



**photonics**  
**precision engineering**

**Do I really need a customized lens for my application?**

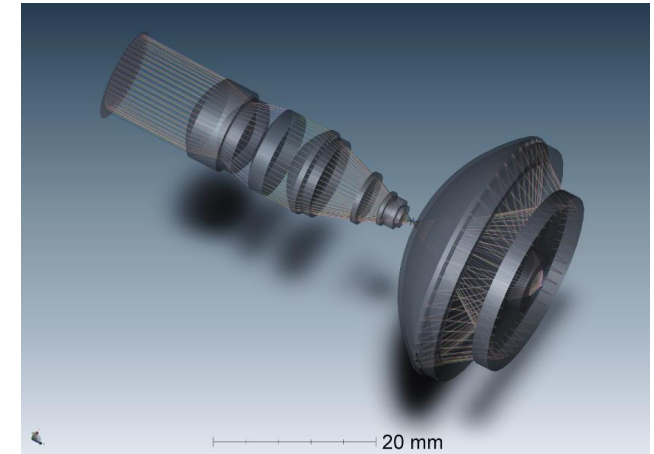
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# Photonics Precision Engineering GmbH

Who are we?



**PPE - Your partner in Optical Engineering.**



- Development of manufacturable lens and system designs
- From concept to supply chain
- 50+ years industry experience

**Optical Design. System Engineering. Prototyping.**

[www.ppe-jena.com](http://www.ppe-jena.com)

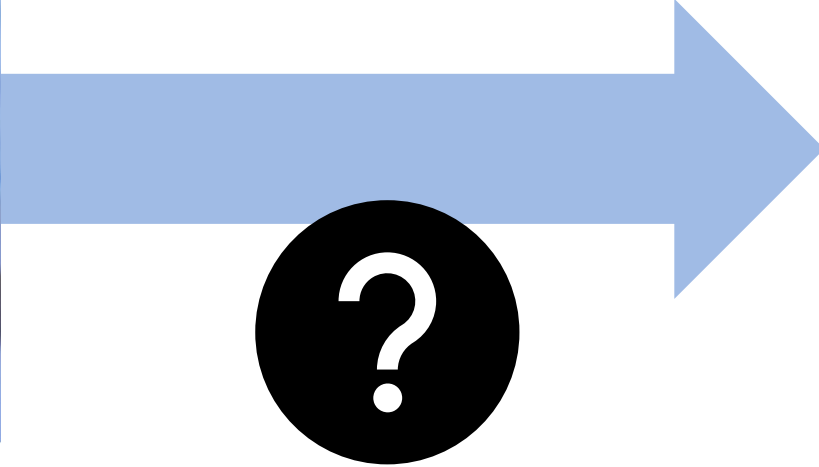


# From Application to Design

How to start?



## Application example: Cell detection



### Input parameters:

- Sample with cell material (e.g. tissue from biopsy)
- Area of interest

### Results:

- Cell diameter
- Cell compactness
- Is it healthy?

# From Application to Design

## How to start?



What algorithms are employed to analyse the acquired image?

What are important image metrics for the algorithm? Distortion? PSF? MTF? Color aberration?

Which field of view (FOV) is needed to give high throughput? (cost of ownership)

