



Smithsonian
Institution

LIGHTING ART **at the** **The Smithsonian American Art Museum**

SCOTT ROSENFELD L.C., IESNA
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The Agony and Ecstasy of Solid State Lighting

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Understanding the controllable properties of light allows people to literally “see the light.”

In other words.....

You can't see what you can't control!

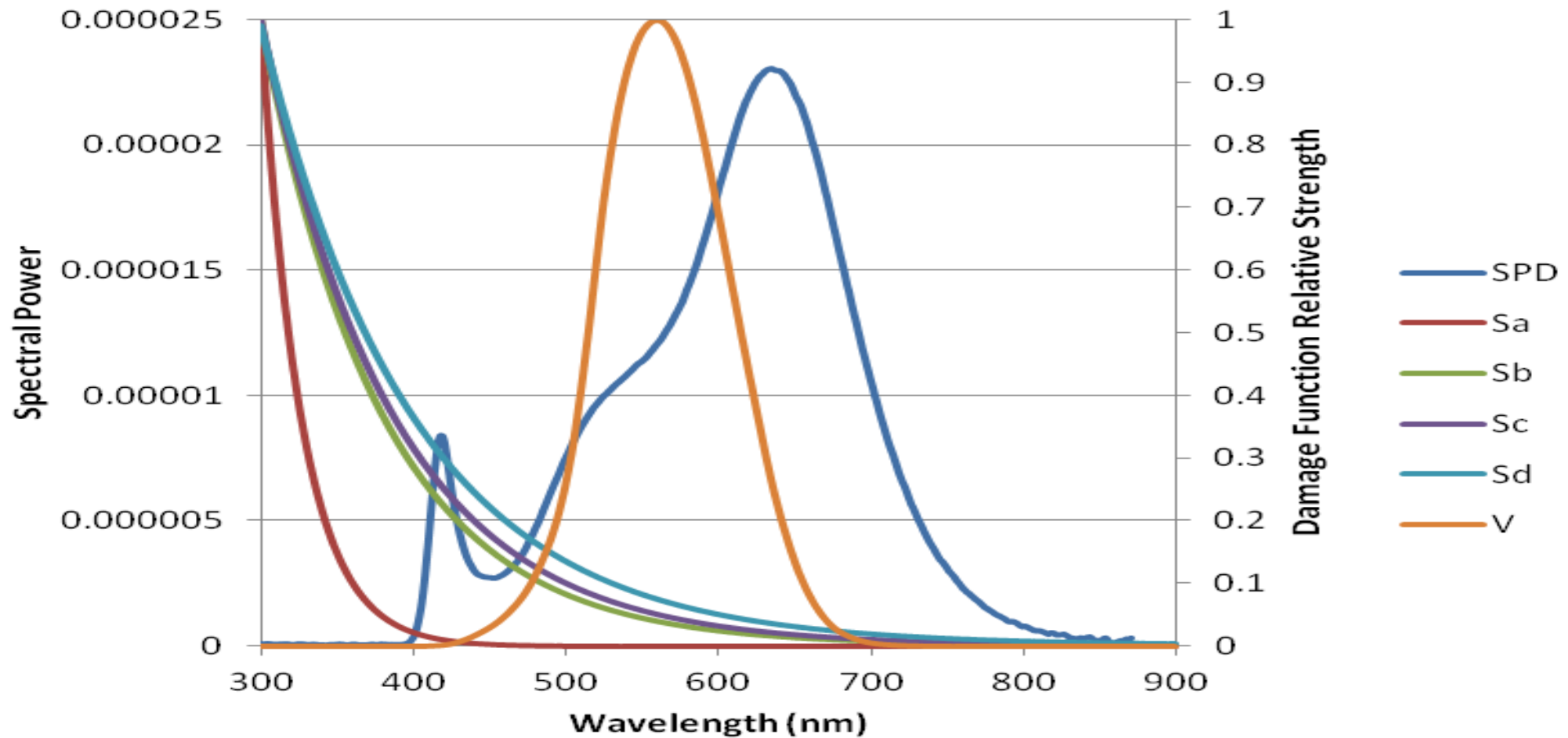
Controllable Qualities of Light

1. Intensity
2. Movement
3. Angle
4. Distribution
5. Color

Typical Museum Lighting Requirements

- Very Light Sensitive: 50-75 Lux
- Low Sensitivity: 150- 300 Lux

Berlin Damage Functions



CIE:157:2004 “Control of Damage to Museum Objects by Optical Radiation”

Resource: Joseph Padfield’s website at the National Gallery UK on SPD
<http://research.nglondon.org.uk/scientific/spd/?page=home>



EARLY MODERNISM GALLERY. 16'4" CEILING





SSL Wish List: High Lumen PAR38 Lamps



RENWICK GALLERY: 35'-0" CEILING



LUCE CENTER : 8'-0" CEILING

Controllable Qualities of Light

1. Intensity
- 2. Movement**
3. Angle
4. Distribution
5. Color

SYLVANIA

Flicker Checker
800-544-4828

FCD

Checkered/Chopped = Lights
Smooth circles = No Flicker
Flickering (Install SYLVANIA electronic ballasts)
(electronics already installed)



SSL Wish list MR16's that don't flicker



Wish List: Light weight MR-16's that equal 50 watts incandescent.





The Robert and Arlene Kogod Courtyard opened with a new glass enclose in 2007.

