Software-supported Development of Optical Components

2007 AutoOptics Short Course at Harz University

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Overview

- Advantages of computer aided optic design
- An example of optic design:

  A Demultiplexer for WDM over POF
- From the basic idea to the design
- Analysis function given by the optic design program
- Optimization of the optic design
- Another attempt for a demultiplexer

Advantages of Computer aided Optic Design

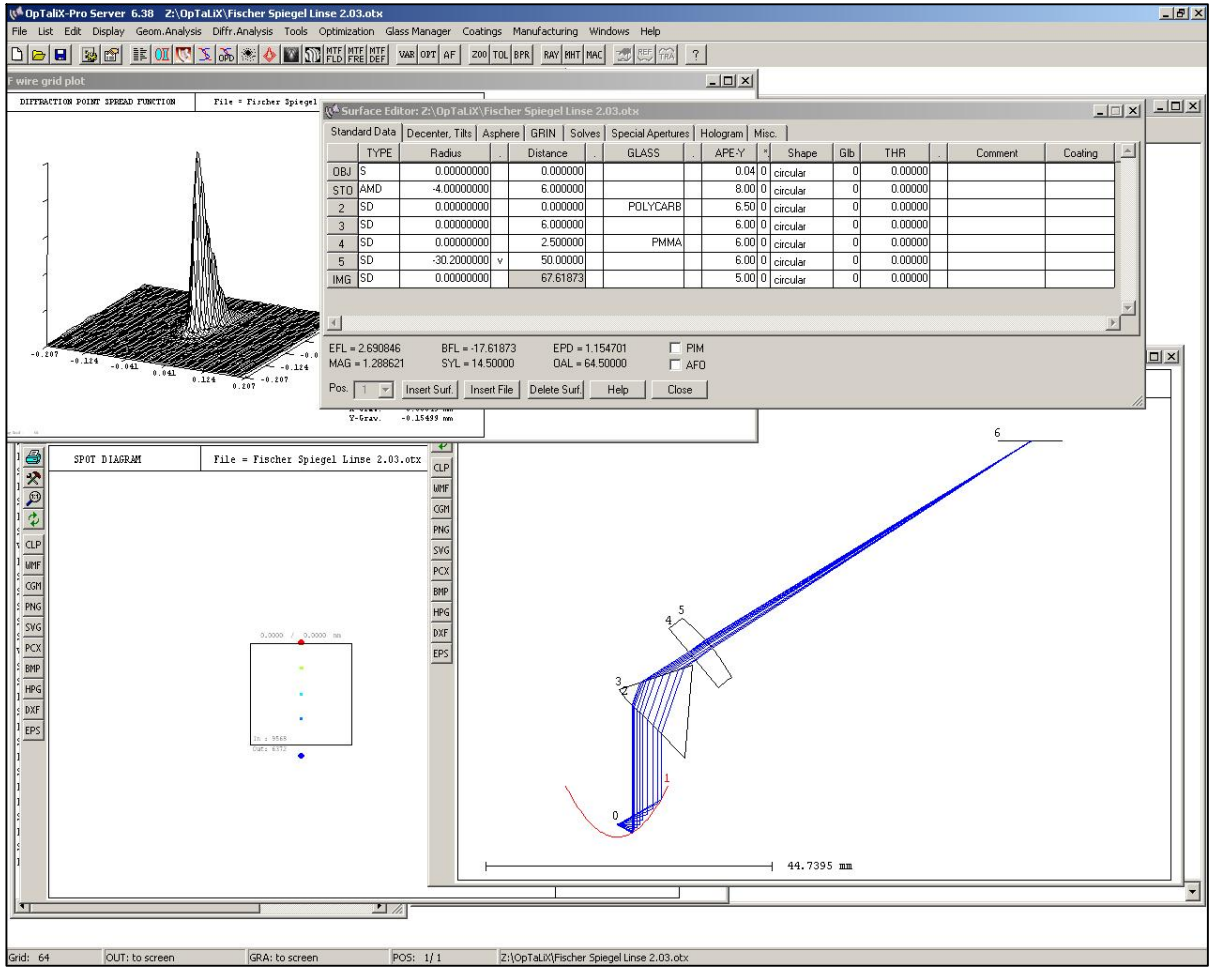
- An inexpensive way to design optical components
- Time saving
- Improvements can be realized fast
- Performance of optical components can be proved and compared with other setups
- Easy optimization of material

OpTaliX

Features of OpTaliX

- Sequential and non-sequential ray tracing
- Full geometrical and diffraction analysis
- User-defined graphics

⇨ Same functionality as "high-end" products (ZEMAX / OSLO)



http://www.optenso.de

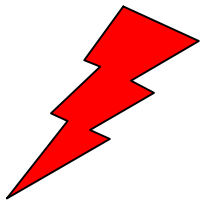
Motivation for VIS-WDM over POF

The applications for POF have high demand on bandwidth!

- **Standard optical transmission system:**

  One wavelength carries the information

  → Limitation in bandwidth → Problem!



- **New technology: VIS-WDM over POF**

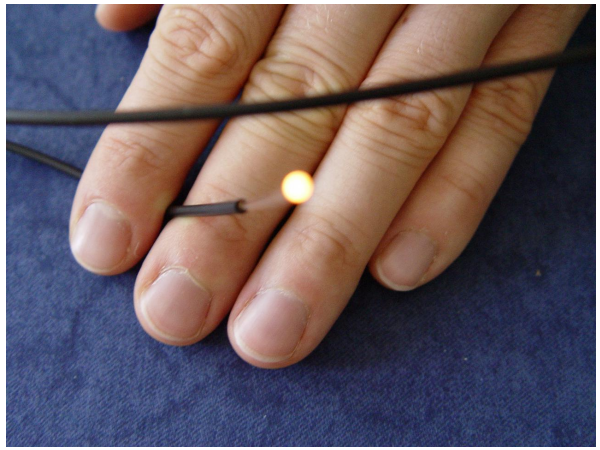
  Multiple wavelengths carry information

