

Simulation workflow with Ansys Optics

*EPIC Online Technology Meeting on Optical
Design and Simulations: Tools and Use-cases*

Flurin Herren, 6 November 2023

/ Presenter: Flurin Herren

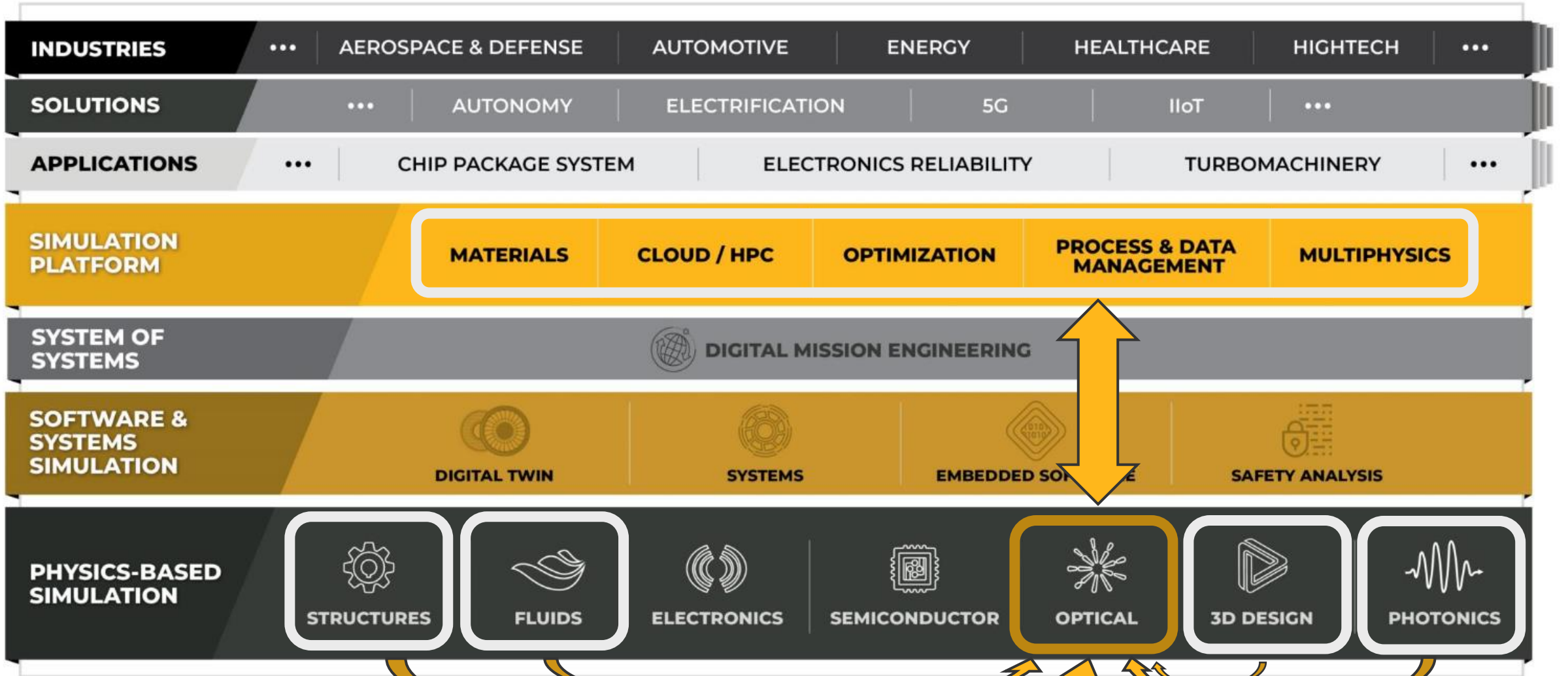
- Optomechanical Engineer at Ansys (previously Zemax, since early 2021)
- Based in the United Kingdom, Ansys Optics ACE Team.
- Background
 - Optical Engineering with focus on Optical Design of Spectrometers and Medical Technology applications such as Optical Coherence Tomography.
 - Mechanical Engineering with a specialization in CAD, CAM, and prototype manufacturing.



