STATUS OF VARIOUS SNS DIAGNOSTIC SYSTEMS*

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Abstract

The Spallation Neutron Source (SNS) accelerator systems are ramping up to deliver a 1.0 GeV, 1.4 MW proton beam to a liquid mercury target for neutron scattering research. Enhancements or additions have been made to several instrument systems to support the ramp up in intensity, improve reliability, and/or add functionality. The Beam Current Monitors now support increased rep rates, the Harp system now includes charge density calculations for the target, and a new system has been created to collect data for the beam accounting and present the data over the web and to the operator consoles. The majority of the SNS beam instruments are PC-based and their configuration files are now managed through the Oracle relational database. A new version for the wire scanner software was developed to add features to correlate the scan with beam loss, parking in the beam, and measuring the longitudinal beam current. This software is currently being tested. This paper also includes data from the selected instruments.

INTRODUCTION

The Beam Instrumentation Group is responsible for all beam instrumentation systems, see Table 1.

Table 1: Current SNS Beam Instruments

Diagnostics Systems	Type	IOCs
Beam Position Monitor	PC	162
Beam Loss Monitor	VME	16
Beam Loss Data Concentrator	PC	3
Fast Beam Loss Monitor	PC	12
Neutron Detector	PC	7
Beam Current Monitor	PC	22
Beam Charge Integrator	VME	2
Wire Scanner	PC	42
Laserwire	PC	31
Faraday Cup	PC	3
Beam Stop	PC	1
Timing System	PC	13
Chumps	VME	1
Harp	PC	1
Beam Shape Monitor	PC	2
Video Foil Monitor	PC	1
Spark Detector	PC	4
MEBT Video	PC	1
Residual Gas Monitor	PC	1
Emittance Scanner	PC	2
Data Collection and Publishing	PC	4

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Most PC-based instruments are rack-mounted and run LabVIEW with the Shared Memory IOC on top of Windows XP Embedded, see [1]. VME systems run VxWorks with a standard EPICS IOC

This paper limits itself to the status and history of selected systems based on the authors' involvement and publication space available. The selected systems are the Configuration File Management System, the Data Collection and Publishing System, the Beam Current Monitors, the Video Foil Monitor, Harp, and the Wire Scanners.

STATUS OF SELECTED SYSTEMS

Configuration File Management

The PC-based systems use configuration files to personalize each system. This includes the name of each system in terms of the EPICS Channel Access protocol, settings for analysis and data-acquisition, and the calibration values. To help maintain these configuration files, we use the SNS Oracle database to store all the values contained in these files. When the PC boots up, it downloads the files from the database. The database maintains a full history of the configuration files so that any file can be reverted to a previous version. See [2] for the database setup.

At first, the web-browser user-interface only supported editing the configuration files. Only after adding additional features was the database system easier to use than our old technique: running scripts to backup the files. We added the capability to upload a file or group of files and use routines (written in WebObjects and PL/SQL) to parse the files. The routines also match the IP address of the browser to an instrument to immediately pop up the appropriate entry, see Figure 1. This has proven to be a much faster method and anyone with proper authorization can perform an update without additional assistance.

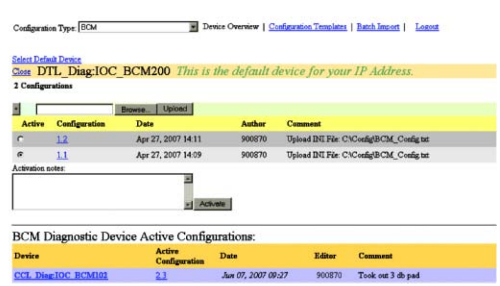

Figure 1: Browser interface to manage the configuration.

