



**Workshop on Colorimetry, Graphic Arts and Colour Management  
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# **Measurement and visual evaluation of fluorescent samples**

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# Non-fluorescent samples

## Visual evaluation and measurement



XYZ,  $L^*a^*b^*$  or any derived quantity may be calculated for any light source or illuminant

Non-fluorescent samples may be viewed under any light source and the results calculated for any source or illuminant

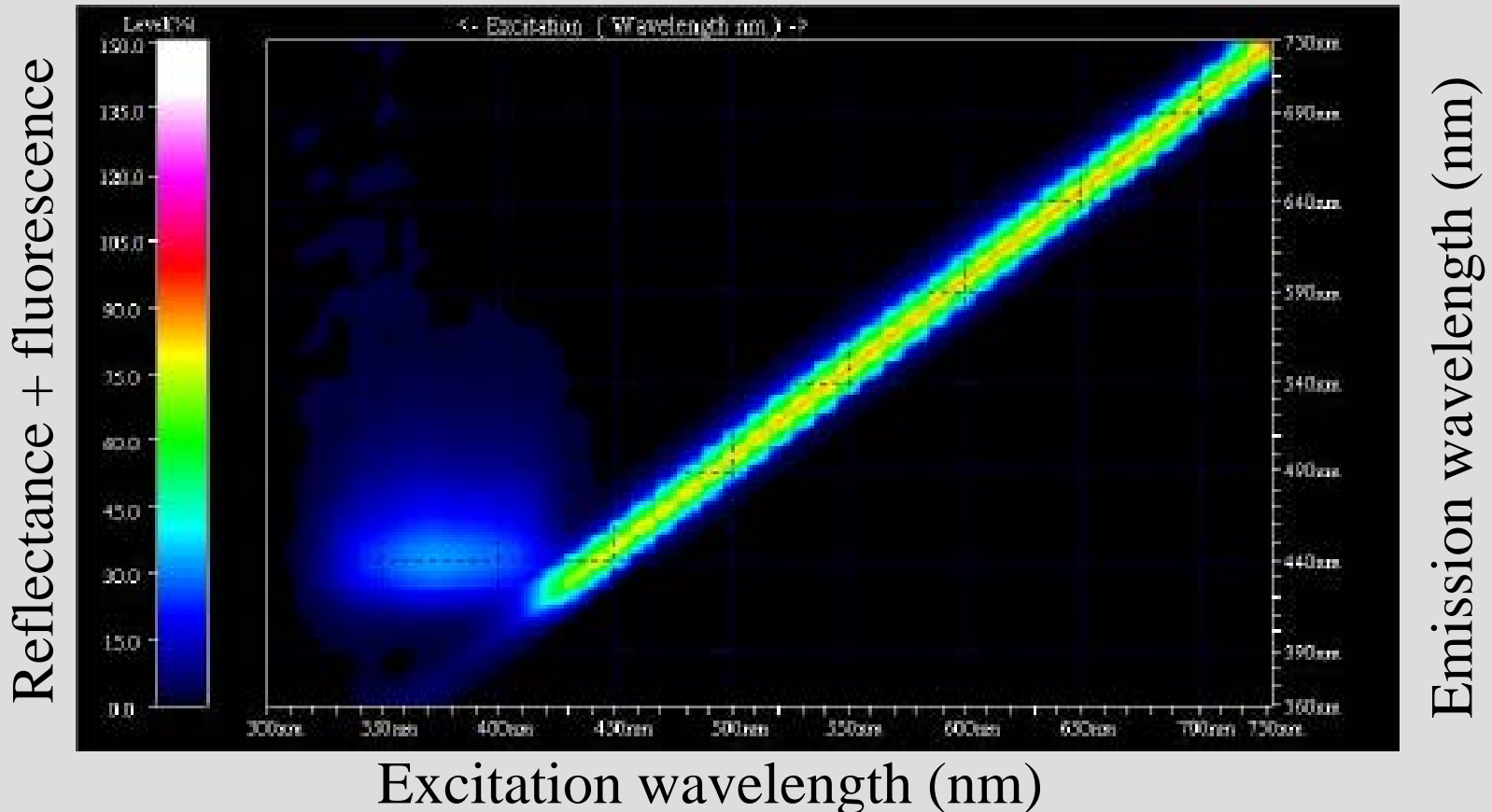
# Fluorescent samples



Fluorescent samples absorb UV radiation and emit visible light

# Fluorescent samples

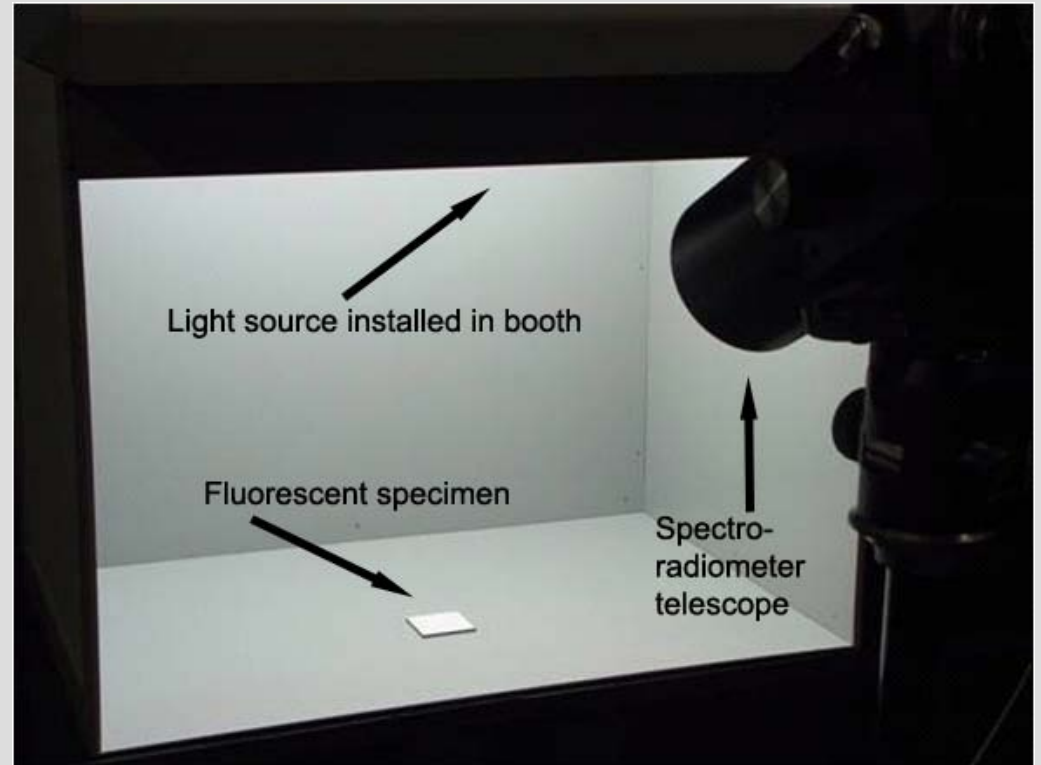
## Measurement



From the Donaldson matrix of the bispectral measurement of a fluorescent specimen the TRF may be calculated for any desired light source or illuminant

