A New Device for
Dynamic Luminance Mapping
& Glare Risk Assessment in Buildings

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Outline

A new Device for dynamic luminance mappings & glare risk assessment in Buildings

- Introduction
  - Visual comfort
  - High Dynamic Range (HDR) imaging technique
- Methodology
  - IcyCAM
  - Calibrations and vignetting correction
  - Validation in real scenes
- Results
  - Luminance maps
  - Glare risk assessments
  - Discussion: different angles of fisheye lens
- Conclusion

Visual comfort

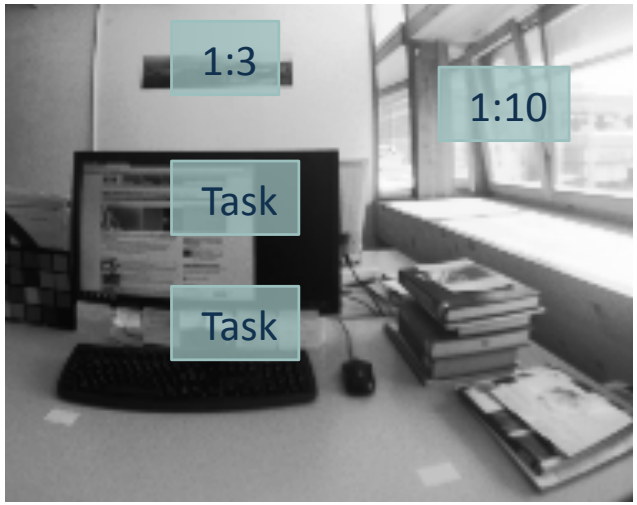
- High Visual Performance & Low Discomfort

- Glare assessment

Glare Indexes		Disturbing
Daylight Glare Index	DGI	24-31
Unified Glare Index	UGR	22-28
Daylight Glare Probability	DGP	0.35-0.45

- Luminance ratio

Office with Video Display Terminal (VDT)

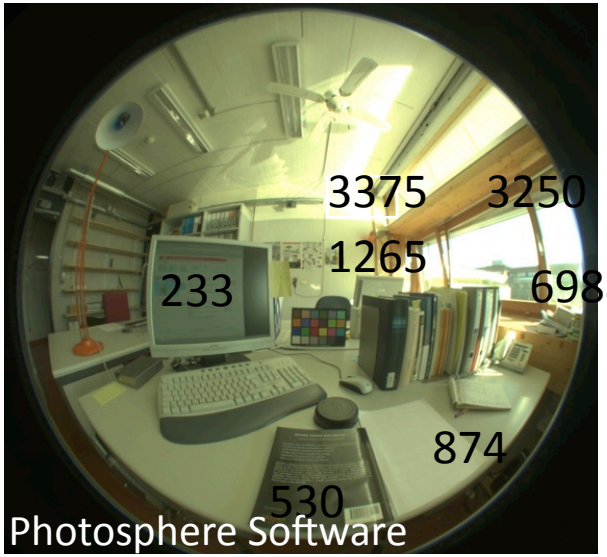


Task area: adjacent surroundings < 1:3
Task area: remote surroundings < 1:10

Luminance mapping and glare risk assessment

by High Dynamic Range (HDR) imaging

- What is luminance mapping?
- How to find glare indexes?



High Dynamic Range imaging technique

To create an « HDR » > combination ofseveral LDR images (different exposures)

- **Problem:** assessment under dynamic daylight
- **Goal**: to produce fast & simple HDR images

« IcyCAM »

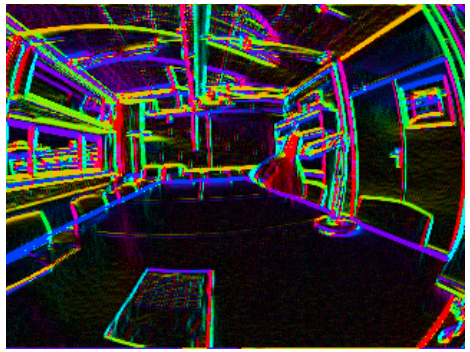
- A camera-like light censor

  Swiss Center for Electronics and Microtechnology (CSEM), Switzerland

- 130 dB intra-scene dynamic range due to the logarithmic compression
- Recorded in 780 µs -2s exposure duration

