CVPR 2019

Data-Driven Computational Imaging

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Vivek Boominathan Tristan Swedish Guy Satat

Data-Driven Computational Imaging

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MIT

Guy Satat

MIT

Vivek Boominathan

RICE

Computational Imaging

Deep Learning

Rendering

3D Reconstruction

Navigation

Open Problems

NLOS Imaging

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Data-Driven Computational Imaging

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08:30 – 08:50	Introduction to Computational Imaging	Guy Satat (MIT)
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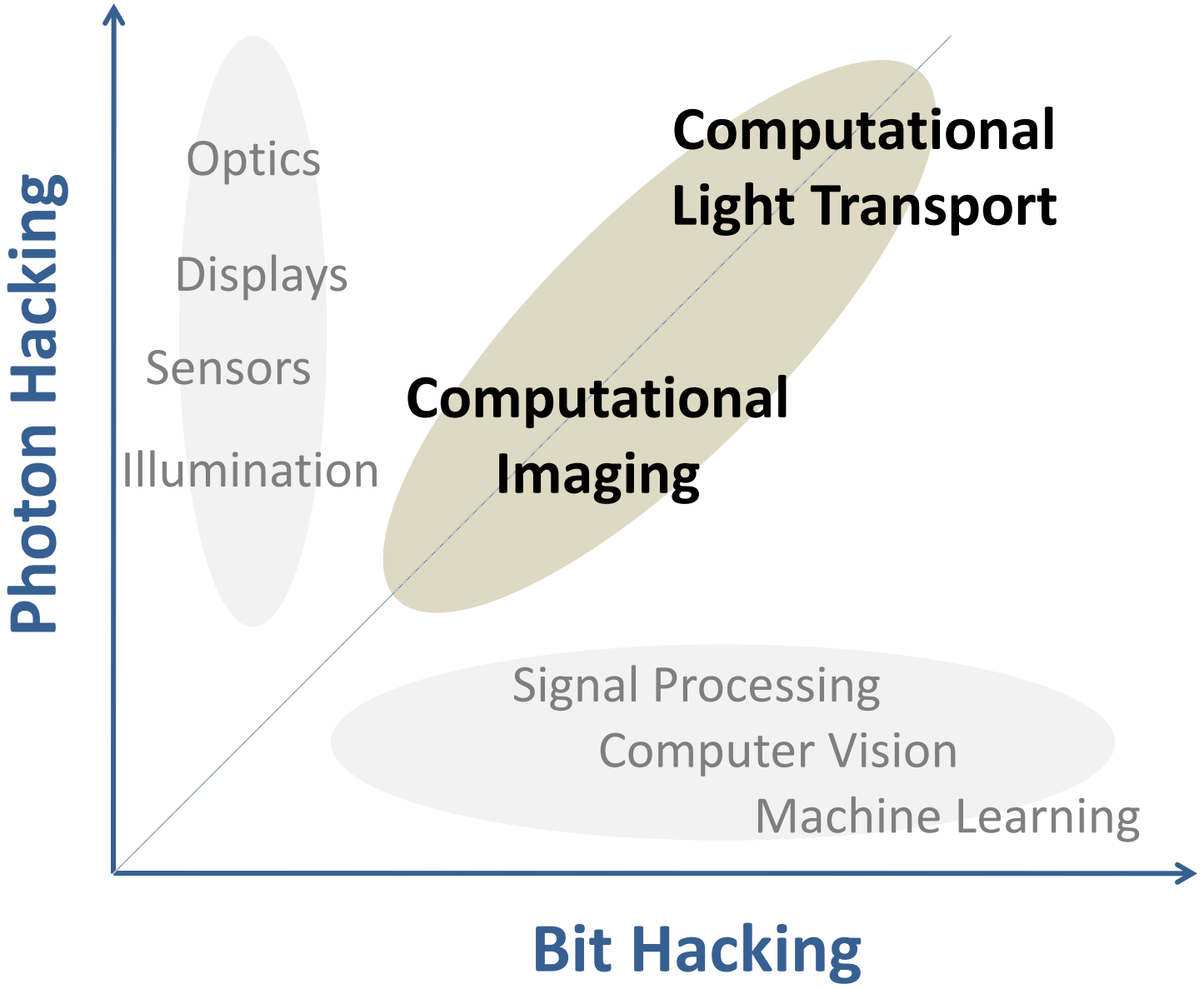
Photon Hacking
Optics
Displays
Sensors
Illumination
Computational
Light Transport
Computational
Imaging
Signal Processing
Computer Vision
Machine Learning
Bit Hacking

The Plenoptic function

$$I(r, \lambda, t, \theta, P, n, \Phi)$$

The Plenoptic function

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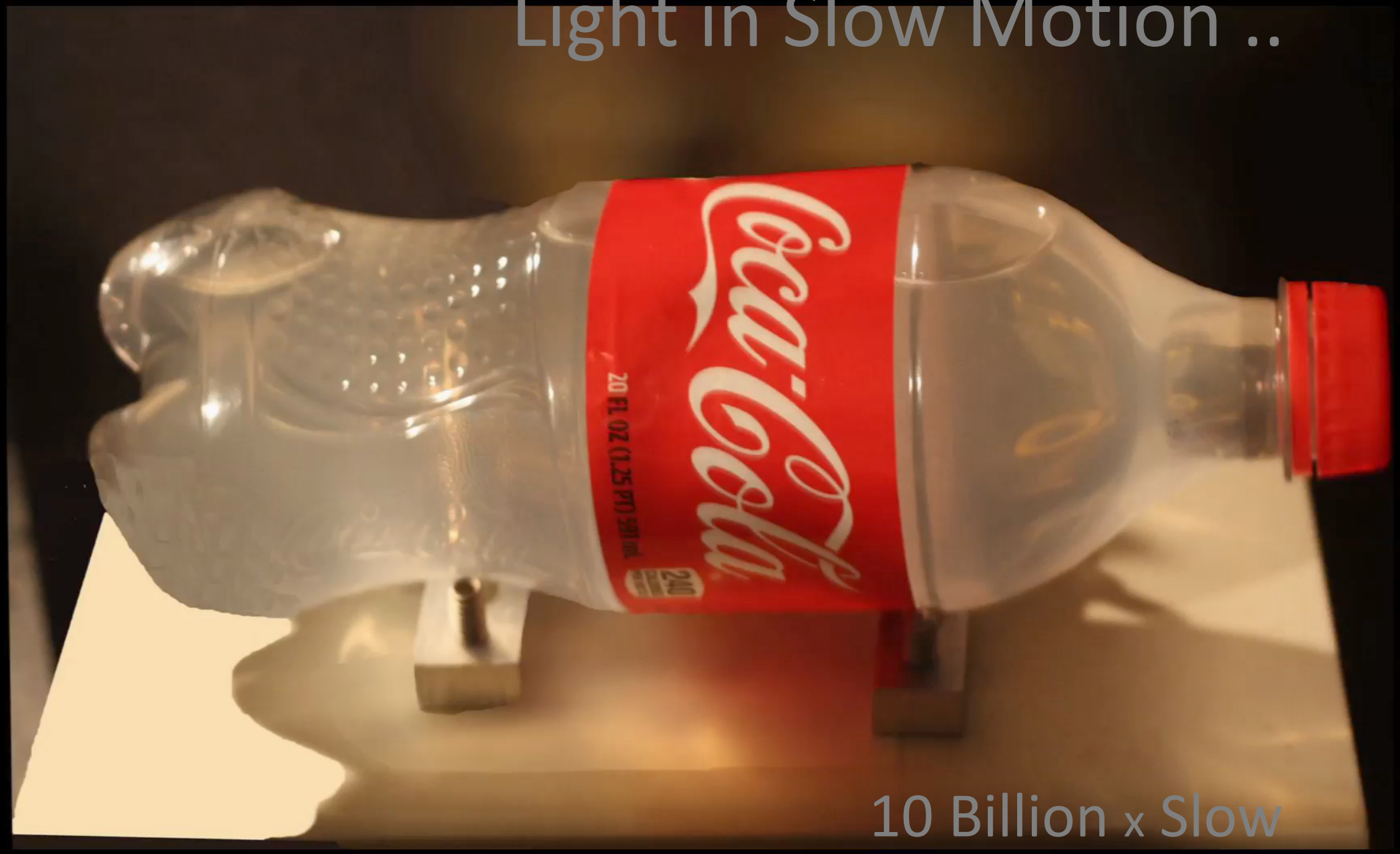
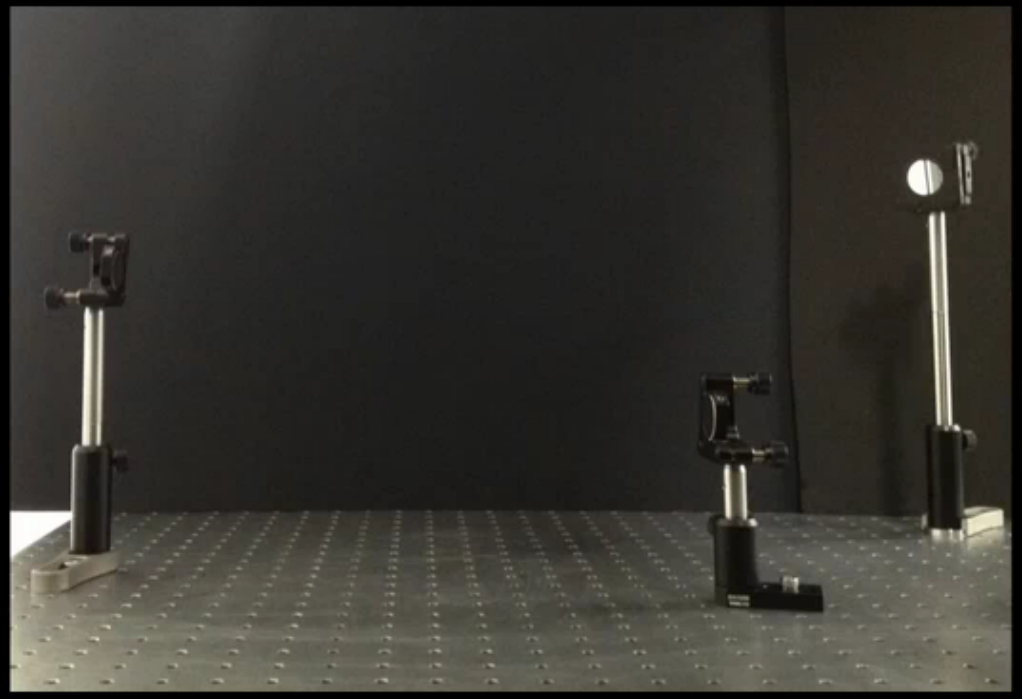
The Plenoptic function

