THE CONTROL AND DIAGNOSTICS SYSTEM FOR THE CEBAF INJECTOR*

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Continuous Electron Beam Accelerator Facility

Introduction

We present the first experience with the CEBAF injector[1] control and diagnostics system. The computer architecture of the control system has been described elsewhere.[2] The injector system is a model for the CEBAF controls. A computer system controls the gun, the steering magnets, and the focusing elements, and in the near future also the injector rf system. The beam parameters such as current, position, and emittance are measured by various monitors and are automatically analyzed by the computer.

The CEBAF injector.

The injector (Fig. 1) is the first part of the CEBAF accelerator beam transport to be operational. After the gun (Fig. 2), it has components that are similar to others that will be used throughout the accelerator: safety interlocks, rf, variable power supplies, intercepting devices, and other beam diagnostics. The injector control system will therefore be developed as a model for that of the entire machine.

The control room.

The operator can direct all accelerator functions by using computers in the control room (Fig. 3). The injector controls consist of a supervisory HP560 computer that drives other computers that actually control the functions; an HP330 controls the gun, while an HP318 runs diagnostics and transport. The supervisory computer also drives a pair of large high-resolution color monitors with keyboards and a common track ball and set of assignable knobs. Smaller monitors are used for program development, and can also be used as remote terminals for local troubleshooting of hardware problems.

Display: gun control.

The gun control panel allows the operator to set the filament current, high voltage, and grid voltage either by typing in the desired values or by knobbing them in.

Display: beam transport and diagnostics.

The injector control panel (Fig. 4) allows the operator to insert or remove viewers or other intercepting devices, set magnet currents, and operate the camera for analysis of the images. The insertion devices are toggled by the switch at the track ball, while the magnet power supplies can be set either by use of the assignable knobs or by typing in the desired settings. The display also shows the status of the local computers and their associated CAMAC crates. Messages such as warnings from the local computers are displayed. The operator can save the settings of all magnets controlled by the display, and can recall and automatically install a previously saved configuration.

Magnet control. The field strength of a magnet is altered by assigning a knob to the power supply of the magnet in question and then dialing in the desired shunt voltage. Alternatively, it can be set by keying in the new value. The display shows the requested shunt voltage and that actually measured.

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Plungers. The plungers that insert or remove intercepting devices into or out of the beam are toggled from the screen. The plungers now in use (Fig. 5) are driven by air cylinders. Mounted on their shafts are viewer foils, Faraday cups, or beam profile monitors (harps).

Viewer screens. Several different materials have been tested successfully for use as phosphors on the viewscreens. The one shown in Figure 6 is a disk of beryllium oxide. Another is a deposit of chromium-doped aluminum oxide on an aluminum backing.

Harp. The harp is a beam profile monitor that consists of a frame supporting a pair of thin (50 μm) tungsten filaments mounted parallel to each other, 1 cm apart. It is driven rapidly through the beam by an air cylinder; the profile is then inferred by observing the current (Fig. 7).

TV monitor analysis. From the control panel, the operator can call for a local computer to grab a CCTV frame and analyze it. Analysis consists of background subtraction, positioning relative to fiducial marks, and profile measurements. The display can show either the analyzed image or a graphical presentation of the two-dimensional position and profile (Fig. 8).

Offline devices.

Some passive devices do not require operator intervention, and so are not yet incorporated into the control system.

Current monitor. Current can be measured with a precision of 0.2μA by means of a toroidal parametric current transformer (Fig. 9) of a type developed and in use at CERN.[3]

Resonant cavity current and position monitor. Beam current as low as 1μA and position at that current as precise as 1 mm can be measured by a pair of resonant cavities (Fig. 10). At higher currents, the position measurement is proportionally more precise.[4]

Loop position monitor. Beam position can be measured with a precision of 1 mm for amplitude-modulated beam currents with modulation as small as 0.1μA. The monitor (Fig. 11) is a ferrite-loaded loop that resonates at approximately 10 MHz.[5]

References

1. W. Diamond and R. Pico, Proceedings of this conference.
2. R. Bork et al., Proceedings of this conference.
3. K. Unser, IEEE Trans Nucl Sci **NS-28**,2344-6 (1981); Klaus B. Unser, Atomkernenergie·Kerntechnik **47**,48-52 (1985).
4. P. Kloeppel, CEBAF technical note TN-0039.
5. W. Barry and M. Wise, Proceedings of this conference.

