Realistic Rendering with Many-Light Methods

Handling Difficult Light Paths

(virtual spherical lights)

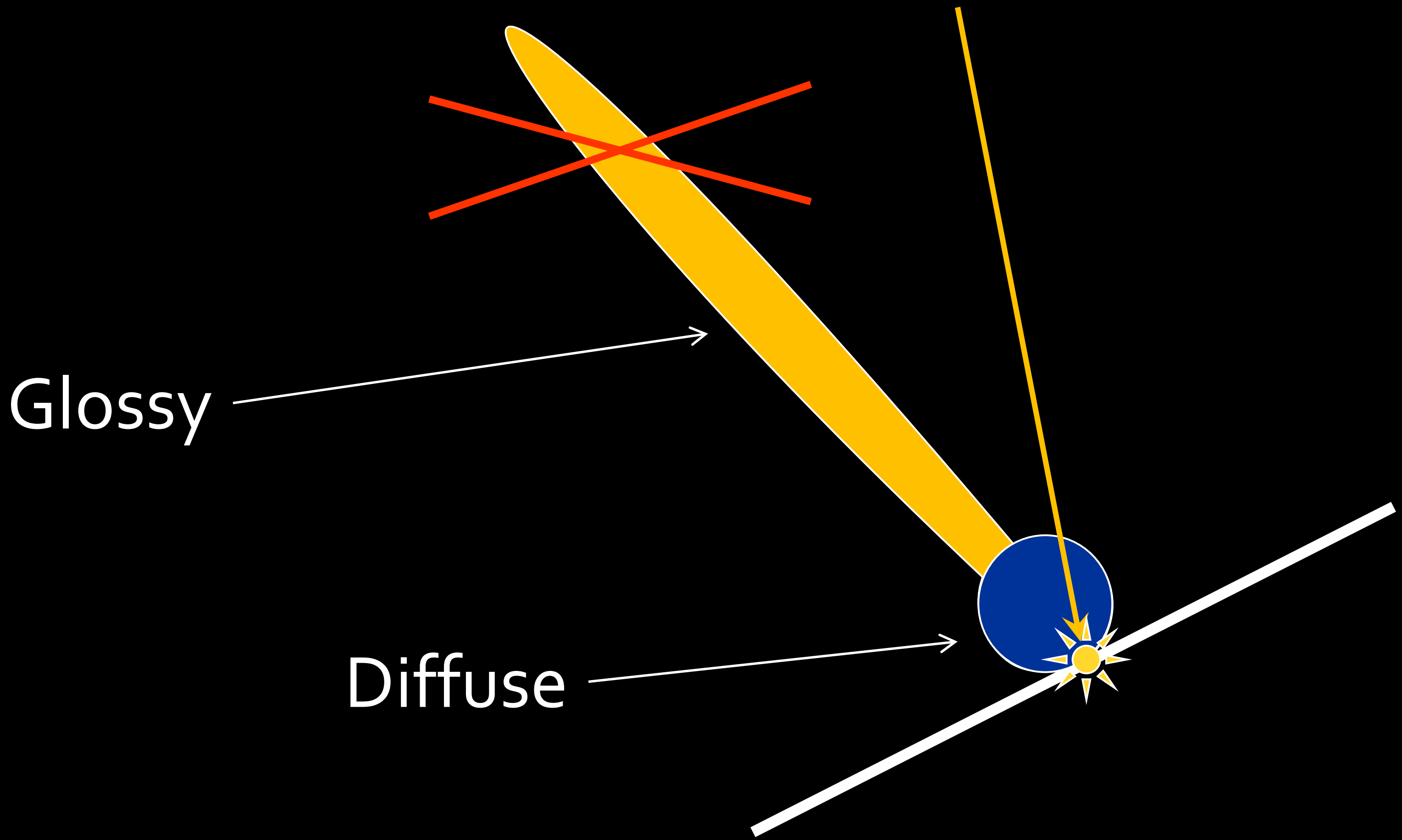
Miloš Hašan

UC Berkeley

Glossy Inter-reflections

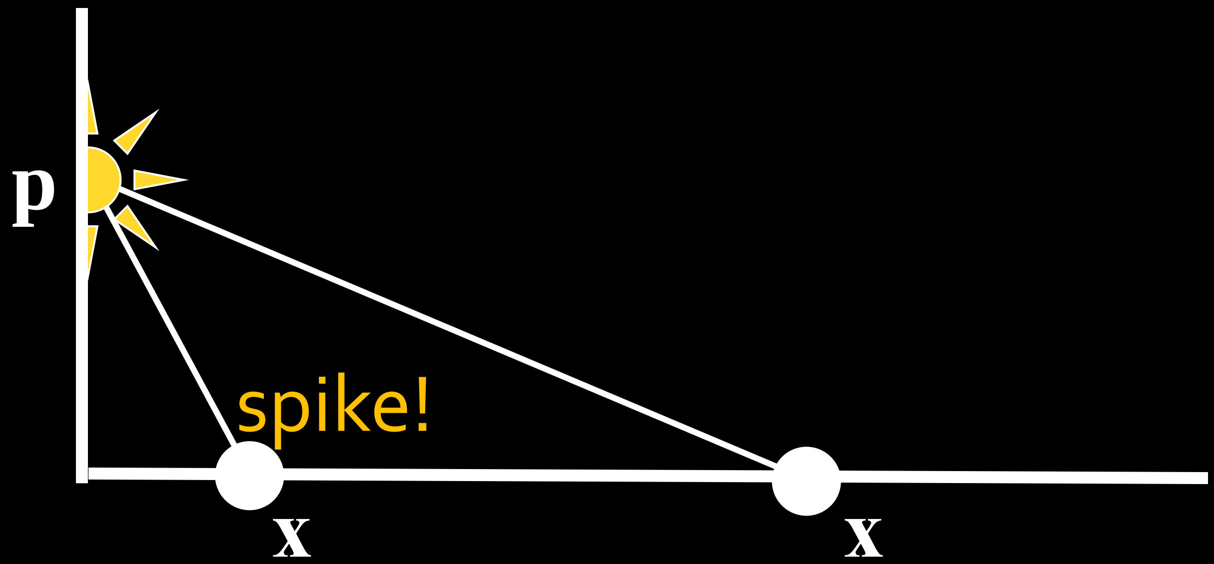
Glossy VPL Emission: Illumination Spikes

