Op
Synthetics

HAZGUARD – ERC PoC project

ERC Proof of Concept Webinar
Thursday 11th Dec 2025

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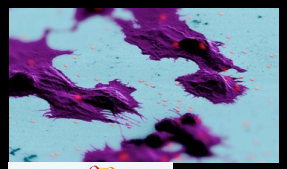
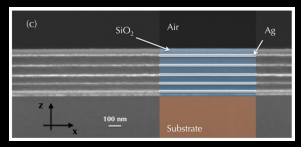
Intracellular nanolasers



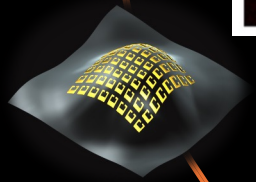
III-V lasers

Holographic metasurfaces



Epsilon near zero metamaterials
(visible – IR – THz)

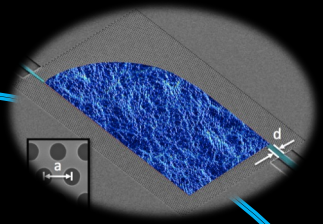
Metamaterials



Ultra-low power nonlinearities
Photonic skin
Optical Neural Networks

Cloud formation monitoring

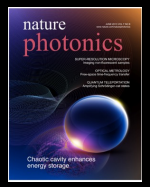
Silicon photonics



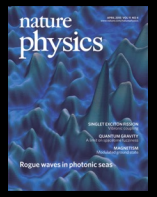
Synthe Optics

Technological platforms

Broadband energy harvesting



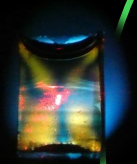
Chaotic resonators
Photonic crystals
Slow light



