

HDR with Plenoptic 2.0 Camera

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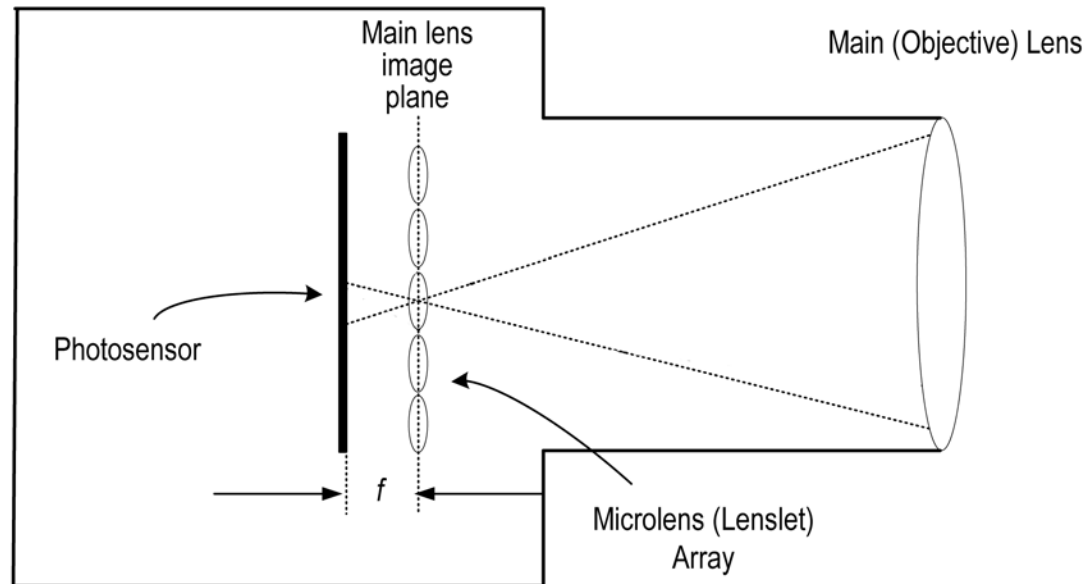
Overview

- ▶ Plenoptic cameras capture the 4D radiance
- ▶ Recently developed plenoptic camera 2.0 has significantly higher resolution than 1.0
It records a multiplicity of focused images
- ▶ We can sample the radiance function flexibly and in extended ways
 - ▶ Simultaneously sample with different apertures
- ▶ HDR with a single snapshot (i.e. dynamic scenes)

