

# COMMISSIONING TRIUMF'S 2C SOLID TARGET FACILITY CONTROLS

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## *Abstract*

The upgraded Beam Line 2C Solid Target Facility was recently commissioned at TRIUMF. The original facility had run successfully producing radioisotopes since 1989. To improve reliability and maintainability, and to allow increased incident beam currents, an upgrade project was established. The basic functionality of the facility was retained but changes were made in a number of areas such as aspects of the control system and physical components in the beam line. The process and results of the commissioning, the reasons for upgrading, and lessons learned are discussed.

## INTRODUCTION

TRIUMF's 500 MeV cyclotron can simultaneously extract protons into 4 primary beam lines. One of these, beam line 2C, has 4 different lines (2C1, 2C4, 2C5, and 2C7) which can be selected via a switching magnet. Beam line 2C4 and the Solid Target Facility (STF), which is located on it, have been in use since 1989 for radioisotope production. The STF received a few changes over the years but had been scheduled for a major upgrade, which was recently completed. During this upgrade various aspects of the facility were refurbished including the control system.

At its inception, the STF used CAMAC/PDP11 hardware and control system software that was written in-house but these items were not integrated with the cyclotron's existing Central Control System (CCS).

Later on, a major design and development period occurred at TRIUMF while a proposal was outstanding for construction of a Kaon Factory. During this time, and as a test of new control system design philosophy, the STF control system software was ported to Vista Control Systems Inc's Vsystem [1]. Since that time, Vsystem has run smoothly providing reliable operation.

While considering the control system upgrade it was decided to integrate the hardware and software into the CCS and to make changes to reflect easier maintenance and new site hardware standards. This resulted in migration to the cyclotron's central control system software and replacement of the STF CAMAC hardware by a site standard PLC.

The new era of Quality Assurance (QA: "the activity of providing evidence needed to establish confidence among all concerned, that quality-related activities are being performed effectively") has come to TRIUMF. As a result of this new QA regime, structured commissioning of the STF controls was pursued. This activity was basically split into two areas, the beam on target aspects and the control system aspects. This formalized commissioning

was a larger component of the project than similar activities in earlier CCS projects.

## STF CONTROLS DESIGN

### *Basic Sections*

There are 3 basic parts to the STF controls, the machine protection system, the operator interface, and the scans/messaging system. The previous STF controls also had these components, and with similar functionality, but in the new system each of these components has changed.

### *PLC and Defeats*

The new controls use a commercial PLC to provide machine protection whereas the previous system used dedicated microprocessors. When conditions are correct to ensure that machine protection will not be compromised by delivery of beam to the STF, an "enable" signal is generated by the PLC that indicates that the facility is "ready for beam". A practical extension of this is that a formal system needs to be in place to allow interlocks to be bypassed (defeated) when it is safe to do so. As part of the upgrade, a specially designed panel was built so that signals can be defeated. The PLC oversees these bypasses and when defeats are applied or removed, messages are automatically entered into the Operations log and X Window displays reflect the state of the defeats.

Communications between the PLC and the CCS were implemented using Ethernet.

Most operator actions regarding the STF equipment, such as raising and lowering the target, are only permitted using dedicated buttons in the hot cell area immediately above the STF. These actions are monitored by the CCS but controlled by the PLC. Full remote control by the CCS can easily be implemented in the future if desired.

### *Operator Interface*

The operator interface runs on servers in the CCS. Initially, one summary display page (as seen in Fig. 1) and 8 display pages of details were developed. The look and feel of the displays follows the existing X Window format used for the rest of the cyclotron and its primary beamlines. This means that normal /warning /trip /defeat /etc colour coding and display information was standardized. The PLC keeps track of the cause of the last trip, even in transient conditions, and last trip data is available on displays and reported in the Operations Log via the CCS.

### *Scans/Messaging*

Within the CCS software there are components that scan signals for changes. Events such as a signal level

going over a warning or trip level are monitored and reported using the Scan Utility and pieces of the messaging infrastructure. The Operations group was

already familiar with these software components and this familiarity eases the task of becoming acquainted with the upgraded facility.

