Update on the Central Control System of TRIUMF's 500 MeV Cyclotron

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Abstract

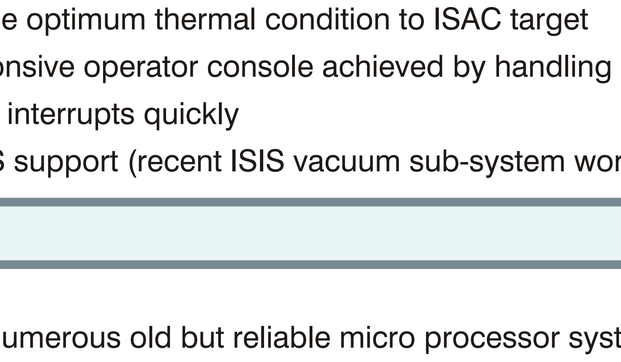
The Central Control System of TRIUMF's 500 MeV cyclotron was initially commissioned in the early 1970s. In 1987 a four year project to upgrade the control system was planned and commenced. By 1997 this upgrade was complete and the new system was operating with increased reliability, functionality and maintainability. Since 1997 an evolution & incremental change has existed. Functionality, reliability and maintainability have continued to improve. This paper provides an update on the present control system situation (2011) and possible future directions.

Introduction

- Running in production mode since mid 1970s
- Incremental evolution since first commissioning with occasional step changes
- Moved from 16 bit, to 32 bit, to 64 bit computers; at present, 64 bit Alphas, Itaniums, and Xeons
- Moved through various generations of disk storage, tape backup & network hardware (no network, thickwire, thinwire, FDDI, switched 10/100/1000 Mb)
- Low downtime
- Good performance
- High level of functionality, easy to add new functionality

Reliability, Performance, Maintainability

- Low downtime for more than 10 years
- Improved diagnostics, online diagnostics, daily checks
- New hardware designs (DACs, ADCs, memories, digital I/Os)
- Typical CPU load is 10 percent or less



Functionality

- Development cluster acts as backup for the Production cluster
- Ability to directly access cyclotron sub-system parameters makes for ease of implementation of distributed interlocks
- Avoid abrupt stoppage of beam by using "soft trip" concept to provide optimum thermal condition to ISAC target
- Responsive operator console achieved by handling console action interrupts quickly
- EPICS support (recent ISIS vacuum sub-system work)

Future

- Replacing numerous old but reliable micro processor systems with PLCs
- Upgrade disk storage, existing fibre channel to new fibre channel
- Site network upgrades
- Enhanced scans (faraday cup summary), better efficiency, clarity, flexibility
- Expansion of ISIS vacuum sub-system using EPICS

Lessons Learned

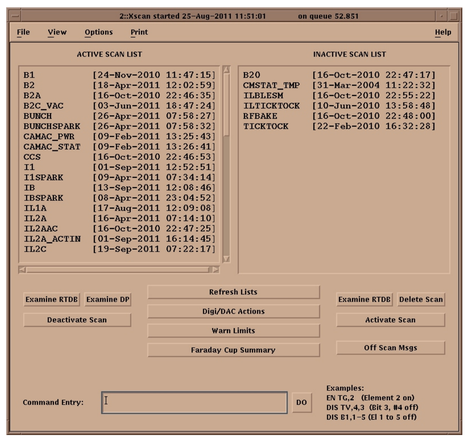
- Single shot and continuous diagnostics contribute to low downtime
- Constant user feedback and co-operative CCS refinement
- Downtime mostly due to electronics failures
- Keep it as simple as reasonably possible
- Incremental evolution has worked well
- Take ownership of the core infrastructure, maintain adequate spares

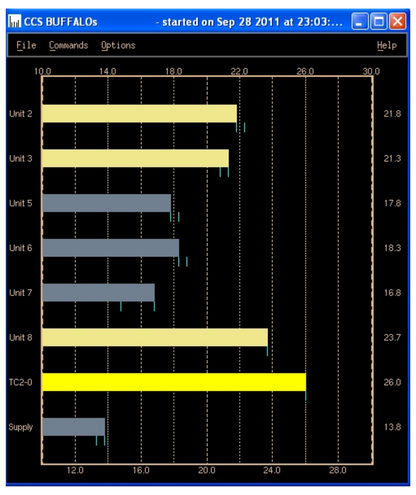
Applications

- **XTpages** - X/Motif based application which serves as a common user-interface for a vast collection of application programs. There are 325 pages currently. It provides display and control for cyclotron parameters.

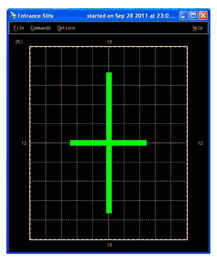
- **Xstrip** - An X/Motif interface for presenting logged data and live data graphically, using the XRT/graph widget. More than 2500 device channels are archived to disk files by the Data_Logger process. Xstrip will retrieve and display up to 10 years per channel at a time.

- **Scan** - A tool to perform actions when a specified event occurs. For example, if current > 100uA, stop the beam and print a message in the operator log. Shown here is the X/Motif user-interface to the Scan.





- **Vector Displays** - X/Motif based display to show cyclotron parameters in vector form. Two configurations are most common: A histogram and a cross. Features include marking the minimum and/or maximum values over the running period.



- **Diagnostics** - (counter-clockwise starting from top left)

Bluelight: Shows the computers that are currently running.

Hardwatch: Performs tests on various types of hardware (e.g., disks, network, CAMAC) and reports the results.

Softwatch: Reports the state of various software processes.

Network Histogram: Displays network activity by port.

Message Log: A log of all messages, warnings, and alerts related to the operation of the cyclotron. They can be viewed in real-time or from archive.

CPU Load: Displays the processing demands on each computer.

Process Load: Displays the number of processes running on each computer.

Summary

- Reliable operation (low downtime, small mean time to repair, large mean time between failures, small number of CPUs)
- Single, static runtime database extracted from Oracle
- No IOCs, only two Production servers
- Easy to add new functionality