Plenoptic Camera, Adelson 1992

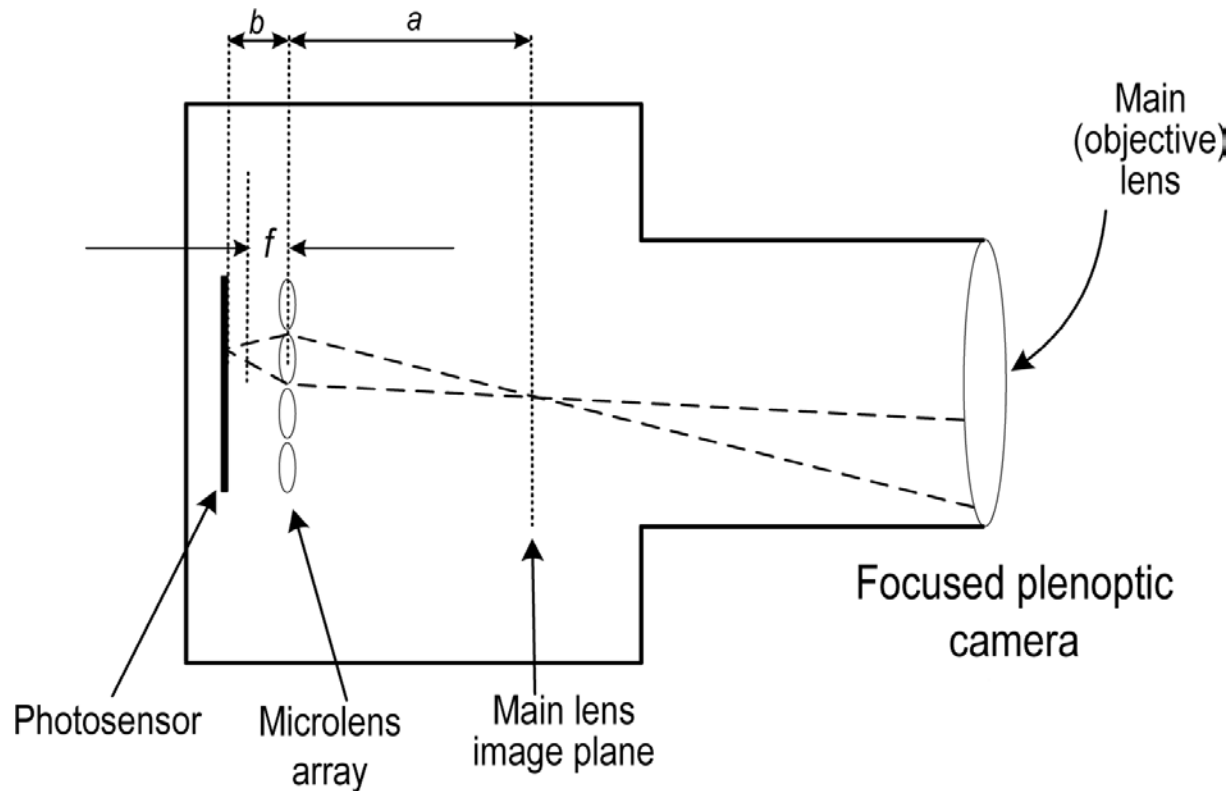
- ▶ Main lens focused on microlenses

Conventional plenoptic camera



Focused Plenoptic Camera

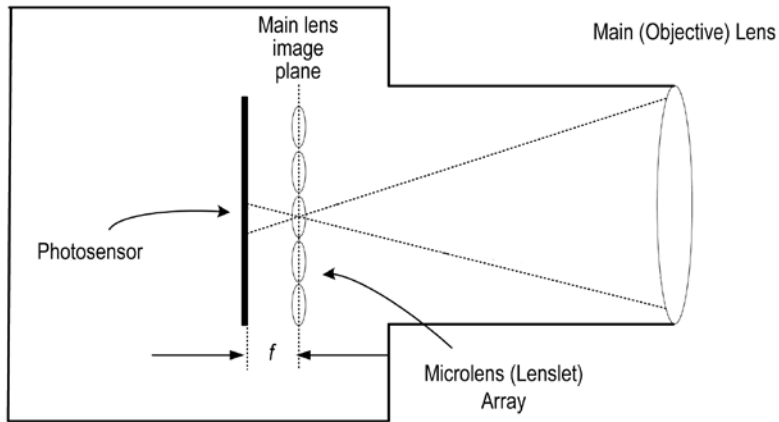
- ▶ Microlenses focused on main lens image



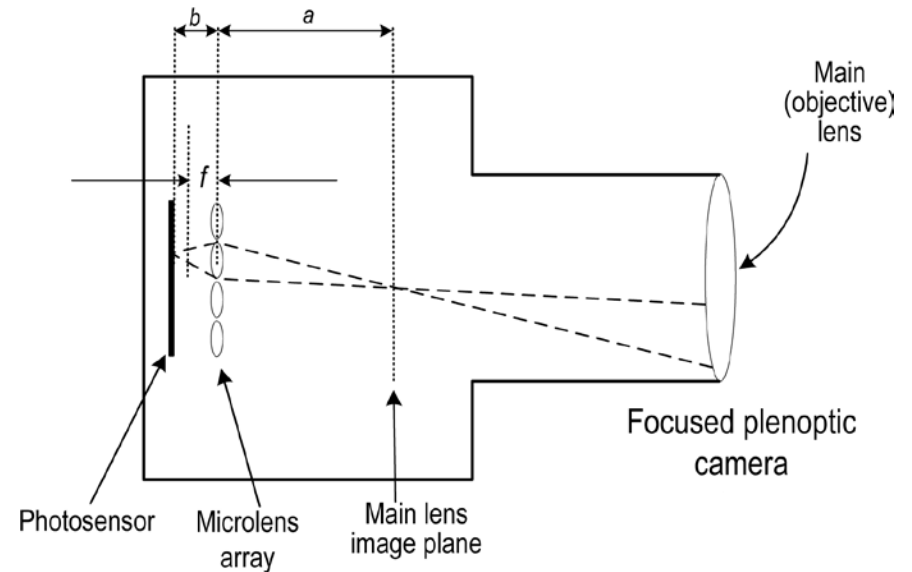
Comparison

▶ Plenoptic Camera (1.0)

Conventional plenoptic camera

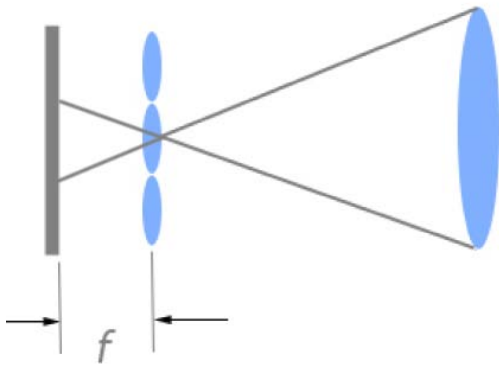


▶ Focused Plenoptic Camera (2.0)



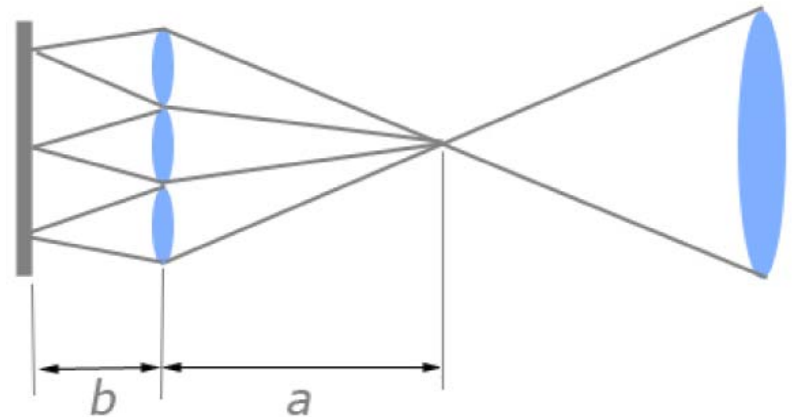
Comparison

▶ Plenoptic Camera



Microlenses focused at infinity.
Completely defocused relative
to main lens image.

