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AUTOMOTIVE NEAR FIELD DAY LIGHT PROJECTION BASED ON HOLOGRAPHIC LIGHT MODULATOR

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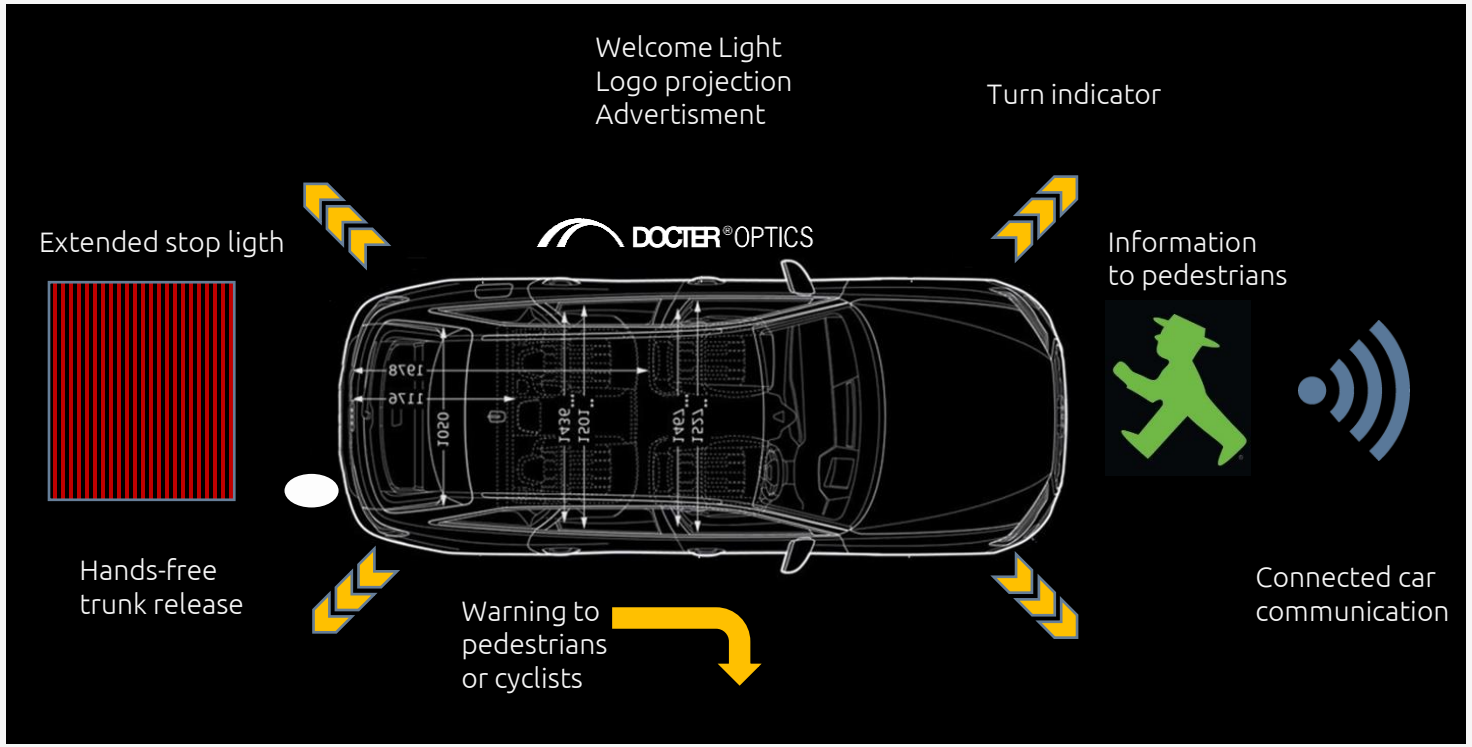
DOCTER®OPTICS

1. INTRODUCTION

- Near field or ground projection means projecting in a short distance to a car
- Projection can be done 360° around the car



Applications:

1) Information and communication (connected cars, messaging, communication to pedestrians)
2) Welcome information (logo projection, advertisement)
3) Safety (extended stop lights, turn indicator)

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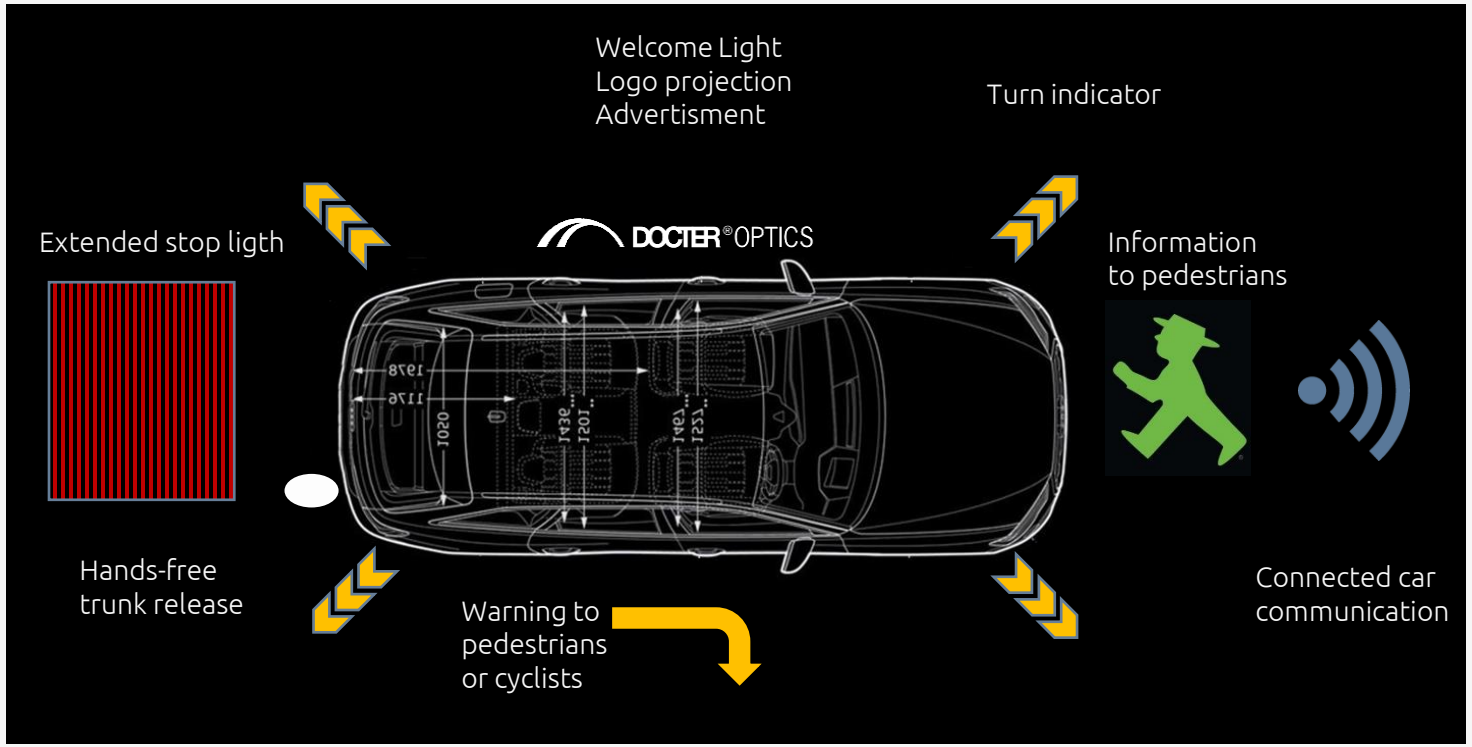
1. INTRODUCTION

- Current projection systems are typically used during night time or twilight conditions
- Day light projection recommended for autonomous driving



