

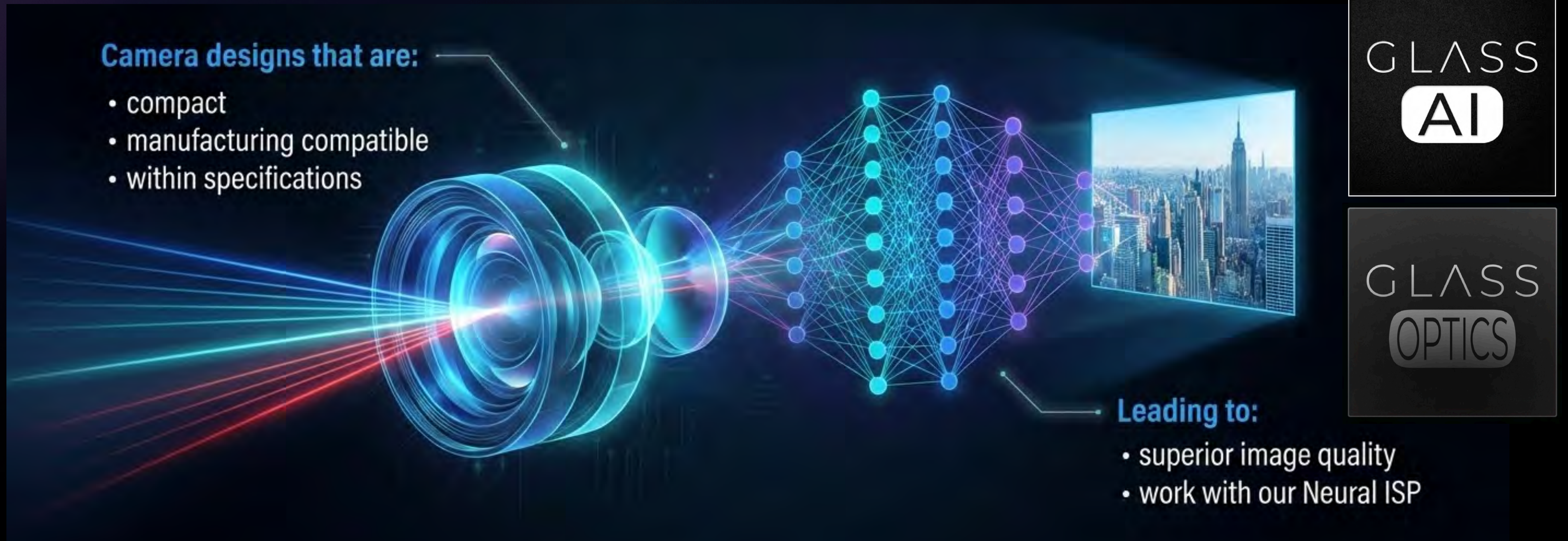
# GLASS

## Computational Imaging



Neerja Aggarwal, Ph.D.  
Deep Optics Engineer

# GLASS's extends computational imaging across industries



AR/VR



Drones



Wearables



Smartphone



Security



Cinema

# How to rapidly bring optimum image quality to any camera?

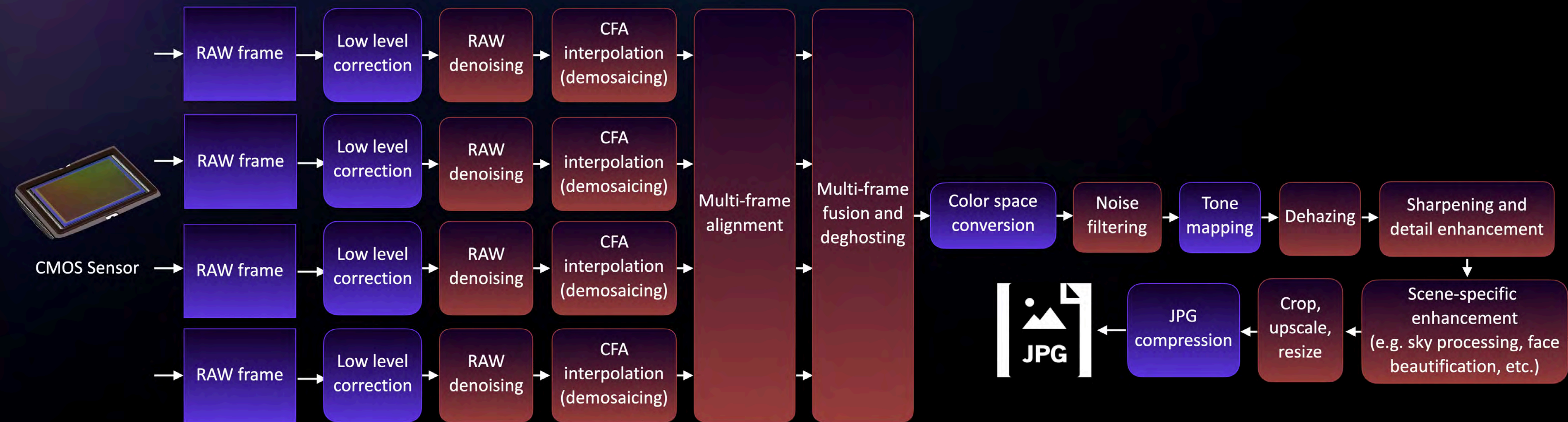
Any device with a camera



GLASS  
AI

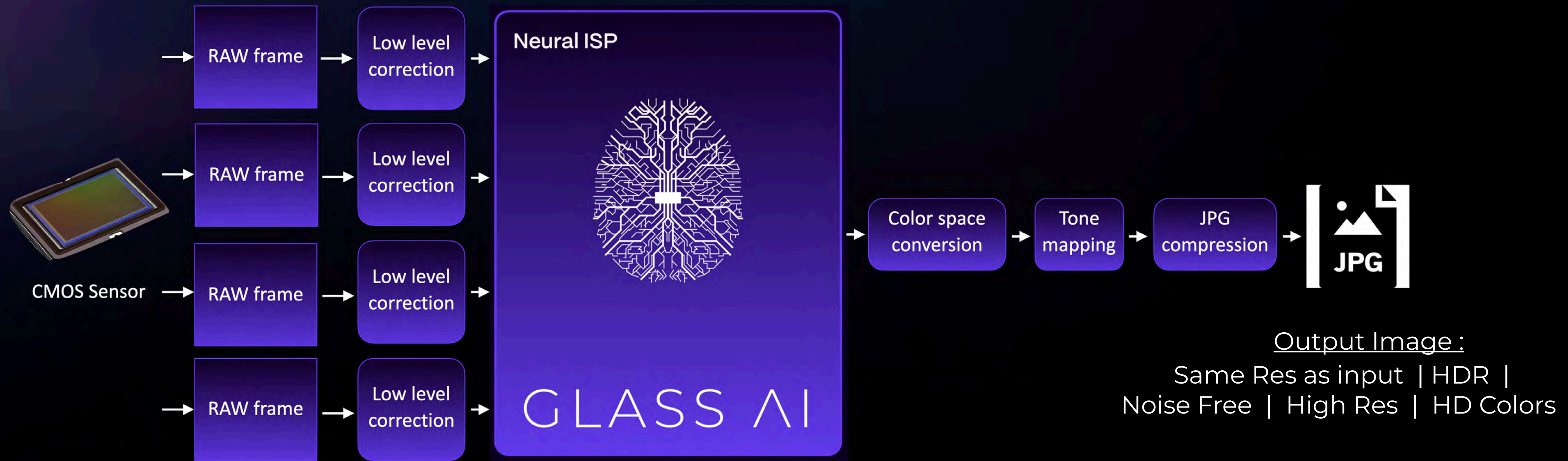
Custom edge neural network  
deployed on device

