Hochschule der Medien

LEDs & Numbers

HdM, Stuttgart 2023

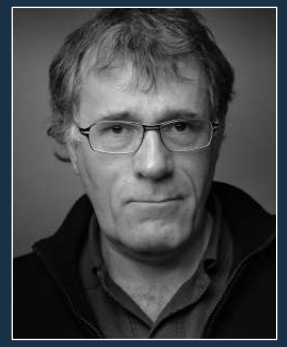
Philippe Ros

www.philipperos.com

2023-03-23

LEDs & Numbers

A presentation by:



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Digital Imaging Supervisor
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IMAGO TC co-chair

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Professor for Cinematography
Hochschule der Medien, Stuttgart
IMAGO TC full member

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Plan

1. General information
2. A different universe
3. LEDs in the cinematography field
4. LEDs and Spectrum
5. LEDs and Power
6. Conference of Light tests & SSI
7. The HdM tests
8. The missing data
9. The conclusions

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Topics

- Color rendering
- Skin tone
- Skin texture
- Image texture

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LEDs

Technical information?

For who ?

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For:

- The gaffer & his team
- The cinematographer & the DIT
- The make-up artist
- The costume designer
- The production designer
- The director / the art designer
- The post-production (the colorist)

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1. General information

LED

Light-Emitting Diode

A semiconductor device that emits light

when a current flows through it

LEDs

- LEDs for signage
- LEDs for daily use

LEDs

- Start in early 1960's
- First use in the movie field:
  - ✓ Around 2003 in USA
  - ✓ Around 2008 in Europe

Considering the LEDs

in the digital era

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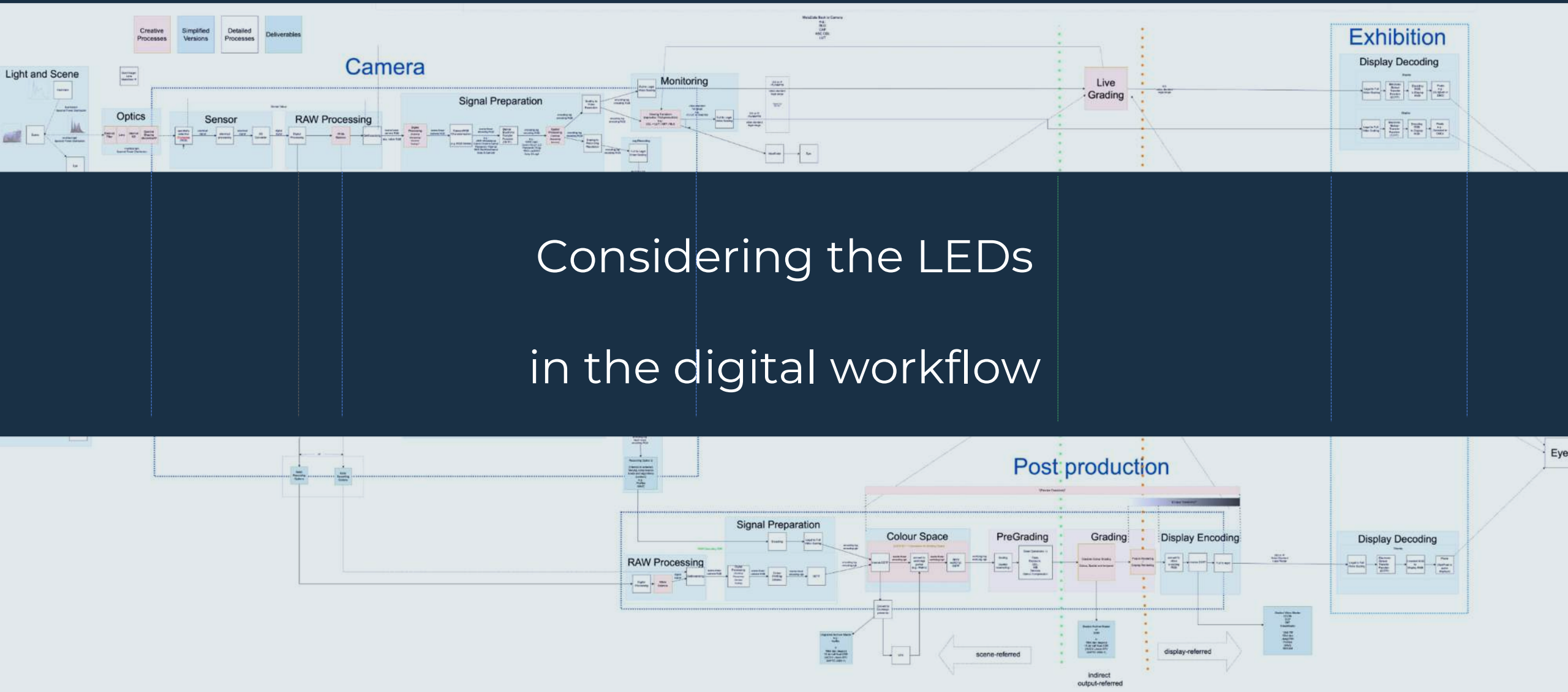

Considering the LEDs

in the digital workflow

Considering the LEDs

as emblem and vector of a different visual universe

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2. A different universe

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"Collateral" (2004) Michael Mann

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Two reasons to talk about this film:

- The lighting style
- The location

"Collateral" (2004) Michael Mann

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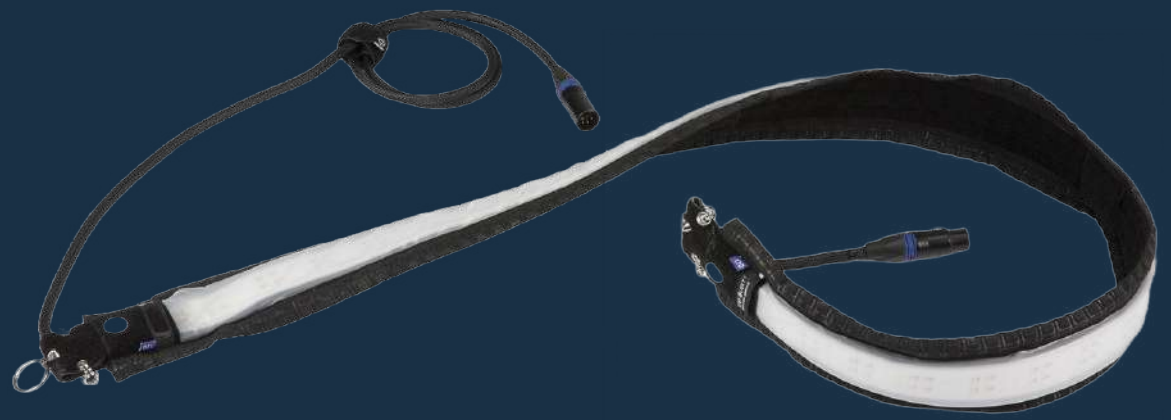
The lighting style

Interior of the taxi fully equipped with LED strips



"Collatera/" (2004) Michael Mann

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The location

"*Collateral*" was supposed to be shot in New York but Michael Mann relocated the filming to Los Angeles because New York had switched to LED street lighting.

The location

In 2004, Los Angeles still had mercury and sodium lighting

in the streets

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The location

In 2004, Los Angeles still had mercury and sodium lighting

in the streets

https://www.thedailybeast.com/los-angeles-has-swapped-out-140000-street-lights-for-highly-efficient-leds

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"Why Hollywood Will Never Look the Same

Again on Film:

LEDs Hit the Streets of LA & NY"

nofilmschool

By Dave Kendricken

February 1, 2014

https://nofilmschool.com/2014/02/why-hollywood-will-never-look-the-same-again-on-film-leds-in-la-ny

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The transition to LED streetlights for the City of Los Angeles

Estimate per year:

- At least $7 million in electricity savings
- The LED fixtures used in Los Angeles:
  - ✓ Consume about 63% less electricity
  - ✓ Last much longer, than the high-pressure sodium (HPS) fixtures they replaced.

nofilmschool

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			Consumption Incandescent / LED
Incandescent	**Halogen**	**LED**	
25W	15W	1,5W	64 KWh / 3,83 KWh
30W	20W	3W	77 KWh / 7,66 KWh
50W	35W	4W	127 KWh / 10,22 KWh
65W	45W	5W	166 KWh / 12,77 KWh
75W	50W	6W	192 KWh / 15,33 KWh
100W	65W	9W	255 KWh / 23 KWh
120W	75W	12W	307 KWh / 30,66 KWh
180W	120W	20W	460 KWh / 51,1 KWh

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Sodium @ 3000 K

LED @ 5600 K

& Sodium in the background

Urban light

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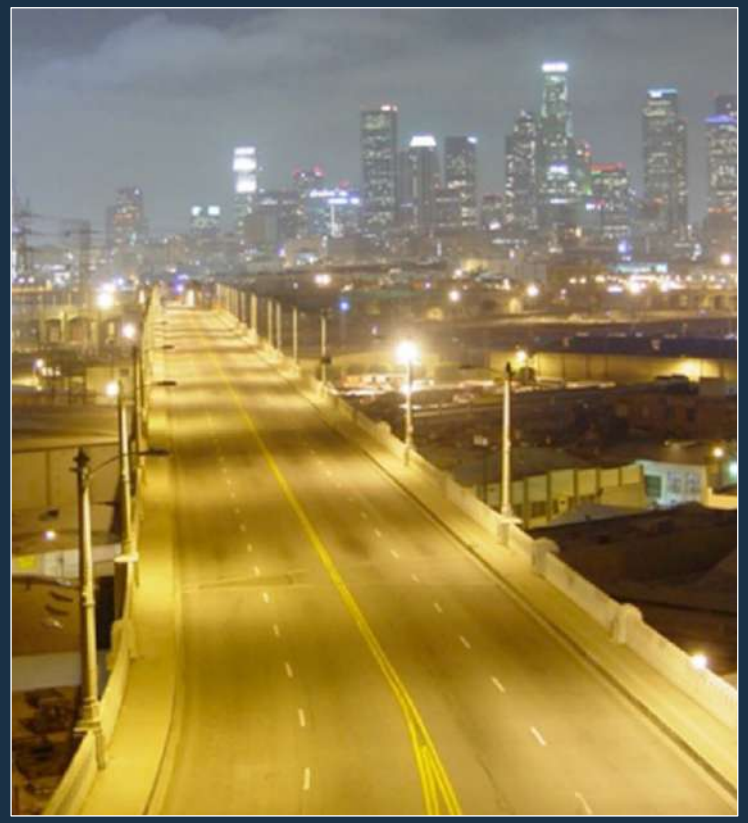

Sodium @ 3000 K

LED @ 5600 K

Urban light

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Urban light

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A different world for:

- Filmmakers
- Documentary filmmakers
- Cinematographers
- All humans

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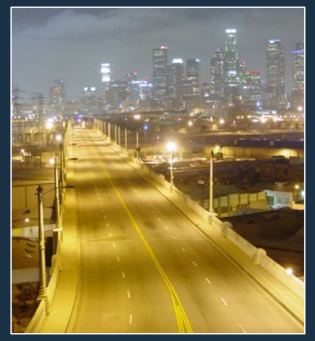
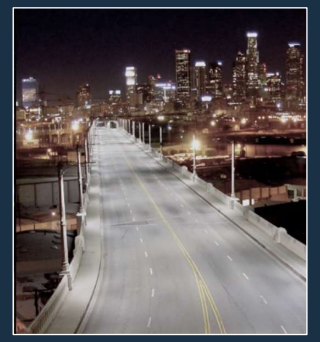


The American Medical Association (AMA)



Several problems:

- Discomfort and glare (too cold / blue light)
- Impact on biological circadian rhythmicity (sleep/wake)
- Possible link between these LED lights and damage to the human retina and eyesight.

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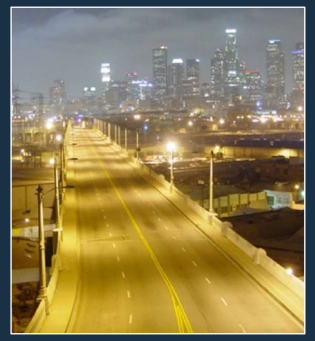

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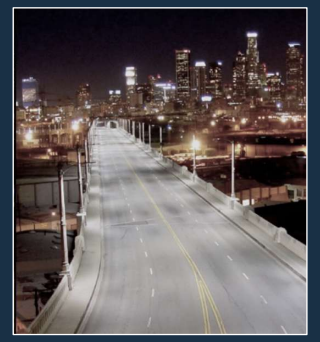

- En 2016, The AMA’s statement recommends that outdoor lighting at night, particularly street lighting, should have a color temperature of no greater than 3000 Kelvin (K)
- Harmful environmental effects of LEDs with a CT above 3000K

3. LEDs in the cinematography field

Advantages in the movie field:

- Low consumption
- Size
- Flexibility

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Possibility to do some shooting

- Whitout genny
- With 16 Amps plugs

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In an electric list of shooting (France):

- In 2012: 2% of LEDs
- In 2023:
  - ✓ 50% of LEDs on feature films (incl. series, TV movies)
  - ✓ 100% of LEDs for TV sets & Commercials

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Have LEDs standardized the style of lighting

in the cinema?

- Few directional lights
- Only realistic light ?
- Freedom for the actors ?

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At last, directional LEDs

- The return of the Fresnels
- Sharp shadows

''Cat people'' – Director: Jacques Tourneur
Cinematographer: Nicholas Musuraca (ASC)

''Road to perdition'' – Director: Sam Mendes
Cinematographer: Conrad L. Hall (ASC)

Disadvantage

For the moment, there are no powerful and qualitative

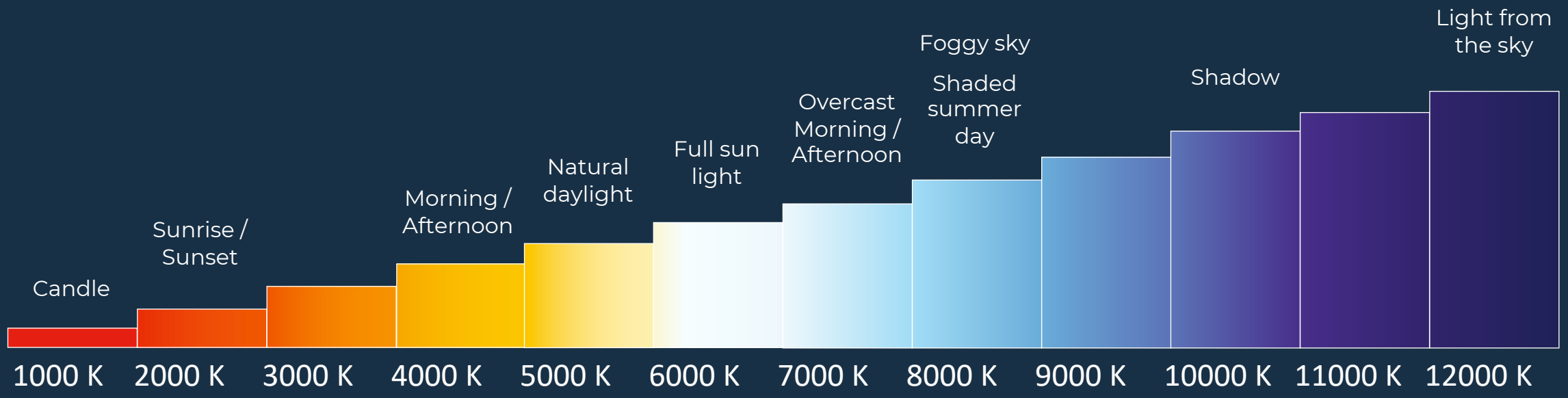
lighting fixtures at the same time

Three types of LEDs:

- Mono-color
- Bi-color
- Full-color

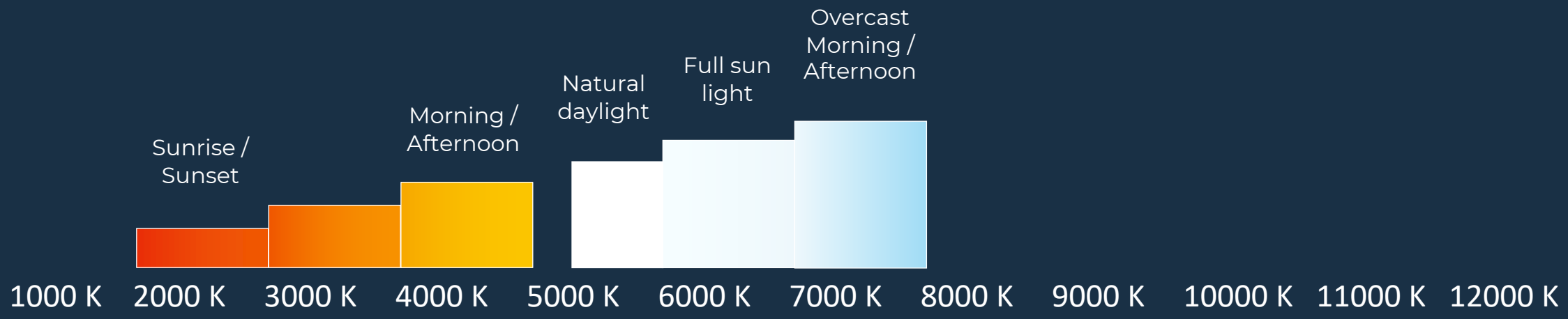
Color temperature (TC)

In Kelvin (K)



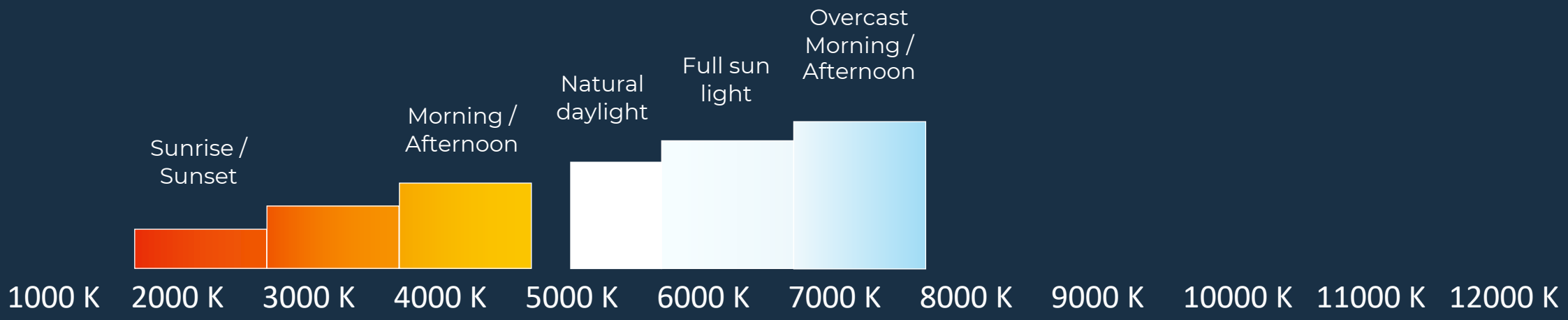
Mono-color

- Only one sigle color temperature
  - ✓ Tungstene
  - ✓ Daylight



Mono-color

- More powerful

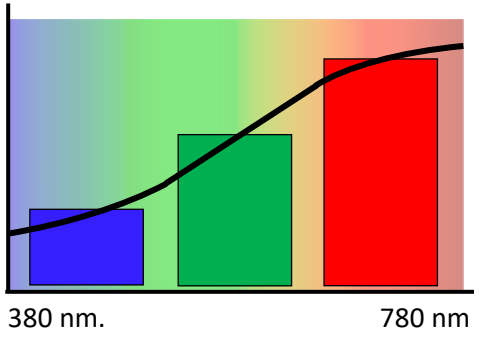


Bi-color

- Only color temperatures

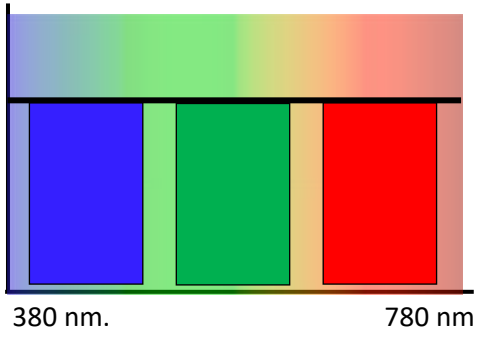
Tungsten lamp
Red or yellow light

Tc = 3200 K



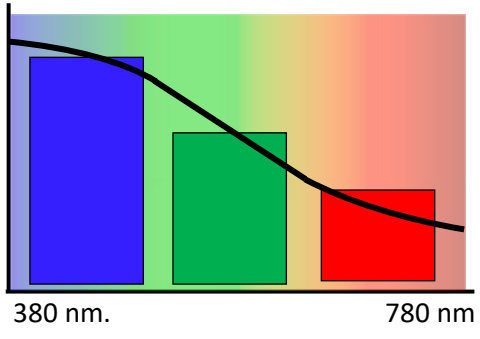
Daylight
White light

Tc = 5500 K



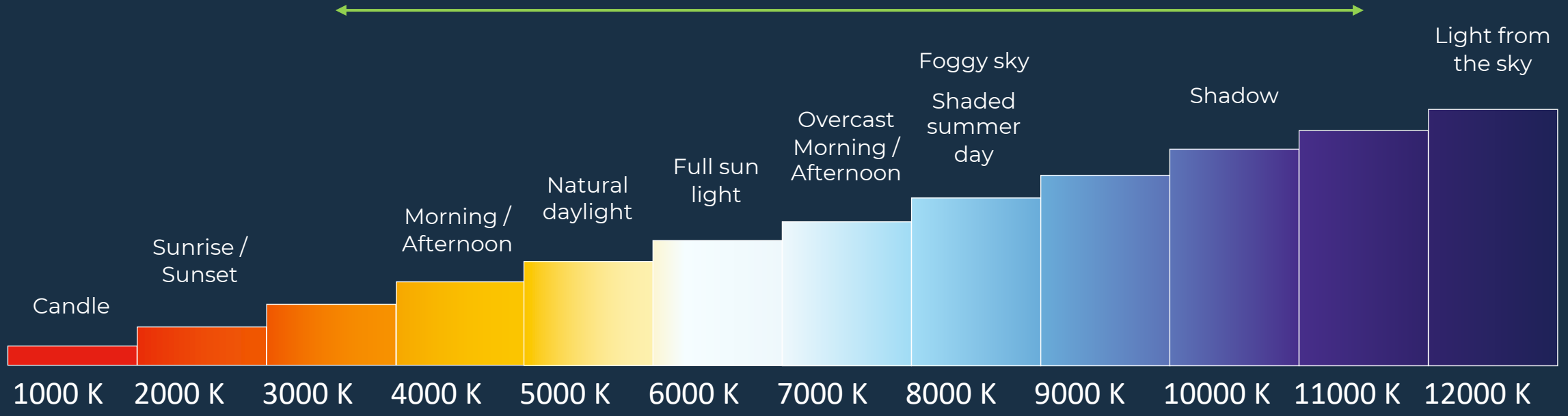
Shadow, Winter
Blue light

Tc = 11000 K



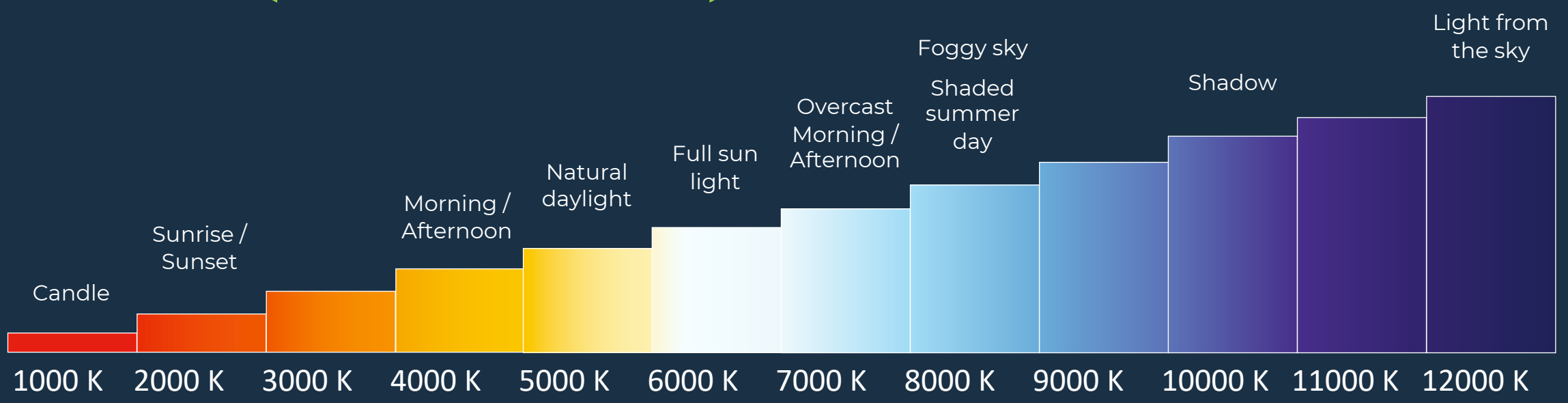
Bi-color

- Only color temperatures
  - ✓ From tungsten to daylight



Bi-color

- Only color temperatures
  - ✓ From tungsten to daylight



Bi-color

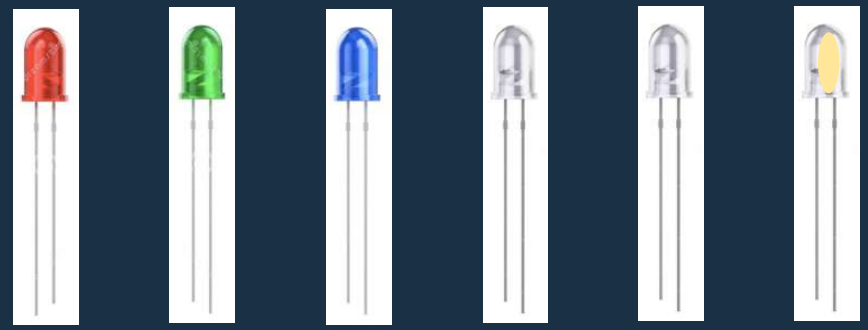
- Advantage:
  - ✓ Longer life span
  - ✓ Power: 1.5 to 3 times more powerful than Full Color

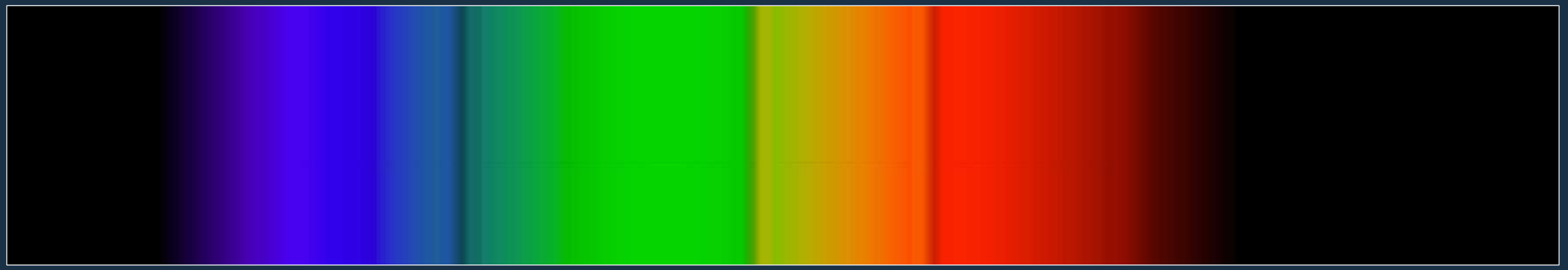
Bi-color

- Disadvantage:
  - ✓ Less quality in color rendering

Full-color

- A large part of the light spectrum
- Several diodes





380 nm

750 nm

Full-color

- Advantages:
  - ✓ No need to change gelatins anymore
  - ✓ The colours are created remotely

Console for gaffers

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Full-color

- Advantages:
  - ✓ Time saving
  - ✓ Especially in the studio

LEDs

Bi-color vs Full-color

- Do we still need all the colors?
- Gelatins are still sold, why?

LEDs

New gaffer’s skills

- More complex tools
- Essential and longer preparation
- Management of the lighting fixtures

linked to the digital workflow (color spaces)

LEDs

New jobs

- Lighting designers
- Programmers
- Electricians (in charge of intelligent lighting)

LEDs

New team building

- Teams must adapt to methodologies that come from the show business

LEDs

The role of the plateforms

- Platform- approved cameras

  Netflix-Approved Cameras

- And soon … approved lighting fixtures

  Netflix-Approved Lighting

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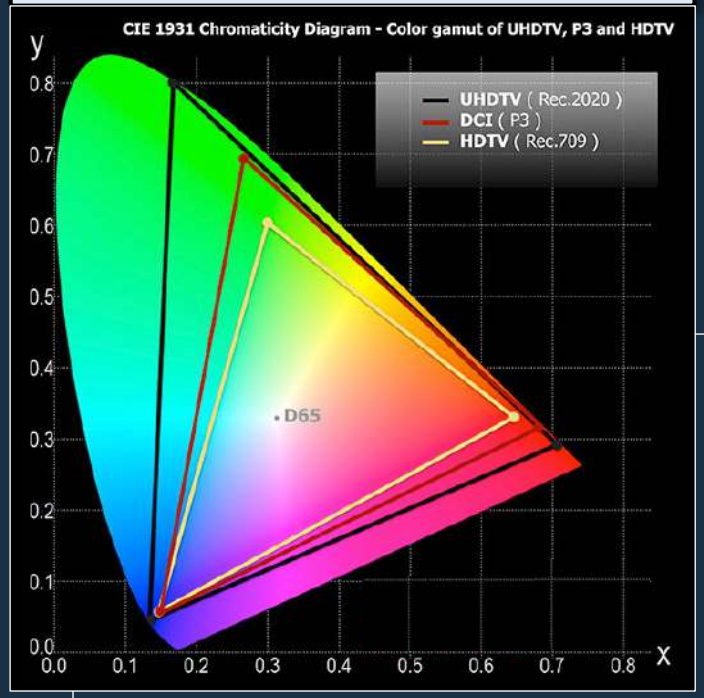
IMAGO TC

- Meeting with Netflix (Camerimage 2019)

LEDs

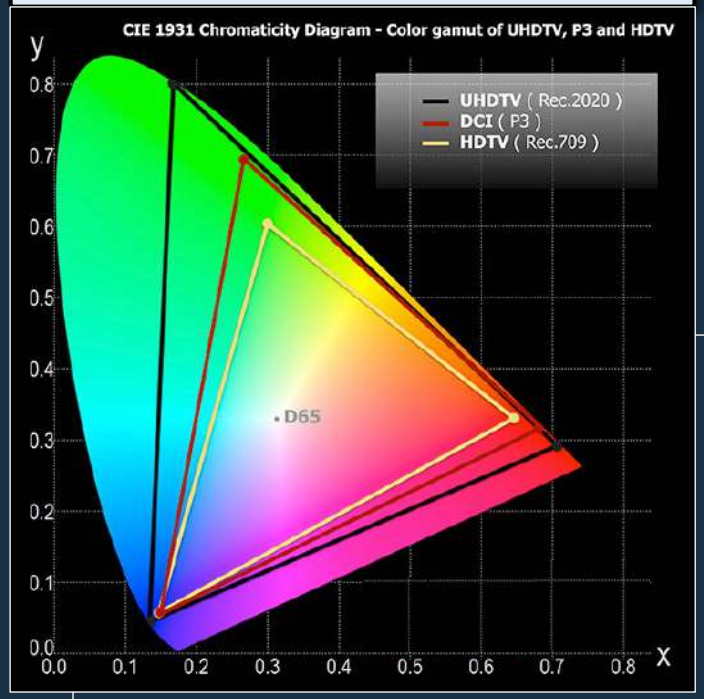
x,y & 2D representation



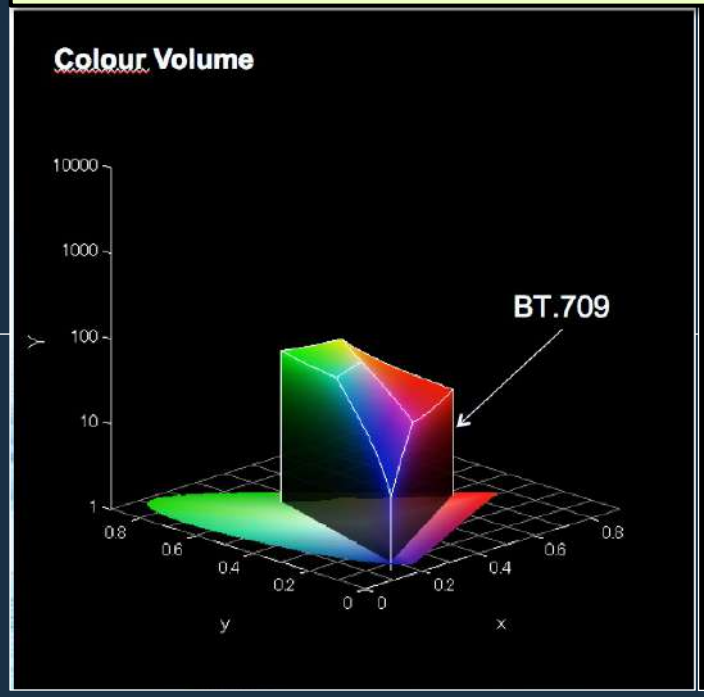
Importance of color spaces

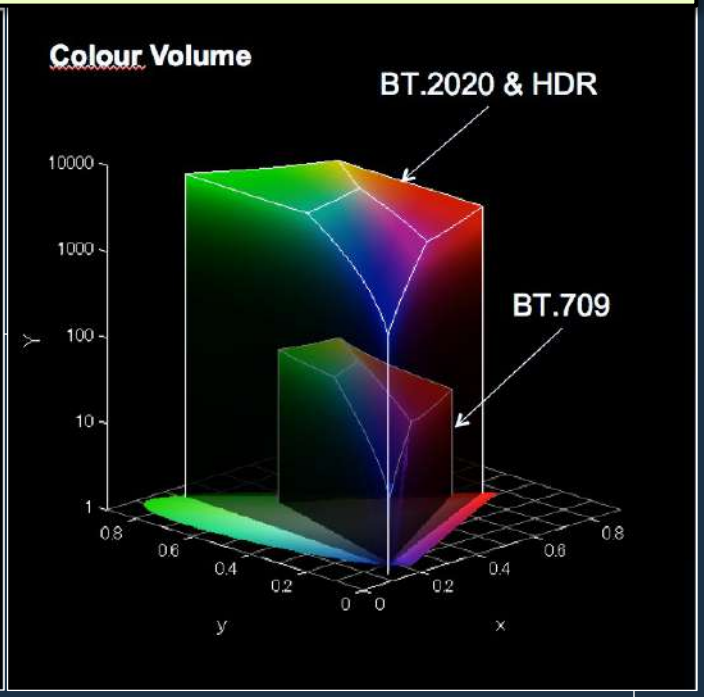
LEDs

x,y & 2D representation



x,y & 3D representation



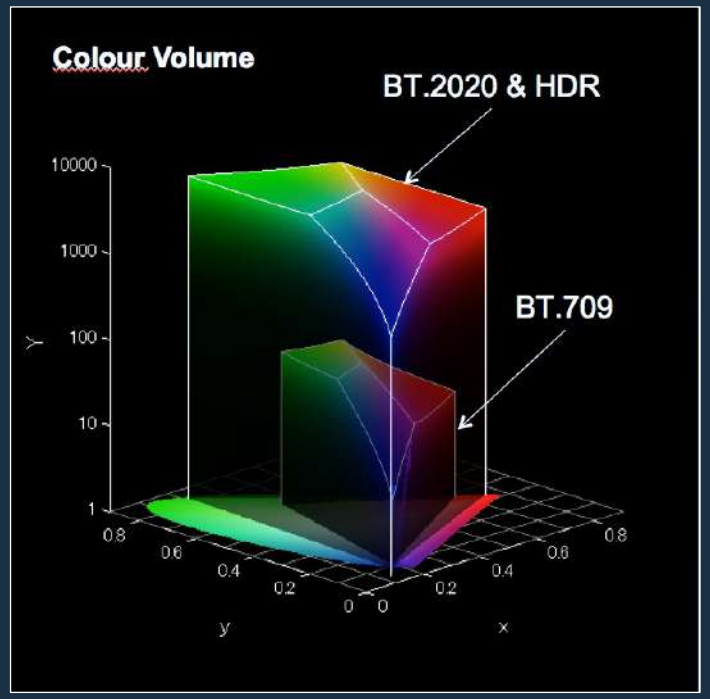


To approach the color space in its three dimensions

LEDs

The future of the use of LEDs is closely linked to the management of the color spaces related to the cameras.

We see many manufacturers offering color space control in their cameras.



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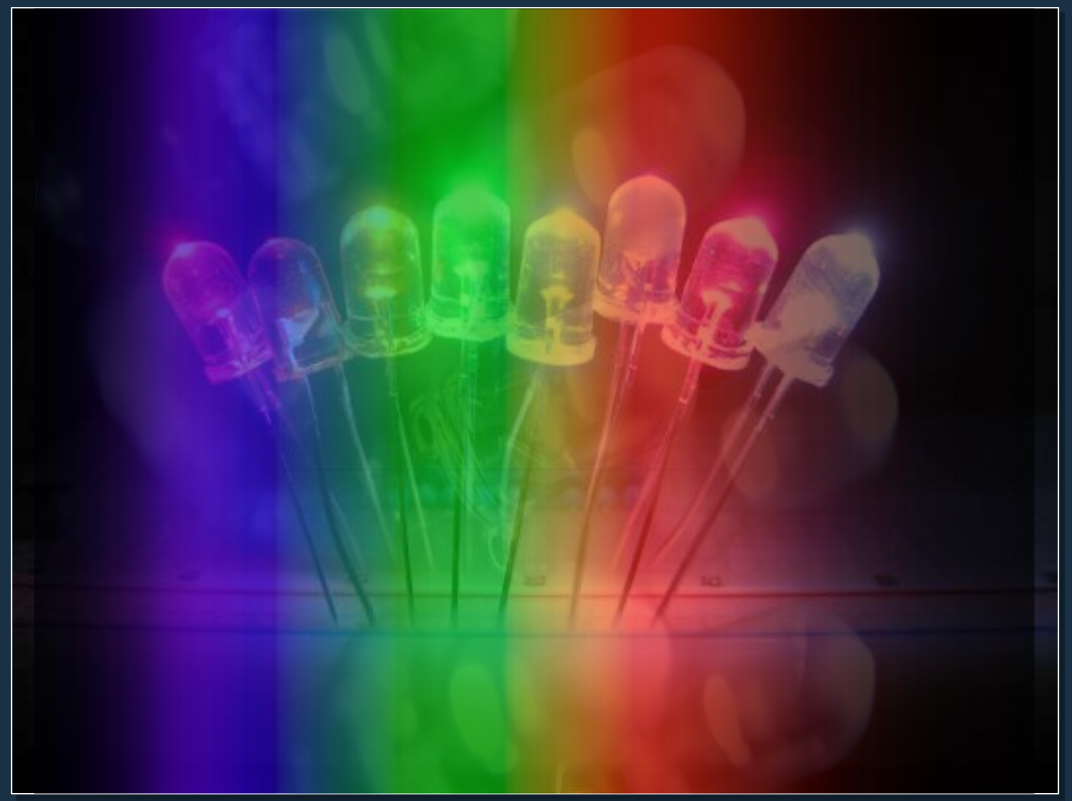


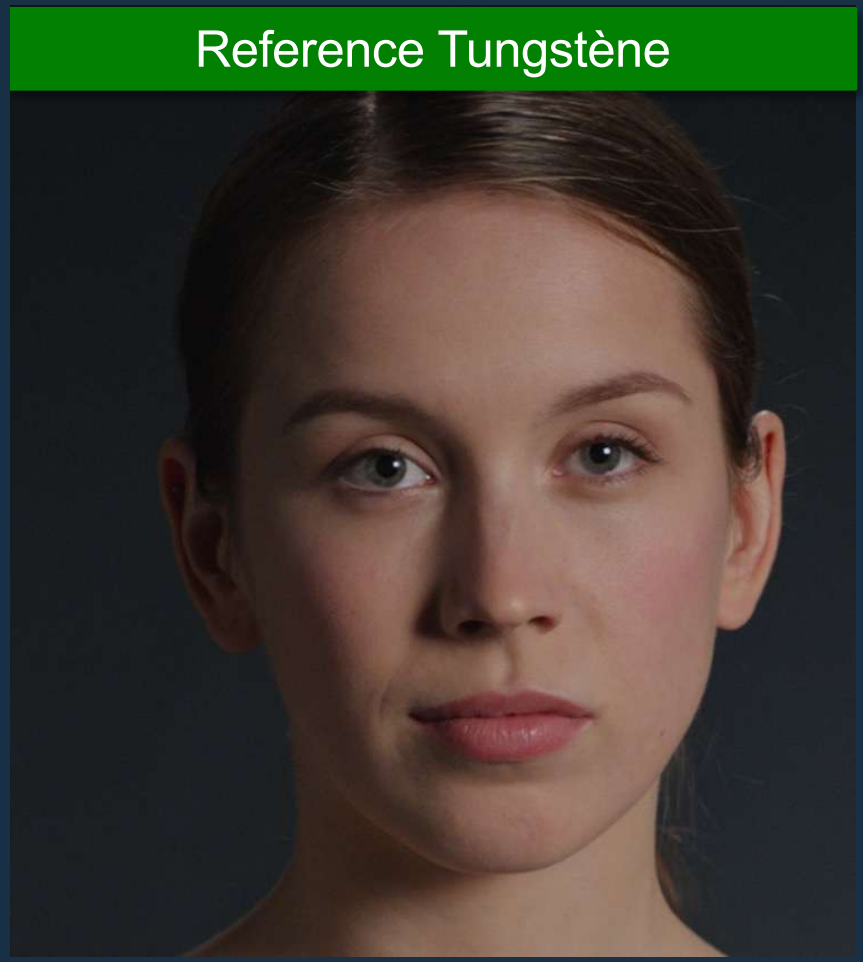
4. LEDs and Spectrum

LEDs

Disadvantages

Discontinuous light spectrum

Color rendering



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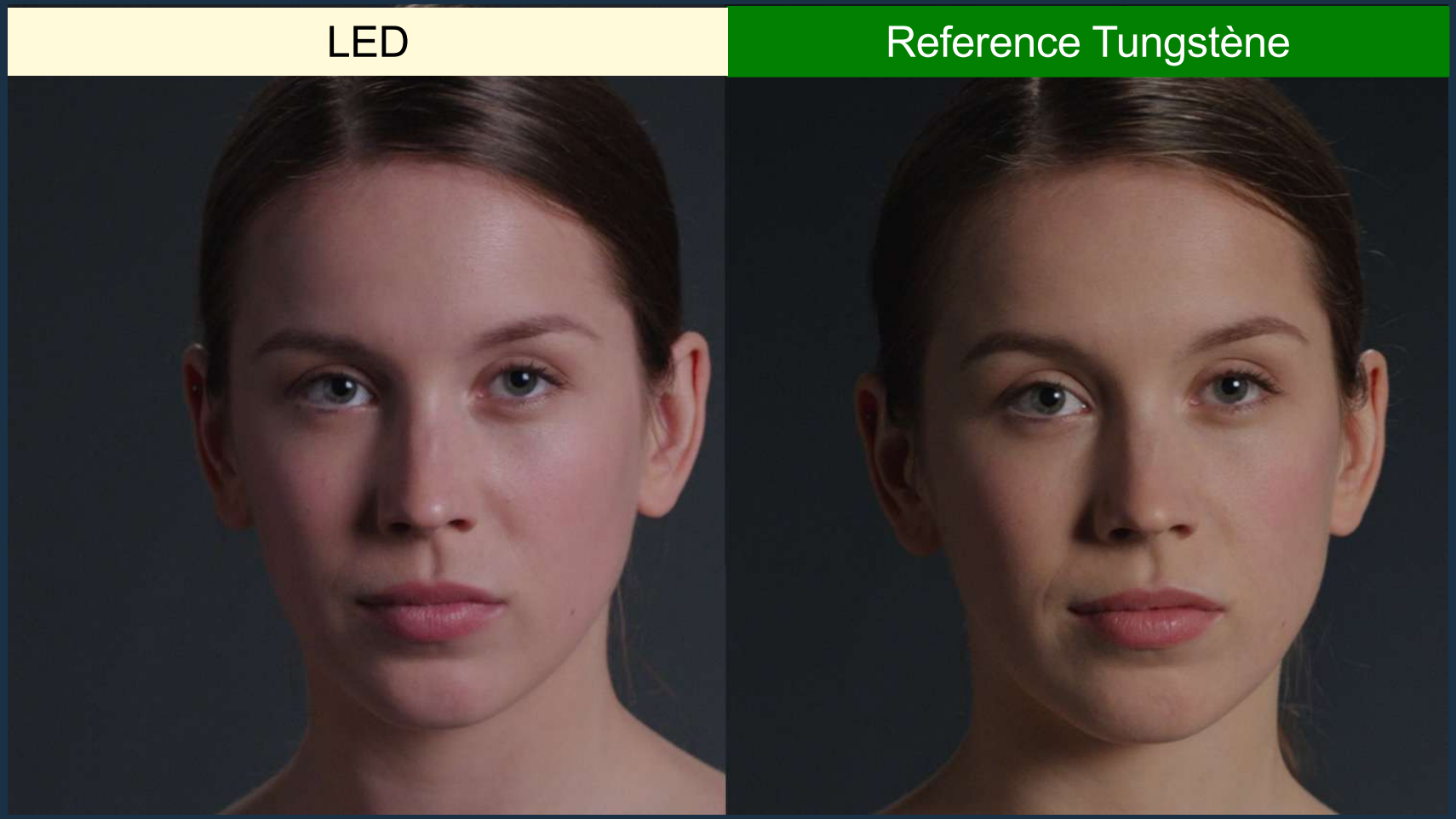
Color rendering



