Eurographics 2015

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Light Field Structure Analysis

With material courtesy of
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Key observation

- Light rays are **highly coherent**
  - Rays originating from same surface point vary smoothly over angle
- Represent light rays in **light field parameterization**
  - Rays correspond to points in a 4D position-direction space
- Exploit coherent, **anisotropic structure of light fields**

Motion blur and depth of field

- Requires lots of samples

Depth of field (defocus blur)

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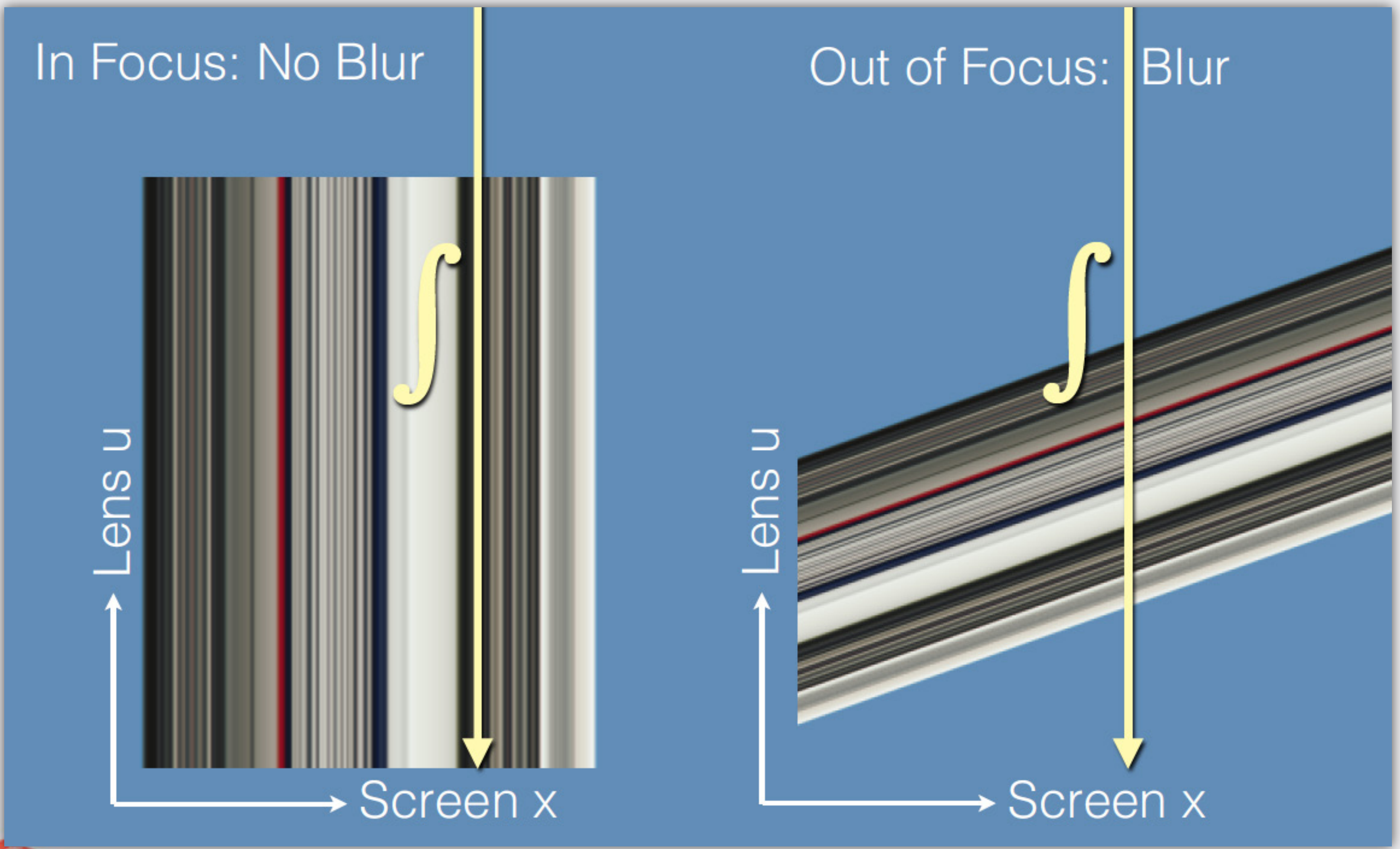
Depth of field (defocus blur)