Data Collection and Publishing

The Instrumentation Group spearheaded the effort to publish accelerator related data over the web and on summary information displays, see [3]. The method in

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which this was done leveraged the group's experience with LabVIEW-based PCs. For example, the LabVIEW-based beam accounting system collects the beam charge data in real-time from various systems and publishes this as a historical array through Channel Access. This is then picked up by the Ch13 display system and transformed into a graph image for use by the web server. See http://neutrons.ornl.gov/diagnostics/channel13/Ch13.html. This data and data from the database are also used by kiosk style displays installed in the office building. See Figure 2.

Figure 2: Kiosk display switching between channels.

Informational channels with safety notices or accelerator messages are also implemented using PCs running the SharedMemory IOC and LabVIEW. As more people from different groups are requesting different data to be collected for additional SNS channels and also requesting differently configured kiosk style displays (e.g. one type for Operations and one type for Users), it has become clear that using individual PCs is no longer the right approach. The next step is to implement the information channels using the same framework as the SNS Electronic Logbook on the Oracle relational database cluster. The database must also be the center to store accelerator data, process the data, and publish the results by means of email, PDF reports, or web pages. For that purpose, a prototype web-based interface has been created in which a user can select what data to acquire from the control system, how to process it, and how to publish it, see Figure 3. This system is now under further development to integrate it with existing Physics Group routines to acquire and store data into the database.

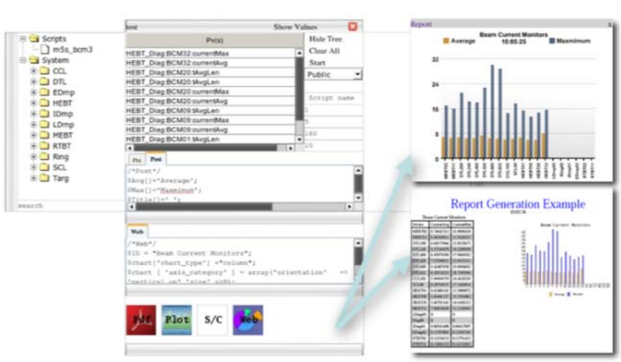

Figure 3: A web-based interface in JavaScript to acquire, process, and publish accelerator data. To the right is the web graph (top) and report (bottom). This version uses the MySQL database and PHP for server side functions.

Beam Current Monitors

The Beam Current Monitors (BCM) use toroids to pick up the beam current signal. These toroids are wideband, up to 1GHz. This allows the BCMs to see the shape of the mini-pulses (including the RF), but also pick up any noise in this frequency range. Noise has been a significant problem with the current monitors, especially with the DTL toroids. The noise comes from various high power supplies (the specific ones have not yet been identified) and is mainly picked up into the center conductor of the cable due to the way the electrostatic shields and toroids are grounded within the cavities. Other linac BCMs also see this noise on their shields and to a much lesser degree on the inner conductor, see Figure 4. Upstream DTL toroids also pick up signals from the Source RF.

Standard approaches such as installing chokes near the electronics or adding amplifiers in the tunnel did not improve the signal to noise ratio. Replacing the toroids is not an option either, as it would require taking the DTL cavity apart.

The charge of the beam pulse can still be attained with about two to five percent accuracy depending on the location, as the noise contribution is diminished during integration. Digital filtering does lower the noise amplitude but also negatively affects the shape of the mini-pulses when the beam is chopped.

Toroids near the Ring extraction kickers see the kicker power signals but, luckily, these signals are separated in time from the beam signal and, thus, are not a problem.

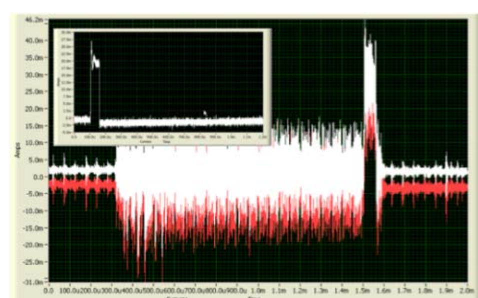

Figure 4: The worst-case signal: DTL BCM200. The insert shows a much cleaner signal from CCL BCM102.

