Uniform light source with LEDs

Dingeman Beuzekom - Laser 2000 Benelux

Outline presentation

- Wensen voor kalibratiebron
- Samenvoegen spectrale verdelingen
- Mogelijke obstakels
- Praktijk resultaten diverse spectrale verdelingen
- Praktijk apparaat
- Conclusies

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Wensen voor kalibratiebron

- Stabiel
- Verschillende lichtverdelingen:
  - Halogeen
  - Led
  - TL-buis
  - Daglicht
- Snel
- Robuust

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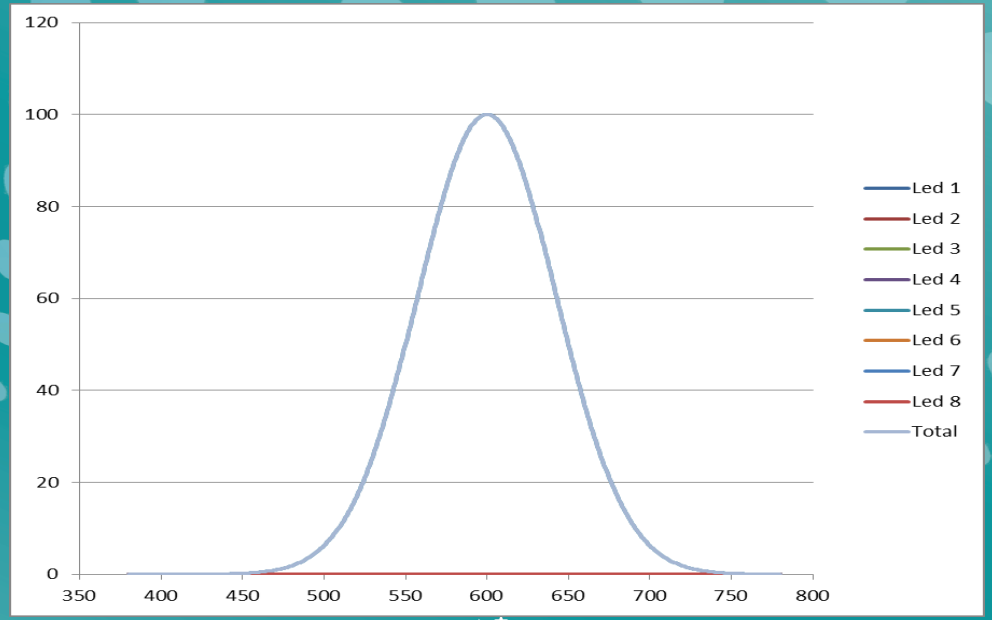
Spectrale verdeling 1

Intensiteitsverdeling

van 1 LED



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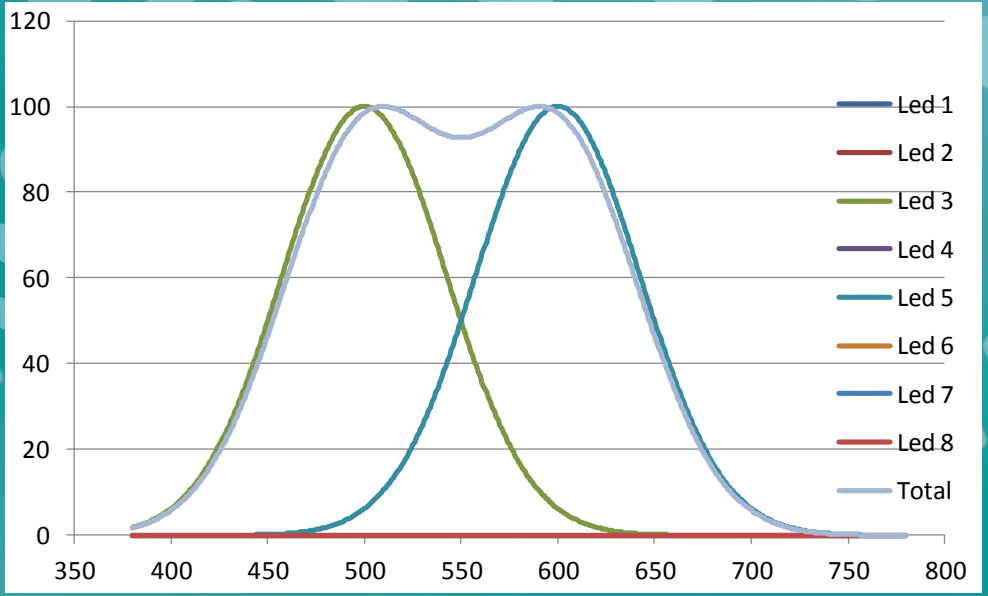
Spectrale verdeling 2

Intensiteitsverdeling

van 2 LEDs



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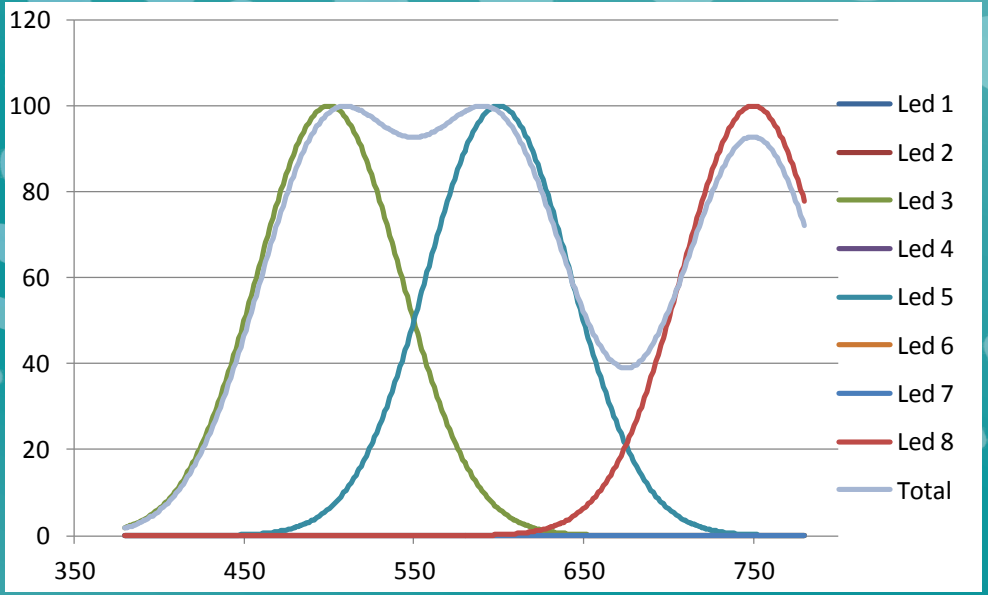
Spectrale verdeling 3

Intensiteitsverdeling

van 3 LEDs.