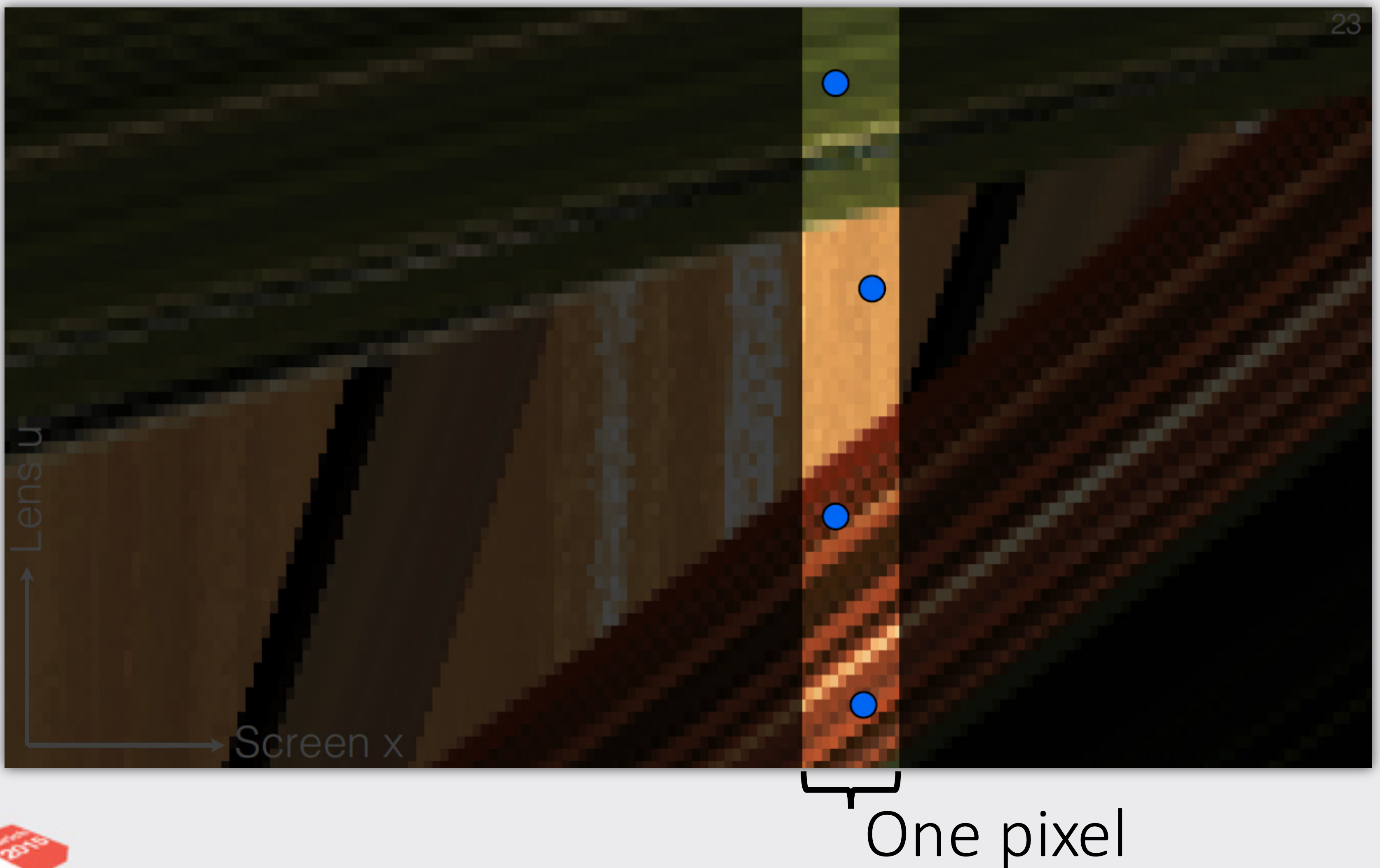
Light field parameterization

Anisotropy

Defocus blur: integration over lens

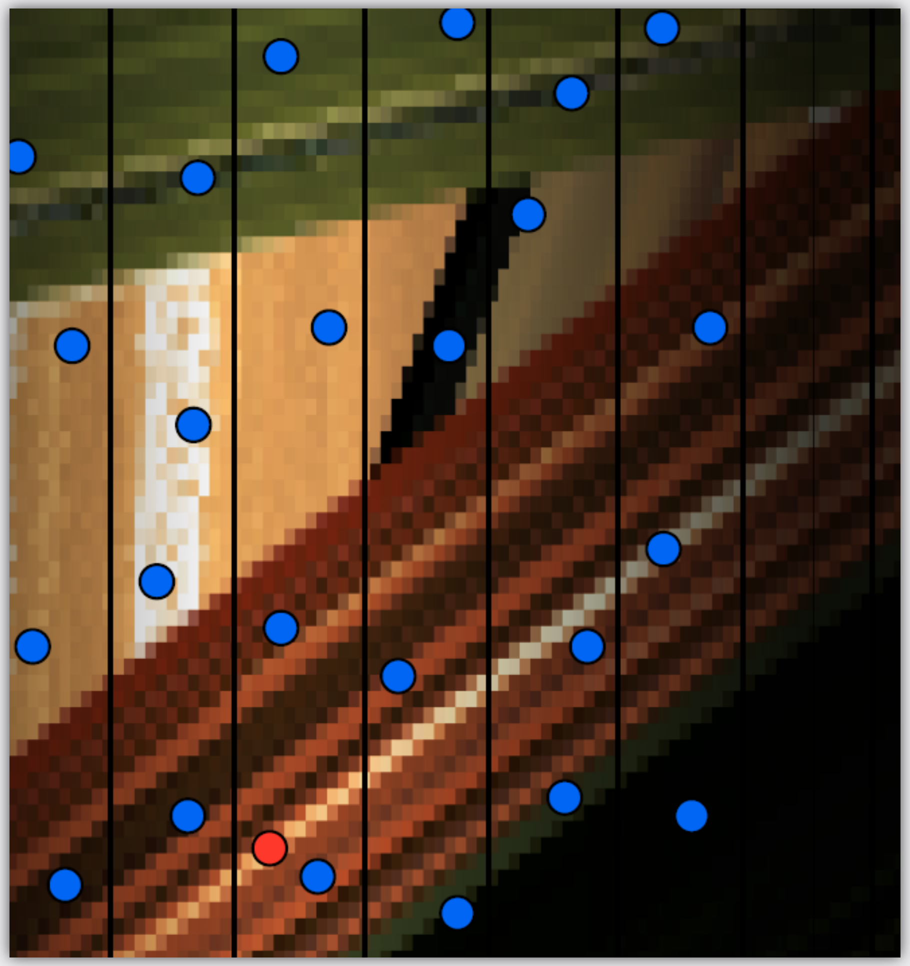


Naive approach



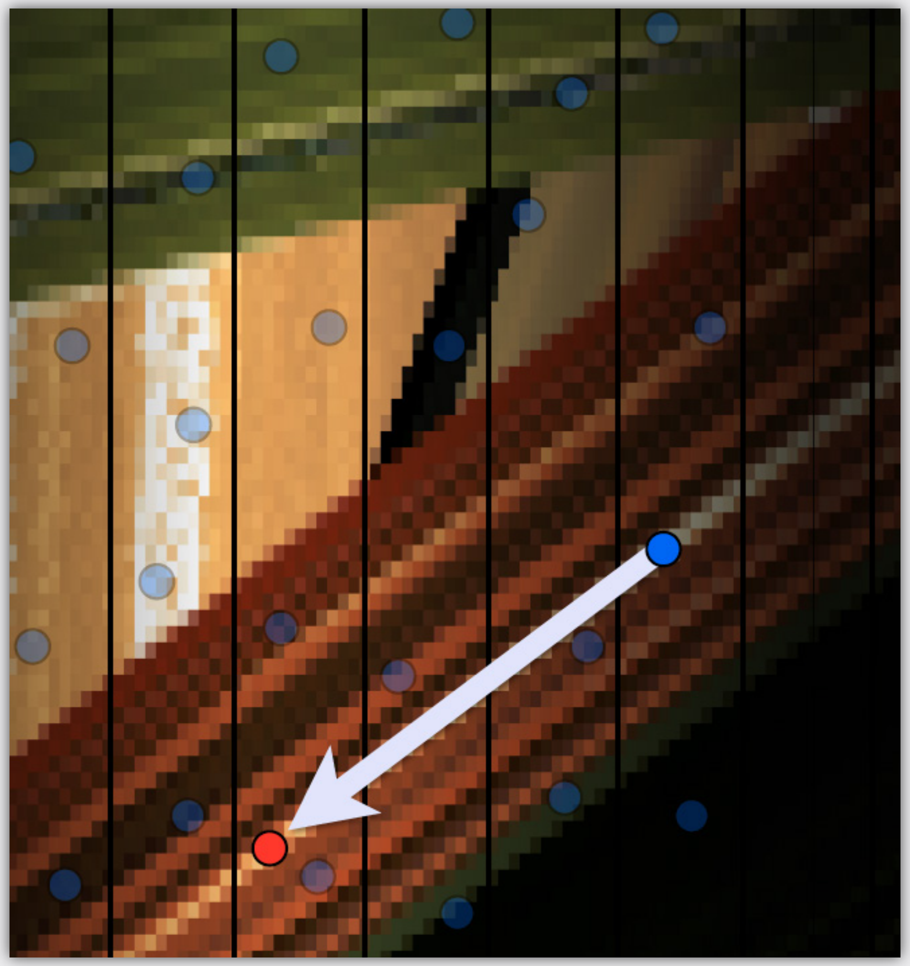
Exploiting anisotropy

- Input: sparse sampling



