The Epipolar Occlusion Camera

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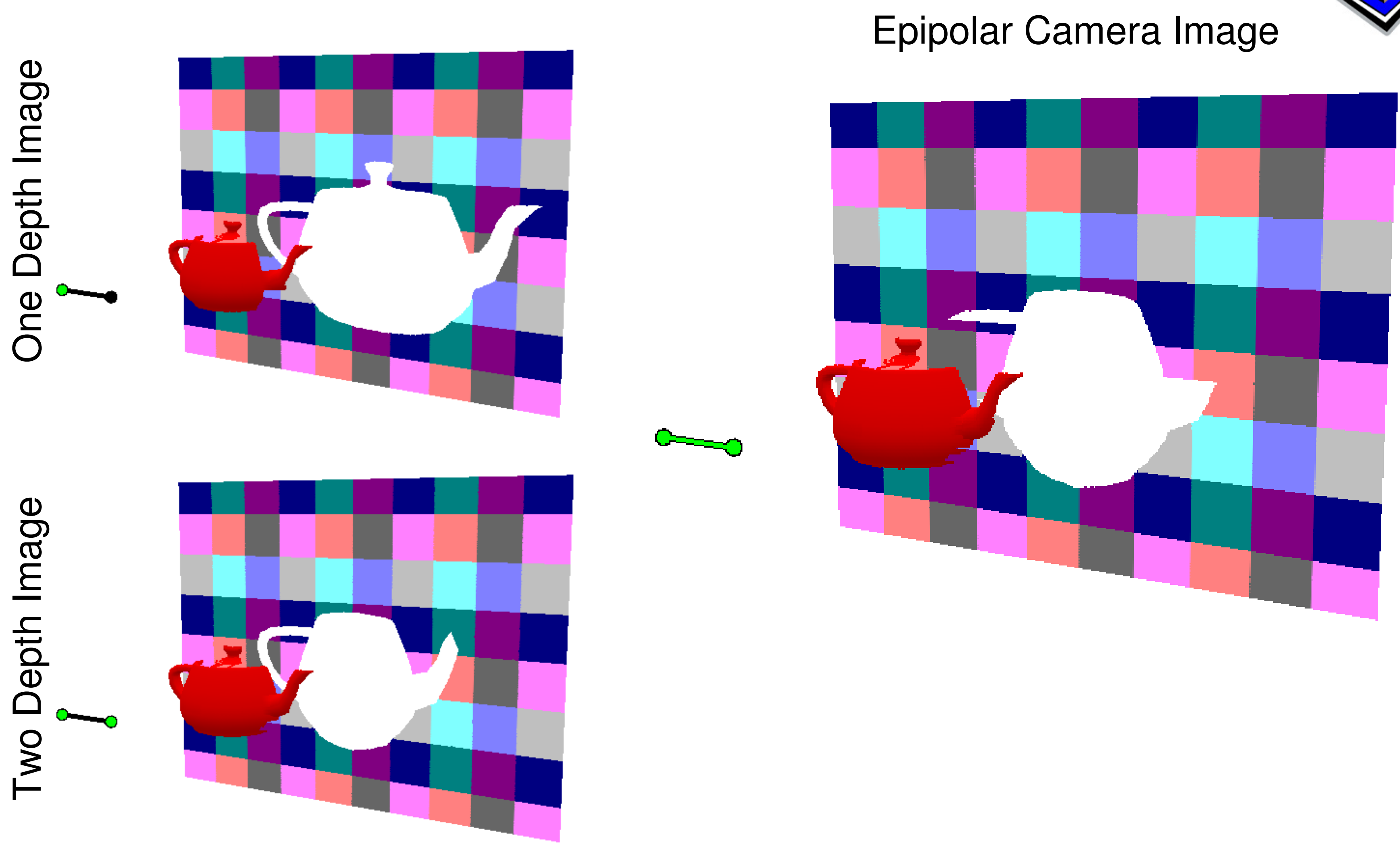
Motivation

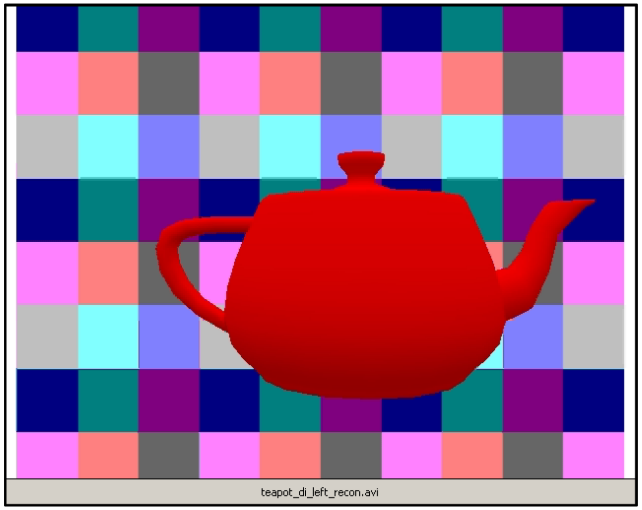
- A traditional pinhole camera captures images from a single view point
- We would like to capture all of samples along a view segment
- This can be done by exploiting the epipolar geometry that exists when translating between 2 view points

Example Reconstructions

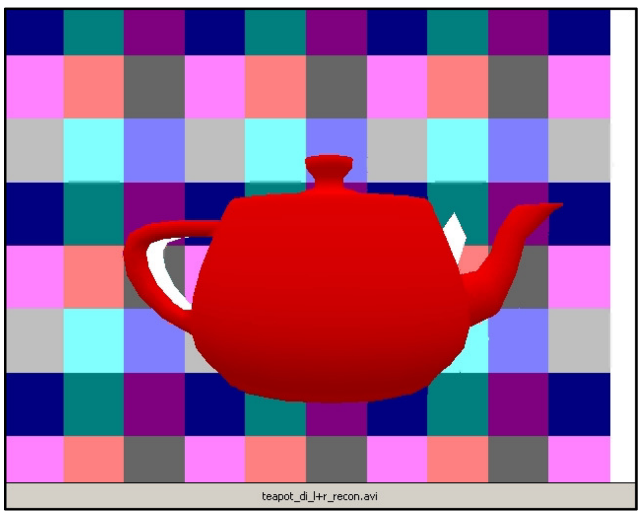


Example Reconstructions

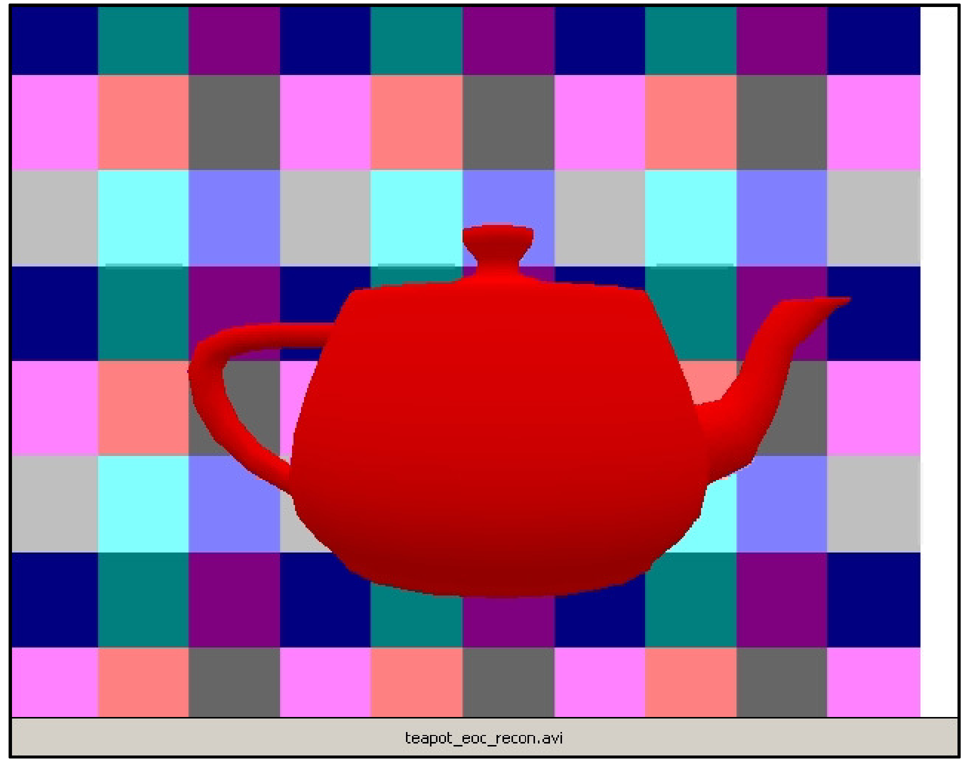
One Depth Image



Two Depth Image



Epipolar Camera Image

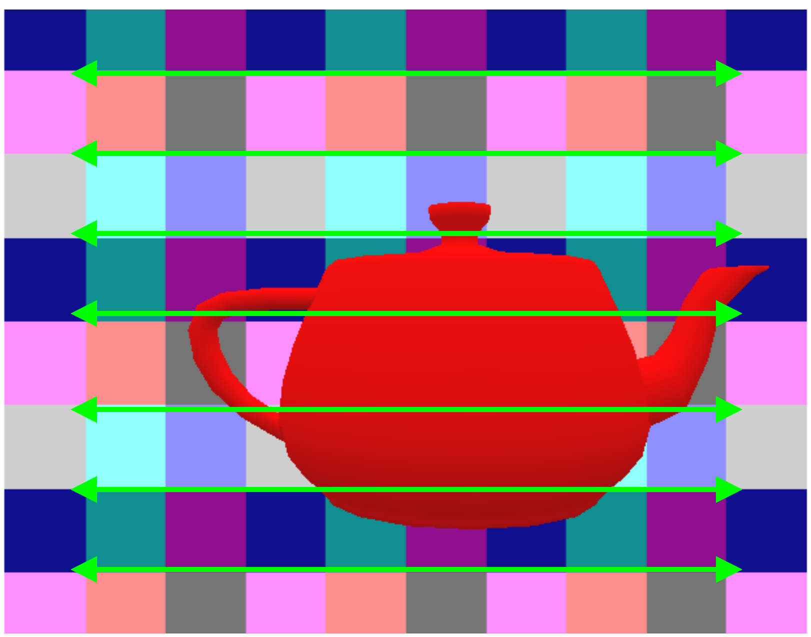


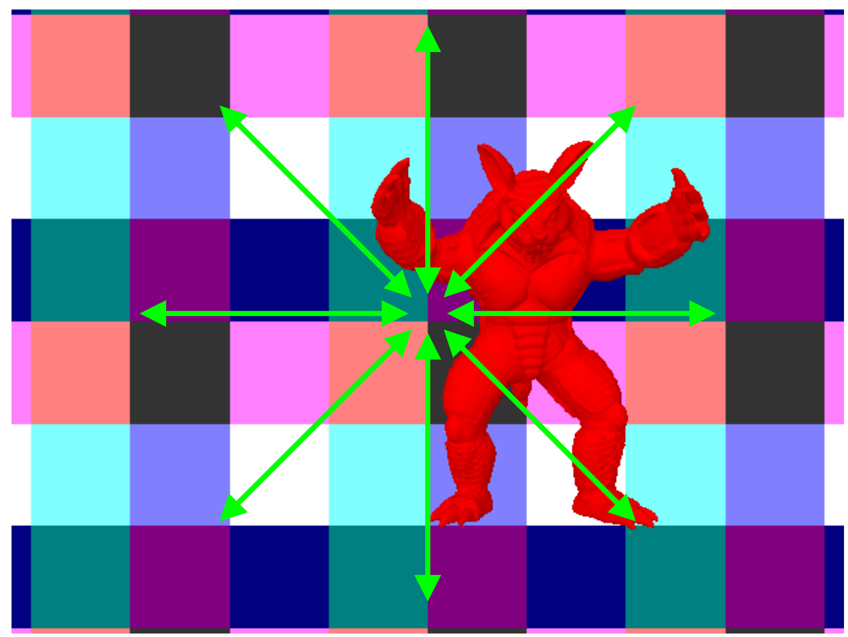
Previous Work

- Depth Images
  - Combined samples of multiple depth images [McMillan 1995, Mark 1997, Popescu 2000]
  - Layered Depth Images (LDIs) [Shade 1998], and LDI Trees [Chang 1999]
  - Vacuum Buffer [Popescu 2001]
- Non-pinhole cameras
  - Pushbroom camera [Gupta 1997], Two-slit Camera [Pajdla 2002], General Linear Camera [Yu 2004]
  - Light Field [Levoy 1996], Lumigraph [Gortler 1996]
  - Multiple-Center-of-Projection Camera (MCOP) [Rademacher 1998]
- Occlusion cameras
  - Single-Pole Occlusion Camera (SPOC) [Mei 2005]
  - Depth-Discontinuity Occlusion Camera (DDOC) [Popescu 2006]