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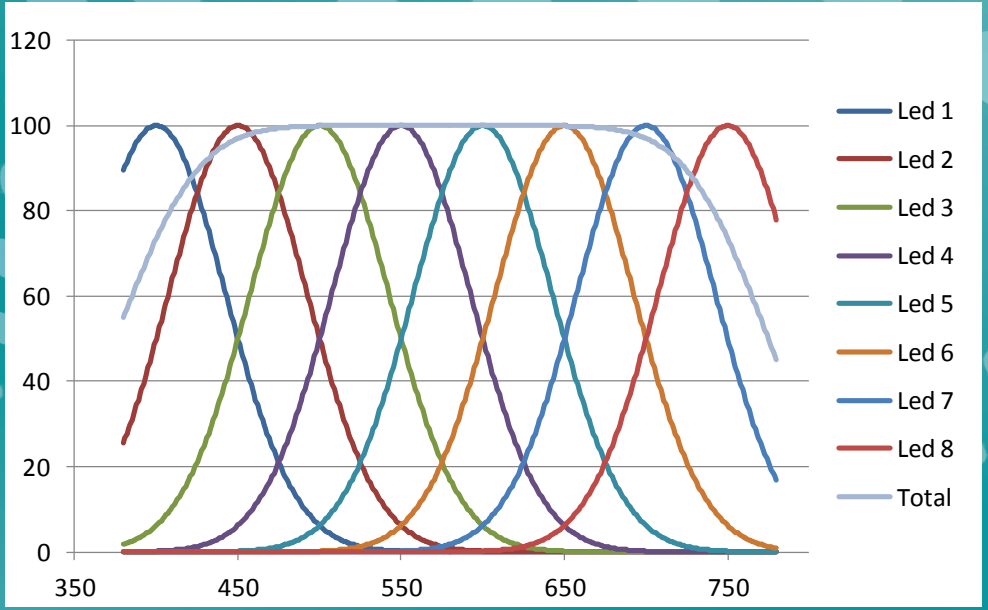
Spectrale verdeling 4

Intensiteitsverdeling

van 8 LEDs



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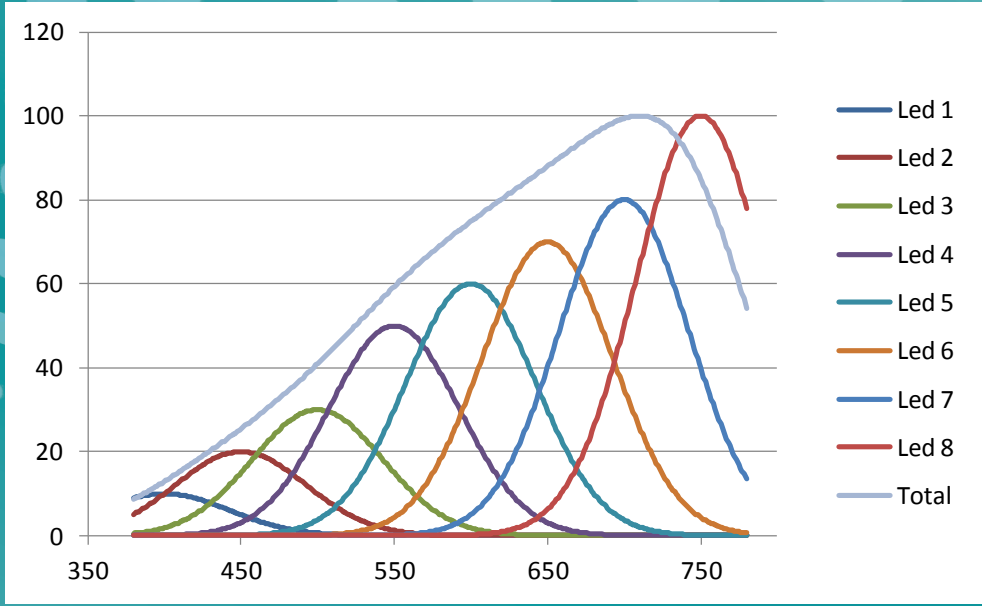
Spectrale verdeling 5

Oplopende Intensiteitsverdeling van 8 LEDs



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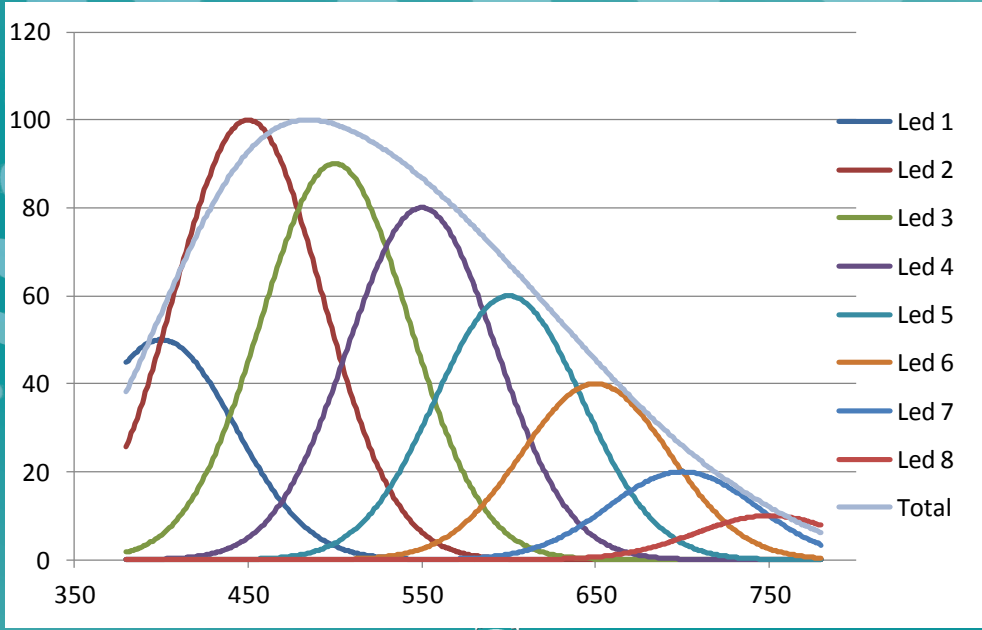
Spectrale verdeling 6

Aflopende intensiteitsverdeling van 8 LEDs



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Mogelijke obstakels

- Temperatuursgedrag led
- Reflecterende eigenschappen en opbouw van de integrerende bol
- Bij pulsbreedte modulatie: flickering
- Niet-homogene verdeling van het licht bij uittreden van de bol
- Stabiliteit bij verschillende intensiteiten
- Enz.

