

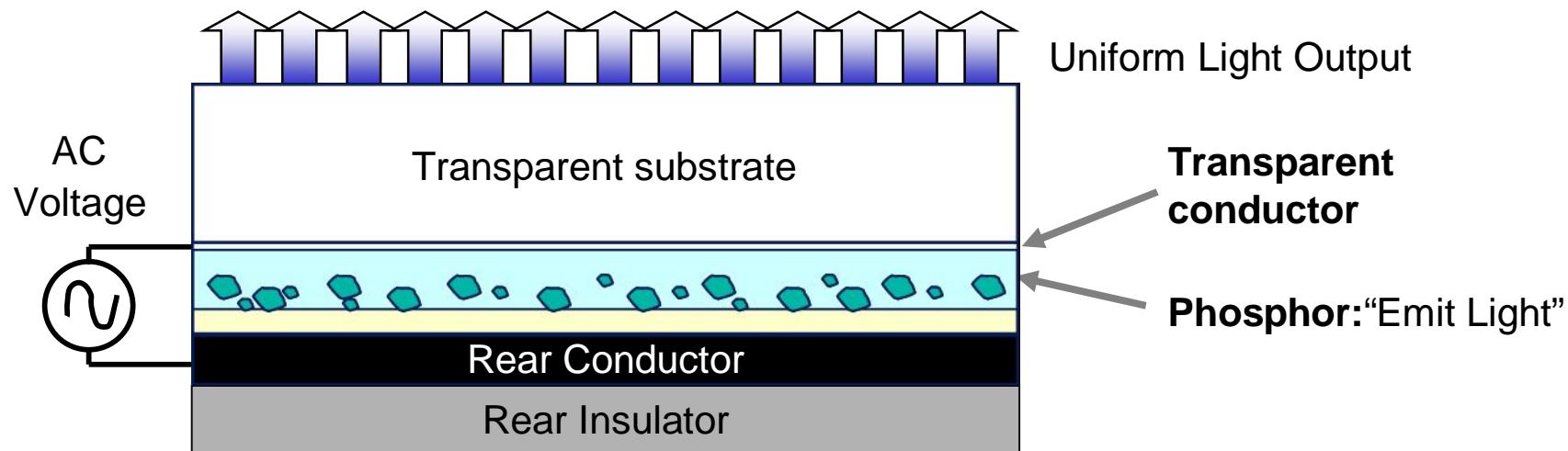
2004

# Shainin Symposium

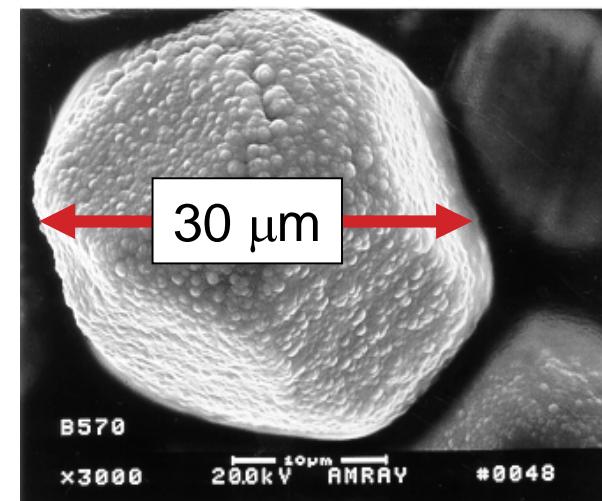
## **Variation in Brightness of Electroluminescent Lamps for Consumer Electronics**

