

COLOR BRIGHTNESS TEST DATA



Summary of Color Brightness Test Data Measured
and Compiled at Professional Testing Laboratories

Intertek

Lumita

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SUMMARY OF COLOR BRIGHTNESS TEST DATA MEASURED AND COMPILED AT PROFESSIONAL TESTING LABORATORIES

COLOR BRIGHTNESS

Color Light Output, or more simply Color Brightness, is an important measurement standard that quantifies the brightness of Red, Green and Blue, the primary colors of light. In contrast to the normal brightness metric, which only measures white light, Color Brightness provides buyers valuable information about the brightness of their Color photos, videos and graphics.

The US National Institute of Standards and Technology in NISTIR 6657 (January 2009) provides detailed guidance on the measurement of Color Light Output. The same guidelines are part of IDMS Section 15.4. The IDMS is an International Standards document published by the Society for Information Displays and VESA.

Additional information on this metric is available from a wide variety of sources. Here are a few links that provide more information:

- General information: www.ColorLightOutput.com
- National Institute of Standards and Technology: http://www.nist.gov/customcf/get_pdf.cfm?pub_id=901354
- The Society for Information Display: <http://www.icdm-sid.org/downloads/>
- Wikipedia: http://en.wikipedia.org/wiki/Color_light_output

TESTING LABORATORIES

Two independent laboratories have conducted Color Brightness testing for this report:

Intertek: With more than 33,000 employees in 1,000 locations in over 100 countries, Intertek is a leader in the field of product testing and compliance. Intertek holds extensive global accreditations, and recognitions.



Lumita Inc: With 20 years of experience in the digital imaging industry, Lumita, Inc. specializes in the development and testing of display hardware with an emphasis on Color measurement, calibration and image processing. Lumita provides display measurement services for a wide variety of imaging companies. For more information about Lumita visit www.Lumita.com.



PROJECTOR DATA

Tests were conducted on individual units of over 200 different models. The measured Color Brightness of those units is presented below. To aid the reader, the data is organized in two tables. First, all of the units tested by Intertek and Lumita are listed in a comprehensive table. Second is a table that lists all of the models for which the manufacturer provides a Color Brightness specification. For additional information about this testing please email: questions@colorbrightness.com

SUMMARY OF DATA

Table One: Complete Summary of All Test Data

Manufacturer	Model	White Brightness ¹	Color Brightness ²
3M	MP225A	32	30
Aaxa	P3	50	20
Aaxa	P4X	95	40
Acer	H5360	2500	600
Acer	H6500	2100	720
Acer	P5271	3100	700
Acer	X110P	2700	700
Acer	X1161p	2700	720
Acer	X1211K	2500	670
Acer	X1261P	2700	640
BenQ	LW61ST	2000	550
BenQ	MP512	2200	610
BenQ	MP515	2500	750
BenQ	MP522	2000	540
BenQ	MP522ST	2000	590
BenQ	MP525P	2500	840
BenQ	MP622	2700	1090
BenQ	MP622c	2200	1010
BenQ	MP780 ST	2500	600
BenQ	MS502	2700	760

Manufacturer	Model	White Brightness¹	Color Brightness²
BenQ	MS510	2700	730
BenQ	MS513	2700	700
BenQ	MS517	2800	700
BenQ	MS612ST	2500	710
BenQ	MS614	2700	710
BenQ	MW516	2800	670
BenQ	MW519	2800	700
BenQ	MW814ST	2500	770
BenQ	MW851UST	2500	460
BenQ	MW860USTi	3000	480
BenQ	MX503	2700	830
BenQ	MX511	2700	700
BenQ	MX518	2800	720
BenQ	MX520	3000	610
BenQ	MX613ST	2500	660
BenQ	MX660P	3000	790
BenQ	MX711	3200	770
BenQ	MX763	3700	830
BenQ	MX764	4200	980
BenQ	MX810ST	2500	490
BenQ	MX815ST	2700	720
BenQ	MX816ST	3000	640
BenQ	MX850UST	2500	400

