



Display Week 2016

Moscone Convention Center
at San Francisco

May 22, 2016 - May 27, 2016

17.1: Daylight as a Model for Electronic Illumination Systems

Steve Paolini

President, Telelum LLC, USA

May 24, 2016

Outline

- Introduction
- Daylight
- Electronic Illumination
- Sky shots
- Summary



- Founded 2007 – Silicon Valley, CA
- Purpose – create any light for human consumption
 - Products/services to create/playback light
- Privately owned
- Current products:
 - Light Replicator (16 color light player)
 - Penta (5 color light player)
 - Light Recorder (spectrometer)
 - LumenScripts (content)
 - Recordings, created, composed digital data
- Customers are researchers



Brooklyn, N. Y. Dec 1910
Mr. J. J. ...



The BROOKLYN CALCIUM LIGHT CO. Dr.
PURE OXYGEN GAS AND CALCIUM LIGHTS
FOR ALL OCCASIONS
TELEPHONE, 3165 MAIN LABORATORY: 112 FRONT STREET.



Two ways of experiencing light

Illumination

- Look at people, objects
- Less saturated colors
- Changes slowly
- Low spatial density
- High spectral density
- CRI – important, RGBWA
- Collimated, Diffuse

- Electric lights, Daylight
 - RGB is NOT sufficient

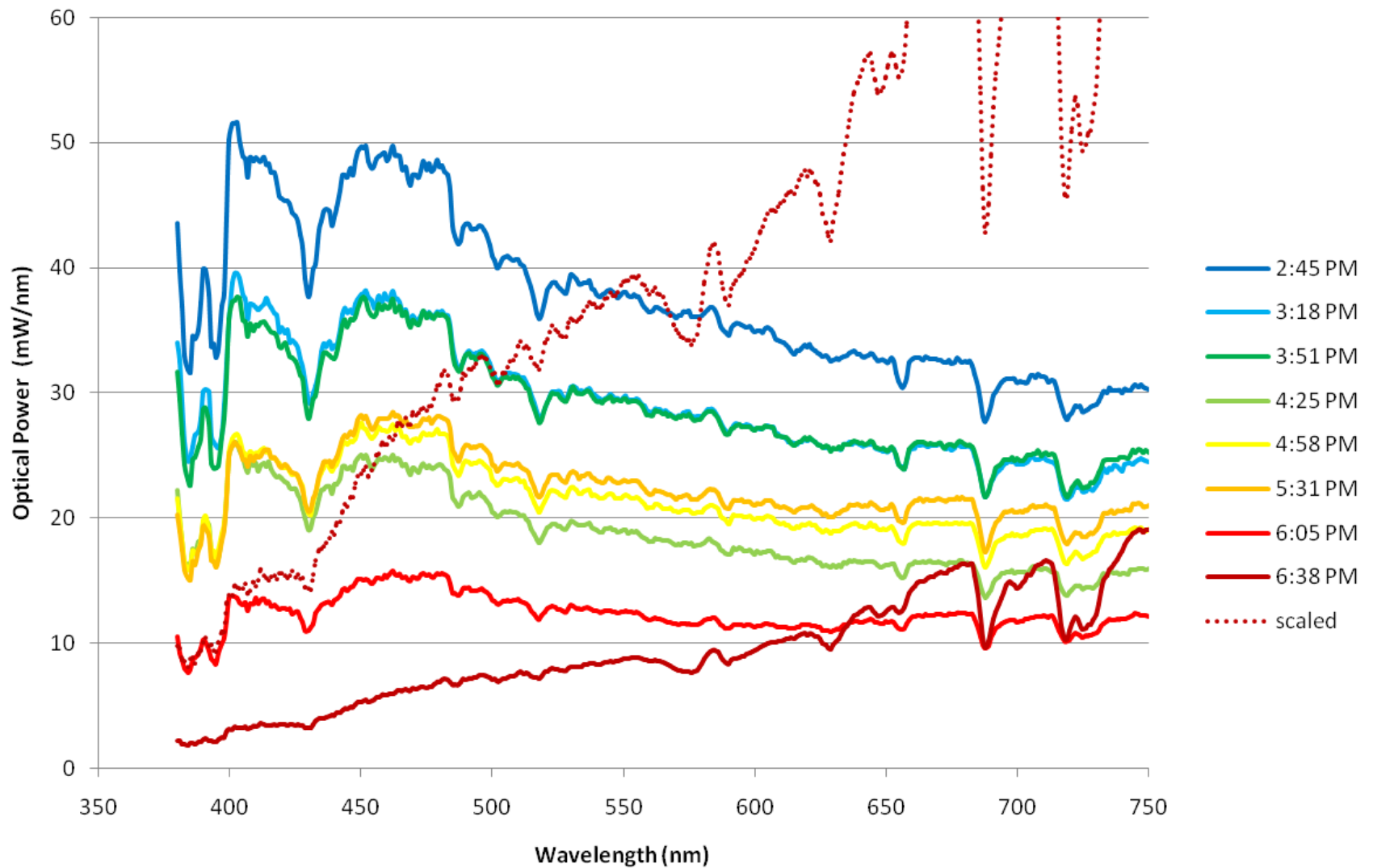
Infotainment

- Look at the light
- Saturated colors
- Changes fast
- High spatial density
- Low spectral density
- CRI – don't care, RGB
- Collimated, Diffuse

