ISBN: 978-3-95450-209-7 ISSN: 2226-0358 doi:10.18429/JACoW-ICALEPCS2019-MOPHA072

AUTOMATION IN NSRC SOLARIS WITH PYTHON AND TANGO CONTROLS

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Abstract

NSRC SOLARIS is a 1.5 GeV third generation light source constructed at Jagiellonian University in Krakow, Poland. The machine was commissioned in April 2016 and operates in decay mode. Two beamlines PEEM/XAS and UARPES were commissioned in 2018 and they have opened for conducting research in fall 2018. Two more beamlines (PHELIX and XMCD) are installed now and will be commissioned soon. Due to small size of the team and many concurrent tasks, automation is very important. Automating many tasks in a quick and effective way is possible thanks to the control system based on TANGO Controls and Python programming language. With facadevice library the necessary values can be easily calculated in real-time. Beam position correction with PID controller at PEEM/XAS and UARPES beamlines, alarm handling in SOLARIS Heating Unit Controller and real-time calculation of various vacuum parameters are shown as examples.

INTRODUCTION

Control system at SOLARIS is based on TANGO Controls. Thanks to tools like PyTango [1] and Taurus [2] and their intuitive APIs creating new controllers and GUIs is fast and easy. In case of data processing, facadedevice library has vital importance. Devices created with it subscribe to events from other, low-level devices and deliver processed signals [3]. With addition of enormous collection of available Python packages, programmers can automate a lot of processes at synchrotron.

PI CORRECTION

SOLARIS operates in decay mode with two injections per day: first one at 7:00 AM and second one at 4:00 PM. Therefore, the position of the beam changes during the shift so beamline operators have to correct it. As this correction requires frequent but very small changes, TANGO device with PI controller was created. To correct the beam position, differences in currents from slits should be minimized. The minimized current difference is described by the formula $\frac{current1-current2}{current1+current2}$. The executive element is the mirror. To ensure that the mirror is not moved too far during the process, the correction is turned off when sum of the moves reaches set threshold. After tests, sample time 10 s and proper values of K_i and K_p were established. With the use of configured PI controller TANGO device, the current difference is kept in range from -0.002 to 0.002 on UARPES beamline. The whole process can be monitored from Taurus-based GUI which is shown at on the Fig. 1.

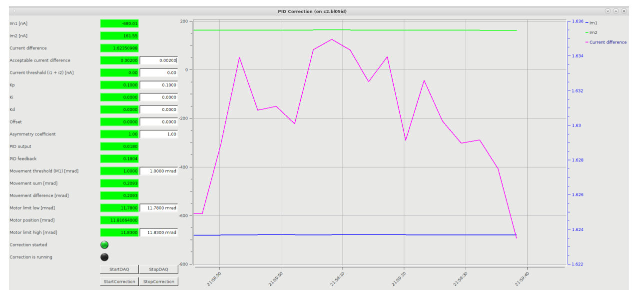

Figure 1: PID correction application.

Beam position correction process' course has been shown on the Fig. 2, Fig. 3 and Fig. 4.

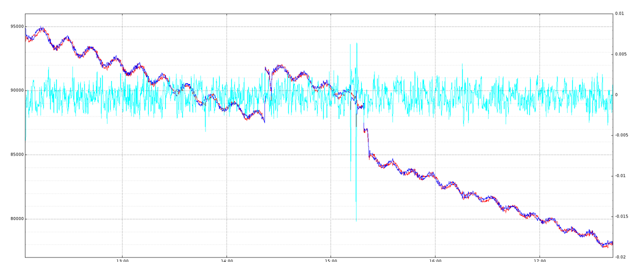

Figure 2: Currents (red and dark blue) and their difference (light blue).

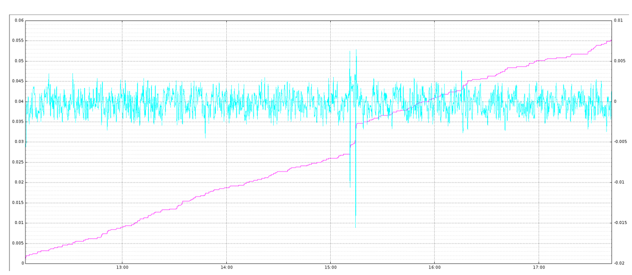

Figure 3: Sumaric movement of mirror's motor (pink) and currents difference (light blue).