BRDF lobe at the VPL location



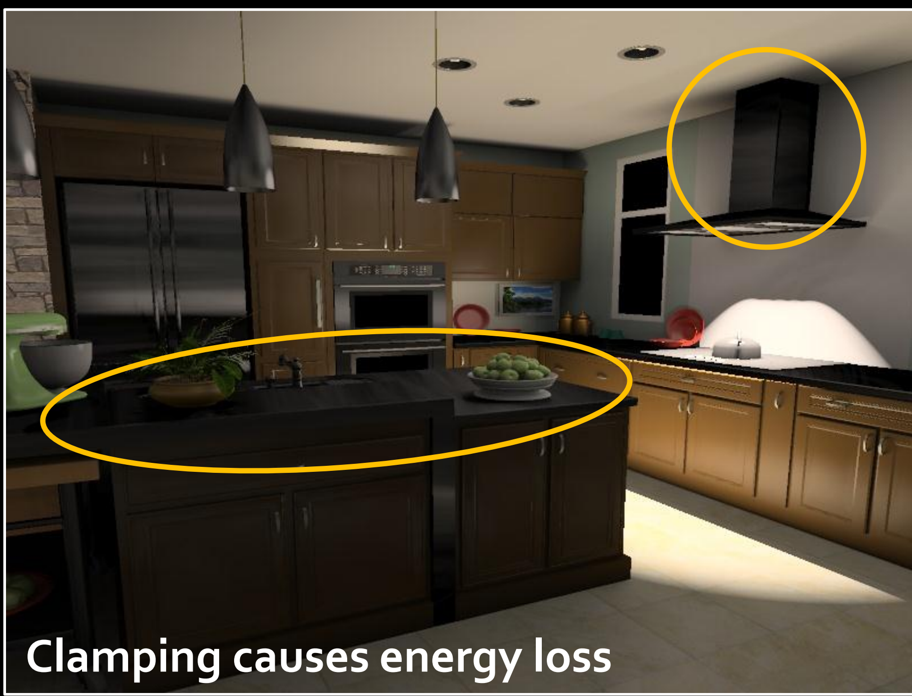
Clamping

As $\| \mathbf{p} - \mathbf{x} \| \to 0$, VPL contribution $\to \infty$



- Common solution: **Clamp** contribution

Energy Loss with Virtual Point Lights



Clamping causes energy loss

Reference

Clamping Compensation

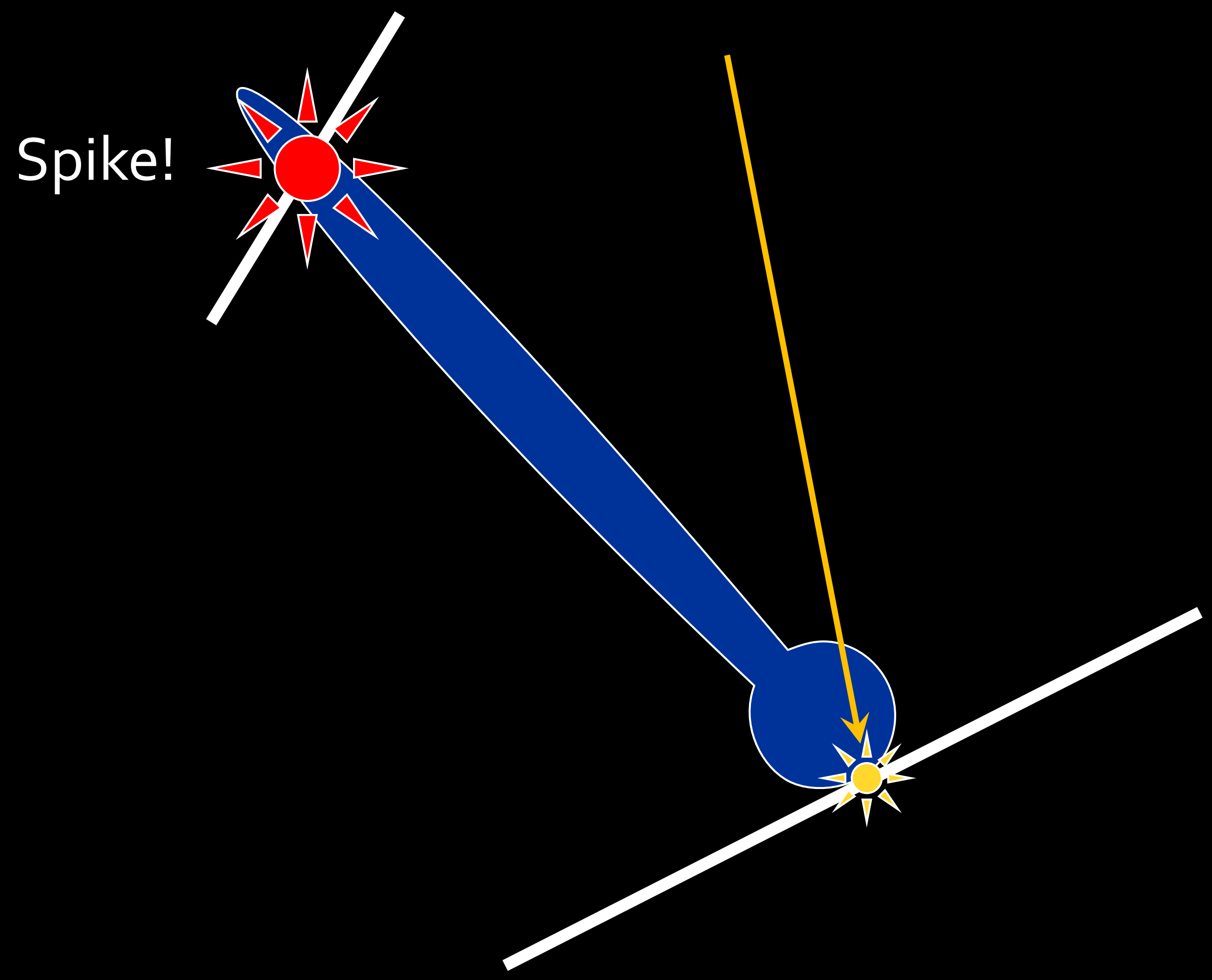
- Compute the missing components by path tracing [Kollig and Keller 2004]