Camera Model

- Epipolar geometry allows us to reduce search space to 1D
- We exploit this in our camera model





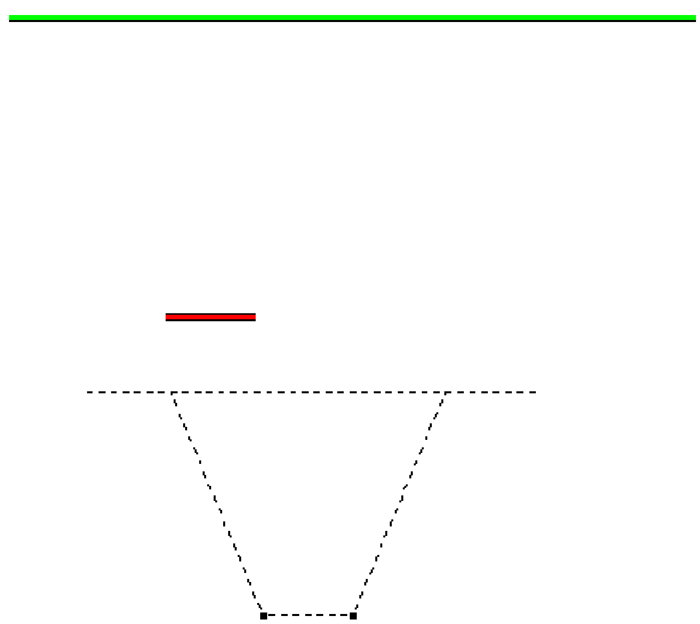
Camera Model

- The camera model requires 2 parts
  - Projection map
  - Ray map
- These maps are built from left to right

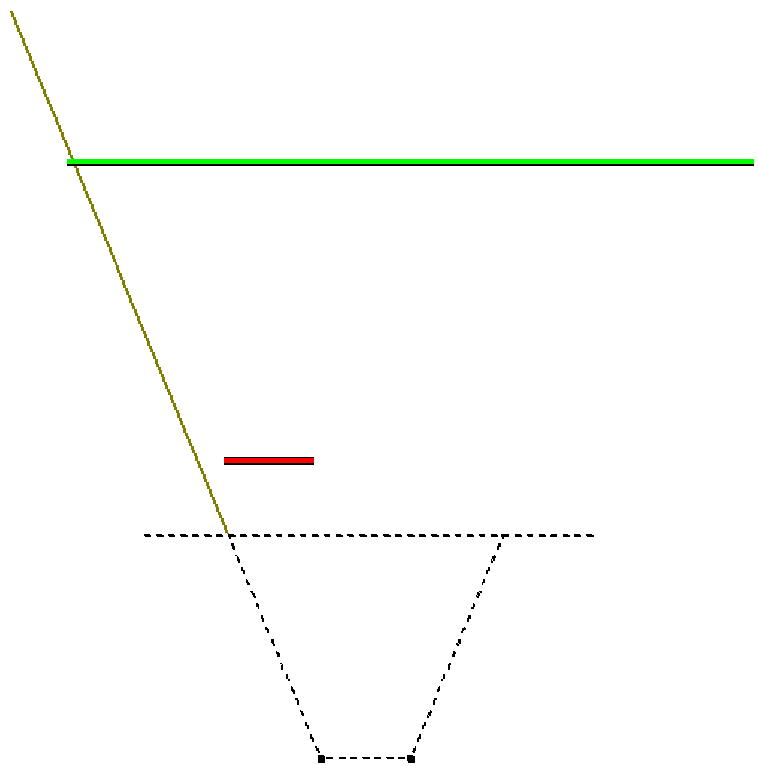
Camera Model

- For every ray on an epipolar segment
  - If has no depth discontinuity
    - Insert ray into ray map
  - Else
    - Calculate new ray set
    - Insert ray set into ray and projection maps