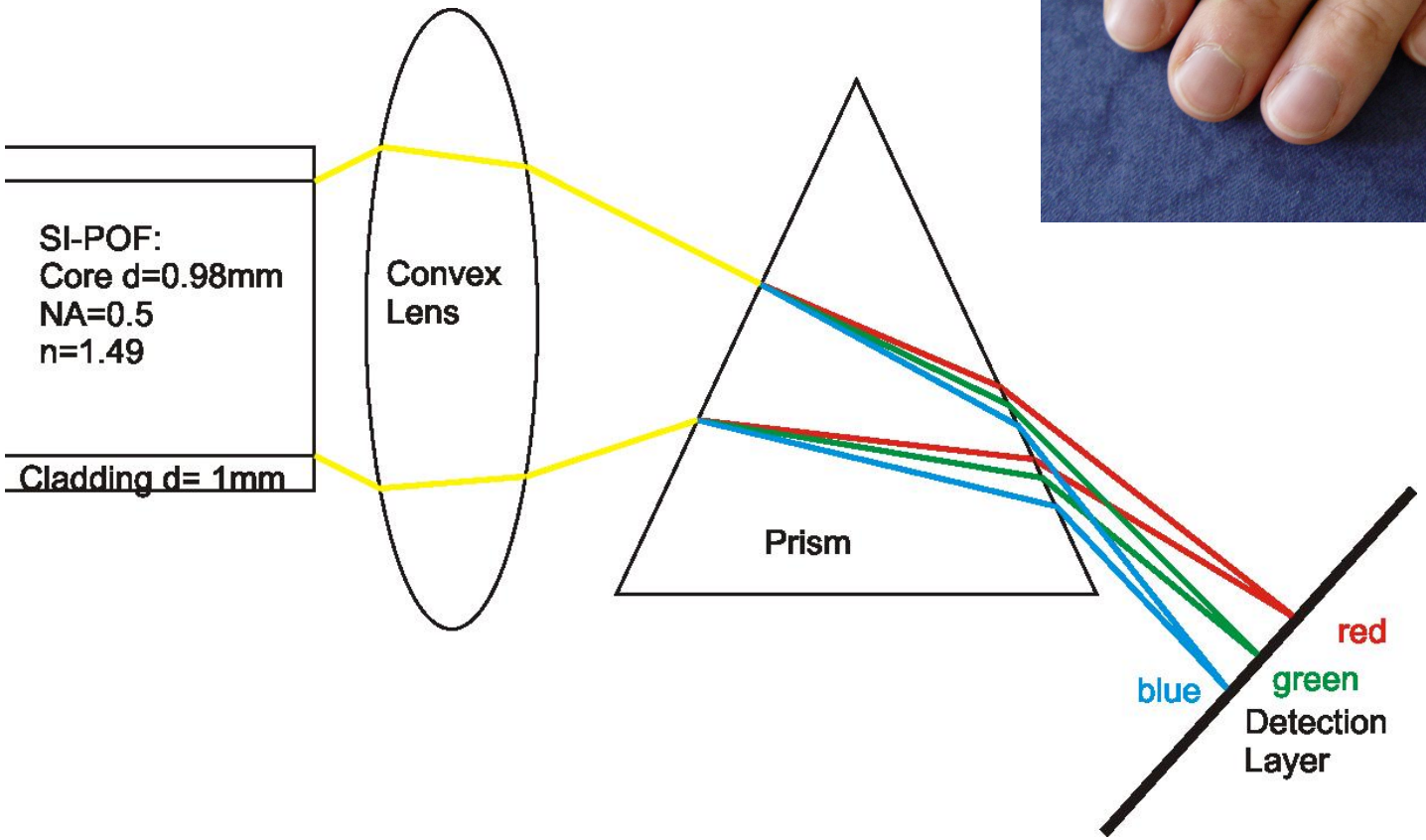
  → A multiple of bandwidth is possible

  → Multiplexer and Demultiplexer are needed

Patented basic concept

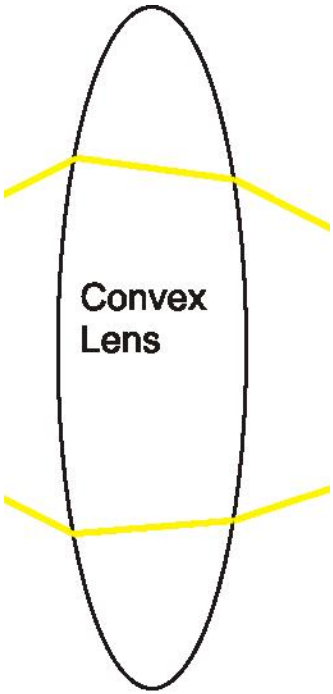
- **Principle setup of the VIS-WDM demultiplexer (unscaled)**

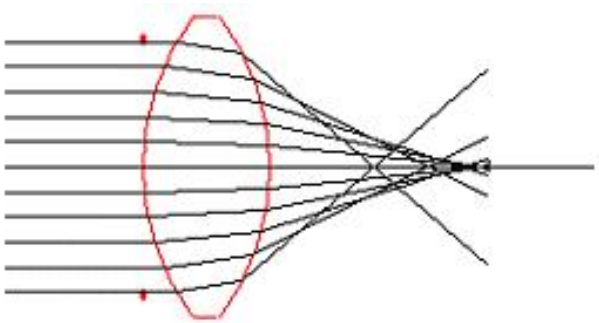




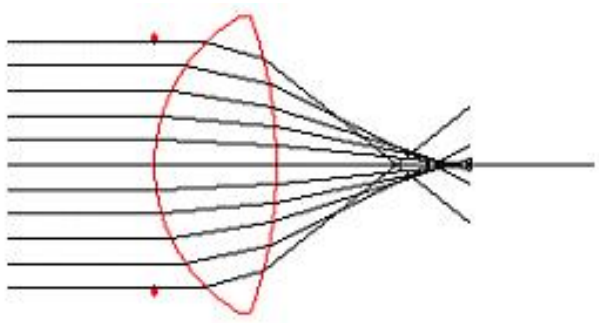
Patented basic concept: Lens

- **Function: to focus light onto detection layer**
- **To minimize spherical aberrations → 2 plano convex lenses**

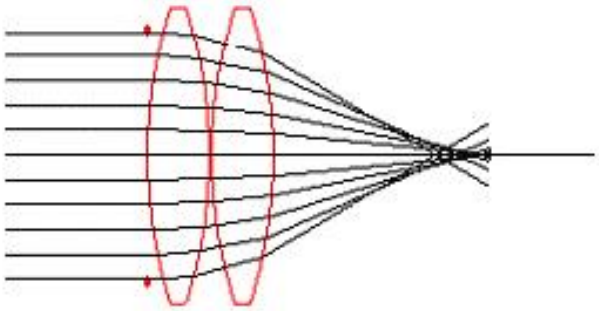




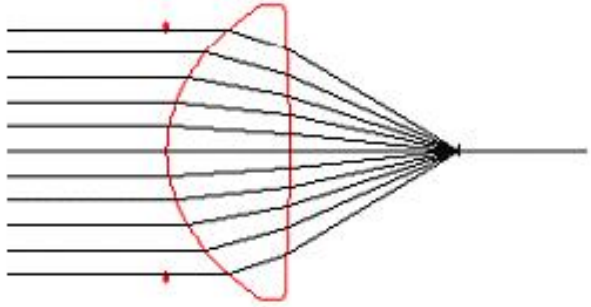
simple biconvex lens



lens “best form”



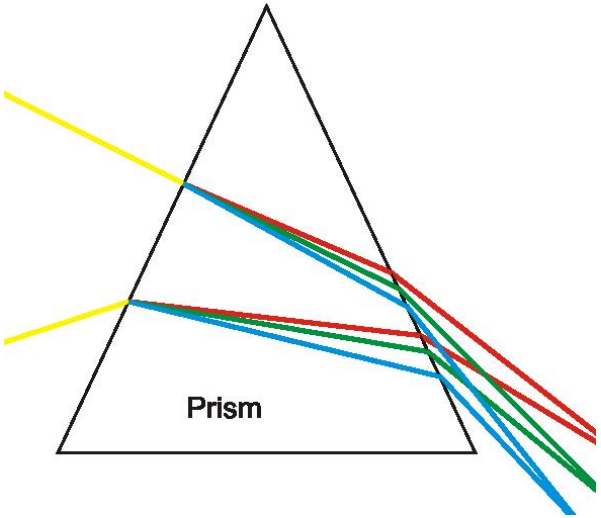
distribution of refraction power in two lenses

