

# Beyond LaserLight there is DataLight: LiFi by KSLD's Dual Emission SMD

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**SLDLASER**

# Key Messages



- Laser-based white light “LaserLight” offers unique benefits over LED;
  - 10-100X the brightness, 10X the range, dynamic beam shaping, fiber delivery, sensing, and LiFi
- LaserLight “DataLight™” LiFi overcomes conventional RF wireless challenges and can enable >100X the data rate of LED based LiFi
- We demonstrate the application potential of SLD’s Laser light surface mount device (SMD) product as the LiFi transmitter
- LaserLight LiFi has an exciting future for a wide range of communication applications from Mobility to Smart Cities, Factories, Healthcare and ultimately Homes
- In this presentation we focus on LiFi for Mobility including Auto, Avionics, Drones



# KSLD INTRODUCTION



## SLDLASER

- Founded in 2013, Acquired 2021
- Auto and Lighting DNA
- >500 patents, GaN LaserLight
- Auto, Illumination, Sensing, LiFi
- CA-based, global presence
- Auto certified, IEC safety certs



**LaserLight**  
1000 lumen  
Dual White/IR

**Fremont, CA**  
4" GaN laser chip factory



# Key Elements of LASERLIGHT

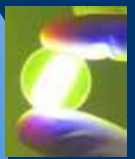


**High efficiency GaN Blue Laser Diode**

- Semipolar InGaN chip
- High power >3W out
- Efficient and reliable

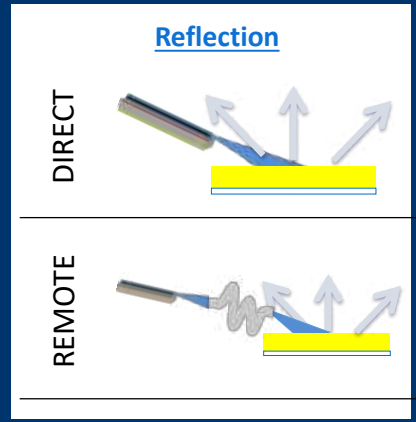
**High performance phosphor**

- Efficient conversion
- Reliable & high perform at high intensity and temp



**Innovative module architecture**

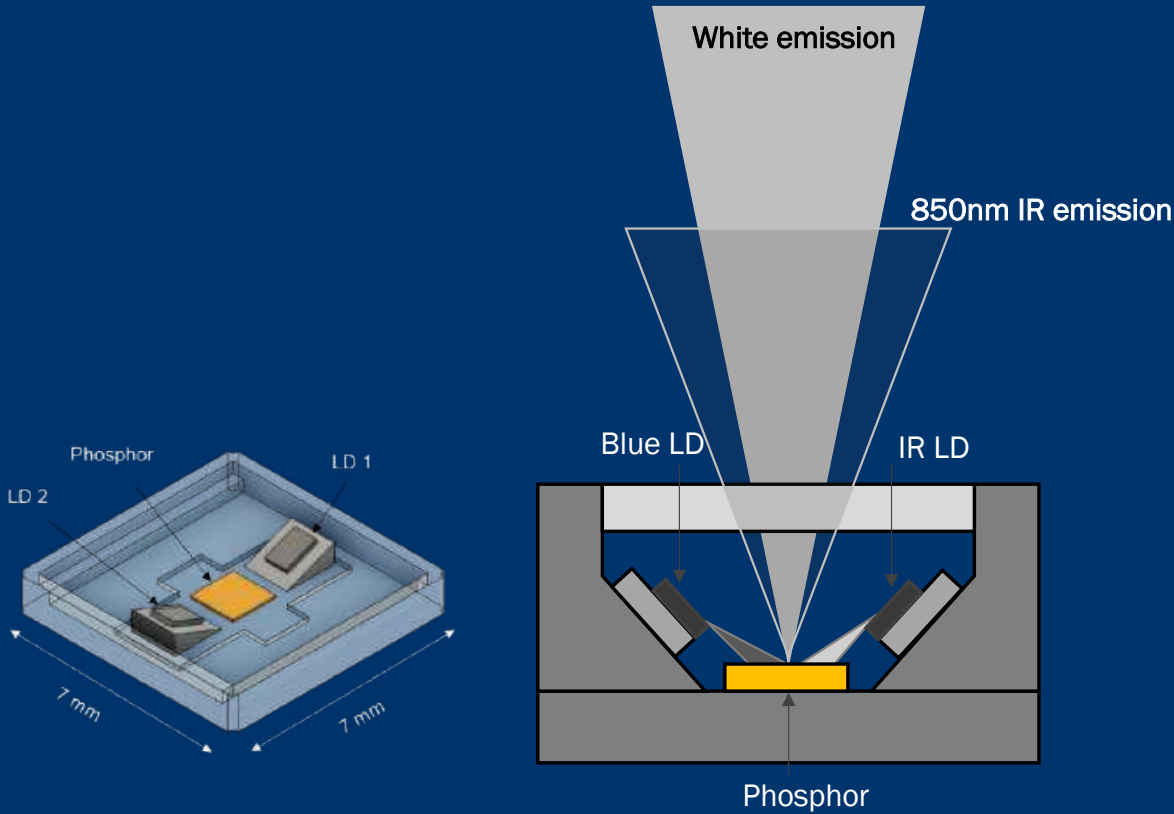
- Safe reflective mode
- Lowest possible Rth




**LaserLight SMD & Fiber**




# Single Chip White + IR LASERLIGHT SMD




THE NEW VALUE FRONTIER.

