MetaSpectra+

A Compact Broadband Metasurface Camera for Snapshot Hyperspectral+ Imaging

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PURDUE UNIVERSITY
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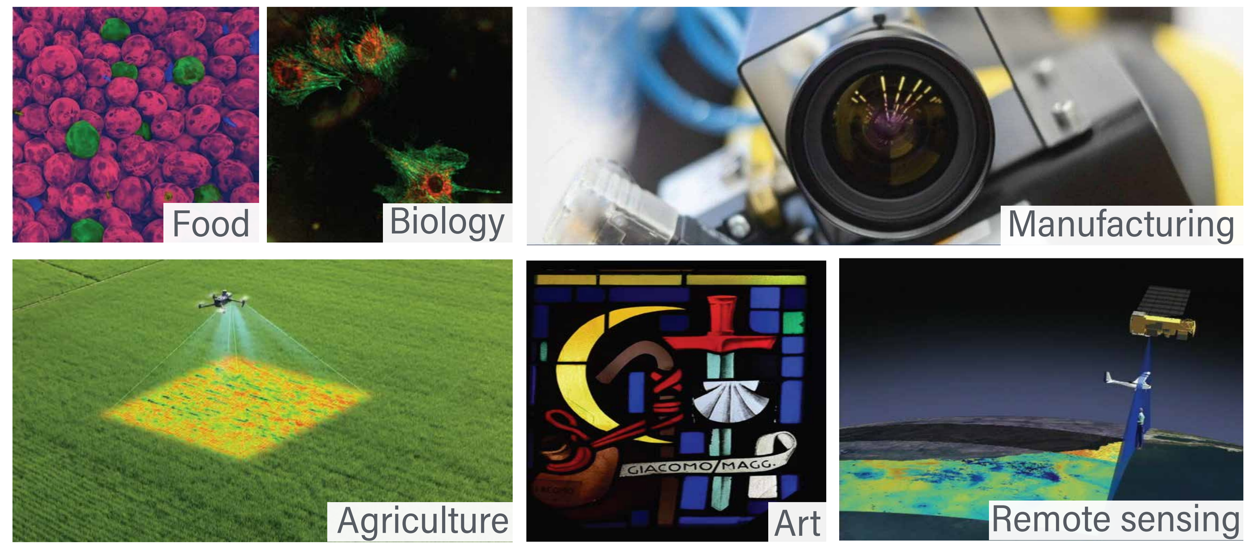
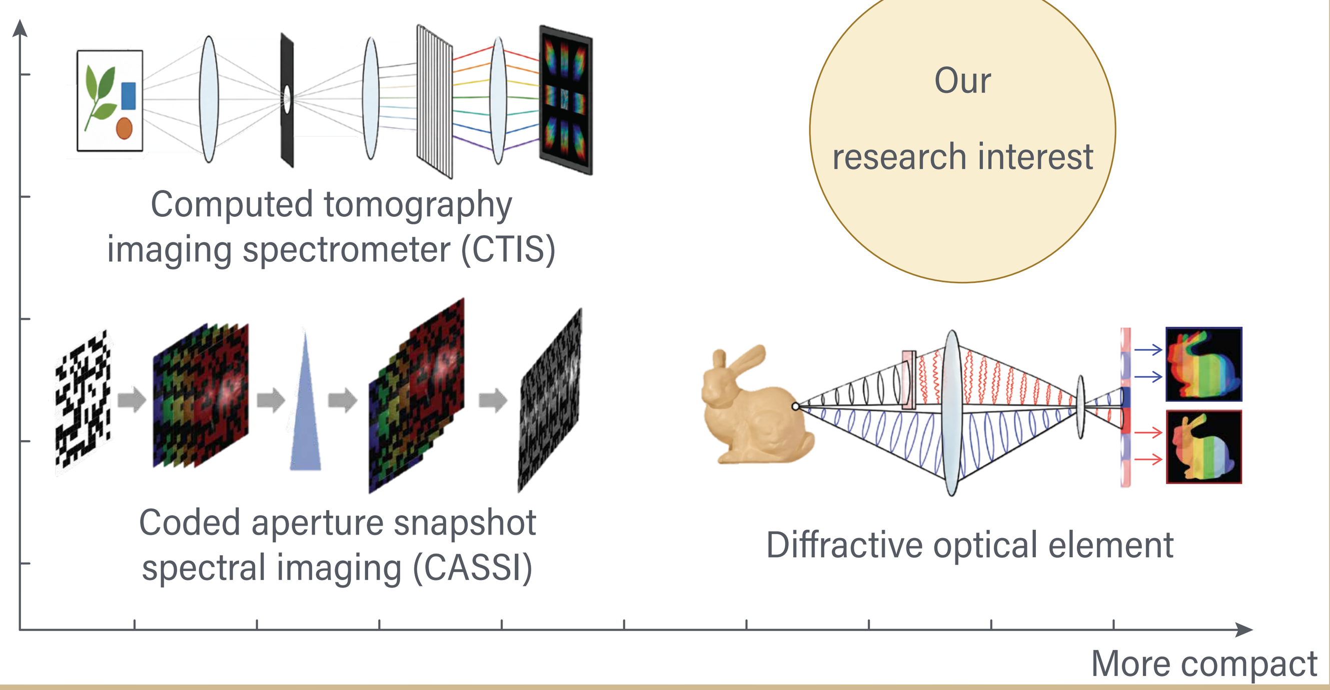
Motivation