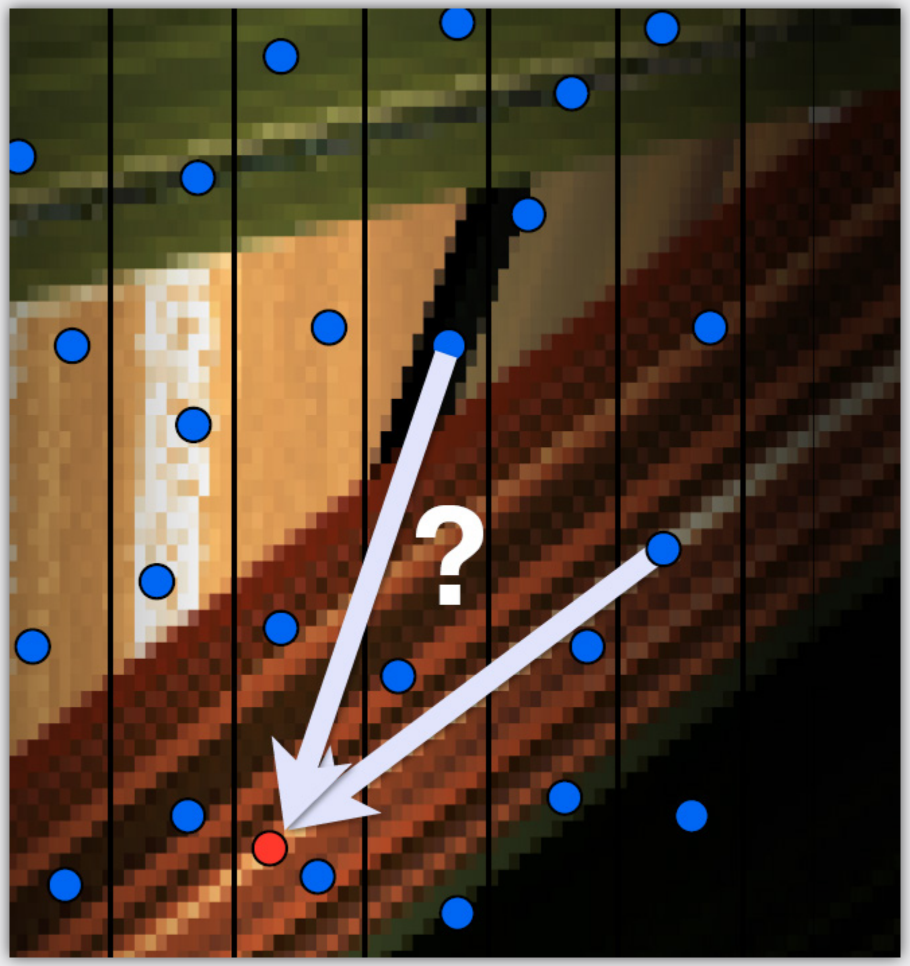
Exploiting anisotropy

- Input: sparse sampling
- Upsampling
  - Extrapolation along known slopes



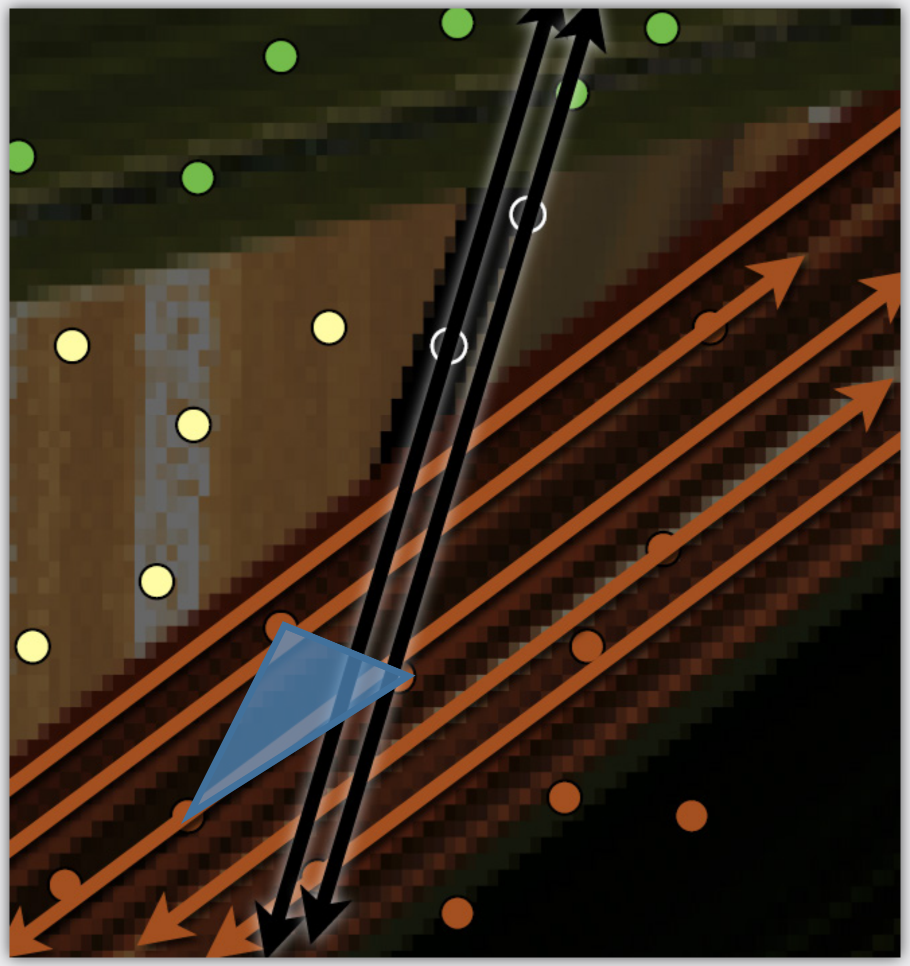
Exploiting anisotropy

- Input: sparse sampling
- Upsampling
  - Extrapolation along known slopes
