What’s New in Photon Mapping

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Outline

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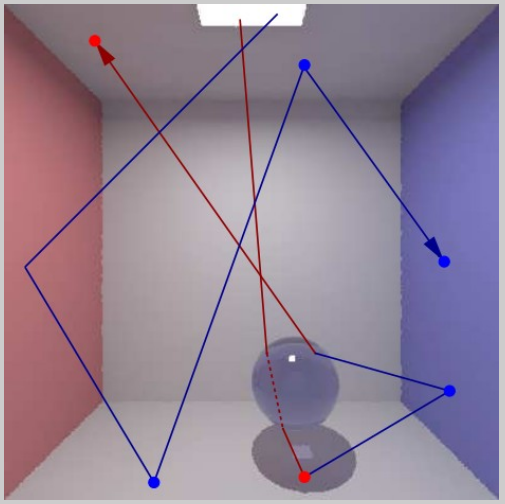
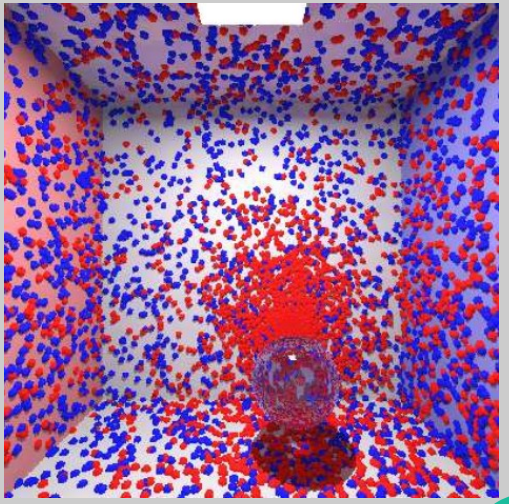
Intro

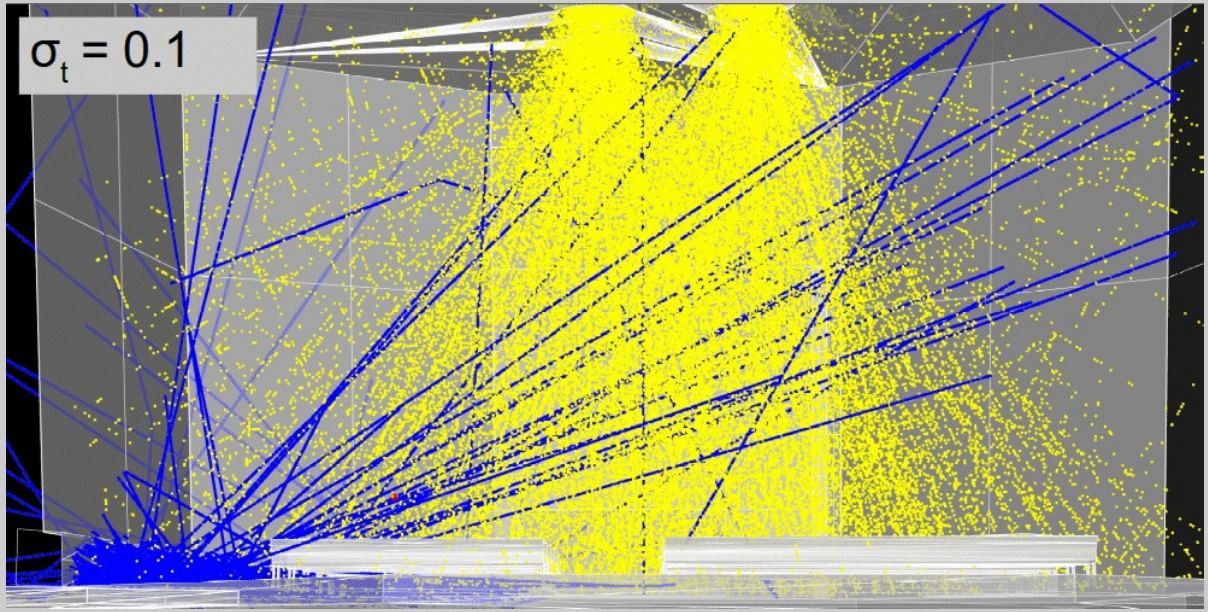
- **Forward raytracer** *mkpmap* deposits “light packets” (photons) on geometry = photon map
- **Backward raytacer** *rtrace/rpict* looks up nearby photons visible to sensor/camera:
- Source → geometry → …→ photon ← sensor
  mkpmap ----------> <-- ***rtrace/rpict***
  = **Bidirectional raytracer!**
- **Irrad/Illum ∝ photon density**
  → Precomputed solution
  → Density estimation problem
- **Uses:** light redirection, curved reflectors
  → Specular blinds, prisms, lightpipes

