New York City **RADIANCE WORKSHOP** Aug 21-23, 2019

A Lume(n) with a View

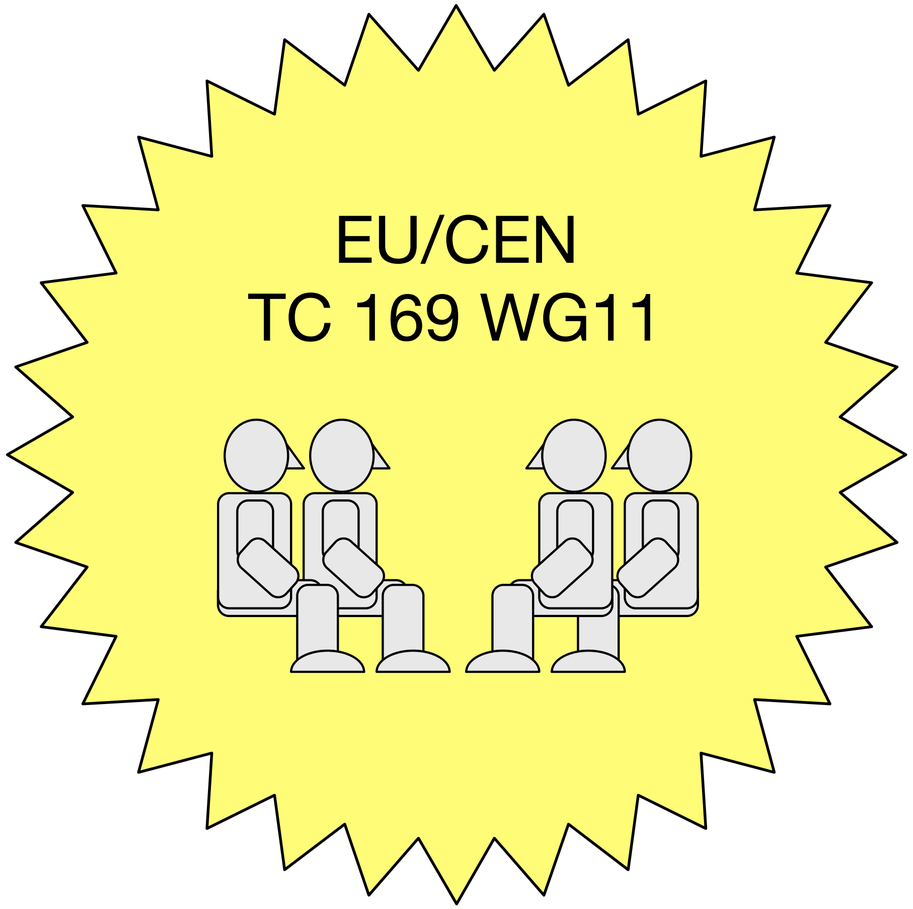
With apologies to E. M. Forster

John Mardaljevic

Professor of Building Daylight Modelling
School of Civil & Building Engineering
Loughborough University, UK

Loughborough University

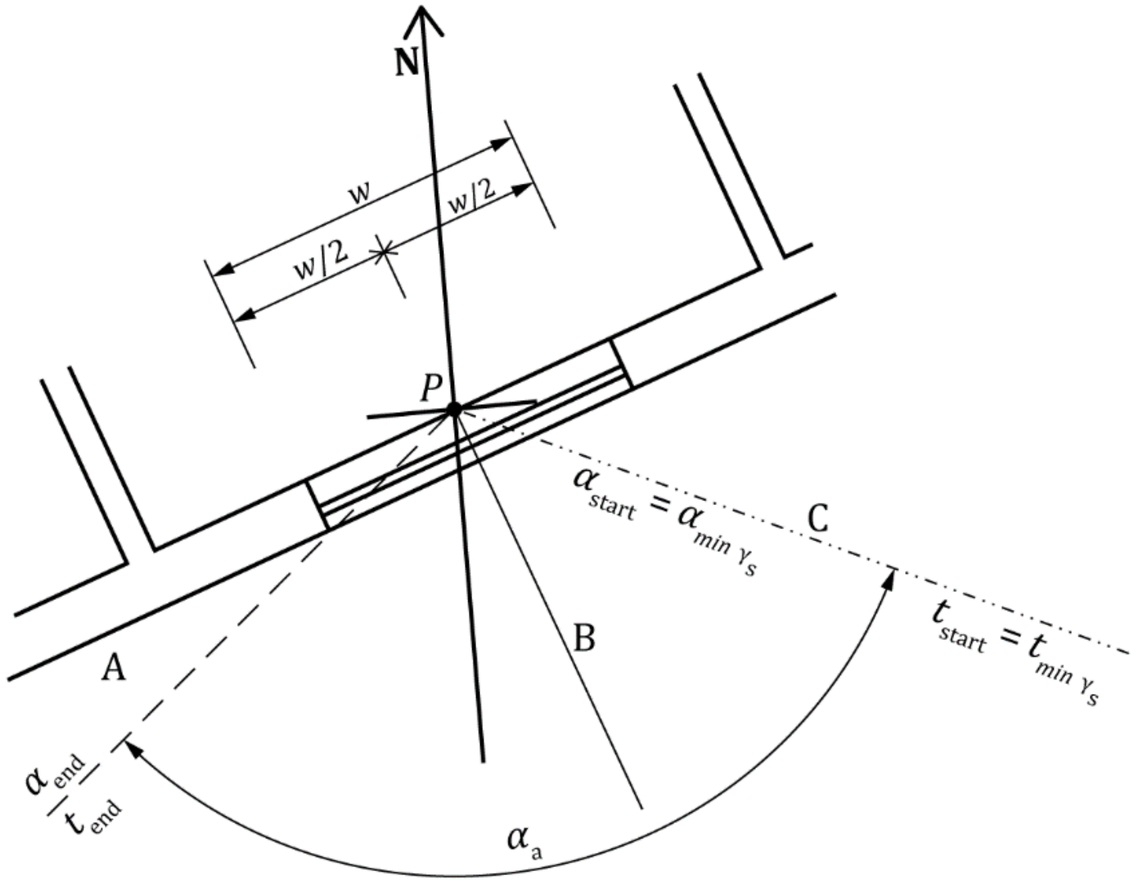
Which is your favourite view?

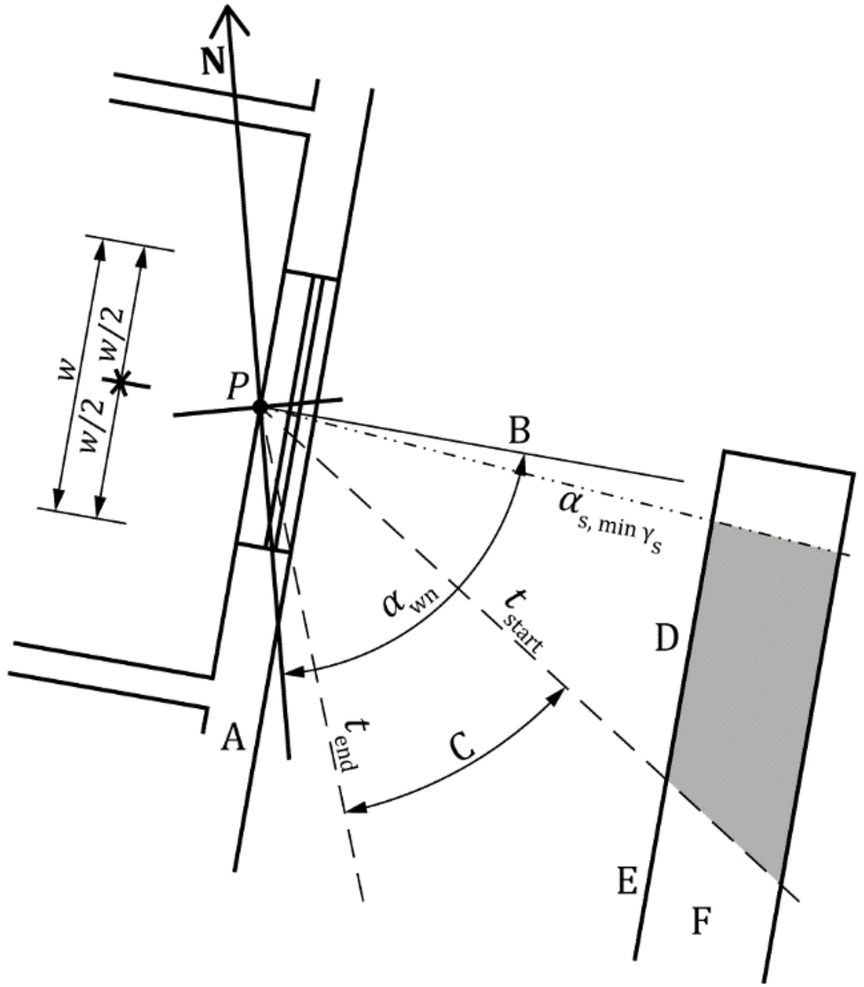


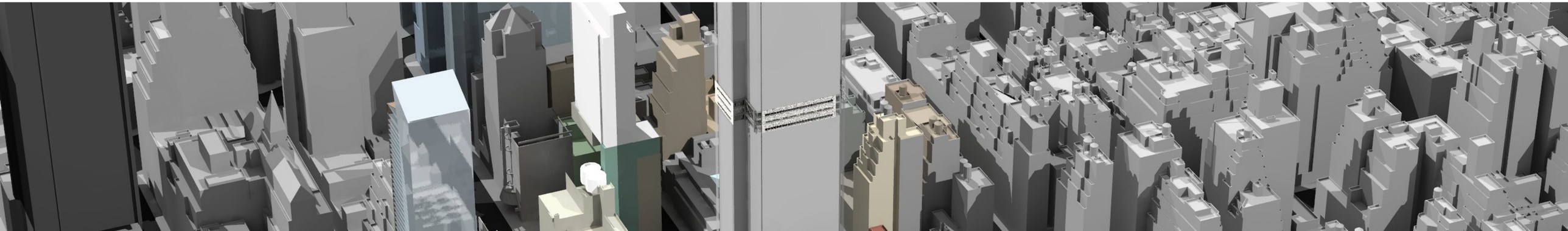
Problems, issues, limitations of the various schema for sunlight planning:

- They consider only certain times of the day and/or year, e.g. one of the equinox conditions.
- They either ignore the direction at which the sun is incident on the window, or employ crude switch mechanisms such as the ‘dead angle’.
- They ignore the size of the window.
- They ignore or cannot adequately account for the shadowing effects of frame bars or window reveals.
- They ignore or cannot adequately account for shadowing caused by surrounding structures or buildings.
- The method employed is restricted to idealised geometry or built forms.
- The evaluation cannot produce a meaningful, aggregate measure for multiple windows and/or an entire dwelling.
- The evaluation provides no information on the temporal dynamics of possible sun exposure.


instant
KATZ


N
w
w/2
w/2
P
A
B
C
$\alpha_{start} = \alpha_{min\ \gamma_s}$
$t_{start} = t_{min\ \gamma_s}$
α_{end}
t_{end}
α_a