- Glossy scenes
  - As slow as path-tracing everything

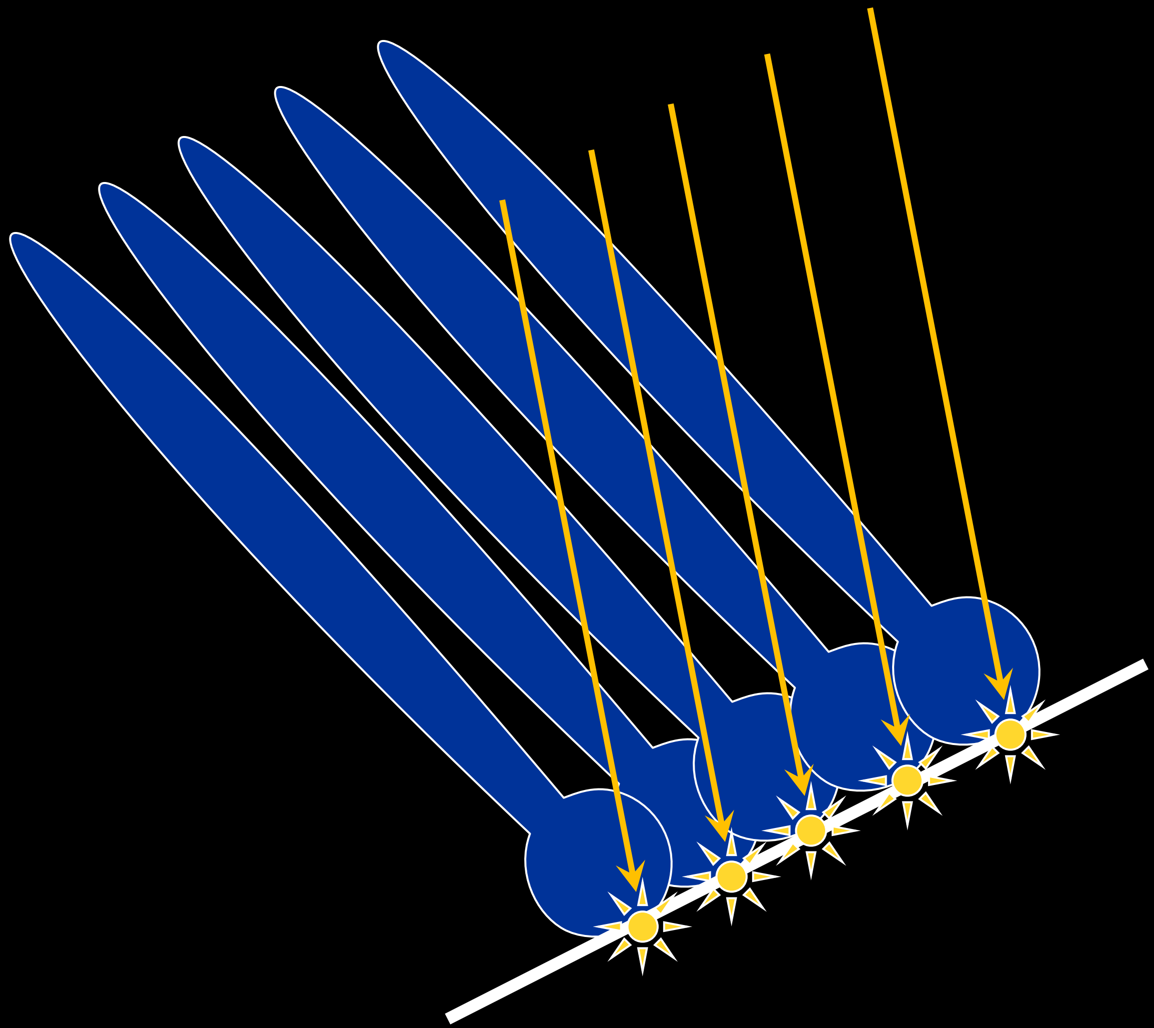
Virtual Spherical Light

- Integration instead of point sampling

Recall: Emission Distribution of a VPL

