PyBeamProfiler: Laser profiling and drift control

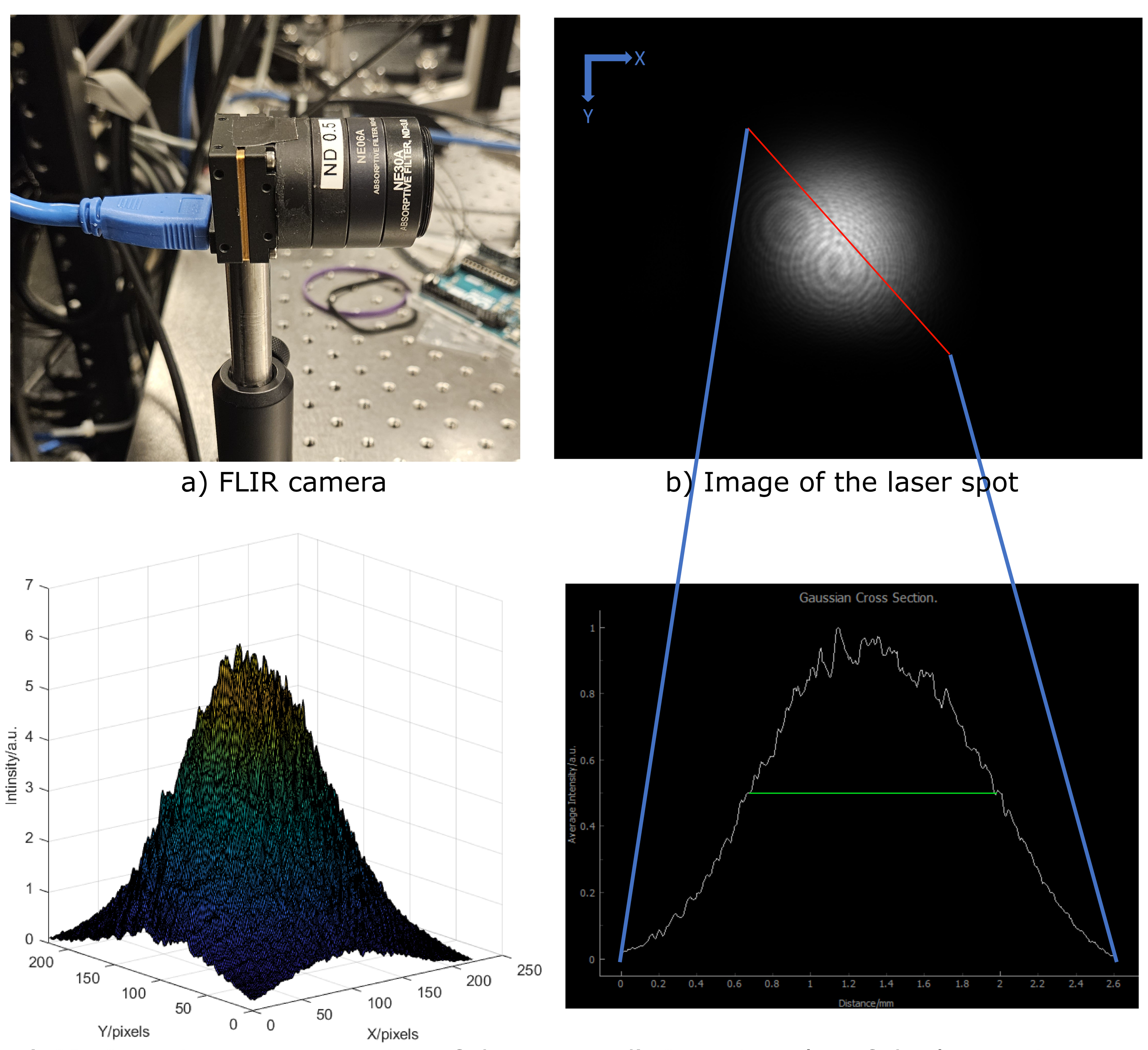
Carl von Ossietzky Universität Oldenburg
University of Applied Sciences Hochschule Emden·Leer
Author: Mohamed Shehata (6062847)
Supervisors: Prof. Dr.-Ing. Philipp Huke
Alipasha Vaziri, Ph.D.
Tobias Önol-Nöbauer, Ph.D.
Internship B.Eng. Engineering Physics: Summer Term 2023

Introduction

This project was done in the Vaziri lab at The Rockefeller University, which is a neuroscience lab that aims to develop technologies to better understand complex behaviors in animals. Imaging time and the quality of the data obtained from the brain were limited due to the slow drift of the laser beam. Therefore open-source software that monitors changes in the laser's position and the profile of the laser is important to optimize the results quality and accuracy. This poster shows PyBeamProfiler (PBP) a software that records those parameters and is easy to further develop and add on to its features.

