Software and Hardware Design for Controls Infrastructure at Sirius Light Source

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Introduction

Sirius, the 4th generation Brazilian Light Source

- Knowledge acquired with current UVX facility
- Under construction since 2014
- Engineering assemblies and installation started in 2018

Figure 1: Sirius (July 2019).

Sirius Controls System

- Scalable, distributed and easy to maintain
- Based on **EPICS framework**
- Integration of a large variety of equipment (commercial and in-house developed ones)
- Hardware and software developments

Infrastructure and Hardware Designs

Figure 2: Controls System central cabinet (core switch, server, connections and ODFs).

Servers

- Dual Intel Xeon E5-2695
- 8x 64GB DDR4
- 16x 8TB HDD for data storage

Switches

- 48 ports SFP+ core switches
- Lower level switches with PoE+, redundant power supply and management module

Infrastructure

- Star + Ring interconnection
- Shared with other subsystems

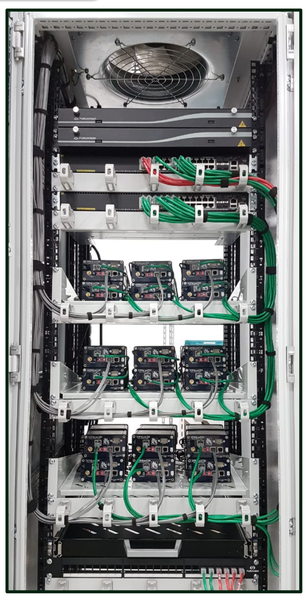


Figure 3: Controls System distributed cabinet, with Beaglebone Black as a node.

Controls System Nodes

Based on Beaglebone Black, an open-hardware single board computer

SERIALxxCON

- Main node, a multi-serial platform
- Up to 15 Mbps for RS-485 (PRUs)
- Serial integrated with Timing System
- Baseboard for multiple subsystems (vacuum, temperature, radiation probes, RF, etc.)

Figure 4: SERIALxxCON, a multi-serial hardware platform.

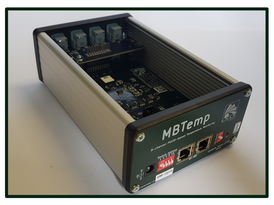


Figure 5: MBTemp hardware, for temperature monitoring.

Temperature monitoring interface

- 8x 4-wire Pt100 temperature sensors (0 to 425 °C)
- Exponential moving average digital filter
- RS-485 communication

Multi-purpose counting system

- Interface to Bergoz BLM and in-house gamma detectors
- 8 channels, counting up to 14.29 MHz
- PoE powered
- Based on Programmable Real-Time Units (PRUs)

Figure 6: Multi-purpose counting hardware.

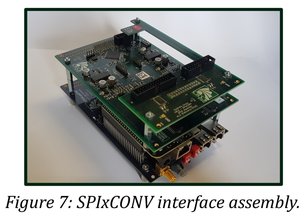
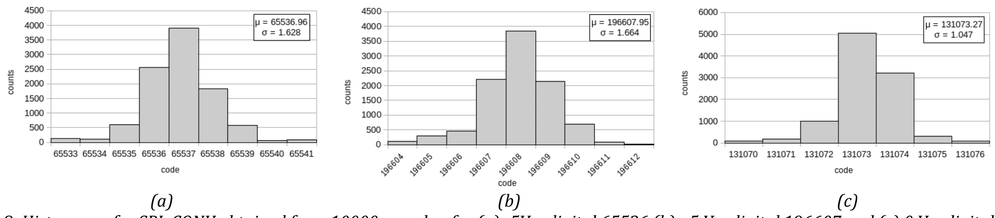


Figure 7: SPIxCONV interface assembly.

SPIxCONV

- SERIALxxCON extension interface board with 18-bit analog input/output (±10 V) and 32 GPIOs
- Interface to Pulsed Magnets subsystem
- Critical board layout



(a) (b) (c)

Figure 8: Histograms for SPIxCONV obtained from 10000 samples for (a) -5V – digital 65536 (b) +5 V – digital 196607 and (c) 0 V – digital 131072.

