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Abstract

A multi-cusp H⁻ ion source has been installed on the K150 cyclotron for the production of high intensity proton beams. These beams will be used to create secondary radioactive ions for the Upgrade Project[1,2]. One of the limiting factors in creating an intense beam comes from poor vacuum along the injection line caused by the ion source itself. A large flow of hydrogen gas is required to make the Hydrogen negative (H⁻) ions in the ion source. As a result, many of the hydrogen molecules exit the ion source, travel past the turbomolecular pumps below the ion source, then migrate into the injection line and deteriorate the vacuum. To reduce the flow of these molecules into the injection line, a computer controlled iris will be installed between the ion source and the injection line. With the iris set at the correct diameter, the vacuum in the injection line should improve and the transport efficiency of the H⁻ ions to the cyclotron inflector should increase. For the project we used an 8" OD Conflat DVM brand iris with an MDrive 17 Plus control motor. The motor will be controlled by a Labview software interface. Once the iris is installed on the injection line, the true diameter of the iris cannot be measured visually so it is critical that the system is reproducible and failsafe.

Materials

The 8" OD Conflat DVM iris is shown in figure 1. The opening of the iris has a diameter of about 4.7" when fully opened and 0.3" when in the closed position. A flange located on the side of the iris assembly contains a driving shaft that controls the diameter of the iris.



Figure 1

The Mdrive 17 Plus is shown in figure 2. The motor utilizes string inputs from an interface capable of communicating with it. The power supply for the motor is shown in figures 5 and 6. The motor will be controlled by a computer with a LabView software interface also located away from the ion source.



Figure 2

Set-up

A coupling apparatus was designed with AutoCAD software to connect the drive shaft of the motor and the control shaft of the iris. The coupling apparatus is comprised a total of eleven pieces. To avoid damage to the iris assembly, the pieces were made from aluminum which is light and sturdy. A schematic of the design is shown below in figure 3.

