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sense and simplicity

Trends in LED Lighting
Looking Beyond Lumens…

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October 18, 2012

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LUMILEDS

Outline

- LED Performance Trends

  "It's like dessert…There's always room for more!"

- LED "Standardization"

  "There's a "standard" for that…and that…"

  VoC: "Where is LM-80 for color product?"

- LED Package Evolution

  "One size DOESN'T fit ALL!"

  VoC: "Why are the LEDs discontinued so often, in just a couple years?"

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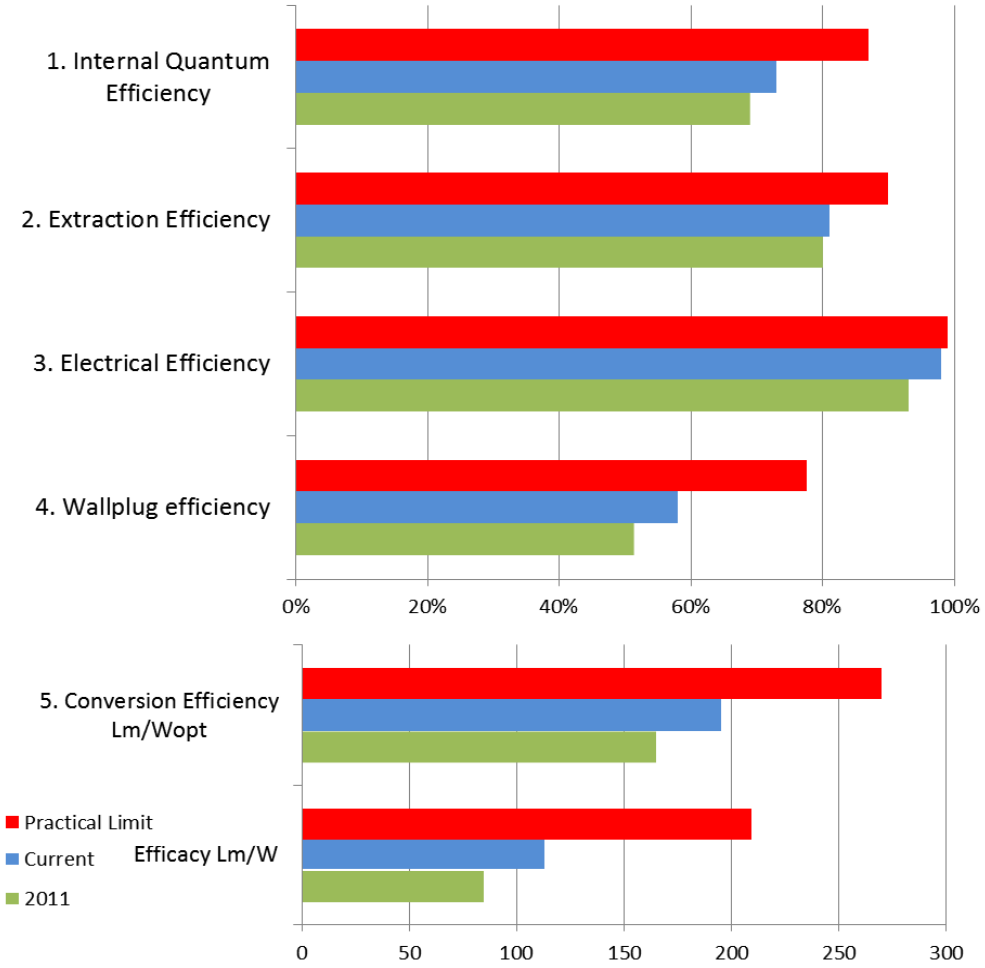
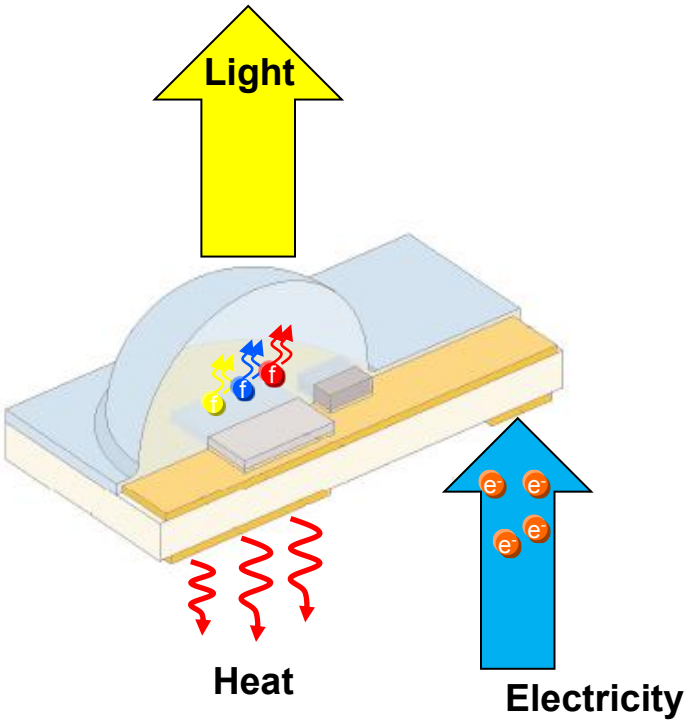
LED Performance

It's like dessert…There's always room for more!





