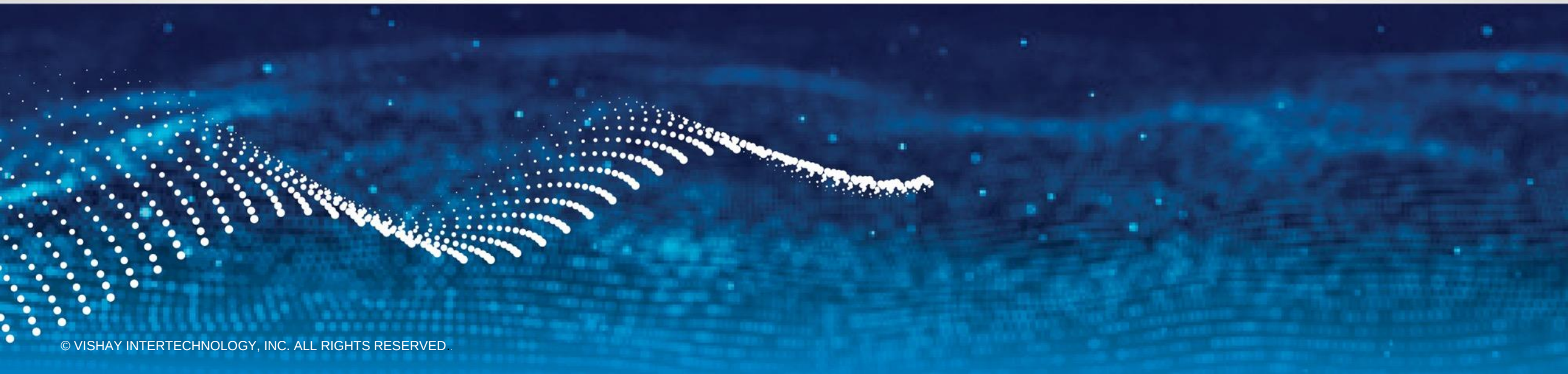
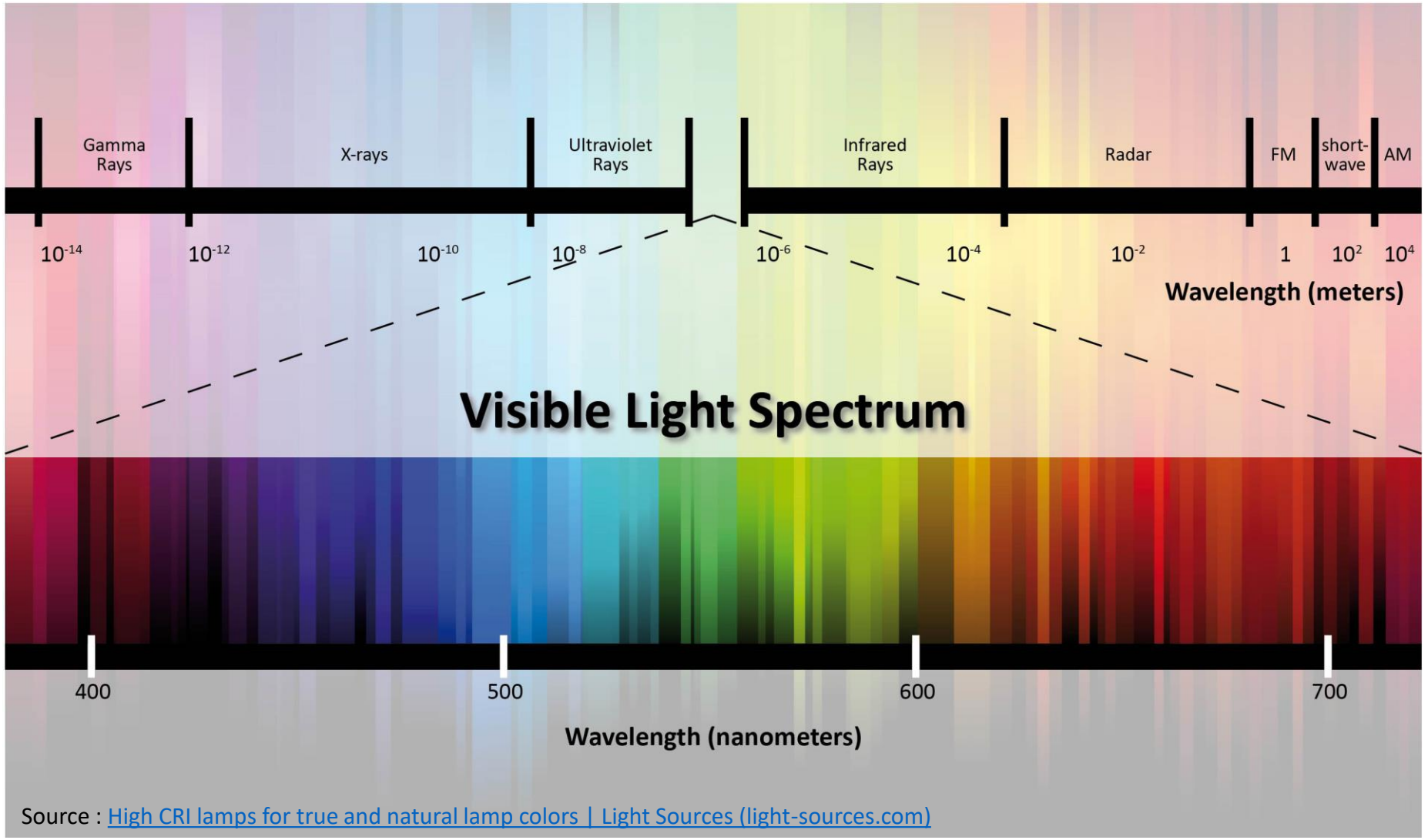
Overview Vishay Sensing Solution

Proximity and Light Sensing



What is light ?

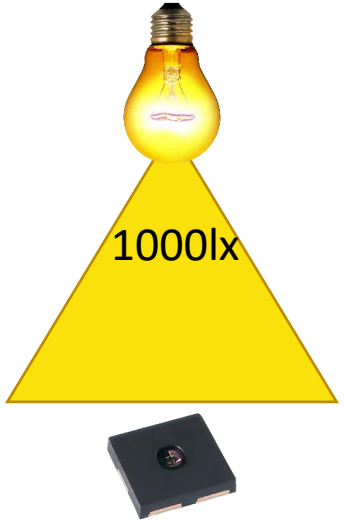


Source : [High CRI lamps for true and natural lamp colors | Light Sources (light-sources.com)]

