A HYBRID APPROACH TO UPGRADE HARDWARE FOR THE PROTON STORAGE RING FAST KICKER

T.Ramakrishnan, J.Duran, H.Watkins - Los Alamos National Laboratory, Los Alamos, NM 87545, USA

Abstract

The Los Alamos Neutron Science Center (LANSCE) Pro-ton Storage Ring (PSR) needs precise timing to ensure successful extraction of the bunched protons. The current control system's hardware is obsolete and unmaintainable. The task was to replace the 1980's era CAMAC control and timing system for the PSR extraction kickers. This included a system which halts charging of the kickers after a duration without firing to prevent equipment damage. A hybrid approach was taken to integrate a Berkeley Nucleonics Corporation (BNC) pulse generator that was controlled by a soft input/output controller (IOC) and National Instrument (NI) compact Reconfigurable Input/Output (cRIO) IOC. This allowed for flexibility and modularity of the software and hardware development. This approach built the framework to streamline robust deployment of hybrid systems and develop a solution for upgrades of other LANSCE kickers.

Proton Storage Ring

The LANSCE proton storage ring (PSR), Fig. 1, is used to collect and bunch protons. The alignment and frequency of the protons are changed continuously to keep them inside the ring for multiple cycles which are then ejected to the Lujan Mark IV target to produce neutrons which are used in several experiments.

