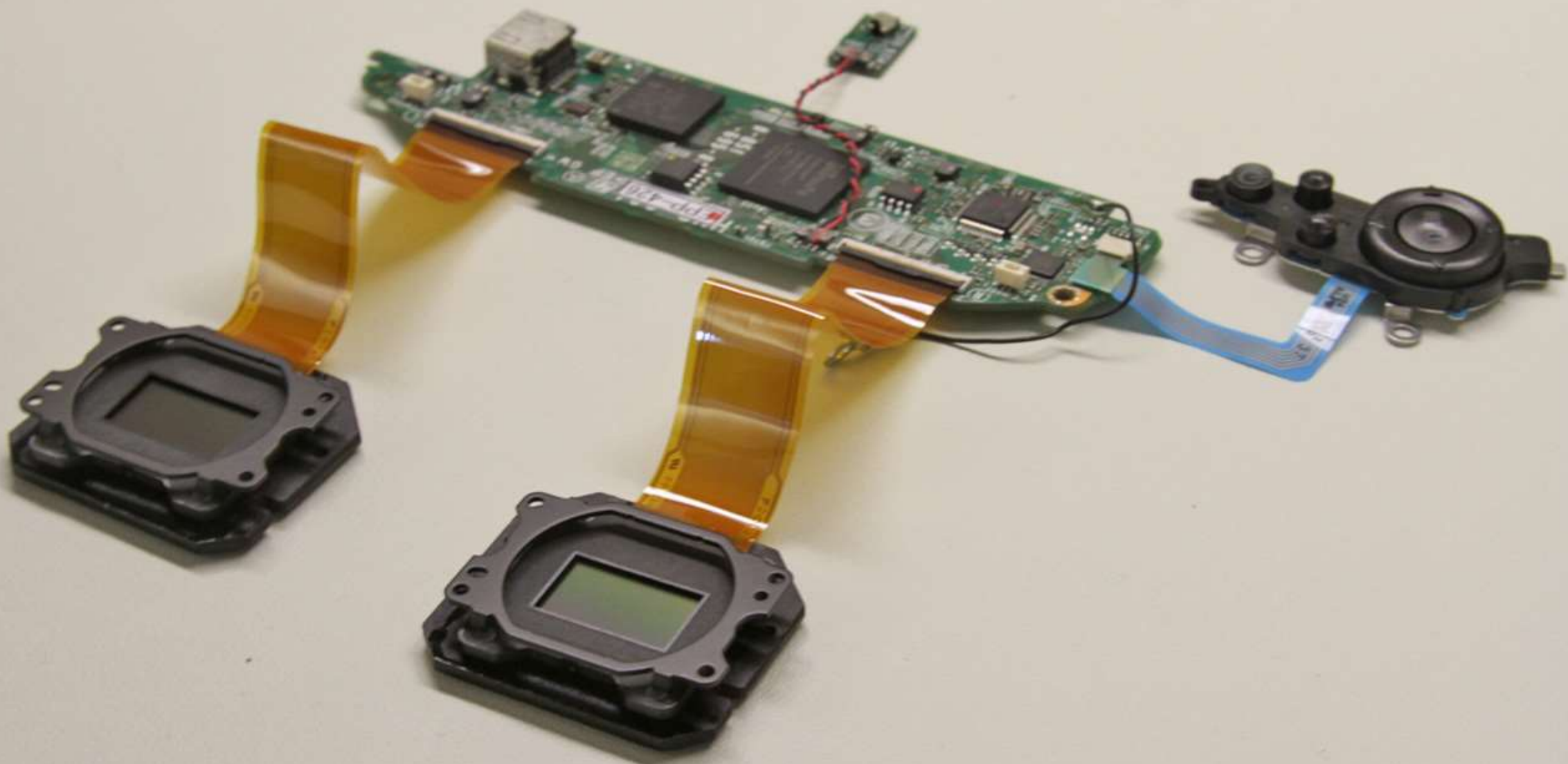




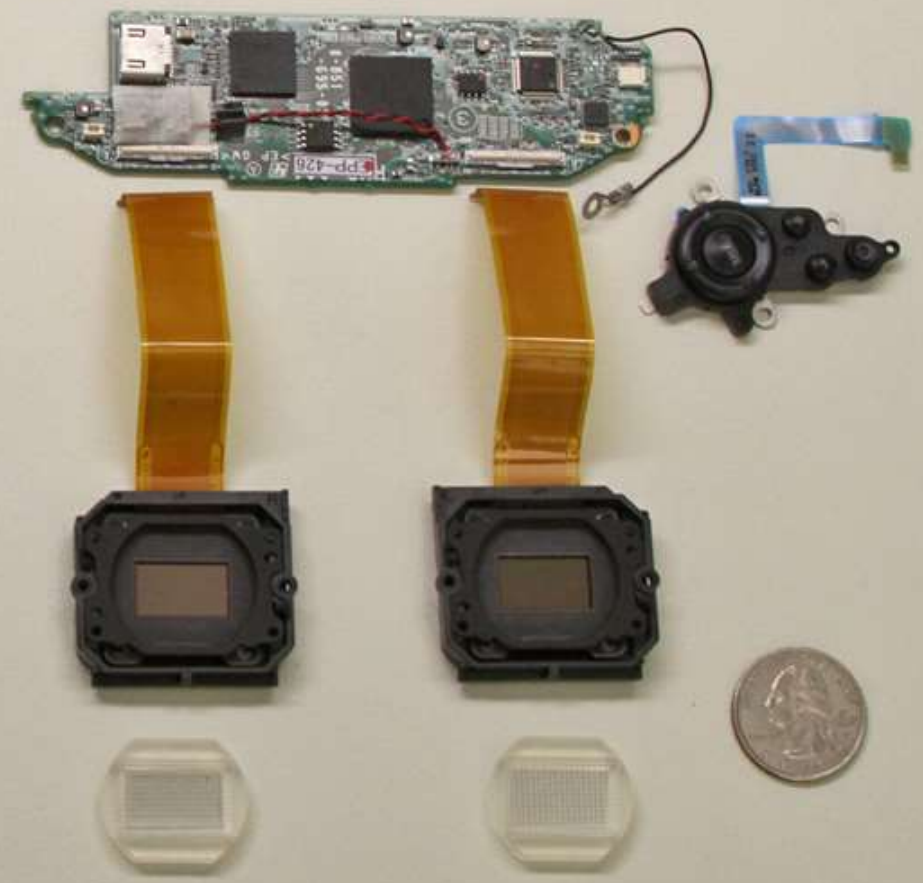


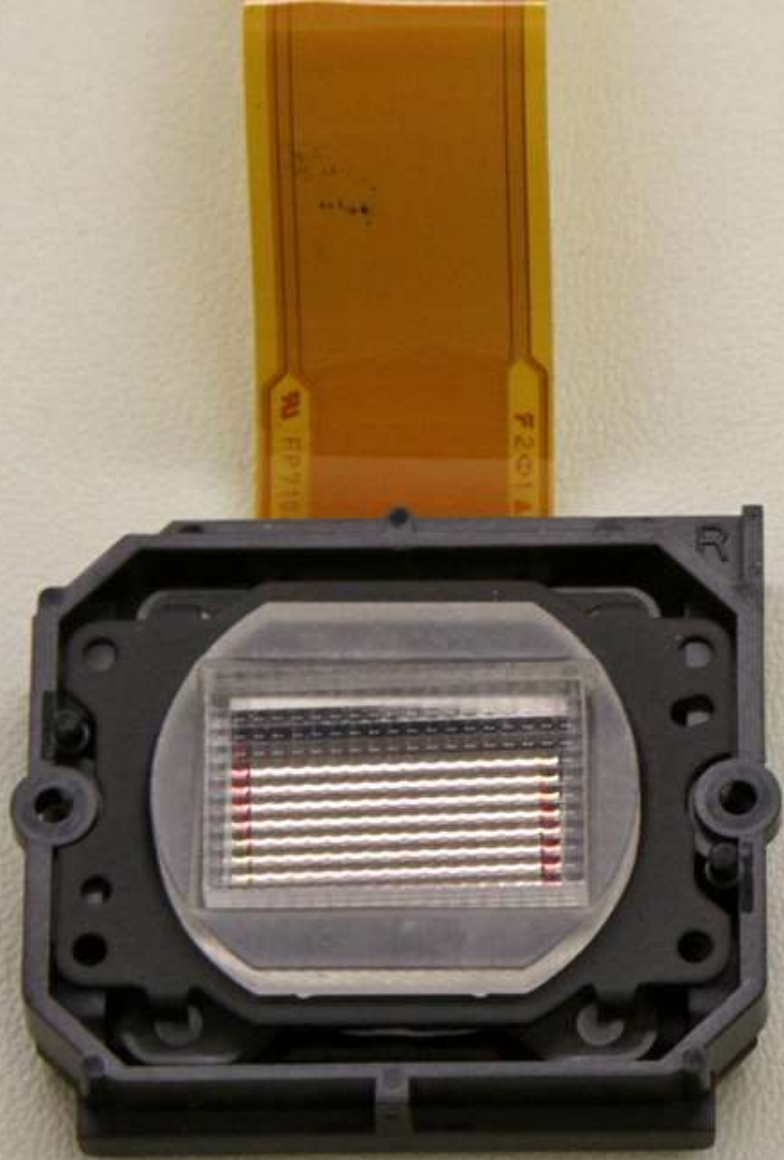