- Core challenge: visibility



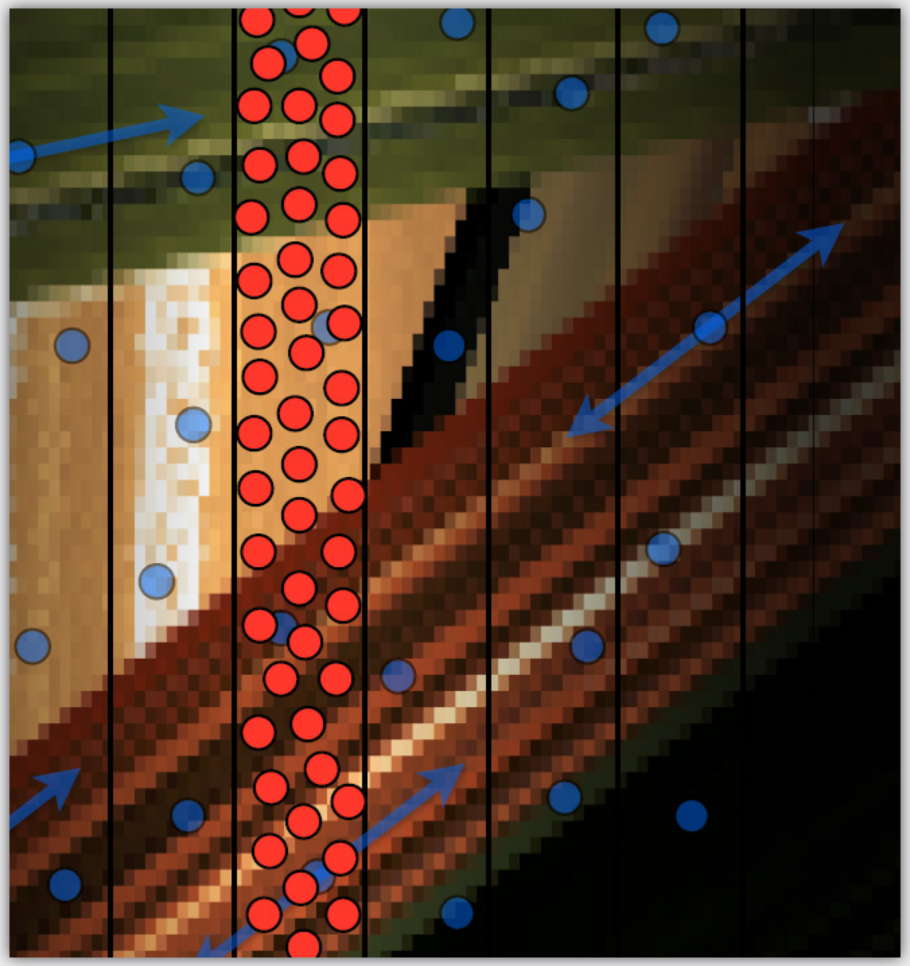
Exploiting anisotropy

- Input: sparse sampling
- Upsampling
  - Extrapolation along known slopes
- Core challenge: visibility
- Visibility events produce intersections
  - Detect by locally triangulating foreground samples



