Modulating Imaging Characteristics Post Recording - A New Pathway in Imaging

Vilnius, Lithuania

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Presenter

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Outline

- Background
- Research Works

   1) Enhanced design of multiplexed coded masks for Fresnel incoherent correlation holography
   2) Sculpting axial characteristics of incoherent imagers by hybridization methods
   3) Post-Ensemble Generation with Airy Beams for Spatial and Spectral Switching in Incoherent Imaging

- Conclusion

Background

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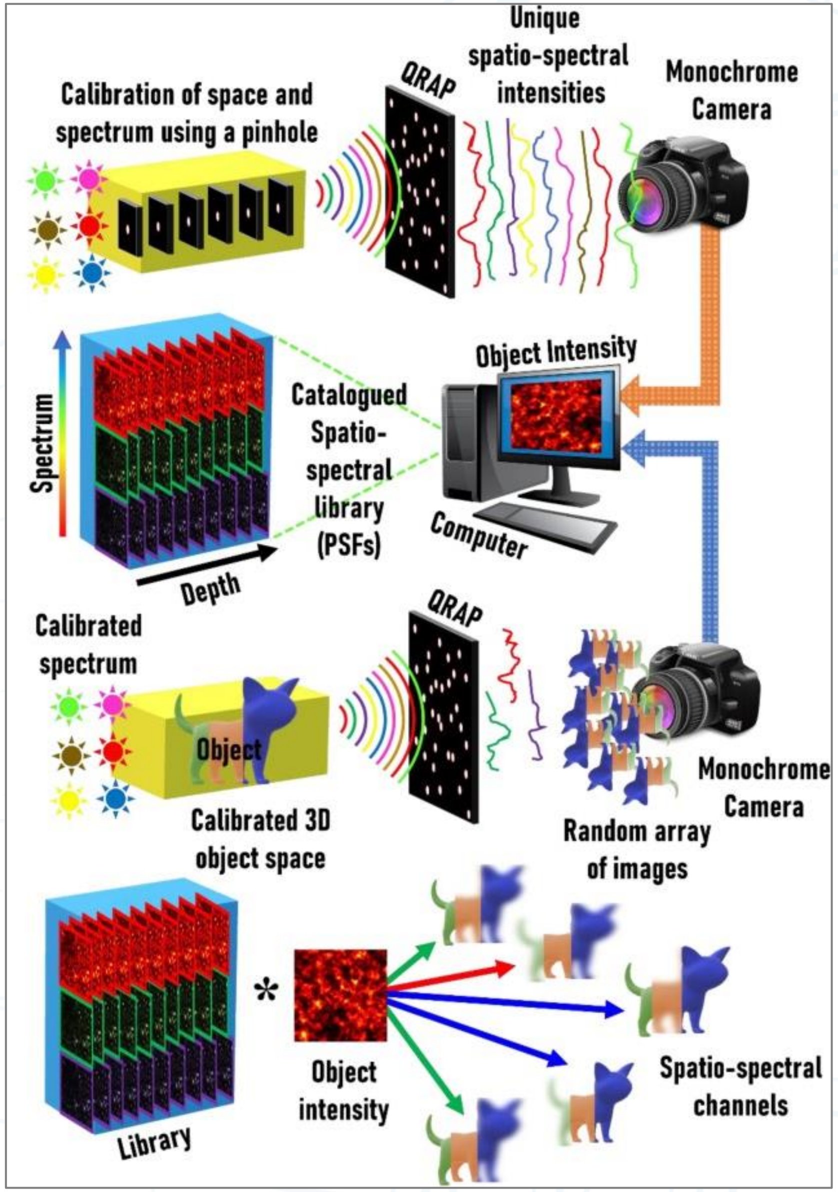
Novel imaging technology using chaos

Multispectral and multidimensional imaging systems



Ensemble of chaotic beams

Tuning image resolutions

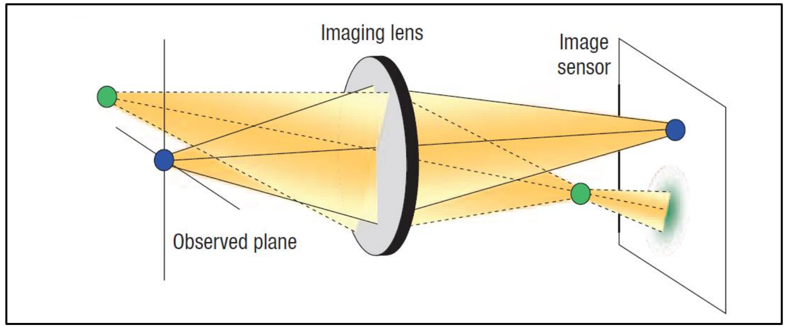
- Spatial and Spectral resolutions
- Interdependencies?

Anand, et al, "Single shot multispectral multidimensional imaging using chaotic waves" Sci. Rep. 10, 13902 (2020)

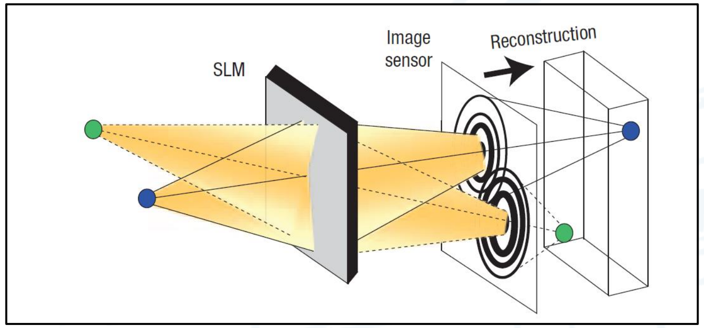
Background

Fresnel incoherent correlation holography (FINCH)