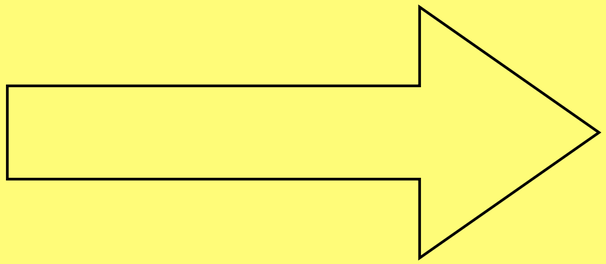

N
w
w/2
w/2
P
A
B
C
D
E
F
$\alpha_{s,\ min\ \gamma_s}$
α_{wn}
t_{start}
t_{end}

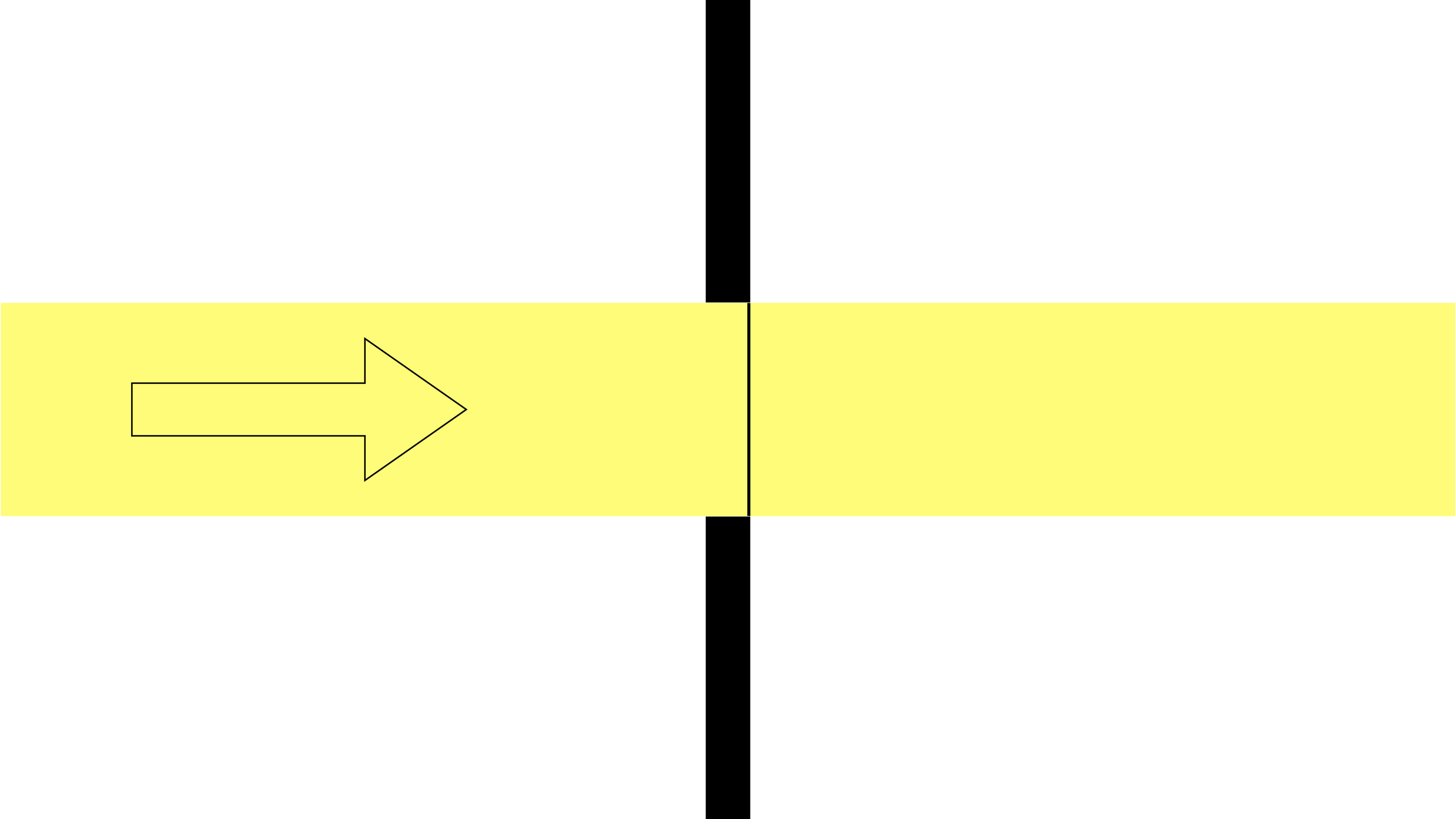


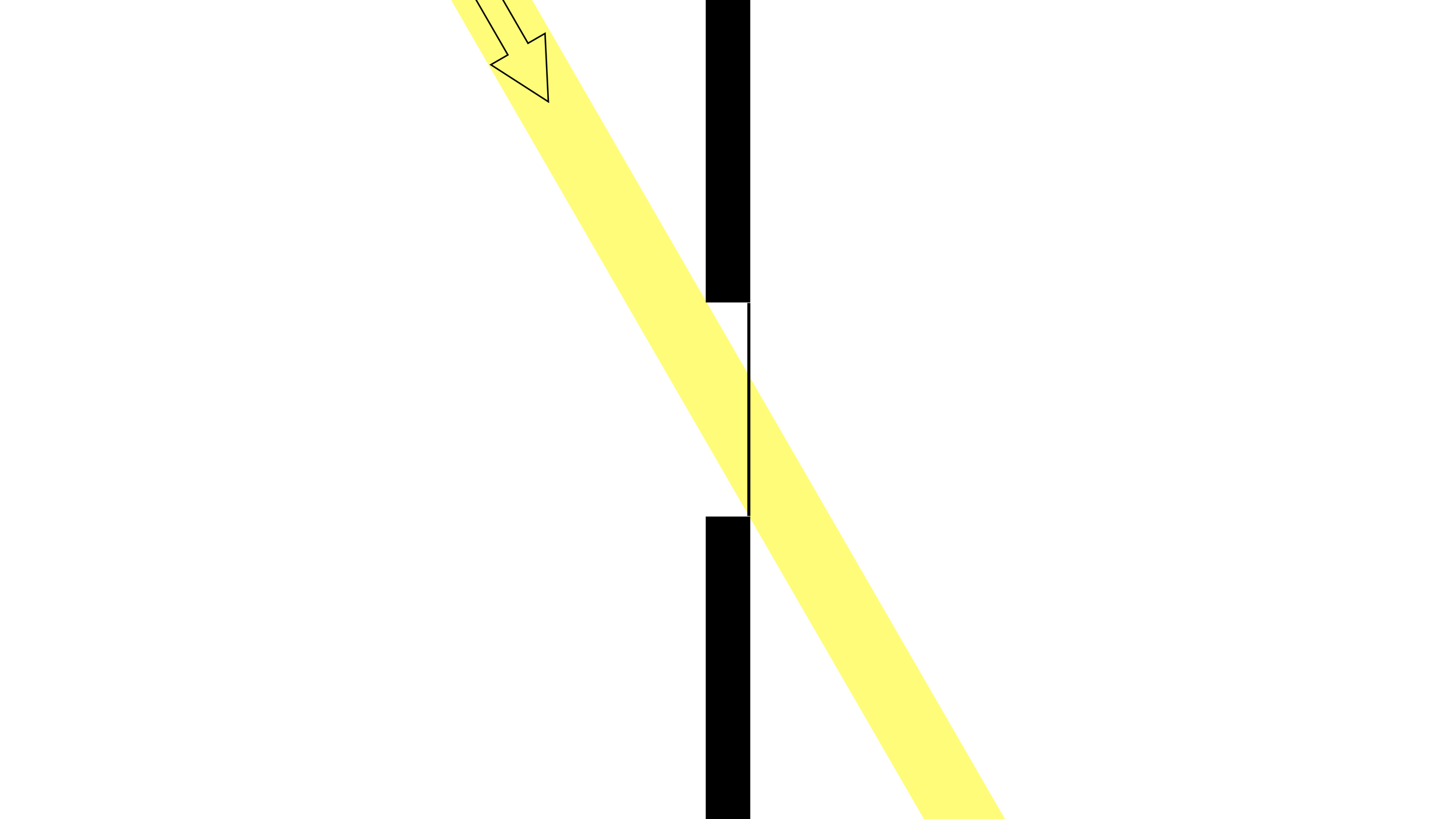
The Sunlight Beam Index

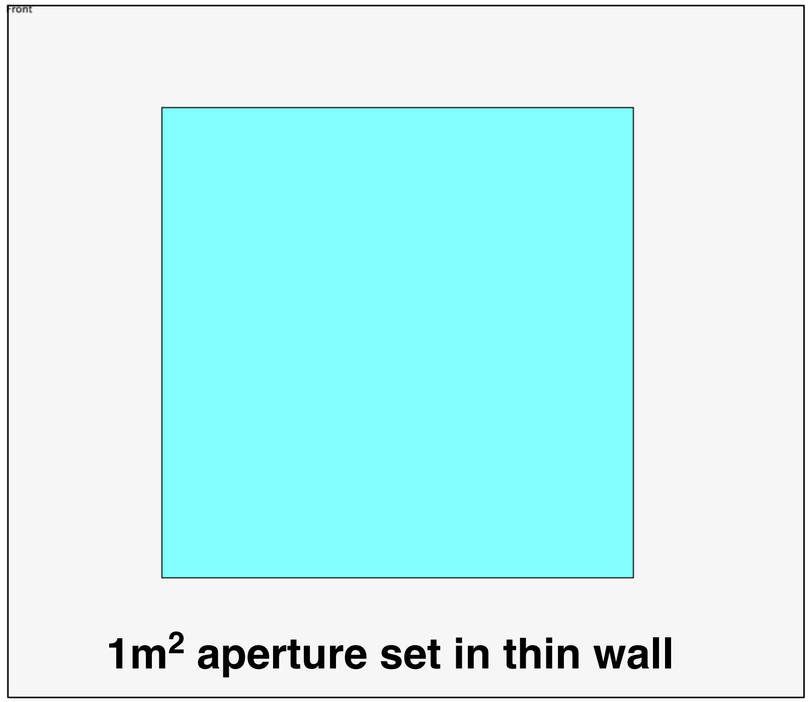
SBI is an **area** measure of the '**connectedness**' of a building aperture to **all** of the possible occurring **sun positions** for that **locale** and for that particular **aspect** of the aperture including **all** possible obstructing surfaces - **averaged** across the aperture.

