Dynamically Reparameterized Light Fields

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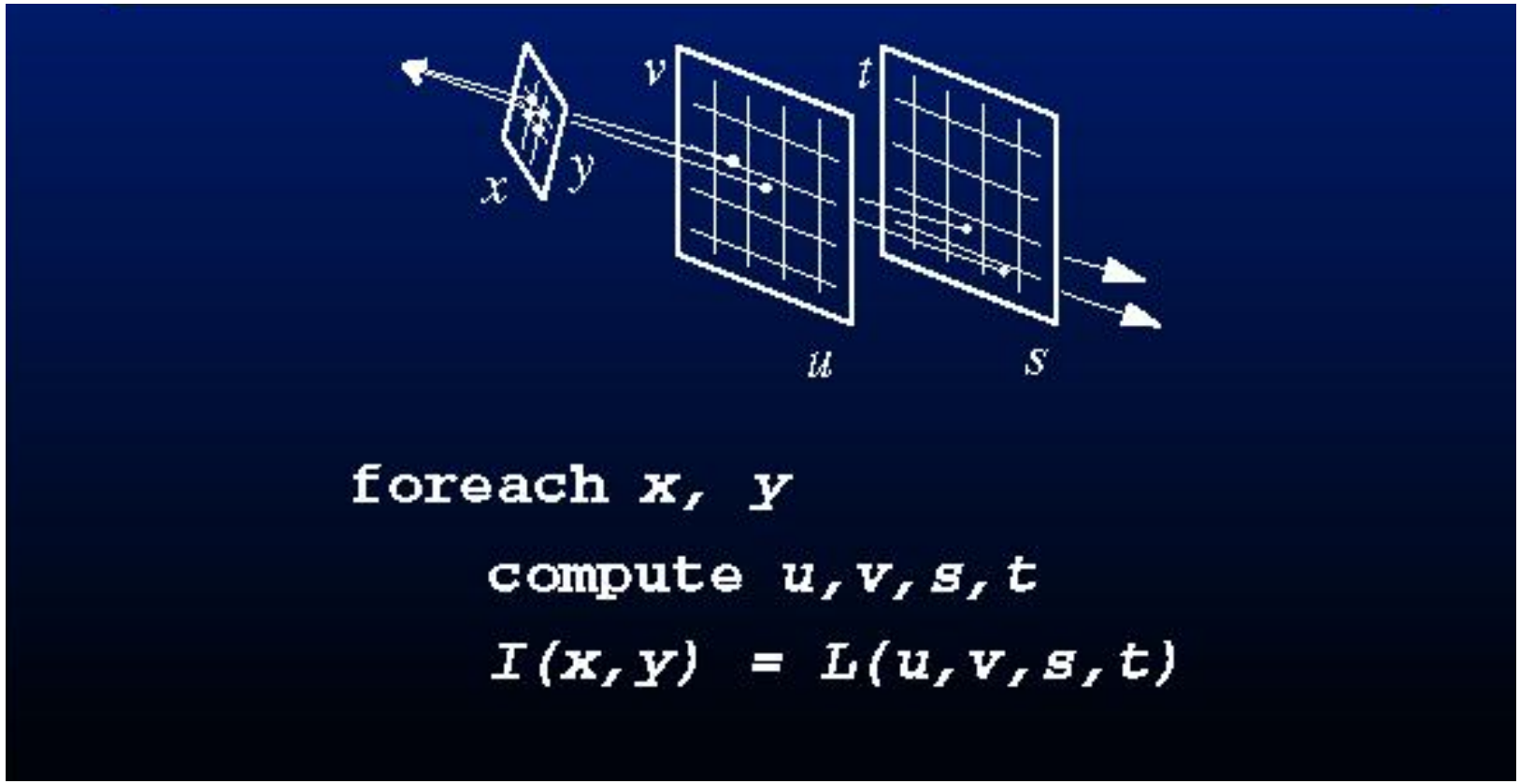
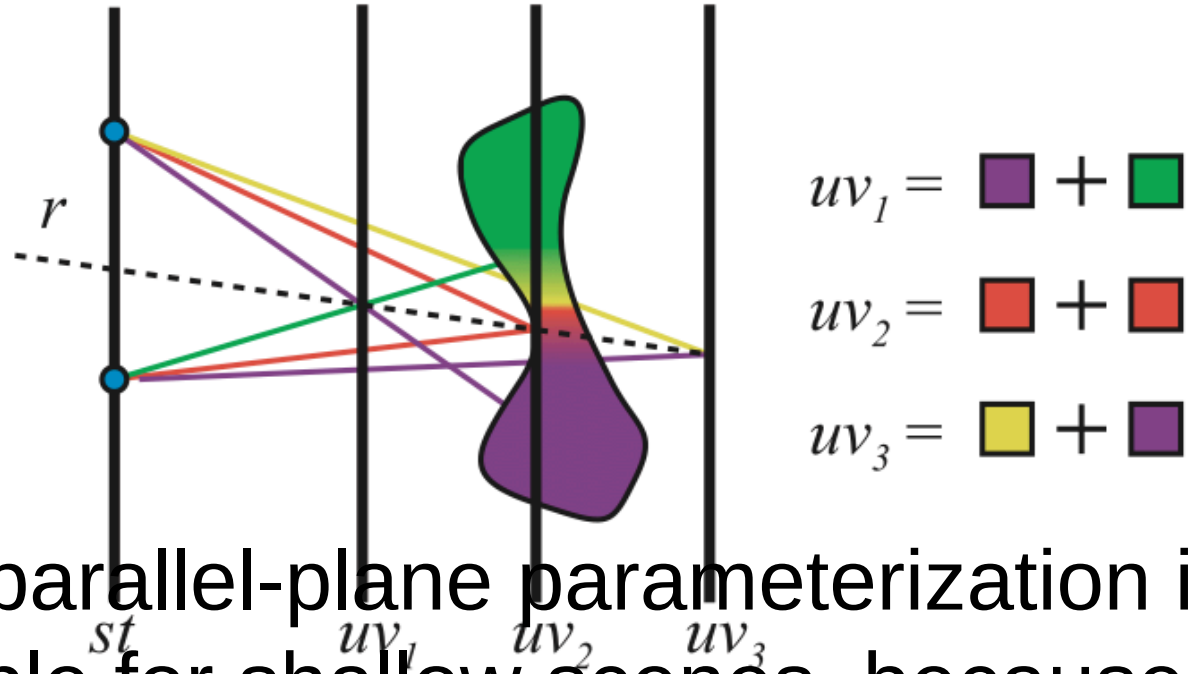
Slide adapted from Li Zhang

