

DYNAMIC LIGHT LEVEL ADJUSTMENT WITH CEDD AGL

Gerbrandt van Staveren
8th of November 2023

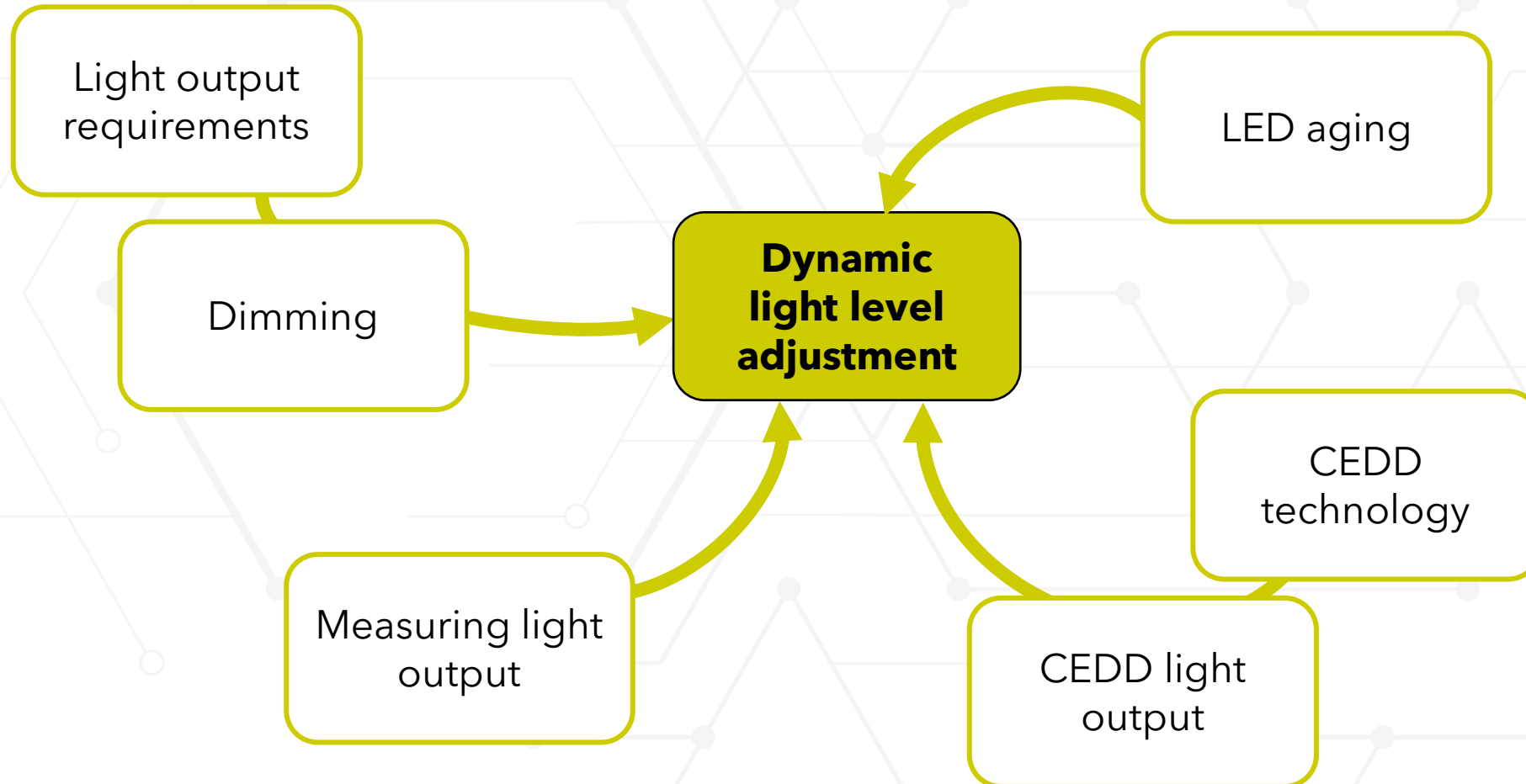


A photograph of an airport runway at night, illuminated by a series of bright white lights that recede into the distance. The sky is dark, and the runway is flanked by green lights. The overall scene is dark, with the lights providing the primary illumination.

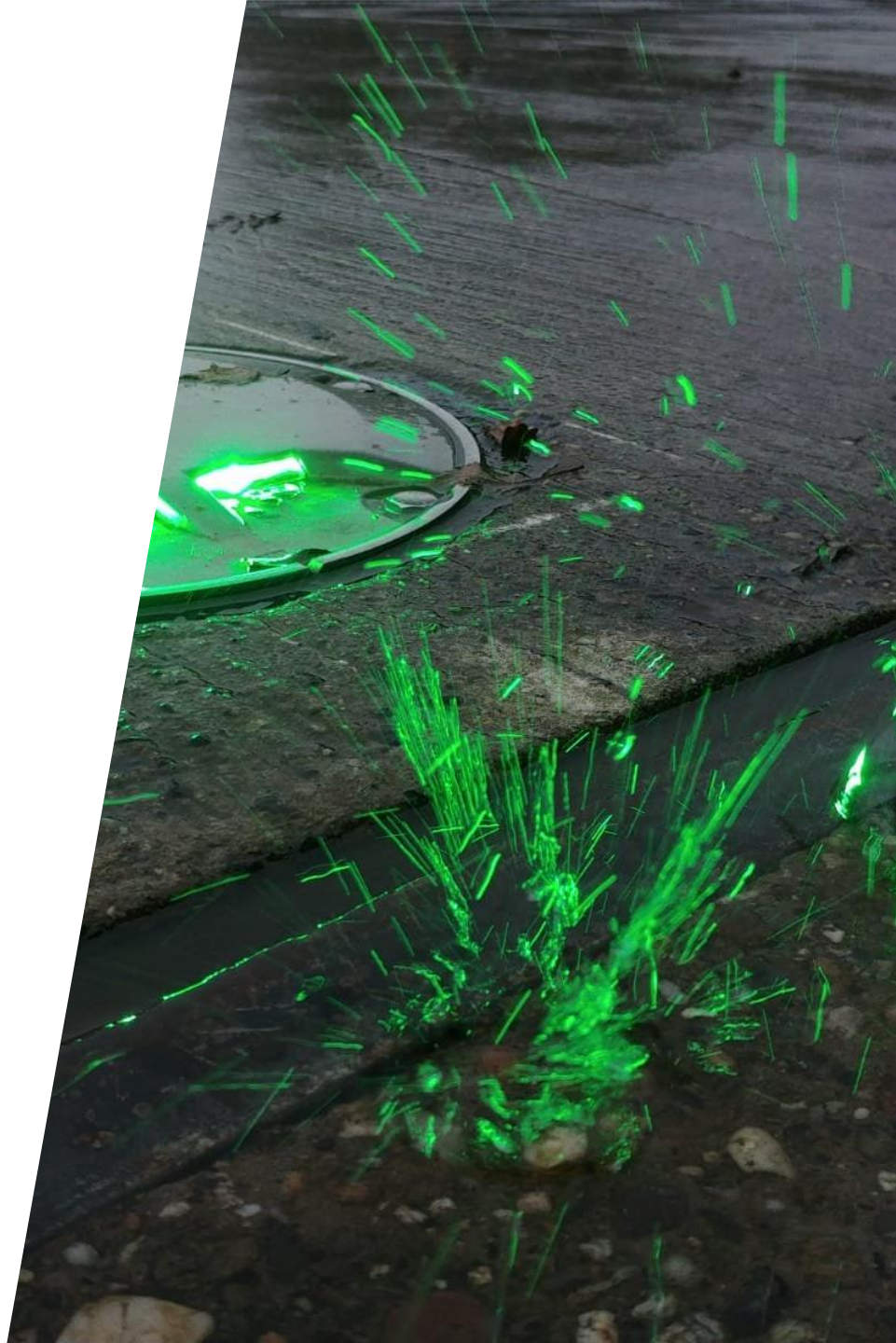
GUIDING THE PILOT IN ALL CIRCUMSTANCES WITH THE RIGHT LIGHT OUTPUT

- Light output compliance
- Correct dimming factor
- Equal brightness
- Not blinding