Sensing Solution - Overview

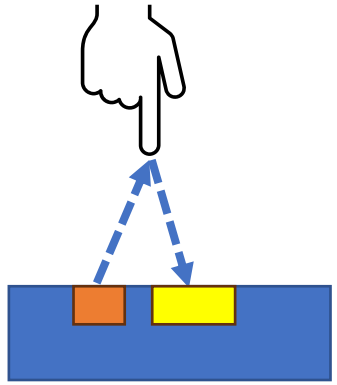
Light sensing

- VEML3328
- VEML6035
- VEML6031X00



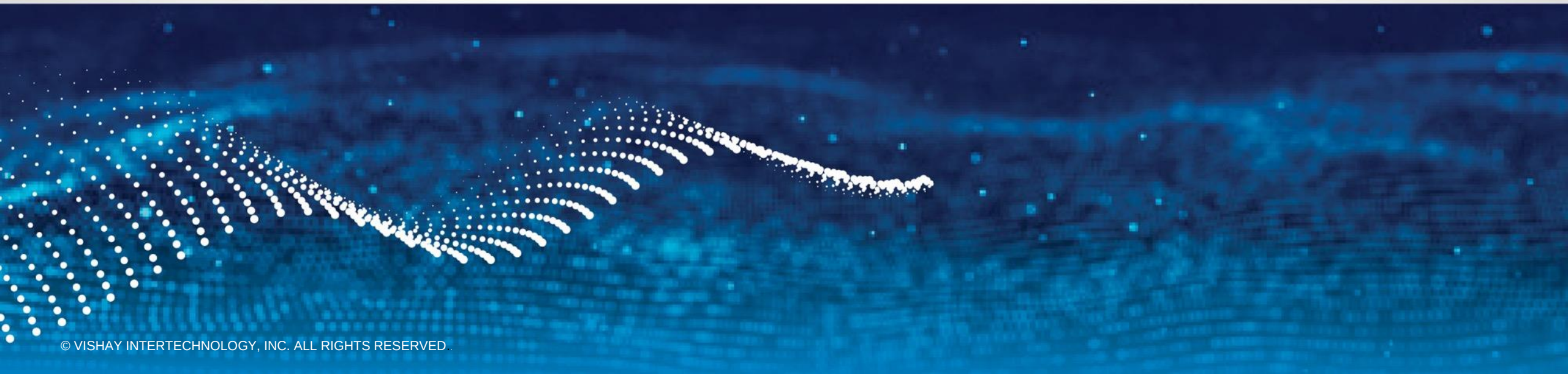
Proximity sensing

- VCNL4200
- VCNL4030X01
- VCNL4035X01
- VCNL36826S

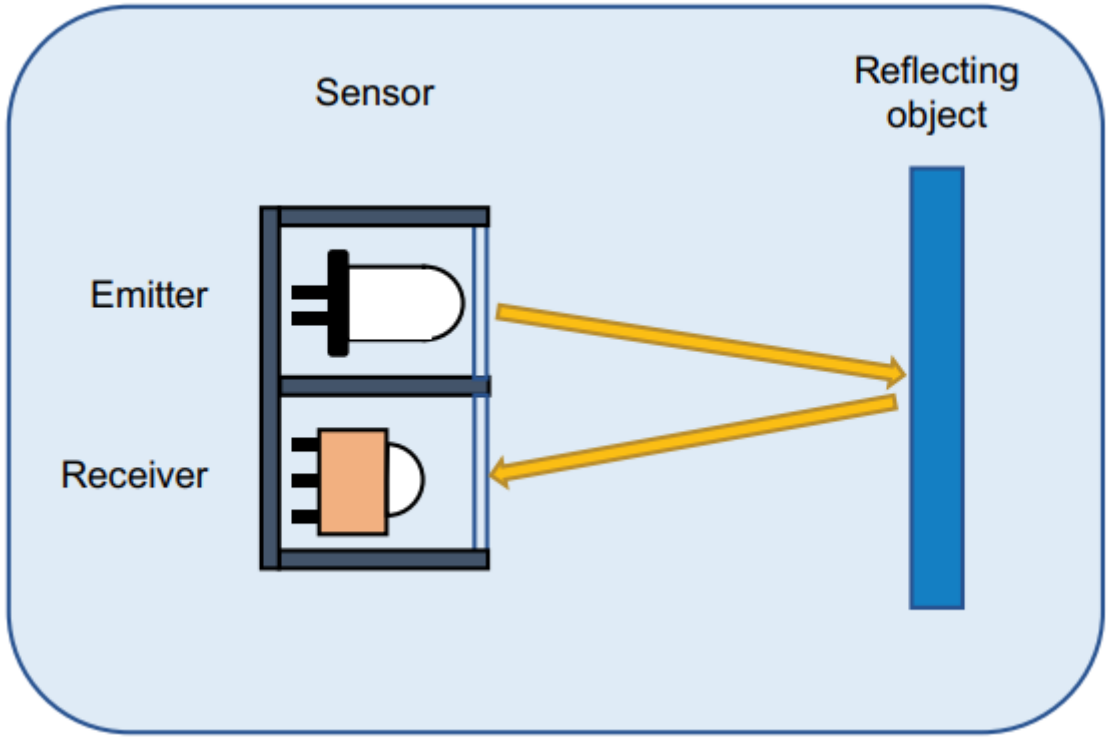


Proximity - Sensors

VCNL4200, VCNL4030X01, VCNL4035X01, VCNL36826S

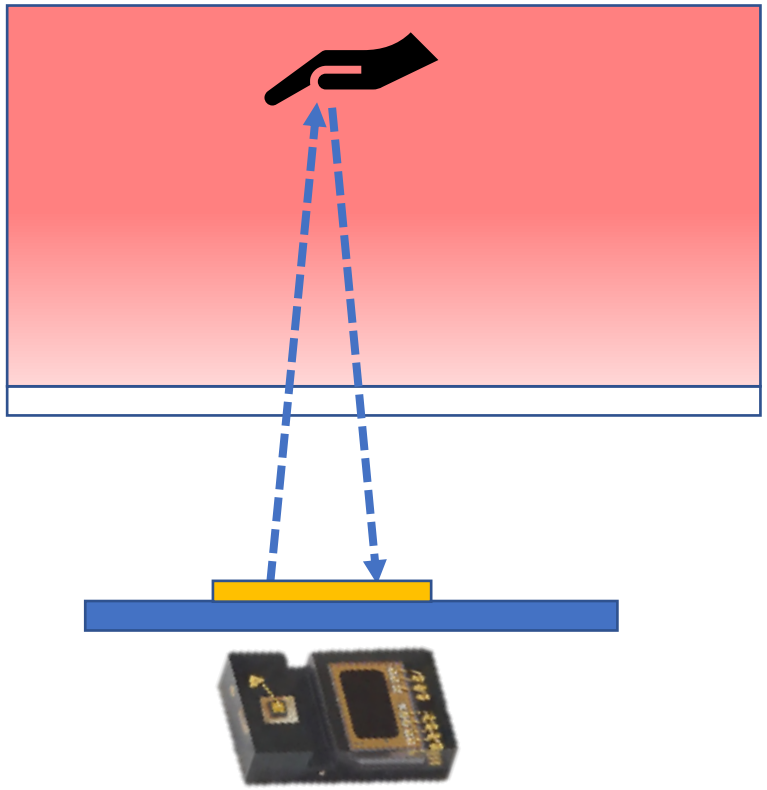


Proximity - Working Principle

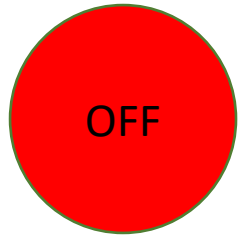


Proximity - Working Principle

- Functionality
  - The object is outside of the defined detection zone – threshold is not yet crossed and the application remains off

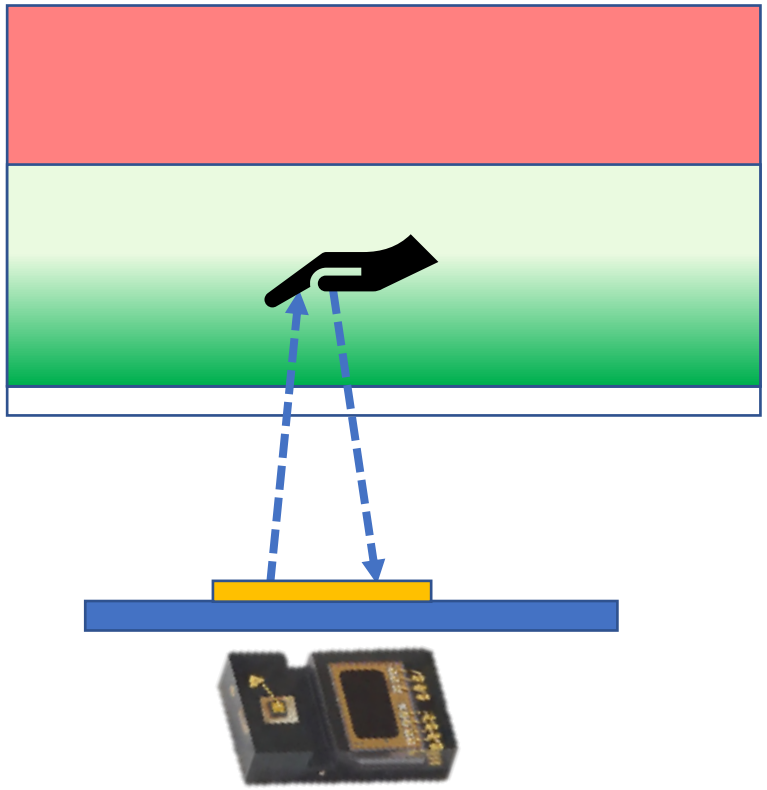


Application status

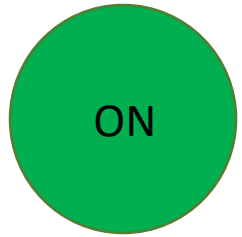


Proximity - Working Principle

- Functionality
  - Object enters the detection zone, the threshold is crossed and the application is turned on

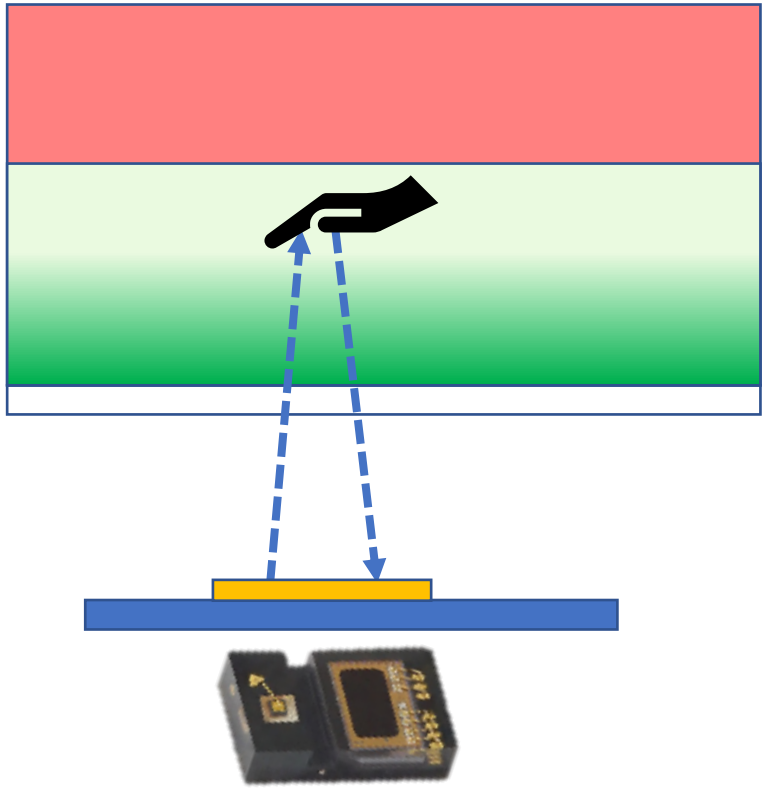


Application status

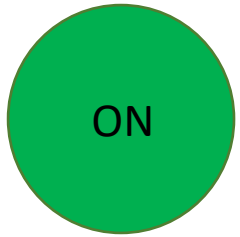


Proximity - Working Principle

- Functionality
  - Threshold is set as long as the object is in the defined detection zone (hysteresis)

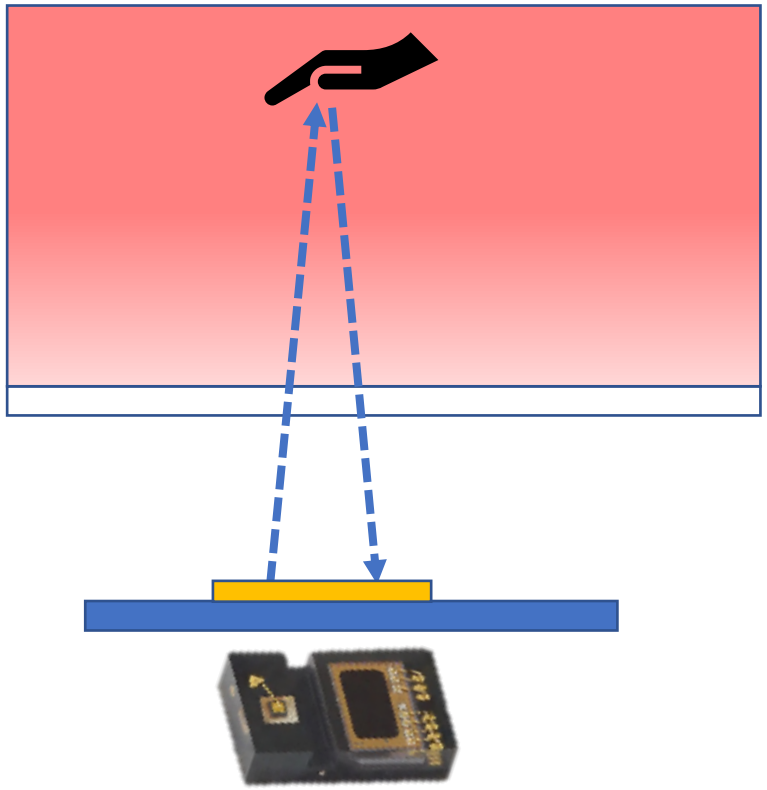


Application status

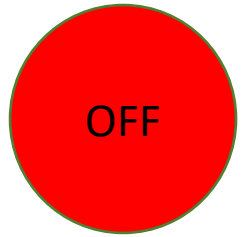


Proximity - Working Principle

- Functionality
  - When the object leaves the defined detection zone the threshold is crossed and the application is turned off again



Application status



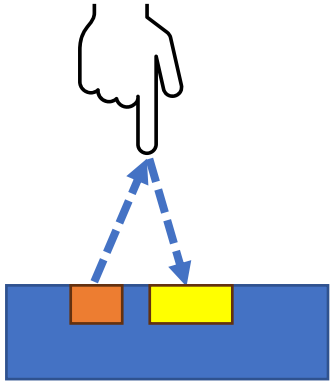
Proximity – Use cases

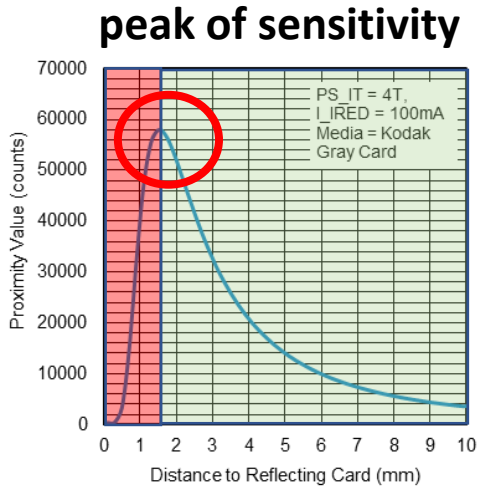
- Touchless switches
  - Soap dispenser
  - Hand dryer
- Wake up detection
  - Monitors
  - Automatic doors
- IOT devices
  - Thermostat
  - Home automation displays