Roy Chancellor

# EL Lamp Technology

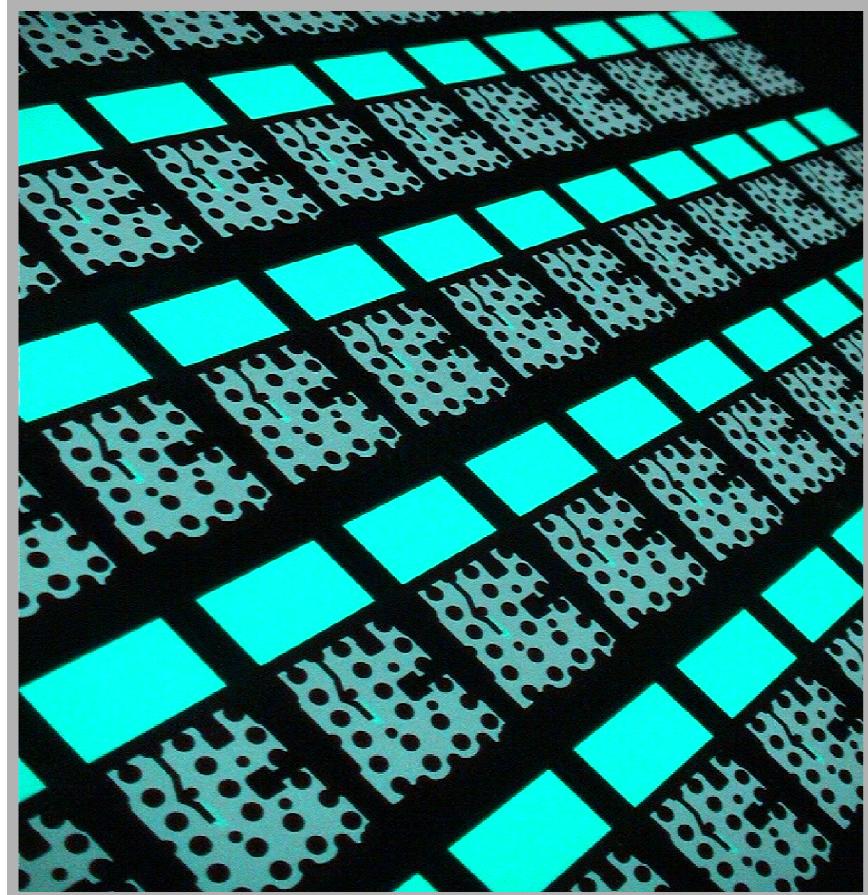


Phosphor  
Particles

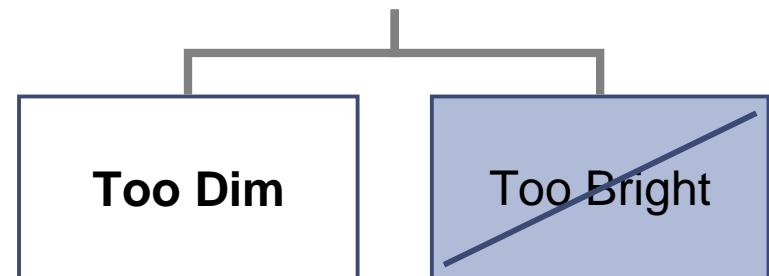
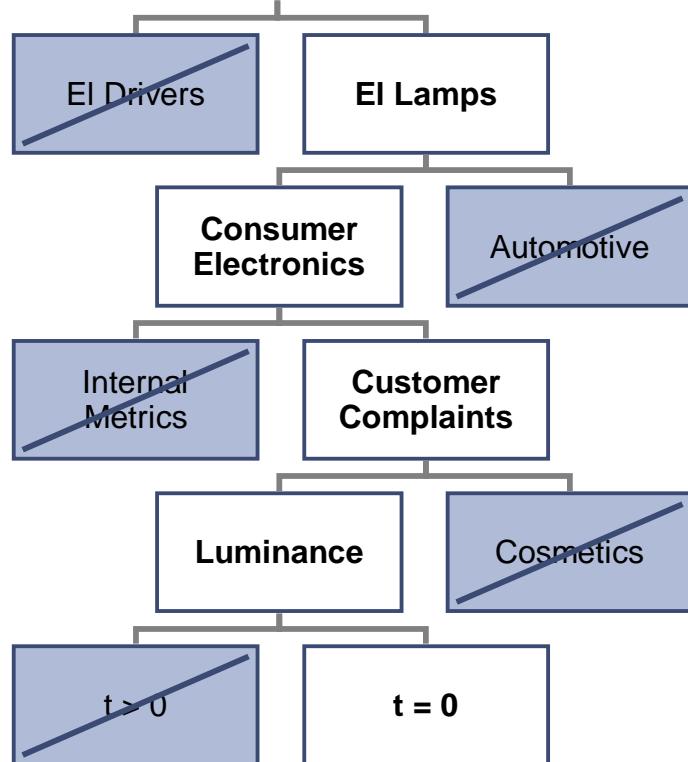


# EL Manufacturing Process

- Series of ink layers deposited on conductive, transparent panels
- Matrix of lamps
- Typically > 100 per panel



# Approach : Project Definition



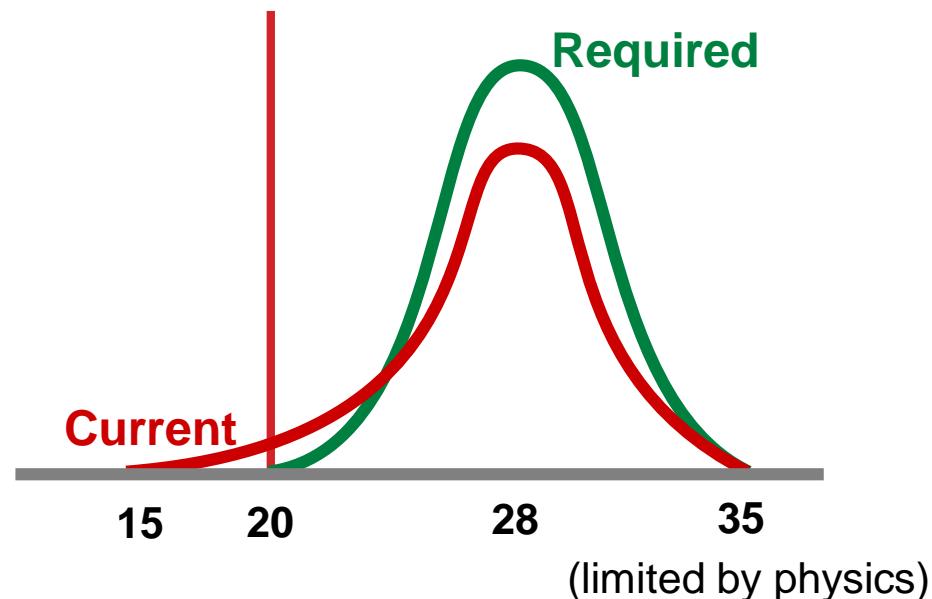
## Rationale:

Lamps can never be too bright!

# Approach : Project Statement

**Project Definition:** Find and eliminate the Red X® that causes customer complaints for luminance variation in EL lamps.

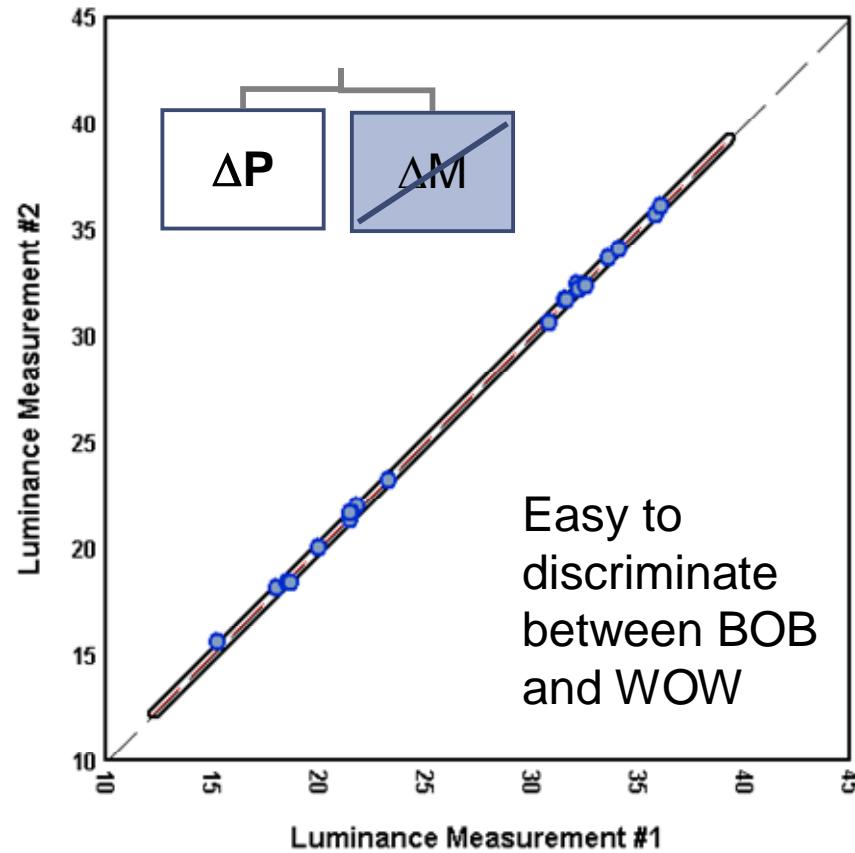
**Green Y®:** Luminance measured at one point on a powered EL lamp