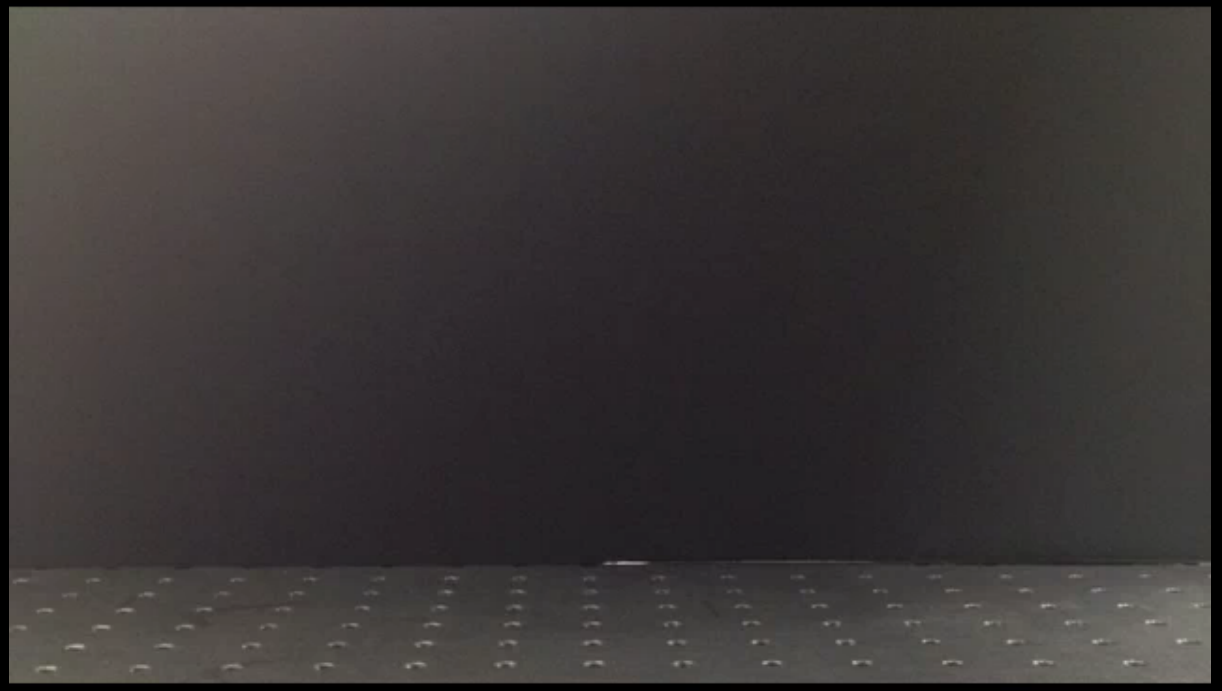
$$I(r, \lambda, t, \theta, P, n, \Phi)$$

Light in Slow Motion ..

