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# Practical and Comprehensive Lighting Quality Measurements using IoT

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## Introduction

- Part of the interdisciplinary project: **OptiLight - Mathematical Optimizations for Human Centric Lighting.**
- Despite growing understanding of the impact of light on wellbeing, performance and circadian rhythms, benefits of this understanding cannot (yet) easily be harvested in practical systems.
- Scalable algorithms are lacking that can be used in automated systems.
- There exists a huge gap between results obtained in controlled environments and practical deployment.

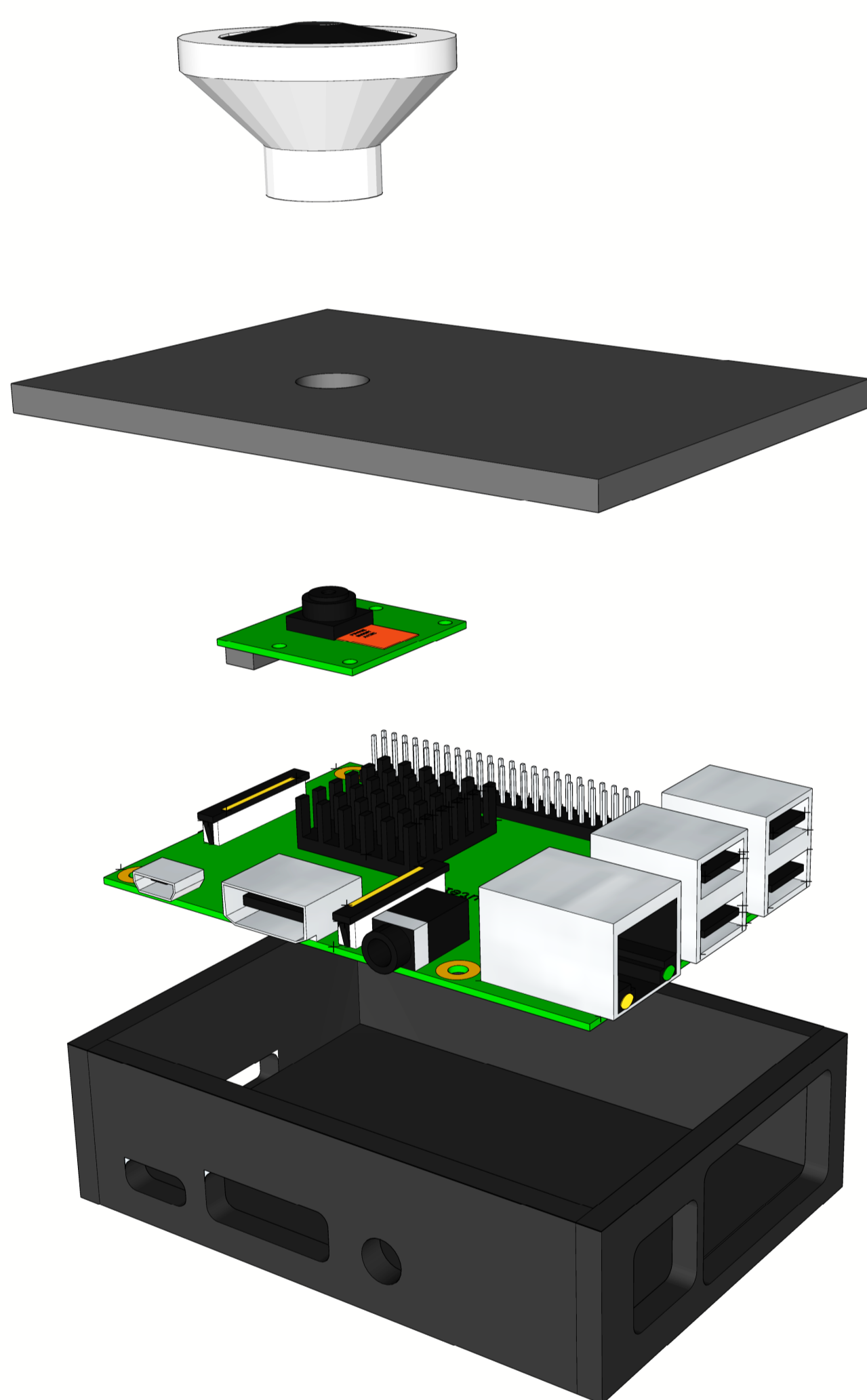


- This project aims to measure lighting quality in a practical and unobtrusive manner using an IoT luminance distribution measurement device.
- "Good-quality lighting is lighting that allows you to see what you need to see quickly and easily and does not cause visual discomfort but raises the human spirit"<sup>1</sup>