Requires illuminance of around 3000lx

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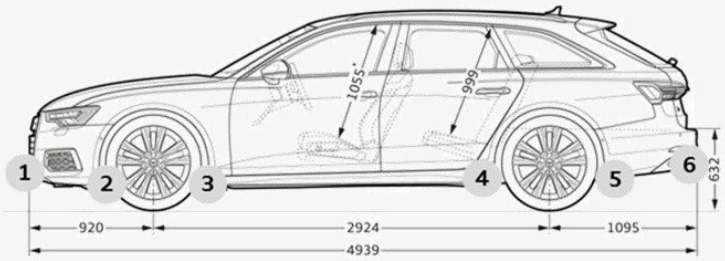
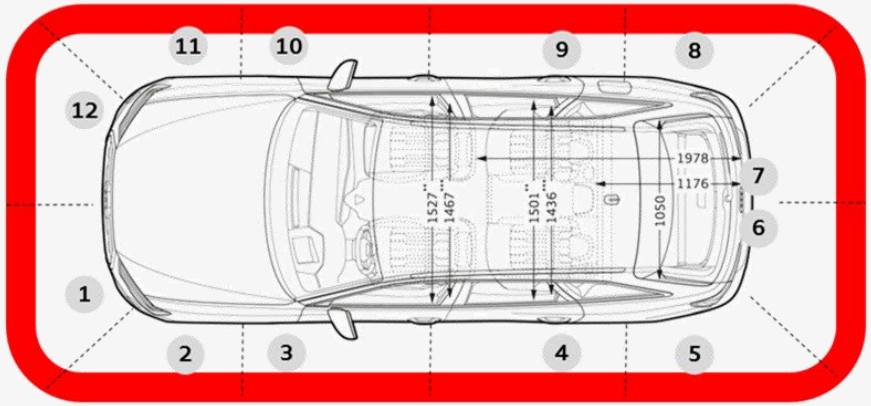
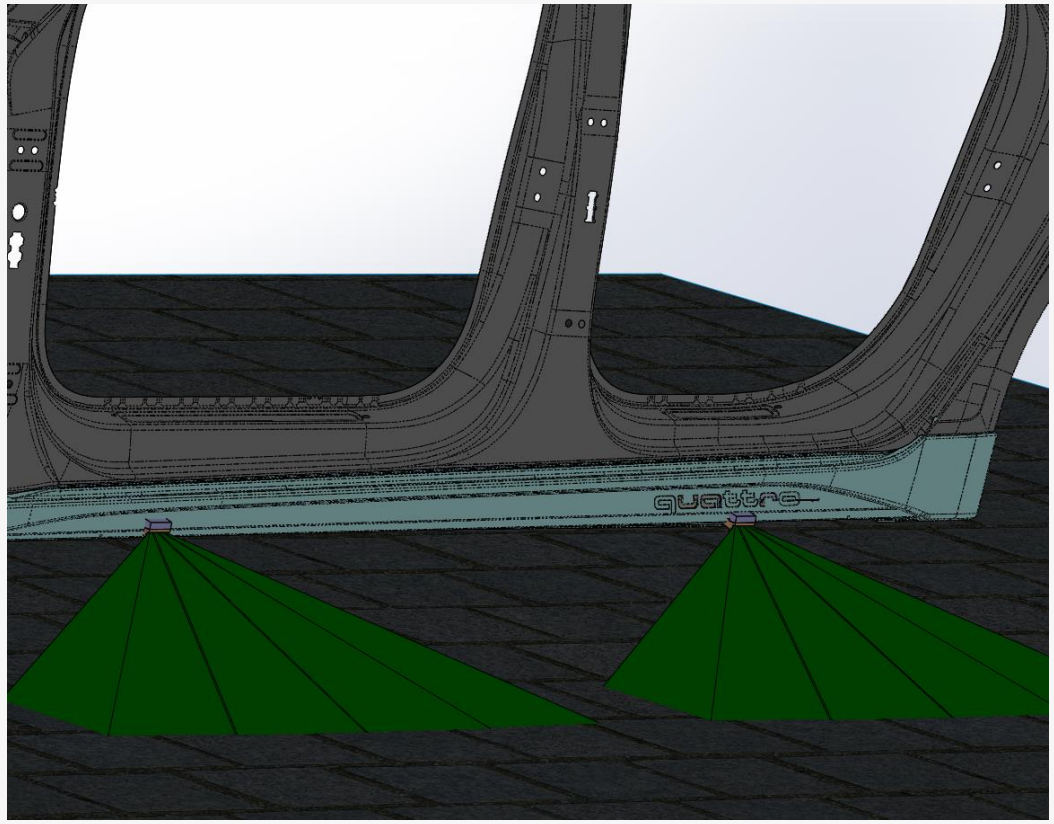
2. PROJECTOR SETUP & PROJECTION PLANE
12 Projectors around Car





360° Ground projection for autonomous driving



Projector position at the sill

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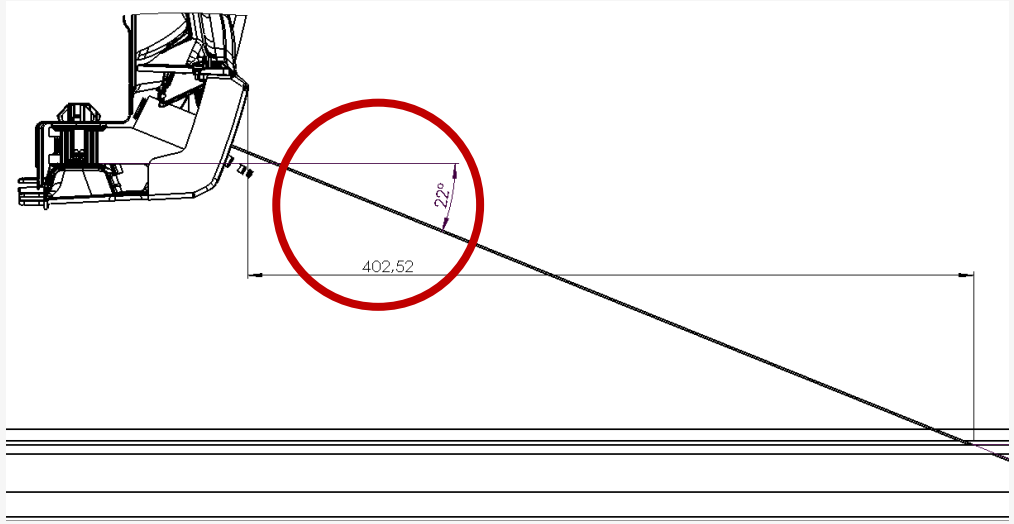
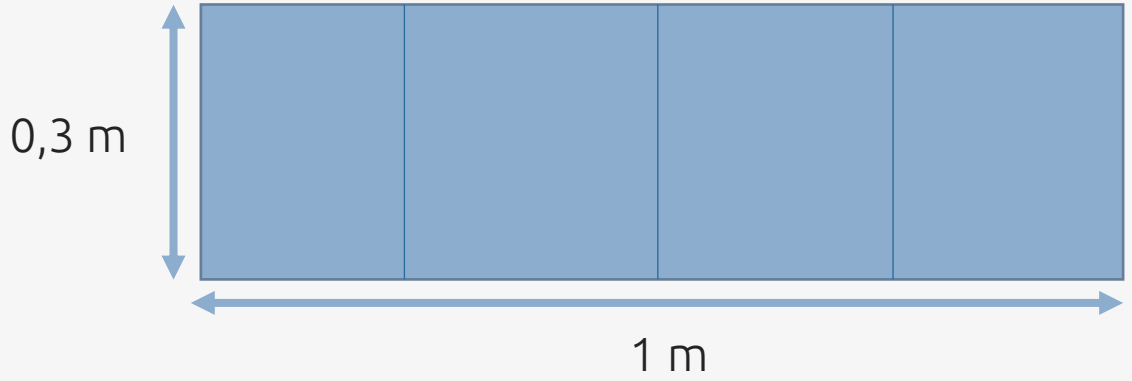
2. PROJECTOR SETUP & PROJECTION PLANE



