DVN 2024 Marelli US ADB Lecture
Dynamic Levelling in US ADB systems

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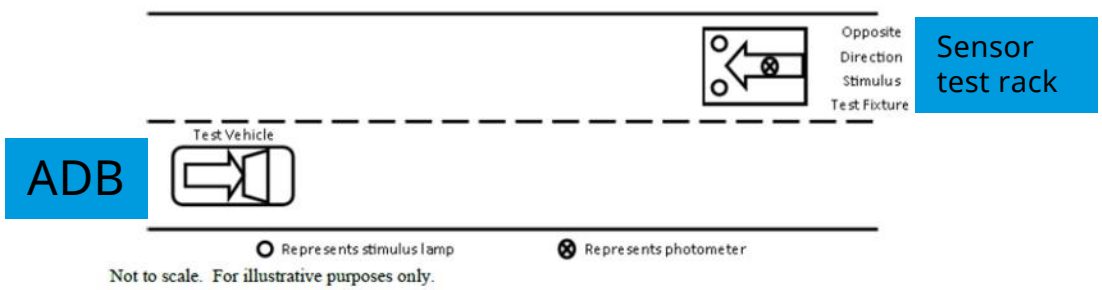
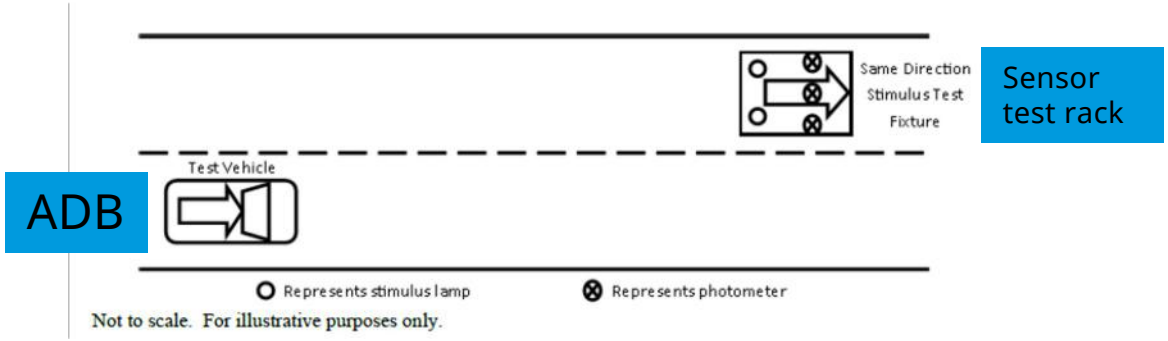
US ADB – NHTSA Final Rule

Vehicle track test
Test of vehicle

Evaluation of ADB System :
Headlamp + ECU parameter + Camera + Algorithm + Dynamic of vehicle

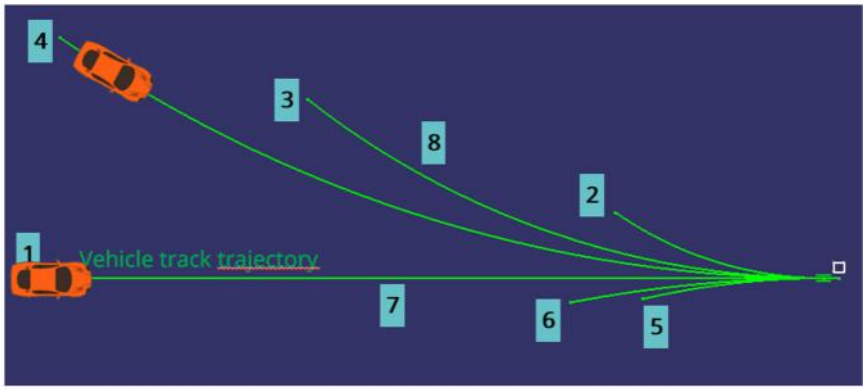
US ADB – NHTSA Final Rule





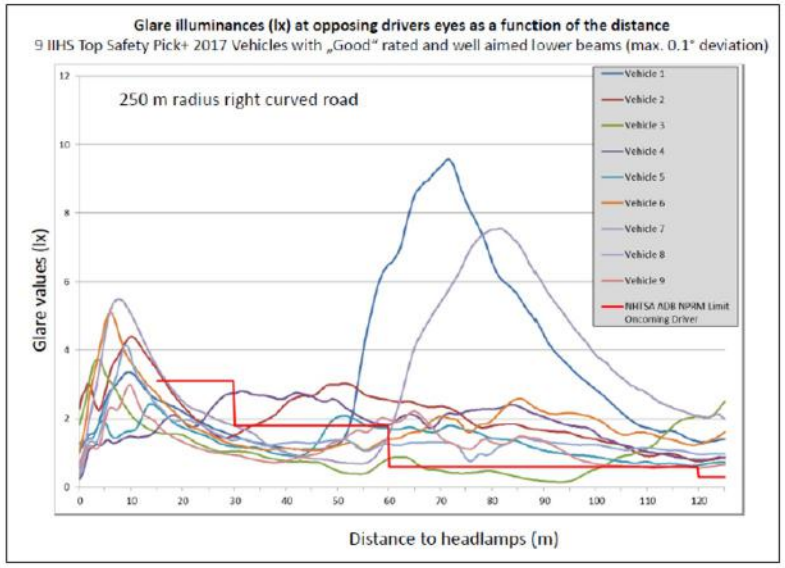
- 8 driving scenarios with ADB vehicle to measure glare limits
- straight and curved roads
- Oncoming and preceding

ADB Vehicle track



US ADB – NHTSA Final Rule

Glare limits are so low that current “state of the art” LB pattern already fail the glare limits with low beam only (w/o ADB activated)



All nine vehicles which qualified for Top Safety Pick+ 2017 with „Good“ rated and well-aimed headlights (max. 0.1° deviation) **exceed the NHTSA ADB glare limits** with their **Lower Beam**!

- State of the art ADB systems will fail dynamic test
- ~350 cd glare limit vs 1000 cd for LB

NHTSA ADB glare values must not exceed glare limits for a vehicle pitch up to 0.3 deg!

→ Solution required to reduce glare in ADB mode to a lower level than LB!
→ Still get good performance in LB mode for IIHS

ADB USA – Final Rule - dynamic vehicle test

NHTSA opens the door to use dynamic levelling to reduce glare during driving.

