Path Integral Methods for Light Transport Simulation: Theory & Practice

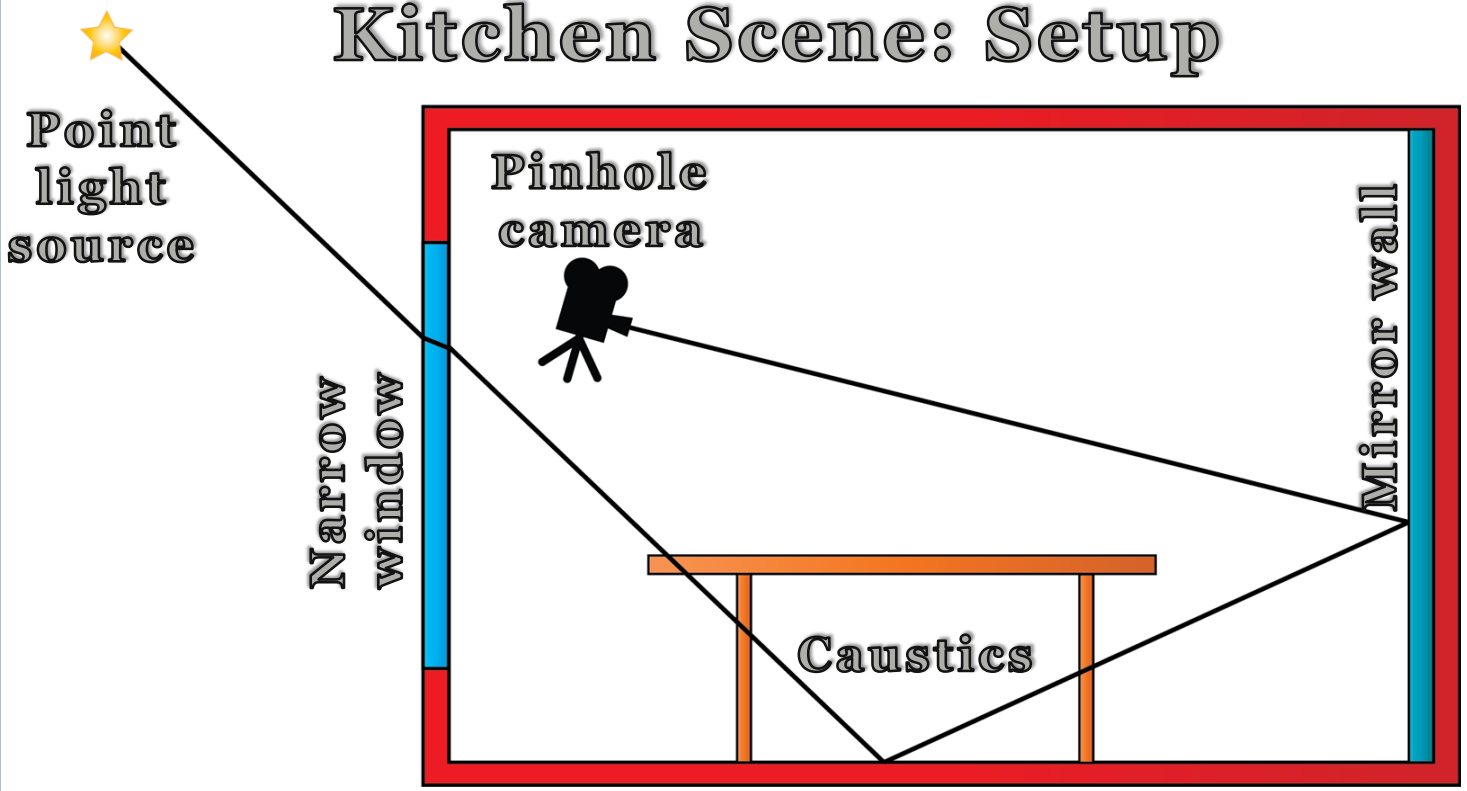
Comparison of

Advanced Light Transport Methods

Equal Time Comparison

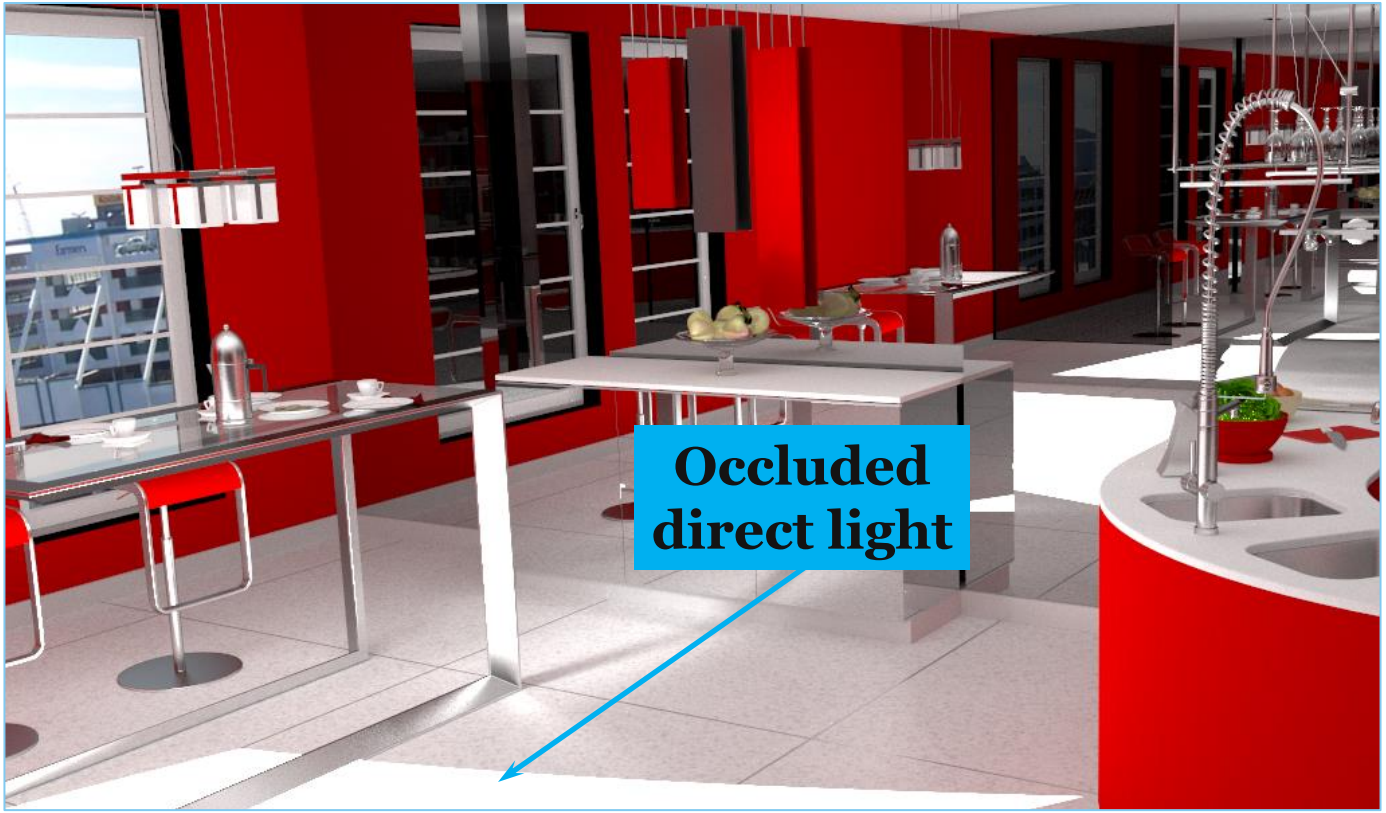
- Rendering time: 1 hour on GeForce 580
  - Some are rendered with Mitsuba [Jakob10]
- *Kitchen* – a hard-to-render scene
  - Light occluded by glass, caustics
  - Many mirrors, reflected caustics
  - Glossy materials
  - Curved glass with many specular interactions