# A typical ISP pipeline is complex and difficult to develop



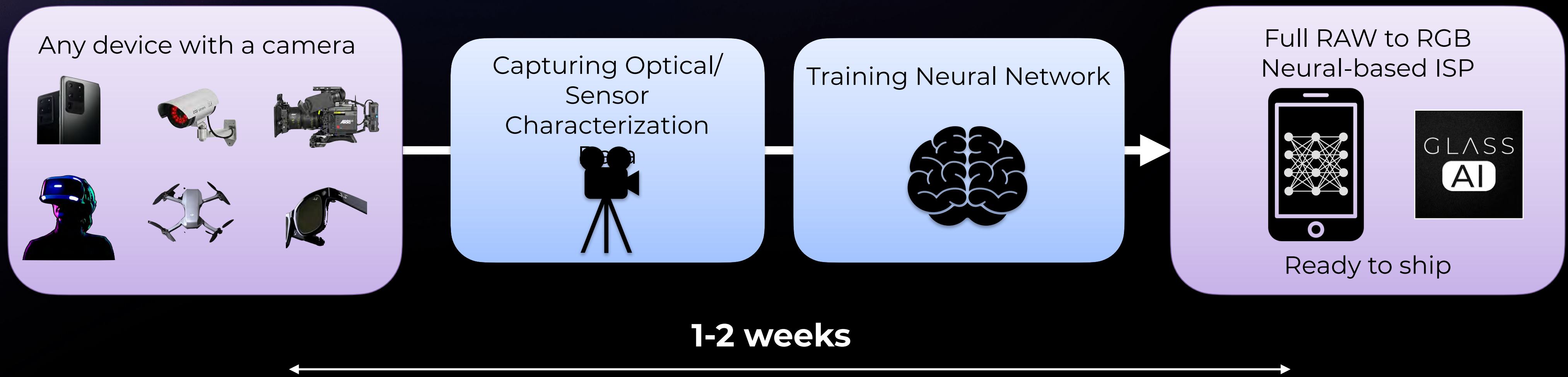
All RED blocks are replaced by Glass Single Neural Network

# Imaging pipeline using Glass AI is *simple and effective*



All RED blocks were replaced by Glass Single Neural Network

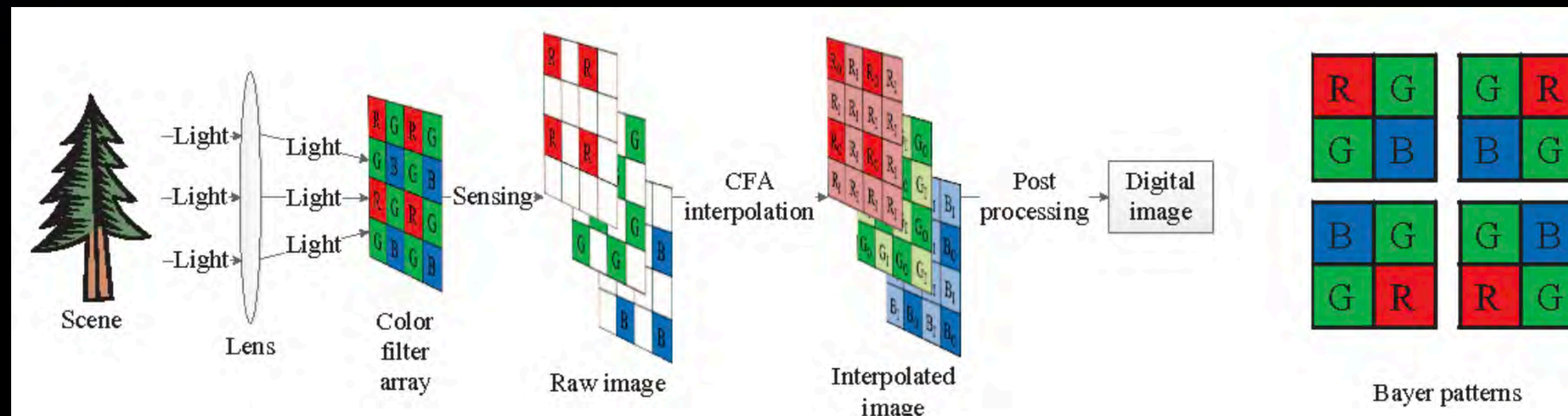
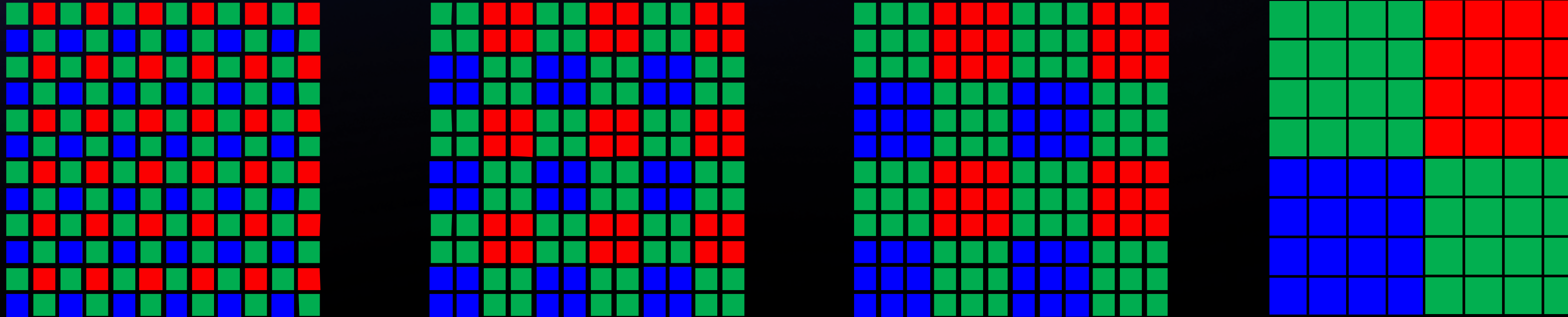
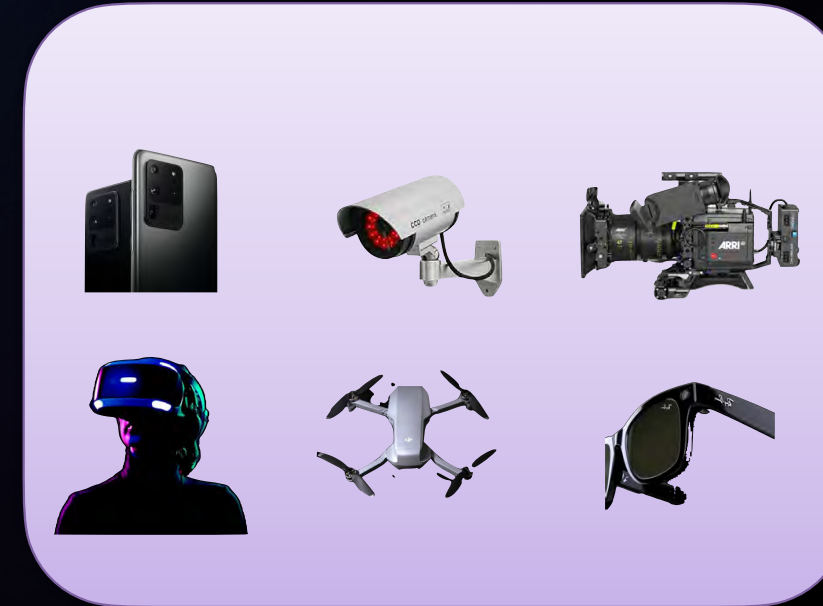
# From months of per-device tuning to a learning system that adapts!