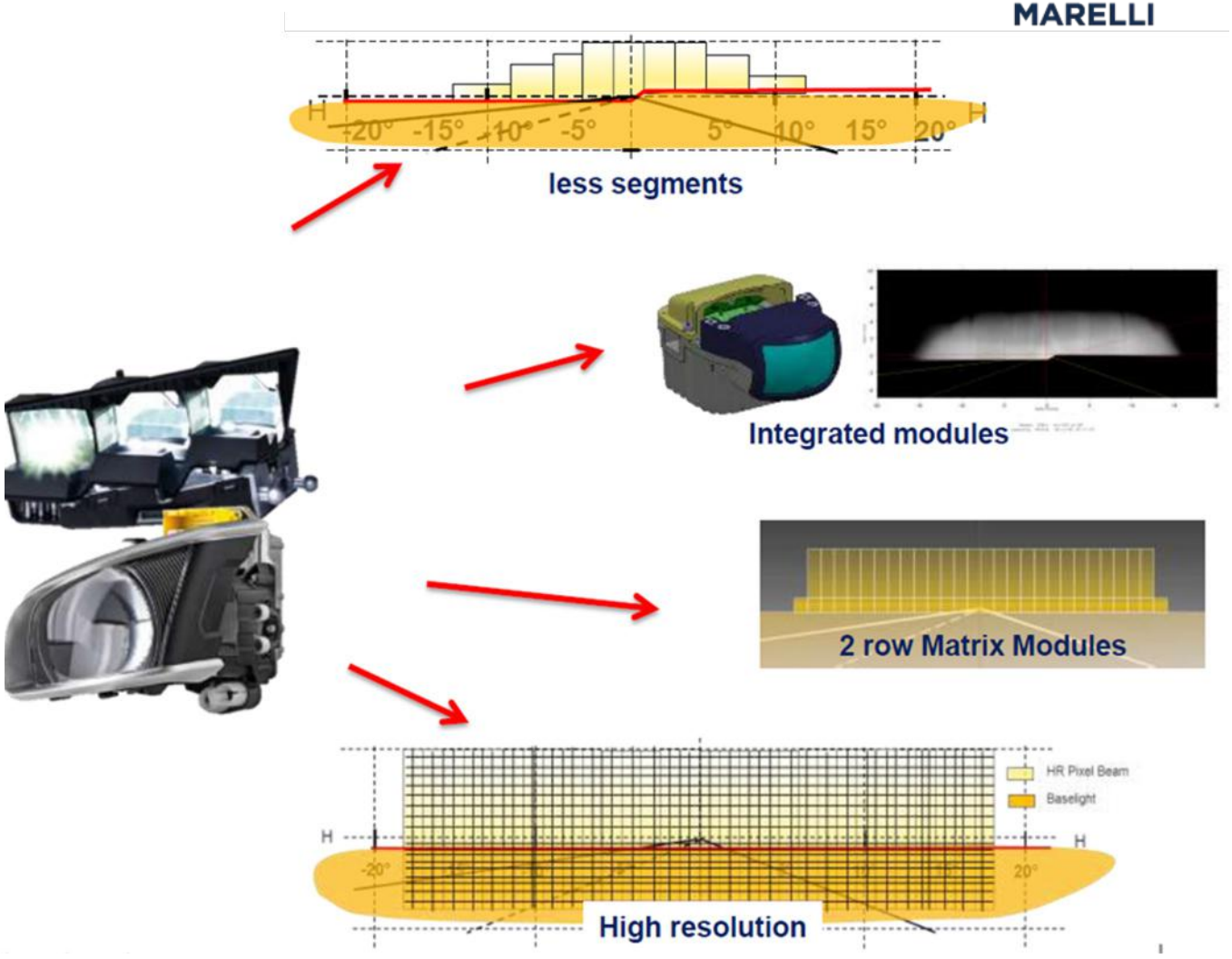
it is currently addressed.[178] Manufacturers might also be able to further minimize glare if they use on-vehicle dynamic aiming. In the past, NHTSA has explained that for headlamp systems capable of dynamically re-aiming the headlamps (for example, based on the steering angle), the laboratory photometry requirements "must be met in the nominal position of the lower beam headlamp (*i.e.*, considering the location of the axis of reference to coincide with the longitudinal axis of the vehicle)." [179] This means, for example, that an ADB system that dynamically re-aimed the headlamps downward when cresting a hill with an oncoming vehicle (which, in line with AAA's comments, is the prime concern motivating the request to not apply the lower beam minima) could effectively shift down the dimmed area so as not to glare the oncoming vehicle.

Lab test of HL will be performed in **nominal position**, without dynamic levelling .

OEM must apply reasonable care to provide a safe and secure illumination in driving situation.

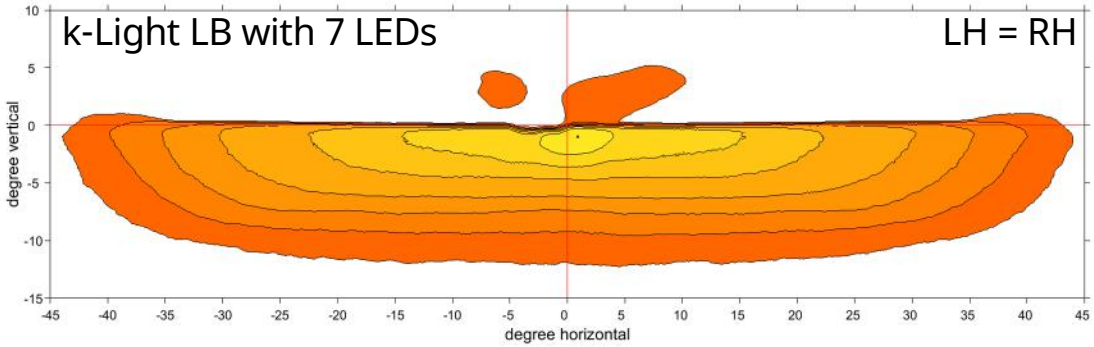
ADB Technology review

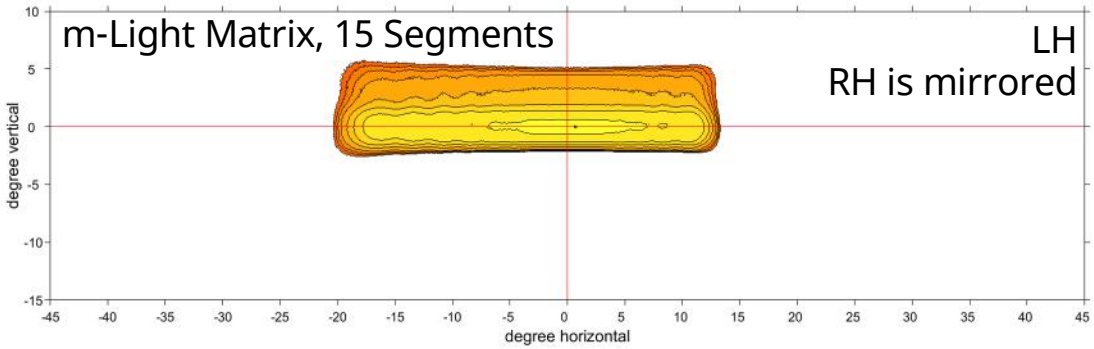
- Budget systems such as reflectors are limited to the number of segments but can be very cost effective
  - 4-8 segments
- Matrix modules can provide smaller segments but use substantially more LEDs and typically must be projectors
  - 12-24 segments
- Pixel Light modules use DMD or micro-LED sources to create freeform patterns limited only by the resolution of the sources
  - 100+ segments
  - Can be used to create cutoff lines for LB



