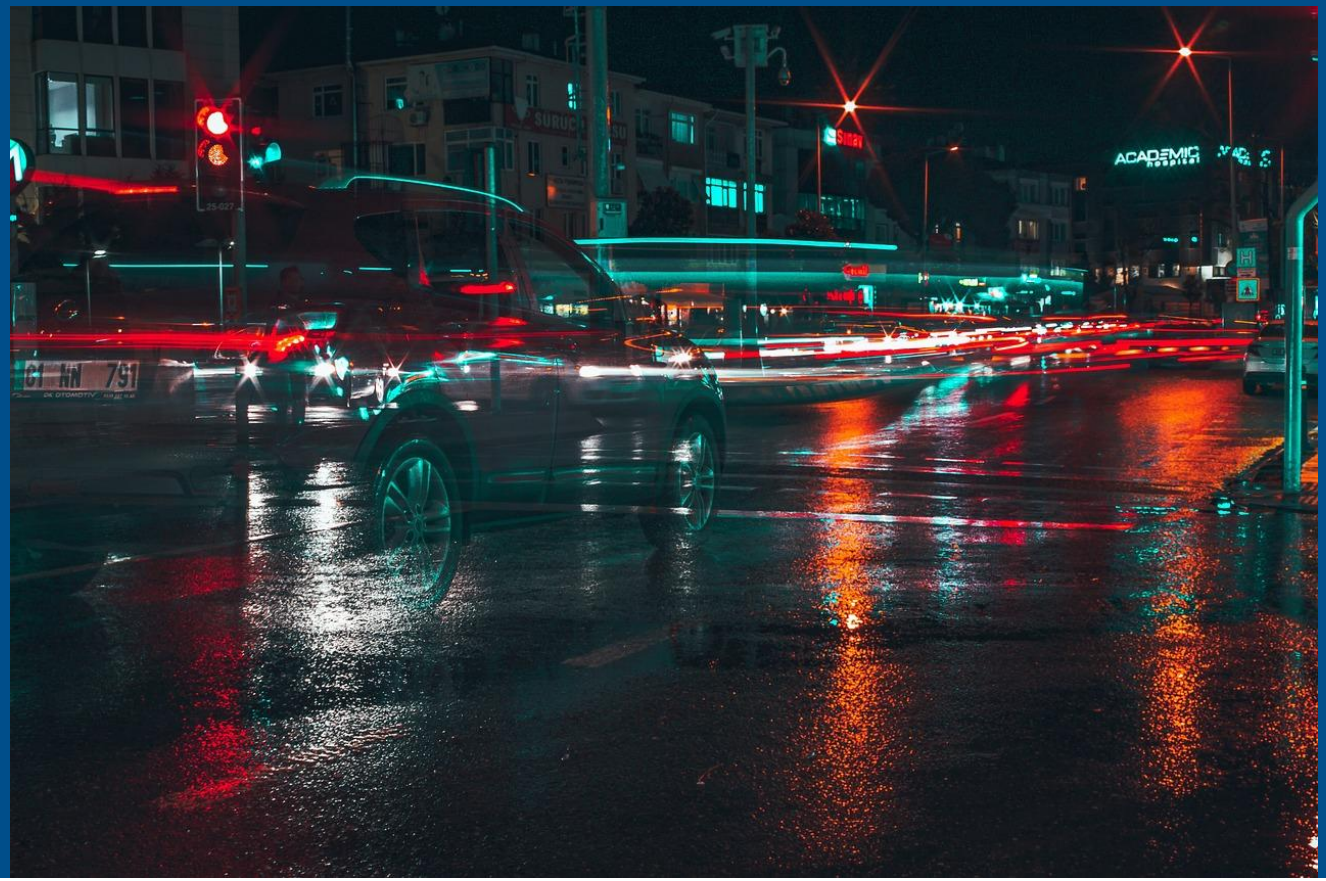
Glare Contributors in Automotive World

TECHNISCHE UNIVERSITÄT DARMSTADT

Adaptive Lichttechnische Systeme und Visuelle Verarbeitung

Dr.-Ing. Michael Hamm

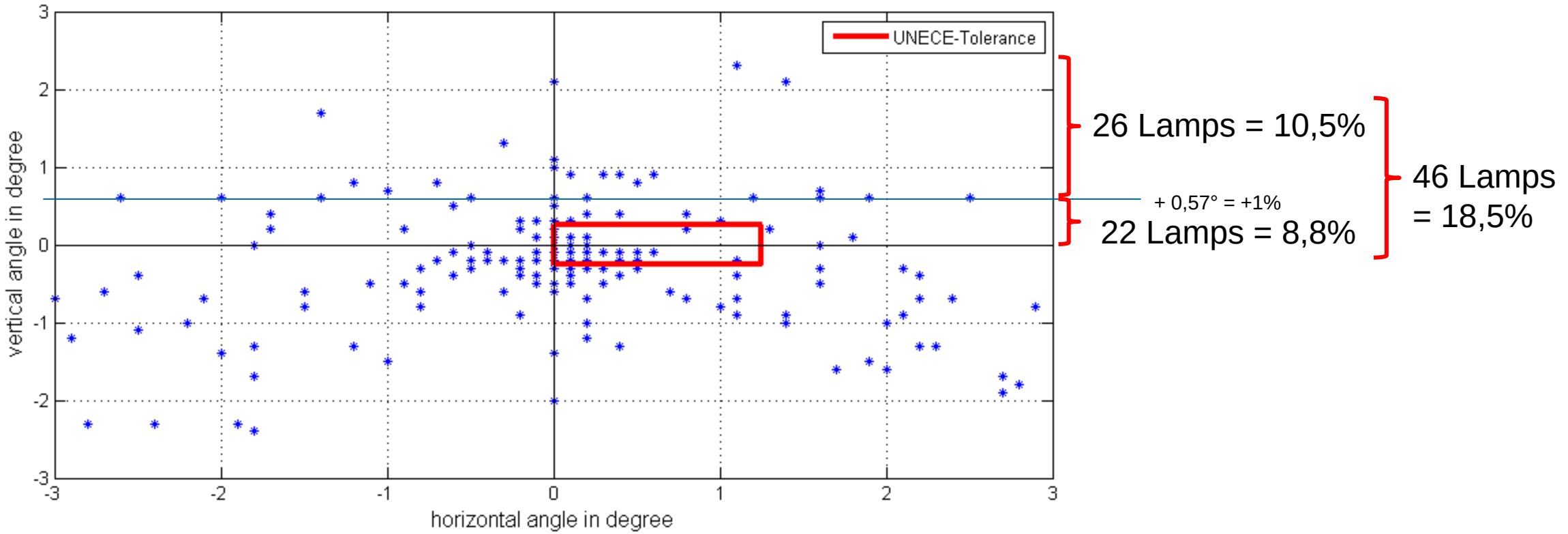


Content


1:
MISAIM AND CONTRIBUTORS
2:
ROAD AND VEHICLE STATISTICS
3:
RECENT CHANGE IN VEHICLE DESIGN

Part 1: Misaim and Contributors

2016 TU Darmstadt: Test of 124 cars = 248 Headlights

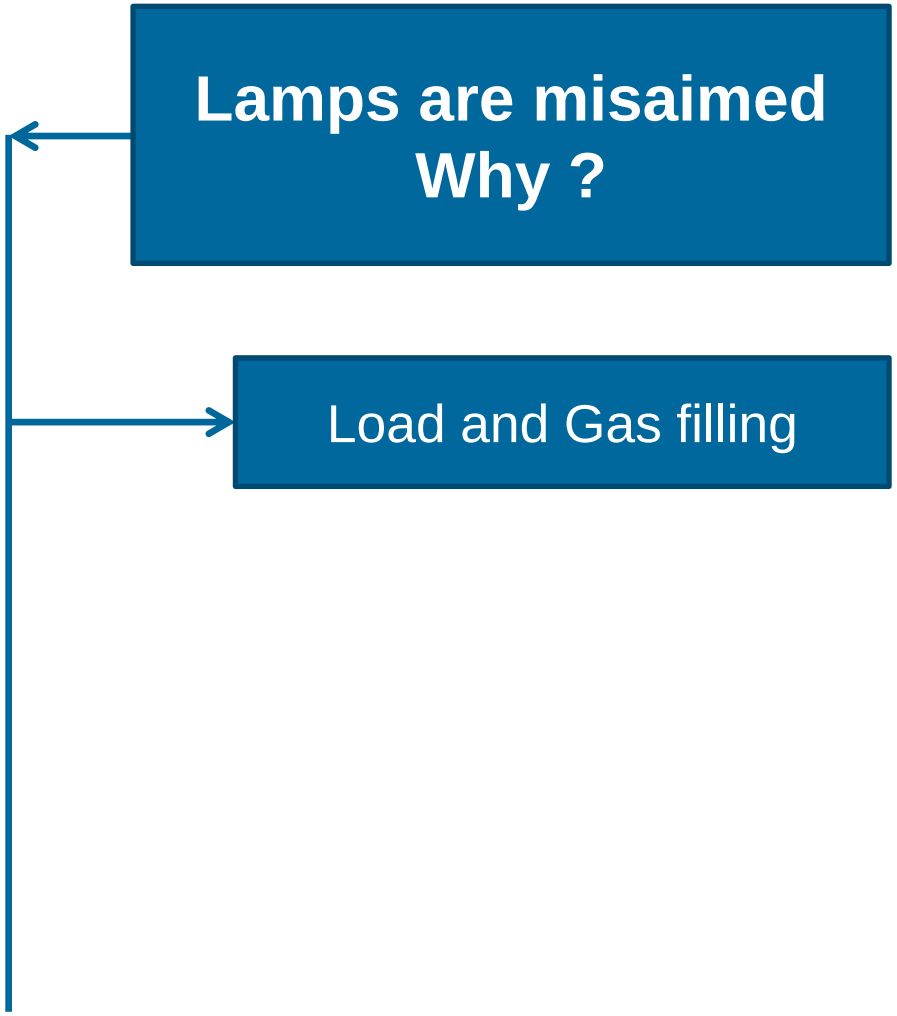


- Rental Cars
- Avg. age 3 months
- Avg. kilometers 10.500km

- ONLY 24 of 248 tested Headlights were in UNECE-Box
- 18,5% were higher than initial aim
- 10,5% were above the horizon

Source: TU Darmstadt, ALSVV, 2016 Field Test Headlamp Aiming

Part 1: MISAIM and Contributors
1.1. Load and Gas filling

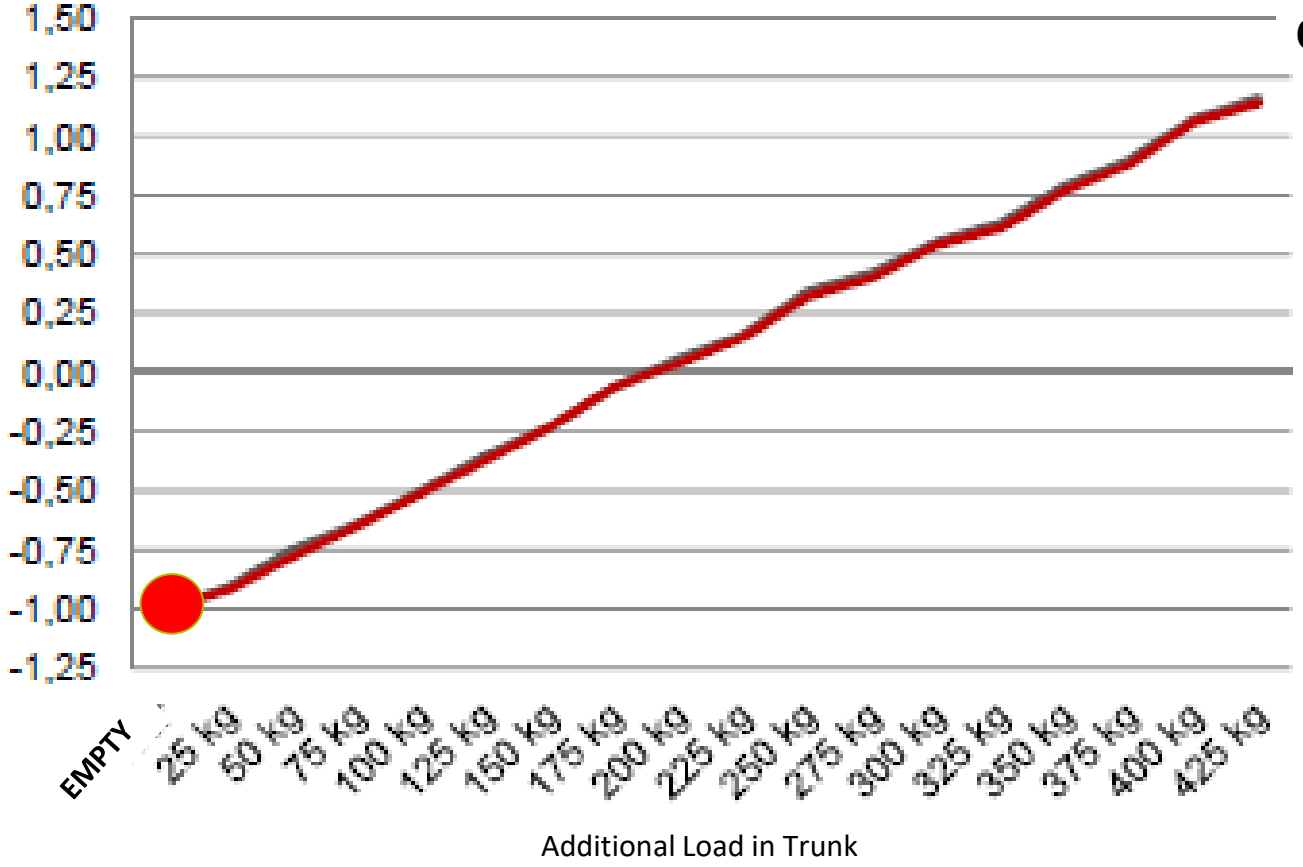


1.2. Load and Gas Filling

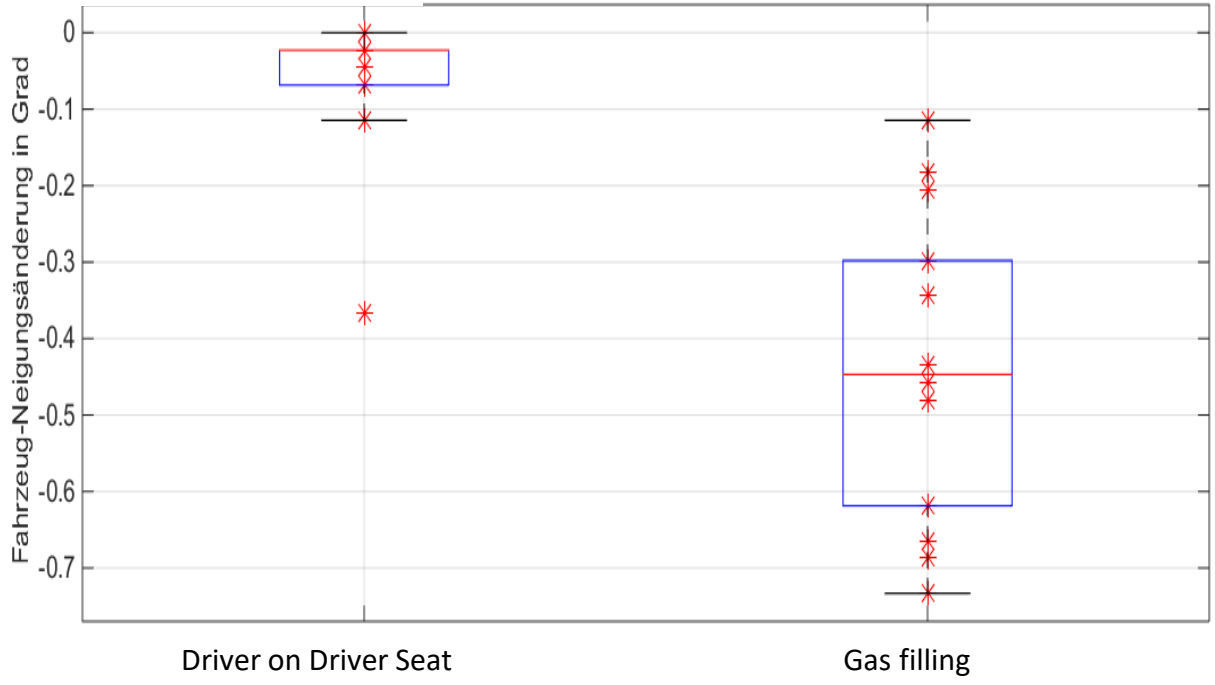
Source: Hamm, M., "Influence Parameters on Headlamp Performance in Rating Systems and Reality,"
SAE Technical Paper 2017-01-1359, 2017, https://doi.org/10.4271/2017-01-1359.

