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CONTROL SYSTEM USING EPICS TOOLS AT TARLA LINAC

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Abstract

The first accelerator based research facility of Turkey-TARLA is under commissioning at Institute of Accelerator Technologies of Ankara University. It is designed to generate free electron laser and Bremsstrahlung radiation using up to 40 MeV continuous wave (CW) electron beam. The control system of TARLA is based on EPICS and are being tested offline. TARLA also has industrial control systems such as PLC based cryoplant and water cooling system. Its control system is under development, it benefits from the latest version of EPICS framework, i.e. V7. In other words, TARLA control system uses existing demonstrated tools of EPICSV3 as well as pvAccess which comes with EPICSv4 for transferring the large data through control network. Archive (CSS BEAUTY) and alarm (CSS BEAST) system have been set up to detect stability and prevent failures. Operator interfaces have been designed using CSS BOY. Currently, CCDs, PSS (Personel Safety System), MPS (Machine Protection System), Superconductive Cavities, RF Amplifiers, microTCA based LLRF system are being integrated into distributed control system. In this proceeding we summarize the current status and future plans of TARLA control system.

TARLA CONTROL SYSTEM

Control system is one of the main issues. TARLA approach so far was to have sub-systems as independent as possible (including all business logic) with local control system while exposing status read-backs and configuration parameters via TCP/IP interface (slow control only).

TARLA LINAC control will be performed by an EPICS based system operating under the Centos7 operating system on industrial rack mount. EPICS was selected as the main medium due to its commitment to new era accelerators as well as distributed structure of architecture and high performance characteristics. The latest addition to EPICS base, EPICS V4 [1] (EPICS 7 was released in August 2017), was also included in the design goals.

The development environment already used:

- CentOS 7
- EPICS base 3.15
- EPICS V4 4.6
- CSS 4.5.6 (basic)
- MySQL
- Git

Hardware platform for slow control is not finalized. United Electronics hardware platform is being used as IOC for analogue and digital interfaces:

- DNR-6-1G: Compact (3U), 6-slot, rugged, Gigabit Ethernet Data Acquisition and control rack
- UEIPAC 600R: Real-Time, GigE, programmable automation controller (PAC) with 6 I/O slots
- UEPAC 300-1G: Real-Time, GigE, programmable automation controller (PAC) with 6 I/O slots

"In-house" developed TCP/IP based general purposed I/O cards or other custom developed hardware will also be used, while product from other manufactures are also possible.

Standard IOC for devices with TCP/IP interfaces is MOXA DA-682A, x886 2U rackmount computer with 6 gigabit Ethernet ports and 2 PCI expansion slots.

When designing the TARLA Control System, priority and purpose is to create an easy to use/maintain, soft IOC-style, fast, stable and extendable control system suitable for the control and monitoring requirements of all auxiliary systems as well as for laser creation and beam diagnostics.

Architectural Design

Control systems for experimental physics facilities are usually structured in three tiers (see Fig. 1):

User Interfaces. These can be either graphical or non-graphical (command line based) and are usually located in the control room. However, there could be some user interfaces used elsewhere during commissioning and maintenance.

Central Systems and Services. Systems like Timing, Machine and Person safety and computer services that need to run continuously irrespective of user activities, e.g., for archiving acquired data, monitoring alarm states, user authentication services etc.

Equipment Interfaces. This tier is responsible for interaction with equipment and devices. It provides an abstract representation of equipment to higher layers through which the equipment can be monitored and controlled.

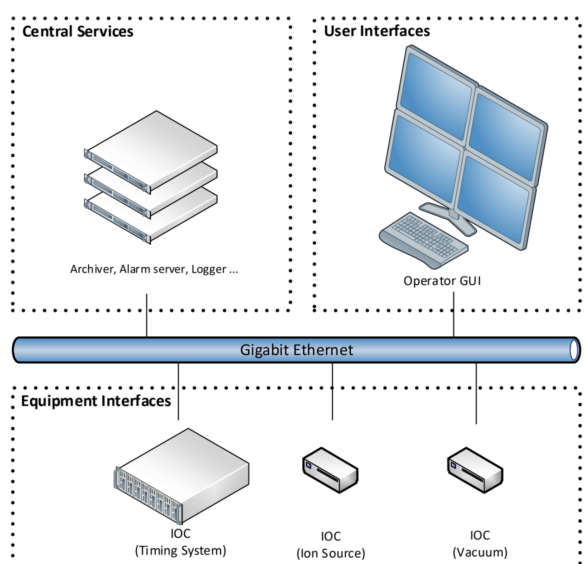

Figure 1: Three tier structure in TARLA control system.