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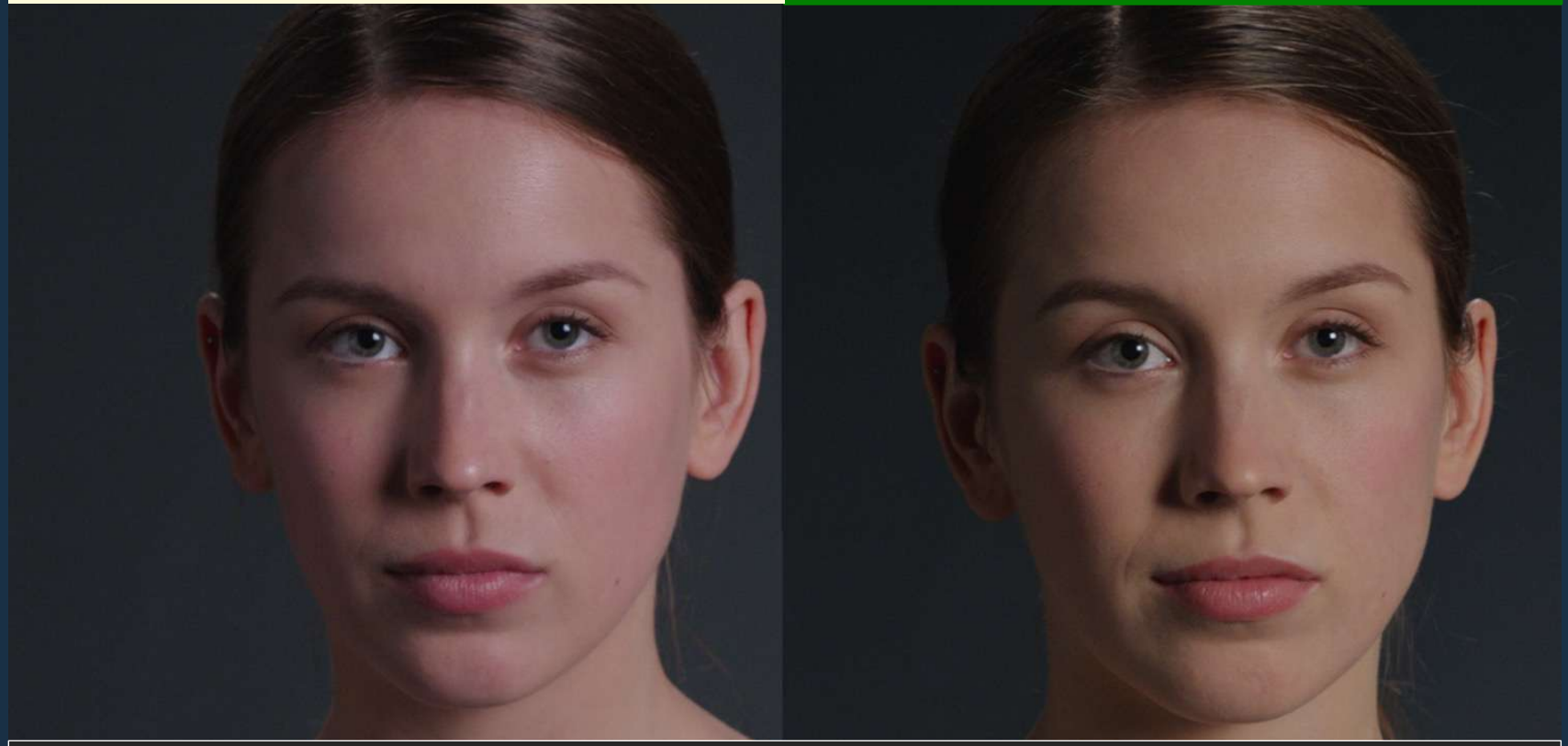
Consequence on:

LED	Reference Tungstène



Skin tone & skin texture

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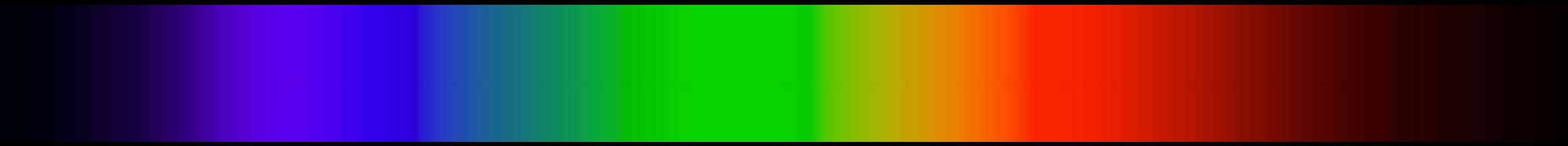
Tungsten light



Continuous light spectrum

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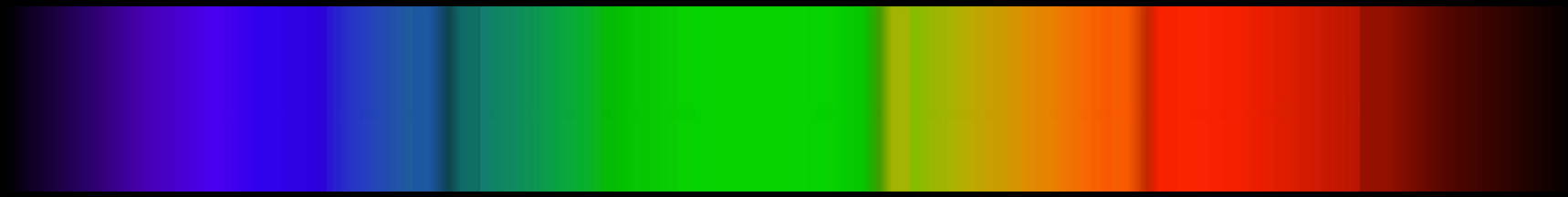
LED light



Discontinuous light spectrum

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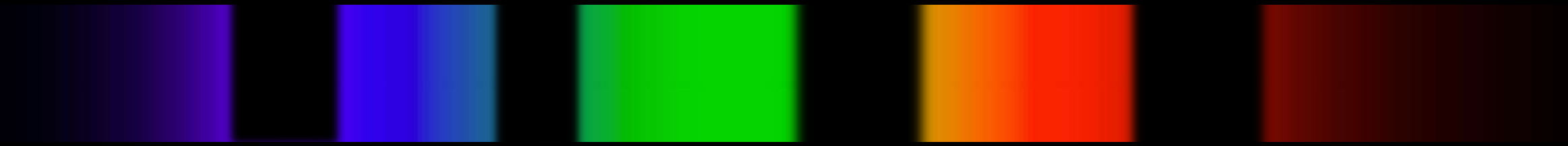
Fluorescent light



Discontinuous light spectrum

5. LEDs & Power

LEDs

Disadvantages

Confusion about the power of the LEDs

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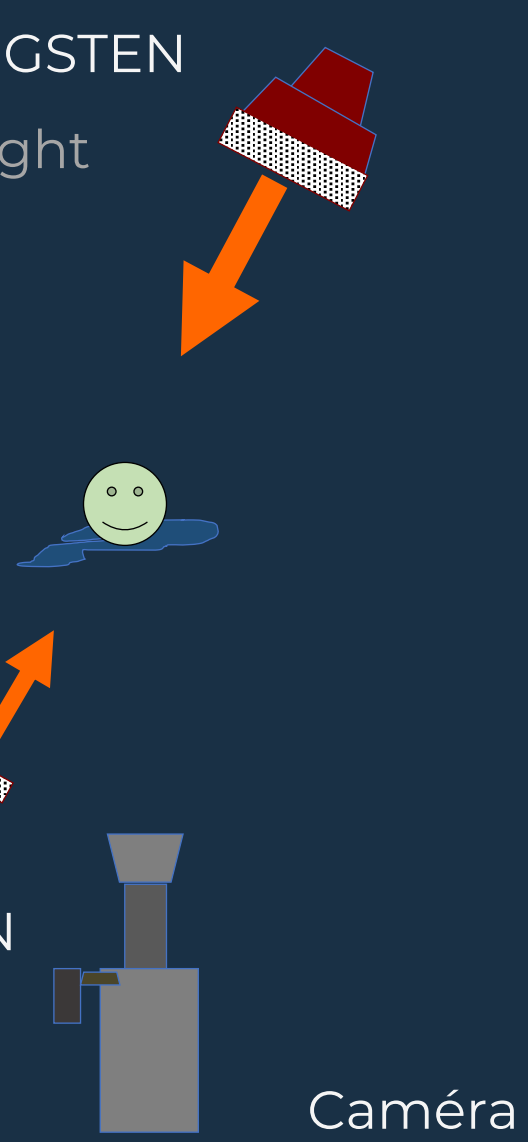
With tungsten or HMI we know:

- What type of lighting fixtures we need in terms of power,
- Regardless of the brand.



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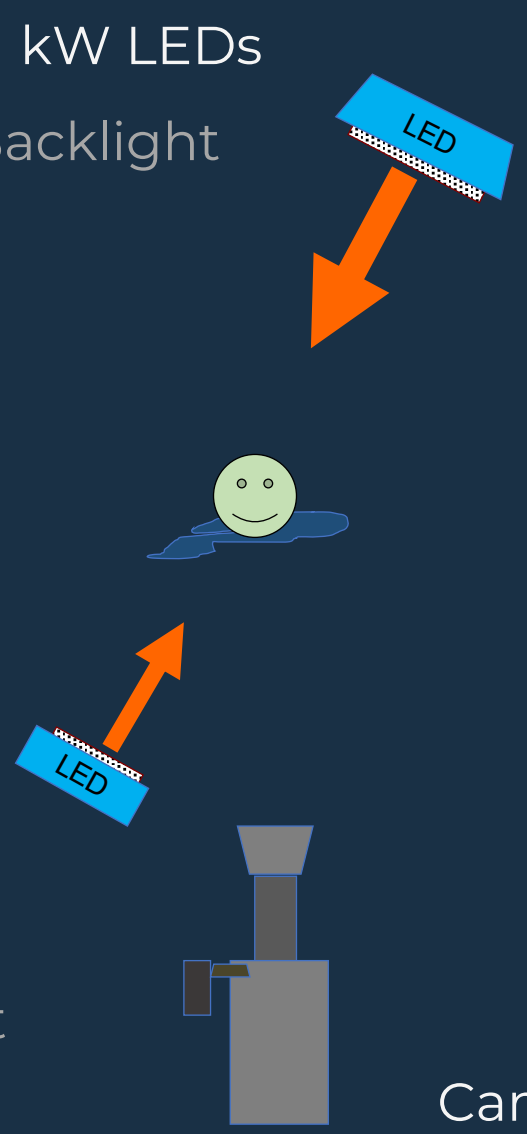
For LEDs, we are often confused by the power indications.

They seem to give very different levels of illumination depending on the brand.



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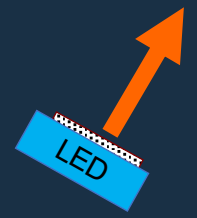
??? kW LEDs

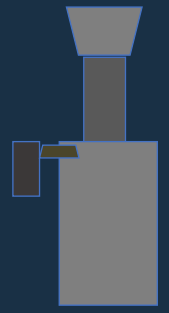
Backlight

Why?



??? W LED

Keylight



Caméra

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LEDs & Numbers

1 LED + 1 LED = 2 LEDs

1 x 100 w LED + 1 x 100 w LED  200 w

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LEDs & Numbers

Exemple: FULL-COLOUR RGBWW

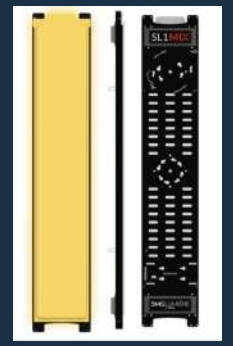
150 w + 150 w + 150 w + 150 w + 150 w

LACK OF TRANSPARENCY

≠ 750 w

LEDs & Numbers

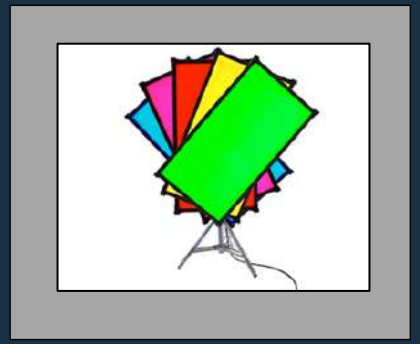
Exemple: ROSCO DMG SL1 MIX (Full-color)



- Softlight designed with groups of 6 LEDs of 0.8 W.
- The SL1 has 96 groups of 6 x LEDs
- Theoretical power would therefore be 96 x 6 x 0.8 = 460 W.
- Why does ROSCO DMG call it a 200W and not a 460W?

LEDs & Numbers

Exemple: KINO FLO CELEB 575 w (Full-color)



- Softlight designed with with 5 x 200 w LED
- Theoretical power 5 x 200W = 1000 w
- Why does KINO FLO call an LED 575 w and not 1000 w?
- LEDs are never used at their maximum power
- Otherwise the device will overheat

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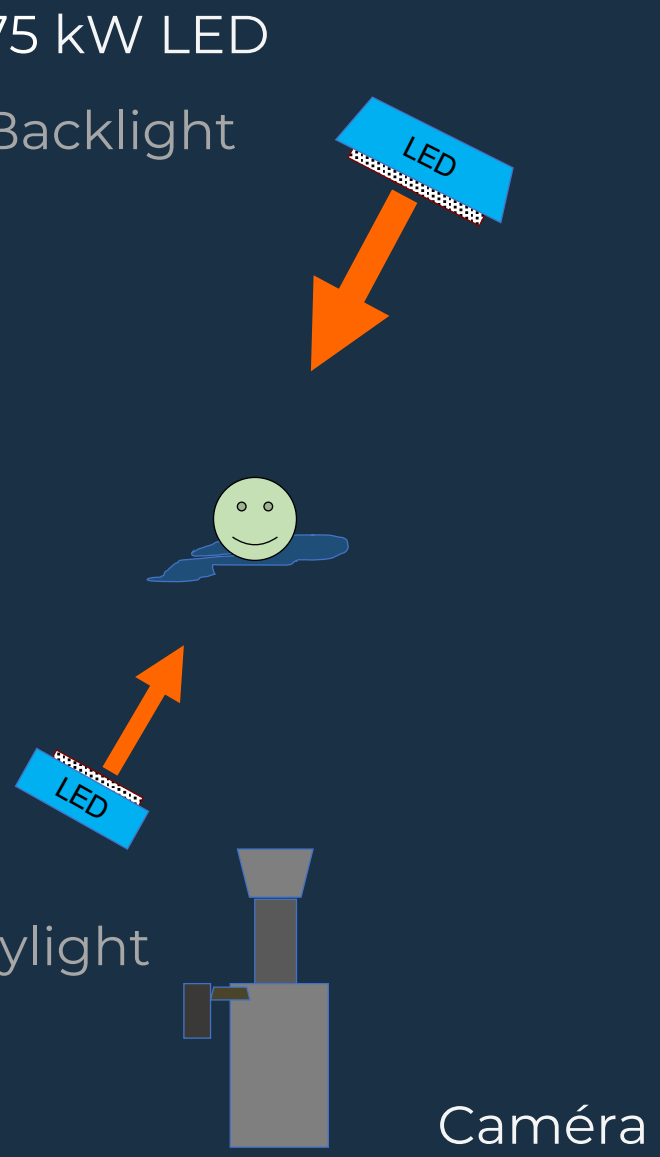
Only a few manufacturers give the real power of their projectors considering that they have a power threshold in order to avoid overheating.



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3. Conference of Light & SSI

CONFERENCE OF LIGHT

LED TESTS

Berlin - May 2019

CONFERENCE OF LIGHT

Tests organised and designed by:

Michael CARSTENS

DRS Delight Rental Services,
Berlin

Timm BRÜCKNER

Gaffer
Berlin

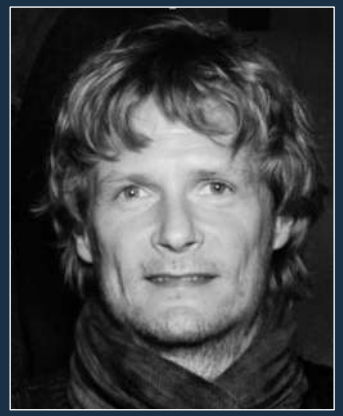
Nick SHAPLEY

Founder & Managing Director
of LCA

London

CONFERENCE OF LIGHT

Cinematography by:

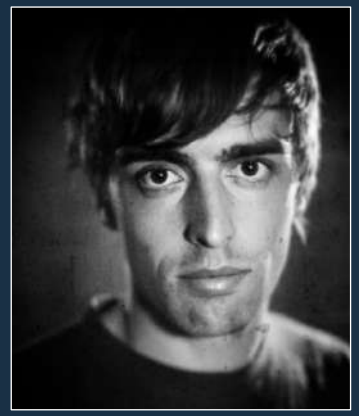


Matthias FLEISCHER

Cinematographer, BVK

Berlin

Grading session by



Tobias WIEDMER

Colorist

CineChromatix

Berlin

Mesureament & color science checked by:

Dirk MEIER

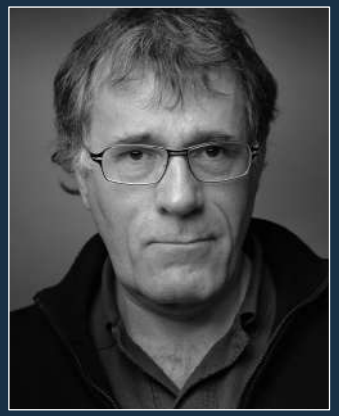
Colorist, BVK, CSI

Consultant

Member of the IMAGO TC

Berlin

Presentation by:



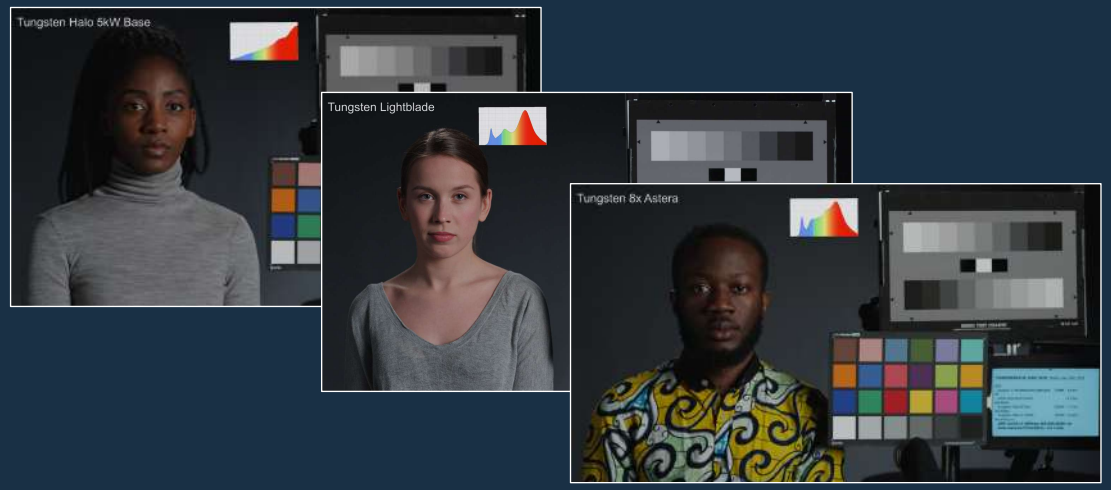
Philippe ROS

Cinematographer, AFC

Co-chair of the IMAGO TC

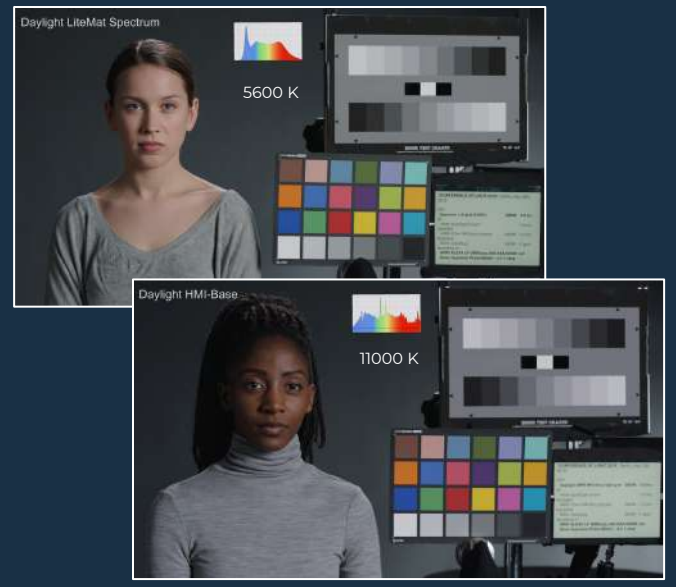
France

CONFERENCE OF LIGHT



12 LED lighting fixtures were tested with:

- Different skin tones
- Different level of lights
- Different color temperatures

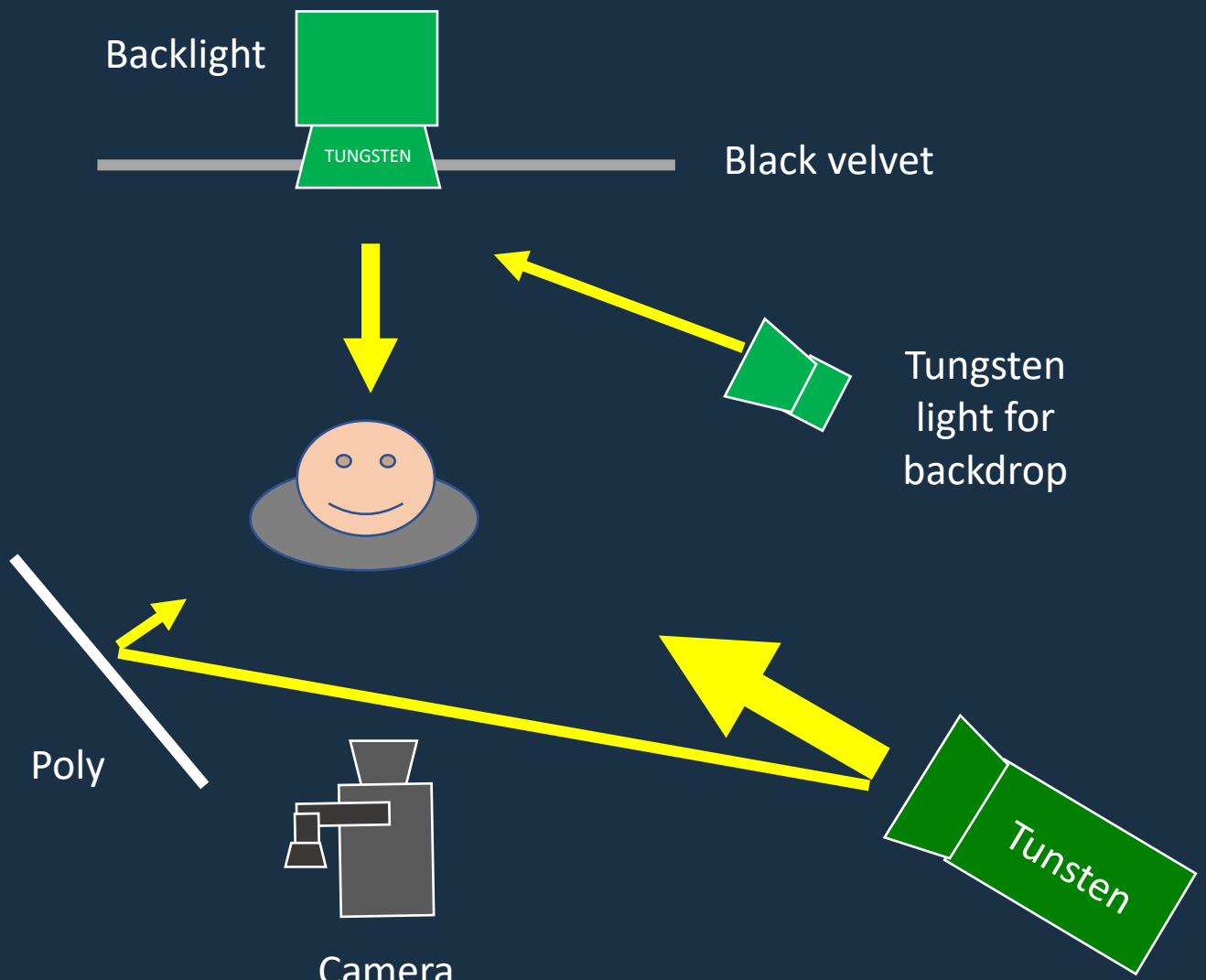


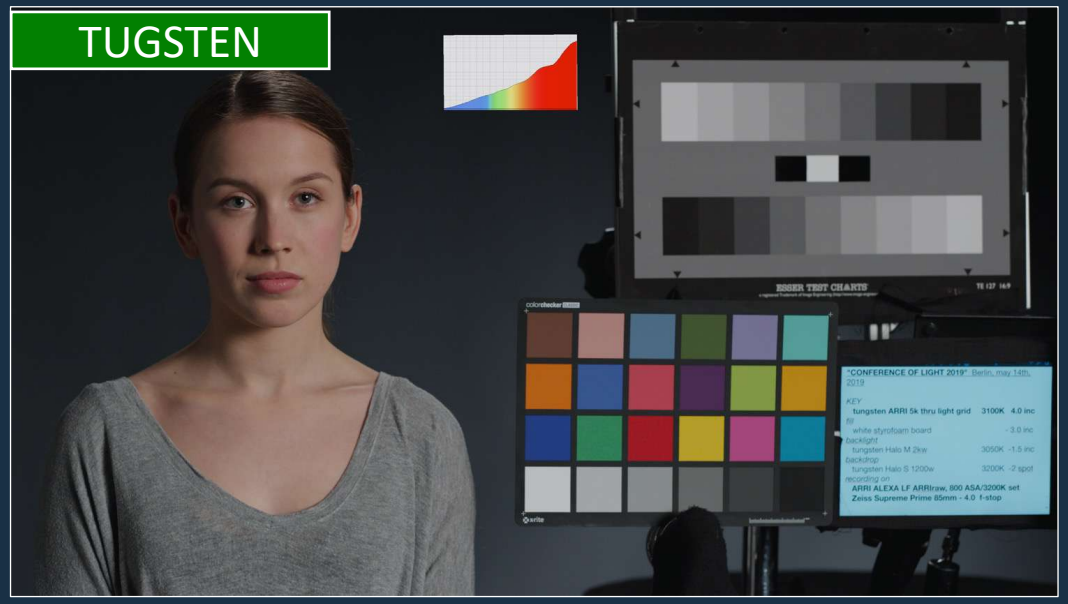
CONFERENCE OF LIGHT

- Shot on an ARRI Alexa LF,
- 75mm Signature Prime at T-stop 4
- RAW recording file,
- 4K D.I workflow (No ACES) on Scratch at Cinechromatix Berlin.

CONFERENCE OF LIGHT

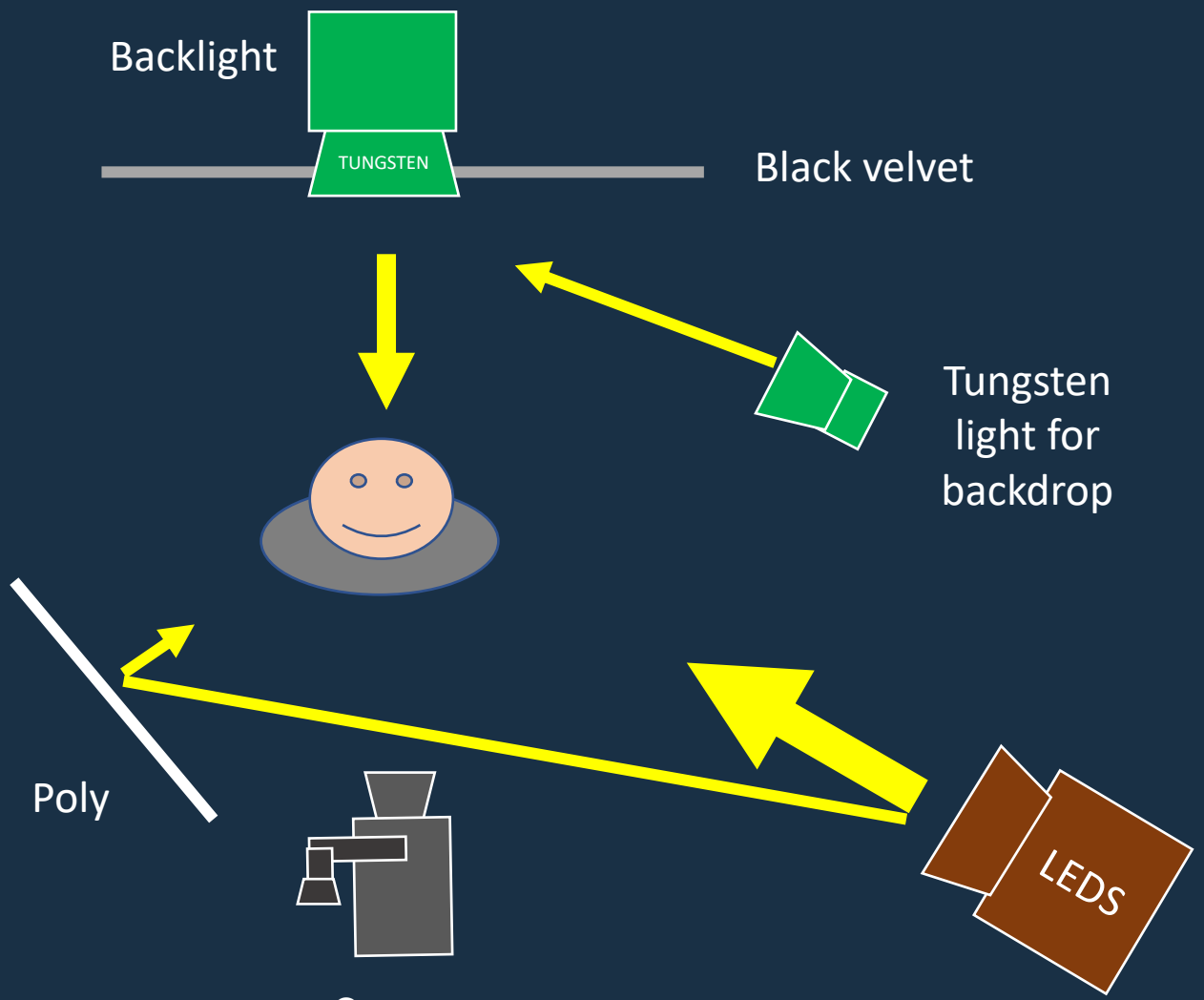
GENERAL SETUP

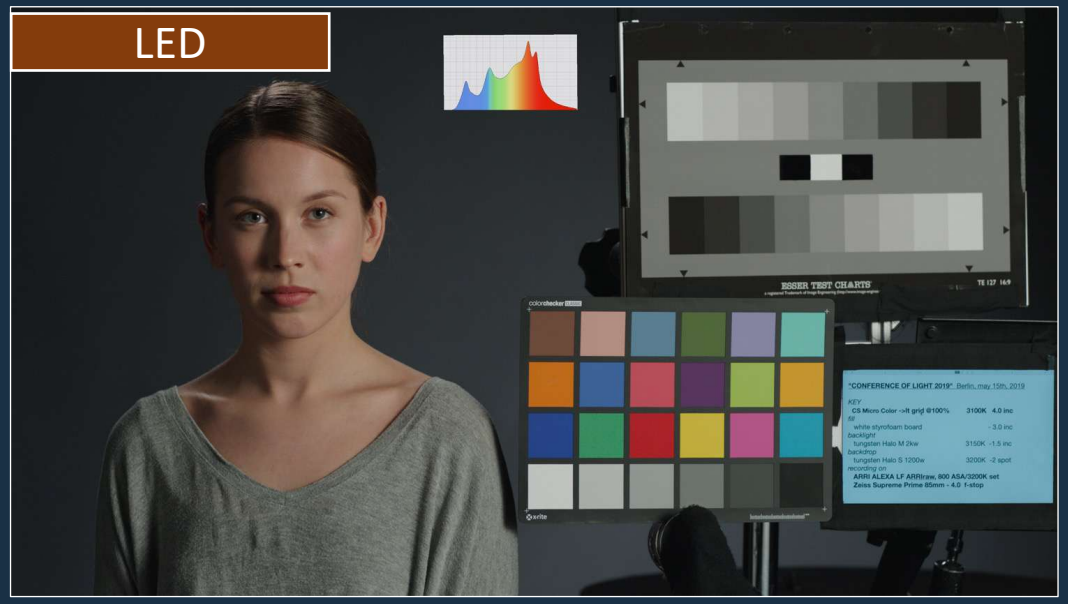




CONFERENCE OF LIGHT

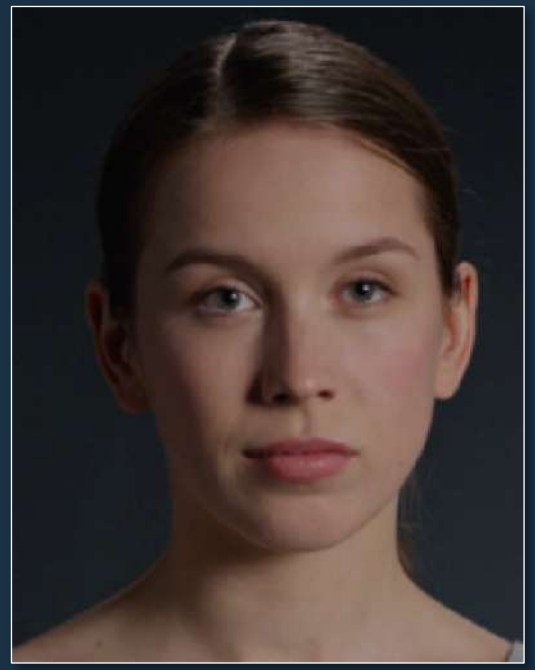
GENERAL SETUP



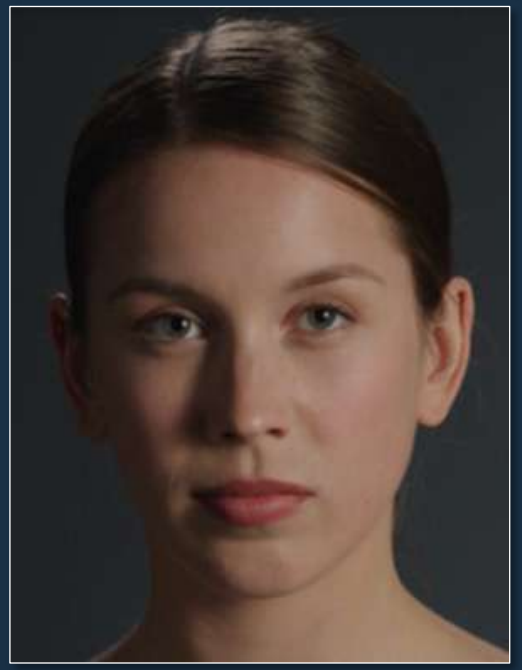


CONFERENCE OF LIGHT

GRADING METHODOLOGY



Applied on LEDs



Tungsten settings

CONFERENCE OF LIGHT

THE FLIPBOOK

CONFERENCE OF LIGHT

THE FLIPBOOK

Cinex

Wedge

Parallel with the film strip used to grade in the analog way

CONFERENCE OF LIGHT

THE FLIPBOOK

Cinex

Wedge

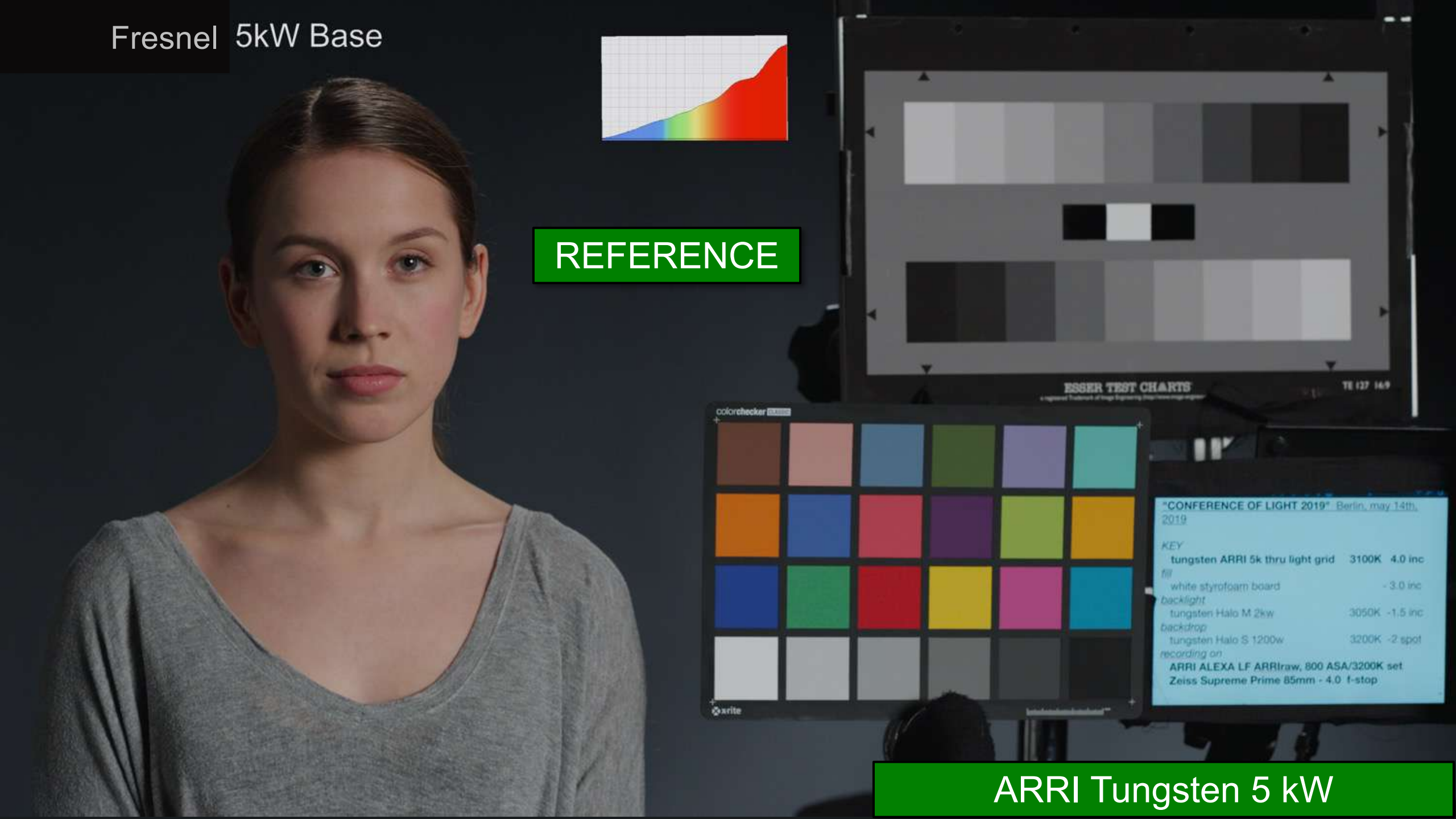
Quickly perceive through visual memory

the harmony or not of a series of images

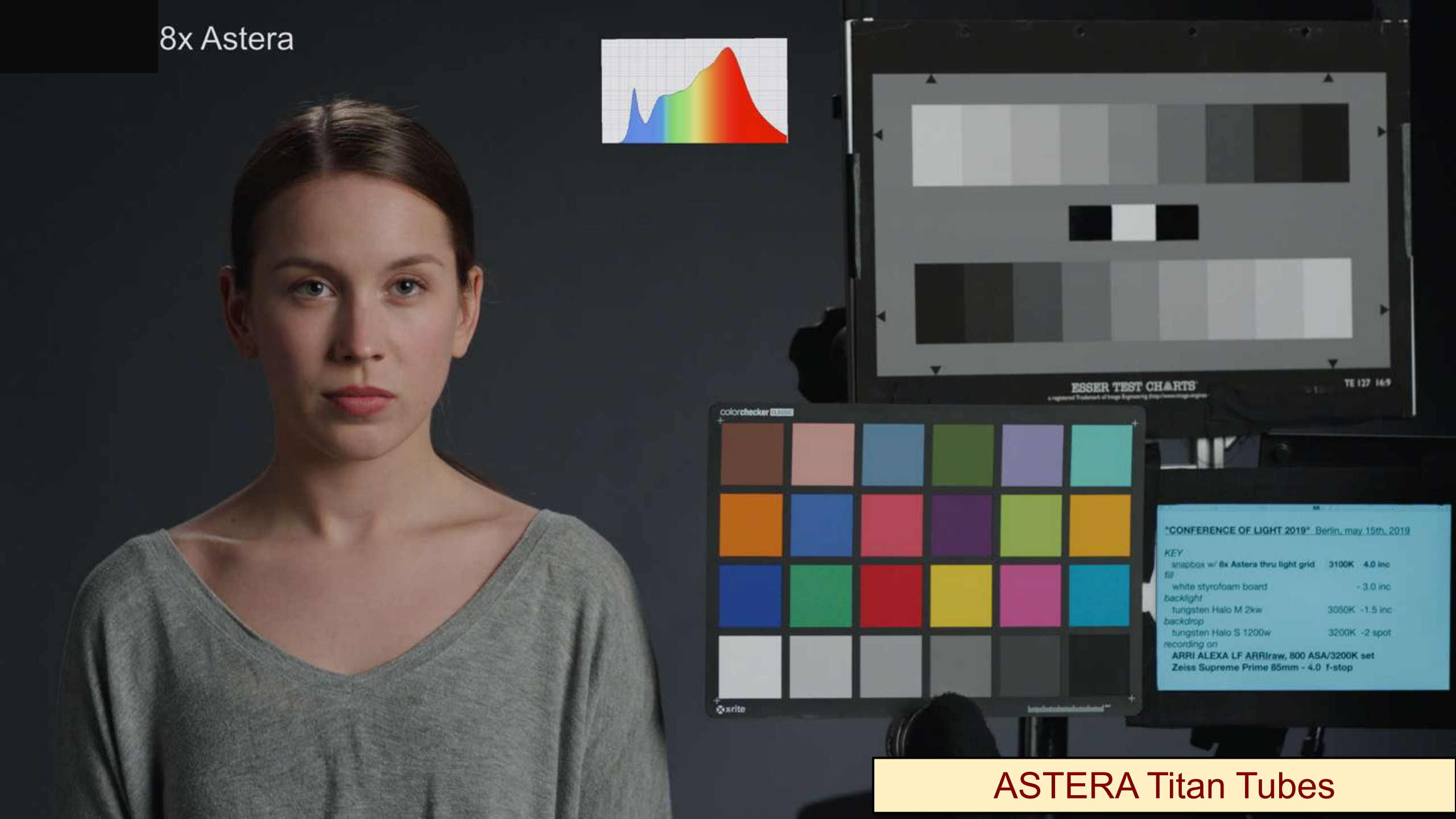
CONFERENCE OF LIGHT

BRIGHT SKIN TONE

Large shot


Fresnel 5kW Base
REFERENCE
ESSER TEST CHARTS
"CONFERENCE OF LIGHT 2019" Berlin, may 14th, 2019
KEY
tungsten ARRI 5k thru light grid 3100K 4.0 inc
fill
white styrofoam board - 3.0 inc
backlight
tungsten Halo M 2kw 3050K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
ARRI Tungsten 5 kW