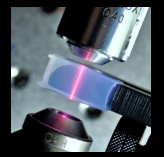
Optical rogue waves

Unbreakable cryptography

Silica aerogel

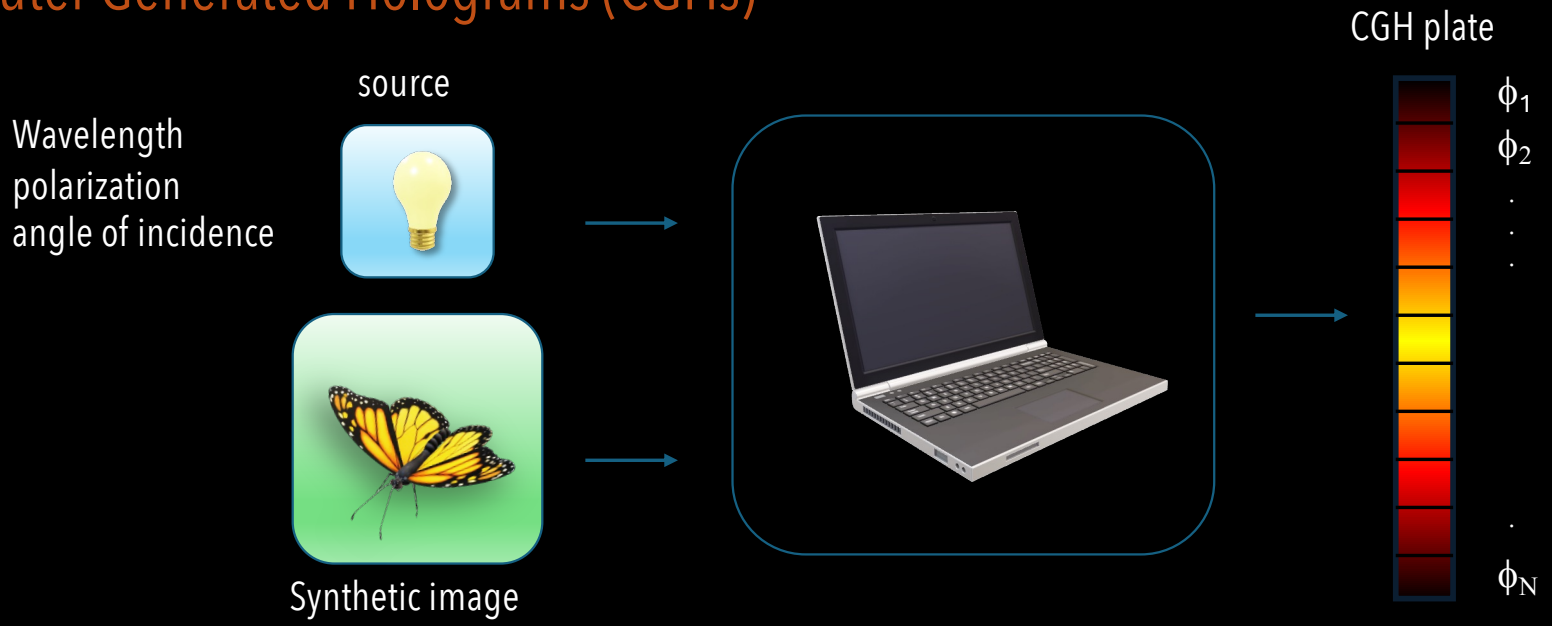


Nonlinear scattering media

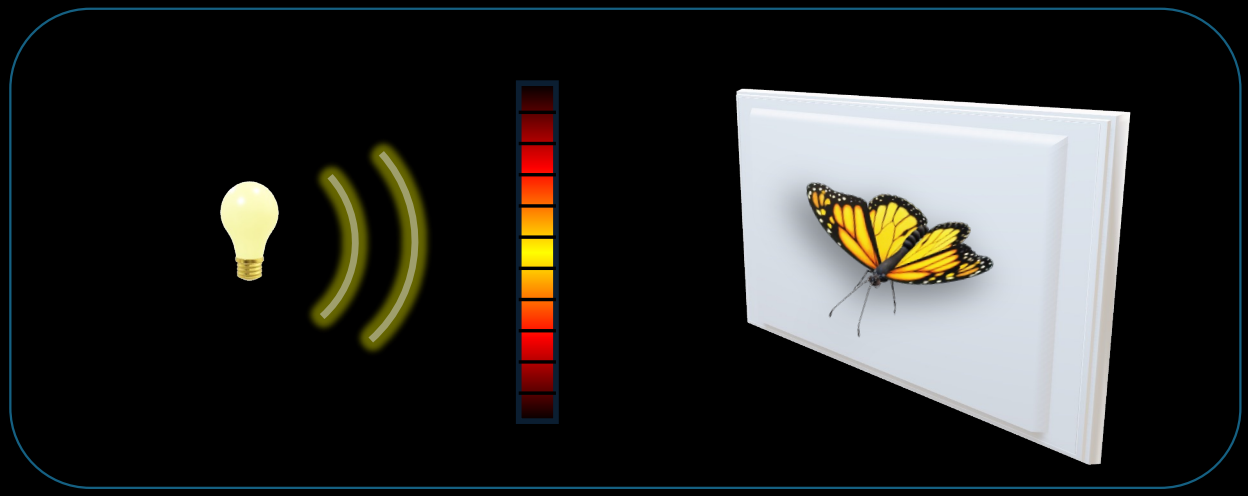


Ultralight
Hydrophobic
Optofluidic circuitry

Computer Generated Holograms (CGHs)



The information can be multiplexed on different degrees of freedom, in one single metasurface

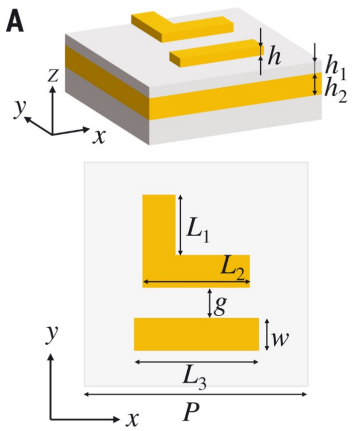


Different images for different propagation angle, color, polarization, etc..

Types of metasurfaces

Resonant (Topology)

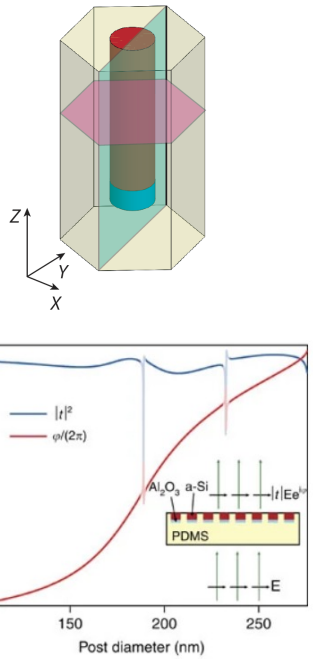
The electric and magnetic resonances are engineered to produce the desired dephasing.



Science 373, 1133 (2021)

Guided mode

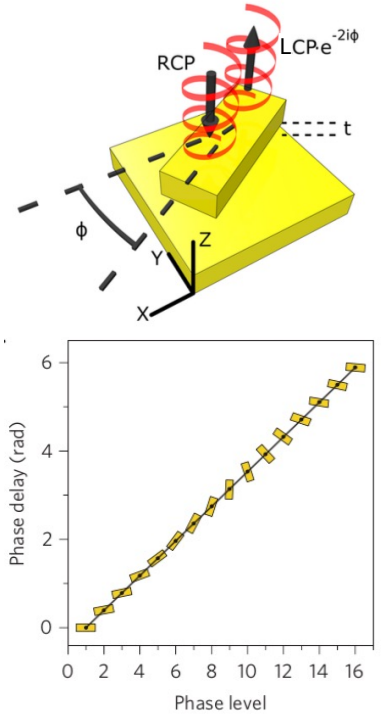
The meta-atoms work like waveguides with effective index depending on the geometry, which produce different dephasing.



Nat. Comm. 7, 11618 (2016)

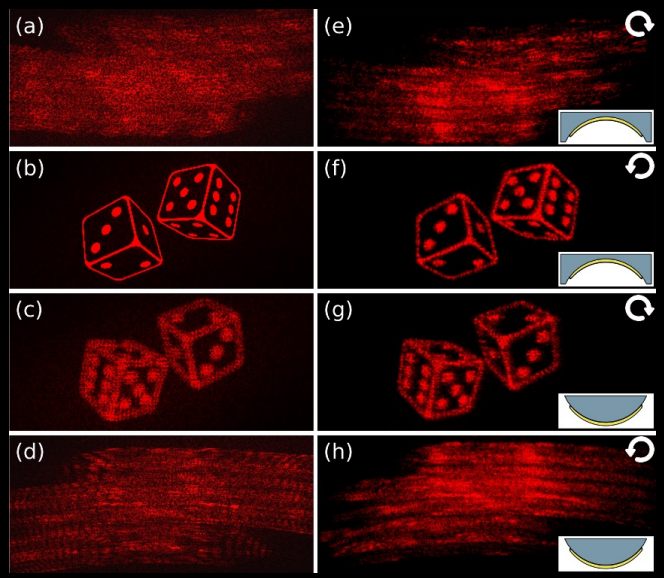
Orientation (PB – elements)

The reflected (or transmitted, for dielectric case) beam acquires a phase dictated by the orientation of the nanorod.