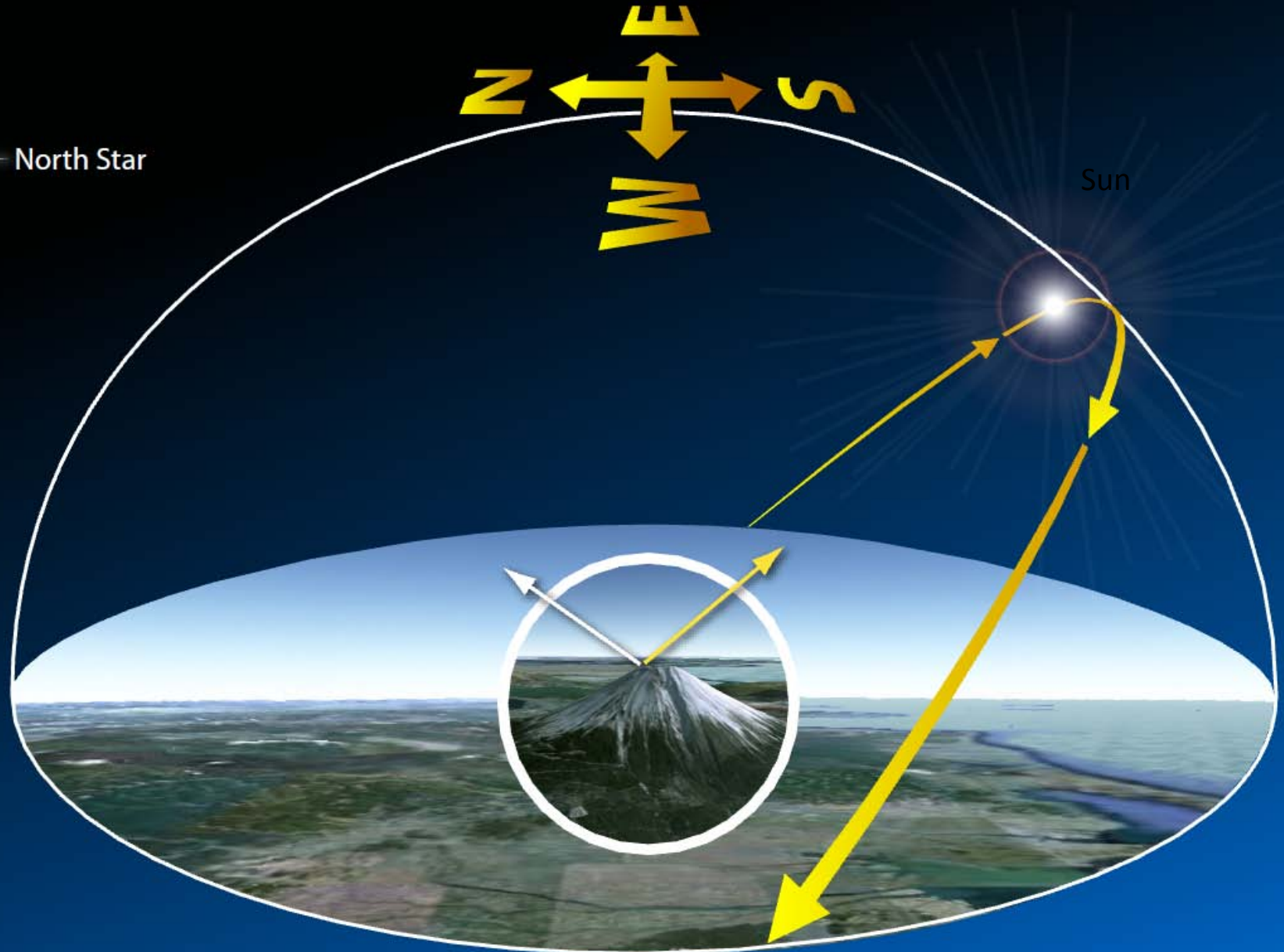
- Computer Display, TV, Rock Concert
 - RGB is sufficient

The sky is a special case. It fits into both categories.