Aladdin FabricLite
ESSER TEST CHARTS
TE 127 16:9
colorchecker
x-rite
"CONFERENCE OF LIGHT 2019" Berlin, may 15th, 2019
KEY
Aladdin FabricLite @100% thru lt. grid 3100K 4.0 inc
fill
white styrofoam board -3.0 inc
backlight
tungsten Halo M 2kw 3050K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
ALADDIN Fabric Lite 350W


8x Astera
ESSER TEST CHARTS
TE 127 16:9
colorchecker
x-rite
"CONFERENCE OF LIGHT 2019" Berlin, may 15th, 2019
KEY
snapbox w/ 8x Astera thru light grid 3100K 4.0 inc
fill
white styrofoam board - 3.0 inc
backlight
tungsten Halo M 2kw 3050K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
ASTERA Titan Tubes

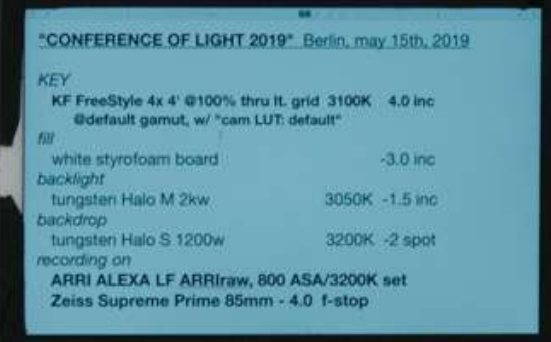

Lightblade
ESSER TEST CHARTS
TE 127 16:9
colorchecker
xrite
"CONFERENCE OF LIGHT 2019" Berlin, may 14th, 2019
KEY
CINEO LB800 ->lt grid @100% 3100K 4.0 inc
fill
white styrofoam board - 3.0 inc
backlight
tungsten Halo M 2kw 3150K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
CINEO LightBlade 800

CS Micro Color

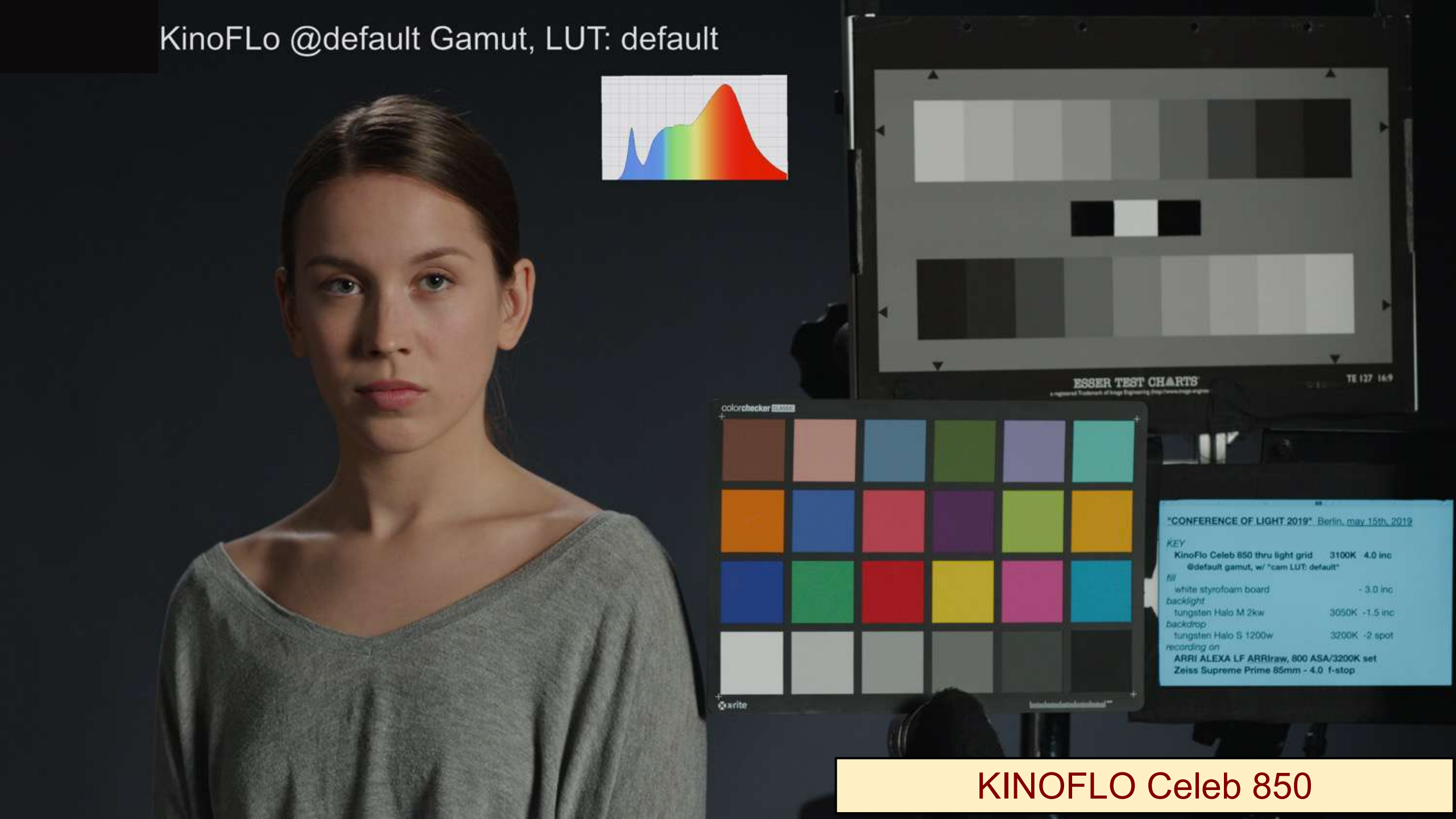
CREAMSOURCE Micro Colour

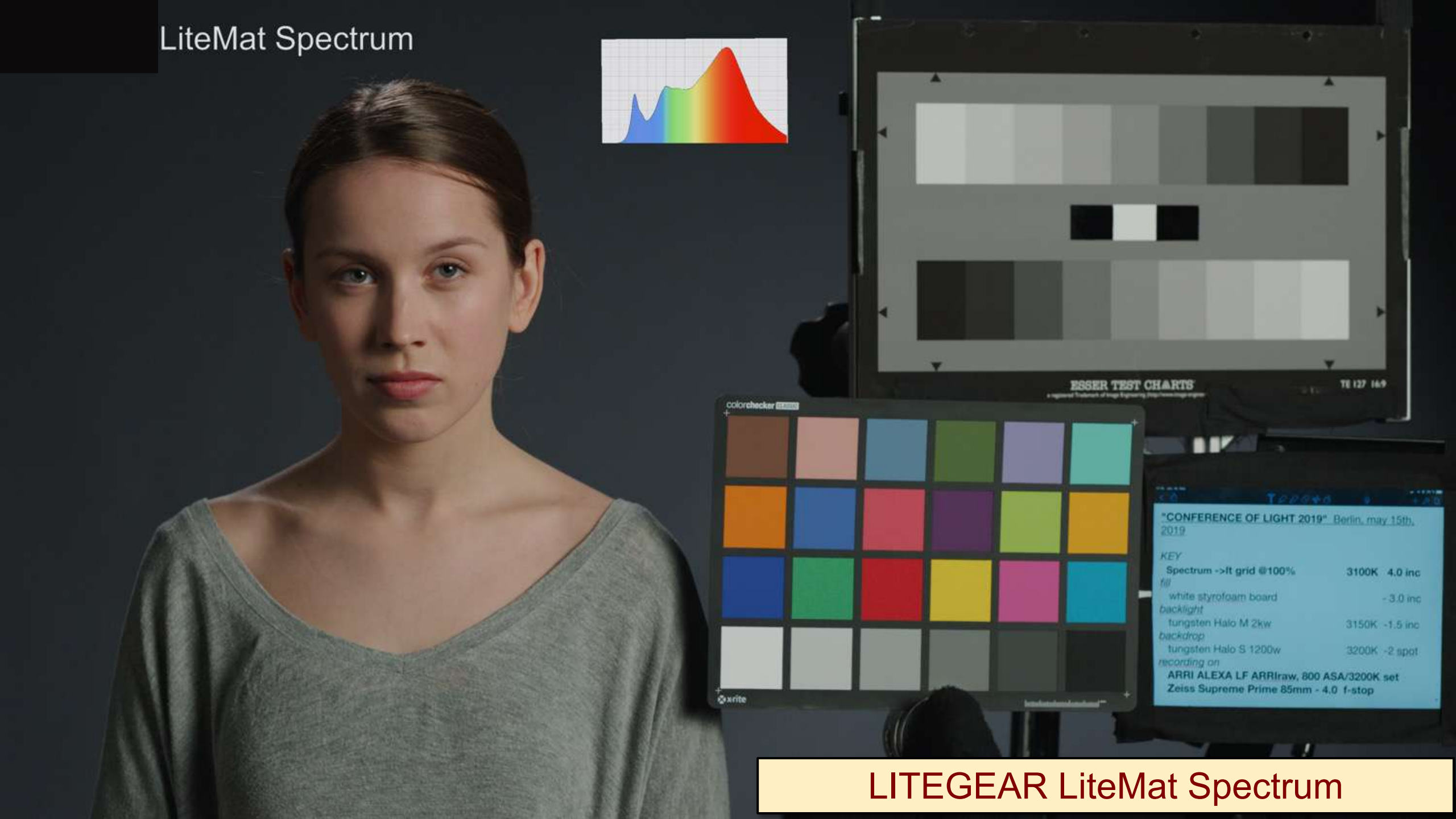

CreamSource
ESSER TEST CHARTS
colorchecker
"CONFERENCE OF LIGHT 2019" Berlin, may 14th, 2019
KEY
Creamsource SpaceX->lt grid @83% 3200K 4.0 inc
fill
white styrofoam board - 3.0 inc
backlight
tungsten Halo M 2kw 3150K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
CREAMSOURCE Space X

KF FreeStyle default Gamut, default LUT



KINOFLO Freestyle 4


KinoFLo @default Gamut, LUT: default
ESSER TEST CHARTS
TE 127 16:9
colorchecker
xrite
"CONFERENCE OF LIGHT 2019" Berlin, may 15th, 2019
KEY
KinoFlo Celeb 850 thru light grid 3100K 4.0 inc
@default gamut, w/ "cam LUT: default"
fill
white styrofoam board - 3.0 inc
backlight
tungsten Halo M 2kw 3050K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
KINOFLO Celeb 850


LiteMat Spectrum
ESSER TEST CHARTS
"CONFERENCE OF LIGHT 2019" Berlin, may 15th, 2019
KEY
Spectrum ->lt grid @100% 3100K 4.0 inc
fill
white styrofoam board - 3.0 inc
backlight
tungsten Halo M 2kw 3150K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
LITEGEAR LiteMat Spectrum

LiteTile

ESSER TEST CHARTS

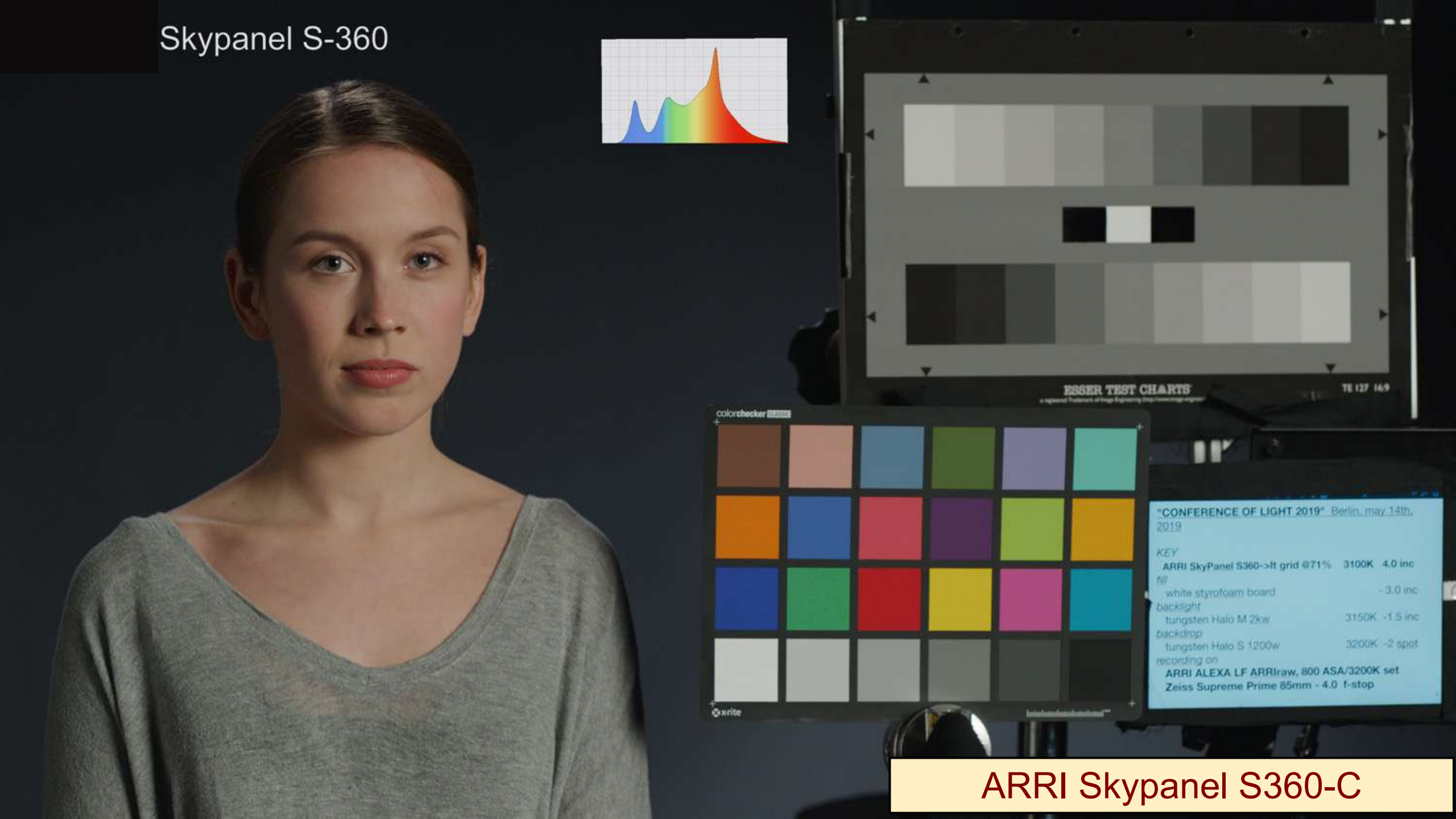
"CONFERENCE OF LIGHT 2019" Berlin, may 15th, 2019

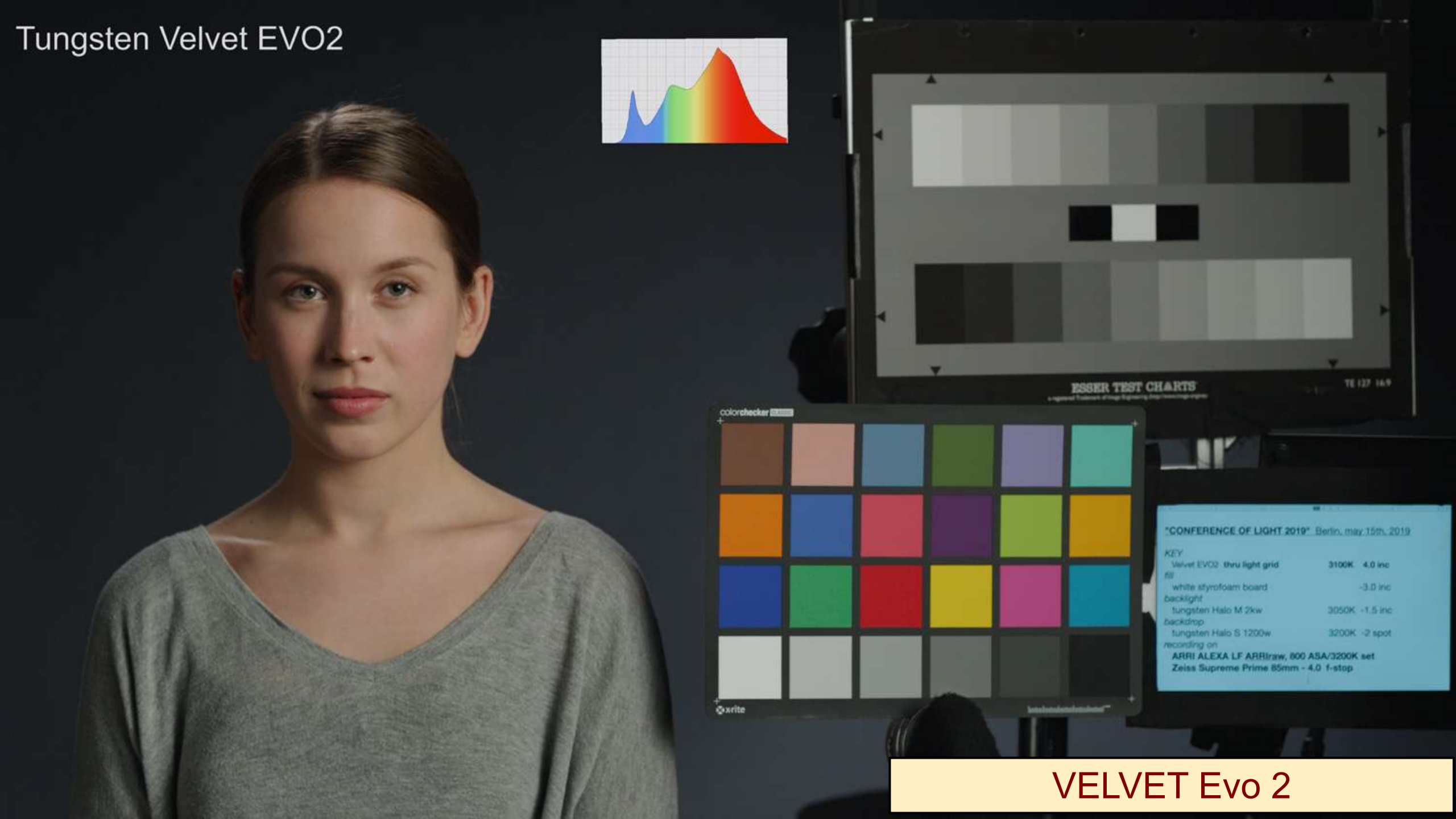
KEY
LiteGear LiteTile 4x4 thru light grid 3100K 4.0 inc
@100%
fill
white styrofoam board - 3.0 inc
backlight
tungsten Halo M 2kw 3050K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop

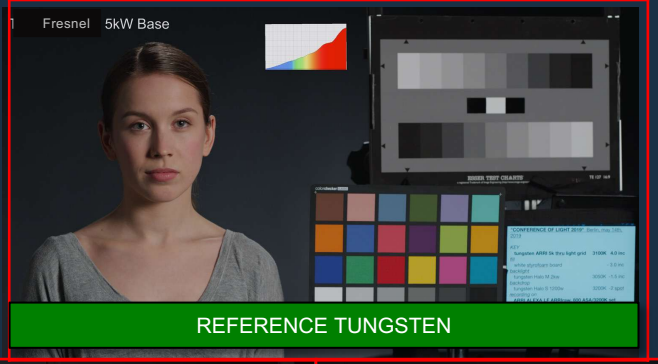
LITEGEAR LiteTile

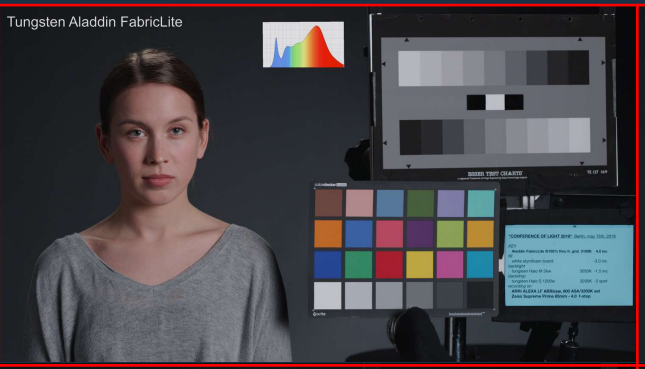
Rosco Lumière

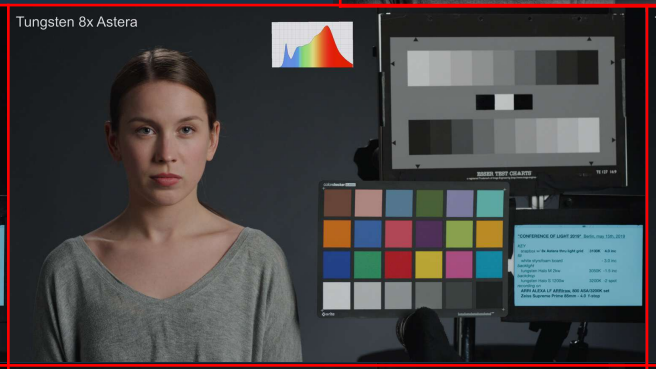
DMG ROSCO SL1 Mix

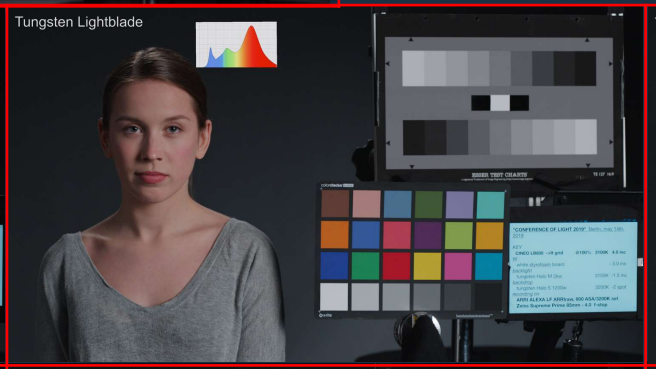

Skypanel S-360
ESSER TEST CHARTS
TE 127 16:9
colorchecker
xrite
"CONFERENCE OF LIGHT 2019" Berlin, may 14th, 2019
KEY
ARRI SkyPanel S360->lt grid @71% 3100K 4.0 inc
fill
white styrofoam board -3.0 inc
backlight
tungsten Halo M 2kw 3150K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
ARRI Skypanel S360-C

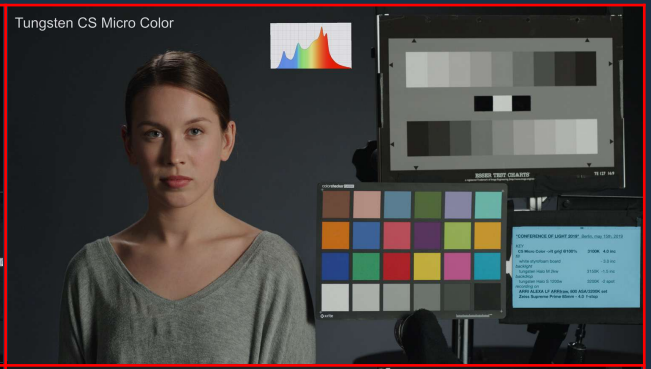

Tungsten Velvet EVO2
ESSER TEST CHARTS
colorchecker
"CONFERENCE OF LIGHT 2019" Berlin, may 15th, 2019
KEY
Velvet EVO2 thru light grid 3100K 4.0 inc
fill
white styrofoam board -3.0 inc
backlight
tungsten Halo M 2kw 3050K -1.5 inc
backdrop
tungsten Halo S 1200w 3200K -2 spot
recording on
ARRI ALEXA LF ARRIraw, 800 ASA/3200K set
Zeiss Supreme Prime 85mm - 4.0 f-stop
xrite
VELVET Evo 2

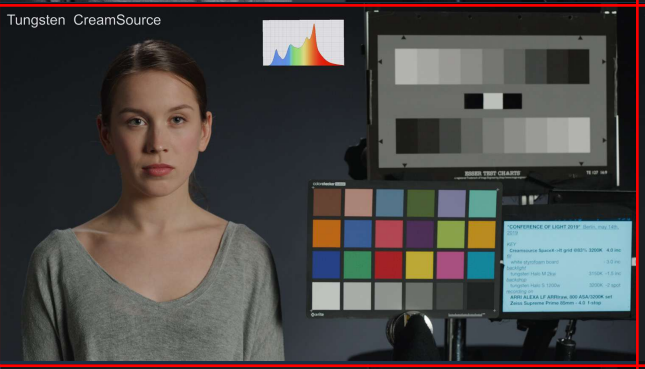

Fresnel 5kW Base
REFERENCE TUNGSTEN

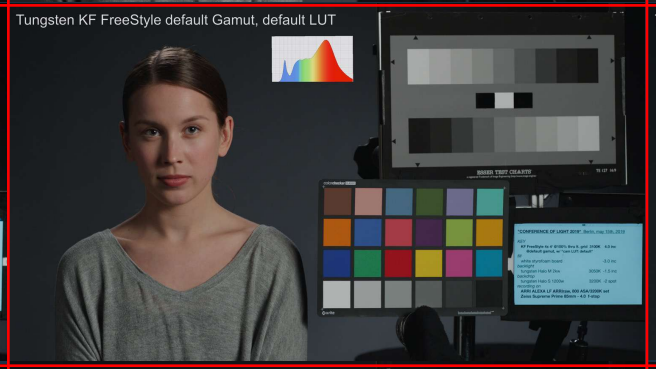

Tungsten Aladdin FabricLite

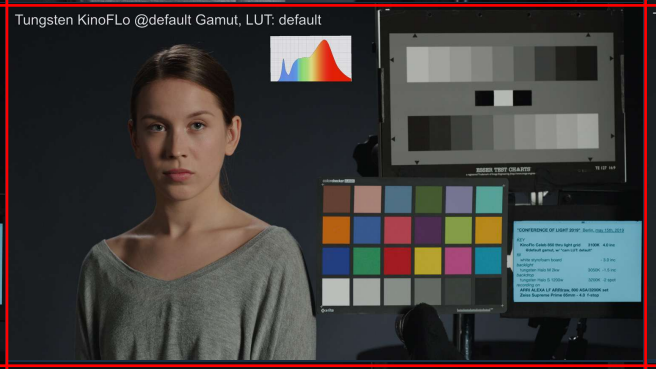

Tungsten 8x Astera

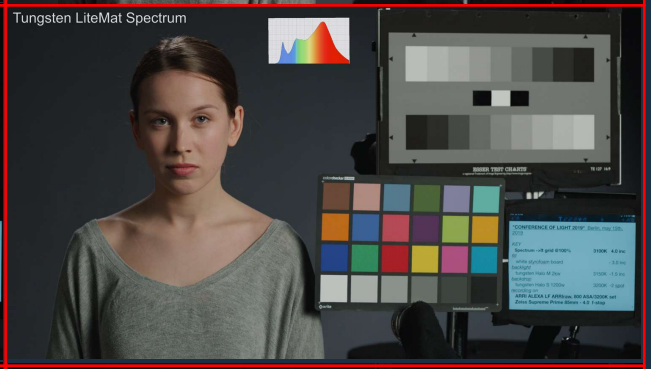

Tungsten Lightblade

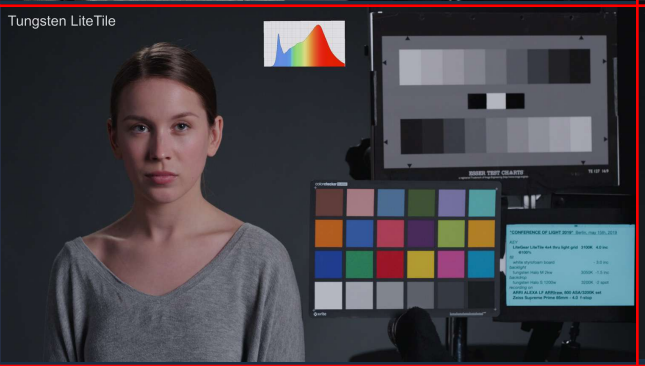

Tungsten CS Micro Color

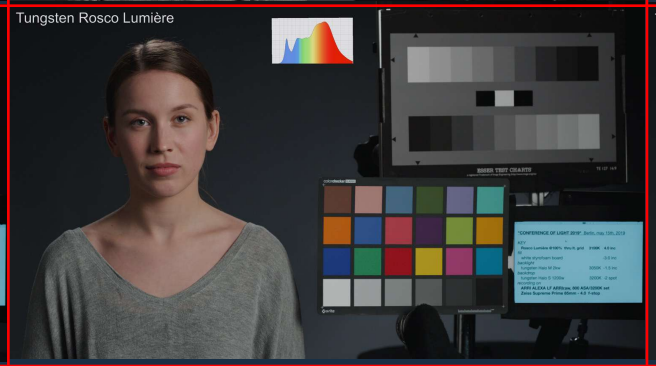

Tungsten CreamSource

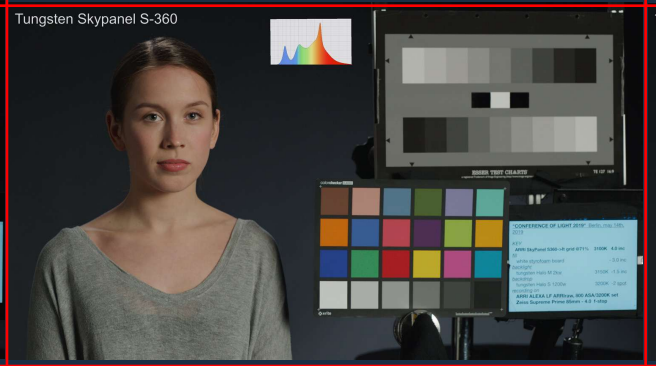

Tungsten KF FreeStyle default Gamut, default LUT

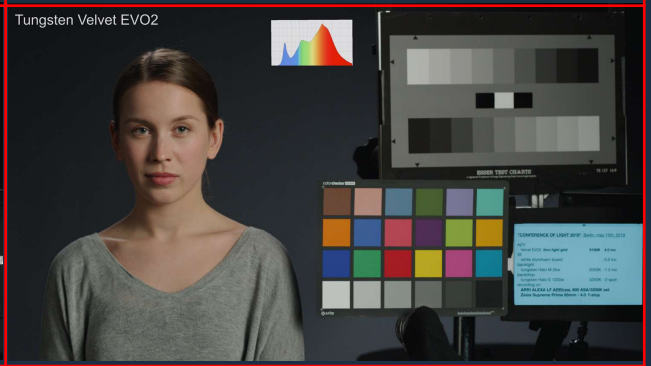

Tungsten KinoFLo @default Gamut, LUT: default


Tungsten LiteMat Spectrum


Tungsten LiteTile


Tungsten Rosco Lumière


Tungsten Skypanel S-360


Tungsten Velvet EVO2

CONFERENCE OF LIGHT

For this series of tests:

- No intention to judge the quality of each LED
- The idea: To see what happens to skin tone when you use different brands of LEDs on set.

CONFERENCE OF LIGHT

With few exceptions:

No electrical list uses only one brand of lighting fixtures

CONFERENCE OF LIGHT

These tests were decided:

- By Timm, the gaffer, and Michael, the renter, who had noticed great disparities between the lighting fixtures
- By Toby and Dirk, the two colorists who had to deal with these defects

