Transmitted by the expert from GTB

Informal document **GRE-71-32**
(71st GRE, 31 March–3 April 2014,
agenda item 4 (b))

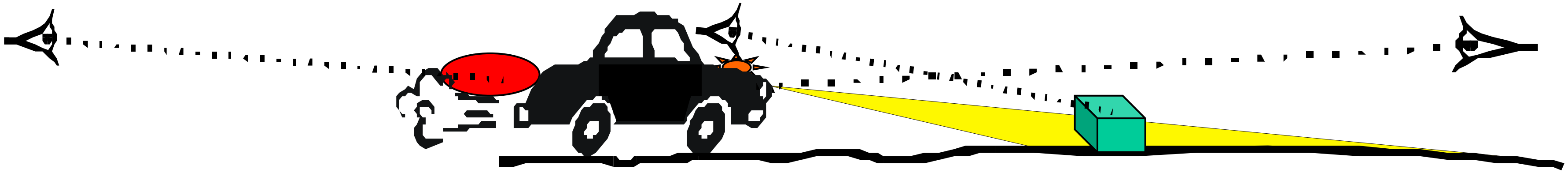
VGS-062
Date: 2014-04-01

GTB Document No. CE-5001
Date: 2014-04-01

GTB Task Force

Coordination of **A**utomotive **V**isibility and **G**lare **S**tudies

Report April 2014



GTB
The International Automotive Lighting and Light Signalling Expert Group

Groupe de Travail "Bruxelles 1952"

Agenda

1. GTB

    Introduction

2. Poland

    Explanation of the background of the Polish proposal for R48

3. GTB

    Literature Review

    Night-time Field Test

    Discussion

        Comparison Klettwitz Outcome with Literature

        Enrichment of Data by Calculation (CIE TC4-45)

4. OICA

    Explanation of load conditions

5. Joint GTB/Poland/OICA

    Conclusion

    Suggestion

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5. <u>Joint GTB/Poland/OICA</u>

   Conclusion

   Suggestion

Introduction

Ad de Visser
chair TF CAVGS

Introduction[1/]

Arrangement of presentations in the program is a mix of

- activities in chronological order
- building blocks to constructing the puzzle
- in logical order for a better understanding

[1/] GRE-71-xx

Start

- Proposal[1/] to introduce gas discharge light sources with an objective luminous flux of 2000 lm
- Proposal[2/] to require automatic levelling for all low beam headlamps independent from
  - the light source technology
  - the light source luminous flux

[1/] WP.29/2011/101
[2/] WP.29/2011/99 and Corr.1

Automatic leveling proposal

- Long transitional period of 90 months
- GRE indicated
  - to be open for relaxation of this new requirement
  - for adopting alternatives based upon study
  - in the beginning of this transitional period
- Proposal[2/] stalled in the GRE agenda and discussion was deferred for ~2 or 3 years
  - until today
- The expert from Poland worked on new initial aiming requirements
  - Different approach
  - OICA commented on this proposal

This is why Poland and OICA contribute with presentations to provide background information

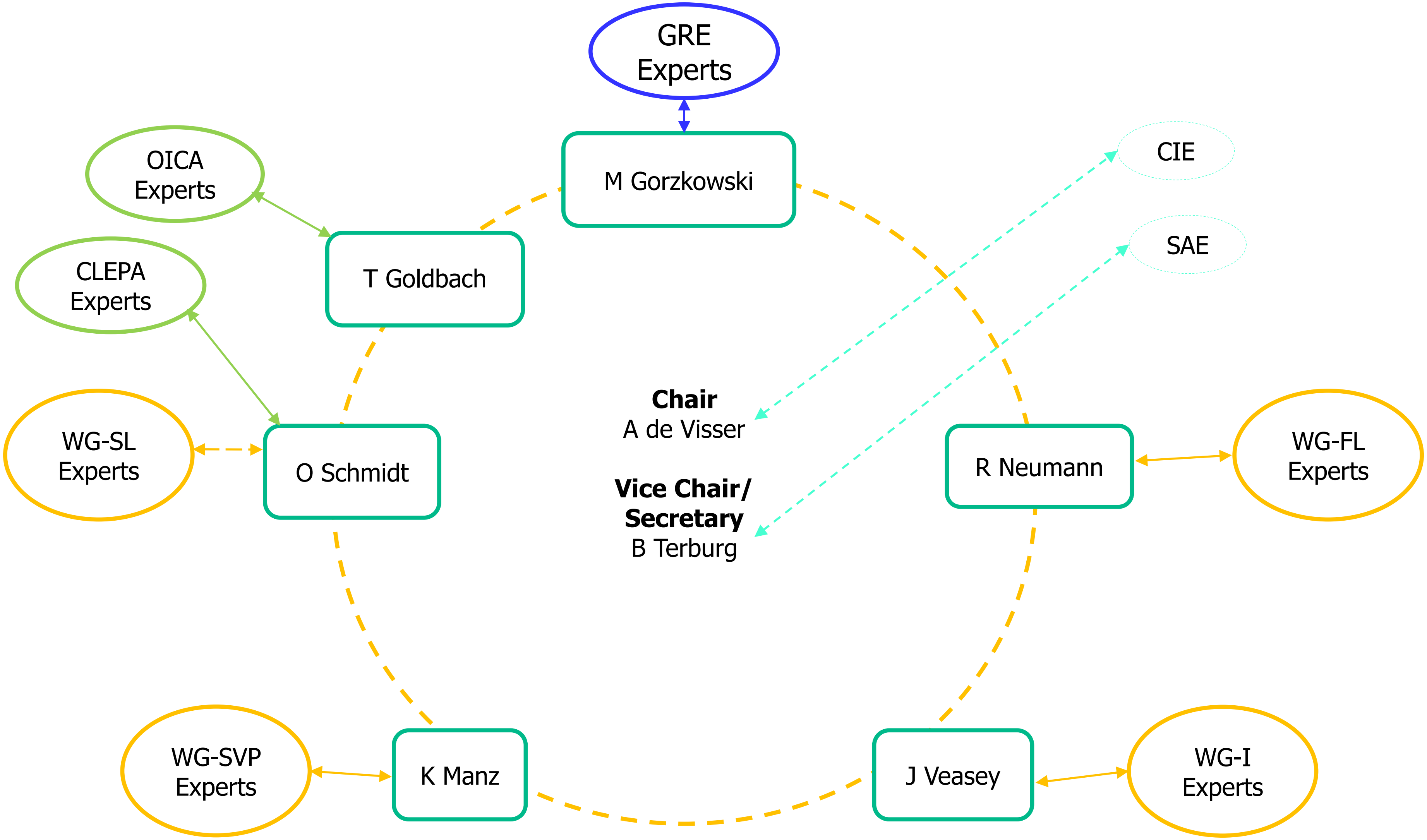
[2/] WP.29/2011/99 and Corr.1

GTB study[1/] *'Visibility and Glare'*

- Task force TF CAVGS
  Coordination of Automotive Visibility and Glare Studies
- Publically accessible home page
  http://www.gtb-lighting.org/VGS/indexVGS.htm
- Concentrated on levelling in relation to load
- Major objectives
  - to improve the understanding of different factors that influence visibility and glare; start of the presentations
  - to identify results of the study that might reveal alternatives for automatic static levelling; end of the presentations

[1/] GRE-66-21
GRE-67-39

GTB Task Force CAVGS



see GRE-66-21

Presentations
Part: "Understanding"

- Extending earlier presentations
  - Literature review by WG SVP[2/]
  - Field test by WG FL[1/]
    - Cooperation with DEKRA and TUD
- Discussion in response to comments/ questions
  - From GRE68
  - From GTB in several sessions
  - By simulations based upon assumptions

    See next slide
  - Field test and simulations were "validated" with literature
  - Simulations were compared with those from the expert from Poland
- Conclusion of the study

[1/] GRE-68-38
[2/] GRE-68-39

Assumptions

- Every testing and simulation is based upon certain assumptions and choice of parameters
  - Each set of assumptions has its weaknesses
  - GTB used an international accepted standard *CIE S 021/E:2011: Vehicle Headlighting Systems Photometric Performance - Method of Assessment*
  - The expert from Poland
    - will explain their set of assumptions
    - agreement with GTB to disagree on some aspects

Presentations
Part “Identifying alternatives”

- Alternatives for automatic static levelling
  - Based upon the outcome of the studies
- Headlamp aiming is always a compromise
  - There is no perfect solution possible
  - Glare complaints are inherent to visibility of the road ahead for the driver

After presentations

Consideration by GRE

Guidance for next steps

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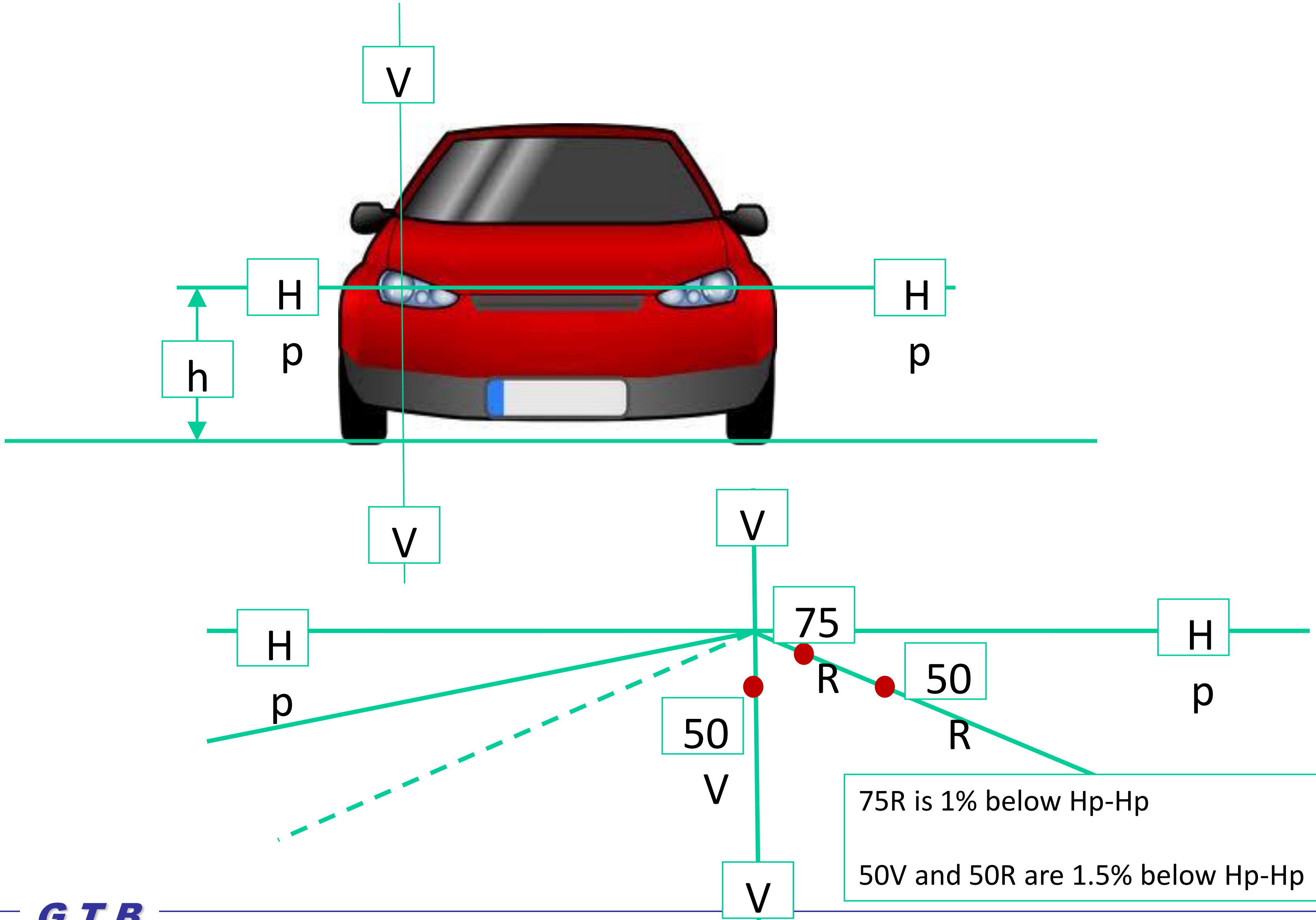
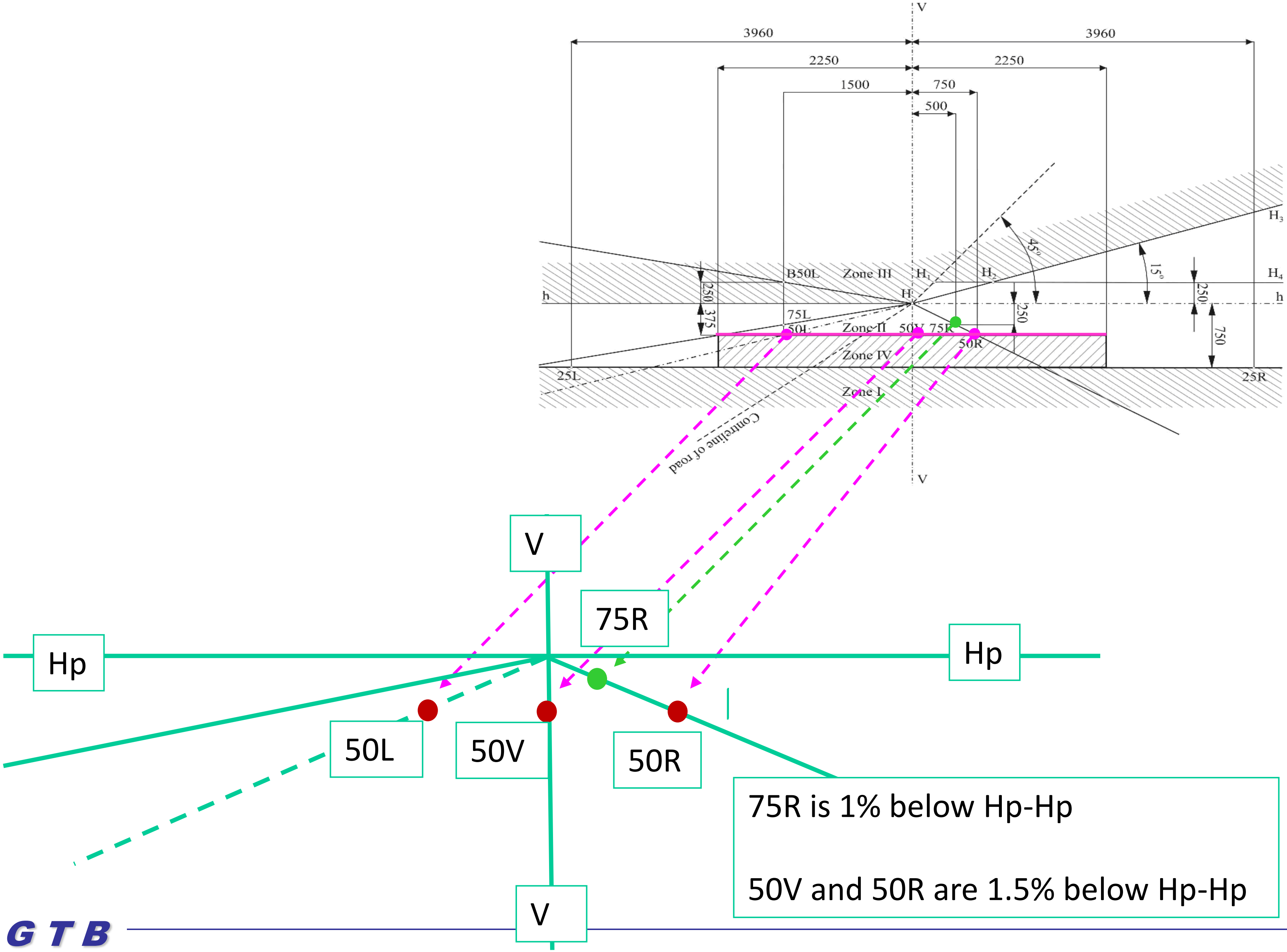


75R is 1% below Hp-Hp

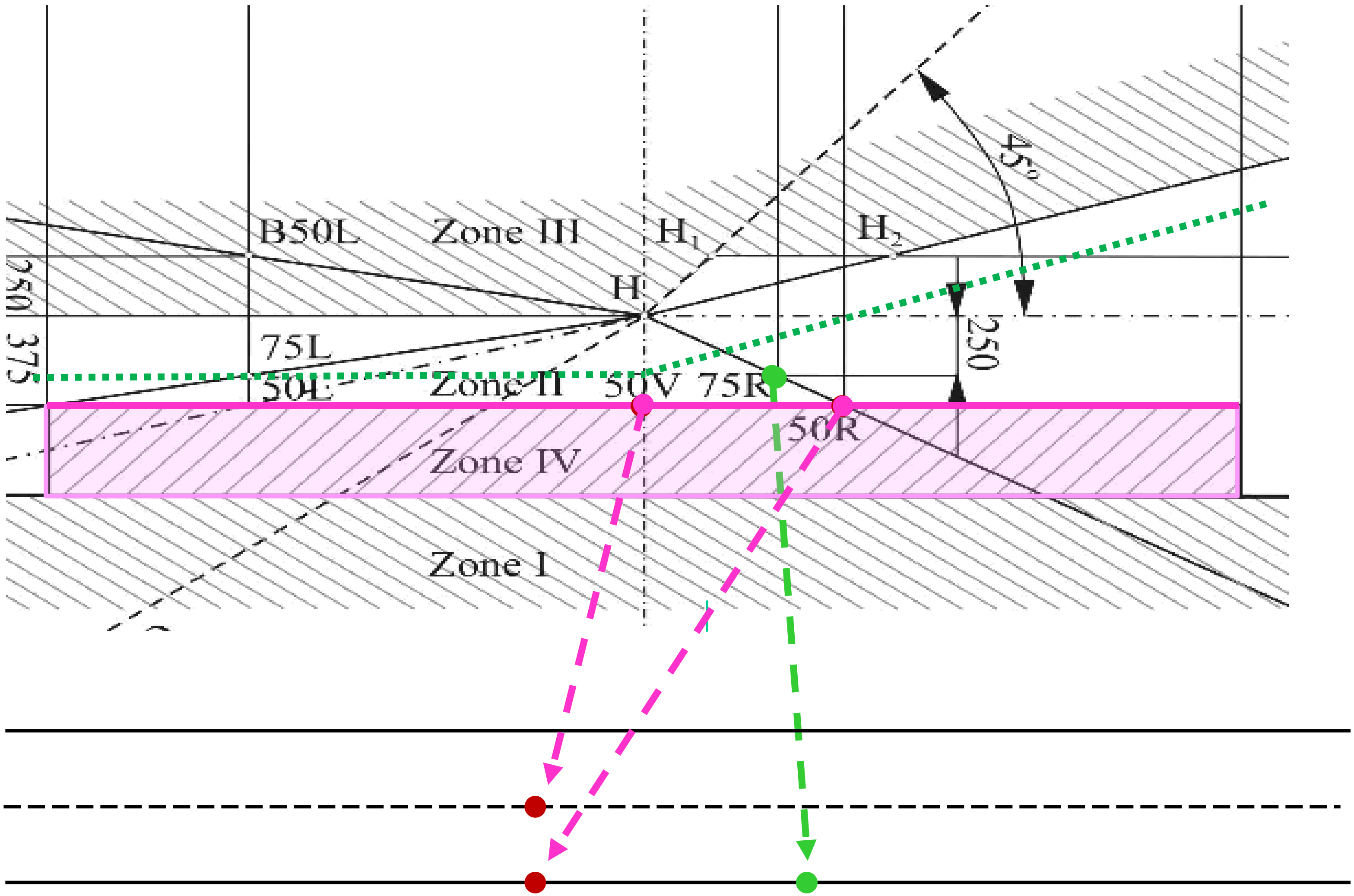
50V and 50R are 1.5% below Hp-Hp



75R is 1% below Hp-Hp

50V and 50R are 1.5% below Hp-Hp

TRANSLATION OF SCREEN PHOTOMETRY TO ROAD **H=0.75m, I=1%D**



Illuminances from 25 m screen translated to the road byheadlamp mounting height (h) of 75 cm

For 75R the minimum value is 16.8 lux @25m

Illuminance at 75 m = 16.8/ $(75/25)^2$ = **1.87 Lux** at the road surface.

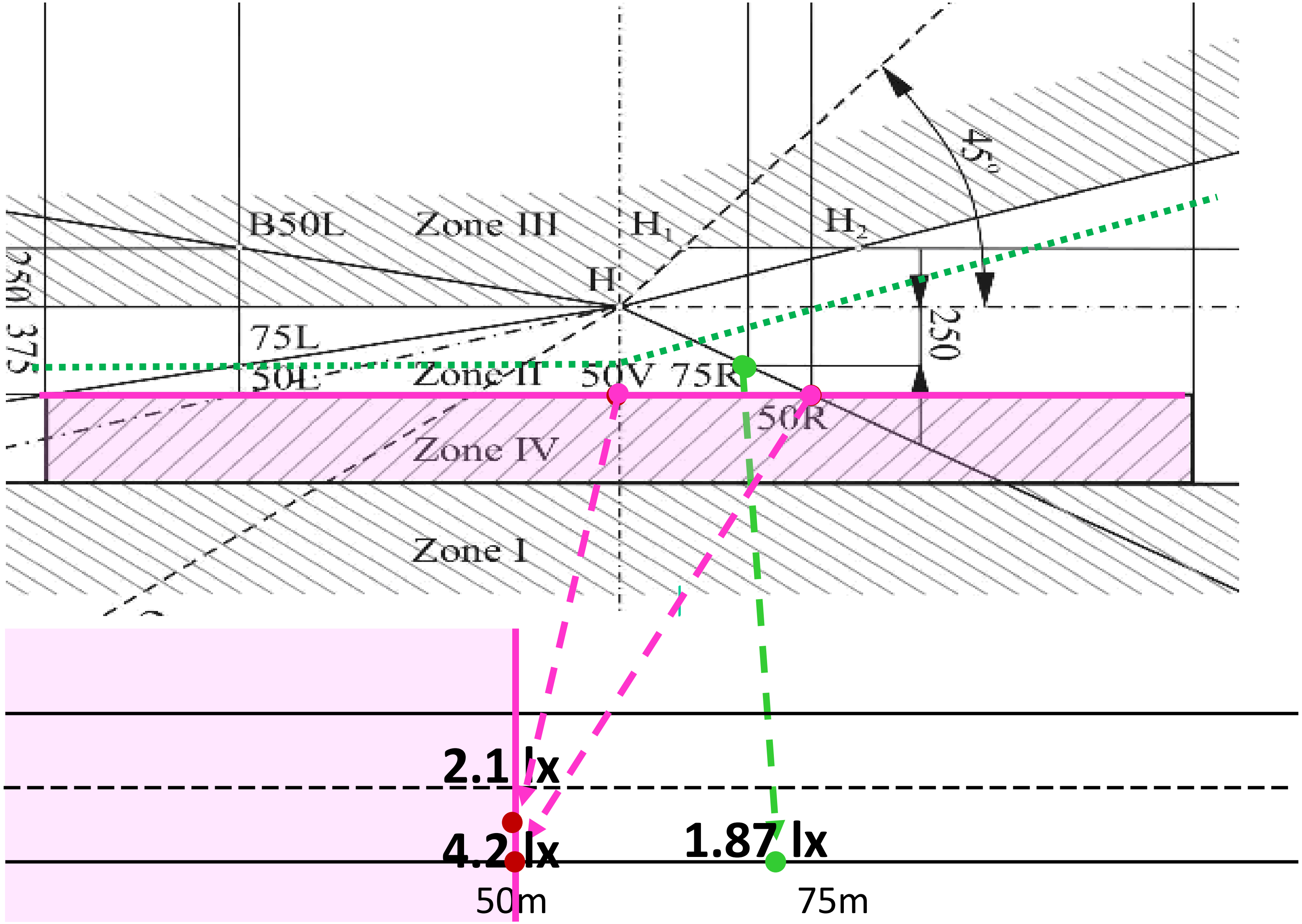
For 50R the minimum value is 16.8 lux @25m

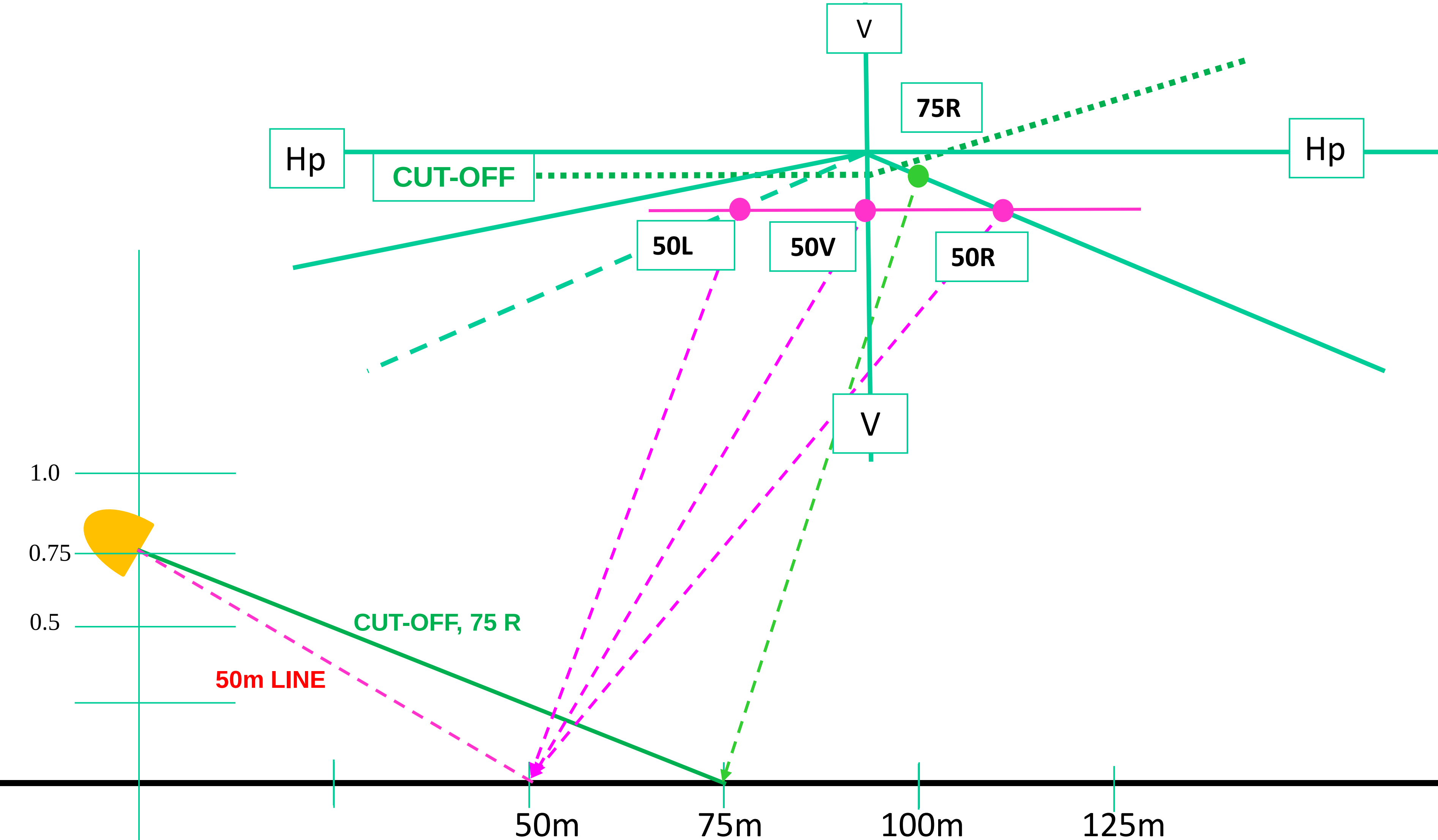
Illuminance at 50m = 16.8/ $(50/25)^2$ = **4.2 Lux** at the road surface.

For 50V the minimum value is 8.4 lux @25m

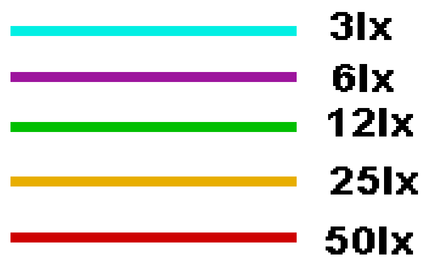
Illuminance at 50m = 8.4/ $(50/25)^2$ = **2.1 Lux** at the road surface.

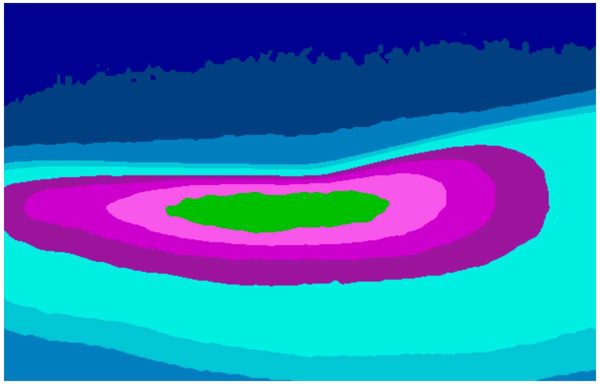
TRANSLATION OF SCREEN PHOTOMETRY TO ROAD **H=0.75m, I=1%D**




V
75R
Hp
CUT-OFF
Hp
50L
50V
50R
V
1.0
0.75
0.5
CUT-OFF, 75 R
50m LINE
50m
75m
100m
125m

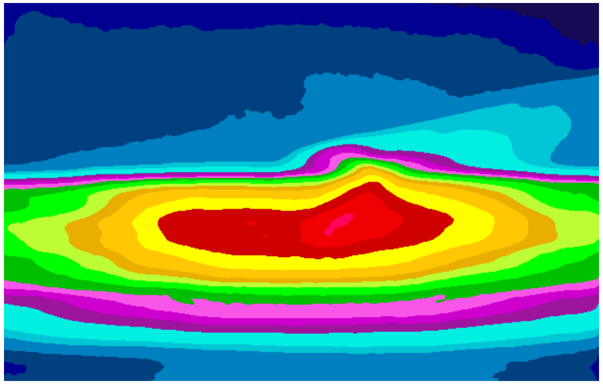
HOW DEPEND ROAD ILUMINATION OF AIMING AND BEAM PATTERNs CALCULATION EXAMPLES





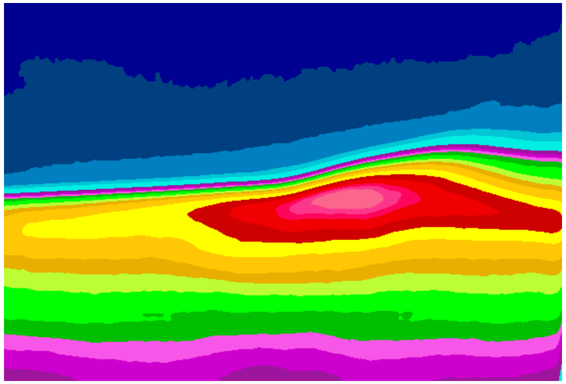
HEADLAMP A

Minimum performing headlamp just over type approval minimums



HEADLAMP B

LED headlamp with horizontally nearly symmetrical beam pattern

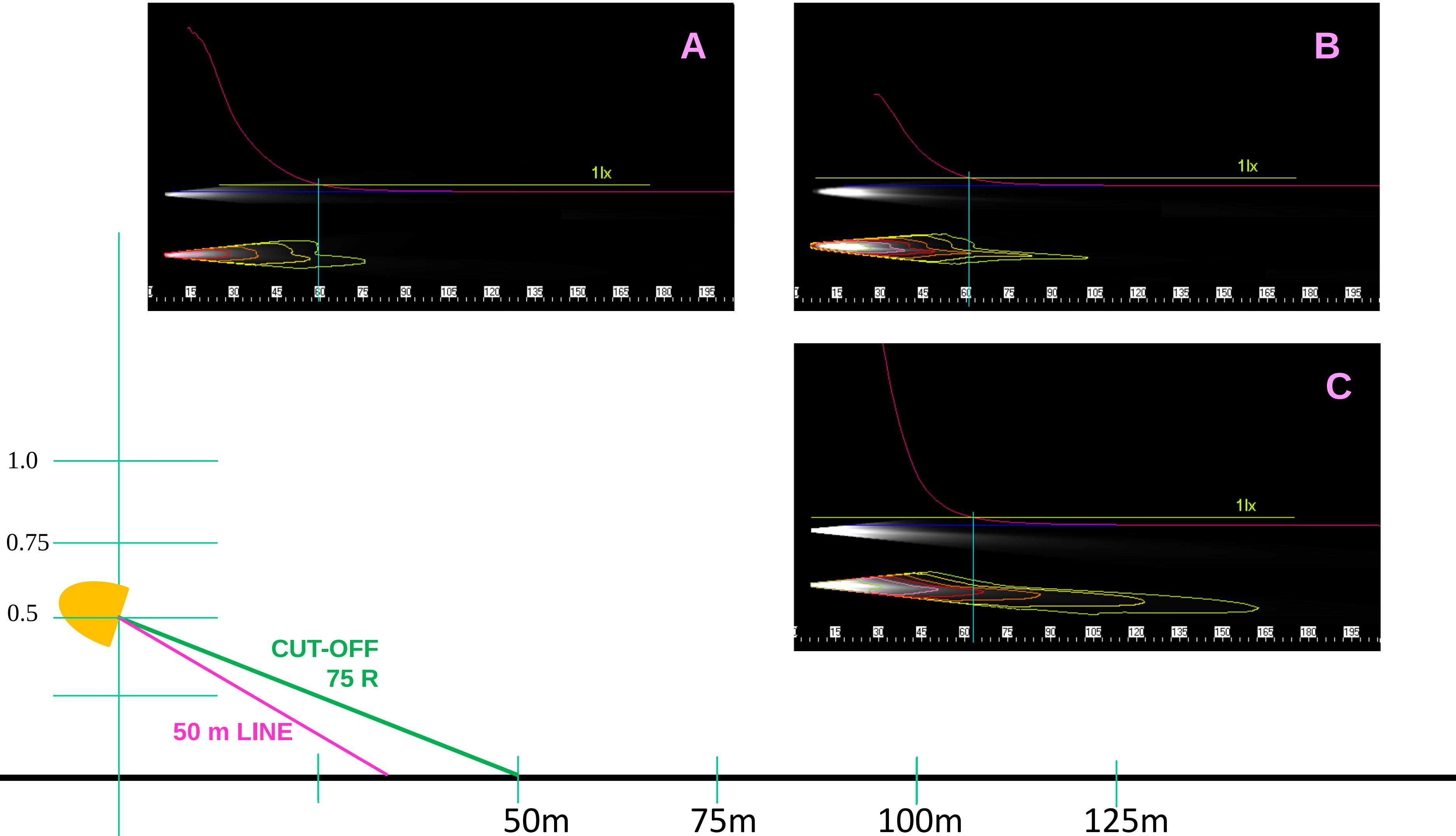


HEADLAMP C

High efficiency HID headlamp much more than required minimum

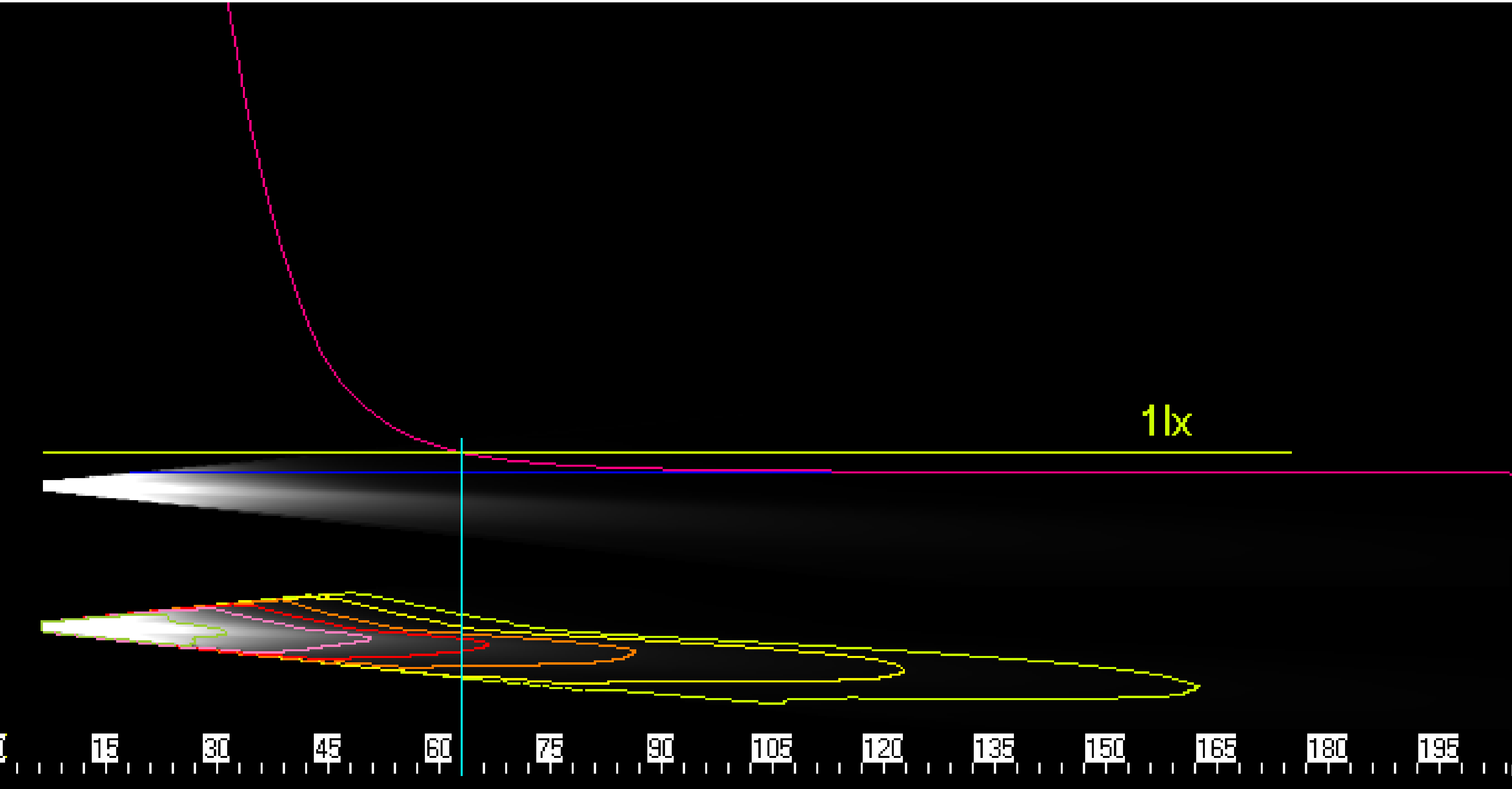
FIXED AIMING **(1.0% D**)
AND DIFFERENT MOUNTING HEIGHTS
= 0.50m, 0.75 m and 1.00m

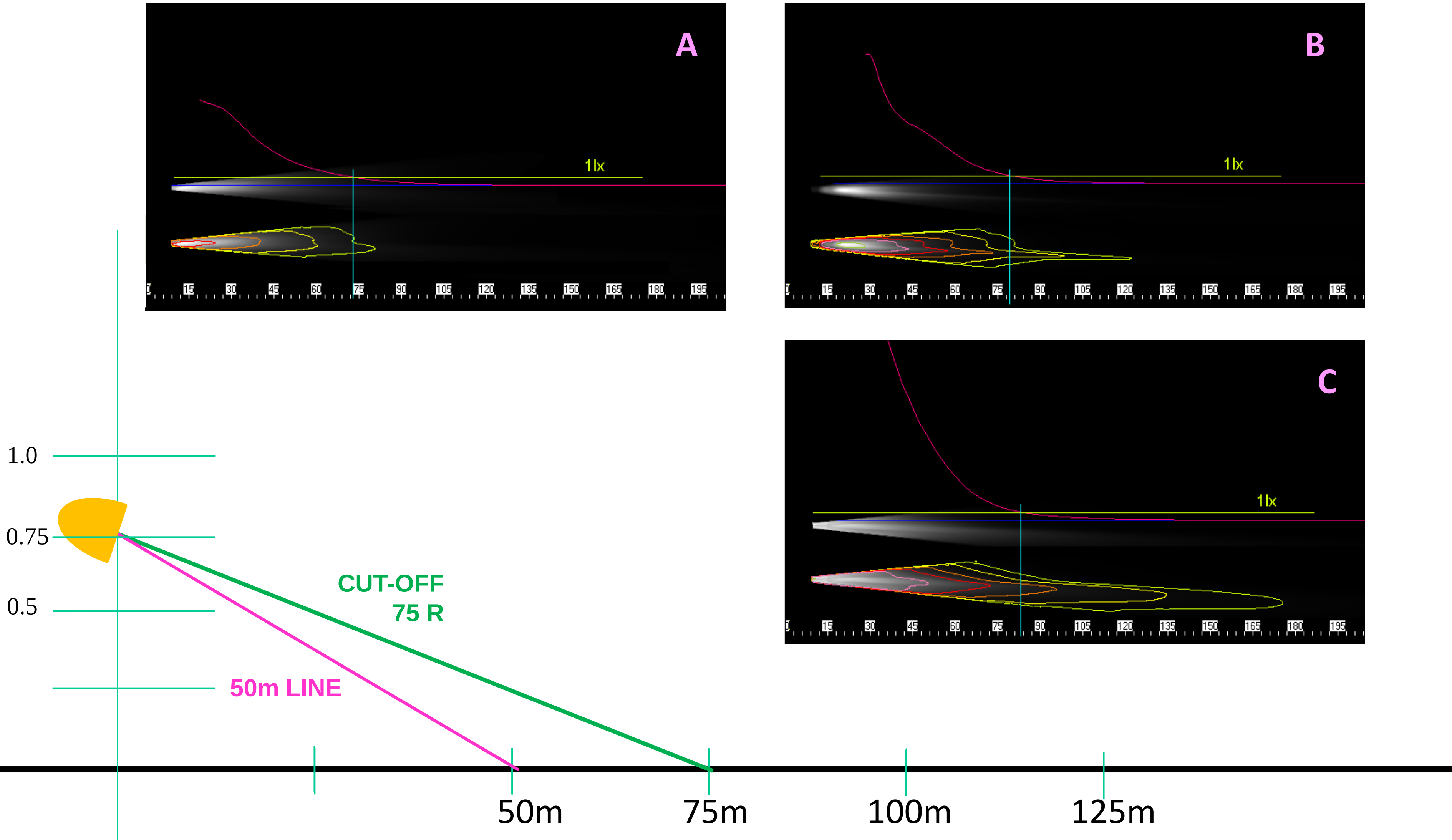
Different headlamps illuminates road differently by the same aiming and mounting height



