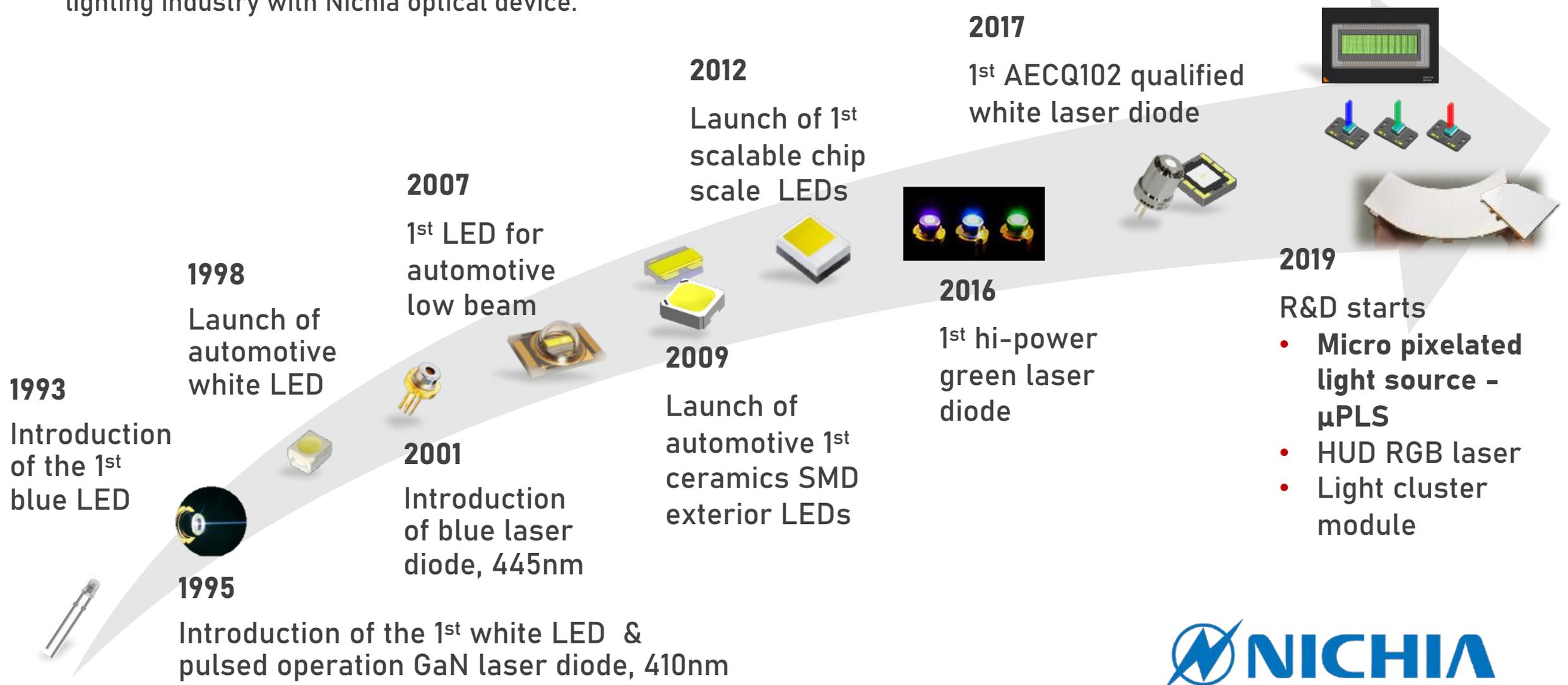


The background of the slide is a dark, nighttime photograph of a winding road. The road is illuminated by the headlights of a car in the foreground, which are visible as bright white beams. The road curves to the right, and there are dashed white lines marking the edge. In the distance, a mountain peak is visible under a dark sky with a single bright star or light source. The overall scene is dark and atmospheric.

# Light digitalization with automotive solid-state lighting

Ted Schriefer, Nichia America Corporation  
DVN San Francisco Workshop, August 2023

More than 20 years from 1998, working for automotive lighting industry with Nichia optical device.