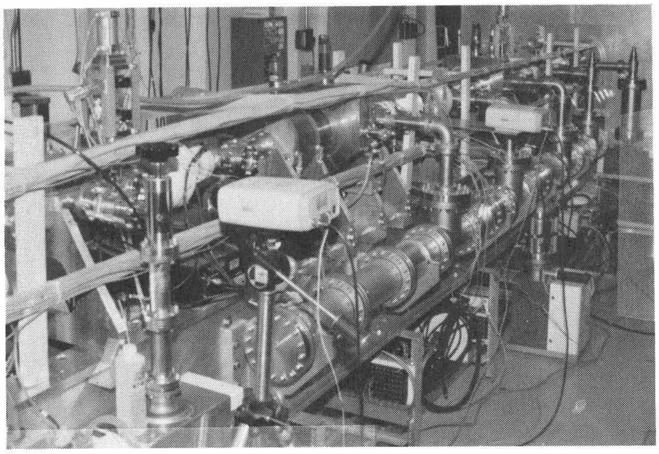


Figure 1. CEBAF injector.

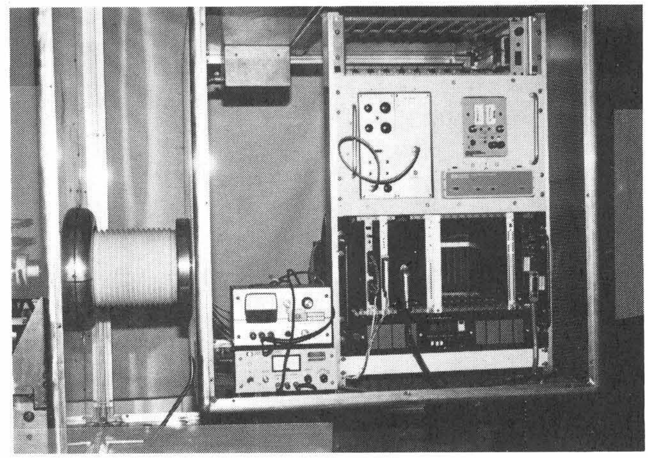


Figure 2. Gun for injector.

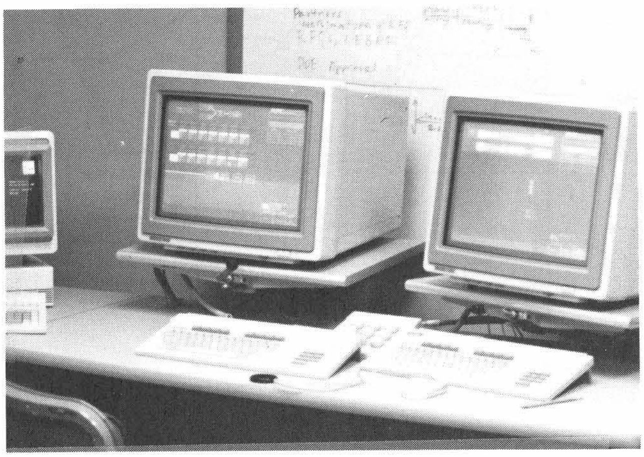


Figure 3. Operator console in injector control room.