Image

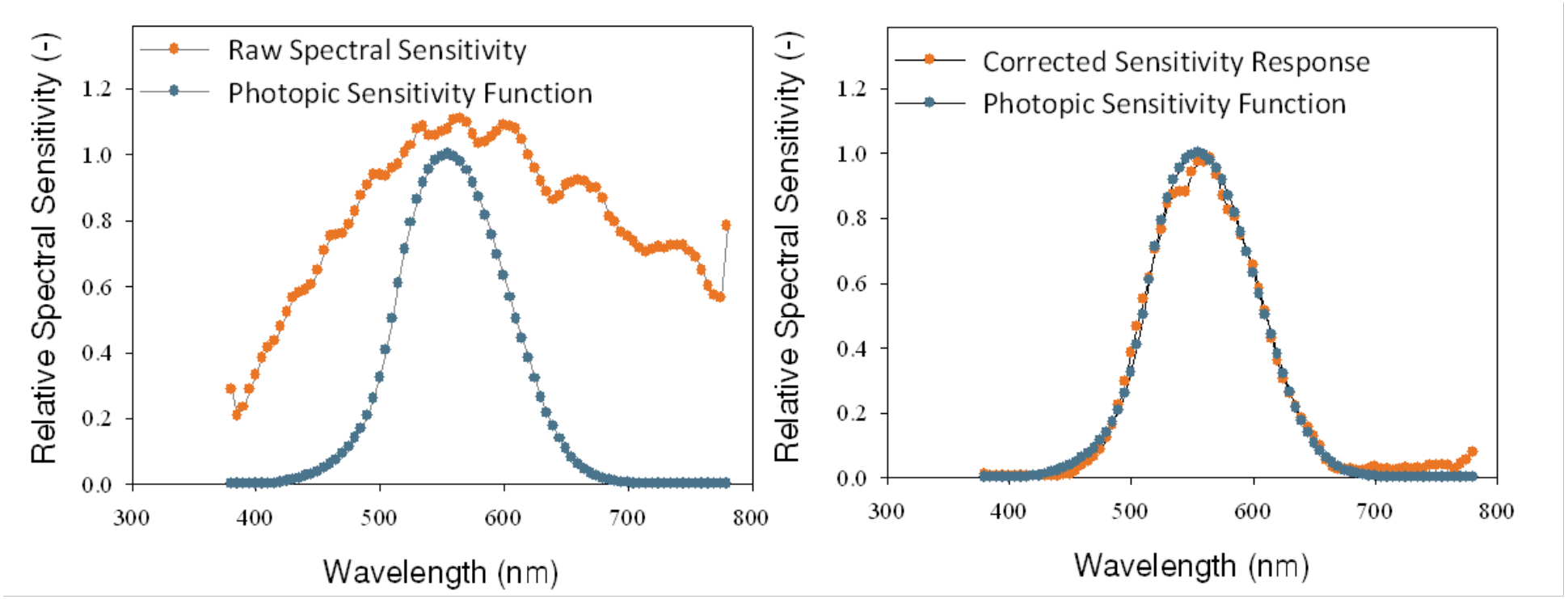
Contrast



Direction

Spectral sensitivity calibration

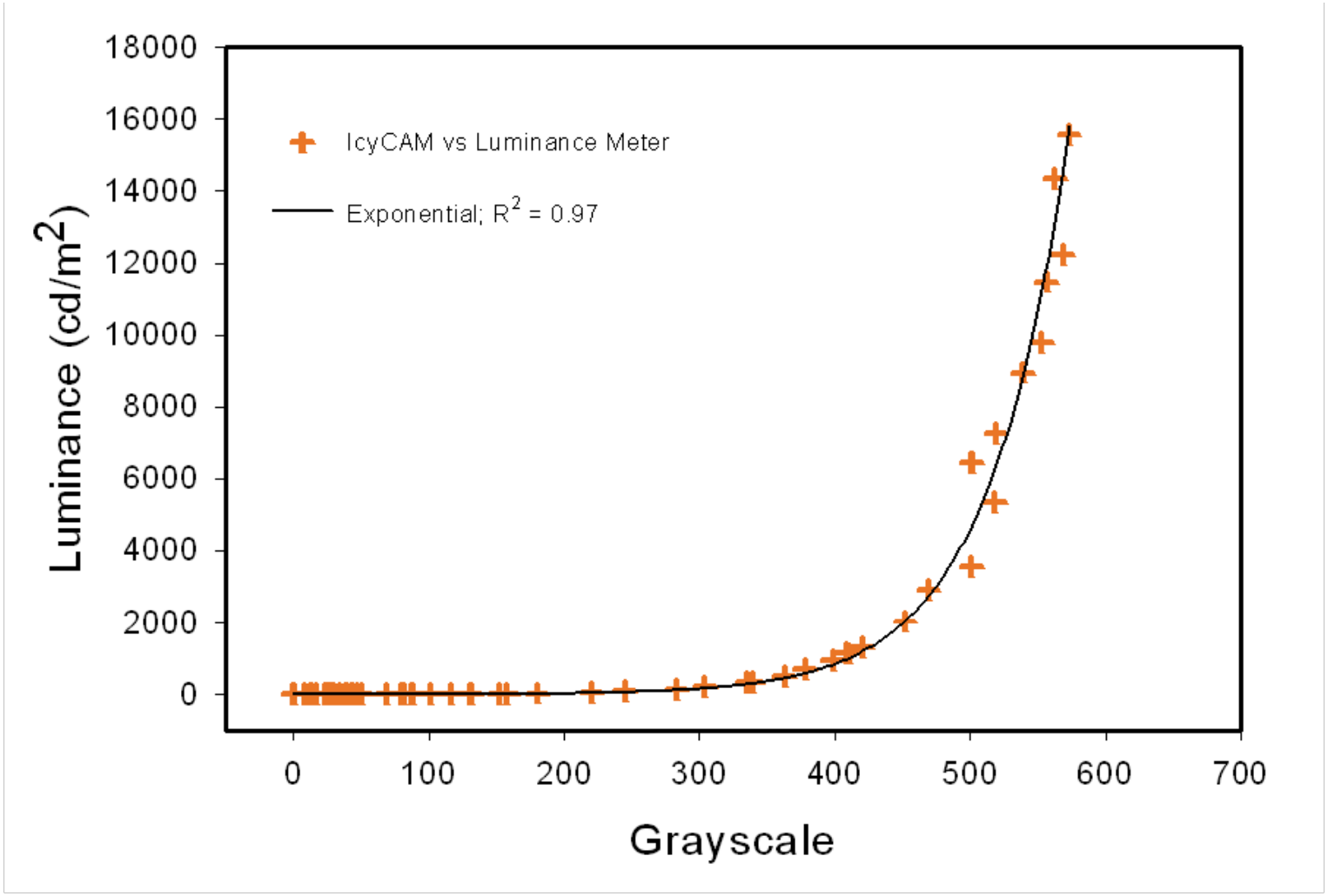
- Monochromatic light (between 380-780 nm)
- Spectroradiometer: emitted radiance



