RTRACE with Equisolid projection

in

Environmental Psychology studies

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Thanks to :
Chikako OHKI
Toshihide OKAMOTO

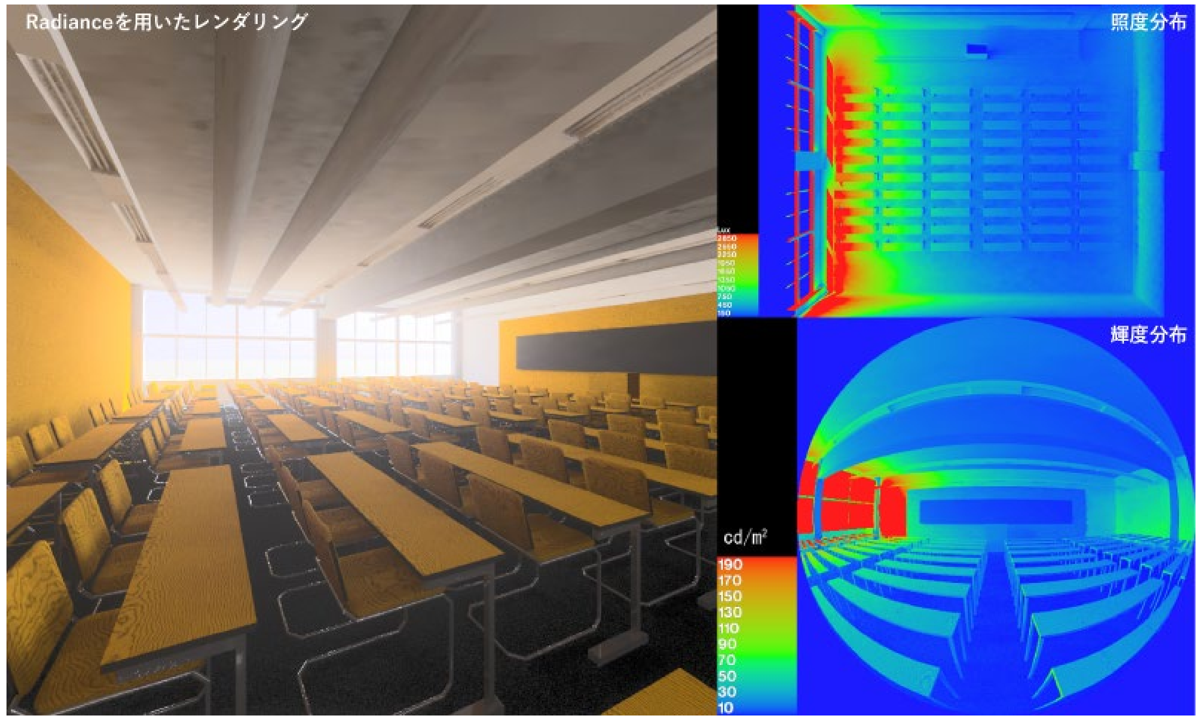
Tokyo University of Science - Nozomu YOSHIZAWA Lab.

2019.08.22 Radiance Workshop @ Arup New York

Application of Rtrace in Environmental Psychology Laboratory

Table of Contents

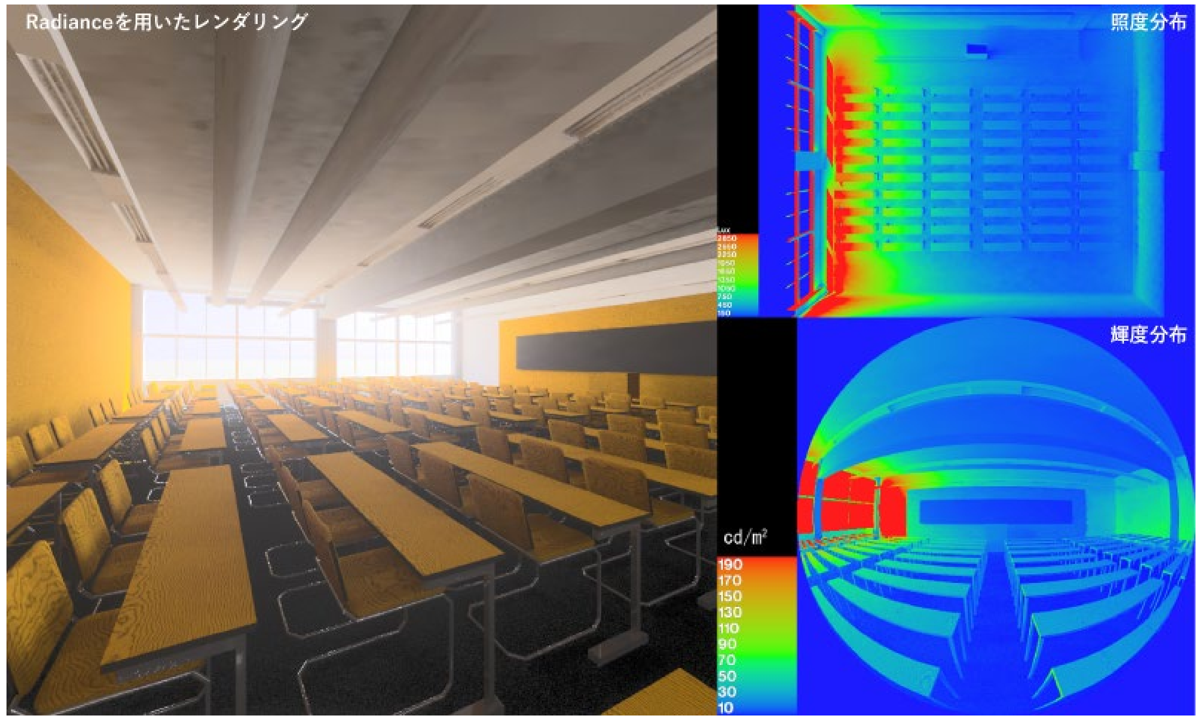
Radiance is



for simulation !

Radiance is

not only

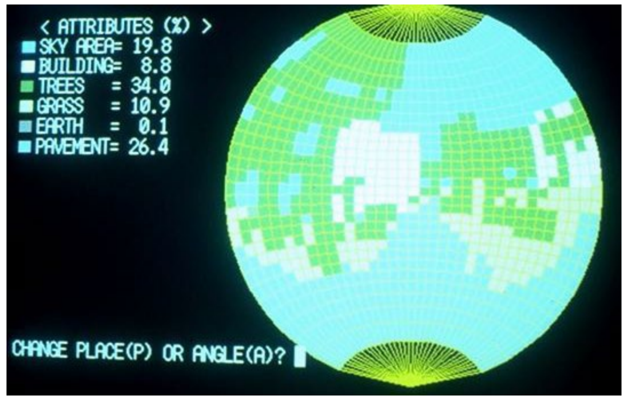


for simulation !

RTRACE + Equisolid projection can be used for researches

Spaciousness

Image : scjohnson.com



Sense of security

(Ambient Visual Information)

Image : Ryuzo OHNO

Quality of View Out

Image : DIN EN 17037:2019-03

Environmental Psychology

(finding a model how people perceive space)

Application of Rtrace in Environmental Psychology Laboratory

Table of Contents

- What is Environmental Psychology Laboratory ?

- Application examples

  [case 1] Spaciousness calculation with 3D luminance mapping

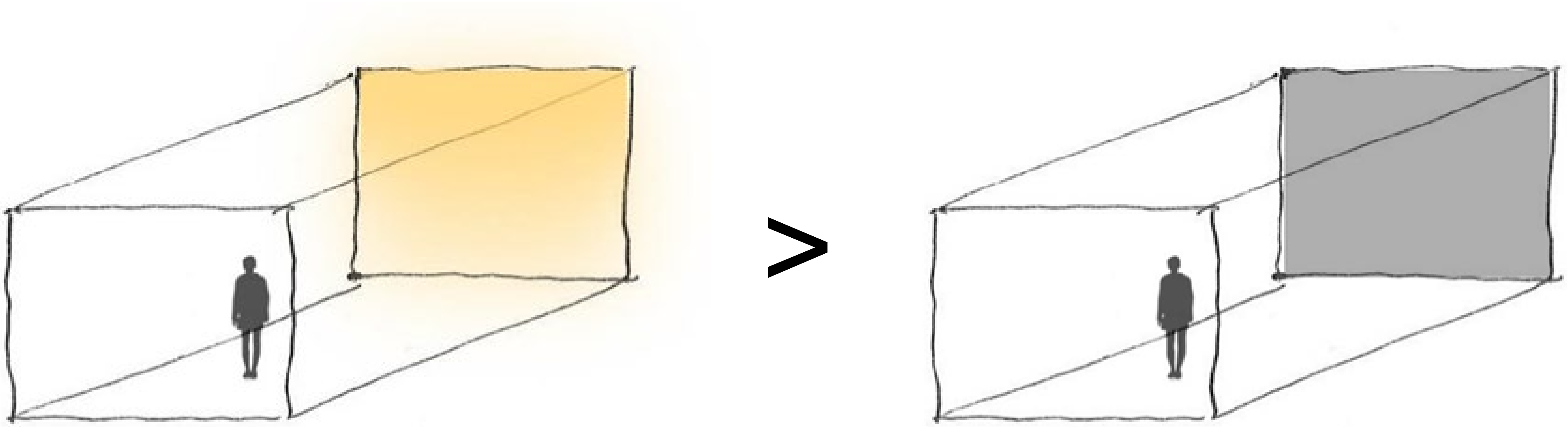
  [case 2] Ambient visual information for Sense of Safety from Crime

