



3-5 September, Loughborough University, UK

2018 International Radiance Workshop

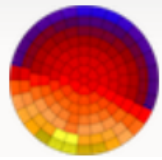
Modeling of Prismatic Film Glazing with Climate- Based Weather Data and Field Measurement

Zhen Tian, School of Architecture, Soochow University

Yaping Lei, Suzhou Institute of Building Science Group

Jacob Jonsson, Lawrence Berkeley National Laboratory

Sep. 4, 2018



Prismatic Film Glazing Applications



Prismatic film on the side windows



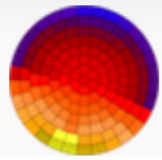
Prismatic film glazing on the atrium



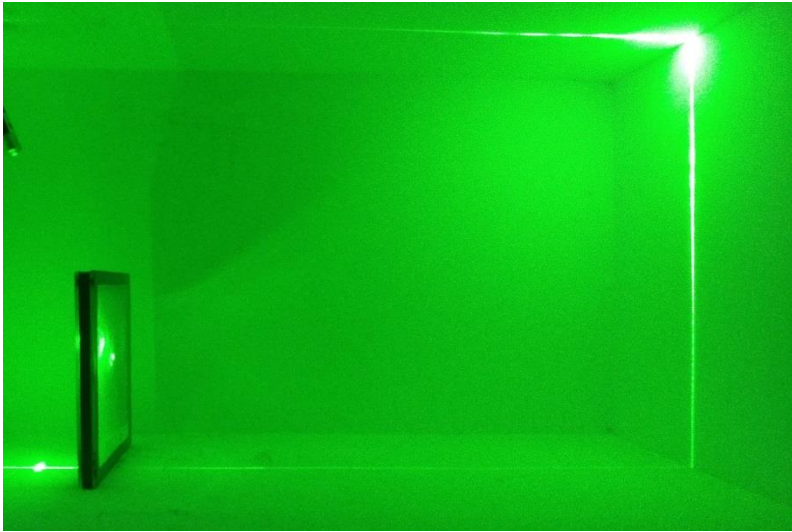
Combined prismatic and conventional glazing



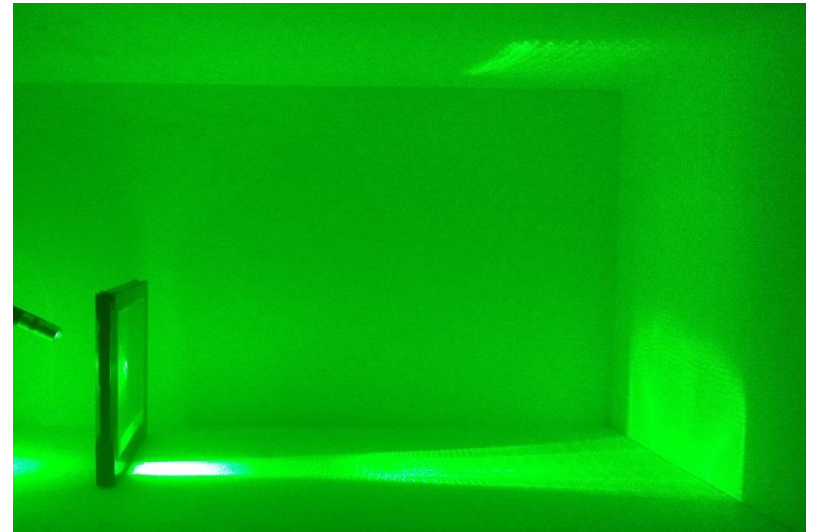
Prismatic film as part of blinds in offices



Light Transmittance of Prismatic Film Glazing

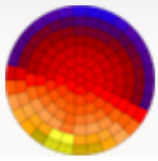


Light transmittance properties through
a prismatic film clear glazing (High Zenith Angle)



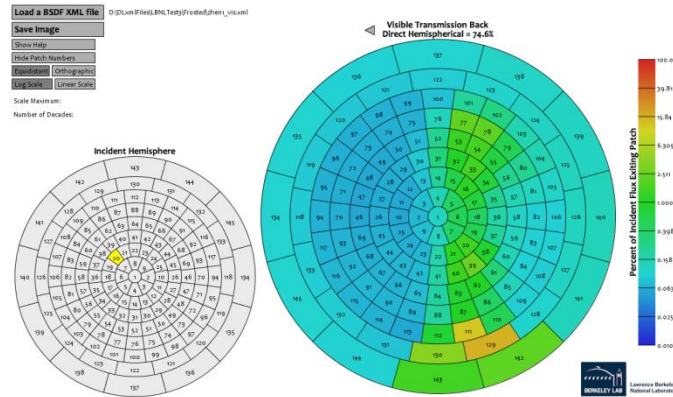
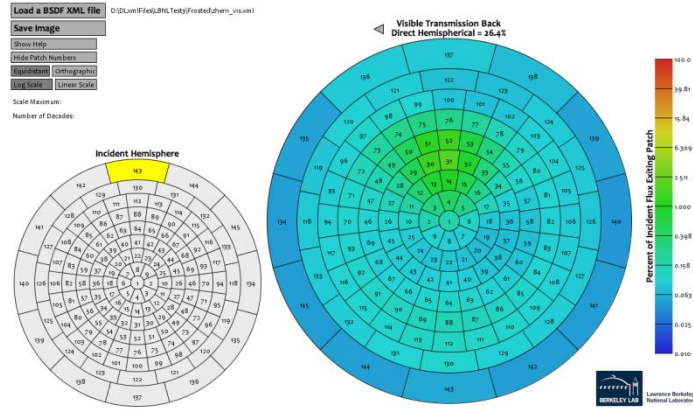
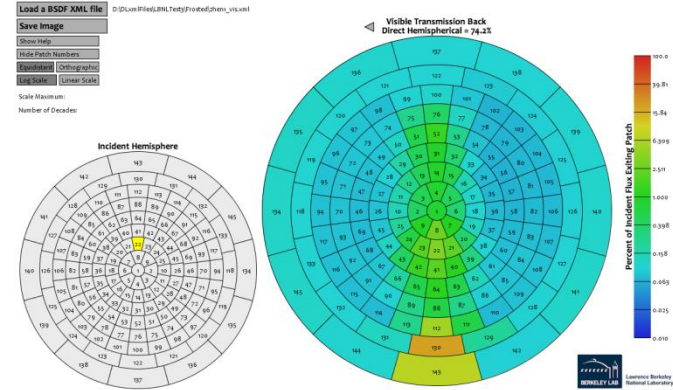
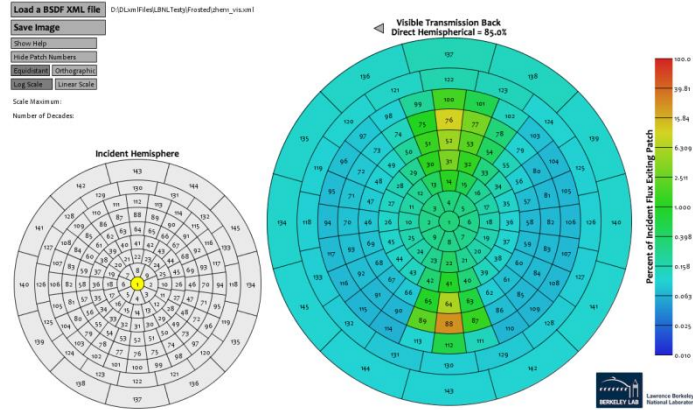
Light transmittance properties through
a prismatic film frosted glazing (Low Zenith Angle)

As different manufacturers may produce specific shape, size and configuration of prismatic film products, the light scattering properties of different prismatic film products need to be analysed.