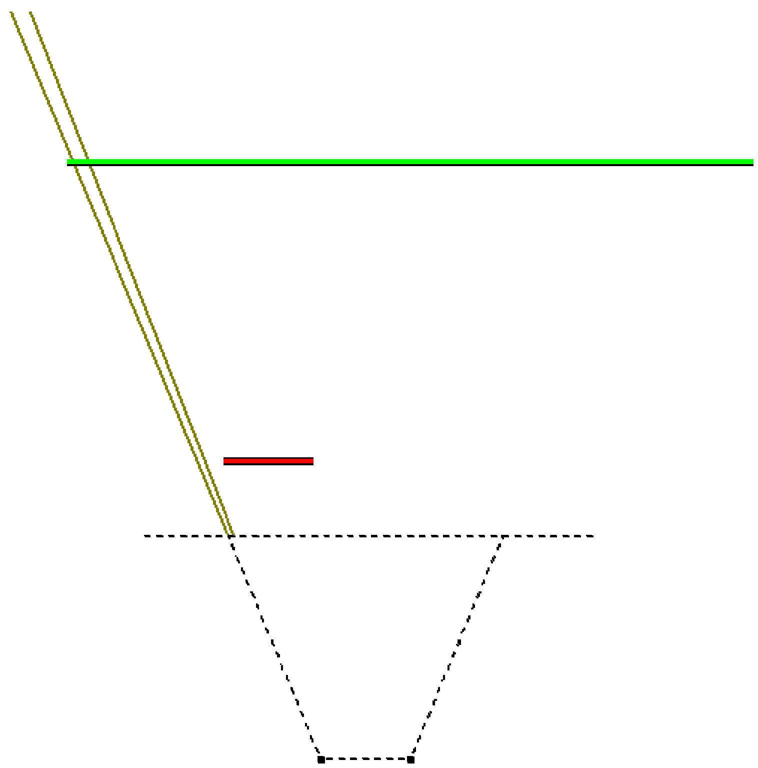
Camera Model



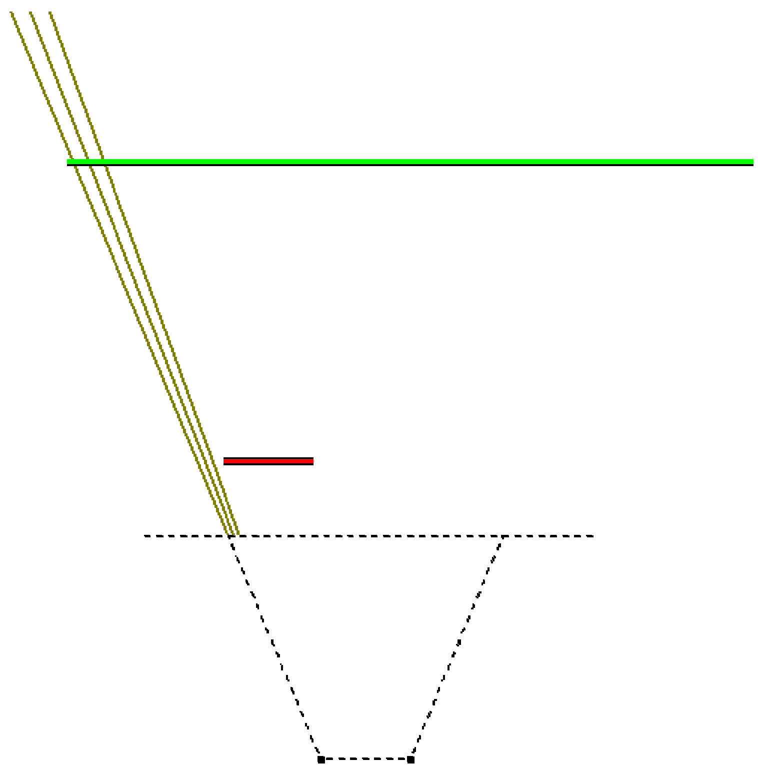
Camera Model



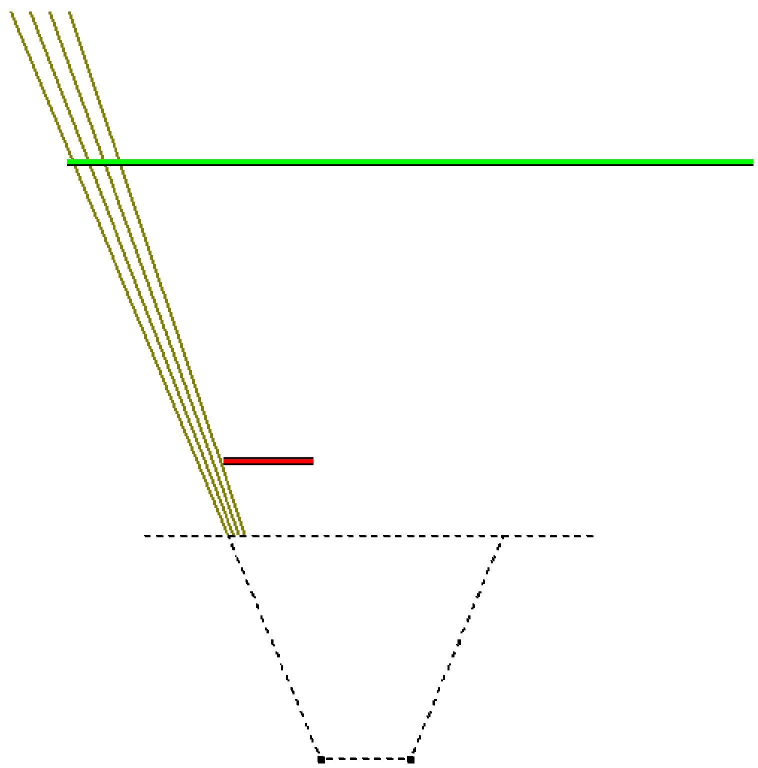
Camera Model



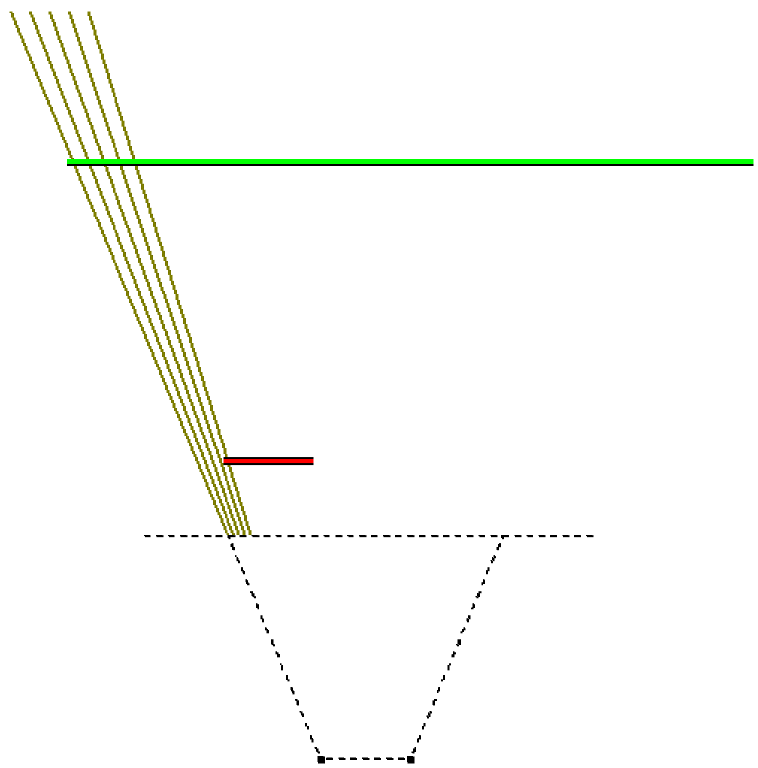
Camera Model



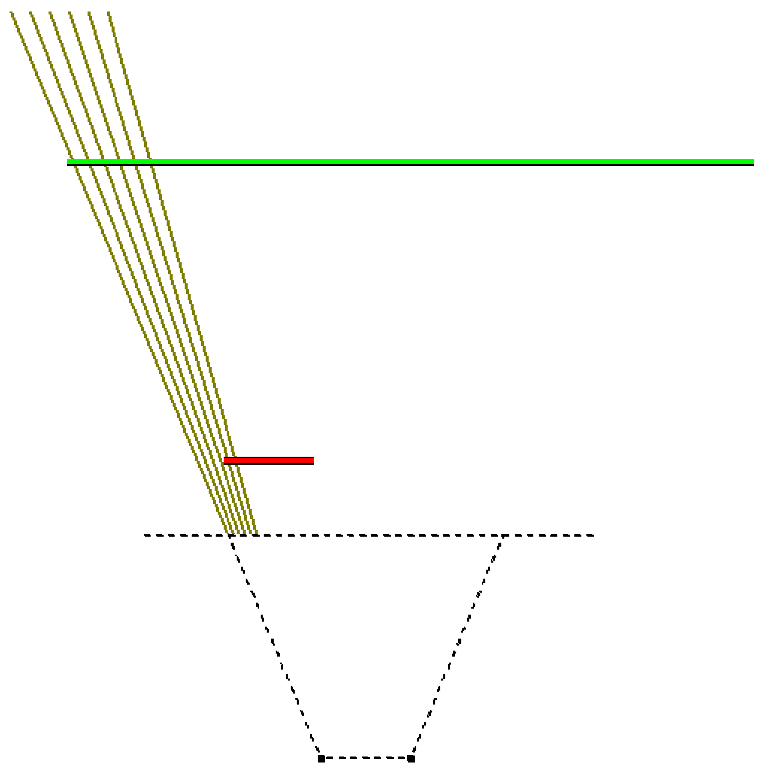
Camera Model



Camera Model



Camera Model



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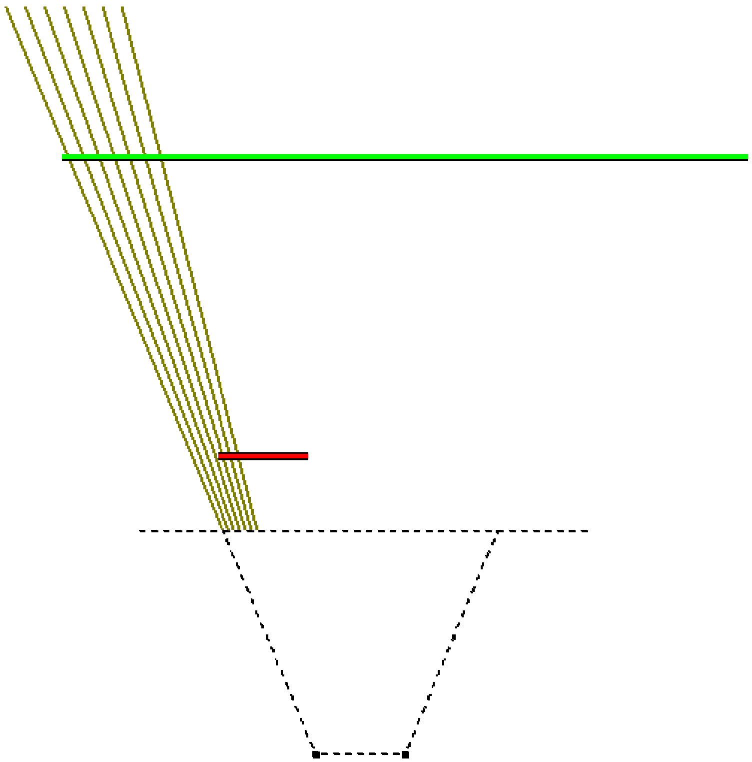
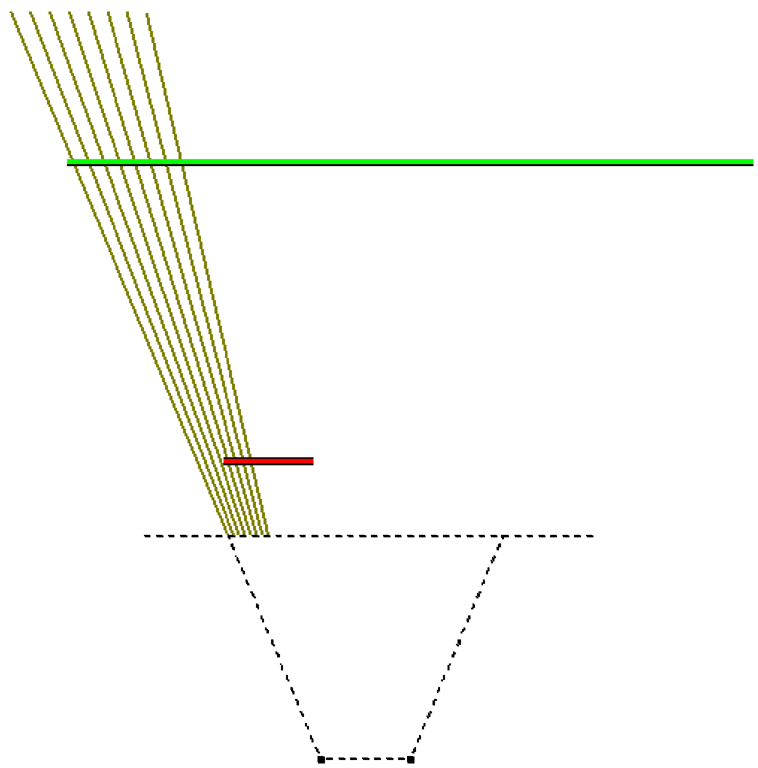
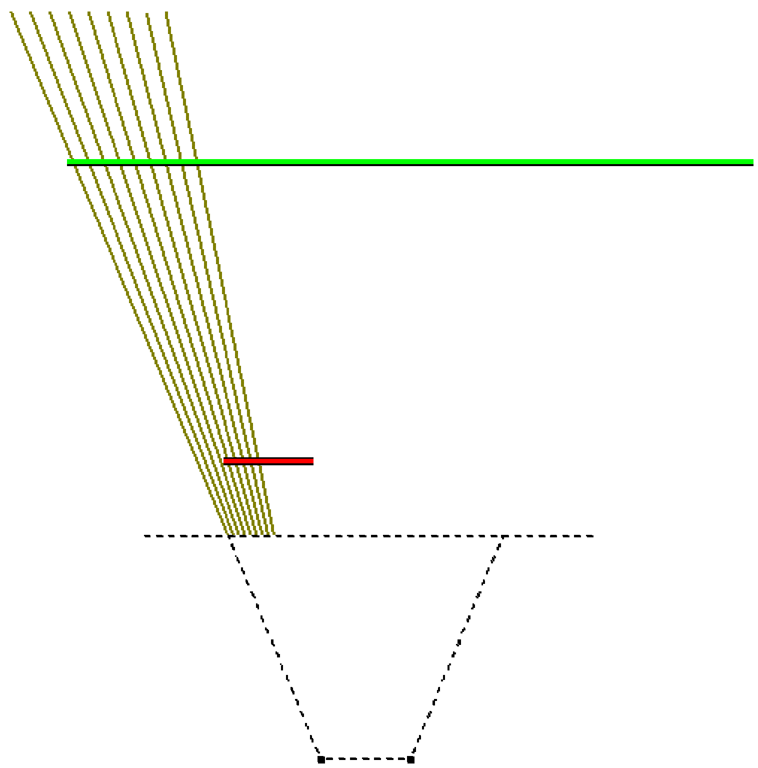


Camera Model



Camera Model



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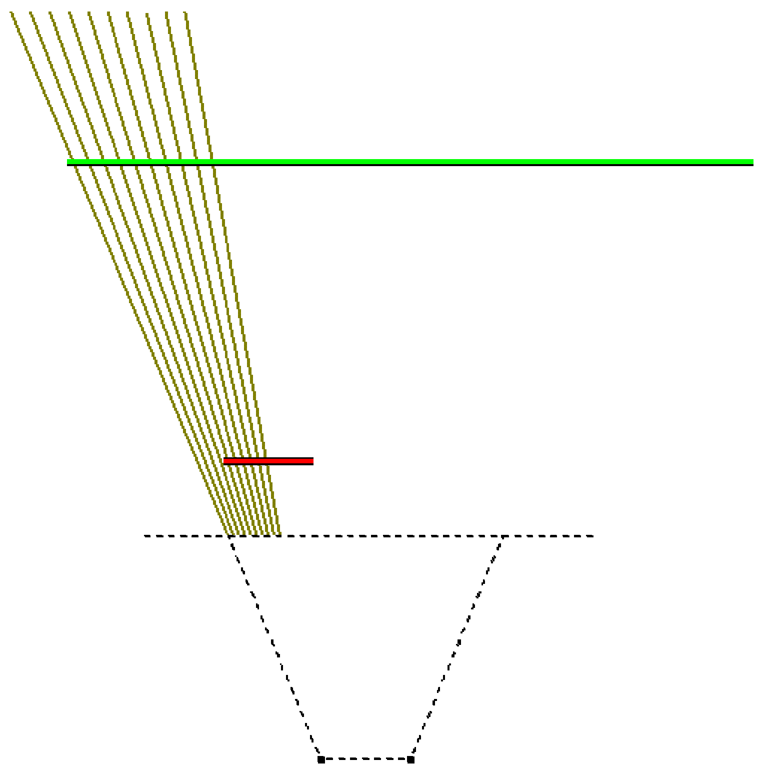

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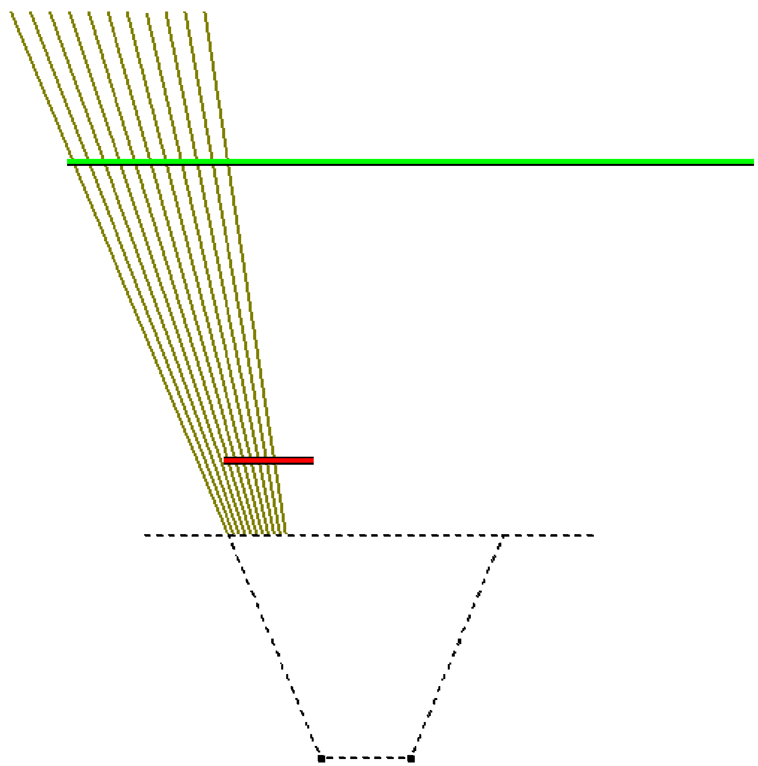