## LASERLIGHT SMD

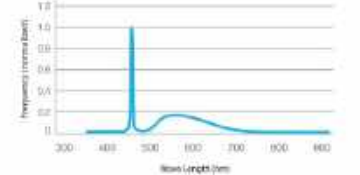
### LASERLIGHT Blue+IR SMD



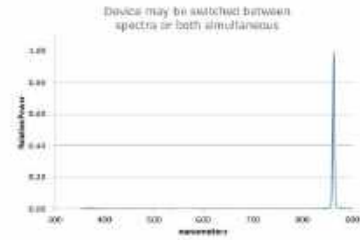
PRODUCT SPECIFICATIONS SUMMARY

Parameter	Units	Typical Value
<b>White Light Channel</b>		
Luminous Output	lm	450
Emitting Region (dia.)	mm	0.35
Luminance	Mcd/m <sup>2</sup>	1000
Color Temperature (CCT)	K	6000
Color Rendering Index	CRI	70
Forward Current	A	2.3
Forward Voltage	V	5.0
<b>Infrared Channel</b>		
Dominant wavelength	nm	850, 905, 940
Output Power	mW	250
Emitting Region (dia.)	mm	0.5
Forward Current	A	1.0
Forward Voltage	V	1.8
<b>Mechanical Characteristics</b>		
Package Dimensions	mm	7.0 sq x 2.6
Max oper. temp. (case)	°C	50
Viewing Angle	deg.	120

#### SPECTRAL POWER DISTRIBUTIONS



Device may be switched between spectra or both simultaneous.



# Why “DataLight™” Laser Diode Based LiFi?

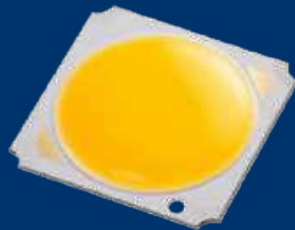
## Legacy WiFi:

- RF, mm-wave
- Short range
- Limited speed
- Poor efficiency
- Limited available spectrum
- Not secure



## LED LiFi

- High Efficiency
- High Reliability
- Mercury-Free (SSL)
- Not bright enough for long range
- Not capable of fast comm or sensing
- Low spectral efficiency



## Laser LiFi:

- High Efficiency
- High Reliability
- Mercury-Free (SSL)
- 100 times Brighter than LEDs
- 1/50th the Size & 1/20th the Weight
- 5-10X further range (1km distance)
- High spectral efficiency
- >100x faster communication and sensing:  
>10GHz Laser vs. 100MHz LED
- Sharp patterns for precise control
- Spotlighting for directional and outdoor
- No RF/EMC issues



# 100 Gbps Demonstration: CES 2022



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## KYOCERA SLD Laser Achieves World Record LiFi Communications Data Rate 100 times faster than 5G

*Company to Demonstrate Award-Winning >90 Gbps DataLight LiFi Innovation and for Automotive and Consumer Applications at the Consumer Electronics Show, January 5 - 7, 2022 in Las Vegas, NV*

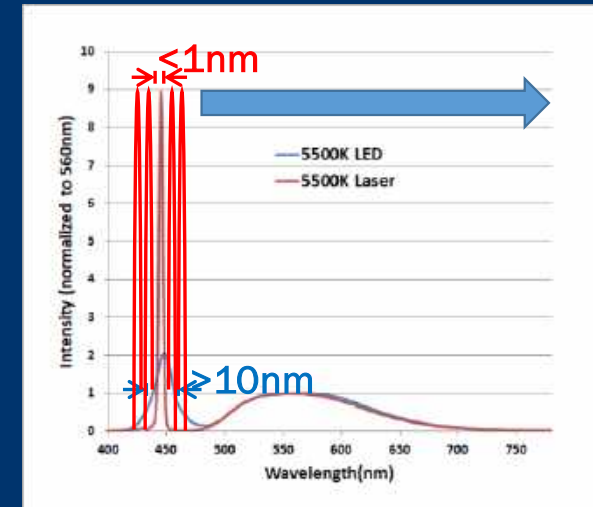
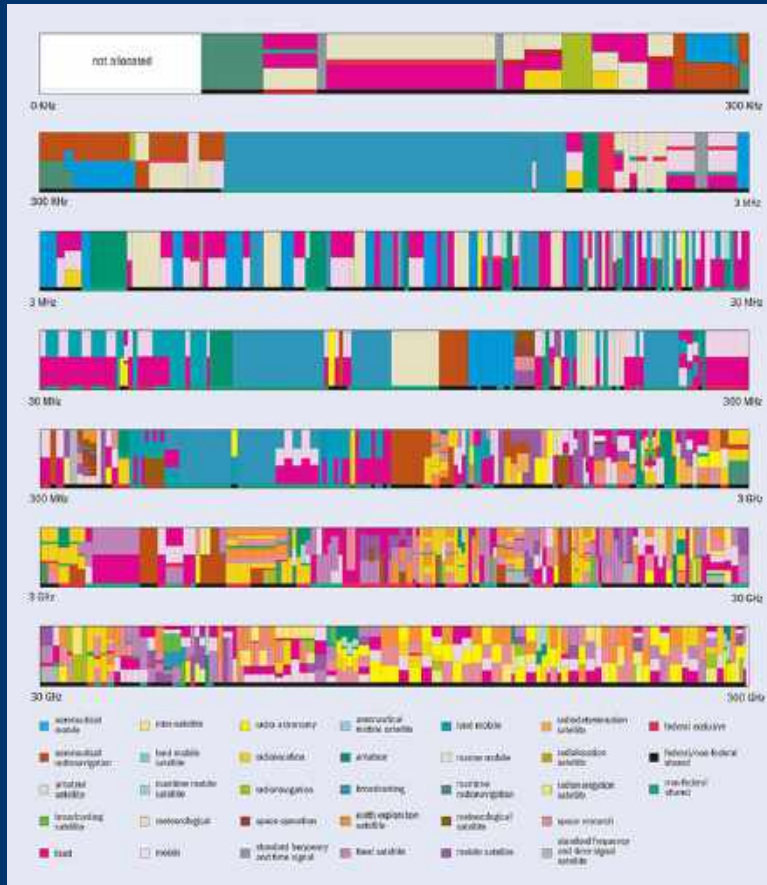
January 05, 2022 05:19 PM Eastern Standard Time