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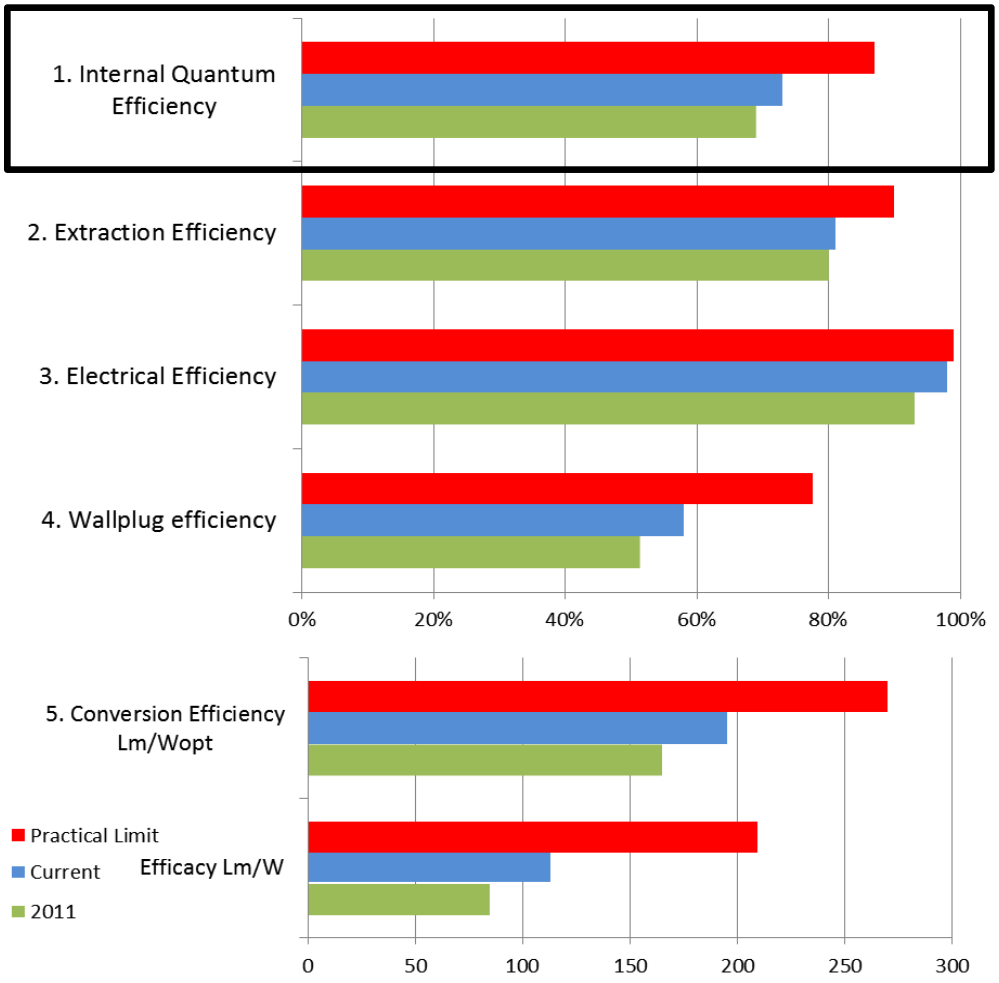
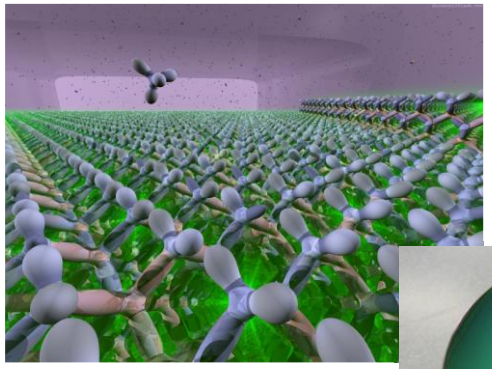
LED Performance

Advancements INSIDE the LED





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LED Performance

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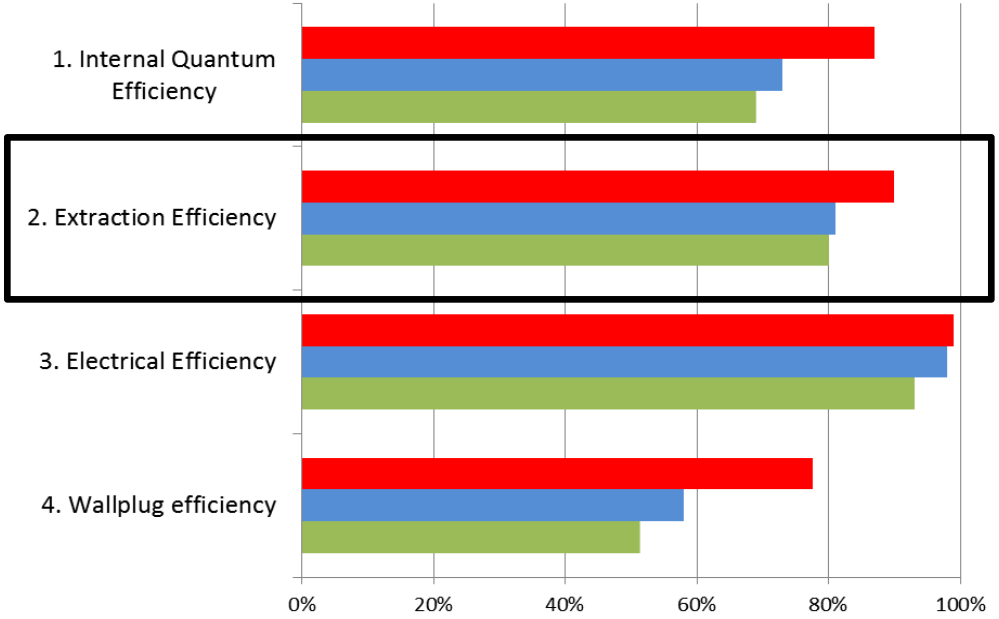