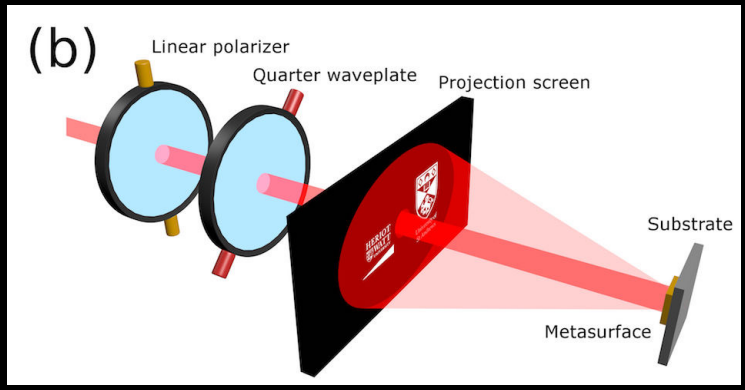


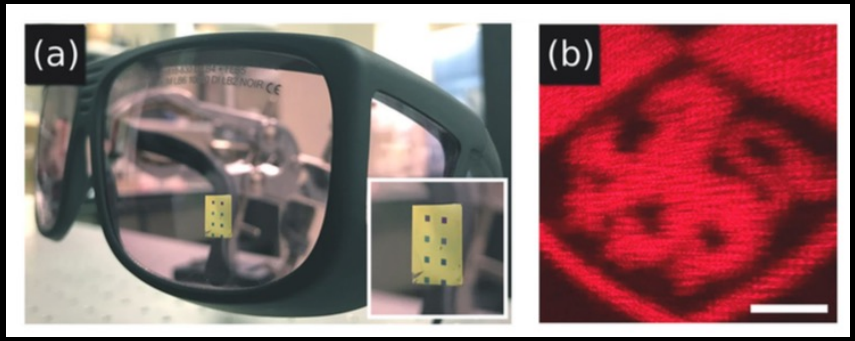
Scientific Reports 7, 501 (2017)

Flexible holographic metasurfaces



The holographic MM can be applied also to curved surfaces, with controllable effects on the quality.

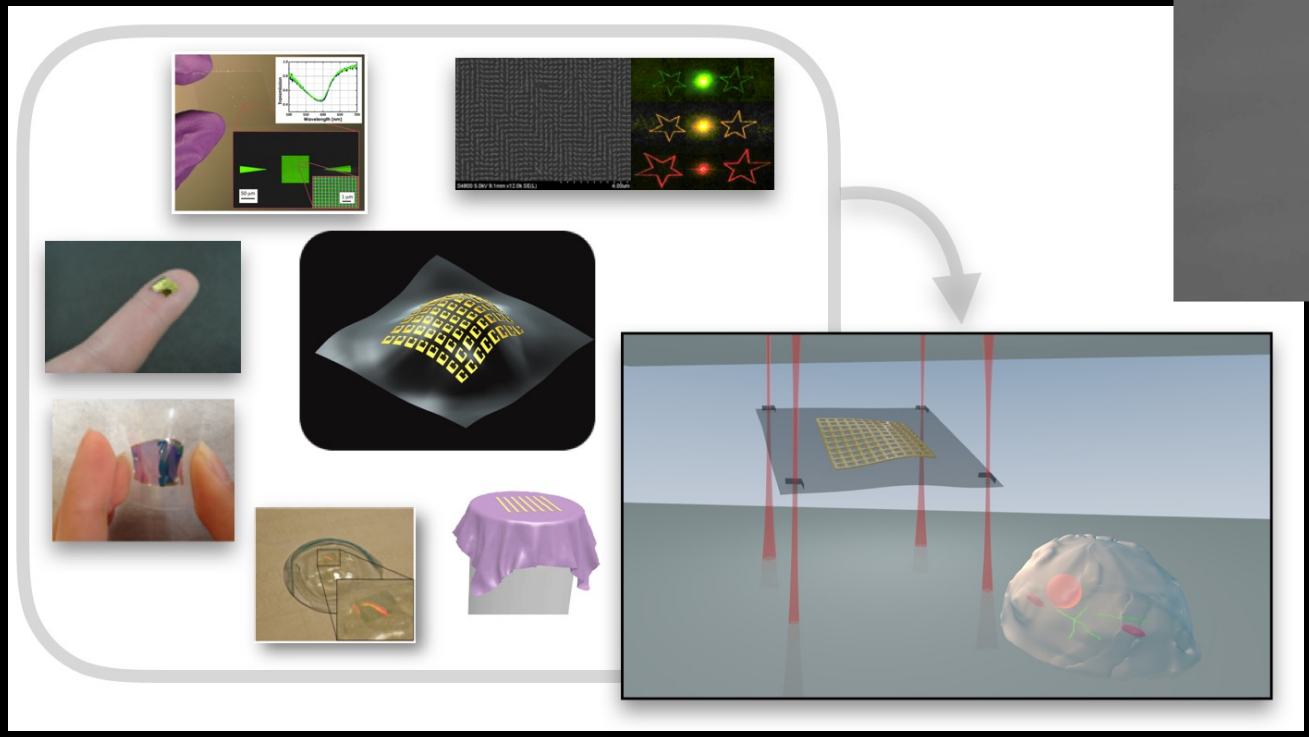




J. Burch and A. Di Falco, ACS Photonics 5, 1762–1766 (2018)

J. Burch *et al.*, Scientific Reports, 7, 501 (2017)

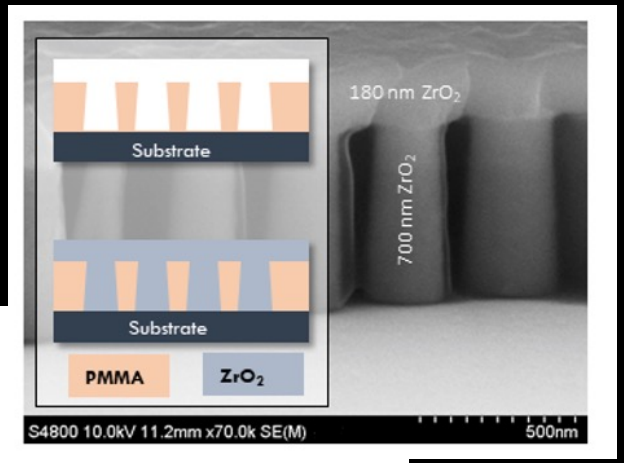
All optical manipulation of photonic metasurfaces in microfluidic environments for biophotonics applications – AMPHIBIANS (ERC Consolidator 2019-2025)