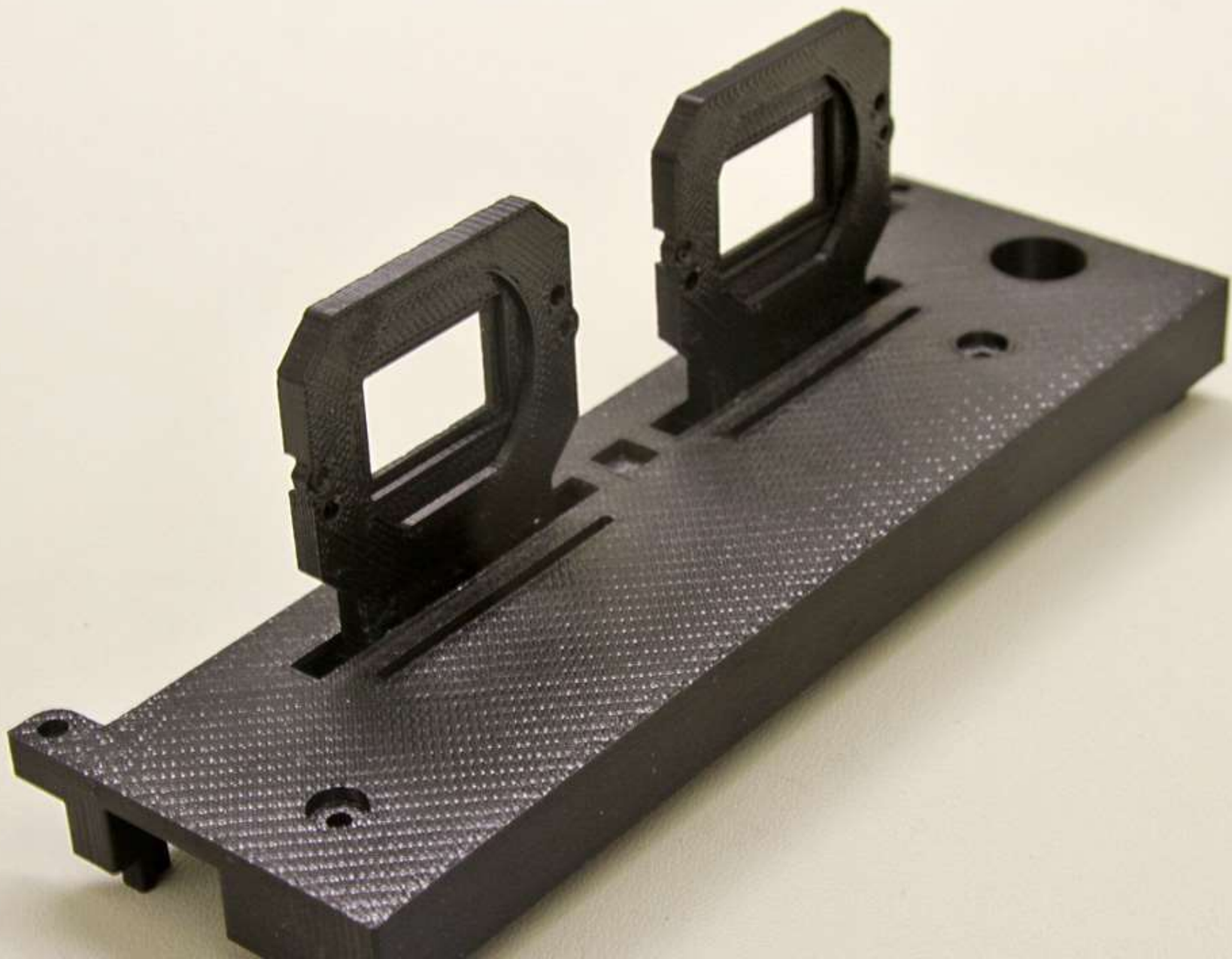


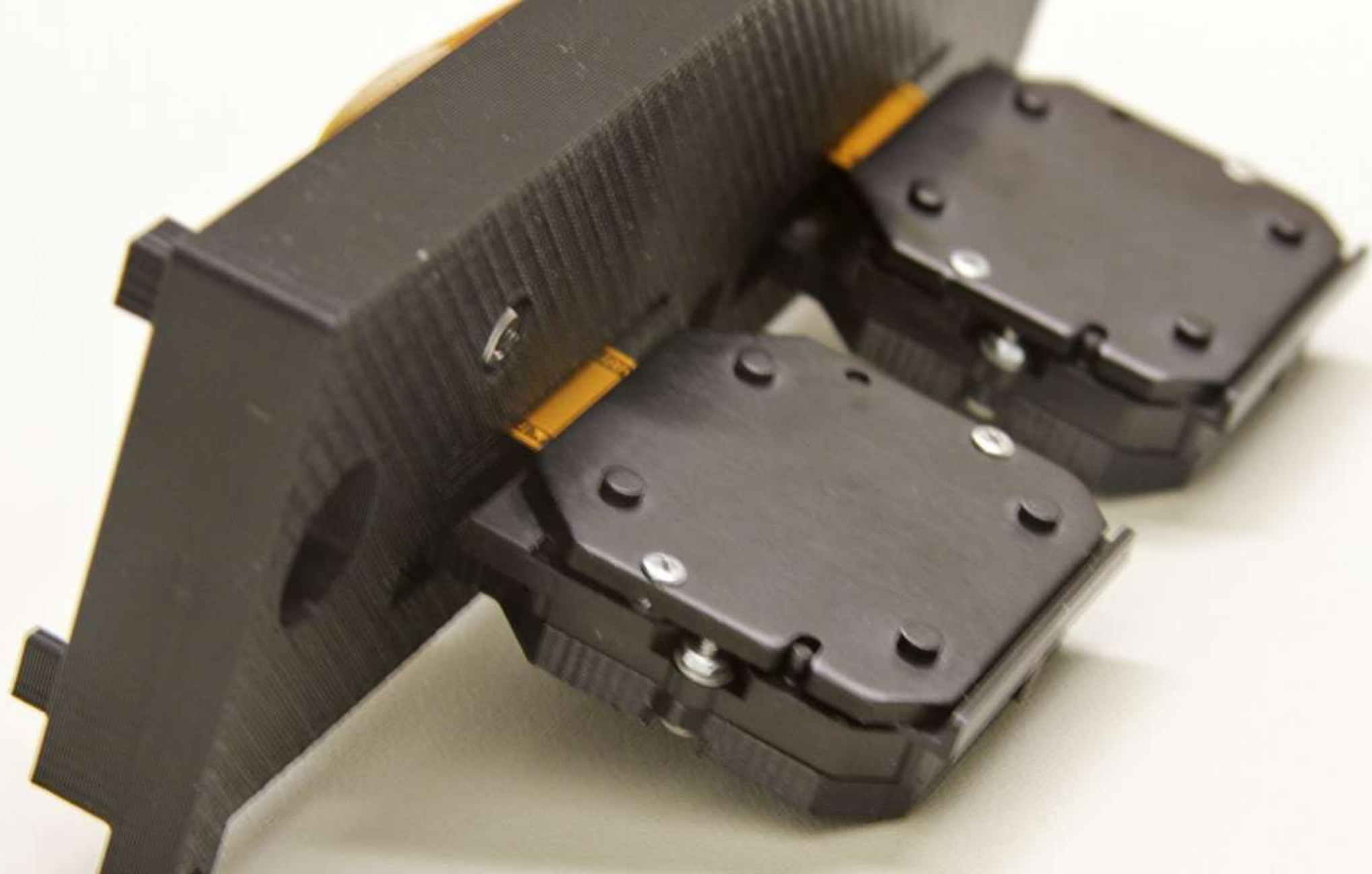