Manufacturer	Model	White Brightness¹	Color Brightness²
BenQ	W1070	2000	1500
BenQ	W7000	2000	1500
Canon	REALiS X700	4000	3830
Casio	XJ-A130	2000	540
Casio	XJ-A141	2500	1200
Casio	XJ-A256	3000	1370
Casio	XJ-H1700	4000	770
Casio	XJ-M140	2500	1440
Casio	XJ-M240	2500	1280
Casio	XJ-M245	2500	1160
Casio	XJ-ST145	2500	510
Dell	1409X	2500	820
Dell	2400MP	3000	710
Dell	4320	4300	1080
Dell	S300wi	2200	480
Dell	S500wi	3200	840
Hitachi	CP-DX250	2500	480
Hitachi	CP-DX300	3000	440
InFocus	IN102	2500	740
InFocus	IN1110	2100	530
InFocus	IN1112	2200	590
InFocus	IN112	2700	640
InFocus	IN114	2700	660

Manufacturer	Model	White Brightness¹	Color Brightness²
InFocus	IN114ST	2700	560
InFocus	IN116	2700	630
InFocus	IN122	3200	760
InFocus	IN124	3200	840
InFocus	IN124ST	3000	690
InFocus	IN126	3200	810
InFocus	IN126ST	3000	630
InFocus	IN2102	2500	760
InFocus	IN2104	2500	650
InFocus	IN2112	3000	750
InFocus	IN2114	3000	760
InFocus	IN2116	3000	730
InFocus	IN2124	3200	660
InFocus	IN2126	3200	840
InFocus	IN3102	3000	840
InFocus	IN3104	3500	1010
InFocus	IN3114	3500	910
InFocus	IN3116	3500	930
InFocus	IN35	2500	840
InFocus	IN37	3000	970
InFocus	IN3914	2700	730
InFocus	IN5312	4500	1190
InFocus	Work Big IN24+	2400	720

Manufacturer	Model	White Brightness¹	Color Brightness²
InFocus	Work Big IN26+	2400	640
InFocus	Work Big IN32	2000	940
InFocus	Work Big IN34	2500	670
InFocus	Work Big IN36	3000	870
LG	BS-275	2700	700
LG	PA-75U	700	230
Mitsubishi	EX240	2500	510
Mitsubishi	HC1500	1600	720
Mitsubishi	HC4000	1300	400
Mitsubishi	HC7800D	1500	1090
Mitsubishi	HD4000U	2000	690
Mitsubishi	WD380U-EST	2800	660
Mitsubishi	XD211U	2200	660
Mitsubishi	XD221U	2300	810
Mitsubishi	XD221U-ST	2000	650
Mitsubishi	XD250U	2700	1050
Mitsubishi	XD3500U	5000	940
Mitsubishi	XD360U-EST	2500	350
Mitsubishi	XD460U	2600	850
Mitsubishi	XD490U	3000	780
Mitsubishi	XD500U	2200	640
Mitsubishi	XD700U	5000	850
NEC	NP110	2200	640

Manufacturer	Model	White Brightness¹	Color Brightness²
NEC	NP200	2100	480
NEC	NP40	2200	830
NEC	NP4001 4S	4500	1640
NEC	NP4001 6S	4500	1180
NEC	NP50	2600	740
NEC	NP60	3000	790
NEC	NP61	3000	700
NEC	NP-U300X	3000	770
NEC	NP-U310W	3100	690
NEC	NP-V260	2600	620
NEC	NP-V260W	2600	620
NEC	NP-V260X	2600	640
NEC	NP-V300W	3000	740
NEC	NP-V300X	3000	740
NEC	NP-VE281	2800	590
NEC	NP-VE281X	2800	700
NEC	PX750U	7500	1250
NEC	U260W	2600	540
Optoma	DS339	2600	760
Optoma	DS550	2600	650
Optoma	DX550	2600	640
Optoma	EP1691	2500	820
Optoma	EP716	1800	510