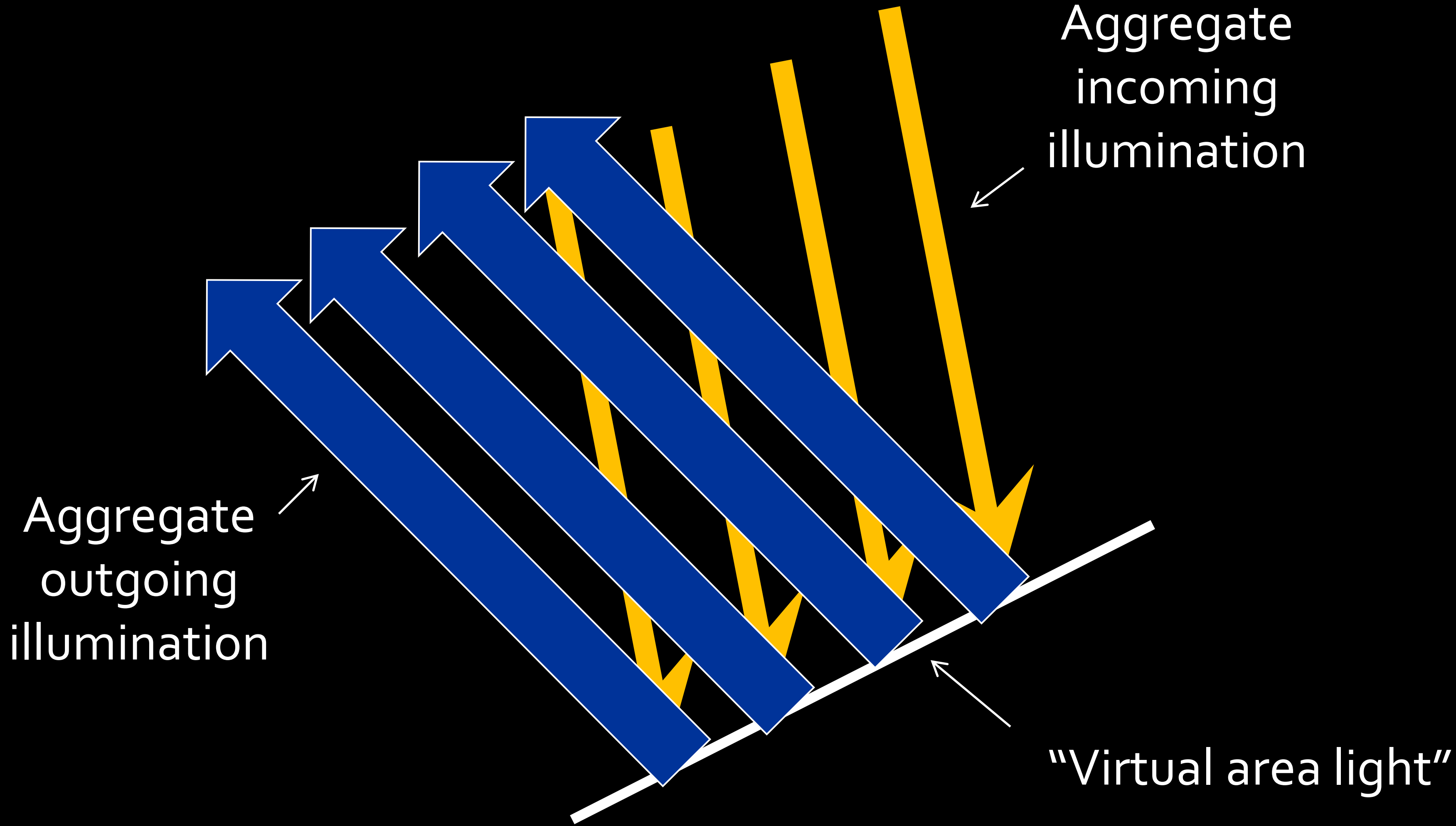


What happens as #lights $\rightarrow \infty$?



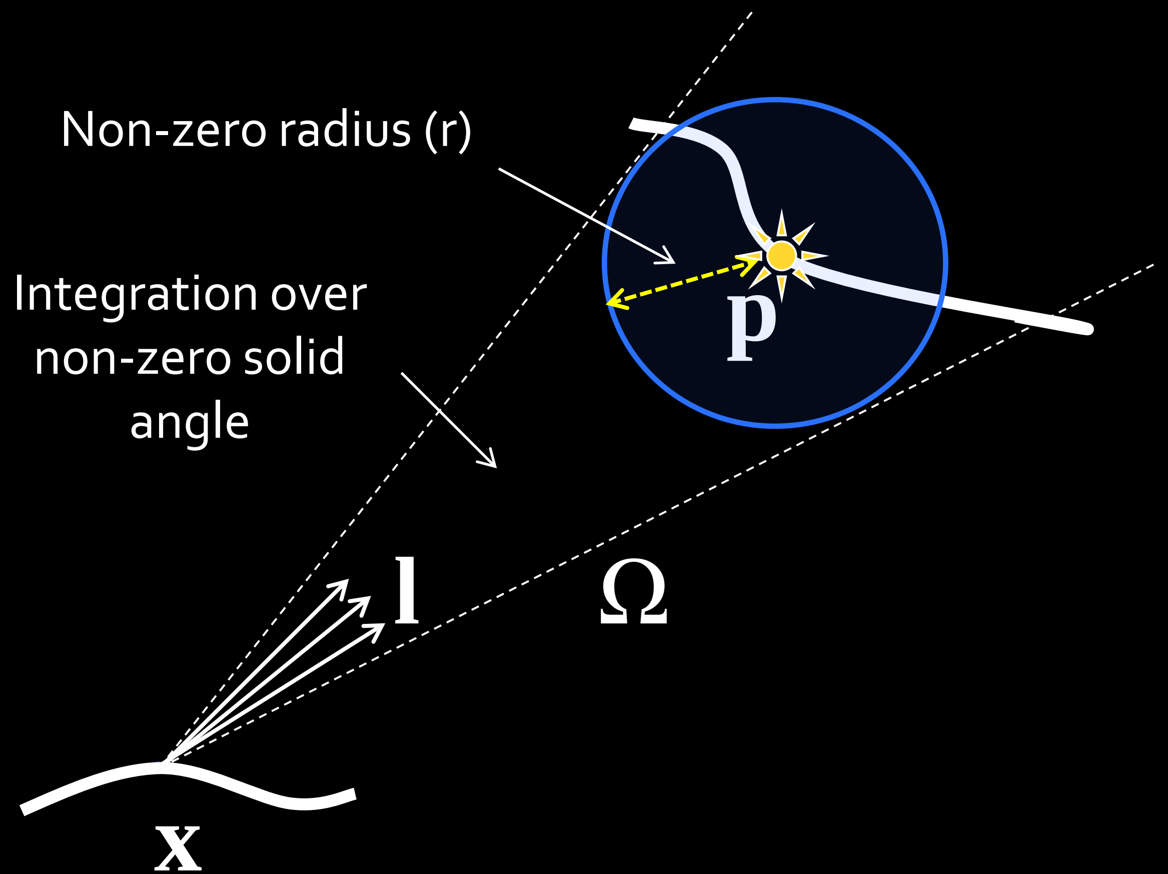
Spiky lights converge to a continuous function!