→ **Derive requirements for optical system**

# From Application to Design

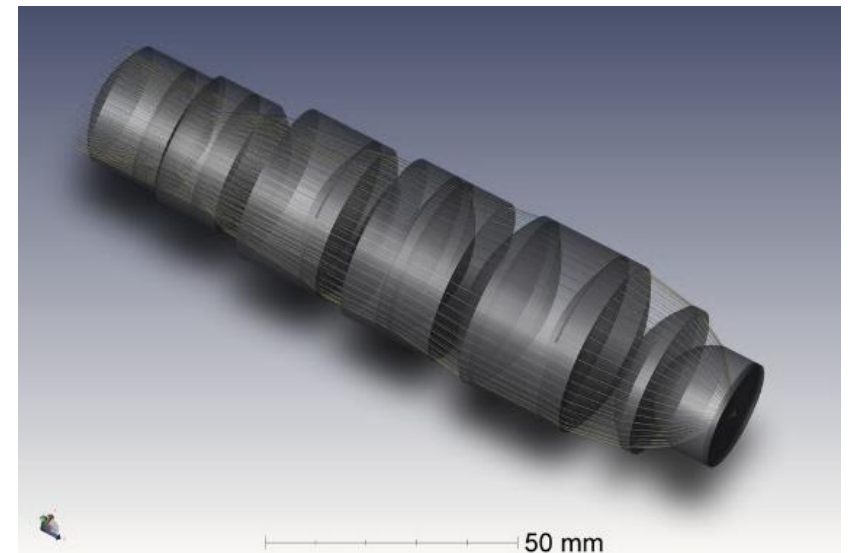
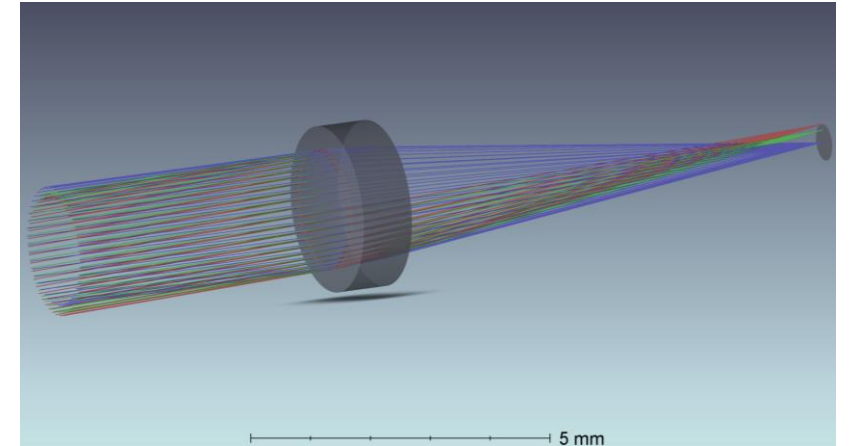
## Requirements for optical system specification

### What are the optical system requirements?

- Numerical aperture
- Field size
- Working distance
- Telecentricity
- No or low vignetting (over field)
- Polychromatic design
- Space claim (e.g. to replace or upgrade systems)

### → These requirements determine what is needed?

- Single Lens
- Achromat (Doublet)
- Off the shelf Microscope objective
- Customized objective
- Alien technology



# From Application to Design

## Example: PSF as a quality metric

- Assessment of imaging quality by using Point Spread Function (PSF)

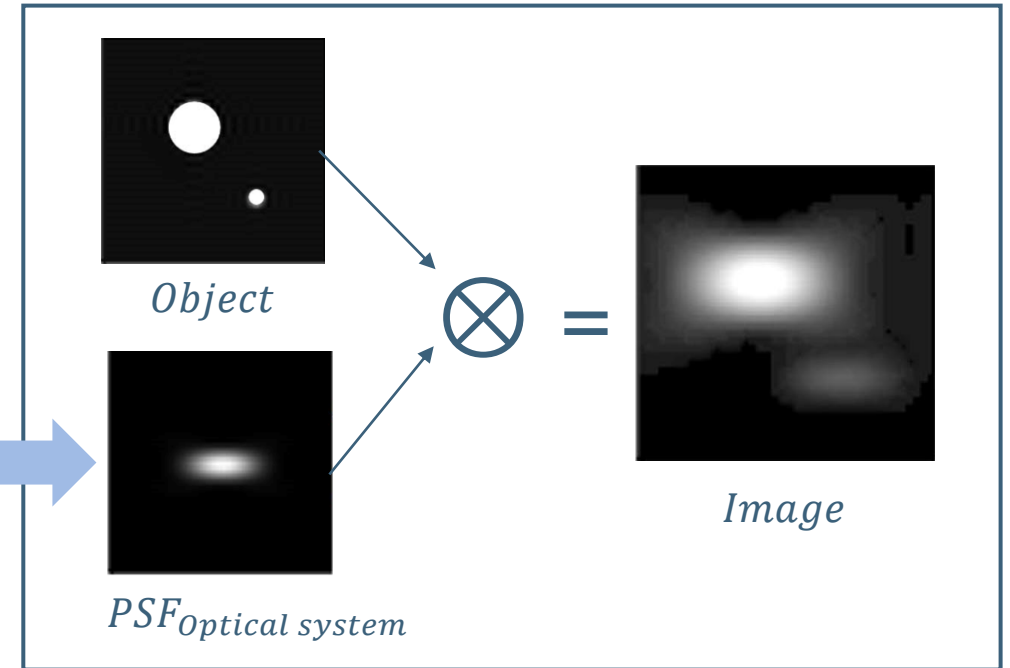
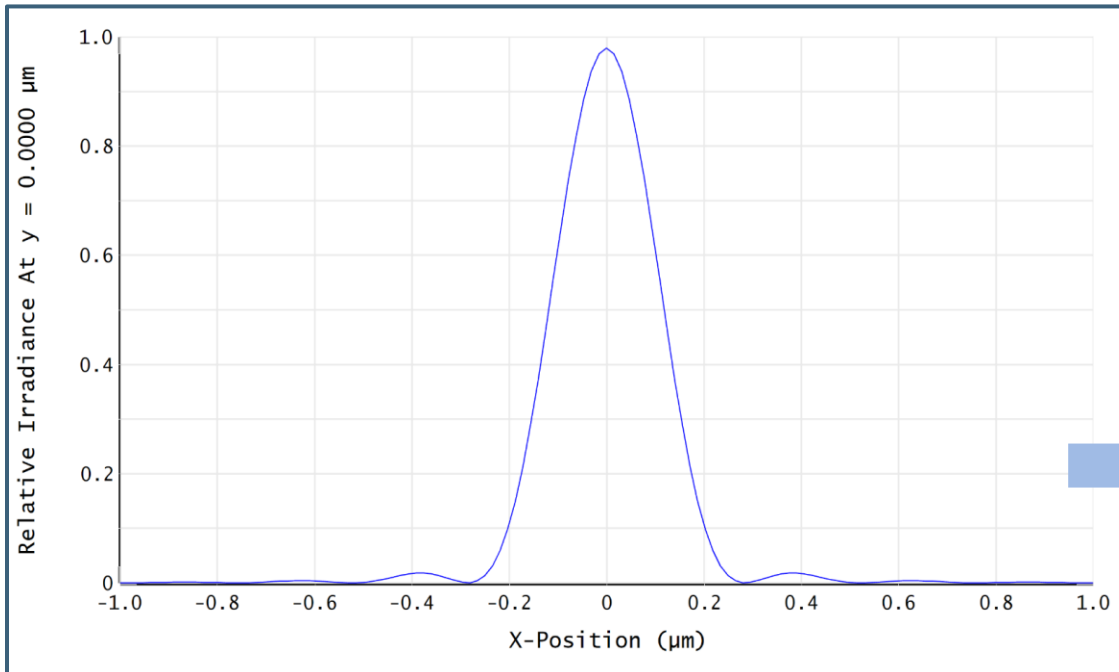


