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IMPLEMENTING CS-STUDIO AT ReA3*

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Abstract

ReA3 is the 3 MeV/u rare isotope beam (RIB) reaccelerator at Michigan State University's National Superconducting Cyclotron Laboratory (NSCL) [1]. ReA3 is unique in that it reaccelerates RIBs produced in-flight by projectile fragmentation. These beams are currently provided by the Coupled Cyclotron Facility (CCF) and will be provided in the future by the Facility for Rare Isotope Beams (FRIB), which is currently under construction and early commissioning.

A transition to Control System Studio (CS-Studio) [2] as the graphical user interface tool is underway to align ReA3 Human-Machine Interfaces (HMIs) with the FRIB style, providing operators with a consistent, integrated environment. This contribution will describe the challenges and strategies for implementing new HMIs at an operating facility.

STATUS

Over the past few years, many of ReA3's control interfaces have been transitioned to CS-Studio. This includes operator interface pages (OPIs) and tuning pages (OpsTuners), live and archived data browsing, alarm handling, and save/restore functionality. The previous interfaces include a set of local tools written in QT, Tcl/TK and Perl.

CHALLENGES AND STRATEGIES

There are two general types of challenges in implementing new HMIs at any facility: changing the tools themselves, and changing people's behavior. Difficult at any time, this process is made more challenging due to the need to maintain the operational program with a high level of availability.

There are several strategies for encouraging adoption of new interfaces while minimizing the disruption of learning to use new tools. People generally hesitate to learn new ways of doing their current work. They are busy, and new tools are often a source of new quirks and conventions to learn. Often, they will acknowledge that their current tools are not perfect but they have learned to use them well enough to be effective. The following strategies attempt to ease the transition period by providing a familiar workflow for basic tasks and focusing new development on high-level overviews and tailored control pages. Using online mock-up tools and realistic simulated prototypes for preliminary design, user testing and training can reduce disruptions to the operational system.

Provide New and Exciting Tools

Providing content that was not available previously is one of the easiest ways to encourage people to use a new HMI tool. At ReA3, the addition of two 50-inch, 4K display TVs provided an opportunity to develop a new set of status pages. Figure 1 shows the contents of these new screens, displaying three key pages: accelerator equipment status, safety information and alarms. This layout provided enough extra space to allow for a history plot of device temperatures.

Figure 1: New large screen status displays for the ReA3 control room.

Creating tailored control pages is another way to encourage the transition. Figure 2 show a page for an ion source which combines controls across various subsystems and displays the status in an easy to understand schematic. Figure 3 shows a page for the task of starting up the electron beam ion trap (EBIT). This style of page can be used to turn a procedural document into a guided walkthrough that gathers all relevant information and controls into one place. This provides an opportunity to capture the knowledge of experts, reduces operational

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errors and gives non-experts confidence to successfully complete complex tasks.

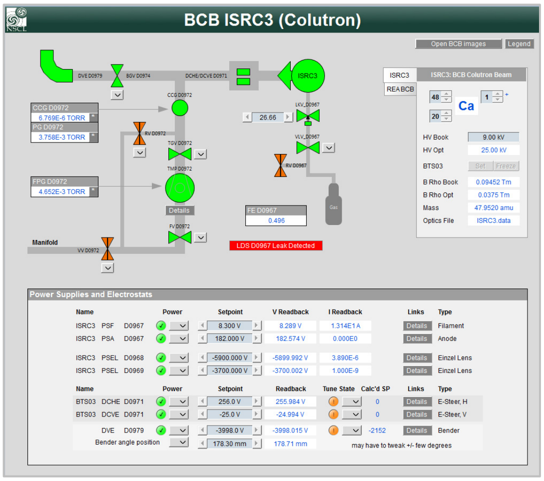

Figure 2: Specialized display for an ion source combining status and controls for vacuum, power supplies, gas leak and beam selection.