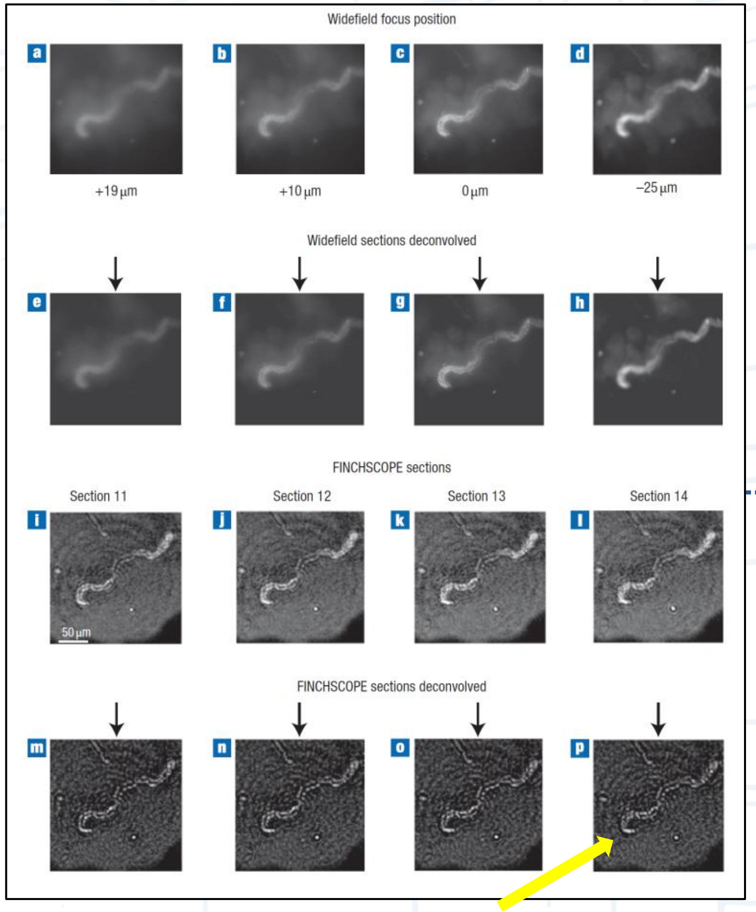
Conventional imaging



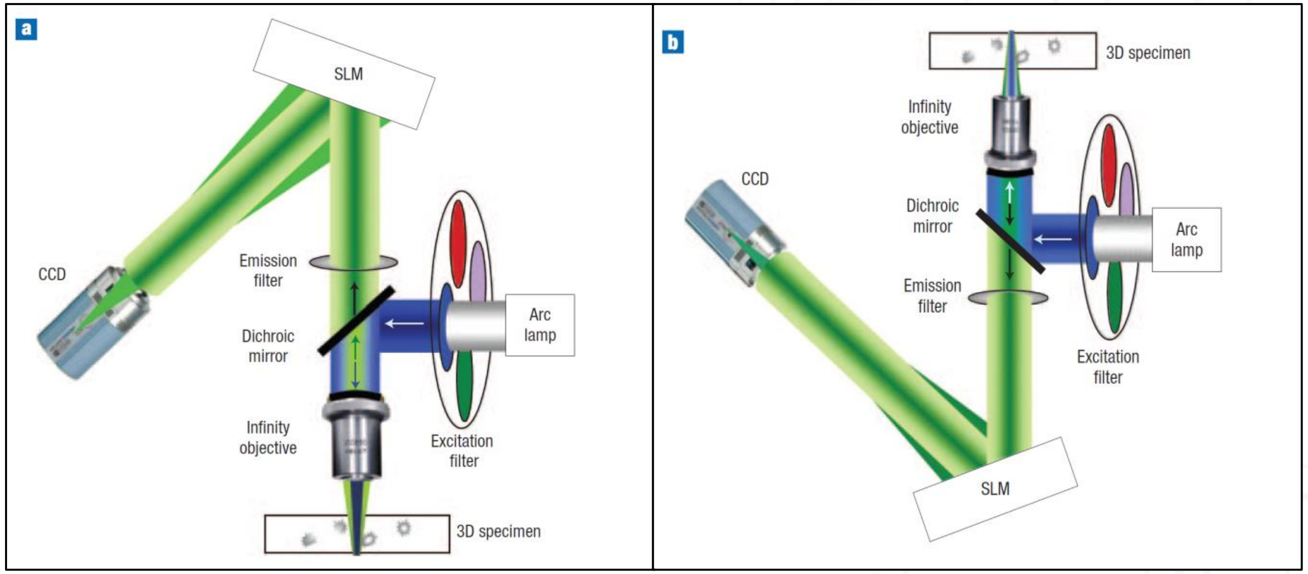
FINCH



Results - FINCHSCOPE



Configuration - FINCHSCOPE

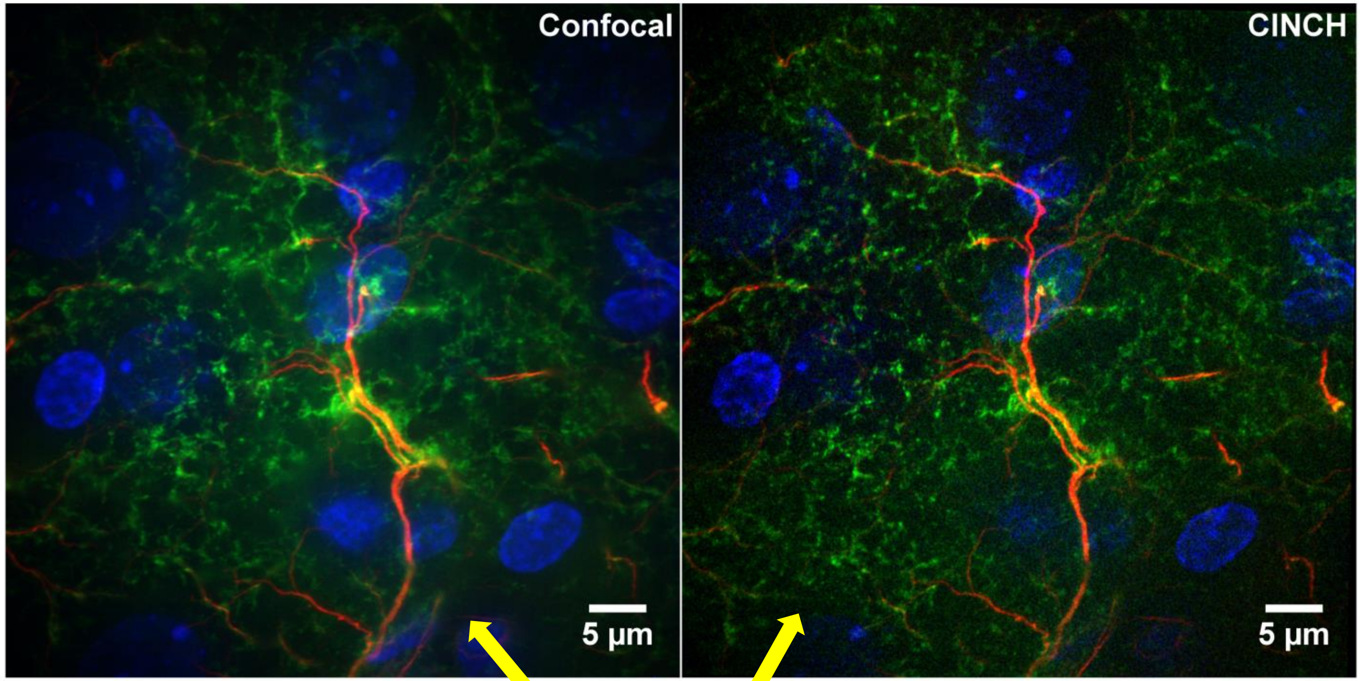


Nerve fibers of the skin

Rosen, et al, “Non-scanning motionless fluorescence three-dimensional holographic microscopy” Nature Photon 2, 190–195 (2008)

Background

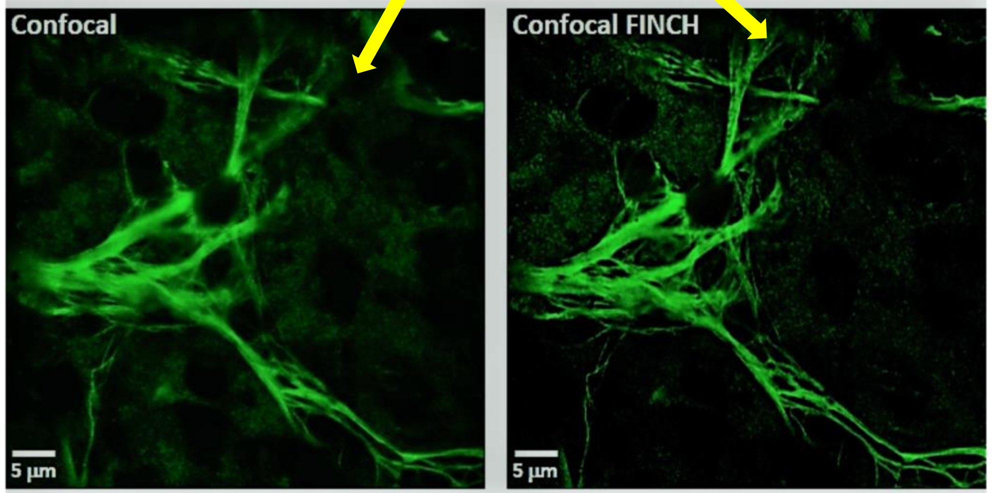
Fresnel incoherent correlation holography (FINCH)



Mouse brain astrocytes. Blue: DAPI, Green S100B, Red GFAP. Maximum intensity projection of 13 planes, 0.25 micron/slice. Both [illegible]focal and CINCH images have been deconvolved. Sl[illegible] courtesy of Lynne Holtzclaw, NICHD Microscopy & Imaging Core Facility at NIH. Images generated using CellOptic's CINCHSCOPE with 100X 1.4 NA objective.

Mouse brain astrocytes

Mouse retinal astrocytes



Comparison of single plane confocal and FINCH confocal images (CINCH) of the same plane of mouse retinal astrocytes labeled with Cy3. Slide courtesy of Dr. Gerard Lutty and Dr. Adam Wenick, Johns Hopkins University Wilmer Eye Institute. Images generated using CellOptic's CINCHSCOPE with 100X 1.4 NA objective.

http://celloptic.com/image-gallery

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Research Works

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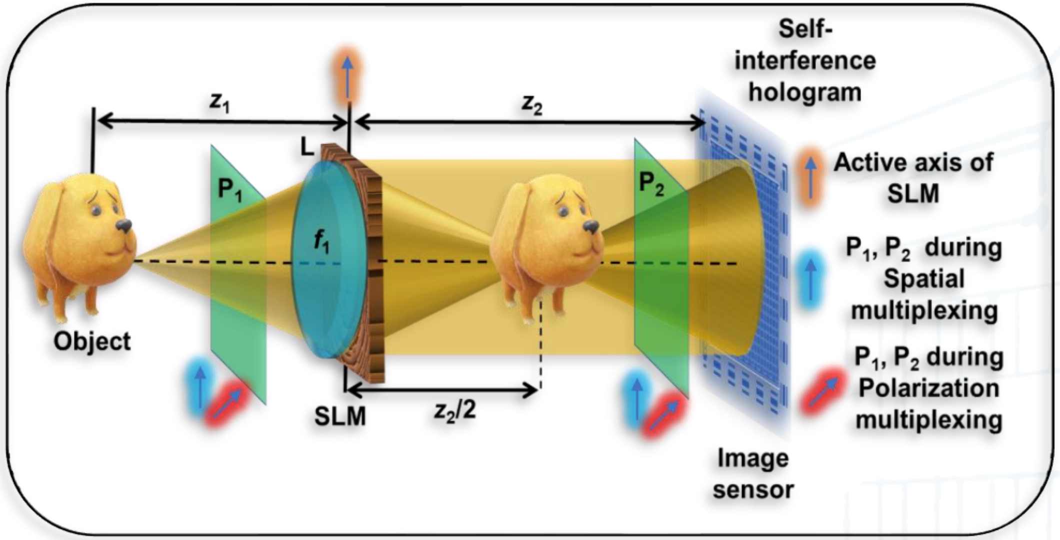
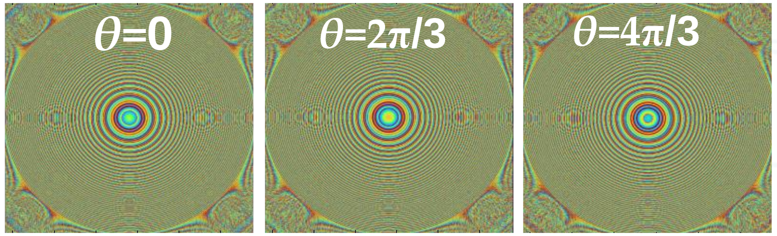
1) Enhanced design of multiplexed coded masks for Fresnel incoherent correlation holography