# Fluorescent samples

## Visual evaluation and measurement



The other possible solution is to measure fluorescent samples under the same light source as that used for visual evaluation



# Fluorescent samples

## Visual evaluation and measurement



ISO 3664:2009 compliant



ISO 13655:2009 M1 compliant

The viable practical solution is to have light sources both in visual systems and in instruments simulate a standard CIE illuminant

# Fluorescent samples

## Evaluation of daylight simulators

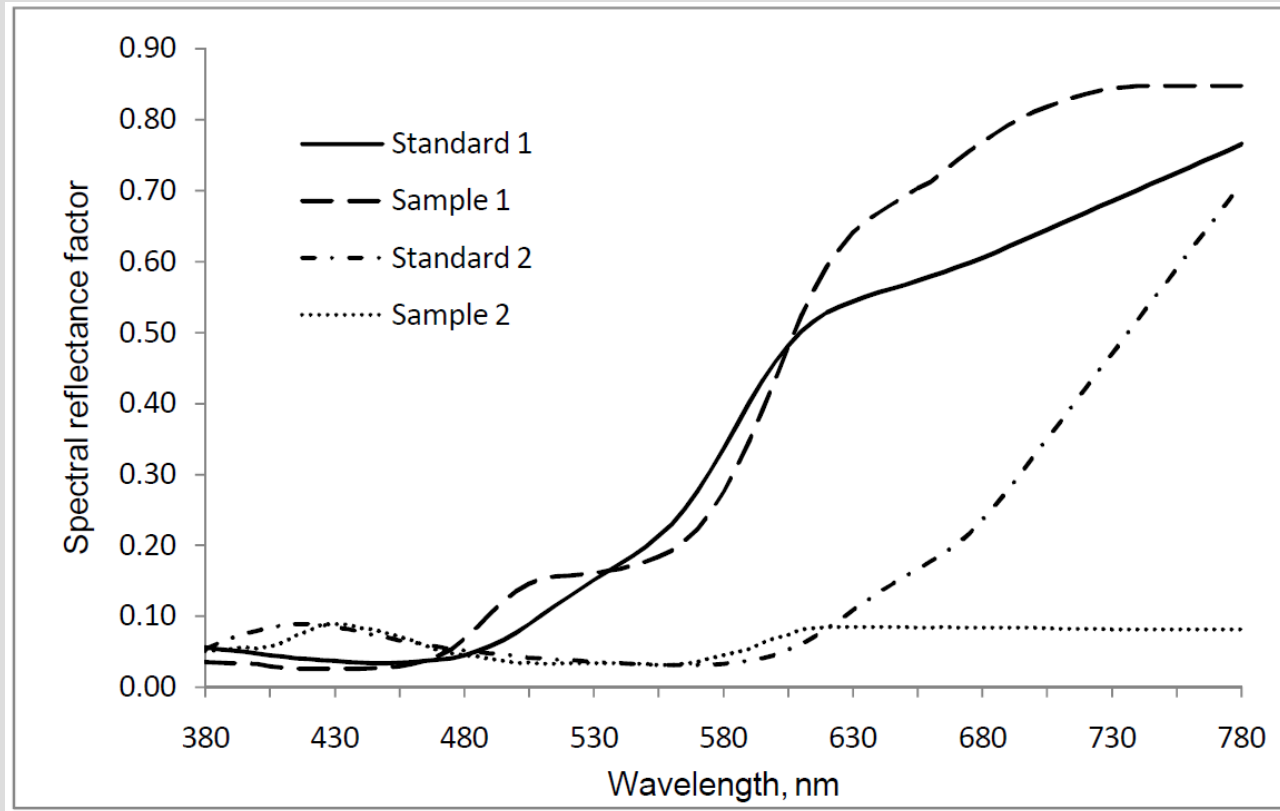
**MI-type evaluation of light sources:** colour difference between pairs of metameric samples under the test source which show  $DE^*=0$  under the reference illuminant