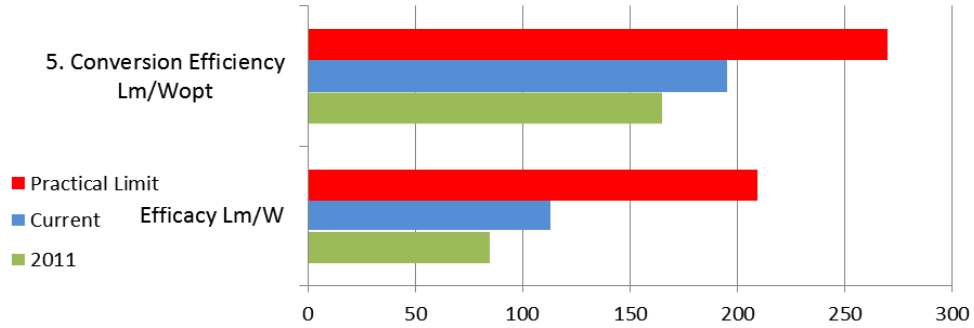

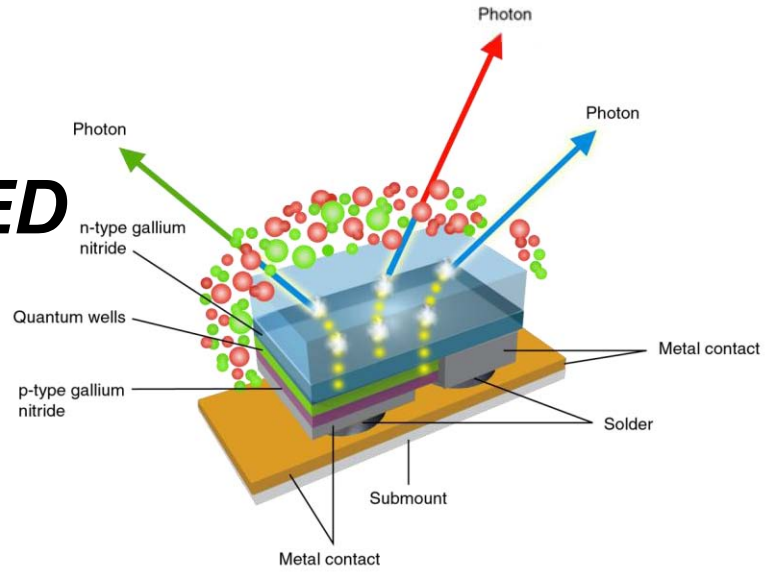

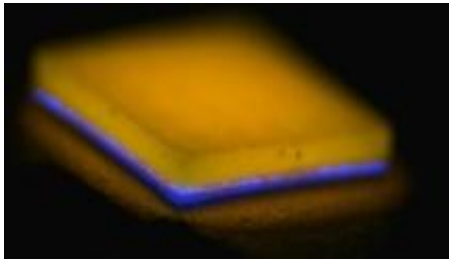

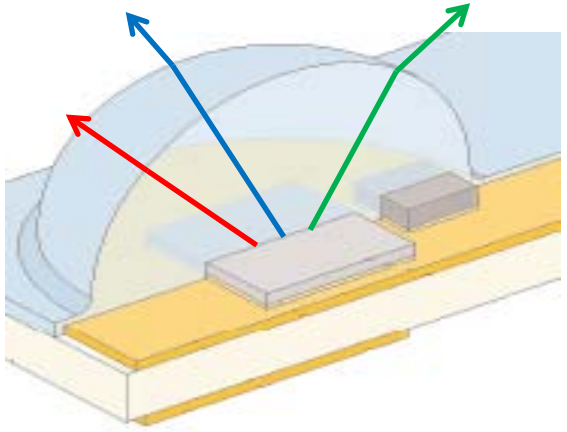

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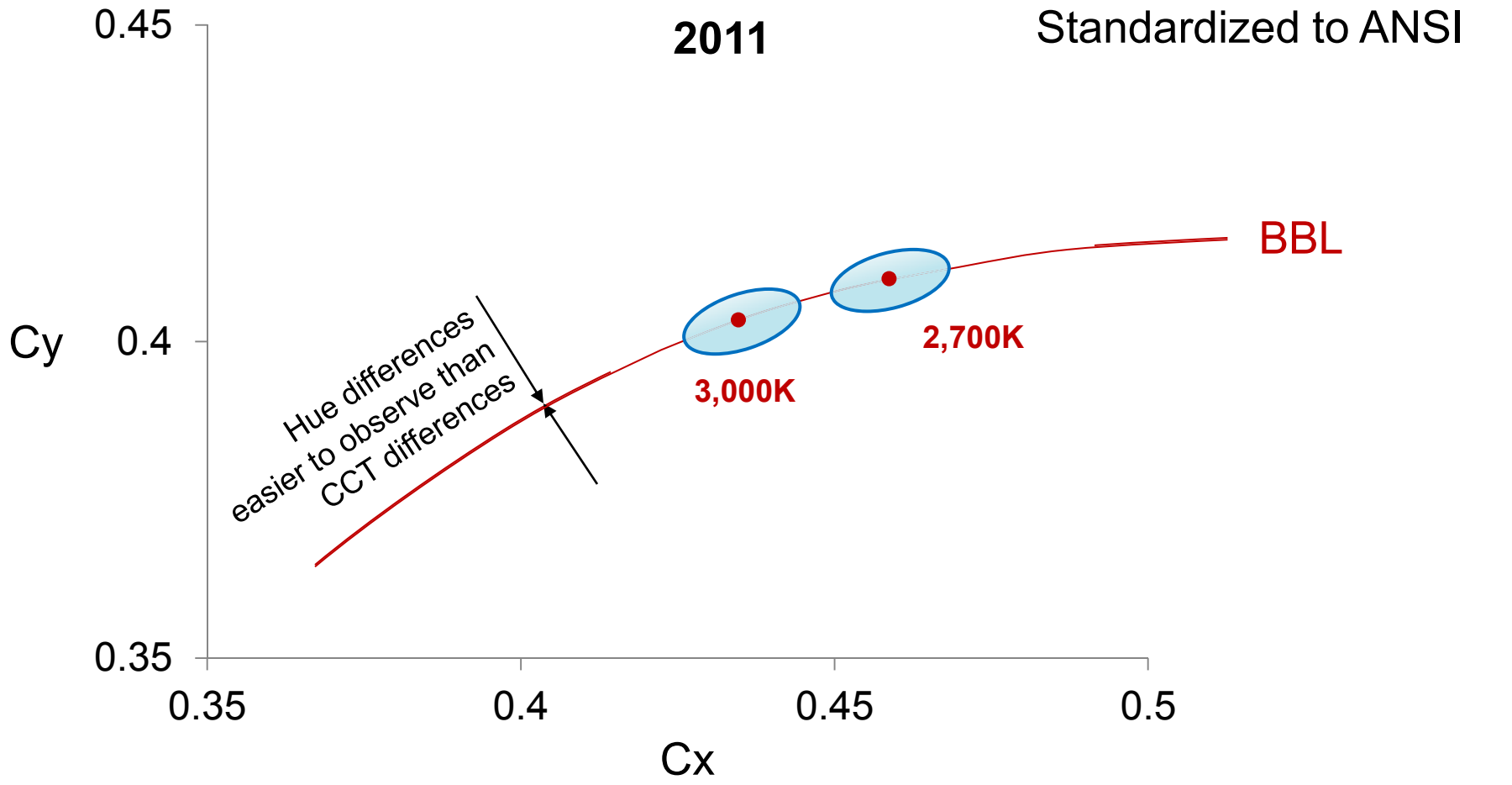
LED Performance

Advancements in Making the LED



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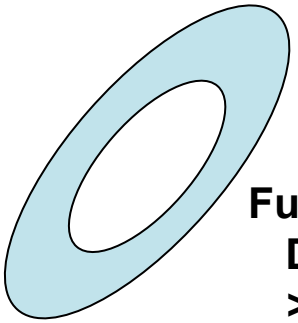
LED Performance

Different Ways to Achieve Freedom From Binning

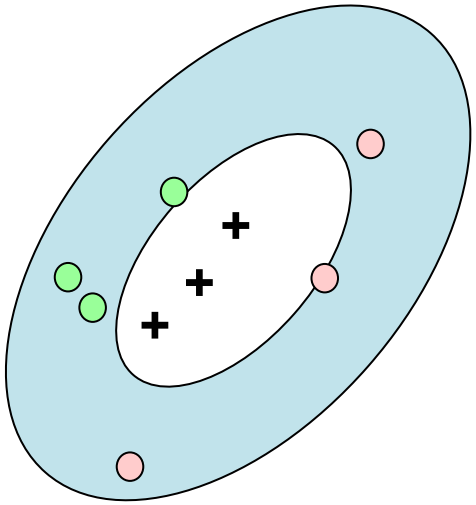
Post Production Sorting	Targeted Kitting	Production Targeting



