SLR-30-20

Influence of Illuminance and Luminance on Headlamp Glare

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LLAB
LIGHT | HUMAN | MACHINE

Studies in the light tunnel

Laboratory studies

Influence of glance behavior

Intended study

Problem

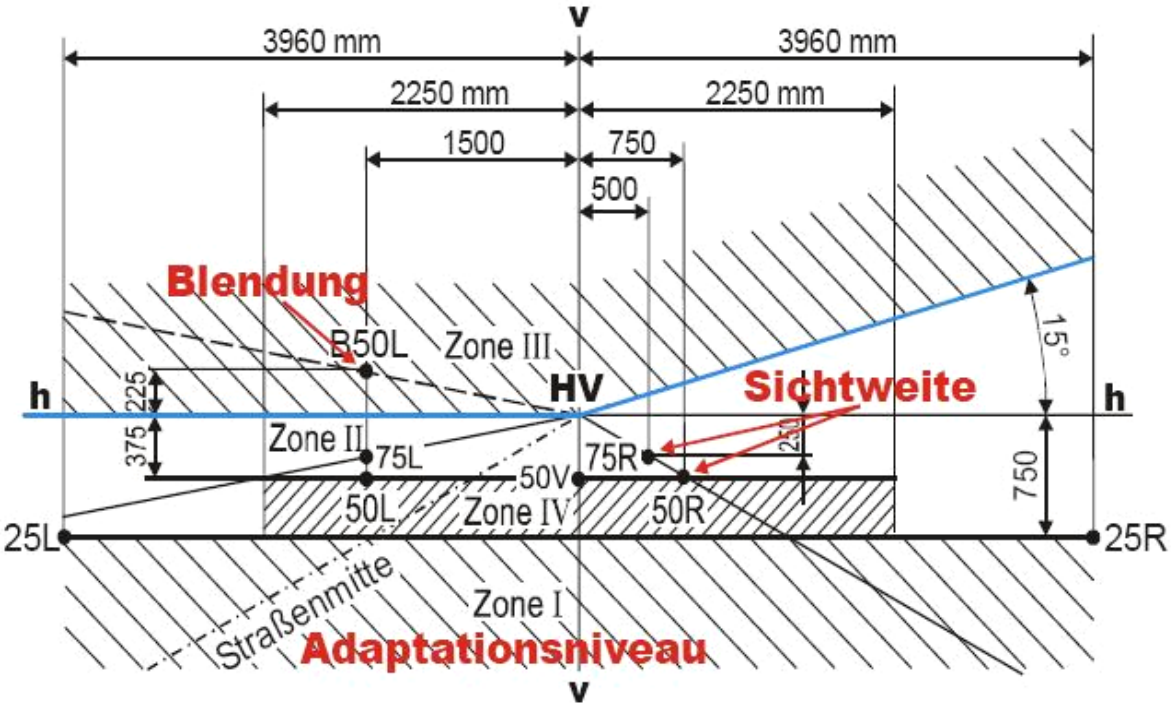
Reflection systems - Projection systems

Study I:

- Do Xenon headlamps dazzle more than Halogen headlamps?
- Do projection systems dazzle more than reflection systems?

Study II:

- How does the visual performance change if a car with correct adjusted headlamps is oncoming?
- How does the visual performance change if a car is oncoming, which headlamps don‘t fulfill the legal requirements?



B50L

25 m 1 headlamp: 0.4 – 0.5 lux (ECE 98, ECE 112, tube)

→ 50 m 2 headlamps: 0.2 – 0.25 lux

→ actual illuminance: ~ 0.4 – 0.5 lux

Why B50L?

Inverse square law: Illuminance is decreasing squared to distance.
→ The lower the distance the higher the illuminance.

But:

The lower the distance the larger the angle between glance direction (straight ahead) and glare source. It will be mapped peripherally in the eye.

In B50L the distance is quite short and the glance direction is still near the glare source. Looking at his own lane oncoming headlamps will be mapped centrally in the drivers eyes.

Disability glare

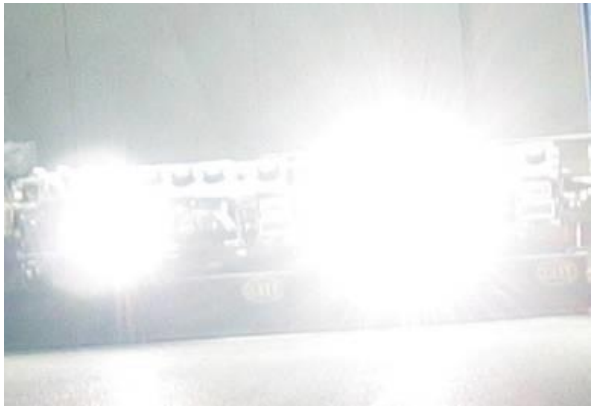
Discomfort glare

De Boer-Scale

Nine levels,

1: unbearable

9: unnoticeable



Disability glare:

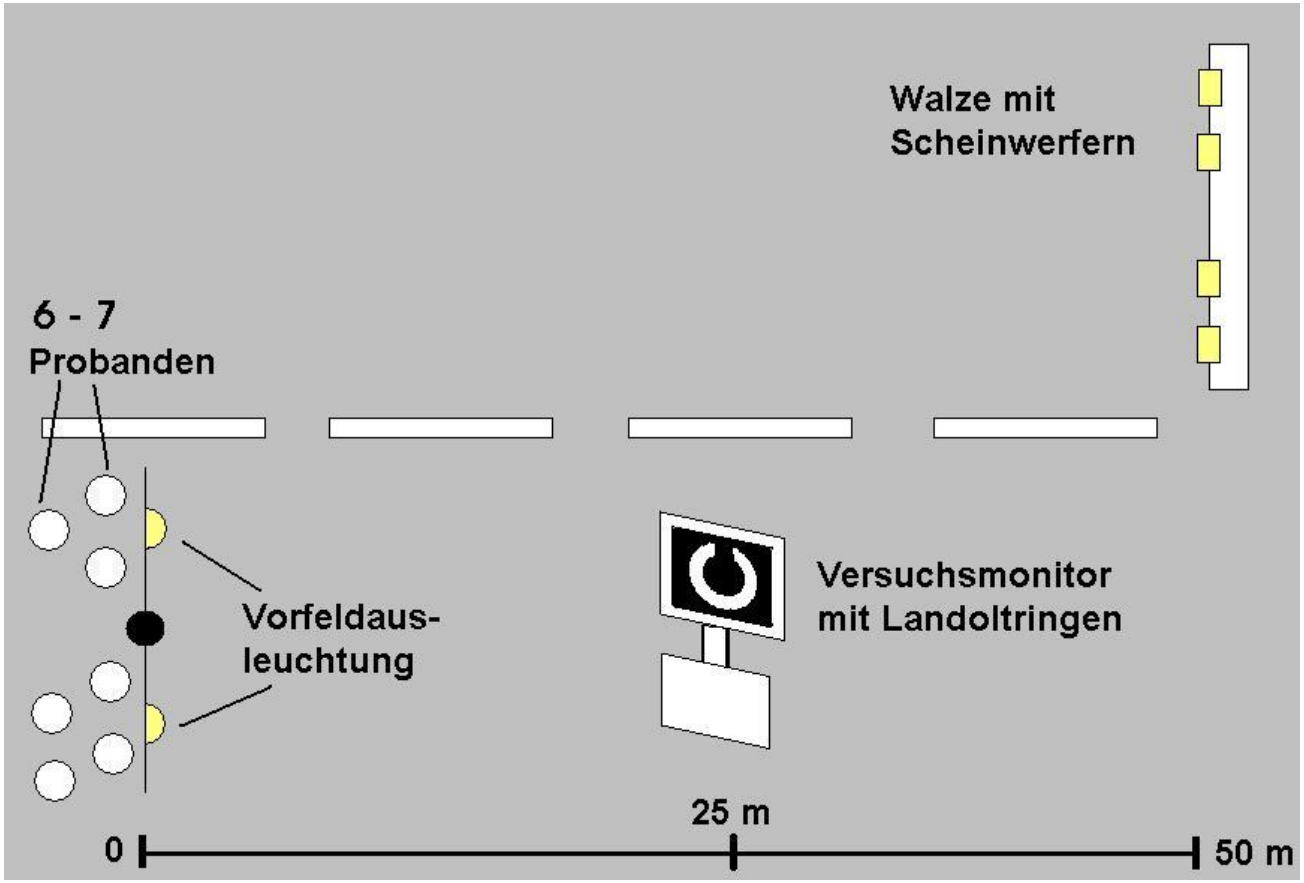
→ Safety

Discomfort glare

→ Complaints!

