

# Transparent Camera

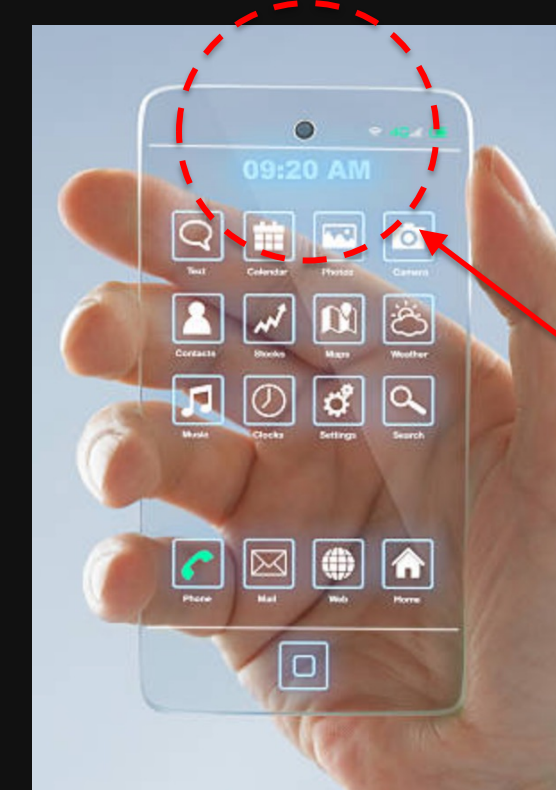
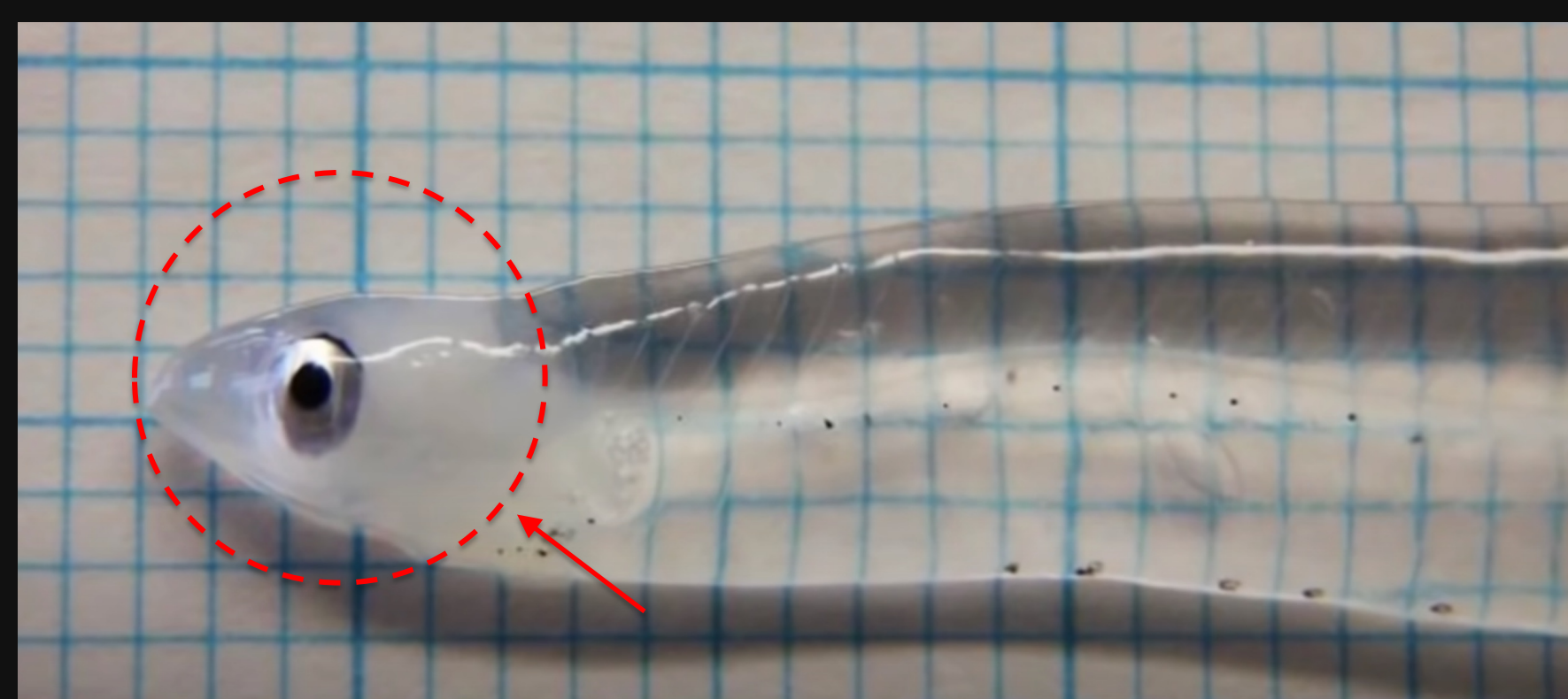
Jian Wang<sup>1</sup>, Zhanghao Sun<sup>2</sup>, Deja Xu<sup>1,3</sup>, Mr./Ms. Cool<sup>†</sup>