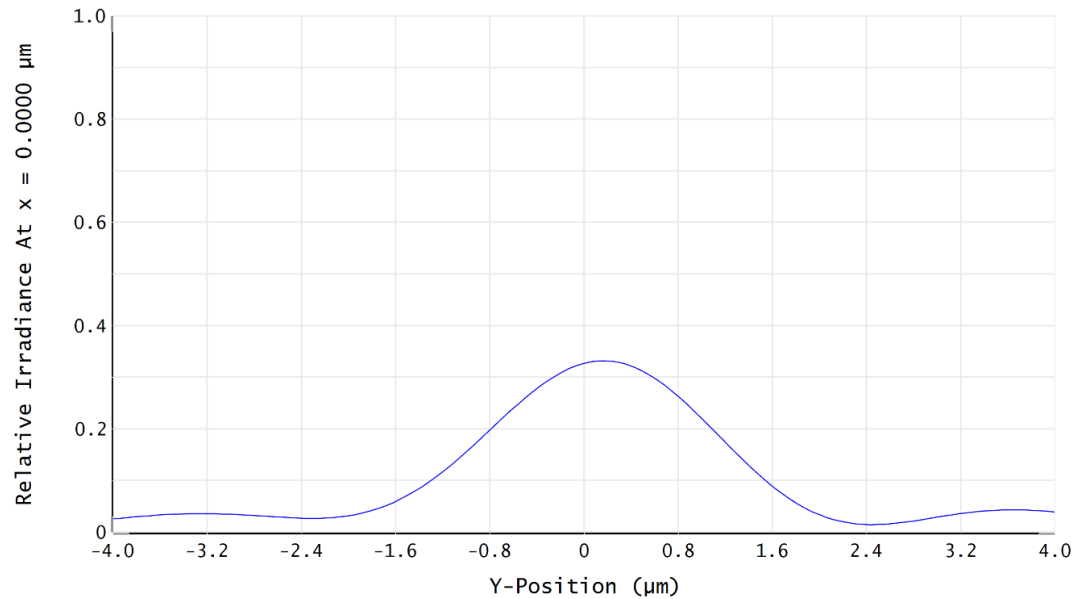
Image source: [www.globalsino.com/EM](http://www.globalsino.com/EM)

- Which quality of the PSF does the algorithm need to give reliable output?