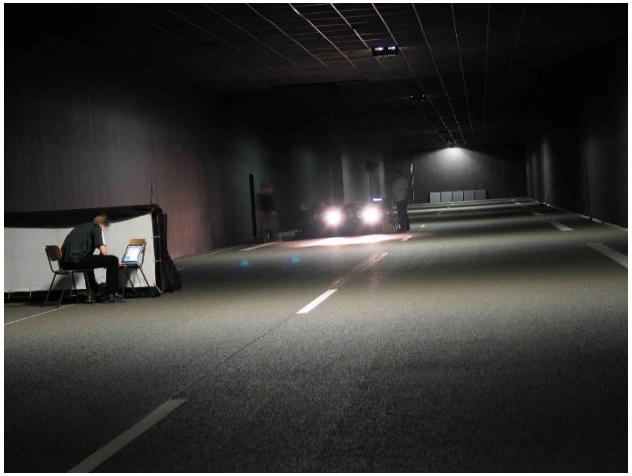
- Difficult to assess.
- Inconsistent results in studies.
- In each study a particular internal „system of reference“ is generated by test persons.
- References depending on anchor stimuli and changing perspectives.
  E.g. „Considering, that I look directly into the headlamp it is quite good.“
- Results of different studies can hardly be compared.

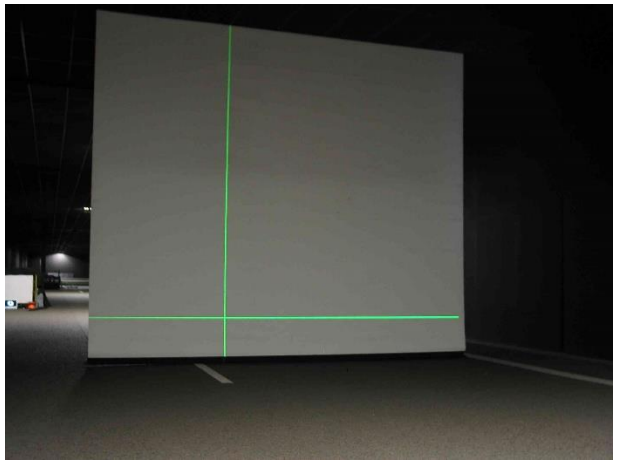
Studies in the Light Tunnel
- Experimental setup

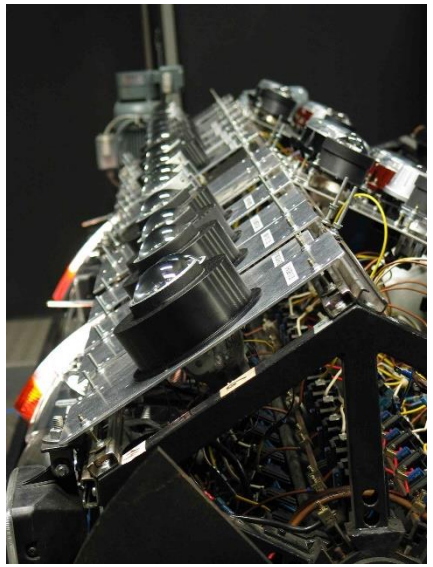


Test setup

Light tunnel





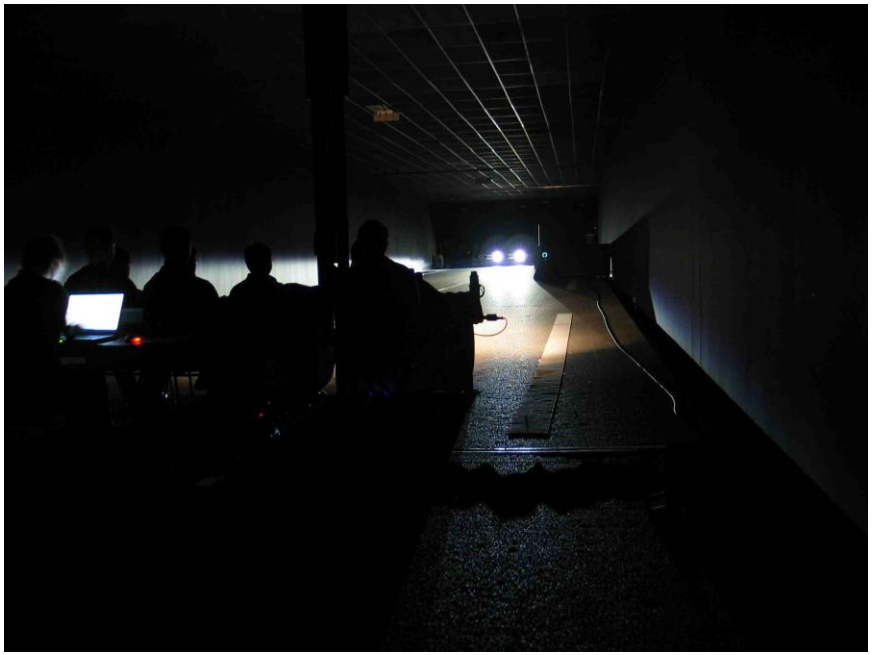


Studies in the Light Tunnel
- Experimental setup

glare source

test persons

Studies in the Light Tunnel
- Experimental setup



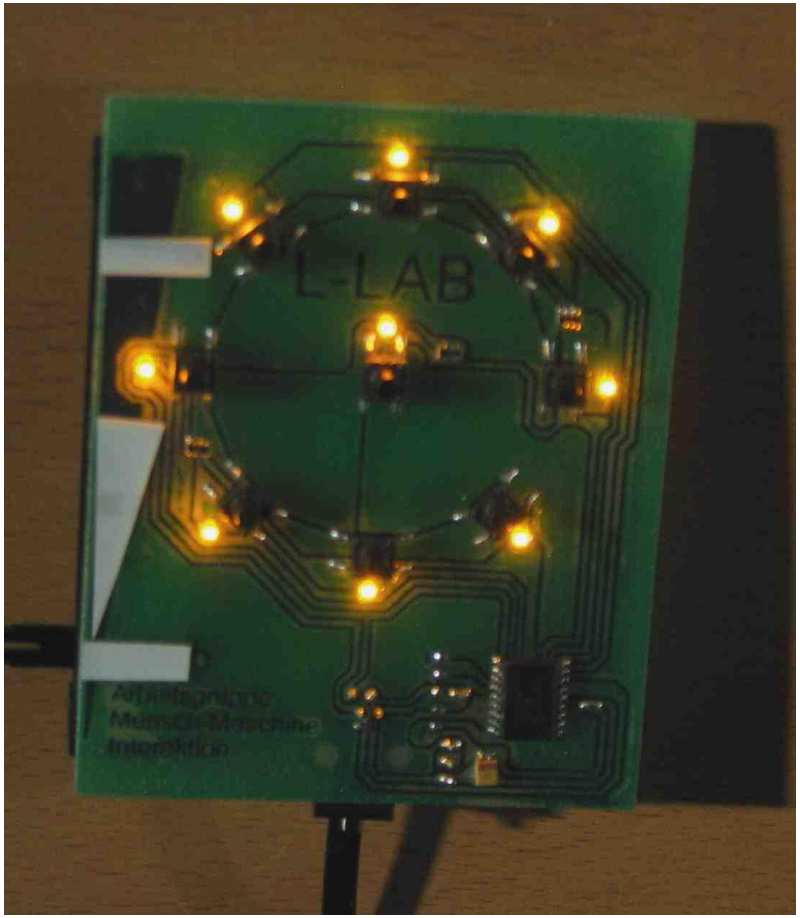
Test persons and their

view to the glare source

and the Landolt rings

Landolt ring

Studies in the Light Tunnel
- Experimental setup



Input board with buttons for the Landolt openings and slider for discomfort glare

Studies in the Light Tunnel
- Experimental setup

Study I:

- Halogen reflection system
- Halogen projection system
- Xenon projection system
- LED system I (prototype)
- LED system II (prototype)

N = 61

Study II:

- Xenon projection system
- Halogen projection system

misaligned, 1.5 lux

Study II:

- Xenon projection system
- Halogen projection system

  misaligned, 1.5 lux
- Halogen reflection system

  blue foil, 1,82 lux

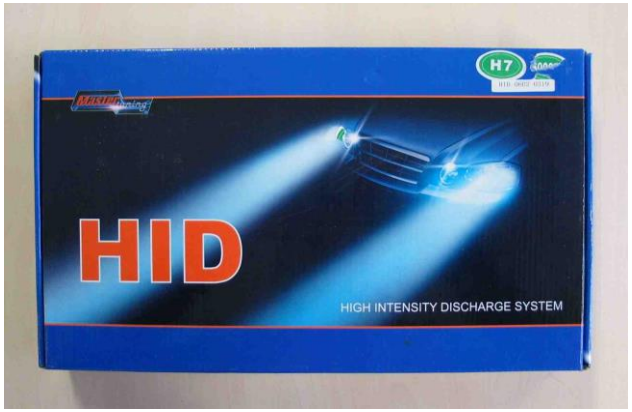
Study II:

- Xenon projection system
- Halogen projection system

  misaligned, 1.5 lux
- Halogen reflection system

  blue foil, 1,82 lux
- Halogen reflection system

  Xenon upgrade „ebay“, 1.58 lux



Studies in the Light Tunnel
- Experimental setup

- Xenon projection system
- Halogen projection system

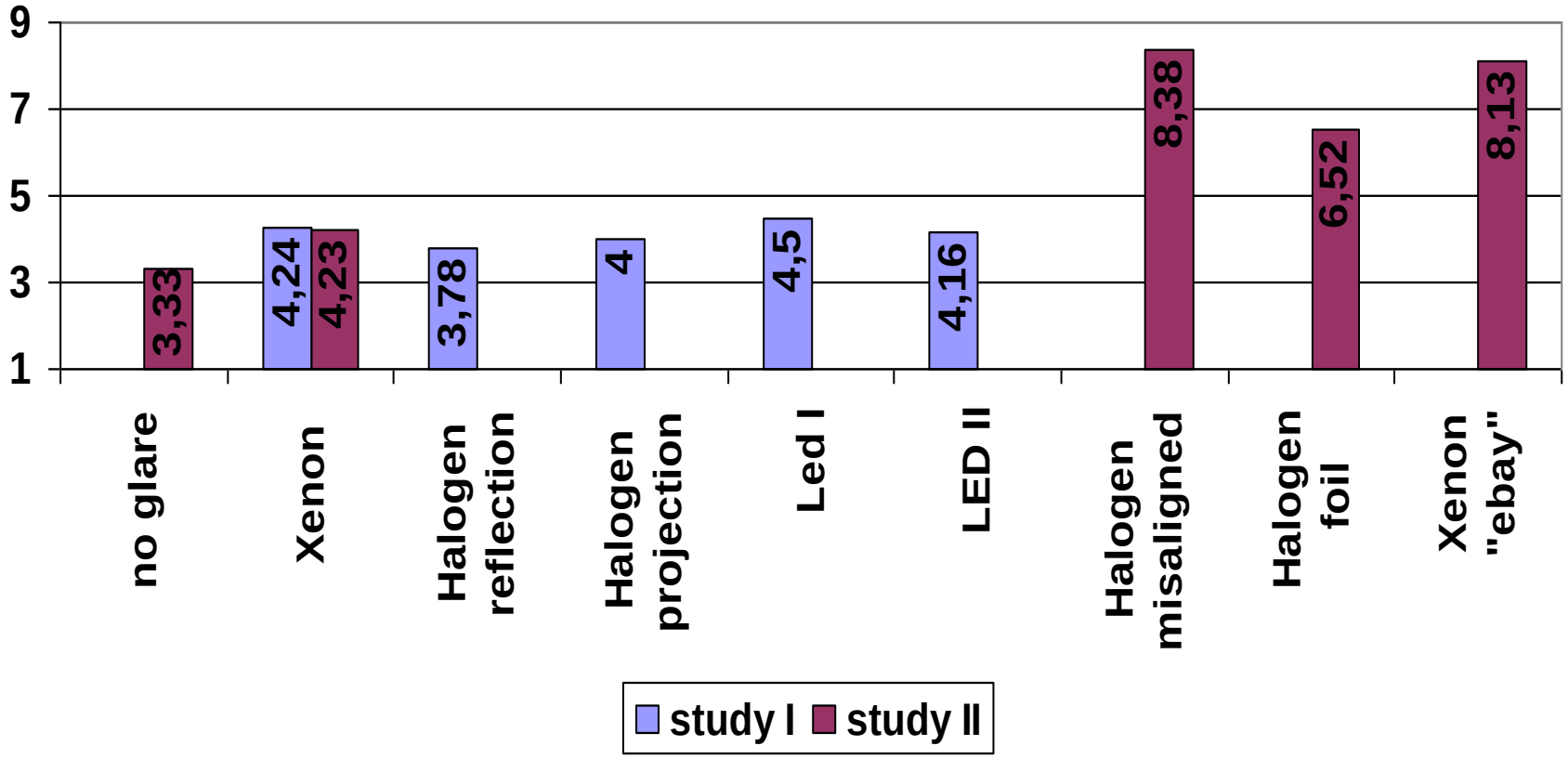
  misaligned, 1.5 lux
- Halogen reflection system

  blue foil, 1,82 lux
- Halogen reflection system

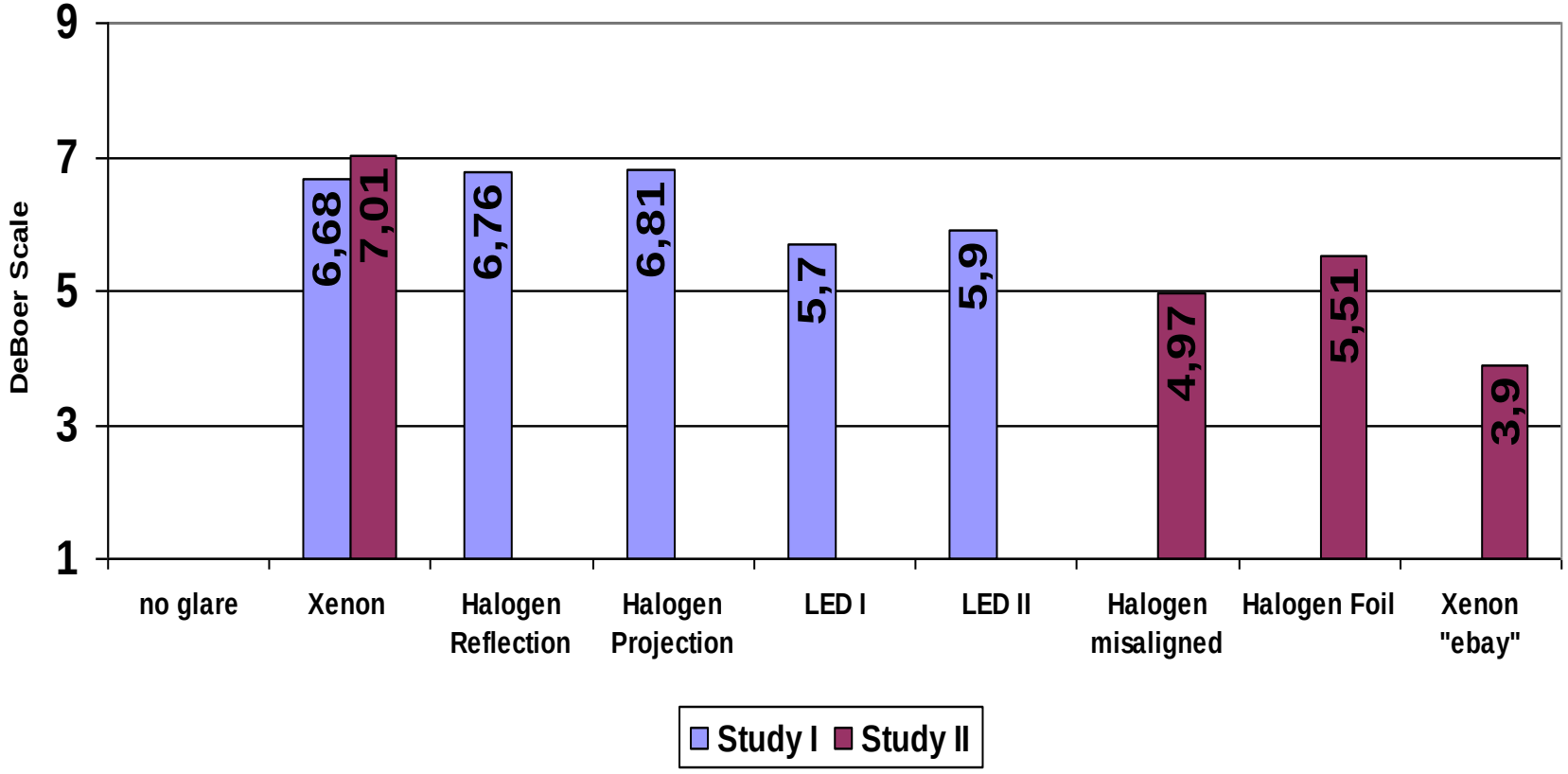
  Xenon upgrade „ebay“, 1.58 lux
- no glare source, 0,22 lux

N = 34

Results: disability glare



Results: discomfort glare



Studies in the Light Tunnel
- Results I

- No differences in disability glare if headlamps are correctly adjusted
- No „danger“ in case of Xenon lamps or projection systems
- Visual performance decreases dramatically if the legal requirements are not fulfilled

Problem:

- How to make sure, that headlamps comply with the standards?