The five standard specimens used in the visual range evaluation of daylight simulators, according to CIE 51.2 / S 012

# Fluorescent samples

## Evaluation of daylight simulators

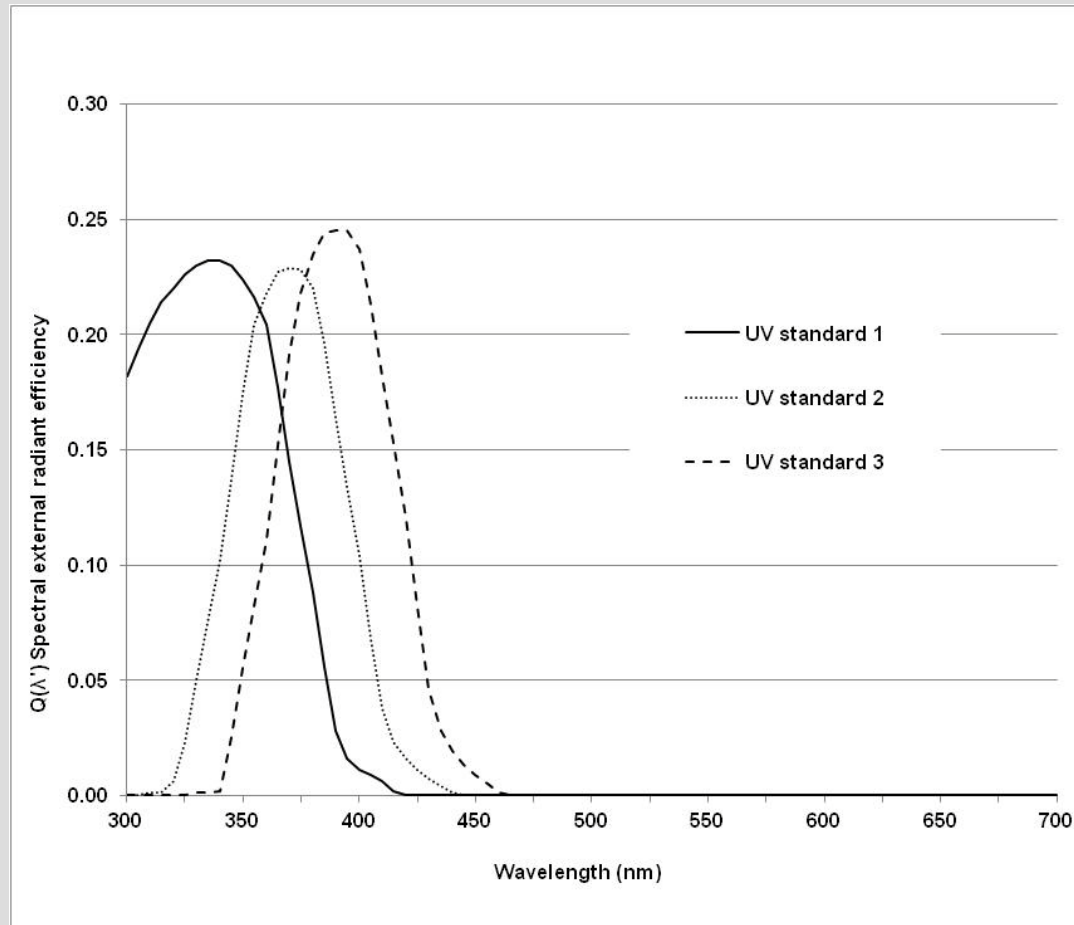


Spectral reflectance factor of the first two (of five) metameric specimens for the evaluation of D65 simulators in the visible range by the CIE 51 method