Wish List: Lamps that are guaranteed not to flash on failure

Controllable Qualities of Light

1. Intensity
2. Movement
- 3. Angle**
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5. Color



Catharine Macaulay Graham, January 8, 1790



TED SLAVIN AND PATRICIA BERMAN GALLERY

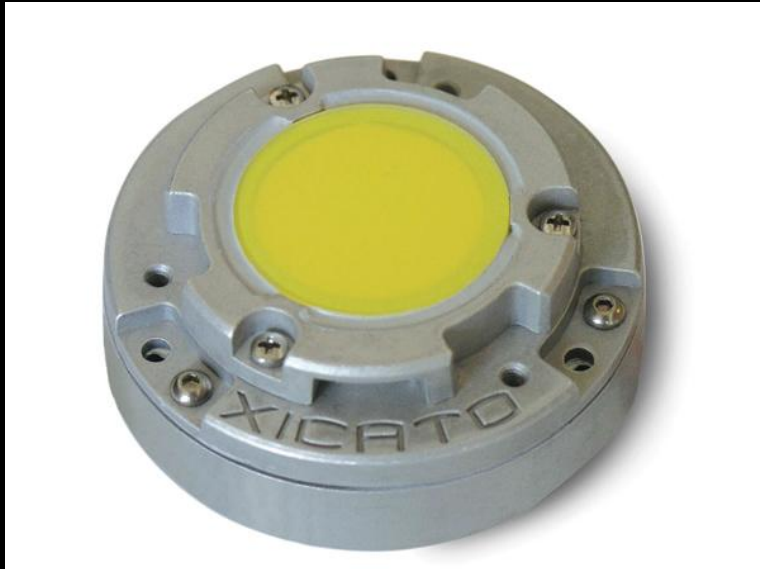


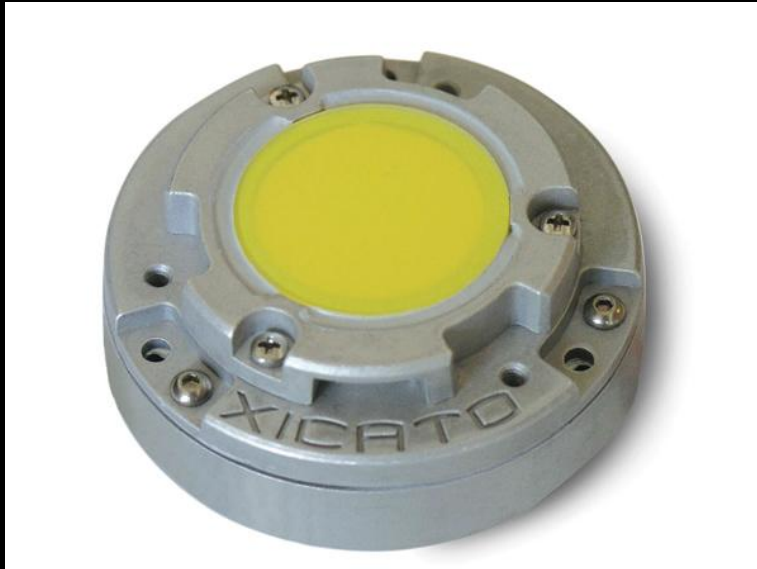
Controllable Qualities of Light

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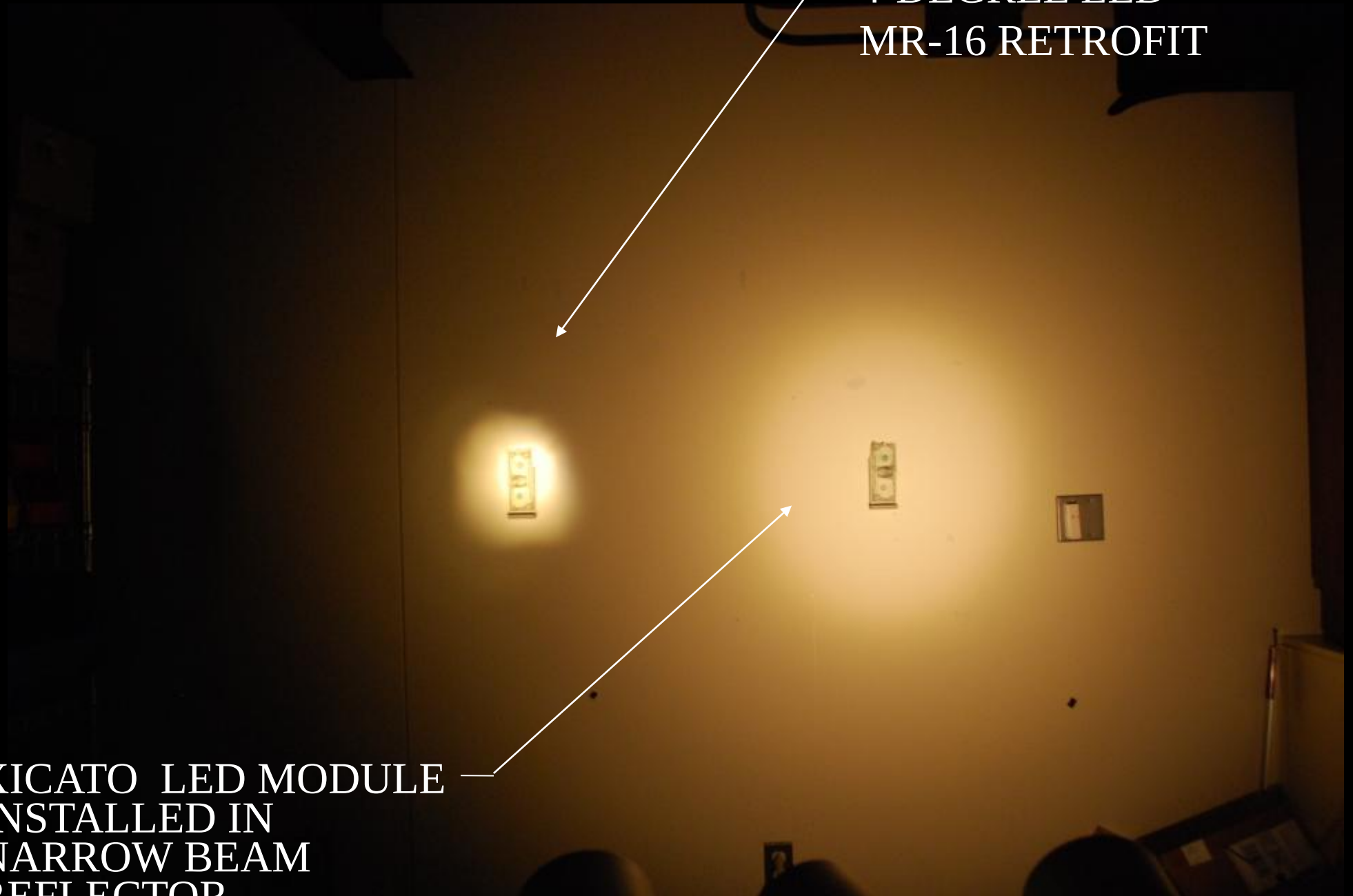