Manufacturer	Model	White Brightness¹	Color Brightness²
Optoma	EP719	2000	600
Optoma	EP721	2200	550
Optoma	EP727	2200	590
Optoma	EP728	2700	810
Optoma	EP771	3000	930
Optoma	ES522	2800	660
Optoma	EW1691e	3000	770
Optoma	EW536	2800	700
Optoma	EX525ST	2500	650
Optoma	EX530	2600	570
Optoma	EX532	2800	650
Optoma	EX551	2800	640
Optoma	EX765	4000	810
Optoma	EX784	5000	1060
Optoma	EX785	5000	1300
Optoma	GT750e	3000	950
Optoma	HD20	1700	1020
Optoma	HD23	2500	680
Optoma	HD33	1800	940
Optoma	HD65	1600	650
Optoma	HD66	2500	710
Optoma	ML300	300	130
Optoma	ML500	500	140

Manufacturer	Model	White Brightness¹	Color Brightness²
Optoma	PK320	100	60
Optoma	PRO150S	2800	810
Optoma	PRO160S	3000	810
Optoma	PRO250X	2800	740
Optoma	PRO260X	3000	770
Optoma	PRO360W	3000	820
Optoma	PT100	50	10
Optoma	PT110	100	20
Optoma	TS526	2800	700
Optoma	TS551	2800	640
Optoma	TW766W	4000	800
Optoma	TX536	2800	670
Optoma	TX542	2800	680
Optoma	ZW210ST	2000	410
Optoma	ZW212ST	2500	390
Optoma	ZX210ST	2000	360
Optoma	ZX212ST	2500	280
Panasonic	PT-CW230EA	2500	550
Panasonic	PT-D5700U	6000	3050
Panasonic	PT-DZ570U	4000	2240
Panasonic	PT-DZ6710	6000	2990
Panasonic	PT-DZ770UK	7000	2340
Panasonic	PT-LS26U	2600	670

Manufacturer	Model	White Brightness¹	Color Brightness²
Panasonic	PT-RZ370U	3500	840
Sharp	PG-F212X	2300	860
Sharp	PG-LX2000	2800	790
Sharp	XR-30X	2300	740
Sharp	XR-32X	2500	750
Sharp	XR-41X	2600	660
Smart	LightRaise 40wi	2500	750
Smart	UX60	2000	730
Toshiba	TDP-T45U	2500	670
Viewsonic	PJ506D	2000	630
Viewsonic	PJD5123	2700	730
Viewsonic	PJD5132	2800	730
Viewsonic	PJD5133	2700	700
Viewsonic	PJD5223	2700	680
Viewsonic	PJD5232	2800	580
Viewsonic	PJD5233	2700	640
Viewsonic	PJD5523W	2700	620
Viewsonic	PJD6220	2300	640
Viewsonic	PJD6531W	3000	940
Viewsonic	PJD6553w	3500	870
Viewsonic	PJD7583w	3000	730
Viewsonic	PLED-W500	500	120
ViewSonic	Pro8200	2000	780

Manufacturer	Model	White Brightness¹	Color Brightness²
Viewsonic	Pro8450w	4500	980
Viewsonic	PRO8500	5000	1300
Vivitek	D512-3D	2600	560
Vivitek	D530	3200	790
Vivitek	D535	3200	620
Vivitek	D537W	3200	720
Vivitek	D538-W	3200	680
Vivitek	D791ST	3000	340
Vivitek	D795WT	3000	320
Vivitek	D832MX	3200	780
Vivitek	D940VX	4300	930
Vivitek	Q2-W	300	50
Vivitek	Qumi Q2	300	50

Table Two: Summary of All Models for which the Manufacturer Specifies Color Brightness