Projection angle 22° to the ground surface



Projection plane with 4 different sub regions

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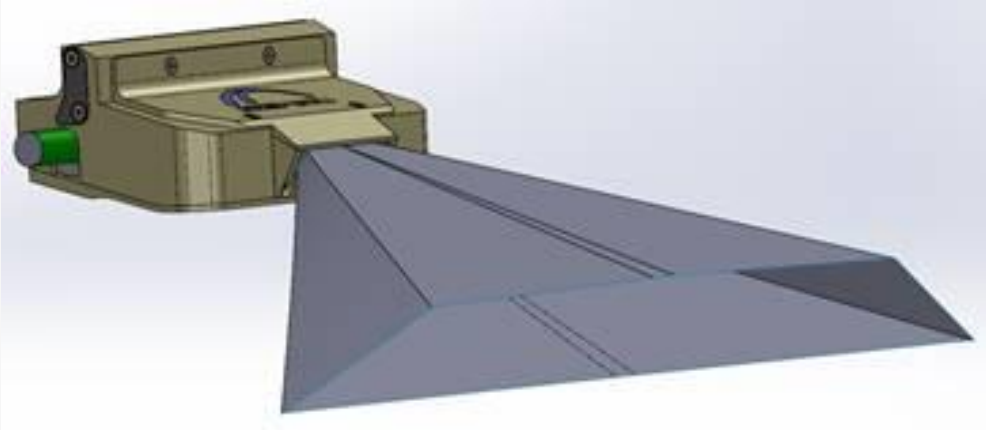
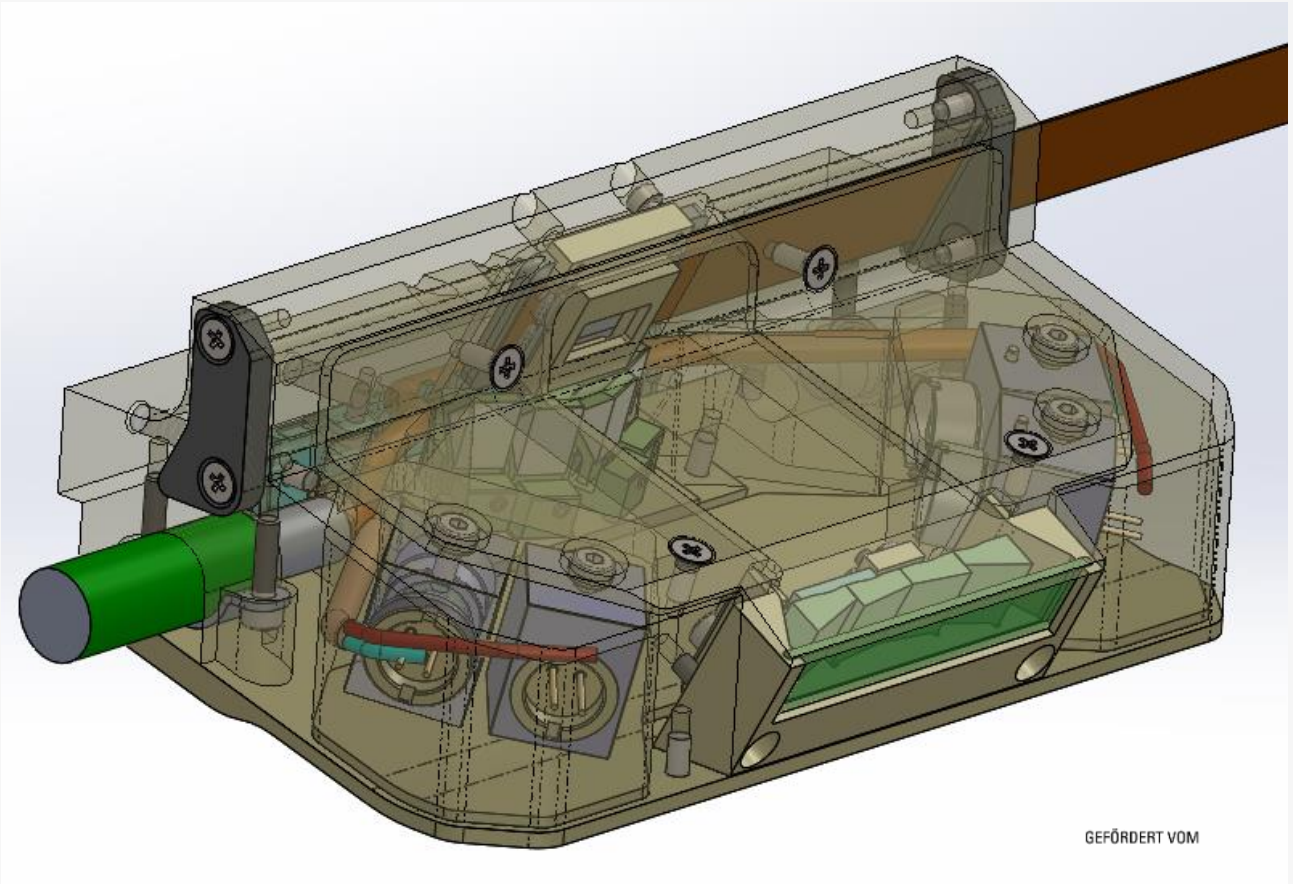
3. HOLOGRAPHIC PROJECTOR





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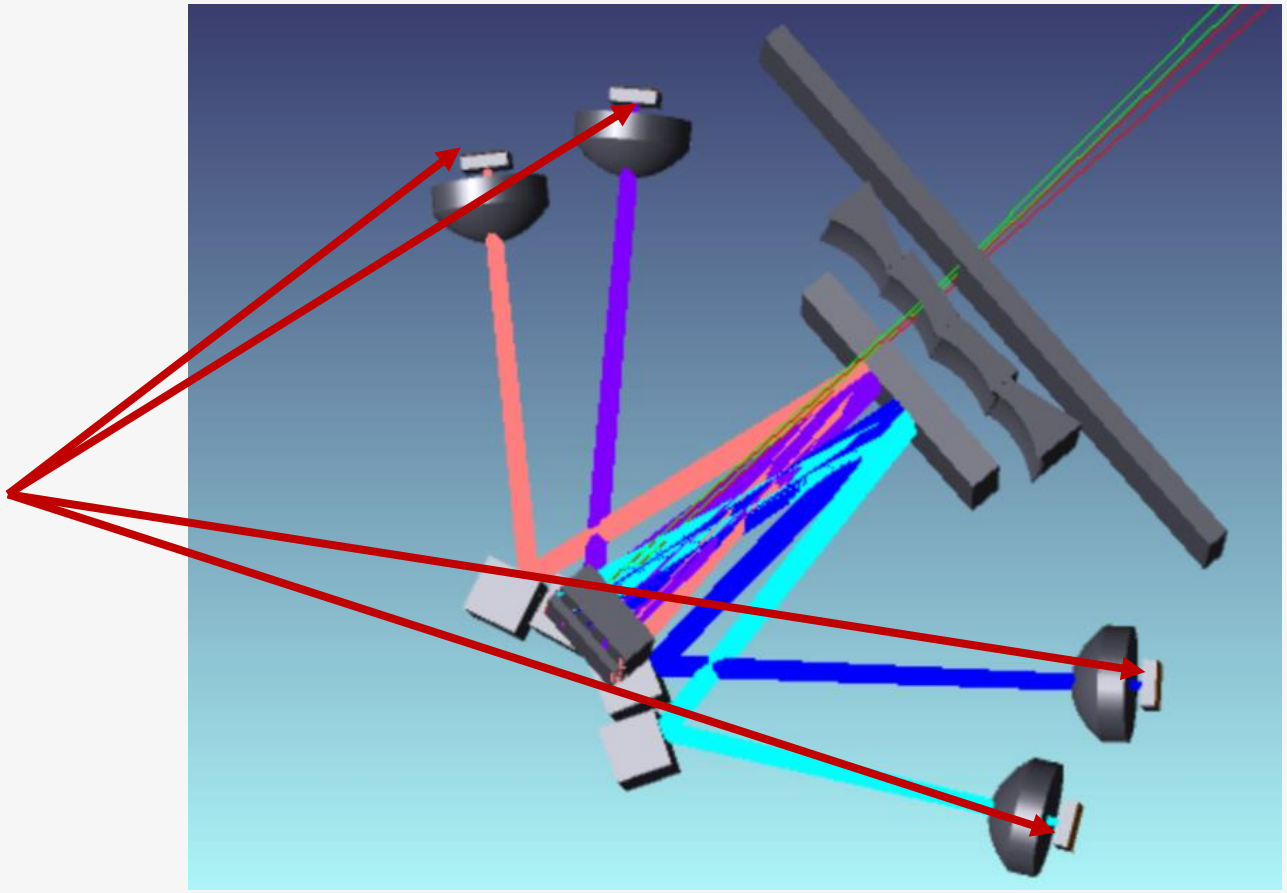
4. OPTICAL SETUP & PRINCIPLE