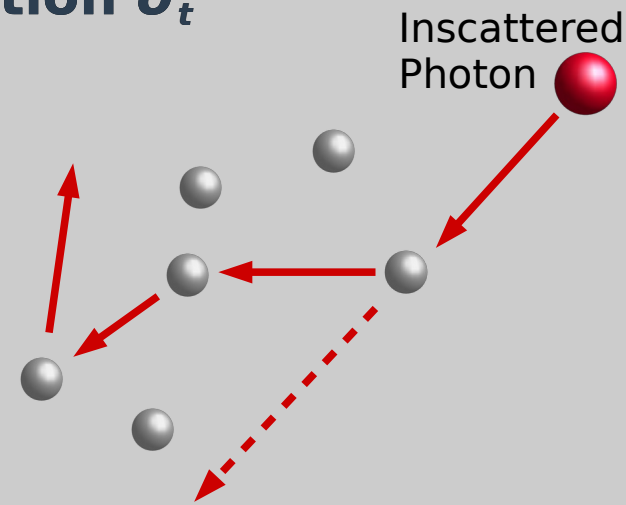


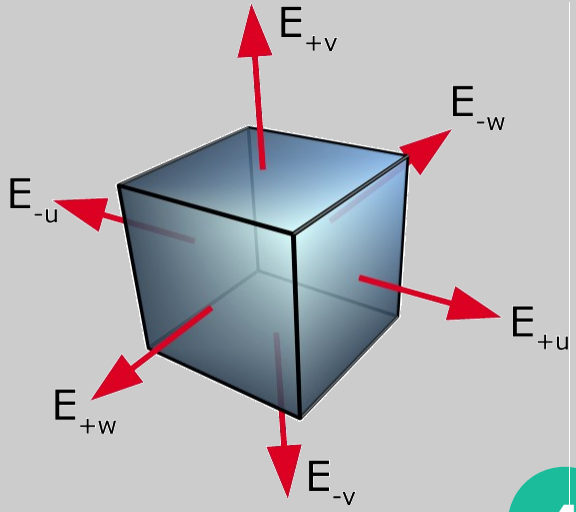


Photon Types: Lightflow ("Photon Flow")

- **Variant of volume pmap, density ∝ extinction σ_t**
- **Evaluates cubic illuminance (Cuttle)**
- **Visualisation as point list via *pmapdump***
- *mkpmap -me σ_t -apV pmap.vpm N_p ...*

