

A high-resolution headlighting system  
based on hybrid light-source architecture

基于多种光源的高分辨率前照灯系统

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## Agenda 议程

- Micro-LED Light Source Requirements for a Digital Beam 数字化照明对MicroLED光源的要求
- Full Field-of-View Demonstrator Design 全视场照明样件的设计
- Beam Composition 光型结构
- Foreground and ADB Module Utilizing Matrix-LEDs 使用MicroLED的近场照明及ADB模块
- Lumileds Micro-LED: Key Specification Parameters & Interfaces 亮锐MicroLED: 核心规格参数及接口
- Video of the Demonstrator Beam 数字化照明的视频

# Micro-LED Light Source Requirements for a Digital Beam 数字化照明对MicroLED光源的要求

Derived from Application 来源于应用

Source: Driving Vision News



## ADB

$I_{max} > 70\,000\text{ cd}$   
Field-of-View 视野:  
H:  $> \pm 10.5^\circ$   
V:  $+3^\circ/-4^\circ$

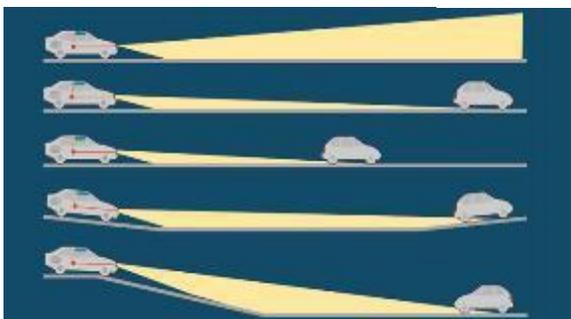
Source: Gommelblog.it



## Lane Marking Resolution 车道标识分辨率

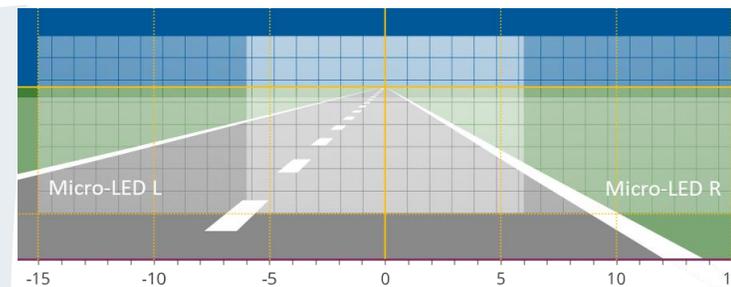
$< 7.5\text{ cm in } 50\text{ m}$   
 $= 0.085^\circ$

Source: Driving Vision News



## Dynamic Leveling Resolution 动态调平分辨率

$< 12\text{ cm in } 75\text{ m}$   
 $= 0.085^\circ$



## Key Application Requirements 核心应用需求

Full Beam Width 全光型宽度 [°]	21
Full Beam Height 全光型高度 [°]	7
Angular Resolution 角分辨率	0.085
$I_{max}$ [cd]	70 000



## Micro-LED Device Solution 器件解决方案

Pixel Matrix 像素数量	20k (82 x 246)
Luminance 亮度	$> 80\text{ cd/mm}^2$
Flux (Light Source) for Full HB Drive 全远光所需光通量	$> 2400\text{ lm}$

# Full Field-of-View Demonstrator Design 全场景照明样件的设计

Utilizing One Single Micro-LED per Headlamp 单个头灯仅使用一片Micro-LED

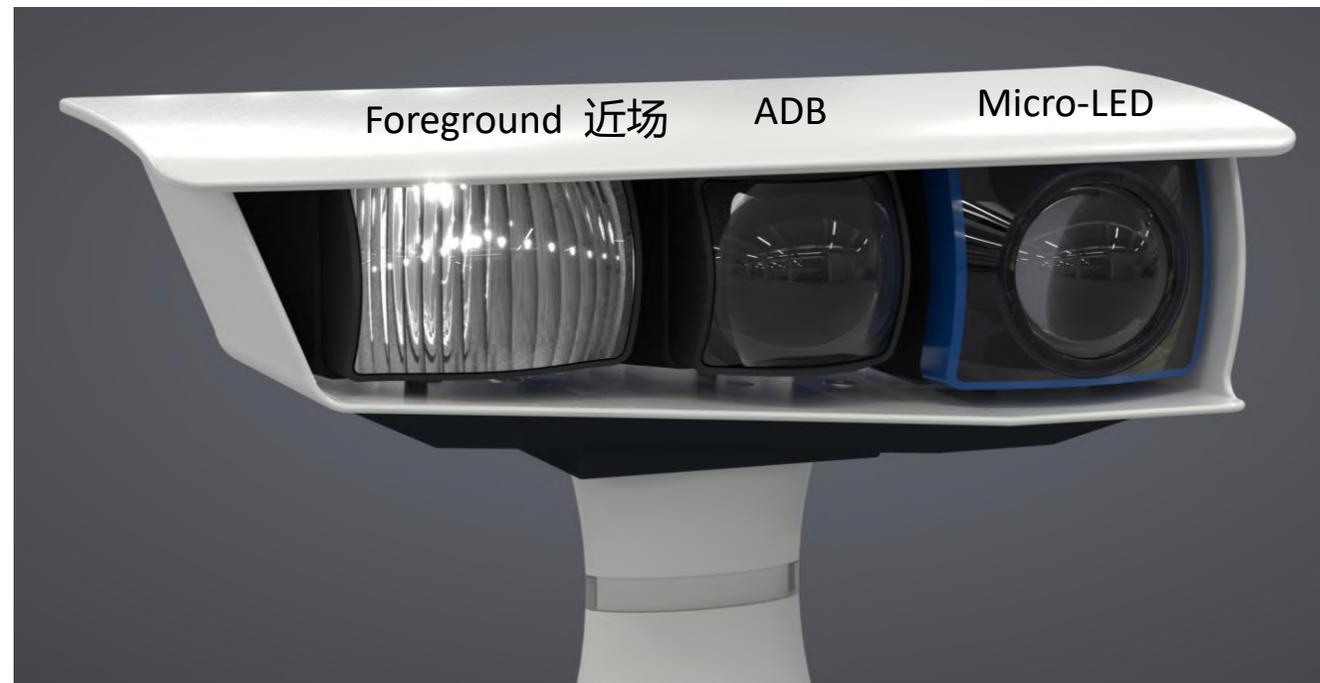


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Utilizing One Single Micro-LED per Headlamp 单个头灯仅使用一片Micro-LED

## Foreground Module 近场模组

- Horizontal range 水平范围:  $\pm 40^\circ$
- LED product 产品: LUXEON NeoExact
- Light-emitting area 发光面积:  $4 \text{ mm}^2$
- Optical concept 光学实现方式: Direct image 直接成像
- Optic size 镜头尺寸:  $60 \text{ mm} \times 40 \text{ mm}$