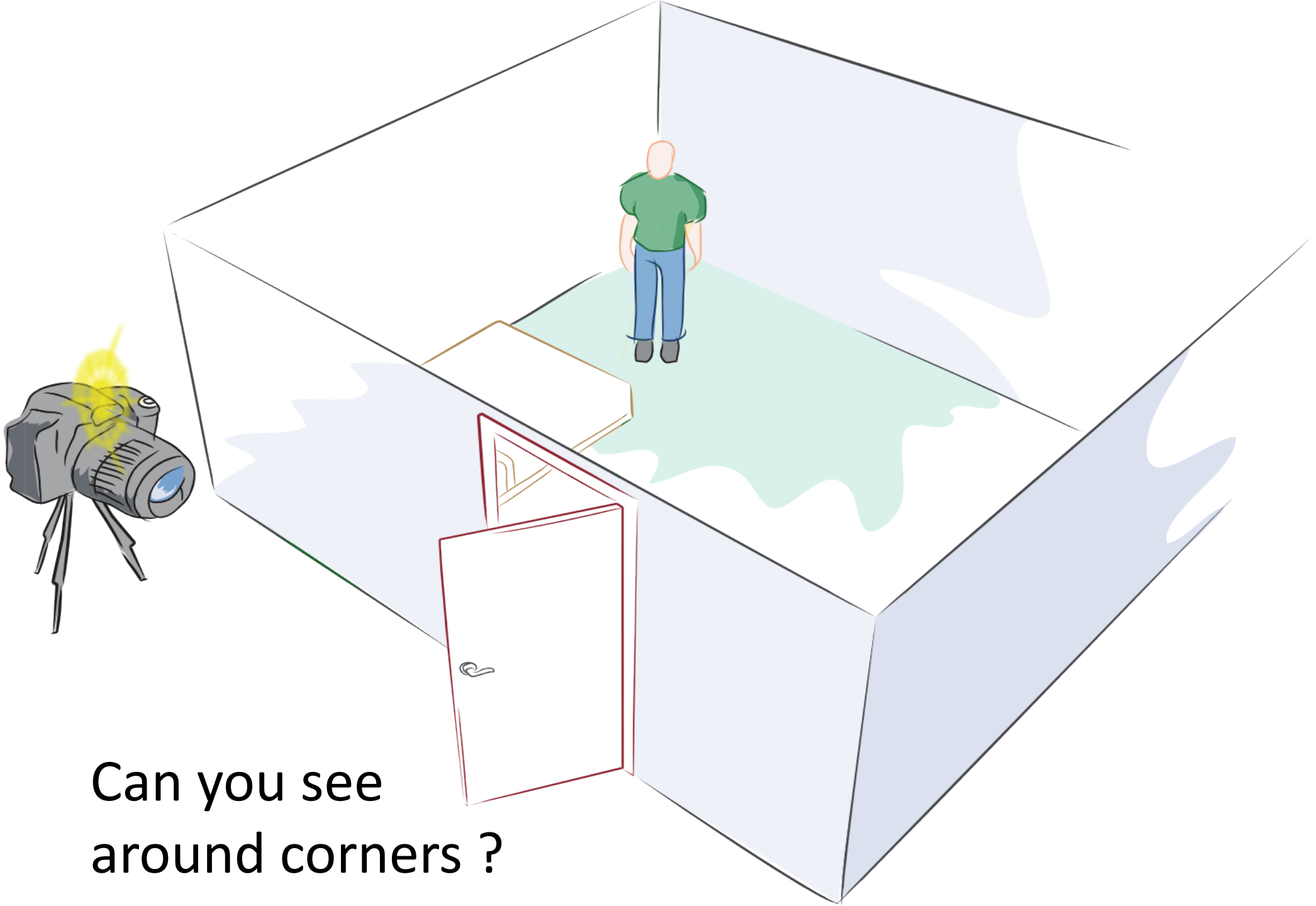


Single Photon Sensitive Imaging



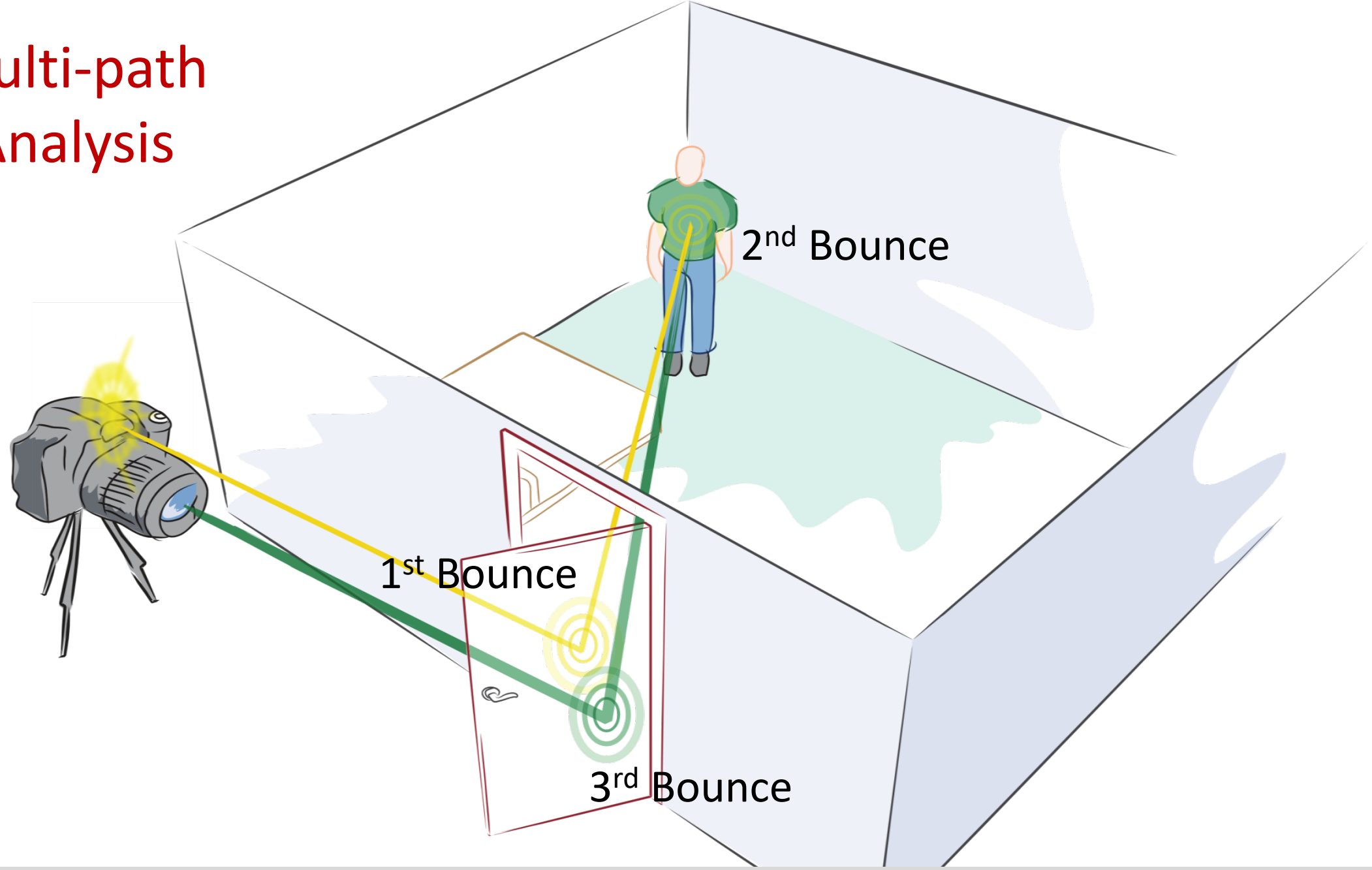


Gariepy et al. Nature Comm (2015)



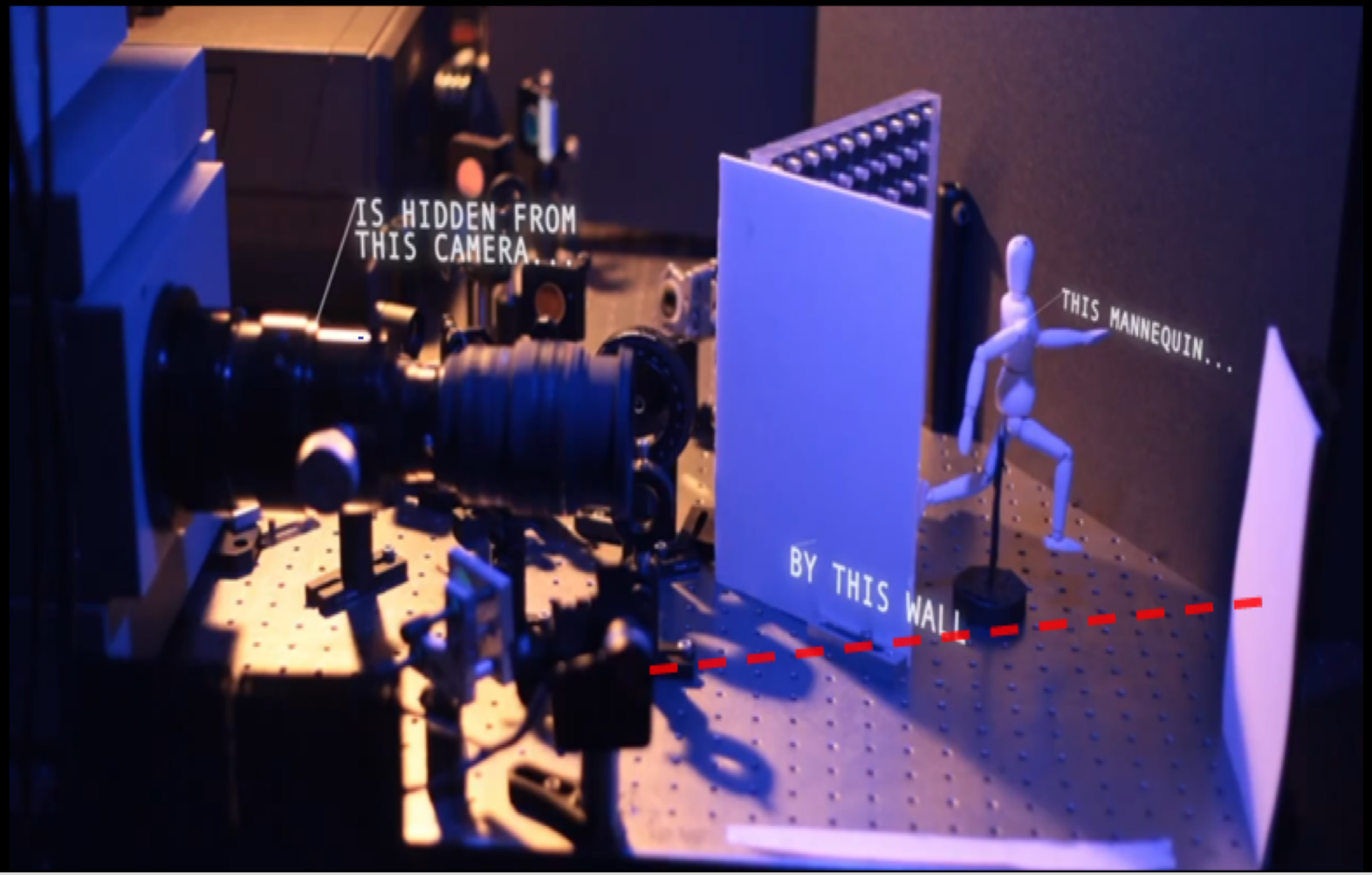
Can you see
around corners ?

