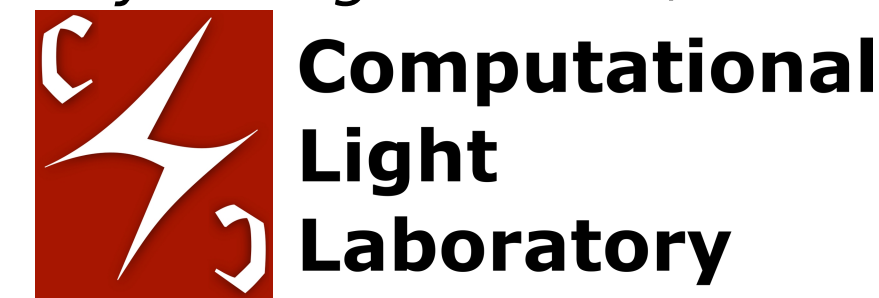


# MITIGATING EDGE FRINGE EFFECTS IN MULTIPLANE HOLOGRAPHY

Koray Kavaklı, Hakan Urey  
Department of Electrical and Electronics Engineering  
Koç University, Istanbul, Turkey

Yuta Itoh  
Interfaculty Initiative in Information Studies  
University of Tokyo, Tokyo, Japan

Kaan Akşit  
Department of Computer Science  
University College London, London, UK



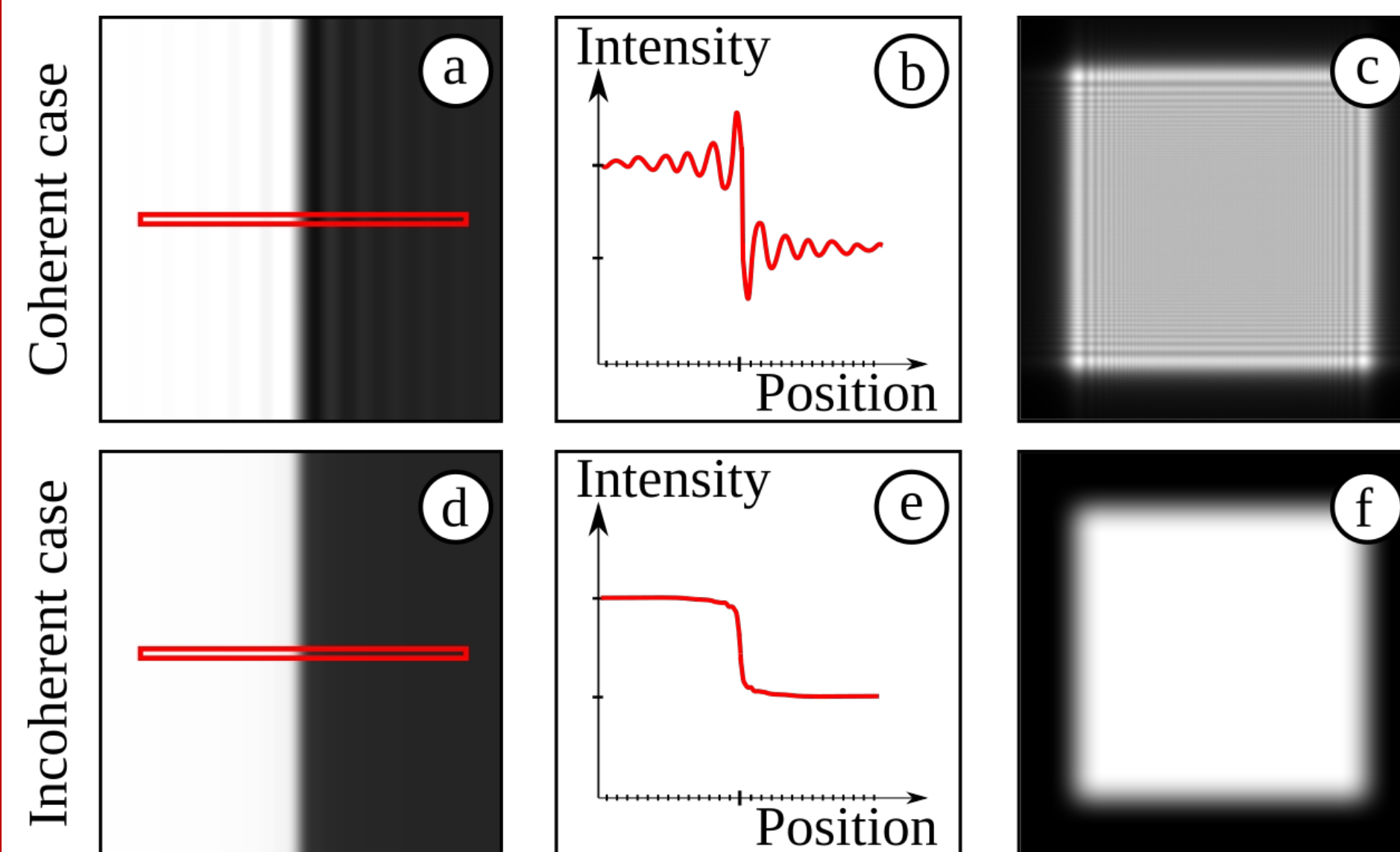
Project webpage:  
[https://complightlab.com/publications/realistic\\_defocus\\_cgh](https://complightlab.com/publications/realistic_defocus_cgh)