Light sources:

- 4 multimode diodes light with 1W light power each
- 4 projection channels

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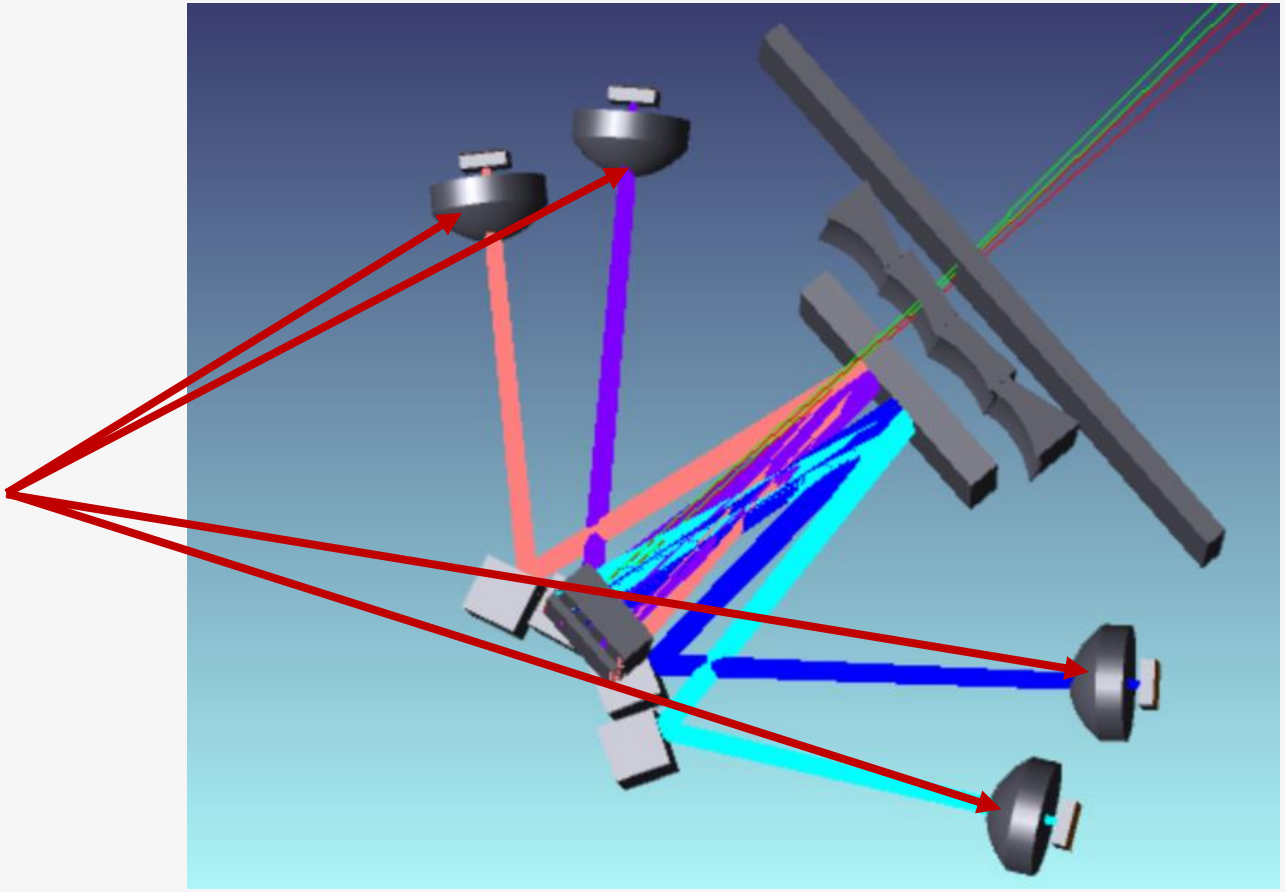
4. OPTICAL SETUP & PRINCIPLE

- Collimation lenses generate a narrow laser spot at the projection plane.



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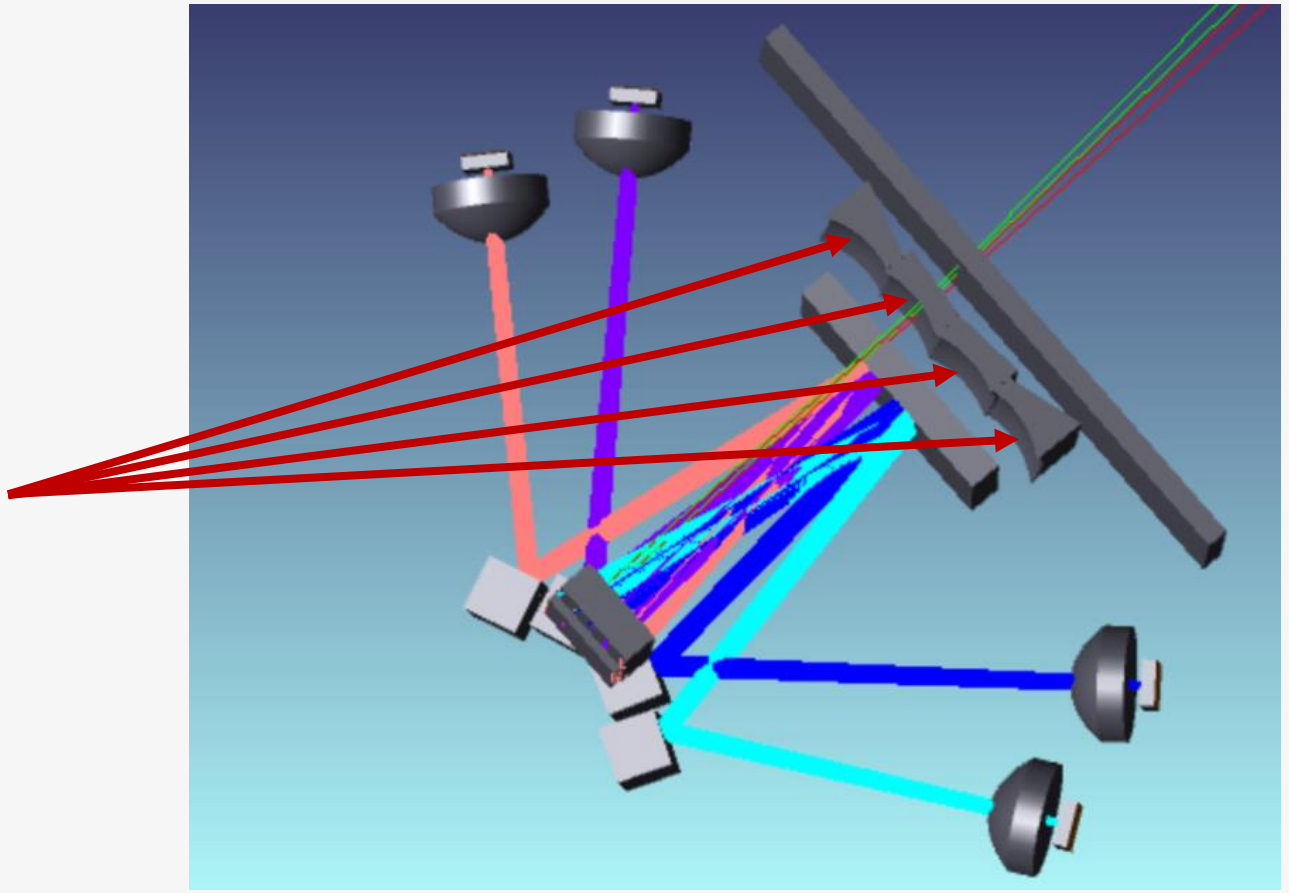
4. OPTICAL SETUP & PRINCIPLE

- Field lenses increase field of view at the projection plane.