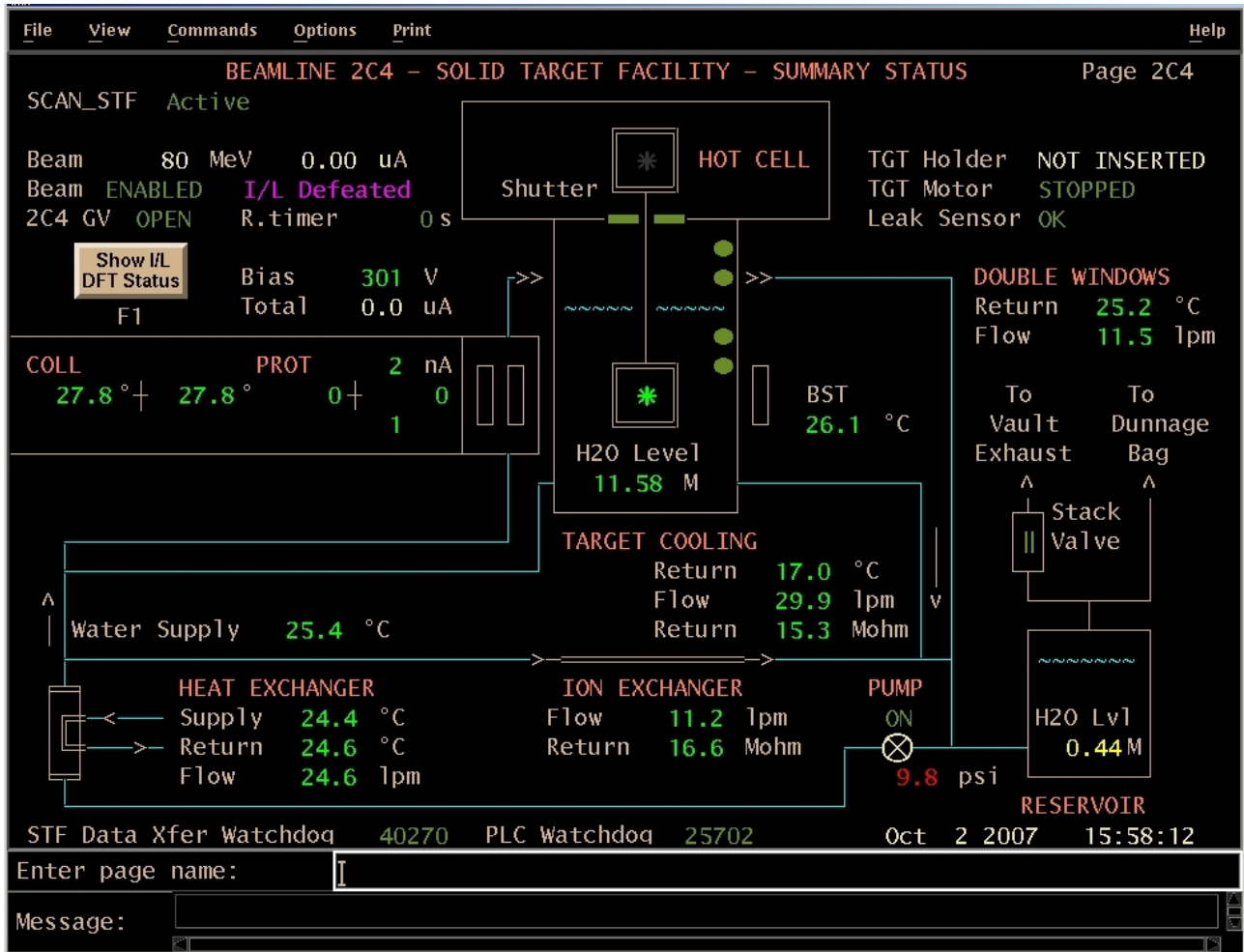


Figure 1: Summary display page for the Solid Target Facility.