CIE standard error from V(λ): f' = 8.3%

Photometric calibration

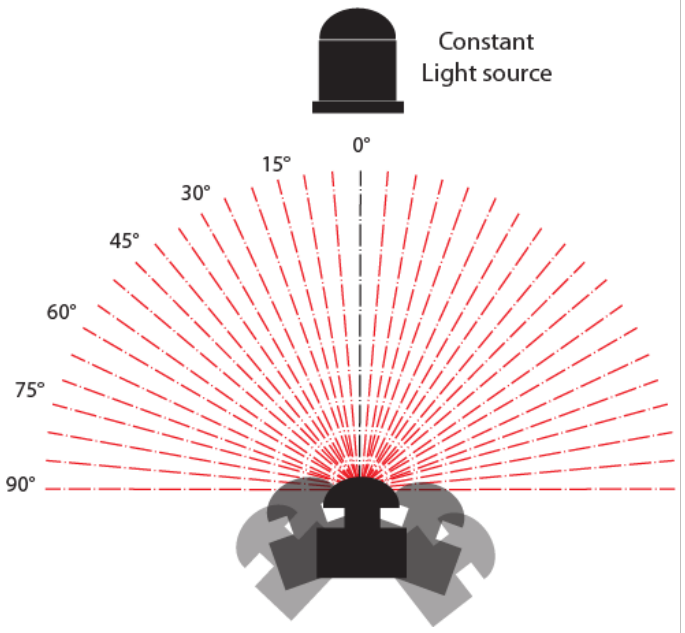
- White light (Xenon: 4100K, CRI 93 + Metal Halide: 6000K, CRI 90)
- Luminance meter: luminance