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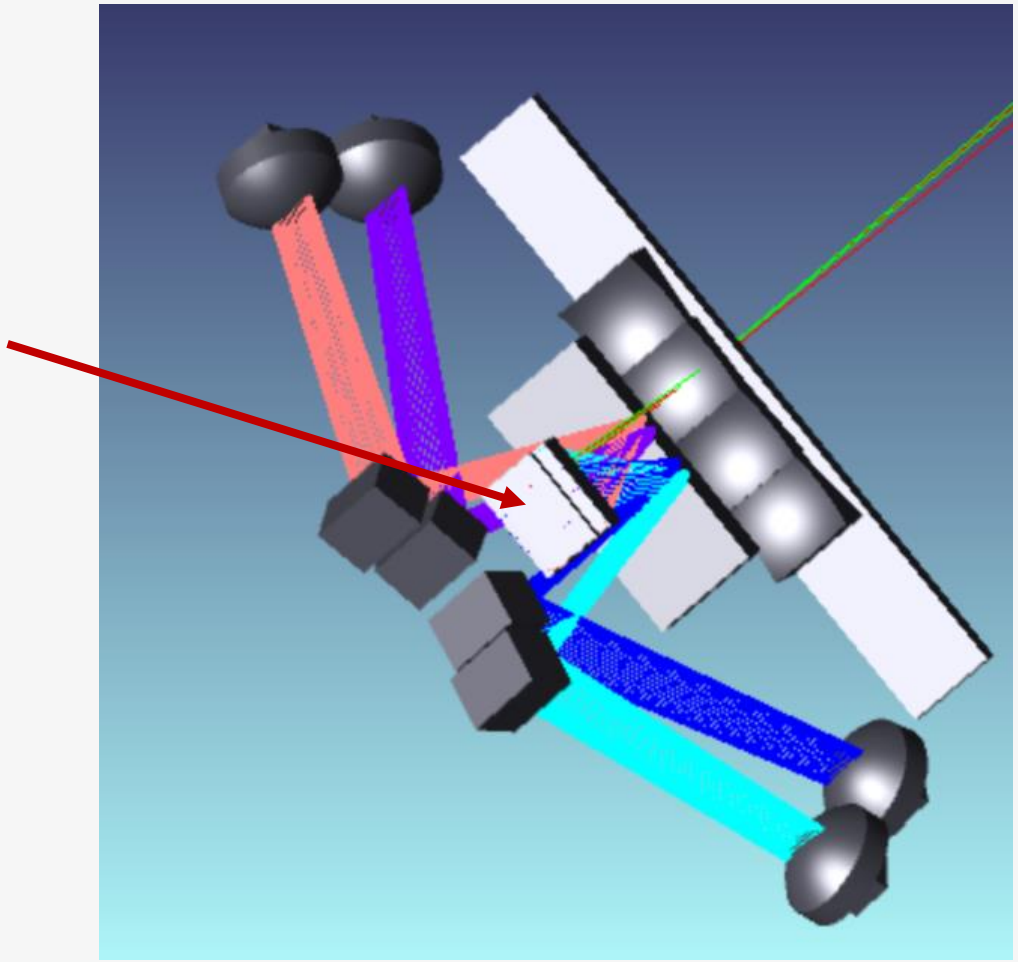
4. OPTICAL SETUP & PRINCIPLE

LCOS based holographic spatial light modulator (SLM) made by Holoeye:

- Introduces phase modulation into the laser beam.
- Phase modulation means introducing per pixel a small delay to the incident laser light.
- Phase modulation creates image in the projection plane by diffraction.
- Single SLM for parallel modulation of all 4 projection channels.



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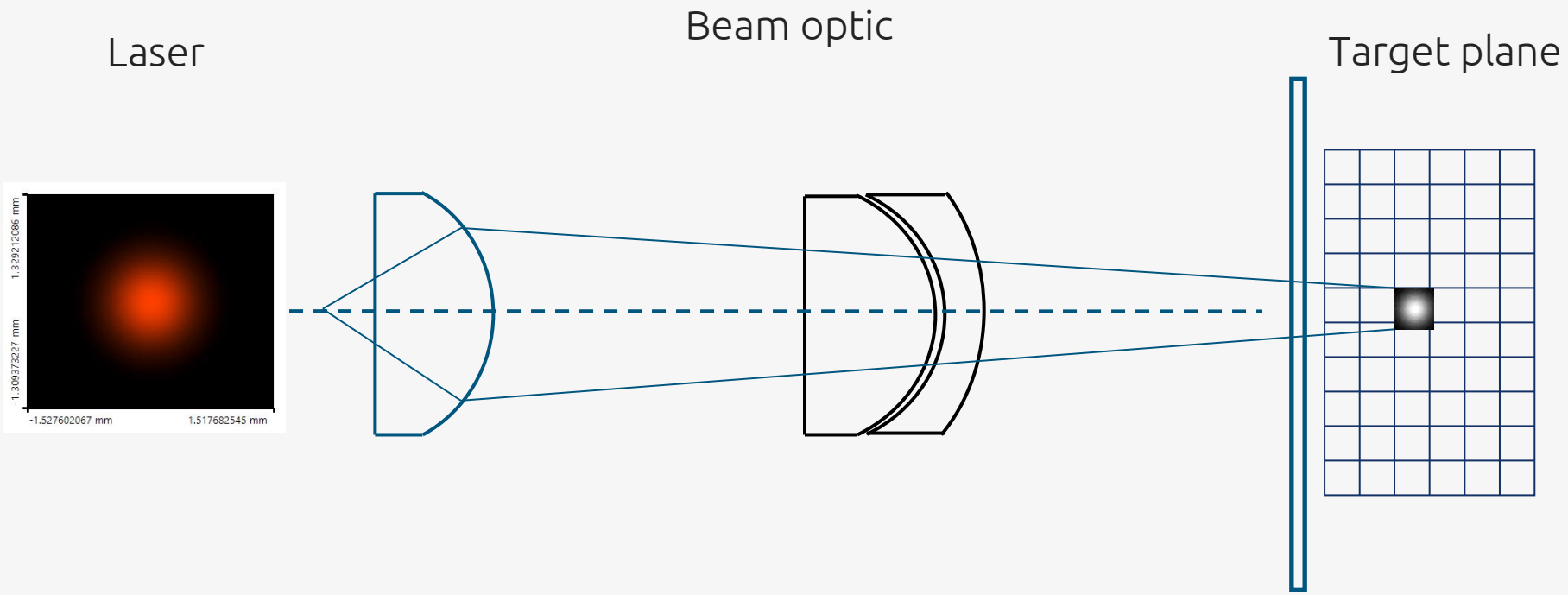
4. OPTICAL SETUP & PRINCIPLE

