

04/05  
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MUNICH OLYMPIA PARK  
GERMANY



# DVN MUNICH WORKSHOP

SOCIAL COCKTAIL & DINNER • CONFERENCE • PANEL DISCUSSION • AWARD CEREMONY • EXPO



## Future Communication by Light: New Options by External Displays and Ground Projections

04.02.2026, Munich

Felix Freytag / Innovation Optical Design

# Future communication by light



1. Communication by light today and in the future
2. Study: External Displays
3. External Displays: Regulation recommendations

# Future communication by light



## Gestures and eye contact:

**"I have seen you", "I'm letting you pass", "I'm going to stop", "Thank you!", "I'm mad at you"**

Urban Communication (unregulated)

Towards: vehicles + pedestrians

## Rear:

**"I'm breaking", "I'm reversing"**

Indicated by stop light, reverse light on / off

Towards: vehicles + pedestrians

## Flashing of HB:

**"I'm going to overtake", "Be careful", "I'm letting you pass", "Thank you"**

Communication depended on the situation

Towards: mostly vehicles

## Turn Indicator:

**"I'm turning", "I'm changing lane", "I'm indicating a hazard"**

Indicated by TI (flashing)

Towards: vehicles + pedestrians

# Future communication by light



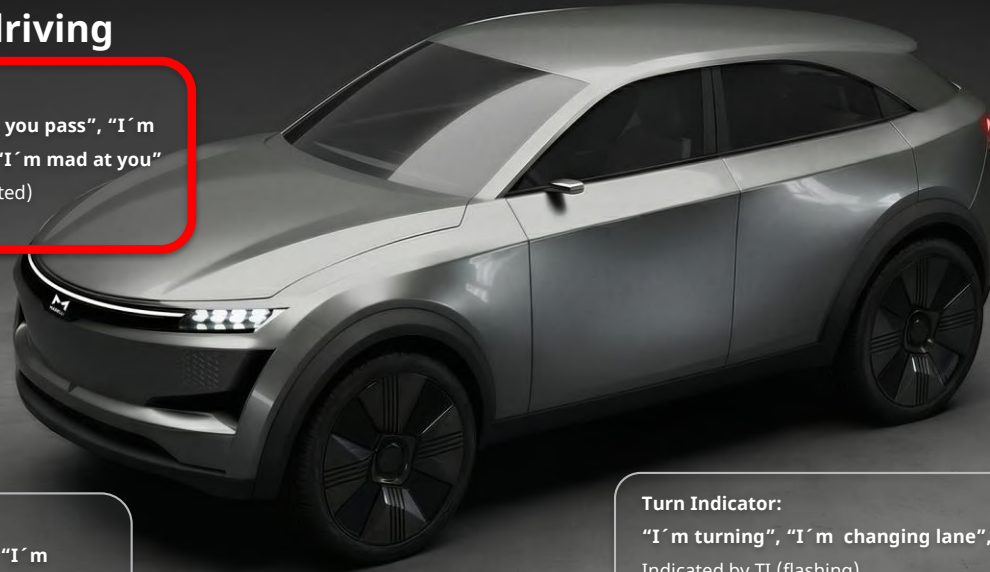
## Autonomous driving

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**New ways for future V2X communication must be found**

# Future communication by light



## Ground Projections:

"Welcome", "Be aware of snowy roads",  
"Enjoy your movie"

Projectors: Head /-Rearlamp, Sidemirror,  
Rockerpanel

Towards: driver

## ECE regulation 26/27

## Signaling Road Projections:

"I'm reversing", "I'm turning"

Projectors: Head /-Rearlamp, Bumper

Towards: pedestrians + bicycle drivers



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### External Display Communication:

"I'm going to stop", "I'm driving on",

Indicating the intention of the car

Integration: front / rear

Towards: vehicles + pedestrians



Can displays communication replace or even become more than eye contact?

**New ways for future V2X communication must be found**

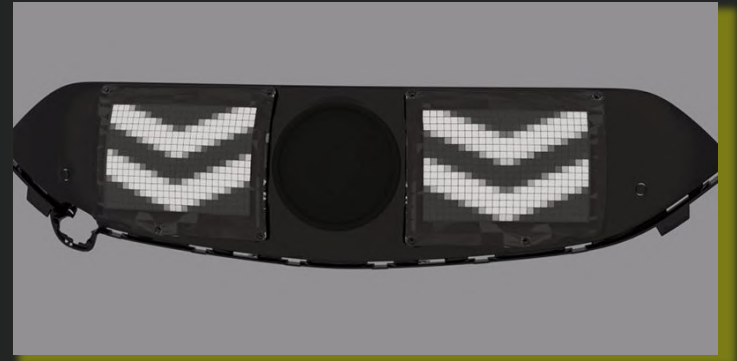
# External Display Demonstrator



- EU founded project
- 2 displays: 16 x 24 pixel
- RGB color
- adaptive brightness