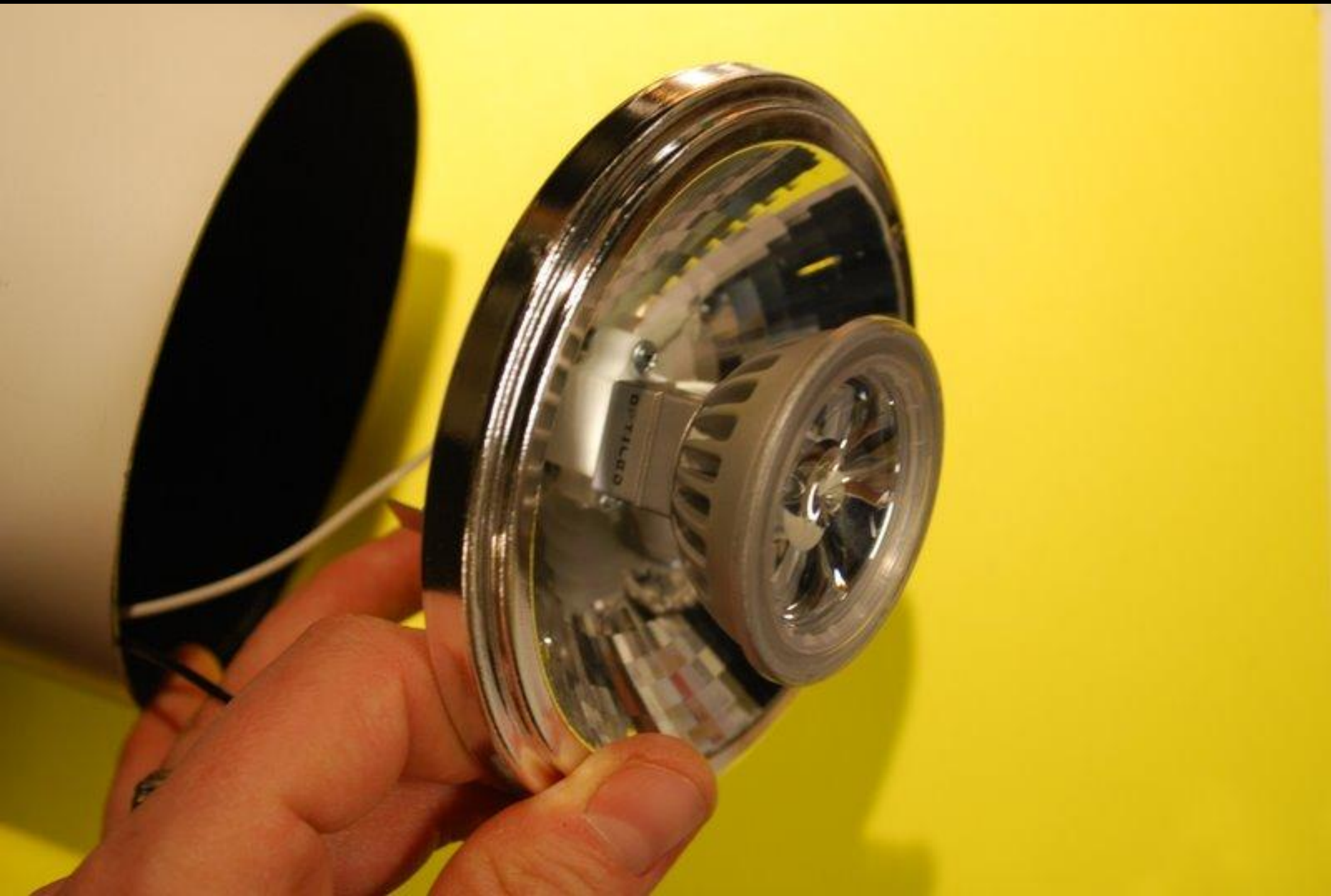
REMOTE PHOSPHOR
LED MODULE
INSTALLED IN
NARROW BEAM
REFLECTOR

4-DEGREE LED
MR-16 RETROFIT

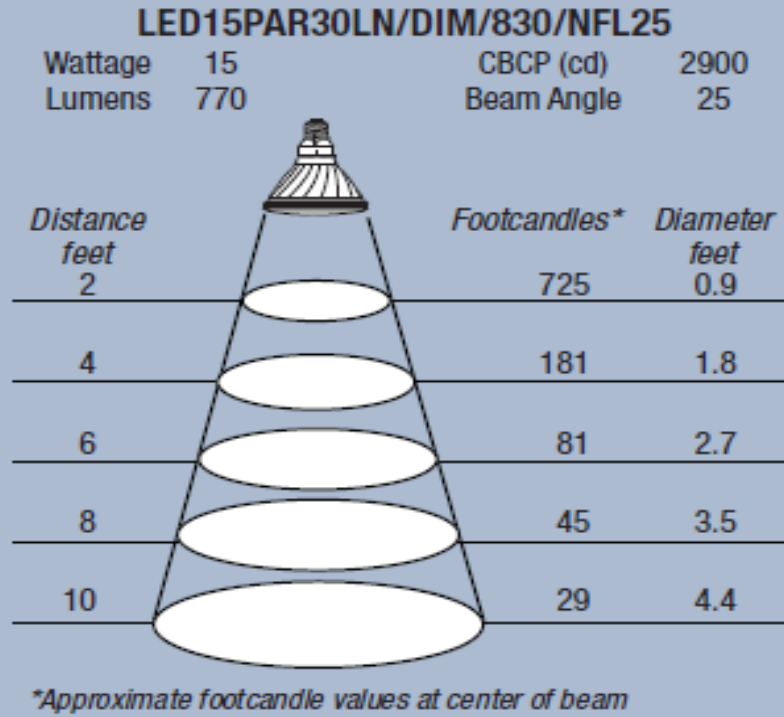
XICATO LED MODULE
INSTALLED IN
NARROW BEAM
REFLECTOR



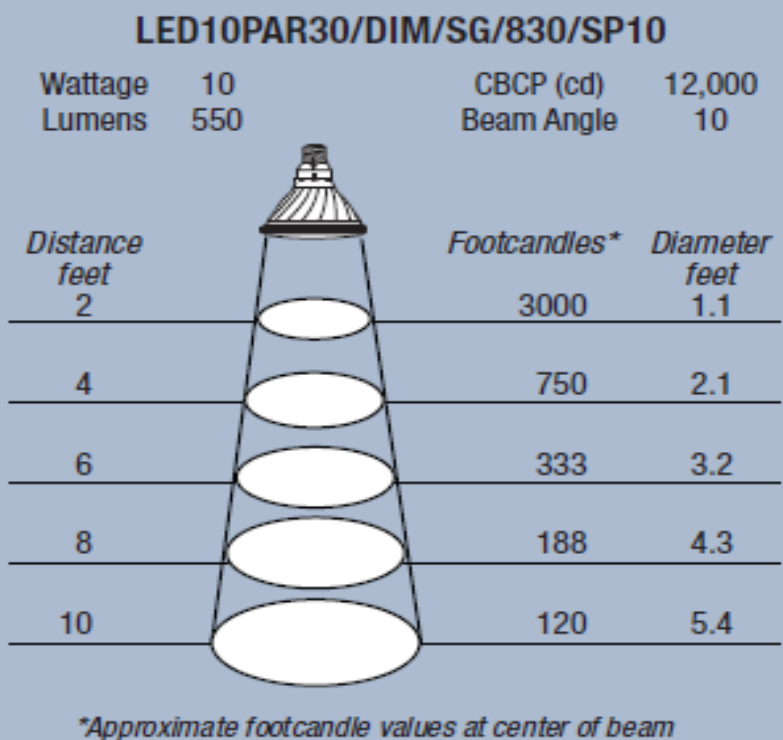
SSL Wish List: AR111 retrofit lamps!



Similar Halogen	50PAR30LN
Watts (W)	50
Avg. Rated Life (hrs.)	2,500
Lumens	660
CBCP (cd)	2100
Beam Angle	25°



Similar Halogen	50PAR30
Watts (W)	50
Avg. Rated Life (hrs.)	2,500
Lumens	660
CBCP (cd)	8,800
Beam Angle	9°



BEAM SPREADS

4°

8°

15°

25°

40°

EXAMPLE OF DISTRIBUTION OF OSRAM SYLVANIA LED PAR LAMPS

SSL Wish list: All new fixtures should include passive ventilation!



SSL Wish List: New luminaires that extra value like variable beam-spreads





Flight of Europa, 1925 by Paul Manship



Flight of Europa, 1925 by Paul Manship



Flight of Europa, 1925 by Paul Manship

Smithsonian American
Art Museum

1934

A NEW DEAL
FOR ARTISTS







PAR-30 OBJECT LIGHT

3 TYPES OF LENS

- 70 Degree
- 55 Degree
- 55 X 75 Degree

CUT-OFF AND CROSS BAFFLE







Small informational label next to the painting.



Small informational label next to the painting.



Small informational label next to the painting.



Small informational label next to the painting.

















112



112



112





≠



≠



CLEAR

FROSTED

Controllable Qualities of Light

1. Intensity
2. Movement
3. Angle
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THE COLOR OF LIGHT

1) Chromaticity.

What is the apparent color light?

2) Color Rendering.

What colors are the light capable of reflecting?

3) Damage Factor.

How does spectrum impact damage potential?