# Laser LiFi Motivation: Abundant Spectrum



RF spectral usage



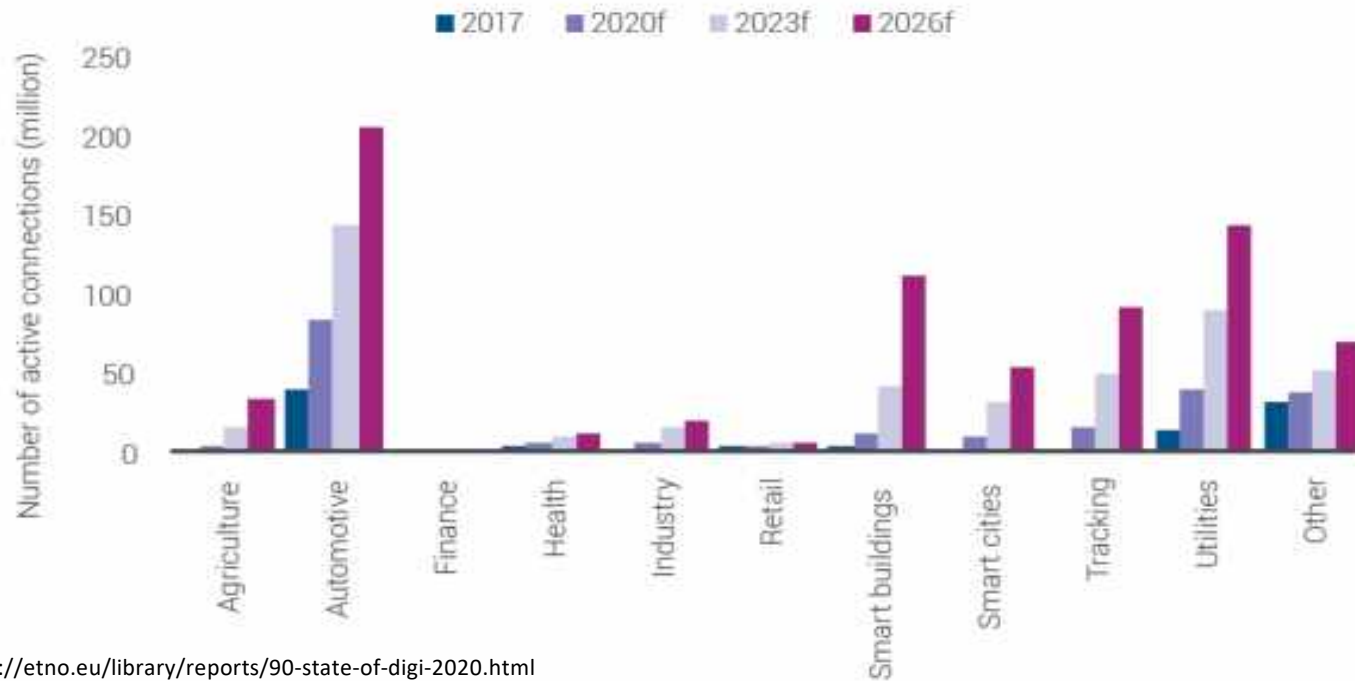
- RF is highly regulated and available spectrum is full
- Congestion by multi-use of same frequency causes interruption and reliability issues
- Sub-nm linewidth of laser offers higher spectral efficiency than LED
- $N \times$  Channels in visible spectrum without congestion are available



# Laser LiFi: Automotive Data needs



Figure 2.15: Number of active IoT connections by vertical industry sector, Europe



