Current challenges in optical design
EPIC Online Technology Meeting

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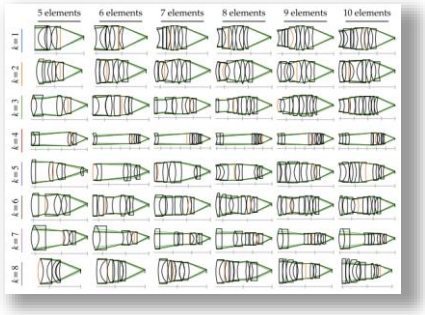
Trends in optical design
Optical design is much more than just optimizing lenses

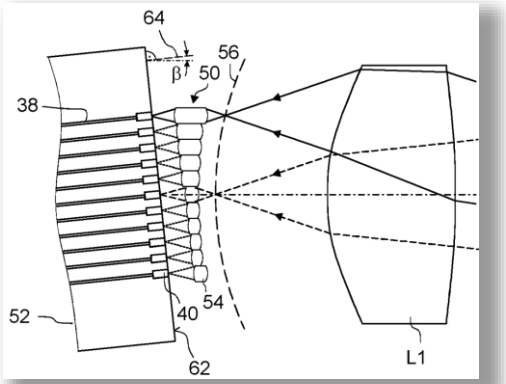
Use of artificial intelligence & novel design methodologies

- Starting systems generation
- AI-assisted design workflows
- Generative design
- Inverse design



Classical optical design

Multi-scale & hybrid systems



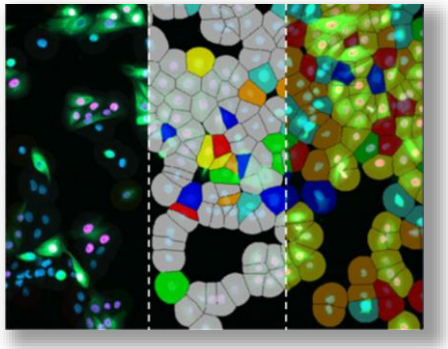
Merging macroscopic/ classical optics with

- Photonic integrated circuits (PIC)
- Microoptics
- Metasurfaces
- …

Design to X & multi-objective optimization

- Design to cost
- Design for manufacturability
- As-built-performance optimization
- Stray light
- Thermal
- …

Computational imaging, sensing & end-to-end optimization

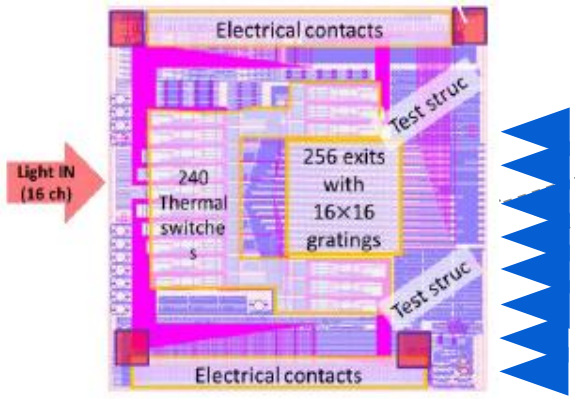


- 3D reconstruction
- Denoising
- Deconvolution
- Segmentation
- Classification
- General sensing

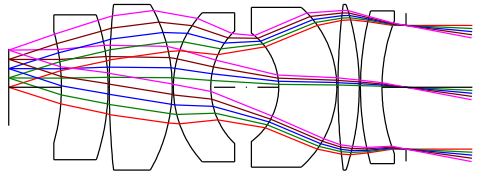
Multi-scale & hybrid systems
Significant benefit from co-design of micro- and macroscopic optics

“Classical” approach for an automotive Lidar system

- Fully solid state 2D scanner demonstrator for Scantinel
- Separate design of multi-beam PIC emitter and collimator lens



flat field, fixed NA



~ 25 mm exit pupil

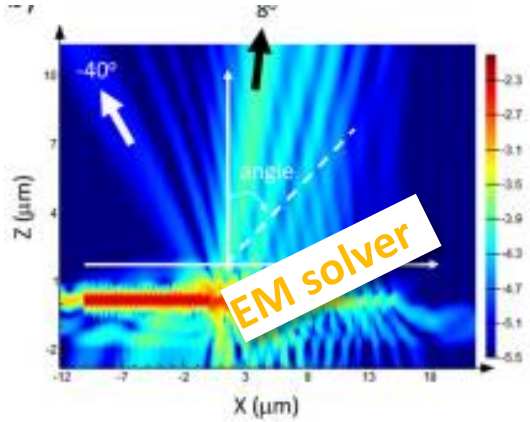
PIC emitters **collimator**

Estimated signal gain: +10 dB

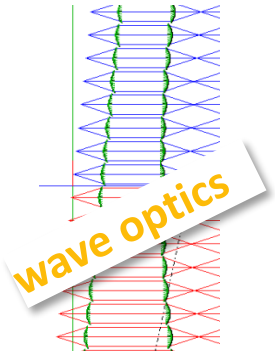
Co-design concept to be optimized for optical performance:

- PIC coupler emission angle & NA
- Intermediate focal plane field tilt and field curvature

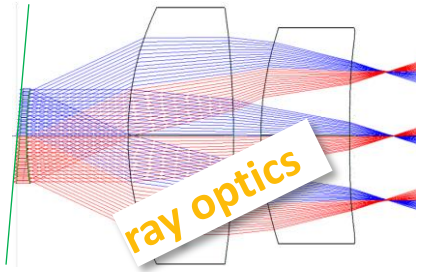
grating coupler



lenslet array



aspheric collimator



V. Blahnik, “Merging optics and photonics”, UKODM 2022

End-to-end optimization

Significant benefit from co-design of micro- and macroscopic optics

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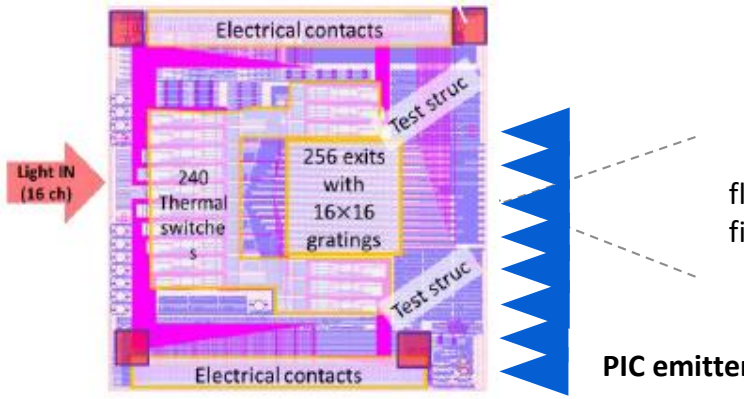
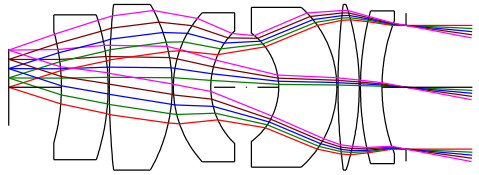


flat field, fixed NA



~ 25 mm exit pupil

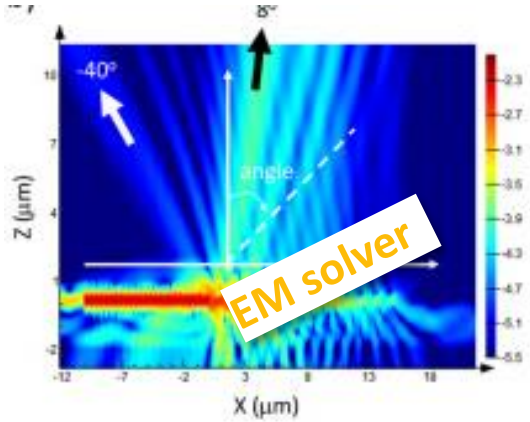
PIC emitters **collimator**

Estimated signal gain: +10 dB

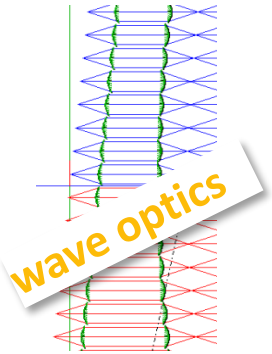
Co-design concept to be optimized for system performance:

- PIC coupler emission angle & NA
- Intermediate focal plane field tilt and field curvature
- Beam shape and wavefront

