Template for GUI-based device control and data acquisition system for P02 beamline at Petra III

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P02 beamline at Petra III is dedicated to high resolution powder diffraction and research at extreme conditions. The control of beamline devices and data acquisition will be performed using graphical user interface based control system. As all the functions performed by users will be similar from software point of view, it is important to have a template that accounts for the main features of such a system. In this report, production and testing of such a template is described. It is based on TANGO control system, Python programming language, PyTango binding and PyQt bindings to create a graphical user interface.

1 Introduction

About the beamline

Still under construction, P02 beamline at Petra III will have two experimental stations, both of them operating in the hard X-ray regime. One station is dedicated to High Resolution Powder Diffraction (HRPD) at ambient pressure. The second station, the Extreme Conditions Beamline (ECB), is designed to be used for experiments at high pressure and variable temperature. The high pressure is achieved using Diamond Anvil Cell and the Paris Edinburgh Press. Such experiments are very important for geophysical sciences as well as petrology as this is the only way to replicate the conditions in the inner earth. In addition, in both stations it is possible to have a time resolved diffraction, which enables exploration of the kinetics of physical processes such as metastabilities during a phase transition (1).

Control system

It is important to be able to control the beamline parameters and obtain the data remotely. For that, one needs to have software that facilitates the communication between the devices in the beamline and a computer operated by a user. It is done using scripts based on TANGO control system(described below) that define the important parameters and allows intuitive manipulation. Production of a versatile template for this software is described in this report.

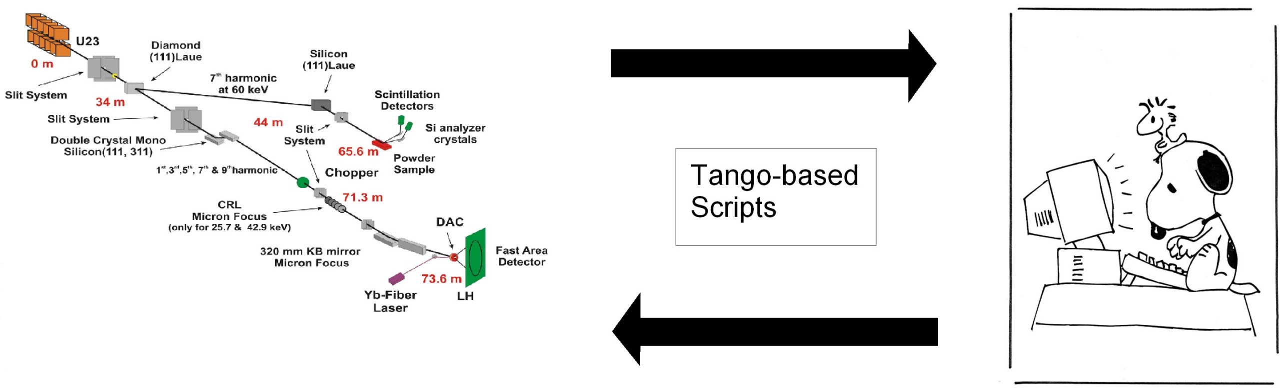

Figure 1: A schematic diagram for the control system of beamline components. Tango-based scripts allow the communication between the user and the devices.

Beamline can be controlled using both command-line based applications as well as Graphical User Interface(GUI). Generally, command-line based versions are more powerful and allow greater flexibility. However, they require a lot of prior knowledge. On the other hand, GUI can be immediately used by users and it enables them to manipulate the beamline intuitively.

Use of control system

The initial aim of such piece of software was to control the ruby fluorescence – based pressure measurements. It is the most commonly used pressure measurement method in high pressure research. The method employs a number of ruby crystals placed close to the sample. At high pressure, the rubies are stimulated by strong laser light and their fluorescence spectrum is measured using a spectrometer. There are many in-depth discussions of the method in the literature (2, 3).

In addition, such control system can be utilized to position samples in the beam to get the biggest flux through the samples. Among many other applications, it could also be used to control the optics components.