Summary

- Input: sparse sampling
- Upsampling
  - Extrapolation along known slopes
  - Resolve visibility
- For each pixel, usual Monte Carlo integration of upsampled data



Results (depth of field, motion blur)

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Extension to indirect illumination

- **Challenge**: at each pixel, compute incident indirect illumination over hemisphere

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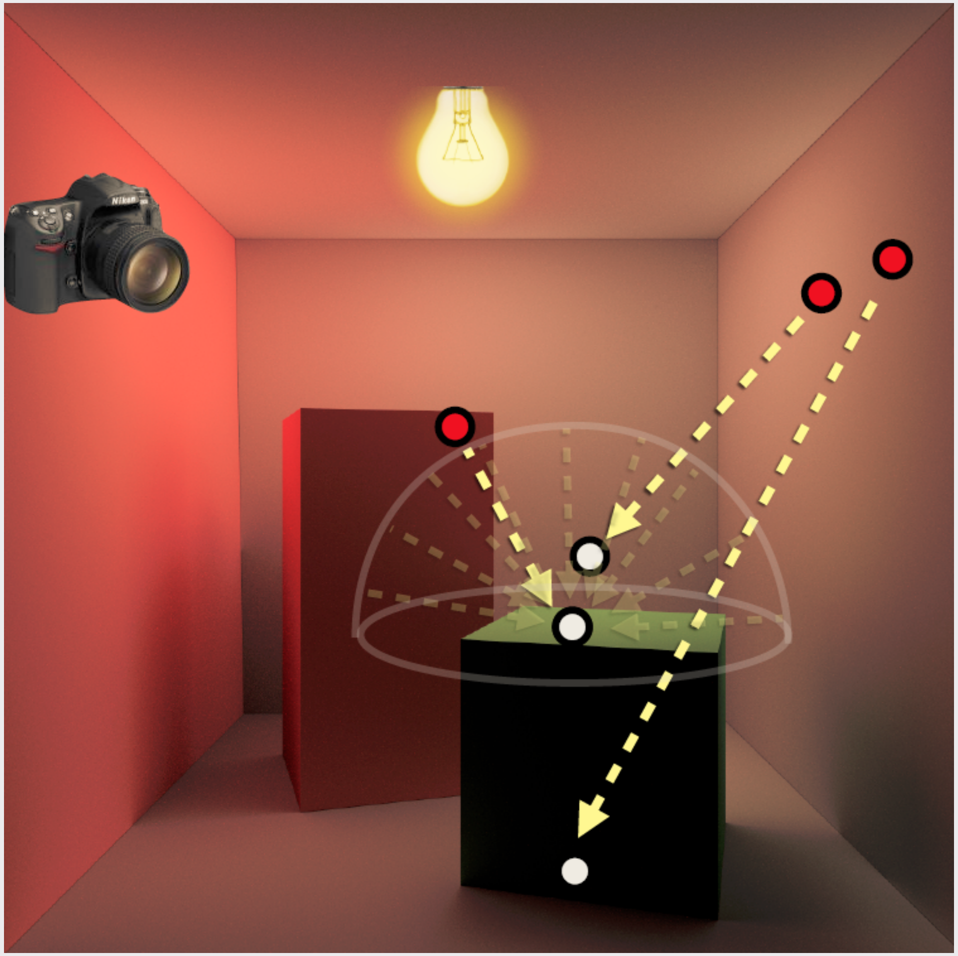
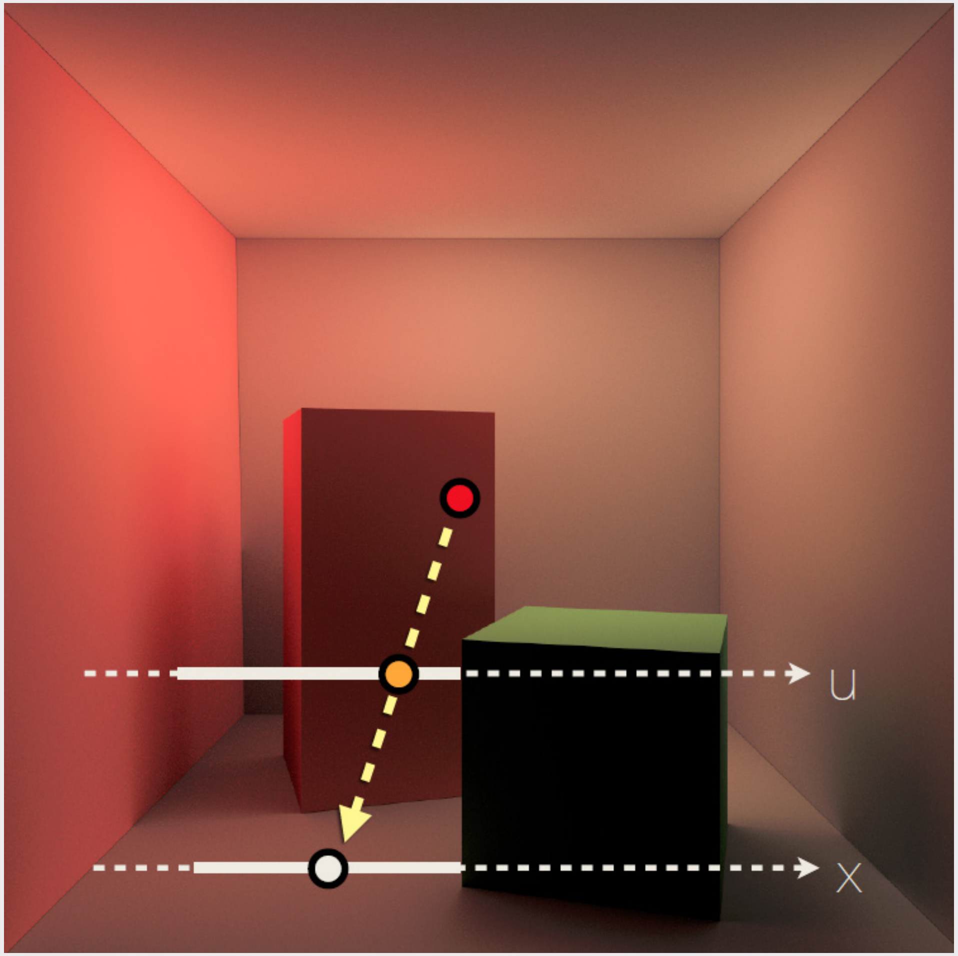
- **Challenge**: at each pixel, compute incident indirect illumination over hemisphere
- **Key idea**: interpolate incident rays from **sparsely sampled, scattered ray segments**