## I. The Bee-Eye: An IoT-Device for Measuring the Luminance Distribution<sup>2</sup>

### Low cost components:

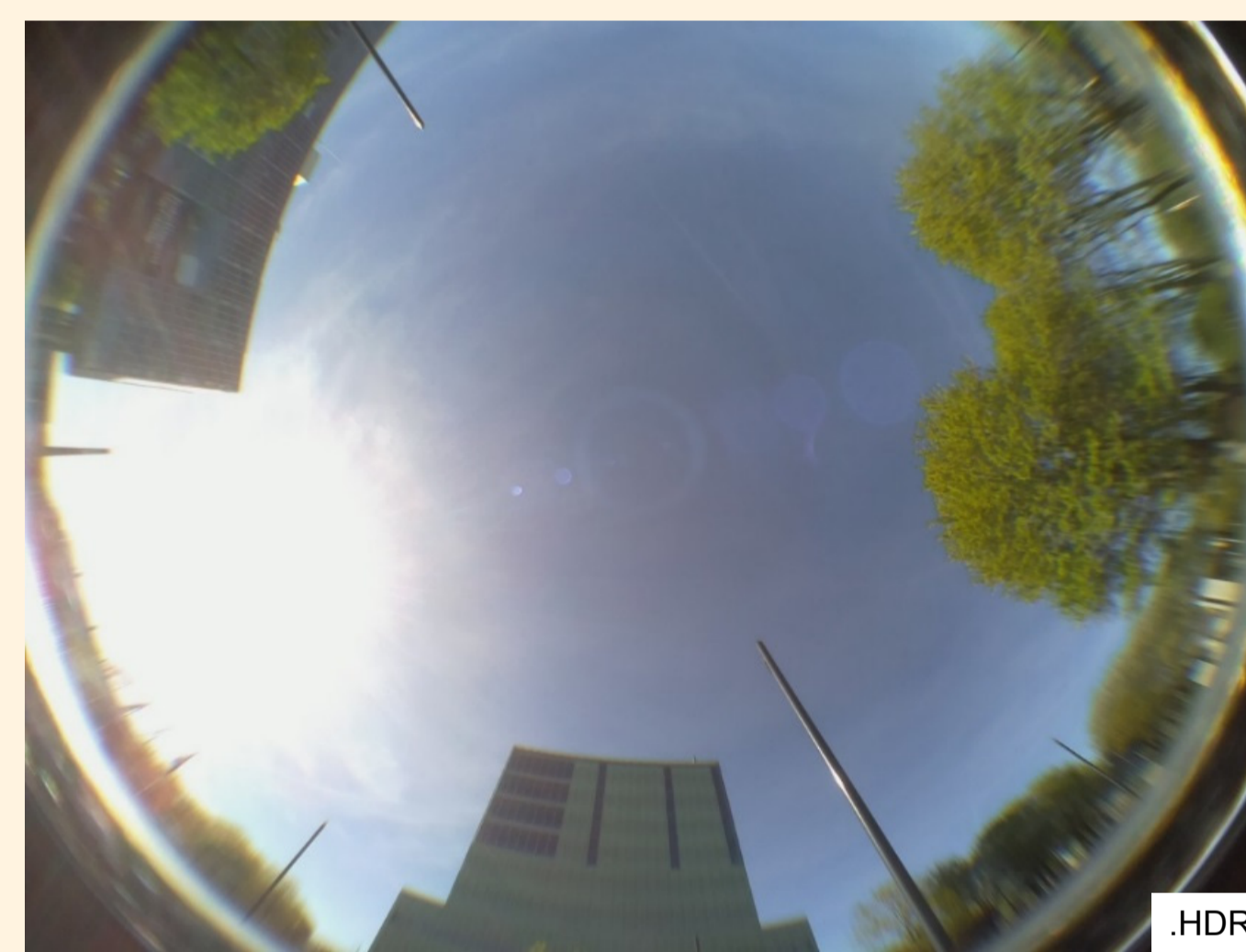
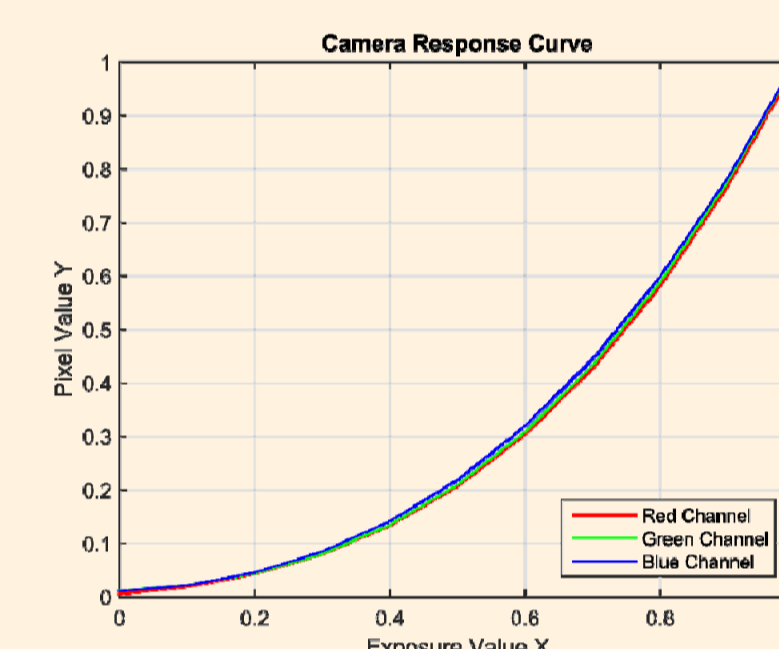