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Complete system optimization

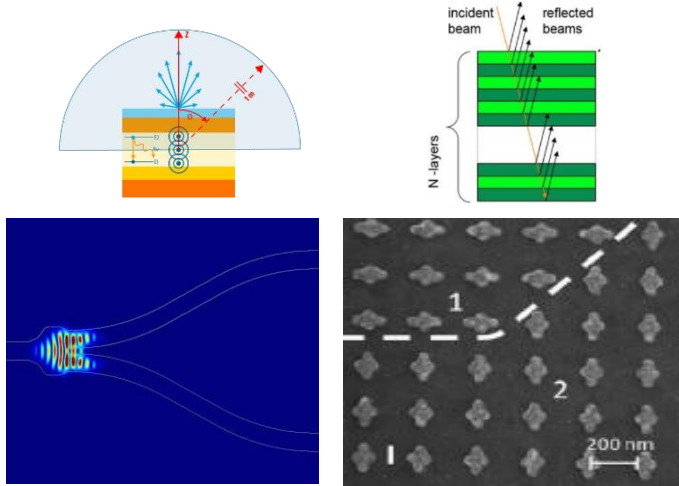
Driving efficiency, optimization, collaboration and consolidation



Ansys Optics Portfolio

Ansys

LUMERICAL



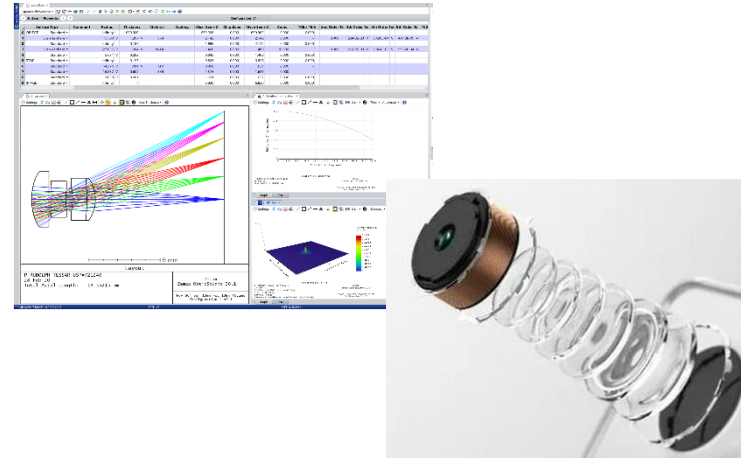
Photonic Engineering

Nano-Chip-Level

- Waveguide development
- Sensor & Emitter development
- Nanostructure design
- HR-AR coating layer design

Ansys

ZEMAX



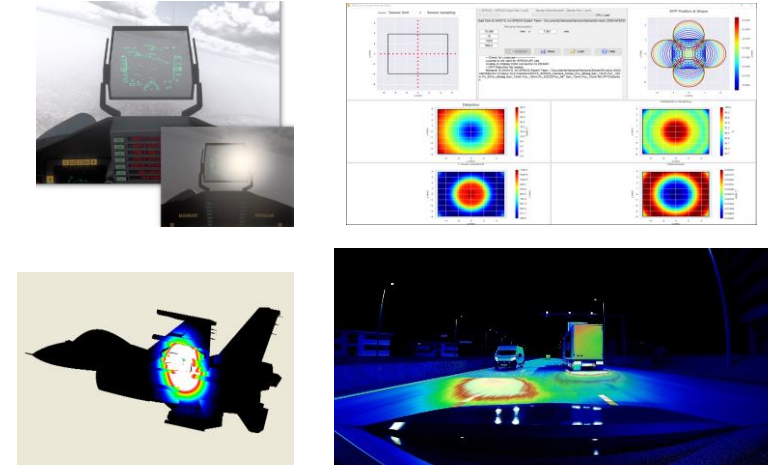
Optical design engineering

Optical-Design-Level

- Optical design
- Optical validation
- Optical tolerance analysis
- Mechanical tolerance analysis