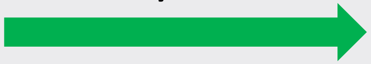


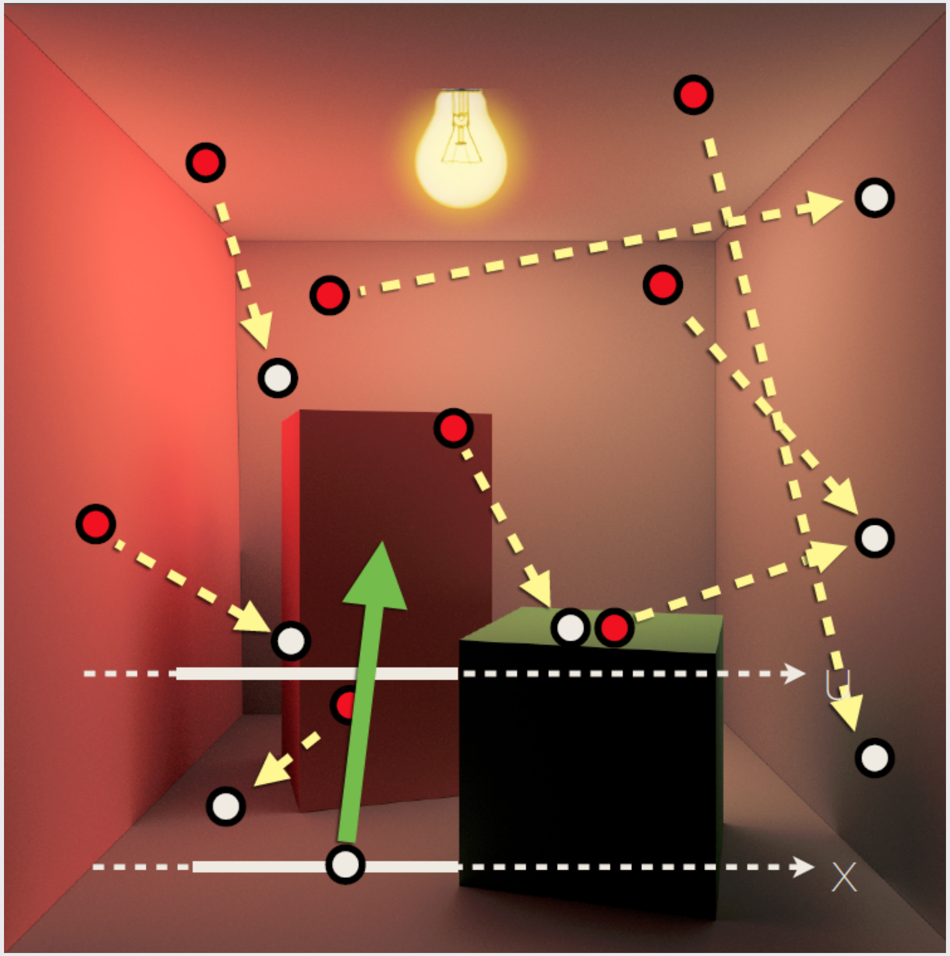
Light field parameterization

- Represent incident rays using light field parameterization



Approach

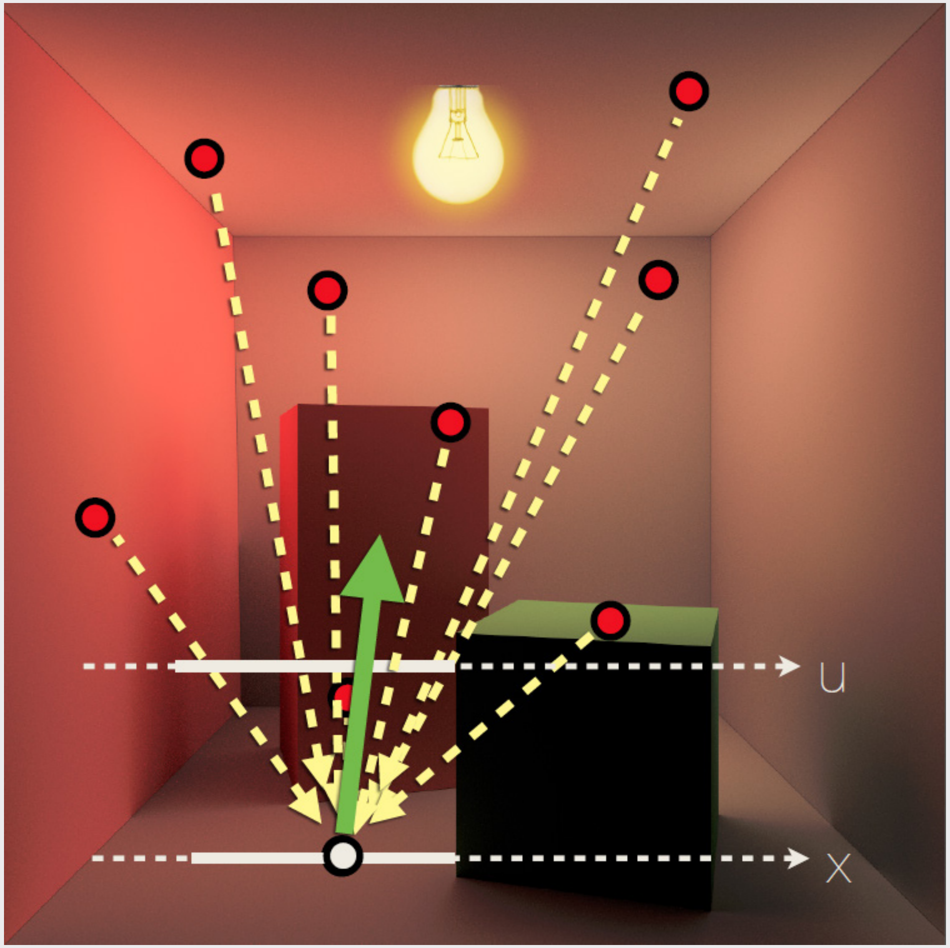
- Input: path tracing with sparse samples
- Store path segments  for indirect illumination
- Query incident ray  by interpolating in light-field parameterization