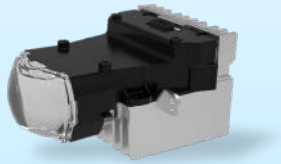
US ADB – non-HD headlamps

US ADB - non-HD headlmaps

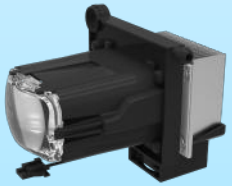




Setup:
2 Modules



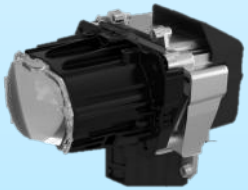
k-Light LB



m-Light ADB 12-16 Segments

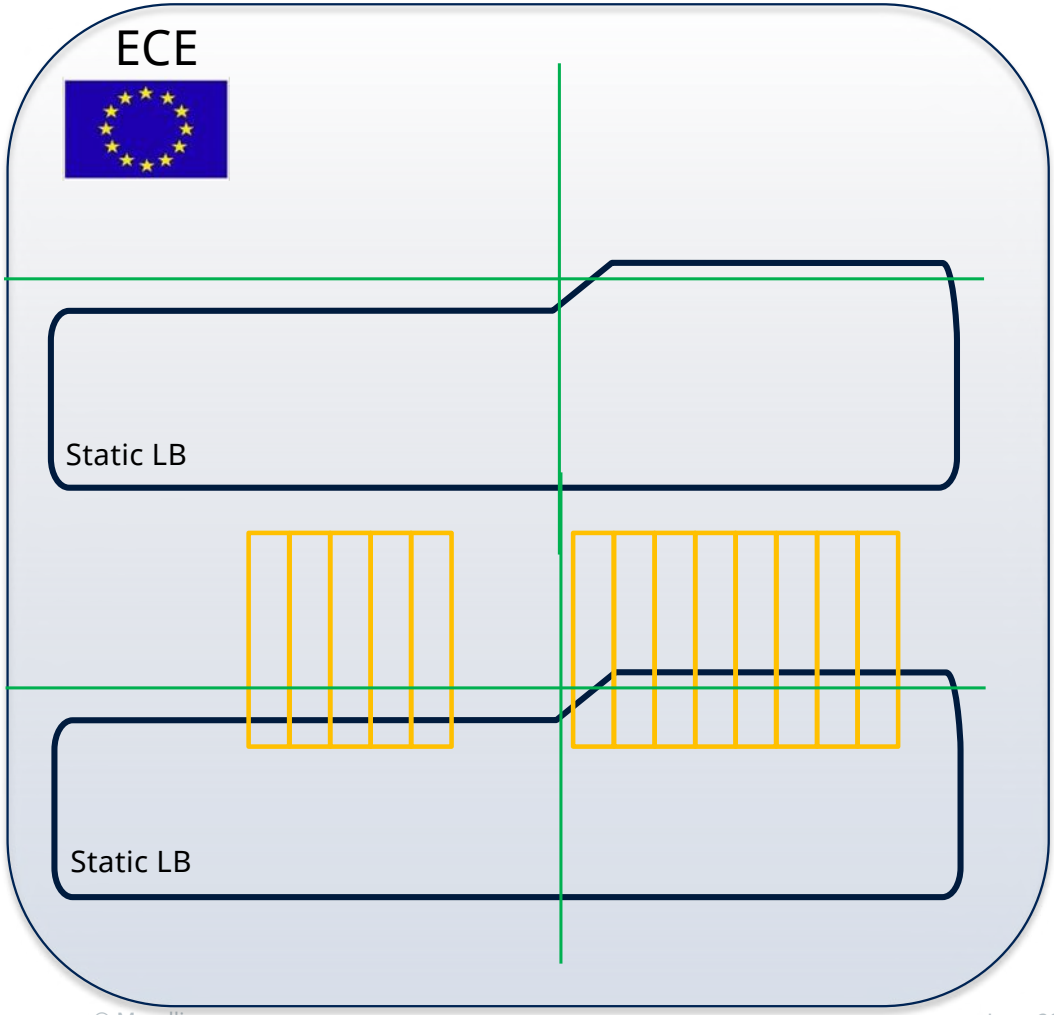
or

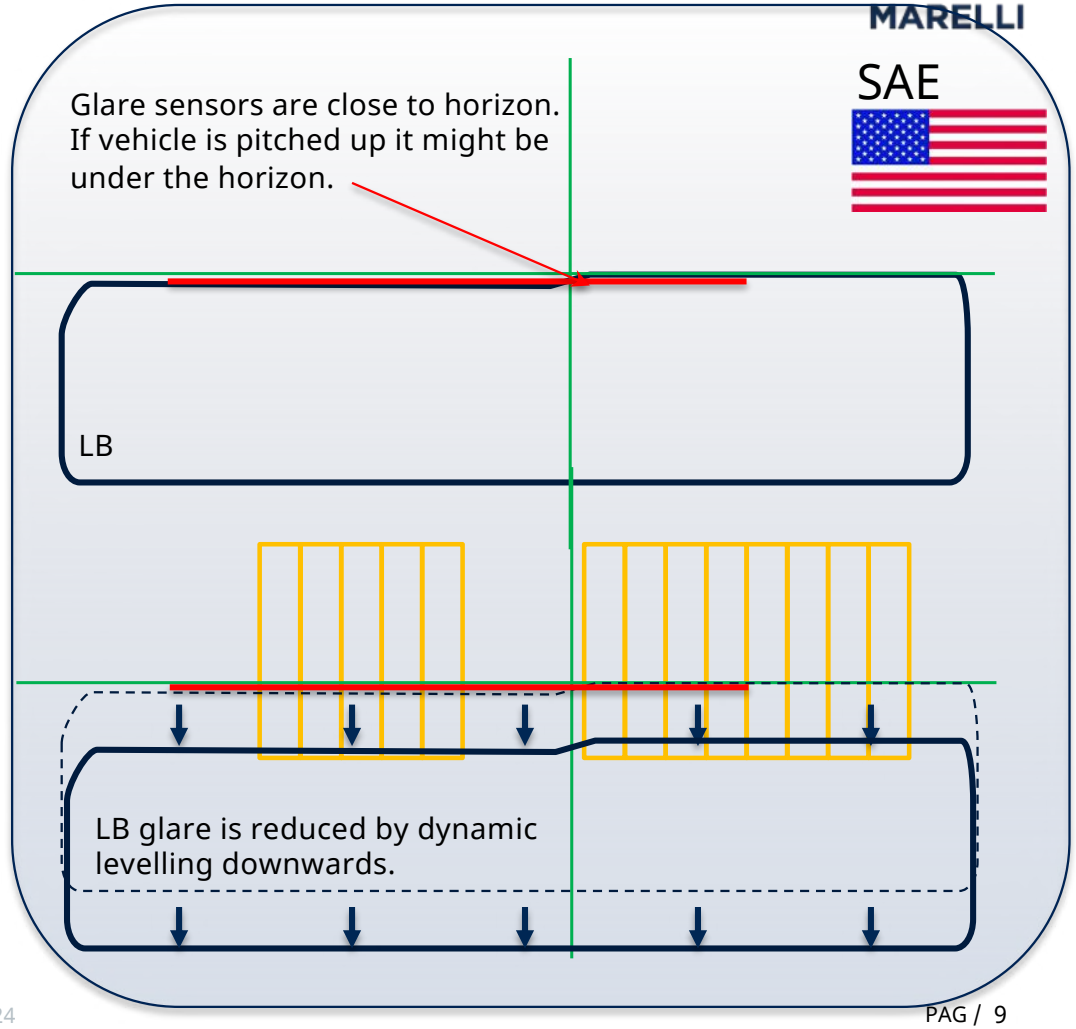
Setup:
1 Module



e-Light LB & ADB 12-16 Segments

US ADB - non-HD Systems





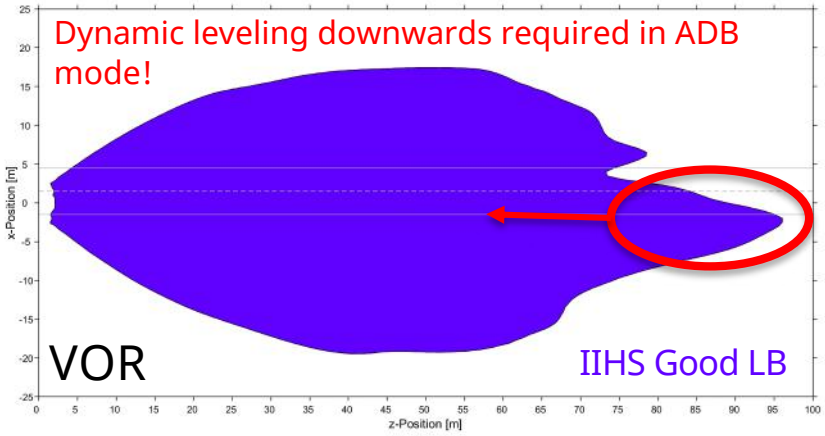
US ADB - non-HD headlmaps