Light field rendering



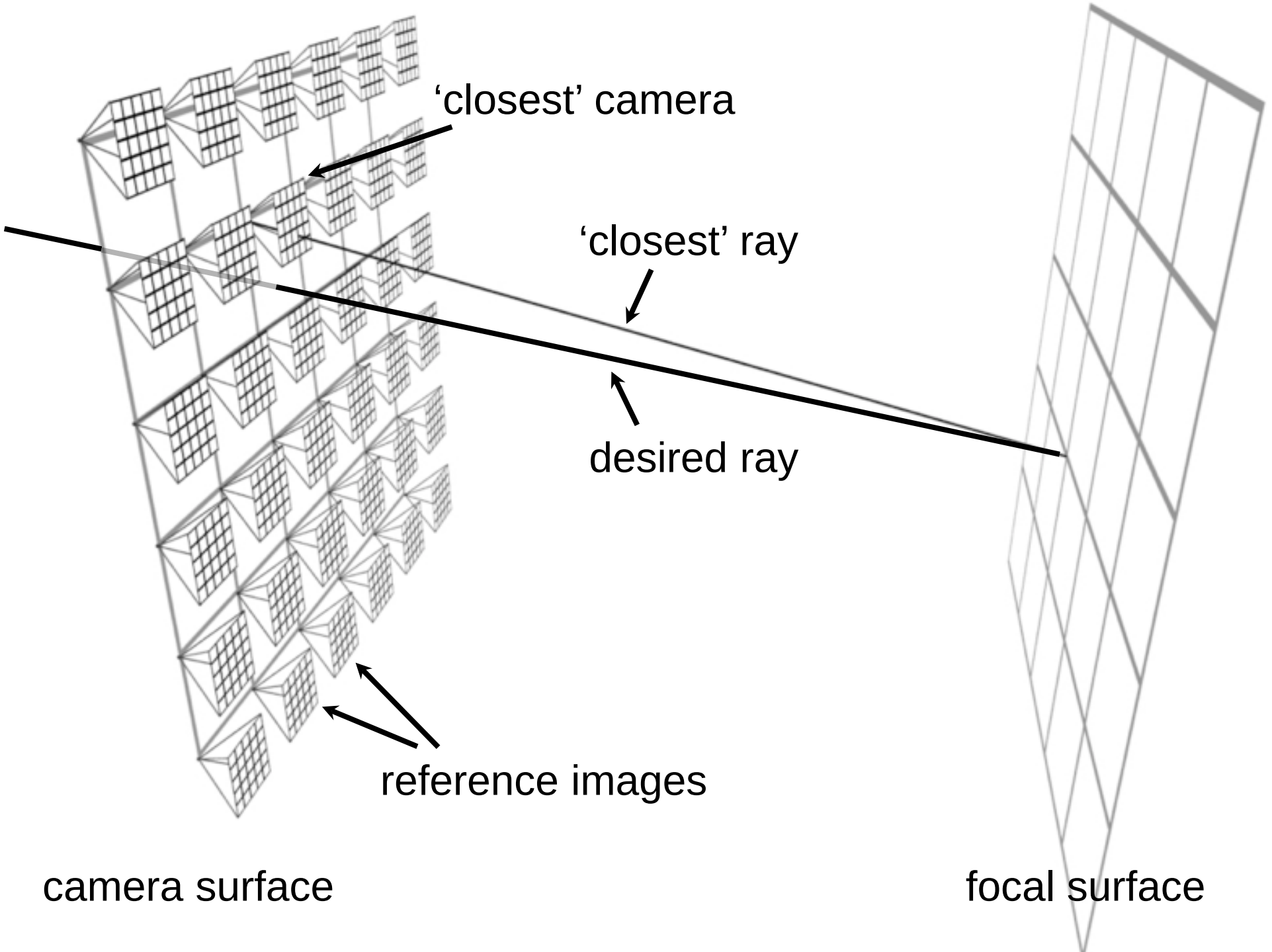
- Fast reconstruction of arbitrary scene views
- Parameterized to make sampling practical