Interpolation

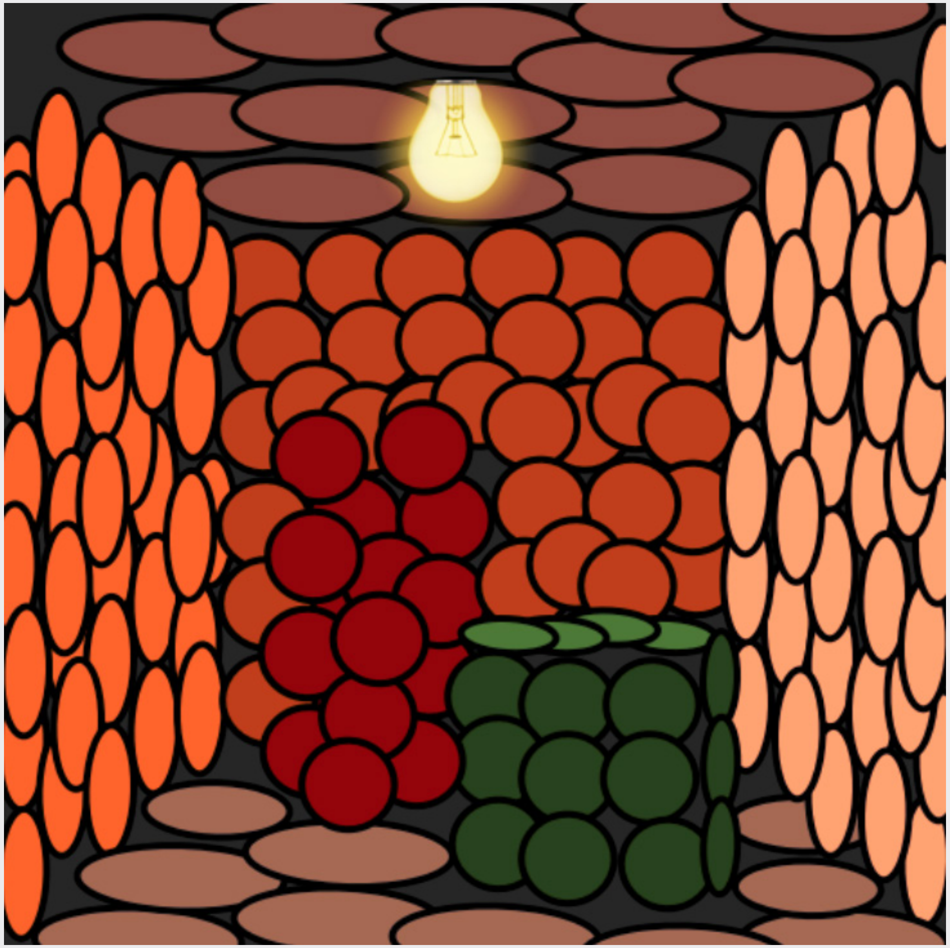
- Reproject input sample rays into light field parameterization at query location
- Interpolate at query ray