<sup>1</sup>Snap Research, <sup>2</sup>Stanford Univ., <sup>3</sup>UT Austin (<sup>†</sup>Call for collaborators)



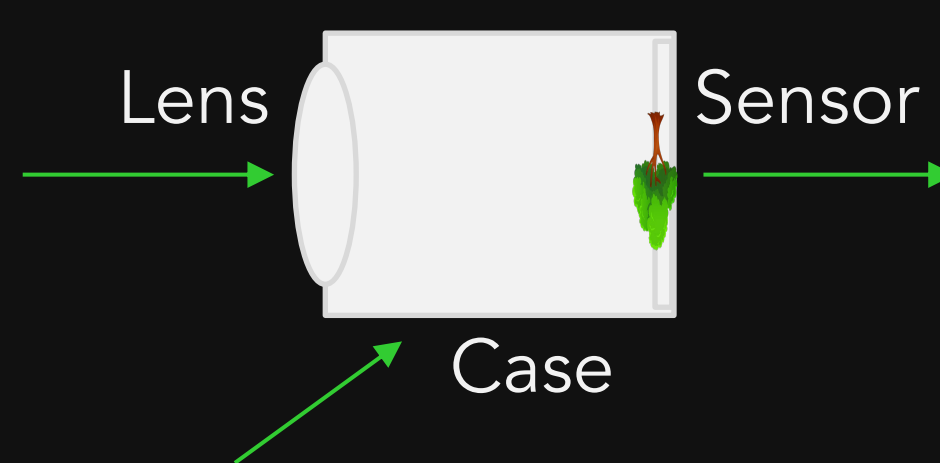
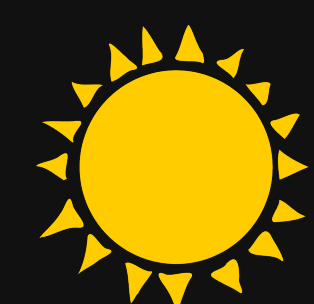
ICCP 2022

## Why Hard?



Transparent fish has evolved for 140 million years...