WHAT I WILL TALK ABOUT



LIGHT OUTPUT REQUIREMENTS

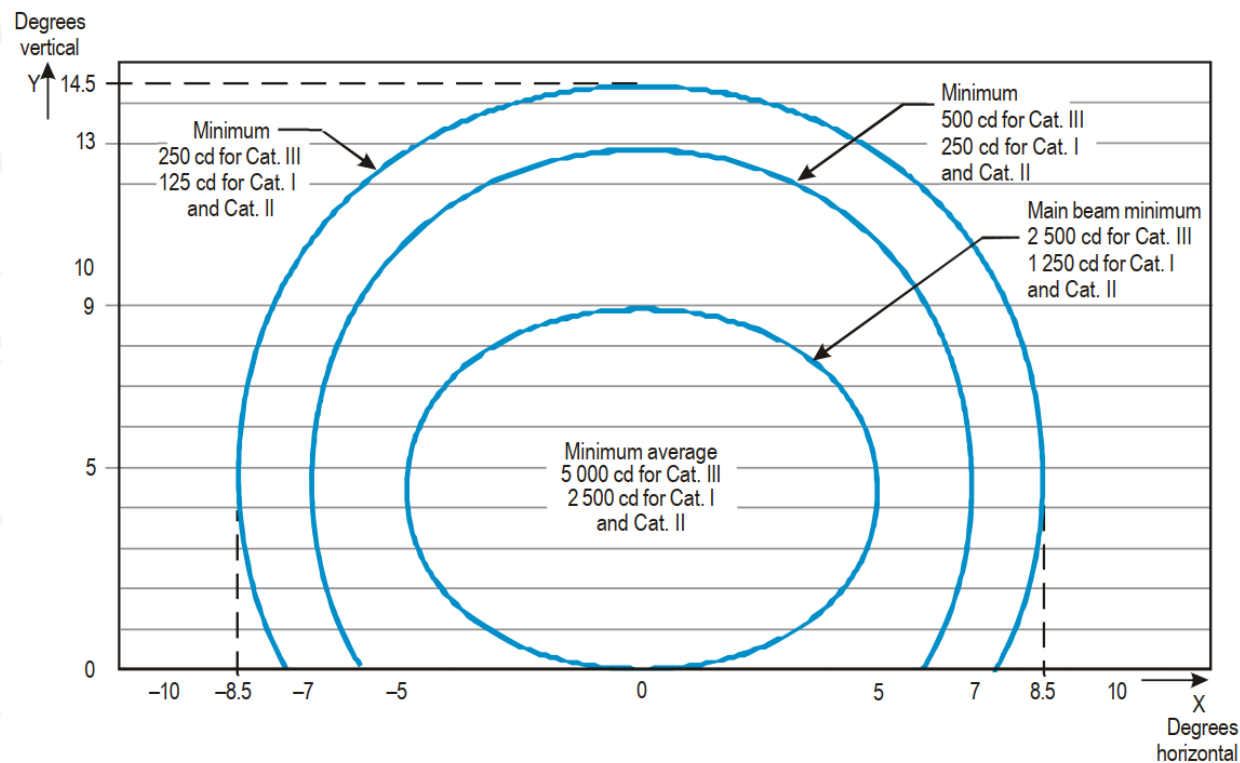


FAA AC150/5345-46E

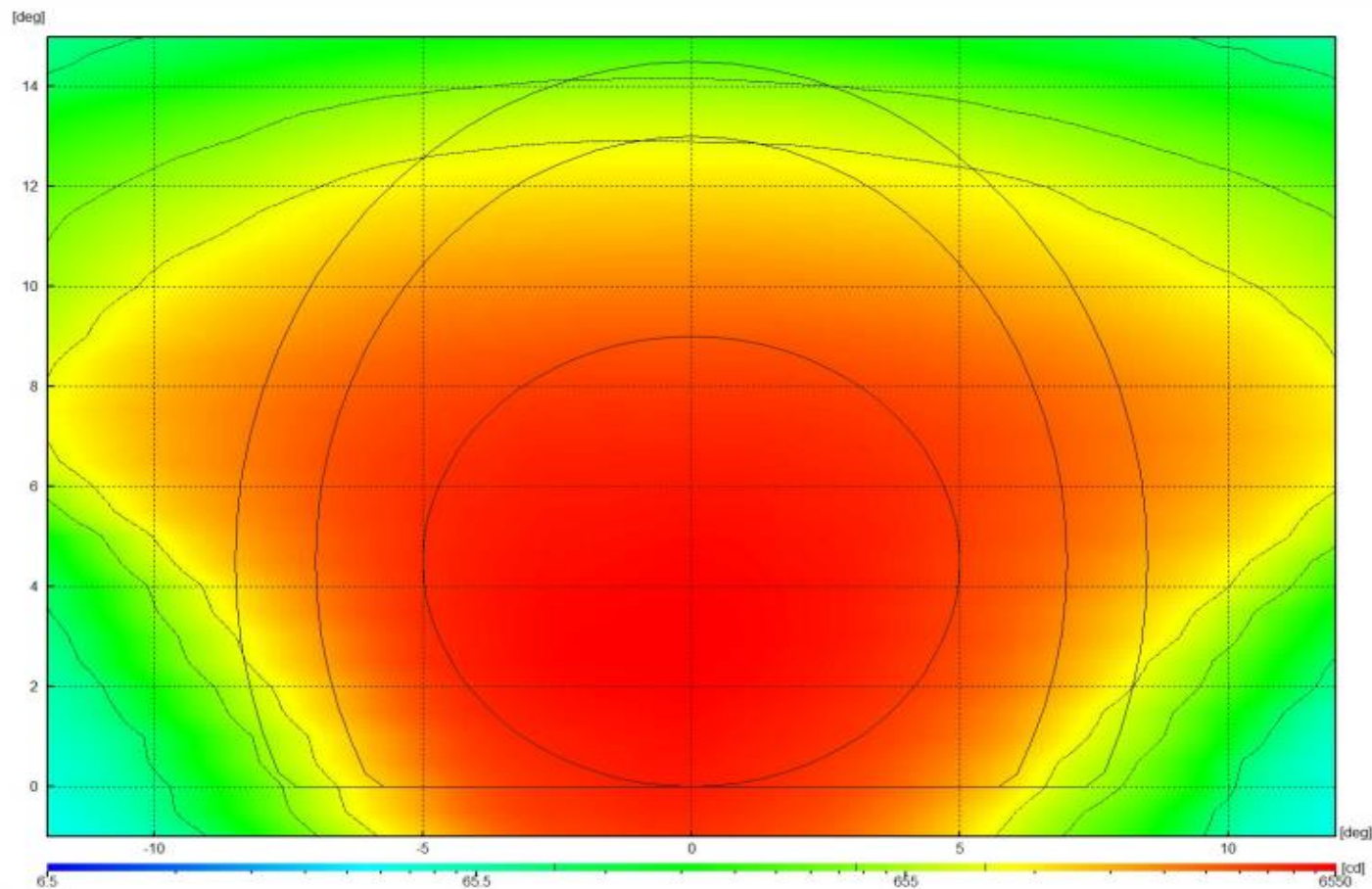
Table 1. Photometric Requirements for In-pavement Lights.

Type	Minimum beam coverage (degrees) (a)				Intensity (candelas) (b)				
	Main beam (c)		10 percent (d)		White	Yellow	Green	Red	Blue
	H	V	H	V					
L-850A	±5	0.2 to 9	±7	-4 to 13	5,000			750	
L-850T (g)	±5	0.2 to 9	±7	-4 to 13				1500	
L-850B (i)	-1 to 9	2 to 9	-3 to 11	-0.5 to 11.5	5,000				
L-850C	-2 to 9	0.2 to 7	-4 to 11	-2.5 to 9.5	10,000	5,000	3,300	1,500	
L-850D (j)	-2 to 9	1 to 10					3,300		
	±6	0.2 to 4.7	±7.5	-2.5 to 7.5				2,500	
L-850E	±6	1 to 9					5,000		
L-850F	±5	0.2 to 9	±7	-4 to 13	5,000(e)				
L-852A	±10	1 to 4	±16	0.5 to 10		20	20		
L-852B	±30	1 to 4	±30	0.5 to 10		20	20		
L-852C	±3.5	1 to 8	±4.5	0 to 13		200	200		
L-852D	±30	1 to 10	±30	0 to 15	150	100	100		
L-852E	360	1 to 8				50(f)			
L-852F	360	1 to 10				200(f)			
L-852G	±24	1 to 10	±30	0.5 to 13		1,000(g)			
L-852J	-3.5 to 35	1 to 4	-4.5 to 36	0.5 to 15		20	20		
L-852K	-3.5 to 35	1 to 10	-5.5 to 37	0 to 15		100	100		
L-852S	±24	1 to 10	±30	0.5 to 13				300(g)	
L-852T	360	1 to 6							2(h)

L-850A Runway centerline white
Main beam average: 5000 candela



RUNWAY CENTERLINE OUTPUT



LIMITS

Maximum 3 times

e The average measured intensity may be no more than three times the specified average intensity. For fixtures with a minimum but no average intensity specification, the measured minimum may be no more than three times the specified minimum intensity. This paragraph does not apply to bi-directional, split color light fixtures if a single light source is used.

(2) After cleaning, realignment or repair, to check the effectiveness of the maintenance action. High intensity elevated runway edge lights that have a light output below 70% of the minimum light output required when operated at maximum intensity per AC 150/5345-46, Specification for Runway and Taxiway Light Fixtures, should be targeted for maintenance. Any light with measured output less than 70% of the minimum light output required per AC 150/5345-46 is ineffective for high background brightness, low visibility conditions. See Appendix A, Standards and Tolerances, Table 8.

Minimum 70%

DIMMING



LED VS INCANDESCENT

(DOC 9157 AERODROME DESIGN MANUAL PART 5)

