Infrastructure-independent Device Control

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Abstract

In modern accelerator control systems there is often a need for controlling devices which have been developed with interface to a different control infrastructure. For example, the future EIC collider will have mixture of **EPICS**, **ADO**[1] and **liteServer**[2] controlled devices. In this paper we describe the control tools and middle-level interface which allows to control the devices independently of their dedicated architecture.

Infrastructure-independent tools:

- **pype**t: spreadsheet-based parameter editing tool which covers functionality of the EDM, MEDM and PET.
- **ImageViewer**[3]**:** interactive image analysis tool, supporting AreaDetector, USB and ADO - controlled cameras.
- **pvplot** is simple parameter plotting tool.
- **apstrim**: logger and extractor of time-series data.

The tools are operational at RHIC collider and they provide control for devices from various infrastructures (ADO, EPICS and liteServer).

Simple middle-level interface

Interface to an infrastructure-depended level is provided by an Access class of corresponding module. All functions accept multiple Control System parameters (EPICS PV) as arguments.

The Access class provides set of 5 functions, which covers all required functionality:

- **info(*args)**: Returns information on device or PV as a 3-level dictionary.
- **set(*args)**: Set multiple PVs to values.
  get(*args): Get values of multiple PVs.
- **subscribe(callback, *args)**: Sets up a user-supplied callback function to be called on change of the first of requested PVs.
- **unsubscribe()**: Cancel all subscriptions.

The returned objects are two-level maps, the first level is mapped with PV name, the second level - with PV properties (‘value’, ‘timestamp’, etc.).

[1] D.S. Barton et al. RHIC control system, NIM A, Volume 499, Issues 2–3, 1 March 2003, Pages 356-371
[2] https://pypi.org/project/liteserver/
[3] https://accelconf.web.cern.ch/icalepcs2019/doi/JACoW-ICALEPCS2019-TUCPR06.html

Pypet application

- control of EPICS PVs and ADO parameters,
- automatic generation of control pages for devices [2],
- configuration format: **Python modules**,
- macro substitution from command line: single configuration file can be used for many similar devices,
- merged cells, adjustable size of rows and columns, fonts and colors,
- horizontal and vertical **slider widgets**,
- **embedded** displays from other programs,
- plotting of selected cells using pvplot,
- content-driven cell **coloring**,
- pypet pages are managed by **git,**
- **snapshots**: full page can be saved and the selected cells could be restored from the saved snapshots,
- **history** of parameter settings [3].
- **slicing** of vector parameters.

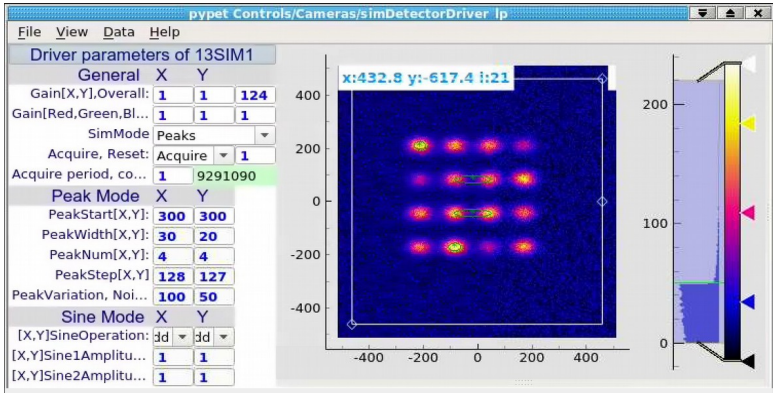

Fig.1 pypet page for EPICS simDetectorDriver with embedded display from imageViewer.

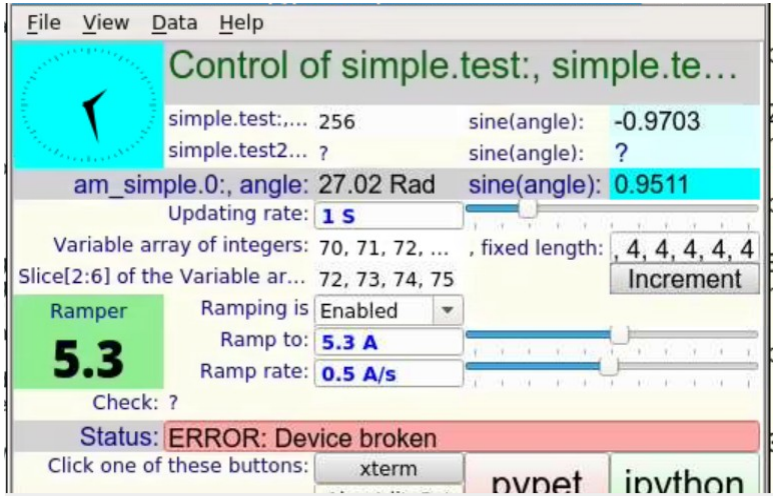

Fig.2 pypet page for a test ADO.

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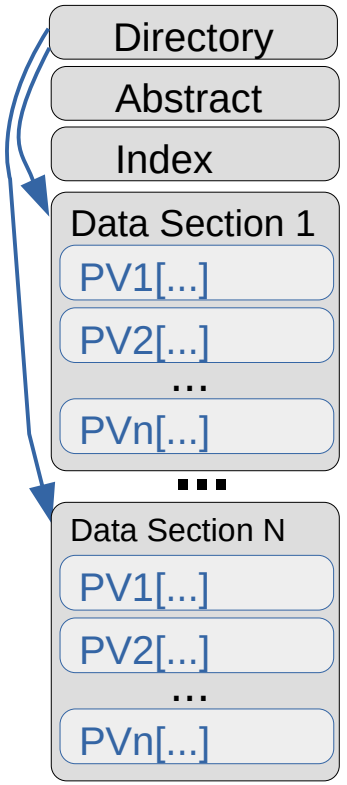
[2] not supported for EPICS, due to lack of introspection in EPICS devices.
[3] not supported for EPICS.

apstrim: Logger and extractor of time-series data

- Data are objects, indexed in time order.
- Wide range of data objects: strings, lists, maps, numpy arrays, custom.
- Data objects could be inhomogeneous and have arbitrary frequency.
- Self-describing data format.
- Data objects are binary-serialized using MessagePack.
- Fast online **compression**.
- Fast **random-access** retrieval of data objects for selected time interval.
- Simultaneous writing and reading.
- Typical speed of compressed serialization to a logbook file is **70 MB/s**.
- De-serialization speed is up to **1200 MB/s** when the logbook is cached in memory.

Implementation:
apstrim code: Python
msgpack: all languages.

File format



Positions of data sections.

Version, compression type, etc.

List of all PV names

List of PV read during time interval #1

List of values and timestamps of PV1

List of values and timestamps of PV2

List of values and timestamps of PVn

Time-based bucketing.
Data are accumulated asynchronously during section intervals into time-stamped sections.
When interval elapses, the section is compressed and dumped to the logbook.

Python installation:
https://pypi.org/project/apstrim

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Summary and Acknowledgments

Simple middle level Python interface to underlying infrastructure-dependent modules (**caproto** for EPICS and **cad_io** for ADO).

Complete toolset to control devices from different infrastructures.

The tools are operational at RHIC collider and they provide control for devices from ADO, EPICS and liteServer infrastuctures.

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