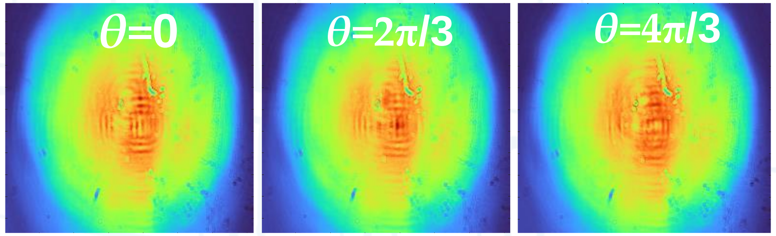
Optical configuration (FINCH)



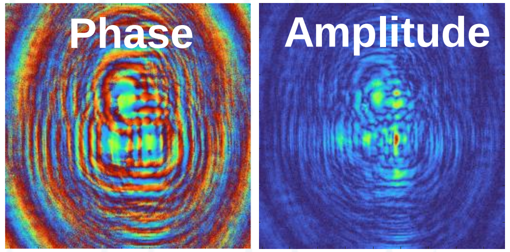
Phase-shifted masks on SLM



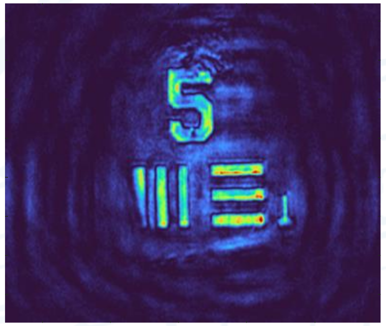
Phase-shifted Holograms



Complex Hologram



Reconstruction

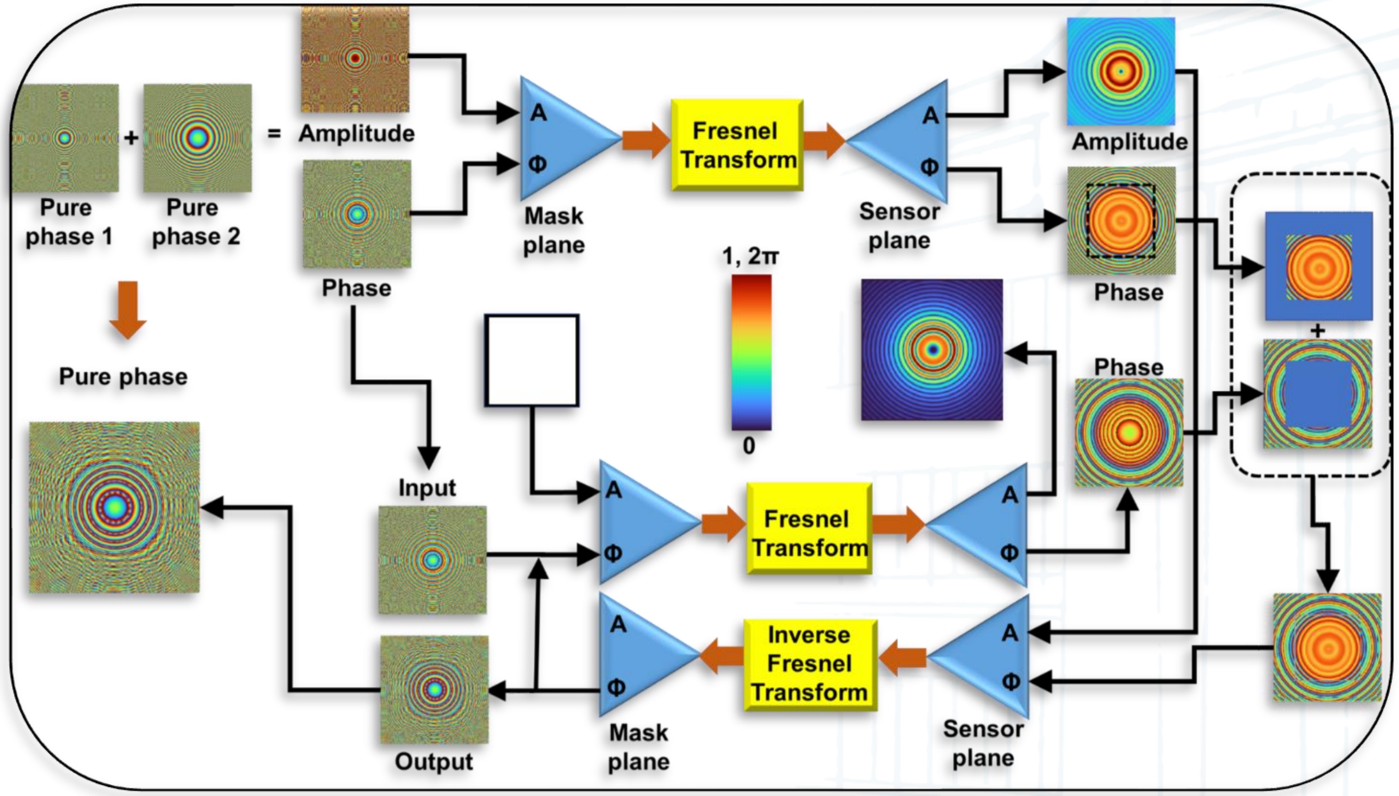


Challenges in FINCH

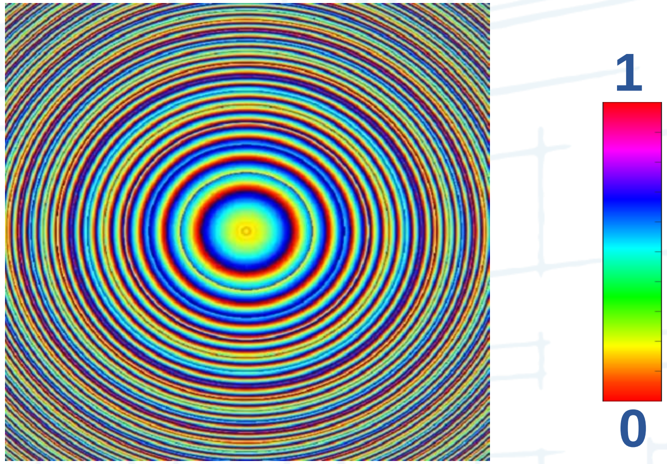
- Low SNR due to random multiplexing
- Low axial resolution than direct imaging
- Loss of light due to scattering

Research Works

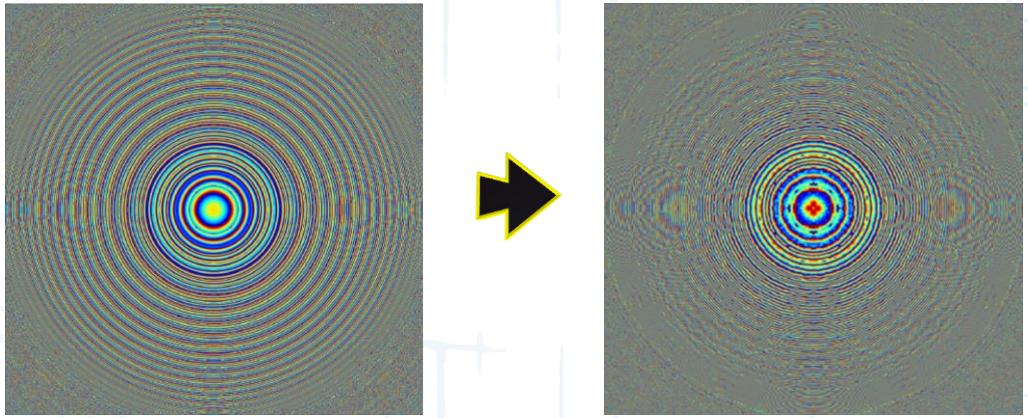
Transport of amplitude into phase based on Gerchberg - Saxton algorithm (TAP – GSA)



