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Trade Show and Conference

Designers Lighting Forum

Not All RGBW Is The Same

Challenges of designing RGBW luminaires

David Grassi

3/19/2024

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Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Learning Objectives

At the end of this course, participants will be able to:

1. Know the history of color changing LED luminaires in architectural lighting applications and how these luminaires have changed over time
2. Understand the difference between discrete LEDs and quad chips and what the tradeoffs are for each luminaire type, so that specifiers can deliver the best solution for their project.
3. Understand how driving different LEDs affects their output and color consistency, and how best to use different color changing luminaires in your project to get the best result
4. Look to the future of architectural lighting from a manufacturer's standpoint, and how luminaire design could change from a standpoint of technological advancements and sustainability

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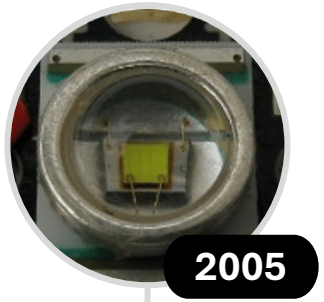
1988

NICHIA
1996


1997


2005


2008


2012

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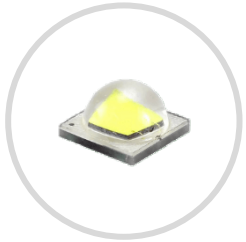

Discrete

Quad

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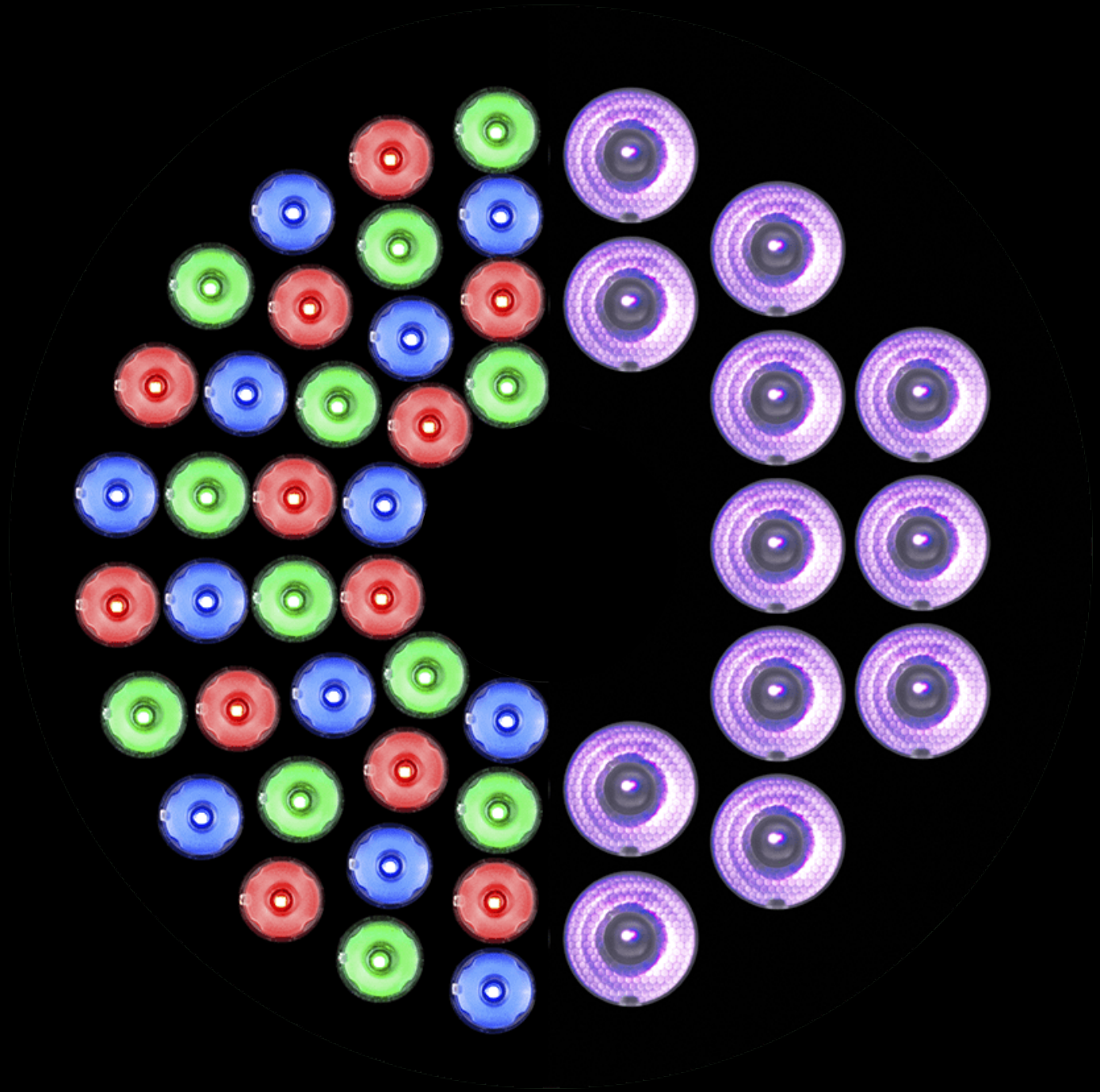
- Near-Field Color Mixing Ability
- Far-Field Color Mixing Ability
- Optical Source Size
- Total Potential Light Output
- Customizability
- LED Color Consistency



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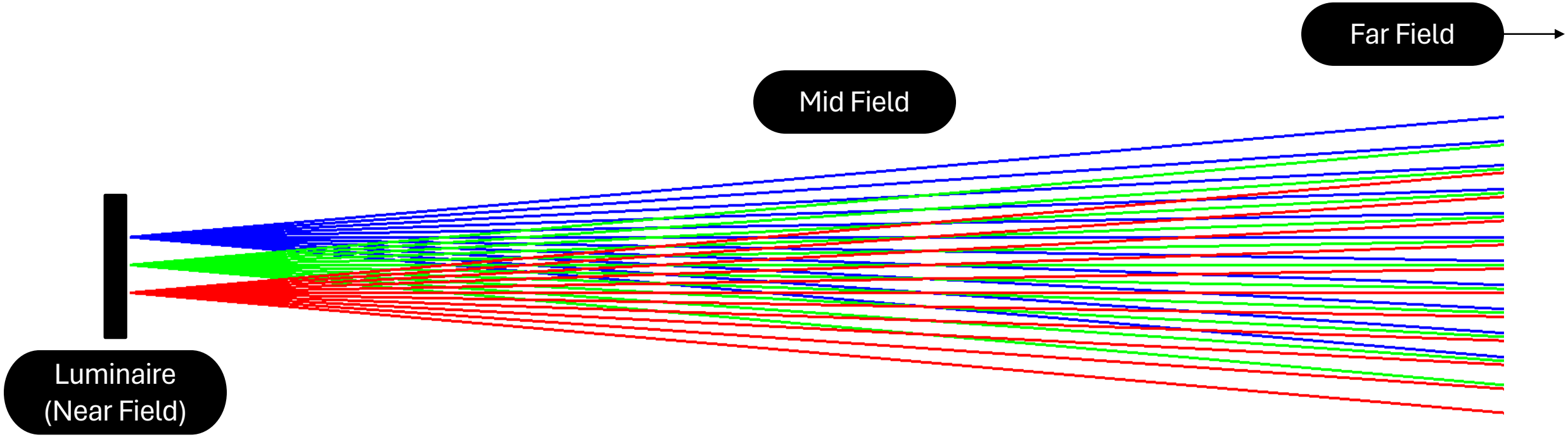

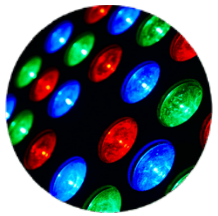

Discrete 6° beam angle

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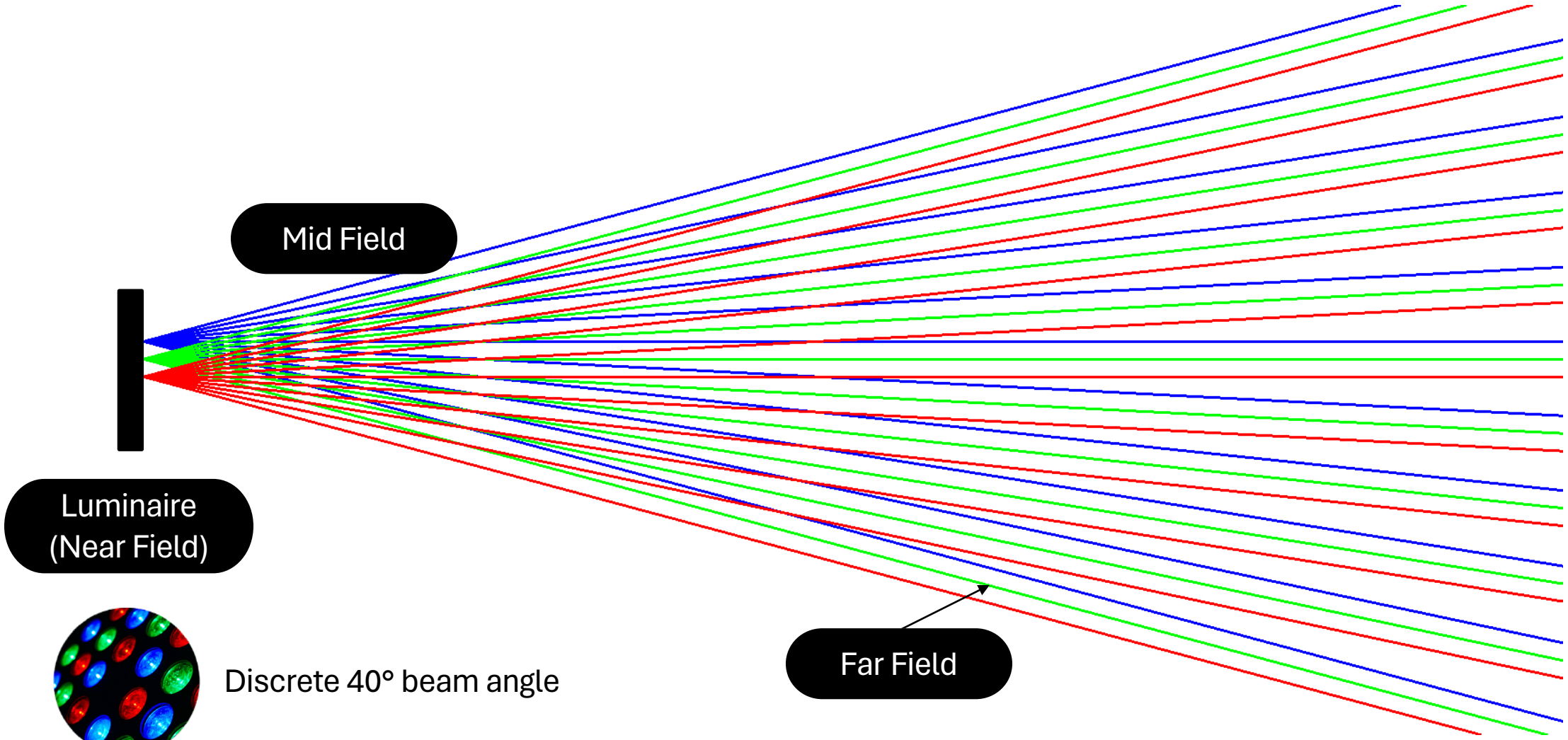