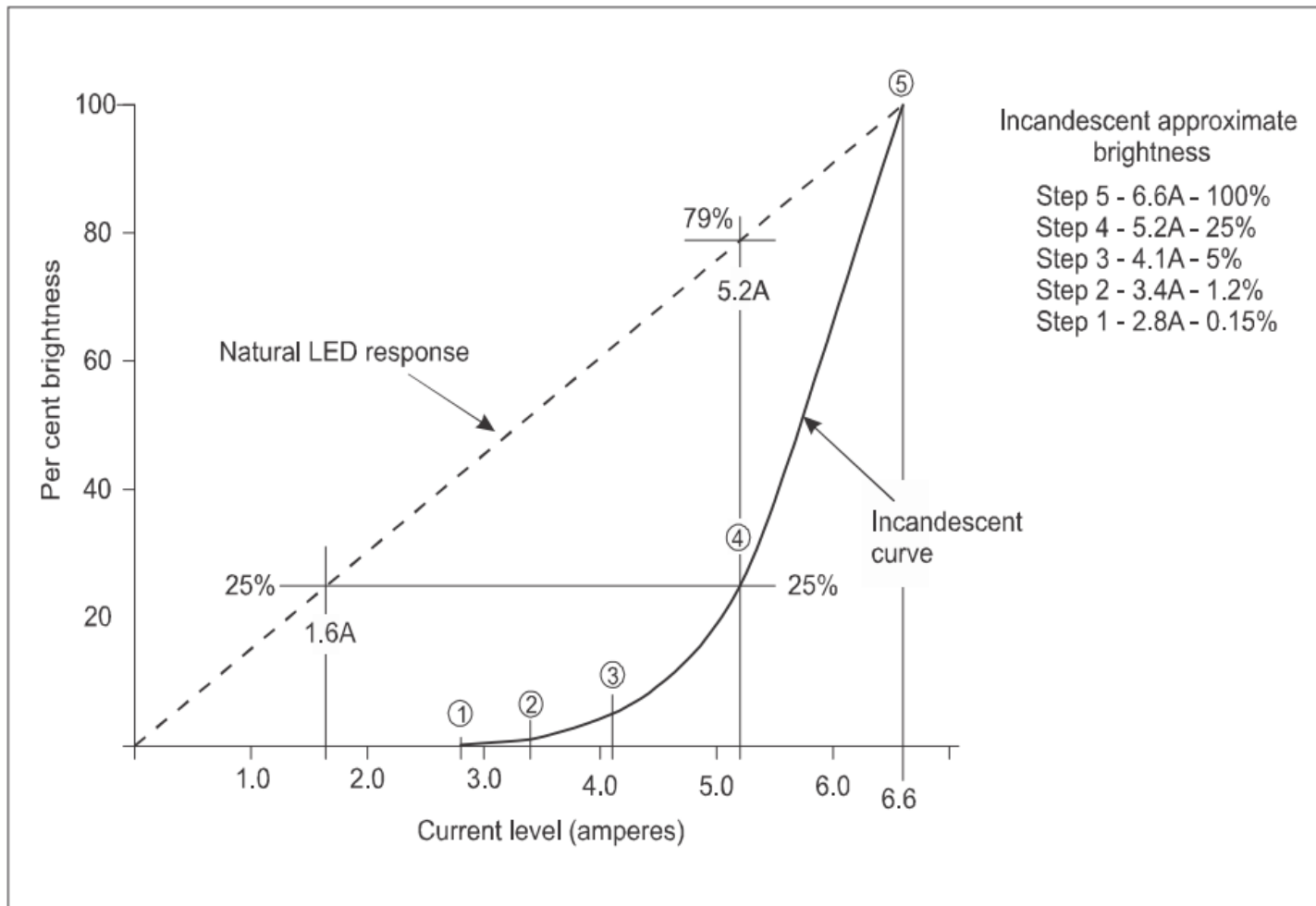
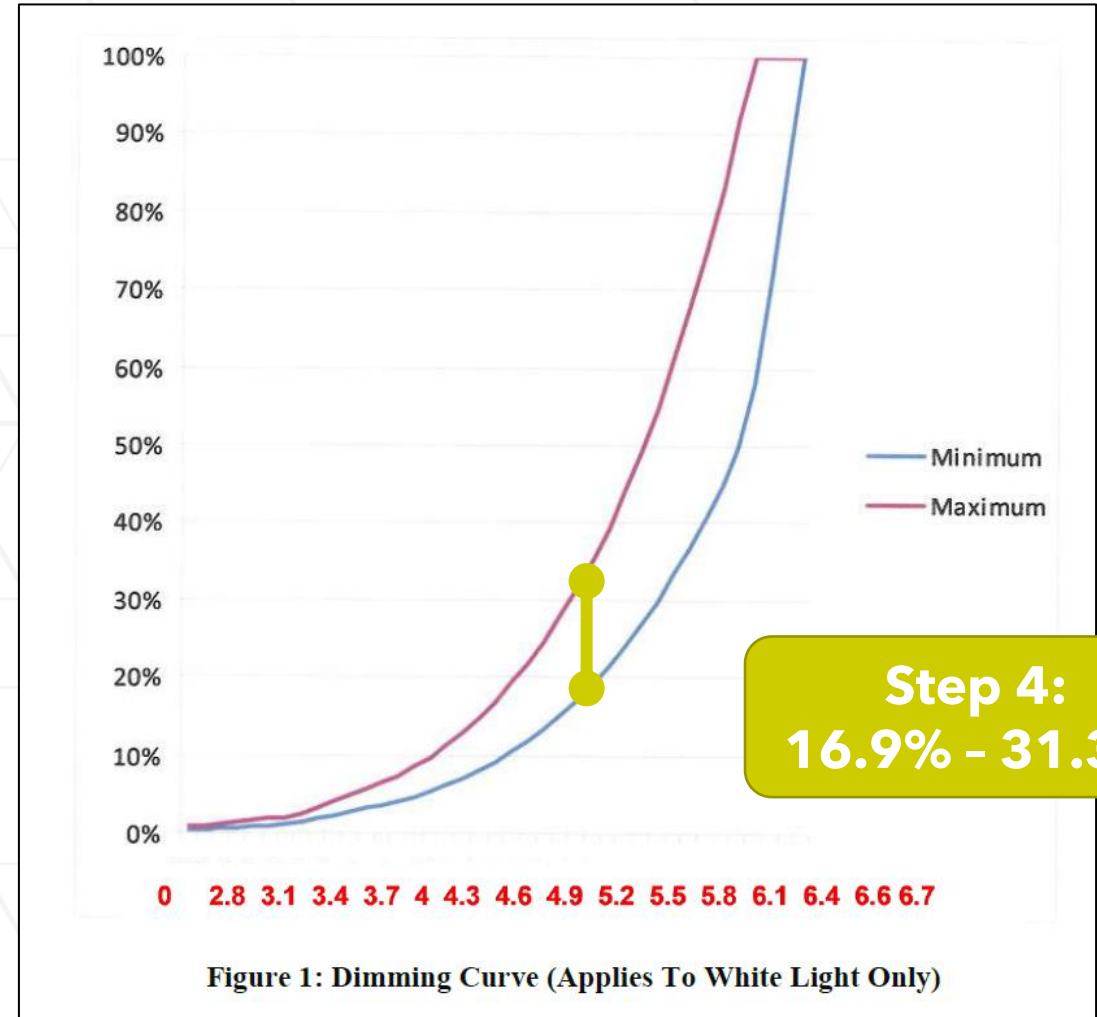


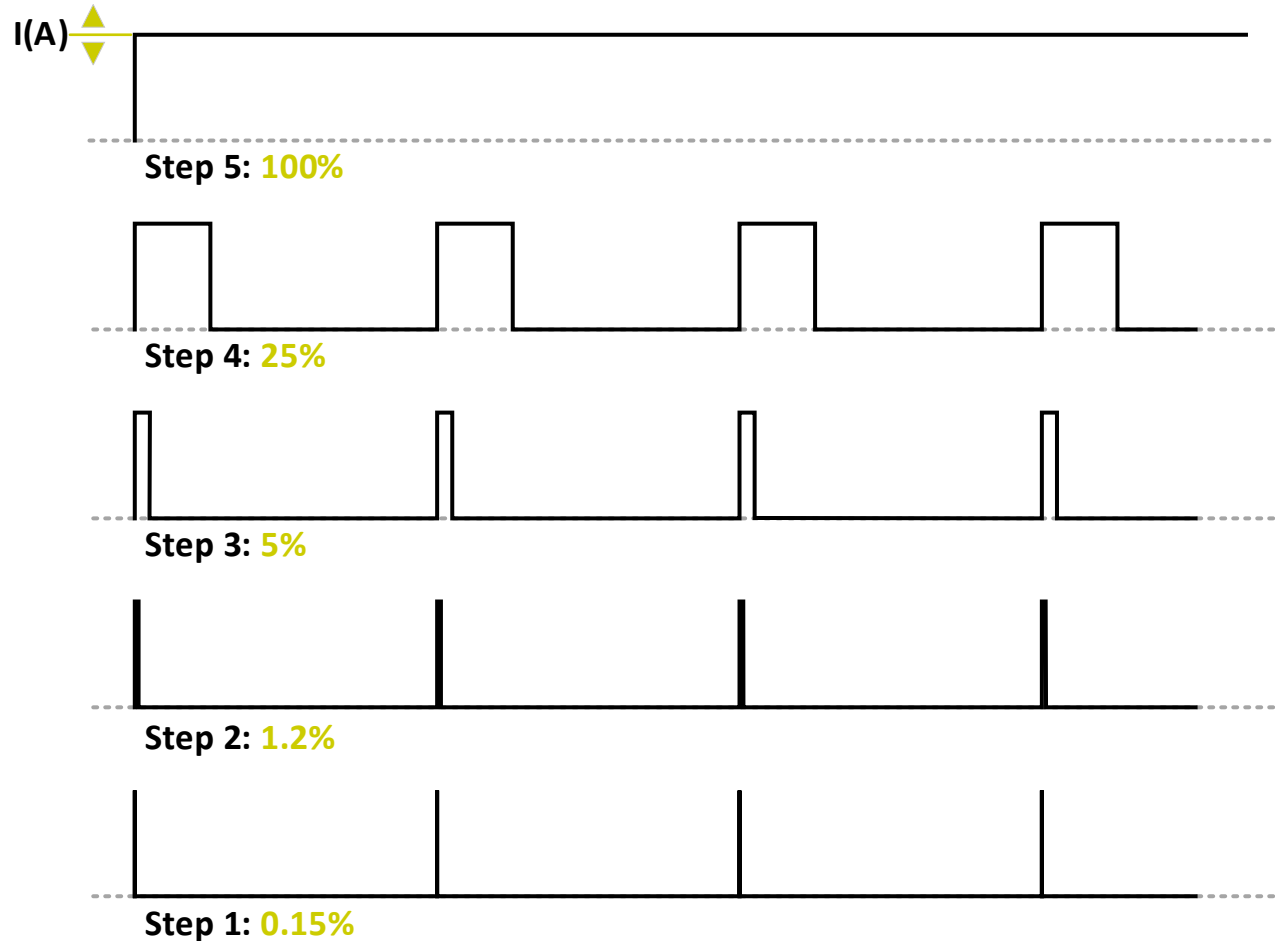
Figure 12-9. LED and incandescent lighting response curves

AC150/5340-30J - FAA EB67D

	Percent Brightness	Lamp Current
Step 5	100	6.6 A
Step 4	25	5.2 A
Step 3	5	4.1 A
Step 2	1.2	3.4 A
Step 1	0.15	2.8 A

