4. Operating Instruction
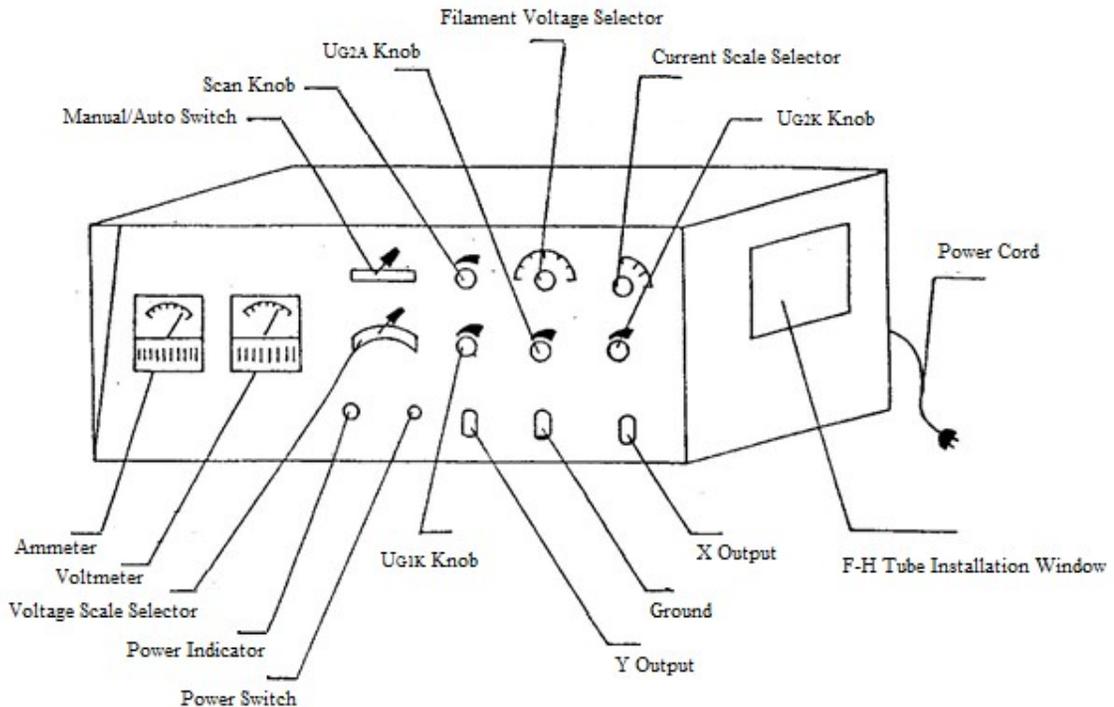
Figure 3 Schematic of apparatus

Prior to operating the instrument, please read the warnings in Section 5 below.

1) Make sure the instrument is unplugged, remove the cover of the Franck-Hertz tube installation window, insert the Franck-Hertz tube into the lamp socket, and restore the cover.
2) Turn the four voltage adjust knobs anti-clockwise to minimum.
3) Plug power cord to power supply. Turn on the power, and preheat the apparatus for 5 minutes.

Record data from panel meters:

4) Set "Manual/Auto" switch to "Manual", "Scan" knob anti-clockwise to end, "Filament Voltage" selector to U_H =3.0~5.0V, and "Current" scale selector to 10^{-8}.It is recommended to set Filament voltage at a relatively low voltage at the beginning, e.g. 3.0 V. If later the current observed is too small,then increase the filament voltage gradually.
5) Set "Voltage" scale selector to 1.3 ~ 5V, and rotate U_{G1k} knob until the voltmeter reads 2.5 V (U_{G1k}=2.5V).
6) Set "Voltage" scale selector to 1.3 ~ 15V, and rotate U_{G2A} knob until the voltmeter reads 4.5V(rejecting voltageU_{G2A}=4.5V).
7) Set "Voltage" scale selector to 0 ~ 100V, and rotate U_{G2K}knob until the voltmeter reads 0V(accelerating voltageU_{G2K}=0V).
8) Rotate U_{G2K}knob while observing the readings of both ammeter and voltmeter.As U_{G2K} (accelerating voltage) increases, the ammeter reads peak and valley periodically.

Record the corresponding voltage and current values and plot the acquired $U_{G2K} \sim I_A$ curve.

