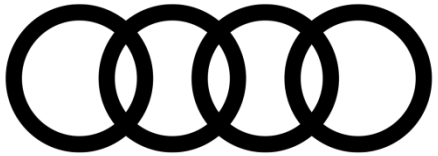


DVN Workshop Novi, MI , 21.09.2021

Dr. Michael Hamm, AUDI AG

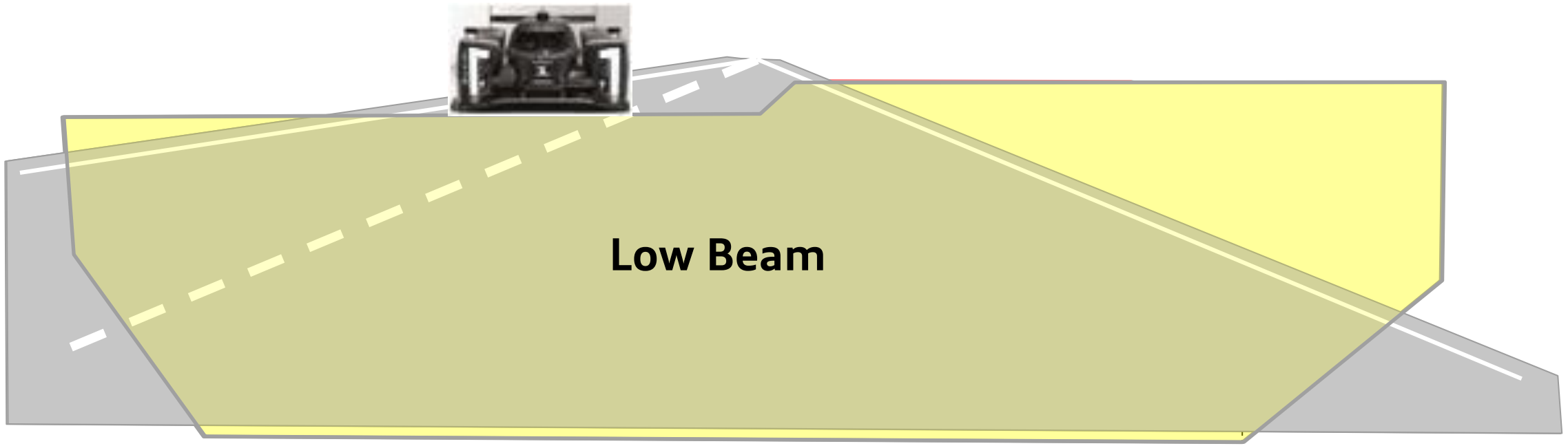
Worldwide ADB Experience
Research, Statistics and Worldwide ADB Volumes

ADB Research, Statistics and Worldwide ADB Volumes

ADB today

- High Beam and ADB
- ADB in the World Market
- ADB and Approval
- ADB and Traffic Safety Research
- ADB in a Hypothetical Accident Avoidance Analysis

Driving Situation at Night

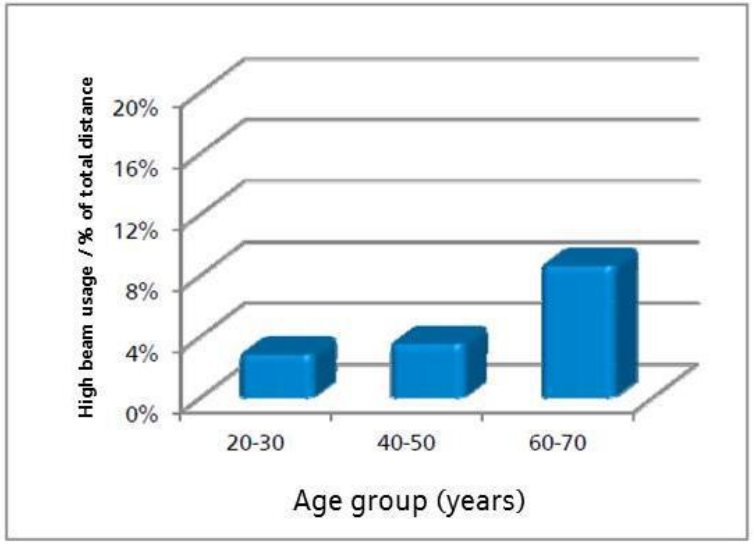


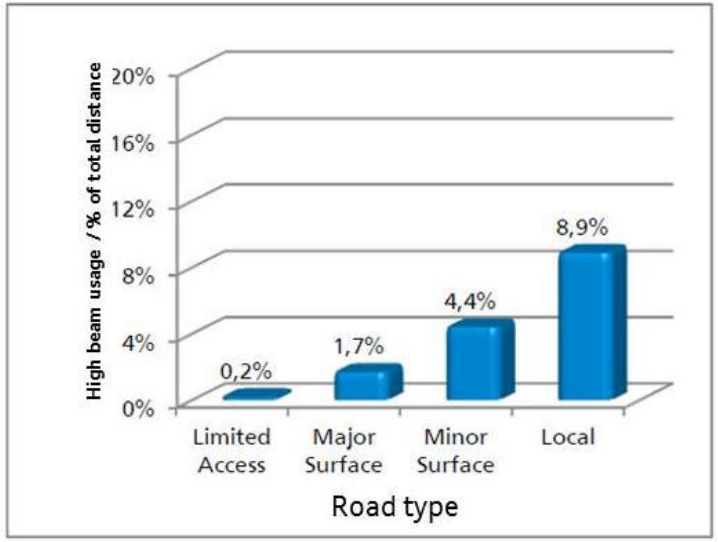
This **Situation happens quasi every night. Do we know exact numbers how often ?**

Literature Data on High Beam Usage

Authors	Year	Region	Test Type	HB Usage (AVG)
Mefford, Flannagan, Bogard, Sivak	2007	USA	**South East Michigan Every Day Use**	**3,1%** (most favorable condition 25,4%)
Böhm, Krems, Locher	2009	D	**Rural Roads**	**19,1%**
Sprute	2012	D	**3 different Rural Straight Roads**	**25,5%**