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Voorbeelden uit praktijk

- Een bol met 14 leds
- Illuminant A (Halogeen, 3000 K)
- Illuminant F2 (Fluorescentie, 4250 K)
- Illuminant D50 (5000 K)
- Illuminant D65 (Daglicht, 6500 K)

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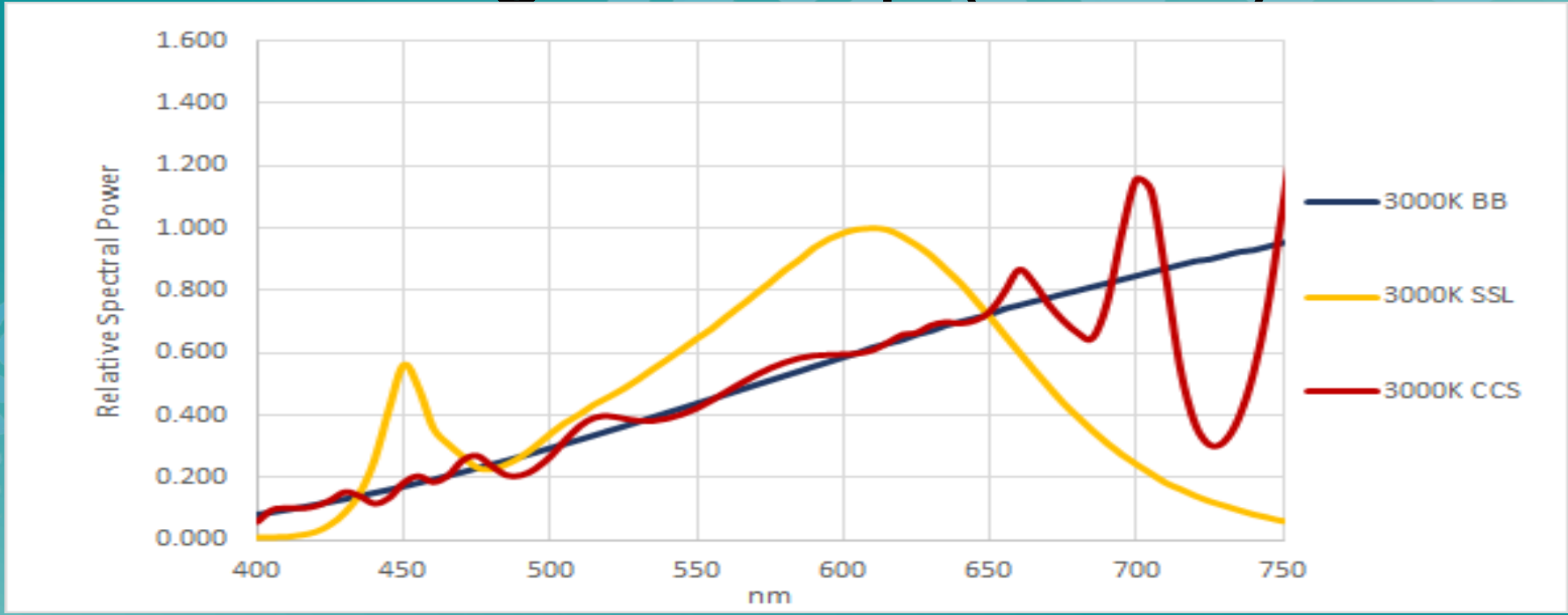
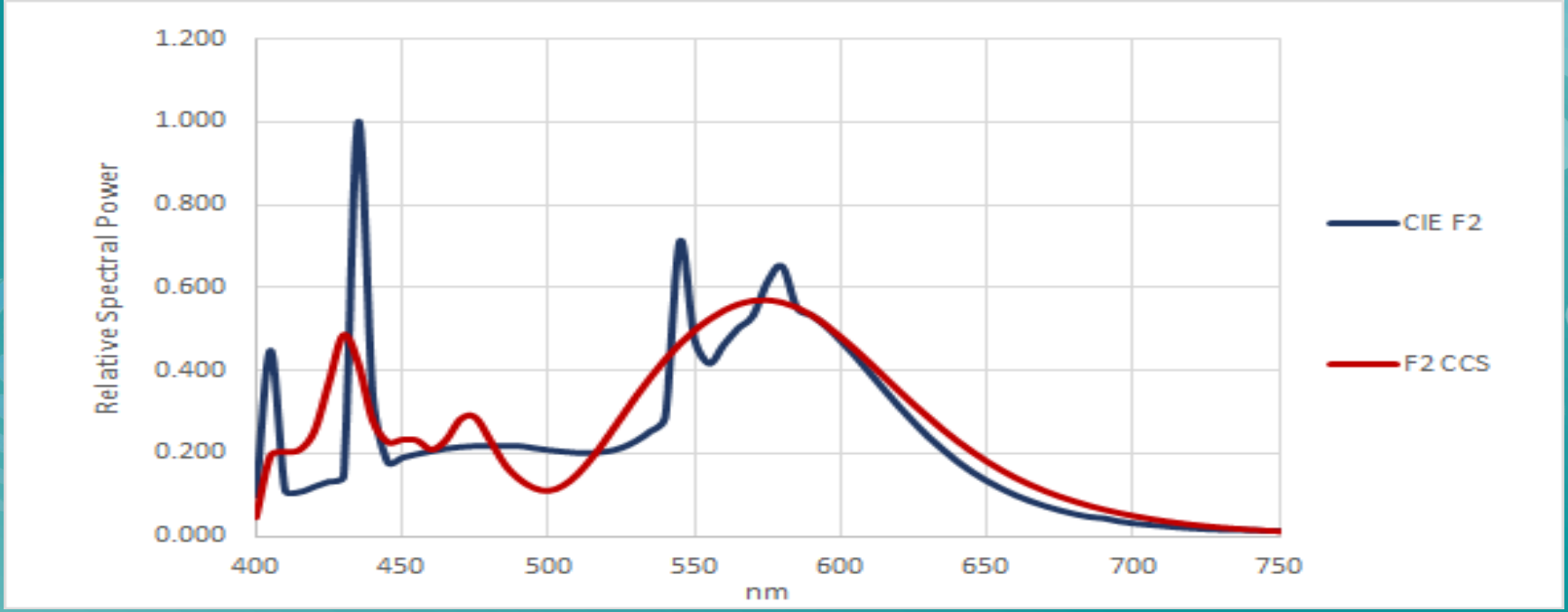
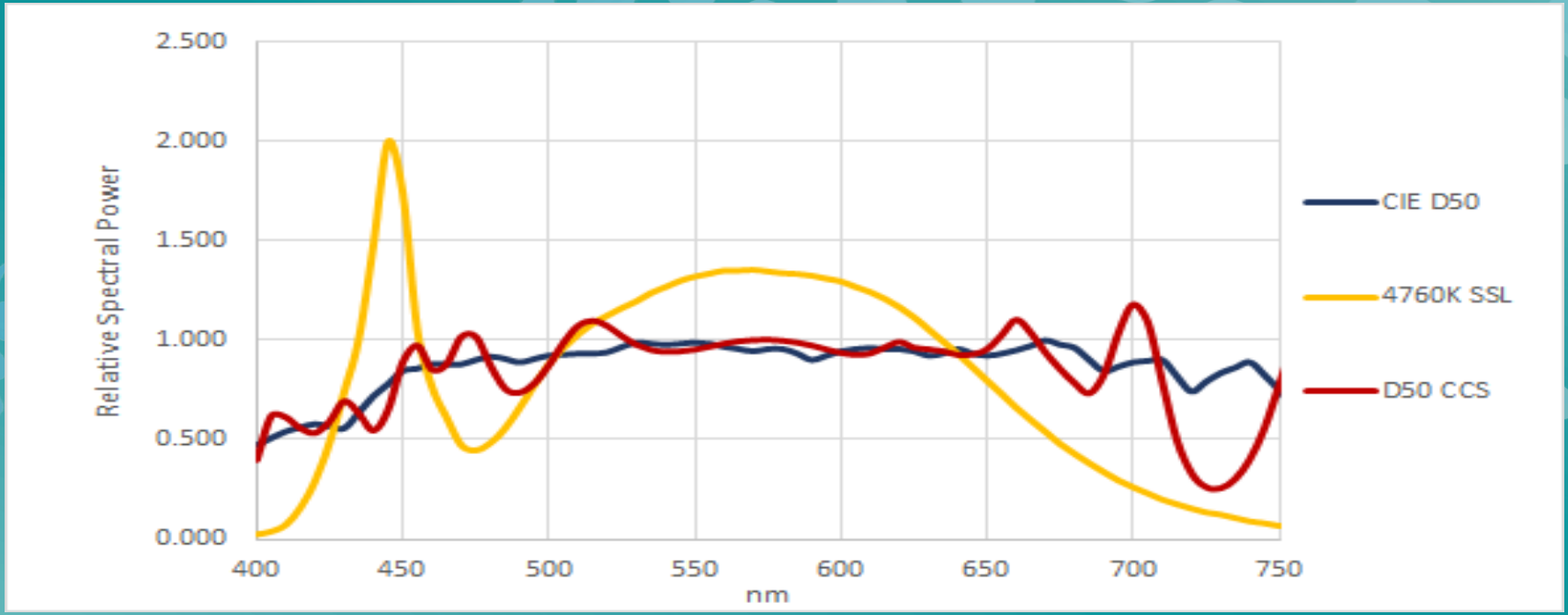
Halogeen lamp (3000K)



