



World's  
Smallest  
Projection  
Display

Phabulous online workshop: Free-form micro-optics For AR/VR

## **Laser beam scanners for high-volume consumer augmented reality applications**

Presented by Dr. Jörg Reitterer, CTO TriLite

May 24, 2022

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Everyone enjoys augmented vision as  
lightweight as the eyewear of today



**We have a clear focus on:**

- Laser beam scanners for augmented reality
- Technical requirements for consumer products
  - Size
  - Weight
  - Brightness
  - Image quality
  - Power consumption
- Manufacturing platform with scalable processes

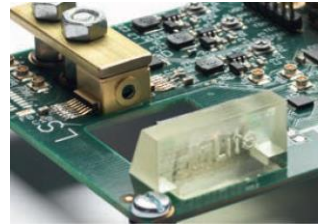
## Nonstop LBS innovation for consumer AR



### **Trixel Alpha Red** [1]

World's smallest LBS up to this point

- 1D MEMS mirror
- 3 red laser diodes
- Non-hermetic light module package



### **Trixel Beta**

TriLite's first LBS with 2D MEMS mirror

- New optics integrated in light module
- New driving electronics
- Optical engine mounted on main board



### **Trixel 2** [3]

World's smallest 2D RGB LBS

- Substantially improved specs
- Reduction in size
- New MEMS mirror with larger FoV
- Improved optics
- New laser chips with higher output power

2013

2016

2017

2018

2020

Q4 2021

### **Trixel Alpha RGB** [2]

World's smallest RGB LBS up to this point

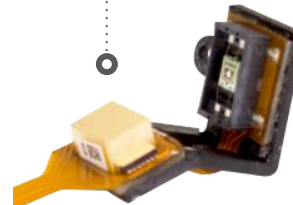
- 1D MEMS mirror
- Red, green, and blue laser diodes
- Hermetic light module package
- Integrated laser diode and MEMS driver ASIC



### **Trixel 1**

World's smallest 2D RGB LBS up to this point

- Reduction in size
- Optical engine separated from main board, connected via flex PCB



### **Trixel 3** [4]

World's smallest LBS designed for TriLite Manufacturing Service Platform



[1] Reitterer et al., DOI: 10.1016/j.proeng.2014.11.593

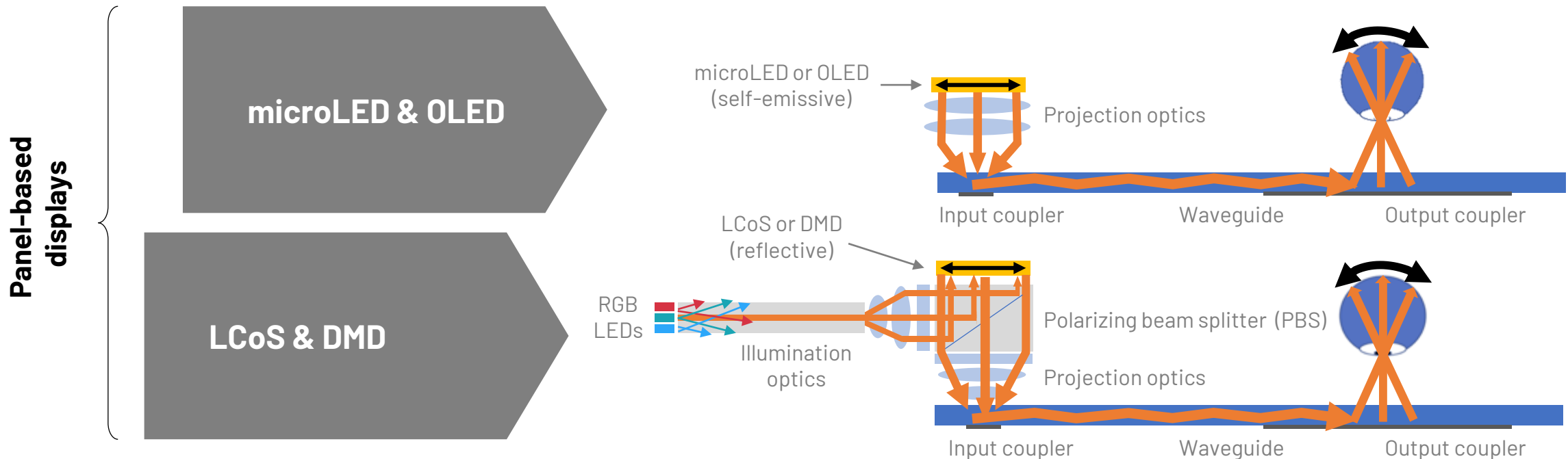
[2] Reitterer et al., Proc. LDC 2016, pp. 38–39