Source: Research Report FE 82.0611/2014: Anforderungen an die dynamische Leuchtweitenregulierung zur Vermeidung der Blendung entgegenkommender Verkehrsteilnehmer BASt 2019 ISBN 978-3-95606-469-2

Cutoff Position [%]



Cutoff Position [°]



Klettwitz Test 2014 (GTB, Co-funding LSS)

Source: B. Zydek: Blendungsbewertung von Kraftfahrzeugscheinwerfern unter dynamischen Bedingungen. PhD Thesis 2014

- 25 different vehicles (HAL; XEN, LED)
- 3 different Load Conditions (0%, 50%, 100%l)
- Resulting pitch angle varied from

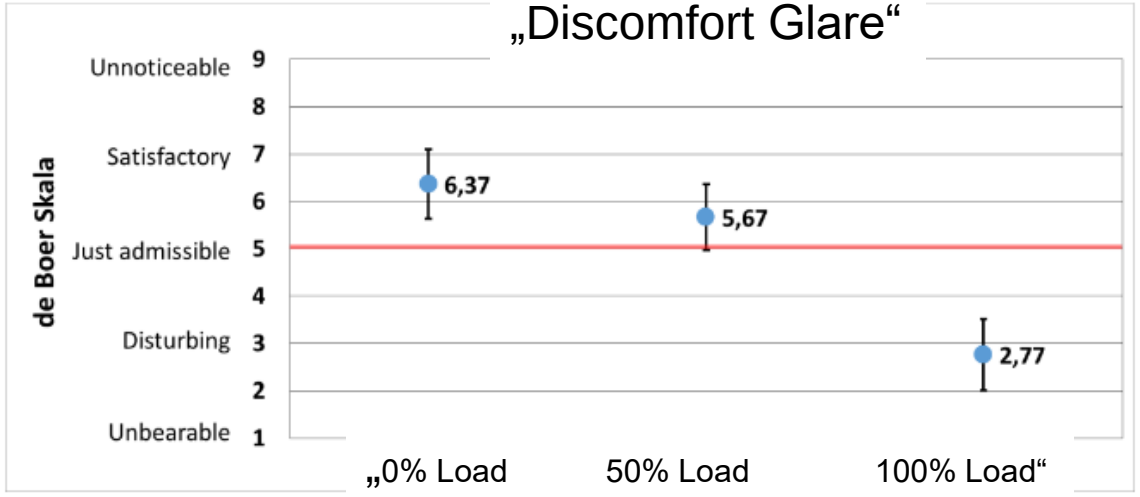


Abbildung 5.5: Mittlere psychologische Blendung in Abhängigkeit von der Beladung

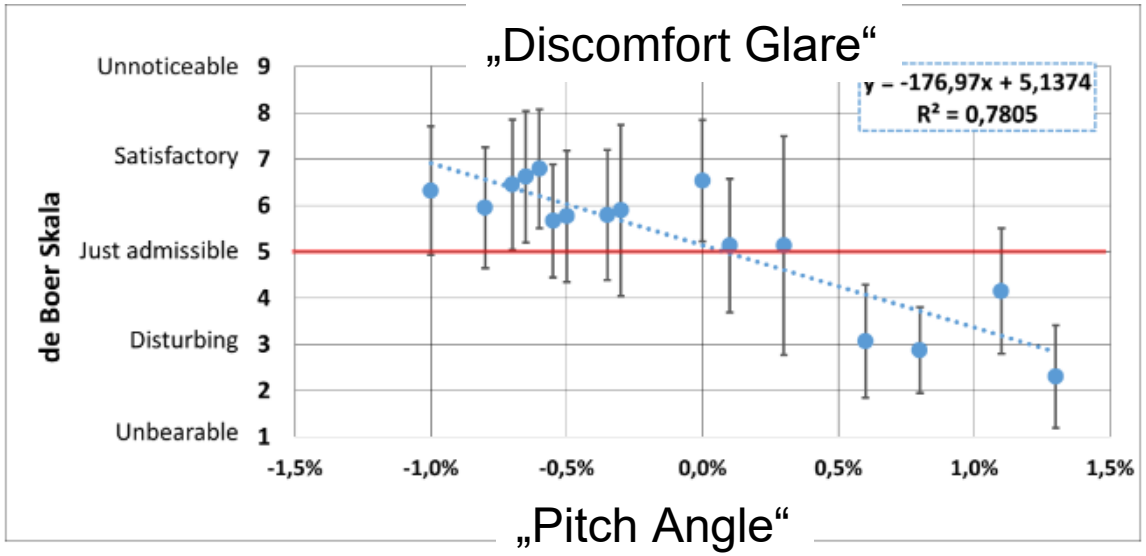


Abbildung 5.7: Mittlere psychologische Blendung in Abhängigkeit von dem Nickwinkel

Part 1: MISAIM and Contributors
1.1. Load and Gas filling

Lamps are misaimed
Why ?

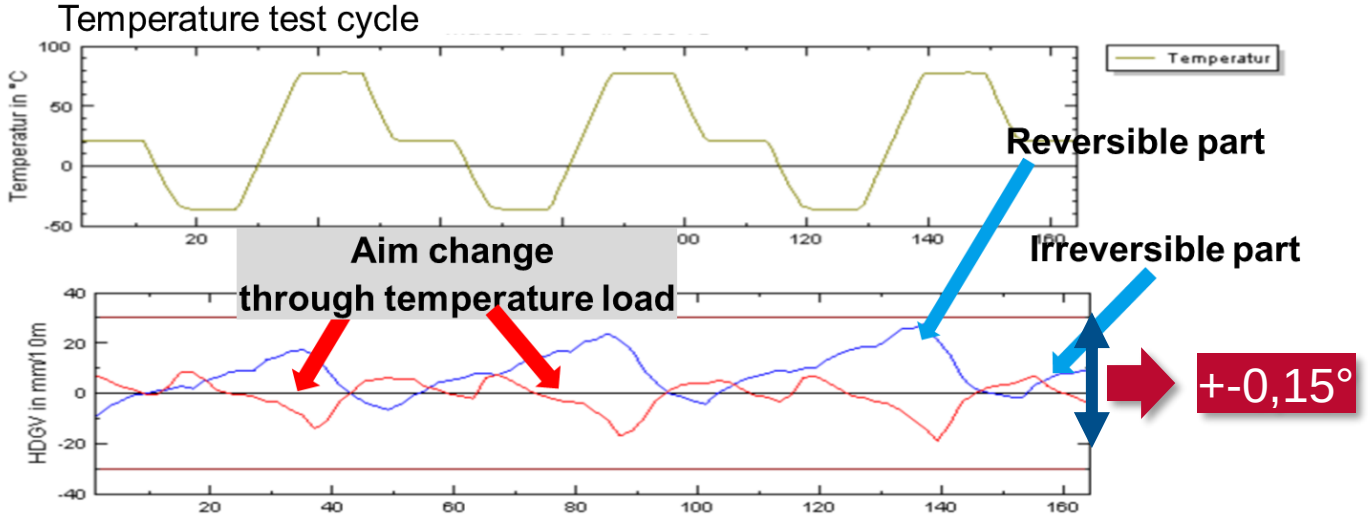
Load and Gas filling

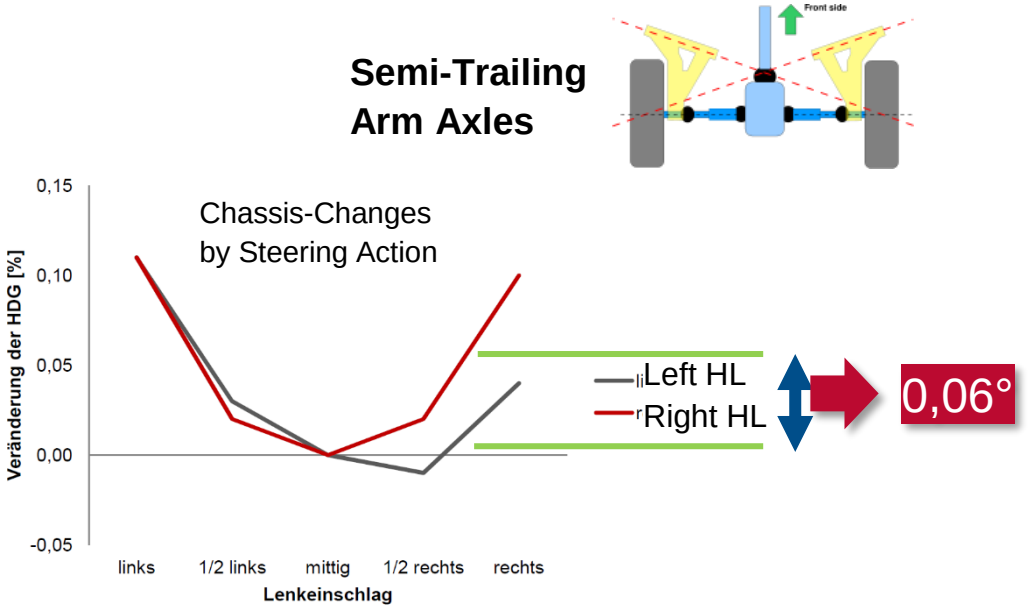
Potential Glare Contribution	Idea to control	Inforce
High	Static Levelling	✓

Part 1: MISAIM and Contributors

1.3. Other effects: Temperature, Slip-Stick, Tire Pressure, Semi-trailing Arm Axis

Source: Hamm, M., "Influence Parameters on Headlamp Performance in Rating Systems and Reality,"
SAE Technical Paper 2017-01-1359, 2017, https://doi.org/10.4271/2017-01-1359.



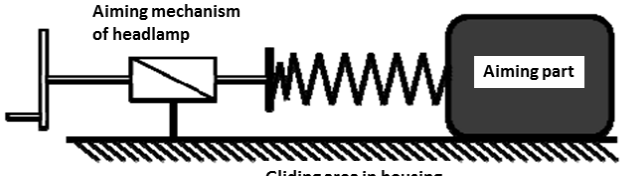


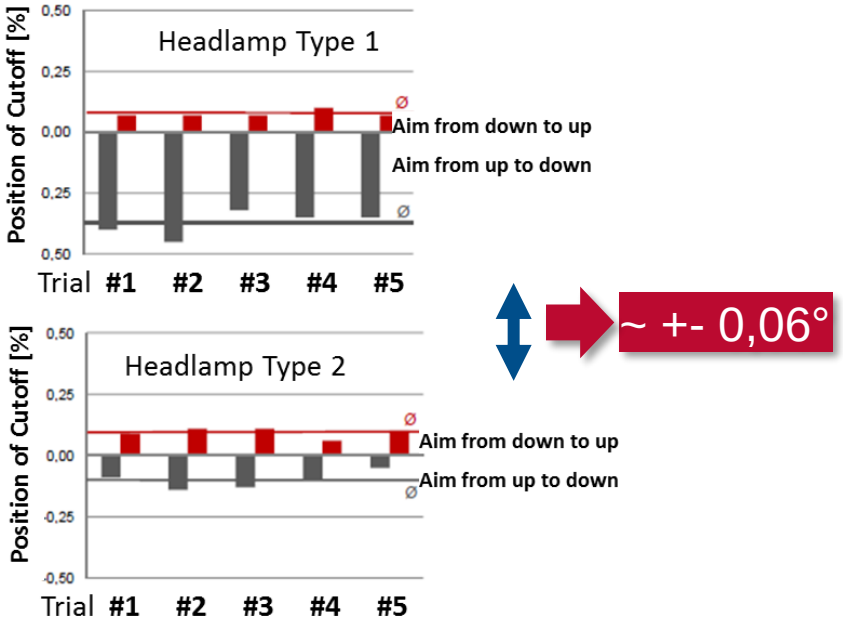
shock.

Part 1: MISAIM and Contributors

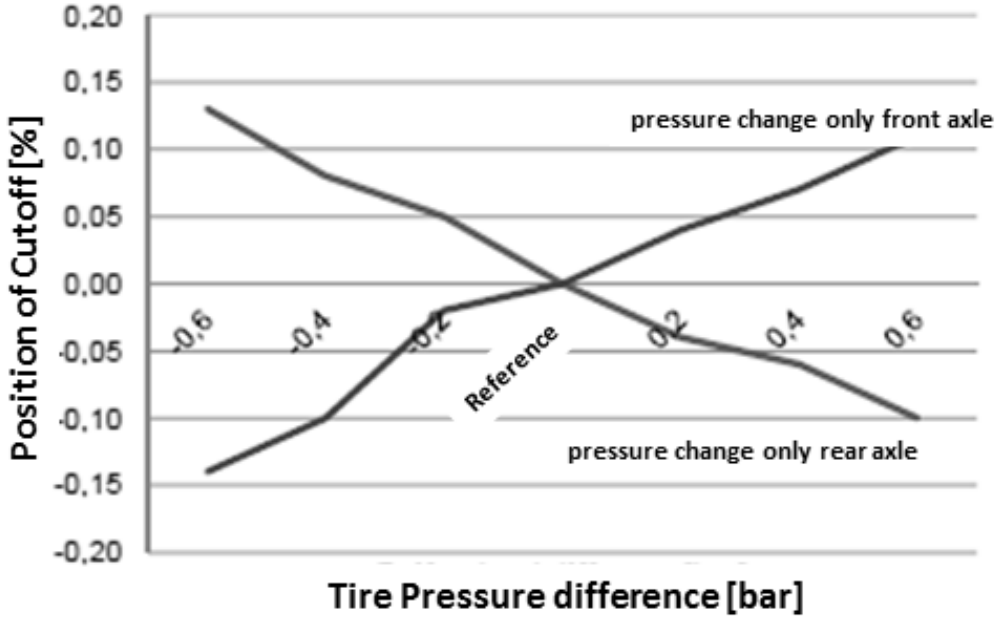
1.3. Other effects: Temperature, Slip-Stick, Tire Pressure, Semi-trailing Arm Axis

Source: Hamm, M., "Influence Parameters on Headlamp Performance in Rating Systems and Reality," SAE Technical Paper 2017-01-1359, 2017, https://doi.org/10.4271/2017-01-1359.