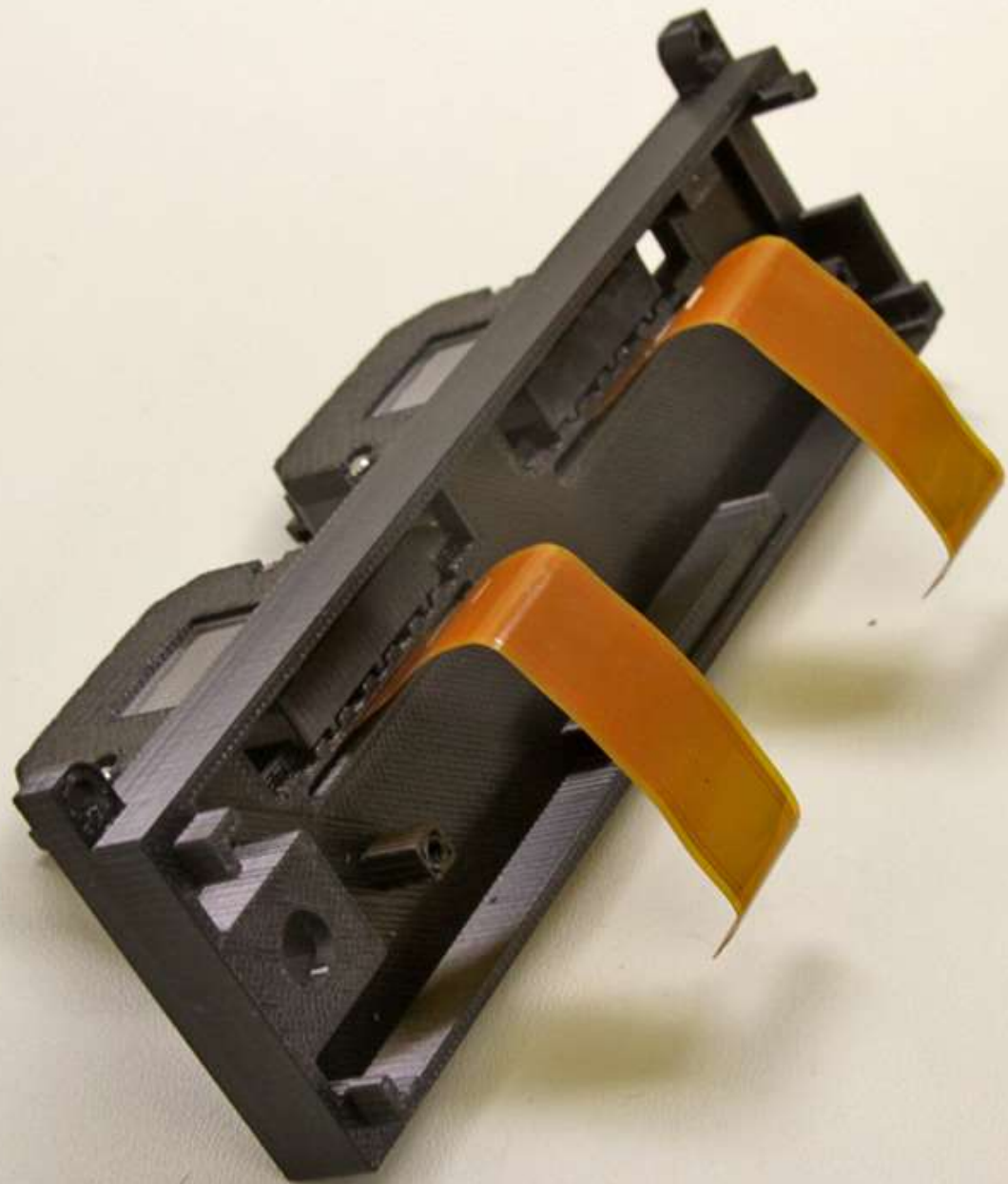






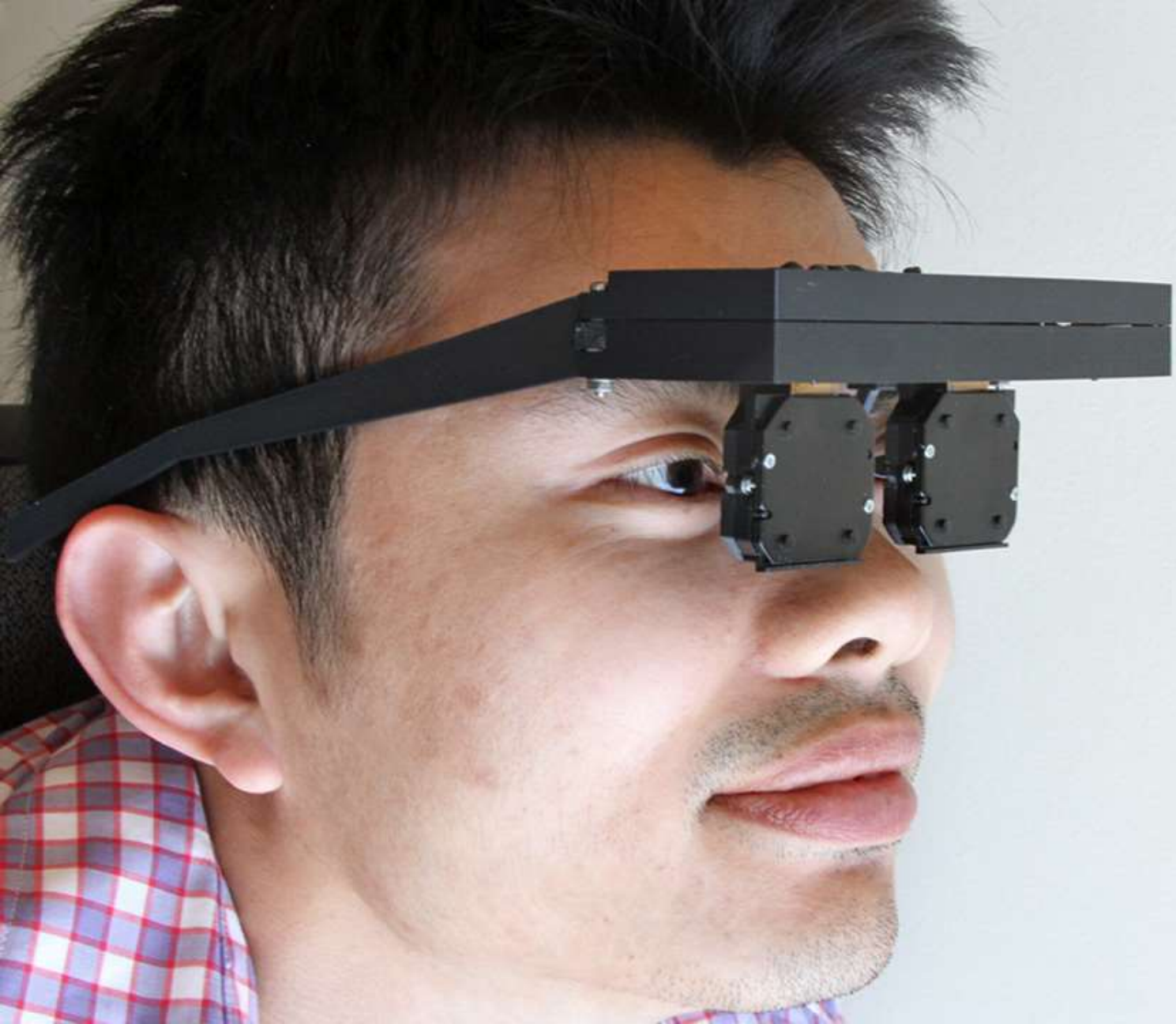


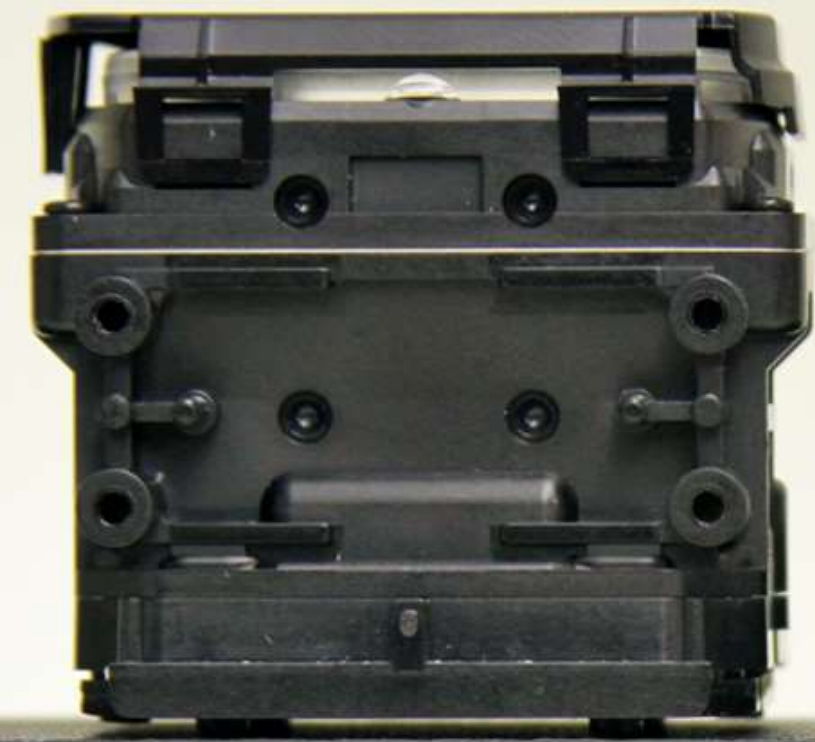