[3] Reitterer et al., DOI: 10.1117/12.2576704

[4] Reitterer et al., DOI: 10.1002/msid.1227

# Laser beam scanners for augmented reality

LBS overcome today's micro-display limitations by being smaller, lighter, and brighter

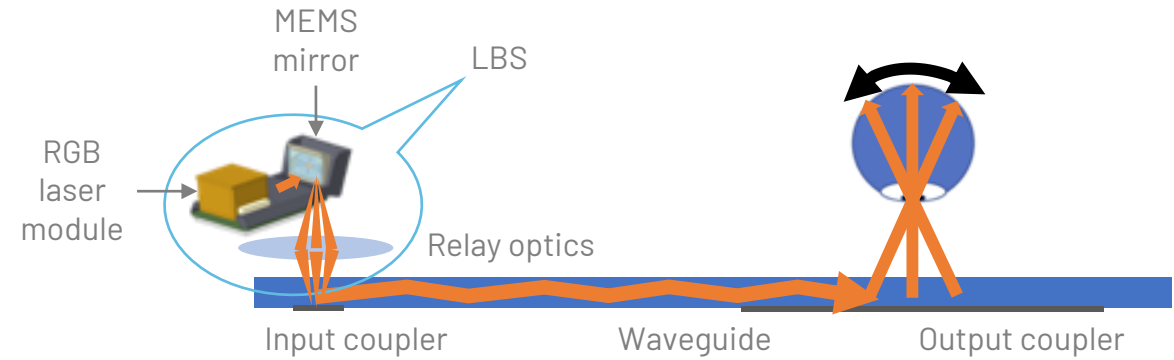


# Laser beam scanners for augmented reality

LBS overcome today's micro-display limitations by being smaller, lighter, and brighter