Full Production Distribution > 5-7 SDCM

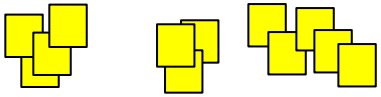
Production Sorting < 3 SDCM

Relative Distribution < 3 SDCM

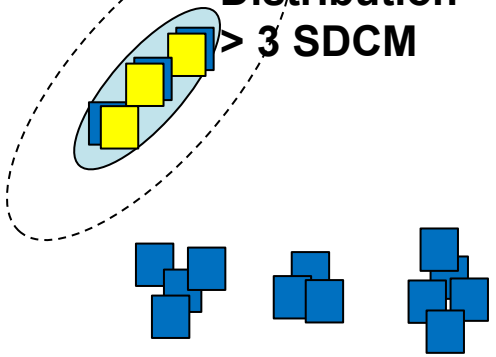


Full Production Distribution > 5-7 SDCM

Characterized Phosphor System



Full Production Distribution > 3 SDCM



Characterized Blue Pump

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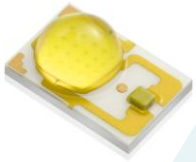
LED “Standardization”

There’s a “standard” for that…And that…



Component Design, Manufacture & Test

- LM-80
- Lumen Maintenance of discreet LED component

Fixture Design , Manufacture & Test

- LM-79
- In-situ fixture testing
- System Lumen Maintenance calculated based on LM-80

Product Testing & Qualification

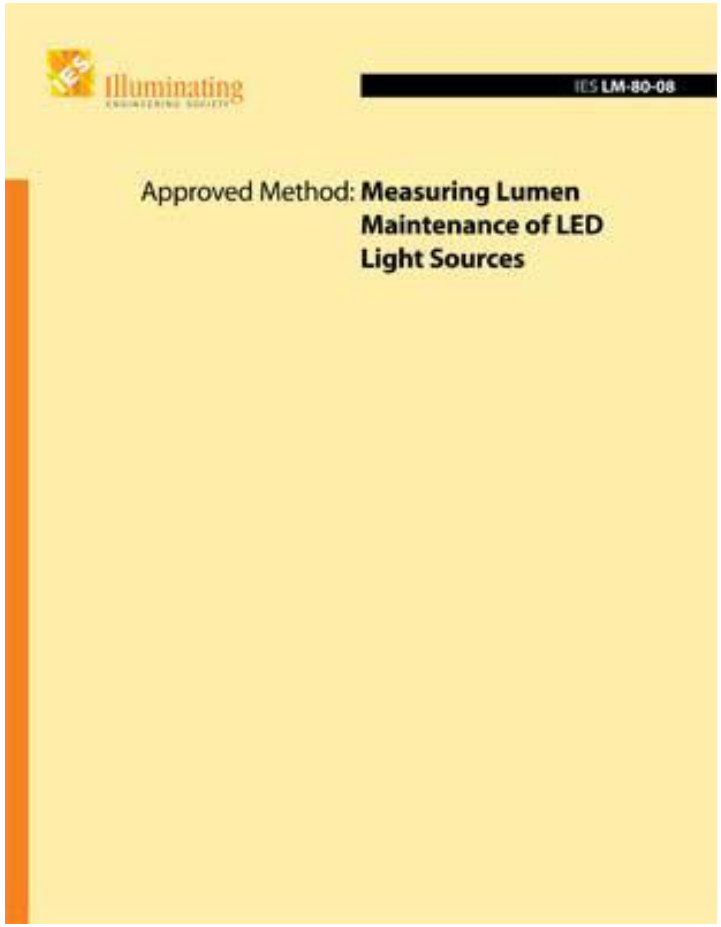
- Specifications defined by individual organizations (e.g. DLC, ES, etc.)
- Fixture Manufacturers submit test results from certified sources

DESIGNLIGHTS CONSORTIUM

energy ENERGY STAR

LED “Standardization”
What is LM-80…Really?

- Lumen maintenance test method written by IESNA (Illuminating Engineering Society of North America)
- Test method for LED package, array or module driven by auxiliary driver
- LEDs are driven with external current sources during operation and lumen maintenance testing
- LED Case temperature is controlled during operation
- During lumen maintenance testing, LED is allowed to cool to room temperature and tested at room temperature (25°C)



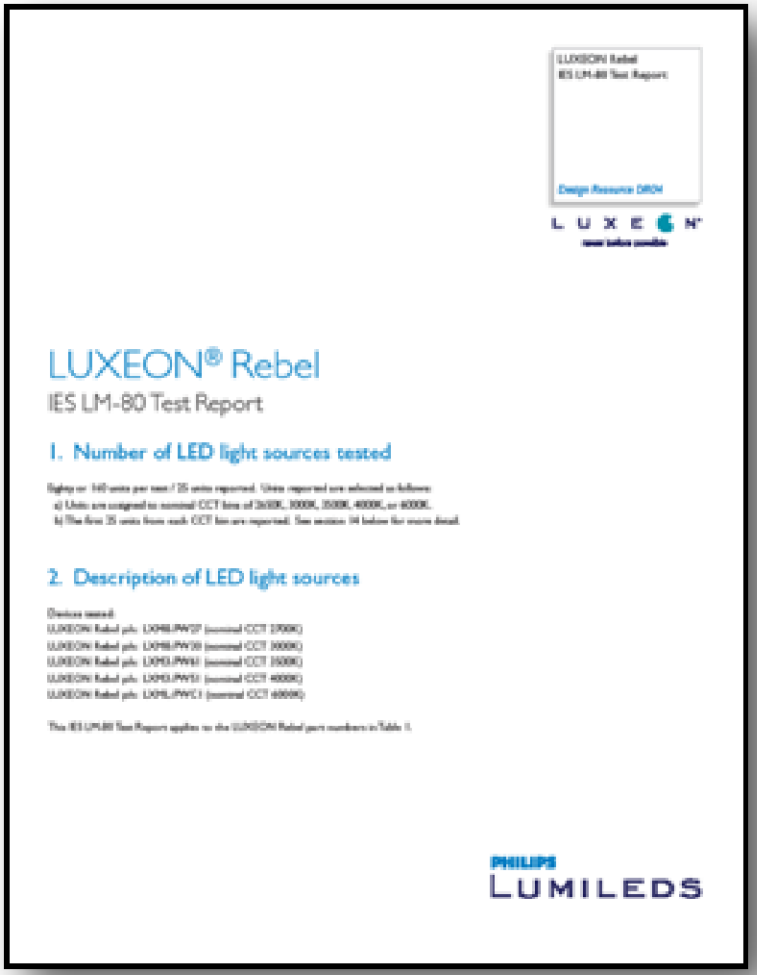
LED “Standardization”

The Actual LM-80 Test Method

- Operation at three case temperatures (55°C, 85°C and one selected by manufacturer)
- Air Temperature to within +/-5°C, Case Temperature to within +/-2°C
- RH less than 65%
- Minimum 6,000 hours, data collected every 1,000 hours
- Data collection at 25°C
- Constant current, rated voltage
- Record Lumen Maintenance, Chromaticity, Catastrophic Failures

LED “Standardization”

What Do You Get in an LM-80 Test Report?



