



Mirrorless and Lighting

Dominic Hillenbrand
October, 2014



Design of Headlamps

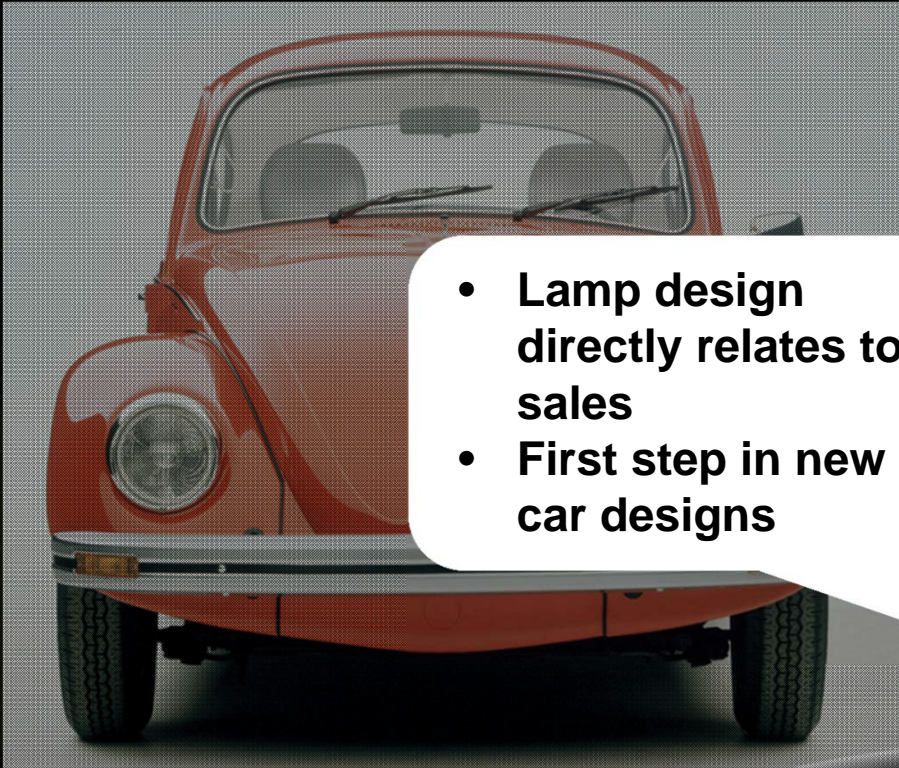


Round shape – like eyes



**Line style-design
Lamp defines brand-signature – especially DRL**

Design of Headlamps



- Lamp design directly relates to sales
- First step in new car designs

Round shape – like eyes



Line style-design
Lamp defines brand-signature – especially DRL

Design of Mirrorless Cars



Side cameras replace mirrors



Line style-design
Lamp defines brand-signature – especially DRL

Design, Safety and Cost



Regulations

Vehicle Manufacturer

Design



„Good design sells“

Government

Safety
e.g. glare, ghosting

