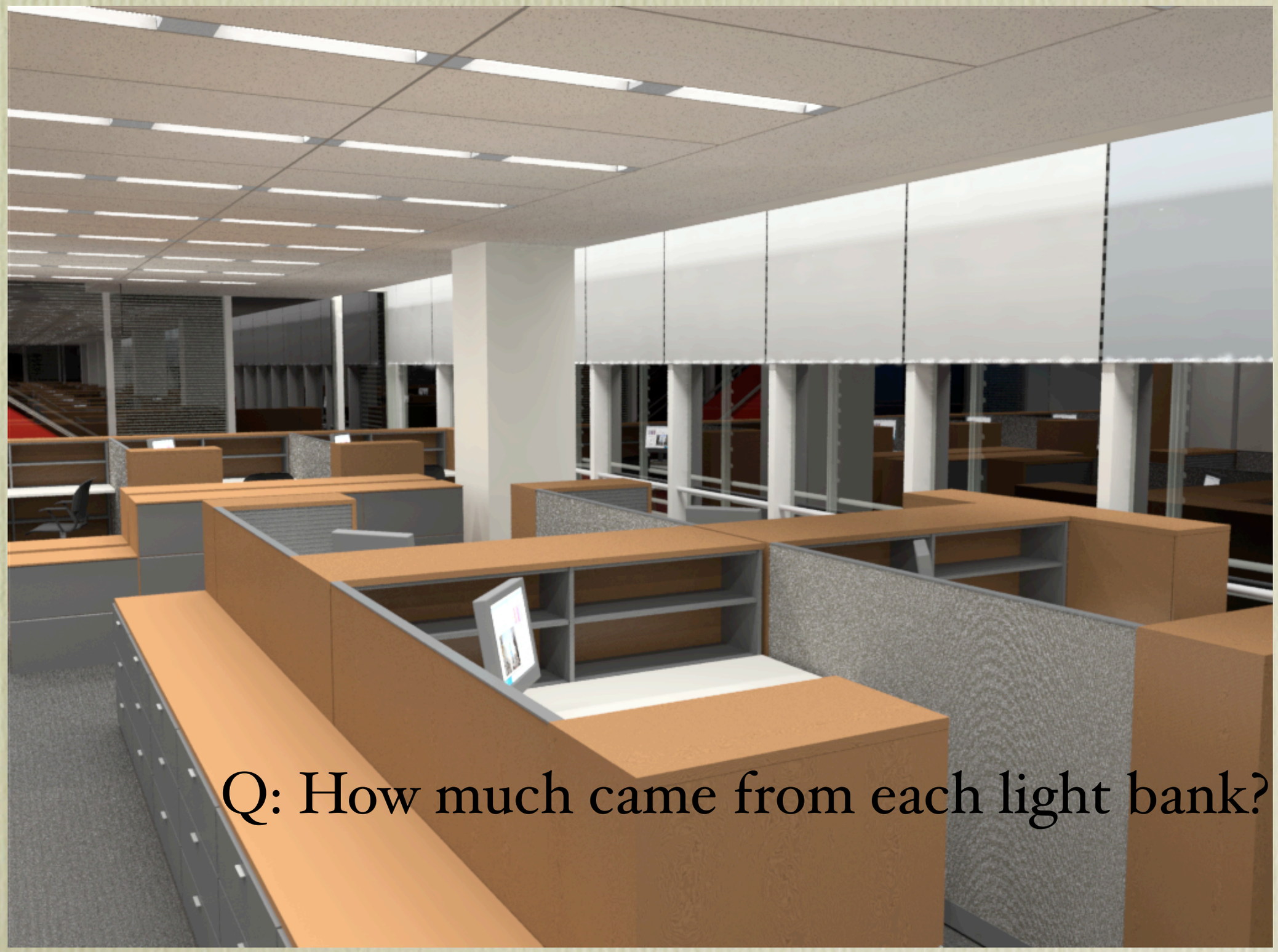
# The *Radiance* **rtcontrib** Program

Greg Ward
Anyhere Software

# Quantify Contributions



# Background

- Core *Radiance* rendering routines recursively evaluate radiance, hence the name
- Potentially useful information about where light originates is lost during this process
- Prior to version 3.7, there were two solutions:
  - Repeat rendering for each source (costly)
  - Switch to *Daysim* (daylight coefficients only)

# Method

- New member in `RAY` structure for storing current ray coefficient (3 floats for RGB)
- Minor change to evaluation ordering in *Radiance* rendering routines
- Function for multiplying ray coefficients back to the root of the tree (i.e., the `PRIMARY` ray)
- Improvement to `-aa 0` speed & accuracy
- New '`T`' and '`W`' options for **rtrace** `-o`