Ansys

SPEOS

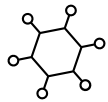


Lighting & System Engineering

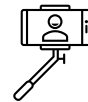
System-Design-Level

- Individual 3D environment integration
- Lighting evaluation
- Human Vision rendering
- Customer's perception for decision making

From Nano



To Micro



To Macro



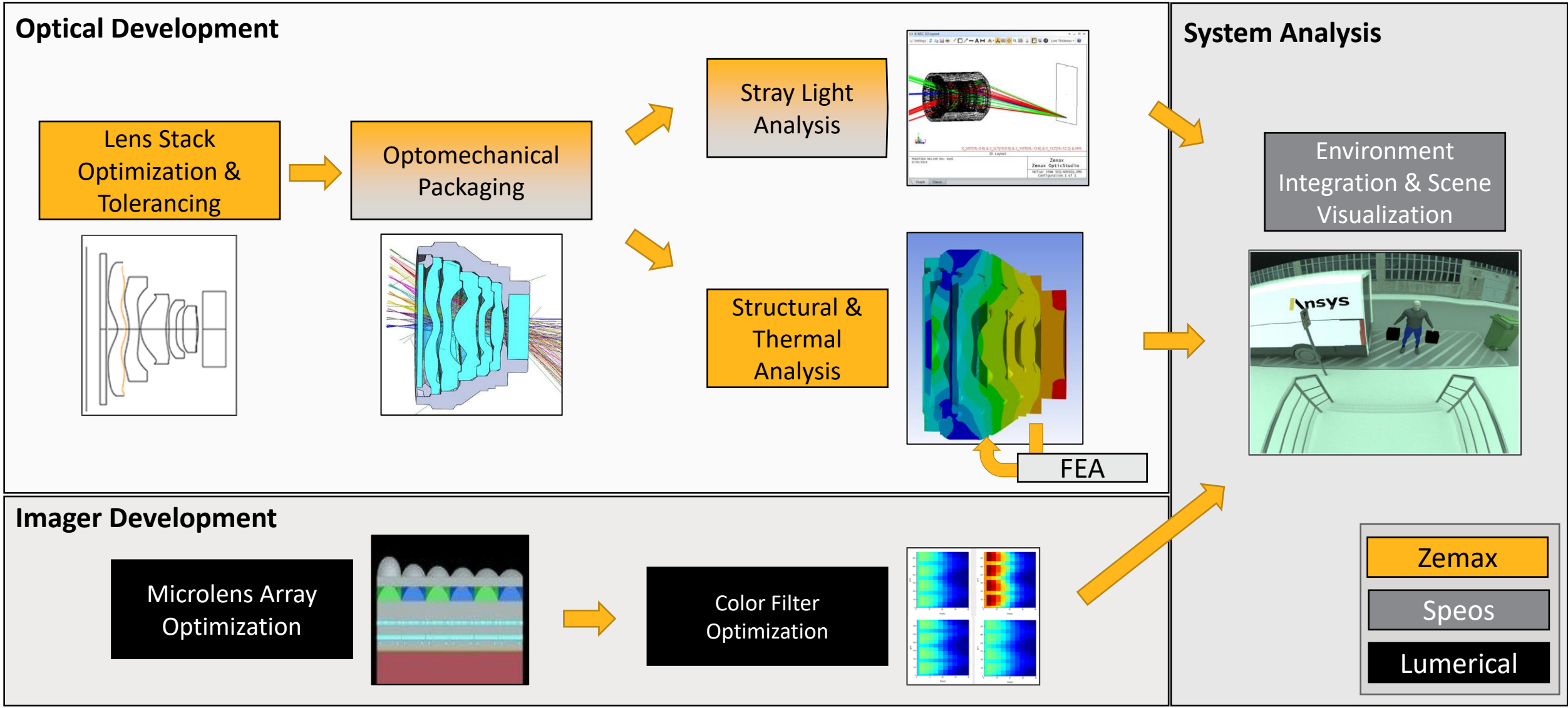
Ansys

Benefits of using full Ansys optical solution



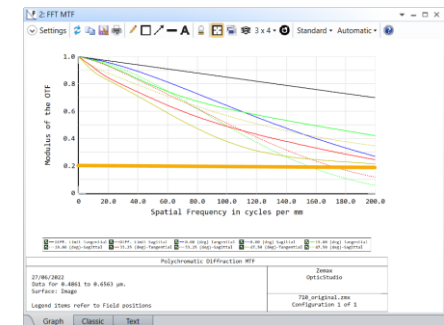