  [case 3] View Out from a window through Sun Shading Devices

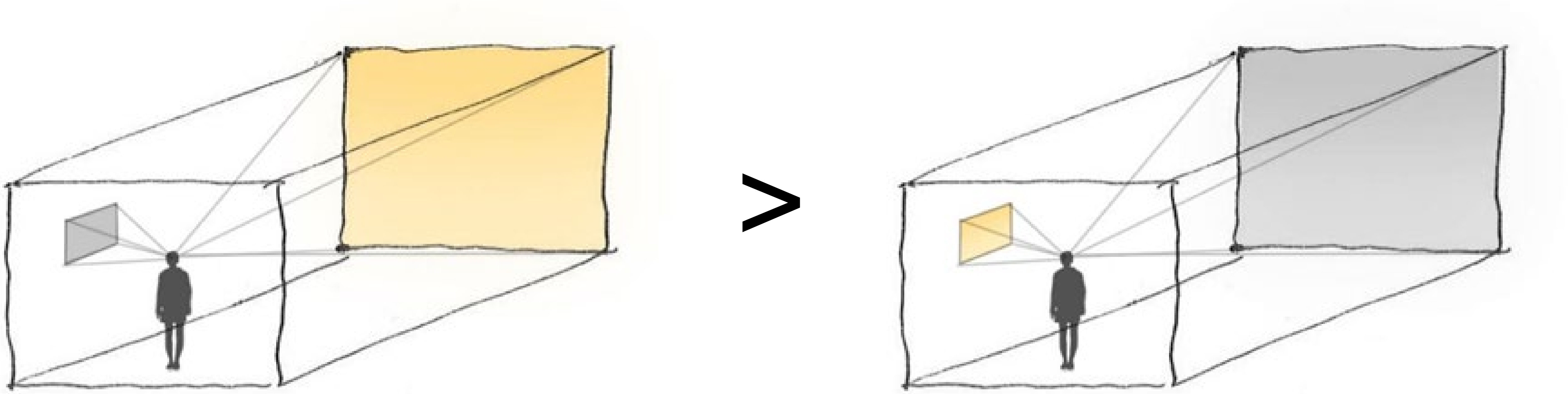
Light seems to affect spaciousness

Image : scjohnson.com

Light seems to affect spaciousness

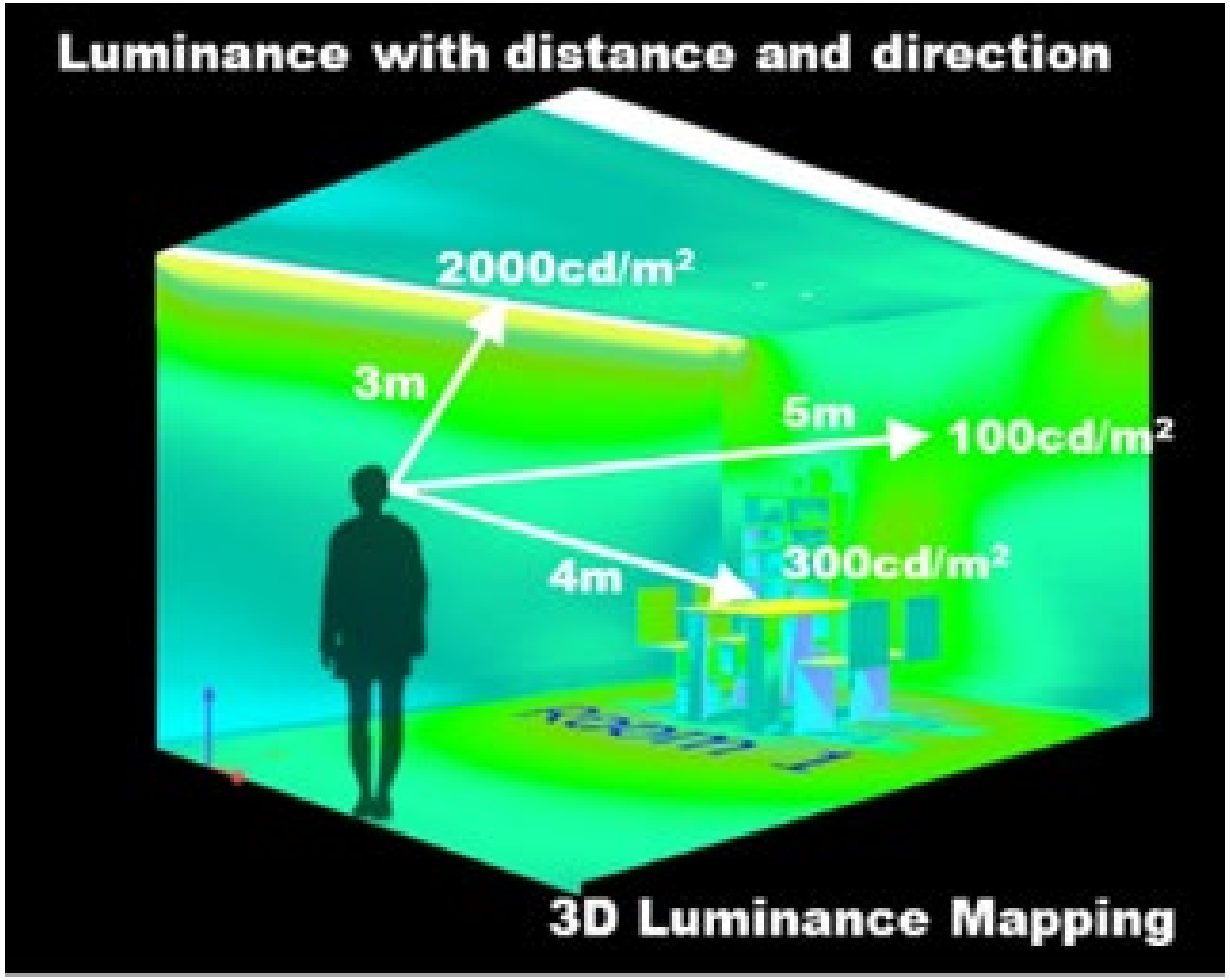


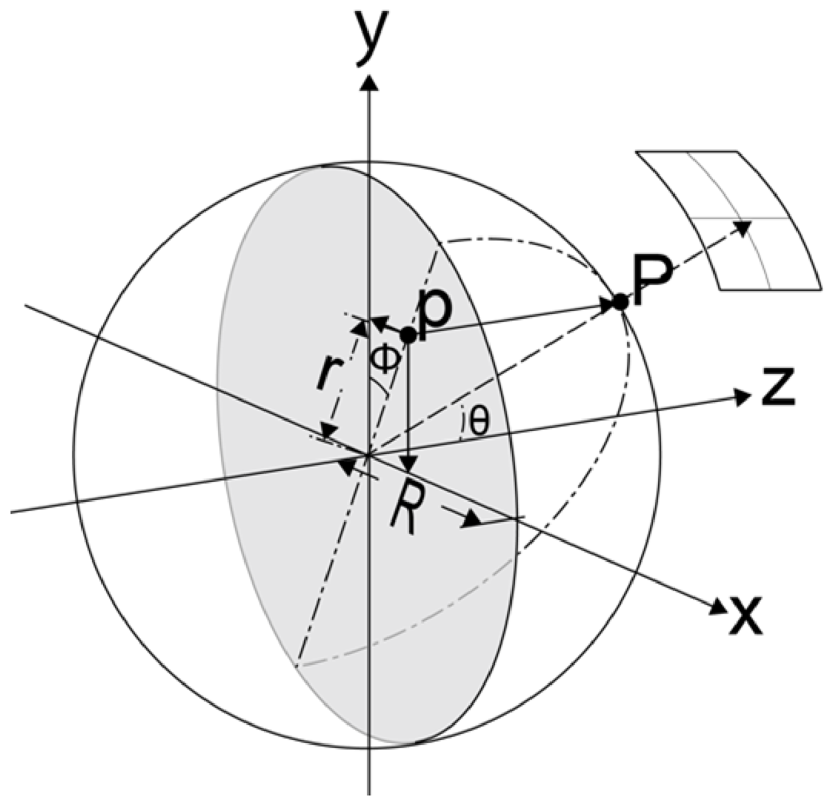
1. The brighter the space is, the more spaciousness is perceived.

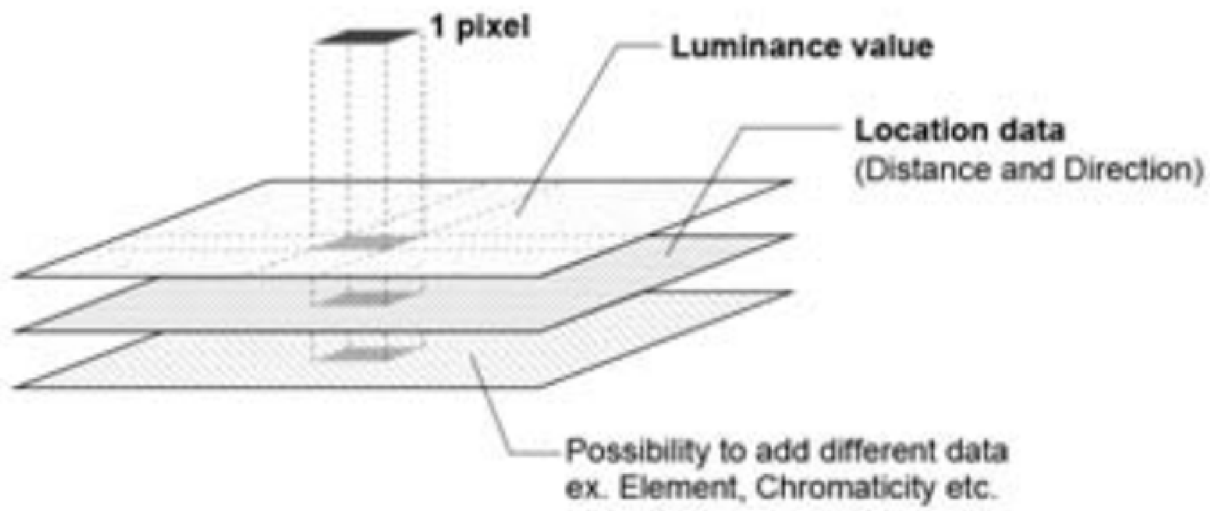


2. The farther the light is localised from the observer, the more spaciousness is perceived.

CIE 2019
EFFECTS OF LIGHTING ON PERCEPTION OF SPACIOUSNESS
Hiroyuki MIYAKE et al.
DOI 10.25039/x46.2019.PO140
http://files.cie.co.at/x046_2019/x046-PO140.pdf







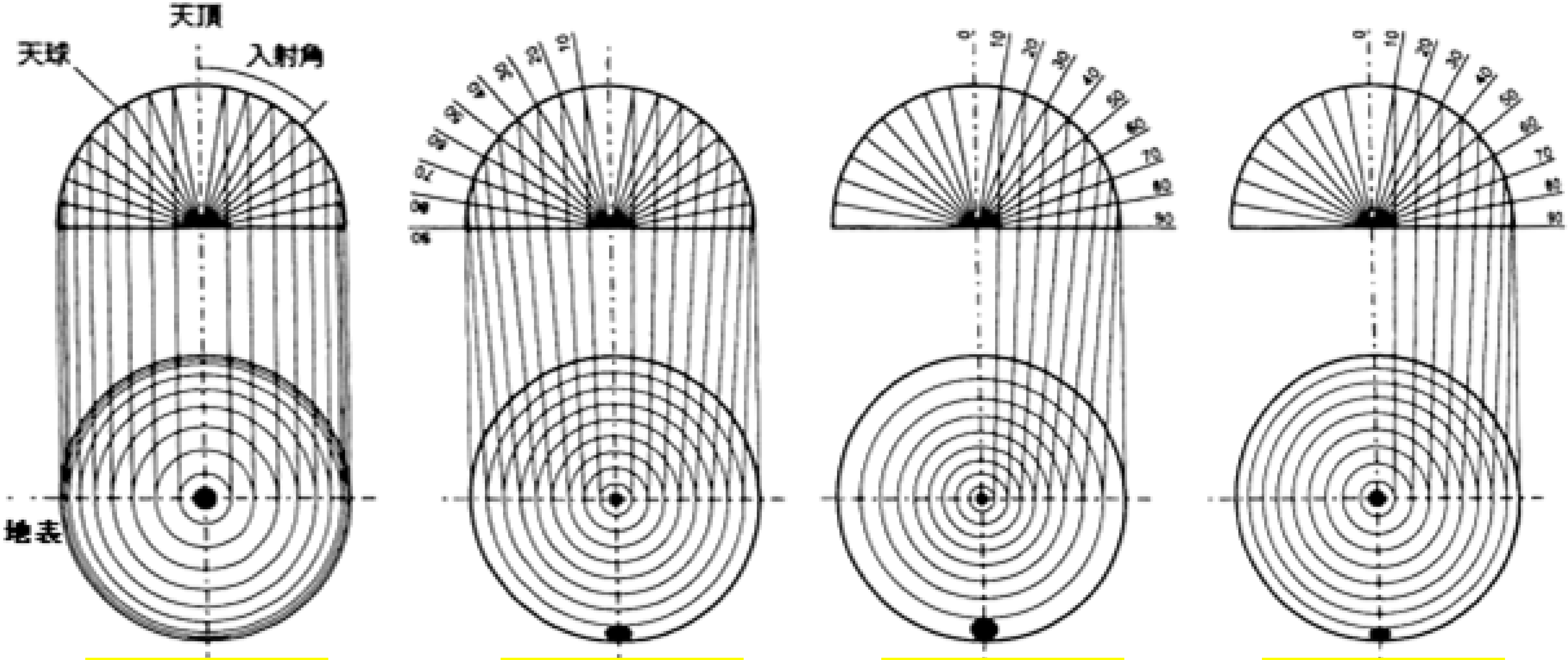
Spaciousness = Log_{10} (Arithmetic mean of (L (cd/m²) x D (mm) x cosθ)) *(to be further developed)*

L = luminance of each pixel : -ov

D = distance from the observing point to the surface in that pixel : -oL

θ = angle between the direction to that pixel and the view axis : od (normalised vector)

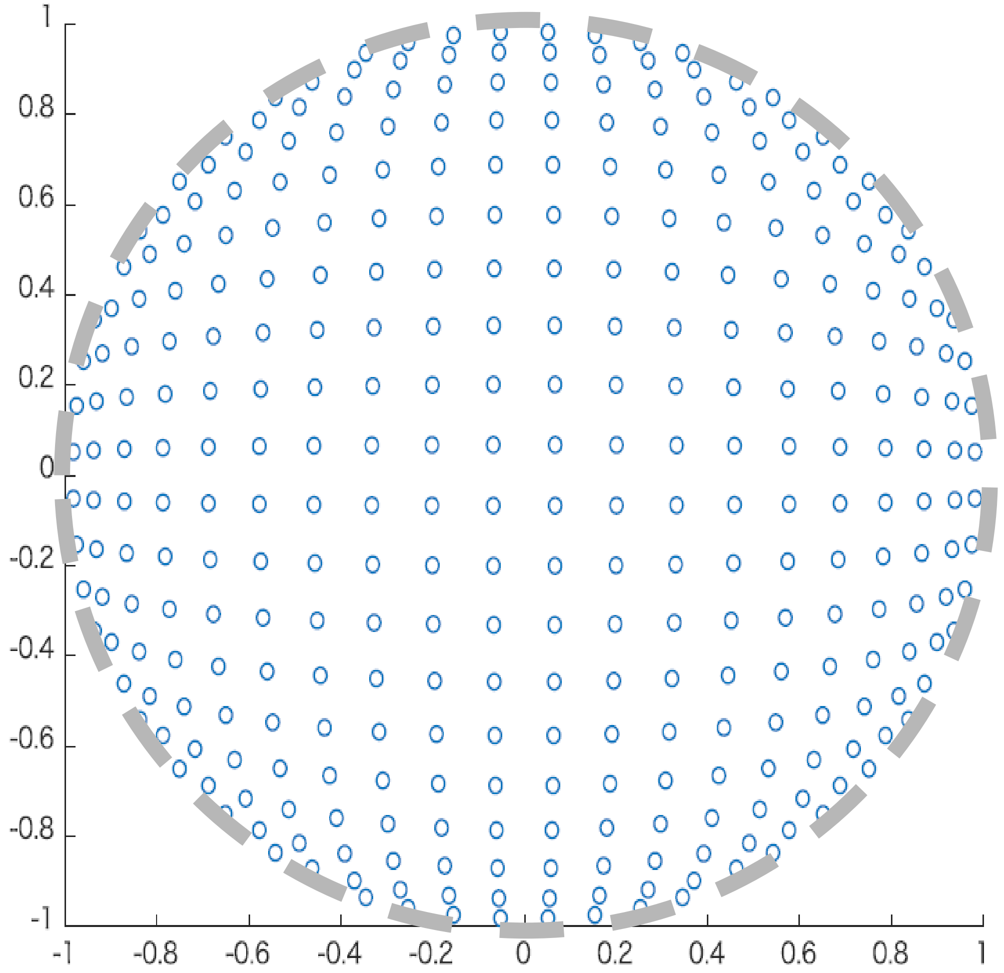
*cnt 512 512 | rcalc -f **equisolid.cal** -e "XD=512;YD=512" |*
***rtrace** -ab 6 -af p.amp **-odvL** -x 512 -y 512 -fa model.oct > case.csv*