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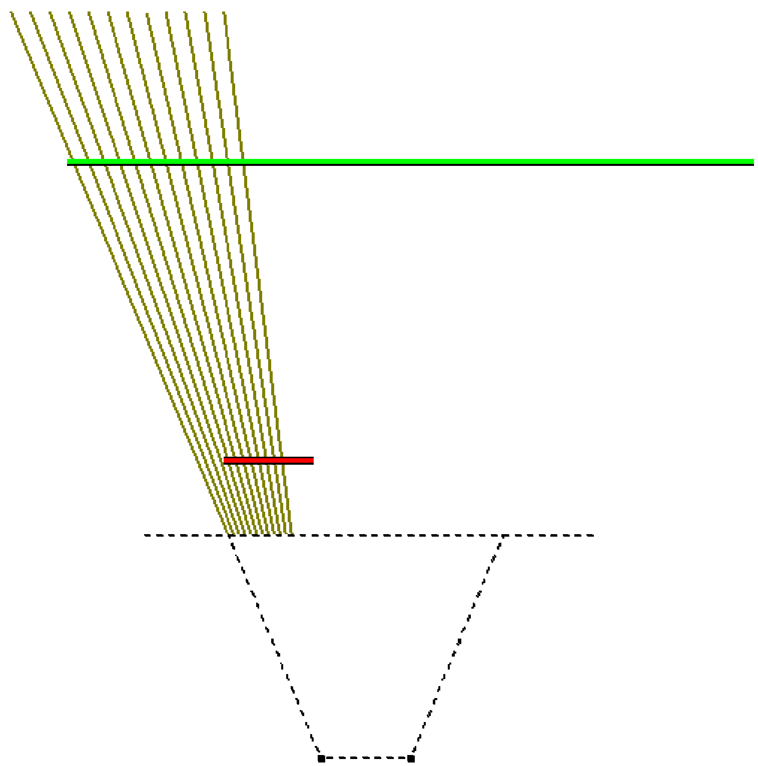

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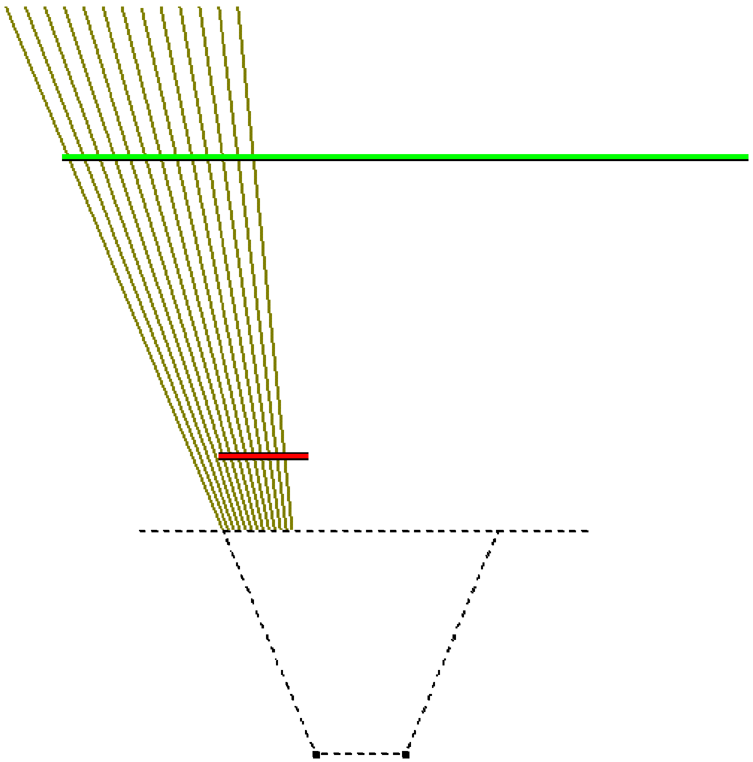

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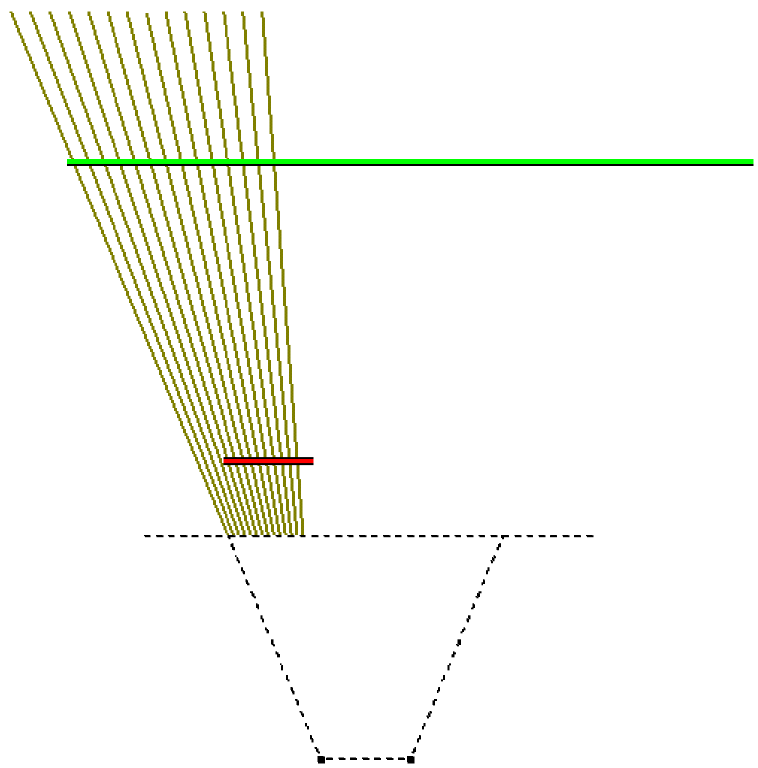

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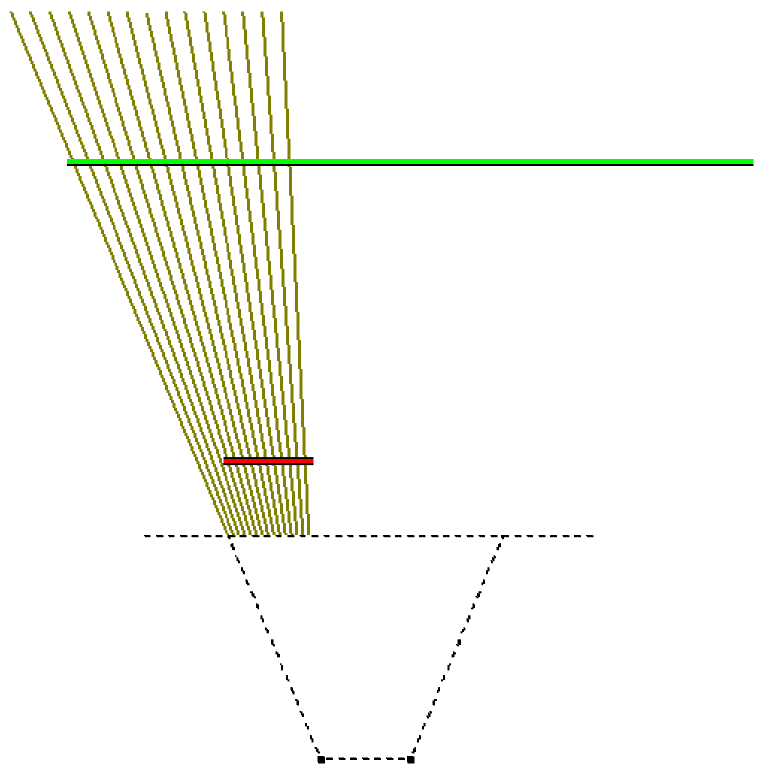

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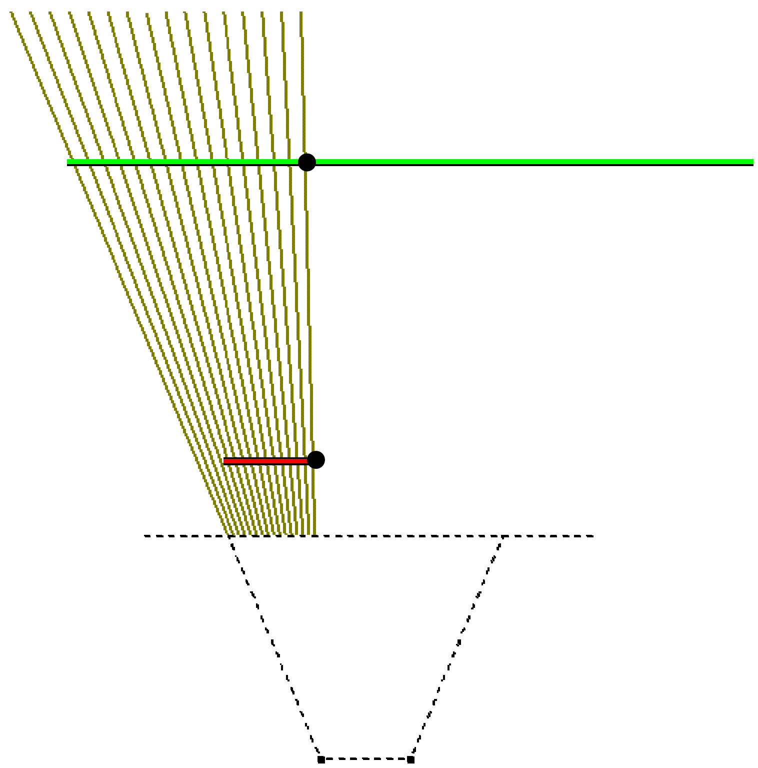

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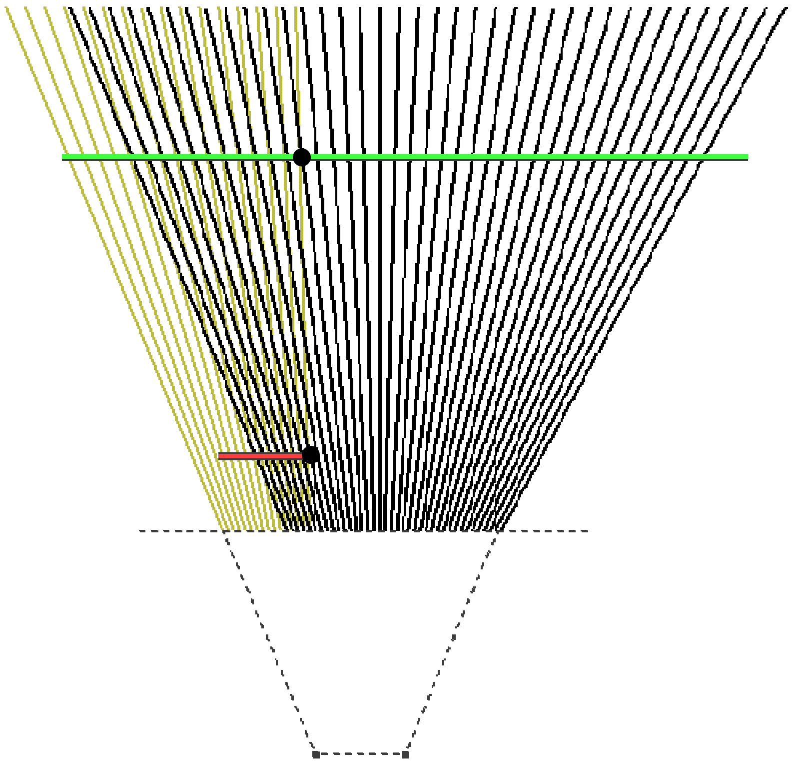