~ +- 0,06°



+- 0,1°

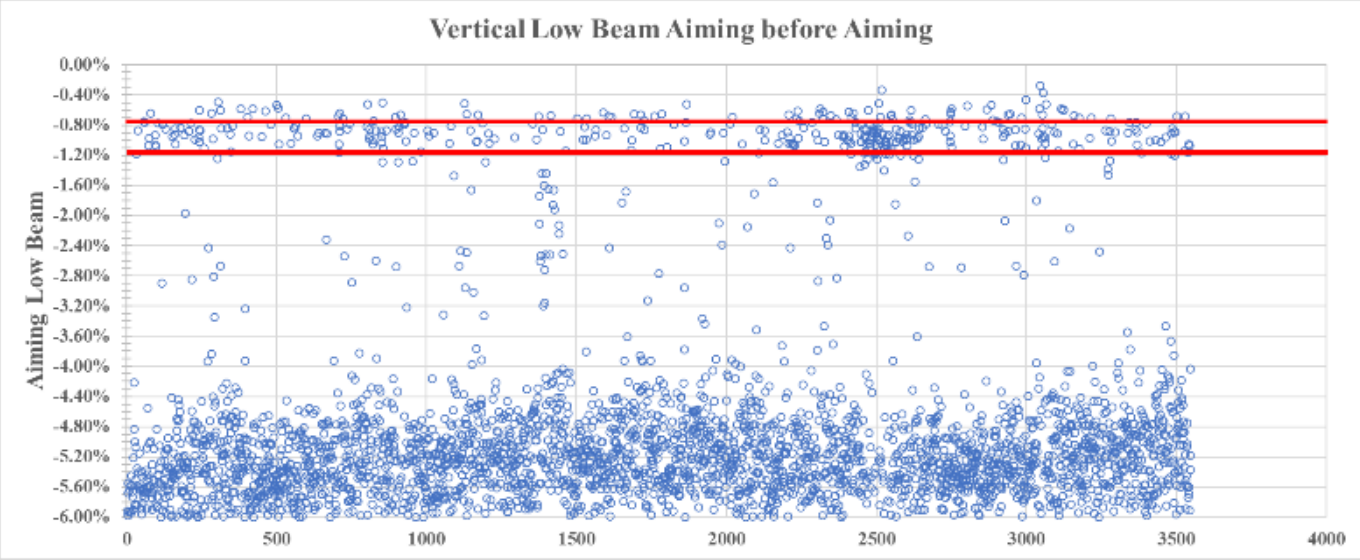
Part 1: MISAIM and Contributors
1.2. Other Effects, Temperature,Slip Stick, Tire Pressure..

Lamps are misaimed
Why ?

- Load and Gas filling
- Other Effects:Temperature, Slip-Stick, Tire Pressure, Semi-trailing Arm Axis…

Potential Glare Contribution	Idea to control	Inforce
High	Static Levelling	✓
Medium	Closed Aiming Loop	☒

Part 1: MISAIM and Contributors
1.3. Initial Aiming

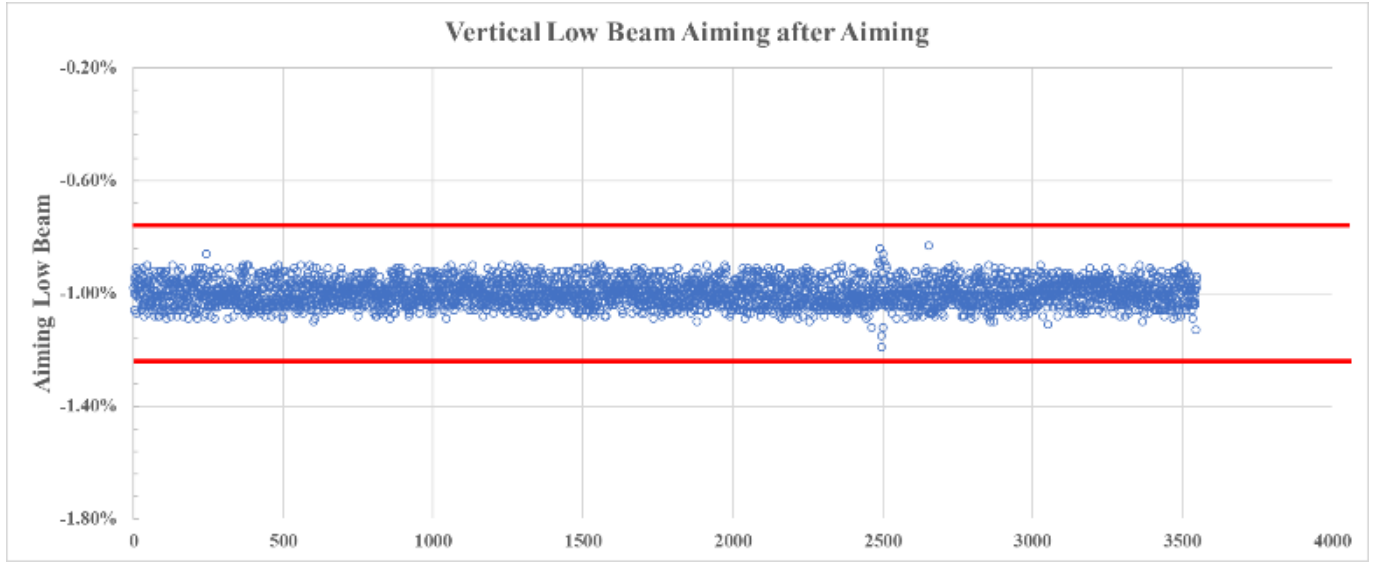


Source: The Aiming of Headlamps and Resulting Influences on Benchmarks and Road Users ISAL 2022, ISBN 978-3-8316-4953-2

Example of Aminig Station
Source: Dürr

- 3500 vehicles
- Aiming inside factory aiming station
- Initial aiming low in order to make only one direction move

Part 1: MISAIM and Contributors
1.3. Initial Aiming



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- Outgoing Lamps: Tolerance +- 0,2 % clearly kept.

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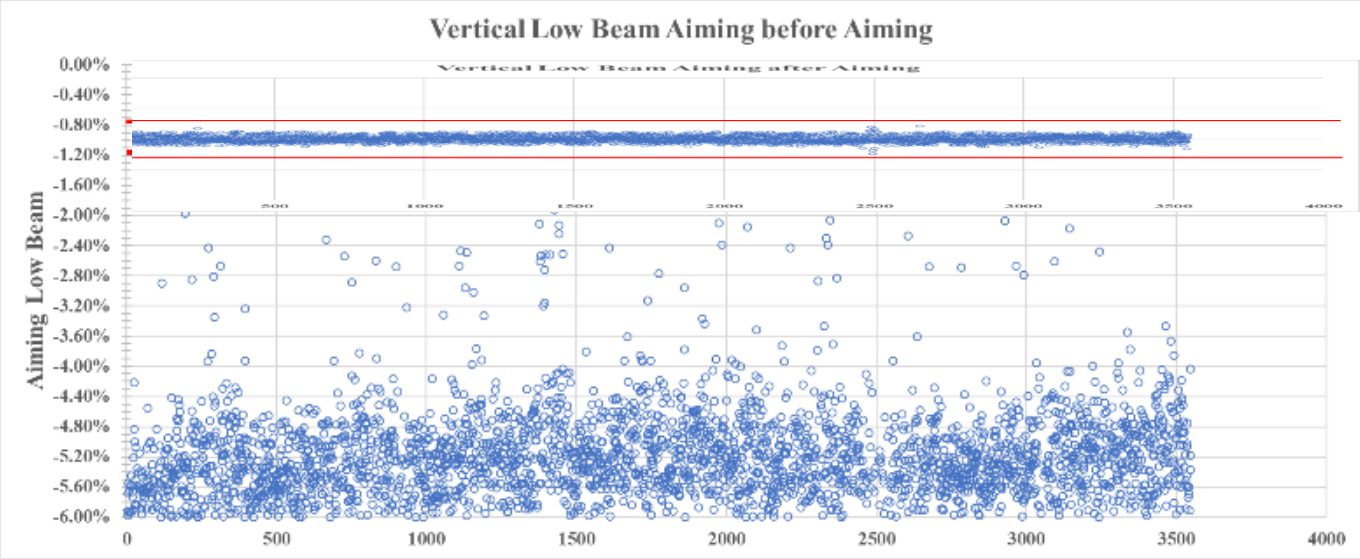
1.3. Initial Aiming



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Example of Aminig Station Source: Dürr

- 3500 vehicles
- Aiming inside factory aiming station
- Initial aiming low in order to make only one direction move

- Outgoing Lamps: Tolerance +- 0,2 % clearly kept.

→ There is one single place where tolerances are low and kept

Part 1: MISAIM and Contributors
1.3. Initial Aiming

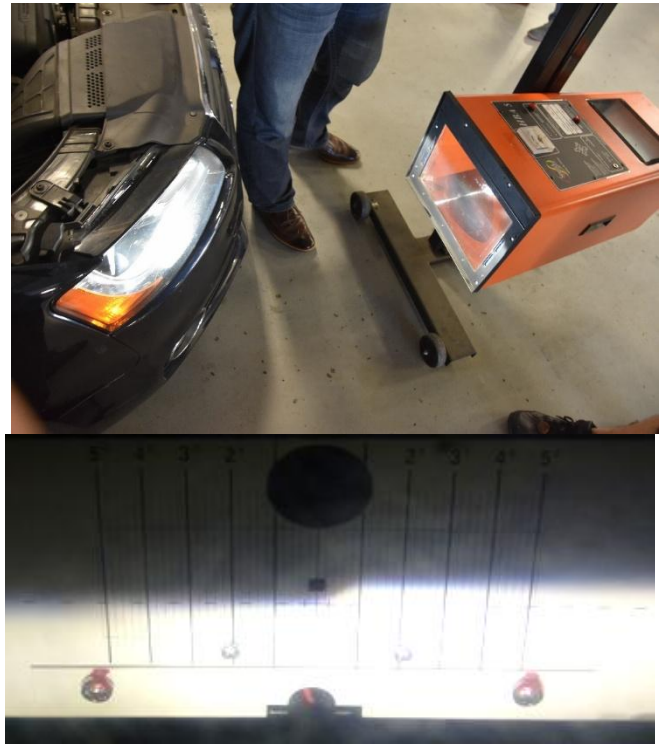
Lamps are misaimed
Why ?

- Load and Gas filling
- Other Effects:Temperature, Slip-Stick, Tire Pressure, Semi-trailing Arm Axis…
- Initial Aiming at Factory

Potential Glare Contribution	Idea to control	Inforce
High	Static Levelling	✓
Medium	Closed Aiming Loop	☒
High	Digital Aiming Station in Factory	✓

Part 1: MISAIM and Contributors
1.4. Aiming Devices, Methods and Garages

Analog Fresnel Station

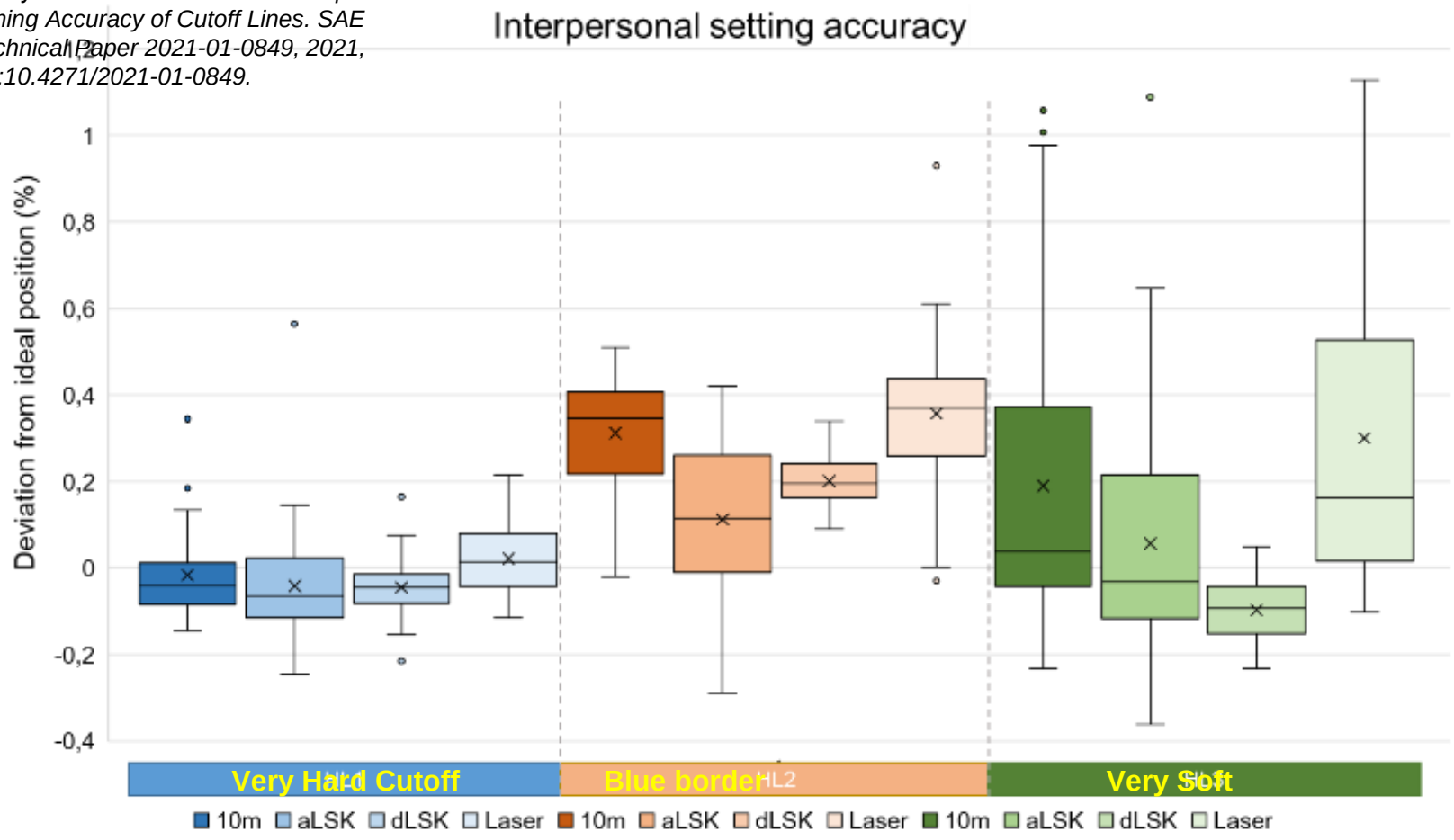


Digital Station

At a wall with or without line or laser

Part 1: MISAIM and Contributors
1.4. Aiming Devices, Methods and Garages

Source: Hinterwaelder, C. ;Hamm, M., "Analysis of Human Intra- and Interpersonal Aiming Accuracy of Cutoff Lines. SAE Technical Paper 2021-01-0849, 2021, doi:10.4271/2021-01-0849.