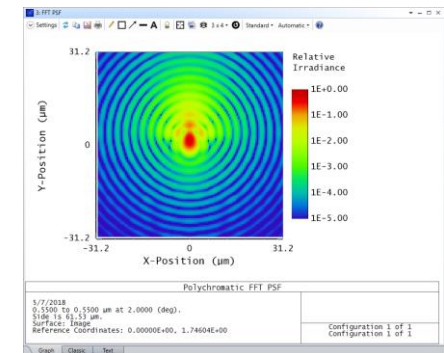
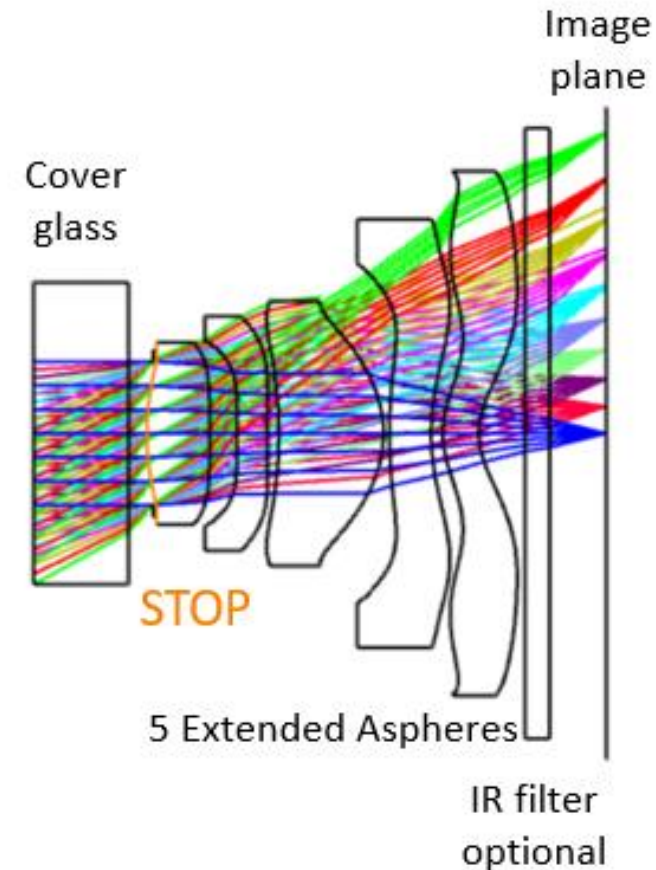
1. Best in class optical tools through product development process
2. Single point of contact for simulation process development support
3. Seamless workflow and simplified data transfer from photonics design and optical design to in-context system
 - Direct integrations with Multiphysics software solutions, enabling robust system design