Software Applications

Controls Servers: Running on CentOs

EPICS Archiver Appliance

- Deployment Docker Swarm
- ~ 34000 PVs – 40 GB/day
- Database: MySQL → MariaDB
- Web Viewer: SLAC inspired JavaScript (chart.js)
- LDAP authentication
- Constant upgrades
- Open source and highly stable
- Community-supported

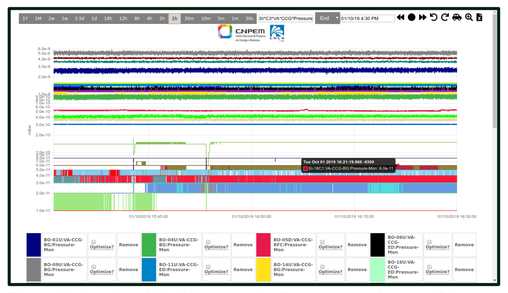


Figure 9: Archiver Web Viewer, with Booster and Storage Ring cold cathode vacuum gauge data series. Version is inspired on SLAC tool with improvements and constant upgrades.

Alarm System: BEAST (Control System Studio – CS-Studio) and Zabbix tool

Container Orchestration

- Docker Swarm
- Deployments: Archiver, Olog, EPICS IOCs, monitoring tools, etc.
- Docker Hub for base images http://hub.docker.com/u/lnlscon

EPICS IOCs

- Mostly run in controls servers
- StreamDevice based

RF Subsystem

- Interlock PLCs: EtherIP module

Controls System Screens

- CS-Studio and PyDM based
- Constant upgrades

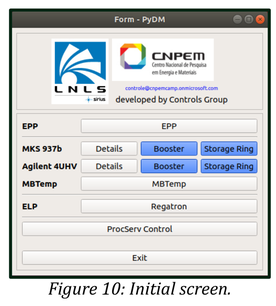


Figure 10: Initial screen.

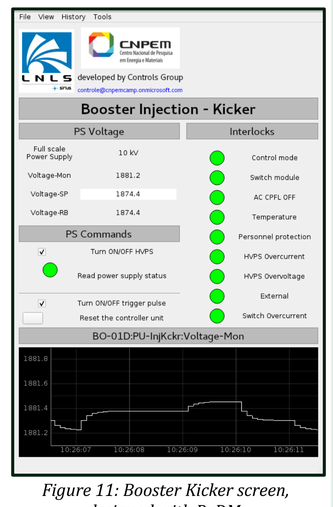


Figure 11: Booster Kicker screen, designed with PyDM.

Beaglebone Black Managing

- Modularity, start-up, remote monitoring and configuring
- *BBB-Function*
  device discovery and needed applications launched
- *BBB-Daemon*
  remote monitoring (Redis database) and commands (reboot, IP and hostname changing)

Zabbix Monitoring Tool

- Open-source tool for monitoring network, infrastructure and devices

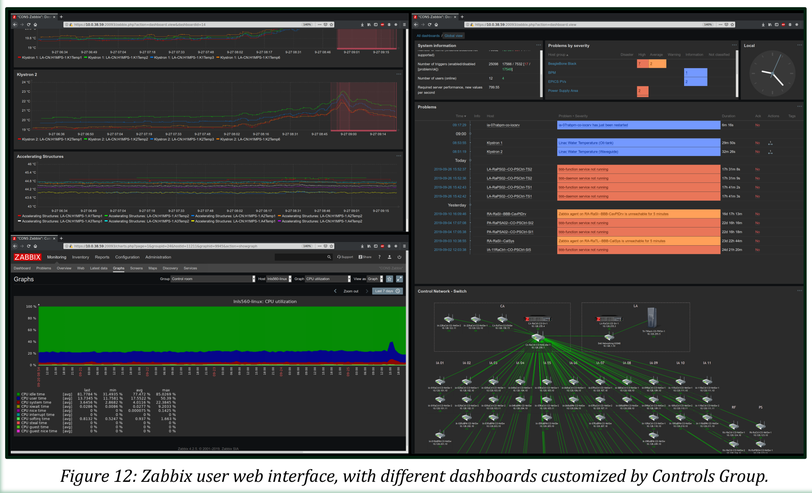


Figure 12: Zabbix user web interface, with different dashboards customized by Controls Group.

- Web interface
- Equipment and device registration
- Customized templates and dashboards (CPU usage, storage left, services running, etc)
- Notification services
- Integration with EPICS

Conclusion

New improvements and implementations are in progress simultaneously to installation activities. The features currently available at Controls System allow a reliable operation, commissioning and optimization for all machine subsystems, which are usually performed from Controls Room. Having such a system is an important step and essential to Sirius commissioning progress.

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