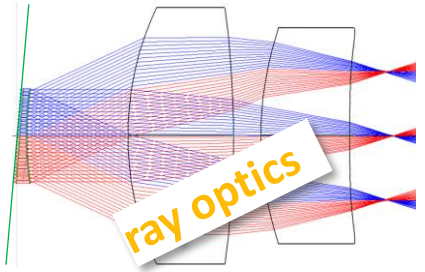
grating coupler



lenslet array



aspheric collimator

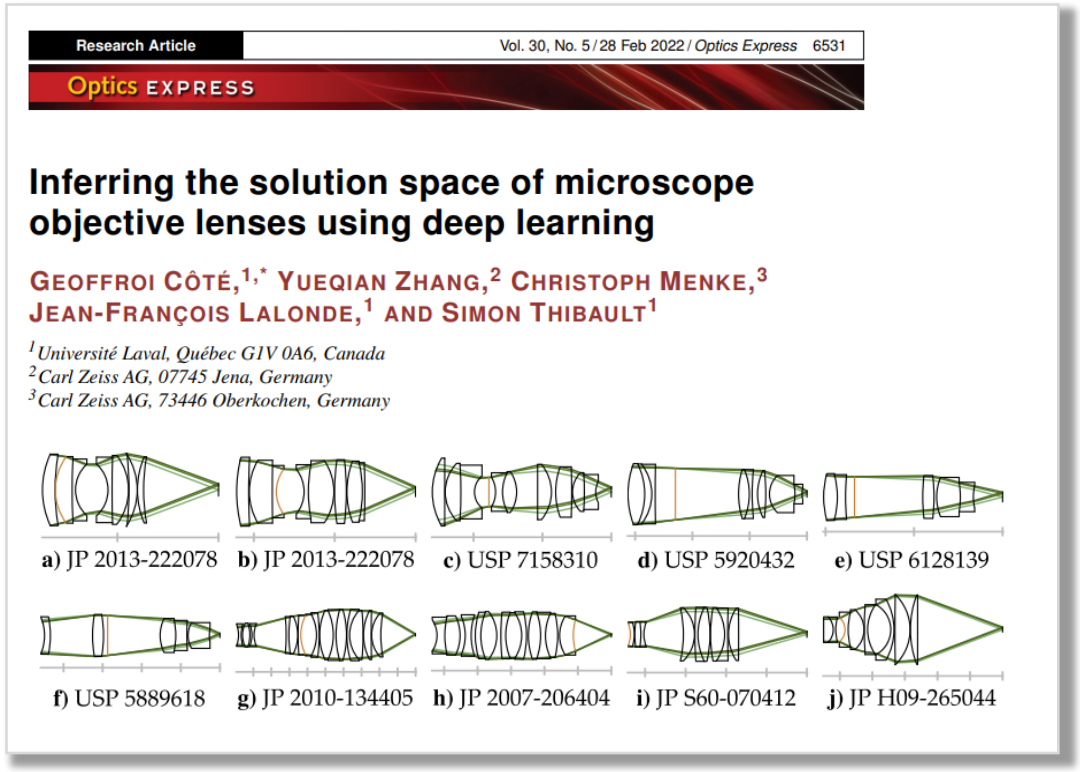


Signal generation

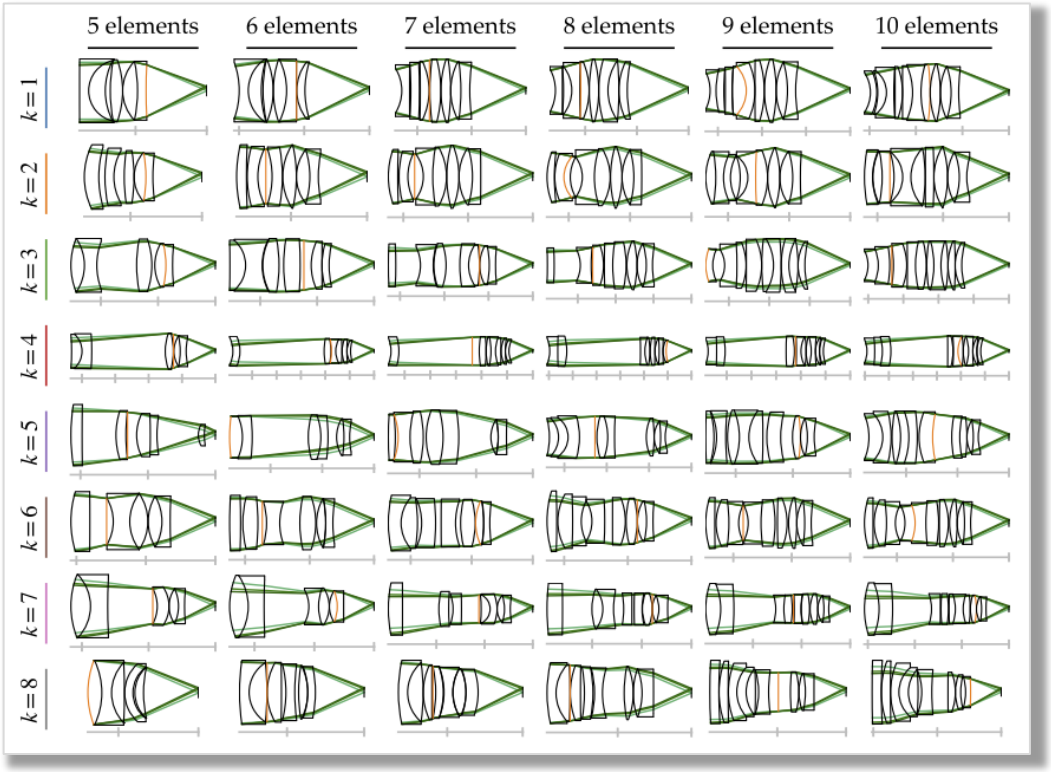
V. Blahnik, “Merging optics and photonics”, UKODM 2022