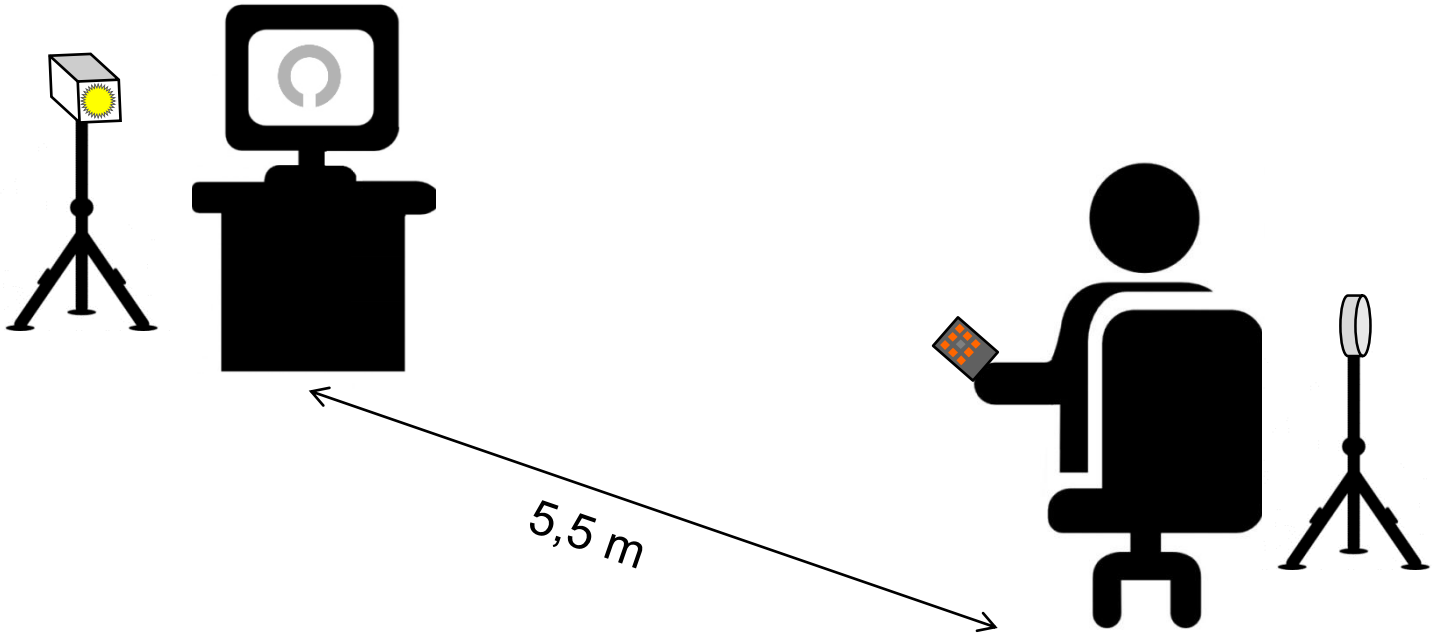
Studies in the light tunnel

Laboratory studies

Influence of glance behavior

Intended study

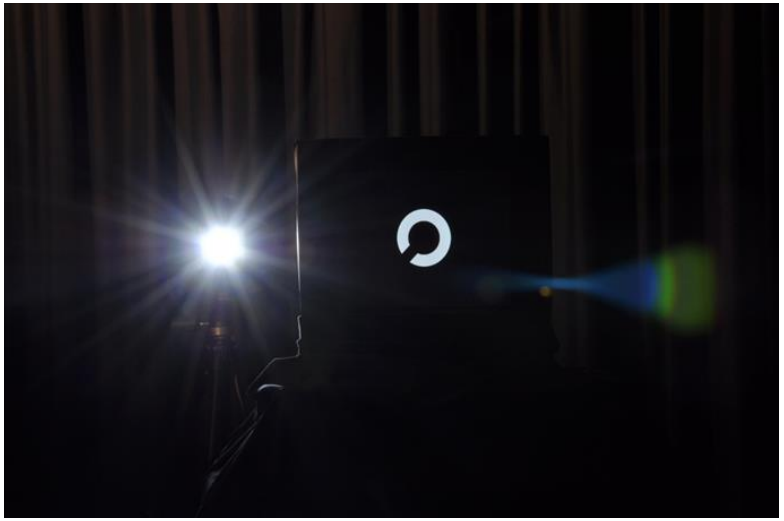
Laboratory Studies
- Setup



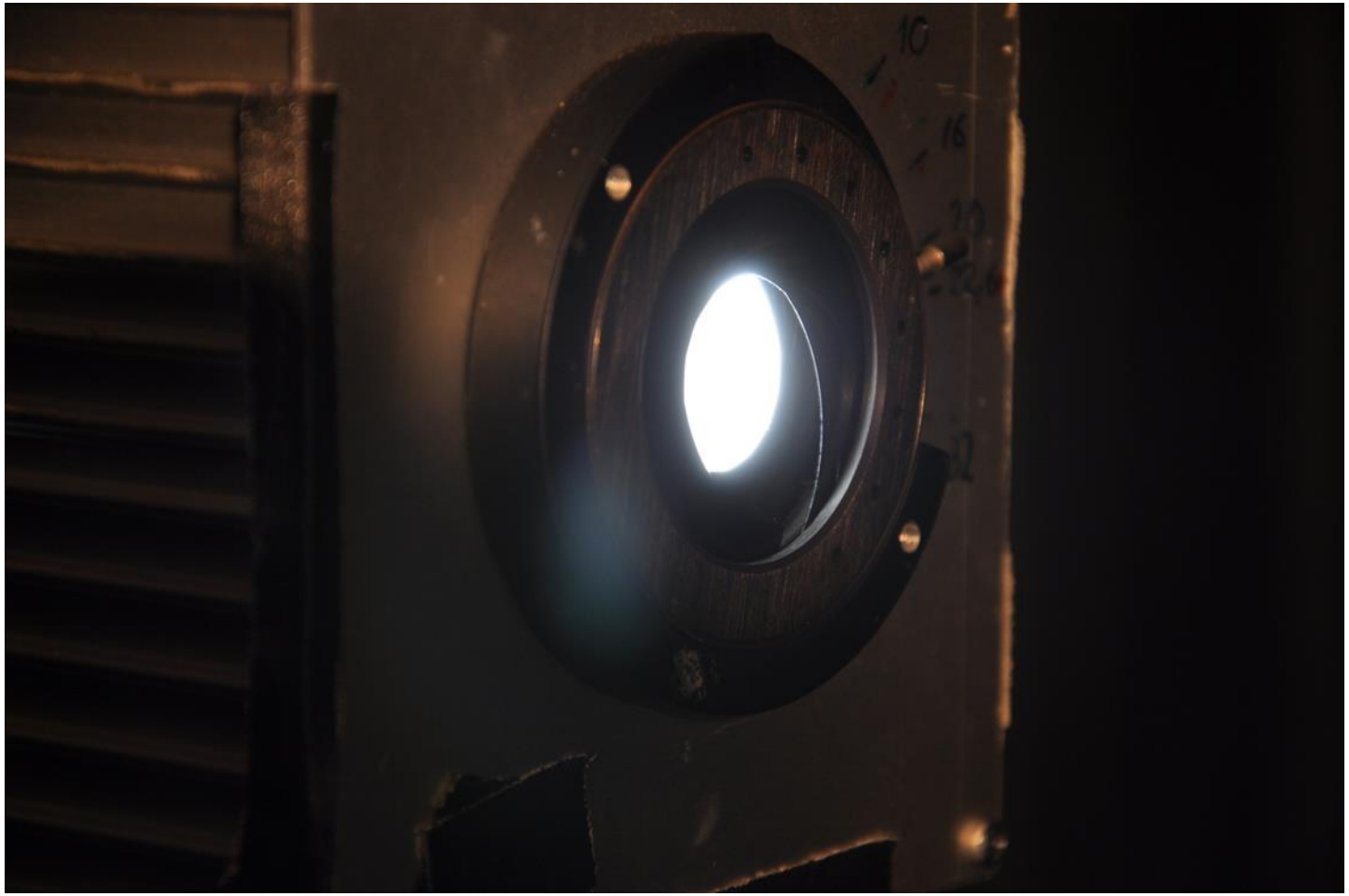
Why an additional Lab-Study?

- Systematic variation of luminance and illuminance as independent variables
- Control over all important confounding variables