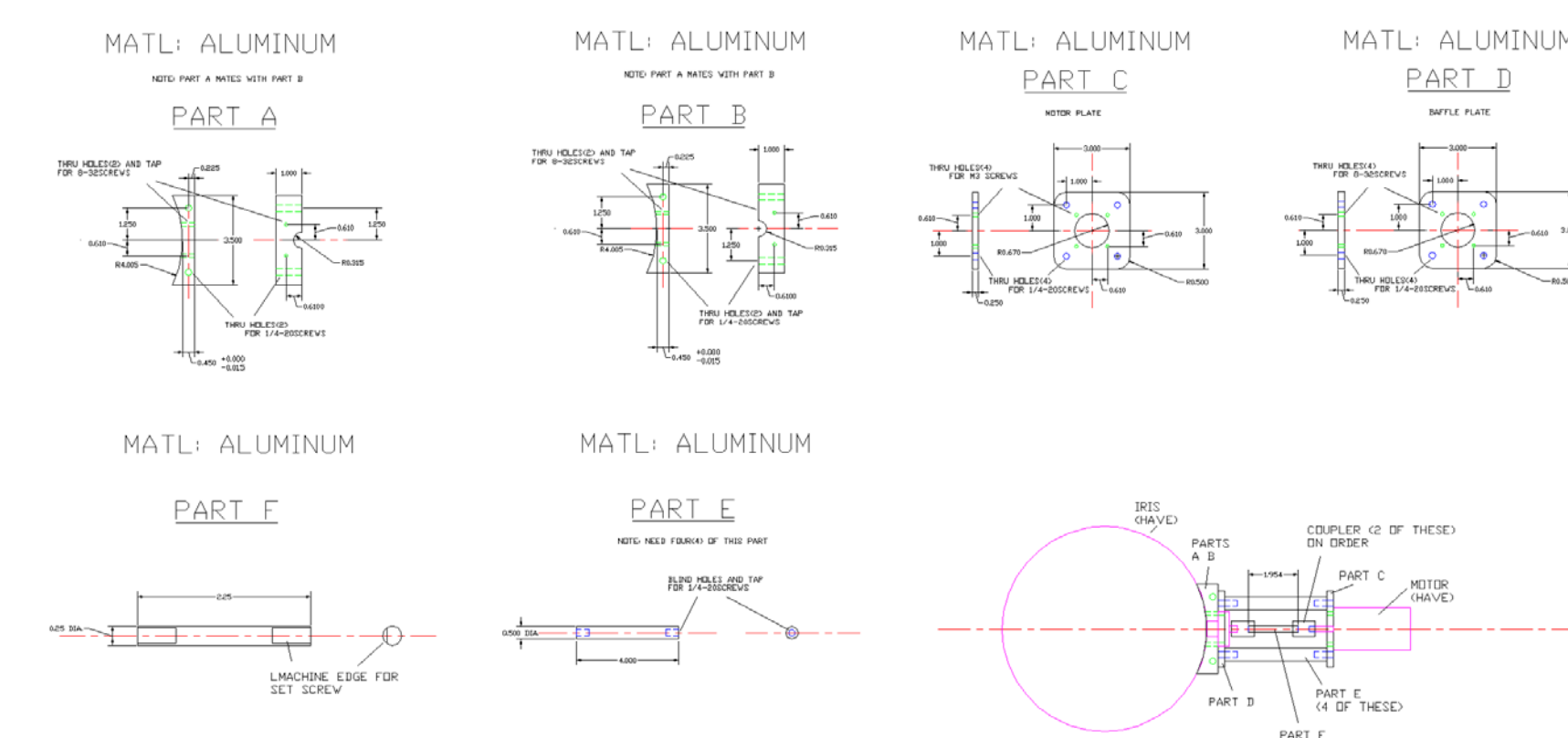


Figure 3

The assembled coupling apparatus is shown in figure 4. The direct connection of the shafts utilizes two anodized aluminum set screw couplers. The couplers dampen the accelerating and decelerating torque between the motor and valve and are connected by a small rod. The fitting sizes of the couplers vary due to the diameter of the drive shaft.



Figure 4

The power supply for the control motor is shown in figure 5. It will be mounted in a rack away from the ion source. The power supply will be properly grounded to the rack and covered for electrical safety. A red LED is mounted on the face plate of the box to indicate whether or not the power supply is on, pictured in figure 6.