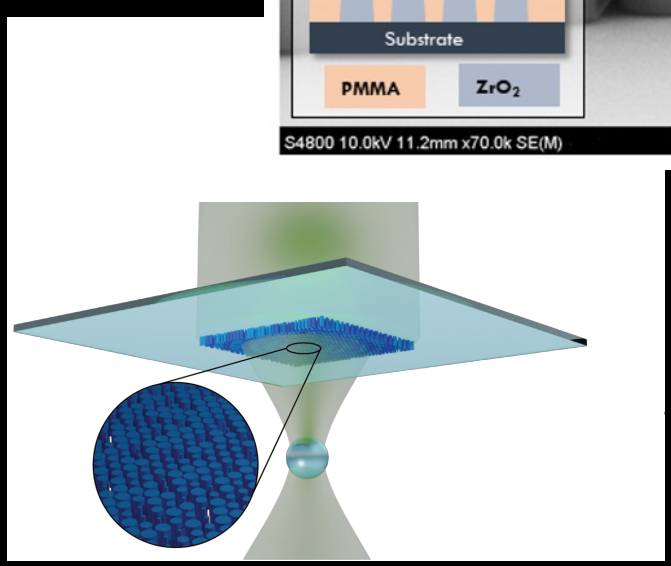


Tuning the behavior of flexible MMs with nanoscale features require precise manipulation on μm scale and below

Metasurfaces can be scaled down and used in microfluidic environments

Trapping

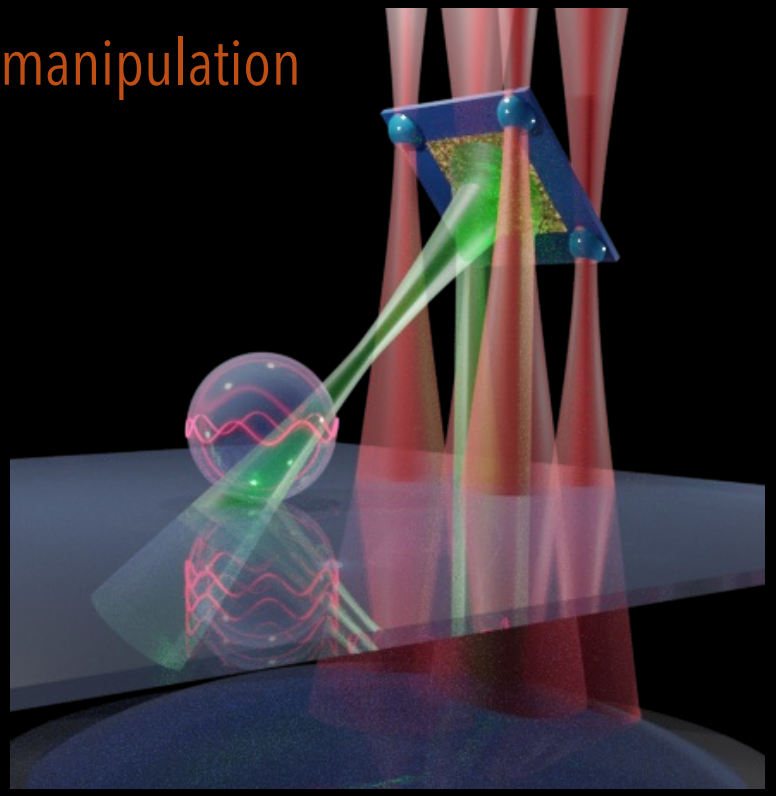




J. Xiao *et al.*, ACS Photonics 10, 1341–1348, 2023

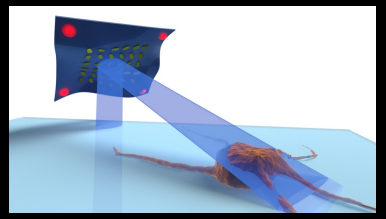
M. Biabanifard et al., Advanced Optical Materials, 2400248 (2024)

Advanced manipulation

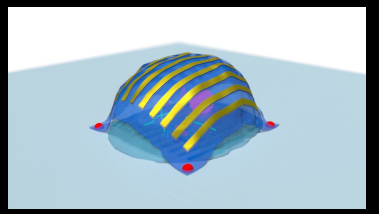


T. Plaskocinski, et al., Adv. Opt. Mat. 2302024 (2023)

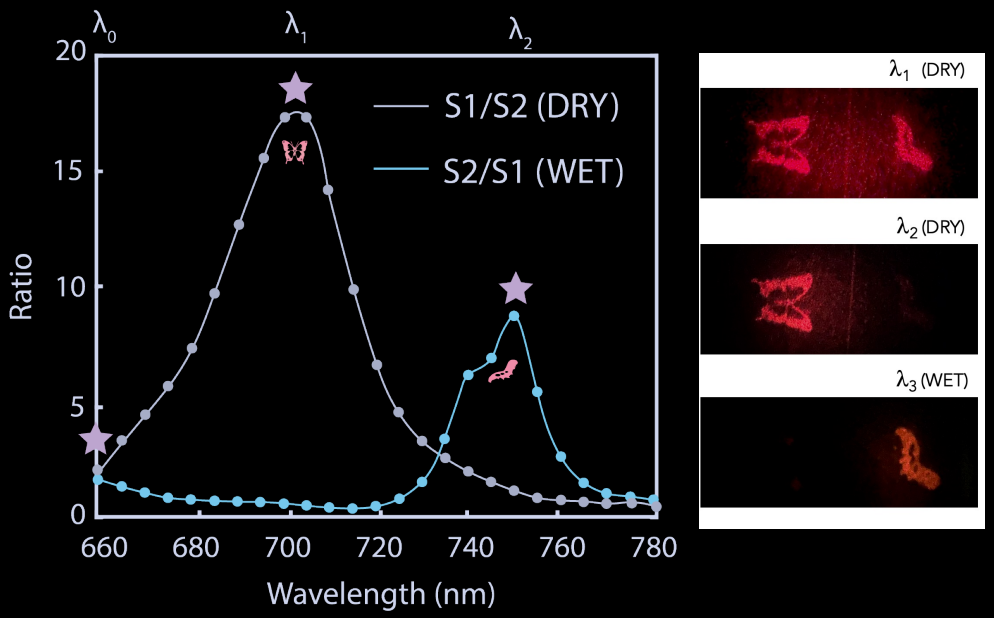
Light sheet imaging



Cell Mechanobiology



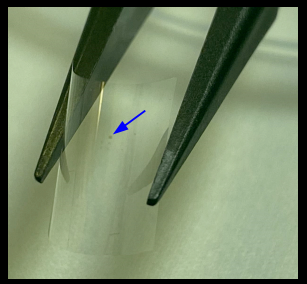
Sensing

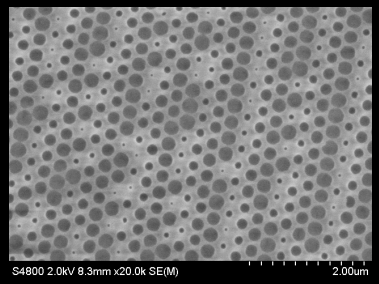


The holographic image depends on the refractive index of the medium and the wavelength used