Transparent cellphone

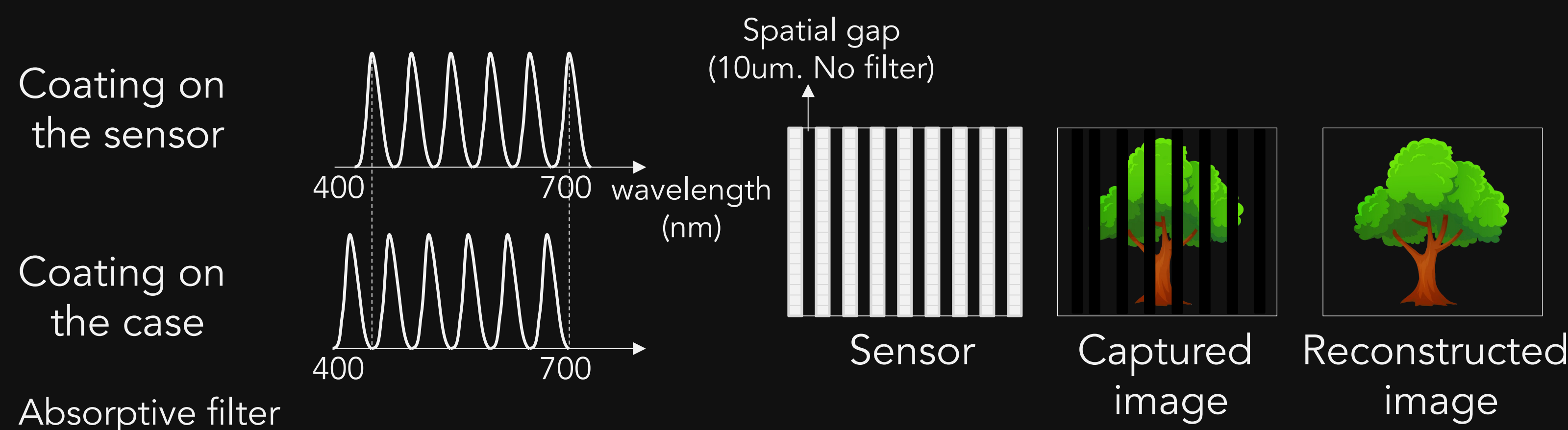


- Counter-intuitive?
  - How does the sensor accept light?
  - How to stop stray light if case is transparent?