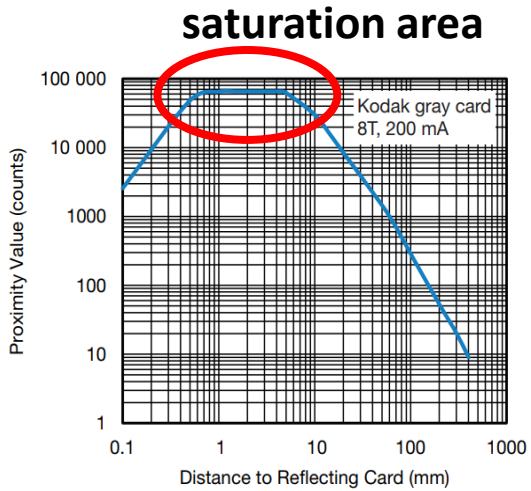
Proximity – Design considerations

General proximity working principle

- The peak of sensitivity (highest absolute measurement value is achieved by the sensor) is defined by the distance between emitter and detector which is mostly determined by the fixed package design
- The right-hand side of the peak is defined by the inverse square law
  - Proximity applications are typically operated on the right-hand side of the peak.
- The saturation area around the peak leads to a blind spot of the sensor where no detection is possible. This can be influenced by the sensor settings (IT, driving current)





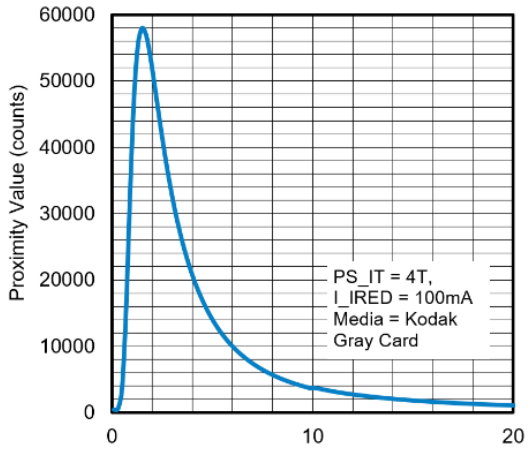


Proximity – Design Considerations

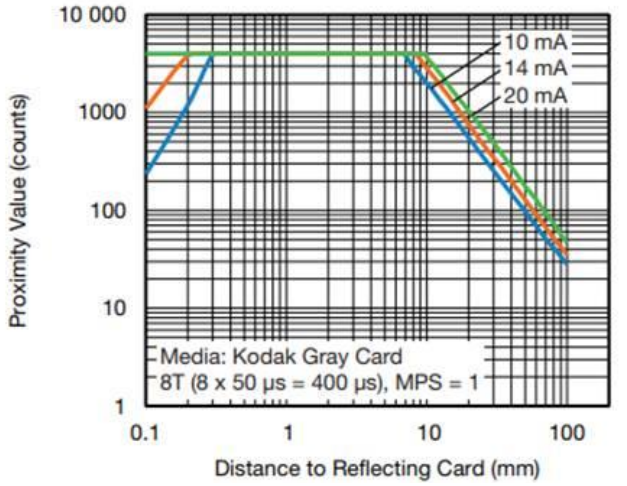
Parameters

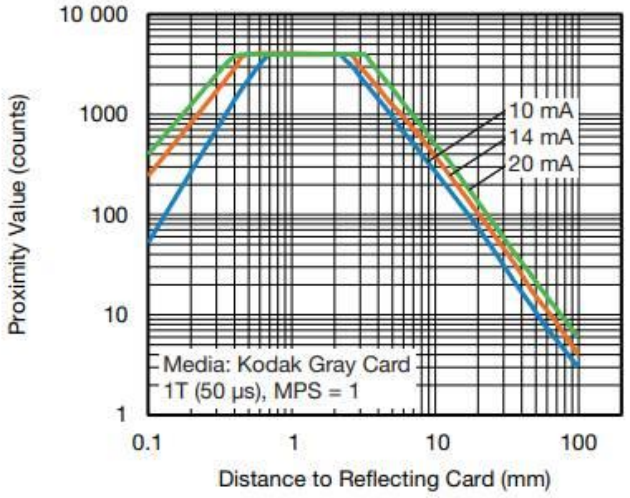
Sensor side

- Integration time (measurement time)
- VCSEL/IR-Emitter current (driving current)
- MPS (multi pulse) setting (number of consecutive measurement pulses per cycle)



Influence





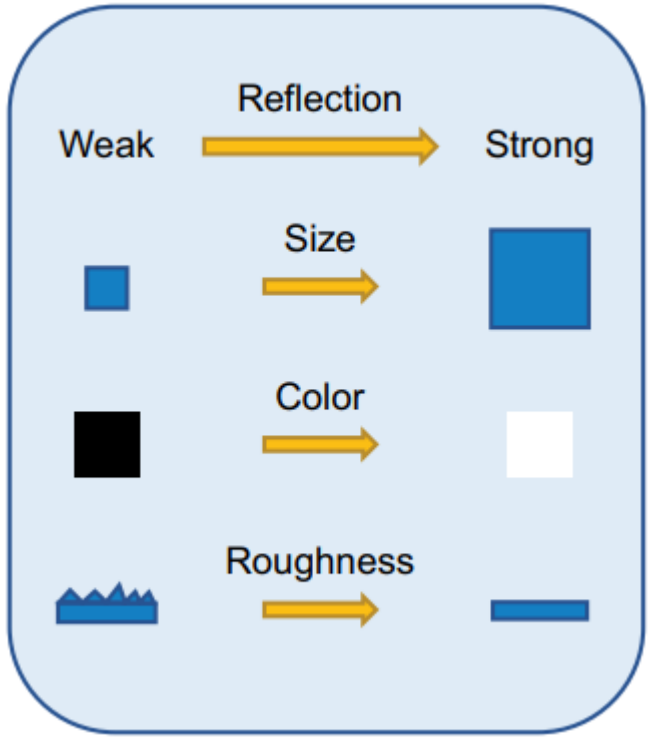
Proximity – Design Considerations

Parameters

Application Side

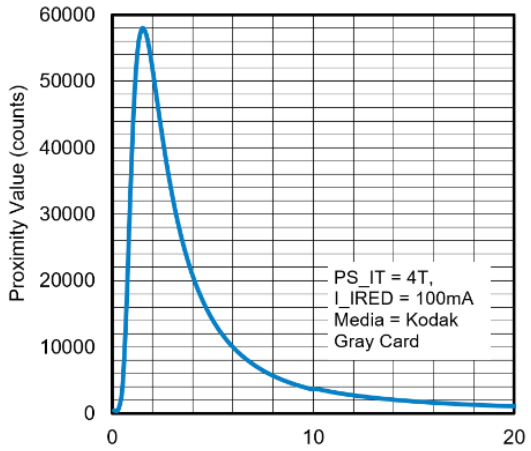
- Reflectivity of the used reflection material
- Surface type & size
- Distance between object & sensor

Influence



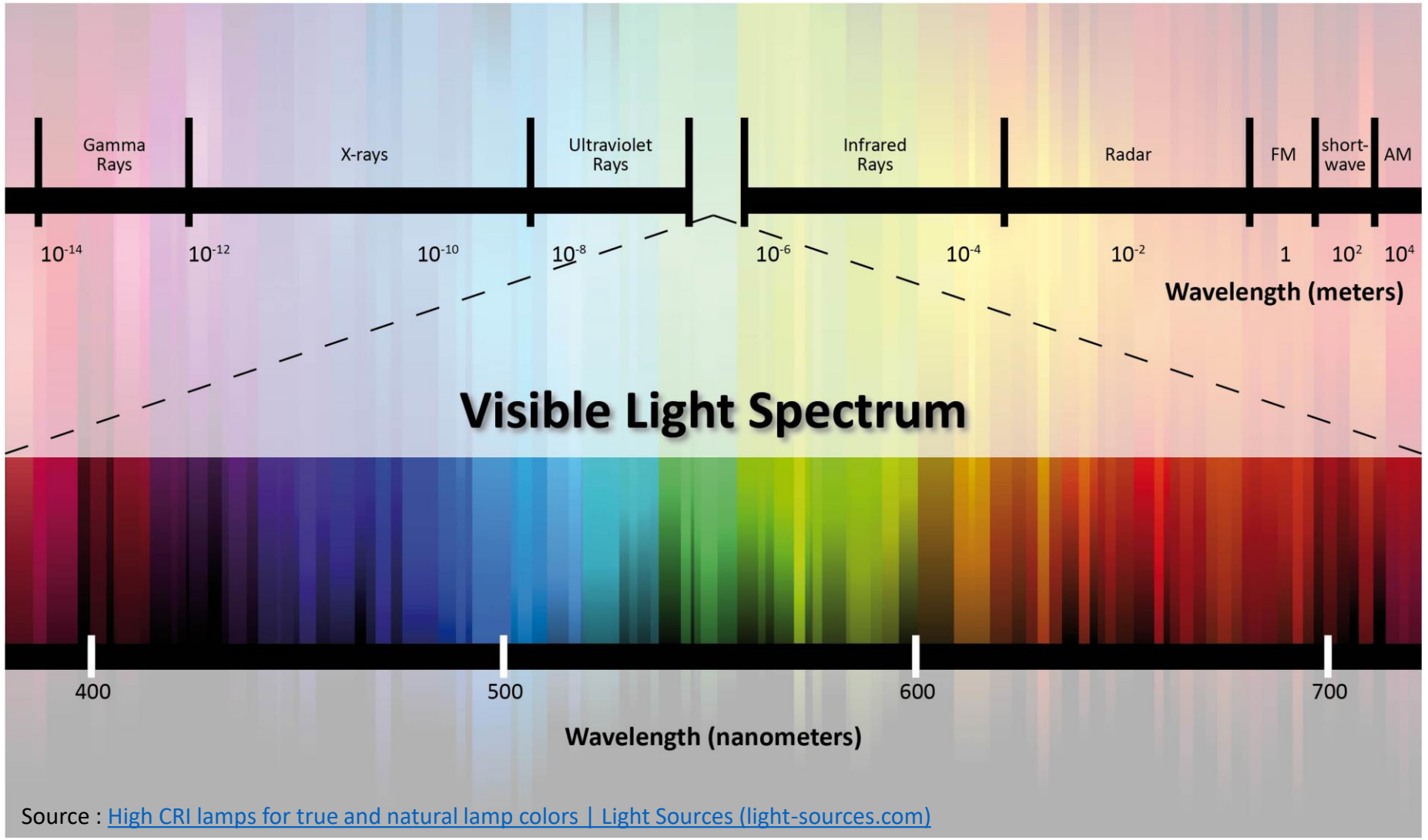
Proximity – Important take aways

- The output value of the digital proximity sensor is given in digital counts (not in an actual distance!)
- The output value depends on the applied settings (internally as well as externally)
- The overall output behavior is described by its distance curve
- Every distance curve behaves based on the inverse square law (E= I/d^2) and therefore always declines by the power of two
- The differences in between the sensor determines the possible detection range



Smart Lighting

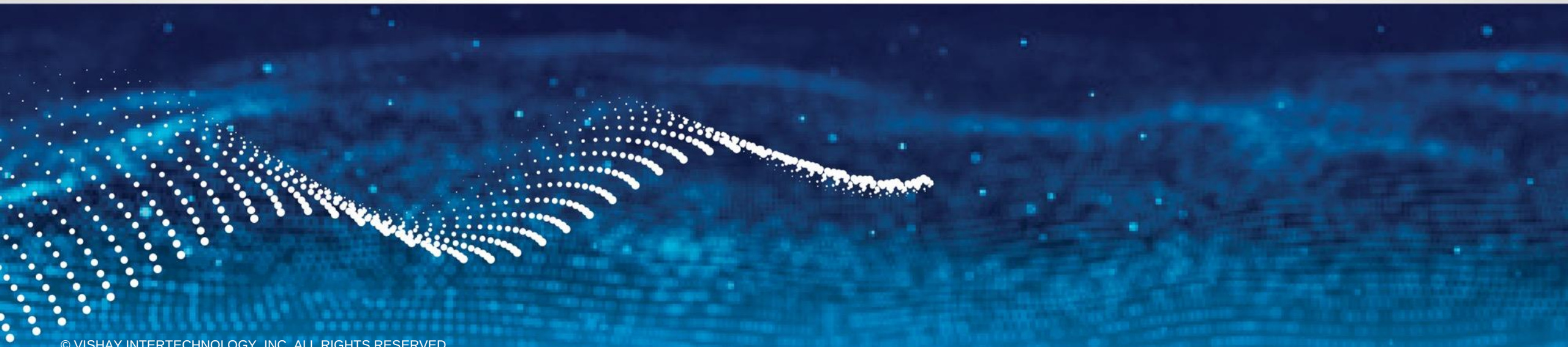
What is light ?