# Example Code Change

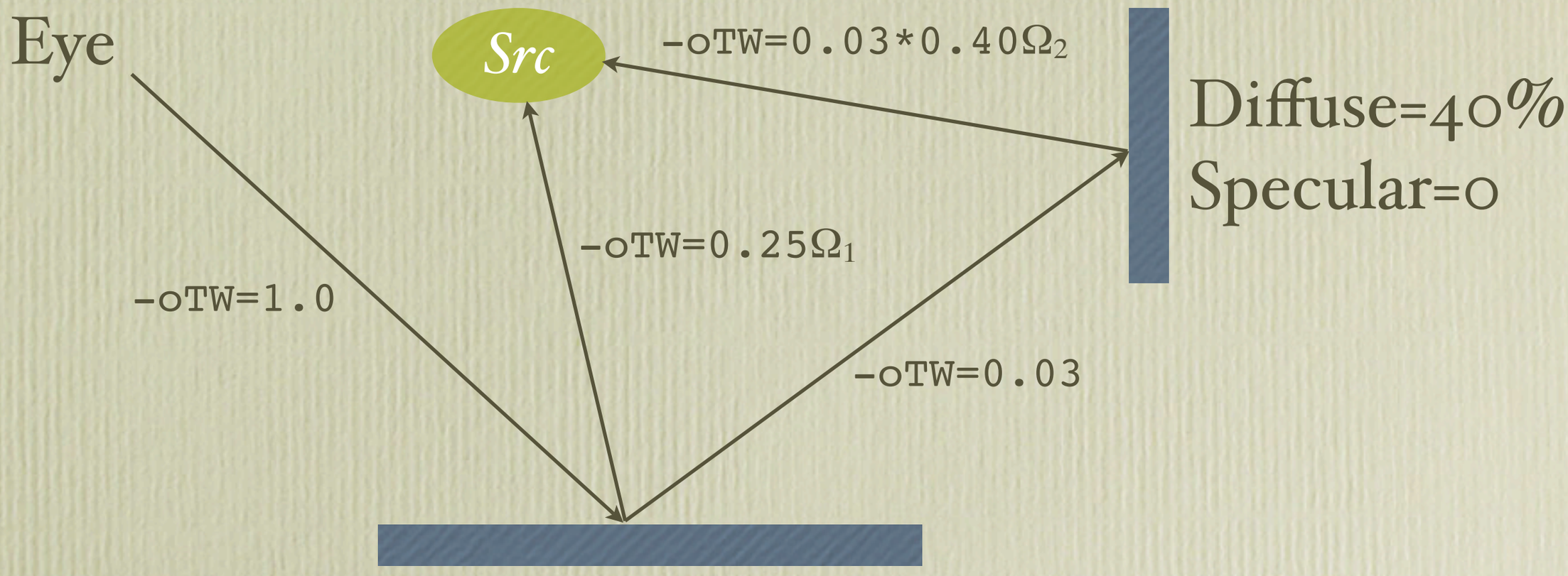
**Diff for /ray/src/rt/normal.c between version 2.49 and 2.50**

| version 2.49, 2005/01/05 19:34:11 | version 2.50, 2005/04/19 01:15:06 |
|---|---|
| **Line 258** | **Line 258** |
| /* transmitted ray */ | /* transmitted ray */ |
| if ((nd.specfl&(SP_TRAN\|SP_PURE\|SP_TBLT)) == (SP_TRAN\|SP_PURE)) { | if ((nd.specfl&(SP_TRAN\|SP_PURE\|SP_TBLT)) == (SP_TRAN\|SP_PURE)) { |
| RAY lr; | RAY lr; |
| if (rayorigin(&lr, r, TRANS, nd.tspec) == 0) { | copycolor(lr.rcoef, nd.mcolor); /* modified by color */ |
| | scalecolor(lr.rcoef, nd.tspec); |
| | if (rayorigin(&lr, TRANS, r, lr.rcoef) == 0) { |
| VCOPY(lr.rdir, nd.prdir); | VCOPY(lr.rdir, nd.prdir); |
| rayvalue(&lr); | rayvalue(&lr); |
| scalecolor(lr.rcol, nd.tspec); | multcolor(lr.rcol, lr.rcoef); |
| multcolor(lr.rcol, nd.mcolor); /* modified by color */ | |
| addcolor(r->rcol, lr.rcol); | addcolor(r->rcol, lr.rcol); |
| transtest *= bright(lr.rcol); | transtest *= bright(lr.rcol); |
| transdist = r->rot + lr.rt; | transdist = r->rot + lr.rt; |