Iteration video of a pure phase mask by TAP-GSA



Phase mask before and after iterations



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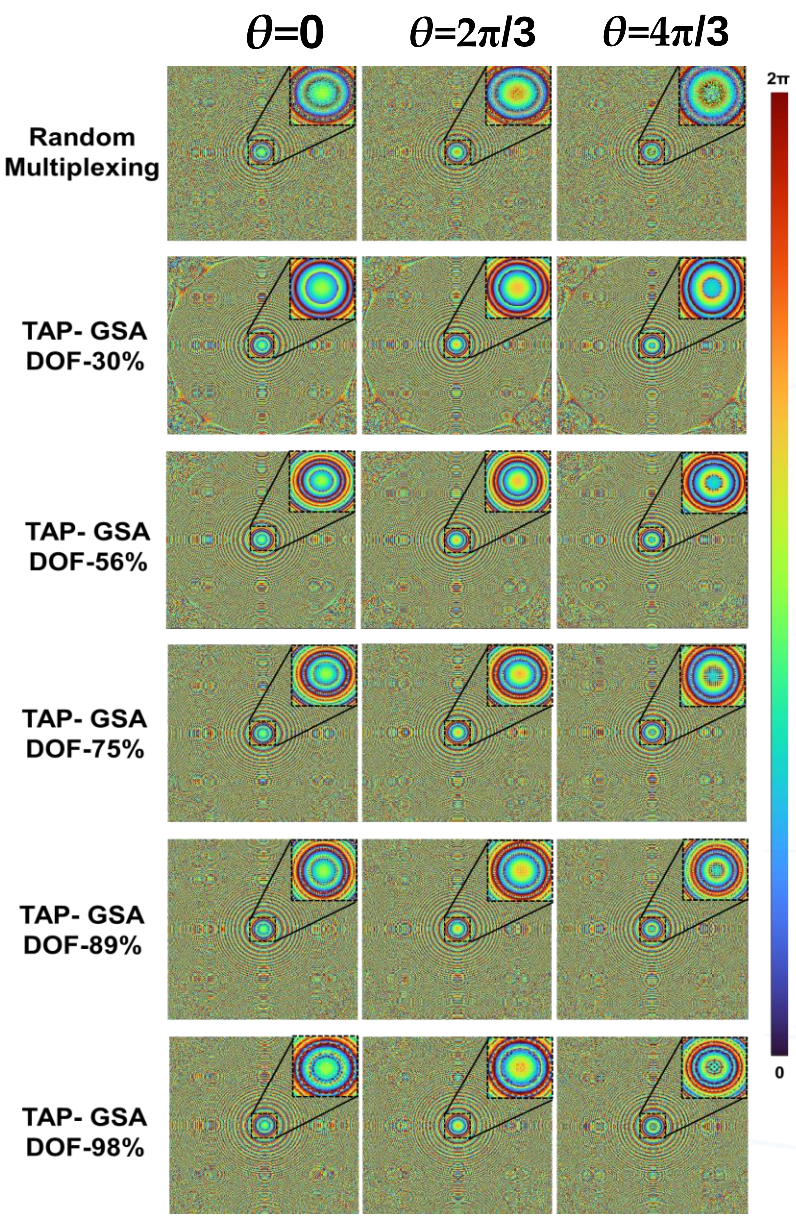
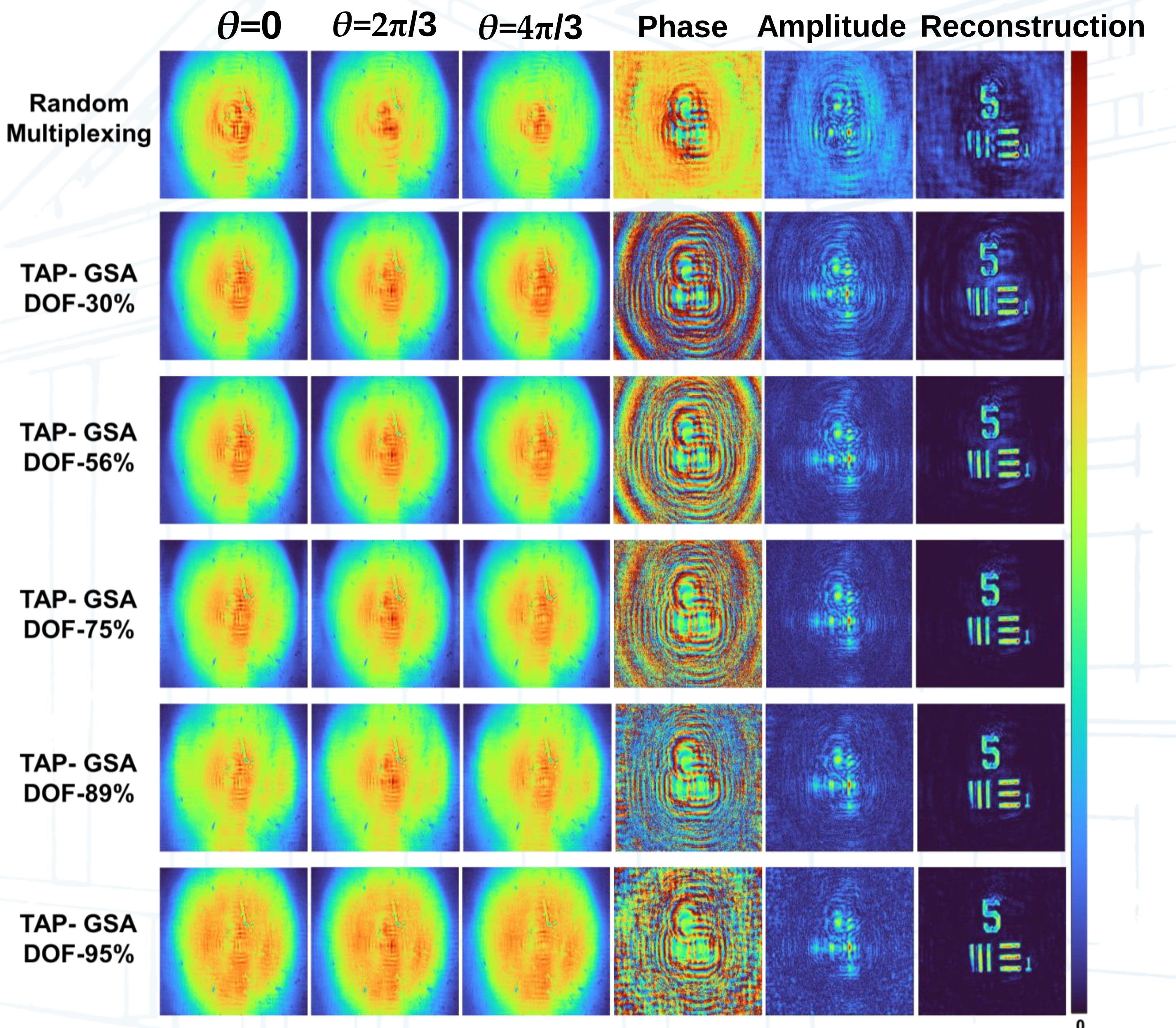
Phase Masks



Experimental Results



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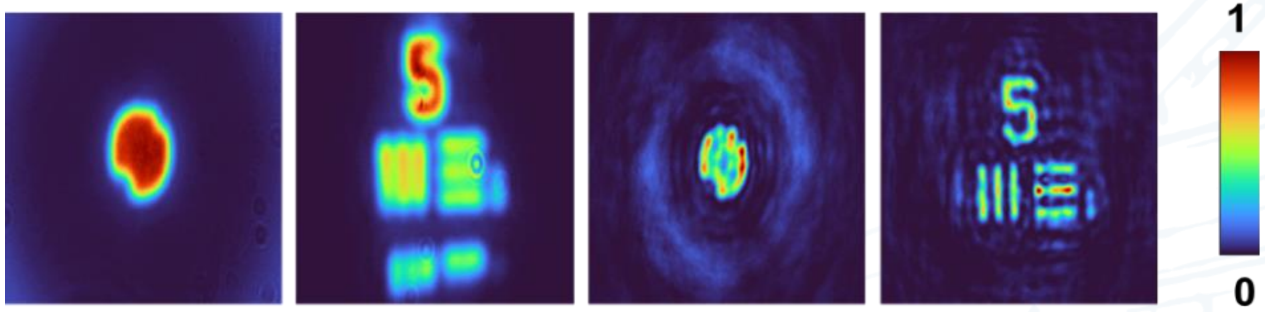
Research Works

Super Resolution

Direct imaging — FINCH with TAP-GSA

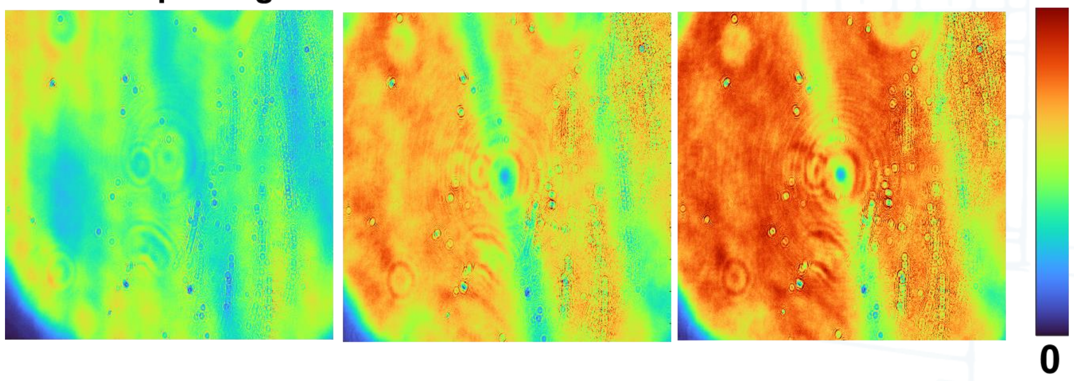


Problems solved by FINCH with TAP-GSA

- Reconstruction noises reduced
- High light throughput

Holograms recorded at the same exposure time

Polarization multiplexing — Random multiplexing — TAP- GSA



https://www.youtube.com/watch?v=r99UGMCxwkk

Published on May 6, 2023

nature SCIENTIFIC REPORTS

Gopinath, et.al, "Enhanced design of multiplexed coded masks for Fresnel incoherent correlation holography," Sci. Rep. 13, 7390 (2023)