Idea: We want a "virtual area light"

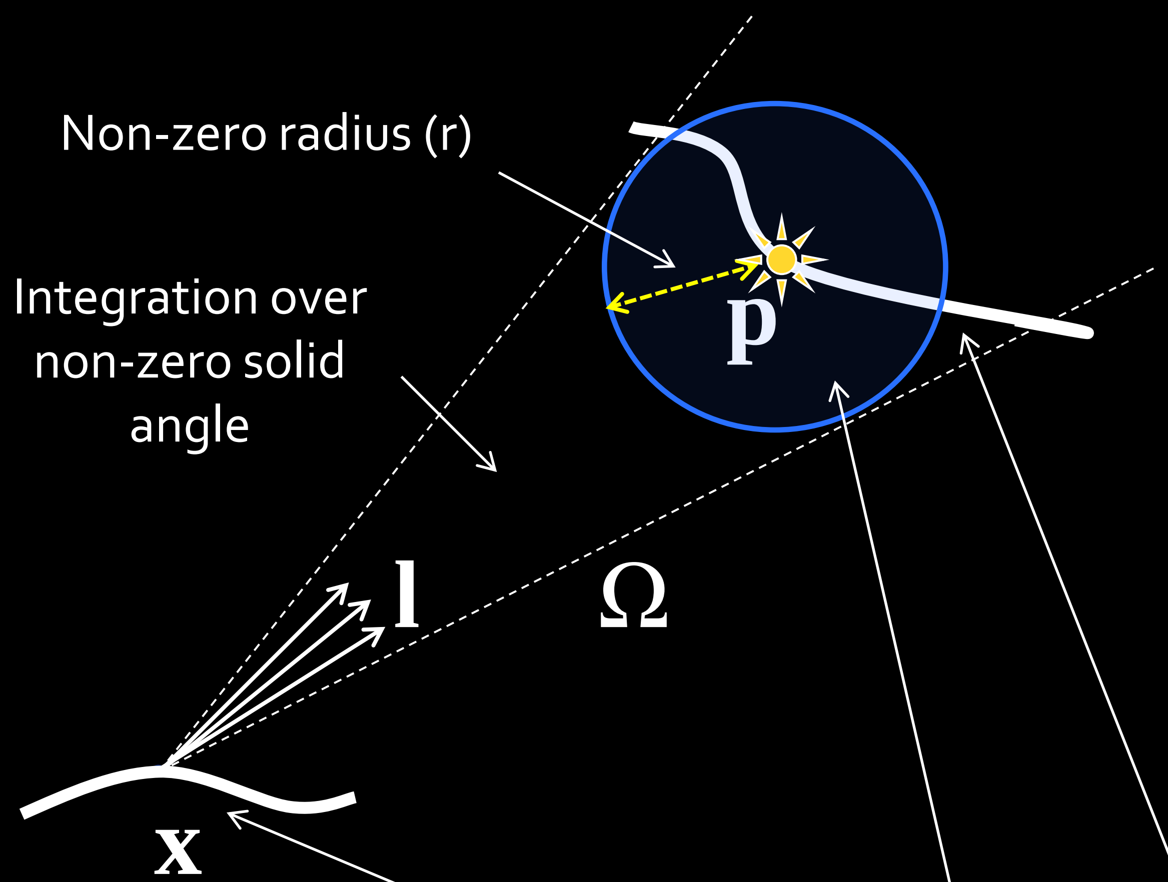


Problem: What if surface is not flat?