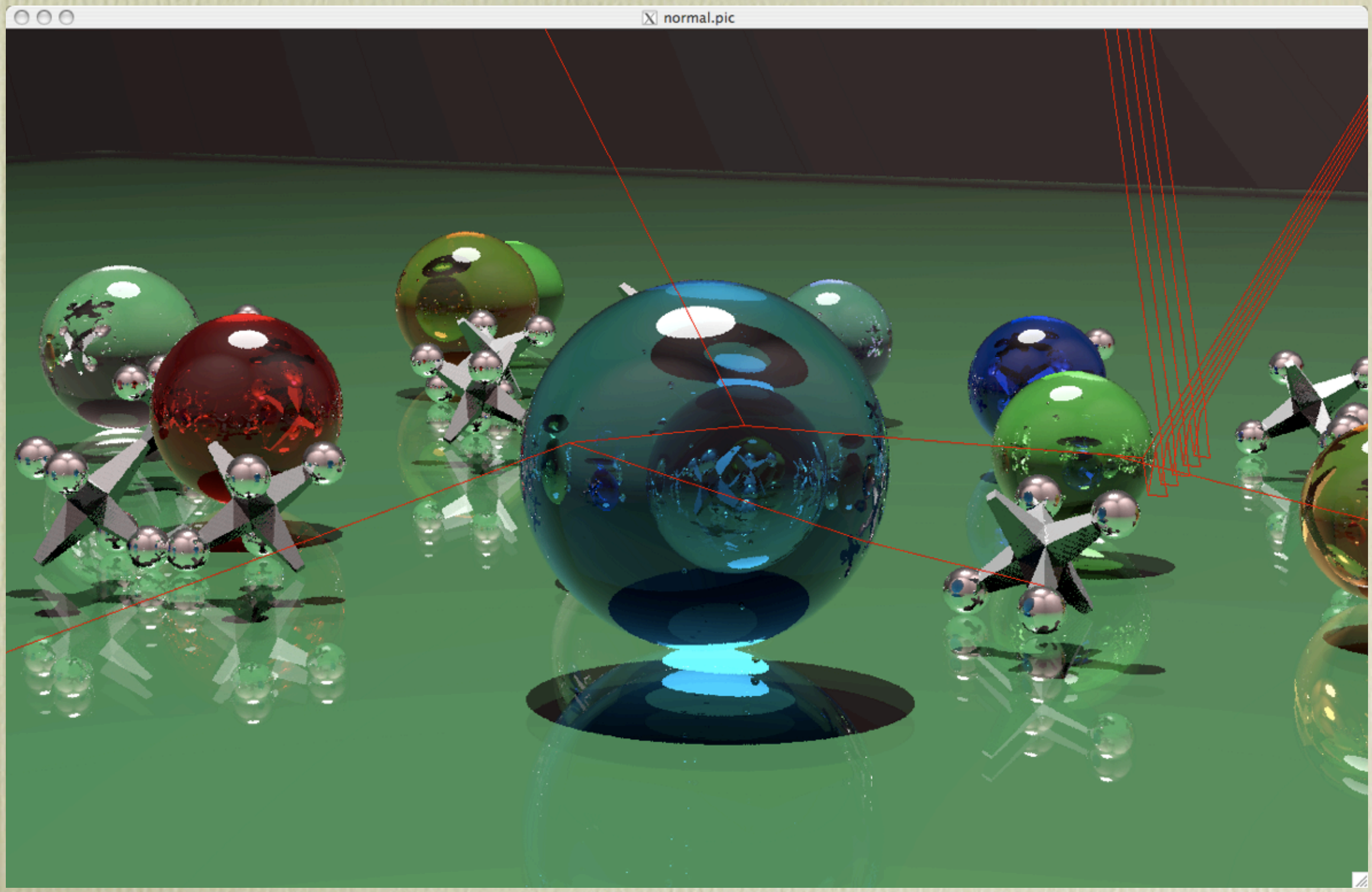
# Contribution Coefficients

- A “contribution coefficient” is the fraction of a ray’s return value that will ultimately apply
  - This is closely related, but not equal, to the “ray weight” reported by `-otw`
- ‘`T`’ option for **rtrace** `-o` traces to light sources
- The ‘`W`’ option reports contribution coefficient