Source : [High CRI lamps for true and natural lamp colors | Light Sources (light-sources.com)]

ALS - Sensors

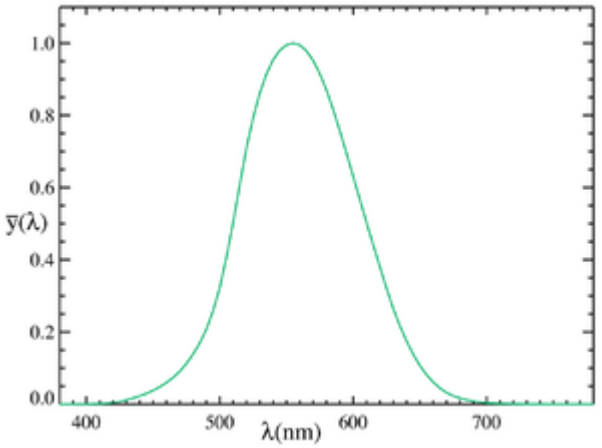
VEML6031X00, VEML6035



Smart Lighting – Overview

Ambient light sensing (ALS)

- Mimics the photopic vision of the human eye
- Output value can be transferred in lux (Brightness)

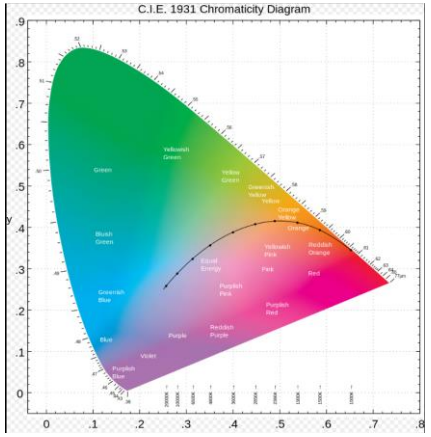


Application

- Display dimming & brightness control
- Light source differentiation

RGB - Sensing

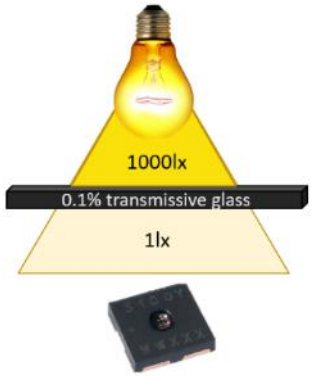
- Provides more information about the visible light range
- Output value can be transferred into color values



Application

- Correlated Color Temperature (CCT)
- Optical encoding

Ambient light sensing – Design considerations



Necessary

- Define mechanical dimension (FOV)
- Define resolution based on the optical requirements
  - Integration time, Photodiode Size, Gain

Optional

- Implement automatic gain control algorithm to automatically adjust the result based on the lighting environment
- Implement light source differentiation based on IR-Channel to active more reliable results regardless of the used light sources

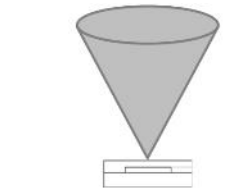


Fig. 4 - Angle of Half Sensitivity: Cone

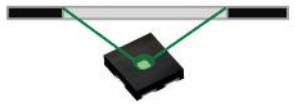


Fig. 5 - Windows Above Sensitive Area

TABLE 5 - RESOLUTION AND MAXIMUM DETECTION RANGE AT PD_DIV4 = 0 (= x 4/4)

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0034	0.0068	0.0103	0.0136		223	446	675	891
200	0.0068	0.0136	0.0206	0.0272		446	891	1350	1783
100	0.0136	0.0272	0.0412	0.0544		891	1783	2701	3565
50	0.0272	0.0544	0.0824	0.1088		1783	3565	5402	7130
25	0.0544	0.1088	0.1648	0.2176		3565	7130	10 803	14 260
12.5	0.1088	0.2176	0.3297	0.4352		7130	14 260	21 607	28 521
6.25	0.2176	0.4352	0.6594	0.8704		14 260	28 521	43 213	57 042
3.125	0.4352	0.8704	1.3188	1.7408		(-) (1)	(-) (1)	(-) (1)	(-) (1)

TABLE 6 - RESOLUTION AND MAXIMUM DETECTION RANGE AT PD_DIV4 = 1 (= x 1/4)

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0136	0.0272	0.0412	0.0544		891	1783	2701	3565
200	0.0272	0.0544	0.0824	0.1088		1783	3565	5402	7130
100	0.0544	0.1088	0.1648	0.2176		3565	7130	10 803	14 260
50	0.1088	0.2176	0.3297	0.4352		7130	14 260	21 607	28 521
25	0.2176	0.4352	0.6594	0.8704		14 260	28 521	43 213	57 042
12.5	0.4352	0.8704	1.3188	1.7408		28 521	57 042	86 427	114 083
6.25	0.8704	1.7408	2.6376	3.4816		57 042	114 083	172 854	228 167
3.125	1.7408	3.4816	5.2752	6.9632		(-) (1)	(-) (1)	(-) (1)	(-) (1)

ALS – Important take aways

- The ALS channel (green channel) mimics the response of the human eye
- The output value can be transferred into a lux value (brightness) by the given resolution
- The sensitivity of the sensor is determined by the photodiode size, gain and integration time

TABLE 5 - RESOLUTION AND MAXIMUM DETECTION RANGE AT PD_DIV4 = 0 (= x 4/4)

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0034	0.0068	0.0103	0.0136		223	446	675	891
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6.25	0.2176	0.4352	0.6594	0.8704		14 260	28 521	43 213	57 042
3.125	0.4352	0.8704	1.3188	1.7408		(-) [1]	(-) [1]	(-) [1]	(-) [1]

TABLE 6 - RESOLUTION AND MAXIMUM DETECTION RANGE AT PD_DIV4 = 1 (= x 1/4)

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0136	0.0272	0.0412	0.0544		891	1783	2701	3565
200	0.0272	0.0544	0.0824	0.1088		1783	3565	5402	7130
100	0.0544	0.1088	0.1648	0.2176		3565	7130	10 803	14 260
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3.125	1.7408	3.4816	5.2752	6.9632		(-) [1]	(-) [1]	(-) [1]	(-) [1]

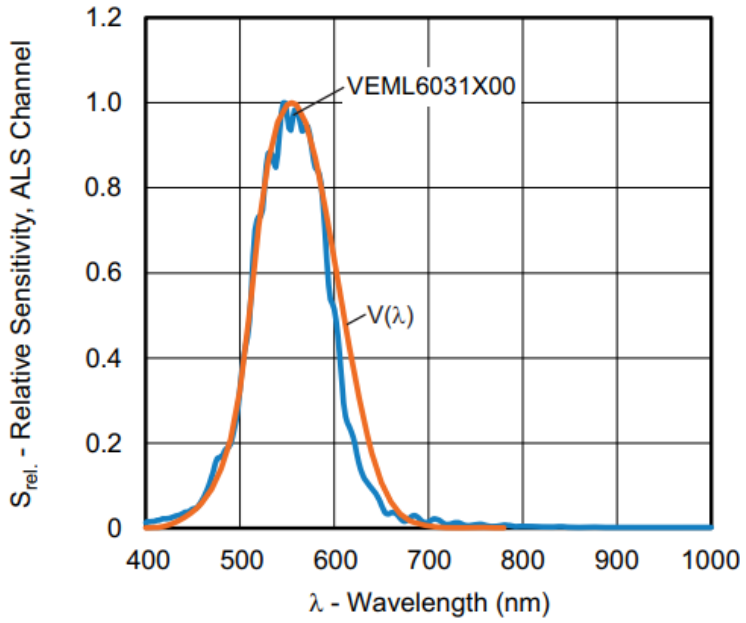
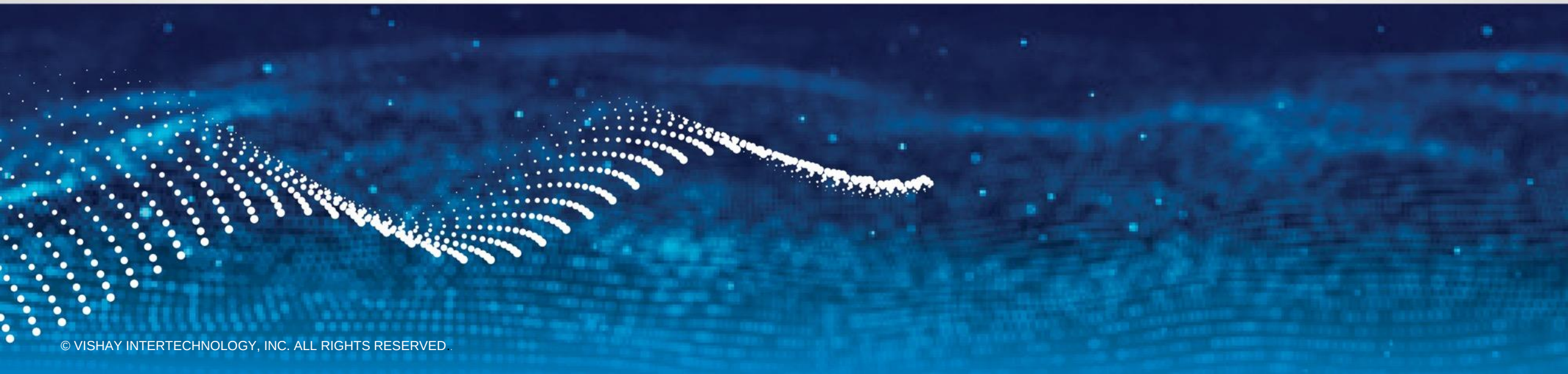