SPD Snapshots of Daylight Over 4-Hour Period



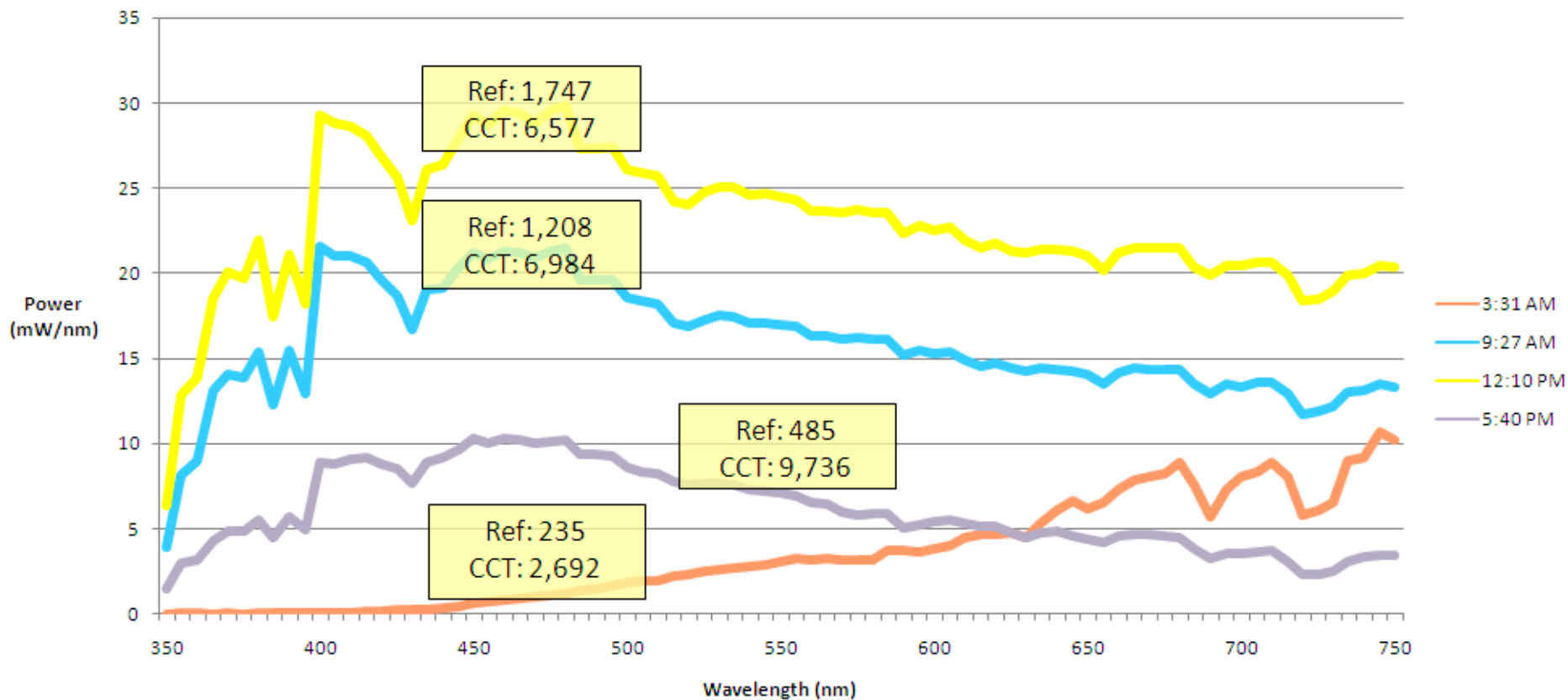




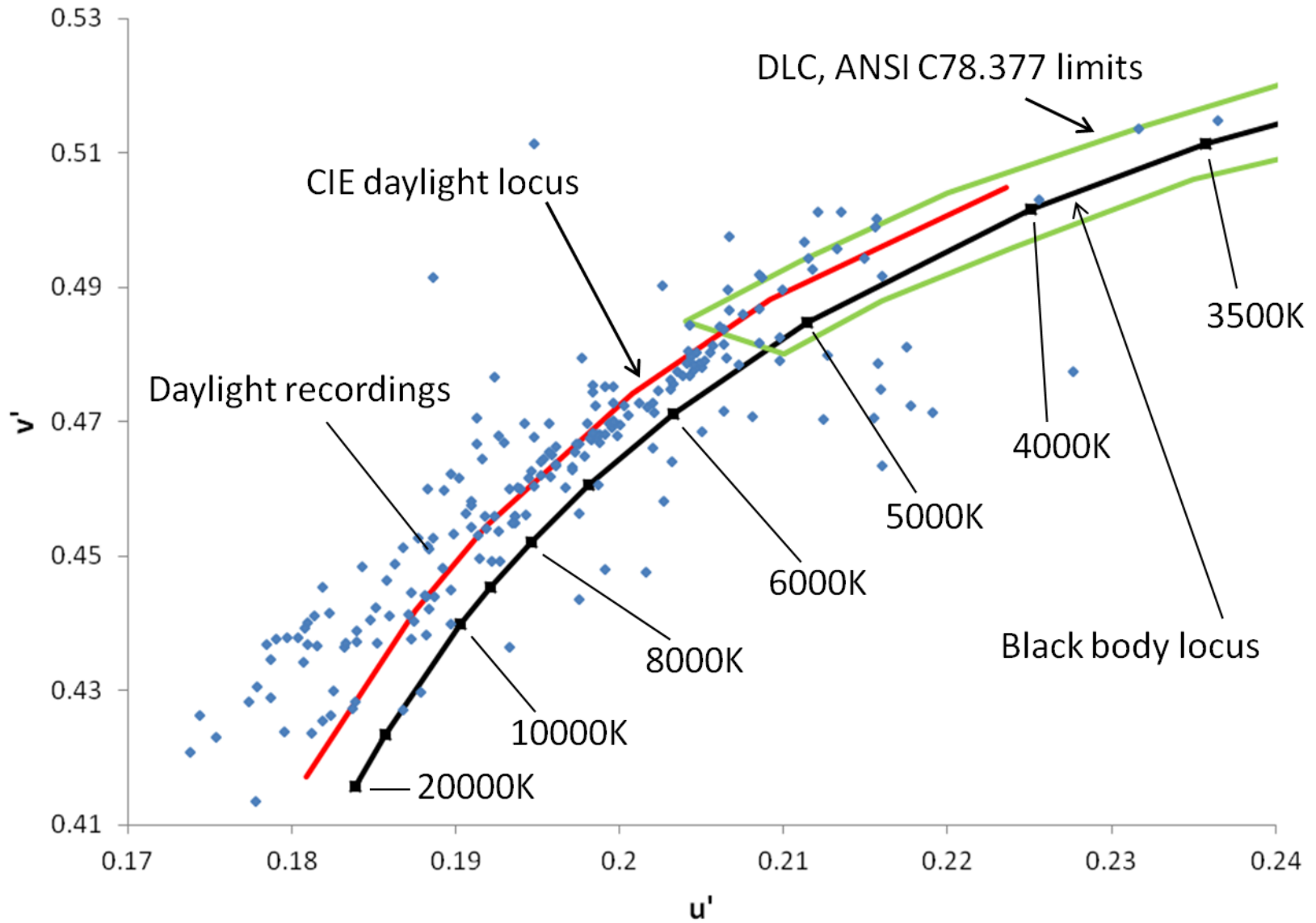


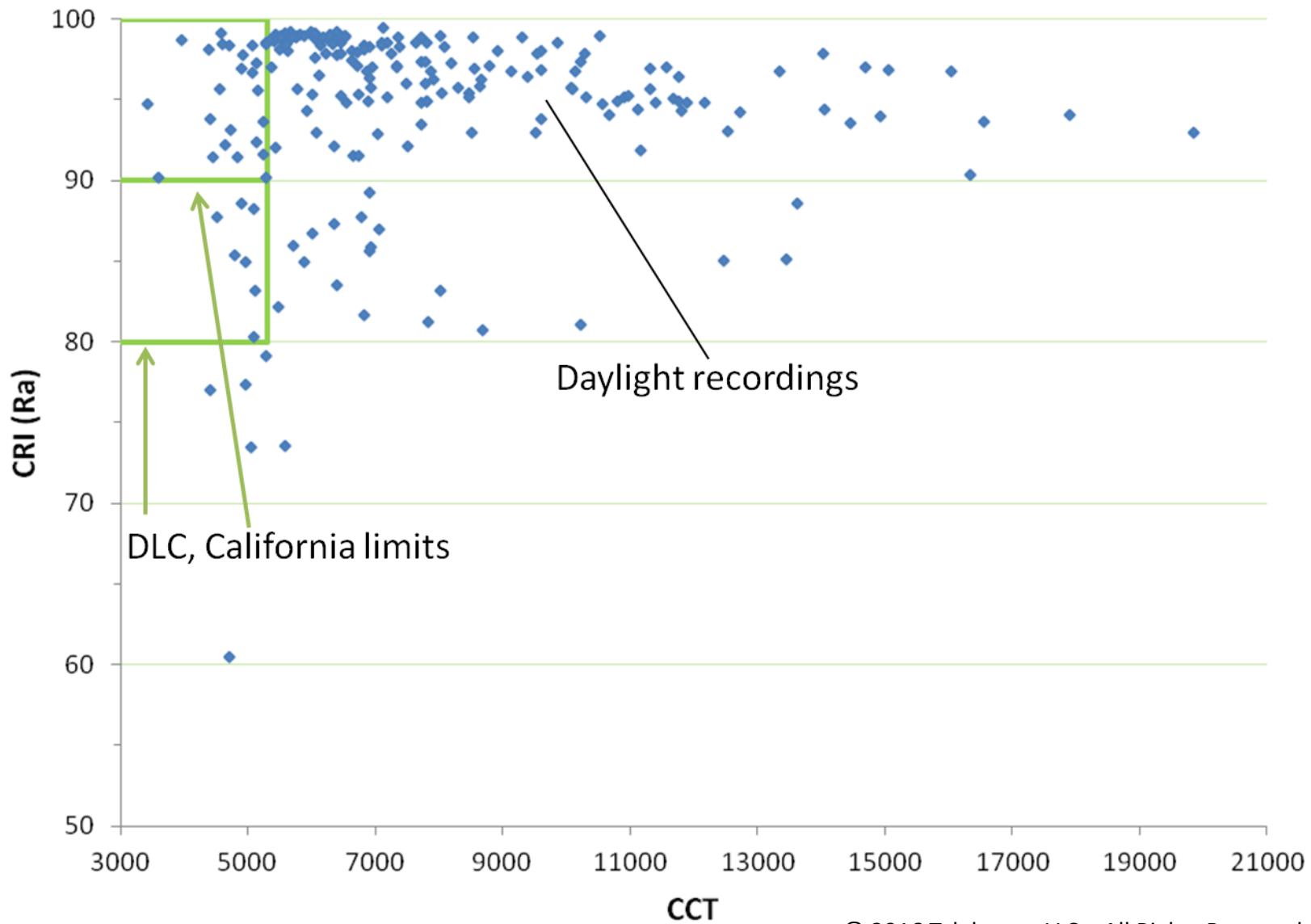
Sunlight Snapshots