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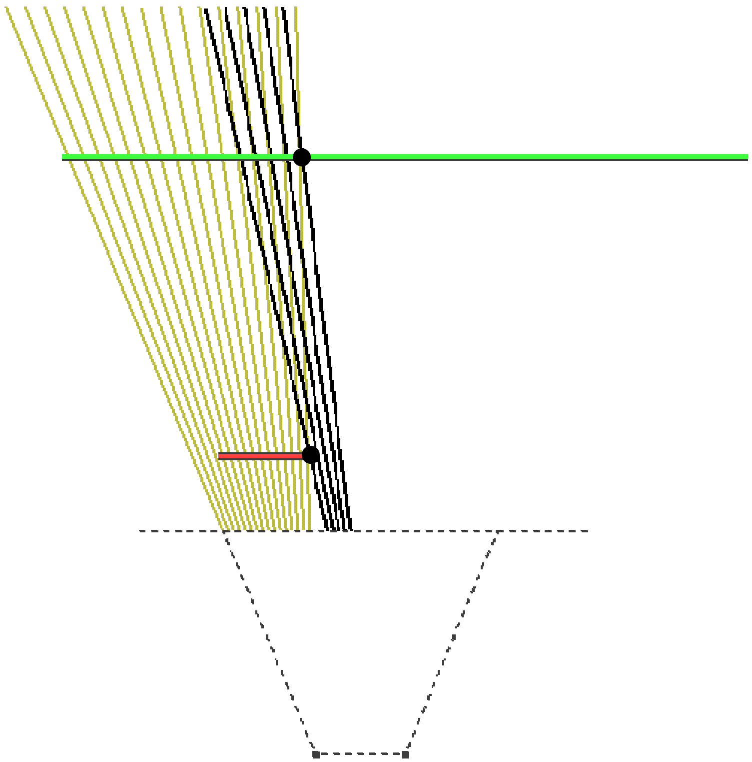

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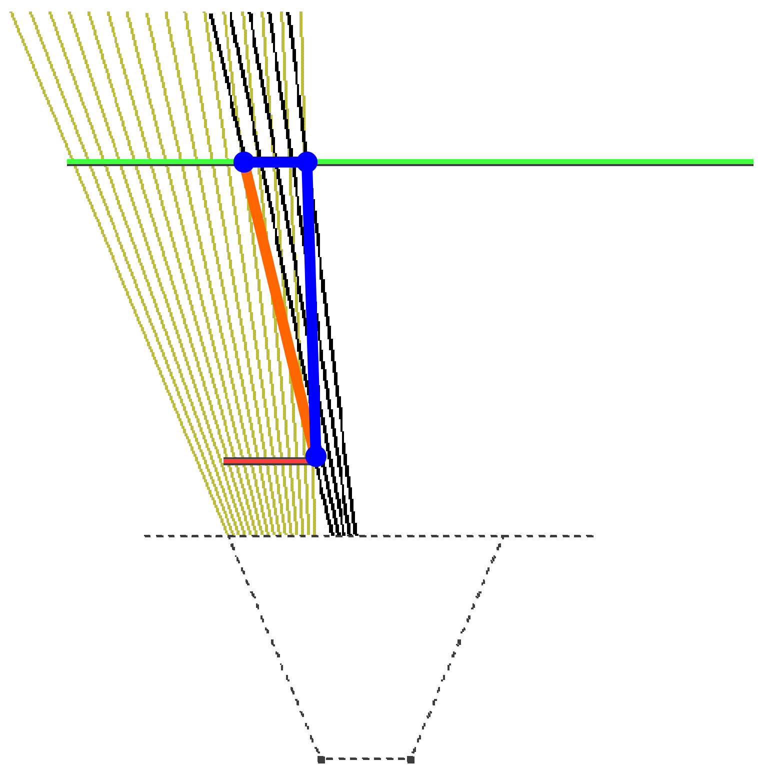

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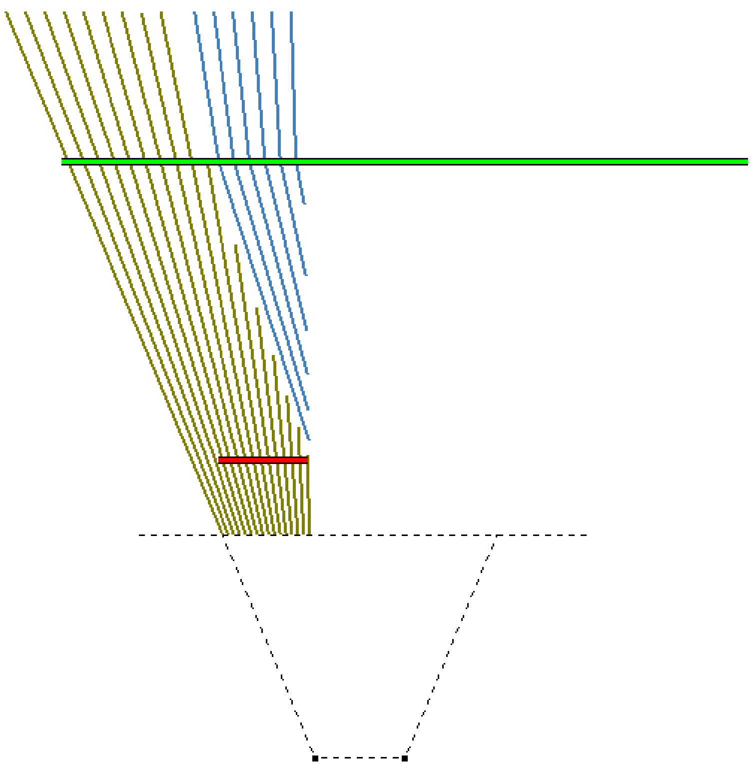

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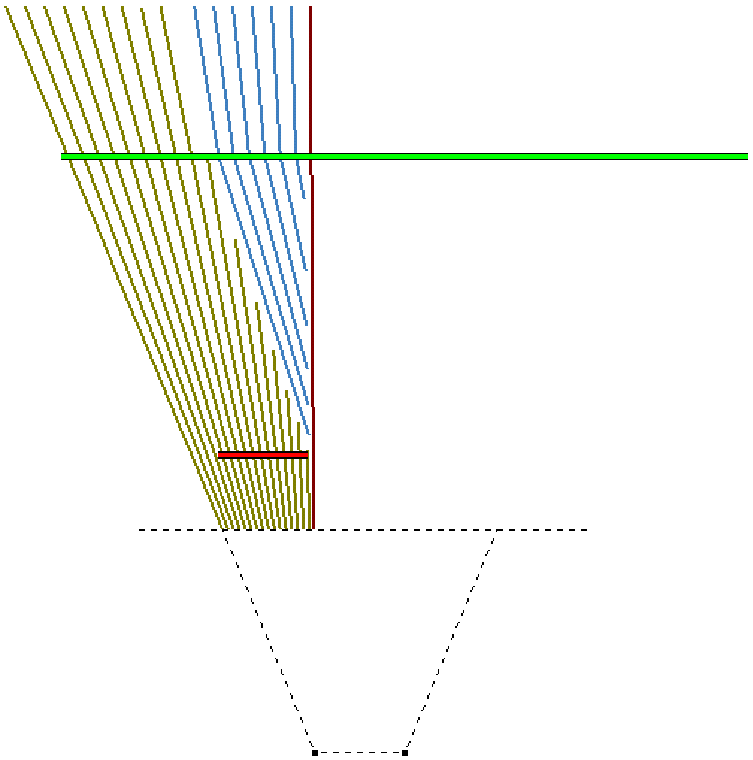

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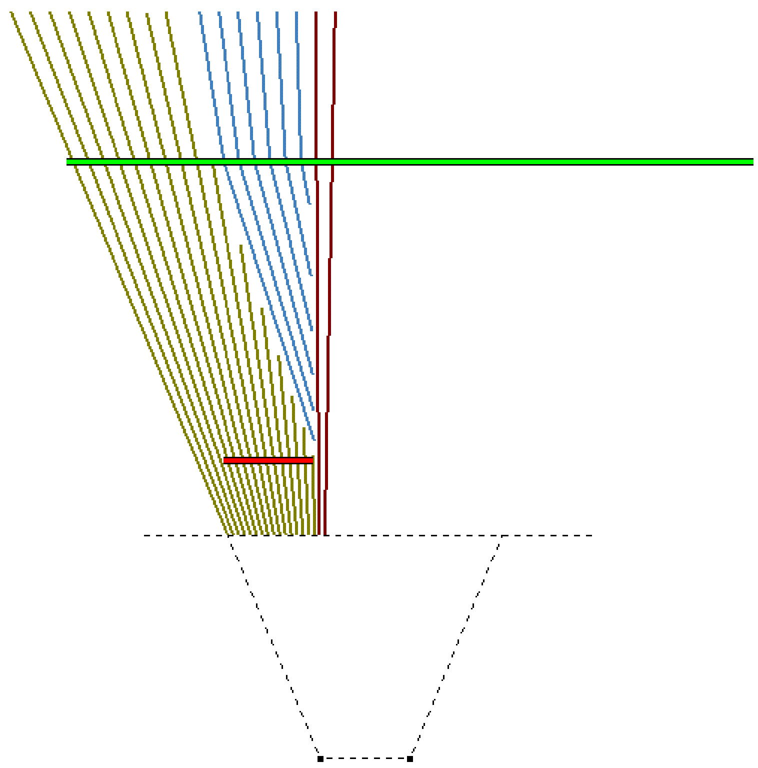

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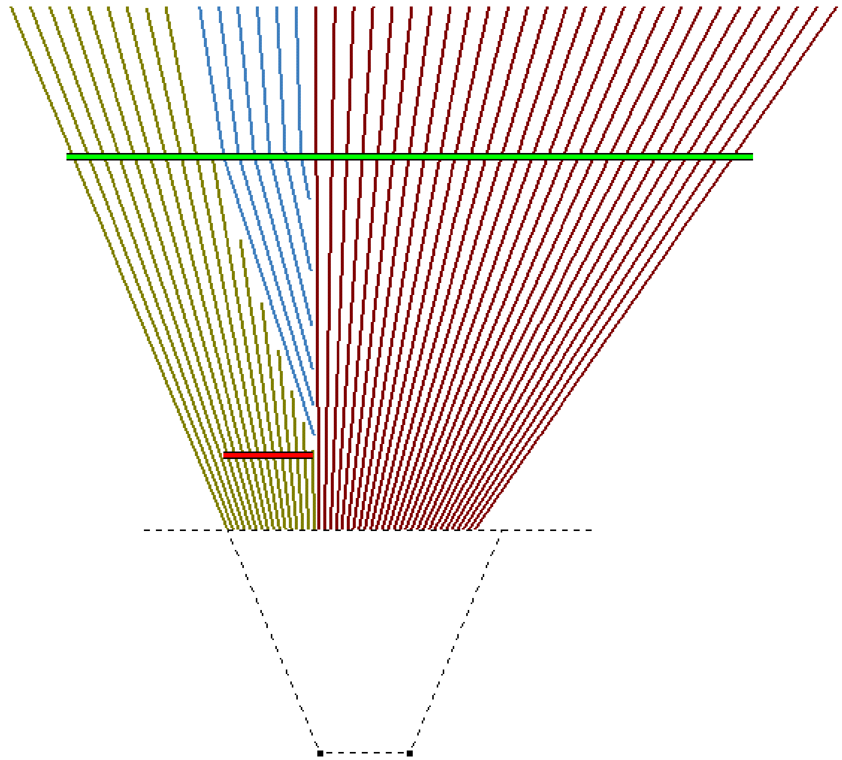