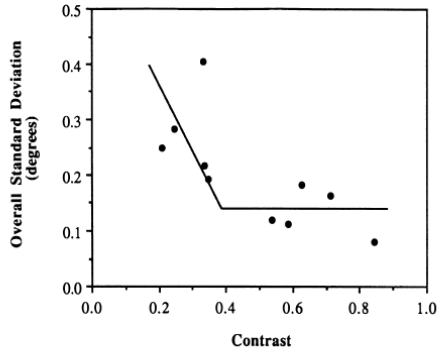
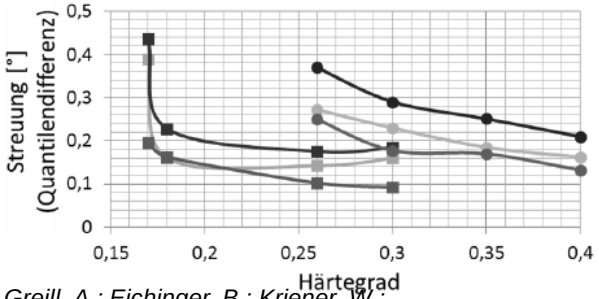


Figure 19. Relation between contrast and overall standard deviation of the aiming performance. The straight lines assume a critical value of contrast, above which contrast has no effect on performance.

Source: Sivak, M.; Flannagan, M.; et al.: Visual Aiming of European and U.S. Low Beam Headlamps Ann Arbor: UMTRI-91-24 Report, 1991.

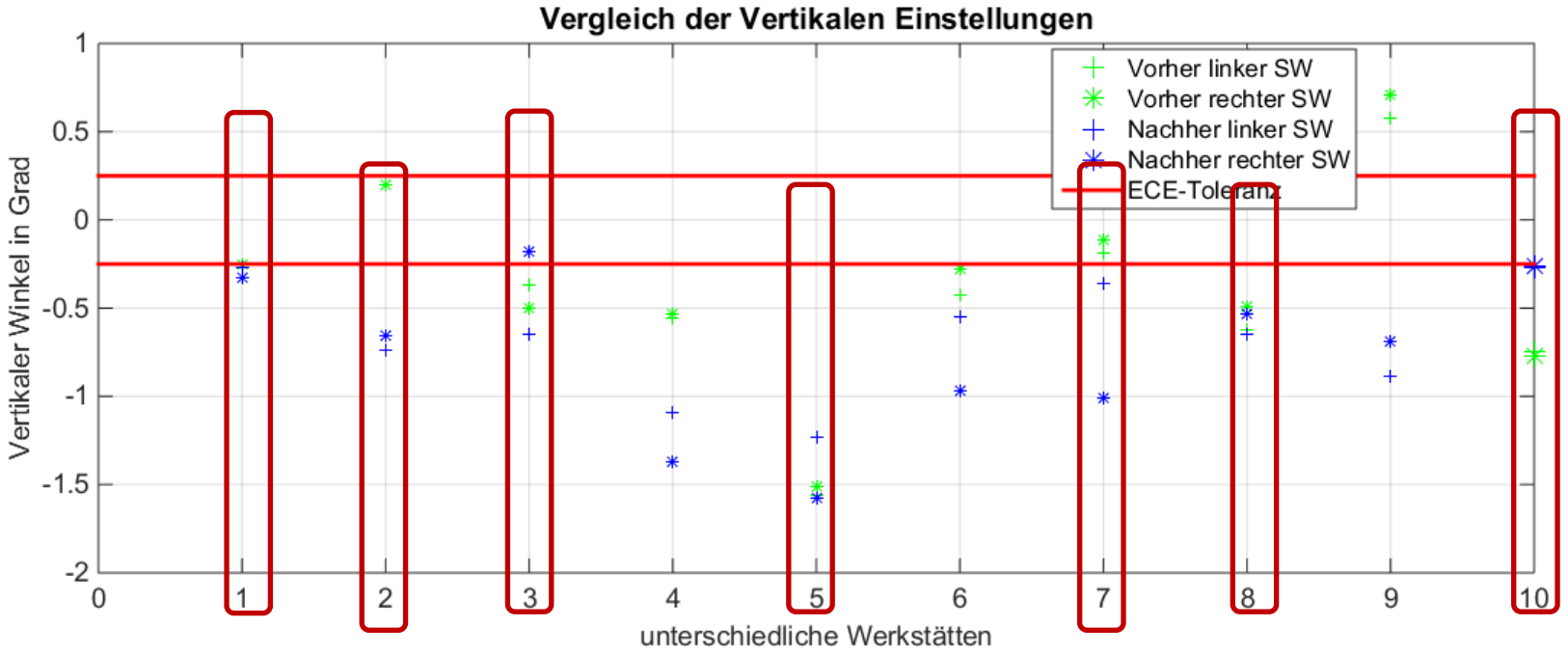


Source: Greill, A.; Eichinger, B.; Kriener, W.: Appropriate Accuracy of LED Headlight Adjustment Processes. In: VDI Optische Technologien in der Fahrzeugechnik, Karlsruhe: 2016.

Part 1: MISAIM and Contributors
1.4. Aiming Devices, Methods and Garages

Advertisement „Licht-Test 2024“

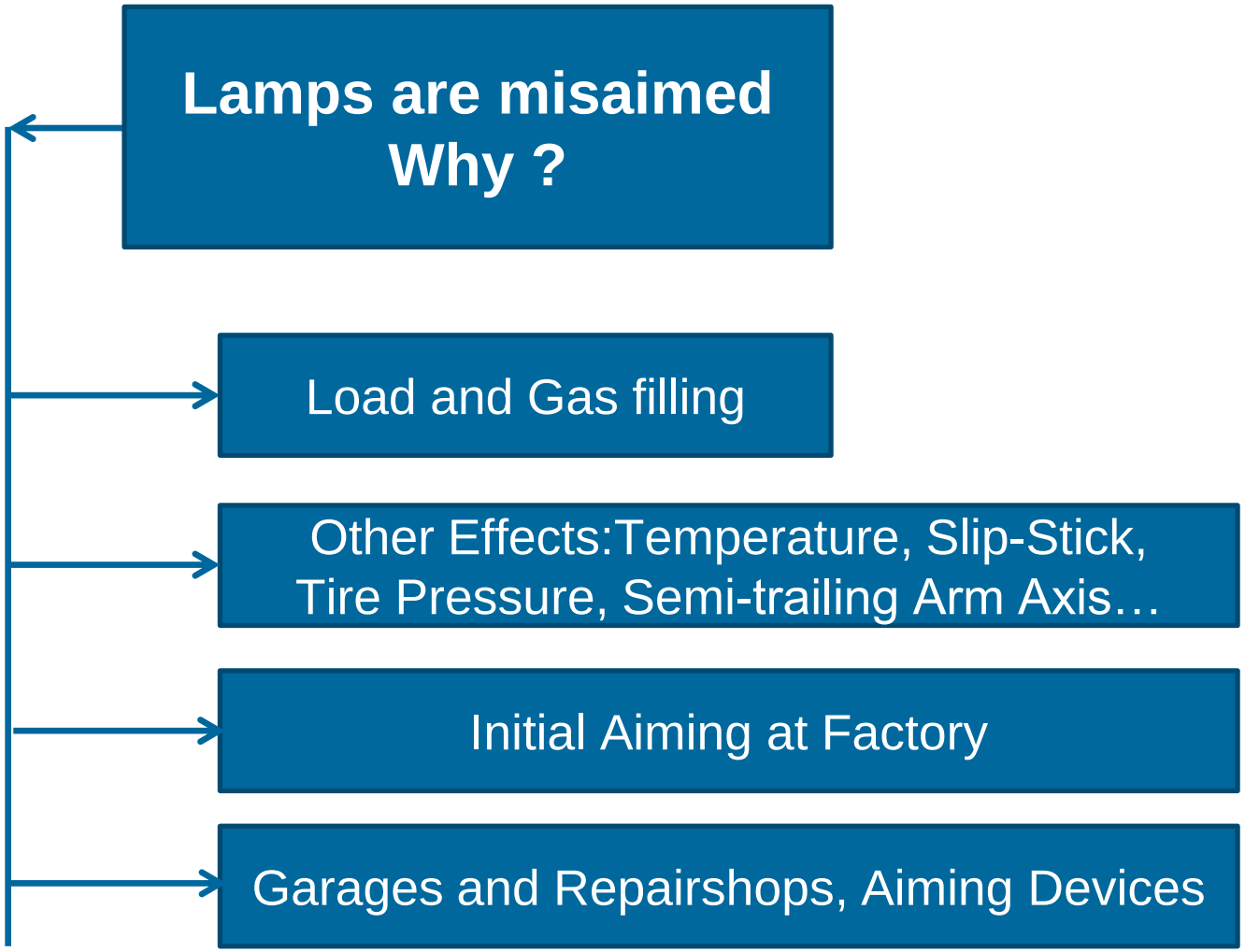
Reality (or even worse)



Source: Research Report FE 82.0611/2014: Anforderungen an die dynamische Leuchtweitenregulierung zur Vermeidung der Blendung entgegenkommender Verkehrsteilnehmer

- 3 Garages did aim into ECE box
- 2 Garages did just nothing
- 6 Garages did not aim left and right equal
- Even „good“ aim was replaced by bad one
- Not a single garage respected driver load and gas filling

Part 1: MISAIM and Contributors



Potential Glare Contribution	Idea to control	Inforce
High	Automatic Static Levelling	✓
Medium	Closed Loop Aiming	☒
High	Digital Aiming Station in Factory	✓
High	Eliminate Human Contribution Closed Loop Aiming	☒

Part 2: Road and Vehicle Statistics

Part 2: Road and Vehicle Statistics
2.1.1 Glare: Scientific Analysis of Car & Street Dynamics

	Max Aim deviation b_{max} /°
Car #1	-0,76 / +1,4
Car #2	-1,29 / +1,37
Car #3	-1,34 / +1,42
Car #4	-1,56 / +1,24
Car #5	-1,81 / +1,49
Car #6	-1,70 / +1,40
Car #7	-1,18 / +1,06
Avg.	**-1,38 / +1,34 ~ ± 24cm**
2 –Sigma	**~ ± 0,3°**

Statistics on 175km road in Germany
(city , country, motorway roads around Munich)
8 different cars from normal to stiff suspension
Analysis Method:
Laser Triangulation of car position relative to street

Part 2: Road and Vehicle Statistics
2.1.1 Glare: Scientific Analysis of Car & Street Dynamics

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	Max Aim deviation b_{max} /°
Car #1	-0,76 / +1,4
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Car #6	-1,70 / +1,40
Car #7	-1,18 / +1,06
2 Sigma	**-1,38 / +1,34** **~ ± 0,3°**

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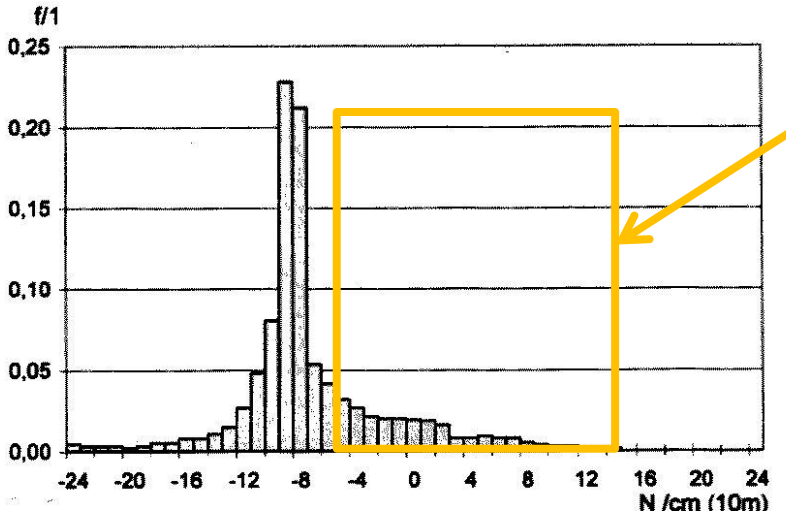
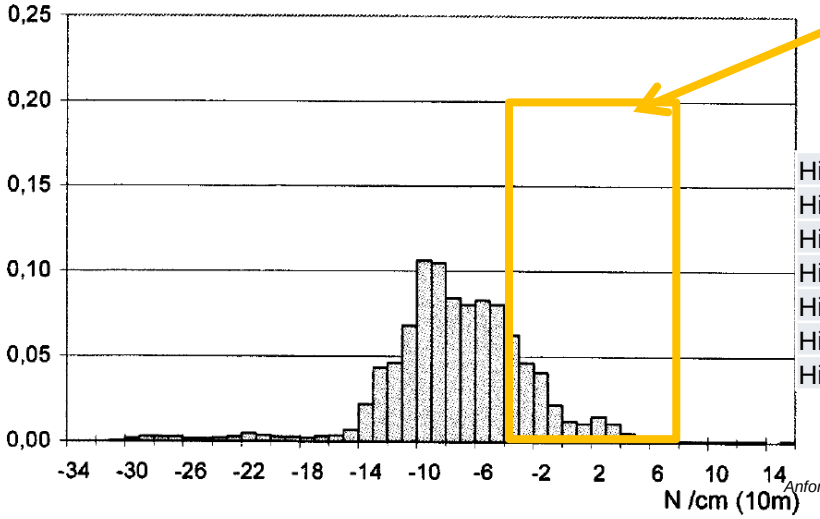


Pitch higher than -0,37°	28,2%
Pitch higher than -0,31°	24,7%
Pitch higher than -0,26°	20,9%
Pitch higher than -0,20°	17,9%
Pitch higher than -0,14°	15,9%
Pitch higher than -0,07°	13,9%
Pitch higher than 0,0°	11,9%