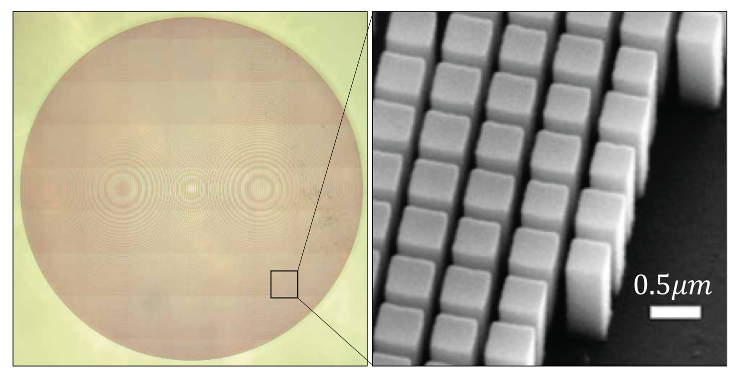
Snapshot hyperspectral imaging



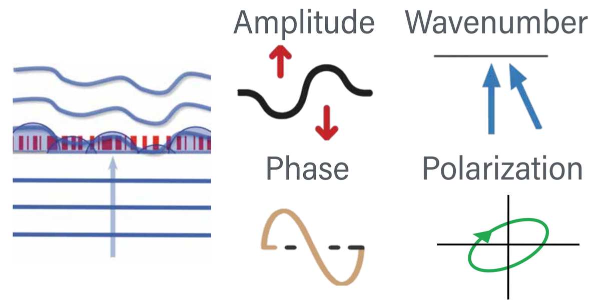
Toward compact and diverse spectral encoding