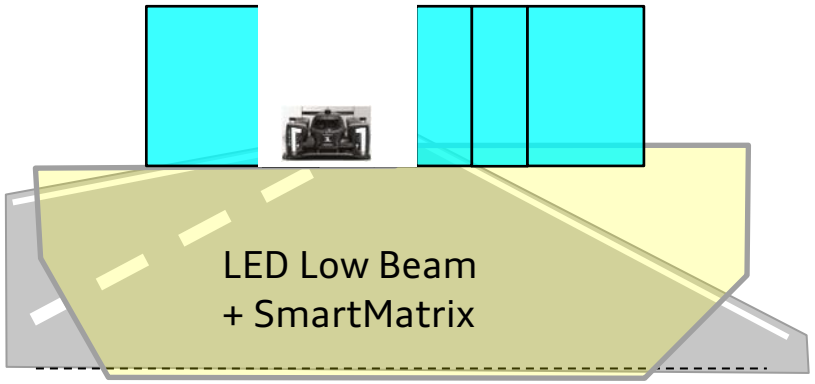
High Beam Usage in USA 2007

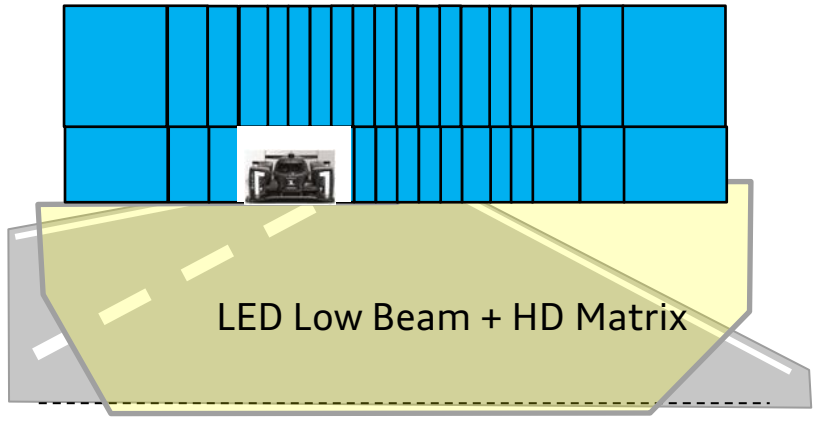




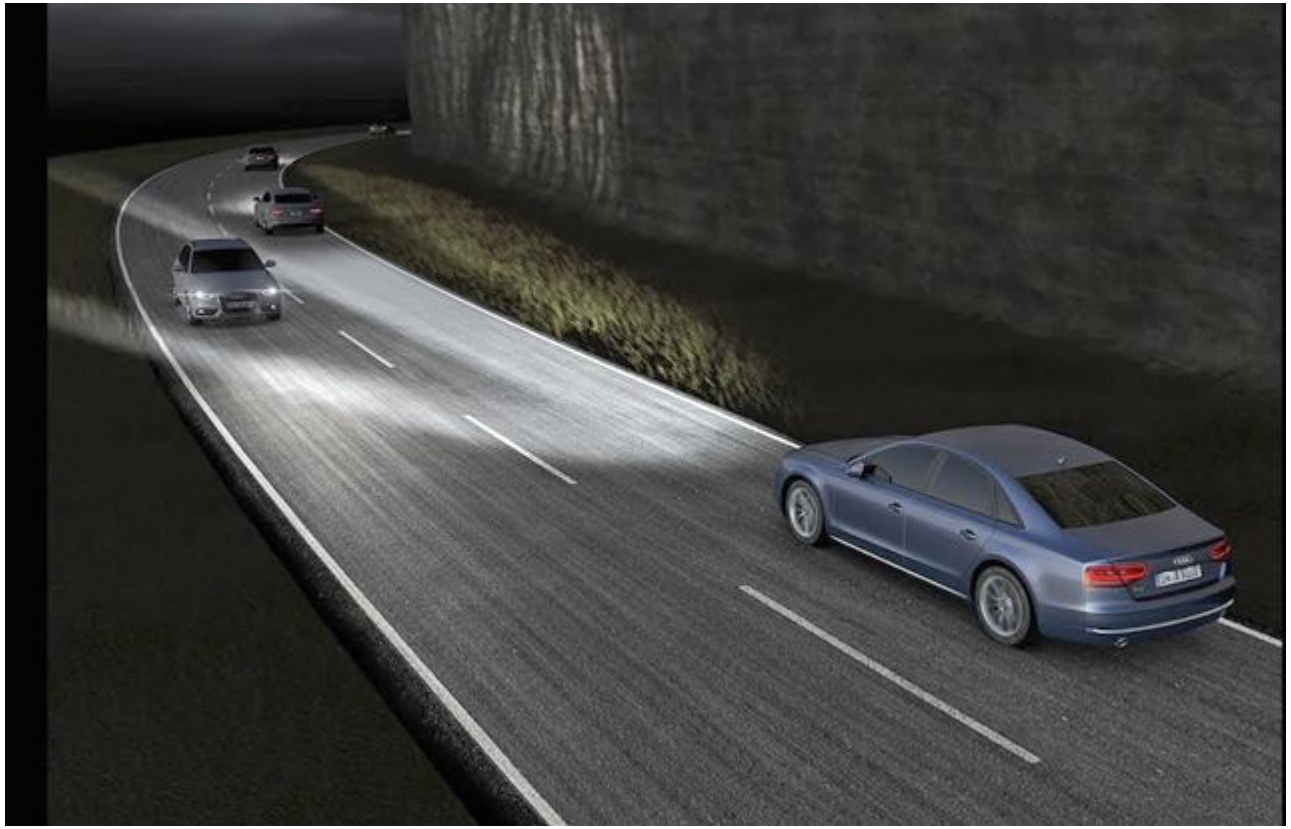
Source: Mefford, Flannagan, Bogard,, Sivak: Real-World Use of High Beam Headlamps. ISAL 2007

ADB and Matrix: Many Solutions



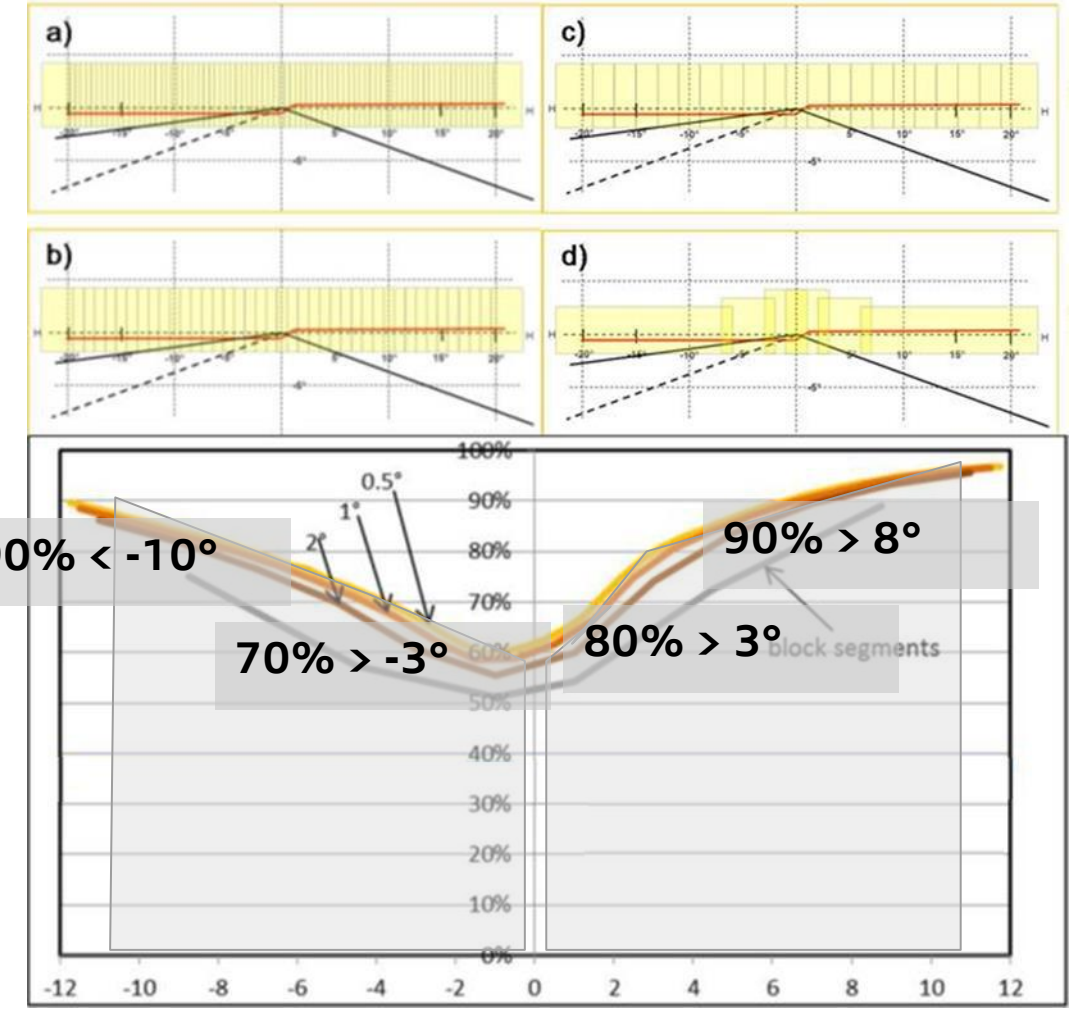


Usage Time of MXB Systems



Variable Segment Number and Fixed Traffic Density

(3,1 veh./km → ~ 240 veh./hr, ISAL 2013



From:
Austerschulte, A., Dreier, B., Rosenhahn, E.-O.: "Analysis of Safety Aspects for LED Matrix High Beam Functions". ISAL 2013, Vol 15.

ADB Research, Statistics and Worldwide ADB Volumes

ADB today

- High Beam and ADB
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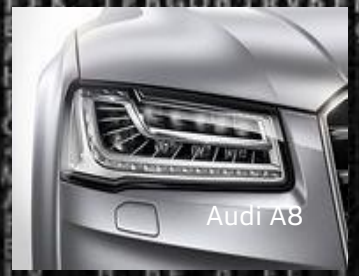
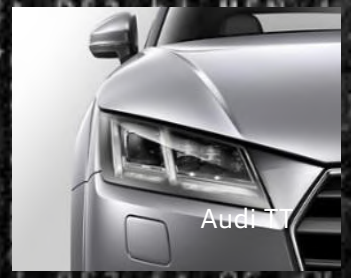
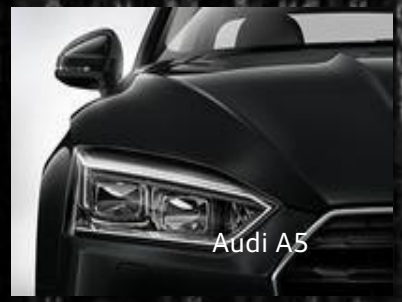
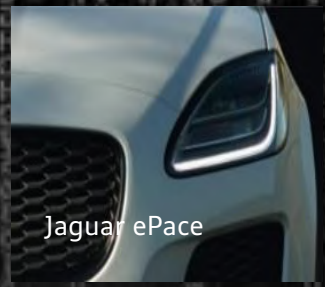
- ADB and Traffic Safety Research
- ADB in a Hypothetical Accident Avoidance Analysis

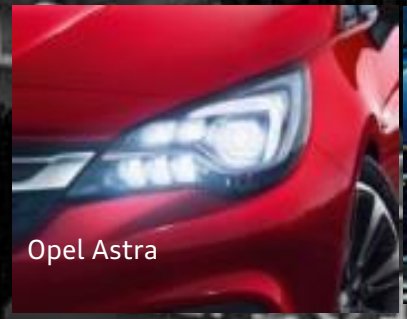
Matrix LED in Series production (2018)

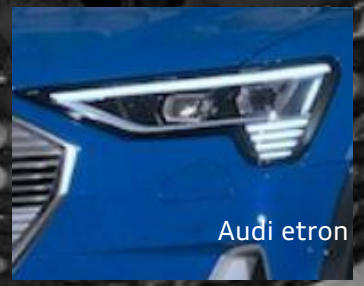


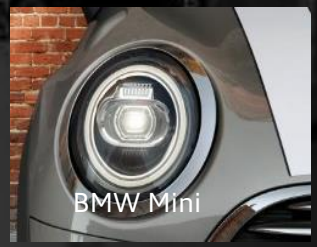












Source: OEM Websites

2018: Many ADB names have been invented

- Adaptive LED Headlights
- Active High Beam
- Dynamic Light Assist
- High Beam Control
- Intelligent Light System
- Maskiertes Dauerfernlicht
- Matrix LED
- Multibeam

Source: OEM Websites

2021: And even more names.....