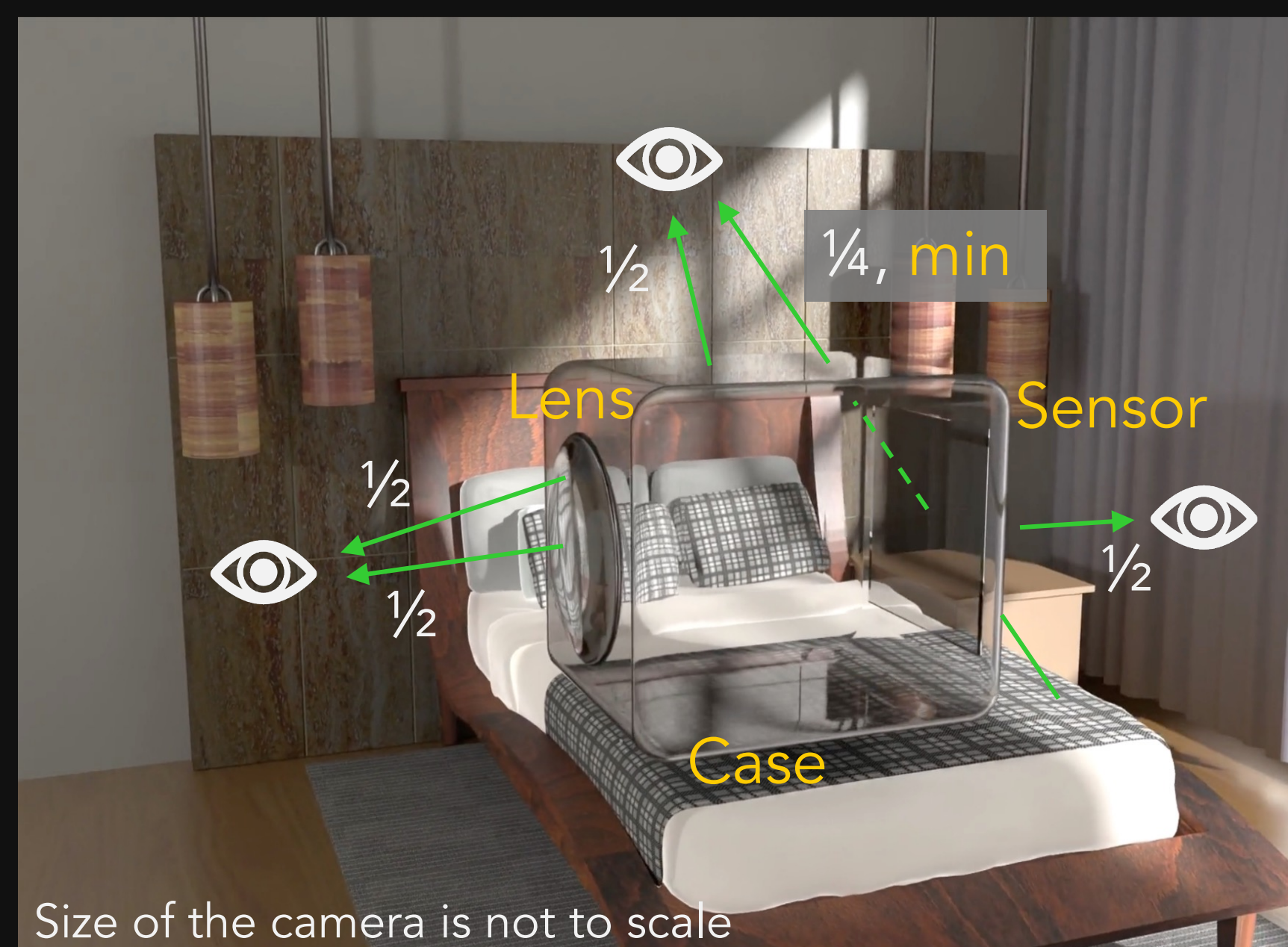
