Improved methods for adjusting the UV contents of standard illuminants in paper industry

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Technolocal activities

1. **Improved methods for adjusting the UV contents of measurement instrument illumination for the Paper Making and the Graphics Industries**
2. **New fluorescent reflectance standards for the Paper Industry and for the Graphics Industry**
3. **Methods for mutual conversions between D/0º, D/8º, and 45º/0º measurement geometries**

Activity 1

- Goal
  - Improved methods for the adjustment of the UV spectral contents of the standard illuminants
    - For paper industry
      - D65 and C
    - For graphic industries
      - CIE A; D50;
- Current ISO standards
  - UV adjustment against one single assigned value
    - CIE whiteness (D65);
    - ISO brightness (C)
  - Fluorescent metamerism

Status of the project

- Report1—deliverable 3.2.1 (due May,31,2014)
  - Improved methods for adjusting the UV contents of standard illuminations for papermaking industry.
  - SPIE, “Novel Optical Systems Design and Optimization XVII” Conference, Aug. 17-22, San Diego, CA.
  - Oral presentation.
- Report2 – deliverable 3.2.2 (due Aug. 31, 2014)
  - UV content adjustment based on spectra for papermaking and graphic industries
  - Internal report
  - Draft for journal publication

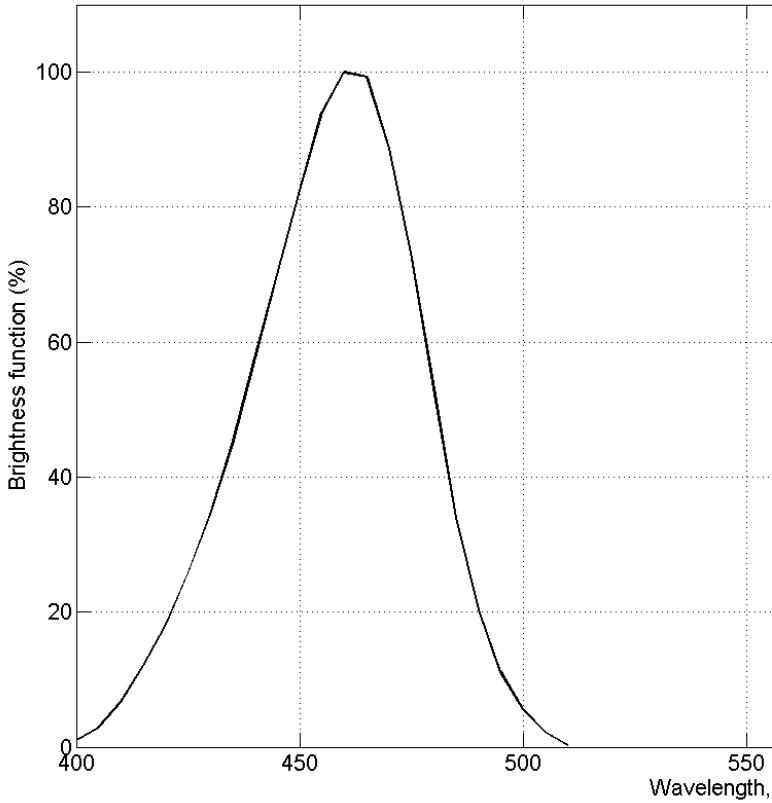
- Artefacts – D 3.2.1 (due Nov-30,2014)
  - For paper making industry
  - At least 4 fluorescent reference standards (D65 and C illuminants)
  - Ongoing