# Approach : Measurement System Evaluation



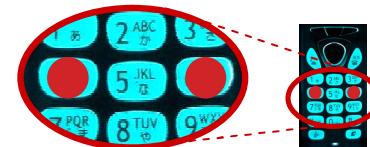
Measure  
brightness  
at a point



# Converge : Strategy Diagram™

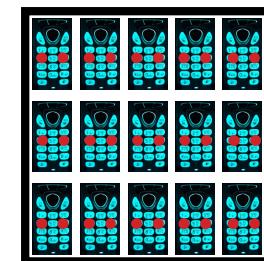
**Key - Key**

**Same Lamp**



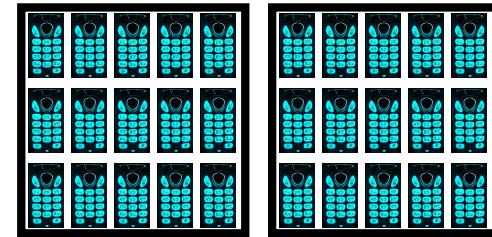
**Lamp - Lamp**

**Same Panel**



**Panel - Panel**

**Same Run**

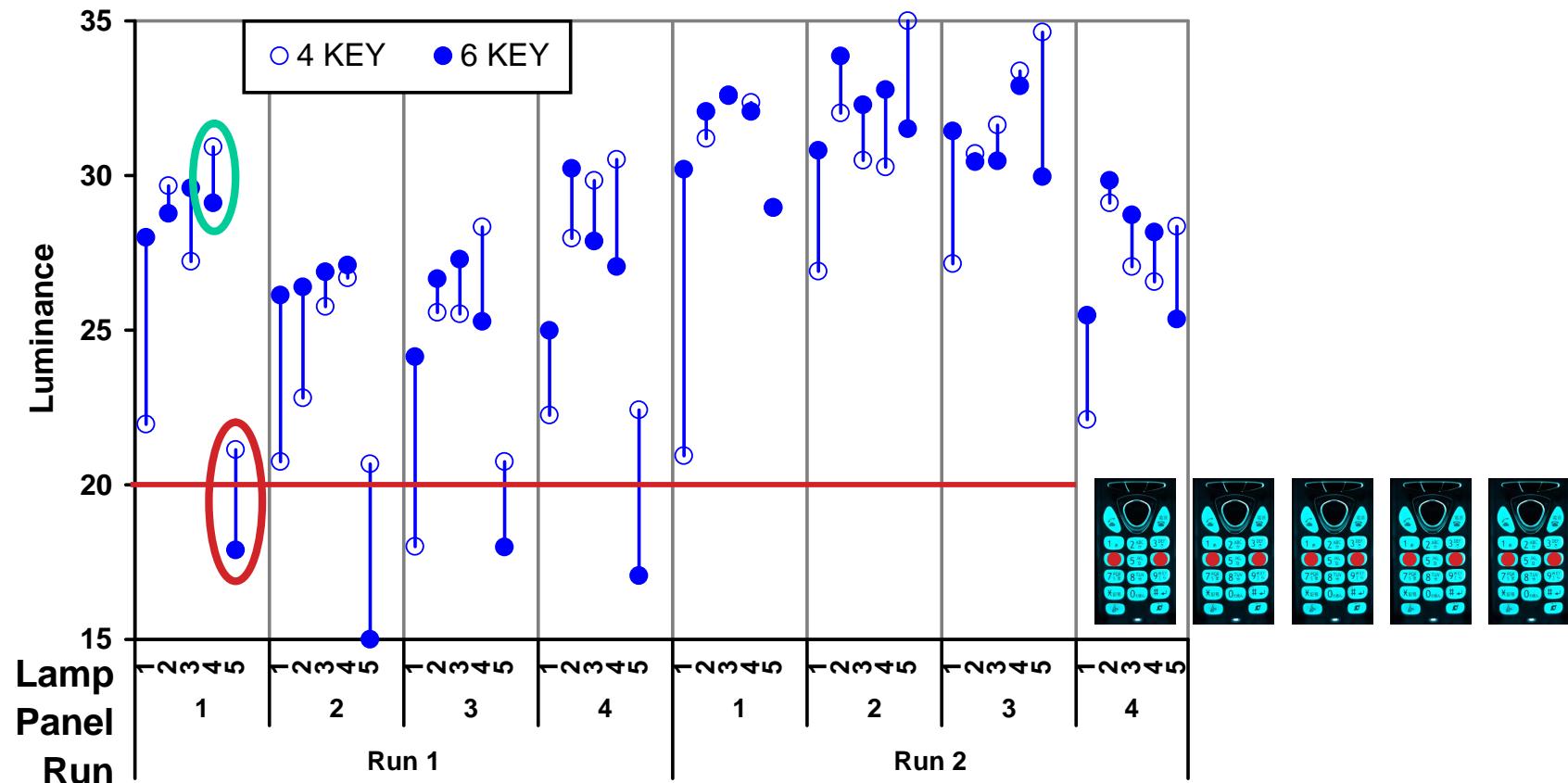
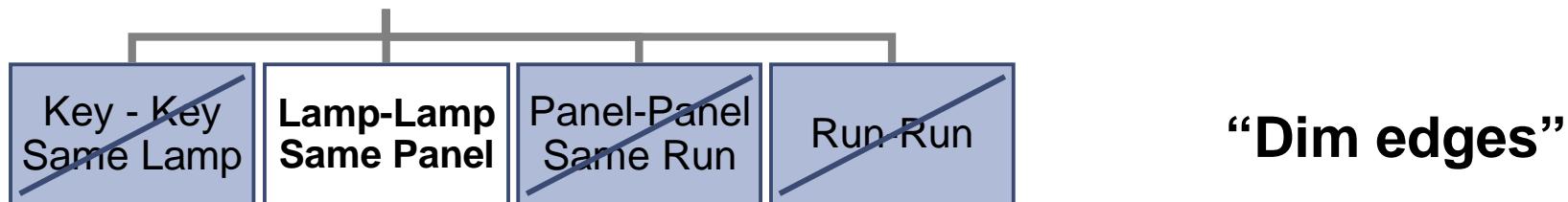