Units: $1 \times 1 = 1\,\mathrm{m}^2\,\mathrm{hrs}$

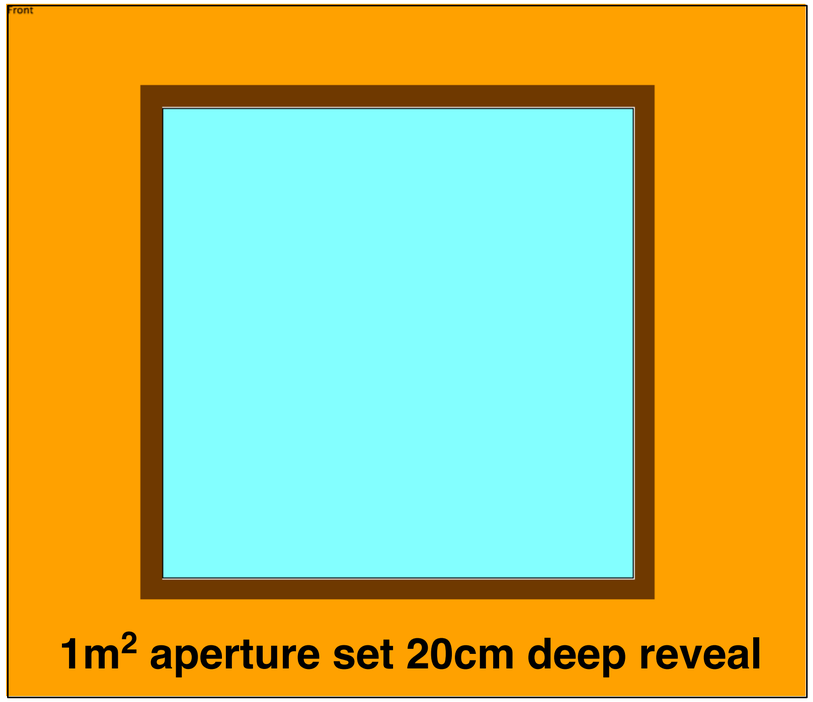








1m^2 aperture set in thin wall

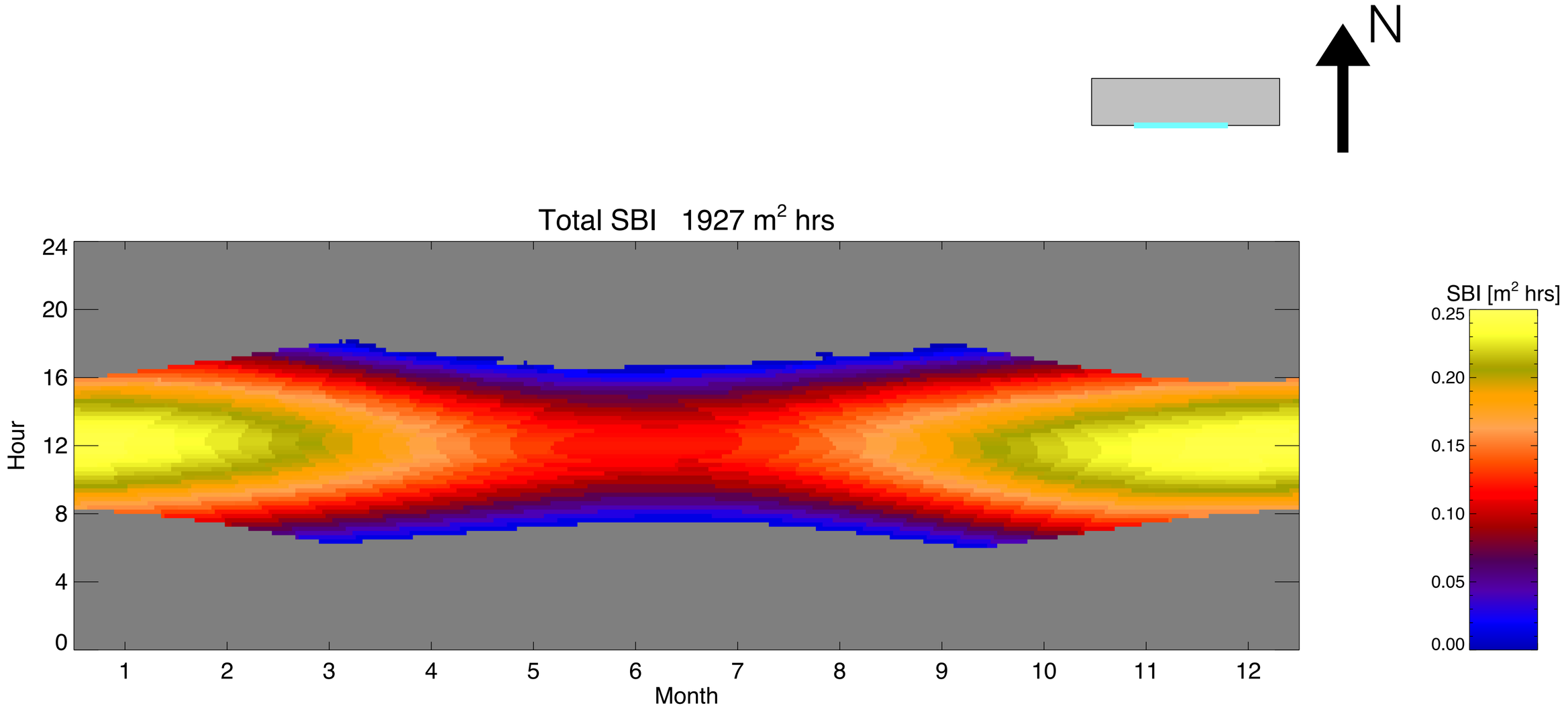


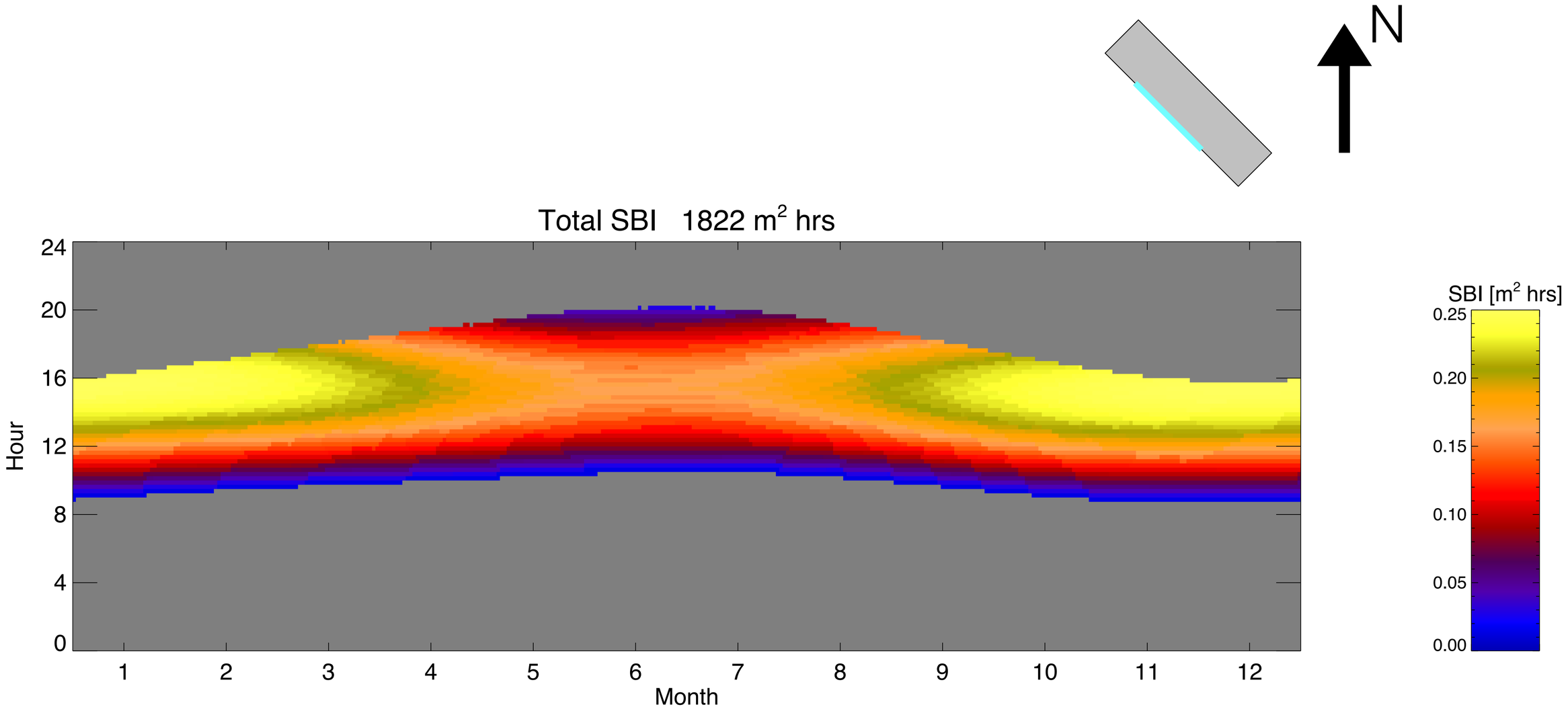
1m^2 aperture set 20cm deep reveal

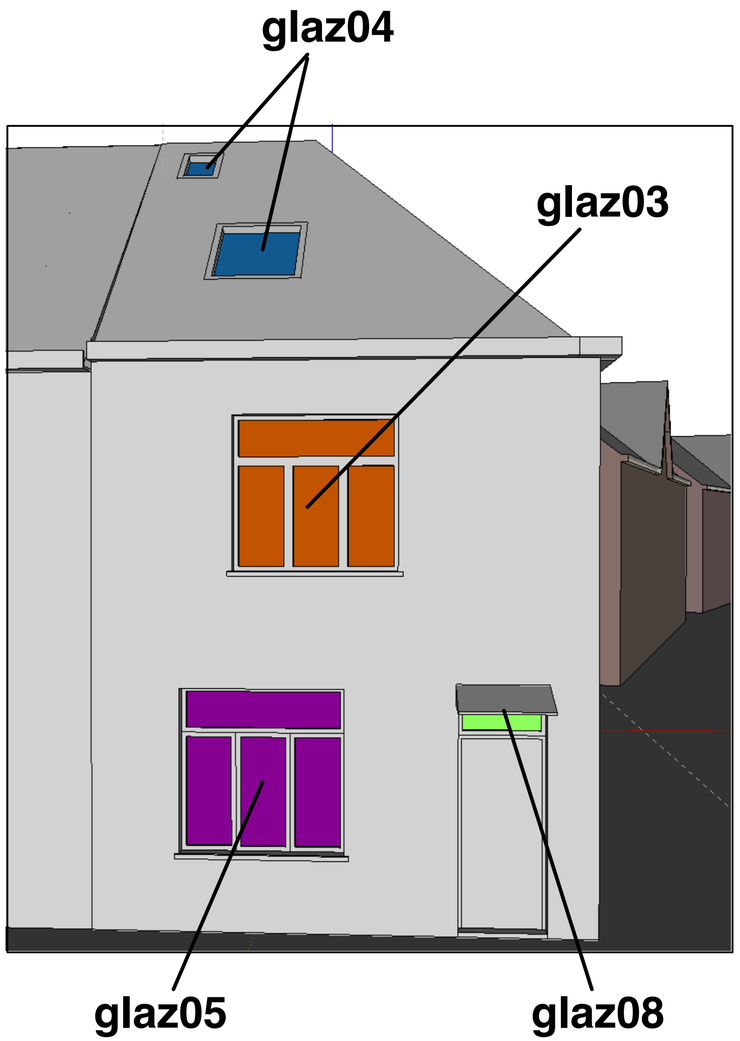
Cumulative annual sunlight beam index

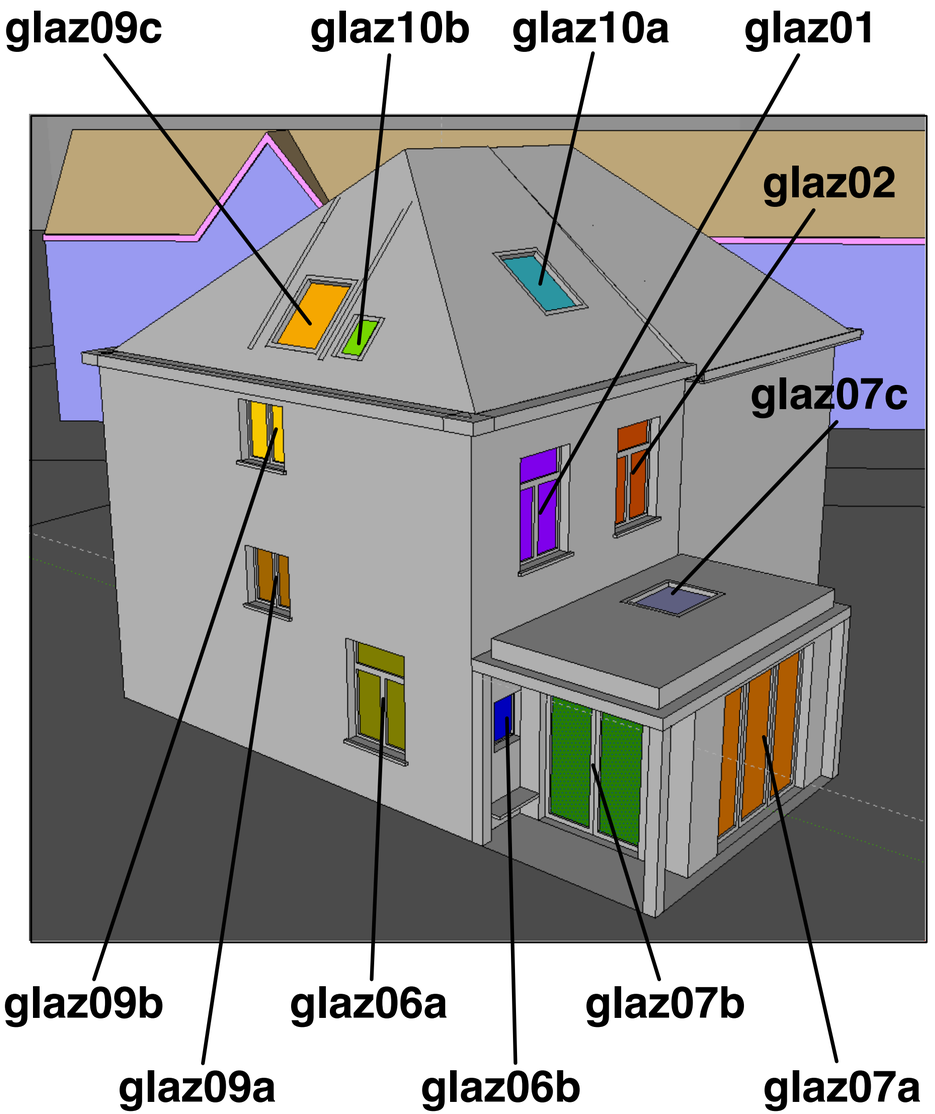
1m² vertical aperture in London (UK)

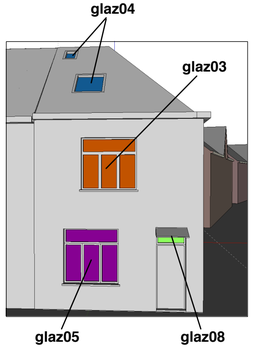
Aperture orientation	Without reveal SBI [m^2 hrs]	With reveal (20 cm) SBI [m^2 hrs]
North	204	84
NE	608	414
East	1,348	1,037
SE	1,826	1,343
South	1,927	1,340
SW	1,822	1,342
West	1,345	1,033
NW	604	411

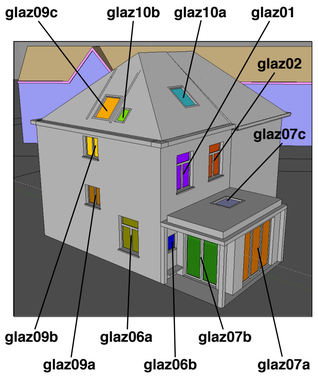

N
Total SBI 1927 m2 hrs
Hour
Month
SBI [m2 hrs]
0.25
0.20
0.15
0.10
0.05
0.00


N
Total SBI 1822 m2 hrs
Hour
24
20
16
12
8
4
0
1
2
3
4
5
6
7
8
9
10
11
12
Month
SBI [m2 hrs]
0.25
0.20
0.15
0.10
0.05
0.00


glaz04
glaz03
glaz05
glaz08

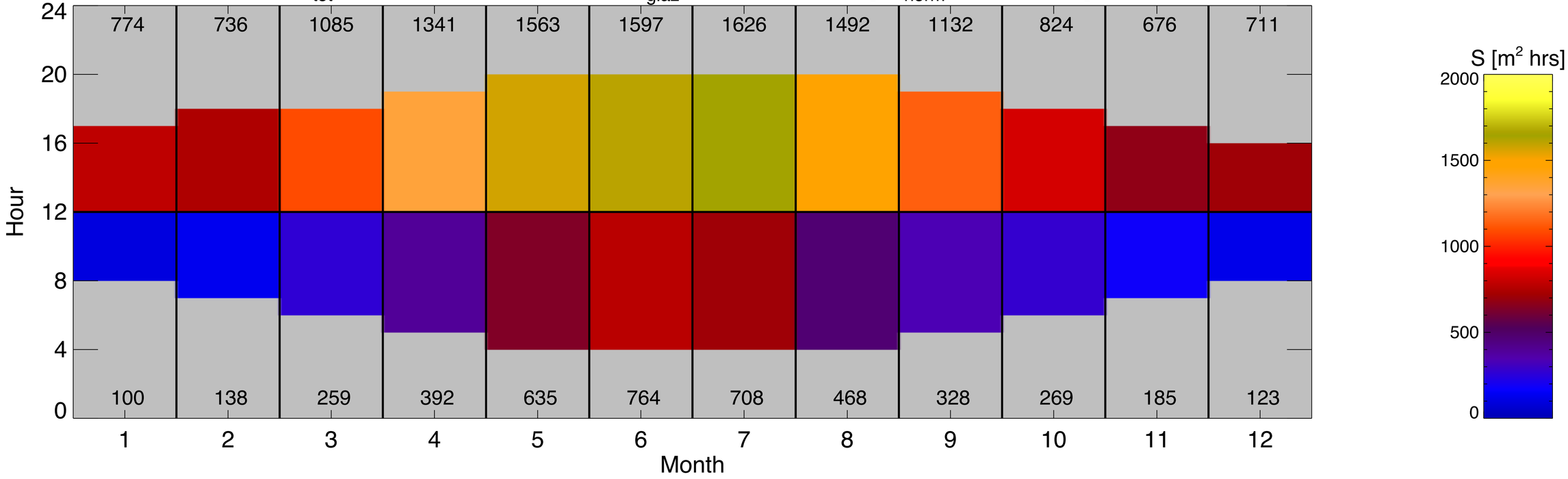

glaz09c
glaz10b
glaz10a
glaz01
glaz02
glaz07c
glaz09b
glaz06a
glaz07b
glaz09a
glaz06b
glaz07a

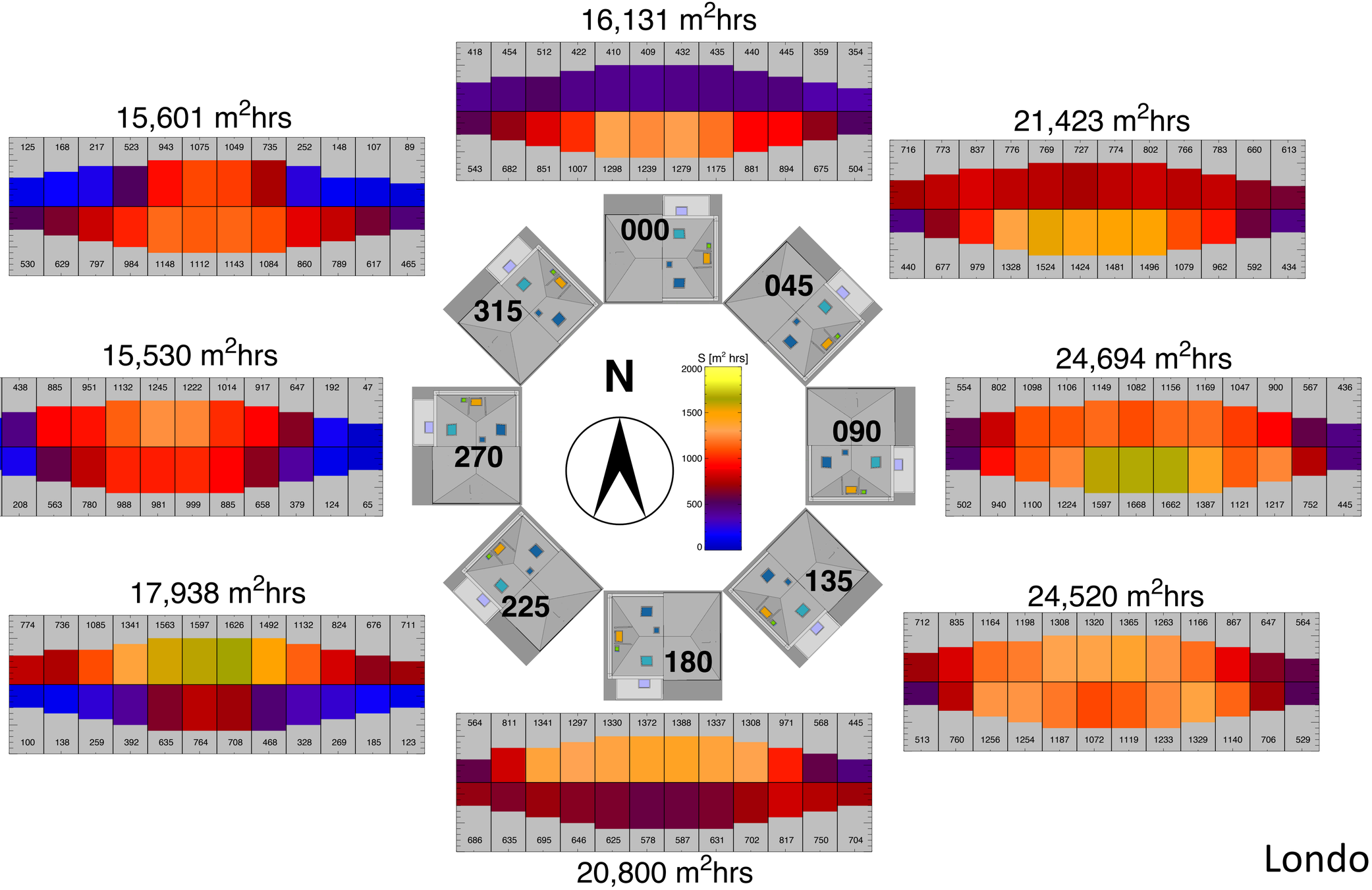




Total am/pm SBI per month

S_{tot} = 17938 m^2 hrs : A_{glaz} = 25.52 m^2 [S_{norm} = 703 hrs]