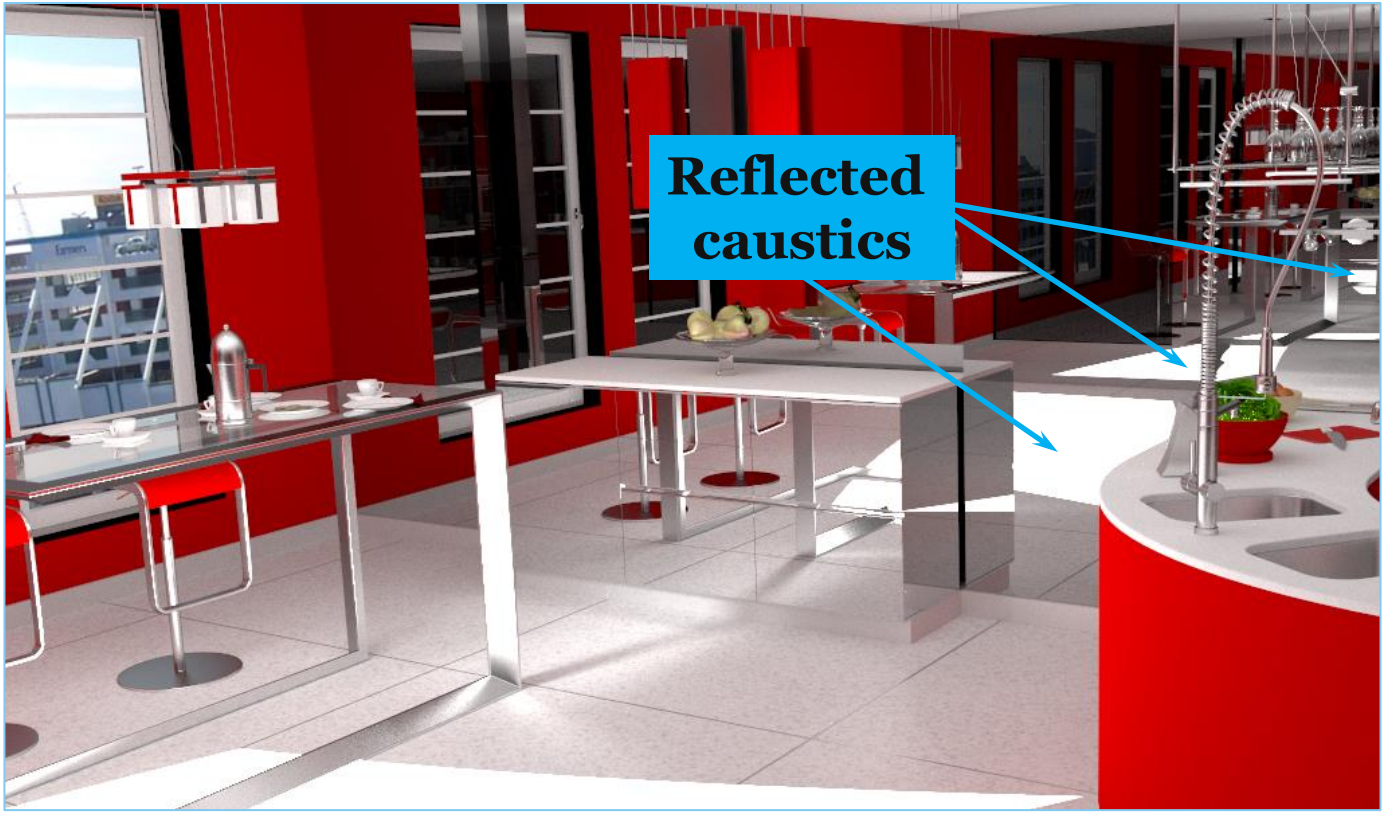
Kitchen Scene: Setup



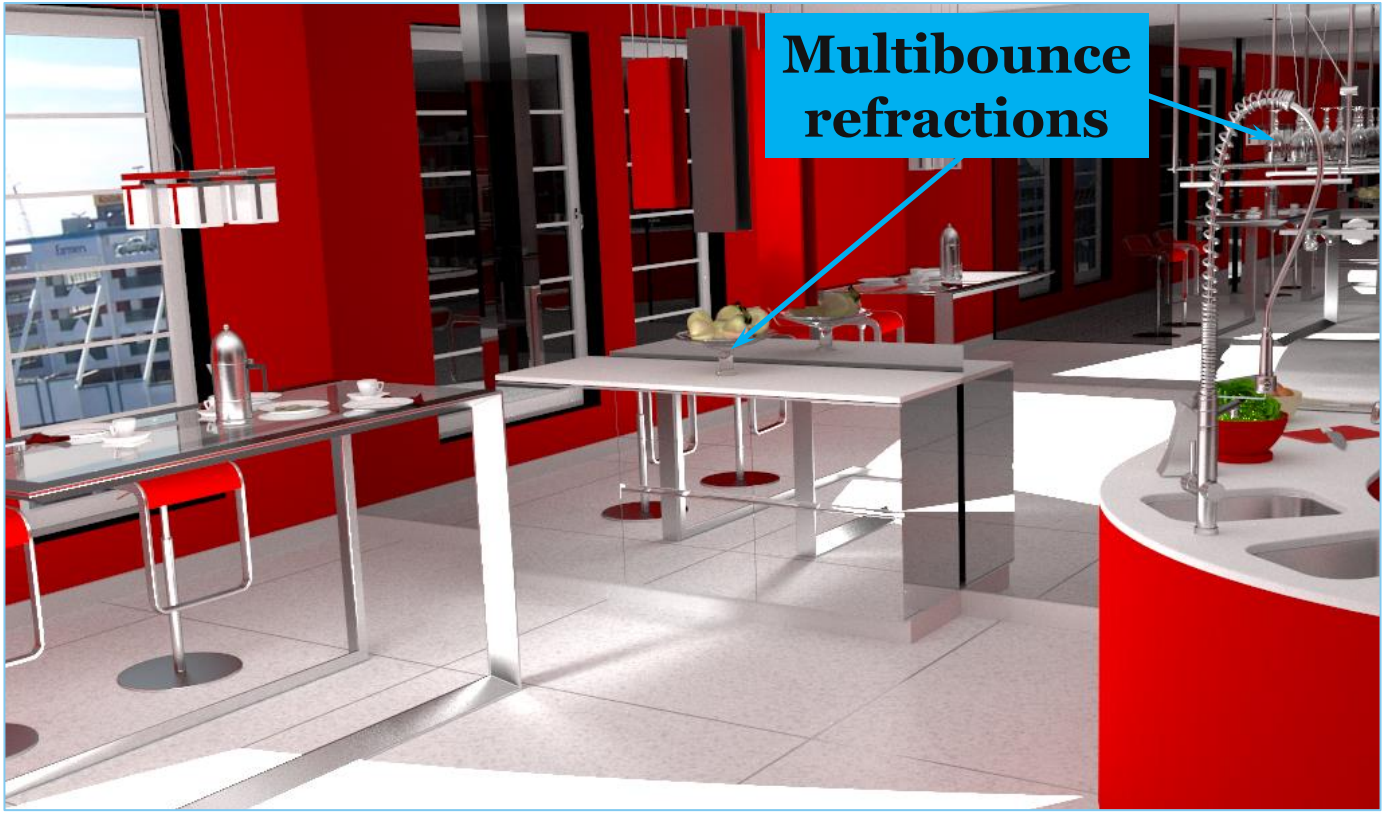

