

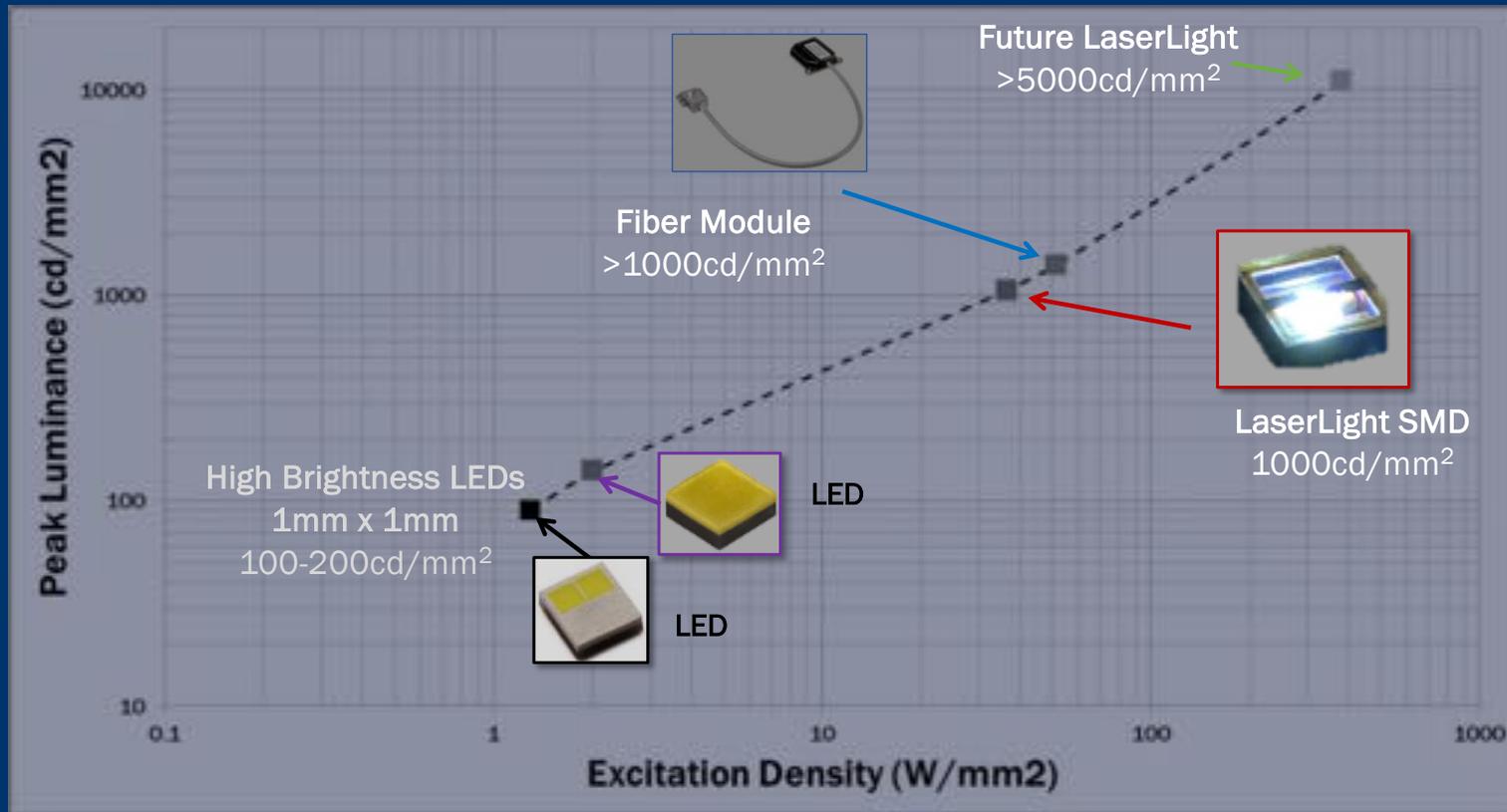
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LaserLight - white light sources,
applications and potential

