DELTA LIGHT PROPAGATION VOLUMES FOR MIXED RELITY

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Problem definition

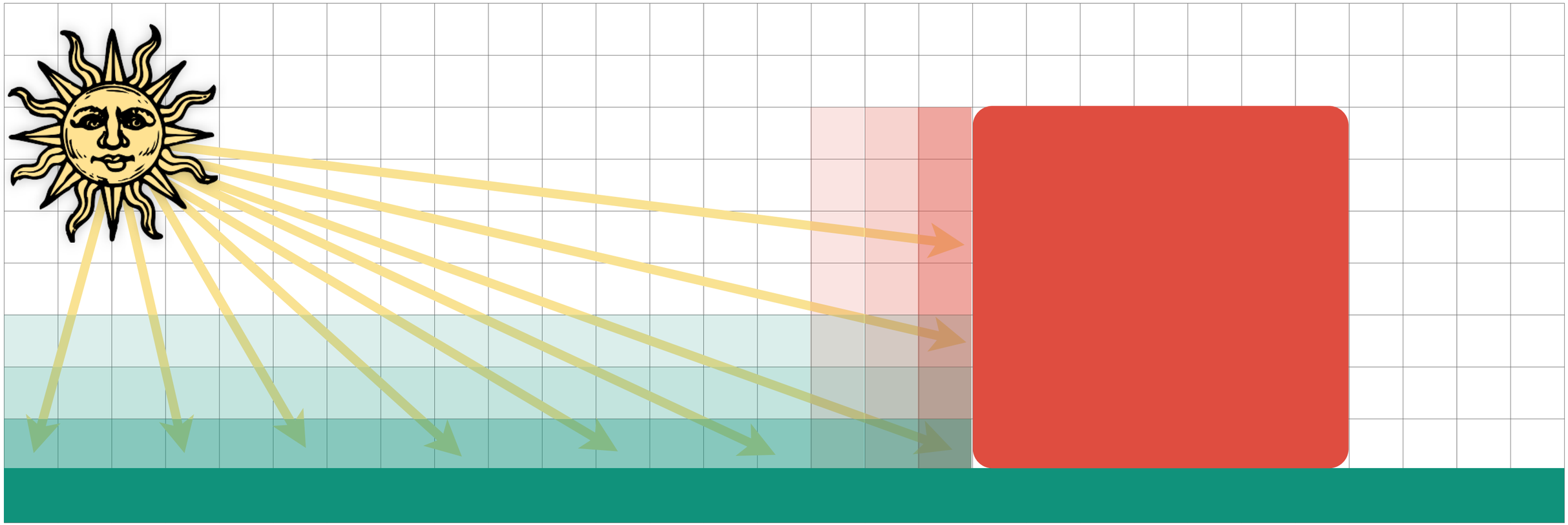
Global Illumination between real and virtual worlds

- Mixed Reality needs proper relighting
  - Real to virtual → e.g. real light on virtual surface
  - Virtual to real → e.g. virtual lights illuminating real surfaces
  - **Real to virtual to real** → e.g. real light bouncing off virtual surface back on reality, real light blocked by virtual geometry casting shadows
- So far two (*three*) reliable real-time Global Illumination solutions
  - Differential Instant Radiosity
  - Multi-resolution splatting
  - (*Irradiance Caching by Peter and Hannes*)
- **Temporal coherency** and **speed** issues