Two-parallel-plane Parameterization

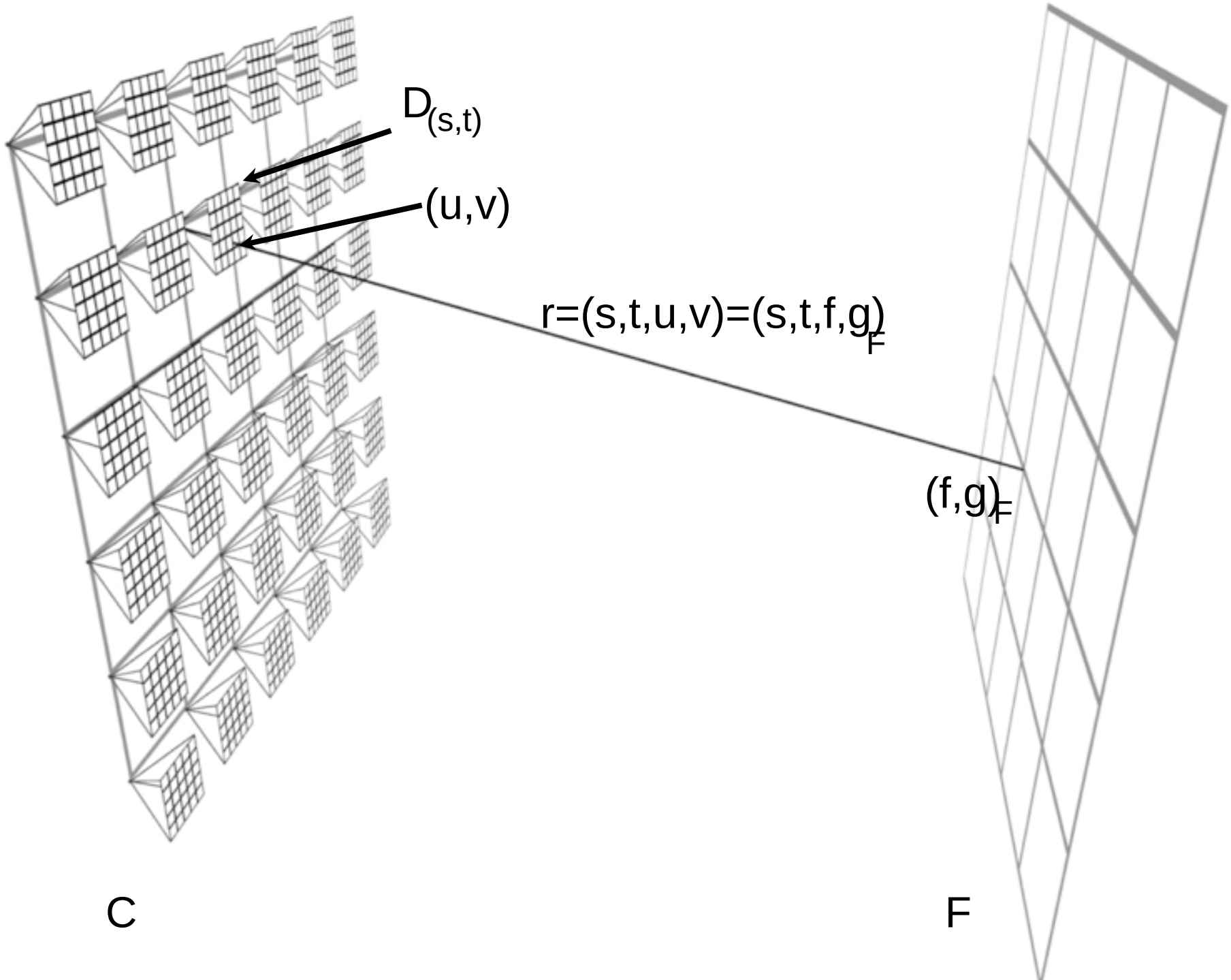


- Two-parallel-plane parameterization is only suitable for shallow scenes, because only parts of the scene near the exit plane can be reconstructed in focus.
- Lumigraphs can reconstruct deeper scenes by using depth correction. Approximate geometry is used to remap rays to more suitable exit coordinates.