AIMING **1.0% D** MOUNTING HEIGHT **0.50m**

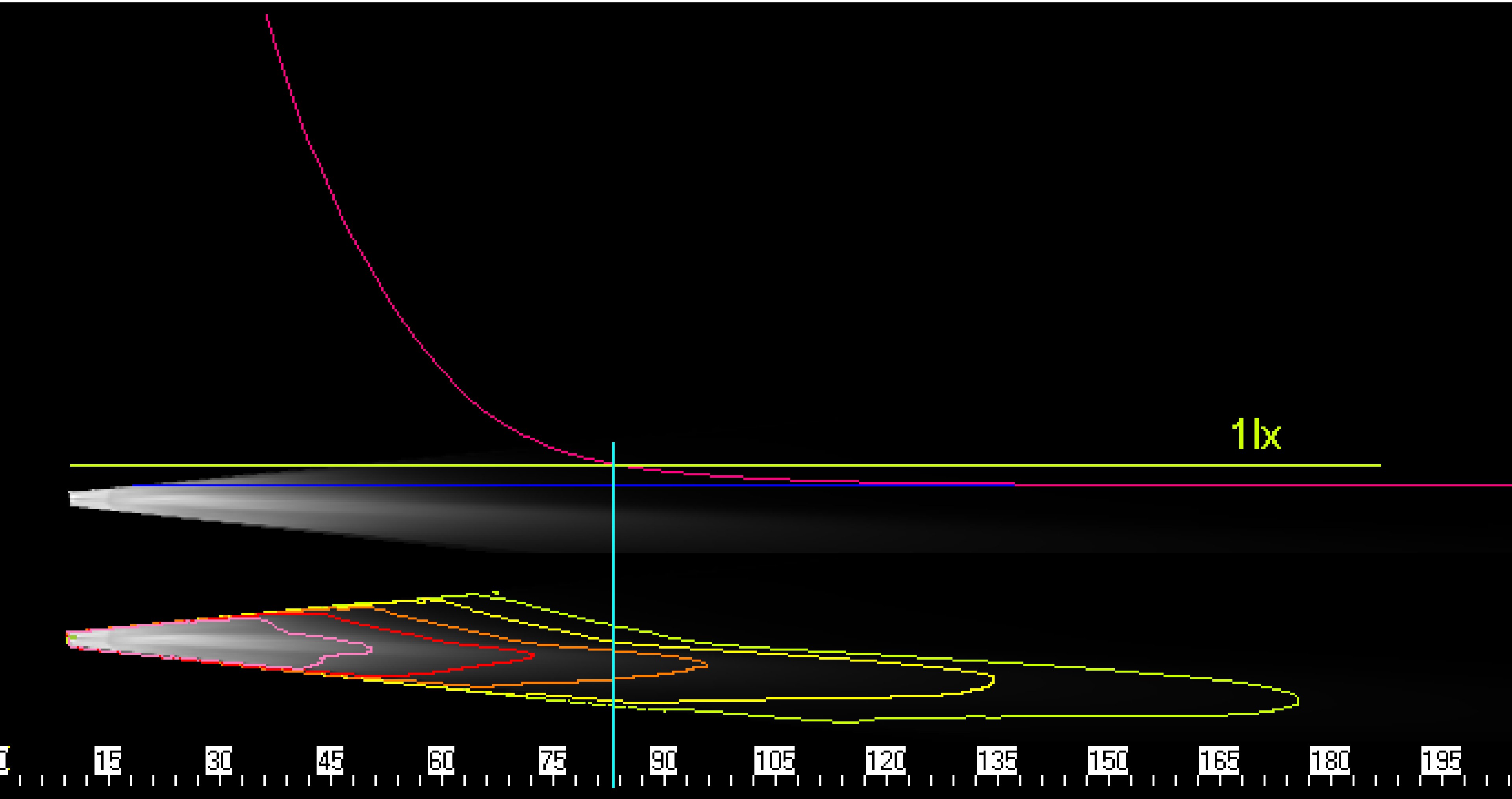
ROAD ILLUMINATION, AIMING **1% D,** HEIGHT **0.5m**

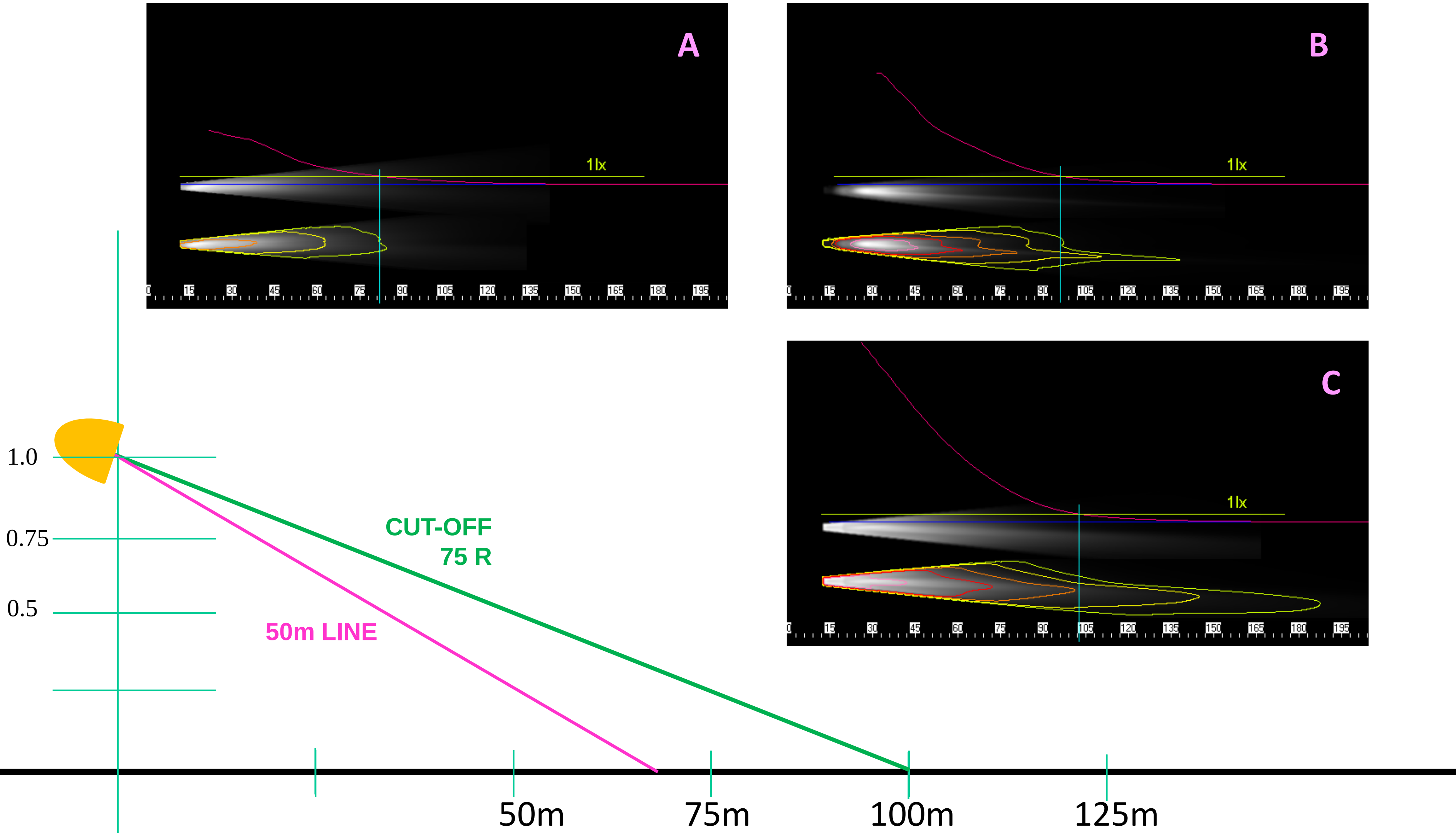




AIMING **1.0% D** MOUNTING HEIGHT **0.75m**

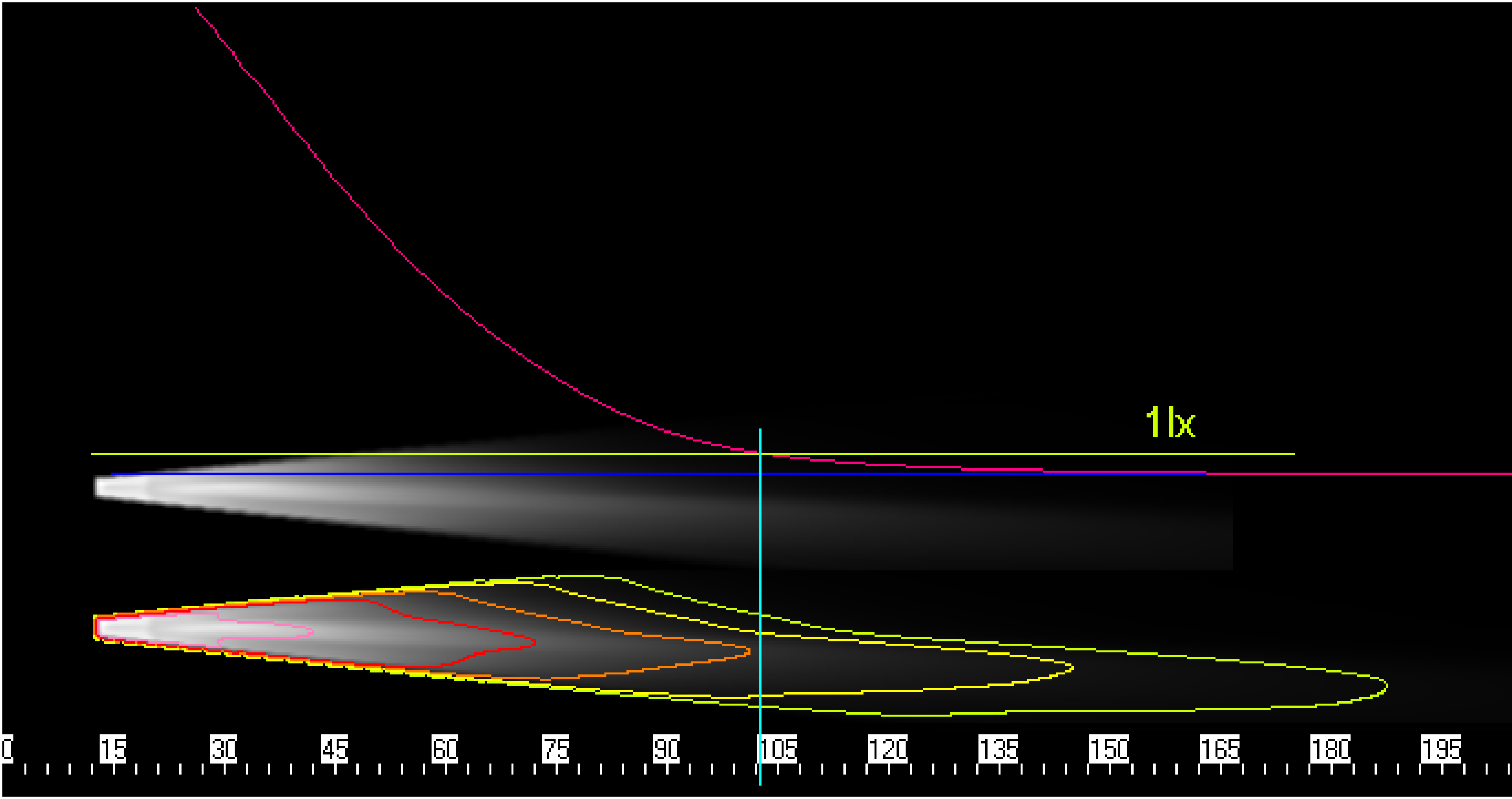
ROAD ILLUMINATION, AIMING **1% D,** HEIGHT **0.75m**



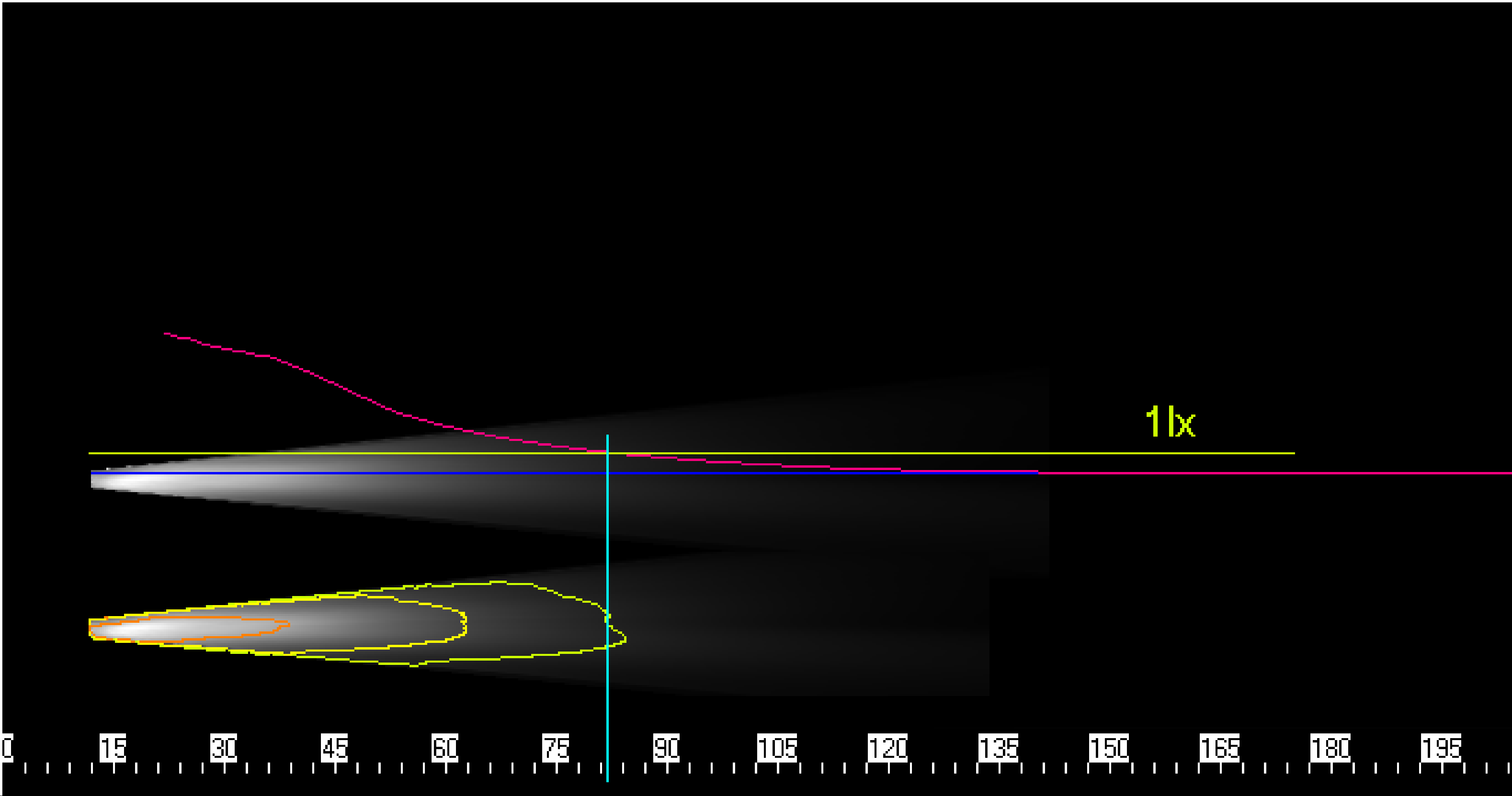


AIMING **1.0% D** MOUNTING HEIGHT **1.00m**

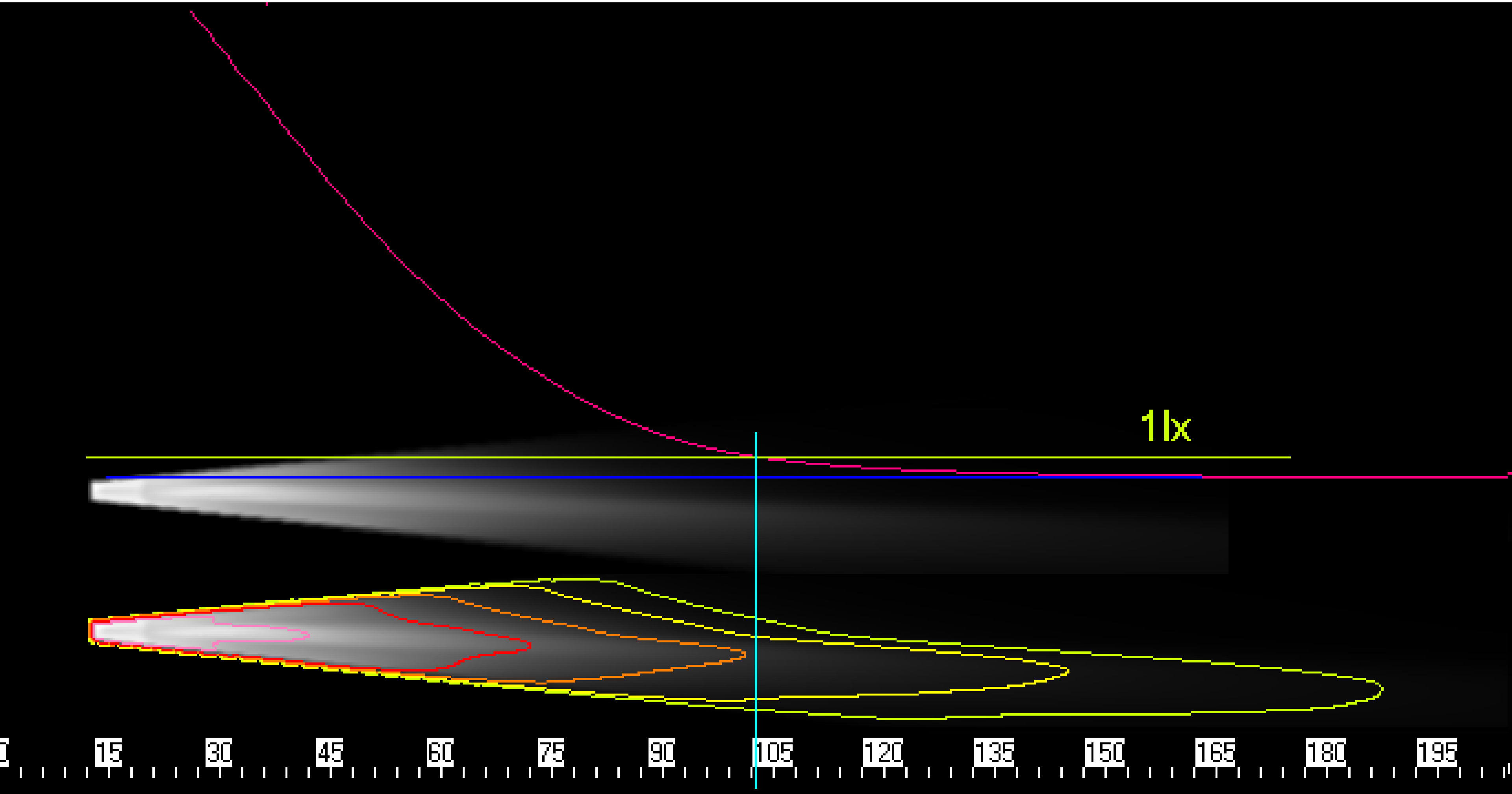
ROAD ILLUMINATION, AIMING **1% D,** HEIGHT **1.0m**



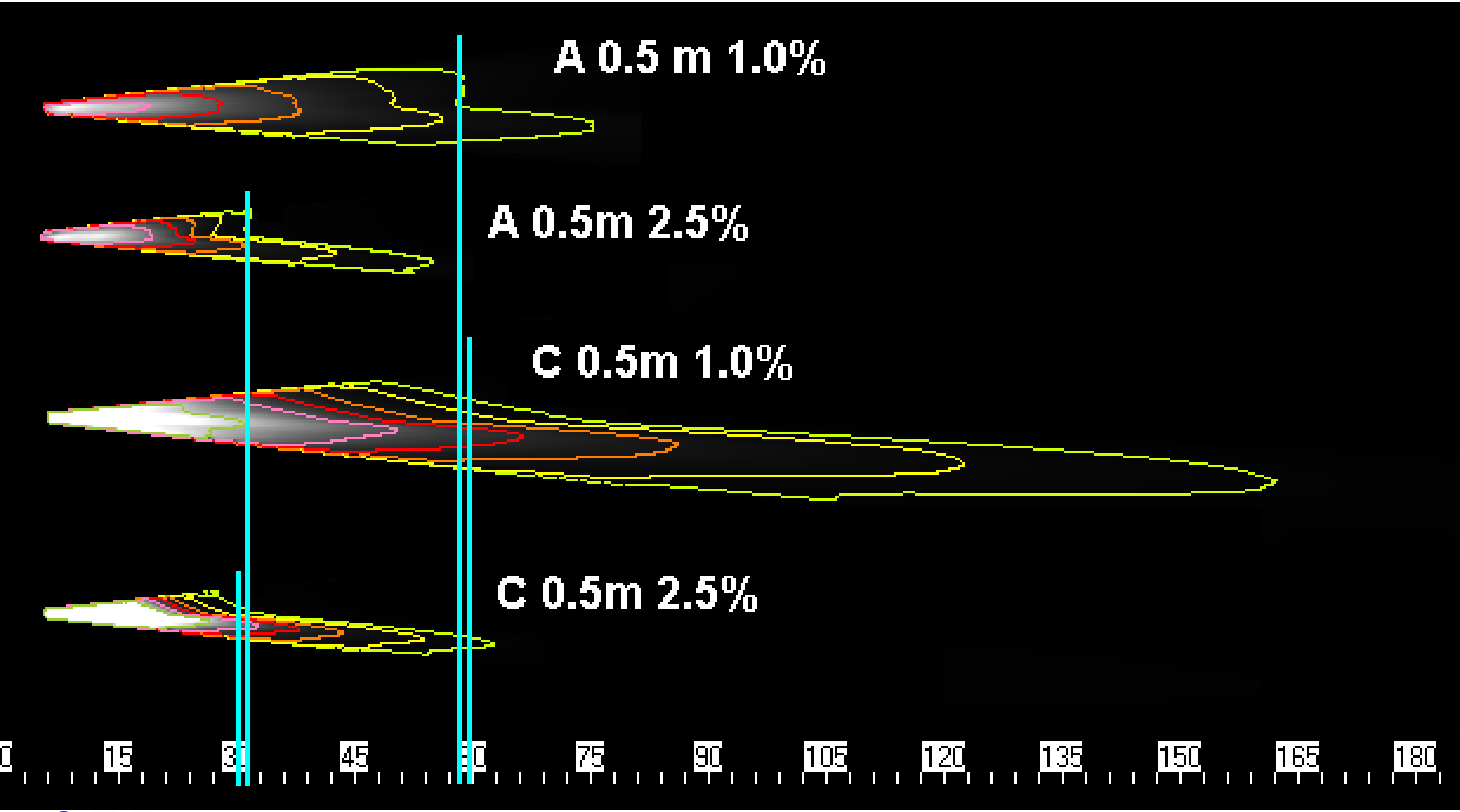
HEADLAMP A , AIMING 1%D, HEIGHT CHANGE 0.5 m, 0.75m 1.0m



HEADLAMP C , AIMING 1%D, HEIGHT CHANGE: 0.5 m, 0.75m 1.0m



COMPARISONS OF RANGE FOR DIFFERENT AIMING AND BEAM PATTERN

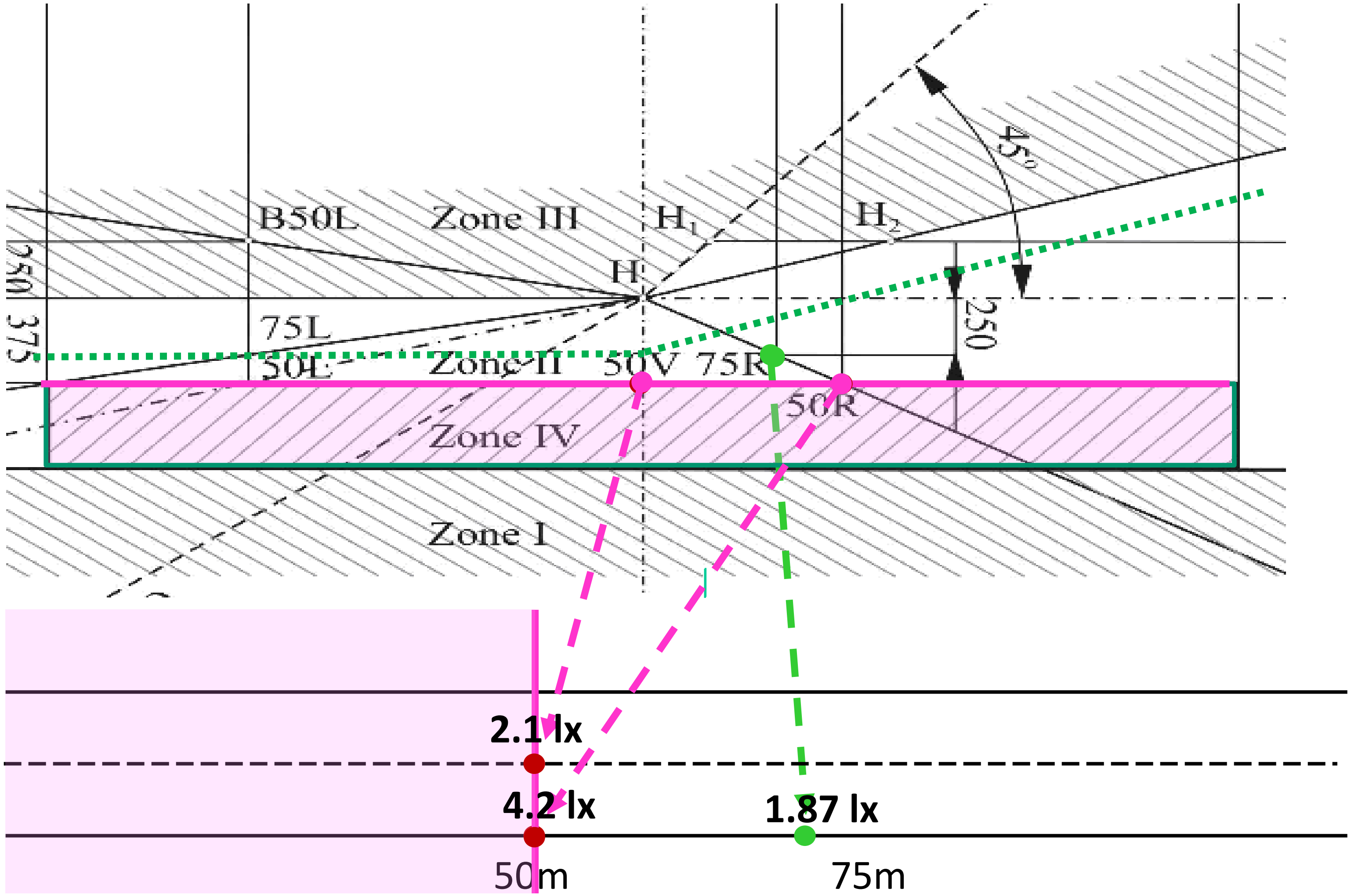


Reg. 48 aiming / levelling provisions

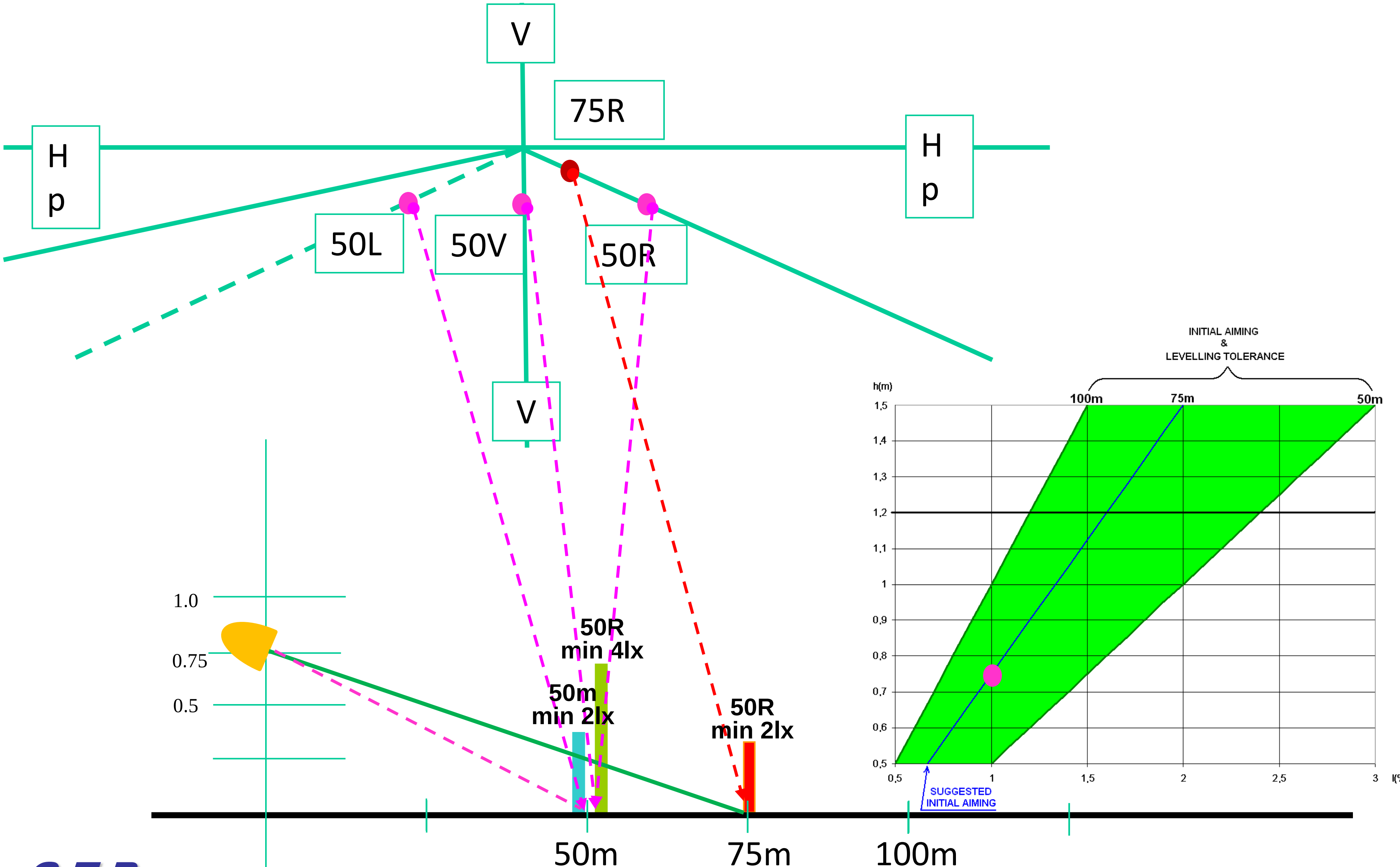
OR

ESSENCE OF POLISH PROPOSAL

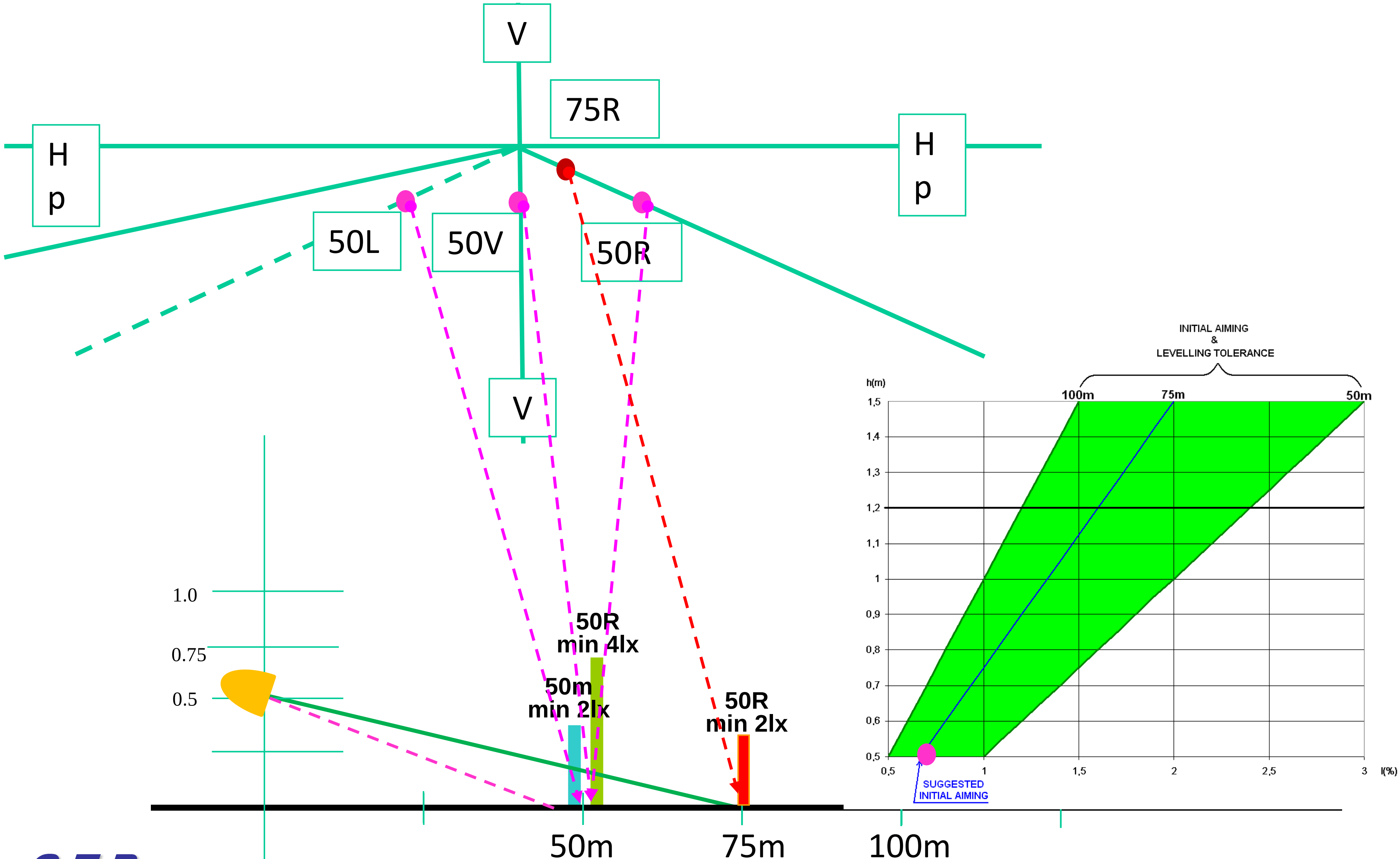
NO MEASURABLE CHANGE
OF ROAD ILLUMINATION
IN REFERENCE POINTS
WITH MOUNTING HEIGHT


B50L
Zone III
H1
H2
H
45°
250
375
250
75L
50L
Zone II
50V
75R
50R
Zone IV
Zone I
2.1 lx
4.2 lx
1.87 lx
50m
75m