**Run - Run**

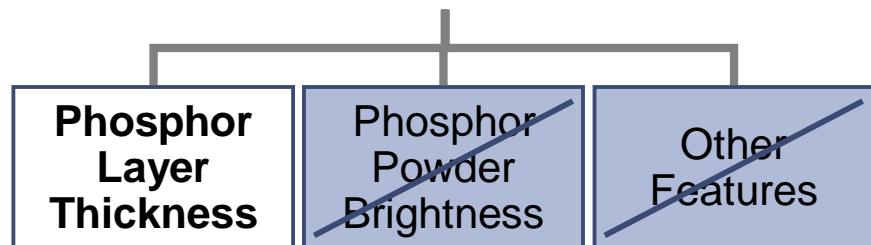


**Lot 1234      Lot 5678**

# Converge : Multi-Vari

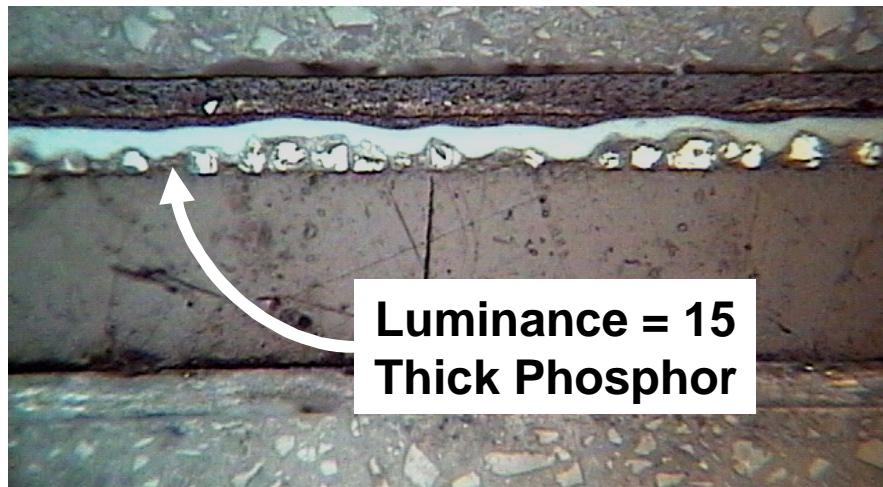


# Converge : Clue Generation

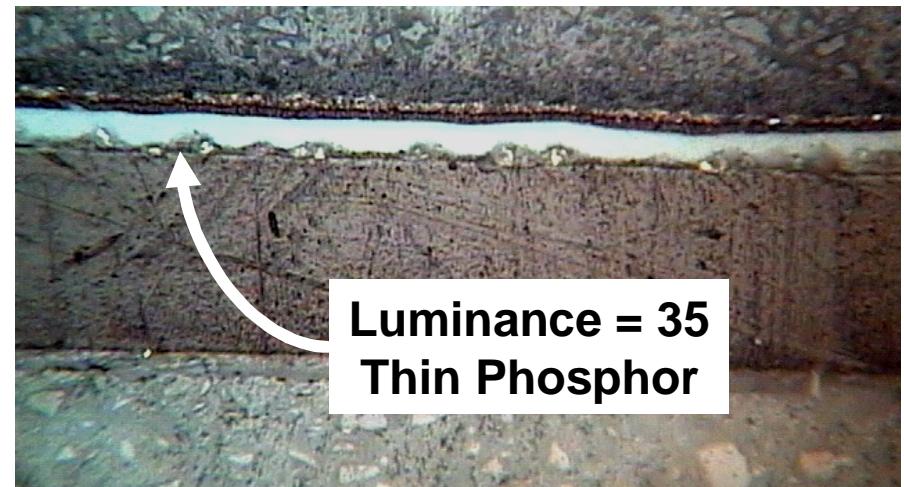


- Powder not smart enough to vary lamp to lamp
- Phosphor layer is thick in WOW and thin in BOB