Discrete 40° beam angle

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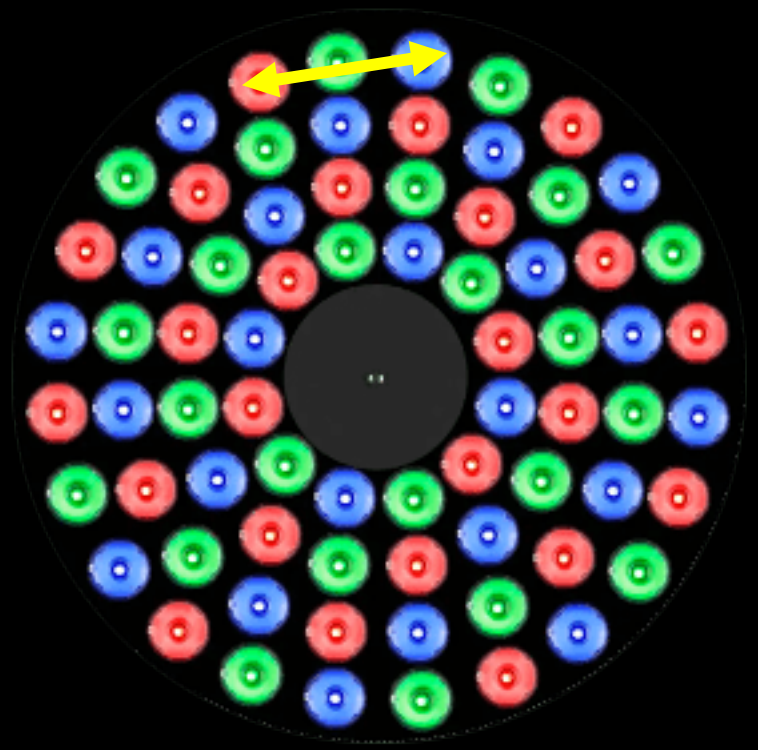
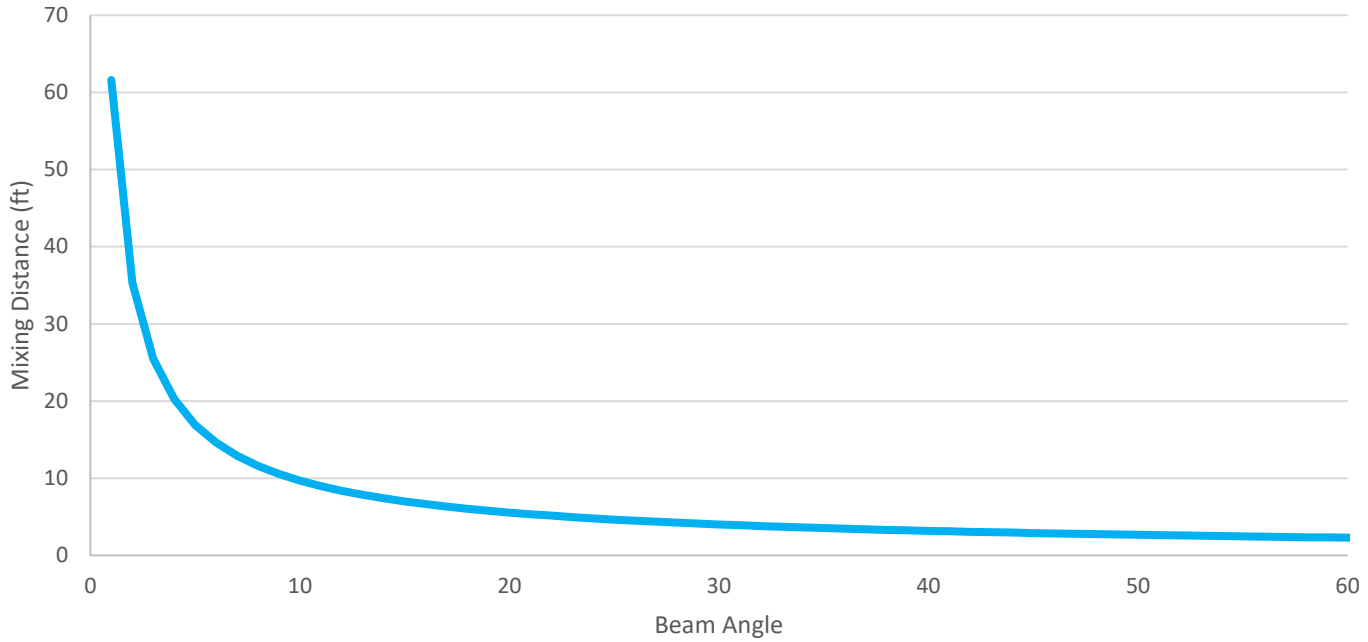


Mixing Distance vs Beam Angle for a discrete color-changing luminaire



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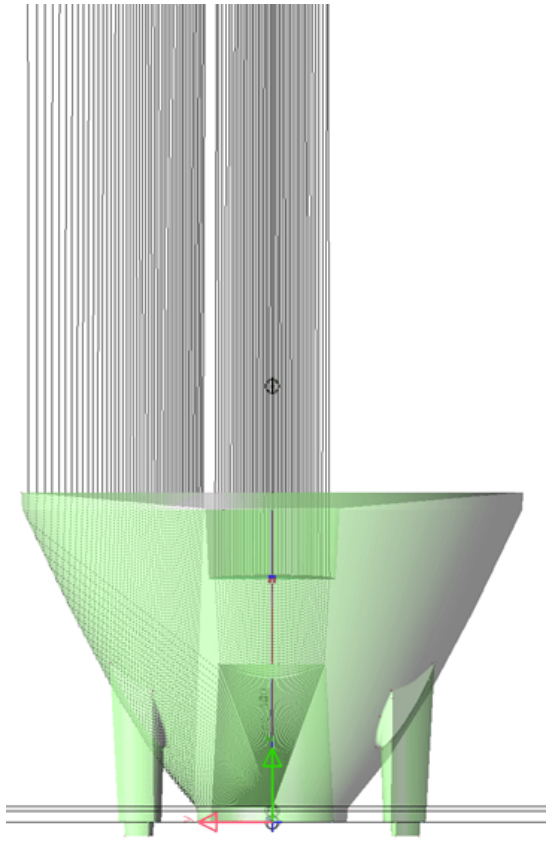