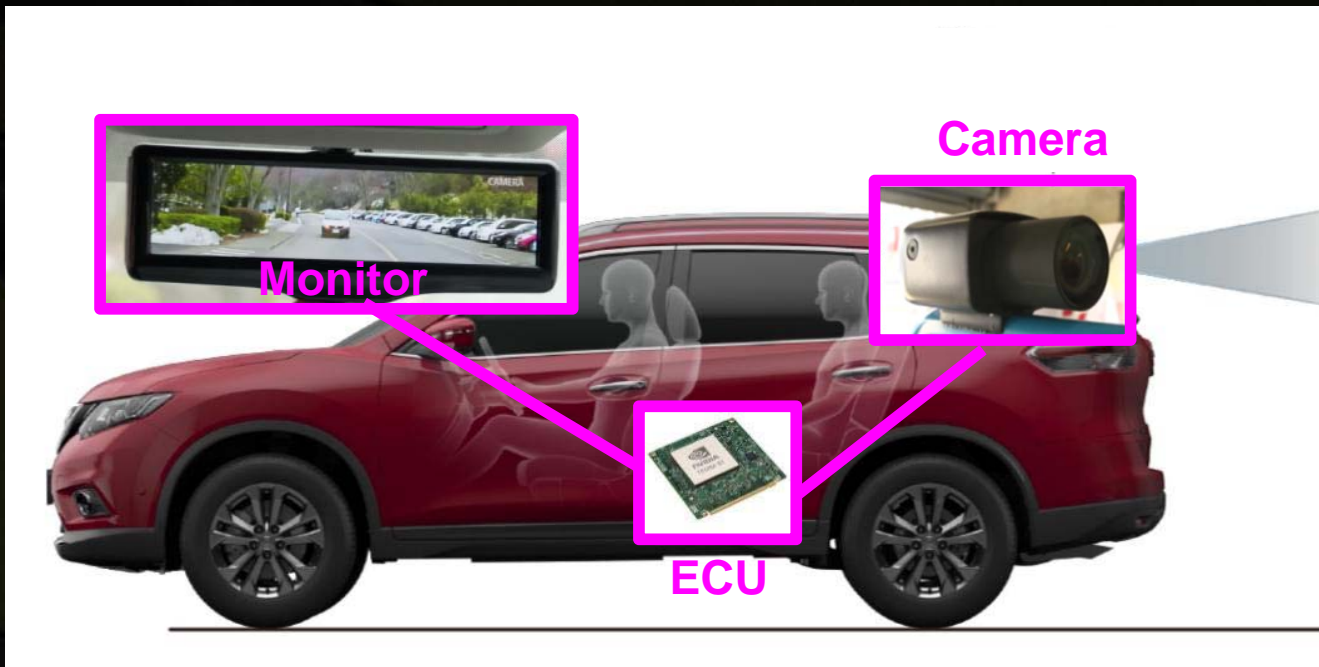
Accidents



Customer

Cost
e.g. LED replacement,
Camera
repair/calibration

Example: Upcoming Rear-Mirror CMS



- CMS provides wider (unobstructed) field of view
- Overlays feasible

Challenges:

- Flip-mirror due to liability/government approval
- Night time: head lamps cause halos
- → Positions of cameras crucial - conflicts with design
- Display – limited dynamic range, requires tone mapping

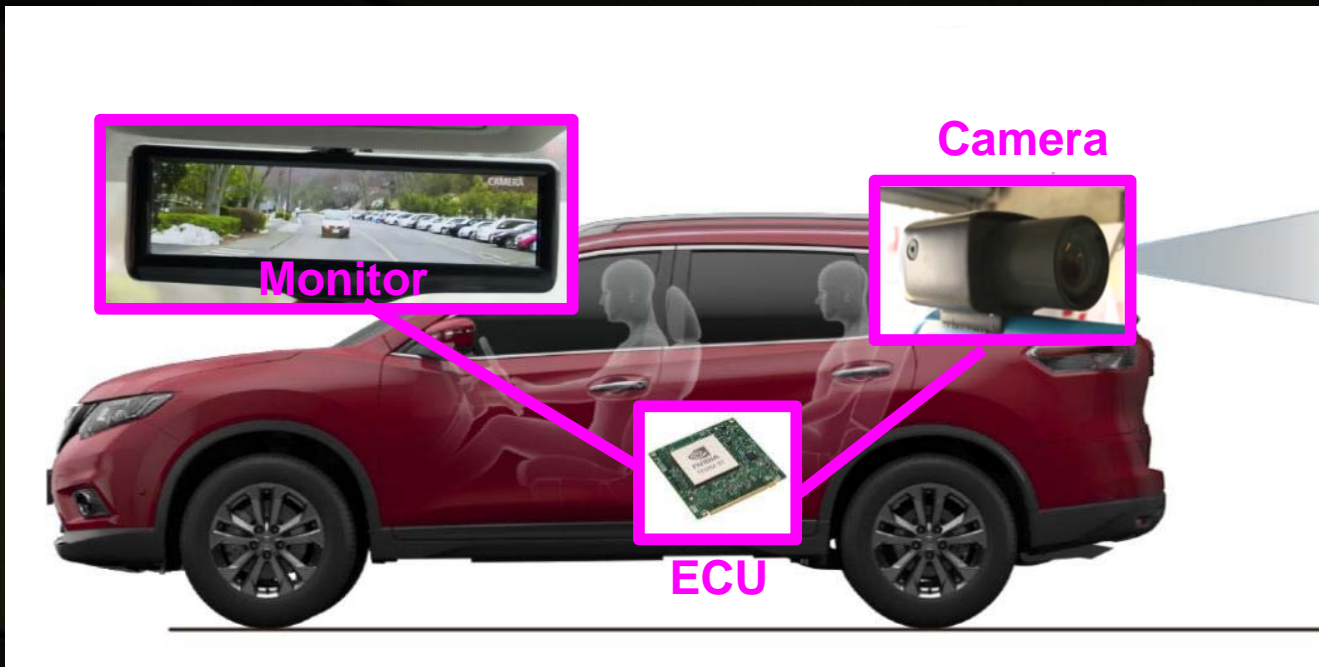
Ref: <http://nissannews.com/en-US/nissan/usa/releases/nissan-motor-develops-the-smart-rear-view-mirror-which-helps-provide-clear-rearward-visibility-in-various-conditions>