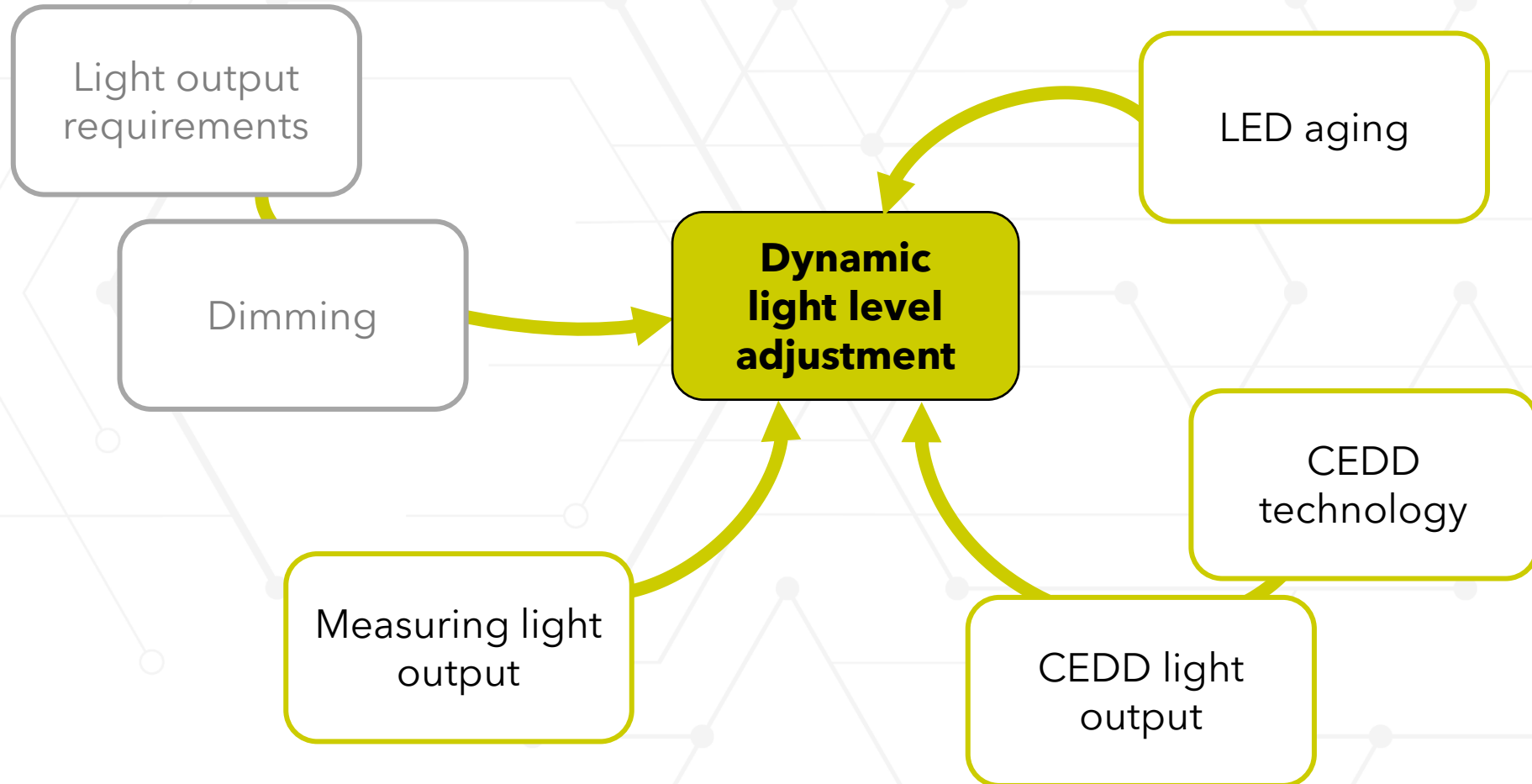


PULSE WIDTH MODULATION



- ✓ To establish the right dimming with LED fixtures, pulse with modulation (PWM) is often used
- ✓ The light output is equivalent to the percentage of the time current is applied
- ✓ The maximum intensity is determined by the current applied

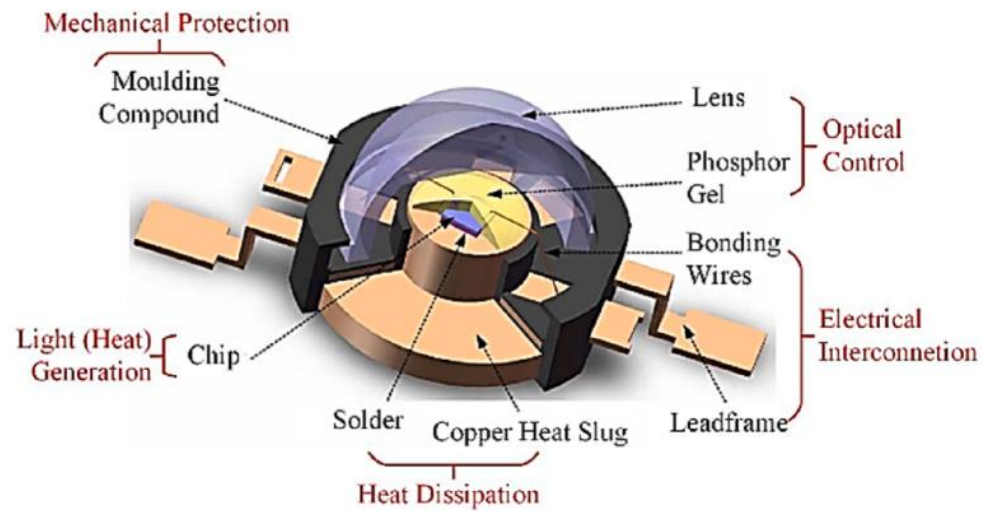
WHAT I WILL TALK ABOUT



LED AGING



LED AGING MECHANISMS



- **LED chip degradation**

- Relates to operating current
- Increase of non-radiant recombination centers

- **Phosphor layer degradation**

- Relates to temperature
- Browning of the phosphor

- **LED lens degradation**

- Relates to temperature
- Cracking and yellowing

LED AGING MECHANISMS



Fig. 5. Browning of LED phosphor layer according to thermal stress (The left figure before and the right, after degradation) (Yazdan Mehr et al., 2020).



Fig. 7. Silicon lens cracking after degradation (Yazdan Mehr et al., 2020).

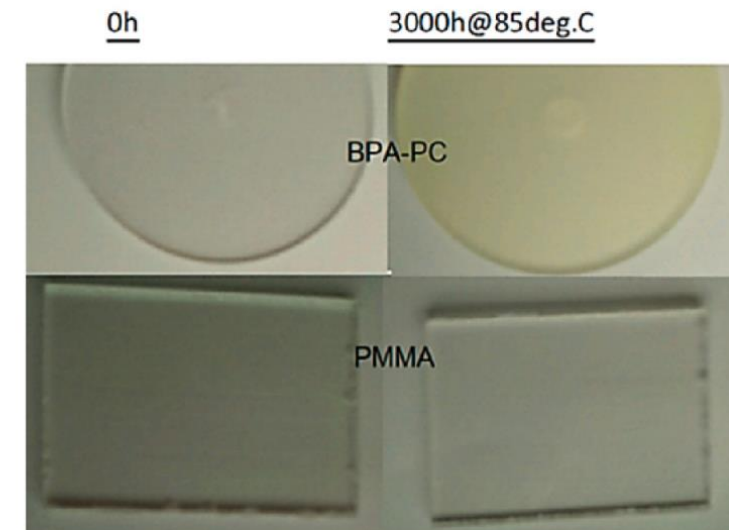
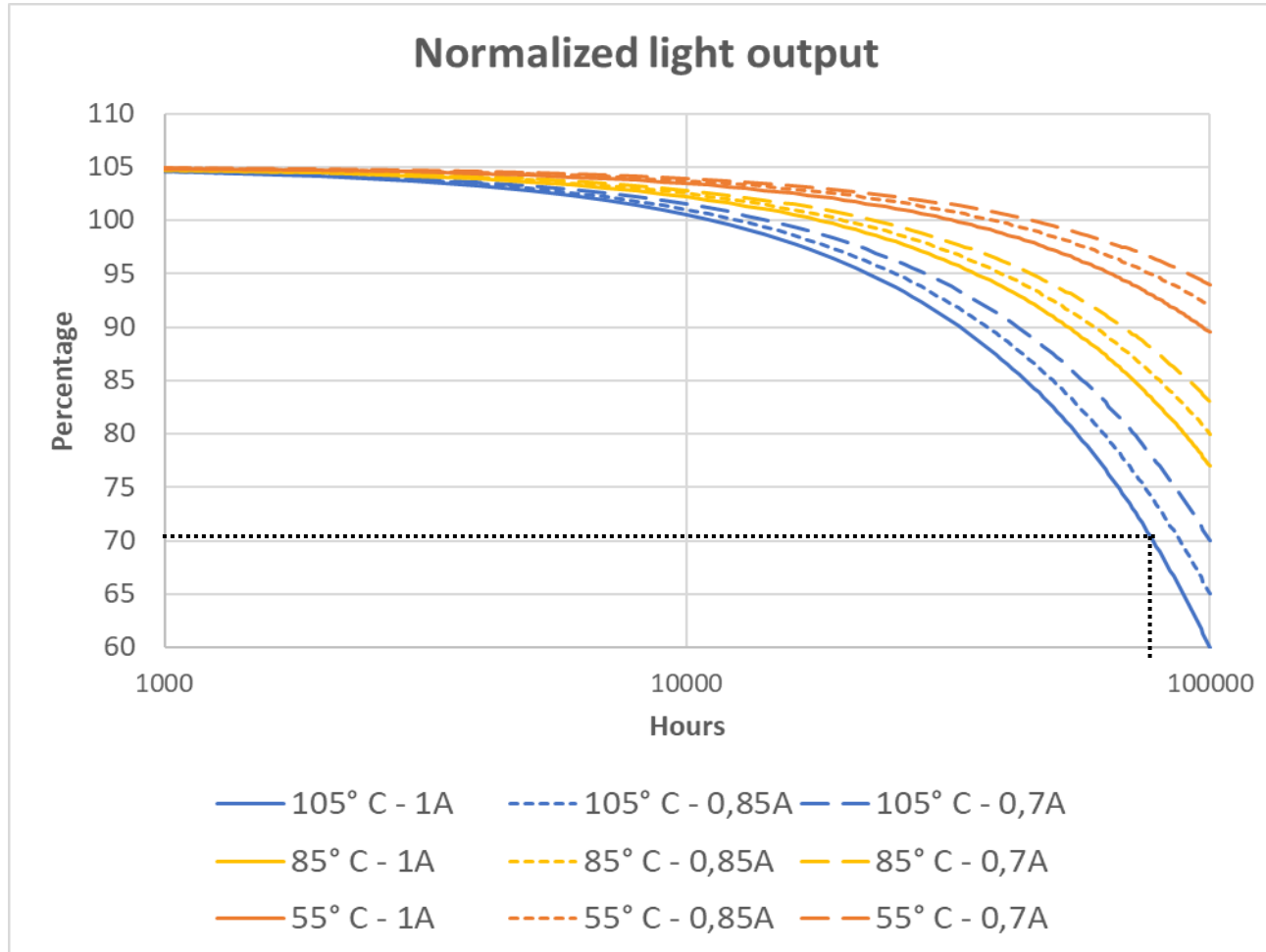


Fig. 8. Uniform yellowing degradation in lens materials (Yazdan Mehr et al., 2020).