Methods

There are two ways to measure the beam position. First with the center of mass (slow but accurate) and second with the geometric center of the ellipse that represents the spot (fast but less accurate). For the profiling, the second method is used as it allows the detection of the long axis (red line) of the ellipse (laser spot). From the profile, the full width at half maximum (FWHM, green line) can be measured.



a) FLIR camera
b) Image of the laser spot
c) 3D Gaussian representation of the laser spot
d) Gaussian plot of the long axis

Fig. 1: Beam profilling

The position signal can serve as feedback to a motor-controlled mirror to stabilize the laser at a certain position.

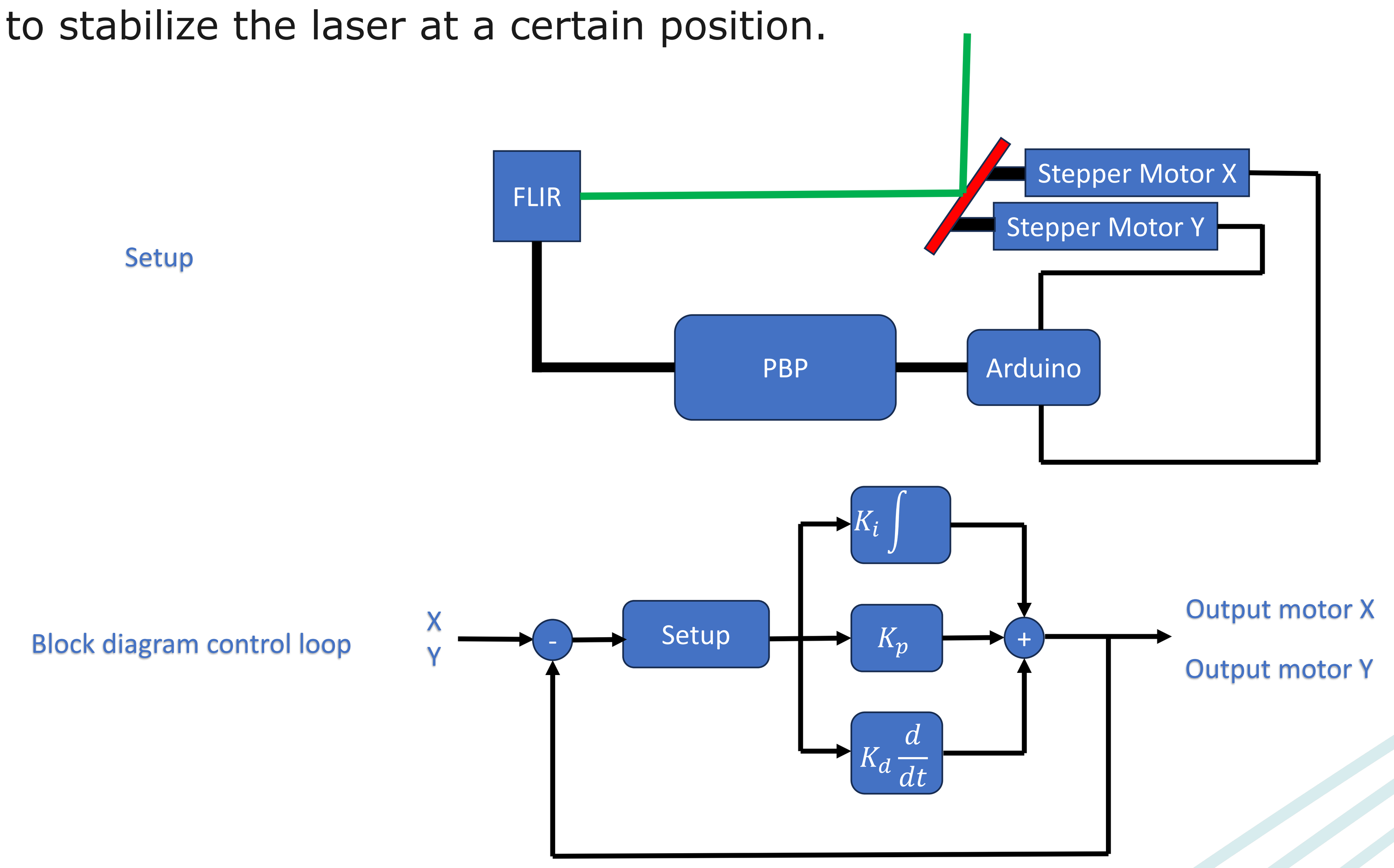
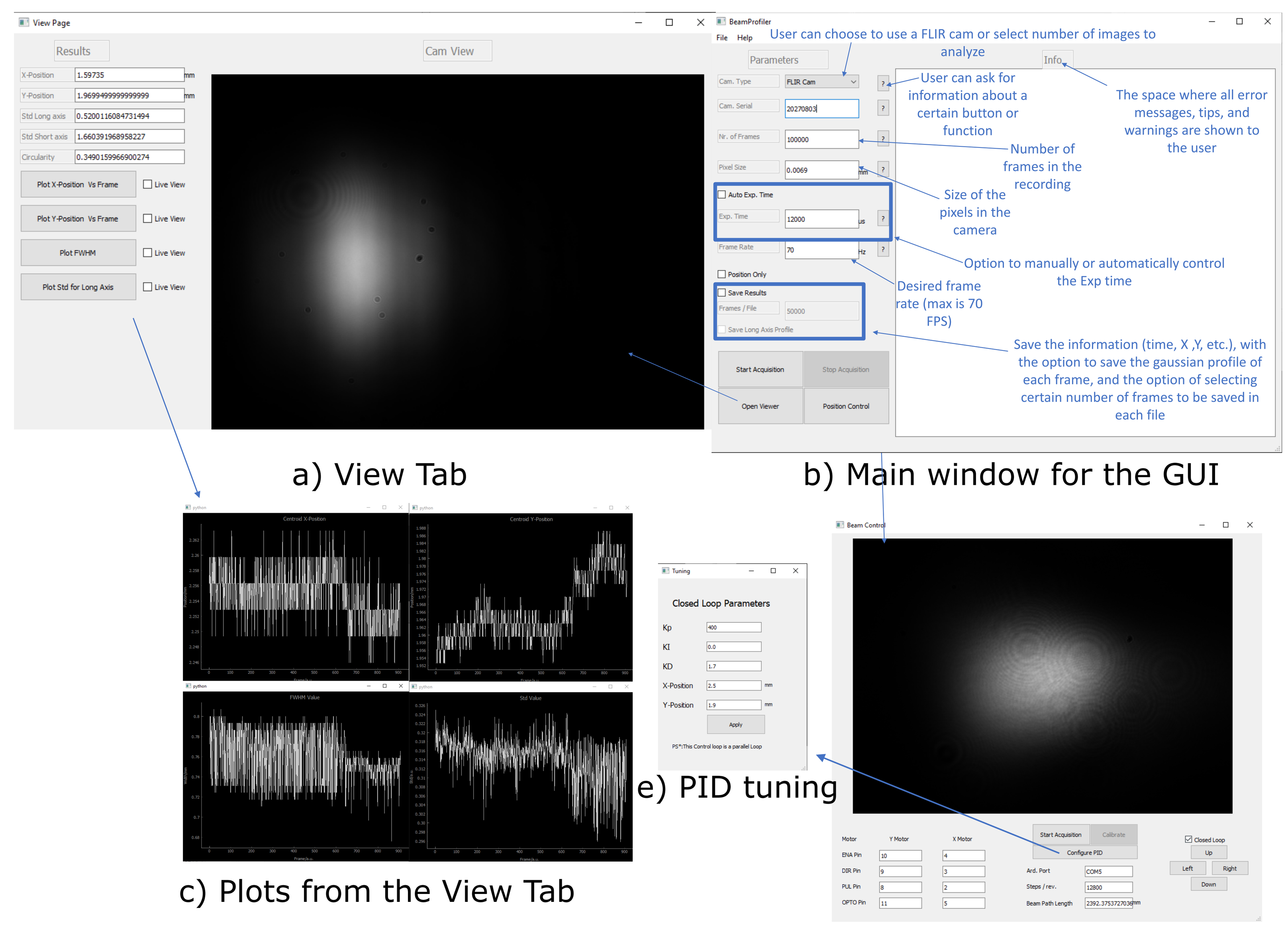