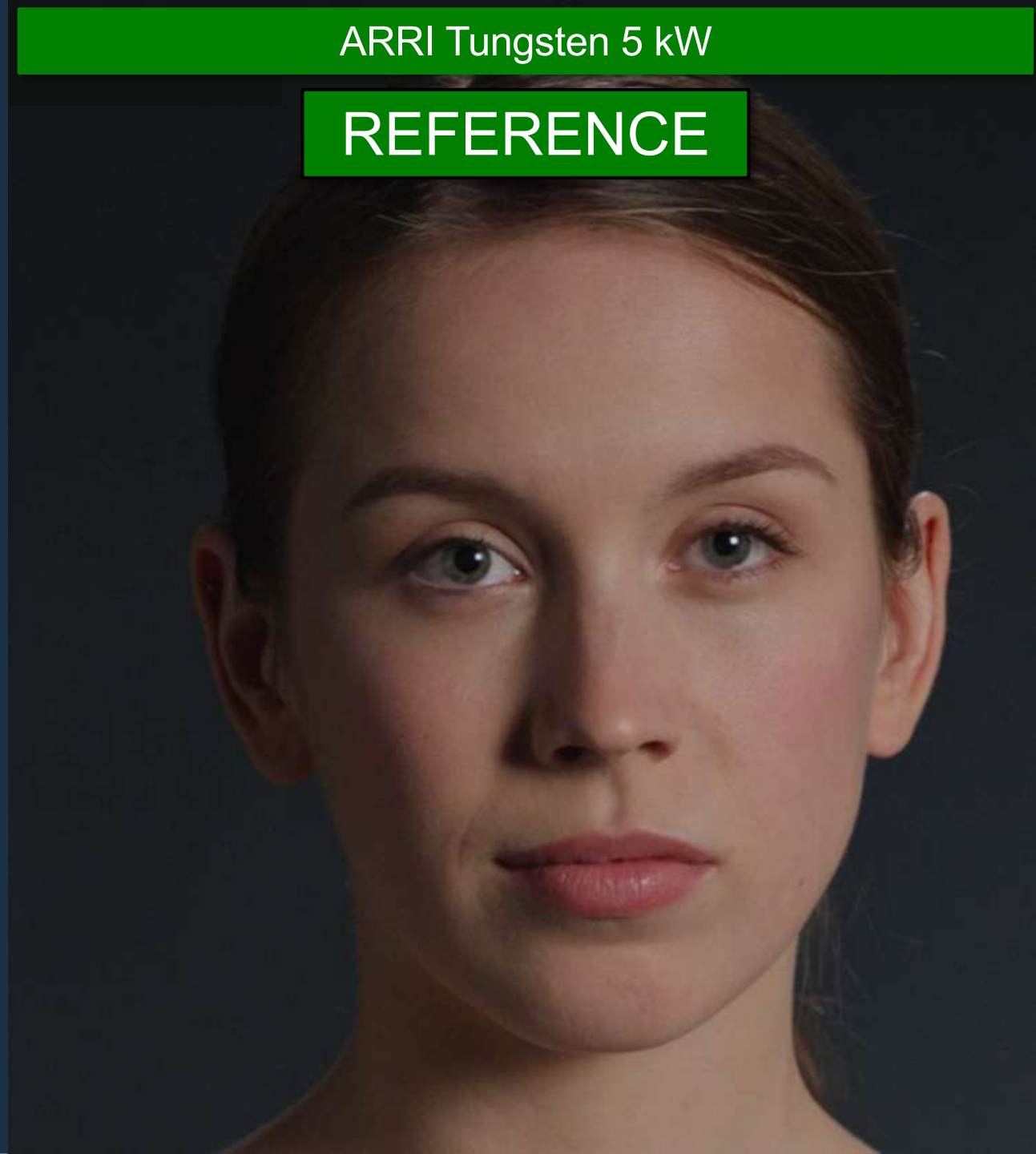
CONFERENCE OF LIGHT

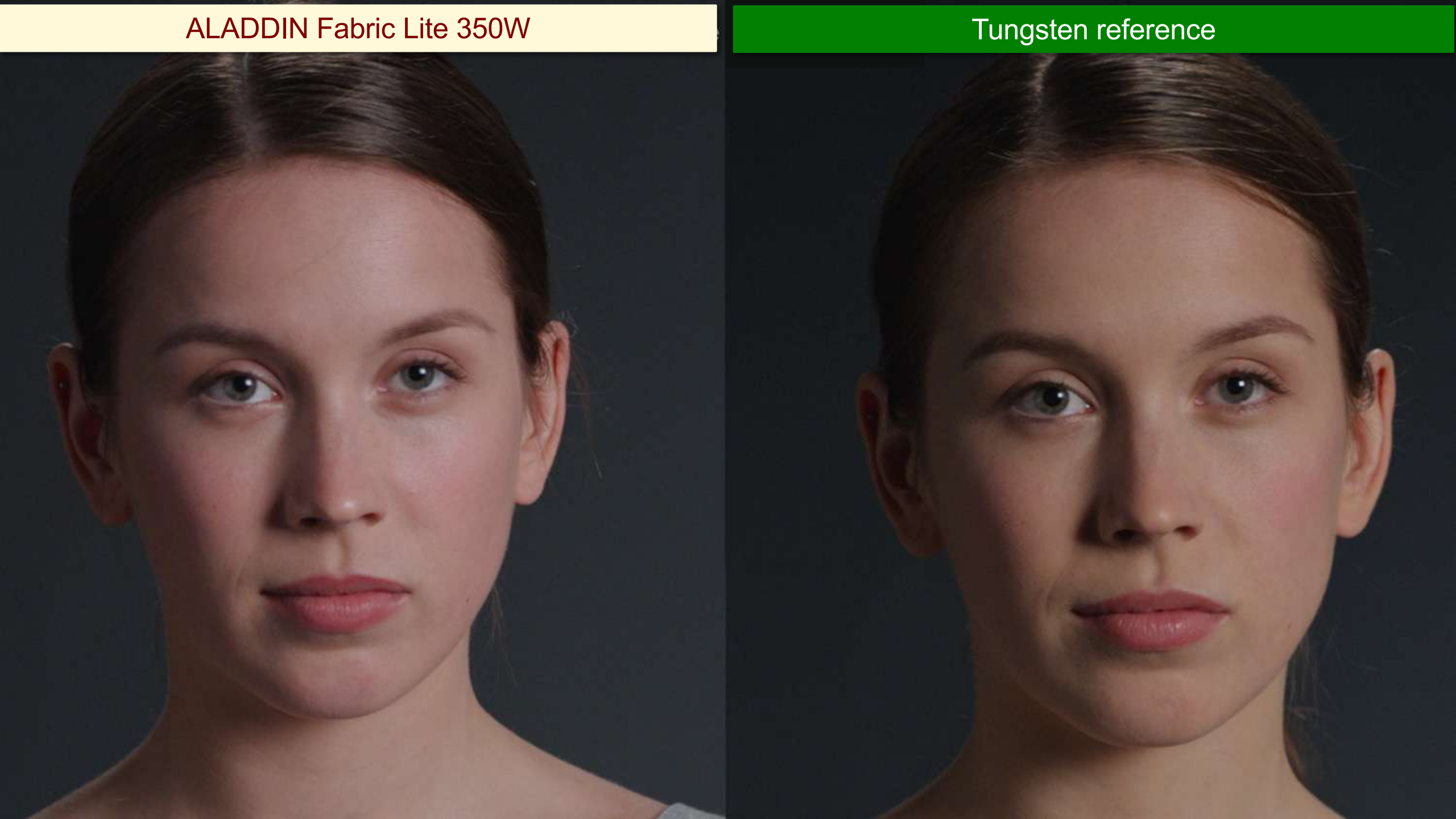
BRIGHT SKIN TONE

Close shot

ARRI Tungsten 5 kW

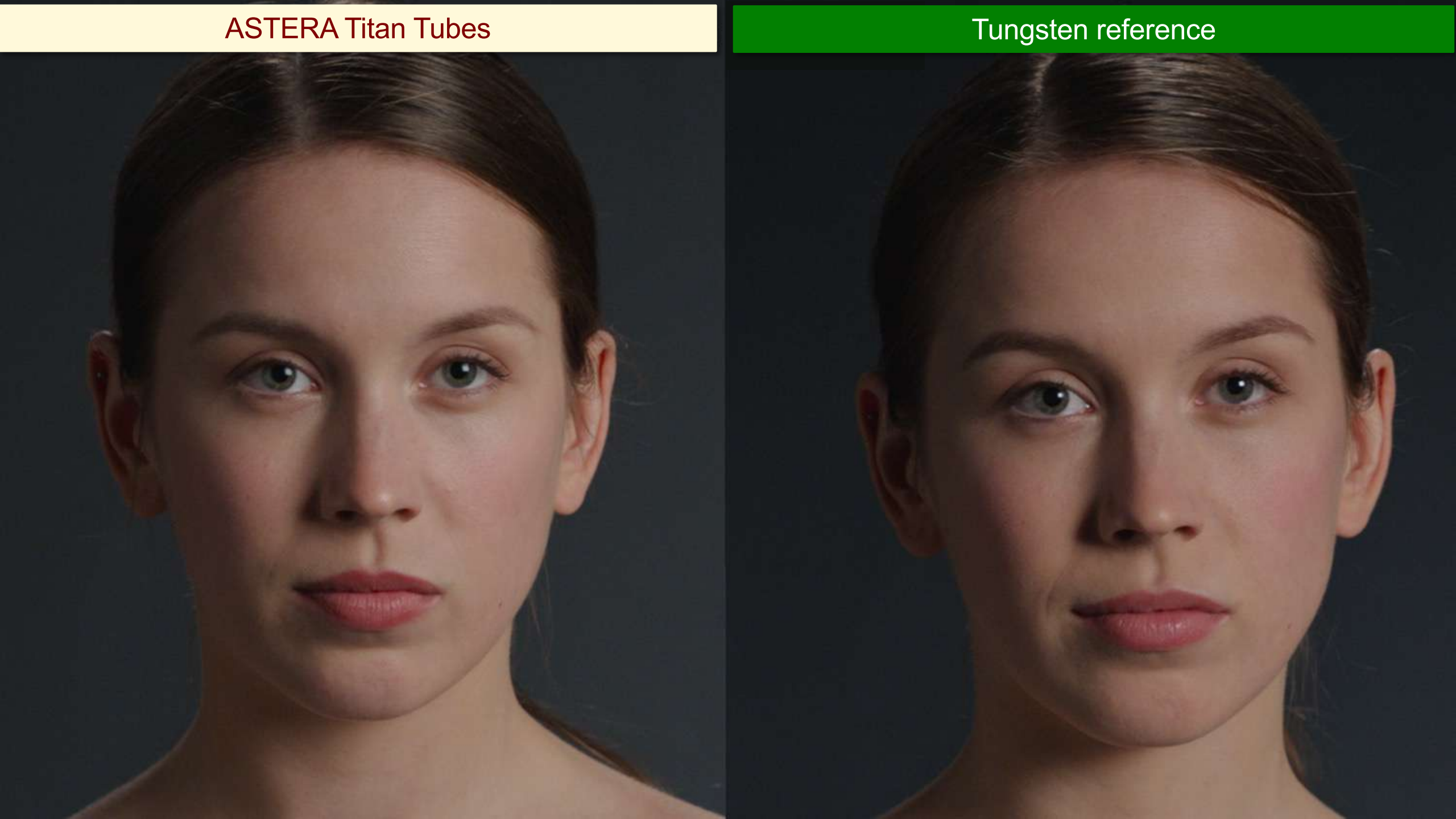
REFERENCE

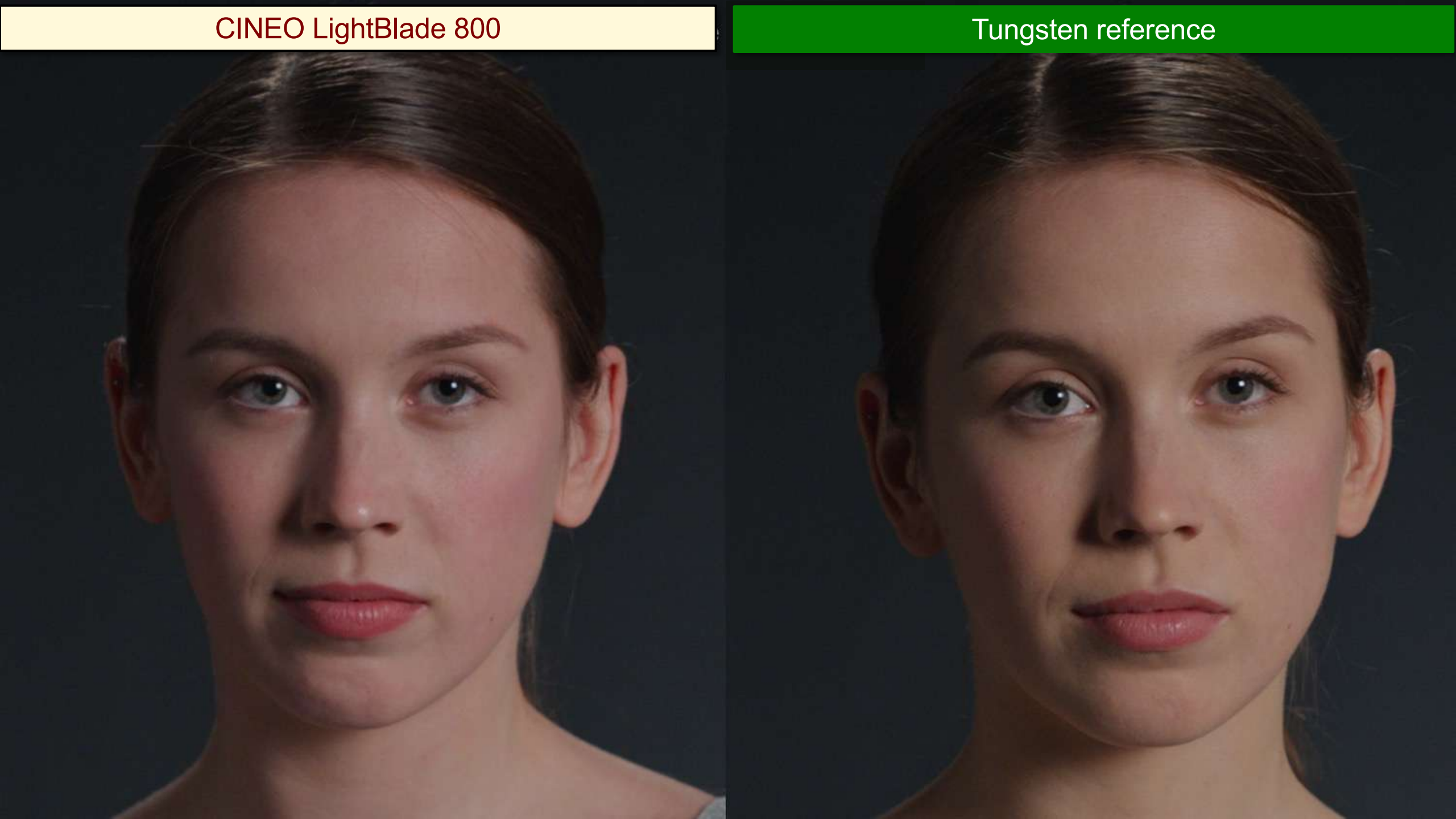


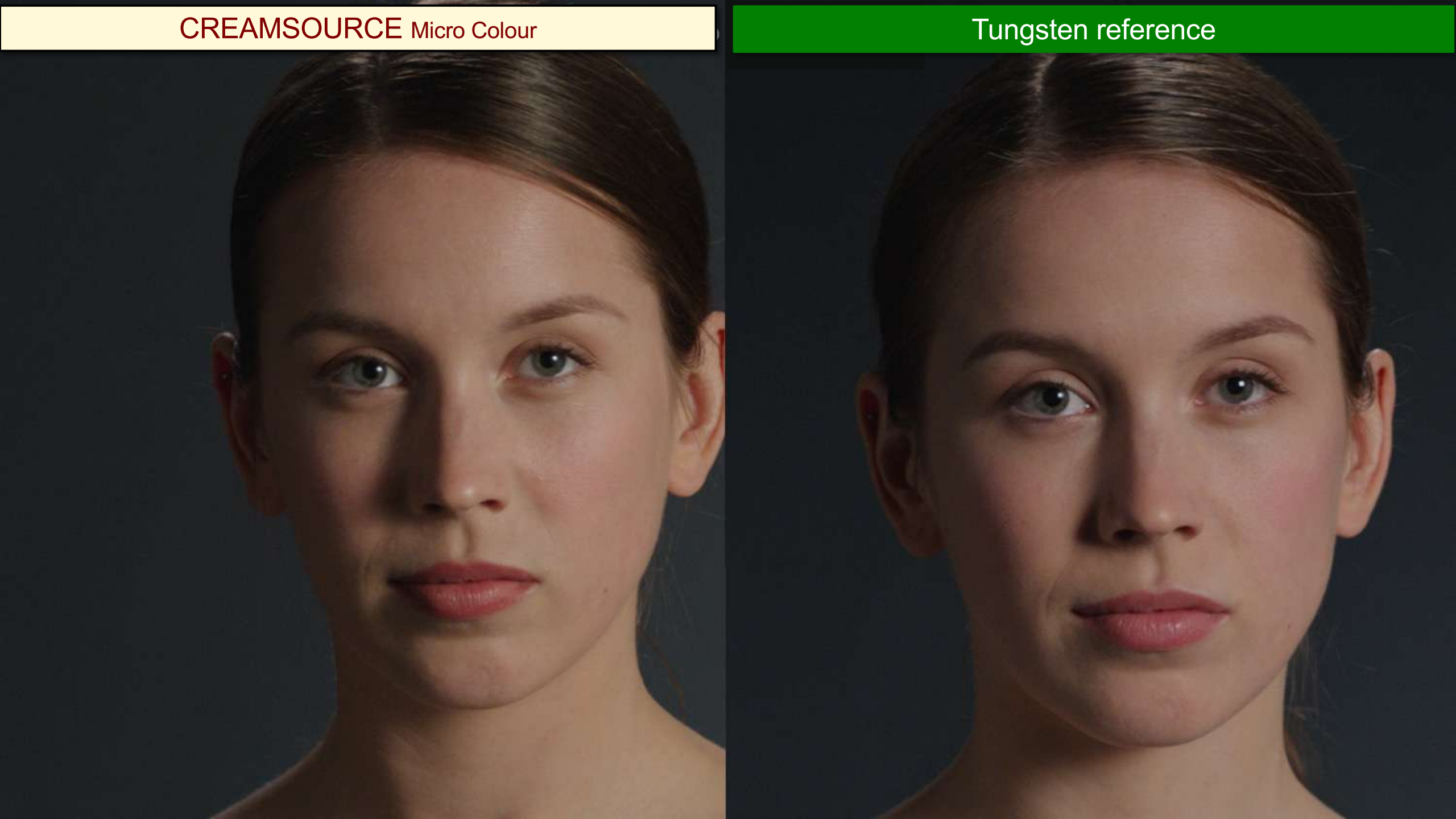

ALADDIN Fabric Lite 350W
Tungsten reference

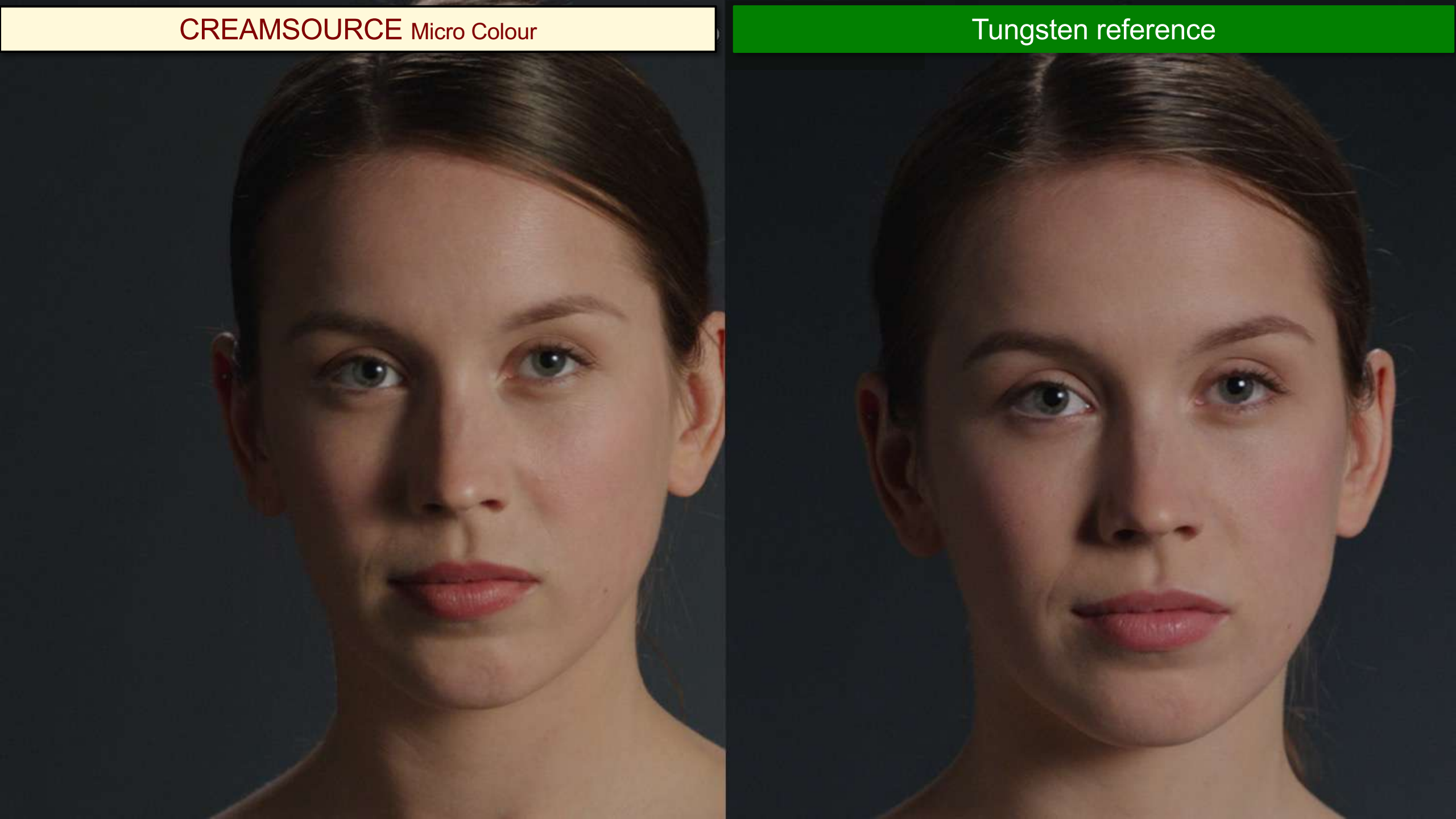
ASTERA Titan Tubes

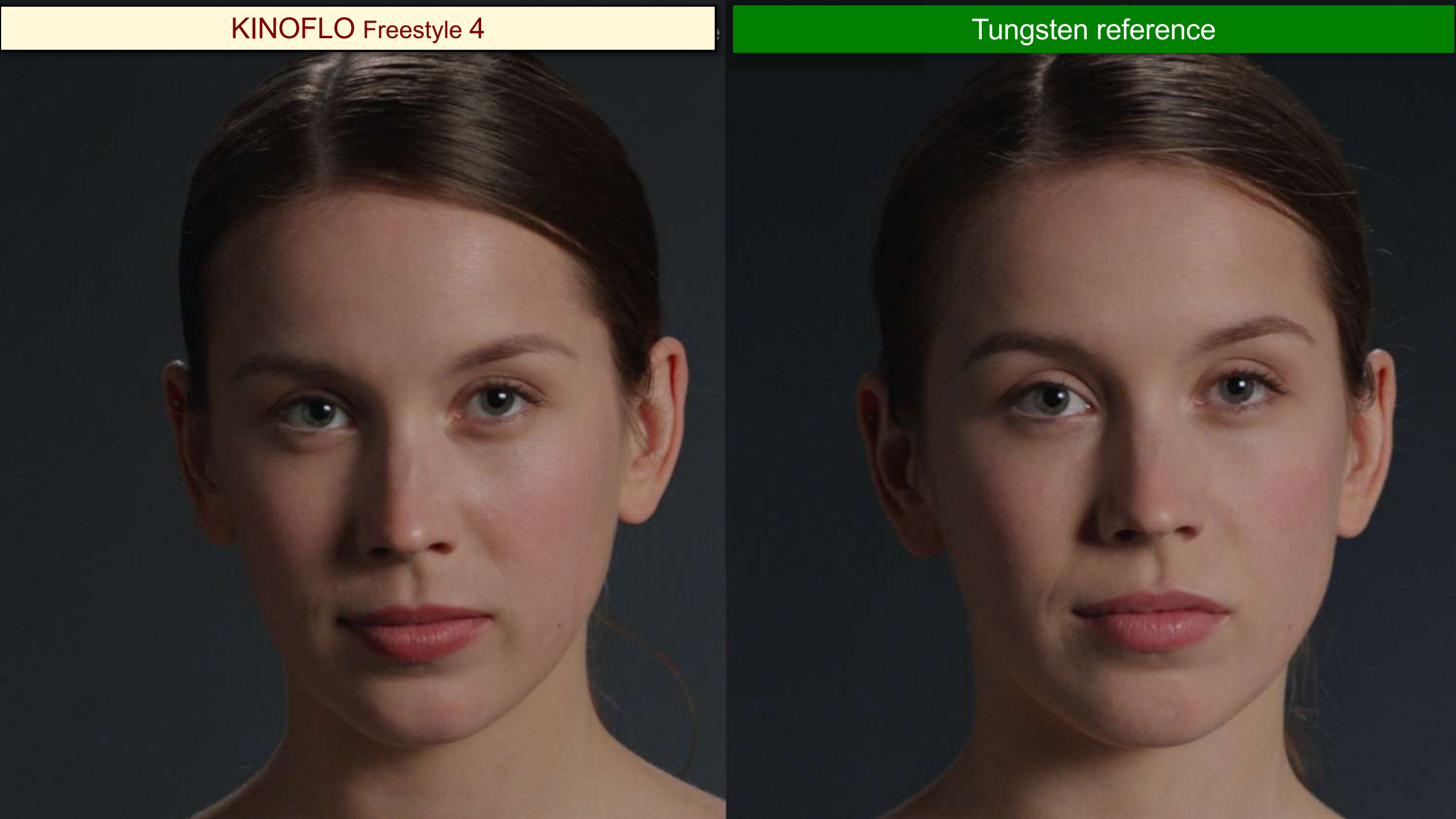
Tungsten reference

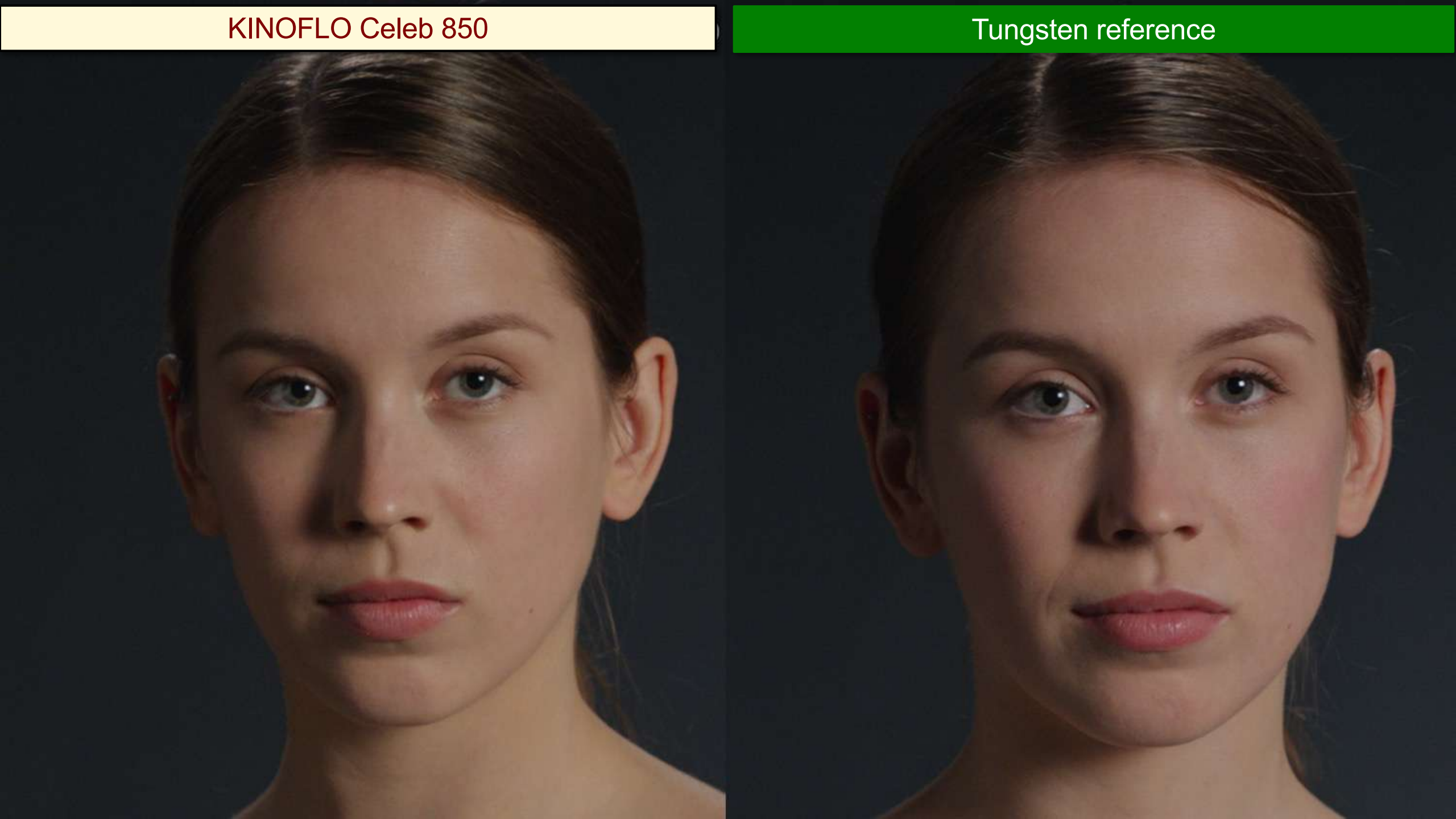


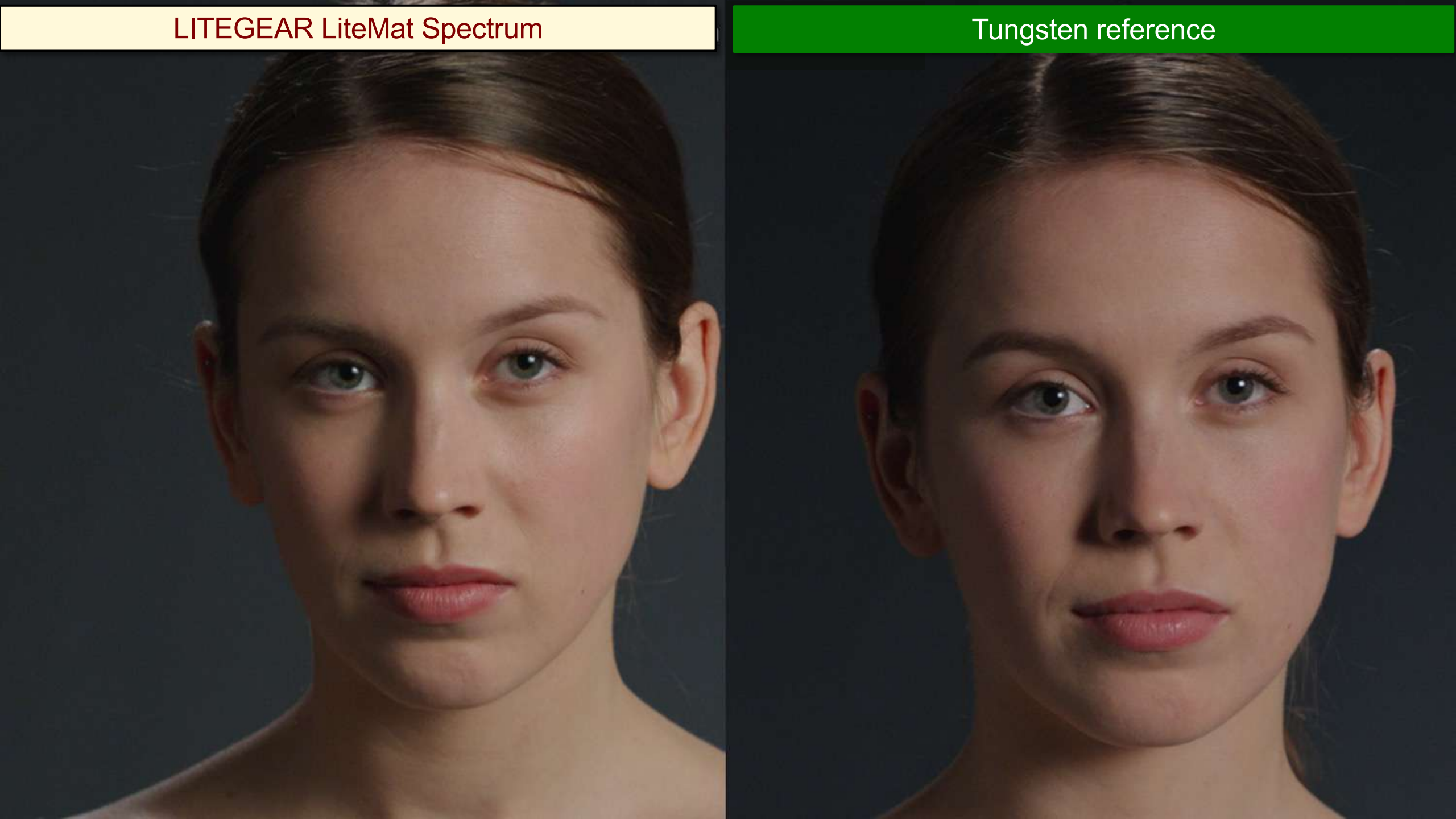

CINEO LightBlade 800
Tungsten reference

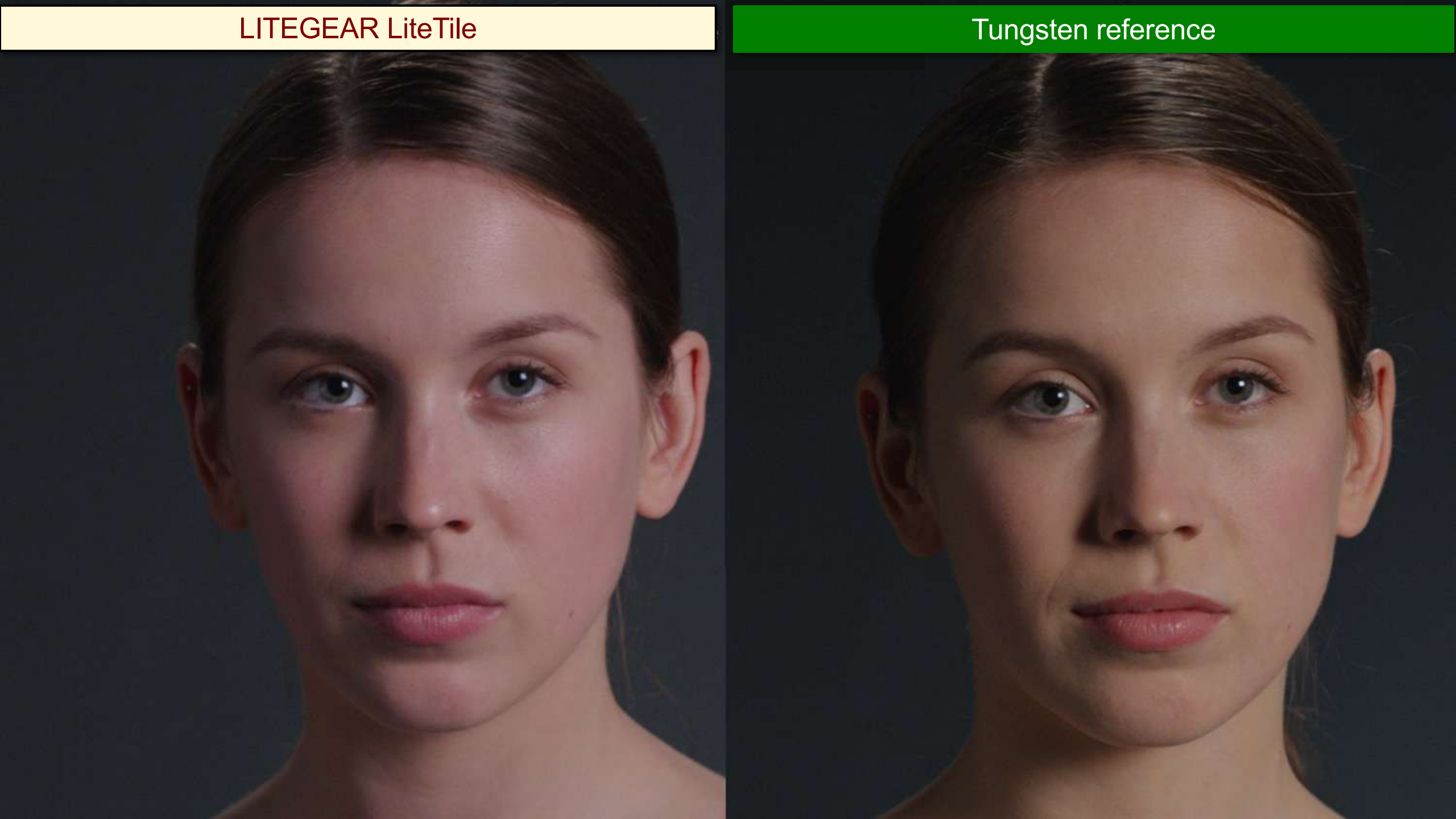

CREAMSOURCE Micro Colour
Tungsten reference

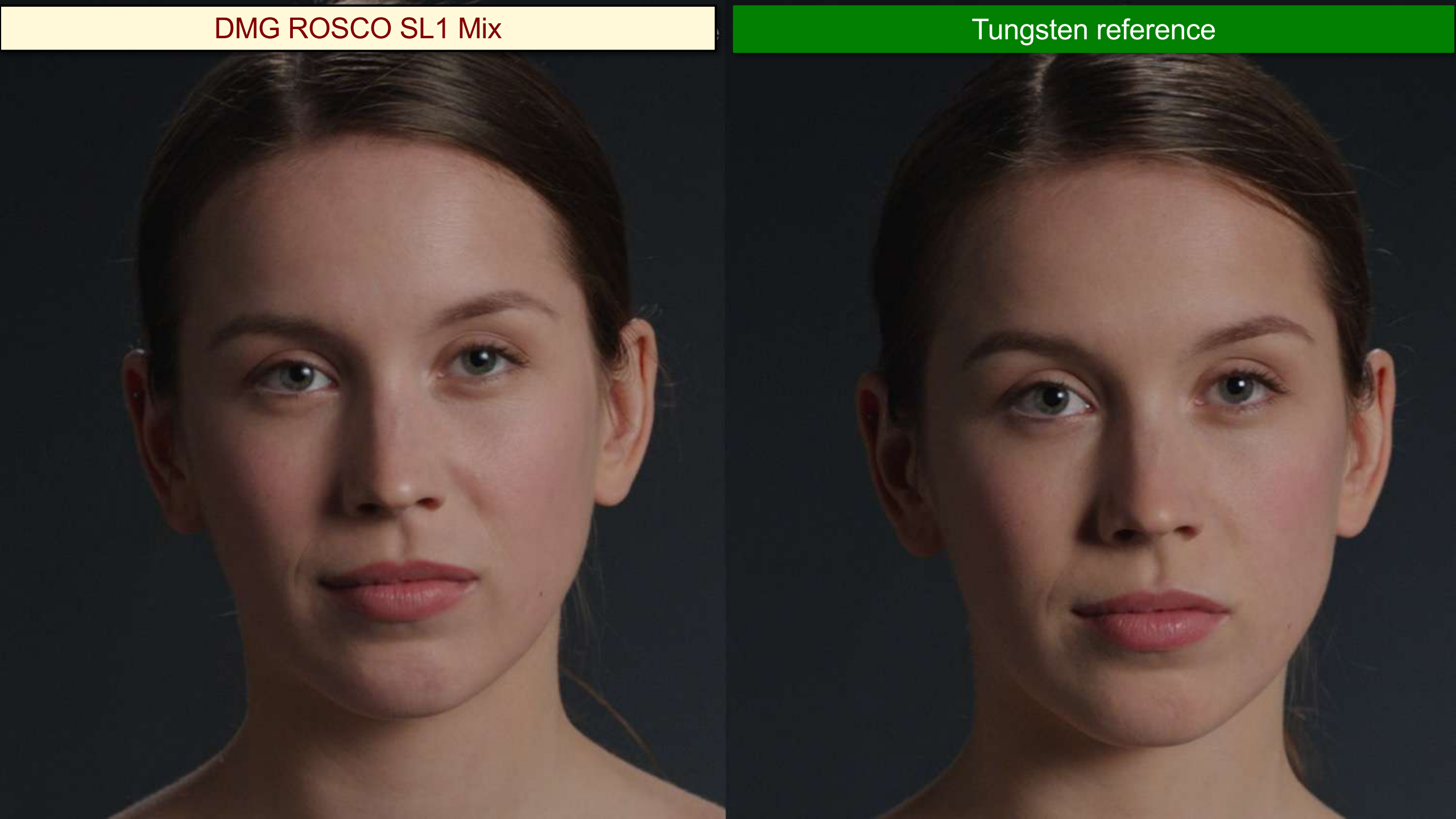

CREAMSOURCE Micro Colour
Tungsten reference

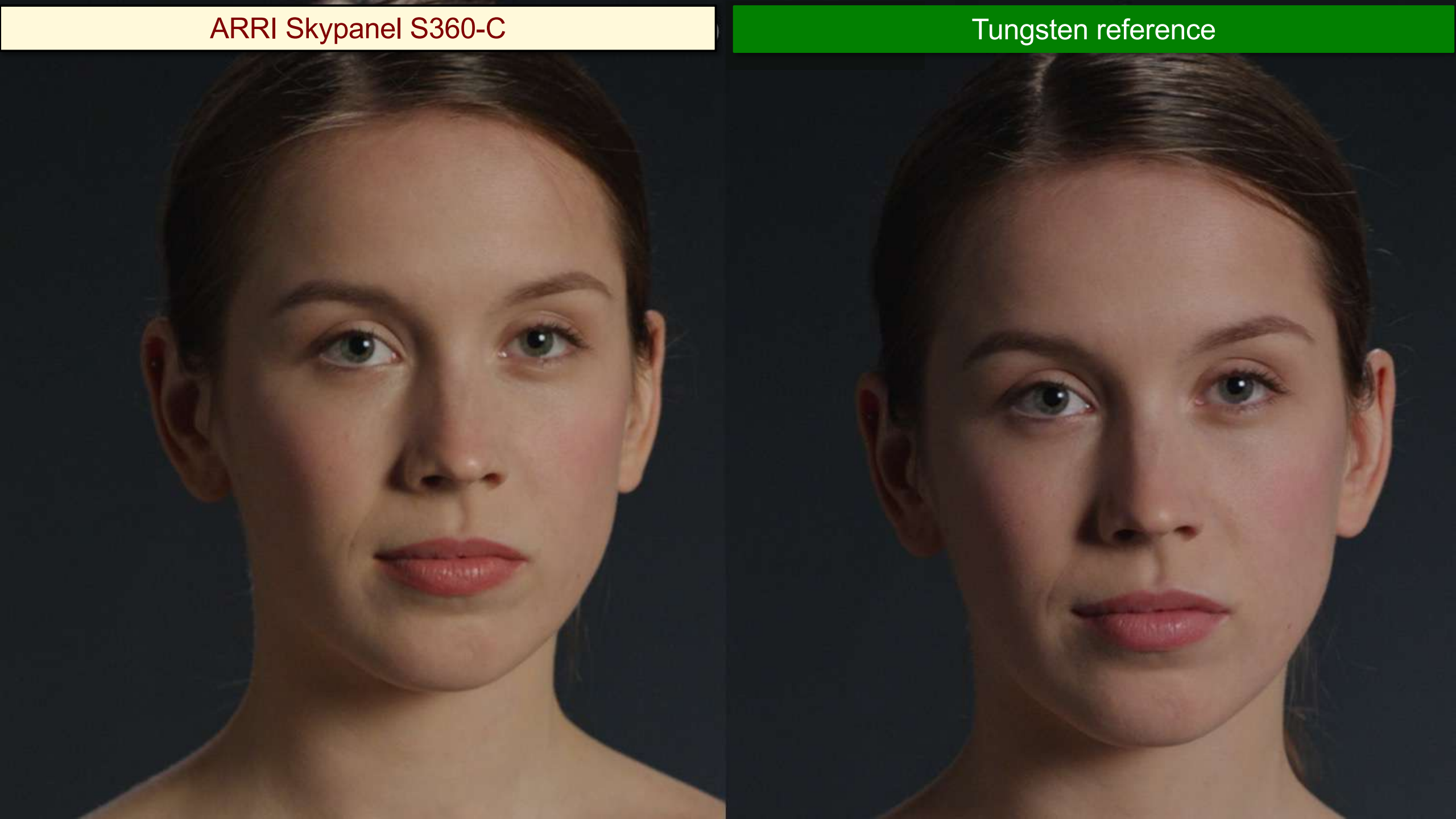

KINOFLO Freestyle 4
Tungsten reference

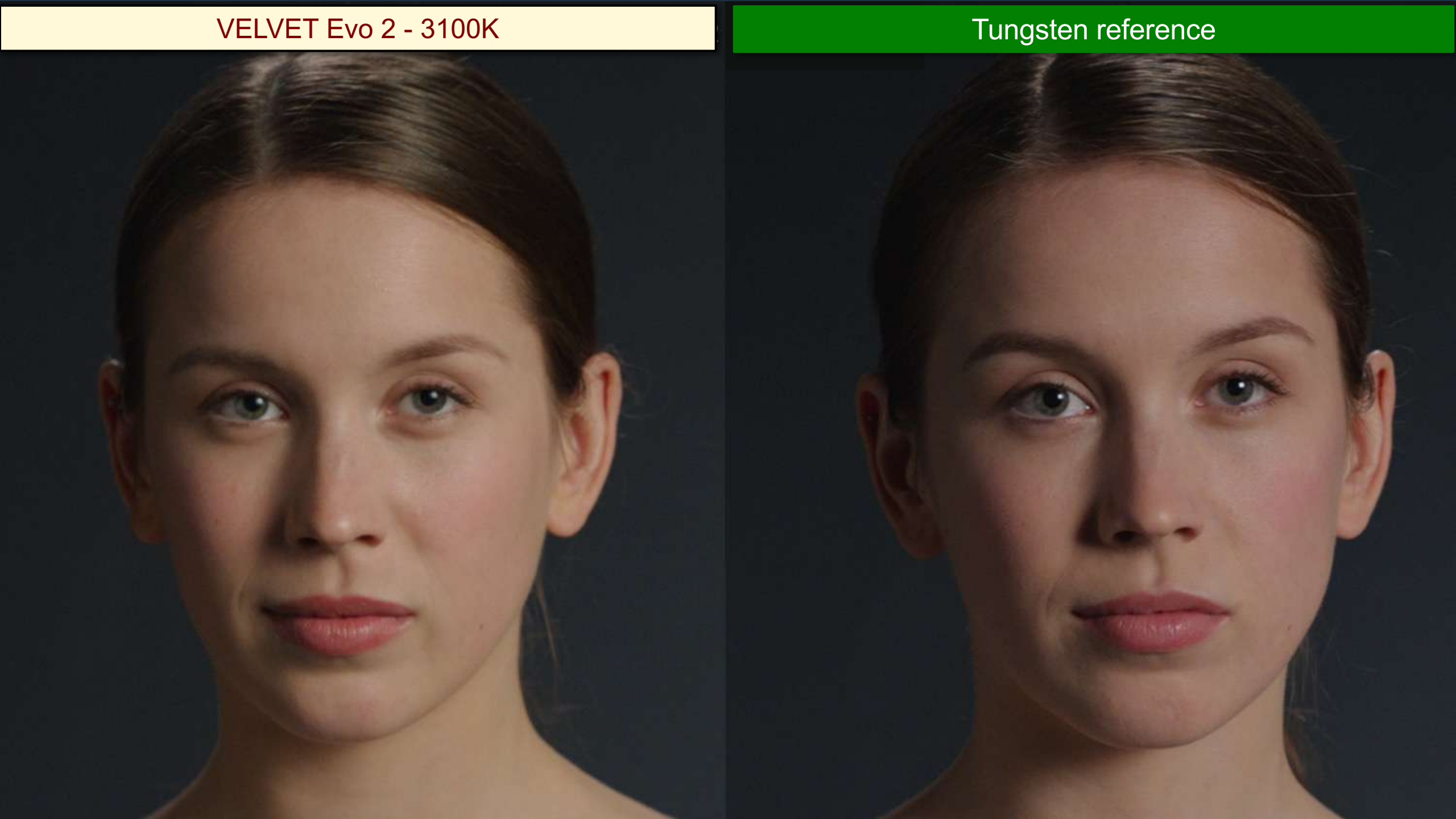

KINOFLO Celeb 850
Tungsten reference

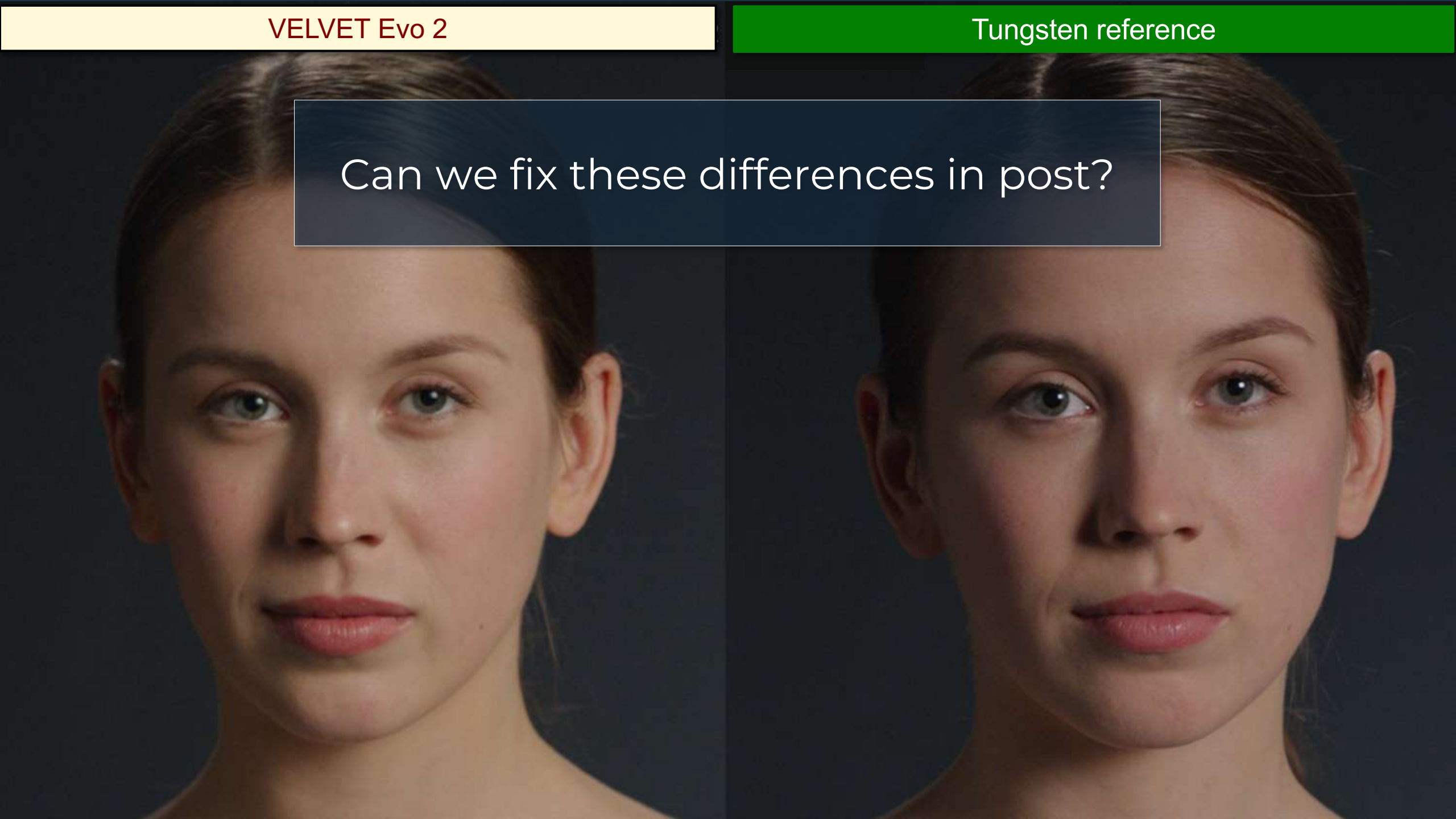

LITEGEAR LiteMat Spectrum
Tungsten reference


LITEGEAR LiteTile
Tungsten reference


DMG ROSCO SL1 Mix
Tungsten reference


ARRI Skypanel S360-C
Tungsten reference


VELVET Evo 2 - 3100K
Tungsten reference


VELVET Evo 2
Tungsten reference
Can we fix these differences in post?

CONFERENCE OF LIGHT

No, we cannot

But it also depends on the colour science of :

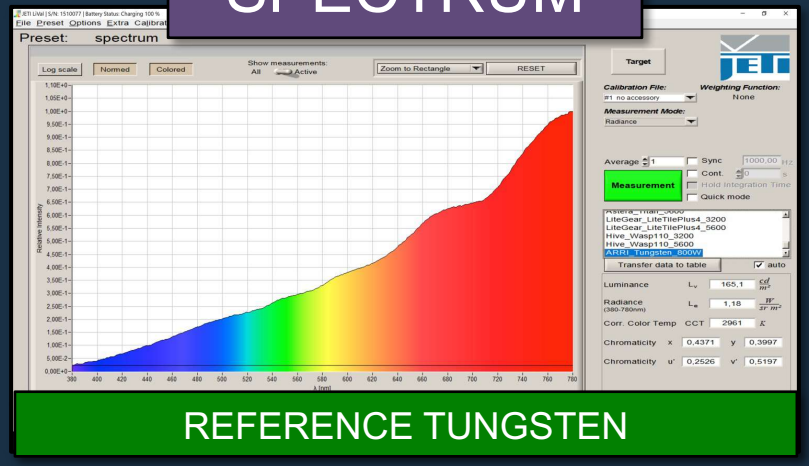
- The camera
- The post-production

CONFERENCE OF LIGHT

How to judge the quality of a led?

