LRIO Philippe Truchon

Quantitative aberrations measurements with a PSM

May 2022

1 List of Equipment

- Collimated point source (laser diode coupled with a monomode fiber used)
- Various lenses (12.7mm diameter and 20mm focal used)
- 3 linear stage and 1 rotation stage
- The PSM (including computer)

2 Setup

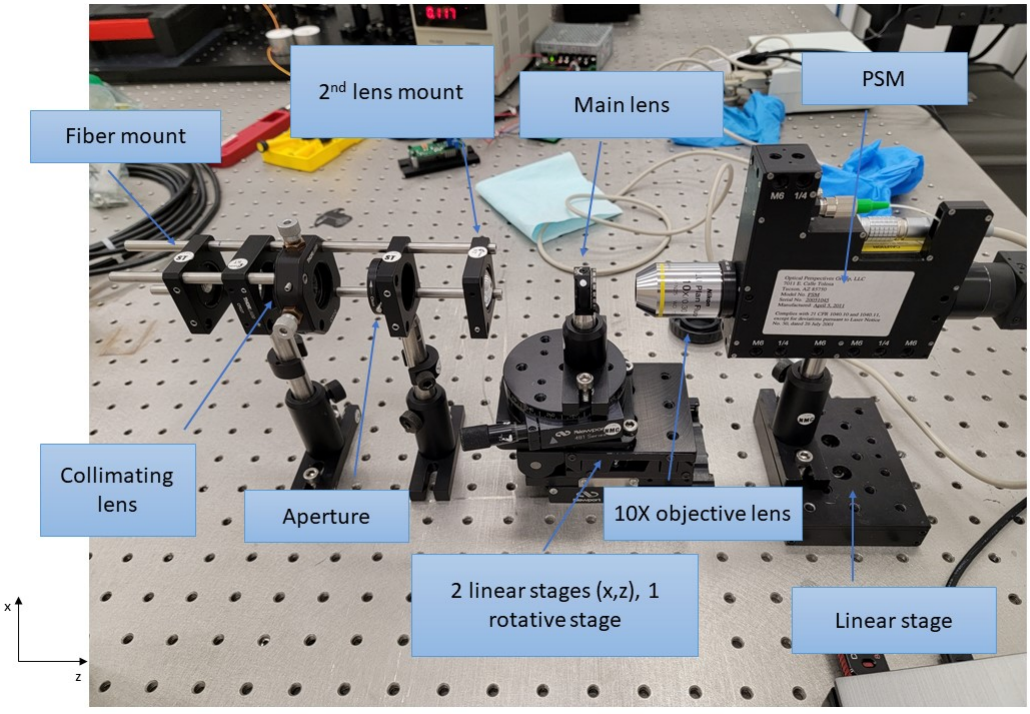


Figure 1: Used setup for the characterization of lens aberrations with the PSM

A single-mode optic fiber source must be connected to the fiber mount to do the experiment. The details for the lenses will be explored in the results section.

3 Protocol

1. Start the laser source for alignment (low intensity, but visible)
2. Align the single-mode laser source in order to see it with the PSM. If needed, use internal PSM source to help with the alignment.
3. Find the focal point by moving the lens with z axis linear stage
4. Take a picture with the PSM at the best perceived focus and name the picture '0.png'
5. Move the main lens along the z axis with the linear stage at fixed intervals in both direction. Take a picture at each point and name it '±XX.png' (for example '+50.png' for +50 μm from the focal point)
6. Export these images in a folder

4 Image processing

Image processing is done with the following python code: (https://github.com/PHTRU11/image-processing-for-psm.git). To use it, run it with your folder name on line 395 or import the PSM class and create and an instance. Use the 'psm' method with the folder name (str) as an argument.

5 Results

These results were obtained with a single lens. The specifications of the lens were 1" diameter and 15 mm focal point. The aperture in the setup was open at 8 mm.[1].

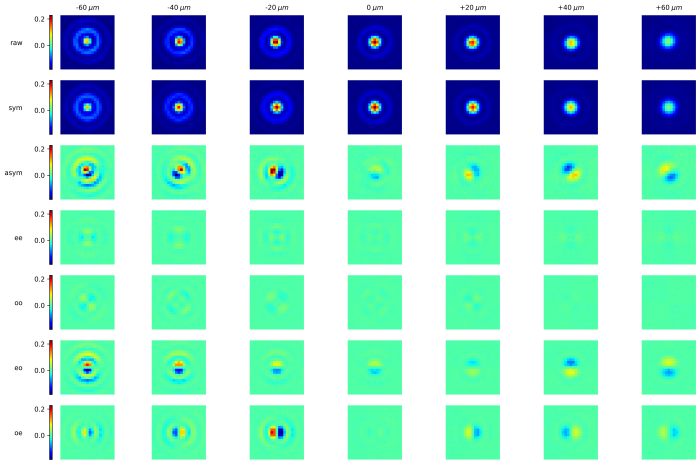
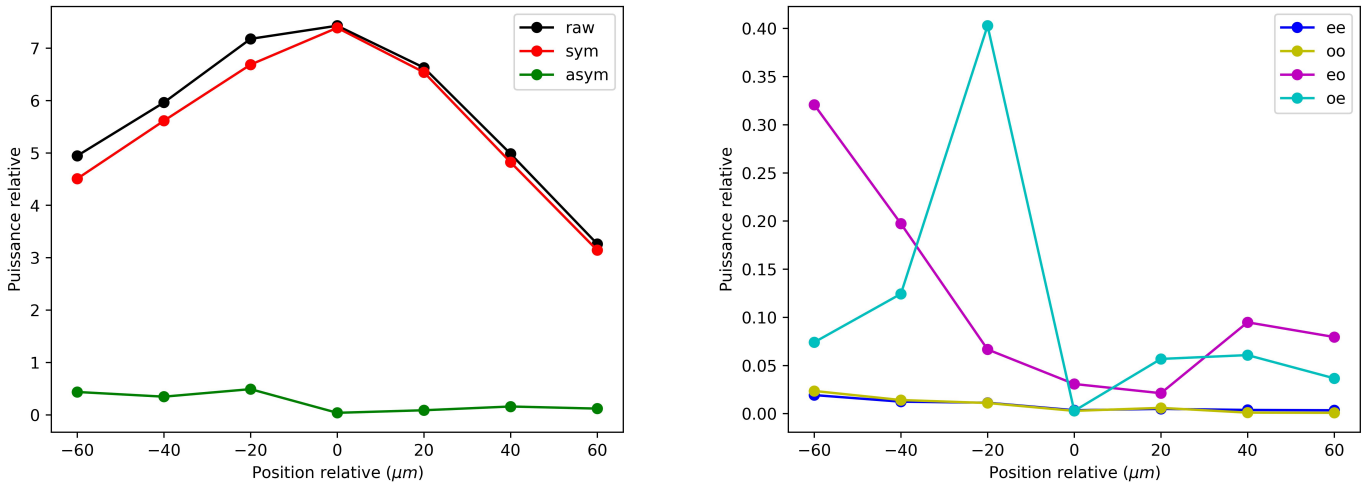