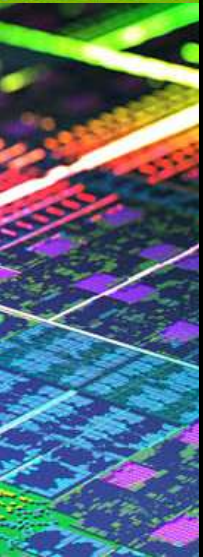




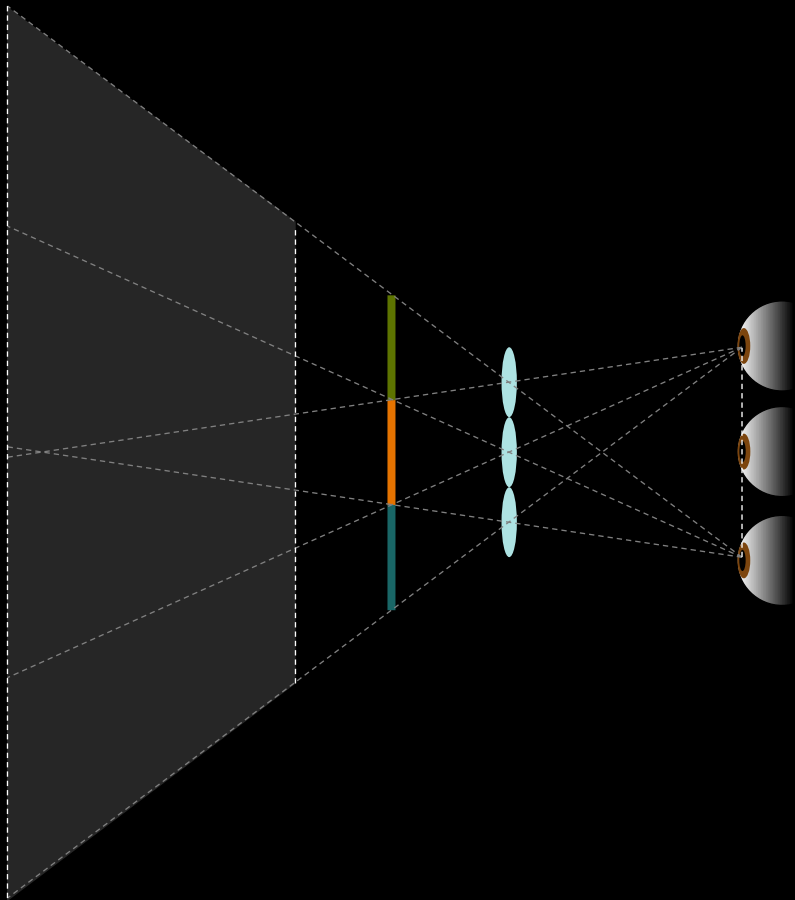




