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Luminance-based Metrics for Evaluating Human Visual Preference 8.12.2013

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Background

- There are insufficient human factors research studies available that examine luminance-based measures as they relate to human visual preference and acceptance in spaces with daylight.
- Control problems persist in daylight-sensing electric lighting applications
- Automated blinds market penetration is low

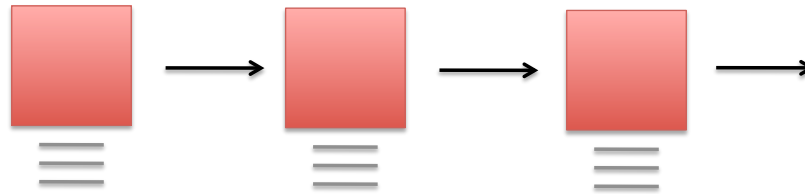
Aim 1 – Preference-Acceptance

- To determine which lighting metrics (luminance-based and illuminance-based) are more strongly associated with *subjective measures* of human visual preference and acceptance (using Likert-type and semantic differential questionnaire items) in an office space with daylight only, and with both daylight and electric light (integrated lighting), and to identify recommended design criteria.



Methods

Analyze quantitative lighting measures in relation to qualitative assessments of participant comfort



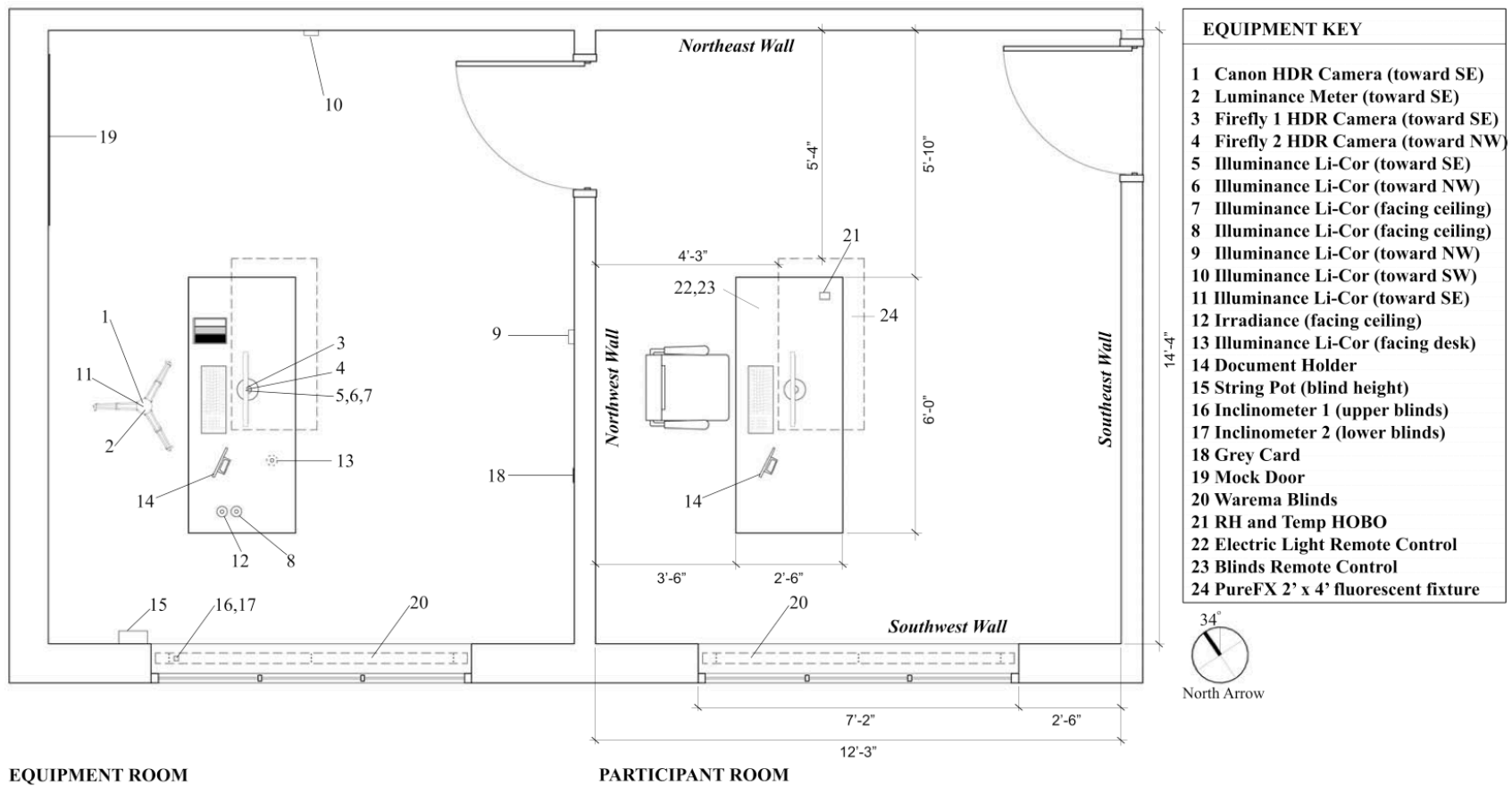
18 participants in a short-term pilot study...

*45 participants in a six-month study, using a repeated measures design
in a mock office space under naturally occurring (and systematically categorized) daylight conditions*





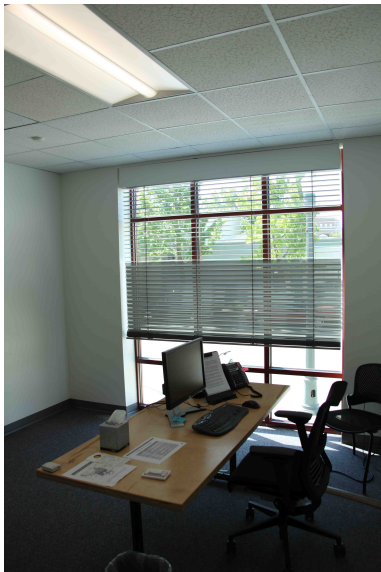
Location



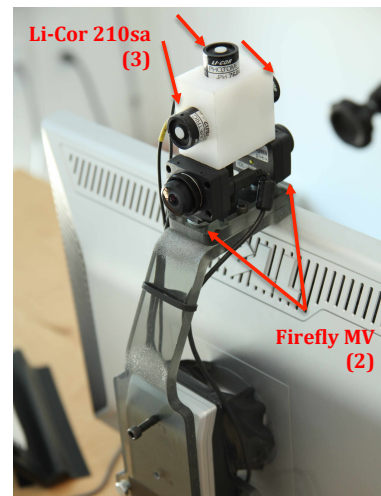
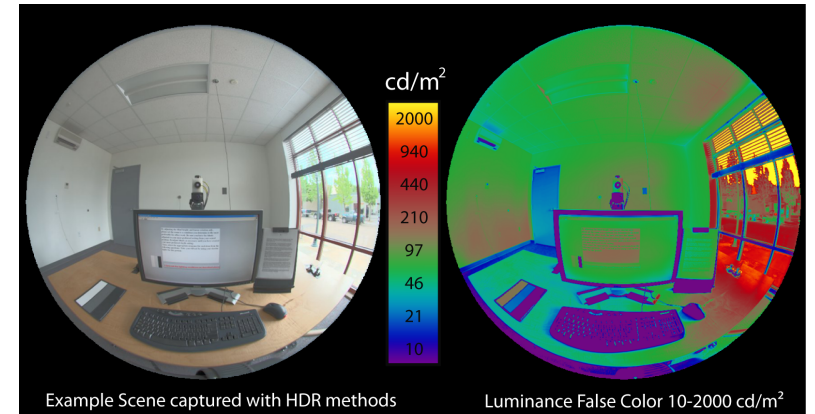
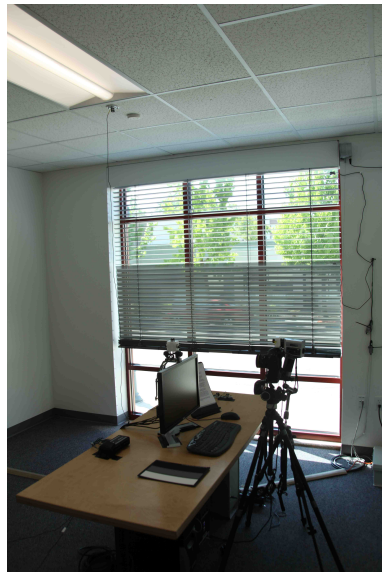
Plan of equipment and participant rooms with data collection locations and description

Data collection

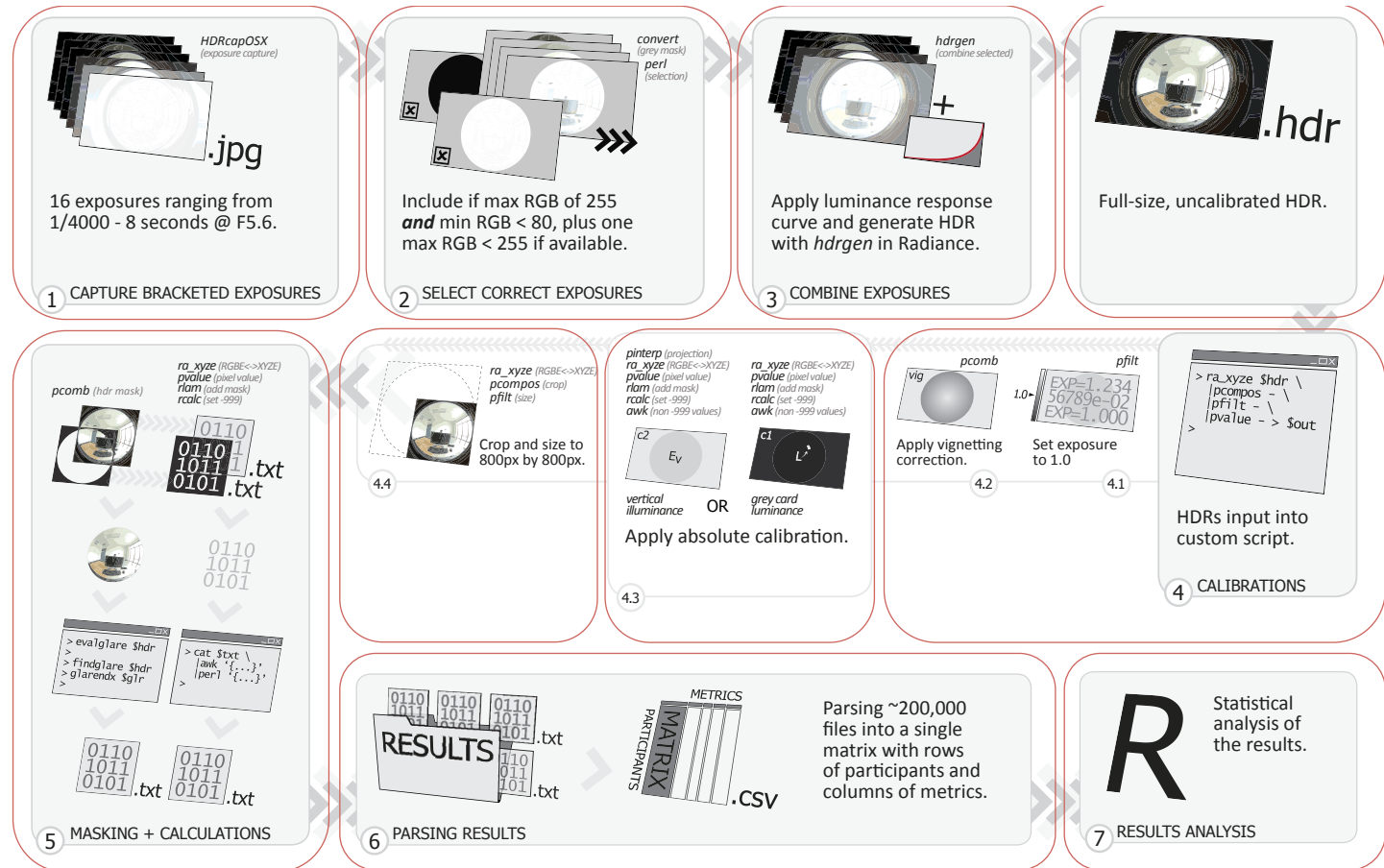
Participant Room



Equipment Room



HDR workflow



Conditions descriptions

AM

C1 Most Preferred Daylight
 C2 MP Daylight, Electric Light to Improve
 C3 MP Daylight, Electric to worsen

C4 Just Uncomfortable Daylight Glare
 C5 JU Daylight Glare, Electric to improve
 C6 No Daylight Glare, E if desired
 C7 MP Integrated Daylight and Electric

PM

C8 MP Daylight
 C9 Darkest possible
 C10 JU Daylight Glare

C11 MP Integrated Daylight and Electric
 C12 Electric sameC11, Darkest Daylight
 C13 Electric sameC11, JU Daylight Glare
 C14 MP Integrated Daylight and Electric
 C15 MP Daylight, Electric too dim (or off)
 C16 MP Daylight, Electric too bright

Condition Sequence Shuffled Every Month

Presentation Order	Jun 21 – Jul 20	Jul 21 – Aug 20	Aug 21 – Sep 20	Sep 21 – Oct 20	Oct 21 – Nov 20	Nov 21 – Dec 20
1st - AM	C 1,2,3	C 4,5,6,7	C 1,2,3	C 4,5,6,7	C 1,2,3	C 4,5,6,7
2nd - AM	C 4,5,6,7	C 1,2,3	C 4,5,6,7	C 1,2,3	C 4,5,6,7	C 1,2,3
3rd - PM	C 8,9,10	C 14, 15, 16	C 11,12,13	C 8,9,10	C 14, 15, 16	C 11,12,13
4th - PM	C 11,12,13	C 8,9,10	C 14, 15, 16	C 14, 15, 16	C 11,12,13	C 8,9,10
5th - PM	C 14, 15, 16	C 11,12,13	C 8,9,10	C 11,12,13	C 8,9,10	C 14, 15, 16