Meng Han
Jan.16 2019

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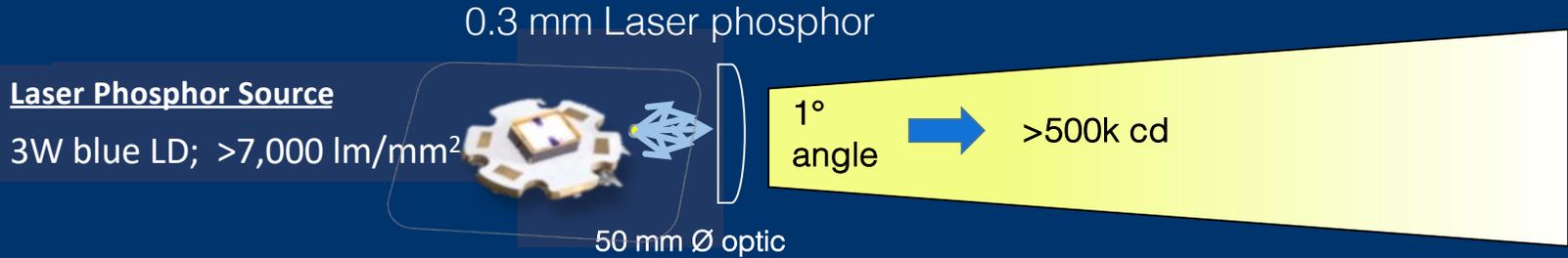
Evolution of LaserLight for Automotive Lighting



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LaserLight SMD for directional lighting



Fiber coupled laserLight for Automotive



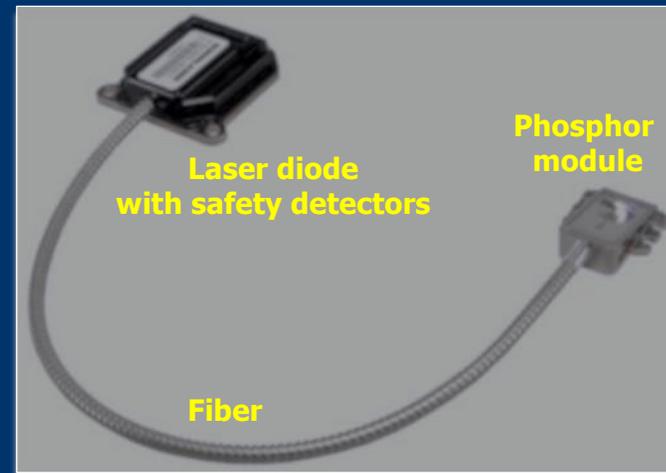
Technology approach

- High power blue semipolar laser diode
- Thermally stable, military standard package
- Monitor detectors integrated in laser module for safety
- Remote lighting with **reflective** phosphor
- Passive illumination head