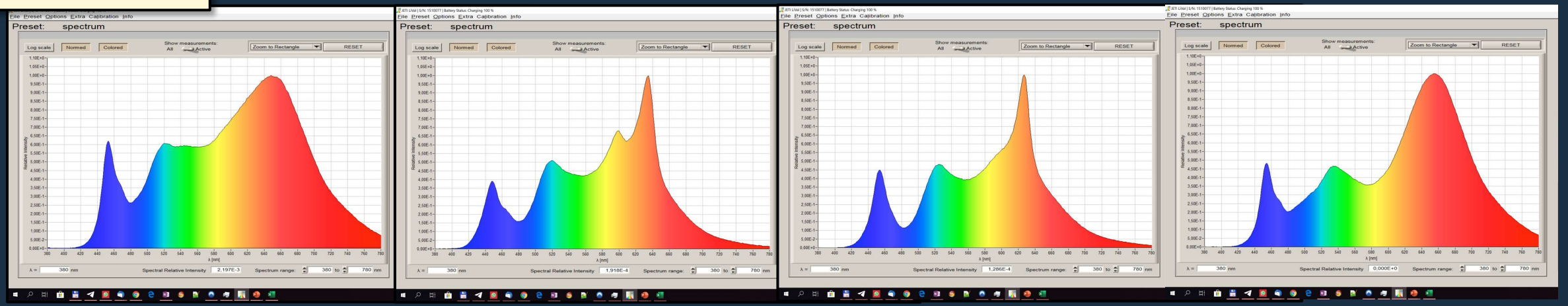
THE SPECTRUM

SPECTRUM

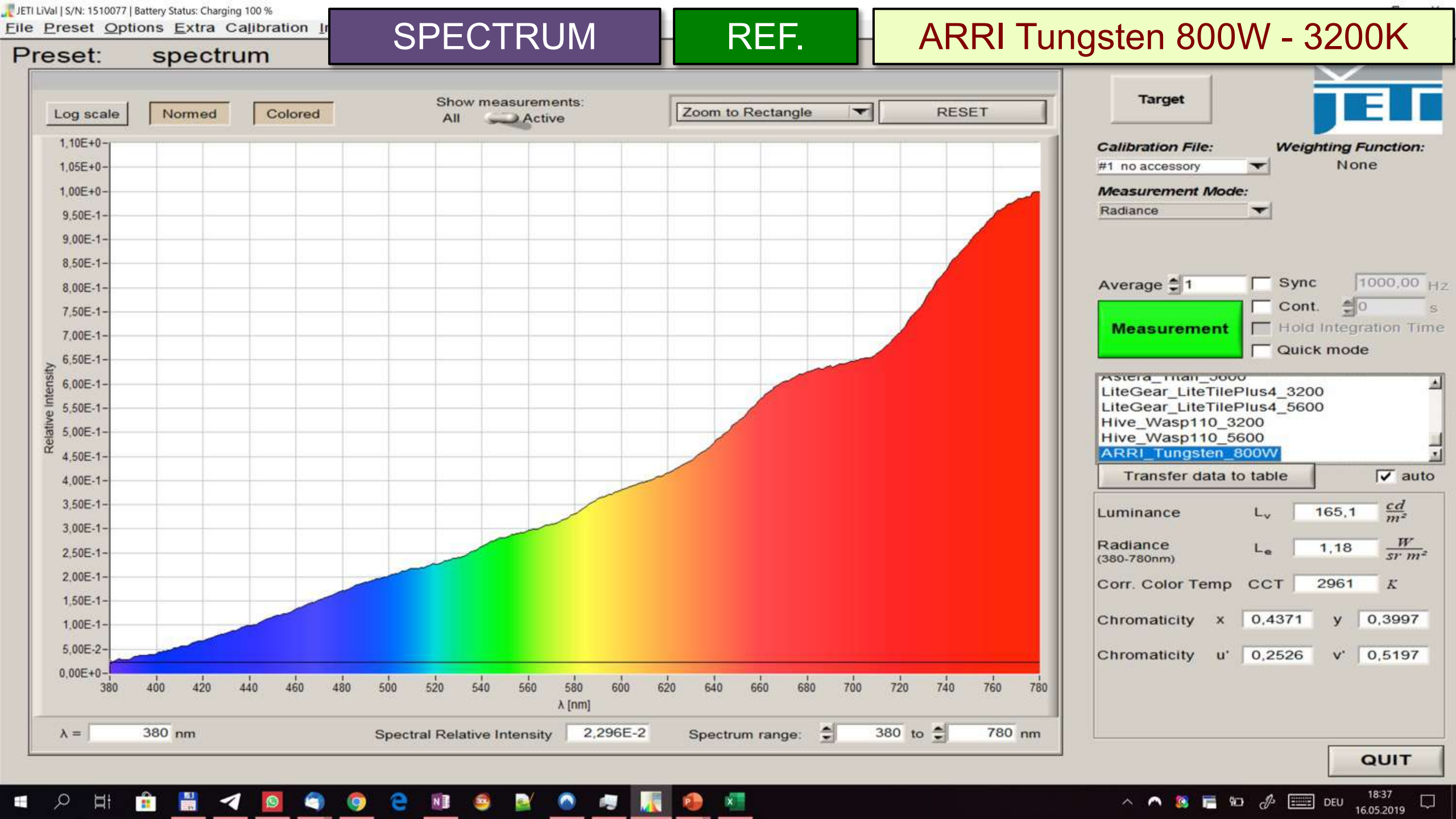


REFERENCE TUNGSTEN

LEDs

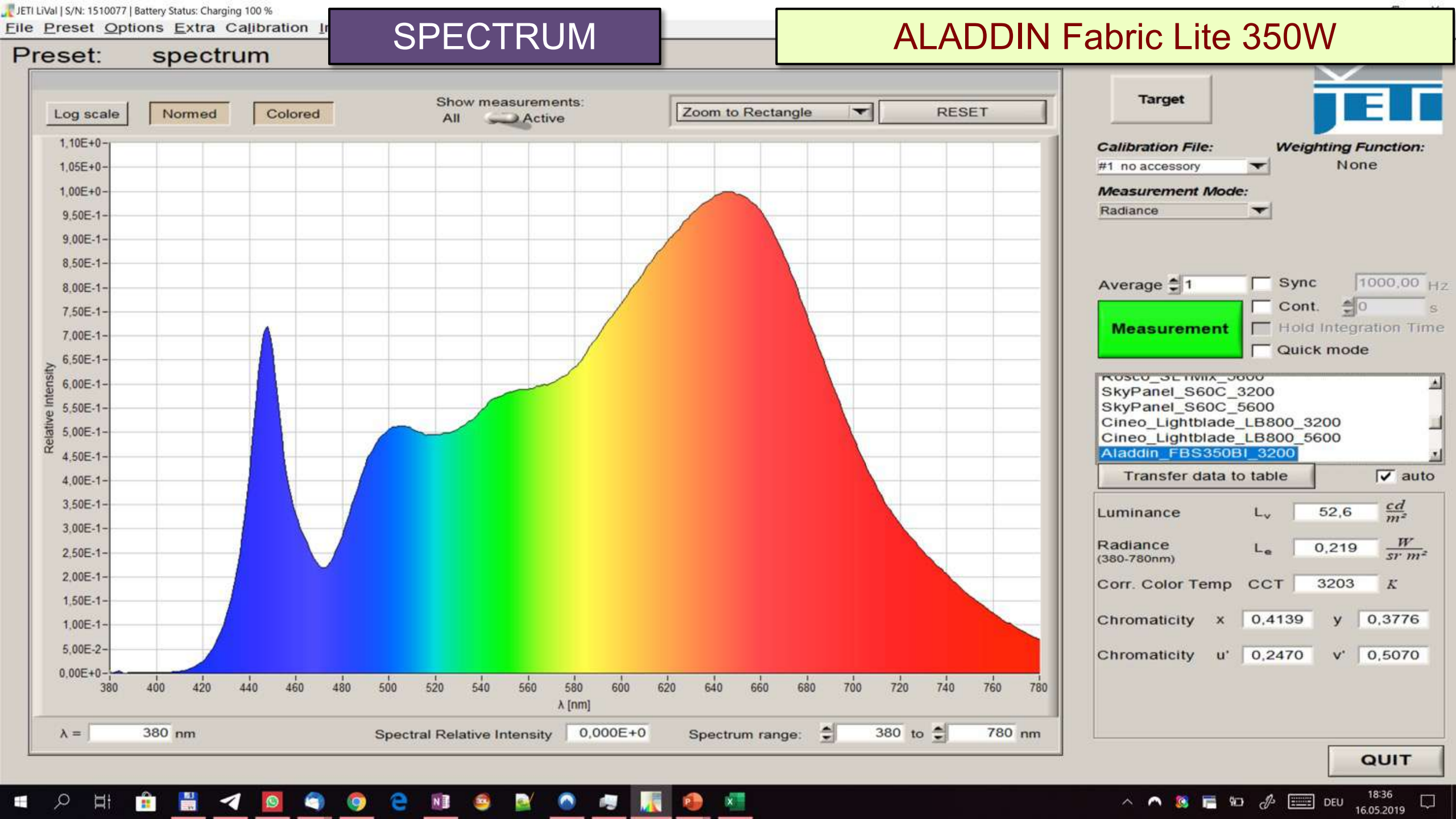


SPECTRUM | REF. | ARRI Tungsten 800W - 3200K



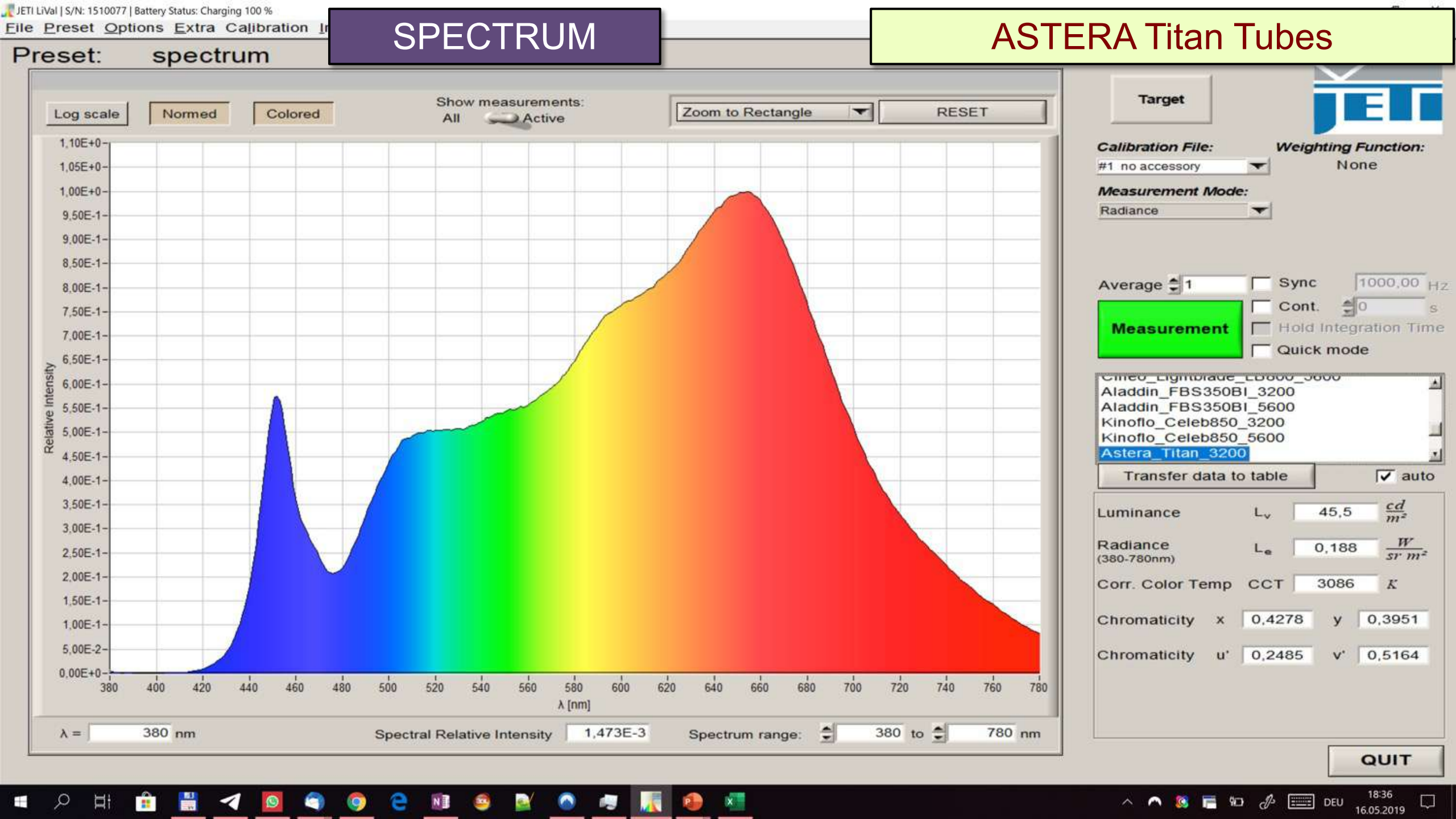
SPECTRUM

ALADDIN Fabric Lite 350W



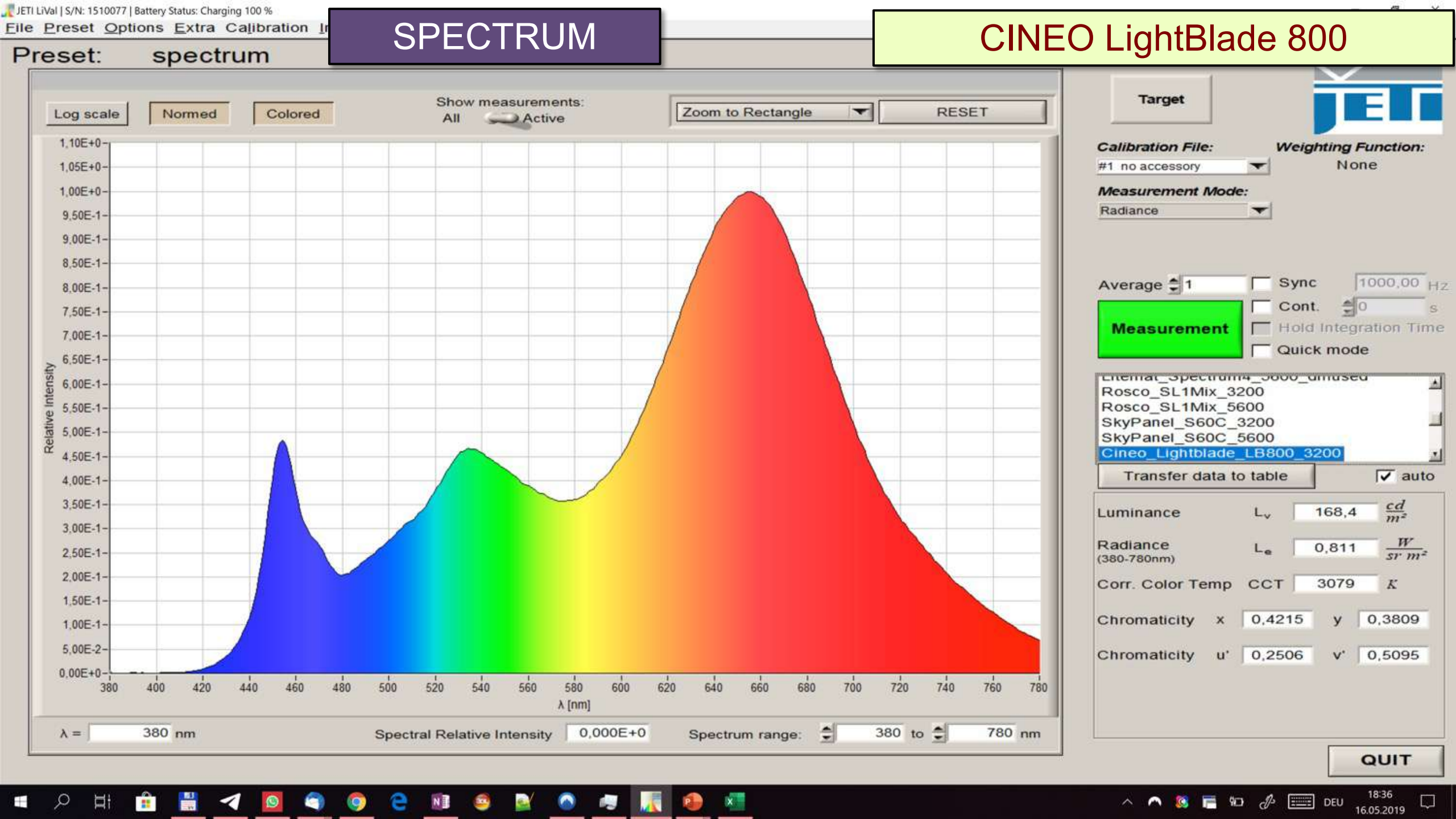
SPECTRUM

ASTERA Titan Tubes



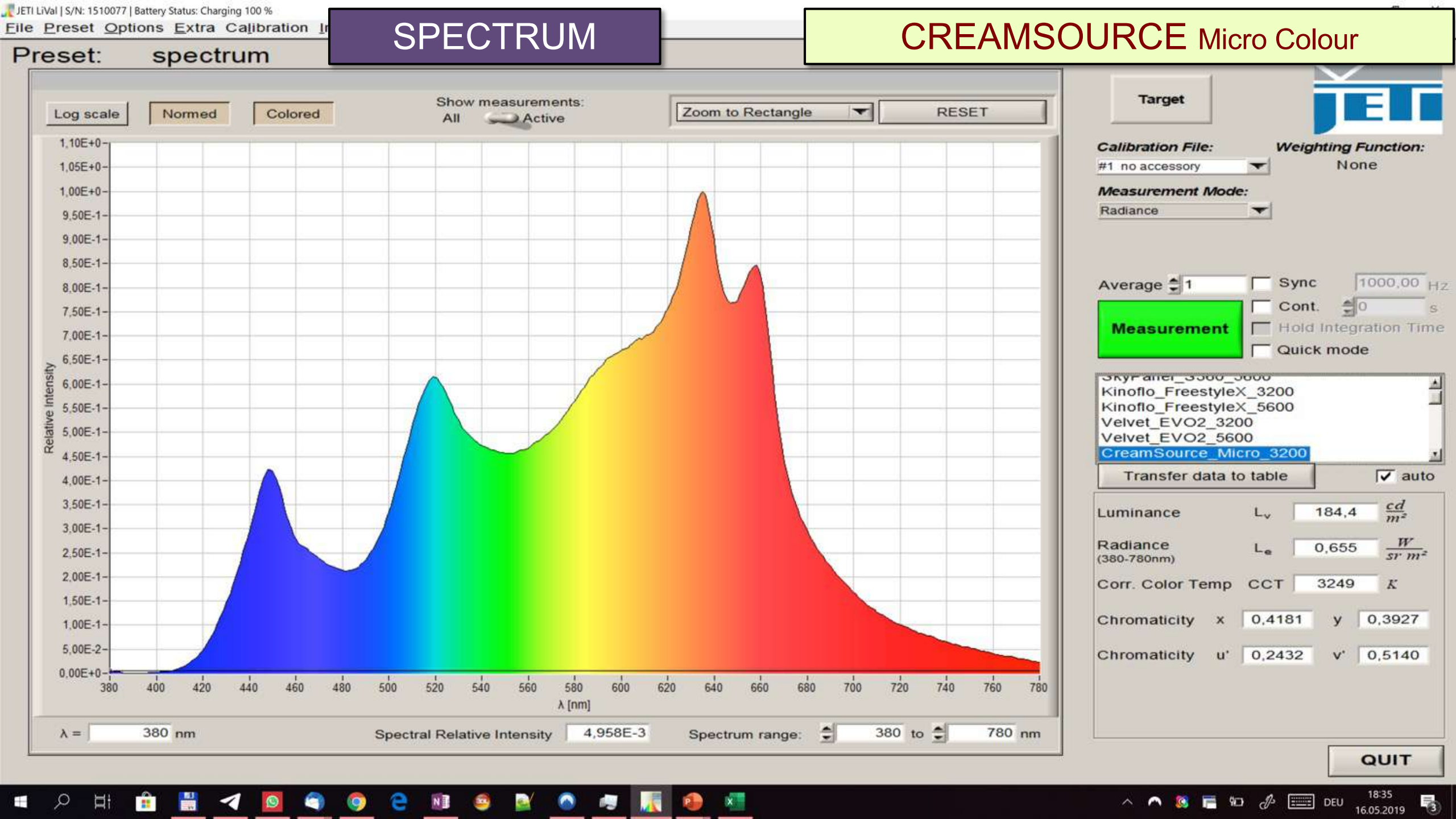
SPECTRUM

CINEO LightBlade 800



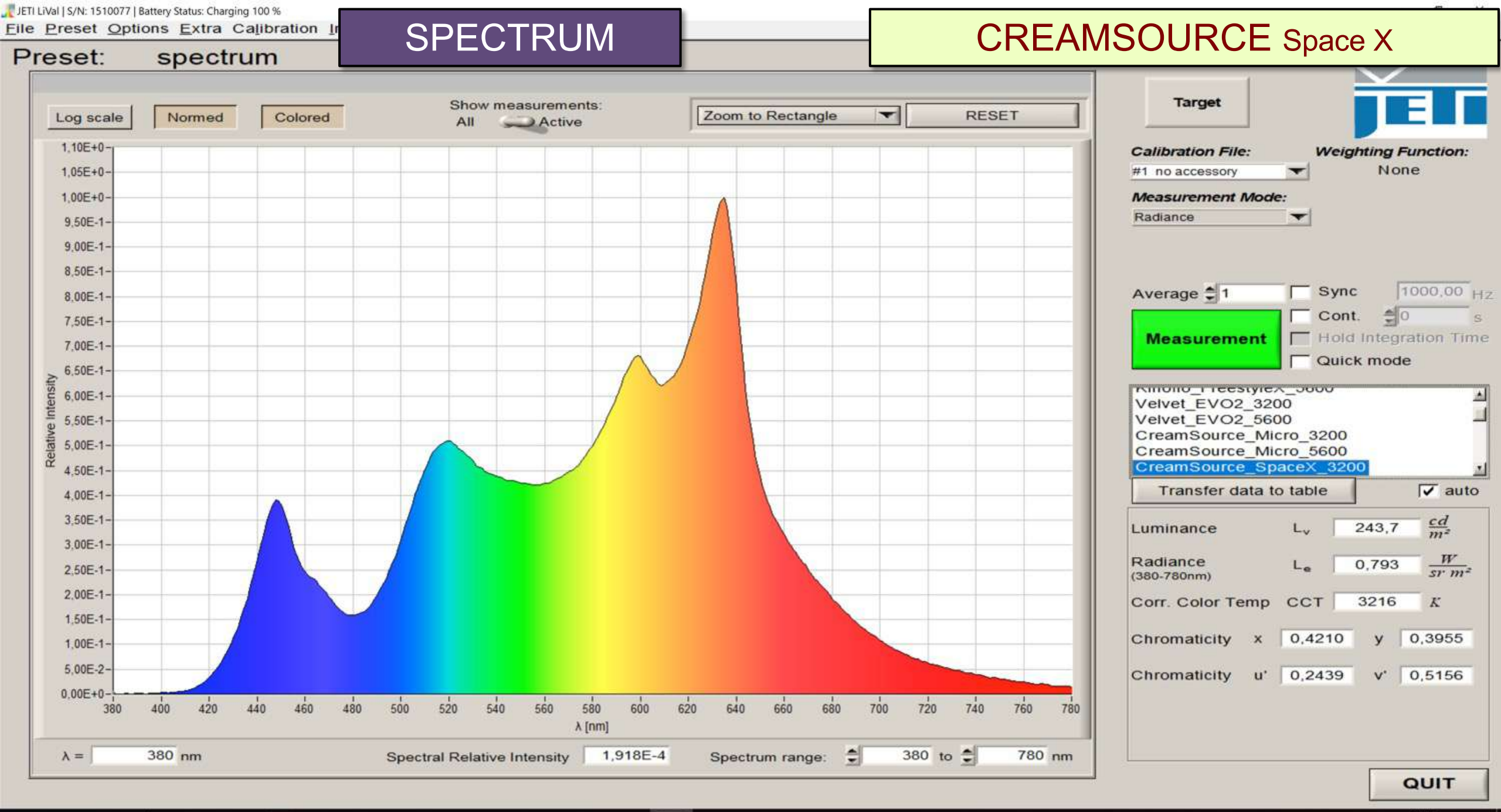
SPECTRUM

CREAMSOURCE Micro Colour



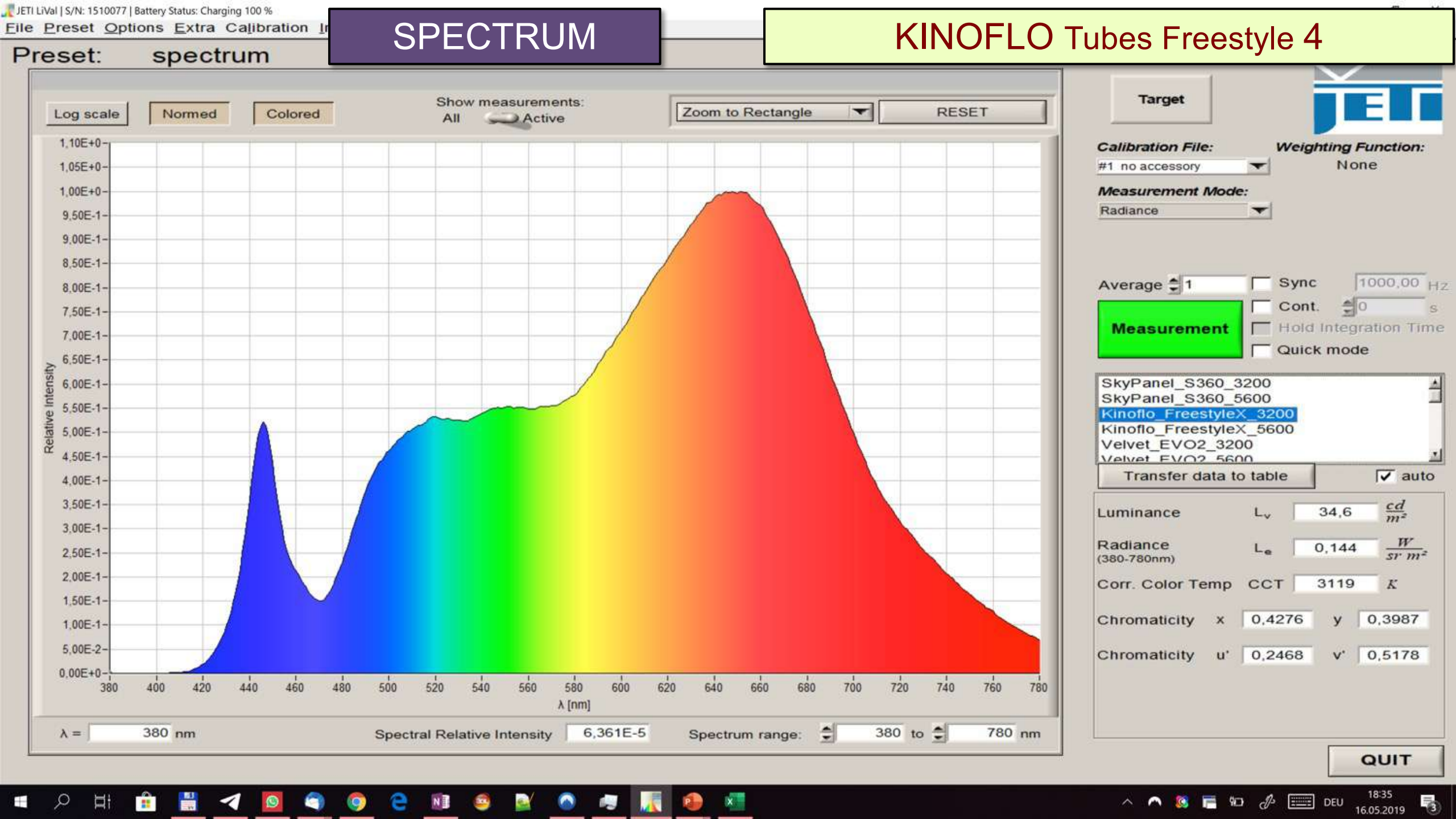
SPECTRUM

CREAMSOURCE Space X



SPECTRUM

KINOFLO Tubes Freestyle 4



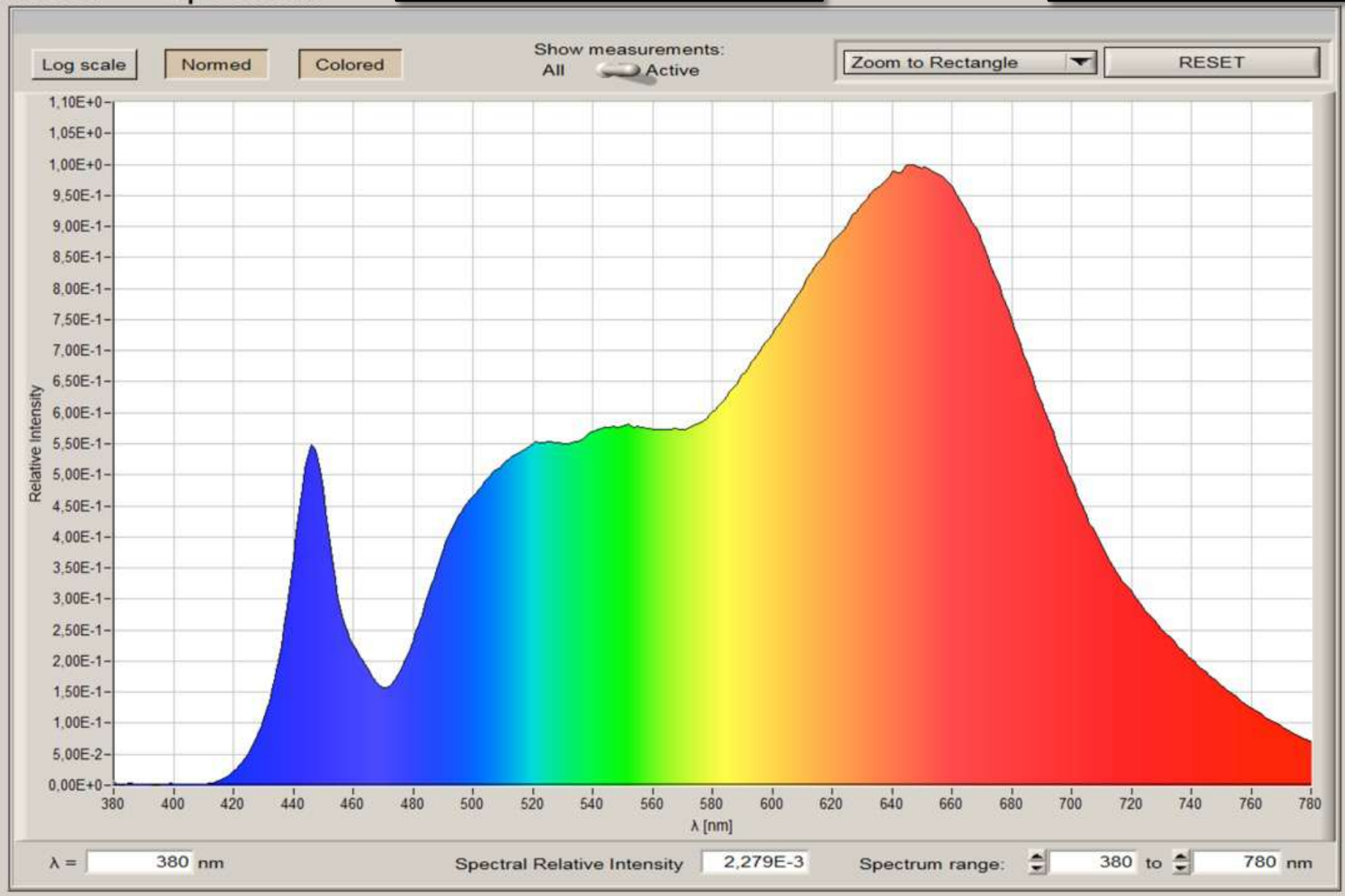
SPECTRUM

KINOFLO Celeb 850

JETI LiVal | S/N: 1510077 | Battery Status: Charging 100 %

File Preset Options Extra Calibration Ir

Preset: spectrum



Target

Calibration File: #1 no accessory

Weighting Function: None

Measurement Mode: Radiance

Average 1 Sync 1000,00 Hz

Measurement Cont. 0 s

Hold Integration Time

Quick mode

Cineo_Lightblade_LB800_3200
Cineo_Lightblade_LB800_5600
Aladdin_FBS350BI_3200
Aladdin_FBS350BI_5600
Kinoflo_Celeb850_3200

Transfer data to table auto

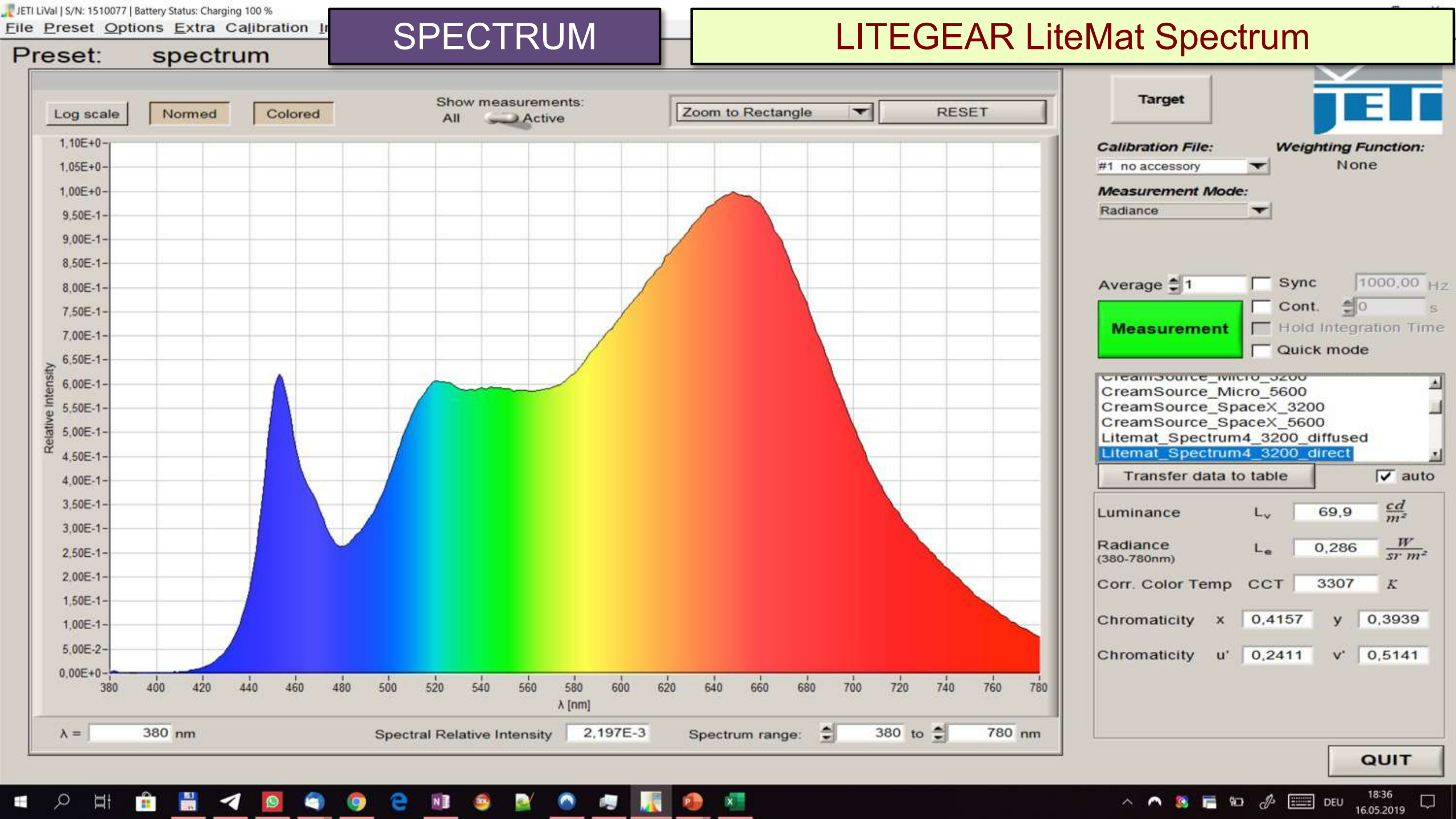
Luminance	L_v	115,7	$\frac{cd}{m^2}$
Radiance (380-780nm)	L_e	0,472	$\frac{W}{sr\ m^2}$
Corr. Color Temp	CCT	3178	K
Chromaticity	x	0,4245	y 0,3989
Chromaticity	u'	0,2447	v' 0,5175

QUIT

DEU 18:36 16.05.2019

SPECTRUM

LITEGEAR LiteMat Spectrum



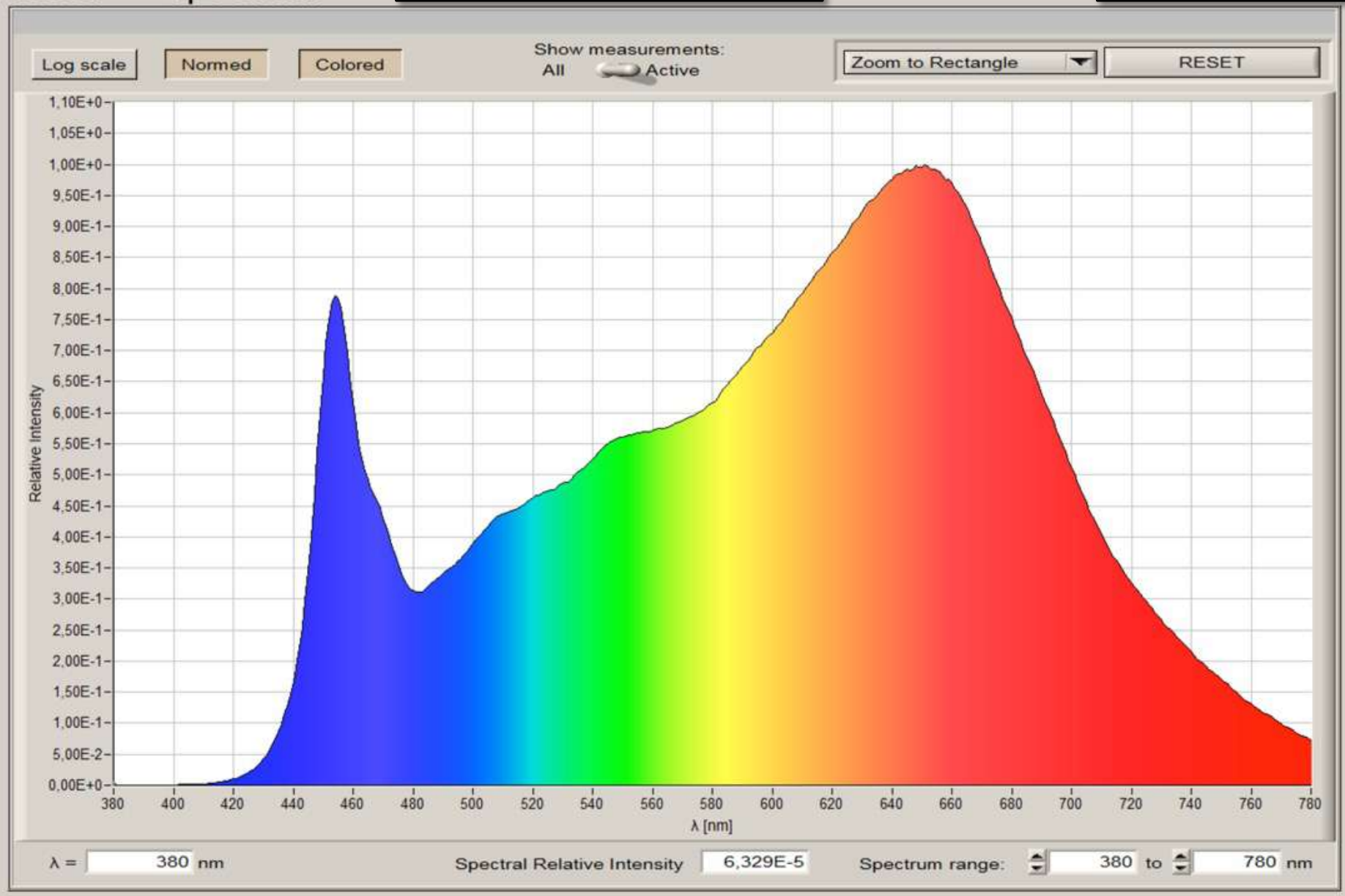
SPECTRUM

LITEGEAR LiteTile

JETI LiVal | S/N: 1510077 | Battery Status: Charging 100 %

File Preset Options Extra Calibration Ir

Preset: spectrum



Target

Calibration File: #1 no accessory

Weighting Function: None

Measurement Mode: Radiance

Average 1 Sync 1000,00 Hz

Measurement Cont. 0 s

Hold Integration Time

Quick mode

Kinoflo_Celeb850_3200
Kinoflo_Celeb850_5600
Astera_Titan_3200
Astera_Titan_5600
LiteGear_LiteTilePlus4_3200

Transfer data to table auto

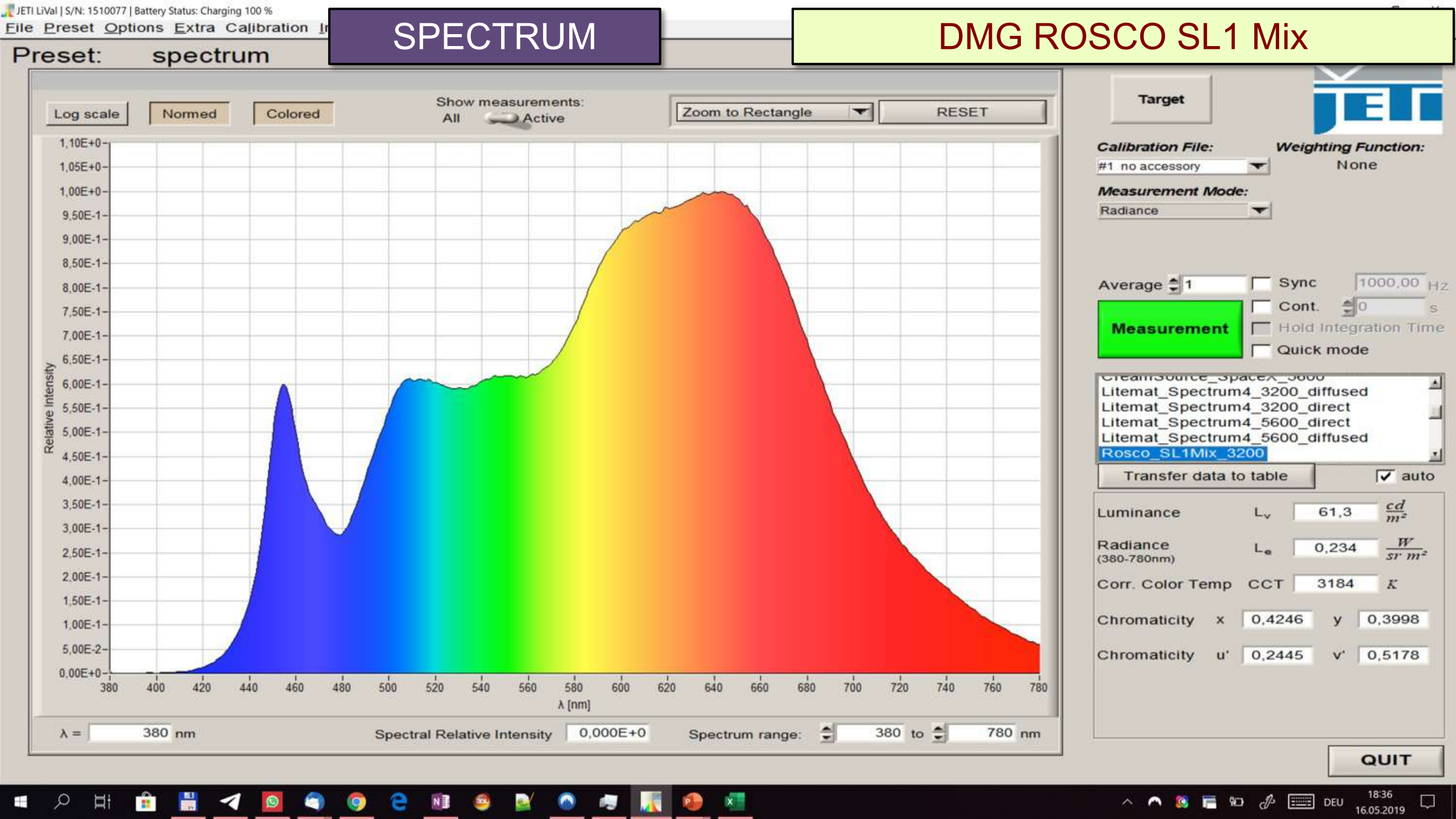
Luminance	L_v	40,8	$\frac{cd}{m^2}$
Radiance (380-780nm)	L_e	0,174	$\frac{W}{sr\ m^2}$
Corr. Color Temp	CCT	3201	K
Chromaticity	x	0,4105	y 0,3698
Chromaticity	u'	0,2482	v' 0,5030