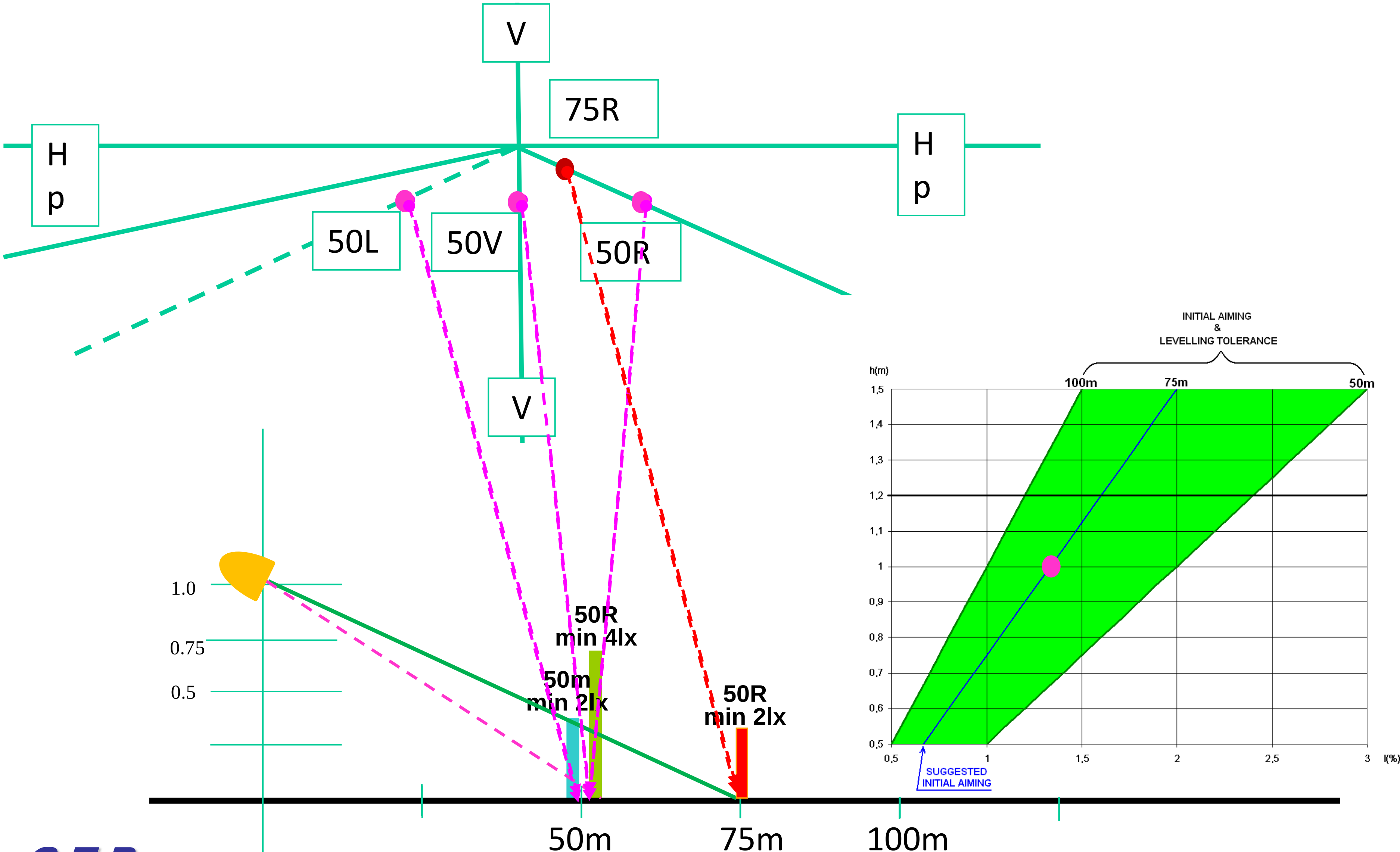
ESSENCE OF POLISH PROPOSAL



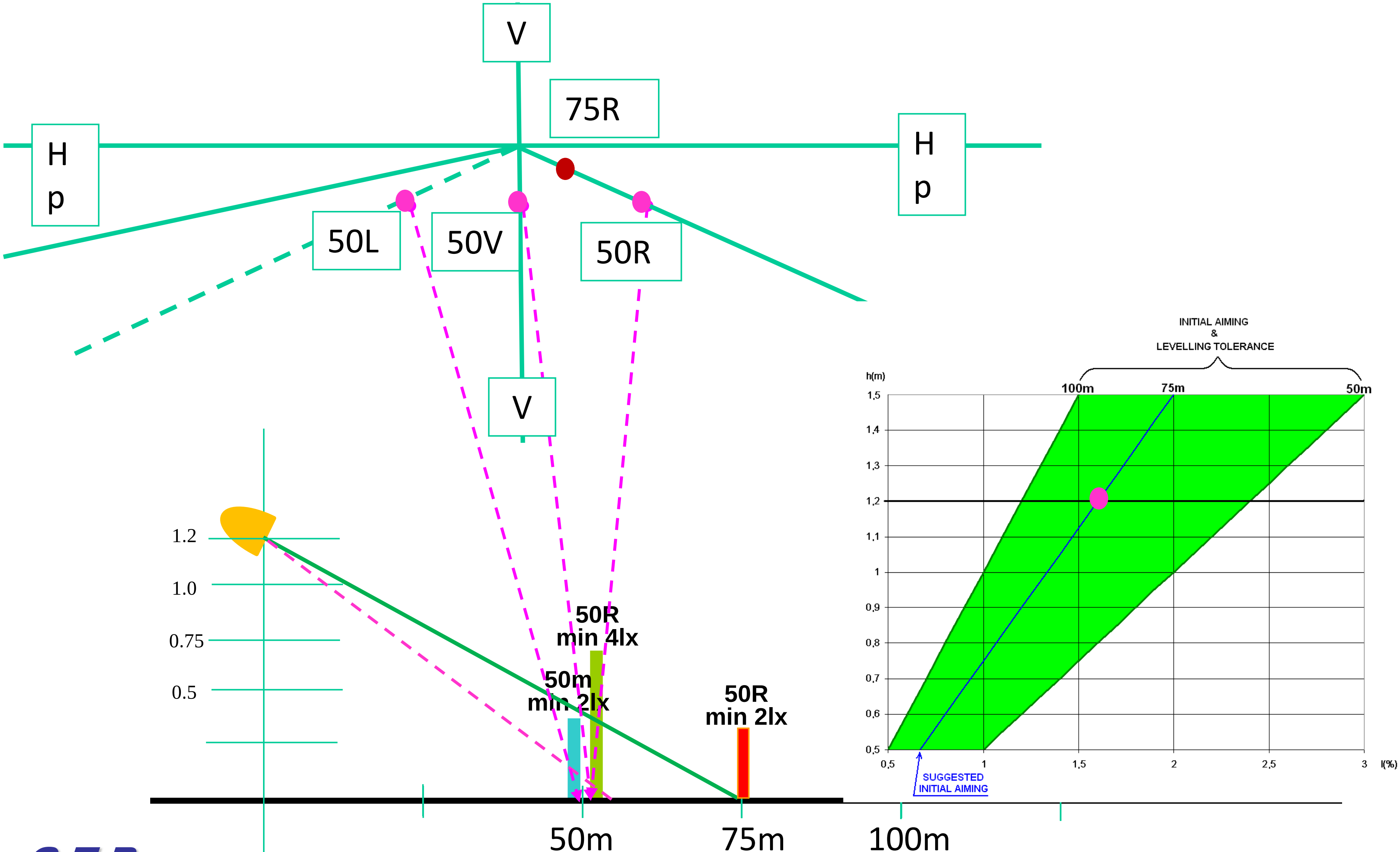
ESSENCE OF POLISH PROPOSAL



ESSENCE OF POLISH PROPOSAL



ESSENCE OF POLISH PROPOSAL

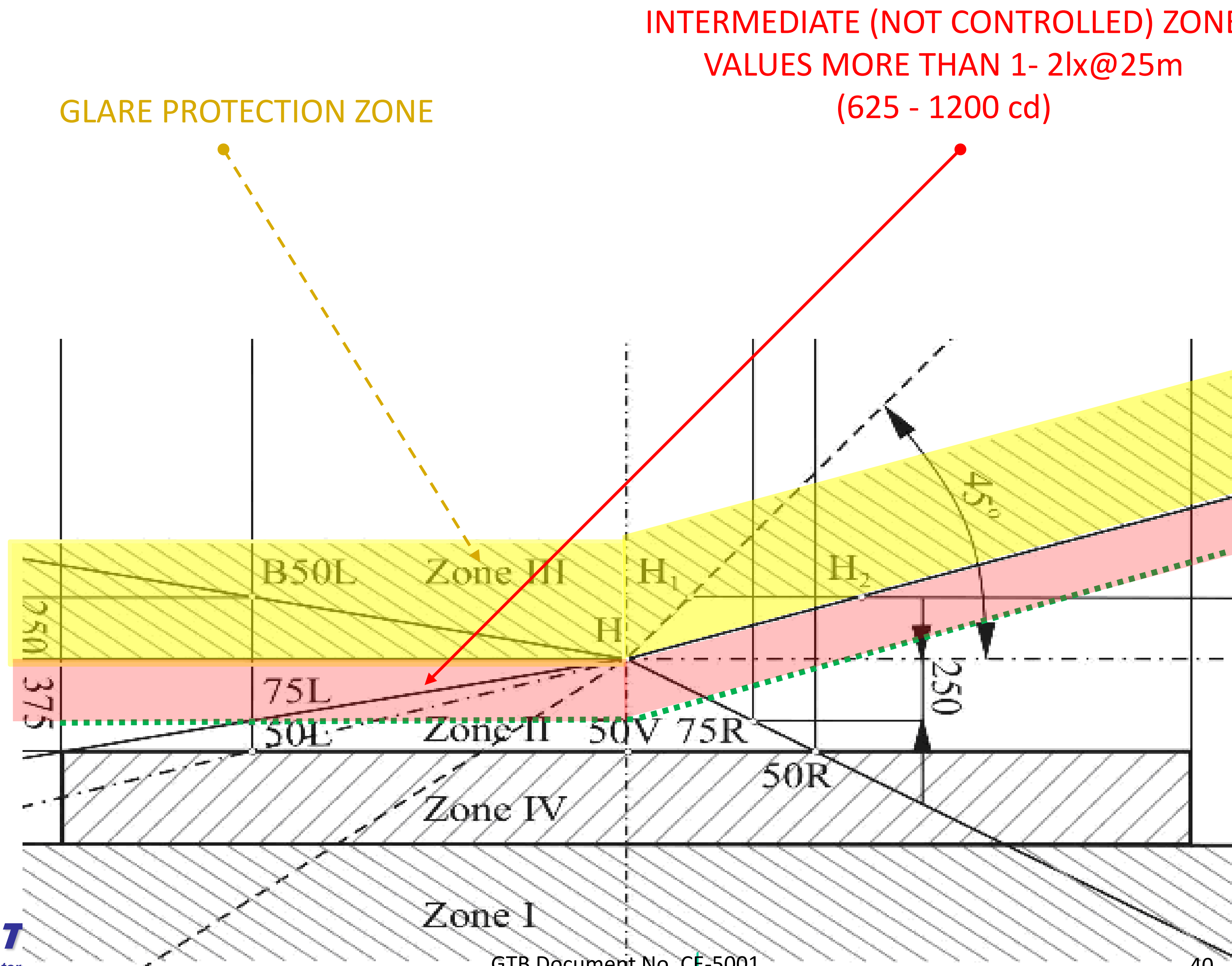


GLARE

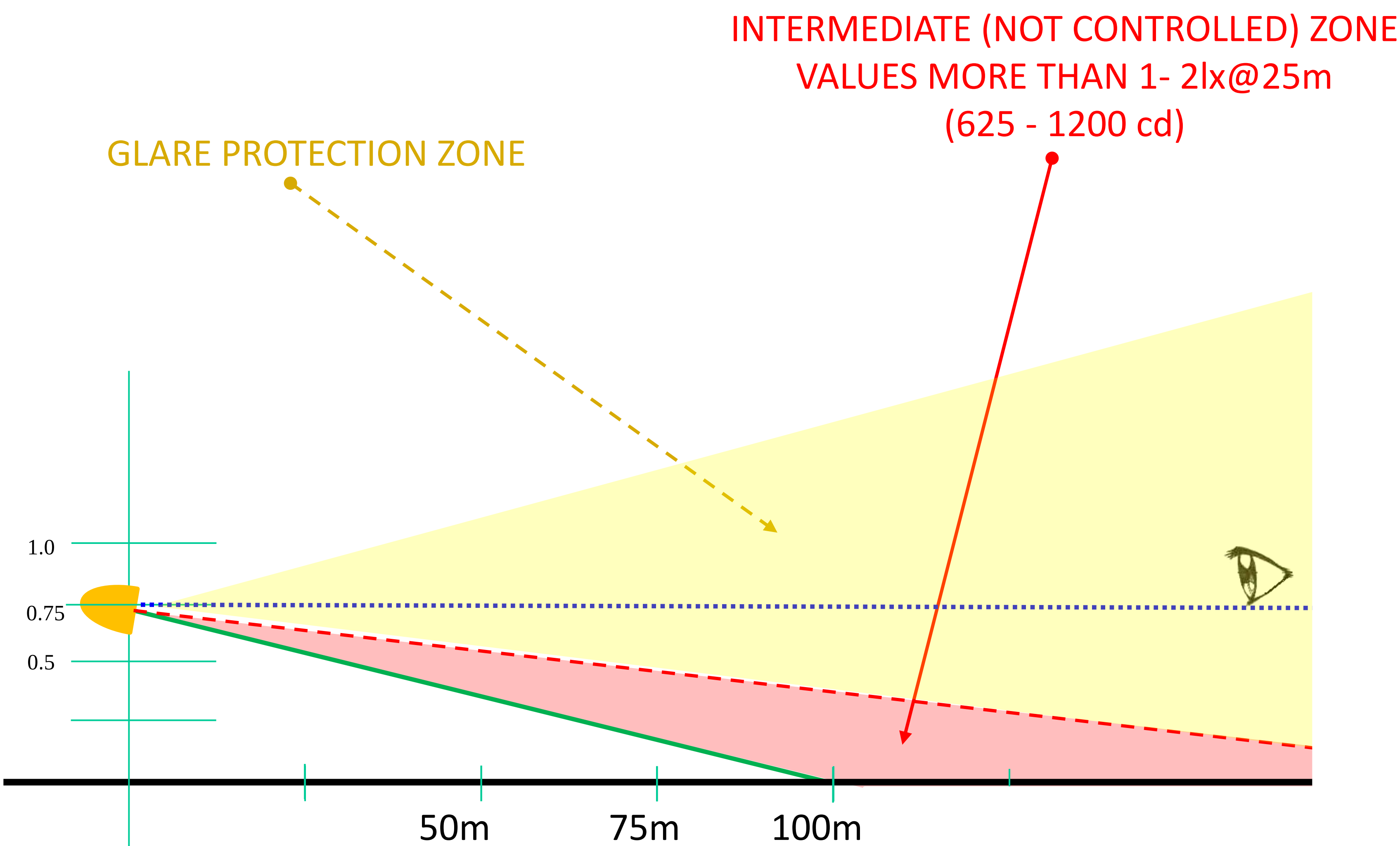
In Polish proposal is assumed that **over horizon** should not to be significantly more light then allowed by type approval headlamp regulation.

These requirements are based on research concerning disability glare.

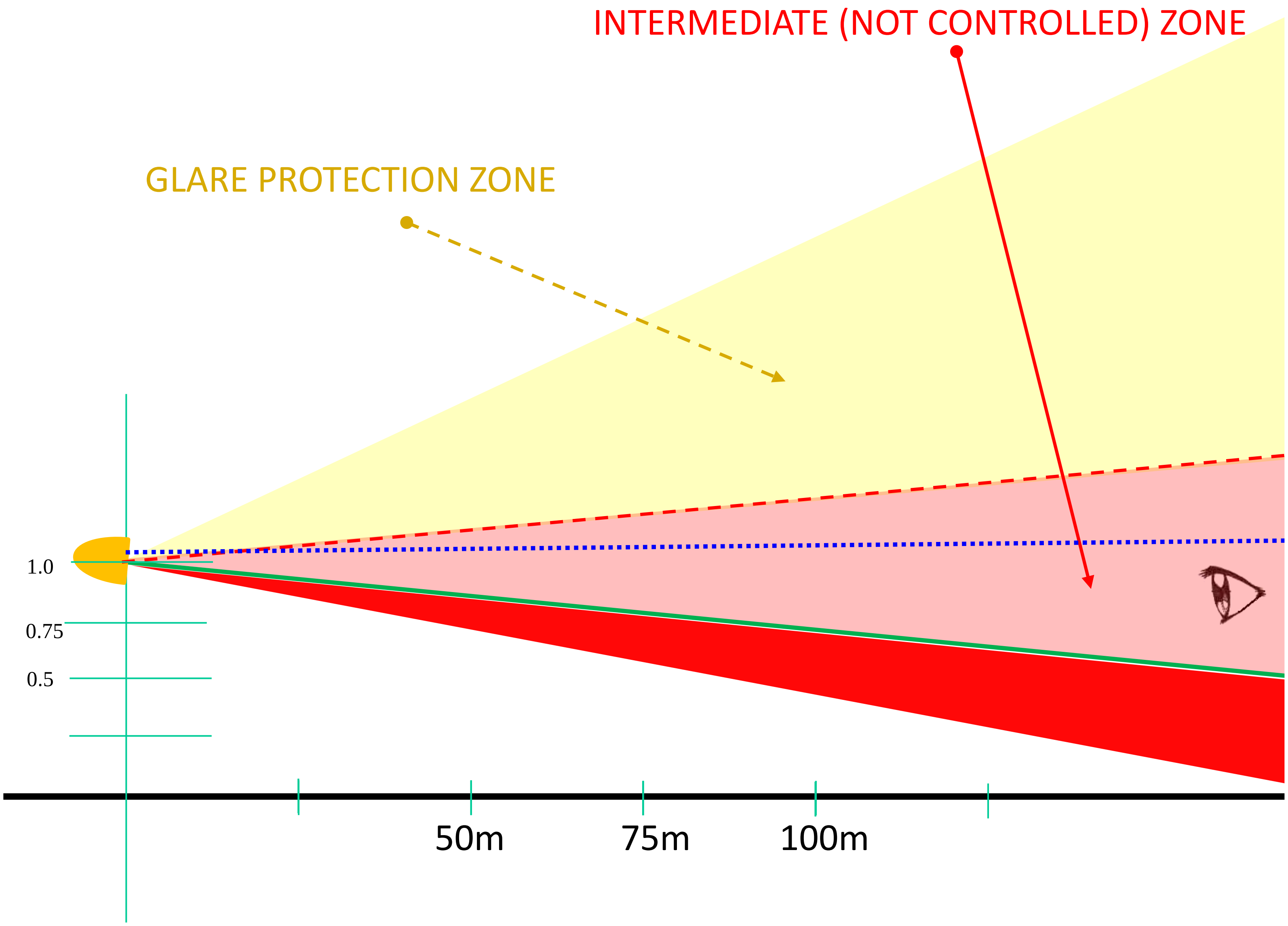
Presently Reg.48 does not allow aiming higher than 0.5% down



INTERMEDIATE (NOT CONTROLLED) ZONE
VALUES MORE THAN 1- 2lx@25m
(625 - 1200 cd)
GLARE PROTECTION ZONE
B50L
Zone III
H1
H2
H
45°
250
375
75L
50L
Zone II
50V
75R
250
50R
Zone IV
Zone I



AIMING NOT HIGHER THAN 100m CUT-OFF & ROAD CROSSING



AIMING HIGHER AND NOT CONTROLLED

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5. **Joint GTB/Poland/OICA**
   - **Conclusion**
   - **Suggestion**

Literature Studies regarding Glare and Visibility on Road Traffic

Carried out in GTB WG SVP for GTB TF CAVGS

Karl Manz
Chairman GTB WG SVP ….

Geneva, 01 April 2014

Literature studies regarding glare and visibility on road traffic

The current list contains more than 300 references, which are still under review and furthermore secondary literature is investigated.

In the following slides only a small number of references are highlighted!

- Basic documents and further literature reviews are:
- Hanno Westermann, History and Scientific Back-up , Informal Document No. 30 (48th GRE, 9-12 April) 2002 (Concept Basis)
- Ernst-Olaf Rosenhahn; Headlamp Glare and Auto-Levelling: Degree of Influence and Future Outlook; Presentation at WG FL, Turin, January 25, 2011
- (Basis mainly investigations of TU Darmstadt)
- Mace, D., P. Garvey, R. Porter, R. Schwab, and W. Adrian, Countermeasures for Reducing the Effects of Headlight Glare, AAA Foundation for Traffic Safety, Washington, D.C., 2001.
- (More general view)
- Bullough J. D.; Skinner N. P.; Pysar R. M.; Radetzky L. C.; Smith A. M. ; Rea M. S.; Nighttime Glare and Driving Performance: Research Findings; DOT HS 811 043; NHTSA Washington DC, September 2008
- Hills B. L., PhD; Visibility under night driving conditions Part:
  - 1. LABORATORY BACKGROUND AND THEORETICAL CONSIDERATIONS ; Lighting Research and Technology, 1975, Vol.7(3), pp.179-184
  - 2. FIELD MEASUREMENTS USING DISC OBSTACLES AND A PEDESTRIAN DUMMY.; Lighting Research and Technology, 1975, Vol.7(4), pp.251-258
  - 3. DERIVATION OF (DELTA L,A) CHARACTERISTICS AND FACTORS IN THEIR APPLICATION.; Lighting Research and Technology, 1976, Vol.8(1), pp.11-26

Targosiński T. ; Testing of headlamps beam patterns using computerized device with photometrical image analysis ISAL 2007 Darmstadt 09.2007
- headlamps photometric characteristics and aiming in real road in use condition research.

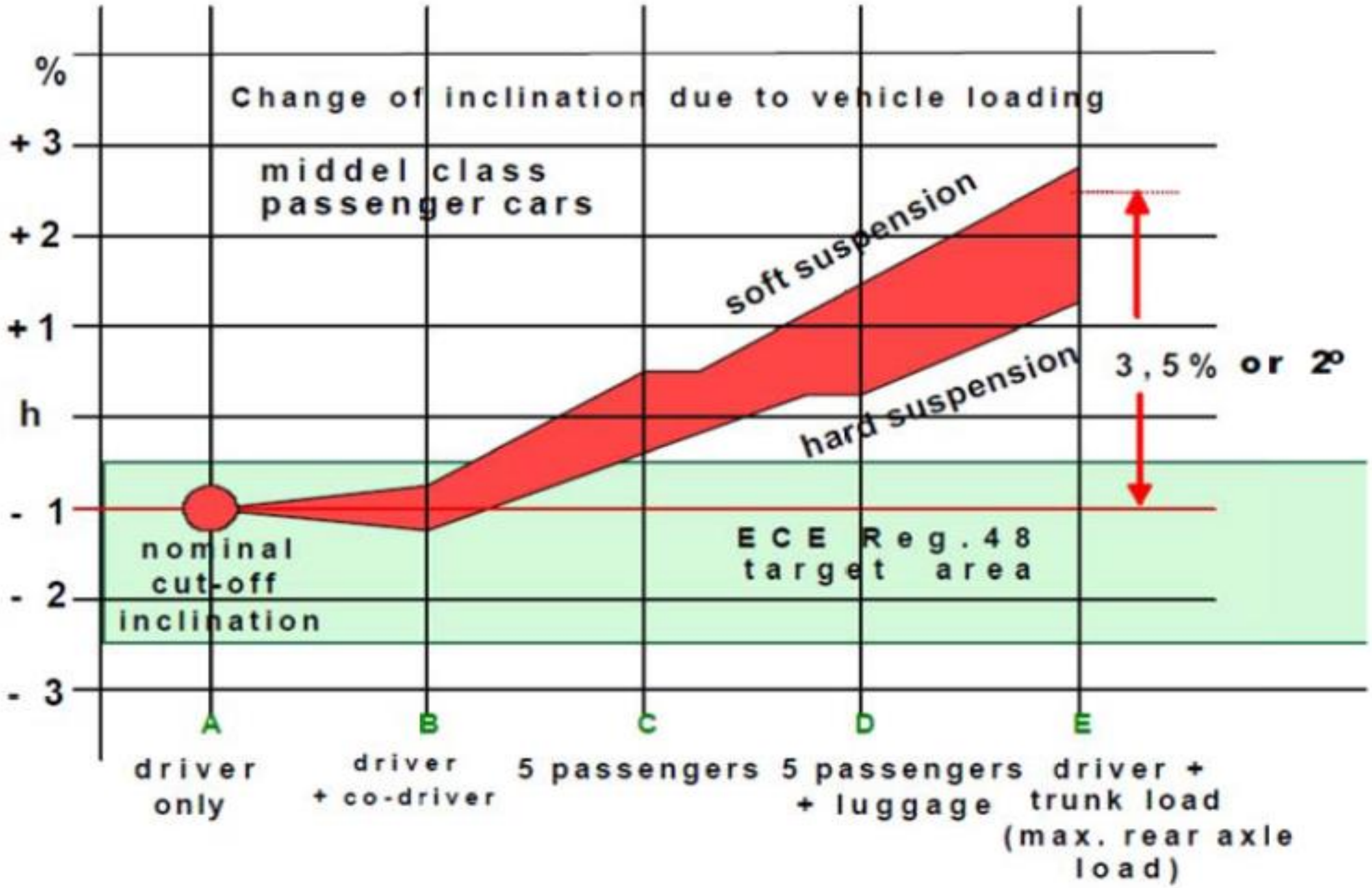
Targosiński T.; Passing Beam Visibility Distance - Technical Possibilities, Legal Requirements and Road Safety, JOURNAL OF KONES Vol. 18, No. 4 2011 ss. 511-517
- Analysis of real road illumination distance possibilities and practice

Damasky, J., "Anforderungen an Kraftfahrzeugscheinwerfer"; Thesis D17, TU Darmstadt, 1995

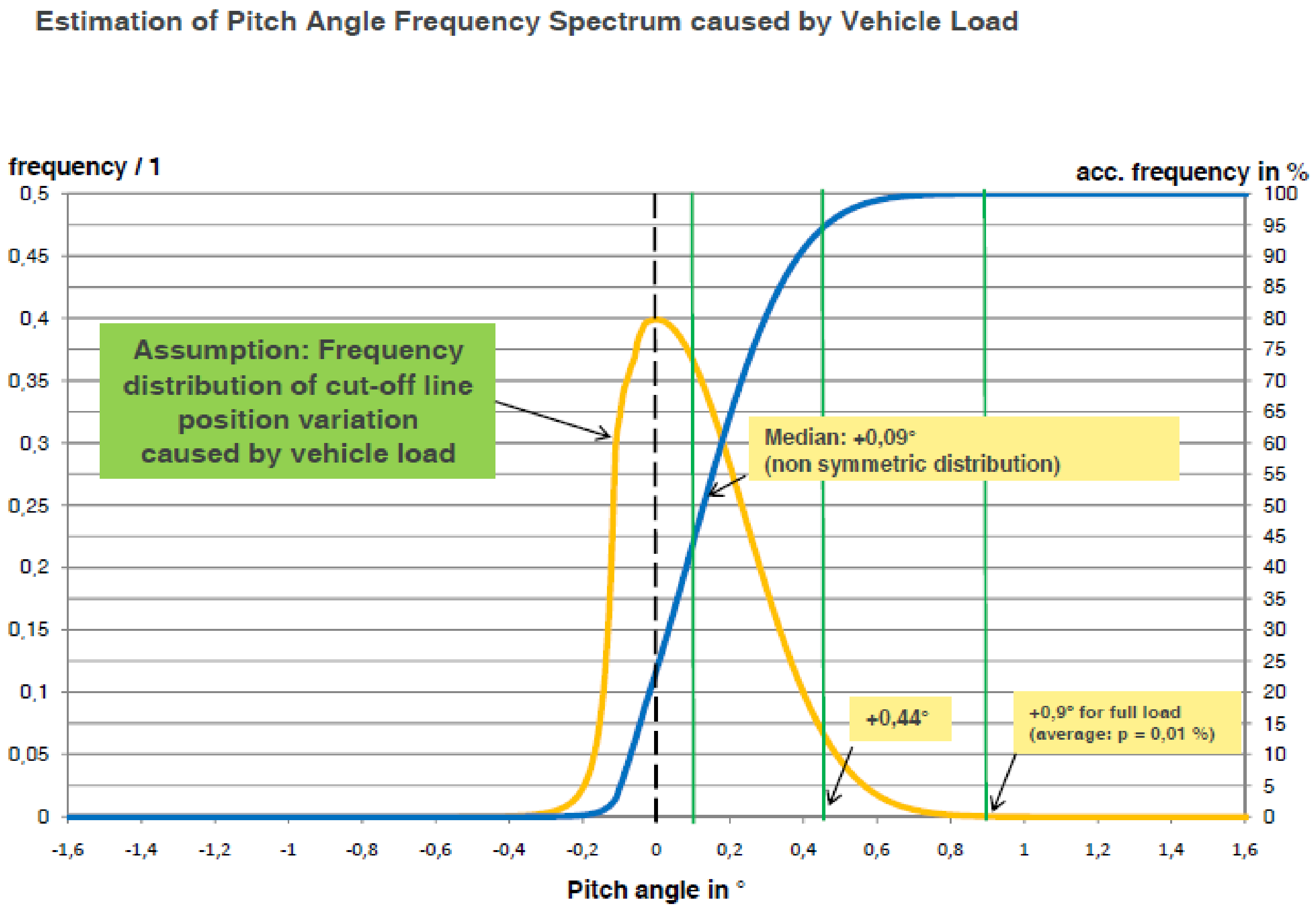
FLANNAGAN, MICHAEL J. ; SIVAK, MICHAEL; SCHOETTLE, BRANDON; "BENEFITS OF HEADLAMP LEVELING AND CLEANING FOR CURRENT U.S. LOW BEAMS"; Report No. UMTRI-2007-46 NOVEMBER 2007

Wolfgang Huhn: Anforderungen an eine adaptive Lichtverteilung für Kraftfahrzeugscheinwerfer im Rahmen der ECE-Regelungen; Thesis, TU Darmstadt, 1999 .

Hanno Westermann,
History and Scientific Back-up



Ernst-Olaf Rosenhahn;
Headlamp Glare and Auto-Levelling

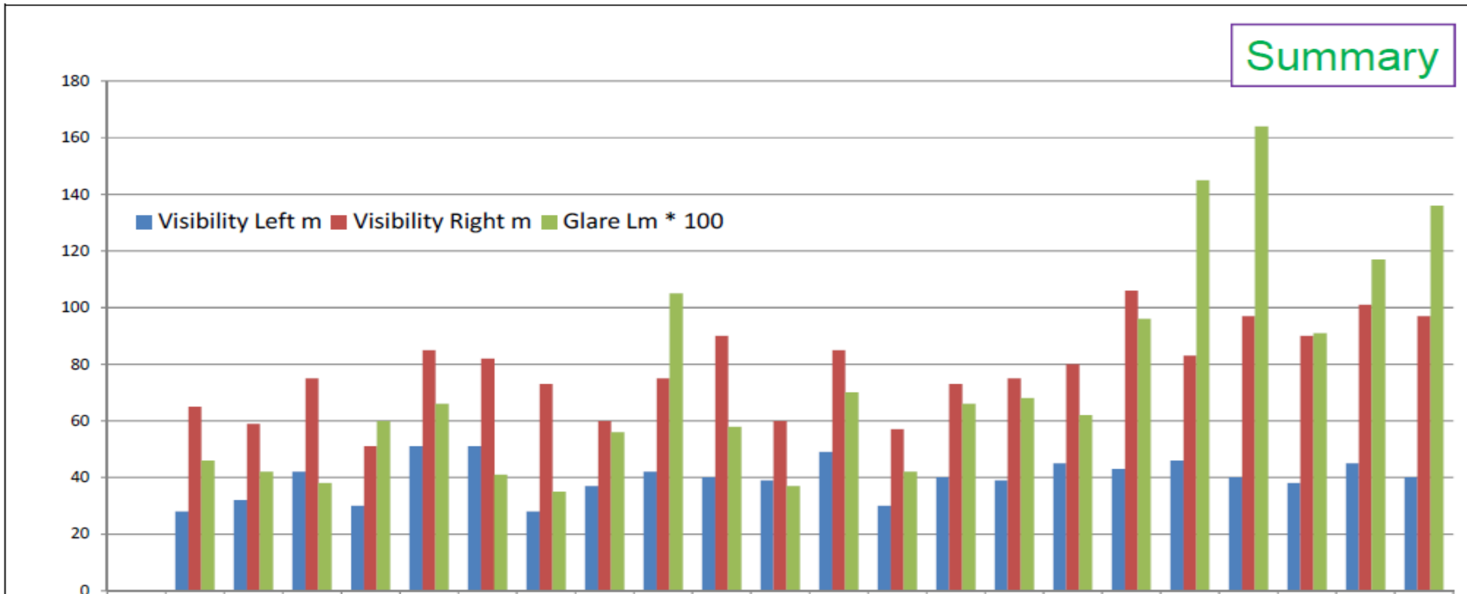


Geoff Draper (Chairman);

Performance Assessment Method for Vehicle Headlighting Systems

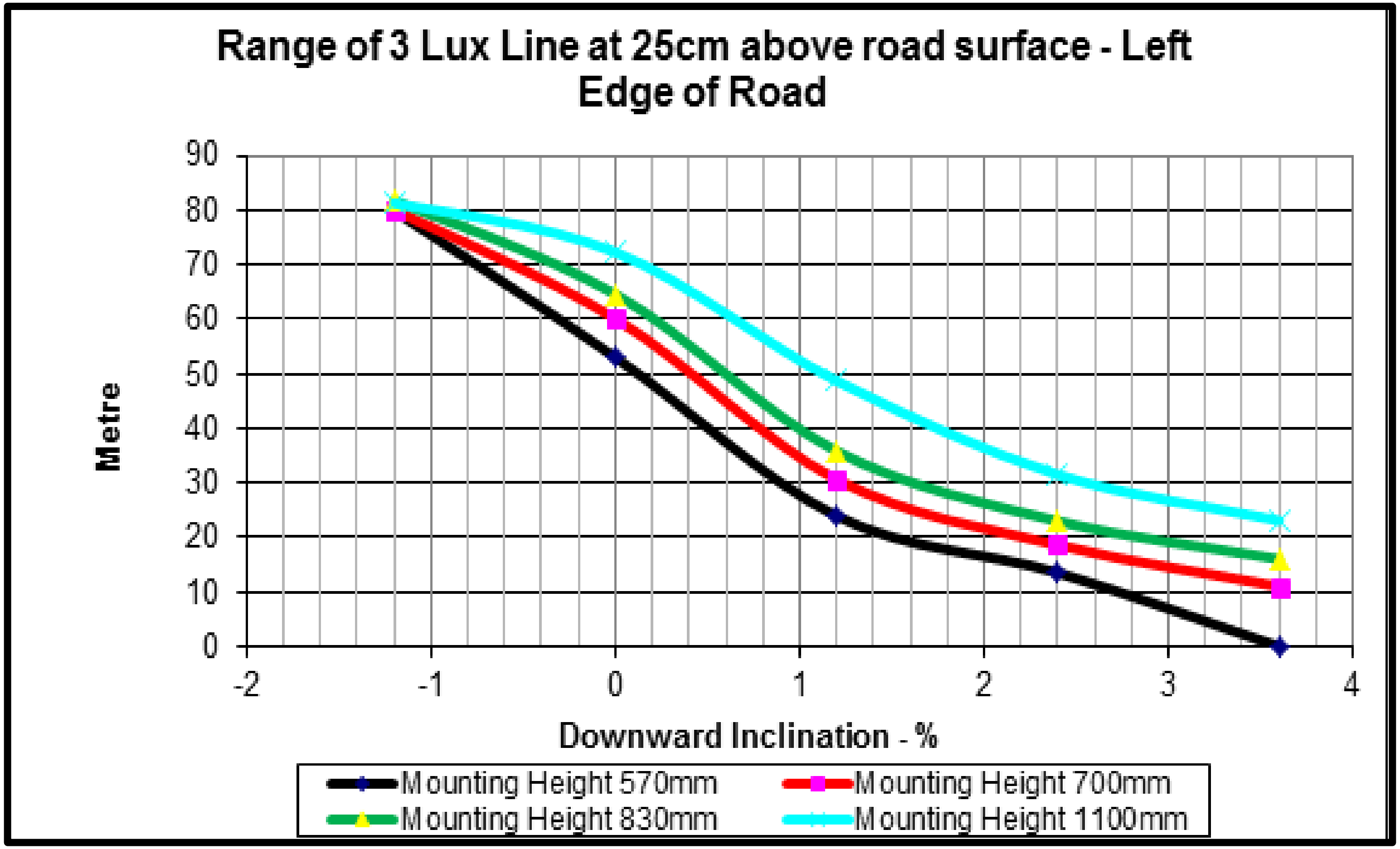
CIE 188:2010

The Work in CIE TC4-45 continues under the chairmanship of Gert Langhammer

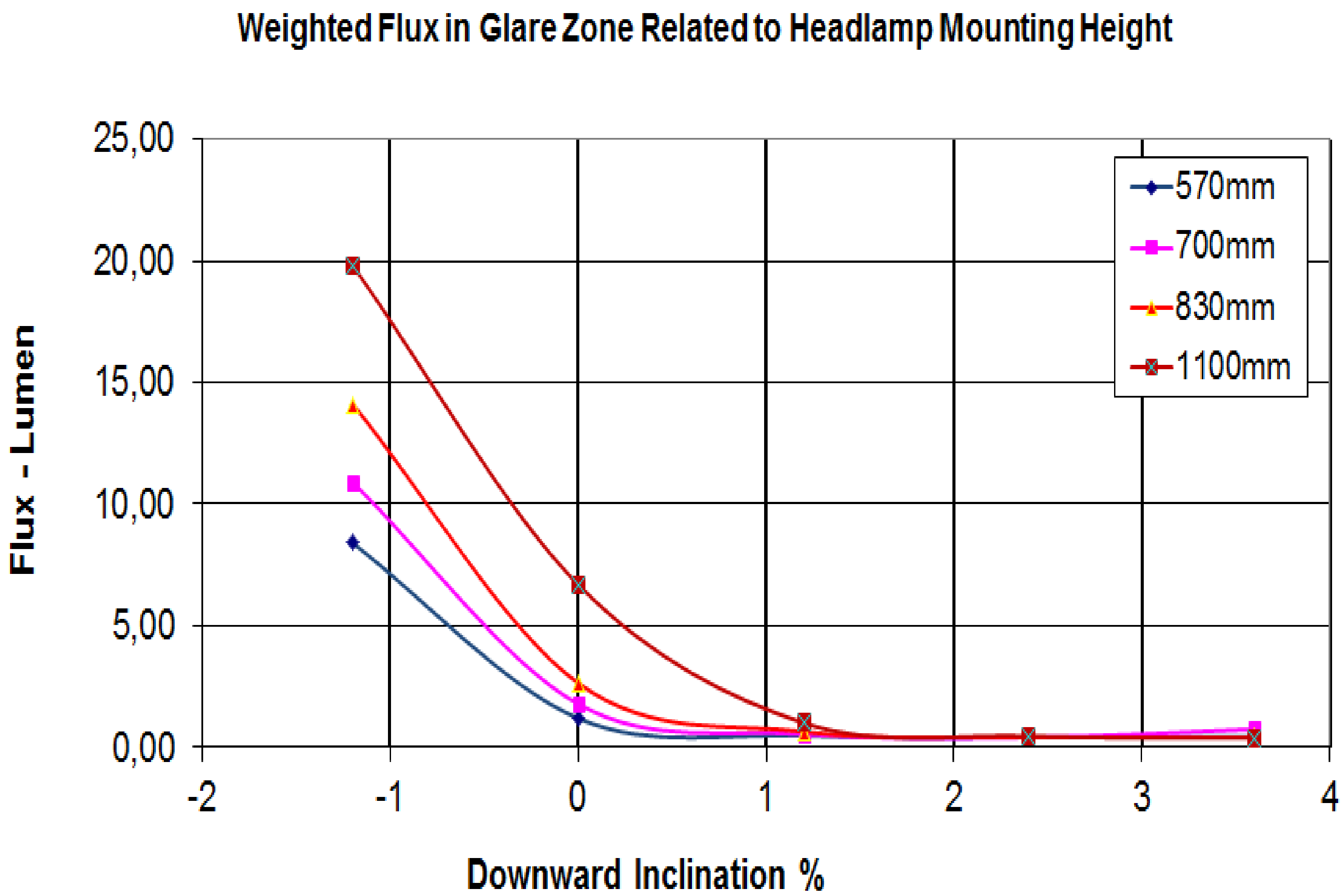


Sample	ECE01	ECE02	ECE03	ECE04	ECE05	ECE06	ECE07	ECE08	ECE09	ECE10	ECE11	ECE12	ECE13	ECE14	ECE15	ECE16	USA1	USA2	USA3	USA4	USA5	USA6
Optics	REF	REF	PROJ	REF	PROJ	PROJ	PROJ	REF	REF	PROJ	PROJ	PROJ	REF	REF	REF	REF	PROJ	REF	REF	PROJ	PROJ	PROJ
Bulb	HAL	HAL	GDL	HAL	GDL	GDL	GDL	HAL	HAL	GDL	GDL	GDL	HAL	HAL	GDL	HAL	HAL	HAL	HAL	HAL	GDL	HAL
Mount height mm	670	630	665	679	715	745	661	900	889	670	717	695	700	824	637	711	644	930	630	720	845	660

Geoff Draper (Chairman); ***Pedestrian* Visibility - Low Beam Optimization to Reduce Night-time Fatalities** ; **SAE SURFACE VEHICLE INFORMATION REPORT J2829 - 2011-02-24;**



Geoff Draper; *Pedestrian* Visibility



Downward inclination (pitch angle) and

mounting height of head lamps

control visibility distance and glare

in the opposite direction!

Glare

Adrian, Werner; "Proceedings of the First International Symposium on Glare“; New York: Lighting Research Institute;

Schmidt-Clausen, H. J. and Bindels, J. T. H. ; “Assessment of discomfort glare in motor vehicle lighting.” ; Lighting Research and Technology, 6(2), 79–88.

Vos Johannes J. ; Reflections on glare; *Lighting Res. Technol.* 35,2 (2003) pp. 163–176

Gibbons Ronald B. ; Edwards Christopher J.; A Review of Disability and Discomfort Glare Research and Future Direction, Submitted for Presentation at the TRB Biennial Visibility Symposium 2007

Von Hoffmann Alexander; Lichttechnische Anforderungen an adaptive Kraftfahrzeugscheinwerfer für trockene und nasse Fahrbahnoberflächen; Publikationsreihe Nr. 4; Thesis TU Ilmenau 2003

Stephan Völker; Hell- und Kontrastempfindung - ein Beitrag zur Entwicklung von Zielfunktionen für die Auslegung von Kraftfahrzeug-Scheinwerfern; Habilitationsschrift der Universität Paderborn Fakultät für Maschinenbau; Paderborn 2006

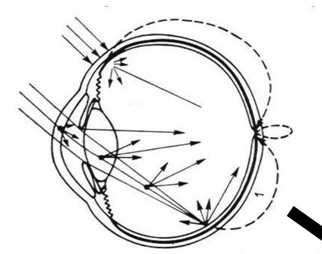
Hartmann, E.; Ucke, Ch. ; "effect of size of glare source on disability glare at small glare angles"; NASA technical translation, NASA TT F-15,581; national aeronautics and space administration Washington, D.C. 20546 MAY 1974; Lichttechnik 26 (1974) p. 20 - 23

Blendung durch kleine Lichtquellen hoher Leuchtdichte im peripheren Gesichtsfeld / Paul W. Schmits; Berlin, Techn. Univ., Diss., 1988

Finsterwalder, Josef (1991). Untersuchungen zur Physiologischen blendung bei sehr Kleinen Blendwinkeln. ("Investigations on Disability Glare at Very Small Glare Angles"). Ph.D. thesis at the Faculty of Physics of the Ludwig-Maxililian University, Munich, Germany.

Sprute, Jan Holger; "Entwicklung lichttechnischer Kriterien zur Blendungsminimierung von adaptiven Fernlichtsystemen„; Dissertation D17 , Darmstadt 2012

Disability Glare:



$$L_{seq} = K \cdot \frac{E_G}{\Theta^2}$$

$$C = \frac{(L_T + L_{seq}) - (L_B + L_{seq})}{(L_B + L_{seq})} = \frac{(L_T - L_B)}{(L_B + L_{seq})}$$

L_{seq} equivalent veiling luminance;

E_G Illuminance at the eye

Θ Glare anglebetween fixation point and glare source (Holladay Exponent 2)

k Proportional factor which depends on the age of the observer, typical value 9.2

L_T Luminance of the target; L_B surrounding luminance (Adaptation level)

Disability Glare:

For practical reasons, it is very helpful to describe disability glare as the so called threshold increment TI according to CIE.
TI described the percentage with which the threshold luminance of the target must be increased to compensate the glare effect.

$$TI = 65 \cdot \frac{L_{seq}}{L_B^{0,8}} \cdot [\%]$$

For further calculations it is better to define a “Threshold Increment Factor” TIF as:

$$TIF = 1 + TI / 100$$

Which describe directly the amount of increase to guarantee the visibility of the target.

$$TIF = 1 + 0.65 \cdot \frac{L_{seq}}{L_B^{0,8}}$$

For discomfort glare under road traffic geometry
the formula from Schmidt-Clausen, H. J. and Bindels, J. T. H.
is very useful:

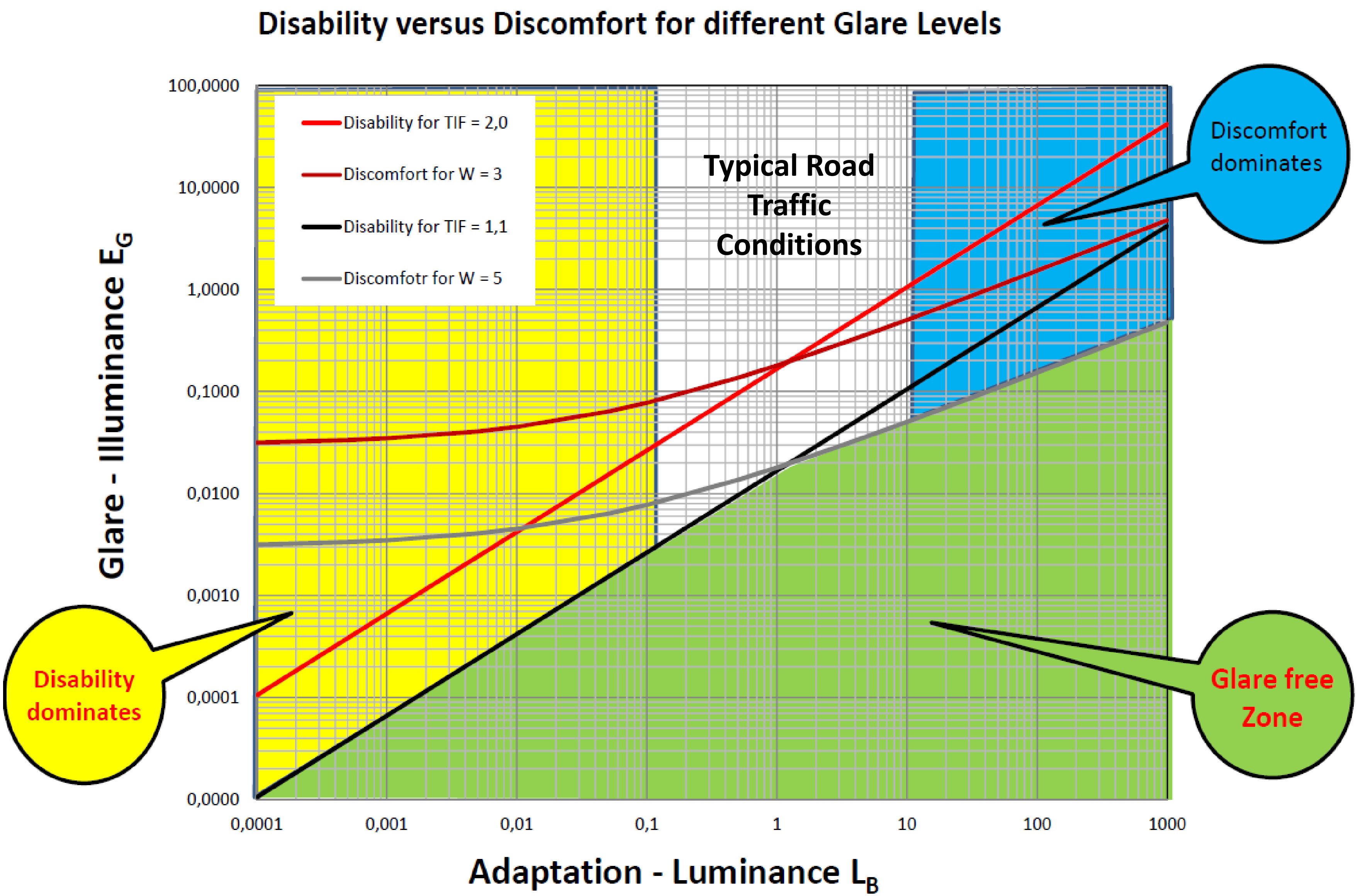
$$W = 5.0 - 2.0 LOG_{10} \frac{Ei}{0.003 * \left(1 + \sqrt{\frac{La}{0.04}}\right) * \theta_{max}^{\;0.46}}$$

W = mean value on deBoer's scale

E_i = Average level of illumination directed towards the observer's eye from the headlamps (lux)

θ_{max} = glare angle between observer's line of site and the headlamps at location where maximum illumination occurs (minutes)

L_a = adaptation luminance (cd/m^2)


Disability versus Discomfort for different Glare Levels
Disability for TIF = 2,0
Discomfort for W = 3
Disability for TIF = 1,1
Discomfotr for W = 5
Typical Road Traffic Conditions
Discomfort dominates
Disability dominates
Glare free Zone
100,0000
10,0000
1,0000
0,1000
0,0100
0,0010
0,0001
0,0000
0,0001
0,001
0,01
0,1
1
10
100
1000
Glare - Illuminance E_G
Adaptation - Luminance L_B

Conclusion:

At typical road traffic conditions at night
we must not differentiate between
disability and discomfort glare, because

<u>if we feel glared we are objectively glared!</u>

That means, we can simply speak about glare and the terms disability and discomfort glare are related only
to the methods to evaluate or to measure this phenomena.