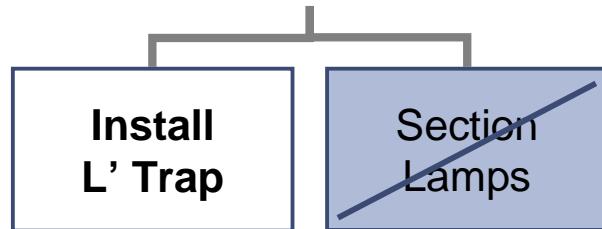
**WOW Lamp**



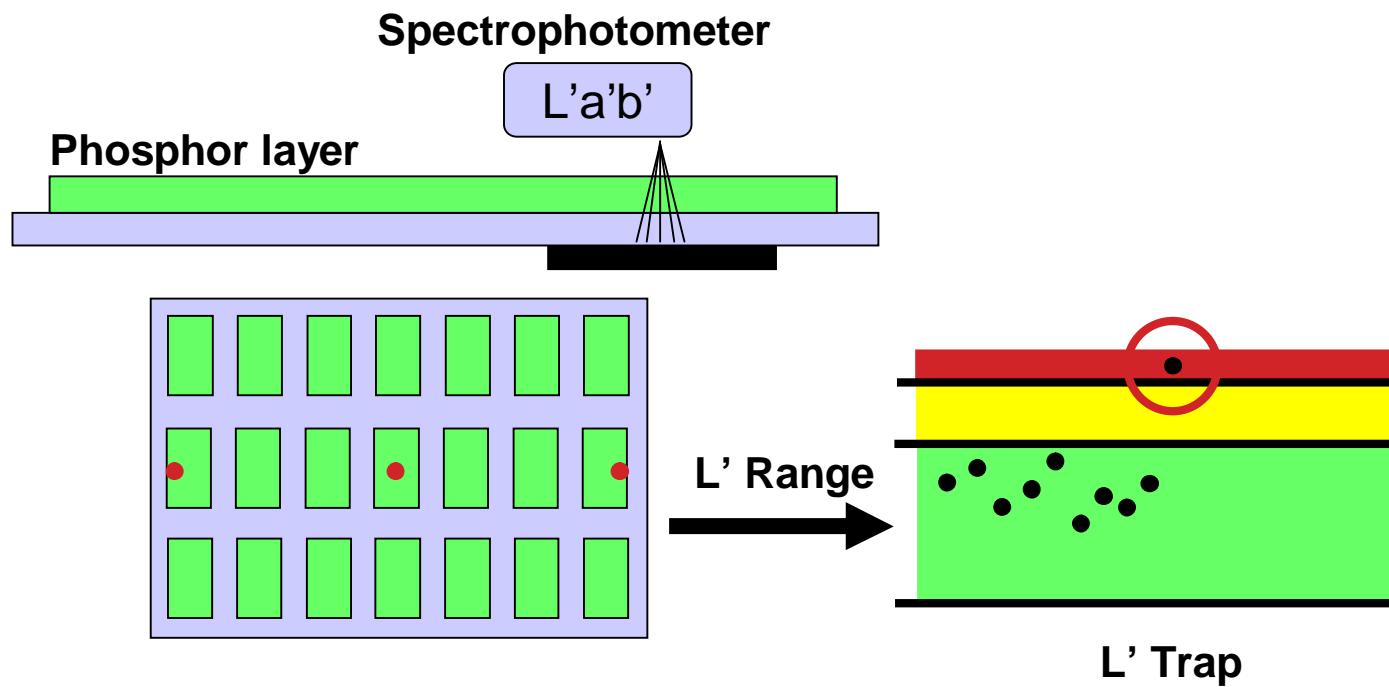
**BOB Lamp**



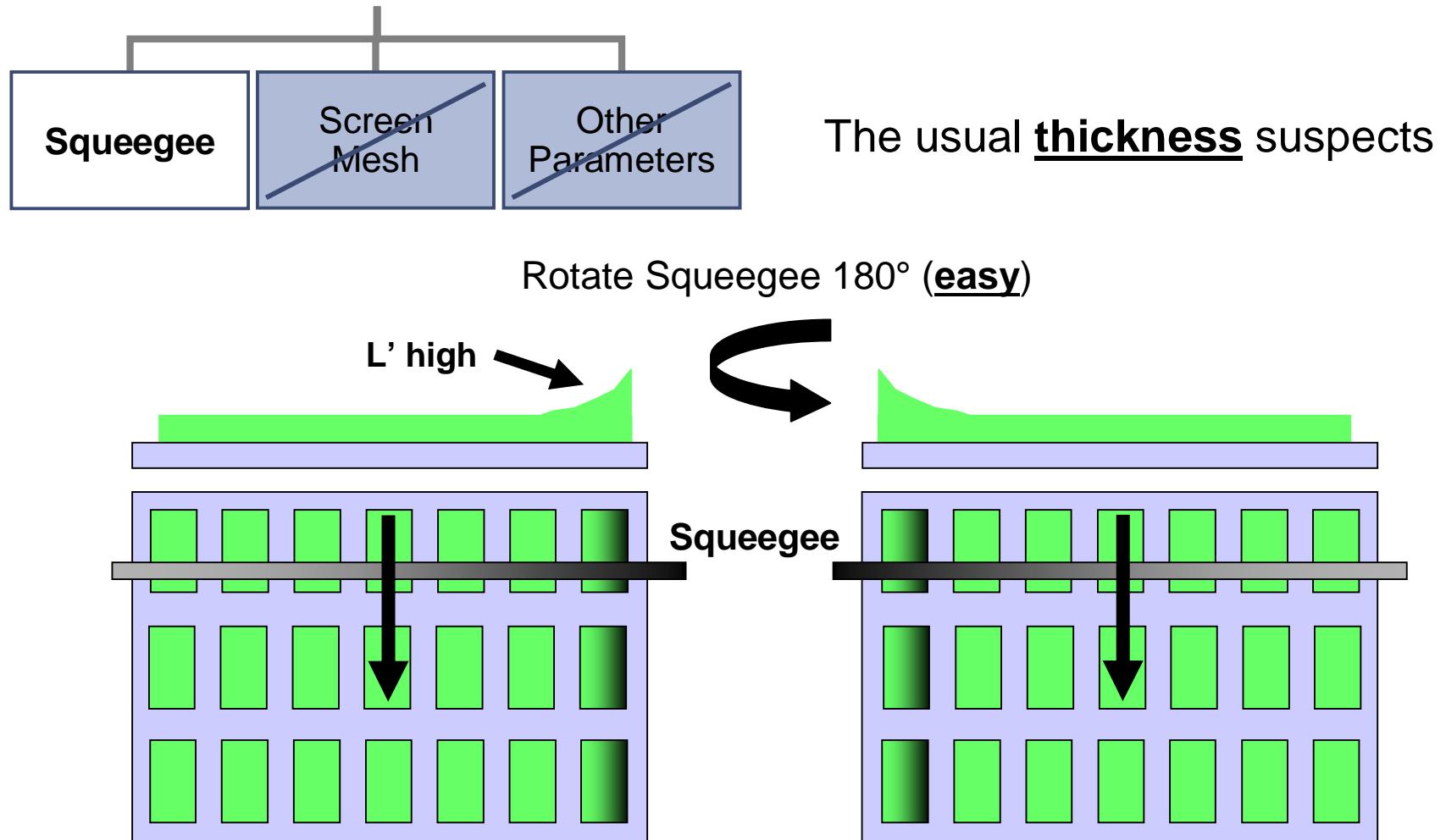
# Converge : L' Trap (Catch the Red X®)



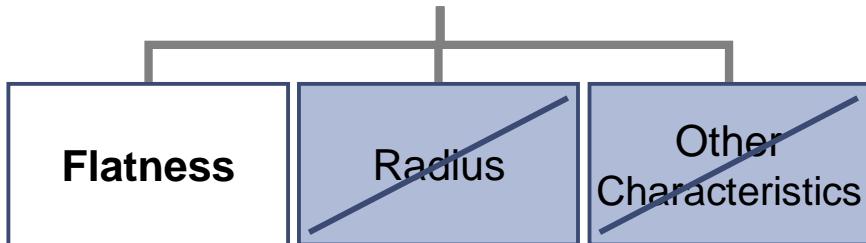
- Cross sections show contrast, but traceability lost
- Shade of layer changes with thickness
- L' measures shade of color (passes Isoplot)
- Connectivity between L' and thickness