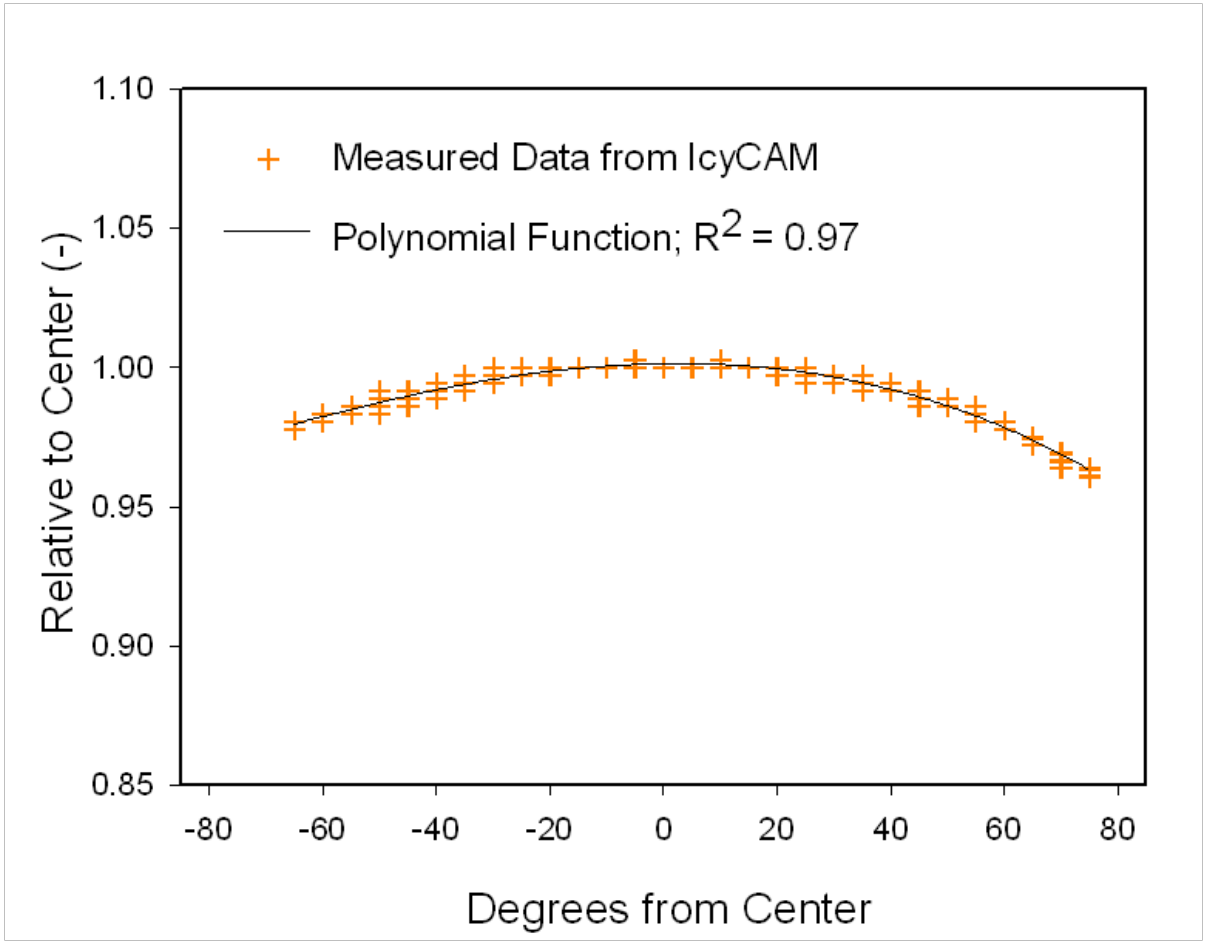


Vignetting correction

Equipped with120° Fisheye lens

- Constant light source
- Different angles

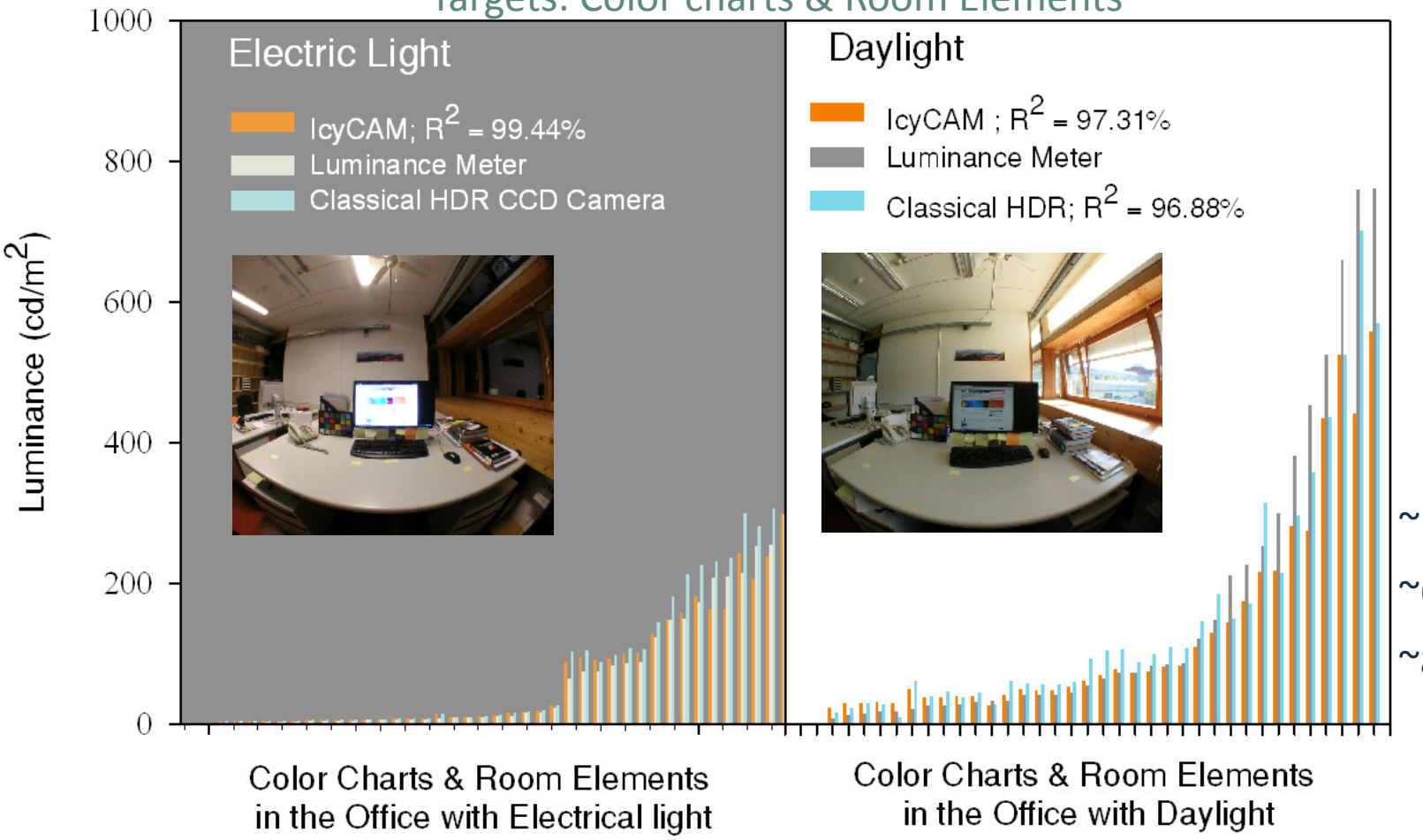




Luminance maps: Comparison of luminance map by IcyCAM

- with luminance measured by luminance meter
- with luminance extracted from HDR Nikon Coolpix (classical HDR)