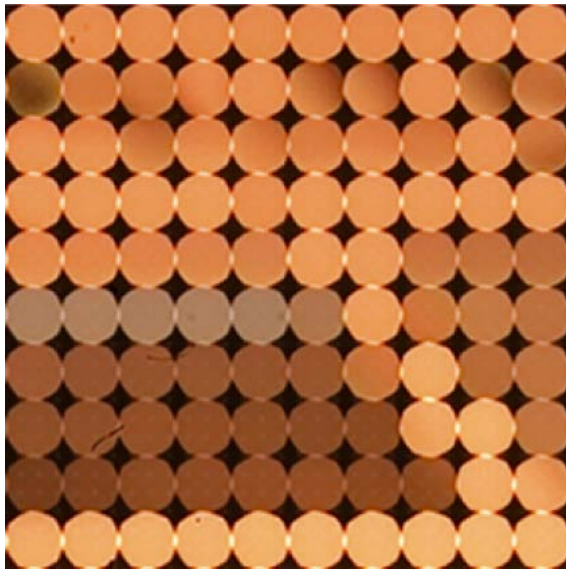
▶ Focused Plenoptic Camera



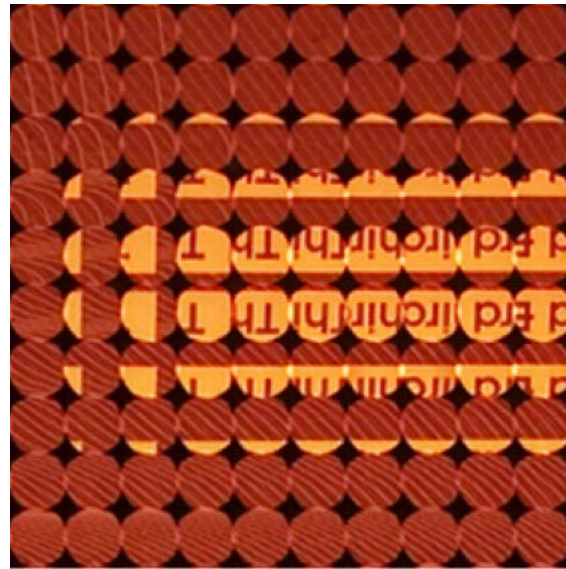
Microlenses satisfy the lens
equation. Exactly focused on
the main lens image.