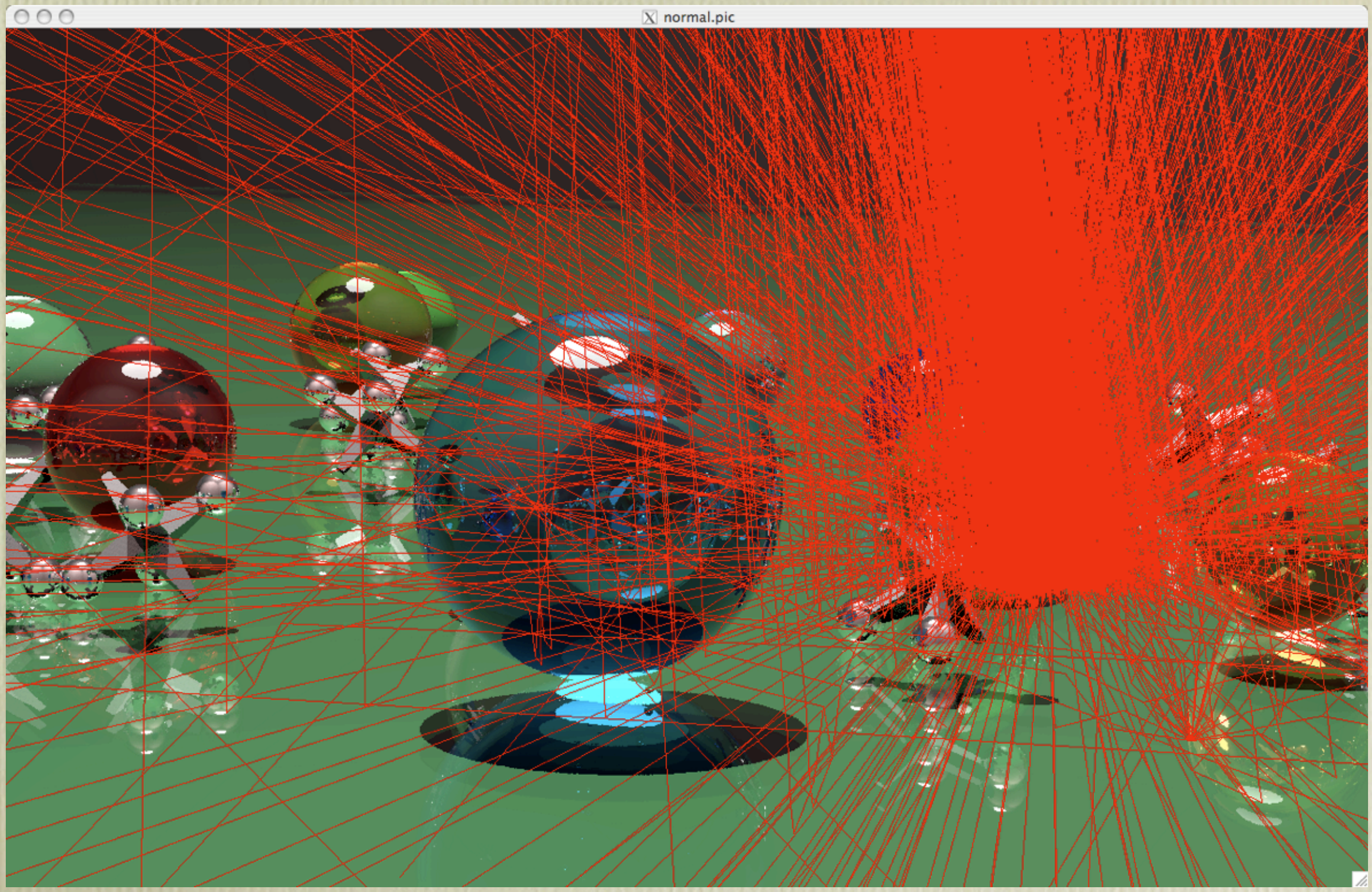
# A Simple Example



# Problem: Daughter Rays



# Diffuse Interreflections



# Solution: Gather Rays

- Need a general method to gather contribution coefficients and sum them together
- Different applications require different sums:
  - Daylight coefficients sum at sky patches
  - Luminaire model may sum at lamp surface
- How do we do it all?

# Enter **rtcontrib**

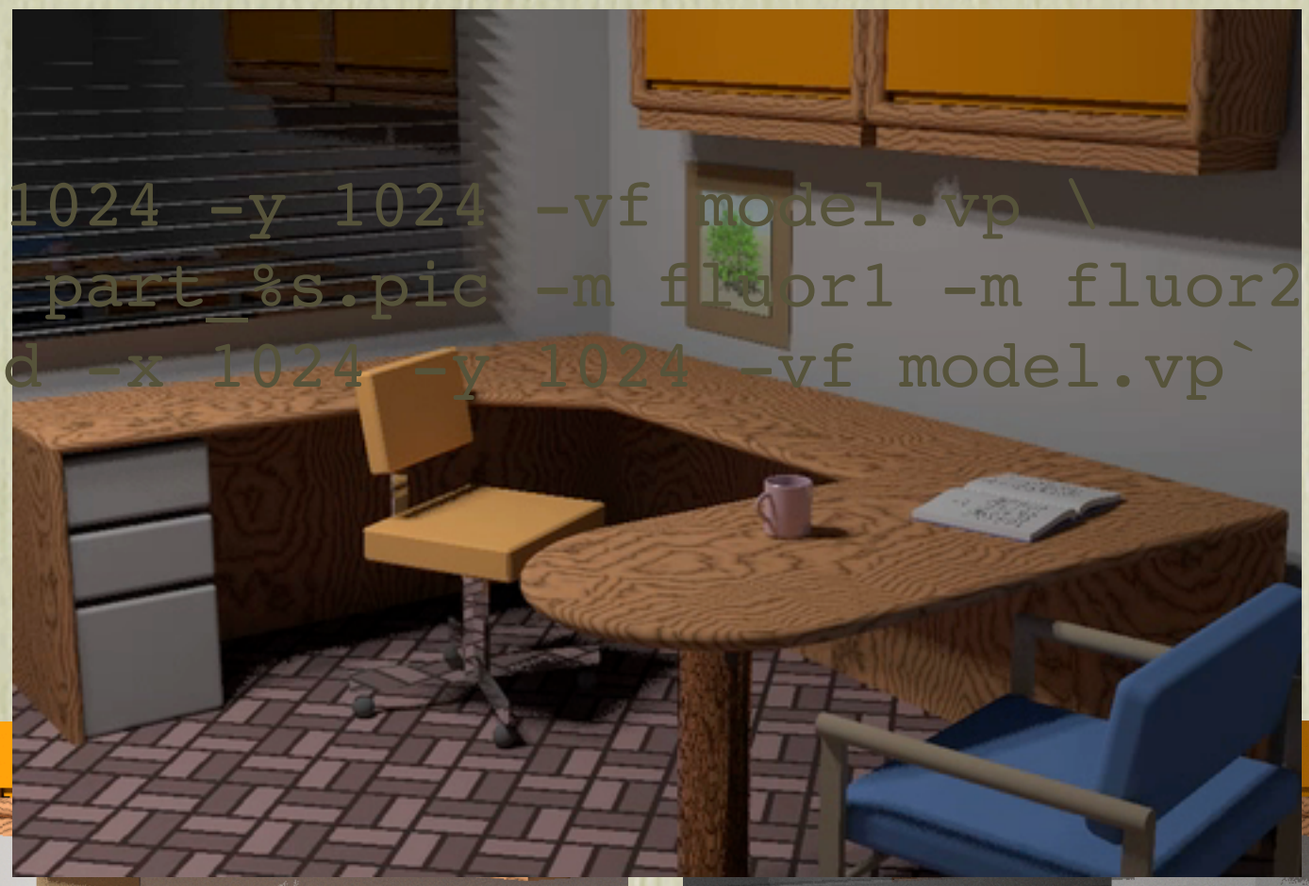
- Manage the calculation of ray contribution coefficients by **rtrace**
- Gather contributions for use in linear light combinations (e.g., daylight coefficients)
- Facilitate analysis of optical systems such as light pipes and luminaires
- Provide flexible output (ASCII and binary data as well as *Radiance* pictures)