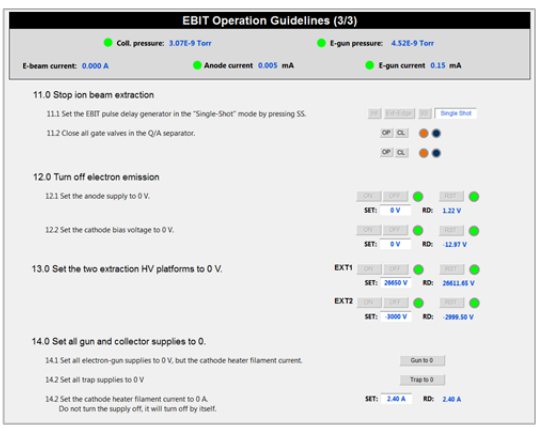

Figure 3: Specialized display with a guided walkthrough for starting the EBIT.

Decide on an Overall Plan and Style Guide

There is a well-established hierarchy of user interface design [3] that should be kept in mind when creating a new set of interfaces. At ReA3, the general structure is split into the four layers shown in Figure 4.

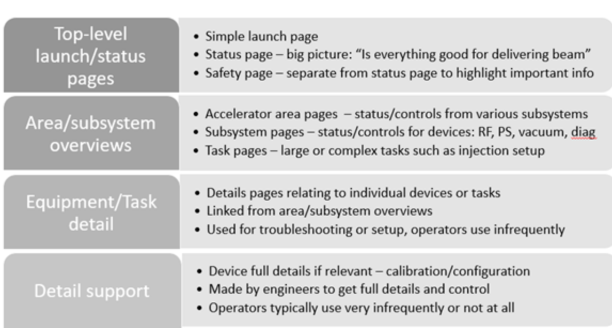

Figure 4: Hierarchical plan for interfaces: top level launch status, area/subsystem overviews, equipment/task detail, and detail support.

A consistent style reduces training time and user error. In addition to a written style guide, there are several ways to help maintain consistency across interfaces. Having a practical set of named fonts and colors in the CS-Studio definition files as well as creating a *schema* file defining default configuration for widgets will make it easy for content developers to use the same conventions. Figure 5 shows ReA3's color and symbol legend demonstrating the conventions chosen for status and control widgets.

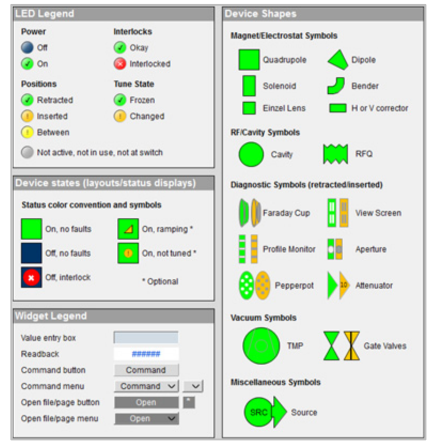

Figure 5: ReA3's symbol and color legend.

Minimize Risk with Mock-ups and Simulation

Minimizing the risk of changing interfaces on an operator machine can be accomplished with mockups and a simulation environment for design, testing and training.

Mockups are an invaluable tool for designing new interfaces, particularly in the early stages. An online tool such as *Balsamiq Mockups* [4] provides a collaborative environment for making fast prototype pages such as the vacuum display shown in Figure 6. These can be used to test layout and style as well as the transitions from one page to the next. This saves development time since iterating through sketches is fast while iterating on fully functional control screens can be long and complex. Involving operators and stakeholders at this stage of design will also foster a sense of engagement and ownership.

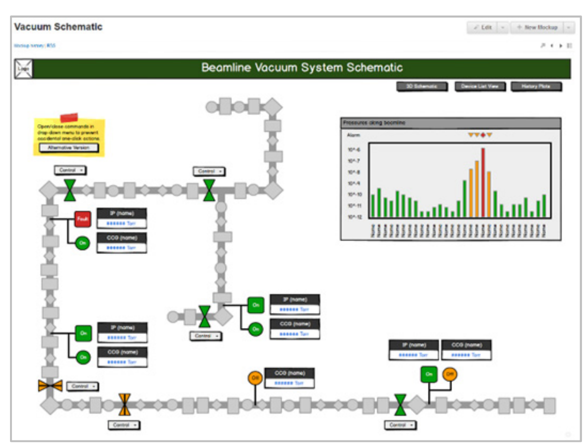

Figure 6: Vacuum display mock-up in *Balsamiq*.