C1
11:20 am
Most Preferred (MP) Daylight
S001_2011-12-12-112019_c1



C2
11:40 am
MP Daylight, Electric Light to improve
S001_2011-12-12-114018_c1



C3
11:45 am
MP Daylight, Electric to worsen
S001_2011-12-12-114510_c1



C4
10:02 am
Just Uncomfortable (JU) Daylight Glare
S001_2011-12-12-100222_c1



C5
10:22 am
JU Daylight Glare, Electric to improve
S001_2011-12-12-102247_c1



C6
10:32 am
No Daylight Glare, Electric if desired
S001_2011-12-12-103222_c1

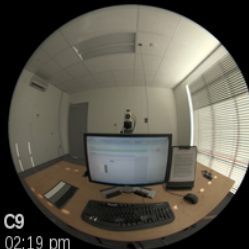


C7
10:42 am
MP Integrated Daylight and Electric
S001_2011-12-12-104239_c1

S001
2011-12-12
F, 60-70 yrs



C8
01:55 pm
MP Daylight
S001_2011-12-12-135539_c1



C9
02:19 pm
Darkest possible
S001_2011-12-12-141905_c1



C10
02:34 pm
JU Daylight Glare
S001_2011-12-12-143406_c1



C11
01:01 pm
MP Integrated Daylight and Electric
S001_2011-12-12-130118_c1



C12
01:17 pm
Electric same C11, Darkest Daylight
S001_2011-12-12-131709_c1



C13
01:29 pm
Electric same C11, JU Daylight Glare
S001_2011-12-12-132943_c1



C14
02:57 pm
MP Integrated Daylight and Electric
S001_2011-12-12-145709_c1



C15
03:12 pm
MP Daylight, Electric too dim (or off)
S001_2011-12-12-151214_c1

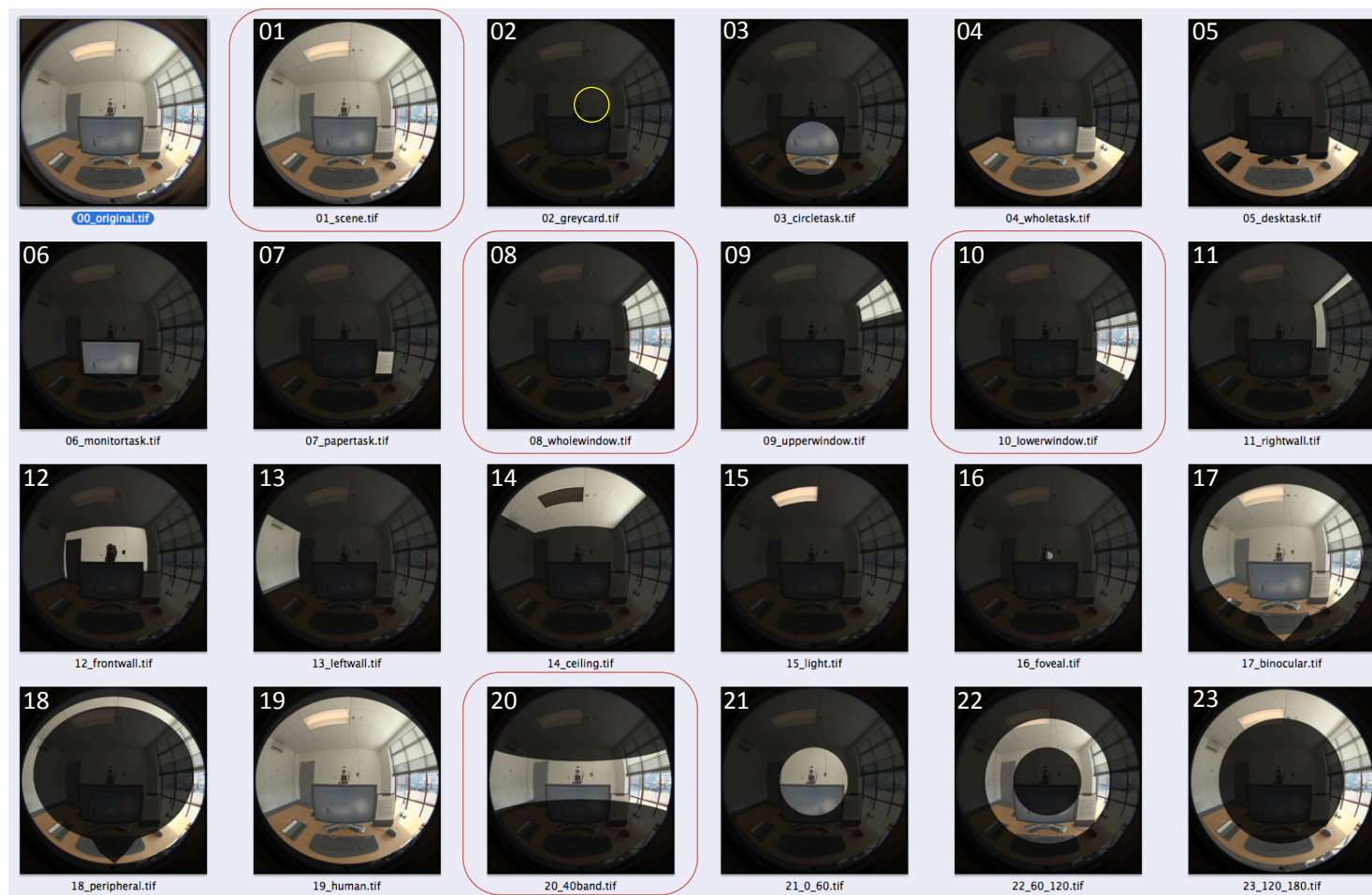


C16
03:19 pm
MP Daylight, Electric too bright
S001_2011-12-12-151914_c1

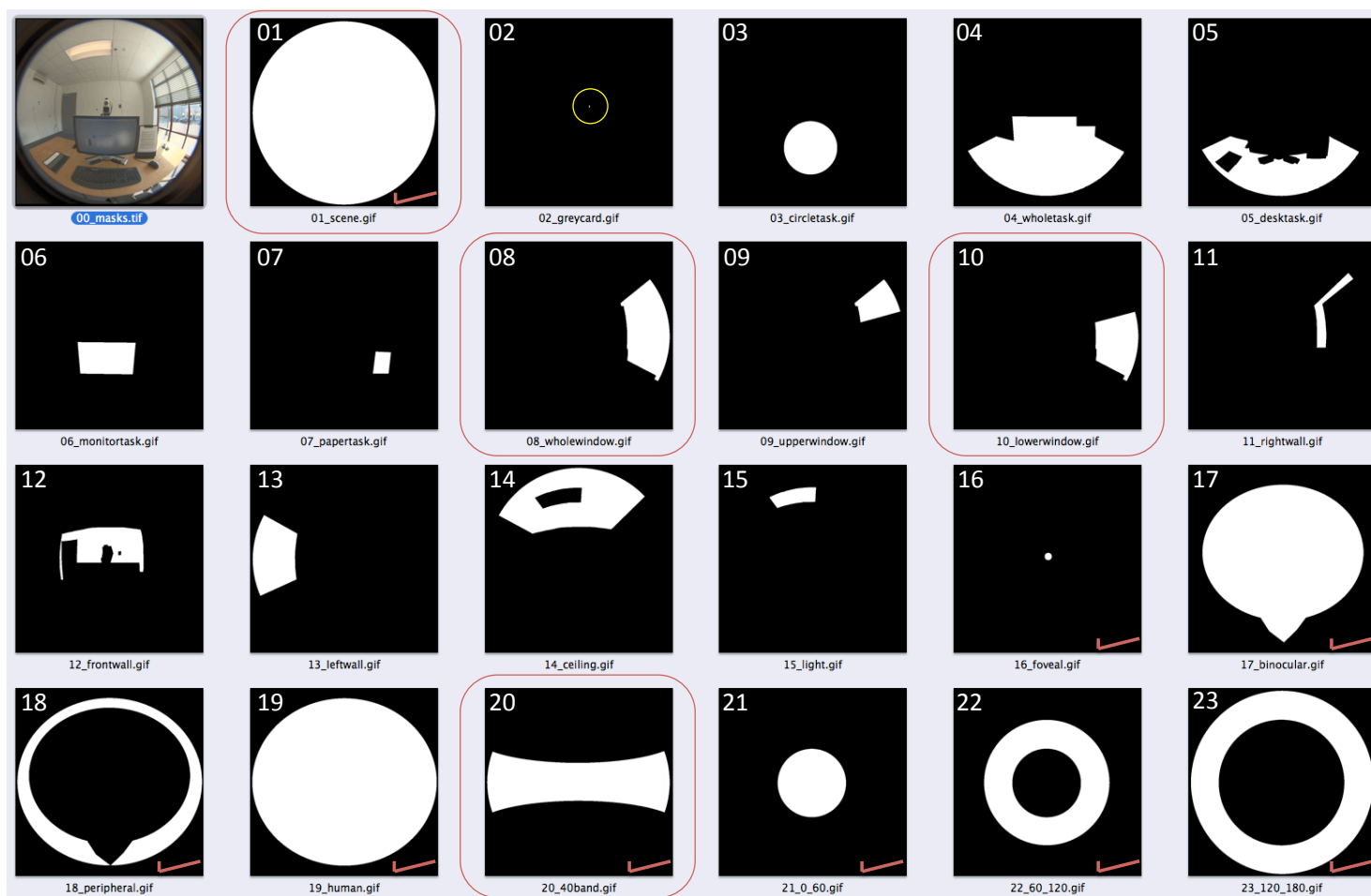
Questionnaire items

- **Rate the following statements using the scale provided (7-point Likert type, Very Strongly Agree=7)**
 - **QU1** - *This is a visually comfortable environment for office work.*
 - **QU2** - *I am pleased with the visual appearance of the office*
 - **QU3** - *I like the vertical surface brightness*
 - **QU4** - *I am satisfied with the amount of light for computer work*
 - **QU5** - *I am satisfied with the amount of light for paper based reading work*
 - **QU6** - *The computer screen is legible and does not have reflections*
 - **QU7** - *The lighting is distributed well*
- **Rate the following using the scale from Too Bright – Too Dim provided**
 - **front_scene** - *When I look up from my desk does the scene I see in front of me seems:*
 - **left_scene** - *When I look to my left the scene that I see seems:*
 - **right_scene** - *When I look to my right the scene that I see seems:*
 - **ceiling** - *I find the ceiling to be:*
- **Rate the following using the scale from Least Preferred – Most Preferred** (this item was only completed for Conditions 09, 10, 12, 13, 15, and 16).
 - **light_in_scene** - *I find this lighting condition to be:*
- **Estimate how you think your personal productivity increased or decreased working under the present lighting conditions**
(this item was not asked for the first condition of each day).
-30%, -20%, -10%, 0%, +10%, +20%, +30%
- **Rate your level of fatigue using the scale provided.**

Scene masks



Scene masks







✓ Scene-independent

Luminance metrics (per mask)

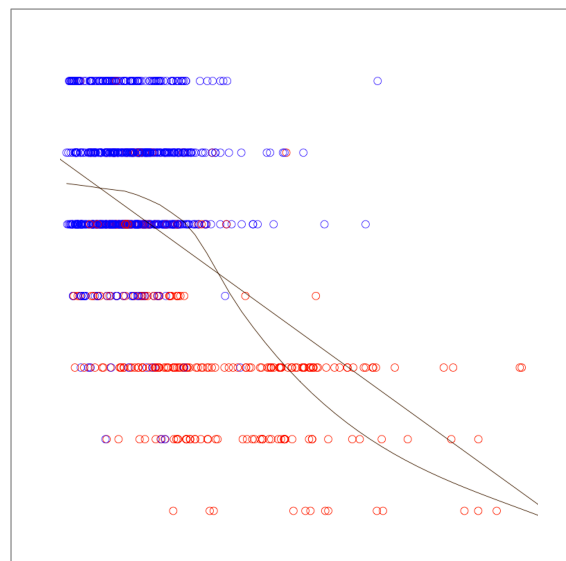
For each mask:

- minimum, maximum, mean, standard deviation, coefficient of variation (std.dev/mean)
- several percentiles (2nd, 10th, 50th, 75th, 90th, 98th)
 - ratios of these (e.g. 2nd percentile : 98th percentile)
- percentage of scene pixels above or below certain absolute luminance thresholds
 - below 5, 10, 40, 50, 100, 250, 500, 1000 cd/m²
 - above 1500, 2000, 2500, 3000, 4000, 5000 cd/m²
 - ratios of these (e.g. % below 5 cd/m² : 5000 cd/m²)
- glare indices
 - From Evalglare - DGP, DGI, VCP, UGR, CIE Glare Index (CGI), and the average luminance of the glare sources identified
 - glare source identification
 - mean luminance multipliers (3*mean, 5*mean, 7*mean, 10*mean)
 - absolute luminance values (1500, 2000, 2500, 3000, 4000, 5000 cd/m²)
 - From *findglare-glarendx* – DGI
 - glare source identification
 - mean luminance multipliers (7*mean)
 - absolute luminance values (1500, 2000, 2500, 3000, 4000, 5000 cd/m²)

Luminance metrics (between masks)

Mean	Mean	Luminance Ratios	Luminance Contrast Ratios
		$X03_{\bar{x}} : X01_{\bar{x}} ; (X03_mean_to_X01_mean)$	$\frac{X01_{\bar{x}} - X03_{\bar{x}}}{X01_{\bar{x}}}$
		$X21_{\bar{x}} : X01_{\bar{x}} ; (X21_mean_to_X01_mean)$	$(X01_to_03_contrast)$
		$X21_{\bar{x}} : X22_{\bar{x}} ; (X21_mean_to_X22_mean)$	
		$X21_{\bar{x}} : X23_{\bar{x}} ; (X21_mean_to_X23_mean)$	
		$X21_{\bar{x}} : X01_{\sigma} ;$ $(X21_mean_to_X01_standard_deviation)$	$\frac{X22_{\bar{x}} - X21_{\bar{x}}}{X22_{\bar{x}}}$
		$X21_{\bar{x}} : X23_{\sigma} ;$ $(X21_mean_to_X23_standard_deviation)$	$(X22_to_21_contrast)$
		$X21_{\bar{x}} : X01_{90^{th}} \% ;$ $(X21_mean_to_X01_{90^{th}}\%percentile)$	
		$X21_{\bar{x}} : X01_{98^{th}} \% ;$ $(X21_mean_to_X01_{98^{th}}\%percentile)$	
Where: $X01_{90^{th}}\%$ is the luminance value of the 90 th percentile brightest pixel in mask 01, $X01_{98^{th}}\%$ is the luminance value of the 98 th percentile brightest pixel in mask 01.			

Results





C1
10:43 am
Most Preferred (MP) Daylight
S001_2011-06-29-104358_c1



C2
11:06 am
MP Daylight, Electric Light to improve
S001_2011-06-29-110630_c1



C3
11:13 am
MP Daylight, Electric to worsen
S001_2011-06-29-111315_c1



C4
11:32 am
Just Uncomfortable (JU) Daylight Glare
S001_2011-06-29-113252_c1



C5
11:53 am
JU Daylight Glare, Electric to improve
S001_2011-06-29-115310_c1



C6
12:03 pm
No Daylight Glare, Electric if desired
S001_2011-06-29-120318_c1



C7
12:16 pm
MP Integrated Daylight and Electric
S001_2011-06-29-121624_c1

S001
2011-06-29
F, 60-70 yrs



C8
01:39 pm
MP Daylight
S001_2011-06-29-133900_c1



C9
01:56 pm
Darkest possible
S001_2011-06-29-135602_c1



C10
02:11 pm
JU Daylight Glare
S001_2011-06-29-141133_c1



C11
02:39 pm
MP Integrated Daylight and Electric
S001_2011-06-29-143930_c1



C12
02:55 pm
Electric same C11, Darkest Daylight
S001_2011-06-29-145541_c1



C13
03:08 pm
Electric same C11, JU Daylight Glare
S001_2011-06-29-150850_c1



C14
03:23 pm
MP Integrated Daylight and Electric
S001_2011-06-29-152358_c1



C15
03:39 pm
MP Daylight, Electric too dim (or off)
S001_2011-06-29-153919_c1



C16
03:46 pm
MP Daylight, Electric too bright
S001_2011-06-29-154612_c1



C1
11:20 am
Most Preferred (MP) Daylight
S001_2011-12-12-112019_c1



C2
11:40 am
MP Daylight, Electric Light to improve
S001_2011-12-12-114018_c1



C3
11:45 am
MP Daylight, Electric to worsen
S001_2011-12-12-114510_c1



C4
10:02 am
Just Uncomfortable (JU) Daylight Glare
S001_2011-12-12-100222_c1



C5
10:22 am
JU Daylight Glare, Electric to improve
S001_2011-12-12-102247_c1



C6
10:32 am
No Daylight Glare, Electric if desired
S001_2011-12-12-103222_c1

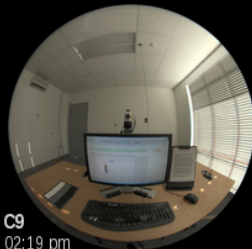


C7
10:42 am
MP Integrated Daylight and Electric
S001_2011-12-12-104239_c1

S001
2011-12-12
F, 60-70 yrs



C8
01:55 pm
MP Daylight
S001_2011-12-12-135539_c1



C9
02:19 pm
Darkest possible
S001_2011-12-12-141905_c1



C10
02:34 pm
JU Daylight Glare
S001_2011-12-12-143406_c1



C11
01:01 pm
MP Integrated Daylight and Electric
S001_2011-12-12-130118_c1



C12
01:17 pm
Electric same C11, Darkest Daylight
S001_2011-12-12-131709_c1



C13
01:29 pm
Electric same C11, JU Daylight Glare
S001_2011-12-12-132943_c1



C14
02:57 pm
MP Integrated Daylight and Electric
S001_2011-12-12-145709_c1



C15
03:12 pm
MP Daylight, Electric too dim (or off)
S001_2011-12-12-151214_c1



C16
03:19 pm
MP Daylight, Electric too bright
S001_2011-12-12-151914_c1



C1
11:17 am
Most Preferred (MP) Daylight
S016_2011-07-28-111736_c1



C2
11:33 am
MP Daylight, Electric Light to improve
S016_2011-07-28-113333_c1



C3
11:38 am
MP Daylight, Electric to worsen
S016_2011-07-28-113841_c1



C4
09:48 am
Just Uncomfortable (JU) Daylight Glare
S016_2011-07-28-094835_c1



C5
10:08 am
JU Daylight Glare, Electric to improve
S016_2011-07-28-100825_c1



C6
10:18 am
No Daylight Glare, Electric if desired
S016_2011-07-28-101835_c1



C7
10:49 am
MP Integrated Daylight and Electric
S016_2011-07-28-104953_c1

S016
2011-07-28
M, 40-49 yrs



C8
02:09 pm
MP Daylight
S016_2011-07-28-140947_c1



C9
02:25 pm
Darkest possible
S016_2011-07-28-142524_c1



C10
02:35 pm
JU Daylight Glare
S016_2011-07-28-143552_c1



C11
03:09 pm
MP Integrated Daylight and Electric
S016_2011-07-28-150951_c1



C12
03:25 pm
Electric same C11, Darkest Daylight
S016_2011-07-28-152525_c1



C13
03:38 pm
Electric same C11, JU Daylight Glare
S016_2011-07-28-153800_c1



C14
01:01 pm
MP Integrated Daylight and Electric
S016_2011-07-28-130142_c1



C15
01:17 pm
MP Daylight, Electric too dim (or off)
S016_2011-07-28-131747_c1



C16
01:24 pm
MP Daylight, Electric too bright
S016_2011-07-28-132406_c1



C1
11:08 am
Most Preferred (MP) Daylight
S016_2011-10-13-110807_c1



C2
11:27 am
MP Daylight, Electric Light to improve
S016_2011-10-13-112758_c1



C3
11:33 am
MP Daylight, Electric to worsen
S016_2011-10-13-113315_c1



C4
09:56 am
Just Uncomfortable (JU) Daylight Glare
S016_2011-10-13-095623_c1



C5
10:18 am
JU Daylight Glare, Electric to improve
S016_2011-10-13-101857_c1



C6
10:30 am
No Daylight Glare, Electric if desired
S016_2011-10-13-103039_c1

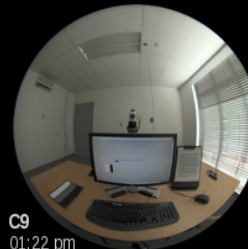


C7
10:37 am
MP Integrated Daylight and Electric
S016_2011-10-13-103758_c1

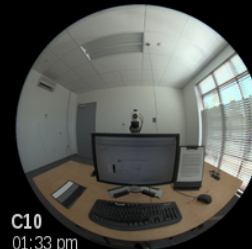
S016
2011-10-13
M, 40-49 yrs



C8
01:05 pm
MP Daylight
S016_2011-10-13-130551_c1



C9
01:22 pm
Darkest possible
S016_2011-10-13-132220_c1



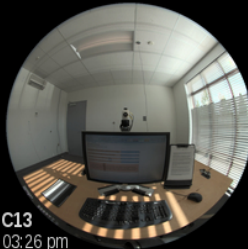
C10
01:33 pm
JU Daylight Glare
S016_2011-10-13-133331_c1



C11
03:01 pm
MP Integrated Daylight and Electric
S016_2011-10-13-150126_c1



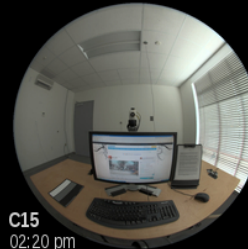
C12
03:16 pm
Electric same C11, Darkest Daylight
S016_2011-10-13-151629_c1



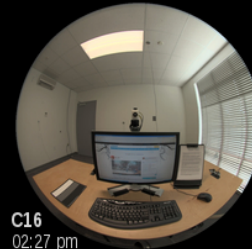
C13
03:26 pm
Electric same C11, JU Daylight Glare
S016_2011-10-13-152629_c1