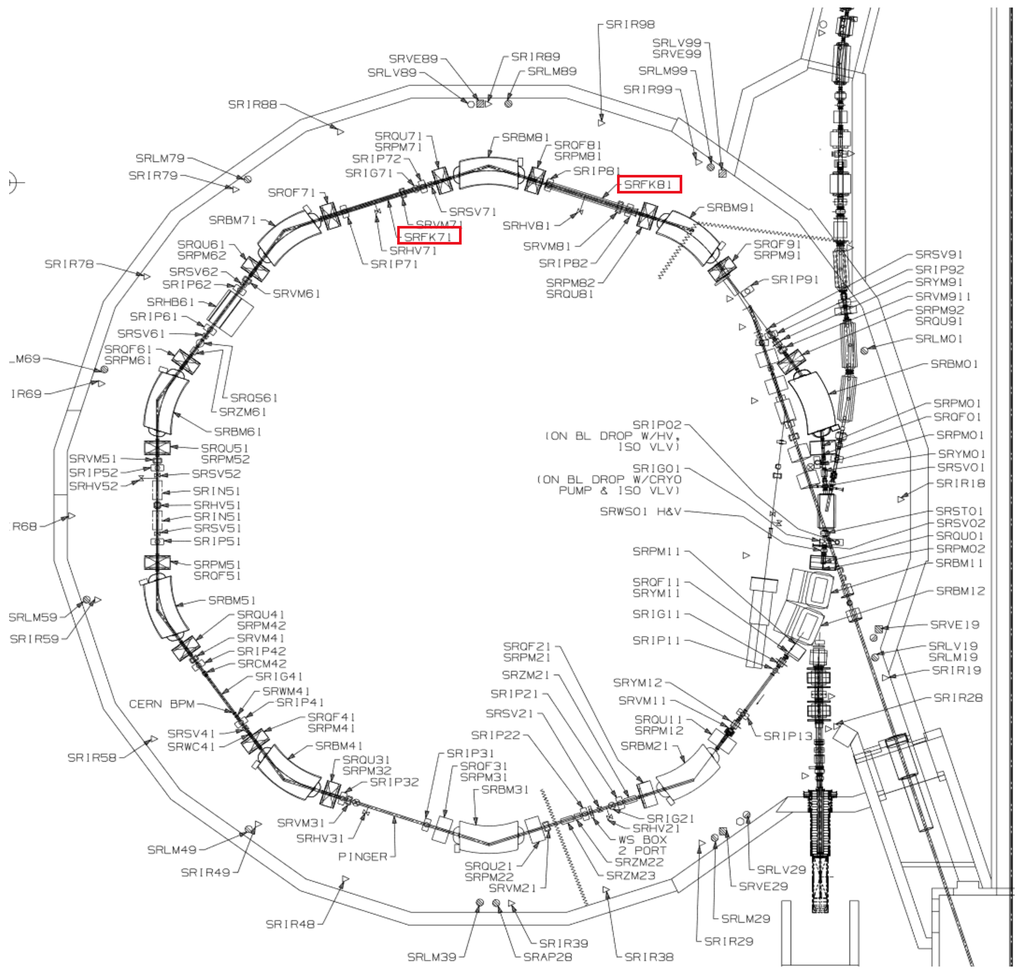

Figure 1: Proton Storage Ring with SRFK71 and SRFK81 locations

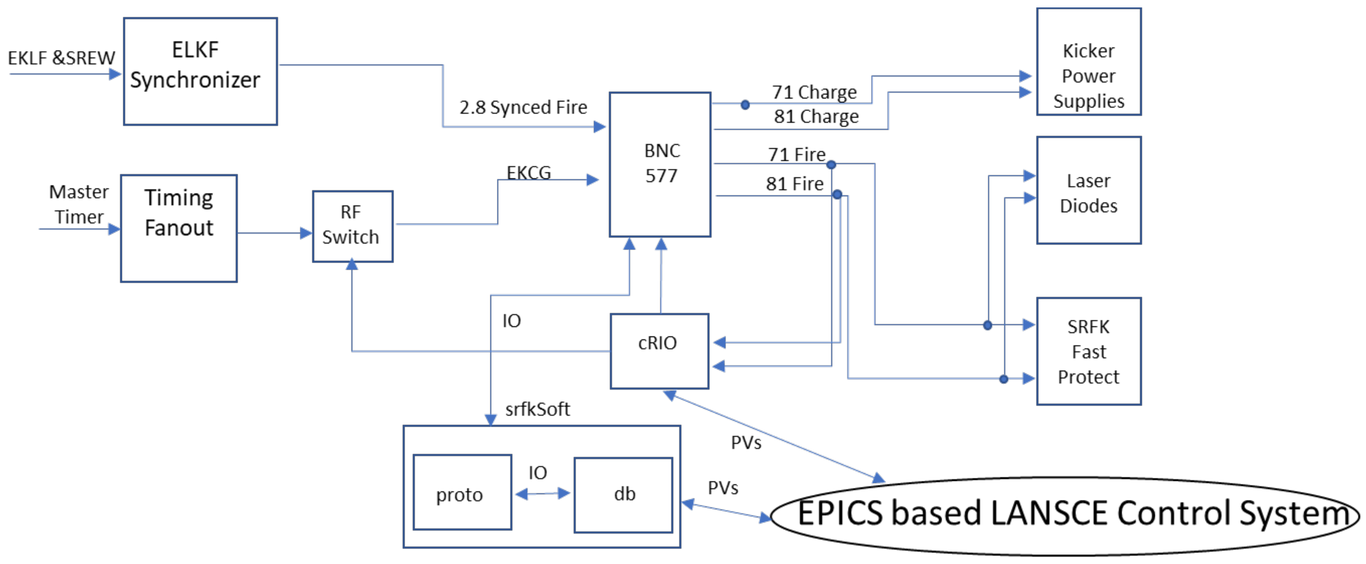

Figure 2: Software and Hardware Architecture for SRFK upgrade

Fast Kicker Purpose & Controls Upgrade

The storage fast kicker (SRFK) system consists of a DC power supply, a Blumelein that acts as a capacitor, and two plates (SRFK71 and SRFK81), Figure 2, as well as a control system that directs and monitors certain functionality. The fast kicker system is responsible for extracting the bunched protons from the PSR and sending them down the beam line towards the neutron producing target.

The control system that was upgraded used an obsolete, 1980's, CAMAC form factor. It is worth mentioning that it had no safety mechanisms in place for over charging the fast kicker Blumlein which is holding the charge that is being provided in a pulsed fashion by a DC power supply. The newly deployed and functionality advanced control system utilizes a hybrid approach by using two commercial of the shelf systems (a) BNC 577 pulse generator, Fig.3, for generating delayed pulses and (b) NI cRIO, Fig.4, for reading back the status of an RF switch and keeps track of charging pulses to the Blumlein. The hybrid approach also extends to the controls software implementing (a) soft IOC to control the BNC 577 and (b) NI cRIO based IOC that has a field programable gate architecture (FPGA)backplane interacting with the modules for high-speed data acquisition.

HYBRID APPROACH

The hybrid approach that was undertaken for this project focused on establishing versatility for system design by having two simple approaches to hardware and soft-ware architectures that were both integrated in the larger LCS framework. The ability to create PVs using soft IOCs on virtual machines for the BNC 577 pulse generator and physical IOCs using NI cRIO's FPGA backplane. This effort flows well with our long term LANSCE modernization project that is focused on reducing the number of disparate control systems to a more unified approach. We used this homogenous approach principle to incorporate a soft IOC to handle the stream device input/output control PVs and use an existing deployed cRIO to handle the readbacks, counters, and set time delays for the pulses.

A hybrid approach by incorporating stream device protocol for BNC pulse generator accompanied by a soft IOC and an industrial input output (IIO) using cRIO with a self-contained IOC helped us easily upgrade the legacy CAMAC system that was used to control the SRFKs for over a decade. The flexibility this approach offers without introducing additional complexity to providing solutions will be useful moving forward with upgrading control systems at LANSCE and at other accelerator facilities that rely on the EPICS architecture.

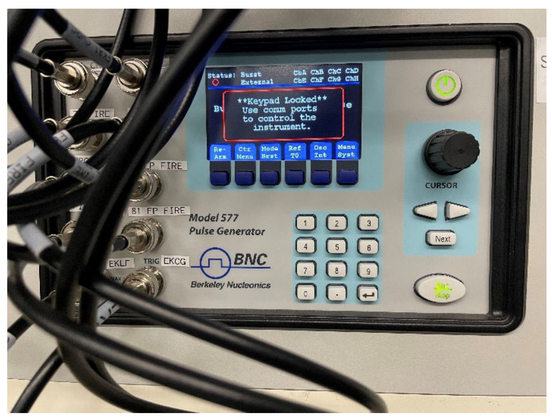

Figure 3: BNC Pulse Generator

Figure 4: 8 card NI cRIO

IBIC2023
12th INTERNATIONAL BEAM INSTRUMENTATION CONFERENCE
SASKATOON, CANADA
September 10-14, 2023
Canadian Light Source
Centre canadien de rayonnement synchrotron

LA-UR-23-30143