Kitchen scene (diffuse materials)

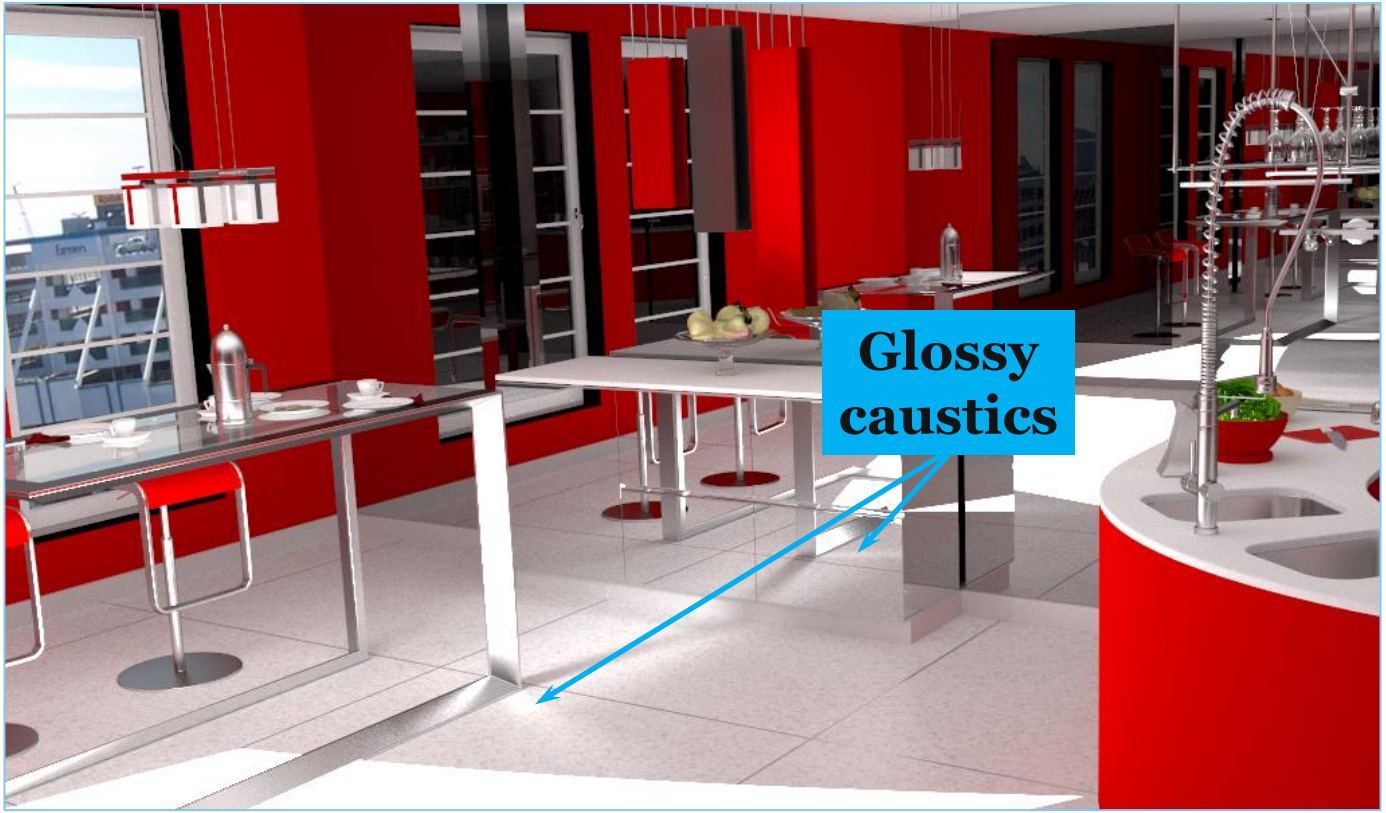

Kitchen scene (reference)