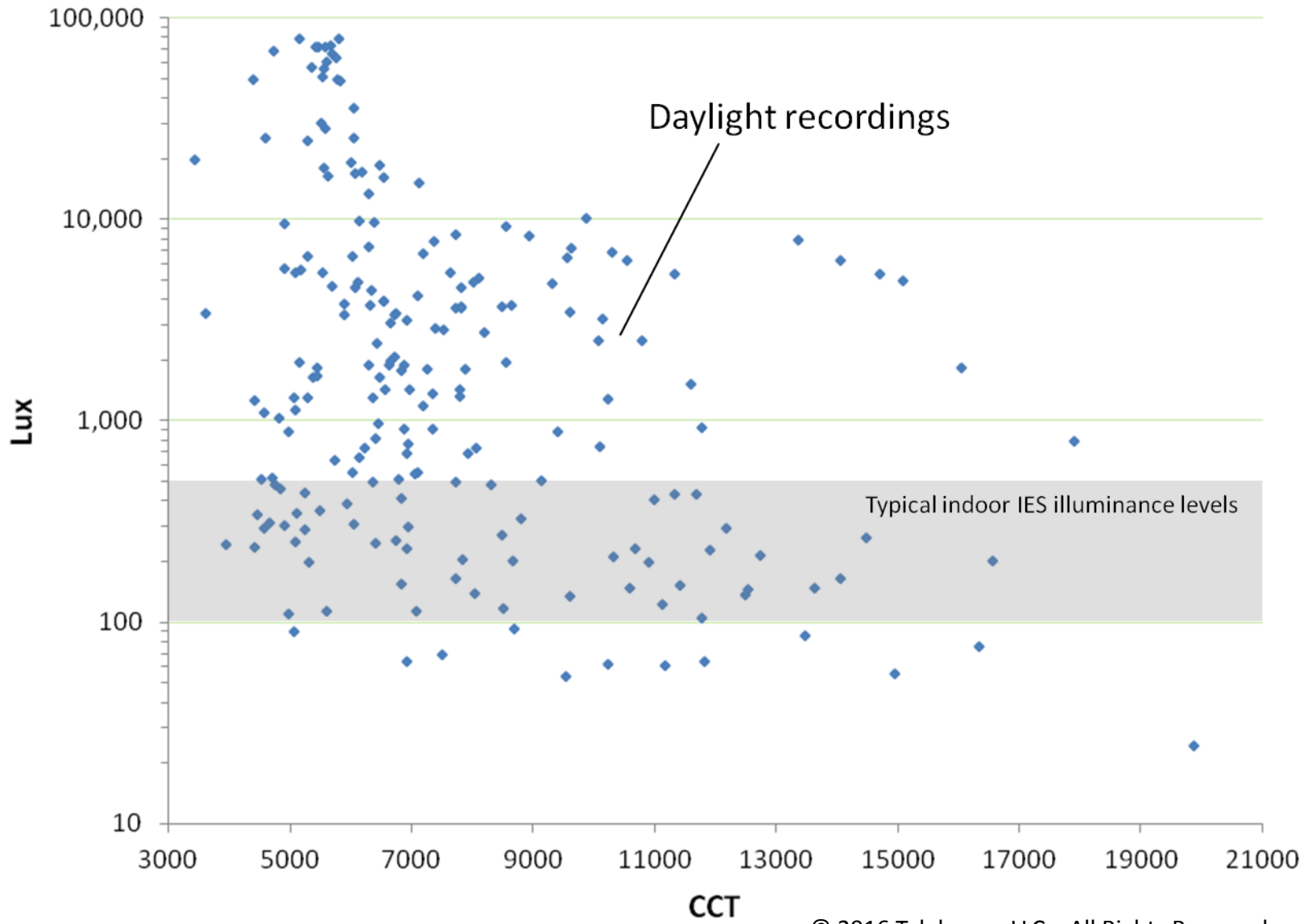
Mt. Fuji, Full Day, 7/14/2011



Daylight recordings and Convention



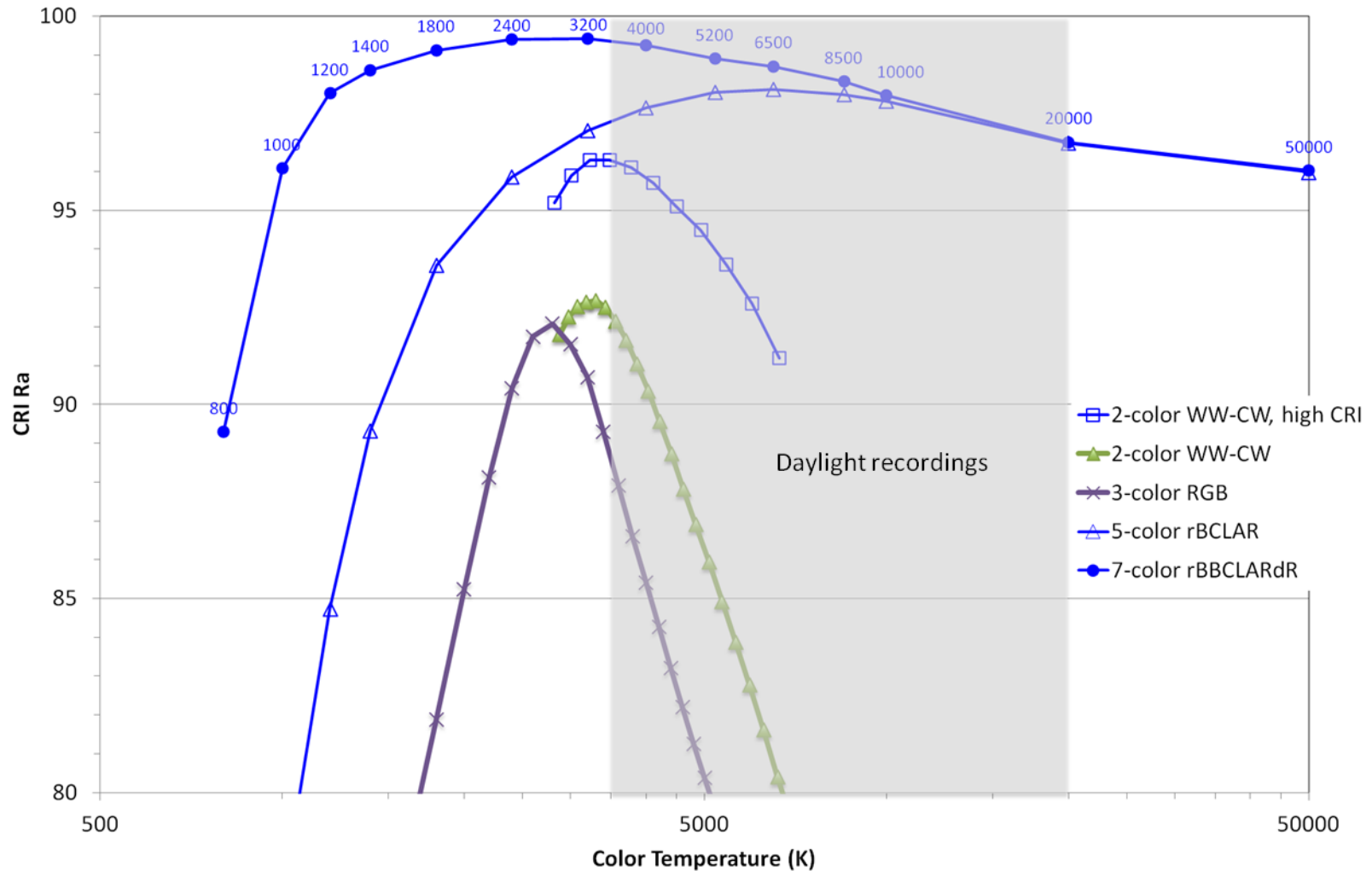




Why go beyond RGB

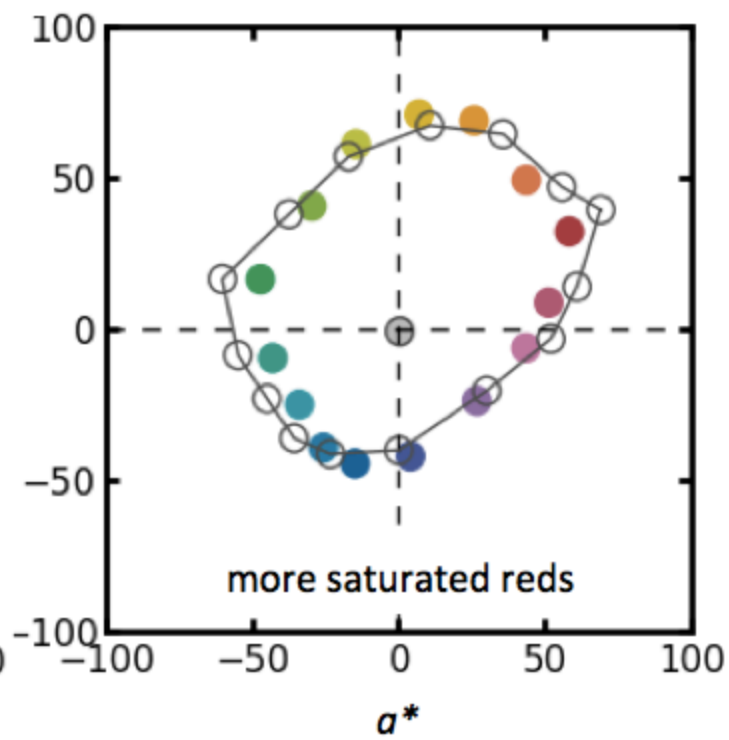