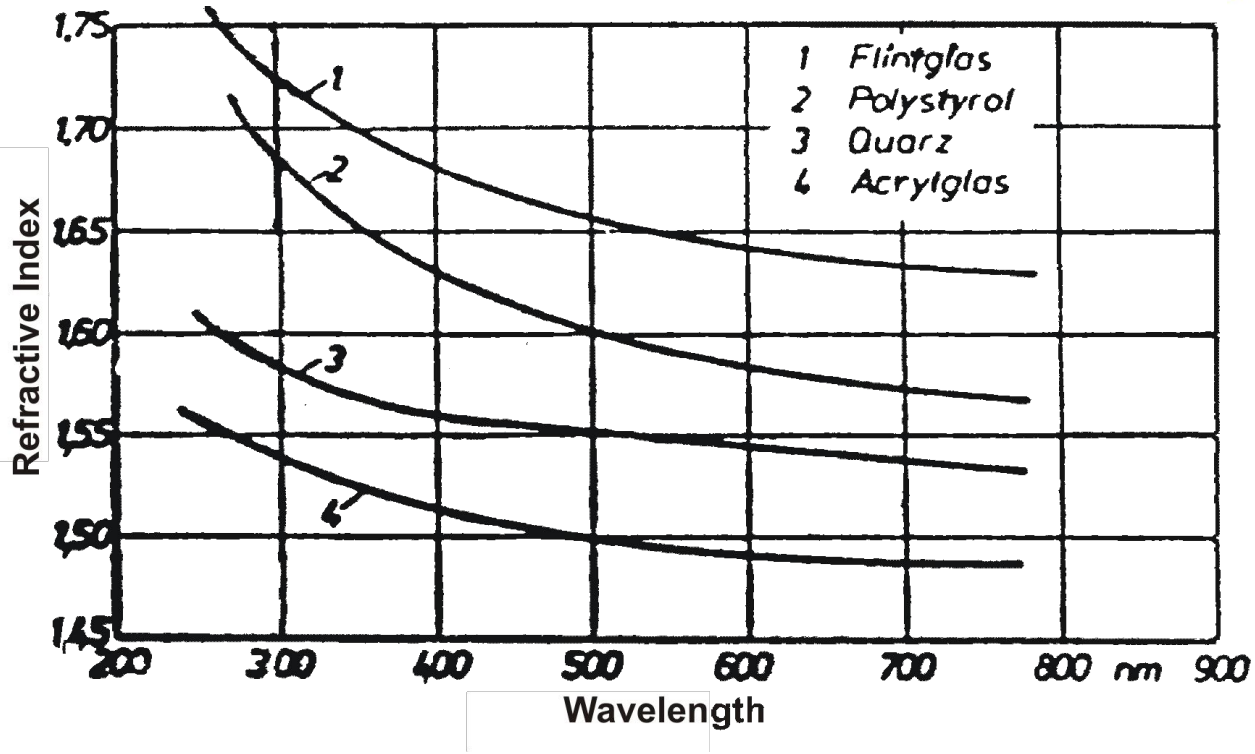


aspheric, almost plano convex lens

Patented basic concept: Prism

- Prism separates monochromatic parts of light
- Separation of colors by high dispersive materials (low Abbe Number V)