# General Operation

- User specifies **rtrace** options and octree
- User tells **rtcontrib** where to collect values
  - required modifier name(s)
  - optional bin number based on ray direction and intersection point
- Output sent to one or more files or commands
  - specified by modifier name and bin number

# Lighting Example

```
vwrays -ff -x 1024 -y 1024 -vf model.vp \
| rtcontrib -o part_%s.pic -m fluor1 -m fluor2 \
-ffc `vwrays -d -x 1024 -y 1024 -vf model.vp` -u+ model.oct
```



# **rtcontrib** Options

General options:

`-n` *N* start *N* **rtrace** processes

`-r` recover previously aborted calculation

`-e` *expr* compile definitions string

`-f` *source* compile definitions file

} Used by `-b`

Modifier options:

`-o` *ospec* output specification — May contain '`!`' and '`%d`' or '`%s`'

`-b` *binv* bin number — Integer expression, or '`0`' to disable

Modifier specification:

`-m` *mod* modifier name

`-M` *file* modifier list from file

# Lighting Example Dissection

```
vwrays -ff -x 1024 -y 1024 -vf model.vp \
| rtcontrib -o part_%s.pic -m fluor1 -m fluor2 \
-ffc `vwrays -d -x 1024 -y 1024 -vf model.vp` -u+ model.oct
```

# Lighting Example Dissection

**vwrays** provides primary ray origins and directions (in floating point) for pictures to be generated by rtcontrib

```
vwrays -ff -x 1024 -y 1024 -vf model.vp \
| rtcontrib -o part_%s.pic -m fluor1 -m fluor2 \
-ffc `vwrays -d -x 1024 -y 1024 -vf model.vp` -u+ model.oct
```

Second invocation reports actual resolution (-x 1024 -y 690)