Occluded
direct light


Reflected
caustics


Multibounce
caustics


Multibounce
refractions

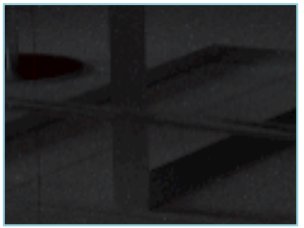

Glossy
caustics

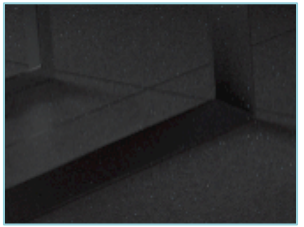
Ordinary
Monte Carlo Methods

Ordinary Monte Carlo Methods

- Path tracing [Kajiya86]
- Light tracing [Arvo86, Dutre93]
- Bidirectional path tracing [LaFortune93, Veach94]
- Vertex connection and merging [Hachisuka12, Georgiev12]

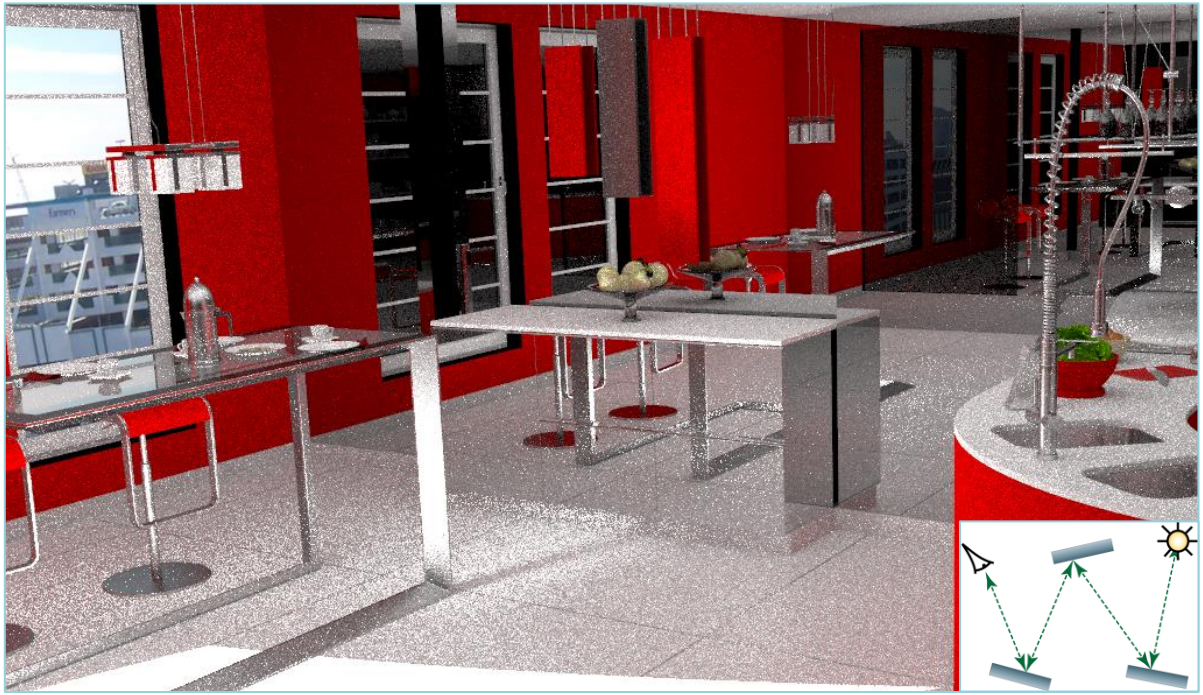
Path Tracing

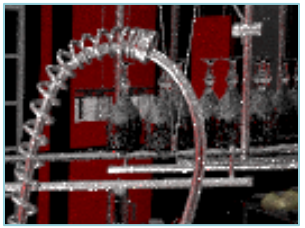


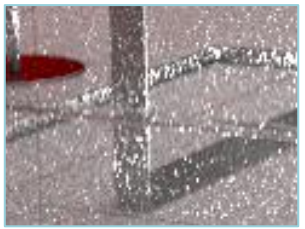


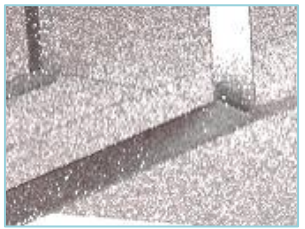
Light Tracing

Bidirectional Path Tracing

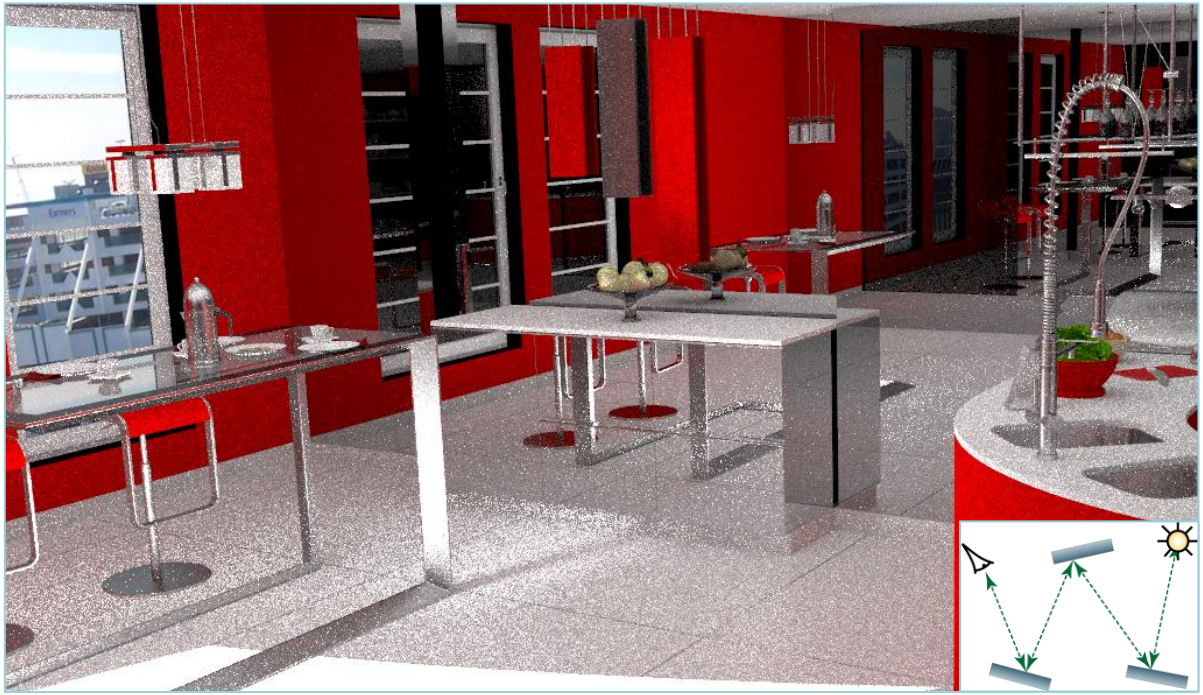


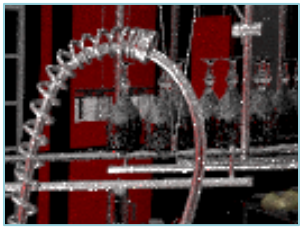