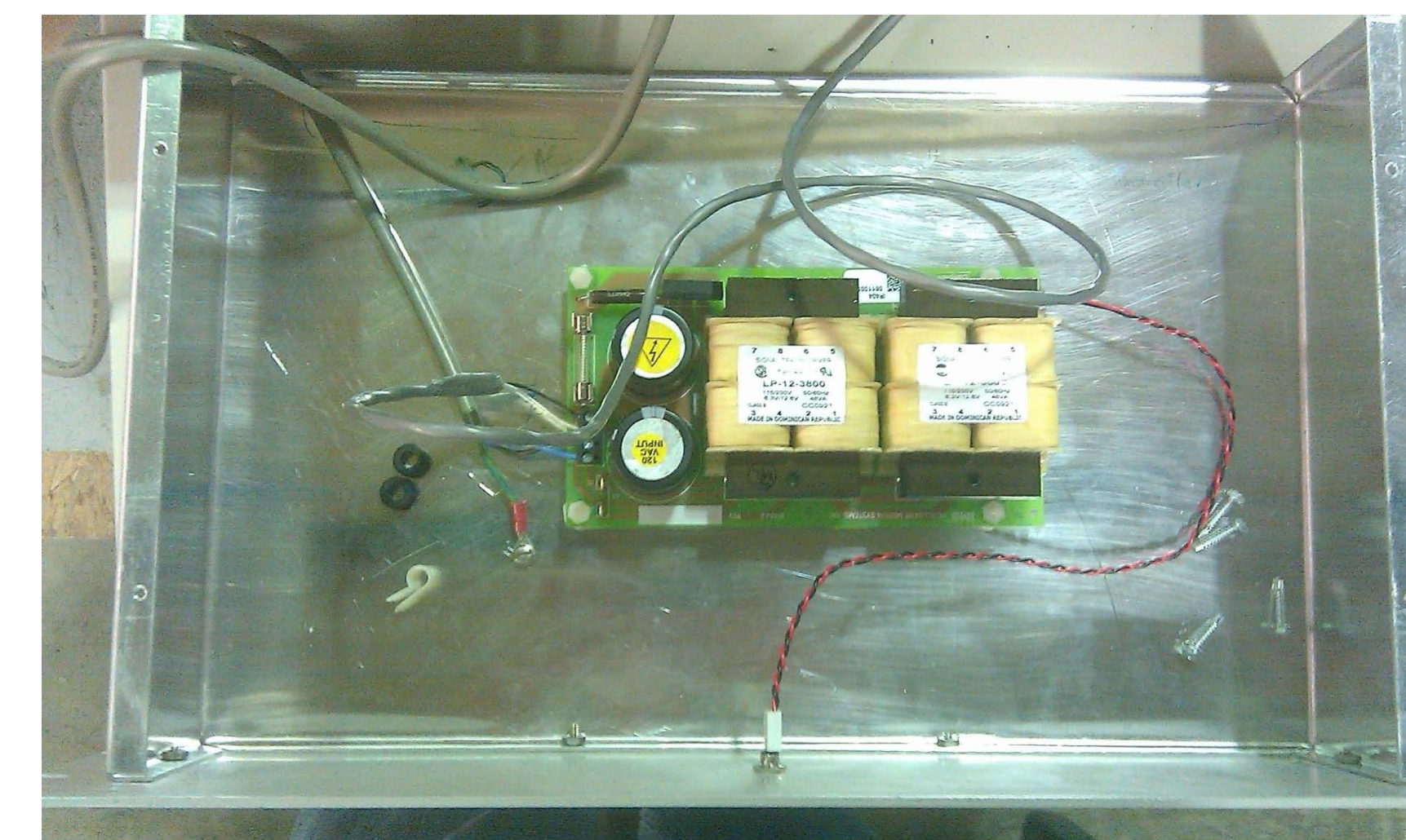


Figure 5

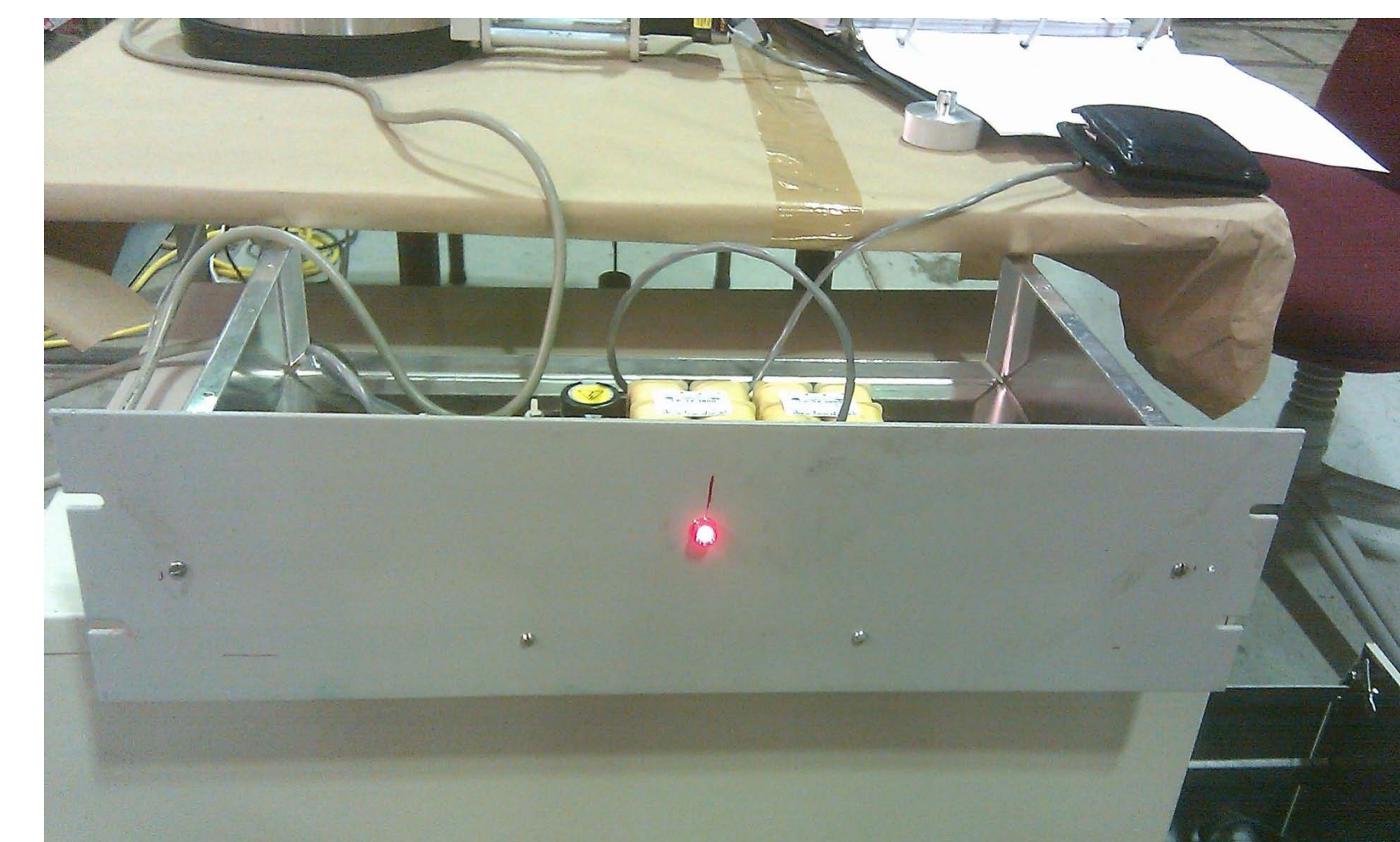


Figure 6

A direct translation from the motor encoder to the desired size of the iris diameter in inches requires an equation. For ease of translation in later programming, the open position of the iris was set as the home position for the motor. The iris diameter and the motor's units of movement were both recorded at certain intervals of about 200 motor units. This would equate to approximately one tenth of an inch. A plot of the data taken and two different fits are shown in figure 7 and 8. The better of these two fits is a 3rd order polynomial and was found to produce more accurate results when tested.