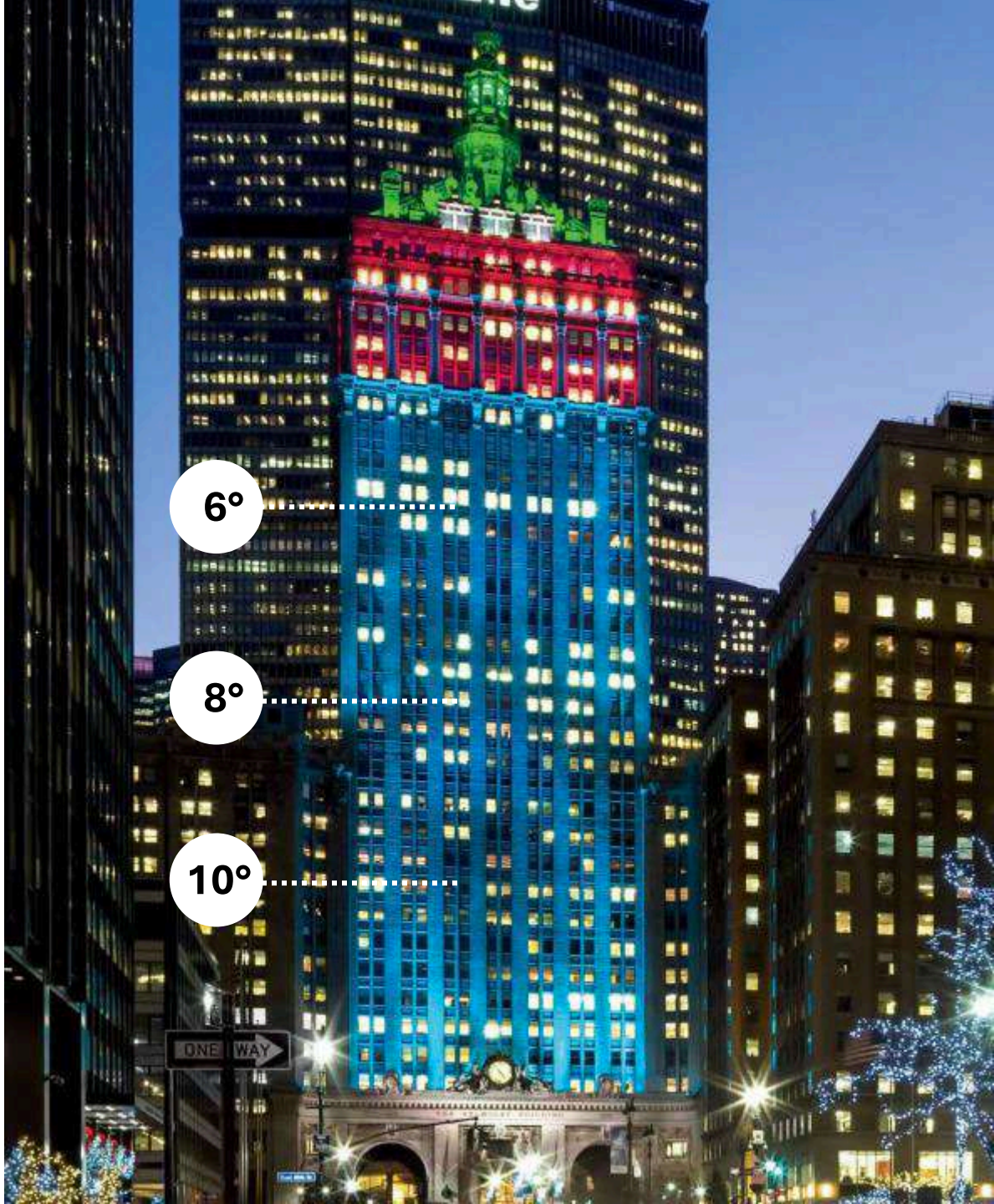

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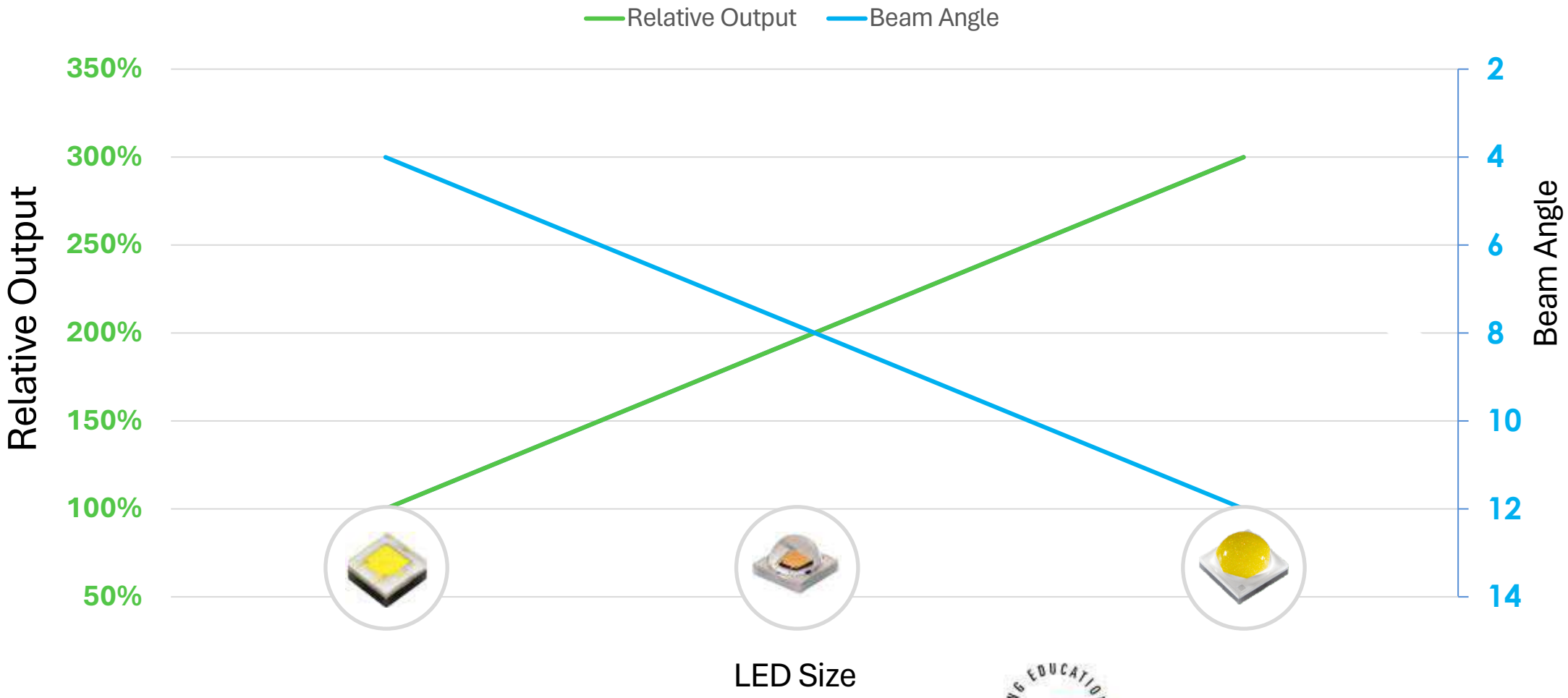
LED Size versus Output vs Beam Angle



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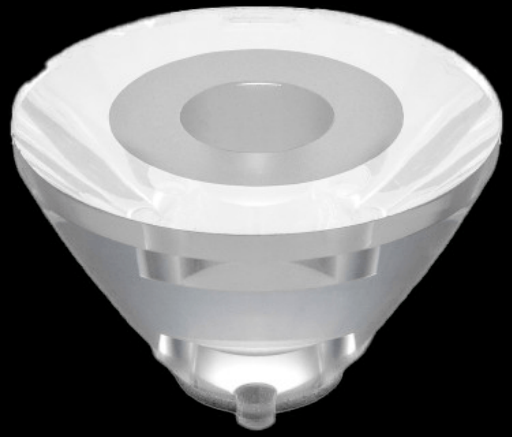
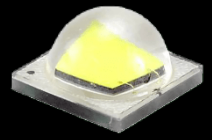
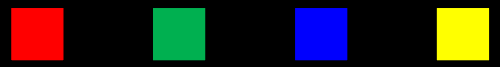
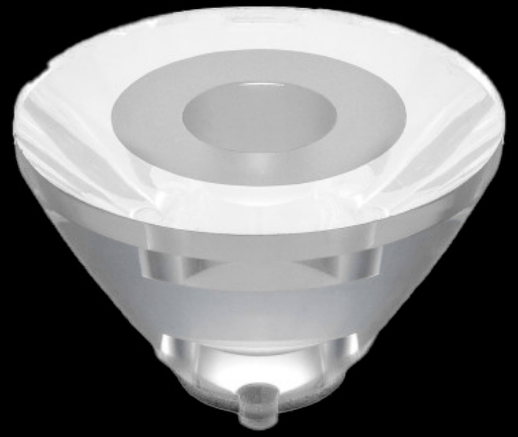
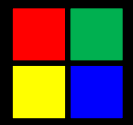






Luminous Area = 1mm^2
Optic Diameter = 35mm
Beam Angle = 3 degrees





Luminous Area = 4.4mm^2
Optic Diameter = 35mm
Beam Angle = **12 degrees**

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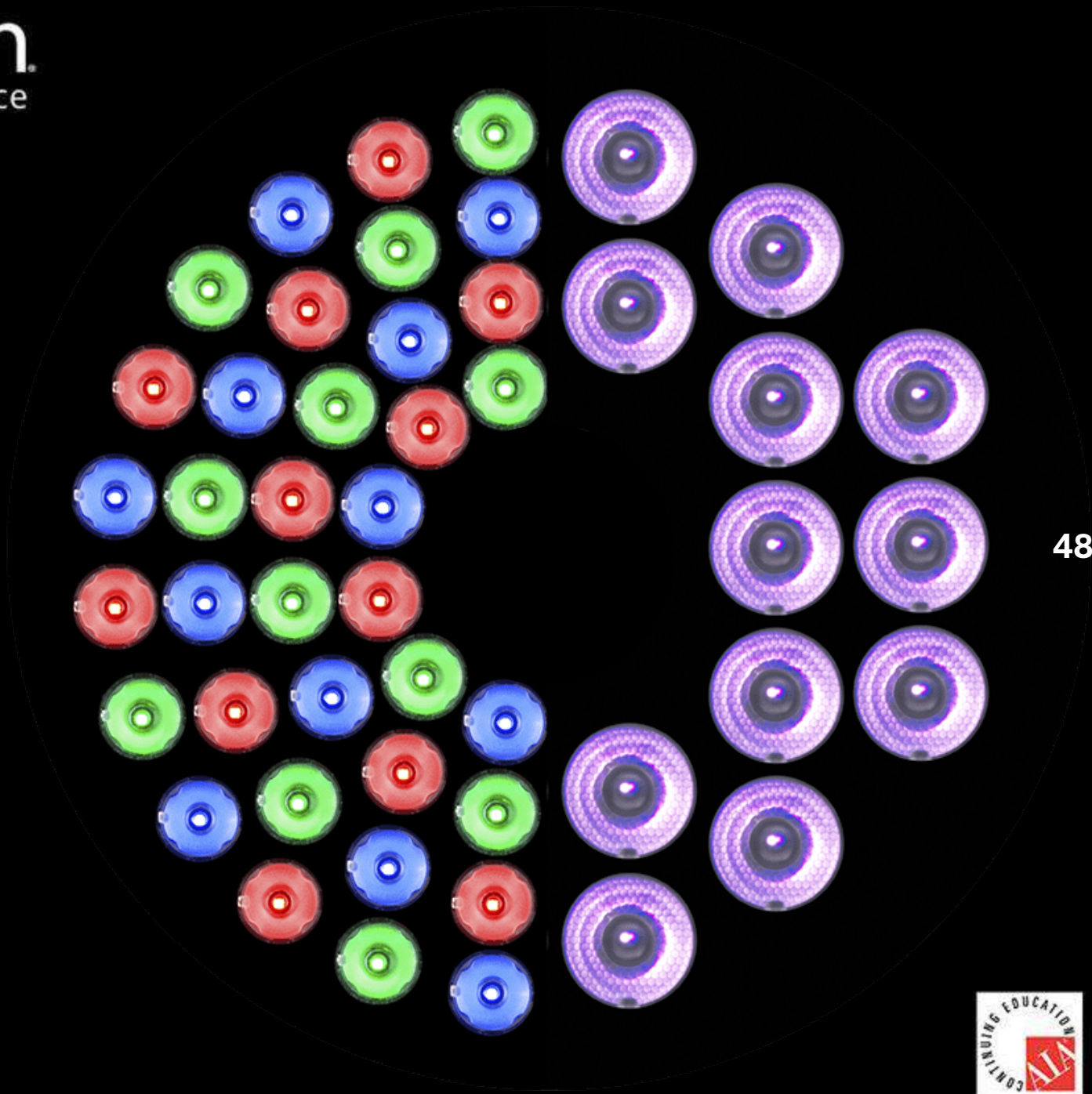
36 LEDs in total



48 LEDs in total

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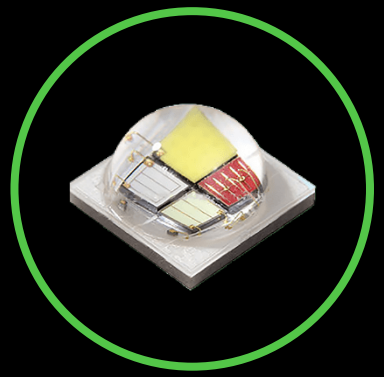
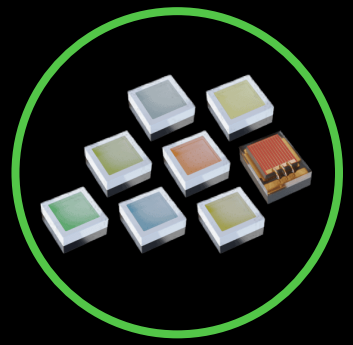