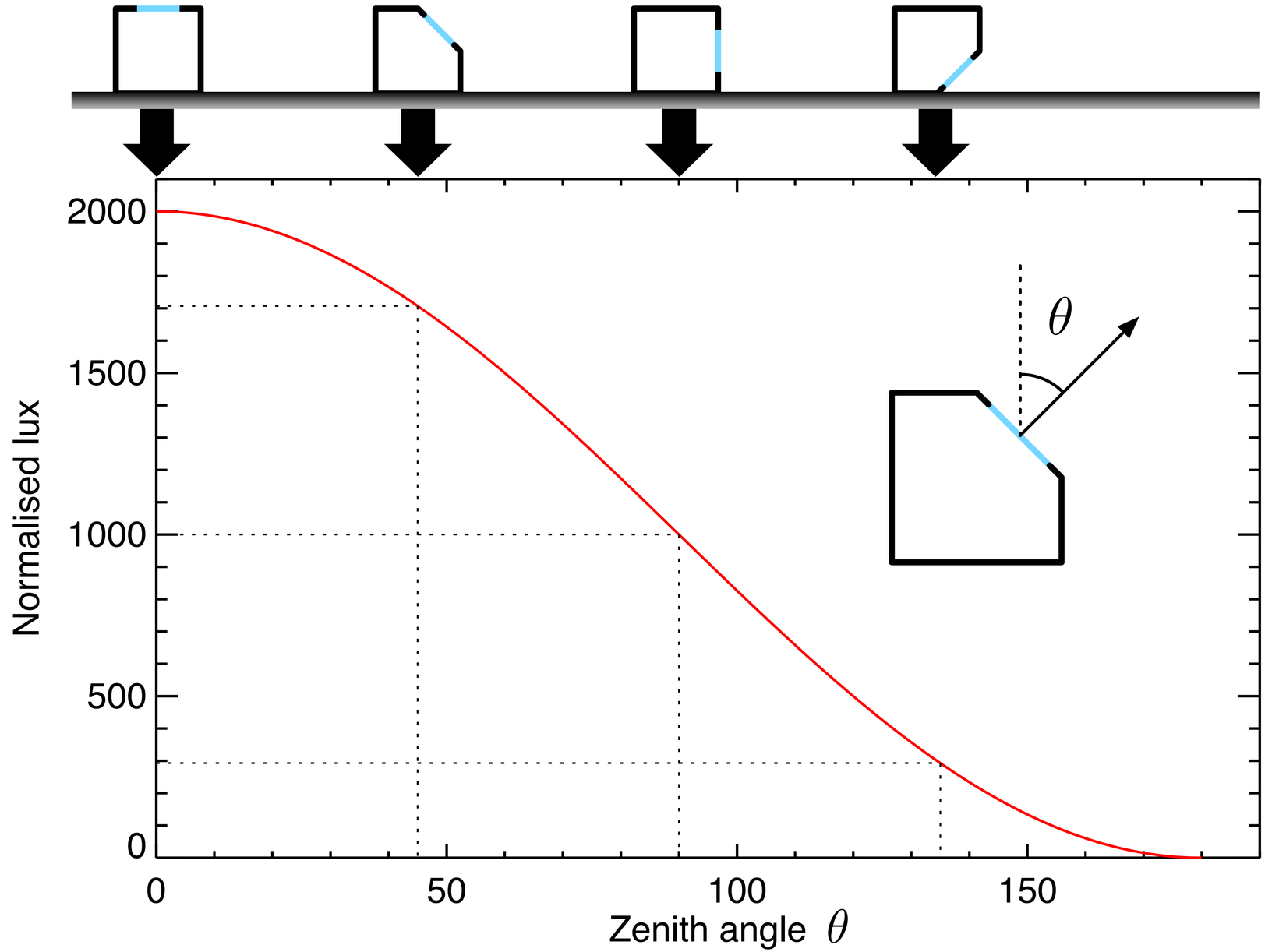



16,131 m2hrs
418 454 512 422 410 409 432 435 440 445 359 354
543 682 851 1007 1298 1239 1279 1175 881 894 675 504
15,601 m2hrs
125 168 217 523 943 1075 1049 735 252 148 107 89
530 629 797 984 1148 1112 1143 1084 860 789 617 465
21,423 m2hrs
716 773 837 776 769 727 774 802 766 783 660 613
440 677 979 1328 1524 1424 1481 1496 1079 962 592 434
000
045
315
N
S [m2 hrs]
2000
1500
1000
500
0
090
270
15,530 m2hrs
110 438 885 951 1132 1245 1222 1014 917 647 192 47
88 208 563 780 988 981 999 885 658 379 124 65
24,694 m2hrs
554 802 1098 1106 1149 1082 1156 1169 1047 900 567 436
502 940 1100 1224 1597 1668 1662 1387 1121 1217 752 445
135
225
180
17,938 m2hrs
774 736 1085 1341 1563 1597 1626 1492 1132 824 676 711
100 138 259 392 635 764 708 468 328 269 185 123
24,520 m2hrs
712 835 1164 1198 1308 1320 1365 1263 1166 867 647 564
513 760 1256 1254 1187 1072 1119 1233 1329 1140 706 529
564 811 1341 1297 1330 1372 1388 1337 1308 971 568 445
686 635 695 646 625 578 587 631 702 817 750 704
20,800 m2hrs
London, UK


The sunlight beam index
needed a companion…

The Aperture Skylight Index

ASI is an **area** measure of the **‘connectedness’** of an aperture to the sky vault in terms of the **illumination** received from a **uniform** luminance sky dome - **averaged** across the aperture.

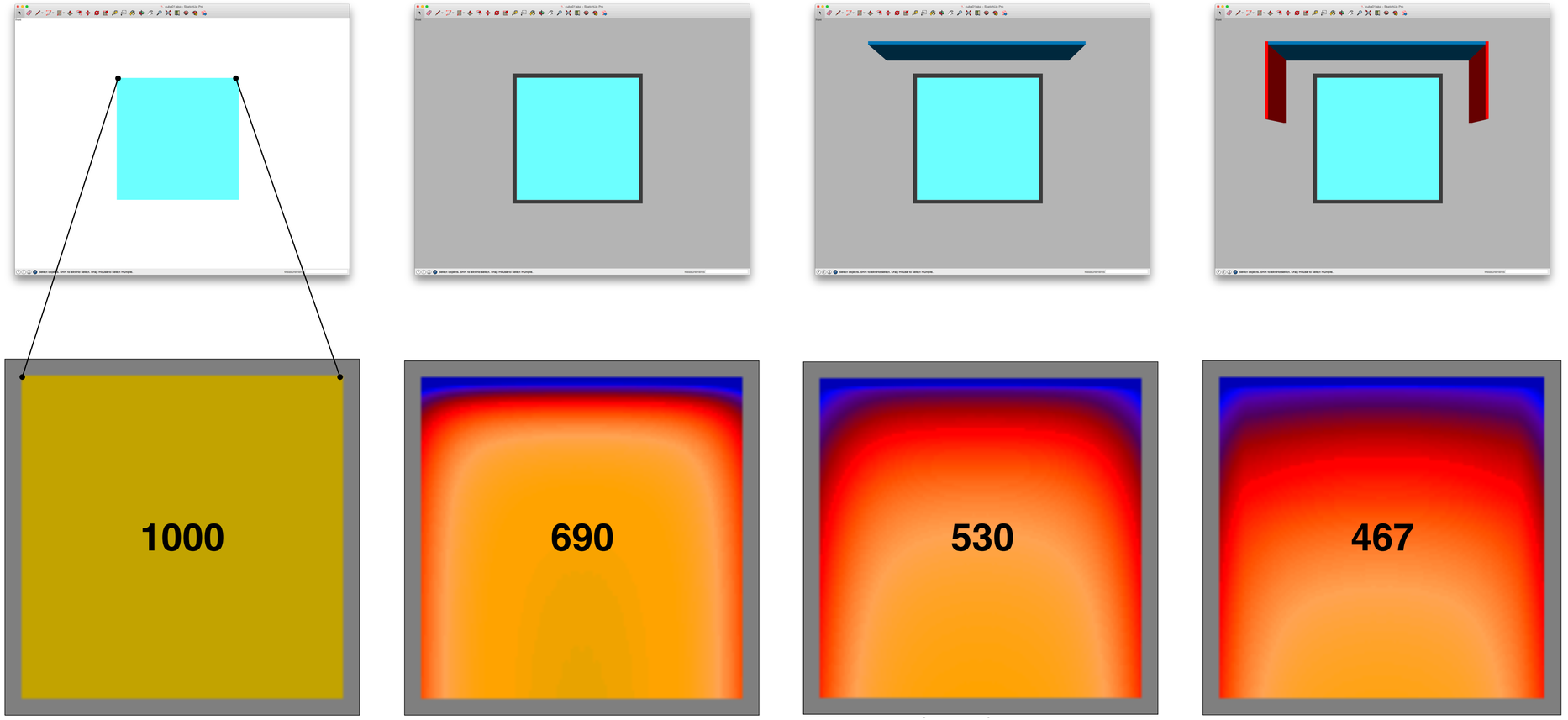

2000
1500
1000
500
0
Normalised lux
0
50
100
150
Zenith angle θ
θ

Thin wall

20cm reveal

50cm overhang
& 20cm reveal

50cm sides,
overhang
& 20cm reveal

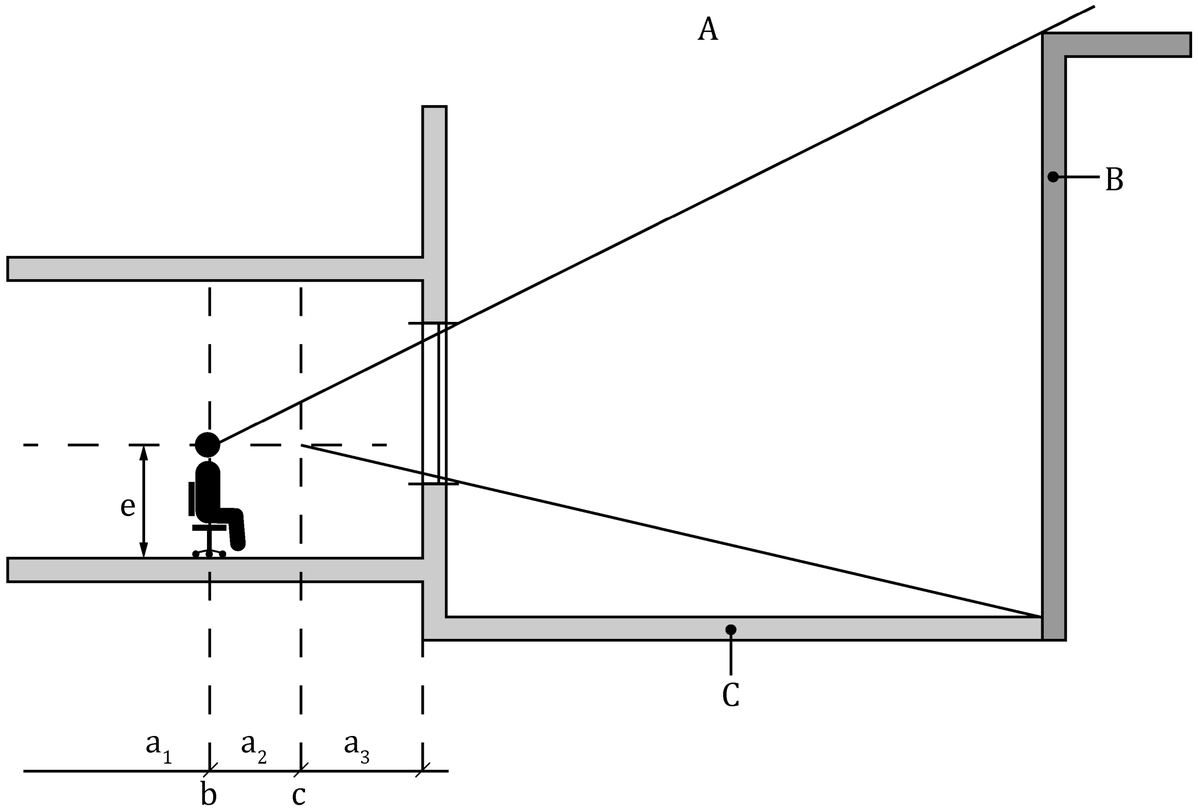


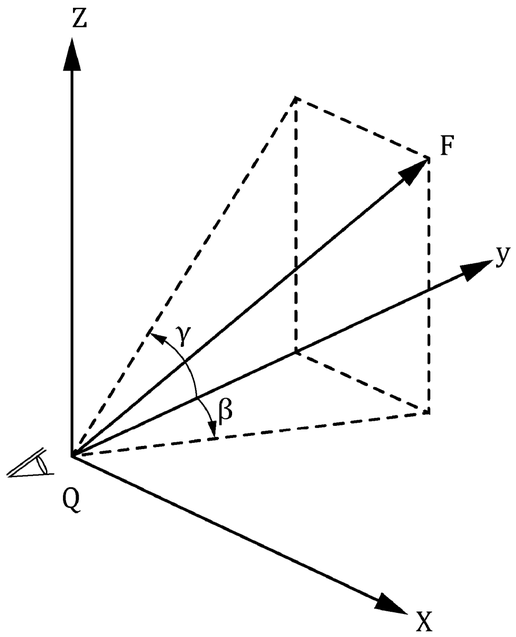
Aperture skylight index for a 1m^2 vertical aperture (anywhere)

APERTURE CONNECTEDNESS

=

VIEW POTENTIAL





BS EN 17037:2018

BSI Standards Publication

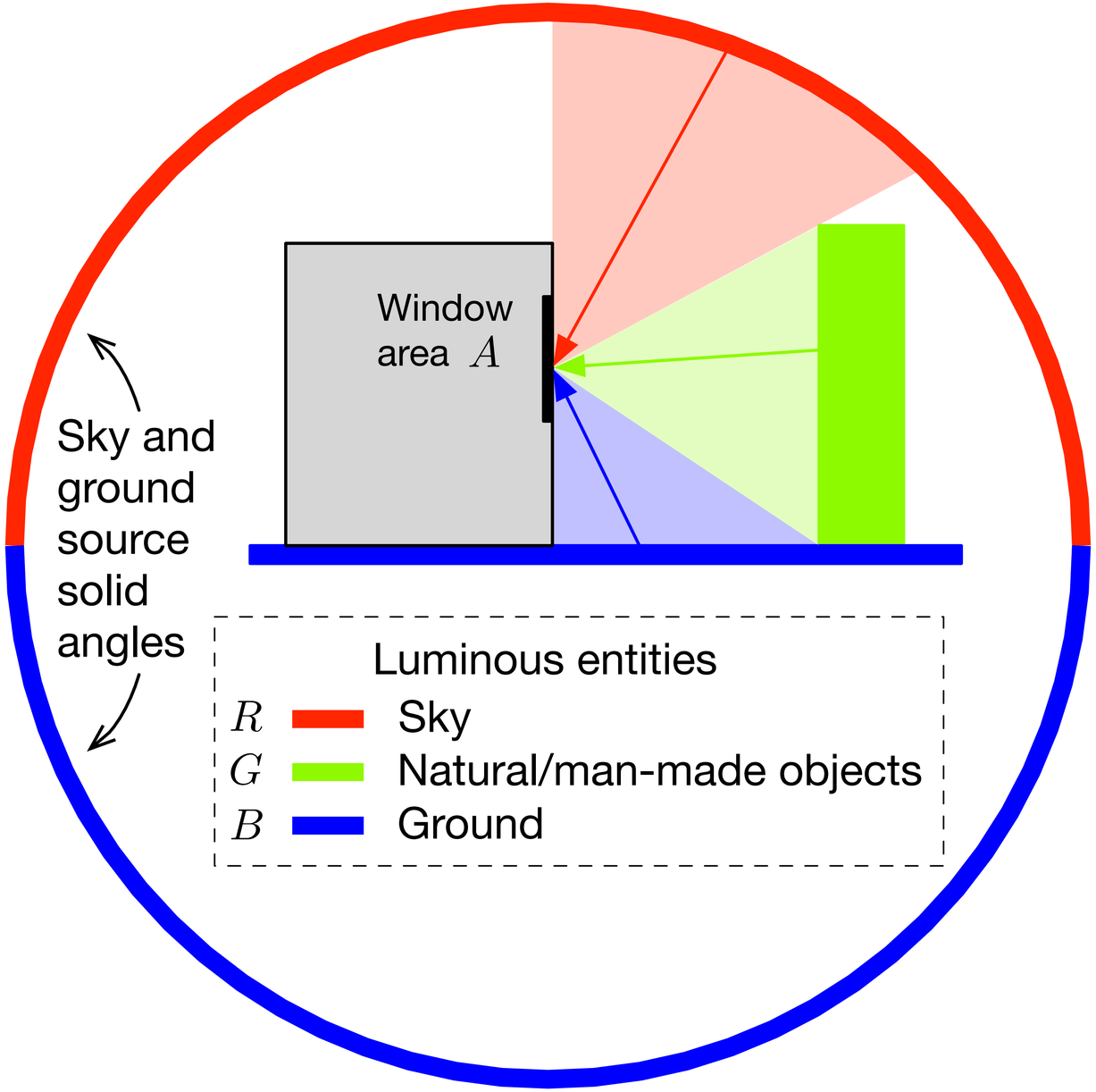
Daylight in buildings

BS 8206-2: 2008

An interior which looks gloomy, or which does not have a view to the outside when this could reasonably be expected, will be considered unsatisfactory by its users.