C14
02:03 pm
MP Integrated Daylight and Electric
S016_2011-10-13-140343_c1



C15
02:20 pm
MP Daylight, Electric too dim (or off)
S016_2011-10-13-142005_c1



C16
02:27 pm
MP Daylight, Electric too bright
S016_2011-10-13-142722_c1



C1
11:06 am
Most Preferred (MP) Daylight
S027_2011-08-20-110625_c1



C2
11:22 am
MP Daylight, Electric Light to improve
S027_2011-08-20-112230_c1



C3
11:29 am
MP Daylight, Electric to worsen
S027_2011-08-20-112901_c1



C4
10:05 am
Just Uncomfortable (JU) Daylight Glare
S027_2011-08-20-100545_c1



C5
10:24 am
JU Daylight Glare, Electric to improve
S027_2011-08-20-102433_c1



C6
10:35 am
No Daylight Glare, Electric if desired
S027_2011-08-20-103511_c1



C7
10:45 am
MP Integrated Daylight and Electric
S027_2011-08-20-104521_c1

S027
2011-08-20
F, 18-19 yrs



C8
02:10 pm
MP Daylight
S027_2011-08-20-141016_c1



C9
02:25 pm
Darkest possible
S027_2011-08-20-142544_c1



C10
02:34 pm
JU Daylight Glare
S027_2011-08-20-143407_c1



C11
03:10 pm
MP Integrated Daylight and Electric
S027_2011-08-20-151022_c1



C12
03:25 pm
Electric same C11, Darkest Daylight
S027_2011-08-20-152510_c1



C13
03:37 pm
Electric same C11, JU Daylight Glare
S027_2011-08-20-153733_c1



C14
01:10 pm
MP Integrated Daylight and Electric
S027_2011-08-20-131039_c1



C15
01:27 pm
MP Daylight, Electric too dim (or off)
S027_2011-08-20-132707_c1



C16
01:34 pm
MP Daylight, Electric too bright
S027_2011-08-20-133450_c1



C1
09:57 am
Most Preferred (MP) Daylight
S027_2011-11-05-095732_c1



C2
10:25 am
MP Daylight, Electric Light to improve
S027_2011-11-05-102540_c1



C3
10:30 am
MP Daylight, Electric to worsen
S027_2011-11-05-103037_c1



C4
11:00 am
Just Uncomfortable (JU) Daylight Glare
S027_2011-11-05-110027_c1



C5
11:21 am
JU Daylight Glare, Electric to improve
S027_2011-11-05-112101_c1



C6
11:28 am
No Daylight Glare, Electric if desired
S027_2011-11-05-112832_c1

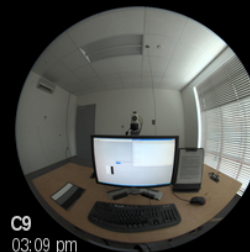


C7
11:36 am
MP Integrated Daylight and Electric
S027_2011-11-05-113633_c1

S027
2011-11-05
F, 18-19 yrs



C8
02:56 pm
MP Daylight
S027_2011-11-05-145619_c1



C9
03:09 pm
Darkest possible
S027_2011-11-05-150935_c1



C10
03:29 pm
JU Daylight Glare
S027_2011-11-05-152915_c1



C11
02:06 pm
MP Integrated Daylight and Electric
S027_2011-11-05-140655_c1



C12
02:21 pm
Electric same C11, Darkest Daylight
S027_2011-11-05-142117_c1



C13
02:33 pm
Electric same C11, JU Daylight Glare
S027_2011-11-05-143336_c1



C14
01:09 pm
MP Integrated Daylight and Electric
S027_2011-11-05-130939_c1

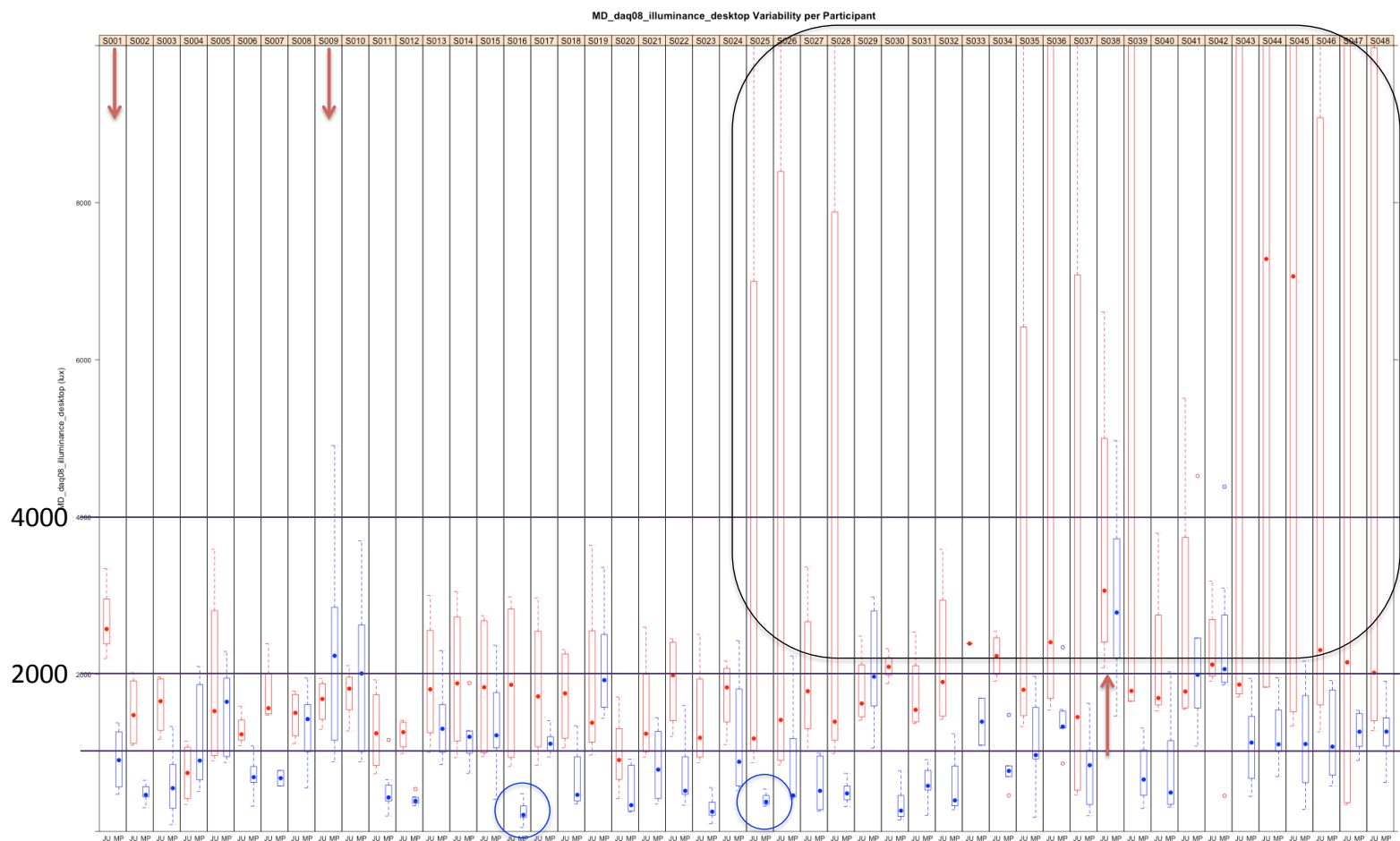
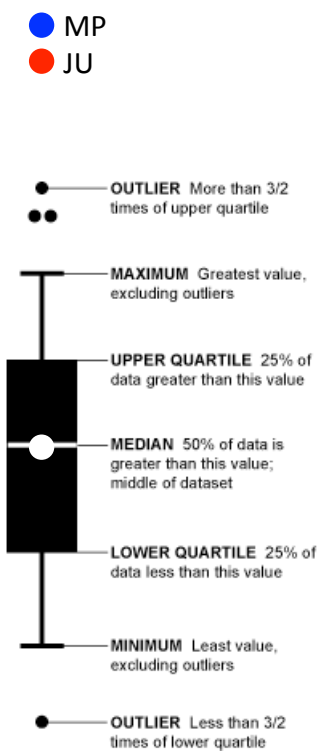


C15
01:25 pm
MP Daylight, Electric too dim (or off)
S027_2011-11-05-132501_c1



C16
01:32 pm
MP Daylight, Electric too bright
S027_2011-11-05-133211_c1

Variability $E_{desktop}$



Variability Lum-ratio



● MP
● JU

● OUTLIER More than 3/2 times of upper quartile

— MAXIMUM Greatest value, excluding outliers

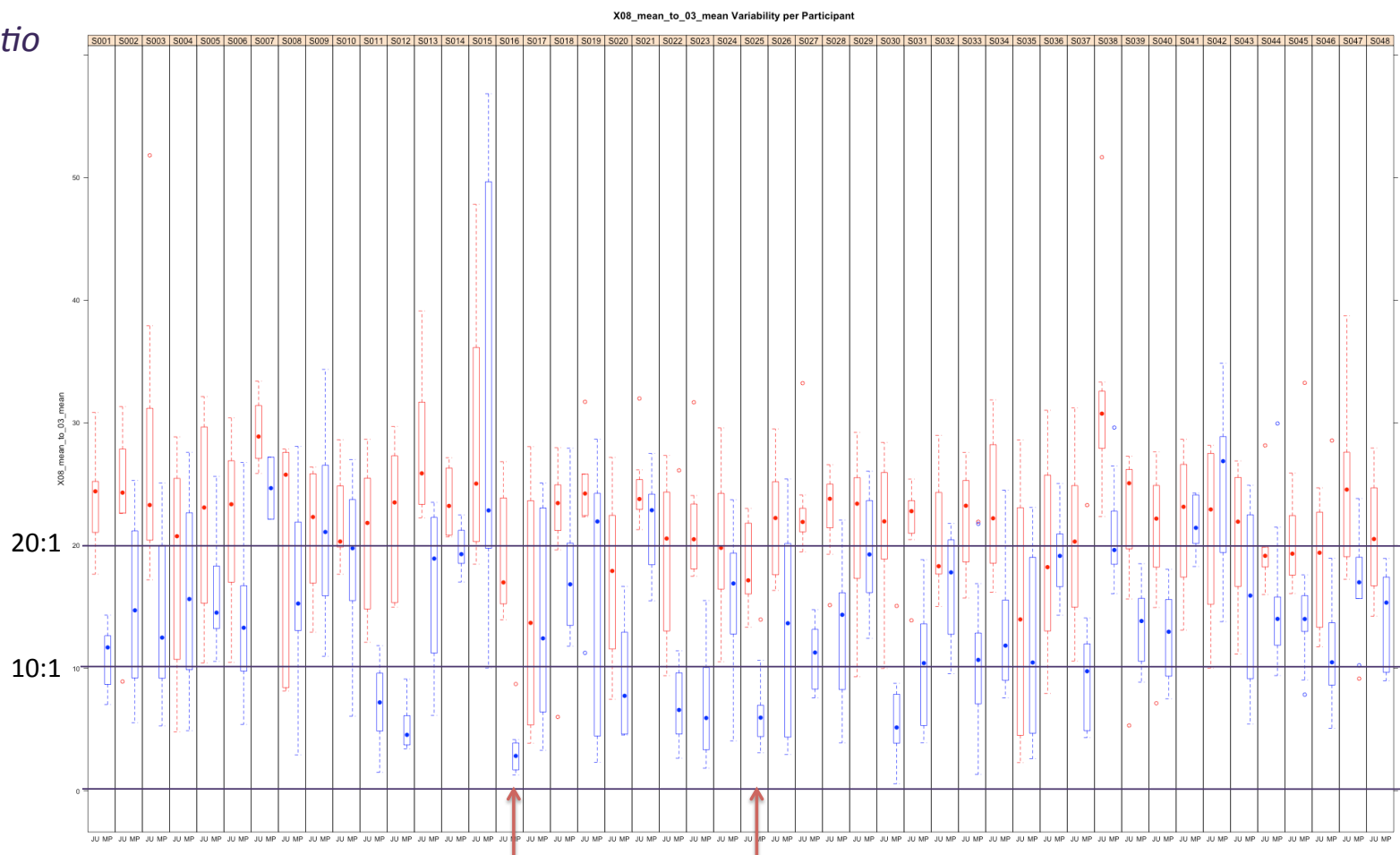
— UPPER QUARTILE 25% of data greater than this value

● MEDIAN 50% of data is greater than this value; middle of dataset

— LOWER QUARTILE 25% of data less than this value

— MINIMUM Least value, excluding outliers

● OUTLIER Less than 3/2 times of lower quartile



Friedman test of differences (conditions by question)

MP
JU

Cond.	QU1*	QU1**	Cond.	QU2*	QU2**	Cond.	QU3*	QU3**
C7	650.5	b	C7	642.5	b	C7	626	b
C11	647	b	C11	630.5	b	C11	617.5	b
C14	612	bc	C14	626	b	C14	600	bc
C2	565.5	cd	C2	588.5	bc	C2	563.5	bcd
C1	557	d	C1	555	cd	C1	538.5	cde
C8	544.5	d	C6	527	d	C8	522	de
C6	530	d	C8	510.5	d	C6	497.5	e
C15	399	e	C15	412.5	e	C15	391	f
C12	365	ef	C5	386	e	C5	373	f
C5	365	ef	C4	324.5	f	C4	333.5	fg
C4	329	f	C12	308	fg	C12	287.5	gh
C9	249	g	C16	257.5	gh	C16	265.5	hi
C16	240.5	g	C9	240	hi	C3	252	hi
C3	175	h	C13	193.5	ij	C13	246	hi
C13	161.5	h	C3	177.5	j	C10	214	i
C10	146.5	h	C10	157.5	j	C9	209.5	i

(Continued)

Cond.	QU4*	QU4**	Cond.	QU5*	QU5**	Cond.	QU6*	QU6**	Cond.	QU7*	QU7**	Cond.	right_scene*	right_scene**
C7	615.5	b	C14	629.5	b	C1	588.5	b	C11	632	b	C13	705	b
C11	608.5	b	C11	618.5	b	C7	580.5	b	C14	599.5	bc	C10	697	b
C14	608	b	C2	600.5	b	C11	559	b	C7	589.5	bc	C4	571.5	c
C2	576.5	bc	C7	594.5	b	C2	545	bc	C2	578.5	bc	C5	553	c
C1	544.5	cd	C1	499.5	c	C14	531.5	bed	C6	553.5	c	C16	486	d
C6	531	cd	C6	491.5	c	C6	486	cde	C1	540	cd	C3	408.5	e
C8	494.5	d	C8	455	cd	C8	483	de	C8	490.5	d	C2	390.5	ef
C15	398.5	e	C5	426.5	d	C12	441.5	ef	C15	400	e	C8	372	ef
C12	388.5	e	C16	353	e	C15	441	ef	C5	380	ef	C1	361	efg
C5	387	e	C4	331.5	e	C9	420.5	fg	C12	363.5	ef	C14	359	efg
C4	318	f	C15	331	e	C4	365	gh	C4	335.5	fg	C15	352.5	efg
C9	285	fg	C12	316	ef	C5	322	h	C9	277.5	gh	C6	349	fg
C16	252.5	g	C13	265.5	fg	C3	242.5	i	C16	235.5	hi	C11	336.5	fg
C3	189	h	C3	254	fg	C16	220.5	ij	C3	217	ij	C7	312	g
C13	180.5	h	C10	202.5	gh	C10	168.5	jk	C13	181	ij	C12	169.5	h
C10	159.5	h	C9	168	h	C13	142	k	C10	163.5	j	C9	114	h

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 QU6 - The computer screen is legible and does not have reflections

QU7 - The lighting is distributed well
 right_scene - When I look to my right the scene that I see seems: (too dim - too bright)

Pearson (r^2) top 20 for right_scene (composite data set)



Rank	Top 20 Metrics (ordered by right_scene)	QU1	QU2	QU3	QU4	QU5	QU6	QU7	Likert_all	front_scene	left_scene	right_scene	ceiling	light_in_scene
→ 1	X08_standard_deviation	0.2983	0.2543	0.1635	0.3019	0.1495	0.2809	0.2322	0.2875	0.0908	0.0721	0.4252	0.1133	0.0646
→ 2	X10_25th_percentile	0.2713	0.2240	0.1410	0.2887	0.1334	0.2690	0.2178	0.2636	0.1243	0.1004	0.3890	0.0790	0.0770
→ 3	X10_50th_percentile	0.2447	0.1921	0.1256	0.2511	0.1149	0.2239	0.1853	0.2283	0.1452	0.1034	0.3697	0.0616	0.0847
→ 4	X08_25th_percentile	0.2570	0.2233	0.1590	0.2874	0.1304	0.2877	0.2163	0.2662	0.1130	0.1127	0.3589	0.1009	0.0418
→ 5	X08_mean	0.2411	0.1931	0.1280	0.2502	0.1165	0.2367	0.1777	0.2291	0.1132	0.0917	0.3401	0.0769	0.0790
→ 6	X20_mean	0.2436	0.1939	0.1301	0.2518	0.1130	0.2358	0.1892	0.2315	0.1247	0.1098	0.3312	0.0670	0.0793
7	X13_75th_percentile	0.2421	0.2080	0.1564	0.2630	0.1224	0.2698	0.2070	0.2506	0.1233	0.1715	0.3242	0.1028	0.0934
8	X14_10th_percentile	0.2261	0.1916	0.1347	0.2486	0.1079	0.2535	0.1849	0.2293	0.1177	0.1444	0.3214	0.0988	0.1051
→ 9	X10_10th_percentile	0.2406	0.2066	0.1237	0.2573	0.1355	0.2494	0.2092	0.2431	0.0802	0.0718	0.3199	0.0763	0.0440
→ 10	X20_percent_below_1000_cd	0.2149	0.1594	0.1130	0.2276	0.0913	0.2031	0.1560	0.1982	0.1341	0.1067	0.3185	0.0517	0.1140
11	X23_50th_percentile	0.2306	0.1995	0.1431	0.2549	0.1098	0.2682	0.1952	0.2384	0.1046	0.1356	0.3147	0.1005	0.0782
→ 12	X20_75th_percentile	0.2299	0.1907	0.1348	0.2539	0.1076	0.2687	0.1898	0.2336	0.1189	0.1399	0.3135	0.0924	0.0814
13	X14_25th_percentile	0.2188	0.1855	0.1315	0.2417	0.1049	0.2494	0.1802	0.2232	0.1074	0.1399	0.3097	0.0938	0.0847
→ 14	X20_25th_percentile	0.2250	0.1883	0.1302	0.2474	0.1082	0.2672	0.1914	0.2307	0.1026	0.1262	0.3084	0.1064	0.0738
15	X14_2nd_percentile	0.2131	0.1806	0.1249	0.2355	0.1002	0.2407	0.1736	0.2157	0.1116	0.1361	0.3073	0.0937	0.1025
→ 16	X20_90th_percentile	0.2122	0.1592	0.1076	0.2175	0.0896	0.2026	0.1527	0.1941	0.1516	0.1122	0.3052	0.0517	0.0695
17	X18_50th_percentile	0.2311	0.2026	0.1457	0.2518	0.1118	0.2716	0.1994	0.2407	0.0946	0.1221	0.3043	0.0970	0.0594
→ 18	X20_50th_percentile	0.2106	0.1787	0.1291	0.2355	0.0990	0.2467	0.1760	0.2168	0.1107	0.1415	0.2999	0.1014	0.0907
19	X19_25th_percentile	0.2157	0.1889	0.1326	0.2420	0.1007	0.2695	0.1862	0.2265	0.0964	0.1218	0.2993	0.1126	0.0767
→ 20	X08_50th_percentile	0.2036	0.1604	0.1233	0.2209	0.0914	0.2145	0.1548	0.1989	0.1365	0.1078	0.2991	0.0723	0.0461