<https://etno.eu/library/reports/90-state-of-digi-2020.html>

# Laser-Based LiFi system: >20 Gbps per SMD



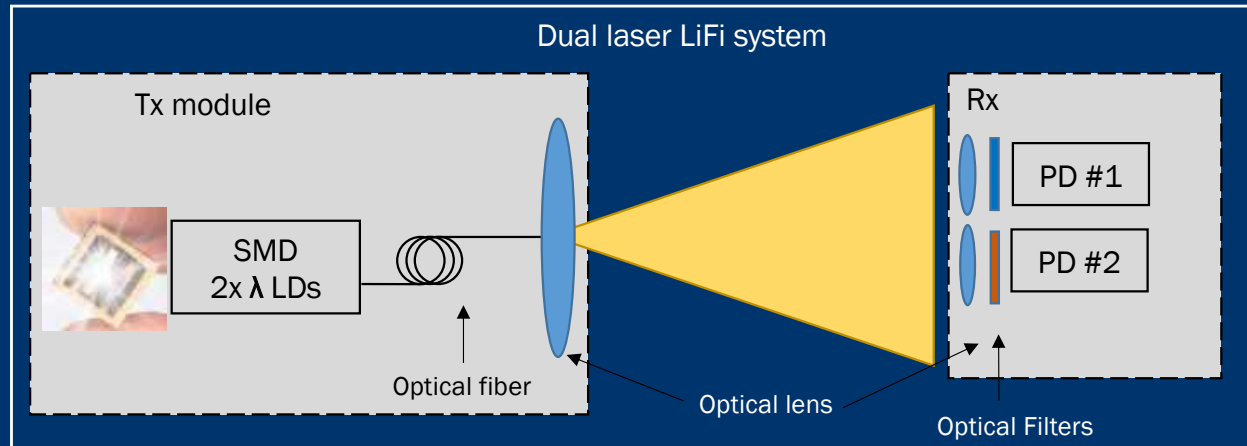
## KSLD LiFi transmitter modules



Micro-spot module

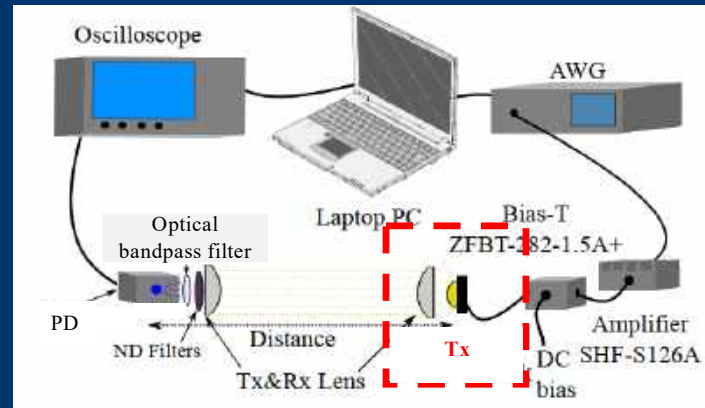


Fiber-coupled module



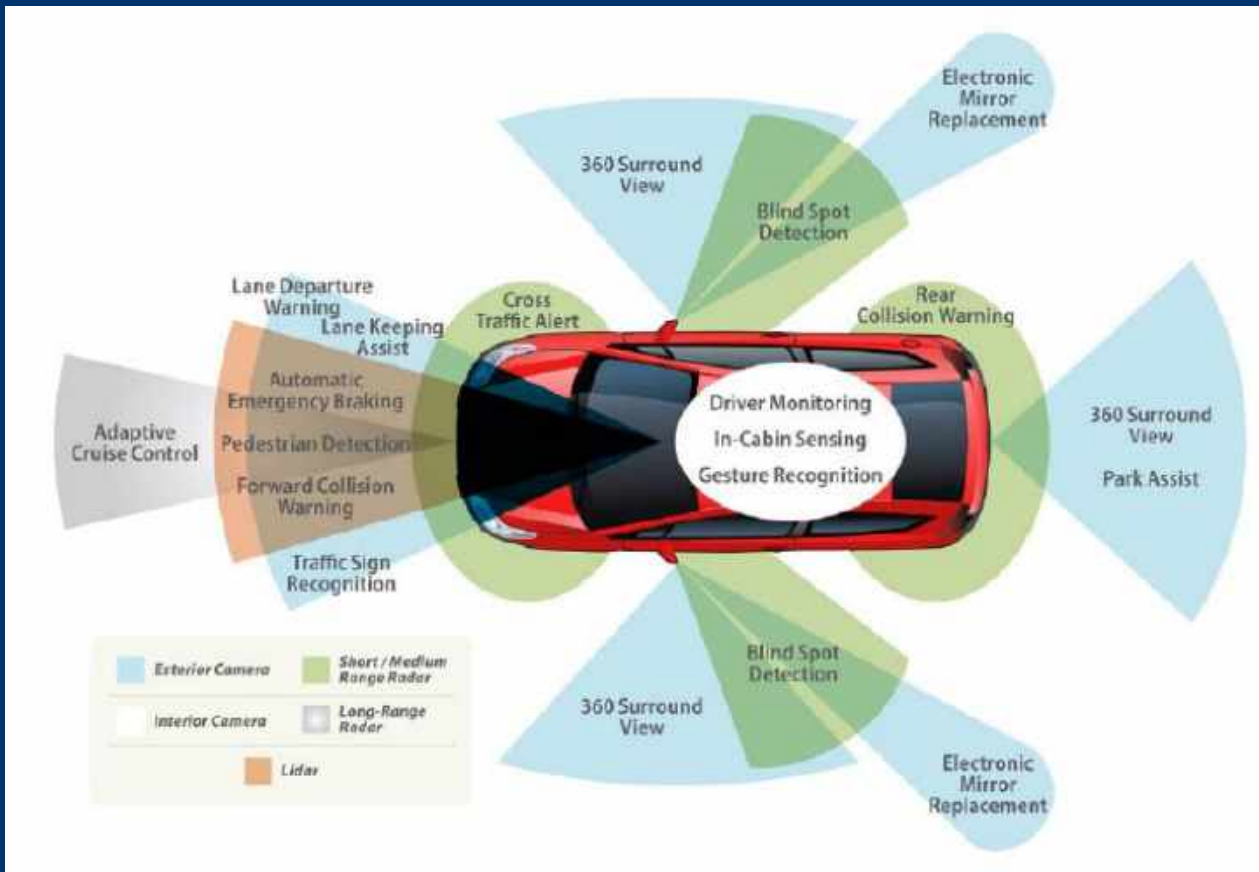
## Modulation/signal processing scheme

- ✓ QAM (Quadrature amplitude modulation)
- ✓ OFDM (Orthogonal frequency division multiplexing)