Higher than -0,6°	28,8%
Higher than -0,5°	21,3%
Higher than -0,4°	14,8%
Higher than -0,3°	10,3%
Higher than -0,2°	6,3%
Higher than -0,1°	4,3%
Higher than 0,0°	3,3%

ref: PhD Publication:
Technical University Darmstadt, Germany: , 1999 / W. Huhn:
Anforderungen an eine adaptive Lichtverteilung für Kraftfahrzeugscheinwerfer im Rahmen der ECE Regelungen, 1999

Part 2: Road and Vehicle Statistics
2.1.1 Glare: Scientific Analysis of Car & Street Dynamics

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Type	Axle Dist. / mm	Cutoff above Horizon / %		
		Inner-City	Country Road	Motorway
BMW 328i	2700	4,1	2,5	2,5
BMW 325tds	2700	3,7	1,5	1,4
BMW 523i	2830	5,8	5,6	4,2
BMW 740i	2930	3,3	2,2	2,1
BMW 750il	3070	3,6	2,3	3,6
Merc. C280	2690	10,9	7,7	4,5
VW Golf	2475	4,1	1,3	0,9
Fiat Punto	2420	2,7	1,5	0,5
Avg		4,78	2,86	2,46

Table 24: Wheelbase and temporal glare components (Cutoff above Horizon) in % of different vehicles.

ref: PhD Publication:
Technical University Darmstadt, Germany: , 1999 / W. Huhn:
Anforderungen an eine adaptive Lichtverteilung für Kraftfahrzeugscheinwerfer
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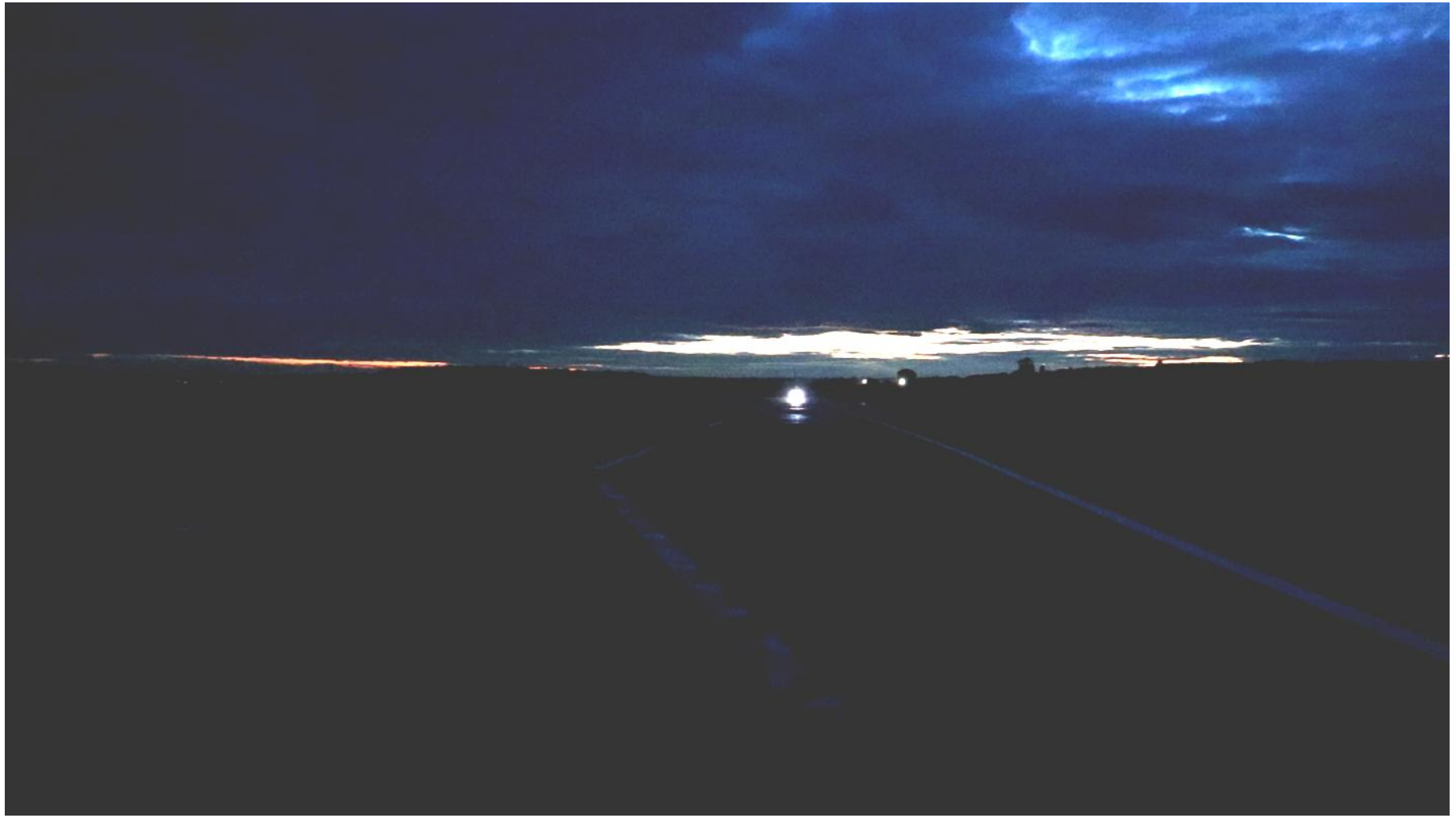
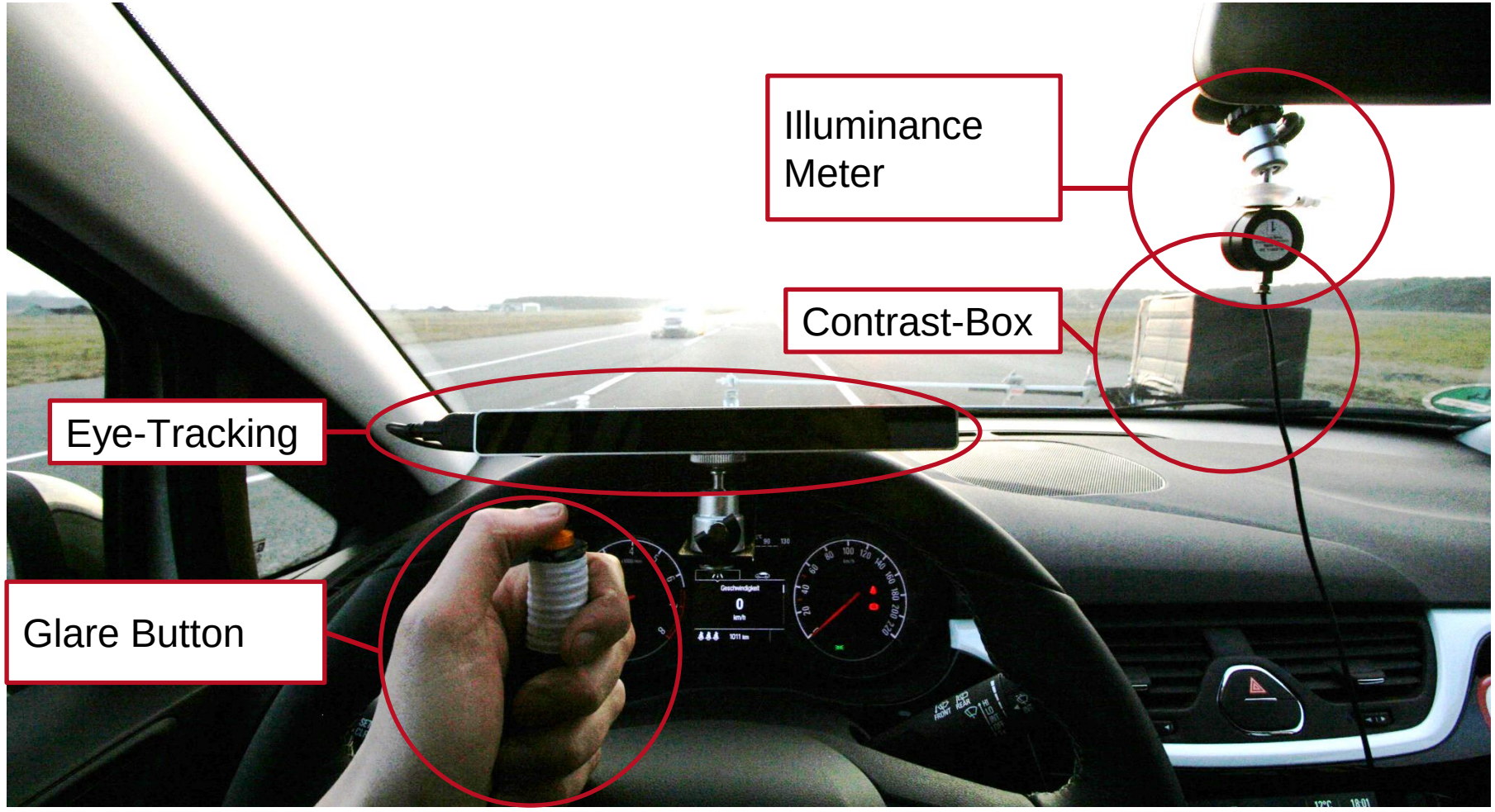
Part 2: Road and Vehicle Statistics
2.1.2 Glare: TU Darmstadt Dynamic Glare Experiments



Source: Research Report FE 82.0611/2014: Anforderungen an die dynamische Leuchtweitenregulierung zur Vermeidung der Blendung entgegenkommender Verkehrsteilnehmer

Part 2: Road and Vehicle Statistics
2.1.2 Glare: TU Darmstadt Dynamic Glare Experiments



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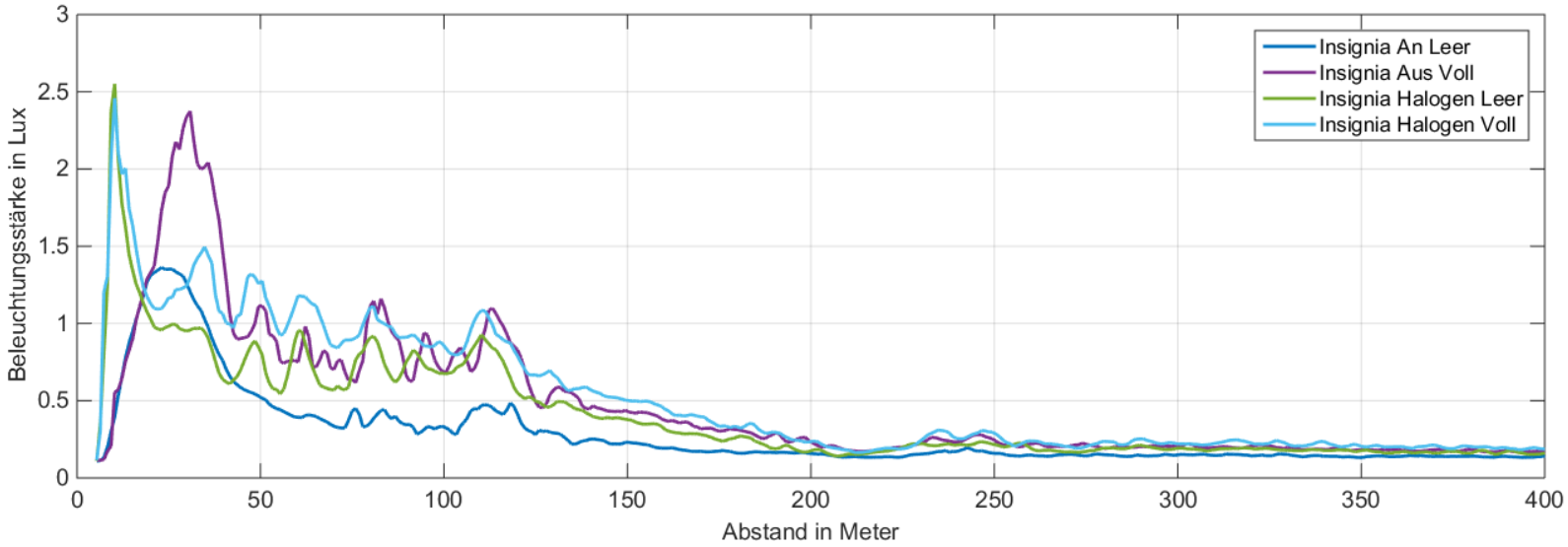
Part 2: Road and Vehicle Statistics
2.1.2 Glare: TU Darmstadt Dynamic Glare Experiments



De Boer Glare Rating

1:	Unbearable
2:	_
3:	Disturbing
4:	_
5:	Just acceptable
6:	_
7:	Satisfactory
8:	_
9:	Just noticeable

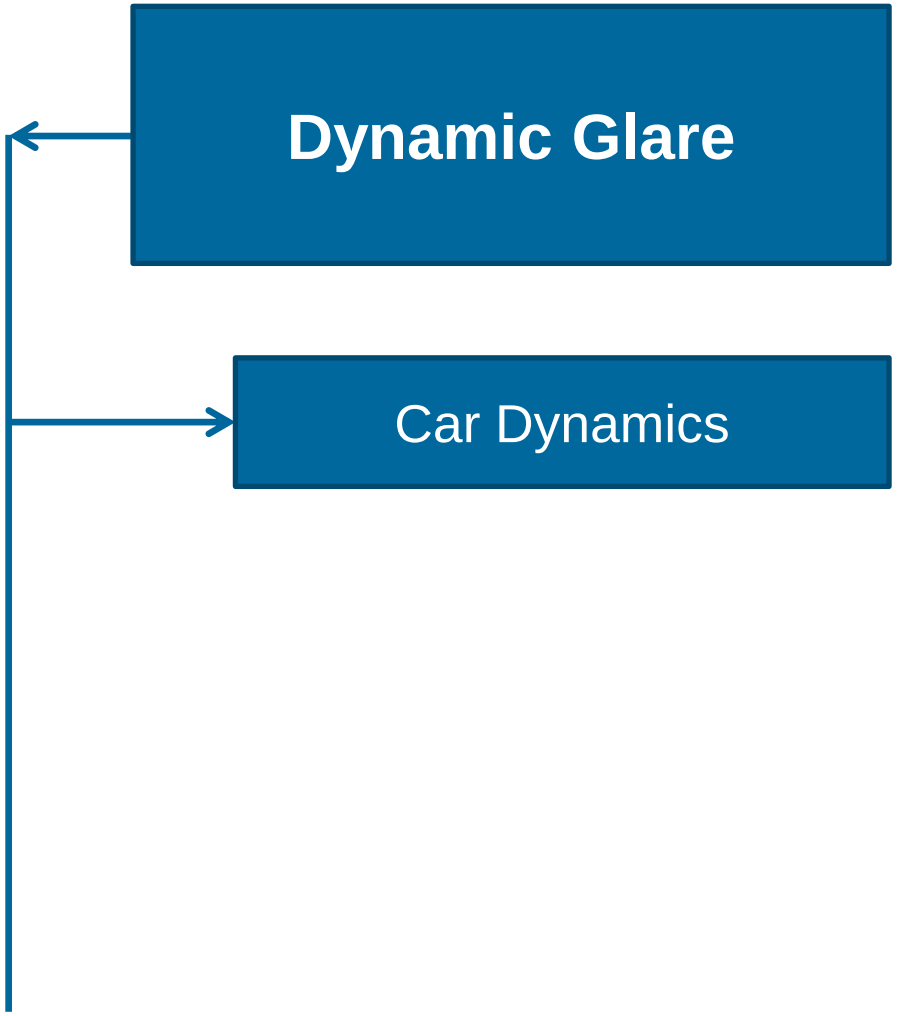
	Max E	H	deBoer
Xenon “empty” DynLevelling ON	1,4	6,8	5,5
Xenon “full loaded” DynLevelling OFF	2,4	10,0	3,5
Halogen “empty” No Levelling	2,6	9,6	3,9
Halogen “full loaded” No Levelling	2,5	12,4	2,8