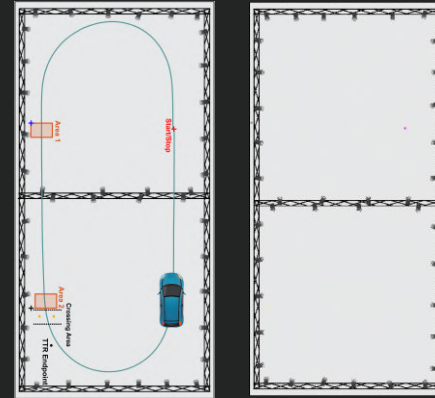
„I´m going to stop“



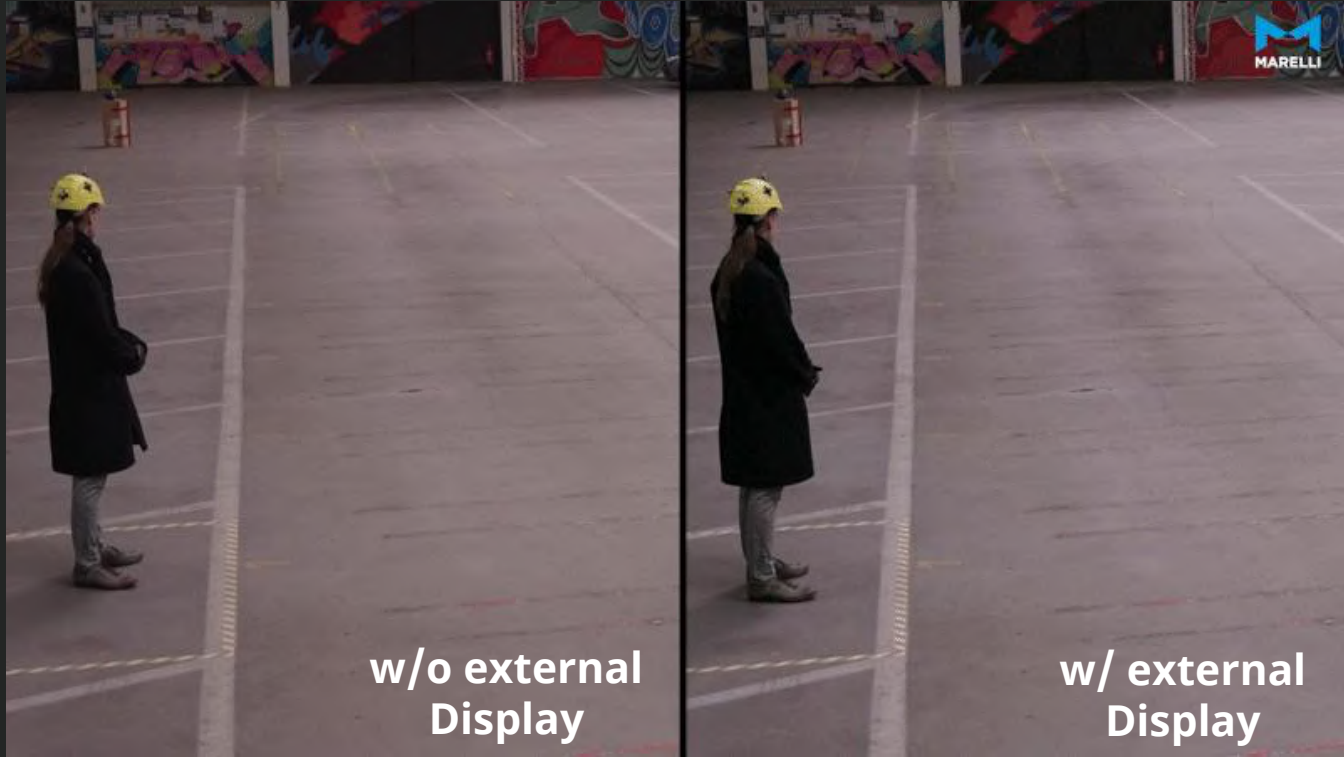
# 3D Motion Tracking



- 60 x 30 m „Trackable“ Area
- 38 IR Motion Tracking Cameras
- Multi-Object Tracking
  - Simultaneous Tracking of Car and Pedestrian