IES LM80 - TM21 METHOD

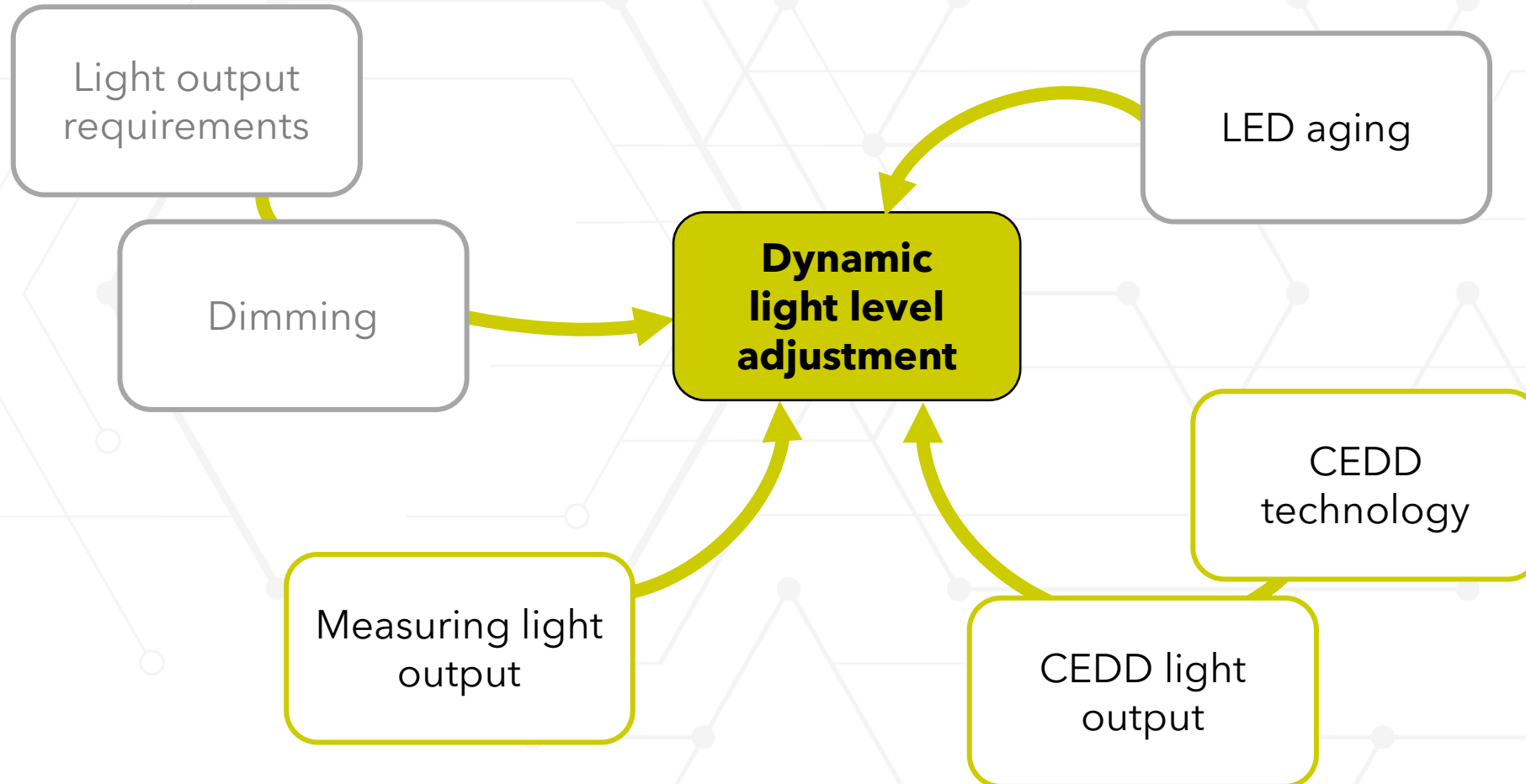


- ✓ IES Standard for measuring lumen maintenance of LED light sources
 - ✓ 6000+ hour test
 - ✓ 3 temperatures: 55°, 85°, 105°
 - ✓ Different drive currents
- ✓ Depreciation curve (TM21)
 - ✓ L70 @ 105°C and 1A > 78.000 hours
 - ✓ Maximum 6x LM80 test duration

LM80 TESTING

Data Set	Case Temp. [T _s]	Ambient Temp. [T _A]	Drive Current [I _F]	ANSI CCT Target	Sample Count	Test Duration	Reported TM-21 Lifetimes
6	105 °C	105 °C	1050 mA	3000 K	20	12,096 hrs	L90(12k) > 72,600 hrs L80(12k) > 72,600 hrs L70(12k) > 72,600 hrs
5	85 °C	85 °C	1500 mA	3000 K	20	18,144 hrs	L90(18k) > 109,000 hrs L80(18k) > 109,000 hrs L70(18k) > 109,000 hrs
3	105 °C	105 °C	1500 mA	3000 K	25	11,592 hrs	L90(12k) = 66,600 hrs L80(12k) > 69,600 hrs L70(12k) > 69,600 hrs
4	85 °C	85 °C	2100 mA	3000 K	25	10,080 hrs	L90(10k) = 42,100 hrs L80(10k) > 60,500 hrs L70(10k) > 60,500 hrs
1	105 °C	105 °C	2100 mA	3000 K	25	6,048 hrs	L90(6k) = 24,000 hrs L80(6k) > 36,300 hrs L70(6k) > 36,300 hrs
2	85 °C	85 °C	3000 mA	3000 K	25	6,048 hrs	L90(6k) = 16,300 hrs L80(6k) = 35,800 hrs L70(6k) > 36,300 hrs

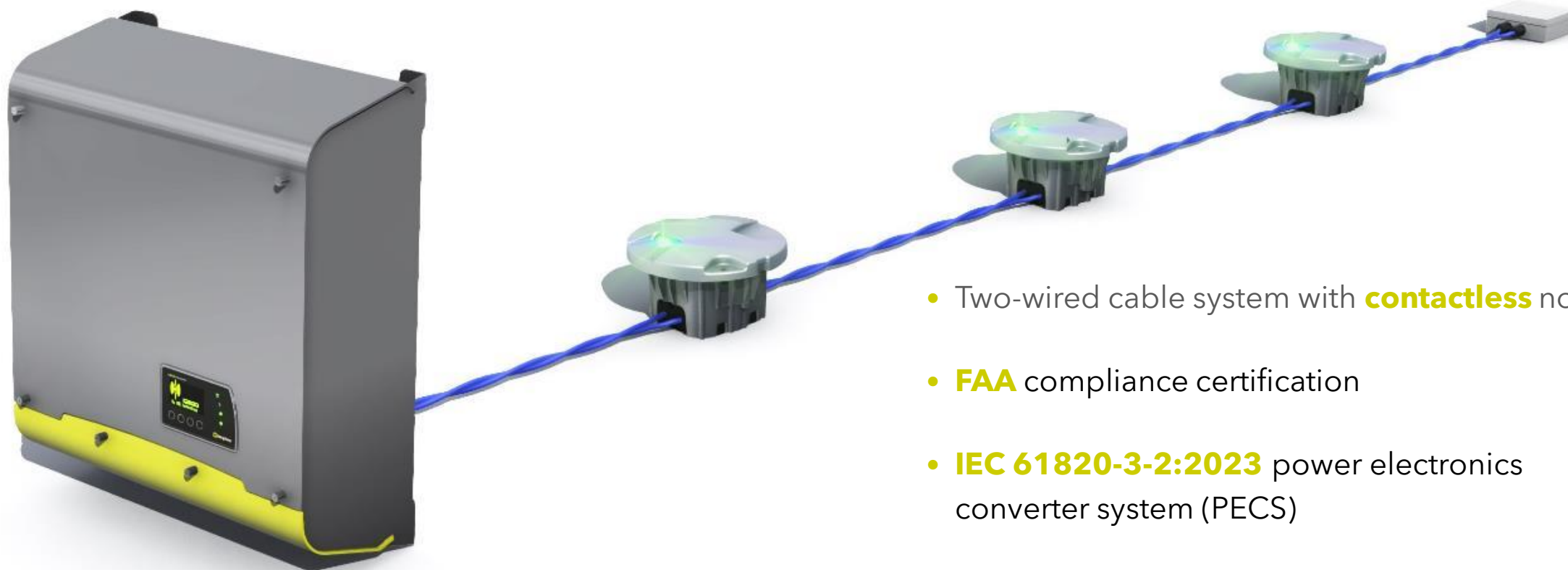
WHAT I WILL TALK ABOUT



CEDD TECHNOLOGY



CEDD AIRFIELD GROUND LIGHTING SYSTEM



- Two-wired cable system with **contactless** nodes
- **FAA** compliance certification
- **IEC 61820-3-2:2023** power electronics converter system (PECS)
- **Low energy** consumption (up to 70% less compared to 6.6 A LED AGL)
- **Low voltage** (750 V)



QUICK AND EASY INSTALLATION

- **No transformers, transformer pits or deep cans** required, since no secondary circuits
- **Low voltage** system > safer
- **Water proof** since no connectors used
- Cost of civil installation down to 20% of cost of traditional AGL installation*