## Demand of lights with hi-functional digital control

Apps.	Today	Future. 2030	Transition	
Headlamp	ADB	Projection and Drawing	Enlarged <b>Digital intelligent headlights</b>	
Signature	Front DRL Signature	all around body	<b>Body lighting</b> <b>Animated Indicator</b>	
Int. Lighting	Individual Lighting	like Living Room in-vehicle	<b>Humancentric lighting in the vehicle</b>	
Int. Display	Dashboard	Expansion of size HUD to AR and 3D	"Illuminate" to <b>"Display"</b>	
Service		*AR: Augmented Reality		
Model	Sales of individual vehicles	Digital Control, Vehicle online	Remote communication and control	



## Environment

### Less consumption

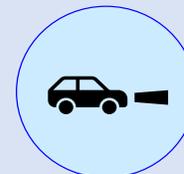
System miniaturization  
Aggregation of control functions



## Safety

### Safety features

Navigation light  
Light Alerts



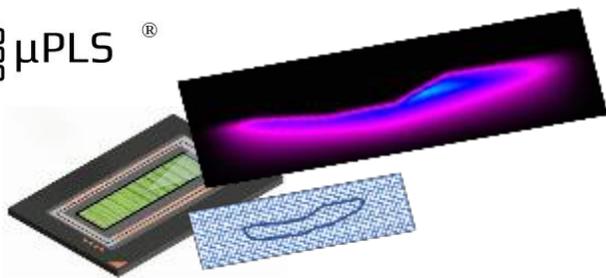
## Comfort

### Visibility improvement

Stress-free ADB  
Glare free spotlight



Micro LED x ASIC integrated devices



Irradiating light images with digital signals

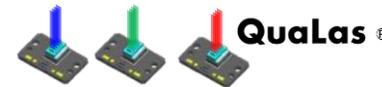
## Light Digitalization

Opto.-semi technology



Co-working technology

HUD laser devices



Light cluster module

Nichia Light Cluster

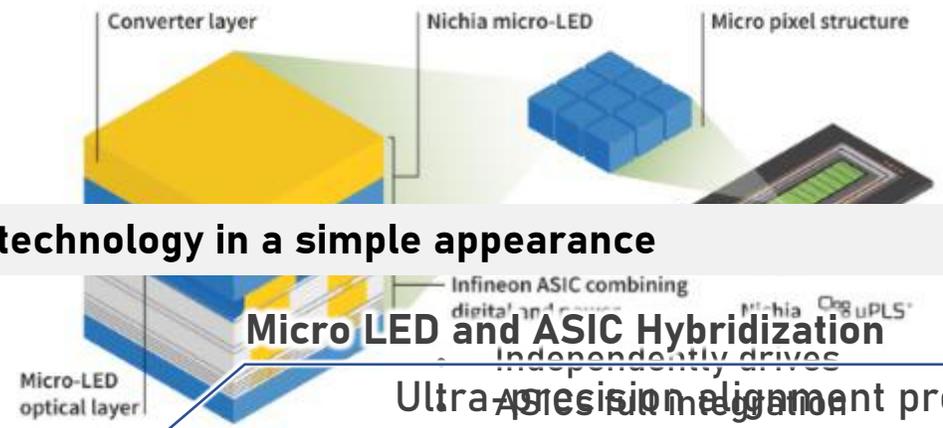
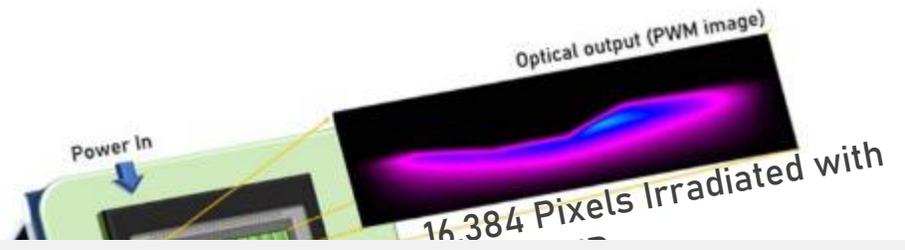


Displaying with hi-bright, hi-freedom, low-consumption



Concept to feasibility : 2018 - 2019

Integration : 2020 - 2022



The light source with complex microfabrication technology in a simple appearance

Micro-LEDs technology

High brightness and output stability



Micro LED and ASIC Hybridization

Ultra-precision alignment process

ASIC technology

Onboard PWM engine  
 Gradation control  
 Video Interface  
 16 sensors and func.  
 Diagnosis, monitor func. etc.