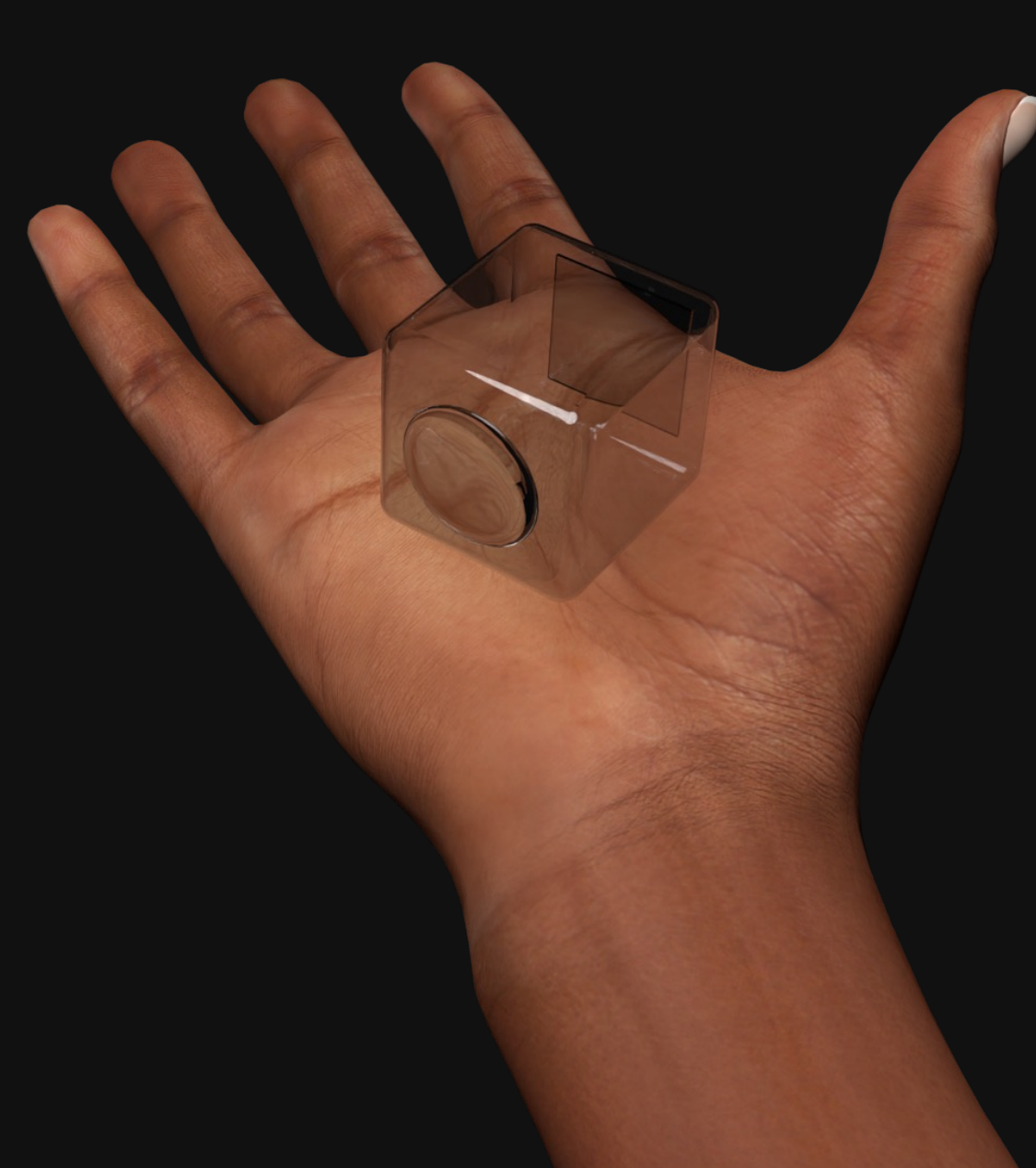
## Proposed Solution