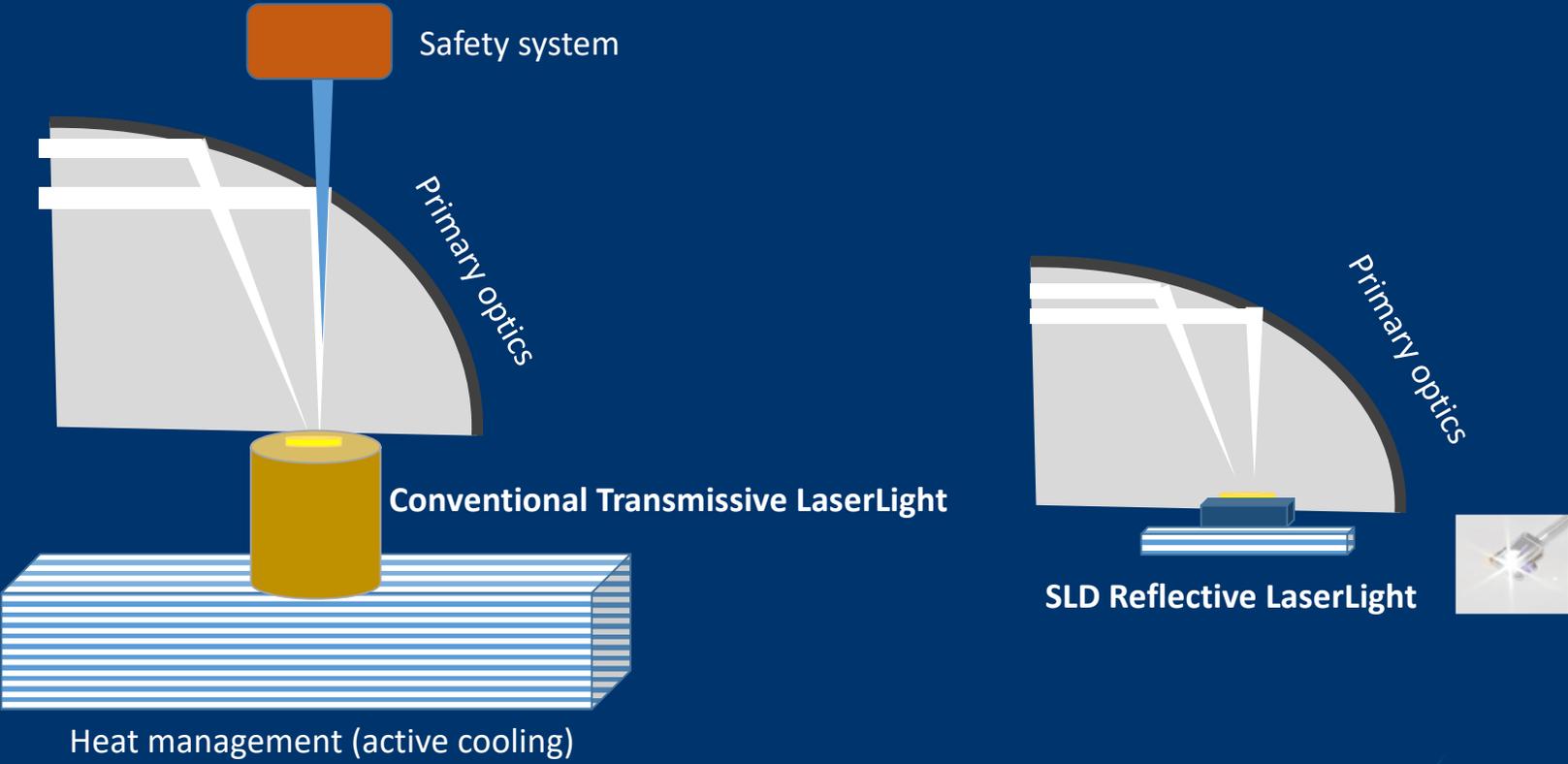
Advantages for Automotive Applications:

- High Luminance → long range of high Beam for visibility & safety
- Fiber solution → Light source thermally & electrically separated from head lamp for styling and high temperature at headlight
- Active Safety System → no risk of damages or injuries