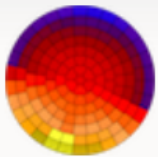


Climate-Based Daylight Modelling

Prismatic Film Glazing Flux Scattering

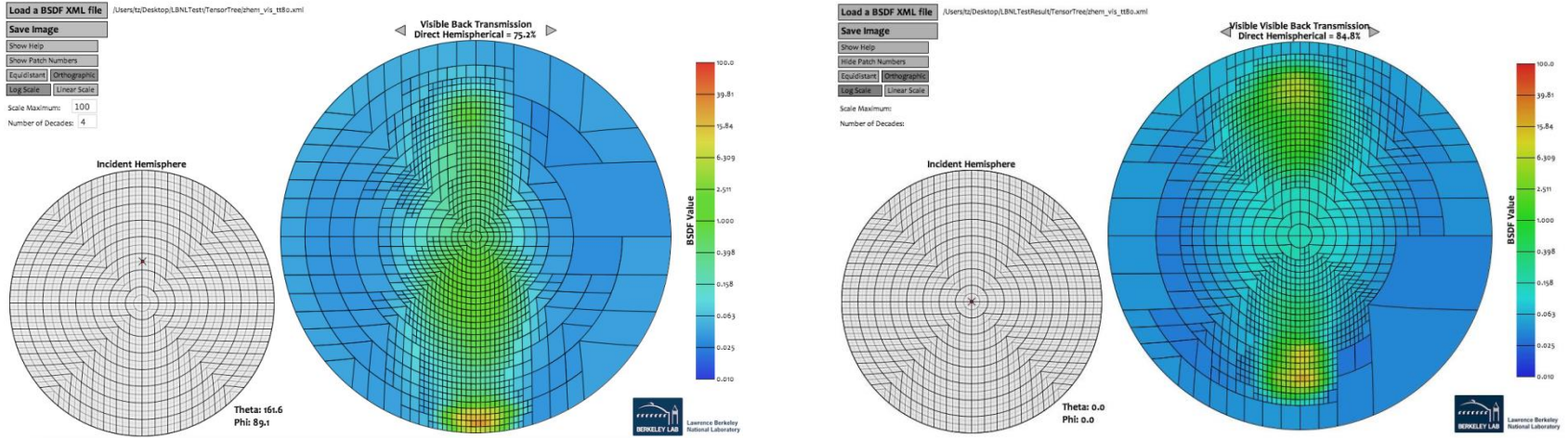


Incident light and outgoing flux scattering distribution for prismatic film plus frosted glazing (Measured at LBNL, Klems data)

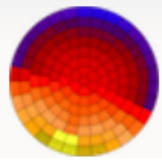


Climate-Based Daylight Modelling

Prismatic Film Glazing Flux Scattering



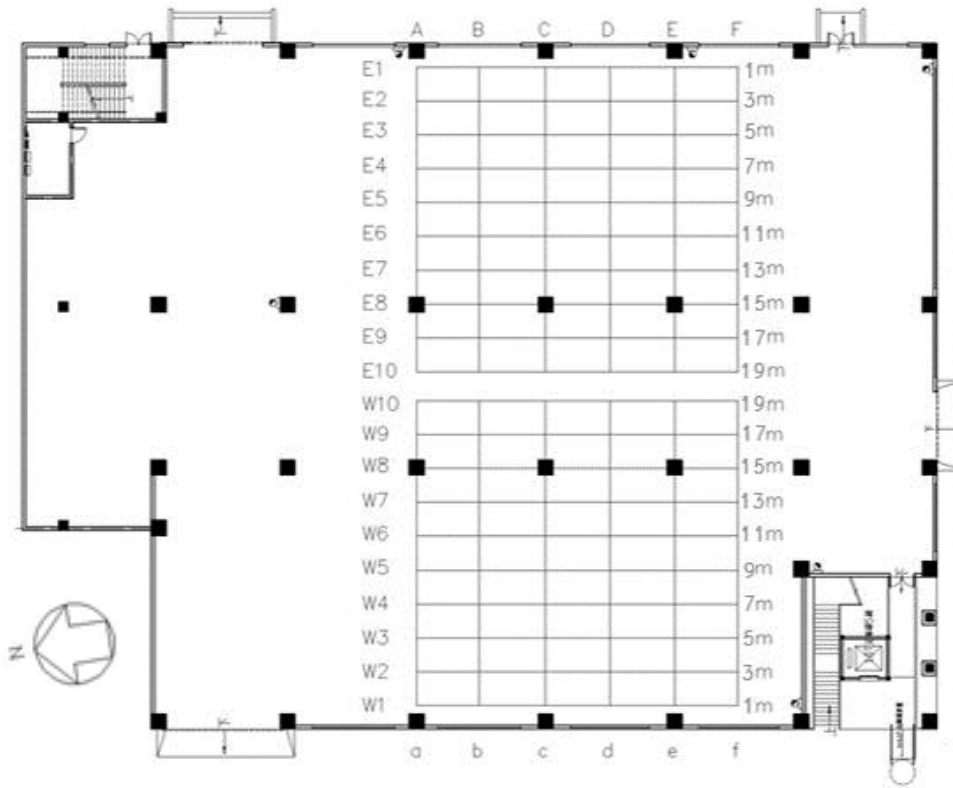
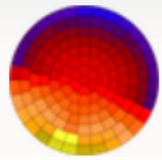
Incident light and outgoing flux scattering distribution for prismatic film plus frosted glazing (Measured at LBNL, Tensor Tree Data)



Exterior view of the Suming Decoration Building



Interior view of the first floor in the Suming Decoration Building



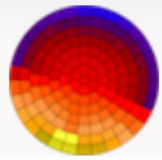
Illuminance field measurement spots grid



T-10A Illuminance meter

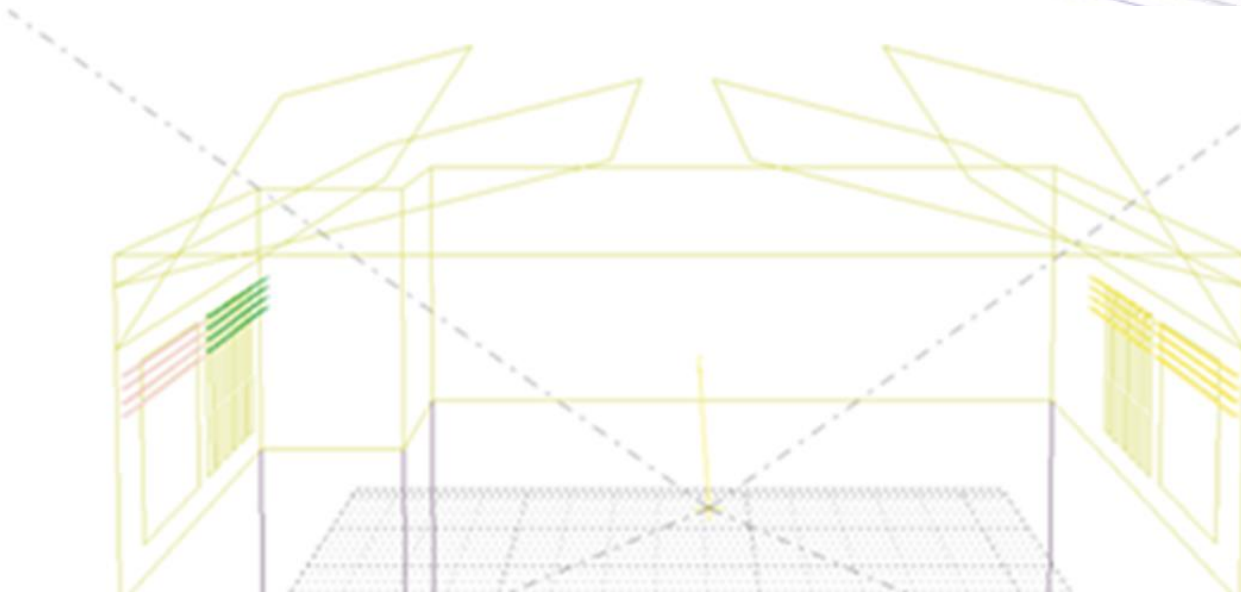
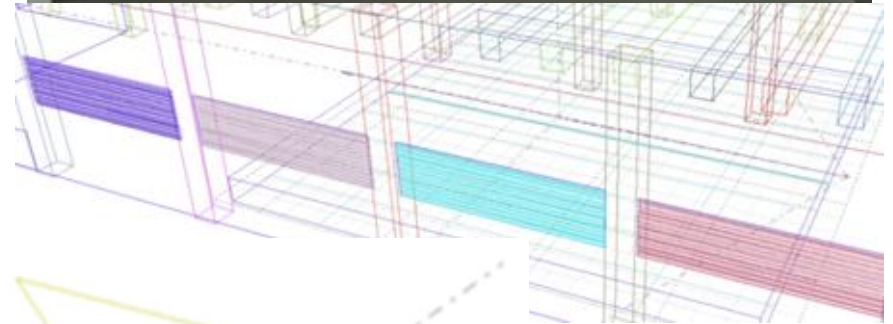
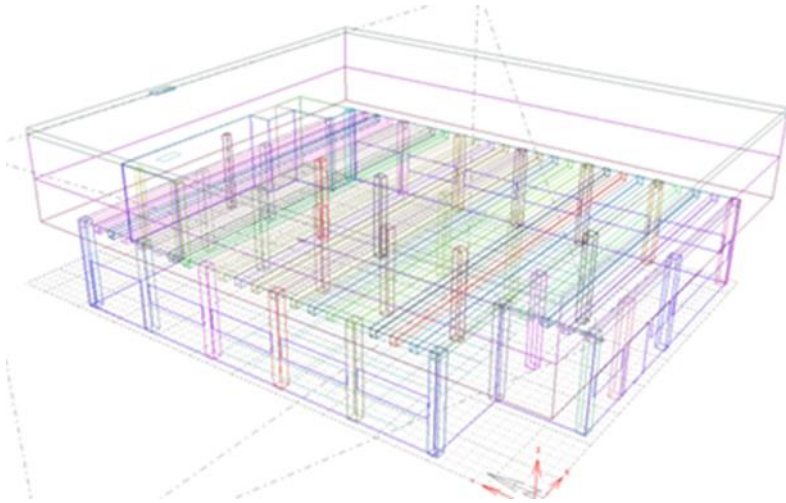