2 Tools

Python and PyQt
The software was written using Python. Python is a high level object-oriented programming language. One of the main features of Python is that it is intrinsically very readable. PyQt are a set of Python bindings for Qt - a cross-platform application development framework that is used for creating GUI programs. PyQt allows creating custom-designed, Python-based GUI easily. The main concept behind the PyQt is the idea of signals and slots. When user interacts with the application (presses a button, checks a box, etc.) a signal is released. Using *connect* method, a signal is linked to the slot – usually a method defined by the developer. This makes it easy to understand and modify the functioning of application.

TANGO and PyTANGO
TANGO is an object oriented control system which was initially created in ESRF and is now being used and developed in the light sources all over the world. It allows the communication between the devices and computers. TANGO also has some built-in applications, for example *Pogo* that helps to create and update the device classes. More important to this project is the *Jive* application that allows browsing TANGO device database and testing the devices. Also, it allows controlling them and acquiring data manually.

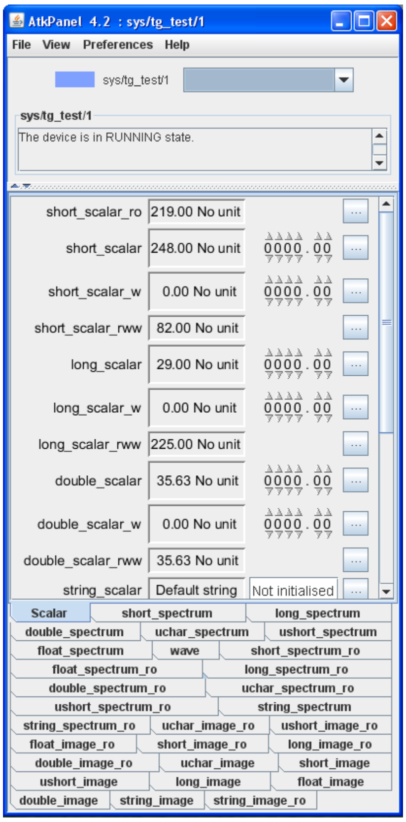

Figure 2: An example of TANGO Jive application window. The device displayed in this Jive screenshot is a virtual TANGO device that was used to test the application in the later stages. Using Jive, names of attributes can be looked up and the device can be controlled manually.

After the properties of a certain device is known, one can use PyTANGO bindings for Python to import the devices in the command line(or script). It is then possible to access information and control devices. Usually, the commands were tested in the command line before including them into the GUI script.

3 Production

A simple GUI widget was created to do all the basic useful tasks. Initially, it was planned to test it with a spectroscope, hence functions to start and stop taking spectrum were included. The data is readout when either 'Plot' or 'Save data' buttons were pressed. In the case of 'Plot', Python module Matplotlib is invoked to create a graph. One can then choose to 'Save Plot' to save a .png figure into a desired folder. In the case of 'Save data', a .csv file with the spectrum is saved into disk.

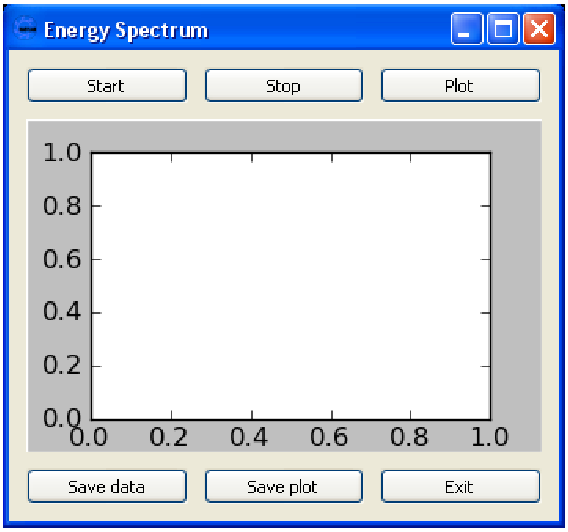

Figure 3: A simple GUI widget created with PyQt. Initially created for spectroscope, it has buttons to start and stop spectrum acquisition, as well as plot and save the data.

In addition to working on the independent GUI applications, a widget for manipulating the ruby-system using p3centr package(a Python package created specifically for Petra 3 synchrotron) was updated with an area for graphs and made suitable for positioning sample.