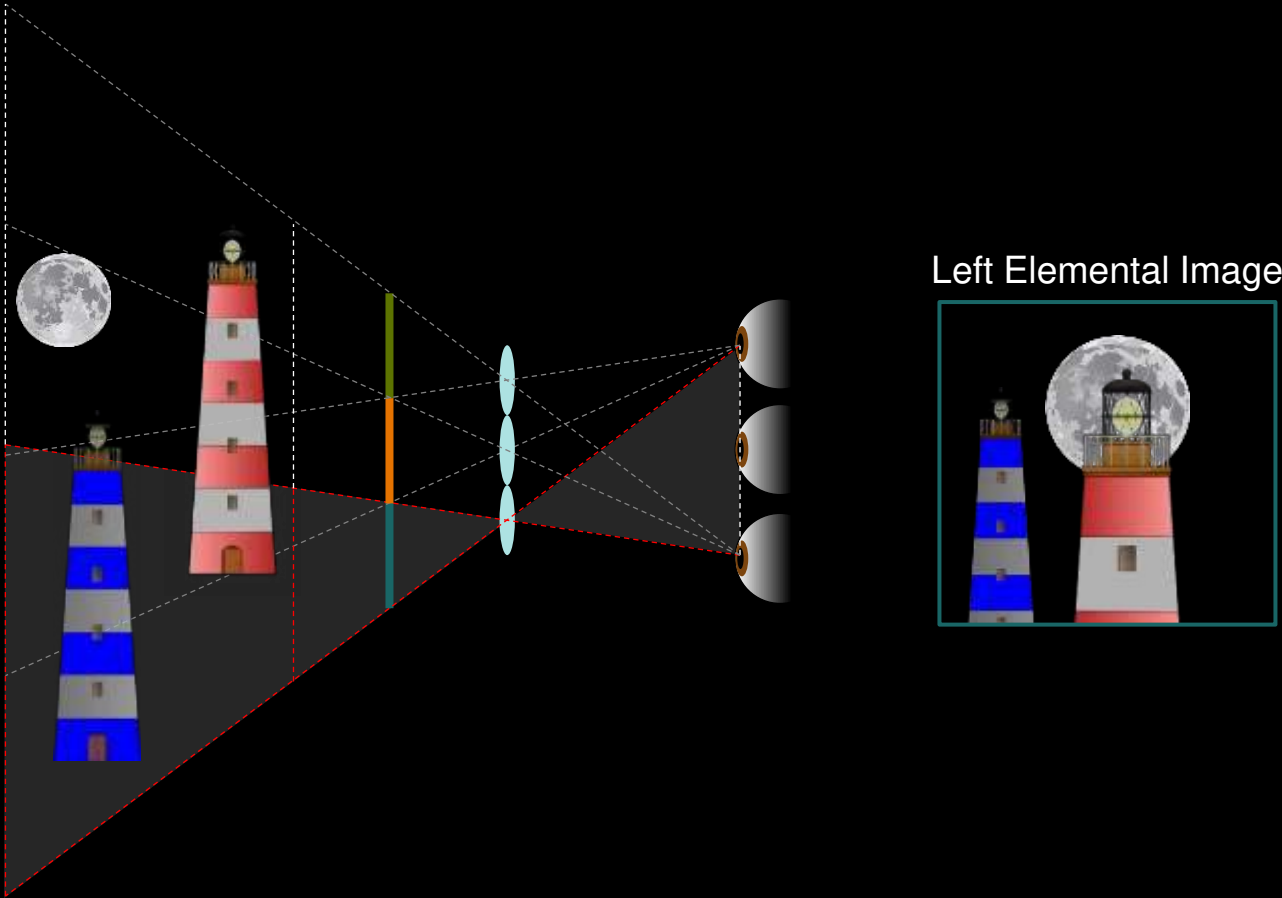
Binocular OLED-based Prototype Stereoscopic Light Field Rendering