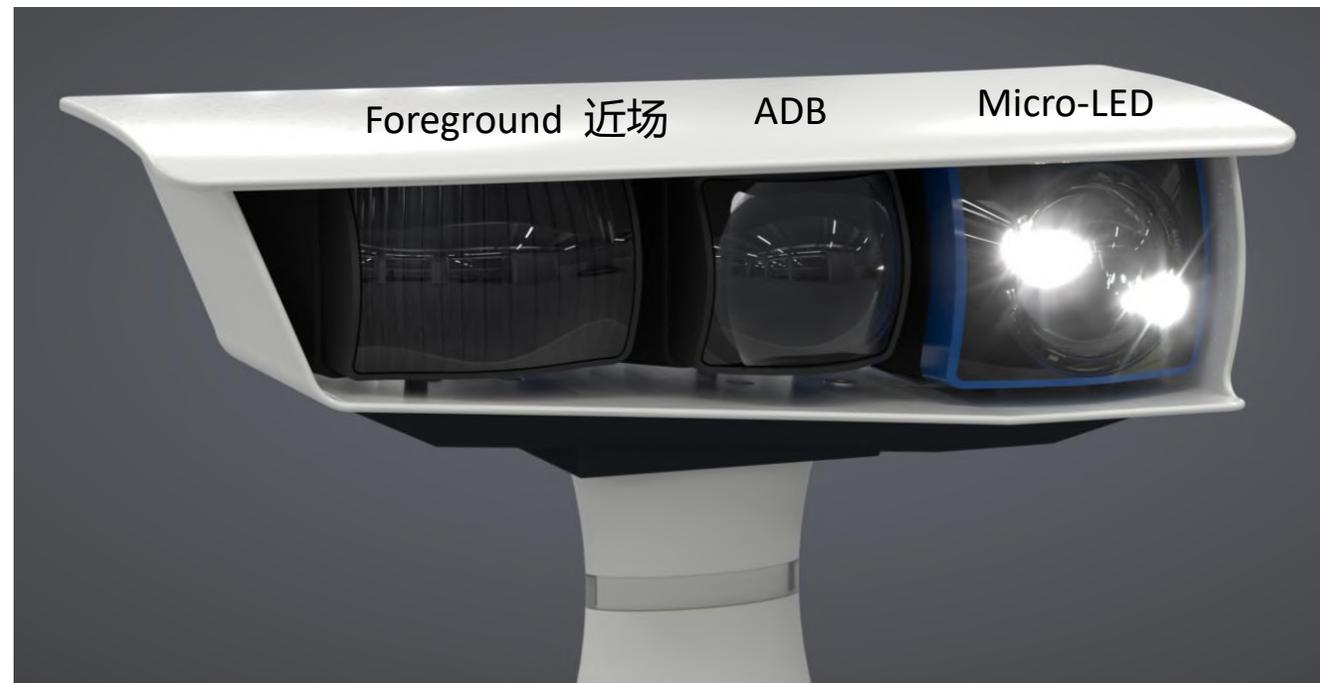


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## Micro-LED Module / Micro-LED模组

- Field-of-View 视场范围:  $7^\circ \times 21^\circ$
- LED product 产品: Micro-LED
- Light-emitting area 发光面积:  $32 \text{ mm}^2$
- Optical concept 光学实现方式: Direct image
- Lens diameter 镜头尺寸:  $40 \text{ mm}$

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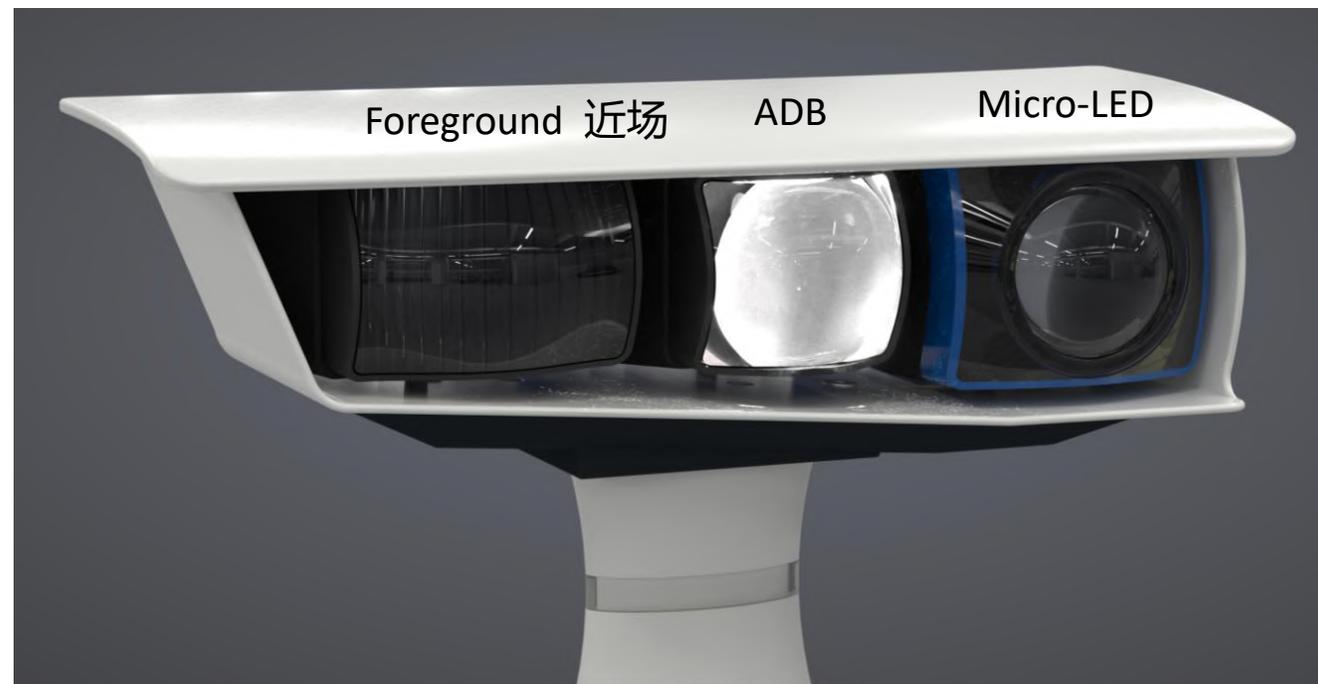
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## ADB Module / ADB模组