# From Application to Design

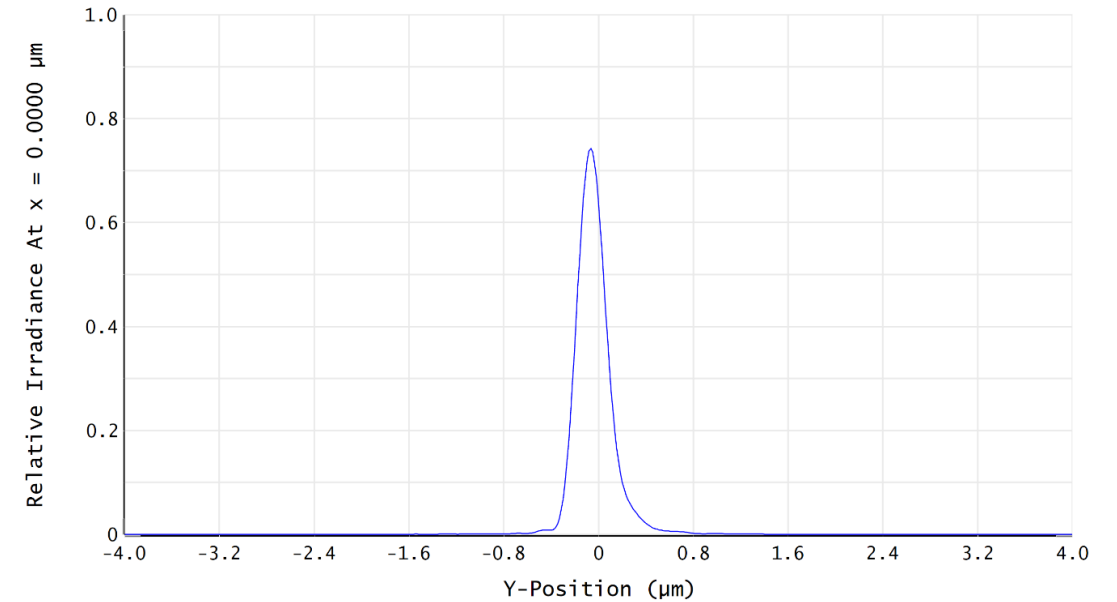
Example: PSF as a quality metric

## Single Lens



$\lambda = 530 \text{ nm} \dots 612 \text{ nm}$   
 $f = 8.95 \text{ mm}, \text{FOV} = 0.55 \text{ mm}$   
 **$NA = 0.14$**

## Customized Objective

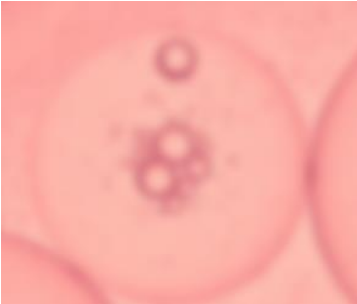
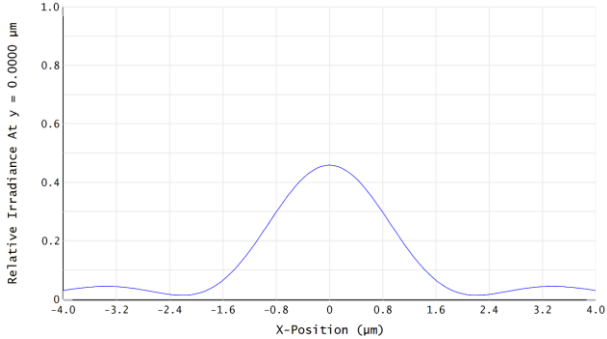
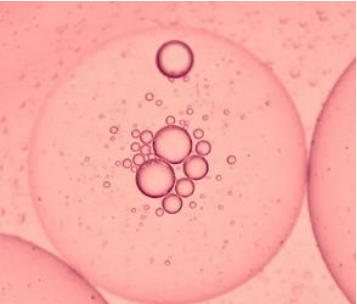


$\lambda = 530 \text{ nm} \dots 612 \text{ nm}$   
 $f = 8.95 \text{ mm}, \text{FOV} = 0.55 \text{ mm}$   
 **$NA = 0.9$**