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 QU6 - The computer screen is legible and does not have reflections
 QU7 - The lighting is distributed well

front_scene – When I look up from my desk does the scene I see in front of me seems: (too dim - too bright)
left_scene – When I look to my left the scene that I see seems: (too dim - too bright)
right_scene – When I look to my right the scene that I see seems: (too dim - too bright); this direct included the window
ceiling – I find the ceiling to be: (too dim - too bright)
light_in_scene - I find this lighting condition to be: (least preferred – most preferred), [C09,C10, C12, C13, C15, C16 only]

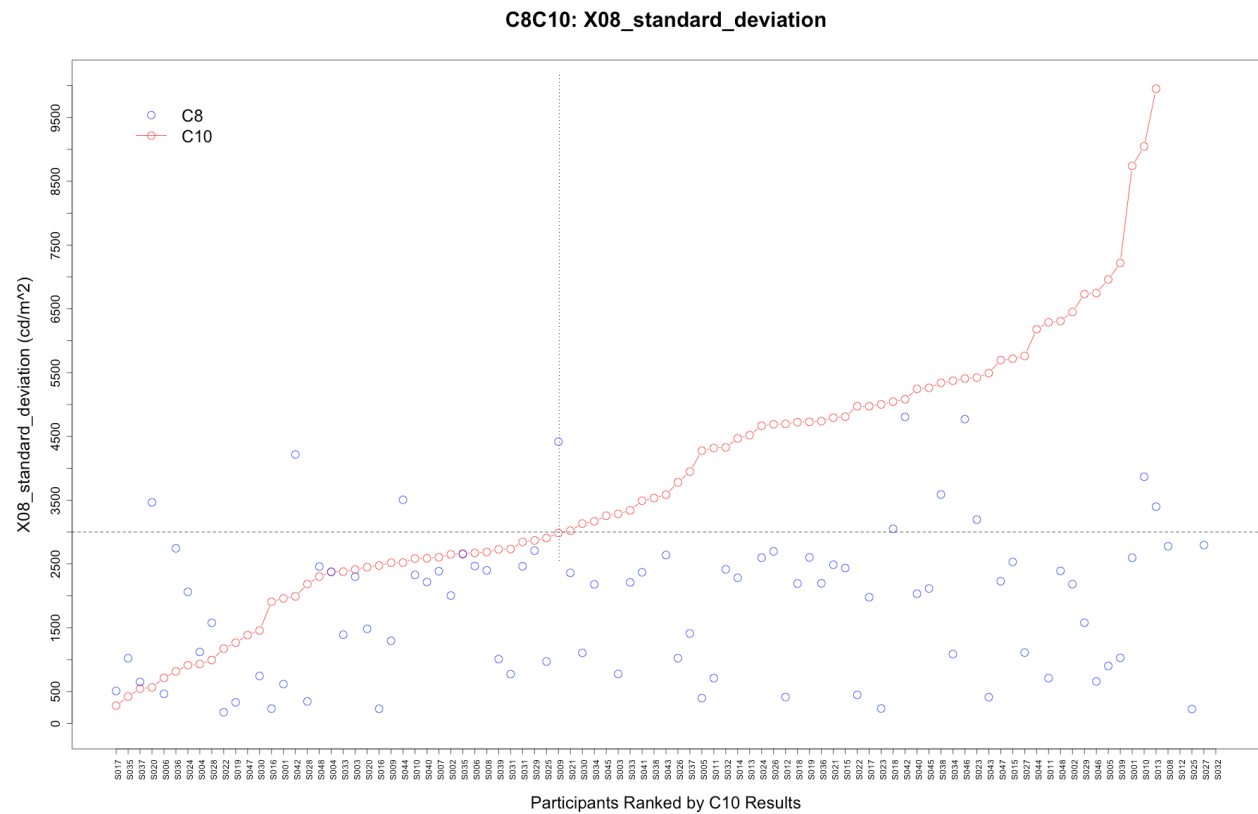
Pearson (r^2)
other selected metrics

Rank	Other metrics of interest (by right_scene)	QU1	QU2	QU3	QU4	QU5	QU6	QU7	Likert_all	front_scene	left_scene	right_scene	ceiling	light_in_scene
21	MD_daq02_illuminance_topFF406 (E _v)	0.2389	0.2004	0.1500	0.2602	0.1182	0.2833	0.2132	0.2496	0.1044	0.1308	0.2982	0.0909	0.0494
→ 58	X03_evalglare_mL0005_dgp	0.1983	0.1632	0.1079	0.2156	0.0931	0.2257	0.1667	0.1989	0.0772	0.0861	0.2808	0.0703	0.0572
59	X20_standard_deviation	0.2107	0.1713	0.1155	0.2095	0.0976	0.1851	0.1694	0.1982	0.0757	0.0582	0.2805	0.0464	0.0164
68	X01_evalglare_mL0005_dgp	0.1832	0.1510	0.1011	0.2010	0.0879	0.2109	0.1564	0.1855	0.0748	0.0859	0.2783	0.0740	0.0786
69	X01_mean	0.2001	0.1718	0.1152	0.2230	0.0968	0.2431	0.1681	0.2068	0.0852	0.1035	0.2780	0.0946	0.0645
91	X01_standard_deviation	0.2017	0.1793	0.1135	0.2185	0.1040	0.2231	0.1736	0.2070	0.0588	0.0595	0.2755	0.0894	0.0627
129	daq01_illuminance_topcanon	0.2068	0.1700	0.1210	0.2351	0.0968	0.2633	0.1814	0.2161	0.0846	0.1031	0.2667	0.1175	0.0102
162	X01_evalglare_mL0005_lum_sources	0.1945	0.1692	0.1061	0.2099	0.0994	0.2222	0.1623	0.1981	0.0666	0.0741	0.2596	0.0956	0.0527
164	X20_percent_above_2000_cd	0.1638	0.1206	0.0818	0.1618	0.0648	0.1460	0.1027	0.1429	0.1257	0.0966	0.2574	0.0447	0.1149
193	X01_brightest_10percent	0.1749	0.1500	0.0956	0.1932	0.0868	0.2089	0.1449	0.1791	0.0681	0.0762	0.2410	0.0785	0.0495
244	X01_98th_percentile	0.1643	0.1382	0.0861	0.1782	0.0795	0.1820	0.1313	0.1632	0.0816	0.0796	0.2208	0.0632	0.0572
256	X01_percent_above_2000_cd	0.1516	0.1202	0.0820	0.1623	0.0598	0.1886	0.1126	0.1477	0.0897	0.0880	0.2138	0.0763	0.0553
309	X08_percent_above_2000_cd	0.1243	0.0840	0.0605	0.1299	0.0428	0.1232	0.0725	0.1072	0.1006	0.0720	0.1920	0.0367	0.0676
→ 340	X01_findglare_dgi_th0500	0.1251	0.0927	0.0654	0.1383	0.0455	0.1401	0.0919	0.1182	0.0905	0.0670	0.1784	0.0480	0.0687
404	SW_vert_irradiance_adjusted	0.1070	0.1003	0.0669	0.1321	0.0608	0.1447	0.1058	0.1217	0.0380	0.0704	0.1487	0.0514	0.0078
→ 408	X08_mean_to_03_mean	0.0914	0.0581	0.0403	0.0963	0.0324	0.0682	0.0498	0.0736	0.0610	0.0281	0.1454	0.0156	0.0051
→ 445	daq08_illuminance_desktop	0.1070	0.1132	0.0859	0.1178	0.1282	0.1136	0.1347	0.1369	0.0095	0.0198	0.1133	0.0183	0.0005
466	X21_mean_to_01_mean	0.0902	0.0751	0.0559	0.0926	0.0302	0.0998	0.0790	0.0883	0.0334	0.0298	0.0968	0.0410	0.0092
467	daq04_illuminance_topmonitor	0.0789	0.0755	0.0491	0.0867	0.0431	0.1194	0.0745	0.0892	0.0460	0.0524	0.0961	0.0739	0.0494
483	X21_mean_to_23_mean	0.0881	0.0734	0.0564	0.0872	0.0298	0.0907	0.0771	0.0851	0.0295	0.0249	0.0898	0.0375	0.0088
485	X01_percent_below_30_cd	0.0515	0.0423	0.0348	0.0785	0.0172	0.1057	0.0444	0.0607	0.0424	0.0517	0.0877	0.0350	0.0174
490	X12_mean_to_03_mean	0.0508	0.0334	0.0287	0.0681	0.0112	0.0636	0.0311	0.0469	0.0556	0.0583	0.0857	0.0253	0.0002
499	X22_to_21_contrast	0.0653	0.0526	0.0403	0.0793	0.0184	0.1007	0.0560	0.0681	0.0410	0.0411	0.0821	0.0364	0.0167
500	X21_mean_to_22_mean	0.0653	0.0526	0.0403	0.0793	0.0184	0.1007	0.0560	0.0681	0.0410	0.0411	0.0821	0.0364	0.0167
503	X01_to_03_contrast	0.0580	0.0424	0.0391	0.0762	0.0141	0.0854	0.0448	0.0591	0.0466	0.0415	0.0814	0.0276	0.0000
504	X03_mean_to_01_mean	0.0580	0.0424	0.0391	0.0762	0.0141	0.0854	0.0448	0.0591	0.0466	0.0415	0.0814	0.0276	0.0000
528	X21_mean_to_23_standard_deviation	0.0742	0.0635	0.0506	0.0609	0.0315	0.0547	0.0613	0.0679	0.0083	0.0042	0.0639	0.0244	0.0226
529	X21_mean_to_01_standard_deviation	0.0740	0.0630	0.0515	0.0625	0.0326	0.0559	0.0605	0.0685	0.0080	0.0030	0.0633	0.0221	0.0221
532	X21_mean_to_01_90th_percentile	0.0335	0.0308	0.0231	0.0492	0.0077	0.0597	0.0344	0.0388	0.0334	0.0447	0.0621	0.0330	0.0095
535	X01_findglare_dgi_default	0.0456	0.0278	0.0188	0.0427	0.0151	0.0315	0.0235	0.0346	0.0240	0.0053	0.0583	0.0011	0.0045
563	X01_cov	0.0509	0.0504	0.0298	0.0382	0.0324	0.0306	0.0497	0.0484	0.0000	0.0003	0.0430	0.0171	0.0044
595	X21_mean_to_01_98th_percentile	0.0473	0.0368	0.0273	0.0402	0.0131	0.0370	0.0373	0.0405	0.0196	0.0038	0.0303	0.0082	0.0203
616	X08_mean_to_12_mean	0.0283	0.0178	0.0128	0.0175	0.0192	0.0047	0.0154	0.0192	0.0034	0.0032	0.0267	0.0009	0.0000
QU1 - This is a visually comfortable environment for office work QU2 - I am pleased with the visual appearance of the office QU3 - I like the vertical surface brightness QU4 - I am satisfied with the amount of light for computer work QU5 - I am satisfied with the amount of light for paper-based reading work QU6 - The computer screen is legible and does not have reflections QU7 - The lighting is distributed well										front_scene – When I look up from my desk does the scene I see in front of me seems: (too dim - too bright) left_scene – When I look to my left the scene that I see seems: (too dim - too bright) right_scene – When I look to my right the scene that I see seems: (too dim - too bright); this direct included the window ceiling – I find the ceiling to be: (too dim - too bright) light_in_scene - I find this lighting condition to be: (least preferred – most preferred), [C09,C10, C12, C13, C15, C16 only]				

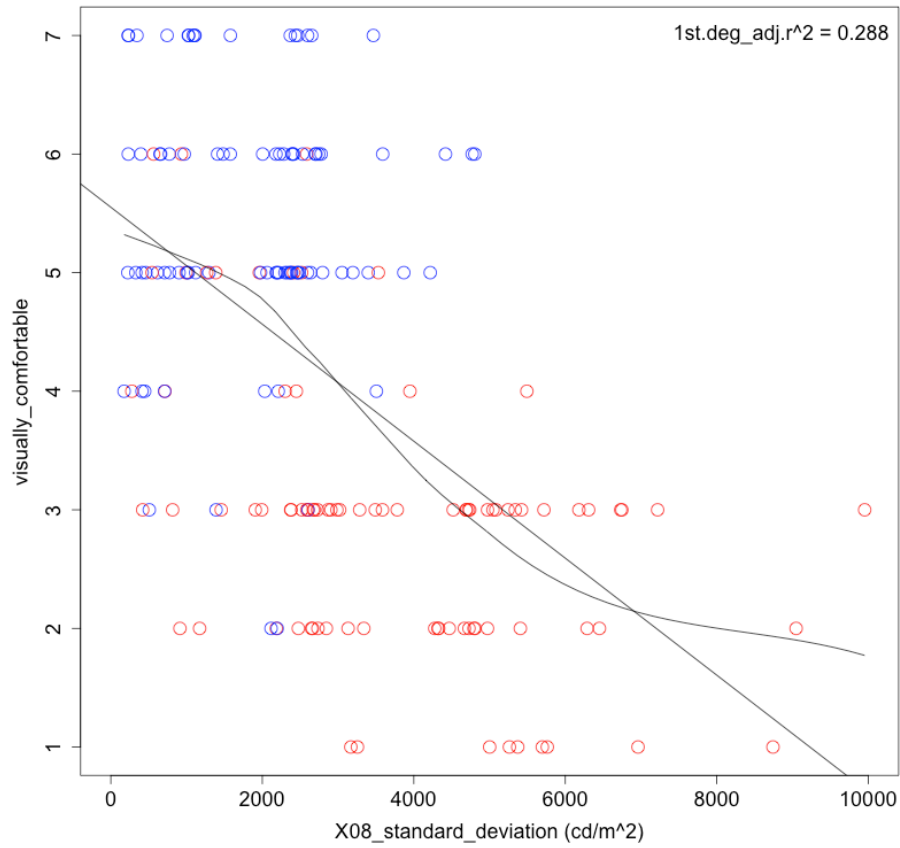
Standard deviation of window luminance (X08)



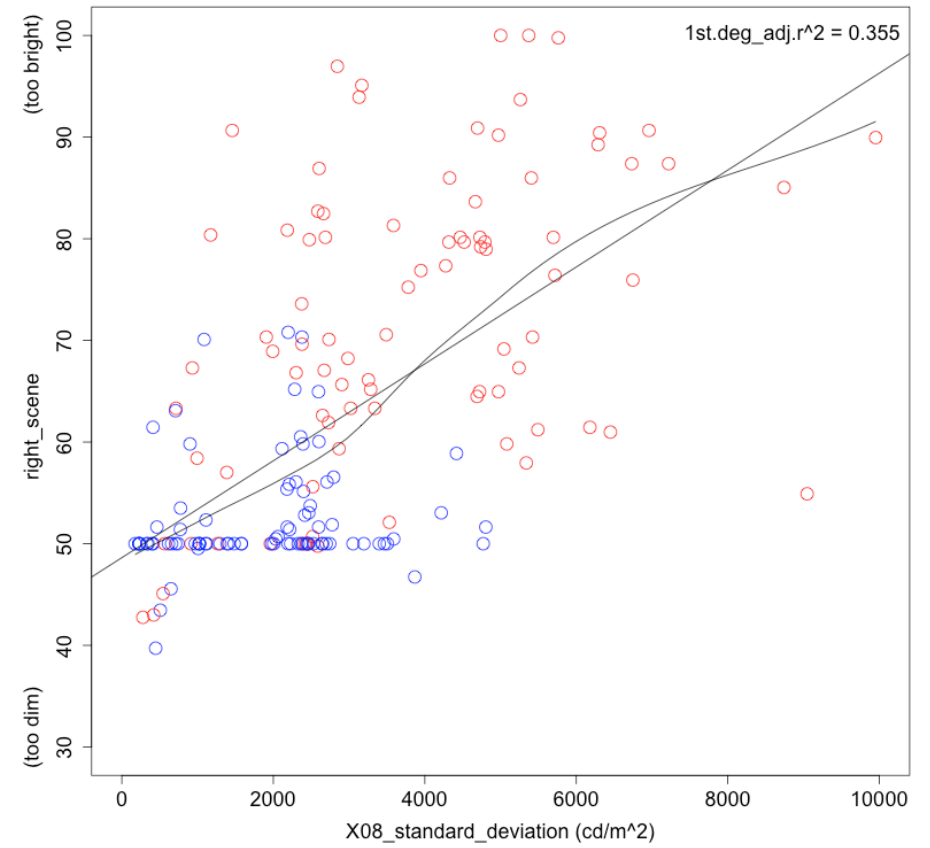
C8C10: X08_standard_deviation (cd/m ²)				
DV	adjR ²	F-statistic:	DF	p-value
C8C10				
QU1	0.2880	70.98	172	1.39E-14
right_scene	0.3553	96.32	172	2.20E-16
Composite_data_set				
QU1	0.2667	314.10	860	2.20E-16
right_scene	0.3834	536.40	860	2.20E-16
C8C10Computer_split53				
QU1	0.3108	59.18	128	3.36E-12
right_scene	0.3526	71.26	128	5.81E-14
Composite_data_set_Computer_split53				
QU1	0.2973	293.40	690	2.20E-16
right_scene	0.4244	510.40	690	2.20E-16