Disability glare and visibility of pedestrians on straight traffic roads

Some input from SAE TF Pedestrian Protection;

Road scene with targets and a glare source

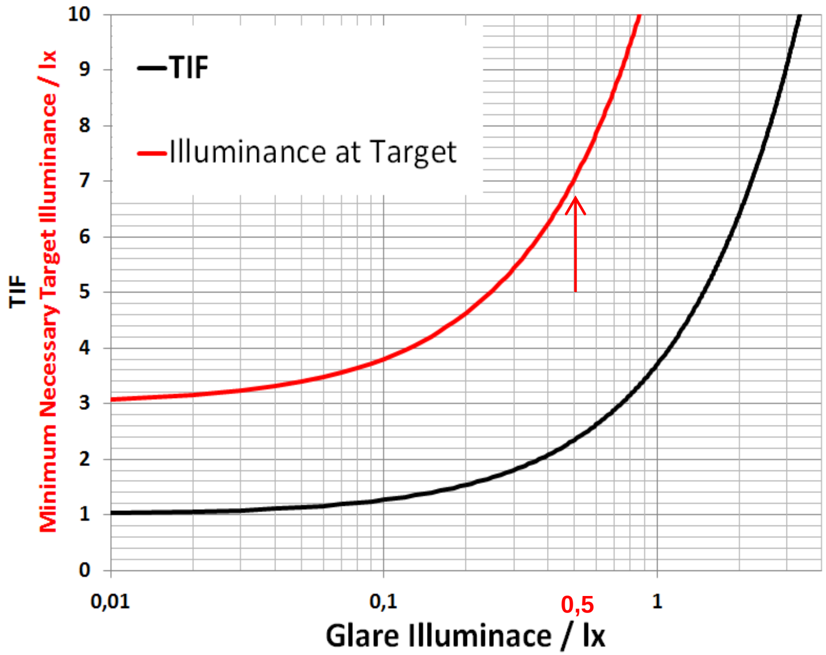
Walter Kosmatka and Rainer Rattunde Criteria:

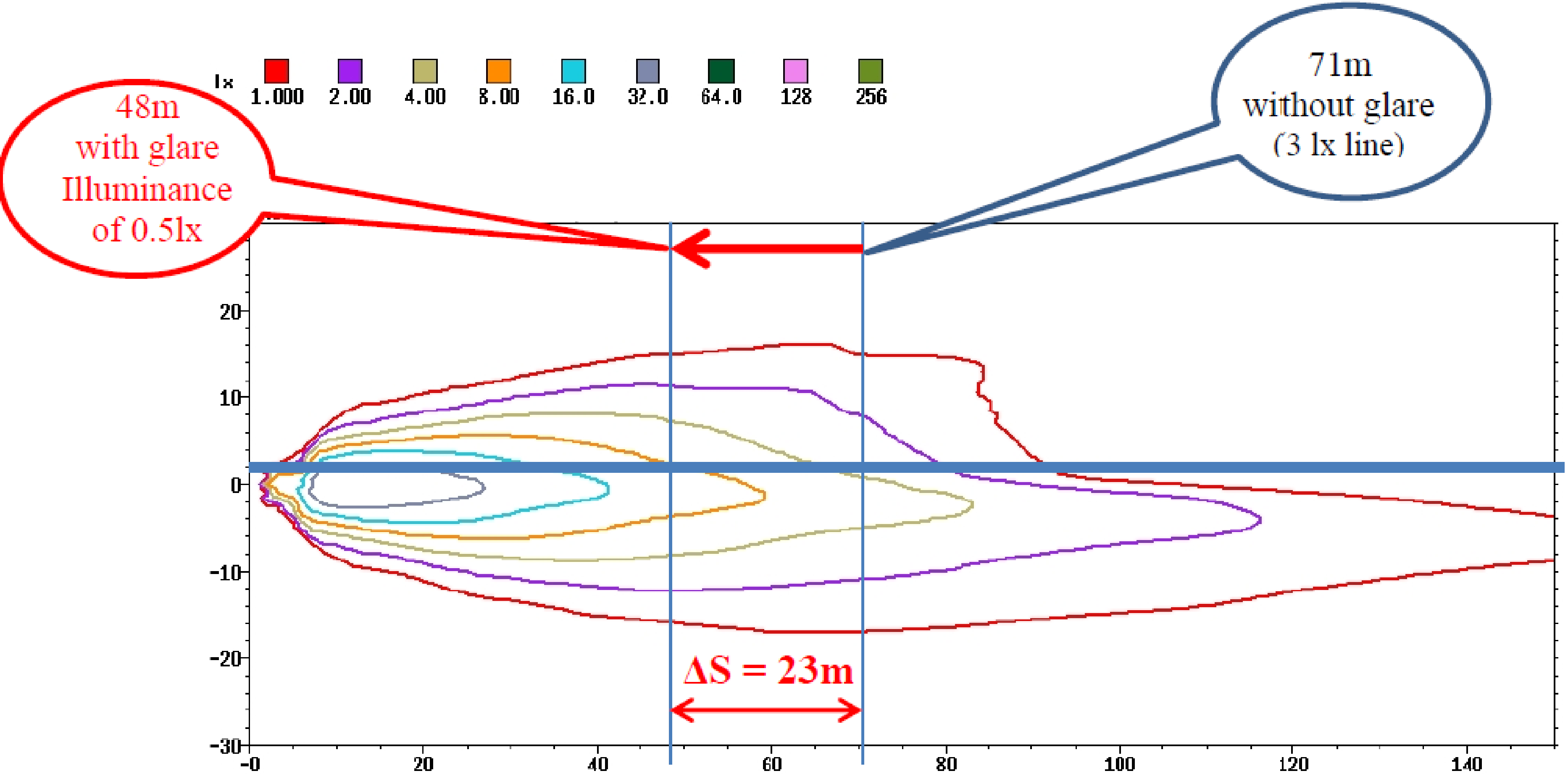
$E_{required} = L_{threshold} \times F_{expectancy} \times F_{Vad.} \times F_{adaptation/glare} \times F_{age} /(r)$

determined a value for **$E_{required}$ = 3lx** to produce on the target a **minimum luminance necessary for the detection of that obstacle**.

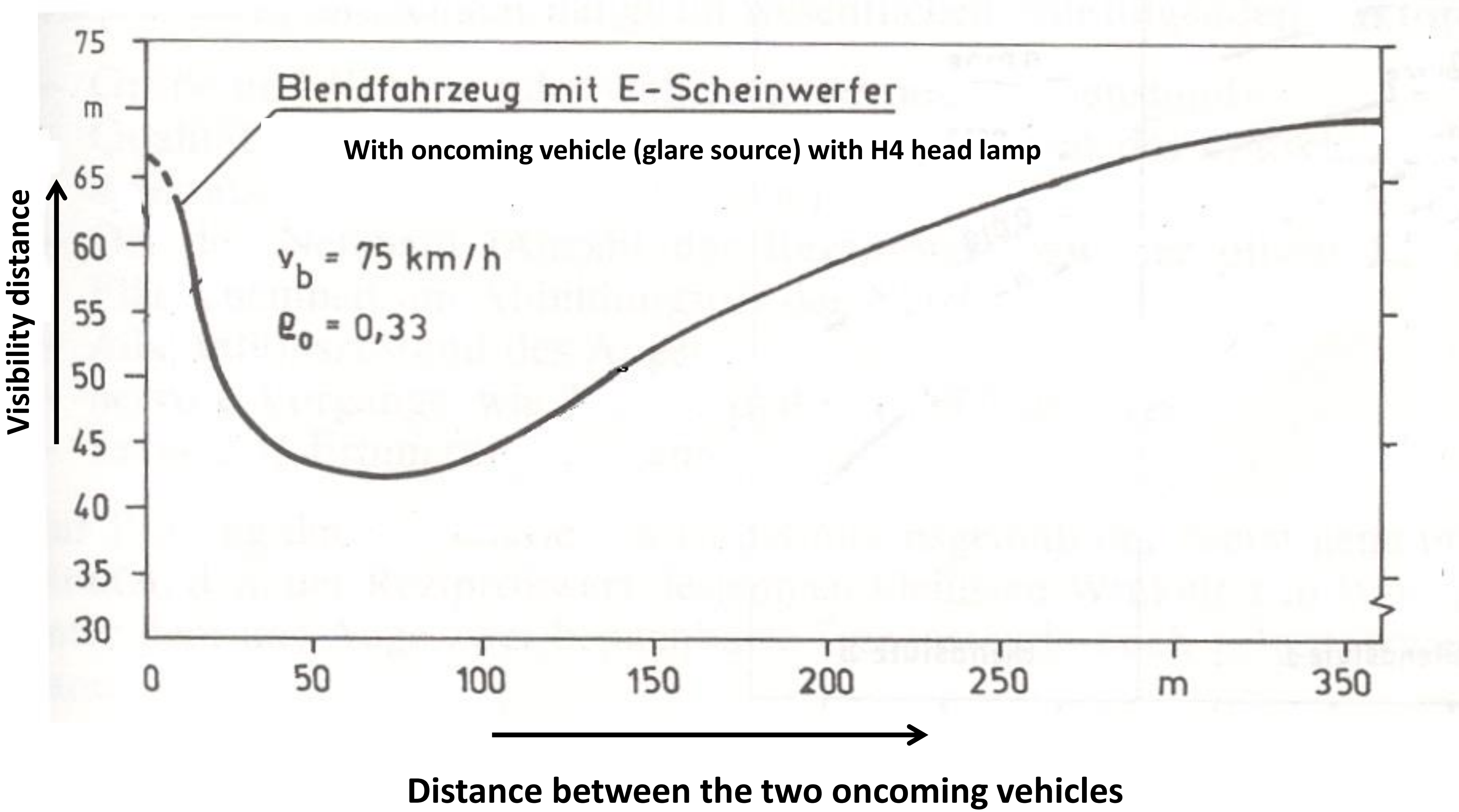
By the influence of glare the value for **$E_{required}$ became higher:**

$$E_{required+glare} = TIF \cdot E_{required}$$





H7 head lamp (H7 – Diagram: private communication from Rainer Neumann)



Picture detail from : Martin Eckert, Lichttechnik und optische Wahrnehmungssicherheit im Straßenverkehr, Verlag Technik Berlin, München 1993, p.63

Glare reduces the visibility and therefore the visibility distance;

Visibility distance is a key factor for safe driving!

Dynamic (Transient) Glare

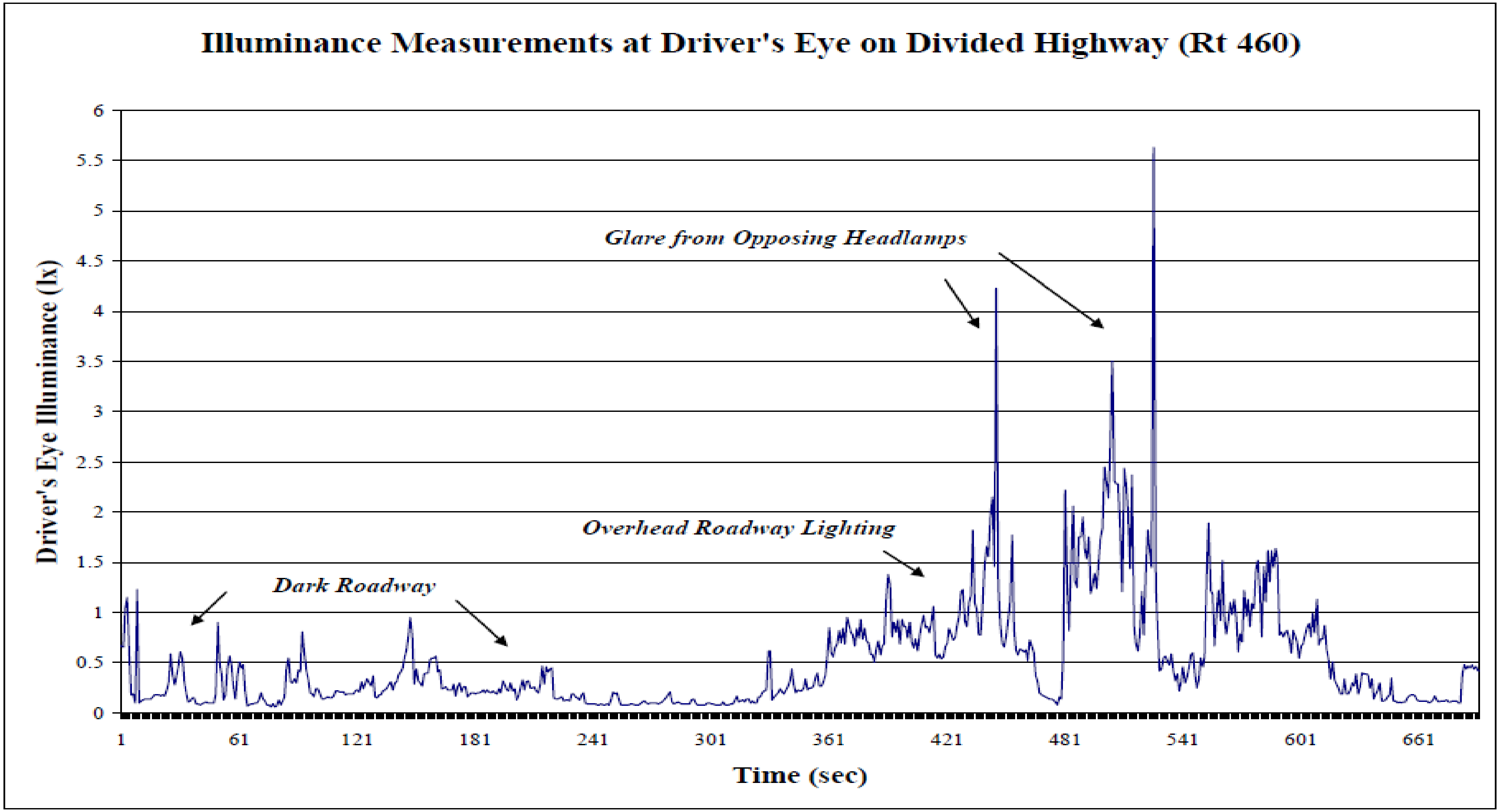
Murray, I.; Feather, J.; Carden, D.: "Dynamic Discomfort Glare and Driver Fatigue“; The Lighting Journal, July August 2002, pp 20 – 23

Lenhert, P. ; "Disability and Discomfort Glare under Dynamic Conditions- The Effect of Glare Stimuli on Human Vision“; PAL 2001 Symposium, Darmstadt University of Technology, 2001. Pp 582-592

Diem, Carsten ; "Dynamic glare“; AFS-research report FO-xx/98, TU-Darmstadt, 1998

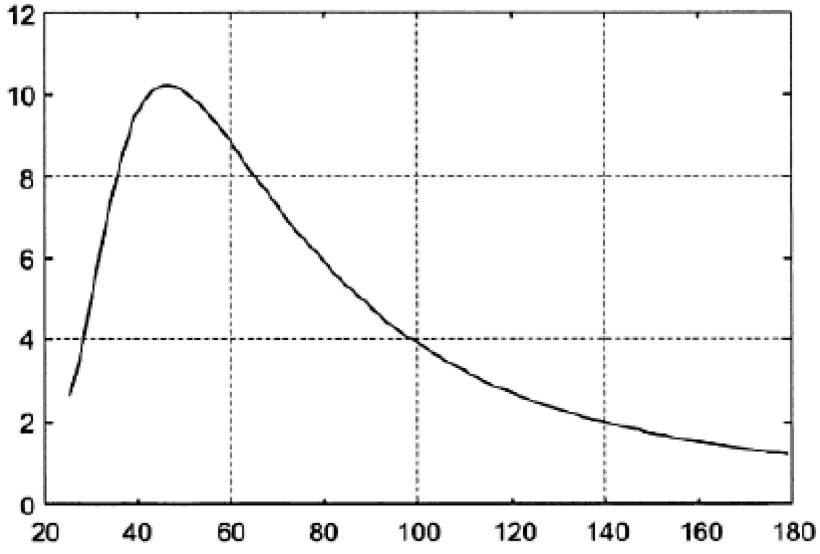
van Derlofske, Chen, Bullough and Akashy ; Headlight Glare Exposure and Recovery, SAE Paper 2005-01-1573; SAE World Congress Detroit 2005

Clark Jason ; Nighttime Driving Evaluation of the Effects of Disability and Discomfort Glare from Various Headlamps under Low and High Light Adaptation Levels ; Master Thesis; Blacksburg, Virginia November 17, 2004



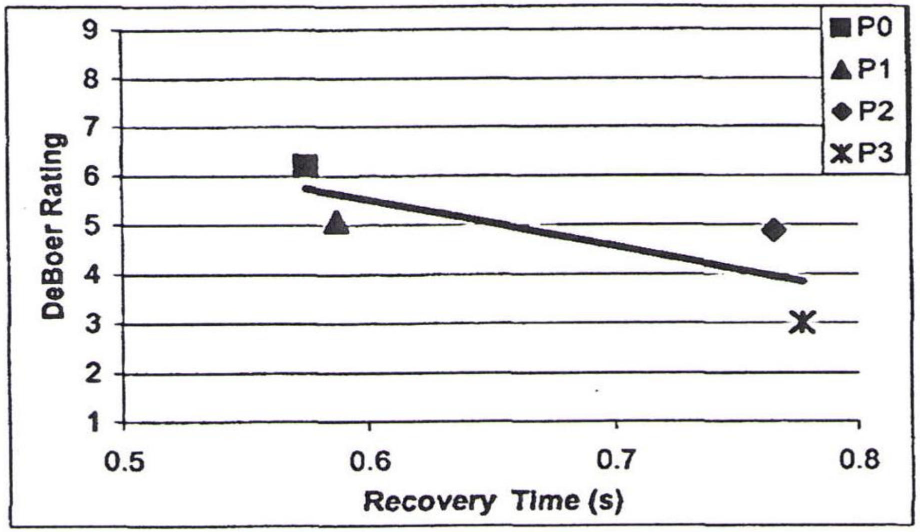
Illuminance Readings Taken on Route 460 at Night with and without Overhead Lighting and Glare. from Jason Clark

Lenhert, P.



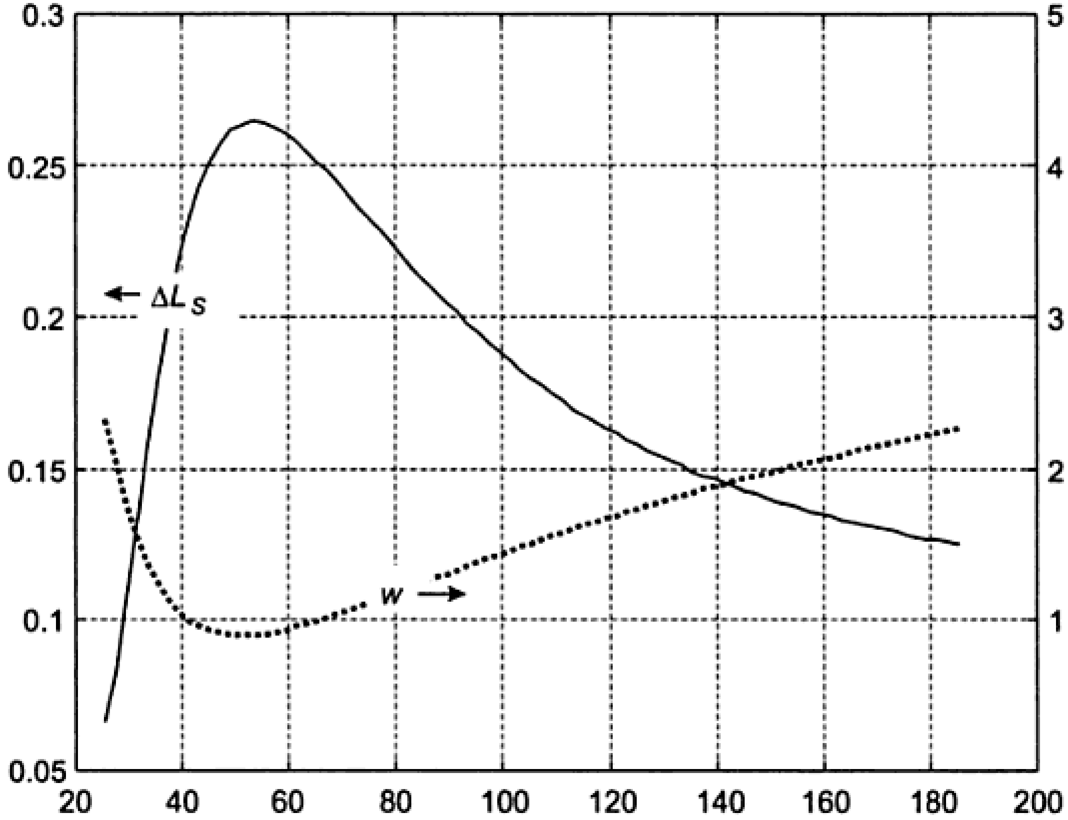
Maximum Glare Pulse Illuminance [lx] at the maximum pitch angle as a function of the distance between two meeting vehicles

van Derlofske, Chen, Bullough and Akashy



Evaluation of correlation between rating of discomfort and recovery time

Lenhert, P.



Distance between two oncoming vehicles

This diagram shows the glare situation of driver as a function of the distance to the oncoming vehicle.

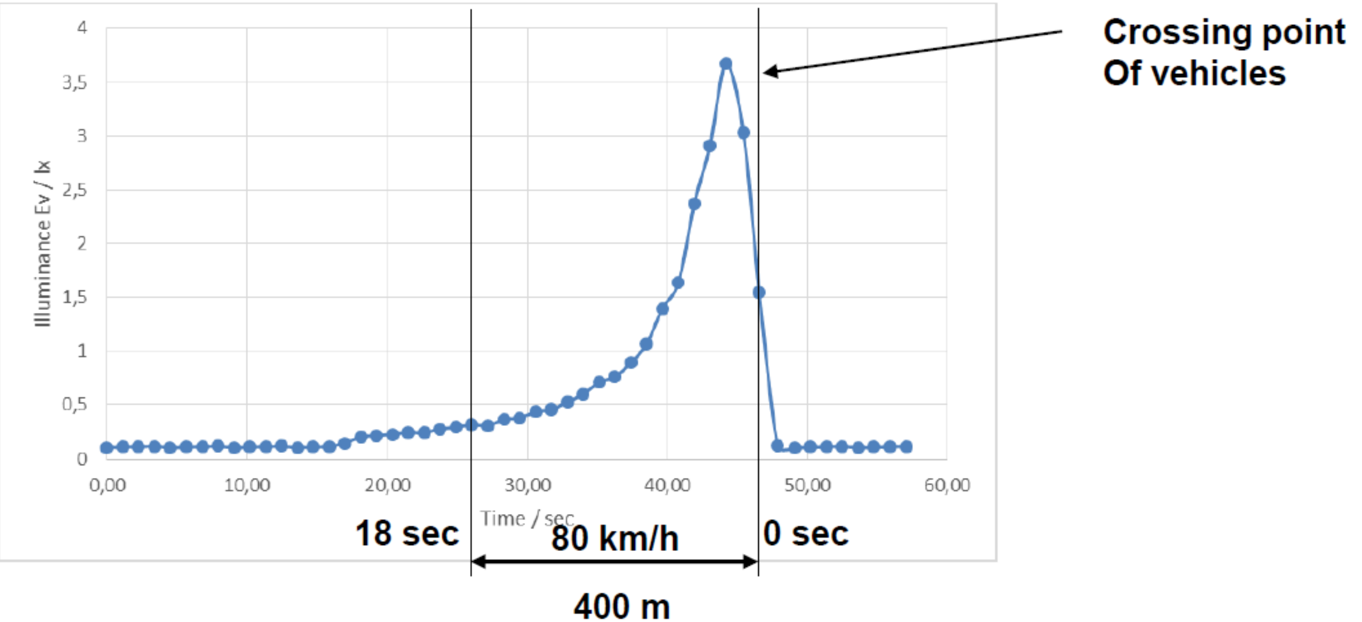
A Result of the Klettwitz Study:

Evaluation of Illuminance

TECHNISCHE UNIVERSITÄT DARMSTADT

- Maximum of illuminance Ev_max
- Exposure in 400 m (Sprute): 80 km/h →18 sec exposure time

$$H_v = \int_0^{18} E_v(t)\, dt$$



Accident Studies:

who.int/violence_injury_prevention/road_traffic/activities/roadsafety_training_manual

Risk factors for road traffic injuries

World Health Organization

Risk factors influencing crash involvement

— inappropriate and excessive speed;
— presence of alcohol, medicinal or recreational drugs;
— fatigue;
— being a young male;
— having youths driving in the same car;
— being a vulnerable road user in urban and residential areas;
— travelling in darkness;
— vehicle factors – such as braking, handling and maintenance;
— defects in road design, layout and maintenance, which can also lead to unsafe behaviour by road users;
— inadequate visibility because of environmental factors (making it hard to detect vehicles and other road users);
— poor eyesight of road users.

Road Safety Research Report No. 80

Analysis of the On the Spot (OTS) Road Accident Database

Page 30

Visual impairment or obscuration	Cross from behind parked car	21
	View obscured from window	18
	Glare from sun	20
	Glare from headlights	5
	Surroundings obscured by stationary or parked car	43
	Surroundings obscured by moving vehicle	21
	Obscuration due to weather	5
	Failure to see pedestrian in blind spot	1

Department for Transport
Great Minster House
76 Marsham Street
London SW1P 4DR
Telephone 020 7944 8300
Web site www.dft.gov.uk

Hannah Mansfield and Alex Bunting,
QinetiQ Ltd
Marieke Martens and Richard van der Horst,
TNO Human Factors

February 2008

Department for Transport: London

Synthesis of Human Factors Research on Older Drivers and Highway Safety Volume I: Older Driver Research Synthesis U. S. Department of Transportation Federal Highway Administration; Publication No. FHWA-RD-97-094

Page 16 …

Despite evidence that glare sensitivity and glare recovery are important age-related visual changes, evidence is sparse that glare is associated with actual driving performance.
Burg's (1967) study and the reanalysis by Hills and Burg (1977) **demonstrated a significant relationship between glare recovery rate and crash rate**; however, **the relationship was relatively weak.**

Headlight glare was attributed as a possible "environmental" factor in approximately 2.3 percent of night accidents in another study (Indiana University, 1975) cited in Mortimer, 1988).

Glare was mentioned as a factor in 3 of 30 crashes where drivers ran off of the road, in a study by Boyce, Hochmuth, Meneguzzer, and Mortimer (1987; cited in Mortimer, 1988).

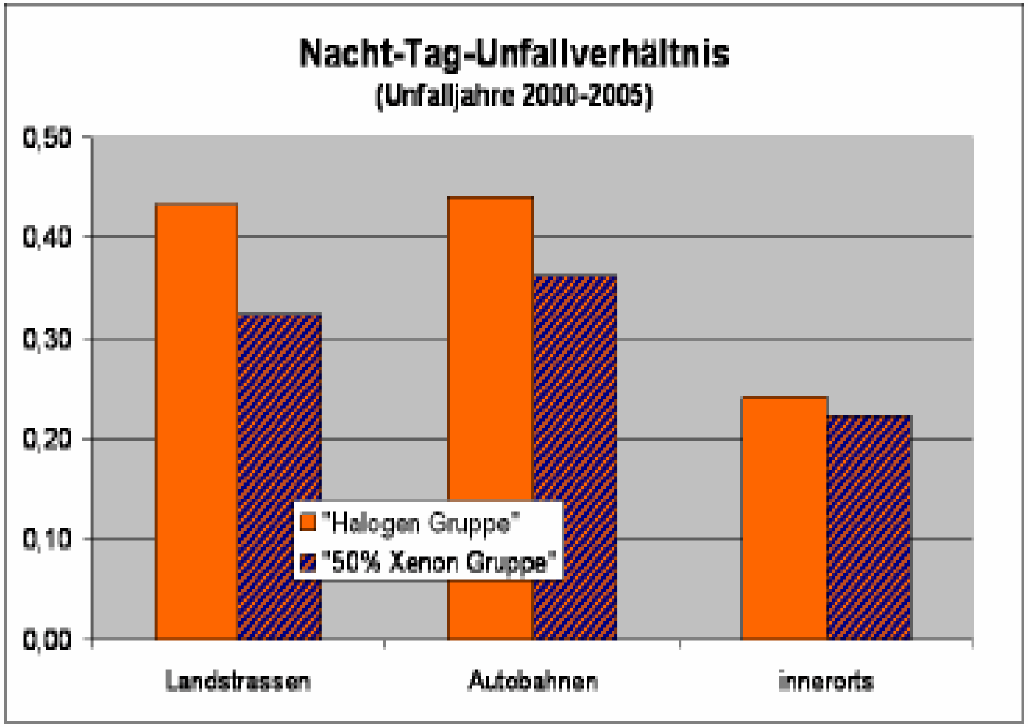
Further, **glare was named as a factor in 30 of 231 crashes in which adverse environment was involved** (Sabey and Stoughton, 1975; cited in Mortimer, 1988).

The time needed to recover from glare was also included in Burg's (1971) study, and was found to **correlate weakly with accident rates**.

Other studies, however, have failed to find a direct relationship between glare sensitivity measures and driving performance (Shinar et al., 1977; Wolbarsht, 1977; Burg, 1967; Owsley et al., 1991)

Mortimer, R. G. ; "Headlamp performance factors affecting the visibility of older drivers in night driving."; **In Transportation in an Aging Society: Improving Mobility and Safety for Older Persons, Special Report 218, Vol. 2, pp. 379–403. Committee for the Study on Improving Mobility and Safety for Older Persons, Transportation Research Board, Washington, DC, (1988)**

Investigation from the Light.Sight.Safety Group:



With the conclusion: Headlamps with improved light distribution and better performance are also a clear improvement for road safety.

Schlager Walter, Philips Technologie; Geywitz-Senn Johannes, Automotive Lighting Xenon-Licht *zur* Reduzierung *des* Unfallrisikos bei Nacht.; Light.Sight.Safety Report

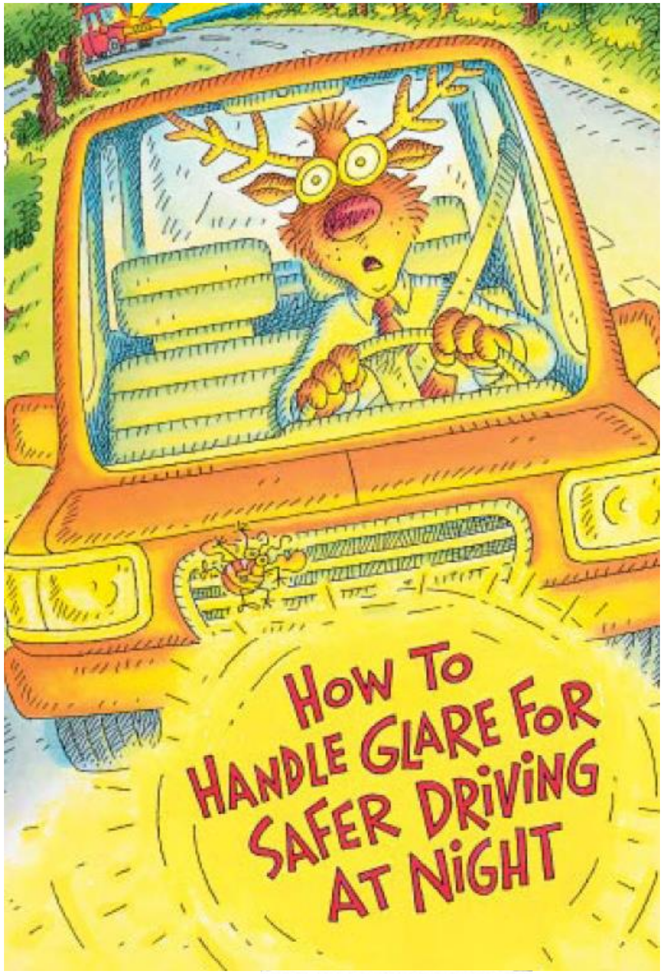
Hull Roy W.; Hemion Roger H.; Cadena David G.; Guidelines for Improving the Stability of Headlamp Aim; DOT/HS-800 739; U.S. Departement of Transportation NHTSA, Washington D.C. ; 1972

. Headlamp Load-levelling Devices

Numerous methods have been devised to provide automatic headlamp aim compensation for changes in vehicle loading; however, very few have ever been incorporated in production vehicles available to the public. More numerous designs have been developed and made available, for providing vehicle load-levelling. This latter concept accomplishes the effect of headlamp aim control but also provides improved vehicle handling characteristics. It is seldom, if ever, promoted or incorporated on vehicles primarily to improve headlamp aim.

With the trend toward higher intensities for vehicle headlamps to improve highway vision, it is essential that better headlamp aim be achieved and maintained. Automatic headlamp levelling would appear to be essential to this effort.

Literature studies regarding glare and visibility on road traffic



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Thank you for your attention

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   - Conclusion
   - Suggestion

GTB Field Test

Dr. Rainer Neumann
Chairman GTB WGFL

Geneva , 1.4.2014

Agenda

Introduction: Glare and Visibility
Klettwitz Field Test 2012
Discomfort Glare
Disability Glare
Special WGFL Meetings in Darmstadt (9/2013), Vienna (11/2013), and Torino (2/2014)
Summary

Introduction

- Influencing Parameters for discomfort glare in Night Time Driving * :

- - Initial aiming of the headlamps
- - geometry of the road
- - weather conditions
- - dynamic behaviour of vehicle

* : GTB Lighting ForumTorino 1/2011

Introduction

- and loading condition of vehicles

- Report of statistical analysis of cars involved in accidents (France) :
-
  - **<u>Accidental data : EACS + EDA</u>**
  - ✓ **74% of cars involved in an accident have an empty trunk**
  - ✓ **21% of cars involved in an accident contain 0 - 40kg in the trunk**
  - ✓ **4% of cars involved in an accident contain 40 - 100kg in the trunk**
  - ✓ **0,5% of cars contain 100 - 190kg in the trunk**

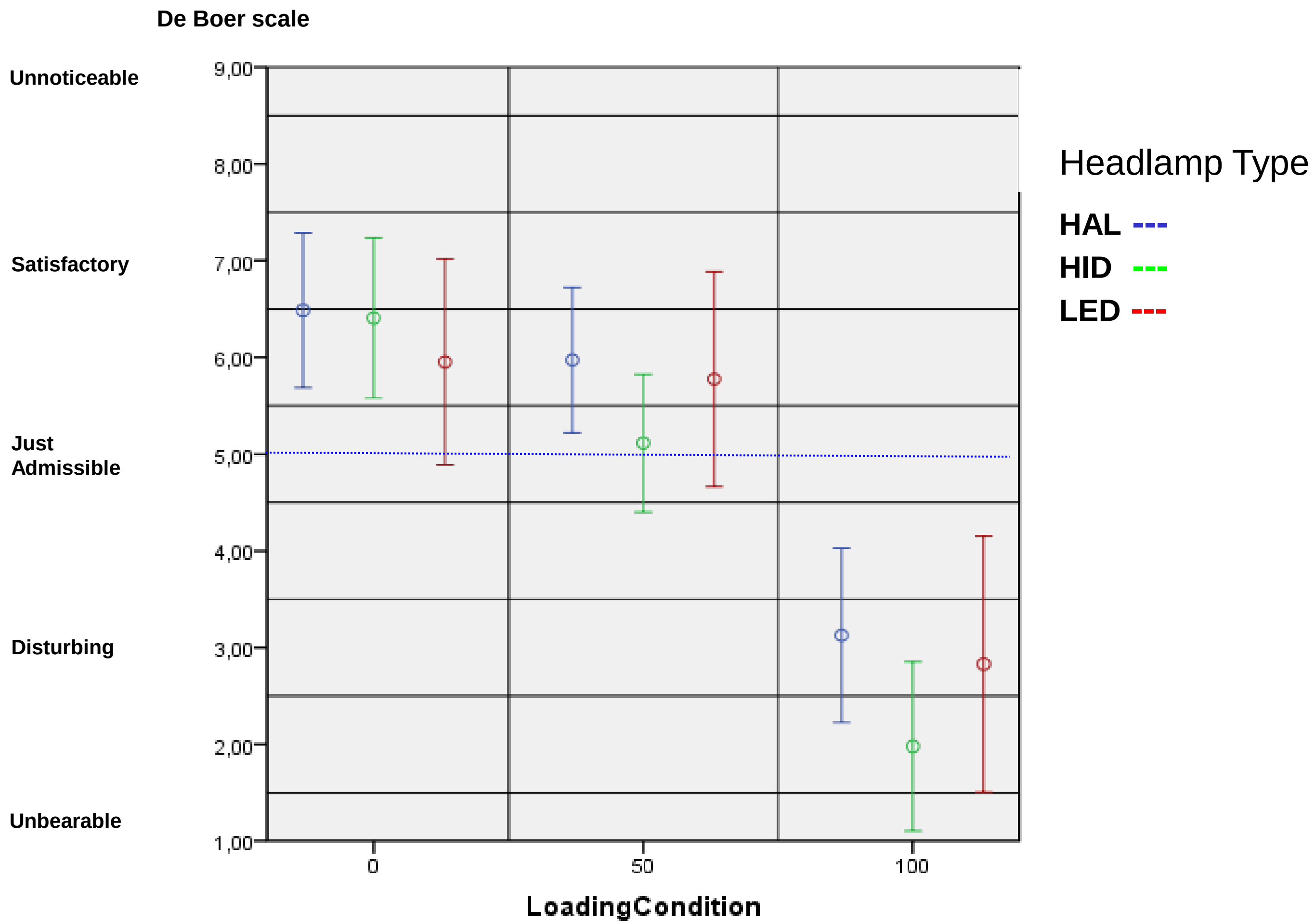
Questionaire - de Boer Scale

Discomfort Glare Rating – (Please perform rating from top to bottom)

	Unnoticeable		Satisfactory		Just Admissible		Disturbing		Unbearable
1	9	8 X	7	6	5	4	3	2	1
2	9	8	7 X	6	5	4	3	2	1
3	9	8	7	6	5 X	4	3	2	1
4	9	8	7	6	5	4	3	2 X	1
5	9	8	7	6 X	5	4	3	2	1

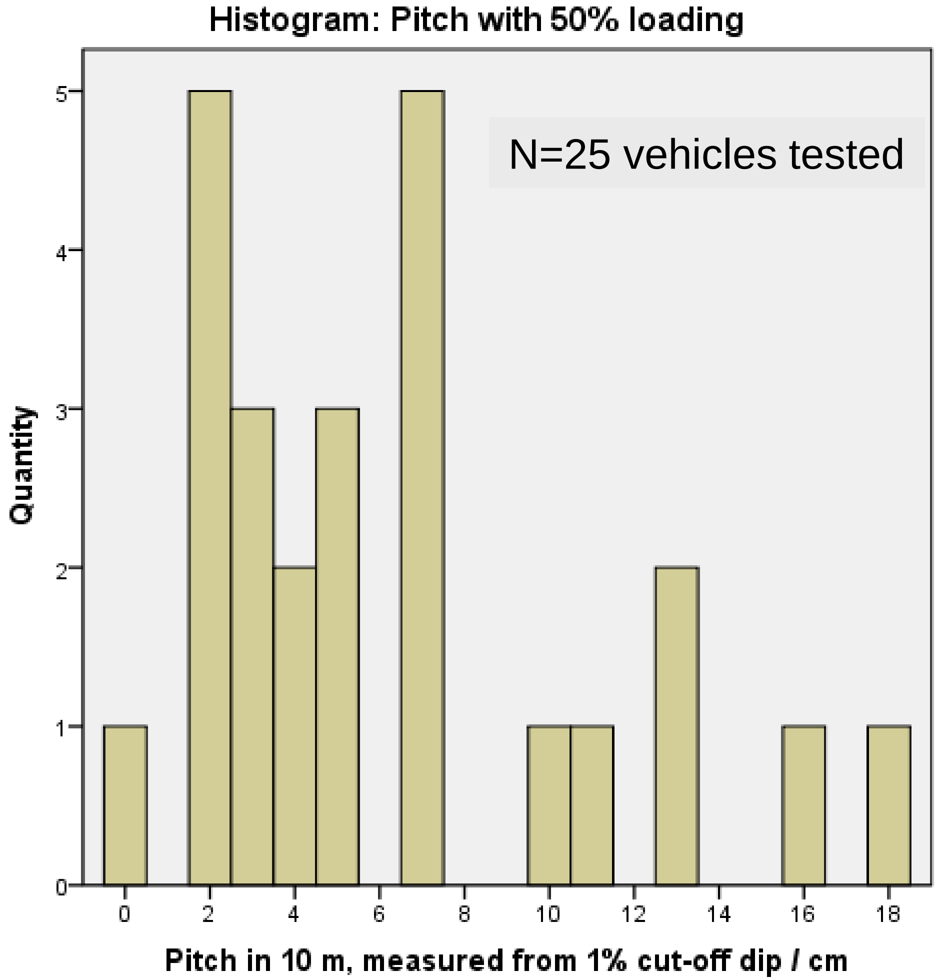
	Unnoticeable		Satisfactory		Just Admissible		Disturbing		Unbearable
6	9	8	7	6 X	5	4	3	2	1
7	9	8	7	6	5	4	3 X	2	1