Beam optics generates a single spot



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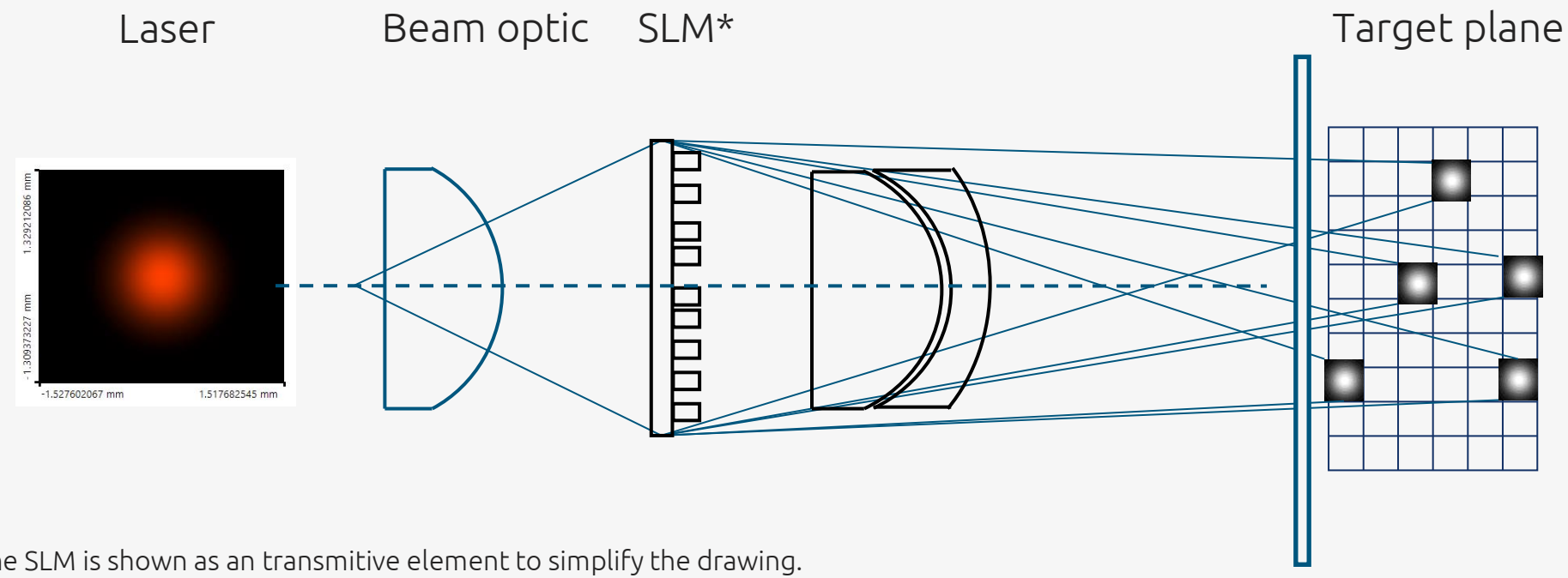
4. OPTICAL SETUP & PRINCIPLE

SLM replicates the spot and deflects it into different positions.



*The SLM is shown as an transmitive element to simplify the drawing.
The used LCOS SLM works in transmission.

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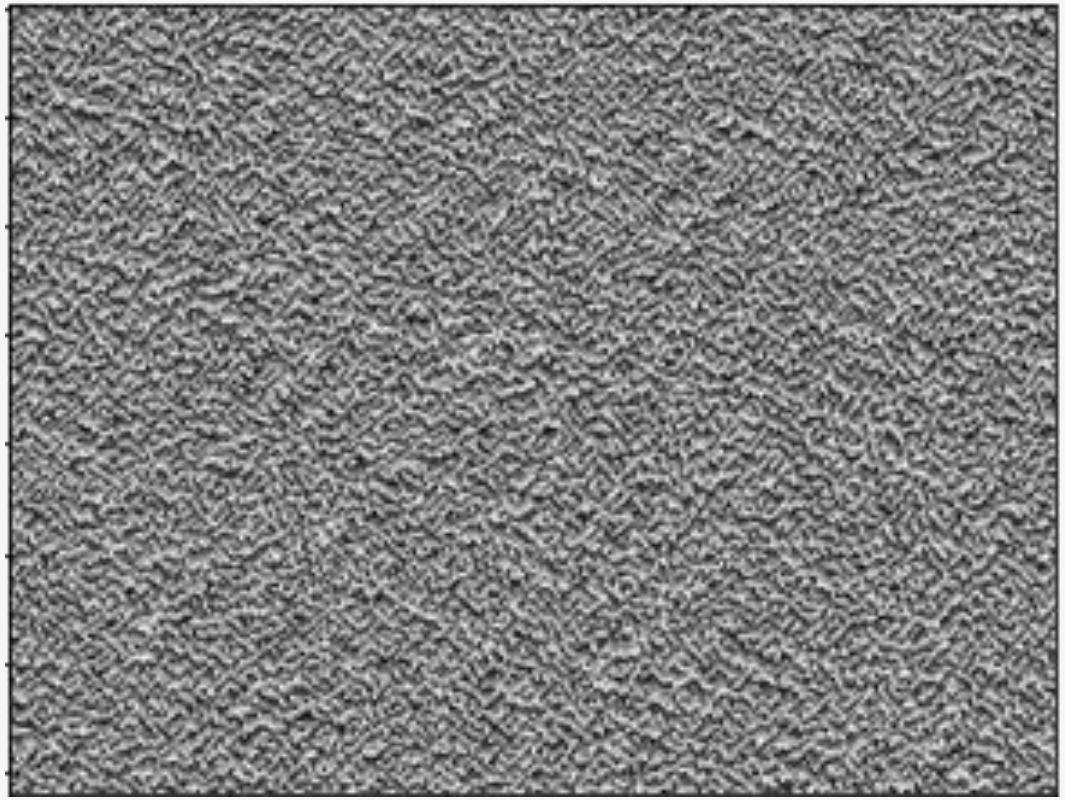
4. OPTICAL SETUP & PRINCIPLE