Flip-mirror: Liability/Approval



Flip mirror: display vs. glass

Example: Upcoming Rear-Mirror CMS



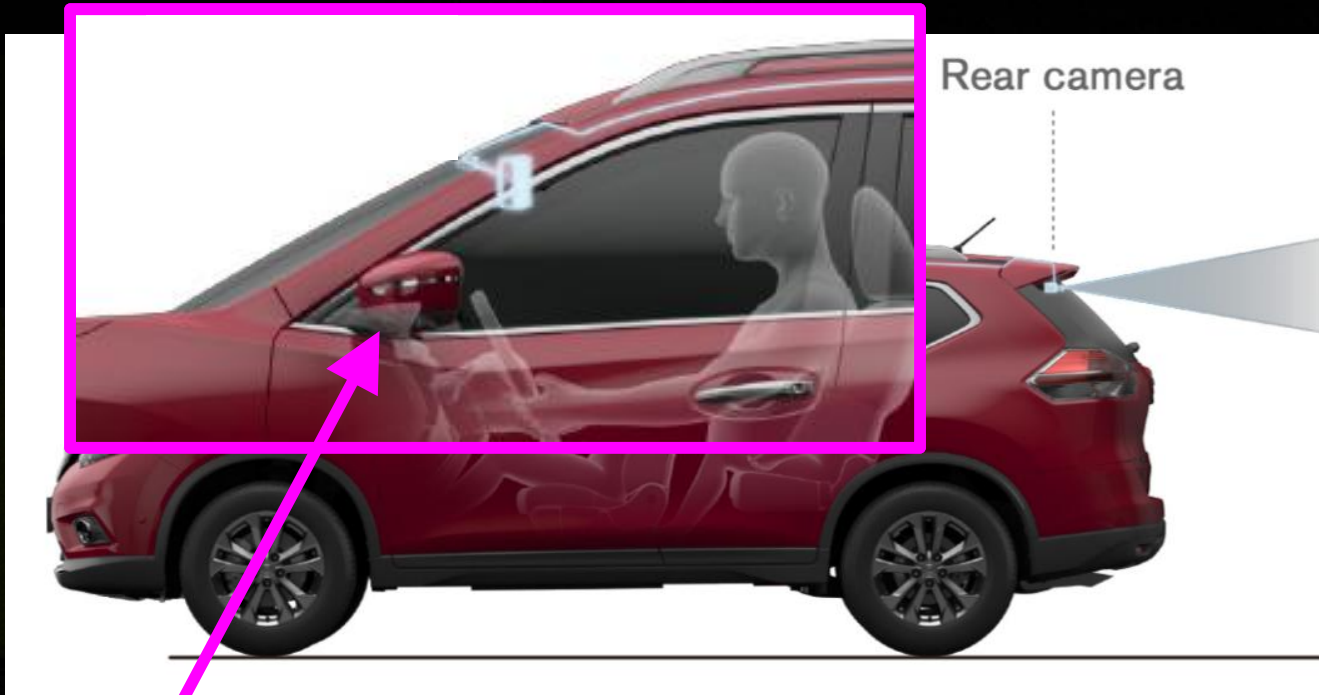
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Example: Upcoming Rear-Mirror CMS