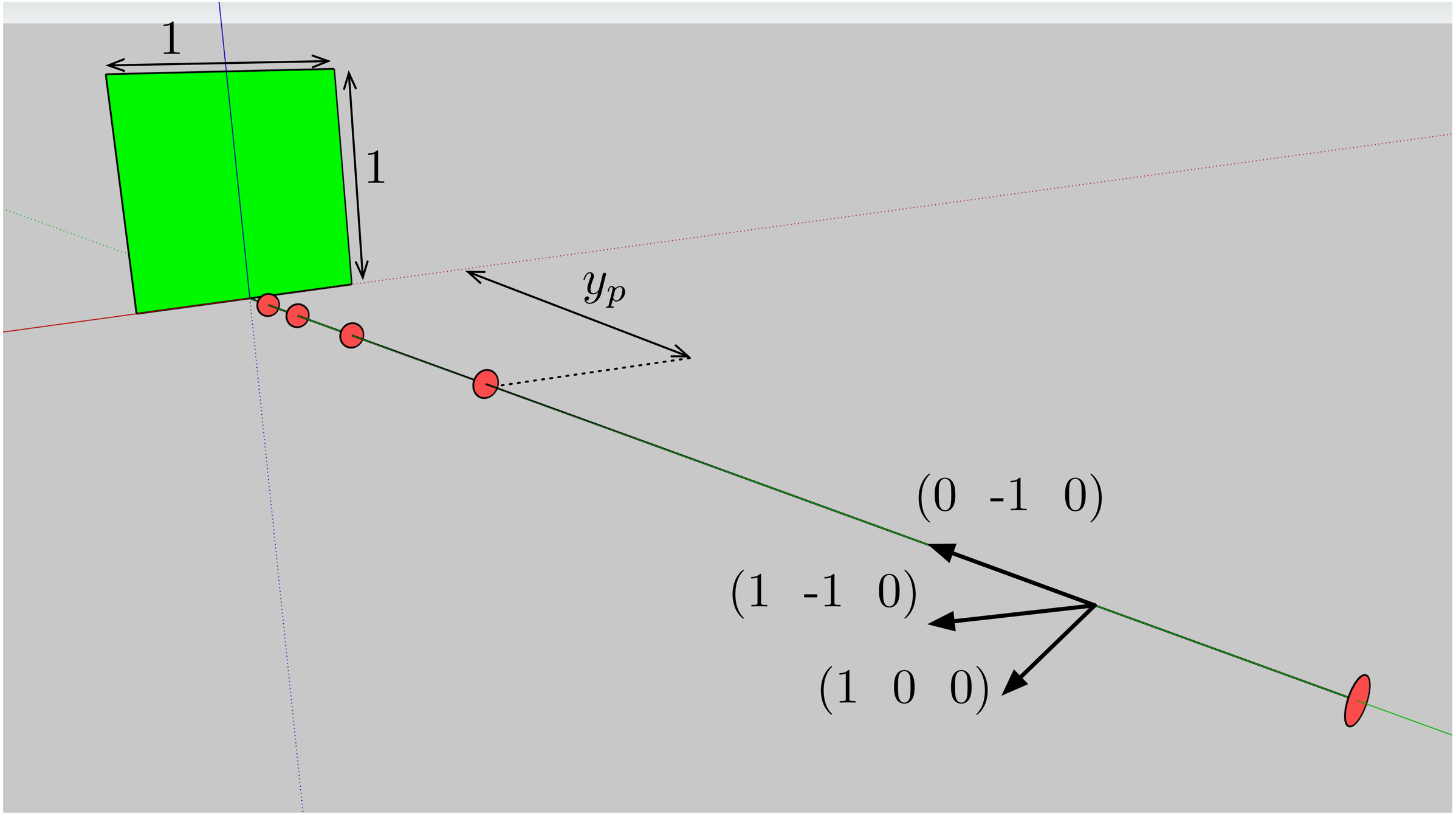
Most unrestricted views have three 'layers', as follows:

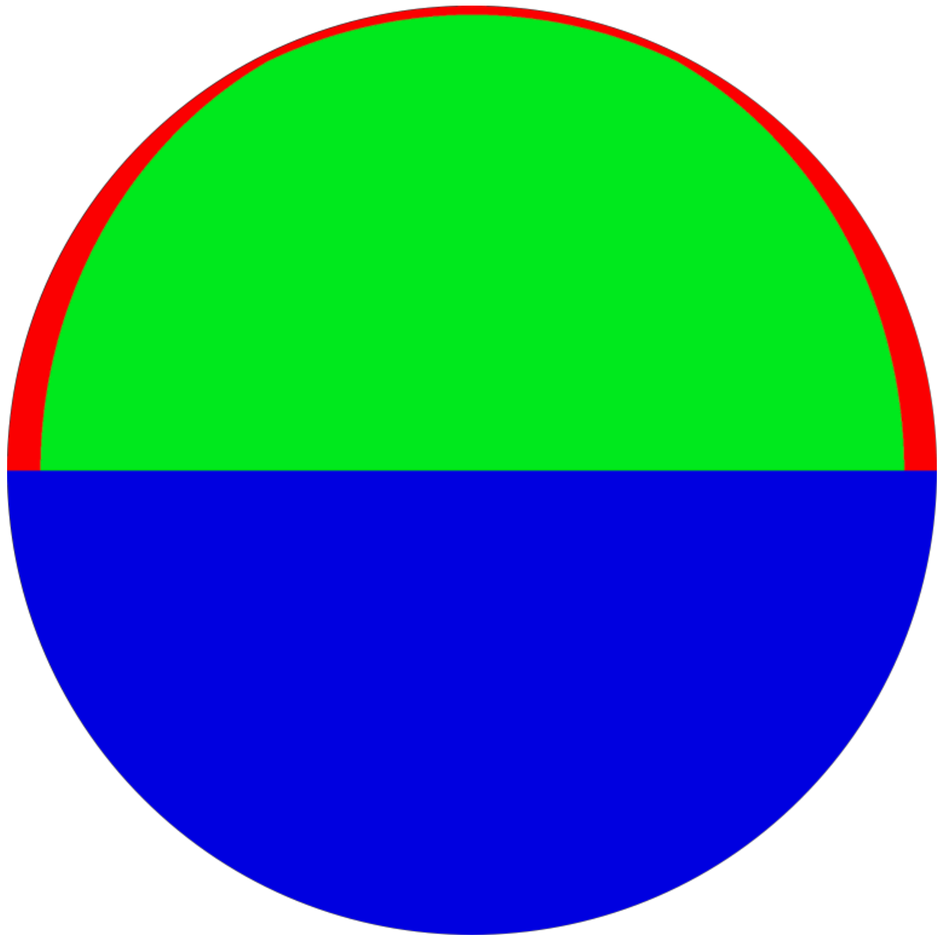
1. *upper (distant), being the sky and its boundary with the natural or man-made scene;*
2. *middle, being the natural or man-made objects themselves;*
3. *lower (close), being the nearby ground.*



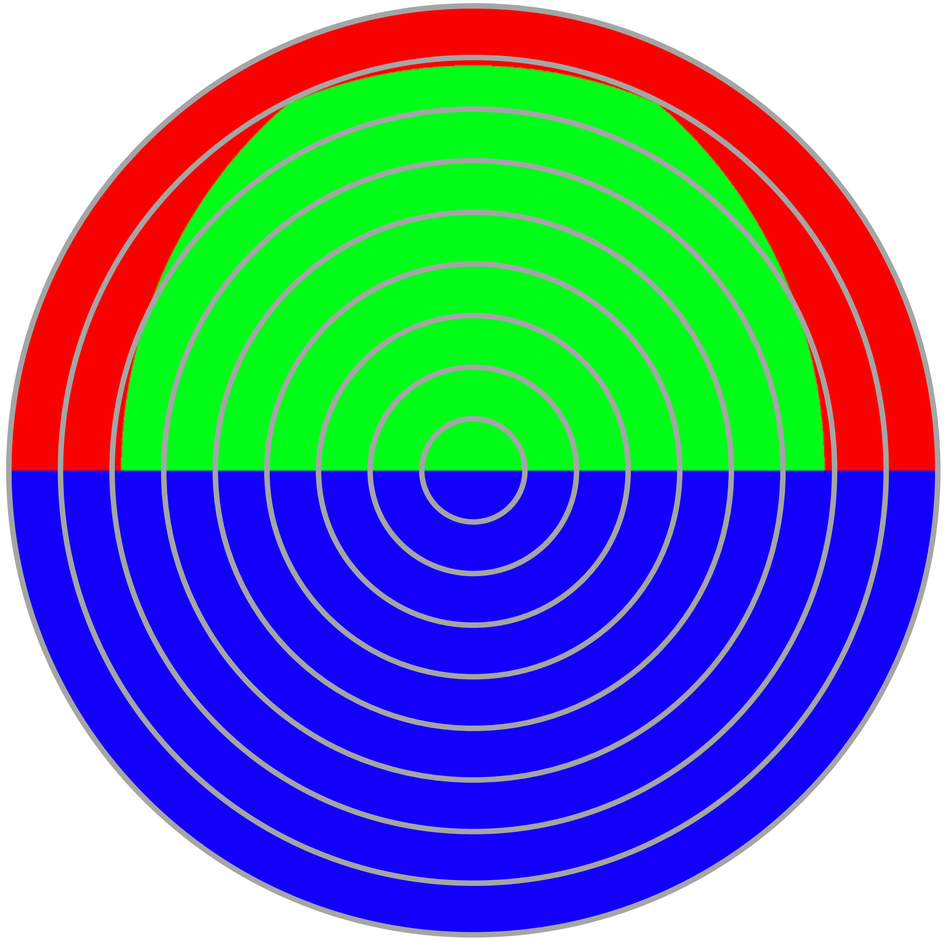
Each 1m^2 of aperture can receive a maximum of 2000 ‘view lumens’

Does this idea make any sense?


1
1
y_p
(0 -1 0)
(1 -1 0)
(1 0 0)