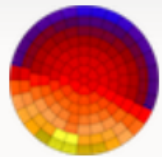
PR 670 Luminance meter



Climate-Based Daylight Modelling

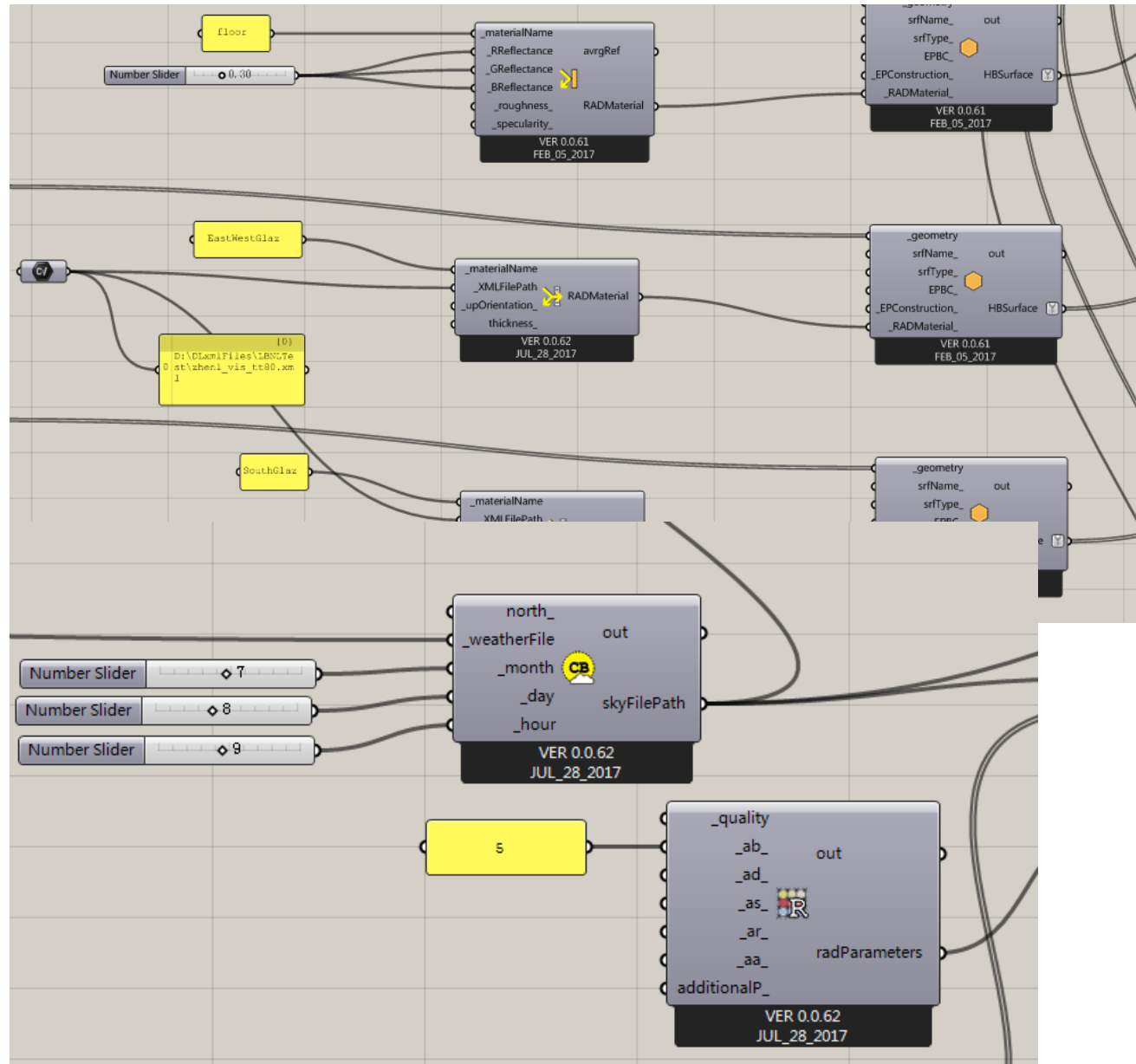
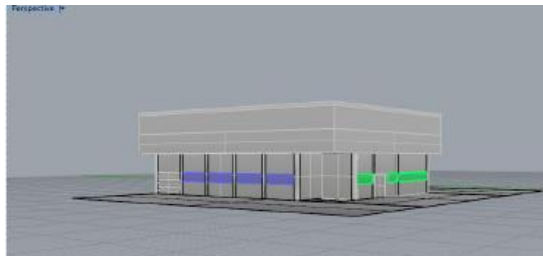
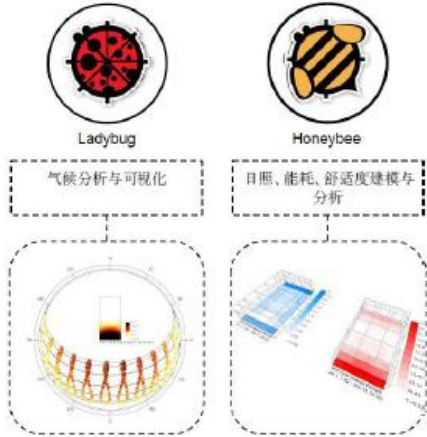
Initial Modeling with ECOTECT + Desktop Radiance