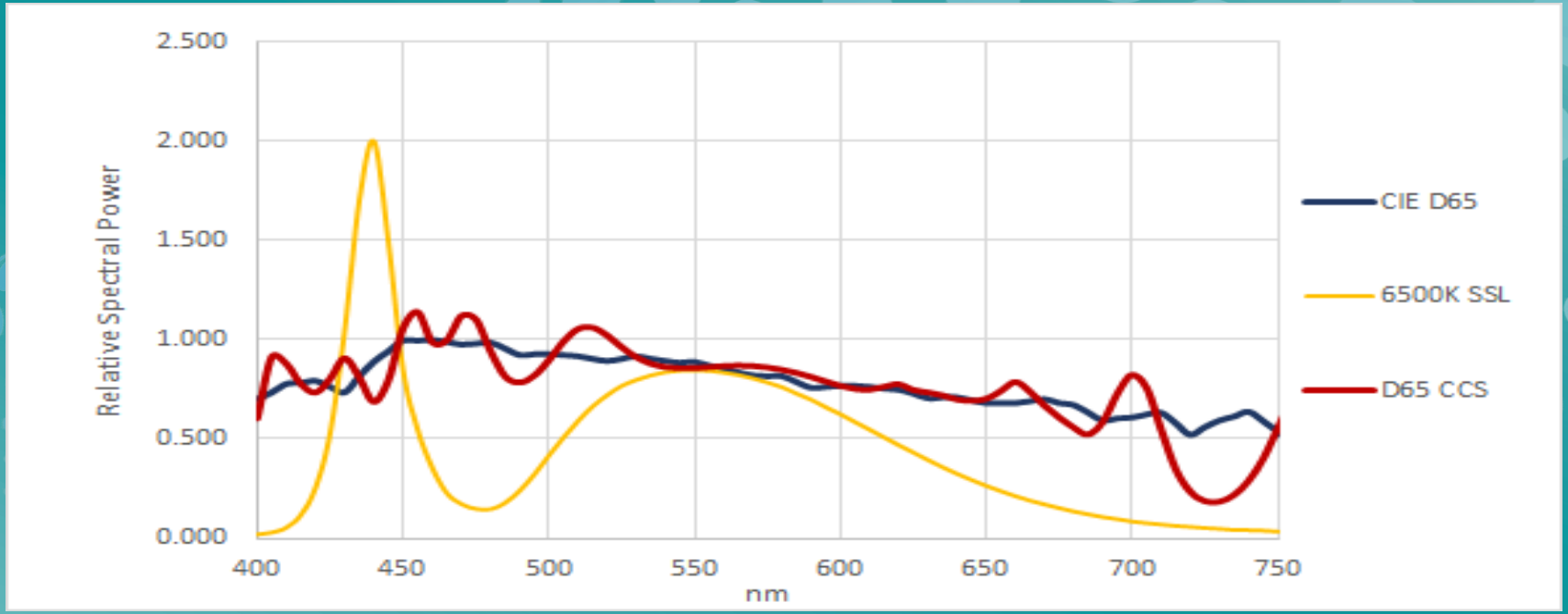
F2-lichtbron (4250 K)