Laboratory Studies
- Setup

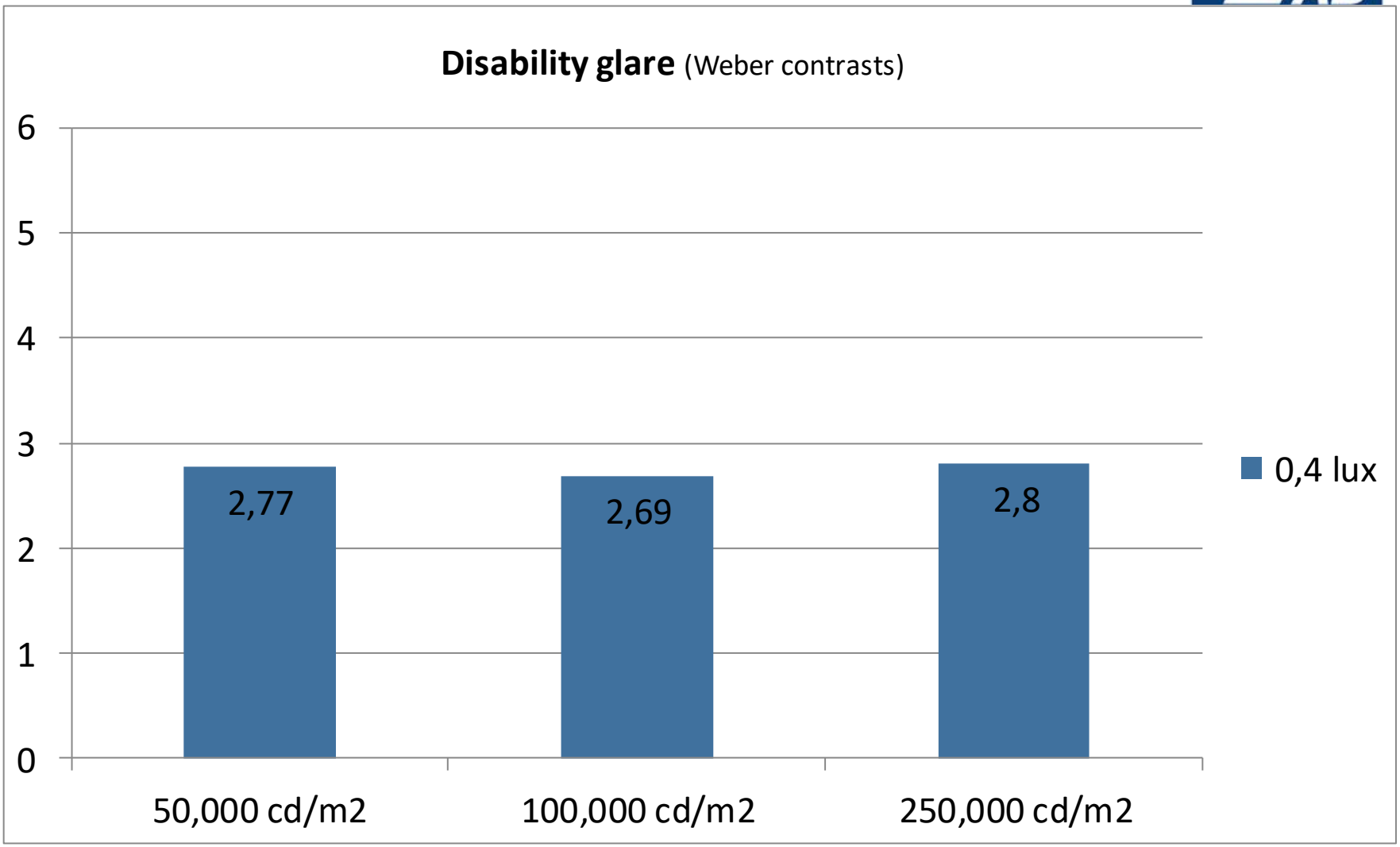


Laboratory Studies
- Setup

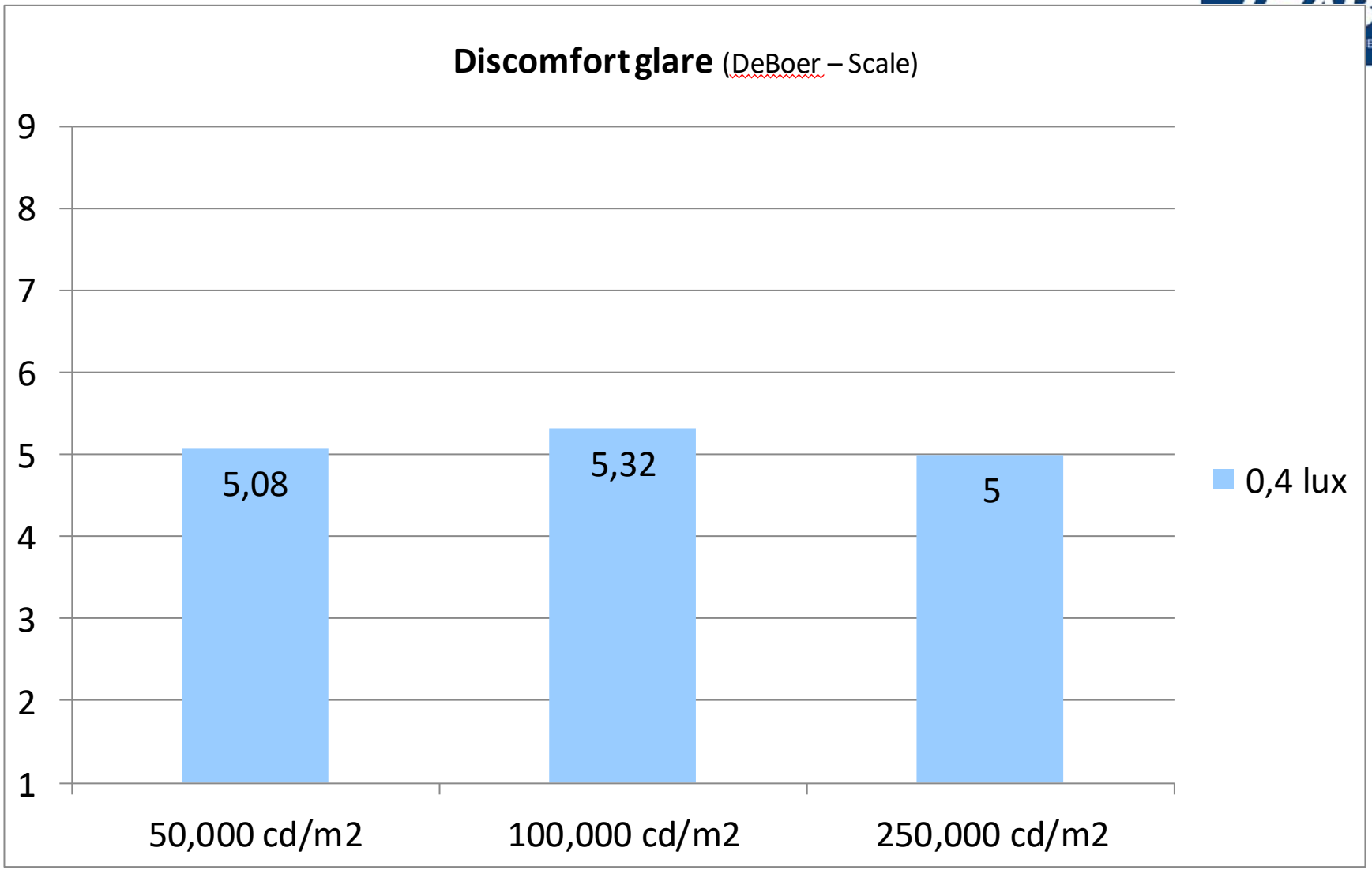


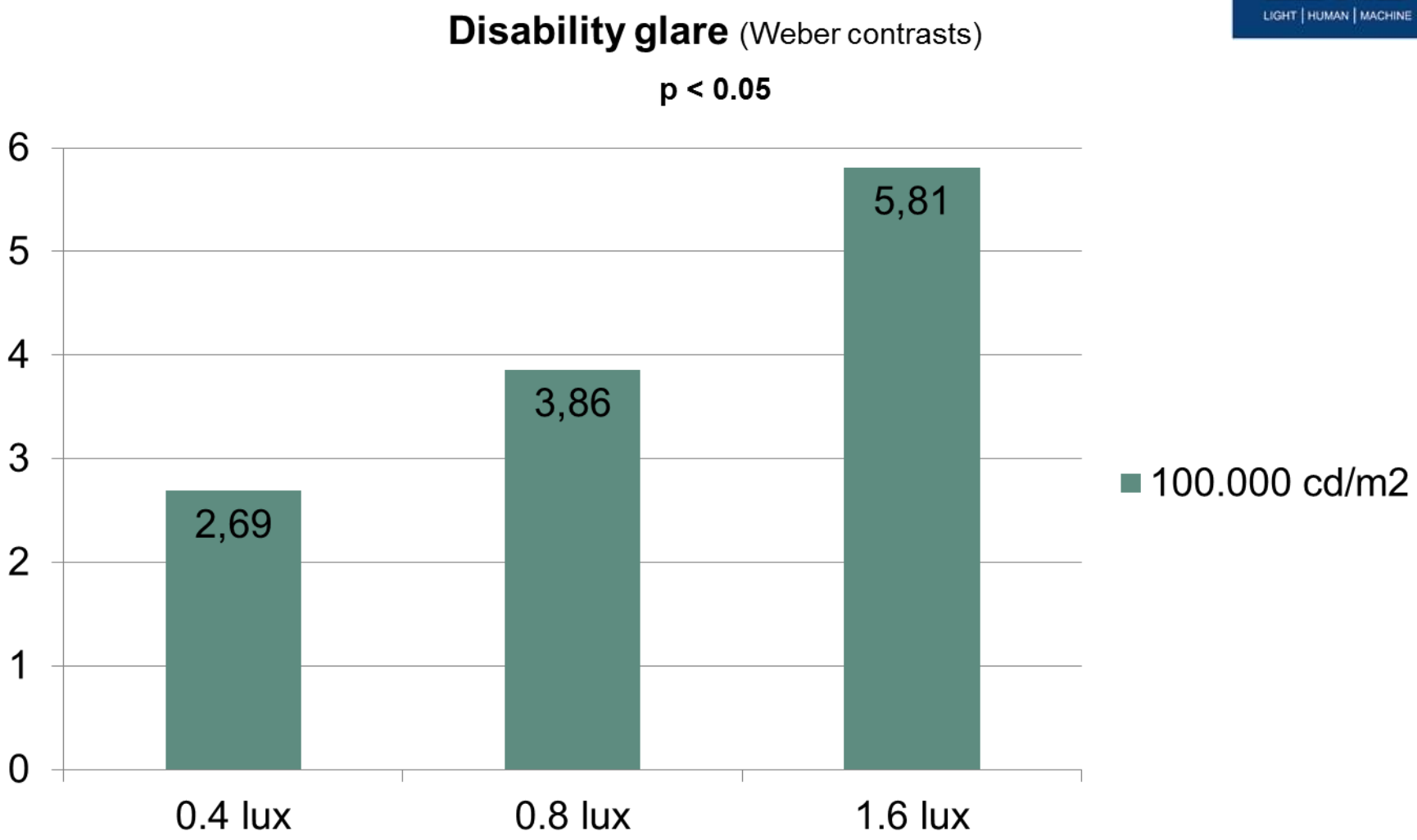
	Experiment 1	Experiment 2
Independant variable:	Luminance	Illuminance
	50,000 cd/m^2	0.4 lx
	100,000 cd/m^2	0.8 lx
	250,000 cd/m^2	1.6 lx
Dependant variables:	Discomfort glare (DeBoer-Scale) Disability glare (Weber contrasts)	
Basic condition:	0.4 lx; N = 60	100,000 cd/m^2 ; N = 60