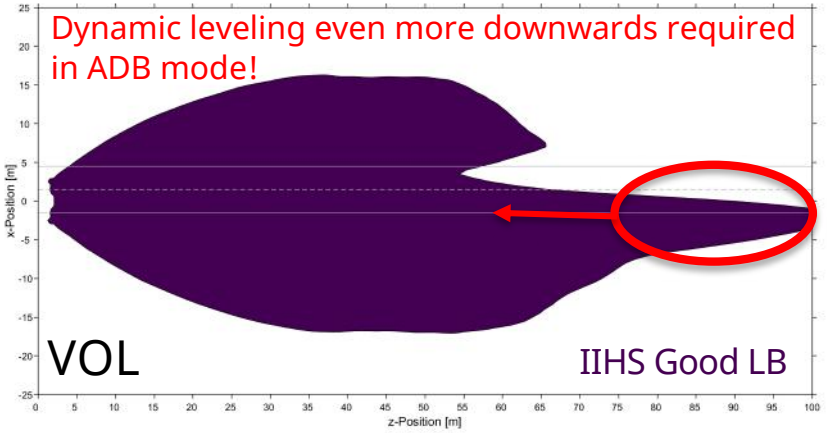
Comparison VOR vs. VOL

Critical test situation: Right curve at distance 60-70 m

COL on right side of road must be leveled downwards!

5 lx area 25 cm above road (IIHS visibility sensor height)

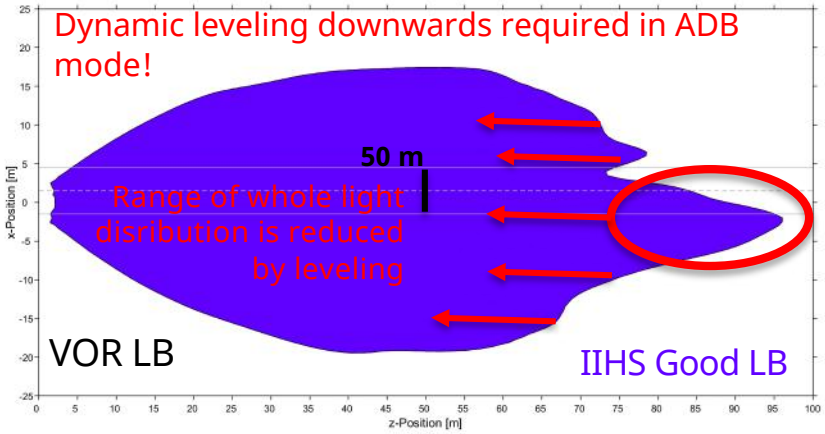




Dynamic leveling angle in ADB mode depends on mounting height:

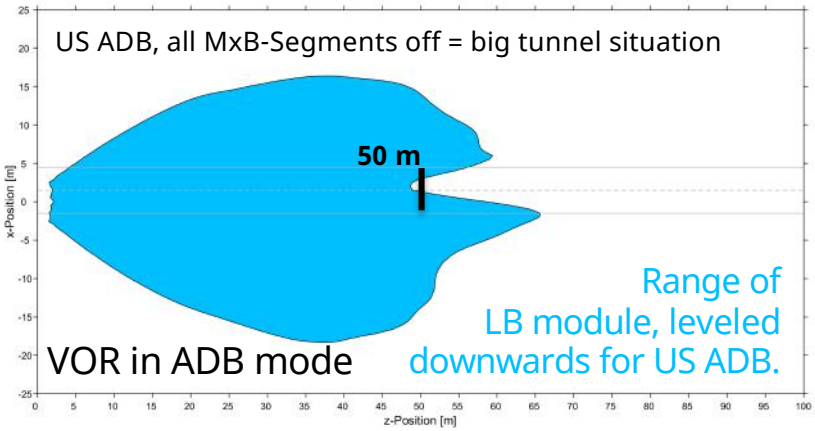
Mounting height	VOR	VOL
~ 850 mm	~ -0.6 deg	~ -0.8 deg
~ 650 mm	~ -0.4 deg	~ -0.6 deg