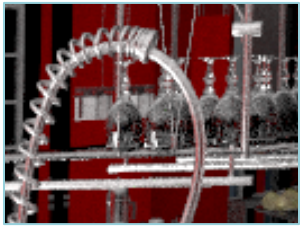


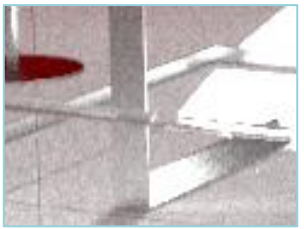
Bidirectional Path Tracing





Vertex Connection and Merging





Markov Chain Monte Carlo Methods

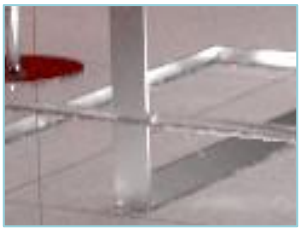
Markov Chain Monte Carlo Methods

- Metropolis light transport [Veach97]
- Different mutations
  - Primary sample space mutation [Kelemen02]
  - Path space mutations [Veach97]
  - + Manifold exploration mutation [Jakob12]
- Energy redistribution path tracing [Cline05]

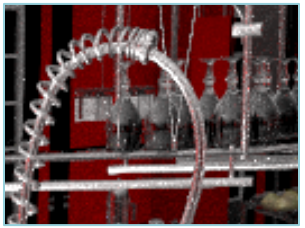
Markov Chain Monte Carlo Methods, part II

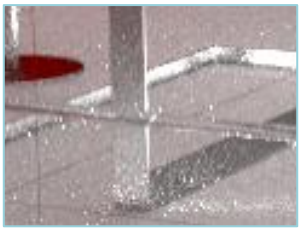
- PPM with MCMC photon tracing [Hachisuka11]
- Population Monte Carlo energy redistribution [Lai07]