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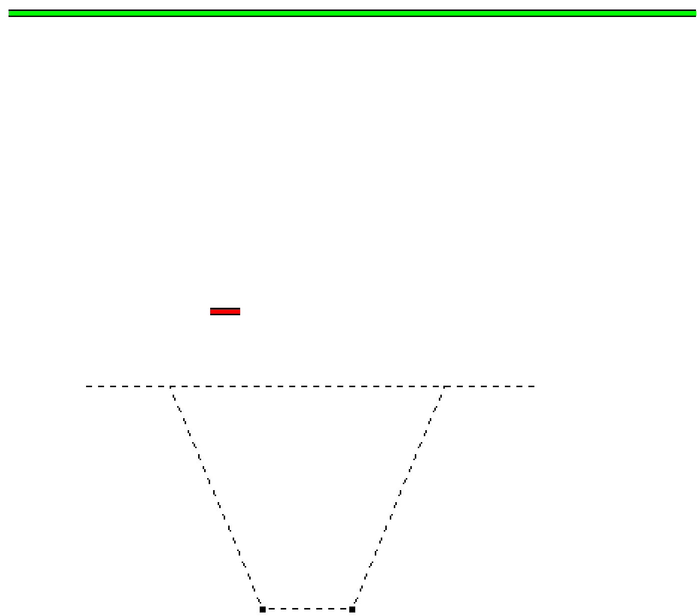

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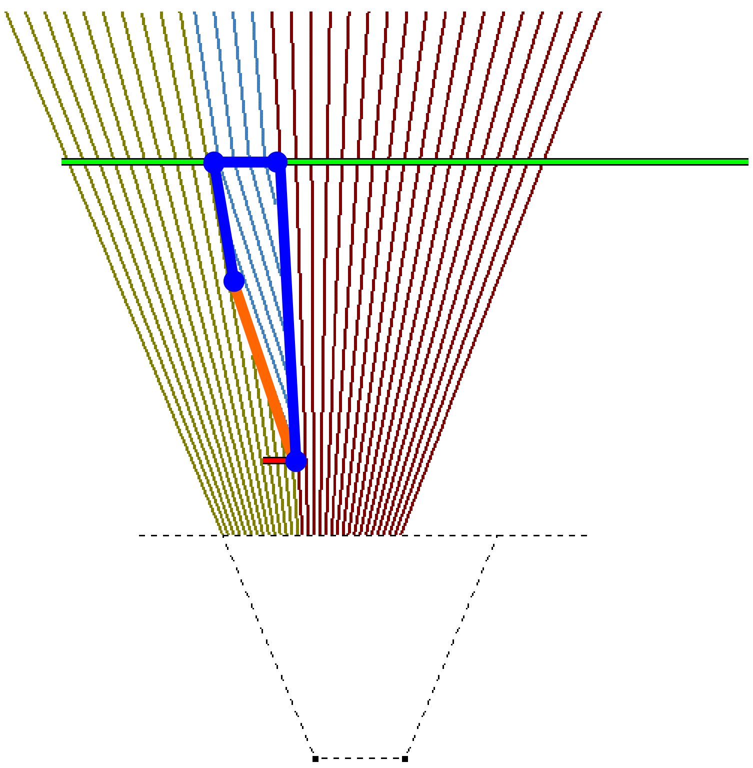

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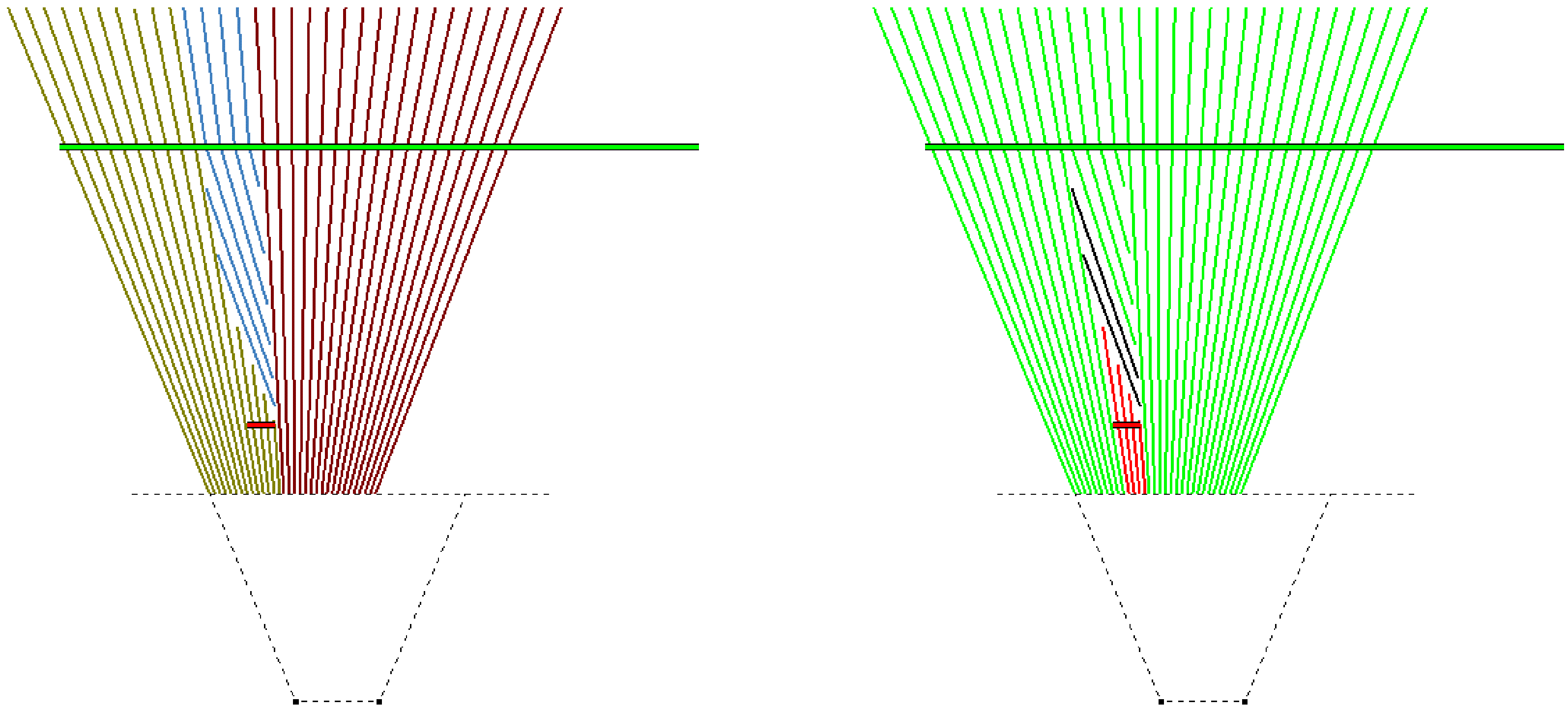


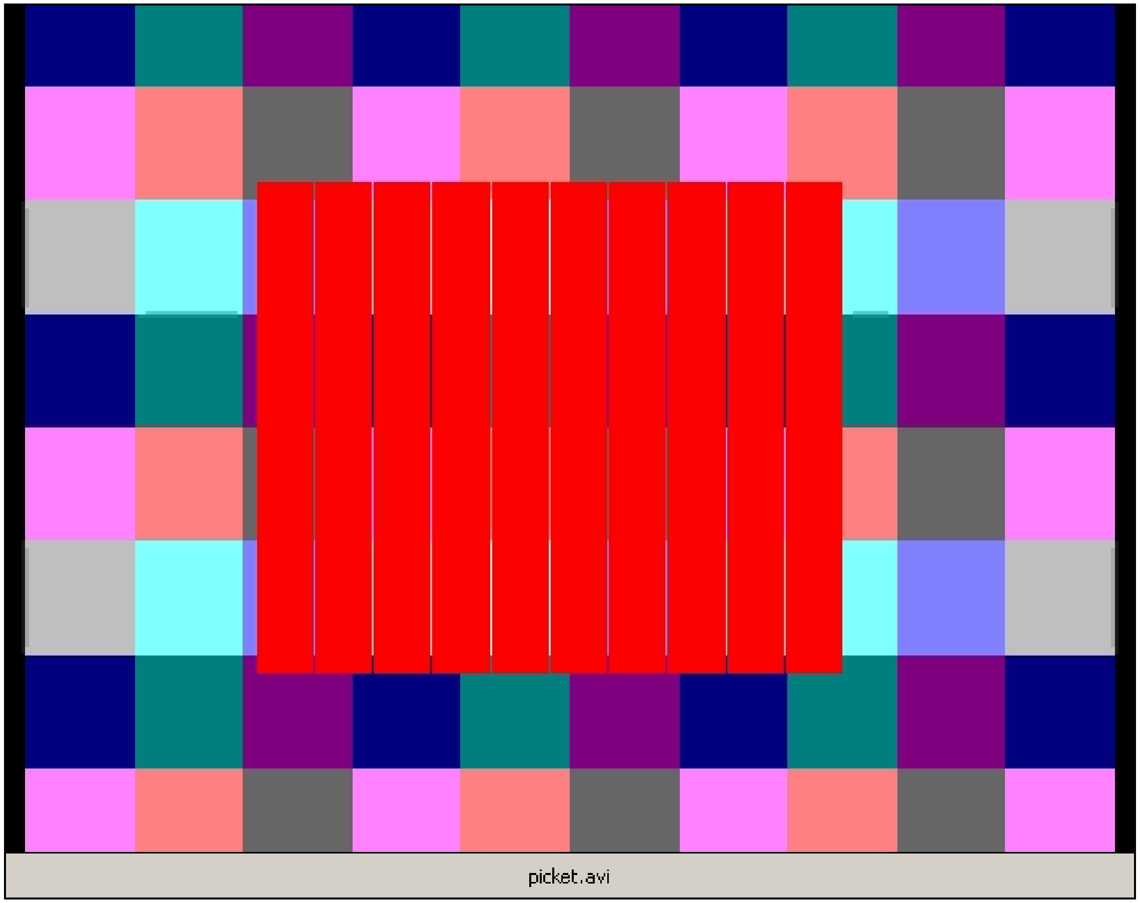
Camera Model

- Ray Map
  - Stores the rays (of at most 2 segments)
- Projection Map
  - Stores a minimum and maximum offsets
  - z_n and z_f for the offsets
  - Does not provide a precise project for a point
    - Instead, provides a segment on which the point exists