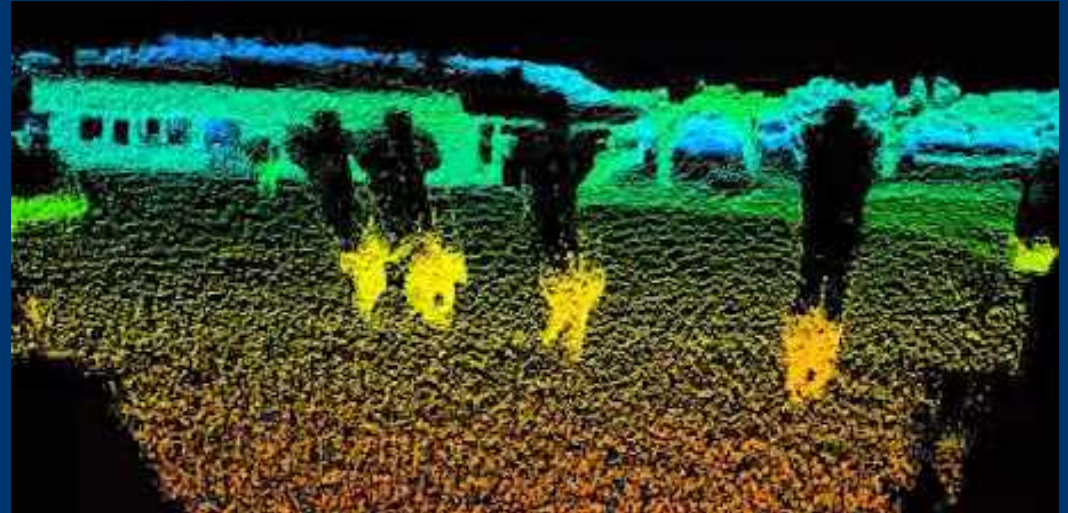
20 Gb/sec demo  
400 lumen  
2 deg spot module

# Towards Autonomous Driving: L3 (>L4>L5) KYOCERA



- For L3 AD, cars must be equipped with numerous sensors.
- LiDAR (various principles) is being implemented.
- Steadily larger demands for resolution and performance
- Data sharing & exchange - V2V and V2X - become imperative.
- High Speed – Large Bandwidth data management is required.

