

The Cyclotron

- The UW Medical Center Cyclotron accelerates atomic particles, such as protons, for use in medical treatment and research purposes.
- Particles are accelerated by high frequency alternating voltages on two D-shaped electrodes.

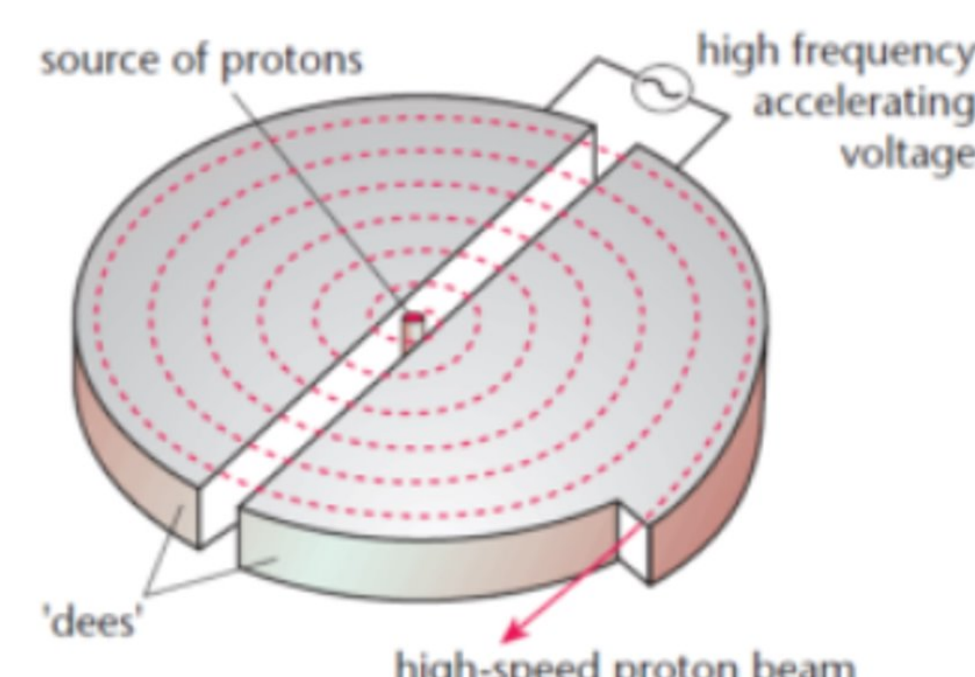


Figure 1. Cyclotron: Particle Accelerator

Purpose of RF Controller

- Different particles are required for different purposes, and those particles have different energies associated with them, resulting in different necessary Radio Frequencies to be utilized.
- Four motors in each of the two RF towers control the cavity sizes that in turn produce the appropriate frequency and minimize signal reflection through impedance matching.



Figure 2. UWMCF RF Towers



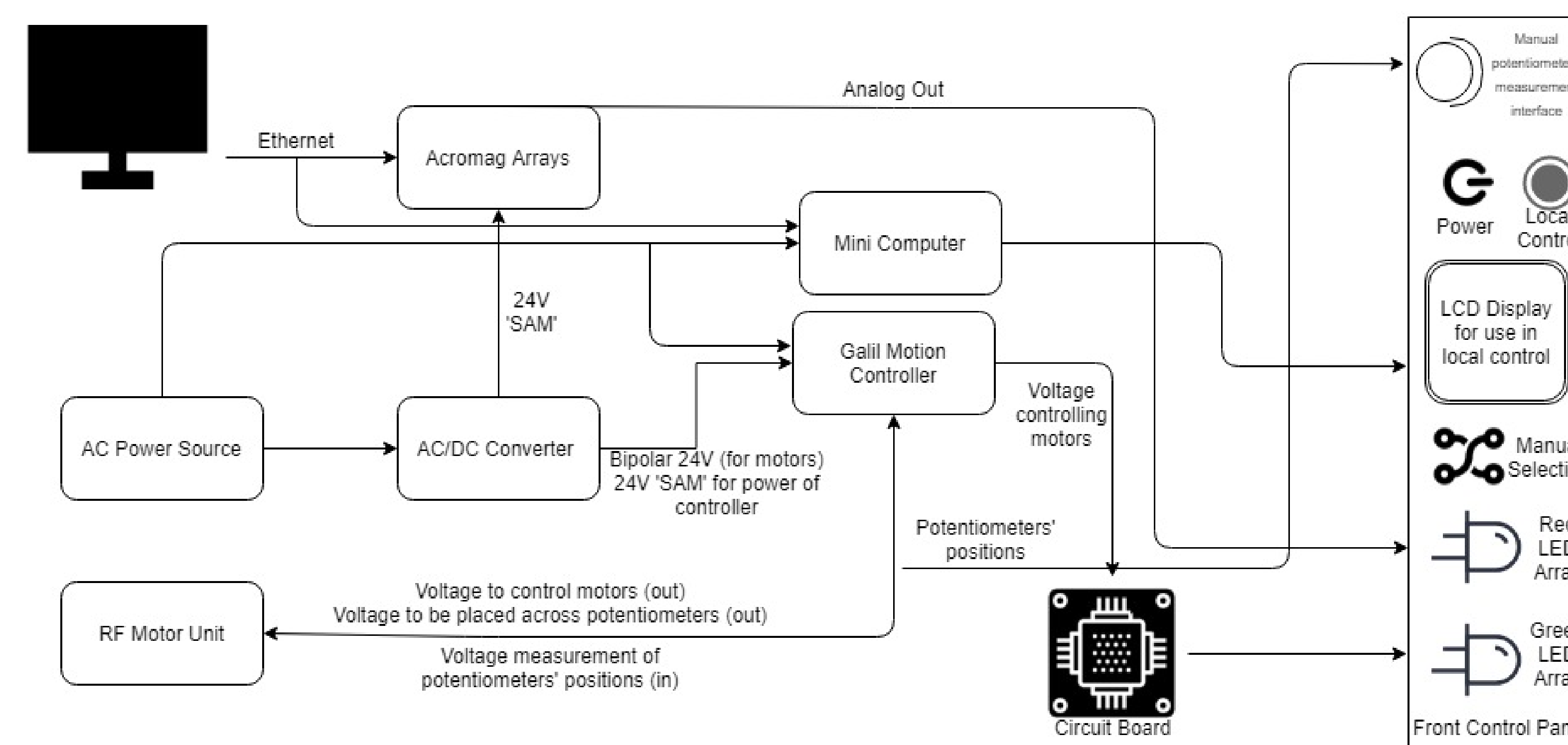
Figure 3. Available Particle Beams in UWCF