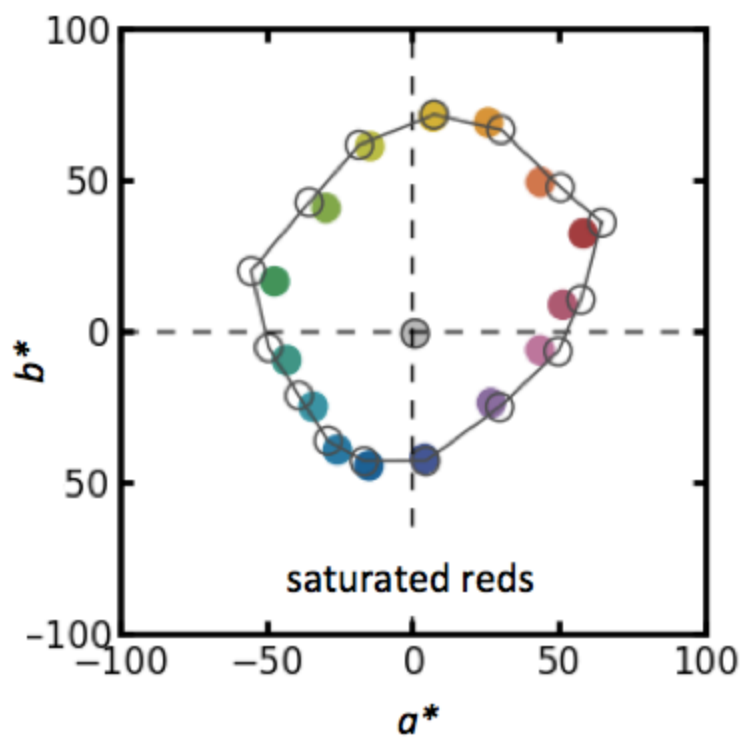
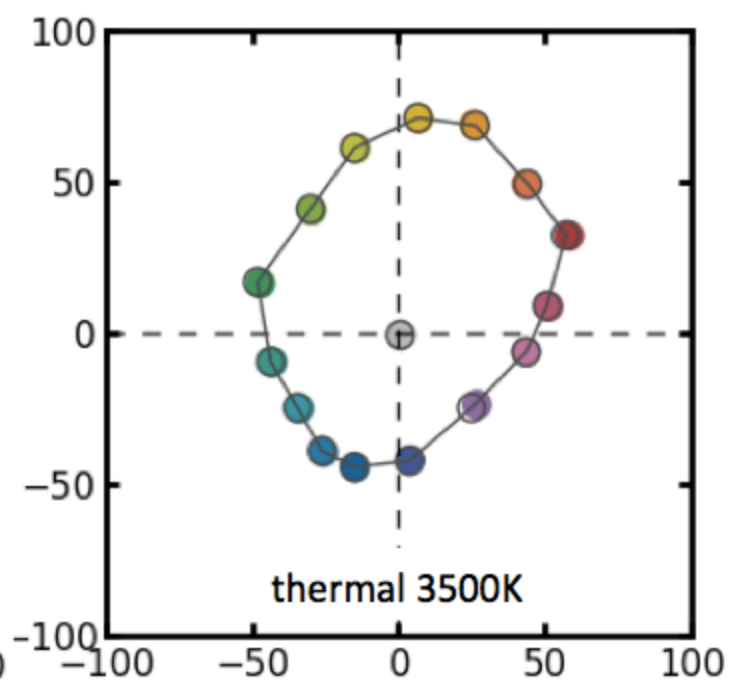
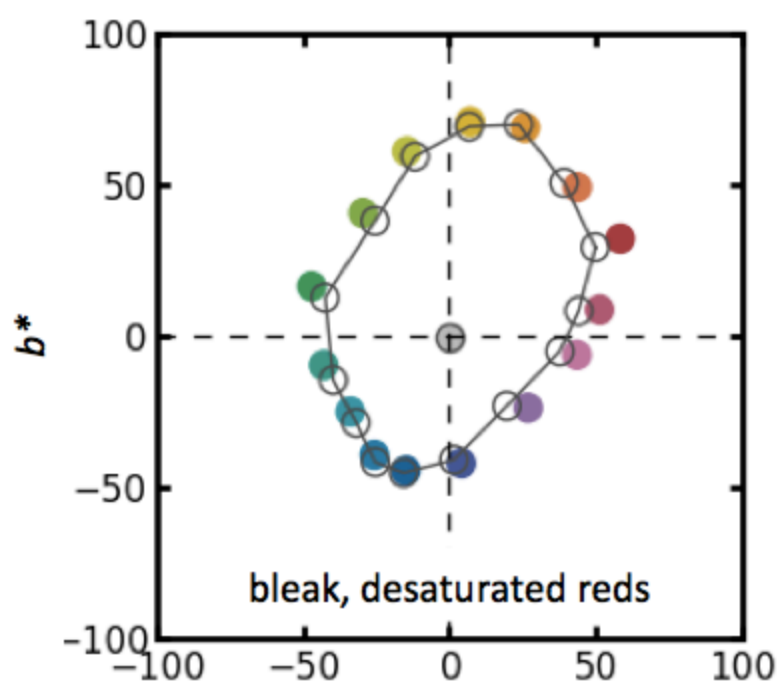
- Broader CCT range at higher color quality
- Multiple solutions for a given chromaticity
- Larger gamut area

