Automated Tests for Control Devices

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Introduction

Test automation is carried out by running a special test script that executes a series of commands that controls the hardware. The script then compares the predicted outcome with the actual outcome in order to determine the presence of bugs or defects. Automating tests, provides several advantages over manual testing:

→ More accurate test results
→ Consistent testing methods
→ Earlier detection of issues
→ Thorough test coverage
→ Reusability of automated tests
→ Reduced expenses

For this project, tests were developed to verify Hard X-Ray Offset Mirror System (HOMS) and Sample Delivery System functionality. The tests were written using the PCDS python/EPICS framework.

Development

HOMS Checkout:

A jupyter notebook python script was used to establish the baseline on how the mirror system works in order to be used as the reference during experiment.

Based on user's input, the test is carried out for the chosen HOMS mirror.
After verifying axes are coupled, the test records average noise level and gantry difference for each axis. Then it records time to complete a move. For pitch axis, the script records time for small move (within piezo range ~20 urad) and for large move (where stepper motor is enabled ~100 urad). For all axes, the script records the position of high and low limits. Furthermore, the script requests a large move, changes request before the move is complete, and verifies that the target change is accepted and final position matches second command. Finally, the script restores the mirror to original position.

Outcome:

The automated test script revealed the following issues. First, Pitch commanded position was ignored after hitting the limit switch because the DMOV flag would reset to 0 if an error occurred, including hitting a limit switch and axis would forever appear not done with the move.
Second, pitch axis took very long to settle at the requested value, it kept fluctuating around the target. It was solved using dynamic target range based on the noise floor.
These issues were resolved and the test was carried out successfully.

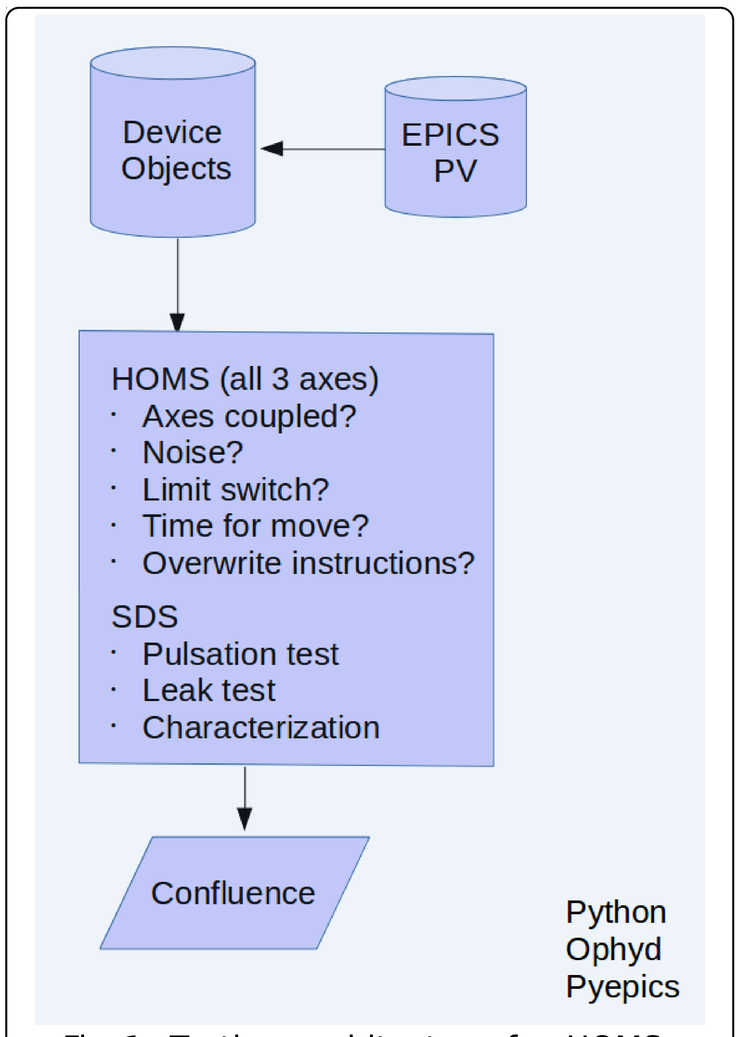

Fig 1. Testing architecture for HOMS and SDS

Sample delivery system:

The purpose of this test is to characterize each port of sample delivery system. But first, pump pulsation is measured and each tube is tested for leak. All these steps are carried out automatically by the python script.

HPLC Pump Pulsation Test
At the beginning of the test, the software measures and reports pulsation of the pump, with the option to repair the device and rerun the test.