Power of System

- There are four internal mini power sources in the system, which converts the external 208VAC power source to two 24VDC 1.3A power sources, one 24VDC 3A power source, and one +/-15VDC 1A power source.
- The 1.3A power sources provide power for the motors.
- The 3A power source referred to as 'SAM' provides power for all components not in the original system and to determine when switches have been flipped, such as when limits in the motors are reached.
- The bipolar 15VDC power source is used in the circuit that controls automatic fine tune control adjustments.
- Additionally, an external 24V power source is utilized to help power light indicators present on the system.

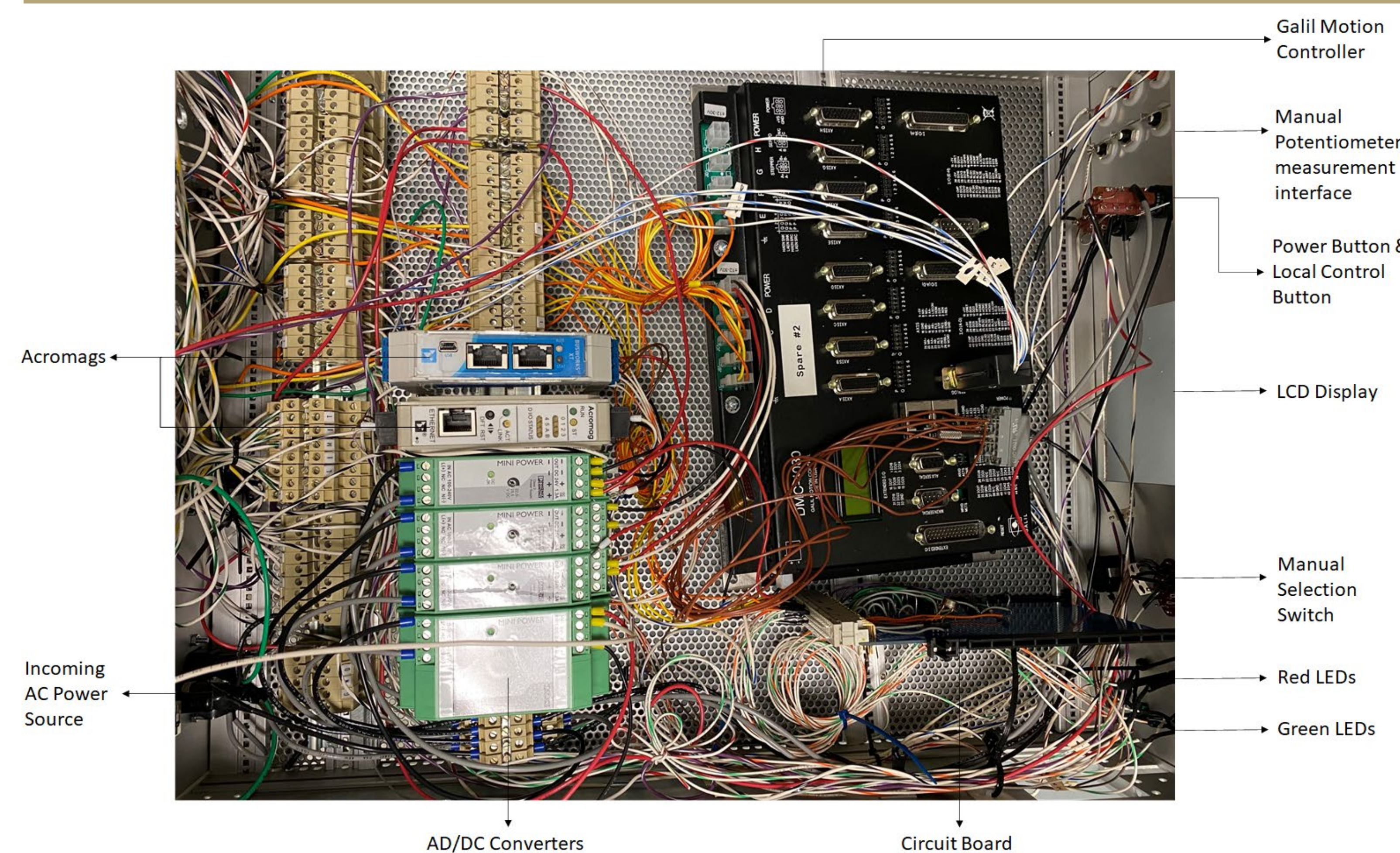


The System Block Diagram



- AC/DC Converter: Phoenix Contact Power Supply Module that takes in 85V-350V AC and outputs 24V DC
- Acromag Busworks: Analog and Digital I/O Ethernet Modules
- Galil Motion Controller: Tunes the servo motor units with built-in Proportional-Integral-derivative (PID) controller, Outputs Voltage power to move the controlled units
- Circuit Board: Full-bridge rectifier circuits to regulate LEDs