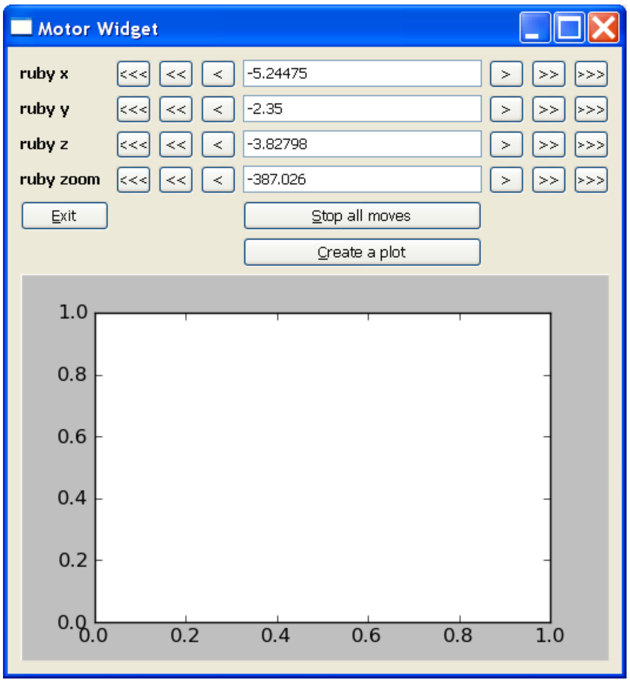

Figure 4: A widget for ruby system to manipulate the 3 position motors and the motor for zooming in.In addition, it also has area for plotting the intensity

4 Testing

The application at its initial stages was tested with the spectrometer but the spectrometer was later used for other purposes and could not be used for testing this piece of software. Hence, a virtual TANGO device was created which could be started and stopped and would output a random spectrum was created to test the functionality of the widget.

At the early stages of testing, the obtained data was simply printed out to screen. Also, the status of device was displayed. At later stages, the data was plotted and saved both as numbers as well as a figure.

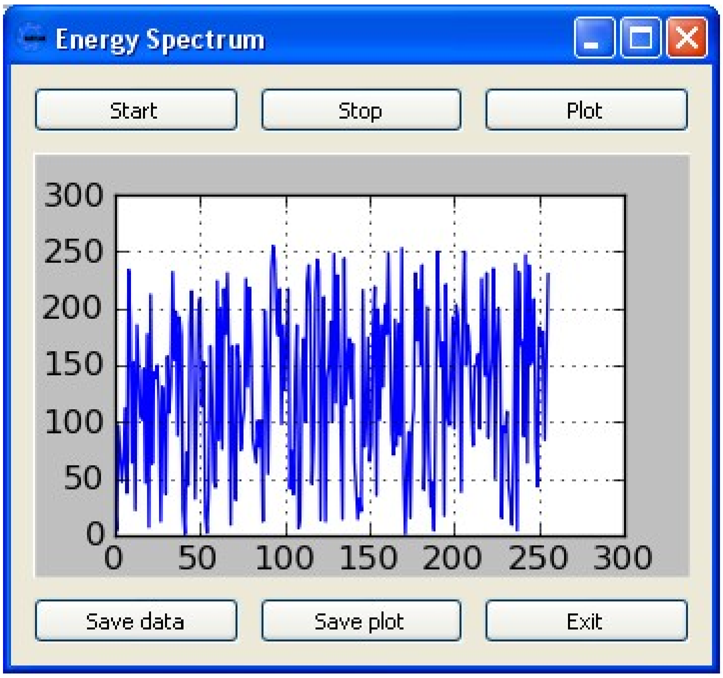

Figure 5: A random spectrum produced by the virtual TANGO device

One of the aims of the project was to create framework that would operate on both Windows and Linux operational systems. It was initially developed using Windows system. The independent widget was then adapted to work on Linux environment, however, due to the time constrains, p3centr module was not fully changed to operate on Linux.

5 Conclusions

A basic, yet versatile piece of software was produced, using Python, PyQt, PyTANGO and TANGO. It is clear and very easy to modify. In addition to the planned use in Ruby system and sample positioning, it has many potential applications and is a powerful tool for controlling beamline components and acquiring data from detectors.

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7 References

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