Workflow of a Camera module



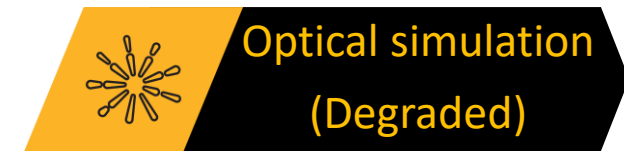
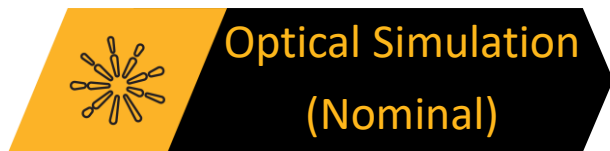
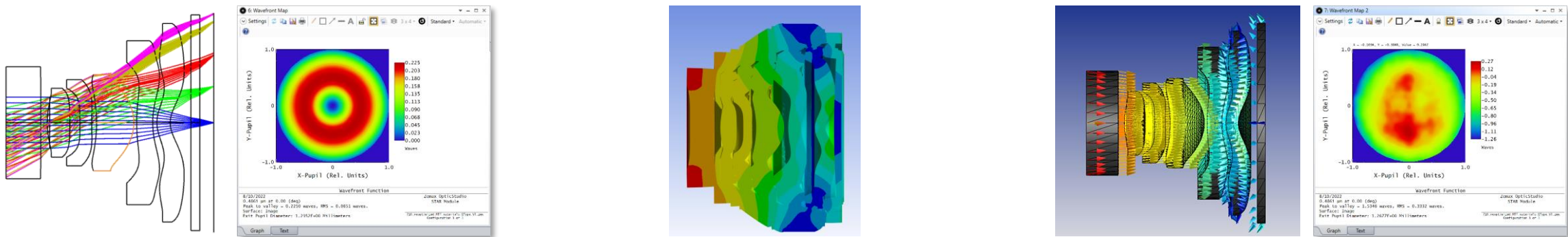
Lens Stack Optimization

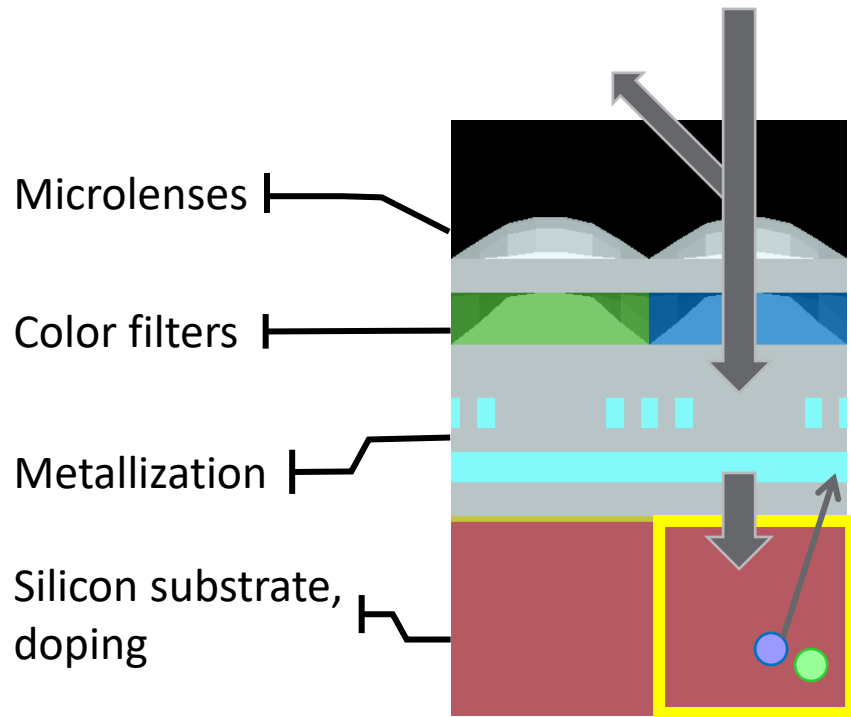
- Design Templates for Starting Point Selection
- Select from glass & plastic lens materials
 - Built-in & custom defined
 - Industry standard analysis methods to track system performance
 - PSF, MTF, Wavefront Error, Relative Illumination
- Optimize for manufacturability
 - Control surface slope and system tolerances
- Automation via ZOS-API
 - Connections with Matlab, Python, Mathematica