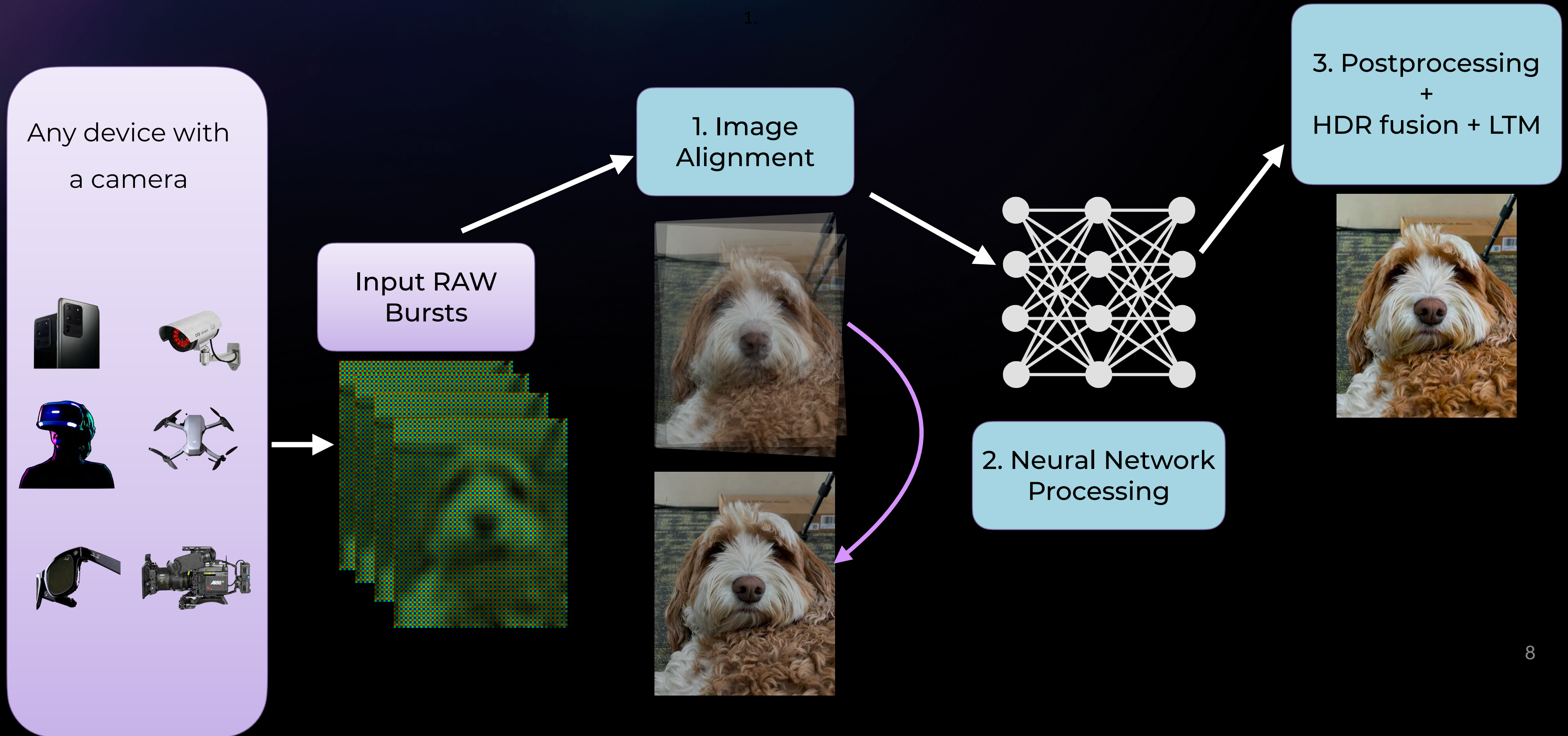
*For comparison, competitor company employs thousands of engineers, dedicating multiple months each year to similar development efforts.*

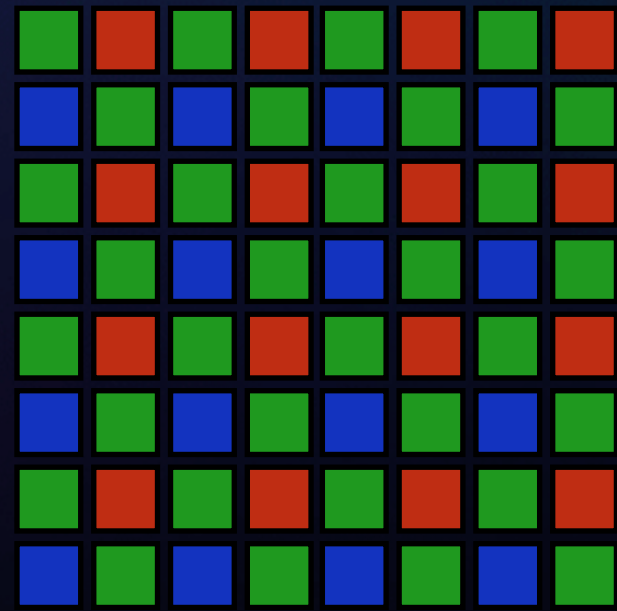
# We support a variety of camera types

- All pixel sizes
- Any CFA type (RGB, RGBW, ...)
- Any CFA pattern (bayer, quad, hex...)
- Any type of lens modules (wide, tele, super-tele (super-high zoom) ...)