Non-customizable



Customizable

Characteristics	Discrete Color LED	Quad Color LED
Near-Field Color Mixing Ability /Appearance	✗	✓
Far-Field Color Mixing Ability	✓	✓
Optical Source Size / Beam Angle Control	✓	✗
Total Potential Light Output	✗	✓
Customizability	✓	✗

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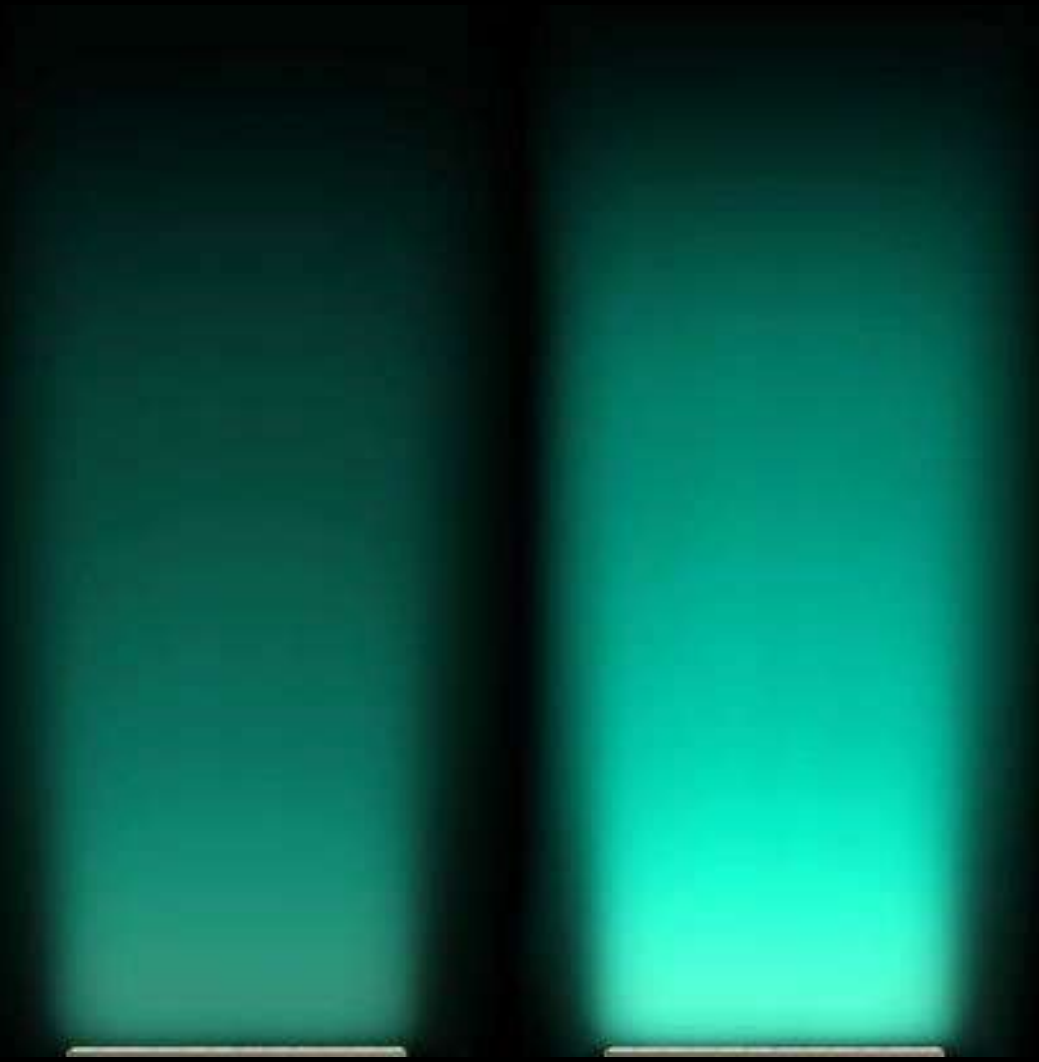

Traditional distribution
Each channel receives 33% of power
(or 25% in RGBW, RGBA)

Advance technology
Each channel can receive full power

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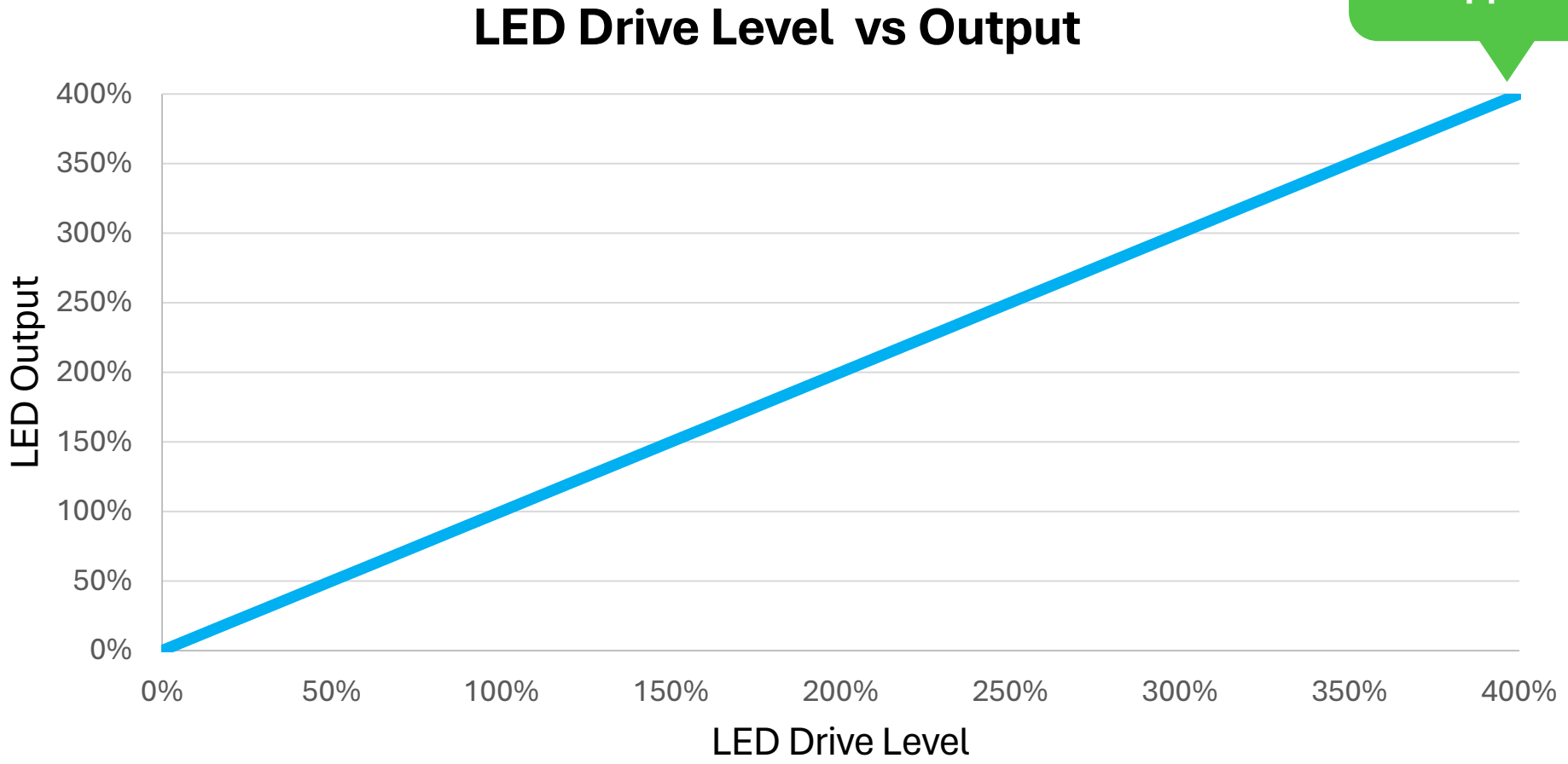
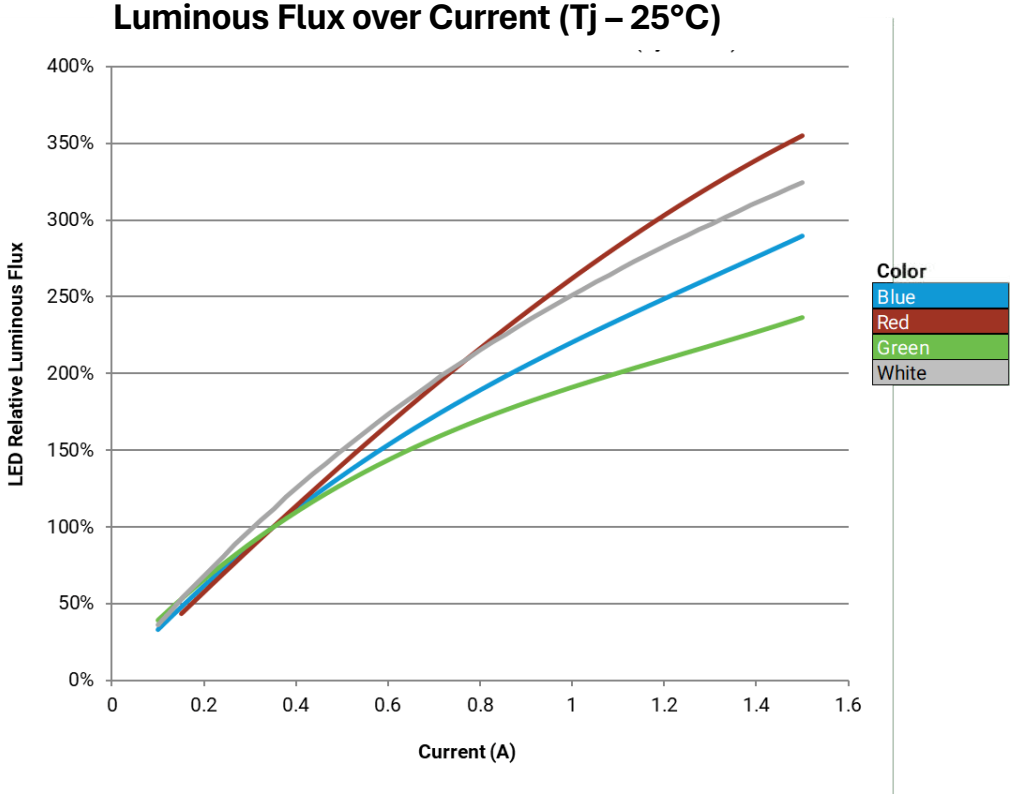
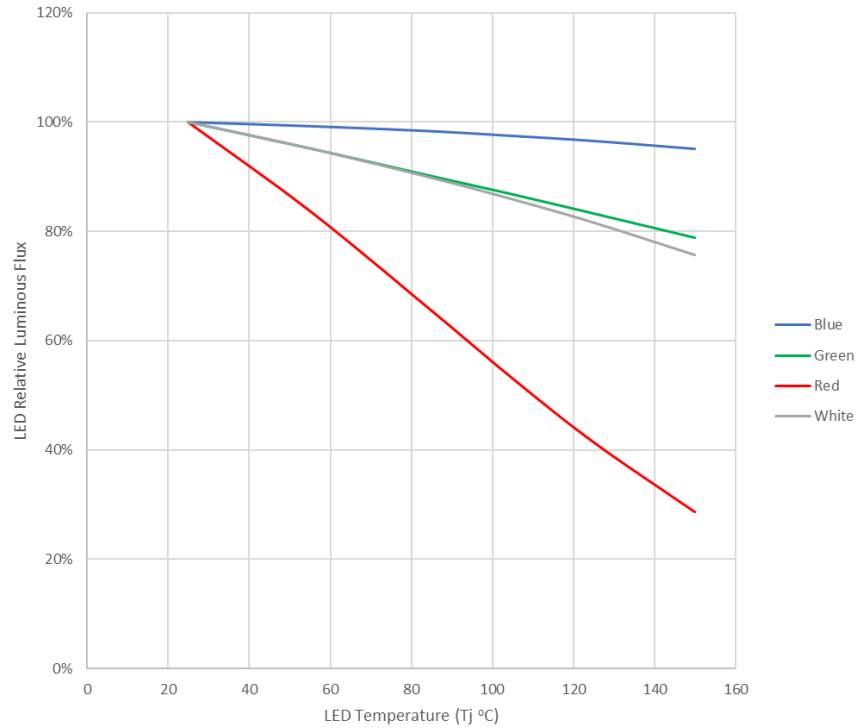
This doesn't actually Happen in reality!