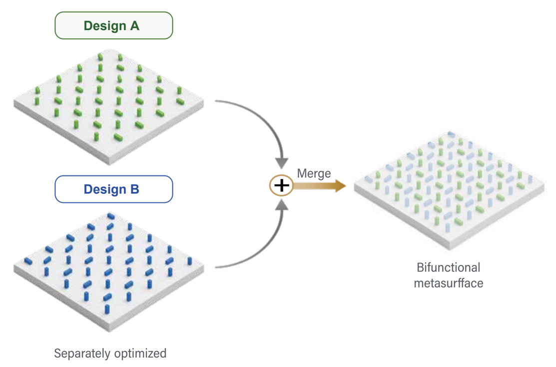
Metasurface 101

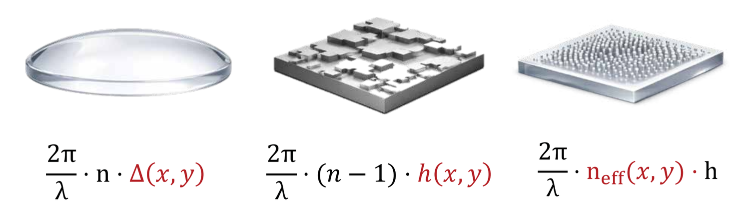


Versatile wavefront control



Multifunctionality

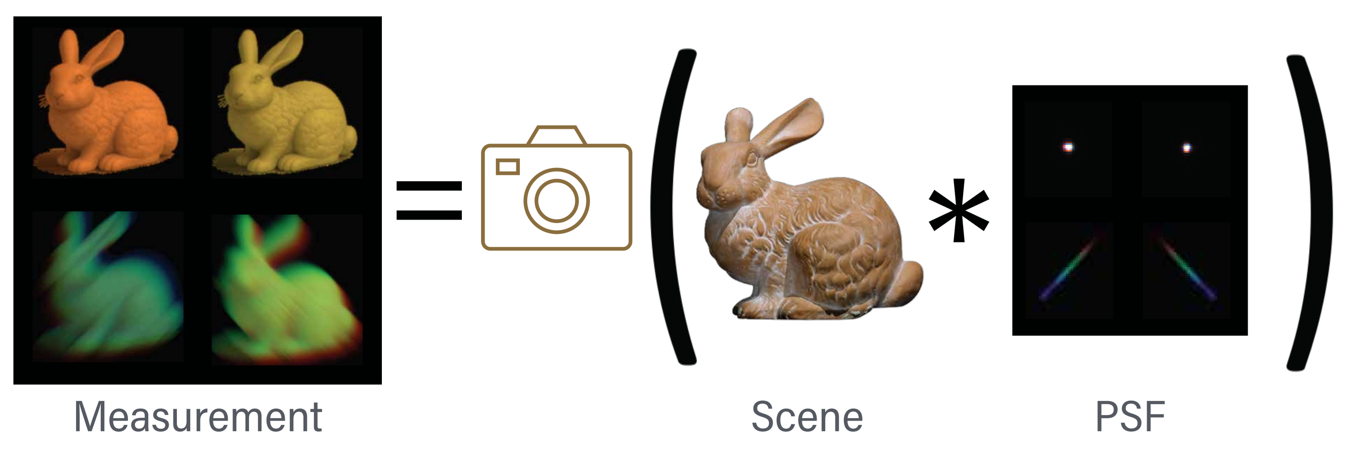




$\frac{2\pi}{\lambda} \cdot n \cdot \Delta(x,y)$ $\frac{2\pi}{\lambda} \cdot (n-1) \cdot h(x,y)$ $\frac{2\pi}{\lambda} \cdot n_{\mathrm{eff}}(x,y) \cdot h$