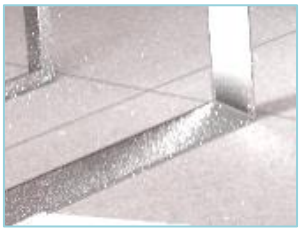
Metropolis Light Transport



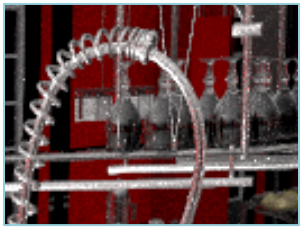
MLT in Primary Sample Space

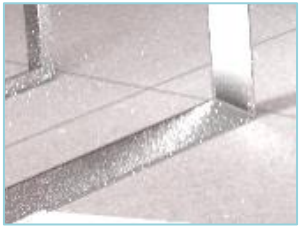




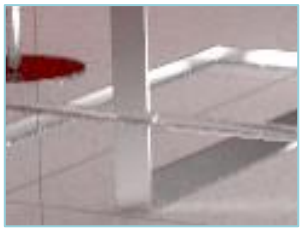


MLT in Primary Sample Space

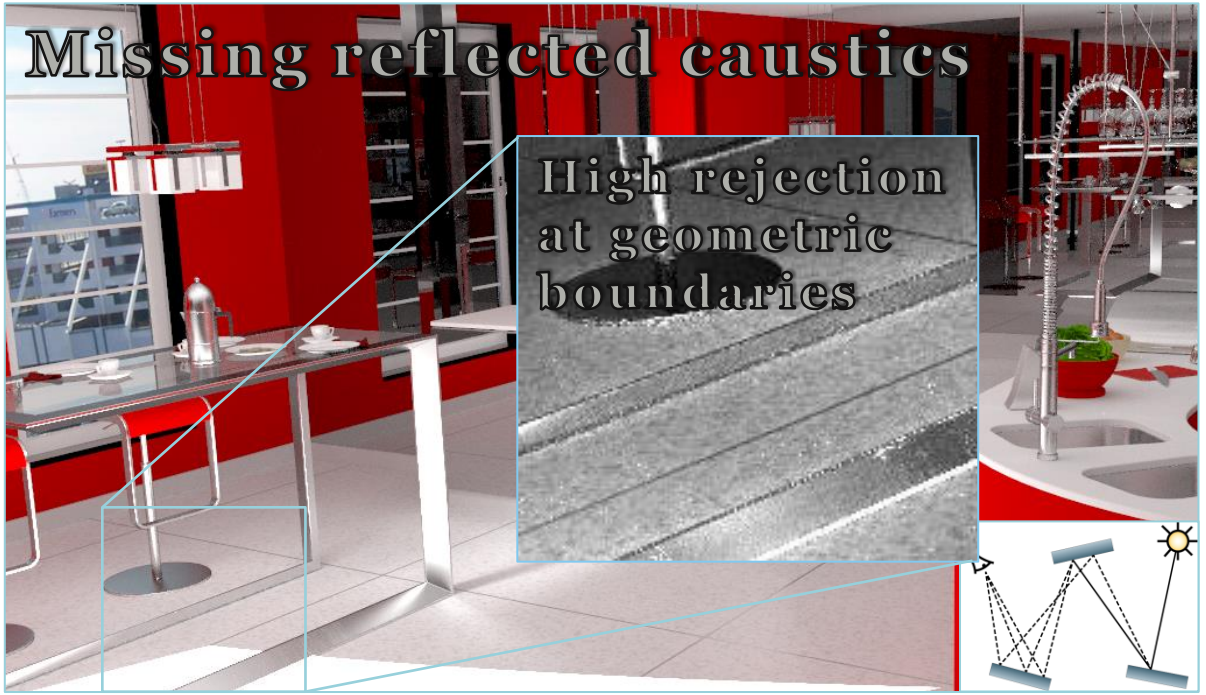


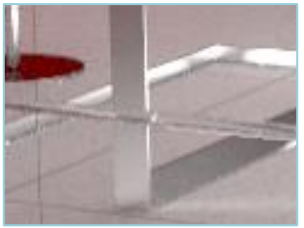


MLT with Manifold Exploration

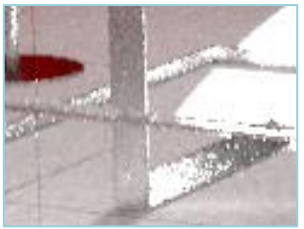


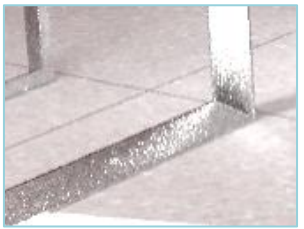
MLT with Manifold Exploration



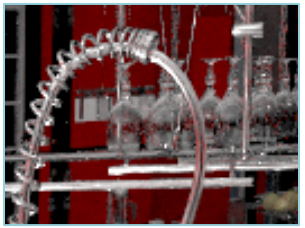


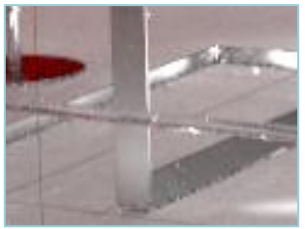
Markov Chain PPM

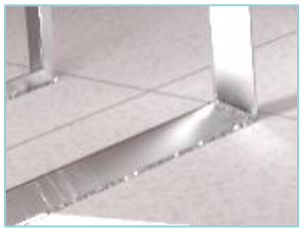




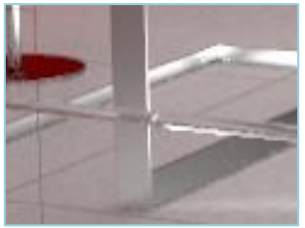
Energy Redistribution Path Tracing (ERPT)