Luminous Flux over Current (Tj – 25°C)



Luminous Flux over Temperature (If = 350mA)



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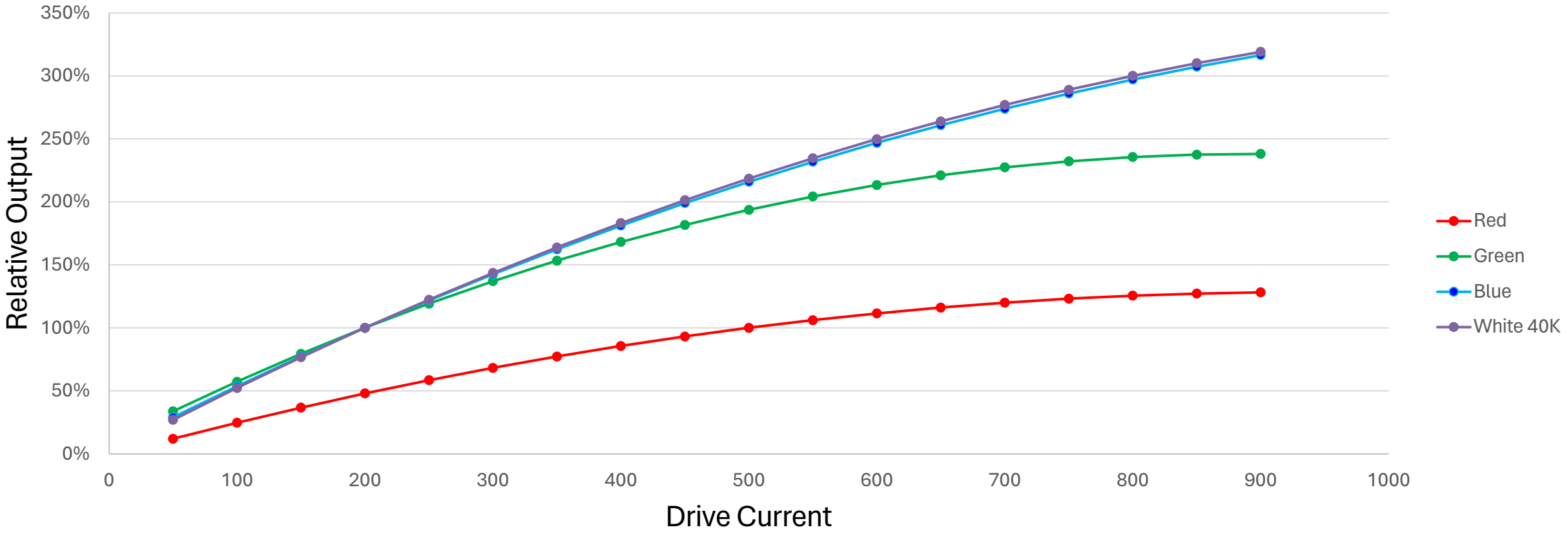
Typical Drive Capability by Color



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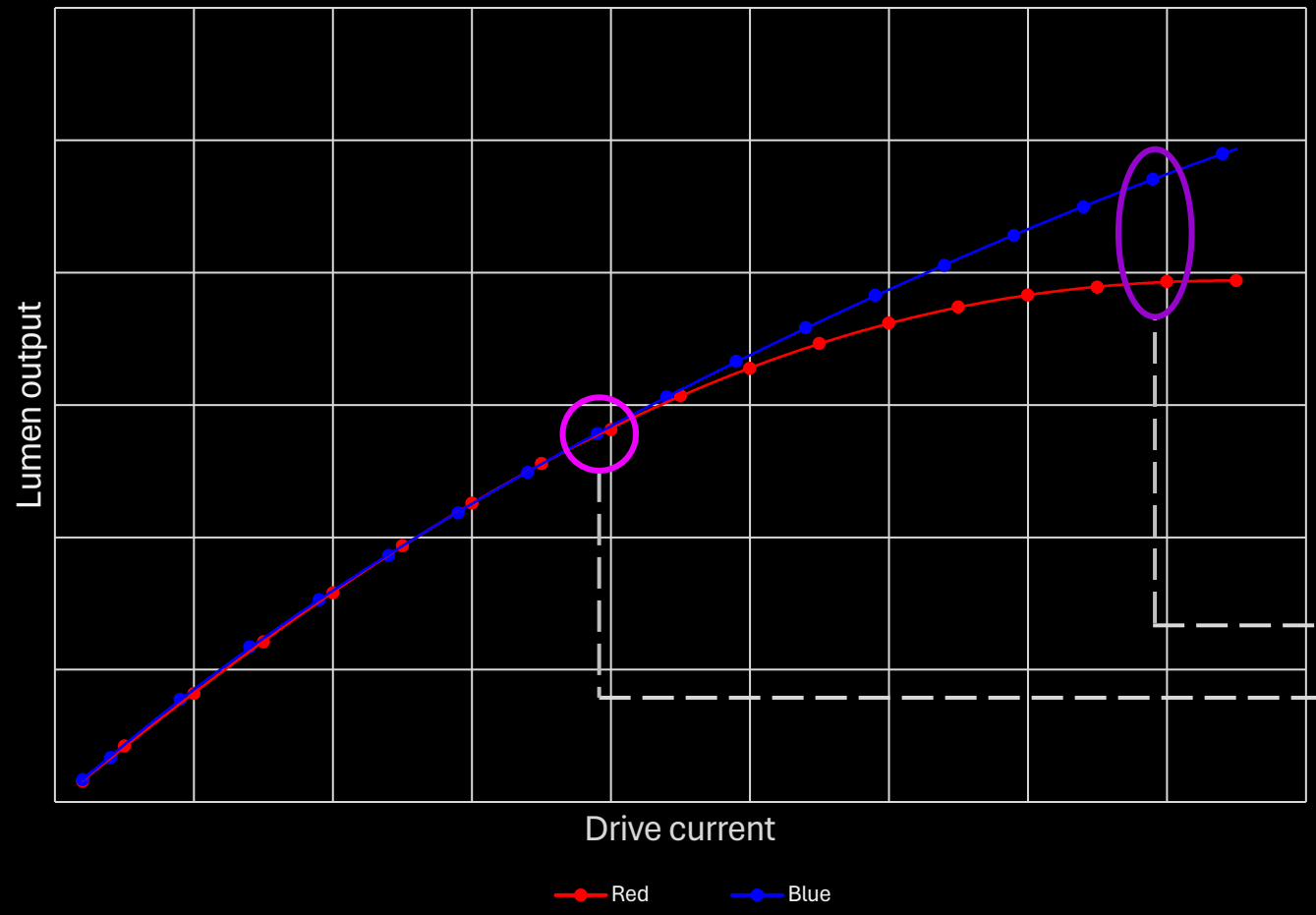

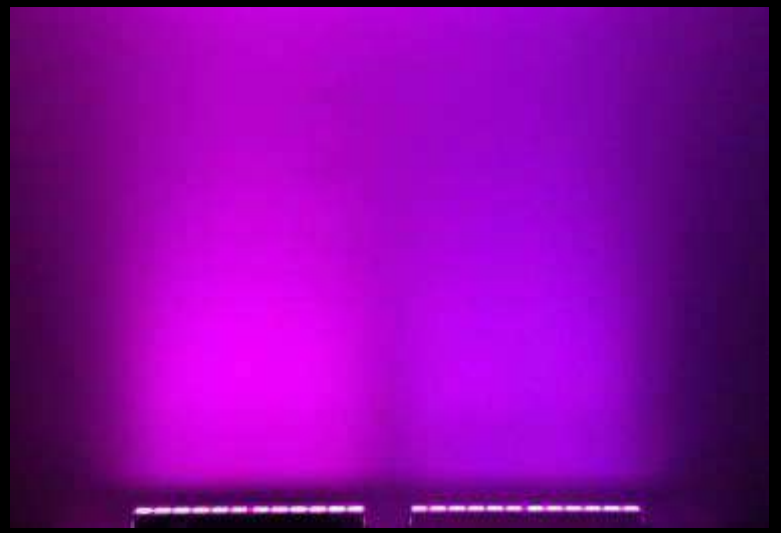

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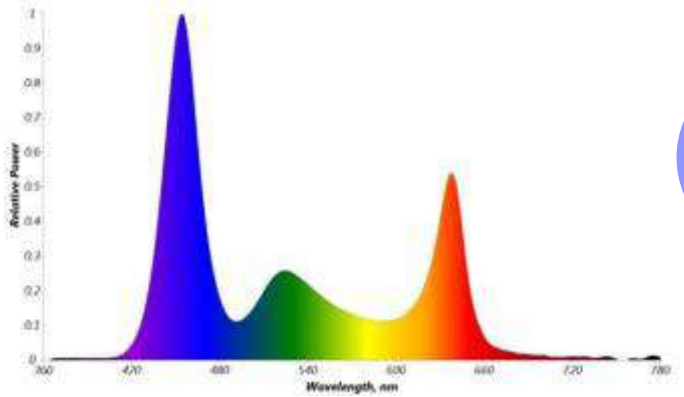
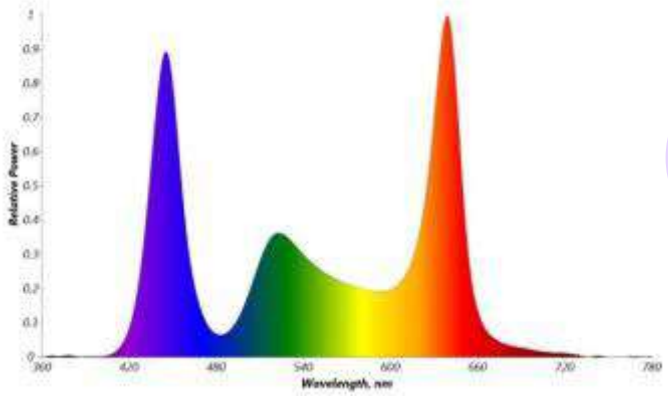
Inconsistency between fixture sizes