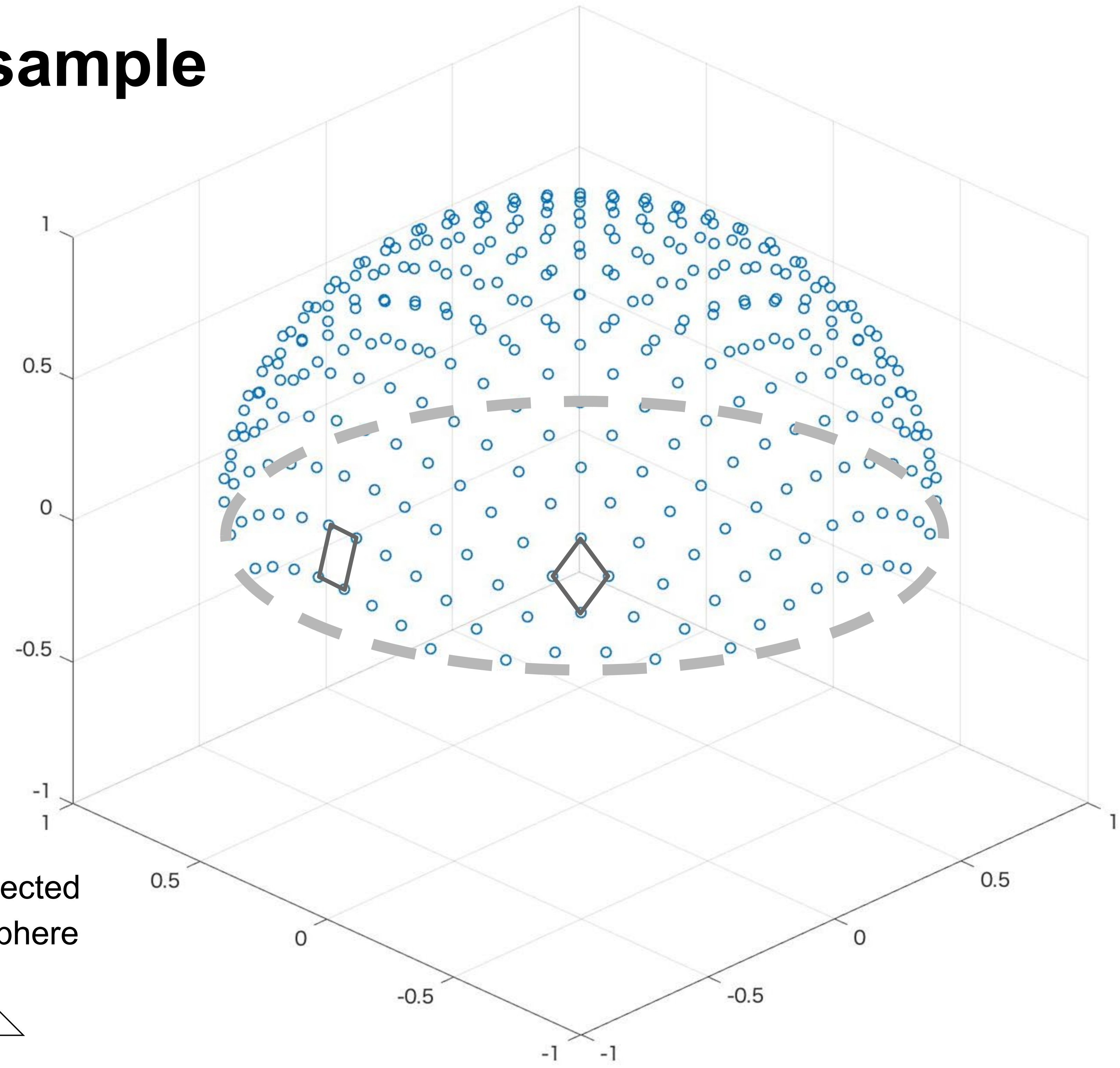


Orthographic projection	**Equidistant** projection	**Stereographic** projection	**Equisolid** projection
$y = f\sin\theta$	$y = f\theta$	$y = 2f\tan(\frac{\theta}{2})$	$y = 2f\sin(\frac{\theta}{2})$
-vth option available	**-vta** option available	**-vts** option available	**We need THIS !!!**

cnt 512 512 | rcalc -f ***equisolid.cal*** *-e "XD=512;YD=512 |*
rtrace *-ab 6 -af p.amp* ***-odvL*** *-x 512 -y 512 -fa model.oct > case.csv*

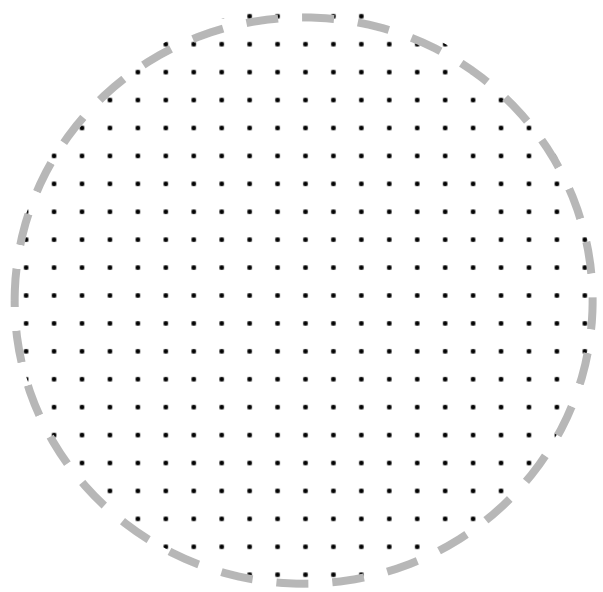
RTRACE points projection sample





Dots projected
to hemisphere

Square grid dots
on a plane



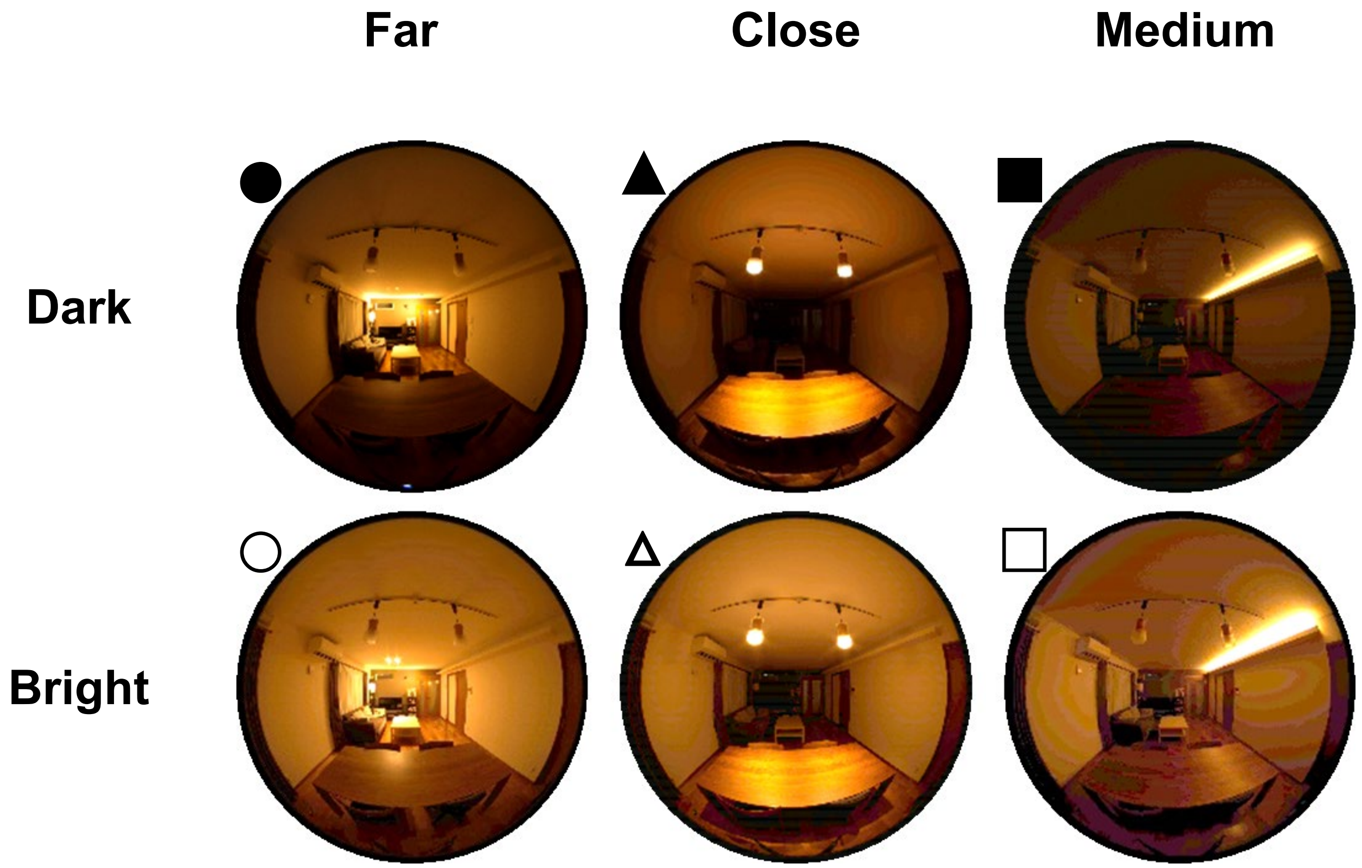
Visualization of RTRACE points

Square grid dots projected to hemisphere

(diameter 21 px = 344 dots in this example)

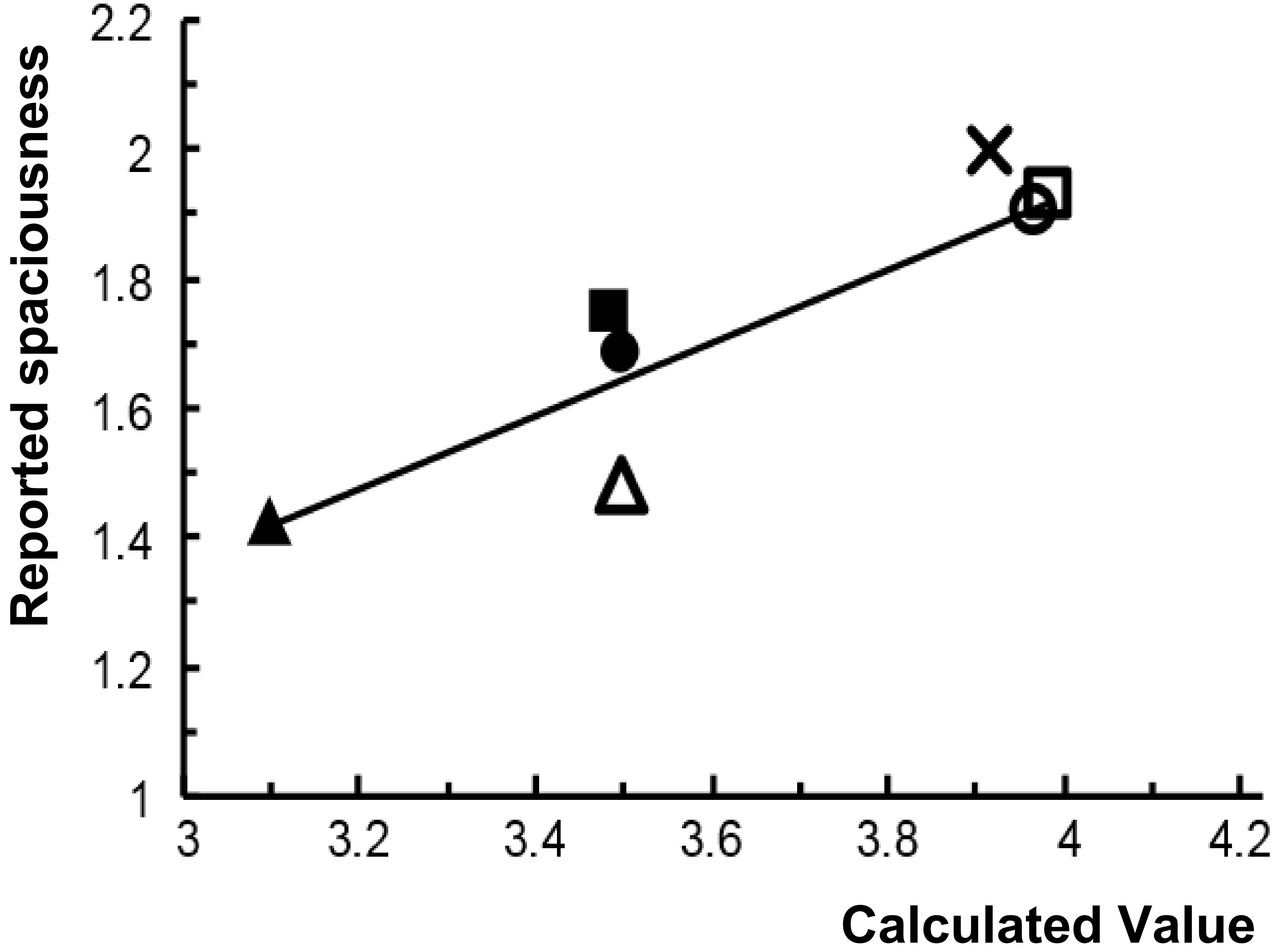
(in the research, diameter 512 px = 205,884 pixels are projected)