Laboratory Studies
- Results

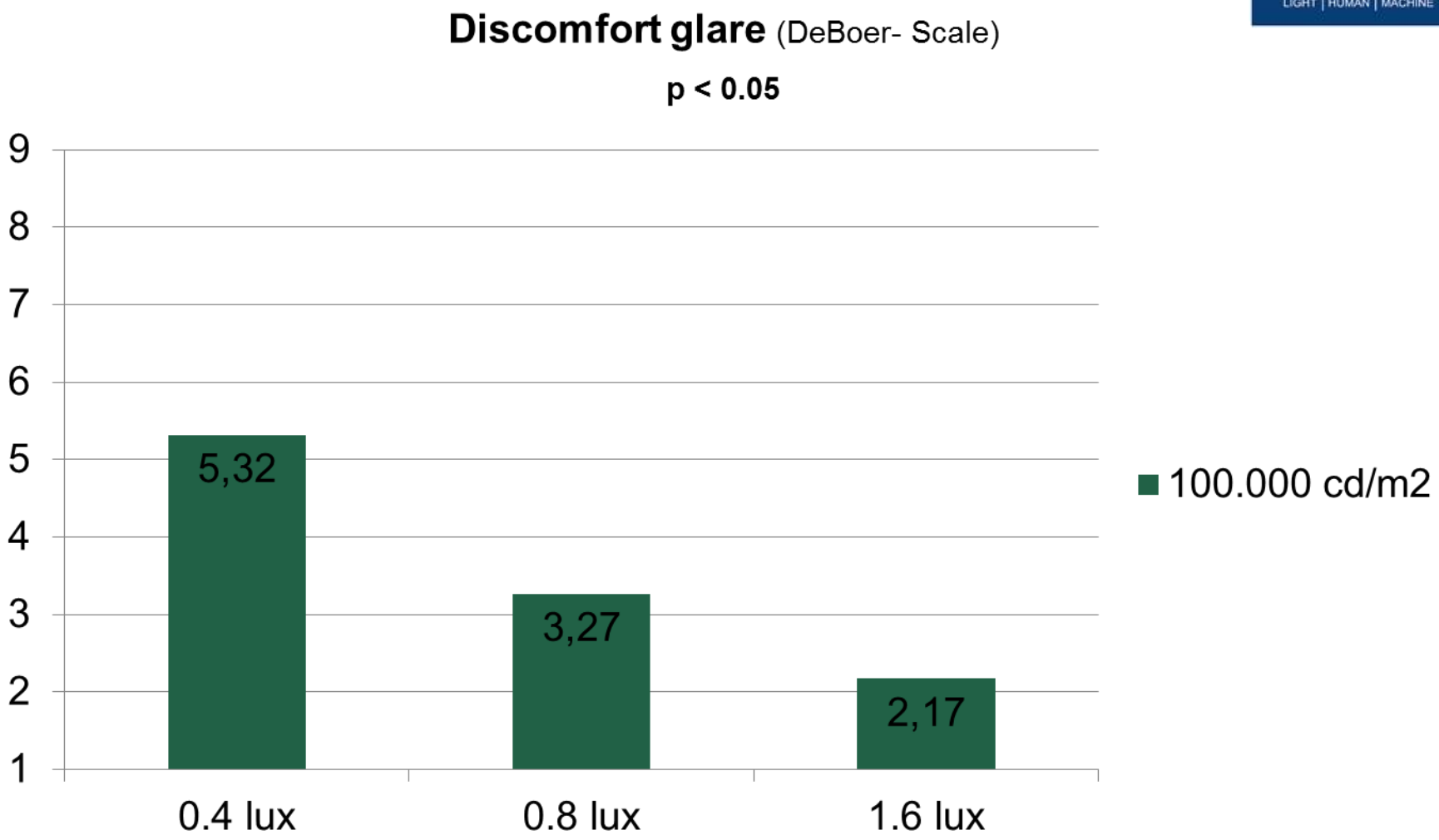


Laboratory Studies
- Results





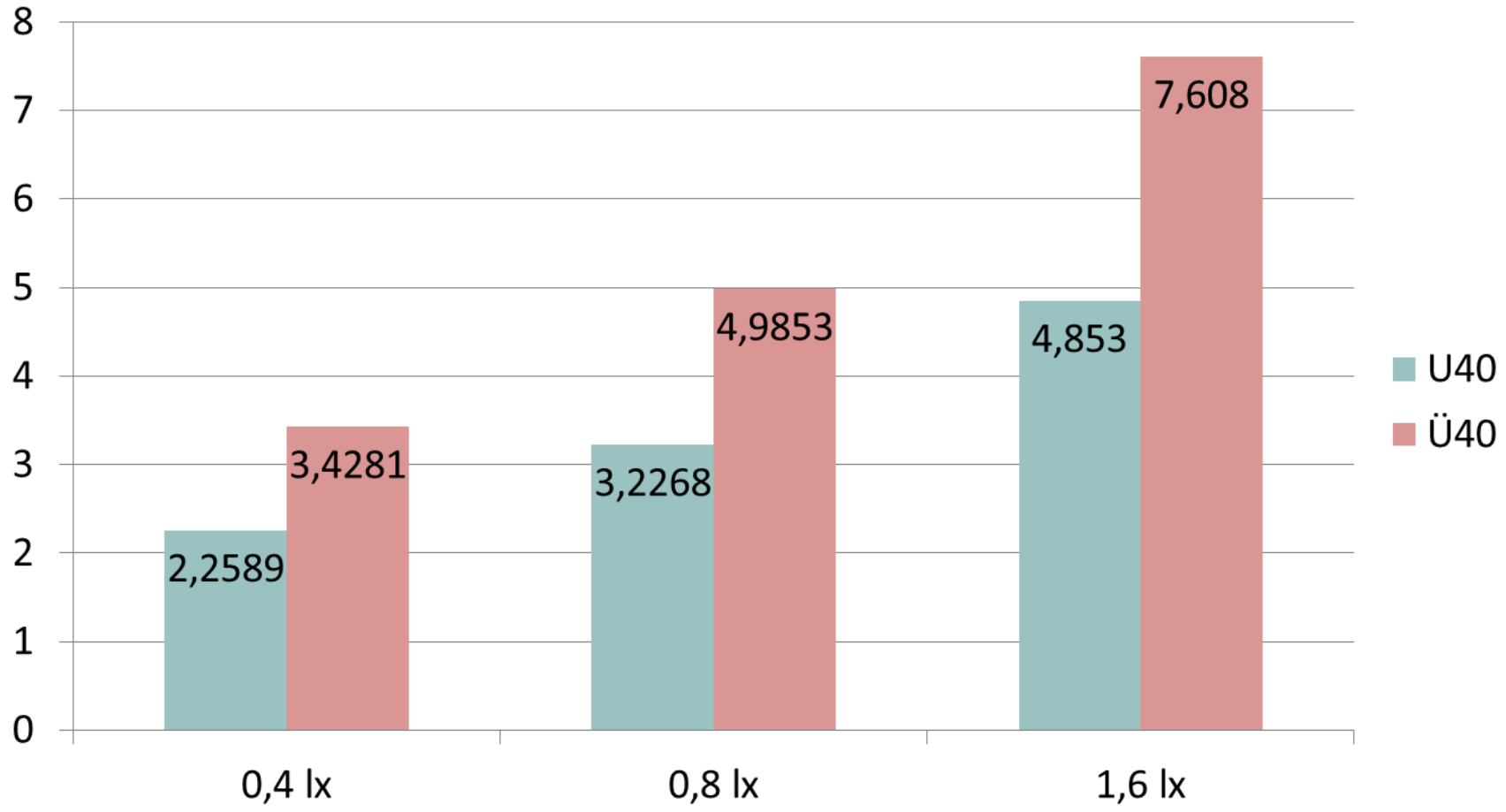
Laboratory Studies
- Results



Disability glare

Weber contrasts

100.000 cd/m2



- Currently no clues to negative effects caused by high luminance.

  Boundary values: B50L, 50 – 250 kcd/m^2.

- Clear effect of the illuminance at the subject‘s eye.

➔ Urgent need to meet the legal requirements!