„H“ = Exposure
- Relevant for GLARE

$$H_v = \int_{t_1}^{t_2} E_v(t)dt \rightarrow \mathrm{H}_{0\ to\ 400\ m}\left(80\,\frac{km}{h}\right) = \int_{0\ s}^{18\ s} E_v(t)dt$$

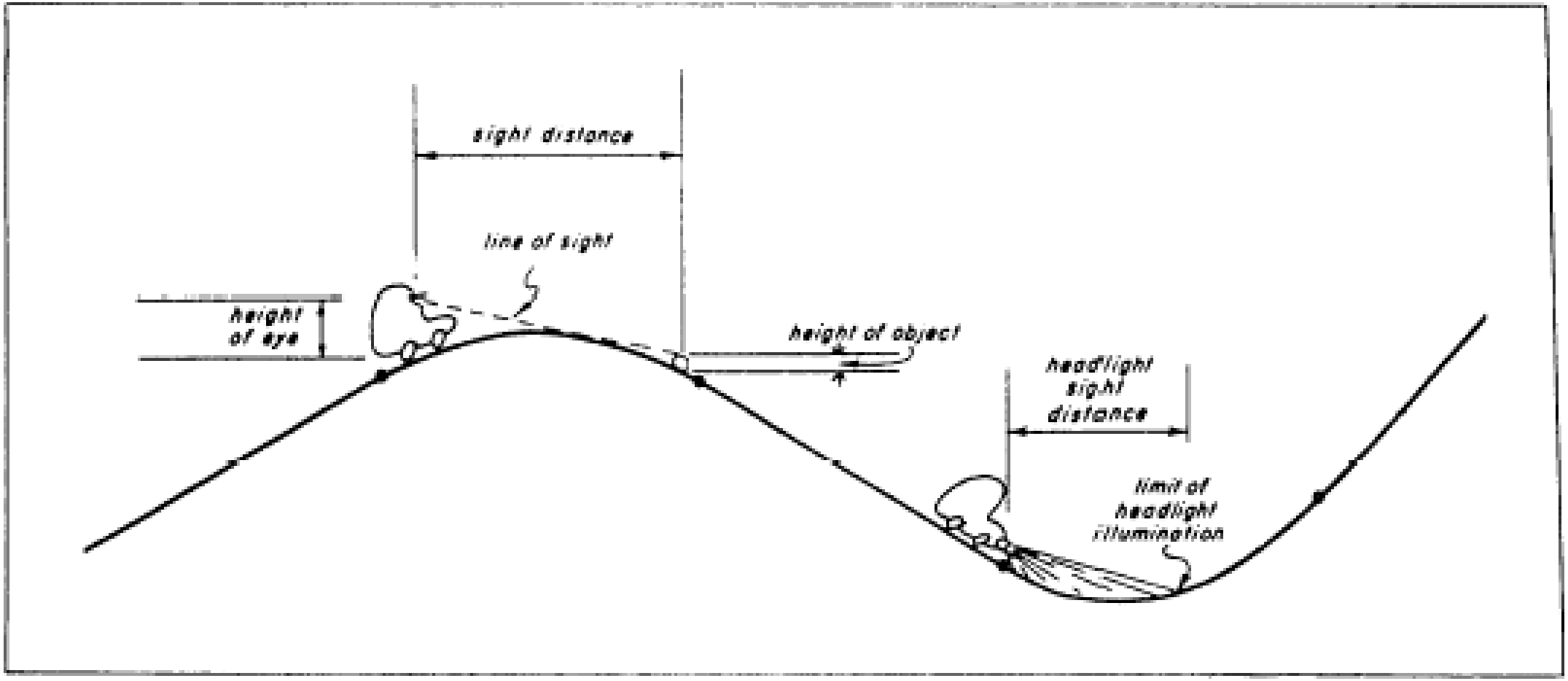
Source: Research Report FE 82.0611/2014: Anforderungen an die dynamische Leuchtweitenregulierung zur Vermeidung der Blendung entgegenkommender Verkehrsteilnehmer

Part 2: Road and Vehicle Statistics
2.1.2 Glare: Dynamic Glare Experiments

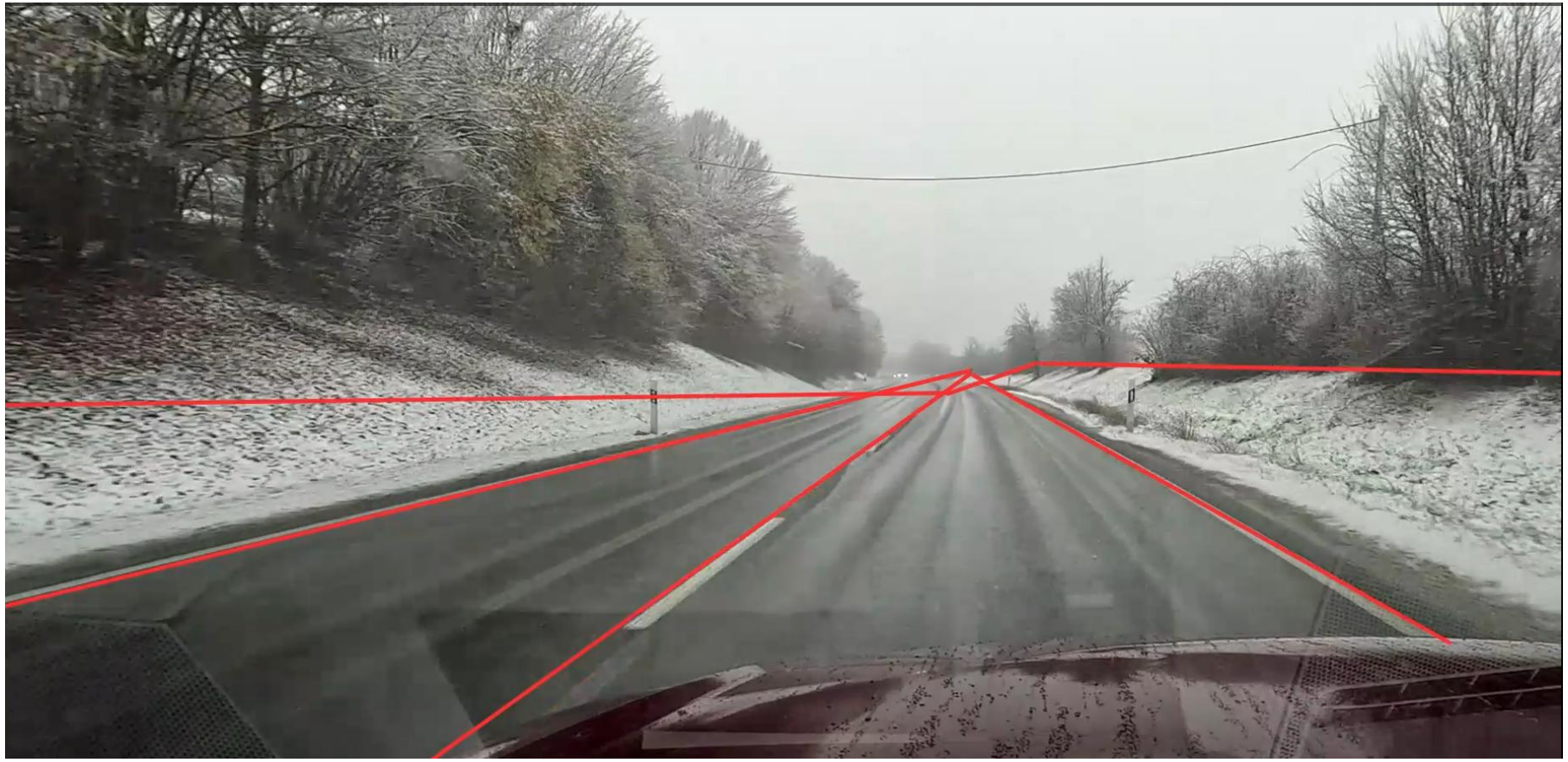


Potential Glare Contribution	Idea to control	Inforce
2.46%..4,78% of all times	**Automatic** Dynamic Levelling	☒

Part 2: Road and Vehicle Statistics
2.2 Road Geometry



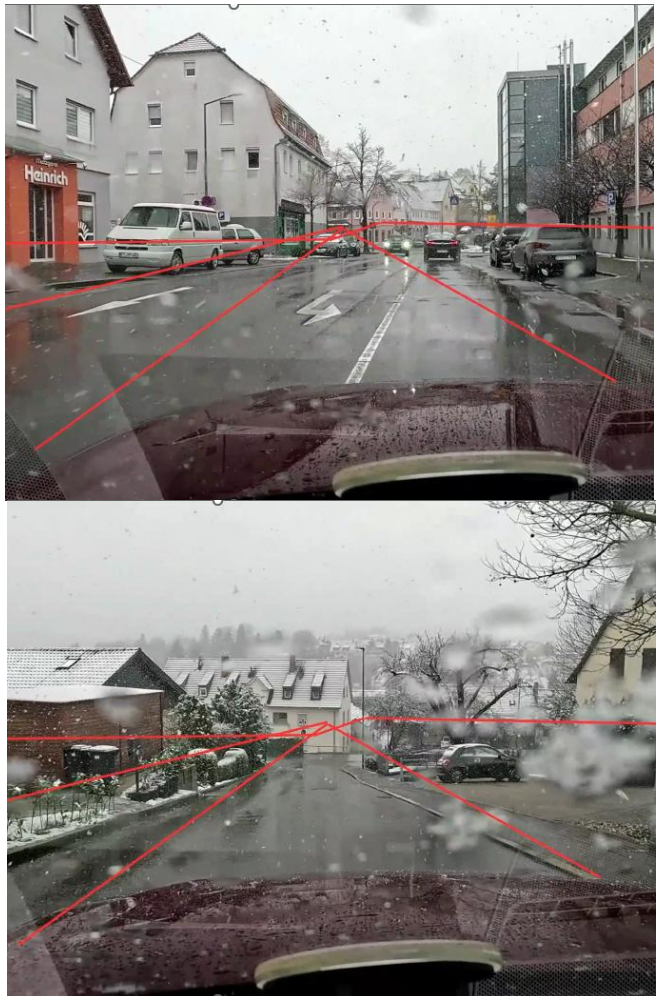
Part 2: Road and Vehicle Statistics
2.2 Road Geometry



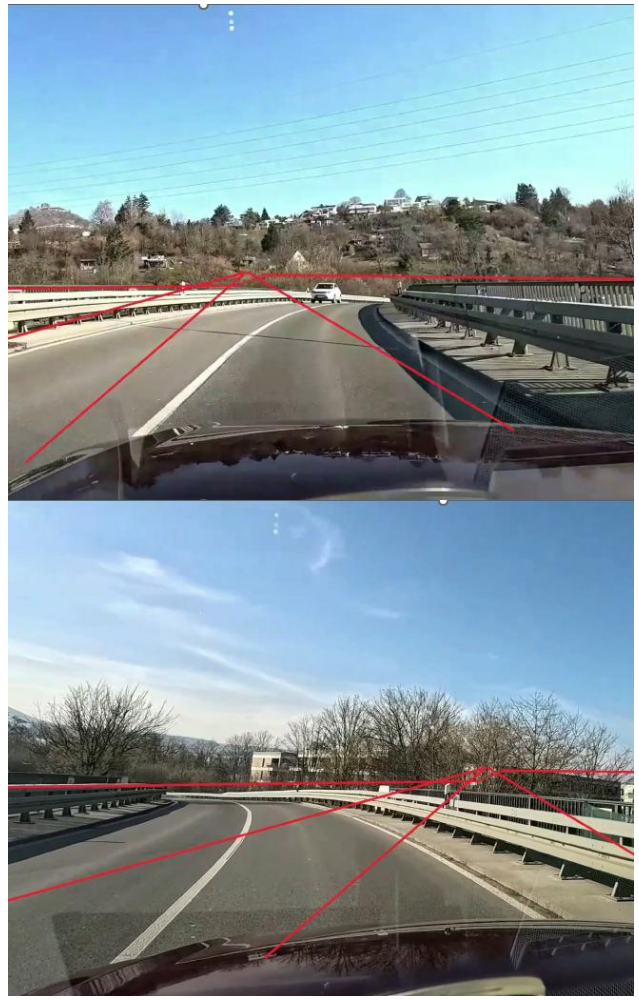
Calibration: „Quasi-flat“ ROAD

Part 2: Road and Vehicle Statistics
2.2 Road Geometry

Country Roads



Inner City

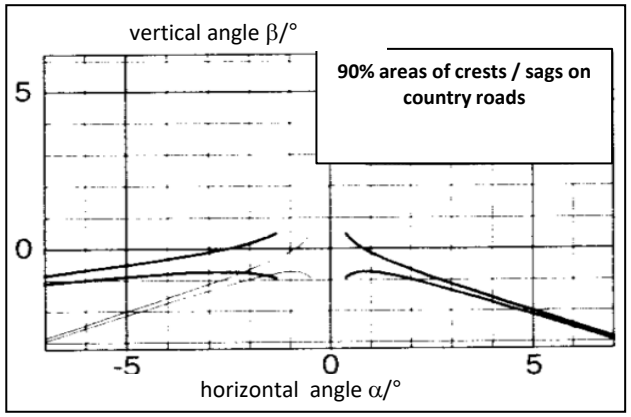


Bridges

Part 2: Road and Vehicle Statistics
2.2 Scientific Analysis Road Geometry

Statistics on 5.500 km road in Germany
(city , country, motorway roads)

Video analysis of car position relative to street
Object analysis 50 / 100m ahead