Comparison

- ▶ Plenoptic Camera
Blurry microimages

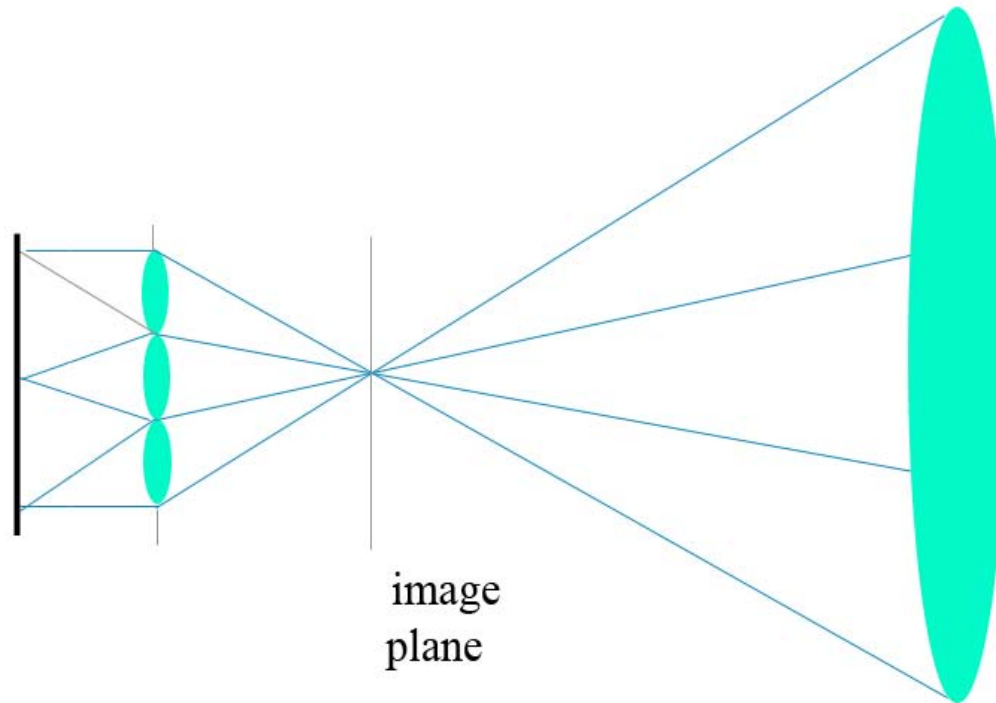


- ▶ Focused Plenoptic Camera
Sharp and inverted microimages



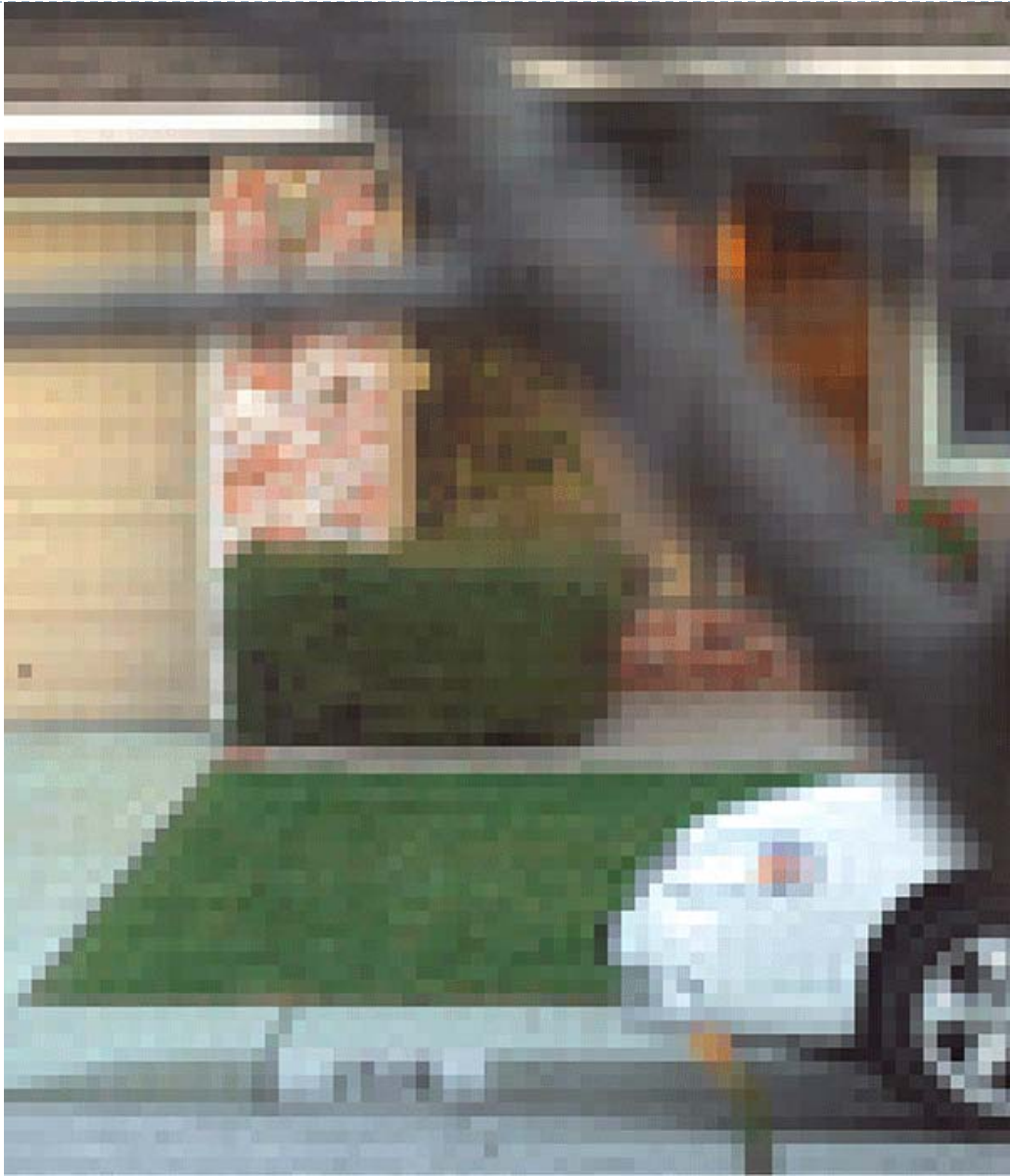
Why inverted images?

- ▶ Simple relay imaging! This is like a telescope with multiple eyepieces.





Lightfield Rendering Small Part of a Scene





Plenoptic 2.0 Rendering: 500X Improvement!





Plenoptic 2.0 Refocusing





Plenoptic 2.0 Refocusing



Plenoptic 2.0 Refocusing

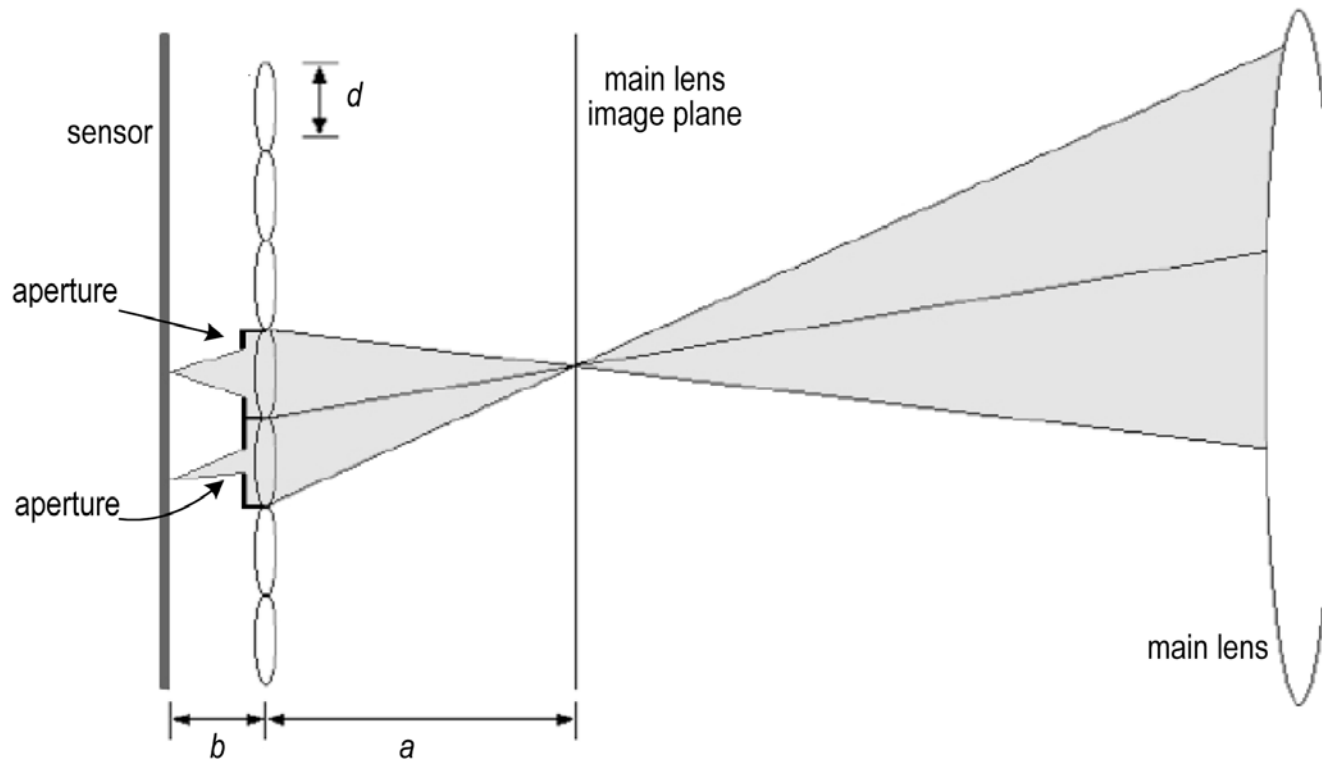




Plenoptic 2.0 HDR

HDR with Plenoptic Camera 2.0

- ▶ Each point is seen multiple times in different microlenses
- ▶ We put different apertures on different microlenses