Expand Point into Sphere



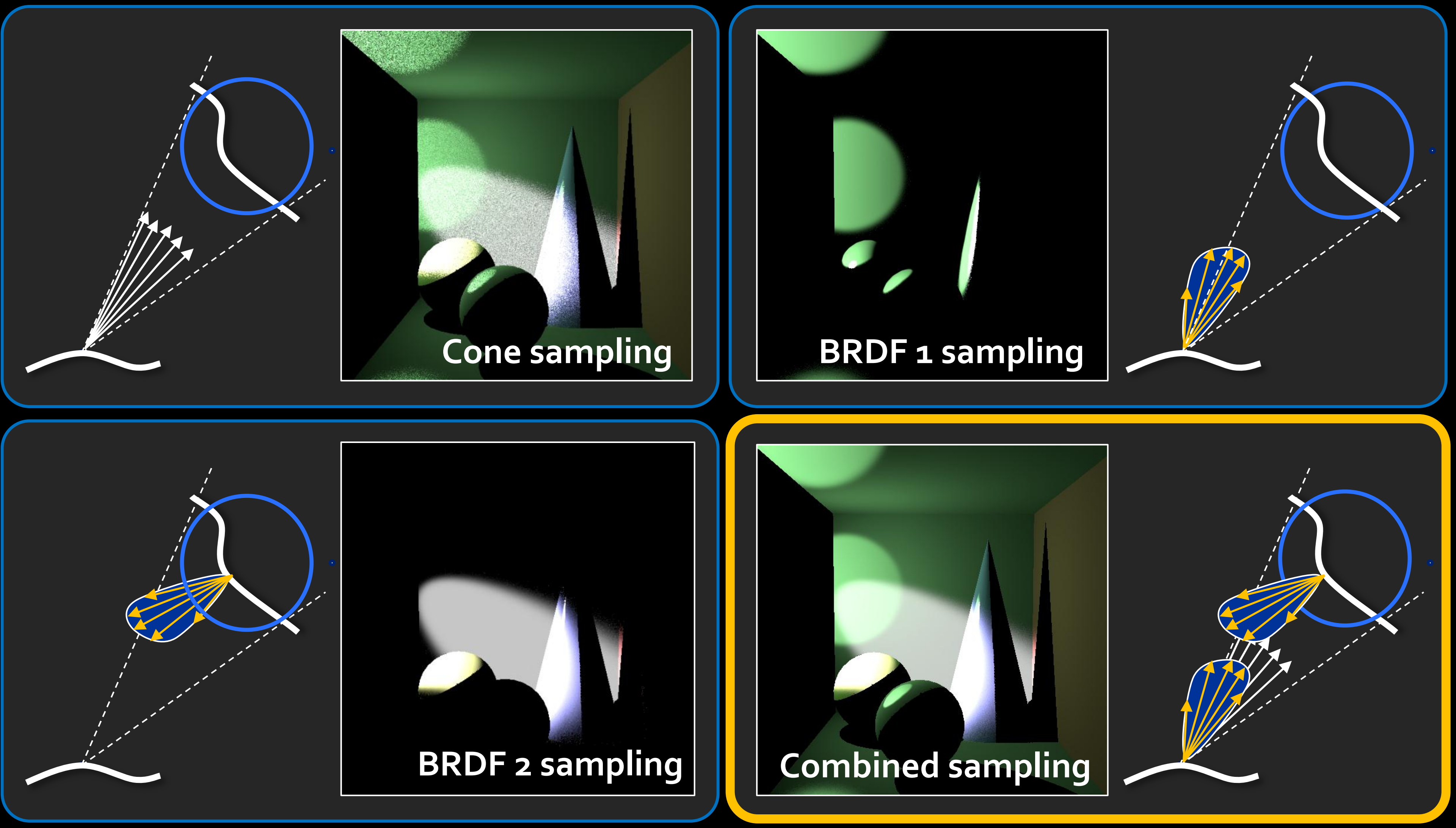
Light Contribution



$$V\,\frac{\Phi}{\pi r^2}\int_{\Omega}\boxed{f_r(\mathbf{x})\cos\theta_{\mathbf{x}}}\;\boxed{f_r(\mathbf{p})}\;\boxed{\cos\theta_{\mathbf{p}}}\,\mathrm{d}\mathbf{l}$$

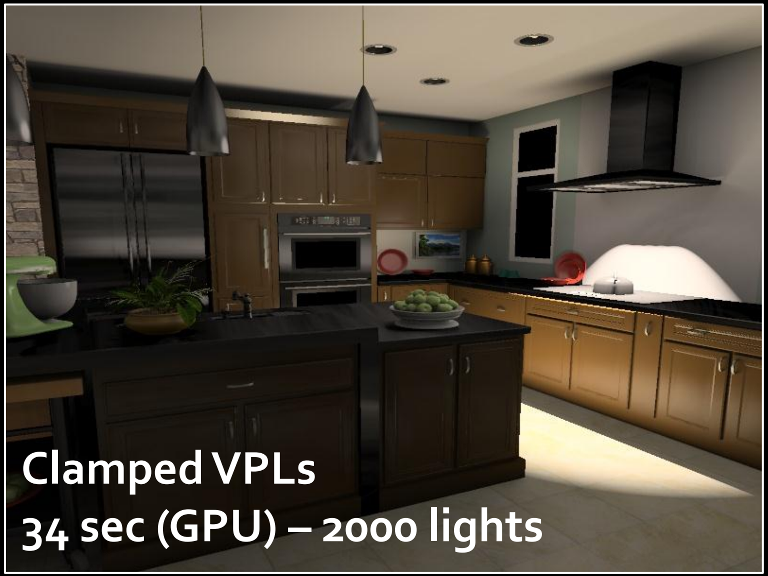
Computing the VSL integral

- Stratified Monte Carlo in a shader



Results: Kitchen

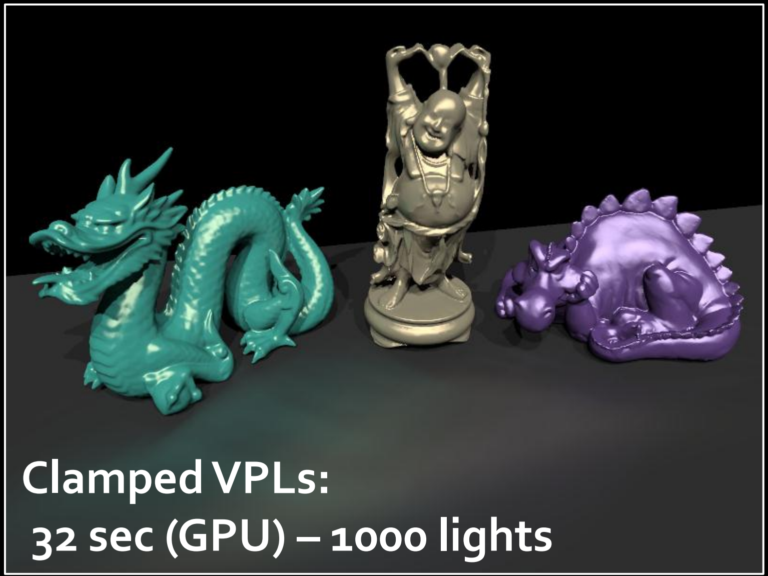
- Most of the scene lit indirectly
- Many materials glossy and anisotropic



Results: Anisotropic Tableau

- Difficult case
- Standard VPLs capture almost no indirect illumination

Path tracing:
2.2 hours (8 cores)