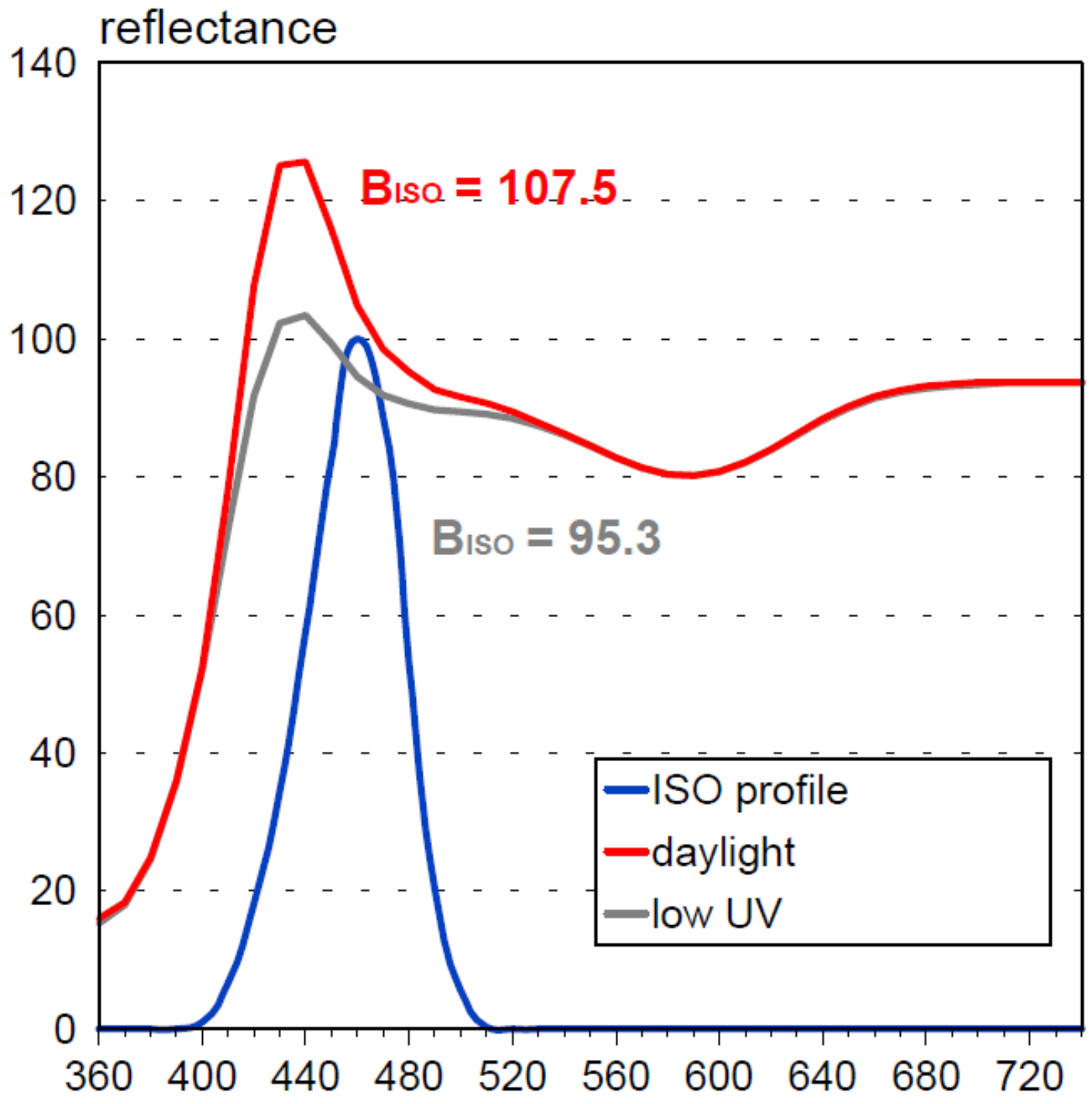
- Artefact – D 3.2.4 (Due Feb-28, 2015)
  - For graphic industry
  - At least 2 fluorescent reference standards (D50 and A illuminants)
  - Has started

Definition of ISO brightness

- Illuminant
  - CIE C
- Calculated from spectral reflectance factor
  - Weighted by the ISO blue filter
    - Between 400 and 500 nm
    - Peak at 457 nm.

$$R_{457} = \frac{\sum_{400}^{510} F(\lambda) R(\lambda)}{\sum_{400}^{510} F(\lambda)}$$




reflectance
140
120
100
80
60
40
20
0
360
400
440
480
520
560
600
640
680
720
BISO = 107.5
BISO = 95.3
ISO profile
daylight
low UV