Side mirrors still present

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Ref: <http://nissannews.com/en-US/nissan/usa/releases/nissan-motor-develops-the-smart-rear-view-mirror-which-helps-provide-clear-rearward-visibility-in-various-conditions>

Bigger Challenge: Side mirrors



Side cameras replace mirrors

Unique to side-mirrors:

- **Mirrorless affects design/sales**
...cars with mirrors may be perceived old-fashioned soon...
- **Reduced wind resistance**
- **Capability to eliminate blind spots**
- **Impact hazard / No broken mirrors**
- **Stricter regulation**
(CMS can be sold - only if the side mirrors are retained!)
- **UNECE Addendum 45:**
Regulation No. 46 → refers to ISO/FDIS 16505

bast study 2014 - tunnel



Vehicle disappears for about 1s

Ref: "Study on Camera Monitor Systems" - Elke A. Schmidt, Rainer Krautscheld -
Informal Group on Camera Monitor Systems in Reg. No. 46
Berlin, 27.03.2014 - Bundesanstalt für Straßenwesen

bast study 2014 – direct sun light



No meaningful picture for about 2s

Ref: "Study on Camera Monitor Systems" - Elke A. Schmidt, Rainer Krautscheid -
Informal Group on Camera Monitor Systems in Reg. No. 46
Berlin, 27.03.2014 - Bundesanstalt für Straßenwesen