QUIT

DEU 18:36 16.05.2019

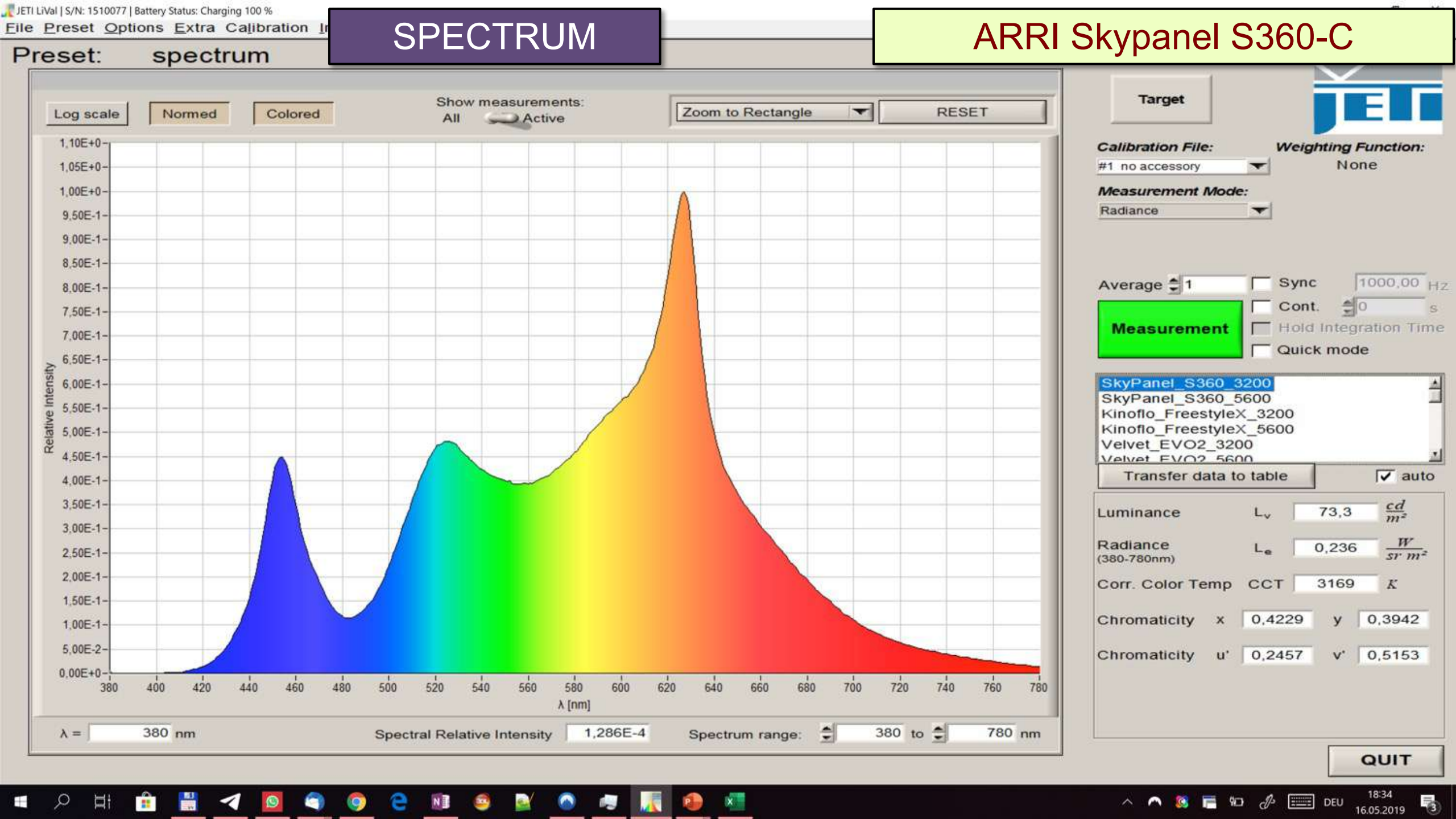
SPECTRUM

DMG ROSCO SL1 Mix



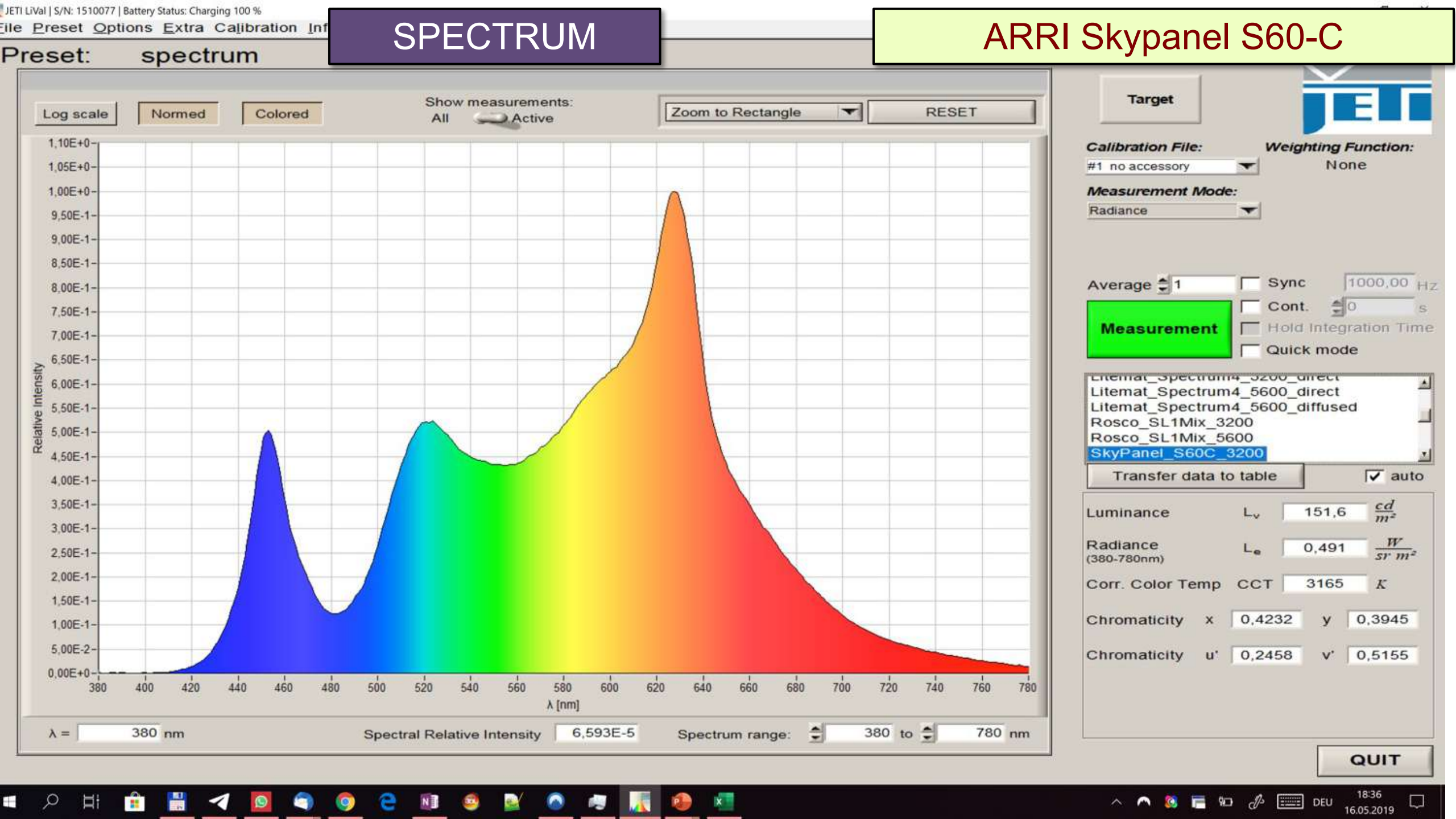
SPECTRUM

ARRI Skypanel S360-C



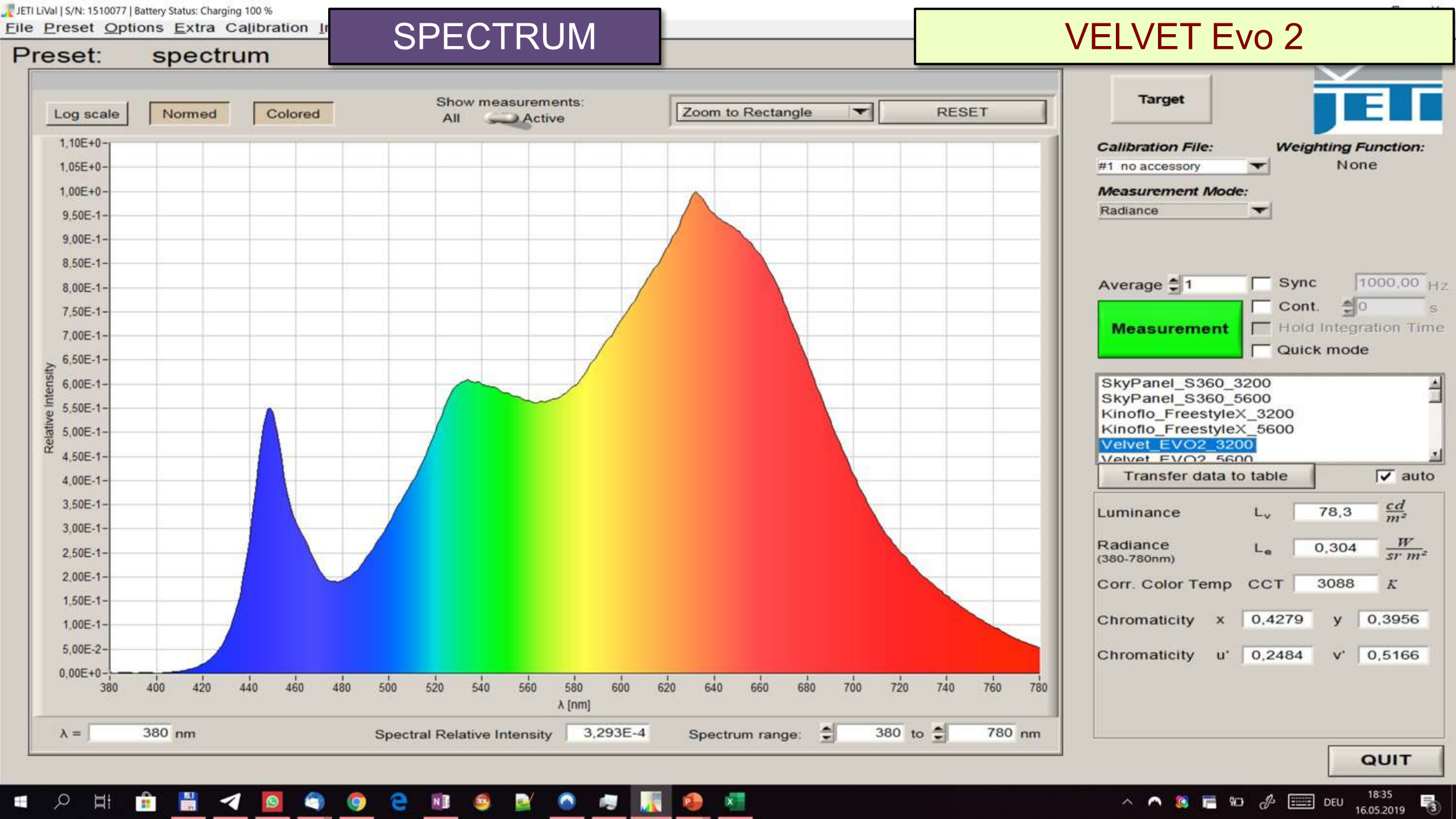
SPECTRUM

ARRI Skypanel S60-C

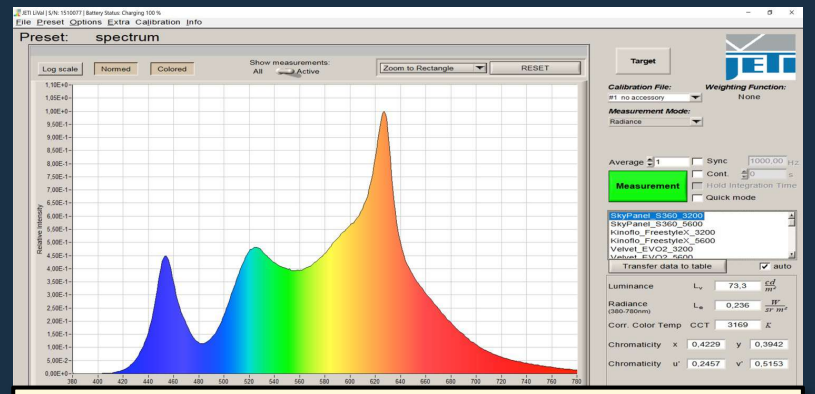


SPECTRUM

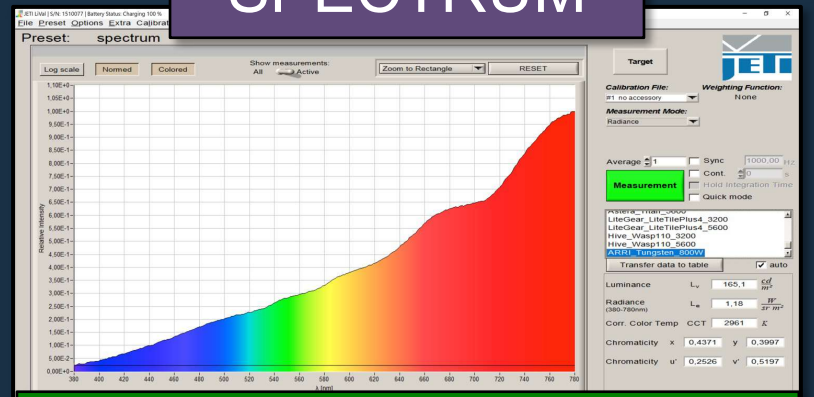
VELVET Evo 2



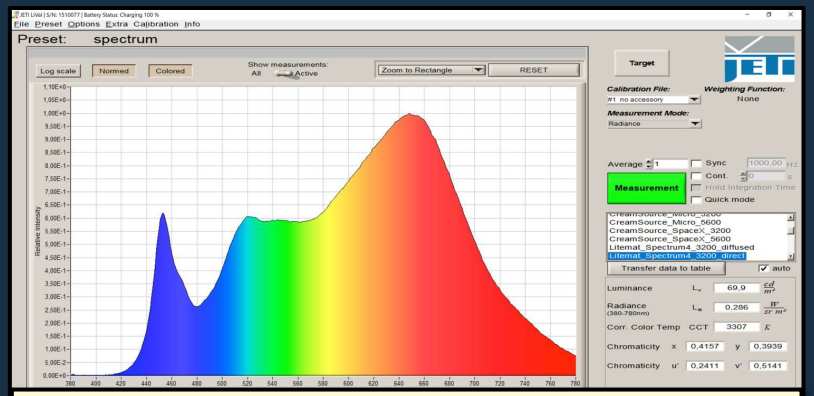
SPECTRUM



LEDs



REFERENCE TUNGSTEN



LEDs

- Ideally the distribution of the spectrum should be continuous as smooth as possible without particular peaks and dips
- The width of the spectrum is also an important parameter.

CONFERENCE OF LIGHT

- Why such differences?
- Can they be measured?
- With which tools?

Measurements:

WHICH TOOLS?

CONFERENCE OF LIGHT

Commonly used by cinematographers & gaffers

ASENTEK Lighting Passport Pro

1200 €

SEKONIC C800

1400 €

GOSSEN MAVOSPEC

1700 €

UPRtek MK350N Premium Spectrometer

2100€

Used by the Academy

Photo Research PR-740

spectroradiometer

20000 €

METRICS & SSI

A simple tool to judge a spectrum

David Stump

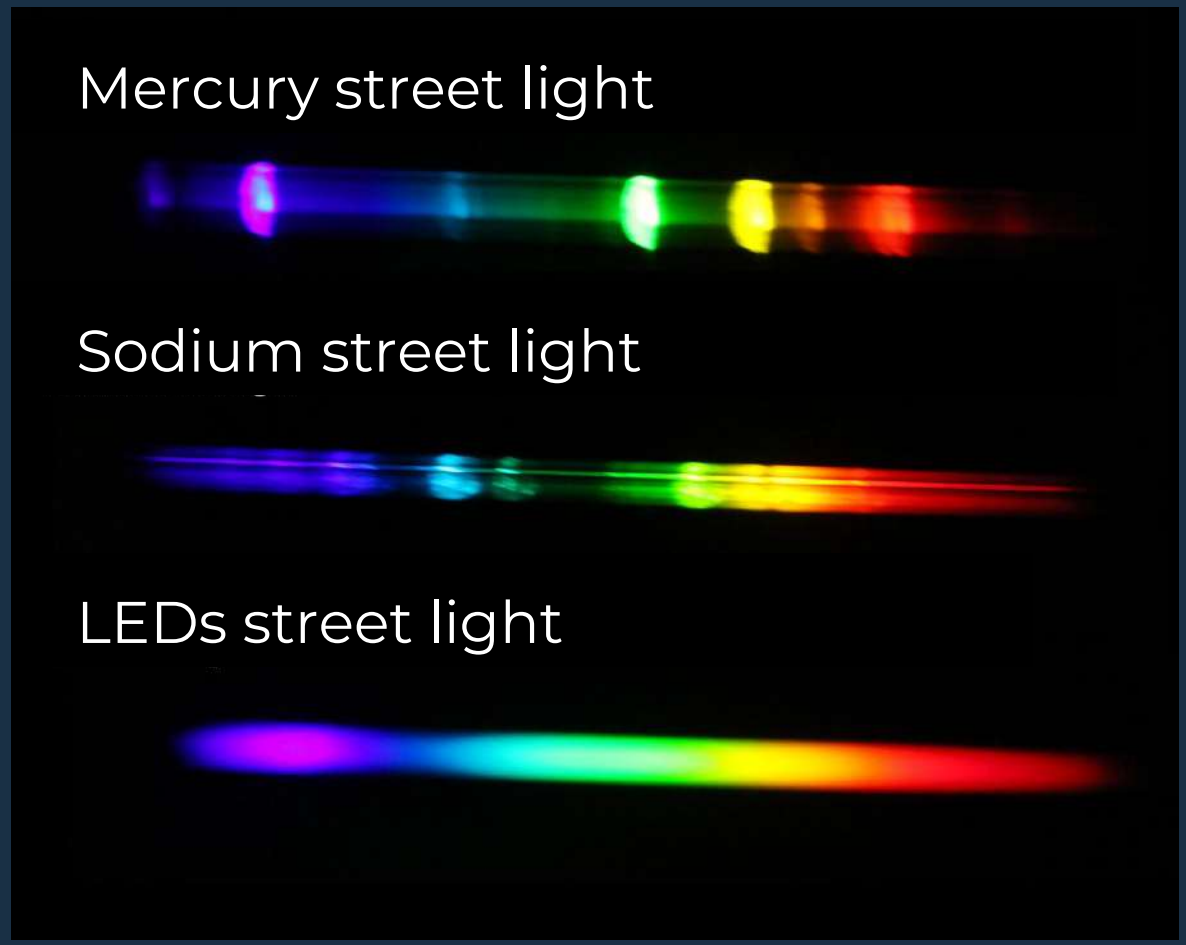
Cinematographer, ASC

MITC

IMAGO TC co-chair

METRICS & SSI

$ 8



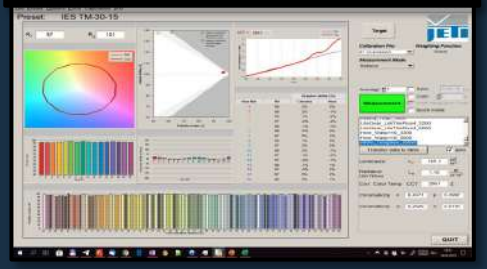
METRICS & SSI

Measurements:

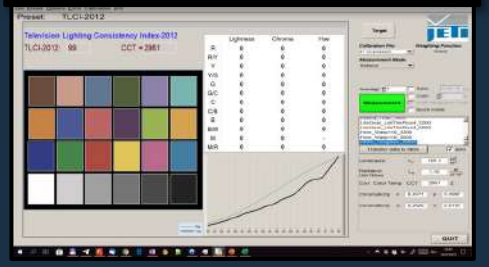
WHICH METRICS?

METRICS & SSI

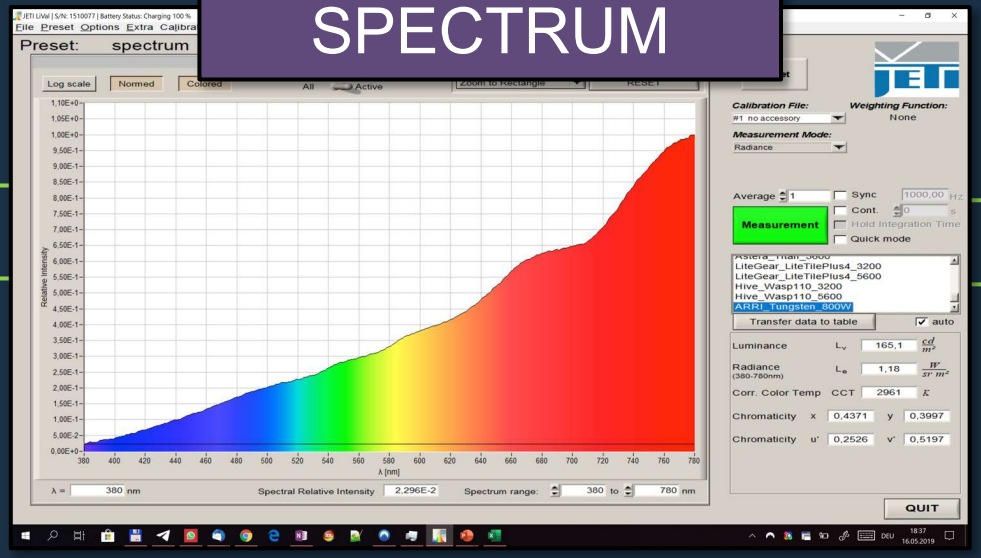
TM-30-18/20



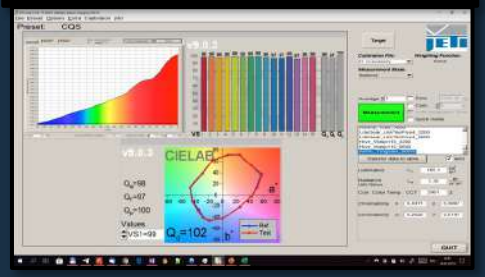
TLCI/TLMF



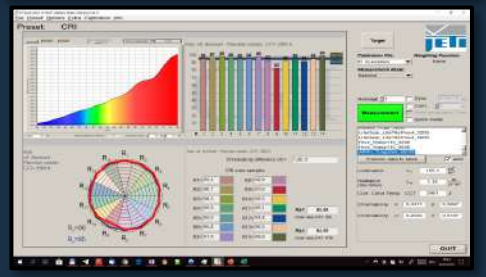
SPECTRUM



CQS



CRI

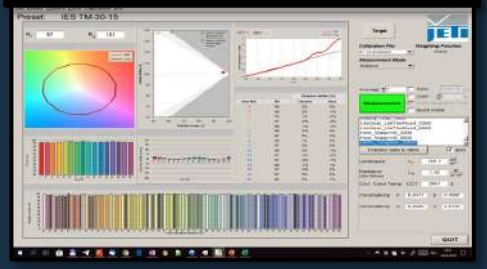


METRICS & SSI

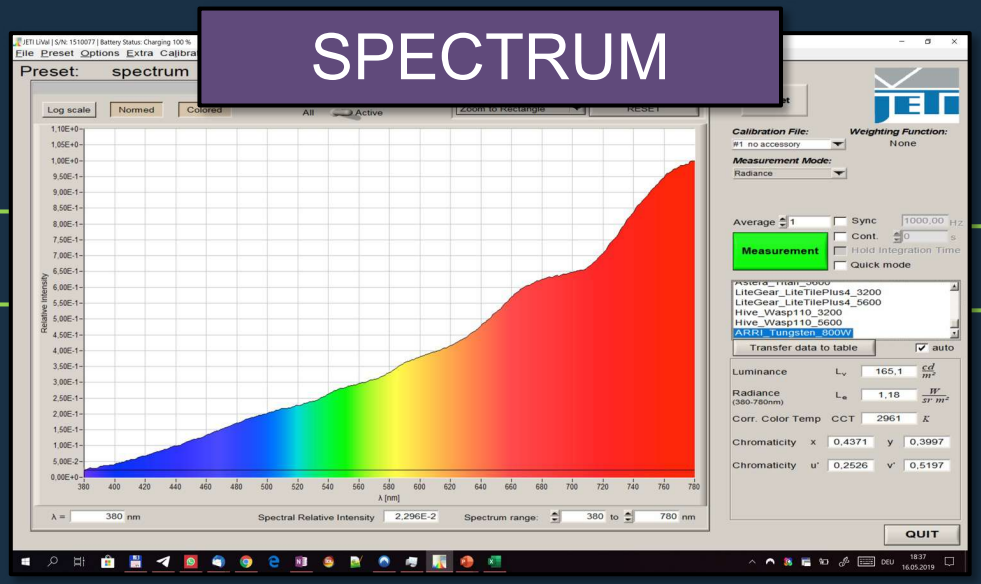
These 4 index refer to the eye

or to TV cameras

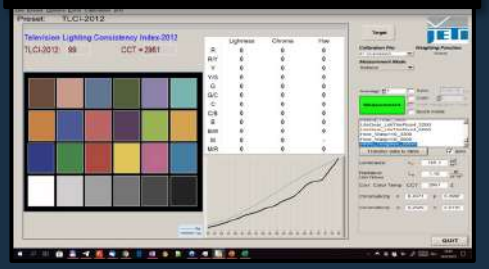
TM-30-18/20



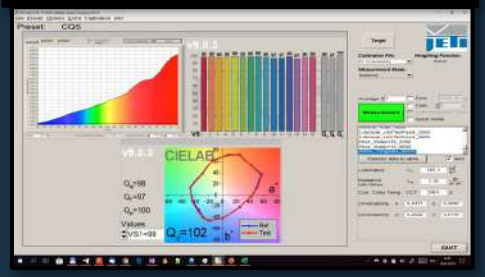
SPECTRUM



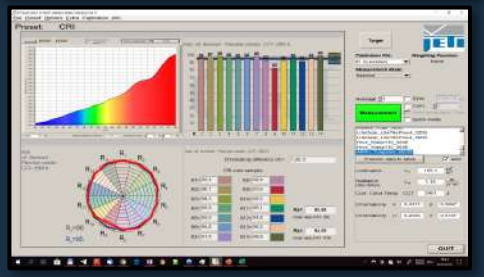
TLCI/TLMF



CQS



CRI

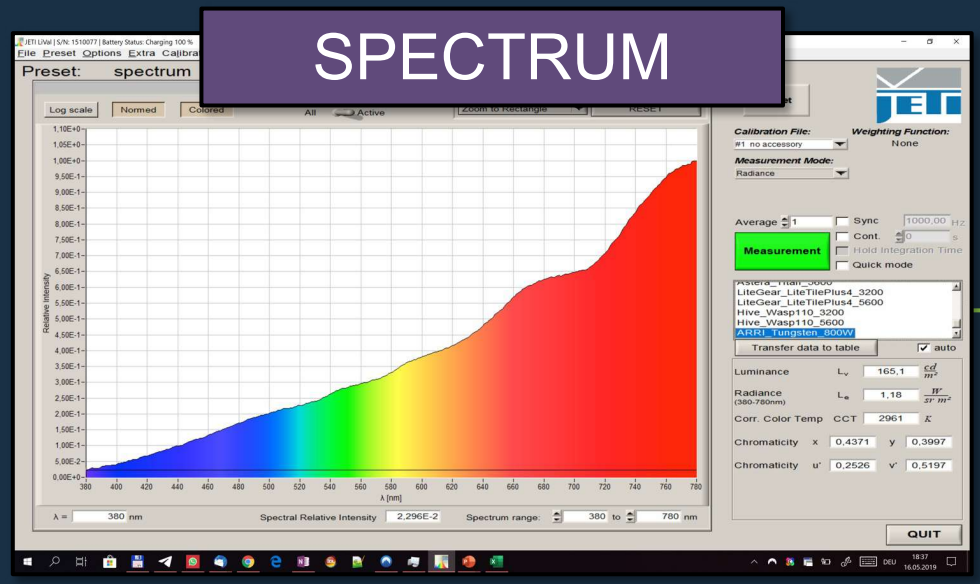


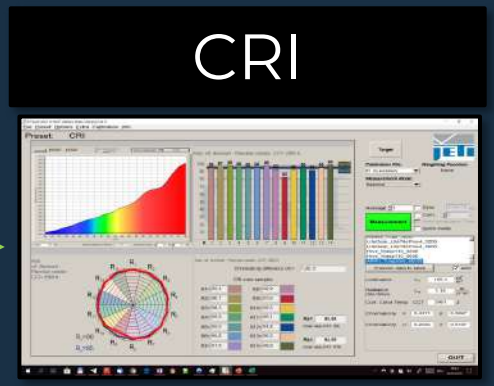
METRICS & SSI

It is important to note that CRI is no longer considered a valid way to measure

LEDs.

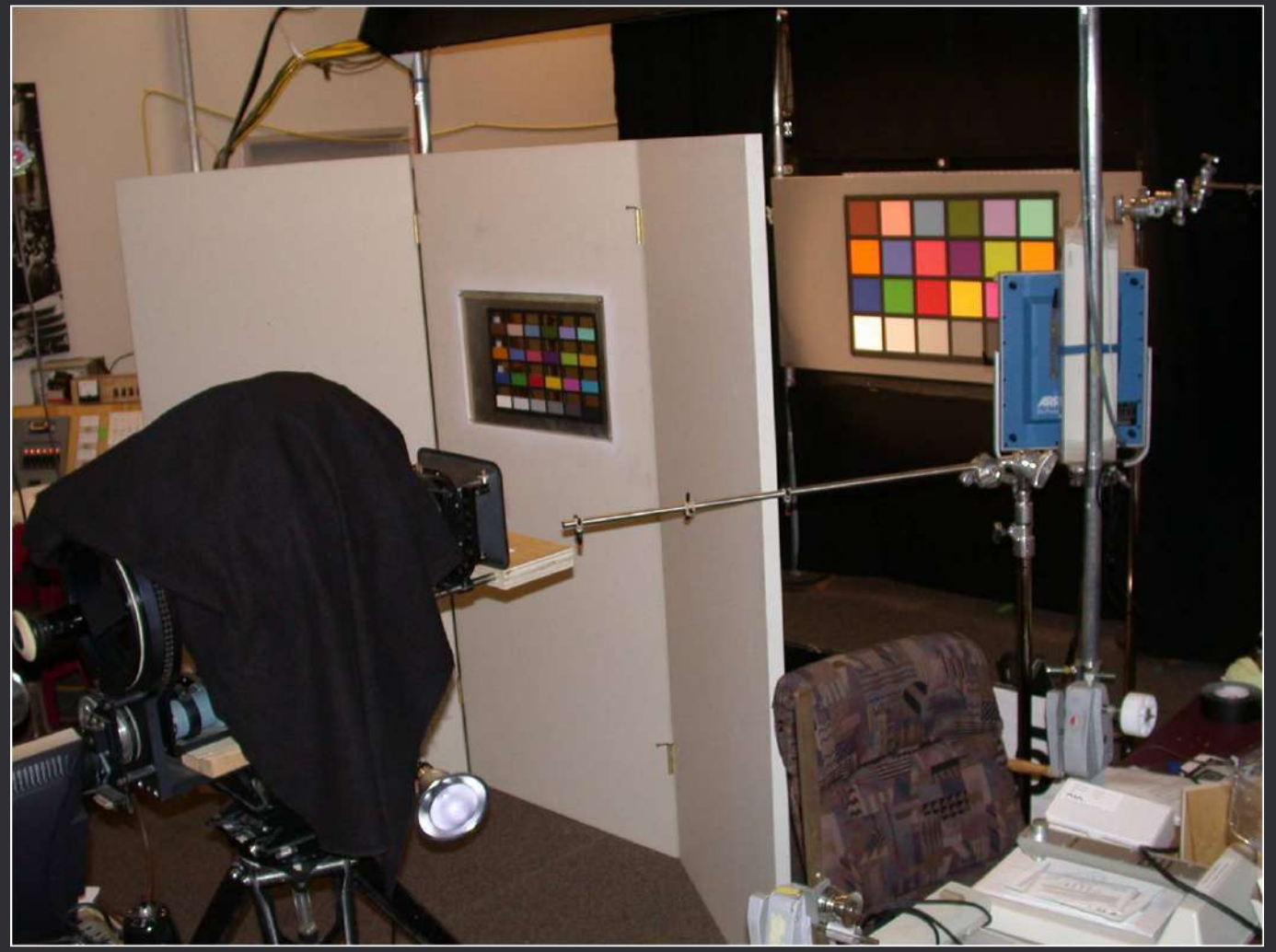
But it is very often used.





METRICS & SSI

Esmeralda Easel Split-Macbeth



METRICS & SSI

Esmeralda Easel Split-Macbeth

Two Macbeth Color Checker charts:

- The first in the foreground lit by a tungsten source consists of squares of color with only the upper part preserved. The other recessed part allows you to see behind, the second larger chart.
- The second chart is it lit by an LED

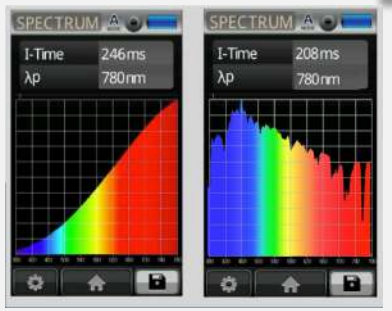
Academy Spectral Similarity Index (SSI): Overview 2020-09-16 © 2020 Academy of Motion Picture Arts and Sciences

METRICS & SSI

Esmeralda Easel Split-Macbeth

METRICS & SSI

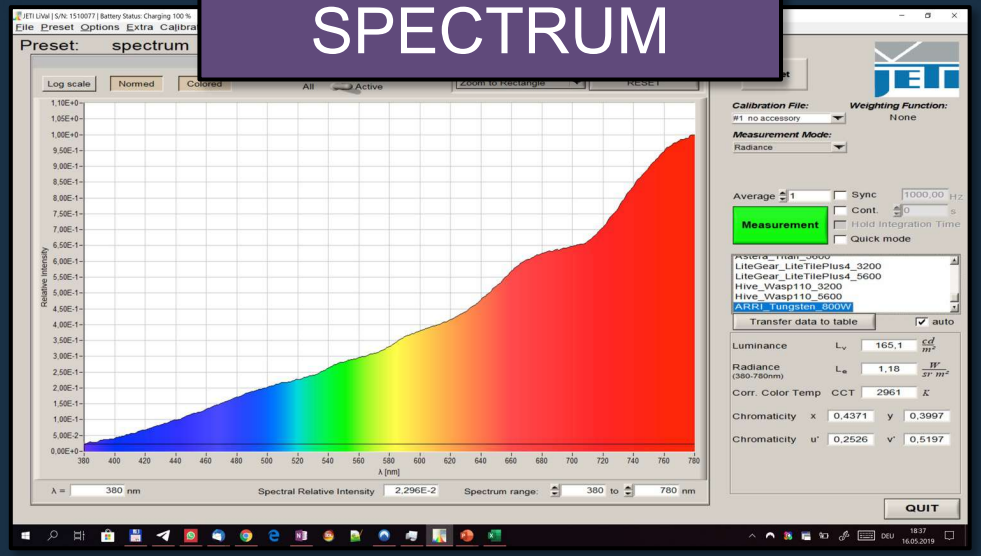
SSI



Spectral Similarity Index

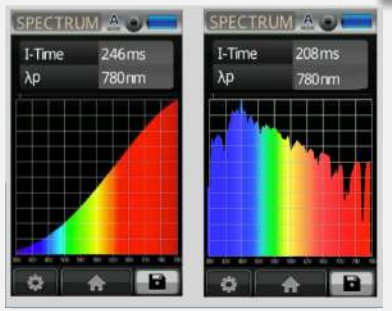
A metric dedicated to LEDs used in cinematography.

SPECTRUM



METRICS & SSI

SSI



Spectral Similarity Index

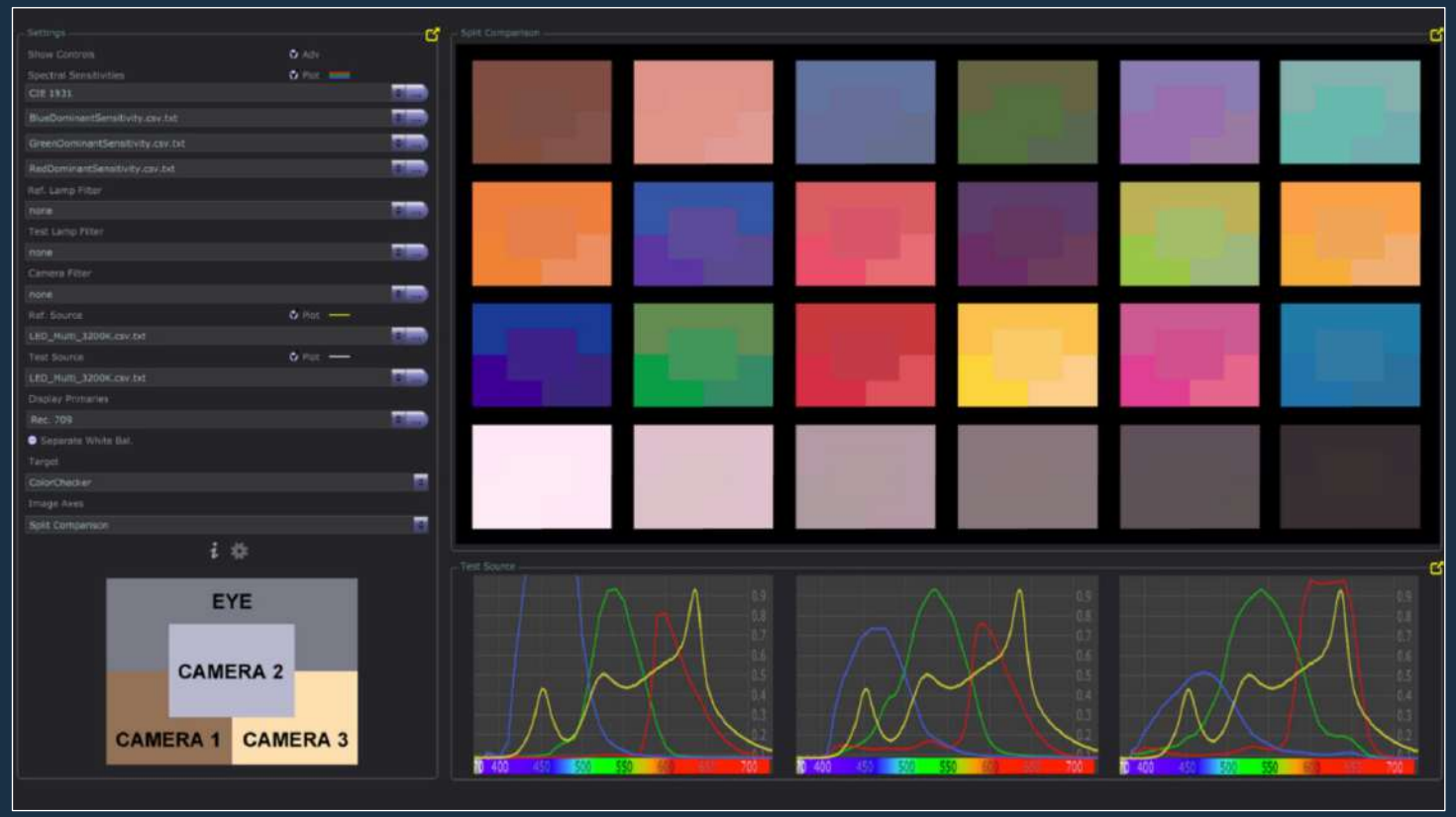
A metric dedicated to LEDs

used in cinematography.

All digital cameras for cinematography

have a unique perception of color

METRICS & SSI



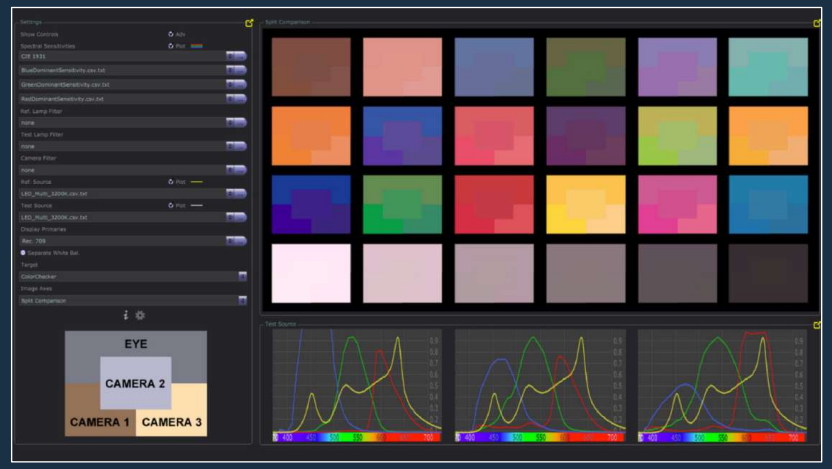
Academy Spectral Similarity Index (SSI):

Overview 2020-09-16

This figure is a graphic simulation of how the human eye and three digital cameras with different spectralsensitivities “see” color.

The yellow curve represents an actual LED source commonly used in cinematography.

METRICS & SSI



Academy Spectral Similarity Index (SSI):

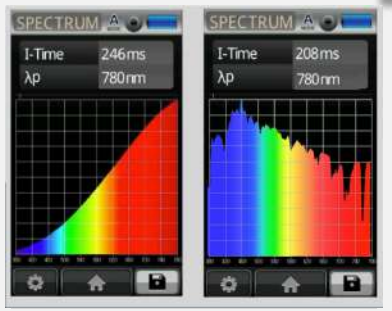
Overview 2020-09-16

The red, green and blue curves represent the spectral sensitivities of the three cameras. Each of the color patches, from a Macbeth Color Checker chart, is rendered in distinct sections that correspond to the human eye and cameras 1, 2 and 3 (the key is located at the lower left of the figure).

As Figure 1 illustrates, a light source's CRI – in this case, a relatively high value of 92 – is not a reliable predictor of color-rendering accuracy.

METRICS & SSI

SSI



Spectral Similarity Index

A metric dedicated to LEDs used in cinematography.