L. Yan *et al.*, *Opt. Express* 30, 19145-19151 (2022)

Flexible and conformable MSs and actuation





Biabanifard et al., Appl. Phys. Lett. 123, 231702 (2023)

J. Xiao *et al.*, Adv. Mat. Techn. 8, 2202006 (2023)

Different grants require different styles

- **UKRI (e.g.. EPSRC standard grant**): Vision&approach / Ability to deliver / Responsible Research & Innovation / Resources. High quality and high priority research, strongly rooted in the UK community, relevance to EPSRC portfolio, impact, risk management, good return on investment

- **UKRI Future Leader Fellowship / ERC**: Compelling idea / development of the individual / personal career development. Designed to attract and retain talents. Must be written to highlight the trajectory of a (future) leader

- **UKRI / ERC Proof of Concept**: Designed to increase the TRL of a technology / Business-like language (sprints, planning, execution). Problem – solution – impact structure is often more suitable.

HAZGUARD
Hazard sensors based on holographic metasurfaces for near-eye augmented reality displays (Jan 2025 – June 2026)

Breakthrough Idea

The problem: Need

The solution

Value proposition

Origin

Approach and Methodology

IP strategy / Spinout / Licensing

Research to be undertaken

Stakeholder and End-users

Plan: Optimisation / Market analysis / business strategy /

Resources and team

PI lead and management

Strategy

Management

The importance of a good start

Lay summary / abstract: Clear and engaging communication is at the heart of a successful proposal

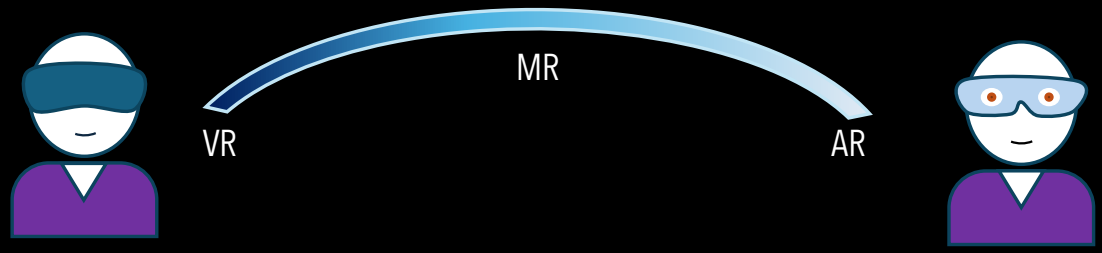
- Reviewers include not discipline-specific experts
- The jargon trap

Lessons from story telling

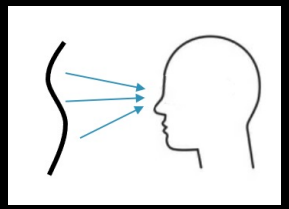
1. BACKGROUND set the scene
2. PROBLEM what needs solving? why?
3. ACTION what do you do each day?
4. SOLUTION how does this contribute?
5. RESULT what could be the end result?

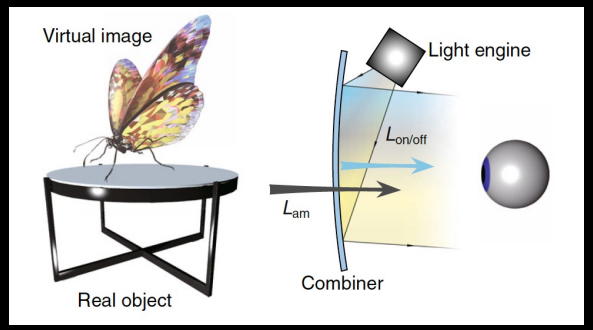
1. *Augmented reality (AR) technology is…*
2. *Existing and next-generation AR glasses…*
3. Our project […] transforms any standard pair of glasses into advanced AR headsets.
4. Our solution overcomes common challenges of […] AR glasses…
5. Our […] goal is to enhance the day-to-day experiences…