Result



× is the base lighting scene for magnitude estimation comparison

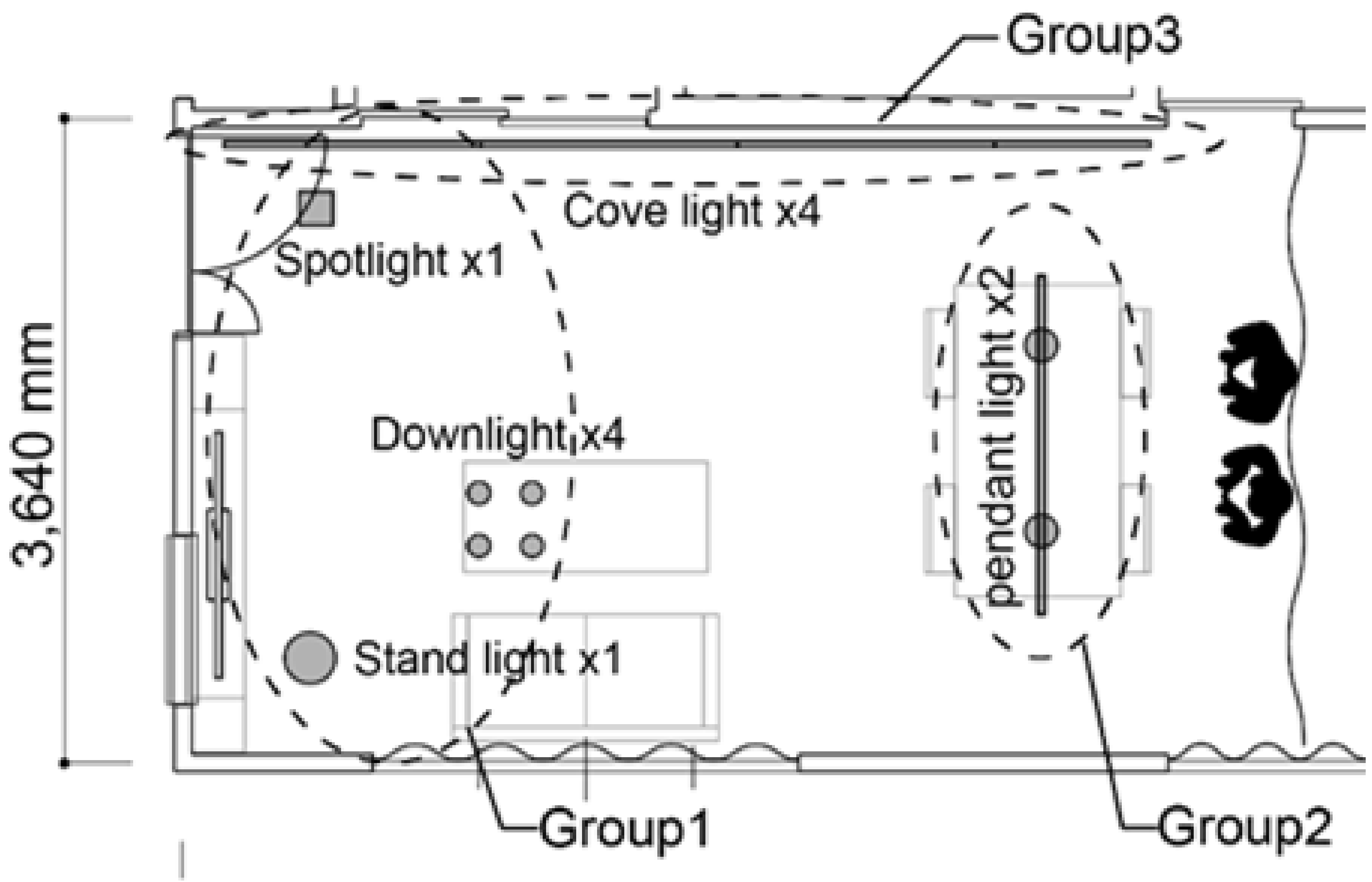
$y = 0.56\,x - 0.31 \quad R^2 = 0.81$

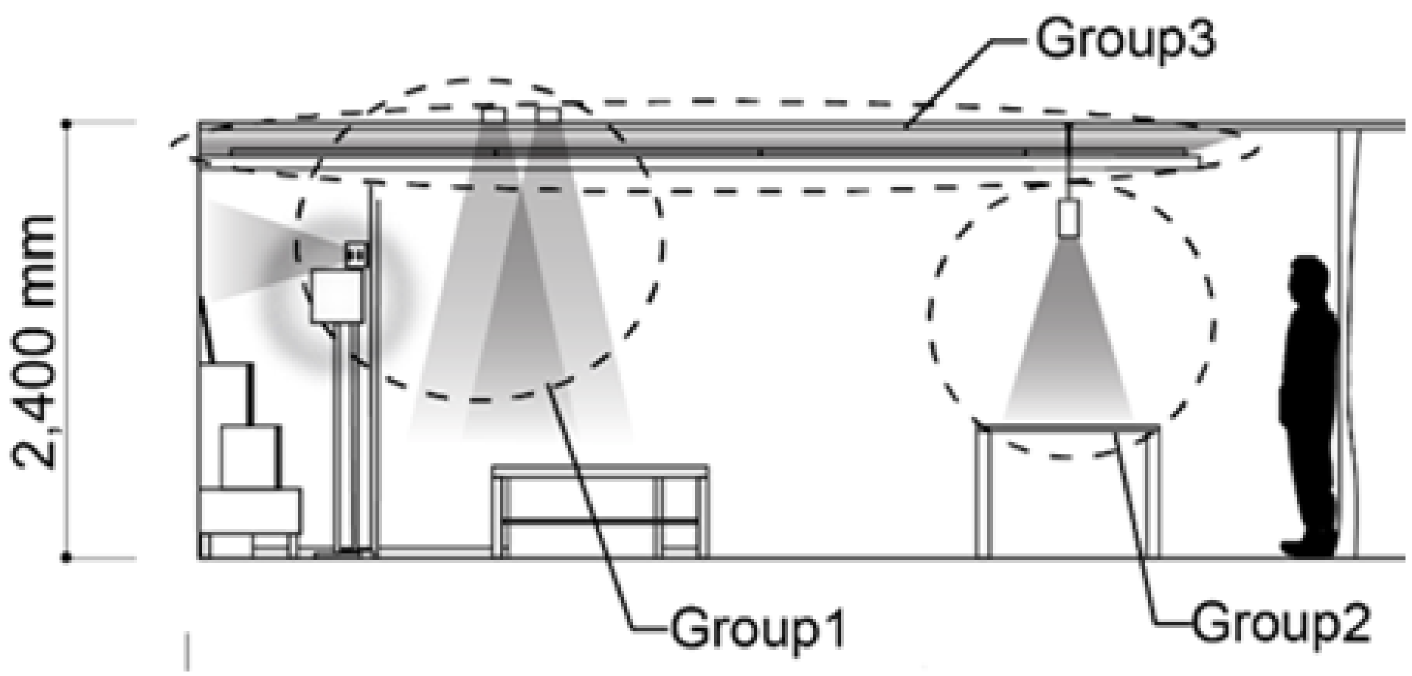


Spaciousness = Log_{10} (Arithmetic mean of (L (cd/m^2) x D (mm) x cosθ)) ***(to be further developed)***

(luminous surfaces of fixtures are excluded from calculation)

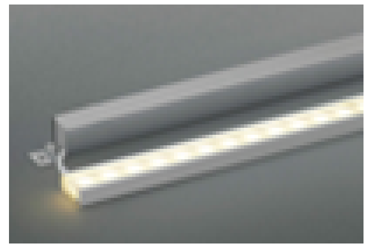
Experiment Configuration





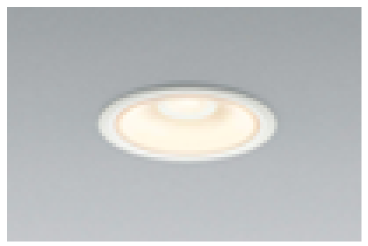
Group 2: Near side
Pendant lights
Koizumi AP40784L

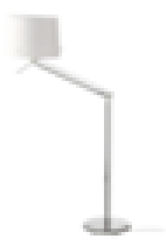
Group 3: Continuous
Ceiling indirect light
AP40784L

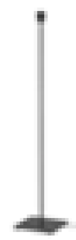


Group 1: Far side

Downlight	Stand light
Koizumi AD40308L	IKEA 102.865.68, unknown







Experiment
Lighting scenes

Far **Close** **Medium**

Dark

Bright

Produced data

Pixel number

Normalized direction vector (x,y,z)

Distance to the pixel

Luminance of the pixel

94408	0.871	0.305	0.385	1166	61.4
94409	0.873	0.299	0.385	1186	58.2
94410	0.875	0.294	0.385	1207	52.3
94411	0.876	0.289	0.385	1229	46.0
94412	0.878	0.284	0.385	2335	3.2
94413	0.880	0.278	0.386	2334	3.2
94414	0.881	0.273	0.386	2333	3.2
94415	0.883	0.268	0.386	2332	3.2
94416	0.884	0.263	0.386	2331	3.1

same as cosθ

=15 de =237 cd/n =260 m	ϕ=14.4 de L =250 cd/n P =250 m	ϕ=14.6 de L =252 cd/n P =253 m	ϕ=15 de L =249 cd/n P =256 m	ϕ=15 de L =251 cd/n P =260 m	ϕ=15 de L =237 cd P =260 m
=0.0 de =15 de =250 cd/n =259 m	θ=0.2 deg ϕ=14.4 deg L =249 cd/m2 P =250 mm	θ=0.2 deg ϕ=14.6 deg L =250 cd/m2 P =253 mm	θ=0.2 deg ϕ=14.8 deg L =235 cd/m2 P =256 mm	θ=0.2 deg ϕ=15 deg L =237 cd/m2 P =260 mm	θ=0.0 de ϕ=15 de L =250 cd P =259 m
=0.0 de =15 de =249 cd/n =259 m	θ=0.0 deg ϕ=14.4 deg L =285 cd/m2 P =249 mm	θ=0.0 deg ϕ=14.6 deg L =247 cd/m2 P =252mm	θ=0.0 deg ϕ=15 deg L =249 cd/m2 P =255 mm	θ=0.0 deg ϕ=15 deg L =250 cd/m2 P =259 mm	θ=0.0 de ϕ=15 de L =249 cd P =259 m
=0.2 de =15 de =251 cd/n =260 m	θ=0.0 deg ϕ=14.4 deg L =255 cd/m2 P =249 mm	θ=0.0 deg ϕ=14.6 deg L =249 cd/m2 P =252 mm	θ=0.0 deg ϕ=15 deg L =250 cd/m2 P =255 mm	θ=0.0 deg ϕ=15 deg L =249 cd/m2 P =259 mm	θ=0.2 de ϕ=15 de L =251 cd P =260 m
=0.2 de =15 de =237 cd/n =260 m	θ=0.2 deg ϕ=14.4 deg L =250 cd/m2 P =250 mm	θ=0.2 deg ϕ=14.6 deg L =252 cd/m2 P =253 mm	θ=0.2 deg ϕ=15 deg L =249 cd/m2 P =256 mm	θ=0.2 deg ϕ=15 deg L =251 cd/m2 P =260 mm	θ=0.2 de ϕ=15 de L =237 cd P =260 m
=0.0 de =15 de =250 cd/n	θ=0.0 de ϕ=14.4 de L =285 cd/n	θ=0.0 de ϕ=14.6 de L =247 cd/n	θ=0.0 de ϕ=15 de L =249 cd/n	θ=0.0 de ϕ=15 de L =250 cd/n	θ=0.0 de ϕ=15 de L =250 cd

Spaciousness = Log_{10} (Arithmetic mean of (L (cd/m²) x D (mm) x cosθ)) *(to be further developed)*

L = luminance of each pixel : -ov

D = distance from the observing point to the surface in that pixel : -oL

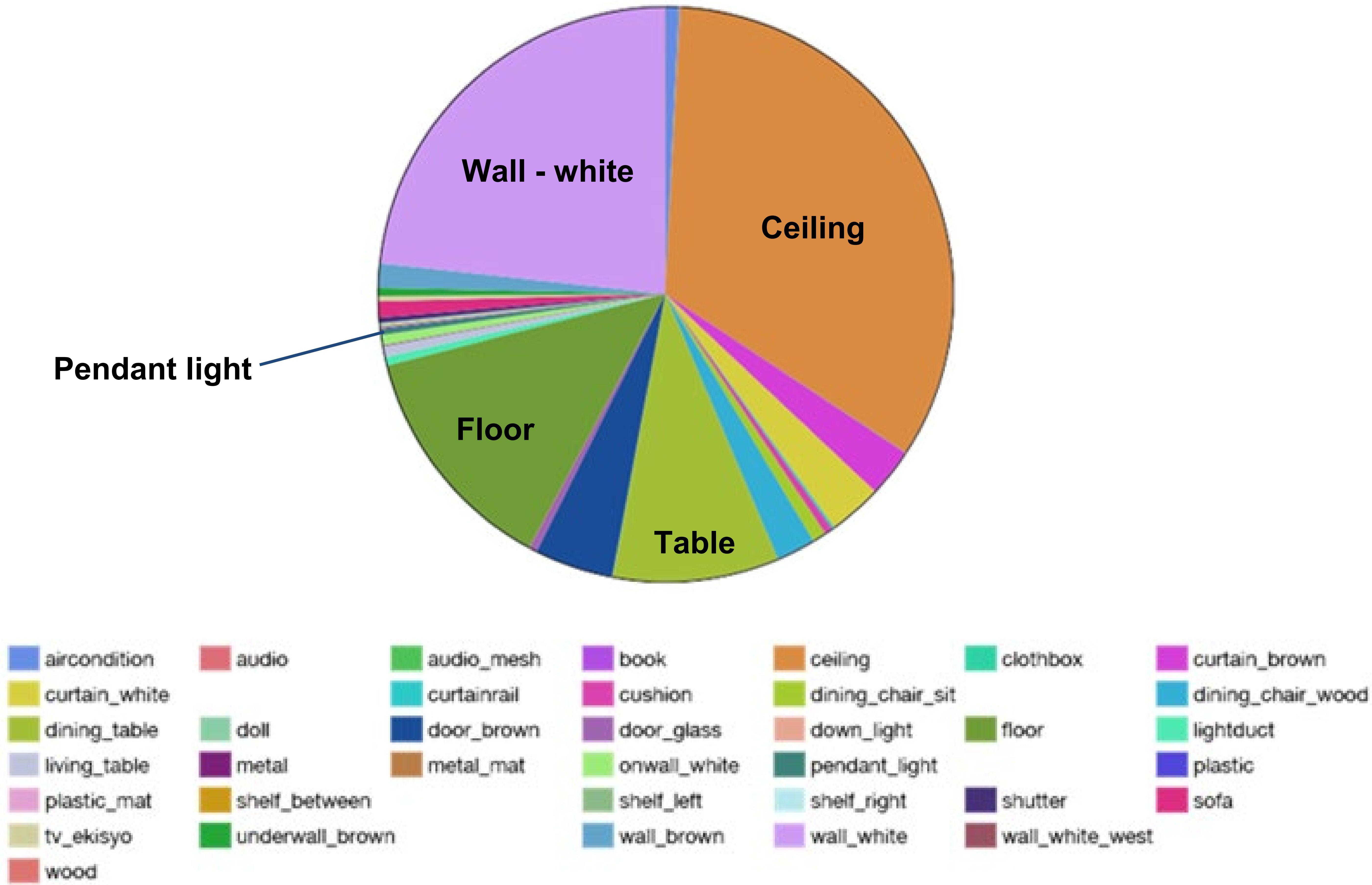
θ = angle between the direction to that pixel and the view axis : od (normalised vector)