Definition of CIE whiteness

- CIE D65/10º

$$W = Y + 800(x_0 - x) + 1700(y_0 - y)$$

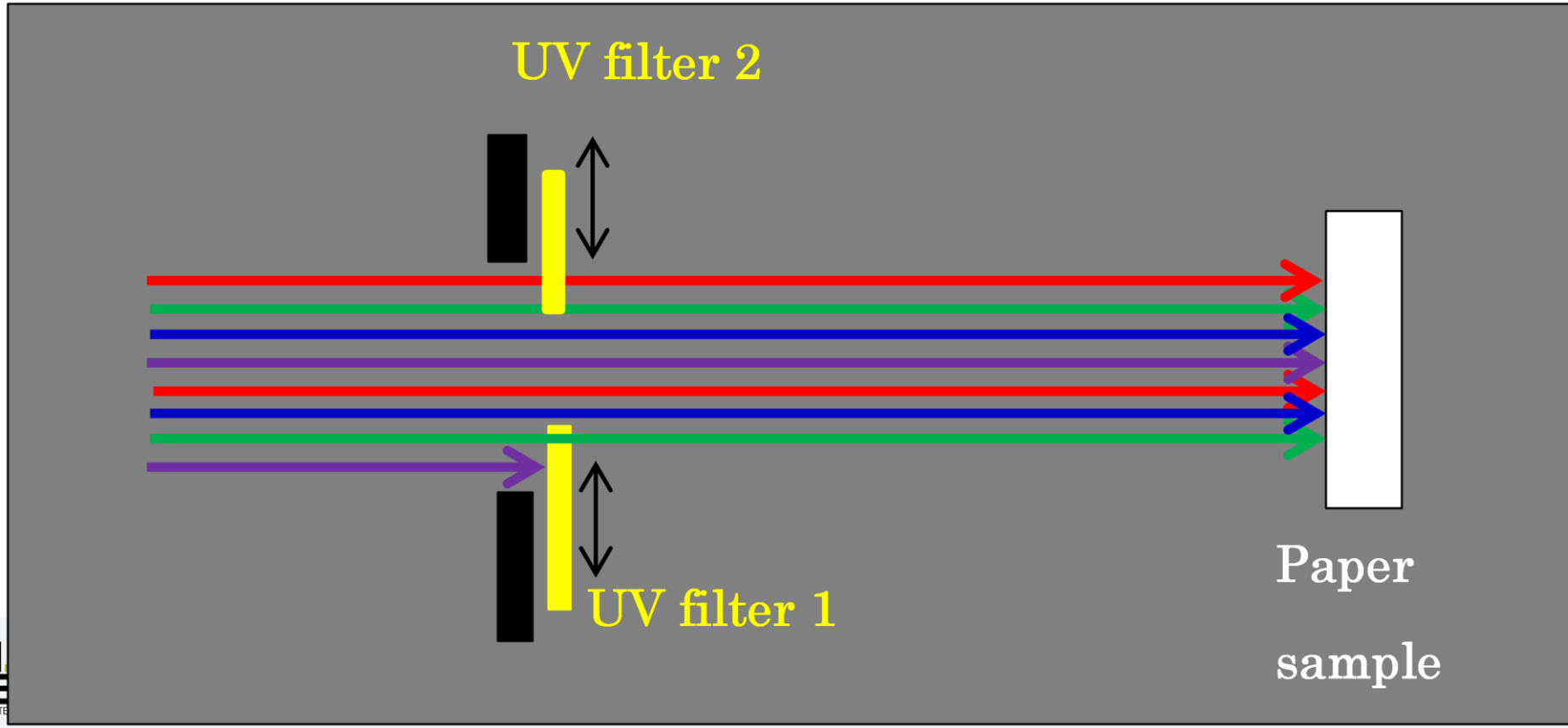
$$T_w = 900(x_0 - x) - 650(y_0 - y)$$

- Important critera
  - $-3 < T_w < 3$ ➔ is white
  - Otherwise ➔ not white

- Approach
  - UV adjustment against total spectrum
  - Numerical UV filtering

Conventional UV filtering technique