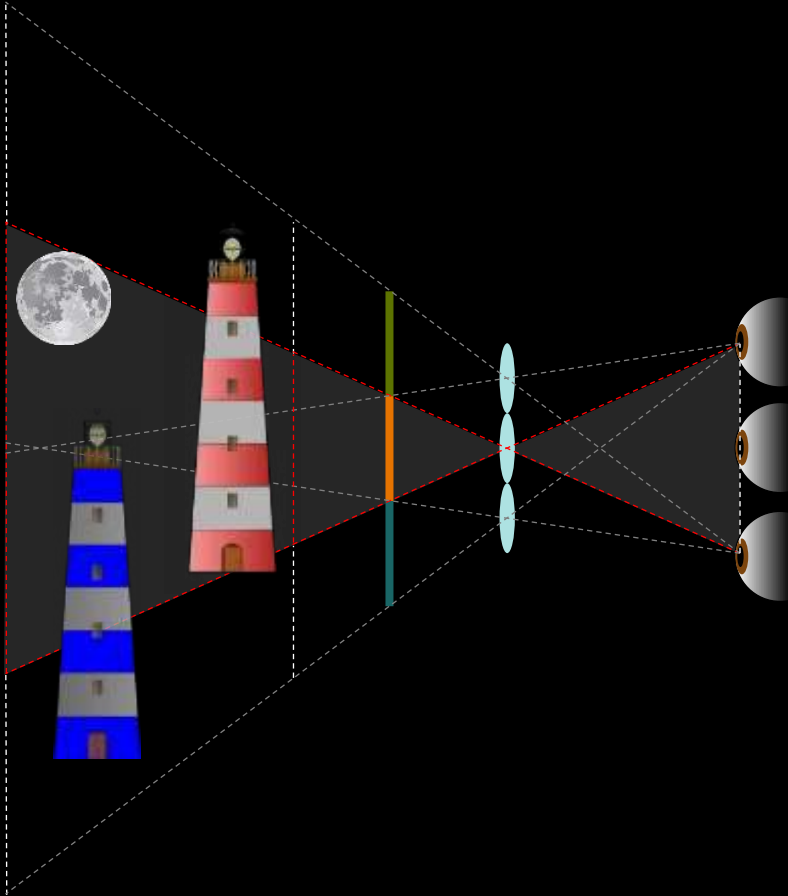
Near-Eye Light-Field Rendering



Rendering as Off-Axis Perspective Projections



Rendering as Off-Axis Perspective Projections



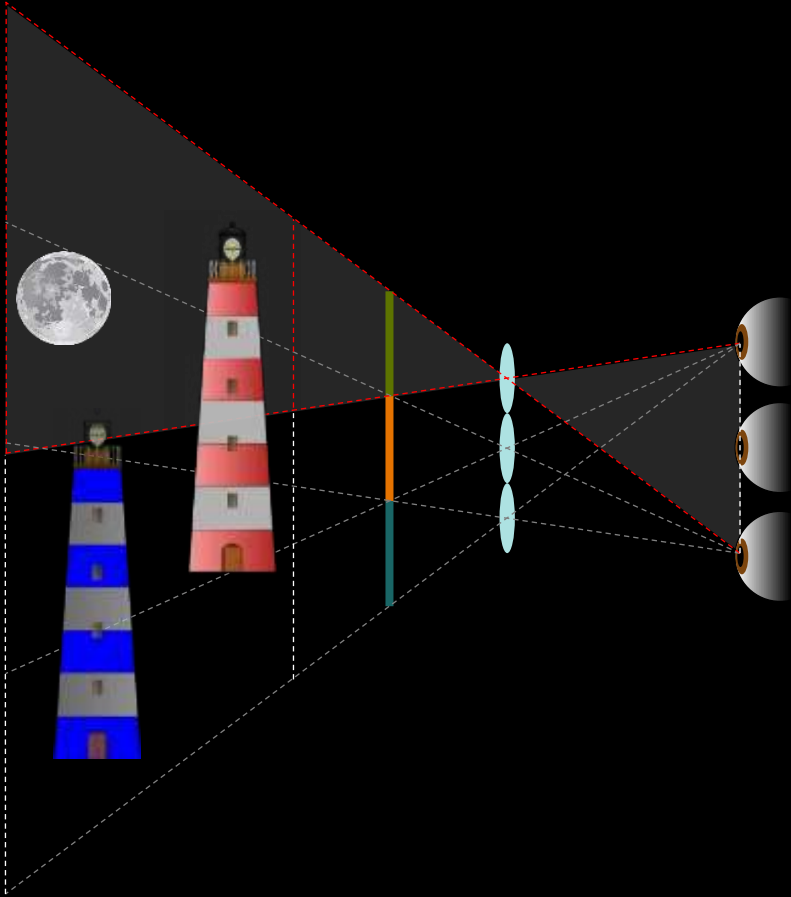
Left Elemental Image



Center Elemental Image



Rendering as Off-Axis Perspective Projections



Left Elemental Image



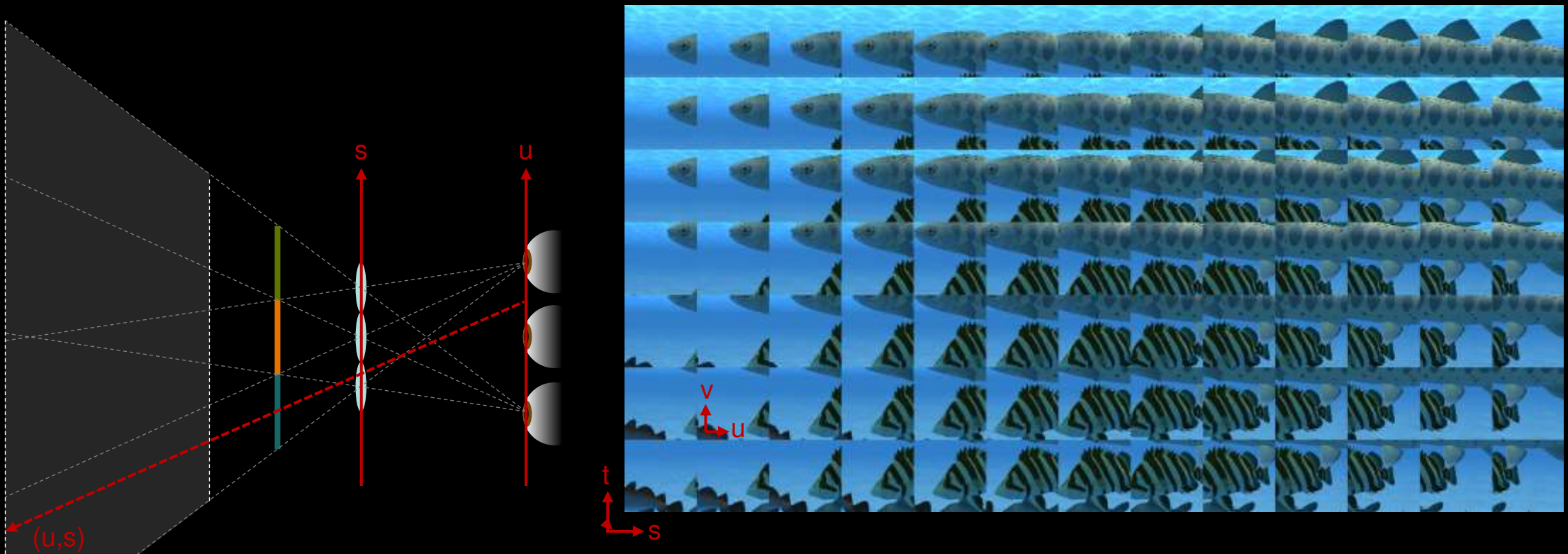
Center Elemental Image



Right Elemental Image