RTRACE OPTIONS

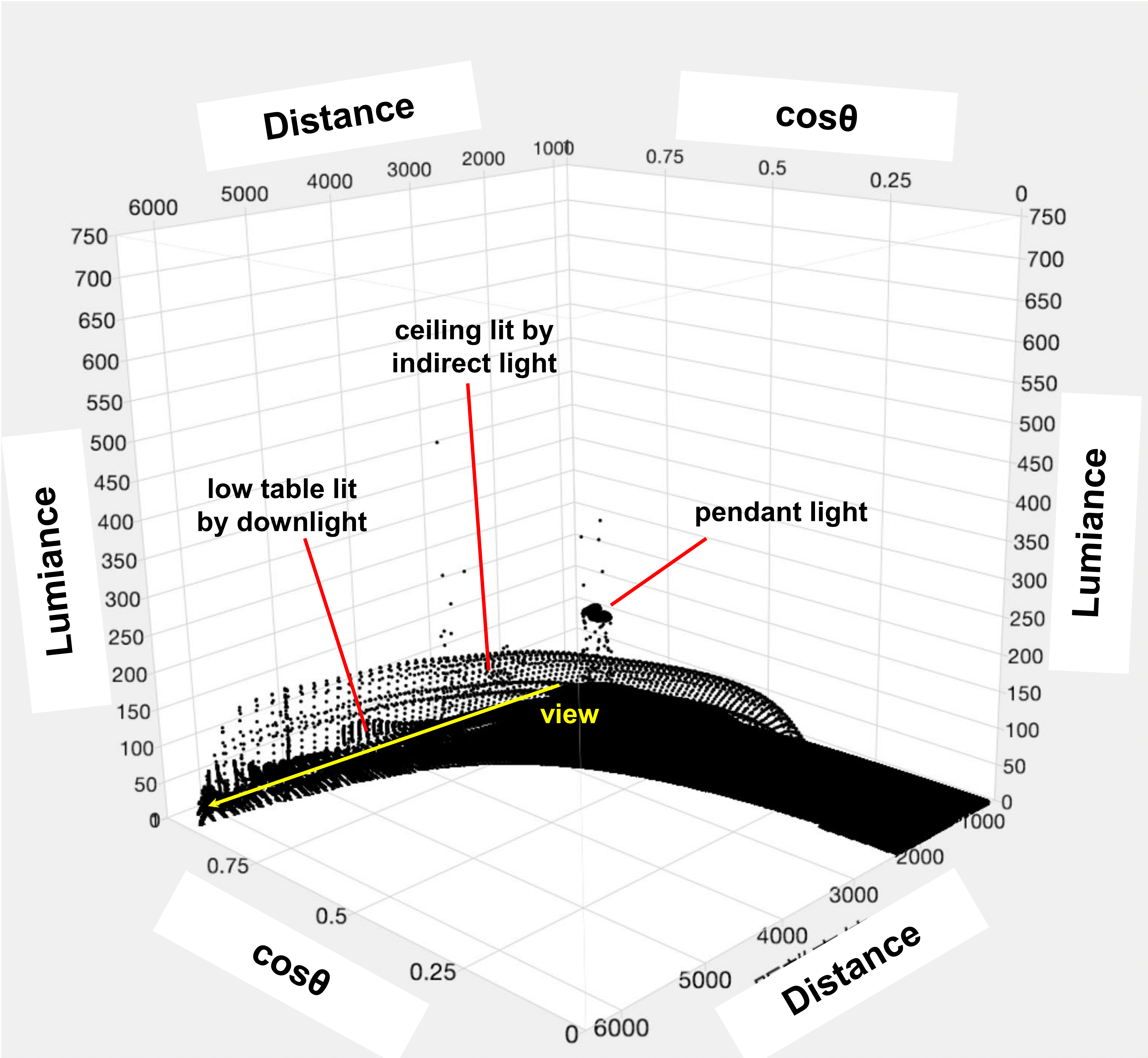
-o*spec* Produce output fields according to *spec*. Characters are interpreted as follows:

o
origin (input)
d
direction (normalized)
v
value (radiance)
V
contribution (radiance)
w
weight
W
color coefficient
l
effective length of ray
L
first intersection distance
c
local (u,v) coordinates
p
point of intersection
n
normal at intersection (perturbed)
N
normal at intersection (unperturbed)
s
surface name
m
modifier name
M
material name
~
tilde (end of trace marker)

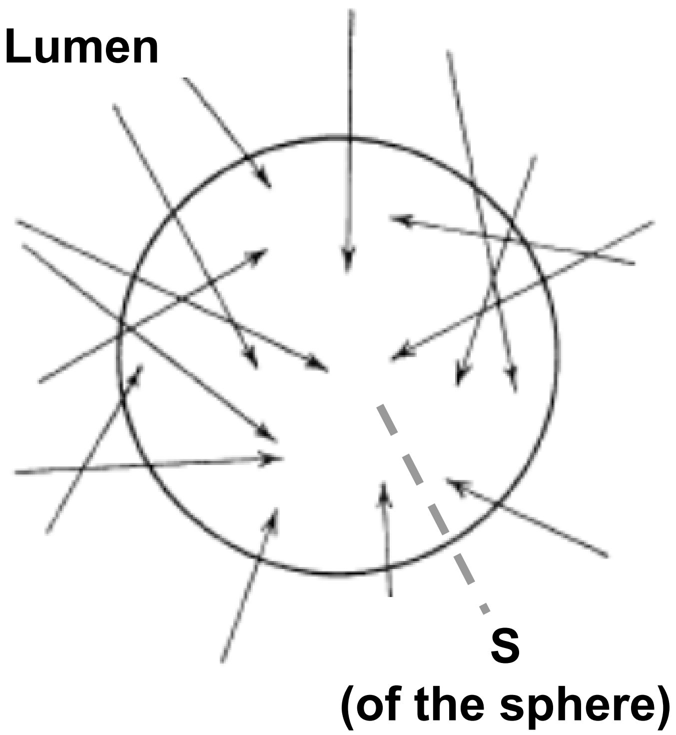
Ratio of each surface type (material name)

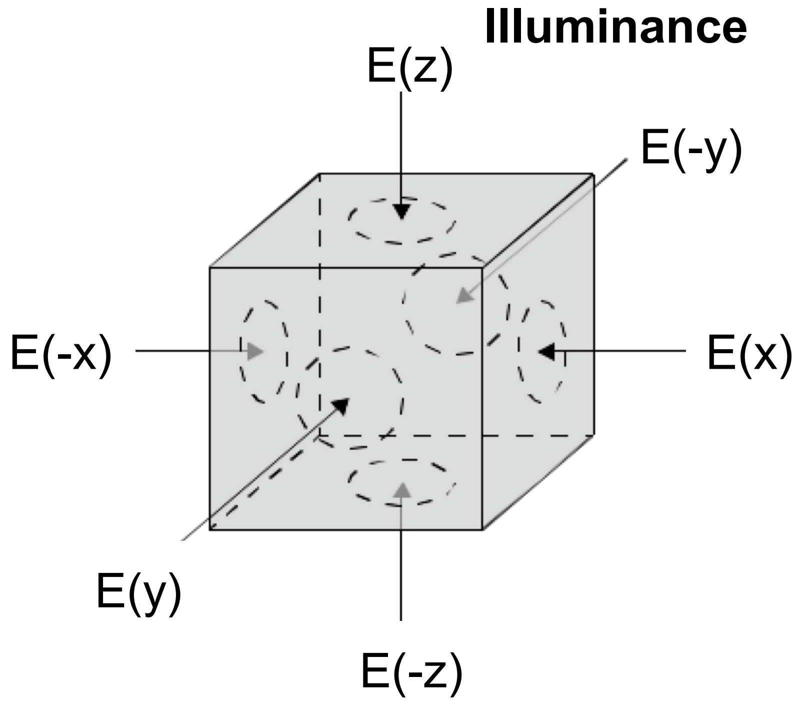


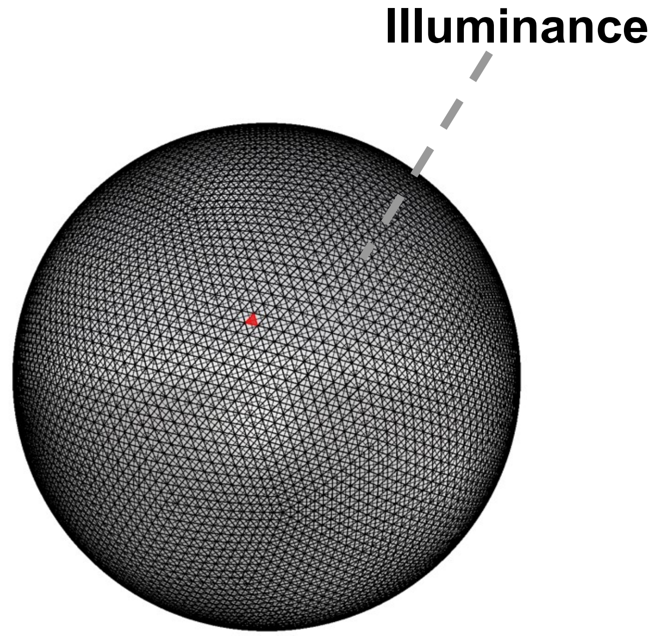
3D Scattering Graph of Luminance, Distance and Direction

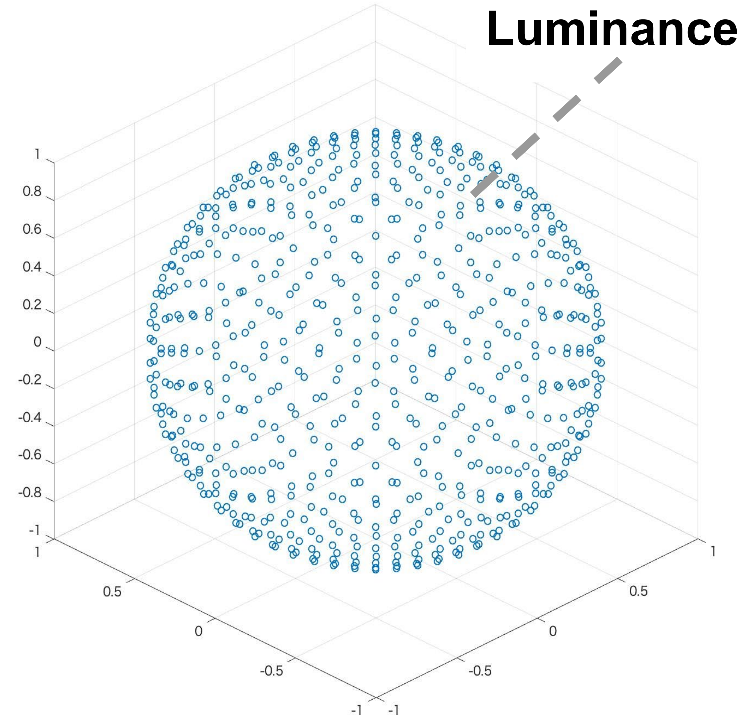


Scaler illuminance









Definition	Calculation. 1	Calculation. 2	Calculation. 3
Scaler Illuminance	Cubic Illuminance for practical use	Average illuminance of geodesic dome surfaces	Average of effect of luminance to Esr

$$\frac{\text{Quantity of Light going through infinitesimal sphere}}{\text{the area of the infinitesimal sphere}}$$

Vector component /4
+Symmetric component

E*sr = |E|/4 + ~*E

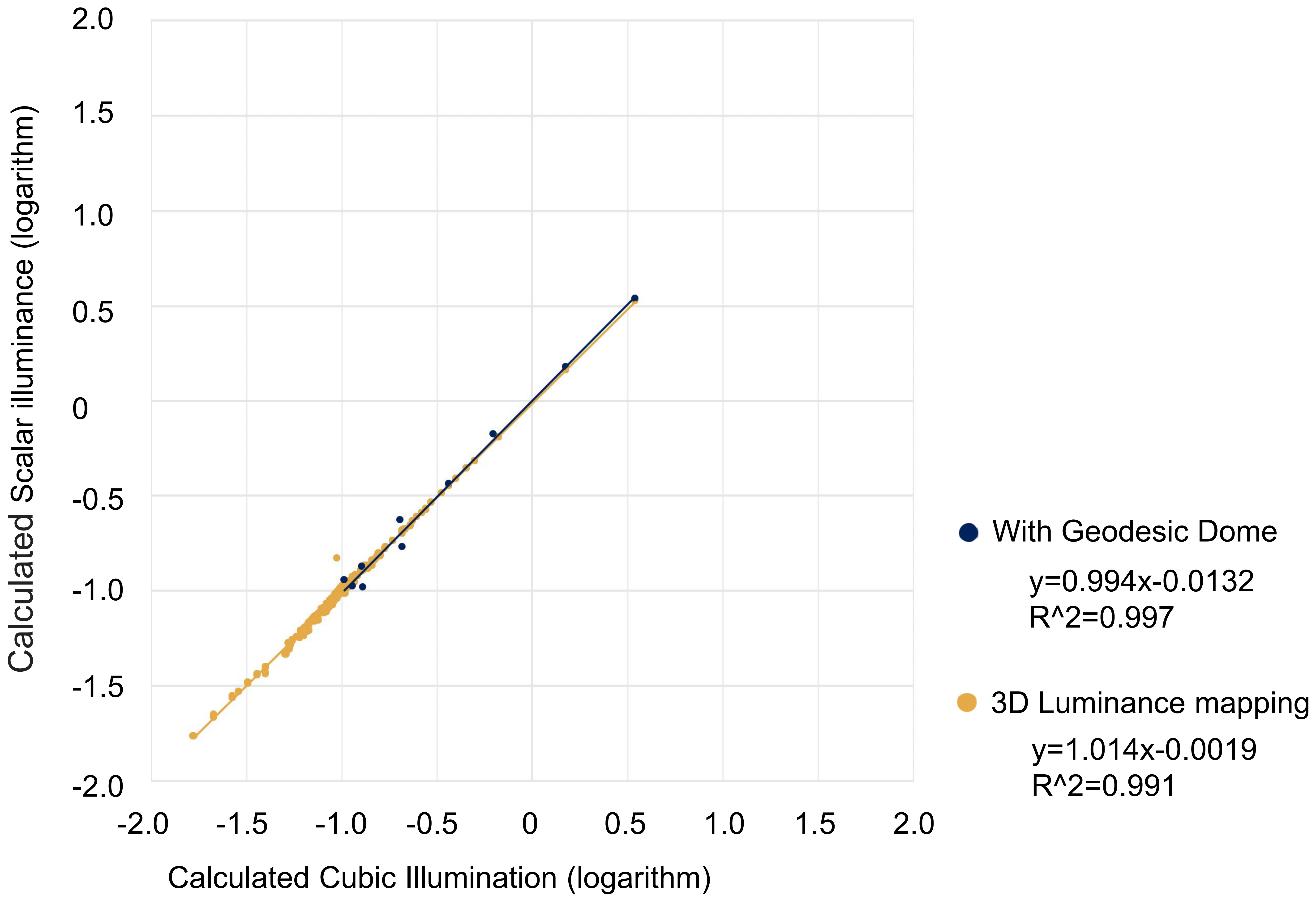
$$\frac{1}{n}\sum_{i=1}^{n} E_i$$

(18,000 points)

$$E_s = \frac{1}{4}\int_{4\pi} L \, d\omega$$

(1,570,792 points)