Structural Thermal Optical Performance

1. Perform nominal optical system design in OpticStudio
2. Send to CAD to incorporate optomechanical system design
3. Send to FEA to apply structural and thermal loads (surface deformation & thermal index variation)
4. Import deformed system to OpticStudio to analyze optical performance.





light absorbed by silicon substrate



free carriers generated in substrate



collect free carriers

Optical simulation for microstructure

- Color filter array, and microlens optimization
- Optical pixel cross-talk
- Scattering and absorption in metallization layers

Electrical simulation for charge behavior

- Electrical pixel cross-talk
- Dark current and thermal effects
- Signal-to-Noise Ratio

Optical efficiency

Internal quantum efficiency

External quantum efficiency

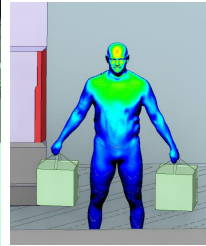
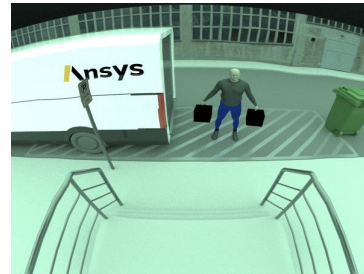
Key results

$$OE = \frac{\# \text{ of absorbed photons}}{\# \text{ of incident photons}}$$

$$IQE = \frac{\# \text{ of collected carriers}}{\# \text{ of generated carriers}}$$

$$EQE = IQE \times OE = \frac{\# \text{ of collected carriers}}{\# \text{ of incident photons}}$$

Workflow Overview: Full Scene Visualization



Ansys / SPEOS

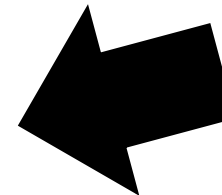
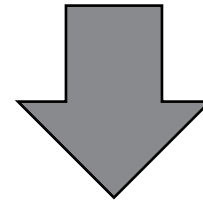
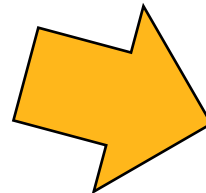
Scene
3D environment, moving objects, lighting & materials

Ansys / LUMERICAL

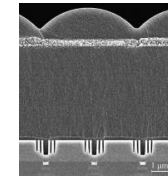
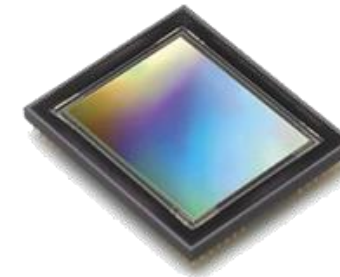
Zemax
/An Ansys Company



Lens Stacks
Lenses shape, optical materials, mechanical packaging



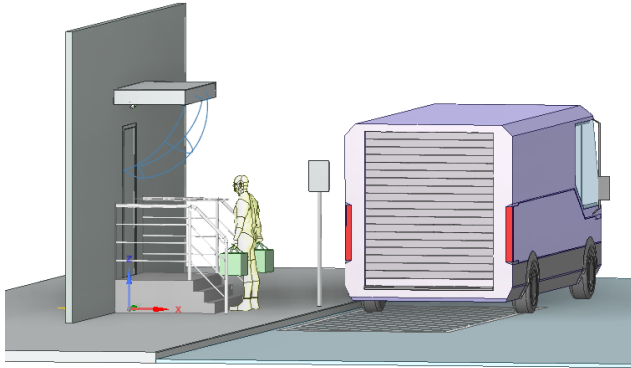
Full Camera Simulation



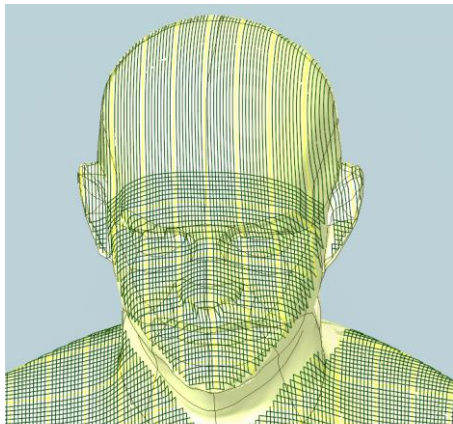
Imager
Micro lenses array
Color filter array