Multi-path Analysis



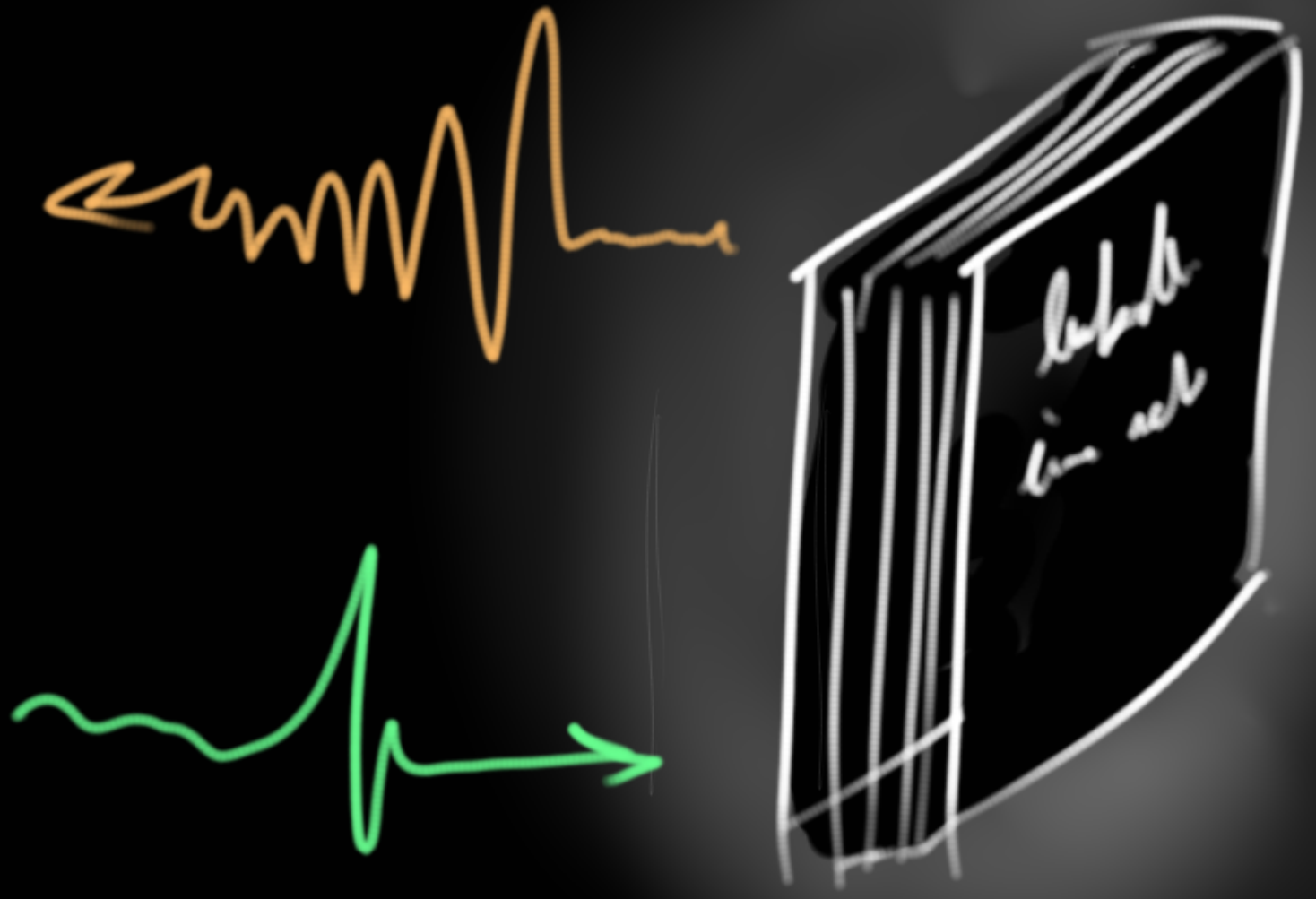
Velten et al. Nature Comm 2012

Seeing Around Corners



Velten et al. Nature Comm 2012

Reading a Closed Book



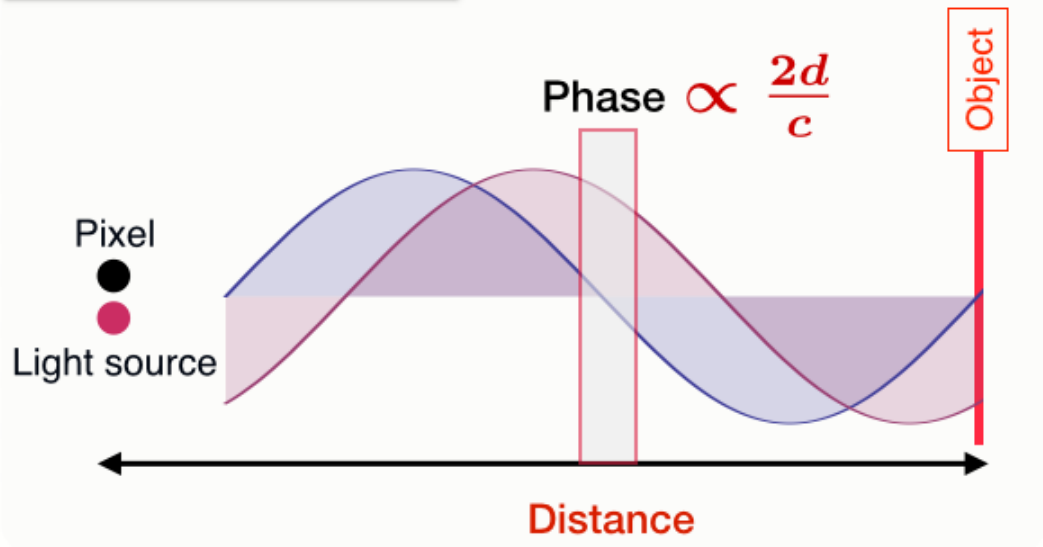
Sanchez, Heshmat, Reza, Romberg, Raskar, Nature Communications 2015

Time-of-Flight Imaging Sensors

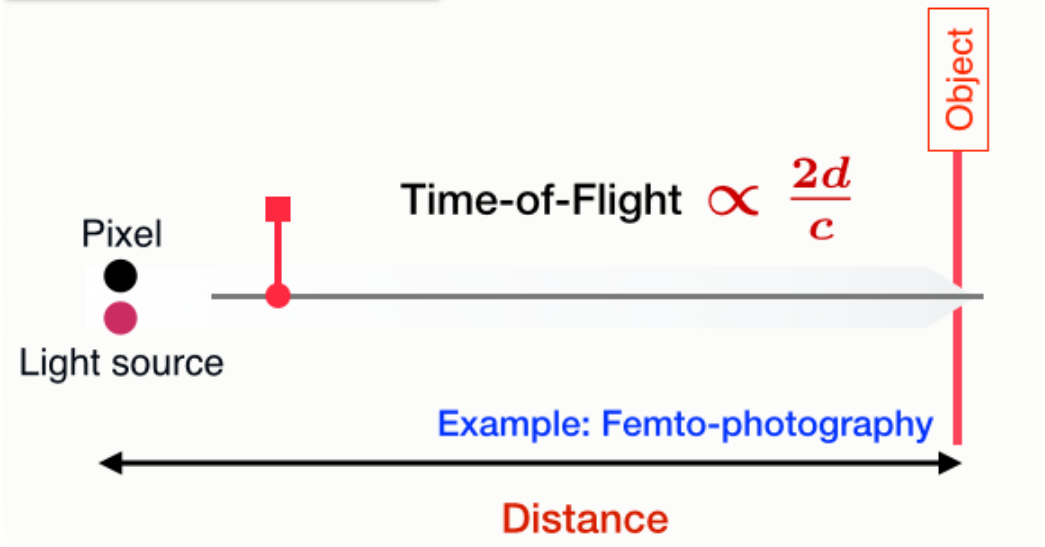
Time-of-Flight Sensors: Computes depth based on speed of light (aka SONAR with light.)