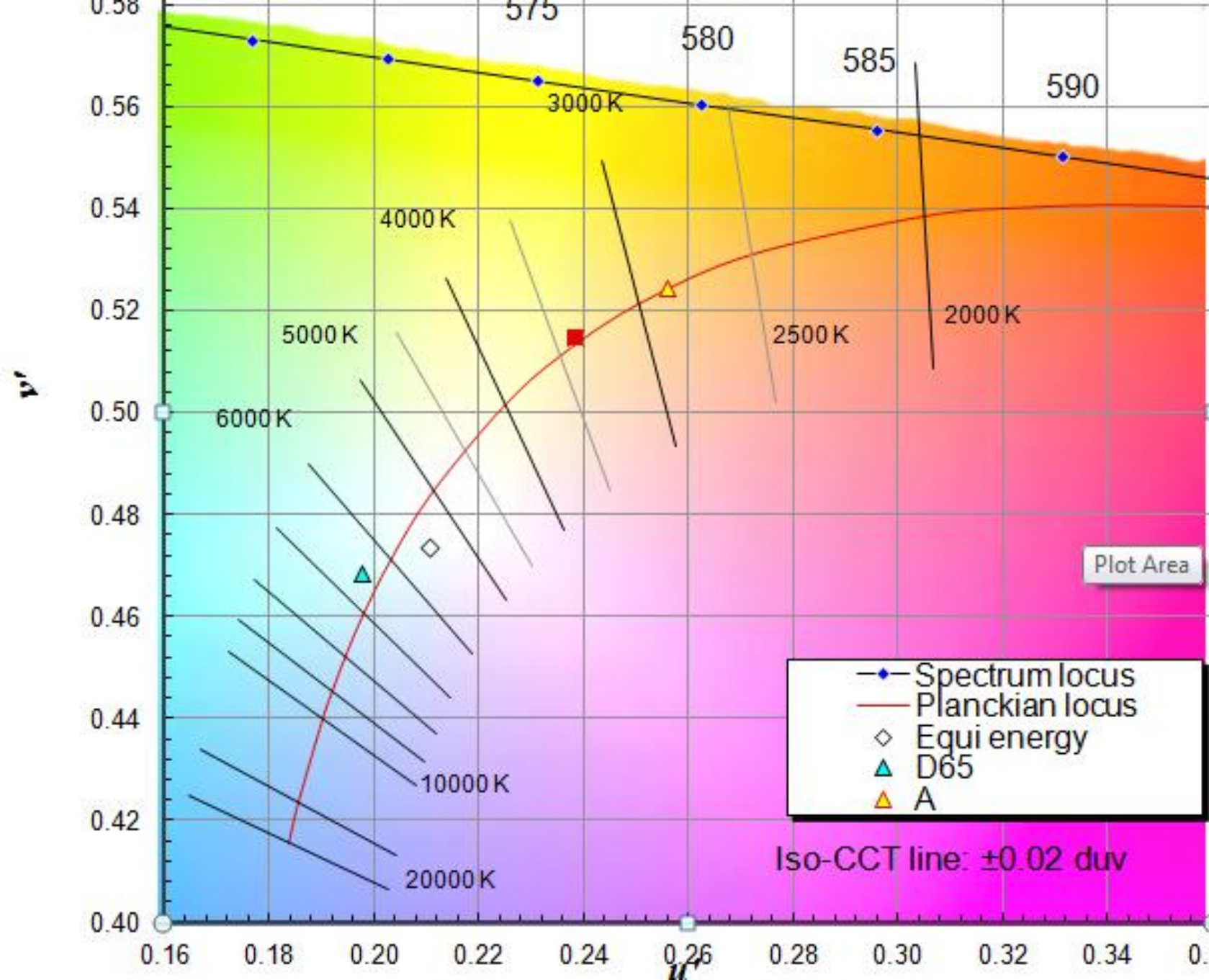
COLOR RENDERING



CHROMATICITY



COLOR TEMPERATURE



ANSI C78.377-2008 Tolerances
 $\pm .0006 Du'v'$
 $\pm 145K$ at 2700 Kelvin



2700K LED (86 CRI)



Halogen (100 CRI)



3000K LED (95 CRI)







3000K



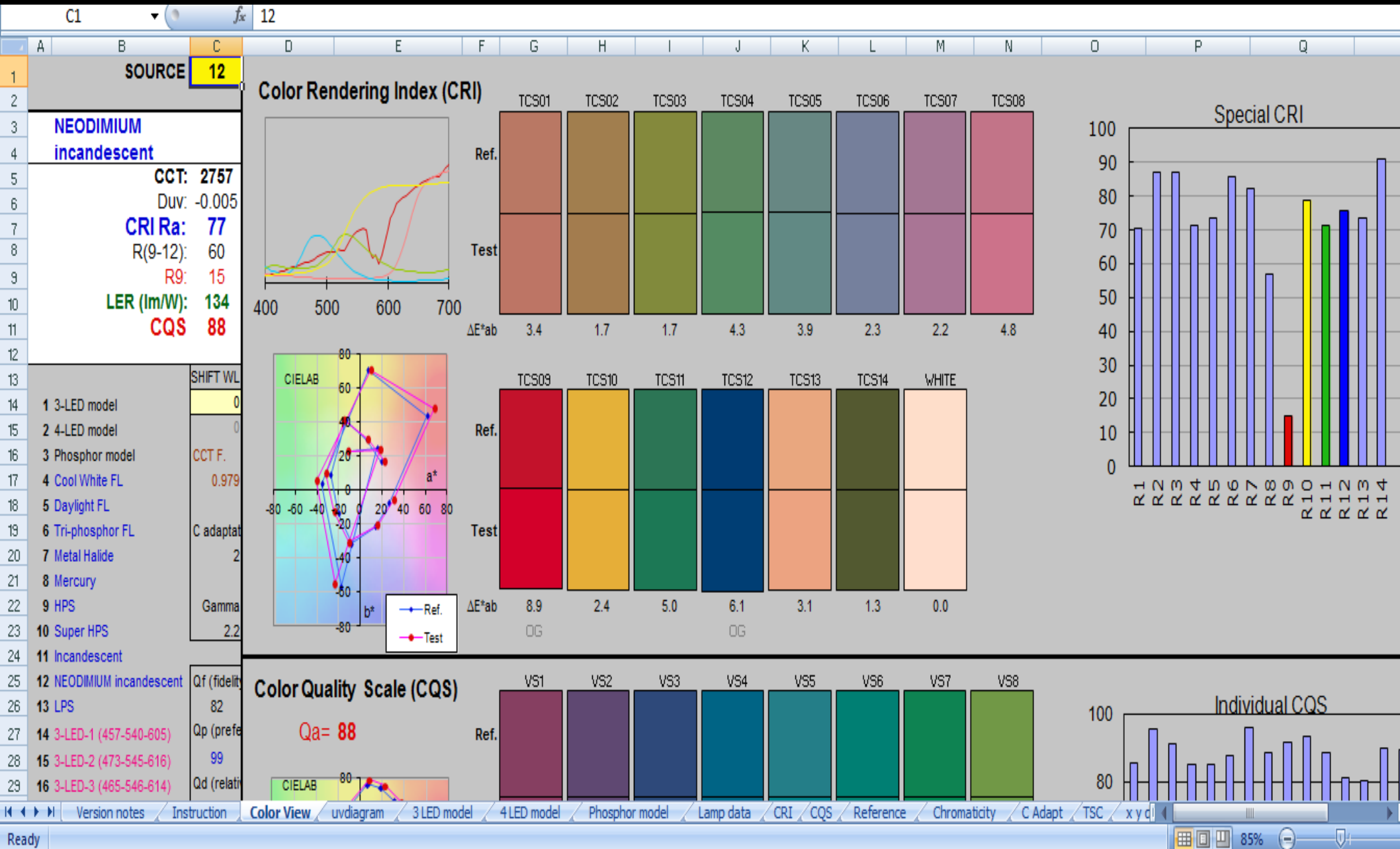




Challenges of relying on CRI

- Only 8 colors pastel colors represented
- No saturated colors are included (RGB and CMY)
- The CRI score does not correlate well with visual evaluation in many cases” (Ohno, Davis 2010).
- CRI only measures fidelity and does not access; “increased color saturation, color discrimination ability, and visual clarity (K. Hashimoto and Y. Nayatani 1994)
- Increased color saturation may be use to counter Hunt effect at low illuminances.