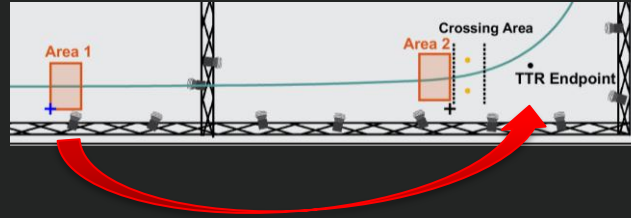
# Crossing situation w/o and w/ External Display



w/o external  
Display

w/ external  
Display

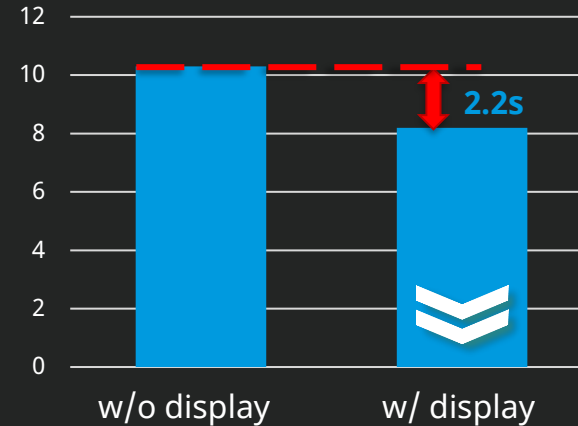
# Display Experiment: Results

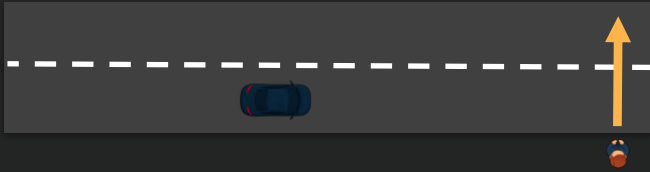


- 27 Participants
- 1050+ Interactions
- Survey data
- Several Parameters calculated
  - Velocities, distances, Time to collision
  - Time to resolve (TTR)

## Time To Resolve (TTR)

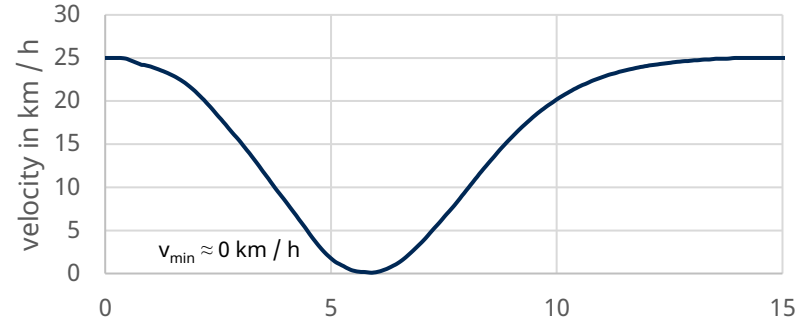
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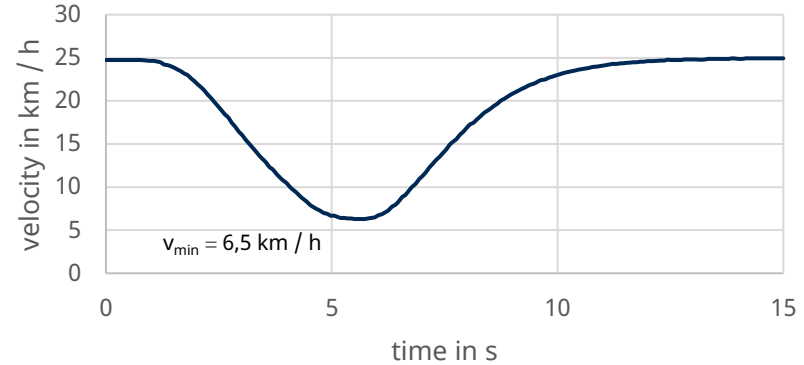


## Traffic flow: speed

w/o external Display



w/ external Display



# Traffic Flow Simulation

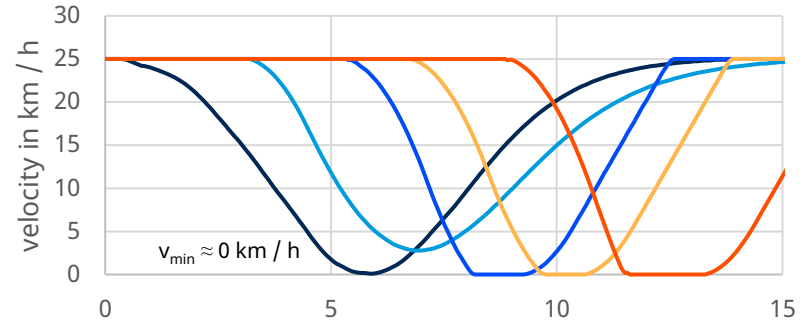


Simulation:

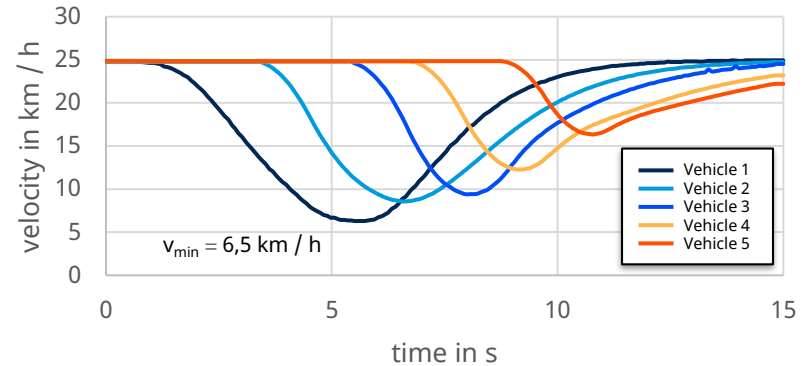
- 5 vehicles
- Distance between cars 18 m
- Velocity at start: 25 km / h

## Traffic flow: speed

w/o external Display



w/ external Display



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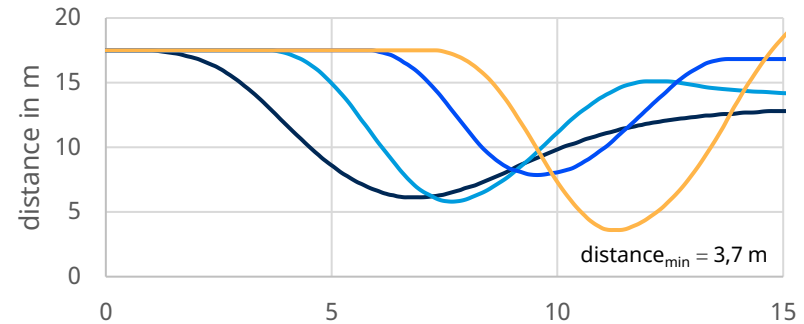
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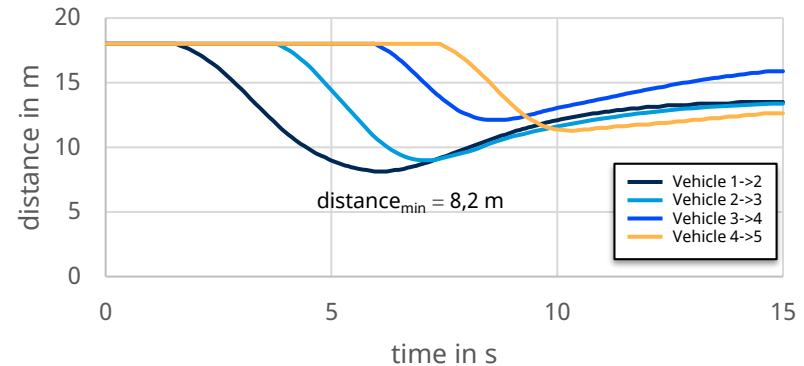
Communication by an External Display works + it can increase both safety and traffic efficiency

## Traffic flow: distance V2V

w/o external Display



w/ external Display



# Recommendations for Regulation of External Displays (eHMI)



## Key Recommendations

- Placement: 350–1500 mm above ground, below the windshield
- Visibility: Min. 45° horizontal, 15° downward, 45° upward; always clearly recognizable
- Brightness: Adaptive (9,000 cd/m<sup>2</sup> daylight, 3,000 cd/m<sup>2</sup> dusk, 700–1,500 cd/m<sup>2</sup> night)
- Color: White (standard), cyan for high automation, red allowed in emergencies
- Apperent Surface: 100 cm<sup>2</sup> - 800 cm<sup>2</sup>



## Communicated Messages

- Chevrons down: “I’m going to stop”
- Chevrons up: “I’m driving on”
- Animation: Flashing/moving symbols for emphasis and urgency

„I´m going to stop“



„I´m driving on“



Finalised recommendations for legislation  
proposal and standardisation

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Author(s) Robert Leute (MAR)

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# Future communication by light



Starting point for external displays regulation is set:  
You are all invited to join the discussion!



Thanks!