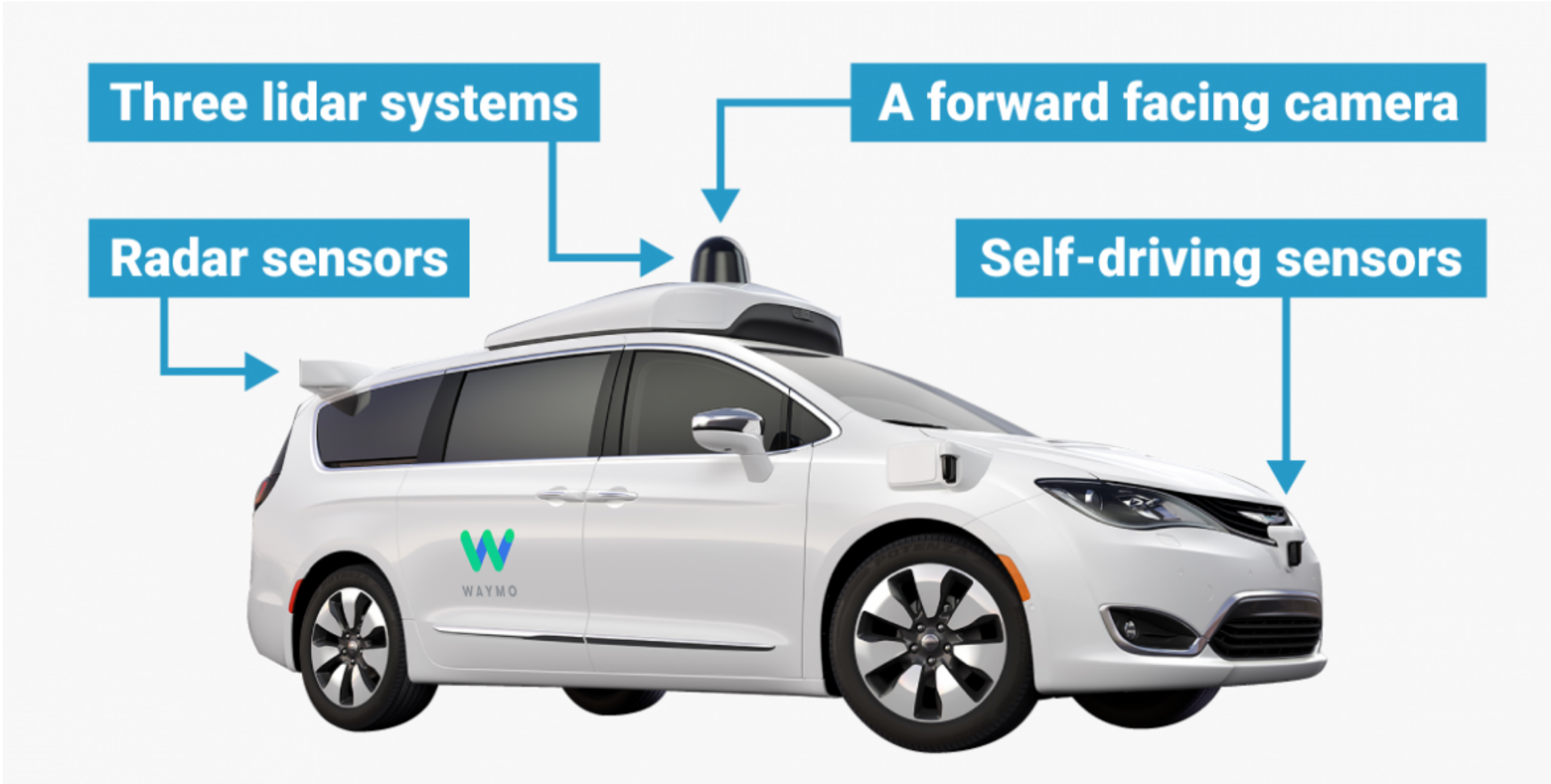
Time-of-Flight Principle: Distance of object is proportional to time traveled by light