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A simulated controls environment can be used to design, build, test and train people on realistic interfaces without the risk of affecting operating equipment. To achieve this at ReA3 a set of simulated devices were created in an EPICS softioc with embedded python scripts. Simple simulated magnets, cavities, Faraday cups, vacuum gauges and gate values can be controlled and observed. This simulation can potentially be extended to use more realistic device control templates including external interlocks or by incorporating a simple accelerator model. A set of CS-Studio pages, such as that for magnets shown in Figure 7, was developed to control the simulated devices. Several templates that were developed in this environment are now in operational use.

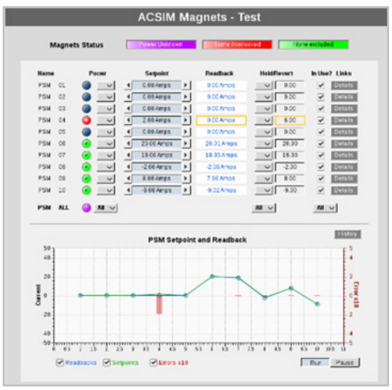

Figure 7: CS-Studio screen for simulated magnets.

Reduce Stress by Providing Familiar Experience

Several of ReA3's initial CS-Studio pages were created to mimic the style of the previous interface tool, an example of which is shown in thse area overview page in Figure 8. This reduces the amount of learning effort as people can focus on using the new environment while having familiar control screens.

However, care should be taken not to import practices that are very different from the new conventions. For example, if the new guidelines forbid combining status and action in a single widget, these mimic pages should be adjusted to reflect that. For this reason, bulk conversions from the old tool to the new one may not be the best approach, or should only be considered a starting place. The goal should be to update these pages to the new style within a reasonable timeframe, as operator's familiarity and skill with the new system improves.

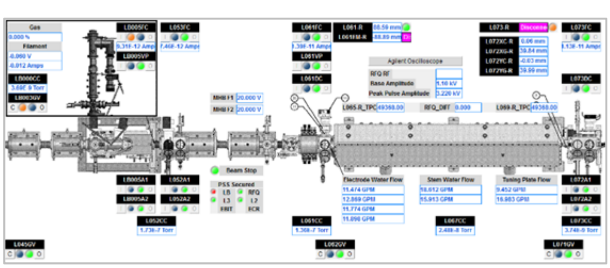

Figure 8: Area overview in the style of the previous tool.

One of the previous tools at ReA3 was a program tailored to the manual tuning of devices. Several features of that program were not available in CS-Studio so a new 'OpsTuner' application was created to provide them. Convenient features of the application include being able to use the keyboard to move between enabled devices and step the setpoints, hotkeys to change the step size, and an ability to group devices for coordinating adjustments. Snapshots of the current settings can be stored locally and reverted. OpsTuner files are simple comma-separated files with a row for each device and columns for control or readback type. An example of an OpsTuner display for the ReA3 RF cavities is shown in Figure 9.

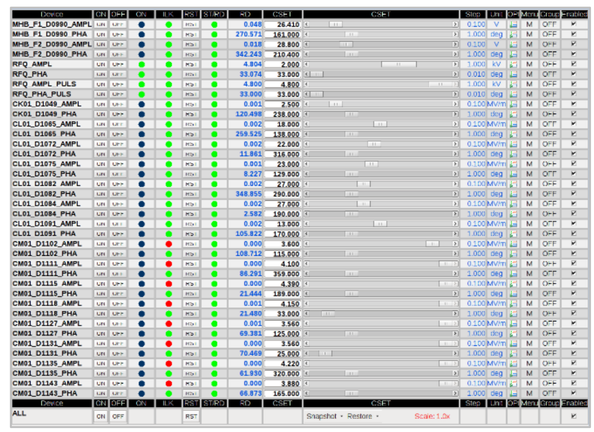

Figure 9: OpsTuner display for tuning ReA3 RF cavities.

CONCLUSION

There are several strategies for encouraging adoption of new interfaces while minimizing the disruption of learning to use new tools. Focusing on providing novel content while preserving (to a reasonable extent) the familiar workflow and style of the previous tools will encourage people to make the transition. Using online mock-up tools and realistic simulated prototypes for preliminary design, user testing and training can reduce disruptions to the operational system while building confidence that when the new content is deployed it will be functional, correct, and operators will be comfortable using it.

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[4] Balsamiq Mockups, http://balsamiq.com