Manufacturer	Model	White Brightness³	Color Brightness³
Dukane	ImagePro 8971	6,000	6,000
Dukane	ImagePro 8973W	5,500	5,500
Dukane	ImagePro 8970	5,000	5,000
Dukane	ImagePro 8975WU	5,000	5,000
Dukane	ImagePro 8974WU	4,200	4,200
Dukane	ImagePro 8972W	4,000	4,000
Dukane	ImagePro 8930	3,200	3,200
Dukane	ImagePro 8112	3,000	3,000
Dukane	ImagePro 8931W	3,000	3,000
Dukane	ImagePro 8928	2,700	2,700
Dukane	ImagePro 8755N	2,400	2,400
Epson	PowerLite Pro Z8250NL	10,000	10,000
Epson	PowerLite Pro Z8255NL	10,000	10,000
Epson	PowerLite Pro Z8350WNL	8,500	8,500
Epson	PowerLite Pro Z8150NL	8,000	8,000
Epson	PowerLite Pro Z8050WNL	7,000	7,000
Epson	PowerLite Pro Z8450WUNL	7,000	7,000
Epson	PowerLite Pro Z8455WUNL	7,000	7,000
Epson	PowerLite Pro Z8000WUNL	6,000	6,000
Epson	PowerLite 4300	5,200	5,200
Epson	PowerLite Pro G5950	5,200	5,200
Epson	PowerLite Pro G5950NL	5,200	5,200
Epson	PowerLite 1960	5,000	5,000
Epson	PowerLite 1965	5,000	5,000
Epson	PowerLite 1950	4,500	4,500
Epson	PowerLite 1955	4,500	4,500
Epson	PowerLite 4100	4,500	4,500
Epson	PowerLite 4200W	4,500	4,500
Epson	PowerLite Pro G5550	4,500	4,500
Epson	PowerLite Pro G5550NL	4,500	4,500
Epson	PowerLite Pro G5650W	4,500	4,500

Manufacturer	Model	White Brightness³	Color Brightness³
Epson	PowerLite Pro G5650WNL	4,500	4,500
Epson	PowerLite Pro G5750WU	4,500	4,500
Epson	PowerLite Pro G5750WUNL	4,500	4,500
Epson	PowerLite 1940W	4,200	4,200
Epson	PowerLite 1945W	4,200	4,200
Epson	PowerLite 1880	4,000	4,000
Epson	PowerLite D6250	4,000	4,000
Epson	PowerLite Pro G5450WU	4,000	4,000
Epson	PowerLite Pro G5450WUNL	4,000	4,000
Epson	VS400	4,000	4,000
Epson	VS410	4,000	4,000
Epson	PowerLite 1850W	3,700	3,700
Epson	VS350W	3,700	3,700
Epson	PowerLite 1835	3,500	3,500
Epson	PowerLite D6150	3,500	3,500
Epson	PowerLite D6155W	3,500	3,500
Epson	PowerLite 915W	3,200	3,200
Epson	BrightLink 485Wi	3,100	3,100
Epson	PowerLite 485W	3,100	3,100
Epson	BrightLink 430i	3,000	3,000
Epson	BrightLink 435Wi	3,000	3,000
Epson	BrightLink 480i	3,000	3,000
Epson	PowerLite 1770W	3,000	3,000
Epson	PowerLite 1771W	3,000	3000
Epson	PowerLite 1776W	3,000	3,000
Epson	PowerLite 430	3,000	3,000
Epson	PowerLite 435W	3,000	3,000
Epson	PowerLite 480	3,000	3,000
Epson	PowerLite 905	3,000	3,000
Epson	PowerLite X15	3,000	3,000
Epson	EX3210	2,800	2,800
Epson	EX3212	2,800	2,800
Epson	EX5210	2,800	2,800
Epson	EX7210	2,800	2,800