Fig.2: Sketch for the setup and control loop

Results

The resulting GUI (Graphical user interface) has many functions that can help measure the laser's stability and profile (Fig. 1d, Fig. 3b). The GUI was designed in a way that makes it easy for the user to manipulate and further add on to its features.



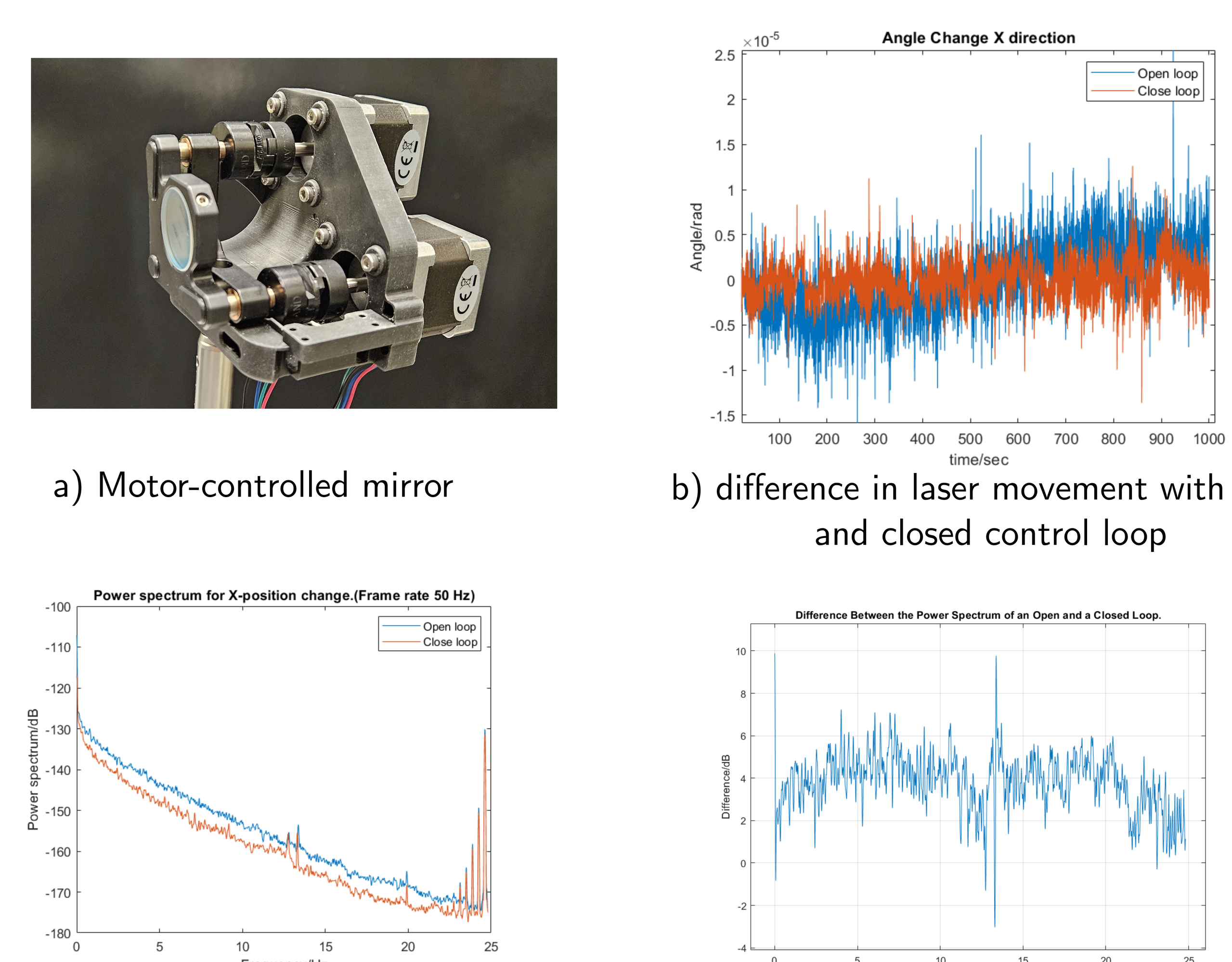
a) View Tab
b) Main window for the GUI
c) Plots from the View Tab
e) PID tuning
d) Position control and stabilisation

Fig. 3: Photos of PyBeamProfiler tabs

The laser profile was inspected with PBP and a DataRay Inc. profiling product.

- FWHM from PBP = 1.3196 mm
- FWHM from DataRay Inc. = 1.325 mm

PBP has the option of controlling drifts and stabilizing the laser at a certain location as shown in Fig. 2. The design for the setup and the Arduino code are included in the PBP GitHub repository.



a) Motor-controlled mirror
b) difference in laser movement with open and closed control loop
c) Power spectrum of the Angle change in x
d) Effect of the closed loop on the system

Fig. 4: Stability control system

Discussion

PBP provides a robust, cheap, and accurate system for laser monitoring. It can be used in a variety of laser applications that require long or short-term monitoring for lasers, or studying laser stability. The code for the GUI is structured in a way that makes it easy for a developer to add extra features like the closed loop example in Fig. 4. The limitations of the system are the small size of the FLIR sensor (5 × 5 mm) and the max possible frame rate which is 70 fps (50 fps in case of position control). To access the GitHub repository please scan this QR code.

Contact: mohamed.shehhata@uni-oldenburg.de
Summer Term 2023