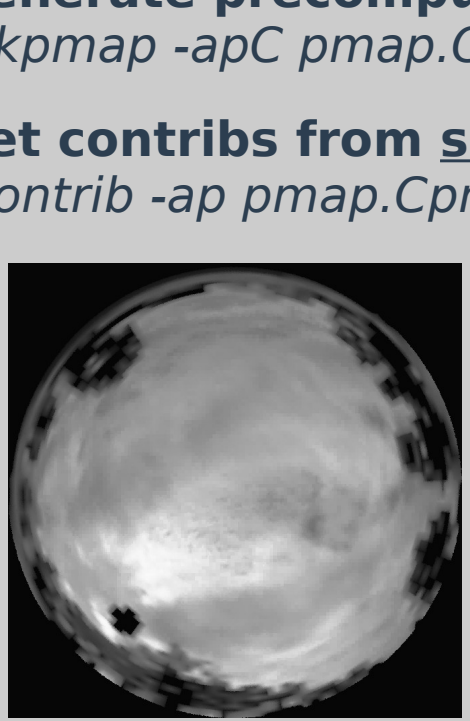




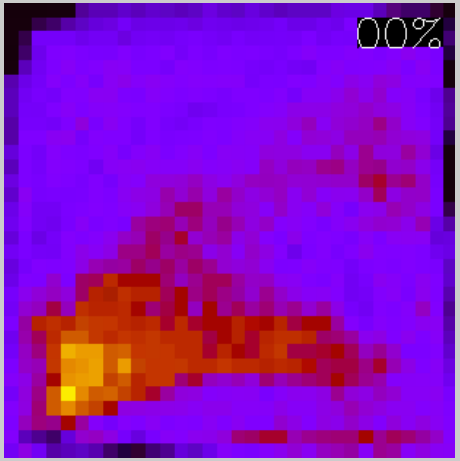


Photon Types: Precomputed Contributions

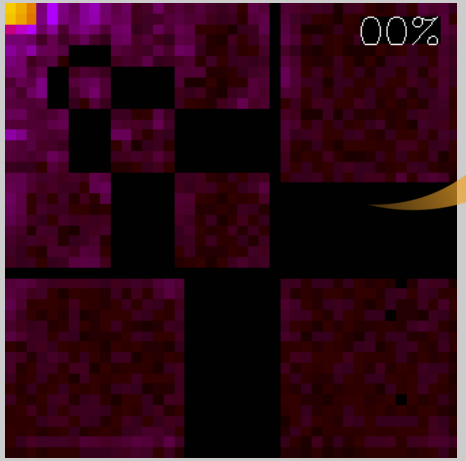
- **Photons carry wavelet compressed contributions**
  → Only Shirley-Chiu disk-to-square binning supported!
- **Precomputed contribs encoded as thresholded wavelet coeffs**
  → Lossy compression
- **Generate precomputed, per-modifier contrib photon maps:**
  mkpmap -apC pmap.Cpm N_p bwidth comp -bn N_{bins} -m mod ...
- **Get contribs from <u>single closest</u> photon, binning opts via @:**
  rcontrib -ap pmap.Cpm @pmap.Cpm.opt ...