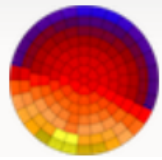




Climate-Based Daylight Modelling

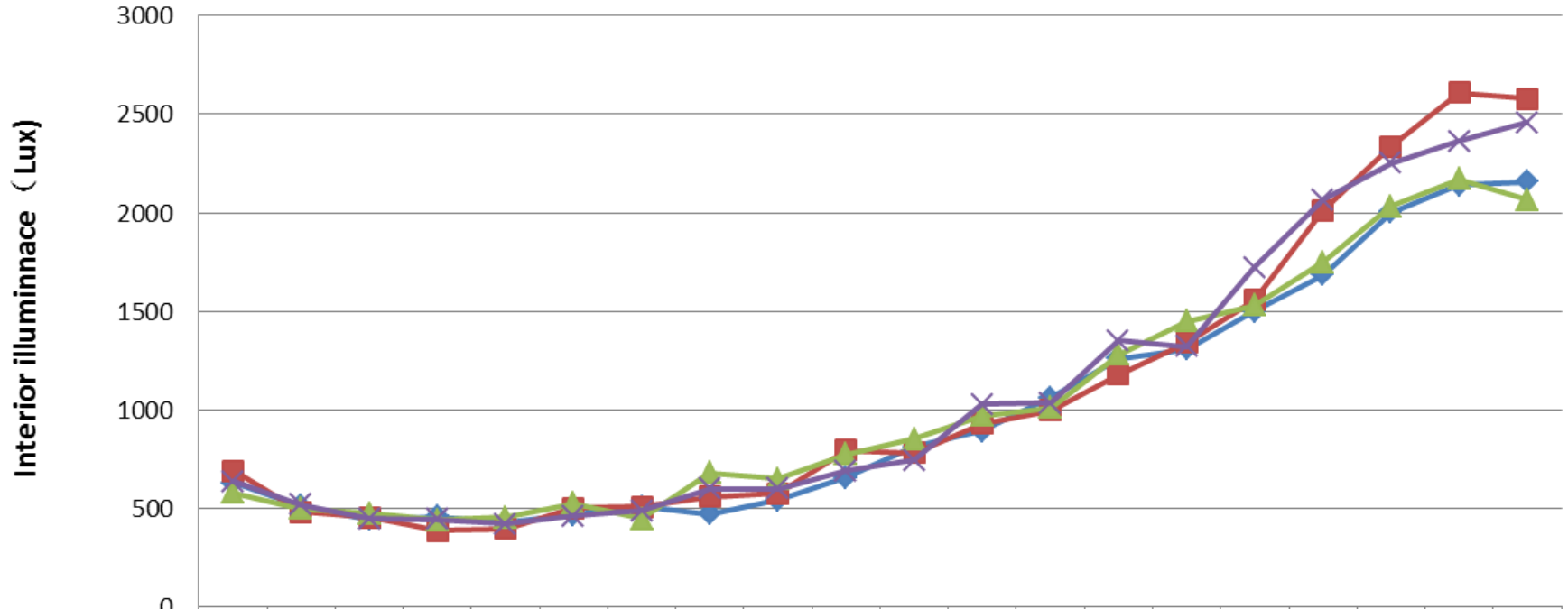
Case Study Simulation Setup



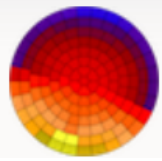


CIE Clear Sky with Klems and TT Data for Prismatic film glazing

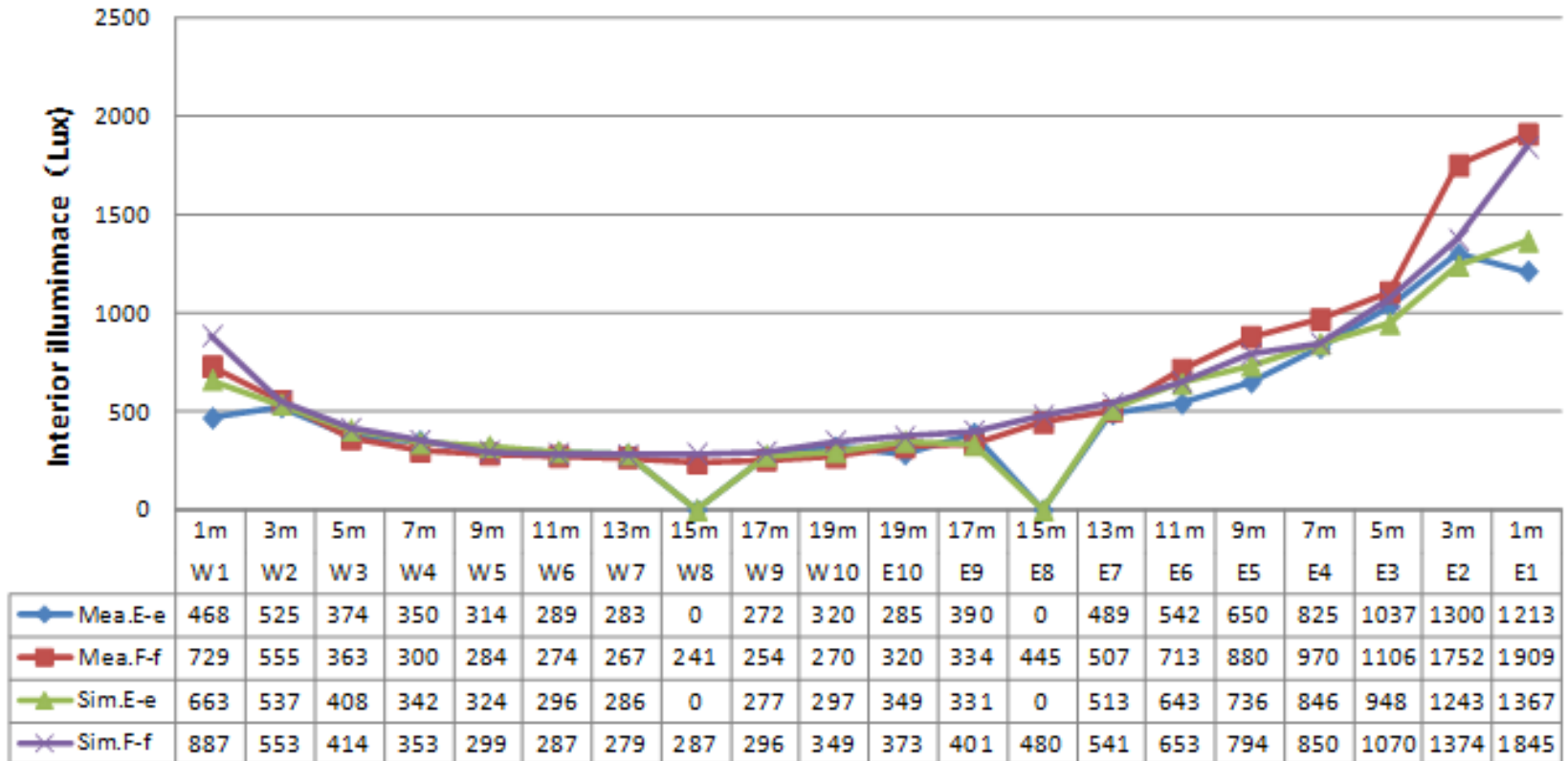
CIE Clear Sky Simulated Illuminance with Klems and TT Data (9:00)

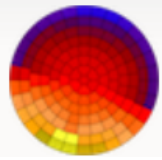


	1m W1	3m W2	5m W3	7m W4	9m W5	11m W6	13m W7	15m W8	17m W9	19m W10	19m E10	17m E9	15m E8	13m E7	11m E6	9m E5	7m E4	5m E3	3m E2	1m E1
◆ CIE Klems E-e	631	513	447	460	429	469	510	474	545	658	813	894	1061	1261	1307	1499	1686	2002	2140	2156
■ CIE Klems F-f	692	482	454	388	400	503	508	560	576	798	782	931	997	1179	1342	1558	2012	2334	2608	2578
▲ CIE TT E-e	580	499	478	444	456	528	448	680	650	776	853	972	1011	1280	1451	1530	1750	2032	2169	2067
✕ CIE TT F-f	638	519	449	446	421	463	488	601	600	692	747	1030	1035	1353	1322	1723	2066	2250	2362	2457