Manufacturer	Model	White Brightness³	Color Brightness³
Epson	MegaPlex MG-850HD	2,800	2,800
Epson	PowerLite 1221	2,800	2,800
Epson	PowerLite 1261W	2,800	2,800
Epson	PowerLite Home Cinema 710HD	2,800	2,800
Epson	PowerLite X12	2,800	2,800
Epson	PowerLite 96W	2,700	2,700
Epson	BrightLink 475Wi	2,600	2,600
Epson	PowerLite 1751	2,600	2,600
Epson	PowerLite 1761W	2,600	2,600
Epson	PowerLite 470	2,600	2,600
Epson	PowerLite 475W	2,600	2,600
Epson	PowerLite 93+	2,600	2,600
Epson	PowerLite 95	2,600	2,600
Epson	PowerLite S11	2,600	2,600
Epson	VS210	2,600	2,600
Epson	VS310	2,600	2,600
Epson	VS315W	2,600	2,600
Epson	BrightLink 425Wi	2,500	2,500
Epson	BrightLink 455Wi-T	2,500	2,500
Epson	MovieMate 85HD	2,500	2,500
Epson	PowerLite 420	2,500	2,500
Epson	PowerLite 425W	2,500	2,500
Epson	PowerLite Home Cinema 705HD	2,500	2,500
Epson	PowerLite Presenter	2,500	2,500
Epson	PowerLite Home Cinema 5010	2,400	2,400
Epson	PowerLite Home Cinema 5010e	2,400	2,400
Epson	PowerLite Home Cinema 5020UB	2,400	2,400
Epson	PowerLite Home Cinema 5020UBe	2,400	2,400
Epson	PowerLite Pro Cinema 6010	2,400	2,400
Epson	PowerLite Pro Cinema 6020UB	2,400	2,400
Epson	PowerLite Home Cinema 3020	2,300	2,300
Epson	PowerLite Home Cinema 3020e	2,300	2,300
Epson	MegaPlex MG-50	2,200	2,200
Epson	PowerLite Home Cinema 3010	2,200	2,200

Manufacturer	Model	White Brightness³	Color Brightness³
Epson	PowerLite Home Cinema 3010e	2,200	2,200
Epson	PowerLite 410W	2,000	2,000
Epson	PowerLite Home Cinema 8350	2,000	2,000
Epson	PowerLite Pro Cinema 9350	2,000	2,000
Epson	PowerLite Pro Cinema 9700 UB	1,600	1,600
Hitachi	CP-X8160	6,000	6,000
Hitachi	CP-WX8255	5,500	5,500
Hitachi	CP-WU8450	5,000	5,000
Hitachi	CP-X8150	5,000	5,000
Hitachi	CP-WU8440	4,200	4,200
Hitachi	CP-WX8240	4,000	4,000
Hitachi	CP-X4014WN	4,000	4,000
Hitachi	CP-X4015WN	4,000	4,000
Hitachi	CP-X3014WN	3,200	3,200
Hitachi	CP-X3015WN	3,200	3,200
Hitachi	CP-X3021WN	3,200	3,200
Hitachi	CPX11WN	3,200	3,200
Hitachi	CP-A301N	3,000	3,000
Hitachi	CP-D31N	3,000	3,000
Hitachi	CP-WX3014WN	3,000	3,000
Hitachi	CP-WX3015WN	3,000	3,000
Hitachi	CP-WX2515WN	2,700	2,700
Hitachi	CP-X2515WN	2,700	2,700
Hitachi	CP-X2521WN	2,700	2,700
Hitachi	CP-RX93	2,600	2,600
Hitachi	CP-RX94	2,600	2,600
Hitachi	CPWX8	2,600	2,600
Hitachi	BZ-1	2,500	2,500
Hitachi	BZ-1M	2,500	2,500
Hitachi	CP-AW2519N	2,500	2,500
Hitachi	CP-AW2519NM	2,500	2,500
Hitachi	CP-AW251N	2,500	2,500
Hitachi	CP-X2015WN	2,400	2,400
Hitachi	CP-A221N	2,200	2,200