Targets: Color charts & Room Elements



~100 ms: IcyCAM

~60 ms: HDR

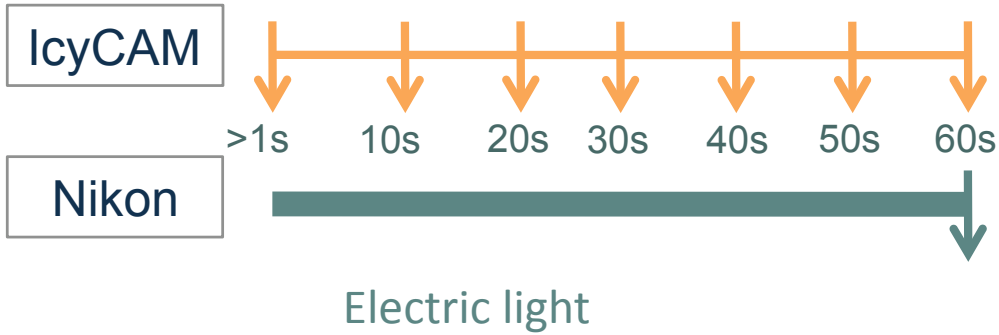
~8 min: luminance meter

$R^2 > 0.994$

$R^2 > 0.969$

Glare risk assessment

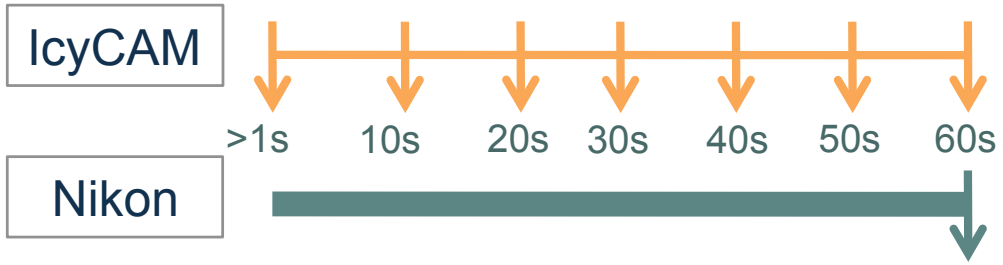
- different durations



`Time	DGP	DGI	UGR	Background Luminance
IcyCAM <1s	0.18	11.71	13.91	42.34
IcyCAM ~ 10s	0.18	11.66	13.85	42.48
IcyCAM ~ 20s	0.18	11.74	13.94	42.58
IcyCAM ~ 30s	0.18	11.68	13.88	42.53
IcyCAM ~ 40s	0.18	11.65	13.84	42.50
IcyCAM ~ 50s	0.18	11.76	13.98	42.46
IcyCAM ~ 60s	0.18	11.64	13.83	42.51
'Classical HDR' ~ 60s	0.18	11.49	13.52	49.79

Glare risk assessment

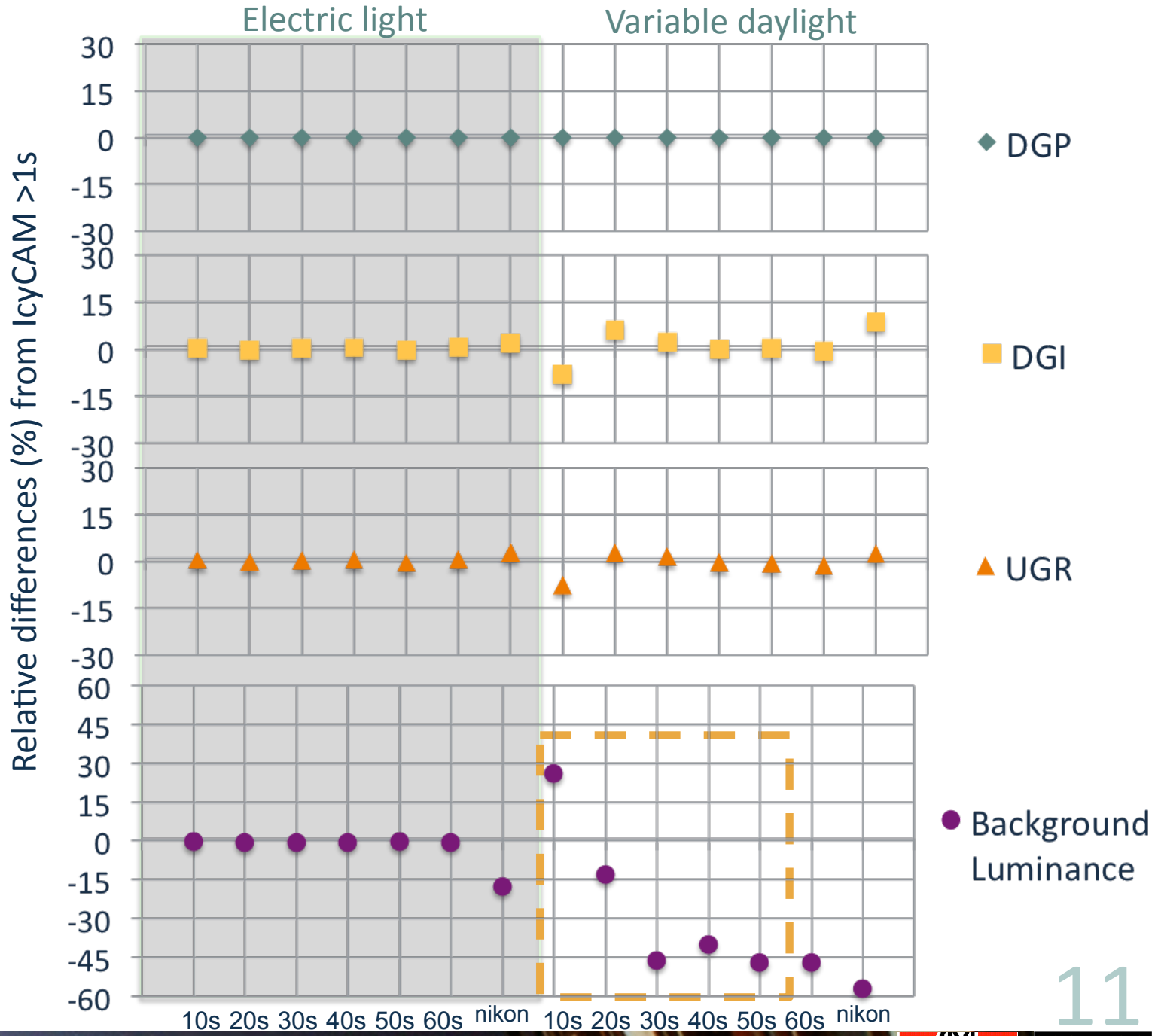
- different durations



Variable daylight

Time	DGP	DGI	UGR	Background Luminance
IcyCAM <1s	0.23	11.61	15.53	137.2
IcyCAM ~ 10s	0.23	12.55	16.70	101.62
IcyCAM ~ 20s	0.23	10.89	15.08	154.96
IcyCAM ~ 30s	0.23	11.36	15.29	200.61
IcyCAM ~ 40s	0.23	11.60	15.60	191.82
IcyCAM ~ 50s	0.23	11.58	15.62	201.58
IcyCAM ~ 60s	0.23	11.68	15.75	201.65
'Classical HDR' ~ 60s	0.23	10.79	15.21	215.14

