PHOTOMETRY OF SOLID STATE LIGHTING IN THEORY AND PRACTICE

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Overview

- Current photometric systems
  - Standard system
  - Experimental systems
- Challenge by modern light sources
- Up to date photometric detectors
  - Illuminance meters
  - Image resolving luminance meters
- Calculated stimulus related quantities – perception related descriptions
- Needed „accuracy” in real life measurements
- Conclusions

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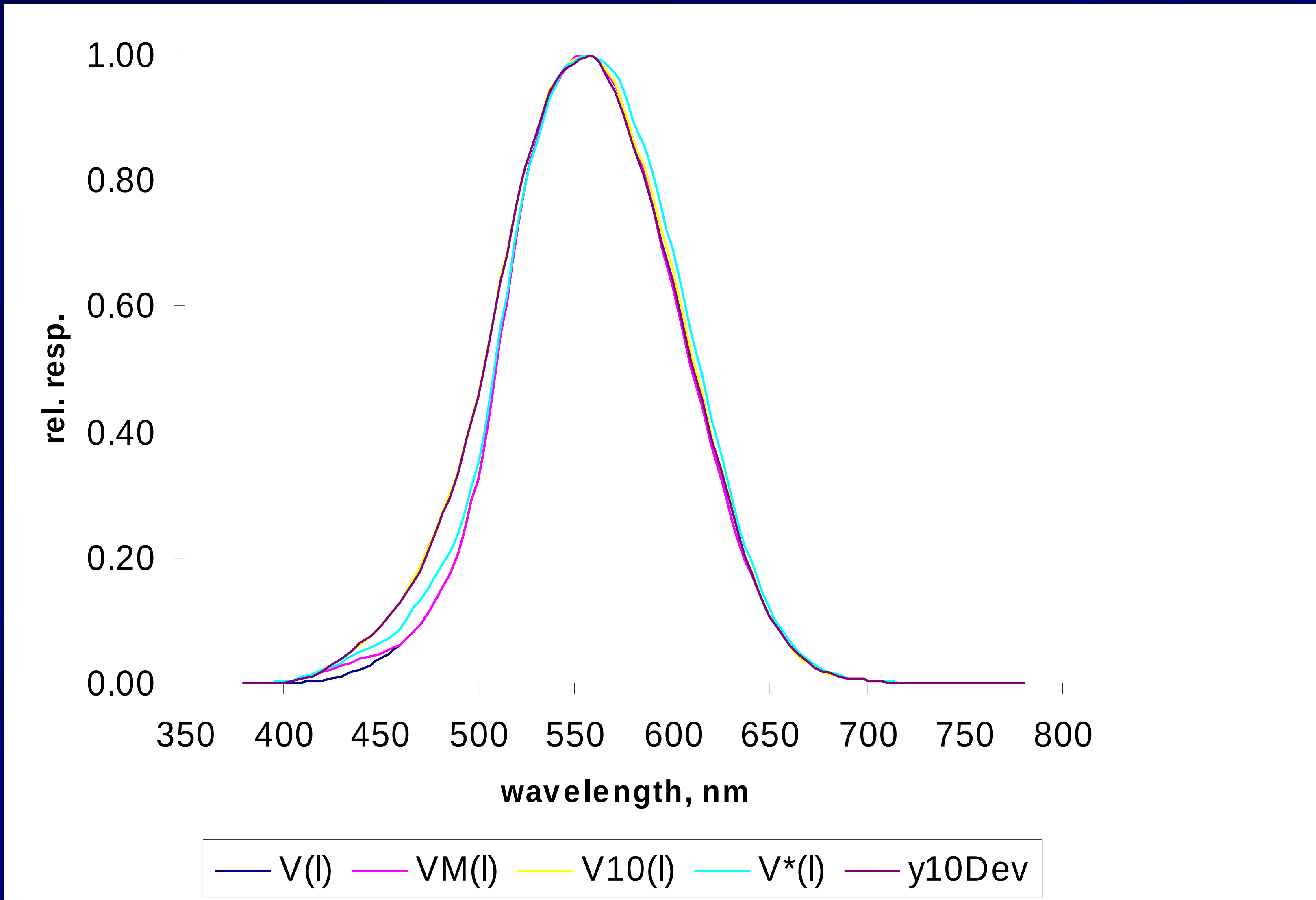
Spectral luminous efficiency functions