- LM-80 Test Report
  - Tested product information
  - Summary tables/graphs
  - Raw data tables

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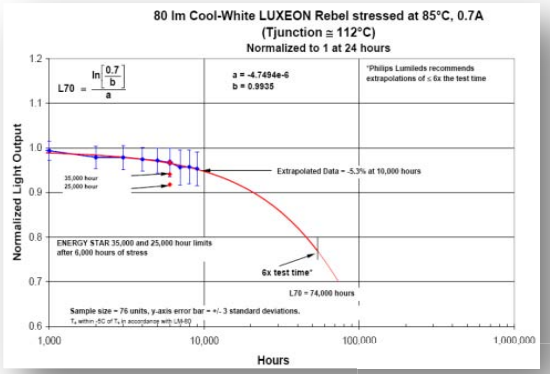
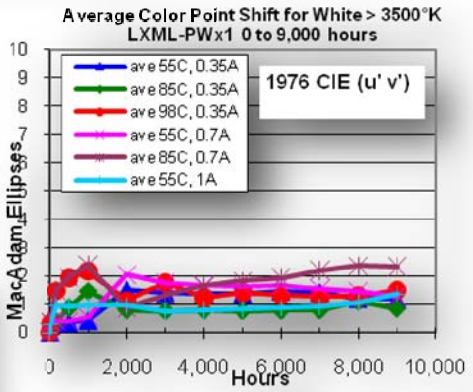
LED “Standardization”
What Can You Do With It?

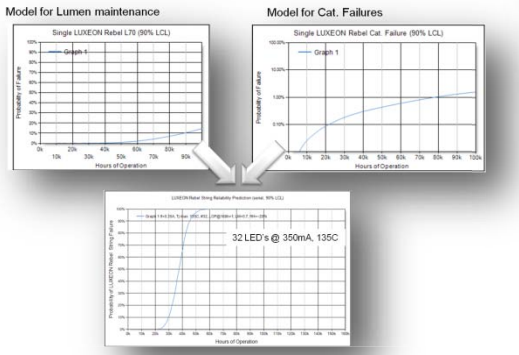
- Lumen Depreciation
  - Extrapolation (per TM-21)
  - Reference for LM-79 testing



- Chromaticity Stability



- Sub-System Reliability Modeling



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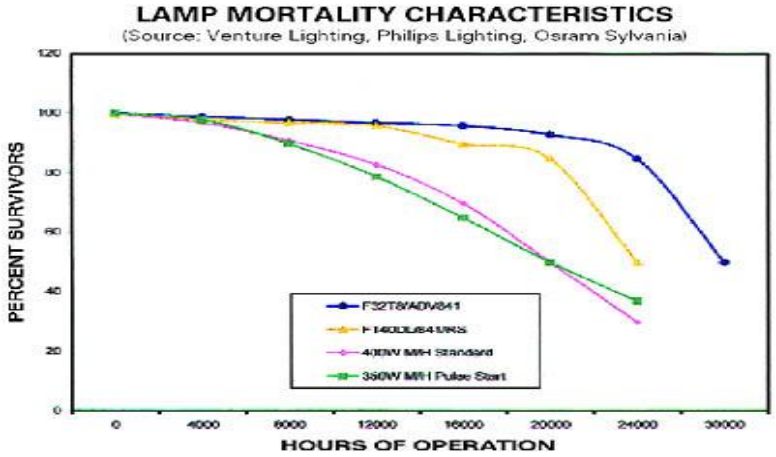
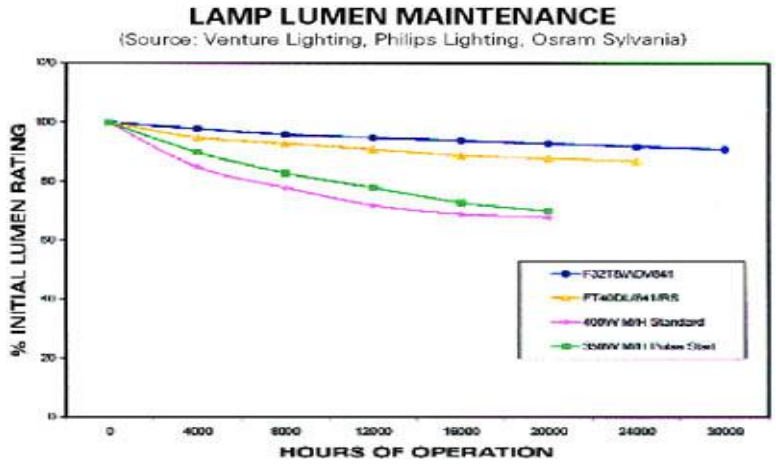
LED “Standardization”

Traditional Lamp Metrics ≠ LM-80 Results





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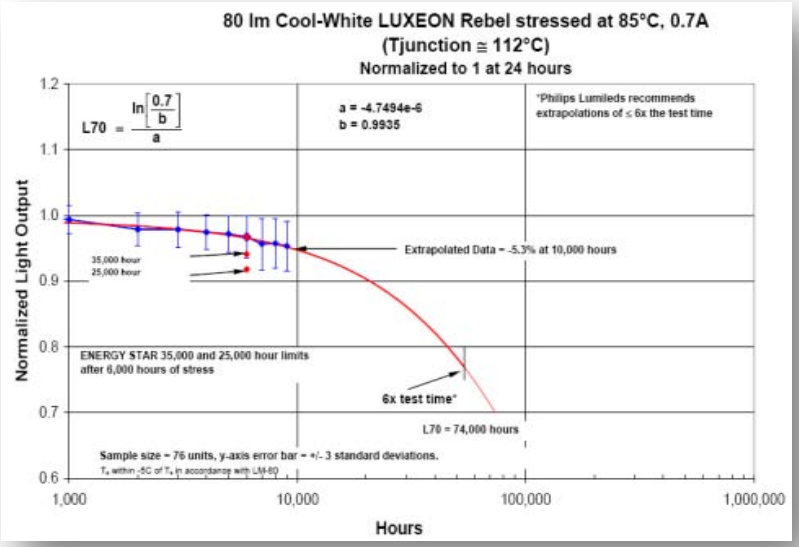

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LED “Standardization”
VoC: “Where is LM-80 for color product?”