Extended Reality (XR) – NEED

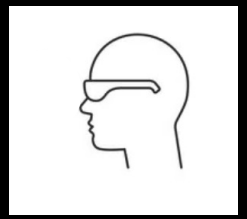


Heads up





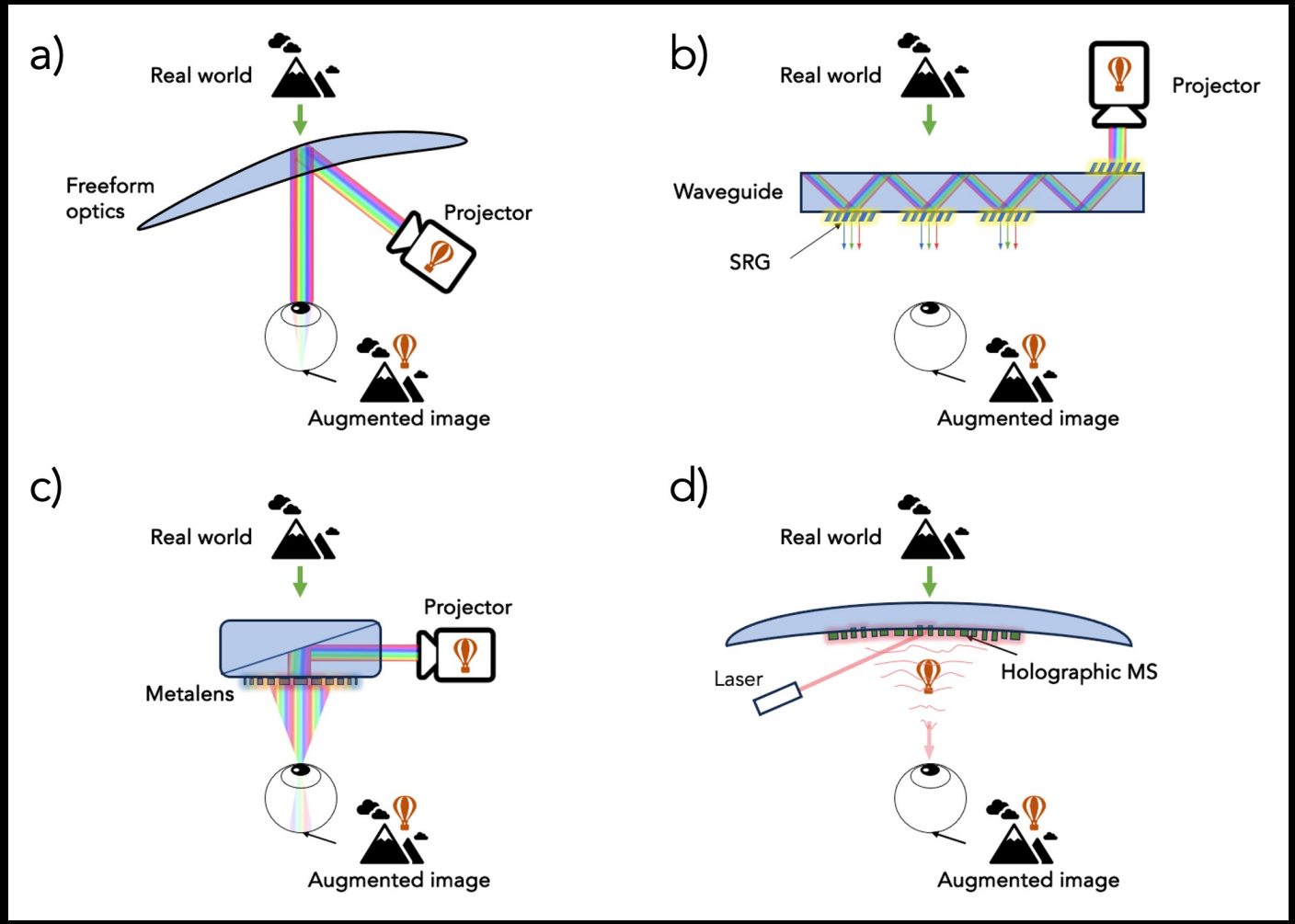
Heads on (near eye)



Light: Science & Applications 10, 216 (2021)

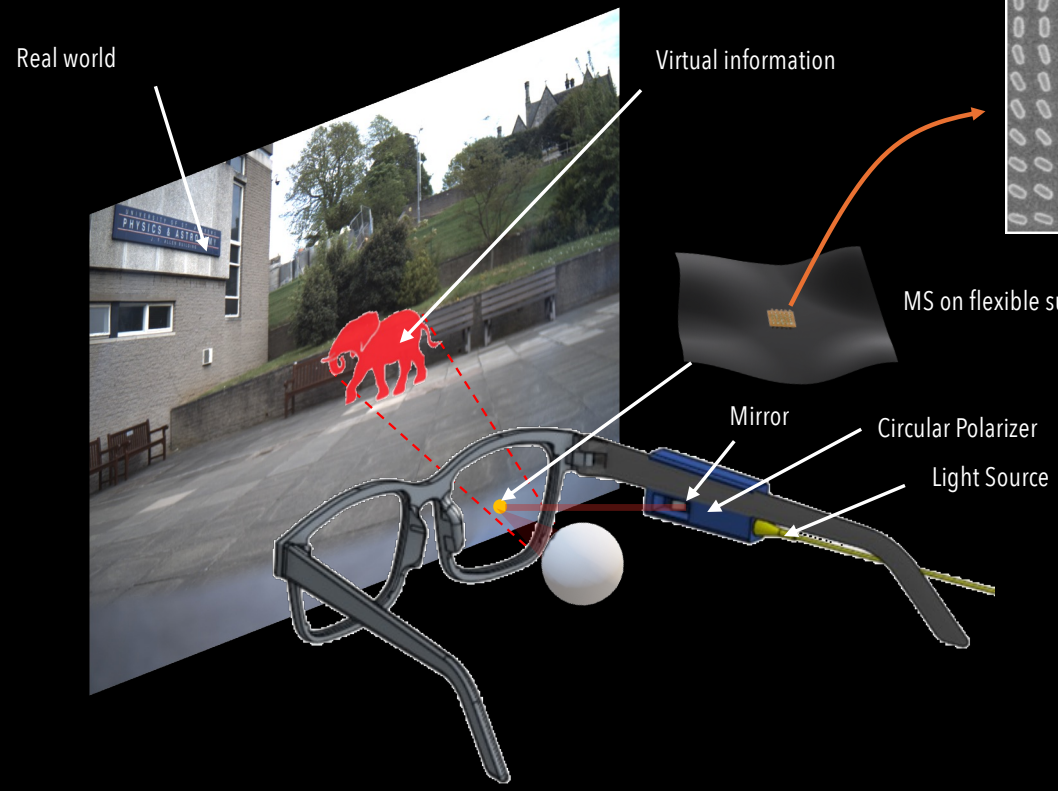
Barriers for eyeglass wearers
Opportunity to satisfy requirements for e.g. auditory impaired users