Value of more color channels



Multiple Solutions Example

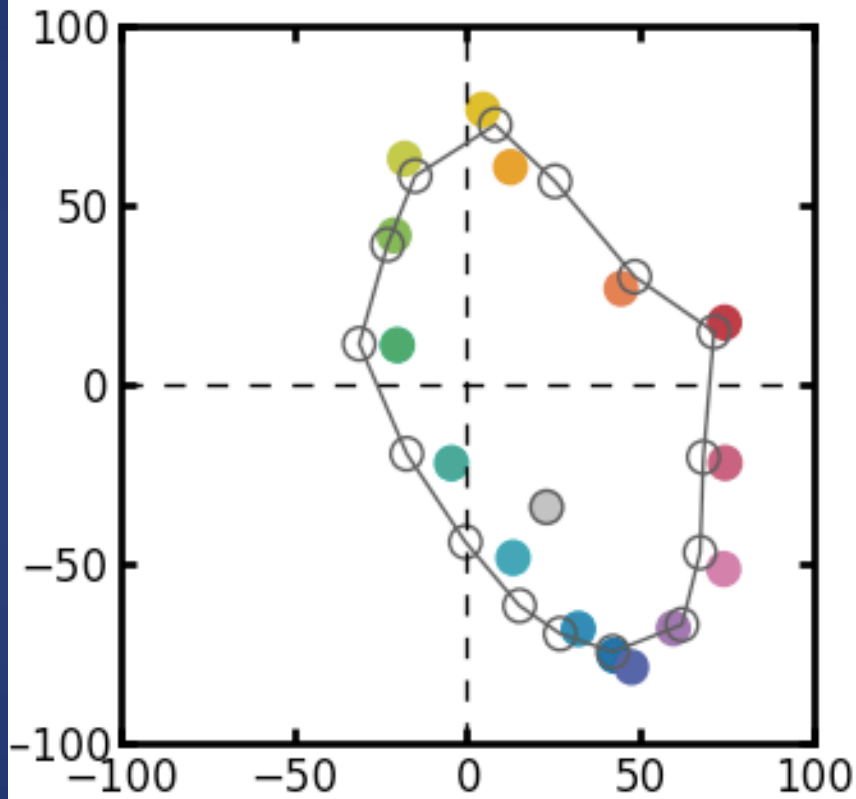
- 5-channel system producing 3500K with a progression from desaturated reds to a thermal radiator to saturated reds
- In general more saturated reds and greens are more appealing.
- More saturated blues and yellows are less appealing.



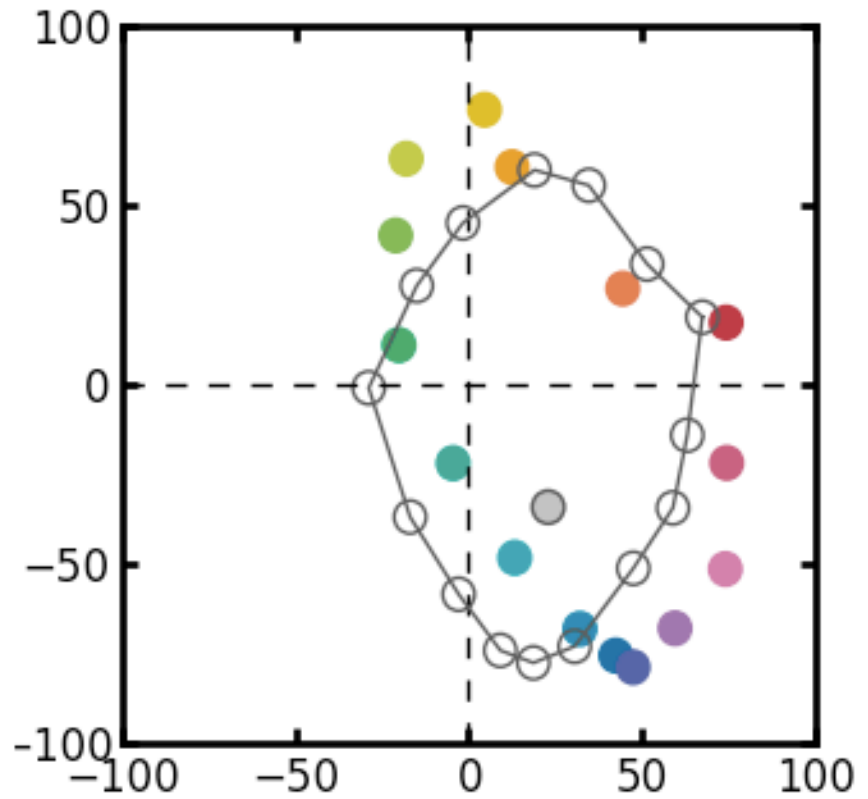
More Channels, More Fidelity

- Not all sources of interest are thermal radiators.
- The Aurora Borealis is an example of excitation and ionization of atmospheric gases.
- 12 and 7 channel systems are shown