- Good question…

- For InGaN (Blue/Green) LEDs LM-80 testing has been done in support of Remote Phosphor general illumination products

- For AlNGaP (Red/Orange) LEDs no formal LM-80 testing has been done w/in the industry.
  - There is design validation and long term test results available – not to any formal, industry test criteria (e.g. LM-80) for Lighting

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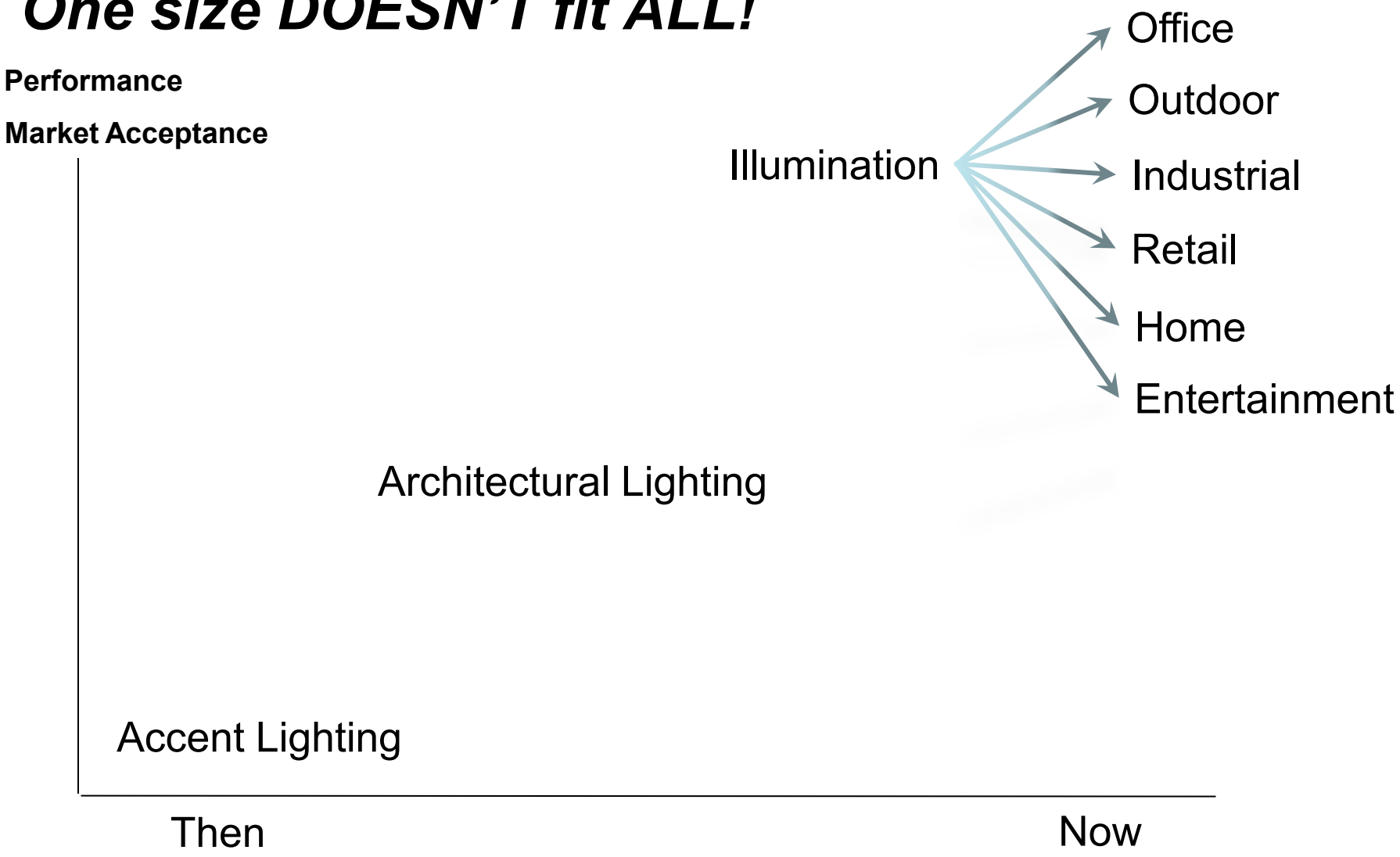
LED Package Evolution

One size DOESN'T fit ALL!



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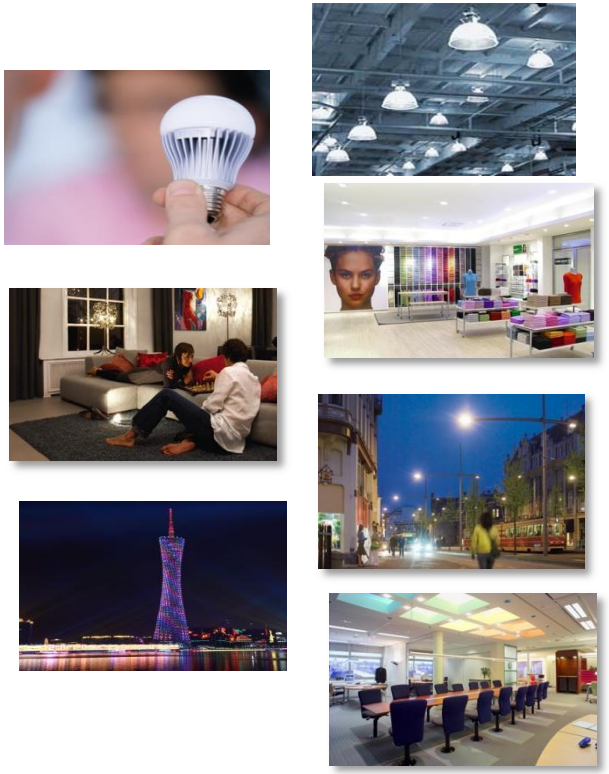
LED Package Evolution

One size DOESN'T fit ALL!