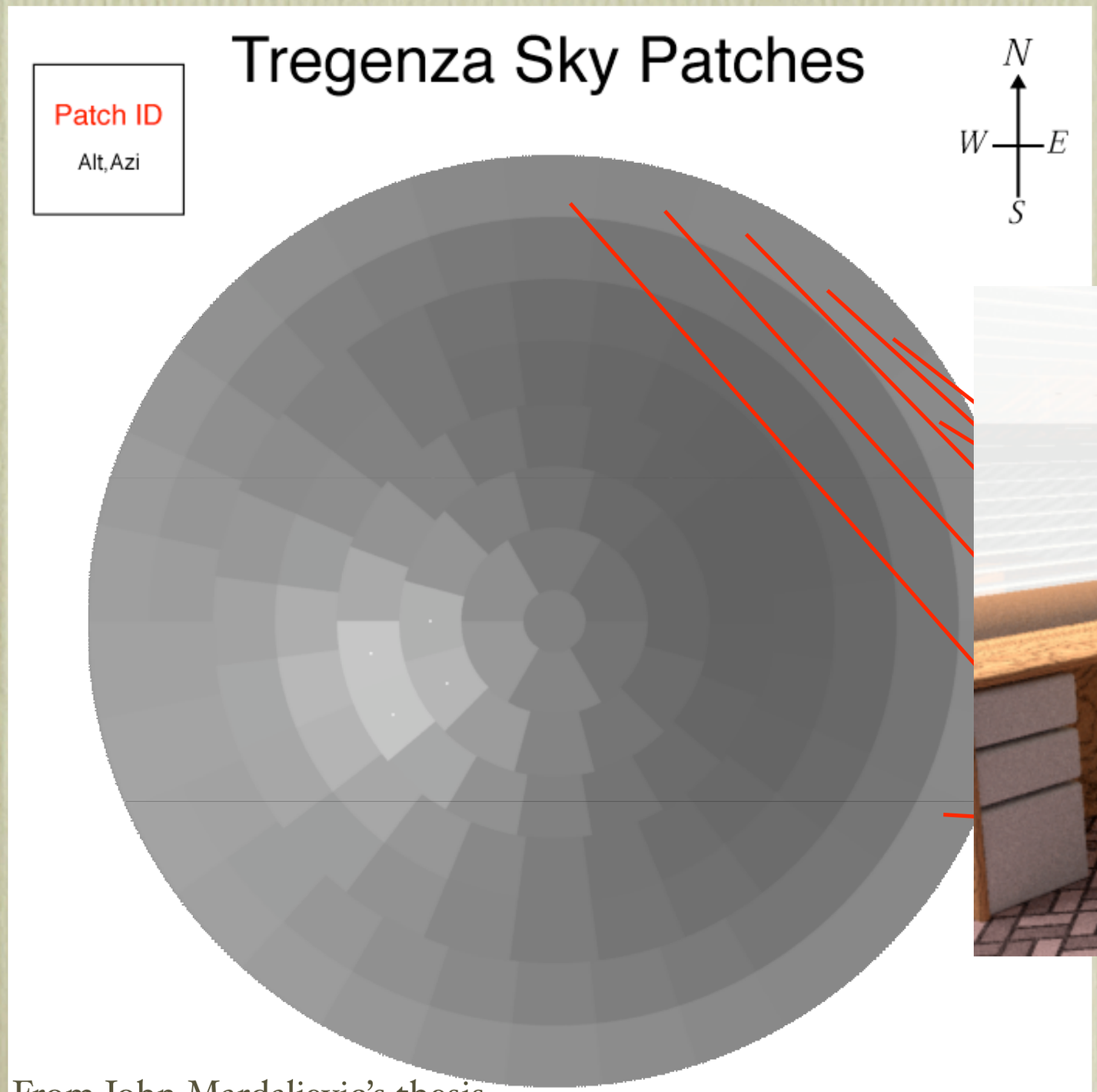
# Lighting Example Dissection

Specifies output files and associated modifiers, creating `part_fluor1.pic` and `part_fluor2.pic`.

```
vwrays -ff -x 1024 -y 1024 -vf model.vp \
| rtcontrib -o part_%s.pic -m fluor1 -m fluor2 \
-ffc `vwrays -d -x 1024 -y 1024 -vf model.vp` -u+ model.oct
```

The `-ffc` option is an **rtrace** option telling **rtcontrib** to expect single-precision floats on input and produce RGBE colors on output. The `-u+` option specifies pure Monte Carlo sampling.

# Daylight Coefficients




From John Mardaljevic's thesis

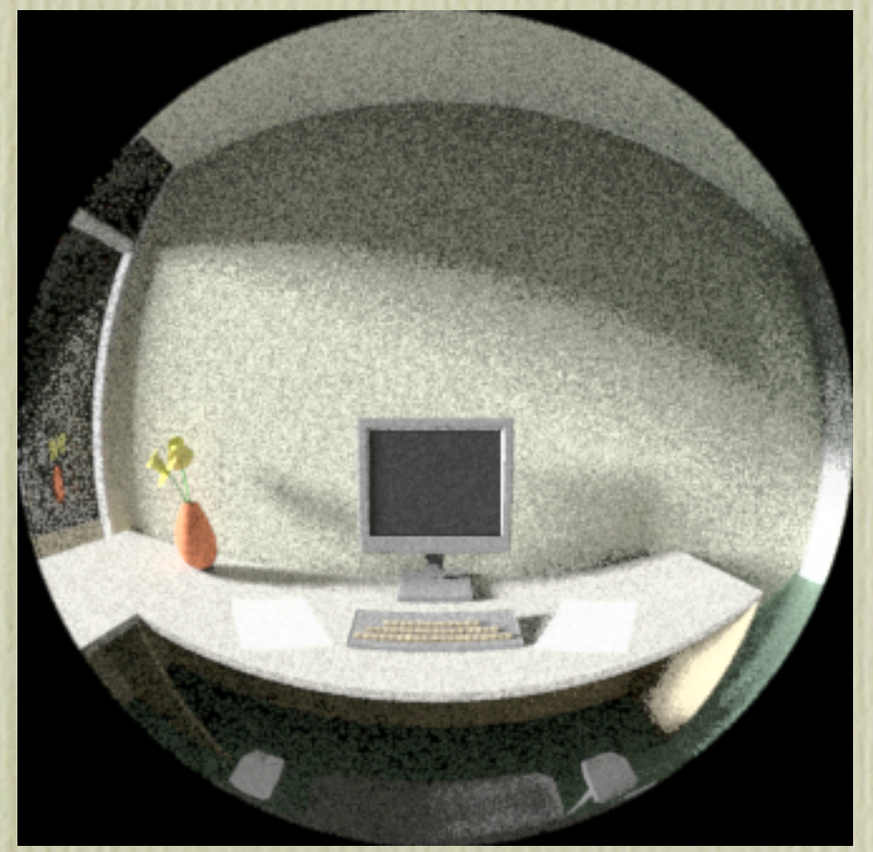
# Daylight Coefficient Example

Blinds: up, top, down
@ 10° increments

Optional overhang

Upper & lower glass:
42 separate runs
of 146 sky patches
& 145 solar patches
One hemispherical
fisheye view