- Challenges
  - Visibility
  - Non-diffuse surfaces



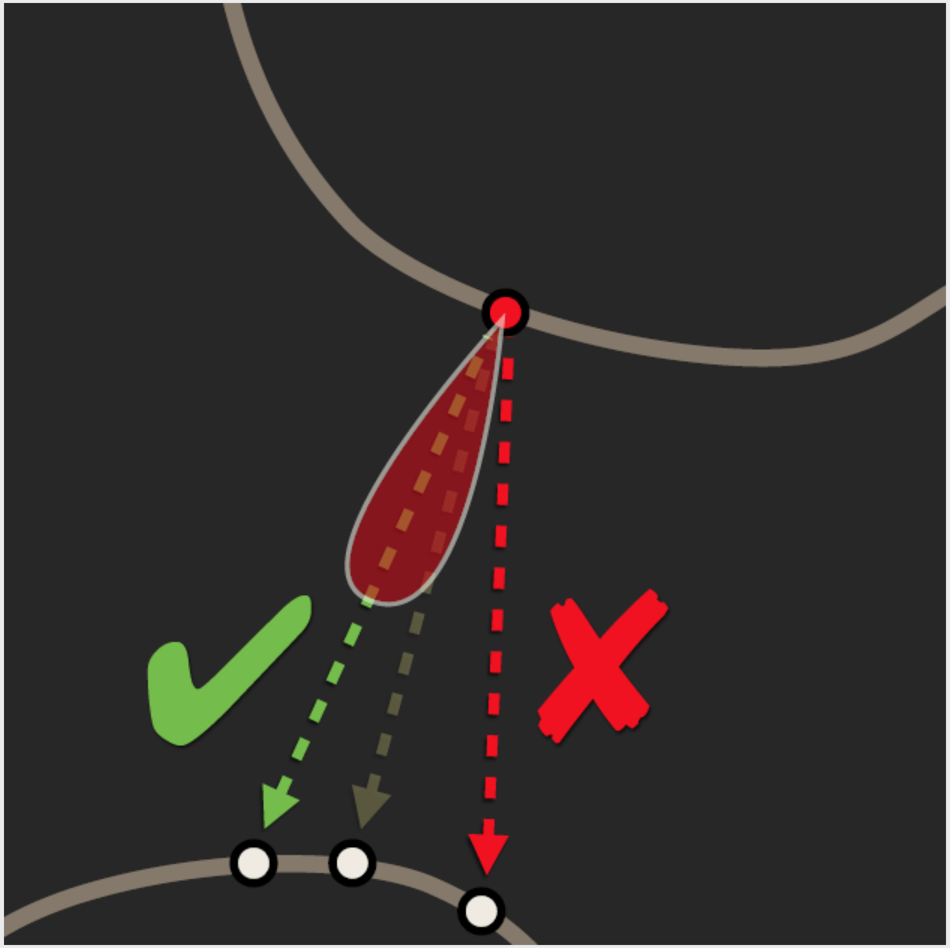
Visibility

- Detect occlusions using a coarse point-based scene representation

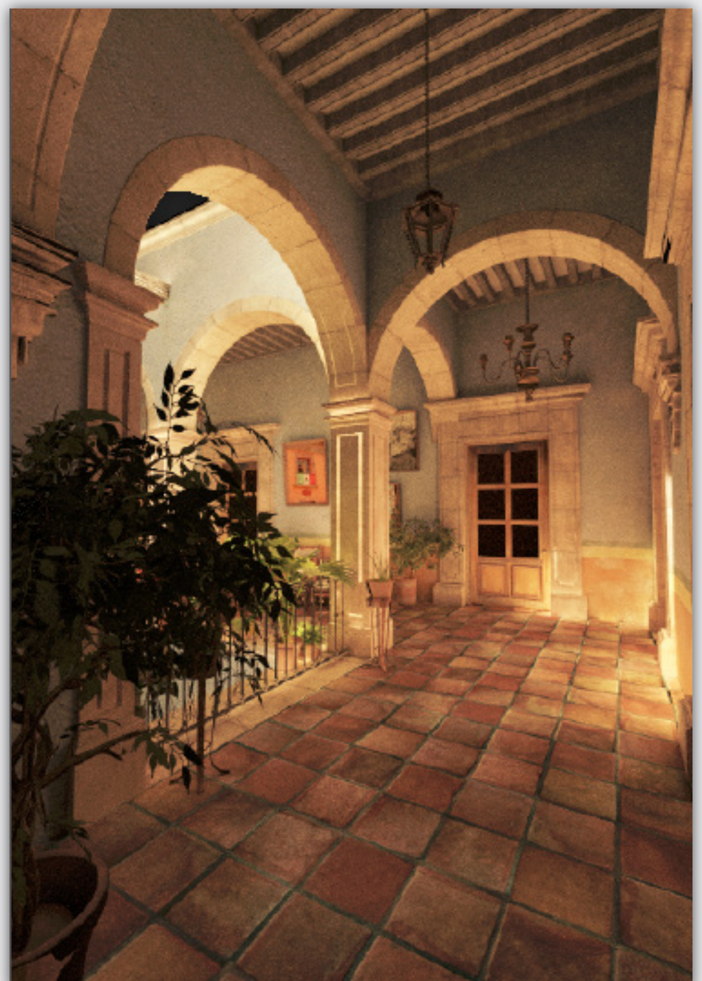


Glossy surfaces

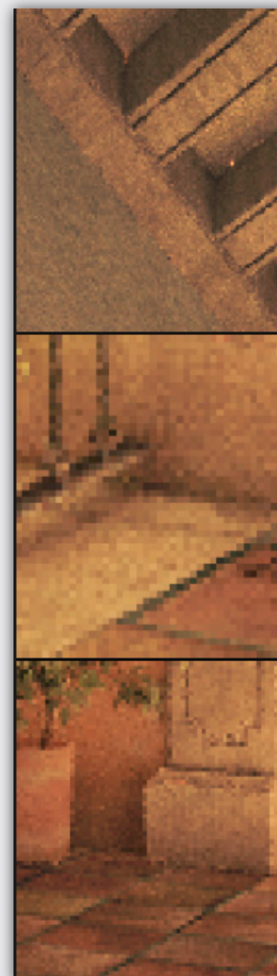
- Store glossy BRDF lobe
- Use as weight when extrapolating sample



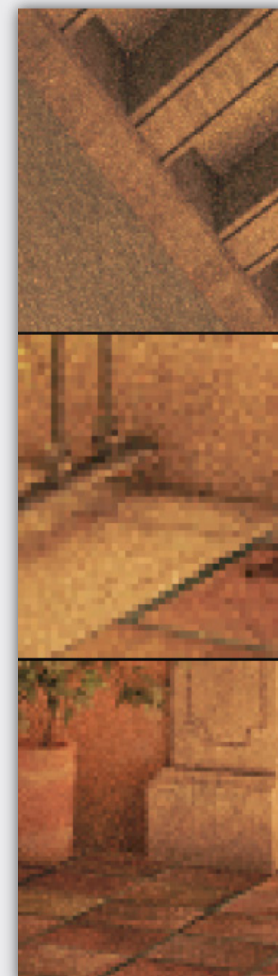
Results: diffuse indirect illumination



Input 8spp



Reconstruction



PBRT 512spp

Results: ambient occlusion

Input 4spp

Reconstruction

Conclusions

- Light field parameterization reveals anisotropic structure of incident light
- Convenient representation for upsampling and interpolation
  - Easy to preserve light field structure
- Good results from very sparse input
- Challenges
  - Visibility
  - Glossy surfaces
  - Memory requirements