SLM phase function

Reconstructed Intensity distribution

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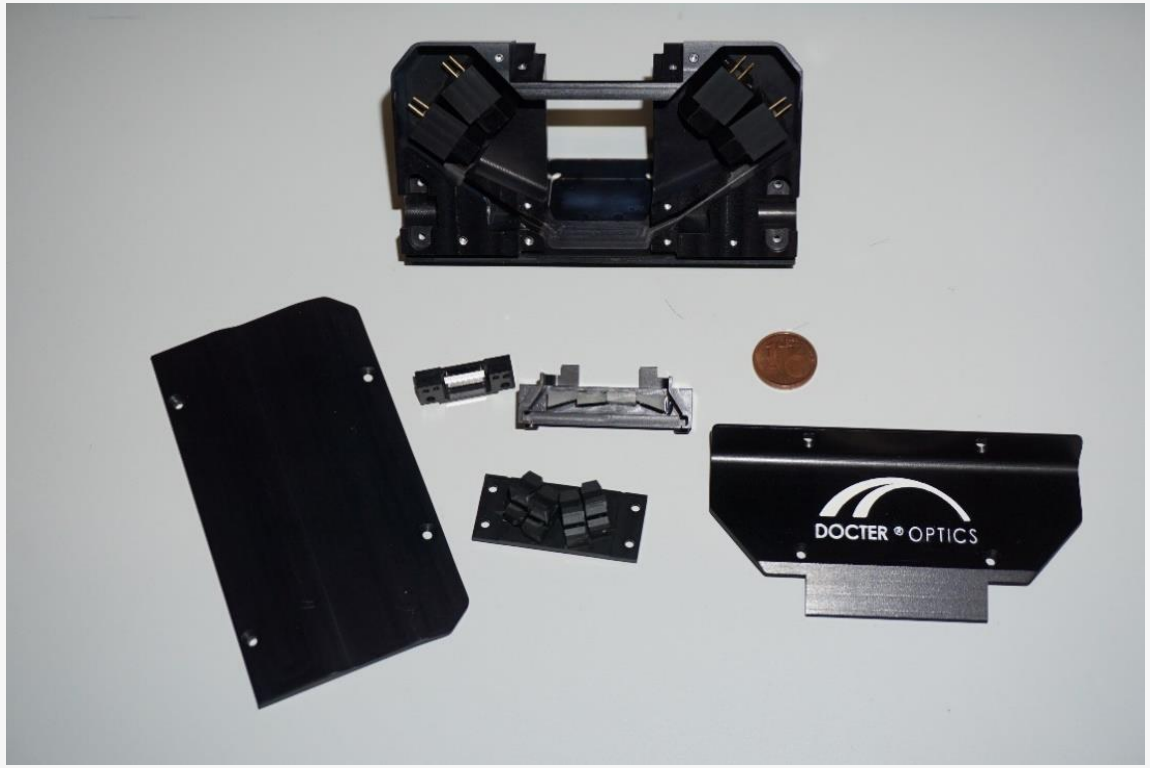
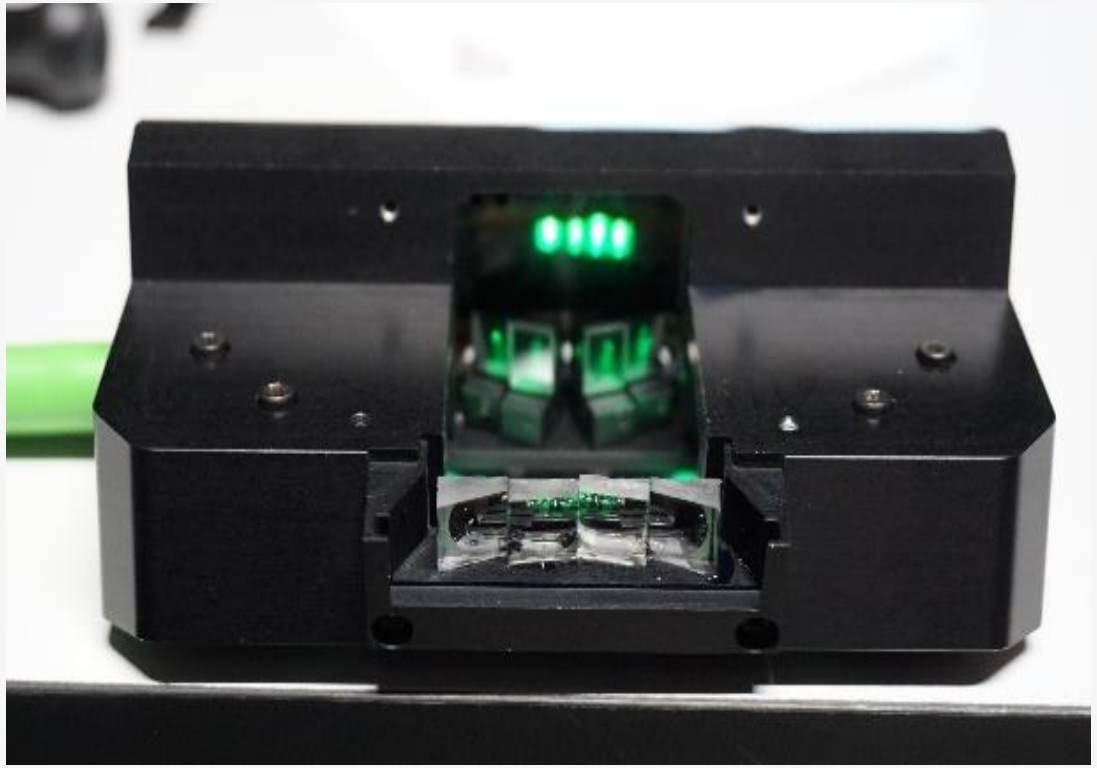
5. TECHNOLOGY DEMONSTRATOR
Holographic Projector





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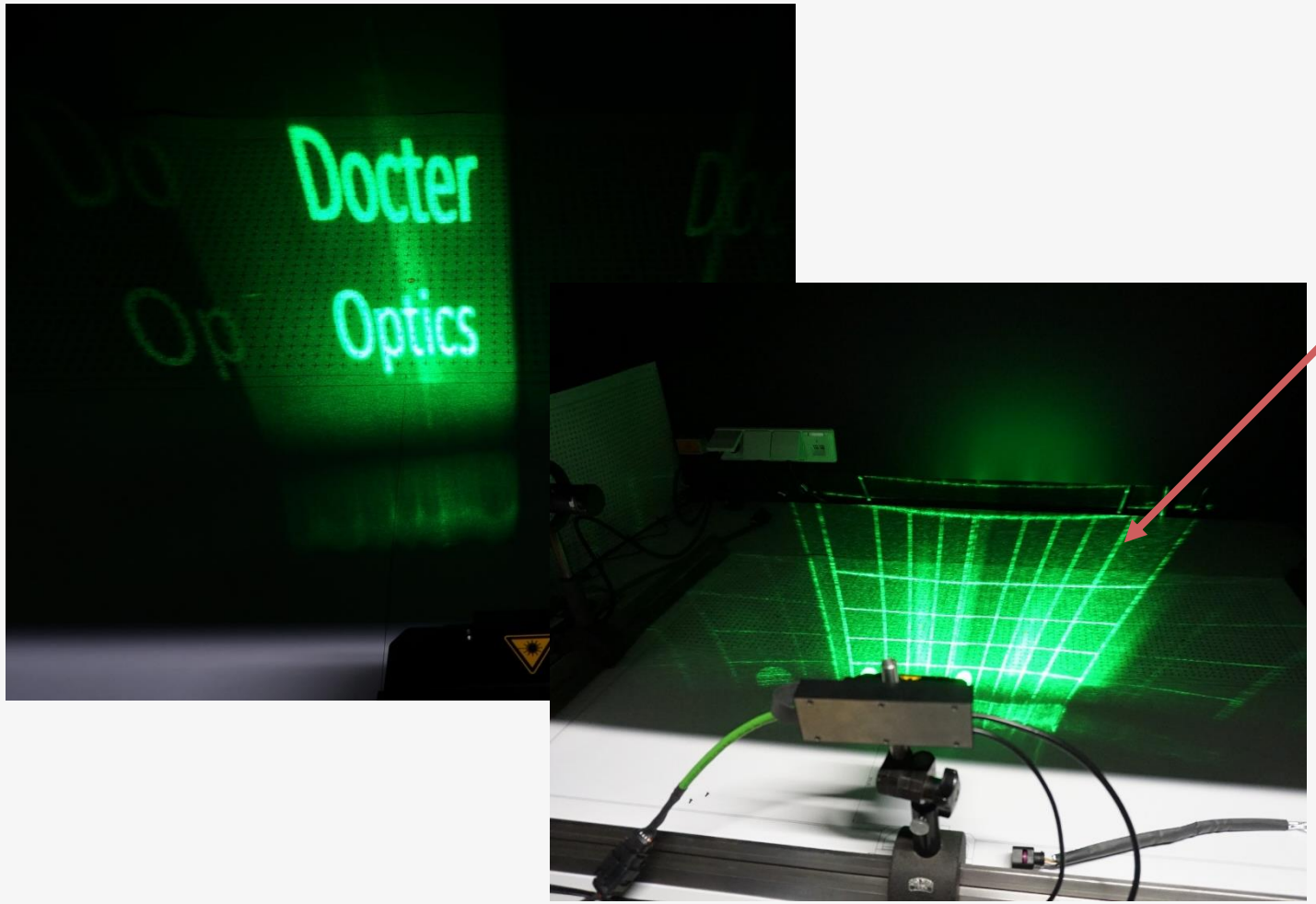
5. TECHNOLOGY DEMONSTRATOR
Projected Light Pattern



- Geometrical distortion caused by wide angle projection and small angle of 22° between projector axis and ground surface.
- Distortions can be compensated by software.