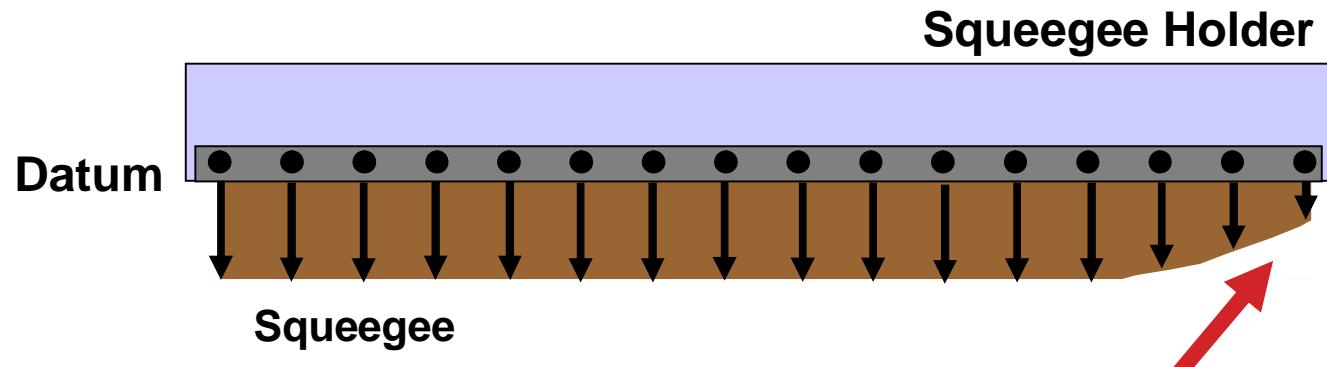
# Converge : Dictionary Split



# Converge : Flatness Drives Thickness



The usual squeegee suspects



- Squeegee rubber not ground flat near the end
- Pattern follows deposit thickness on WOW panel
- Show me the physics
  - Lack of flatness causes low print pressure
  - Low pressure increases deposit thickness

# Test : Red X® Confirmation

**Green Y®** = EL Lamp Luminance at **WOW** Location

**Red X®** Candidate = Squeegee Flatness

B = Flat ground squeegee (< 0.004")

C = Non-flat squeegee (> 0.010")

Confidence = 95%

Run Order			
B or C	Flatness	L' PH	Lum
B	0.0022"	62.7	33.6
C	0.0135"	67.9	18.6
B	0.0036"	63.1	29.0
B	0.0023"	62.4	32.8
C	0.0161"	68.0	16.9
C	0.0185"	68.0	16.3

Rank Order			
B or C	Flatness	L' PH	Lum
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C	0.0185"	68.0	16.3

- With 95% confidence, Squeegee Flatness drives Luminance.
- BOB-WOW contrast in Luminance demonstrates practical significance.

# Understand : Corrective Actions

- Fix squeegee flatness (new process Green Y<sup>®</sup>)
  - Red X<sup>®</sup> investigation on squeegee grinders
  - Red X = grinder rail parallelism
  - Shims installed and confirmed with B vs C<sup>TM</sup>
  - Implemented process control of flatness

# Understand : Linkage

Green Y<sup>®</sup> = Luminance



Product Red X<sup>®</sup> Feature = Layer Thickness



Process Red X Parameter = Squeegee Flatness  
(new Green Y)

