



Microscopy without Lenses: Digital Lensless Inline Holographic Microscopy

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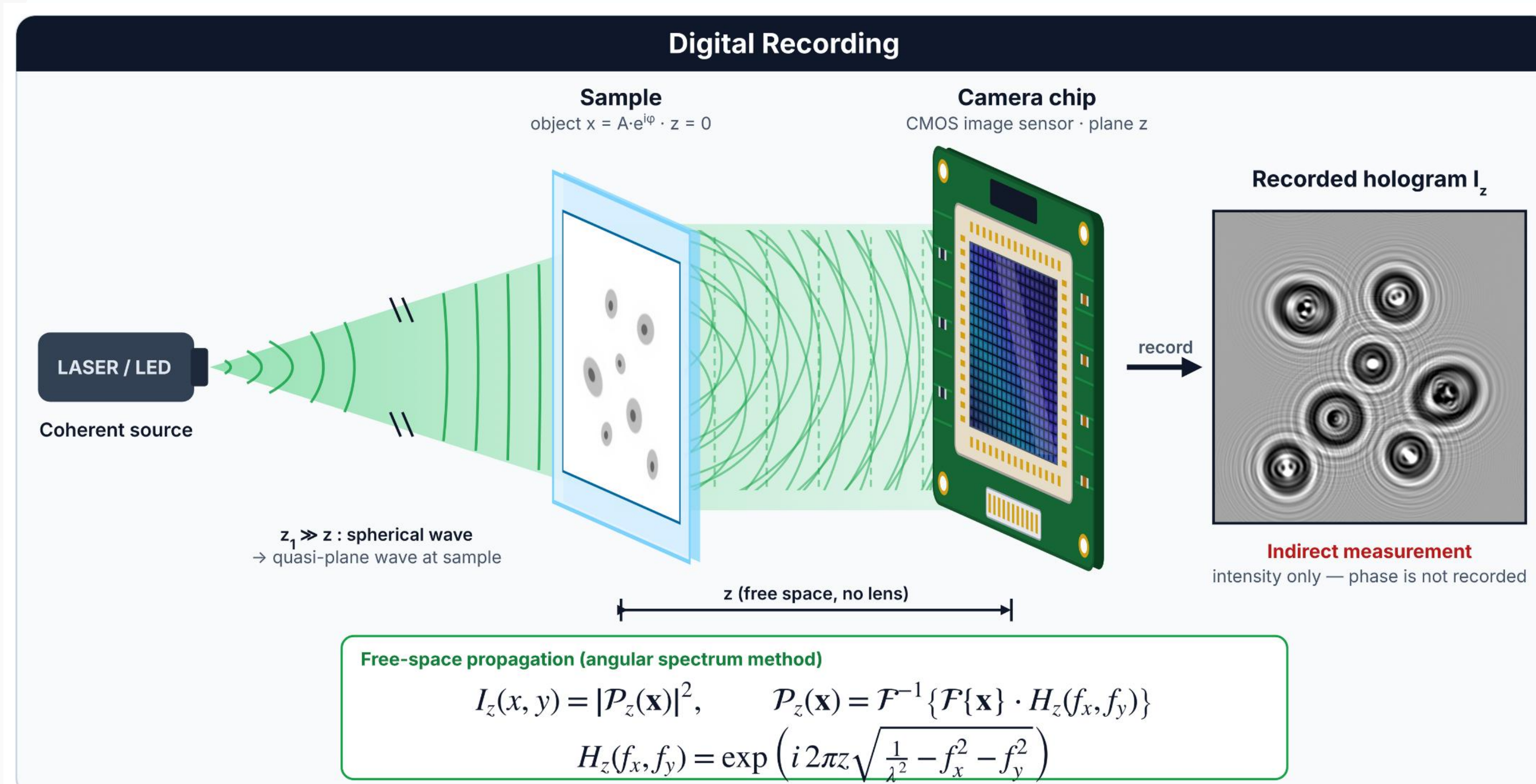
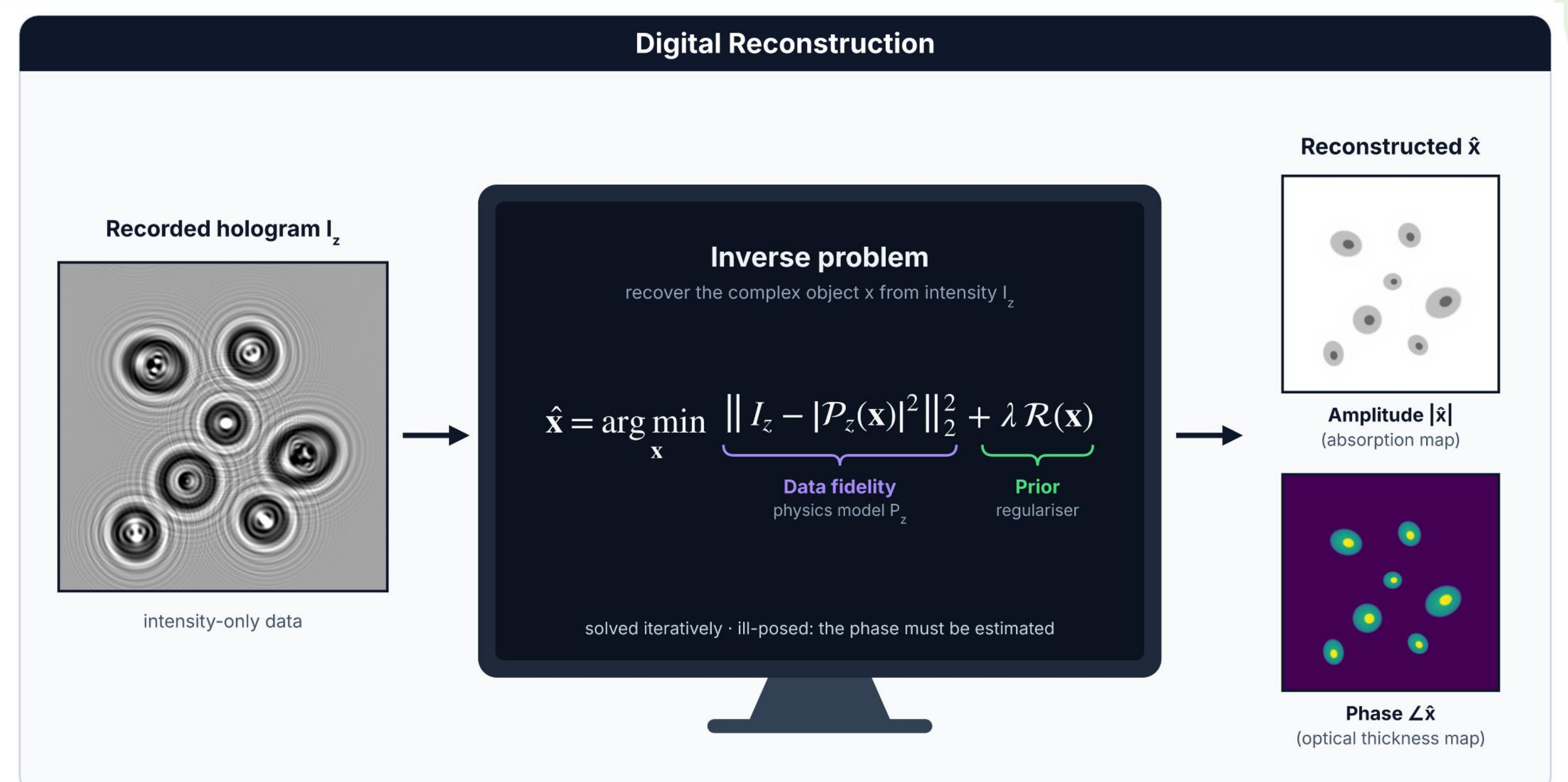


