UPGRADE OF TRIUMF'S 2C STF CONTROL SYSTEM

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Abstract

One of TRIUMF's isotope production facilities, the 2C Solid Target Facility (STF), is being upgraded. This installation is located on a primary beamline of TRIUMF's 500 MeV Cyclotron. As a part of this upgrade project, the STF Control System is also being revised. Changes to the STF are meant to enhance reliability and maintainability. The existing STF controls have run very reliably and have provided the required functionality but were implemented in part using different technology to that used for the majority of the cyclotron's Central Control System. The new hardware and software controls should provide a simpler, more easily maintained configuration. Additional goals are to modify the user interface to more closely resemble the interface used for running the 500 MeV Cyclotron, to enhance the event annunciation, and to increase the number of parameters logged.

INTRODUCTION

Five facilities were originally built on TRIUMF's Beamline 2C. Radioisotopes have been produced at the Solid Target Facility on Beamline 2C since 1989 [1]. The cyclotron can extract protons for 2C in the range of 70 to 115 MeV and in currents from nanoamps to the licensed maximum of 80 microamps.

With the proposal to upgrade many aspects of the STF, it seemed appropriate to also upgrade the controls. The upgrade follows the facility's evolutionary approach for changes.

This would not be the first change for these controls. Starting in 1990 the operator interface aspects of the controls for Beamline 2C and its isotope facility were ported from in-house programmed software running on a PDP 11 to Vista Control Systems Inc.'s Vsystem running on a VAX. This configuration subsequently evolved from that 32 bit architecture to run Vsystem on 64 bit Alpha computers. Vsystem is a commercial, full-function, data acquisition and control toolkit. This software has run very well and adapted to changes since the 1990s. New versions of Vsystem have periodically been installed and changes to the configuration were made as new functionality was requested.

With the decision to upgrade the controls, a review of the continued use of Vsystem was made. The 500 MeV Cyclotron controls and other primary beamline controls are implemented with in-house software and thus the STF controls have been a separate system from the cyclotron's Central Control System.

Two topics dominated the decision on what software to use. The first was the familiarity of support staff with the software to be maintained. The STF/Vsystem software is just a small fraction of the overall cyclotron software and the STF facility and its software change much less frequently than other aspects of the cyclotron and its software. As a result, the staff that maintain the existing STF Controls find they are less familiar with the Vsystem controls than the Central Control System. This lack of familiarity has lead to some reluctance to make changes and upgrades. The second topic involves human factors. The STF is primarily monitored and controlled from the 500 MeV Cyclotron Control Room, and the look-and-feel of the Vsystem display pages is somewhat different than the cyclotron display pages. With the increased awareness of human factors, it is felt that having the same look-and-feel for these two systems would be an improvement. These considerations lead to the decision to use the existing Central Control System software for the operator interface.

The STF Control System Upgrade will also allow some of the older and less supportable hardware to be phased out and the use of more common, site standard components. One significant area where this can be seen is in the machine protection topics where a commercial Programmable Logic Controller (PLC) will replace TRIUMF-built microprocessor modules. The duties of the machine protection system are basically the same as they were previously.

CONFIGURATION

The configuration of the upgraded STF controls can be divided into 2 broad areas, the Machine Protection System (MPS) and the Operator Interface System (OIS). A logical layout of the basic control system components in the new system is shown in Figure 1. As can be seen on this diagram, there are several other components than those of the MPS and OIS, including the sensor inputs, the control points, the communication link, and the signal to the Central Safety System.

The Machine Protection System is basically a Programmable Logic Controller that is connected to the sensors that provide input on temperatures, water flows, water heights, conductivity, interlock defeats, and other parameters. All of the input signals and controls points are connected to the MPS. This allows the MPS to run independently. The Machine Protection System monitors these parameters and provides a single output signal to the Cyclotron's Central Safety System (CSS) to indicate "STF ready for beam" or not. The CSS will disable beam delivery to the 2C STF if it is not ready to receive beam. The MPS will also accept operator commands requesting that specific control actions be executed. Actions such as raising and lowering the target holder are required.