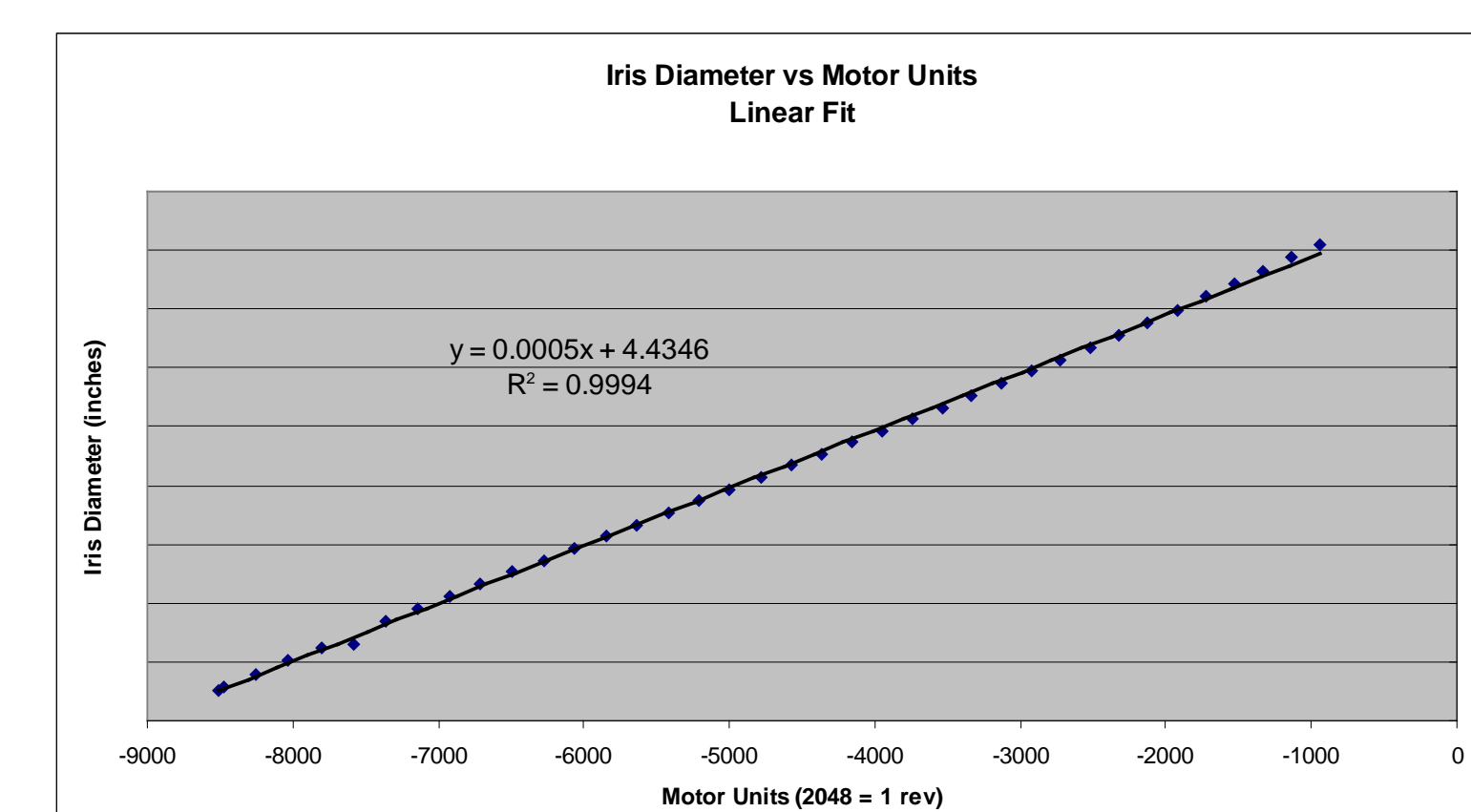


Figure 7