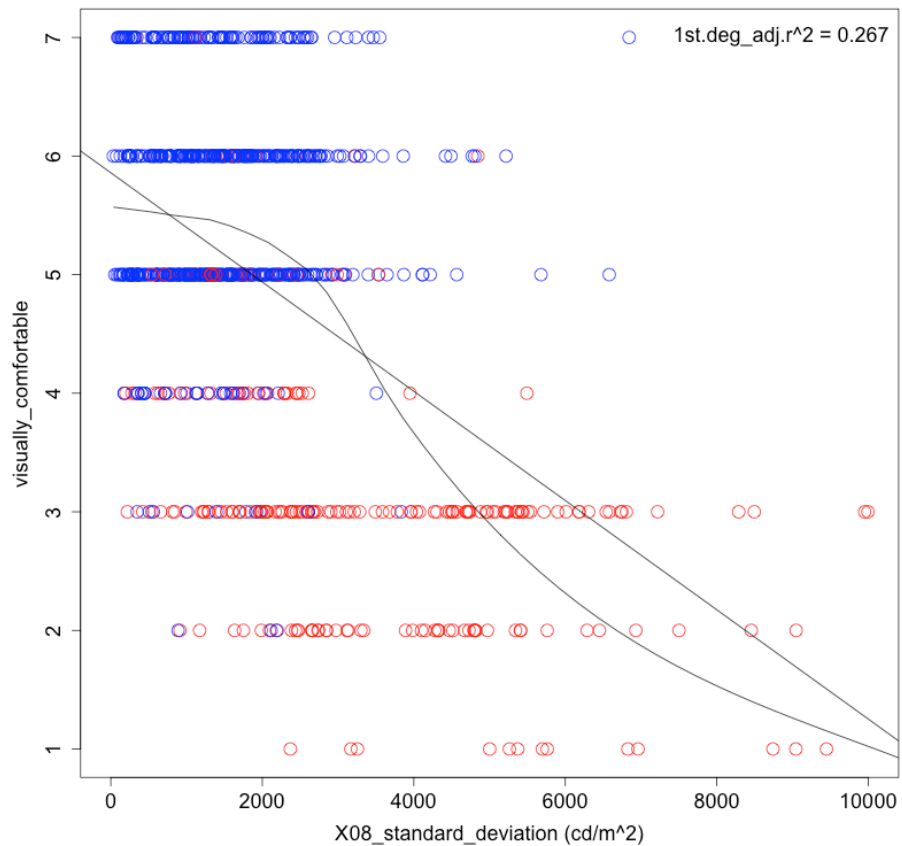
C8C10: visually_comfortable VS X08_standard_deviation



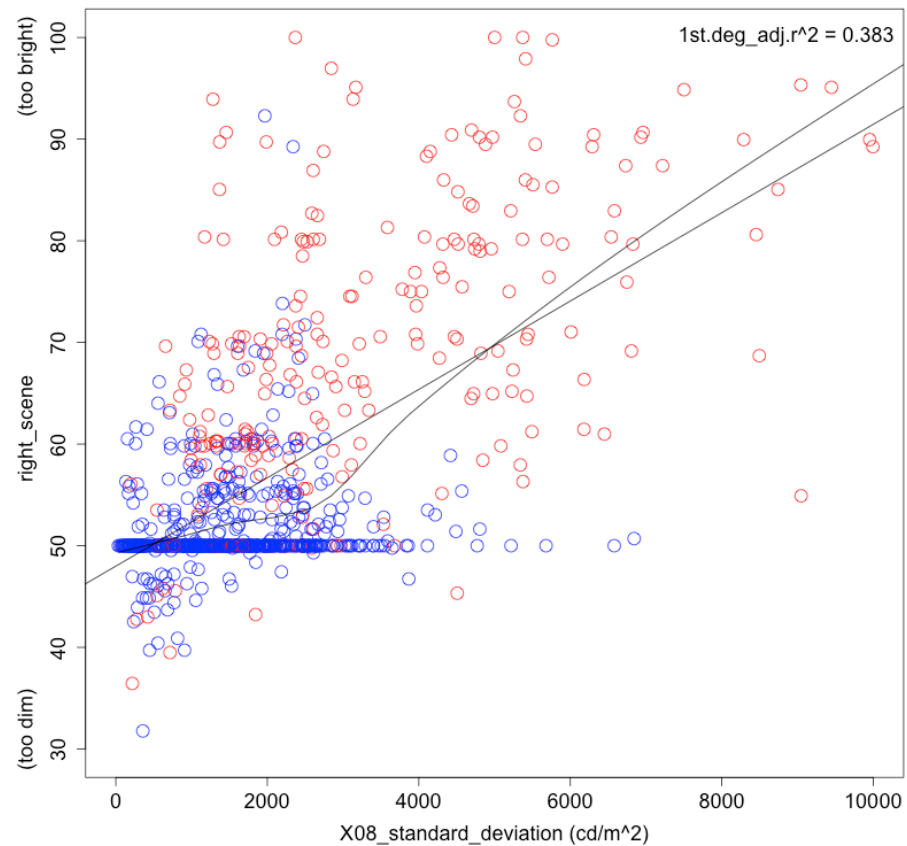
C8C10: right_scene VS X08_standard_deviation



C1C2C4C6C7C8C10C11C13C14: visually_comfortable VS X08_standard_deviation

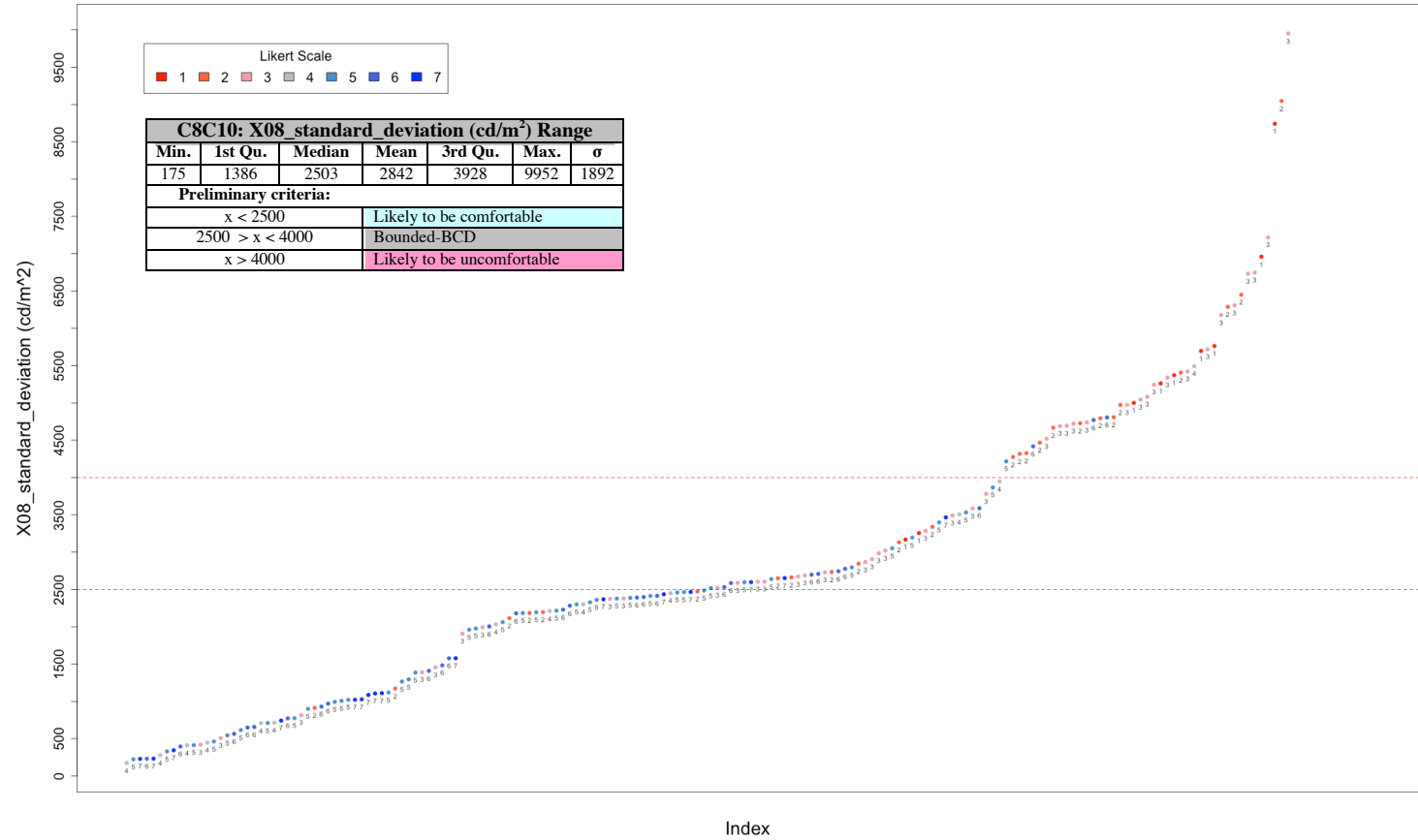


C1C2C4C6C7C8C10C11C13C14: right_scene VS X08_standard_deviation





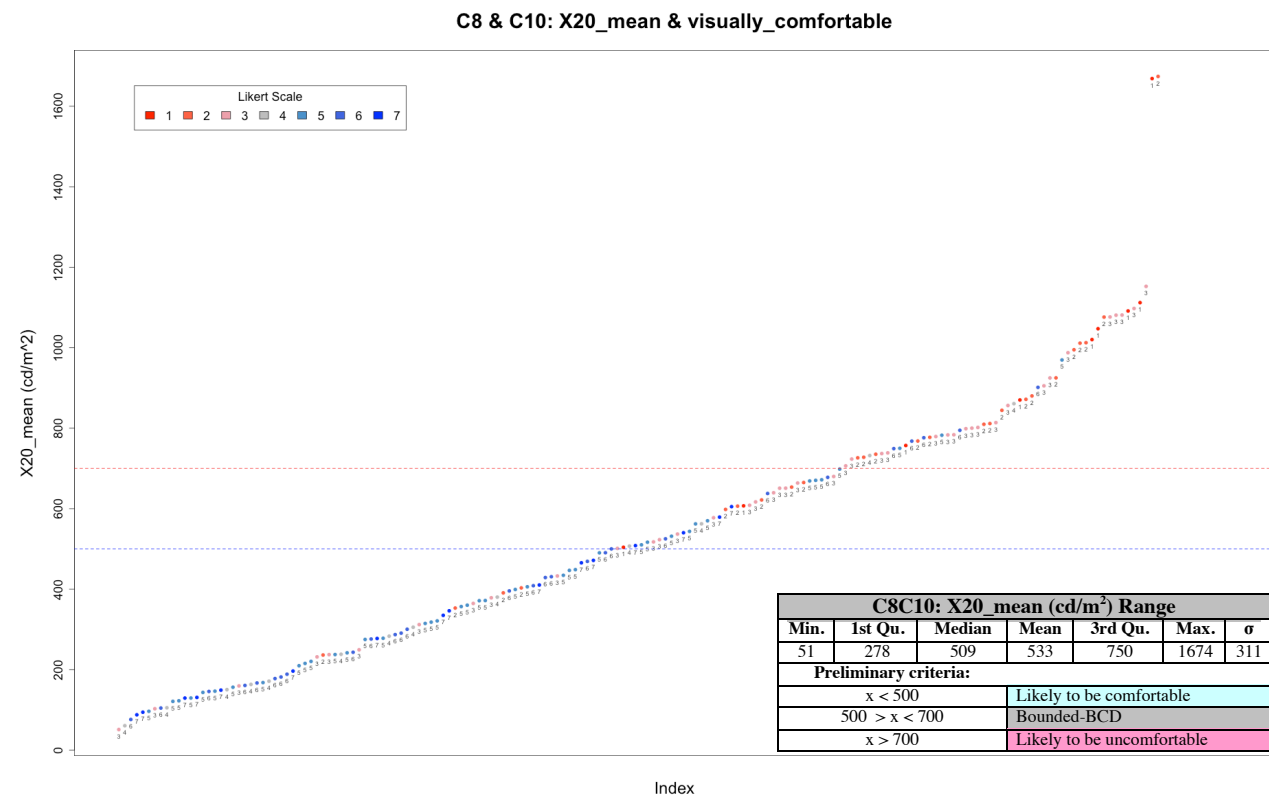
C8 & C10: X08_standard_deviation & visually_comfortable



Mean luminance of 40° horizontal band (X20)



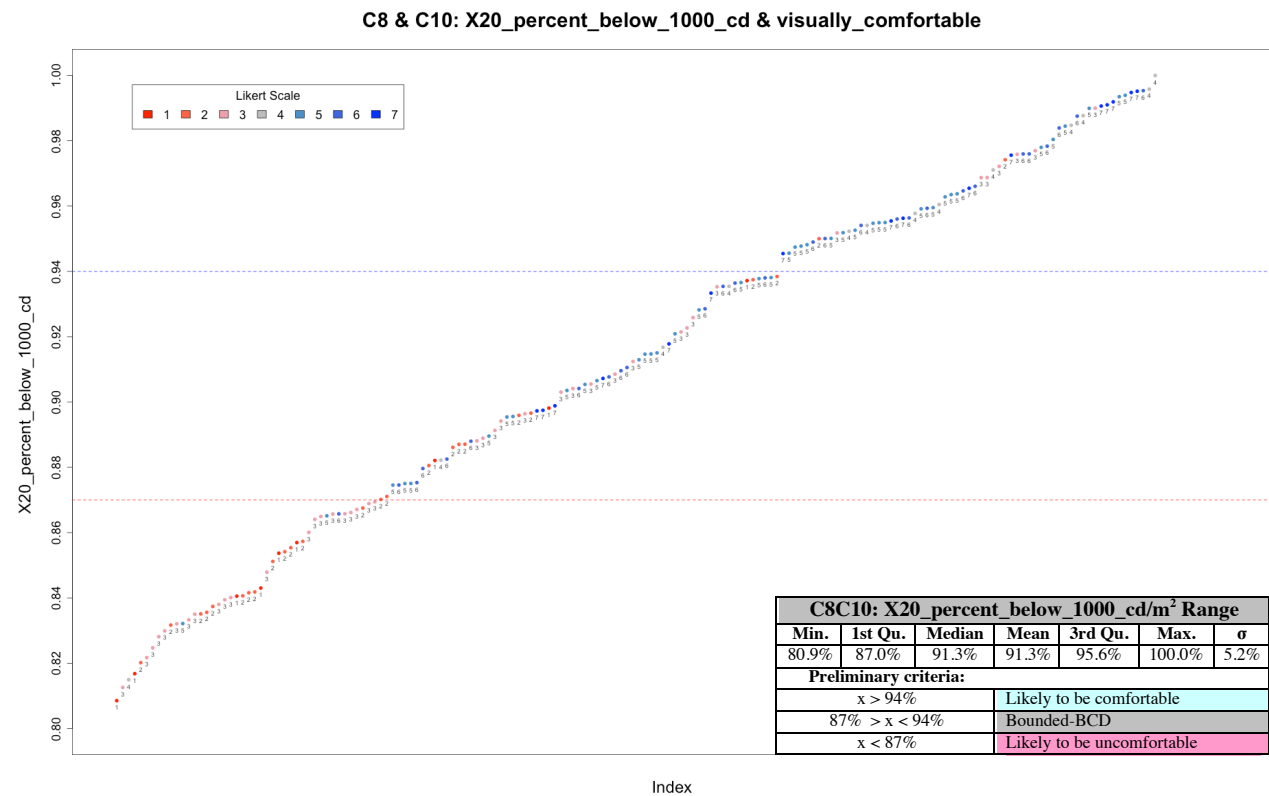
C8C10: X20_mean (cd/m ²)				
DV	adj R ²	F-statistic	DF	p-value
C8C10				
QU1	0.2889	71.27	172	1.25E-14
right_scene	0.3230	83.54	172	2.20E-16
Composite_data_set				
QU1	0.2234	248.7	860	2.20E-16
right_scene	0.3075	383.3	860	2.20E-16
C8C10Computer_split53				
QU1	0.3615	74.02	128	2.38E-14
right_scene	0.3601	73.6	128	2.72E-14
Composite_data_set_Computer_split53				
QU1	0.2425	222.2	690	2.20E-16
right_scene	0.3302	341.7	690	2.20E-16



Percent below 1000 cd/m² within a 40° horizontal band (X20)



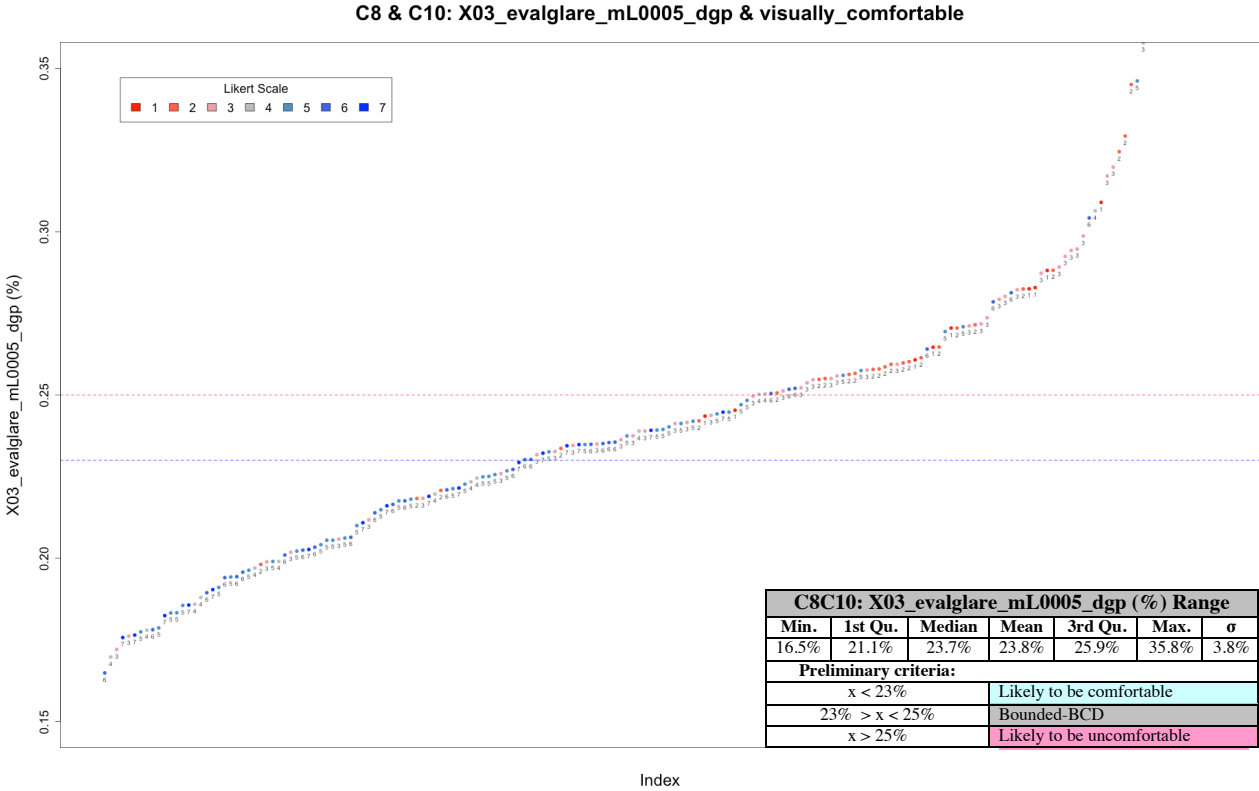
C8C10: X20_percent_below_1000_cd/m ²				
DV	adjR ²	F-statistic:	DF	p-value
C8C10				
QU1	0.287	70.64	172	1.57E-14
right_scene	0.3512	94.63	172	2.20E-16
Composite_data_set				
QU1	0.1968	211.90	860	2.20E-16
right_scene	0.3017	373	860	2.20E-16
C8C10Computer_split53				
QU1	0.373	77.74	128	7.29E-15
right_scene	0.3948	85.16	128	7.36E-16
Composite_data_set_Computer_split53				
QU1	0.2137	188.80	690	2.20E-16
right_scene	0.3176	322.5	690	2.20E-16