# Neural ISP block has 3 main steps





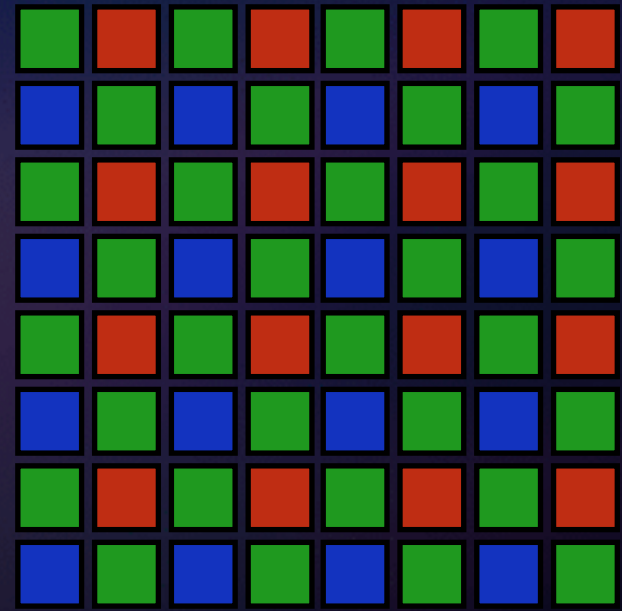
# Bayer CFA

iPhone 16 Pro Vs. Iphone 16 Pro + Glass AI Vs. iPhone 17 Pro

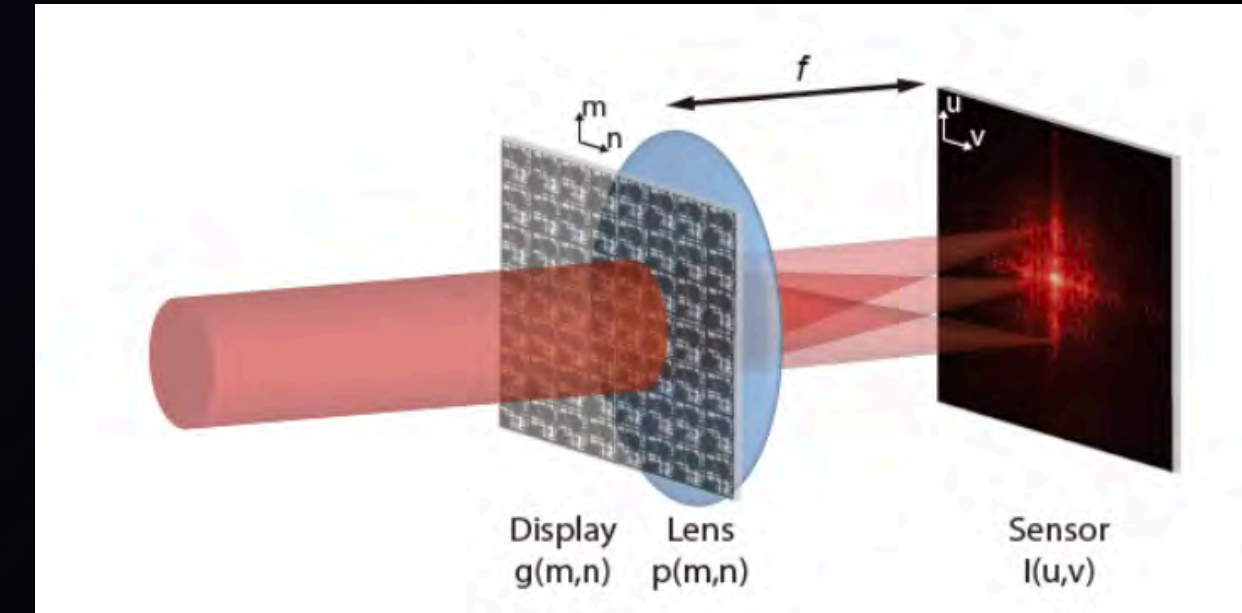








# Bayer CFA



## Under Display Selfie Camera Xiaomi Mix 4 Vs. Xiaomi Mix 4 w/ Glass AI







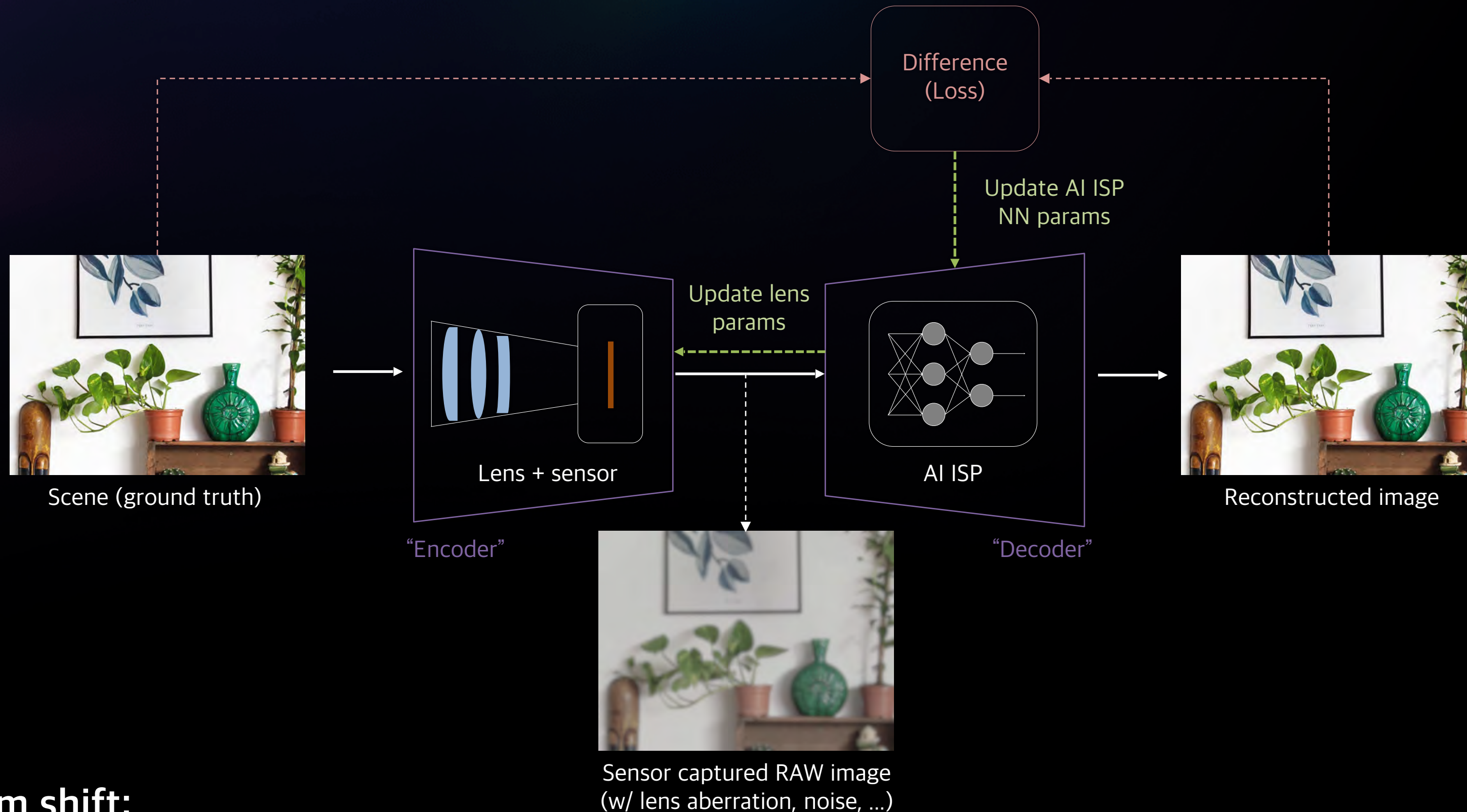




What if we want to further push the capabilities of camera hardware?

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# Deep Optics is co-designing optics + ISP systems



- **Paradigm shift:**  
From sequential “optics, then algorithms” to **end-to-end, jointly optimized** camera system
- **Differentiable pipeline:**  
Optical simulation + sensor model + ISP/NN in **one graph**. Gradients update **NN weights + lens parameters** and **sensor** etc. together



This requires new kinds of simulation  
tools

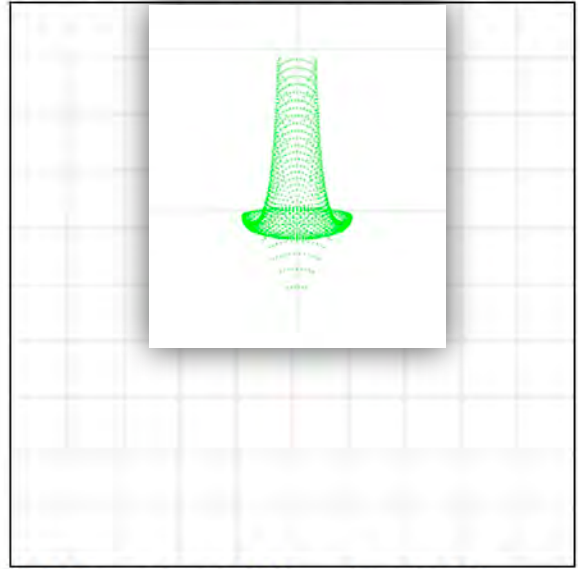
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# Our GPU-based ray tracing tool matching precision of the results from commercial software

Spot diagrams for **geometrical PSFs** by Zemax

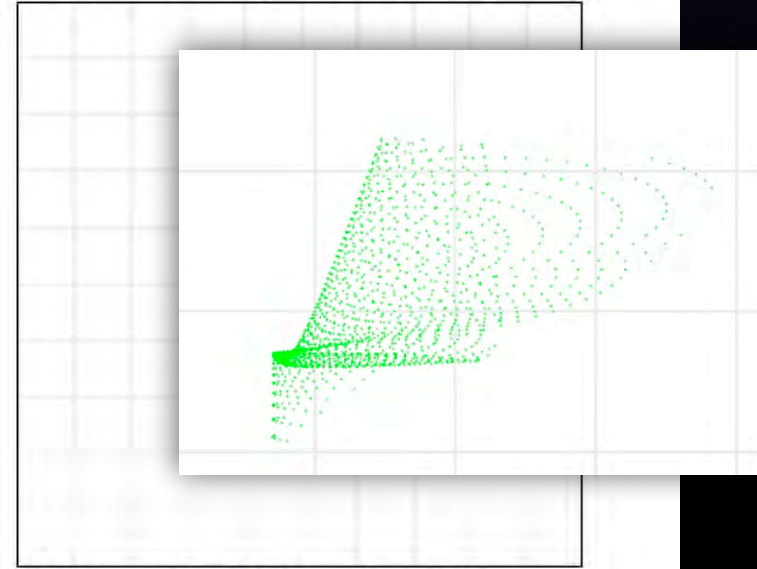
Same PSFs computed with our in-house tool on GPU

OBJ: 0.00, 13.00 (deg)



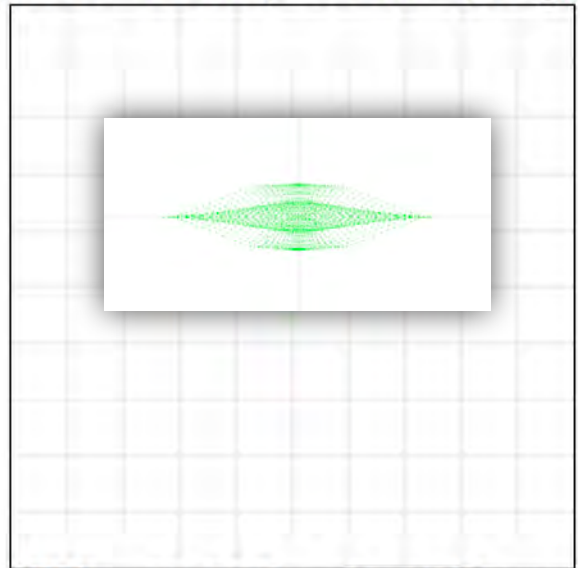
IMA: 0.000, 6.642 mm

OBJ: 9.75, 13.00 (deg)