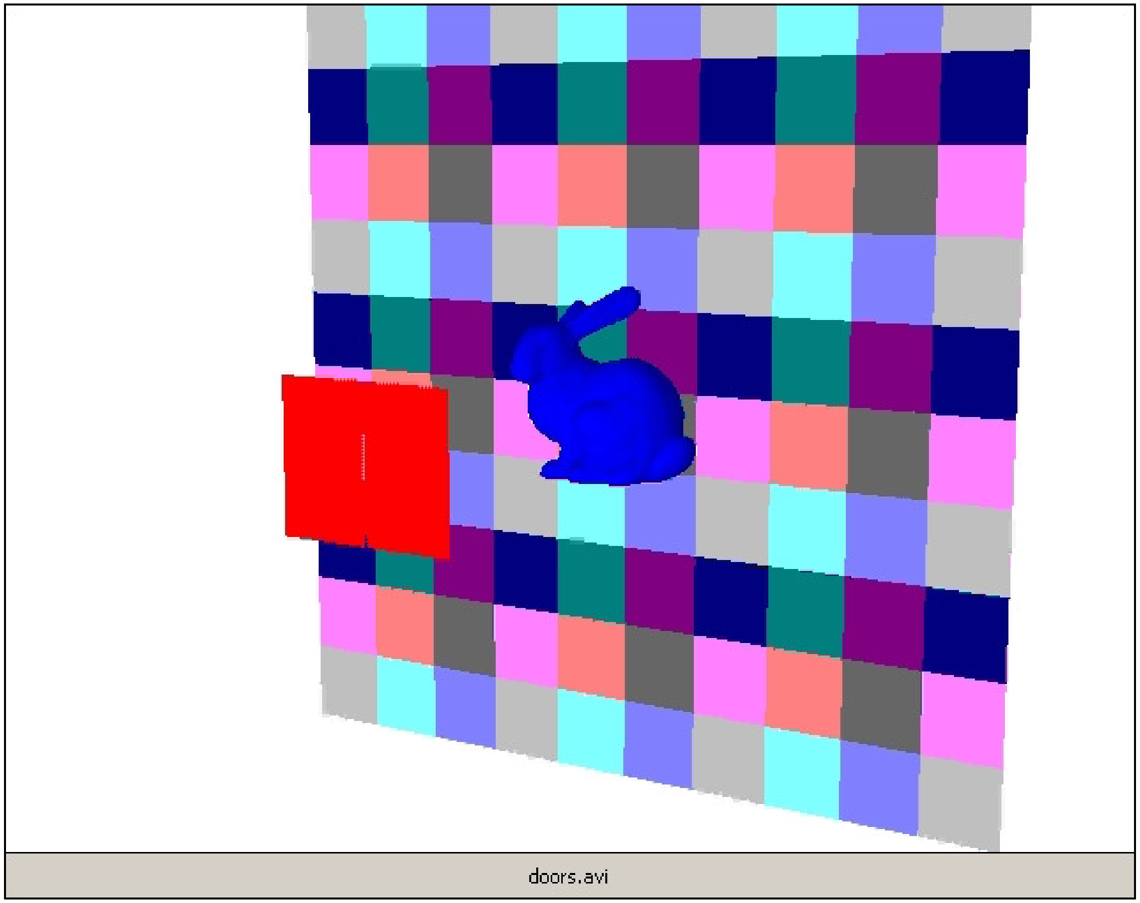
Rendering

- CPU and GPU implementation
  - GPU implementation requires a card supporting DX 10
- Algorithm
  - Project a triangle with the Left PHC
    - For every epipolar span for the triangle
      - Project the end points with the EOC *Projection Map*
      - Rasterize by intersecting the EOC projected segment with the corresponding rays in the *Ray Map*