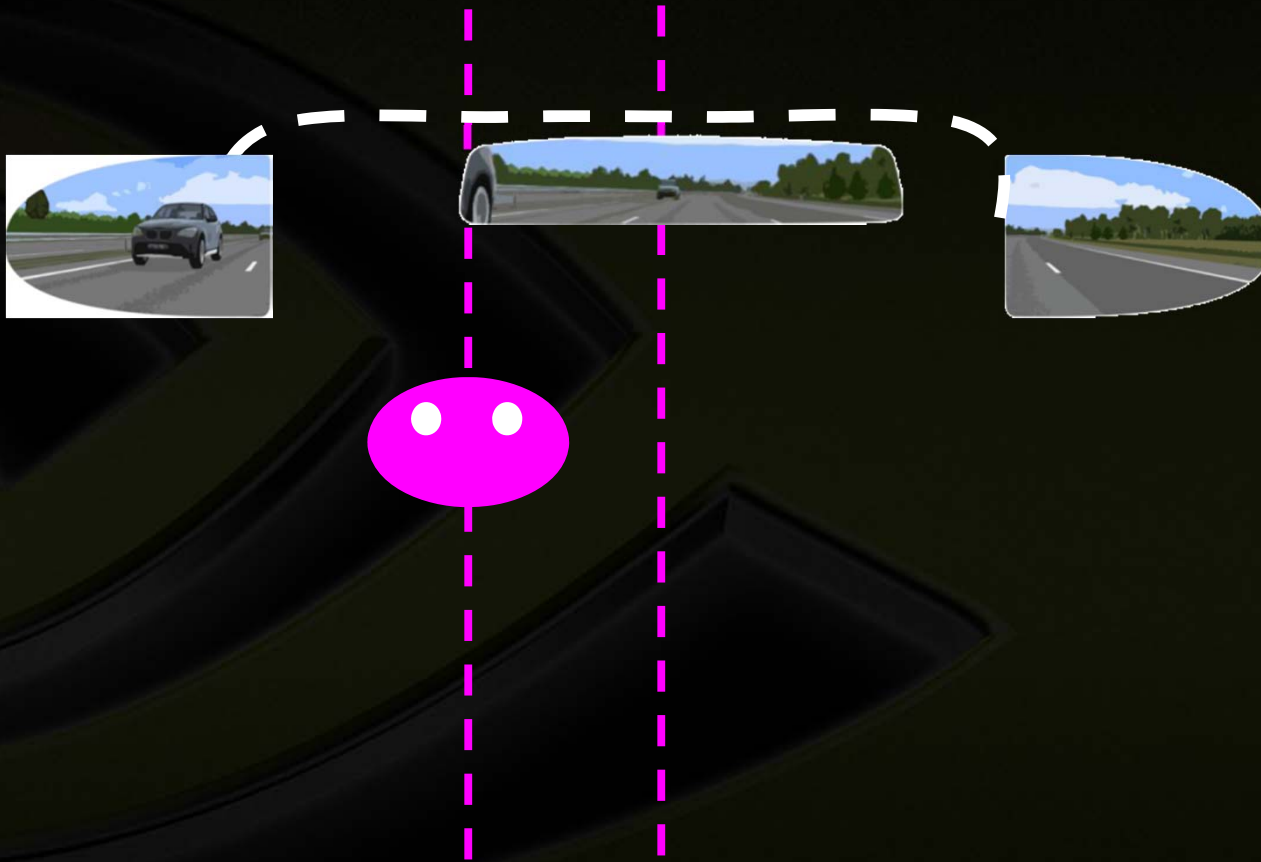
bast study 2014 – night



- Smear / blooming
- No discomfort glare
- Point light sources are displayed as points light sources

Ref: "Study on Camera Monitor Systems" - Elke A. Schmidt, Rainer Krautscheld -
Informal Group on Camera Monitor Systems in Reg. No. 46
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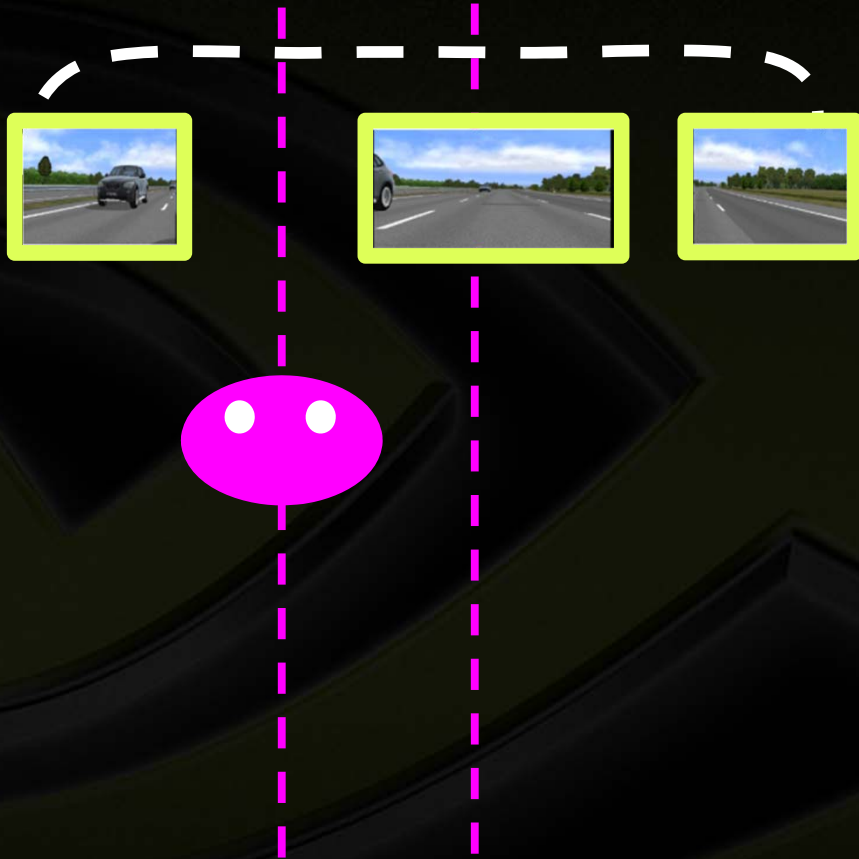
UNECE Regulation No. 46: Monitor Placement



with
Mirrors

Based on: Annex 12 #2.6.4 - Camera Monitor arrangement – OICA
Link https://www2.unece.org/wiki/download/attachments/17760482/IGCMS-11-03-12%20Monitor%20Arrangement_V6%20-%20OICA.pptx?api=v2
Ref: UK proposal for CMS monitor arrangement - Paris, 5th June 2014 -
Department for Transport