HYSTERESIS MODE IN SOLARIS' HUC

The Heating Unit Controller (HUC) is used to bake-out the vacuum elements [4]. In basic mode if average pressure from input analog channels is higher than defined maximum pressure value the heating process is paused. If this alarm is present longer than configured Waiting Time then the heating process is turned off. This works well for leaks,

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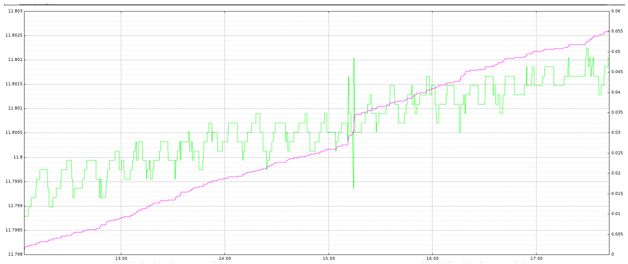

Figure 4: Mirror's motor position (green) and its sumaric movement (pink).

but if the maximum pressure threshold has been set too low and alarm will not be noticed by the operator, then the system may be cooled. This can result in the need to repeat the entire, usually long, process. The solution to this problem is hysteresis mode. If the maximum pressure is exceeded, the system is cooled slowly. If the average pressure drops below a certain value (the default value is 80% of the maximum pressure), then the heating is resumed. Otherwise, the system is still cooled until the ambient temperature is reached. Configuration of hysteresis process has been shown on the Fig. 5.

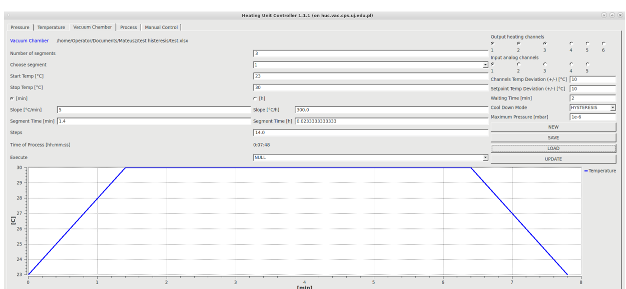

Figure 5: Heating process configuration in hysteresis mode.

VACUUM PARAMETERS CALCULATION

In order to analyze the condition of individual synchrotron elements, operators perform calculations on signals extracted from archiving. However, for some of the most-checked attributes, this is not productive. In this case, it is worth using the facadedevice library to calculate values in real time. Thanks to this, operators have access to both archival and current values. An example of such calculations are the SectionVacuum and RingVacuum classes, which provide information about the state of individual vacuum sections and the entire accelerator. In addition, the VacuumProduct class provides data for a so-called vacuum product $\frac{pressure}{beam\ current}$. Signals from device of SectionVacuum class is shown on the Fig. 6 and from VacuumProduct class on the Fig. 7 .

CONCLUSION

As shown in the examples above, Python and TANGO Controls enable programmers to efficiently automate many different tasks. This is possible thanks to the versatility of

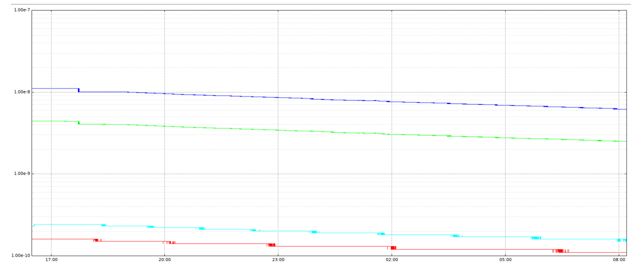

Figure 6: Pressures.

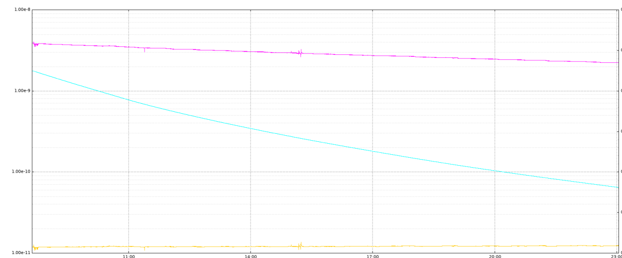

Figure 7: Vacuum product.

Python programming language, its many available packages and the transparent API of PyTango. Automation is especially important in small laboratories with a short number of employees, as it significantly increases productivity. Employees do not have to focus on simple, repetitive tasks and can devote to more complex challenges.

REFERENCES

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