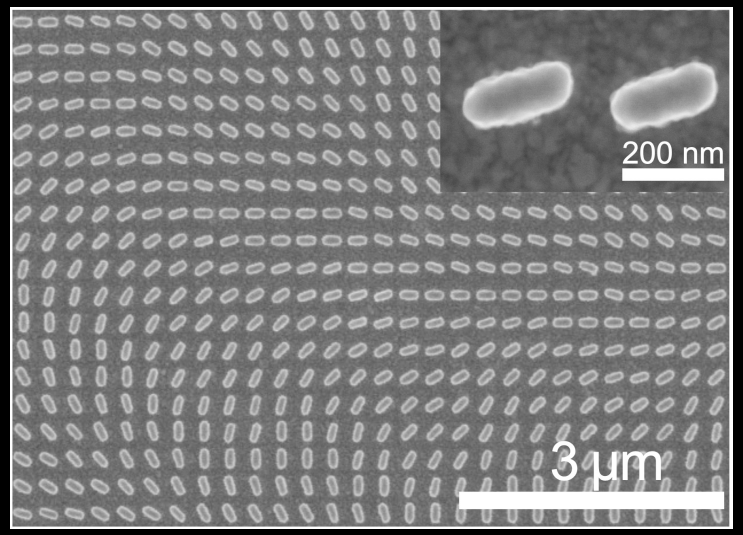
AR solutions - NEED II

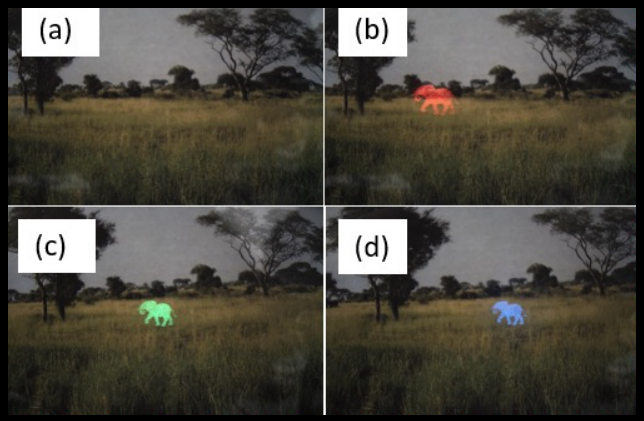


S. Schulz et al., Appl. Phys. Lett.124, 260701 (2024)

Augmented reality patches – ACTION/SOLUTION

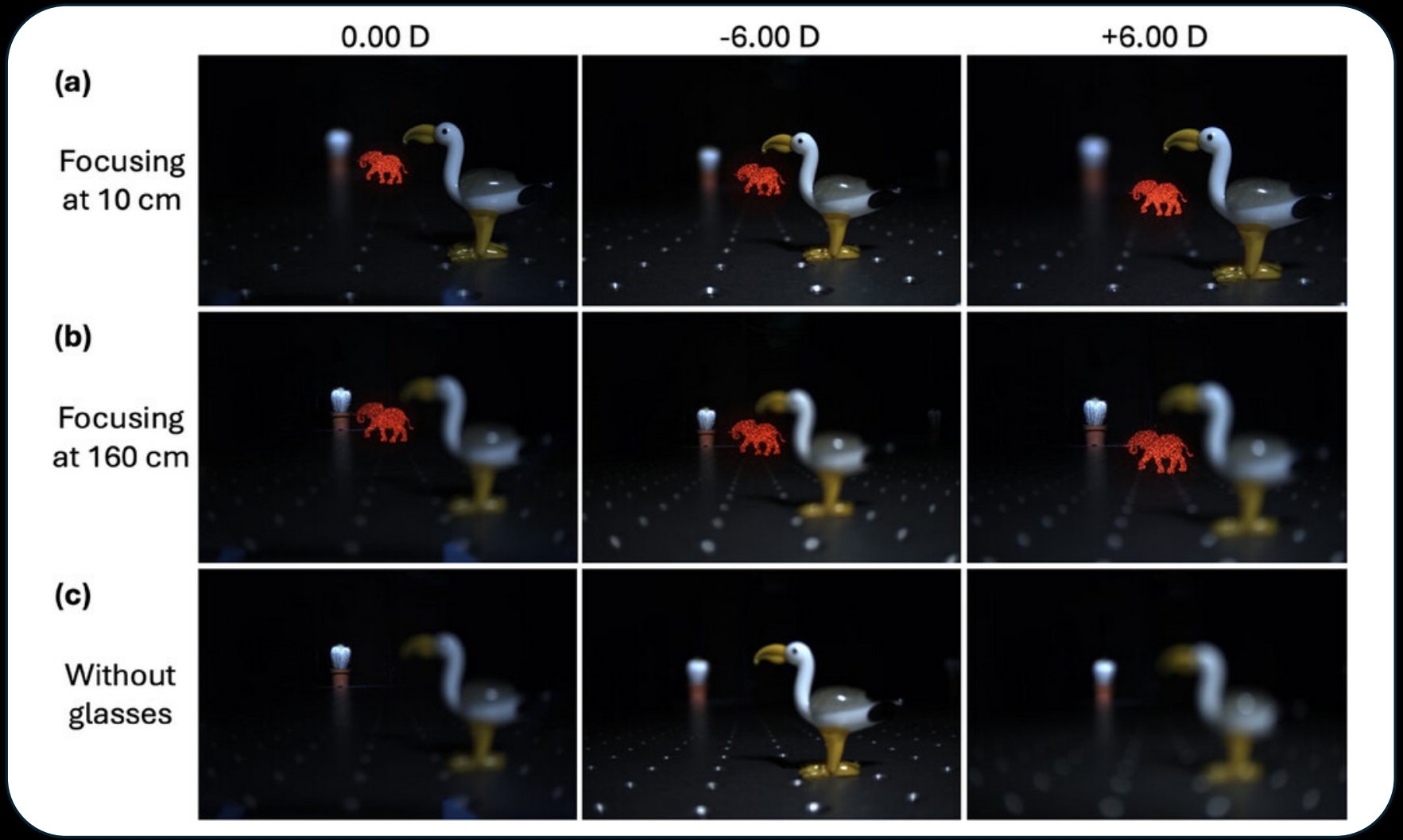




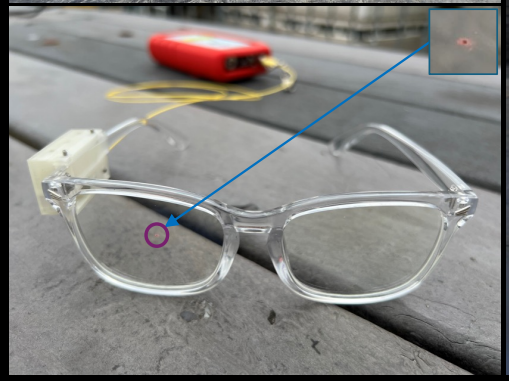


Y. Gan et al., Laser Photonics Rev 2401240 (2024)

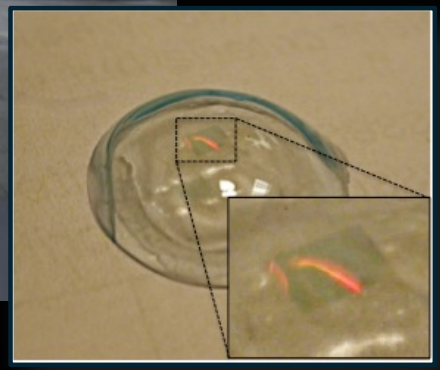
Value proposition: AR with commercial prescription glasses and triggered response



Stakeholder / End-user engagement and business plan



Excellent hologram visibility even in full daylight



Biomedical applications

Now exploring translation in automotive, health and safety and efficient encoding algorithms

Y. Gan et al., Laser Photonics Rev 2401240 (2024)
Patent pending

Resources

The funding model offers exceptional flexibility

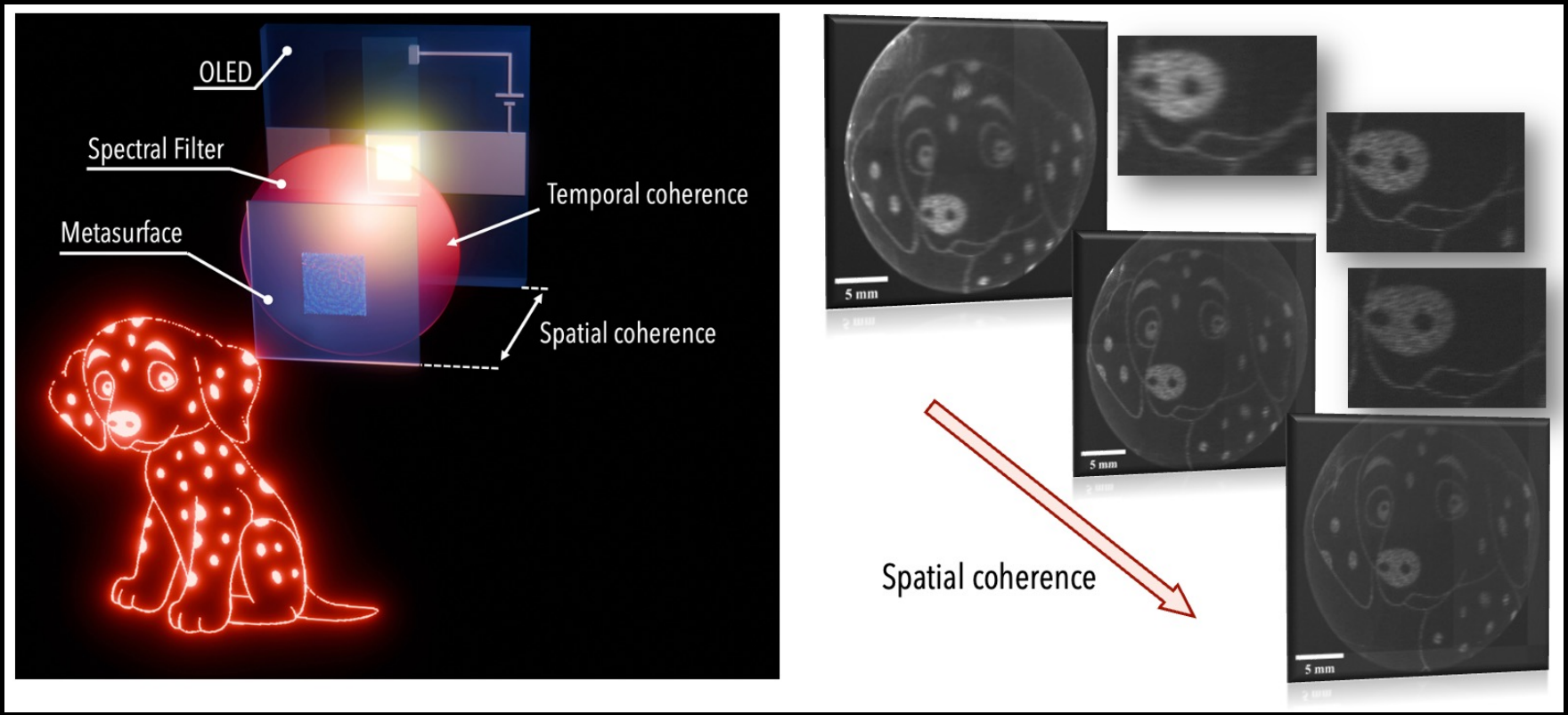
Research costs

Salary for PDRAs (12 months)

Funds leveraging

Yuhui Gan

Holographic metasurfaces for incoherent illumination



Gong et al., Light Sci Appl 14, 294 (2025)

Conclusions

Proof of Concepts are ideal to support the translation of technologies developed in ERC projects

Alignment with ERC research not necessarily with main objectives

The spending flexibility is a formidable tool to achieve goals of the project

Take all the opportunities (up to 3 PoC) - Start early!

Synthetic Optics Group

PDRAs

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Tomasz Plaskocinski
Sarah-Jane Twigg
Innes Bakkali
Farhan Ali
Zaka Ullah
Shiju Prasad
Femy Francis
Stefanus Wijaya
Aravind Binukumar

Acknowledgments

ARIA
erc
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dstl
AWE
wellcome trust
THE ROYAL SOCIETY
Defence and Security Accelerator
Granted

UK META MATERIALS NETWORK

EPSRC Network +
Main point of contact for metamaterials community in the UK: ~1200 academic and industrial members