Spectral distribution



400W Projector

Spectral distribution



50W Projector

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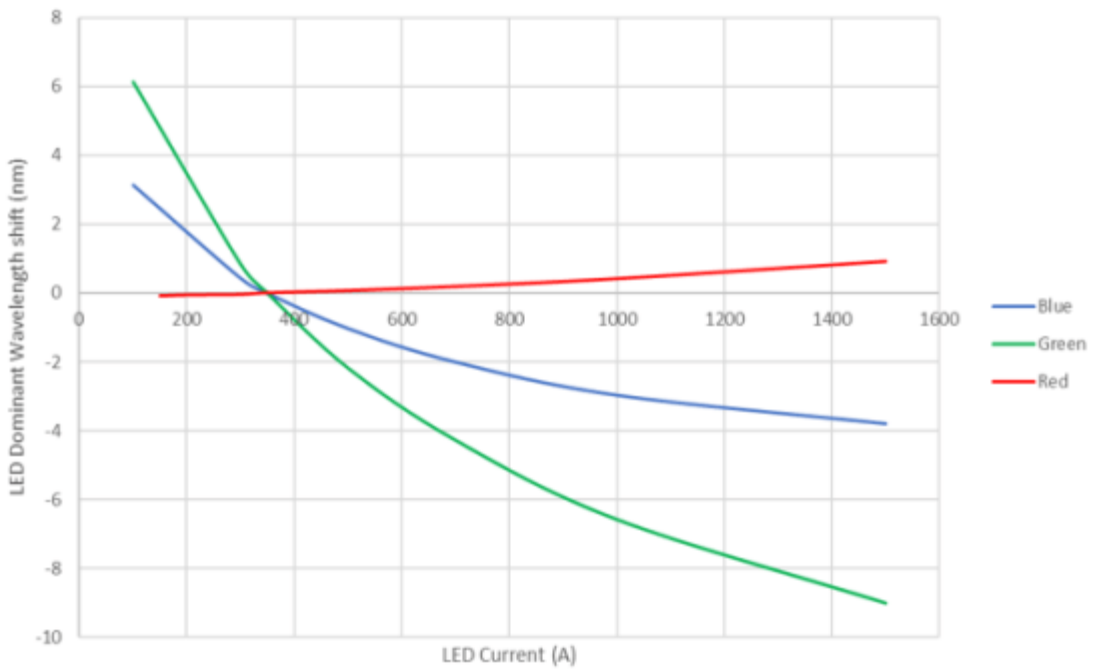
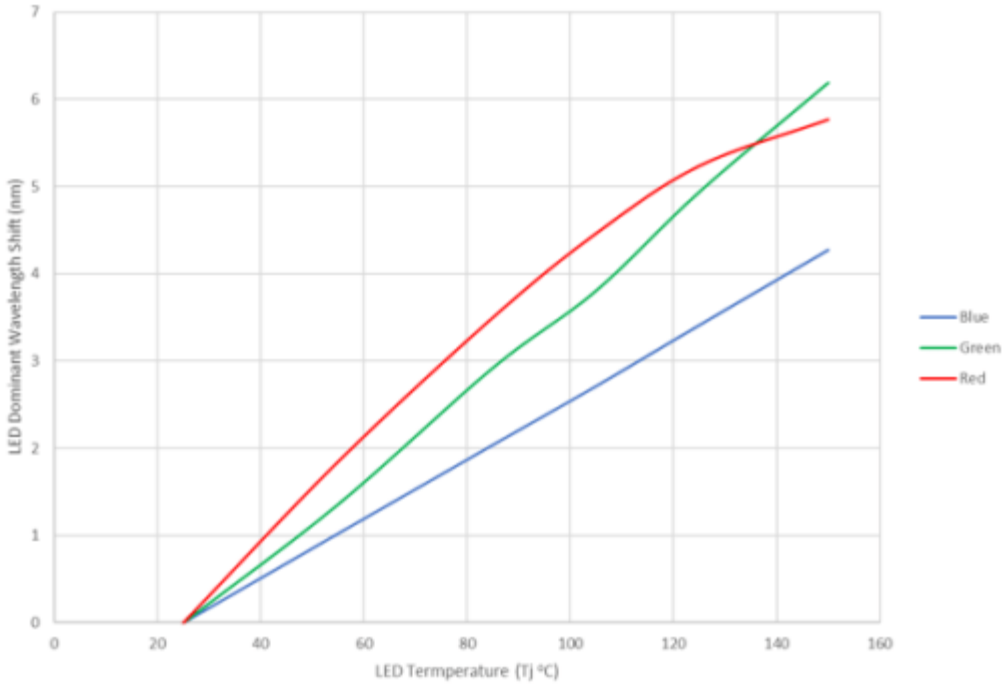
Dominant Wavelength over current (Tj = 25°C)



Dominant Wavelength over temperature (If = 350mA)



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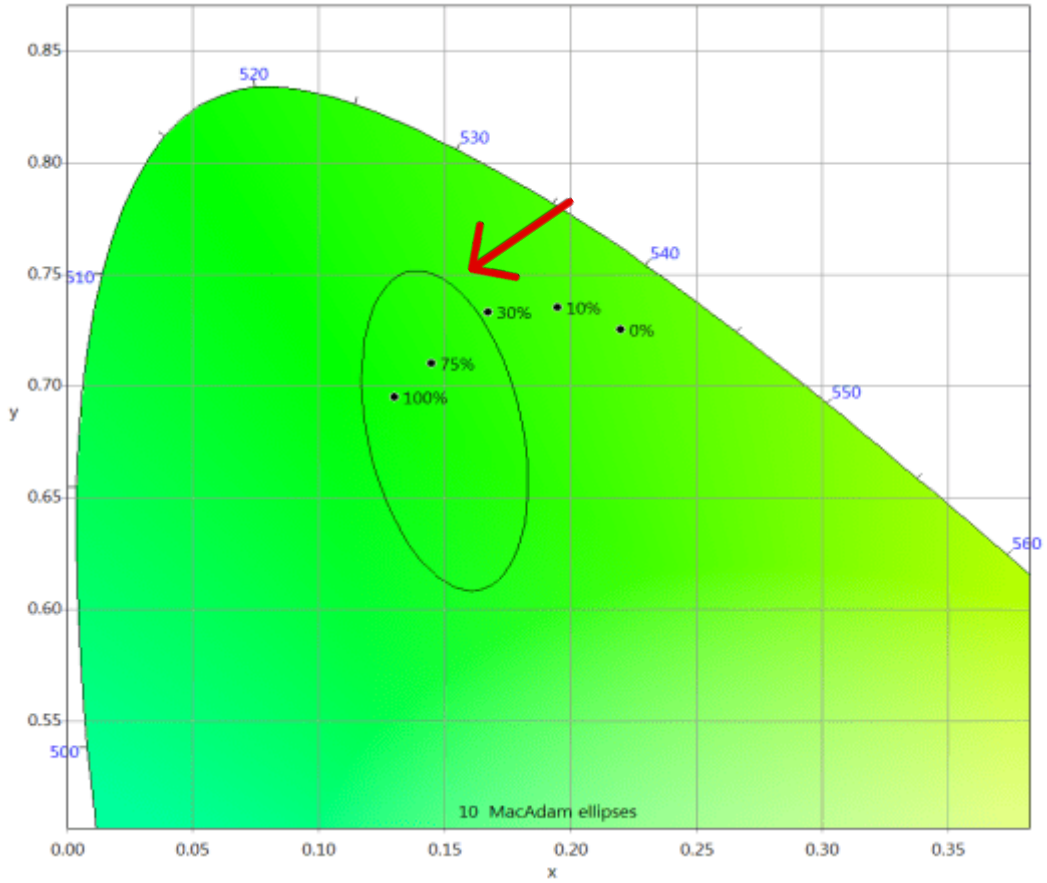

Blue at 25%

Blue full output

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Accuracy

1. Spectral Mismatch of the Measuring Device
2. Far Field vs. Near Field measurements
3. Stray Light
4. Simulated Data
5. **Difficult to measure in the field**
6. **Use an accredited 3rd party lab**