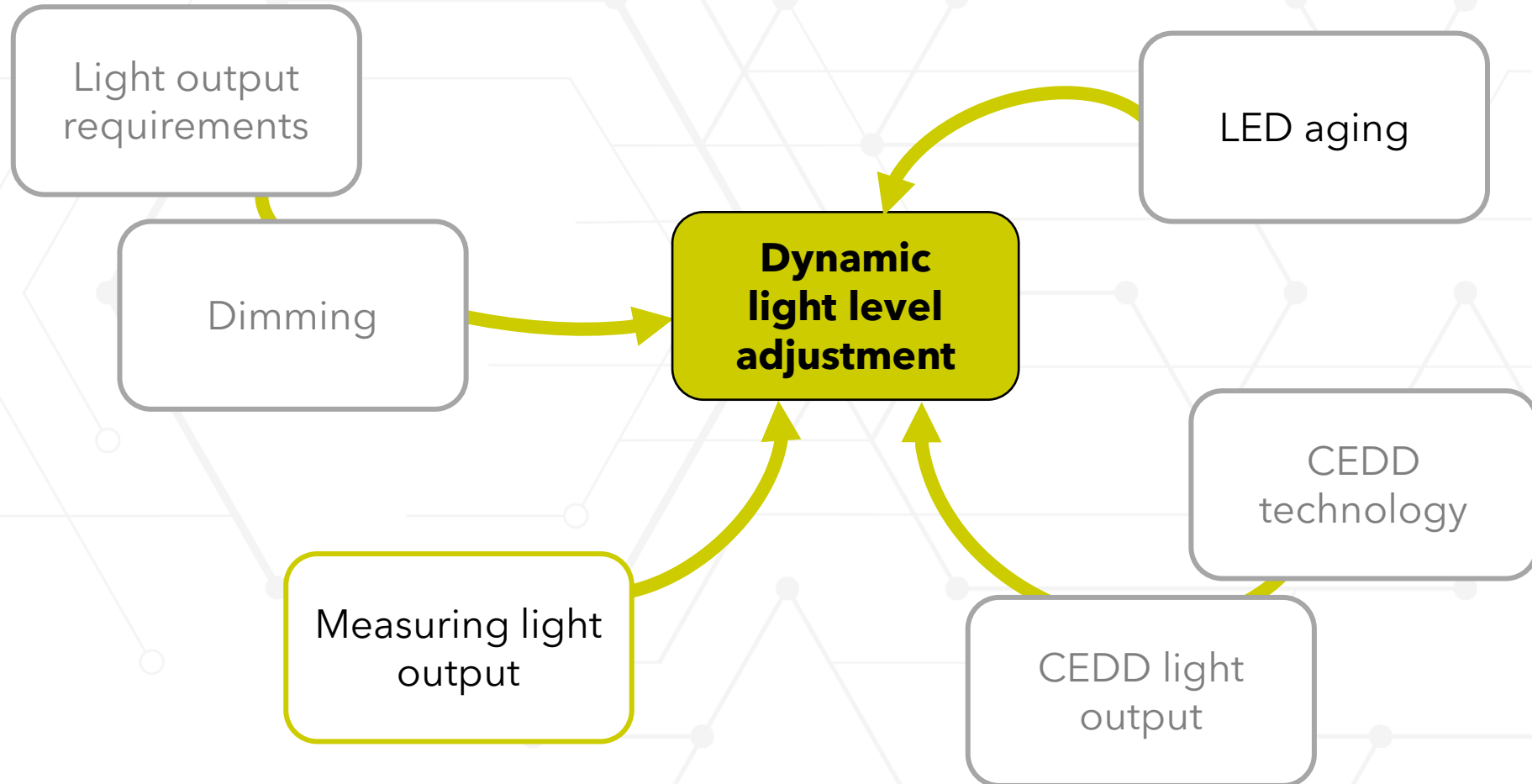
* Figures from business case study, available on request

CEDD LIGHTS AND FIXTURES



- ✓ **Induction** for data and energy transfer
- ✓ **Rugged** bi-directional communication
- ✓ Single light intensity control and monitoring all through the built-in **software** (ILCMS 2.0)
- ✓ Parallel fixture feedback (< **500 ms**)
- ✓ Significant data: **1 kbit/s per fixture**