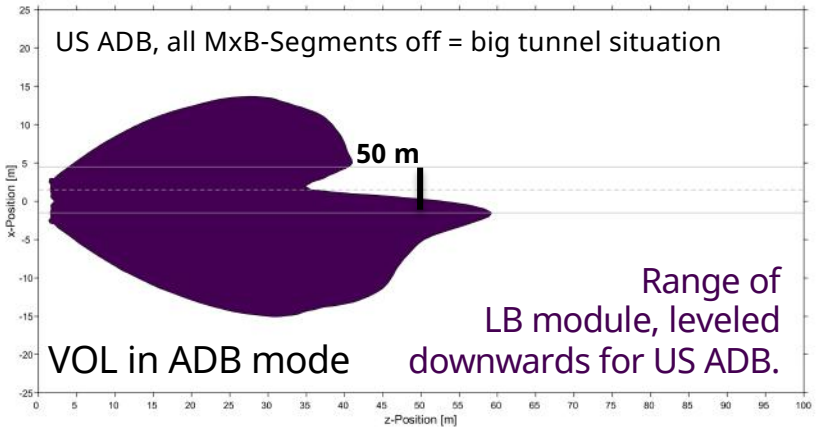
US ADB - non-HD headlamps



Levelling the lighting module downwards for glare reduction in ADB mode leads to a loss of visibility range in the area where no matrix segments are switched on.

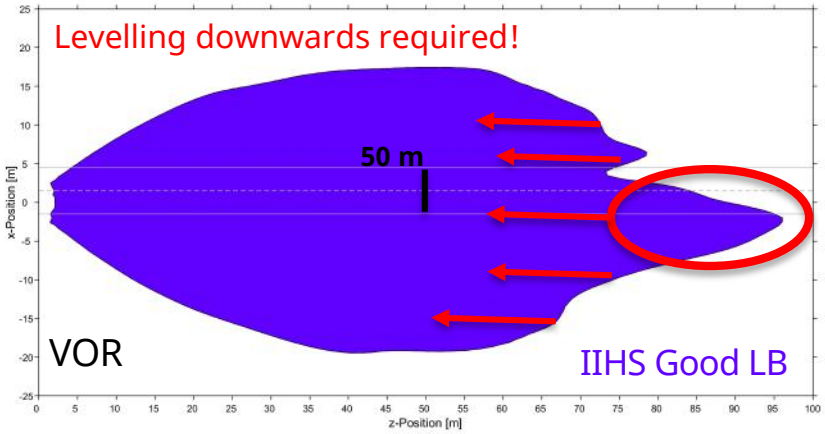
The performance of
non-HD US ADB Systemen with VOR light distributions
is superior to VOL systems!



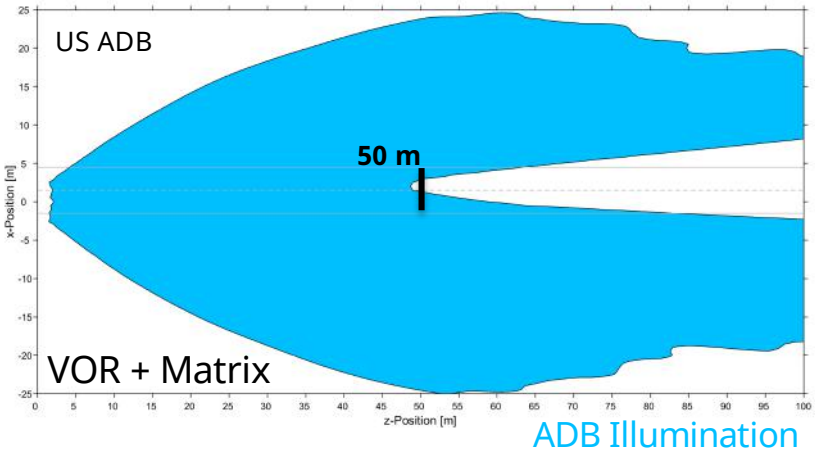


50 m line is a guide to the eye to show the differences between the ranges of 5 lx areas.

US ADB - non-HD headlmaps



- Range of the complete light distribution is reduced



- ADB fills in the rest of the pattern, but the depth of the “notch” is retained from LB pattern
- VOR notch ~ 20 m further down road than VOL example

US ADB - non-HD headlmaps

Following visualizations show that the performance of
non-HD US ADB systems with VOR light distributions
are superior to lighting system with VOL.