- CIE standard 2° SLE function: $V(\lambda)$
- CIE modified 2° SLE function: $V_M(\lambda)$
- CIE 10° SLE function: $V_{10}(\lambda)$
- CIE deviate observer functions: $y_{10Dev}(\lambda)$

- CIE TC 1-36 tentative SLE function: $V^*(\lambda)$

Spectral luminous efficiency functions



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Investigated sources

- Current photometric systems
  - Standard system
  - Experimental systems
- Challenge by modern light sources
  - CFL-s
  - P-LED
  - RGE-LED
- Up to date photometric detectors
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2856 K group				
Lamp designation	Correlated colour temperature, K	General colour rendering index, Ra	x	y
Illuminant A	2856	100	0,4476	0,4420
Compact fluorescent lamp	2895	85,7	0,4420	0,4016
p-LED	2879	72,5	0,4508	0,4165
RGB-LED	2885	31,5	0,4466	0,4091
6500 K group				
D65 illuminant	6503	100	0,3127	0,3290
CFL	6081	73,6	0,3189	0,3514
p-LED	7153	79,6	0,3023	0,3240
RGB-LED	6782	46,5	0,3091	0,3212

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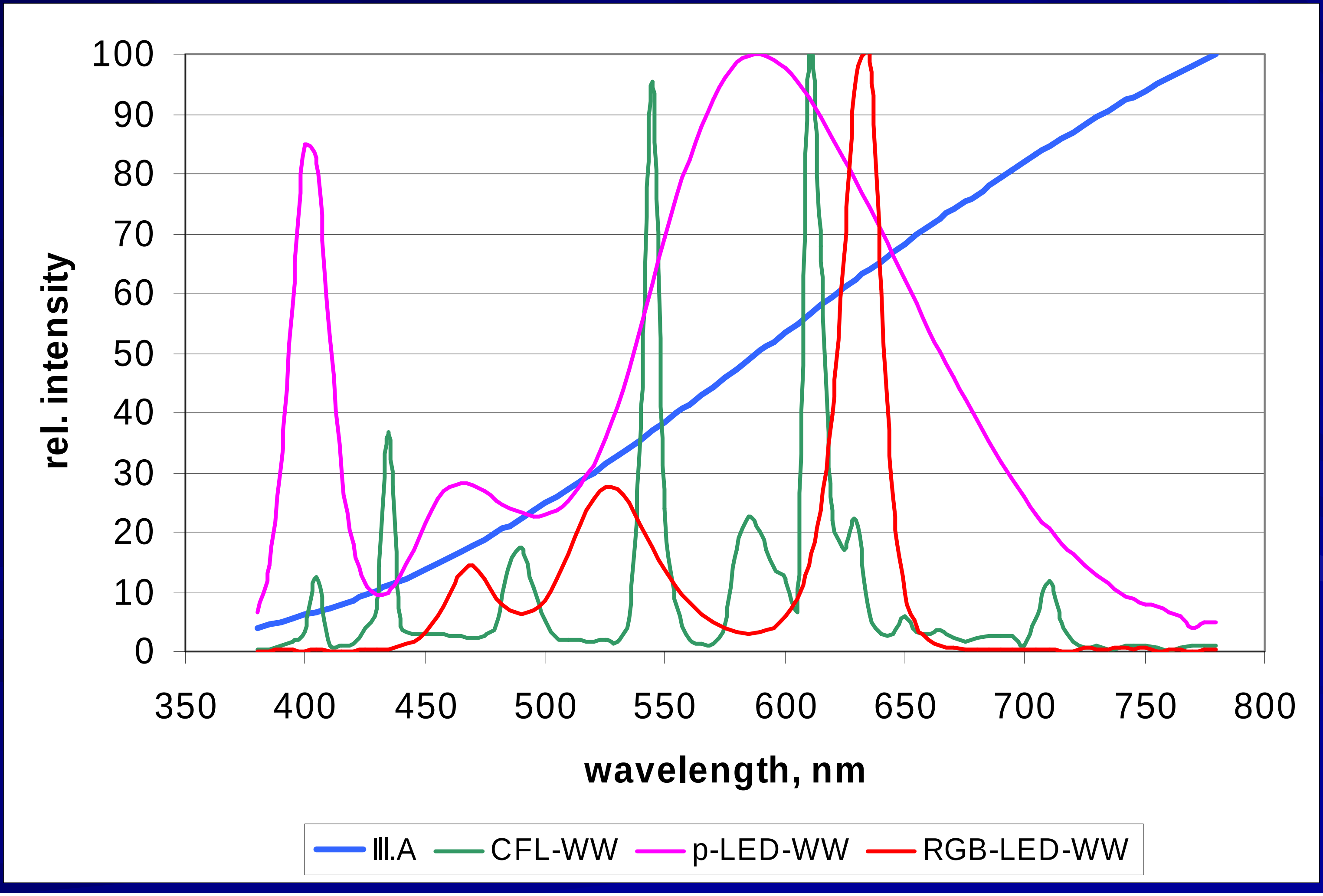
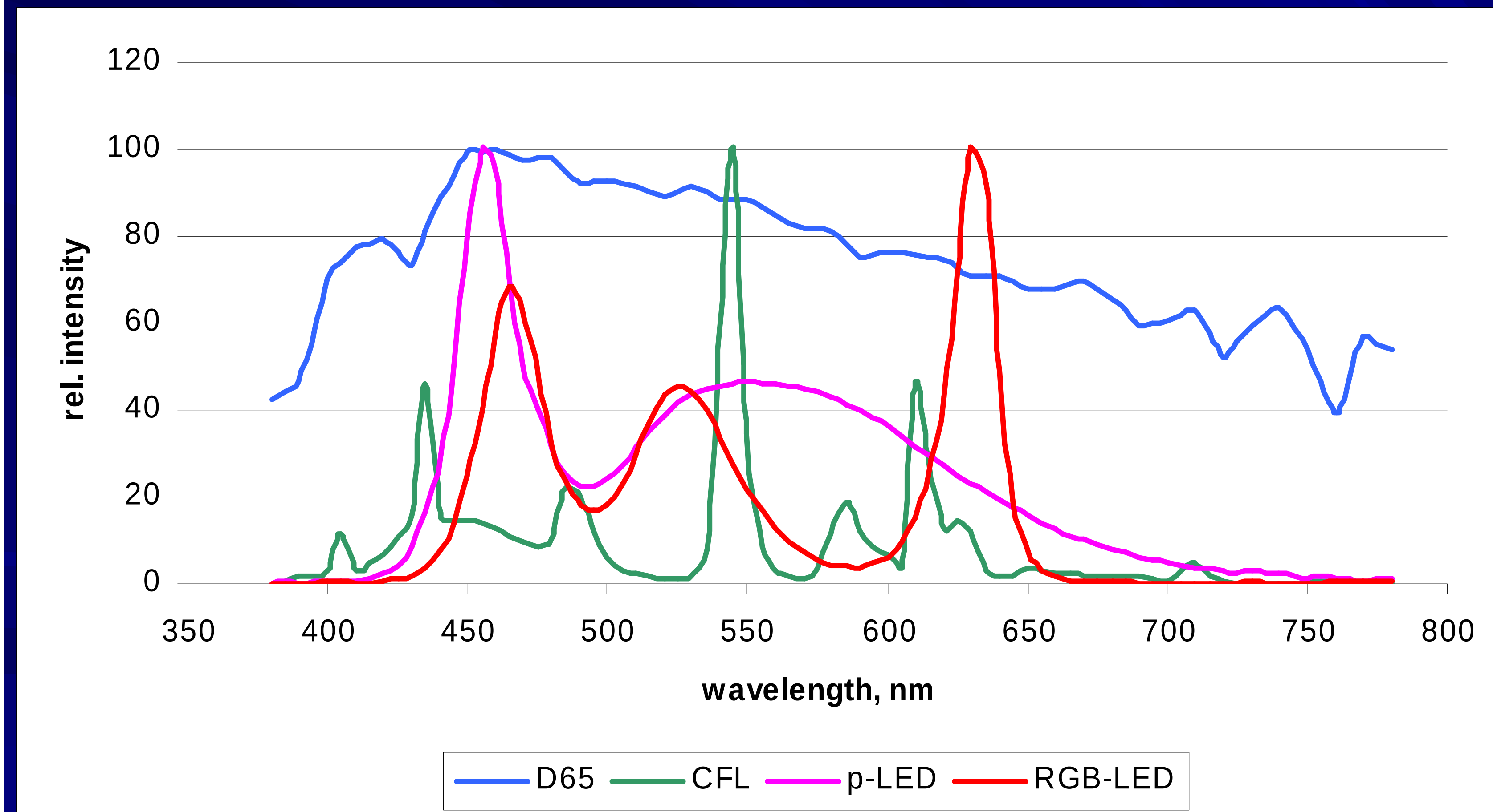
Spectral Power Distributions 1
WarmWhite spectra