D50 lichtbron (5000 K)



D65 lichtbron (6500 K)



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Verschillende lichtbronnen vergeleken

	R/G	B/G	CCT
3000K BB	3.733	0.304	3000K
3000K SSL	2.942	0.293	2999K
3000K CCS	3.764	0.296	2988K
CIE F2	1.139	0.378	4224K
F2 CCS	1.287	0.366	4148K
CIE D50	1.382	0.479	4999K
4760K SSL	1.270	0.411	4760K
D50 CCS	1.386	0.471	4964K
CIE D65	0.943	0.580	6478K
6500K SSL	0.756	0.466	6532K
D65 CCS	0.943	0.572	6419K

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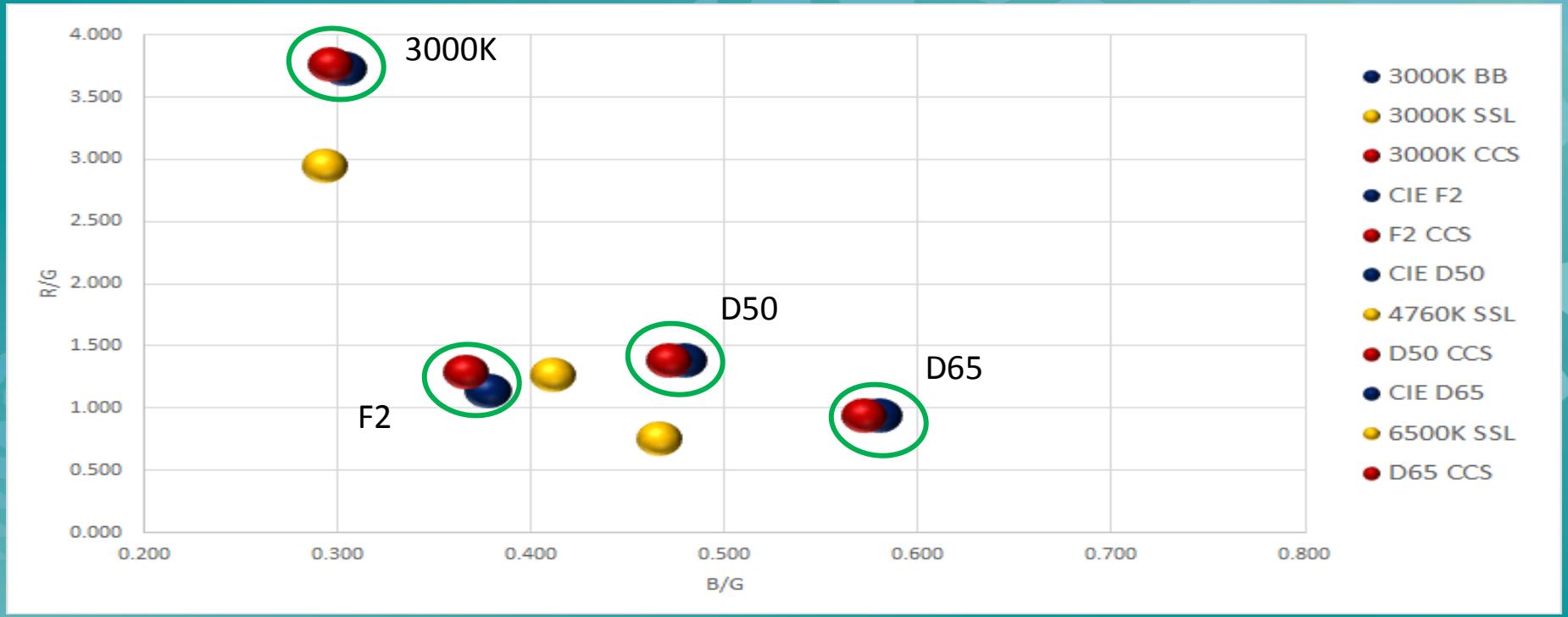

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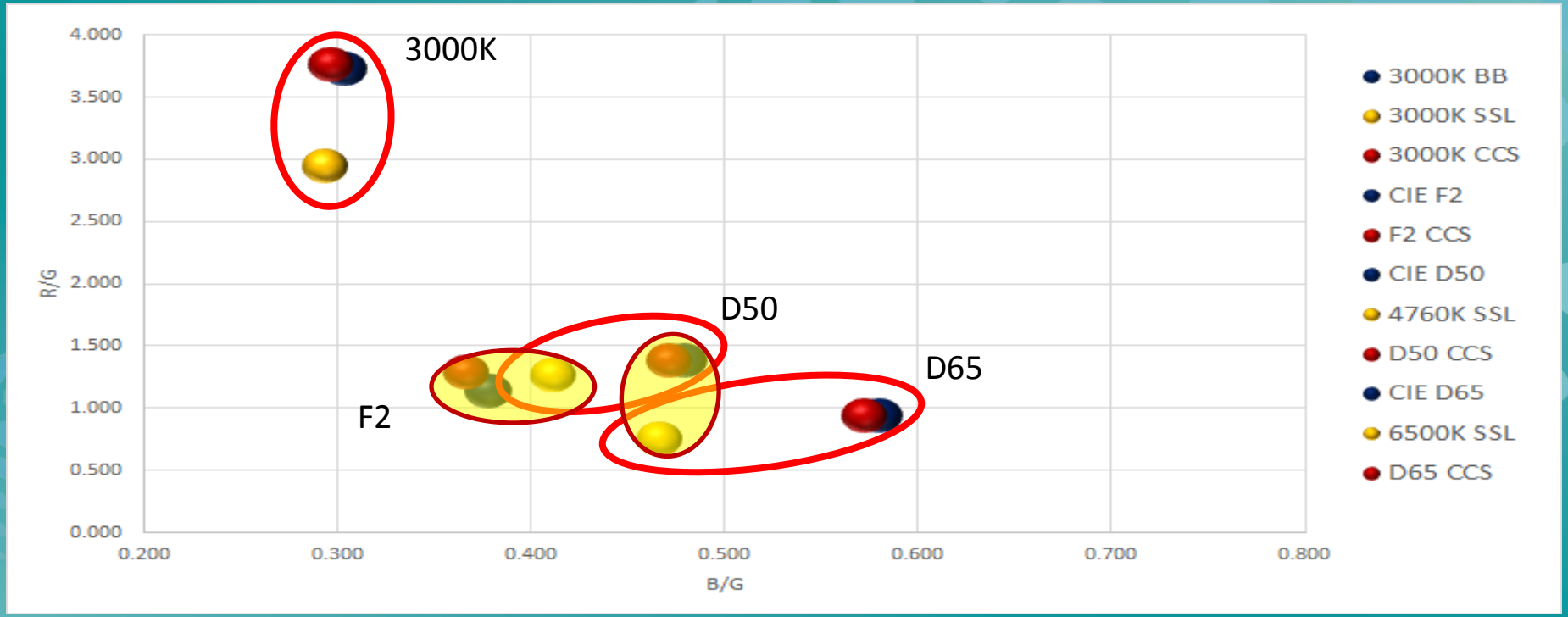