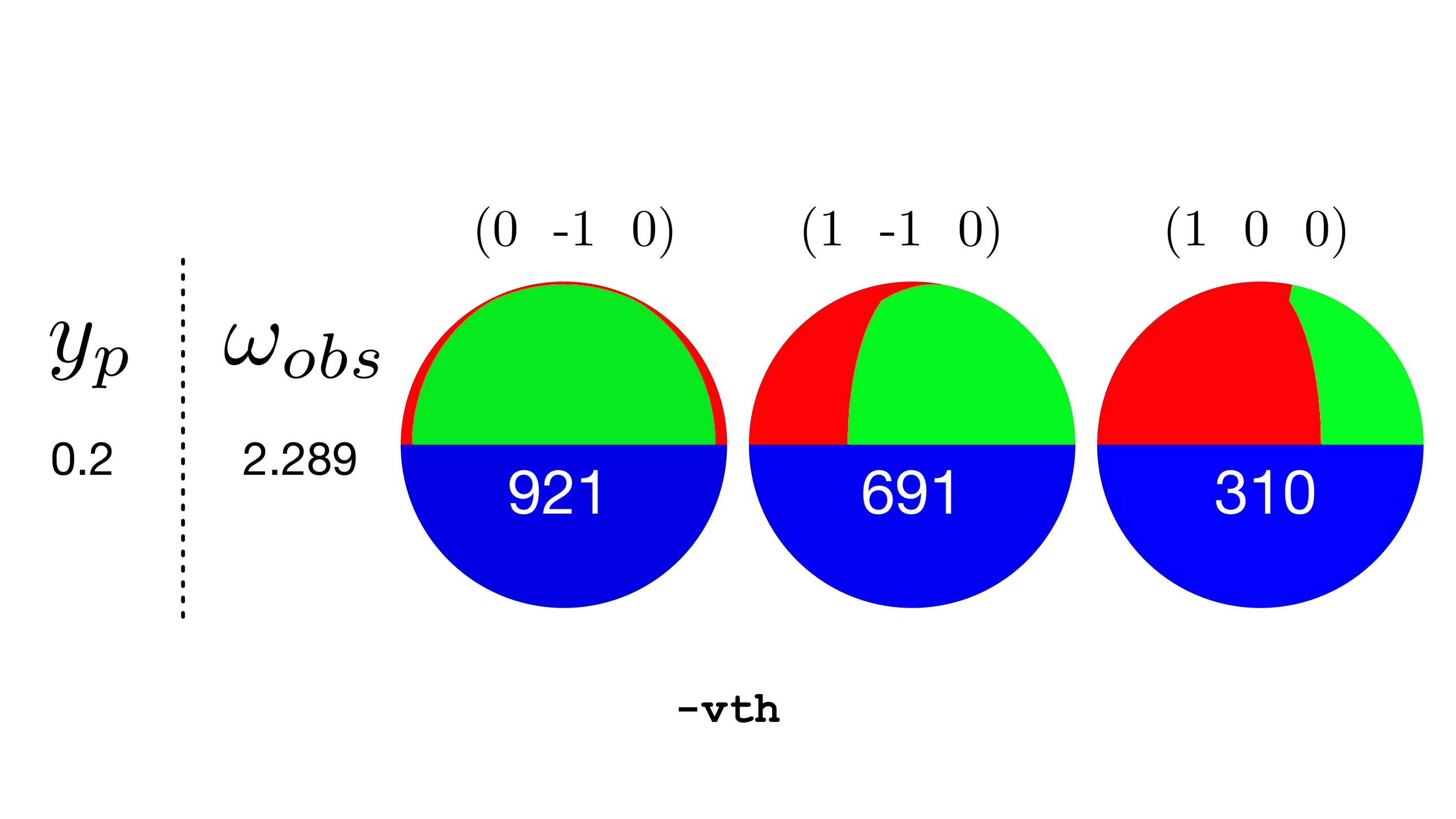


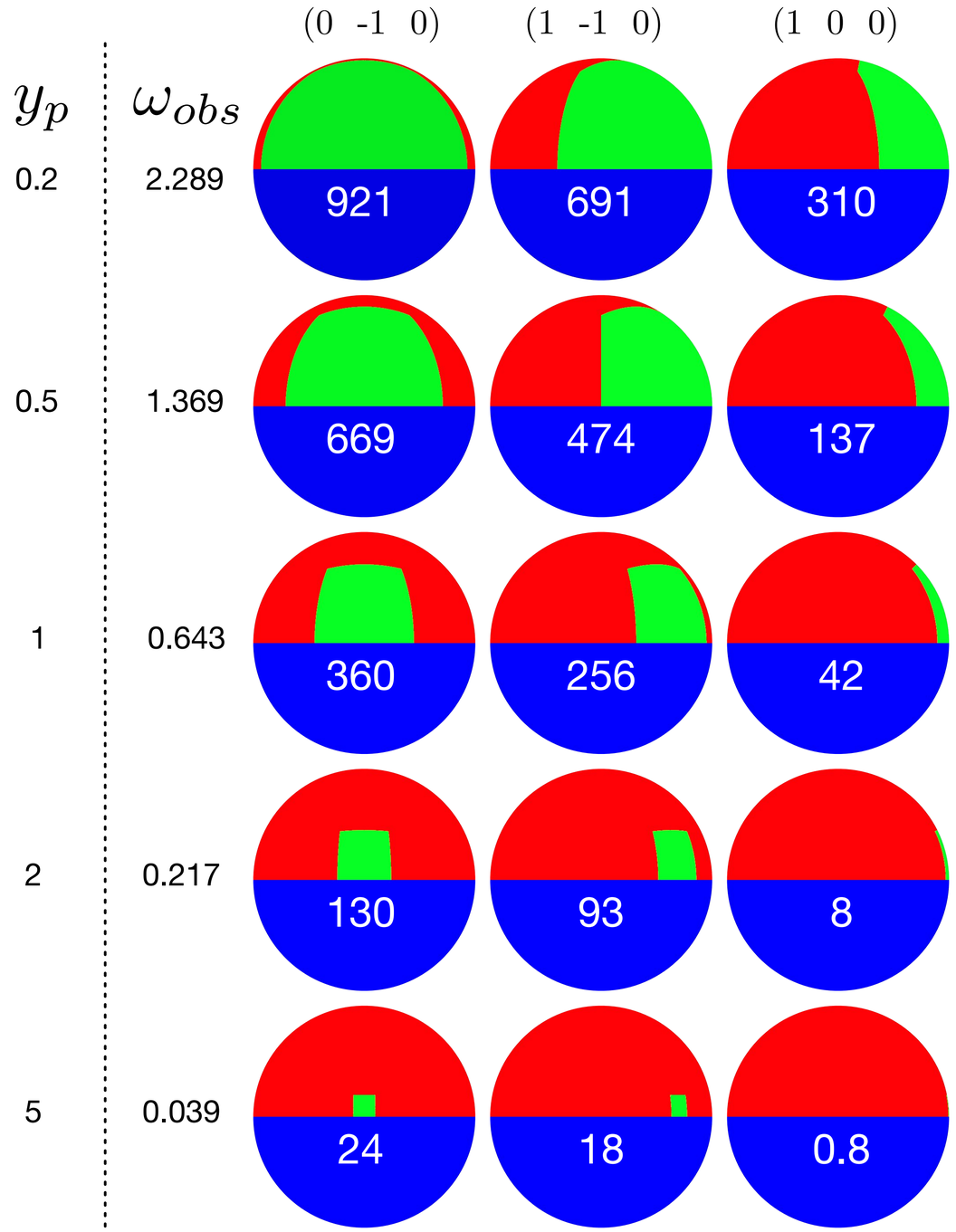
Hemispherical

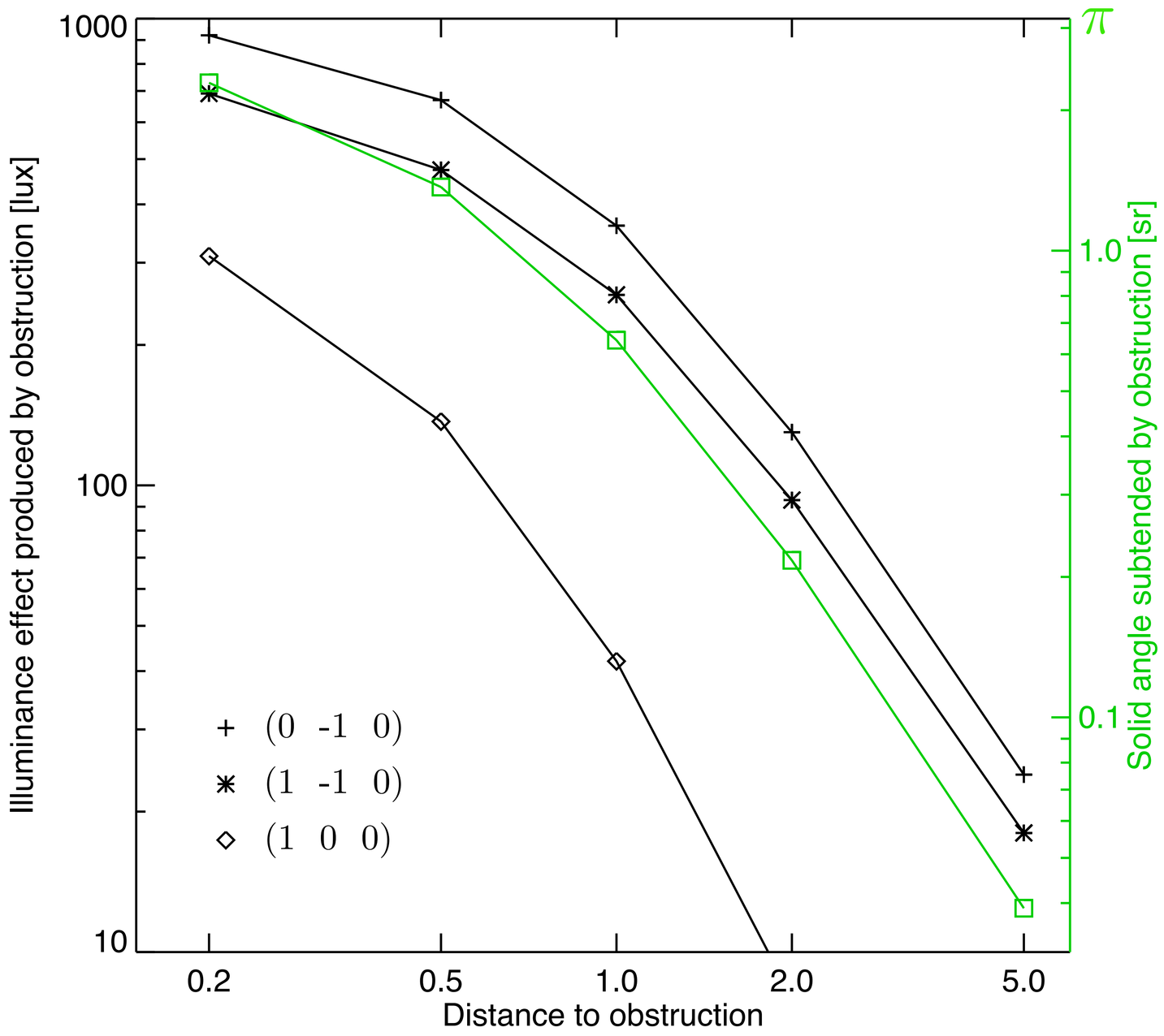


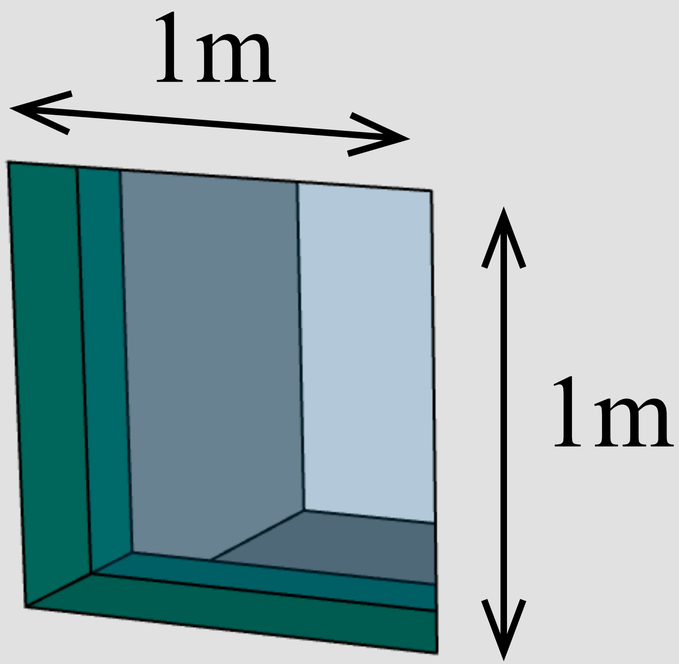
Angular

$$y_p = 0.2$$

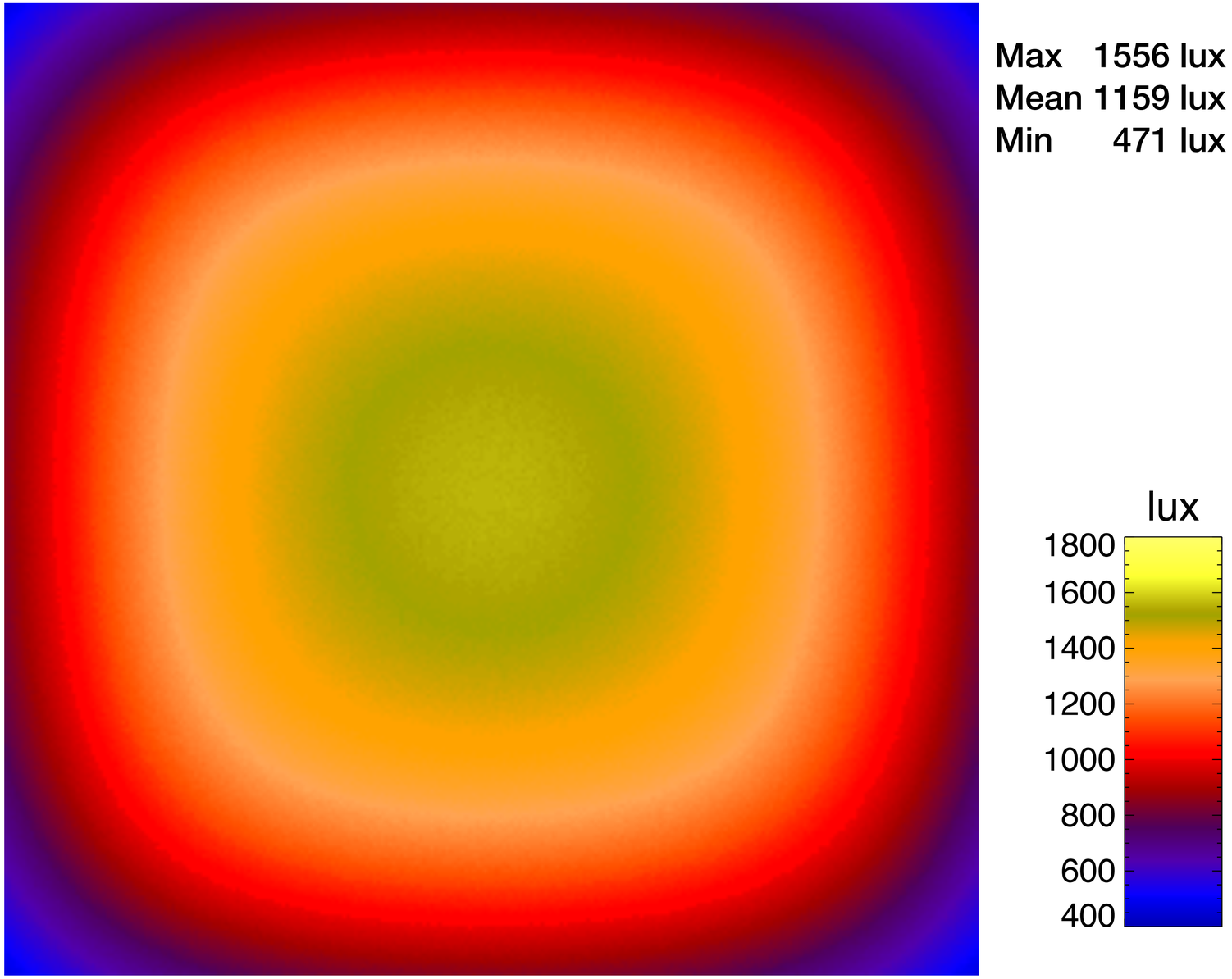

y_p
ω_{obs}
0.2
2.289
(0 -1 0)
(1 -1 0)
(1 0 0)
921
691
310
-vth

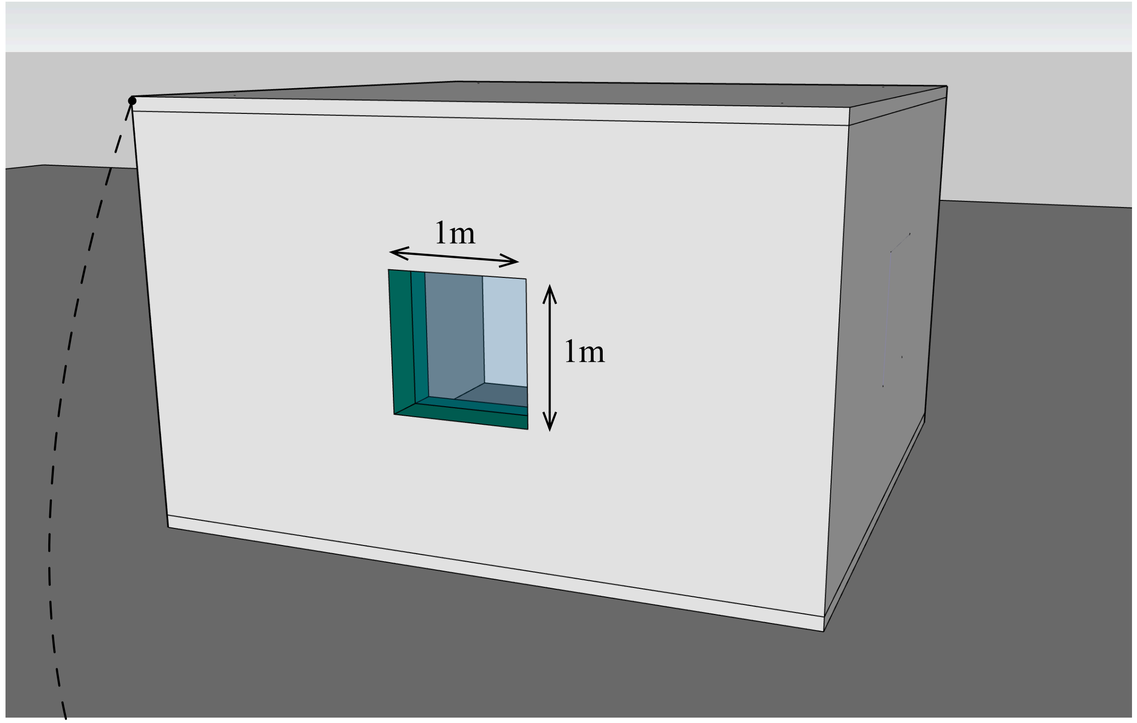

(0 -1 0)
(1 -1 0)
(1 0 0)
y_p
ω_{obs}
0.2
2.289
921
691
310
0.5
1.369
669
474
137
1
0.643
360
256
42
2
0.217
130
93
8
5
0.039
24
18
0.8