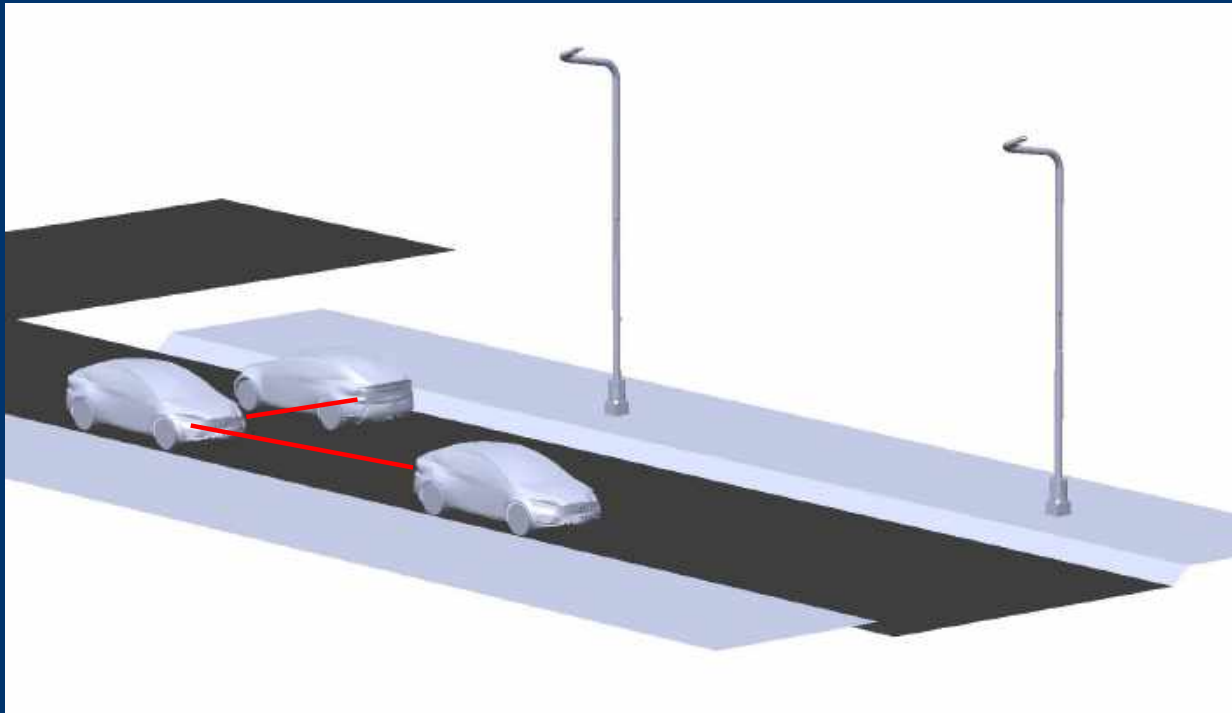
# LASERLIGHT: 3D LiDAR for Automotive



## Non-scanning Flash LiDAR

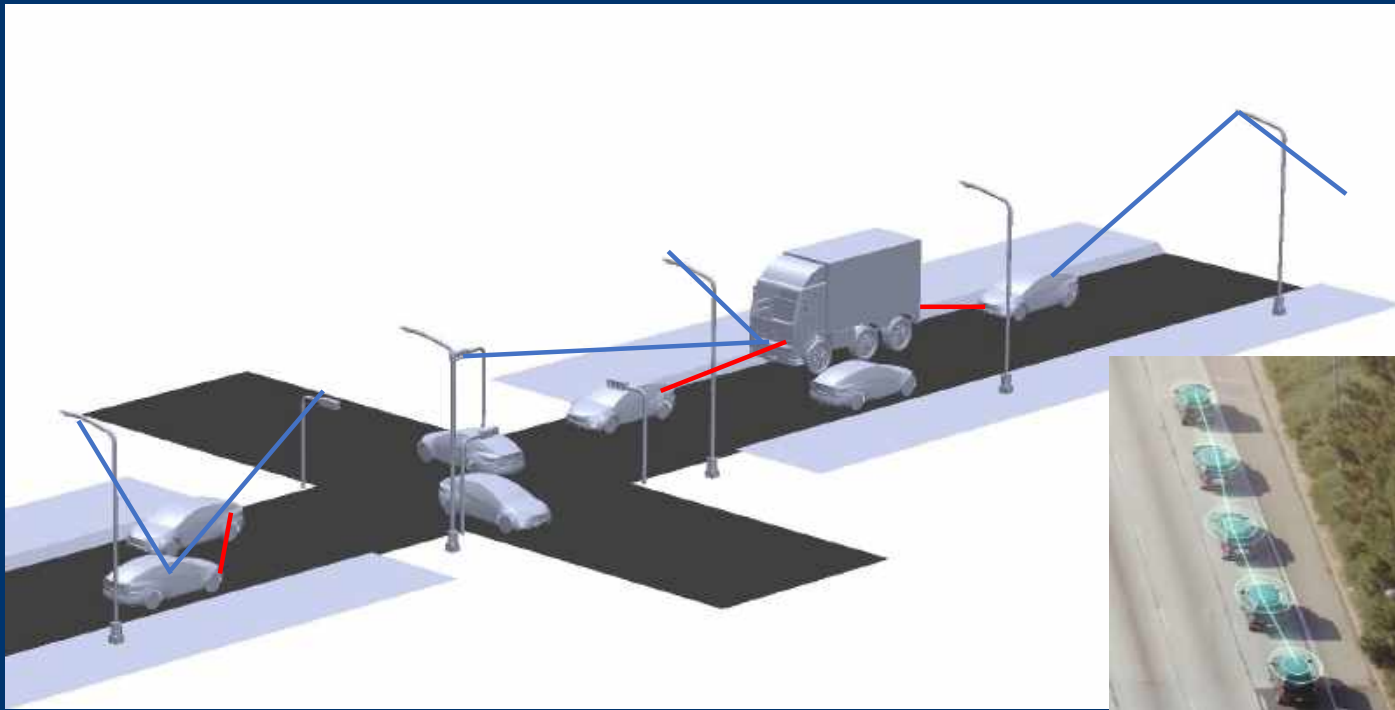
- Based on Dual Emission SMD
- No moving part, all solid state
- High resolution (640x360 pixels)
- Middle range detection (50-100m)
- High intensity IR laser required

# LASERLIGHT LiFi: V2V communication



- LiDAR Point Clouds /Data / Video & information sharing between cars
- Interoperability via protocols, which comply with the upcoming LiFi networking standard IEEE 802.11 bb (2023)

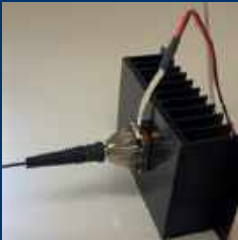
# LASERLIGHT LiFi: V2V and V2X



- Vehicles at varying speeds and distances.
- e.g. LiDAR data of 1<sup>st</sup>/2<sup>nd</sup> car is shared via V2V and/or V2X by LiFi.
- Data being processed in cars (fleets) or via infrastructure at high speeds.
- Infrastructure may process data and/or add specific information.
- Accessibility to data through individual IP protocols (safety).