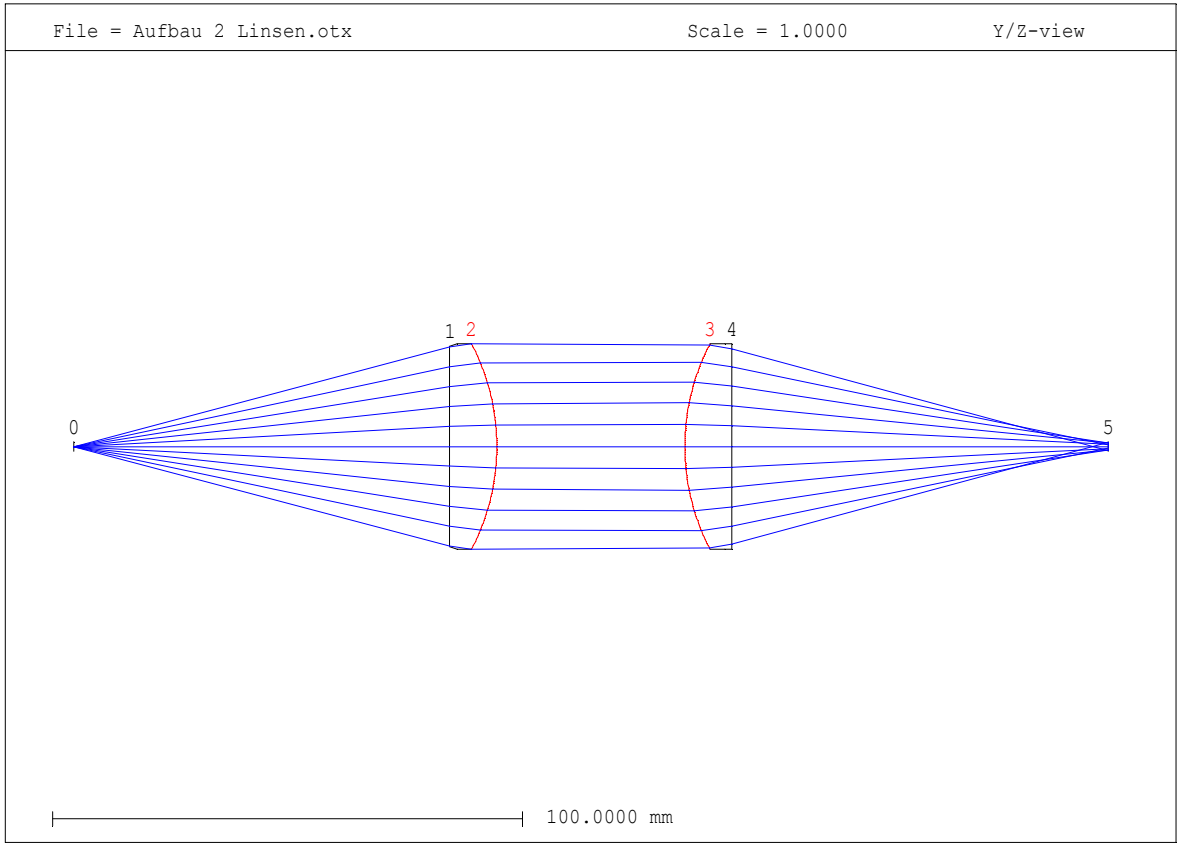


$$V = \frac{n_D - 1}{n_F - n_C}$$

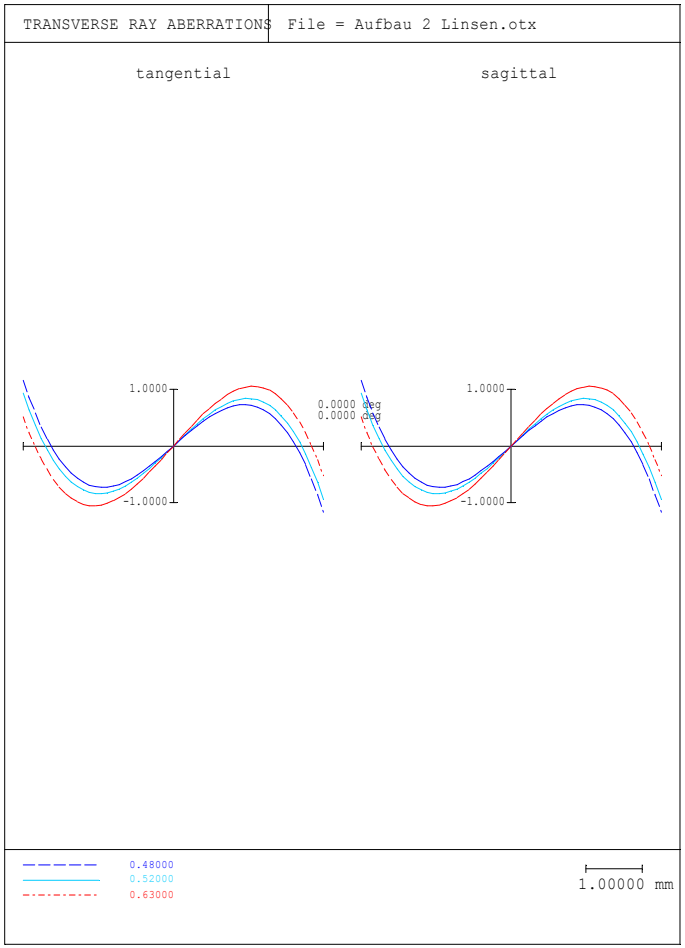
$n_D(\lambda)$= 598.2nm
$n_F(\lambda)$= 486.1nm
$n_C(\lambda)$= 656.3nm

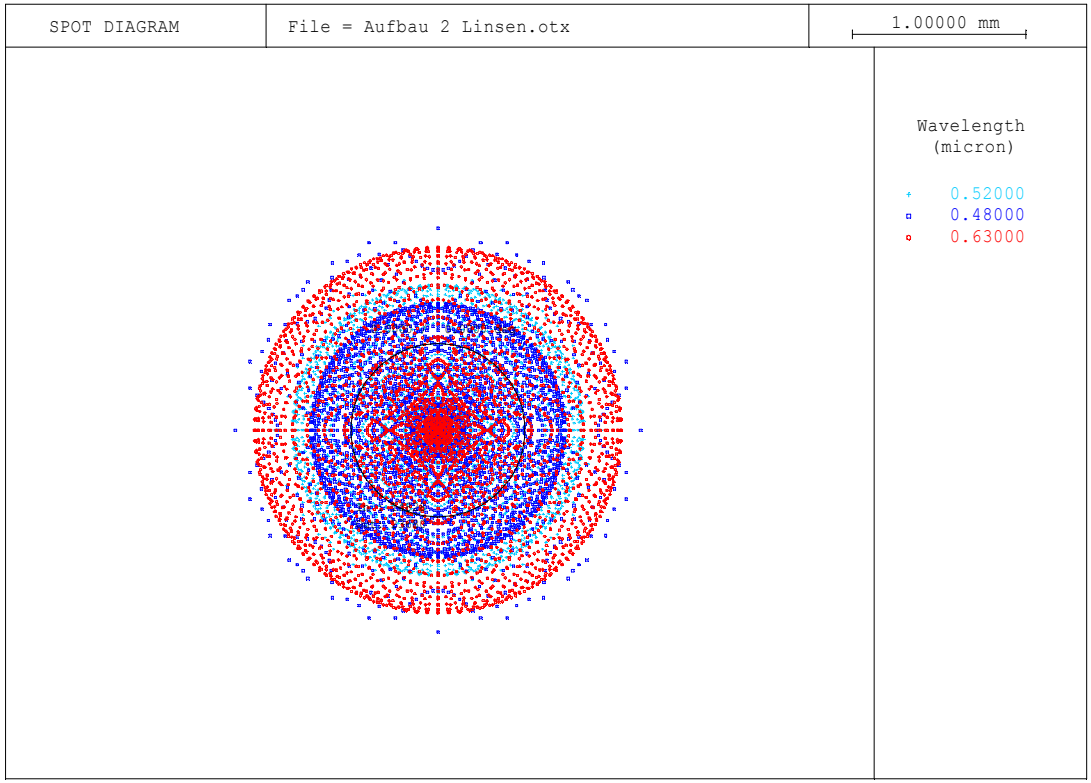
Aberrations of Lenses and Mirrors (I)

- 2 aspheric Lenses to show spherical and chromatic aberrations



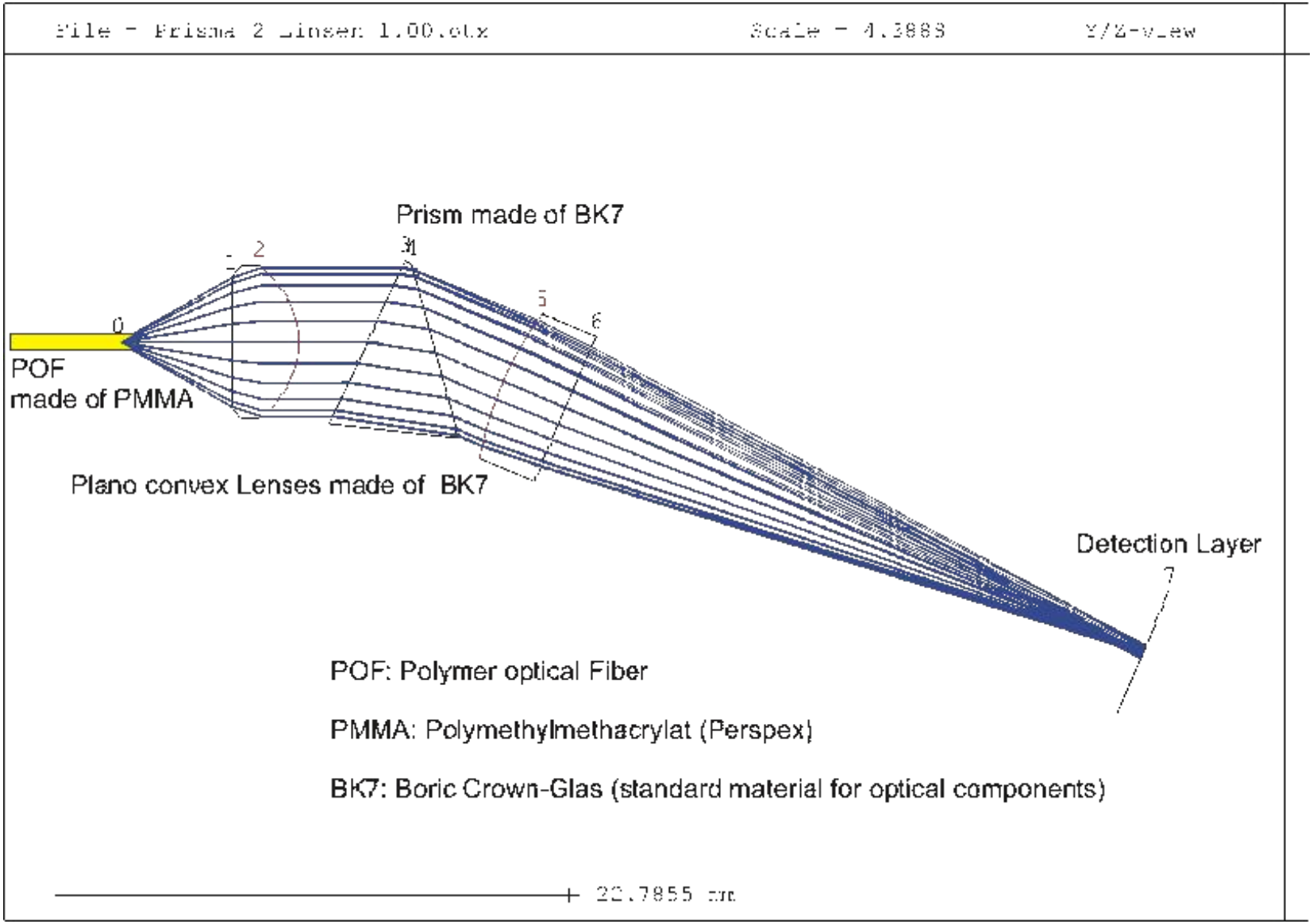
Aberrations of Lenses and Mirrors (II)