- Different lighting conditions
- Different durations
- Changes of each parameters



- Different lighting conditions
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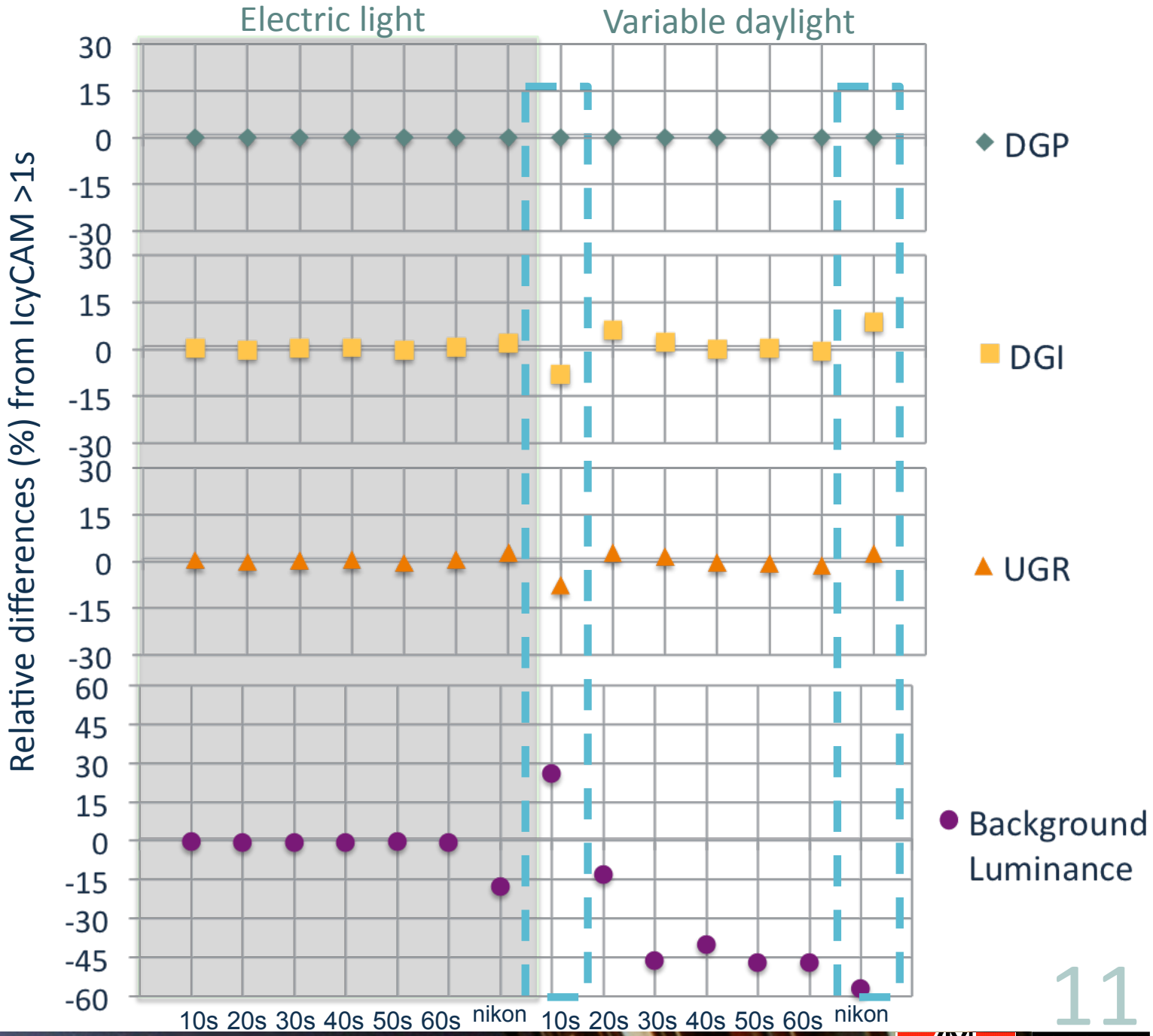


Glare risk assessment

IcyCAM

- DGP = 0.228
- DGI = 12.55
- UGR = 16.70

Light Source I = 5455 cd/m2

Light Source II = 6929 cd/m2

Background Luminance = 102 cd/m2

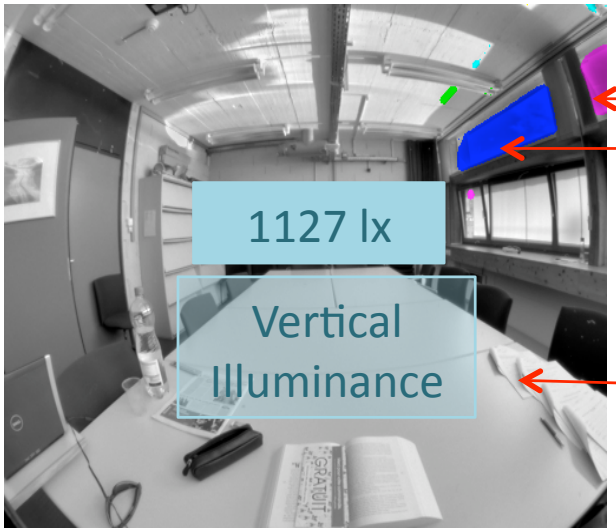
Main Parameters

- Glare Source Intensity (luminance/size/location)
- Background Luminance
- Vertical Illuminance

DGI, UGR → DGP

'Classical HDR'