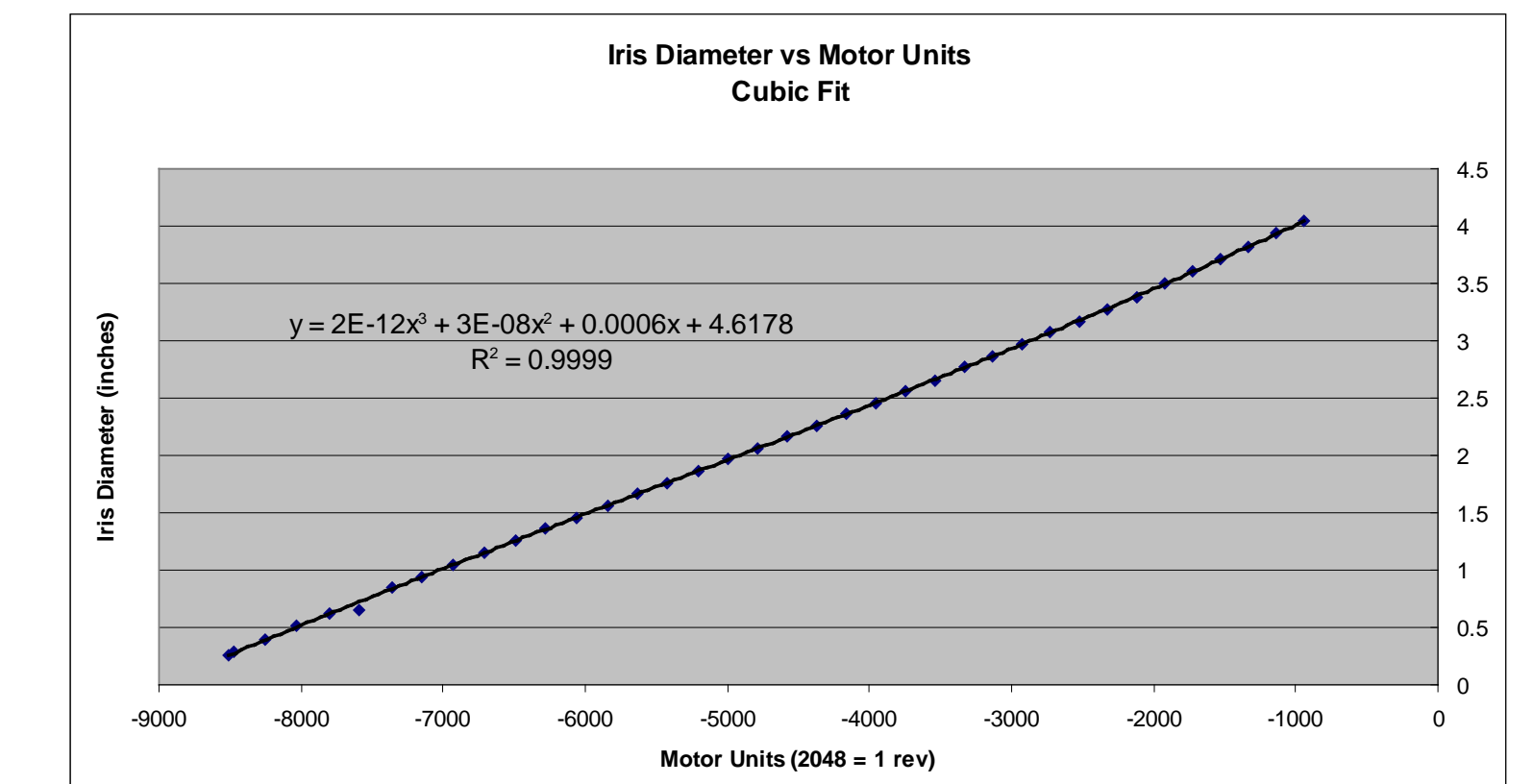
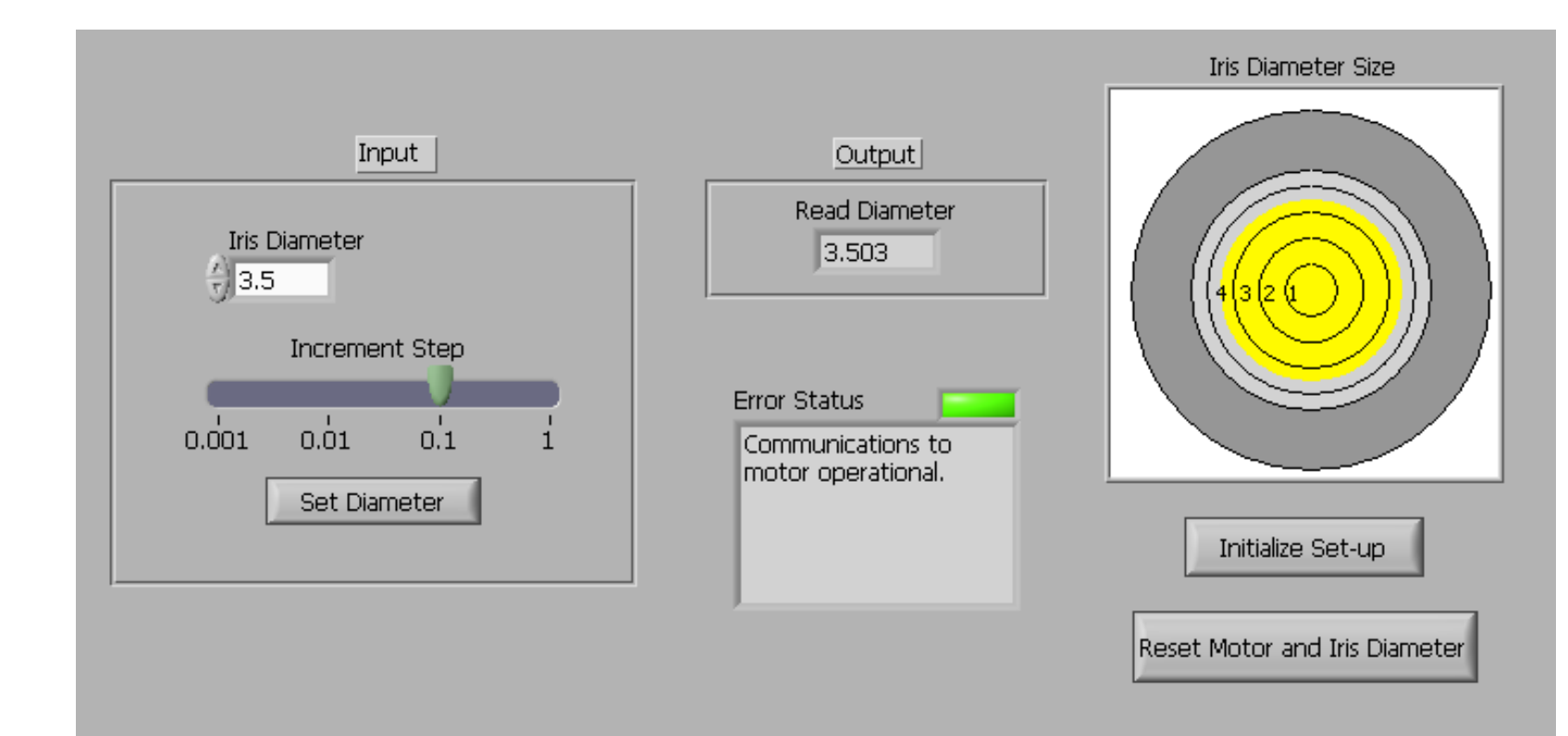