Spectral Power Distributions 1
Daylight spectra



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Up to date photometric detectors

- Photometric detectors with Si cells
  - Cosine corrected full filtered detectors
  - Full filtered thermo-stabilised luminous flux detectors
  - f_1' values: ~ 1.2 % - 1.5 %

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Up to date photometric detectors

- Image taking luminance/colorimetric instruments
  - – CCD detectors
  - – Usually not temperature stabilized

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Tested theoretical functions and photo-meters

	f_1'
$V(\lambda)$	0
$V_M(\lambda)$ function	0,73
$V^*(\lambda)$function	5,65
$y_{10,d}(\lambda)$ function	9,47
$V_{10}(\lambda)$ function	9,51
CCD luminance meter-1	1,18
Photometer-l	1,2
y-channel of a tristimulus colorimeter	1,35
Photometer-2	1,7
Photometer-3r	1,87
Photometer-4	2,27
Photometer-5	3,01
CCD luminance meter -2	14,26

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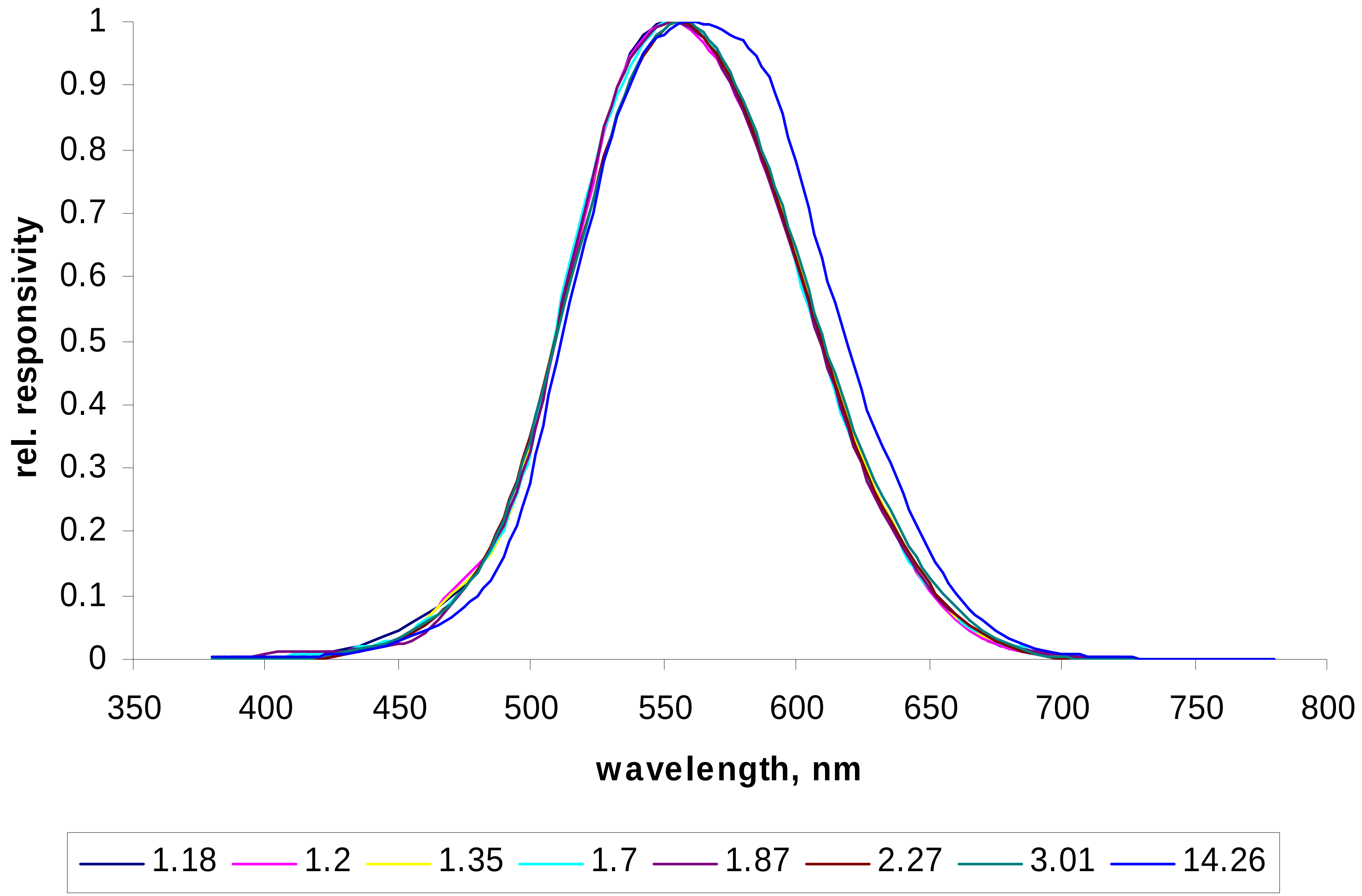

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f_1* value of theoretical functions

$V(\lambda)$ 0,0

- $V_{\mathrm{M}}(\lambda)$ function 0,73
- $V^{*}(\lambda)$function 5,65
- $y_{10,\mathrm{d}}(\lambda)$ function 9,47
- $V_{10}(\lambda)$ function 9,51

$V_{\mathrm{M}}(\lambda)$: practically no deviation;
but the other functions compare to poor detectors

Photometric evaluations

- Photometric calibrations are usually made using as reference:
  - CIE st. Illum. A
  - CIE 1924 2°standard $V(\lambda)$ function

$$\int_{380\,\mathrm{nm}}^{780\,\mathrm{nm}} S_\lambda(Ill.A)V(\lambda)\,\mathrm{d}\lambda$$

- Tests with the enumerated
  - sources
  - functions

$$\int_{380\,\mathrm{nm}}^{780\,\mathrm{nm}} S_\lambda(Test.Illum.)s(\lambda)\mathrm{d}\lambda$$