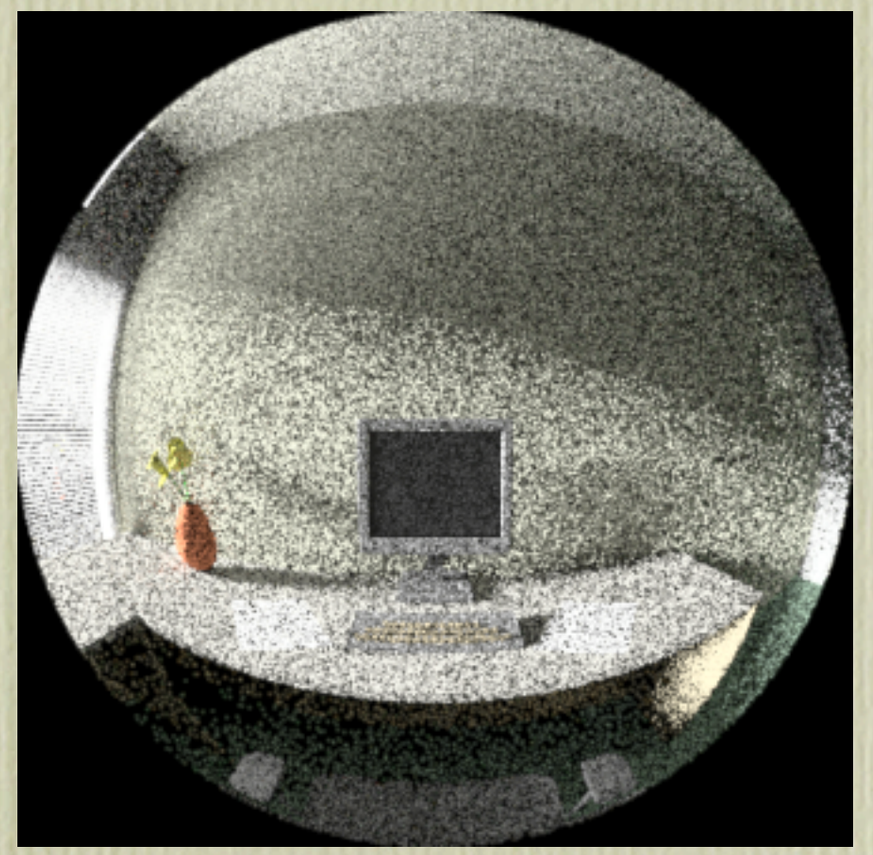
# Example Contributions (1)



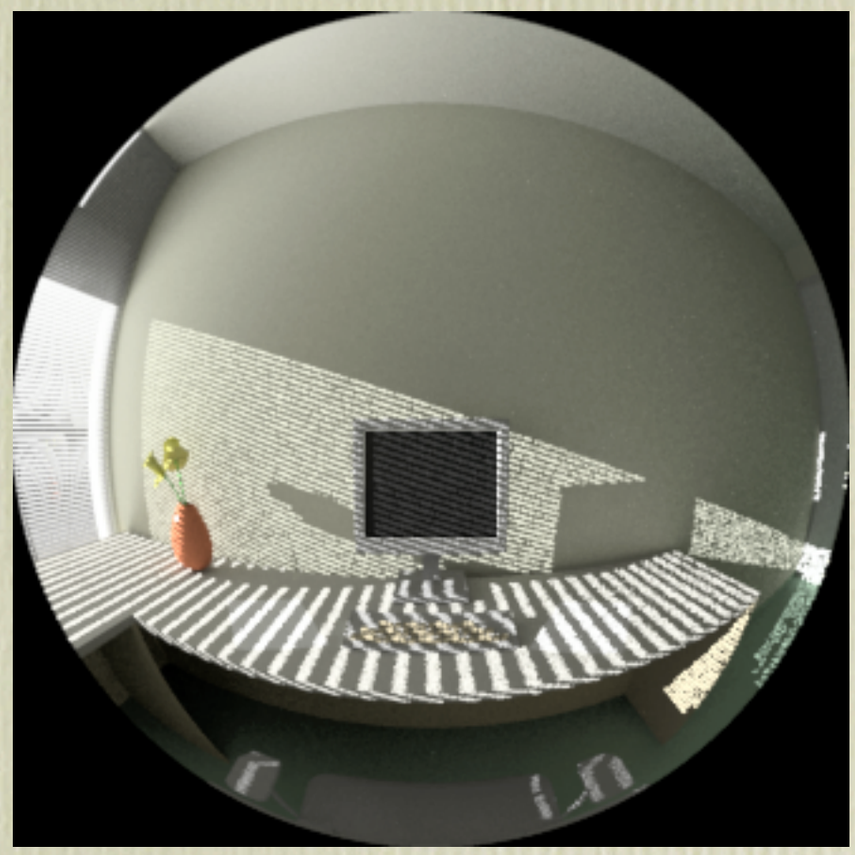
Sky patch 045
from lower glass
no overhang
no blinds