Studies in the light tunnel

Laboratory studies

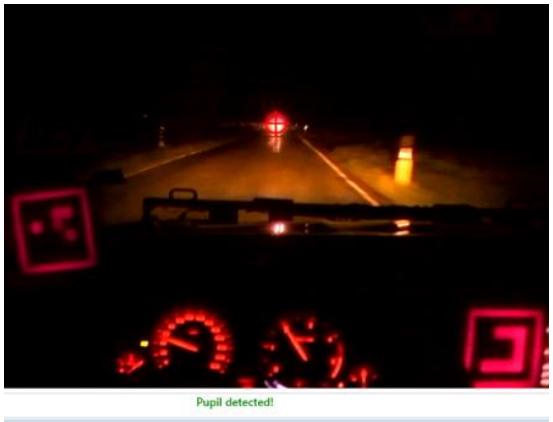
Influence of glance behavior

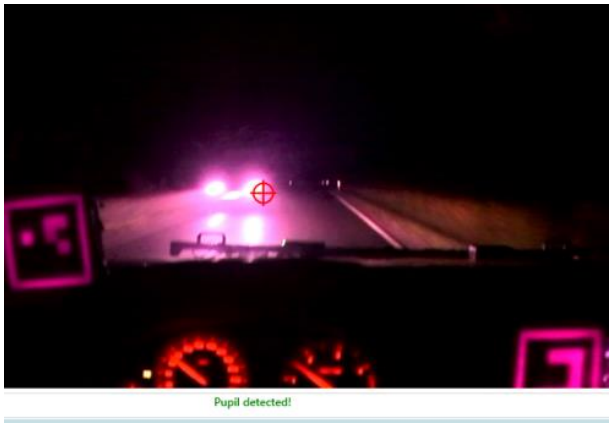
Intended study

Influence of Glance Behavior
- Problem

– Explorative Analysis of eye-tracking videos

– Drivers often look directly into the headlamps of oncoming cars





↳ **Glance into the glare source has to be considered!**

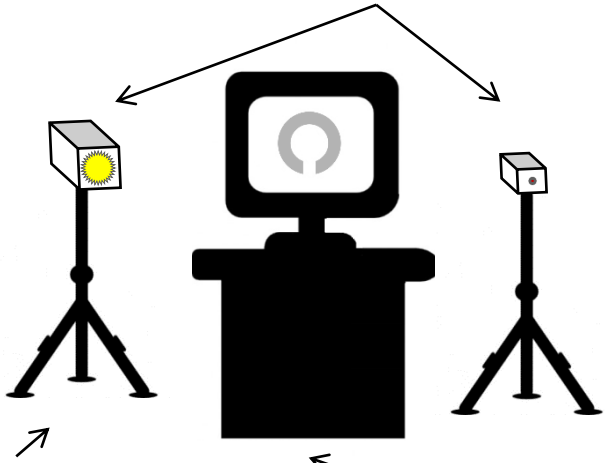
Influence of Glance Behavior
- Questions

1. What is the influence of looking directly into the glare source or aside on disability and discomfort glare (luminance and illuminance constant)?

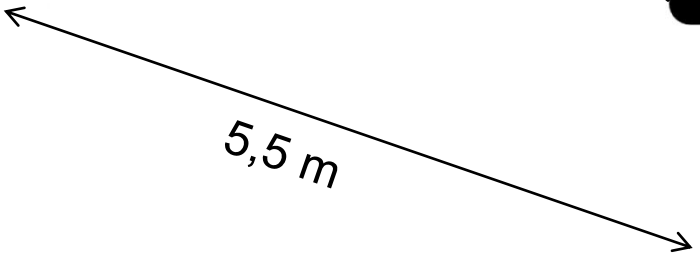
2. What is the influence of different luminances on disability and discomfort glare (looking directly into the glare source, illuminance constant)?

Influence of Glance Behavior
- Setup

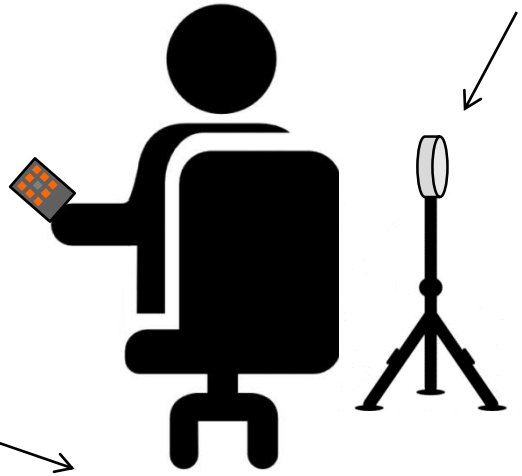
Look into the glare source: yes vs. no



Luminance [cd/m²]:
- 15,000
- 50,000
- 100,000
- 250,000



Illuminance: 0,4 lx



N=20

- Disability glare: Landolt rings (threshold contrast)
- Discomfort glare: DeBoer – Scale

Influence of Glance Behavior
- Setup

- Illuminance: 0,4 lx

- Descriptive statistics

Luminance	Look into glare source	Mean	SD
15000 cd/m²	Yes	4,38	1,67
50000 cd/m²	Yes	4,79	1,72
100000 cd/m²	Yes	4,64	1,78
250000 cd/m²	Yes	4,54	1,48
100000 cd/m²	No	3,26	1,80

- Experiment „Look into the glare source“

- Experiment Luminance

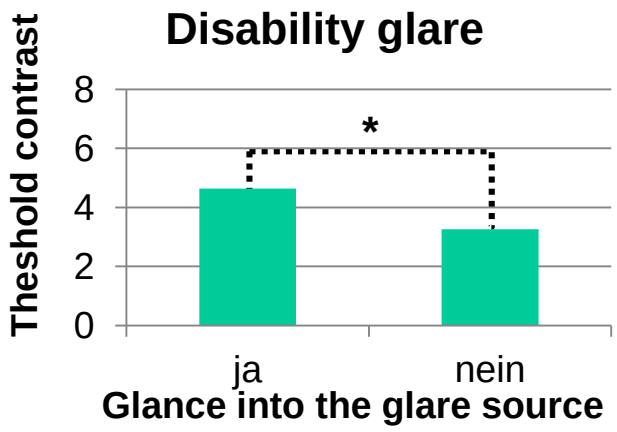
- Illuminance: 0,4 lx

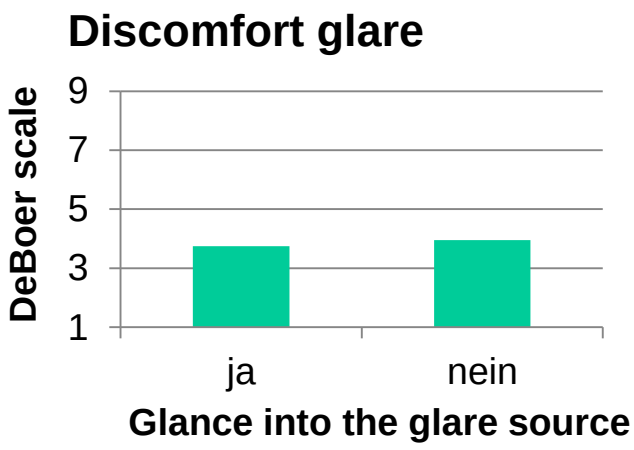
- Desriptive statistics

Luminance	Look into glare source	Mean	SD
15000 cd/m²	Yes	4,15	1,81
50000 cd/m²	Yes	4,05	1,76
100000 cd/m²	Yes	3,75	1,48
250000 cd/m²	Yes	3,60	1,60
100000 cd/m²	No	3,95	1,93

Influence of Glance Behavior
- Glance into the Glare Source

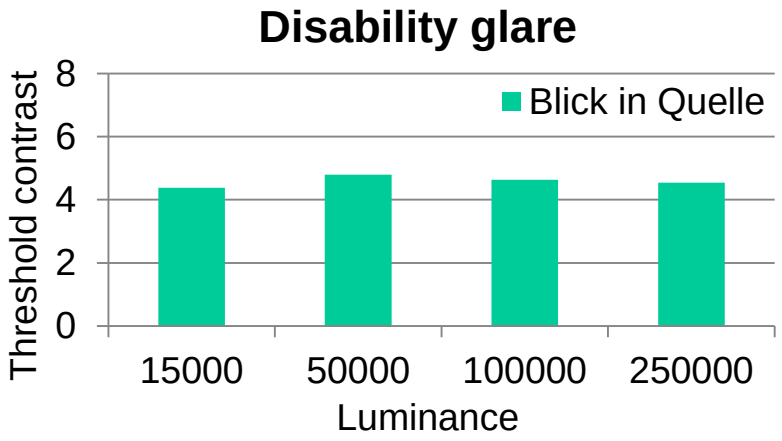
Disability glare	Discomfort glare
- Significant difference (Z = -2,94; p < 0,05) → Visual performance inferior if looking into the glare source	- No difference - De Boer-Scale highly dependent on context

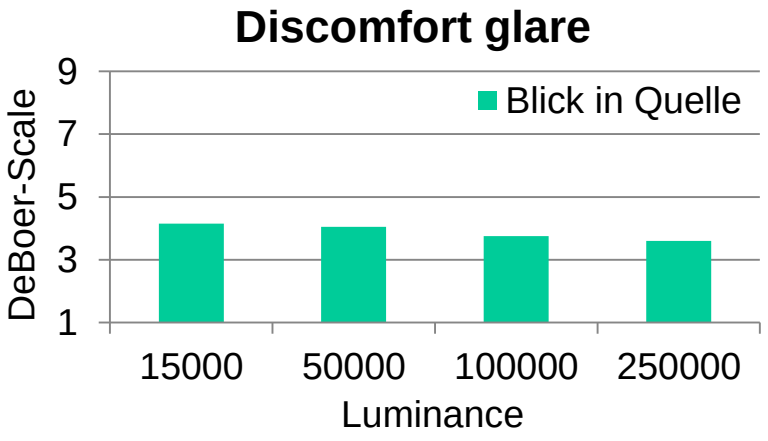




Influence of Glance Behavior
- Effect of Luminance

Disability glare	Discomfort glare
- No influence of luminance on disability glare	- No or very slight influence of luminance on discomfort glare





Small light emitting areas don‘t cause more glare

Influence of Glance Behavior
- Conclusion

- Direct glance into the glare source increases disability glare, not necessarily discomfort glare

- No influence of luminance was found if test persons were looking directly into the glare source

- Looking directly into the glare source causes an „offset“ in disability glare compared to looking aside. But the „structure“ related to influence of luminance seems to be identical.