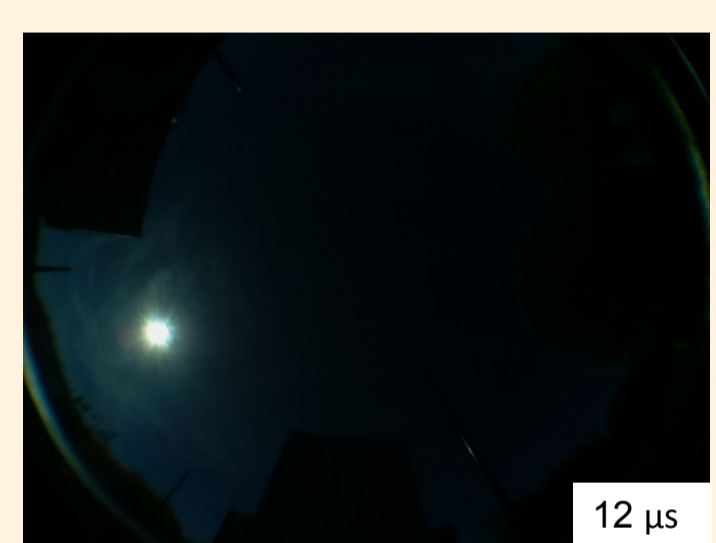
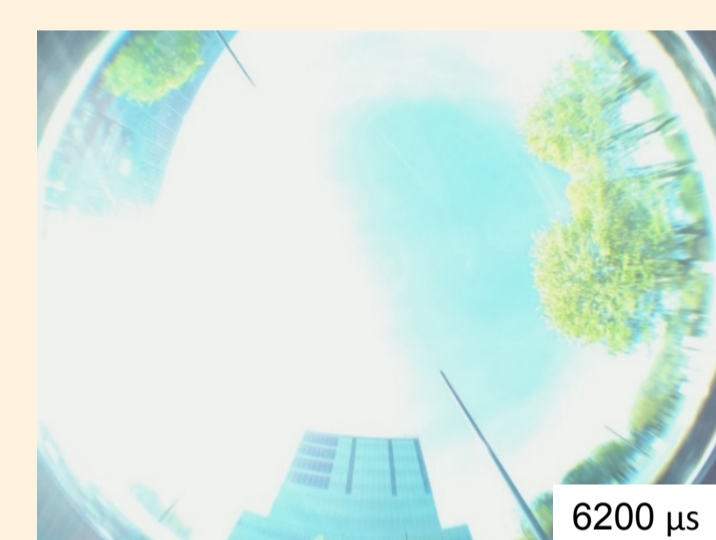
- Single board computer
- Camera
- Fisheye lens



High Dynamic Range (HDR) technology is required to capture contrasts occurring in real world.