- DGP = 0.23
- DGI = 10.79
- UGR = 15.21



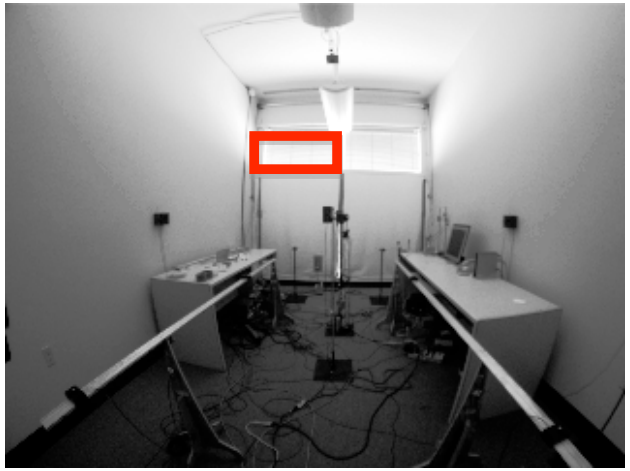
Light Source I = 6579 cd/m2

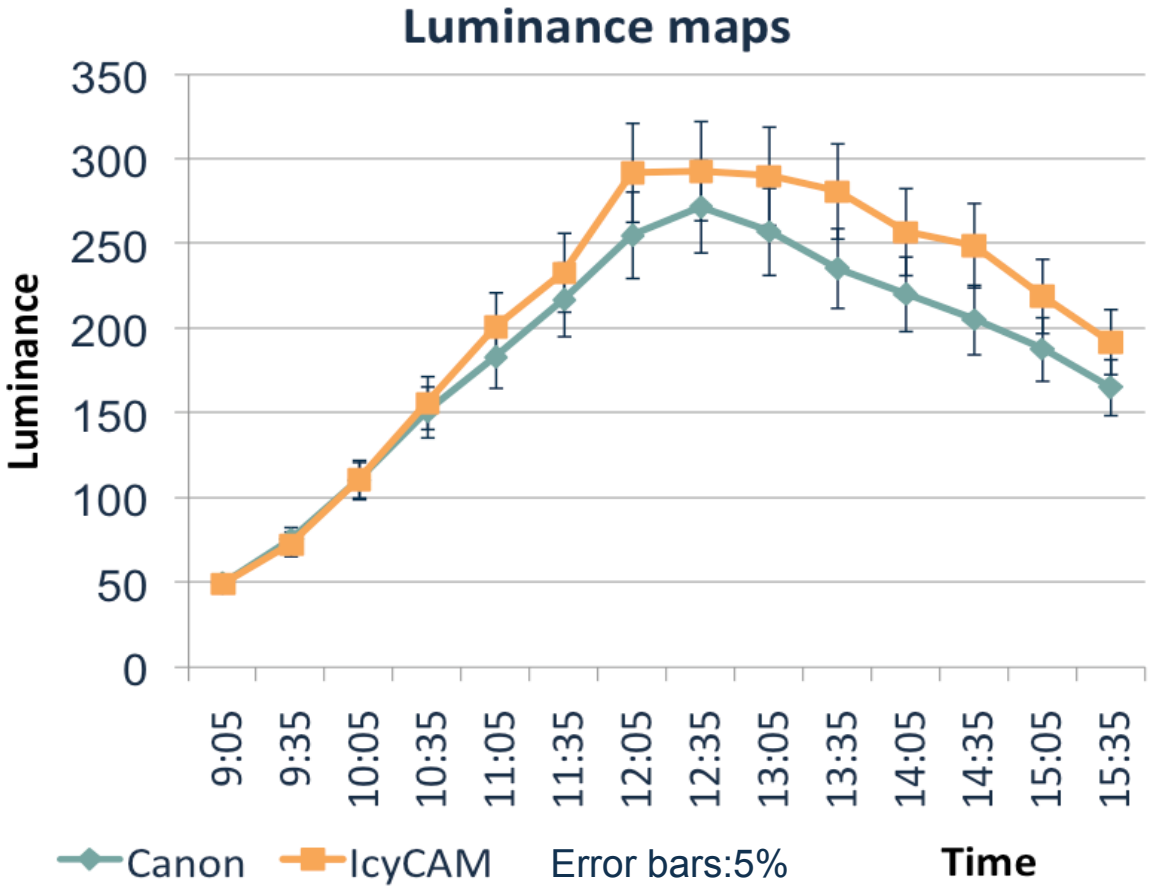
Light Source II = 7672 cd/m2

Background Luminance = 215 cd/m2

Discussion: Different angles of fisheye lens

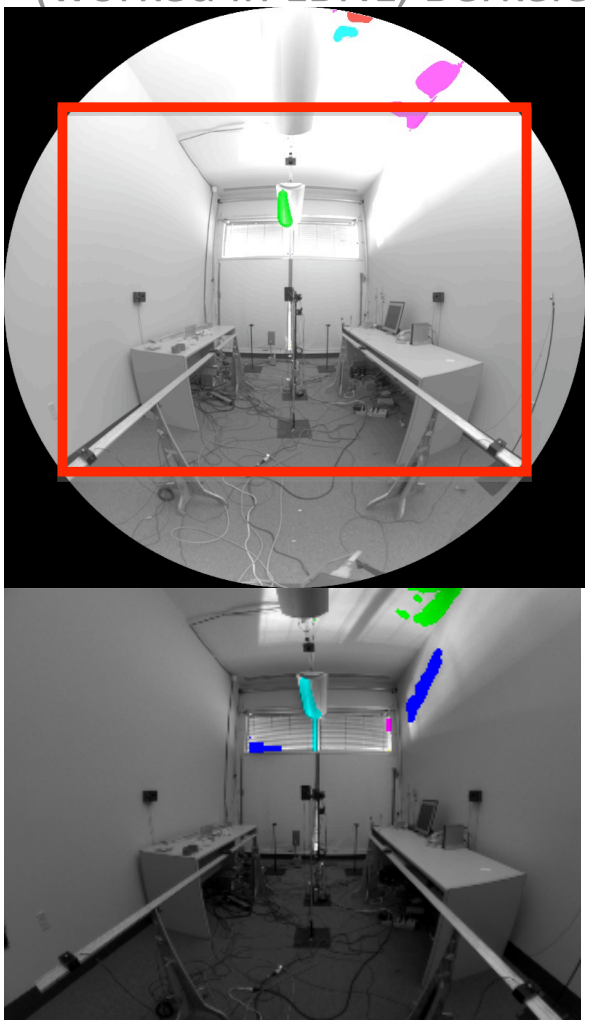
- Comparing IcyCAM 120° fisheye with Canon5D 180°full frame fisheye (worked in LBNL, Berkeley)

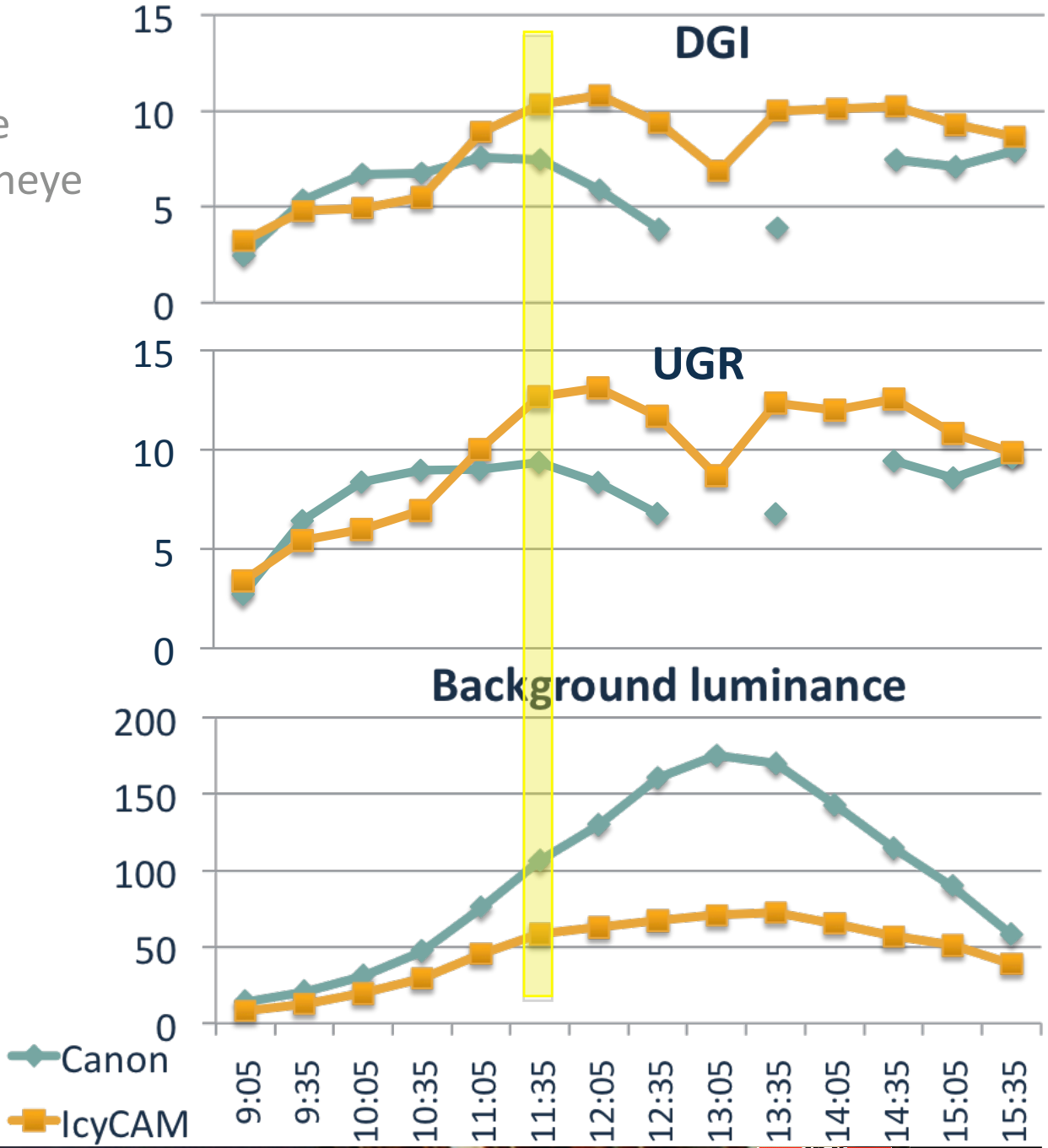




Different angles

- Comparing IcyCAM 120° fisheye with Canon5D 180°full frame fisheye (worked in LBNL, Berkeley)





Conclusion

- Summary
  - Highly correlated luminance mapping: HDR imaging vs luminance meter
  - Advantage of IcyCAM: Rapid image captures with greater benefit in dynamic daylight
- Future work
  - To use IcyCAM also under dynamic outdoor light conditions – 'sky scanner'
  - To use IcyCam with circadian sensitivity filters in order to assess luminance distribution related to physiological functions in humans

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Questions ?

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