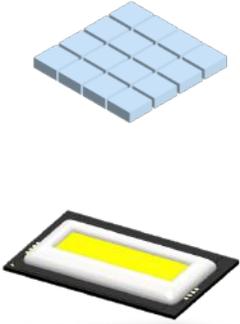
Convertor and protective courting

Hi-heat release Packaging technology

Nichia Opto.

Infineon ASIC

AECQ100/102

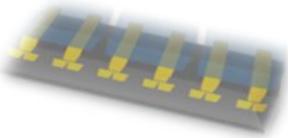


## Product dev.

- Micro-LEDs with hi-current density capability on ASIC

Typ. cd/mm <sup>2</sup>	I <sub>out</sub>	T <sub>j</sub>
116 cd/mm <sup>2</sup>	5.5 mA	120 degC
83 cd/mm <sup>2</sup>	3.5 mA	120 degC
73 cd/mm <sup>2</sup>	2.5 mA	25 degC

- Hi-thermal performance
  - Max. 0.74 K/W @All pixel on
- Automotive qualification
  - Comply with AEC-Q100/102



## Process dev.

- New process establishment
- 3D-hybridization LED/ASIC
- Ultra-precision alignment



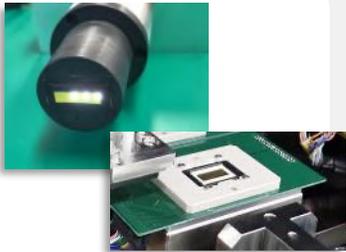
## Machine dev.

- In-house machine dev.
- 50um pitch stability 16,384 px Array and interconnection



## Side materials dev.

- Convertor and substrate
- Protection layer
- Reflection layer



## Test env. dev.

- Pixel level evaluation method
- Functional inspection
- All inspection scheme and software in-house dev.



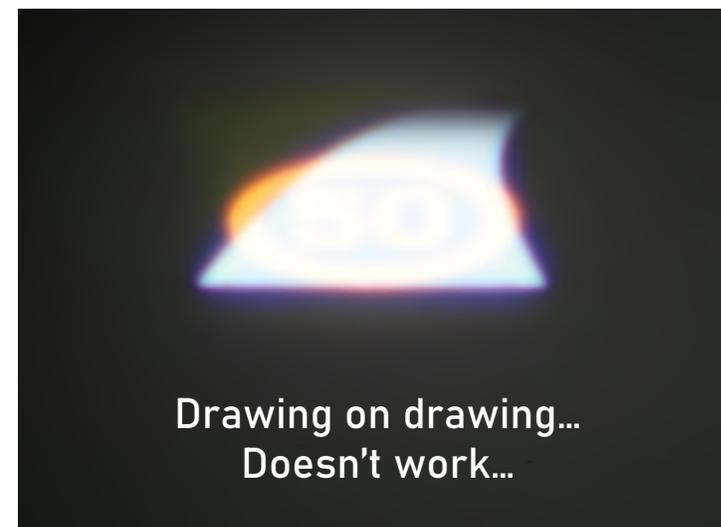
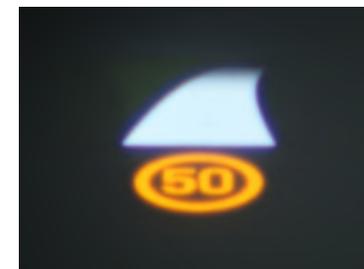
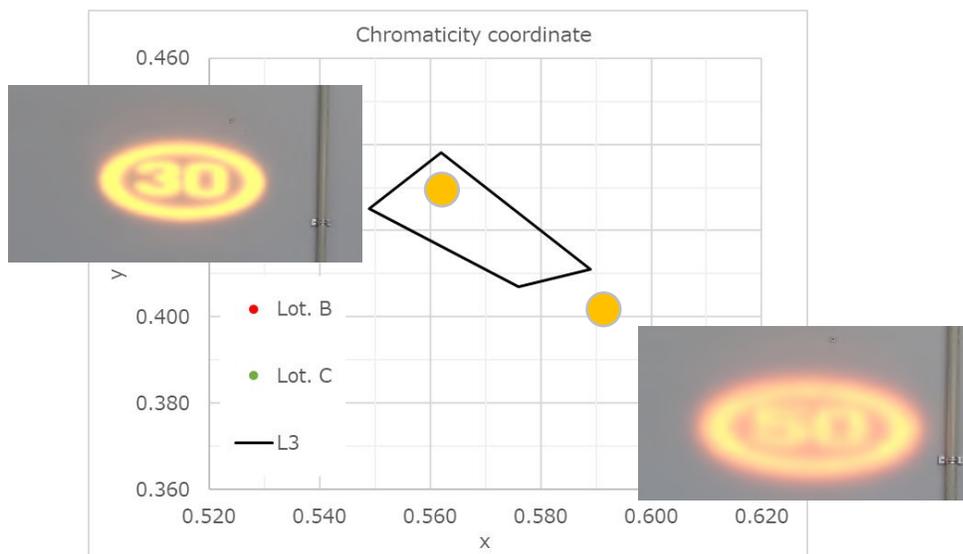
Digital Headlight	Entertainment	1,000,000px	Specialized in projection Optimization of optics, heat, and power consumption	DMD + Hi-power light source <small>DMD: Texas Instruments</small>
	PREMIUM	100,000px	<b>Resolution</b> Improved drawing performance Partial entertainment use	
	MEDIUM	10,000px	<b>Today The starting point of Light digitization</b> Hi-resolution ADB and rendering	
	ECONOMY	1,000px	<b>Dedicated function</b> Improvement of ADB performance and simple drawing	
Conventional	100px 10px	Market spread of ADB Sustainable, continuous imp.	Small LED and Array	