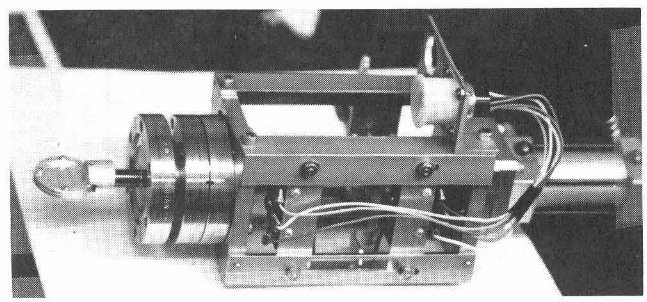


Figure 5. Plunger, unmounted.

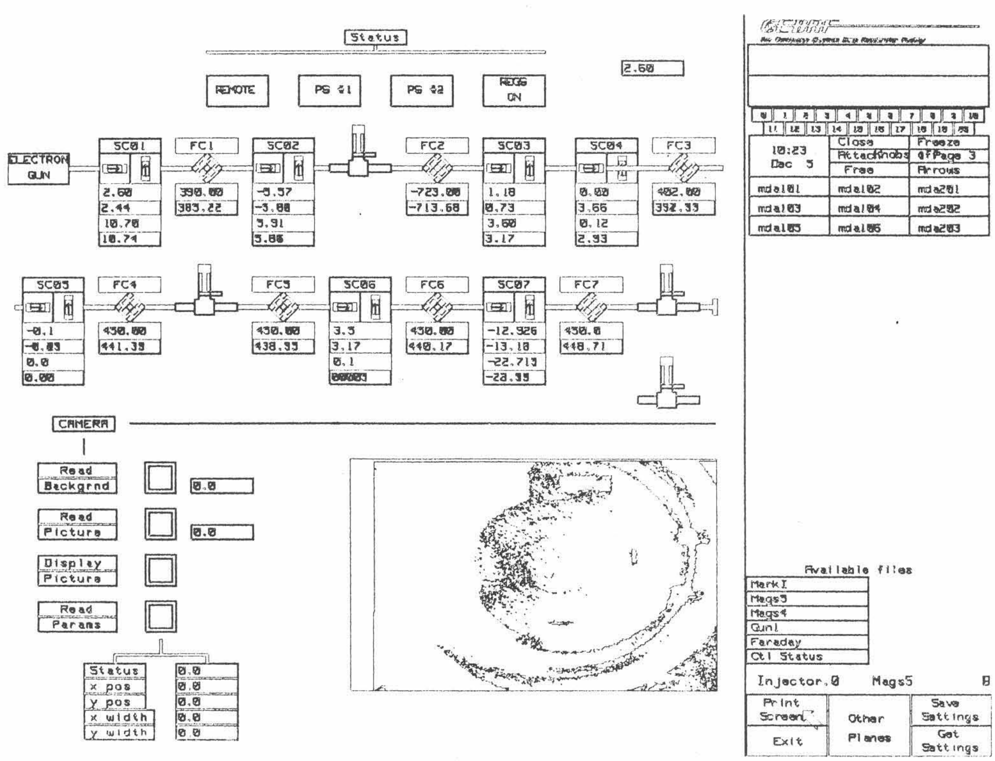


Figure 4. Display panel: injector beamline control.

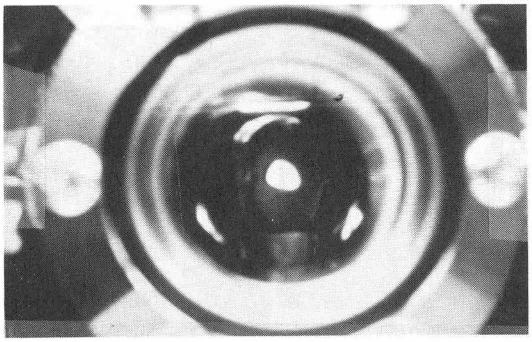


Figure 6. Beam striking phosphor; TV monitor image.