Figure 2: Example for the look of the laser source and its aberrations for a good alignment.

[1]The full resolution figures can be found on the GitHub with the link above



(a) (b)

Figure 3: Relative power of the images in figure 2.

With 'raw' for the power of the cropped original , 'sym' the symmetrical part of 'raw' and asym the difference between 'raw' and 'sym'. Furthermore, ee represents 0° astigmatism, oo 45° astigmatism, eo y coma and oe x coma. Unexpected peaks are observed for the eo and oe components. This could be caused by the real center of the spot being between two pixels of the digital sensors creating a false offset in either the x or y direction. This effect is more apparent in low aberrations situations.

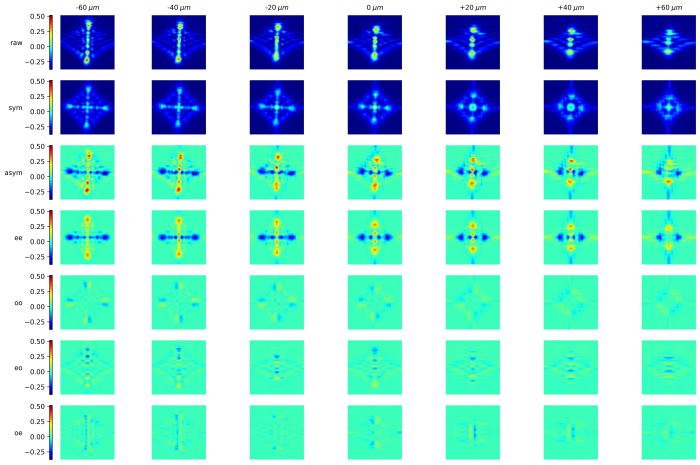
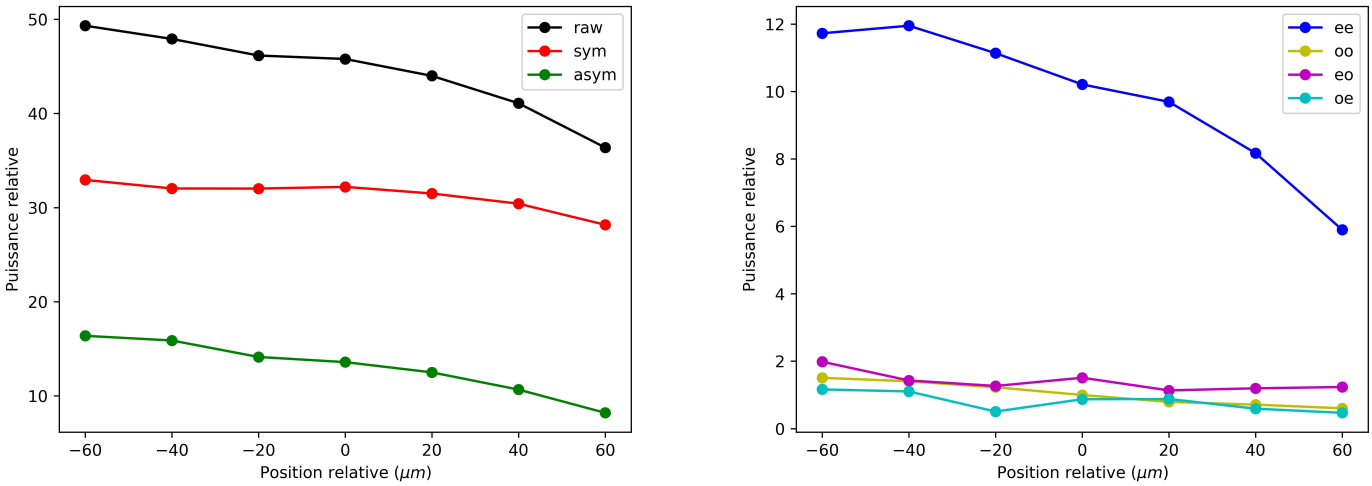


Figure 4: Example for the look of the laser source and its aberrations with the main lens having a 10° rotation.



(a) (b)

Figure 5: Relative power of the images in figure 4.

In this case significant aberration is observed, mainly 0° astigmatism. The PSF of the system can also be observed in these images, but since the PSF for a good alignment was symmetrical, its effect are set aside in the aberration analysis.