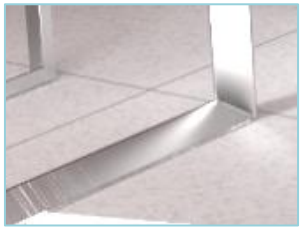




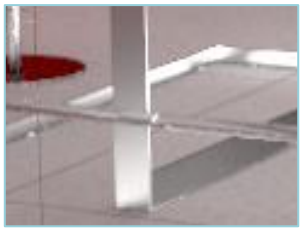


ERPT + Manifold Exploration

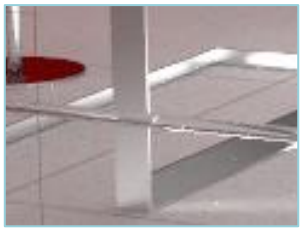




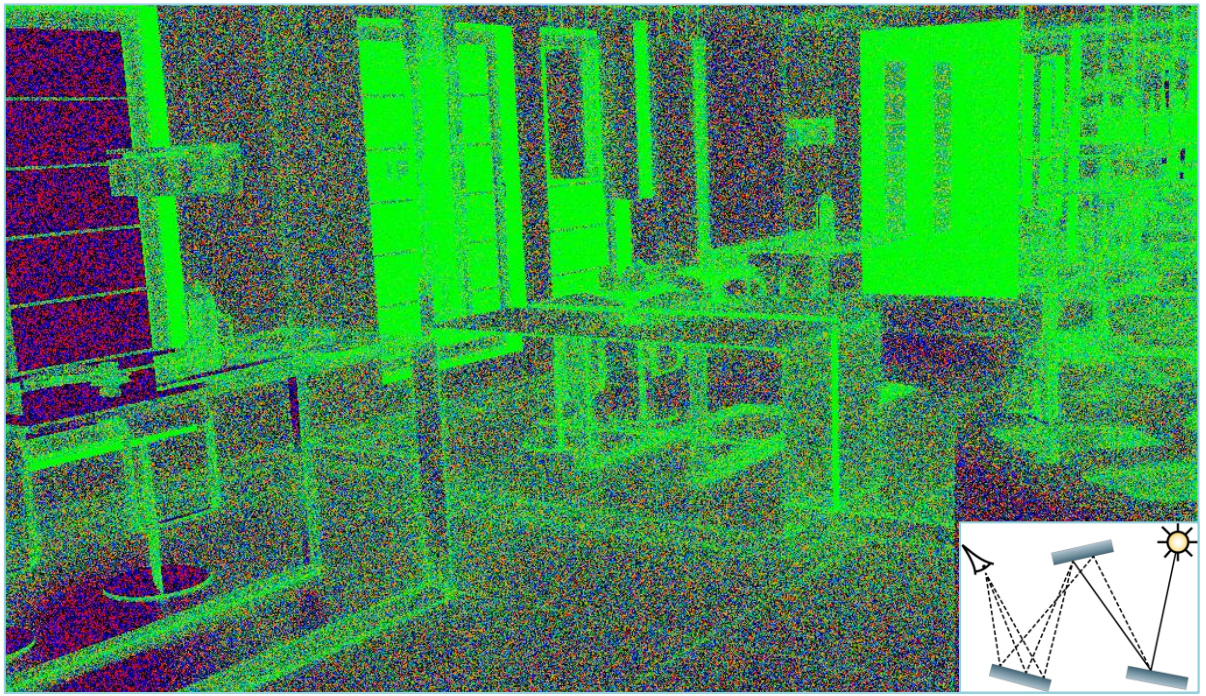
ERPT, Manifold Exploration Only

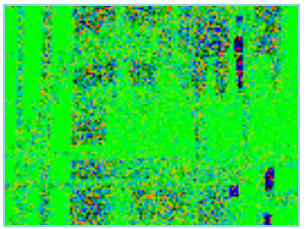


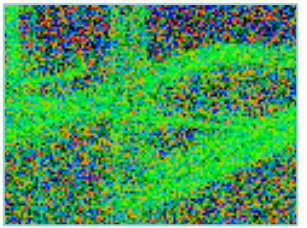
Population Monte Carlo ER + ME

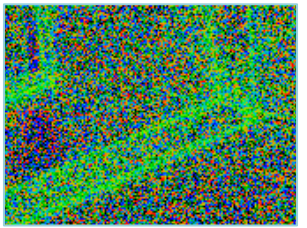


Population Monte Carlo ER + ME









Conclusion

- MCMC is more robust to complex lighting
  - \+ Better survives the *curse of dimensionality*
  - \+ Rule of thumb: for ≥~7-10 bounces → MCMC
  - \+ Helps with highly occluded and glossy scenes
  - – Non-uniform convergence: bad for animation and previews
- PMC adapts mutation parameters

Thank You for Your attention.

Part two questions?