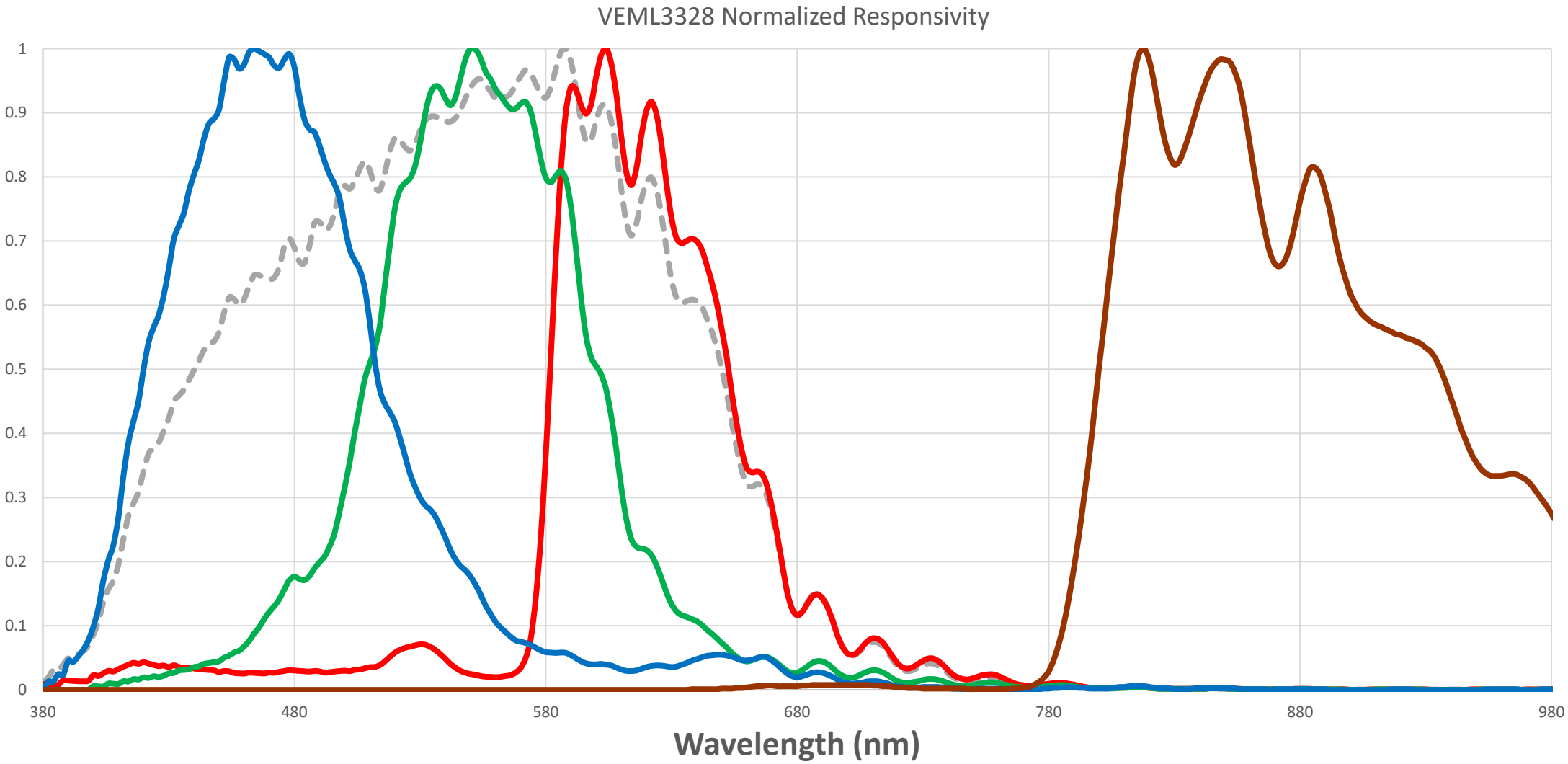
Fig. 5 - Relative Sensitivity, ALS Channel vs. Wavelength

RGB - Sensors

VEML3328



Color and light detection – What can we see ?



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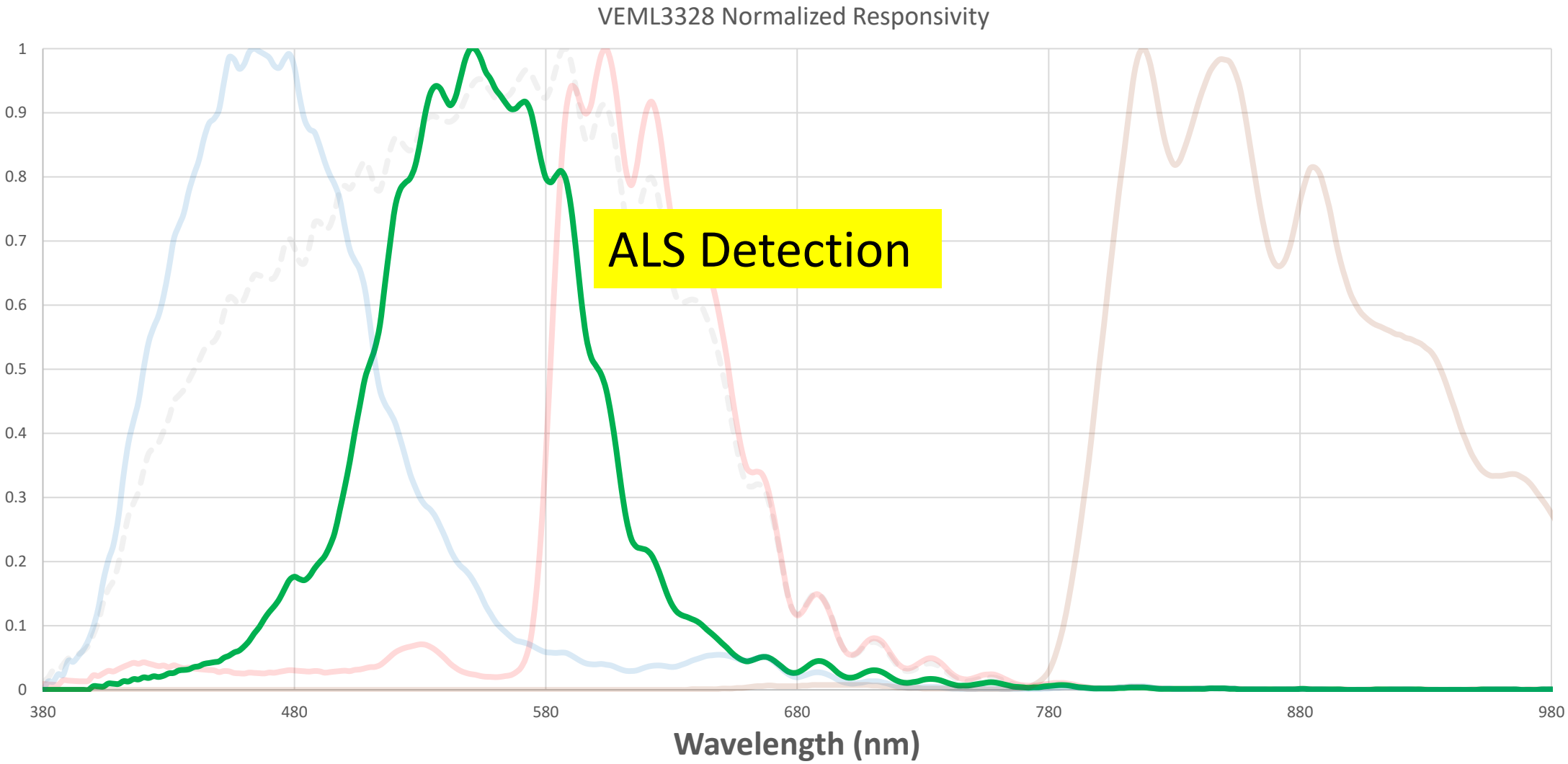
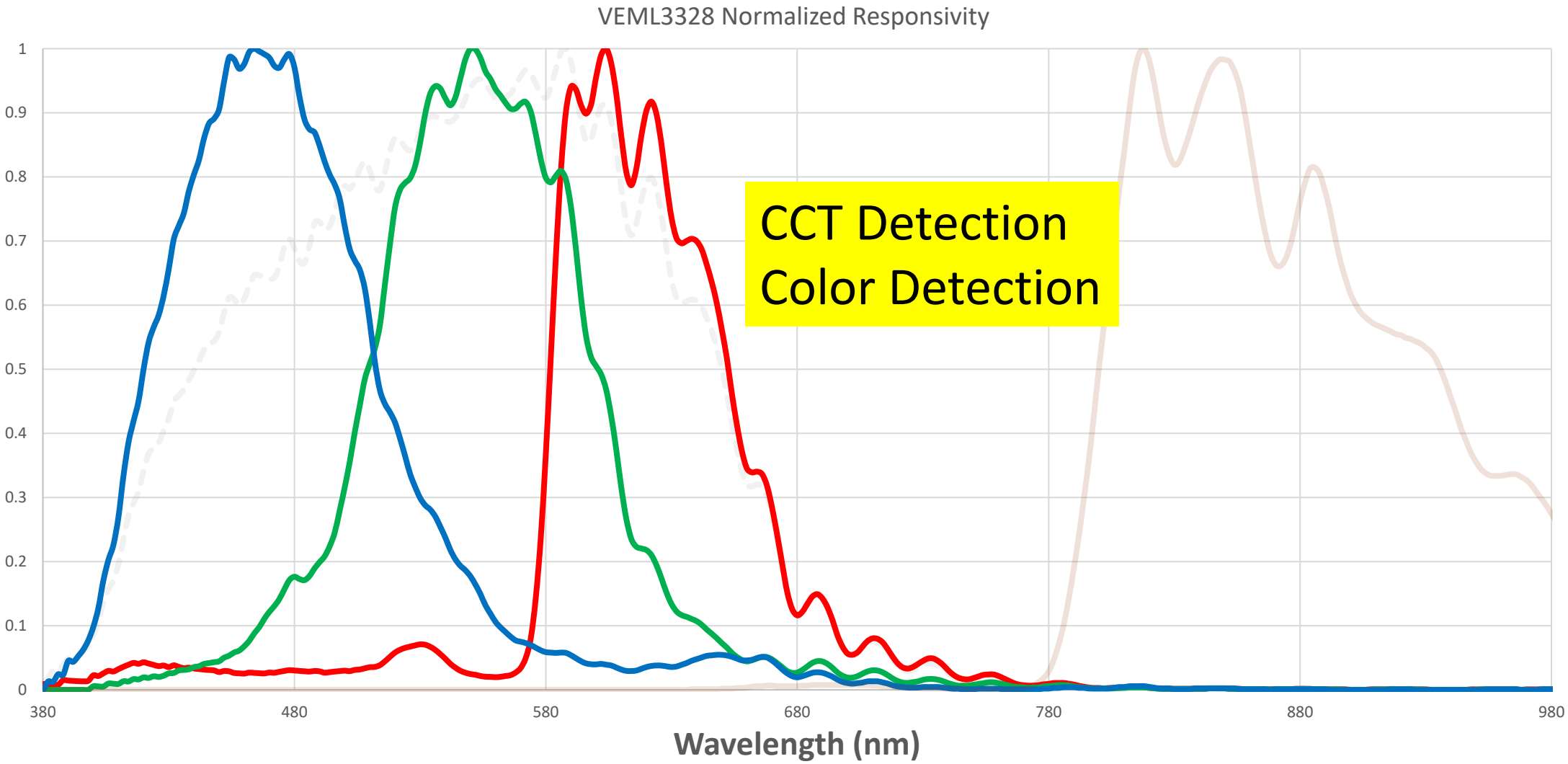
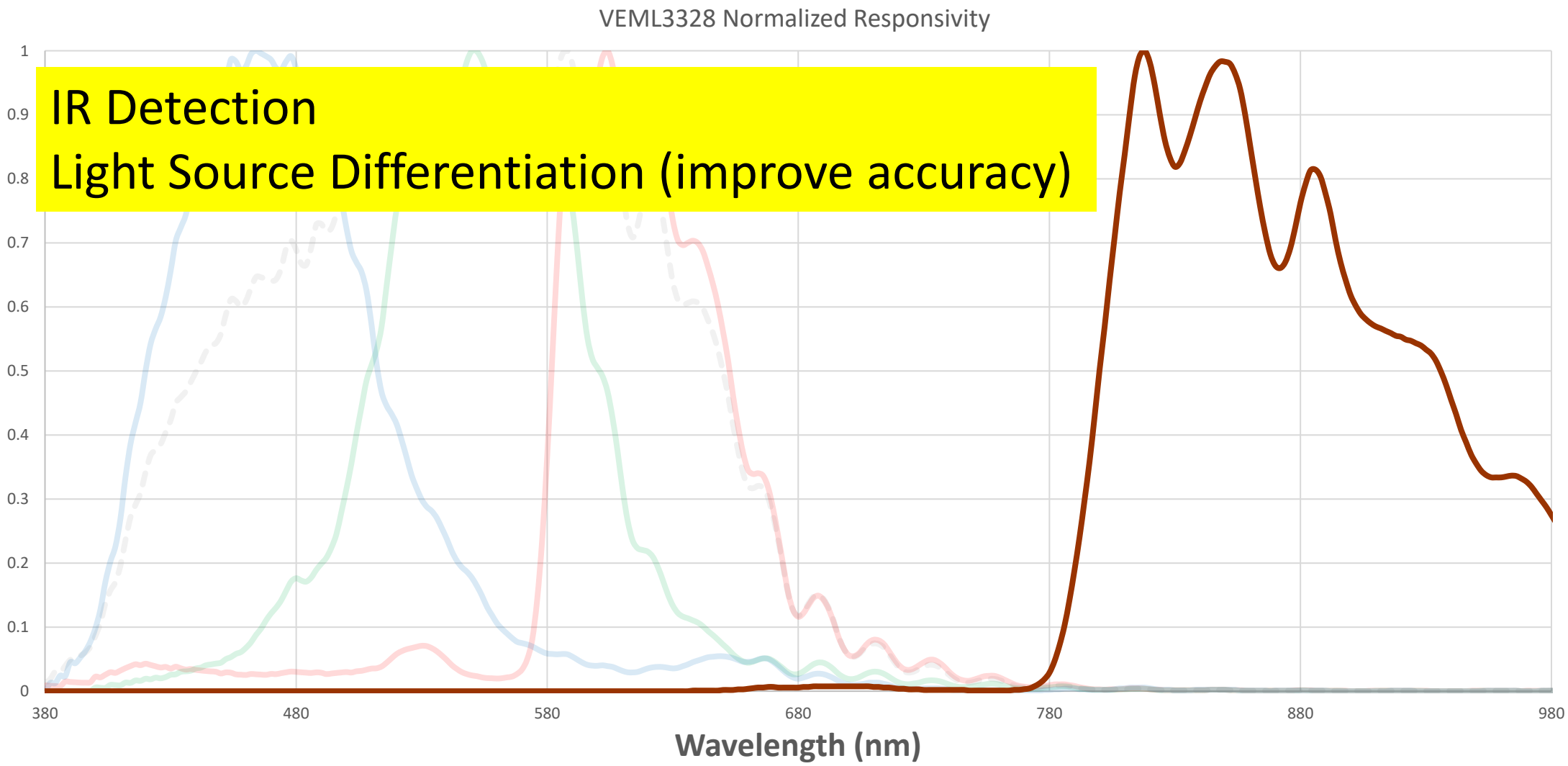