## Multiple color approach, e.g. Animated Indicator

μPLS



- Converter
- Optics



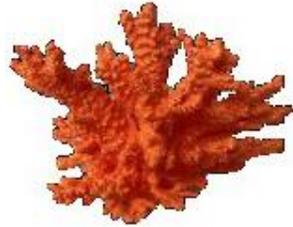
## 3D remote phosphor technology

LEDs  
Phosphor



Mixing  
techniques

- Red phosphor coating on 3D PMMA objects.
- Possible to process with **highly complex shape**



Coral shape 3D object

Without emitting



Excited by **Blue LEDs**



## Body lighting use

- PMMA 3D rear lamp complex design
- Flexible 2D pattern, like panel.
- Consider Blue light irradiant patten, direction to objects

Light cluster module

## Nichia Light Cluster®



LEDs  
Panelization



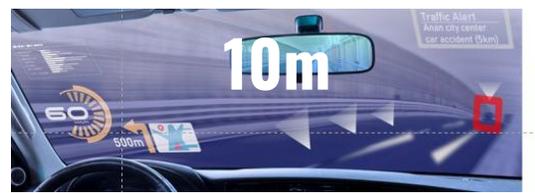
• Coating  
• Driver

- Hi-Intensity, Low power consumption
- Thin flexible shape
- Smoothing driver



HUD laser devices

## QuaLas®

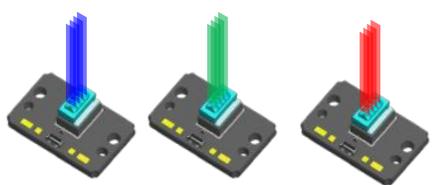


RGB Laser  
Optics



Projection  
devices

- 4 laser chip with optics
- Blue 9.2 W
  - Green 5.2 W
  - Red 13.2 W



System	LEDs	RGB Laser
Gamut	Narrow BT.2020 62%	Wide BT.2020 98%
Light engine	Large Mounting area	Small 30% of LEDs
Projection devices	Medium Size 0.33 inch -	Small Size 0.23 inch -
Optics	Large	Small
Consumption	High	Low



### 1. Challenge of the light digitalization

- $\mu$ PLS
- Side R&Ds will be followed
- Other R&Ds, Light cluster and LD

### 2. Collaboration

- Internal and external co-working

### 3. Credibility with you from the market



Light Digitalization  
光のデジタル化

Opto.-semi  
technology



Co-working  
technology



Thank you  
Arigato