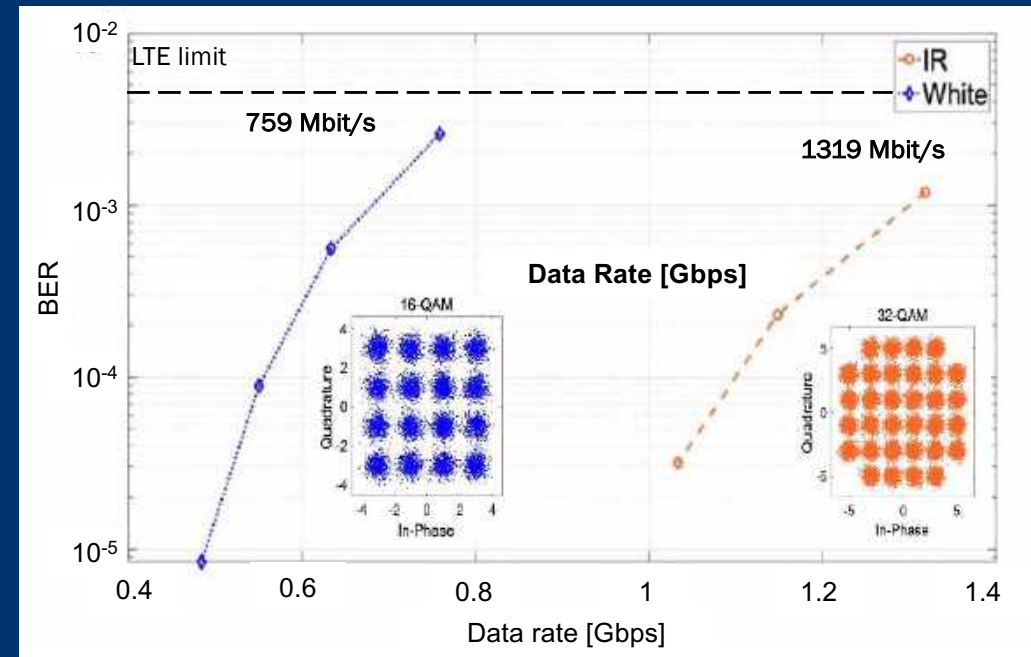
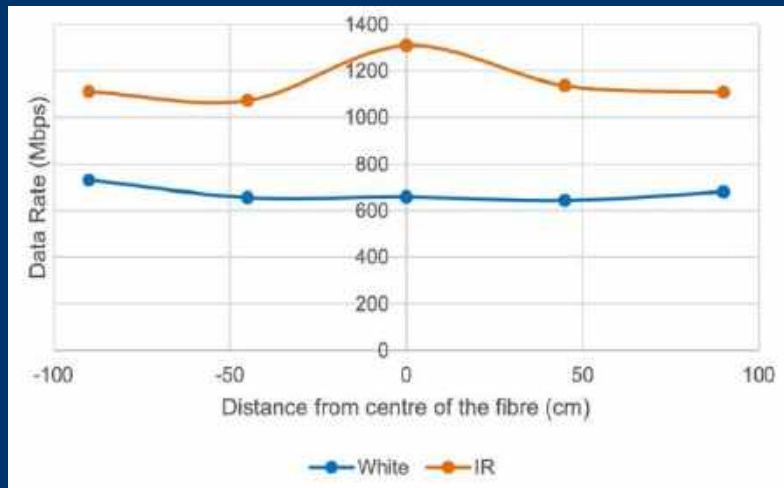
Car2Car, Fleets, Convoys, Car2X

# LASERLIGHT LiFi with Emissive Fiber



- Blue + IR SMD transmitter light source
- DataLight is laterally emitted from fiber
- Data signals travel through 4-8m of emissive fiber (loop)

# 2 Gbps Demonstrated with Emissive Fiber LiFi



>2 Gbit/s data rate achieved with stable transmission over 1.8m fiber

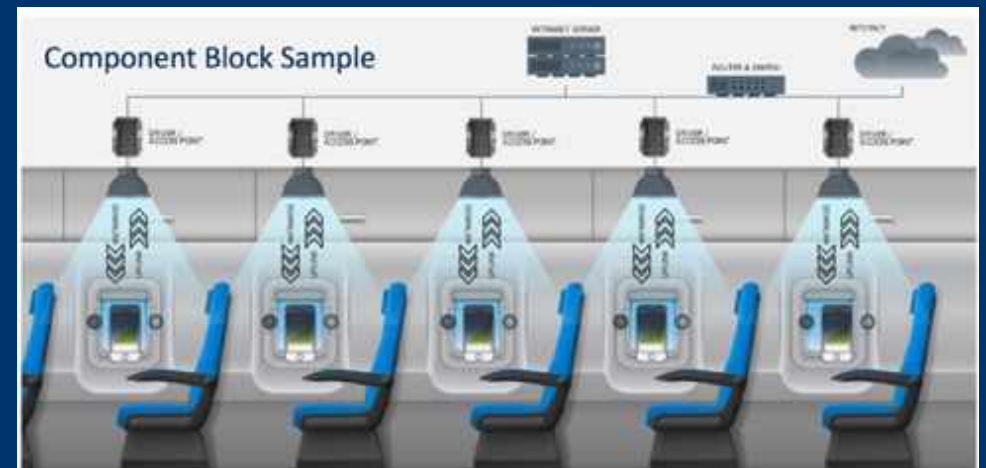
- Higher SNR from IR channel enabled higher data rate
- Bit loading for IR and white of 32-QAM and 16-QAM, respectively



# LASERLIGHT LiFi: AVIONICS



- Leverages lighting infrastructure
  - Fusion of lighting and data streaming saves size, weight, cost
  - Lightweight
- High speed: 100x faster communication than LED
- RF-free, High spectral efficiency
- Spatial control
  - Through Fiber Transport or Direct Illumination
  - Sharp light patterns for precise control
- Integration of additional functionalities
  - Violet disinfection
  - Sensing integration
  - Dynamic beam shaping
  - Power over fiber