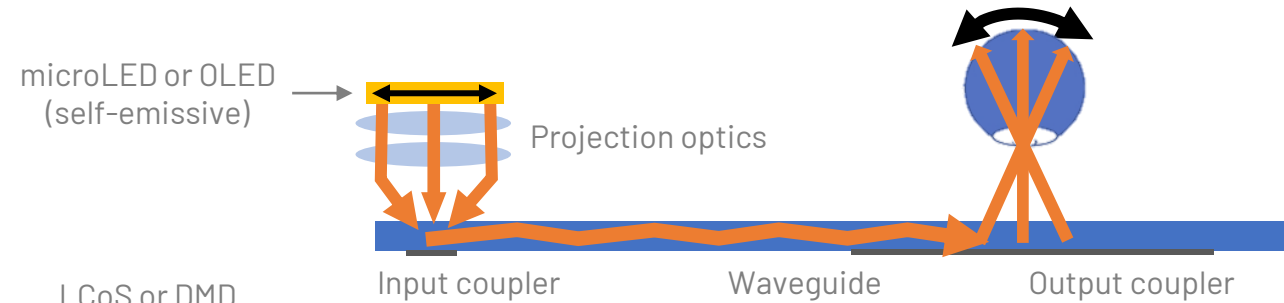
Scanning-based  
displays

Laser beam scanner

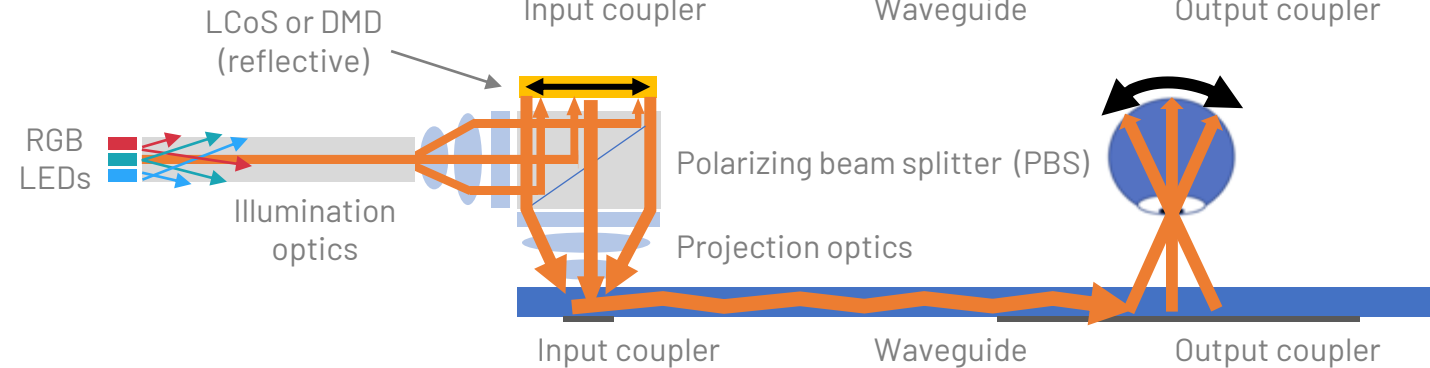


Panel-based  
displays

microLED & OLED



LCoS & DMD



LBS overcome today's micro-display limitations by being smaller, lighter, and brighter

Scanning-based  
displays

## Trixel® 3 Laser beam scanner

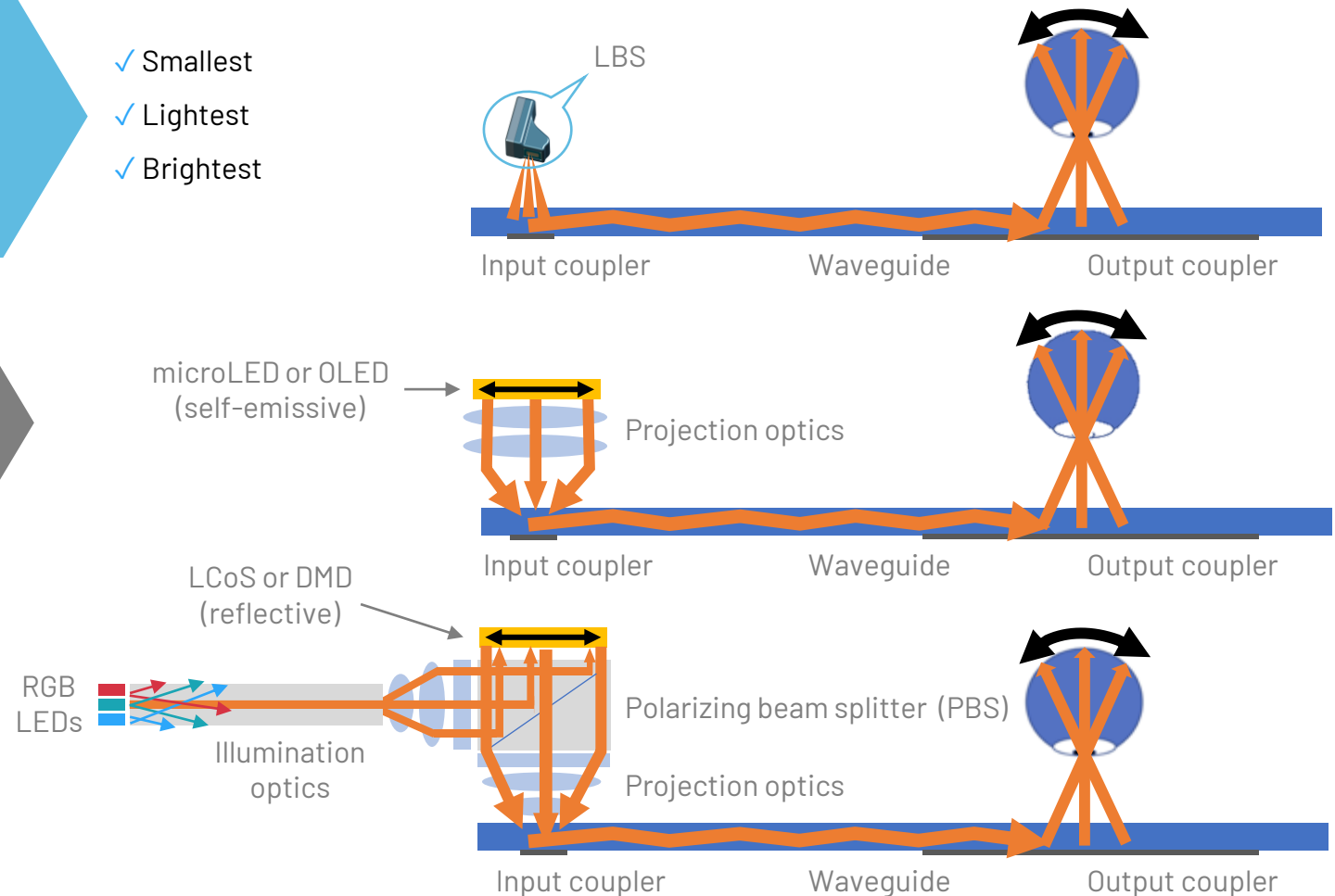
- Single 2D MEMS mirror
- No relay optics