WHAT I WILL TALK ABOUT

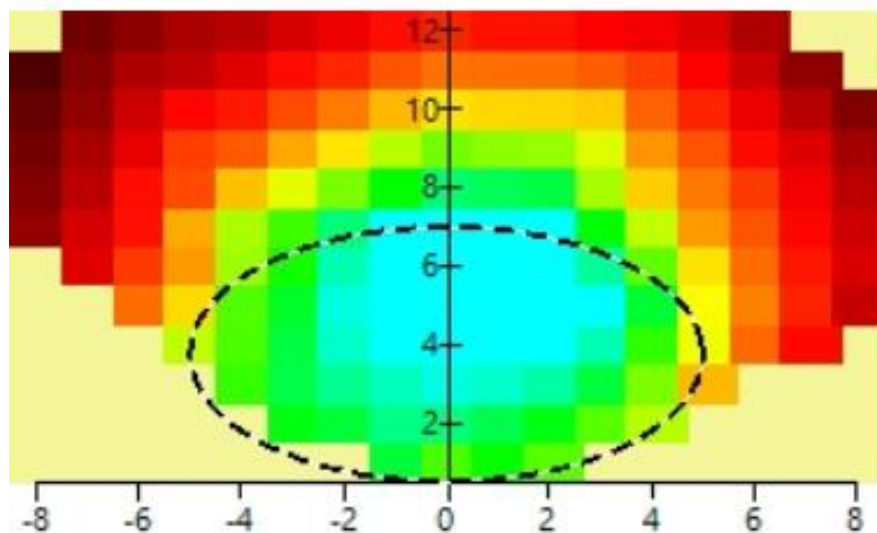


MEASURING LIGHT OUTPUT



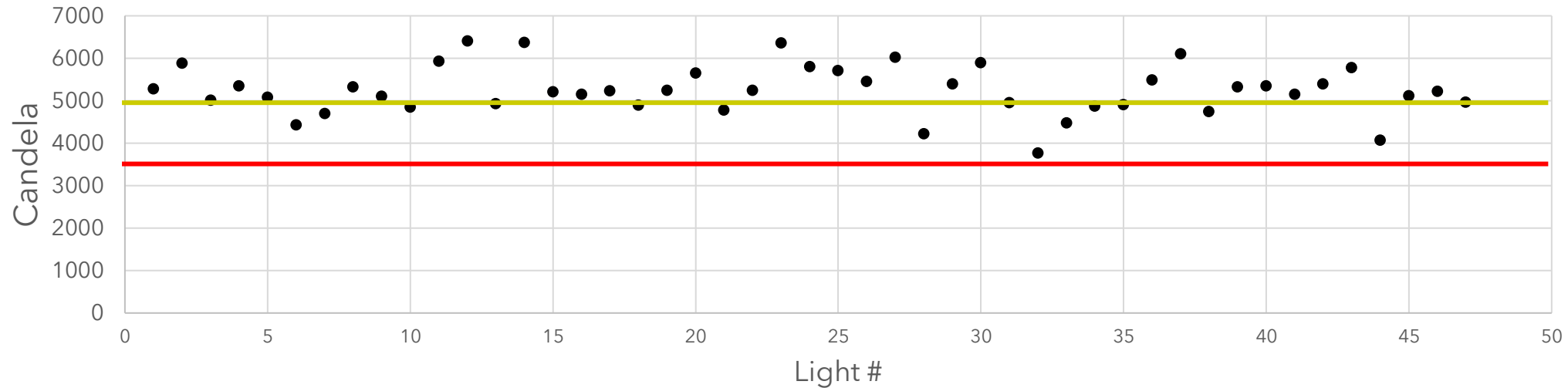
LIGHT OUTPUT MEASUREMENTS

Id	Colour	Avg	%
RCL1/47	White	3472	69

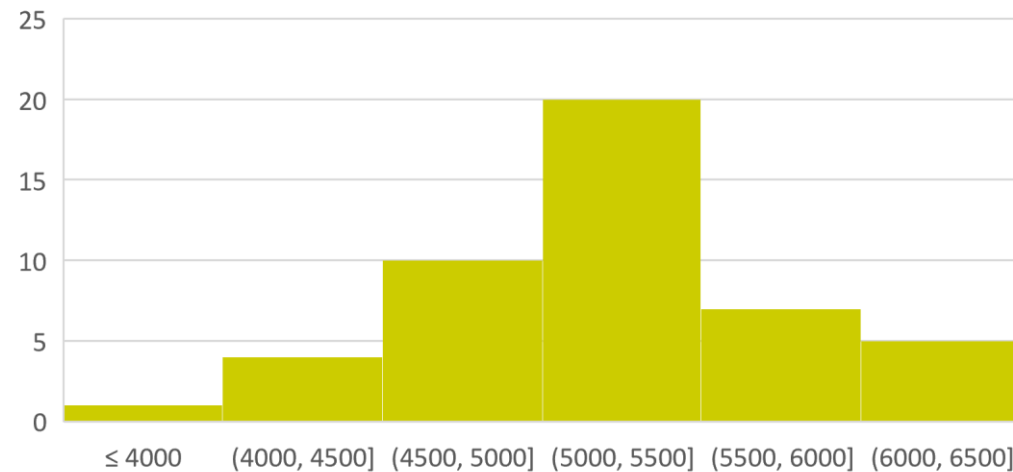


LIGHT MEASUREMENT OUTPUT

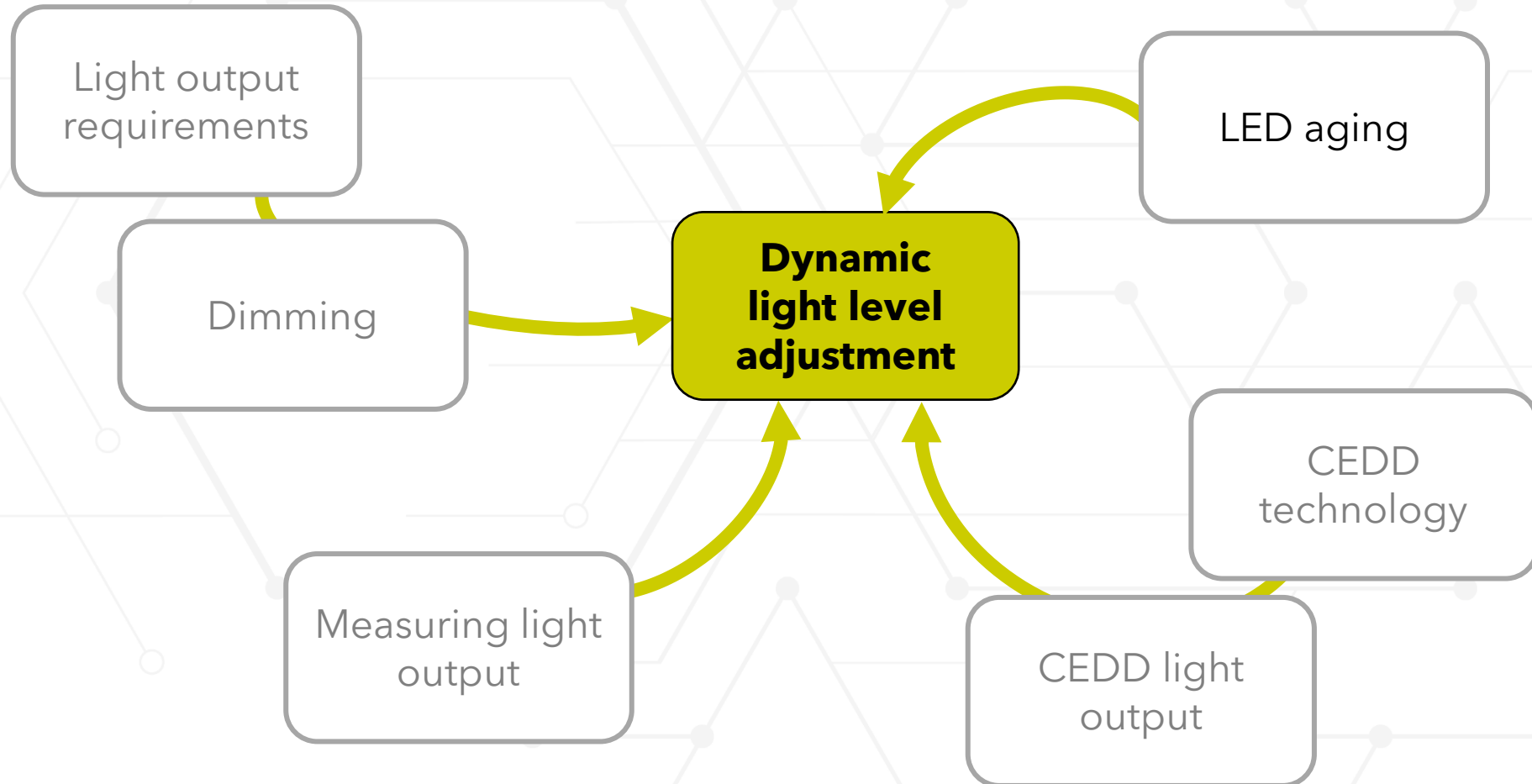
Runway Centerline measurements



- Output range - 25% up to + 30%



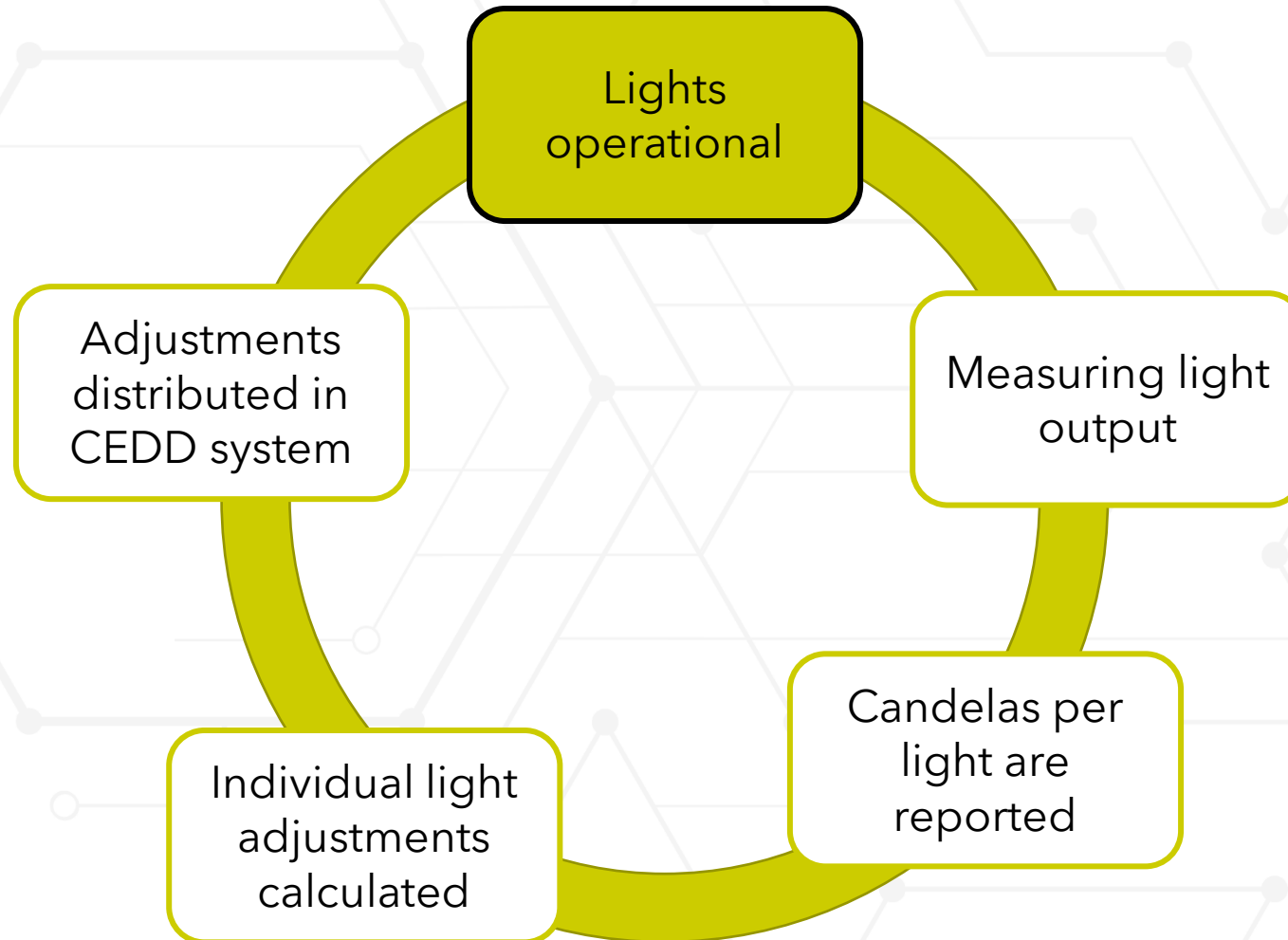
WHAT I WILL TALK ABOUT



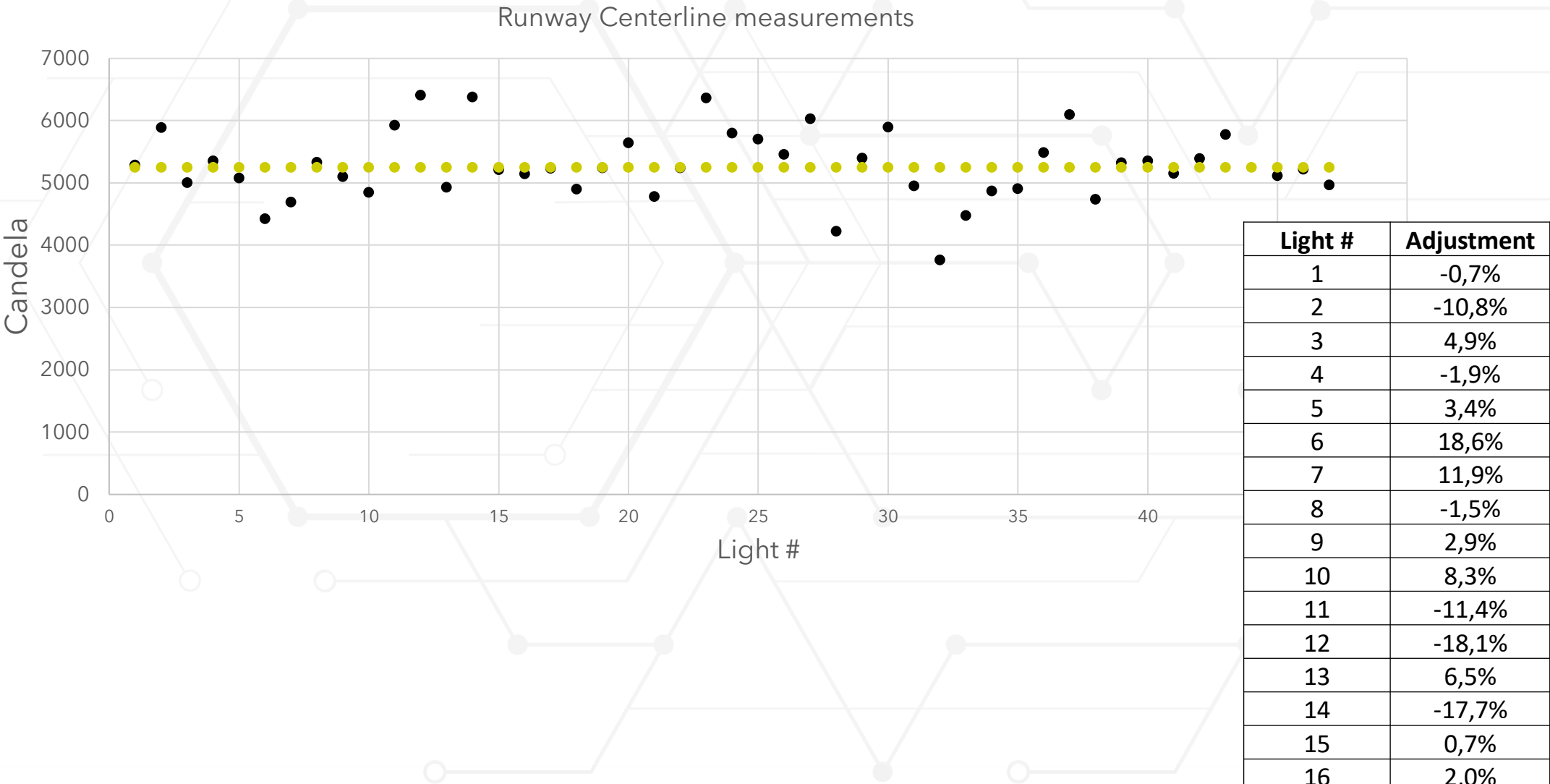
DYNAMIC LIGHT LEVEL ADJUSTMENT



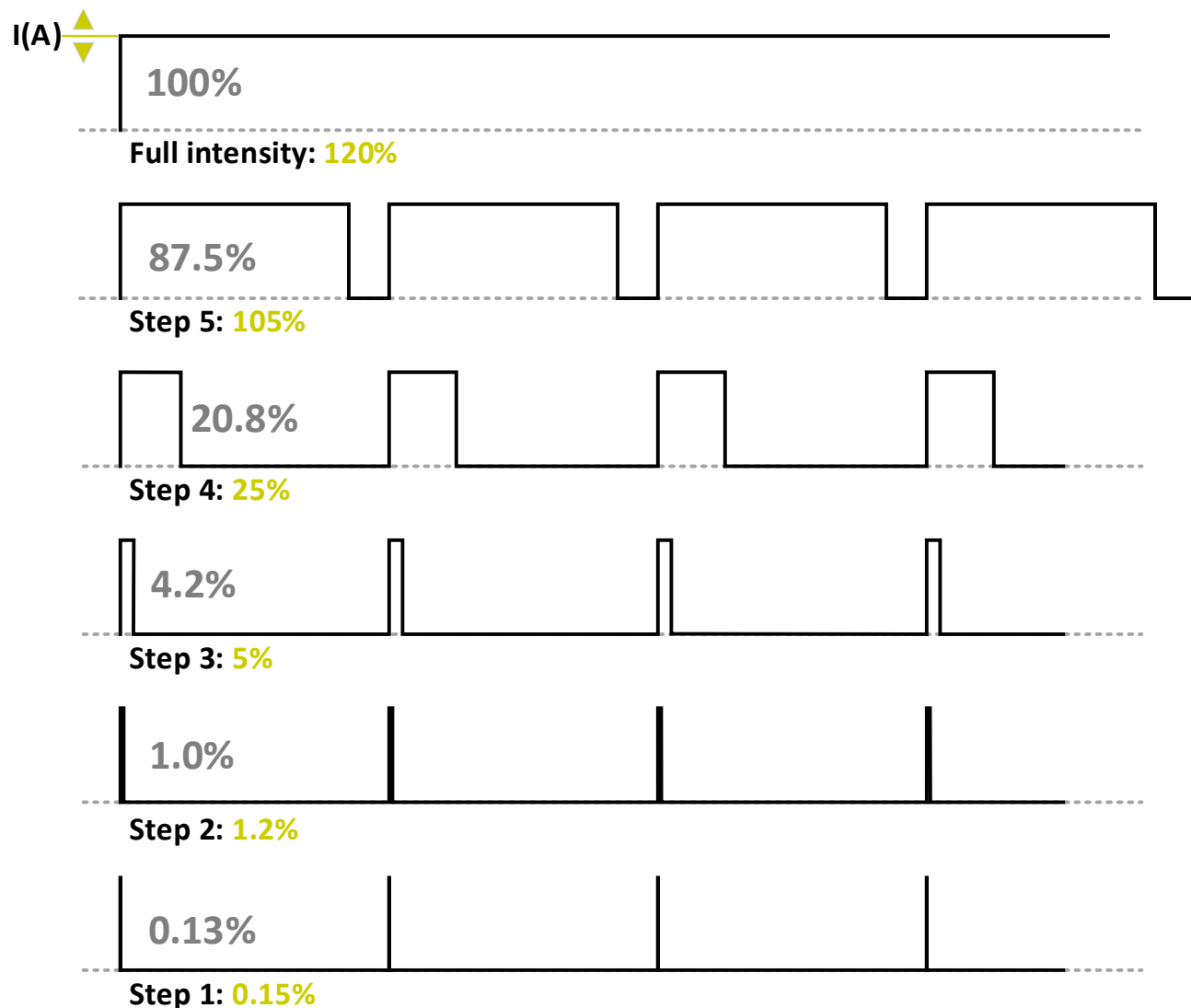
ADJUSTMENT PROCES



ADJUSTMENT LEVELS

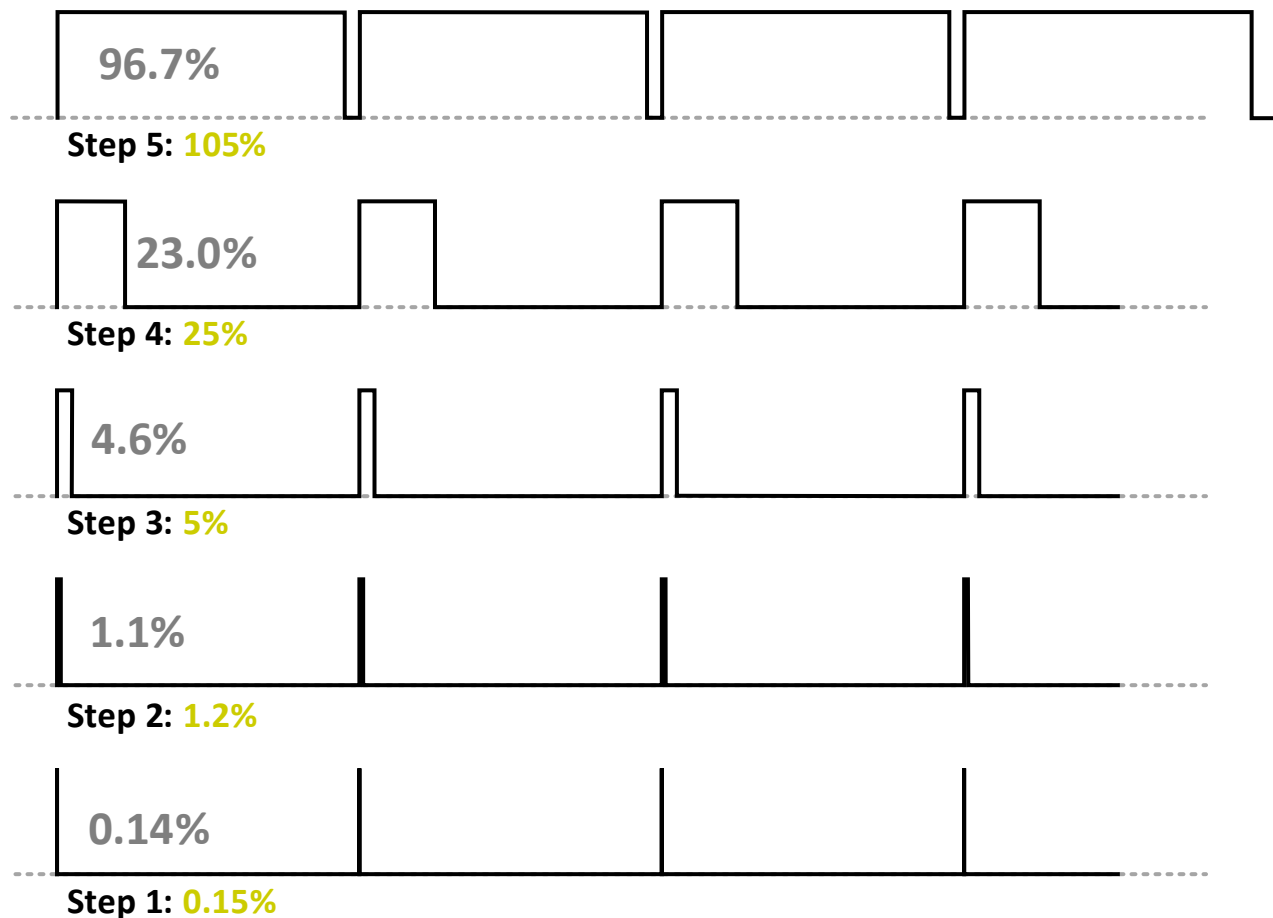


INITIAL CEDD LIGHT OUTPUT SETTING



- ✓ LED current is set to deliver 120% - 150% of the light output
- ✓ Step 5 (100%) is set to provide 105% intensity
- ✓ All other steps are adjusted to match the intensity correction

CORRECTED CEDD LIGHT OUTPUT SETTING



- ✓ Intensity measurement shows 95% light output at level 5 for a certain fixture
- ✓ PWM width for that fixture is adjusted to increase the light output
- ✓ Correction is applied to all intensity levels



RESULTS OF LIGHT ADJUSTMENT

- **Light level compliance** achieved during light measurement
- **Extending fixture lifetime** low performing lights don't need direct replacement
- **Leveled light output** helps optimizing visibility in all conditions
- **Reduced** pilot **blinding** chances



ADJUSTMENT QUESTIONS

- What is the optimal light output margin?
- What is the value of factory calibration?
- What is the value of adjustment of all dimming levels?
- Should the measuring interval be re-evaluated using this technology?

QUESTIONS?





THANK YOU FOR YOUR ATTENTION!

Gerbrandt van Staveren

g.vanstaveren@tkh-airportsolutions.com

www.tkh-airportsolutions.com

