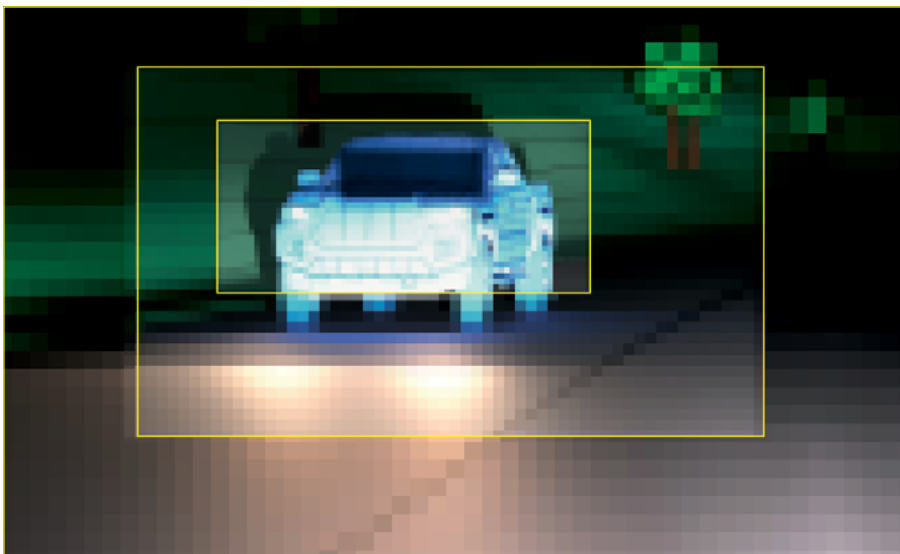


The Road to Digital Headlighting

A Race of enabling high-definition technologies



Three competing lighting technologies, each with different advantages, are enabling the digitalization of the main front lighting functions. This digitalization is driving several new applications (e.g. lane marking and spot lighting).

FEATURES AND BENEFITS

These HD solutions do not necessarily create the complete beam but will extend the functionality of an LED matrix or LED basic beam. The three potential technologies are:

- DMD
- μ LED
- Laser scanner

PRIMARY APPLICATIONS

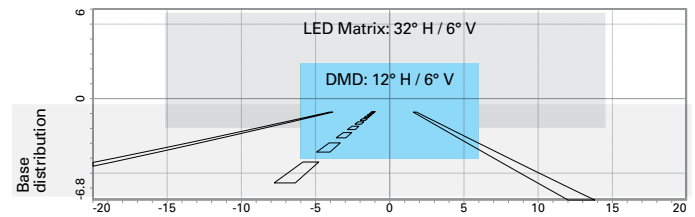
- High-resolution ADB
- Digital cut-off and leveling
- Passing beam enhancement

HD Setup and Beam sections

Enabling stylish solutions for existing and emerging use cases

DMD

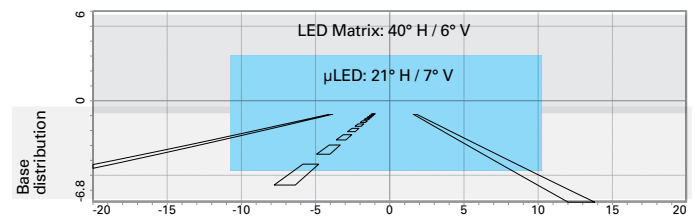
High Luminance LEDs ($> 200 \text{ Mcd/m}^2$) are illuminating a multi-mirror device that projects the light (objects) on the road.



DMD: 1 000 000 Pixel; 4 000 lm installed / 100 % used

μLED

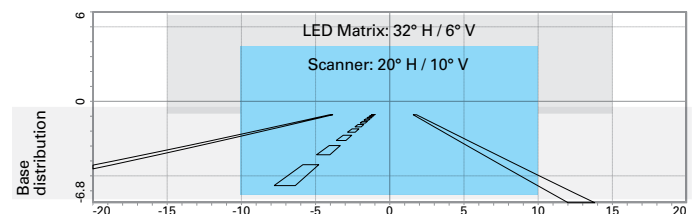
An array of multiple individually switchable (at least $> 10\,000$ pixel) LEDs is projected onto the road. The emitting LED surface must be very small ($< 50 \mu\text{m}$) and spaced very closely and homogeneous to each other. This can only be realized by specific technology which processes the array as a whole (and not by placing individual LEDs next to each other).



μLED: 20K Pixel / $0.09 \times 0.09^\circ$ / 9 000 lm installed / 20 % used

LASER Scanner

A blue LASER beam is placed on a single tiltable mirror which projects the beam onto a phosphor in a scanning mode. By that light movement, versatile patterns on the phosphor can be created. The phosphor converts the blue light into yellow, and the resulting white light is projected onto the road.



Scanner: 200 lm installed / 100 % used

Base distribution: LED 2 mm^2 Epi – minimal switching
LED Matrix: 24 Pixel; 3600 lm installed / 20 % used

Performance Map

	Contrast [within 0.2°]	Resolution [0.1° max]	Max Intensity [120 000 cd max]	Total Flux [useable in beam]	Power Efficiency [lm/W on the road]
Micro LED	Good	Very good	Solution critical	Very good	Solution critical
DMD	Good	Very good	Good	No solutions	No solutions
LASER Scanner	Good	Solution critical	Very good	Solution critical	Solution critical
Assessment	Good contrast is achievable for all solutions	High-resolution in foreground demands high pixelation technology	Micro LED might need some complement in HB range	DMD and Laser scanner practically limited for full beam pattern	Low efficiency of subtractive technologies may cause some practical constraints

Legend	Weak	Moderate	Good	Very good	Best
	⚠ = Solution critical		⊠ = No solutions		

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