# From Application to Design

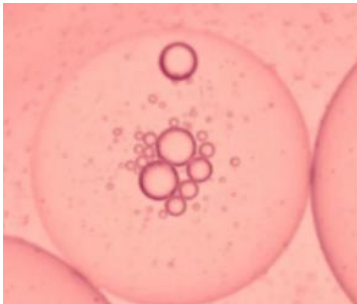
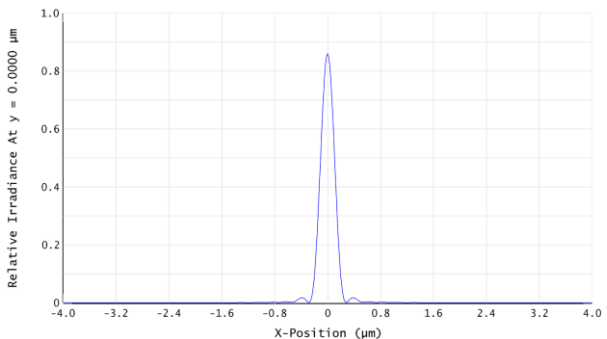
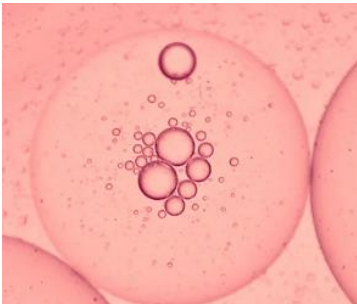
## How to choose my optical system?

**Object**  $\otimes$  **PSF<sub>Single Lens</sub>** = **Image**



Ok – for counting but...  
...single characteristic features cannot be extracted

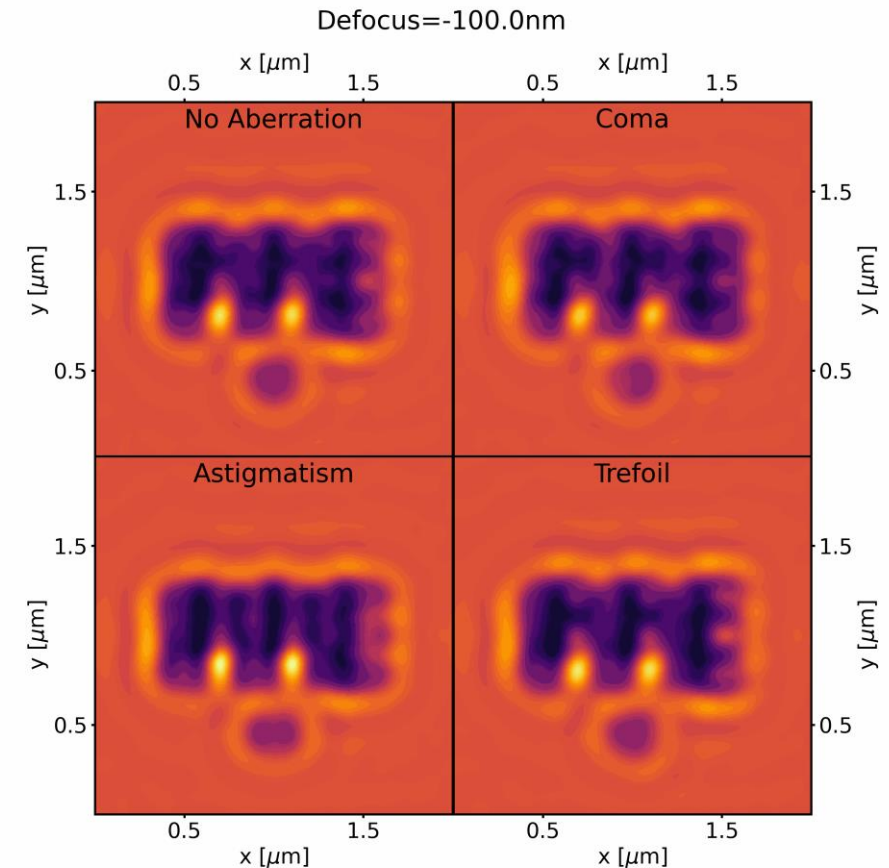
**Object**  $\otimes$  **PSF<sub>Customized Objective</sub>** = **Image**



High quality image...  
... allows extraction and evaluation of single characteristic features



- Computer-based evaluation of images drives requirements on optical systems.
- The PSF can provide a good image quality metric for these systems.
- (Extreme) example between singlet and high-end customized lens to demonstrate the gain.
- Customized lens systems are a remedy of last resort but have the capability of achieving unique selling propositions for your device.



Thank you for your attention!



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