Fiber-Coupled LaserLight



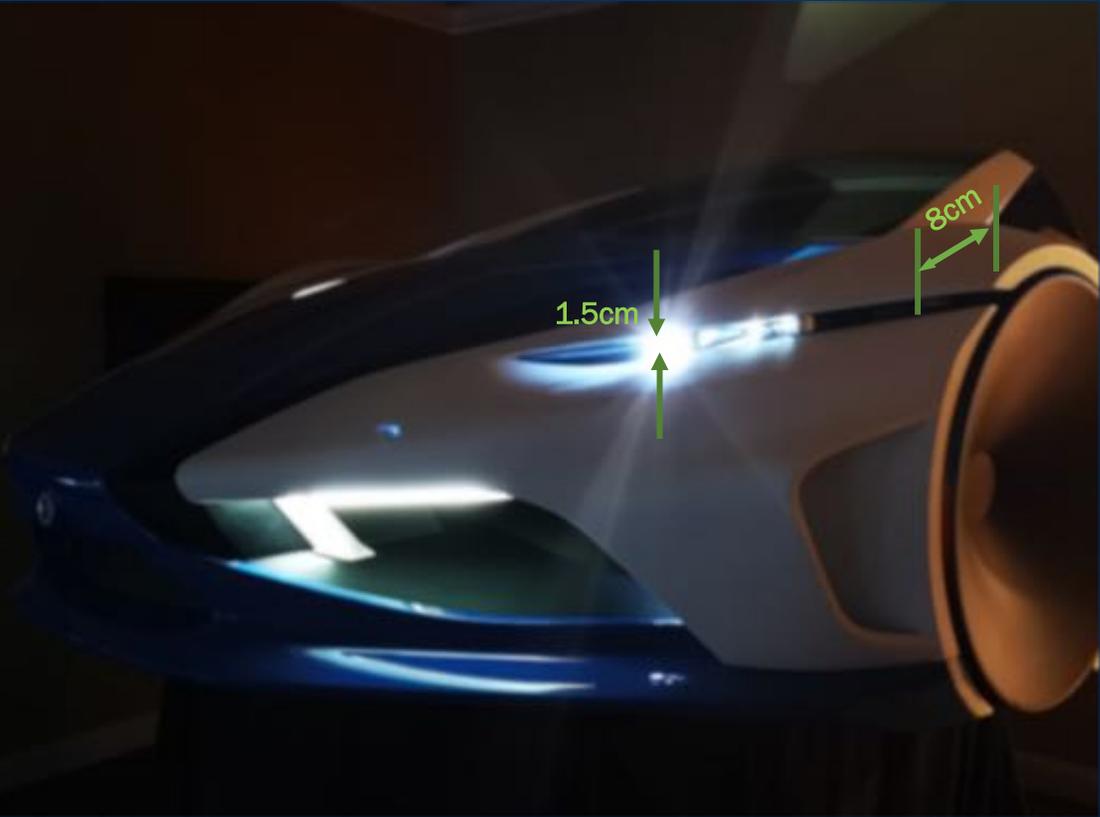
LaserLight design for safety and heat management



LaserLight for automotive frontlighting

LaserLight	Luminance	Flux @25°C, CW	Heat management	System size	Safety
SLD fiber coupled reflective LaserLight	1400cd/mm ²	500lm	Passive cooling	Most compact	Integrated safety measures
Conventional transmissive LaserLight	500cd/mm ²	250lm	Active cooling	compact	External safety measures

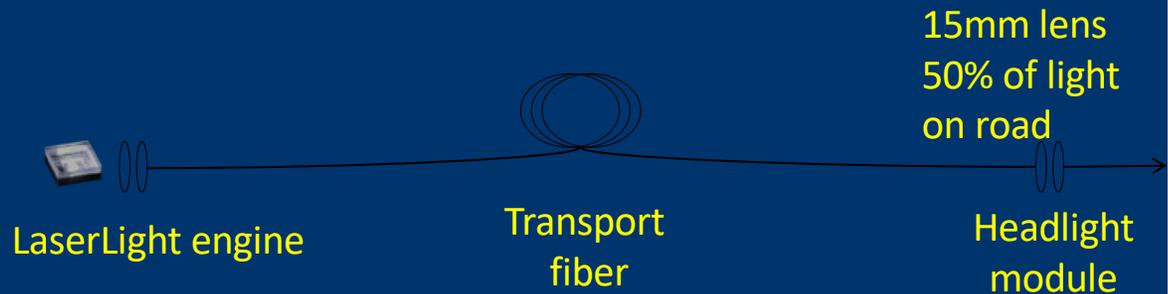
LaserLight for automotive frontlighting



Fiber coupled LaserWhite for frontlighting



50mm Lens
50% light
on road



Conventional headlight includes:

- Light source: LED, LaserLight
- Optics: reflector/lens
- Thermal: Heatsink
- Electronics: Driver
- Mechanical assembly

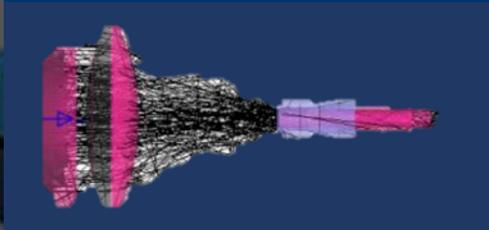
Fiber delivered Headlight includes:

- High luminance LaserLight & primary collimating optics
- Transport fiber & beam shaping optics

Features:

- Maximize reliability by removing laser source from high Ta area
- Slim headlamp design with 1mm optics
- Sharp light gradient & beam homogeneity with transport fiber
- Minimize temperature/size/weight/cost of headlamp
- Enable "plug & play" LaserLight, eliminate scrapping headlights due to a failed component.