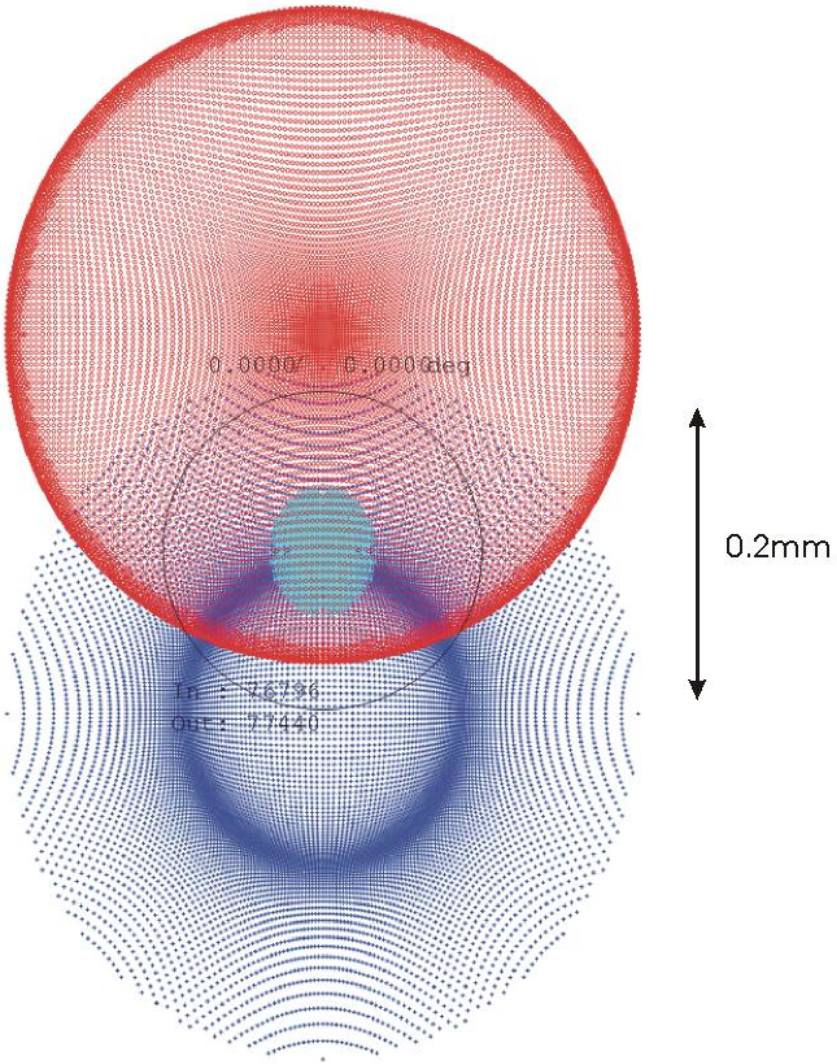
- **Spherical and Chromatic Aberrations lead to a large Spot Size**

First Results (I)



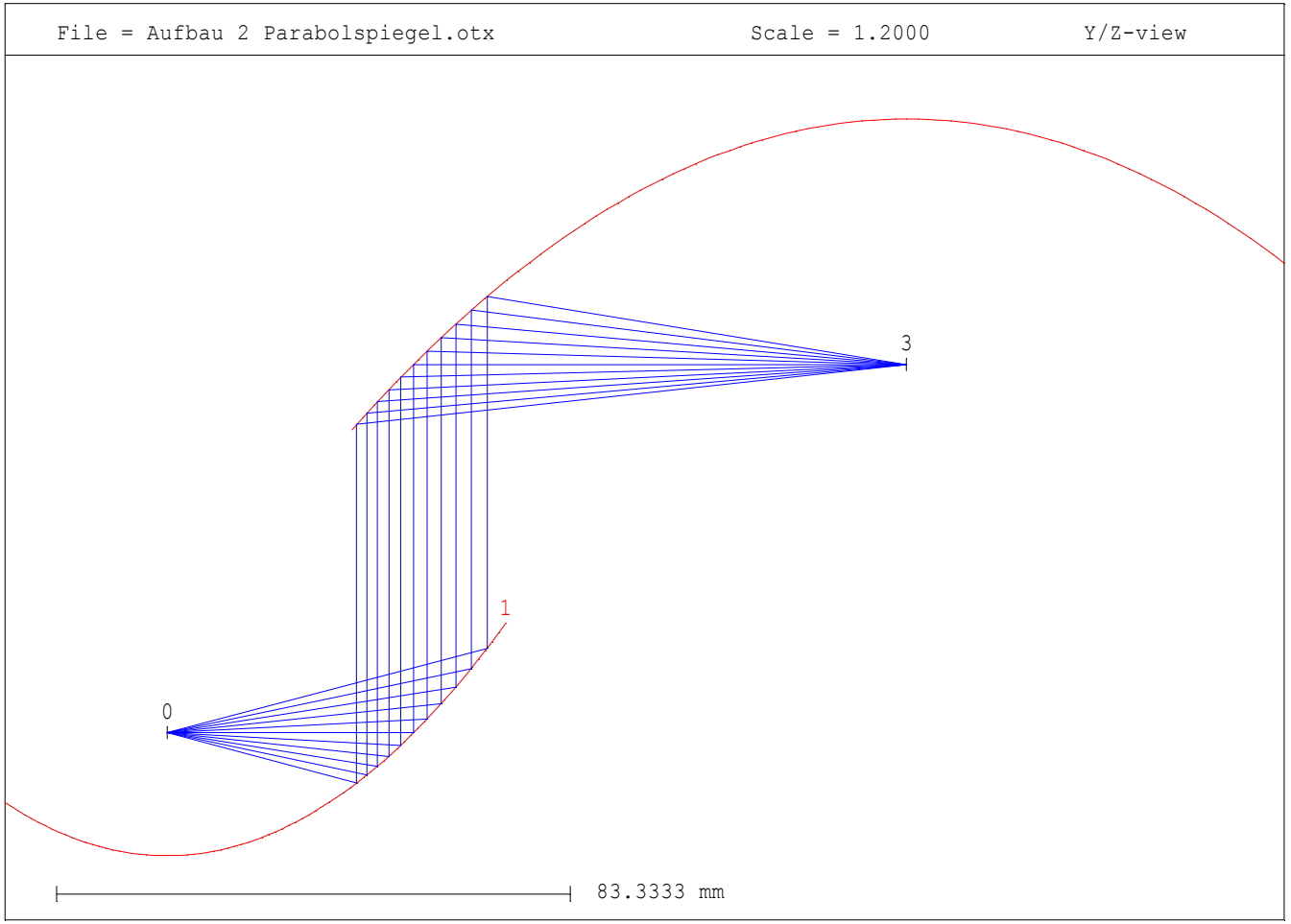
First Results (II)