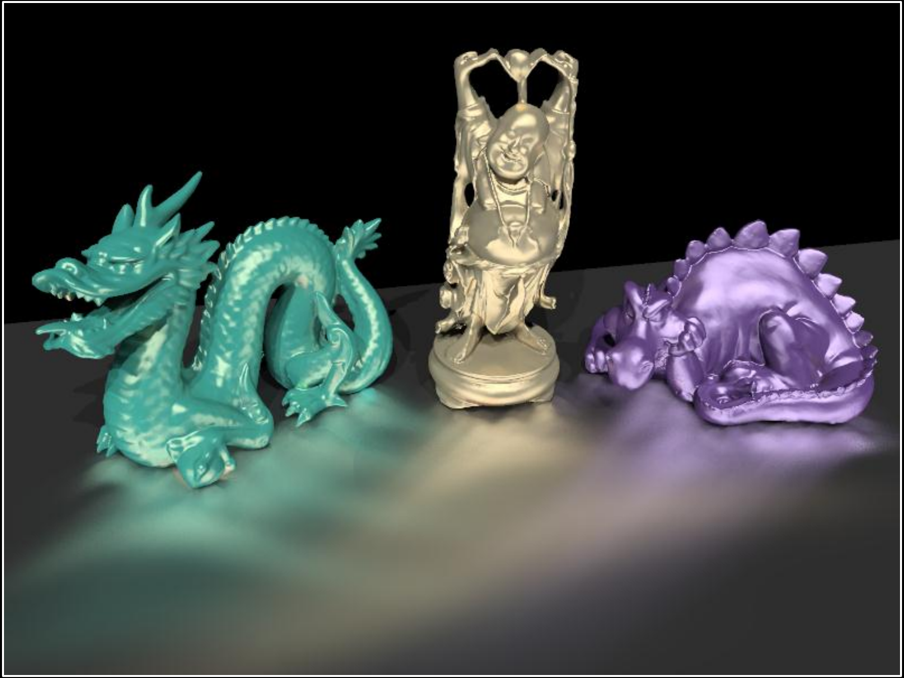


Clamped VPLs:
32 sec (GPU) – 1000 lights

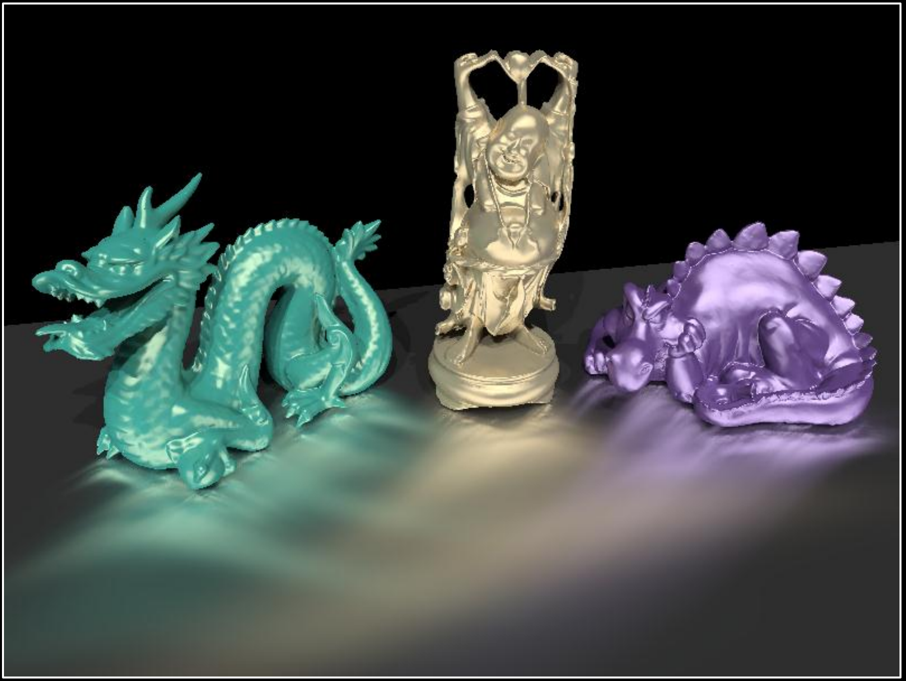
New VSLs:
1 min 44 sec (GPU) – 5000 lights