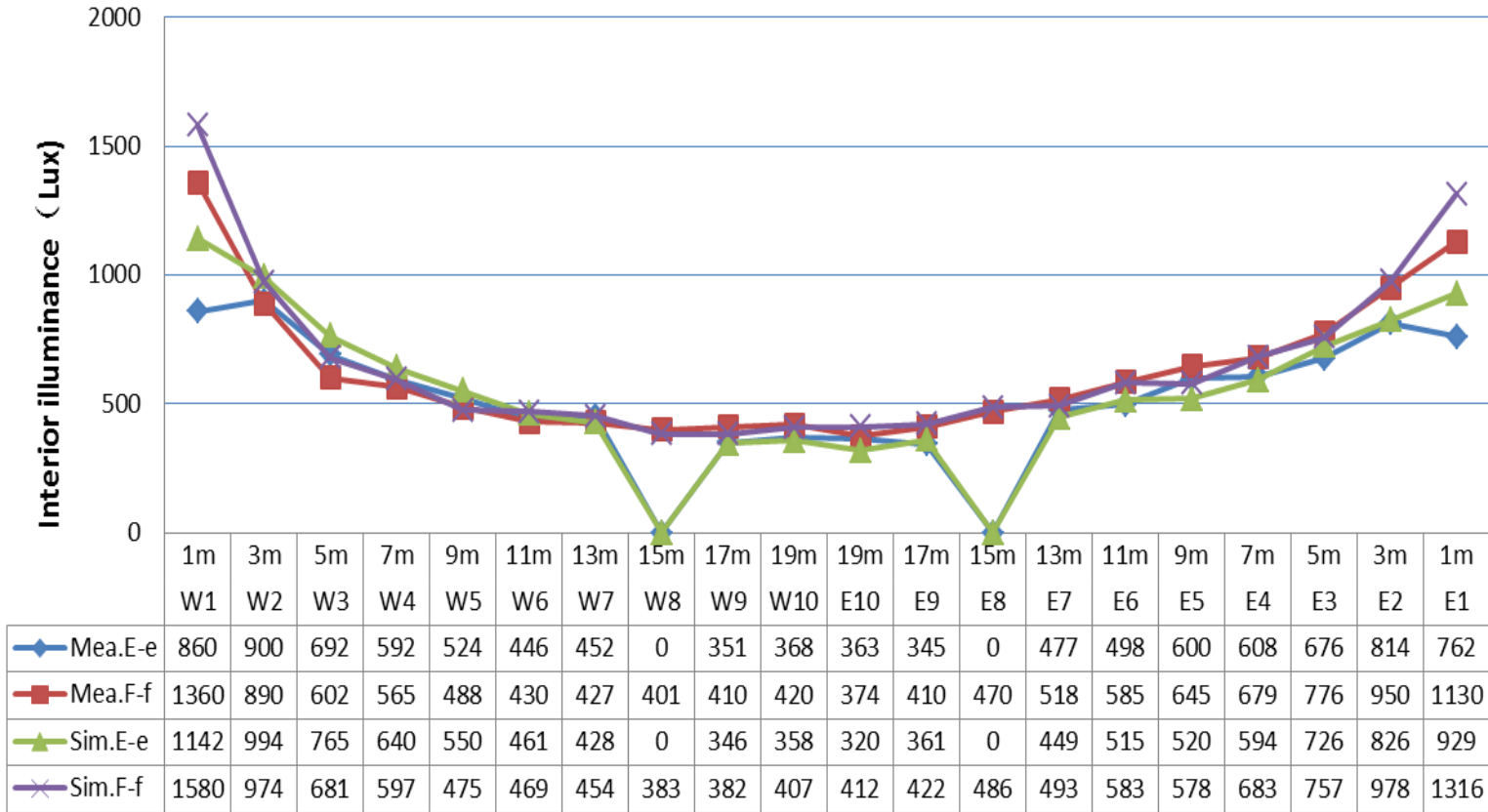


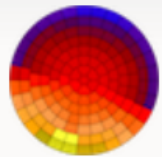
Summer Clear Sky Interior Measured Vs.Simulated Illuminance (9:00)



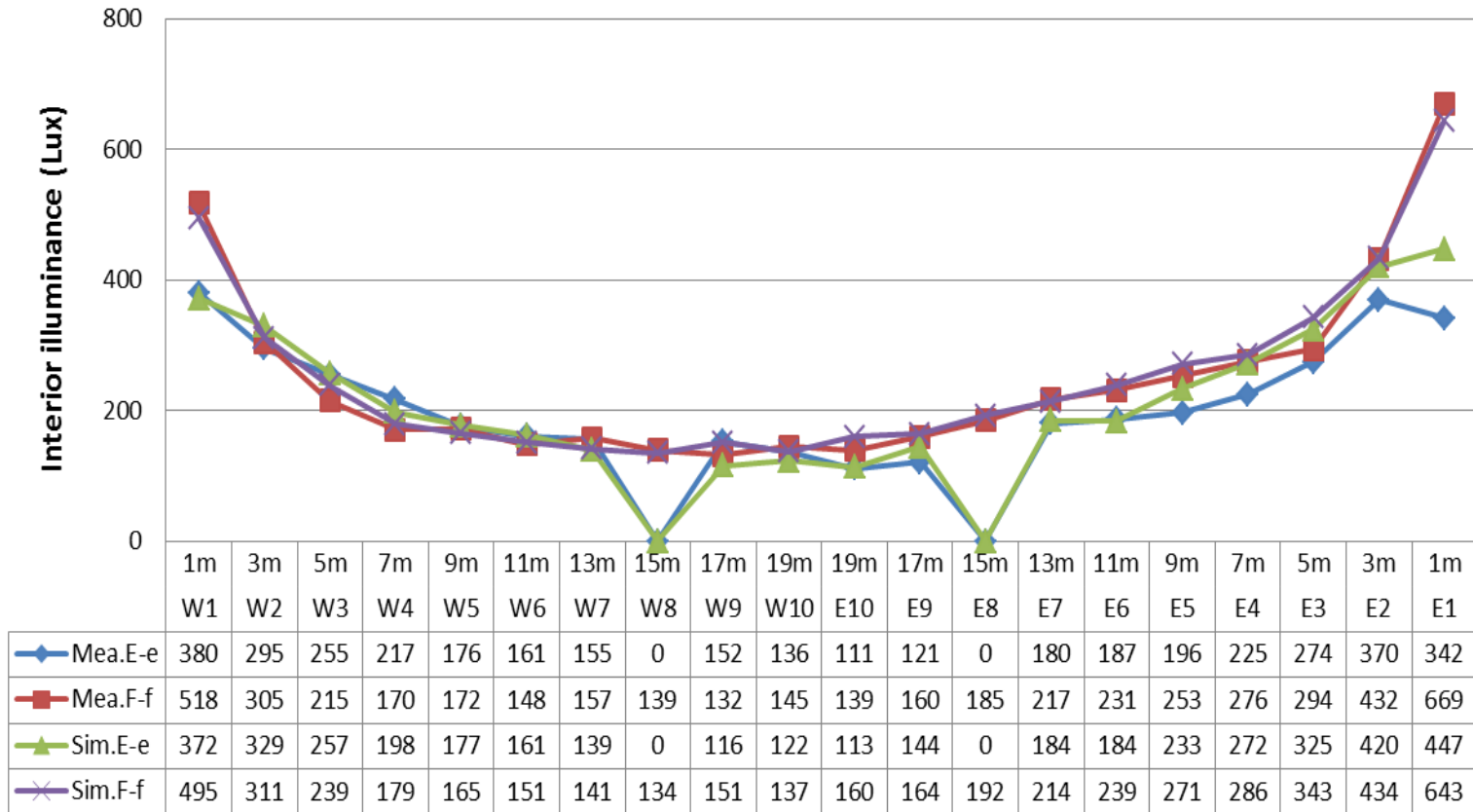


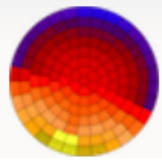
Summer Clear Sky Interior Measured Vs.Simulated Illuminance (12:00)