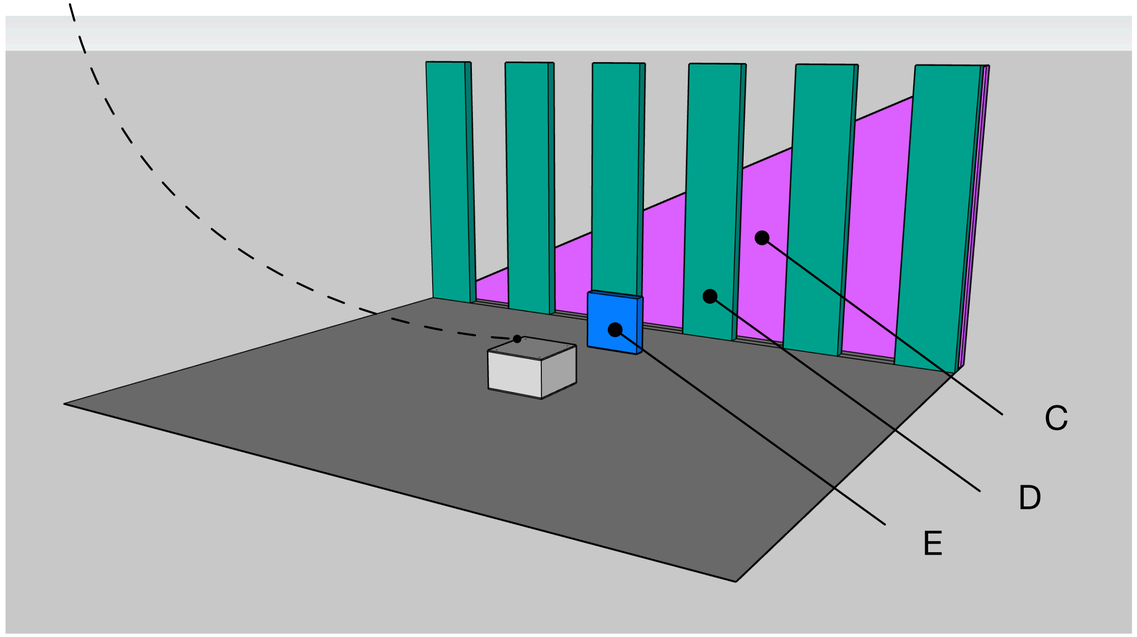

1000
100
10
Illuminance effect produced by obstruction [lux]
π
1.0
0.1
Solid angle subtended by obstruction [sr]
0.2
0.5
1.0
2.0
5.0
Distance to obstruction
(0 -1 0)
(1 -1 0)
(1 0 0)



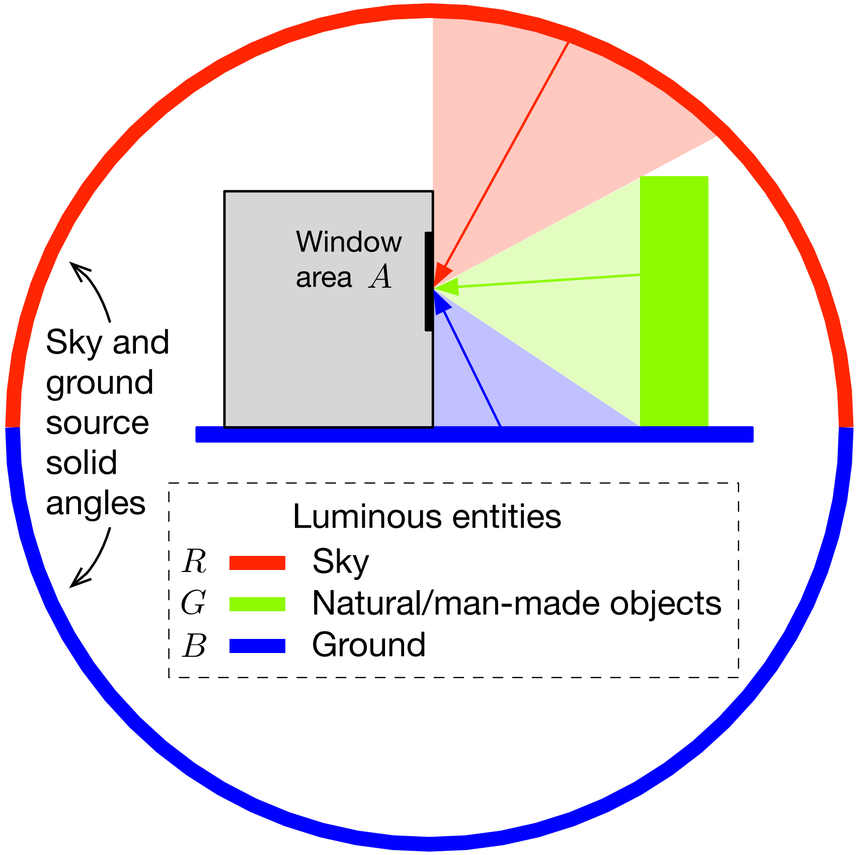
0.3m reveal depth

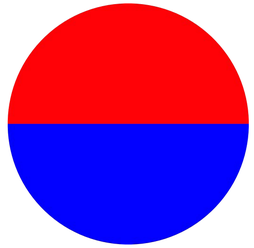
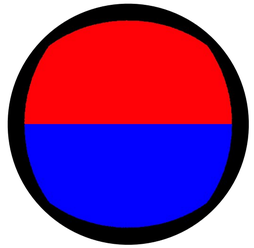
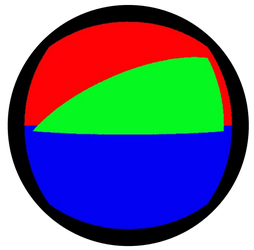
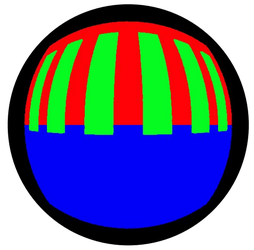
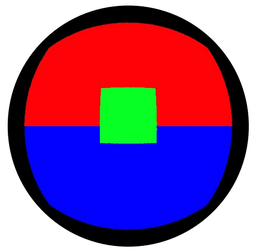

Max 1556 lux
Mean 1159 lux
Min 471 lux
lux
1800
1600
1400
1200
1000
800
600
400

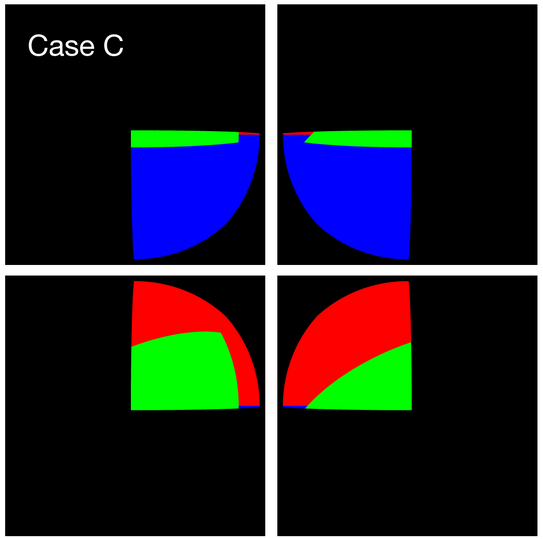


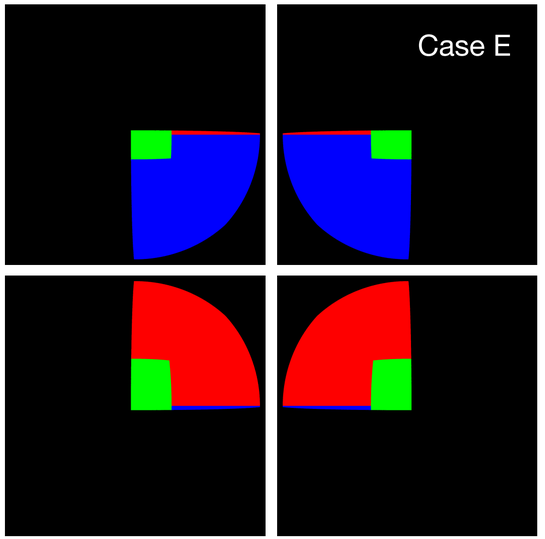


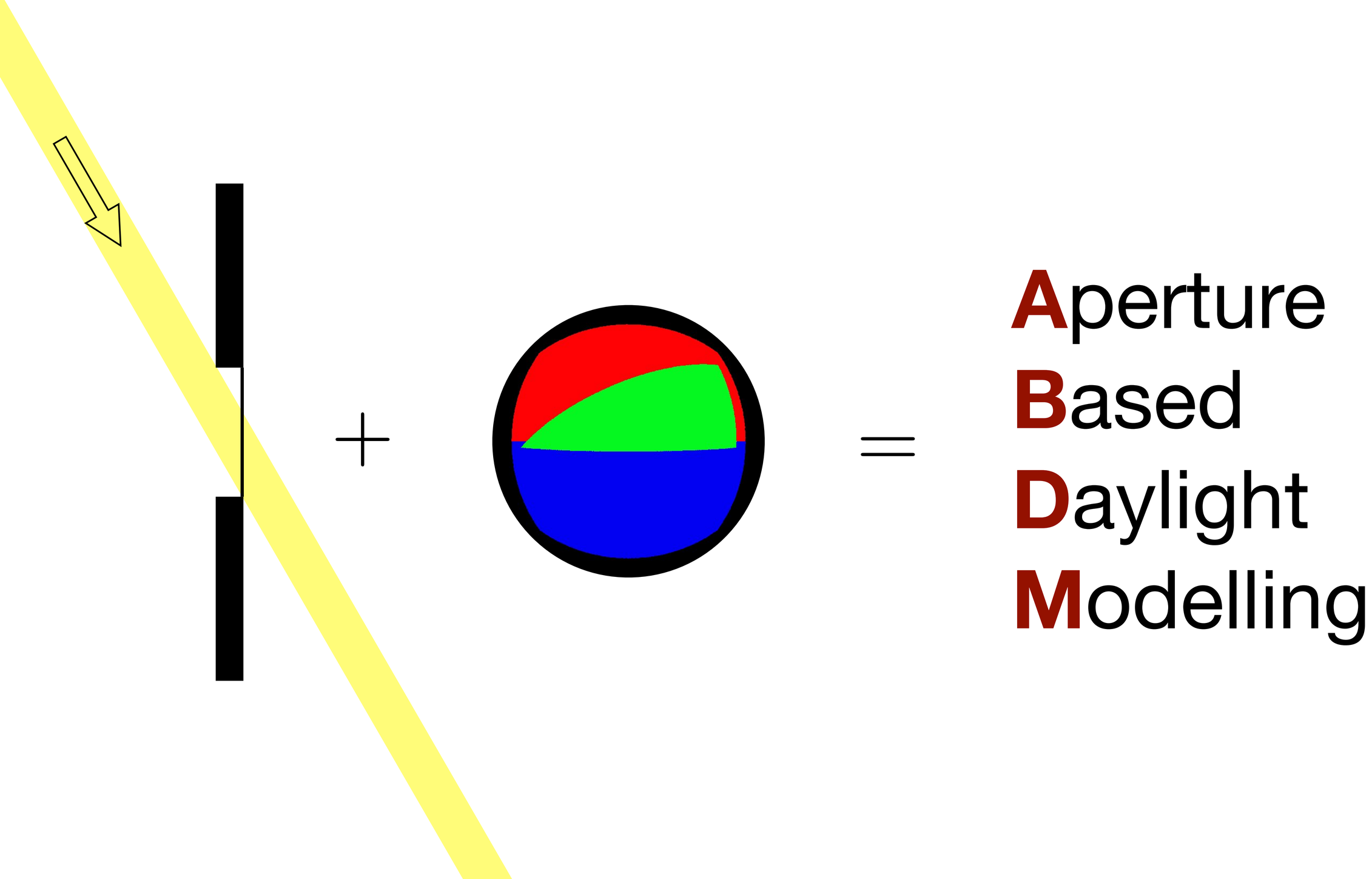
$$\phi_{lost} = 2000A - (\phi_{sky} + \phi_{obs} + \phi_{gnd})$$



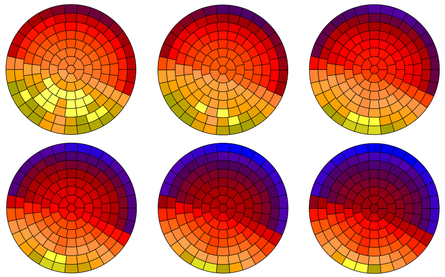
		Point	Aperture	
A		1000 0 1000	1000 0 1000	R G B
B		774 0 774	580 0 580	R G B
C		393 447 708	274 363 522	R G B
D		393 423 732	304 311 543	R G B
E		680 136 731	491 130 537	R G B





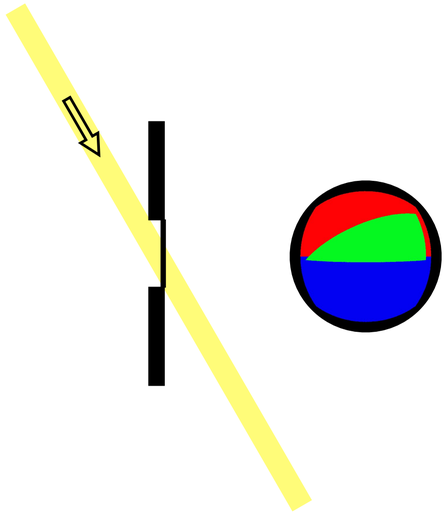


Aperture
Based
Daylight
Modelling



Climate
Based
Daylight
Modelling

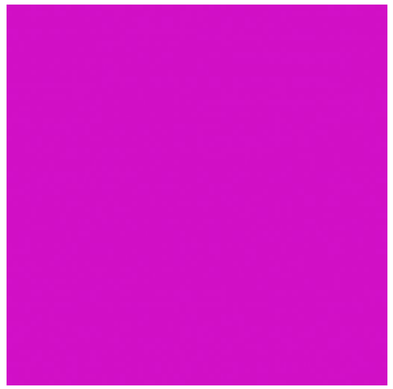
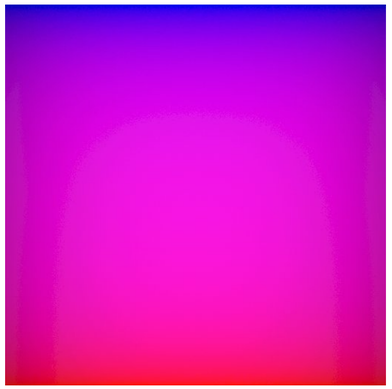
1990s