Studies in the light tunnel

Laboratory studies

Influence of glance behavior

Intended study

Intended Study

Quelle: Audi

In the studies shown above a certain range of luminances has been covered.

New headlamp prototypes with extrem small light emitting areas are available.

Are the results valid for the new headlamps?

→ Replication of the light tunnel study I in summer 2019.

References

Locher, J., Aldiek, L. & Stroop, P. (2015). Influence of Luminance and Illuminance on Headlamp Glare. In *ISAL 11th International Symposium on Automotive Lighting* (679 – 686). München: Herbert Utz Verlag.

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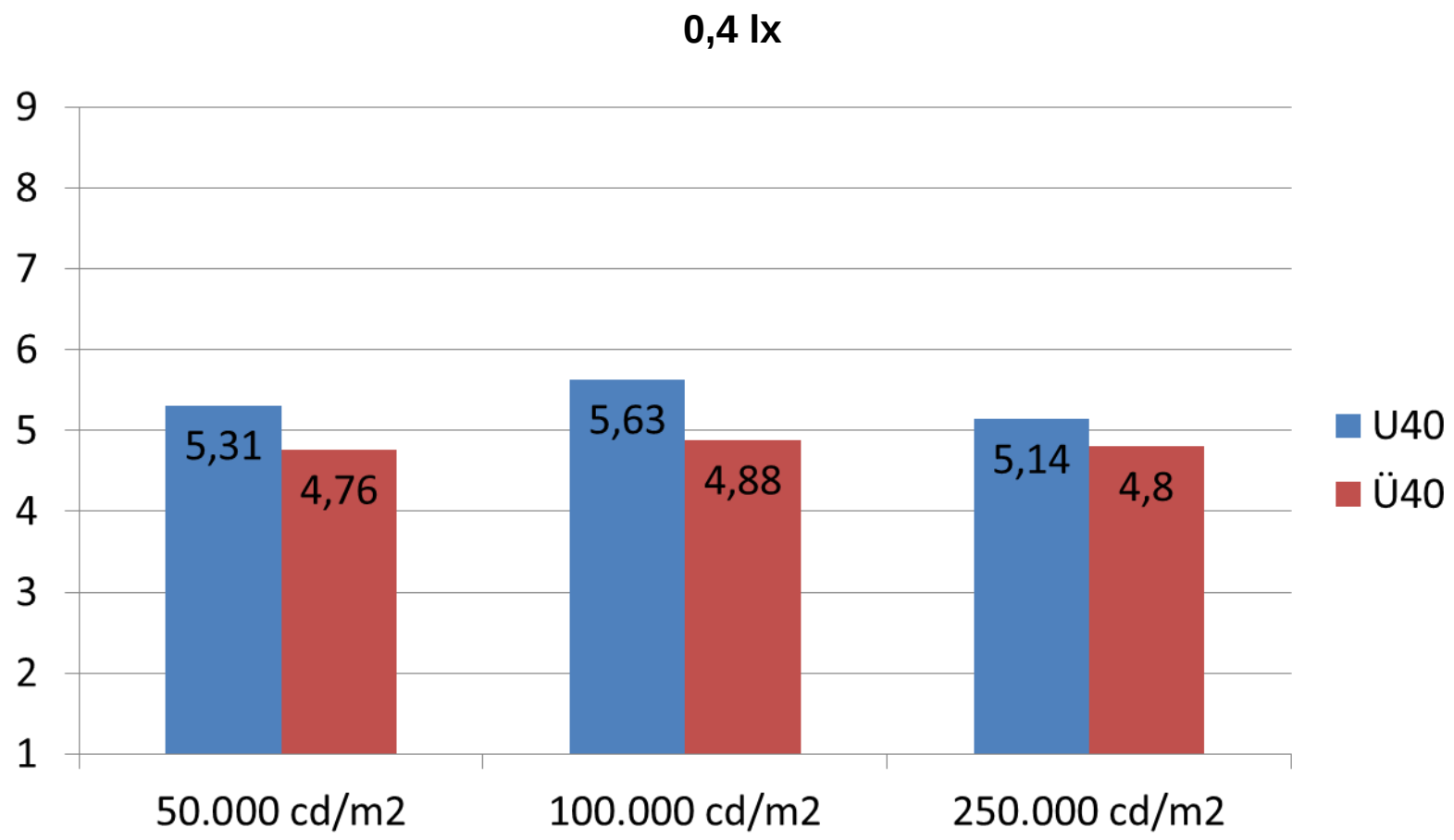
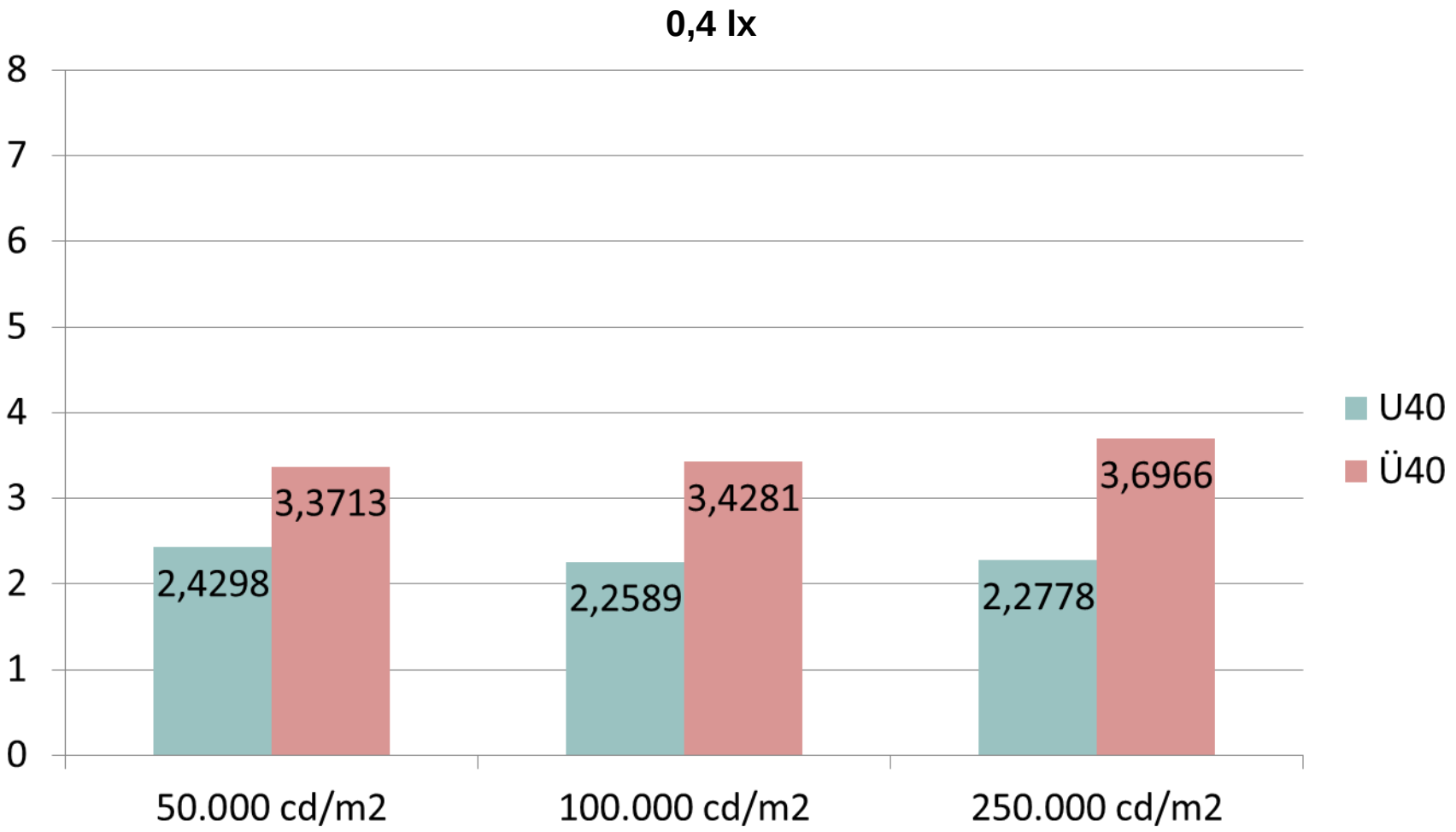
Discomfort glare

gemessen in DeBoer – Werten



Disability glare

gemessen in Weberkontrasten



Discomfort glare

gemessen in DeBoer – Werten