Fiber coupled LaserWhite



Fiber coupled LaserWhite enables:

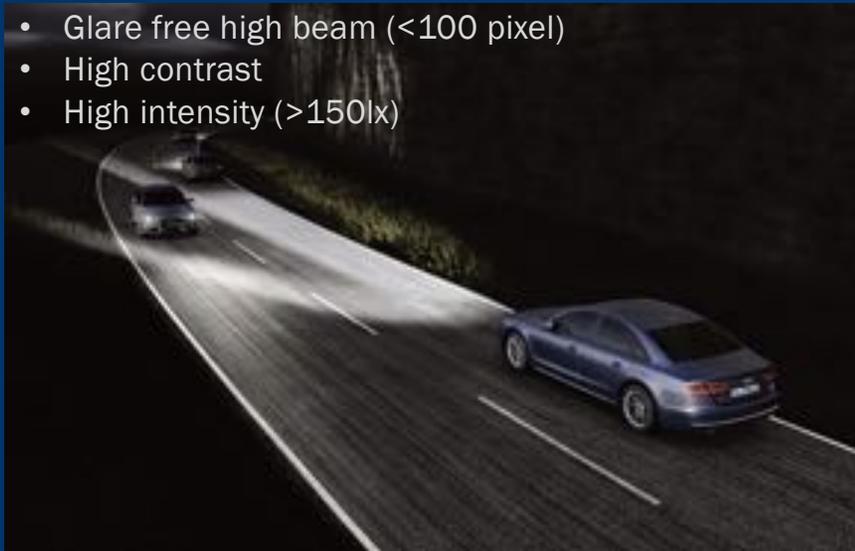
- ✓ Integrated light engine
- ✓ Uniformity in color
- ✓ High luminance and beam gradient
- ✓ Compact size
- ✓ No heat generated at fiber end
- ✓ Possibility to include LiFi, LiDAR

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ADB/HD matrix on the market

- Glare free high beam (<100 pixel)
- High contrast
- High intensity (>150lx)