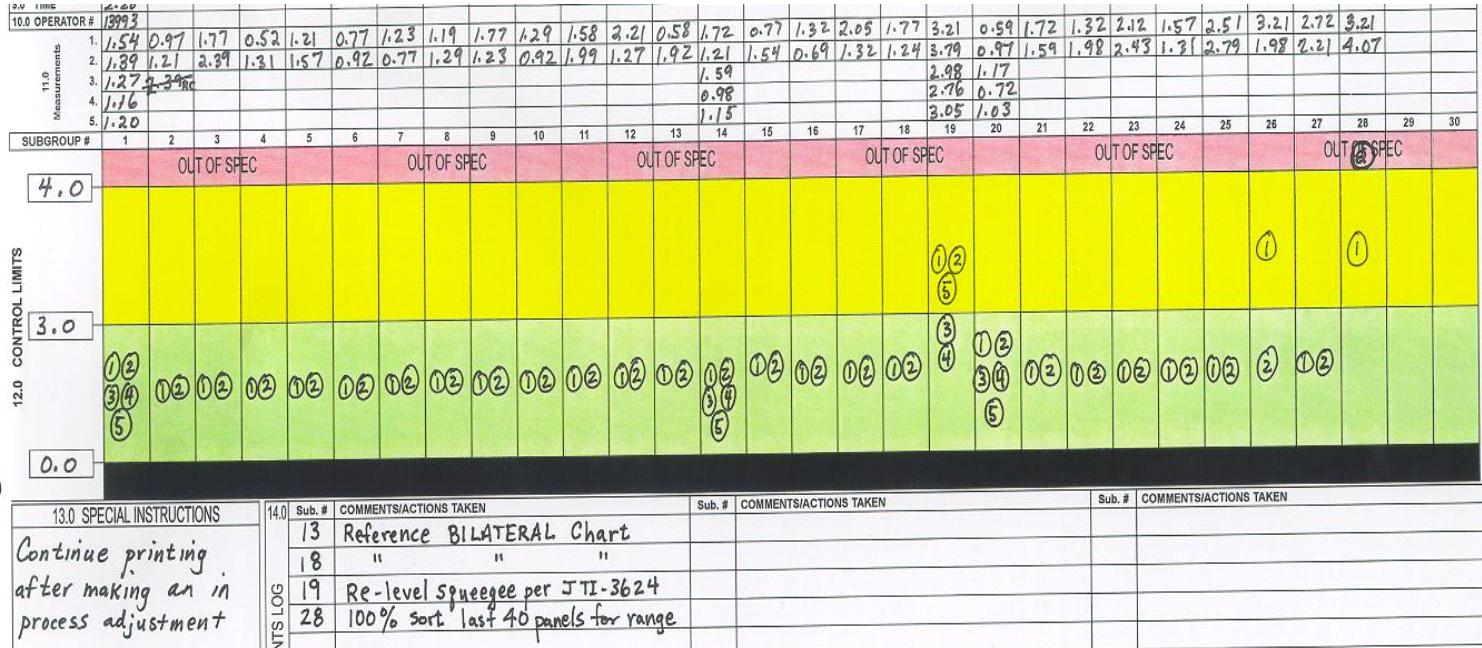


Process Red X Parameter = Rail Parallelism



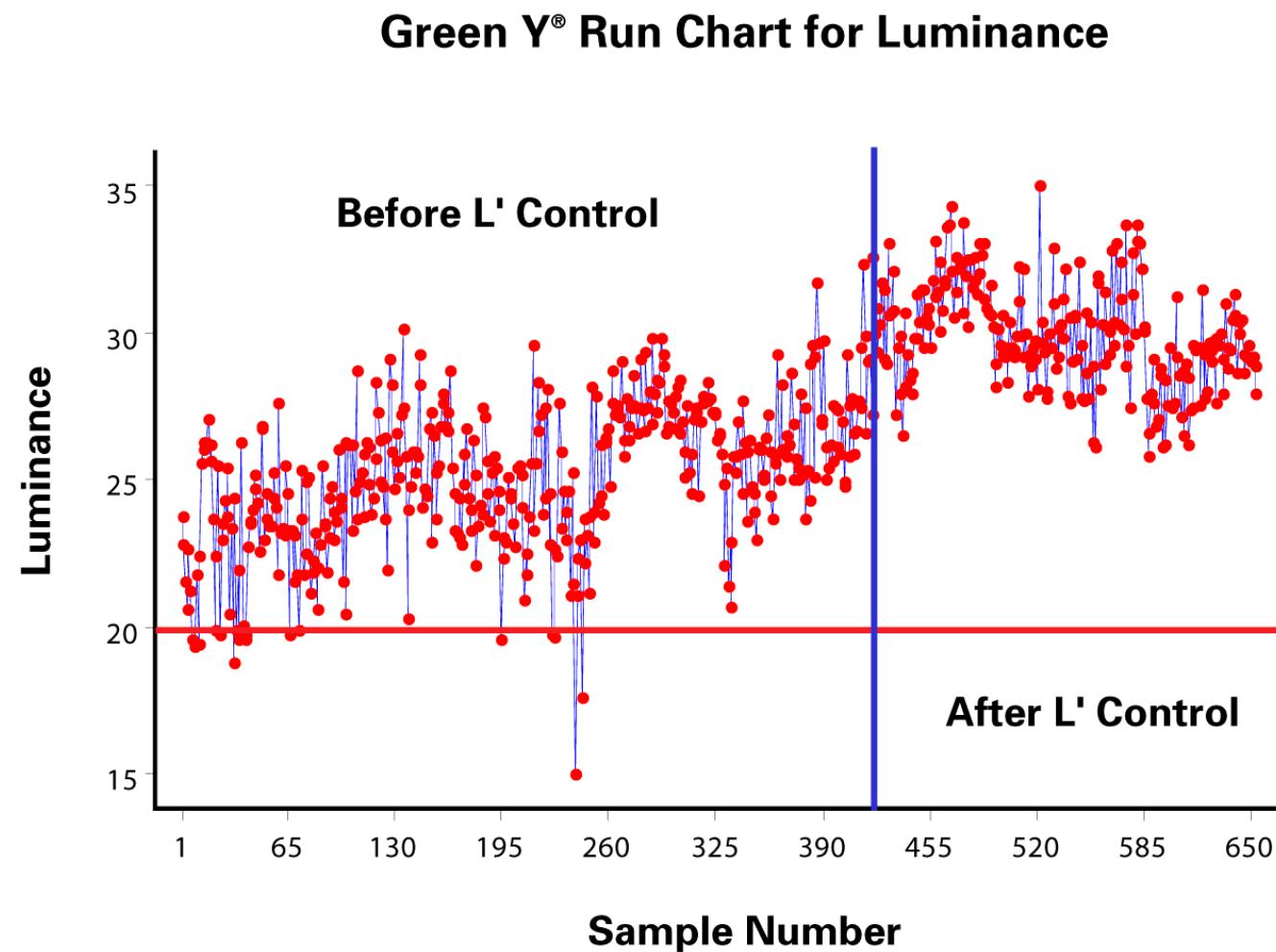
**“The devil’s in the details”**

# Understand: Precontrol of L' Range

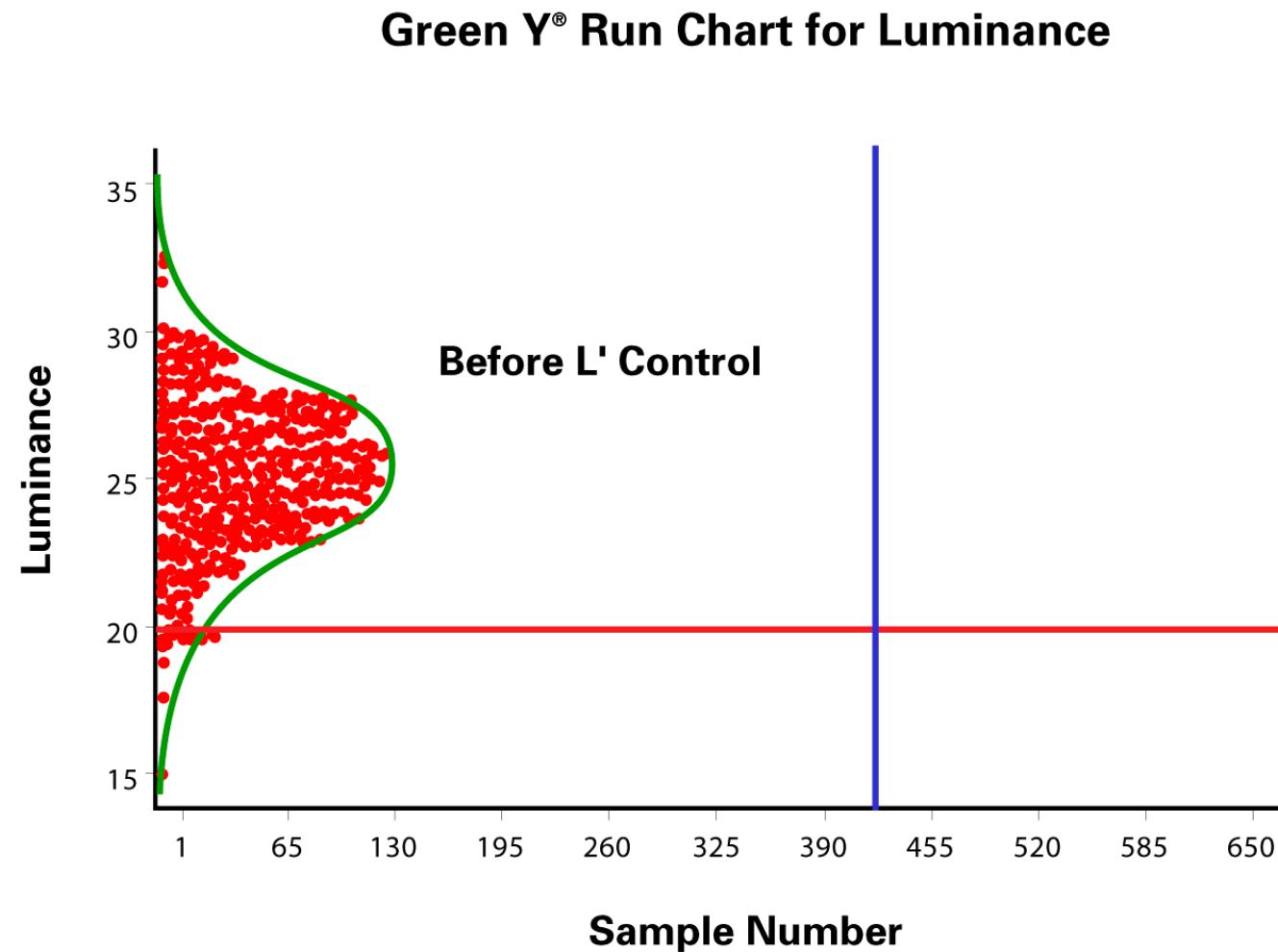


- Precontrol of L' range on all lamp layers
  1. Protect the customer from dim edges
  2. Protect profitability
- **KNOW** parts are good **AT SETUP**