Hardware Overview



Integration with Software

- Connecting the Galil Motion controller and the analog to digital converter to the local network with an ethernet cables removes the need of users to come up to the power room to change between preset settings.
- The software EPICS is integrated with the hardware to direct the Galil Motion Controller when to move the motors by taking in the inputs of the slave potentiometers' positions of each of the four motors and the fine tune's phase differential input.

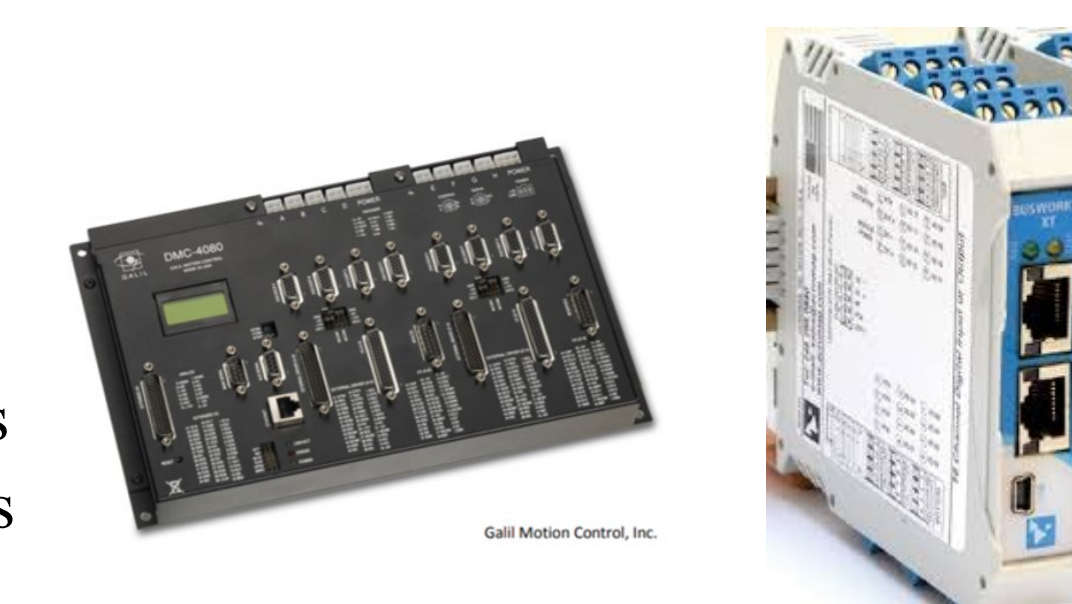


Figure 4. Galil Motion Controller (left), Acromag (right)

Manual Control

- Local control can be activated pressing the 'Local Control' button on the front panel of the system.
- This allows for the user to create novel motor positions, with by switching between motors with a switch, manipulating a built-in potentiometer to be read by the analog to digital converter.
- The motor being manipulated can be viewed on the LCD, which is connected to the minicomputer.
- Additionally, on the front panel the states of the limit switches can be viewed by light switches, and the potentiometer positions can be manually measured.