Color and light detection – What can we see ?

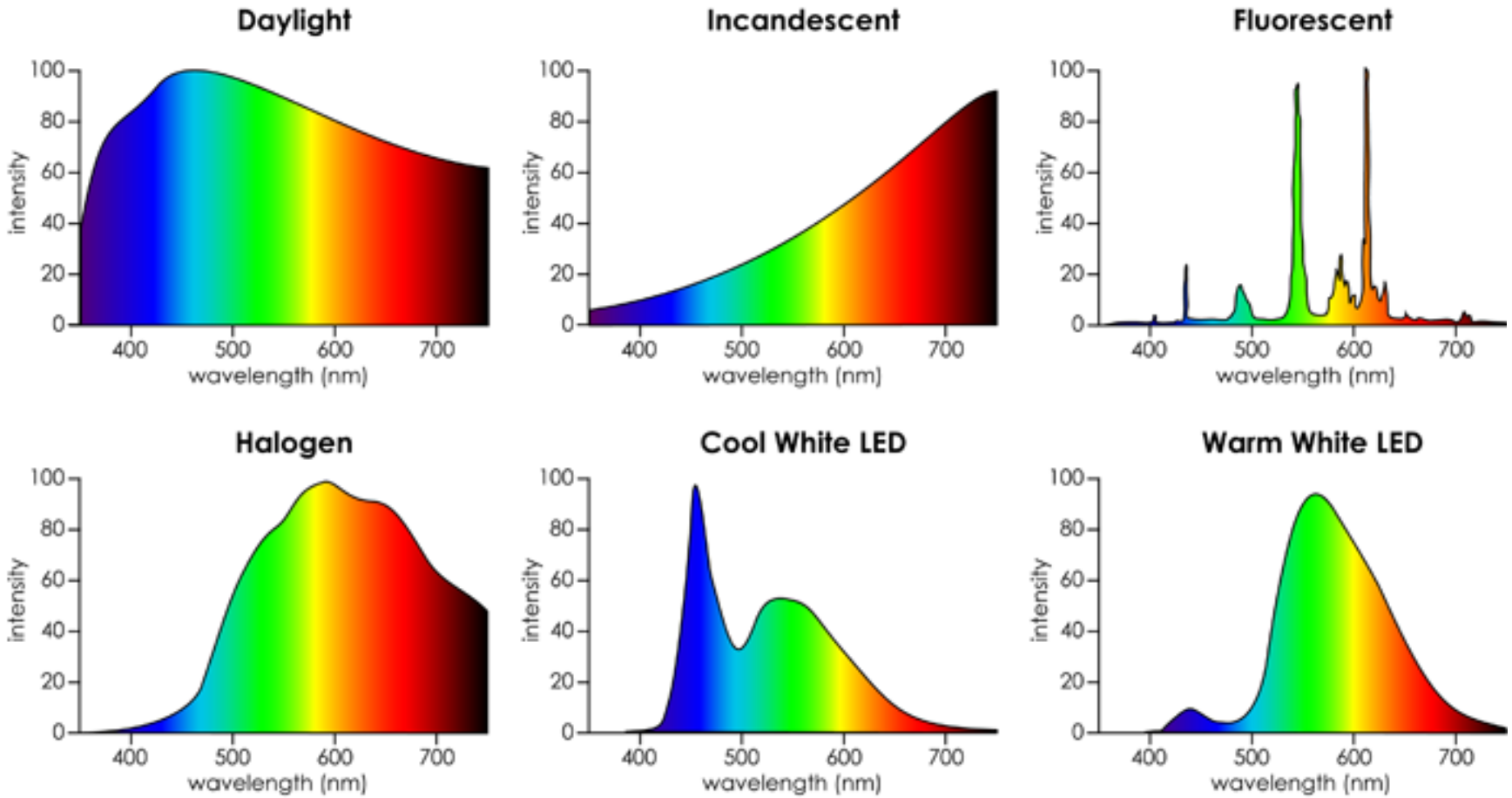


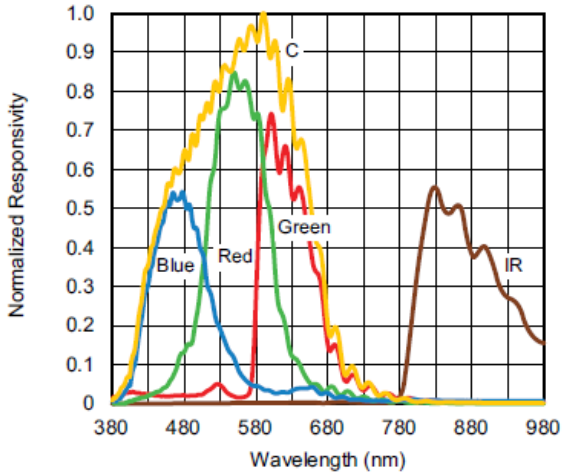
Color and light detection – What can we see ?



Color and light detection- Light source detection

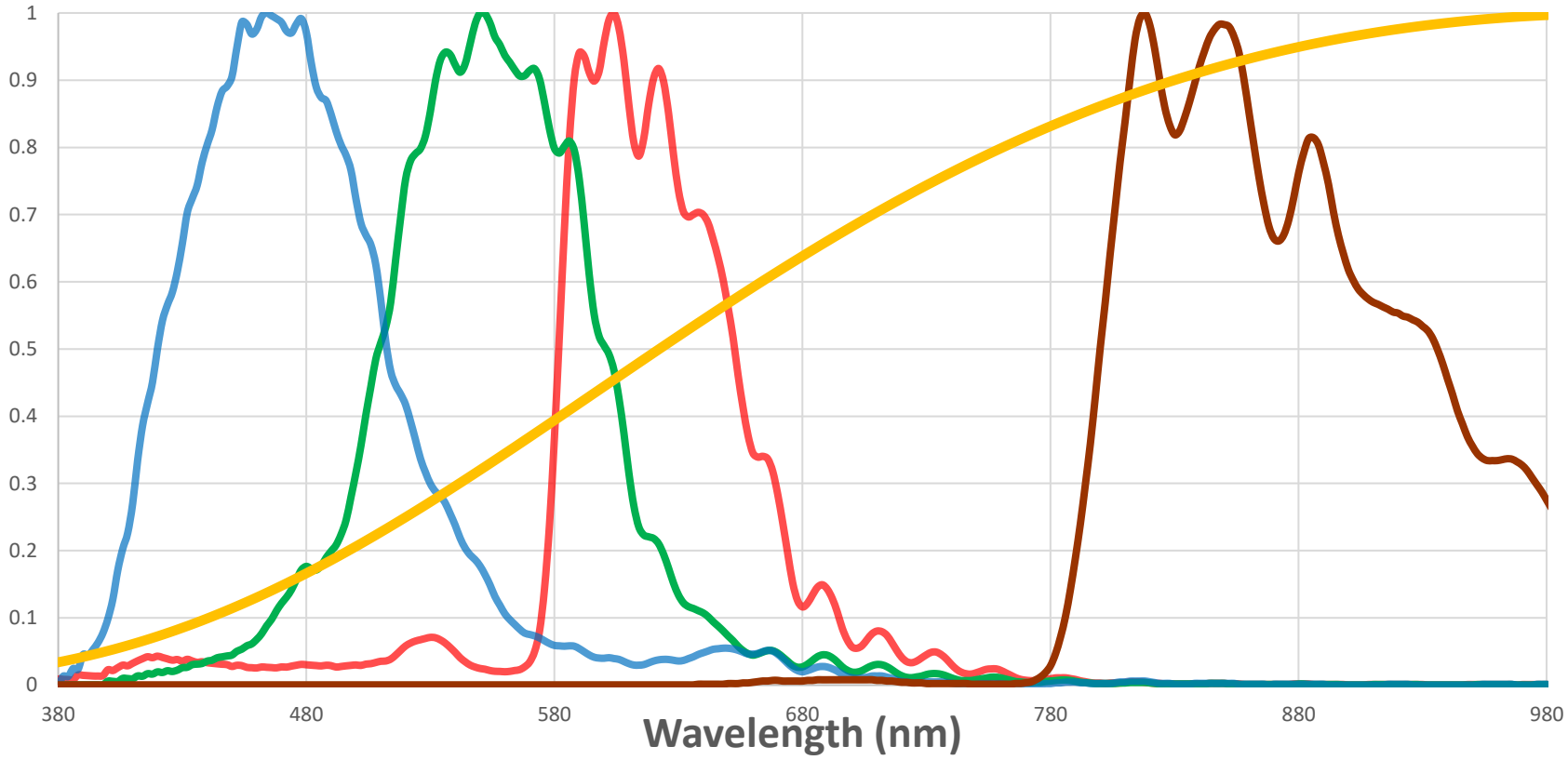
The more channels we have to “break down” the light , the more we know about the type of light being used