- Spot diagram: collects the transverse aberrations in the image plane
- Spherical and chromatic aberrations avoid better results

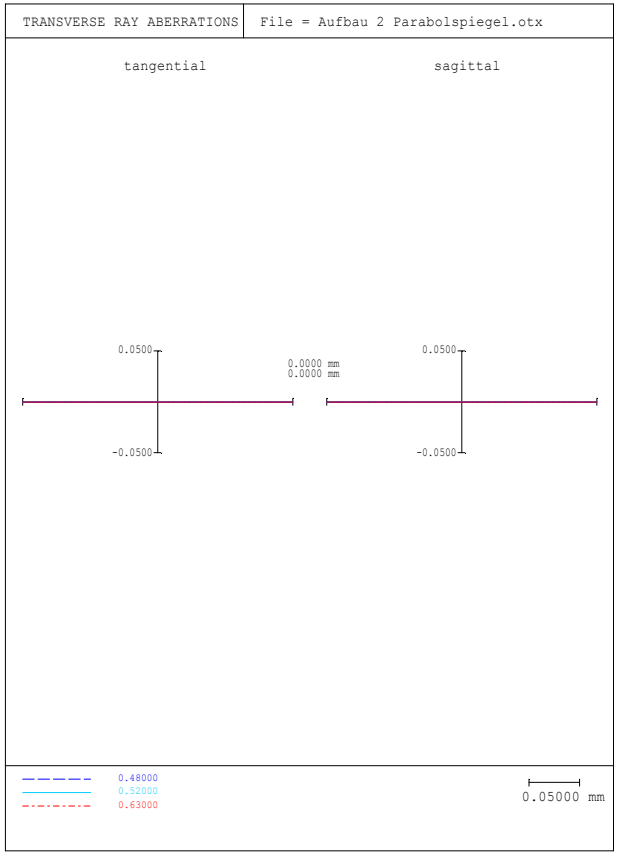


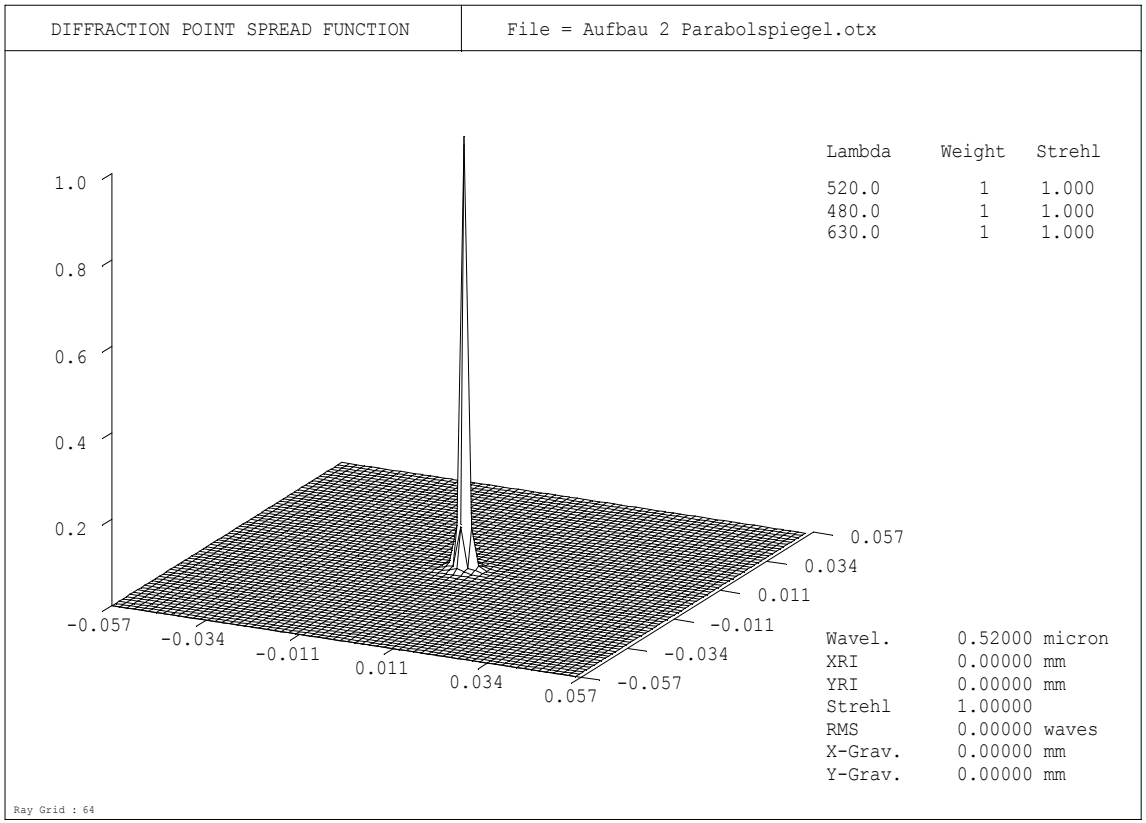
Aberrations of Lenses and Mirrors (III)

- 2 off-axis parabolic mirrors



Aberrations of Lenses and Mirrors (IV)