- ✓ Smallest
- ✓ Lightest
- ✓ Brightest

Panel-based  
displays

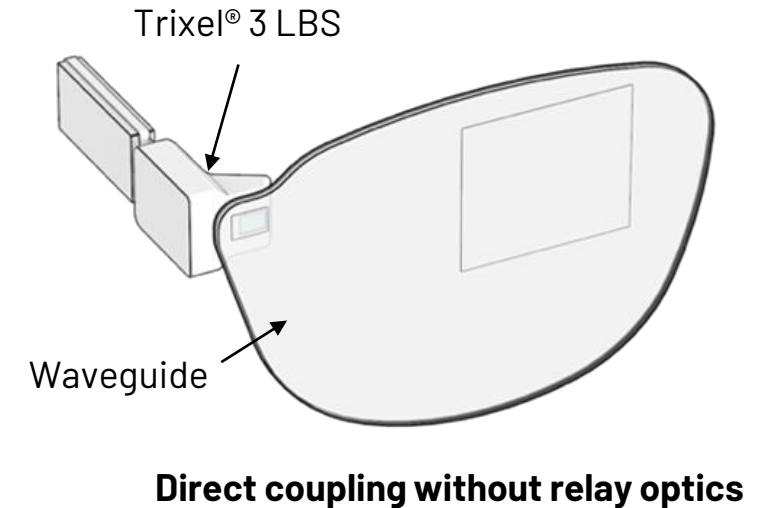
microLED & OLED

LCoS & DMD



# Trixel® 3 is fully optimized for high-volume consumer AR applications

- World's smallest, lightest, and brightest LBS for high-volume consumer AR applications
- **Ultra-compact RGB laser modules** with custom optical components
- **Class-leading 2D MEMS mirrors**
- Fully optimized for state-of-the-art **waveguide combiners without relay optics** → smaller and more efficient
- Trixel® 3 is also compatible to **holographic combiners**
- Unique display features purely for AR applications



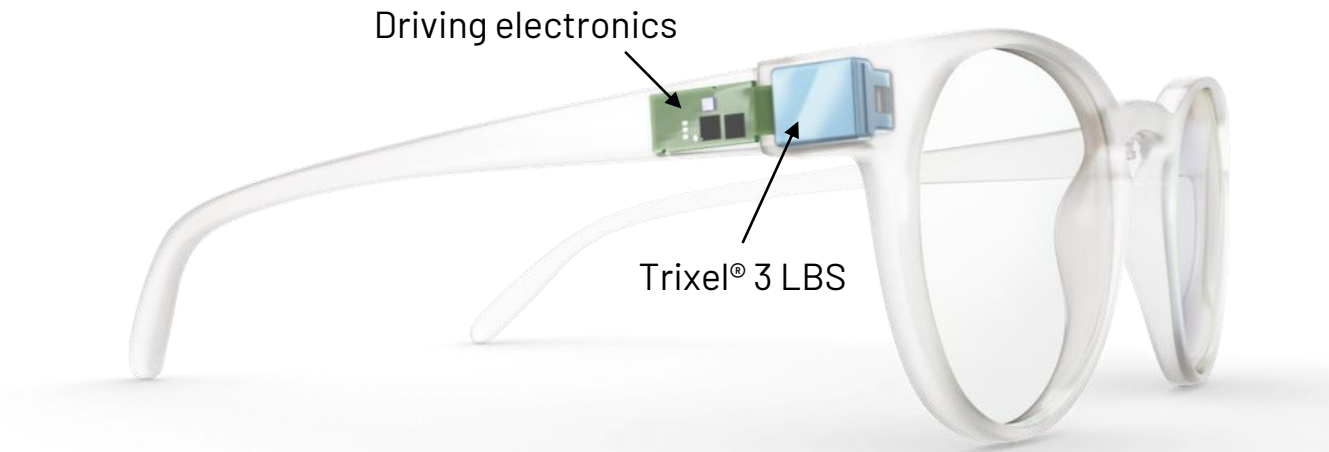
### Trixel® 3 offers class-leading specifications