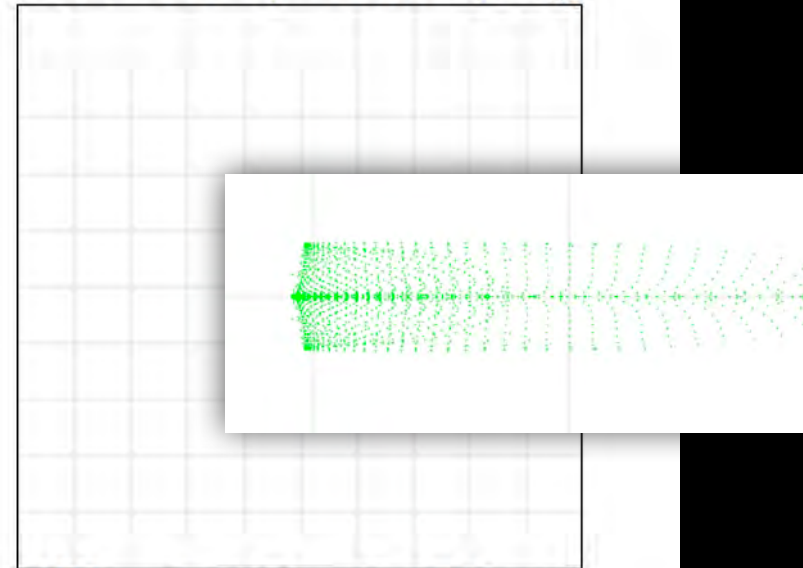
IMA: 3.705, 6.635 mm

OBJ: 0.00, 0.00 (deg)



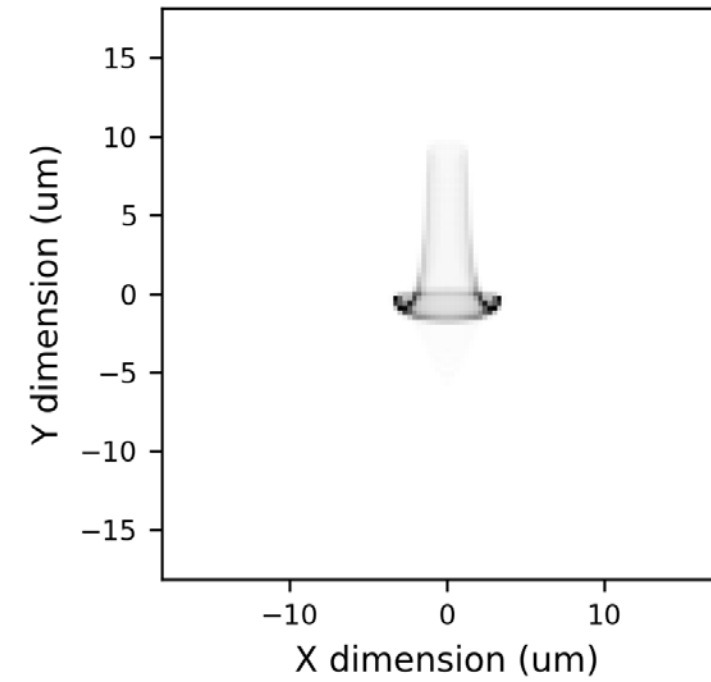
IMA: 0.000, 0.000 mm

OBJ: 9.75, 0.00 (deg)