Performance

Market Acceptance



Then

Now

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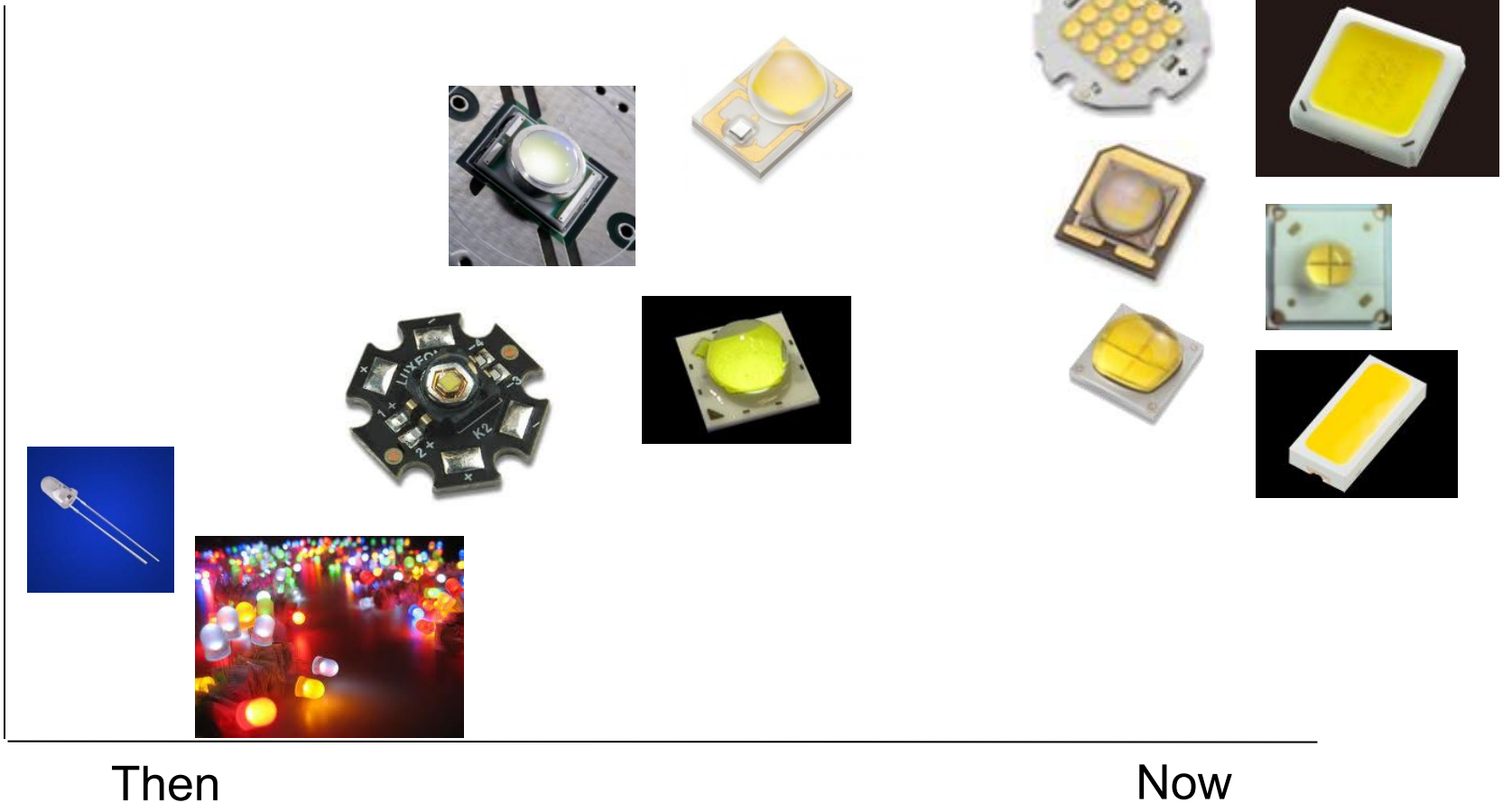
LED Package Evolution

One size DOESN'T fit ALL!

Performance

Market Acceptance



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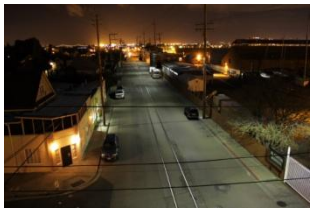
LED Package Evolution

Why Do The LEDs Have To Change?

Market & Applications				
	Outdoor Street Light	Indoor Troffer	Retrofit E29 vs. PAR	Retail Track Light
System Output	High 15K lumens	Medium 5000+ lumens	Low-Medium 600+ lumens vs. 3000+ cd (CBCP)	Medium 50000 cd (CBCP)
Optical Requirements	Uniformity on Target	Low Glare Uniformity w/in the space	Omnidirectional vs. CBCP	"Punch"



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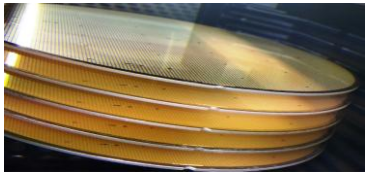
LED Package Evolution

VoC: "Why are the LEDs discontinued so often, in just a couple years?"

- Why?..."Capital Utilization"
  - The cost to maintain the production "line"

- In the past, products had more ***dedicated*** capital than ***shared***


- More recently, the production process and supporting capital are shared more…

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LED Package Evolution

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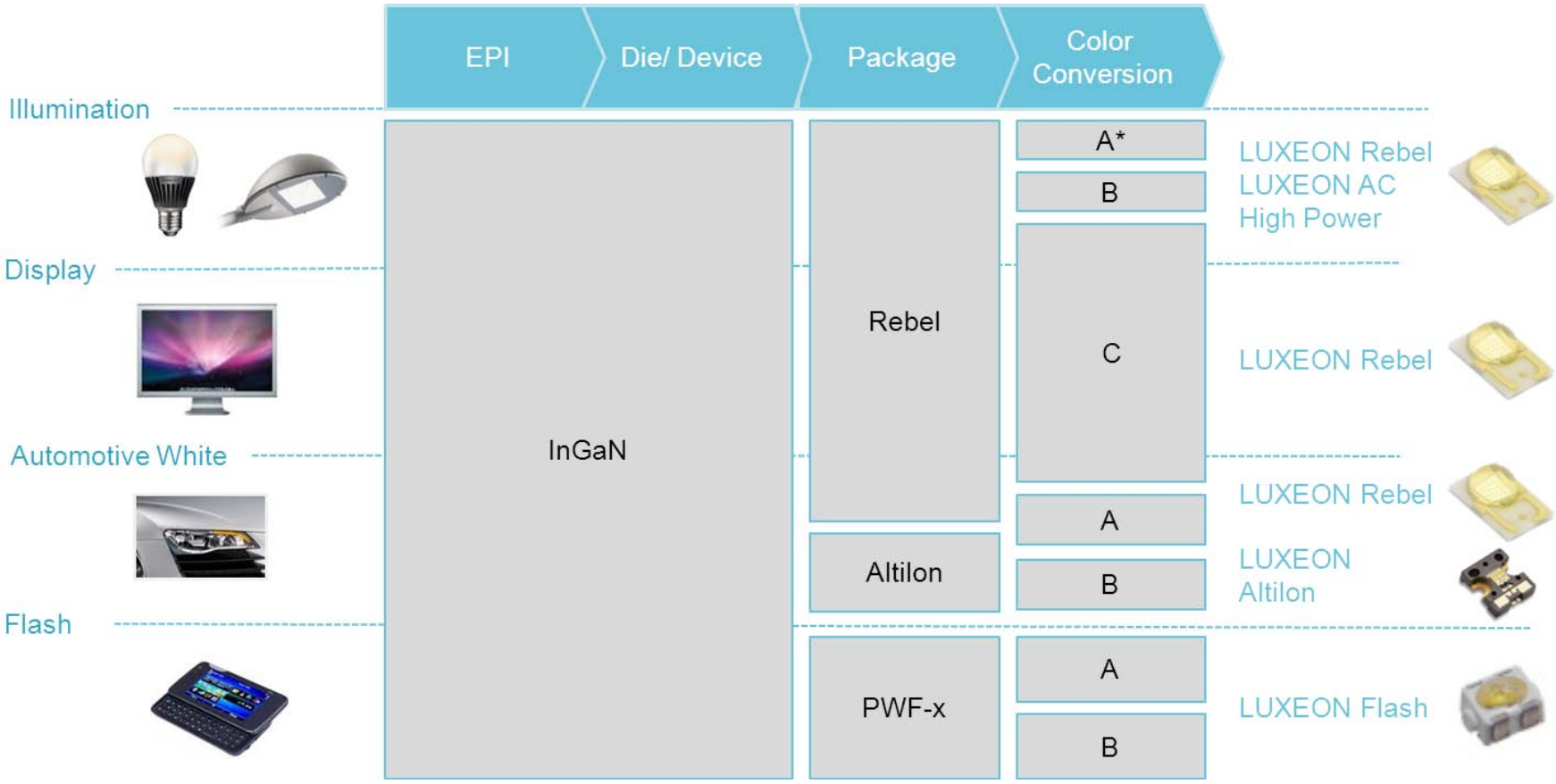