Proposed Parameterization



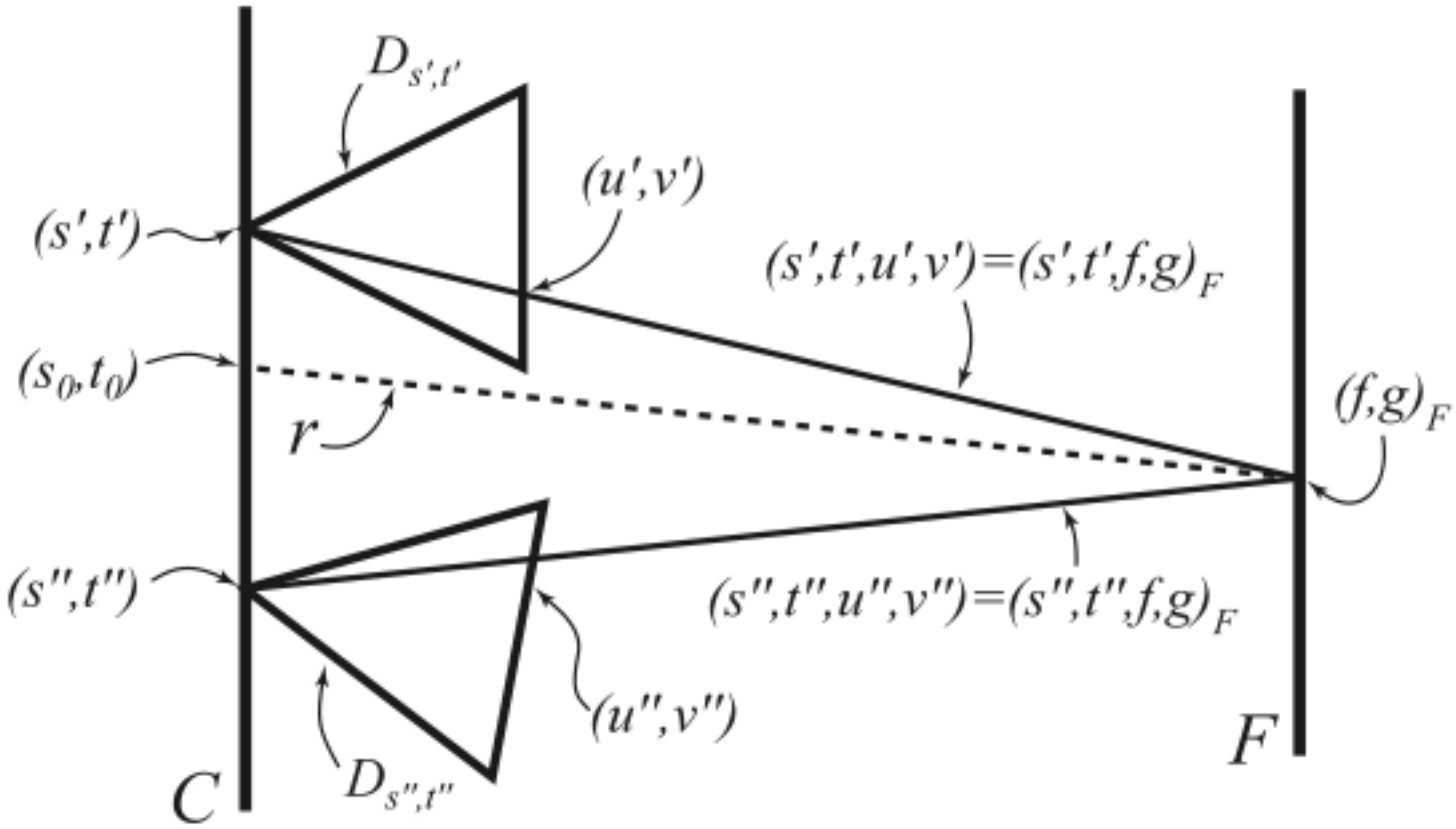
Proposed Parameterization



Proposed Parameterization

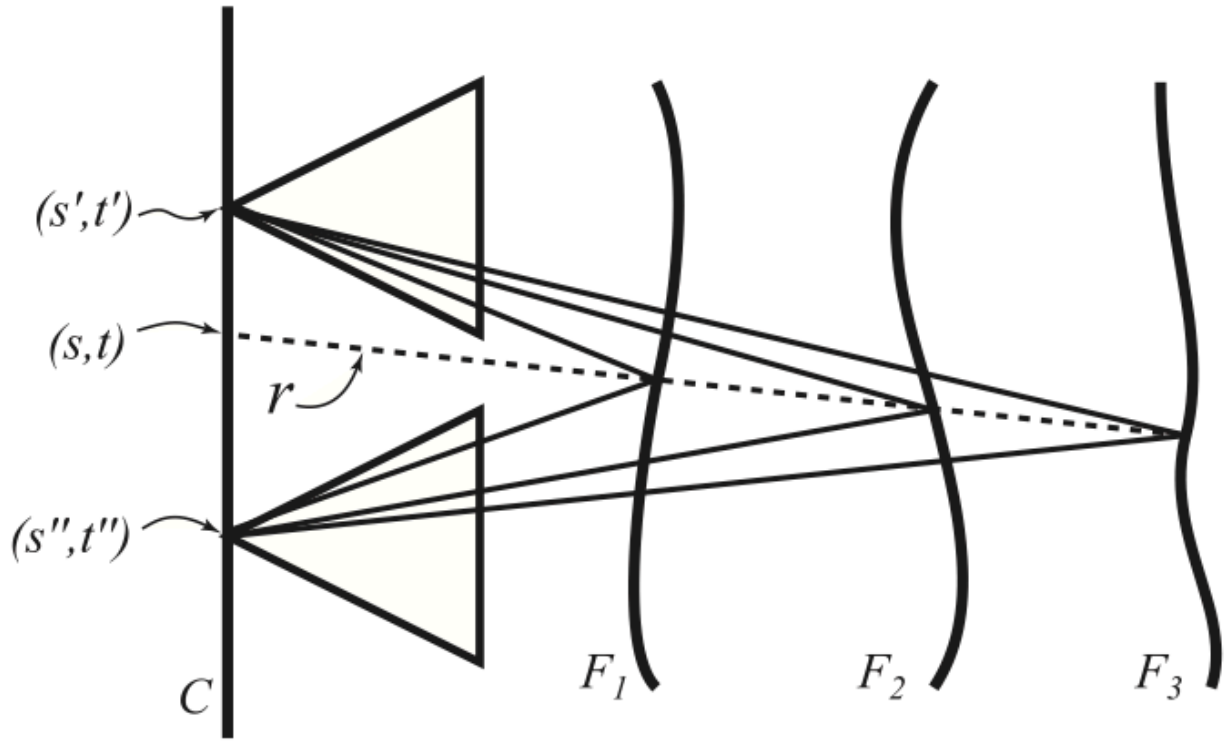
- We define a mapping $M_{F \rightarrow D} : (f,g) \rightarrow (u,v)$
- Given that we know the projection mapping for each of our cameras $P_{(s,t)} : (X,Y,Z) \rightarrow (u,v)$
- And we have a mapping $T_F (f,g) \rightarrow (X,Y,Z)$ for the focal plane:
- $M_{F \rightarrow D} = P_{(s,t)} \circ T_F$