# Fluorescent samples

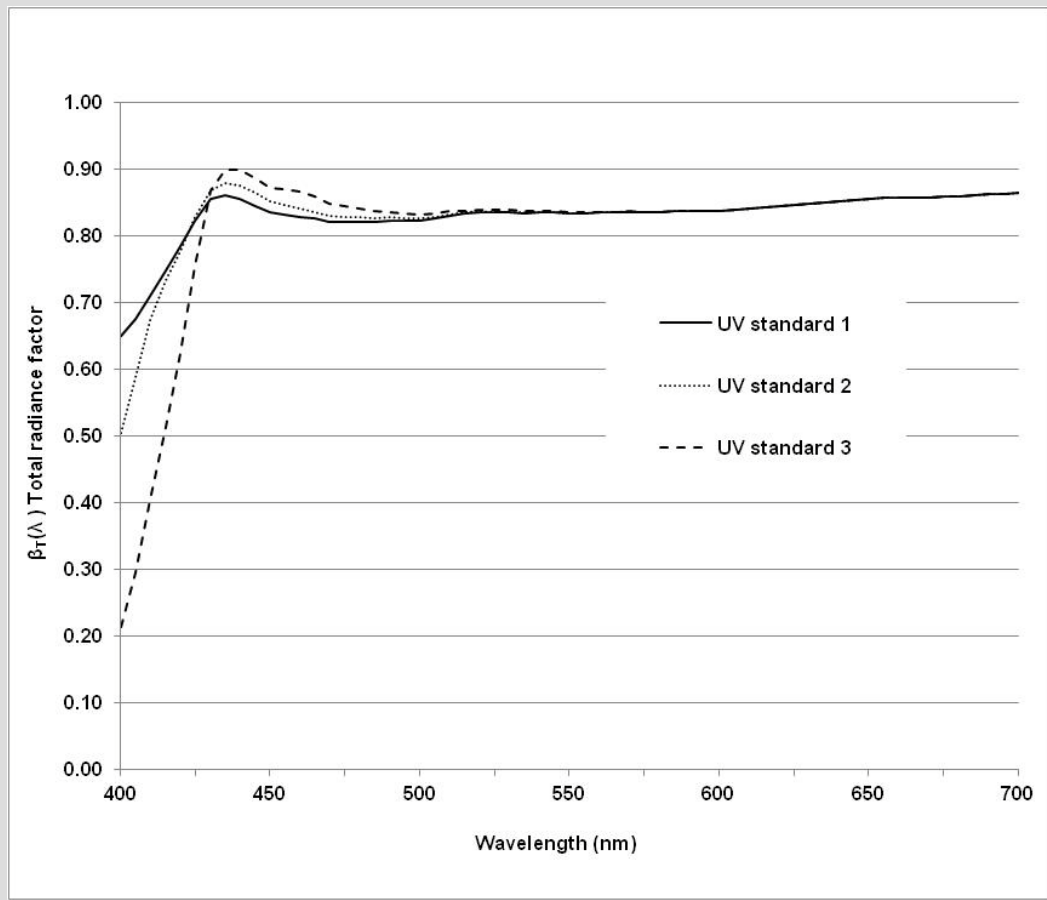
## Evaluation of daylight simulators



Spectral external radiant efficiency  $Q(\lambda')$  for the three UV standards in the UV range by the CIE 51 method

# Fluorescent samples

## Evaluation of daylight simulators



Total spectral radiance factor  $\beta_T(\lambda)$  for the three UV standards for illuminant D65 in the CIE 51 method

# Fluorescent samples

## Evaluation of daylight simulators

CIE Quality Grade	Metamerism Index $M_v$ or $M_u$
A	$\leq 0.25$
B	$> 0.25$ to 0.50
C	$> 0.50$ to 1.00
D	$> 1.00$ to 2.00
E	$> 2.00$