**For mounting heights < ~85 cm*

US ADB - non-HD headlmaps

Visualizations

Vehicle Distance: 50 m

mounting height: 75 cm

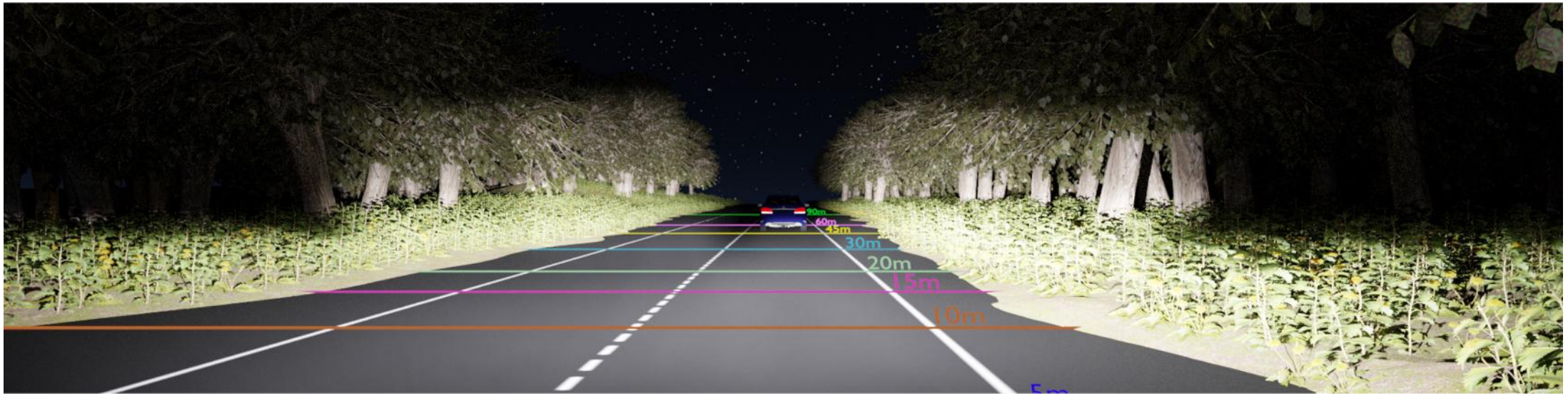
VOR
LB

US ADB - non-HD headlmaps

Visualizations

Vehicle Distance: 50 m

mounting height: 75 cm



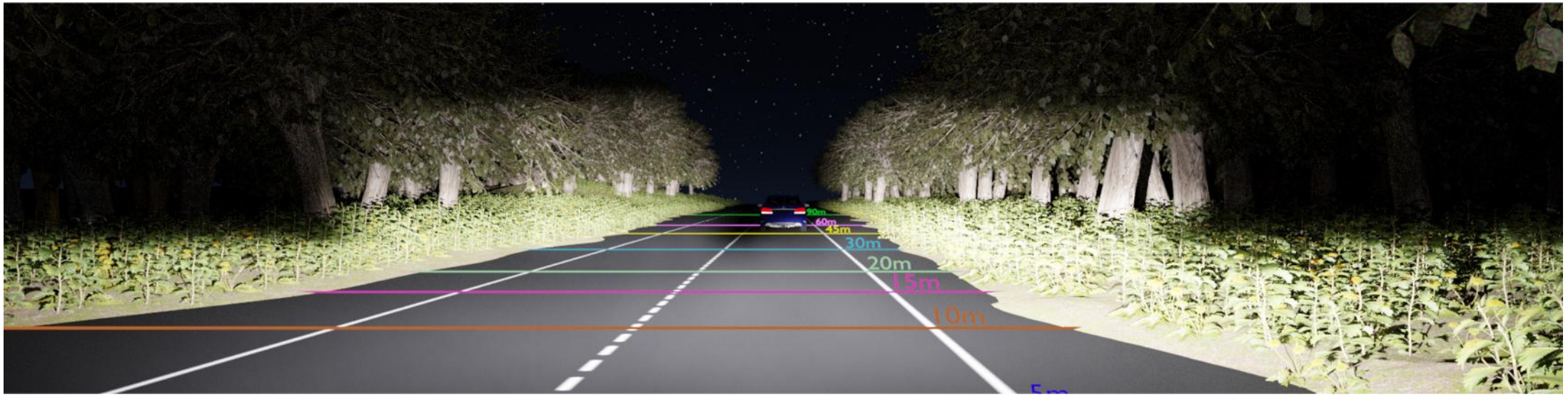
VOR
ADB

US ADB - non-HD headlmaps

Visualizations

Vehicle Distance: 50 m

mounting height: 75 cm



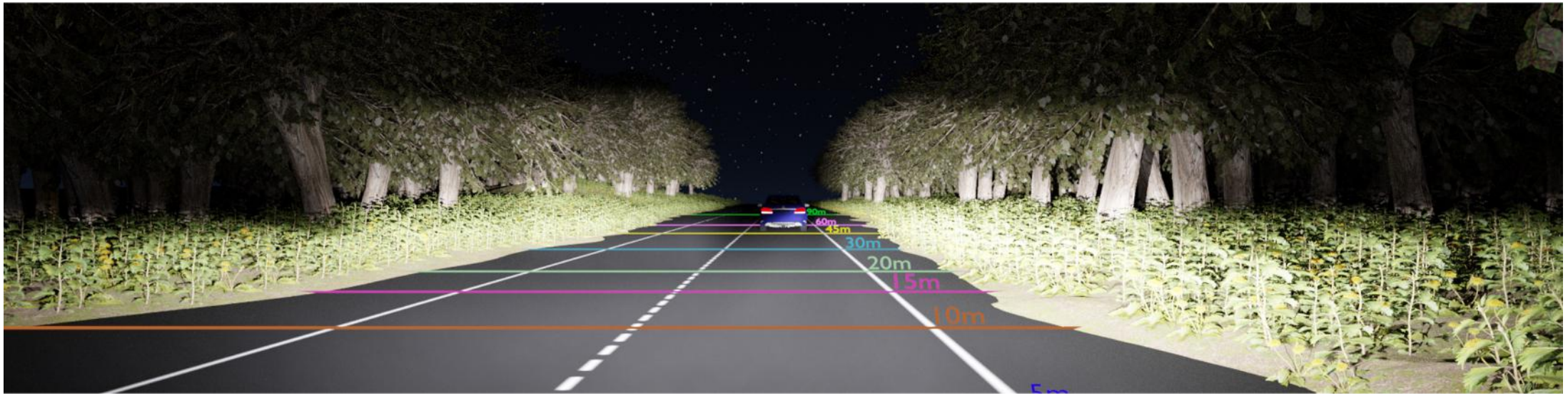
VOL
ADB

US ADB - non-HD headlmaps

Visualizations

Vehicle Distance: 50 m

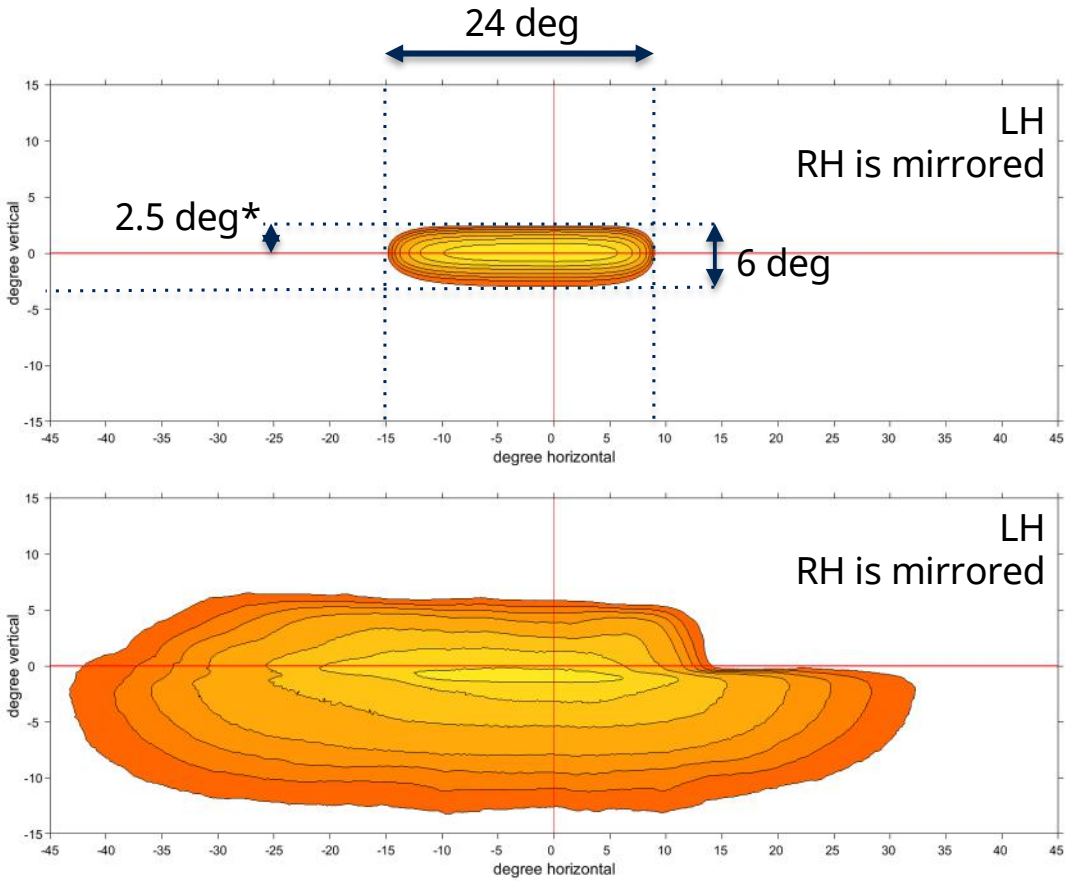
mounting height: 75 cm



ECE
ADB

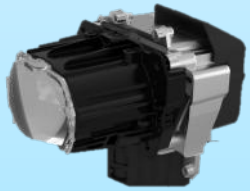