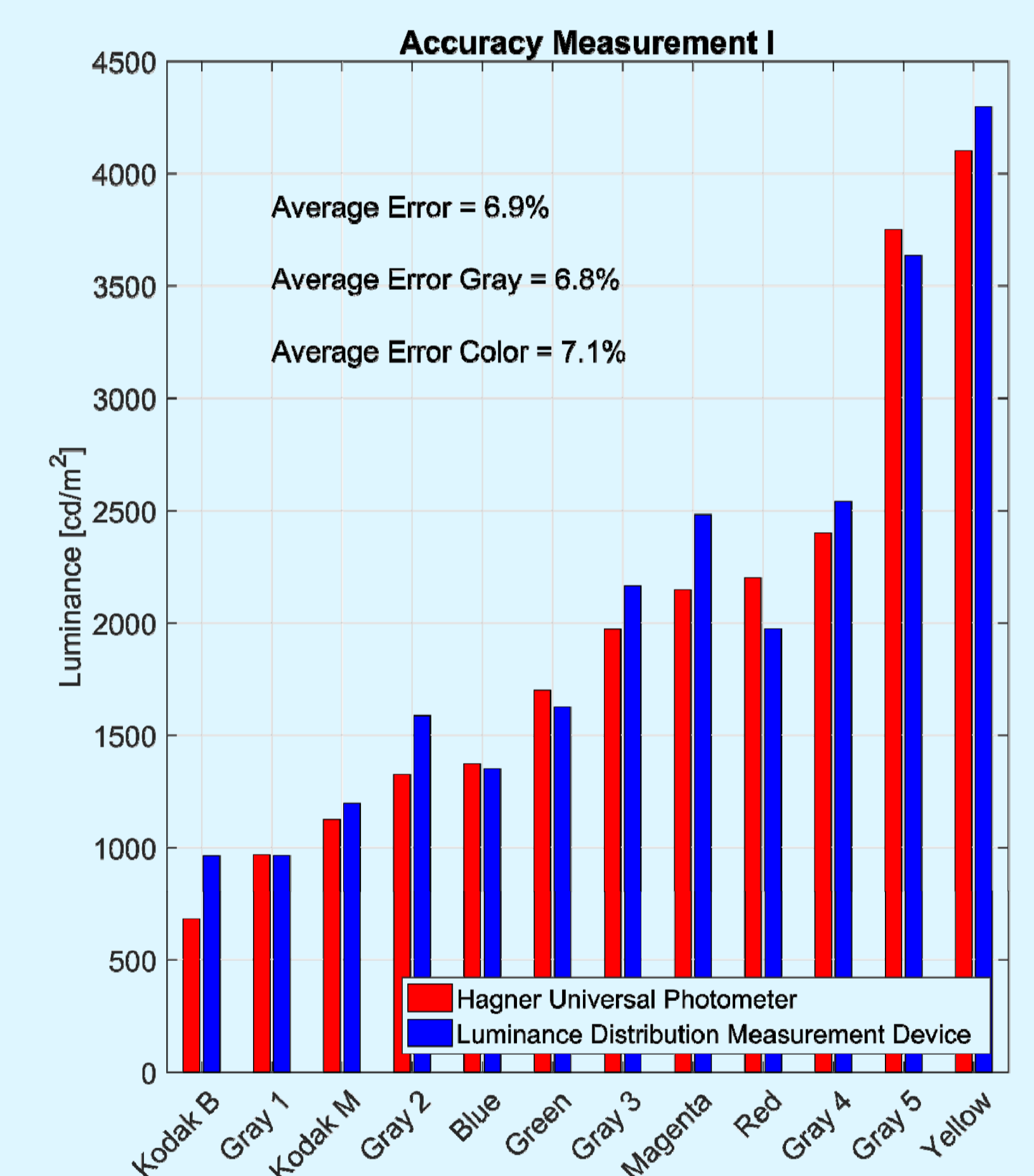
HDR images are formed based on:

- 7 exposures with shutterspeeds ranging from 250,000 to 12  $\mu$ s
- Specific camera response curve by radiometric self-calibration