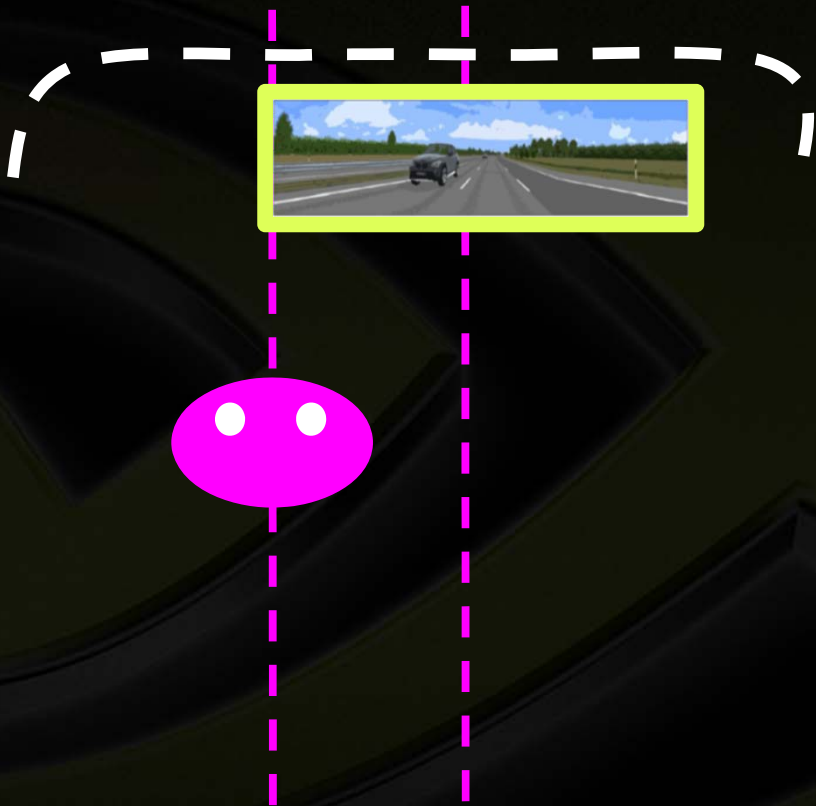
UNECE Regulation No. 46: Monitor Placement



CMS
1:1 monitor
placement

Based on: Annex 12 #2.6.4 - Camera Monitor arrangement – OICA
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Ref: UK proposal for CMS monitor arrangement - Paris, 5th June 2014 -
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UNECE Regulation No. 46: Monitor Placement



**Central Display
Continuous view**



**OICA
proposal
from June
2014**

Based on: Annex 12 #2.6.4 - Camera Monitor arrangement – OICA
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Takeaways

Step from image processing to
advanced computer vision/graphics

● Upcoming CMS

- Replace rear mirrors
- 1:1 camera to monitor
- Processing – e.g.
 - Tone mapping
 - Color calibration
 - Lens undistortion



● Future CMS

- Replace side and rear-mirrors
- Continuous central monitors
- Processing
 - **Stitching of multiple FOVs**

● Challenges

- Night time –
Halos/blooming/flicker
- Dynamic range
- Motion blur

● Challenges

- Ghosting / Artefacts
- Processor performance
- Regulation
- Liability

Front Lighting Technology - Innovations



UNECE regulations

HID No. 98

AFS No. 123 Adaptive Front Lighting

DRL No. 87

LED No. 112 rev2.

“hot topics”

- Headlamp leveling
- Change of LED/light source
- Color boundaries
- Dynamic turn indicator
- Variable Intensity DRL
- Adaptive Driving Beam System

Regulation & Technology always in flux



HID Low beam High Intensity Discharge (HID)