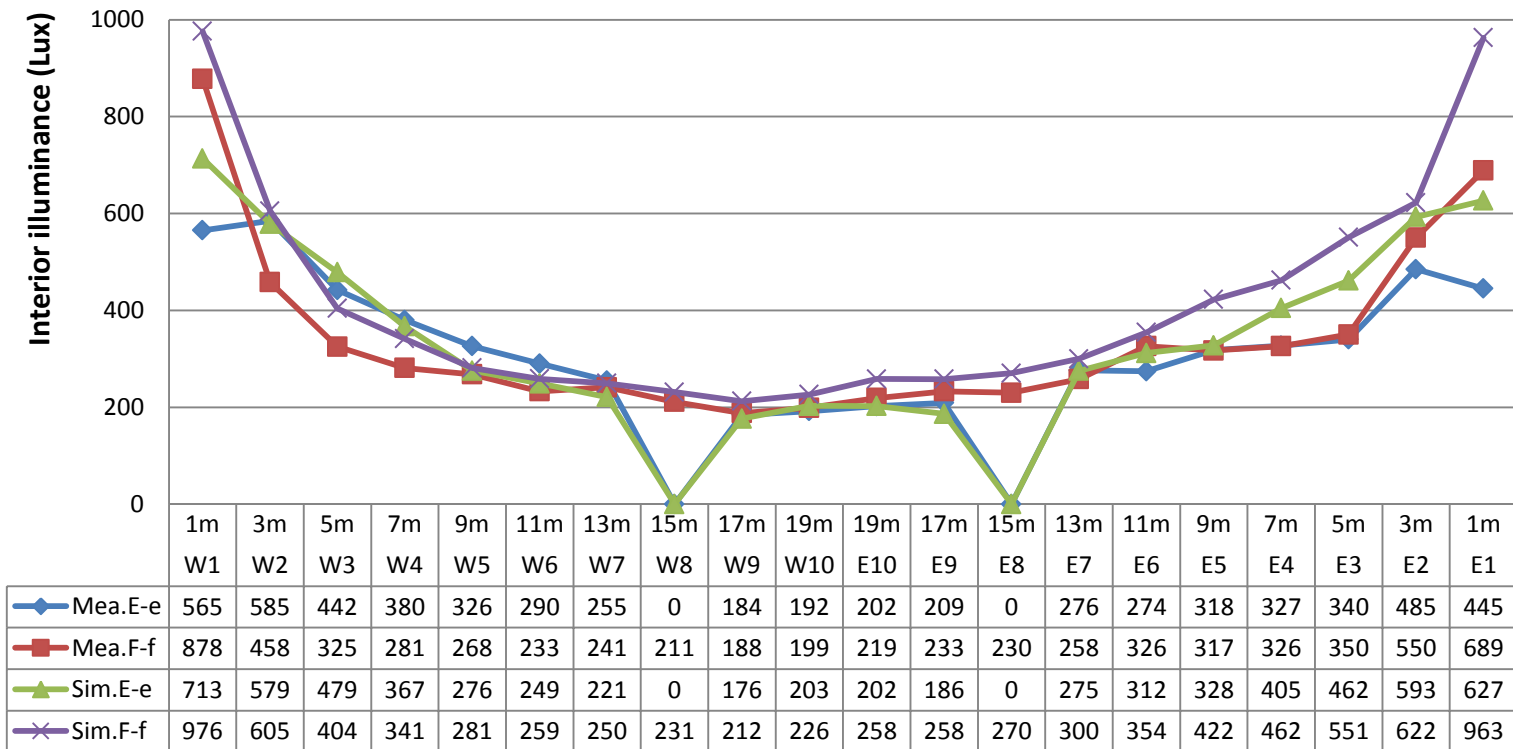


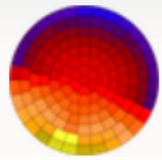
Winter Overcast Sky Interior Measured Vs. Simulated Illuminance (9:00)





Winter Overcast Sky Interior Measured Vs. Simulated Illuminance (12:00)





Climate-Based Daylight Modelling

Climate-based Sky Prismatic film Vs. conventional glazing illuminance

		Date 14-Oct 9:00																				
Unit (Lux)	Points Distance	W1 1 m	W2 3 m	W3 5 m	W4 7 m	W5 9 m	W6 11 m	W7 13 m	W8 15 m	W9 17 m	W10 19 m	E10 19 m	E9 17 m	E8 15 m	E7 13 m	E6 11 m	E5 9 m	E4 7 m	E3 5 m	E2 3 m	E1 1 m	Illuminance Uniformity [Uo]
Prismatic	F-f	865	939	760	620	559	529	627	568	546	606	625	640	819	899	983	1031	1218	1322	1563	2069	0.56
Glazing	E-e	785	1021	865	646	563	538	480	X	498	499	523	626	X	880	884	886	1000	1201	1452	1470	
Conventional	F-f	881	1008	726	637	520	430	465	366	360	360	433	286	523	642	675	758	1178	1537	2281	9231	0.20
Glazing	E-e	802	1084	884	625	558	442	386	X	250	298	338	235	X	479	509	629	958	1353	2253	8815	

		Date 14-Oct 12:00																				
Unit (Lux)	Points Distance	W1 1 m	W2 3 m	W3 5 m	W4 7 m	W5 9 m	W6 11 m	W7 13 m	W8 15 m	W9 17 m	W10 19 m	E10 19 m	E9 17 m	E8 15 m	E7 13 m	E6 11 m	E5 9 m	E4 7 m	E3 5 m	E2 3 m	E1 1 m	Illuminance Uniformity [Uo]
Prismatic	F-f	1504	1643	1152	983	819	900	970	882	804	878	855	1108	1285	1394	1447	1588	1624	1657	1895	2305	0.50
Glazing	E-e	1616	1796	1351	940	986	814	855	X	598	642	666	802	X	934	1106	1143	1397	1373	1591	1516	
Conventional	F-f	1903	1885	1248	817	749	637	539	526	429	434	556	469	652	764	865	785	1056	1262	1691	2151	0.34
Glazing	E-e	1881	2082	1477	1100	807	672	665	X	320	370	303	363	X	494	654	660	880	1057	1379	1583	

		Date 14-Oct 15:00																				
Unit (Lux)	Points Distance	W1 1 m	W2 3 m	W3 5 m	W4 7 m	W5 9 m	W6 11 m	W7 13 m	W8 15 m	W9 17 m	W10 19 m	E10 19 m	E9 17 m	E8 15 m	E7 13 m	E6 11 m	E5 9 m	E4 7 m	E3 5 m	E2 3 m	E1 1 m	Illuminance Uniformity [Uo]
Prismatic	F-f	3522	2750	1623	1160	927	691	684	559	538	523	470	552	569	587	614	663	780	778	963	1207	0.39
Glazing	E-e	2717	3076	1996	1477	1208	895	990	X	423	397	445	424	X	459	491	511	576	670	789	824.2	
Conventional	F-f	2440	15003	13874	1075	894	639	486	350	312	371	296	359	399	413	496	662	747	967	1175	1191	0.09
Glazing	E-e	1894	14919	14422	1513	1002	867	706	X	203	238	322	237	X	297	383	371	474	669	915	866.1	

Note: the cells marked as “X” mean there are columns and no measurements were conducted at these points

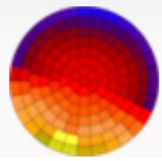


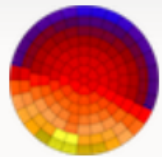
Table 2. Illuminance levels with prismatic and conventional glazing (overcast sky)

		Date 16-Nov 9:00																				
Unit (Lux)	Points Distance	W1 1 m	W2 3 m	W3 5 m	W4 7 m	W5 9 m	W6 11 m	W7 13 m	W8 15 m	W9 17 m	W10 19 m	E10 19 m	E9 17 m	E8 15 m	E7 13 m	E6 11 m	E5 9 m	E4 7 m	E3 5 m	E2 3 m	E1 1 m	Illuminance Uniformity [Uo]
Prismatic Glazing	F-f	495	311	239	179	165	151	141	134	151	137	160	164	192	214	239	271	286	343	434	643	0.47
Conventional Glazing	E-e	372	329	257	198	177	161	139	X	116	122	113	144	X	184	184	233	272	325	420	447	0.24
Prismatic Glazing	F-f	814	605	368	231	182	143	125	110	103	93	126	110	156	168	197	312	376	520	724	1032	0.24
Conventional Glazing	E-e	669	586	391	223	185	150	118	X	76	78	86	83	X	181	169	208	309	464	666	801	0.24

		Date 16-Nov 12:00																				
Unit (Lux)	Points Distance	W1 1 m	W2 3 m	W3 5 m	W4 7 m	W5 9 m	W6 11 m	W7 13 m	W8 15 m	W9 17 m	W10 19 m	E10 19 m	E9 17 m	E8 15 m	E7 13 m	E6 11 m	E5 9 m	E4 7 m	E3 5 m	E2 3 m	E1 1 m	Illuminance Uniformity [Uo]
Prismatic Glazing	F-f	976	605	404	341	281	259	250	231	212	226	258	270	299	311	354	422	462	551	622	963	0.45
Conventional Glazing	E-e	713	579	479	367	276	249	221	X	176	203	202	186	X	275	312	328	405	462	593	627	0.21
Prismatic Glazing	F-f	1659	1206	662	448	304	257	227	169	147	190	192	258	260	300	324	438	577	827	1088	1440	0.21
Conventional Glazing	E-e	1623	1105	718	548	317	273	257	X	135	117	165	151	X	243	263	381	487	742	1032	1166	0.21