Reconstructing a ray

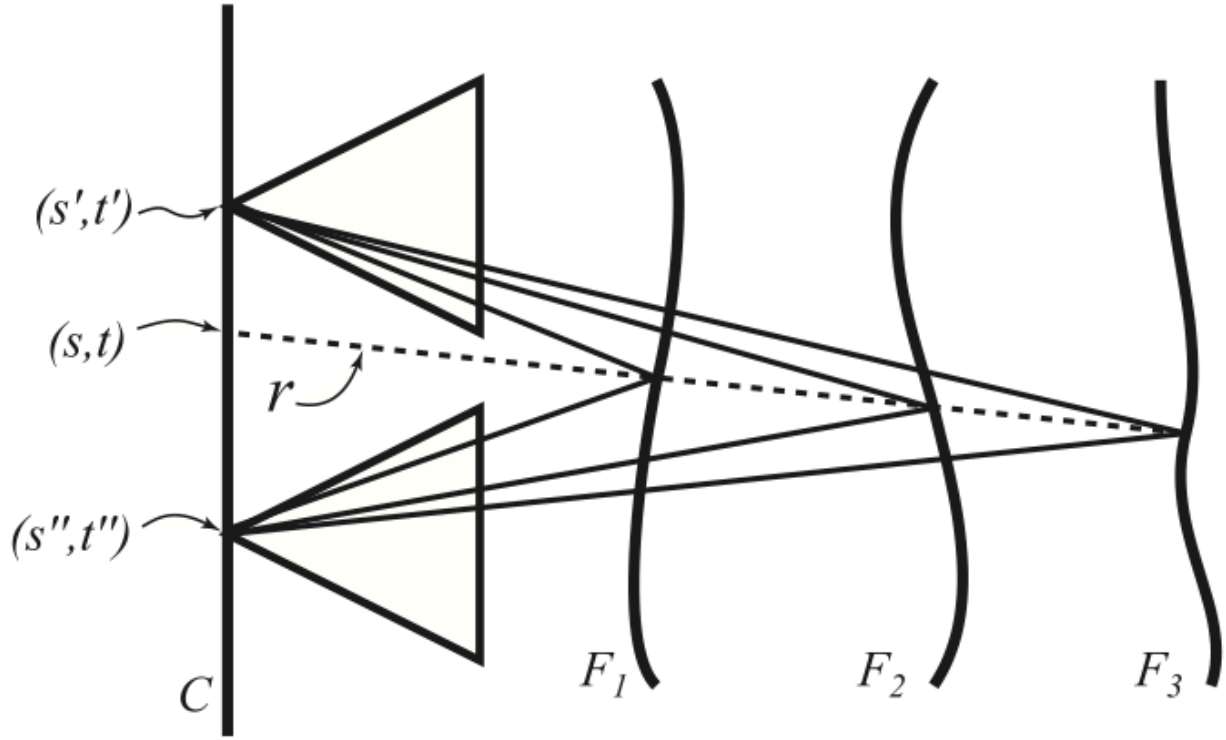


- Find intersection of ray r with C and F
- Using cameras near (s,t), apply mapping M to recover pixels (u,v)
- Filter pixels to combine rays

Variable Focus



- Changing the shape of the focal surface controls which data cameras contribute to the reconstructed ray.
- This allows refocusing of images!