1991-94

HID low + high beam



2001

LED low + High beam



2006-2008

LED „Matrix“



2014

LASER High beam booster

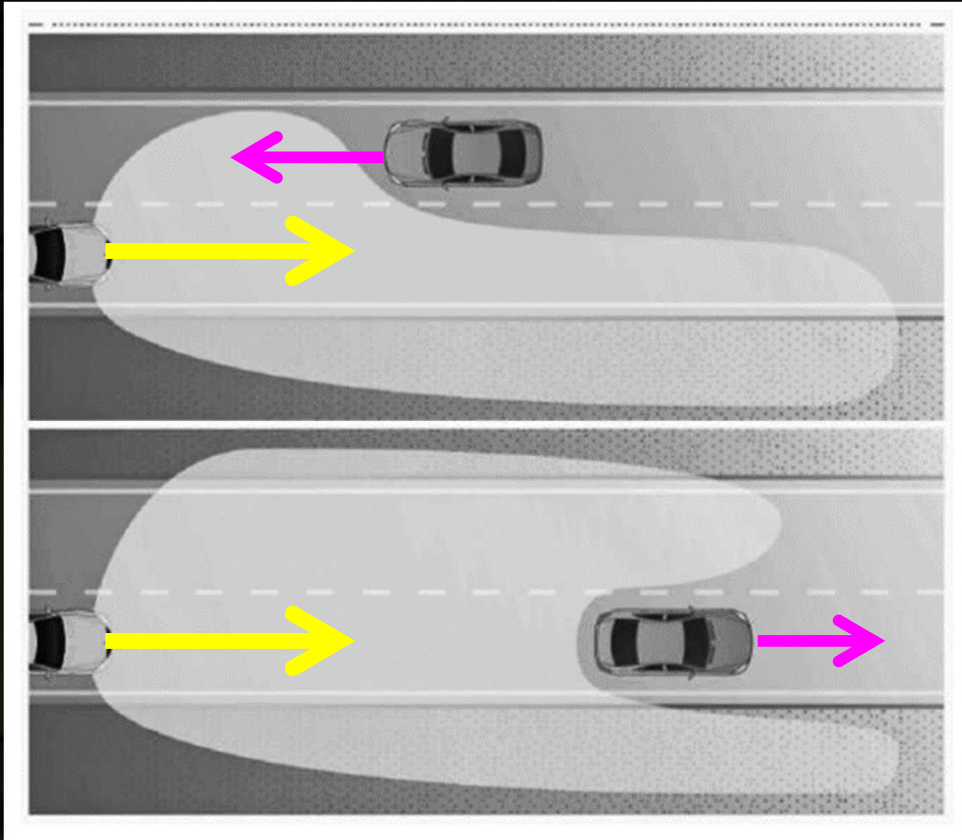


„Pixel-Light“ Research



201X

Adaptive Driving Beam



Prevent glare for oncoming vehicles

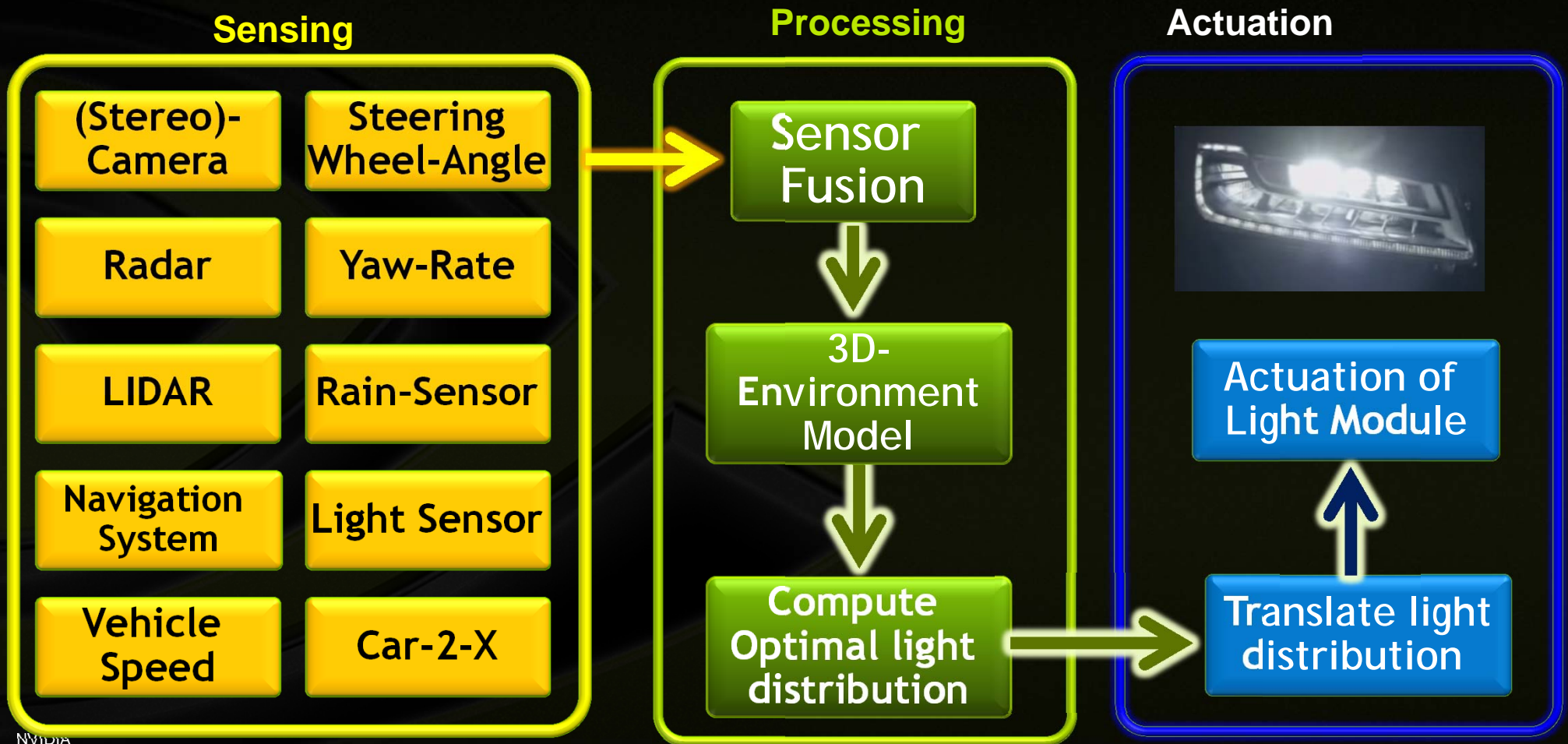


LED „Matrix“



Ref: "Regulatory Impacts of Advanced Lighting Systems" - Stephan Berlitz
Ref: <https://www.youtube.com/watch?v=kwlLY-00bJQ>
Ref: Lighting Roadmap 2020 - Stephan Berlitz - ISAL 2013 Proceedings

System Architecture of a fully adaptive Headlamp System



NVIDIA

Ref: "First approach to reach the goal of a fully adaptive Headlamp" - Ingo Hoffmann et al. ISAL 2013 Proceedings

Parallels: CG- and automotive Lighting



3D-models required for accurate lighting



Computer graphics scene e.g.