The SSI compares an LED light to a known reference light, commonly used for cinema lighting :

- Incandescent studio light or
- Standard daylight

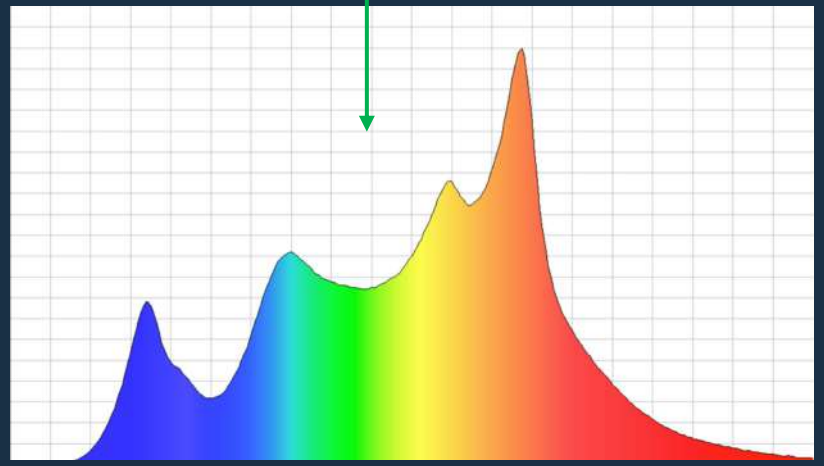
METRICS & SSI

Comparison between:

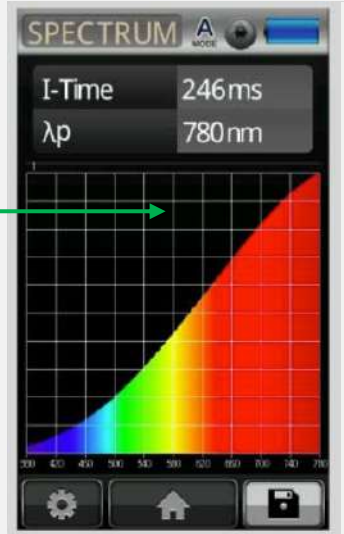
Tungsten Reference

and

LED @ 3200K

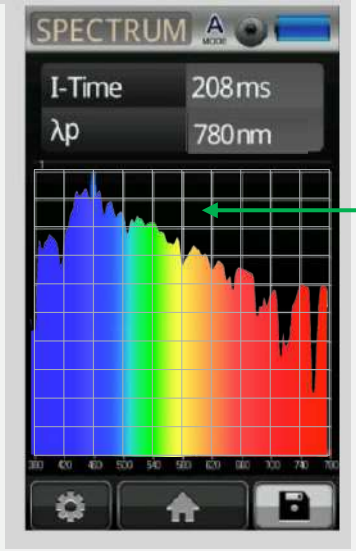


SSI



METRICS & SSI

SSI

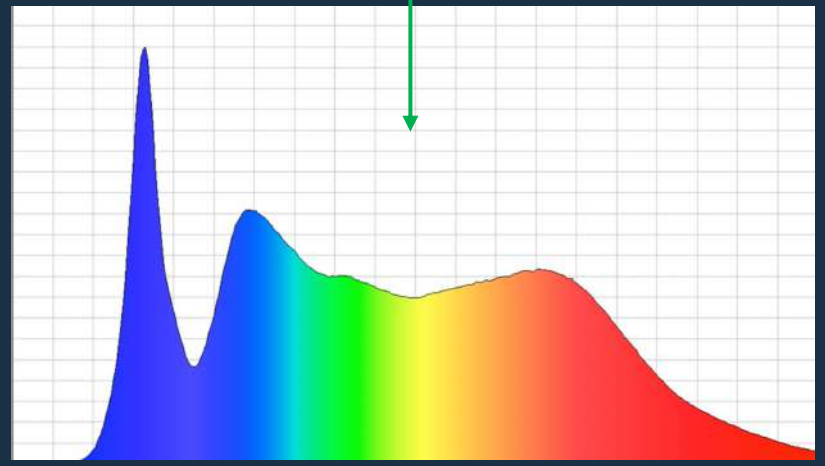


Comparison between:

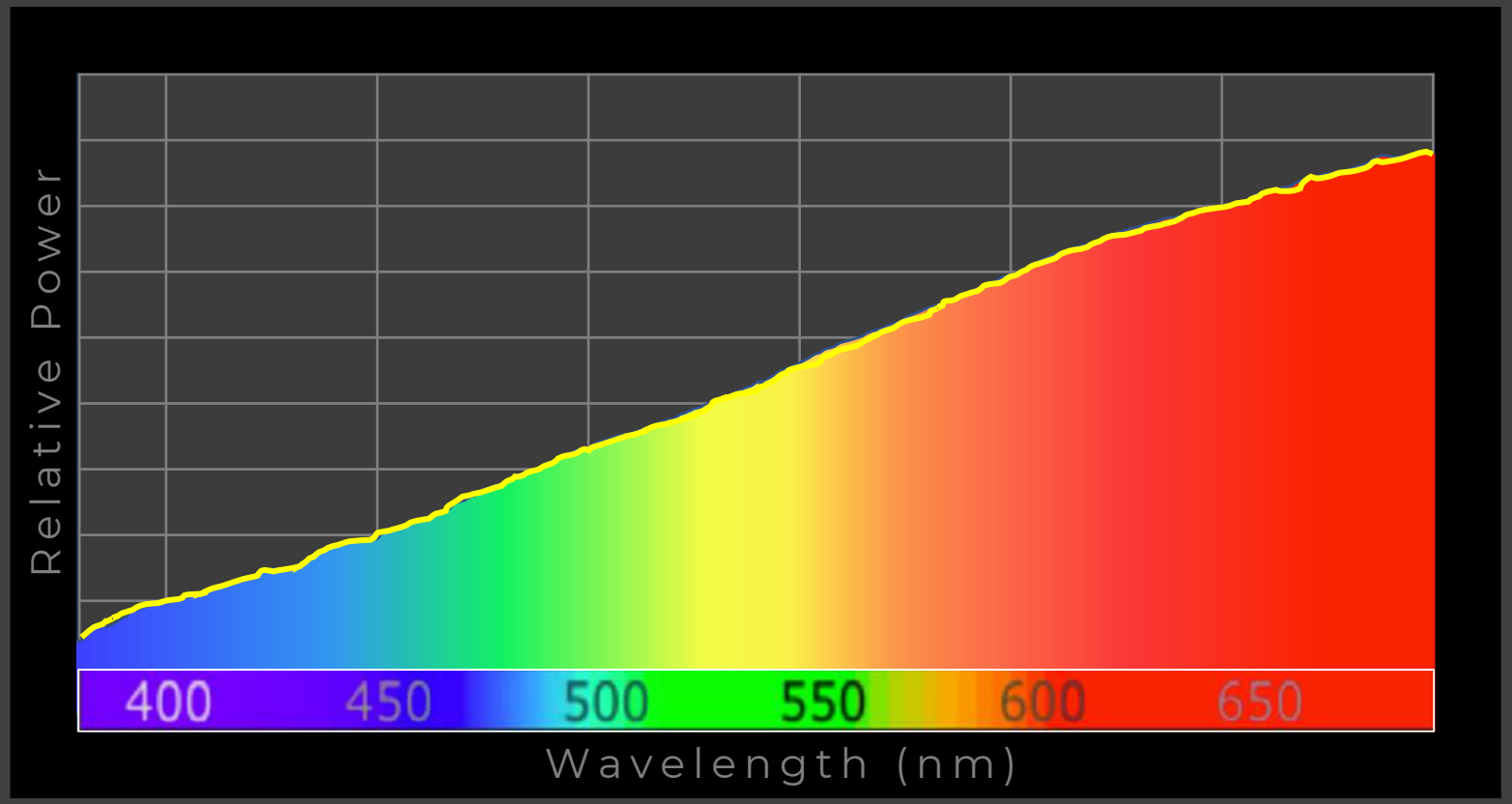
Daylight Reference

and

LED @ 5600K

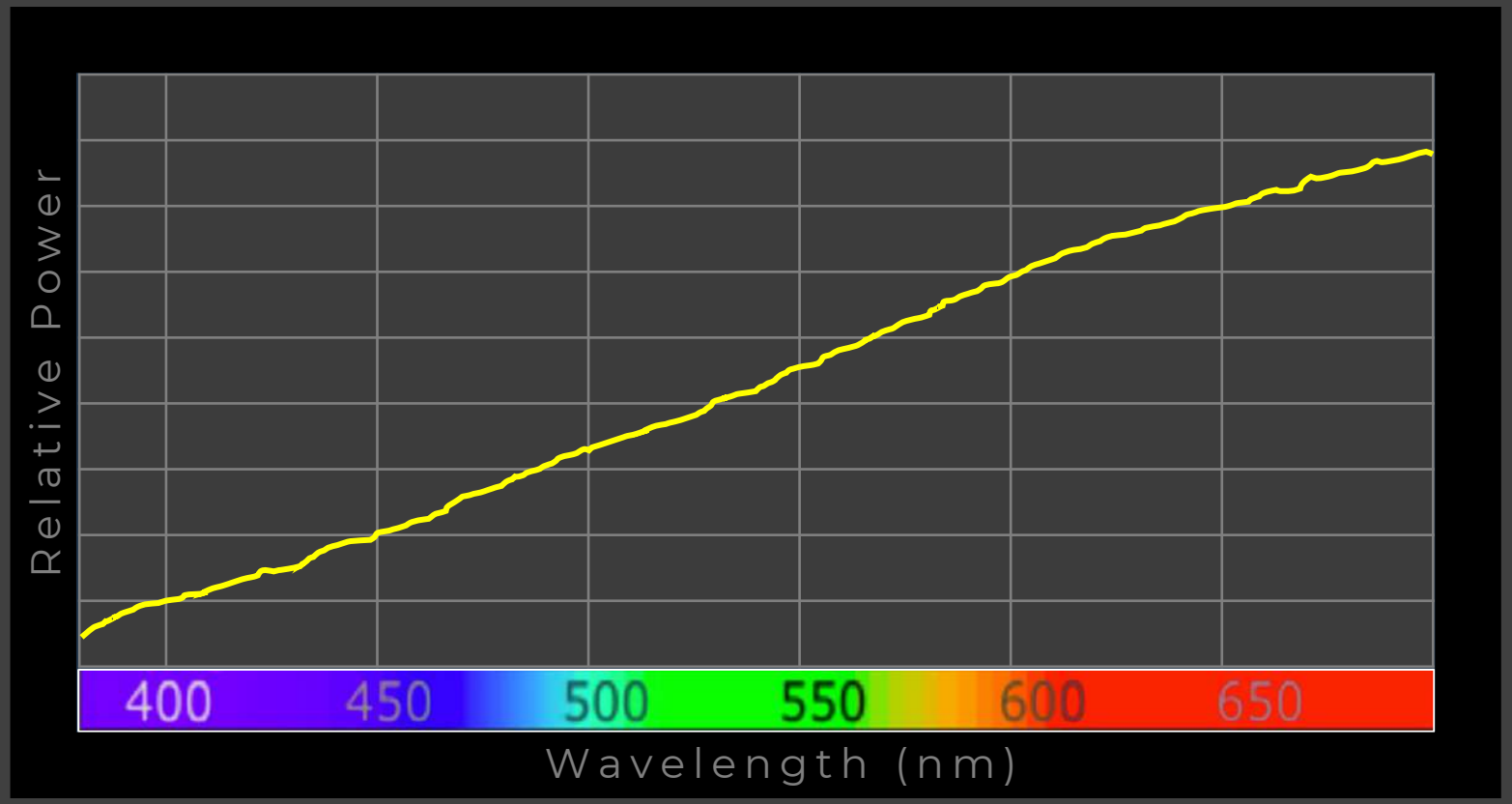


METRICS & SSI



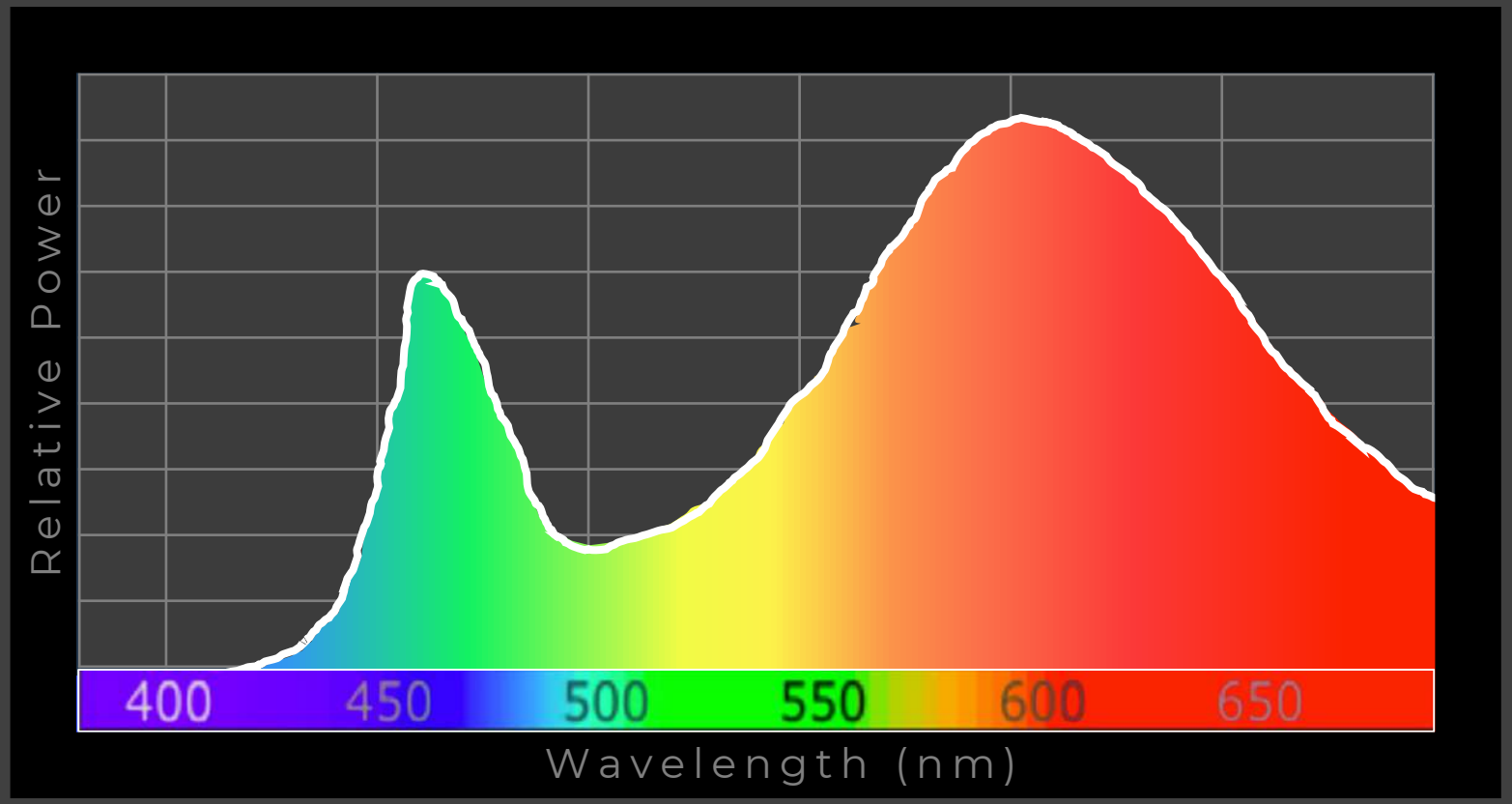
Reference spectrum

METRICS & SSI



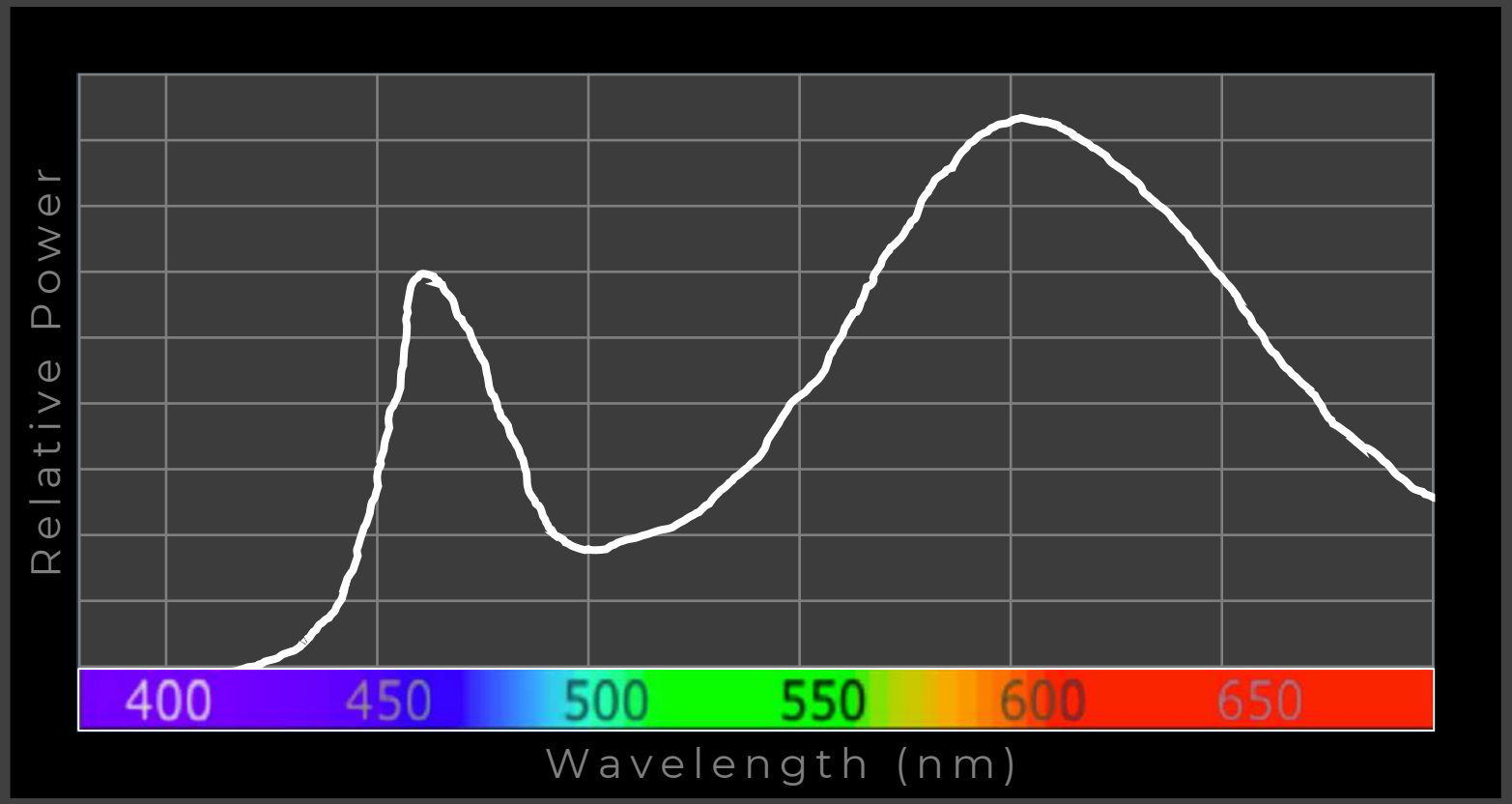
Reference spectrum

METRICS & SSI

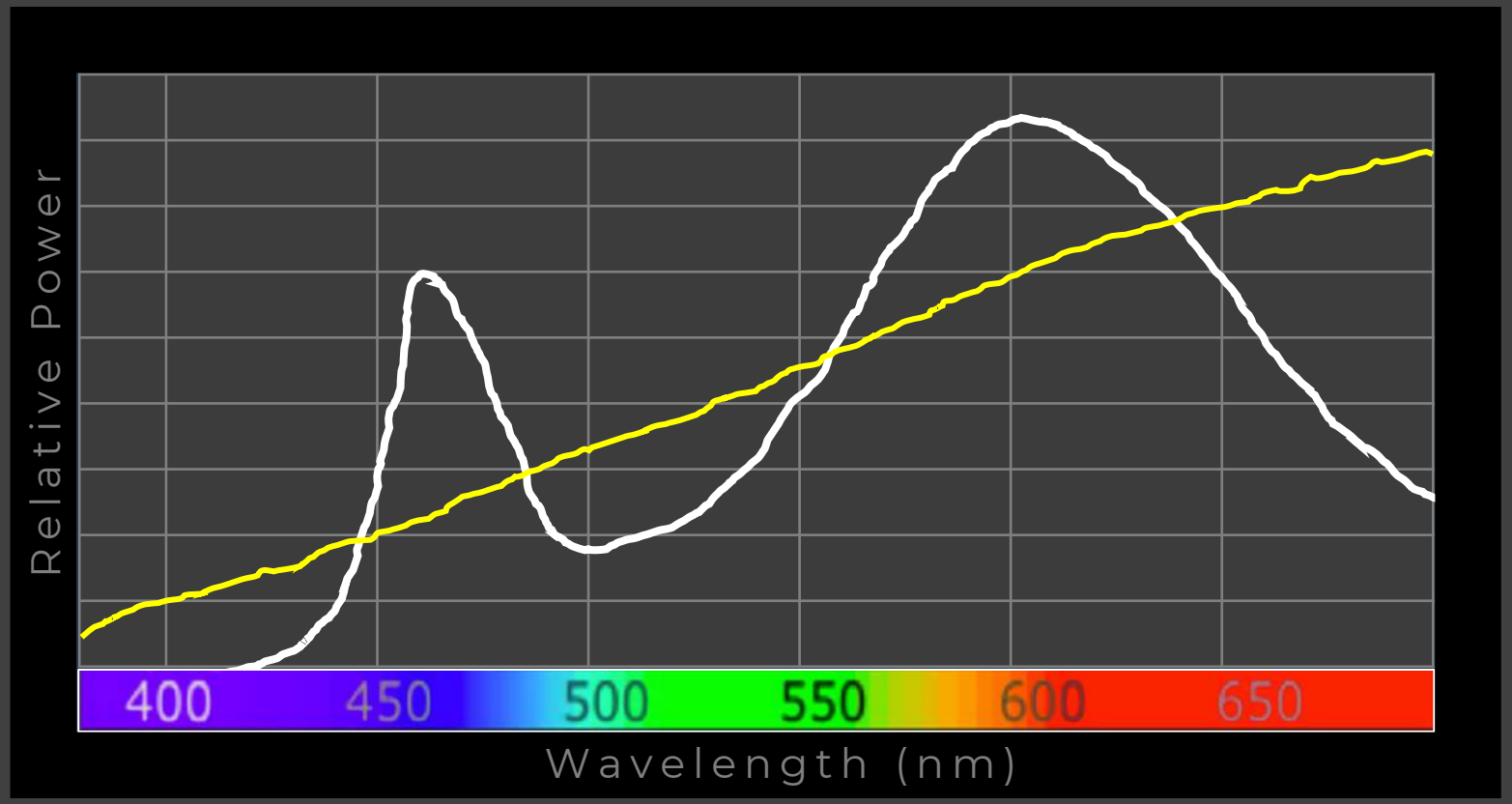


Test spectrum

METRICS & SSI


Relative Power
400
450
500
550
600
650
Wavelength (nm)
Test spectrum

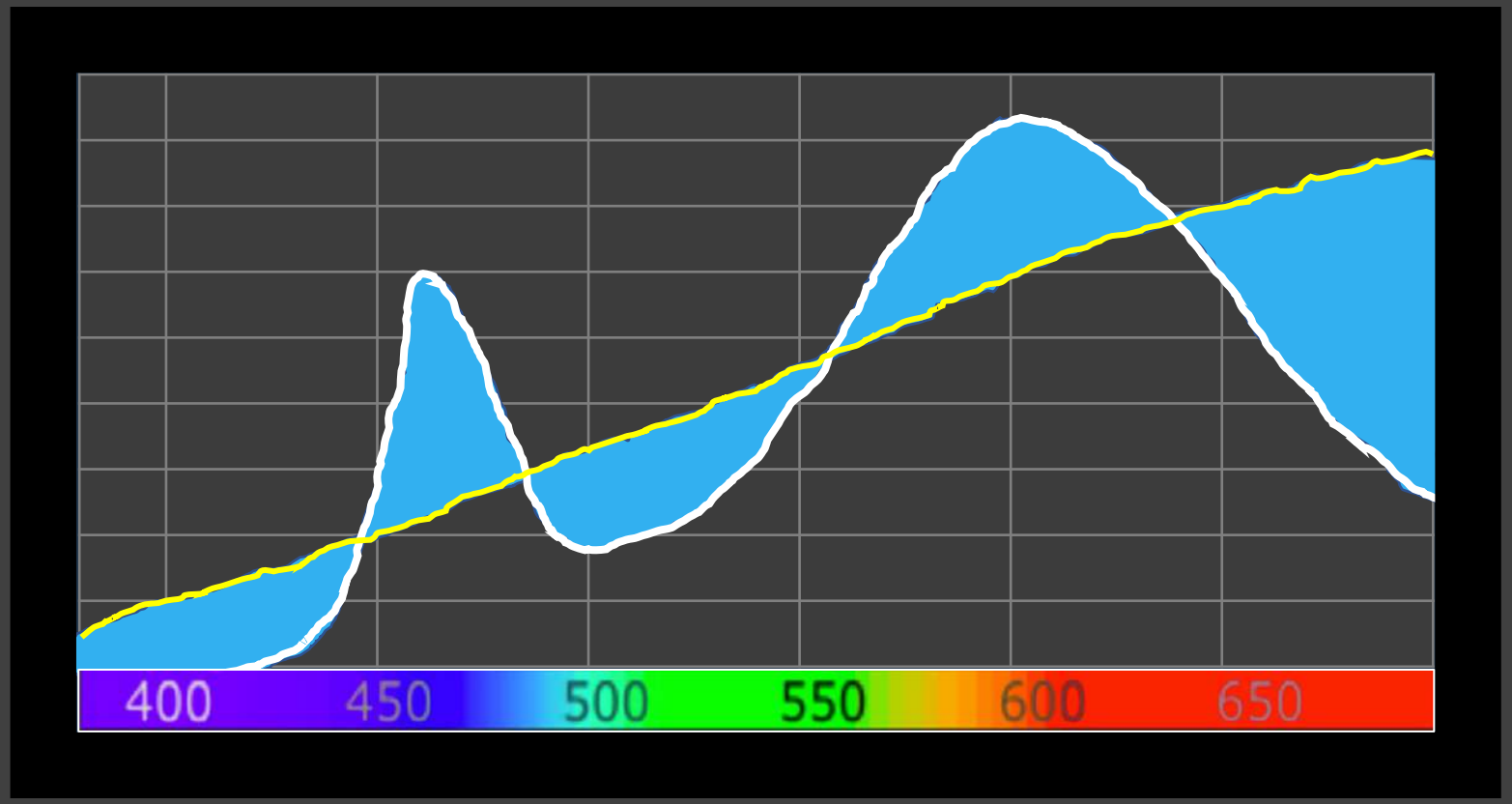
METRICS & SSI



Reference spectrum

Test spectrum

METRICS & SSI

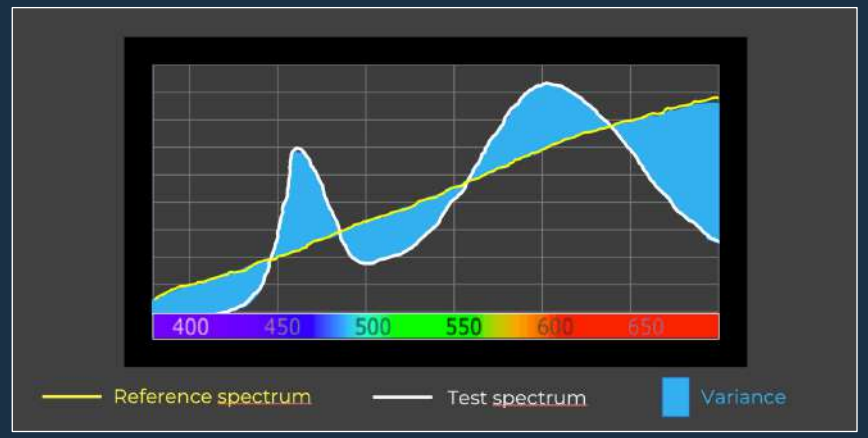


Reference spectrum

Test spectrum

Variance

METRICS & SSI



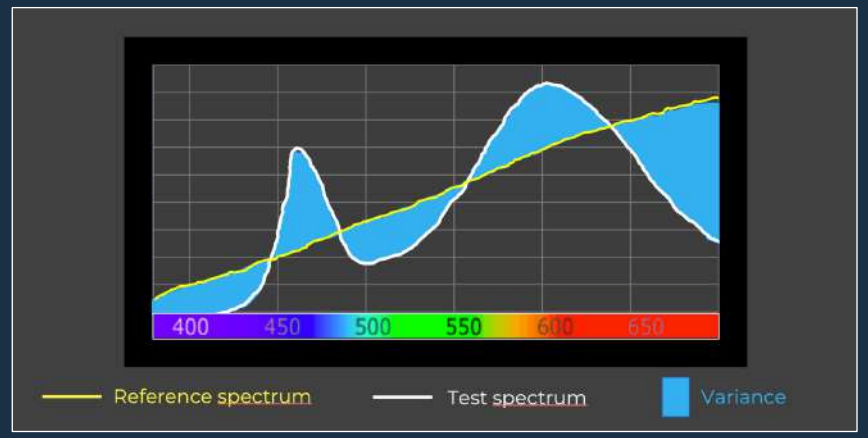
Academy Spectral Similarity Index (SSI): Overview

2020-09-16

This figure illustrates the SPD (Spectral Power Distribution) variance between a typical tungsten incandescent source (represented by the yellow curve) and a typical white LED source of the same correlated color temperature (represented by the white curve).

In each case, relative power has been graphed as a function of wavelength across the visible spectrum.

METRICS & SSI



Academy Spectral Similarity Index (SSI): Overview

2020-09-16

The cyan-shaded area shows the variance. SSI essentially scales this variance: the smaller the area between the two curves, the higher the SSI value, and the better the match.

The simplicity of this approach makes it relatively easy to compare sources for a desired color-rendering result.

METRICS & SSI

SSI Scores

The SSI value is always denoted with respect to the reference,

which is indicated within square brackets; examples:

SSI[P3200] = 86 SSI

[CIE D55] = 78

0 - 70	70 - 80	80 - 90	90 - 100
Color Rendering Issues	Possible Problems	Good	Excellent

METRICS & SSI

SSI Scores

LED wall

LED walls have a very poor color rendering.

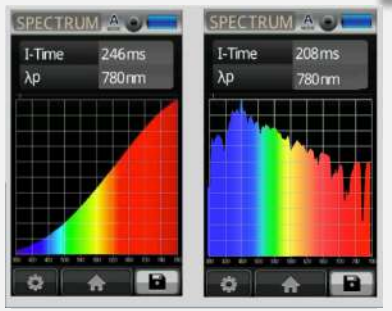
Consequences:

Never light faces with LED walls!

0 - 70	70 - 80	80 - 90	90 - 100
Color Rendering Issues	Possible Problems	Good	Excellent

METRICS & SSI

SSI



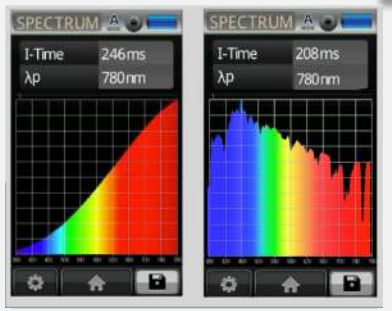
Spectral Similarity Index.

A metric dedicated to LEDs used in cinematography.

This index is the result of the collaboration between the ASC (American Society of Cinematographers) And AMPAS (Academy of Motion Picture Arts and Sciences - Oscars).

METRICS & SSI

SSI



Spectral Similarity Index.

A metric dedicated to LEDs

used in cinematography.

AMPAS*, CIE** & IES*** suggest using the SSI

& the TM-30-18/20

*AMPAS (Academy of Motion Picture Arts and Sciences)

**CIE : International Commission on Illumination

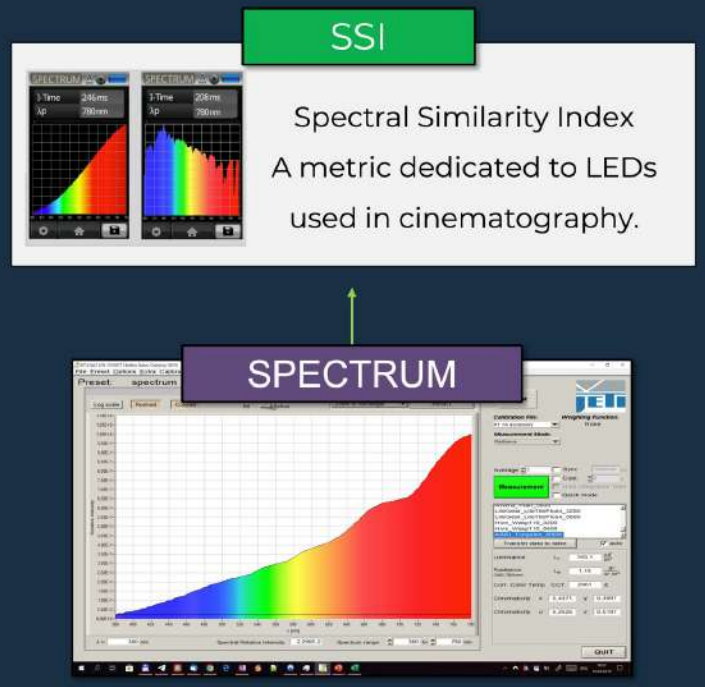
***IES : Illuminating Engineering Society

Special thanks to George Joblove

Senior Director, Technology and Standards, AMPAS (Oscars)

METRICS & SSI

Unfortunately the SSI is a very little used standard!



CONFERENCE OF LIGHT

Understanding the gaps

CONCLUSION OF THE CONFERENCE OF LIGHT

- Compared to a laboratory tool: A field tool will give color temperature differences of 200 K to 2000 K as well as different measurement values such as TLCI, TM-30-20
- 1 out of 12 manufacturers give the SSI
- All manufacturers still give the wrong index (CRI)

VISUAL MEDIA LAB CONFERENCE

6. HdM LEDs tests

VISUAL MEDIA LAB CONFERENCE

Hochschule der Medien

NEW TESTS
ON LEDS

Stuttgart – February 2023

VISUAL MEDIA LAB CONFERENCE

Tests organized and designed by:

Stefan Grandinetti

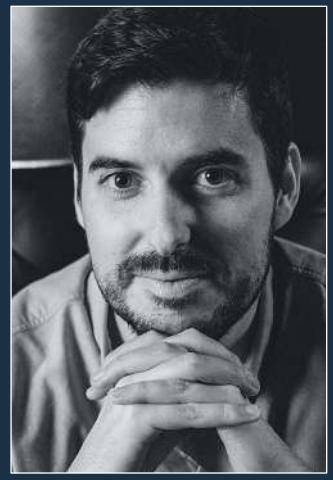
Cinematographer

BVK (Germany)

Professor for Cinematography

Hochschule der Medien, Stuttgart

IMAGO TC full member



Andy Minuth

Lead Colorist

Color Workflow Specialist

FillmLight (Germany)

IMAGO TC Associate member

VISUAL MEDIA LAB CONFERENCE

- Shot on an ARRI Alexa 35
- 50 mm Zeiss CP3 at T-stop 4
- RAW recording file
- HDR 4K D.I workflow (No ACES) on FilmLight at HdM

VISUAL MEDIA LAB CONFERENCE

LEDs

Full color :

- ARRI Orbiter
- DMG Maxi Mix

Bi color :

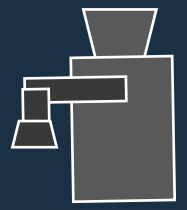
- Felloni

VISUAL MEDIA LAB CONFERENCE

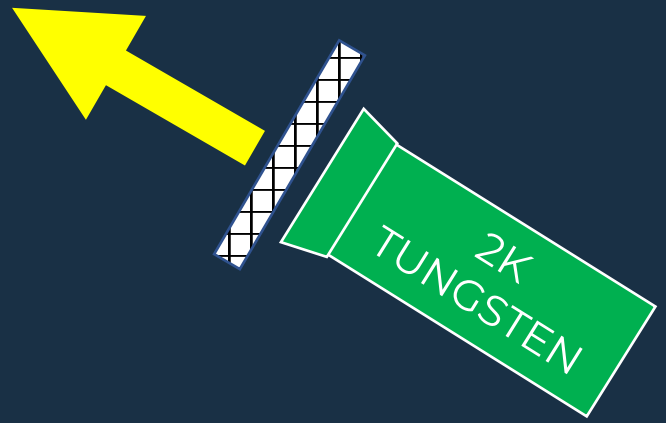
GENERAL SETUP

Black wall

Chart



Alexa 35

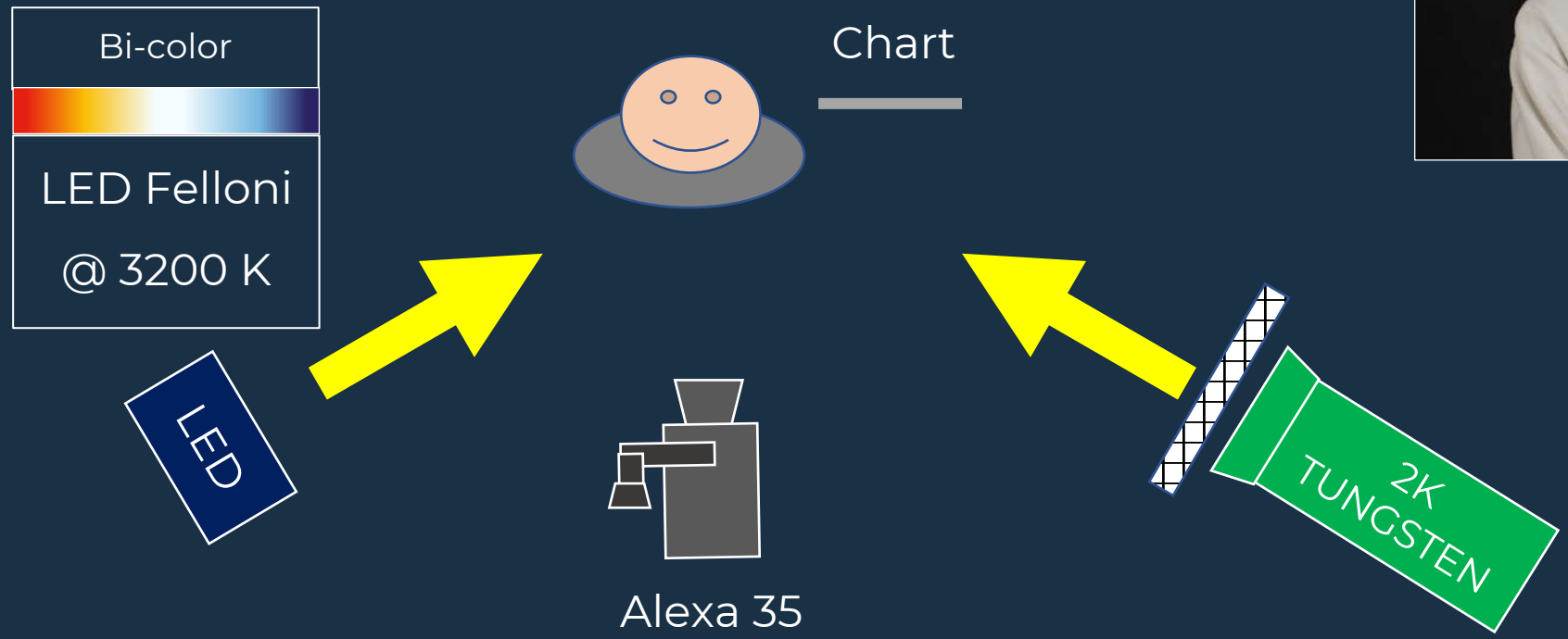


TUNGSTEN REFERENCE

2 kW
TUNGSTEN
Fresnel
(+ Light Grid)

VISUAL MEDIA LAB CONFERENCE

GENERAL SETUP



LED	TUNGST. REF.