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Objective

Conventional optical imaging systems, such as cameras and microscopes, form an image by using lenses to project the scene onto an image sensor. However, lenses make these systems bulky and costly, and the intensity images they record do not reveal the sample's optical thickness (phase). Computational imaging splits the work differently: the optics only *encode* the sample into a measurement, and a computer *decodes* that measurement using a physical model of how light travels. **The image is not captured directly; it is reconstructed computationally.** In digital lensless in-line holography, we record a diffraction intensity pattern that encodes both the absorption and the phase of the sample, and solving the inverse problem recovers both. This provides a **compact, cost-effective** technique for **large field-of-view** quantitative phase imaging.

Working Principle

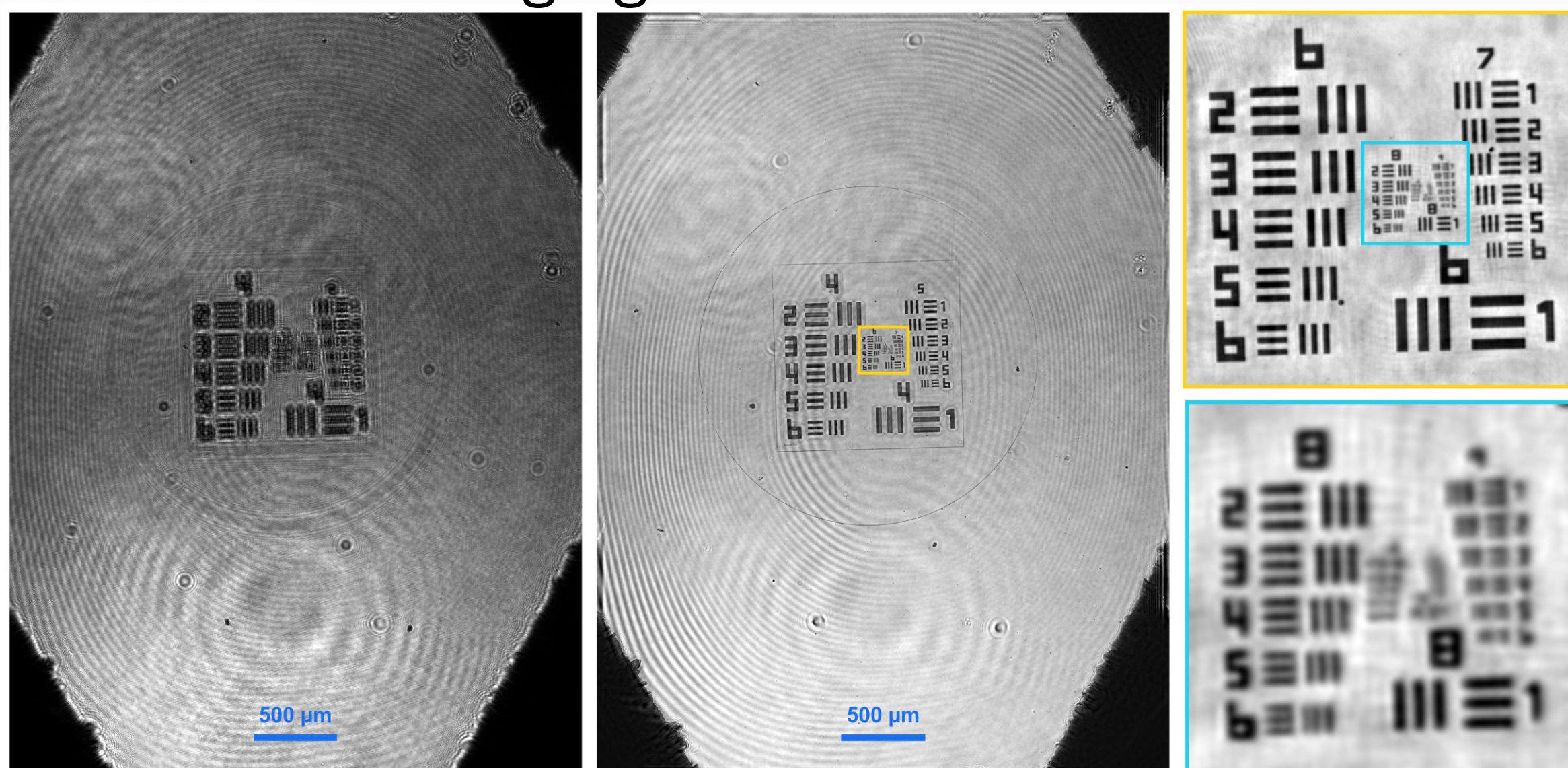