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A vertical column (see Fig. 2) is an abstraction which describes how a concrete device is integrated into the control system. It covers everything from the device sensors to the GUI on the operator machine.

It can be viewed from the two perspectives, presented on EPICS example in Figure 2:

- Looking at hardware it follows signal from the sensors/actuators through device controller to the computer running IOC (EPICS server) and finally to the operator's workstation (EPICS client).
- Software vertical column defines operating system(s), device drivers, required EPICS modules, device specific GUIs etc.

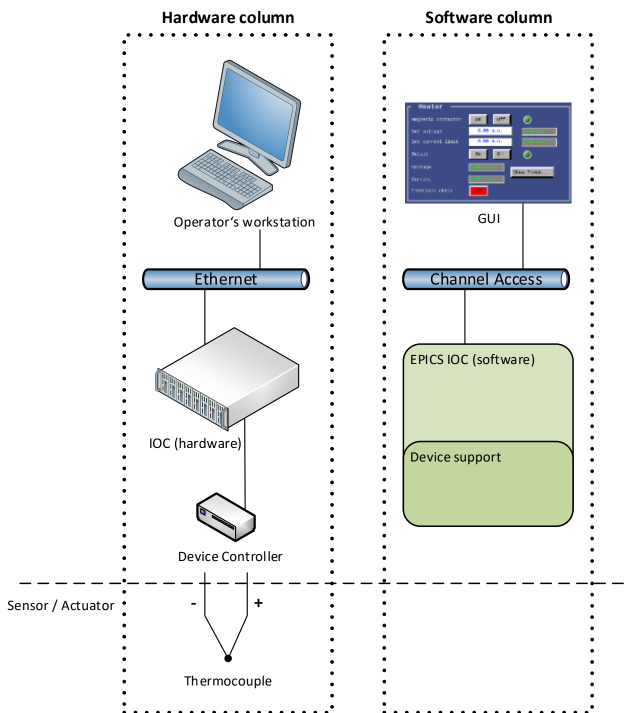

Figure 2: Hardware and software vertical column in EPICS.

Alarm Handler

Alarms are special kind of messages that indicate conditions that need operator awareness and additional actions, supervised by operator. Alarms may range in criticality level.

Alarms are hierarchal structured into levels. Number of levels should be limited and criticality of each level documented, considering the potential effect of the underlying cause of the alarm on operational runtime, equipment damage and safety of personnel.

An alarm server should be responsible for collecting all alarms, storing them in a dedicated database and dispatching them to the operator display.

Most promising alarm server and viewer in EPICS community is BEAST, which is important part of the Control System Studio [2], which is also used in TARLA Control System (see Fig.3).

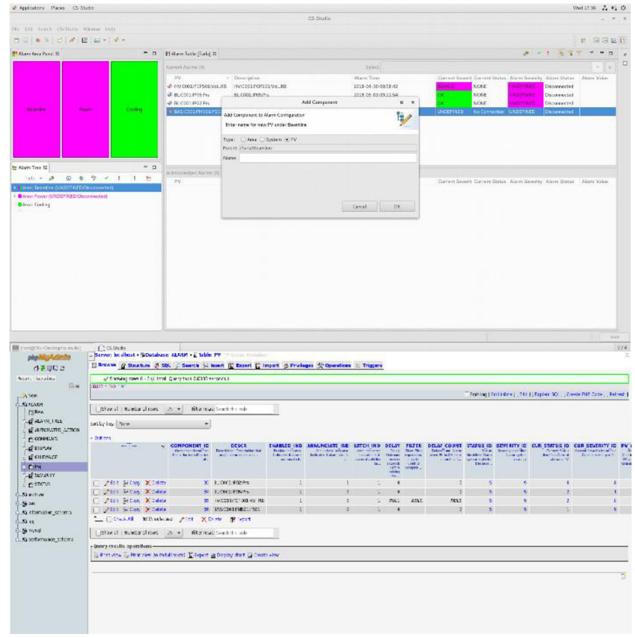

Figure 3: Alarm handler of TARLA control system.

Archive Engine

Providing historical data about the linac operations is up to archiving service. This data is used to evaluate TARLA linac performance, diagnose issues and failures and establish correlations between measurements and several settings for tests. It is important to design of archiving application and the accessibility of the archived data, they will heavily affect machine diagnostic efficiently.

Archiver service for TARLA is EPICS Archiver Appliance (see Fig. 4), which is among others used by ESS and SLAC. It stores data in the binary files on a hard drive, SSD or RAM.