## SUMMARY

We present a novel multiplane computer generated hologram calculation approach that enables artifact free and realistic-looking defocus blur for optical reconstructions in a holographic display. We validate our findings for both the numerical reconstructions and optical captures that are acquired from our holographic display prototype. Main contributions of our work can be listed as:

- Targeting scheme (Depth-of-field rendered multiplane holograms)
- Loss function for multiplane Computer Generated Holograms
- Multiplane hologram generation pipeline
- Proof-of-concept holographic display

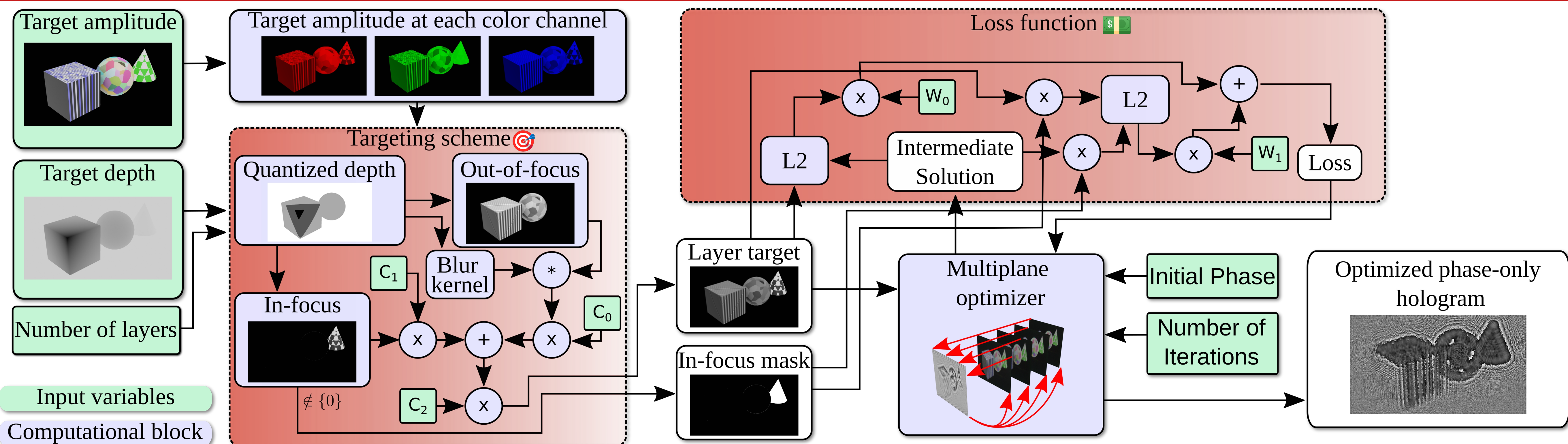
## MOTIVATION



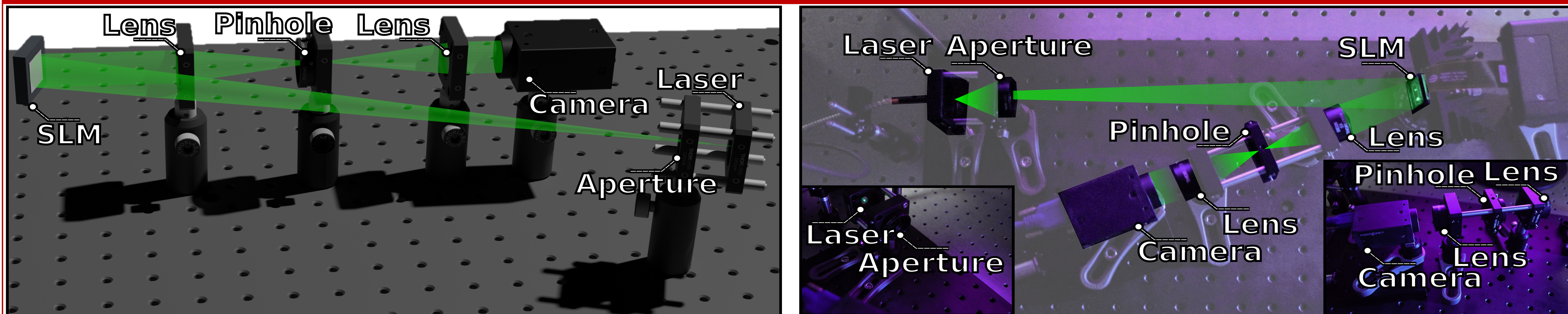
Computer Generated Holography typically relies on coherent light sources such as lasers. Due to the transfer function characteristics of coherent light sources, the defocused parts of scenes look unrealistic to a human observer. Born and Wolf [1] describes these phenomena as edge fringe effects. These fringes are typical in 3D holographic displays at the defocused parts when using coherent illumination (a, b), whereas incoherent illumination (d, e) case does not suffer from such issues.