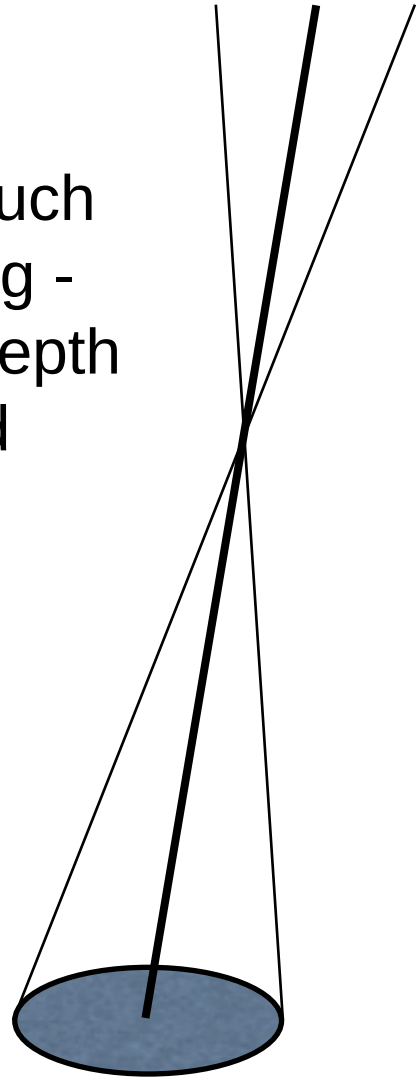

(s',t')
(s,t)
r
(s'',t'')
C
F1
F2
F3

Variable Aperture

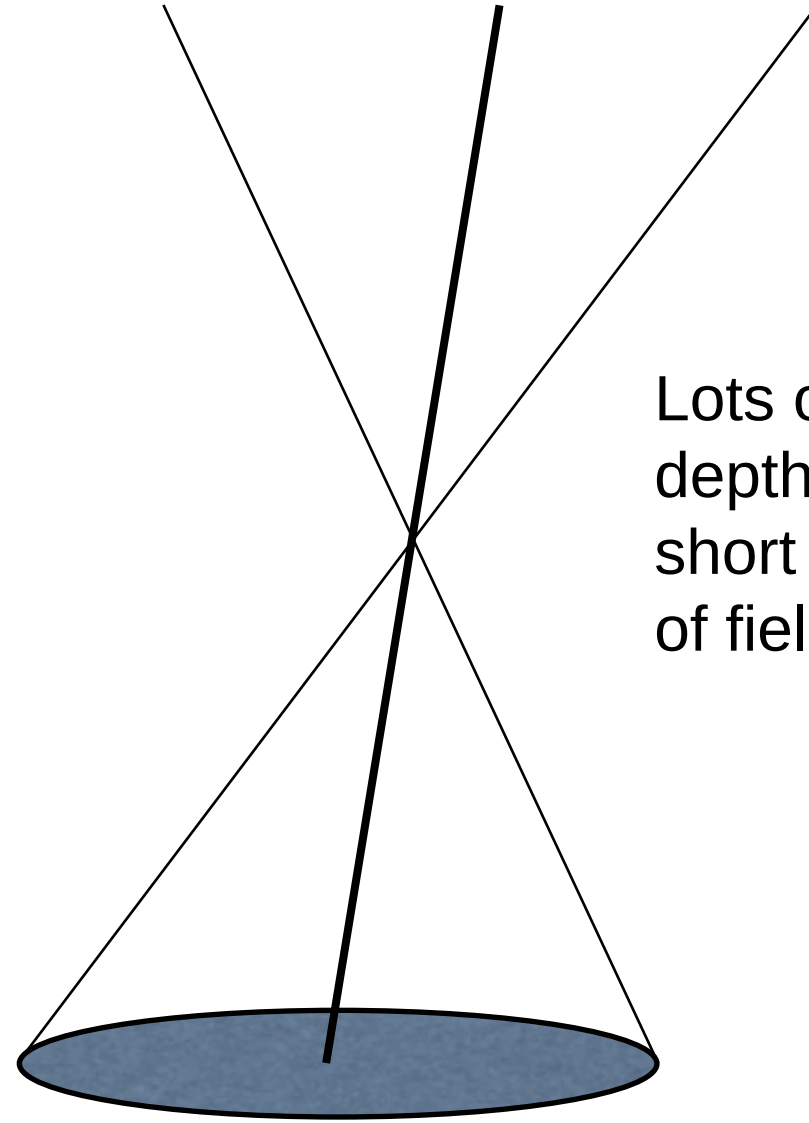
Slide adapted from Orion Sky Lawlor

Aperture size influences depth of field

Not much blurring - long depth of field



small aperture

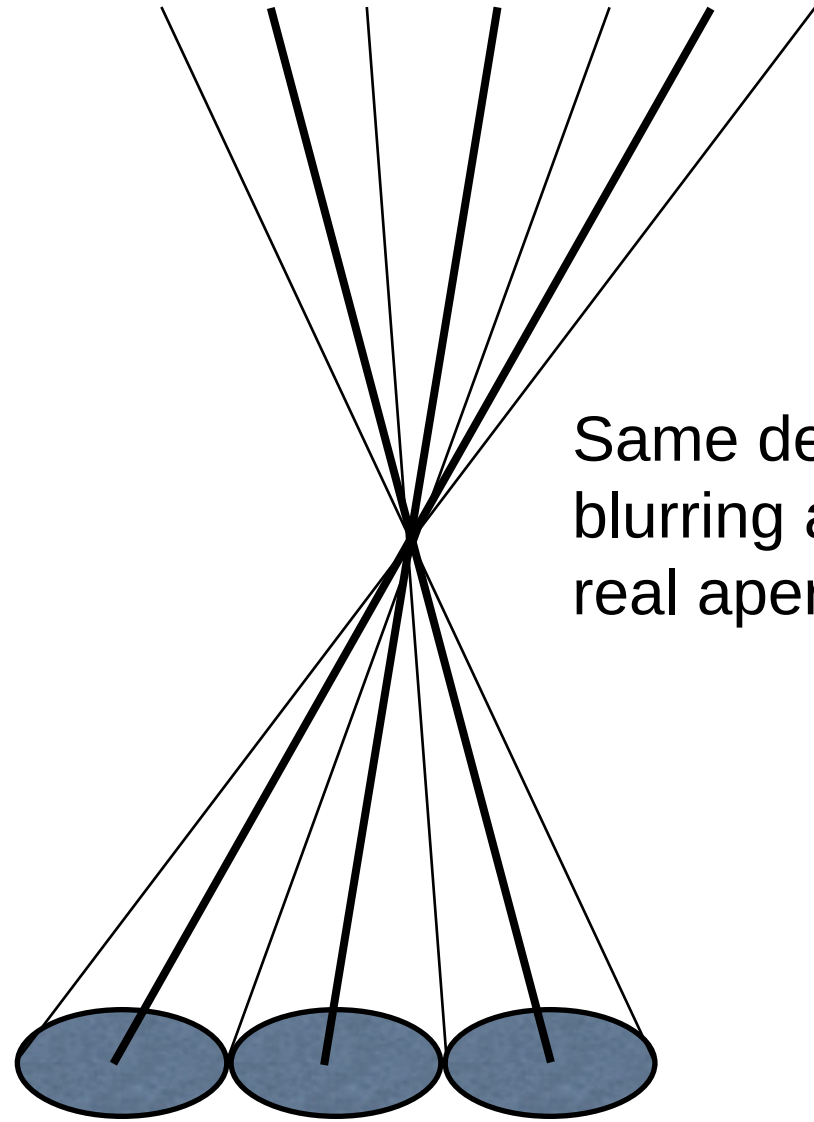


Lots of depth blur - short depth of field

big aperture

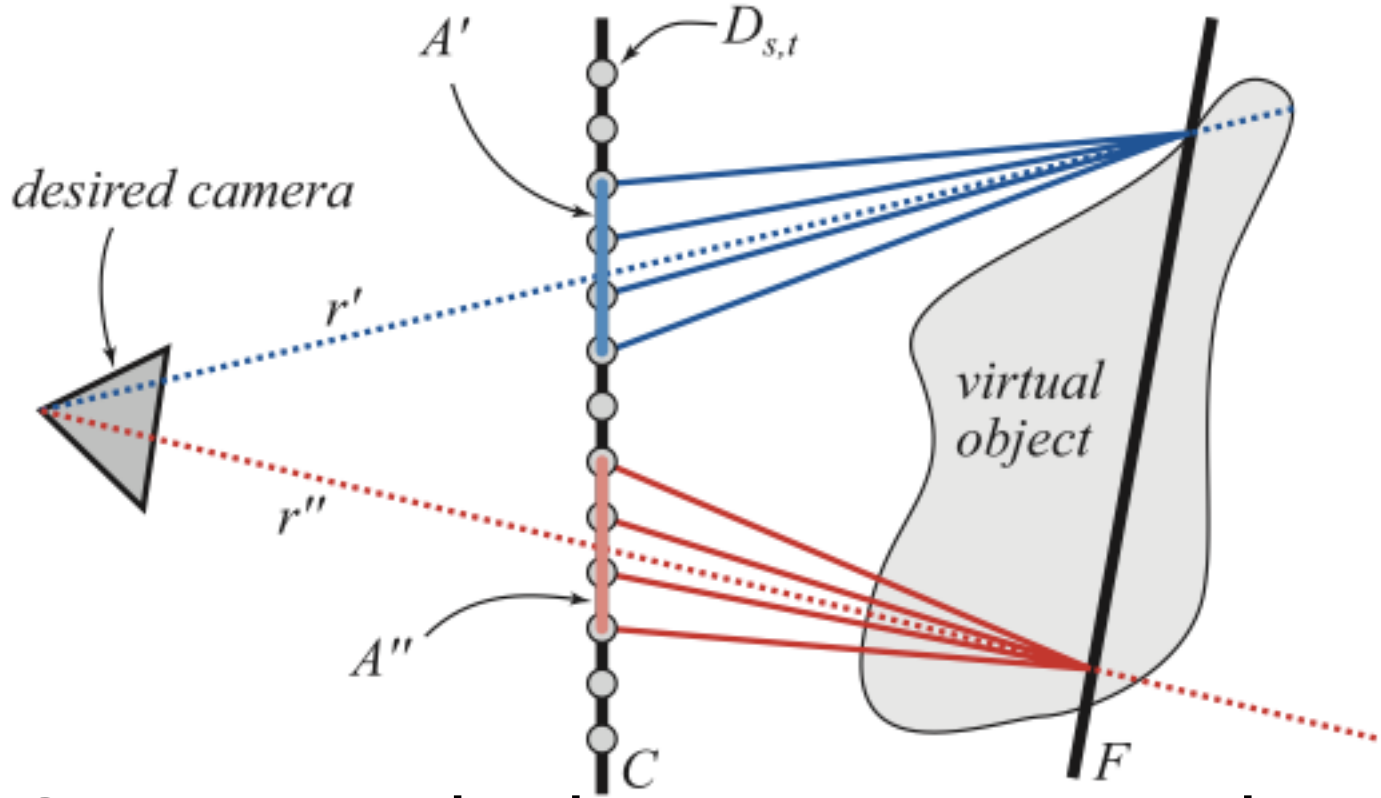
Slide adapted from Orion Sky Lawlor