US ADB – HD headlamps

US ADB - HD headlamps



Setup:
2 Modules

microLED
20k pixel



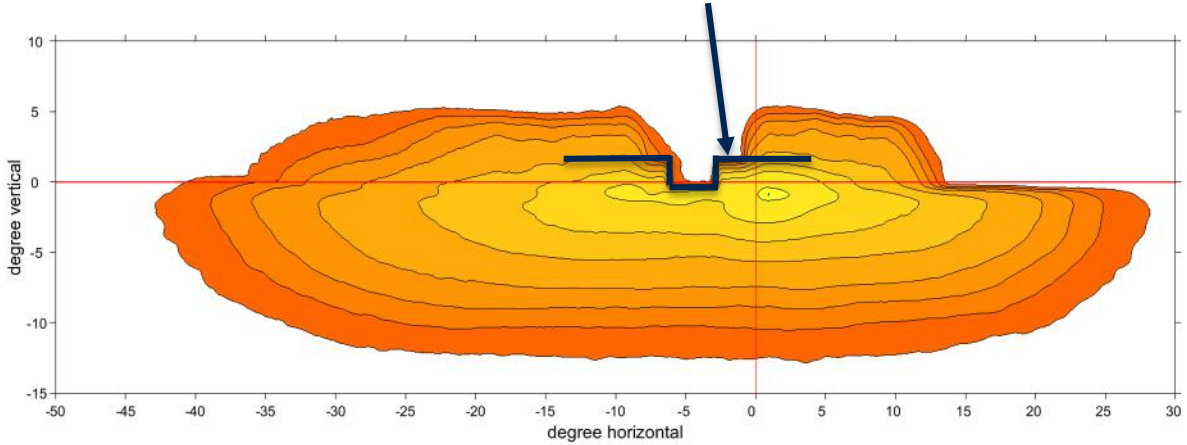
e-Light
LB & ADB 12-16 Segments

IIHS prediction: Good, < 5 demerits

**required for US ADB laboratory test (microLED module must fulfill HB legal test points @ 2 deg Up*

US ADB - HD headlamps

microLED HD MxB:
+ small, accurate tunnel
+ COL height in Tunnel defined by microLED module

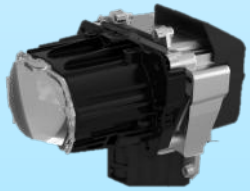


COL height in ADB tunnel lower than COL height in LB!
No glare even if vehicle is pitched up.

COL height in ADB tunnel depends on mounting height and vehicle dynamics.