Limitation: Blurring

- VSLs can blur illumination
- Converges as number of lights increases

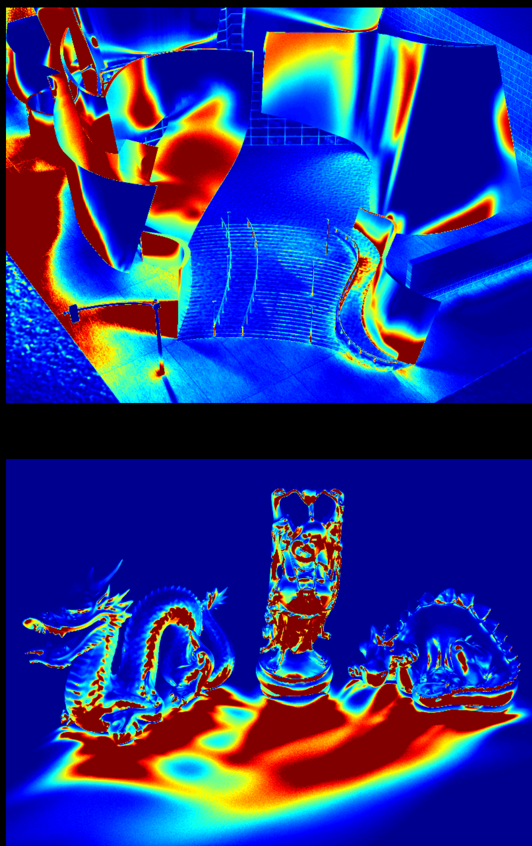


5,000 lights - blurred



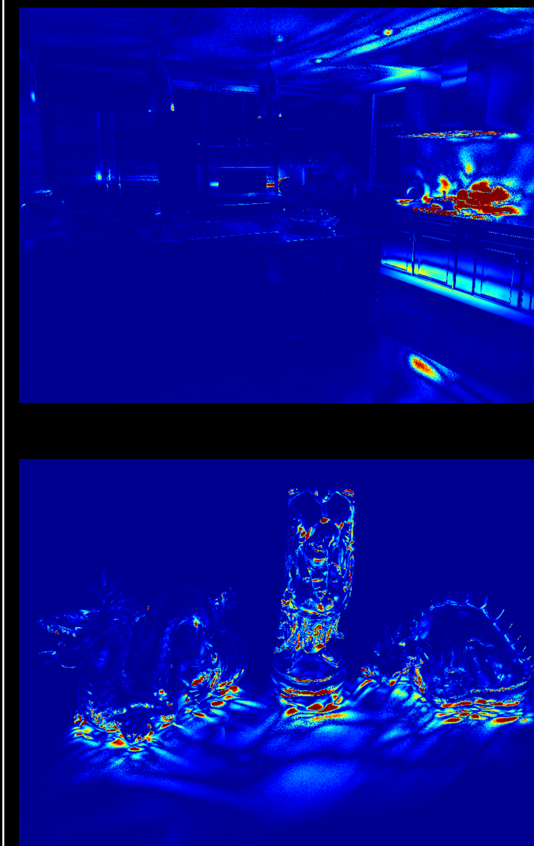
1,000,000 lights - converged

Error Images (Indirect Only)



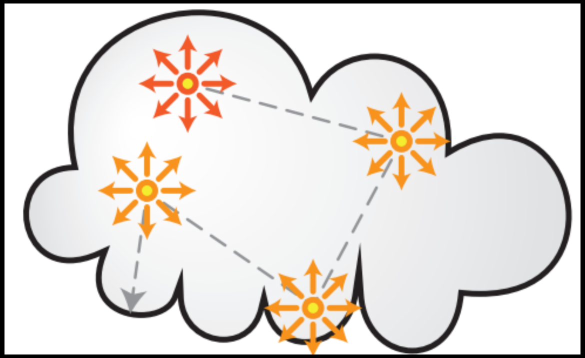
clamped VPL error

ground truth

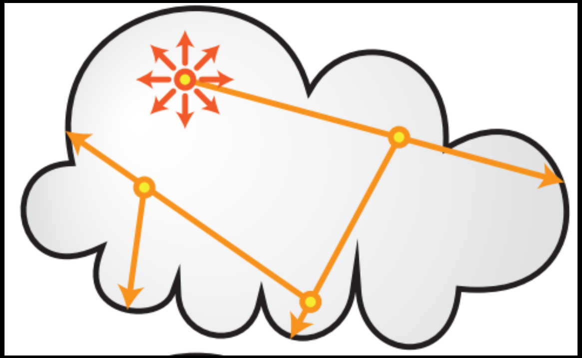


VSL error

Ray/Beam Lights [Novák et al 2012]



virtual point lights

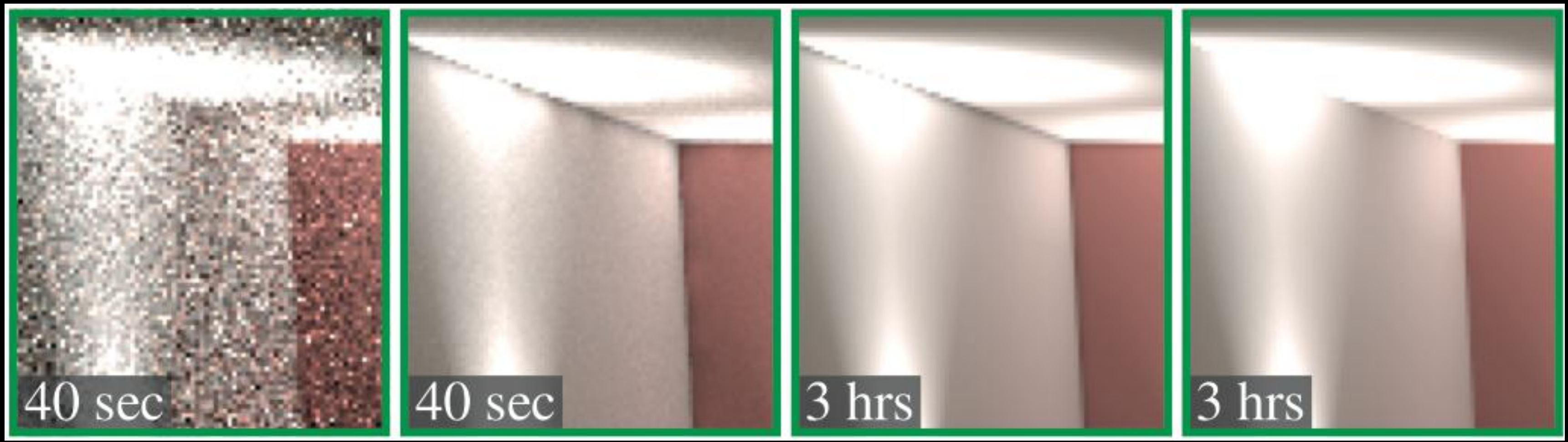


virtual ray lights

virtual beam lights

Progressive Clamping [Davidovič and Georgiev 2012]

- Average separate runs of many-light method while increasing clamping constant



path tracer | many-light | many averaged many-light solutions | with progressive clamping

Conclusion

- Virtual Spherical Lights (VSLs)
  - Integration instead of point-sampling
  - No spikes, no clamping necessary
  - Improve practicality of many lights for real scenes