Results for Halogen, Xenon, LED

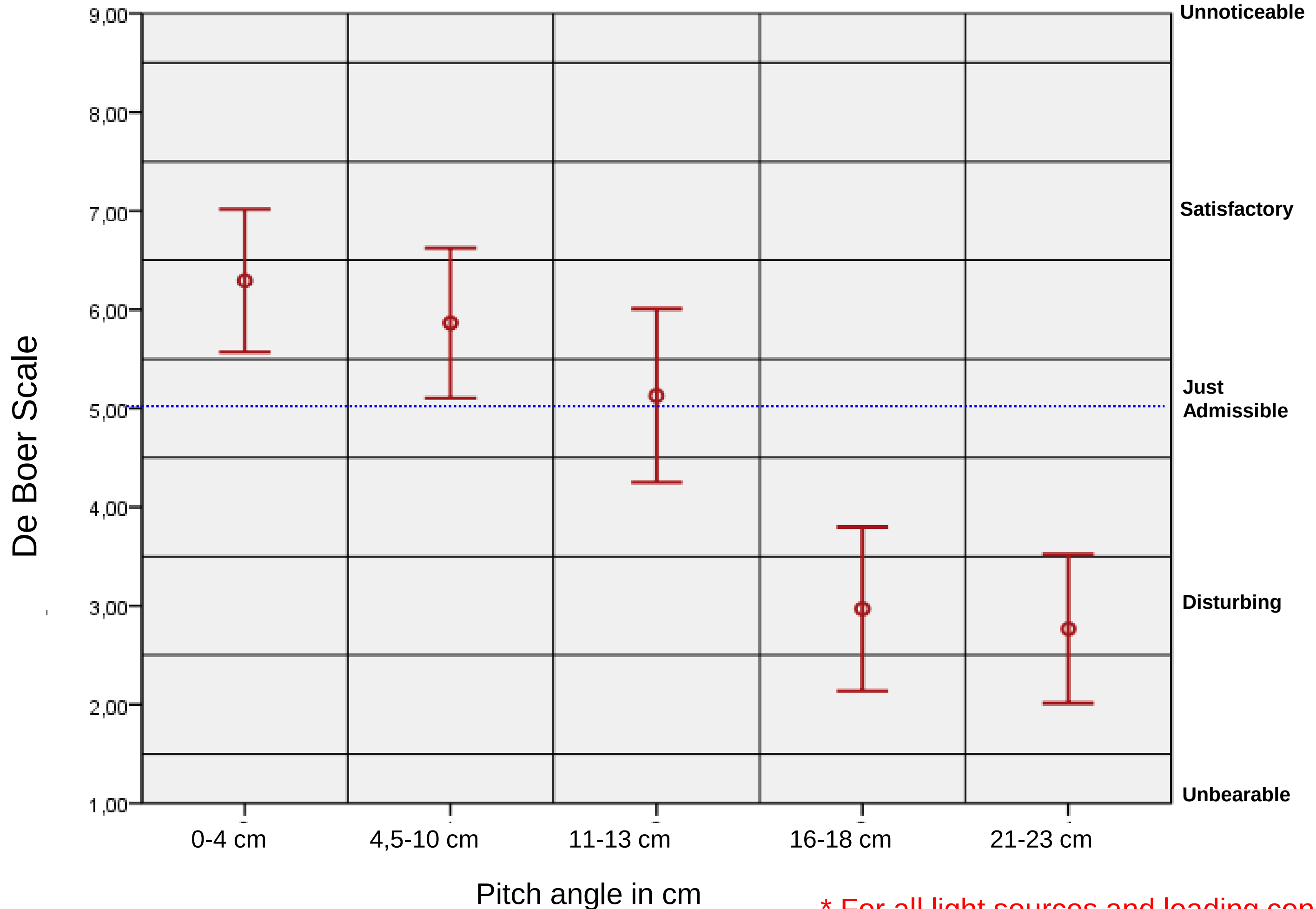


* Width of the bars covers app. 70% of all ratings

Results for all Light Sources



Pitch Angle Results



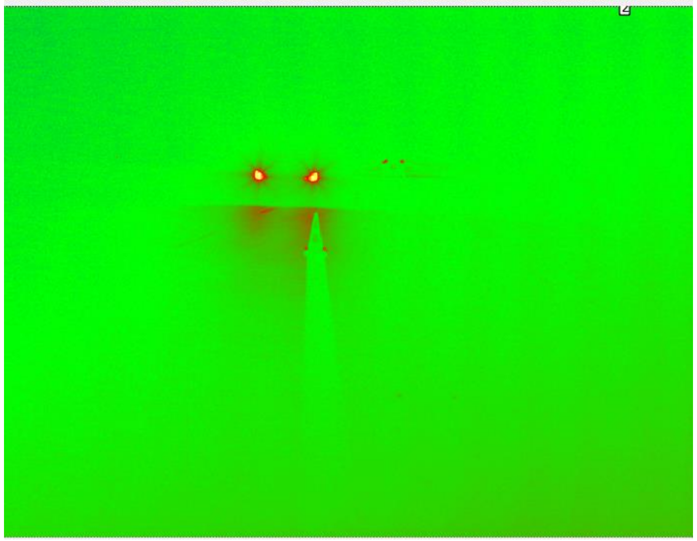
* For all light sources and loading conditions

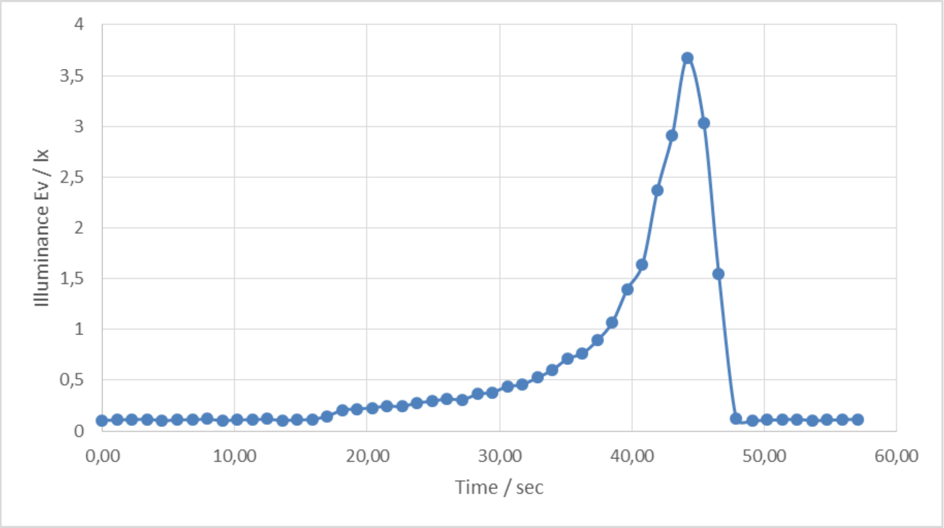
Disability Glare

- Findings from Discomfort Glare based on de Boer rating have been verified by studying the results on luminance and illuminance values of the tested vehicles

Measured Quantities

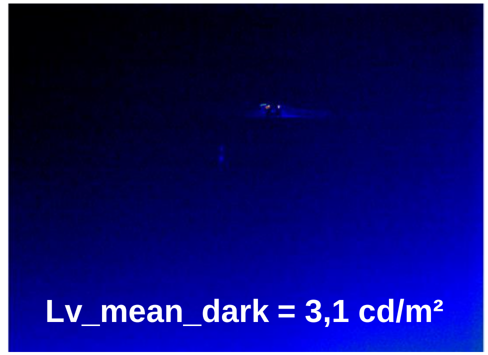
- Luminance Lv
  - Lv @ 25 m and 50 m, driver position
- Illuminance Ev
  - Ev (t), driver- and co-driver position

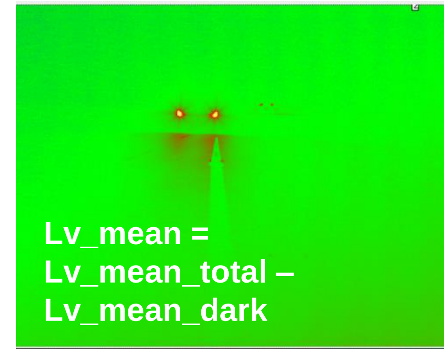




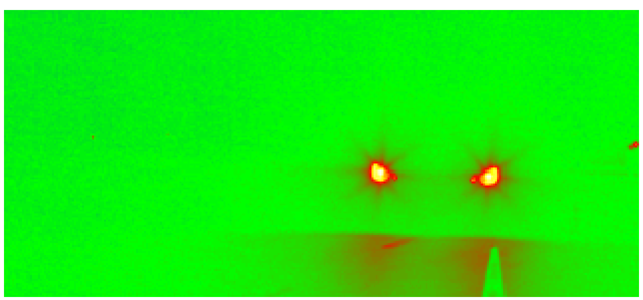
Luminance

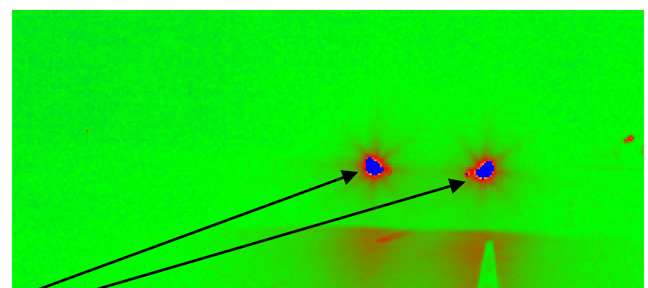
- Total luminance
  - Lv_mean, Lv_max





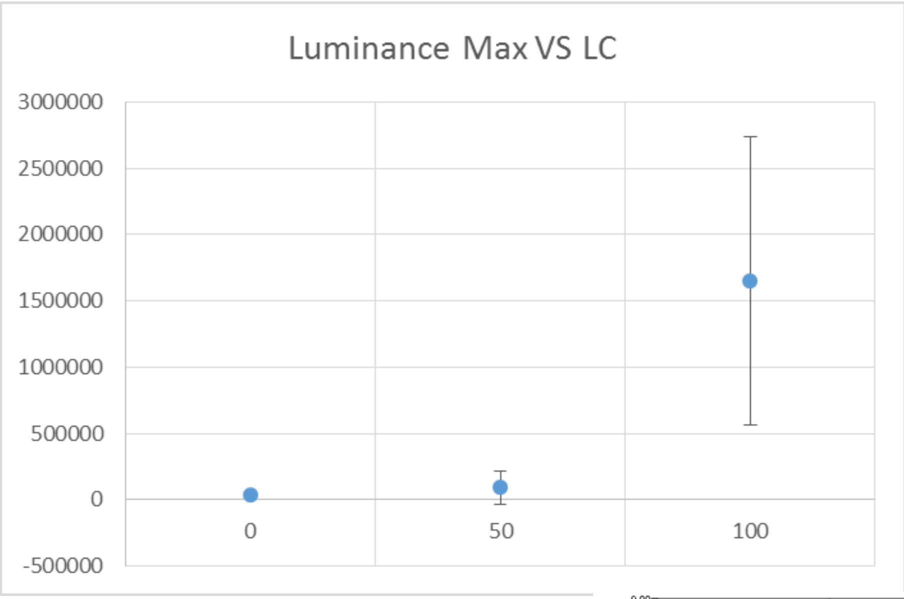
- Area with Lv > 310 cd/m², adaptation was 3,1 cd/m²:
  - In this area: Lv_mean, Lv_max, Size

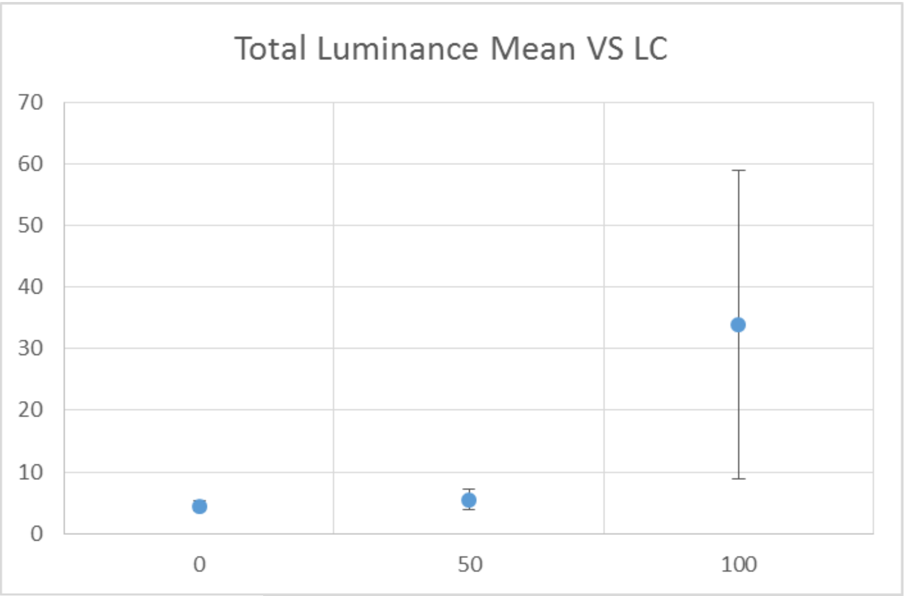


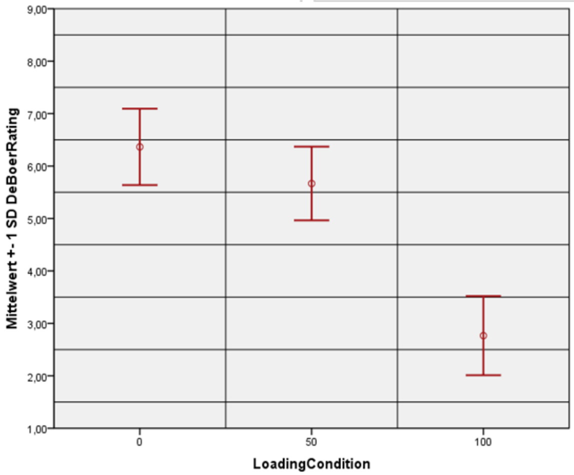


Stat.Nr.	Parameter	Bild	Region	Klasse	Fläche	Min	Max	Mittelwert	Streuung
1	Lum_Gr[1]	Leuchtdichtebild	2	Hell	402	326,6	41000	5121	7509

Luminance VS Loading Condition



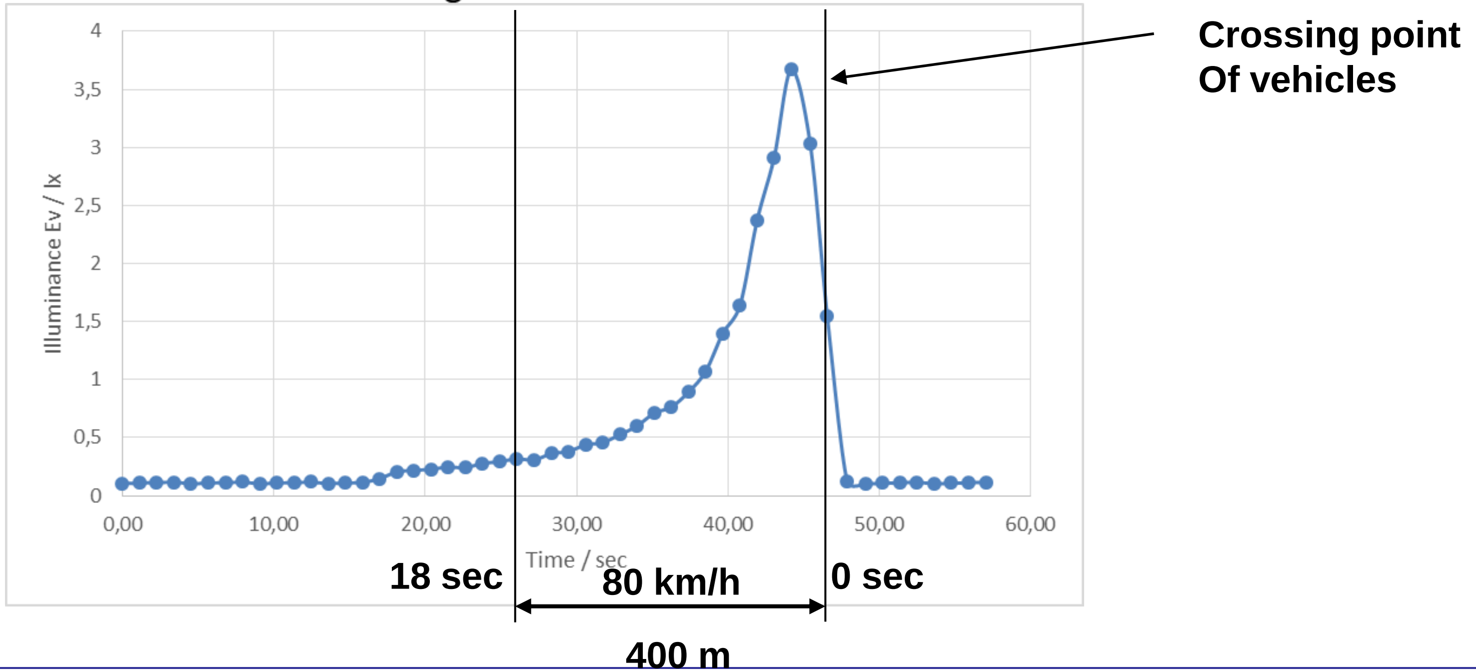




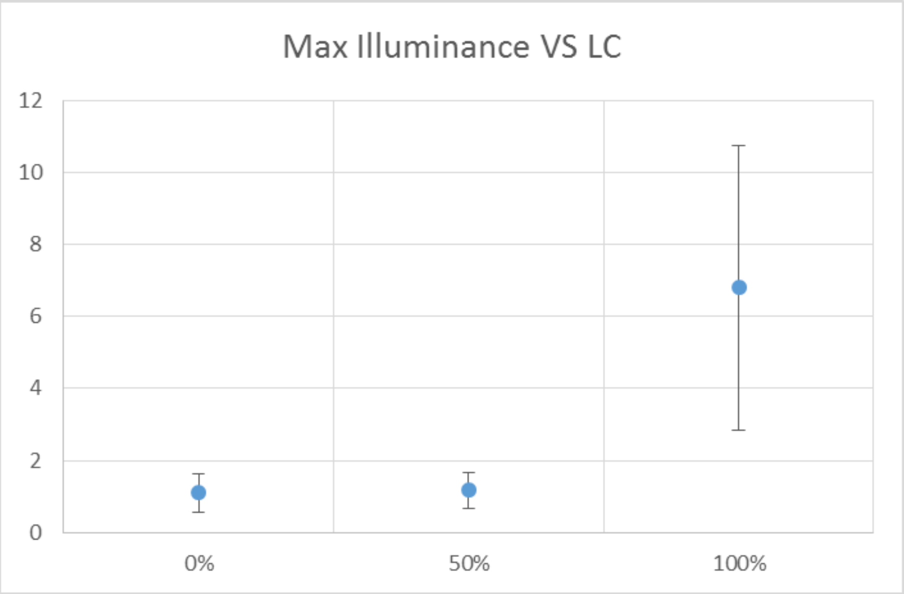
Evaluation of Illuminance

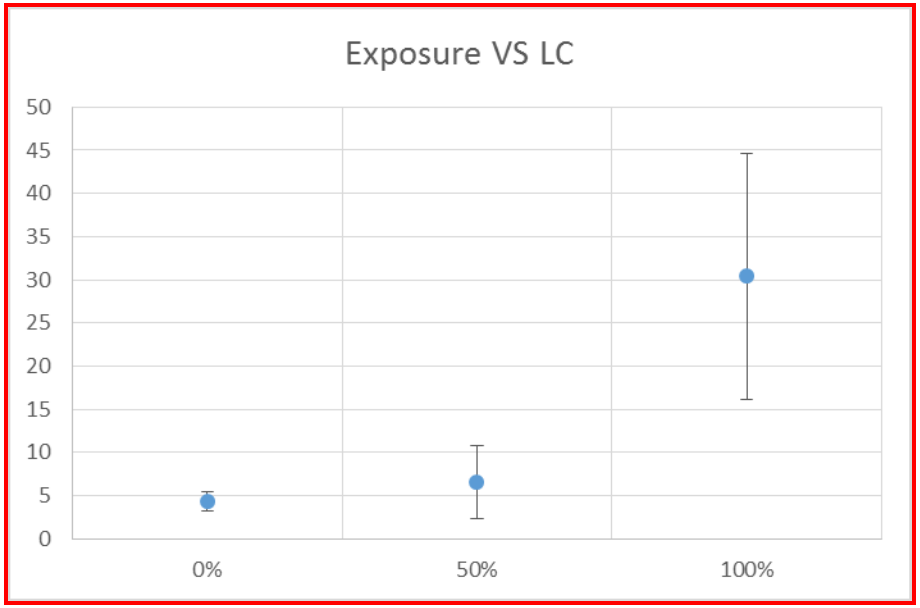
- Maximum of illuminance Ev_max
- Exposure in 400 m (Sprute): 80 km/h →18 sec exposure time

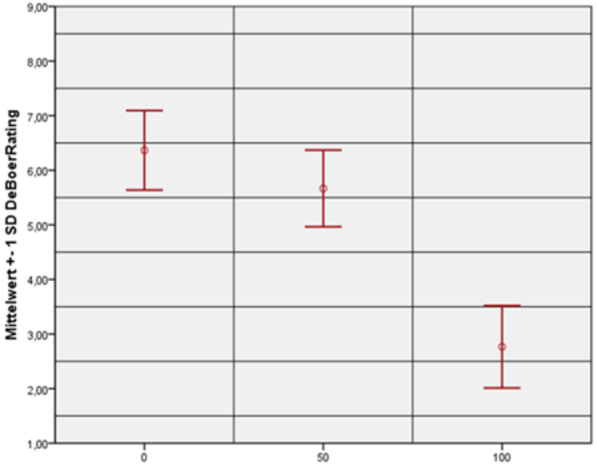
$$H_v = \int_0^{18} E_v(t)\,dt$$



Illuminance VS Loading Condition







Summary

- Results of Discomfort Glare and disability glare show clearly, that the behaviour of the vehicle is the important factor for deciding on levelling needs
- Light source is not significantly contributing
- Pitch angle is a qualified parameter for new regulation criteria

Summary

- The results show clearly, that the pitch angle as a parameter to measure the reaction of the vehicle according to loading could lead to a definition, where levelling is required and where it is not needed
- Car makers have to analyze, how a prediction of the pitch angle of a car under development could be determined

Action

- Special meeting in WGFL was organized in Darmstadt in 9/2013
- Continued discusssion in GTB meeting (11/2013) in Vienna and GTB Intermediate Meeting WGFL in Torino (2/2014)

Summary

- Input from various car makers to a prediction of the behaviour of future vehicles
- Discussion on a method to generate a classification with pitch angle to forecast the sensitivity of loading of newly developed vehicles
- Some car makers presented loading results on pitch angles of existing vehicles
- Statements from car makers have been collected

Summary

- Contributions from car makers show positive signals in being able to predict pitch angle of a vehicle in advance

Acknowledgements

- Thanks to TU Darmstadt Prof. Khanh, Dipl.-Ing. Bastian Zydek
- Thanks to DEKRA
- Thanks to GTB / GRE participants
- Thanks to car makers

Project within GTB TF CAVGS

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Intermediate Summary

- Night Test Measurement Conditions
  - 50% load
  - 1 % aiming
- Visibility and Glare
  - GTB conducted a test drive focused on glare
  - Poland presented a proposal focused on visibility distance
- Correlation Night Test Experimental findings with Literature?

Agenda

1. **GTB**
   Introduction
2. **Poland**
   Explanation of the background of the Polish proposal for R48
3. **GTB**
   Literature Review
   Night-time Field Test
   Discussion
      Comparison Klettwitz Outcome with Literature
      Enrichment of Data by Calculation (CIE TC4-45)
4. **OICA**
   Explanation of load conditions
5. **Joint GTB/Poland/OICA**
   Conclusion
   Suggestion

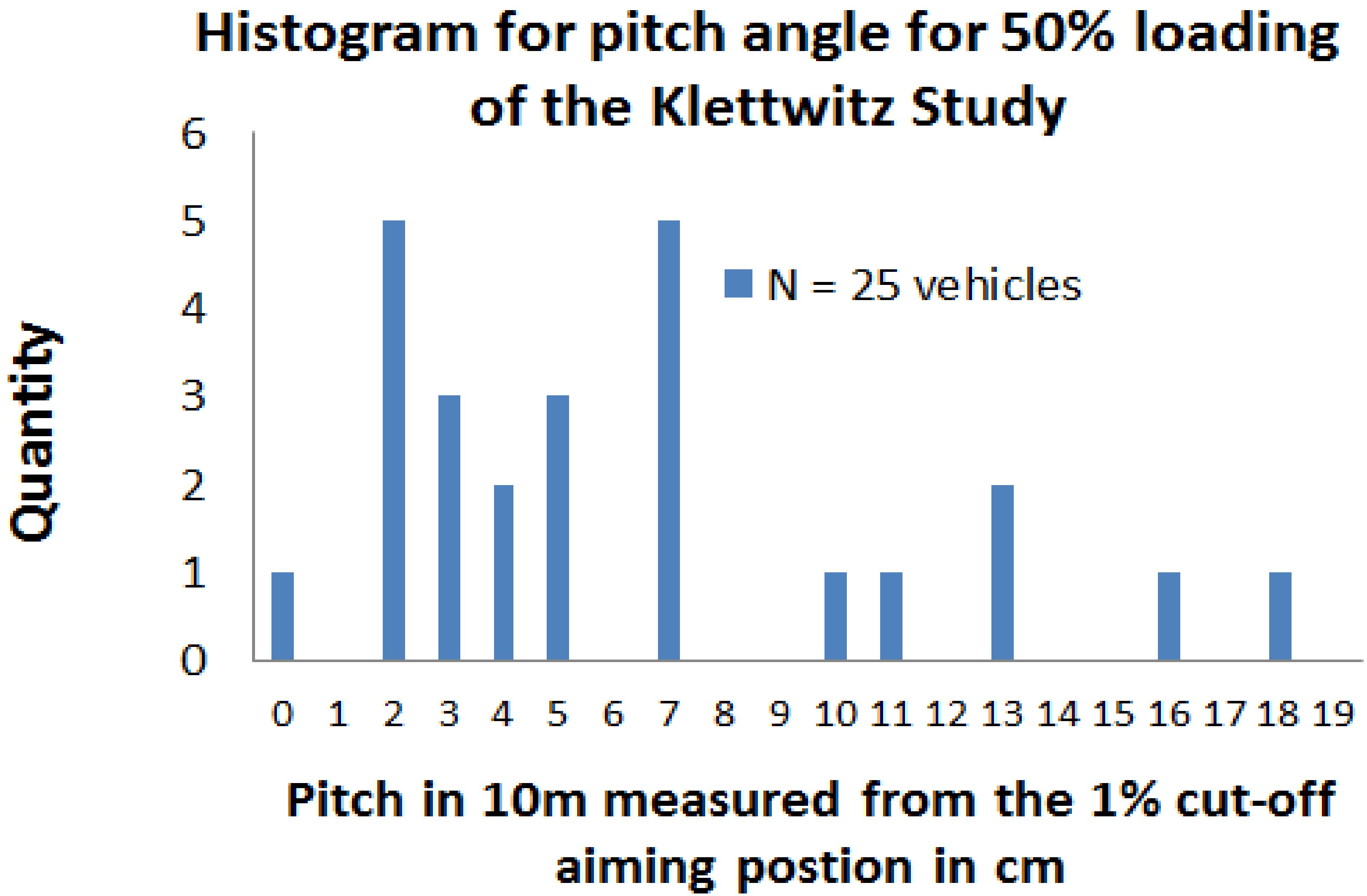
Klettwitz Results in View of the Literature Study of WG SVP

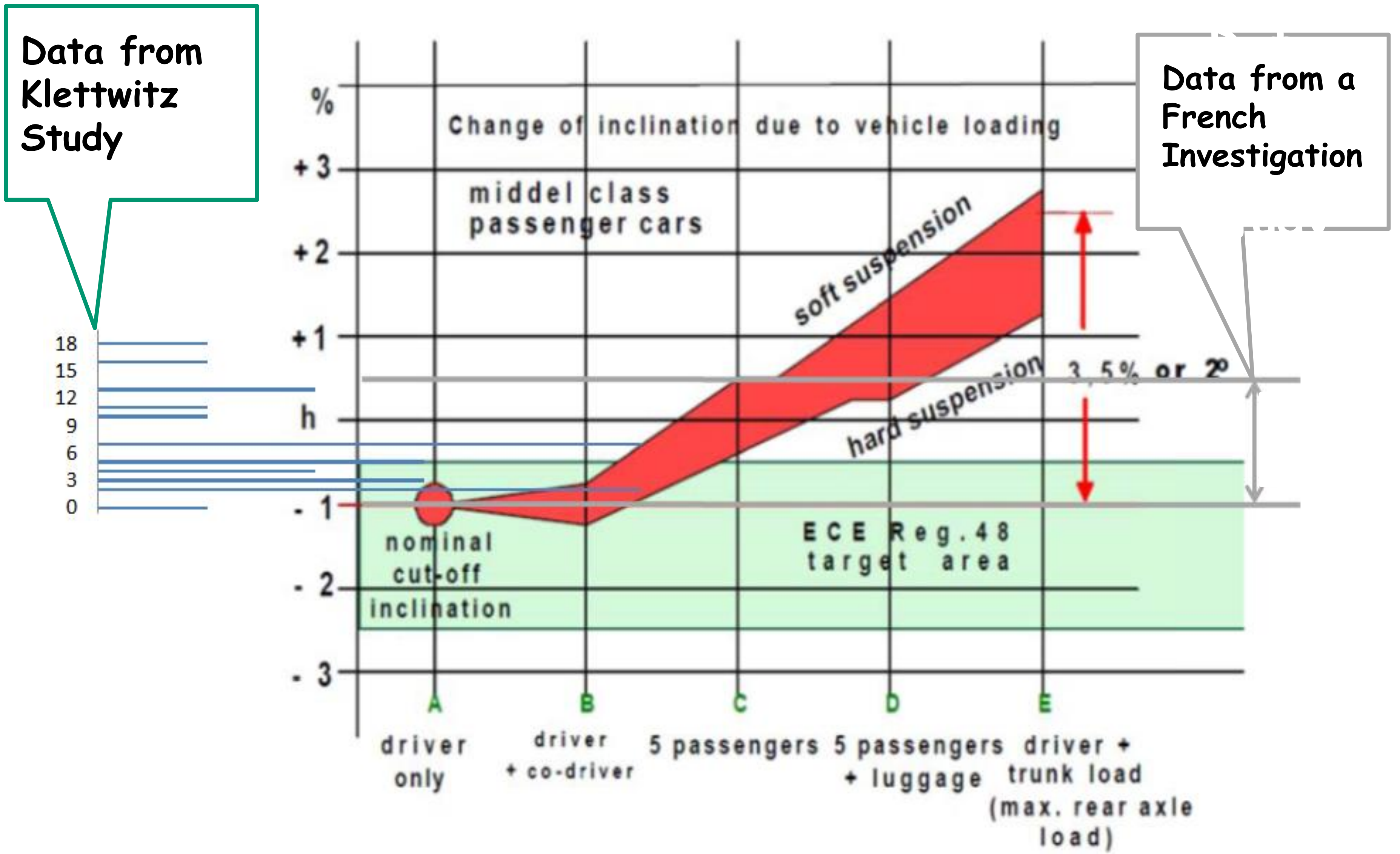
Karl Manz
Chairman GTB WG SVP

Geneva, 01 April 2014

Question 1:

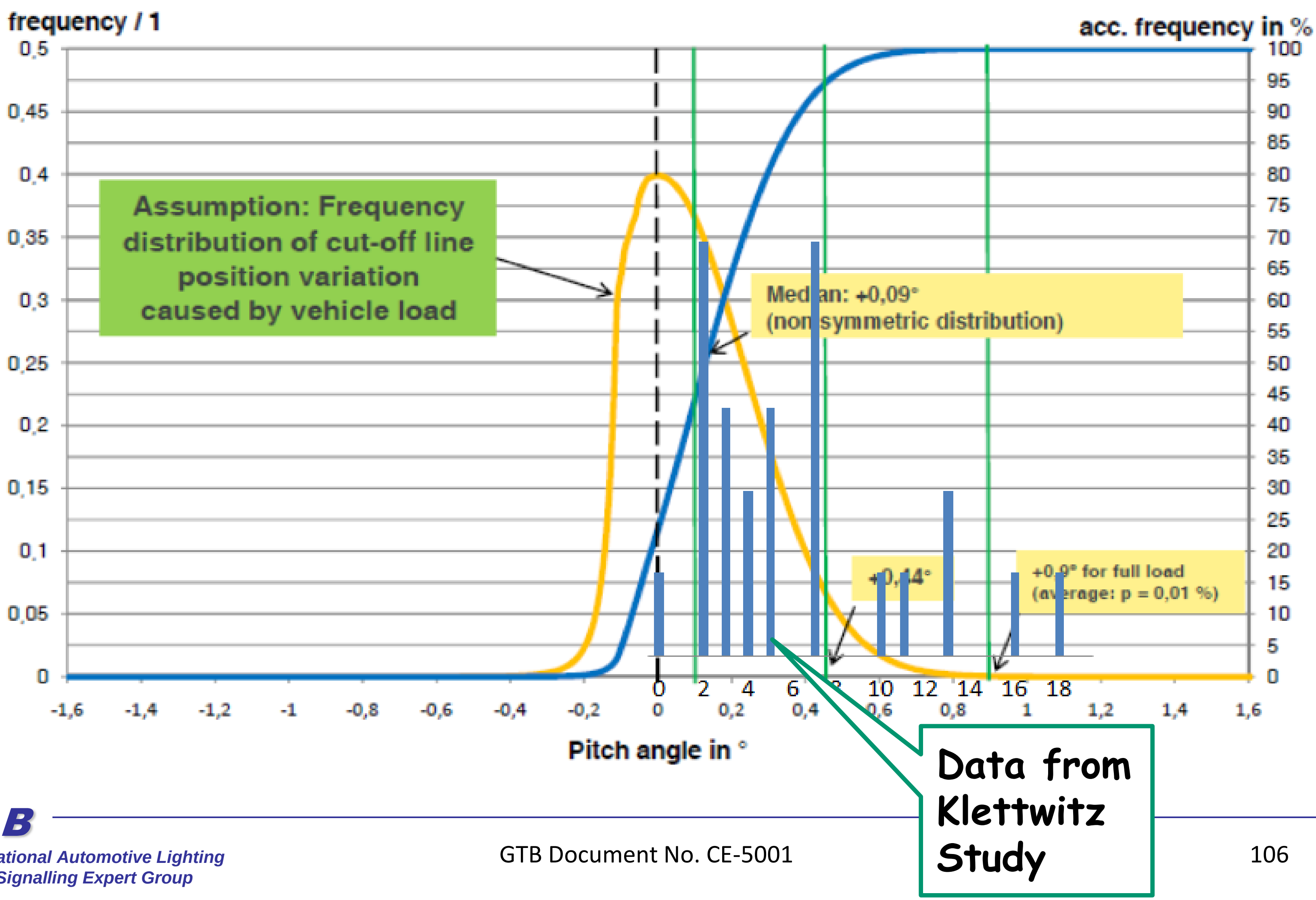
How does the distribution of the pitch angles of the Klettwitz study and of a French investigation fit into the results from Hanno Westermann or rather into the estimation of E.-O. Rosenhahn?


Histogram for pitch angle for 50% loading of the Klettwitz Study
Quantity
6
5
4
3
2
1
0
N = 25 vehicles
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Pitch in 10m measured from the 1% cut-off aiming postion in cm



Data from Klettwitz Study
Data from a French Investigation
18
15
12
9
6
3
0
%
+3
+2
+1
h
-1
-2
-3
Change of inclination due to vehicle loading
middel class passenger cars
soft suspension
hard suspension
3,5% or 2º
nominal cut-off inclination
ECE Reg.48 target area
A
B
C
D
E
driver only
driver + co-driver
5 passengers
5 passengers + luggage
driver + trunk load (max. rear axle load)

Estimation of Pitch Angle Frequency Spectrum caused by Vehicle Load



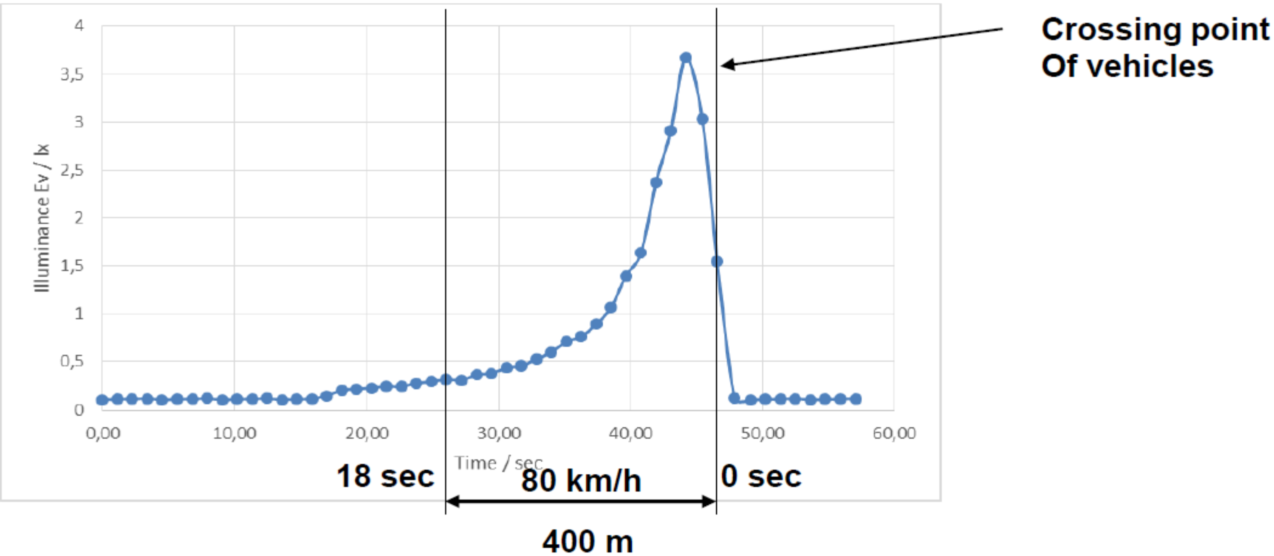
Question 2:

Mr. Zydek from TUD has found a good correlation between glare and exposure.
How does this fit into the literature findings?

Evaluation of Illuminance

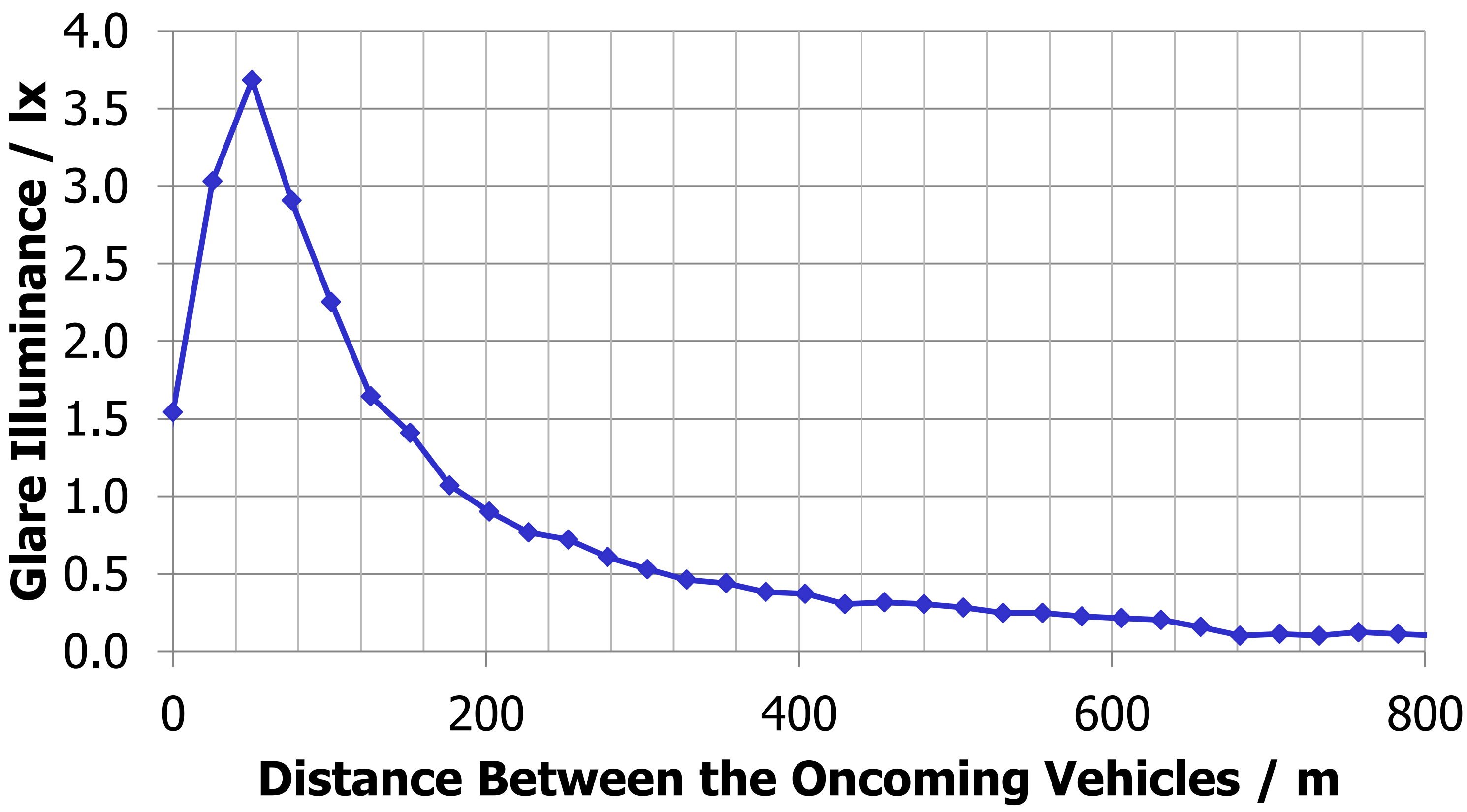
- Maximum of illuminance Ev_max
- Exposure in 400 m (Sprute): 80 km/h → 18 sec exposure time

$$H_v = \int_0^{18} E_v(t)\,dt$$

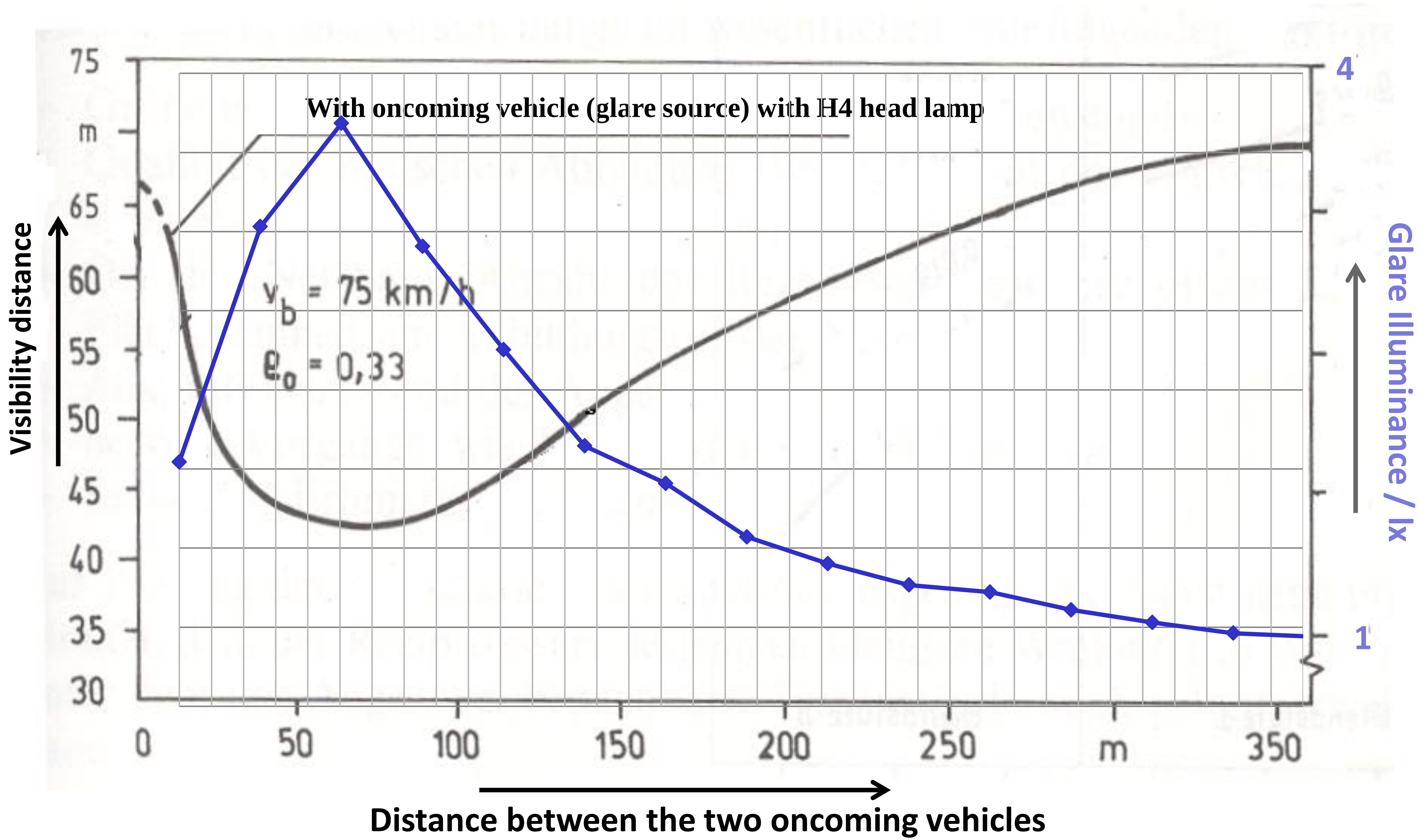


24.05.2013 | Technische Universität Darmstadt | Laboratory of Lighting Technology | Dipl.-Ing. B. Zydek, Prof. T. Q. Khanh | 15

Glare Illuminance as a Function of the Distance Between Oncoming Vehicles



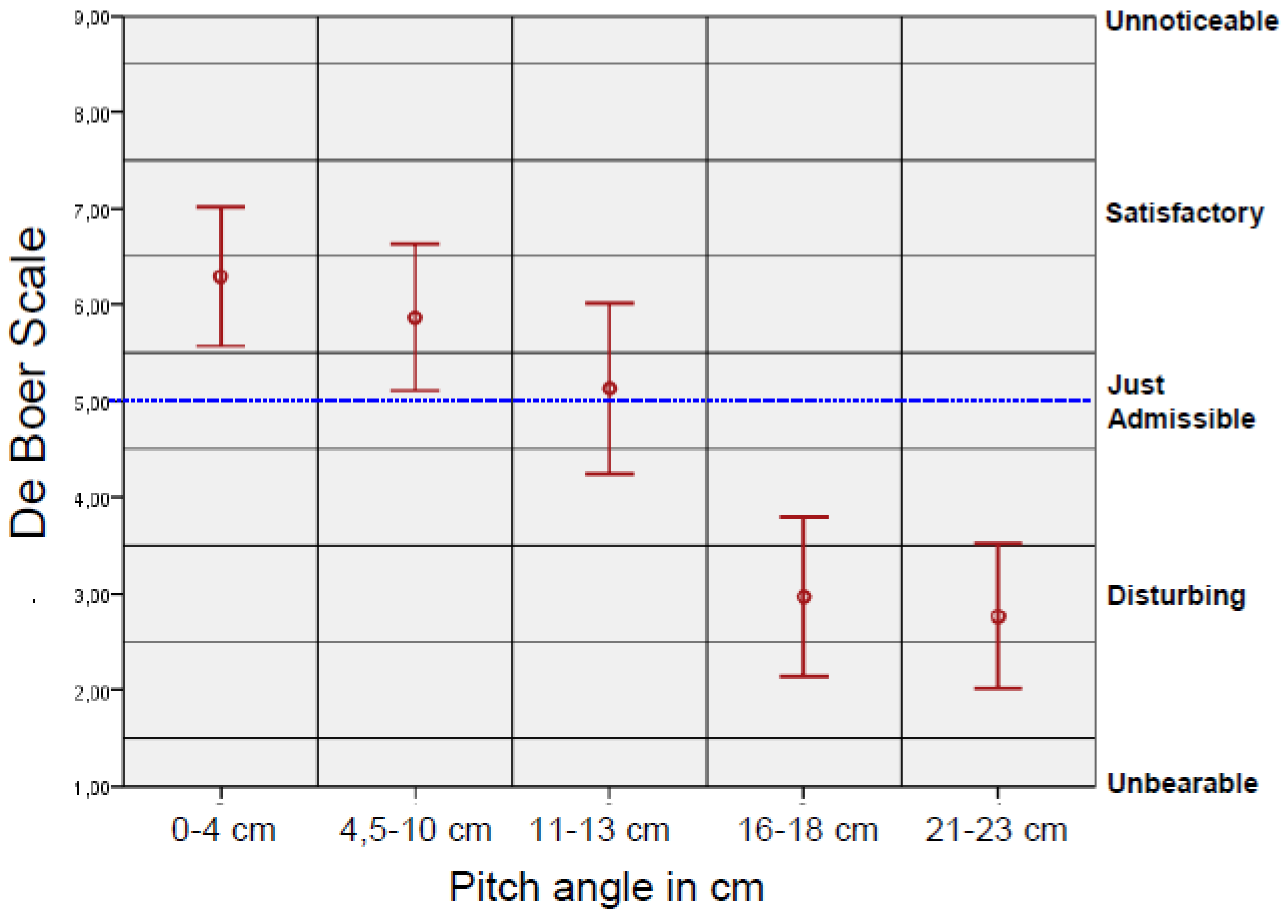
Visibility Distance and Glare Illuminance as a Function of the Distance Between Oncoming Vehicles



Question 3:

How do the results of the glare ratings, over all headlamp technologies used in the Klettwitz study, as a function of the pitch angles of the Klettwitz study fit e. g. to the results from Pedestrian Visibility investigation?

