Motion Control for Cyclotron RF System

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PROBLEM STATEMENT

The Cyclotron is a particle accelerator that is uses RF towers. Tuning to different frequencies in the towers allows the Cyclotron to be used for a variety of different tasks: cancer treatment, isotope creation, and advanced materials testing.

Previously, the system tuning was done manually which takes about 20 minutes and is required every time the usage of the Cyclotron is switched. Automating would make it nearly instant, and allow isotope creation to occur more often in small lapses between patients, leaving more time overall for patient care.

REQUIREMENTS

We were required to design and build a motion control system for 8 servo motors that tune the Cyclotron RF system. We had 2 identical RF system towers. Each tower has 4 servo motors: fine tune, course tune, coupling capacitor, and grid capacitor. These motors needed to be automated, by handling their analog position feedback, and other control signals from the motors for integration in the Cyclotron towers.

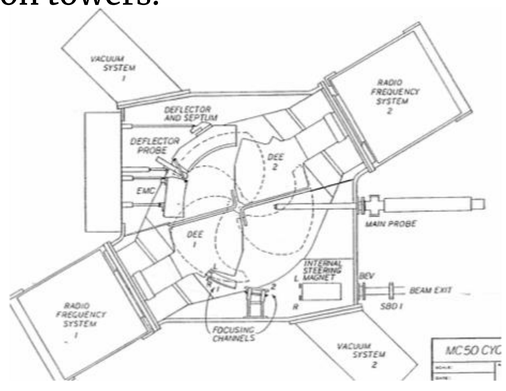

Figure 1: Internal Structure of Cyclotron

ELECTRICAL & COMPUTER ENGINEERING

SOFTWARE IMPLEMENTATION

- **Tools**: EPICs/VDCT software on Linux. EPICs uses records to receive and interpret analog signals
- **Specifications**:
  - Grid/Coupling Capacitors: Follow the control loop outlined in Figure 2.
  - Coarse Tune: Same as the capacitors, but takes input from the Cyclotron's interlock pressure
  - Fine Tune: Takes input from a phase meter

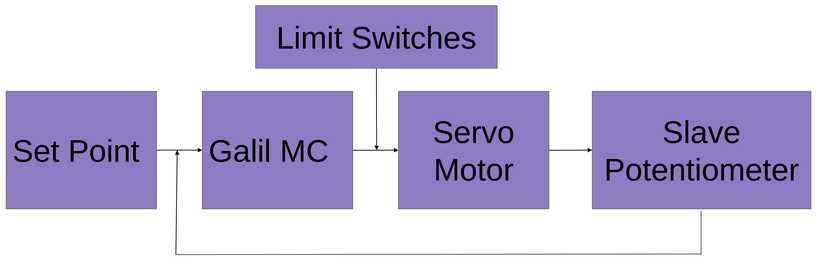

Figure 2: Control Diagram of Motion Control

HARDWARE IMPLEMENTATION

A **rack box** for each RF tower was built that includes:

- Power supplies
- Galil motor controller
- Acromag ADC for potentiometer readings
- Mini computer to drive the display

User Interface includes:

- Potentiometer for local position control
- Dial to select which motor is being controlled
- Test points for maintenance checks
- Original controls for the fine tune motor
- ModBus interface to handle digital inputs and I/O

Figure 3: Panel for Server Rack Box

DISCUSSION

- Grid/coupling capacitor: The motion control worked and was able to move the servo to any position, while receiving feedback from the potentiometer. Limit switches will be read from a different input.
- Coarse Tune: The motor was able to move, and takes input from a temporary interlock record.
- Fine Tune: Three modes were implemented for regular, wait, and manual. Input from the phase meter needs to be tested.

The future goal is to test if the servo motors operate within the RF towers. The RF system should be able to function remotely.

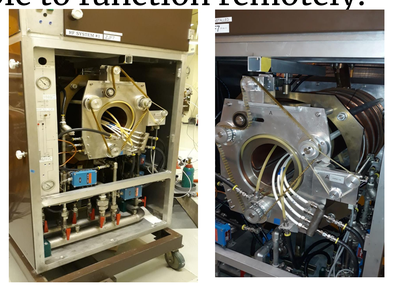

Figure 4: RF towers in the cyclotron

CONCLUSION

We successfully were able to design and implement a remote control motion system for 8 servo motors through EPICs. We also created the panels and box for the system to be placed in the server room and allow the servo motors to be controlled locally and remotely.

ACKNOWLEDGMENTS

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