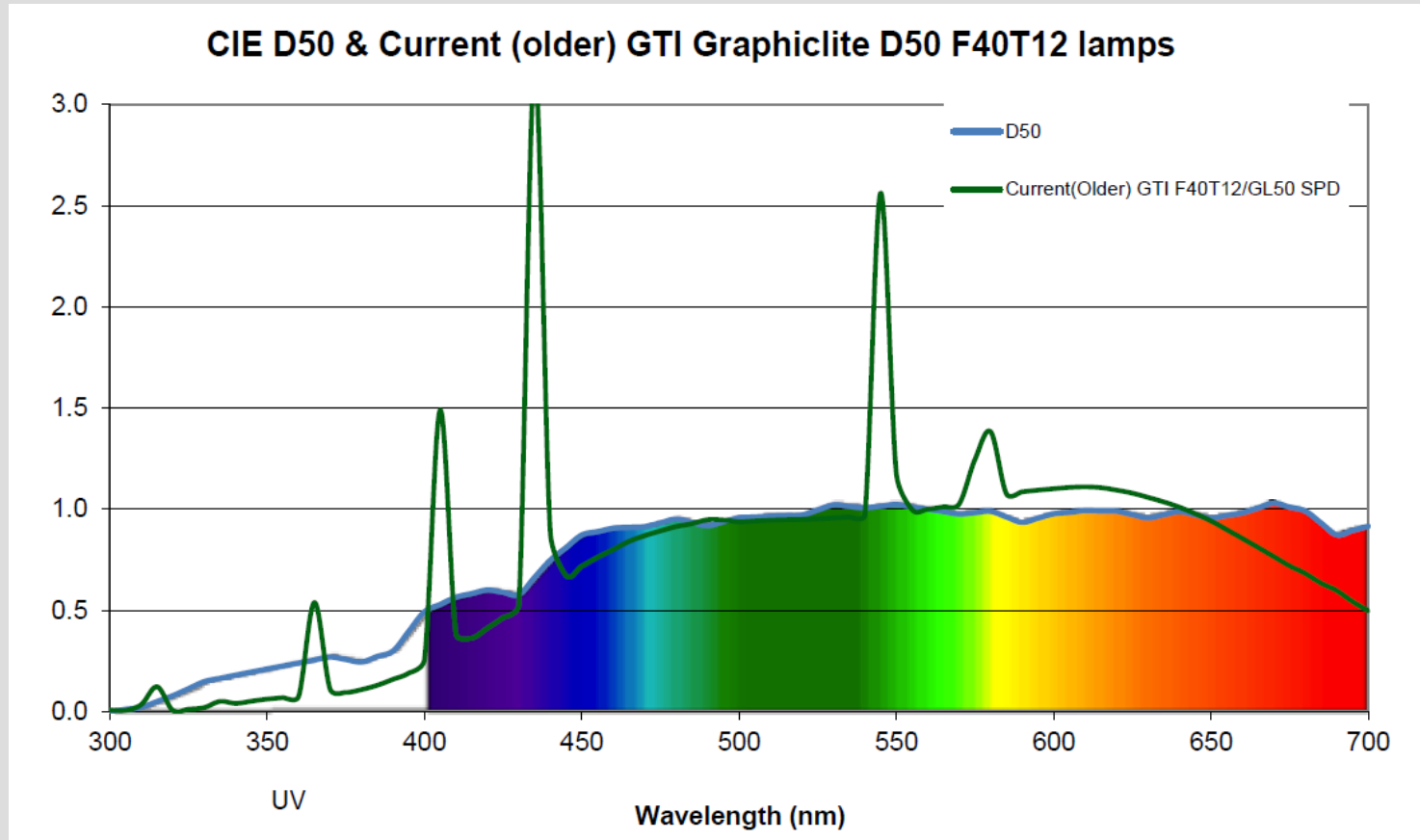
**ISO 3664:2009 and ISO 13655:2009 M1**

**Shall: 1.0 / 1.5 - Should 0.5 / 1.0**

**ASTM E0991: BB; ASTM D1729: BC**

# Fluorescent samples

## Practical implementation: GTI fluorescent lamps

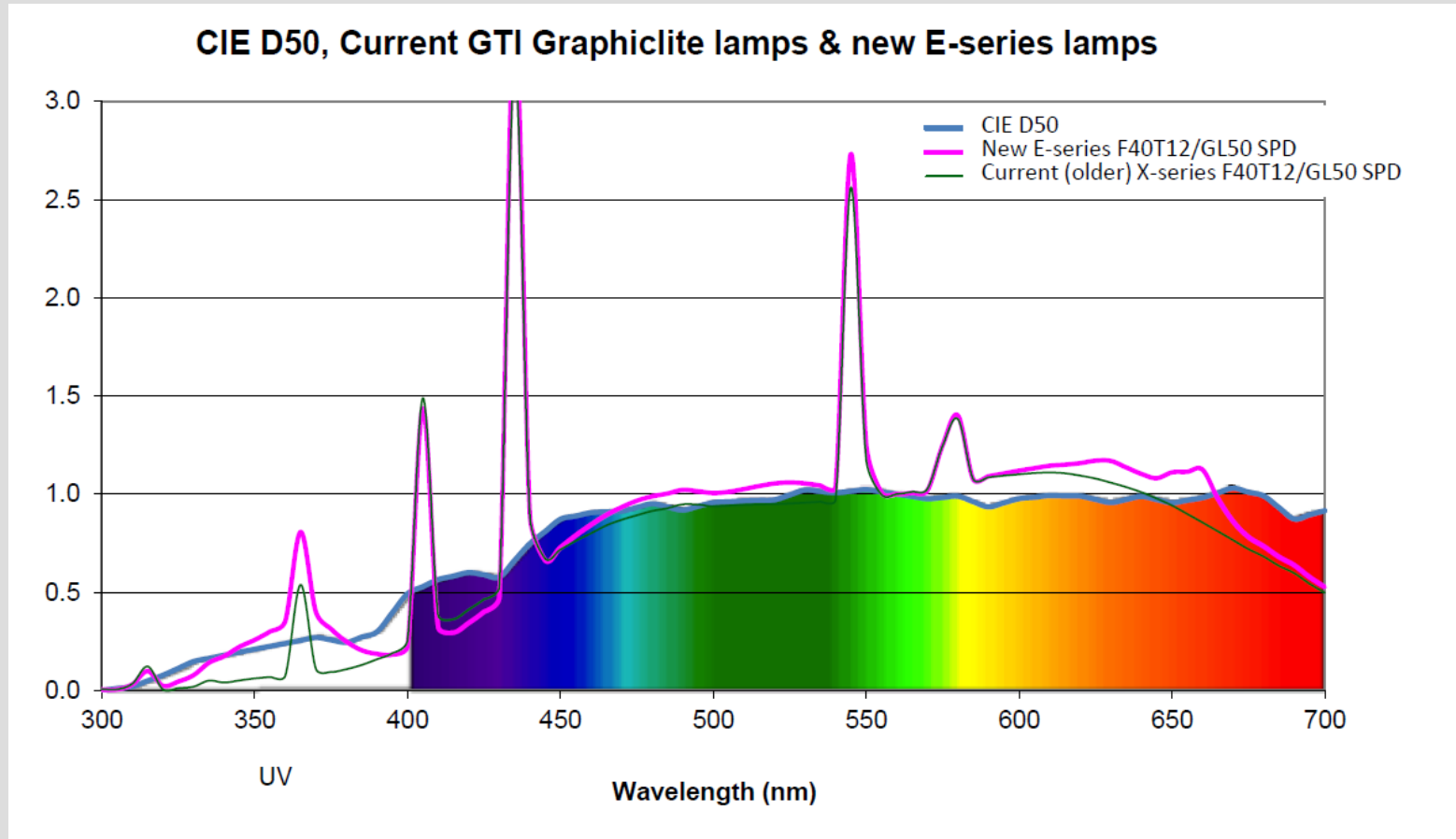


SPD of GTI D50 lamp

X-series (3664:2000 compliant) : 0.88 / 2.50