The Delta Radiance Field

Theory

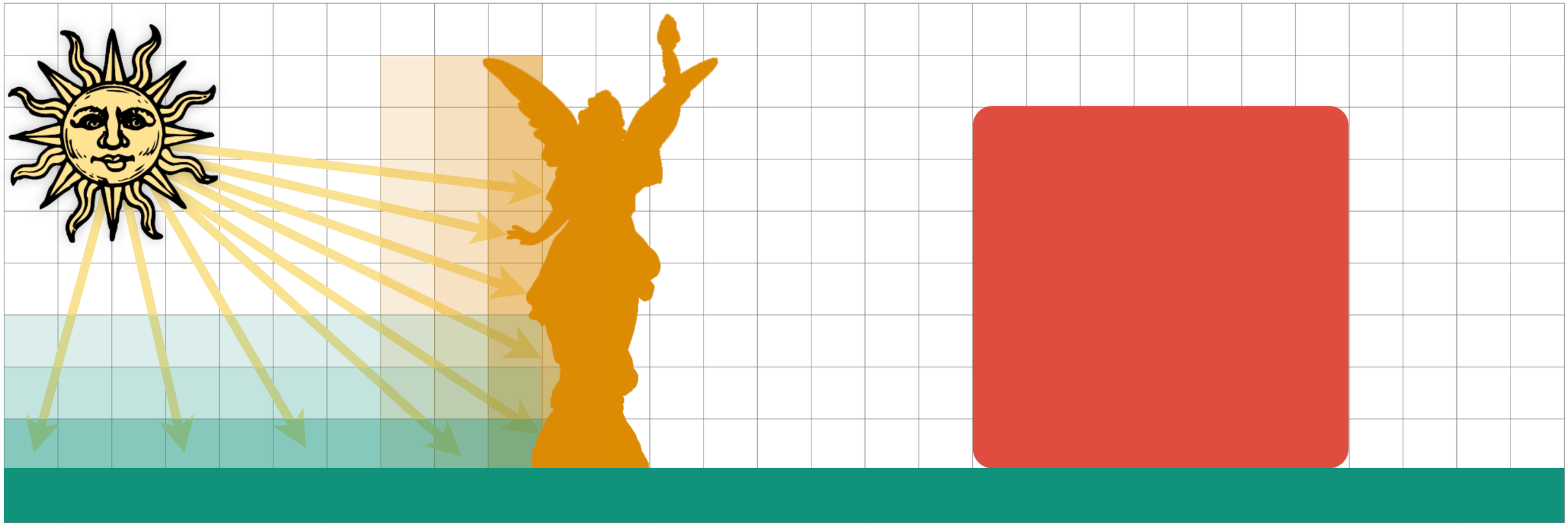
$$L^{\mu}$$



The Delta Radiance Field

Theory

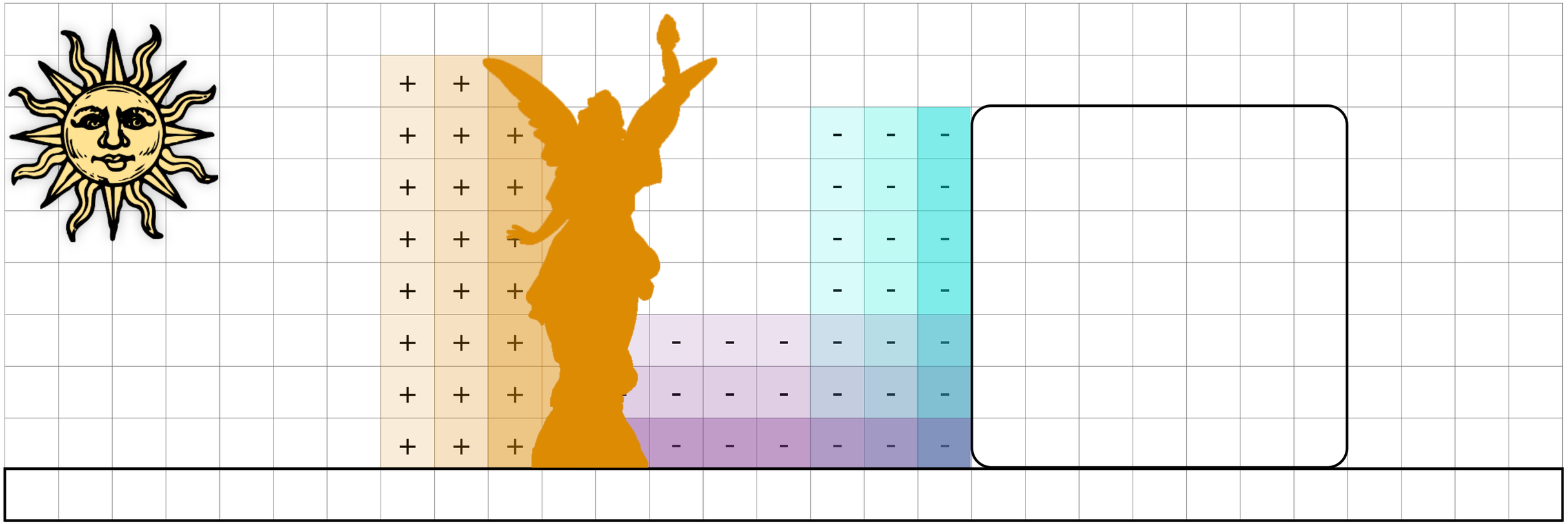
L^{ρ}



The Delta Radiance Field

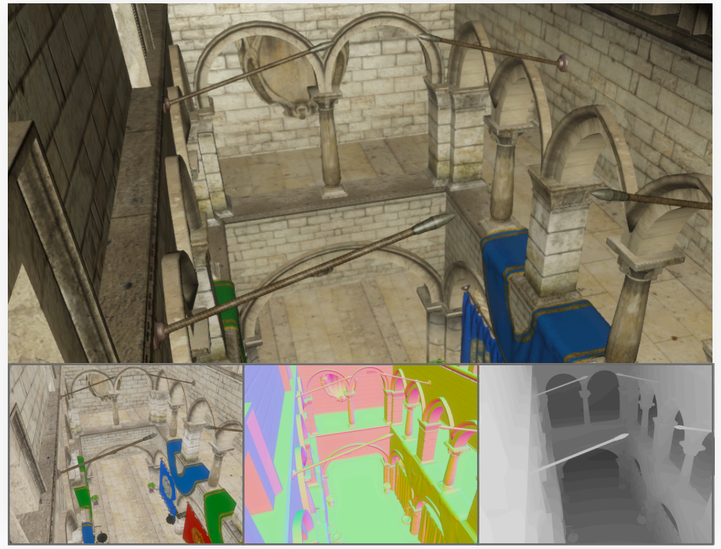
Theory

$$L^{\rho} - L^{\mu} = \sum_{i=0}^{\infty} \mathbf{T}_{\rho}^{i} L_e - \sum_{i=0}^{\infty} \mathbf{T}_{\mu}^{i} L_e = \sum_{i=0}^{\infty} \left[\mathbf{T}_{\rho}^{i} L_e - \mathbf{T}_{\mu}^{i} L_e \right] = \sum_{i=0}^{\infty} \mathbf{T}_{\Delta}^{i} L_e = L^{\Delta}$$