Can emulate a large aperture using post processing by combining several smaller ones.

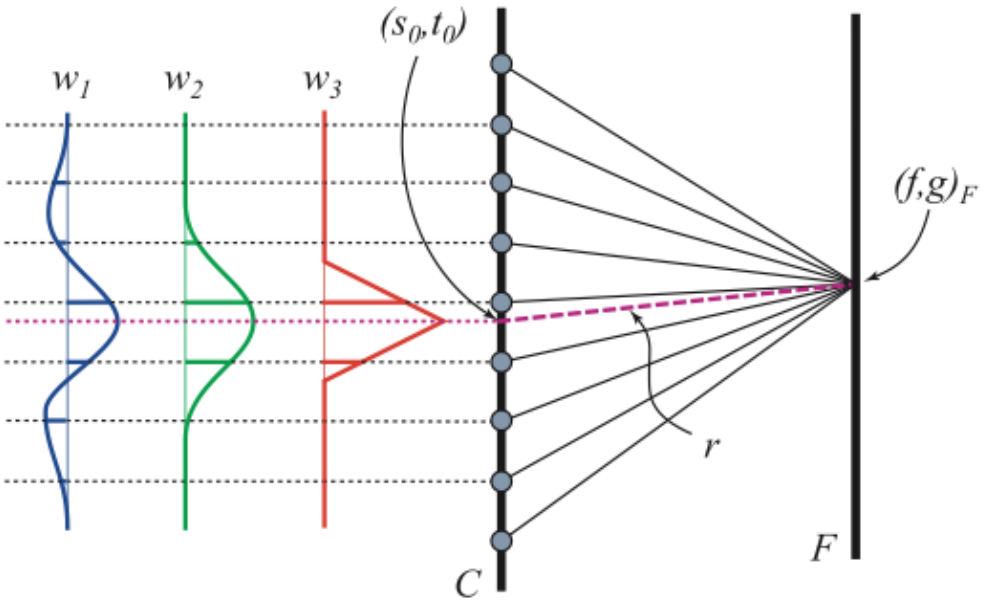


Same depth blurring as real aperture!

big assembled aperture



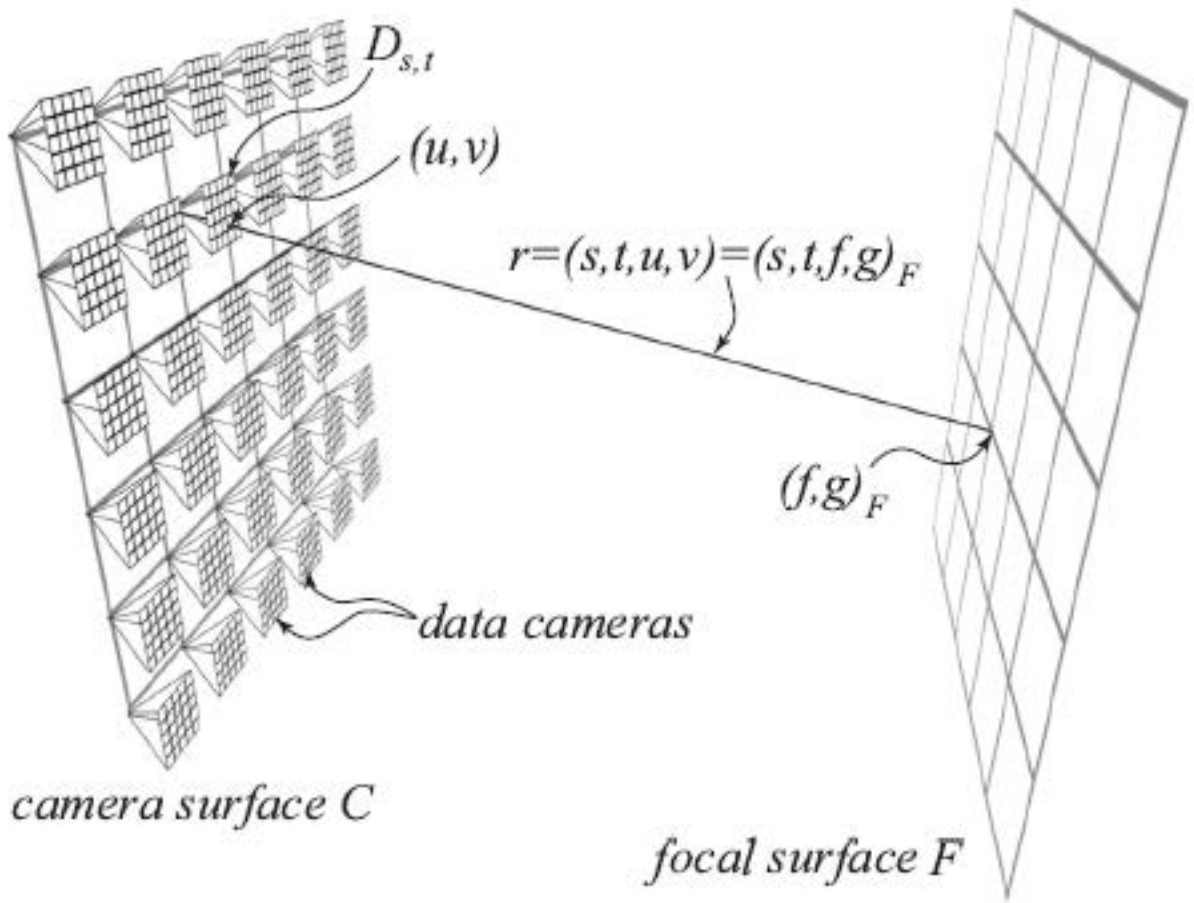
- Center synthetic aperture around each desired ray
- Sample light field for each data camera that falls within aperture
- Combine pixels using some weighted function to reconstruct final ray