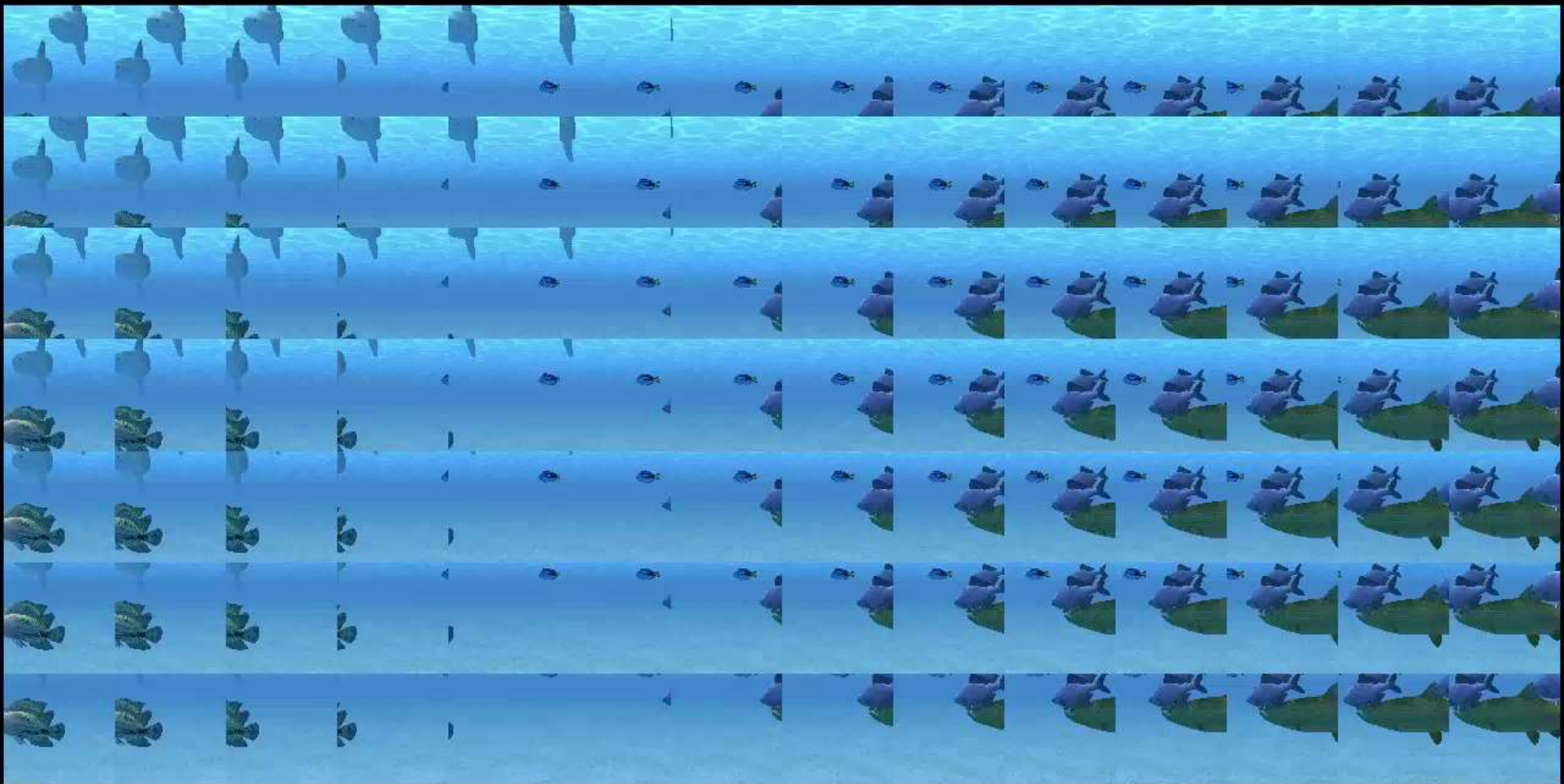
Ray Tracing for Near-Eye Light Fields



Real-Time Ray Tracing for Near-Eye Light Field Displays

- Implemented in NVIDIA OptiX SDK 3.0.0
- Added support for quad-buffered stereo
- Renders 1280×720 rays per eye (simulating 13×7 off-axis perspectives)
- Runs at 30 – 60 frames per second (GeForce GTX TITAN)
- Implemented interactive calibration to compensate for optical aberrations