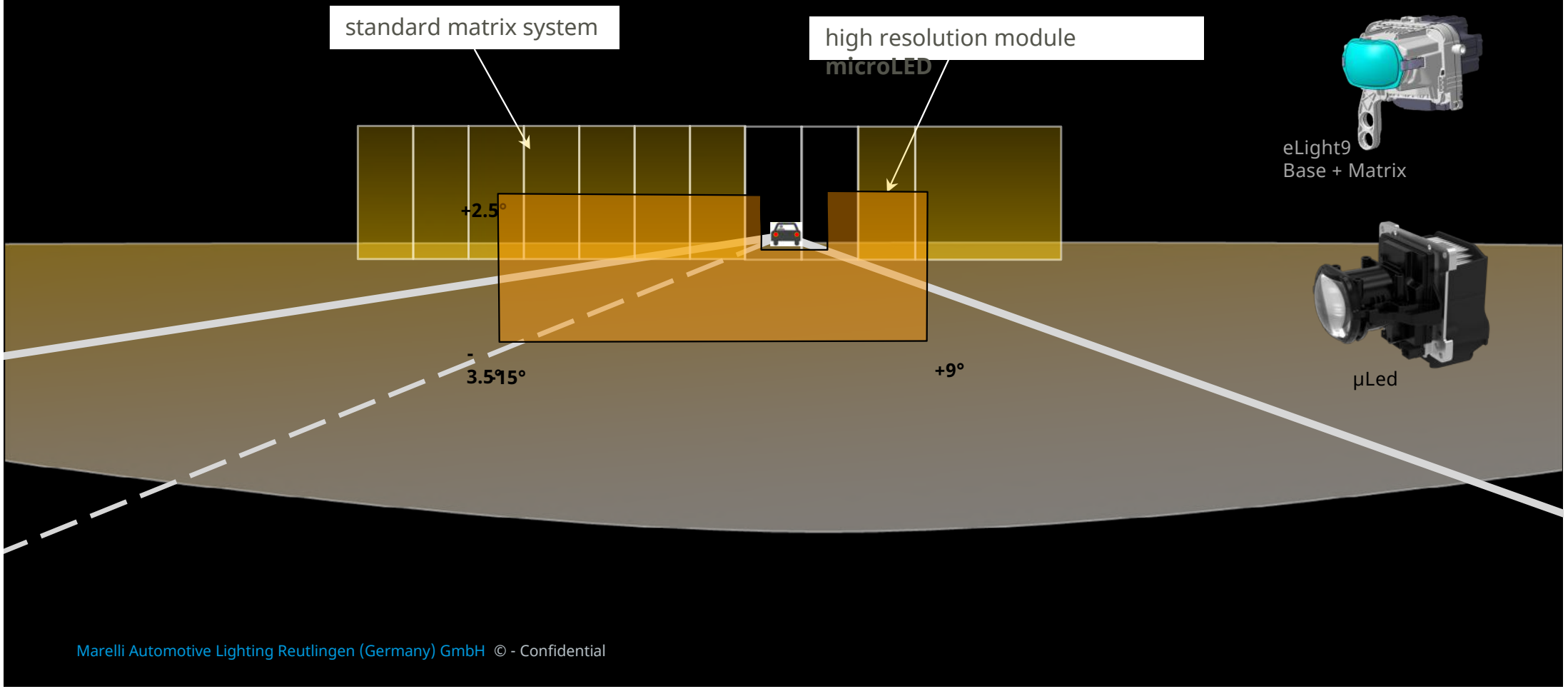
Setup:
2 Modules

microLED
20k pixel



e-Light
LB & ADB 12-16 Segments

HD headlamps
System Setup



eLight9
Base + Matrix

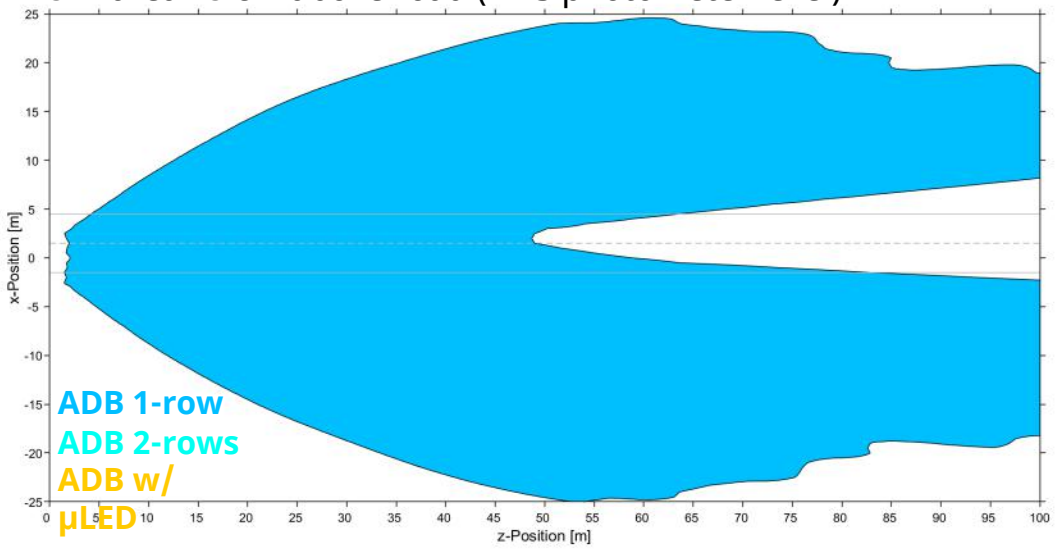
µLed

US ADB - non-HD headlmaps

Non-HD vs. HD ADB for the US

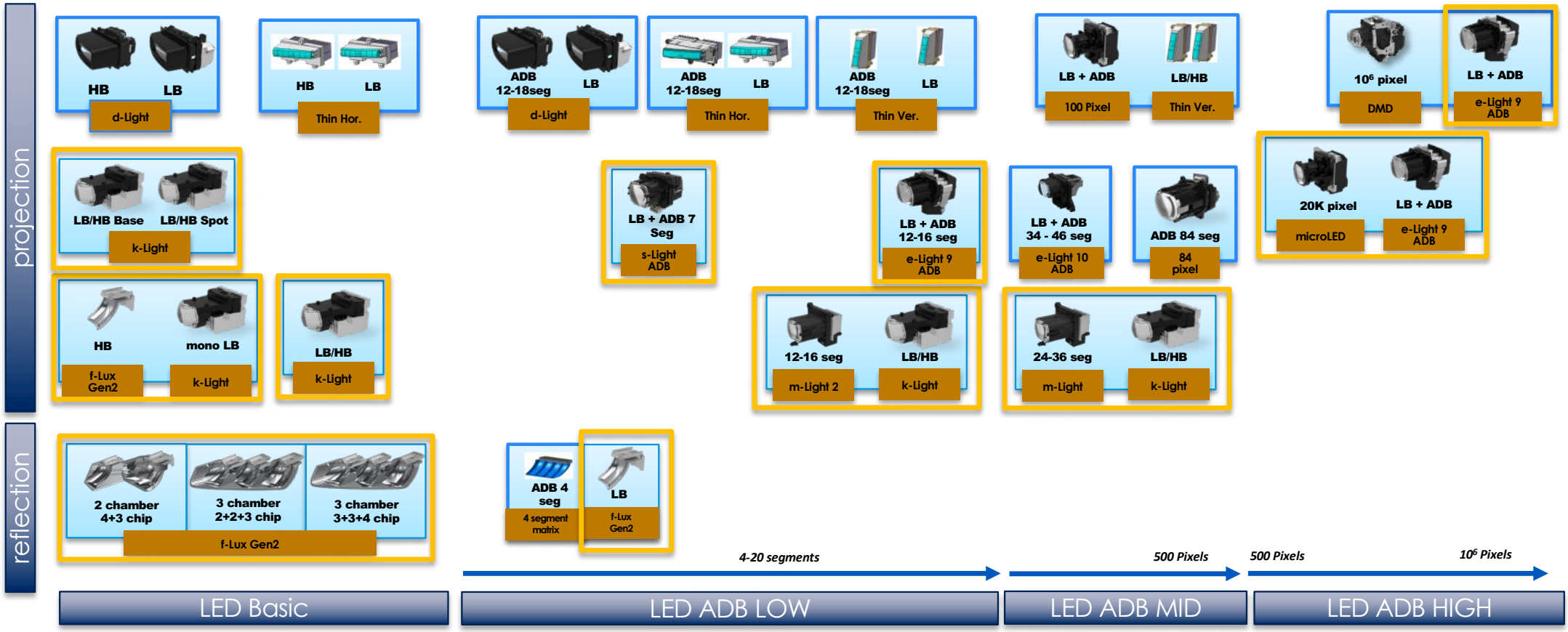
The µLED module enables significantly narrower tunnels in the central area and in the tunnel, the illumination is significantly increased.

5 lx area 25 cm above road (IIHS photometer level)



To visualize the influence of the µLED module, the same background matrix was used (no eLight).

Marelli ADB roadmap



Thanks!