Aurora Borealis



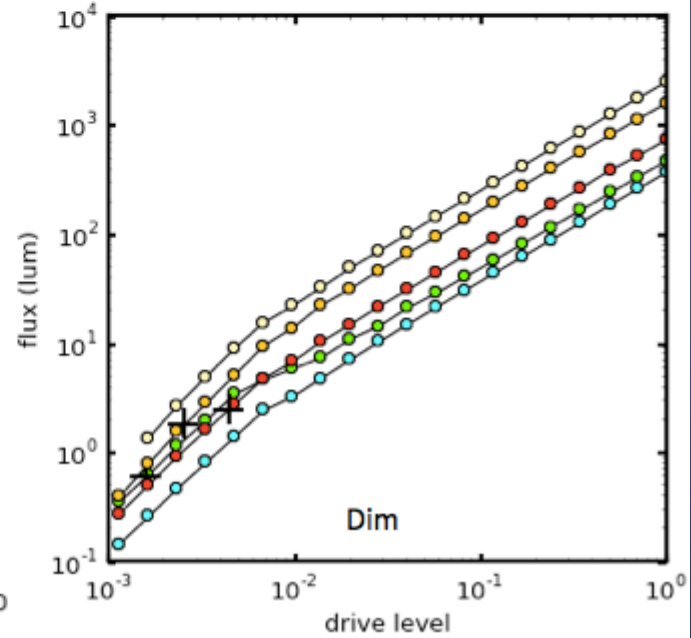
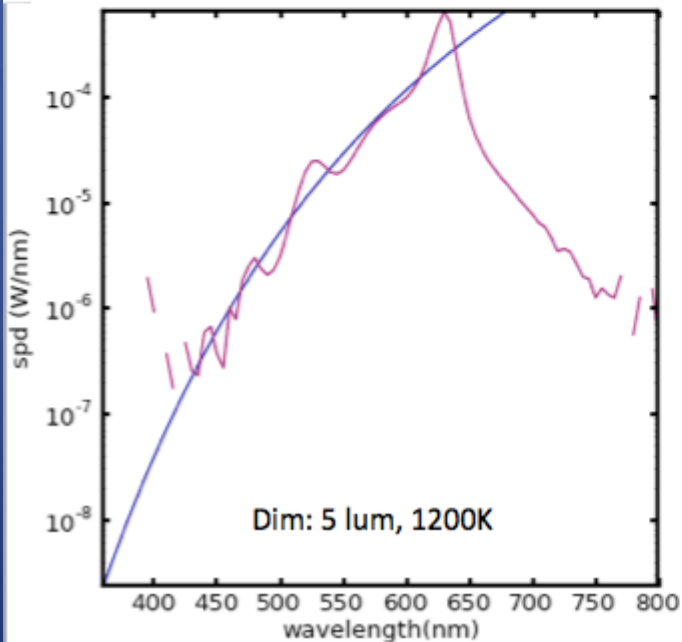
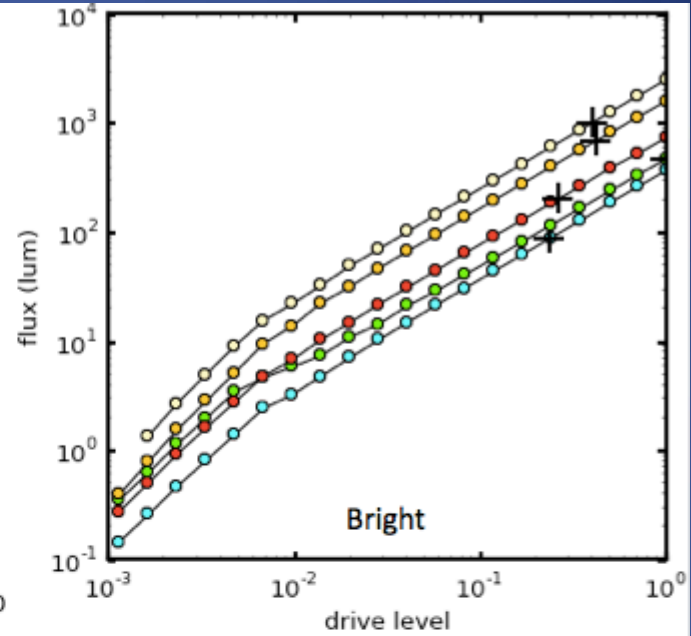
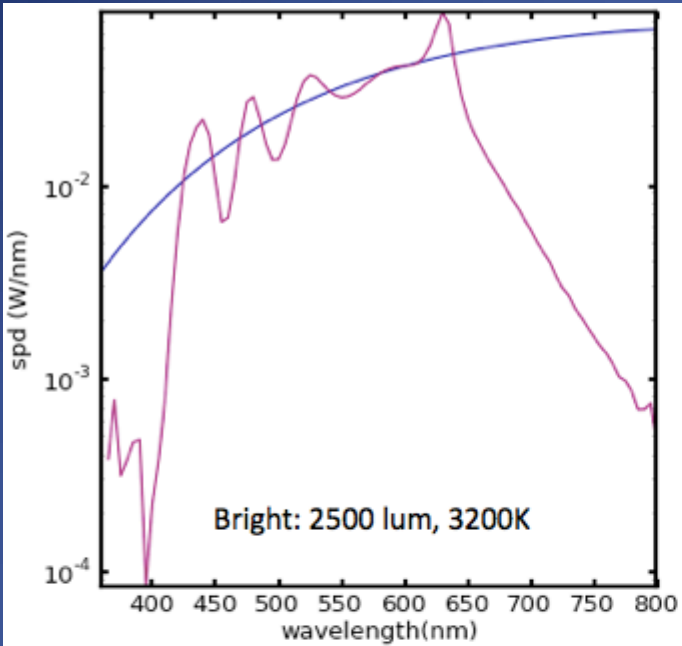
12-channel system