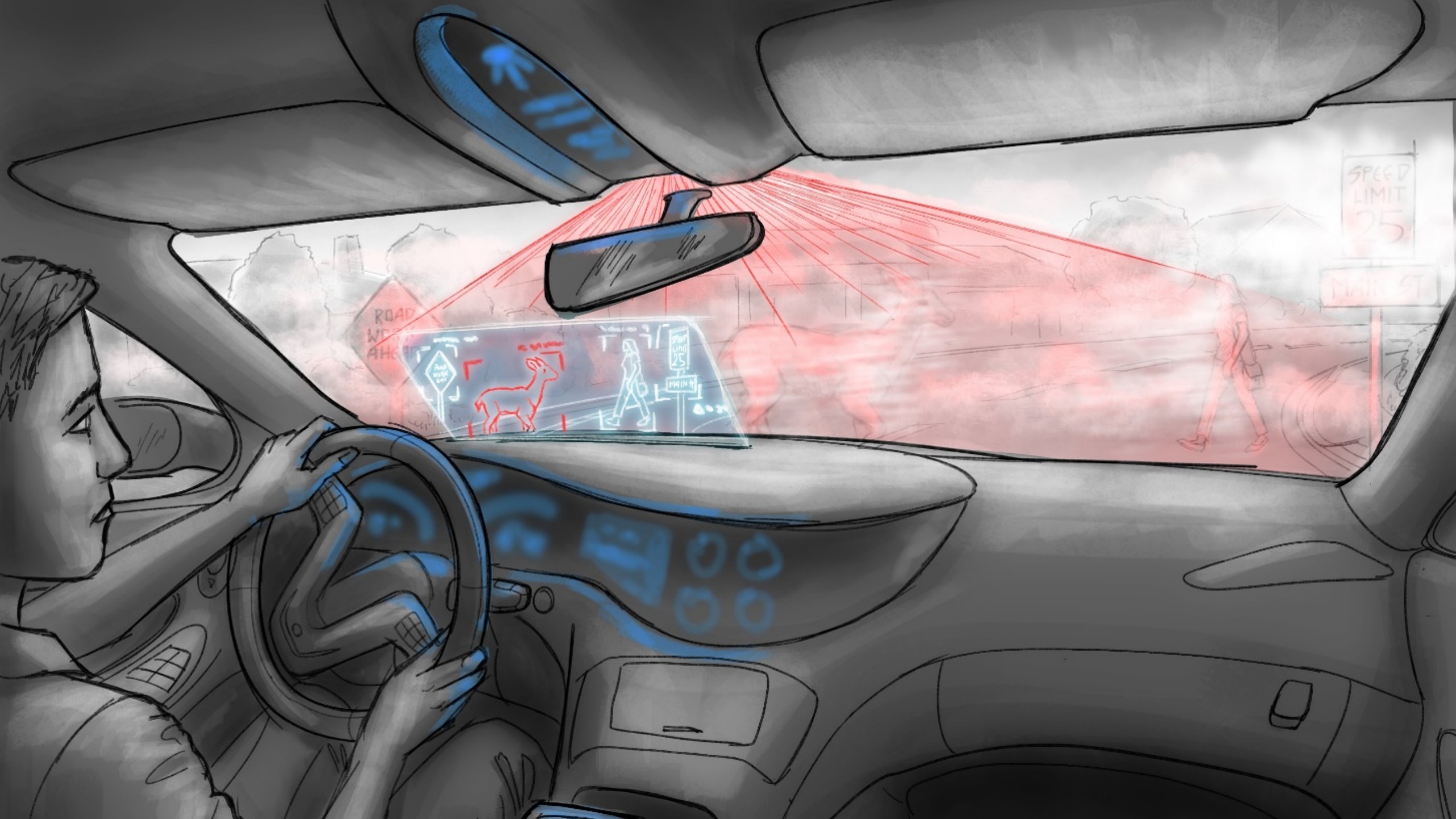
Continuous Wave ToF



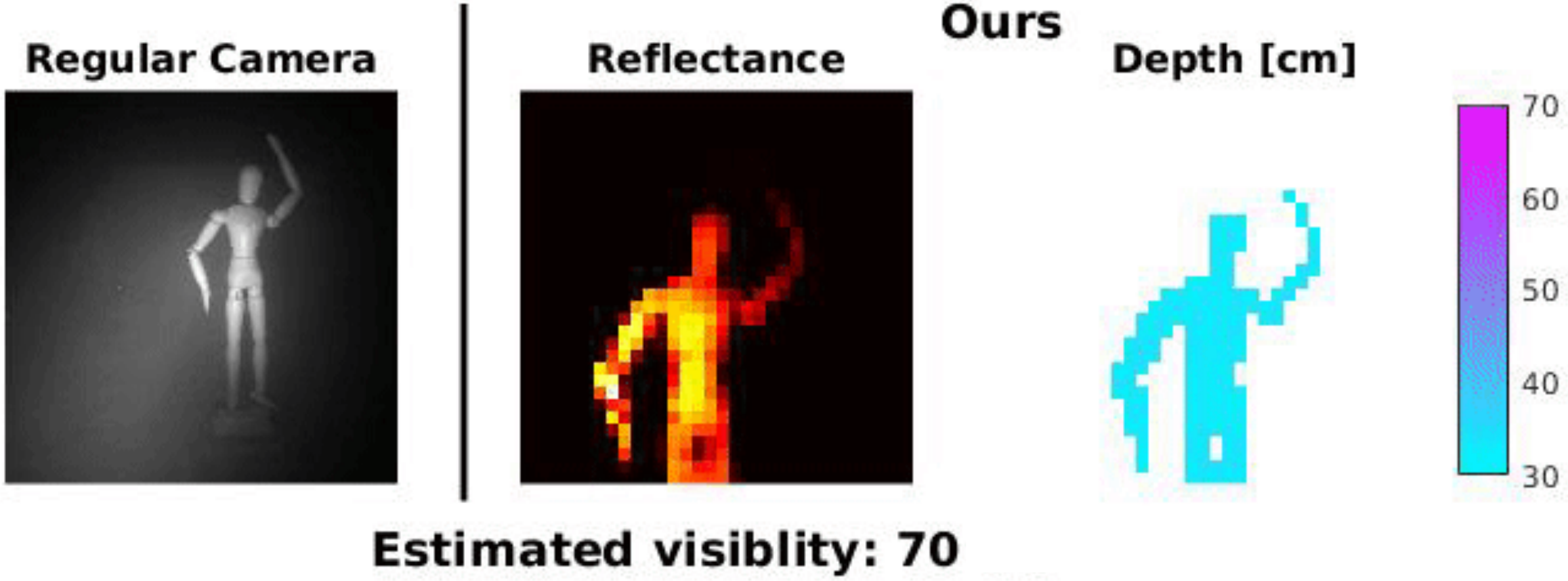
Pulsed/Impulse Based ToF




Three lidar systems
A forward facing camera
Radar sensors
Self-driving sensors
WAYMO

