Utilizing BTDF Window Data

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What Good Is a BTDF?

- The bidirectional transmittance distribution function (BTDF) describes how light passes through a surface
- Some devices exist for measuring BTDFs
- General ray-tracers can compute BTDFs
- Using BTDFs avoids sampling issues/limits

Doesn't Radiance Have a BTDF Material Already?

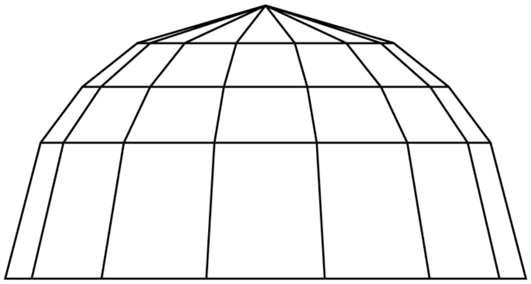
- Yes, but it only works for light sources
- Sky contributions are counted as diffuse
- This is a poor approximation for many materials
- Fully enabling the BTDF type is difficult and would be computationally expensive

How to Use a BTDF in Radiance

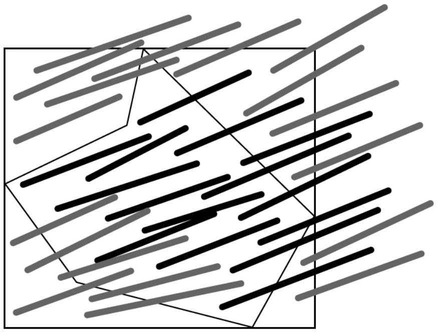
- We can insert the BTDF at the appropriate point in a **mkillum** precalculation
  - Special care is required for light sources
- Annual calculations require **rtcontrib**

Standard **mkillum** Sampling

Ray samples sent towards illum "front"

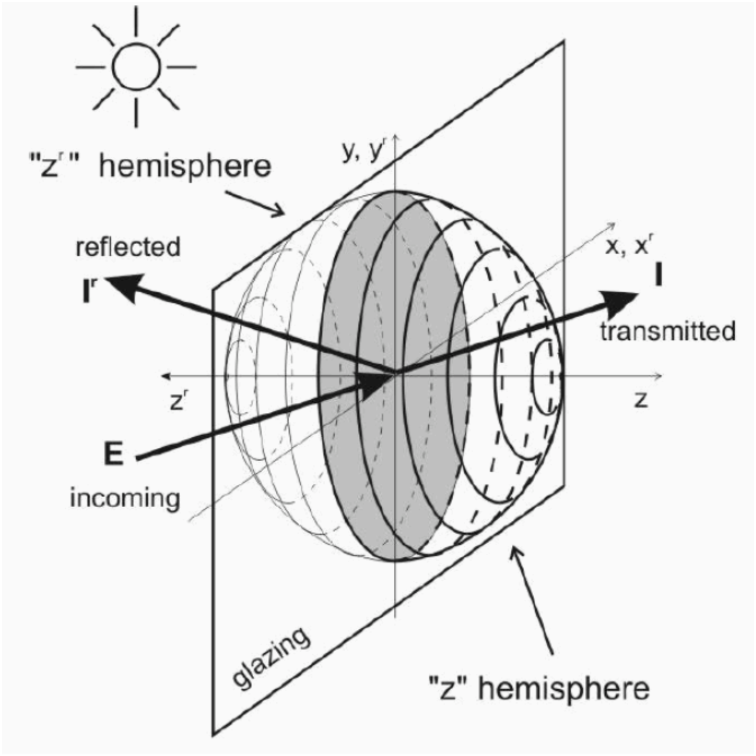


Angle Stratification



Position Distribution

Klems BTDF angle definitions



145 angles for incident/exiting

mkillum BTDF Sampling

- Send outgoing rays from opposite side of fenestration according to BTDF angles
- Sample rays to light sources if needed
- Pass incident light distribution through BTDF
- Resample transmitted light and store as window output distribution (as before)

New **mkillum** Settings

- Up direction (to orient BTDFs on windows):
  u=[+Z]
- Fenestration thickness (for sampling):
  t=[0]
- BTDF data file (alt. samples/steradian):
  d=[48]

Results

- Unfortunately, this is a work in progress
- So far, I've only managed to convert **mkillum** to use library calls rather than **rtrace**
- Need to add source sampling, read BTDF data

Annual Simulations

- In case you haven't tried it, **mkillum** provides for some rather slow annual calculations
- Daylight factor method is fab, but **rtcontrib** cannot compute anything **rtrace** cannot
- BTDFs don't work properly with **rtrace**, so...

Three Phase Method

- First phase:

  Use **rtcontrib** to get daylight coefficients relating sky patches to incident directions

- Second phase:

  Use **rtcontrib** to relate exiting portal directions to __________

- Third phase (time-step calculation):
  sky * incident * BTDF * exiting

Method Advantages

- Precalculation is the only expensive part

- Time-step allows fenestration (BTDF) to change or adapt, since matrix multiplication is relatively quick

- Anything can be produced, including images

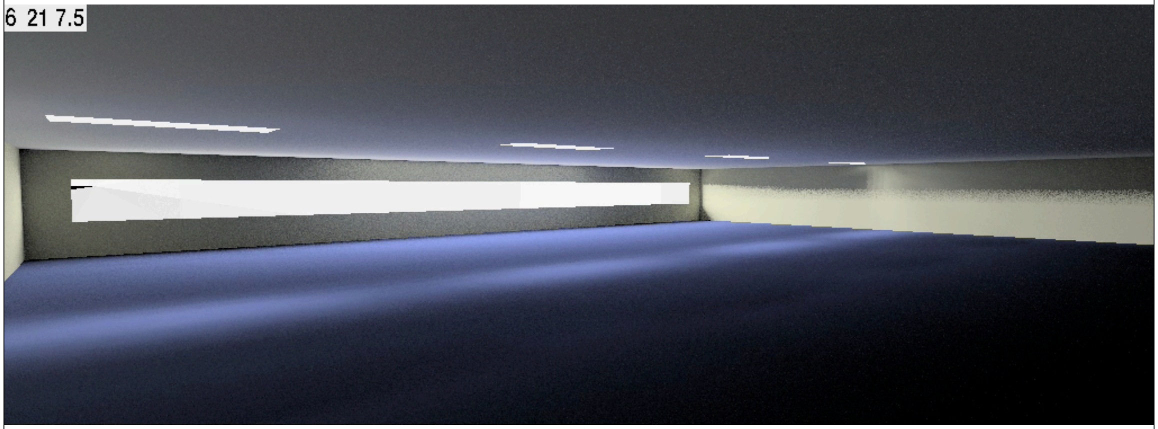
Phase 1

rtcontrib incoming directions to Tregenza patches

Phase 2

Output side of fenestration to image pixels

Phase 3



Time-step calculaiton (matrix multiply)

Method Disadvantages

- Large-scale external geometry (fins, overhangs, etc.) require subdividing opening
    - Best if this can be automated
- Limited resolution of BTDF means direct solar will be approximate at best

Open Questions

- How & when shall we sample light source directions in **mkillum**?
- Should we use BRDF as well for interior reflections?
- How shall we specify opening subdivision and coordinate a three-phase calculation?
- How do we guarantee reliable BTDF input?