rendered to 1024x768 pixels
„**Shader-Programs**“ determine
virtual lighting



„**Pixel**“ Light
Program controls
physical lighting of scene



Outlook

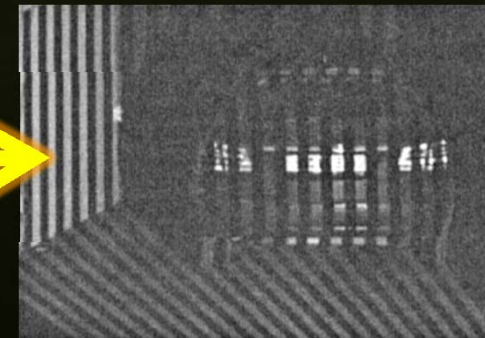


- **Pixel-Light**
 - Research group of Prof. Dr. Cornelius Neumann at KIT
 - Matrix light: 50 pixel
 - Research prototype: 12 million pixel
- **Acquiring 3D-environment models**
 - **Passive: Stereo-camera**
 - **Active – Feedback Camera & Head lamp**
 - Head lamp emits structured light
 - Head lamp pulses - time of flight

Pixel Light – 6 HD projectors



Ref: "Pixel Lighting – An Automotive Lighting Research Head Lamp" - Steffen Michenfelder, Prof. Dr. Cornelius Neumann ISAL 2013 Proceedings



Ref: "Automatische Justage eines hochauflösenden Scheinwerfers" – Boris Kubitzka et al. ISAL 2013 Proceedings



NVIDIA