### Specifications

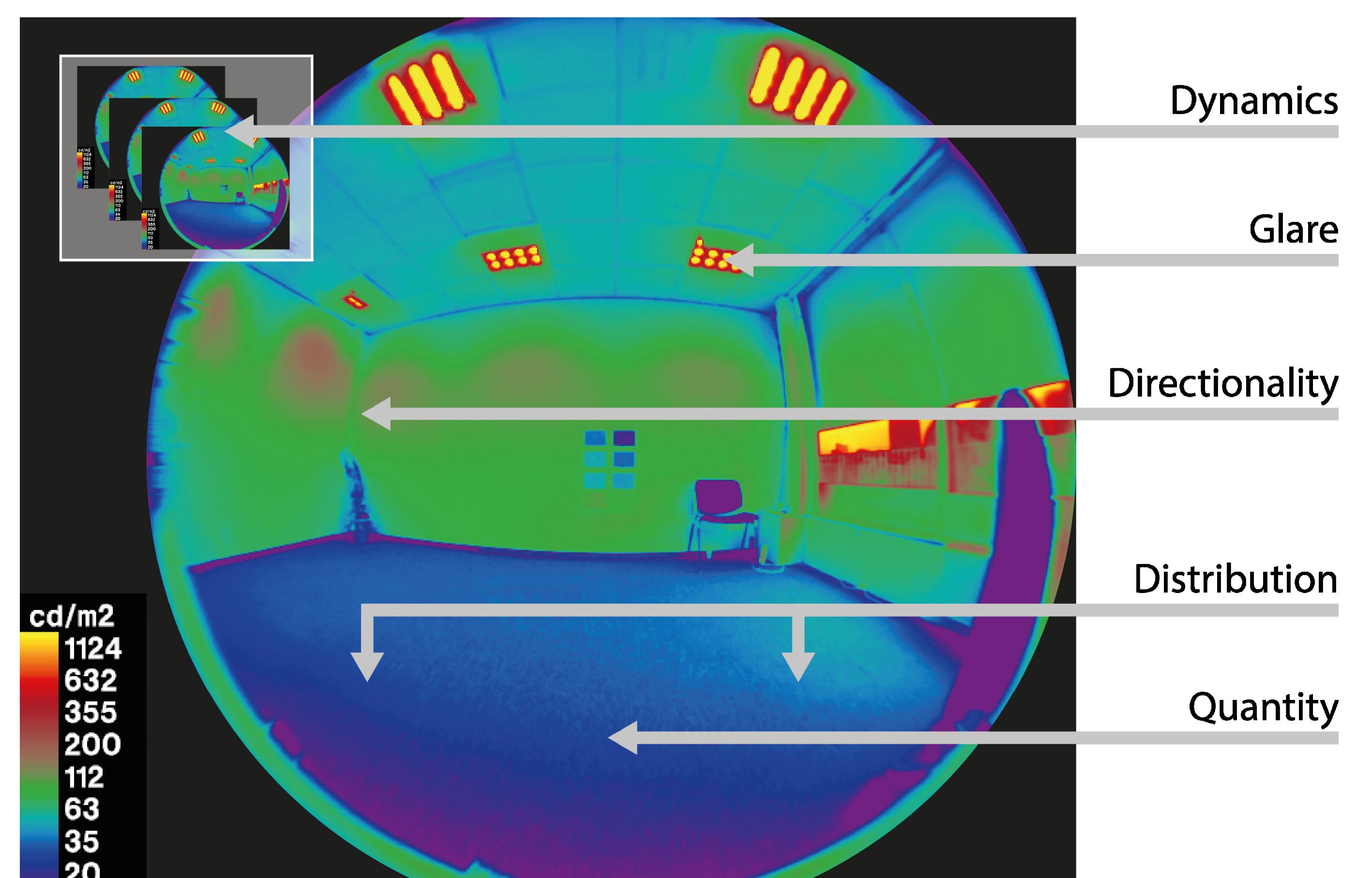
- The accuracy stays within 3.0% to 17.5%.
- Autonomous, Calculation time = 35 s.
- Measurement period = 8 s.



## II. Measuring Lighting Quality<sup>3</sup>



Algorithms aim to optimize variable lighting quality aspects, indicated in green. Except the spectral power distribution (SPD) all aspects can be measured by the Bee-Eye. Hence, the Bee-Eye is an effective Lighting Quality measurement Device



<sup>1</sup>P.R. Boyce, Human Factors in Lighting, third edit, CRC Press, 2014.

<sup>2</sup>T. Kruisselbrink, M. Aries, A. Rosemann, A practical device for measuring the luminance distribution, Int. J. Sustain. Light. 36 (2017) 75–90. <http://lightingjournal.org/index.php/path/article/view/76>.

<sup>3</sup>T. Kruisselbrink, R. Dangol, A. Rosemann, Photometric measurements of lighting quality: An overview, Build. Environ. 138 (2018). doi:10.1016/j.buildenv.2018.04.028.