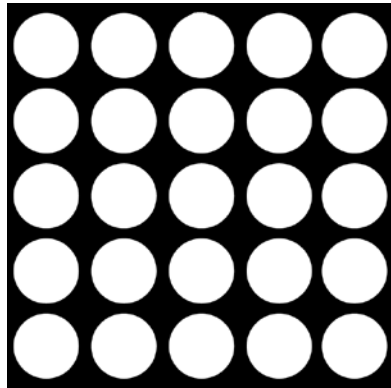
Apertures for Plenoptic Camera 2.0

- ▶ Microlenses are diffraction limited.
- ▶ Apertures should have low F-number to eliminate excessive diffraction blur.
- ▶ The big apertures should match F-number of main lens.
- ▶ Ratio of areas should be > 2 .
- ▶ It would be nice to have more than 2 interleaved apertures.

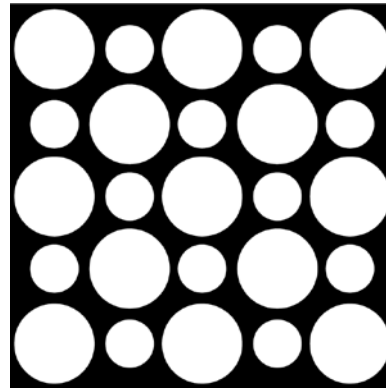
- ▶ Focal length of microlenses 1.5mm due to cover glass.
- ▶ Microimages 500 microns correspond to F/3.
- ▶ Pixels 6.8 microns

Apertures for Plenoptic Camera 2.0

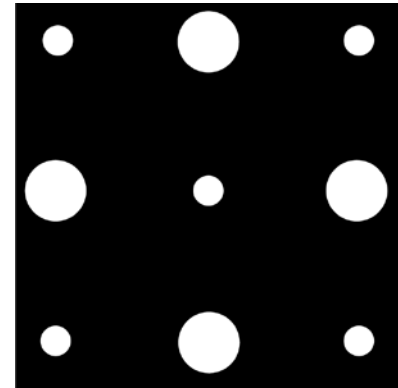
- ▶ We considered different apertures, that would be practical:



1



2

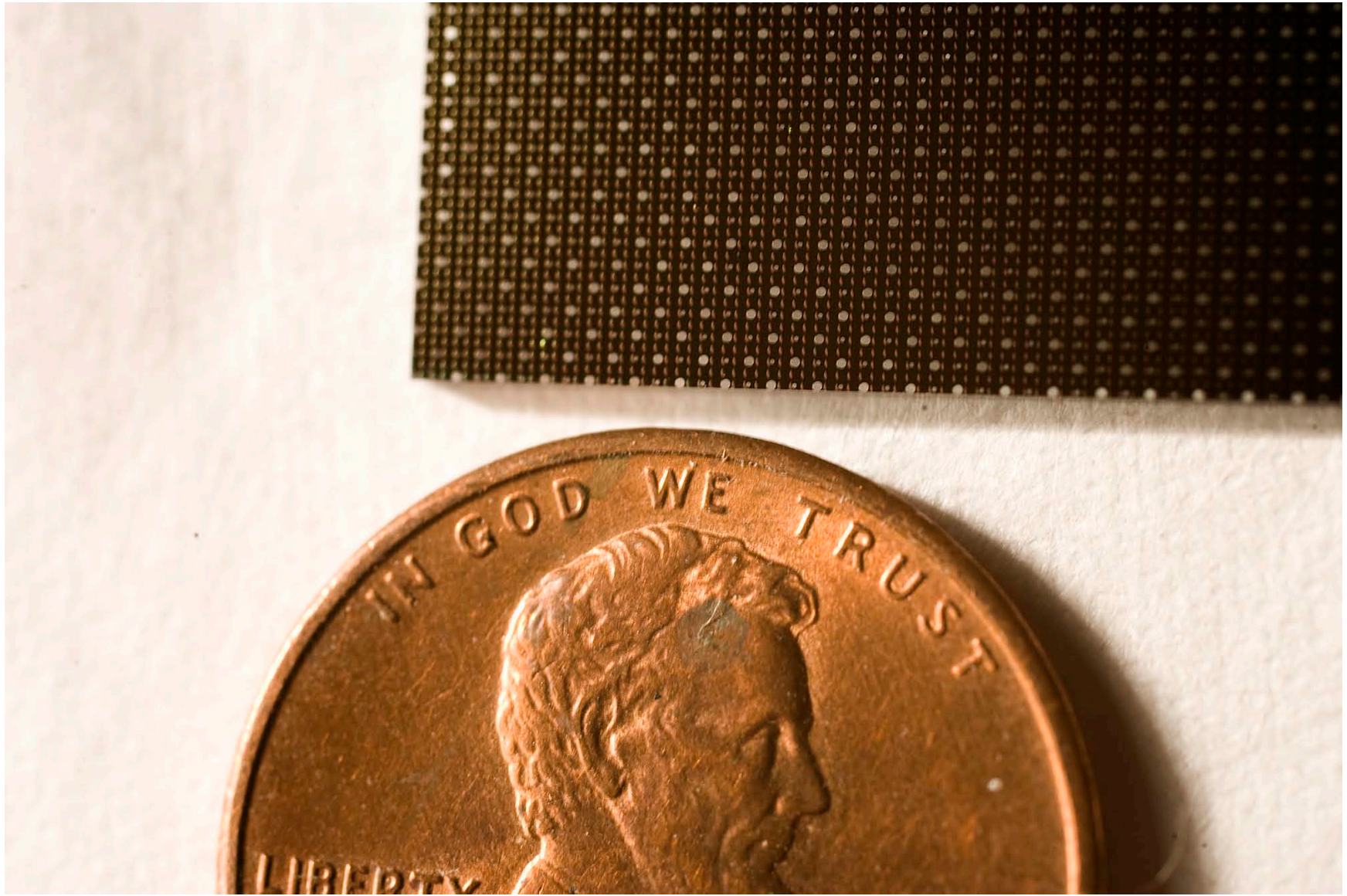


3

- ▶ Our microlens array (choice 3) with black chromium apertures manufactured by **Leister Axetris**, Dec. 2008
100 and 200 micron apertures, separated by 500 microns

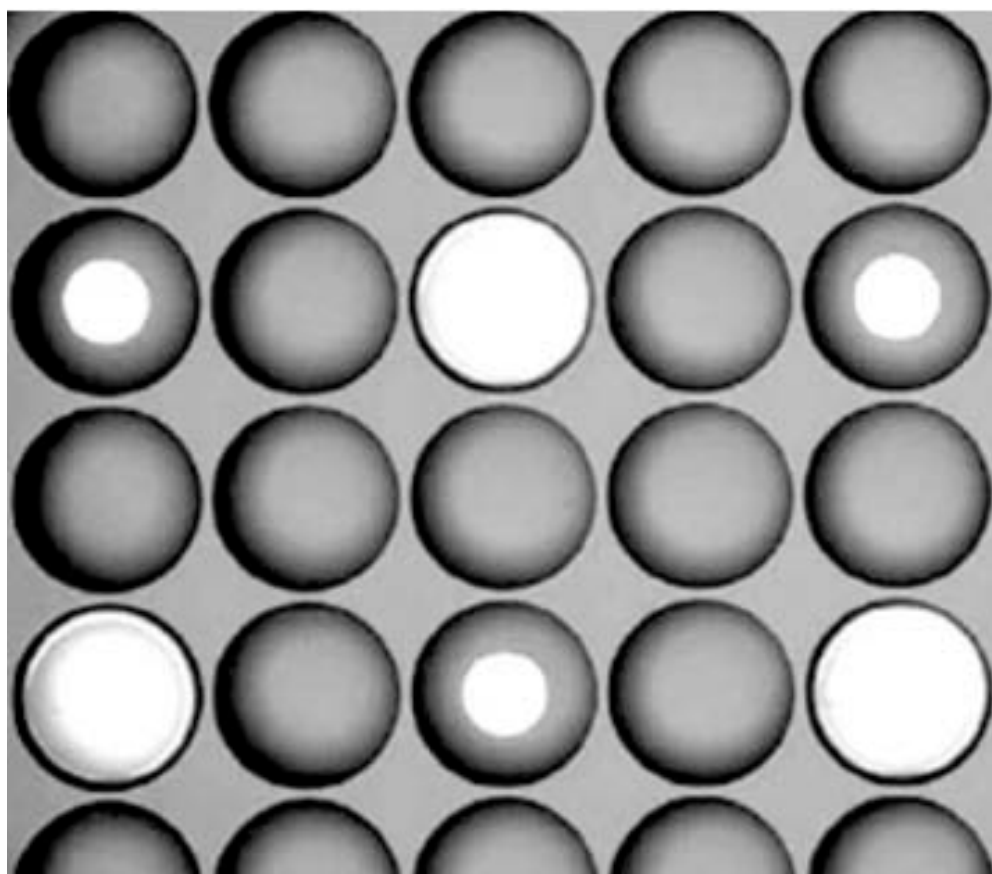
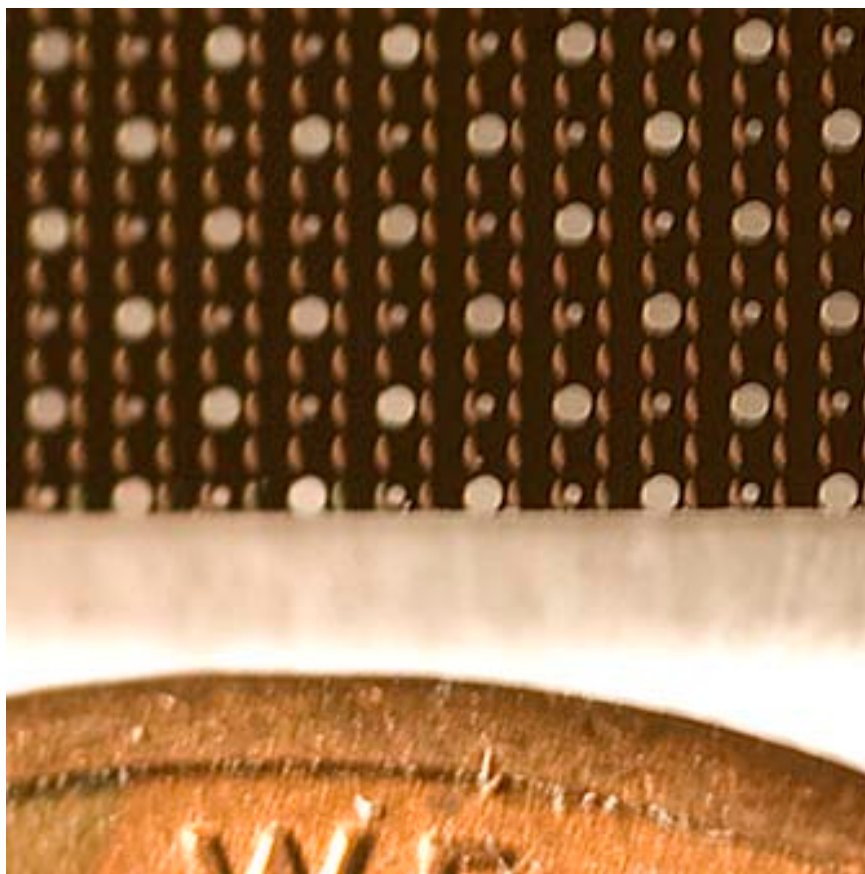