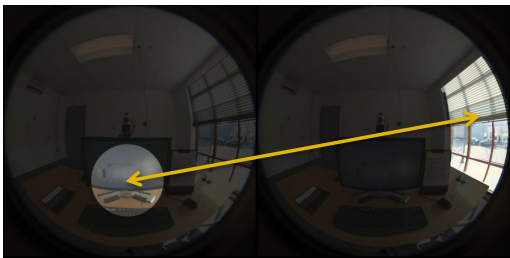
Daylight Glare Probability using 5*mL of the circle task (using X03, X01)



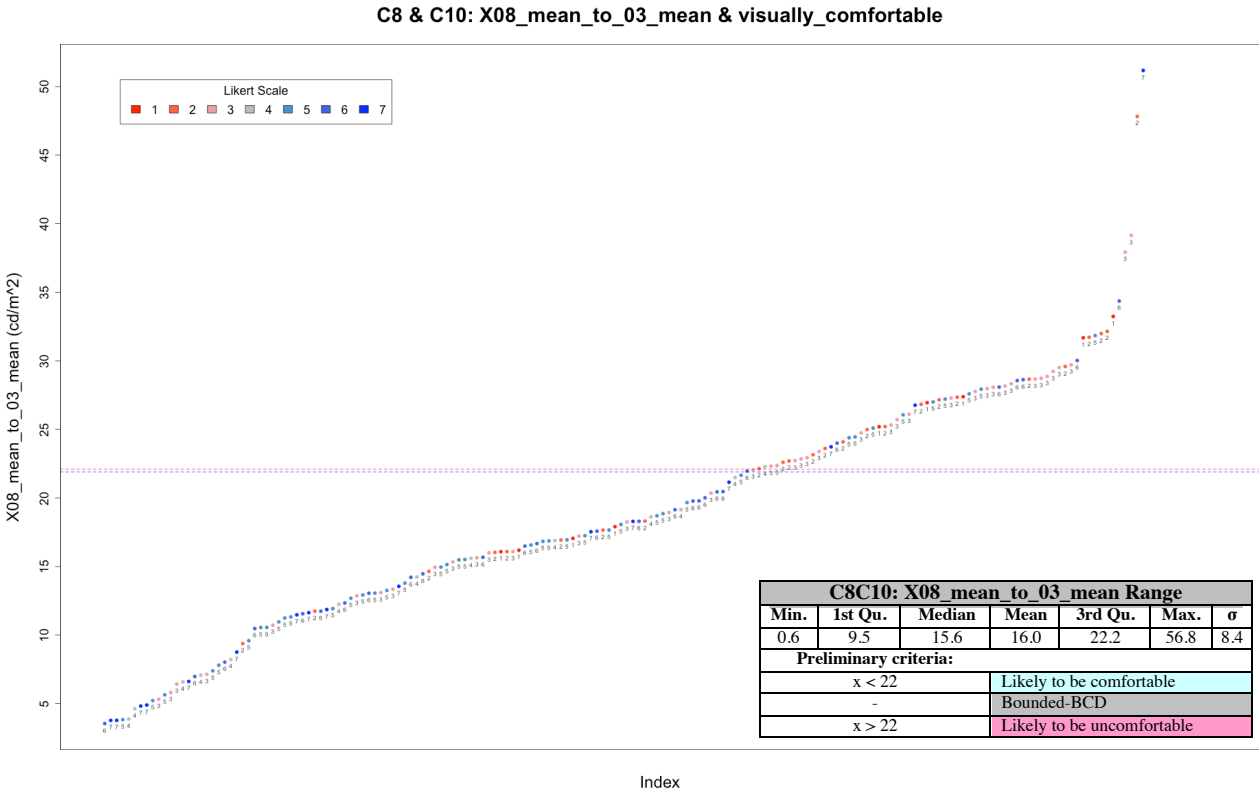
C8C10: X03_evalglare_mL0005_dgp (%)				
DV	adjR ²	F-statistic:	DF	p-value
C8C10				
QU1	0.2207	50	172	3.70E-11
right_scene	0.2905	71.83	172	1.02E-14
Composite_data_set				
QU1	0.1811	191.4	860	2.20E-16
right_scene	0.2643	310.4	860	2.20E-16
C8C10Computer_split53				
QU1	0.2688	48.41	128	1.60E-10
right_scene	0.3019	56.8	128	7.76E-12
Composite_data_set_Computer_split53				
QU1	0.1972	170.7	690	2.20E-16
right_scene	0.2797	269.4	690	2.20E-16



Luminance ratio of daylight source (X08) to task (X03)



C8C10: X08_mean_to_03_mean				
DV	adj R ²	F-statistic	DF	p-value
C8C10				
QU1	0.09584	19.3400	172	1.91E-05
right_scene	0.164	34.9400	172	1.79E-08
Composite_data_set				
QU1	0.09929	95.9200	860	2.20E-16
right_scene	0.1600	165.0000	860	2.20E-16
C8C10Computer_split53				
QU1	0.101	15.5000	128	1.35E-04
right_scene	0.1444	22.7700	128	4.89E-06
Composite_data_set_Computer_split53				
QU1	0.0901	69.4200	690	4.29E-16
right_scene	0.1442	117.4000	690	2.20E-16

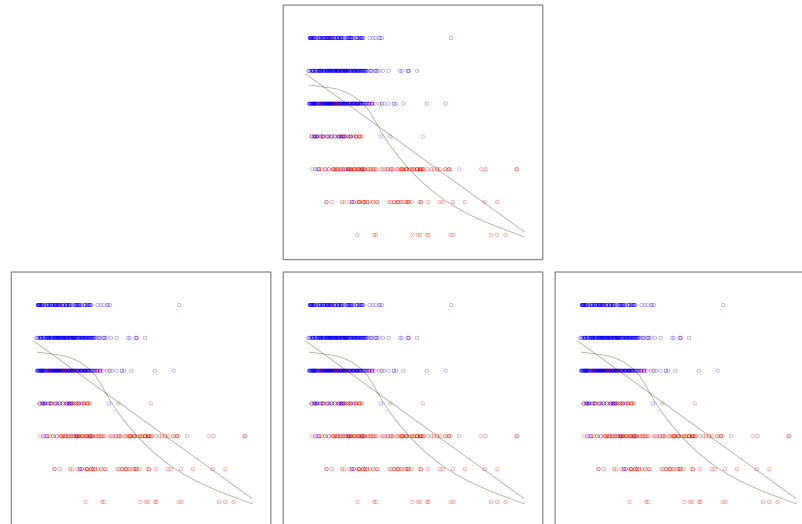


Multiple regression

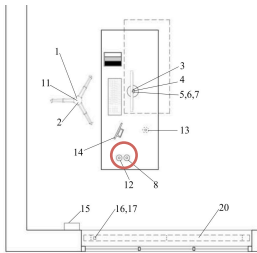
Single Regression						
DV	Metric					
		adj R^2	F-statistic:	# variables	DF	p-value
right_scene	X08_standard_deviation	0.4244	510.4	1	690	2.20E-16
right_scene	X10_50th_percentile	0.3688	404.8	1	690	2.20E-16
right_scene	X20_mean	0.3302	341.7	1	690	2.20E-16
Multiple Regression Summary						
			Estimate	Std. Error	t value	Pr(> t)
	(Intercept)		46.0289947	0.5951	77.352	2.00E-16
	X08_standard_deviation		0.0040222	0.0003	12.326	2.00E-16
	X10_50th_percentile		0.0153788	0.0017	9.022	2.00E-16
	X20_mean		-0.0147608	0.0031	-4.726	2.78E-06
		adj R^2	F-statistic:	# variables	DF	p-value
right_scene	multiple-model	0.4891	221.5	3	688	2.20E-16
Multiple Regression ANOVA Table						
		DF	Sum Sq	Mean Sq	F value	Pr(>F)
	X08_standard_deviation	1	41110	41110	5.75E+02	2.20E-16
	X10_50th_percentile	1	4793	4793	6.70E+01	1.29E-15
	X20_mean	1	1597	1597	2.23E+01	2.78E-06
	Residuals	688	49188	71		
Using: Composite_data_set_Computer_split53						

Top 20, Plus Selected Metrics	X08_standard_deviation
X08_standard_deviation	1.0000
X10_25th_percentile	0.5582
X10_50th_percentile	0.4667
X08_25th_percentile	0.5629
X08_mean	0.7338
X20_mean	0.6629
X13_75th_percentile	0.5906
X14_10th_percentile	0.5806
X10_10th_percentile	0.4436
X20_percent_below_1000_cd	0.4744
X23_50th_percentile	0.6203
X20_75th_percentile	0.5616
X14_25th_percentile	0.5627
X20_25th_percentile	0.5871
X14_2nd_percentile	0.5756
X20_90th_percentile	0.4264
X18_50th_percentile	0.6400
X20_50th_percentile	0.5722
X19_25th_percentile	0.6211
X08_50th_percentile	0.4140
X03_evalglare_mL0003_dgp	0.6360
X20_standard_deviation	0.7186
X01_evalglare_mL0005_dgp	0.5971
X01_mean	0.6293
X01_standard_deviation	0.7067
via_01	0.6352
MD_daq01_illumiance_topcanon	0.5692
X01_evalglare_mL0005_lum_sources	0.7520
X20_percent_above_2000_cd	0.4063
X01_brightest_10percent	0.5953
X01_98th_percentile	0.4758
X01_percent_above_2000_cd	0.4436
X13_mean	0.5090

Discussion

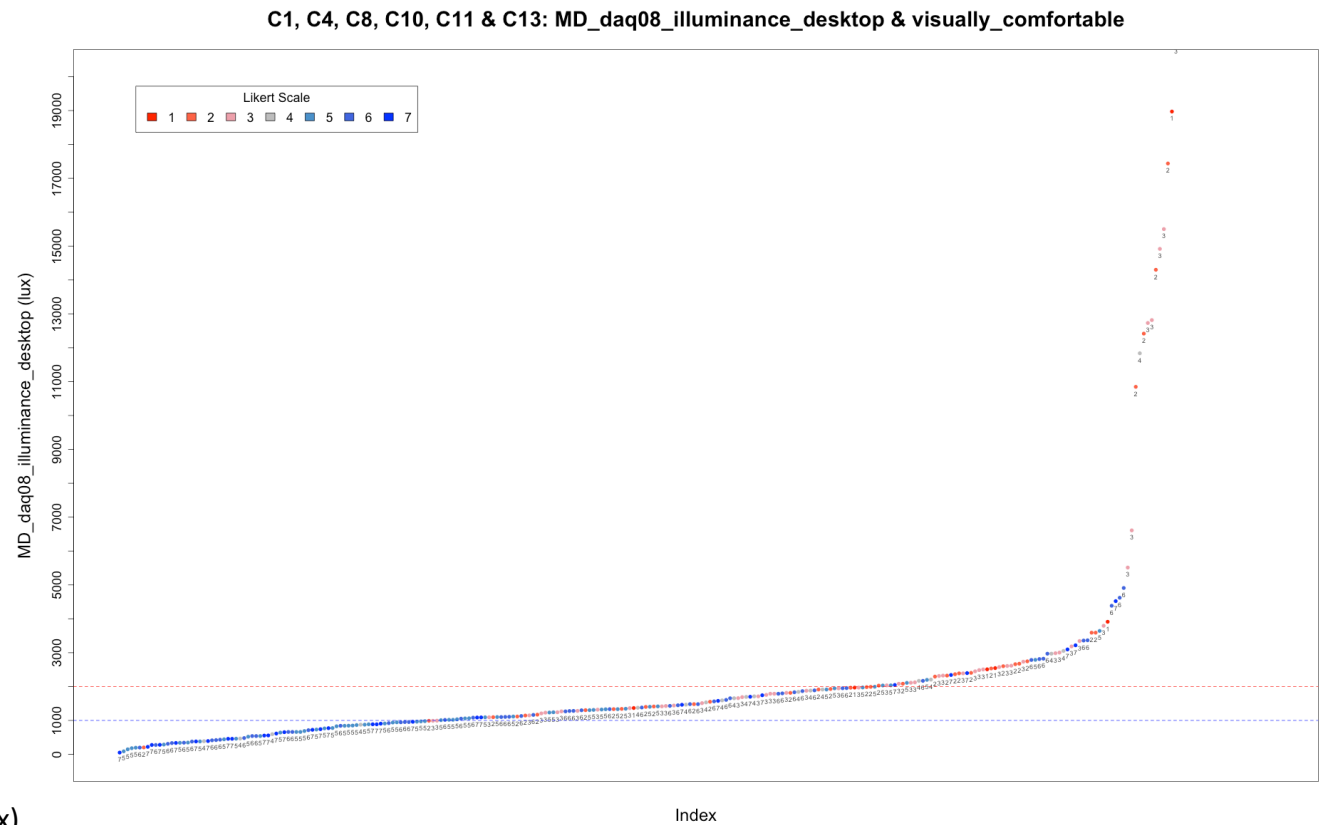


Upper limit? - daylight illumination at desktop

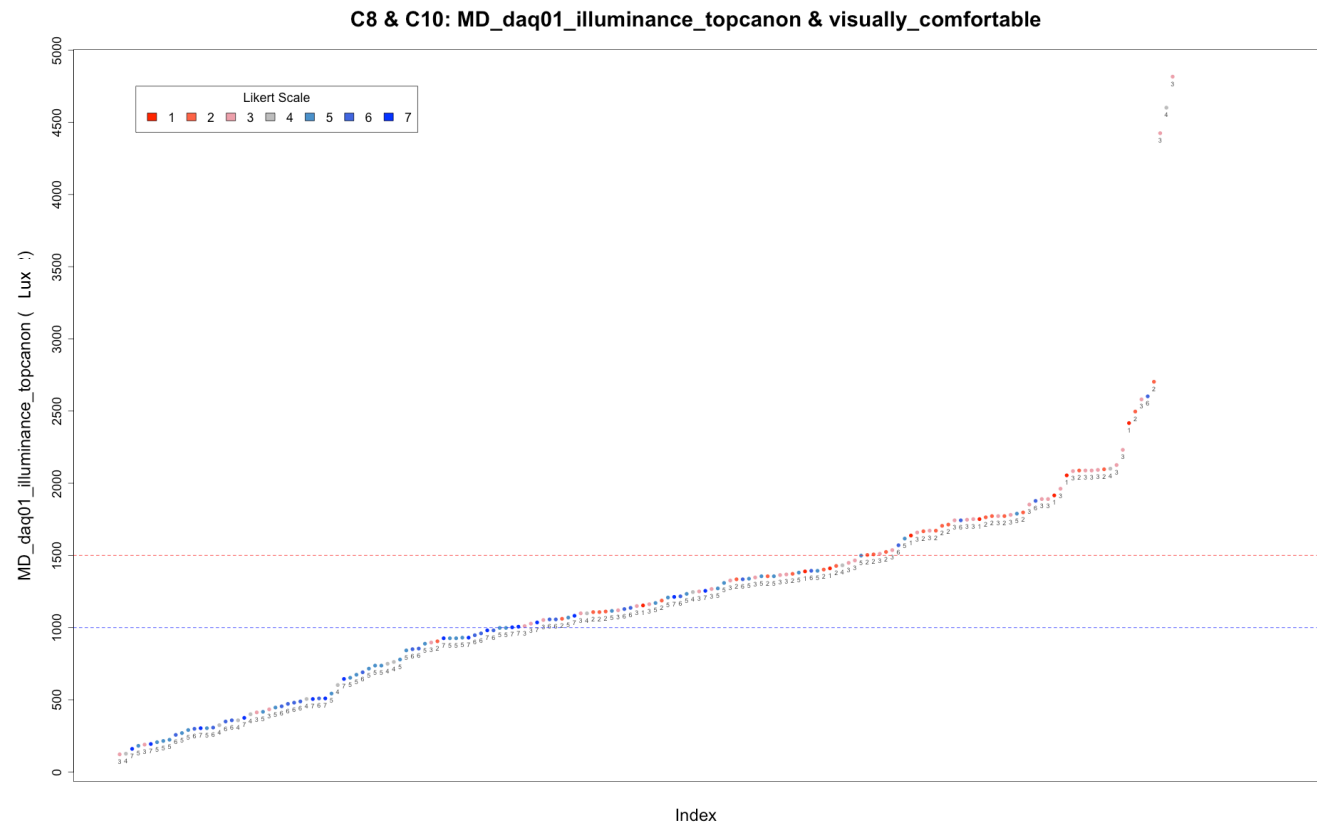


MP daylight only mean = 1250 lux
JU mean = 4300 lux

(pilot MP daylight only mean = 3600 lux)