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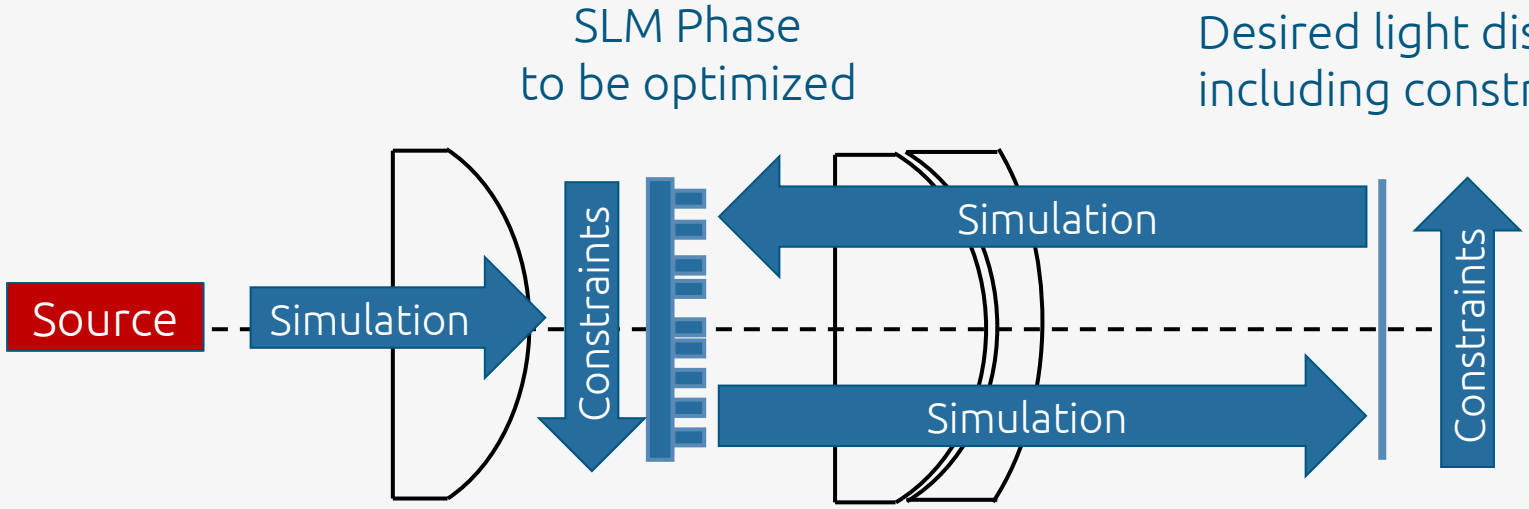
6. OPTIMIZATION OF PHASE OF SLM
Iterative Fourier Transform Algorithm



- **Iterative Fourier Transform Algorithm** known from digital holography and diffractive optics.
- Optical system is analyzed and light distributions in target plane is calculated.
- Light distribution is modified in order to full fill all constraints.
- Modified light distribution is back propagated to SLM.
- Phase-only constraints on SLM modulation function is applied.

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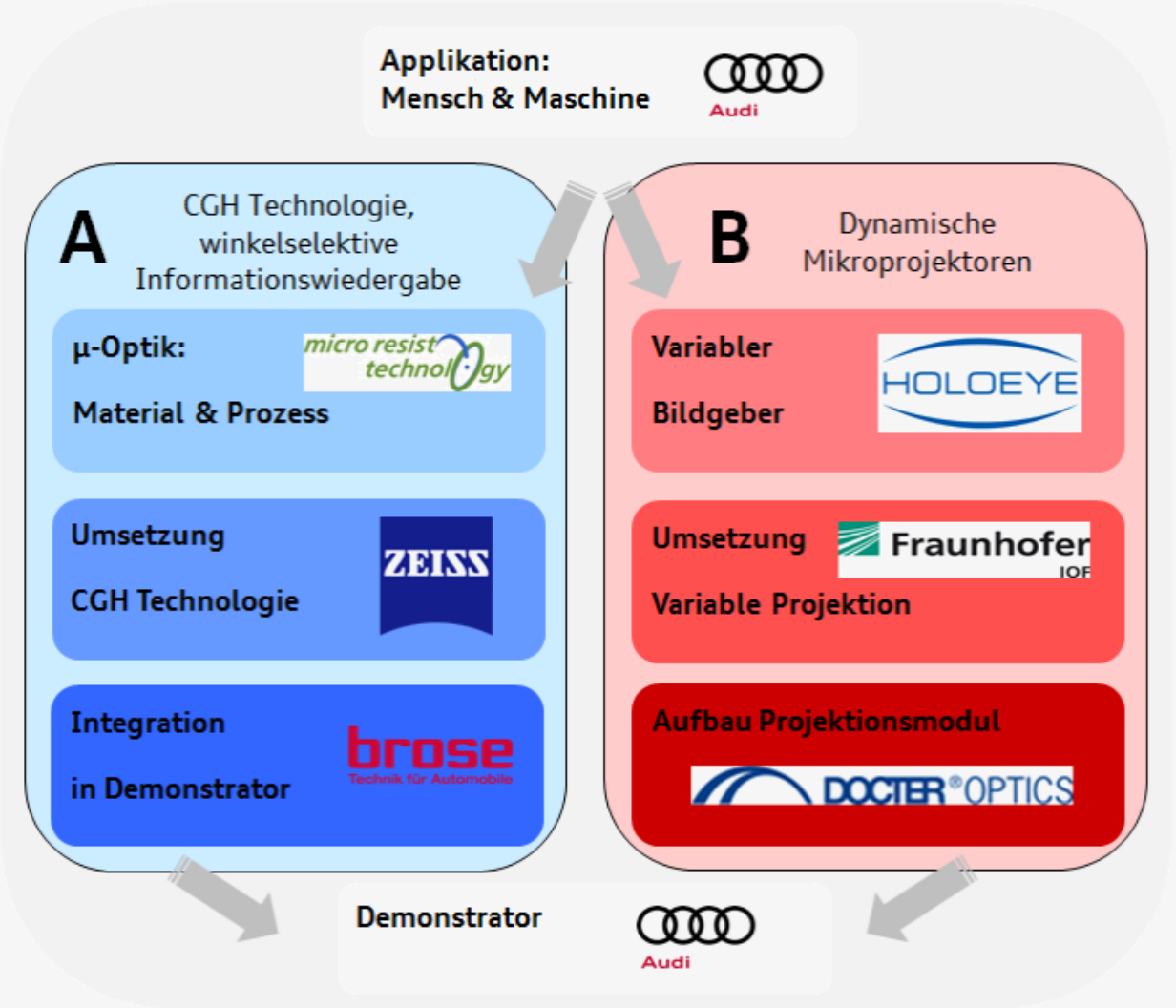
7. PROJECT TEAM / ACKNOWLEDGMENT



Public research project “MAMEK”

Maschine – **Me**nsch – **K**ommunikation

Machine – Human – Communication

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8. SUMMARY AND OUTLOOK

- 360° near field or ground projection enables display of information, communication and can increase safety of traffic users.
- Daylight projection systems enable display of safety information for autonomous driving.
- Technology demonstrator of holographic projection system introduced.
- Holographic projection concept based on 4 diode lasers and a spatial light modulation for image generation.
- Future Systems will be extended to different colors and RGB projection.
- Speckle reduction concepts have to be added to the projector.

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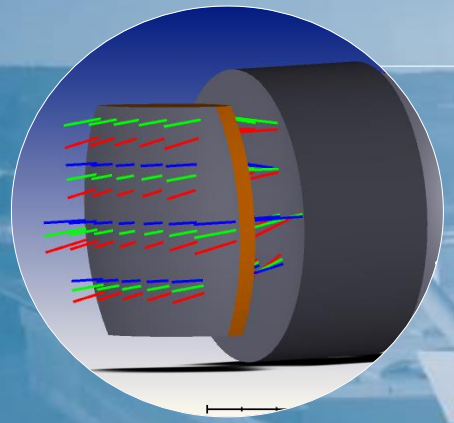

Optical and Mechanical Design

Ready Molded of Polymer- and Glass Lenses

Assembly of Optical Systems

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