Scaler illuminance - calculated values



Application of Rtrace in Environmental Psychology Laboratory

Table of Contents

CONCEPT OF AMBIENT VISION

AND DESCRIPTION METHOD OF AMBIENT VISUAL INFORMATION

A study on description method of ambient visual information and its application (Part 1)

Ryuzo OHNO

Journal of Archit. Plann. Environ. Engng, AIJ, No.451, Sep., 1993

THE AMOUNT OF VISUAL RADIATION

AND THE SENSE OF SAFETY FROM CRIME

Astudy of the site planning of multi − family housing

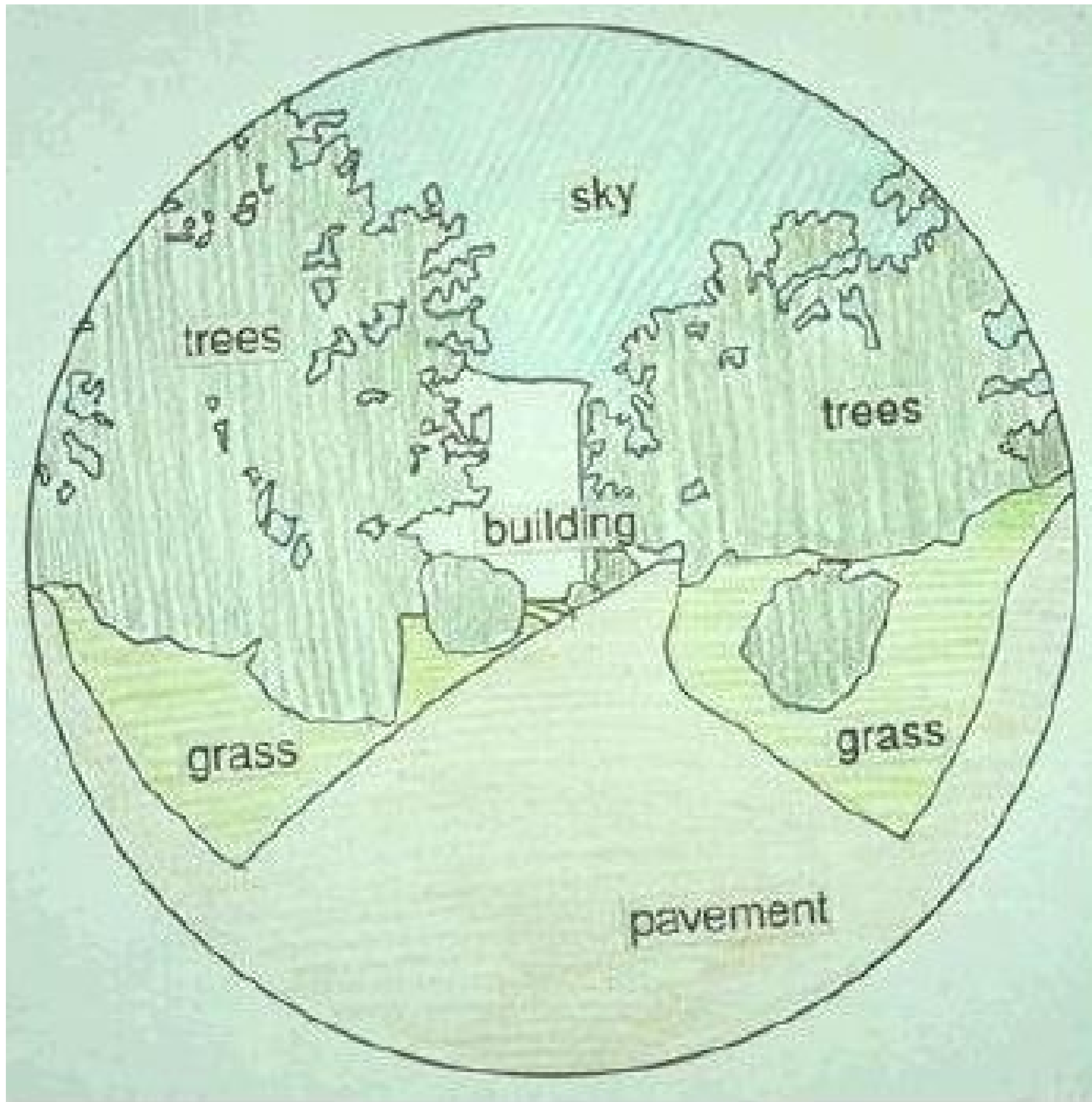
considering the residents' mutual visual interactions (Part 1)

Ryuzo OHNO, Miki KONDO

Journal of Archit. Plann. Environ. Engng, AIJ, No.467, Jan., 1995

Ambient Visual Information (1993)

Image : Ryuzo OHNO

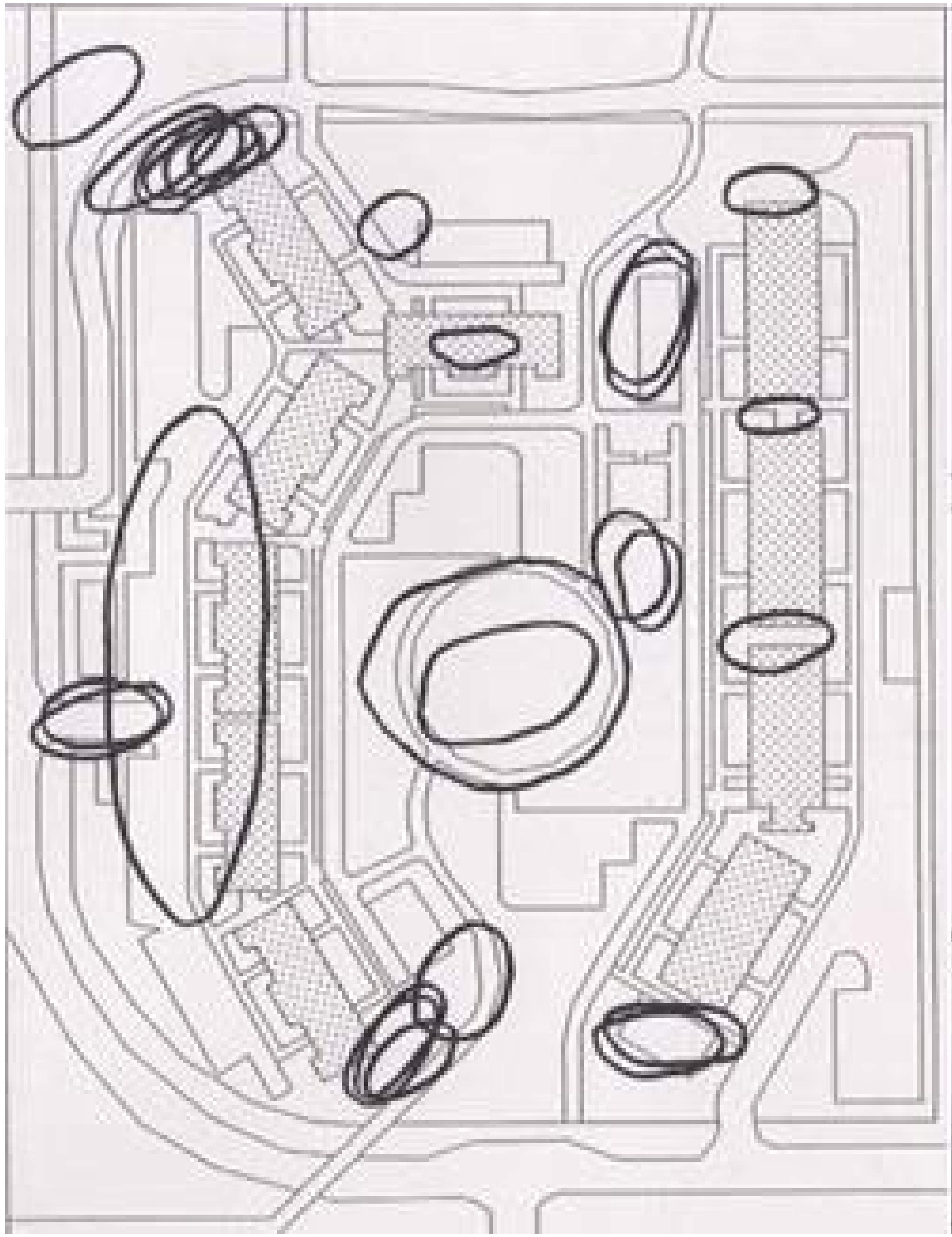


Experiment about sense of security in a housing complex site

Image : Ryuzo OHNO

The ratio of wall with window in the view from each point

Ambient visulal information mapping



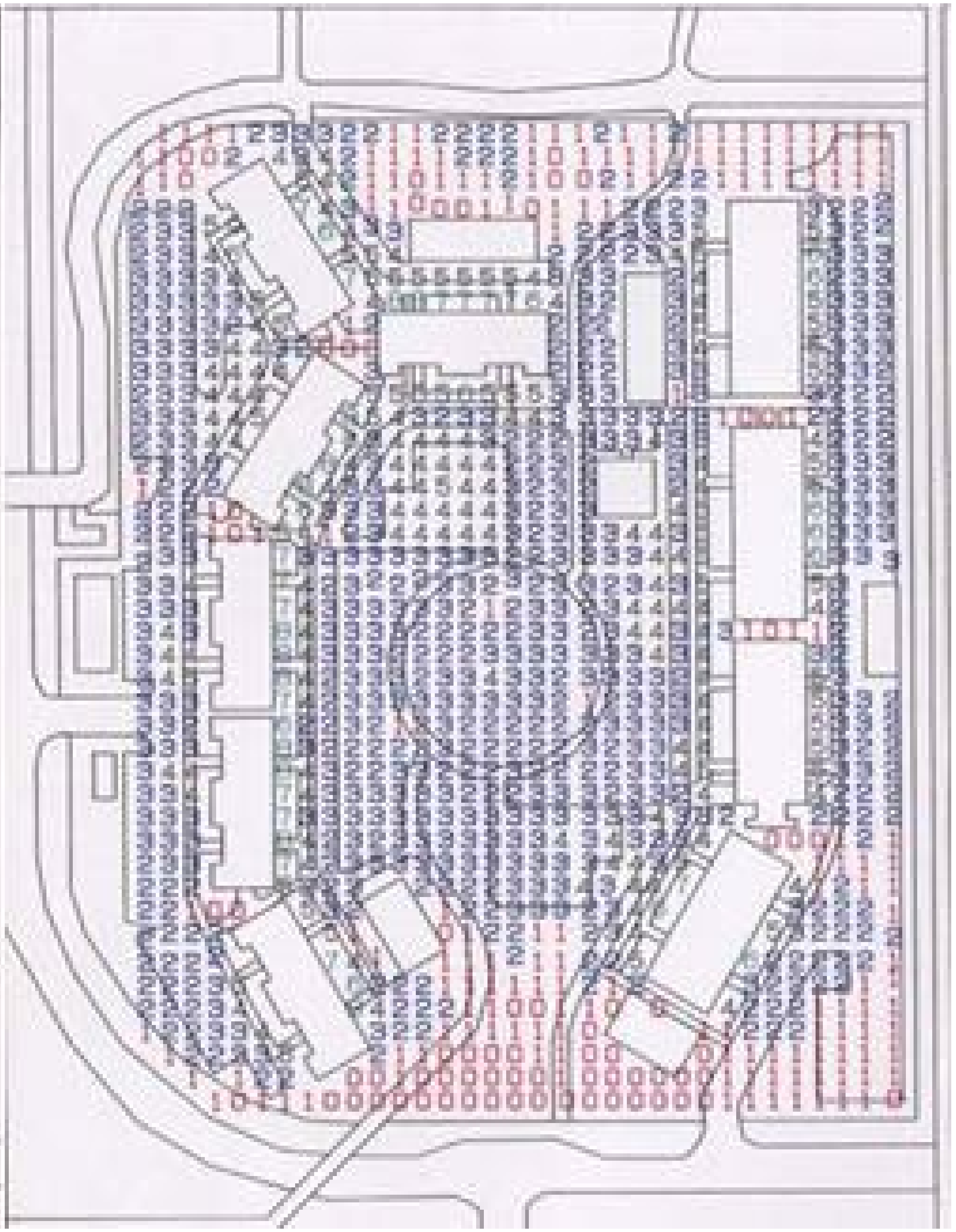


Image : Ryuzo OHNO

Reported area where residents feel unsecured

The ratio level of wall with window in the view from each point

with RTRACE

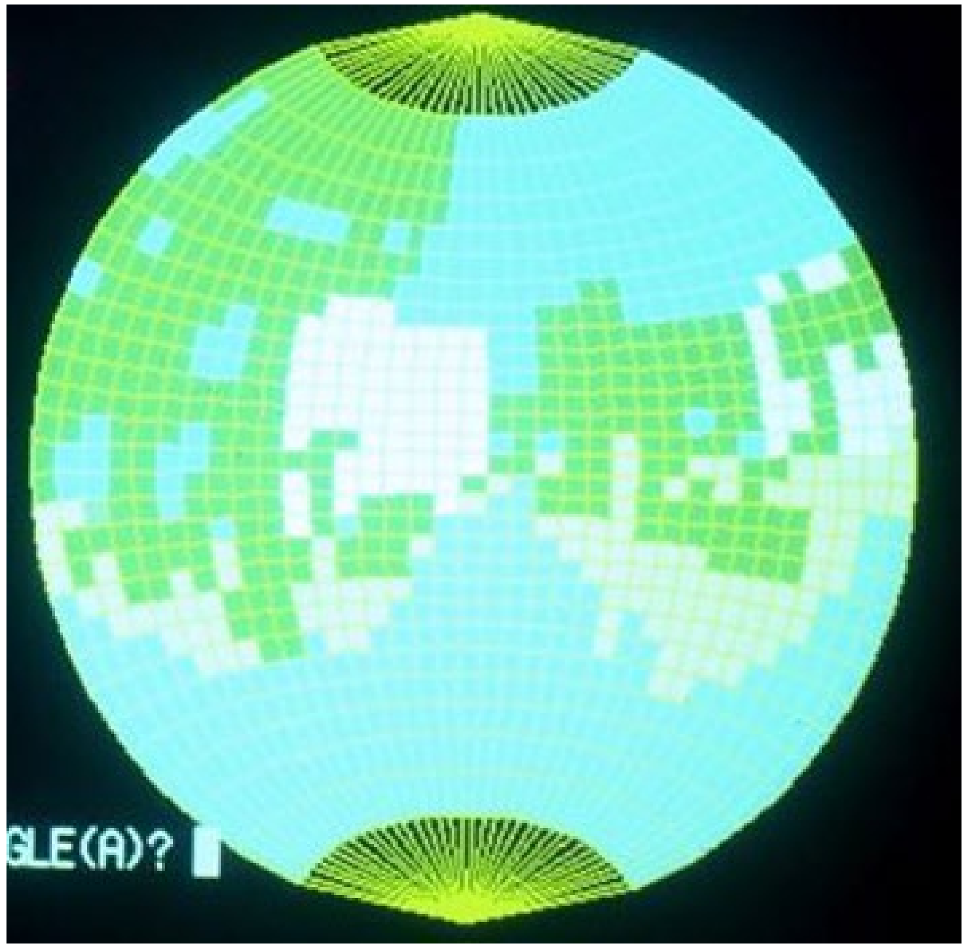


Image : Ryuzo OHNO

Only 1,944 pixels

(Horizontal 72 x Vertical 27)