Color Rendering



ΔC^*_{ab}

ACCESSING SATURATION WITH CQS

VS1	8.33
VS2	4.32
VS3	2.03
VS4	2.18
VS5	1.78
VS6	3.82
VS7	7.09
VS8	5.49
VS9	3.47
VS10	1.48
VS11	0.61
VS12	-0.08
VS13	2.34
VS14	5.71
VS15	6.87





Olek, 2012. *Knitting is for Pus*****,
Yarn and mixed media, courtesy of the artist and the Jonathan LeVineGallery, New York.
Photo by Scott Rosenfeld

Wish List Item #1:

Lamps that maintained their color over time!

The following data was taken to show the color changes perceived by staff at various museums. The measurements were taken using a calibrated Ocean Optics Jaz Spectrometer. The purpose of taking measurements was to quantify the extent of problems found in 5 different manufactures lamp types. The lamps were tested in 4 different museum buildings across the Smithsonian.

Note: the data in the following slides are preliminary and accuracy of the spectrometer has not been fully established. However, the spectroscopy results are consistent with visible color shifts.

Museum Building #1



.0037 $\Delta u'v$ @ 6600 hrs

Manufacture #1, lamp type A



.005 $\Delta u'v$ @ 6600 hrs

Manufacture #1, lamp type B



.016 $\Delta u'v$ @ 6600 hrs

Manufacture #5 (MR16)

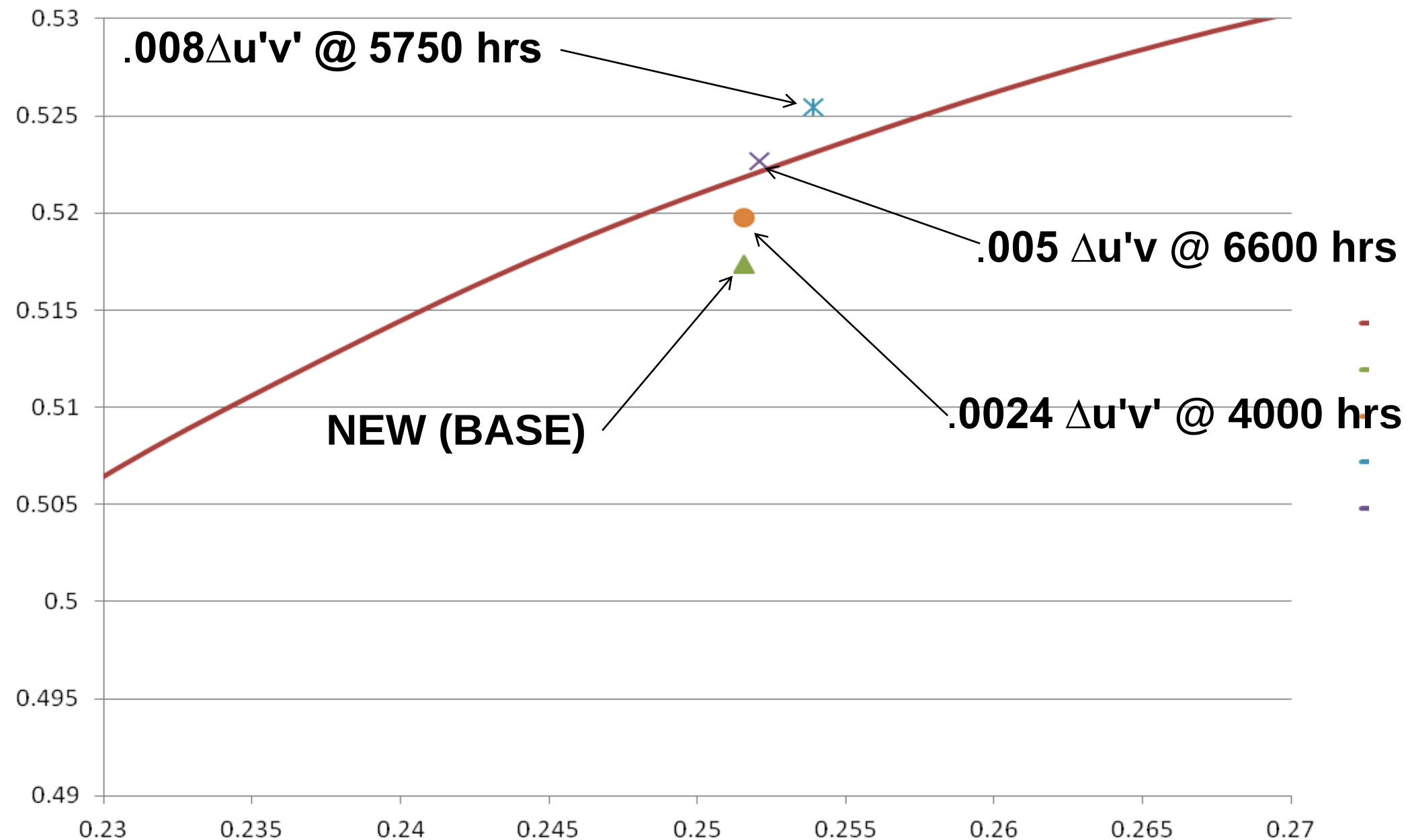


Color Maintenance Nightmare: PAR30/SP, PAR30/FL, MR16 (RIGHT TO LEFT)

Photo from file, not from gallery with color changes.

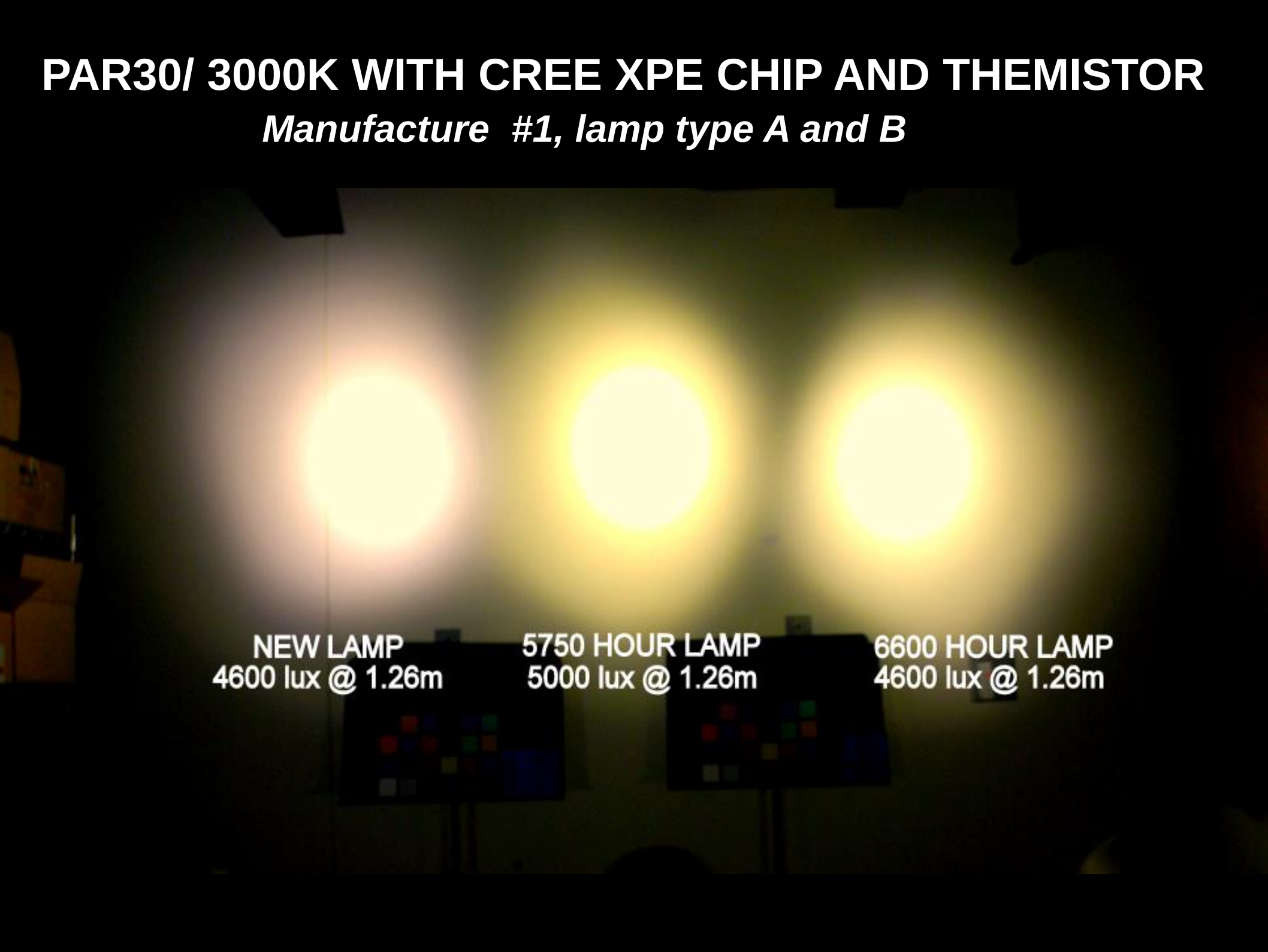
PAR30/ 3000K WITH CREE XPE CHIP AND THERMISTOR