- AHS Adaptive High Beam System
- iQ Light
- ADB LED Array
- Intelligent Frontlighting IFS
- Pixel Matrix LED
- LED Matrix Vision
- Intellilux
- Adaptive LED

2021: Worldwide Models available with Matrix / ADB

Internet Research Result: 143 Models

Audi A8 (Start 2013)	Audi Q8	Audi A7	Audi Q7	Audi A6	Audi e-tron / Sportback	Audi Q5	Audi A5	Audi A4	Audi Q4 etron
Audi A3	Audi Q3 / Q3 Sportback	Audi Q2	Audi TT	Audi e-tron GT	BMW 8-series	BMW 7-series	BMW 6-series / GT	BMW 5-series	BMW 4-series
BMW 3-series / GT	BMW 2-series	BMW 1-series	BMW Mini /Clubman/Countryman	BMW X7	BMW X6	BMW X5	BMW X4	BMW X3	BMW X2
BMW 2-series GranTourer	BMW X1	BMW i3	BMW iX3	Bentley Flying Spur	Bentley Mulsanne	Bentley Bentayga	Bentley Continental	BYD Tang	BYD Quin
BYD Han	Chery Yiedu X90	Chery Tiggo 7 Pro	Chery Tiggo 8 Pro	Changan UNI-T	Changan CS55	Donfeng Fengguan 580	Dongfeng Aeolus AX7	HongQi HS9	HongQi HS7
Maserati Levante	Maserati Ghibli	Lincoln Corsair Adventurer	Ford Edge	Geely Hoayue	Volvo XC90	Volvo S90	Volvo XC60	Volvo S60	Volvo V40
Volvo Polestar	Cadillac XT6	Buick Envision Plus	Buick Verano GS	Wey VV6	Wey VV7	Haval H6	Haval H9	Haval Chitu	Honda Civic
Genesis G80	Genesis G70	Genesis GV80	Hyundai Ioniq 5	LR Evoque	LR Discovery	LR Range Rover	Jaguar I-Pace	Jaguar E-Pace	Jaguar F-Pace
Jaguar XF	Mazda Series 6	Mazda CX5	Mazda CX 30	Mercedes S	Mercedes S-Coupe	Mercedes GLS	Mercedes GLE	Mercedes EQS	Mercedes EQE
Mercedes CLS	Mercedes EQC	Mercedes GLC	Mercedes E /E-Coupe	Mercedes C /C-Coupe	Mercedes GLB	Mercedes GLA	Mercedes CLA	Mercedes B	Mercedes A
Mercedes EQA	Mercedes V	Opel Insignia	Opel Astra	Opel Corsa	Opel Mokka	Opel Grandland	Opel Crossland	Citroen DS3 / DS3 Crossback	Peugeot 5008
Peugeot 308	Nissan Qasqai	Renault Talisman	Renault Espace	Roewe RX5	Roewe Marvel R	Seat Leon	Seat Ateca	Skoda Superb	Skoda Octavia
Skoda Enyiaq	Skoda Kiodiaq	Toyota Prius	Toyota Corolla	Toyota RAV4	Toyota Yaris	Toyota Subaru Outback	Toyota Lexus NX	Toyota Lexus RX	Toyota Lexus UX
Toyota Lexus ES	Toyota Lexus CT	VW T-Cross Coupe	VW ID3	VW ID4	VW Golf	VW Touran	VW Tiguan	VW Passat	VW Passat CC
VW Arteon	VW Sharan	VW Touareg (Start 2010)							

Source: OEM Websites, Online Configurators and Internet search for ADB, Matrix etc. Search Timeslot 08/09, 2021

Worldwide Cars available with ADB

IHS Markit

AUTOMOTIVE

Light Vehicle Sales Forecast

Drive better business decisions with insights into market demand, segment growth, and competitive dynamics.

Unrivaled detail for 97% of the world's light vehicle sales

The Light Vehicle Sales Forecast is built on a thorough examination of the automotive industry from a demand perspective. Using a disciplined forecasting methodology, our expert team of industry analysts marries macroeconomic and statistical analysis with segment trends, brand strategies, model life cycle stages, future model plans, consumer behaviors, and production capacity constraints. Clients use the forecast to analyze

OEMs

- Sales volume planning
- Market trends
- Segment trends
- Competitive product intelligence
- Competitor market entry timing
- Market share assessment

Suppliers

- OEM customer growth analysis
- Segment trends for supplied component and technology adoption
- Regional adoption paths for supplied component and technology growth

Financial institutions

- OEM financial success

Government agencies

- The size of domestic markets
- Taxation revenue forecasts
- Formulation of safety and emissions regulations

Logistics companies

- Sales destinations mapped to production source
- Unit volumes and frequency of shipment for revenue and capacity forecasts
- Vehicle container sizing

Source: https://ihsmarkit.com/index.html

Produced Volumes - ADB content (IHS Database, OEM communication)

(New Cars or respective Facelifts from 2013...2018) **= 51 models**

Audi	A8 (MY2013)	146000
	A8 (MY2017)	31000
	Q8	28000
	A7 (MY2014)	103000
	A7 (MY2018)	25000
	Q7	260000
	A6 (MY 2015)	320000
	A6 (MY2018)	75000
	Q5	330000
	A5	190000
	A4	1030000
	A3	460000
	Q3	23000
	TT	182000
	Audi e-tron	5000
3208000		

BMW:	7-series	286000
	6-series	66000
	5-series	487000
	4-series	398000
	3-series	1033000
	2-series	147000
	1-series	514000
	Mini	192000
	X6	93000
	X5	415000
	X4	112000
	X3	147000
3888000		

Mercedes:	S-Class	484000
	S-Class Coupe	38000
	CLS-Class	36000
	E-Class	1183000
	C-Class	161000
	GLE	58000
	GLC	178000
	V-Class	129000
2267000		

Opel/PSA:	Insignia	262000
	Astra	780000
	Citroen DS3	52000
1094000		

Volvo:	XC90	169000
	S90	62000
	V60	71000
	S60	55000
	V40	184000
541000		

VW:	Touareg	45000
	Arteon	63000
	Passat	404000
	CC	88000
	Tiguan	727000
	Sharan	80000
	Touran	453000
	Golf	1137000
2997000		

Others	Mazda	270000
	Jaguar/Landrover	335000
	Lexus/Roewe et al.	100000
705000		

2018

Estimated Total produced cars with ADB as an option:

14.700.000 cars (2013..2018)

More details: See DVN Rochester 2019 Presentation
https://www.drivingvisionnews.com/news/2018/10/20/2019-dvn-us-workshop-3/

Cumulated Produced Volumes - ADB content (IHS Database, OEM Communication)

New Cars/Facelifts from 2013...2021 (= 143 models)

Audi	A8 (Start MY2013)	241.019
	Q8	183.733
	A7 (Start MY2014)	174.207
	Q7	573.590
	A6 (Start MY 2015)	1.256.730
	Audi e-tron /e-tron Sportback	189.558
	Q5	1.482.290
	A5	534.624
	A4	2.279.900
	Q4 etron	15.004
	A3	1.542.404
	Q3 / Q3 Sportback	661.065
	Q2	231.176
	TT	232.495
	Total Audi	9.597.795

BMW	8-series	71.057
	7-series	503.630
	6-series / GT	153.134
	5-series	1.915.630
	4-series	760.095
	3-series / GT	2.577.686
	2-series	287.788
	1-series	1.277.903
	Mini /Clubman/Countryman	1.581.894
	X7	154.823
	X6	223.620
	X5	1.095.171
	X4	350.110
	X3	1.316.875
	X2	377.361
	2-series GranTourer	401.179
	X1	1.040.321
	i3	139.289
	TotalBMW	14.088.277

Bentley	Flying Spur	8.922
	Mulsanne	1.758
	Bentayga	16.464
	Continental	18.613
	Total Bentley	45.757

BYD	Tang	59.957
	Quin	87.849
	Han	135.056
	Total BYD	282.862

Chery	Yiedu X90	25.979
	Tiggo 7 Pro	53.735
	Tiggo 8 Pro	95.606
	Total Chery	175.320

Changan	Changan UNI-T	104.157
	Changan CS55	217.488
	Total Changan	321.645

Dongfeng	Fengguan 580	80.784
	Aeolus AX7	25.287
	Total Dongfeng	106.071

FAW	HongQi HS9	4.585
	HongQi HS7	22.346
	Total FAW	26.931

FCA	Maserati Levante	19.524
	Maserati Ghibli	9.990
	Total FCA	29.514

Ford/Lincoln	Lincoln Corsair Adventurer	72.134
	Ford Edge	483.260
	Total Ford / Lincoln	555.394

Geely /Volvo	Hoayue	75.378
	XC90	453.438
	S90	190.874
	XC60	448.801
	S60	216.424
	V40	540.602
	Polestar	1.358
	Total Geely/Volvo/Pole	1.926.875

GM	Cadillac XT6	101.181
	Buick Envision Plus	31.367
	Buick Verano GS	19.442
	Total GM	101.181

Great Wall	Wey VV6	64.488
	Wey VV7	19.413
	H6	50.689
	H9	38.779
	Haval Chitu	21.504
	Total GW/Wey/Haval	194.873

Honda	Civic	291.335
	Total Honda	291.335

Hyundai	Genesis G80	117.137
	Genesis G70	23.832
	Genesis GV80	52.073
	Ioniq 5	33.265
	Total Hyundai	226.307

Jaguar /LandRover	LR Evoque	279.163
	LR Discovery	46.176
	LR Range Rover	202.040
	Jaguar I-Pace	58.740
	Jaguar E-Pace	78.810
	Jaguar F-Pace	87.068
	Jaguar XF	30.956
	Total Jaguar/LandRove	782.953

Mazda	Series 6	581.730
	CX5	1.417.427
	CX 30	425.146
	Series 2	165.783
	Total Mazda	2.590.086

Mercedes	S	797.318
	S-Coupe	51.157
	GLS	138.139
	GLE	496.247
	EQS	15.661
	EQE	1.674
	CLS	141.282
	EQC	134.091
	GLC	1.043.673
	E /E-Coupe	2.661.671
	C /C-Coupe	1.827.315
	GLB	270.047
	GLA	708.288
	CLA	231.107
	B	265.820
	A	1.229.003
	EQA	52.360
	V	695.157
	Total Mercedes	10.760.010

Opel	Insignia	496.727
	Astra	1.388.314
	Corsa	536.126
	Mokka	112.320
	Grandland	103.683
	Crossland	374.066
	Total Opel	3.011.236

PSA/Citroen	Citroen DS3 / DS3 Crossback	515.674
	5008	170.785
	308	182.208
	Total PSA Citroen	868.667

Renault /Nissan	Nissan Qasqai	404.272
	Renault Talisman	41.272
	Renault Espace	14.821
	Total Renault/Nissan	460.365