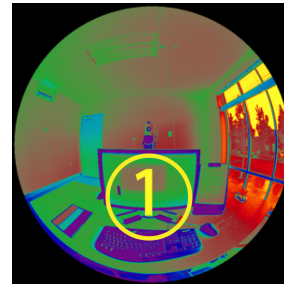


Upper limit? – vertical daylight illumination at occupants' eye position

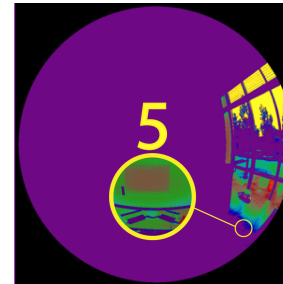


Luminance ratios

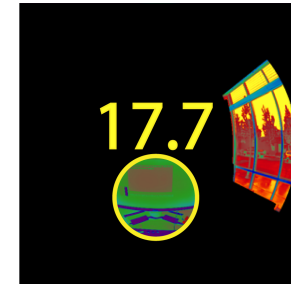
S001 2011.06.29 14:11 (Likert scores of 5)	
Scene values (cd/m ²)	
03_mean	79
01_90th_percentile	373
08_mean	1403
5*01_mean	(5*285)=1425
01_brightest_10percent	1880
03_evalglare_mL0005_lum_sources	1894
01_98th_percentile	3824
01_evalglare_mL0005_lum_sources	4417
01_maximum	8096
Luminance Ratio (values shown:X03_mean)	
01_90th_percentile	5:1
08_mean	17.7:1
5*01_mean	17.9:1
01_brightest_10percent	23.7:1
03_evalglare_mL0005_lum_sources	23.8:1
01_98th_percentile	48:1
01_evalglare_mL0005_lum_sources	56:1
01_maximum	102:1



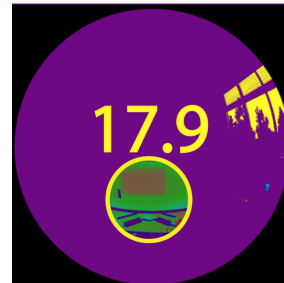
Example Comfortable Scene



373cd/m² X01_90th_percentile



1400cd/m² X08_mean



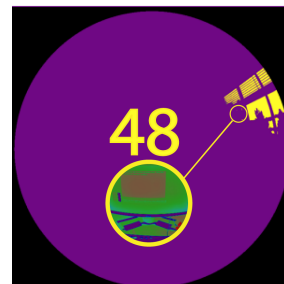
1425cd/m² 5*X01_mean



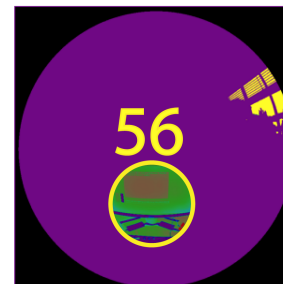
1880cd/m² X01_mean_brightest_10%



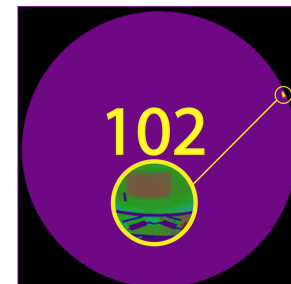
1894cd/m² 5*X03_mean_sources



3824cd/m² X01_98th_percentile

















4417cd/m² 5*X01_mean_sources



8096cd/m² X01_maximum

Metrics range plots

- | | | |
|---|---|------------------------|
| 1 |  | Very Strongly Disagree |
| 2 |  | Strongly Disagree |
| 3 |  | Disagree |
| 4 |  | Neutral |
| 5 |  | Agree |
| 6 |  | Strongly Agree |
| 7 |  | Very Strongly Agree |

- | | | |
|--------|---|------------|
| 86-100 |  | Too bright |
| 71-85 |  | |
| 56-70 |  | |
| 45-55 |  | |
| 30-44 |  | |
| 15-29 |  | |
| 0-14 |  | Too dim |

Std.Dev. Window



C8C10: X08_standard_deviation

Minimum: 175.000
S022 2011-11-15
M, 60-70 yrs



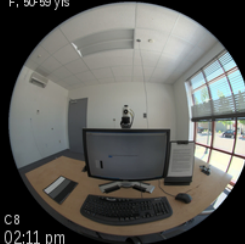
C8
02:59 pm
MP Daylight
S022_2011-11-15-145956_c1

1st Quartile: 1386.000
S047 2011-11-16
M, 30-39 yrs



C10
03:26 pm
JU Daylight Glare
S047_2011-11-16-152506_c1

Median: 2503.000
S021 2011-08-08
F, 50-59 yrs



C8
02:11 pm
MP Daylight
S021_2011-08-08-141150_c1

Mean: 2842.000
S031 2011-08-26
F, 18-19 yrs



C10
03:30 pm
JU Daylight Glare
S031_2011-08-26-153050_c1

3rd Quartile: 3928.000
S037 2011-09-08
M, 40-49 yrs

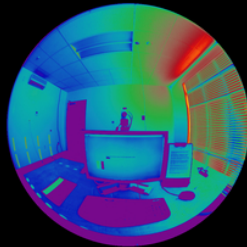


C10
03:27 pm
JU Daylight Glare
S037_2011-09-08-152753_c1

Maximum: 9952.000
S013 2011-12-11
F, 30-39 yrs

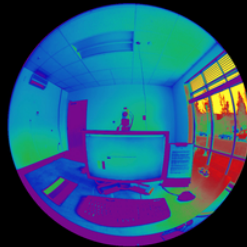


C10
02:18 pm
JU Daylight Glare
S013_2011-12-11-141819_c1



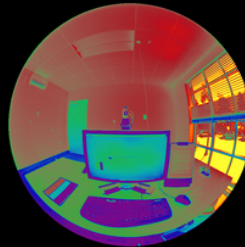
QU1: 4
QU2: 3
QU3: 3
QU4: 3
QU5: 3
QU6: 5
QU7: 4

front_scene: 30.6
left_scene: 40.7
right_scene: 50.0
ceiling: 42.3



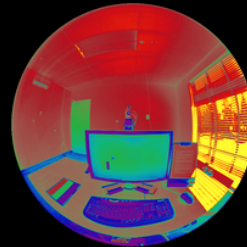
QU1: 5
QU2: 5
QU3: 5
QU4: 5
QU5: 5
QU6: 6
QU7: 5

front_scene: 54.2
left_scene: 54.0
right_scene: 57.0
ceiling: 52.6



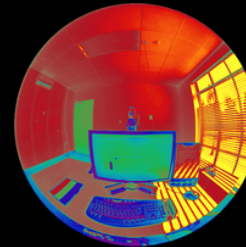
QU1: 5
QU2: 5
QU3: 5
QU4: 4
QU5: 4
QU6: 6
QU7: 5

front_scene: 50.0
left_scene: 50.0
right_scene: 53.7
ceiling: 46.3



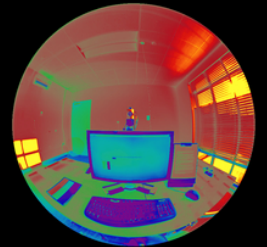
QU1: 2
QU2: 2
QU3: 3
QU4: 2
QU5: 2
QU6: 3
QU7: 2

front_scene: 73.4
left_scene: 50.0
right_scene: 97.0
ceiling: 62.9



QU1: 4
QU2: 3
QU3: 3
QU4: 5
QU5: 5
QU6: 4
QU7: 5

front_scene: 50.0
left_scene: 50.0
right_scene: 76.9
ceiling: 50.0



QU1: 3
QU2: 3
QU3: 4
QU4: 3
QU5: 3
QU6: 3
QU7: 2

front_scene: 50.0
left_scene: 50.0
right_scene: 90.0
ceiling: 90.4



Mean 40° band

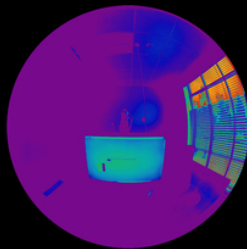


C8C10: X20_mean

Minimum: 51.140
S035 2011-10-05
M, 18-19 yrs



C10
01:36 pm
JU Daylight Glare
S035_2011-10-05-133610_c1



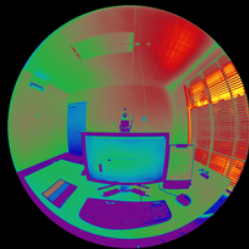
QU1: 3
QU2: 2
QU3: 3
QU4: 2
QU5: 1
QU6: 4
QU7: 3

front_scene: 44.6
left_scene: 23.8
right_scene: 43.0
ceiling: 50.0

1st Quartile: 277.600
S027 2011-08-20
F, 18-19 yrs



C8
02:10 pm
MP Daylight
S027_2011-08-20-141016_c1



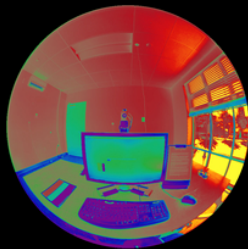
QU1: 7
QU2: 6
QU3: 5
QU4: 7
QU5: 4
QU6: 7
QU7: 5

front_scene: 45.3
left_scene: 30.1
right_scene: 52.3
ceiling: 47.9

Median: 509.200
S018 2011-10-03
F, 30-39 yrs



C8
01:27 pm
MP Daylight
S018_2011-10-03-132714_c1



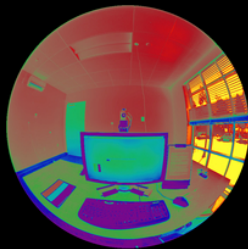
QU1: 5
QU2: 5
QU3: 5
QU4: 5
QU5: 3
QU6: 5
QU7: 5

front_scene: 50.0
left_scene: 50.0
right_scene: 50.0
ceiling: 50.0

Mean: 533.400
S021 2011-08-08
F, 50-59 yrs



C8
02:11 pm
MP Daylight
S021_2011-08-08-141150_c1



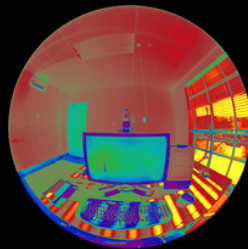
QU1: 5
QU2: 5
QU3: 5
QU4: 4
QU5: 4
QU6: 6
QU7: 5

front_scene: 50.0
left_scene: 50.0
right_scene: 53.7
ceiling: 45.3

3rd Quartile: 749.800
S010 2011-12-10
F, 30-39 yrs



C8
01:53 pm
MP Daylight
S010_2011-12-10-135322_c1



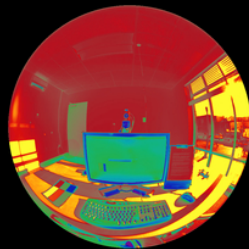
QU1: 5
QU2: 5
QU3: 3
QU4: 3
QU5: 5
QU6: 3
QU7: 3

front_scene: 28.7
left_scene: 43.7
right_scene: 46.7
ceiling: 43.2

Maximum: 1674.000
S010 2011-12-10
F, 30-39 yrs



C10
02:19 pm
JU Daylight Glare
S010_2011-12-10-141951_c1



QU1: 2
QU2: 3
QU3: 5
QU4: 3
QU5: 5
QU6: 2
QU7: 3

front_scene: 64.3
left_scene: 56.1
right_scene: 54.9
ceiling: 50.0

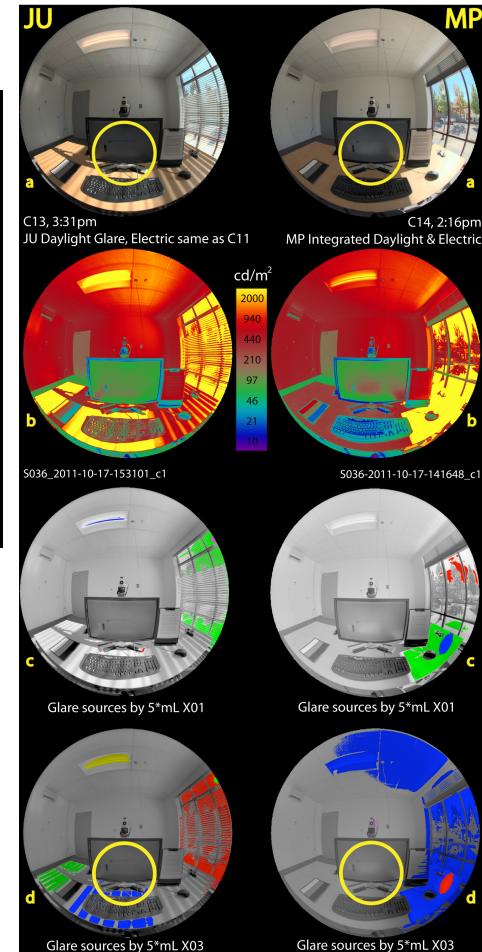


DGP

Participant 36, round 2, 2011-10-17		
	C13 (JU)	C14 (MP)
X01 mean (cd/m ²)	1092	1682
X03 mean (cd/m ²)	455	130
5* X01 mean (cd/m ²)	5460	8410
5* X03 mean (cd/m ²)	2275	650
DGP X01 5*mL	32%	45%
DGP X03 5*mL	32%	44%
X08 standard deviation (cd/m ²)	9043	3073
X20 mean (cd/m ²)	890	848
X14 10 th percentile (cd/m ²)	451	367
X20 percent above 2000 cd	11%	8%
X20 percent below 1000 cd	80%	88%
X10 50th percentile	1876	790
X01 standard deviation (cd/m ²)	3615	7300

V0.9f 0.32 0.44

V1.11 0.32 0.44

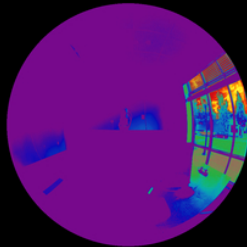


C8C10: X03_evalglare_mL0005_dgp

Minimum: 0.165
S005 2011-07-07
F, 18-19 yrs



C8
01:11 pm
MP Daylight
S005_2011-07-07-131118_c1



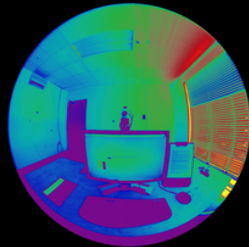
QU1: 6 ●
QU2: 6 ●
QU3: 6 ●
QU4: 6 ●
QU5: 6 ●
QU6: 6 ●
QU7: 6 ●

front_scene: 50.0 ●
left_scene: 50.0 ●
right_scene: 50.0 ●
ceiling: 50.0 ●

1st Quartile: 0.211
S030 2011-08-25
M, 18-19 yrs



C8
03:06 pm
MP Daylight
S030_2011-08-25-150602_c1



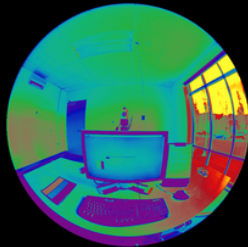
QU1: 7 ●
QU2: 7 ●
QU3: 7 ●
QU4: 7 ●
QU5: 6 ●
QU6: 7 ●
QU7: 7 ●

front_scene: 50.0 ●
left_scene: 50.0 ●
right_scene: 50.0 ●
ceiling: 50.0 ●

Median: 0.237
S038 2011-11-19
M, 40-49 yrs



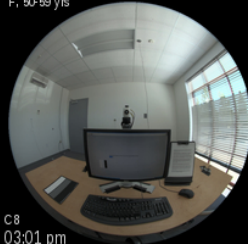
C10
03:19 pm
JU Daylight Glare
S038_2011-11-19-151908_c1



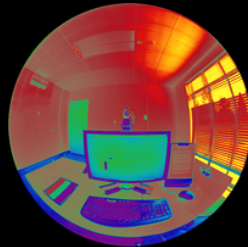
QU1: 5 ●
QU2: 5 ●
QU3: 5 ●
QU4: 5 ●
QU5: 3 ●
QU6: 6 ●
QU7: 3 ●

front_scene: 48.6 ●
left_scene: 50.0 ●
right_scene: 52.1 ●
ceiling: 48.4 ●

Mean: 0.238
S033 2011-08-30
F, 50-59 yrs



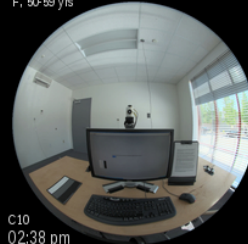
C8
03:01 pm
MP Daylight
S033_2011-08-30-150153_c2



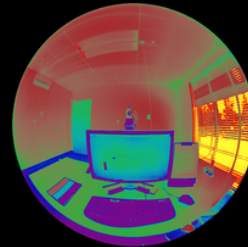
QU1: 4 ●
QU2: 3 ●
QU3: 4 ●
QU4: 6 ●
QU5: 3 ●
QU6: 4 ●
QU7: 3 ●

front_scene: 50.0 ●
left_scene: 46.0 ●
right_scene: 55.8 ●
ceiling: 50.0 ●

3rd Quartile: 0.259
S021 2011-08-08
F, 50-59 yrs



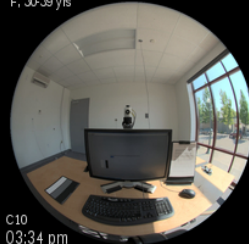
C10
02:38 pm
JU Daylight Glare
S021_2011-08-08-143806_c1



