Usage of Distortion Analyzer
Distortion is a vital aberration to consider in lens design. VirtualLab Fusion provides a specific analyzer for the distortion of an optical system that yields the standard representation of distortion versus angle. Here you can expect to find a definition of distortion and a step-by-step description of how to set the Distortion Analyzer in VirtualLab Fusion, illustrated with the example of a spherical lens.
Modeling Task

How to configure the settings of the Distortion Analyzer? What results does it provide?
Definition of Distortion

- Distortion corresponds to spherical aberration of the chief ray. It is defined as the deviation of the lateral position of the ray bundle to a reference position at the focal plane.
- Using the effective focal length ($f'$) of the scanning lens, one can calculate the position of reference ray at the focal plane, which mainly depends on the incidence angle.

$\begin{align*}
\text{Distortion} &= \text{deviation of lateral position of ray bundle} \\
&= \text{reference position at focal plane} \\
&= f' \cdot \theta \\
\text{Formula} &= y_{\text{Bundle}} = f' \cdot \theta \\
\text{Variables} &= f' : \text{effective focal length} \\
&= \theta : \text{incidence angle} \\
&= y_{\text{Bundle}} : \text{lateral position of ray bundle} \\
&= y_{\text{Ref}} : \text{lateral position of reference ray}
\end{align*}$
**Definition of Distortion**

\[ \text{Distortion} = \frac{y_{\text{Bundle}} - y_{\text{Ref}}}{y_{\text{Ref}}} \]

- **F-Tan(Theta) distortion:**
  \[ y_{\text{Ref}} = f' \cdot \tan(\theta) \]
- **F-Theta distortion:**
  \[ y_{\text{Ref}} = f' \cdot \theta \]
- **Ray bundle position \((y_{\text{Bundle}})\):**
  - Chief ray: connects the outer point of the field of view and the center of the pupil
  - Centroid: physical relevant is the energy centroid
Distortion Analyzer in VLF
Setting of the Analyzer

- Select a lens component to be analyzed. The analysis is independent of the system.
- Check the option to set the detector plane at effective focal length.
- Determine the *Evaluation Distance* by the user’s requirement.
Setting of the Analyzer

- **Positions (distortion type)**
  - Reference position
  - Calculated ray bundle position

- **Output (Result display)**
  - *Absolute Distortion* ([m]) or *Relative Distortion* ([%])
  - *Angle Range*: 4 scan options (x, y, -x, -y)
  - *Distortion Data Array* or *Single Distortion Values*
Distortion of Spherical Lens
Distortion of Spherical Lens

Absolute Distortion Result

Relative Distortion Result
## Document Information

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