The archiver appliance is written in Java and can run on most common Linux distributions.

One of the main advantages of the Archiver appliance is the built-in support for data storage on short term storage, medium term storage and long term storage.

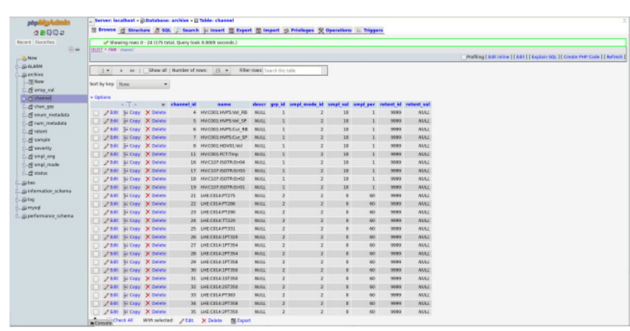

Figure 4: Archive engine of TARLA control system.

Viewer for the archived data is "Data Browser" perspective in the Control System Studio (see Fig. 5). Data can be retrieved from the Archiver Appliance to the Control System Studio with out of the box support.

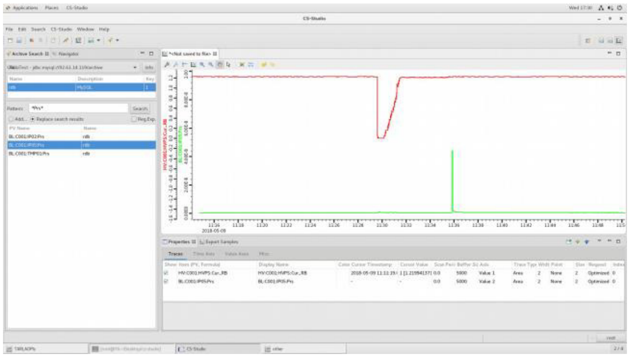

Figure 5: CSS data browser, viewer of archived data.

IocLogServer

Logging provides engineers and developers with insight into the current behaviour of TARLA CS components. It is an important tool for diagnostics when TARLA control system's functionality does not fit with set necessities and allow developers and engineers to resolve problems.

The logging service should collect time-stamped log entries from the control system and store them in a central location, where efficient queries can be performed.

EPICS already provide services for logging such as "iocLogServer" and "iocLogClient" components. Apart from EPICS logs other log files generated by computer nodes (e.g. Linux log files) can also be centrally managed with off the shelf services such a "syslog". Logs provided by the "iocLogServer" are text based.

JAVA-based software for saving IOC's error records to the RDB directory. The modified version of EPICS iocLogServer can read in configuration file in start-up time. This configuration file specifies how the server must process messages from particular IOC (files where messages must be saved, log file limits etc.). Flexible format of configuration file allows to define different methods of message processing. Now three methods are implemented: basic, non-stop and monthly. Each IOC can have its own configuration[3].

OLOG Logbook

Olog is implemented as a REST style web service. Its intended use is as an electronic logbook for accelerator operations [4].

It is a JAVA-based application that enables practical observation of important observations, notes, break-downs.

Control System Studio has an interface for viewing OLOG logs, which can be accessible from path Window > Open Perspective > Other < Log Viewer Perspective (see Fig 6.).

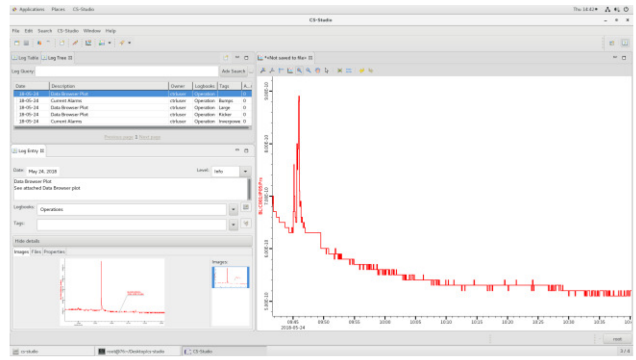

Figure 6: OLOG CSS interface.

CONCLUSION

Control system for TARLA e-gun is capable of producing and controlling the electron beam in DC/CW or macro-pulsed mode at the moment[5].

Device integrations to the EPICS-based control system and infrastructure improvements of the control system continue parallel to the installation of the line. The integration of the injector line control and diagnostic devices of the linac will be completed in the first quarter of 2019.

The purpose of the TARLA team as well as control system group is to build a state-of-art system, fully featured and debugged by the first laser beam generation.

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