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CCS-1000/1100

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CCS Value

Market Needs	CCS-1000/1100 Solution
Ability to scale RGB signals to indoor and natural sunlight spectra	Produces multiple visible spectrums from a single port without mechanical movement or interaction.
Ability to correct for Shading and Vignetting, White and Color Balance And Photometric Response Non Uniformity	Produces highly uniform extended illuminant spectrums and enhanced blue signal
Ability to correct for Pixel Defects, and Flare	A highly uniform extend light source (> 97% uniformity over large area uniform radiance field)
Ability to test gain, gain offset and exposure	A source with luminance level adjustment
Ability Spot Check Quantum Efficiency and the filter Cutoff wavelength	Monochromatic Outputs
"Individual" calibration in high volume production	Long-term and short-term stability – DC driven, with active temperature control - (COV <0.2%)
Sustain or reduce tact time	Fast rise time, source transition, and settling time (6 illuminants <10 seconds)
Ability test NIR noise and filter leakage	NIR source out to 1000nm

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TruLume CCS uniform tunable sources that enable real-time mobile image noise correction

- Meeting needs of leading edge camera module production
  - Extended Light Source with High Uniformity
  - Monochromatic and White Light Equivalent Spectrums
  - Independent control of the spectral output, color and luminance levels
  - Repeatable and stable performance.
  - Compact and Robust

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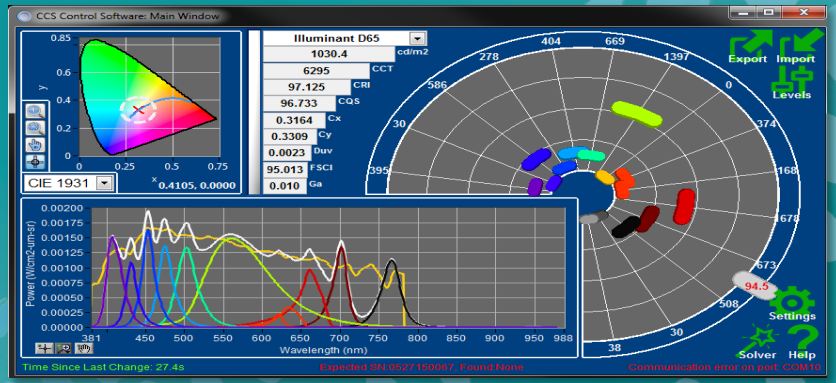
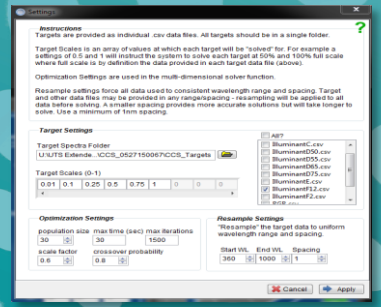
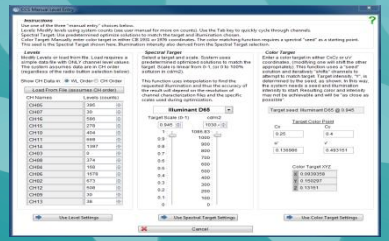
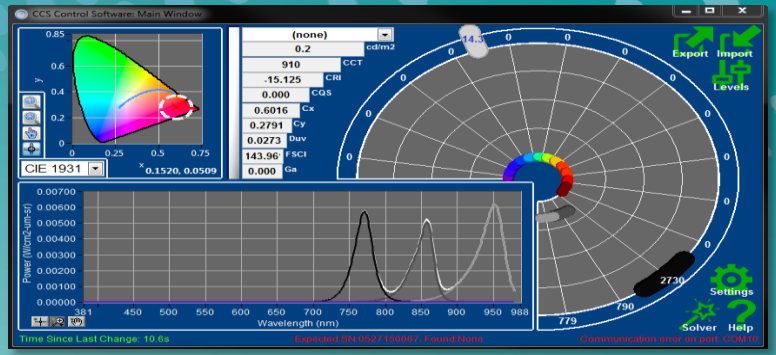
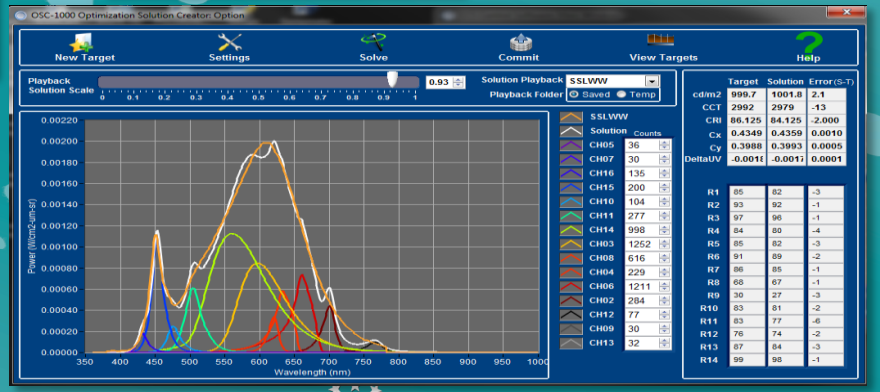
Complete Control Flexibility











