CEBAF-PR-95-020
DOE/ER/40150--331 CONF-950512--389
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JUL 25 1996
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Operational Monitoring of the CEBAF RF System

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An EPICS-based control interface has been developed which enables effective monitoring of the 338 independent RF systems that drive CEBAF's superconducting cavities. Visual screens allow the operator to quickly identify cavities that have faulted, or which are operating out of specification. These screens allow the operator easy access to automated routines for clearing faults, routines for documenting and tracking hardware problems, and expert screens for immediate correction of RF problems. The combination of visual screens and automated scripts has greatly decreased the time required to identify and recover from RF problems, significantly increasing operational uptime.

I. Introduction

CEBAF is a 4 GeV electron accelerator undergoing commissioning to produce a CW beam for nuclear physics research. The accelerator consists of a 45 MeV injector and two parallel 400 MeV linacs that utilize a total of 338 superconducting cavities. The cavities are grouped into 42 cryomodules each containing eight cavities, plus one two-cavity cryostat. The beam is recirculated through both linacs four additional times to achieve a total energy of 4 GeV.

II. RF Status Screens

Two display screens were constructed to show the status of the RF system of all cavities in each linac. Figure 1 shows the screen to monitor CEBAF's Injector and North Linac. The square indicator for each cavity is a composite of seven signals that describe the status of the cavity. These signals are listed in Table 1. The seven signal indicators are layered so that the higher priority signals cover the lower priority signals. Special characters were imbedded in the various indicators to make them distinguishable on non-color printers.

1.	RF on
2.	RF off
3.	Klystron bypassed
4.	Gradient set to zero
5.	Autotrack process is not running
6.	Autotrack process is faulted
7.	Gradient lock feedback loop is not stable

Table 1 - Cavity RF Status Signals

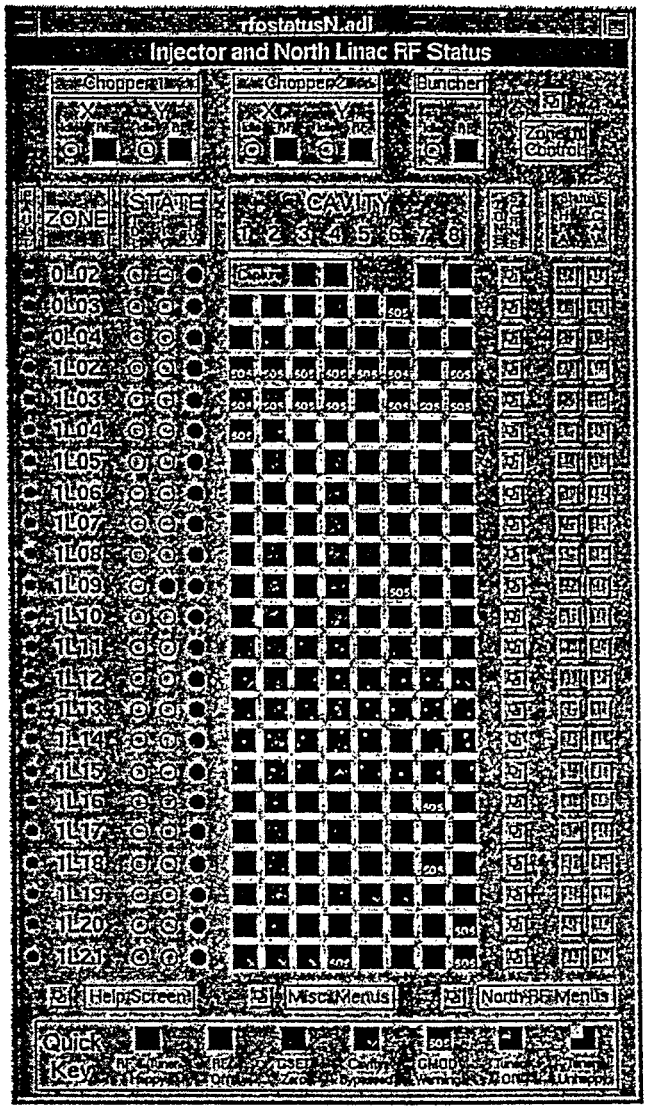

Figure 1 - Linac RF Status Screen

In addition to showing the status of RF in the individual cavities, the status screens also provide:

- The state of the High Voltage Power Supply that feeds the eight klystrons for a given cryomodule.
- Buttons to access expert control screens for diagnosing problems in specific cavities.
- Buttons to access automated routines for documenting changes made to a RF cavity or High Power Amplifier (described in Section III.)
- Buttons to access automated routines for clearing common faults (described in Section IV).

* Supported by DOE Contract # DE-AC05-84ER40150.

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III. RF Operability Database Utility

A routine was developed using the TCL/TK Tool Kit[1] to allow operations personnel to document changes made in the status of individual cavities and High Power Amplifiers. Such changes could occur when a problem cavity is bypassed by an operator or when a cavity is restored to operation by the RF Group. The database would specify:

- status of the cavity's klystron (good or bad)
- status of the cavity's autotrack system (good or bad)
- status of the High Voltage Power Supply
- additional details or comments
- date and time stamp

This database provides two separate groups, the Accelerator Operations Group and the RF Group, an accurate way to communicate and track changes in a common system. Further, the RF Group can identify and correct recurring problems by tracking the history of each cavity's RF system.

In addition to tracking a cavity's RF history, the database provides a template for other control system utilities that interface with the RF system. An example is the CEBAF Linac Energy Management[2] utility that optimizes the gradients of all cavities in a linac to produce the required linac energy. This routine searches the RF Operability Database to determine which cavities are operational before calculating and changing cavity gradients.

IV. RF Fault Recovery Utility

A routine was developed using the TCL/TK Tool Kit to provide a fast and intelligent method of clearing a RF fault and restoring RF to the cavities. In addition to fault-induced RF trips, this utility is also useful for restoring RF following a planned maintenance downtime or after a tunnel access when all RF has been turned off. The utility attempts to bring the hardware configuration into agreement with the RF Operability Database, so that only designated cavities are operating and only the proper cavity tuning processes are activated. The control screen allows the operator to select individual cryomodules (all eight cavities) or an entire linac.

V. Future Applications

Future applications will use the RF Operational Database as part of their configuration input. A RF utility presently being tested provides a non-destructive method of matching the RF phase of each cavity to the phase of the beam. The mechanism for passing information between operations and maintenance personnel is proving very effective for the RF system, and is being applied to the beam position monitor system (550 monitors) of the CEBAF accelerator.

VI. Conclusion

The combination of visual screens and automated scripts has greatly decreased the time required to identify and recover from RF problems, significantly increasing operational uptime. In addition, these tools provide the Operations Group and the RF Group a common method for monitoring the 338 independent RF systems and for communicating any changes made in the operability of specific systems. These techniques are being expanded to new RF utilities as well as to other accelerator hardware systems.

References

[1] J. K. Ousterhout, *Tcl and the Tk Toolkit*, Addison-Wesley Professional Computing Series (1994)

[2] J. van Zeijts, *Rapid Application Development Using the Tcl/Tk Language*, these proceedings.