Research Works

2) Sculpting axial characteristics of incoherent imagers by hybridization methods

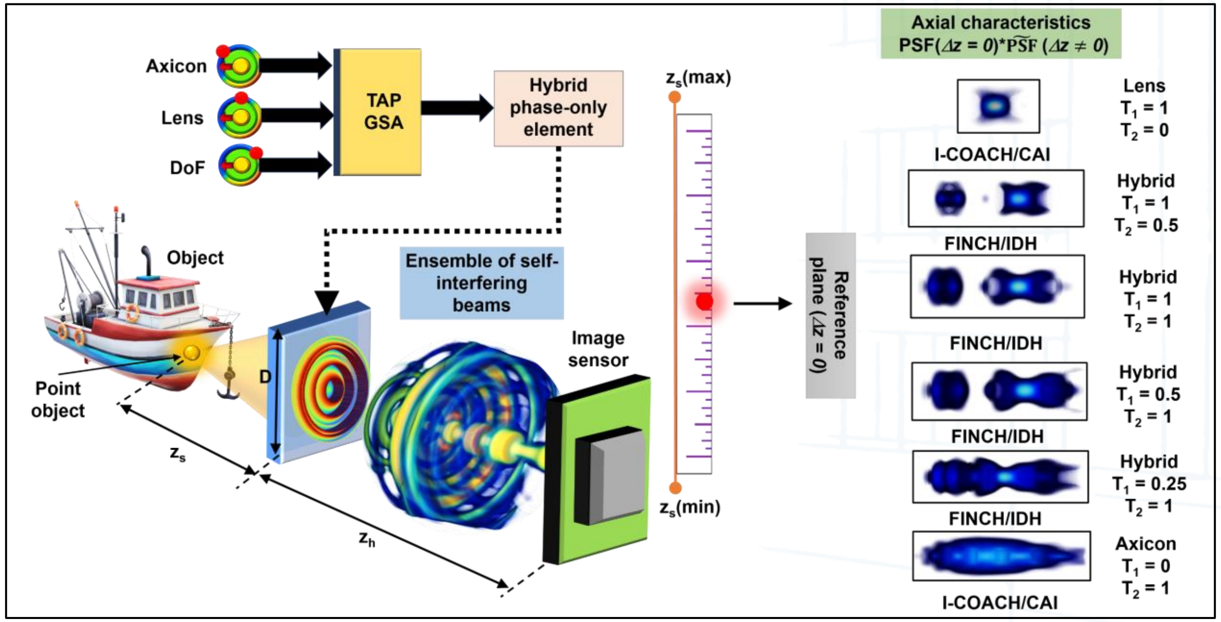
Lateral and Axial Resolutions

Interdependent

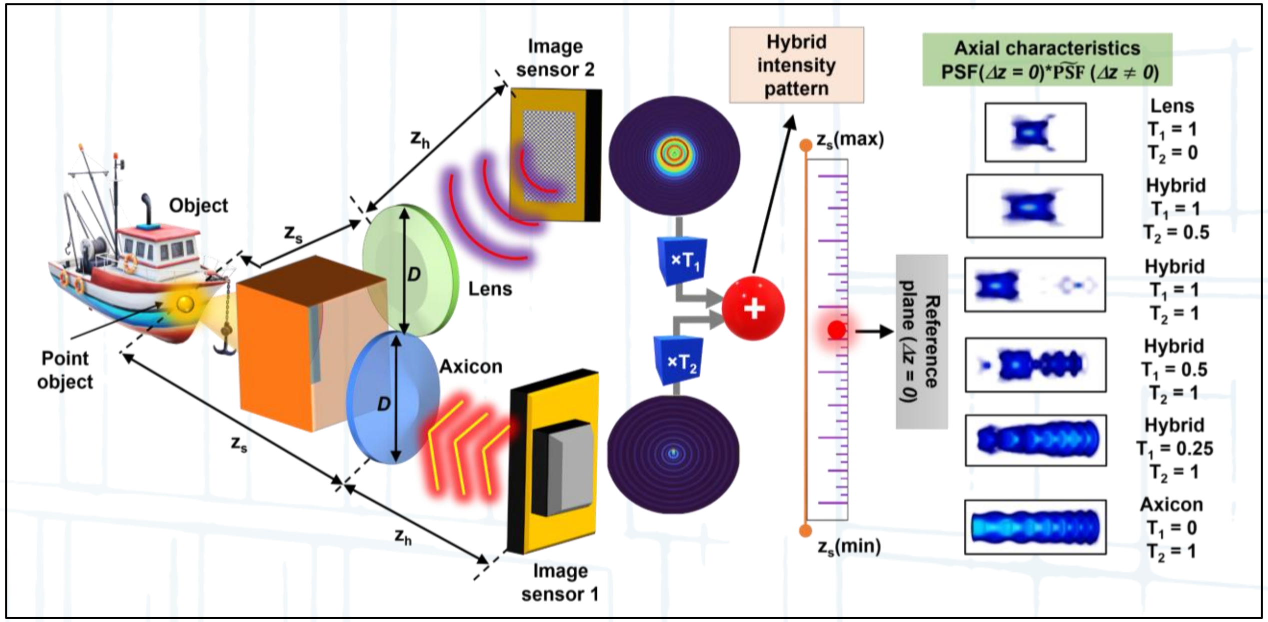
Not possible to change

Incoherent hybrid imaging systems (INCHIS)

INCHIS – H1 (Tuning Real-time)



INCHIS – H2 (Tuning Post-recording)