Manufacture #1, lamp types A and B



PAR30/ 3000K WITH CREE XPE CHIP AND THERMISTOR

Manufacture #1, lamp type A and B



NEW LAMP
4600 lux @ 1.26m

5750 HOUR LAMP
5000 lux @ 1.26m

6600 HOUR LAMP
4600 lux @ 1.26m

Museum Building #2





Chromaticity of lamps looked great out of the box (matched between lamps).

.008 $\Delta u'v'$ @ 4000 hrs/10 watts
(2879K/ .002 Duv) Manufacture #2, lamp at 10 watts

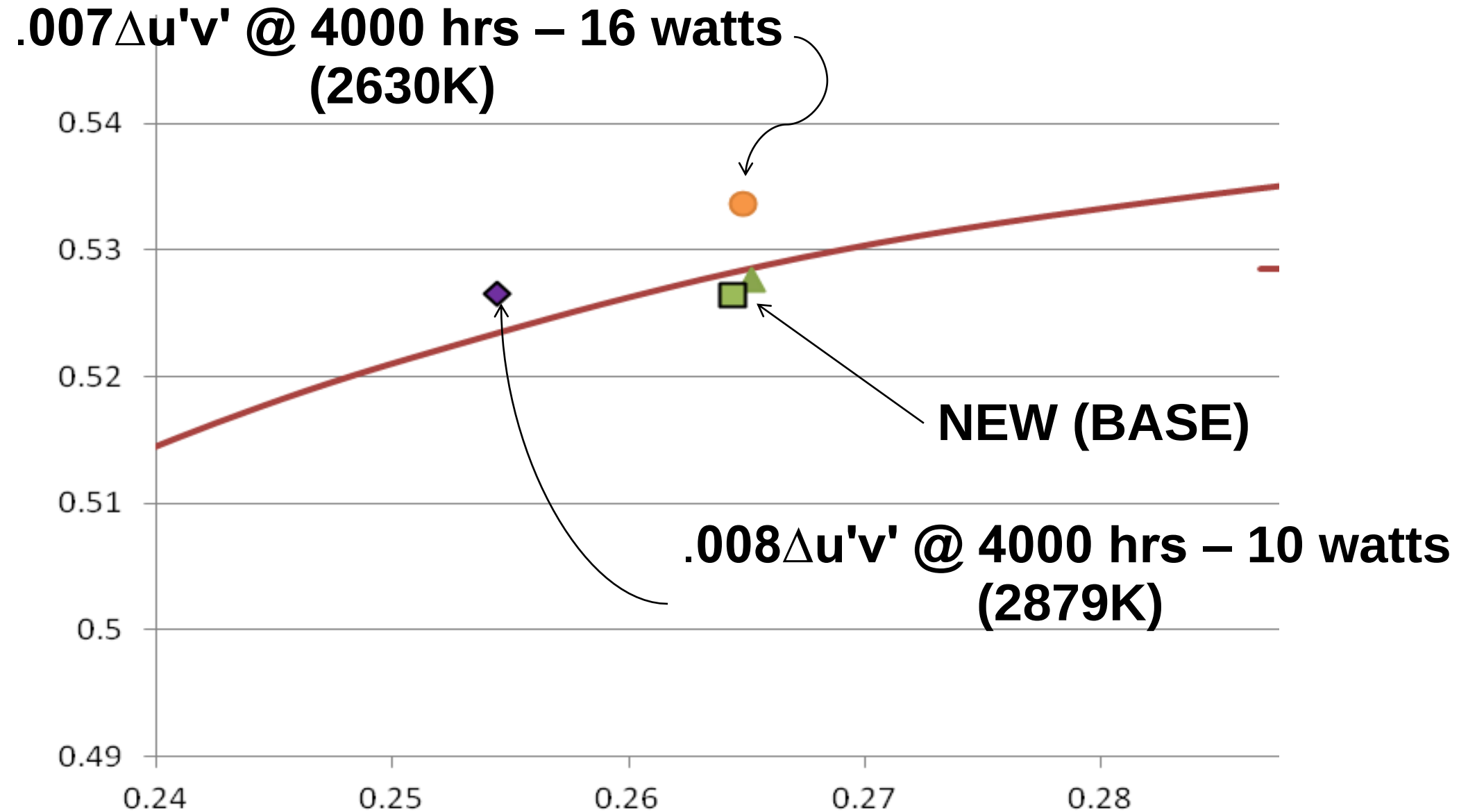
.007 $\Delta u'v'$ @ 4000 hrs/ 16 watts
(2630K/ .003 Duv)