		Date 16-Nov 15:00																				
Unit (Lux)	Points Distance	W1 1 m	W2 3 m	W3 5 m	W4 7 m	W5 9 m	W6 11 m	W7 13 m	W8 15 m	W9 17 m	W10 19 m	E10 19 m	E9 17 m	E8 15 m	E7 13 m	E6 11 m	E5 9 m	E4 7 m	E3 5 m	E2 3 m	E1 1 m	Illuminance Uniformity [Uo]
Prismatic Glazing	F-f	660	397	285	247	191	175	164	155	135	145	132	152	166	170	201	200	229	250	323	425	0.48
Conventional Glazing	E-e	472	402	308	260	211	175	163	X	118	122	110	121	X	142	148	172	175	222	283	299	0.28
Prismatic Glazing	F-f	718	690	474	236	205	197	118	113	86	90	104	115	118	143	176	220	267	375	506	550	0.28
Conventional Glazing	E-e	567	682	529	355	282	168	163	X	90	77	78	105	X	122	142	183	221	315	408	414	0.28

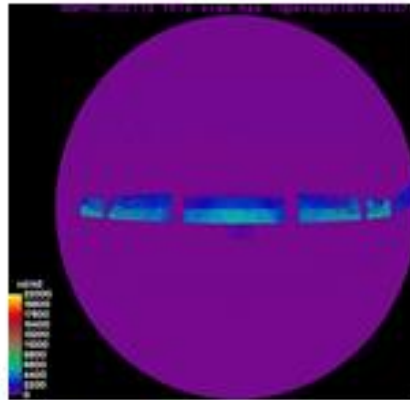
Note: the cells marked as “X” mean there are columns and no measurements were conducted at these points