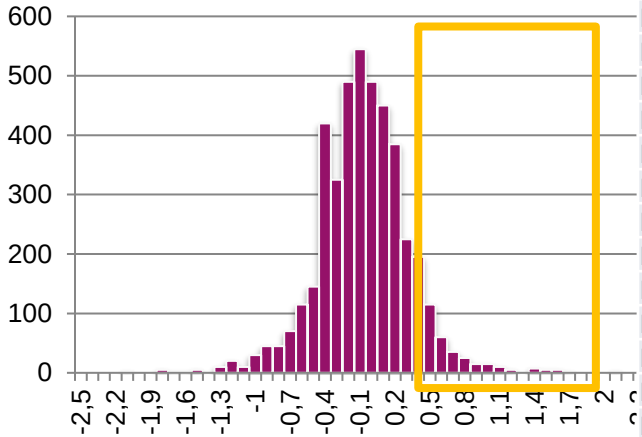


Glare Potential = **LEFT** Cut Off above horizon (β > 0°)

Summary:
Glare potential depending on road type and headlamp type

~ 3,8% …5,2%

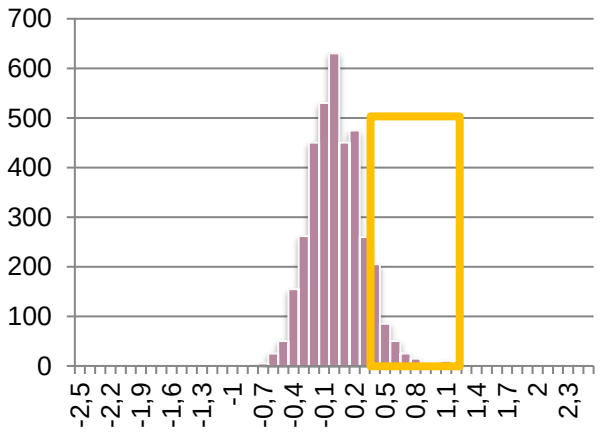
street geometry country road: vertical angle β/°



Higher than -0,6	94,30%
Higher than -0,5	91,65%
Higher than -0,4	88,30%
Higher than -0,3	78,61%
Higher than -0,2	71,11%
Higher than -0,1	59,81%
Higher than 0	47,23%
Higher than 0,1	35,93%
Higher than 0,2	25,54%
Higher than 0,3	16,66%
Higher than 0,4	11,47%
Higher than 0,5	6,97%
Higher than 0,6	4,31%

Glare potential

street geometry motorway: vertical angle β/°



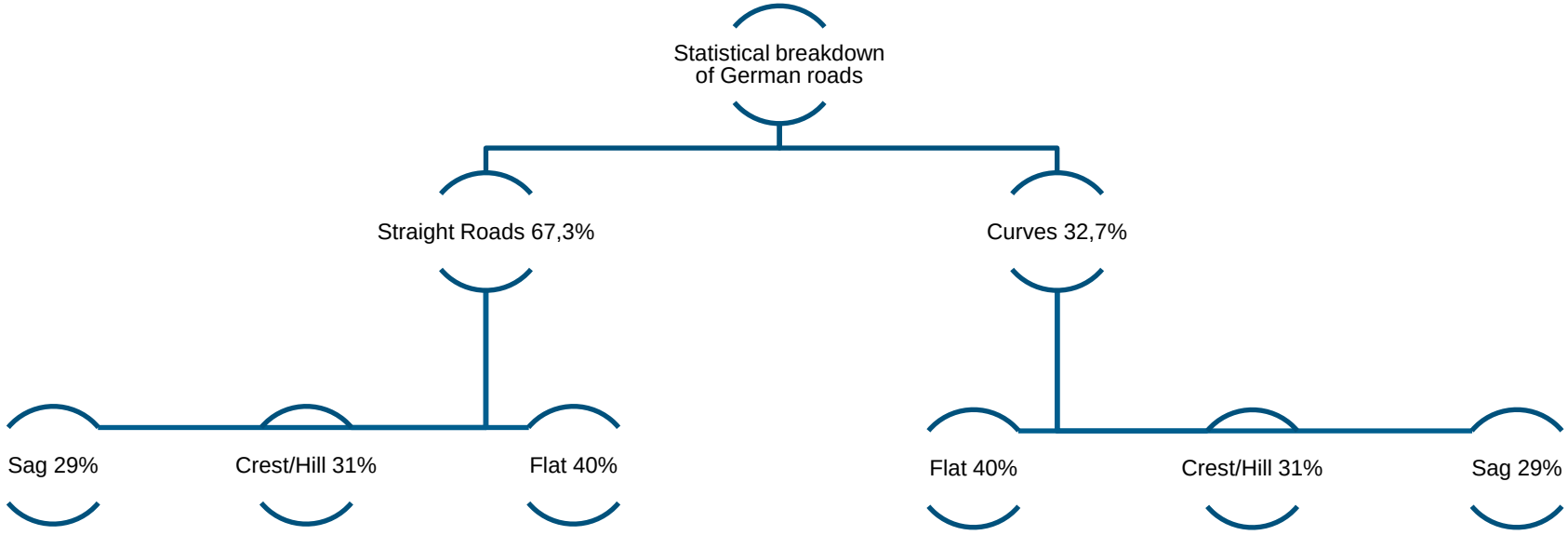
Higher than -0,6	99,86%
Higher than -0,5	99,19%
Higher than -0,4	97,83%
Higher than -0,3	93,64%
Higher than -0,2	86,55%
Higher than -0,1	74,36%
Higher than 0	60,02%
Higher than 0,1	42,96%
Higher than 0,2	30,78%
Higher than 0,3	17,92%
Higher than 0,4	10,88%
Higher than 0,5	5,33%
Higher than 0,6	3,03%

Glare potential

ref: PhD Publication:
Technical University Darmstadt, Germany: June 14, 1995 / J. Damasky: Lichttechnische Anforderungen an Kraftfahrzeugscheinwerfer, 1995

Part 2: Road and Vehicle Statistics
2.2 Scientific Analysis TU Darmstadt

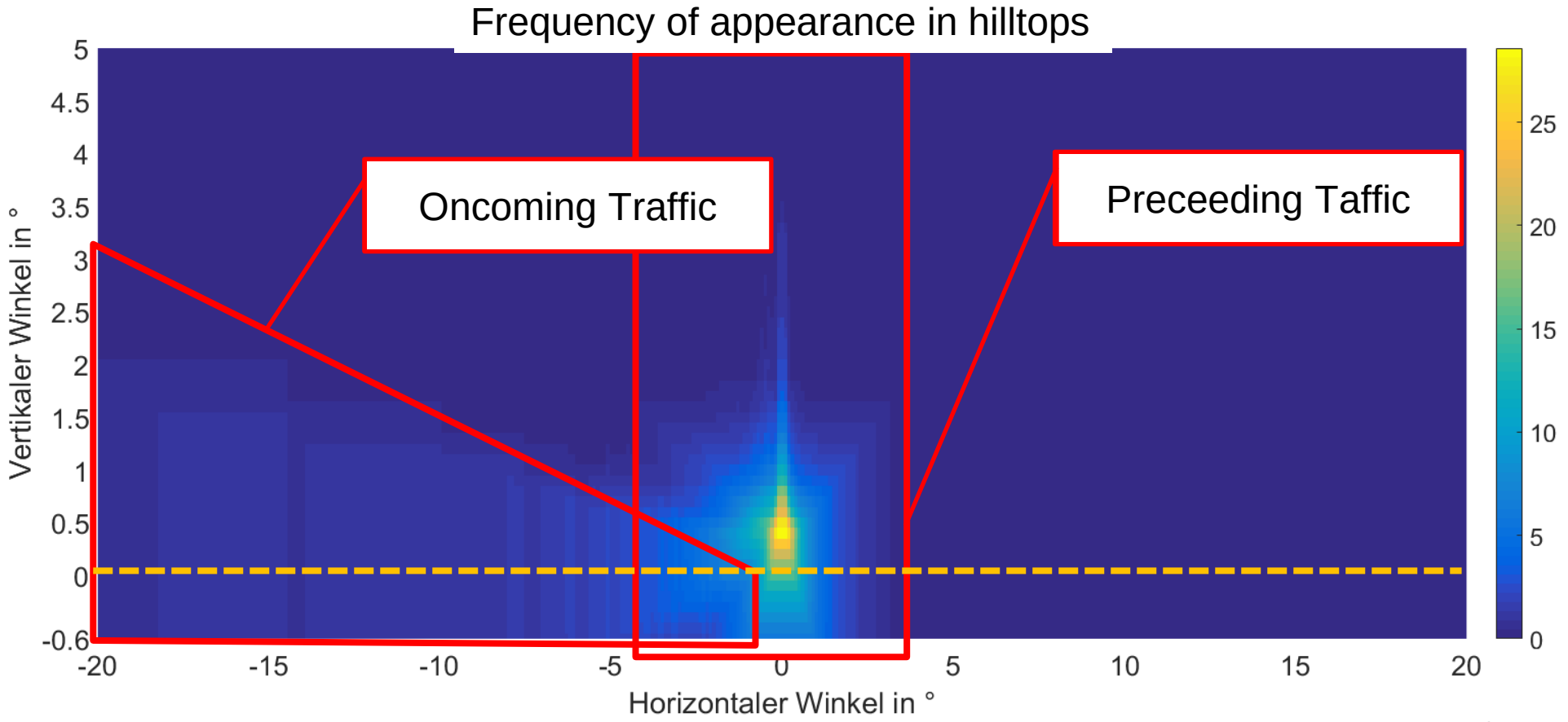
Statistical frequency of all route conditions on German country & city streets and highways



→ 60% of all streets are either sags or crest/hilltops

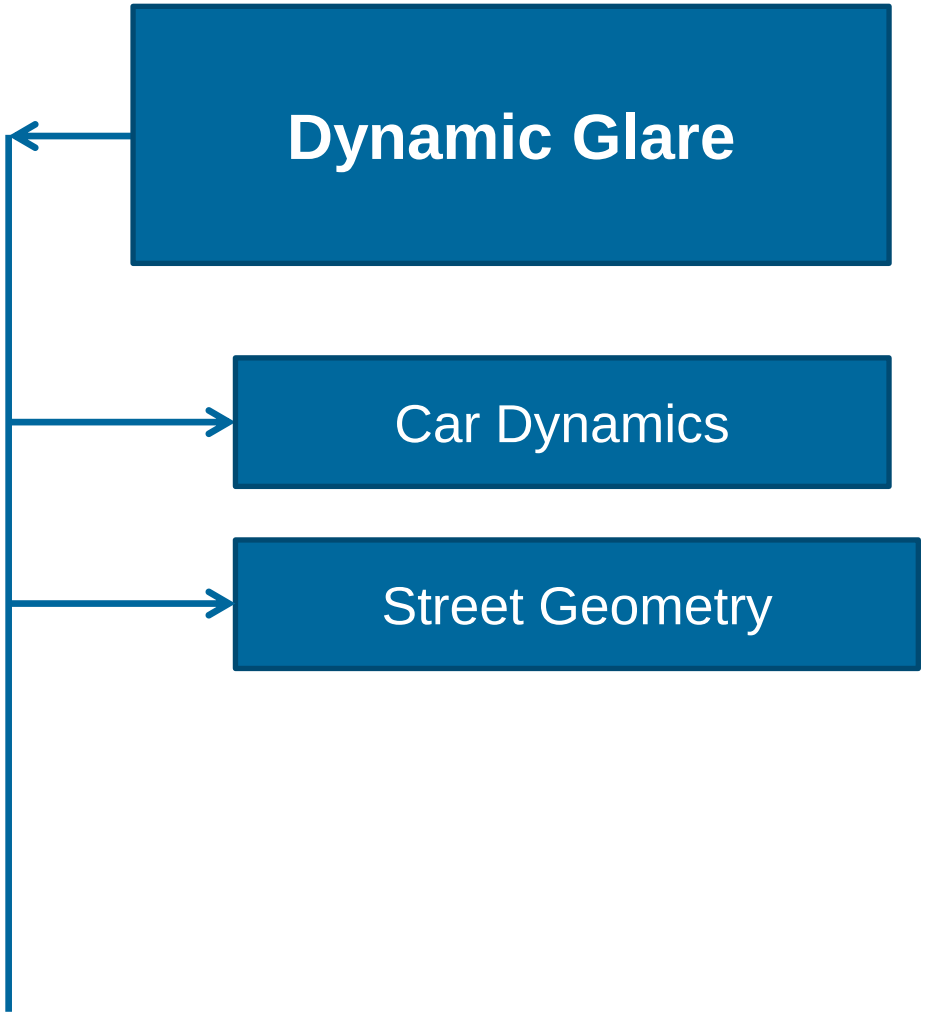
Source: Research Report FE 82.0611/2014: Anforderungen an die dynamische Leuchtweitenregulierung zur Vermeidung der Blendung entgegenkommender Verkehrsteilnehmer

Part 2: Road and Vehicle Statistics
2.2 Scientific Analysis TU Darmstadt



Source: Research Report FE 82.0611/2014: Anforderungen an die dynamische Leuchtweitenregulierung zur Vermeidung der Blendung entgegenkommender Verkehrsteilnehmer

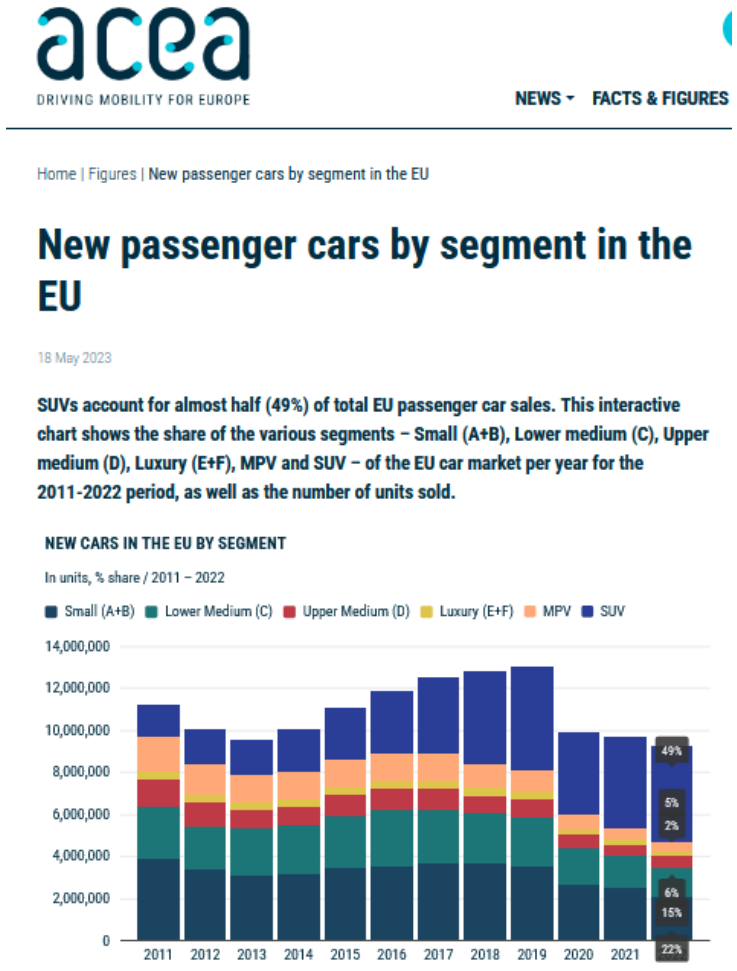
Part 2: Road and Vehicle Statistics
2. Glare: Dynamic Glare Experiments