7-channel system

Dynamic Range

- The dynamic range of the human visual system is at least a million to one (20-bits)
- This is about the range of bright daylight to moon light
- Intensity compression is useful to realize cost effective systems
- A 5-channel system emulating tungsten lamp dimming is shown



Sky Shots



















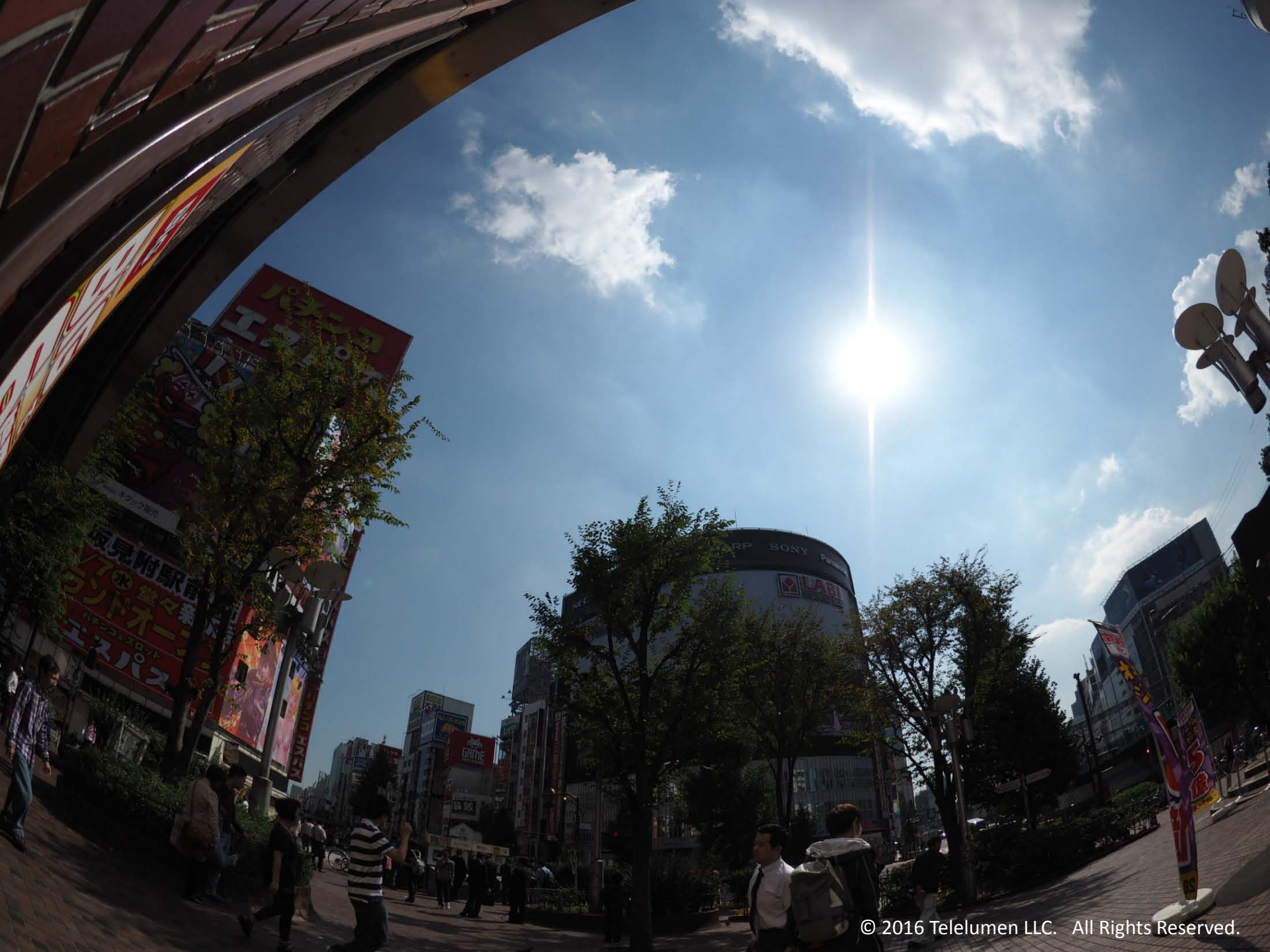




CITTANE









LUXURY BRAND SHOP
Japan-free
Taxi Shop
BIRD

24h OPEN
DISCOUNT
WARRANTY
CASH
MONEY EXCHANGE

MEX
MONEY EXCHANGE

USD
EUR
GBP
AUD
NZD
HKD
KRW
JPY

24h OPEN
DISCOUNT
WARRANTY
CASH
MONEY EXCHANGE

BEER
CLUB
DISCOUNT
WARRANTY
CASH
MONEY EXCHANGE

OPEN
DISCOUNT
WARRANTY
CASH
MONEY EXCHANGE

OPEN
DISCOUNT
WARRANTY
CASH
MONEY EXCHANGE













W
KUALA LUMPUR























Claude Monet – “Haystacks”

The series shows differences in perception of light across various times of day, seasons, and types of weather.

1890-1891 series [\[edit\]](#)



Grainstacks in the Sunlight, Morning Effect, 1890. Oil on canvas. Private collection.



Haystacks, (Midday), 1890-91, National Gallery of Australia



Wheatstacks (End of Summer), 1890-91. Oil on canvas. Art Institute of Chicago



Wheatstacks, 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstacks, Snow Effect, Morning, 1891. Oil on canvas. J. Paul Getty Museum



Haystacks at the End of Summer, Morning Effect, 1891. Oil on canvas. Musée d'Orsay, Paris, France.



Haystacks on a Foggy Morning, 1891. Oil on canvas. Private collection.



Haystack, Morning Snow Effect (Meule, Effet de Neige, le Matin), 1891. Oil on canvas. Museum of Fine Arts, Boston.



Grainstacks Snow Effect, (Meules, effet de neige), 1891. Oil on canvas. National Gallery of Scotland, Edinburgh, Scotland



Wheatstacks (Sunset, Snow Effect), 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstack (Snow Effect, Overcast day) (Meule, effet de neige, temps couvert), 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstack, 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstack (Thaw, Sunset), 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstack (Sun in the Mist), 1891. Oil on canvas. Minneapolis Institute of Arts.



Grainstacks. (Snow effects; sunlight.), 1890-91. Oil on canvas. National Gallery of Scotland, Edinburgh, Scotland.

Summary

- The blackbody locus is a just convenience
- Actual daylight is a good model for electronic illumination systems
- Clock, calendar, location, and many color channels are key elements to rich illumination experiences



Thank You

Steve Paolini

steve@telelumen.com