Figure 8

Programming

An interface for remote user control was designed through the use of LabView software. The interface itself is not only a unit converter but a package of routines necessary to identify the operational status of the motor. The interface is shown below.



The program itself runs continuously to allow individual buttons to be activated within one session. Below the input for the iris diameter is a sliding bar which allows the user to select an input resolution. Regardless of the precision of a conversion, there are still imperfections within the equipment, such as, friction between moving parts. Moving to diameters smaller than 1" can prove a challenge to the driving power of the motor and might cause it to stall. Because of this, the indicator labeled "Read Diameter" reads the true units the motor moved and converts it back to inches. Another aid to the user is a scaled picture of the motor which reads the true diameter of the iris and indicates its open area in yellow. The box below the true diameter is the operational status of the motor. If there is no communication to the motor or if the input diameter is out of bounds, the LED will turn red and the error will be displayed as text. The button labeled "Initialize to Default Value" will read the current of the position of the motor without moving it. In case of power failure or loss of data, the last button will reset the motor preferences and the iris to a fully opened position.

Future Applications

Gas Baffle for the Light Ion Guide for the Upgrade Project
Beam intensity attenuator for the injection line

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References

- [1] H. L. Clark, F. Abegglen, G. Chubarian, G. Derrig, G. Kim, D. May, G. Souliotis and G. Tabacaru, *Progress in Research*, Cyclotron Institute, Texas A&M University (2009-2010), p.V-12 – V-17
- [2] H. L. Clark, F. Abegglen, G. Chubarian, G. Derrig, G. Kim, D. May, G. Souliotis and G. Tabacaru, *Progress in Research*, Cyclotron Institute, Texas A&M University (2010-2011), p.V-2