SAIC	Roewe RX5	396.146
	Roewe Marvel R	6.816
	Total SAIC	402.962

Seat	Leon	310.185
	Ateca	174.193
	Total Seat	484.378

Skoda	Superb	302.616
	Octavia	1.094.713
	Enyiaq	248.684
	Kiodiaq	116.016
	Total Skoda	1.762.029

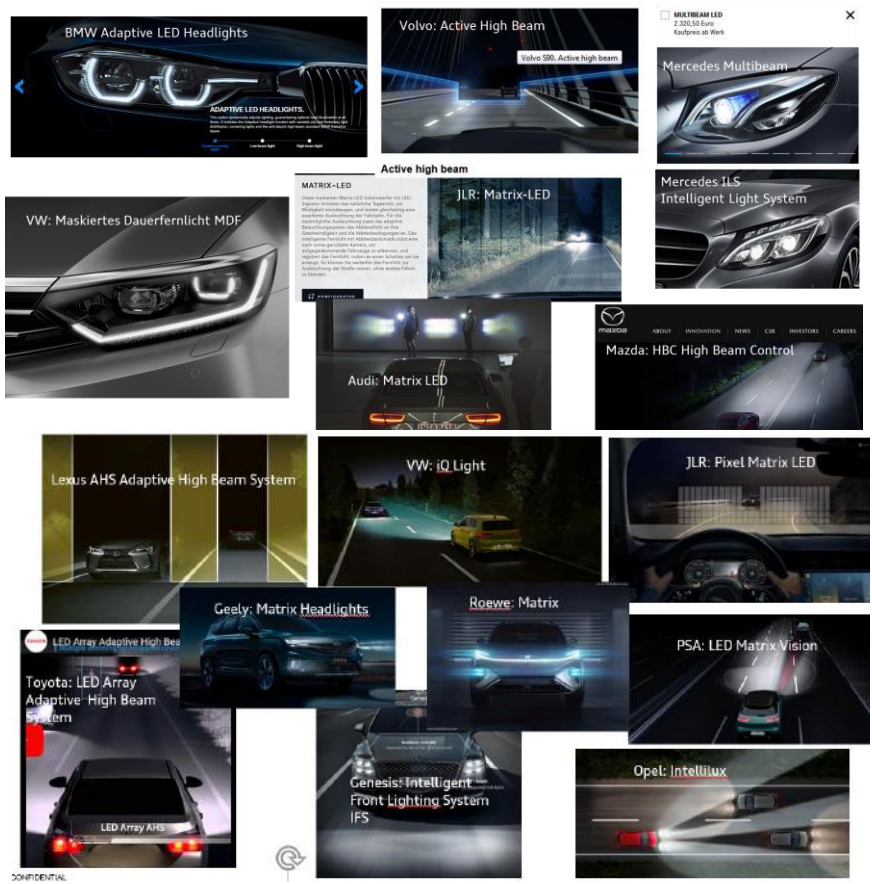
Toyota/Lexus /Subaru	Prius	1.168.606
	Corolla	1.000.477
	RAV4	1.418.764
	Yaris	142.044
	Subaru Outback	202.407
	Lexus NX	627.687
	Lexus RX	601.243
	Lexus UX	255.729
	Lexus ES	417.820
	Lexus CT	55.032
	Total Toyota/Lexus/Su	5.889.809

Volkswagen	T-Cross Coupe	14.870
	ID3	145.664
	ID4	96.676
	Golf	3.151.605
	Touran	533.527
	Tiguan	2.538.811
	Passat	1.844.267
	Passat CC	95.457
	Arteon	160.864
	Sharan	163.022
	Touareg	242.941
	Total Volkswagen	8.987.704

Estimated Total produced cars with ADB as an option:
(143 models = 280 % vs. 2018)

63.970.336 cars = 435 % vs. 2018

Mathematics Data collected 2021



- **Total produced cars:** **63.970.336**
- *Estimated Equipment rate:* 10%
  (conservative approach)
- **Total cars on roads** in ECE and China: 6.397.033

More calculation:
Statistics: Average kilometers 2019 per car EU : 12.000km / a
(Germany was 14.259km/a)
(source enerdata 2019, AutoMotorSport)

Total driven kilometers with ADB cars /(2018): 76.764.396.000 = 76.764 billion kilometers

Assumption: Kilometers driven at night: 33%

Total driven kilometers

at NIGHT with ADB cars /(2021): 25.332.120.000 **= 25,332 billion kilometers / yr.**

(= 438% vs. 2018)

Summary Statistics 2018 and 2021

- More than 25 billion kilometers driven at night with ADB cars

- All 143 models have passed ECE/GB/National homologation
- ECE R. 123 requires measurement of ADB functionality
- ECE R.48 requires ADB functionality test

- **Not a single field recall or regulation authorities investigations about Malfunctioning ADB**

- **ADB according to ECE R.123 has passed the largest imaginable field test**

143 models, 6 Million Cars. 25 Billion kilometers / yr.

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ADB Approval in the World

https://www.caranddriver.com/news/a34881452/audi-adb-headlight-advances/

CAR AND DRIVER SUBSCRIBE SIGN IN

Advanced ADB Headlights Will Save Lives, but Not in the U.S. (Yet)

Audi and others have made advances in car lighting that go way beyond today's adaptive technology, but U.S. regulators are way too slow to let them come here.

BY MICHAEL FRANK DEC 11, 2020

- **Audi is one of many automakers offering advanced headlamp and lighting technology in cars.**
- **Among the tech on the horizon is pedestrian and obstacle detection, OLED taillamps, and the use of lighting to send traffic-safety information to other drivers.**
- **Unfortunately, these advances aren't available on cars in the U.S. because of our regulations.**

You drive into a tunnel and your car's headlights flicker to life. Just on the edge of the horizon you can see a set of taillights glowing back at you. You floor it, trying

ECE Regulation 123: ADB Measurement in R.123, Table 7

E/ECE/324/Rev.2/Add.122/Rev.2-E/ECE/TRANS/505/Rev.2/Add.122/Rev.2

21 October 2013

Agreement

Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions*

(Revision 2, including the amendments which entered into force on 16 October 1995)

Addendum 122: Regulation No. 123

Revision 2

Incorporating all valid text up to:
Supplement 1 to the 01 series of amendments – Date of entry into force: 28 October 2011
Corrigendum 1 Supplement 1 to the 01 series of amendments – Date of entry into force: 28 October 2011
Supplement 2 to the 01 series of amendments – Date of entry into force: 26 July 2012
Supplement 3 to the 01 series of amendments – Date of entry into force: 18 November 2012
Supplement 4 to the 01 series of amendments – Date of entry into force: 15 July 2013

Uniform provisions concerning the approval of adaptive front-lighting systems (AFS) for motor vehicles

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UNITED NATIONS

* Former title of the Agreement: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

Table 7
Requirements concerning the adaptation of the driving-beam according to paragraph 6.3.7. of this Regulation

Part A	*Test point*	*Position / Deg.* *Horizontal*	*Vertical*	*Max. intensity*** *(cd)*
	Line 1 Left Oncoming vehicle at 50 m in the case of right-hand traffic	4.8°L to 2°L	0.57°Up	625
	Line 1 Right Oncoming vehicle at 50 m in the case of left-hand traffic	2°R to 4.8°R	0.57°Up	625
	Line 2 Left Oncoming vehicle at 100 m in the case of right-hand traffic	2.4°L to 1°L	0.3°Up	1 750
	Line 2 Right Oncoming vehicle at 100 m in the case of left-hand traffic	1°R to 2.4°R	0.3°Up	1 750
	Line 3 Left Oncoming vehicle at 200 m in the case of right-hand traffic	1.2°L to 0.5°L	0.15°Up	5 450
	Line 3 Right Oncoming vehicle at 200 m in the case of left-hand traffic	0.5°R to 1.2°R	0.15°Up	5 450
	Line 4 Preceding vehicle at 50 m in the case of right-hand traffic	1.7°L to1.0°R	0.3°Up	1 850
		>1.0° R to 1.7°R		2 500
	Line 4 Preceding vehicle at 50 m in the case of left-hand traffic	1.7°R to1.0°L		1 850
		>1.0° L to 1.7°L		2 500
	Line 5 Preceding vehicle at 100 m in the case of right-hand traffic	0.9° L to 0.5°R	0.15°Up	5 300
		>0.5°R to 0.9°R		7 000
	Line 5 Preceding vehicle at 100 m in the case of left-hand traffic	0.9° R to 0.5°L		5 300
		>0.5°L to 0.9°L		7 000
	Line 6 Preceding vehicle at 200 m in the case of left-hand traffic and right-hand traffic	0.45°L to 0.45°R	0.1°Up	16 000

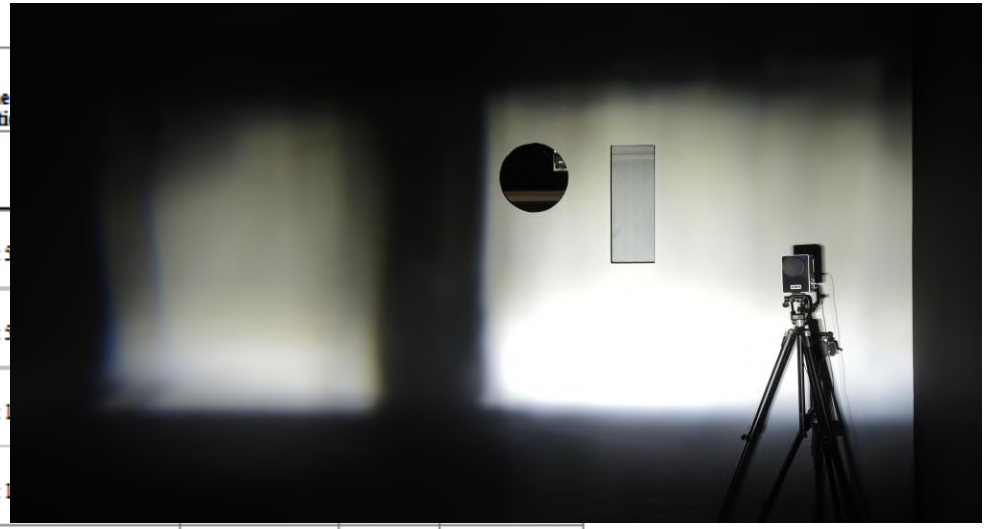
143 models, 6 Million Cars. 25 Billion kilometers / yr.