# Fluorescent samples

## Practical implementation: GTI fluorescent lamps

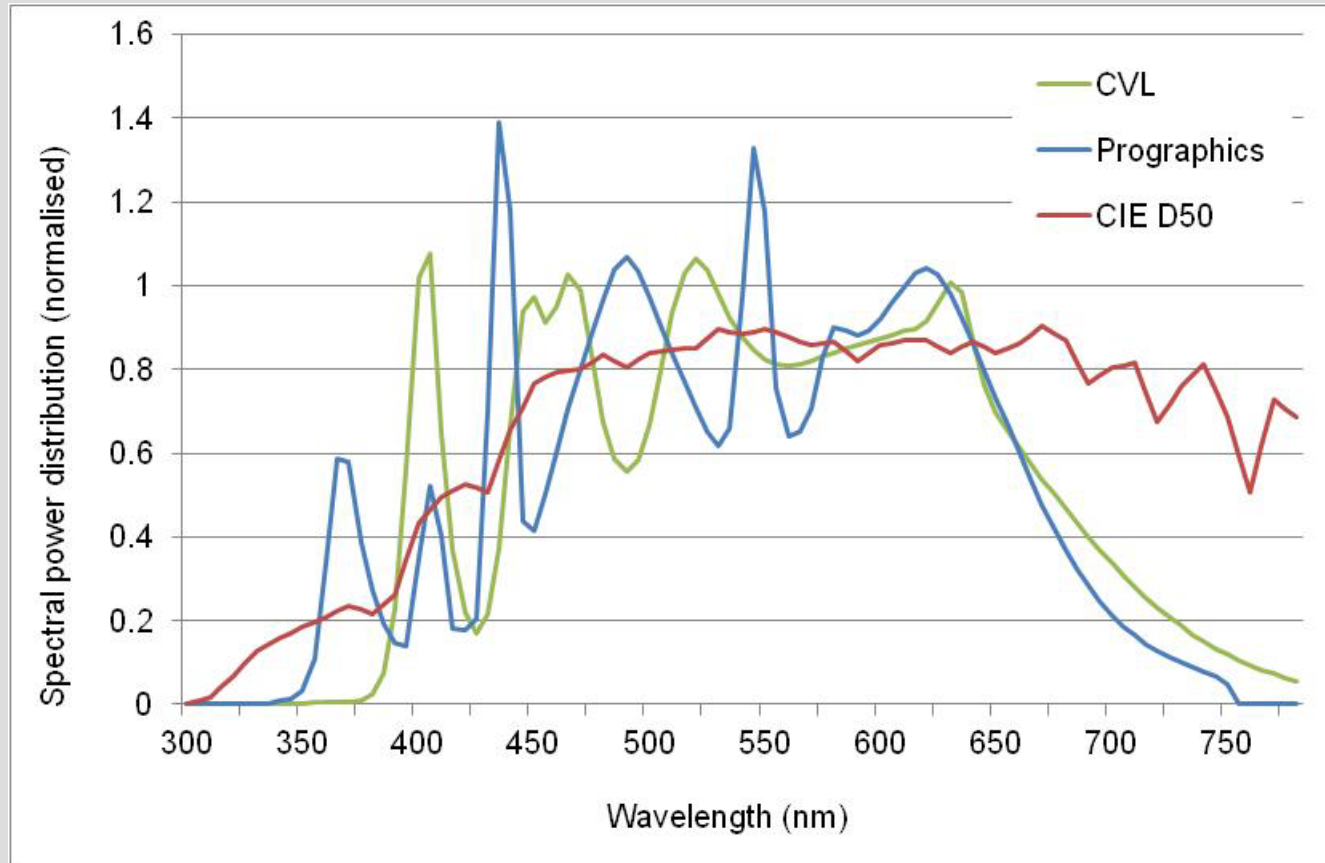


SPD of GTI D50 lamp

E-series (3664:2009 compliant) : 0.84 / 1.20

# Fluorescent samples

## Practical implementation: JUST lamps



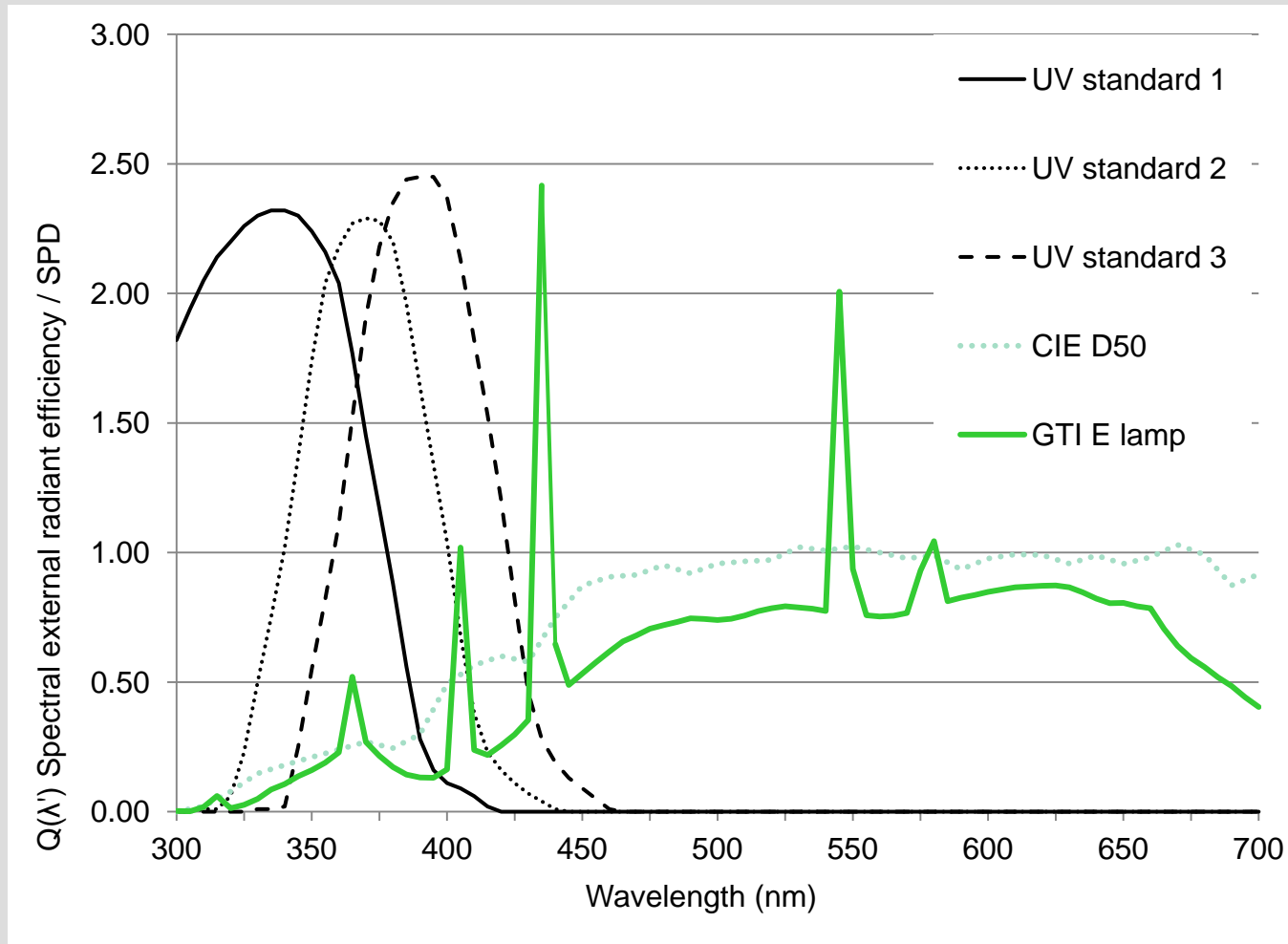
SPD of 3664:2009 compliant JUST Normlicht D50 lights