HDR sky capture

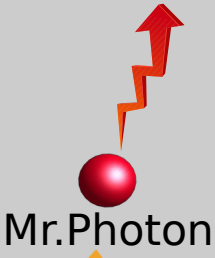


Shirley-Chiu binning



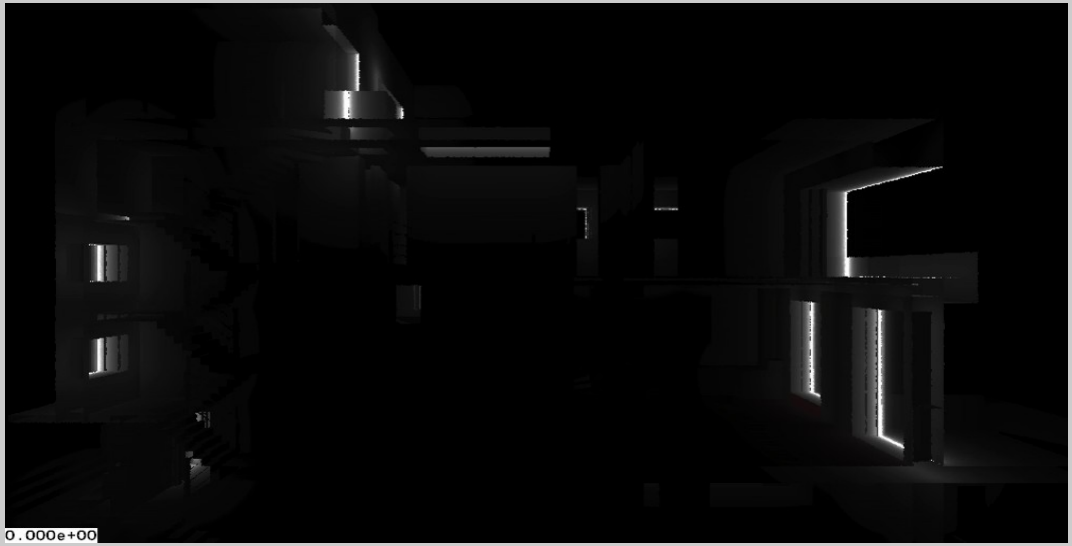
Wavelet coefficients

Approx Detail



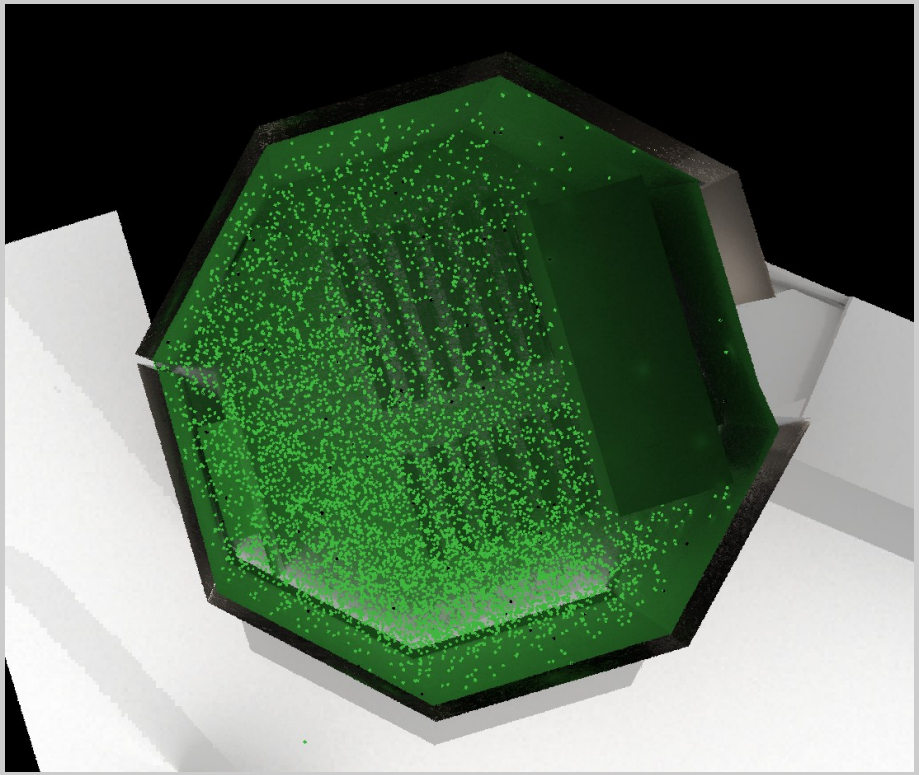
Photon Types: Transient

- **Simulated light propagation with time dilation**
- **Currently only supported by kd-tree data struct**
- **Generate transient pmap with speed of light *c* at scale:** *mkpmap* [*-apt* | *-apT*] *pmap.tpm* N_p *c ...*
- **Render frame at time *t*:** *rpict -ap pmap.tpm bwidth t ...*