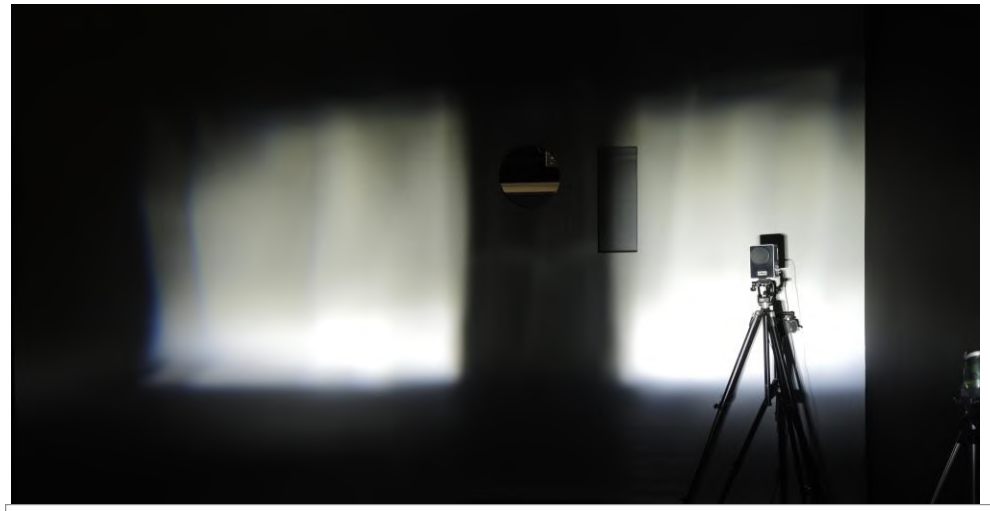
ADB Measurement ECE R. 123, Table 7

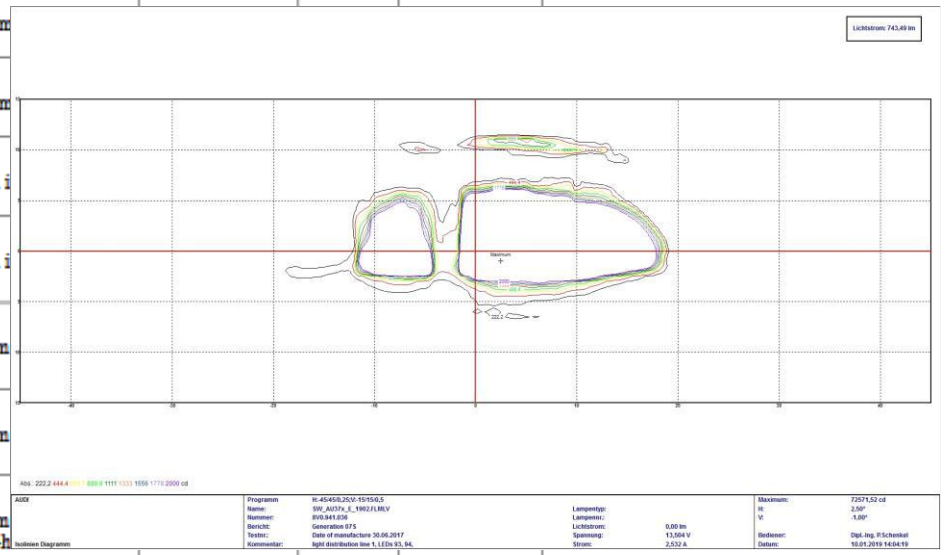
E/ECE/324/Rev.2/Add.122/Rev.2
E/ECE/TRANS/505/Rev.2/Add.122/Rev.2
Annex 3

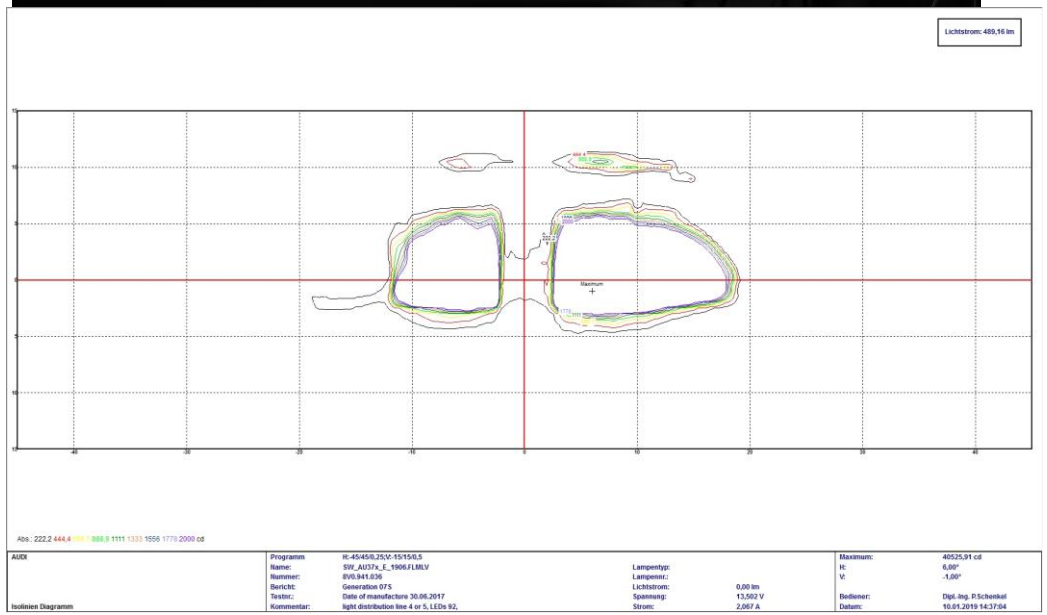
Table 7
Requirements concerning the
paragraph 6.3.7. of this Regulati

Part A	Test point
	Line 1 Left Oncoming vehicle at right-hand traffic
	Line 1 Right Oncoming vehicle at left-hand traffic
	Line 2 Left Oncoming vehicle at right-hand traffic
	Line 2 Right Oncoming vehicle at left-hand traffic
	Line 3 Left Oncoming vehicle at 200 m right-hand traffic
	Line 3 Right Oncoming vehicle at 200 m left-hand traffic
	Line 4 Preceding vehicle at 50 m right-hand traffic
	Line 4 Preceding vehicle at 50 m left-hand traffic
	Line 5 Preceding vehicle at 100 m right-hand traffic
	Line 5 Preceding vehicle at 100 m left-hand traffic
	Line 6 Preceding vehicle at 200 m left-hand traffic and right-h









143 models, 6 Million Cars. 25 Billion kilometers / yr.

ADB in USA

....since March 2013...

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Part 571

[Docket No. NHTSA-2018-0090]

RIN 2127-AL83

Federal Motor Vehicle Safety Standards; Lamps, Reflective Devices, and Associated Equipment

AGENCY: National Highway Traffic Safety Administration ("NHTSA"), Department of Transportation ("DOT").

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This document proposes amendments to Federal Motor Vehicle Safety Standard ("FMVSS") No. 108; *Lamps, reflective devices, and associated equipment*, to permit the certification of adaptive driving beam headlighting systems, if the manufacturer chooses to equip vehicles with these systems. Toyota Motor North America, Inc. (Toyota) petitioned NHTSA for rulemaking to amend FMVSS No. 108 to permit manufacturers the option of equipping vehicles with adaptive driving beam systems. NHTSA has granted Toyota's petition and proposes to establish appropriate performance requirements to ensure the safe introduction of adaptive driving beam headlighting systems if equipped on newly manufactured vehicles.

DATES: You should submit your comments early enough to be received not later than **[INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: You may submit comments to the docket number identified in the heading of this document by any of the following methods:

DEPARTMENT OF TRANSPORTATION

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DATES: You should submit your comments early enough to be received not later than December 11, 2018.

ADDRESSES: You may submit comments to the docket number identified in the heading of this document by any of the following methods:

- *Federal eRulemaking Portal:* Go to *http://www.regulations.gov*. Follow the online instructions for submitting comments.
- *Mail:* Docket Management Facility: U.S. Department of Transportation, 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12–140, Washington, DC 20590–0001.
- *Hand Delivery or Courier:* 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12–140, between 9 a.m. and 5 p.m. ET, Monday through Friday, except Federal holidays.
- *Fax:* 202–493–2251.

Instructions: All submissions must include the agency name and docket number. *Note:* All comments received will be posted without change to *http://www.regulations.gov*, including any personal information provided. Please see the Privacy Act discussion below. We will consider all comments received before the close of business on the comment closing date indicated above. To the extent possible, we will also consider comments filed after the closing date.

Docket: For access to the docket to read background documents or comments received, go to *http://www.regulations.gov* at any time or to 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12–140, Washington, DC 20590, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. Telephone: 202–366–9826.

Privacy Act: Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the **Federal Register** published on April 11, 2000 (Volume 65, Number 70; Pages 19477–78) or you may visit *http://www.dot.gov/privacy.html*.

Confidential Business Information: If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Chief Counsel, NHTSA, at the address given under **FOR FURTHER INFORMATION CONTACT**. In addition, you should submit two copies, from which you have deleted the claimed confidential business information, to Docket Management at the address given above. When you send a comment containing information claimed to be confidential business information, you should include a cover letter setting forth the information specified in our confidential business information regulation (49 CFR part 512).