Figure 5. Minicomputer

Servo Motor Unit

- Fine Tune & Coarse Tune:** Adjust the physical RF cavity length that changes the RF frequency. Fine tune is constantly running.
- The length of the cavity determines the resonant frequency of the cavity. Changing the length changes the resident frequency and thus how the particles are accelerated

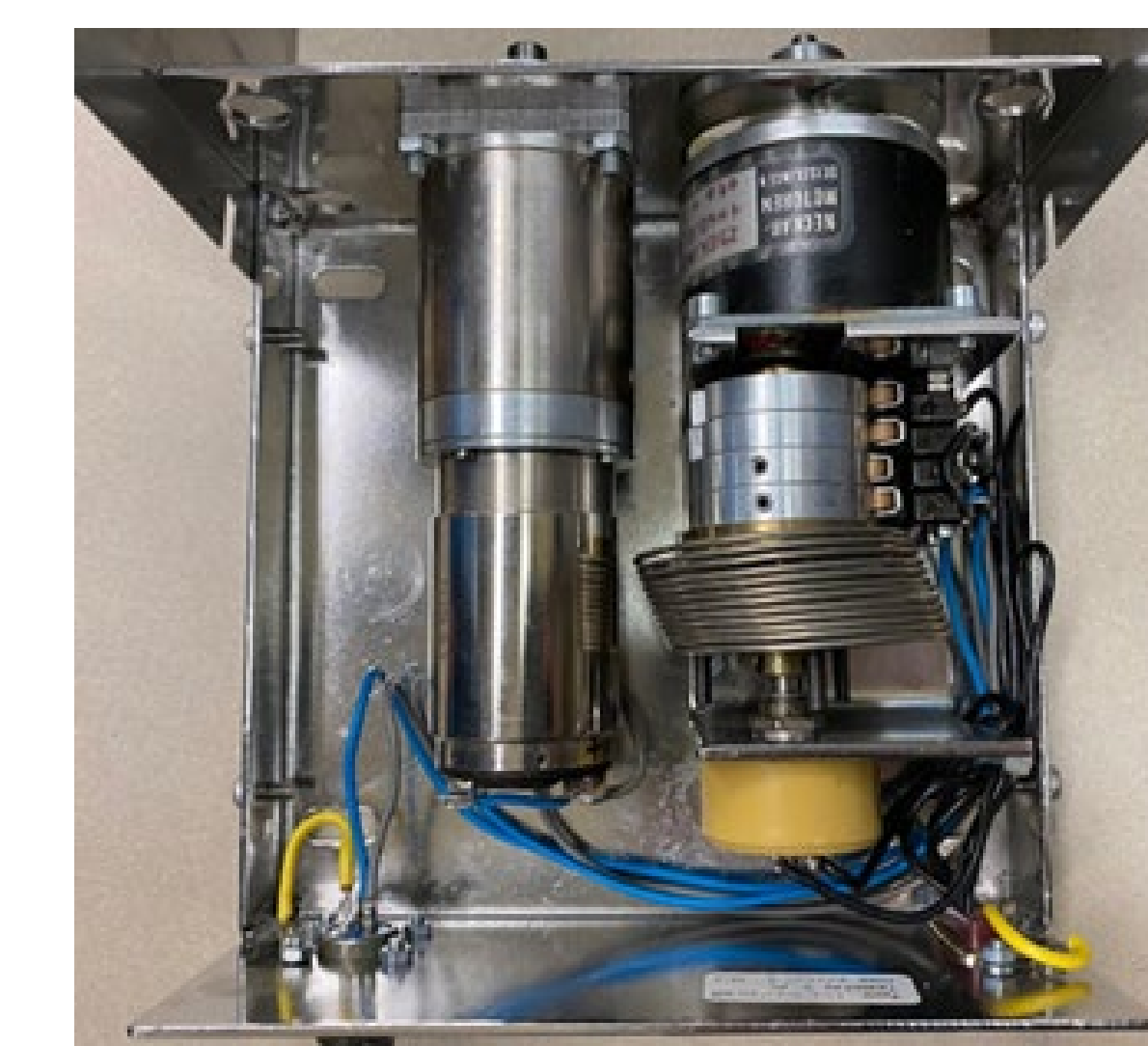


Figure 6. Servo Motor Unit

- Coupling Capacitor & Grid Capacitor:** change the gap in the capacitors to adjust the impedance matching between the power supply and the RF load
- Max power transfer occurs when the impedance at the source matches the impedance at the load. Mismatched impedances result in reflected power, which can lead to damages in parts of the RF system

Future Work

- Finish integrating and debugging the control system with the larger system of the RF Cyclotron.
- Finish an identical control system for the second RF tower.