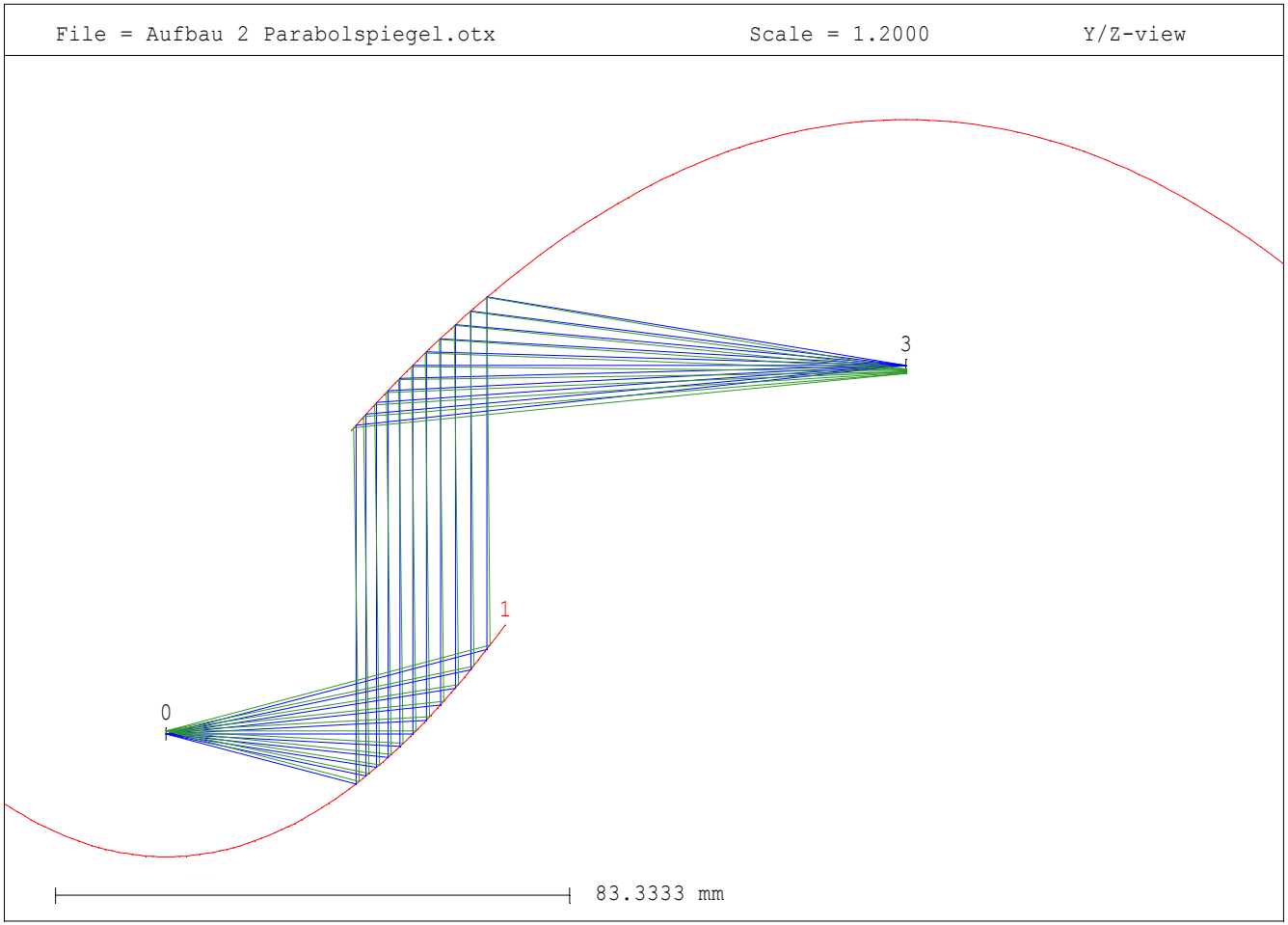




- **A perfect point to point projection without any aberrations**

Aberrations of Lenses and Mirrors (V)

- **Second off-axis source (green rays)**

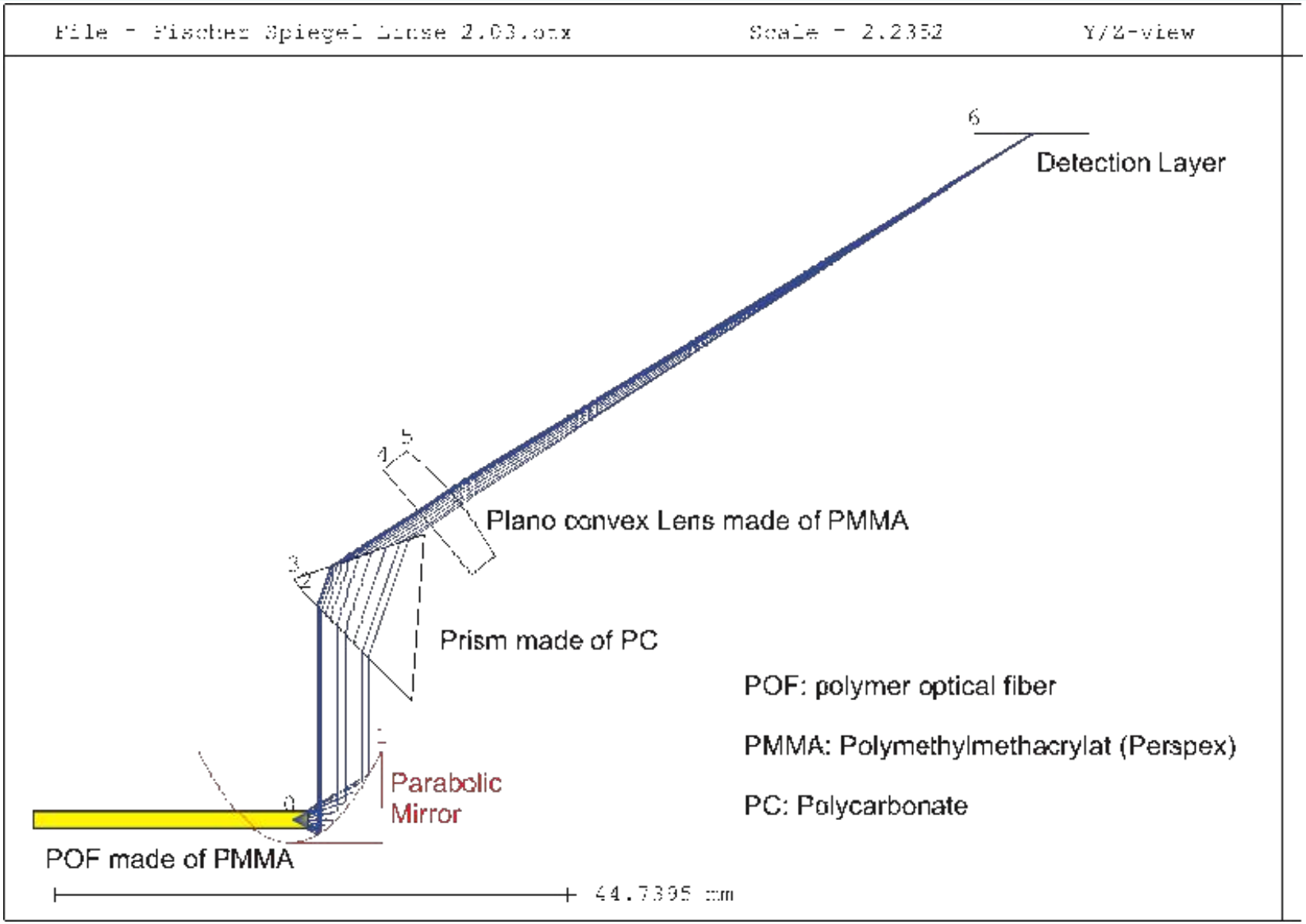


Aberrations of Lenses and Mirrors (VI)

- Large spot size of off-axis source

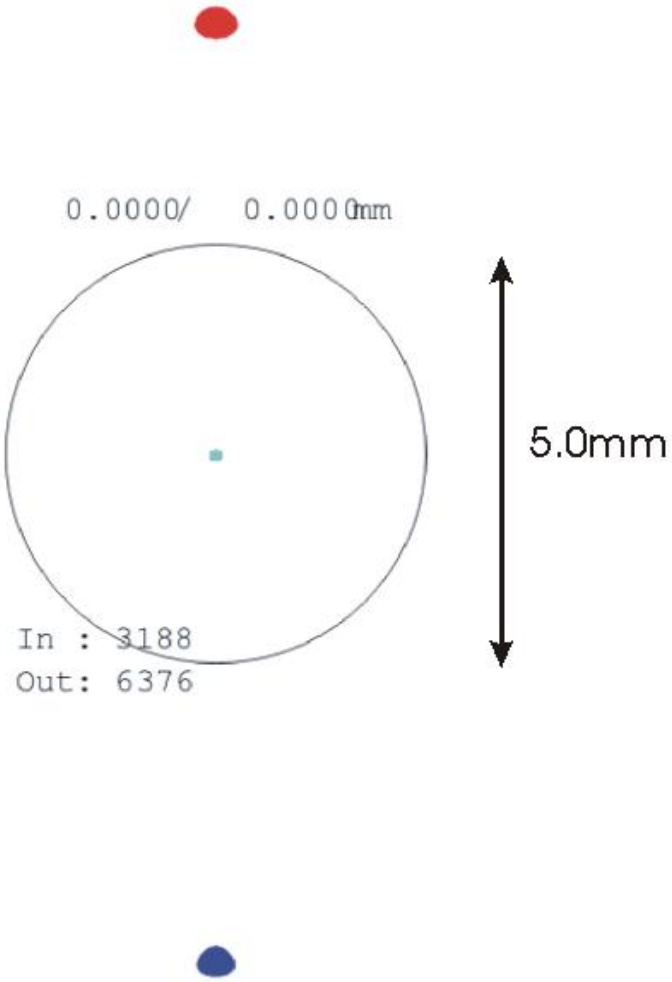
⇨ Tolerancing is more difficult with mirrors