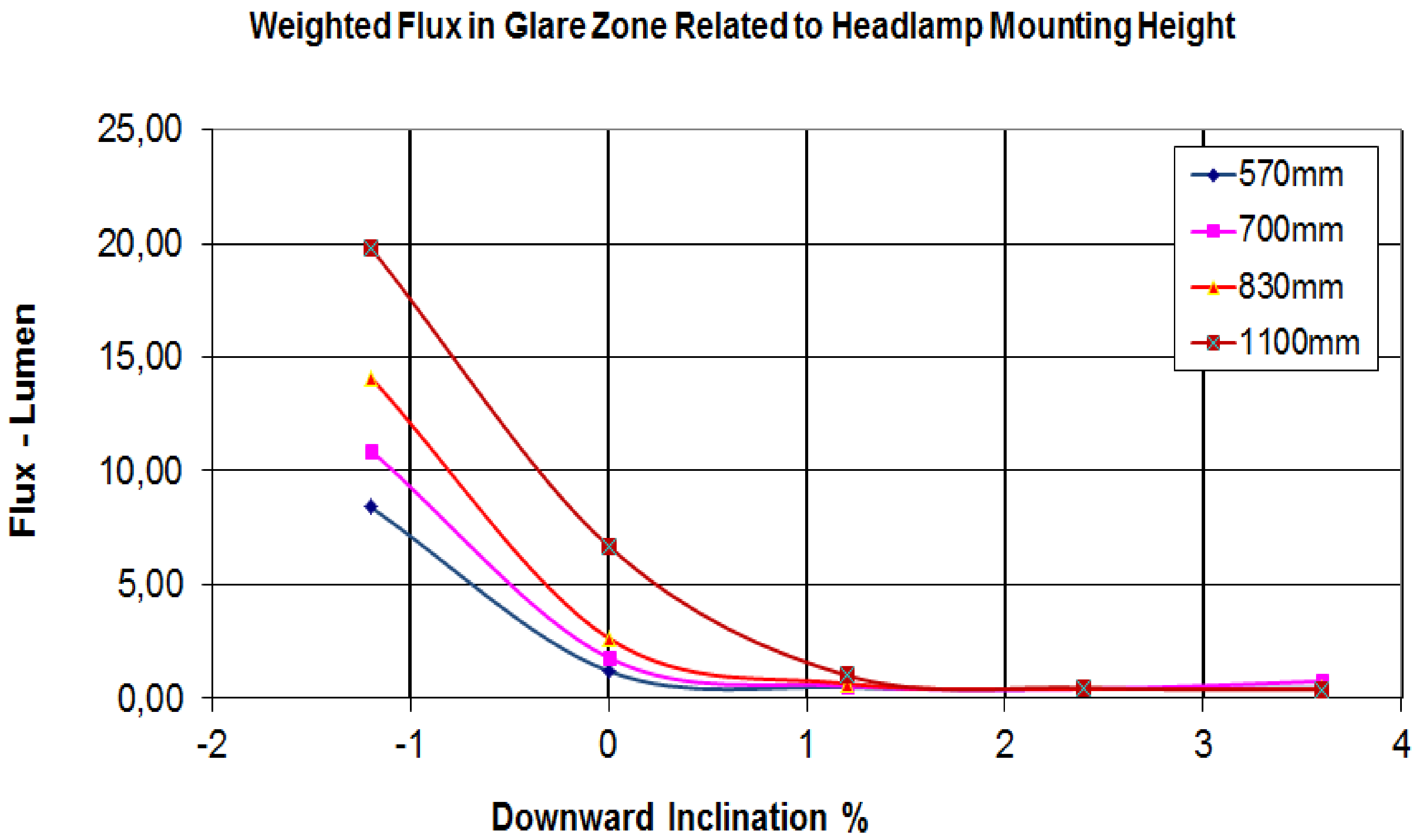
Pitch Angle Results



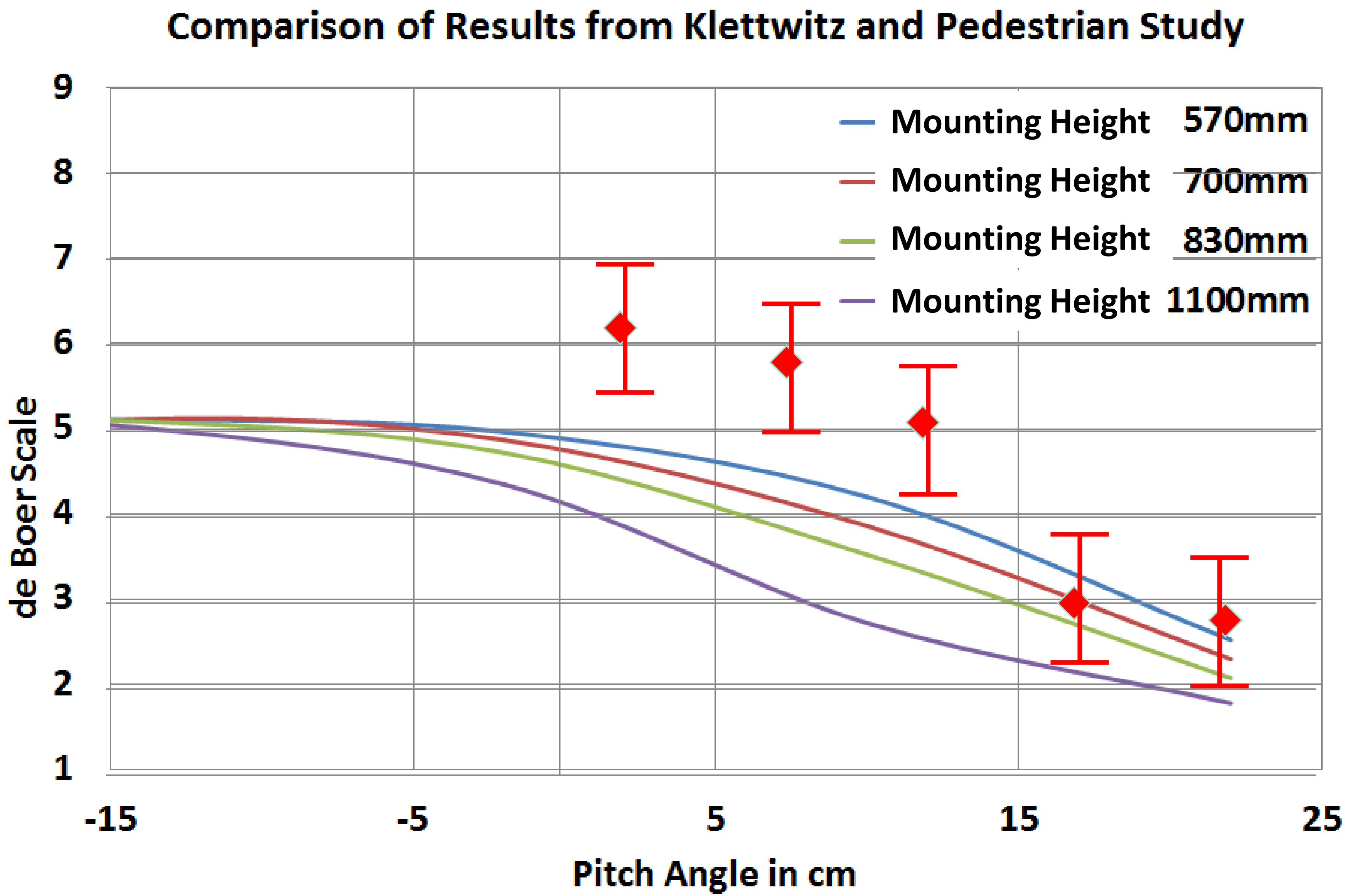
* For all light sources and loading conditions

The bright red values with the error bars are the Klettwitz results;

The lines show the results from a H4 headlamp, used in TC 4/45, for different mounting heights as a function of the pitch angle.
To transform the values from TC 4/45 glare criteria to the de Boer scale, the 1-lumen threshold of TC 4/45 was set to the de Boer rating 5 (just admissible).



Weighted Flux in Glare Zone Related to Headlamp Mounting Height
25,00
20,00
15,00
10,00
5,00
0,00
Flux - Lumen
-2
-1
0
1
2
3
4
Downward Inclination %
570mm
700mm
830mm
1100mm


Comparison of Results from Klettwitz and Pedestrian Study
de Boer Scale
9
8
7
6
5
4
3
2
1
-15
-5
5
15
25
Pitch Angle in cm
Mounting Height 570mm
Mounting Height 700mm
Mounting Height 830mm
Mounting Height 1100mm

Thank you for your attention

Agenda

1. GTB
   Introduction
2. Poland
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      Comparison Klettwitz Outcome with Literature
      Enrichment of Data by Calculation (CIE TC4-45)
4. OICA
   Explanation of load conditions
5. Joint GTB/Poland/OICA
   Conclusion
   Suggestion

Headlamp Glare and Range –

Enrichment of Data by Calculations

Gert Langhammer
Chairman CIE TC4-45

Geneva, 01 April 2014

Headlamp Glare and Range – Enrichment of data by calculation

<u>Agenda</u>

- The role of passing beam cutoff

- CIE TC4-45 - objective method of assessing headlamp glare and range

  → History of CIE TC4-45
  → Headlamp glare and range in TC4-45

- Headlamp glare and range under different conditions – collection of data as result of TC4-45 calculations

- Calculation results in relation to Klettwitz field test outcome

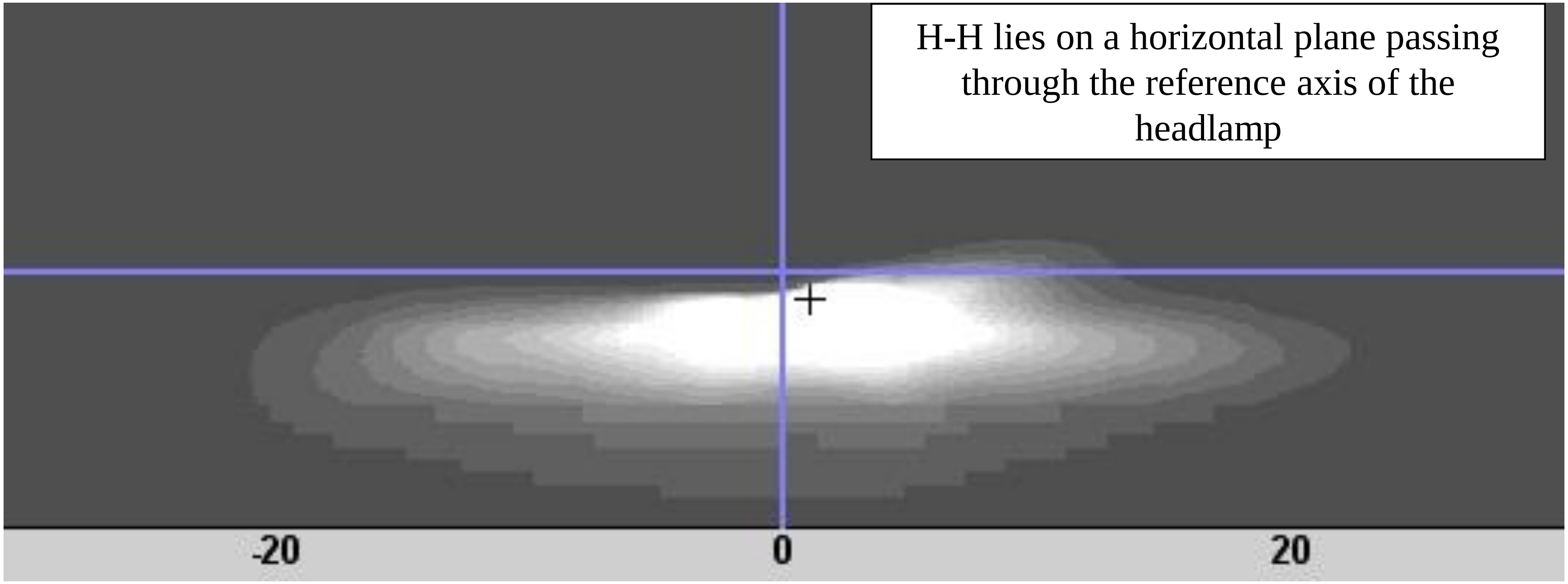
The passing beam cutoff

The role of the passing beam is to **provide good illumination** of the road scene **without causing unacceptable glare to oncoming drivers**. This is achieved by a combination of the control of the performance of the passing beam by means of the provisions in the applicable headlamp regulation and the correct installation according to Regulation 48.

The requirements in the installation regulation would ideally be performance based but as these are fundamentally photometric requirements it is not possible to carry out objective performance testing on a complete vehicle. This means that the **control of the headlamp performance must be achieved through the application of the requirements in the headlamp regulations** and the **"on-road" performance must be assured by correct installation** according to the provisions relating to the initial aim and the maintenance of aim in Regulation 48.

The passing beam cutoff

The Passing Beam Cutoff is the visible line perceived by the eye when the beam pattern is projected onto a vertical screen.



Normally the beam pattern is viewed at a distance of 25m for visual aiming prior to photometry but a viewing distance of 10m is also allowed for practical reasons

The passing beam cutoff

The clarity of the cutoff line varies from diffuse to sharp. Sharpness is defined in the headlamp regulations to ensure that the beam can be visually aimed by means of the cutoff but equally the cutoff is not too sharp as this contributes to glare complaints and driver fatigue.

E/ECE/324/Rev.2/Add.111/Rev.2
E/ECE/TRANS/505/Rev.2/Add.111/Rev.2
Annex 9

2.2. Sharpness of "cut-off"

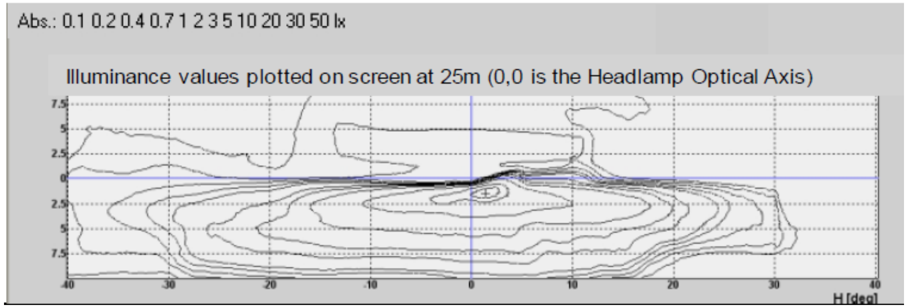
The sharpness factor G is determined by scanning vertically through the horizontal part of the "cut-off" at 2.5° from the V-V where:

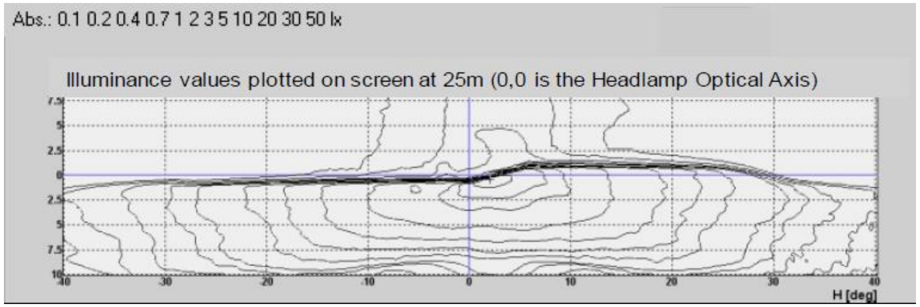
$G = (\log E_{\beta} - \log E_{(\beta + 0.1°)})$ where β = the vertical position in degrees.

The value of G shall not be less than 0.13 (minimum sharpness) and not greater than 0.40 (maximum sharpness).

There is no significant relationship between the cutoff sharpness and the performance of the headlamp on the road. A headlamp that just meets the minimum requirements of the regulation may have a sharper cutoff than a headlamp that exceeds the minimum requirements by a factor of several times.

Two passing beam patterns compared – the passing beam cutoff





Halogen Headlamp with horizontal cutoff aimed 1% down

Range based upon assumption that the horizontal (left side) cutoff line will intersect the road surface at D= H/1%
(D = Range; H = mounting height)

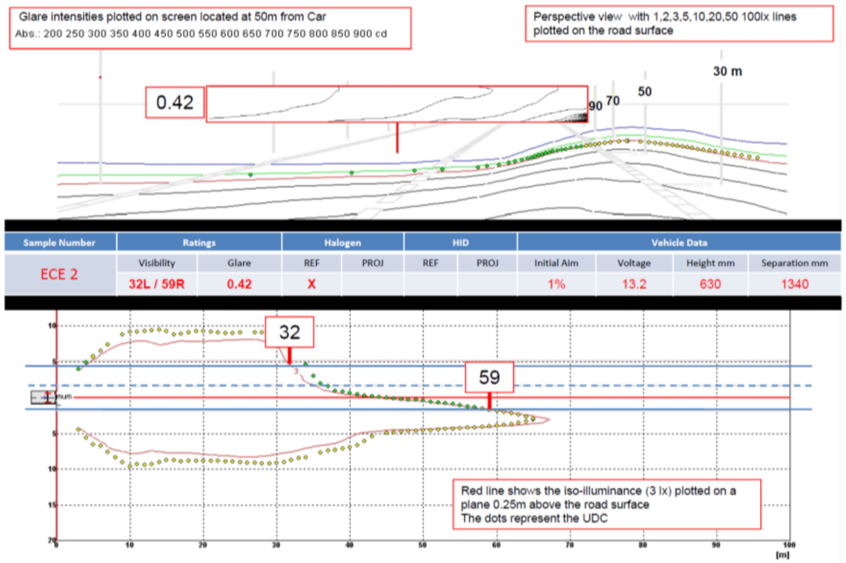
Mounting Height = 0.63m
Assumed Range = 63m

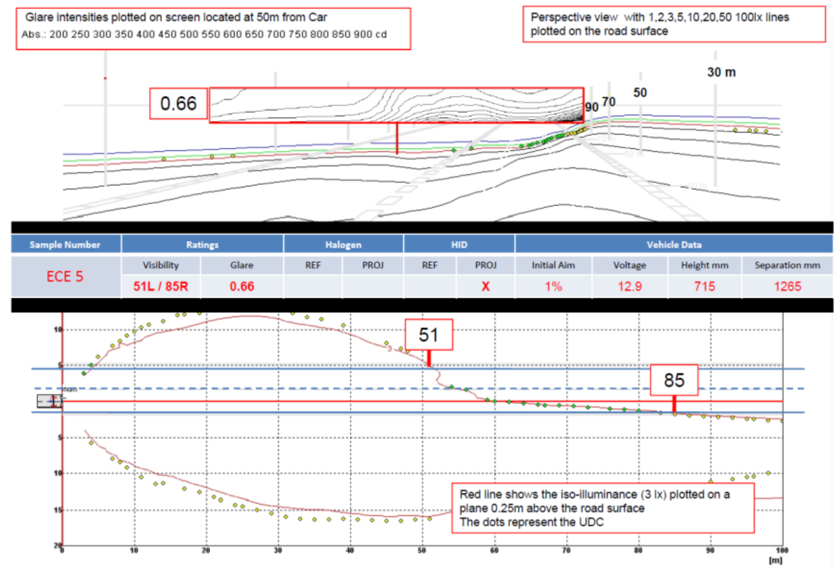
HID Headlamp with horizontal cutoff aimed 1% down

Range based upon assumption that the horizontal (left side) cutoff line will intersect the road surface at D= H/1%
(D = Range; H = mounting height)

Mounting Height = 0.72m
Assumed Range = 72m

Two passing beam patterns compared – Range according to TC4-45





Range based upon CIE TC4-45 Criteria = 32m Left / 59 m Right

Mounting Height = 0.63m

Range based upon CIE TC4-45 Criteria = 51m Left / 85 m Right

Mounting Height = 0.72m

Conclusion

Halogen Headlamp with horizontal cutoff aimed 1% Down

Range based upon CIE TC4-45 Criteria
= 32m Left / 59 m Right
Mounting Height = 0.63m

Range based upon assumption that the horizontal (left side) cutoff line will intersect the road surface at D= H/1%
(D = Range; H = mounting height)

Mounting Height = 0.63m
Assumed Range = 63m

Discrepancy

	Left Side	Right Side
Actual (Calculated)	32m	59m
Assumed	63m	**

HID Headlamp with horizontal cutoff aimed 1% Down

Range based upon CIE TC4-45 Criteria
= 51m Left / 85 m Right Mounting
Height = 0.72m

Range based upon assumption that the horizontal (left side) cutoff line will intersect the road surface at D= H/1%
(D = Range; H = mounting height)

Mounting Height = 0.72m
Assumed Range = 72m

Discrepancy

	Left Side	Right Side
Actual (Calculated)	51m	85m
Assumed	72m	**

** **The assumption of the range is based upon the position of the horizontal part of the cutoff so it does not apply to the Right Side figures**

TC4-45 - objective method of assessing headlamp glare and range

History of CIE TC4-45

TC4-45 - objective method of assessing headlamp glare and range

In 2003 GTB and NCAP created a taskforce with the aim of developing a headlamp performance rating system to be proposed to the European New Car Assessment Programme (Euro NCAP).

After Euro NCAP decision in 2005 not to continue to introduce a headlight rating system the work of this taskforce was transferred into CIE structure.

CIE Technical Committee 4-45, working in conjunction with GTB, continued to work on the refinement of the assessment of headlamp range and glare.

TC4-45 - objective method of assessing headlamp glare and range

Experts from 52 manufacturers, institiutions and test services worldwide were taking part in the development of an objective method of assessing vehicle front lighting. The aim was to create a method which is based just on photometric measurements and calculations.

In 2010 the work of TC4-45 was finalized with the publication of a CIE Technical Report (CIE188: 2010).

In 2011 CIE released the new standard:

CIE S021/E:2011
Vehicle Headlighting Systems
Photometric Performance – Method of Assessment

Standard CIE S021/E:2011

COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

PRESS RELEASE May 2011

New Standard CIE S 021/E:2011

Vehicle Headlighting Systems
Photometric Performance - Method of Assessment

This Standard specifies a method to consistently assess the photometric performance of vehicle headlighting systems to enable the performance of different systems to be compared. The requirements are given in relation to road scene illumination and the limitation of glare, and the performance is assessed using parameters relevant to lane guidance and the detection of pedestrians and objects.

The Standard includes a measurement and calculation procedure. It does not specify the format of an assessment report.

The Standard is written in English and has been approved by CIE National Committees. It is readily available at the National Committees of the CIE or via the website of the Central Bureau of the CIE (www.cie.co.at).

The price of this Standard is EUR 135,- (Members of the National Committees of the CIE get 66,7% discount).

Technical Report CIE 188:2010

ISBN 978 3 901906 84 8

COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

TECHNICAL REPORT

PERFORMANCE ASSESSMENT METHOD FOR VEHICLE HEADLIGHTING SYSTEMS

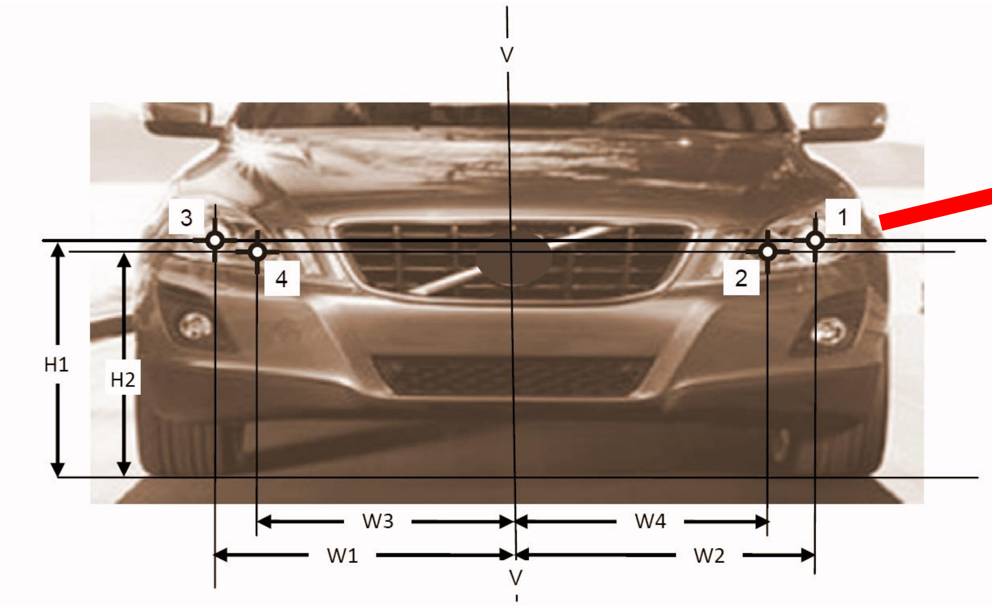
CIE 188:2010

UDC: 628.971.85
628.971.85:629.113.06

Descriptor: Lighting by lamps attached to the vehicle
Lighting by motor vehicle lamps

Headlamp Glare and Range in TC4-45 – input parameters

The system Headlamps + Car is evaluated …

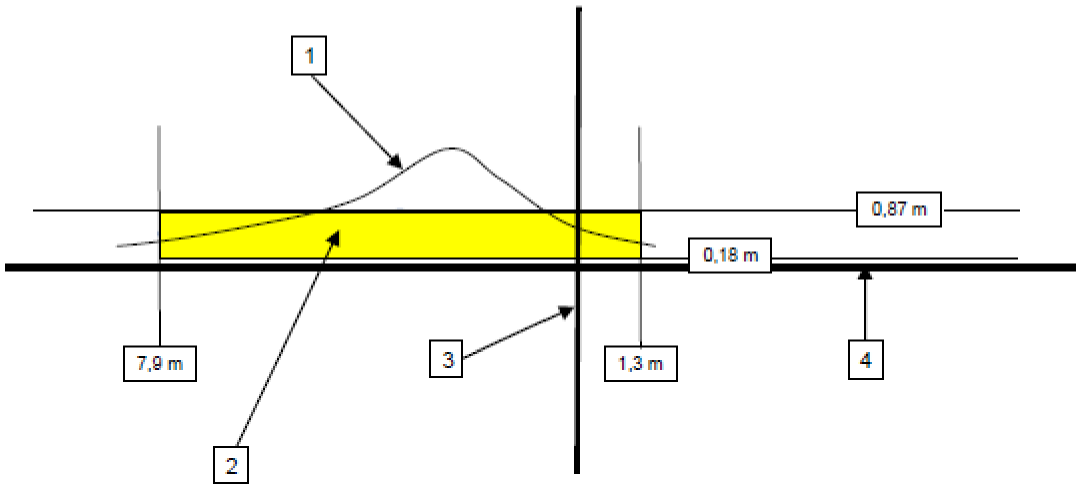


…by recording mounting positions and supply voltage on the car …

…and by measuring the photometric values in a laboratory.

Headlamp Glare and Range in TC4-45 – Definition of Glare Zone

Headlamp Glare and Range in TC4-45 – Definition of Glare Zone

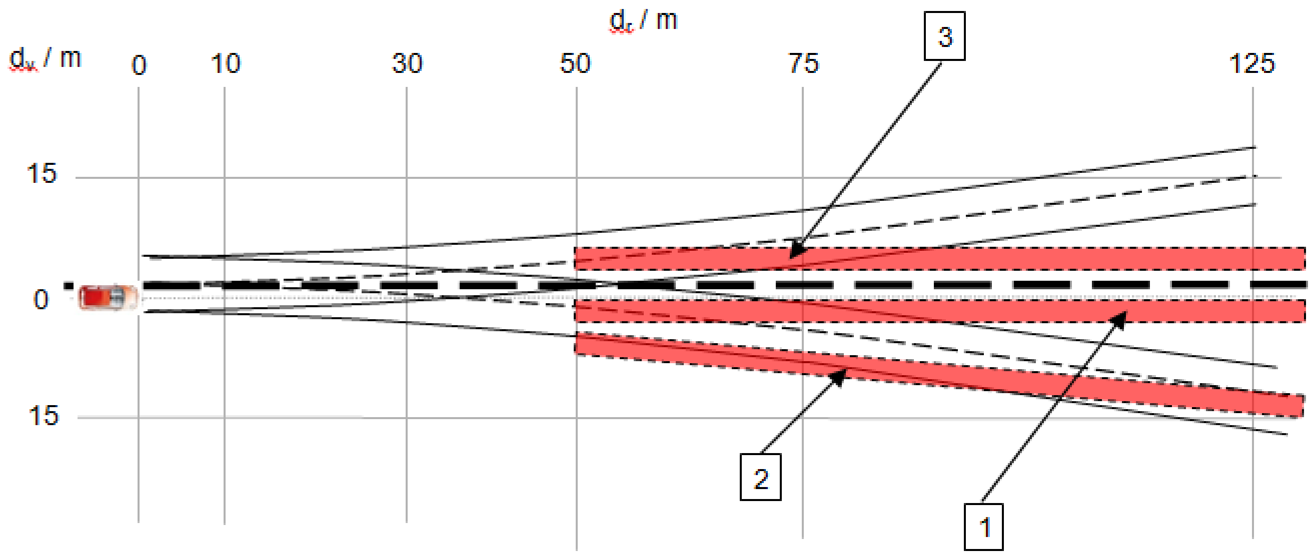


Key

1 the curve indicates the probable location of the oncoming driver's eyes as a percentage of all instances on a range of road types based upon the work of Damasky [3]
2 for detail of this zone see Figure 16
3 vertical line through the longitudinal axis of vehicle
4 this horizontal line is located at a height of 0,75 m above the road surface

Headlamp Glare and Range in TC4-45 – Definition of Passing Beam Range

Headlamp Glare and Range in TC4-45 – Definition of Passing Beam Range



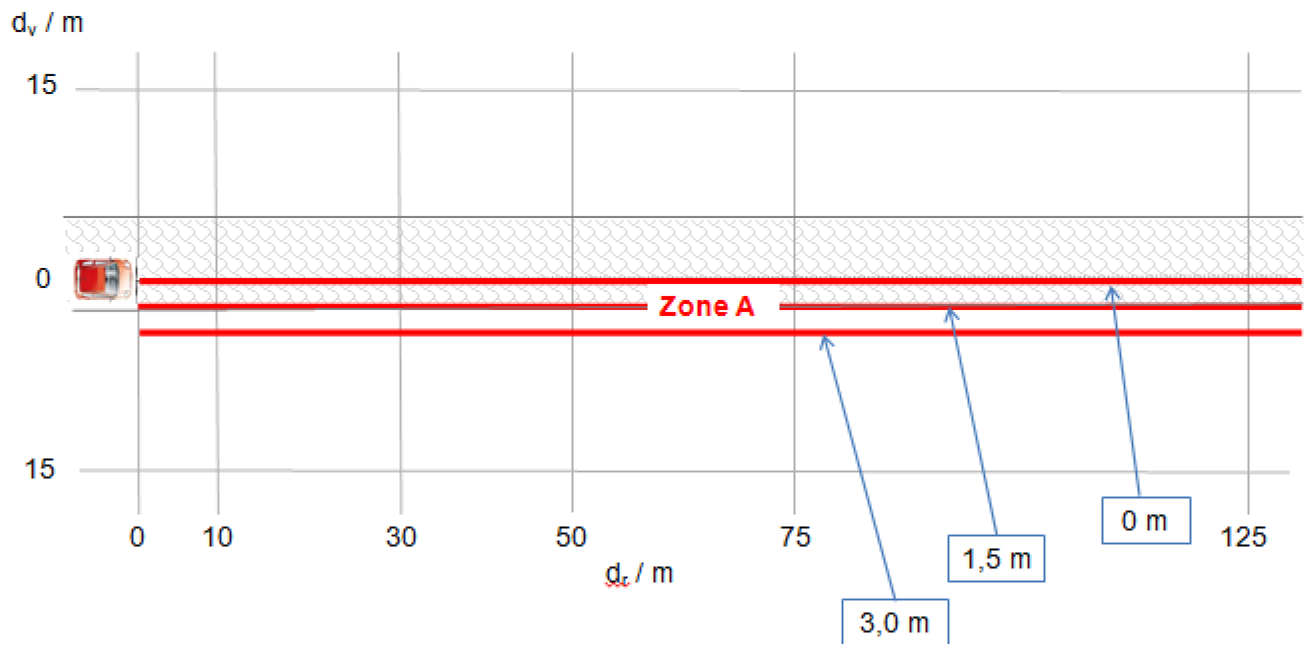
d_r	distance along the road
d_v	distance from vehicle longitudinal axis

1 Zone A range assessment – straight road
2 Zone B range assessment – curved road
3 Zone C range assessment – pedestrian visibility

Road width 6m (3m per lane), 500m curve radius

Headlamp Glare and Range in TC4-45 – Definition of Passing Beam Range

Zone A: Range of Passing Beam on a straight road



d_r distance along the road
d_v distance from vehicle longitudinal axis

NOTE The longitudinal lines in Zone A are situated at 0 m, 1,5 m and 3,0 m to the nearside of the longitudinal axis of the vehicle.