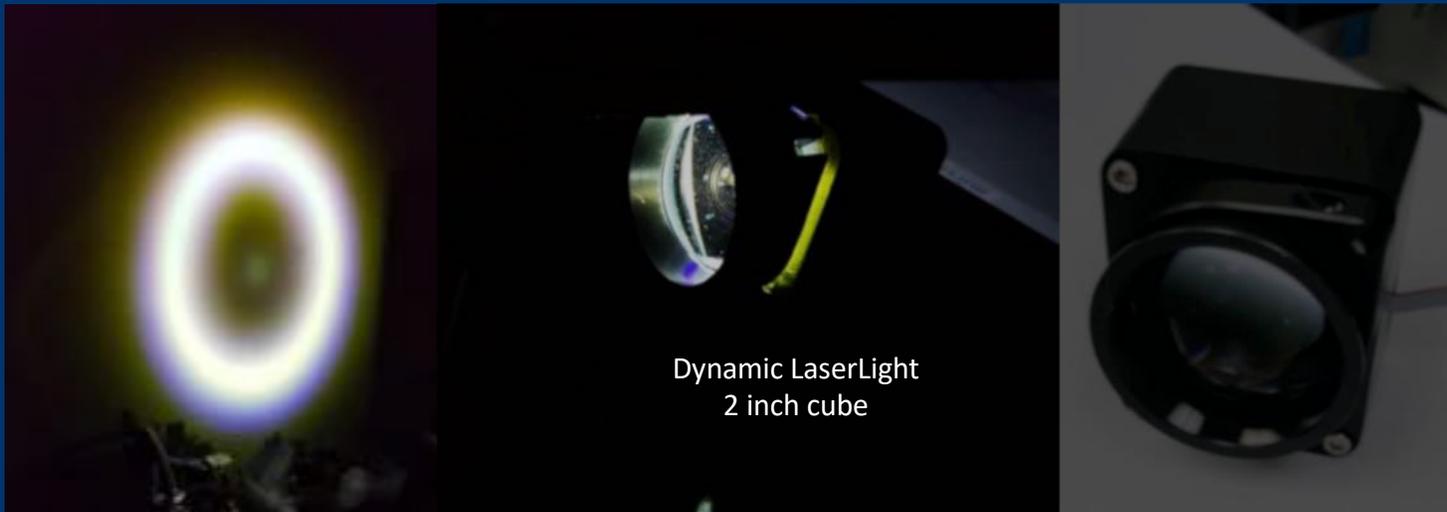


- HD matrix beam (100K-1M pixel)
- High resolution
- Dynamic beam pattern (Car to X)



From “Static” to “Dynamic” laserLight

- Spatially dynamic via MEMS: Micro projector headlights
- Compact (2 inch cube) and highly efficient (10W electric power)
- New lighting functions for autonomous vehicles
- Enormous potential as smart lighting when combined with sensors for 3D imaging, IoT



Dynamic LaserLight
2 inch cube

Automotive LiDAR



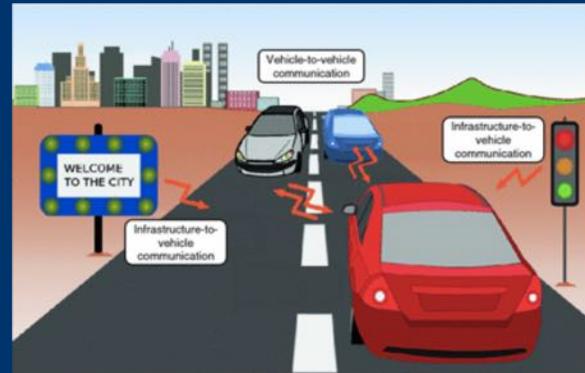
LiDAR integration with headlamp



- LiDAR sensor embedded in headlamp, does not change appearance of the vehicle
- Headlamp front lens protects LiDAR from contaminations
- Earlier detection of objects at headlamp mounted positions
- Simultaneous adaptive illumination and range detection with laser and steering optics
- Cost effective solution as an integral part of Dynamic illumination system

From “see” to “communicate”: LaserLight LiFi

- Laser LiFi is 1,000X faster than wifi and 10X faster than LED LiFi
- Sensor integration for Smartlighting / IoT
- Leverage fiber transport
- Sharp light gradients for control

The LiFi logo consists of the letters "LiFi" in a white, sans-serif font, centered within a green, rounded rectangular shape that has a slight 3D effect.

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From “see” to “communicate”: LaserLight LiFi

Device	Bandwidth	Optical Power	Eye Safe
Micro LED	Medium	Very Low	Yes
COTS LED	Low	Very Low – High	Yes
LASER	High	High	No
SLDLaser SMD	High	High	Yes

Modulation Bandwidth [MHz]	Distance [m]	Data Rate [Gbps]
1500 MHz	0.5 m	7 Gbps
1500 MHz	1.4 m	5 Gbps
690 MHz	7.2 m	3 Gbps



Summary

Fiber coupled LaserLight enables

- High luminance (1000-1400cd/mm²) allows long range visibility & safety
- Fiber coupled laser source thermally & electrically separated from headlamp to achieve styling design and efficient heat management
- Integrated safety measures

Outlook of LaserLight for automotive Lighting

- From “Static” to “Dynamic”: Spatially dynamic via MEMS: Micro projector headlights
- From “See” to “Sense”: smart lighting when combined with sensors for 3D imaging
- From “See” to “Communicate”: possibility of LaserLight LiFi for Car to X, IoT