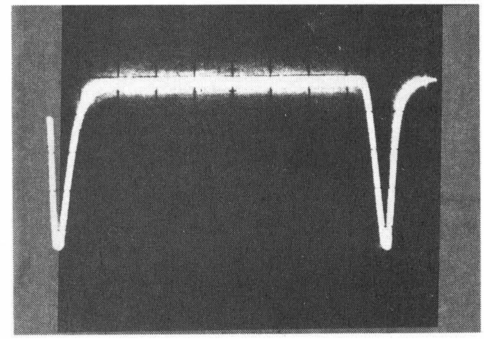


Figure 7. Oscilloscope trace of harp signal.

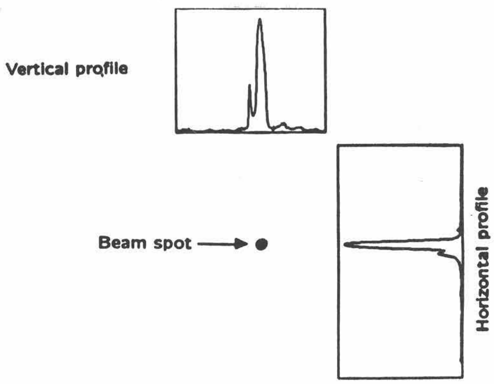
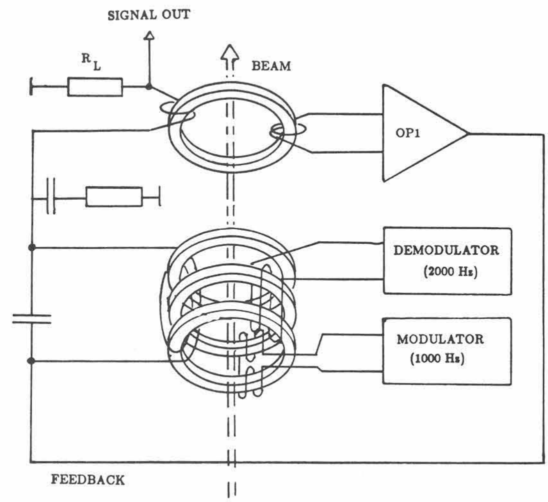


Figure 8. CCTV image of beam analyzed by computer.



(After K. Unser, CERN-ISR-OP/81-14)

Figure 9. Parametric toroidal current monitor.

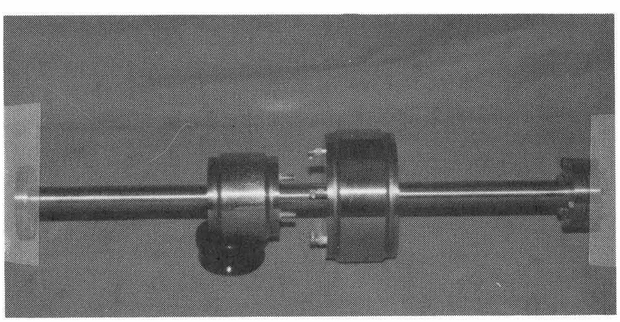


Figure 10. Resonant cavity beam position monitor.

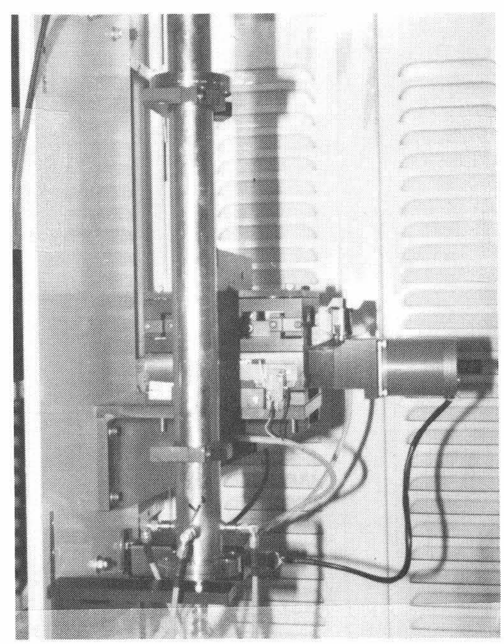


Figure 11. Loop pickup monitor in calibration stand.