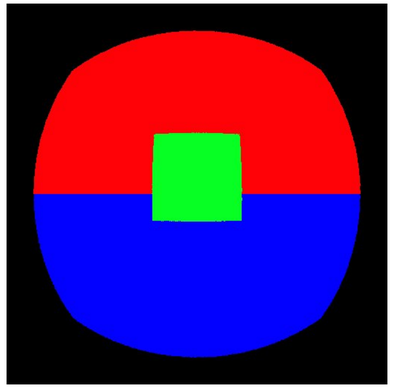
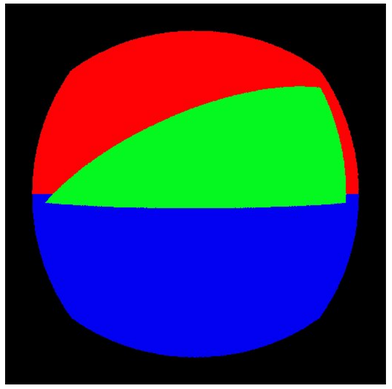
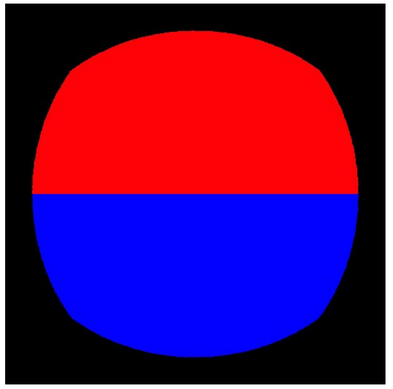
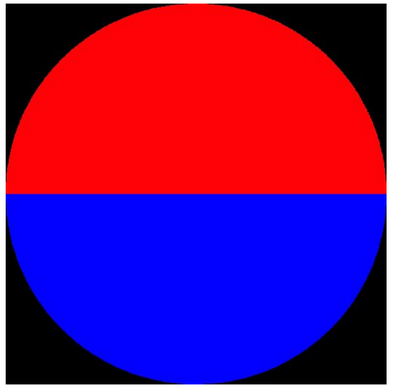
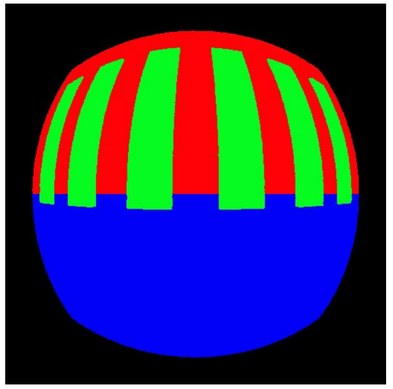


Aperture
Based
Daylight
Modelling

2019

V W X Y Z

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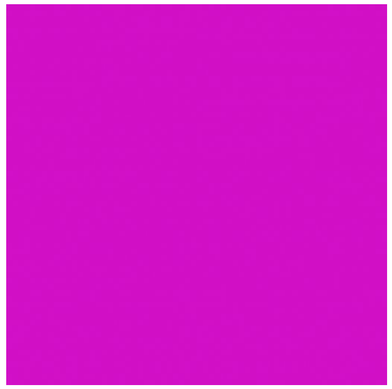
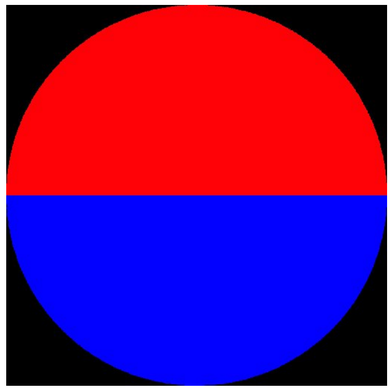
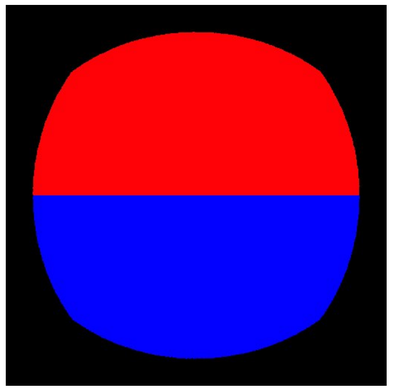
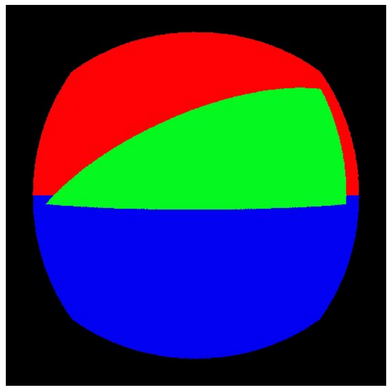
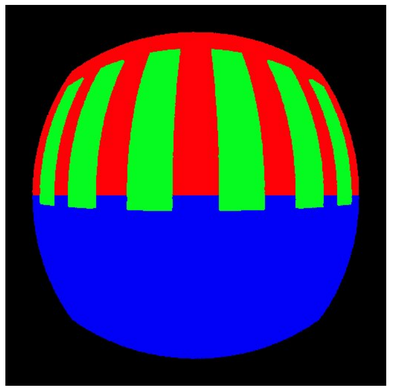
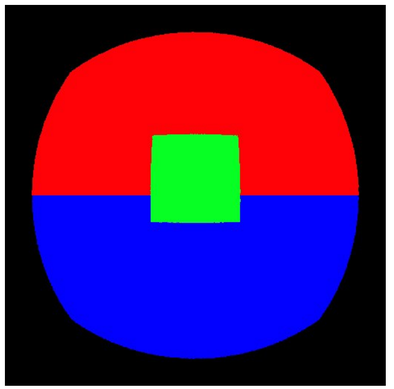




BS EN 17037 2018
“Daylight Brexit”

Daylight Past Presentations

New European Standard for Daylight of Buildings - EN 17037 (30 January 2019)

https://www.cibse.org/networks/groups/daylight/daylight-past-presentations

A Critical Review of BS EN 17037 2018

Published on August 1, 2019

Peter Defoe
Post Doctoral Researcher and Author. Mentor and Supervisor at Anglia Ruskin University

Introduction

A new British Standard dealing with daylight in buildings has now been published and is already attracting criticism amongst daylight practitioners, software providers and others. Concerns have been raised firstly with BRE which would have to consider the application in respect of BR209 and any future updates and subsequently with the British representatives on the panel that approved the new standards. One of these was Professor John Mardaljevic of Loughborough University who is well known amongst practitioners and he was invited to identify the relevant research and to comment upon a specific issue regarding the ‘reference plane’ otherwise considered to be working plane.

https://www.linkedin.com/pulse/critical-review-bs-en-17037-2018-peter-defoe/

John Mardaljevic commented on this

John Mardaljevic
Professor of Building Daylight Modelling at Loughborough University
1w

Response to **Peter Defoe** A Critical Review of BS EN 17037 2018 by **John Mardaljevic** and **Jens Christoffersen**

Dr Defoe's article has been reproduced in full in the attached response to allow inline responses (in red). Both Mardaljevic and Christoffersen welcome comments critical or otherwise on both the paper and the standard. That we disagree with the majority of De Defoe's comments is perhaps not surprising. We hope our responses will help to better illuminate the debate.

John Mardaljevic and **Jens Christoffersen**

Response to "A Critical Review of BS EN 17037 2018" published by Dr Peter Defoe on LinkedIn 01/08/19

by John Mardaljevic and Jens Christoffersen

Link to original article by Dr Defoe:
https://www.linkedin.com/pulse/critical-review-bs-en-17037-2018-peter-defoe/

Dr Defoe's article has been reproduced in full below to allow inline responses (in red). Firstly, both Mardaljevic and Christoffersen welcome comments critical or otherwise on both the paper and the standard. That we disagree with the majority of De Defoe's comments is perhaps not surprising. In addition to the original "Climate Connectivity" article, we recommend that interested parties also read the 2015 paper by Mardaljevic "Climate-Based Daylight Modelling And Its Discontents" - links to both papers (freely available) are given below:

Climate-Based Daylight Modelling And Its Discontents

'Climate connectivity'…

https://www.linkedin.com/posts/john-mardaljevic-42bb069_mardaljevic-and-christoffersen-response-ugcPost-6565611020835004416-rH-X/

Paul Rogers posted in **IBPSA - International Building Performance Simulation Association**

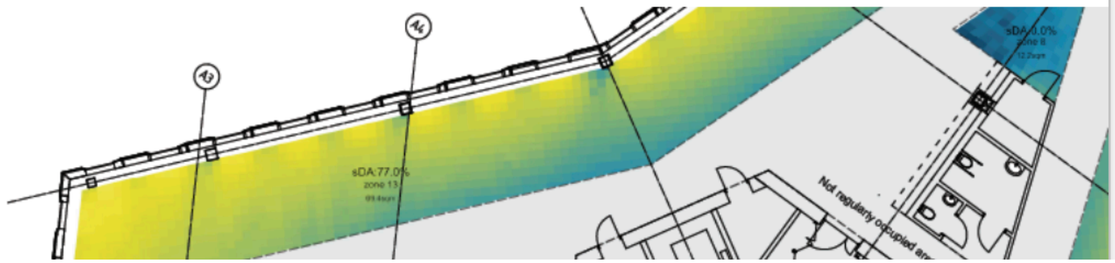
Paul Rogers • 1st
Daylight Specialist at Byrån för Arkitektur och Urbanism
1d • IBPSA - International Building Performance Simulation Association

LEED pilot credit: DAYLIGHT FOR NORDIC PROJECTS

It is well known that the LEED daylight credit is difficult to achieve and with limited daytime hours in winter and low solar angels, this is particularly true for projects in the Nordic region. For this reason, I am very proud to announce that after three years working together with Sweden Green Building Council, our American counterparts at USGBC have approved our proposal for a pilot credit for the Nordics. Amongst other things, LEED projects using this path will be able to prove compliance by exclusively using the methods of the new European Daylight Standard (CEN 17037:2018). For more information please see the following link:

https://lnkd.in/dcBxB_i #

#LEED #Daylight



https://www.linkedin.com/feed/update/urn:li:activity:6569515083465011200/

BS 2019 2-4 SEPT ROME 16th IBPSA INTERNATIONAL CONFERENCE AND EXHIBITION

Aperture-Based Daylight Modelling: Introducing the 'View Lumen'

John Mardaljevic
School of Architecture, Building & Civil Engineering,
Loughborough University, Loughborough, UK
E-mail: j.mardaljevic@lboro.ac.uk

Abstract

This paper presents a new way to determine measures of view at the building aperture. It introduces the concept of the view lumen – this is the illumination effect received at the building aperture from a visible external entity (e.g. ground, sky, obstruction, etc.) which is made self-luminous for this purpose. The paper describes the fundamental principle behind the view lumen, and gives some preliminary illustrations of the technique to show its potential. The examples employ the British Standard framework to define categories of view. That is, three layers named upper, middle and lower comprising, respectively, sky, natural or man-made objects (e.g. buildings) and ground. The proposal is an extension of the recently introduced sunlight beam index.

Introduction

The guidelines and recommendations currently used to evaluate daylight and daylight related quantities for planning purposes are invariably simplistic in conception, having changed little since they were first devised a half-century or more ago. Techniques such as climate-based daylight modelling (CBDM) are generally preferred by practitioners to evaluate building designs (Mardaljevic (2006)). However they are currently deemed too complex for their use to be made mandatory for regulatory purposes, though there is one notable example where evaluation of school building designs using CBDM is compulsory (Mardaljevic (2015)). This paper proposes a novel framework for the evaluation of daylight and view which has all the features necessary to form the basis of a regulatory method for planning purposes. The basis of the approach is to evaluate meaningful measures of sunlight, skylight and view for individual or groups of building apertures, i.e. windows. Importantly, and unlike many of the existing approaches, the new method accounts for the window size. Although this first implementation uses *Radiance*, the calculation is fundamentally geometric and therefore suited for implementation as, say, a BIM plugin. The outcome is largely immune to accidental blunders or deliberate game playing providing the geometry is correct – an essential consideration for any method that could form the basis of, say, a future EU/CEN standard.

The evaluation of sunlight, skylight and view at the building aperture presents something of a paradigm shift compared to existing approaches. The sunlight beam index (SBI) was originally conceived as a means to rate a window aperture's potential to receive sunlight for solar access purposes (Mardaljevic and Roy (2016)). SBI is an area measure of the 'connectedness' of a building aperture to all of the possible occurring sun positions for that locale and for that particular aspect of the aperture including all possible obstructing surfaces – averaged across the aperture. Similarly, the aperture skylight index (ASI) is an area measure of the 'connectedness' of an aperture to the sky vault in terms of the illumination received from a uniform luminance sky dome – averaged across the aperture (Mardaljevic (2017)). This paper introduces the concept of the 'view lumen' as a measure of the aperture's 'connectedness' to the three key layers that provide the components of view: ground, foreground (e.g. buildings) and sky. In effect, the geometry that comprises each of the view layers is made luminous, and the flux of illumination from each layer (received at the aperture and averaged across it) serves as proxy measures for each of the view layers.

View 'layers'

The following is from British Standard BS 8206-2 Lighting for buildings – Code of practice for daylighting (British Standards Institute (2008)):

"Daylighting gives to a building a unique variety and interest. An interior which looks gloomy, or which does not have a view to the outside when this could reasonably be expected, will be considered unsatisfactory by its users."

"Most unrestricted views have three 'layers', as follows:

1. *upper (distant), being the sky and its boundary with the natural or man-made scene;*

2. *middle, being the natural or man-made objects themselves;*

Paper will eventually be available here:
http://www.ibpsa.org/conferences/

But email me for a copy if you'd rather not wait:
j.mardaljevic@lboro.ac.uk

Related papers

The sunlight beam index
https://journals.sagepub.com/doi/abs/10.1177/1477153515621486

Envelope first / Inside later: Aperture sunlight and skylight indices
https://repository.lboro.ac.uk/articles/Envelope_first_Inside_later_Aperture_sunlight_and_skylight_indices/9430067

Thank You

John Mardaljevic

Loughborough University

http://climate-based-daylighting.com

http://www.lboro.ac.uk/departments/abce/staff/john-mardaljevic