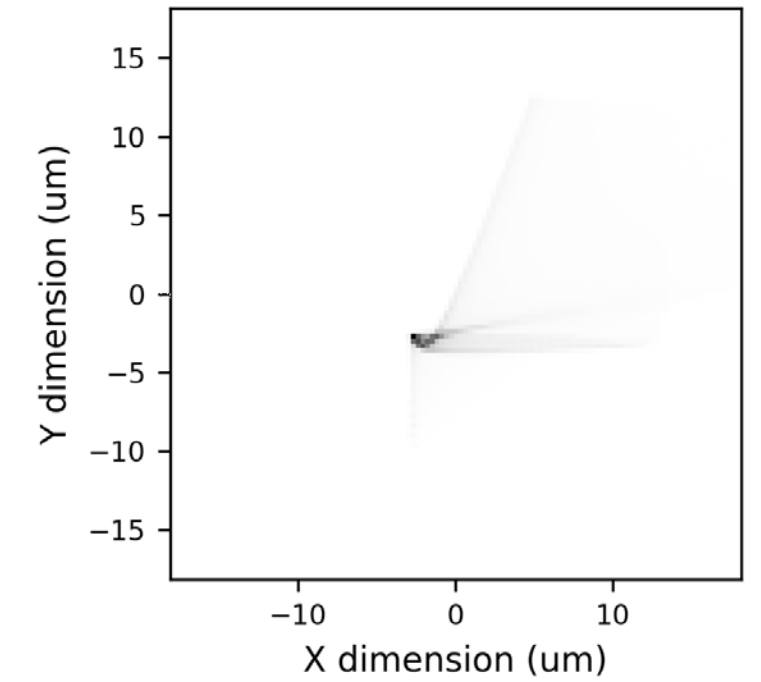


IMA: 3.669, 0.000 mm

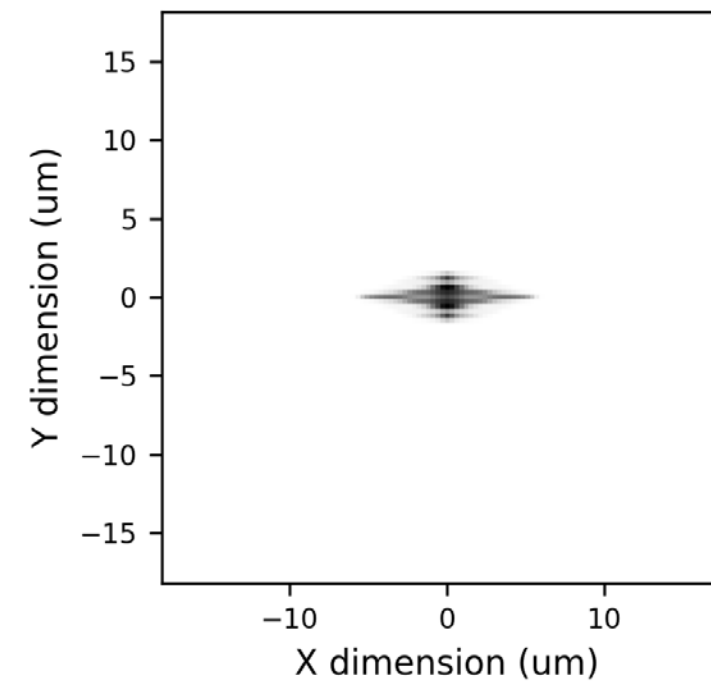
PSF at FOV=(0, 13), z=-1500.0



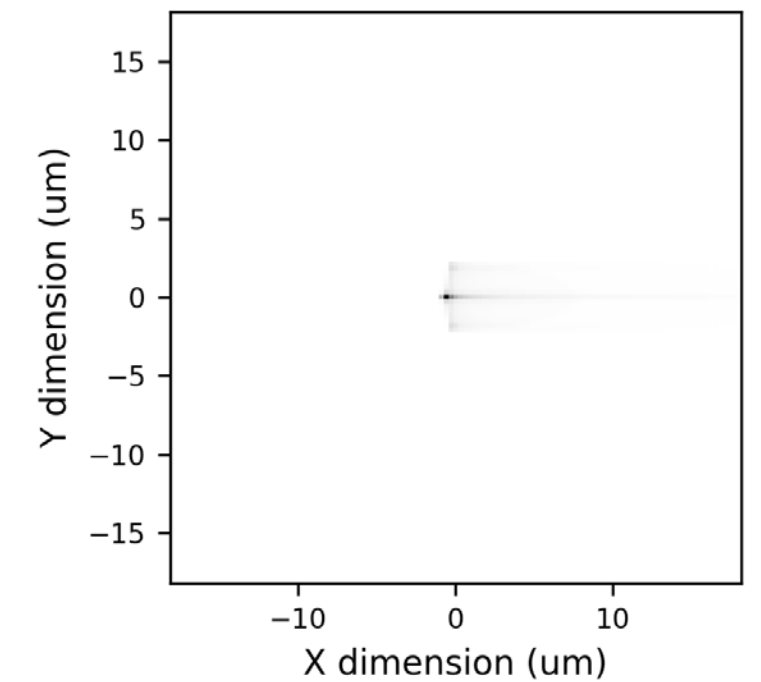
PSF at FOV=(9.75, 13), z=-1500.0



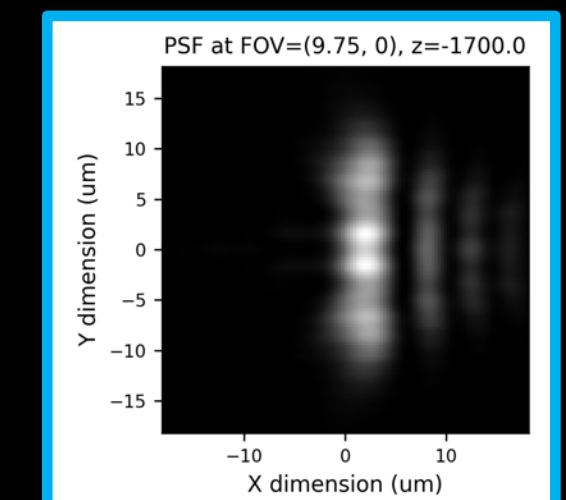
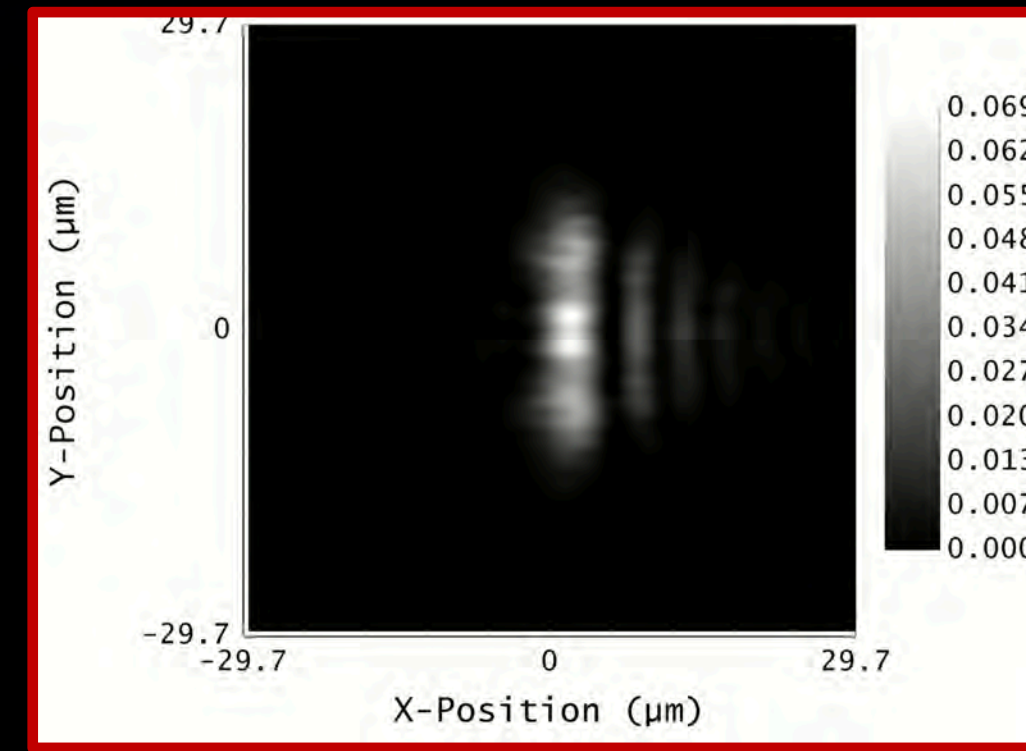