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Hardware Design

Protective cover

Large Area Extended Source

Flush Mounting

Spectral Radiance Monitor option

- Optimized for Uniformity over large area
- Compact form factor for production and R&D applications
- 6” Spectralon™ sphere for spectral stability over time
- Completely Enclosed to protect from contamination
- Thermally controlled for stability and repeatability in factory environment

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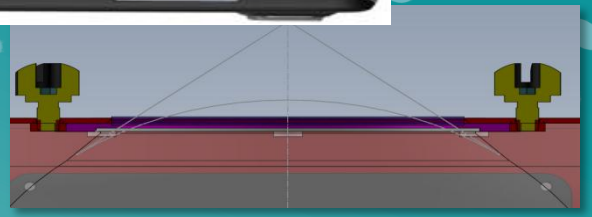
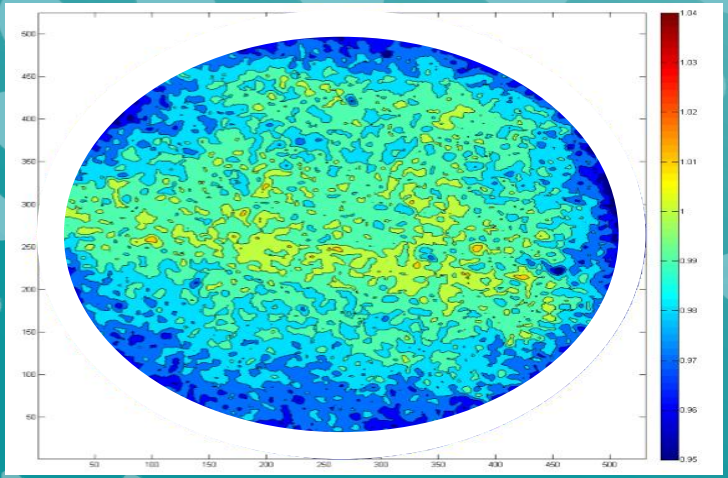
Luminance Uniformity

100° FOV at 28mm or less

Raised window for easy cleaning



75mm aperture



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Luminance Uniformity

A high resolution imaging colorimeter is positioned at a distance of 50cm in front of the SSL-1000 luminance port.

The observation area is 4 cm^2 and segmented into an 11 x 11 grid of 2.1mm x 2.1mm segments, with partial segments about the circular edge.

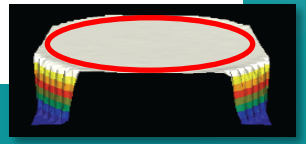
Each segment is measured with approximately **7740, 3.45um pixels** and averaged over that area.

		98.[illegible]%	98.7%	98.6%	98.6%	98.5%	98.3%	98.2%		
	98.8%	98.9%	98.9%	98.9%	99.0%	98.9%	98.7%	98.4%	98.3%	
98.8%	99.2%	99.4%	99.2%	99.2%	99.4%	99.3%	99.1%	98.9%	98.6%	98.3%
99.1%	99.5%	99.6%	99.7%	99.6%	99.6%	99.3%	99.2%	99.0%	98.7%	98.4%
99.4%	99.5%	99.7%	99.7%	99.9%	99.8%	99.6%	99.6%	99.2%	99.1%	98.8%
99.7%	99.9%	100.1%	100.1%	100.0%	100.0%	99.9%	99.7%	99.3%	99.3%	98.9%
100.0%	100.1%	100.2%	100.1%	100.1%	100.1%	99.9%	100.0%	100.0%	99.4%	99.1%
100.1%	100.3%	100.3%	100.2%	100.4%	100.3%	100.3%	100.0%	99.9%	99.8%	99.1%
99.8%	100.6%	100.3%	100.3%	100.6%	100.4%	100.4%	100.3%	99.9%	99.7%	99.4%
	100.2%	100.2%	100.4%	100.6%	100.4%	100.4%	100.4%	100.2%	99.7%	99.3%
		100.1%	100.3%	100.6%	100.5%	100.4%	100.0%	100.1%	99.6%	

Max	100.6%
Min	98.2%
Average	99.6%
Uniformity	98.8%

Color Mapping Key:

White:	100% normalized to center point
Blue:	<100% normalized to center point
Red:	>100% normalized to center point



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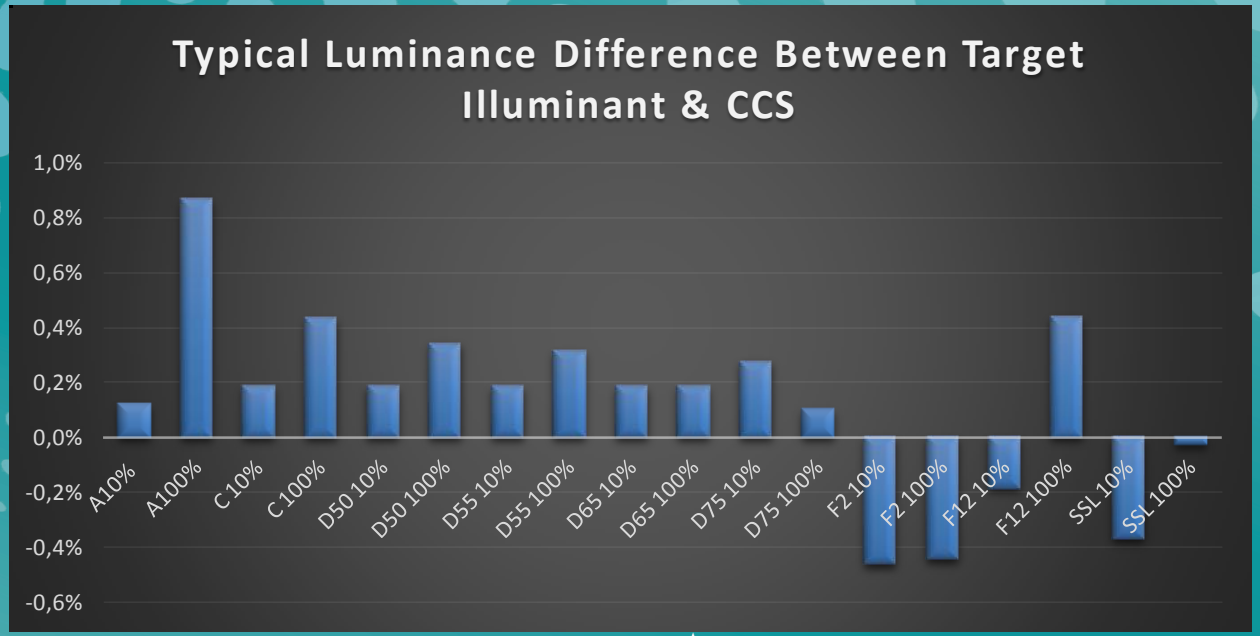
CCS-1000 Luminance Tracking