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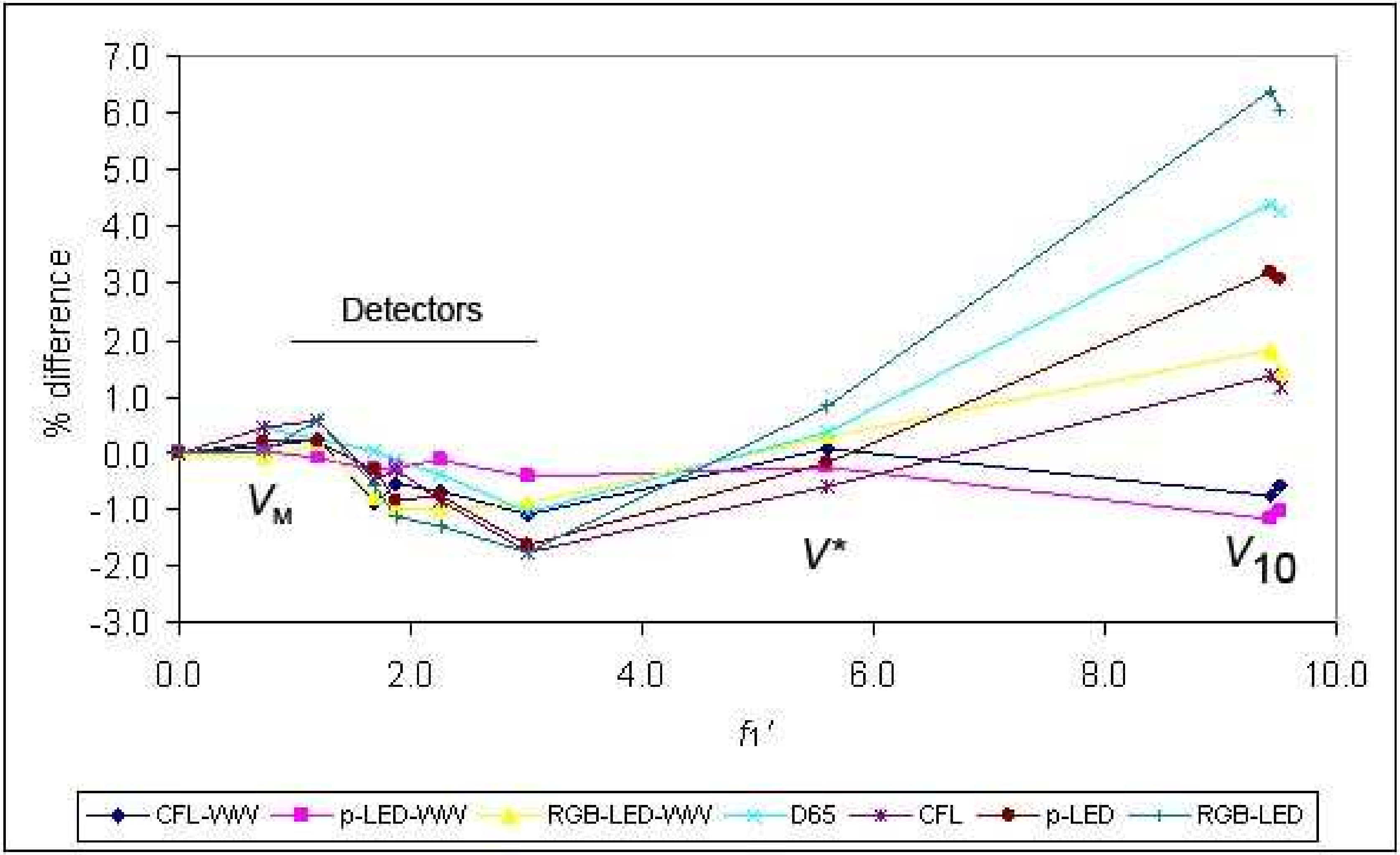
Per Cent difference of measured photometric values



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Perception related descriptions

- New standard descriptors needed for large field photometry
  - Open question: brightness evaluation
- Similar problems in mesopic photometry
  - Reaction time based descriptors: $V(\lambda)$ & $V'(\lambda)$
  - Threshold contrast sensitivity related descriptors: chromatic influence