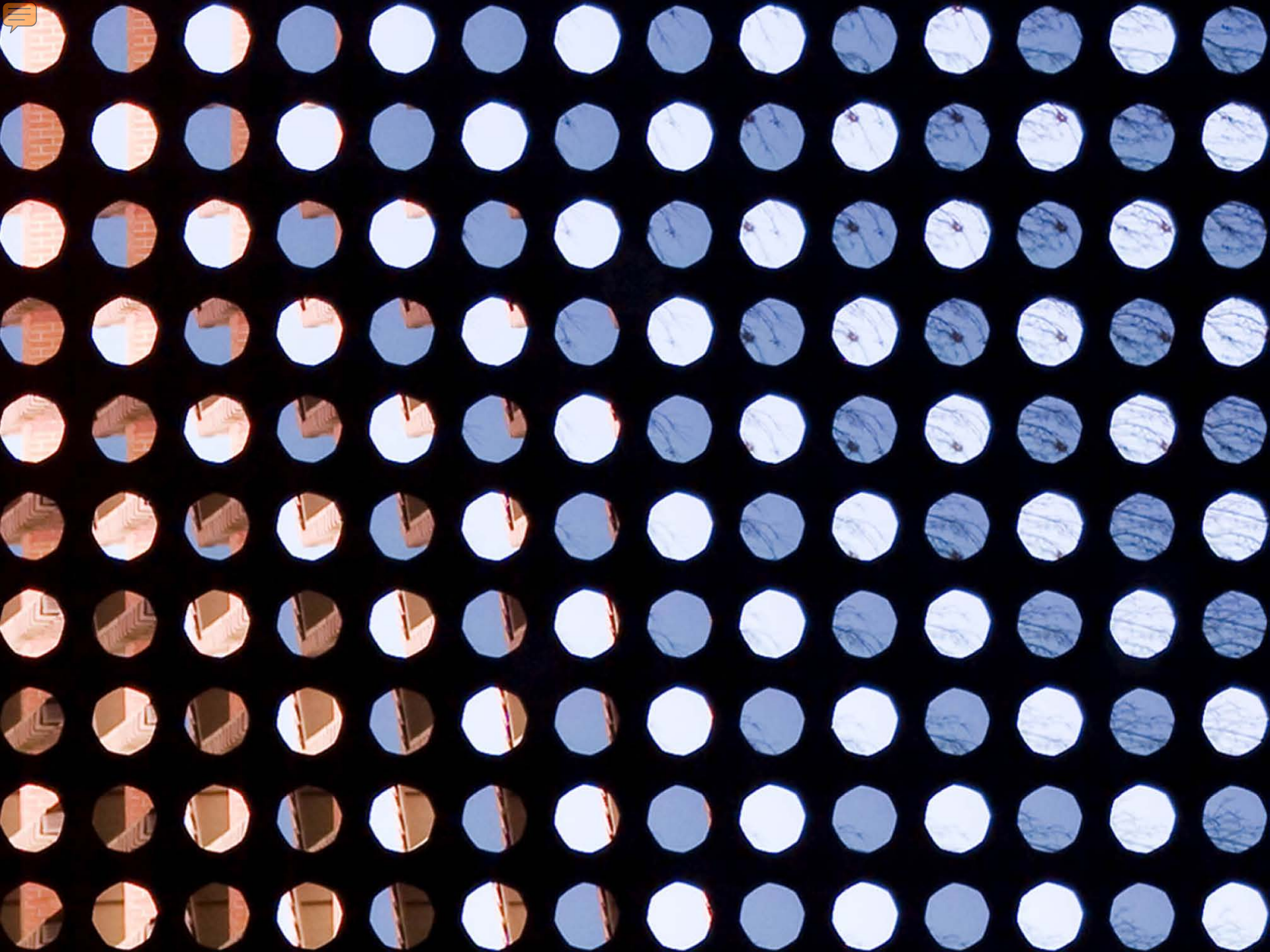
Interleaved Apertures for Plenoptic 2.0





Interleaved Apertures for Plenoptic 2.0



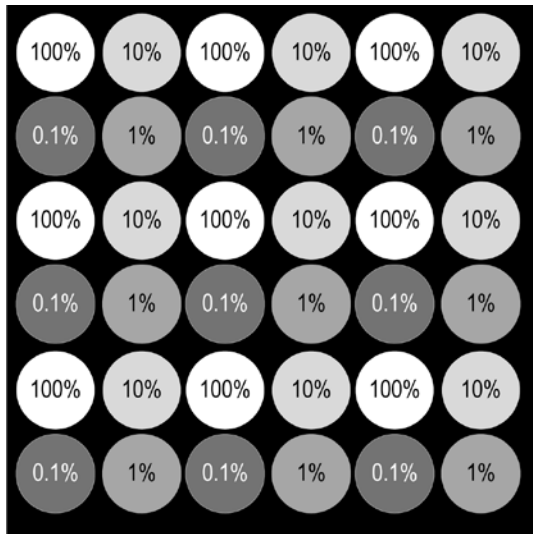




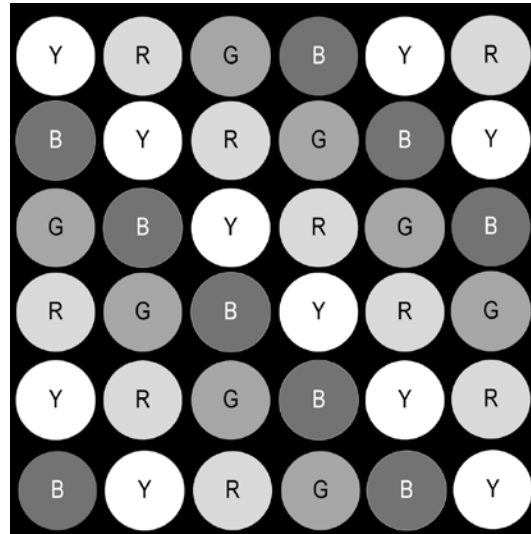


HDR with Plenoptic Camera 2.0

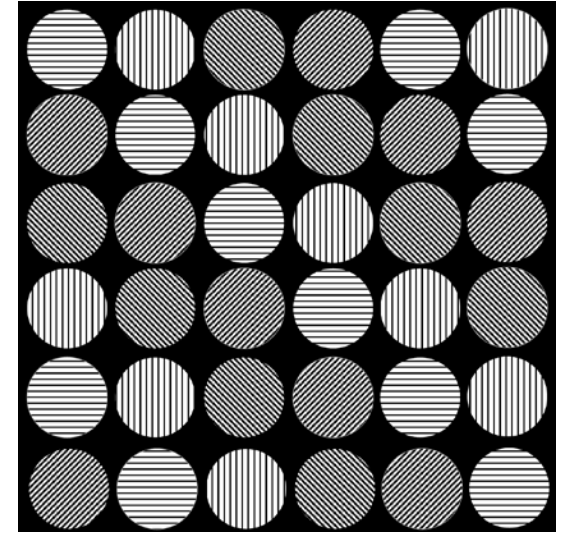
- ▶ We can put different filters on different microlenses: Neutral density, color (for spectral imaging), polarization.



1000 X increase
in dynamic range



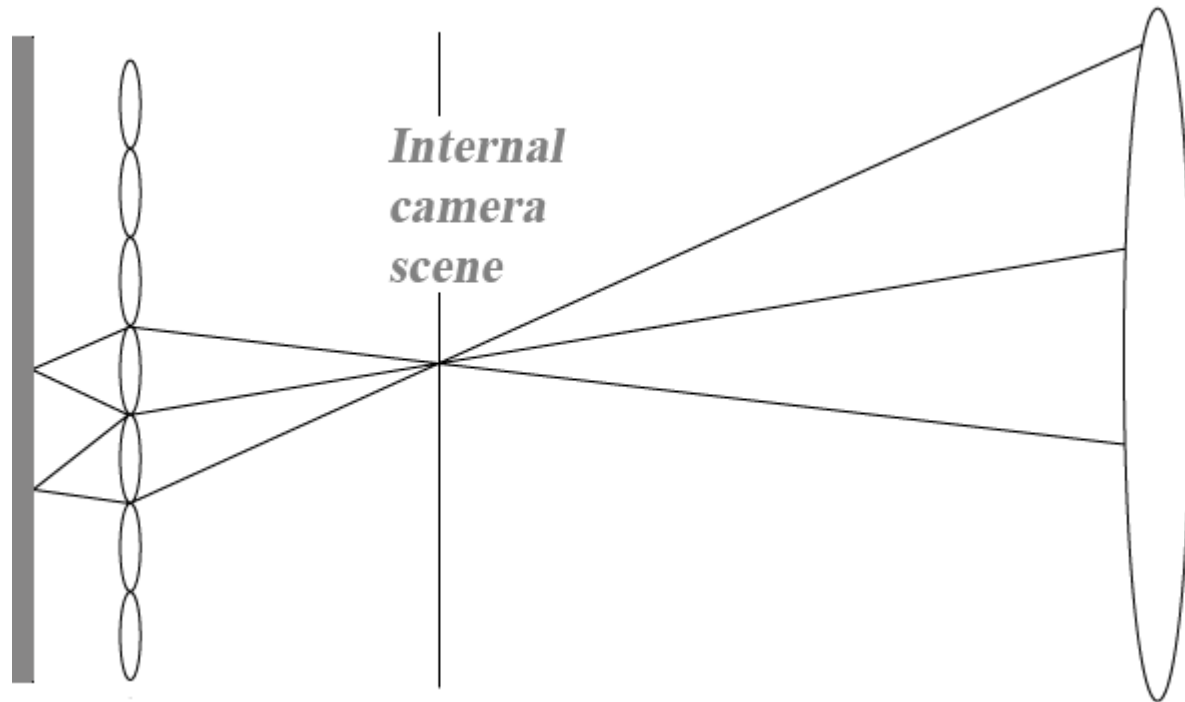
12-color imaging
with RGB sensor



sampling four
linear polarizations

Superresolution with Plenoptic 2.0 Camera

- ▶ Each microlens is observing the scene as a slightly shifted camera. We can compute the subpixel shift based on camera parameters. Then, superresolve.





Plenoptic 2.0 HDR

- ▶ Plenoptic 2.0 sampling is more flexible:
 - ▶ Decouples resolution from number of microlenses
 - ▶ Allows radiance to be sampled more flexibly
 - ▶ Precise alignment between neighboring images & superres.
- ▶ Varying apertures in the microlens array allows simultaneous capture of the scene at different f-stops
- ▶ High Dynamic Range can be captured in a single snapshot (dynamic scenes can be captured)

The End