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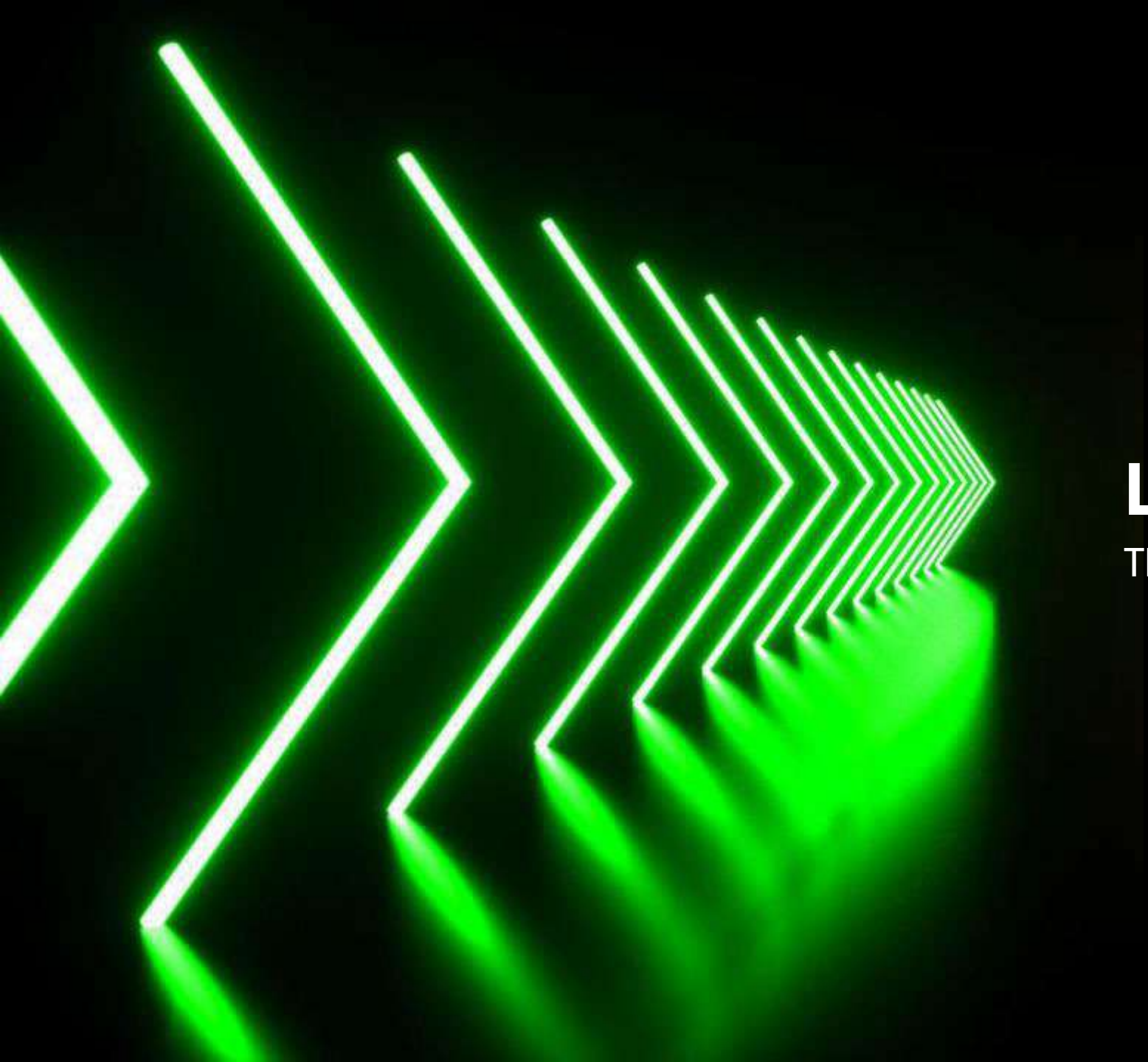
Recommendations for Specifiers and Manufacturers

- Prioritize the user experience, not just the spec sheet numbers. Color consistency should be a desired outcome, gives you more tools to realize your design
  - Color Consistency over dim range
  - Color Consistency between products from a single manufacturer
  - Ability to match on site if needed
- Color LEDs are not tested to the same standards as White Light LEDs, LM-80 and TM-21 were written with white light in mind, Lifetimes should be reported by color
- Performance data should be backed up by 3rd party data
- Due to current optical limitations with mix-at-source solutions, discrete color-changing luminaires still have a place in the market where optical control is prioritized and the luminaires are not in the direct line of sight of the public. As such, mix-at-source color-changing luminaires should be designed to work interchangeably with discrete color-changing luminaires.



Looking Forward

The Future of Luminaire Design

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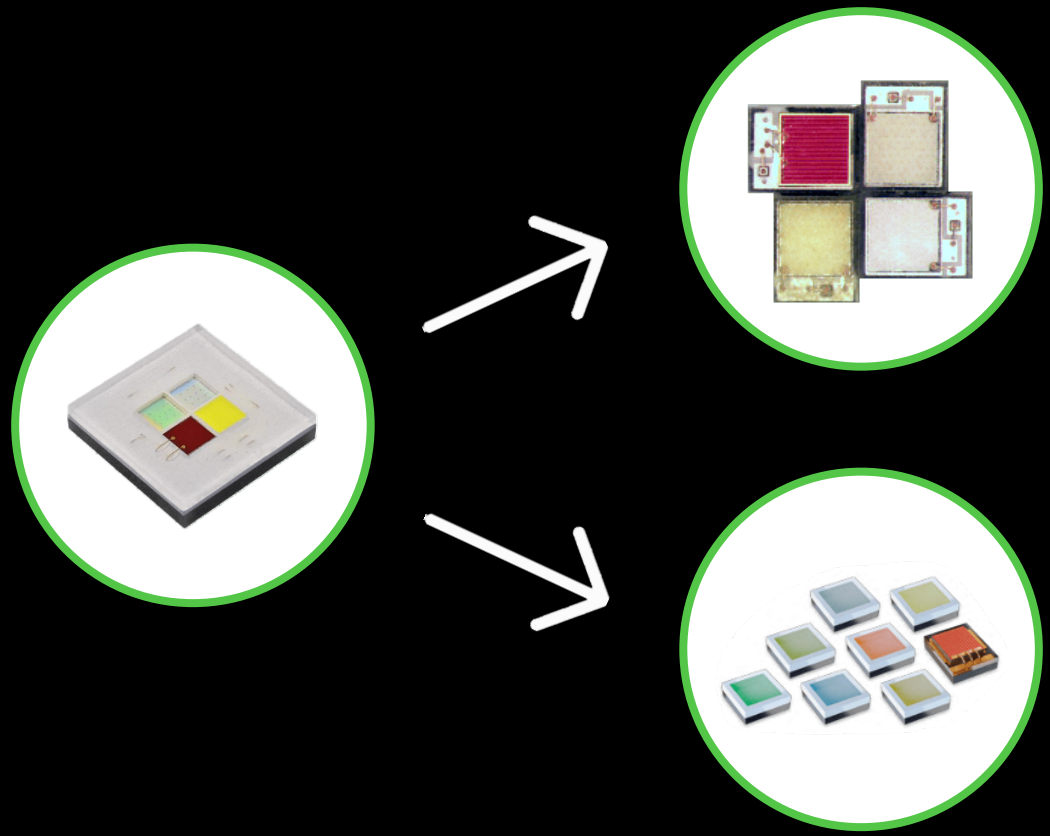
New Generation of LED Development

1. Higher Drive Potential
2. Tighter spacings between diodes
3. More color options than ever!



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Characteristics	Quad Color LED	New Generation LED
Near Field Color Mixing Ability /Appearance	✓	✓
Far Field Color Mixing Ability	✓	✗
Optical Source Size / Beam Angle Control	✓	✗
Total Potential Light Output	✗	✓
Customizability	✗	✓

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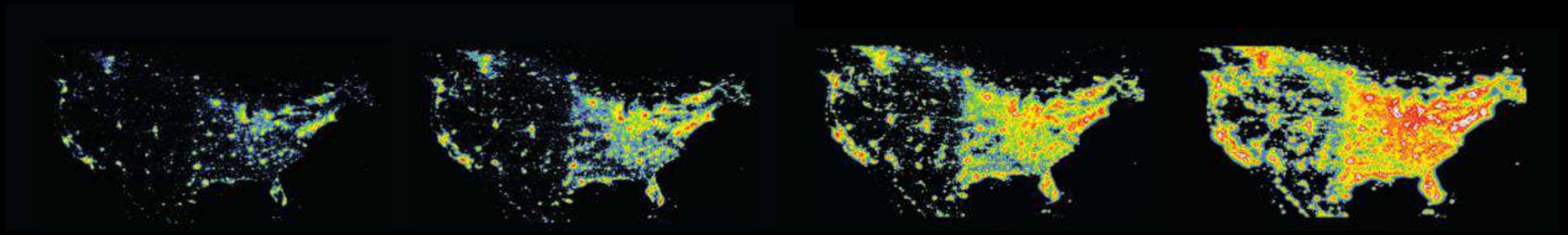

Late 1950s

Mid 1970s

1997

2025

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Continuing Education Systems Course