Environment Integration

1. Import CAD model

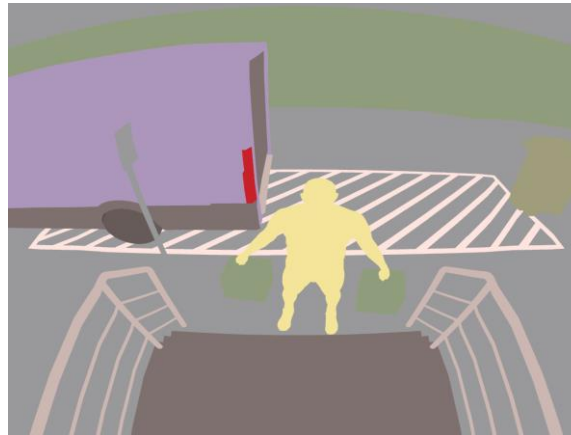


2. Pixel grid projections

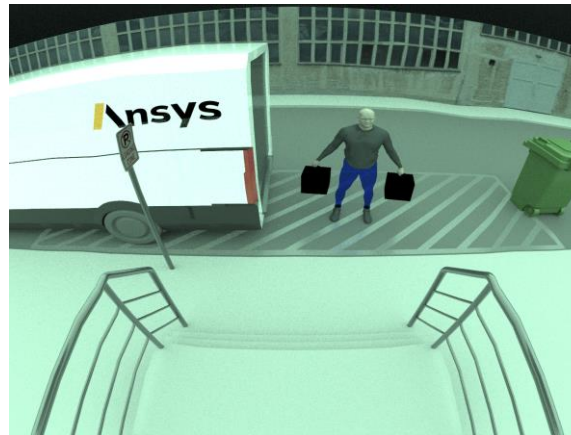


Green lines represent 1-pixel segments
Yellow lines represent 10-pixel segments

3. Geometric and Photometric simulations

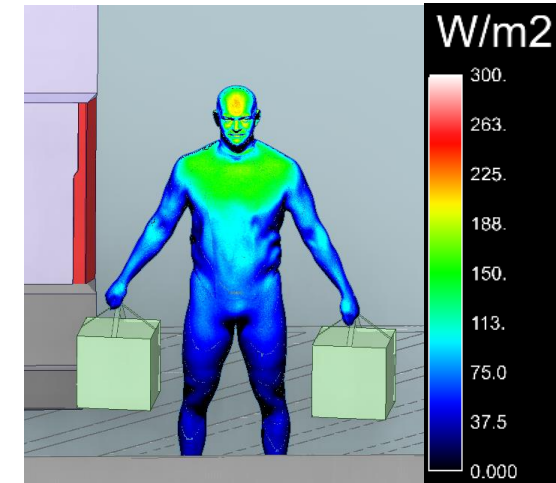


Geometric simulations
Simulation time: < 1 minute



Photometric simulations
Simulation time: 30min on 6 cores computer

4. NIR emitter and camera simulation



Thank you for attending this presentation

➤ **Question section**



Additional Technical Resources:

- [CMOS Sensor Camera - Image Quality Analysis in a 3D Scene – Ansys Optics](#)
- [CMOS Sensor Camera - Sensor Characterization – Ansys Optics](#)
- [Designing Cell phone Camera Lenses Part 1: Optics – Knowledgebase \(zemax.com\)](#)