Conventional vs Lensless Microscopy

	Field of view	Optics	Phase (thickness)	Size & cost
✗ Conventional microscope	~0.1–2 mm ² limited by the objective lens	Objective lenses precise alignment needed	Not measured intensity image only	Bulky, expensive bench-top instrument
✓ Lensless (DLIHM)	~20–30 mm ² the entire sensor area	No lenses LED / laser + camera chip	Measured quantitatively optical thickness map	Compact, low-cost portable, field-deployable

Applications and Impact

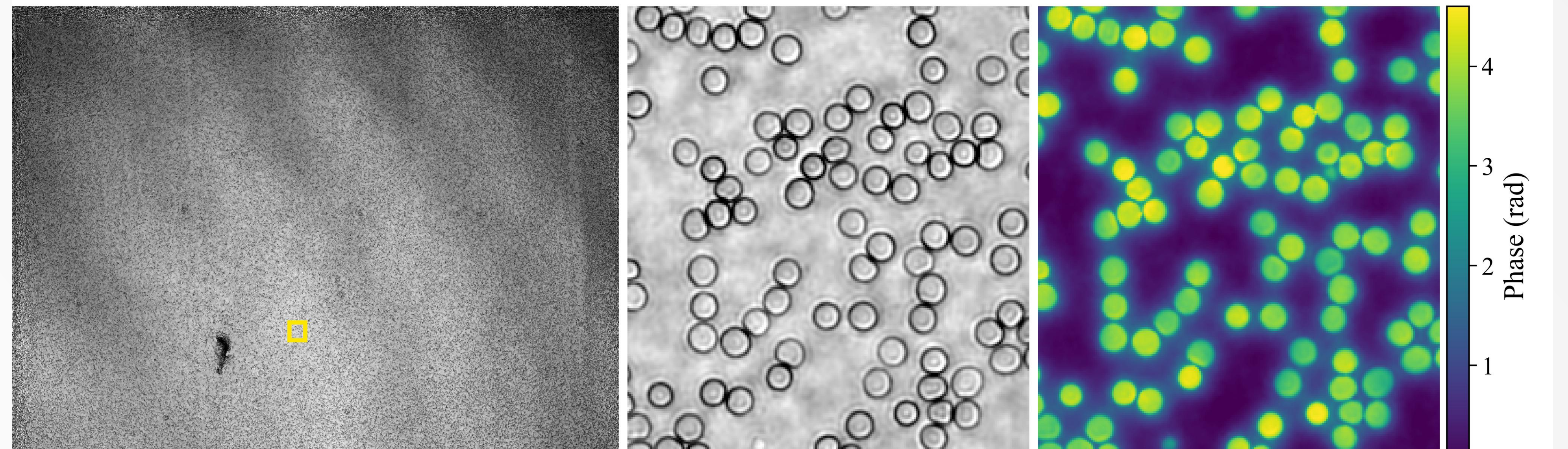
Imaging of USAF Chart



Recorded hologram

Reconstructed image

Imaging of Human RBCs (Blood smear)



Reconstructed absorption map

Reconstructed phase map

Potential Application areas

- Point-of-care diagnostics (blood cell counting, microfilariae screening etc)
- Label-free live-cell and cell-culture monitoring
- Water quality and microplastics/plankton detection
- Low-cost microscopy for education and field use



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