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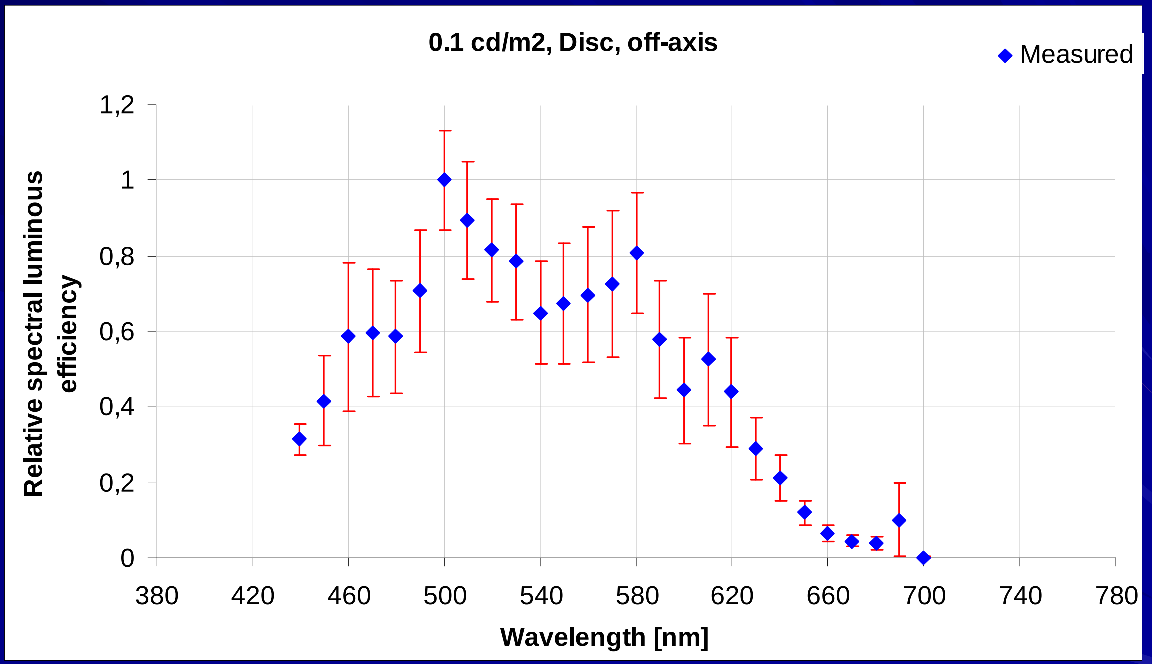
Mesopic visibility

- Threshold contrast sensitivity based spectral responsivity
  - – Additive?
- Many new spectral visibility functions needed



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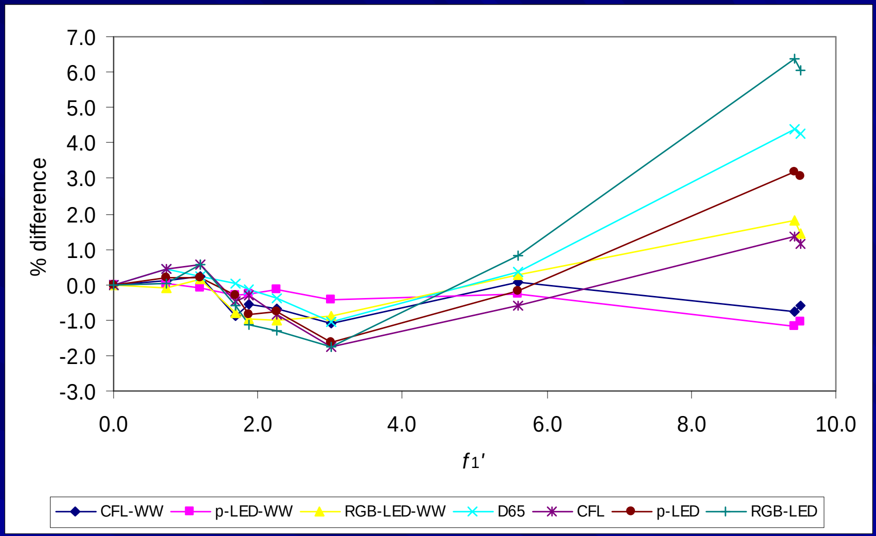
Real life photometry, conclusions

- $V(\lambda)$ uncertain (in error) -> $V^*(\lambda)$:
  - f_1' up to 5 % difference compared to $V(\lambda)$.
- Different sources produce highly different measurement errors
- Better description: error for a number of sources



Thanks for your kind attention!

Best wishes to our host, Professor Pop!

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