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- Optical concept 光学实现方式: Direct image
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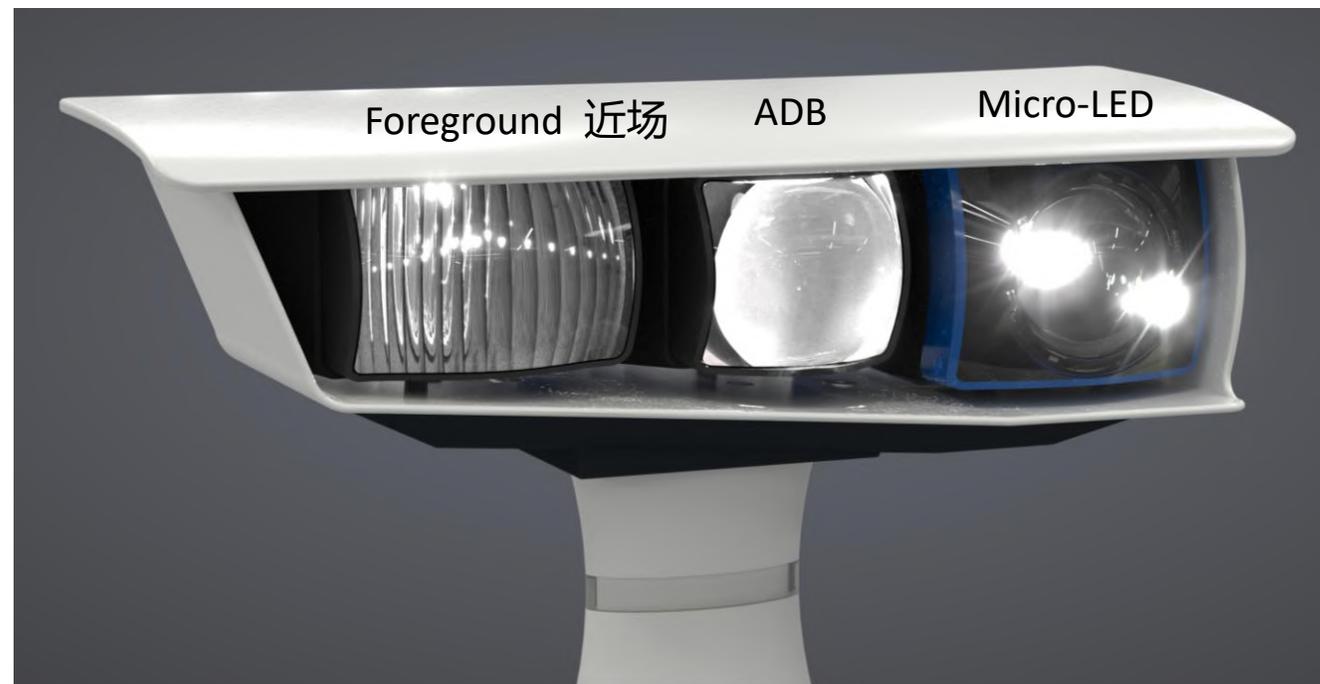
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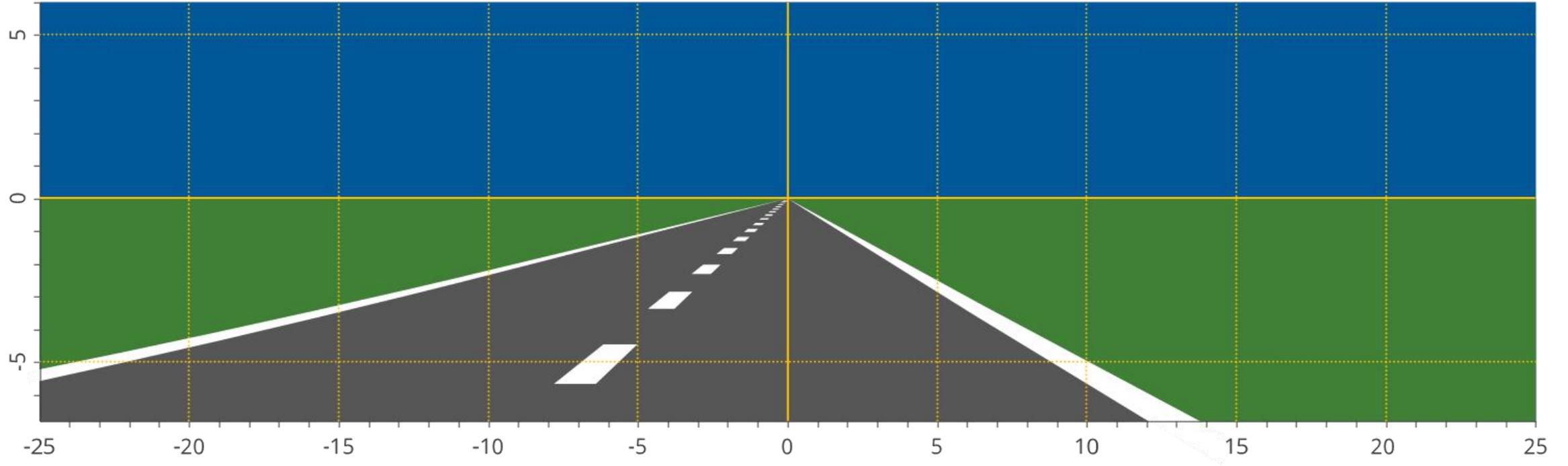
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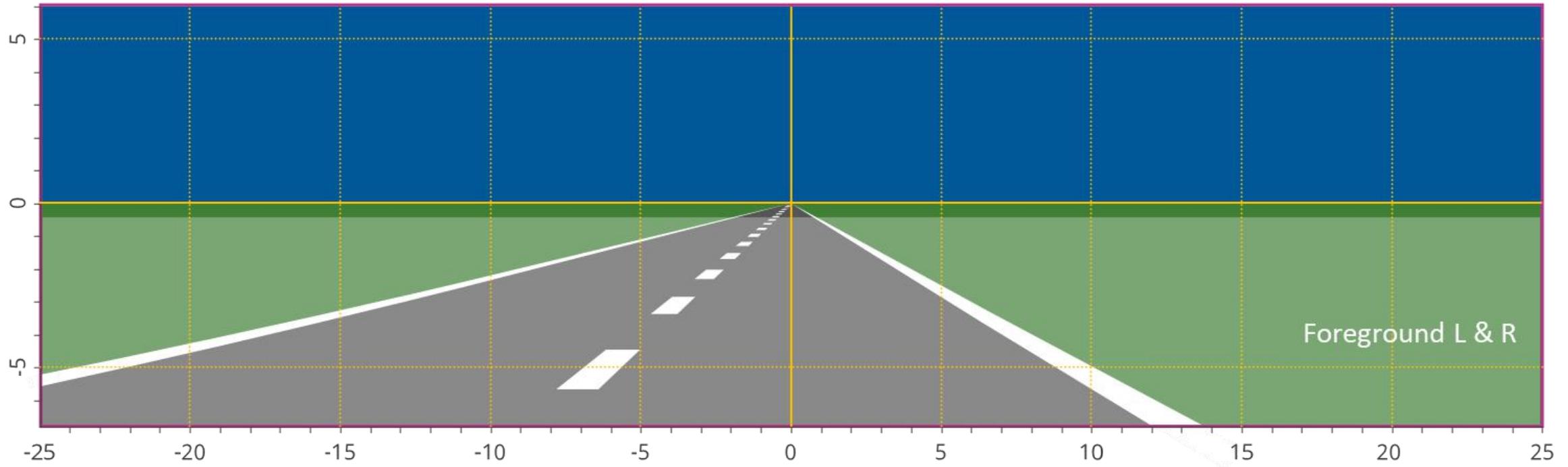


# Beam Composition 光型结构



# Beam Composition 光型结构

## Foreground Performance Estimates 近场性能预估



Foreground Module

### 近场模组

Horizontal Range 水平范围:

± 40°

Vertical Range 垂直范围:

15°

Intensity 光强:

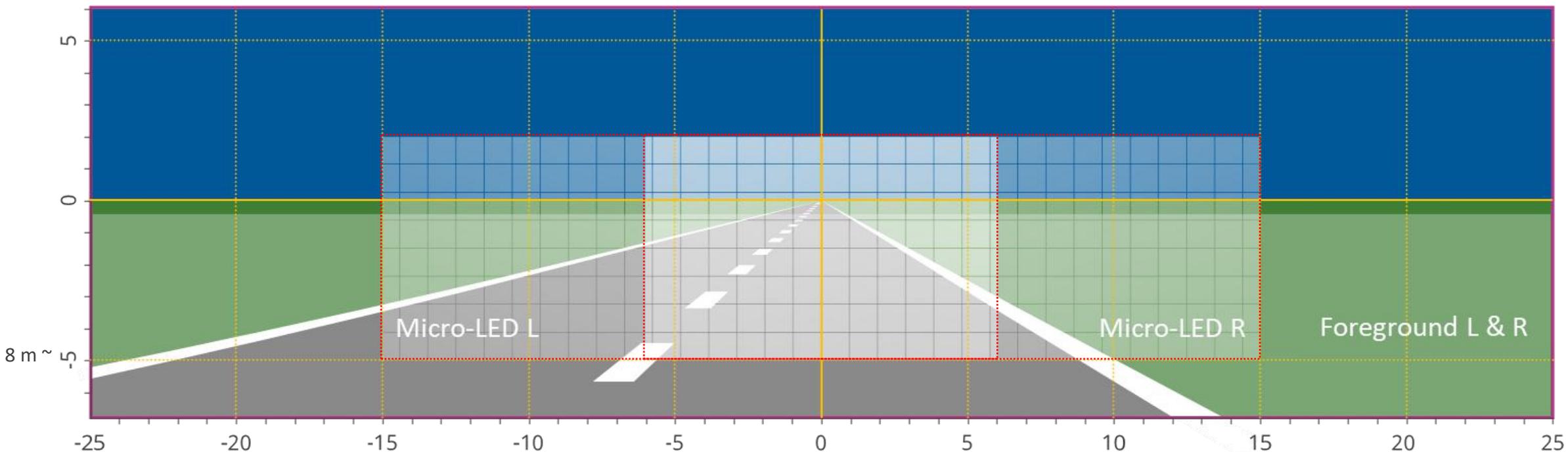
20 000 cd

Flux in Beam 输入光通量:

800 lm

# Beam Composition 光型结构

Foreground + Micro-LED Performance Estimates 近场+Micro-LED性能预估



Foreground Module

Micro-LED Module

近场模组

Micro-LED模组

Horizontal Range 水平范围:

± 40°

21°

Vertical Range 垂直范围:

15°

7°

Intensity 光强:

20 000 cd

60 000 cd

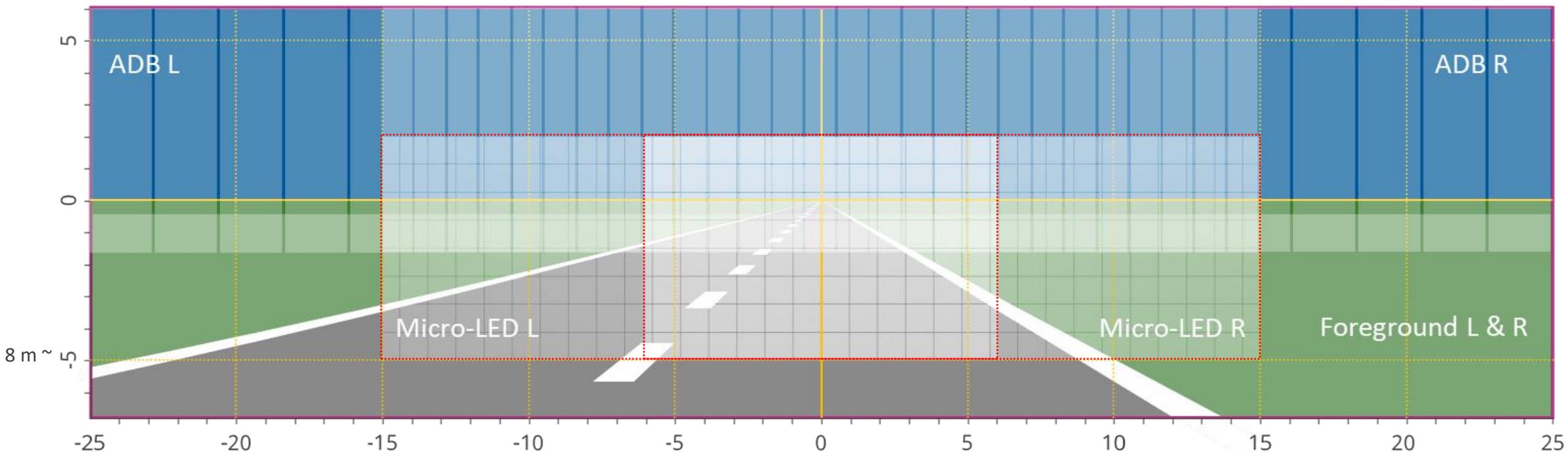
Flux in Beam 输入光通量:

800 lm

800 lm

# Beam Composition 光型结构

Foreground + ADB + Micro-LED Performance Estimates 近场+ADB+Micro-LED性能预估



Foreground Module

ADB Module

Micro-LED Module

近场模组

ADB模组

Micro-LED模组

Horizontal Range 水平范围:

± 40°

Vertical Range 垂直范围:

15°

Intensity 光强:

20 000 cd

Flux in Beam 输入光通量:

800 lm

40°

6°

76 000 cd

2150 lm

21°

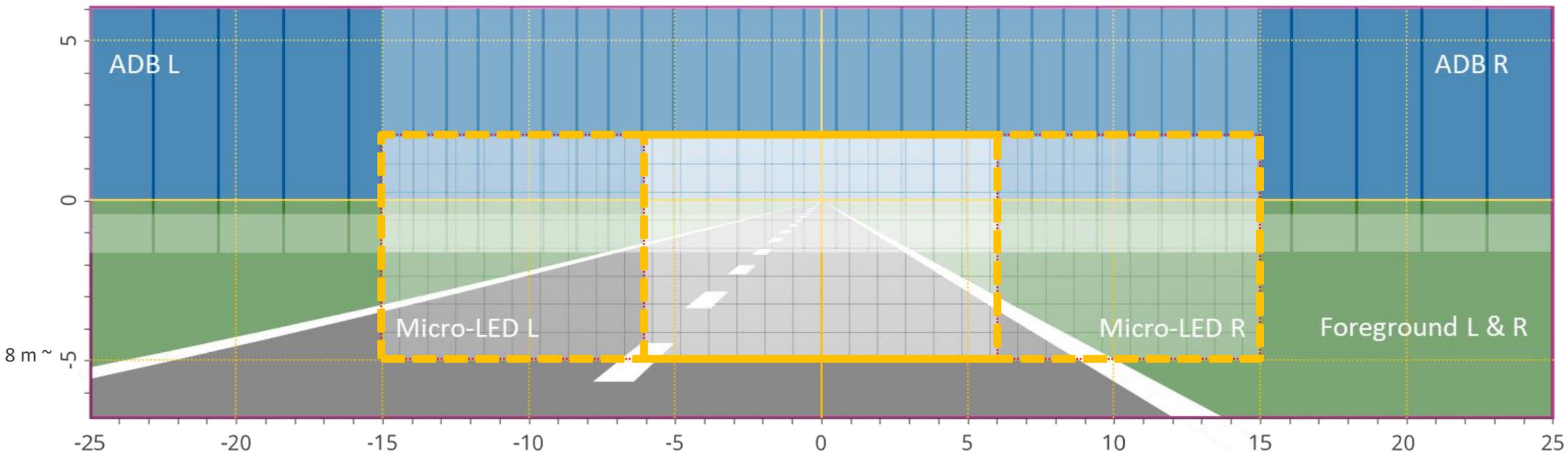
7°

60 000 cd

800 lm

# Beam Composition 光型结构

Foreground + ADB + Micro-LED Performance Estimates 近场+ADB+Micro-LED性能预估



**Foreground Module**

**近场模组**

Horizontal Range 水平范围:

± 40°

Vertical Range 垂直范围:

15°

Intensity 光强:

20 000 cd

Flux in Beam 输入光通量:

800 lm

**ADB Module**

**ADB模组**

40°

6°

76 000 cd

2150 lm

**Micro-LED Module**

**Micro-LED模组**

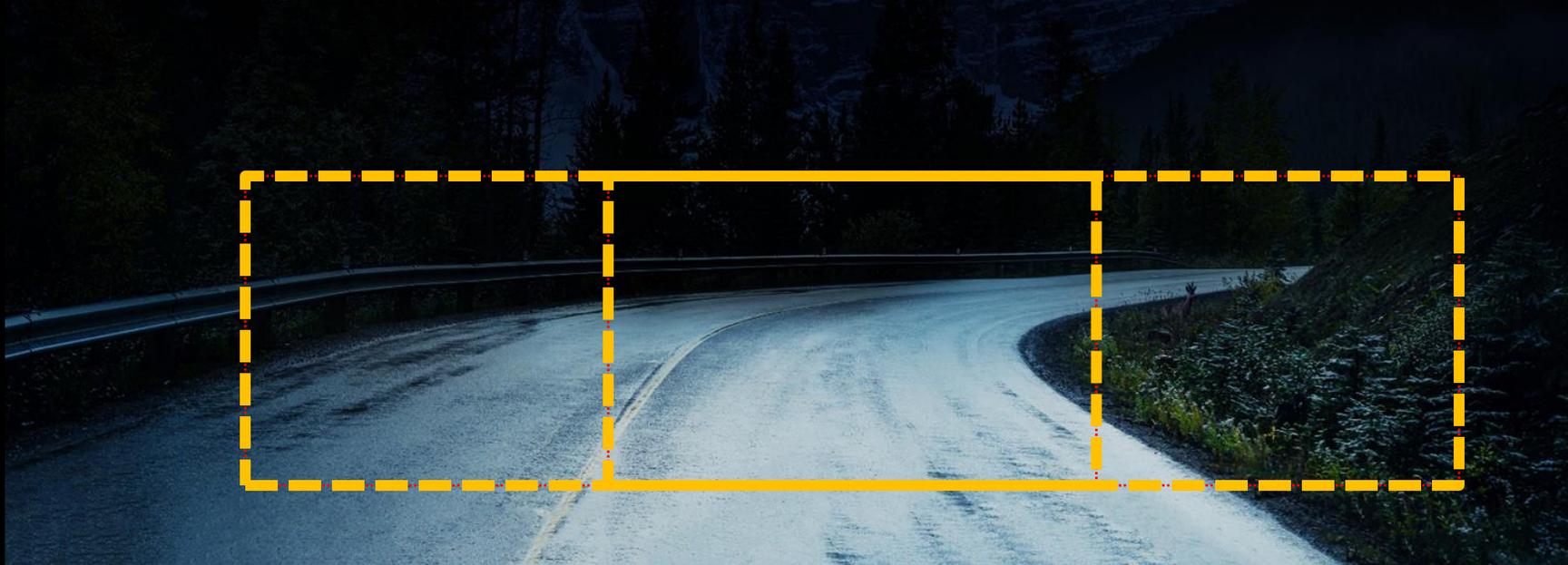
21°

7°

60 000 cd

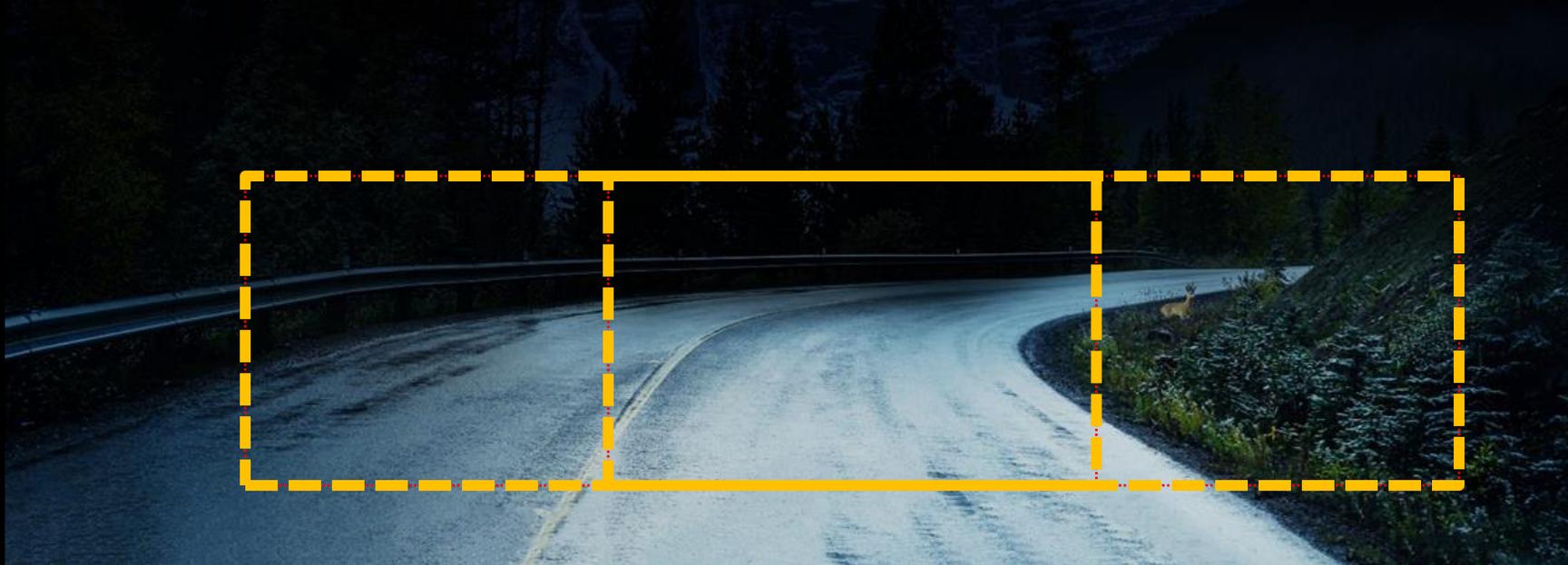
800 lm

# Low Beam in a Curved Road 近光弯道照明



# Low Beam in a Curved Road 近光弯道照明

Beam Swiveling 随动转向照明

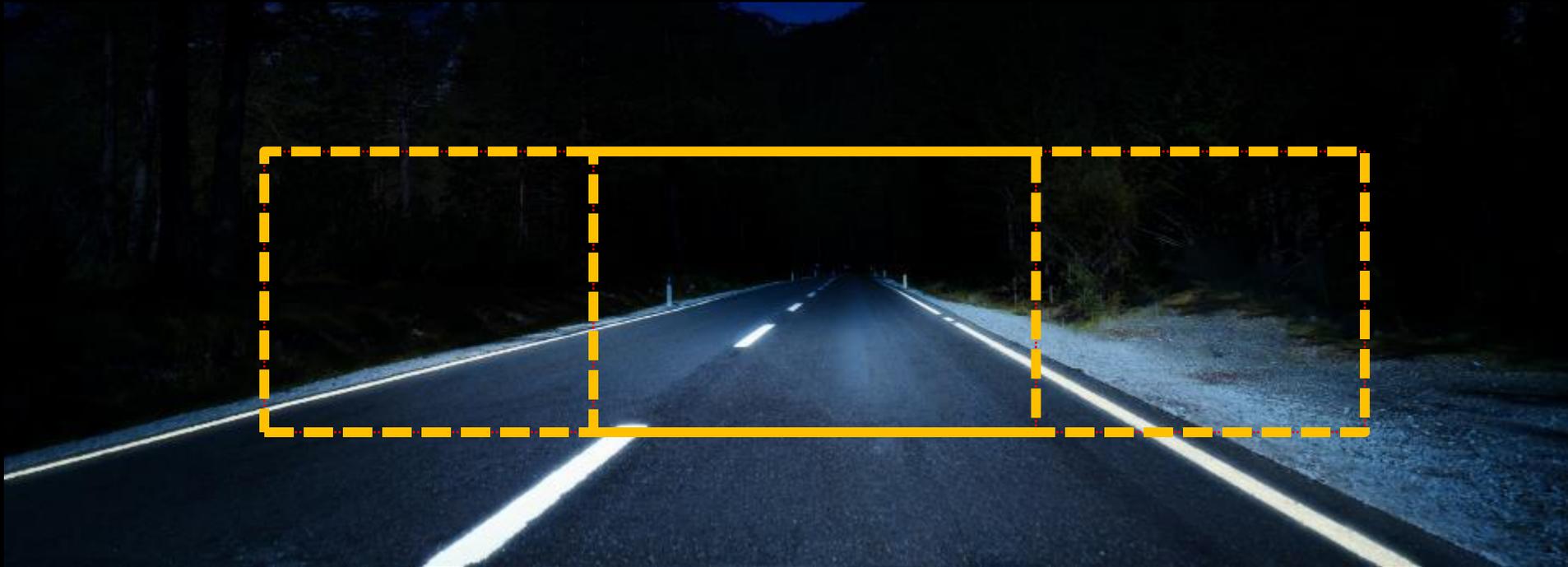


# Low Beam in a Curved Road 近光弯道照明

Beam Swiveling plus Warning Sign 随动转向+警示标志

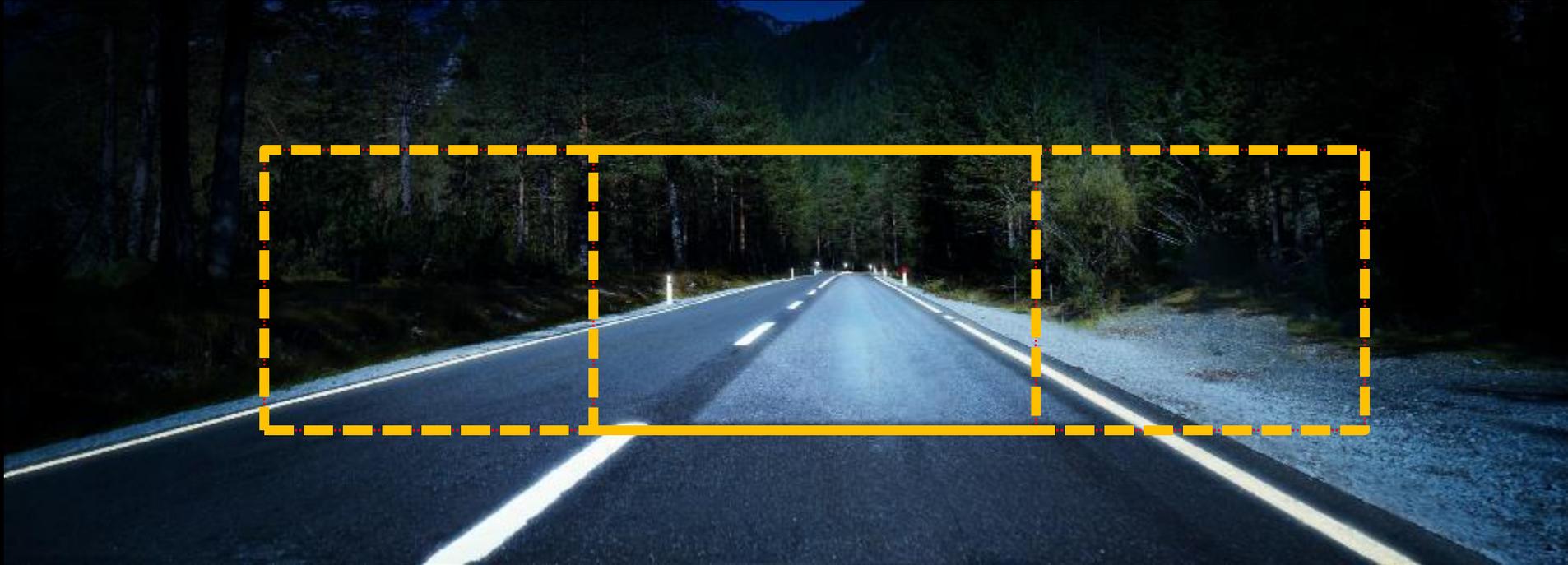


# Country Road 乡村道路照明



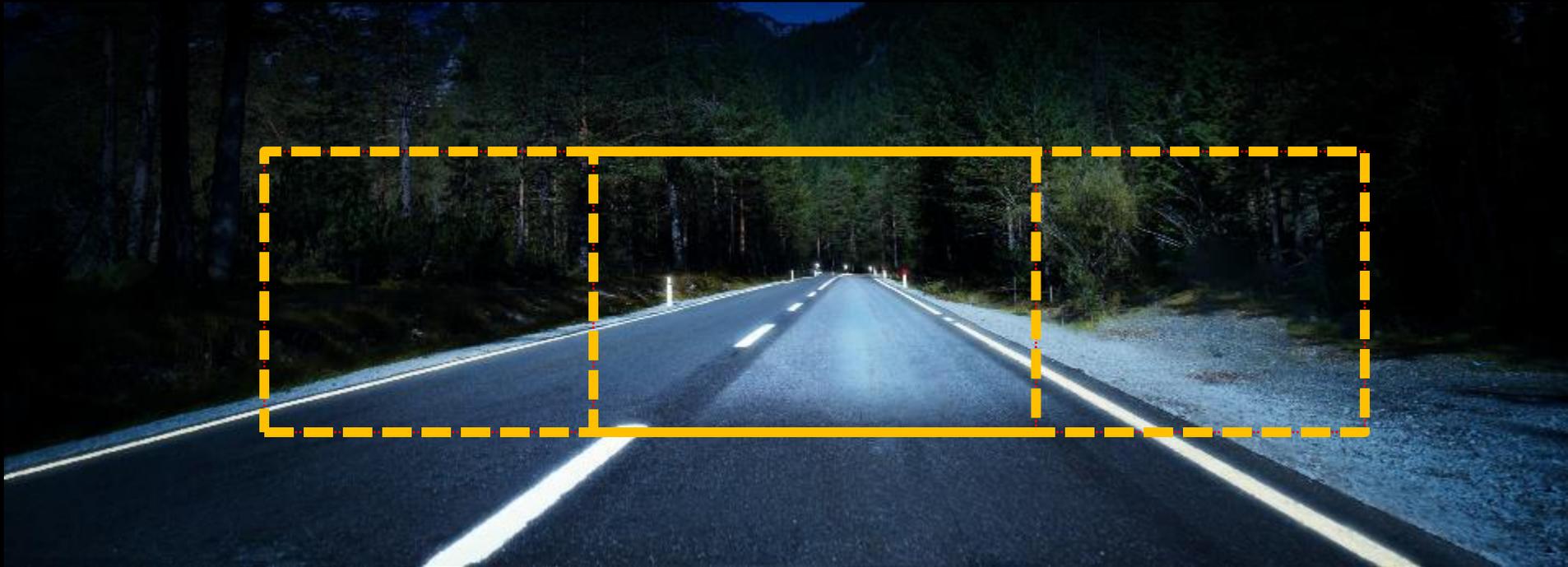
## Country Road 乡村道路照明

High Beam plus Sharp Road Marking 远光+锐利车道标识