↓

411,772 pixels or more

(512 x 512 x Pi/4 x 2)

much better resolution

o
origin (input)
d
direction (normalized)
v
value (radiance)
V
contribution (radiance)
w
weight
W
color coefficient
l
effective length of ray
L
first intersection distance
c
local (u,v) coordinates
p
point of intersection
n
normal at intersection (perturbed)
N
normal at intersection (unperturbed)
s
surface name
m
modifier name
M
material name
~
tilde (end of trace marker)

different information can be deployed

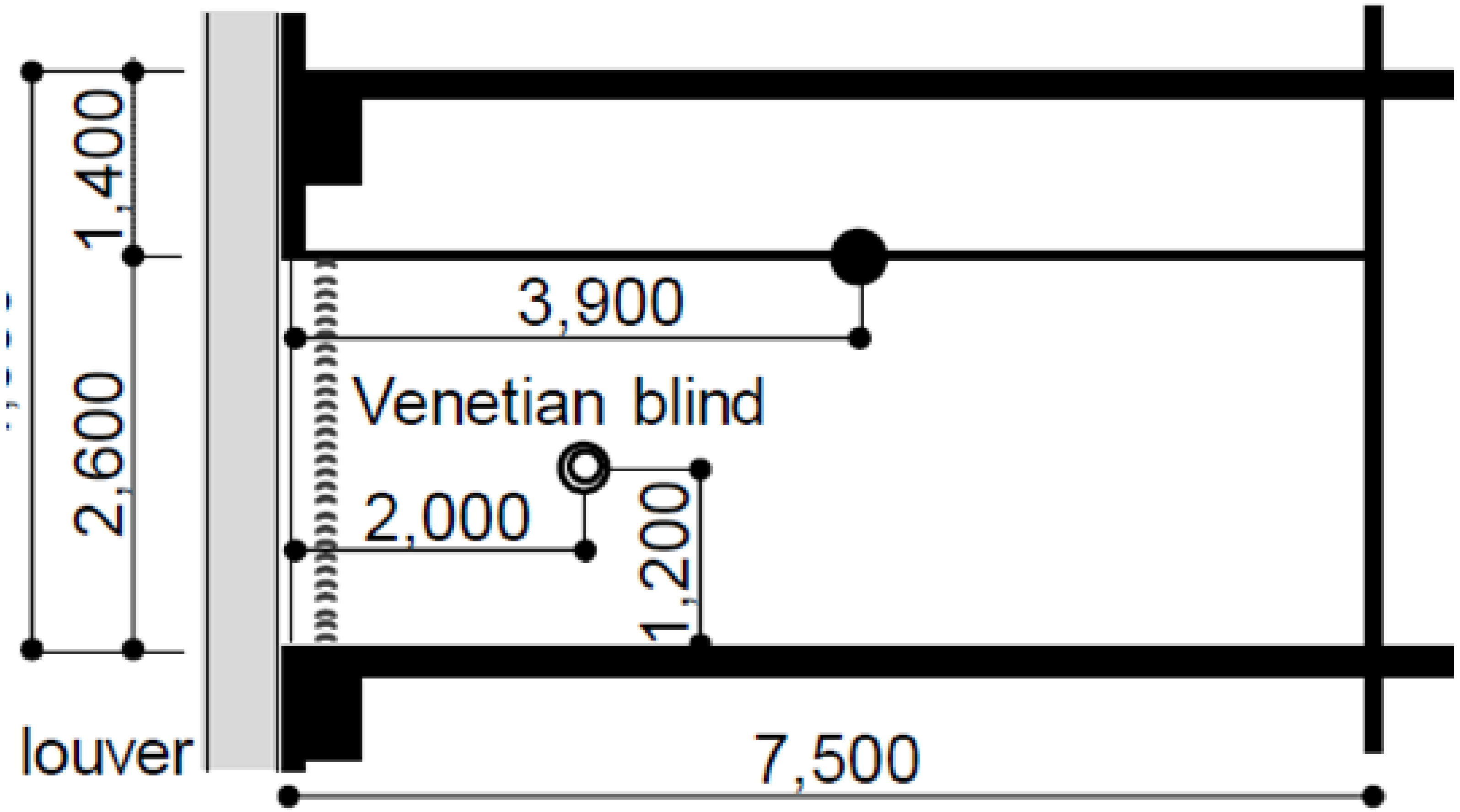
Application of Rtrace in Environmental Psychology Laboratory

Table of Contents

FAÇADE DESIGN OPTIMIZATION BASED ON ENERGY USAGE, GLARE, AND VIEW USING RADIANCE AND NEWHASP

Ohki, C., Okamoto, T., Tadaki, J., Ohga, H., Yoshizawa, N.

CIE x046:2019 Proceedings of the 29th CIE SESSION / DOI 10.25039/x46.2019.PO145



FAÇADE DESIGN OPTIMIZATION BASED ON ENERGY USAGE, GLARE, AND VIEW USING RADIANCE AND NEWHASP

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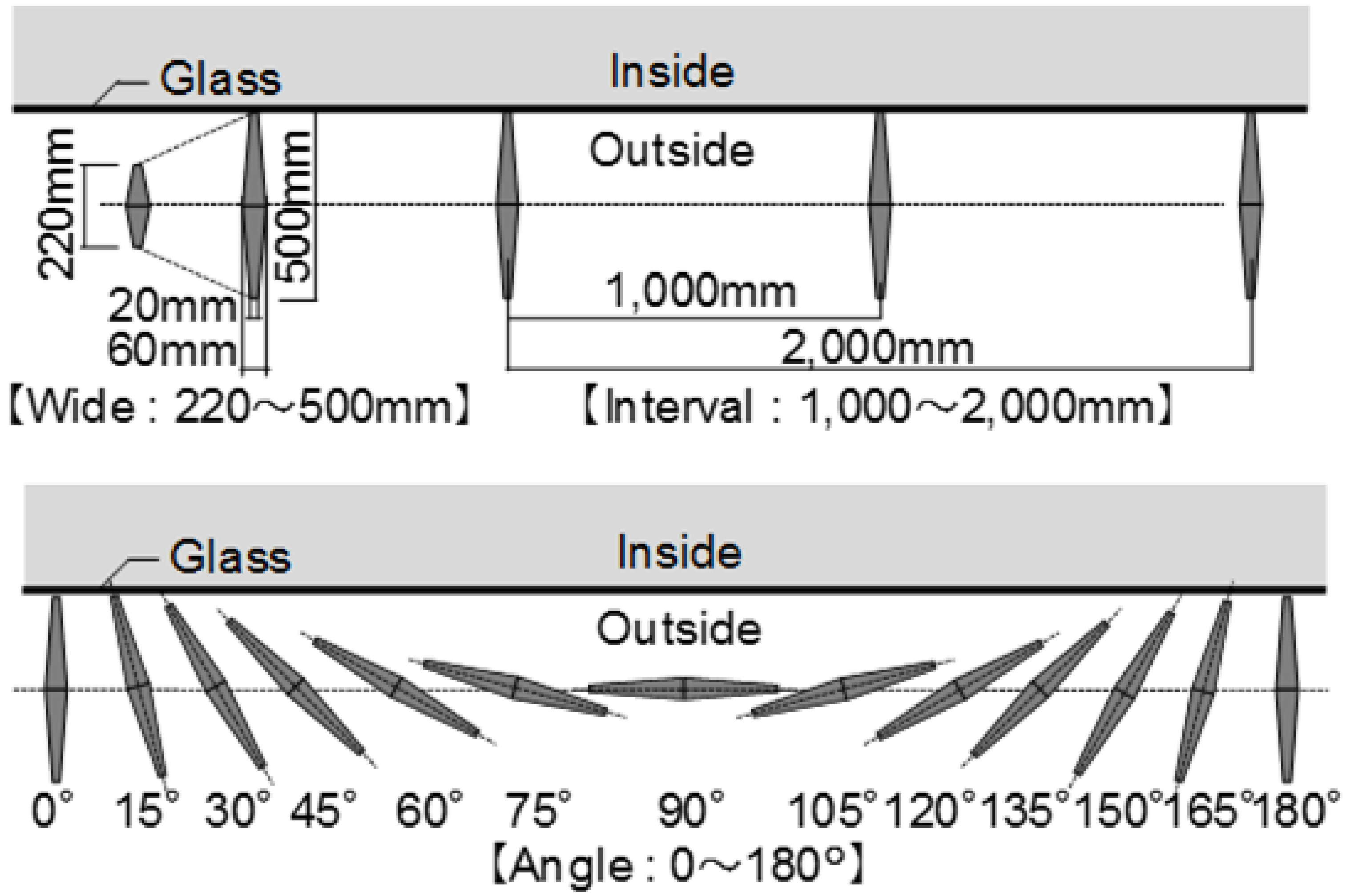