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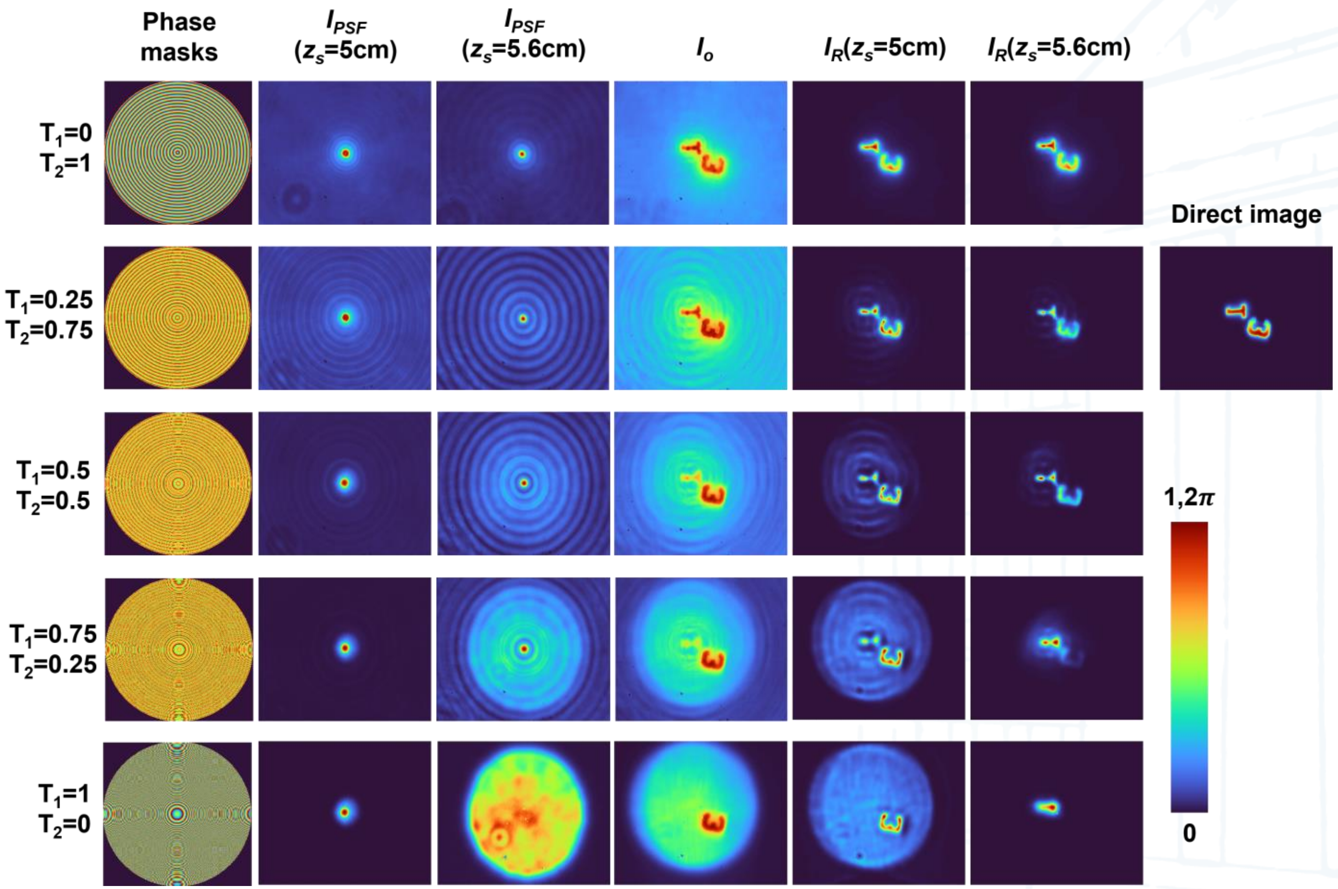
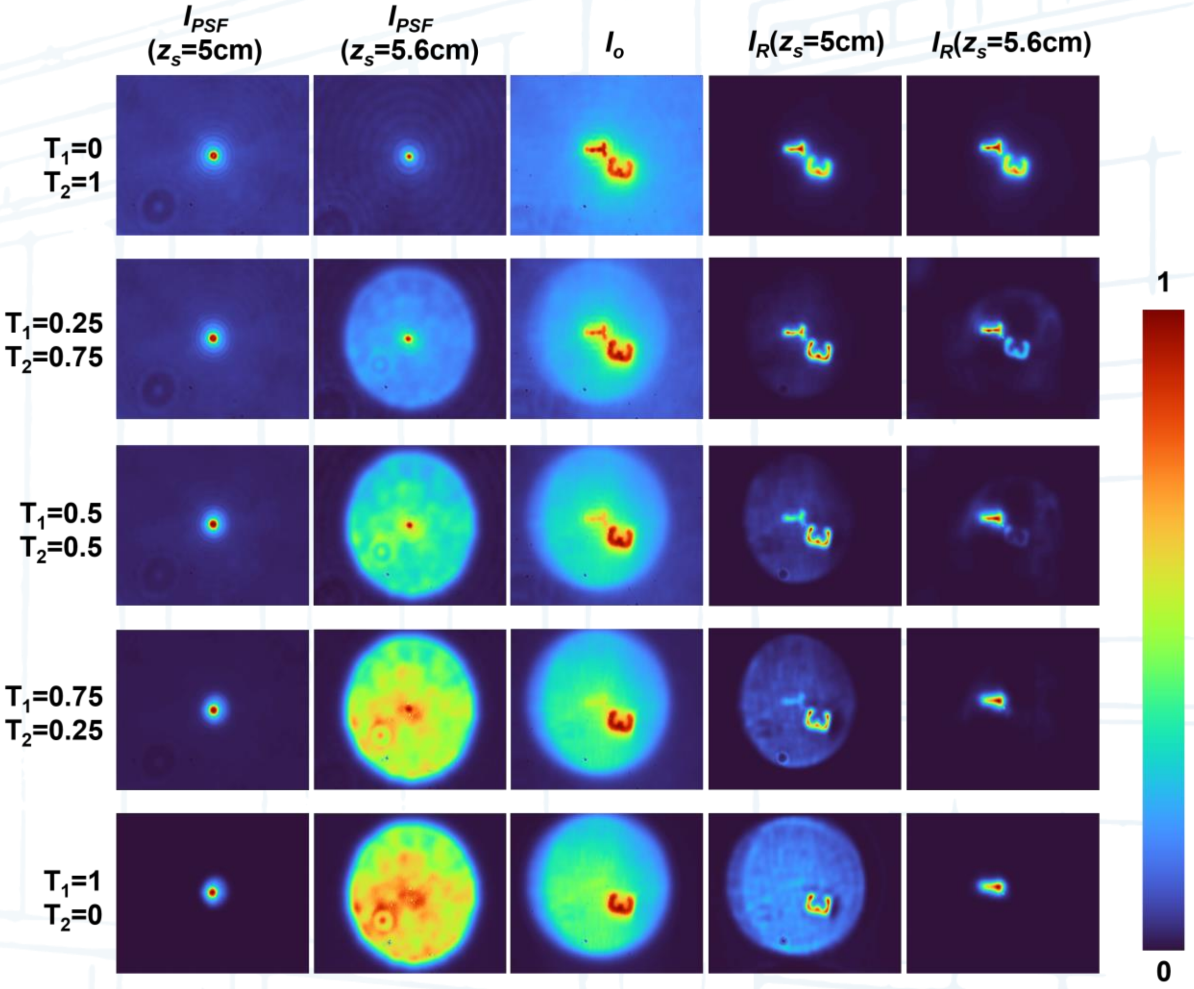
Research Works

INCHIS- Experimental Results

INCHIS – H1 (Tuning Real-time)



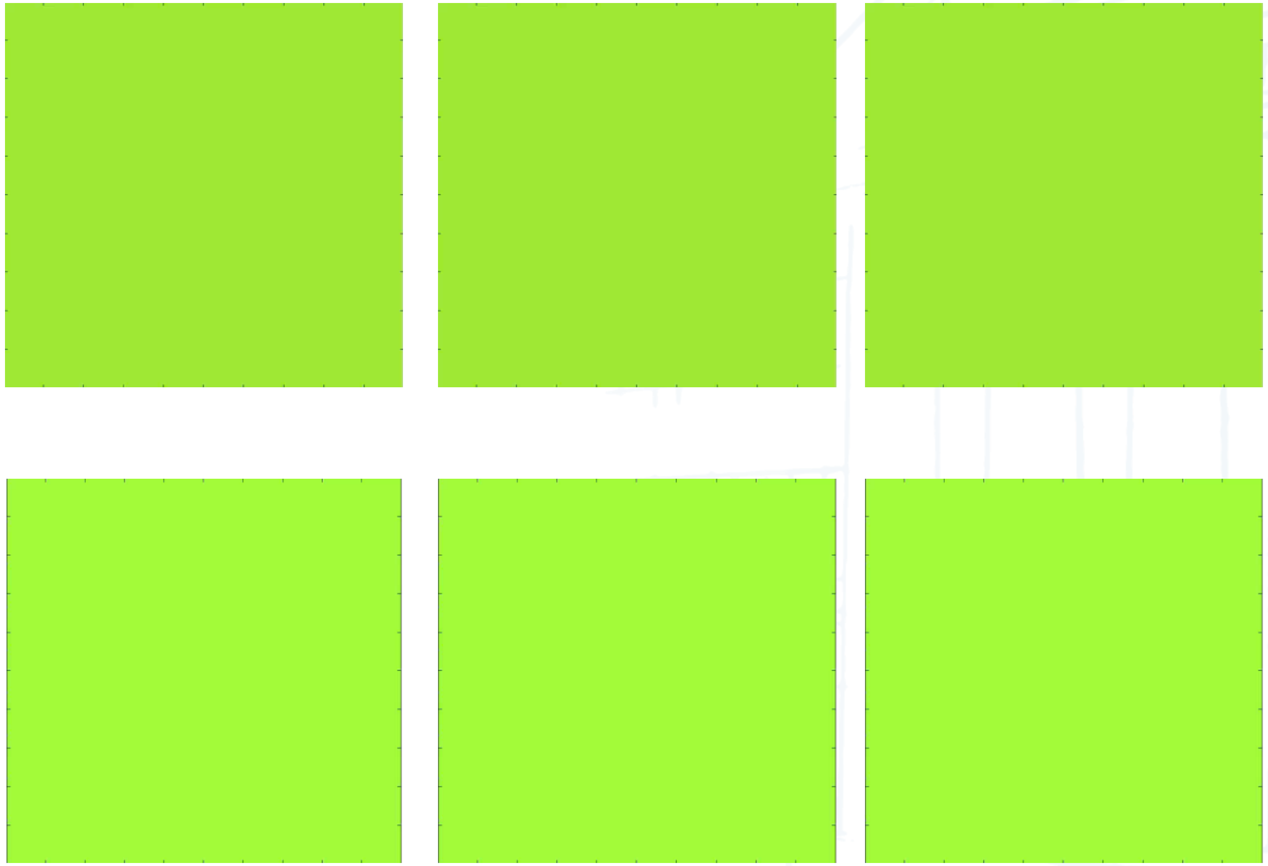
INCHIS – H2 (Tuning Post-recording)