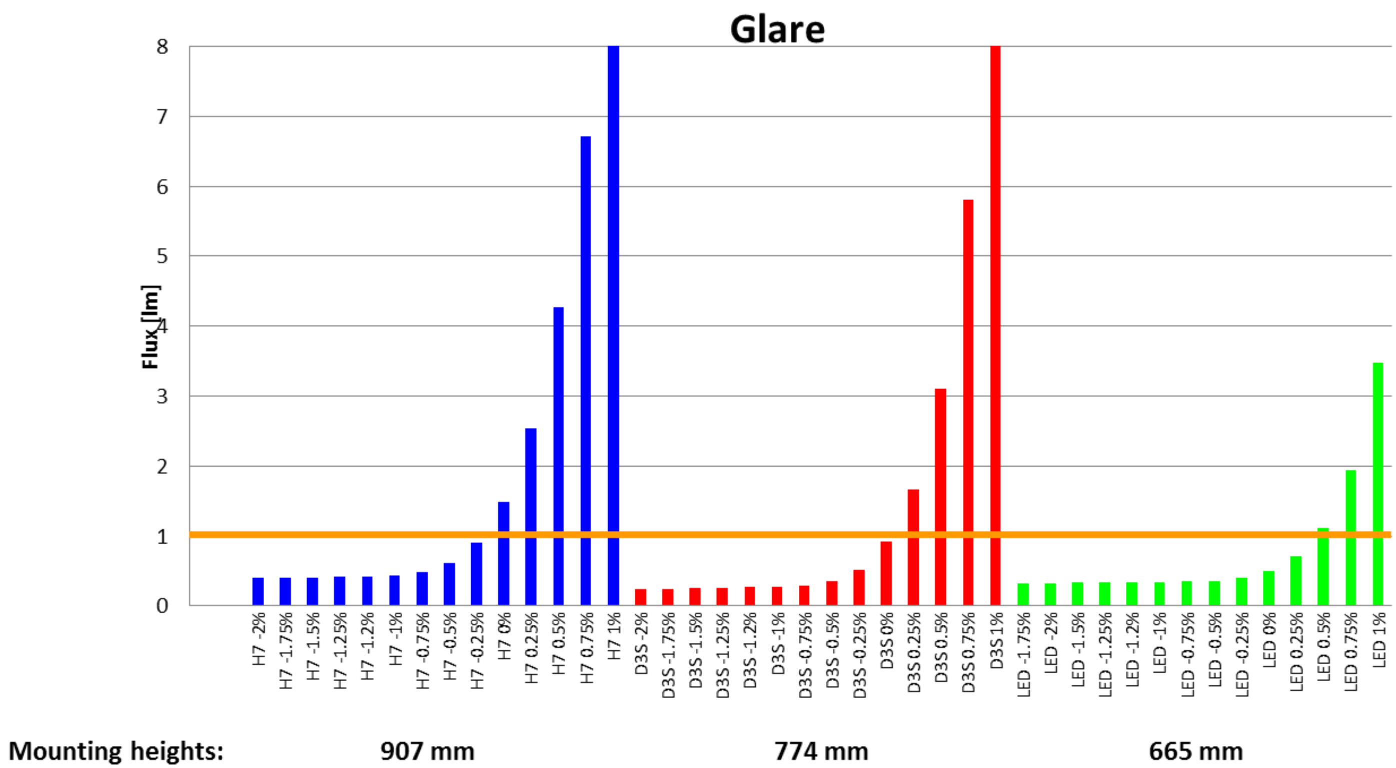
Headlamp Glare and Range under different conditions

Collection of data:

Glare and Range for headlamps

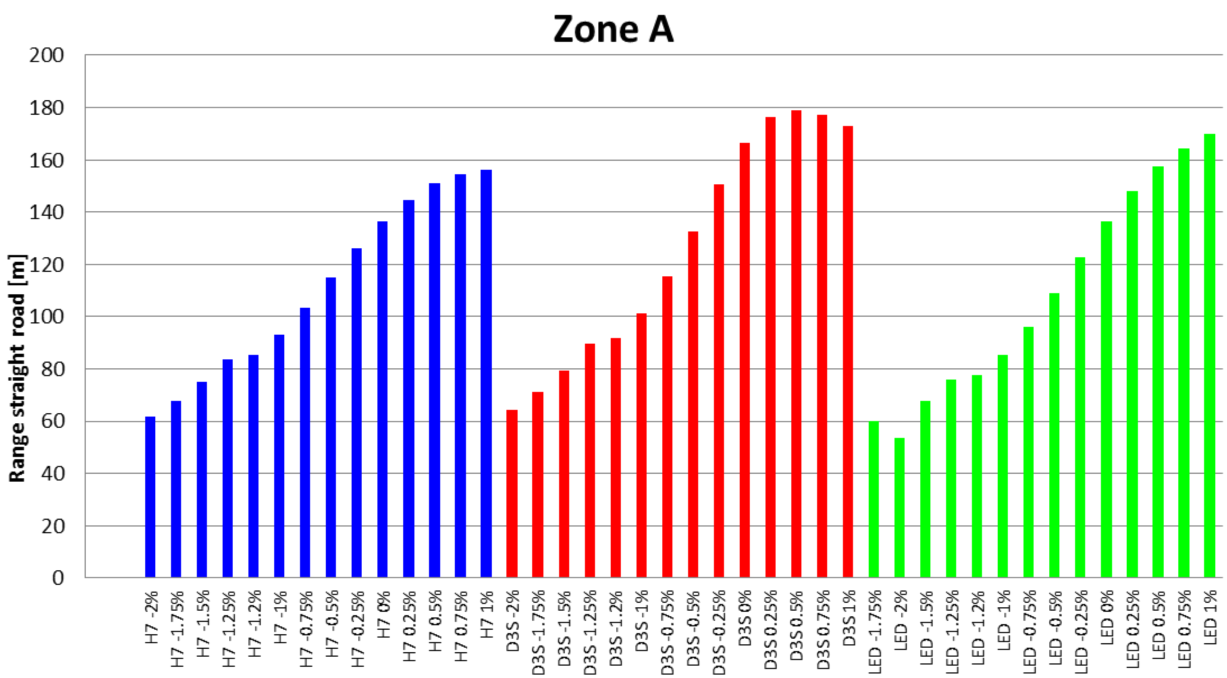
- **with different types of light sources**
- **at different mounting heights**

Luminous Flux in Glare Zone - H7, D3S and LED types of passing beams



→ vertical inclination of 0% means horizontal cut-off at H-H
→ vertical inclination of -1,0% means horizontal cut-off 0,57° below H-H

Zone A - H7, D3S and LED types of passing beams

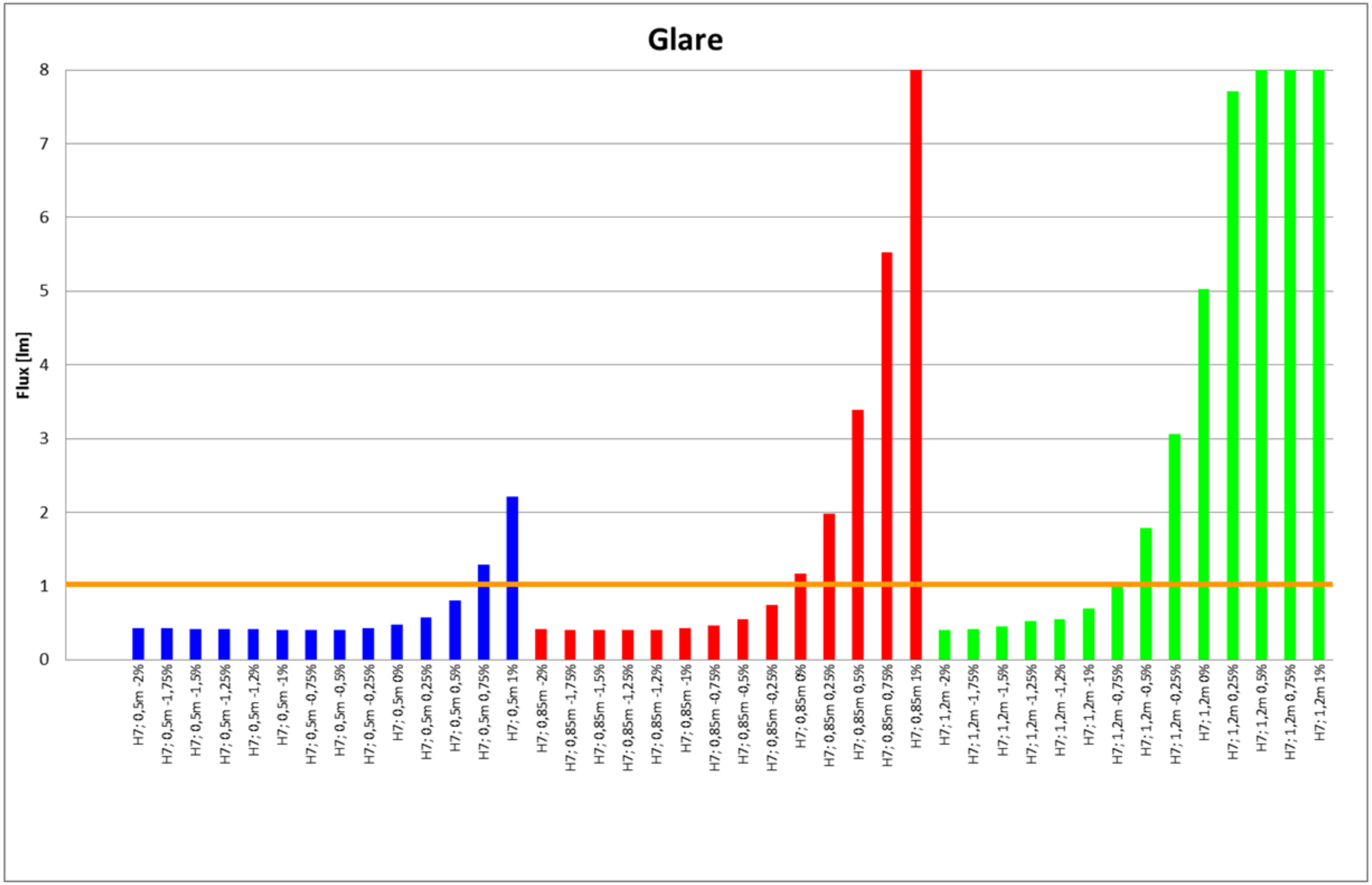


Mounting heights: **907 mm** **774 mm** **665 mm**

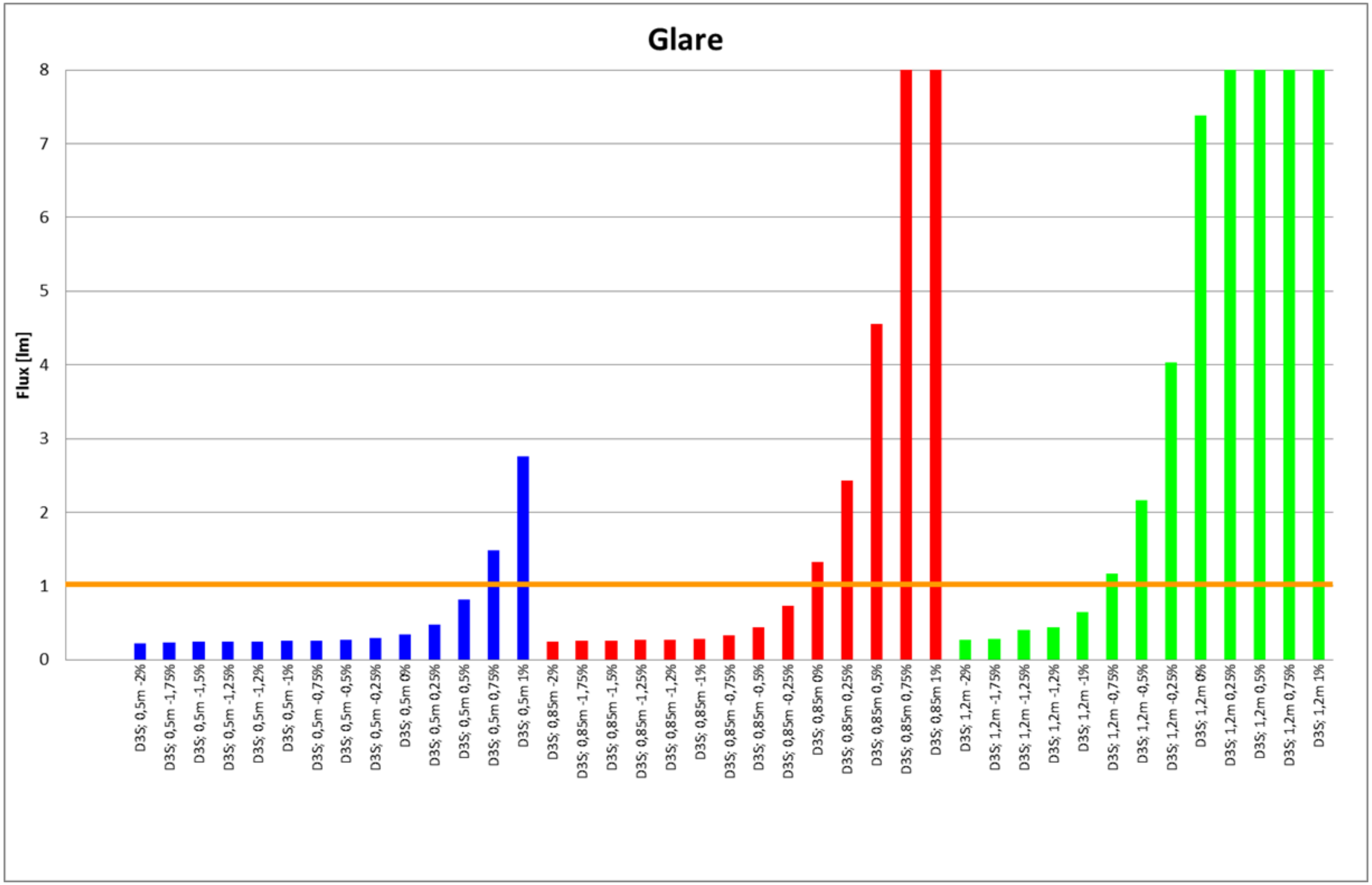
→ vertical inclination of 0% means horizontal cut-off at H-H

→ vertical inclination of -1,0% means horizontal cut-off 0,57° below H-H

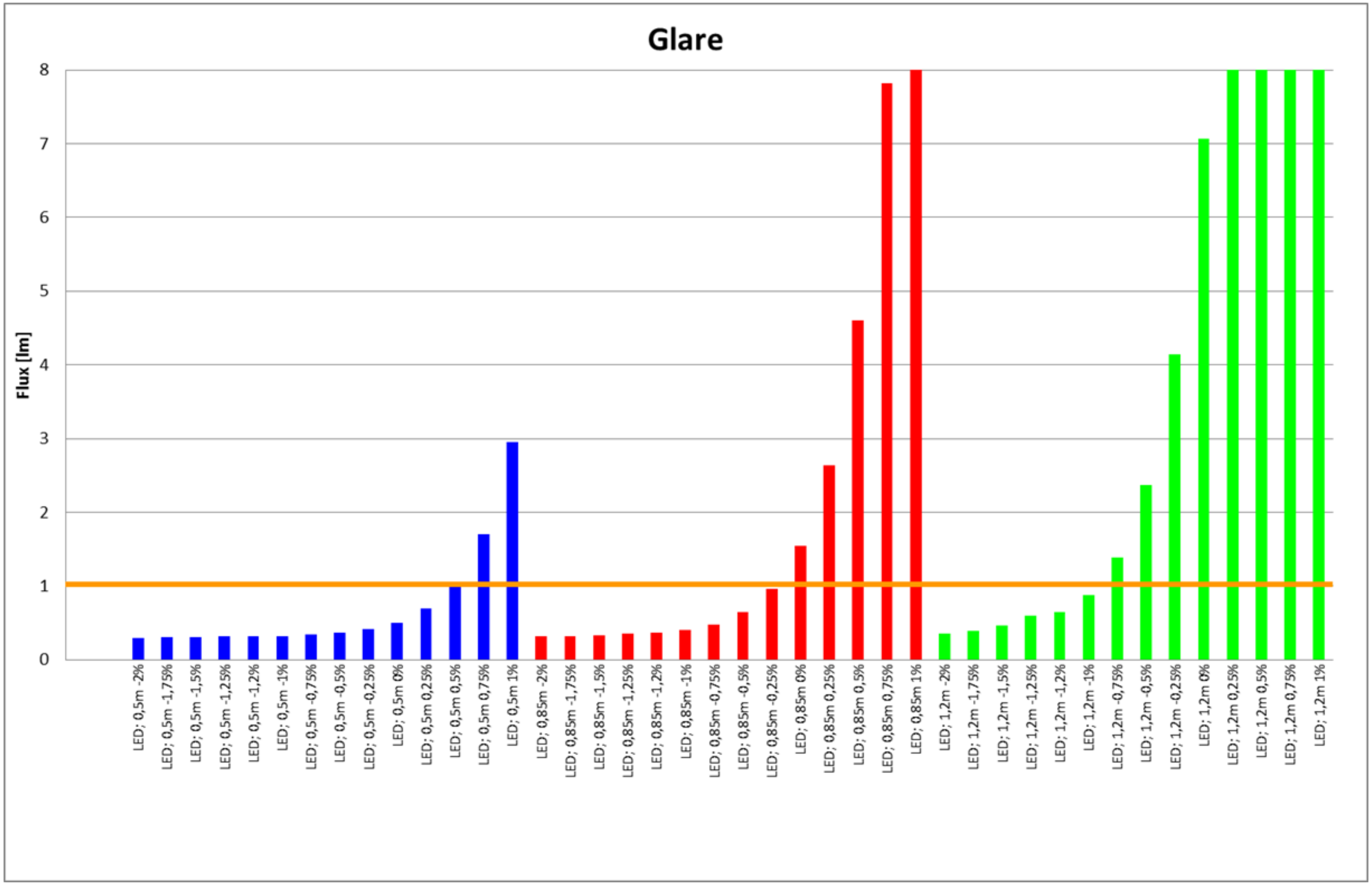
Glare – H7 headlamp at different mounting heights



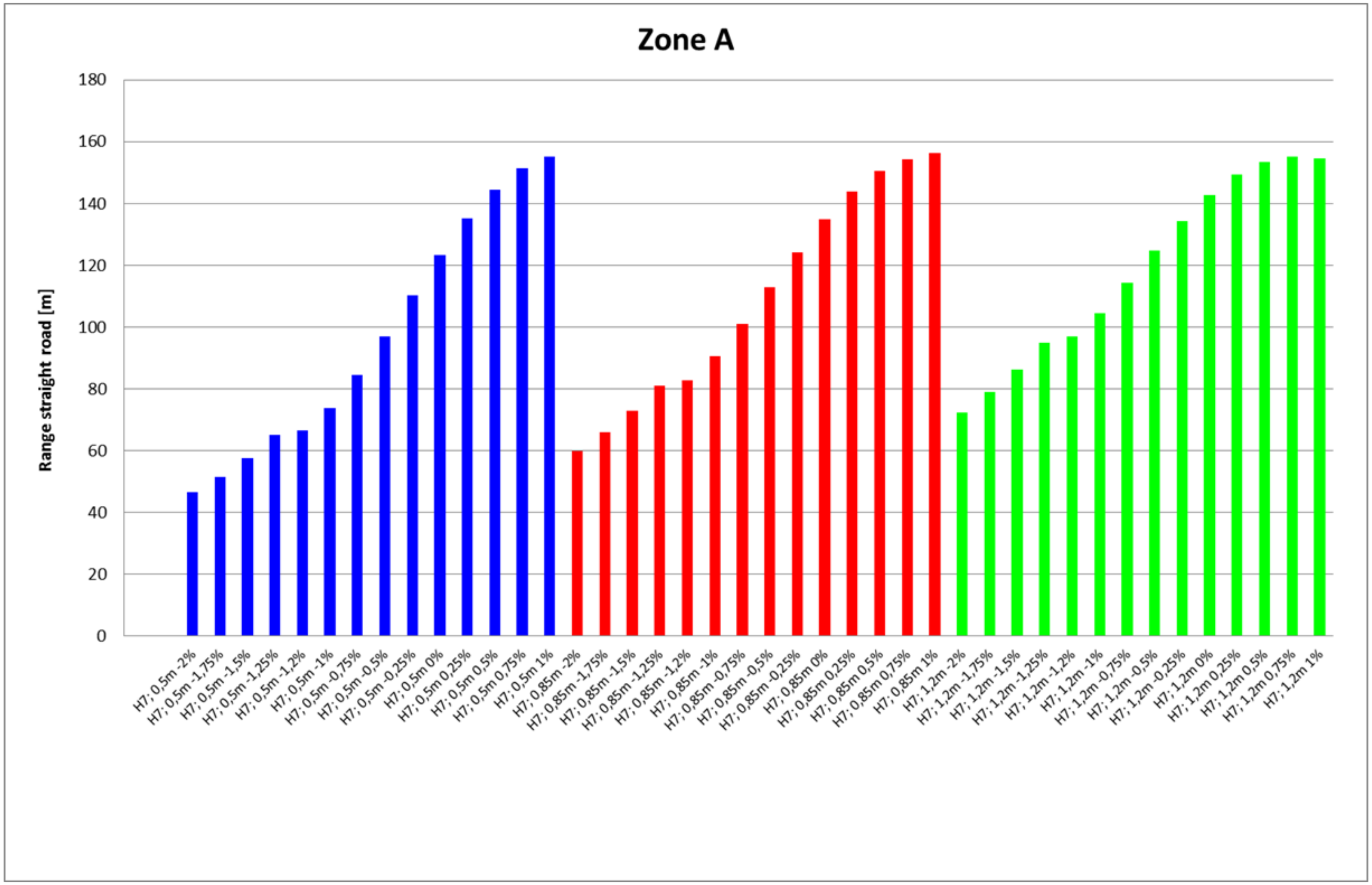
Glare – D3S headlamp at different mounting heights



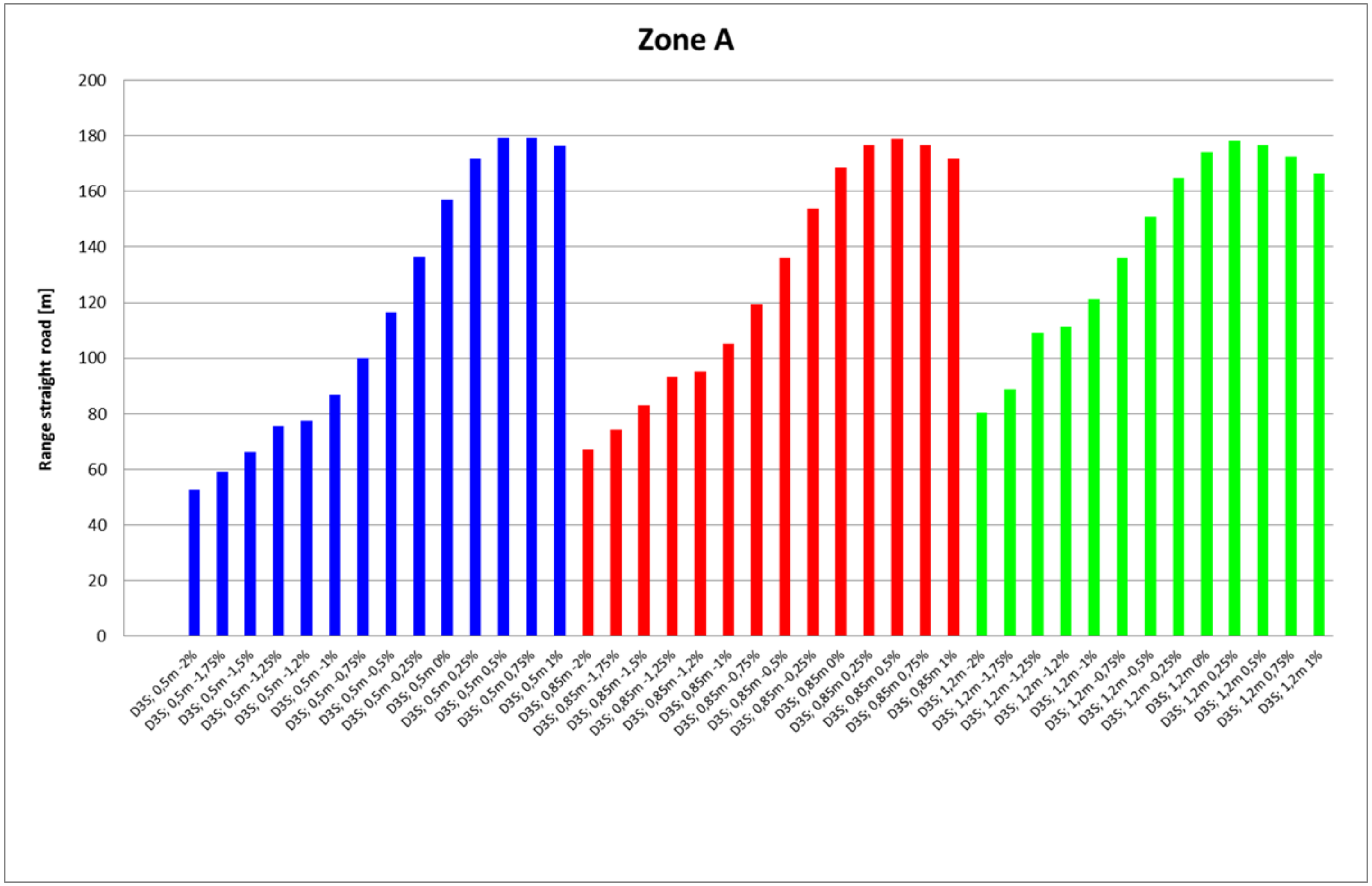
Glare – LED headlamp at different mounting heights



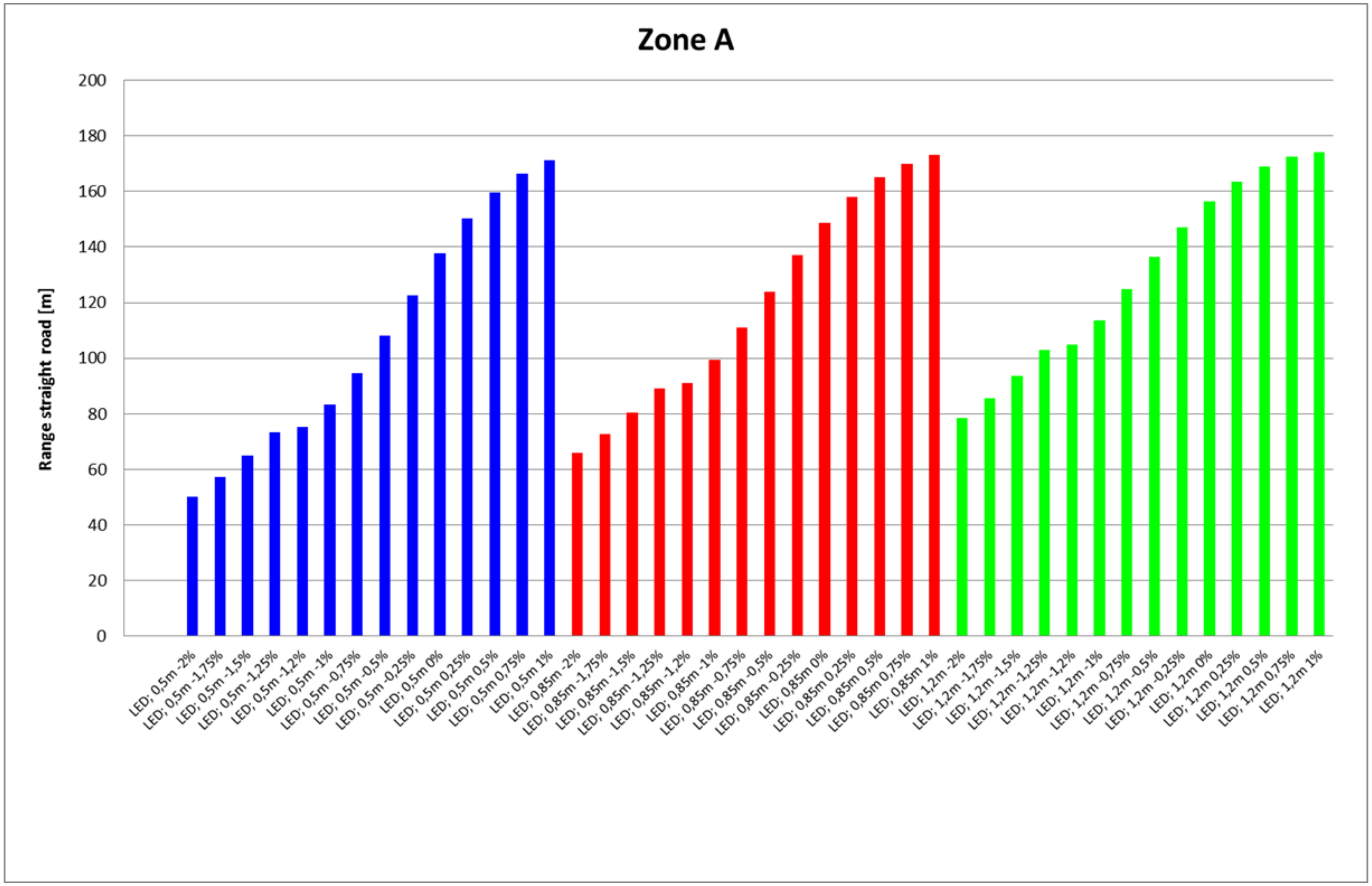
Range in Zone A – H7 headlamp at different mounting heights



Range in Zone A – D3S headlamp at different mounting heights



Range in Zone A – LED headlamp at different mounting heights



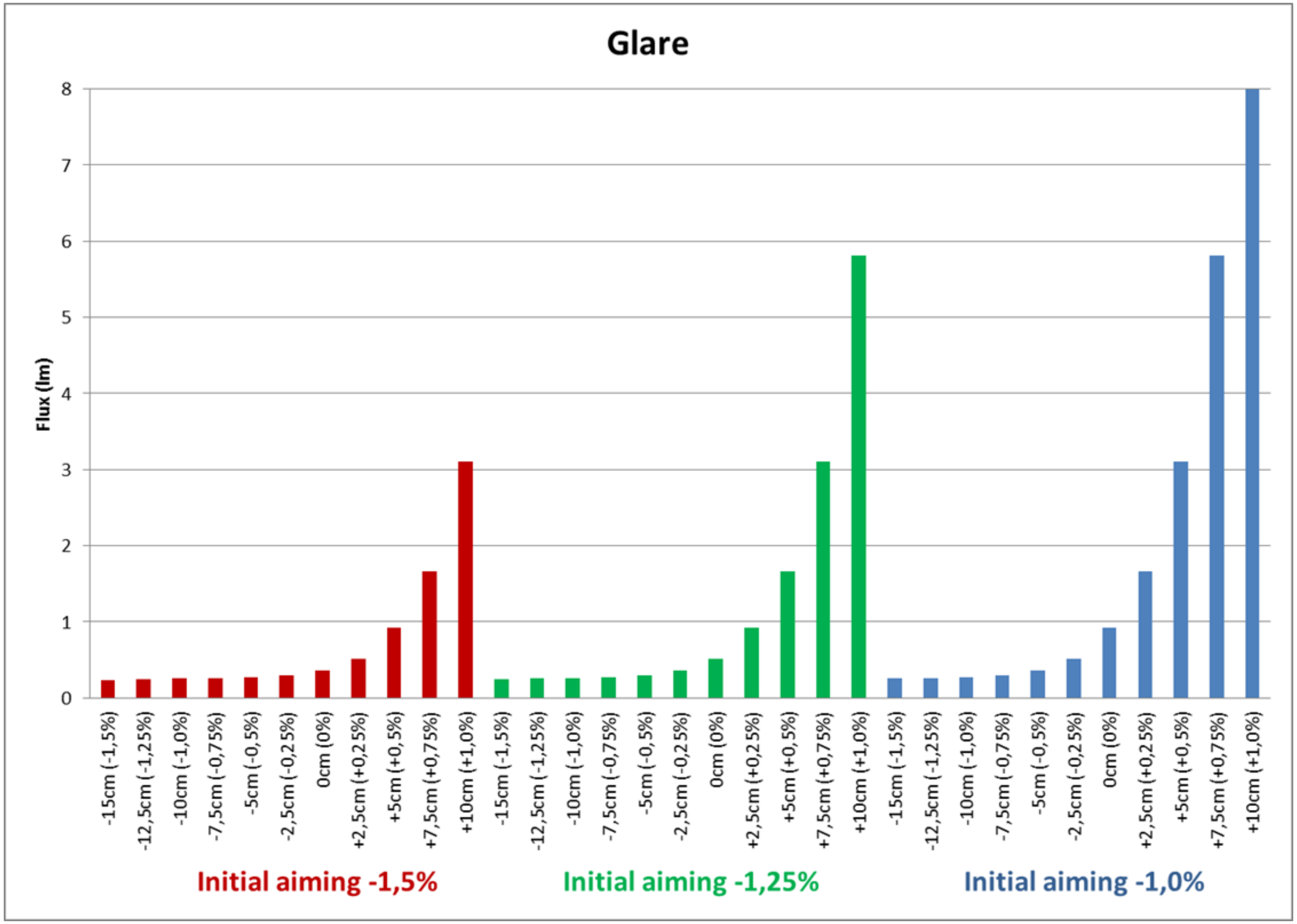
Headlamp Glare and Range under different conditions

Collection of data:

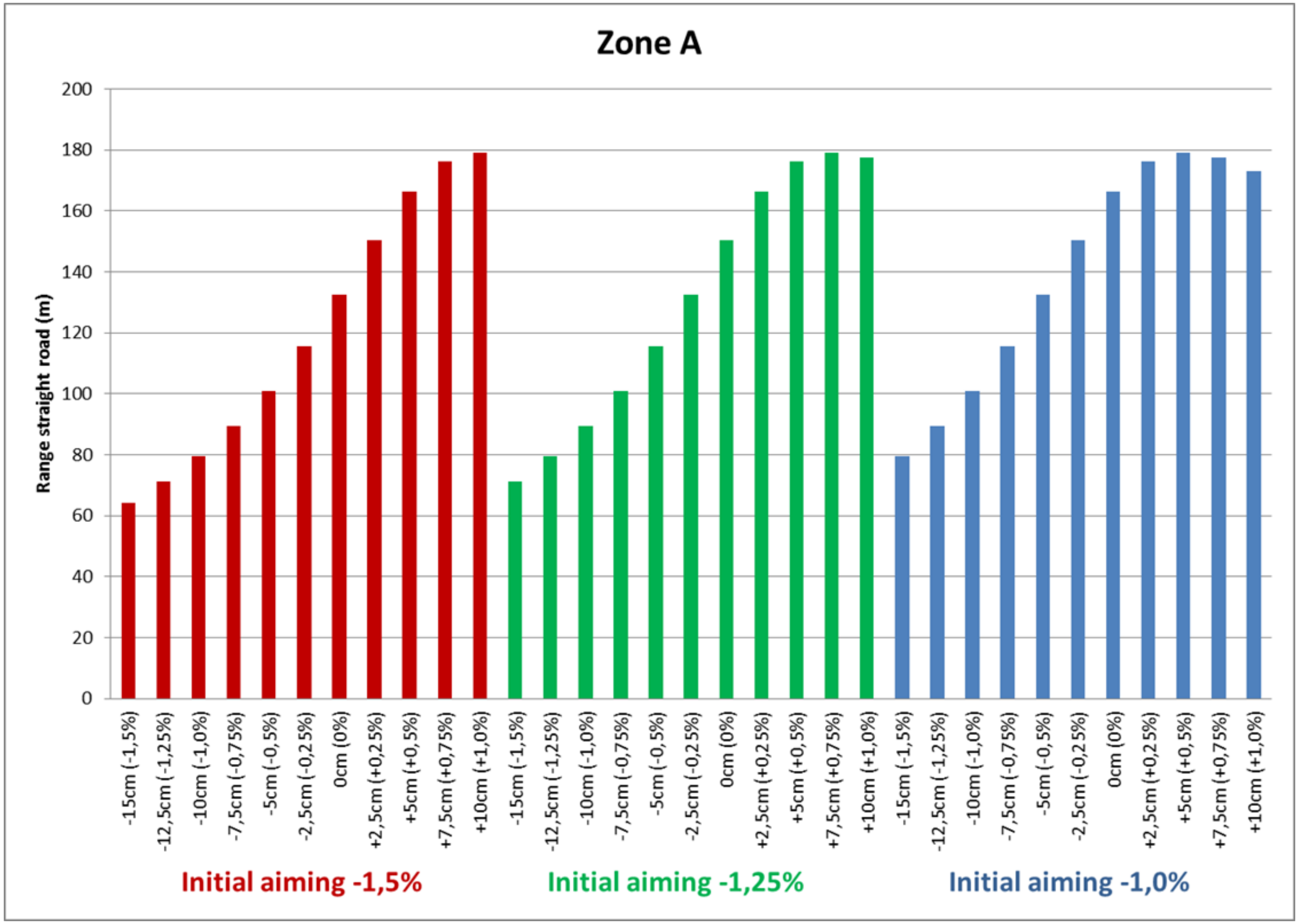
Glare and Range for headlamps

at different initial aiming settings

Glare – D3S headlamp at different initial aiming settings



Range in Zone A – D3S headlamp at different initial aiming settings



Headlamp Glare

Calculation Results

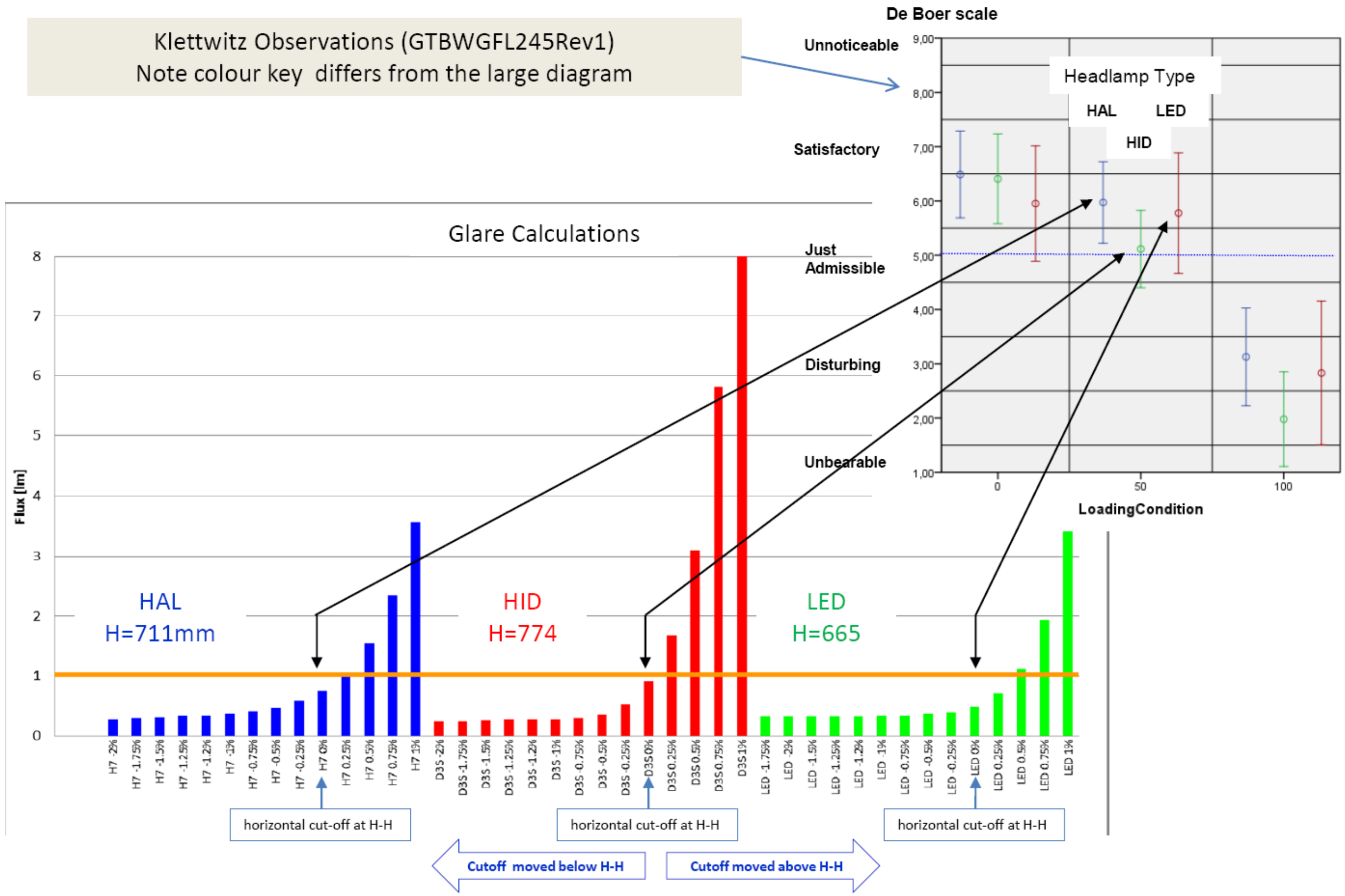
in Relation to

Klettwitz Field Test Outcome

Headlamp Glare – correlation between de Boer and Luminous Flux

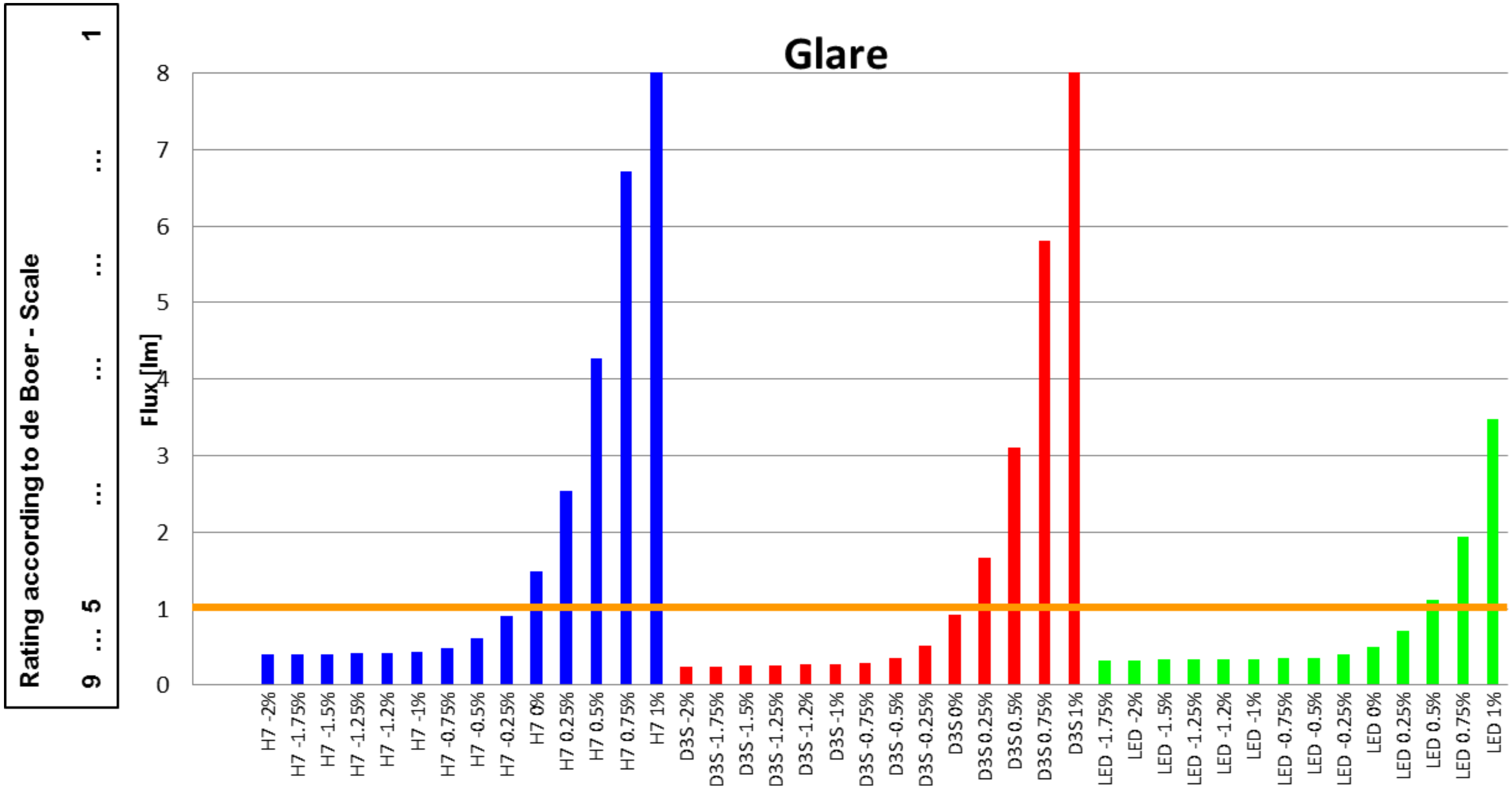
- The results of the Klettwitz field test show a clear relationship between pitch angle and discomfort glare.
- Pitch angles which lead to a passing beam cut-off movement above the horizon increase the discomfort glare for oncoming drivers – depending on the headlamps mounting height – to values below rating 5 („just admissible“) according to de Boer – scale.
- Cut-off positions above horizon lead – undependendly of light source types – to weighted luminous flux values in TC4-45 glare zone above 1 lumen.