Varying the size and shape of the synthetic aperture changes the depth of field.

Questions

How do you choose focal surface F?



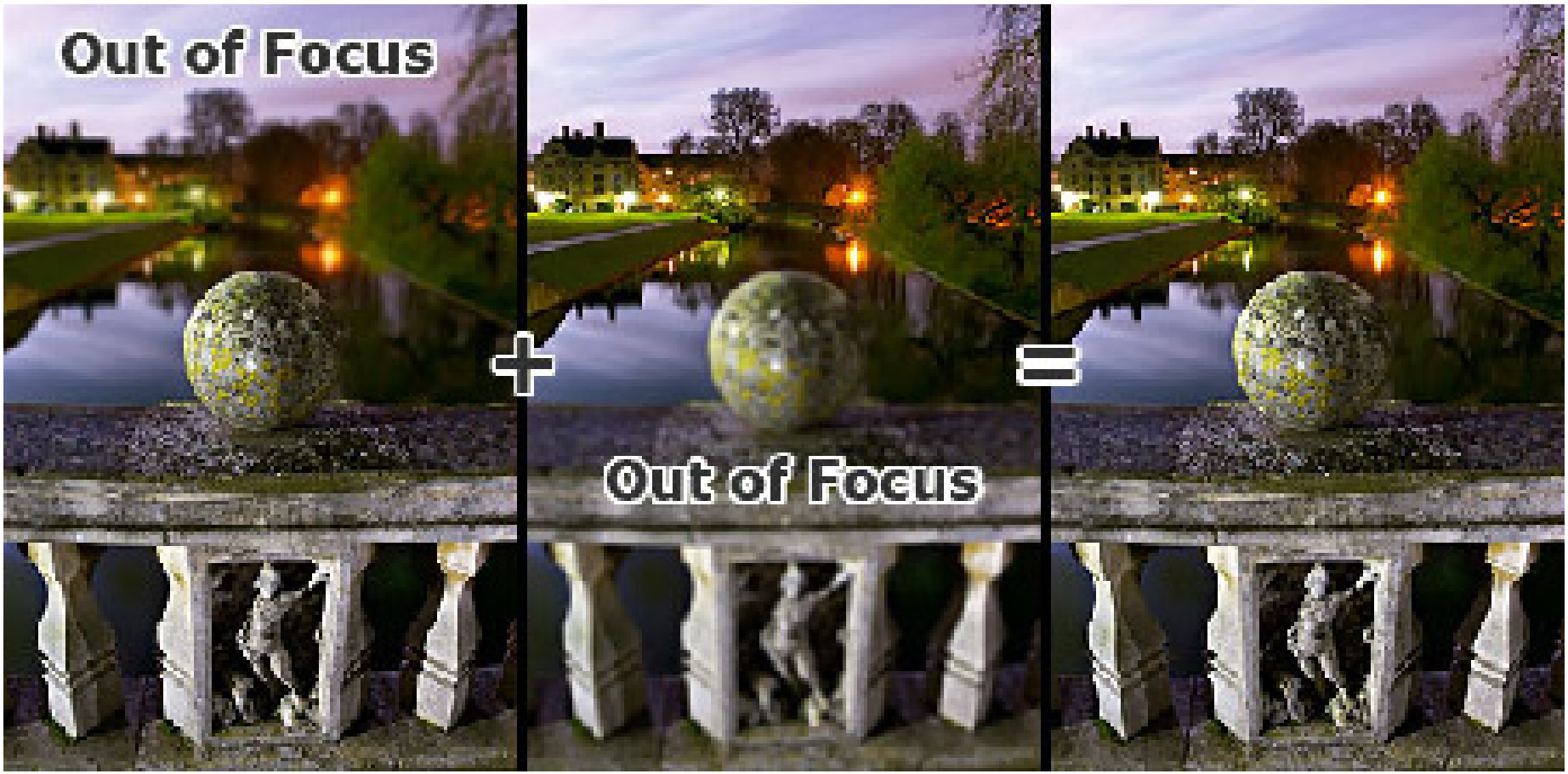
Finding the focal plane

- Lytro http://www.lytro.com/picture_gallery
- How do we find the target focal plane?

- Multiple target focal planes?
- Whole image in focus?

Focus Stacking

- http://en.wikipedia.org/wiki/Focus_stacking


Out of Focus
Out of Focus

- Using light field cameras for focus stacking?

Camera Calibration

- For each Ds,t we define a mapping function:
- $M_{s,t} (F \rightarrow D): (f, g)F \rightarrow (u, v)$
- $P_{s,t} : (X, Y, Z) \rightarrow (u, v)$

- How do we autocalibrate the camera?