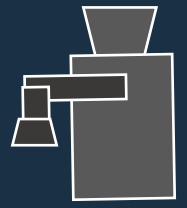
2 kW
TUNGSTEN
Fresnel
(+ Light Grid)

VISUAL MEDIA LAB CONFERENCE

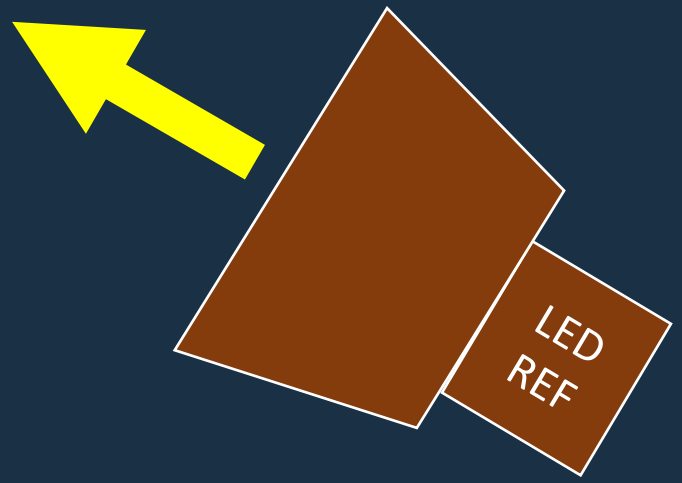
GENERAL SETUP

Black wall

Chart



Alexa 35



LED REFERENCE

ARRI Orbiter

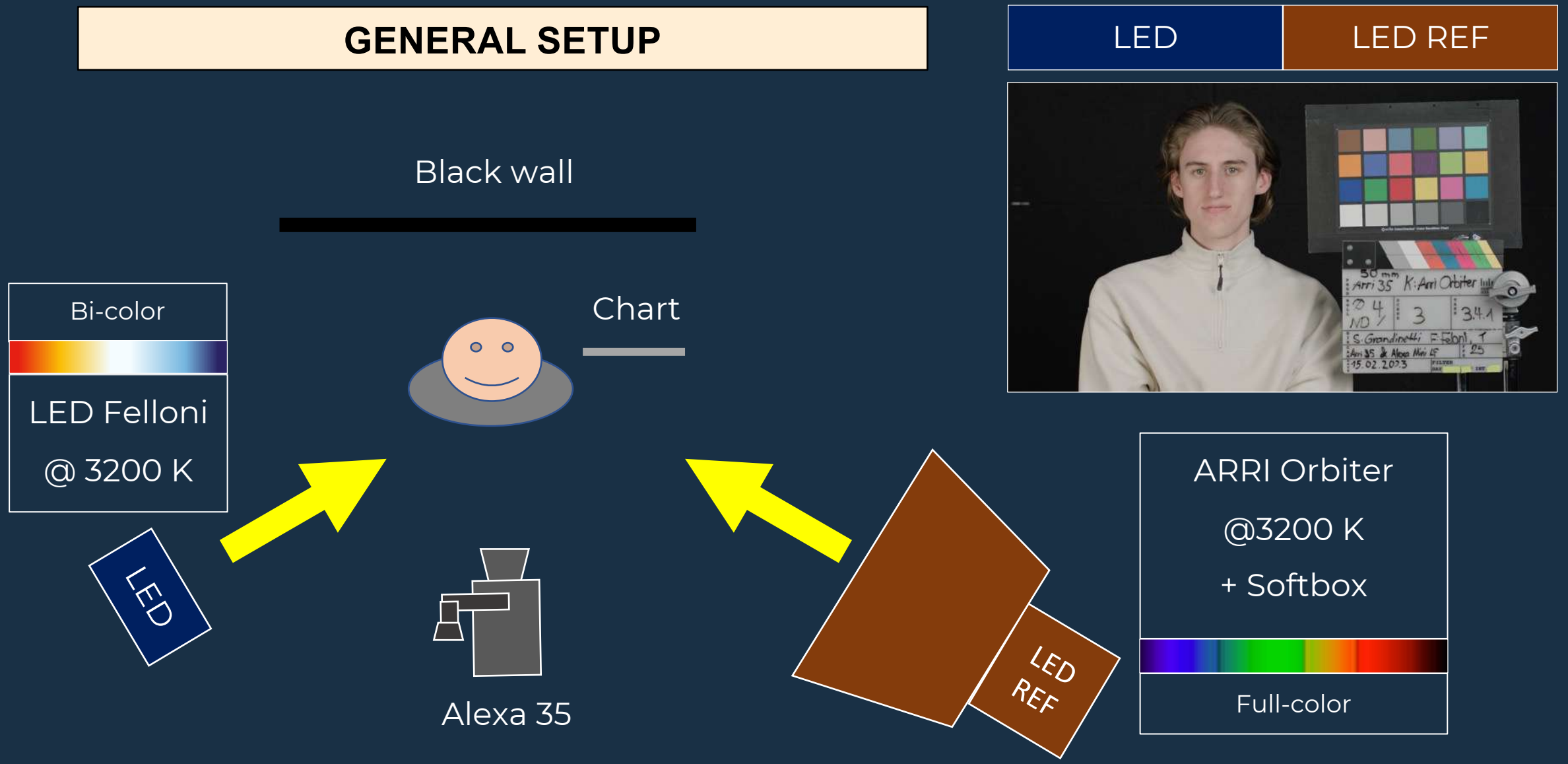
@3200 K

+ Softbox

Full-color

VISUAL MEDIA LAB CONFERENCE

GENERAL SETUP



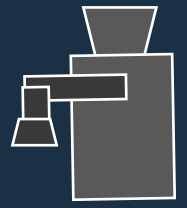
LED	LED REF

VISUAL MEDIA LAB CONFERENCE

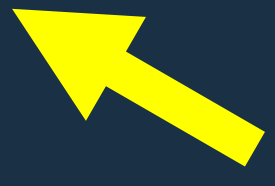
GENERAL SETUP

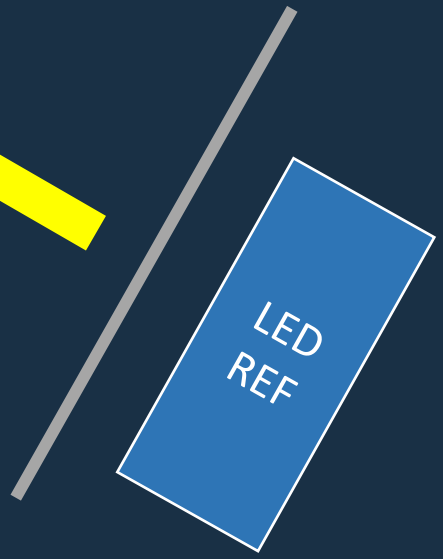
Black wall

Chart



Alexa 35





LED REFERENCE

DMG Maxi fixture

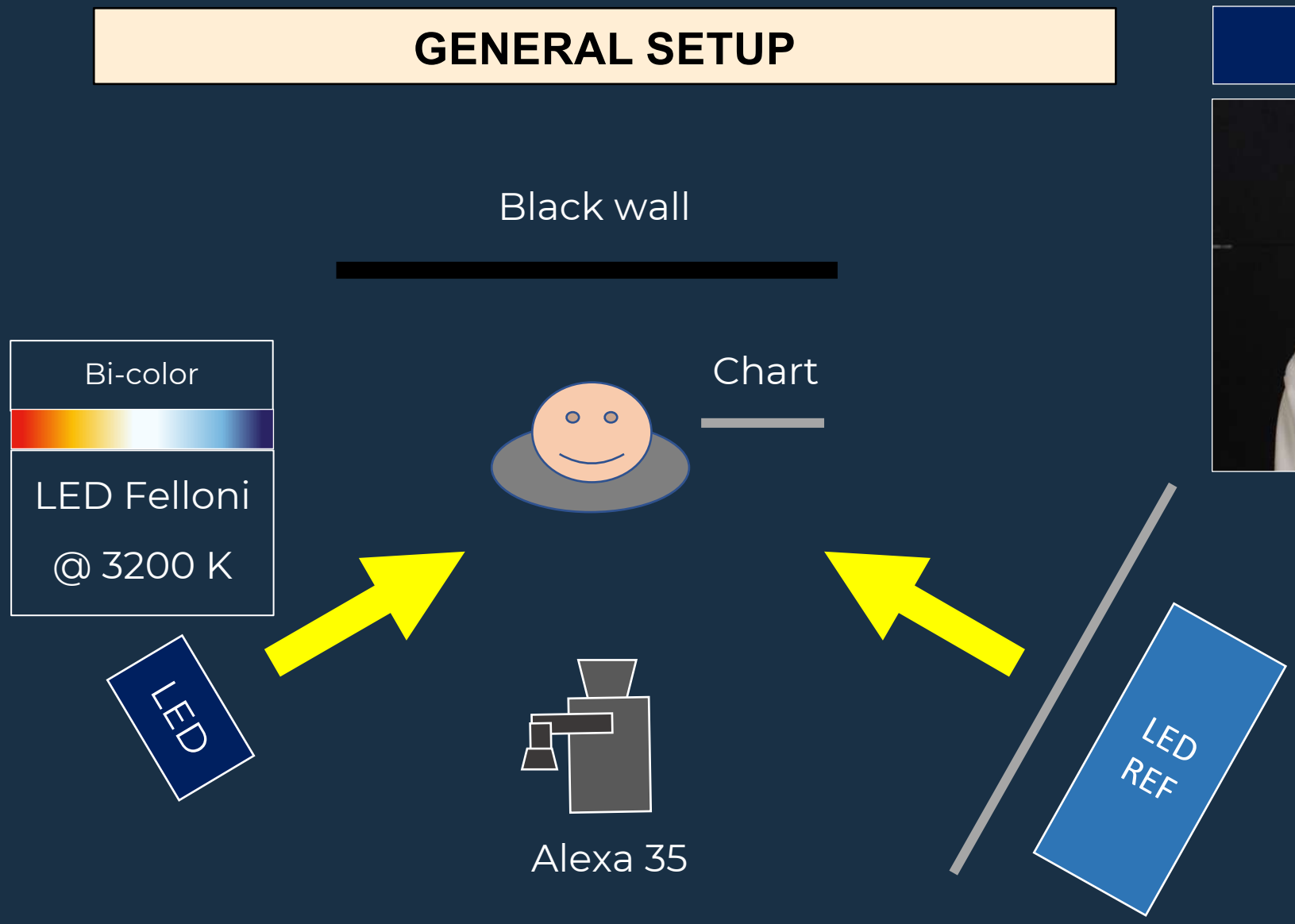
@ 3200 K

(+ Light Grid)

Full-color

VISUAL MEDIA LAB CONFERENCE

GENERAL SETUP



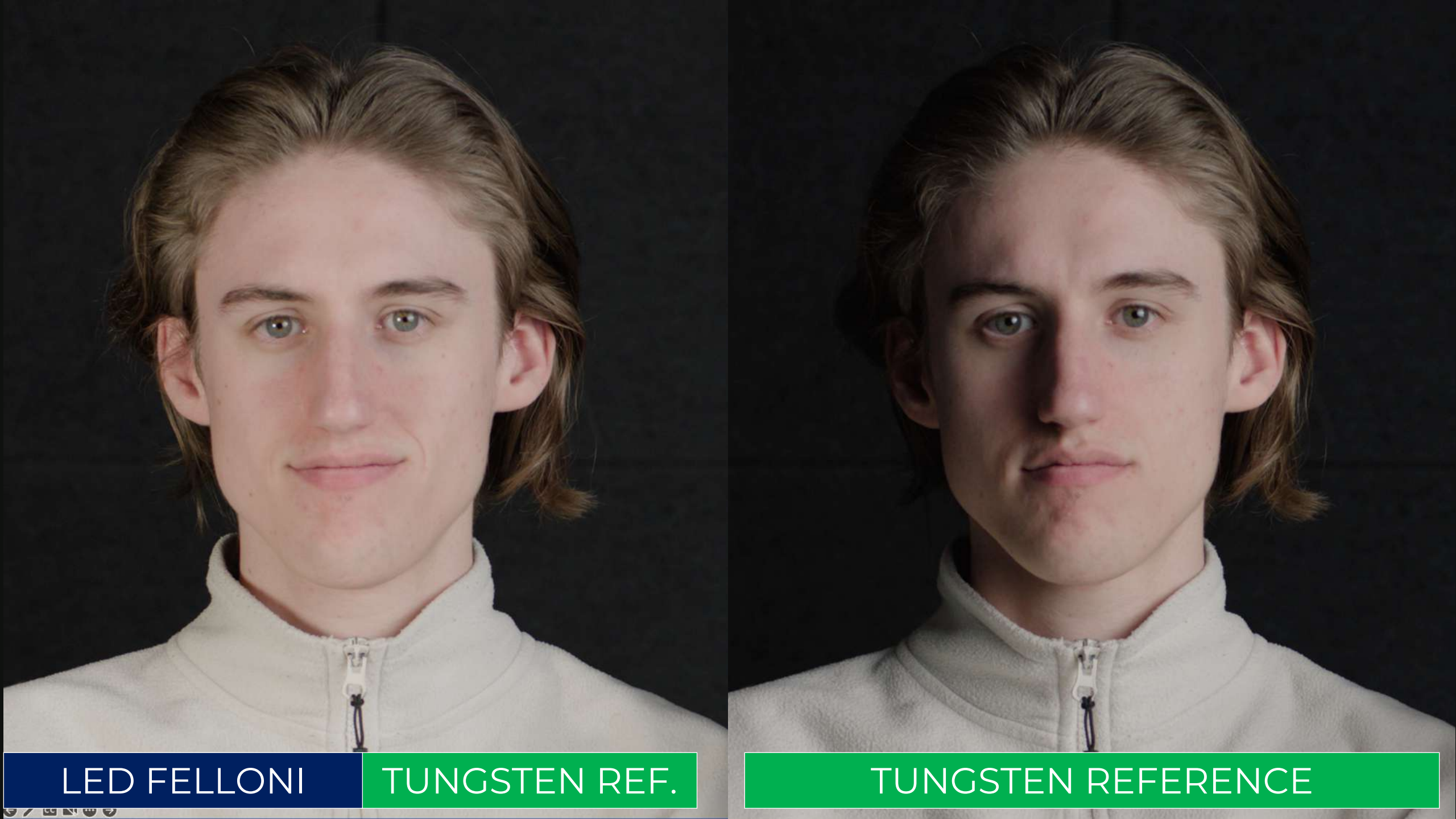
LED	LED REF

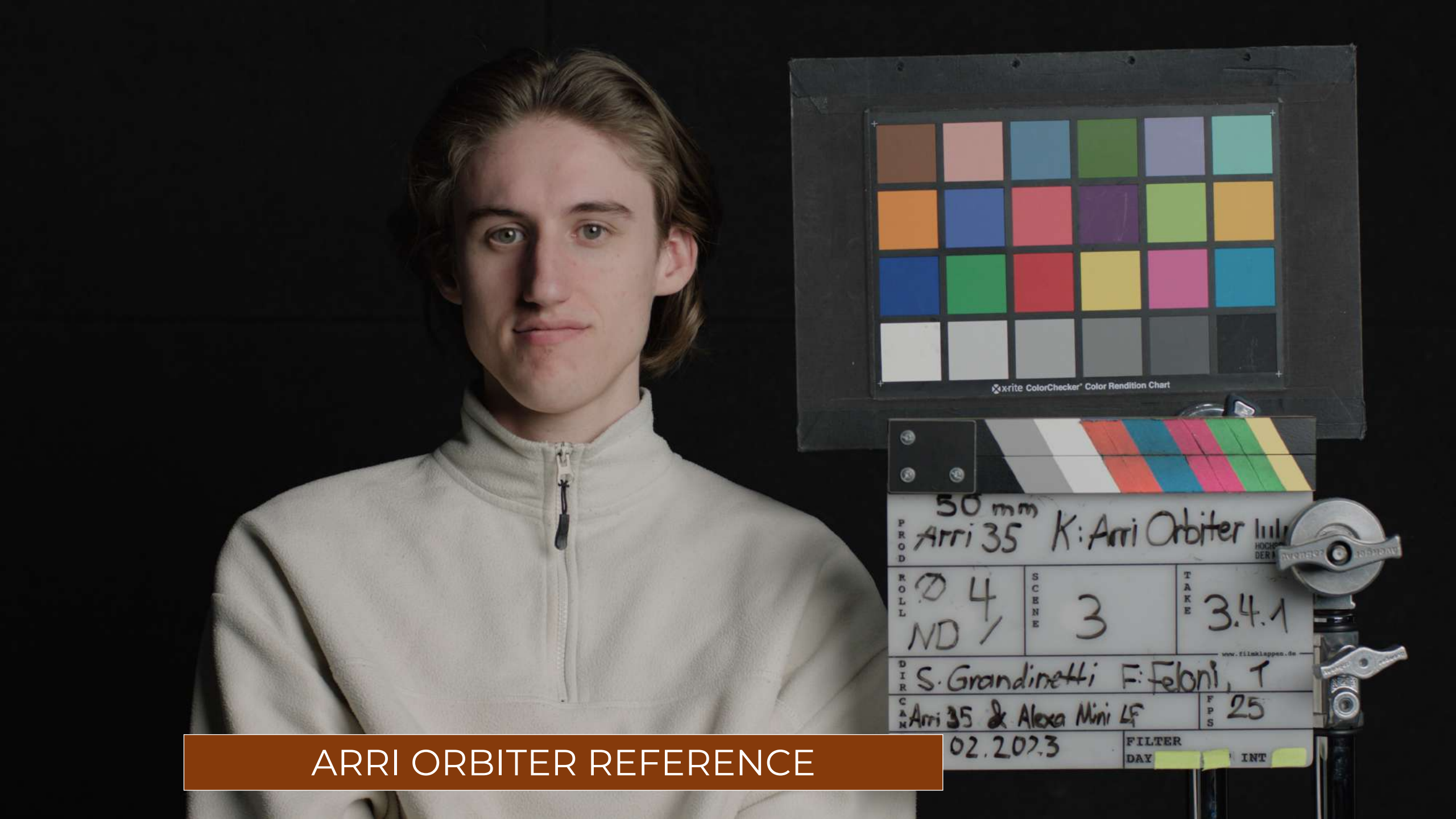
BRIGHT SKIN TONE

Large & Close shot

TUNGSTEN REFERENCE

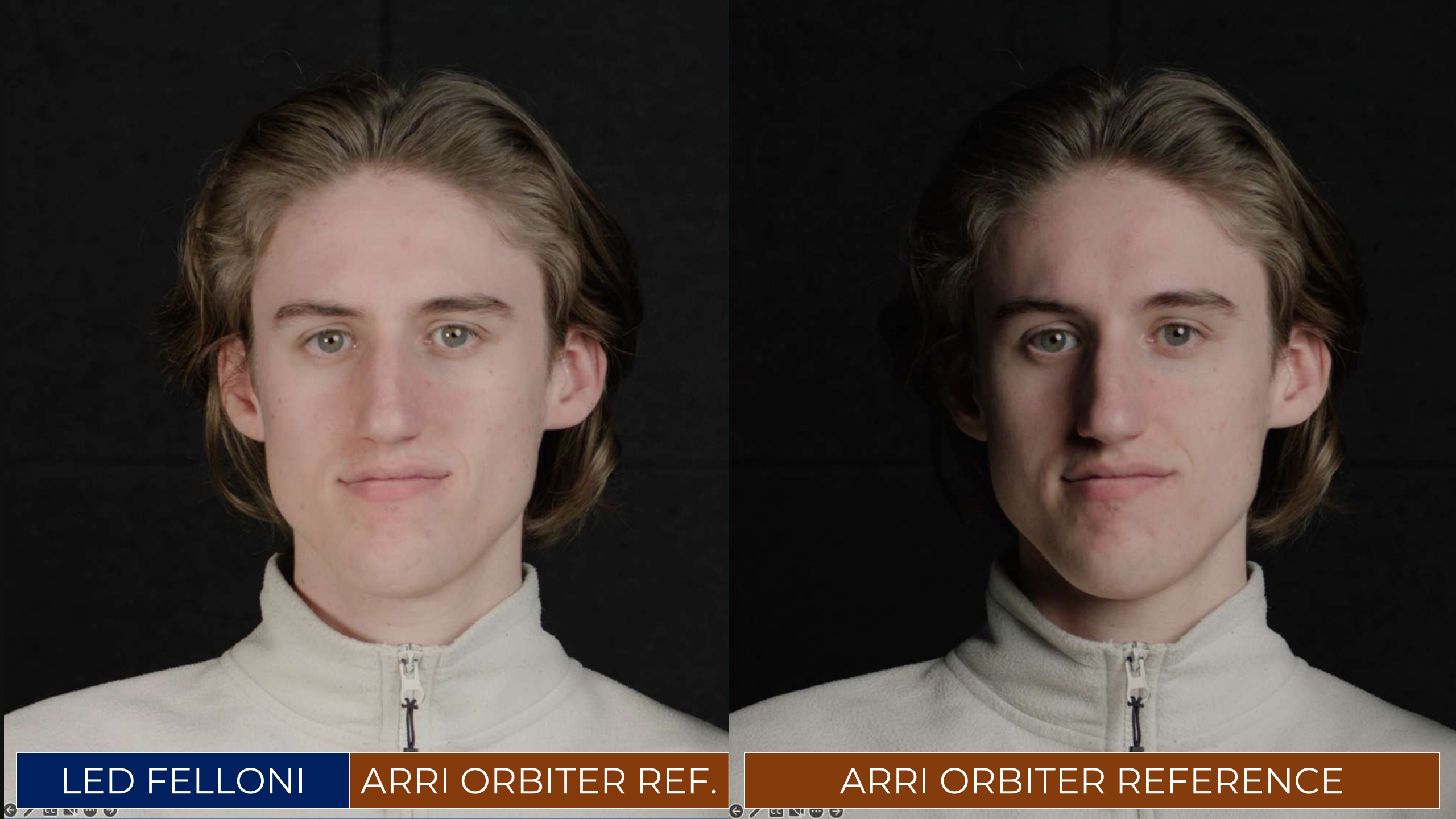

x-rite ColorChecker® Color Rendition Chart
50 mm
Arri 35
K: 2kW Tungsten
PROD
ROLL
4
ND
SCENE
3
TAKE
3.3.1
DIR
S. Grandinetti
F: Felloni, T
CAM
Arri 35 & Alexa Mini LF
FPS
25
02.2023
FILTER
DAY
INT
LED FELLONI
TUNGSTEN REF.

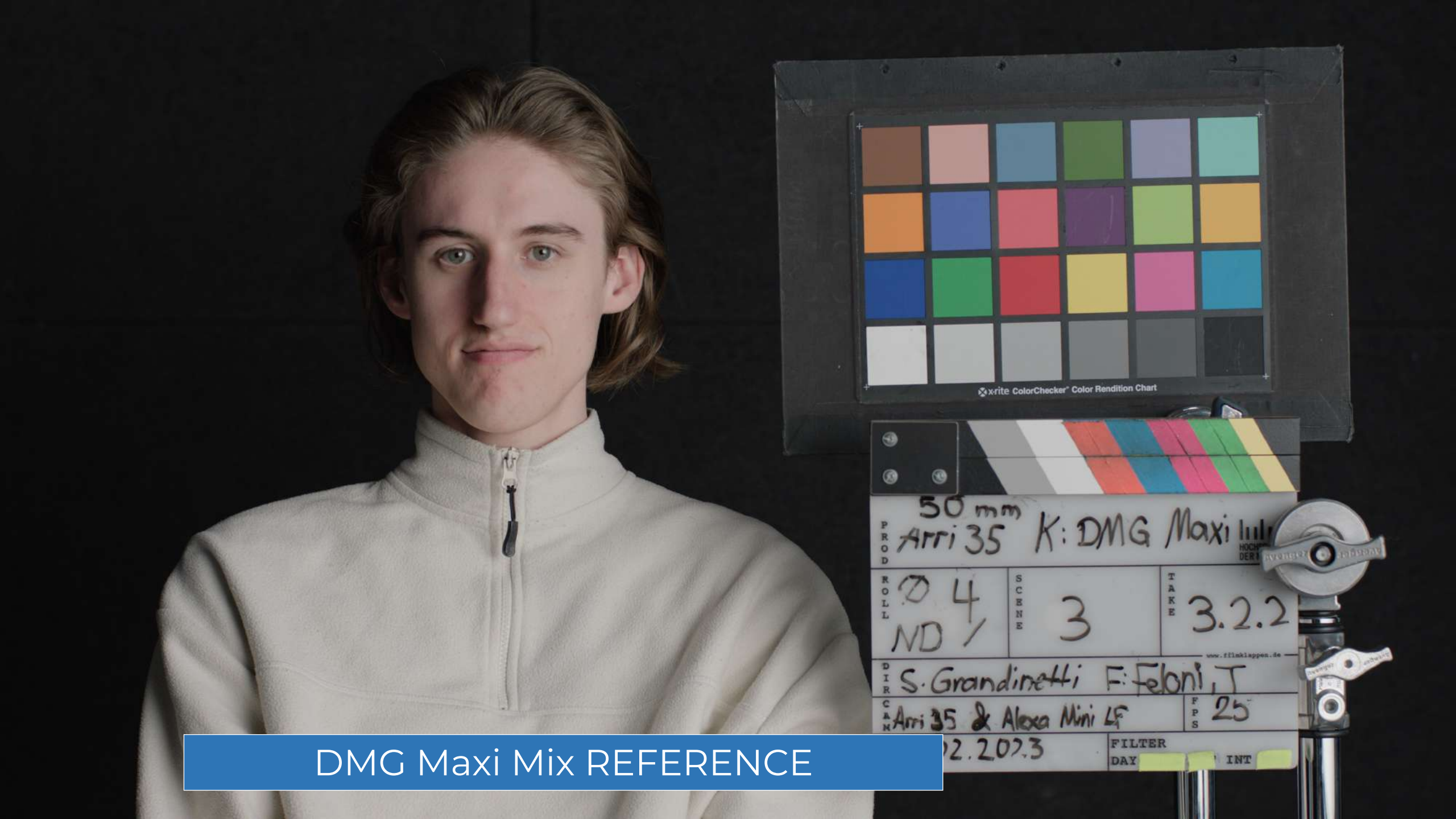

LED FELLONI
TUNGSTEN REF.
TUNGSTEN REFERENCE



ARRI ORBITER REFERENCE

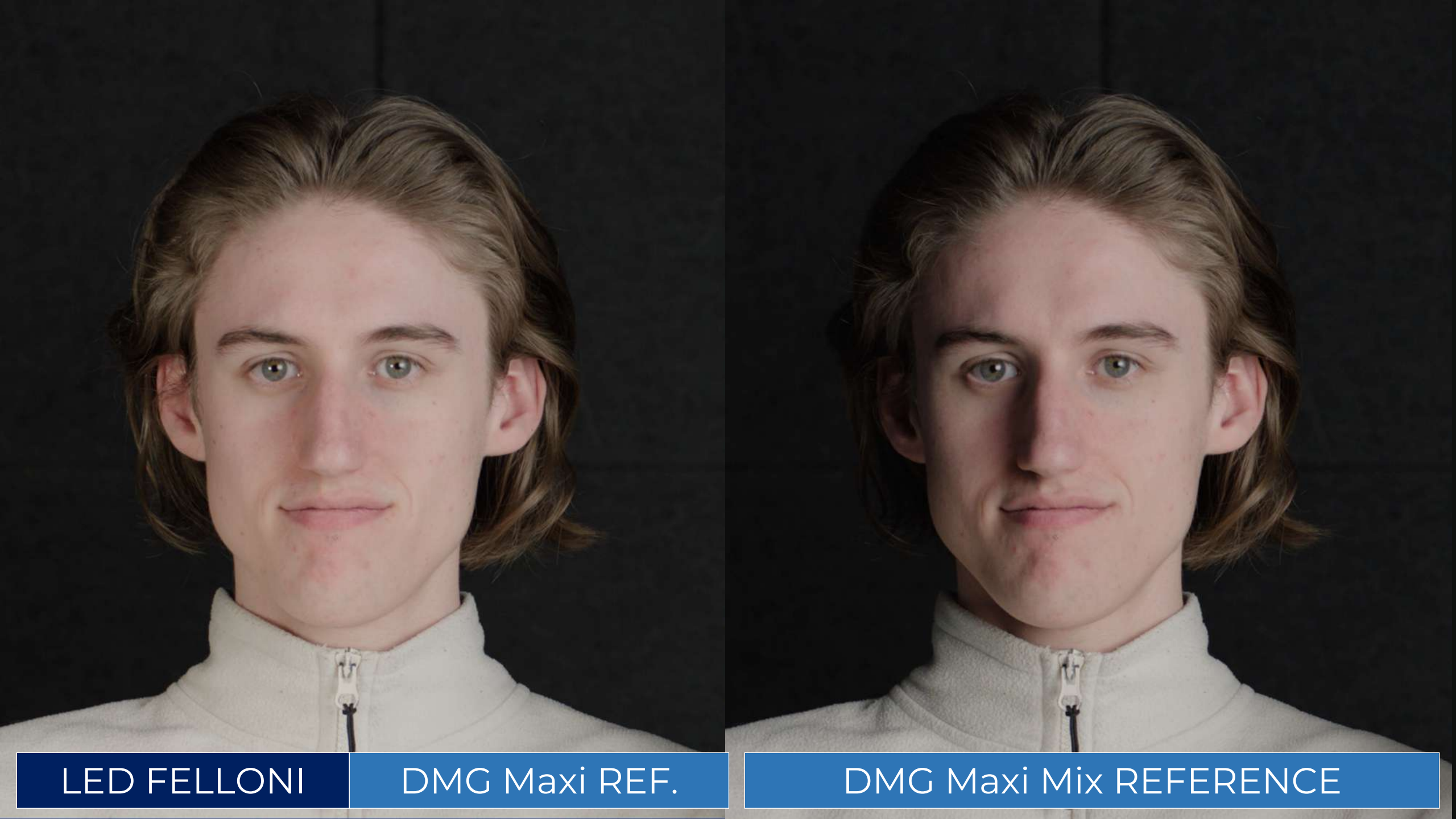
LED FELLONI | ARRI ORBITER REF.


LED FELLONI
ARRI ORBITER REF.
ARRI ORBITER REFERENCE



DMG Maxi Mix REFERENCE

LED FELLONI | DMG Max REF.

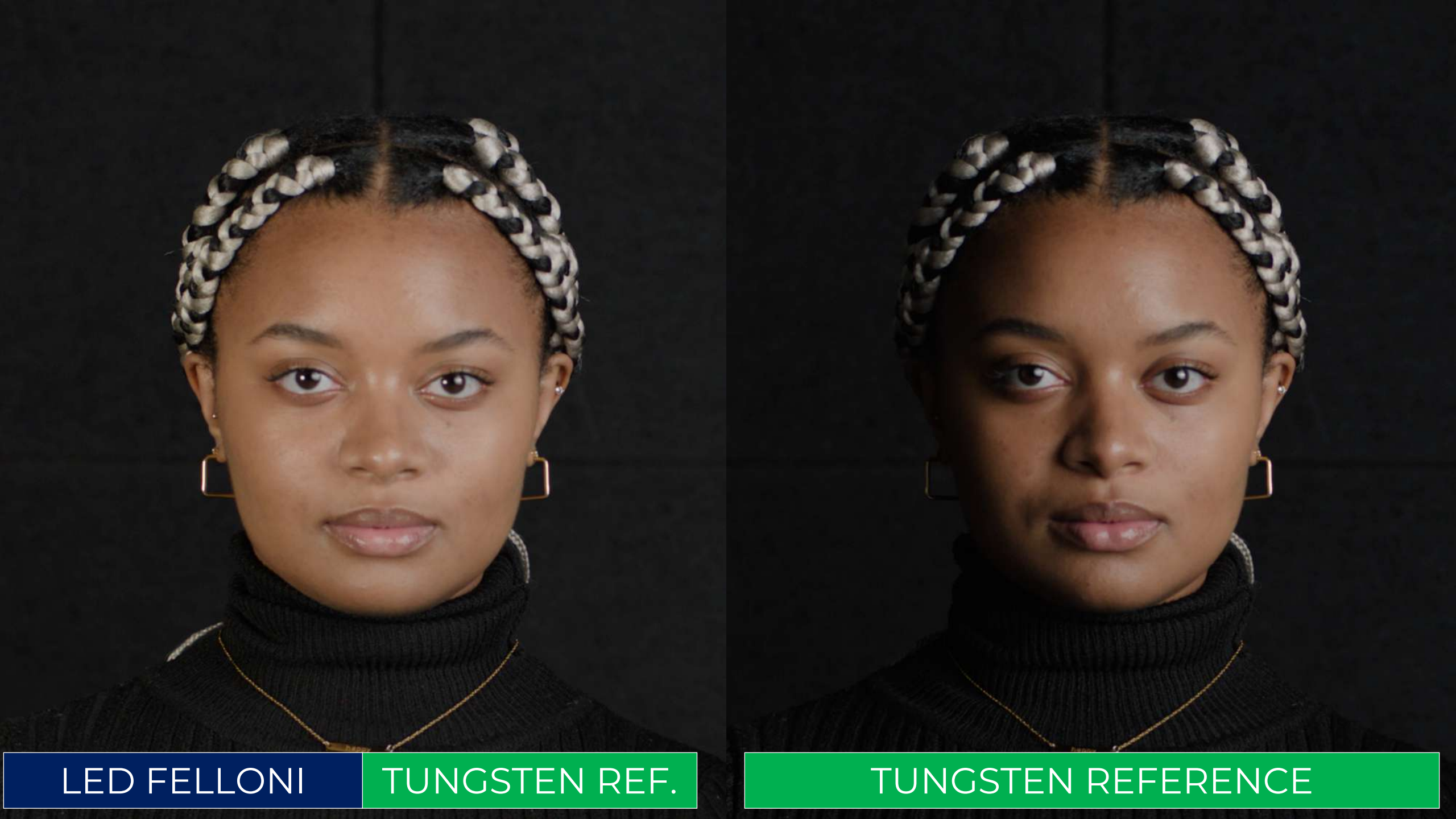

LED FELLONI
DMG Maxi REF.
DMG Maxi Mix REFERENCE

DARK SKIN TONE

Large & Close shot

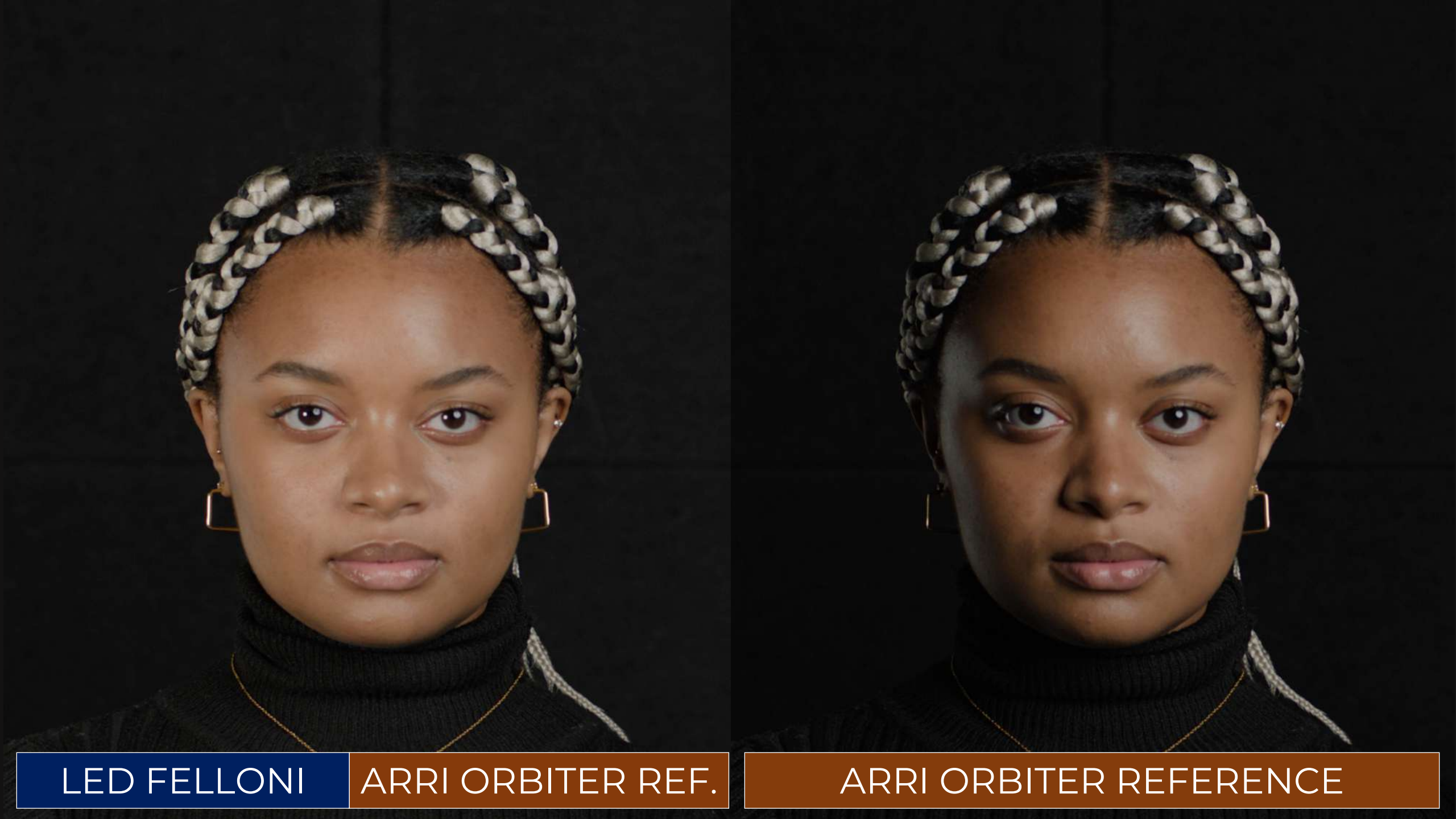
LED FELLONI | TUNGSTEN REF.

TUNGSTEN REFERENCE


LED FELLONI
TUNGSTEN REF.
TUNGSTEN REFERENCE

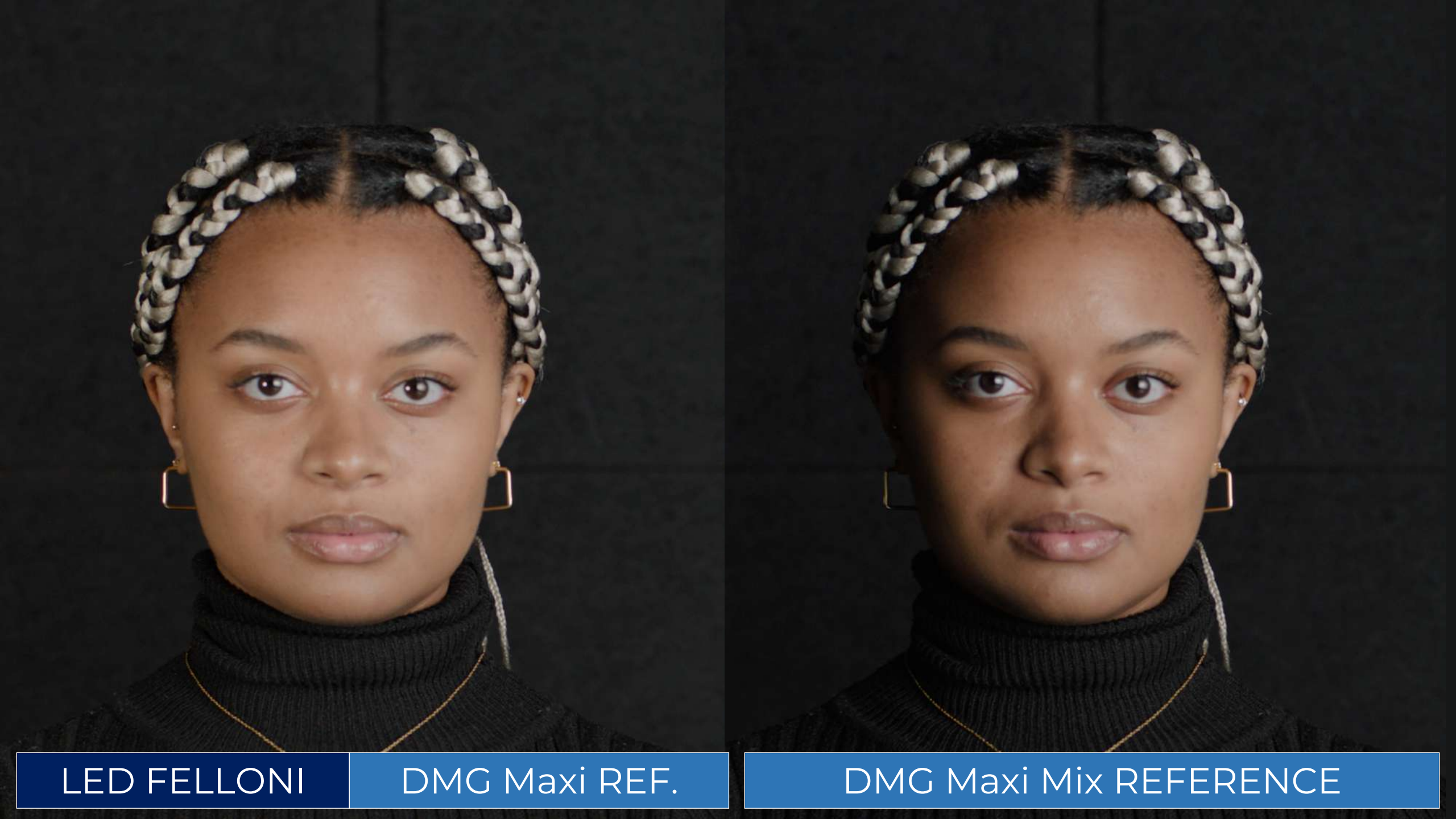
ARRI ORBITER REFERENCE

LED FELLONI | ARRI ORBITER REF.


LED FELLONI
ARRI ORBITER REF.
ARRI ORBITER REFERENCE

DMG Maxi Mix REFERENCE

LED FELLONI | DMG Max REF.


LED FELLONI
DMG Maxi REF.
DMG Maxi Mix REFERENCE

FIRST CONCLUSIONS OF THE HDM TESTS

VISUAL MEDIA LAB CONFERENCE

- Almost no difference between the tungsten reference and the two LEDs (ARRI Orbiter and DMG Maxi Mix)
- Almost no difference between the reference of the two full-color LEDs (ARRI Orbiter and DMG) and the bi-color Felloni LED

CONCLUSIONS

This progress certainly comes from:

- Efforts in camera colour science
- Improvements in LEDs
- Post-production color pipeline

ACKNOWLEDGEMENTS

Stefan Grandinetti likes to thank:

Models: Lauren Gaither and Joschka Kühner

Colorist/Workflow: Andy Minuth (FilmLight)

Team: Ronja Jürgens, Luis Zappe, Alex Isbrecht

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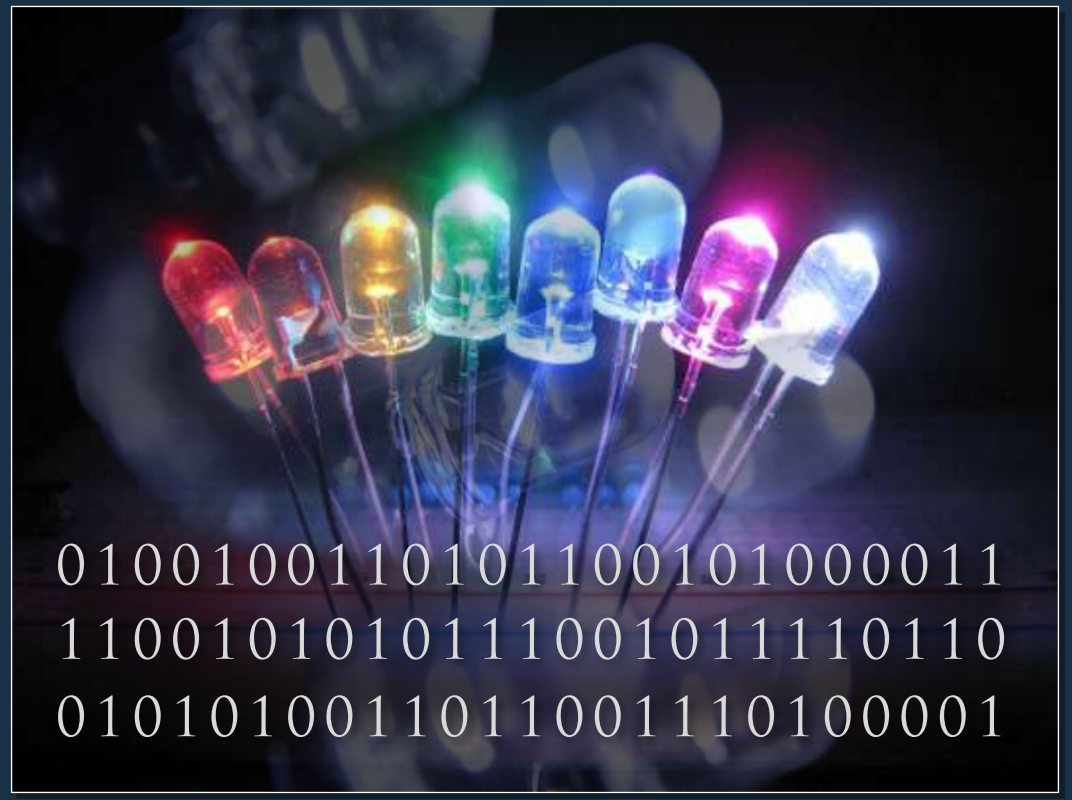

7. The missing data

Back to the Numbers

LED lifetime:

Several thousand hours

But

- The red LED is the most heat sensitive -and beyond 25/28°C it begins to lose his characteristics
- No statistics on the lifespan of the LEDs taking into account the color rendering.

Ecology

- Reduced consumption

But what about of:

- The manufacture of LEDs?
- The renewal of LEDs?
- The waste management?

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Manufacture of LEDs

Extremely polluting mining

Manufacture of LEDs

- The majority of bare diodes are made in China and in Taiwan

Manufacture of LEDs

- Difficulty in supplying bare diodes for American and European manufacturer of LED projectors
- Economic war between USA & China - Europe & China

Permanent renewal of LEDs

- Every week several brands of Chinese LEDs for audiovisuals appear on the market

Permanent renewal of LEDs

- Trendy models appear and disappear
- Inventory management very difficult for rental companies
- Newer LEDs are piling up on shelves and in warehouses

Waste management

- Nothing is planned
- LEDs contain strategic and hazardous metals and plastics
- We are coming to the end of resources for metals

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Paradox

Metals management

"What we create is a world based on metals"

"It is inadmissible in the metallic field to throw,

the job of metal is to last."

Aurore Stephant (mining geologist engeneer)

Paradox

Metrics

- No quality standards really used
- No reliable power reference
- Numbers don't matter anymore

Paradox

Metrics

- We find the same problem in the cameras
- Is a 4K / 8K / 12K camera really aptly named?.

9. Conclusions

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- A lot of possibility in creation
- Need for a digital assessment
- Lack of scientific rigor
- All connected, all isolalted

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- Color rendering is improved
- Comparison with sound (mp3 and mp4)

Next slides: some references of skin tones

VISUAL MEDIA LAB CONFERENCE

‘Far from Heaven’ - Director : Todd Haynes - Cinematographer: Ed Lachman

VISUAL MEDIA LAB CONFERENCE

‘Written on The Wind’ – Director: Douglas Sirk – Cinematographer: Russell Metty - (Technicolor)

VISUAL MEDIA LAB CONFERENCE

‘All That Heaven Allows’ – Director: Douglas Sirk - Cinematographer: Russell Metty (Eastmancolor & Technicolor)

VISUAL MEDIA LAB CONFERENCE

‘Written on The Wind’ – Director: Douglas Sirk – Cinematographer: Russell Metty - (Technicolor)

Recommendations

For some:

- Films with significant artistic direction:
  - ✓ Period films
  - ✓ Beauty movies
- Sophisticated graded movies:

Recommendations

- Choosing & testing LEDs
- Always have an incandescent source and Hmi to illuminate the faces
- Recent camera with very good color science
- Thoroughly test the digital chain: the color pipeline

CONFERENCE OF LIGHT

Link on SSI, Conference of Light

and other comparisons tests

IMAGO Website

- https://imago.org/
- https://imago.org/news/evaluating-led-lighting-for-cinematography-using-ssi-spectral-similarity-index/

Acknowledgements

Jacqueline Delaunay, ACC & LEDs CEO

Marc Galerne, K5600 CEO

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George Joblove, Senior Director, Technology and Standards,
Academy of Motion Picture Arts and Sciences, Science and Technology Council

Dirk Meier, Colorist, CSI, BVK

Nils de Montgrand, DMG CEO

François Roger, CININTER CEO

John-Christian Rosenlund, Cinematographer, FNF

David Stump, Cinematographer, ASC, MITC