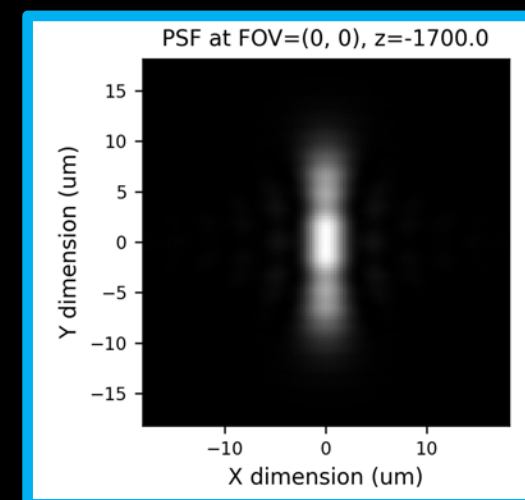
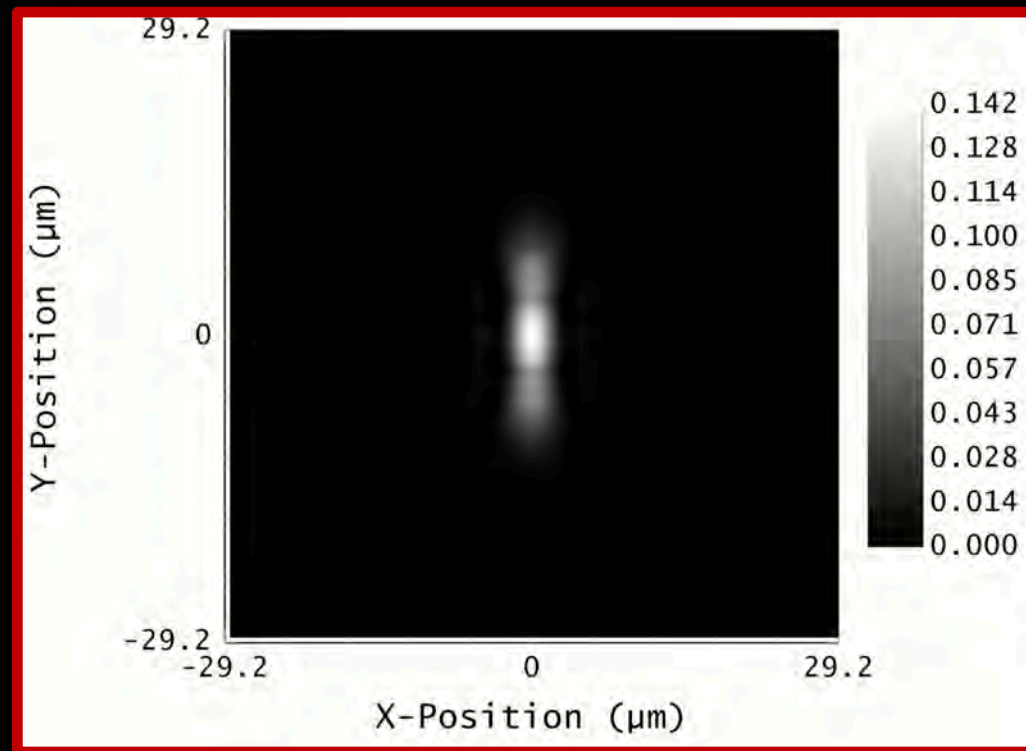
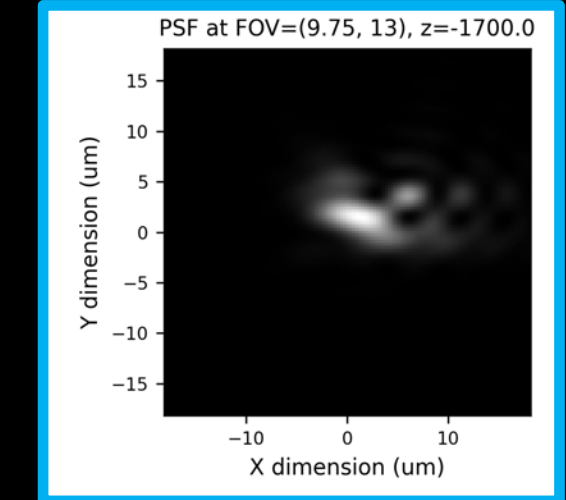
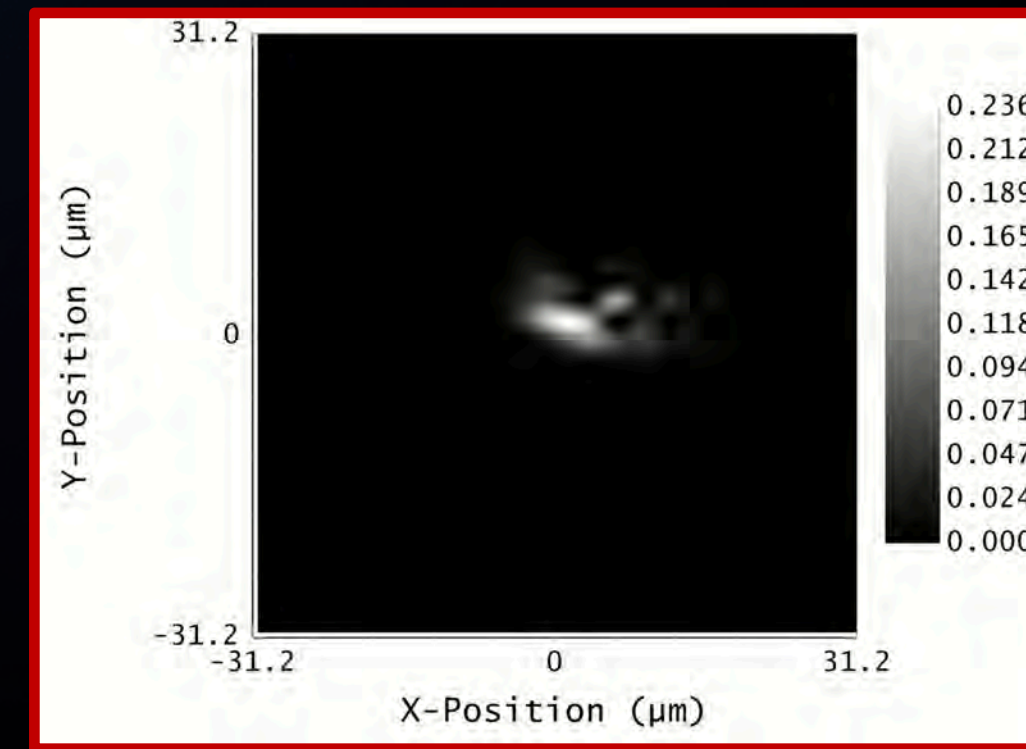
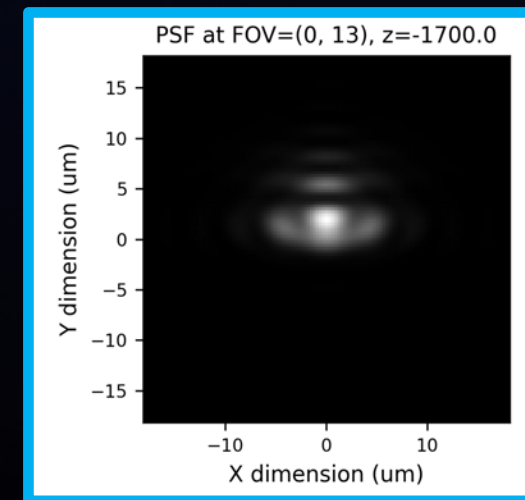
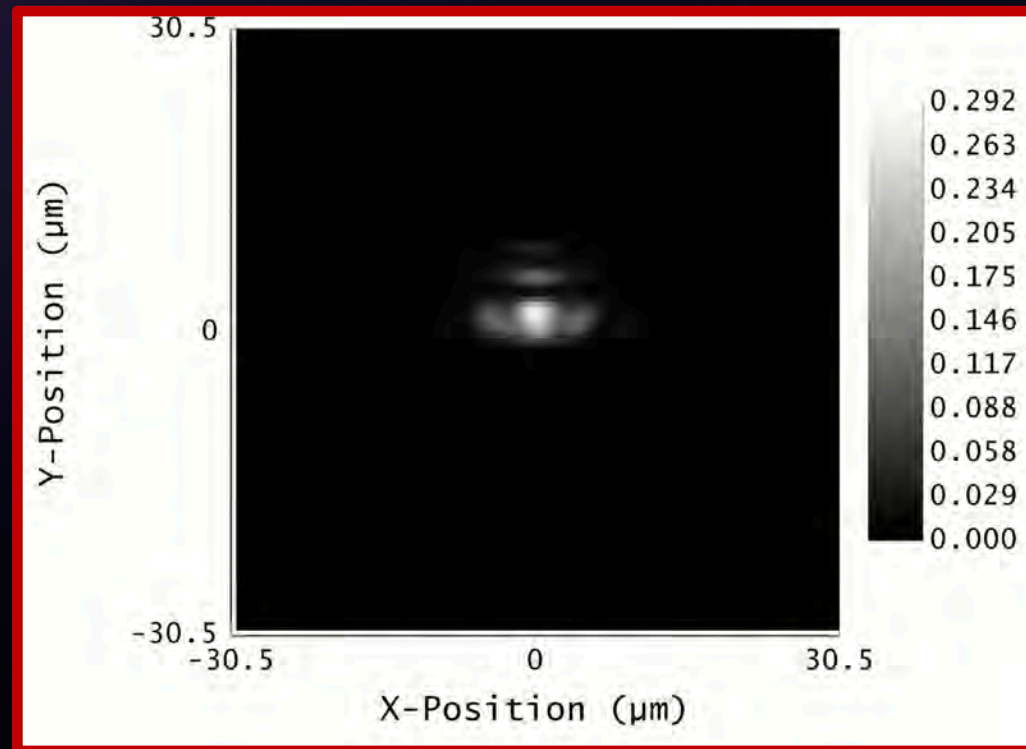
PSF at FOV=(0, 0), z=-1500.0