An alternative approach is to use the BPM as current monitors. The BPMs provide a current waveform derived from the RF harmonics and do not suffer from the noise from the source or the power supplies. The waveforms from the BPMs are cleaner, as the thermal bandwidth is limited to several MHz, but they do depend on the beam pulse harmonic content, see [4].

The focus in the code of the BCMs is changing from being very flexible in setup and implementing specific features to support studies to becoming simpler and thus easier to maintain. The idea is that the data-collection and publishing system handles the specific analysis for the studies. Additionally, with the improved timing decoding, we can now calculate the exact position of the first beam mini-pulse. This allows the BCM code to be further simplified and the rep-rate increased to 30Hz. Increasing the rep-rates up to 60 Hz is under development.

Video Foil Monitor

The foils are used to strip the electrons from the H- beam before injecting the beam into the ring. The Video Foil Video Monitor developed by Brookhaven National Laboratory (BNL), controls the lamps and camera aimed at the foils. The BNL software was further developed by SNS into an operational system. After installation the system performed well and showed most of the foil area with the lamp on. At the end of 2006, most foils were barely visible and improvements were needed. We also found that as the foils were moved, their visibility significantly changed. To confirm this dependency of the visibility on the angle of the light, the reflection of the light of a diamond foil was measured and we found that up to 90% of the light can be directly reflected instead of scattered. Re-alignment of the lamp brought some relief as well as increasing the lamp light output. Increasing the gain of the video amplifiers made the biggest improvement, see Figure 5. The video signal had diminished such that only about a tenth of the normal signal was delivered to the upstairs electronics. A technote provided by BNL with the system on how to adjust this was very appreciated.

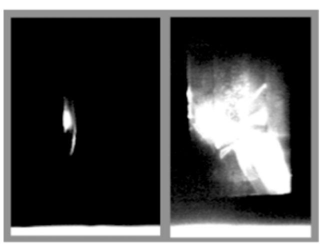

Figure 5: Before (left) and after (right) improvements to the VFM.

Harp

The harp, located right before the target, was designed to be a retractable device to prevent the 96 wires from potential damage during full power beam pulses. After physics calculations and experience from other labs indicated that the wires will survive the initial beam power, it was decided to leave the harp permanently inserted during commissioning and to finish the retraction mechanism later.

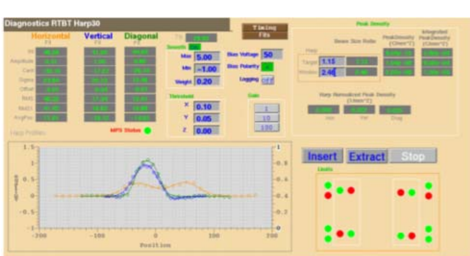

Figure 6: The harp screen with peak density values.

The advantage of the harp always being inserted is that now it can continuously take data during beam operation. Code was added to use the profile measurements and a scaling factor (from the Physics Group RTBT wizard) to calculate the beam peak density on the target, see Figure 6. The peak densities are logged and used for the target longevity calculations.

Wire Scanner

Los Alamos National Laboratory provided SNS with a well running wire scanner program. However, as different wire scanner actuators were added, problems arose regarding time-outs and movements speeds. Fixing this was difficult as each change in time-out affected other parts in the program and we would need different versions for different wire scanners. Because we also wanted to replace the ActiveX-based Channel Access with the higher performance Shared Memory IOC and support additional features, we decided to rewrite the wire scanner program. The new program includes features such as synchronizing the scan steps with a beam loss program, measuring the longitudinal current profile, parking the wire at any location, saving and loading new scan sequences, and selecting which part of the beam pulse is integrated to produce the profile. Initial tests with actual beam showed that the system worked well, see Figure 7.

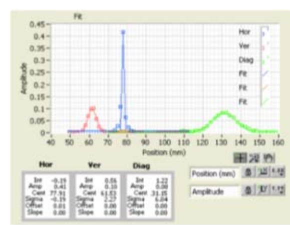

Figure 7: First profiles of new wire scanner application.

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