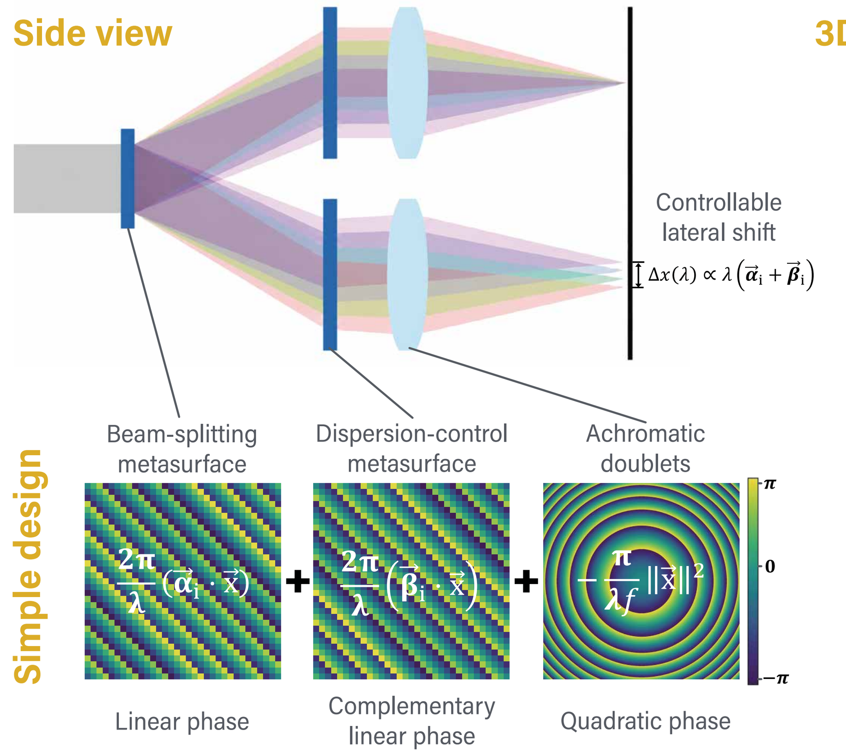
Image Formation

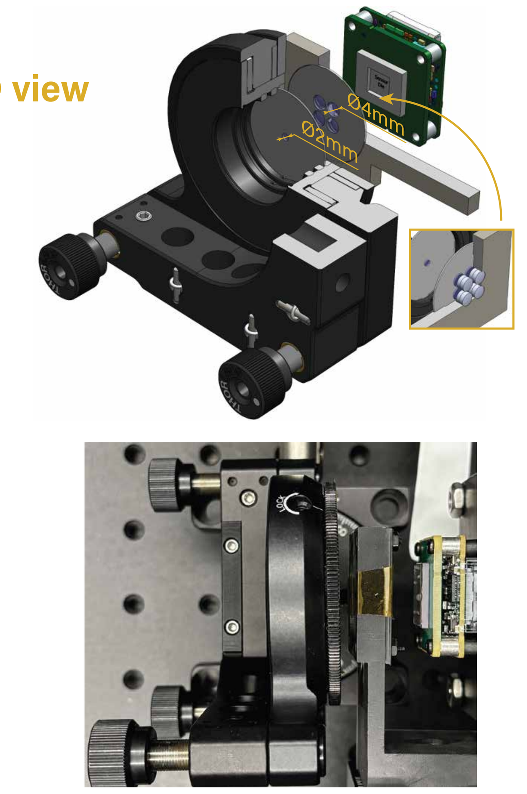
4 images in a single shot, 2 achromatic and 2 dispersive