The Delta Radiance Field

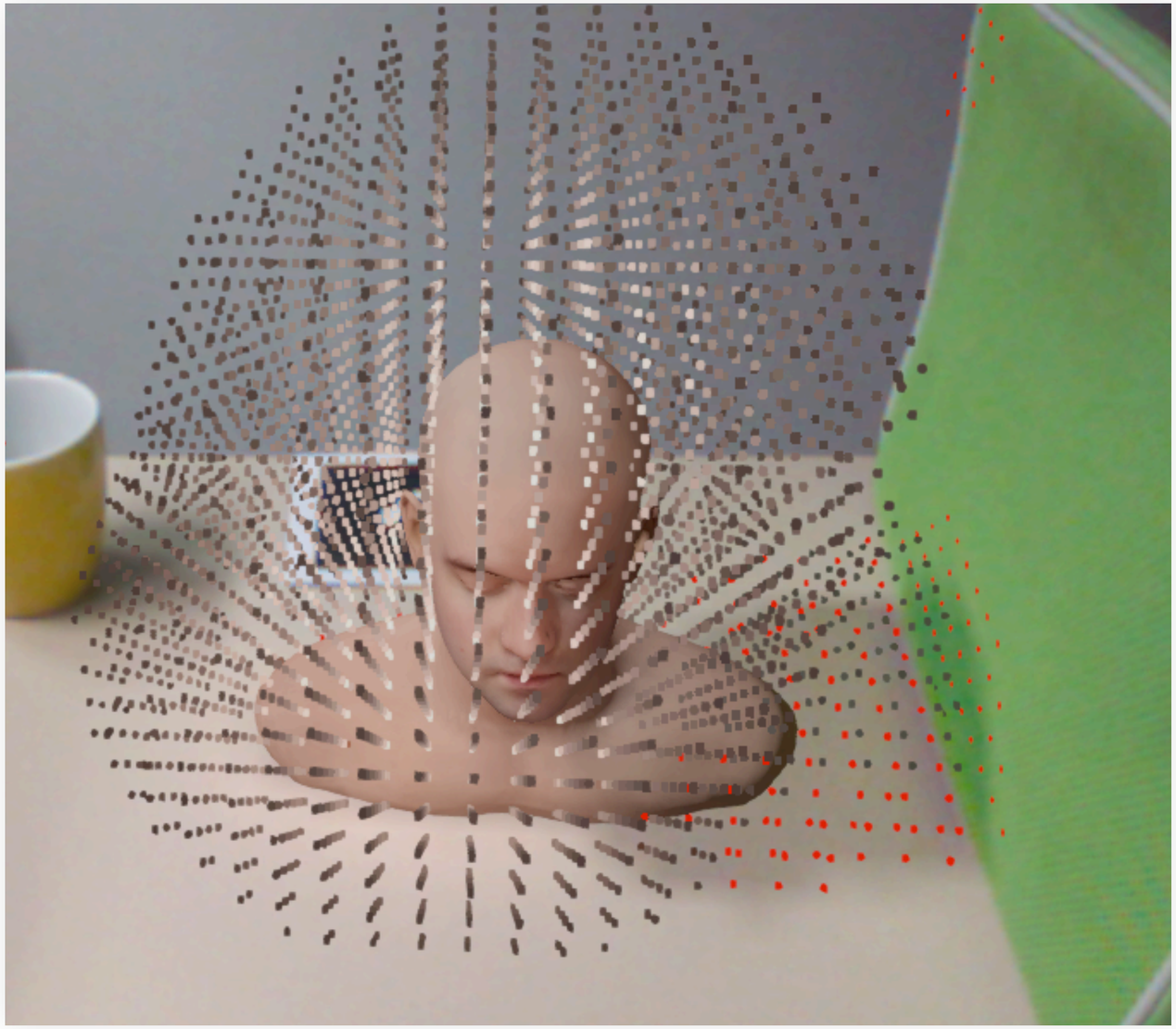
Light Propagation Volumes



- Setup
  - Render Reflective Shadow Map
  - Create empty volume (e.g. 32^3)
- Injection
  - Sample RSM, create VPLs
  - Inject SH encoded VPLs into volume
- Propagation
  - Distribute light from each cell to neighbors for n steps

The Delta Light Propagation Volume

Implementation of a DRF



- Given
  - Real lights, geometry & materials
- Render RSM R^p (object)
- Render RSM R^μ (~~object~~)
- Injection (direct + indirect)
  - Add R^p to volume
  - Subtract R^μ from volume
- Proceed normally

Video available at

http://www.tobias-franke.eu/publications/franke13dlpv/

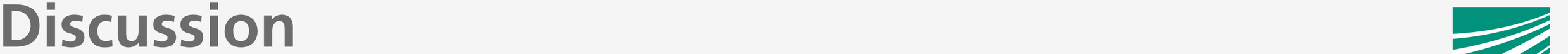
Discussion

Advantages

- **Unified corrective factor** for indirect bounces and shadows
  - Just *plug over real radiance field*
- Solves **temporal coherency** with brute force
  - Just inject *entire* RSM to DLPV
- Volumetric correction **can support lightfield effects**
- **Fast & GPU friendly**
  - Default solution evaluates in ~6 ms
  - Grid solution and propagation steps can be adjusted on new hardware