Coherent (c) and incoherent (f) illumination also differ in defocus blur visually. We propose an improved targeting scheme and a new loss function that accounts for these differences can help reproduce incoherent defocus blur in CGH when reconstructing multiplanar images using coherent light sources [2].

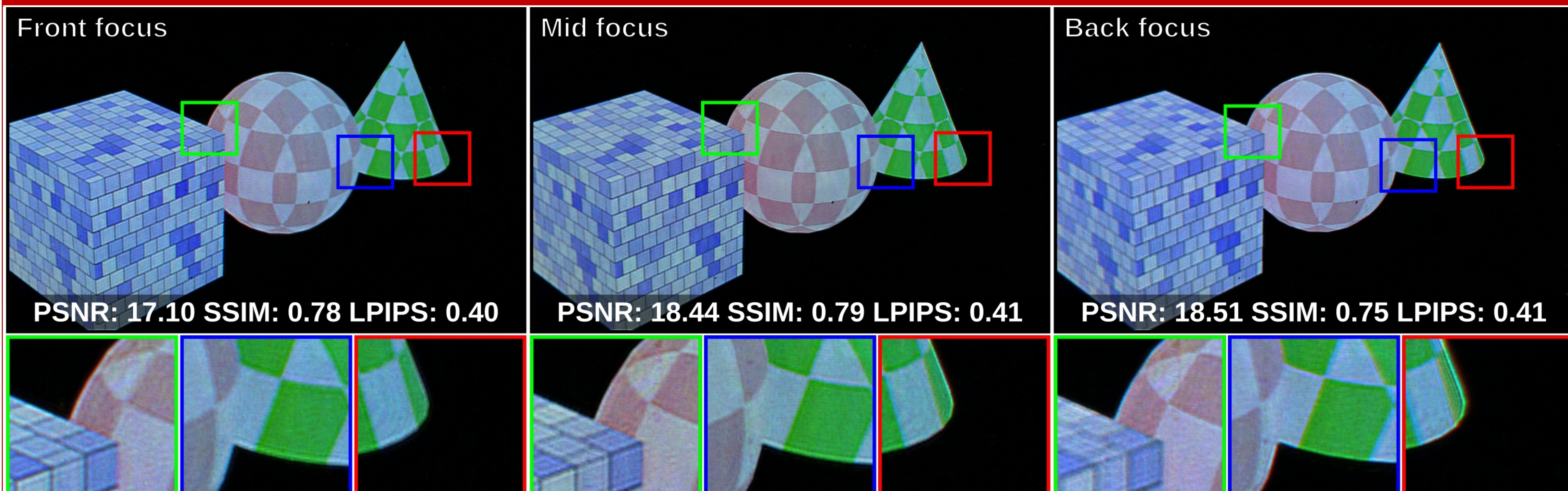
## MULTIPLANE HOLOGRAM GENERATION PIPELINE



## PROOF-OF-CONCEPT HOLOGRAPHIC DISPLAY



## CAPTURES FROM PROOF-OF-CONCEPT HOLOGRAPHIC DISPLAY



## ACKNOWLEDGEMENT

We would like to thank Erdem Ulusoy and Güneş Aydınođan discussions in the early phases of the project; Tim Weyrich and Makoto Yamada for dedicating GPU resources in various experimentation phases.

## REFERENCES

- Max Born and Emil Wolf. 2013. "Principles of optics: electromagnetic theory of propagation, interference and diffraction of light." Elsevier.
- Kavaklı, K., Itoh, Y., Urey, H. & Akşit, K. 2022. "Realistic defocus blur for multiplane computer-generated holography.", arXiv preprint arXiv:2205.07030 DOI: <https://doi.org/10.48550/arXiv.2205.07030>

## FUNDING

Koray Kavaklı is supported by the TÜBİTAK's 2224-A Support Program for Participation in Scientific Activities Abroad grant. Yuta Itoh is supported by the JST FOREST Program Grant Number JPMJPR17J2 and JSPS KAKENHI Grant Number JP20H05958 and JP21K19788. Hakan Urey is supported by the European Innovation Council's HORIZON-EIC-2021-TRANSITION-CHALLENGES Program, Grant Number 101057672 and TÜBİTAK's 2247-A National Lead Researchers Program, Project Number 120C145. Kaan Akşit is supported by the Royal Society's RGS\R2\212229 - Research Grants 2021 Round 2 in building the hardware prototype.