The luminance tracking of illuminant to measured output is <1% over dynamic range of the source output



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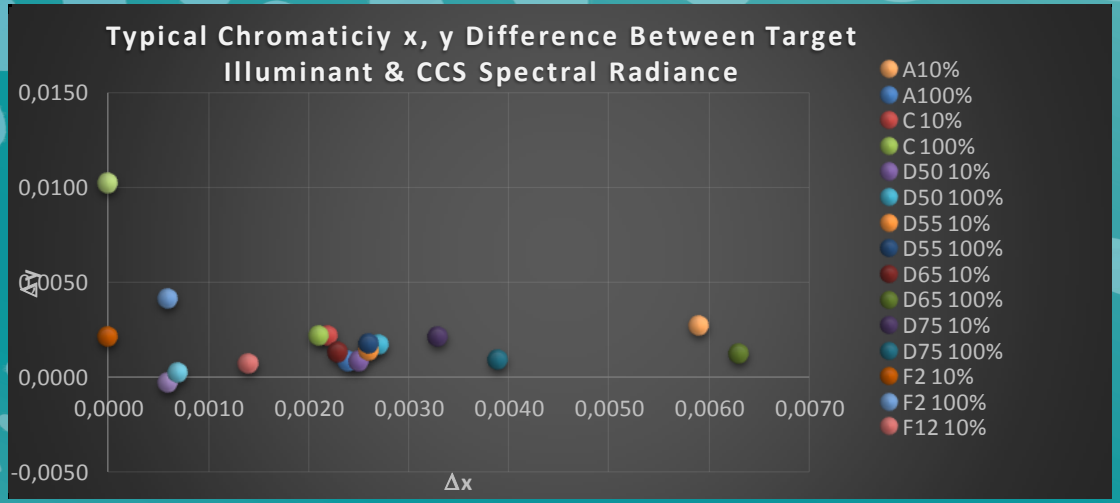
CCS-1000 Chromaticity x, y Tracking

Chromaticity x, y tracking to target illuminants to measured output is <0.007 in x and <0.006 in y over dynamic range of the source output



Target Illuminant	A10%	A100%	C 10%	C 100%	D50 10%	D50 100%	D55 10%	D55 100%	D65 10%	D65 100%	D75 10%	D75 100%	F2 10%	F2 100%	F12 10%	F12 100%	SSL 10%	SSL 100%
Δx	0.0059	0.0024	0.0022	0.0021	0.0025	0.0027	0.0026	0.0026	0.0023	0.0063	0.0033	0.0039	0.0000	0.0006	0.0014	0.0000	0.0006	0.0007
Δy	0.0027	0.0008	0.0022	0.0022	0.0008	0.0017	0.0014	0.0018	0.0013	0.0012	0.0021	0.0009	0.0021	0.0041	0.0007	0.0102	-0.0003	0.0002

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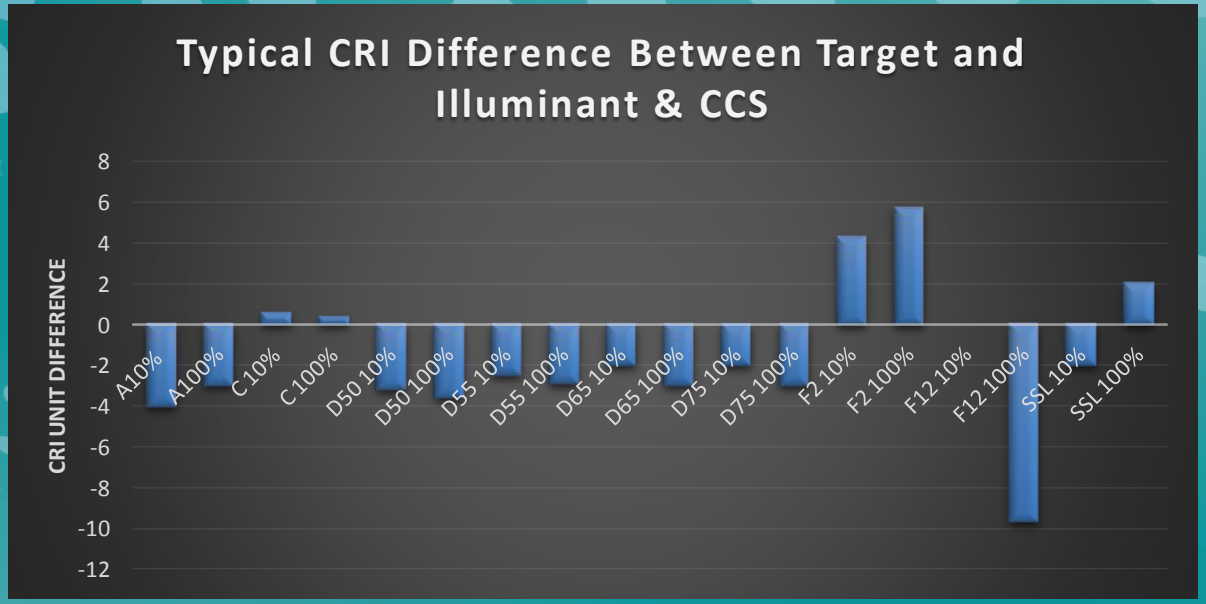
CCS-1000 CRI Tracking

The spectral matching of illuminant to the target illuminant output is less than 4 CRI units over dynamic range of output except for F 2 and F12 Fluorescence Spectra



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Conclusies

- Door de juiste keuze van de LEDs is het mogelijk om binnen zekere toleranties elke gewenste spectrale verdeling te maken
- Met gebruik van een integrerende bol kan een goede ruimtelijke verdeling worden gemaakt
- De CCS-1000 van Labsphere is een goed voorbeeld hiervan.

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Dank voor uw aandacht

Dingeman Beuzekom - www.laser2000.nl

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