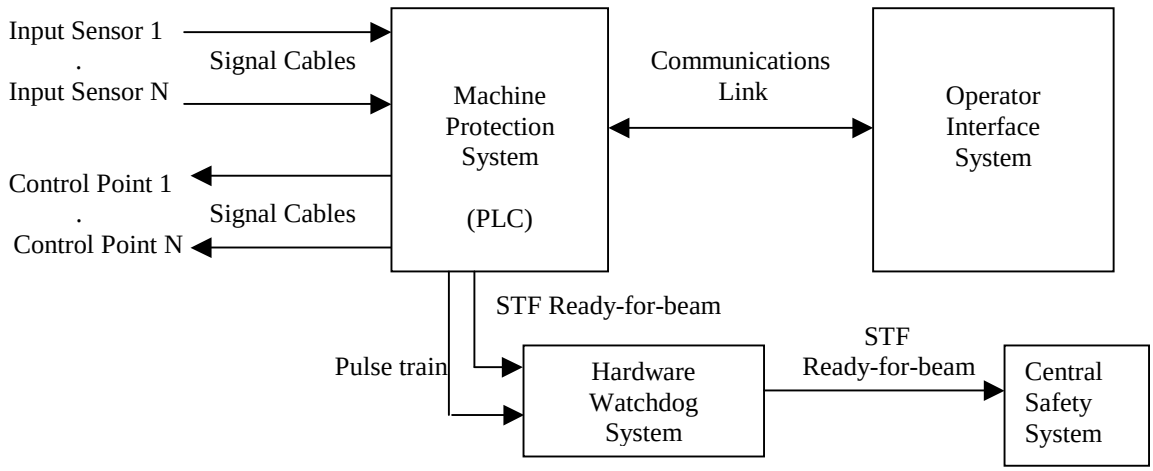

Figure 1: Logical Layout of Control System Components

The Operator Interface System comprises a set of computer-based facilities that allows users to monitor and control the 2C Solid Target Facility. The OIS runs on clustered Alpha and Itanium computers running OpenVMS. The display pages use the X window protocol. There is an ethernet link between the OIS and the MPS, which allows the OIS to get updated parameter values and to request control actions. It is the OIS that formats the data and produces the displays, logs the historic data to disk, provides playback of trends, and sends messages to the operations staff annunciating changes in the STF.

MACHINE PROTECTION SYSTEM

Because the 2C Solid Target Facility has been operating for many years, the basic machine protection requirements have been well established. In addition to these requirements, there are new constraints that also need to be considered. The primary new constraint is that most, recent, machine protection systems at TRIUMF use commercial PLCs and this project should use the common implementation.

Interlocks

The basic layout of 2C Solid Target Facility can be seen in figure 2. There are more than 50 signals to be monitored and a number of devices to be controlled. When a condition arises that makes the facility not ready for beam then the “STF ready for beam” signal that goes to the Central Safety System is disabled. This signal goes first to a hardware watchdog system that also handles failures of the PLC itself.

Interlock Defeats

For the STF to be ready for beam, each of a number of conditions must be met (for example, the 2CS water flow must be greater than 20 liters / minute). Each of these conditions is considered to be an interlock. For various reasons, such as when a sensor fails, operations staff may decide that it is safe to run although one or more of the conditions that are normally required to exist, do not appear to exist because of the failed sensor. To continue to operate in these conditions it is necessary to defeat one or more interlocks.

The system for temporarily defeating interlocks will be a configuration that requires an operator to manually insert a hardware pin into a labeled socket. Both this hardware and the procedure are similar to those in use by the Operations Group on the 500 MeV Cyclotron’s Central Safety System.

Temporary defeats will not be supported from screen driven operator requests. It is necessary to be able to change the logic of the MPS but this will not be the procedure for temporarily defeating an interlock. Changing the logic will need to be done by a staff member that is familiar with reconfiguring the PLC software.

All defeats will be read back continuously and their status will be displayed via the operator interface on the display pages. Changes to defeats will also be automatically annunciated in the Operator Message Log (this is a computer generated list of messages that provides a record of system events).

Timing

The machine protection system is required to turn off the beam within 2.2 seconds. The Central Safety System will disable beam delivery within 200 milliseconds of notification so the PLC has 2.0 seconds to detect and react to a “trip” condition. The Machine Protection System will react much faster than this.

Hardware Watchdog System

There is a hardware watchdog system, which is external to the PLC. The watchdog receives two inputs from the PLC, a pulse train and the “STF ready for beam”. The watchdog outputs 1 signal to the Central Safety System, the “STF ready for beam”. This watchdog system needs the pulse train to be present in order to gate the “STF ready for beam” signal. If the PLC stops running, then the pulse train stops and the “STF ready for beam” is disabled.