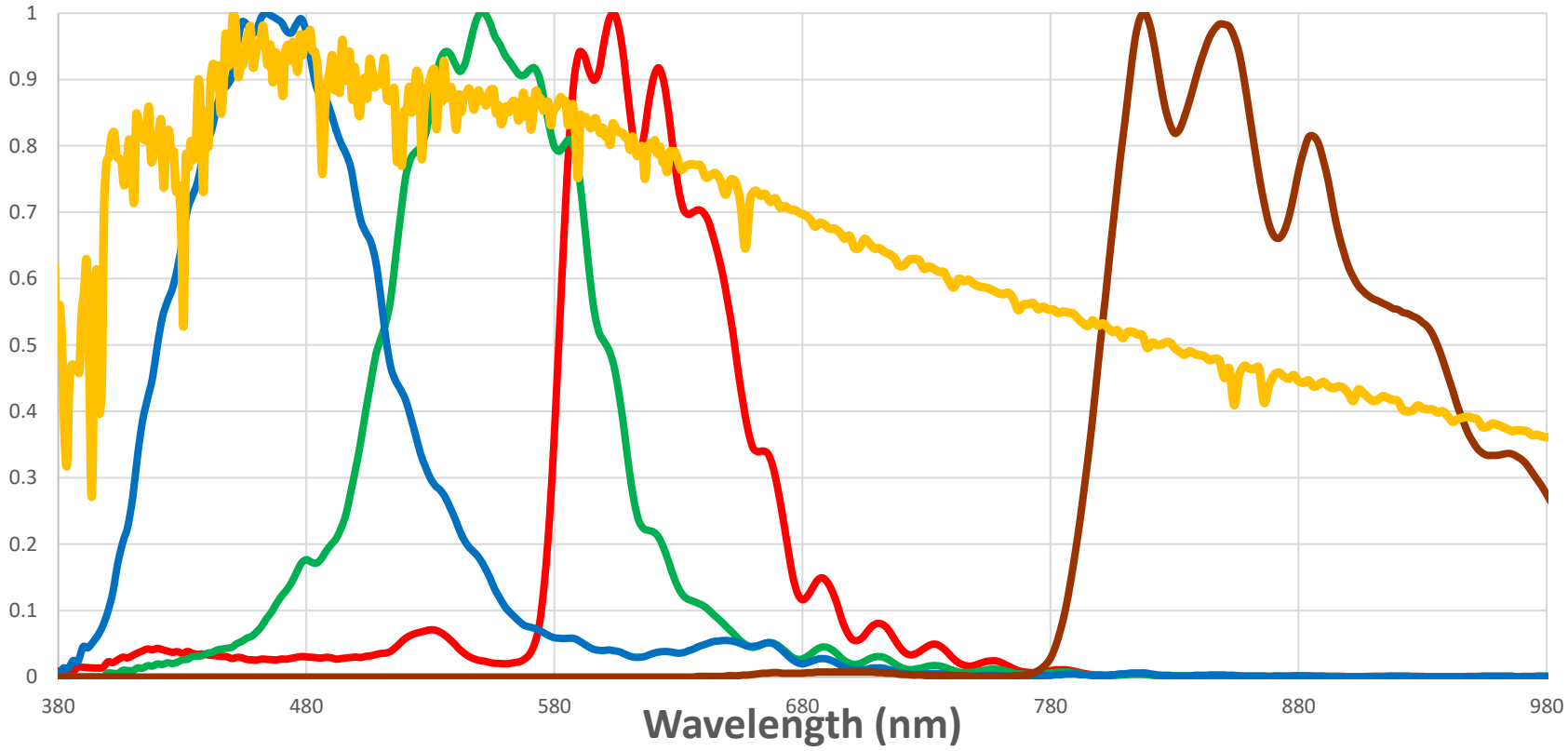
Color and light detection- Light source detection

Incandescent



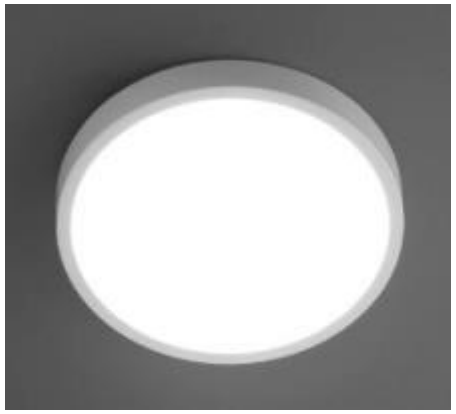
Color and light detection- Light source detection

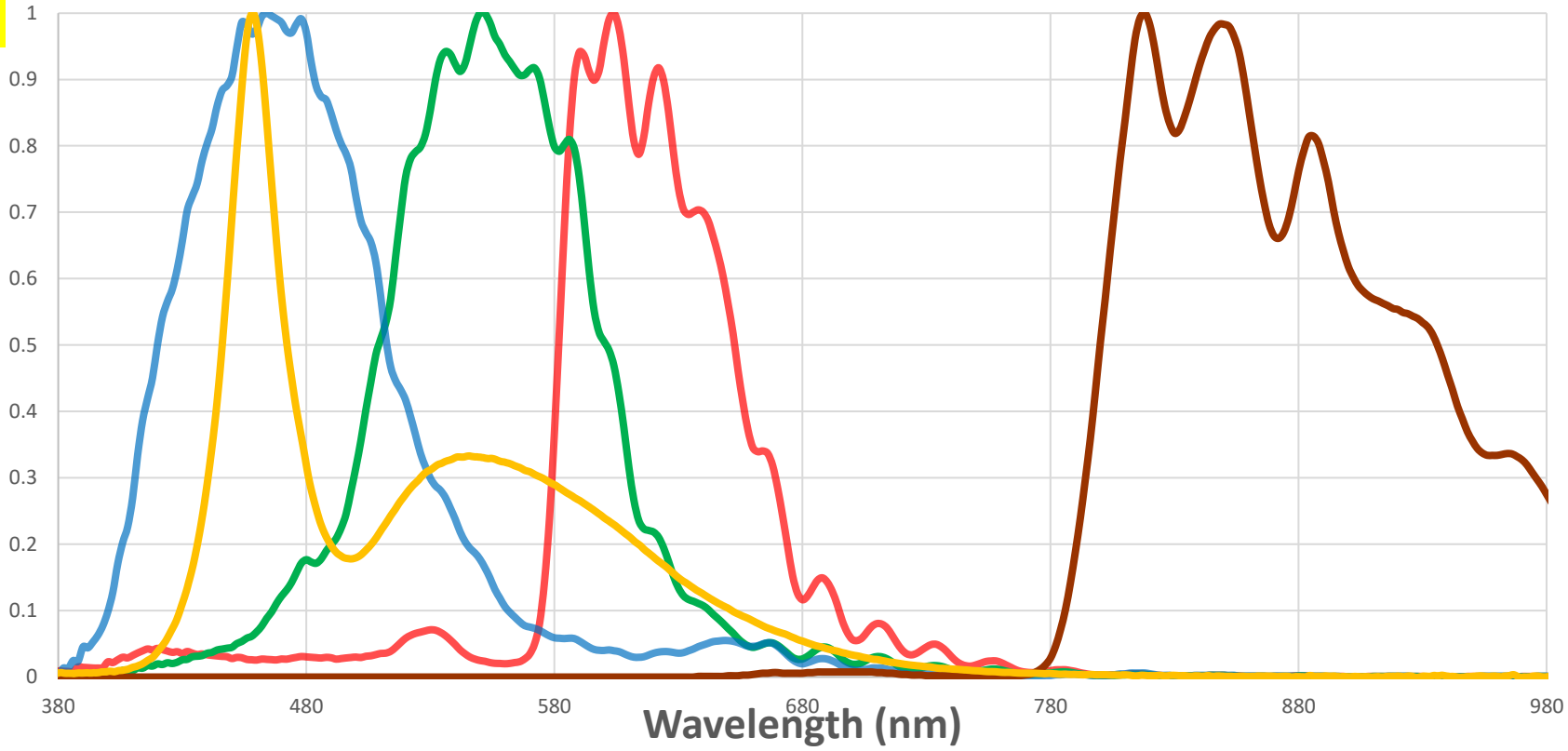
Sunlight



Color and light detection- Light source detection

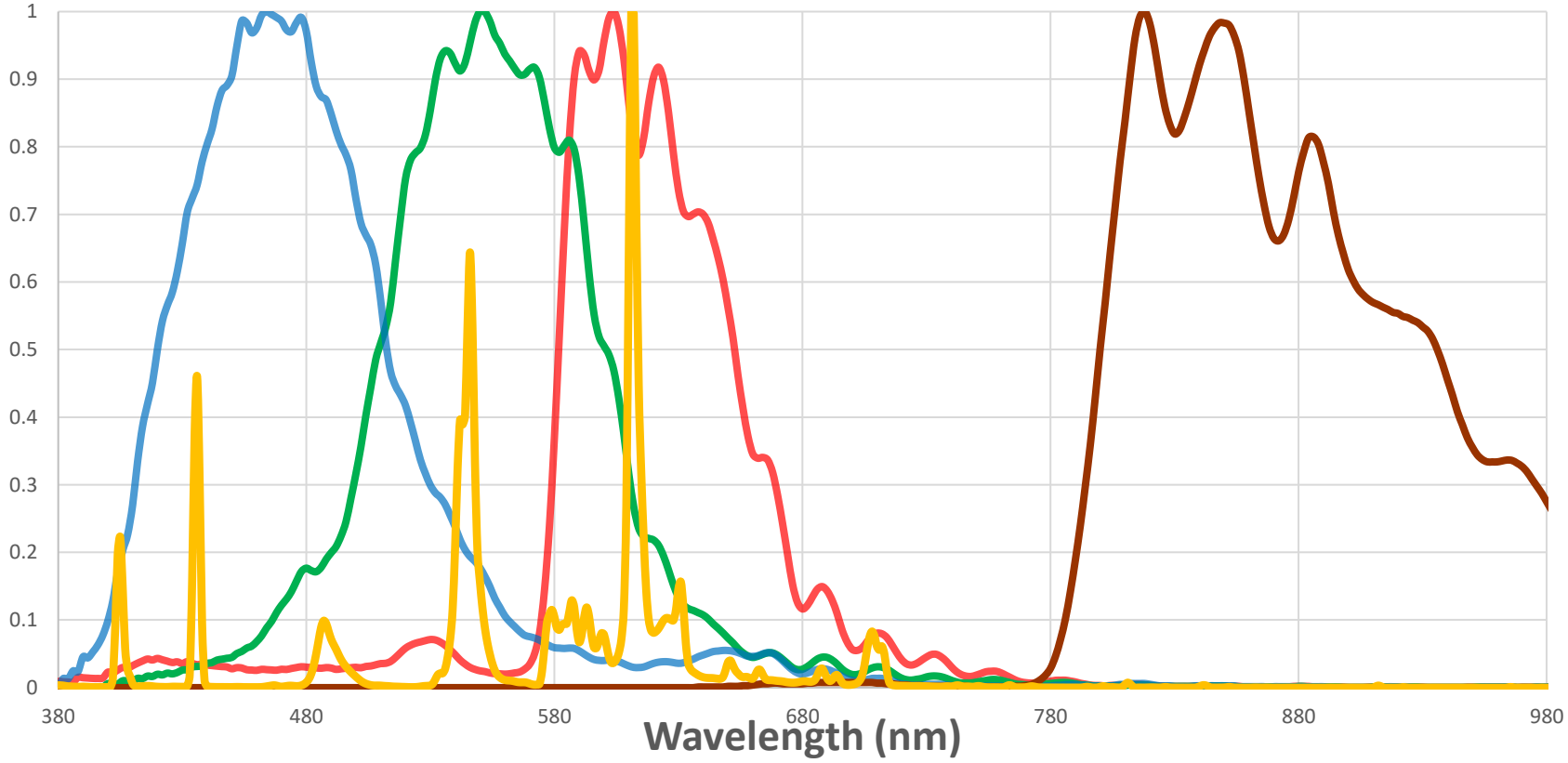
Cool White LED





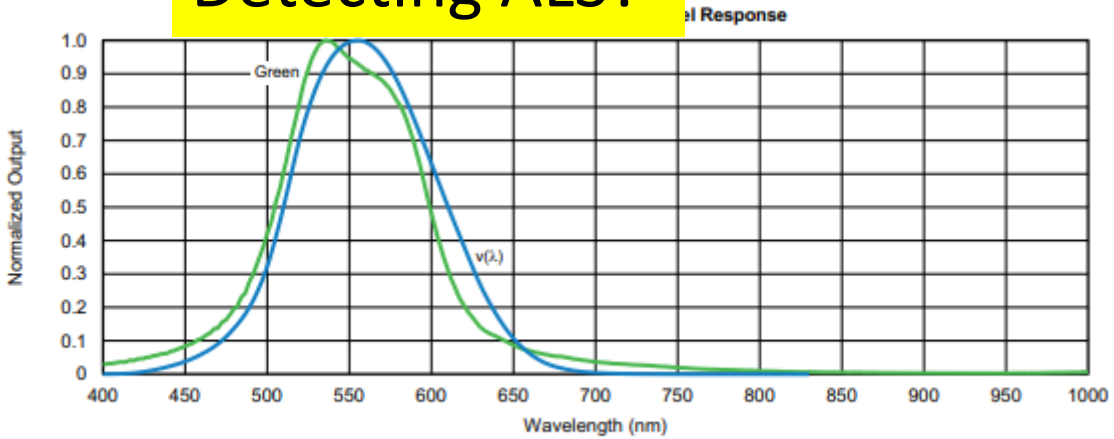
Color and light detection- Light source detection