PSF at FOV=(9.75, 0), z=-1500.0



# Our GPU-based ray tracing tool matching precision of the results from commercial software



**Red:** Diffraction (Huygens) PSFs computed by Zemax  
**Blue:** Same PSFs computed with our ray tracing tool on GPU

GPU-based ray tracing speeds up the simulation by  $\sim 100\times$

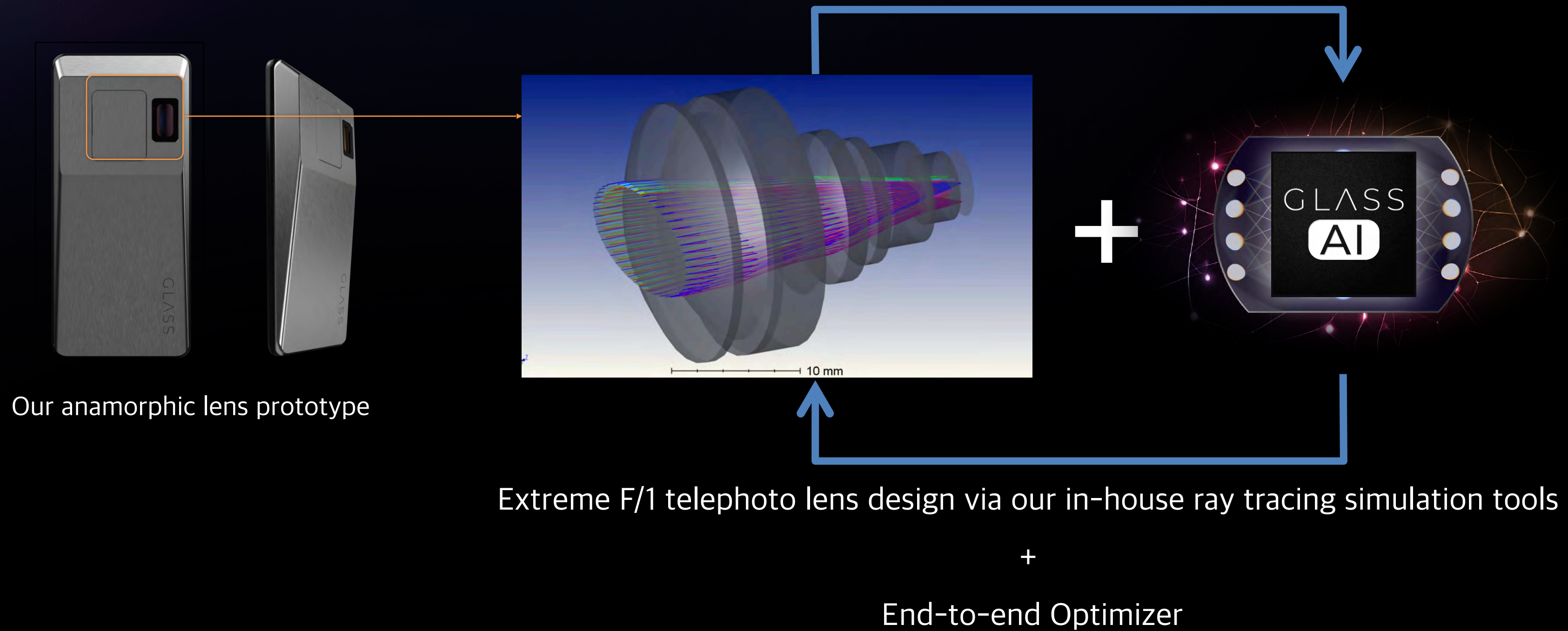
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Case study: Large aperture lens

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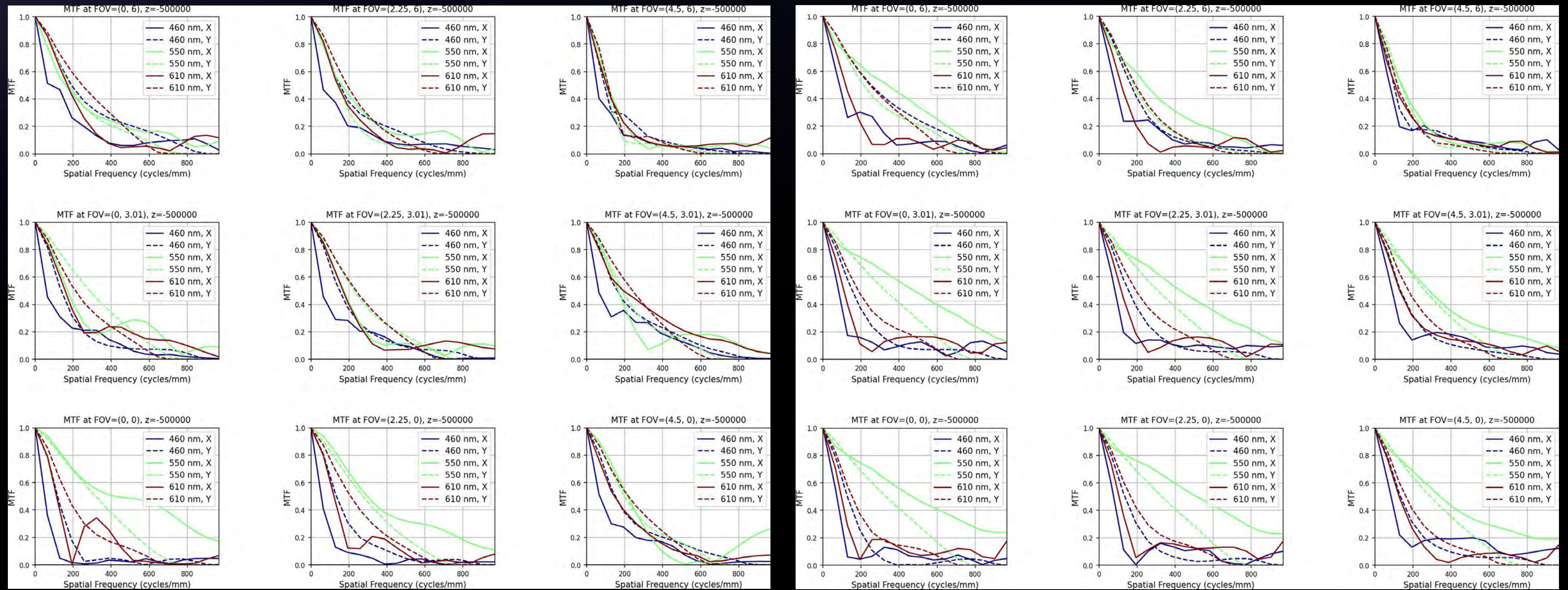
# Example: Anamorphic tele lens module in mobile phone that enables huge aperture



# Co-Optimized Optics & AI Image Restoration Boost Detail Reconstruction

MTF before end2end optimization

MTF after end2end optimization



# Co-Optimized Optics & AI Image Restoration Boost Detail Reconstruction

NN only



Co-optimized  
lens + ISP



Ground truth



# Co-Optimized Optics & AI Image Restoration Boost Detail Reconstruction

NN only

Co-optimized  
lens + ISP

Ground truth

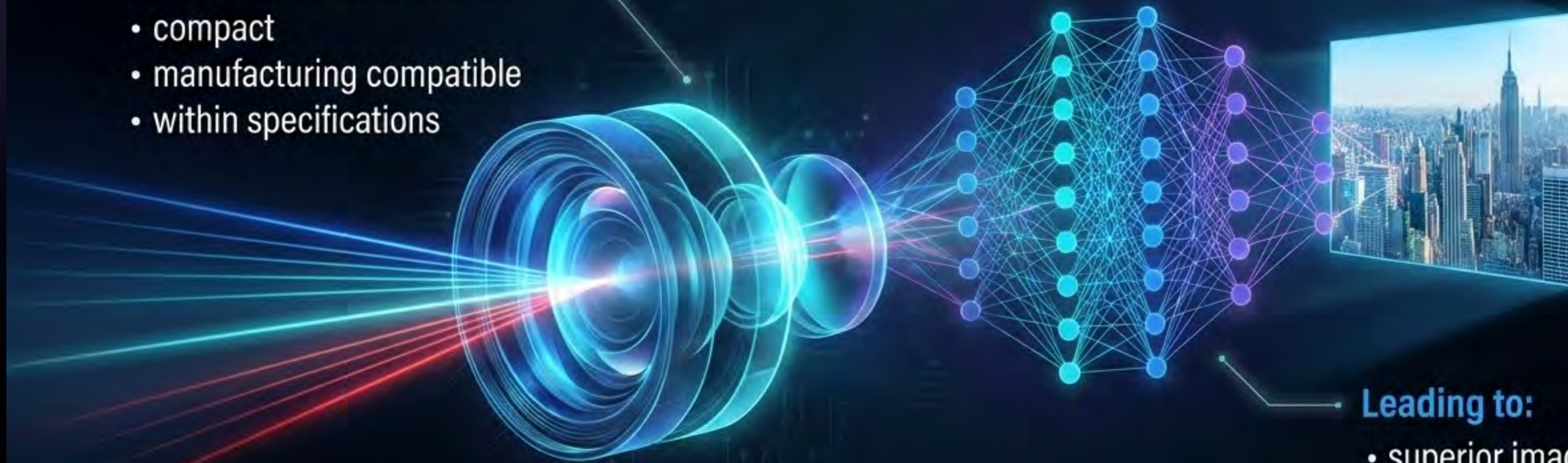


(Zoom-in)

# We want to push deep optics across industries

## Camera designs that are:

- compact
- manufacturing compatible
- within specifications



## Leading to:

- superior image quality
- work with our Neural ISP

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AI

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OPTICS



AR/VR



Drones



Wearables



Smartphone



Security



Cinema

# Our team is hiring!

Contact me: [neerja@glass-imaging.com](mailto:neerja@glass-imaging.com)



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