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ANNEX

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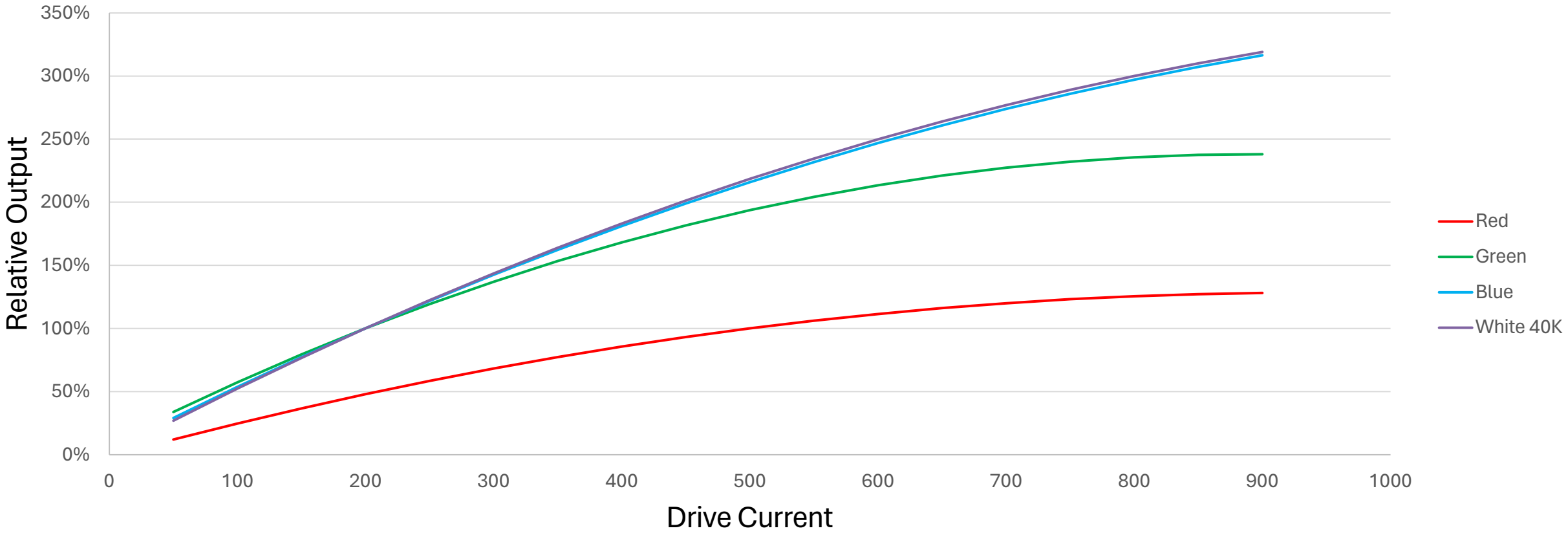
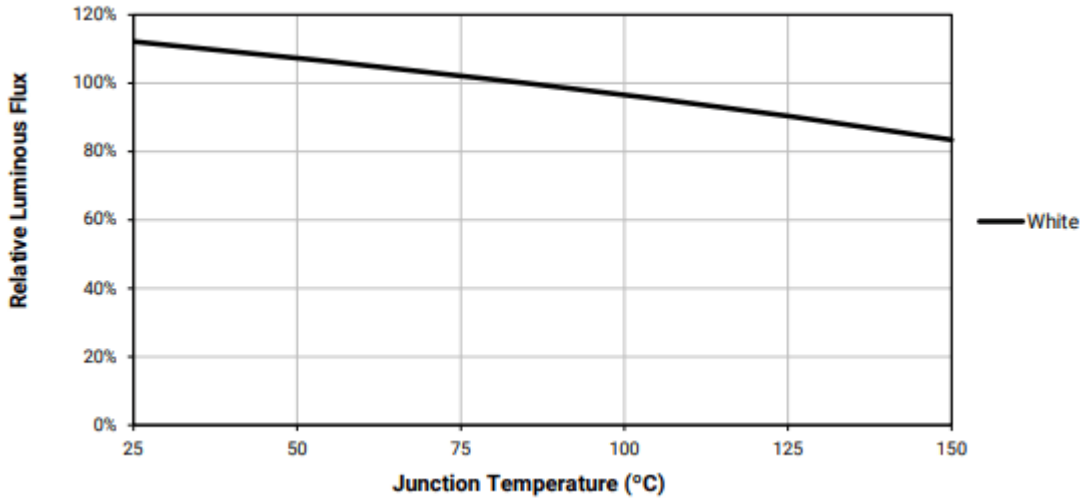
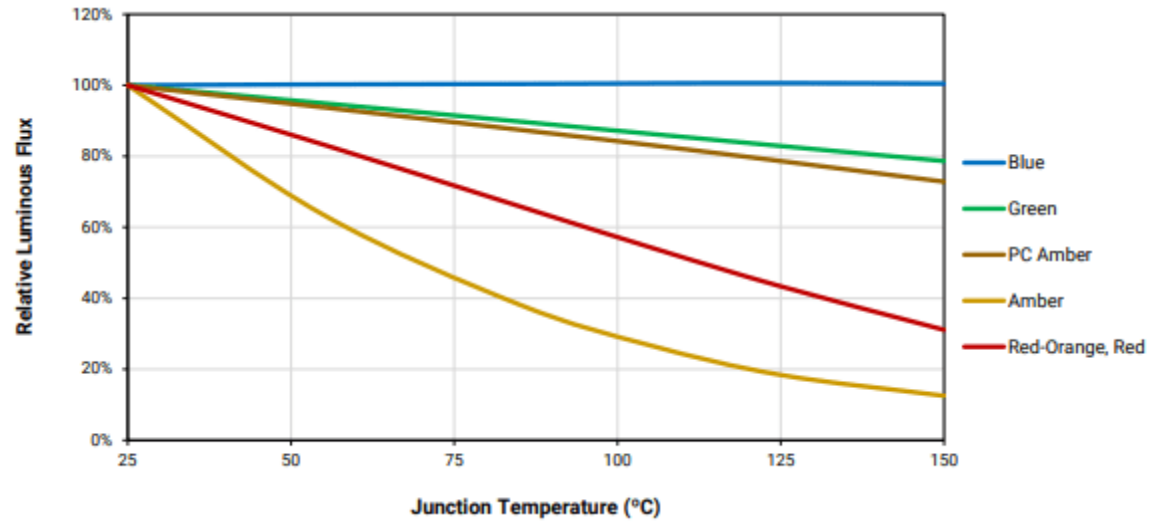
Typical Drive Capability by Color

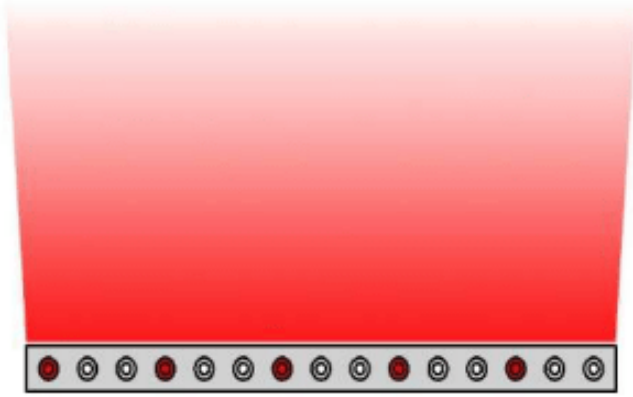



120%
100%
80%
60%
40%
20%
0%
Relative Luminous Flux
25
50
75
100
125
150
Junction Temperature (°C)
White


120%
100%
80%
60%
40%
20%
0%
Relative Luminous Flux
25
50
75
100
125
150
Junction Temperature (°C)
Blue
Green
PC Amber
Amber
Red-Orange, Red

Traditional distribution

Each channel receives 33% of power
(or 25% in RGBW, RGBA)



Advance technology

Each channel can receive full power

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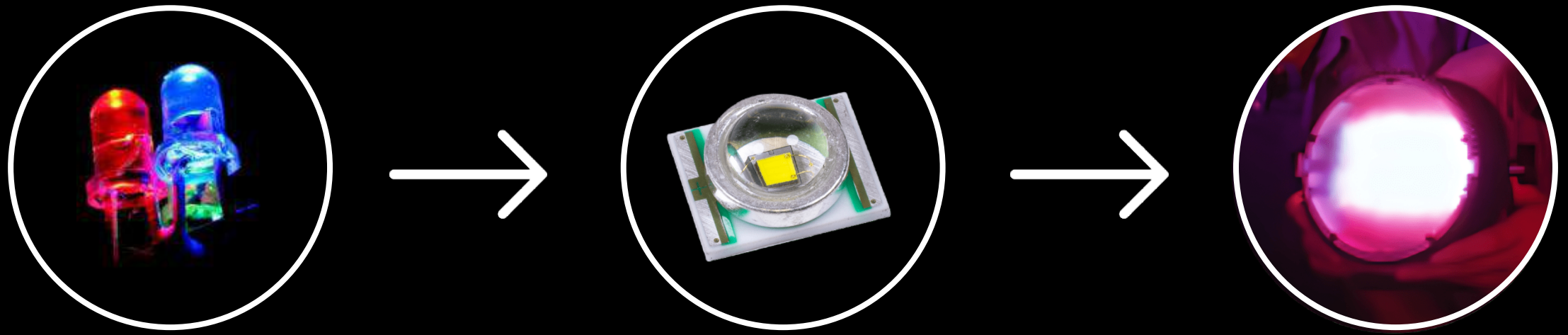

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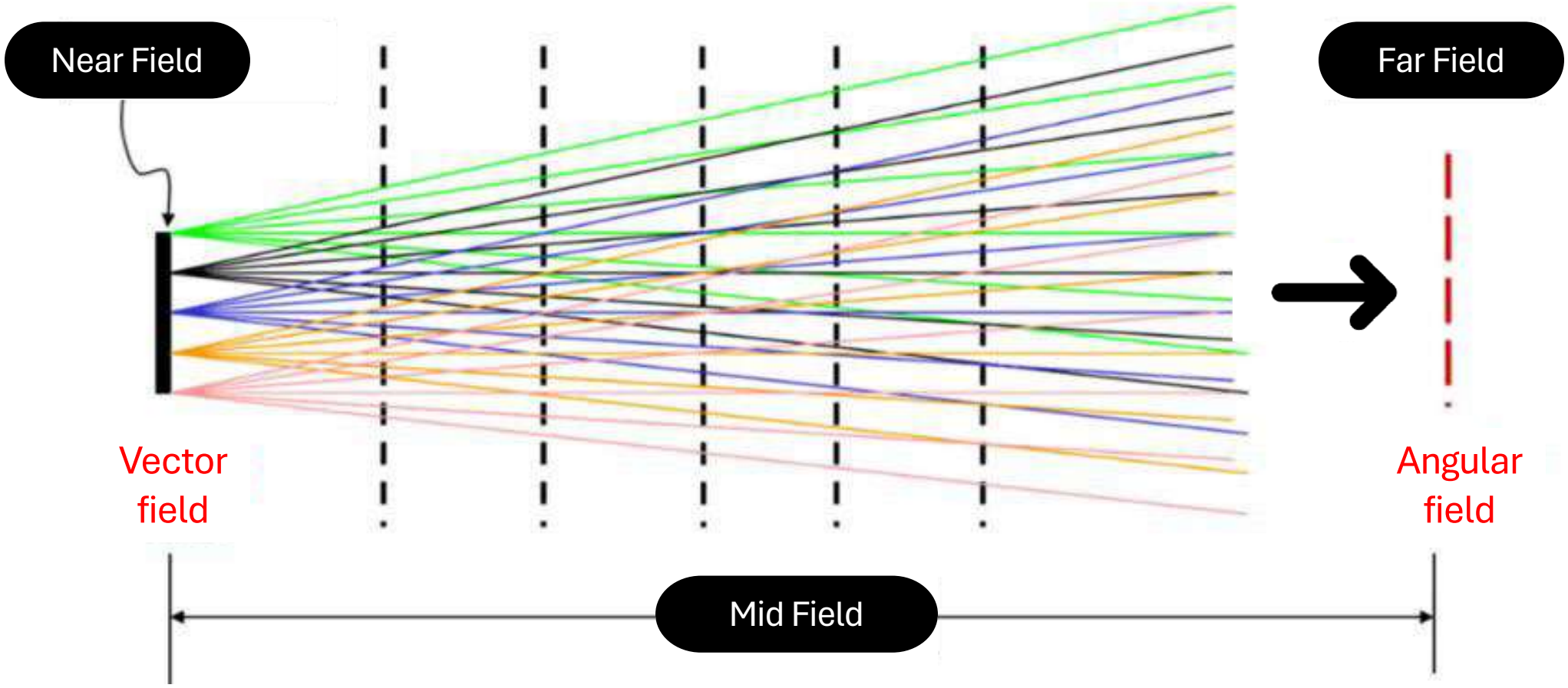
Near Field
Far Field
Vector field
Angular field
Mid Field

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