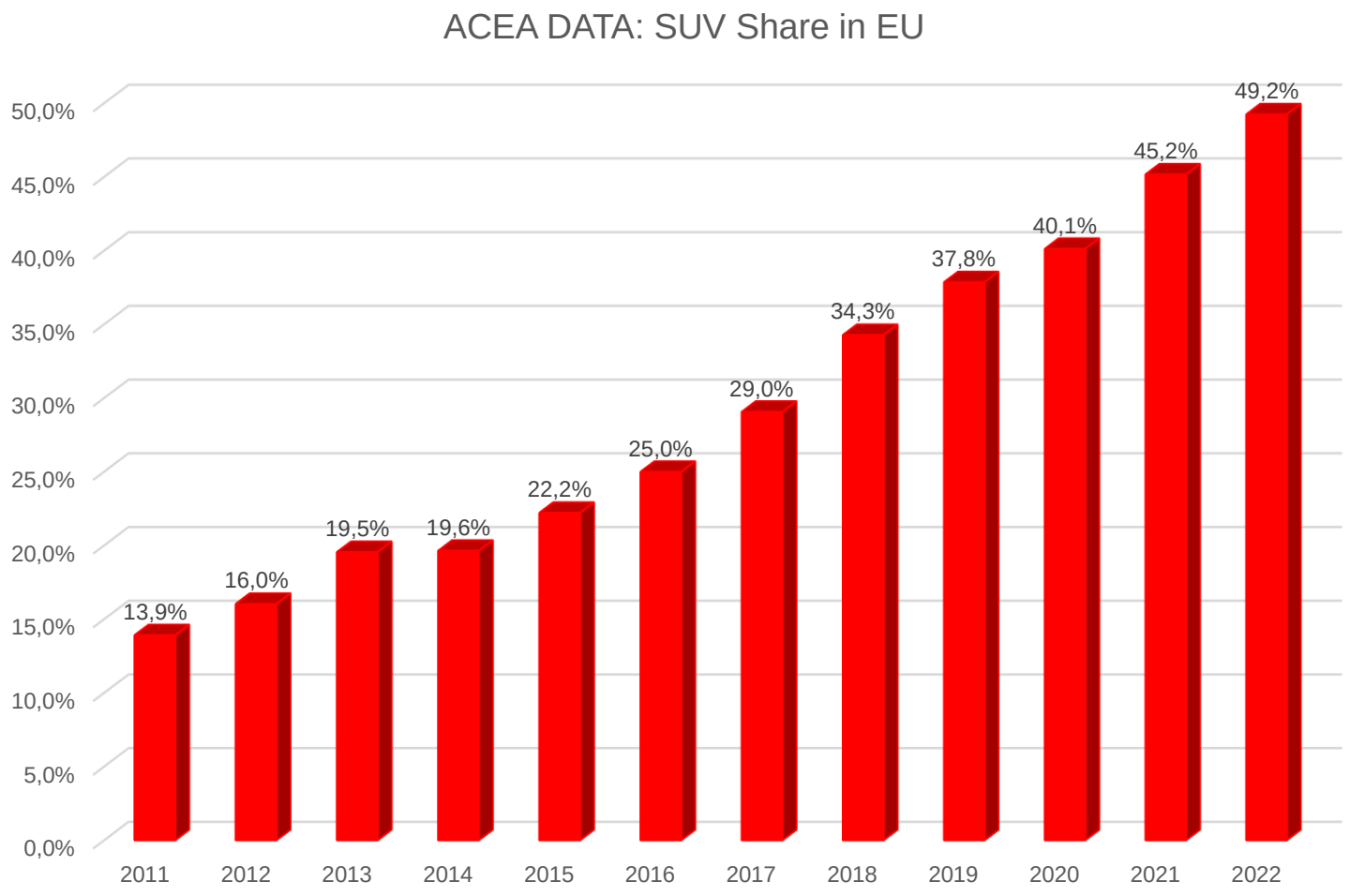
Potential Glare Contribution	Idea to control	Inforce
2.46%..4,78% of all times	**Automatic** Dynamic Levelling	☒
3,8..5,2% of all times	Closed Loop Aiming	☒

Part 3: Recent Changes in Vehicle Design

Part 3: Recent Changes in Vehicle Design
Statistics on Vehicles



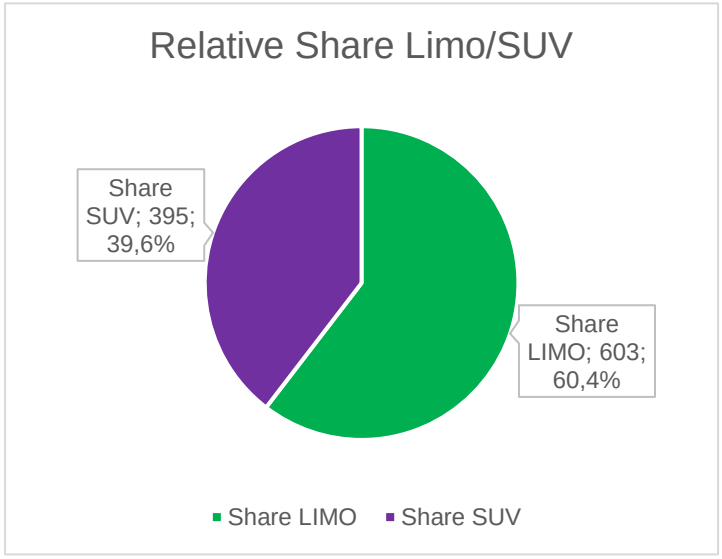
Source: ACEA Website

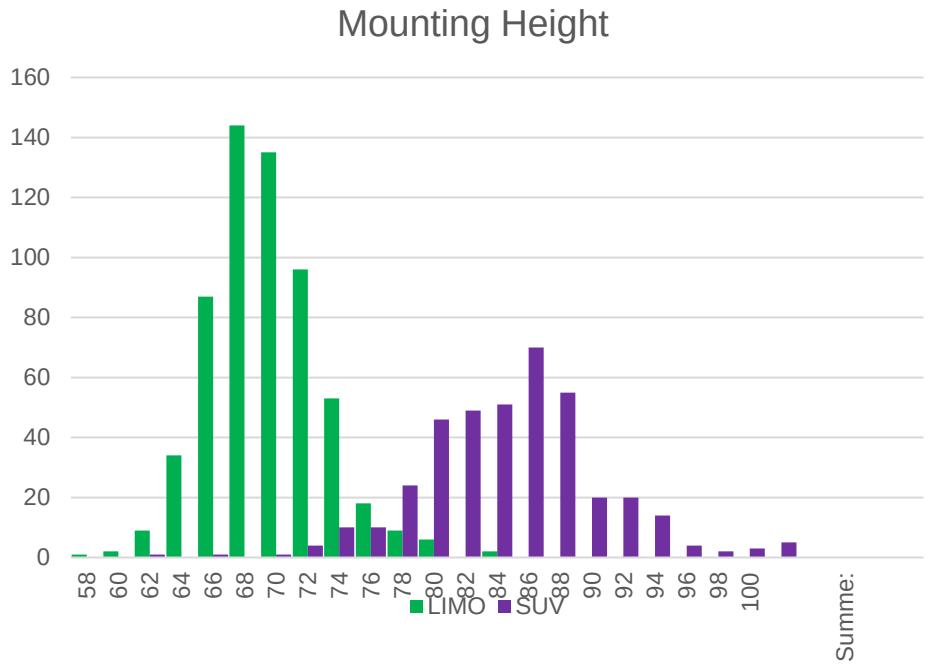


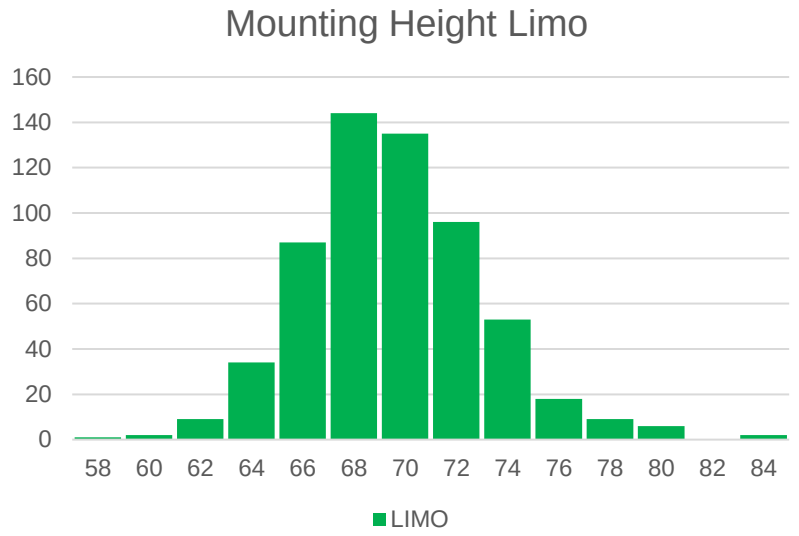
Part 3: Recent Changes in Vehicle Design
Statistics on Mounting Height Limousines / SUV

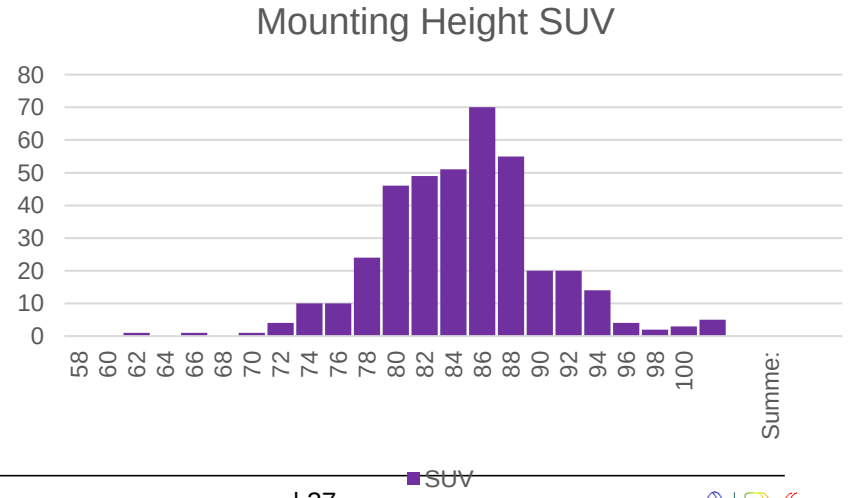
TECHNISCHE UNIVERSITÄT DARMSTADT

998 Vehicles were investigated





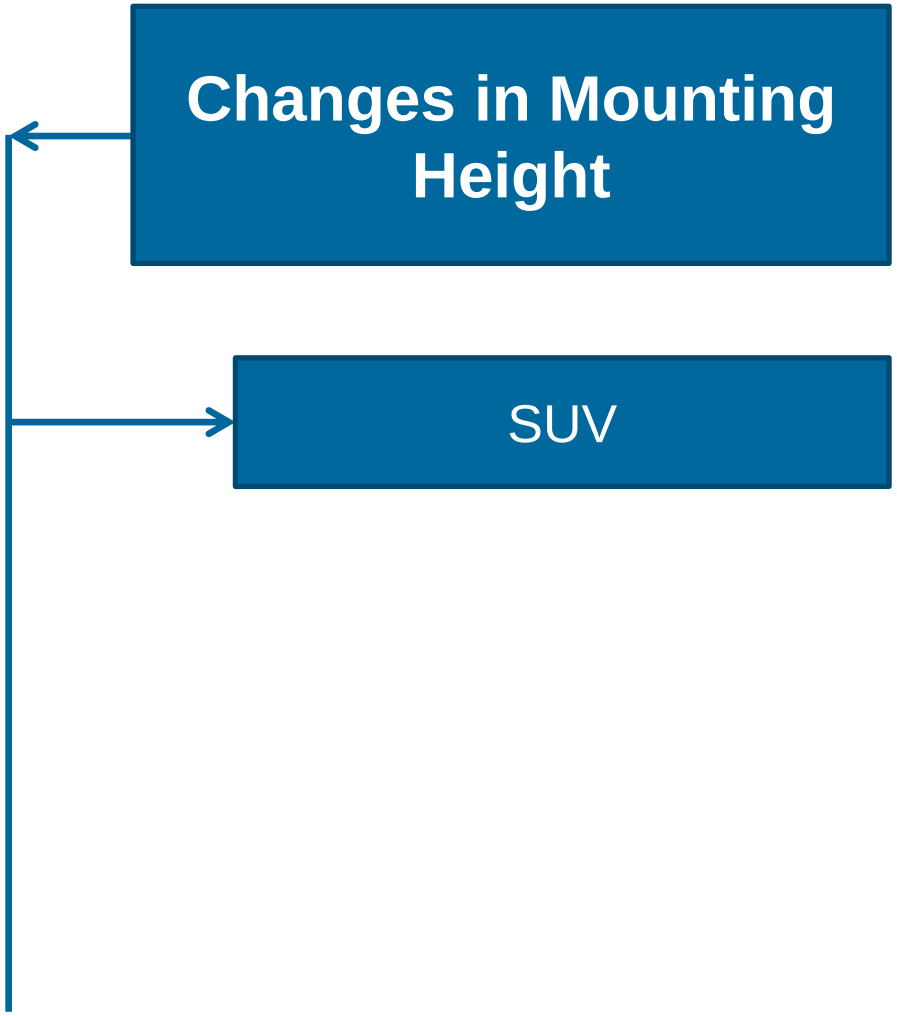




Part 3: Recent Changes in Vehicle Design
Statistics on Mounting Height Limousines / SUV

Total AVG LIMO	Total AVG SUV
69,04	**84,29**
STDDev LIMO	**STD SUV**
3,47	**5,76**

Part 3: Road and Vehicle Statistics
2. Glare: Dynamic Glare Experiments



Potential Glare Contribution	Idea to control	Inforce
Avg. +15 cm Height	**Automatic** - Dynamic Levelling - Even better Closed Loop Aiming	☒

Summary

Potential Glare Contribution	Idea to control	Inforce
High	Automatic Static Levelling	✓
Medium	Closed Loop Aiming	☒
High	Digital Aiming Station in Factory	✓
High	Eliminate Human Contribution Closed Loop Aiming	☒

Potential Glare Contribution	Idea to control	Inforce
2.46%..4,78% of all times	**Automatic** Dynamic Levelling	☒
3,8..5,2% of all times	Closed Loop Aiming	☒

Potential Glare Contribution	Idea to control	Inforce
Avg. +15 cm Height	**Automatic** - Dynamic Levelling - Even better Closed Loop Aiming	☒

Thank You !