Python-Microscope and Microscope-Cockpit: Python-based bespoke microscopy for bio-medical science

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Modern bespoke microscopes need advanced computer control. We have developed open source software to make these systems easier to build and use even when designed for performing complex experiments. We describe two open source software packages for control of bespoke microscopes from Python; Python-Microscope (Microscope) to interface with hardware and Microscope-Cockpit (Cockpit) a generalised graphical user interface for microscopes.

Microscope offers control of a range of microscope related hardware from Python. It provides a defined interface for a range of device classes including cameras, light sources, stages, filter-wheels and deformable mirrors. Microscope uses Python's abstract base classes to ensure that all supported models of a given device type are interchangeable. Additionally, model specific functionality can be implemented by using a customised settings dictionary. Microscope provides a device-server class which starts a separate process for every device, is able to gather multiple devices into a single composite device and provides a network transparent interface, enabling connection to hardware either on the local computer or on a remote computer.

Cockpit provides a GUI front end for controlling simple or complex bespoke microscopes (Figure 1). By utilising Microscope to interface with hardware it is able to utilise a range of devices, provide high performance and present a consistent interface. Cockpit also provides a standardised interface to hardware timing, utilising electronic signals to trigger time sensitive actions during data collection, such as waiting the required time after piezo driven Z position moves before triggering the next image and then triggering a laser just as the camera becomes active. Cockpit is also optimised for use on bespoke systems with no eyepieces, it has a powerful mosaic tool, that is able to image large sections of the sample rapidly, and uploads data to the computer GPU for instant navigation (Figure 1d).

(a) Main Window

(b) Macro Stage

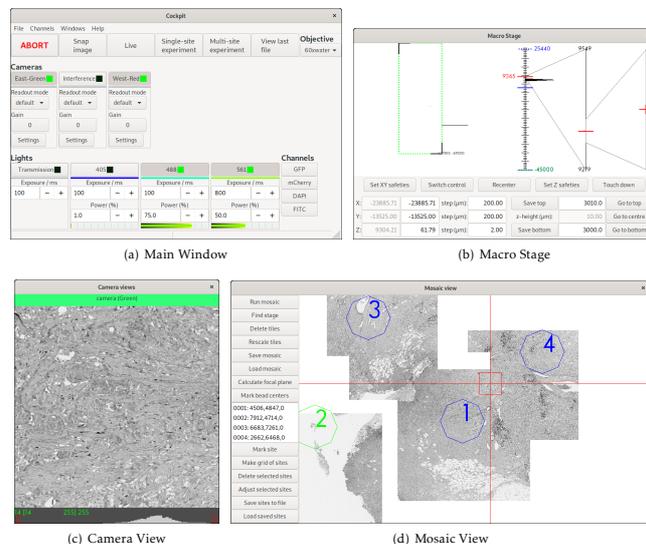(c) Camera View

(d) Mosaic View

Figure 1. The main windows of the cockpit interface

We demonstrate the advantages of the Cockpit platform using several bespoke microscopes, including a simple widefield system and a complex system with adaptive optics and structured illumination.