

Mounting Requirements for Focusing Doublet

Homework 3 – Solution

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1. Summary

This report gives the analysis for assembly tolerances on a given focusing doublet system. The strictest tolerances were the decenters of the two lenses and the tilt of the second lens. Tolerances were made to limit the total system RMS wavefront error (RMS WFE) to 0.07λ , and the assembly tolerances were assigned a tolerance of 0.04λ .

2. Optical System

The doublet that was analyzed is shown below and consists of a positive lens and a negative lens to be used to focus a collimated HeNe laser beam onto a Position Sensing Detector (PSD). The optical design residual was 0.002λ RMS wavefront error.

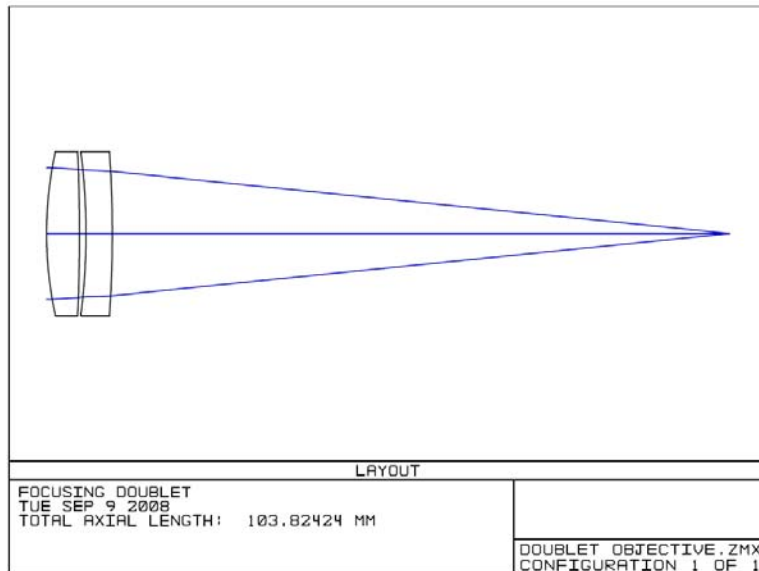


Figure 1. System Layout

SURFACE DATA SUMMARY:

Surf	Type	Radius	Thickness	Glass	Diameter
OBJ	STANDARD	Infinity	Infinity		0
STO	STANDARD	Infinity	0		20
2	STANDARD	58.6	5.0	N-SK15	25
3	STANDARD	-277.0	1.0		25
4	STANDARD	-97.0	4.0	N-SK15	24
5	STANDARD	-174.0	93.824		25
IMA	STANDARD	Infinity			

INDEX OF REFRACTION DATA:

Index data is relative to air at the system temperature and pressure.
Index of refraction at 632.8 nm
N-SK15 1.620702

Figure 2. System Surface Data

3. Mounting Tolerance Analysis

a. Sensitivities

The sensitivities analyzed for this system were determined with Zemax by perturbing each degree of freedom by a small amount and looking at the change in RMS WFE. Since we are using a linear approximation of the sensitivities, the perturbed RMS WFE needed to be larger than the residual design error to only take the perturbation into account.

b. Tolerance

The tolerances were chosen using the technique shown in class by assuming linear sensitivities and “guessing” tolerance values and then adjusting them to meet the total RSS error. For this example the total allocated budget was 0.04λ which corresponds to $0.0253\mu\text{m}$. The table below shows the tolerance values found.

<u>Element</u>	<u>Sensitivity (waves)</u>	<u>Tolerance</u>	<u>Error (waves)</u>
<u>Lens1</u>			
Decenter	0.1700	0.125mm	0.0213
Tilt	0.0910	0.2deg	0.0182
<u>Lens2</u>			
Decenter	0.1700	0.125mm	0.0213
Tilt	0.1800	0.1deg	0.0180
Lens spacing	0.0149	0.25mm	0.0037
RSS			<u>0.0397</u>

Table 1. Tolerance Spreadsheet

4. Conclusion

This report shows the assembly tolerances for the two lenses given. The sensitivities for decenter of the two lenses and tilt of the second lens were the largest which resulted in tighter tolerances for these degrees of freedom. The lens spacing sensitivity is very small, so the resulting tolerance is very loose. Within these tolerances, the system error should fall within the allocated error.