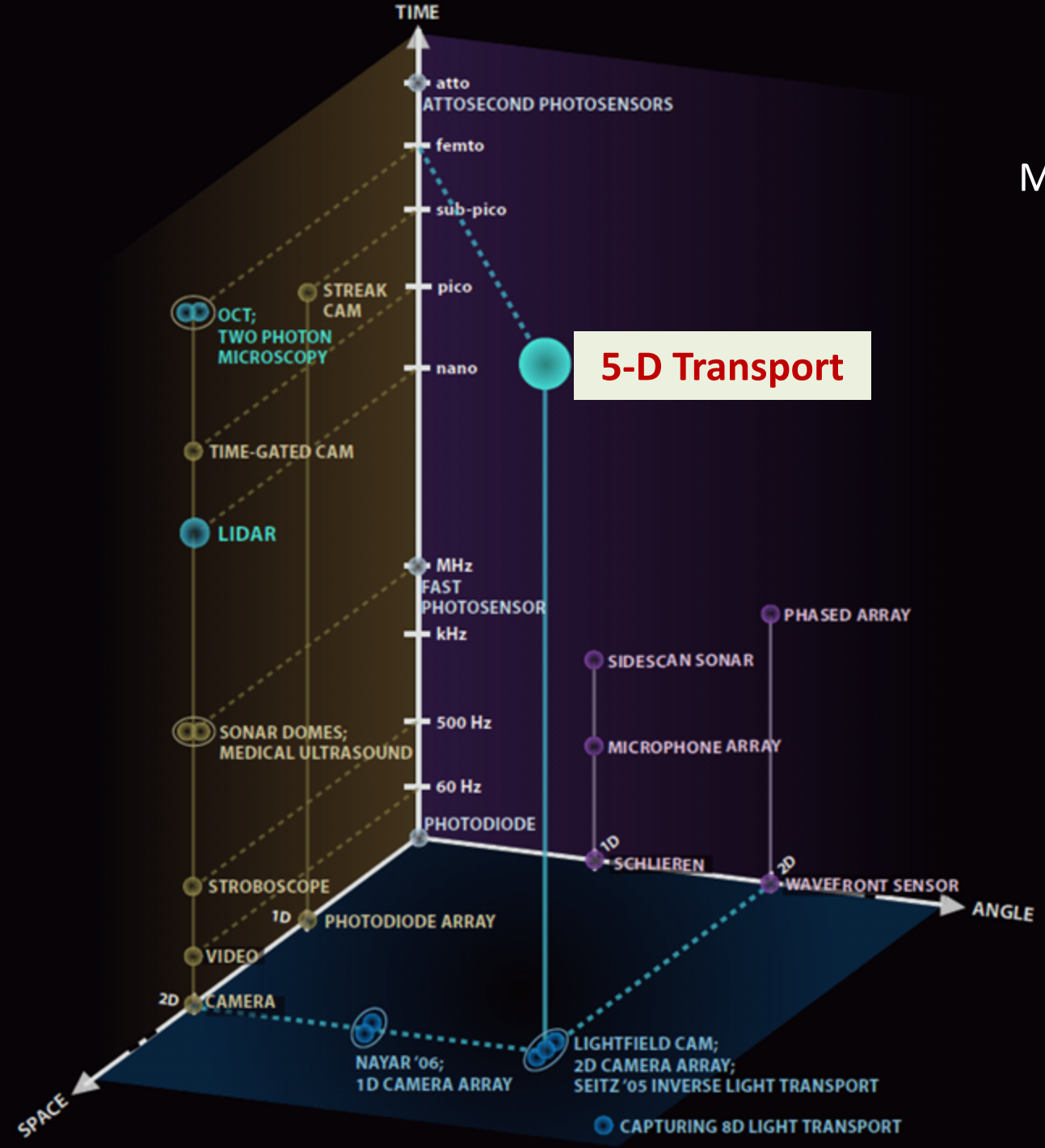

SPEED LIMIT 25
MAIN ST

Seeing thru Fog

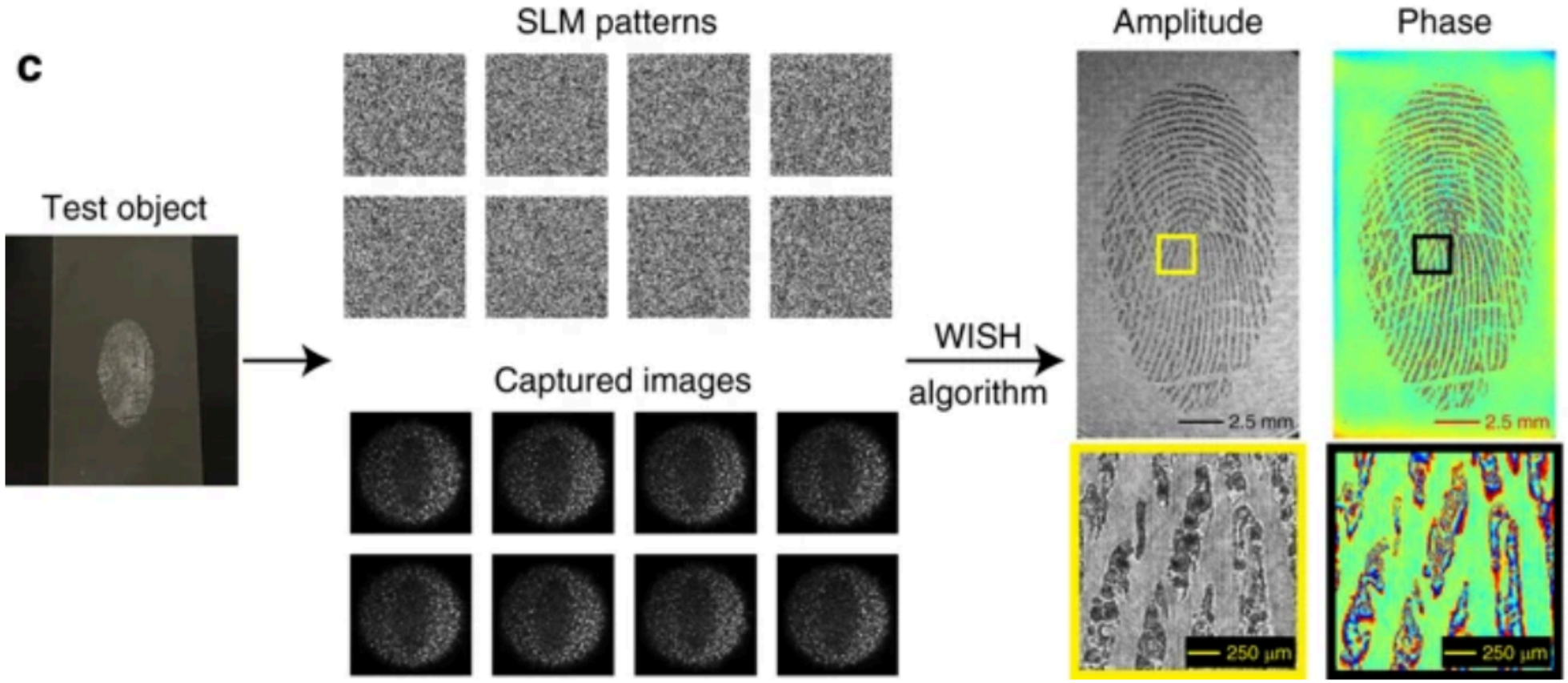


Satat, Tancik, Raskar, *ICCP* 2018

Multi-Dimensional Light Transport

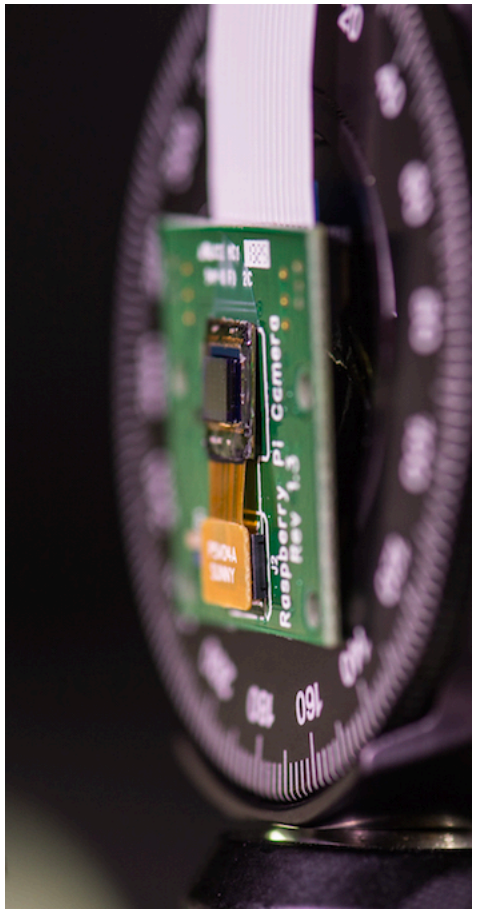


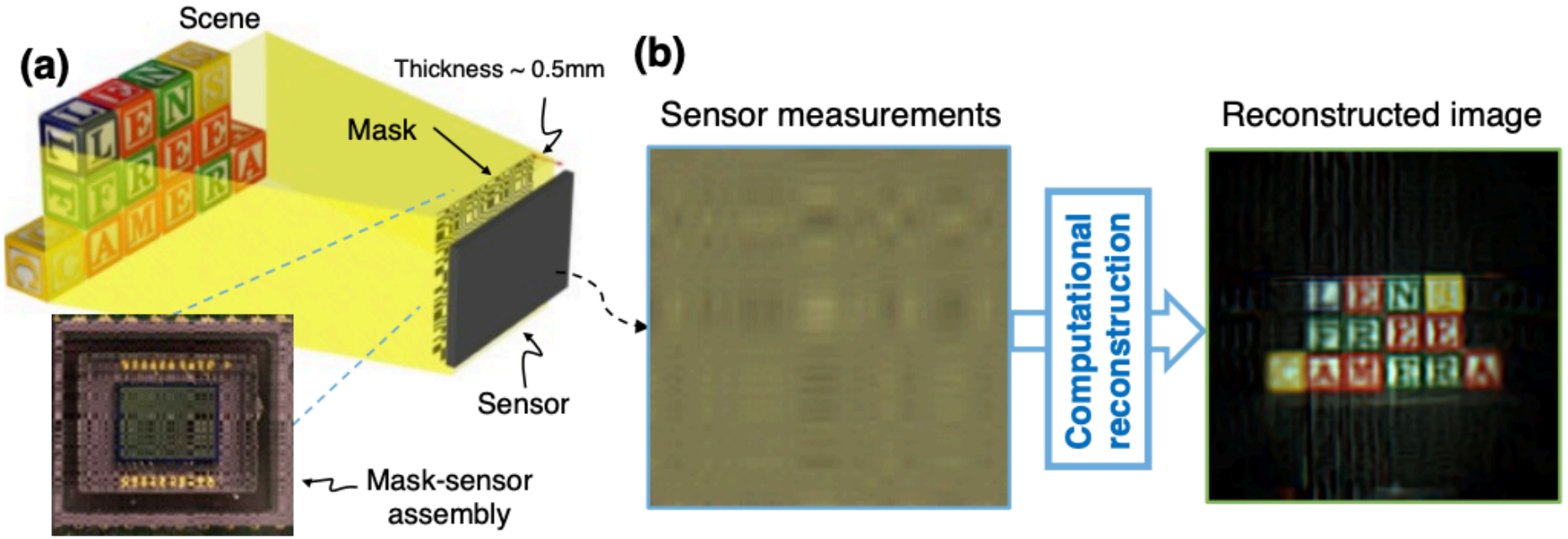
Wavefront Sensing



Wu, Sharma, Veeraraghavan, “WISH: wavefront imaging sensor with high resolution,” 2019

Flat Camera





Asif, Ayremlou, Sankaranarayanan, Veeraraghavan, Baraniuk,
"FlatCam: Thin, Lensless Cameras using Coded Aperture and Computation," 2016

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Data-Driven Computational Imaging Survey

Tristan Swedish (MIT)