Headlamp Glare – correlation between de Boer and Luminous Flux



CIE TC4-45
Performance Assessment Method
for Vehicle Headlamps

Headlamp Glare – correlation between de Boer and Luminous Flux



Headlamp Glare – correlation between de Boer and Luminous Flux

- **Comparison of Klettwitz field test results and TC4-45 calculations leads to the conclusion that de Boer-Rating of „5 – just admissible“ correlates with a weighted luminous flux in TC4-45 glare zone of 1 lumen.**

- **This correlation opens the possibility to use TC4-45 glare calculations for the assessment of glare impact to oncoming drivers in real traffic situations.**

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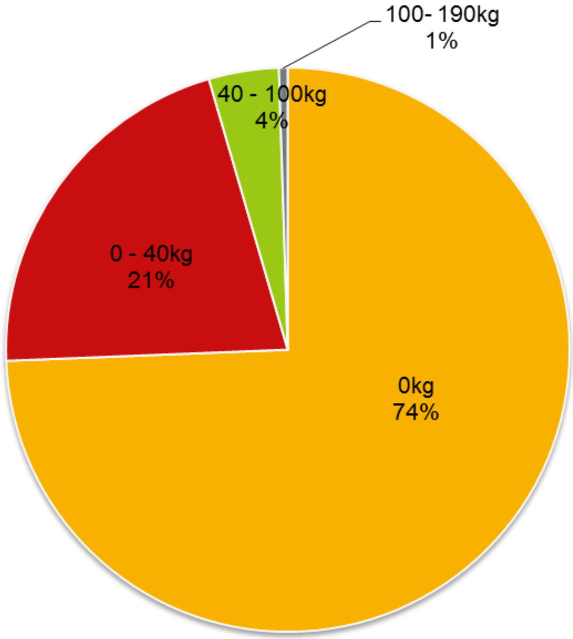
   Conclusion
   Suggestion

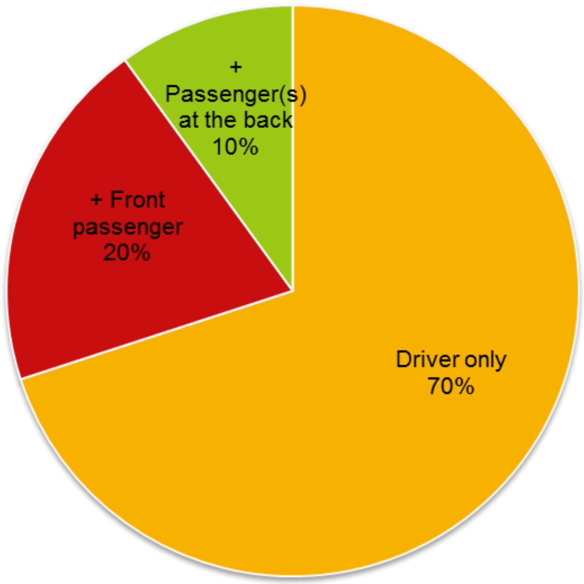
Automatic Headlamp Levelling
“50% Loading” Conditions

LOADING CONDITIONS OF VEHICLES INVOLVED IN ACCIDENT

ECE/TRANS/WP29/GRE/65/16



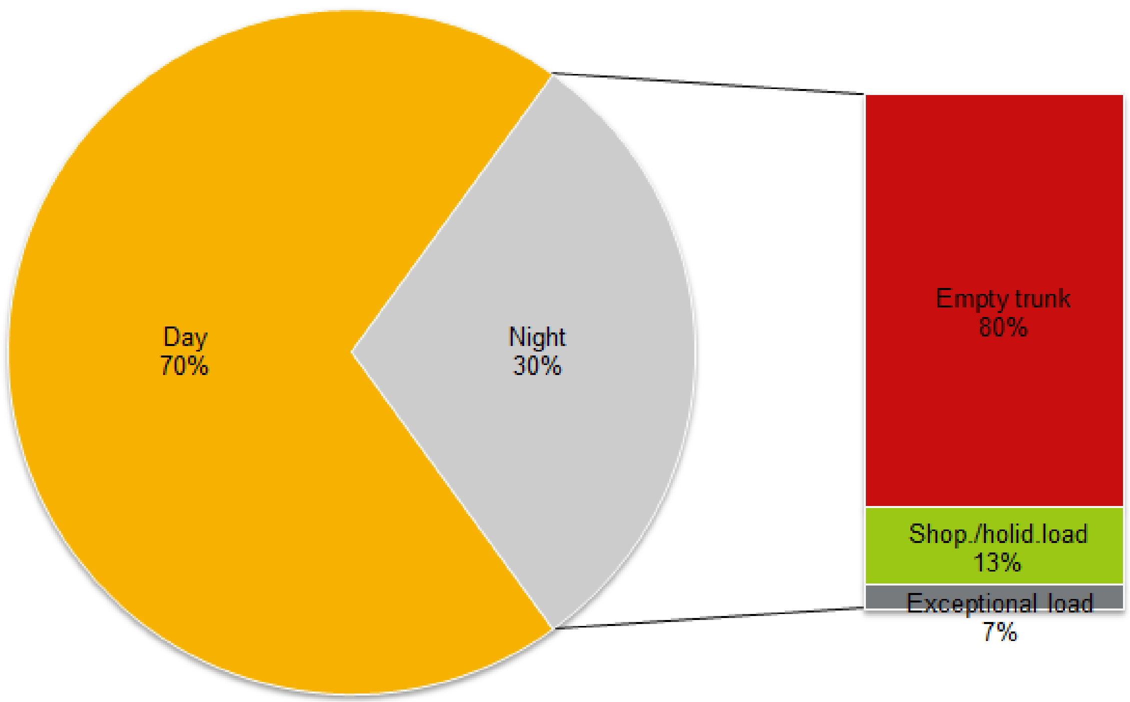
Trunk load



Passengers load

CUSTOMER HABITS REGARDING LOAD IN VEHICLE’S TRUNK

ECE/TRANS/WP29/GRE/65/16



DEFINITION OF "50% LOAD" CONDITION FOR A VEHICLE

- Load Condition 0% : $M_{0\%}$
  - Mass of the vehicle with 90% min. fuel tank and 75kg driver

    (as described in Reg. 48, paragraph 2.4 and Annex 6 paragraph 4.2 plus mass of the driver)
- Load Condition 100% : $M_{100\%}$
  - Mass of the vehicle with maximum load authorized

    (F1 information on Type Approval certificate)
- Load Condition 50% : $M_{50\%}$
  - $M_{50\%} = M_{0\%} + \left(\frac{M_{100\%} - M_{0\%}}{2}\right)$
- The size of a 50% load $\left(\frac{M_{100\%} - M_{0\%}}{2}\right)$ will be approximately 150kg to 300kg and is dependent on the vehicle type.
  - From 74% to 99% of trunk load involved in accident
  - More than 90% of passengers load involved in accident

"50% LOAD"- DISTRIBUTION IN THE VEHICLE

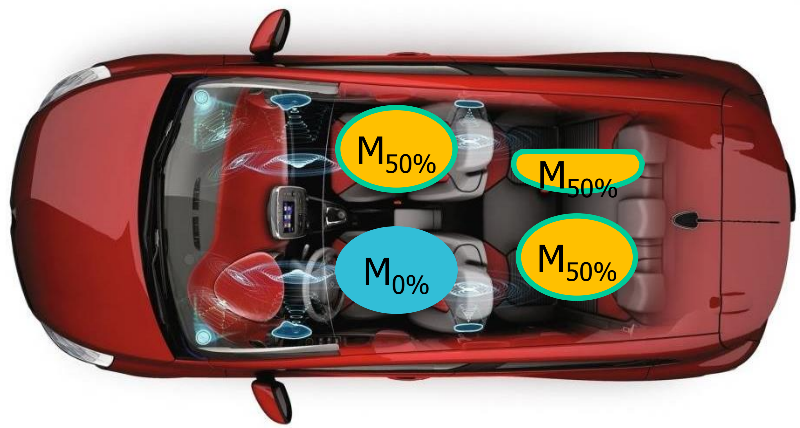
- **1 Passenger (75 kg) on the front seat**

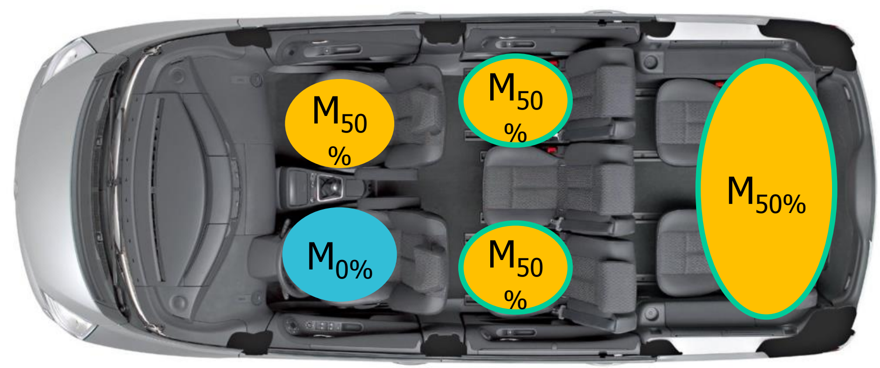
+

- **1 - 2 Passengers (75 kg + 75 kg) on the row closest to driver**

+

- **Rest of the "50 % Load" in the trunk (if necessary)**





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   - Suggestion

Summary

and

Suggestion for Amendment to UN Regulation No. 48

Geoffrey R Draper - GTB President

Headlamp levelling is a challenging subject because glare complaints are inherent to visibility of the road ahead for the driver.
There is no perfect answer!

The Elements of the Glare and Visibility Range Puzzle

Today's presentation has considered:

➢Visibility Range	The Polish approach
	The GTB approach
➢Acceptable Glare Limit	The GTB approach
	The Polish approach

➢The results of the comprehensive literature search

➢Calculations using the CIE method based upon actual vehicle system data

➢The Klettwitz tests clearly identifying the significance of vehicle pitch due to load

➢The concept of "50% loading" resulting from French research data

Focus on maintaining adequate visibility range

- Based upon the translation of the photometric requirements at the test points of the headlamp regulations into an estimate of values produced at points on the road surface.

- “Worst Case” – Takes account of lowest performing headlamps that meet the type approval requirements

Avoidance of glare is not directly addressed

- Assumes that the horizontal cutoff should not extend beyond 100m distance from car.

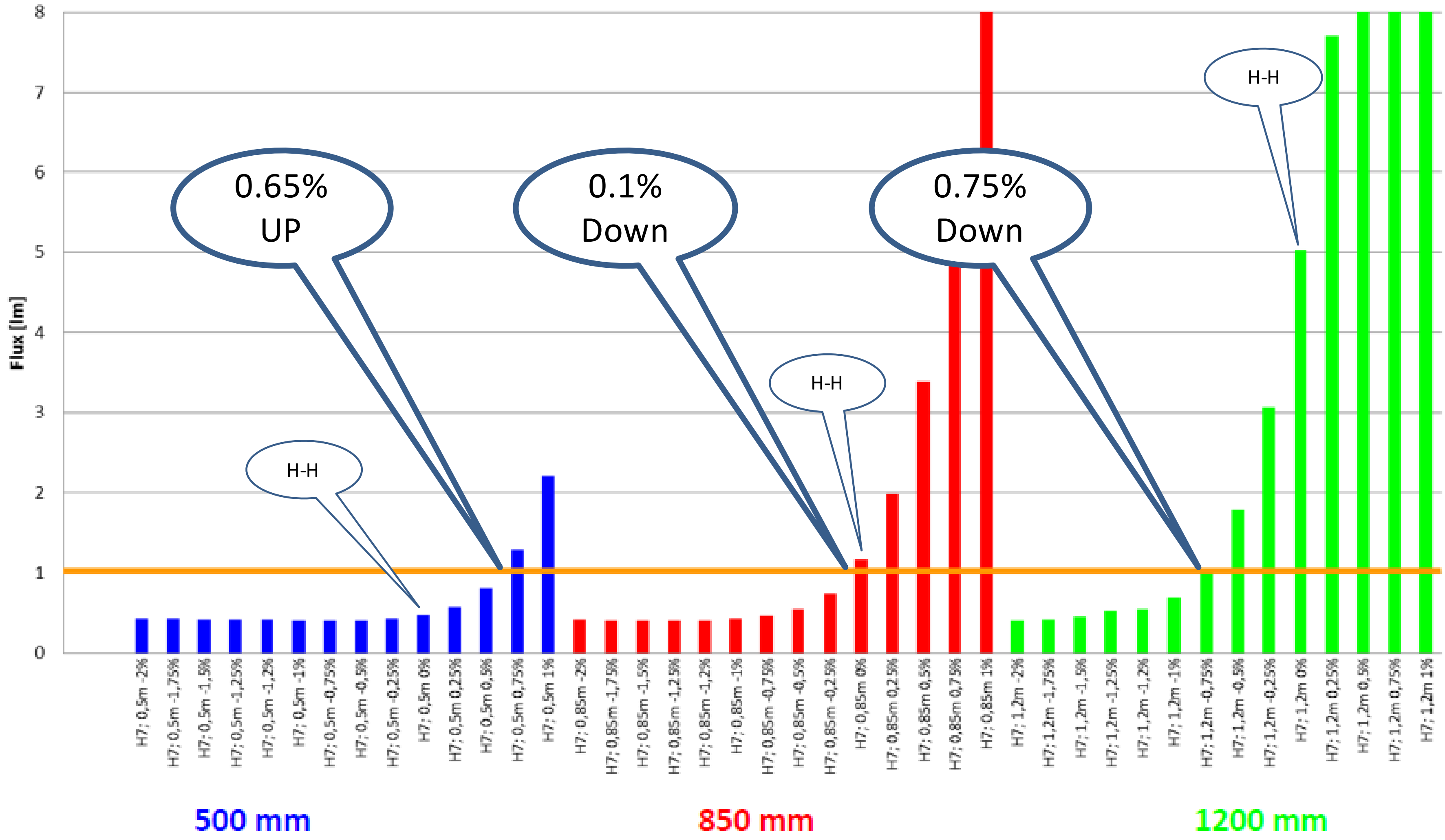
Long debate at GRE resulting in the revised proposal GRE/2014/11

The GTB Proposal

- Vehicle pitch is the influencing factor
- Glare remains acceptable providing the horizontal cutoff remains below the H-H line as defined in the headlamp regulations (Based on a mounting height of 750mm).
- It is necessary to consider the relationship between action to avoid glare complaints with the need to assure sufficient visibility range.
- The initial aim declared by the vehicle manufacturer becomes an important factor
- Data produced to enrich the Klettwitz results to validate the glare conclusions and investigate the relationship with visibility range
- Calculations using the CIE assessment method

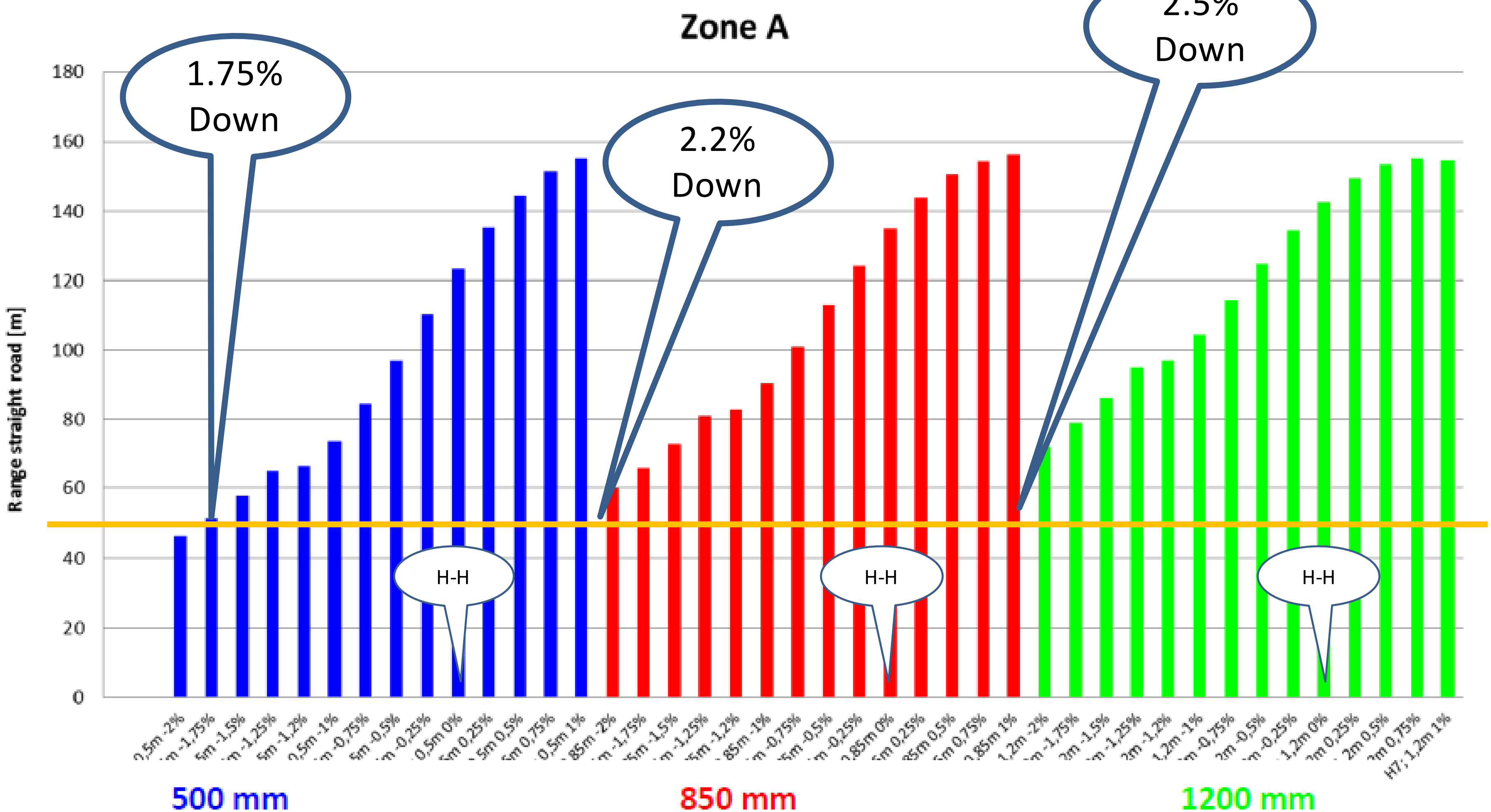
Glare Calculation

Example calculations using the CIE assessment method



Example calculations using the CIE assessment method

Visibility Range Calculation



GTB Proposal for Acceptable aiming limits

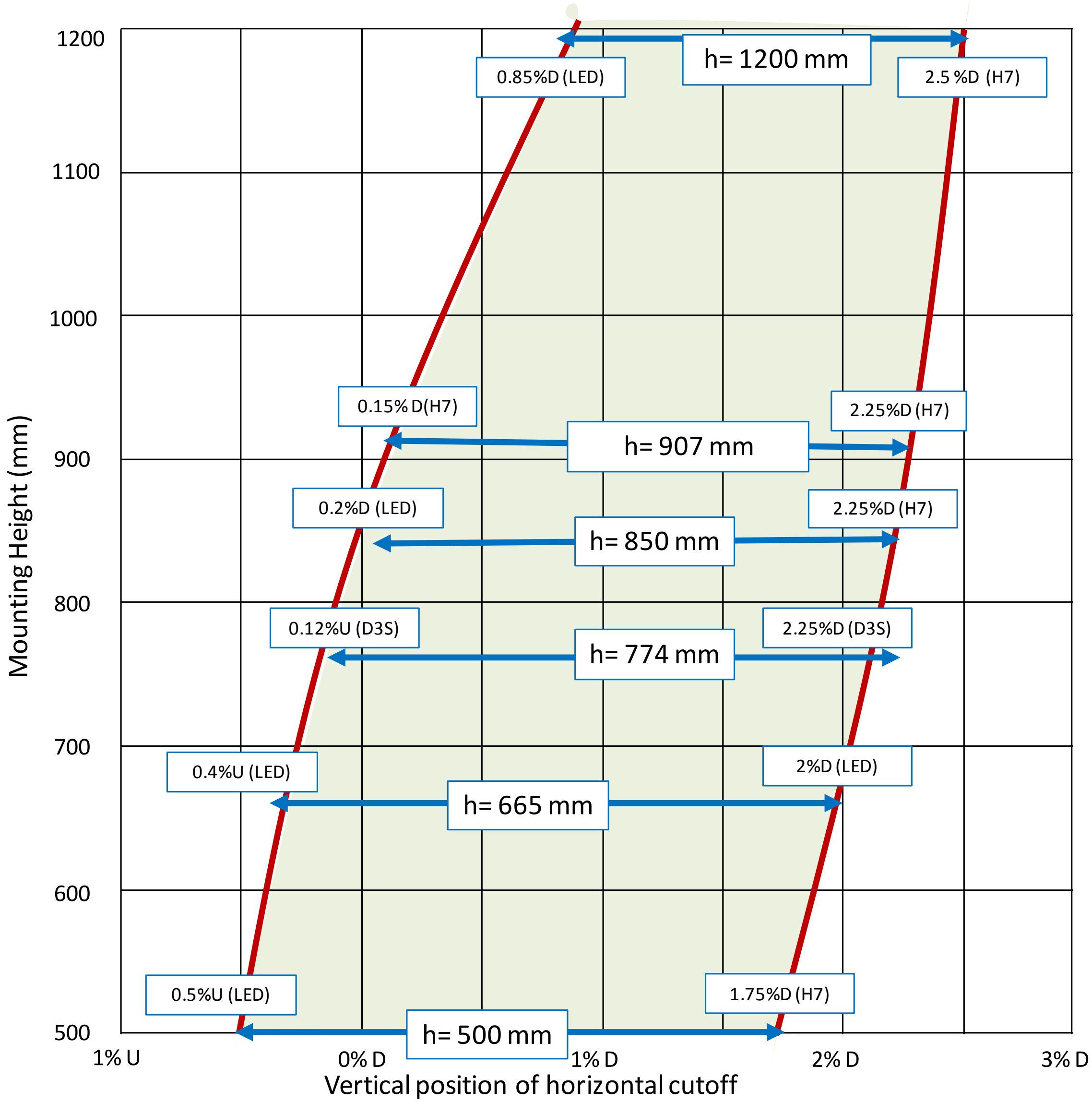
Summary of Results of Glare and Visibility Calculations
Based upon calculations using CIE method

Vertical Position of the Cutoff (+ = UP, - =Down)

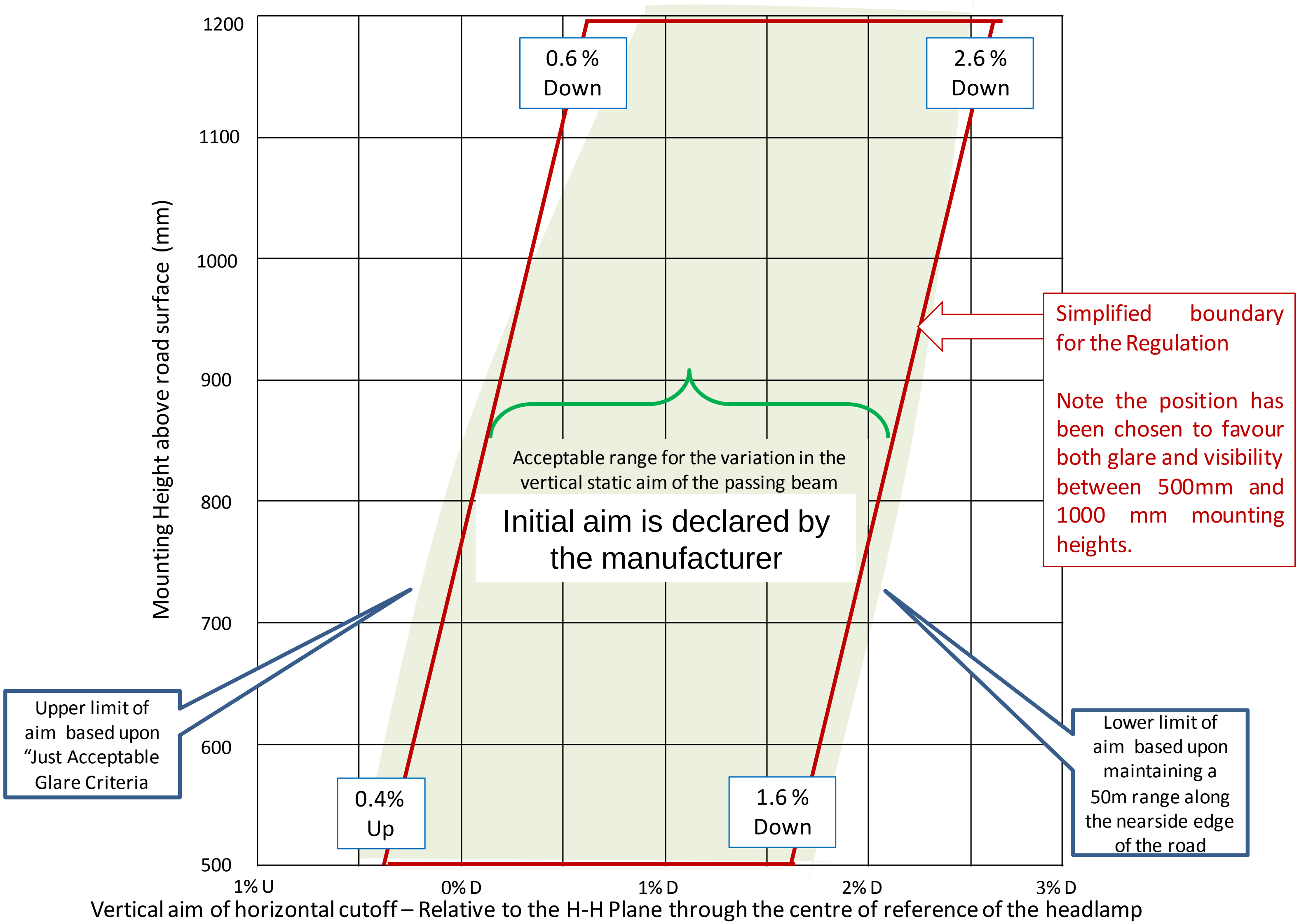
Mounting Height	H7		D3S		LED	
	Glare	Visibility	Glare	Visibility	Glare	Visibility
500	0.65	-1.75	0.6	-2.2	0.5	-2
665					0.4	-2
744			0.12	-2.25		
850	-0.1	-2.25	-0.12	-2.25	-0.2	-2.5
907	-0.15	-2.25				
1200	-0.75	-2.5	-0.85	-3.25	-0.85	-3

The highlighted values indicate the position of the cutoff for the maximum permissible glare and the minimum permissible visibility range (i.e. The boundary conditions)

GTB Proposal for Acceptable aiming limits



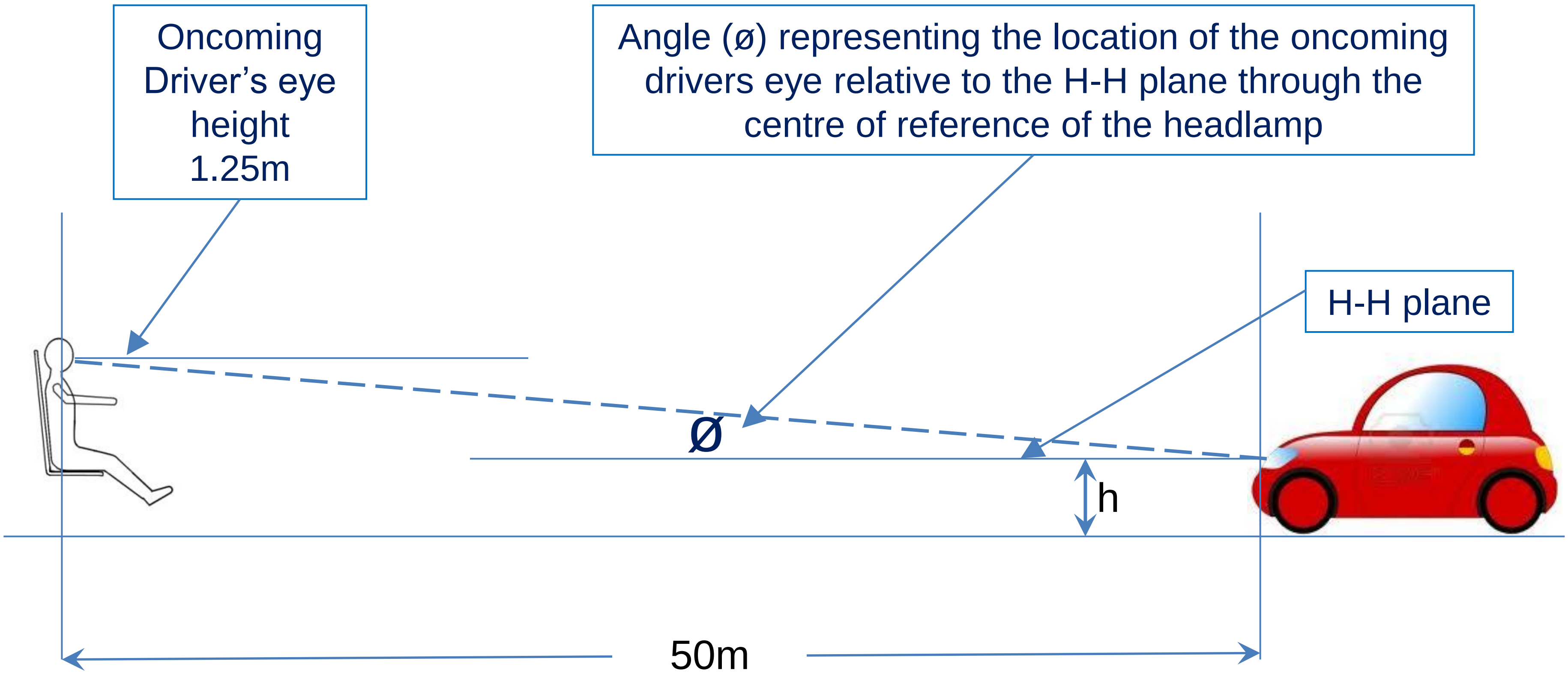
GTB Proposal for Acceptable aiming limits



How can we consider allowing the upper aiming limit to be above the H-H line?

- ✓ Vertical aim of horizontal cutoff is relative to the H-H plane through the centre of reference of the headlamp
- ✓ The headlamp height will vary between 500mm and 1200mm
- ✓ The mean height of the oncoming driver's eye is 1250mm
- ✓ Glare is assessed at a distance of 50m from the headlamp
- ✓ At 50m the important factor concerning glare is the separation of the oncoming driver's eye and the position of the horizontal cutoff
- ❑ This factor has not been taken into account in the current R48 requirements

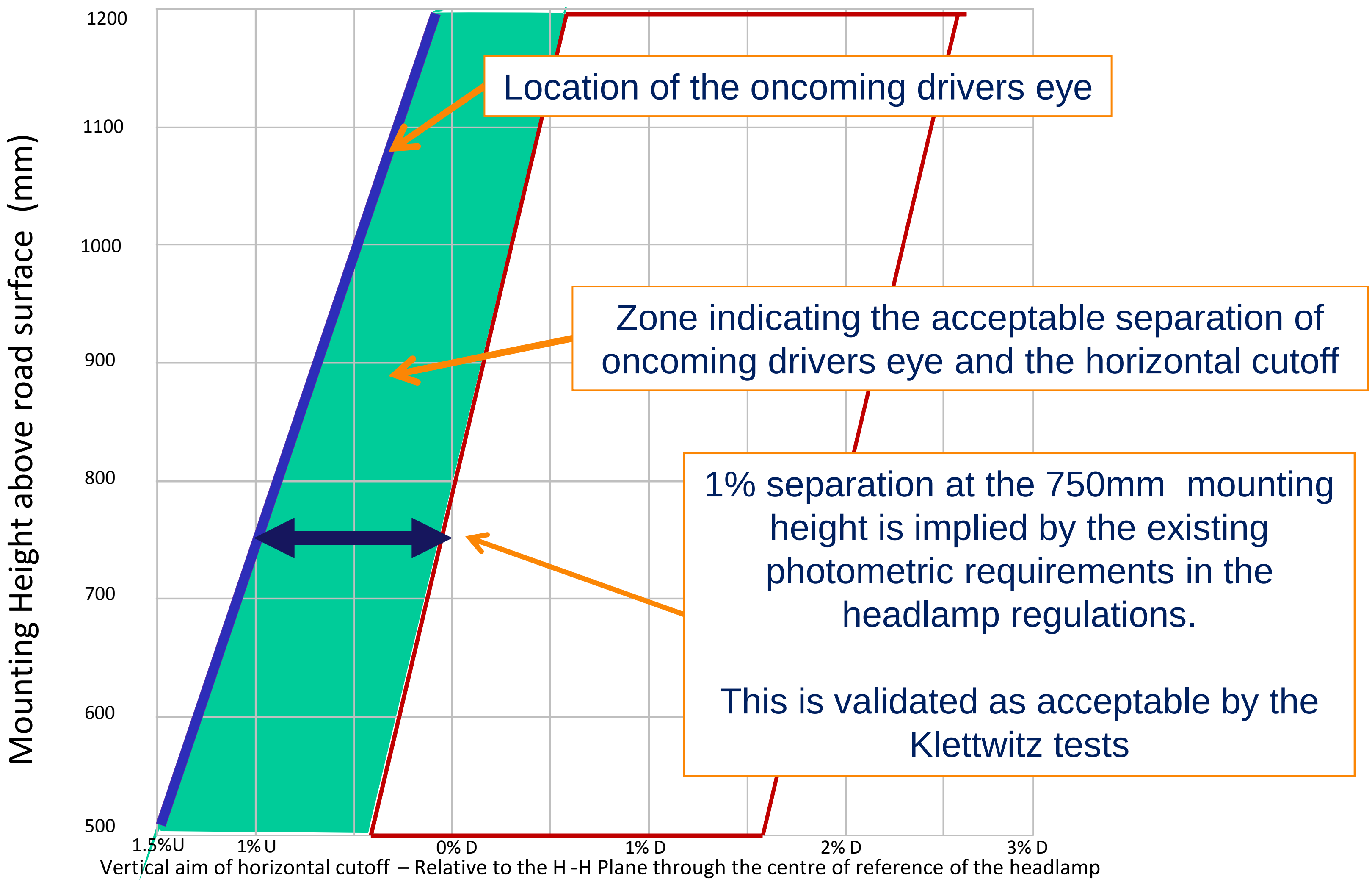
Angular relationship of horizontal cutoff and oncoming driver's eye



$$Ø = ((1.25-h) / 50) * 100 \%$$

Height of oncoming driver's eye	1250	1250	1250	1250	1250	1250	1250	1250
Headlamp mounting height mm	500	600	700	800	900	1000	1100	1200
angular difference Ø - %	1.5	1.3	1.1	0.9	0.7	0.5	0.3	0.1

GTB proposal with oncoming driver's eye position superimposed



GTB Proposal for Acceptable aiming limits

How can we consider raising the upper glare limit when there are already glare complaints from road users?

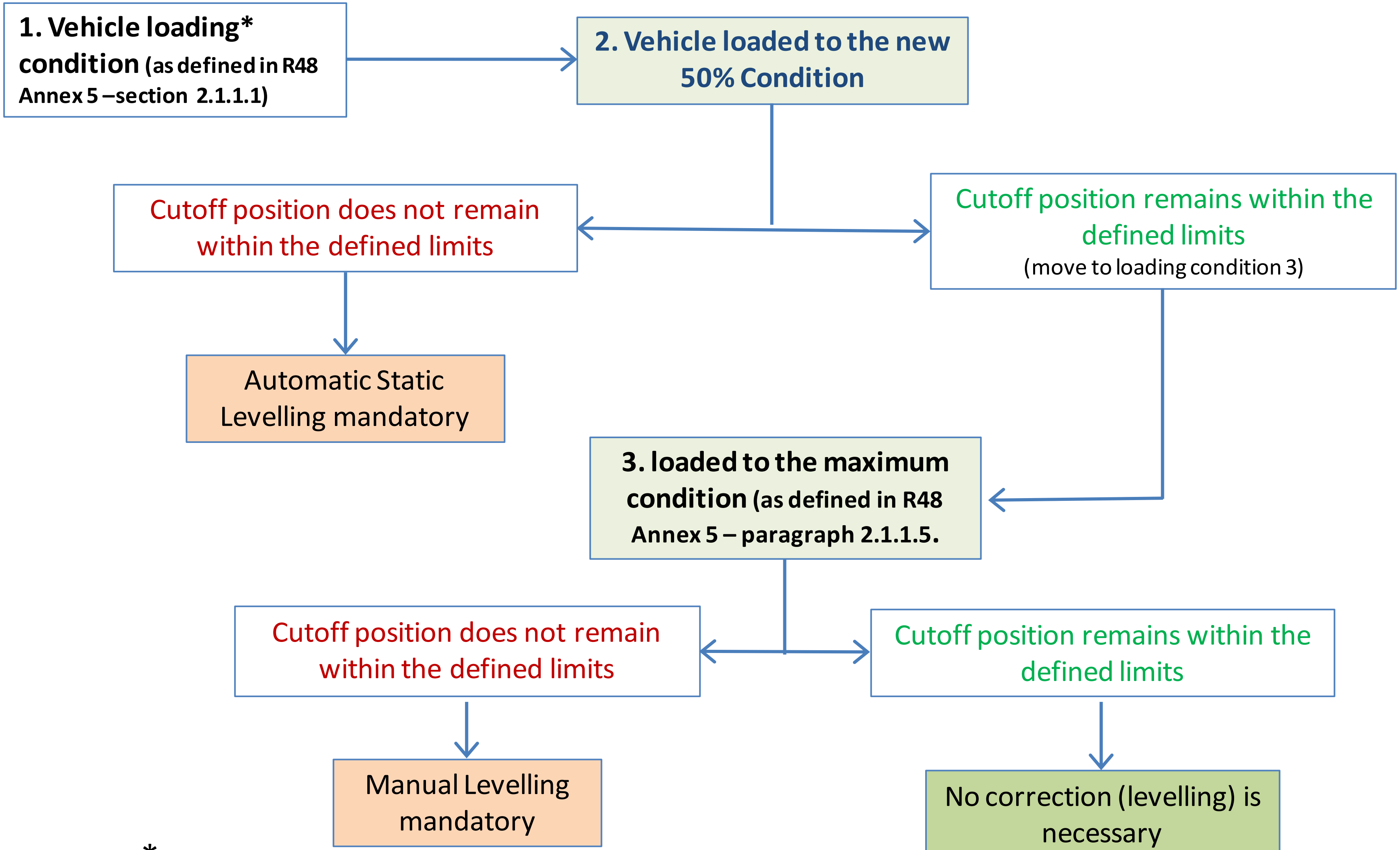
- ✓ The proposed GTB upper aiming limit is based upon research reported in the CIE188: 2010. This established a correlation between the calculated light flux in the glare zone and observations using the De Boer scale.

- ✓ A similar correlation was found between the calculations and the observations in the Klettwitz tests.

- ✓ Glare complaints are common but there are no data to show the relationship between initial aim and glare complaints, despite studies in Europe and USA

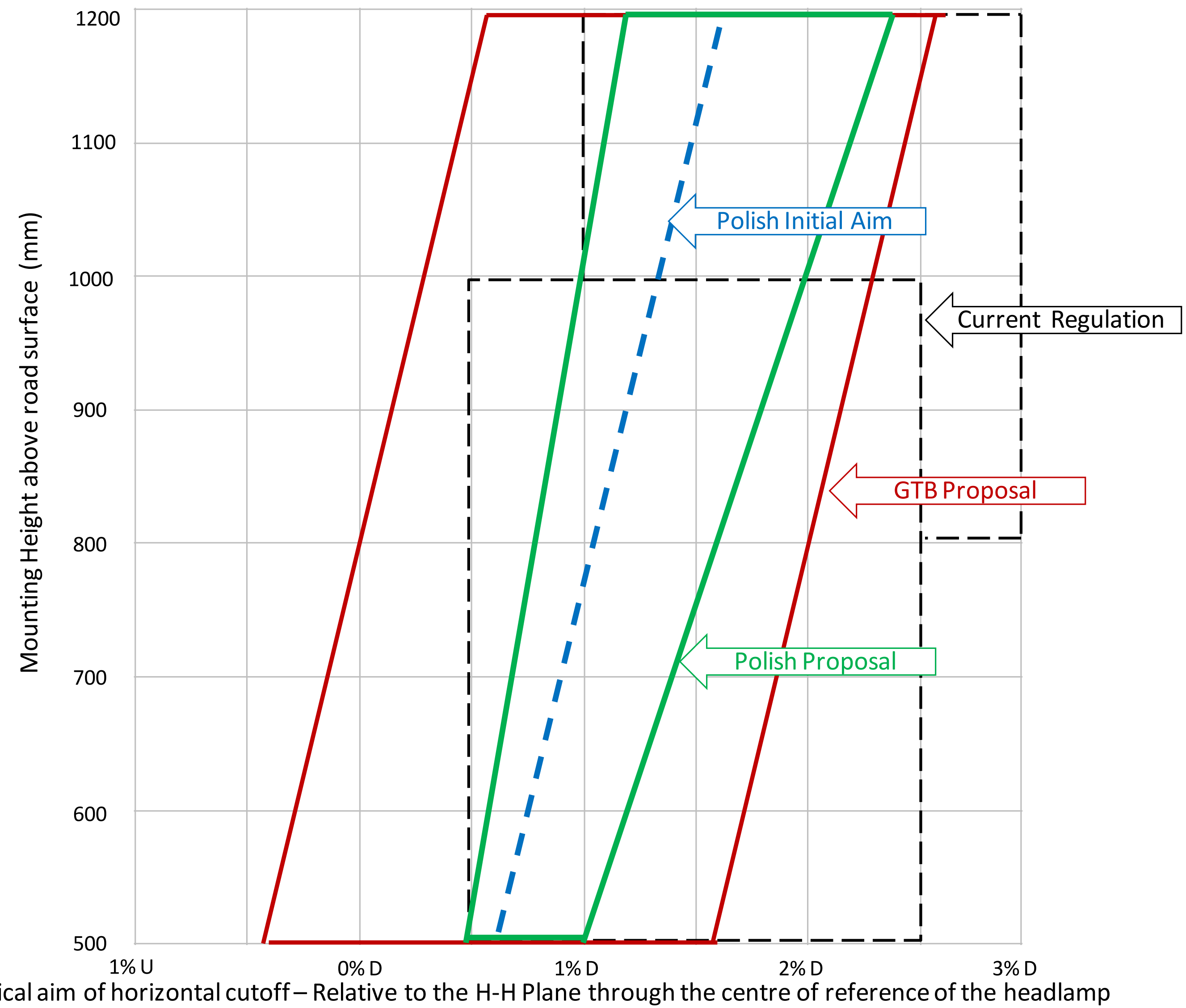
- ✓ Current R48 requirements have assumed HID headlamps will create more glare and are required to have auto-levelling. Klettwitz tests and calculations show that halogen headlamps produce higher values in the CIE glare zone. Halogen headlamps are rarely installed with auto levelling.

GTB Proposal for Amendment to R48



* Note the mass of the passengers shall be 75 kg per person.

Comparison of Polish & GTB Proposals with Current R48



How to Proceed? (1)

The Polish Proposal

- based upon current photometric requirements of the headlamp regulations defines the aiming limits that have to be respected for all loading conditions described in R48 Annex 5.
- intended to apply to all vehicle installations that will use any headlamp type approved to the existing headlamp regulations.
- assumes that the horizontal cutoff levelling tolerances are such that:
  - a) to achieve adequate range the position of the cutoff does not exceed the maximum allowed downward inclination corresponding to a point on the road at 50 m distance.
  - b) for glare avoidance the position of the cutoff does not exceed a vertical position that corresponds to a point on the road at 100 m distance from the car. In this condition the glare values at the oncoming driver's eye are assumed to not significantly exceed the values specified in the headlamp regulations.
- results in tolerances that are significantly smaller that those currently allowed in Regulation 48.

The GTB proposal

How to Proceed? (2)

- based upon headlamp systems typical of the standard of performance currently achieved in popular Western European and Japanese type approved vehicles.
- these headlamps are achieving performance levels in excess of the minimum requirements of the headlamp regulations.
- does not attempt to represent the worst-case situation as is represented by the Polish proposal.
- glare and visibility range values have been determined by calculations based upon actual measured headlamp performance data, using the CIE validated method.
- result is a proposal for aiming tolerances that are similar to those currently specified in Regulation 48 but with an upward shift.
- requires the vehicle manufacturer to declare the vehicle pitch under the specified loading conditions at the early design stage.

How to Proceed? (3)

The GTB and Polish proposals present possibilities:

❖ Determine and declare the pitch characteristics of the vehicle at the time of type approval and confirm compliance with the aiming tolerances in the GTB proposal, or:

❖ Apply for a type approval without the requirement to declare the pitch characteristics and confirm compliance with the levelling tolerances in the Polish proposal.

Next Steps

Depending upon the reaction of GRE:

April 2014	Presentation to GRE / feedback from GRE experts
May 2014	GTB ready for preparation of proposals to amend the text of Reg.48 including revision to annex 5 loading conditions (GTB Meeting – Spain)
July 2014	Deadline for submission of formal proposals to GRE-72

GTB Task Force

Coordination of Automotive Visibility and Glare Studies

Thank you for your attention