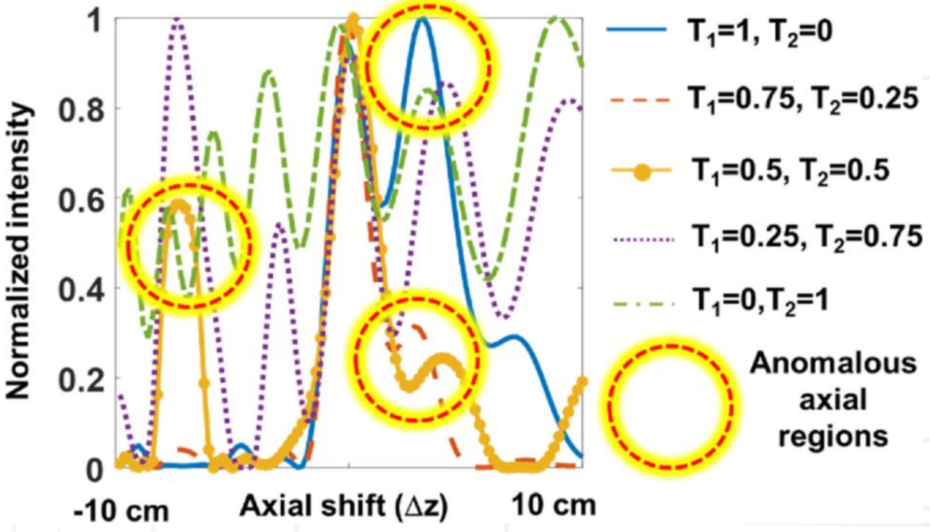
Research Works

Variation in Axial Resolution

	Lens	Hybrid State	Axicon
INCHIS H1			
INCHIS H2			



Axial Intensity Distributions



Research Works

Highlights

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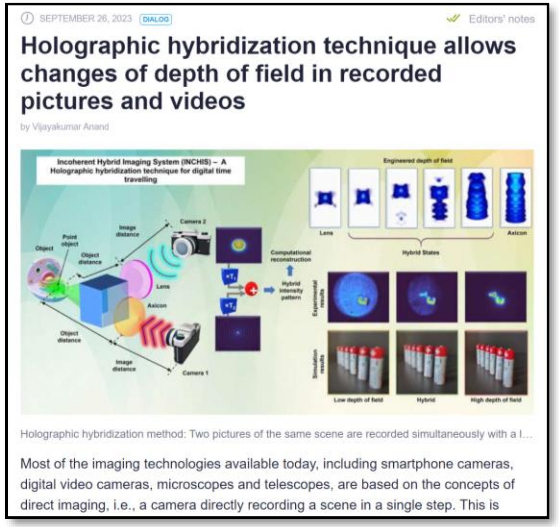
SEPTEMBER 26, 2023 DIALOG Editors' notes

Holographic hybridization technique allows changes of depth of field in recorded pictures and videos

by Vijayakumar Anand

Holographic hybridization method: Two pictures of the same scene are recorded simultaneously with a l...

Most of the imaging technologies available today, including smartphone cameras, digital video cameras, microscopes and telescopes, are based on the concepts of direct imaging, i.e., a camera directly recording a scene in a single step. This is

https://phys.org/news/2023-09-holographic-hybridization-technique-depth-field.html

ERR.ee


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Tartu opticians' new imaging method pleases both doctors and photographers

TECHNIQUE

Airika Harrik

23.10.2023 13:42

Listen to the article 6 min

Gopinath's group creates new imaging technologies: improves image quality and resolution.

Author/source: Rasmus Kooskora

A new imaging method by the optical physicists of the University of Tartu called Incohernt Hybrid Imaging System (INCHIS) can be useful in many fields. In the future, it can be applied, for example, in cinematography, microscopy, holography, medical imaging and smartphone cameras.

https://novaator.err.ee/1609141678/tartu-optikute-uus-pildistusmeetod-roomustab-nii-arste-kui-ka-piltnikke

IEEE Spectrum


NEWS COMPUTING

Impossible Photo Feat Now Possible Via Holography

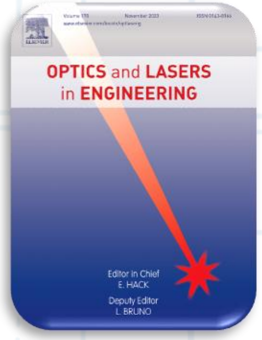
›Now you can focus on anything while giving up nothing, with simple, cheap optics

https://spectrum.ieee.org/depth-of-field

- **INCHIS–H2: First method to tune image resolutions post-recording**

https://www.youtube.com/watch?v=aDi6WrK34hs

Published on September 20, 2023



Gopinath et.al, "Sculpting axial characteristics of incoherent imagers by hybridization methods," Opt. Lasers Eng. 172, 107837 (2024)

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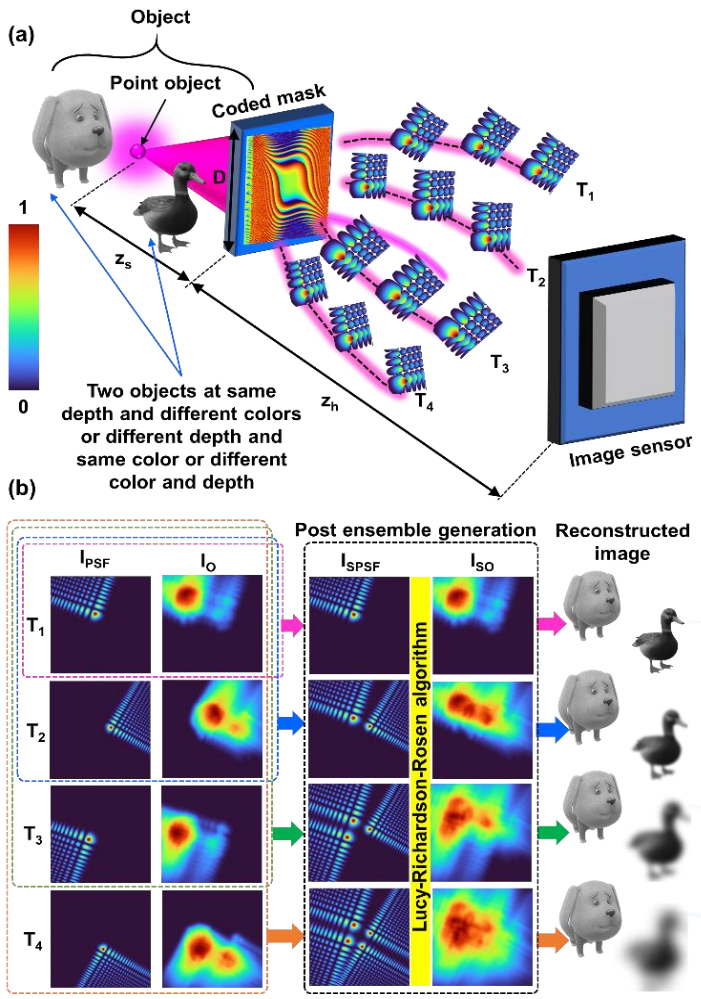
Research Works

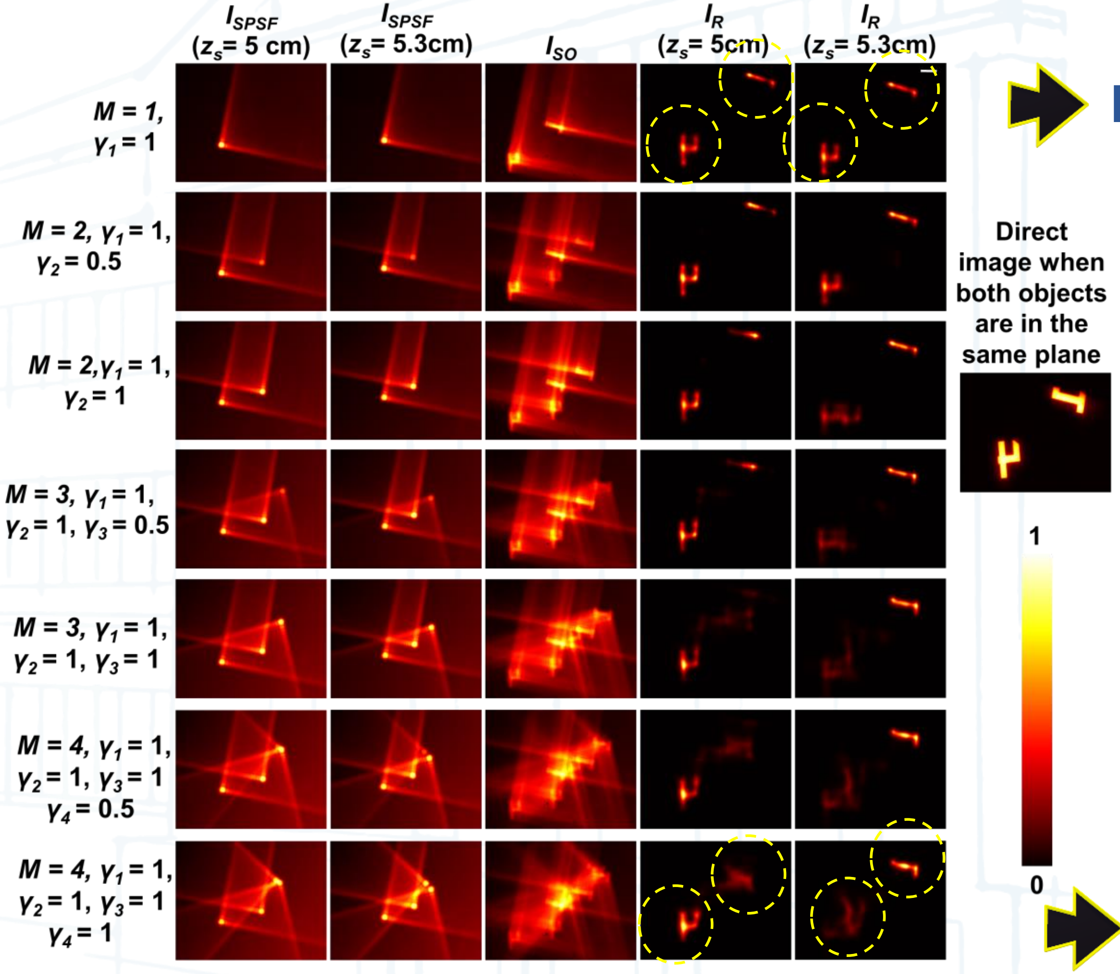
3) Post-Ensemble Generation with Airy Beams for Spatial and Spectral Switching in Incoherent Imaging (PEGASASS)