FOR FURTHER INFORMATION CONTACT: Please contact Mr. Markus Price, 202–366–0098 or Mr. John Piazza, Office of Chief Counsel, Telephone: 202–366–2992. Facsimile: 202–366–3820. You may send mail to these officials at: The National Highway Traffic Safety Administration, 1200 New Jersey Avenue SE, Washington, DC, 20590.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Executive Summary

Glare, Visibility, and Adaptive Driving Beam Technology

This proposal is intended to allow an advanced type of headlighting system referred to as adaptive driving beam to be introduced in the United States. Adaptive driving beam ("ADB") headlamps use advanced technology that actively modifies the headlamp beams to provide more illumination while not glaring other vehicles. The requirements proposed today are intended to amend the existing regulations to permit this technology and ensure that it operates safely.

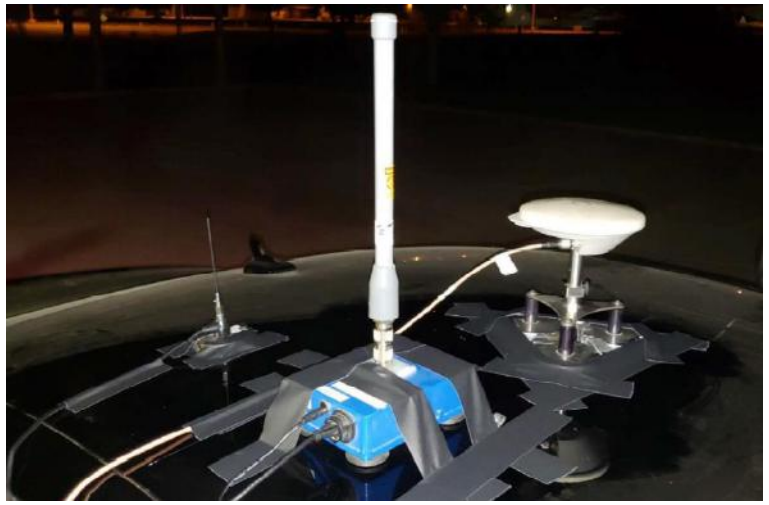
Vehicle headlamps must satisfy two different safety needs: Visibility and glare prevention. The primary function of headlamps is to provide forward visibility. At the same time, there is a risk that intense headlamp illumination may be directed towards oncoming or preceding vehicles. Such illumination, referred to as glare, can reduce the ability of other drivers to see and cause discomfort. Headlighting has therefore traditionally entailed a trade-off between long-distance visibility and glare. This is reflected in the requirement that headlamp systems have both lower and upper beams. The existing headlight requirements regulate

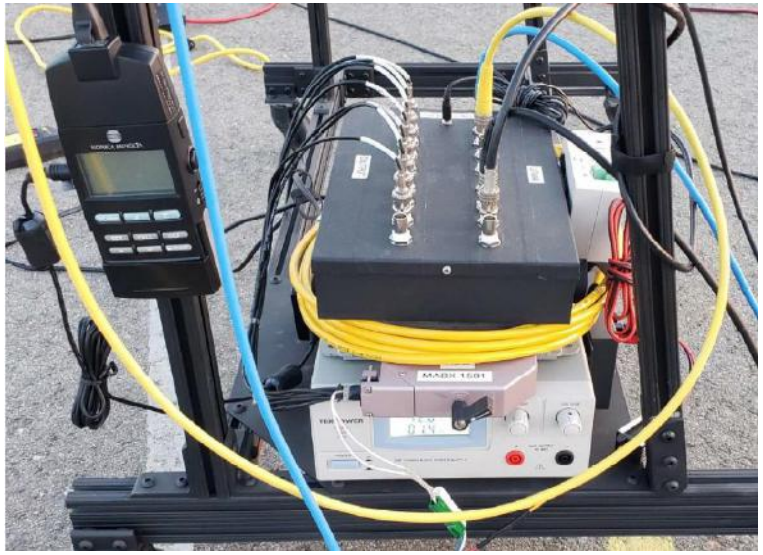
plus 47 pages

143 models, 6 Million Cars. 25 Billion kilometers / yr.

Question to discuss: 143 models. 6 Million Cars. 25 Billion kilometers.

Do we really need more weird and spooky tests to demonstrate ADB does no harm ?





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ADB Research, Statistics and Worldwide ADB Volumes

ADB today

- High Beam and ADB
- ADB in the World Market
- ADB and Approval
- ADB and Traffic Safety Research
- ADB in a Hypothetical Accident Avoidance Analysis

AAA : American Automobile Association, April 16, 2019

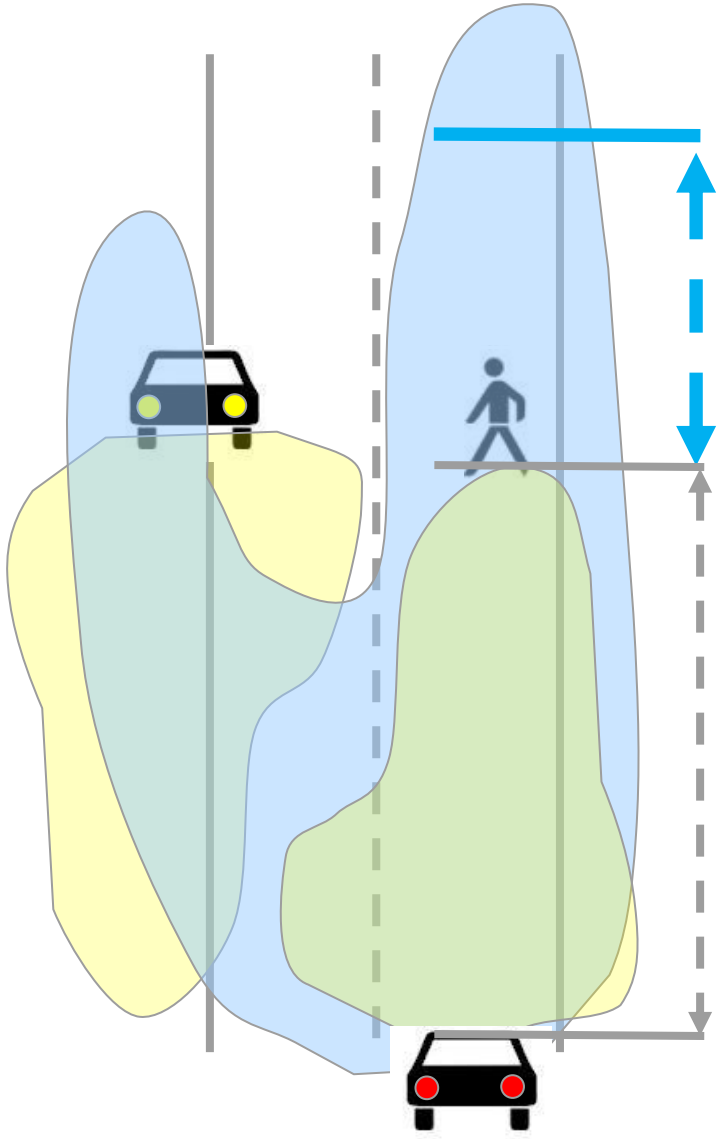
https://info.oregon.aaa.com/aaa-u-s-headlights-lag-behind-those-in-canada-and-europe/

Test Object Detection with Low Beam

Explanation picture

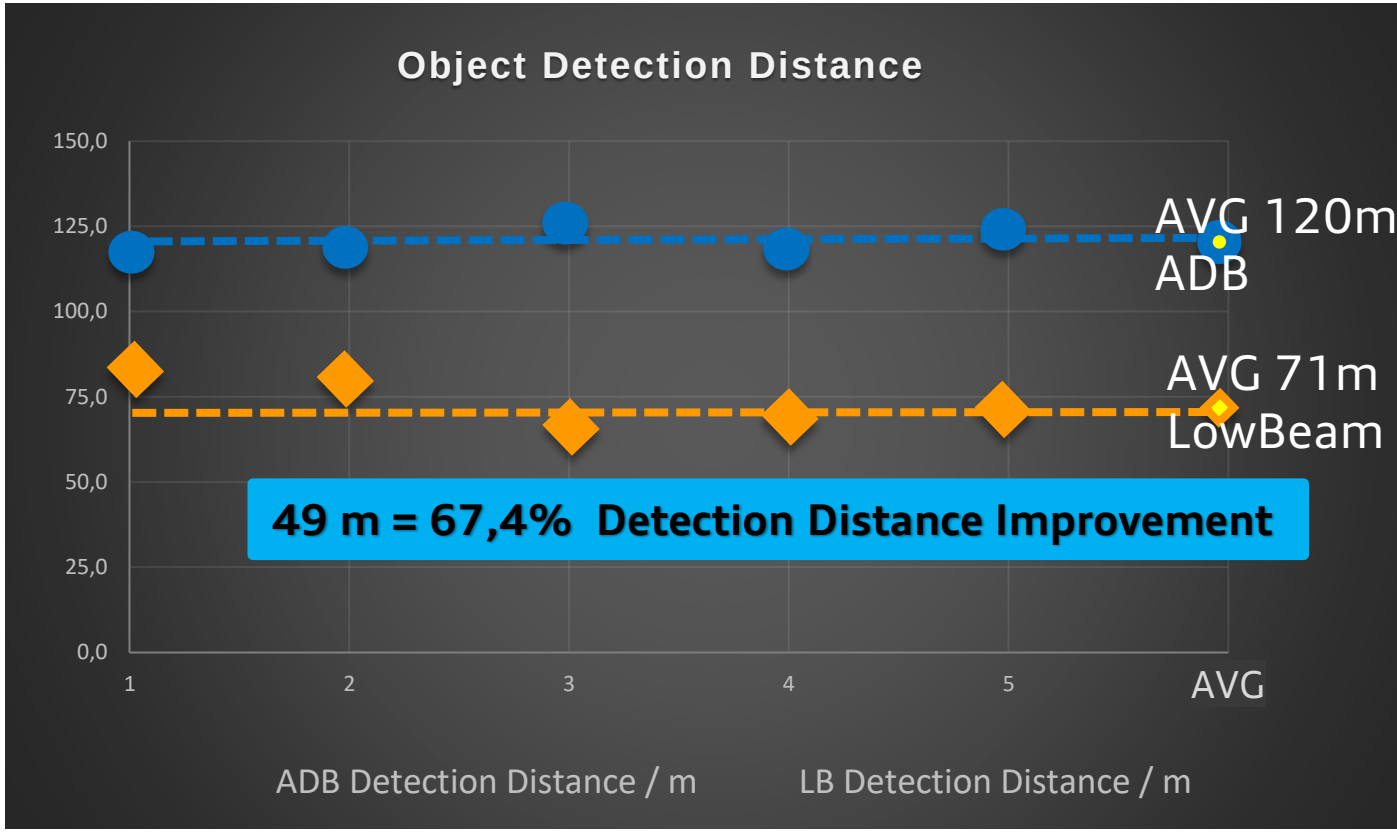

Test Object Detection with ADB
Explanation picture

ADB vs. Low Beam
Detection Distance Investigations:



Test Setup for Detection Distance

- Static situation
- 5 Testpersons
- Dry Road
- Pedestrian Object moving in driving lane



Light Pattern	Detecition Distance	
ADB	**120 m**	Delta =
LB	71 m	+ 49 m **(67,4%)**

Authors	Situation	Function	Detection distance	Delta ADB vs. LB
Kleinkes 2013	Static Oncoming car @100m	Low Beam	82 m	+ 57 m
	Static Oncoming car @100m	**ADB**	**139 m**	
Zydek 2014	Dynamic Oncoming Cars	LB Halogen	58,8 m	+ 61,6 m
	Dynamic Oncoming Cars	LB HID	88,4 m	+32 m
	Dynamic Oncoming Cars	**ADB HID**	**120,4 m**	
Bullough 2016	Dynamic Walkway Detection	Low Beam	52 m	+ 64 m
	Dynamic Walkway Detection	**ADB**	**116 m**	

ADB Research, Statistics and Worldwide ADB Volumes

ADB today

- High Beam and ADB
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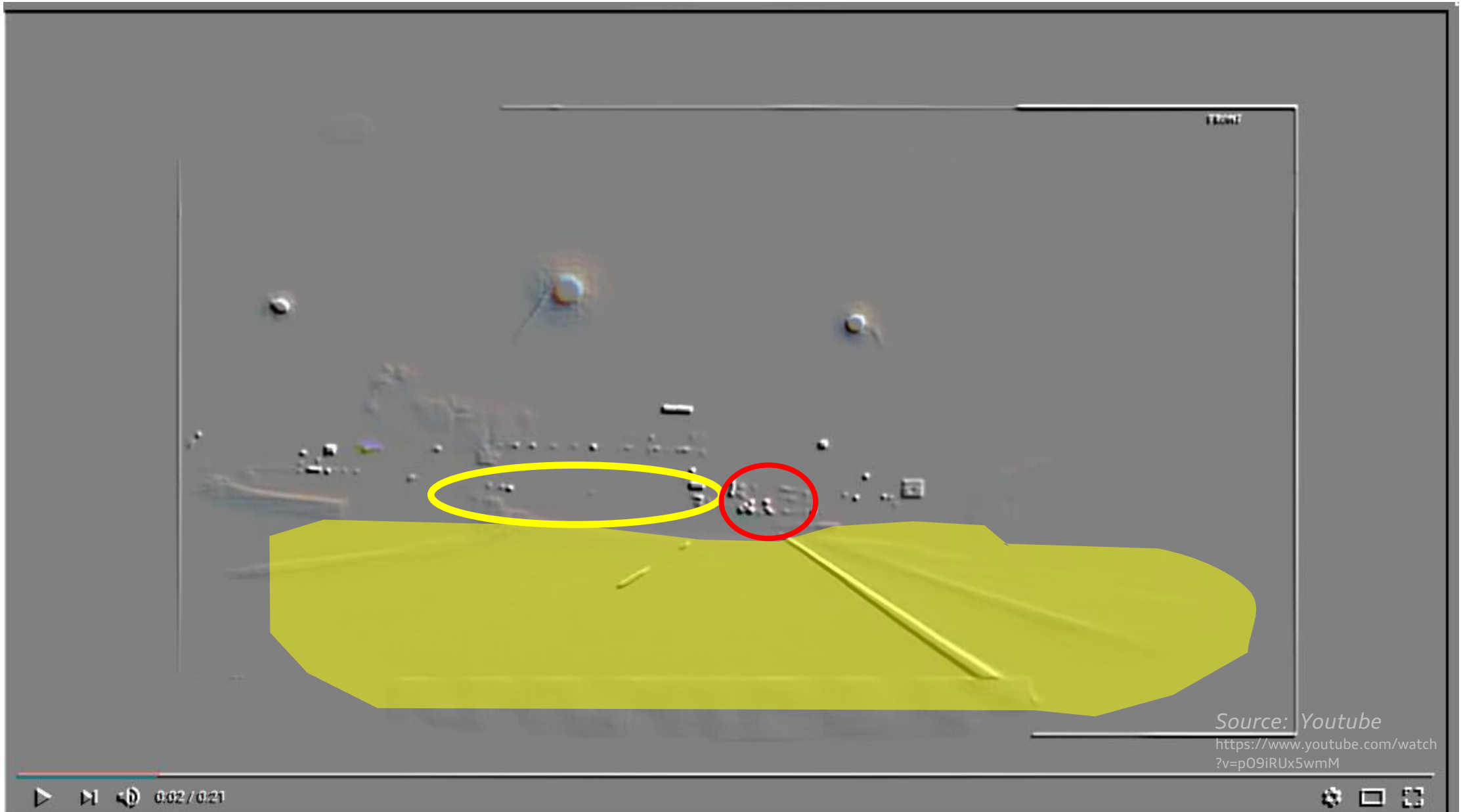
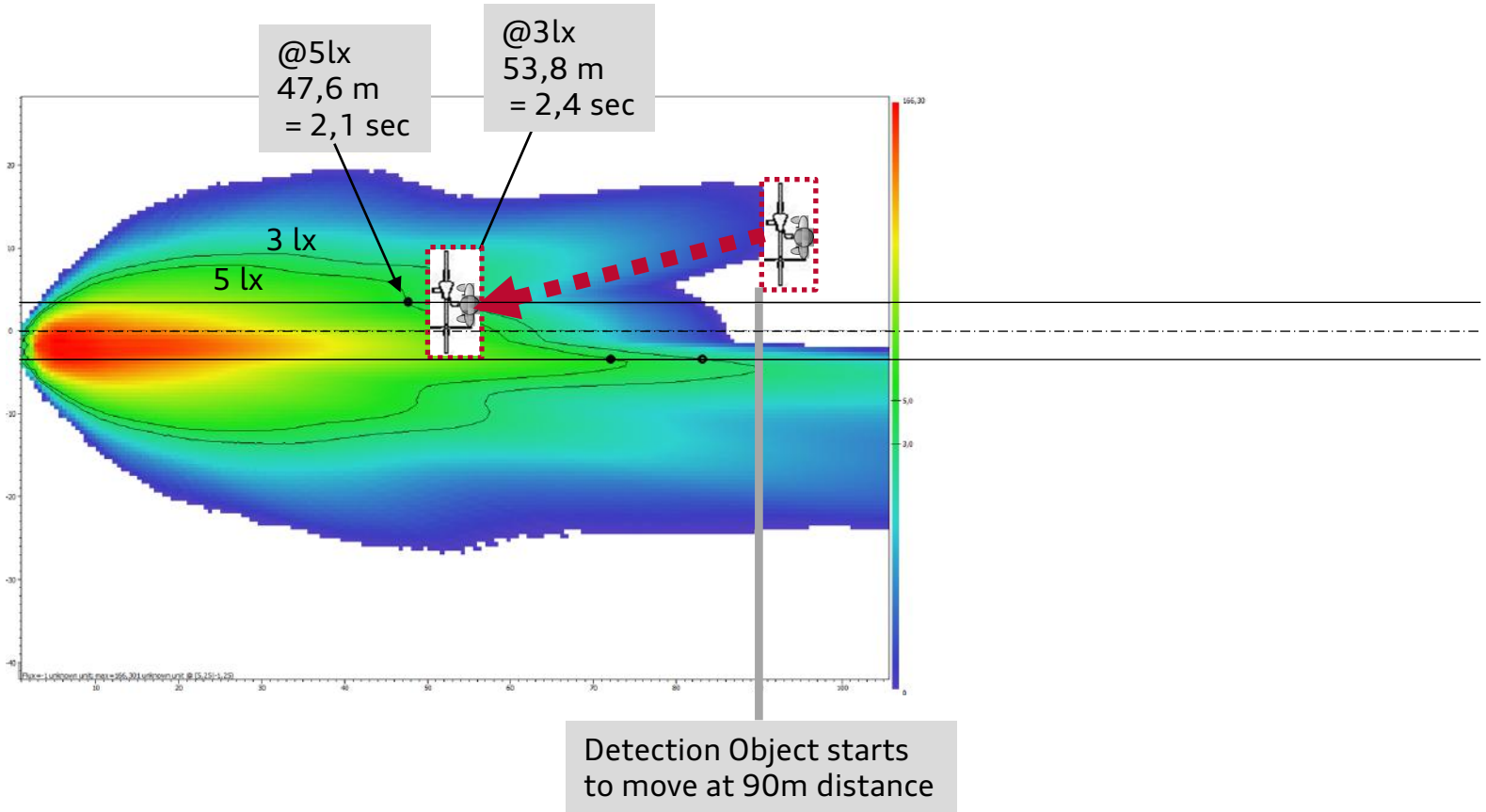
Hypothetical Accident Analysis



Accident Analysis

Simulation and Analysis Assumptions:

- Vehicle speed 50 mph (= 22 m/sec)
- Standard US LED Low Beam with proper aiming
  (e.g. IIHS rating 12 demerits = Acceptable)