Fig.8 Detail of vertical louver

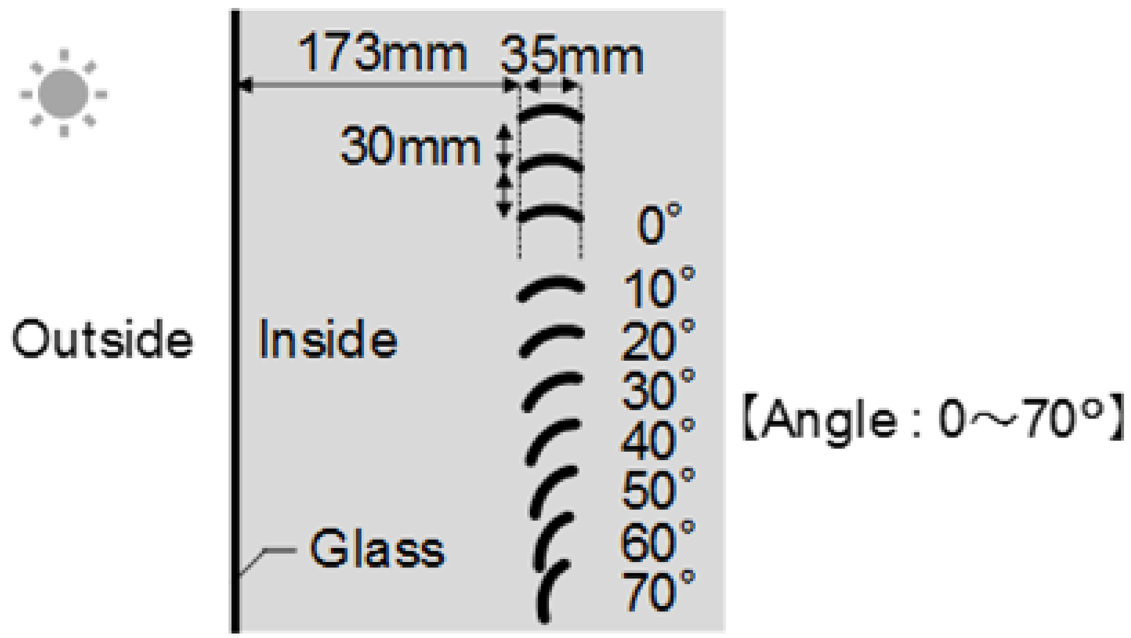
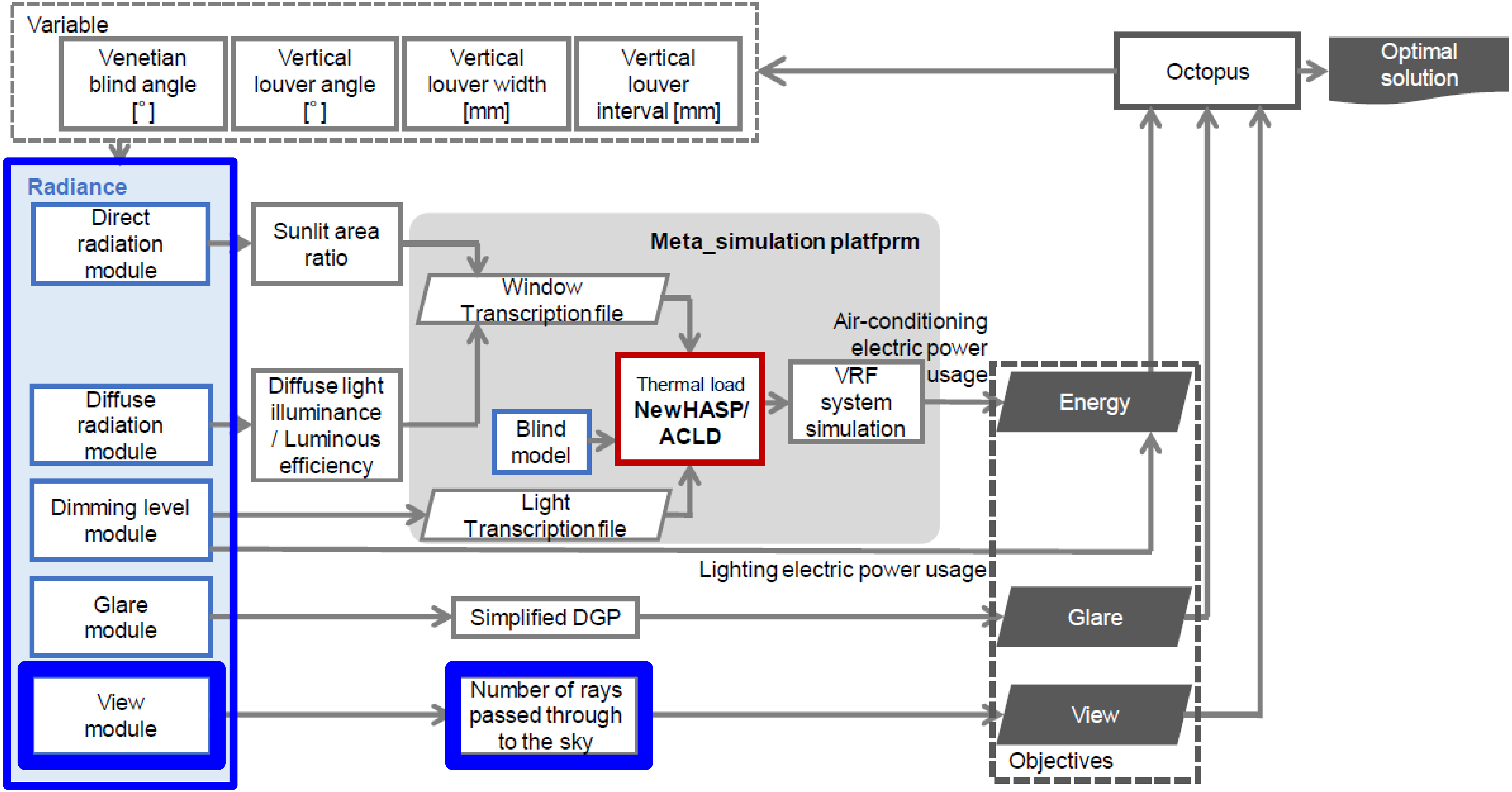
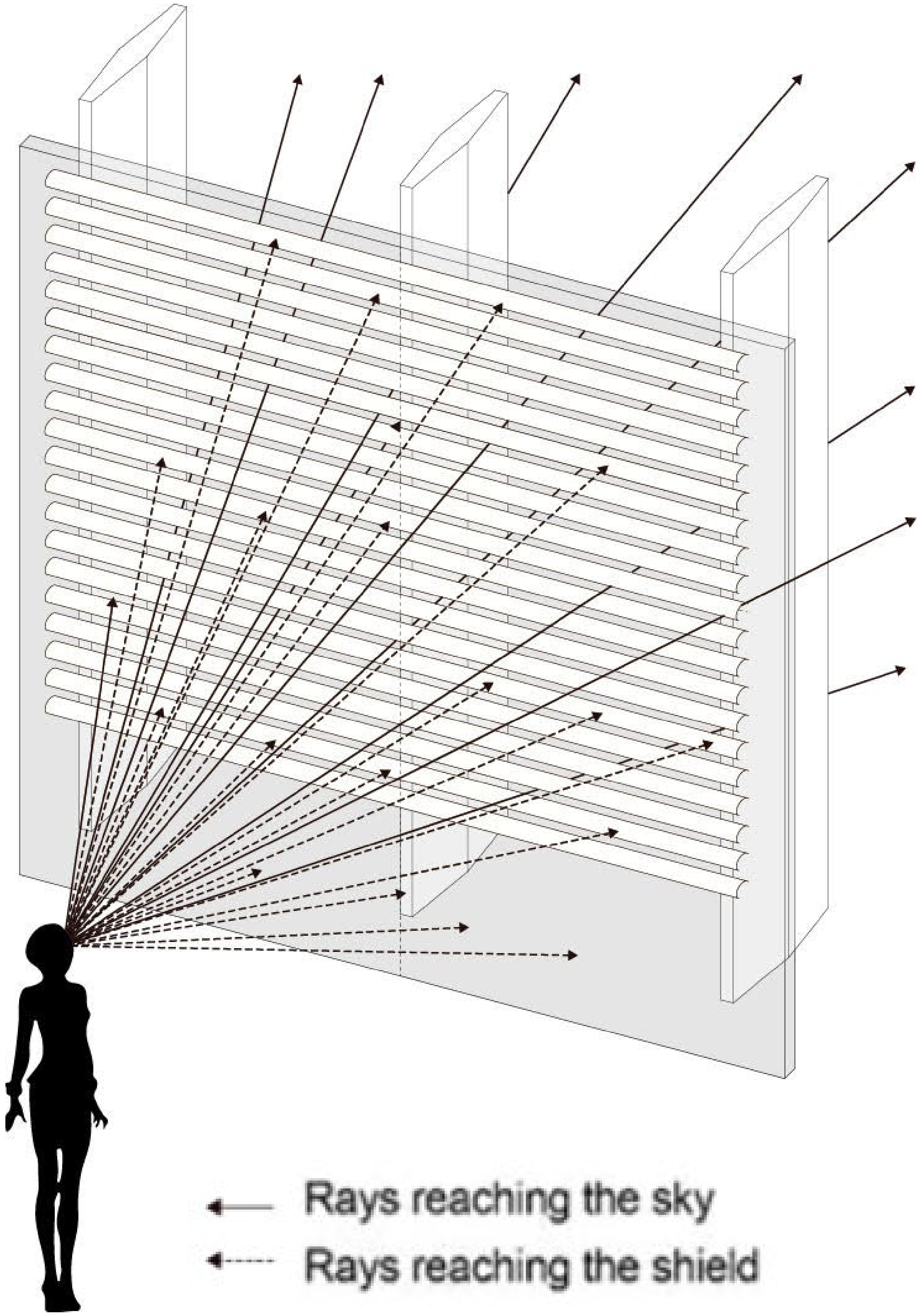


Fig.9 Detail of Venetian blind

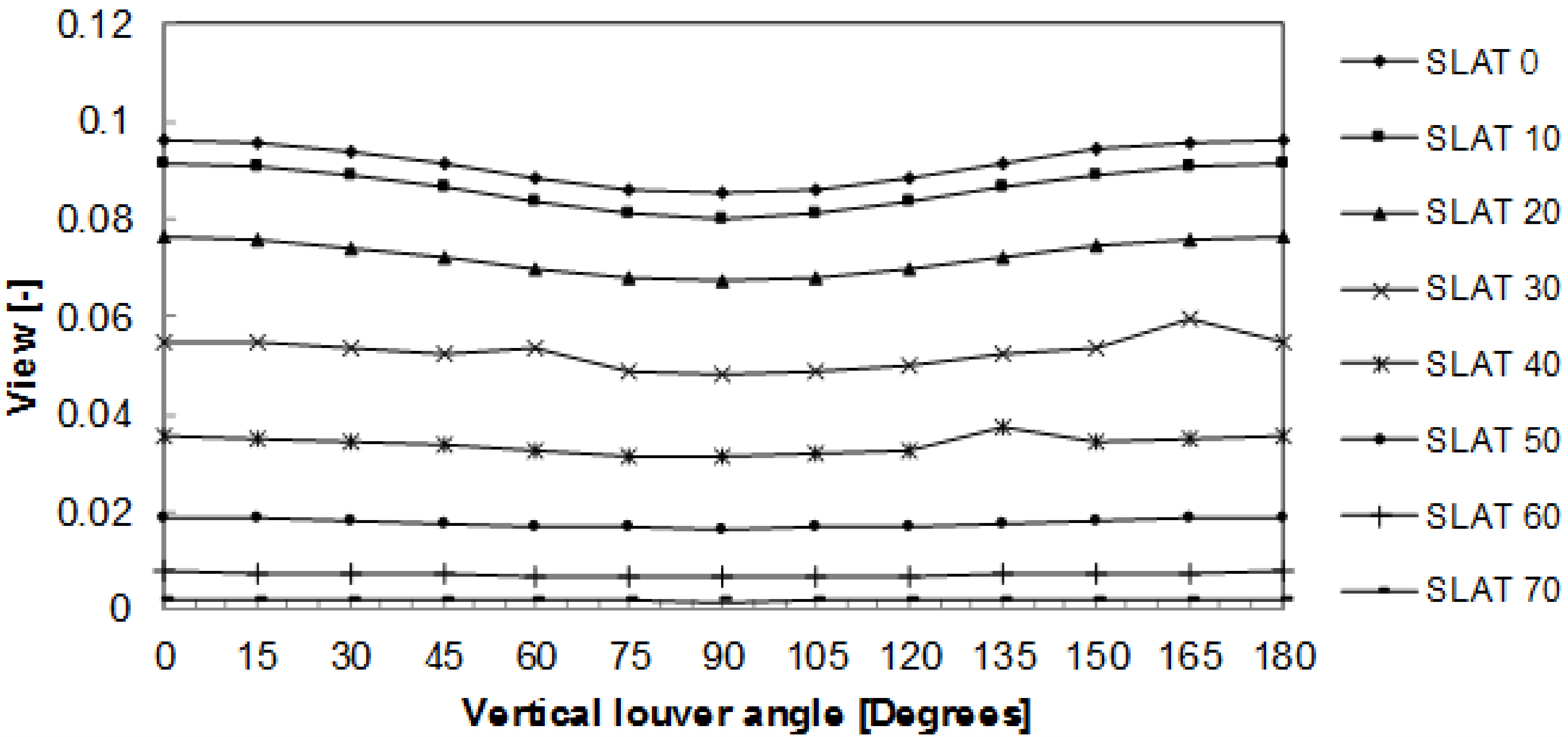


Variable
Venetian blind angle [°]
Vertical louver angle [°]
Vertical louver width [mm]
Vertical louver interval [mm]
Octopus
Optimal solution
Radiance
Direct radiation module
Sunlit area ratio
Meta_simulation platfprm
Window Transcription file
Air-conditioning electric power usage
Diffuse radiation module
Diffuse light illuminance / Luminous efficiency
Blind model
Thermal load
NewHASP/ ACLD
VRF system simulation
Energy
Dimming level module
Light Transcription file
Lighting electric power usage
Glare module
Simplified DGP
Glare
View module
Number of rays passed through to the sky
View
Objectives

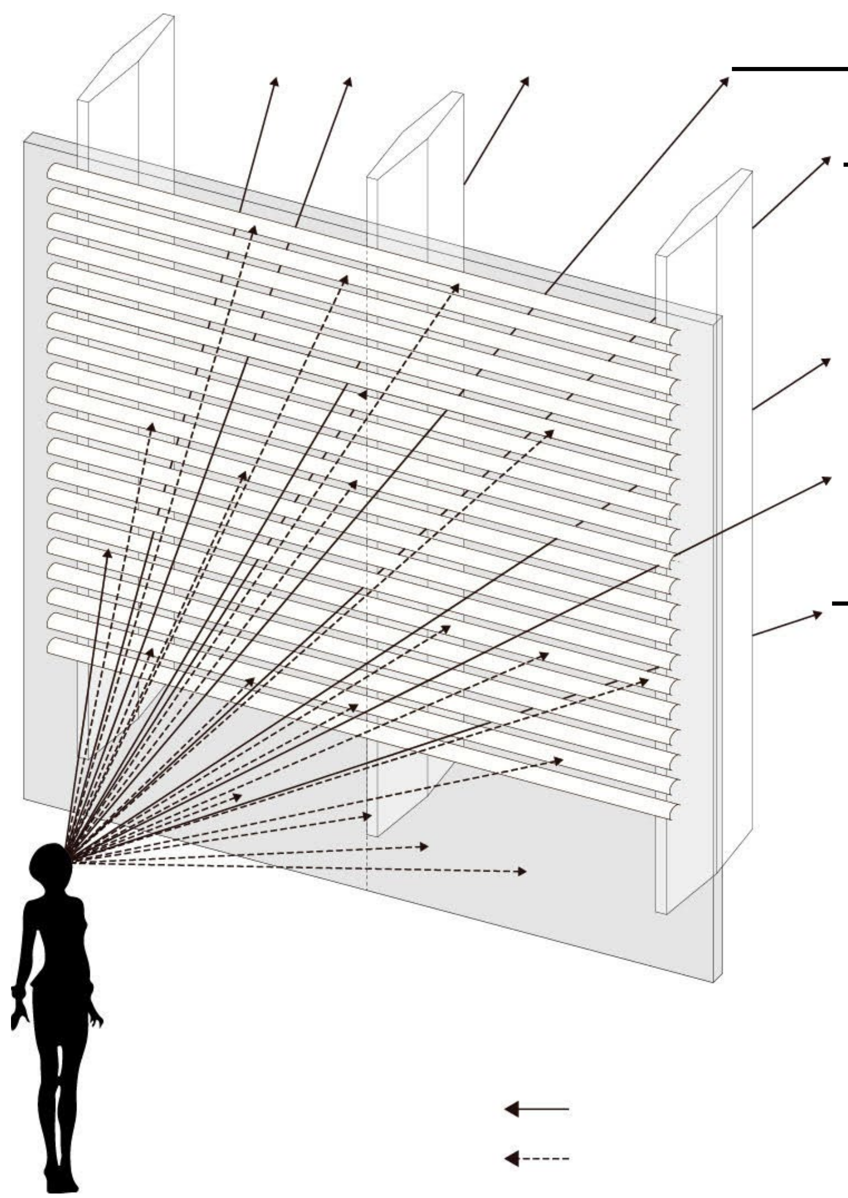


$$V = \frac{N}{\pi R^2}$$

v	View ratio (%)
N	Number of pixels with elements of sky
R	Radius on projection drawings (pixels)



0.12
0.1
0.08
0.06
0.04
0.02
0
View [-]
0
15
30
45
60
75
90
105
120
135
150
165
180
Vertical louver angle [Degrees]
SLAT 0
SLAT 10
SLAT 20
SLAT 30
SLAT 40
SLAT 50
SLAT 60
SLAT 70



example:

Material = sky
rgb = 135, 206, 235
L = 3000
distance = infinite

Material = building
rgb = 211, 211, 211
L= 600
distance = 40m

Material = ground
rgb = 88, 66, 57
L= 100
distance = 16m

From any specific reference point (Q), the view quality depends on:

— the size of the daylight opening(s);

— the width of the view (horizontal sight angle);

— the outside distance of view;

— the number of layers;

— the quality of the environmental information of the view.

DIN EN 17037,
5.2 Assessment for view out

Application of Rtrace in Environmental Psychology Laboratory

Table of Contents

<u>Thank you for your attention</u>