## CONTROLS COMMISSIONING

### *Driving Forces*

Projects at TRIUMF, such as the upgrade of the STF, normally have a commissioning phase. New quality assurance procedures have led to more formal commissioning. The driving forces behind the changes to the commissioning procedures come in part from the external body that regulates TRIUMF as well as internal desires to increase reliability, consistency, and maintainability.

### *Scope*

The scope of the controls commissioning of the STF upgrade covered a number of areas. The PLC trip and enable logic was a significant part. As part of the trip and enable logic, the defeats were also tested. All of the

Control System Evolution

operator interface displays and actions were tested. The messages, which are sent to the master and ops logs, were also checked.

### *Constraints*

Perhaps the biggest constraint to commissioning the STF controls was time. With this project as in many others, the facility was scheduled to be ready on a fixed date. In this case when beam production started, the STF was needed for isotope production. In addition, when beam production started, access to many areas would become difficult because of radiation levels. This means that not being ready in time may lead to significant delays because access would become difficult. If delays occur in earlier parts of the project and the deadline is a fixed date then later parts of the project, such as commissioning, will have their parts of the schedule compressed.

### *Techniques*

A primary goal of the commissioning was to test that the various aspects of the controls system met the specifications. To make this goal meaningful, quality specifications were required. In addition, written, consistent test procedures were required. Creation of the test procedures was a large job that required ongoing review and modifications to accommodate test procedures.

Important aspects of the commissioning were that independent verification occurred and that knowledgeable people did the testing. To achieve independent verification, members of the Operations group were present for all of the control system commissioning and they signed the documents.

### *Difficulties*

Two main types of difficulty during commissioning were encountered. The first difficulty was in writing the test procedures. To test a given specification, there may be more than one possible approach. Without doing a time consuming and possibly dose incurring study, the specific tests were written up in a manner that seemed best at the time. Later, when the test was performed, it turned out on more than one occasion that the test could not be completed as documented. In these cases a modified document would have to be prepared and the new test would then have to be executed. The second difficulty was executing the tests. Many of the procedures were straightforward but some of the tests were physically difficult to do. For example, balancing water flows into and out of a containment vessel while trying to activate a water level sensor.

### *Lessons Learned*

The commissioning phase is an important step in most projects and the schedule should be properly established and maintained. This means that project management needs to be vigilant in not letting the commissioning time be compressed.

When specifications are being established it is valuable to be considering how commissioning and later recommissioning will be done. Additional design features may aid the testing. If possible, testing procedures should be tried before the actual commissioning phase.

In the CCS there are a number of logs. These are computer-based facilities that receive messages from the control system. Two of the primary logs are the main log that receives all messages and the operations log, which is filtered. Although the Operations group was involved in many aspects of the system design, the text of the messages and which messages go to which log was not reviewed ahead of time by Operations. As a result, many unwanted messages were initially being sent to the Operations log. A review of this situation improved the content of the Operations log.

## **SUMMARY / RESULTS**

The STF control system upgrade was installed and the machine protection interlocks, the operator interface, and the scans/messaging components were all successfully commissioned by the required date.

A set of commissioning documents [2] was developed and is available for recommissioning if necessary. These documents can be used in the future as a template-in-part for other commissioning work.

In the process of commissioning, members of the Operations group became familiar with aspects of the upgraded STF and its controls due to their involvement with verification.

The upgraded STF control system is now tightly integrated into the CCS and uses the normal look and feel.

Interlock hardware was upgraded to use a standard TRIUMF PLC and interlock bypass system.

## **REFERENCES**

- [1] Vista Control Systems Inc.'s Vsystem, URL: <http://www.vista-control.com/vsystem.htm>, October 2007.
- [2] The TRIUMF 2C Solid Target Facility Control System Commissioning Tests, URL: [https://documents.triumf.ca/docushare/dsweb/Get/Document-9779/TRI-PRO-TST-STF-004\\_Iss1\\_Rev1.pdf](https://documents.triumf.ca/docushare/dsweb/Get/Document-9779/TRI-PRO-TST-STF-004_Iss1_Rev1.pdf), October 2007.