Standard Leak Test
The software steps through the ports testing for leaks, using the flow profile as determined by the pump model. With the ports plugged, if the pressure reaches stability before the pump reaches an over pressure error, the pump has a leak.

Characterization Run
The standard characterization method is to test each port for settling time, pressure drop and flow rate characteristics of each port.

Outcome:

The software gives pressure and flow settling time, records and displays flow rate vs pressure, pressure vs time and volume vs time at the end of test. The software is able to identify and clear pump alarms such as over pressure error.

Furthermore, all data are uploaded to confluence so that it is easy for the SLAC technicians and the users of that specific selector box to recall it during the beam line experiment.

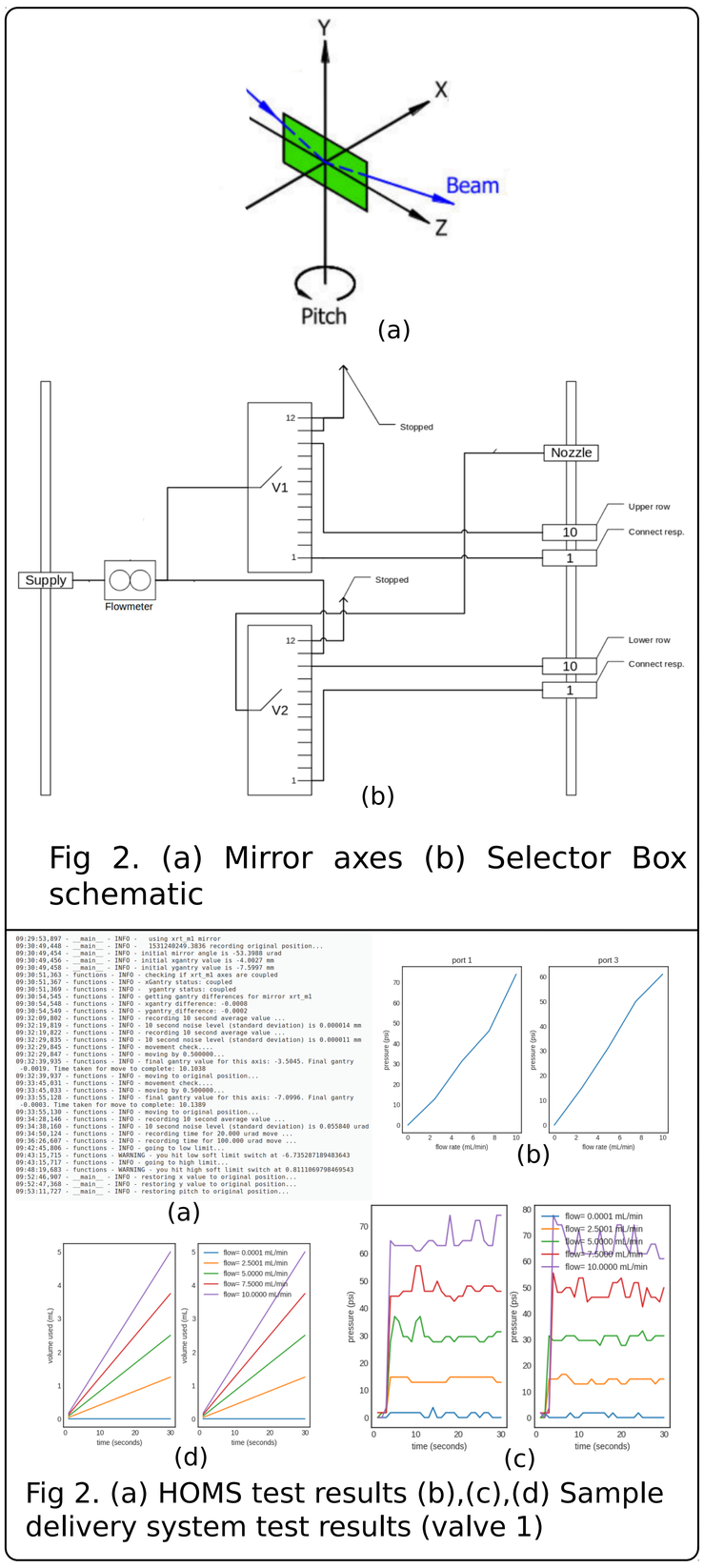

Fig 2. (a) Mirror axes (b) Selector Box schematic

Fig 2. (a) HOMS test results (b),(c),(d) Sample delivery system test results (valve 1)

Conclusions

The tests verifies the use of ophyd objects and pyepics framework to run automation tests and detect issues in order to ensure that a given system is performing as expected. Furthermore, it records data for various operational scenarios and stores them in confluence, so that it can be referenced during the beamline operation.

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