Improved Results (I)



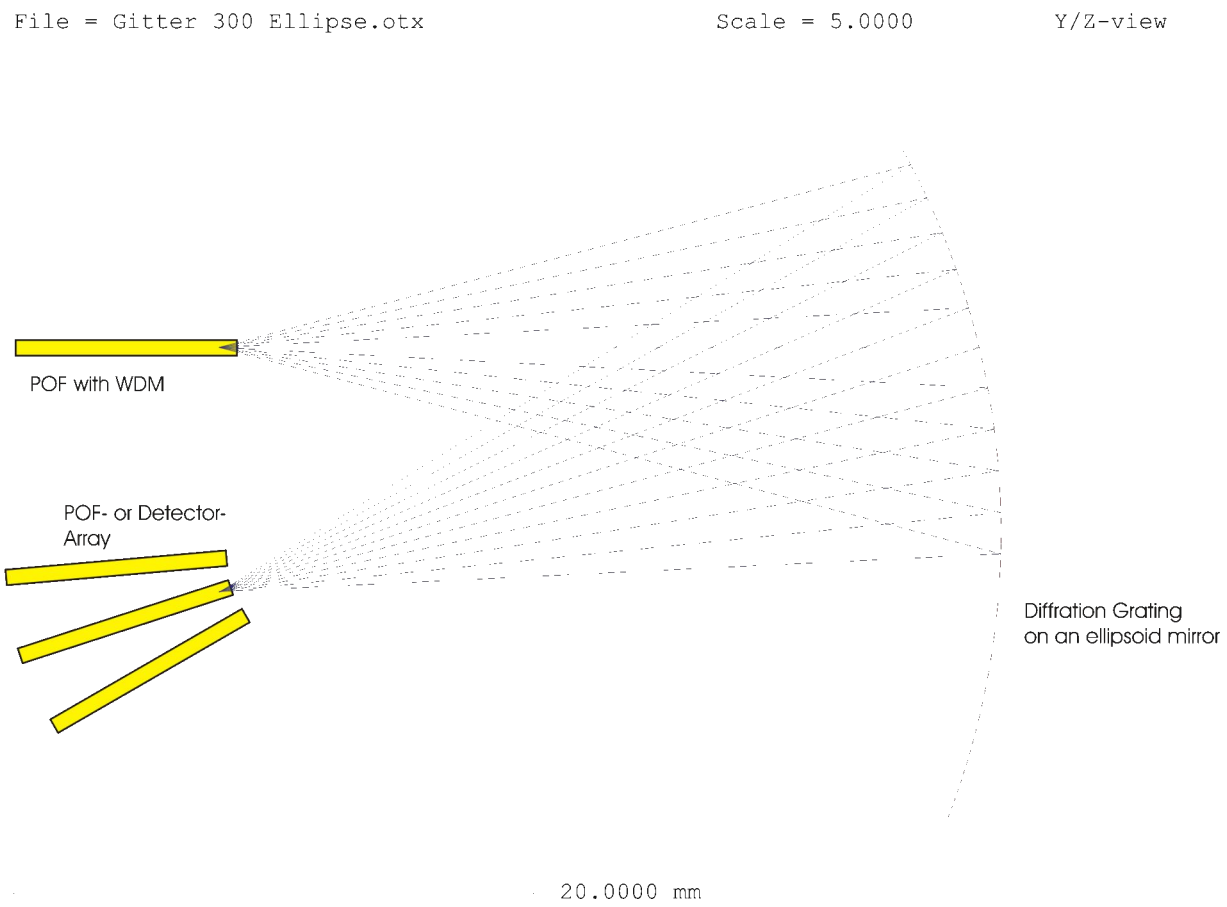
Improved Results (II)

- Low aberrations
  → all colors can be detected
- Gap between colors is large enough for photodiodes
- Cross-talk lower than 30dB



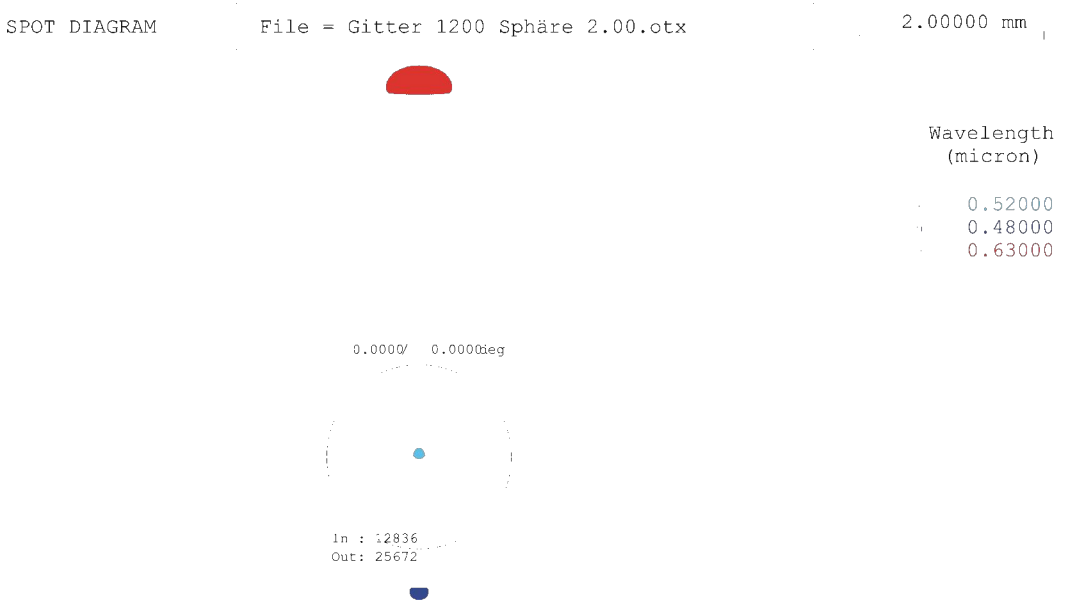
Another Attempt (I)

- Focusing done by an aspherical mirror
- Separating done by a grating
- Setup much smaller



Another Attempt (II)

- Every color can be separated with gap >2mm
- Lower transitions of materials with different refractive indexes
  - ⇨ higher intensity



Conclusion

- Computer aided optic design is a fast and cheap method to design optical components
- OpTaliX allows to evaluate the optical design and to optimize the results
- Designs can be compared with each other easily