Manufacture #2, lamp at 16 watts



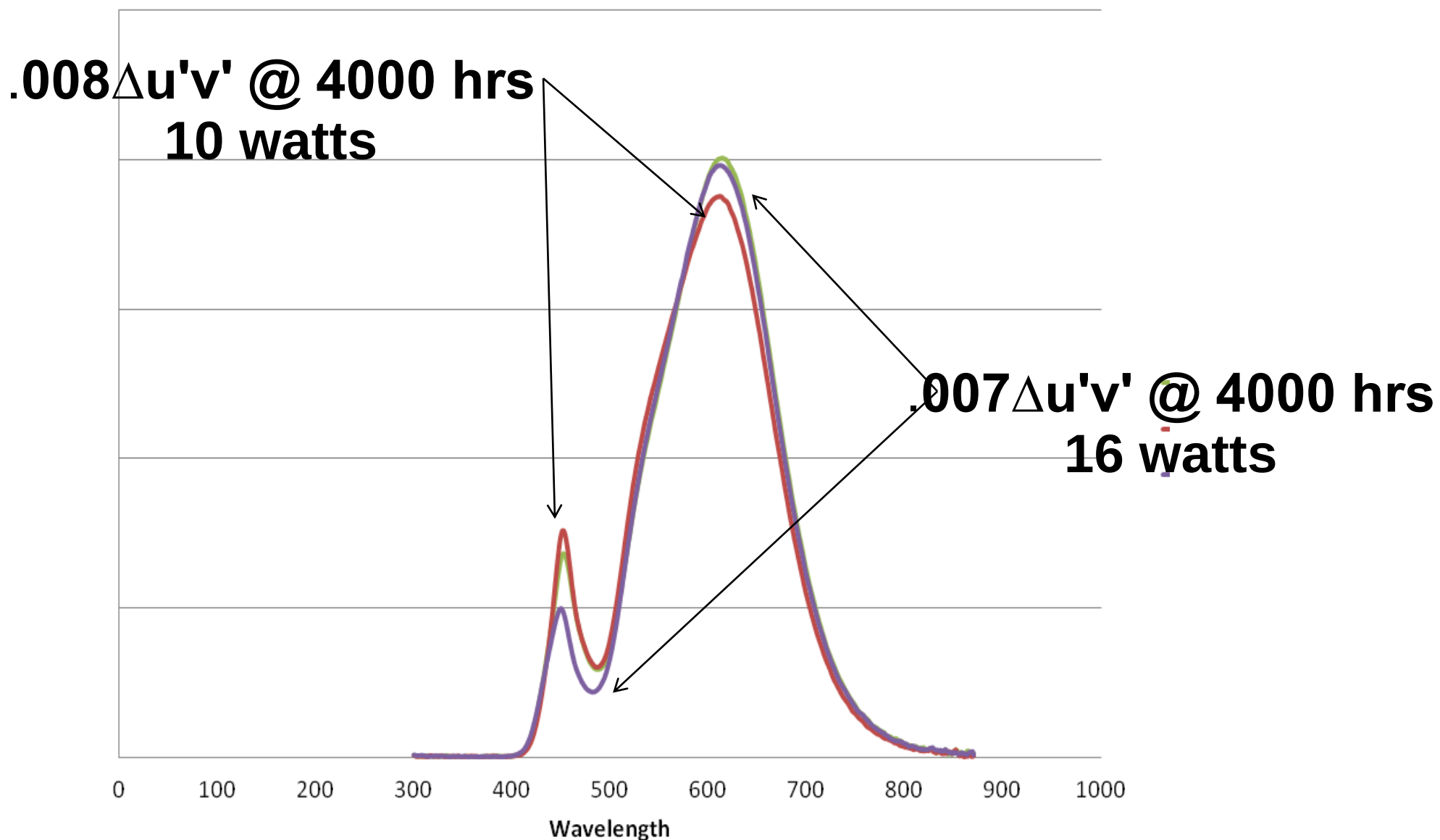
PAR38 LAMP WITH CREE XPG CHIP

Manufacture #2. Comparing lamps driven 10 and 16 watts



PAR38 LAMP WITH CREE XPG CHIP

Manufacture #2. Comparing lamps driven 10 and 16 watts



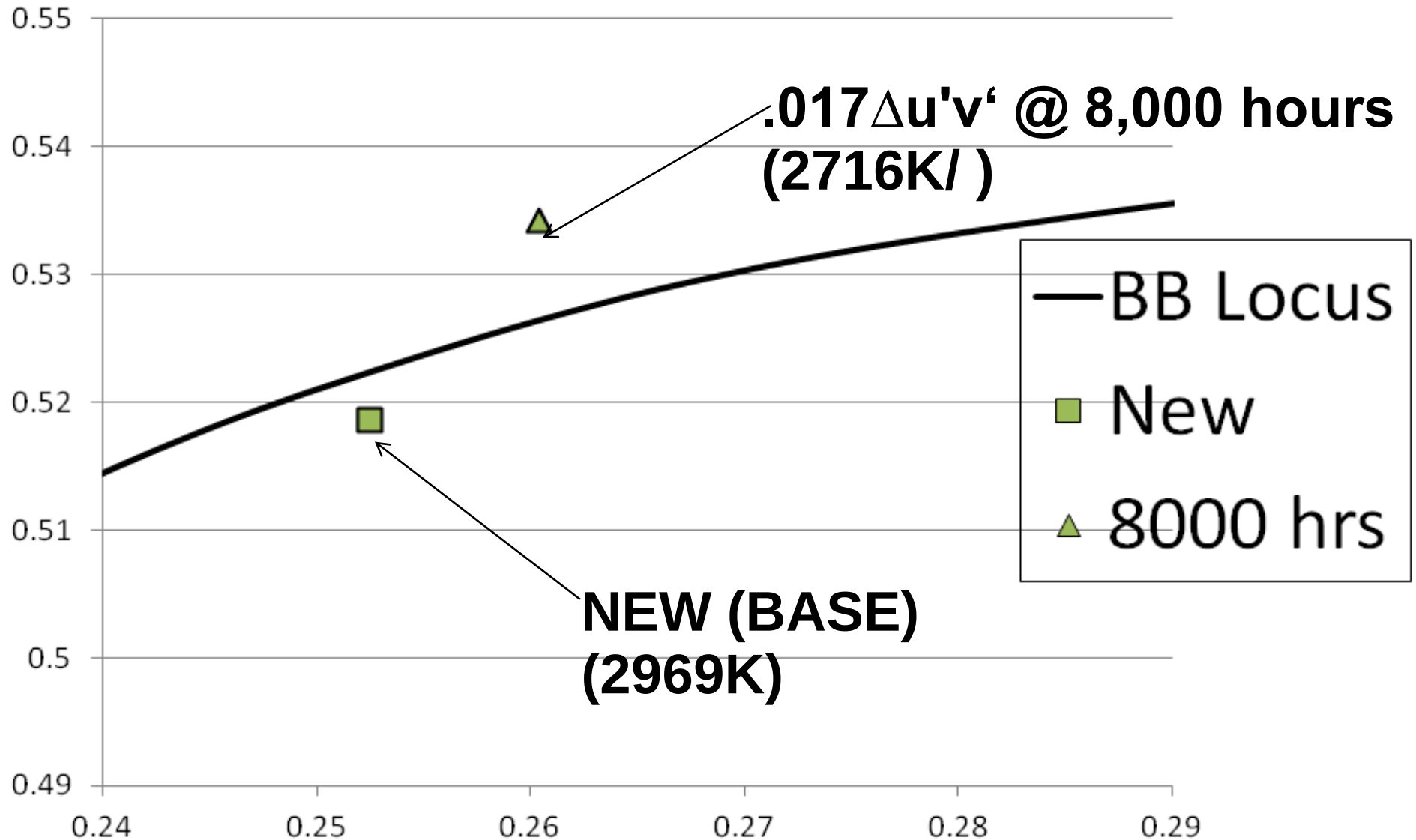
HIRSHHORN MUSEUM AND SCULPTURE GARDEN



photo by: sonofgroucho.com