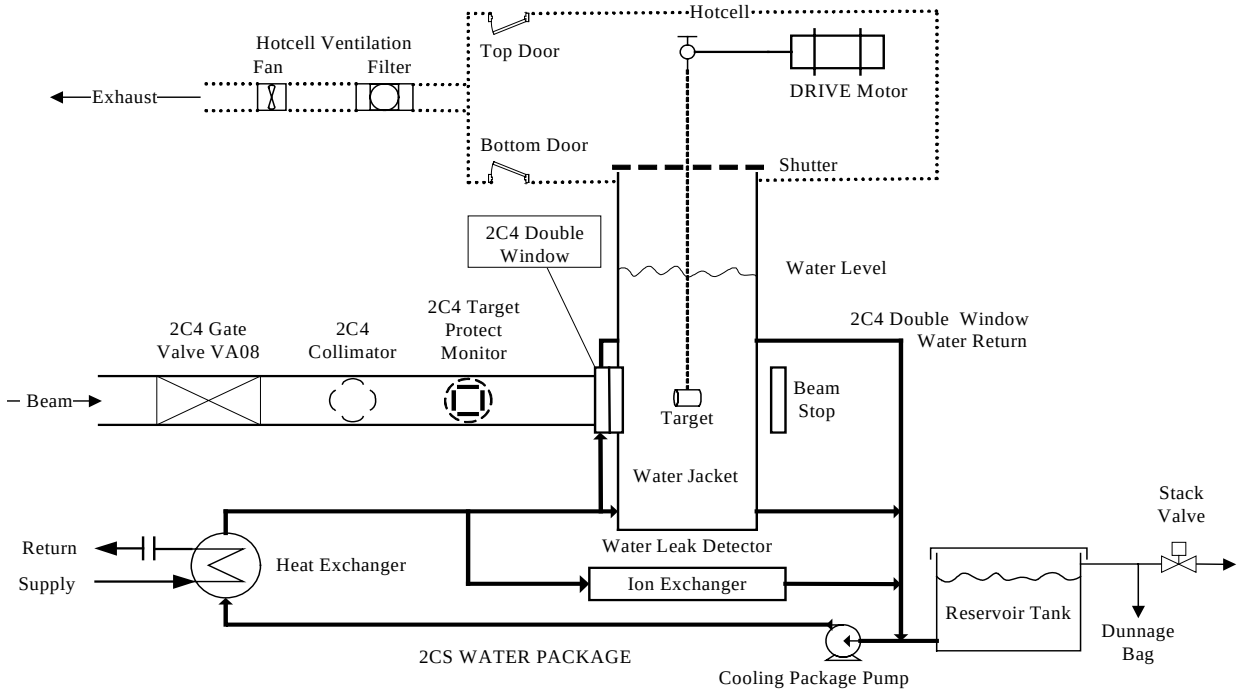

Figure 2: Layout of STF Equipment

OPERATOR INTERFACE SYSTEM

The Operator Interface System that will be employed for the upgraded STF will be the same system that is used for 500 MeV Cyclotron operation [2]. The present system has been operating and evolving for approximately 10 years in its present form and is known to meet the general operational requirements.

Reducing the number of different user interfaces that the Operations Group use is an important goal. This decision to integrate the STF controls interface into the existing cyclotron controls interface is a step in that direction.

The event annunciation will be fully integrated with the existing Operator Message Log.

Data logging of STF parameters will be increased so that all parameters are logged and the logging fully integrated into the existing cyclotron data logging and playback system.

SCHEDULE

The 2C STF upgrade project was originally scheduled to be installed in the Spring 2006 Shutdown, which was an approximately 3 month maintenance period. Due to delays and other priorities the decision was made to postpone installation until the next major shutdown, which is in Spring 2007. Much of the work on the controls upgrade is complete at the present time and completion of all aspects of the controls upgrade by the end of the Spring 2007 Shutdown is planned.

SUMMARY

As a result of the TRIUMF 2C Solid Target Facility Upgrade Project, a new 2C STF Control System has been designed and is presently being implemented. This new control system will fulfill all of the existing requirements and meet the new constraints of having a site standard PLC for machine protection and a common look-and-feel with the existing cyclotron displays. The project is scheduled to be installed and operational by the end of the Spring 2007 Shutdown.

REFERENCES

[1] Roberto Pavan, “Beamline 2C4 Solid Target Facility Safety Report,” Internal TRIUMF Document, Vancouver, November 2005, p.1.

[2] M.M. Mouat, B. Davison, S.G. Kadantsev, E. Klassen, K.S. Lee, J.E. Richards, T.M. Tateyama, P.W. Wilmshurst, P.J. Yogendran, “Status Report on the TRIUMF Central Control System”, Proceedings of the 6th ICALEPCS, Science Press, Beijing China, November 3-7 1997, p. 43-46.