Swimming Shark

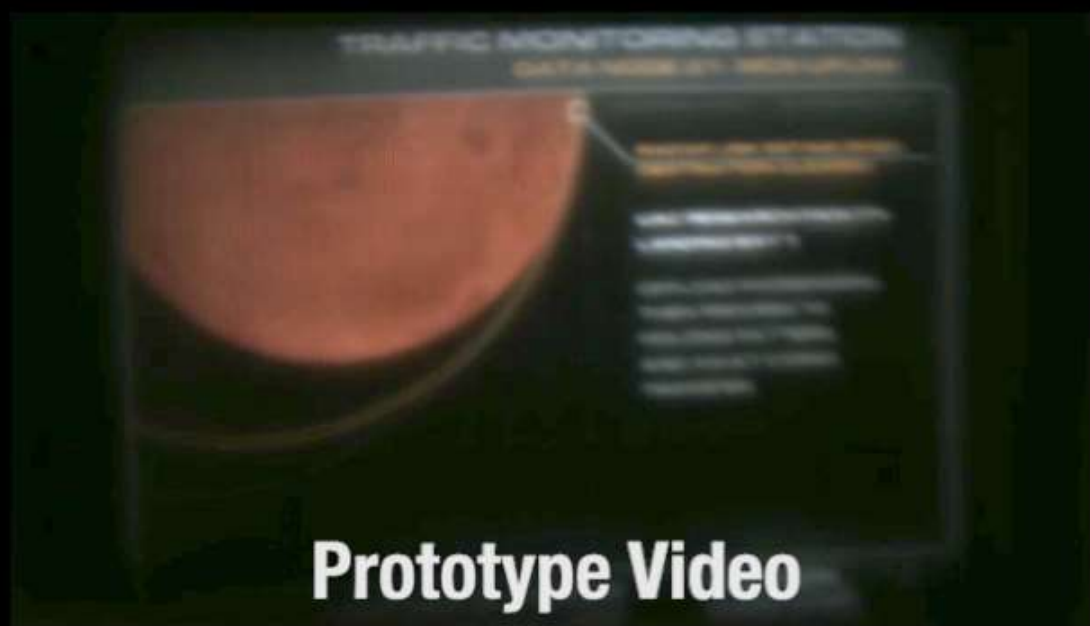
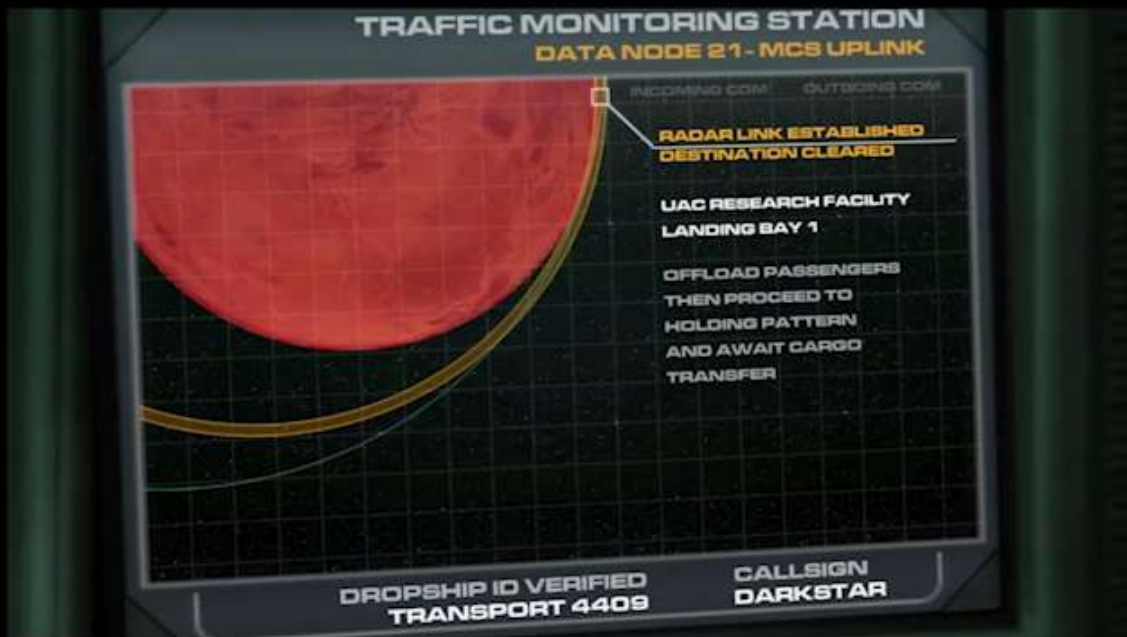


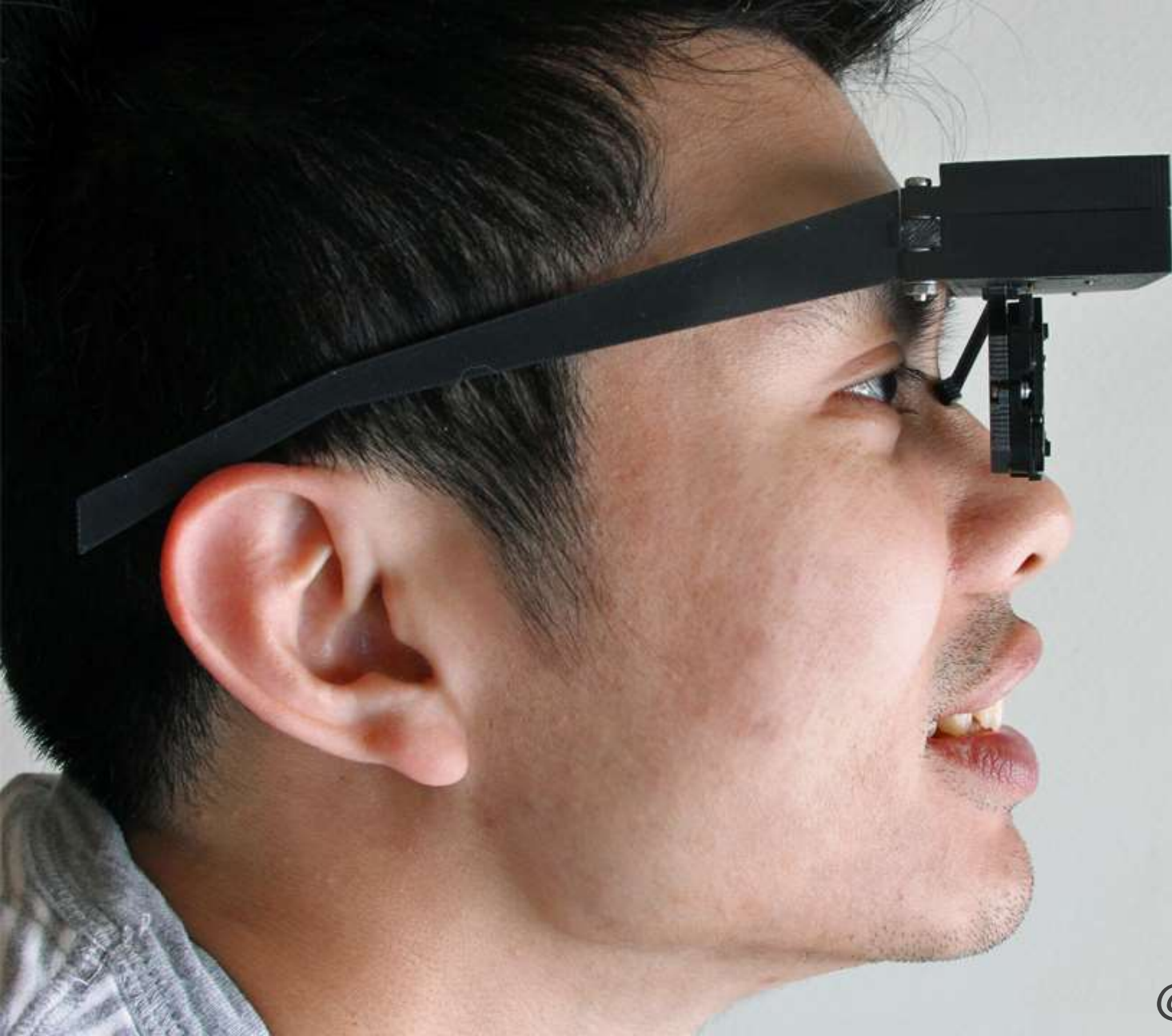
Model Viewer



Sports Car

Backward Compatibility Case Study: Resampling *Doom 3 BFG Edition*





Benefits

- **thin**
- **lightweight**
- **immersive** (wide fields of view)
- **comfortable**
- addresses accommodation-convergence conflict
- approximates retinal defocus cues
- no need for corrective eyewear

Limitations

- **reduced spatial resolution**
- high-resolution or tiled microdisplays
- careful microlens array selection
- **requires larger microdisplays**
- **requires user calibration**

#GTC2014

@douglaslanman @davedotluebke

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Realizing Practical Applications