Work is under review

Optical configuration - PEGASASS



Results – Same wavelength and different depths



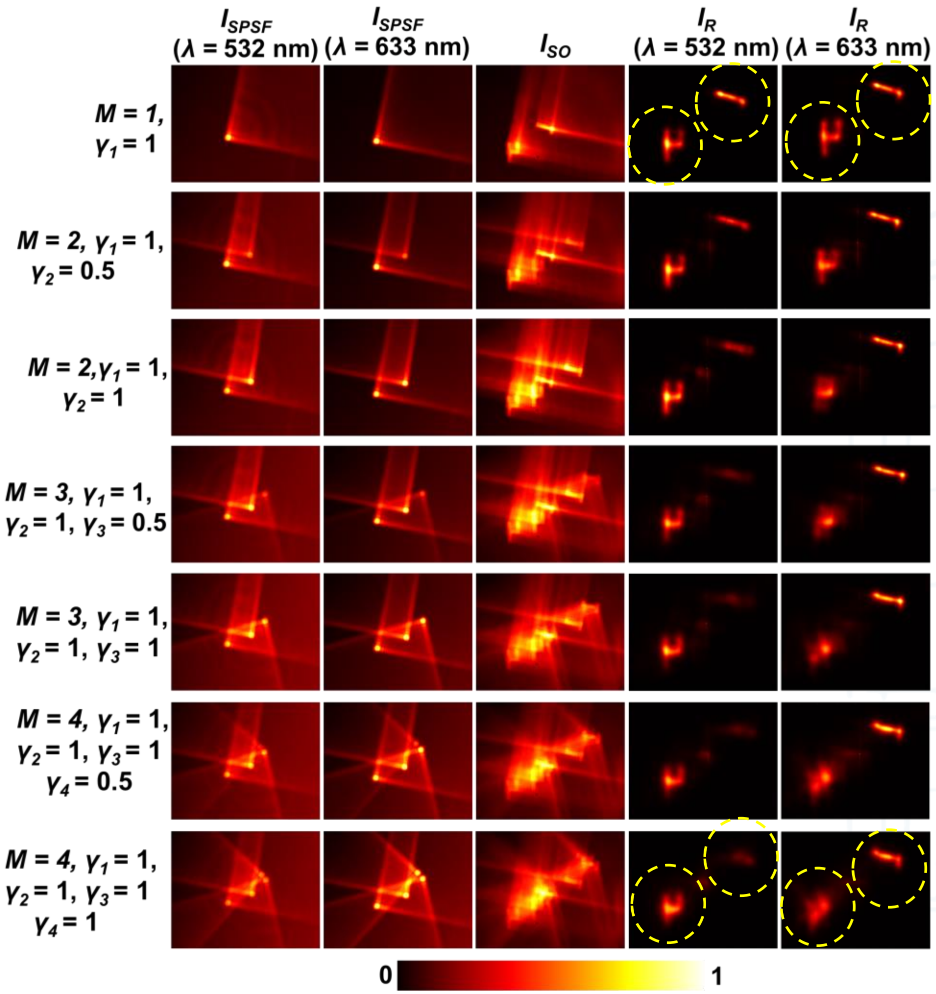
Low axial resolution

Increase in the number of beams

High axial resolution

Research Works

Same depth and different wavelengths

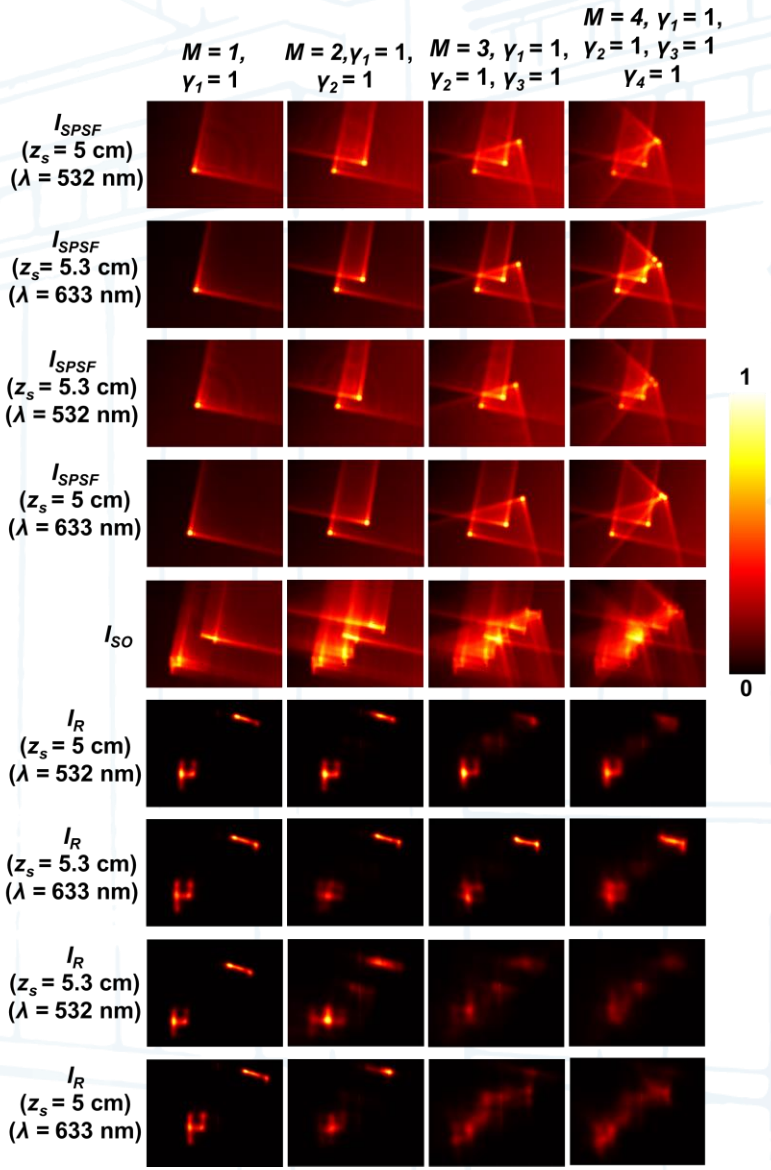


Low spectral resolution

Increase in the number of beams

High spectral resolution

Different depths and different wavelengths



Conclusion

- **FINCH with TAP-GSA:** Solves the drawbacks in the existing FINCH method

- **INCHIS:** Allows to modulate axial resolution both in real-time as well as post-recording

- **PEGASASS:** Allows to modulate both axial and spectral resolutions post-recording.

- **Application areas:** digital holography, microscopy, computer vision, cinematography, etc.

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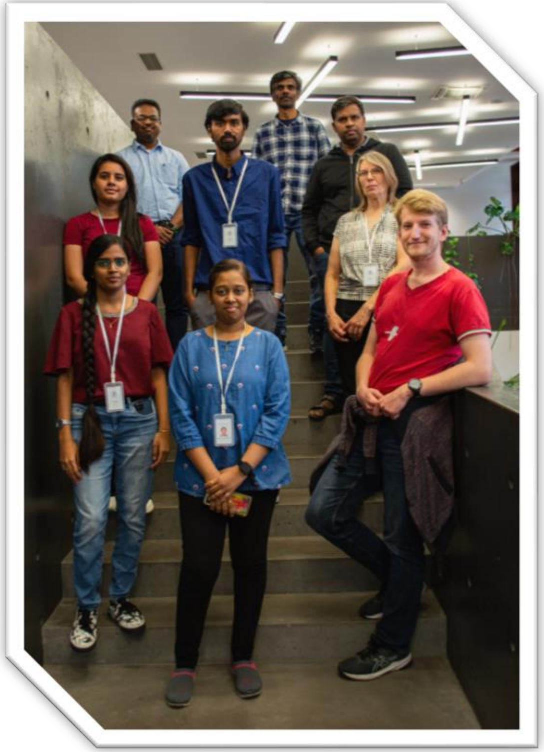
THANK YOU!



OUR TEAM (CIPHR)

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https://www.youtube.com/ @eraciphrlab2865