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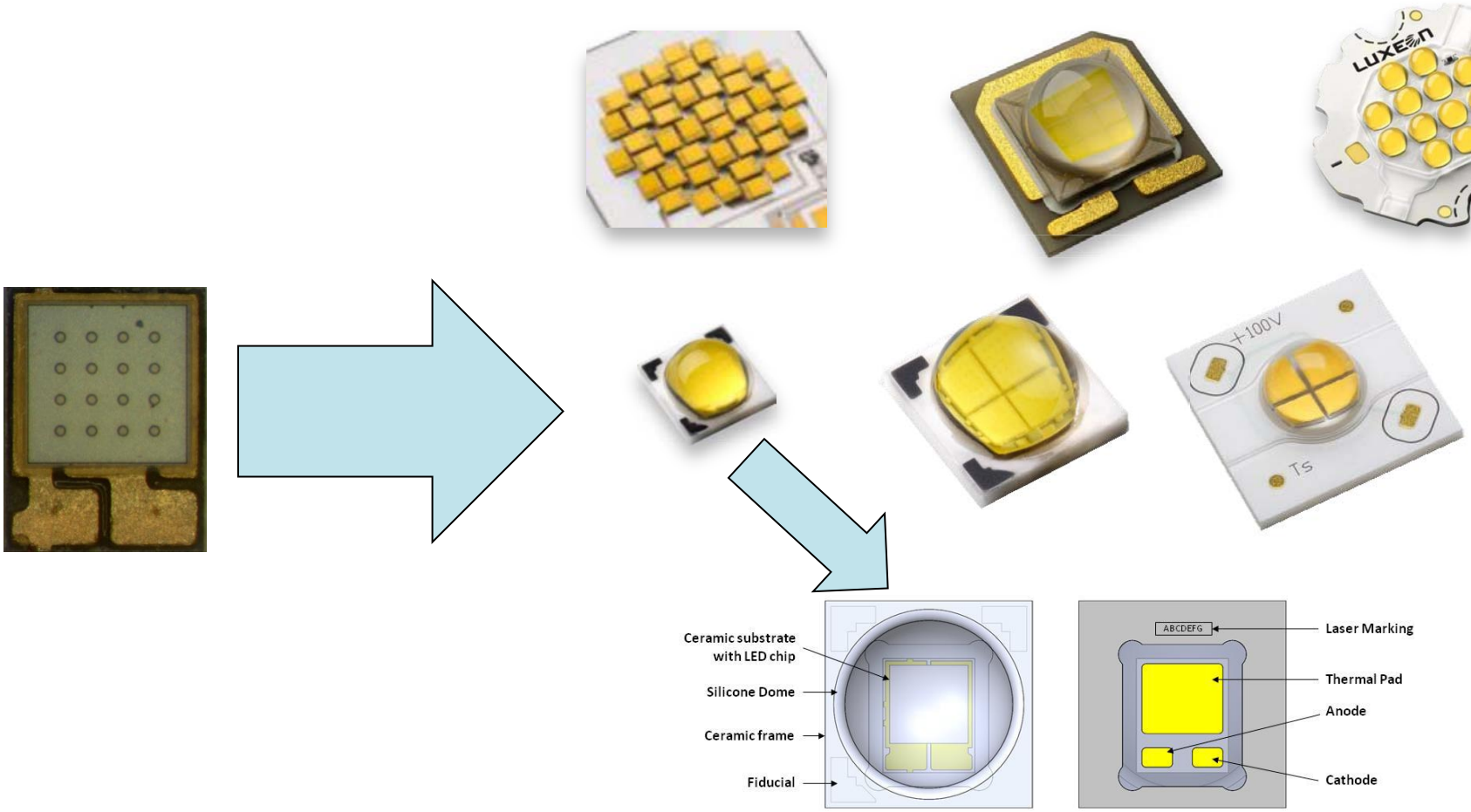
LED Package Evolution

VoC: "Why are the LEDs discontinued so often, in just a couple years?"

- Building block approach…



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Wrap-up

- LED Performance Trends

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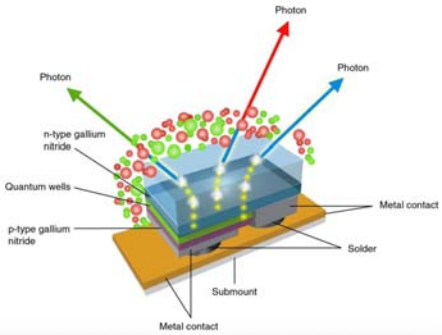

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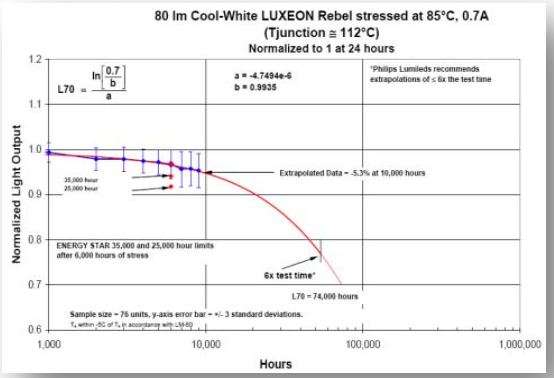

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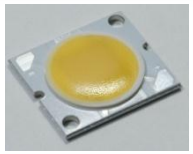

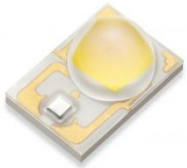

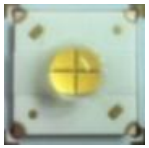

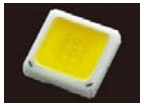


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