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Abstract

A virtual accelerator is being developed for Sirius, the new 4th generation synchrotron light source being built in Campinas, Brazil. The virtual accelerator is an on-line beam simulator which is integrated into EPICS control system. It consists of a command line interface server with a channel access (CA) layer and with an in-house developed tracking code library written in C++ for efficiency gain. The purpose of such server is to facilitate early development and testing of high level applications for the control system.

Virtual accelerator

On-line beam simulator composed of two parts: a back-end machine application implementing a simulated virtual accelerator with a channel access server layer (VACA) and a set of front-end virtual IOCs (vIOCS) with which other control system applications interact.

VACA - Virtual Accelerator with Channel Access

Implemented functionalities

- ▶ Parameter-dependent current decays
- ▶ Closed-orbit control with dipolar correctors
- ▶ Beam optics variations with quadrupoles
- ▶ Injection and ejection that depend on magnet and timing configurations.

Python programming language

- ▶ Allows for rapid development
- ▶ Binding layer between the CA server and a tracking code for simulations.
- ▶ The python package PCasPy is used as the CA server module.
- ▶ Trackcpp is a C++ library of beam dynamics and tracking routines developed at LNL by the accelerator physics group. Trackcpp is converted to Python package with Swig3.0

```
File Edit View Search Terminal Help
ximenes@lnls208-linux:~$ sirius-vaca.py

      (__) | Virtual Accelerator with Channel Access server
    //   (.oo) | Version 0.15.2
# \ , @q | LNLS Accelerator Physics Group
// \ VACA / | Documentation: https://github.com/lnls-fac/va
 ~~~ \\ ~~~ || ~~~~~ | Prefix: VA-
     ^^      ^^ | Number of SI pvs: 3472
           // | Number of B0 pvs: 836
           | | | Number of LI pvs: 6
           | | | Number of TB pvs: 147
           | | | Number of TS pvs: 125

2016-10-05 09:59:03.908: start LI_V00
2016-10-05 09:59:03.909: init epics sp memory for LI pvs
2016-10-05 09:59:03.910: start B0_V02A
2016-10-05 09:59:03.914: start SI_V17_01
2016-10-05 09:59:03.925: start TB_V01
2016-10-05 09:59:03.930: start TS_V01
2016-10-05 09:59:03.965: start waiting model initialisation
2016-10-05 09:59:03.981: init epics sp memory for TS pvs
2016-10-05 09:59:03.981: init epics sp memory for TB pvs
2016-10-05 09:59:04.027: calc transport efficiency for TB_V01
2016-10-05 09:59:04.327: calc closed orbit for B0_V02A
2016-10-05 09:59:04.367: calc linear optics for B0_V02A
2016-10-05 09:59:04.435: calc equilibrium parameters for B0_V02A
2016-10-05 09:59:04.743: calc beam lifetimes for B0_V02A
2016-10-05 09:59:04.803: calc closed orbit for SI_V17_01
2016-10-05 09:59:04.856: calc ejection efficiency for B0_V02A
2016-10-05 09:59:04.945: calc linear optics for SI_V17_01
2016-10-05 09:59:05.105: calc equilibrium parameters for SI_V17_01
2016-10-05 09:59:05.756: calc beam lifetimes for SI_V17_01
2016-10-05 09:59:05.910: init epics sp memory for BO pvs
2016-10-05 09:59:09.269: calc injection efficiency for B0_V02A
2016-10-05 09:59:09.271: calc ejection efficiency for B0_V02A
2016-10-05 09:59:09.431: calc transport efficiency for TS_V01
2016-10-05 09:59:09.638: init epics sp memory for SI pvs
2016-10-05 09:59:22.194: calc on axis injection efficiency for SI_V17_01
2016-10-05 09:59:22.928: start starting server
```

Figure 1 : Screen printout of a command line terminal showing a running instance of VACA.

Virtual IOCs

- ▶ **si bpm, bo bpm, ts bpm, tb bpm**: they serve BPM positions that are read from VACA, adding emulated measurement fluctuations.
- ▶ **si current, bo current**: they provide simulated beam currents with fluctuations.
- ▶ **si ps, bo ps, ts ps, tb ps**: provide read/write access to PVs that correspond to power supplies with associated magnet excitation curves.
- ▶ **si rf, bo rf**: implement radio frequency process variables.
- ▶ **si tune**: emulation of the tune measurement IOC.
- ▶ **si beamsize, bo beamsize**: emulation of beam size measurement IOC.
- ▶ **si lifetime**: emulation of lifetime calculation IOC.

Conclusions

- ▶ Facilitates the development of high level applications
- ▶ Enables commissioning training
- ▶ Can be use to serve model data during Sirius operations

Future improvements

- ▶ Details of the pulsed signals during injection and ejection processes need be considered.
- ▶ Approximate coupling expressions for beam size estimates should be substituted by Ohmi's envelop formalism in trackcpp.
- ▶ Considerations on moving from EPICS database to PCASPy for vLOCS developments.
- ▶ A major revision of PV names has taken place recently and VA should be updated to contemplate the new PV naming standard.