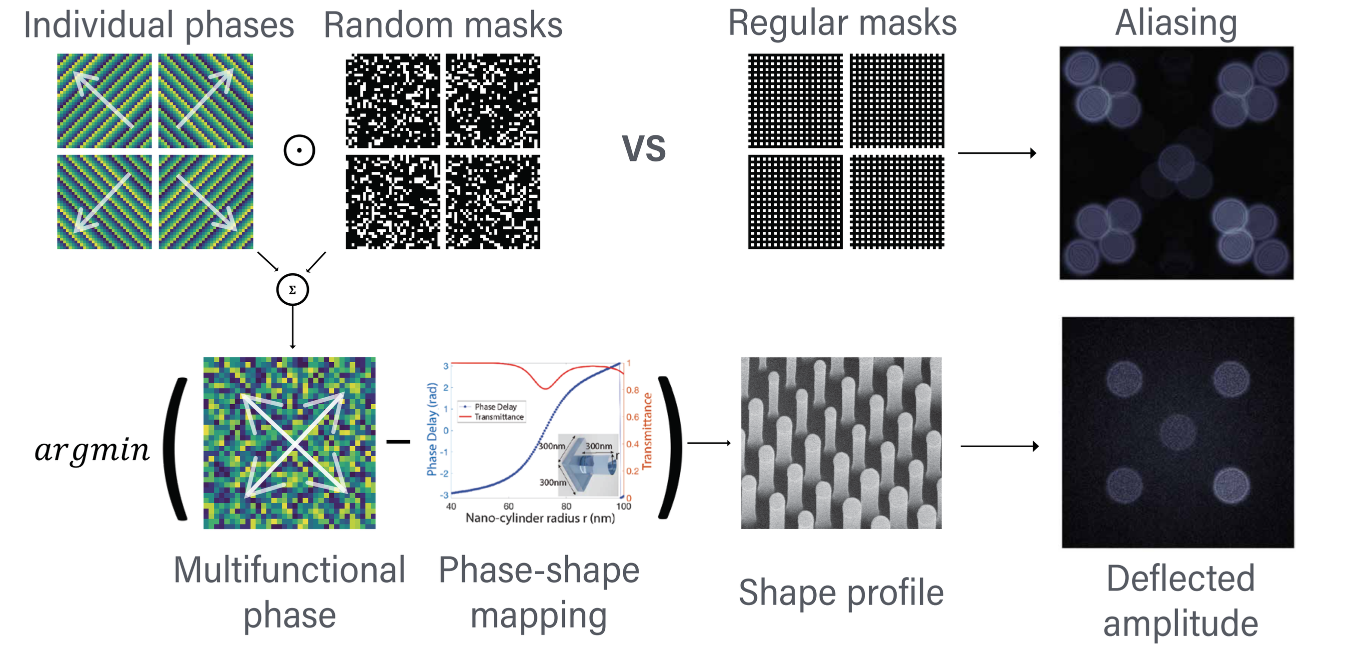
Optical Design

A hybrid meta-refractive system





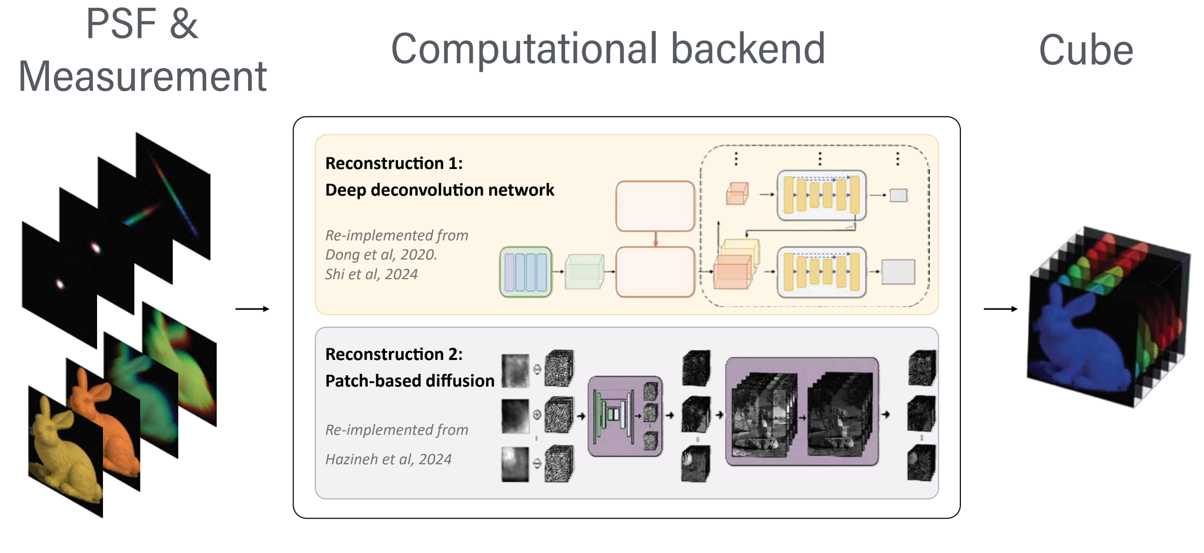