- Coatings on
    - Case and sensor are complementary
    - ~~Lens and sensor are the same~~ No need of coating on lens
  - Spatial gap [1] in the sensor
    - No coating in the gap
- [1] Transparent display

## Implementation

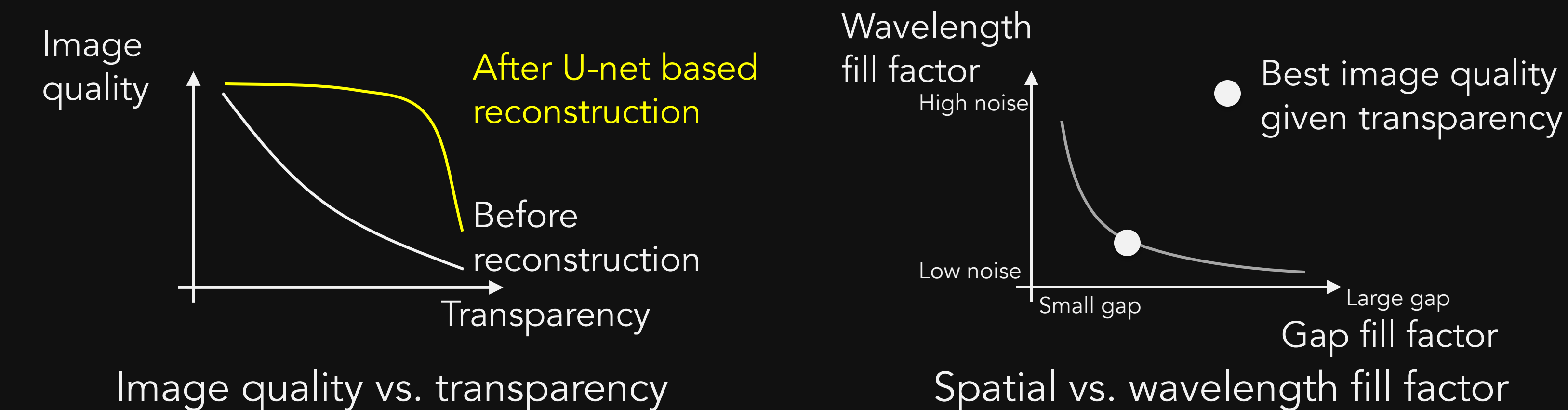


## Transparency Analysis

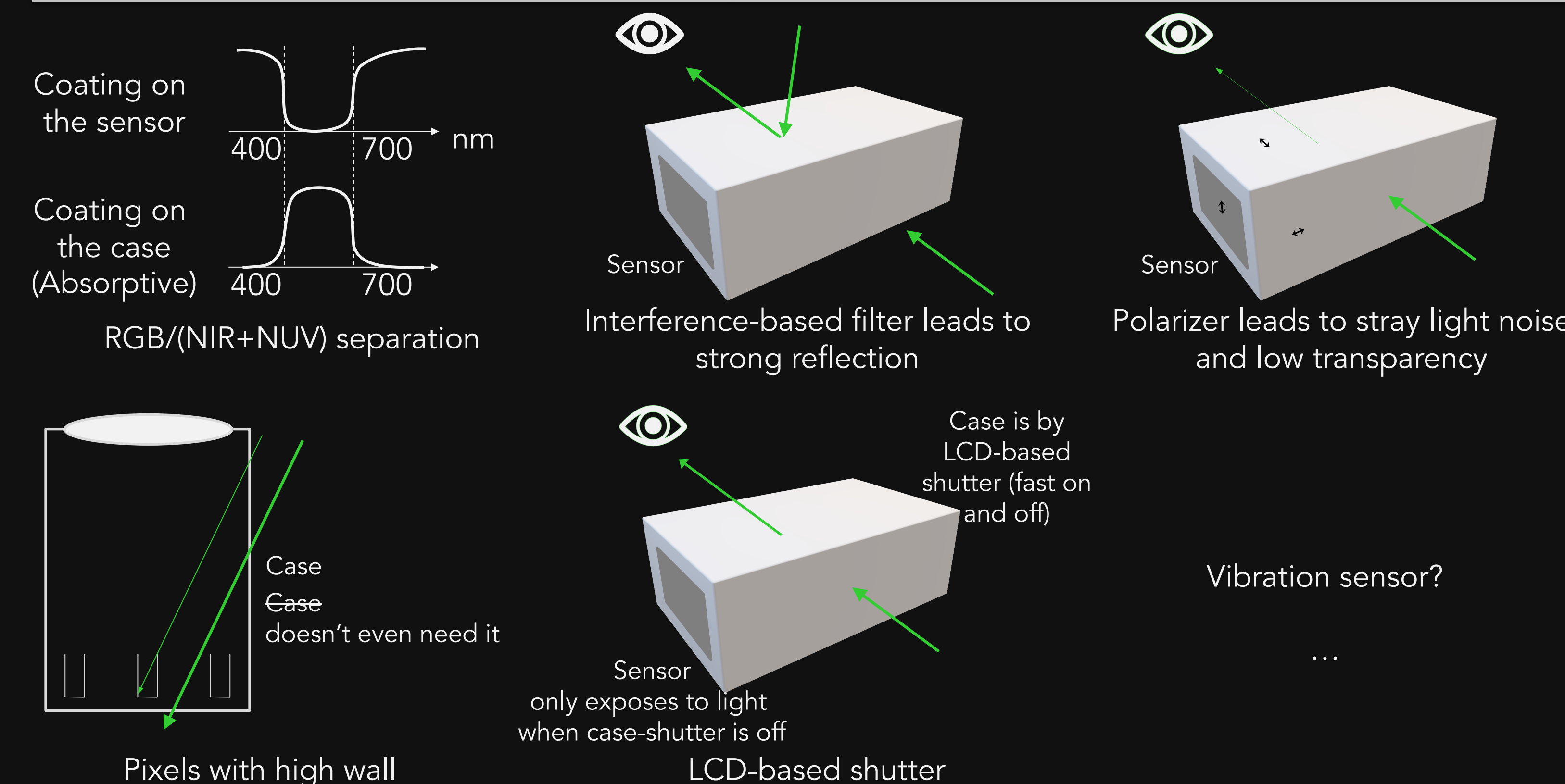


- Transparency is minimum when eye looks through the case and sensor
  - **Transparency = wavelength fill factor × sensor gap spatial fill factor**
- How to improve transparency?
  - (1) Wider bands in the case and narrower bands in the sensor's filter → noisy
    - Or some overlap → stray light leads to an offset, strong photon noise
  - (2) Wider gap in the sensor → larger holes in the image
  - Tradeoff between transparency and image quality

## Image Restoration



## Other Implementations?



## Combined with Others

- Orthogonal to other camera types, and thus can be combined, like pinhole camera, lensless camera, thin camera, and tiny camera