Medical Imaging

Microscopy

Navigation

Shape Recovery

SAR

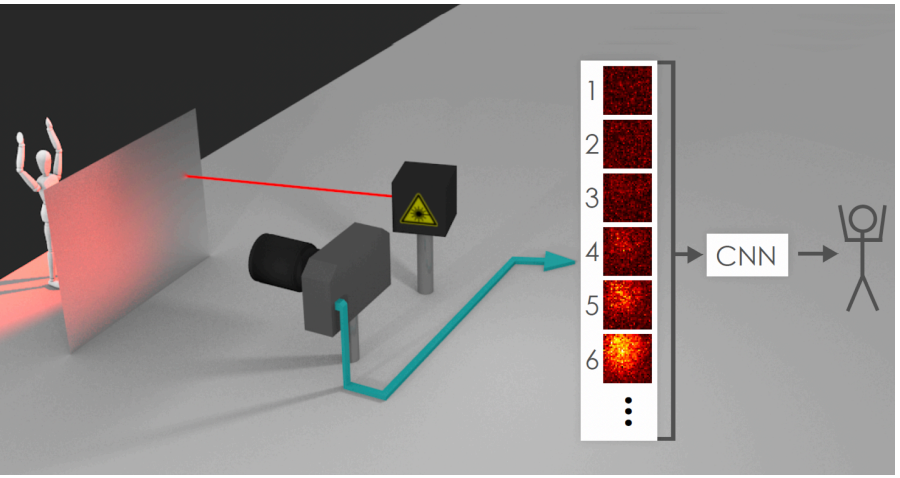
Image Enhancement

Depth Imaging

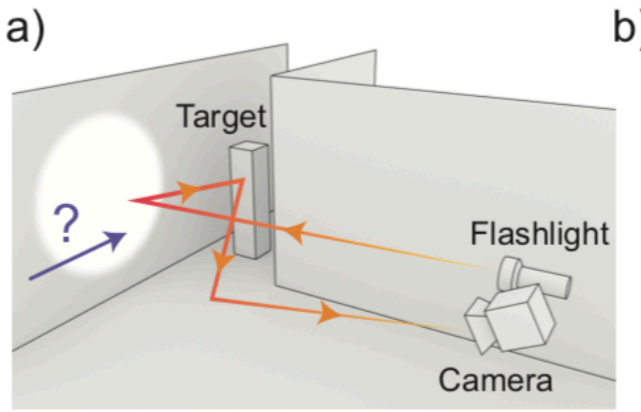
Data Driven Non-line-of-sight Imaging

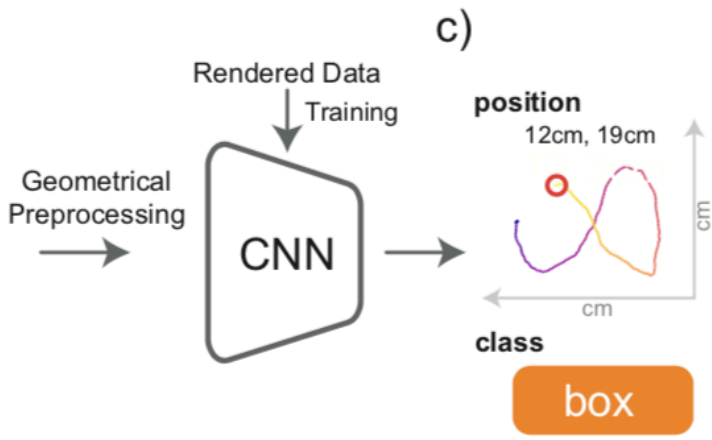
Guy Satat (MIT)

Through Scattering



Around Corners





Why Data-Driven Computational Imaging?

Incorporating Physics

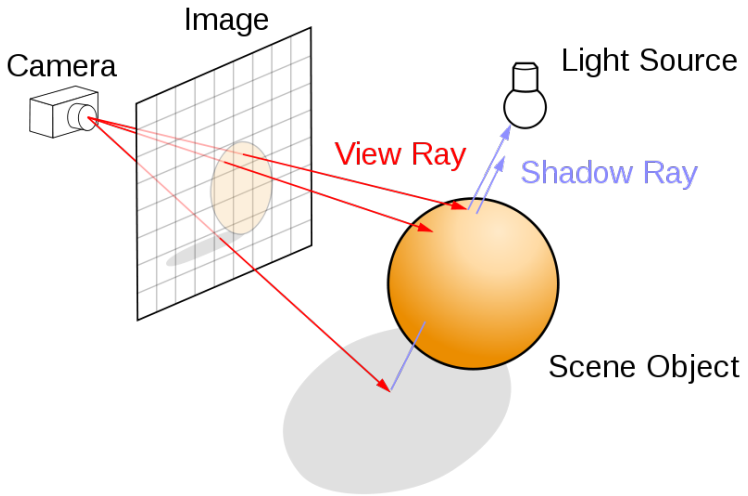
Rendering and Simulation

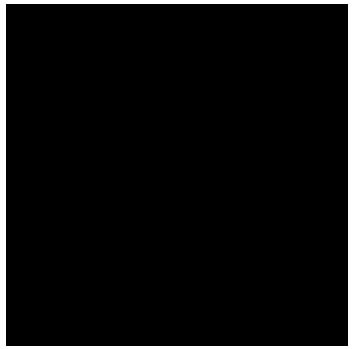
Tristan Swedish (MIT)

Simulation Is Key

Graphics 101

ToF Rendering





Ron Shaver https://www.artstation.com/artwork/r3E8e

Image by Henrik: https://commons.wikimedia.org/wiki/User:Henrik

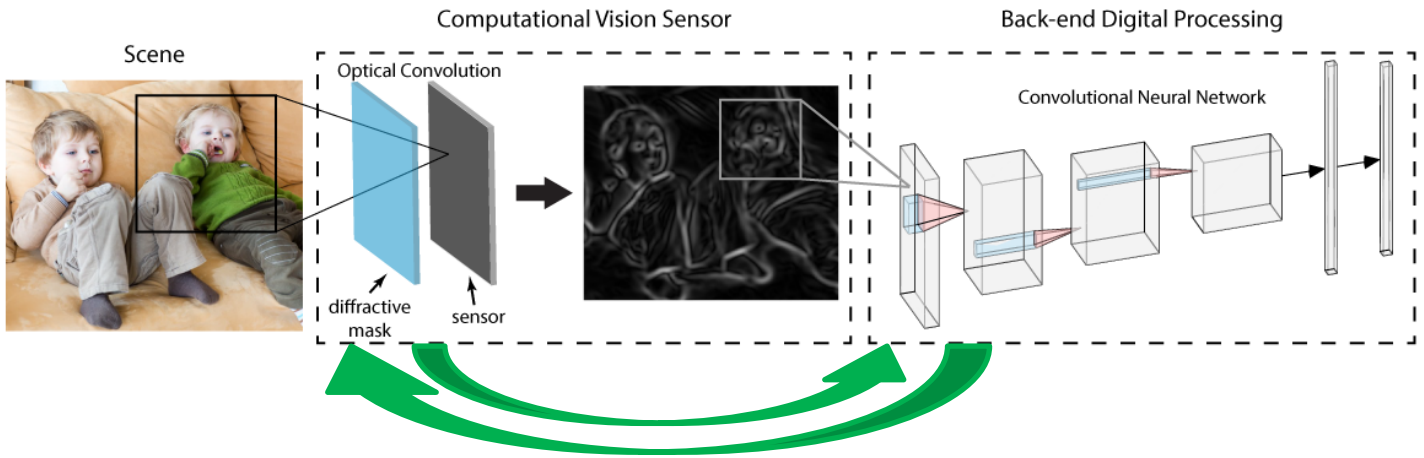
Visual Sensing Using Machine Learning

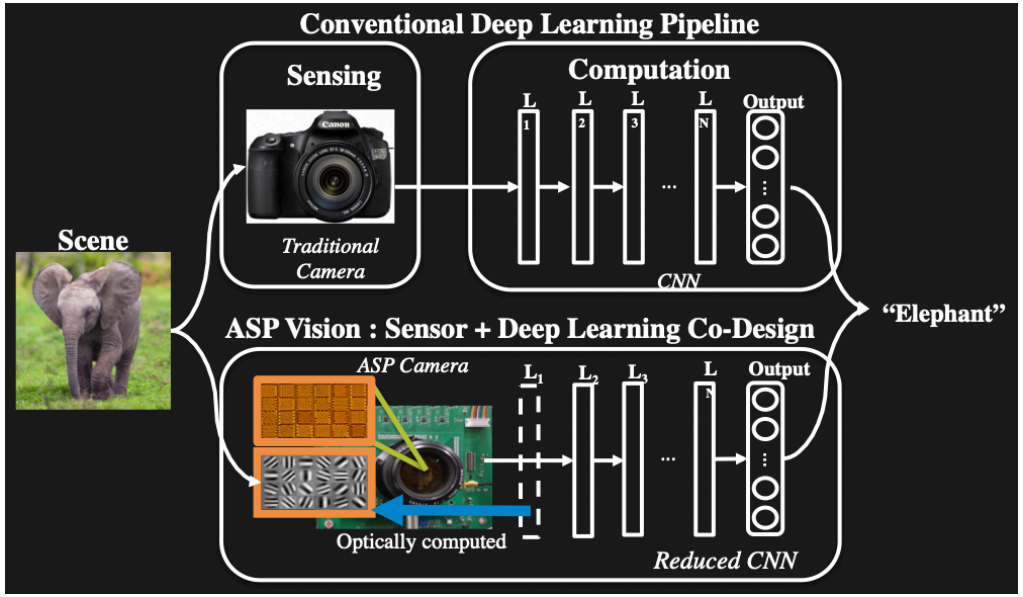
Vivek Boominathan, Ashok Veeraraghavan (Rice)

Data-Driven and Computational Imaging Coupling

Co-Design of Algorithms and Sensing

Optics Replace CNN Layers





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