Sun patch 045
from lower glass
no overhang
no blinds

# Example Contributions (2)



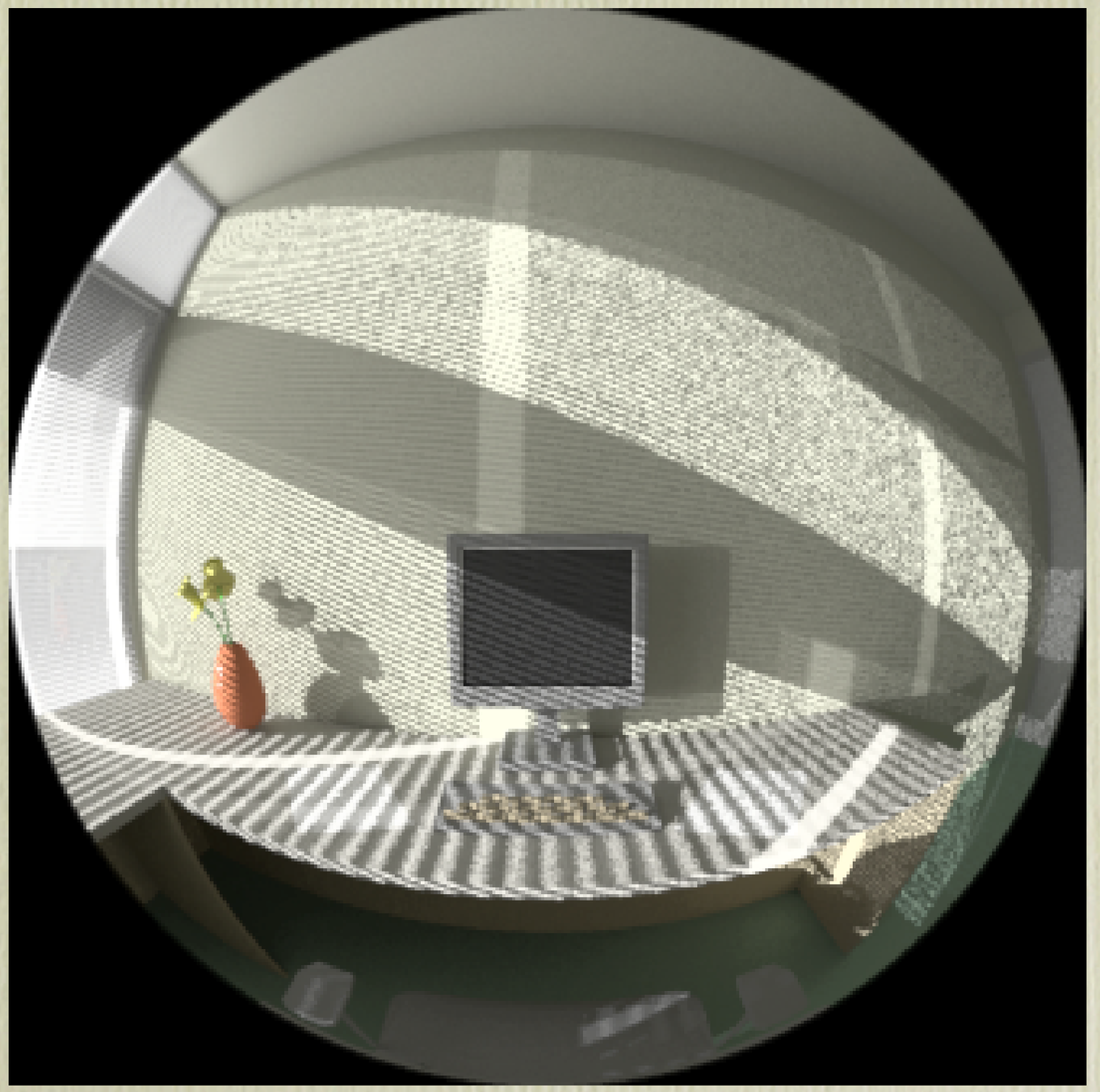
Sky patch 045
from lower glass
with overhang
blinds @ 20°



Sun patch 045
from lower glass
with overhang
blinds @ 20°

# Combined Result

Dec 28
Overhang
10 am
blinds down
@ 10°



# Future Work

- I hope to be working in the future
- Apply **rtcontrib** to optical problems
  - BTDF simulations
  - Luminaires, light pipes, etc.
- Integrate with energy simulation tools