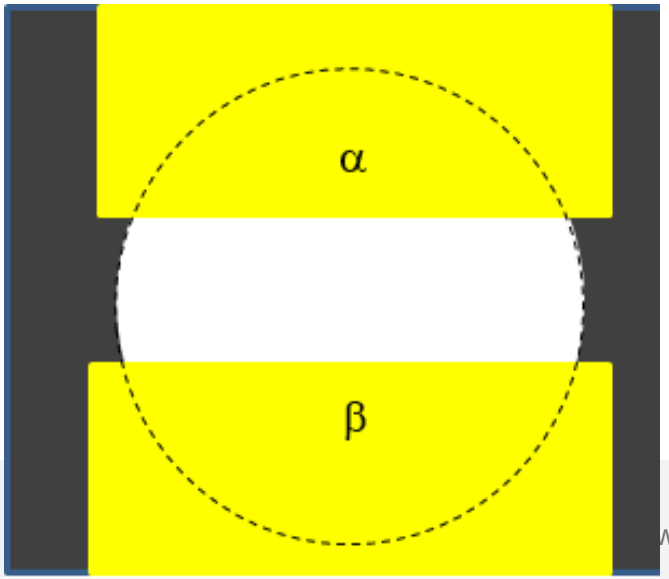
- Two UV filters move in/out
  - UV full
  - UVX(400)
  - UVX(420)



Different UV adjustment techniques

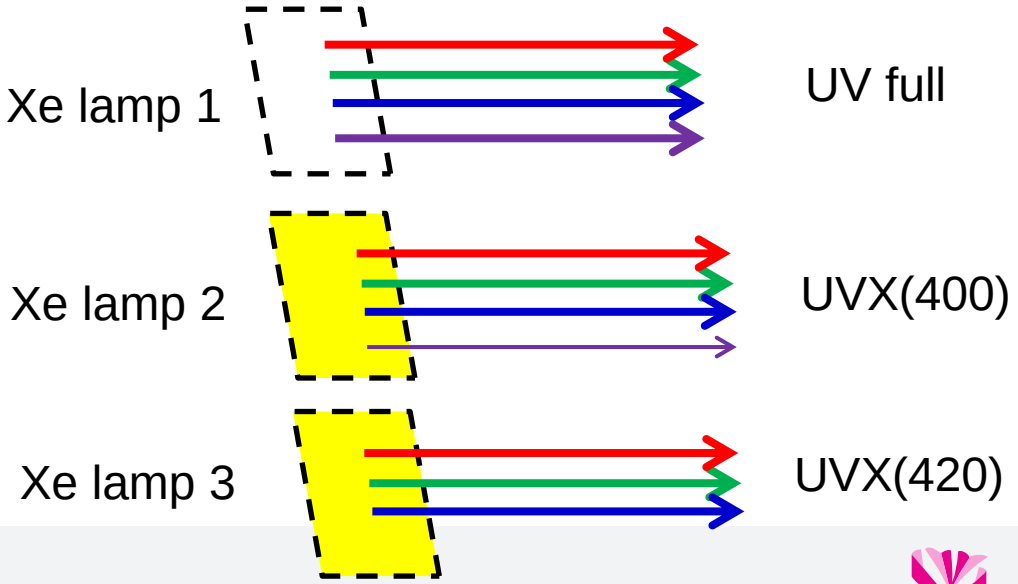
Traditional UV adjustment

- Two UV filters move in/out
  - UV full
  - UVX(400)
  - UVX(420)



Numerical UV adjustment

- Three Xe lamps
  - UV full
  - UVX(400)
- UVX(420)