CVL (LED): 0.84 / 1.40 – ProGraphics: 0.85 / 0.55



# Fluorescent samples

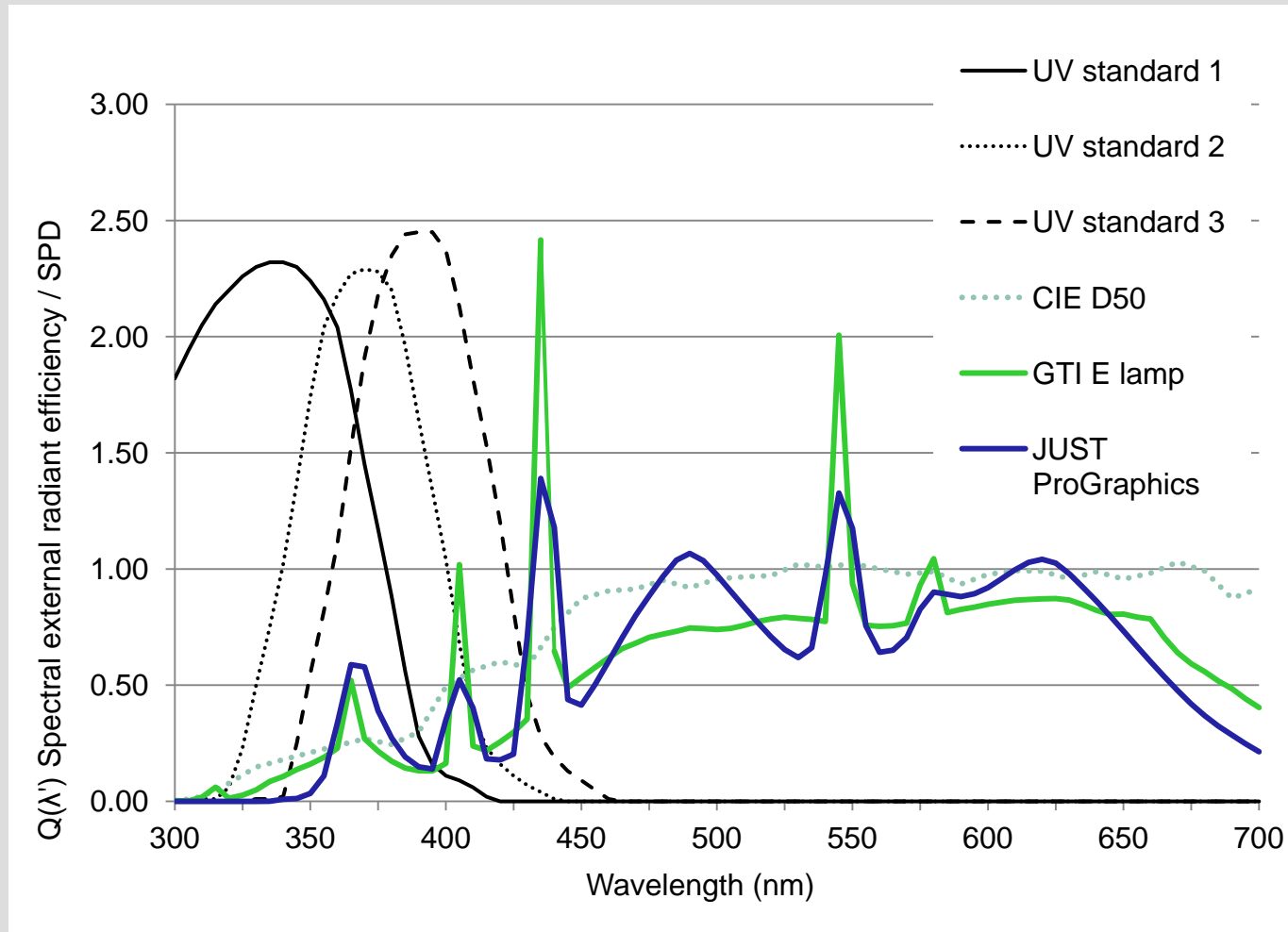
## Practical implementation: different lamps