Metasurface Design



Hyperspectral+

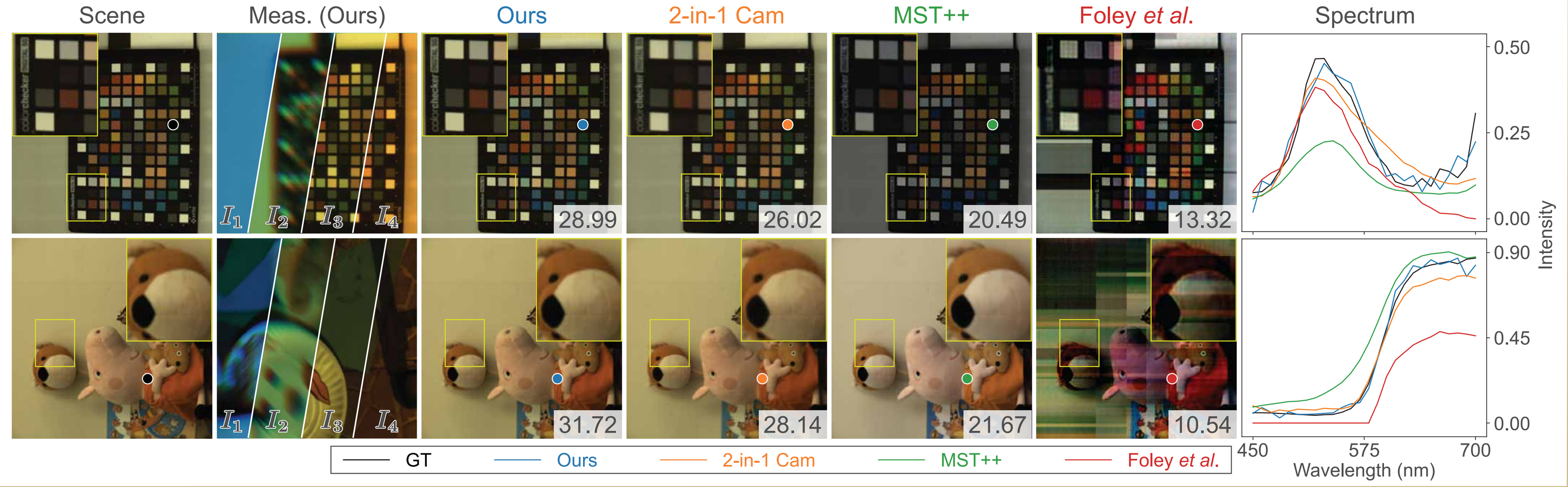
More imaging modalities can be incorporated