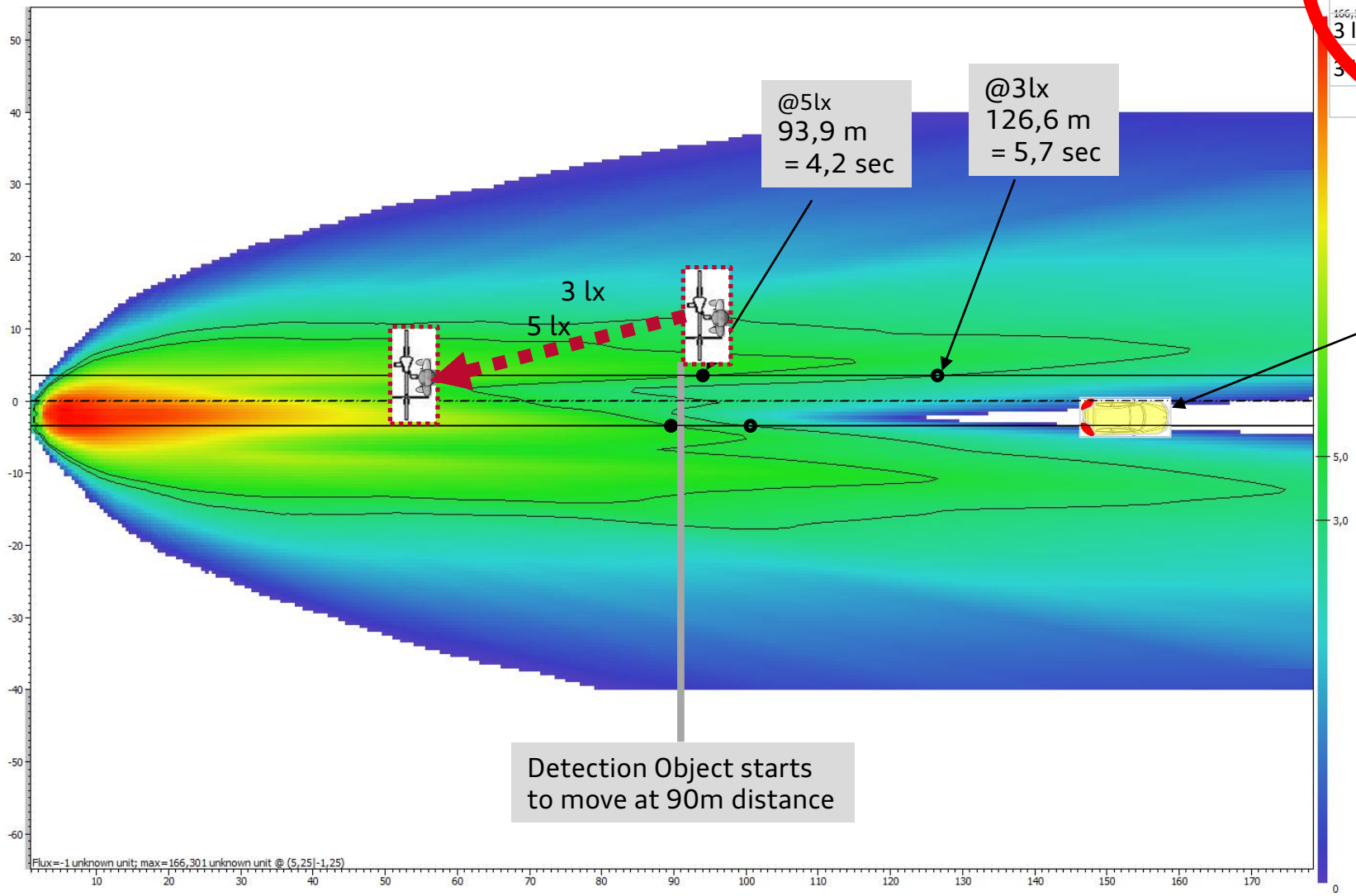


Simulation: Special thanks to Mr. Eichinger, zkw Wieselburg, Austria

Accident Analysis

Simulation and Analysis Assumptions:

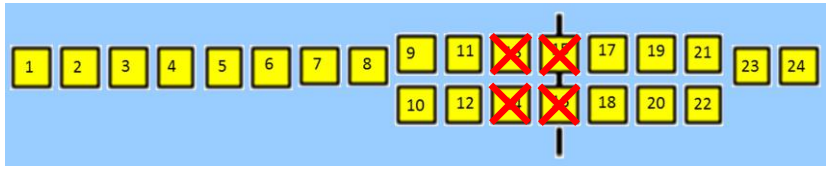
- Vehicle speed 50 mph (= 22 m/sec)
- US Std. LB but ADB activated (GTB HSPR Rating: Premium)



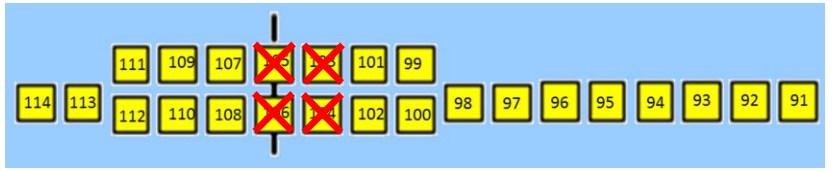
	distance / m	equivalent / seconds		
5 lx Low Beam	47,6	2,1		
5 lx MXB	93,3	4,2	--->	plus 100%
				(2,1 second
3 lx Low Beam	53,8	2,4		
3 lx MXB	126,6	5,7	--->	plus 140%
				3,3 seconds)

Preceeding car @ 150 m

LED of LEFT Highbeam

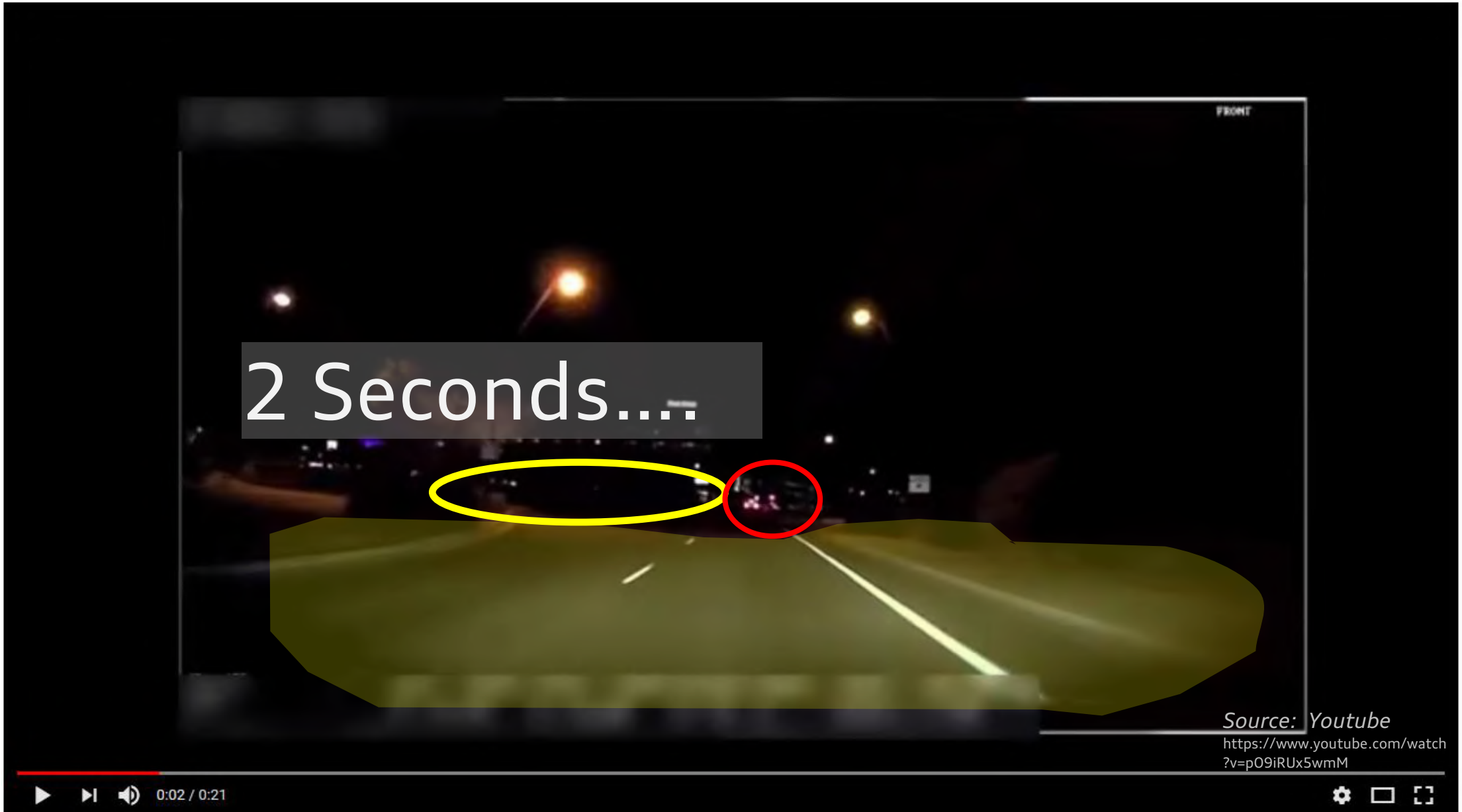


LED of RIGHT Highbeam



Simulation: Special thanks to Mr. Eichinger, zkw Wieselburg, Austria

Hypothetical Accident Analysis



Summary

- **ADB is the Future Standard Safety Technology.**
  143 car models, 6 million cars and 25 billion km / yr.
  are no longer negligible.

- **ADB improves visibility for about 50..65 m,**
  giving detection distance of appr. 120m.

- **This is equivalent to appr. 2..3 seconds more reaction time.**

- **ADB is a Safety Feature. It avoids accidents.**

- **How are the bets for U.S. ?**

143 models, 6 Million Cars. 25 Billion kilometers / yr.

Thank you for your attention!

143 models, 6 Million Cars. 25 Billion kilometers / yr.