Examples
Picket Fence

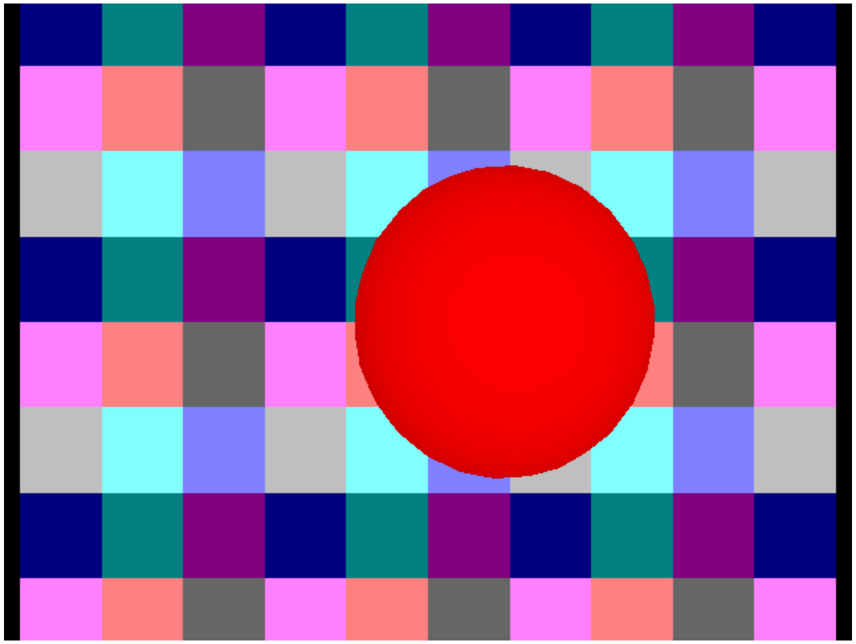


Examples
Double Doors

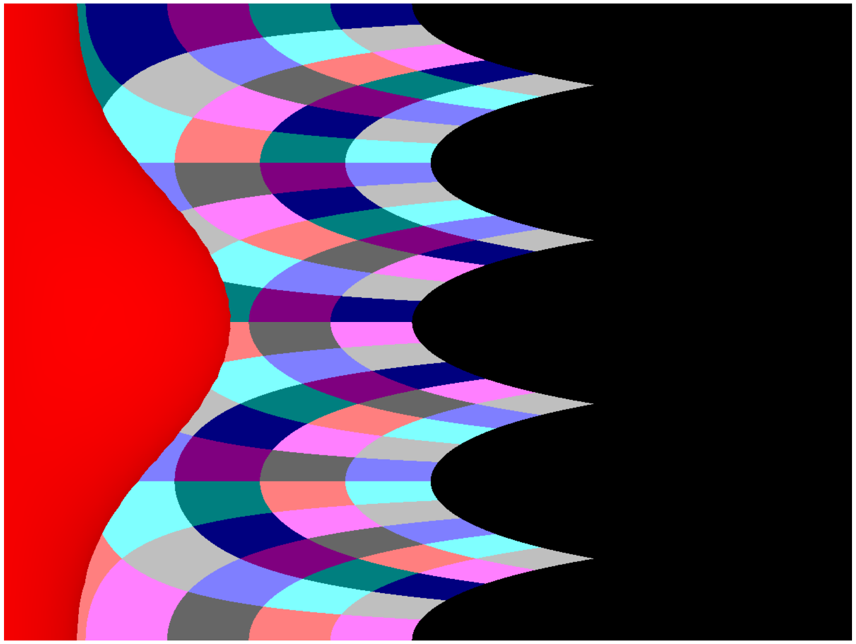


Examples
Radial Sphere

PHC Projection

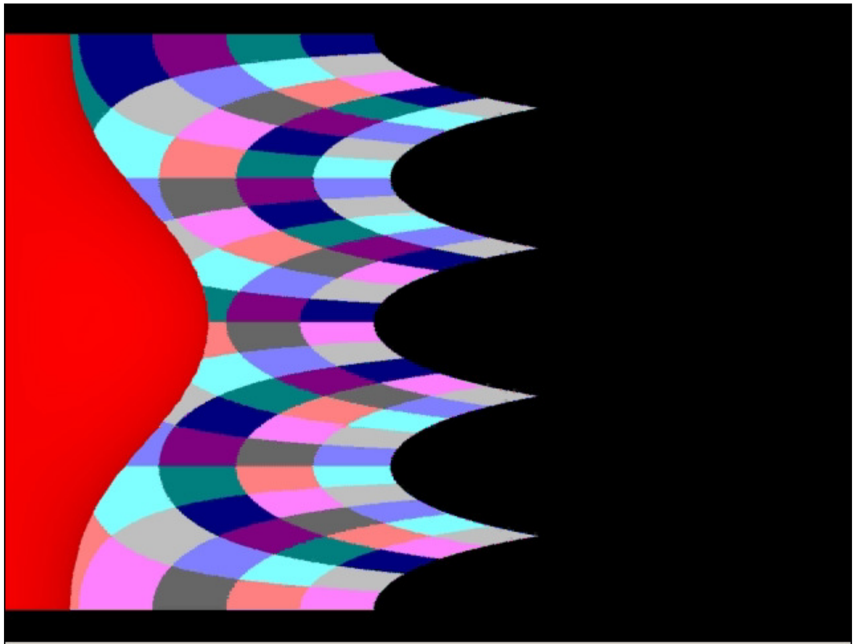


Radial Projection



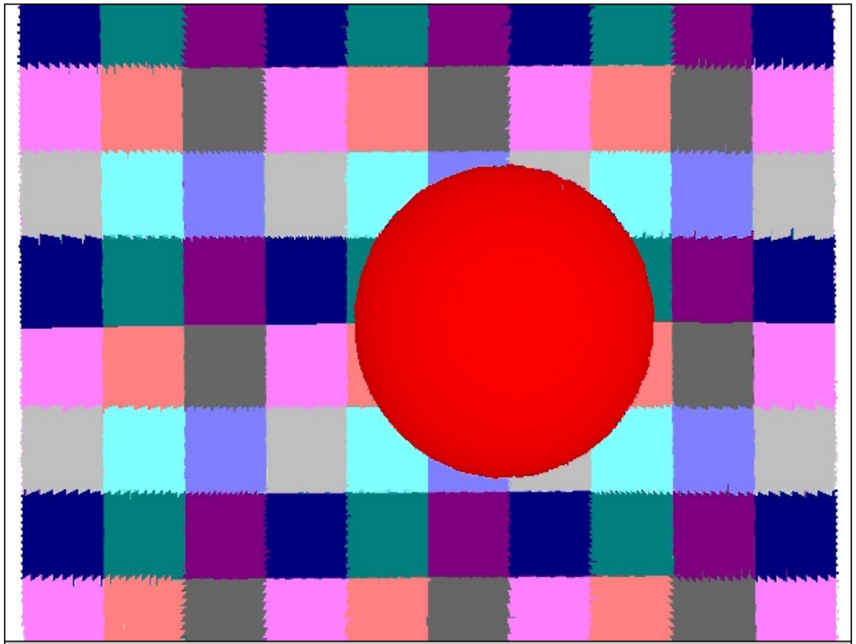
Examples
Radial Sphere

EOCI Progressive Build



sphere_map.avi

EOCI Reconstruction

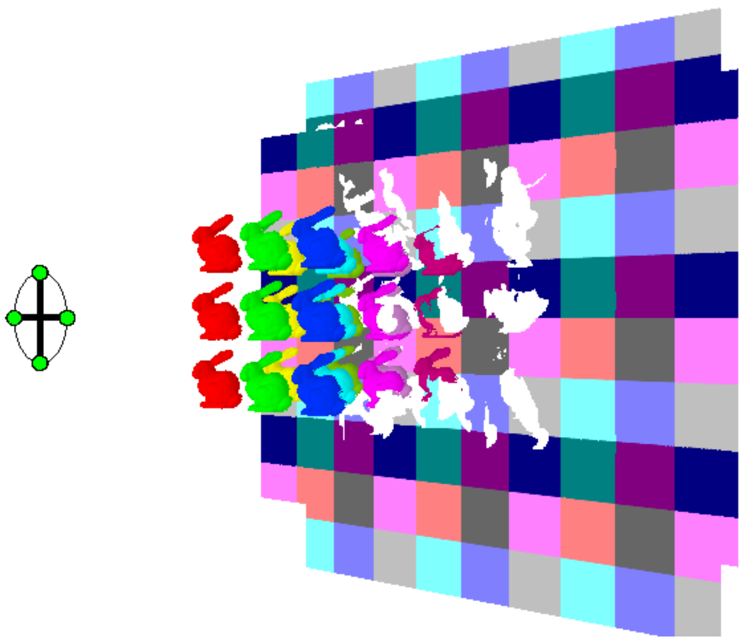


sphere_recon.avi

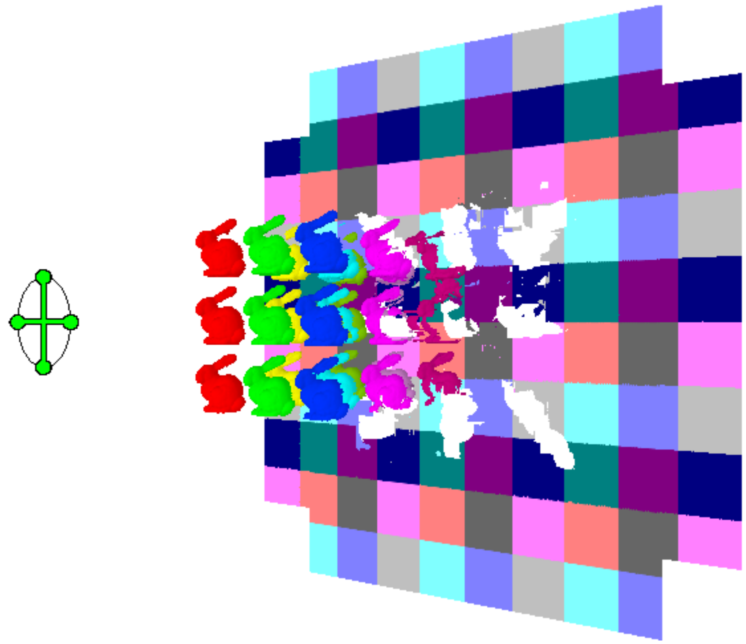
Examples
Radial Armadillo

Examples
Crossing Segments of Projection

Depth Images

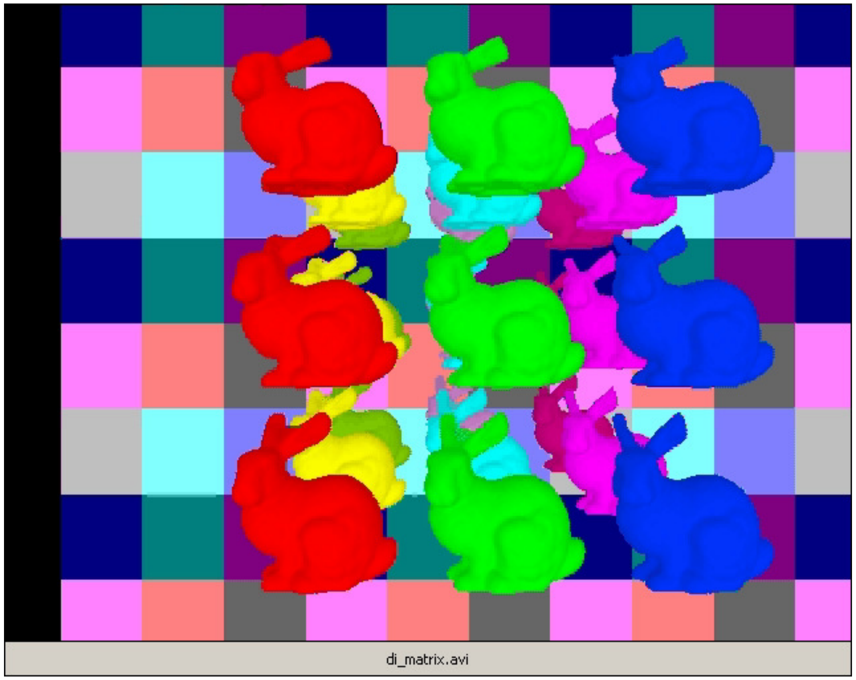


EOC Image

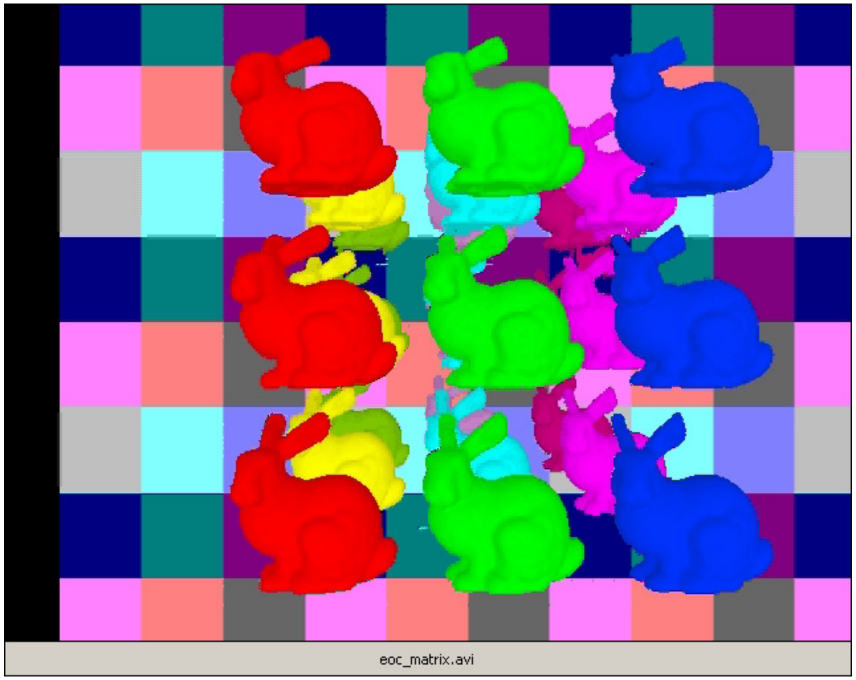


Examples
Crossing Segments of Projection

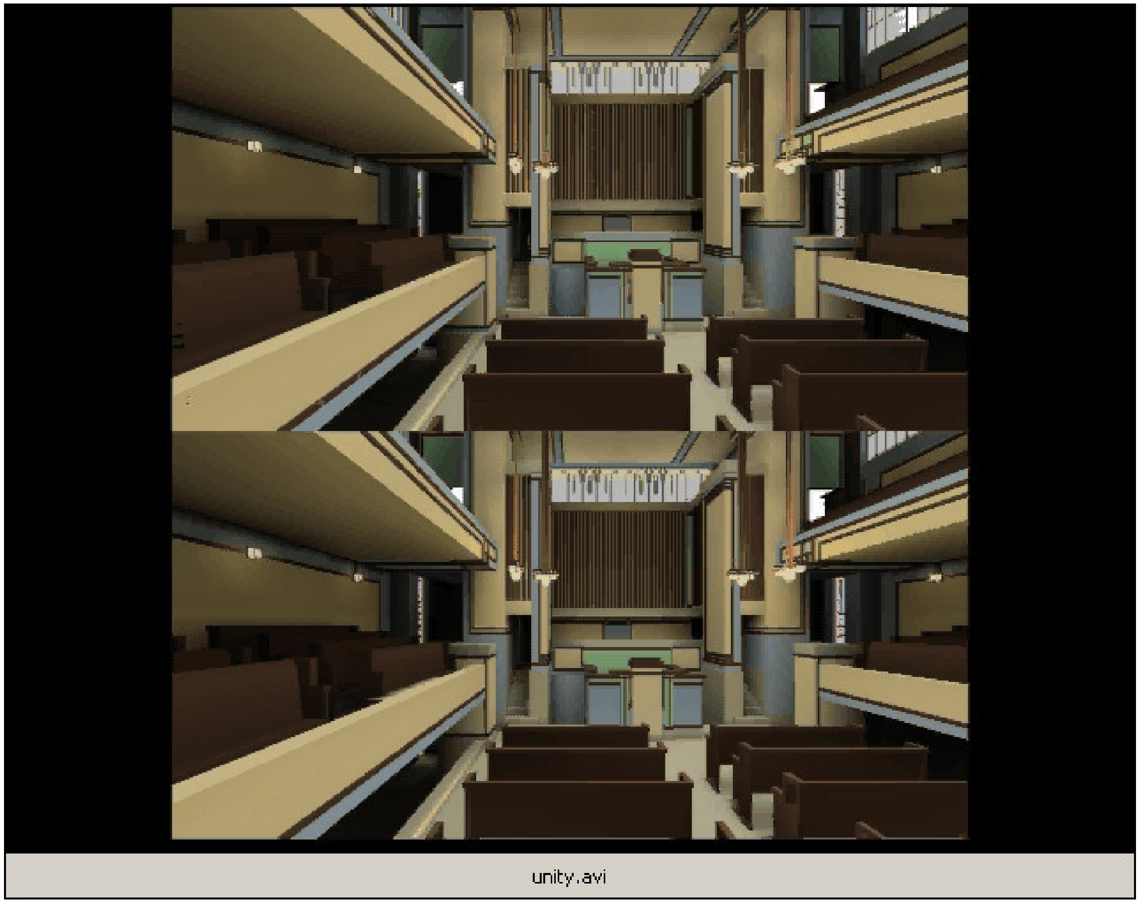
Depth Images



EOC Image

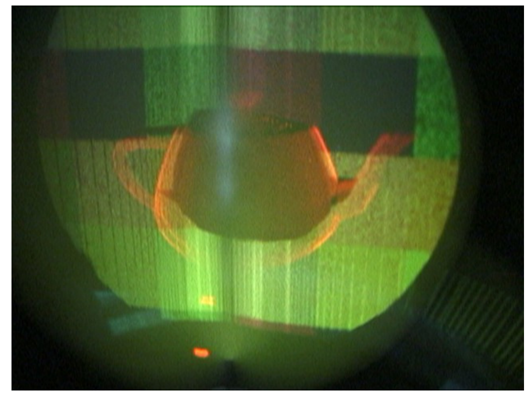


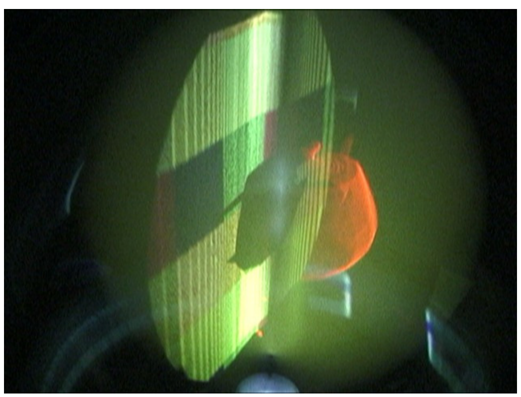
Examples
Complex Scene (Unity)

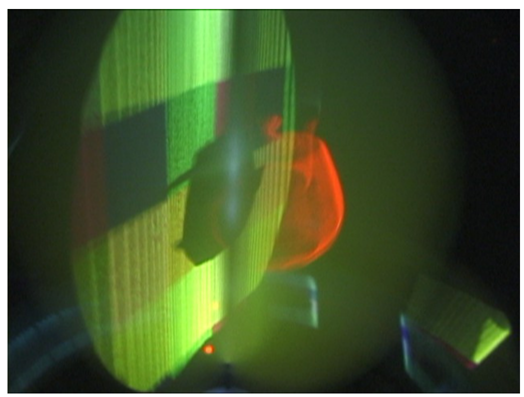


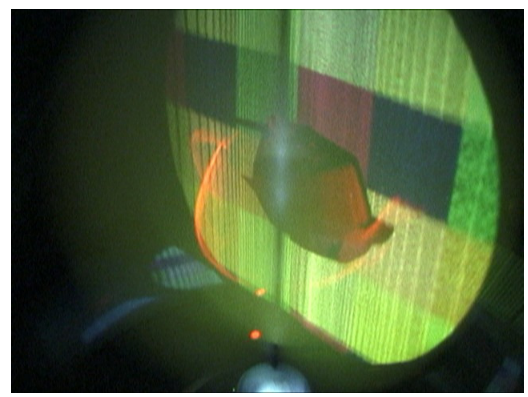
Applications

- Geometry Replacement
- Compression
- 3D Display Acceleration









Conclusions

- Novel non-pinhole camera model designed to gather samples visible along a segment
- Provide fast projection
  - Without redundant sampling
- Unlike previous occlusion cameras, the EOC does not place restrictions on the scene complexity

Future Work

- Accelerating the construction of the EOC model by off-loading it from CPU to GPU
- A rigorous study of the conservativeness of the EOC model
- Non-redundant light field
- Occlusion cameras models that can be constructed from sets of pinhole camera images, without the need of geometry.
- Apply the model to other computer graphics contexts, including motion blur, antialiasing, and soft shadows.

Thank you

- Questions?