<b>Total volume</b>	< 1 cm <sup>3</sup>
<b>Total weight</b>	1.5 g
<b>FOV</b>	30°
<b>Resolution</b>	up to 1152 x 864 (XGA+)
<b>Refresh rate</b>	90 Hz
<b>MEMS mirror type</b>	1 x 2D mirror
<b>Max. luminous flux at LBS output <sup>1</sup></b>	15 lm
<b>Brightness Waveguide Output <sup>2</sup></b>	3000
<b>Power consumption <sup>3</sup></b>	420 mW
<b>Color gamut</b>	214% sRGB
<b>Color depth</b>	3 x 10 bit

<sup>1</sup> At LBS output when 100% pixels are on

<sup>2</sup> Assumed waveguide efficiency 200 nits/lm

<sup>3</sup> Typical AR use case with 30% pixel on at full brightness, incl. all driving electronics





## Shifting complexity from hardware to software domain

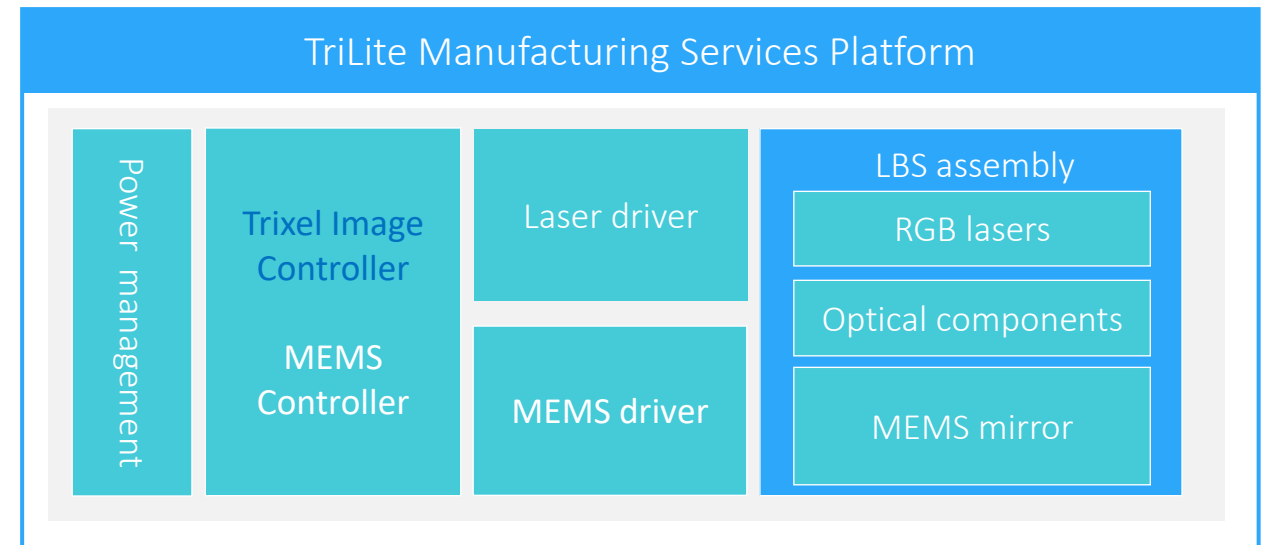
- Proprietary multiparameter algorithms (TriLite Calibration Module) for laser and mirror control to **minimize complexity and size** of the optical system
- **Correction of any image distortion in the system**
- Fully optimized algorithms for **minimal computation overhead**
- Fully automated **machine learning calibration** processes for high-volume production
- **Advantages for mass production**
  - Unique and simplified LBS process flows
  - Looser alignment tolerances
  - Higher assembly yield

### TriLite Calibration Module algorithms



We accelerate our customer's time-to-market through our manufacturing services platform

- We design our LBS products with **manufacturability** in mind
- We **enable and qualify** high volume **contract manufacturers** to generate the TriLite Manufacturing Services Platform
- We combine **TriLite-owned single process know-how** to establish an integrated manufacturing flow
- We source core components from **a network of strategic partnerships**



## Clear path towards mass production

- Our **system know-how** helps us design the ideal LBS considering size, weight, image quality, brightness, and power consumption
- Unique algorithms **shift complexity from hardware to software domain**
- Trixel® 3 has been designed from the ground up for mass manufacturing and is set out to be **the first 2D LBS for AR in production**





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Thank you for joining this session – we are looking forward to talking to you!

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