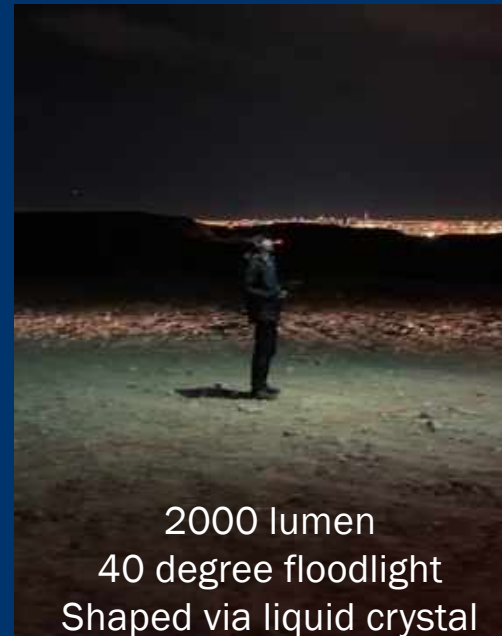
# LASERLIGHT LiFi: DRONES



- Drone high res 3D motion video at high frame rate is data intensive
- Broadcast data between drone & base station w/ same light used for illumination
- Beam shaping via liquid crystal spot to flood to optimize data rate/range



2000 lumen  
2 degree spotlight  
Unshaped beam



2000 lumen  
40 degree floodlight  
Shaped via liquid crystal



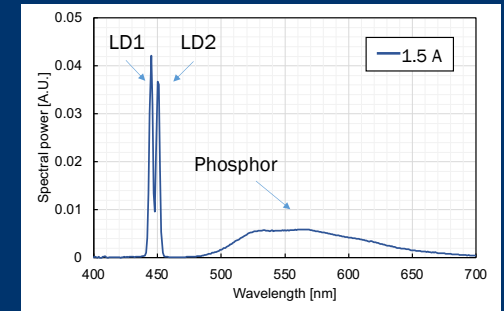
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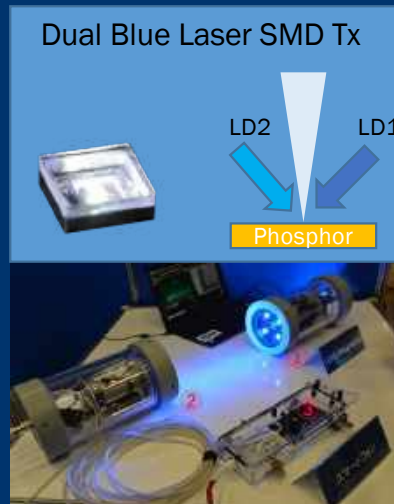
# LASERLIGHT LiFi: Underwater



- Undersea comm is challenging: RF does not work, sonar is too slow
- Blue laser is ideal for best transmission wavelength and high data rates
- Standalone blue, or combined with white if illumination needed
- Defense/security, industrial/professional oil & gas, future consumer apps.



Courtesy of KDDI



Courtesy of Softbank

# CHALLENGES & OPPORTUNITIES AHEAD



## Integration Of Functionalities Into Intelligent Illumination

- Compact Integration Low Beam/High Beam
- Direct Emission, Fiberlight
- Spatially Dynamic Beam Shaping
- Sensing
- LiFi Communication

## Diverse Applications

- Ground & Air, Avionics & Rail, Marine & Undersea
- Auto And Commercial (Drones)
- Exterior And Interior
- Extended Range: Lumen Scaling

## Ongoing Evolution/Revolution In Auto & Mobility Tech

- Electrification & Autonomous Driving
- Subscription Fleet Business Models

# Summary and Key Messages



- Laser-based white light “LaserLight” offers unique benefits over LED;
  - 10-100X the brightness, 10X the range, dynamic beam shaping, fiber delivery, sensing, and LiFi
- LaserLight “DataLight™” LiFi overcomes conventional RF wireless challenges and can enable >100X the data rate of LED based LiFi
- We presented LaserLight LiFi systems for Mobility with up to 20 Gbit/s by utilizing dual wavelength data transmission of either 2x Blue or Blue + IR in an SMD, and >2Gbit/s with emissive fiber.
- With increased channel scaling and/or single-channel bandwidth, 100 Gb/s and beyond is possible
- LaserLight LiFi has an exciting future both as a communication link complimentary to WiFi and as standalone link where LiFi is better suited than WiFi
- LaserLight LiFi is well suited for a wide range of communication applications from Mobility to Smart Cities, Factories, Healthcare and ultimately Homes

# KSLD Laser Based Product Portfolio



**Semipolar  
GaN LD**



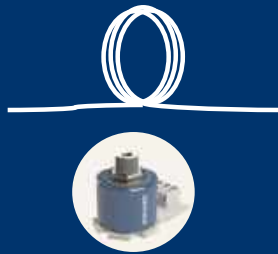
World's first High Gain  
High Power Semipolar  
Blue LD

**LaserLight SMD  
SMD W+IR**



World's only laser light  
and first laser light  
source White + IR with  
UL safety certification

**LaserLight FC**



World's thinnest and  
brightest side emitting  
flexible fiber

**LaserLight  
Microspot & Flashlight**



World's first device with  
1100m range of White  
Laser light

**LaserLight  
Lifi Kit**



World's first portable  
1Gbps DataLight device



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**Thank you for your attention**

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