Algorithms of the UV adjustment techniques

- Traditional UV filtering

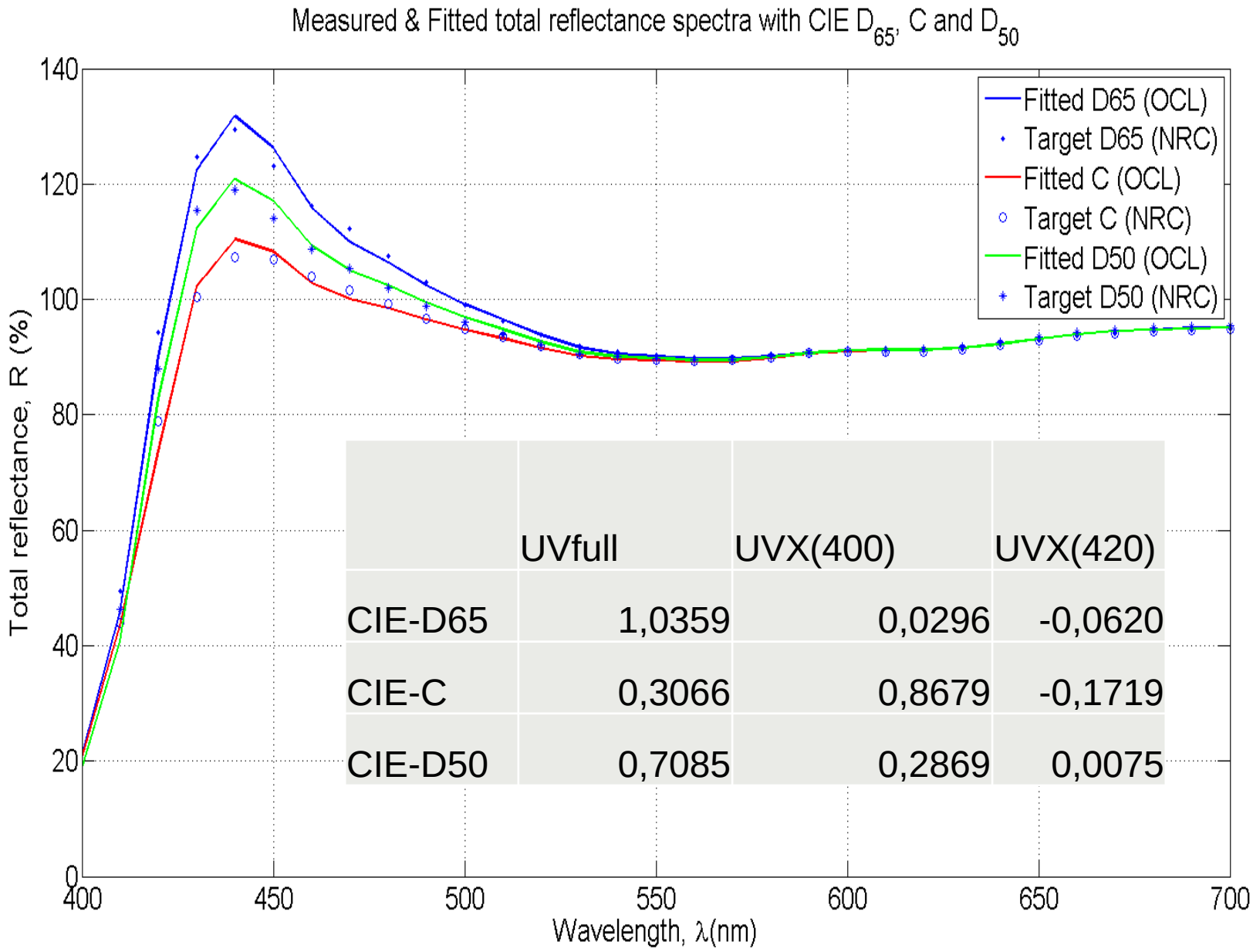
$$R(\lambda) = (1-\alpha-\beta)R_{uvfull}(\lambda) + \alpha R_{uvx400}(\lambda) + \beta R_{uvx420}(\lambda)$$

  - Constraints: $0 \le \alpha \le 1, \quad 0 \le \beta \le 1, \quad 0 \le (1-\alpha-\beta) \le 1$

- Numerical UV filtering

$$R(\lambda) = \gamma R_{uvfull}(\lambda) + \alpha R_{uvx400}(\lambda) + \beta R_{uvx420}(\lambda)$$

  - Constraints: $\alpha + \beta + \gamma = 1$



	UVfull	UVX(400)	UVX(420)
CIE-D65	1,0359	0,0296	-0,0620
CIE-C	0,3066	0,8679	-0,1719
CIE-D50	0,7085	0,2869	0,0075

Summary

- Fluorescent samples have been measued at NRC under standard illuminants, CIE C, D65, and D50.
- A method to reproduce the total reflectance factor (including fluorescent contribution) with numerical UV adjustment technique has been established.
  - Good spectral reproduction has been achieved by numerical UV filtering techniques.
- There are clear advantages with numerical UV-filtering technique than conventional with move-in UV filters