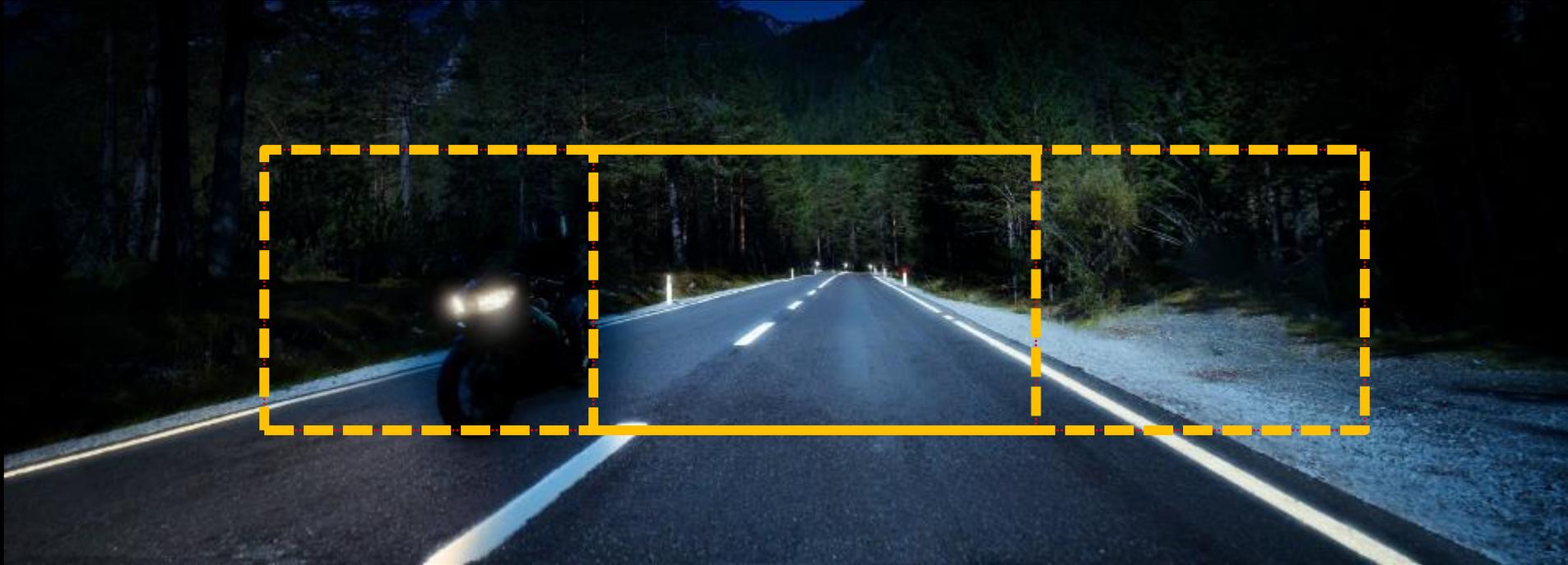
# Country Road 乡村道路照明

High Beam plus Soft Road Marking 远光+柔和车道标识



# Country Road 乡村道路照明

High Beam plus Deglaring of Upcoming Traffic 远光+对向来车防眩光

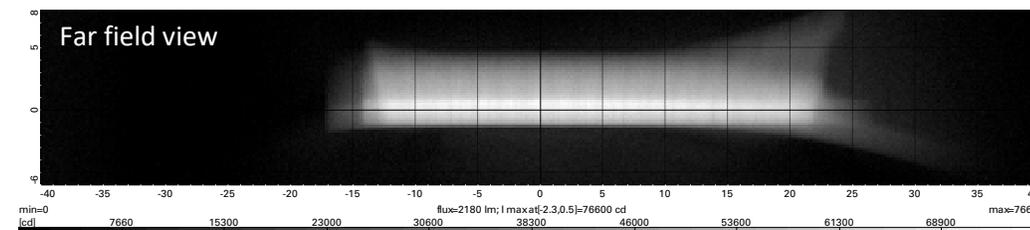


# Full Field-of-View Demonstrator Design 全视场照明样件的设计

Utilizing Lumileds Matrix-LEDs: LUXEON NeoExact 使用亮锐矩阵LED: LUXEON NeoExact

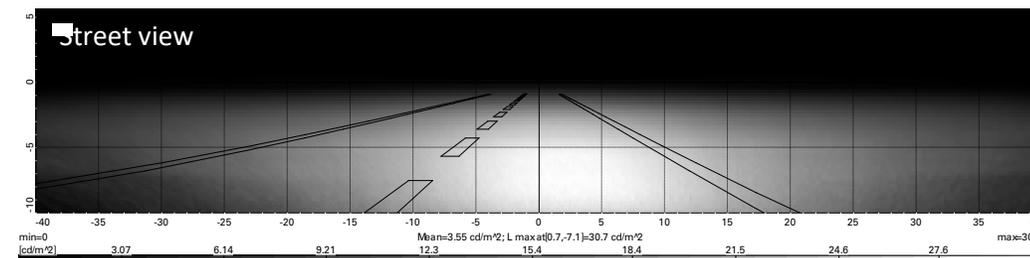
## ADB Module / ADB模组

- 18 LUXEON NeoExact 1.0 mm<sup>2</sup> LEDs in a single row  
单排18颗LUXEON NeoExact 1.0 mm<sup>2</sup> LED
- LED gap / LED间距: 60 μm