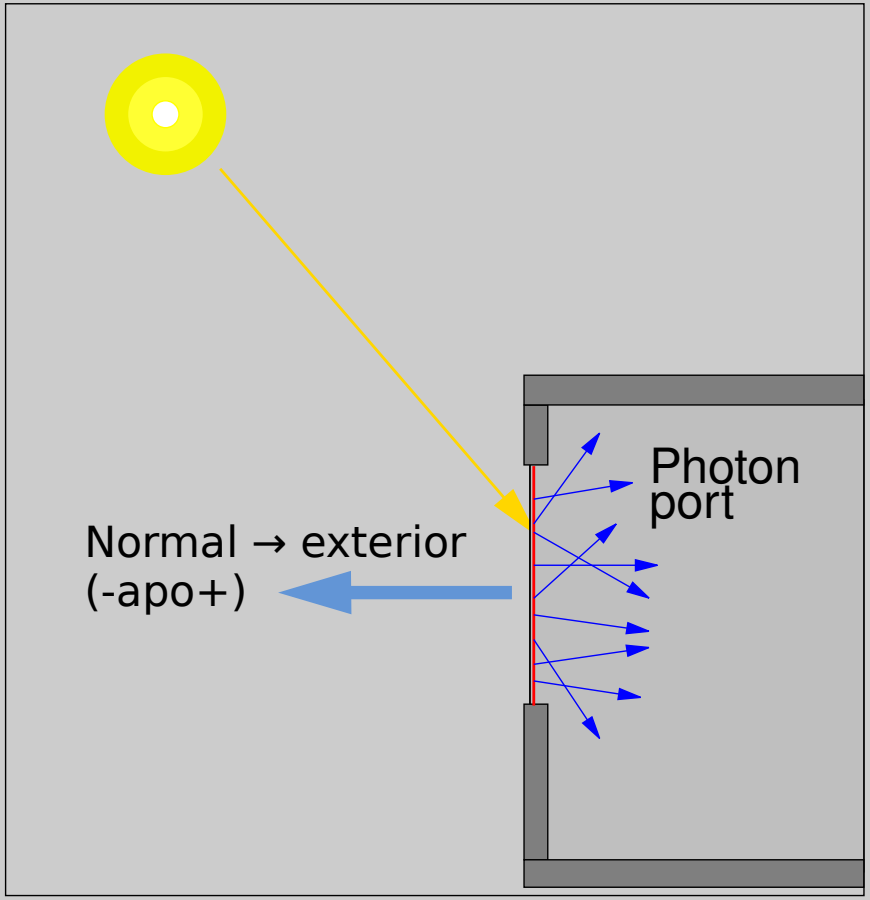
New in *mkpmap*: RoIs

- **Polyhedral Region of Interest; encloses photons via mod:**
  mkpmap -aph mod ...
- **Spherical Region of Interest:**
  mkpmap -apl x y z rad ...



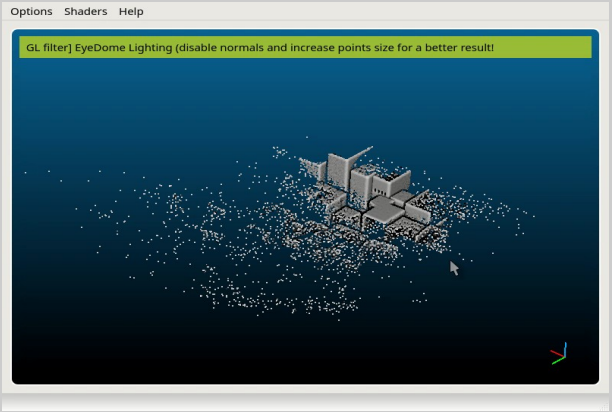
New in *mkpmap*: Ports, Misc

- **Limit photon propagation distance (path length):**
  mkpmap -ld maxdist ...
- **Reversible photon ports (defines emitting side):**
  mkpmap -apo[+|-|0] *mod ...*



New in *pmapdump*

- **-a: Dump ASCII (text) point list:**
  pos(x,y,z), flux(r,g,b) [aux] [norm(x,y,z)]
  ...
- **With -A: Also dump photon auxiliary field (32-bit)**
  - Contributing source & bin
    (contrib photons)
  - Path length / time of flight
    (transient photons)
  - Path ID [*N:M*]
    (all other photon types)
- **With -N: Also dump photon normals**
  (photon direction for volume / lightflow)



Code Status

- **Some refactoring, ca. 12 new modules**
- **Unit tests (wavelet, mRGBE)**
- **Fixed several (old) bugs**
  - Missed octree octant during ooC lookups
  - Emission from irregularly shaped photon ports
  - Lars' "super spectacular specular fix"
    (Fixes omission of spec highlights from transmitted sources)

Code Status

- **Code available at:**
  https://c4science.ch/source/RadiancePmap/repository/pmapmerge/
- **Docs available at:**
  https://c4science.ch/source/RadiancePmapDoc/
- **No hyperspectral support; RGB only**
- **C++ refactoring shelved**

TODO

- Merge with HEAD release
- Hyperspectral support
- Point-in-time dumps of transient photon maps?

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KAKENHI