Artificial intelligence & novel design methodologies
Solution landscapes instead of single designs

- We see first successful applications of AI in optical design
- We can expect automated processes and much larger number of system variants in the future
  ⇨ **our tools should be oriented towards working with many systems**



Training set: 34 lenses

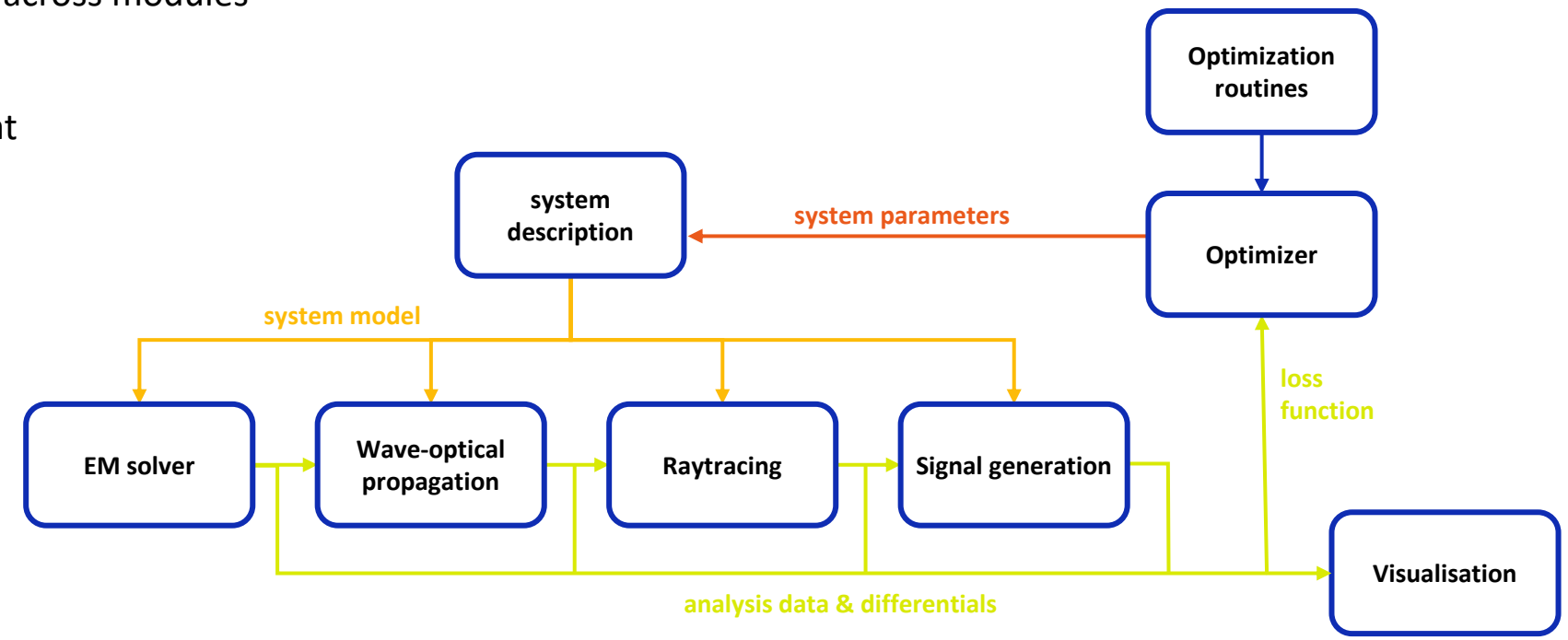


Generated set: 7432 lenses

Requirements for a future tool landscape
System performance optimization in an open environment

- Unified parametric system description
- Standardized model and data interfaces
- Differentiable quantities throughout
- Compound merit/loss function across modules
- Open optimization interface
- Single visualization environment
- Multi-system capability
- Open environment for own & 3rd party modules

e.g. …



Seeing beyond