# CONFIGURATION MANAGEMENT FOR BEAM DELIVERY AT TRIUMF/ ISAC

J. Richards, K. Ezawa, and R. Keitel, TRIUMF, Vancouver, Canada

## Abstract

The ISAC facility at TRIUMF delivers simultaneous beams from different ion sources to multiple destinations. More beams will be added by the ARIEL facility which is presently under construction. To ensure co-ordination of beam delivery, beam path configuration management has been implemented. The process involves beam path selection, beam line device setup and configuration monitoring. Utilities to provide save and restore of device settings, setpoint scaling of optic devices for beam energy and mass, beam path specific operator displays, comparison of present and previous beam tunes, and alarm enunciation of device readings outside prescribed ranges were developed. Design factors, re-usability strategies, and results are described.
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## INTRODUCTION

Until recently the ISAC radioactive beam facility was limited to simultaneous production of only two beams: one stable beam from a single off-line ion source and one radioactive beam from either of two target-ion sources.

The EPICS based control system implemented a simple configuration management scheme which ensured that no operational conflicts occured between these two beams.

This scheme did not easily accommodate the addition of a charge state booster and additional off-line ion sources within the ISAC facility. More complexity will be introduced when the ARIEL facility [1][2], currently under construction, adds two more radioactive beams and a host of new beam source-destination combinations. A new configuration management scheme is being implemented which can handle the increased complexity and an expanded scope. This scheme is extensible and capable to accommodate future growth.

## SCOPE

The new configuration management facility must be able to support

- beam path selection for each ion source to a destination with optional sub-paths
- automatic setting of critical configuration elements for the selected beam path
- configuration monitoring for all selected beams and beam abort if necessary
- save/restore of beam tunes (with selective option)
- comparison of present beam tune to previous tunes
- scaling of beam tune to different beam energy and particle mass

- generation of beam path specific operator displays

In addition, the configuration management system must interact with the fast machine protection system for the ARIEL e-linac [3] to establish and monitor/enforce beam operating modes for the e-linac.

## THE NEW SYSTEM

The control system for the ISAC and ARIEL facilities at TRIUMF is based on the EPICS tool kit. EPICS applications for device setting backup (burt), display manager (edm), and alarm handling (alh) have been utilized in the new configuration management system. A combination of operator interface pages, EPICS IOC databases, and Perl and Python scripts is used to integrate the functionality. The system is supported by the ISAC device web-application with relational database back-end [4].

### Device Groupings

A beam path is defined as an ordered list of specific machine and beam line sections. At the lowest level, the geographically ordered list of all optics, diagnostics, and beam-intercepting devices was segmented using criteria from path branching, alarm settings, scaling sections, and display page layout. A set of orthogonal device list files was thus established consisting of the least common denominator of device groupings across all those criteria. Higher level section files were created by including the orthogonal files, "Lego-like", as required to match beam delivery paths and specific configuration functionality (save/restore, energy scaling, alarm bands, displays). Device configuration parameters for each function are kept in the relational database. Tools have been developed to extract this database information and insert function-specific directives into the orthogonal files. Thus, the system reuses these same low-level configuration files for multiple functions.

### Beam Path Selection

ISAC has a branching structure of beam line sections with over 25 different experiment or sampling stations for beam destinations. Before a beam can be delivered from an ion source to a destination along possibly alternative sub-paths, access to this "beam path" must be successfully acquired. A set of virtual devices ("locks") has been defined, which control beam access to sections which may be shared by different beam paths. Each beam path requires exclusive ownership of a defined sub-set of these locks. Lock ownership is acquired by an ion source on a first-come-first-serve basis and needs to be explicitly

relinquished by the ion source before a different ion source may acquire it. Figure 1 shows the operator screen for the beam path selection and display of the lock states.
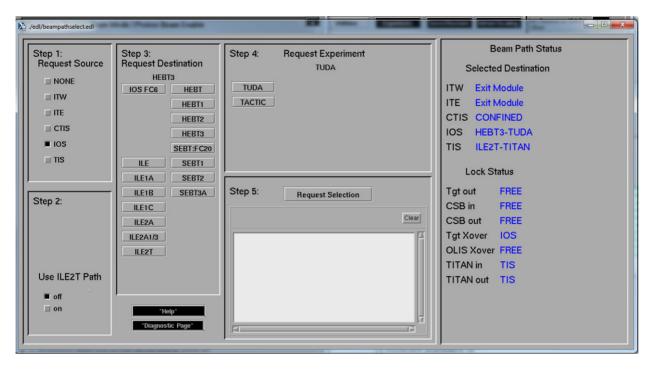


Figure 1: Operator screen for beam path selection and display of the lock states.

## Configuration Setting

Once beam path access is acquired, the control system attempts to establish the device configuration for this path ("Engaging the beam path"). This involves switching devices on, setting correct beam optics polarities, and clearing the beam path of diagnostic devices and isolation valves. A successful engaging allows the operator to request beam enable.

## Configuration Monitoring

Following beam enable for a beam path, all critical device parameters are periodically checked. This is an extension of the previously operating "alarm-bands" facility, which generates alarms if read-back of a beam optics device falls outside a range defined by the set-point. For tuning purposes, the range window is allowed to follow the set-point. It is frozen on a beam enable. The configuration management tools prepare settings for alarm thresholds and use the EPICS backup/restore tool (burt) to load them into the control system. Alarm annunciation is provided using the EPICS alh utility. Device criticality information has been added to the system which determines if a failed configuration check results in a beam stop at the ion source faraday cup.

## Save/Restore/Compare

Beam path specific tunes of device settings are saved, restored, and compared by operators using a Perl utility called scrub (Save, Compare, Restore, Using Burt). The

section and orthogonal configuration files have embedded save/restore directives to dynamically create beam path specific burt request files. Saved snap files are compared with real-time values and presented in an edm display window which highlights differences. A selection mechanism allows operators to restore all or only a partial set of saved settings. Figure 2 shows the edm screen for comparison and selective restore.

## Tune Scaling

Parameters for tune scaling are maintained in the relational database by beam physicists. Any change triggers a tool to extract this information from the database and update the scaling directives in the orthogonal files. Device-specific scaling formulas are applied to saved set-point values and the scaled set-points are applied using a generated burt snap file.

## Beam Path Specific Operator Displays

A Python framework has been developed for generating beam optics displays based on page specifications in the relational database. These specifications are entered into the database via the web-application and added as directives to the orthogonal device files. The device directives are interpreted by the python tools to generate the beam optics displays using a Python version of the EdlBuild facility [5]. The detail of beam optics page generation is beyond the scope of this paper and will be presented in a future publication.

Figure 2: Operator screen for tune comparison and selective restore.

## Operation Modes of the ARIEL e-Linac

This aspect of the configuration management is presently still being specified, but should seamlessly integrate with the configuration engaging and monitoring as described above.

## SUMMARY

To this date, beam path selection and monitoring as well as save/restore/compare have been commissioned and are in use by ISAC operations. Configuration setup utilities, the automated "engage beam path" stage and database driven tune scaling are being prototyped and tested. The basic framework for generating beam optics page displays is in place and requires additional resources for data entry and iterative extension.

Overall, the system captures the information needed and provides the tools for operators to reliably deliver simultaneous beams to multiple approved experiments. It is also ready to handle the future complexity presented by the ARIEL facility.

## ACKNOWLEDGEMENTS

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