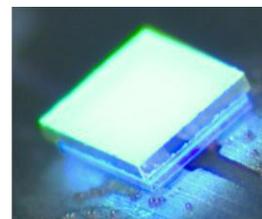
## Foreground Module 近场模组

- 3 x LUXEON NeoExact 1.0 mm<sup>2</sup>
- 2 x LUXEON NeoExact 0.5 mm<sup>2</sup>
- LED gap / LED间距: 60 μm



## LUXEON NeoExact 0.5 mm<sup>2</sup> and 1.0 mm<sup>2</sup>

- Smallest possible package: Light-emitting area same as package size  
可能的最小封装: 发光面积等于封装面积
- Enabling direct imaging projections due to narrow spacing  
窄间距使直接成像成为可能
- Building block for customized level 2 solutions  
提供定制化L2解决方案



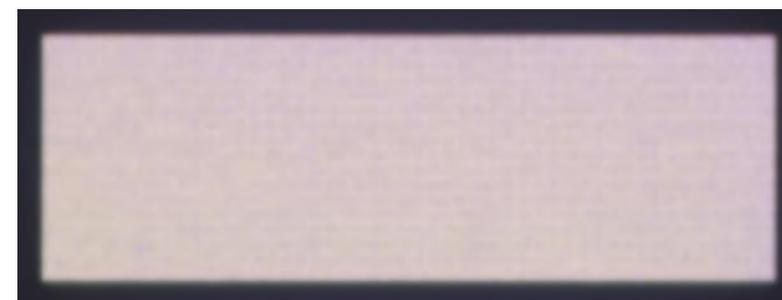
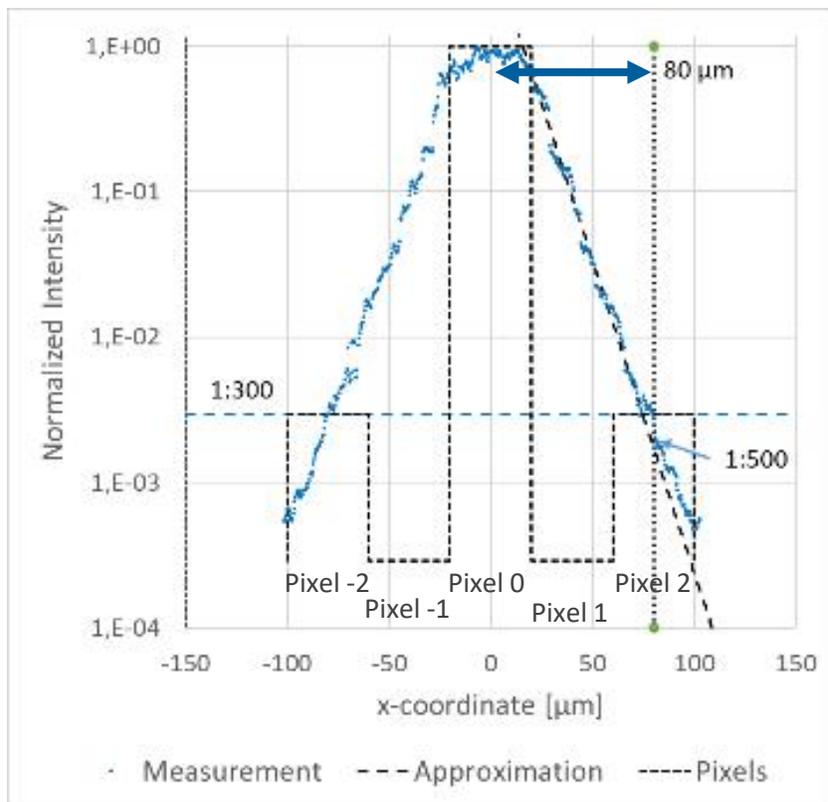
# Lumileds Micro-LED