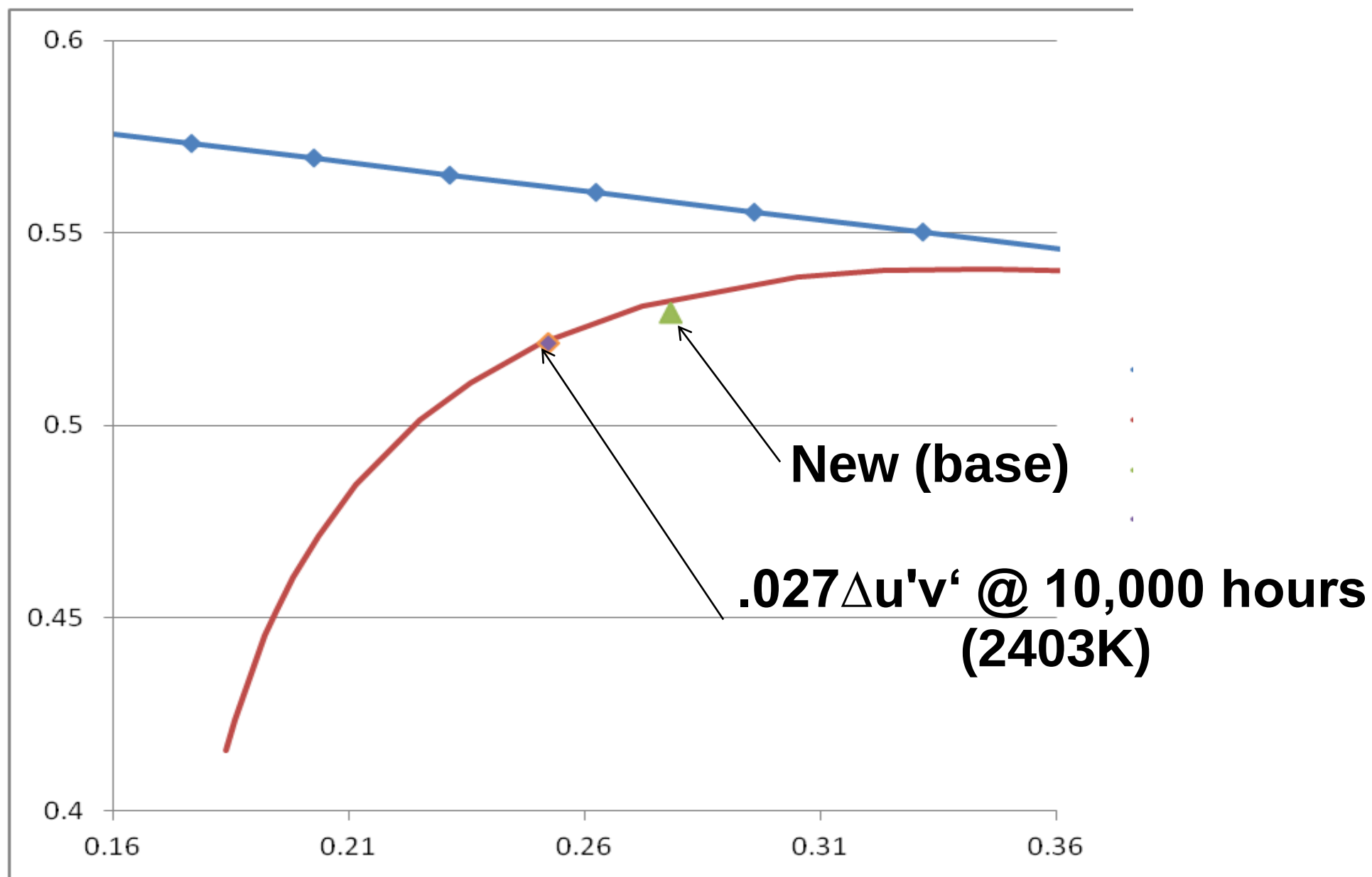
PAR38/3000K /15 degree

Manufacture #3, Museum Building #3



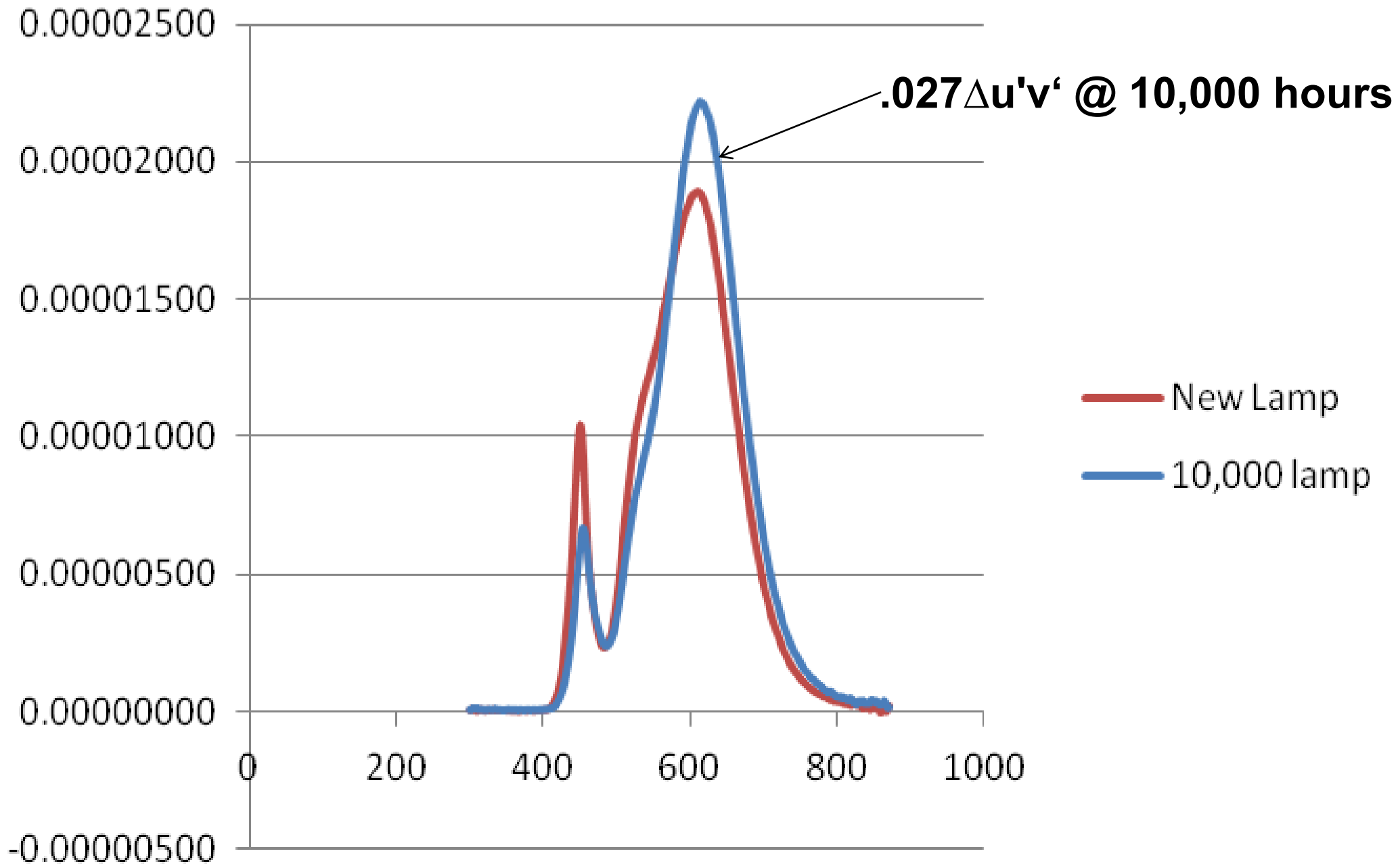
PAR38 LAMP/ 35 DEGREE/ 20.3 WATTS

Manufacture #4 , Museum Building #4



PAR38 LAMP/ 35 DEGREE/ 20.3 WATTS

Manufacture #4 , Museum Building #4





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