Discussion

Comparison with Lensing and Broll

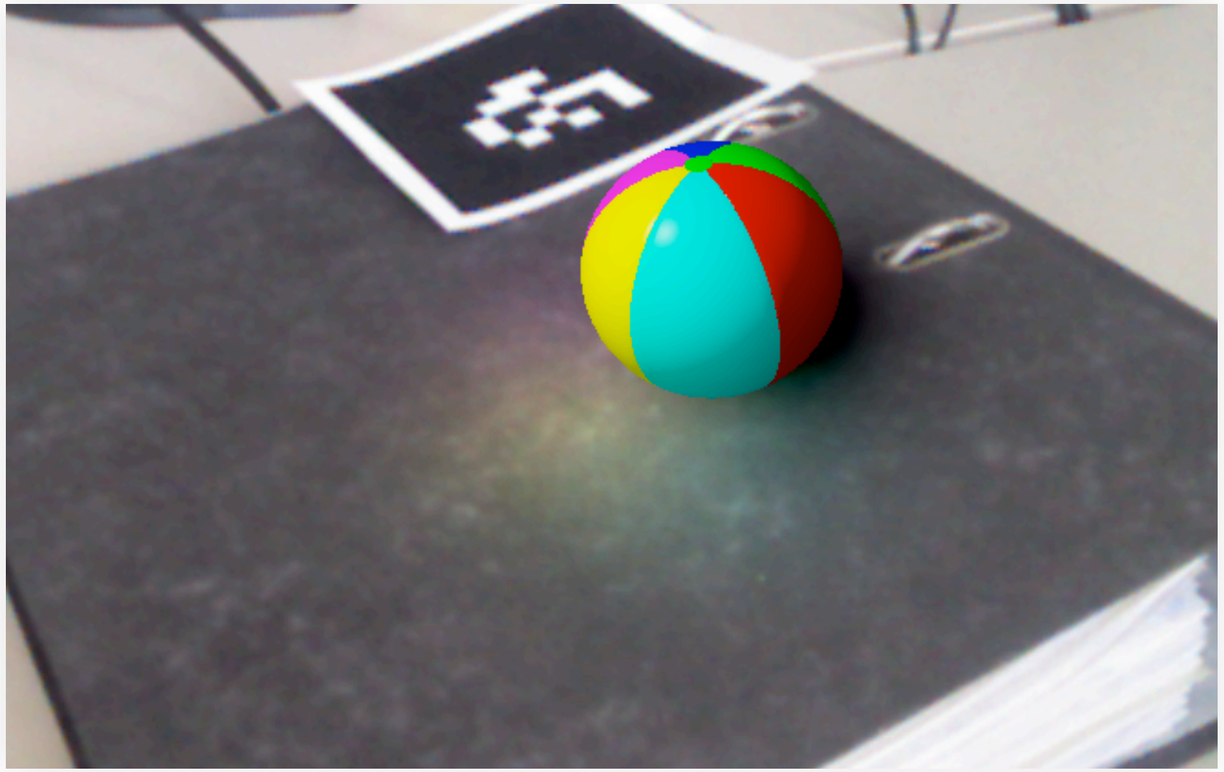


Multi-Resolution Splatting

~4k VPLs, d_{normal} 10°, d_{depth} 1 cm

9.8 ms

Delta Light Propagation Volume

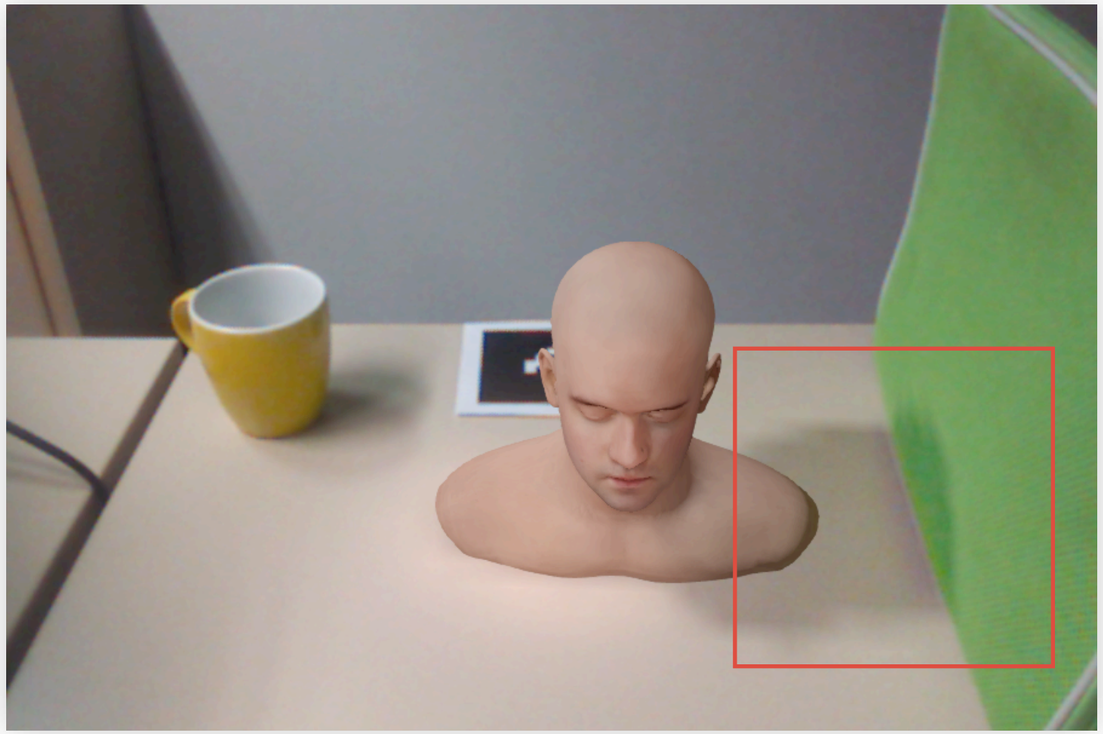


~262k VPLs, 32 Propagations

9.6 ms

Discussion

Open issues



- **Low spatial resolution**
  - Shadows heavily aliased
  - Bleeding artifacts
    - Visible in thin geometry
    - Wrong energy subtraction
  - Self-illumination issues
- Volume size may cut off lights and shadows
- Propagation scheme inefficient in the long run

Thank You

Questions?

Source Code

http://www.tobias-franke.eu/publications/franke13dlpv/

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