Flourescent



Color and light detection- Desinging it in

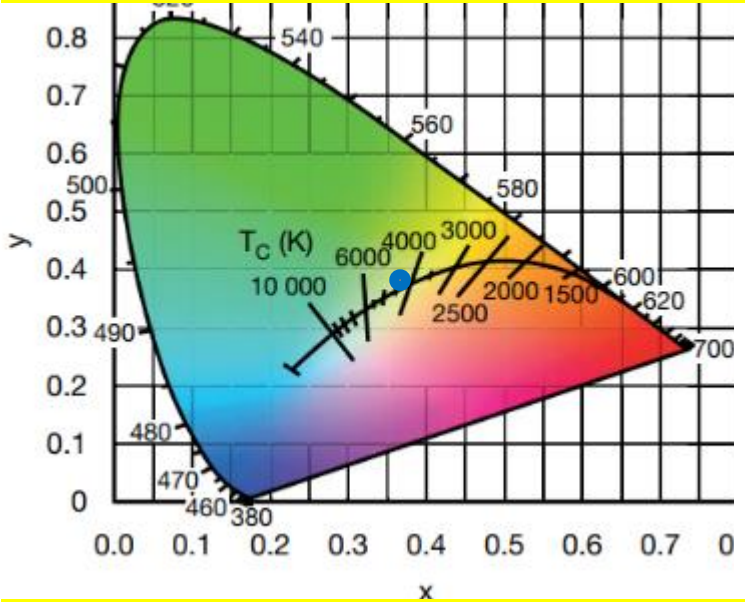
Detecting ALS?

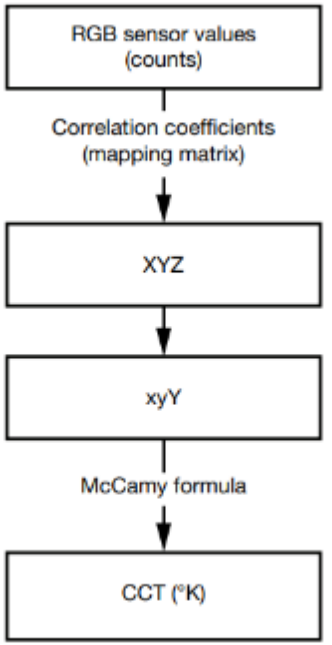


High sensitivity needed ?

TABLE								
	DG: x 4				DG: x 4			
	GAIN: x 4	GAIN: x 2	GAIN: x 1	GAIN: x 1/2	GAIN: x 4	GAIN: x 2	GAIN: x 1	GAIN: x 1/2
IT (ms)	TYPICAL RESOLUTION (lx/cnt)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.003	0.006	0.012	0.024	197	393	786	1573
200	0.006	0.012	0.024	0.048	393	786	1573	3146
100	0.012	0.024	0.048	0.096	786	1573	3146	6291
50	0.024	0.048	0.096	0.192	1573	3146	6291	12 583
	DG: x 2				DG: x 2			
	GAIN: x 4	GAIN: x 2	GAIN: x 1	GAIN: x 1/2	GAIN: x 4	GAIN: x 2	GAIN: x 1	GAIN: x 1/2
IT (ms)	TYPICAL RESOLUTION (lx/cnt)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.006	0.012	0.024	0.048	393	786	1573	3146
200	0.012	0.024	0.048	0.096	786	1573	3146	6291
100	0.024	0.048	0.096	0.192	1573	3146	6291	12 583
50	0.048	0.096	0.192	0.384	3146	6291	12 583	25 165
	DG: x 1				DG: x 1			
	GAIN: x 4	GAIN: x 2	GAIN: x 1	GAIN: x 1/2	GAIN: x 4	GAIN: x 2	GAIN: x 1	GAIN: x 1/2
IT (ms)	TYPICAL RESOLUTION (lx/cnt)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.012	0.024	0.048	0.096	786	1573	3146	6291
200	0.024	0.048	0.096	0.192	1573	3146	6291	12 583
100	0.048	0.096	0.192	0.384	3146	6291	12 583	25 165
50	0.096	0.192	0.384	0.768	6291	12 583	25 165	50 331

Detecting Color or CCT ?





Cover glass material and window size

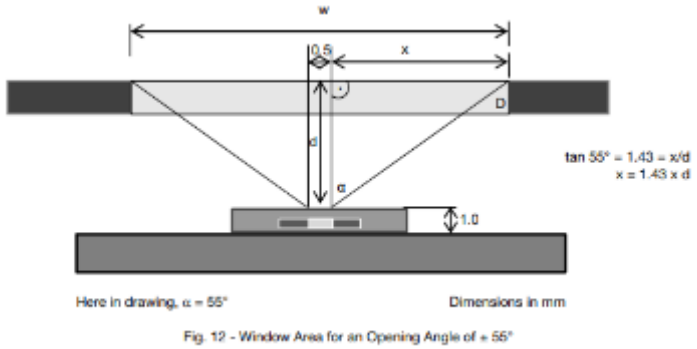
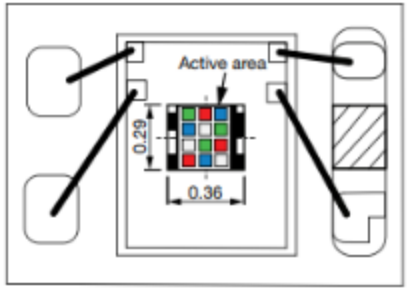
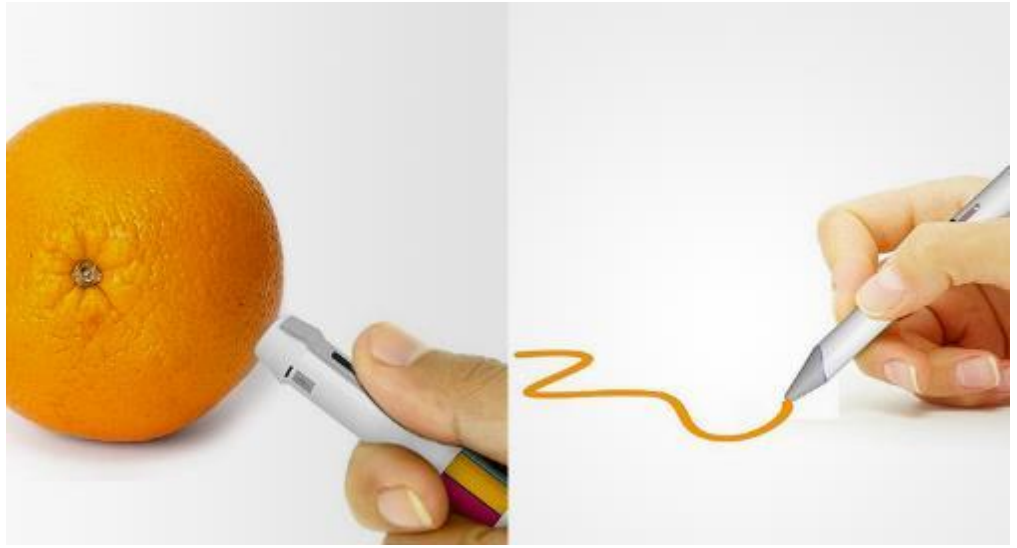


Fig. 12 - Window Area for an Opening Angle of = 55°



Color and light detection- Applications



RGB – Important take aways

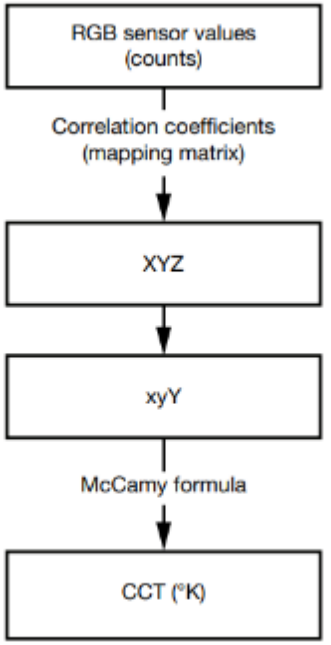
- The green channel mimics the response of the human eye and can be used for ambient light measurement
- The RGB – output levels can be converted with the help of the mapping matrix into actual color values
- The sensitivity of the sensor is determined by the photodiode size, gain and integration time

TABLE 5 - RESOLUTION AND MAXIMUM DETECTION RANGE AT PD_DIV4 = 0 (= x 4/4)

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0034	0.0068	0.0103	0.0136		223	446	675	891
200	0.0068	0.0136	0.0206	0.0272		446	891	1350	1783
100	0.0136	0.0272	0.0412	0.0544		891	1783	2701	3565
50	0.0272	0.0544	0.0824	0.1088		1783	3565	5402	7130
25	0.0544	0.1088	0.1648	0.2176		3565	7130	10 803	14 260
12.5	0.1088	0.2176	0.3297	0.4352		7130	14 260	21 607	28 521
6.25	0.2176	0.4352	0.6594	0.8704		14 260	28 521	43 213	57 042
3.125	0.4352	0.8704	1.3188	1.7408		(-) (1)	(-) (1)	(-) (1)	(-) (1)

TABLE 6 - RESOLUTION AND MAXIMUM DETECTION RANGE AT PD_DIV4 = 1 (= x 1/4)

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0136	0.0272	0.0412	0.0544		891	1783	2701	3565
200	0.0272	0.0544	0.0824	0.1088		1783	3565	5402	7130
100	0.0544	0.1088	0.1648	0.2176		3565	7130	10 803	14 260
50	0.1088	0.2176	0.3297	0.4352		7130	14 260	21 607	28 521
25	0.2176	0.4352	0.6594	0.8704		14 260	28 521	43 213	57 042
12.5	0.4352	0.8704	1.3188	1.7408		28 521	57 042	86 427	114 083
6.25	0.8704	1.7408	2.6376	3.4816		57 042	114 083	172 854	228 167
3.125	1.7408	3.4816	5.2752	6.9632		(-) (1)	(-) (1)	(-) (1)	(-) (1)



Thank you!