## Key Specification Parameters 核心规格参数及接口

- Pixel array 像素排列: 82 x 246 > 20k pixels
- Pixel pitch 像素间隔: 40 μm
- Target flux 目标光通量: 0.4 lm/px @ 85 °C, DC operation
- Contrast performance 对比度性能:



Micro-LED on board designed for SMT assembly  
为实现SMT组装所设计的带载板的Micro-LED



True-color image taken with luminance camera  
亮度相机所拍摄的真彩图像

# Lumileds Micro-LED

## Electrical Interfaces 电气接口

### Highly Integrated Micro-LED 高度集成的Micro-LED

- Utilizing CMOS technology 使用CMOS技术
- LED direct attached to ASIC (single chip approach) / LED直接连接至ASIC (单颗发光芯片可控)
- Most compact and efficiency solution 最集成有效的解决方案



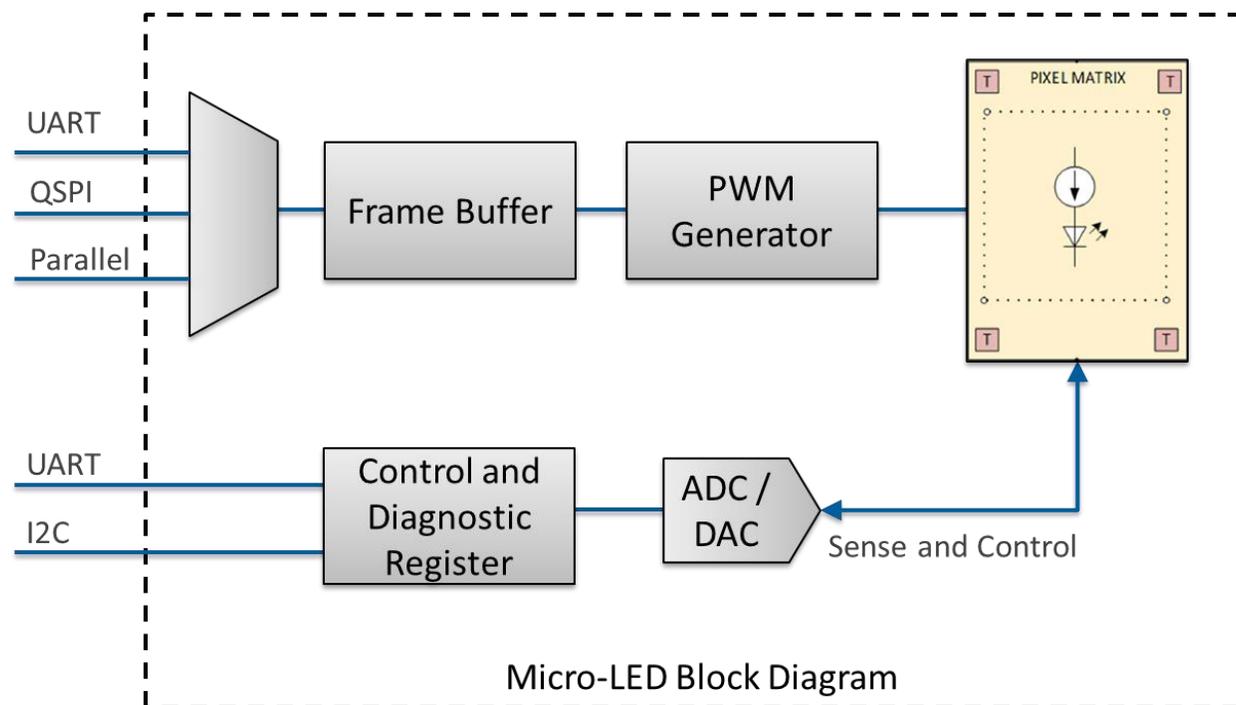
### Video Interface 视频接口

3 different options / 3种不同选择

- UART
- QSPI
- Parallel Port (used for Demonstrator) 并行端口 (使用在样件中)

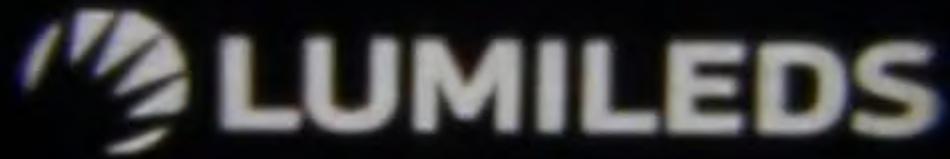
### Control and Diagnostics 控制和诊断

- Via UART or I2C 通过UART或I2C
- Monitoring of e.g. 可监控
  - Temperature 温度
  - Pixel voltage in diagnostic mode 诊断模式下的像素电压
  - Forward current 正向电流



# Video of the Demonstrator Beam 样件光型视频

To a Test Wall 投射至测试墙



## Conclusion 结论

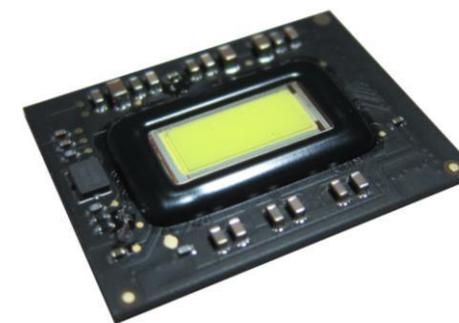
### Realistic and Efficient High-Resolution Headlamp Demonstrator

#### 现实有效的高分辨率头灯样件

- Based on a hybrid system architecture utilizing one single Micro-LED/headlamp  
基于多种系统架构，单个头灯仅使用一片Micro-LED
- Supporting endless high-resolution beam projections  
可支持连续的高分辨率的投射系统
- Enabling compact high-resolution headlamp designs  
可实现紧凑型高分辨率头灯设计

### Lumileds Micro-LED

- Realized with > 20 k pixels 像素数量 > 20k
- Superior contrast performance 高对比度
- Highly integrated (single-chip approach) 高度集成（单颗发光芯片可控）
- Various electronic interfaces to support different electronic architectures 多种电气接口可支持不同的电路架构





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