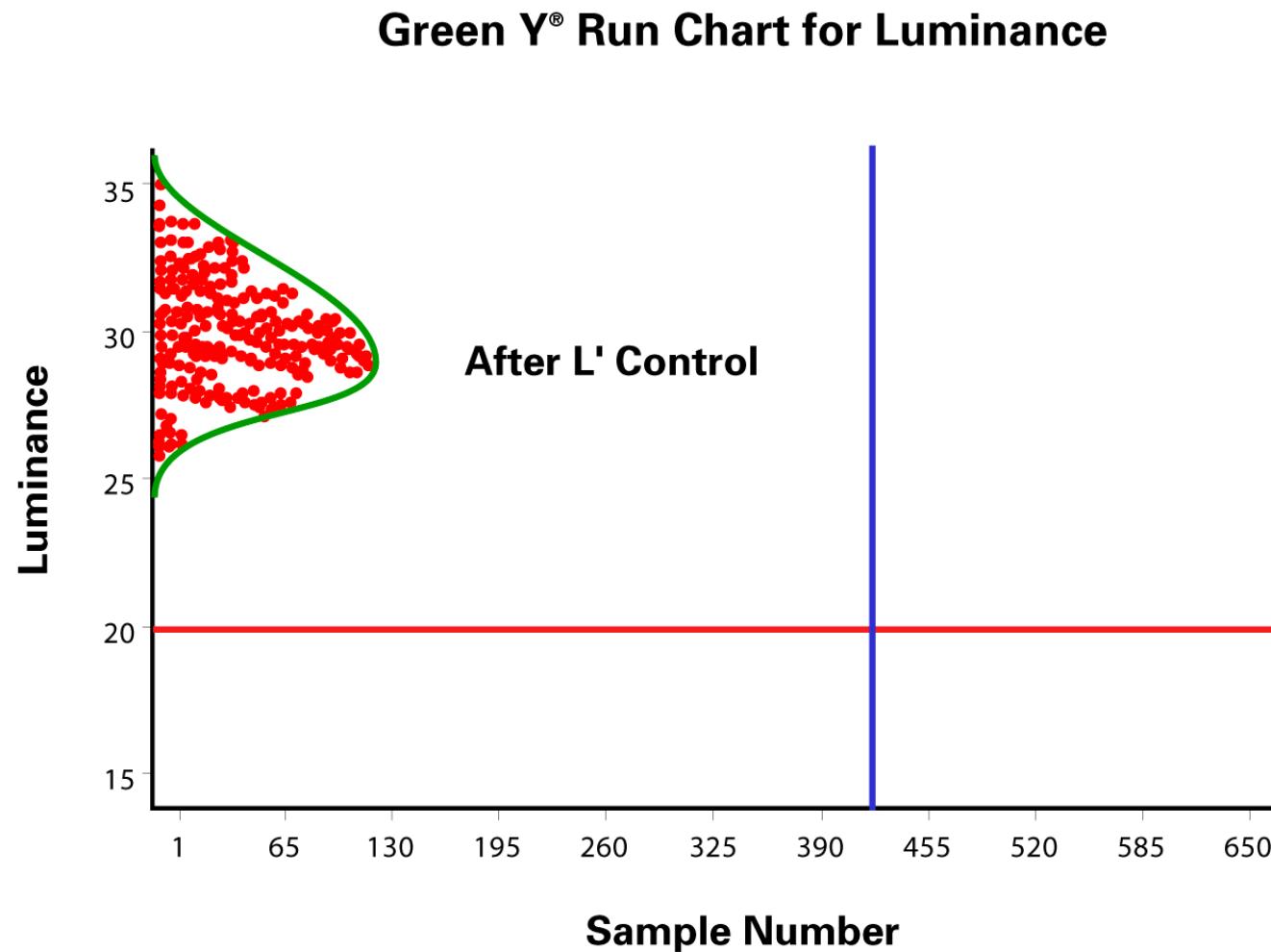
# Apply : Green Y® Run Chart



# Apply : Green Y® Run Chart



# Apply : Green Y® Run Chart



# Leverage : Lessons Learned

- **Stick to the basics**
  - Talk to the parts
  - Play the dictionary game
- **Confirm to protect against a false Red X®**
- **Find out what matters and control it!**
- **Shut it down – don't make scrap!**