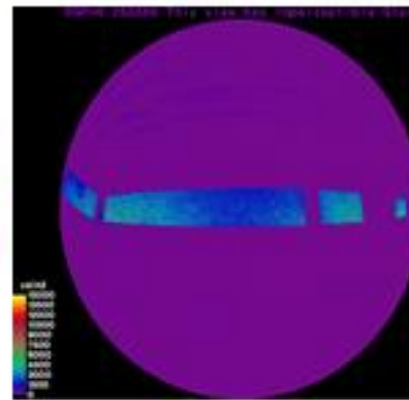
Climate-Based Daylight Modelling

Climate-based Sky Prismatic film Vs. conventional glazing luminance

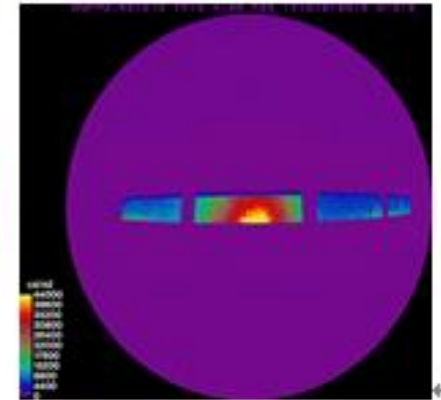
7.8 Prismatic Glazing



East Side 9:00

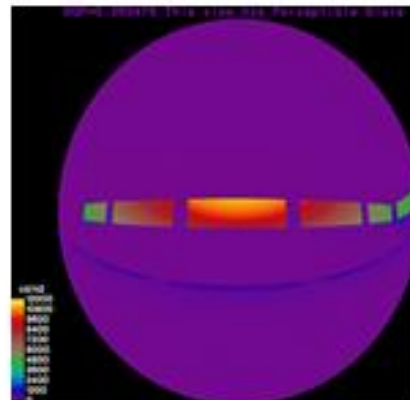


South Side 12:00

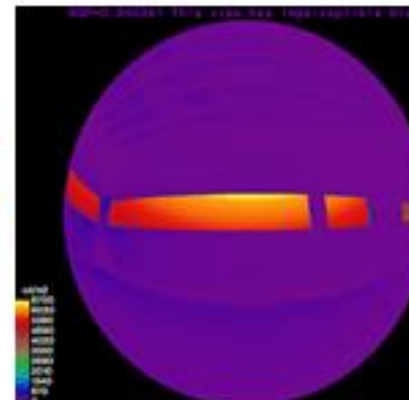


West side 15:00

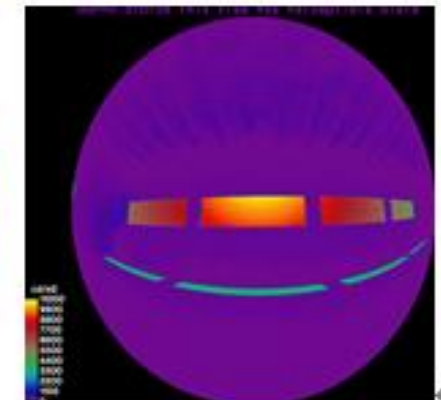
7.8 Convent. Glazing



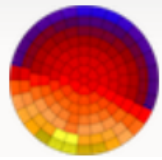
East Side 9:00



South Side 12:00

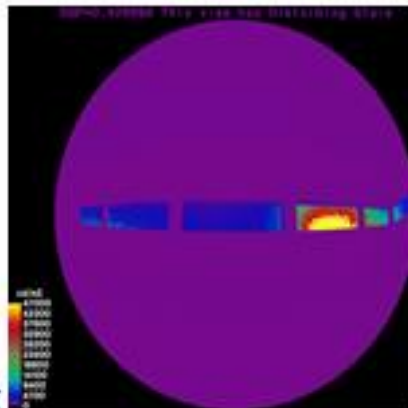


West side 15:00

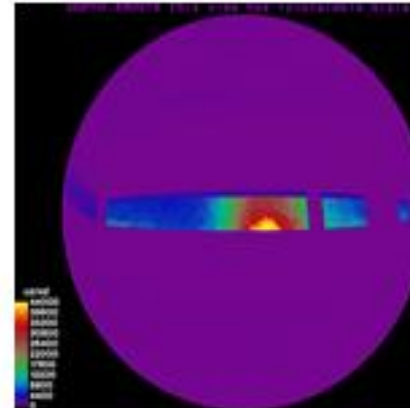


Climate-based Sky Prismatic film Vs. conventional glazing luminance

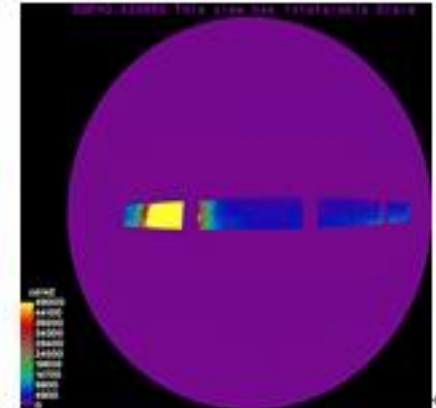
10.14 Prismatic Glazing



East Side 9:00

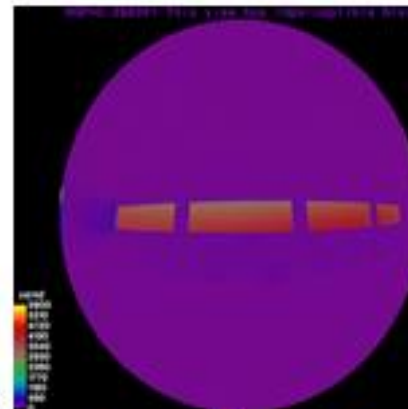


South Side 12:00

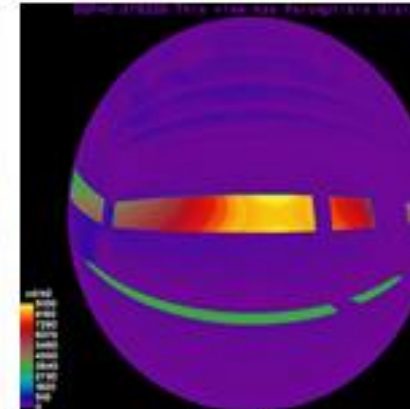


West side 15:00 ↵

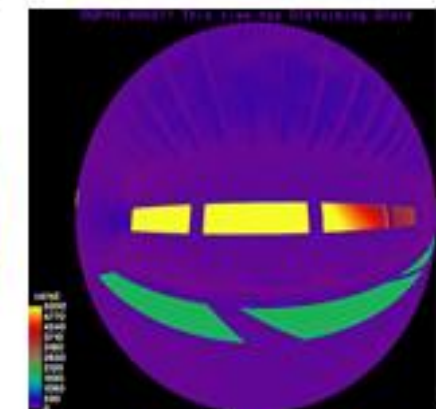
10.14 Convent. Glazing



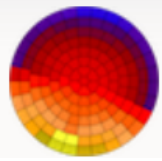
East Side 9:00



South Side 12:00

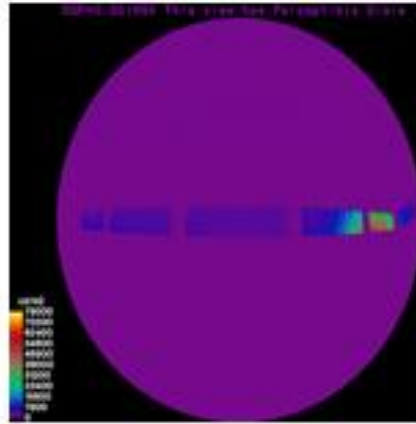


West side 15:00 ↵

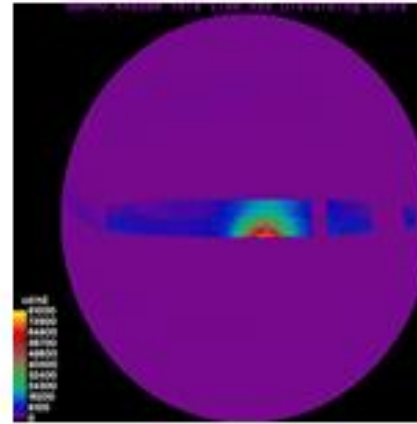


Climate-based Sky Prismatic film Vs. conventional glazing luminance

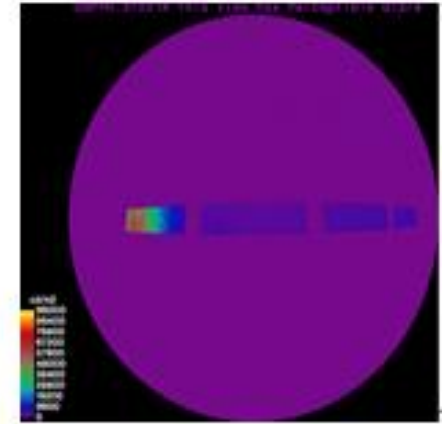
12.12 Prismatic Glazing



East Side 9:00

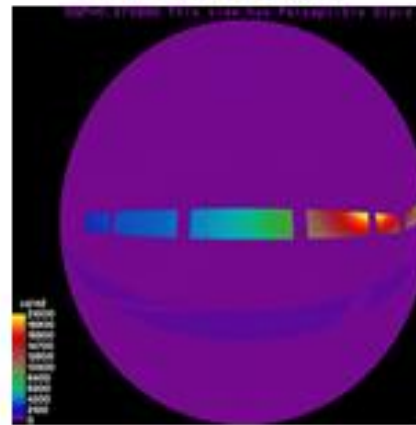


South Side 12:00

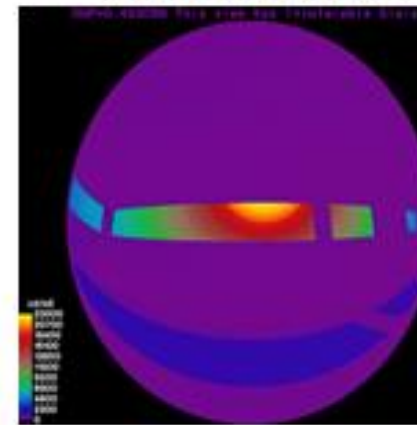


West side 15:00+

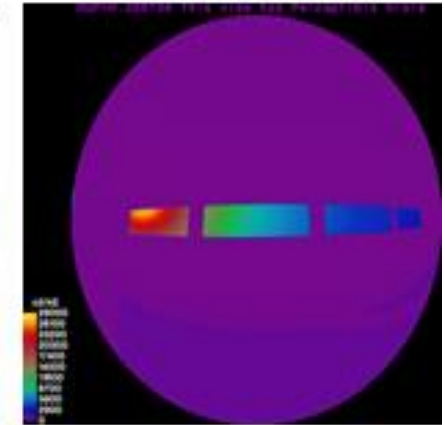
12.12 Convent. Glazing



East Side 9:00



South Side 12:00



West side 15:00+

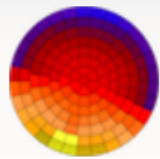
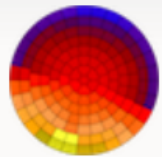
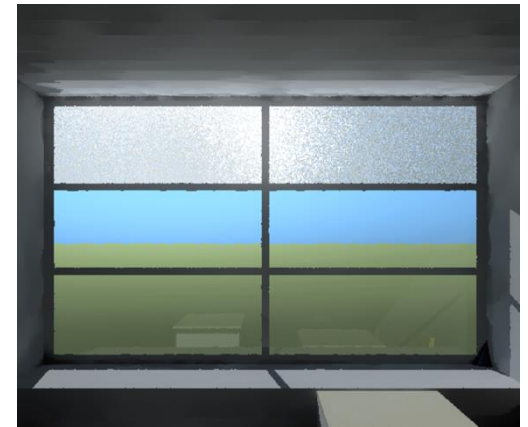


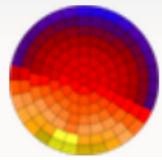
Table 3. Luminance and glare metrics for the simulated prismatic and Low-E glazing

Date	Time	Orientation	Prismatic Glazing			LowE Glazing		
			Max. Luminance	DGP	DGI	Max. Luminance	DGP	DGI
7.8	8:00	East	4300	0.26	23.2	2800	0.28	25.3
7.8	9:00	East	22000	0.30	25.7	12000	0.37	28.2
7.8	10:00	East	28000	0.30	25.8	8500	0.35	27.8
7.8	11:00	South	21000	0.28	23.6	7300	0.35	27.1
7.8	12:00	South	15000	0.28	24.5	6700	0.34	26.7
7.8	13:00	South	11000	0.27	23.3	5200	0.33	26.4
7.8	14:00	West	33000	0.33	26.0	7700	0.34	27.3
7.8	15:00	West	44000	0.46	29.4	11000	0.37	27.9
7.8	16:00	West	43000	0.39	28.4	25000	0.45	29.4
7.8	17:00	West	7200	0.27	23.7	2500	0.30	26.3
10.14	8:00	East	25000	0.30	25.7	18000	0.37	28.5
10.14	9:00	East	47000	0.43	30.4	15000	0.38	27.7
10.14	10:00	East	49000	0.34	27.7	3100	0.35	27.9
10.14	11:00	South	41000	0.38	27.6	11000	0.39	27.4
10.14	12:00	South	44000	0.46	29.4	9100	0.38	27.3
10.14	13:00	South	47000	0.42	28.5	11000	0.37	26.2
10.14	14:00	West	64000	0.39	28.7	14000	0.35	27.8
10.14	15:00	West	49000	0.53	32.2	5400	0.41	27.6
10.14	16:00	West	32000	0.34	26.2	31000	0.41	28.8
10.14	17:00	West	13000	0.27	23.6	15000	0.34	28.3
12.12	8:00	East	17000	0.26	23.3	15000	0.33	27.9
12.12	9:00	East	78000	0.35	28.4	22000	0.38	28.4
12.12	10:00	East	49000	0.36	28.6	17000	0.36	28.3
12.12	11:00	South	59000	0.45	31.1	24000	0.48	28.4
12.12	12:00	South	81000	0.45	31.3	23000	0.48	28.2
12.12	13:00	South	80000	0.43	30.6	25000	0.48	28.3
12.12	14:00	West	61000	0.31	26.4	11000	0.35	27.7
12.12	15:00	West	96000	0.37	29.4	29000	0.39	27.6
12.12	16:00	West	29000	0.29	25.1	1000	0.81	38.8
	Minimum		4300	0.26	23.2	1000	0.28	25.3
	Maximum		96000	0.53	32.2	31000	0.81	38.8
	Mean		39584	0.36	27.2	13285	0.38	27.9
	Median		43000	0.34	27.6	11000	0.37	27.7



1. Applying prismatic film on two classrooms (facing south and west)
2. Onsite questionnaires combined with HDR photos and luminance meter
3. Does the DGP glare index fits for prismatic film glazing?





Thanks for your attention & Questions?

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