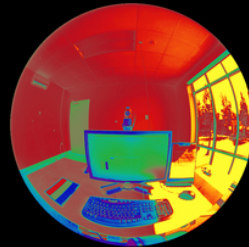
QU1: 2 ●
QU2: 2 ●
QU3: 4 ●
QU4: 4 ●
QU5: 3 ●
QU6: 4 ●
QU7: 2 ●

front_scene: 50.0 ●
left_scene: 50.0 ●
right_scene: 79.7 ●
ceiling: 50.0 ●

Maximum: 0.358
S036 2011-09-07
F, 30-39 yrs



C10
03:34 pm
JU Daylight Glare
S036_2011-09-07-153462_c1



QU1: 3 ●
QU2: 2 ●
QU3: 1 ●
QU4: 3 ●
QU5: 1 ●
QU6: 3 ●
QU7: 1 ●

front_scene: 10.0 ●
left_scene: 29.7 ●
right_scene: 79.2 ●
ceiling: 59.8 ●



V0.9f

0.17

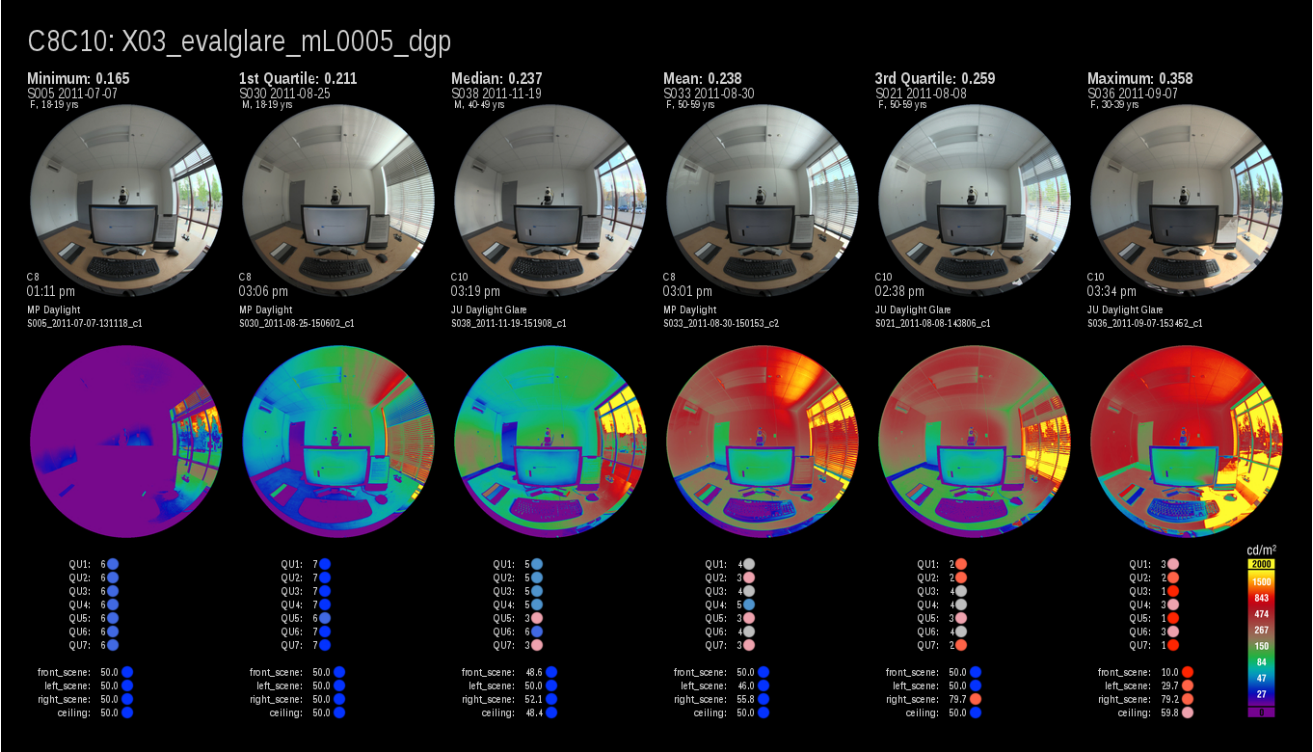
0.21

0.24

0.24

0.26

0.36



V1.11

0.03

0.20

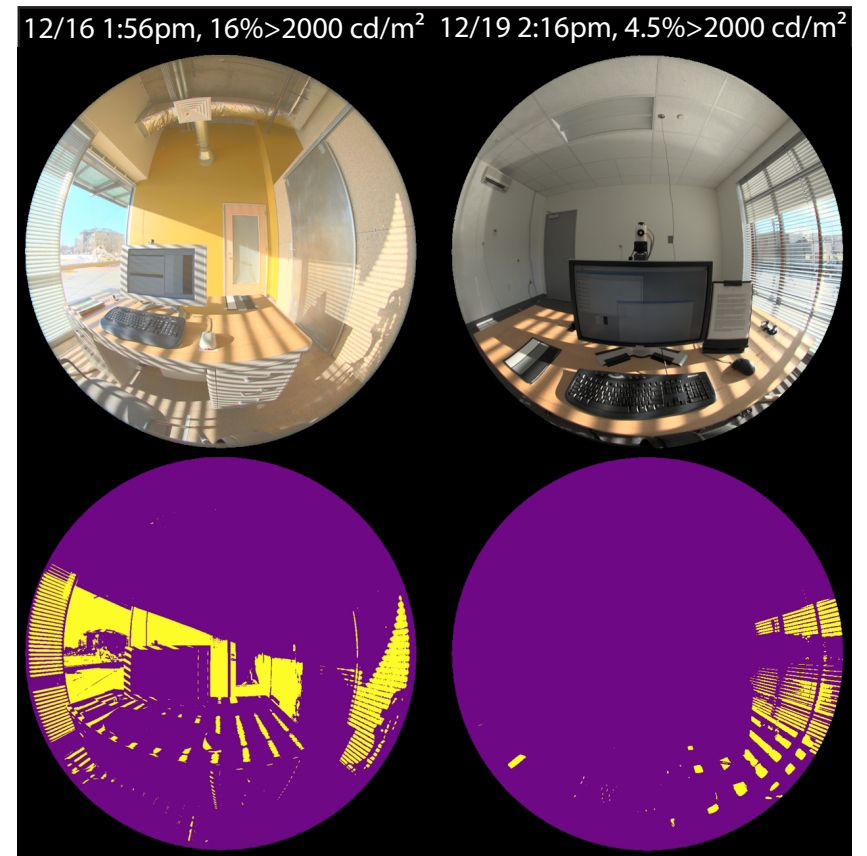
0.21

0.32

0.26

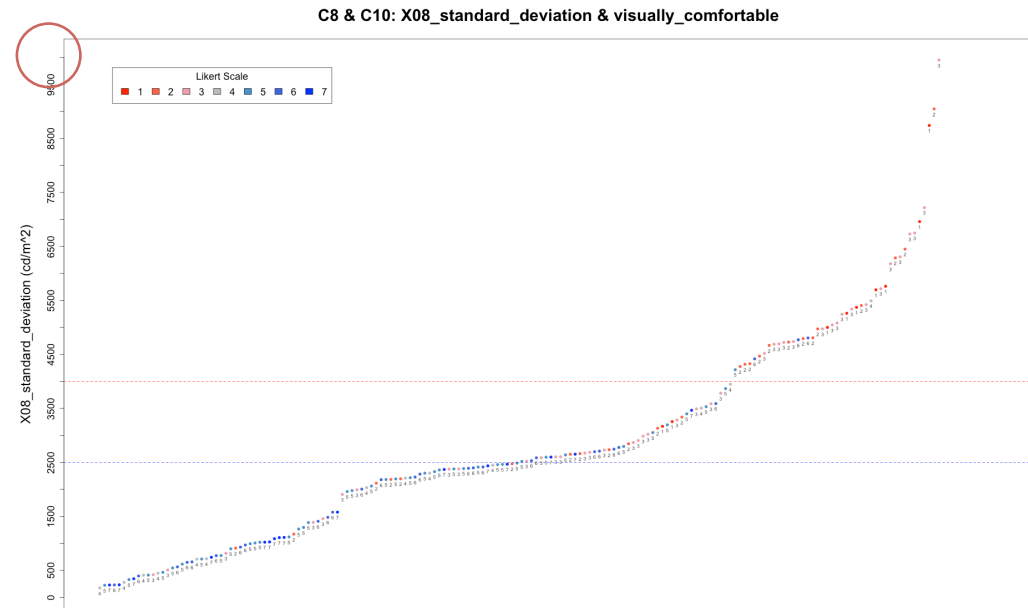
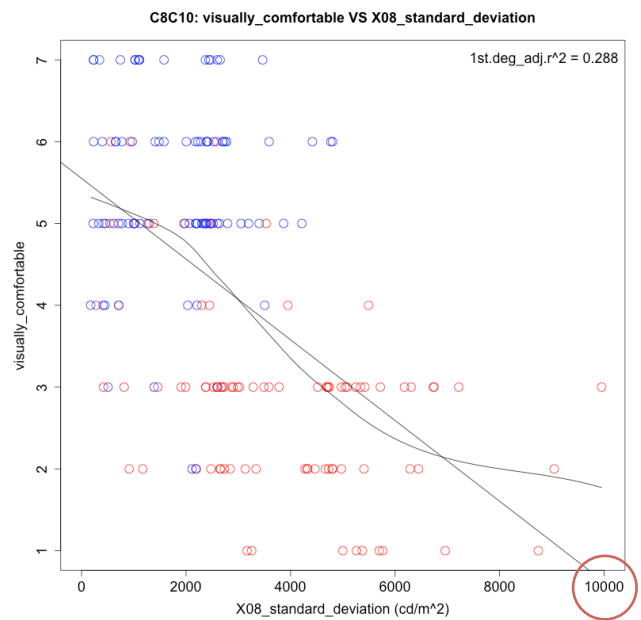
0.35

Generalizability - % of scene pixels exceeding 2000 cd/m²



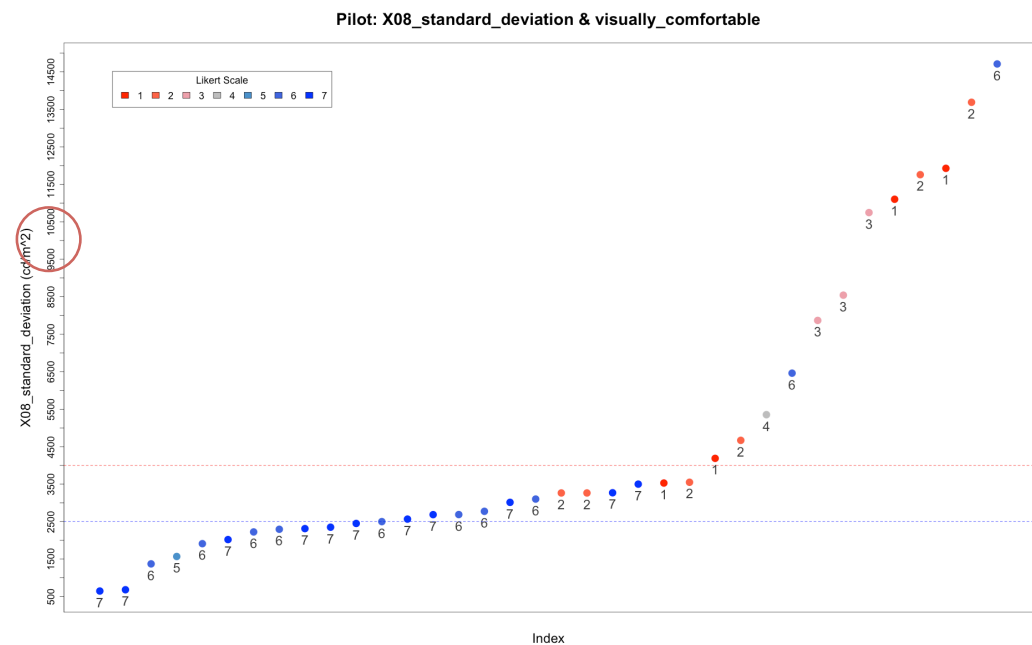
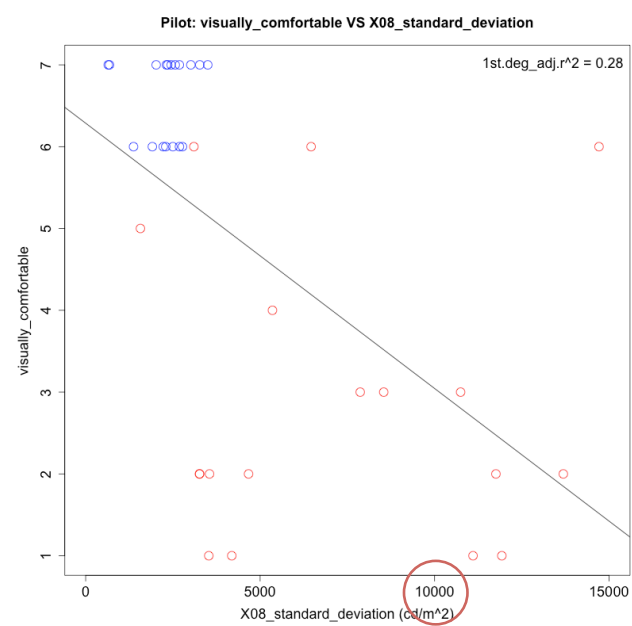
Generalizability – standard deviation of window luminance

six-month data

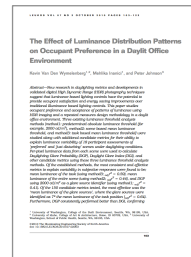
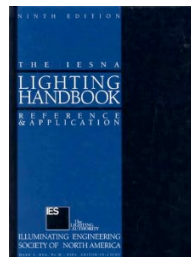
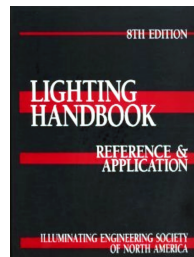


C8C10: X08_standard_deviation (cd/m ²) Range							Index
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	σ	
175	1386	2503	2842	3928	9952	1892	
Preliminary criteria:							
x < 2500			Likely to be comfortable				
2500 > x < 4000			Bounded-BCD				
x > 4000			Likely to be uncomfortable				

Pilot study data



Conclusions

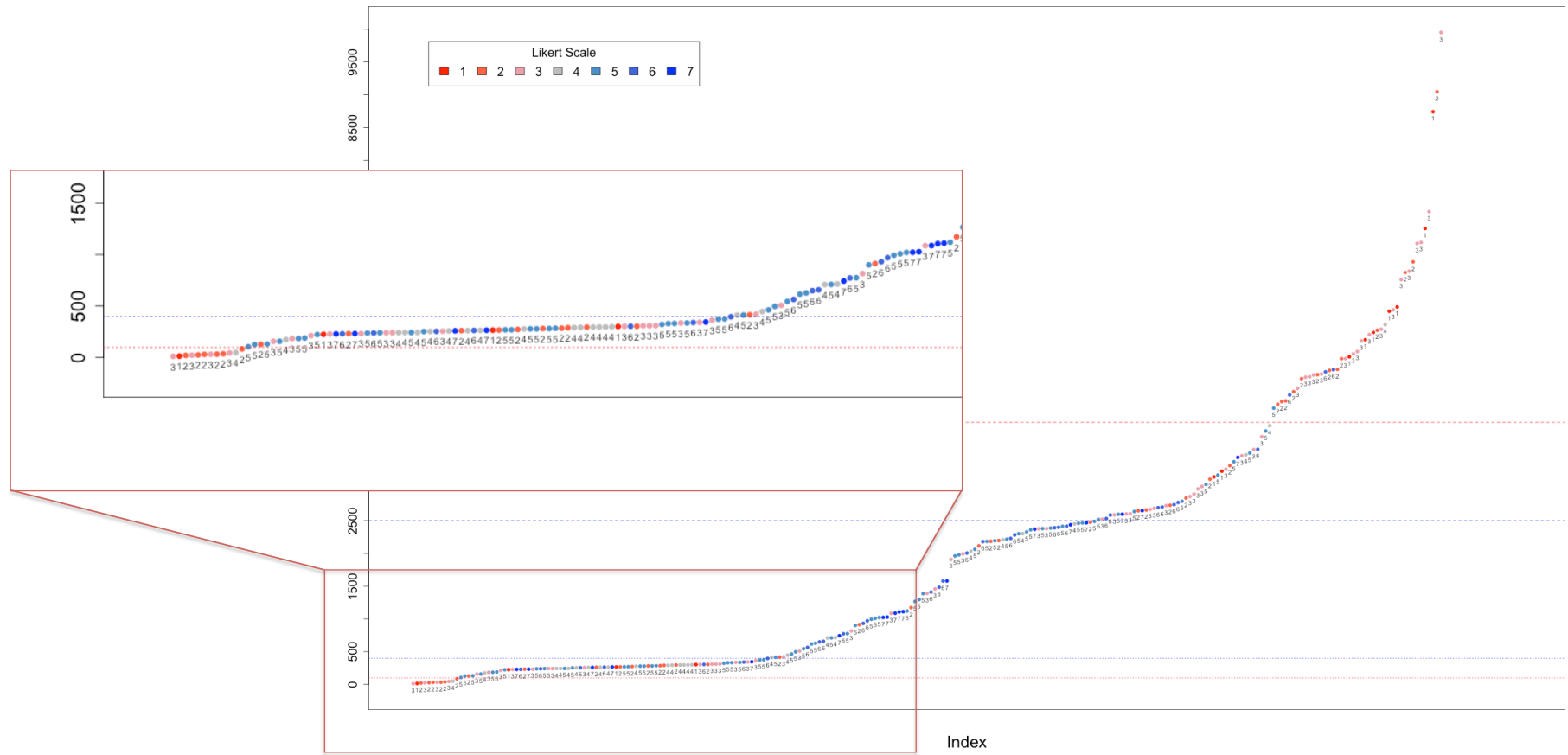


Aim 1 – Preference-Acceptance

- Luminance-based metrics outperformed illuminance-based metrics
- Std.dev. window luminance top on 7 of 12 tests, consistent in 2 spaces
- Luminance metrics within 40° horizontal band promising
- Multiple regression (X08_standard_deviation; X10_50th_percentile; X20_mean)
- Luminance ratio calculations require consistency
- DGP requires refinement before wide-spread use (e.g. IES adoption)
- E_v from occupants' point of view bounded-BCD = 1000-1500 lux
- Upper desktop daylight illumination threshold ~ 2000-4300 lux
- Bounded-BCD concept
- 'Seasonal' sensitivity to brightness



C8 & C9 & C10: X08_standard_deviation & visually_comfortable

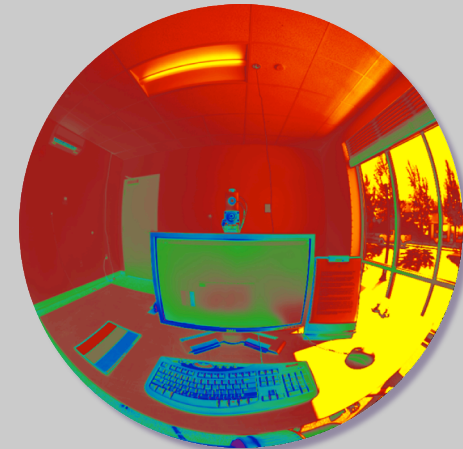
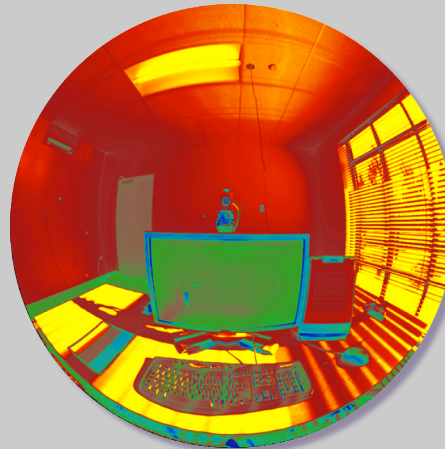


Evaluating Human Visual Preference and Performance in an Office Environment Using Luminance-based Metrics

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thank you