GTI E lamp compared to excitation ( $\mu = 1.20$ )

# Fluorescent samples

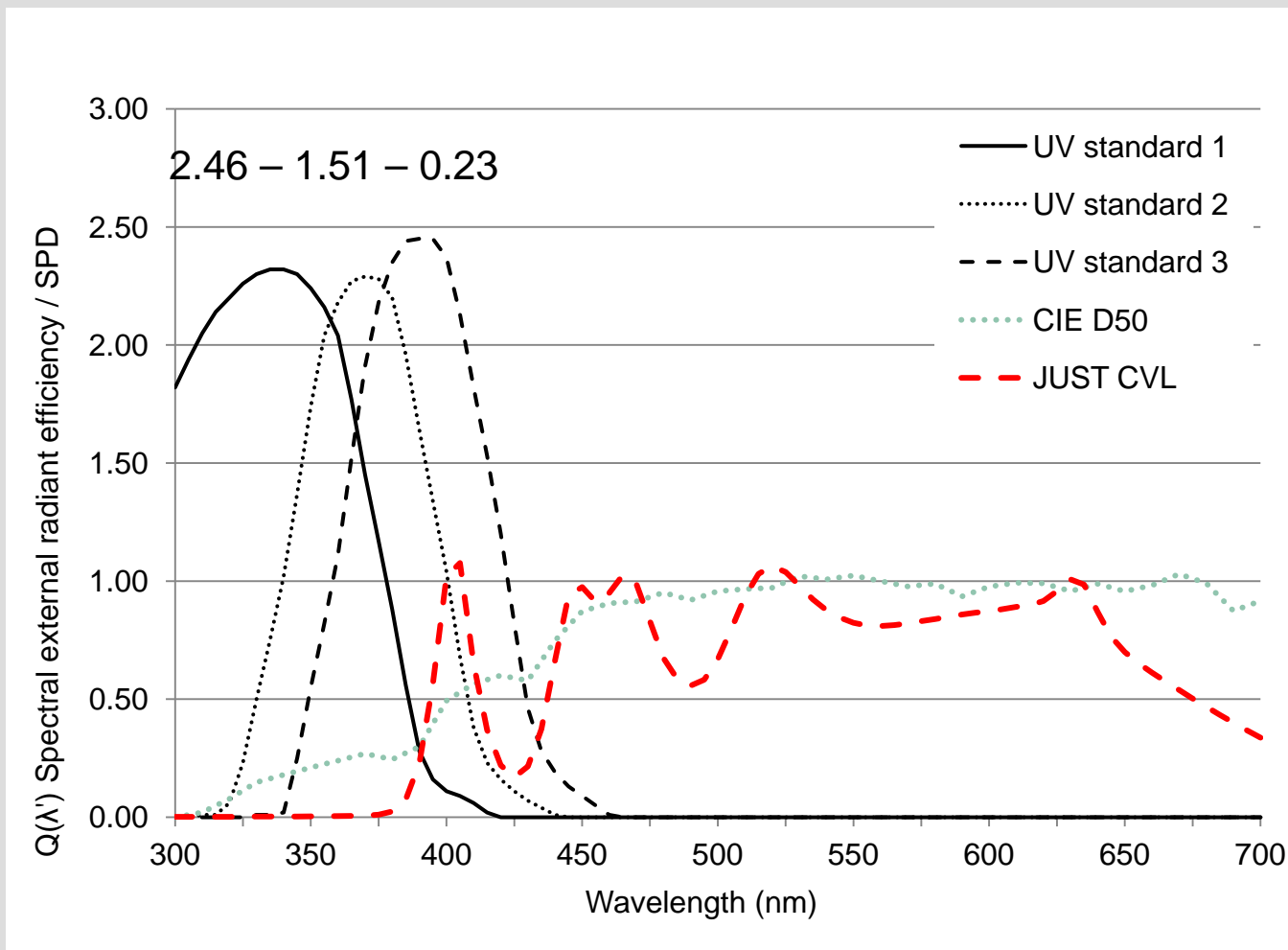
## Practical implementation: different lamps



GTI E and JUST PG lamps compared to excitation

# Fluorescent samples

## Practical implementation: different lamps



JUST CVL LED lamp ( $M_u = 1.40$ ) compared to excitation

# Fluorescent samples

Measurement: KM FD-7 – X-Rite eXact & i1



KM FD-7 with VFS technology and X-Rite eXact  
LED resp. Gas-filled tungsten + UV LED  
Implementation of ISO 13655:2009 M1

# Fluorescent samples

## State of the art

### 1. Standards

- ISO 3664:2009 and ISO 13655:2009 M1 are a good compromise between the desirable and the viable;
- CIE 51.2 / S 012 (ISO 23603:2005) needs to be updated

### 2. Visual evaluation

- Fluorescent lamp and LED technology
- Compliance to the (ISO) standard may or may not be enough

### 3. Instrumental measurement

- Both the VFS (LED) and the Tungsten + UV LED technology are supposed to be ISO M1 conform

# Acknowledgements

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Bob McCurdy (GTI),  
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