Manufacturer	Model	White Brightness³	Color Brightness³
Hitachi	CP-A222WN	2,200	2,200
Hitachi	CP-X2021WN	2,200	2,200
Sony	VPL-FH500L	7,000	7,000
Sony	VPL-FX500L	7,000	7,000
Sony	VPL-FX37	6000	6,000
Sony	VPL-FH35	5,200	5,200
Sony	VPL-FX35	5,000	5,000
Sony	VPL-FH30	4,300	4,300
Sony	VPL-FX30	4,200	4,200
Sony	VPL-EW275	3,700	3,700
Sony	VPL-EX275	3,700	3,700
Sony	VPL-EX175	3,600	3,600
Sony	VPL-DX140	3,200	3,200
Sony	VPL-EX245	3,200	3,200
Sony	VPL-EW245	3,100	3,100
Sony	VPL-EX145	3,100	3100
Sony	VPL-DX11	3,000	3,000
Sony	VPL-DX15	3,000	3,000
Sony	VPL-EW130	3,000	3,000
Sony	VPL-EX225	2,700	2,700
Sony	VPL-DW120	2,600	2,600
Sony	VPL-DX120	2,600	2,600
Sony	VPL-EW225	2,600	2,600
Sony	VPL-EX120	2,600	2,600
Sony	VPL-MX20	2,500	2,500
Sony	VPL-MX25	2,500	2,500
Sony	VPL-EX100	2,300	2,300

METHODOLOGY

Experiment Design

The US National Institute of Standards and Technology in NISTIR 6657 (January 2009) provides detailed guidance on the measurement of Color Light Output. The same guidelines are part of the ICDM-DMS 1.03a Section 15.4 (International Committee on Display Metrology - Display Measurement Standard.) Both of these documents were carefully followed in the design and implementation of the experiment and the apparatus used.

Light Measurement Devices, Calibration and their Experimental Control

Lumita:

Two types of measurement instruments were used by Lumita for this study. Primary data for the 9 standard measurement test points was gathered by a Photo Research PR-524 Illuminance meter with 9 PR-514 remote heads. A NIST traceable calibration was performed at the factory on these heads prior to this experiment and a current certificate of calibration is available.

Spectral measurements used as a control in every experiment and to correct the PR-514 data were made with a Photo Research PR-670 Spectroradiometer and a CR-670 Illuminance head. The PR-670/CR-670 combination also holds a current NIST traceable certificate of calibration for both illuminance and spectral accuracy.

Filter based photopic illuminance meters like the PR-524 are calibrated using Illuminant A (Tungsten.) Due to the mercury lamps and dichroic filters used in DLP front projection displays the absolute accuracy of filter based photometry that is calibrated with a wide spectrum source such as illuminant A could be questioned. In fact our own experiences at Lumita demonstrate wide variability (when measuring projectors) among different brands and models of photometers depending on the quality of their filter set.

In order to remove any error that might result from the unique spectra of the projector, a baseline spectral correction factor was calculated for each projector model. With the projector stabilized, measurements were taken of white at test point 5 (center.) The measurement jig allows the CR-670 head to be accurately (+- 0.5mm) swapped with the PR-514 head. 8 alternating measurements were made and a spectral correction factor for the PR-514 was calculated for each projector type.

As a further control to assure accurate operation of all systems the PR-670 was placed in the center position at the beginning of data collection. For each trial a control spectral illuminance measurement was taken, then the PR-514 head was returned and the trial completed. At the end of each trial the control was checked and compared to the average test point 5 PR-514 data to make sure it was within the expected variability.

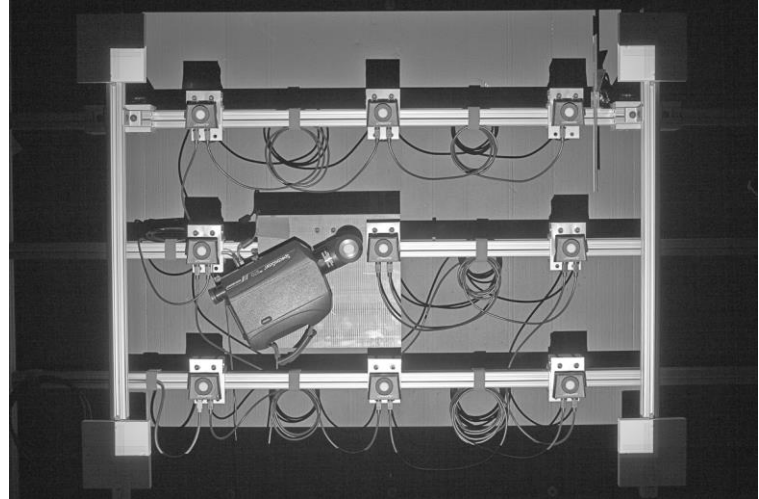
Intertek:

Below is a partial list of the test equipment used at Intertek to measure Color Brightness:

Description	Manufacturer	Model
Digital Power Meter	Yokogawa	WT230
Hydra II Data Acquisition Unit	Fluke	2625A
Programmable Power Source: 0-300 V/DC,15-1kHz / 2KVA	Chroma	1604
Hygro-Thermometer Datalogger	Extech	Easy View 25
Chroma Meter Model CL-200A	Konica Minolta	CL-200A

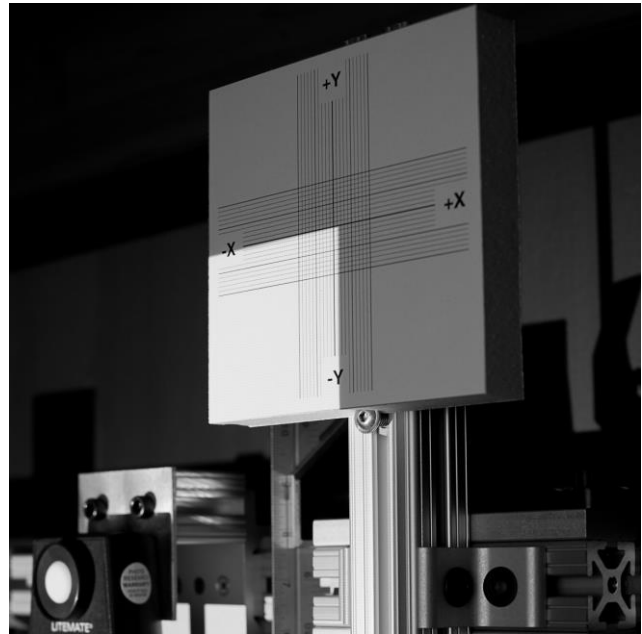
Measurement Jig

A precision measurement jig was constructed to provide precise alignment and positioning of the illuminance heads and the focal plane of the projector. The jig creates a relative repeatability specification of $\pm 2\text{mm}$ for the placement of the measurement heads in all axis X,Y and Z. The Z accuracy of the placement within the focal plane for all the measurement heads is $\pm 2\text{mm}$ and the total focal plane uncertainty based on possible focus error is 6 mm. The jig also allows the precise swapping of the CR-670 and the PR-514 Illuminance heads at position 5. This allows a control measurement to be taken at the beginning of each experiment. The jig provides corner focus targets allowing the projector geometry to be properly aligned to the jig. A laser center line is projected during setup to facilitate aligning the optical axis of the projector perpendicular to the focal plane.



Focal Plane Area

Due to minor anomalies and deviations in each projector's optics, precise placement of all four corners in an exact rectangle can be difficult or impossible to achieve. This can cause inaccuracy in the calculation of light output due to the need for a precise screen area measurement. The focal plane targets in each of the four corners of the jig have a precision x,y grid in 2mm steps. This allows the experimenter to record the deviation in x,y for each of the four corners. The measurement software uses these values to calculate the diagonals of the focal plane from which the actual focal plane area is calculated for each individual trial. This procedure is described in NISTIR 6657 and ICDM-DMS 1.03a.



1. The White Brightness specification for these models was obtained from ProjectorCentral.com as the reported manufacturer's specification.
2. The manufacturers in table one have not provided Color Light Output (Color Brightness) specifications. These models were tested by third party laboratories in accordance with IDMS 15.4 in order to provide critical information to buyers.
3. Many manufacturers provide specifications for both White Light Output (White Brightness) and Color Light Output (Color Brightness). Manufacturers publish specifications on product performance and are responsible for their legitimacy and reliability. See manufacturer's websites or contact the manufacturer for details.

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