Reconstruction

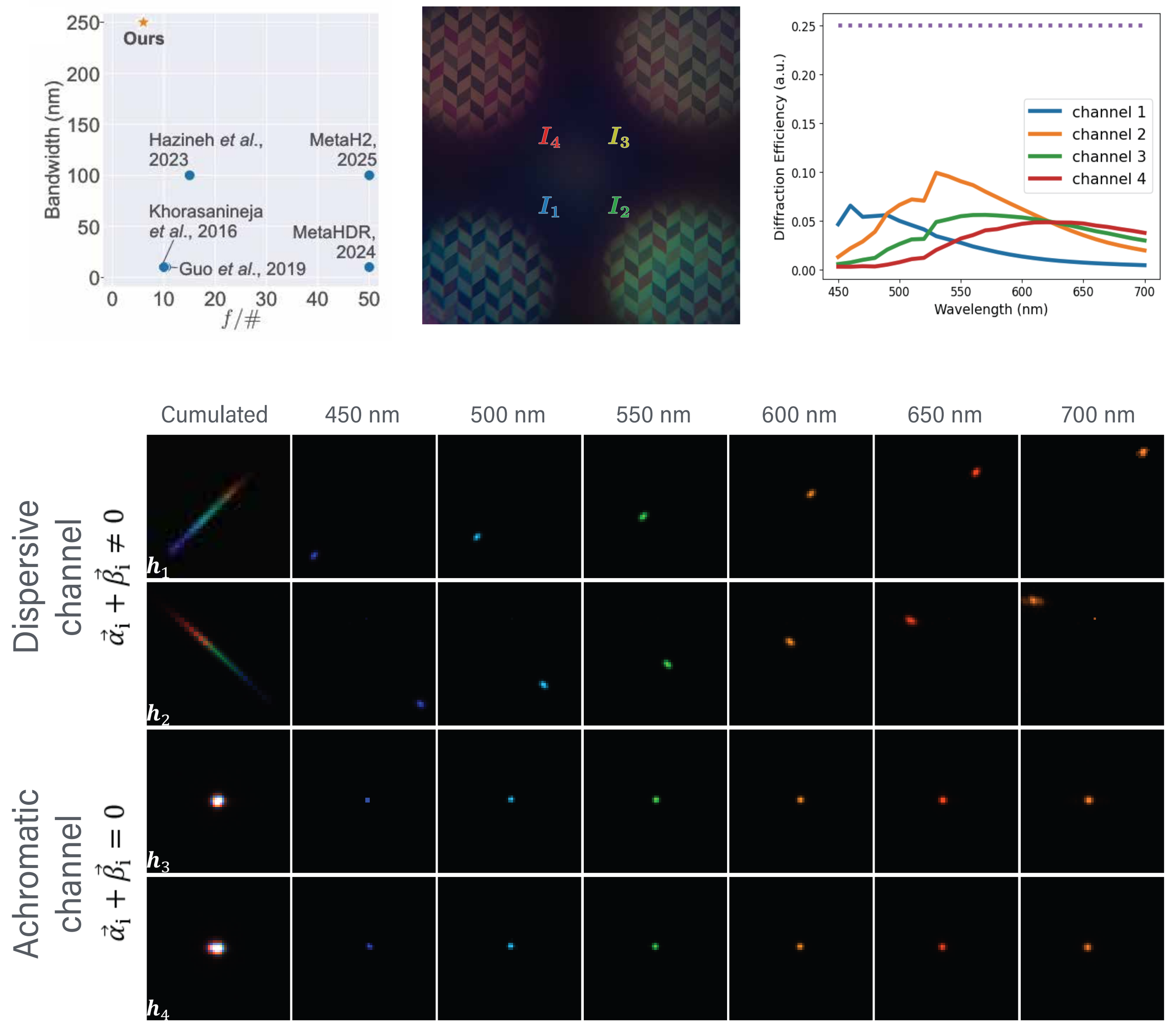


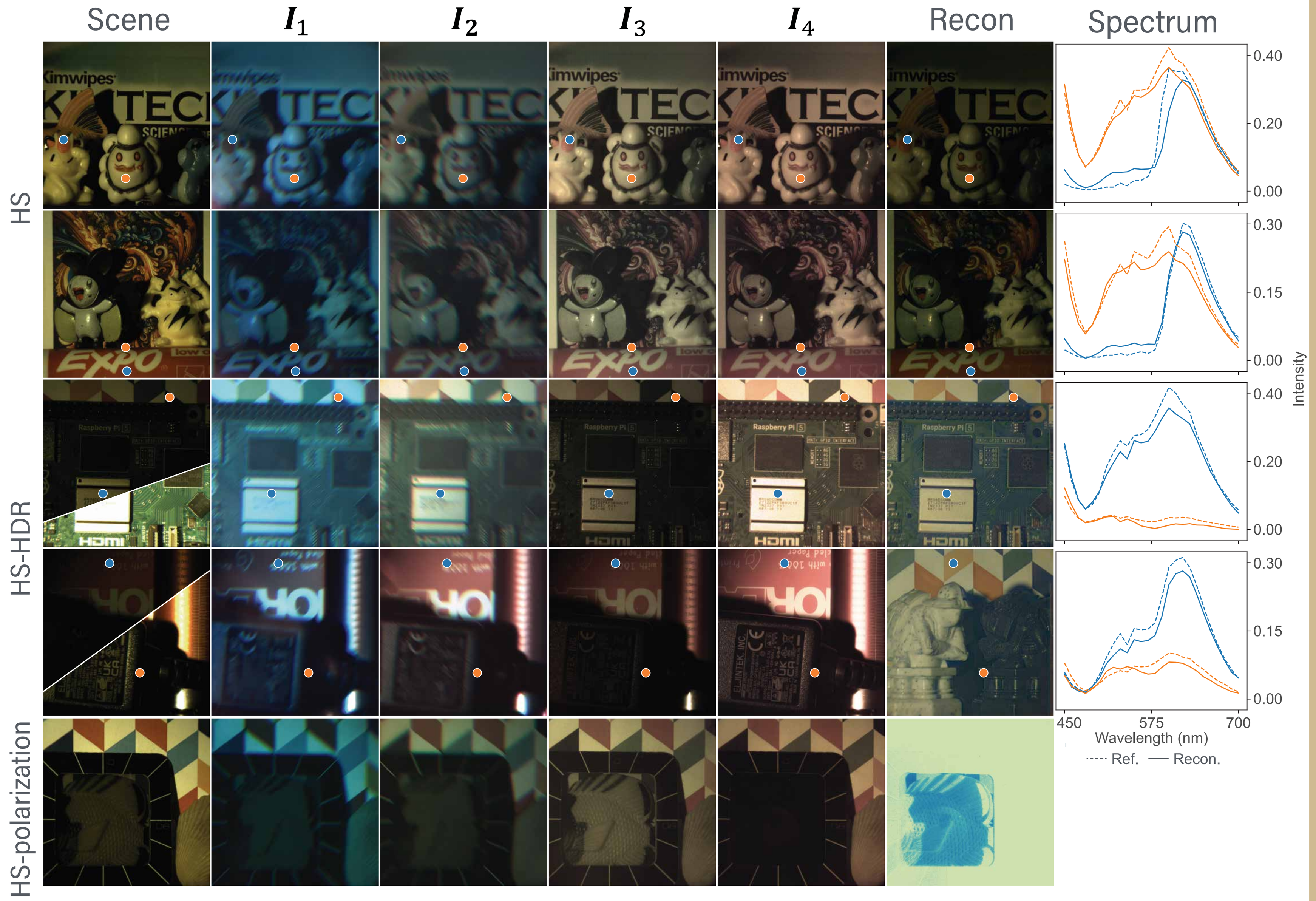
Simulation Results

Method	MS: Ours	DOE: 2-in-1 Camera	DOE: Array - HSI	DOE: SCCD	DOE: Baek et al	Lens: MST ++	Lens: HRNet	Lens: Foley et al	Lens: SfD
# images	4	2	4	1	1	1	1	1-5	5
f/#	6	5.8	6.7	16.7	16.7	-	-	5.8	2
FOV	10	24	12	30	46	-	-	9.8	10
TTL (mm)	17	50	20	50	50	-	-	140	50
PSNR (dB) ↑	32.92	31.14	27.44	26.78	26.68	21.85	23.03	20.40	27.54
SSIM ↑	0.94	0.86	0.89	0.81	0.74	0.68	0.76	0.68	0.82
SAM ↓	0.17	0.24	0.20	0.36	0.39	0.32	0.31	0.29	0.40



Real Results





Presentations: (1) June 3, 11:15 - 12:50, Mile High Room 4CD (#3), Computational Cameras and Displays (CCD) workshop; (2) June 5, 9:15 - 10:30, Mile High Room 3A - 4A, Oral Session 1D. (3) June 5, 10:45 - 12:45, ExHall A-F (#21), Poster Session 1.