Do measurements using an oscilloscope:

9) Set "Manual/Auto" switch to "Auto", and connect the Y output, ground, X output of the apparatus to an oscilloscope. Set the scanning mode of the oscilloscope to "external X". Adjust the Y- and X-shift and X-gain of the oscilloscope if necessary. Turn "Scan" knob of this instrument while observing the waveform on the oscilloscope. In this case, the accelerating voltage adjustment knob is deactivated. Adjust the Y-gain and X-gain of the oscilloscope to optimize the waveform on the oscilloscope. Turn "Scan" knob clockwise to end (now the scan voltage is at the maximum approximately 60V), measure the horizontal distance of adjacentpeaks in terms of grids, and convert the number to voltageusing the referencesawtooth waveform on the oscilloscope(**Note: the output voltage at the "X-Output" terminal is attenuated by a factor of 10 from the actual U_{G2K} voltage which is applied on the F-H tube. So, the voltage measured by the oscilloscope should be multiplied by a factor 10).** The obtained value is the 1st excitation potential of Argon atoms.

10) If the oscilloscope is a digital oscilloscope with a USB port, the experimental data can be acquired from the oscilloscope to a PCfor processing as shown in Figure 4. Using X-Y mode, a Lissajous figure is displayed.
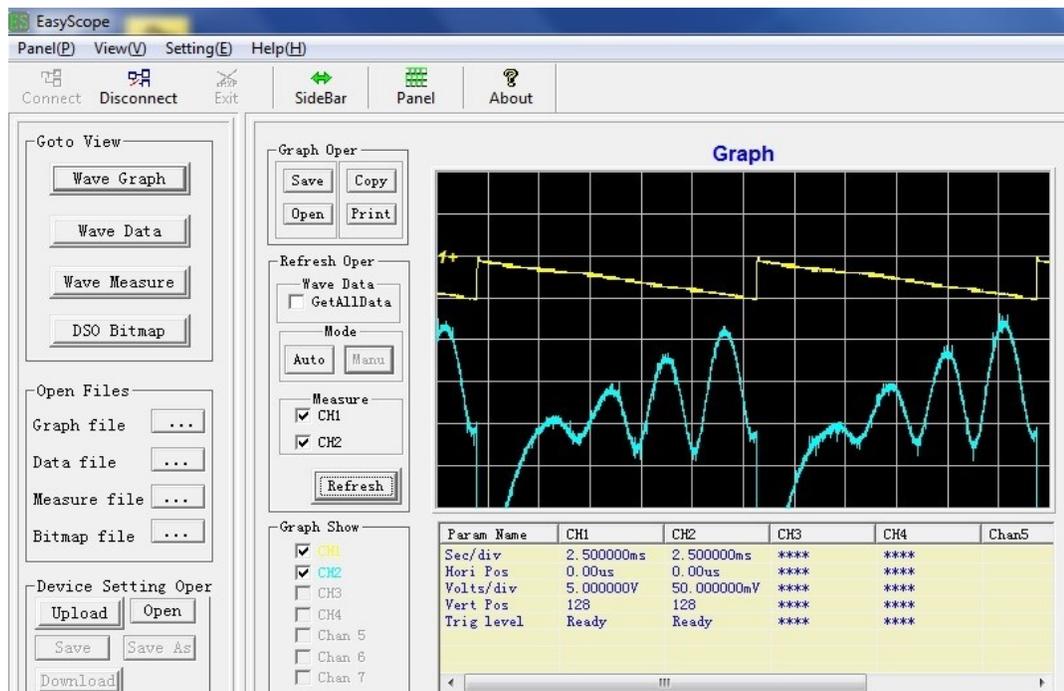
Figure 4 Experimental waveform acquired by PC from oscilloscope

Do measurements using application software (Optional):

11) If the optional DAQ device is equipped, the corresponding data acquisition software named "LEAI-30DAQ" will be provided with this apparatus for PC use via a USB port.By running this software, the relationship curve between plate current (I_P) and accelerating voltage (U_{G2K}) can be acquired by PC as shown in Figure 5, in XY mode

or YT mode, respectively. An instruction for installing and using this program is given in Appendix. The waveform data shown in Figure 5 can be saved into a text file with a file extension of "txt", which can be further imported to Excel for subsequent data processing and analysis.
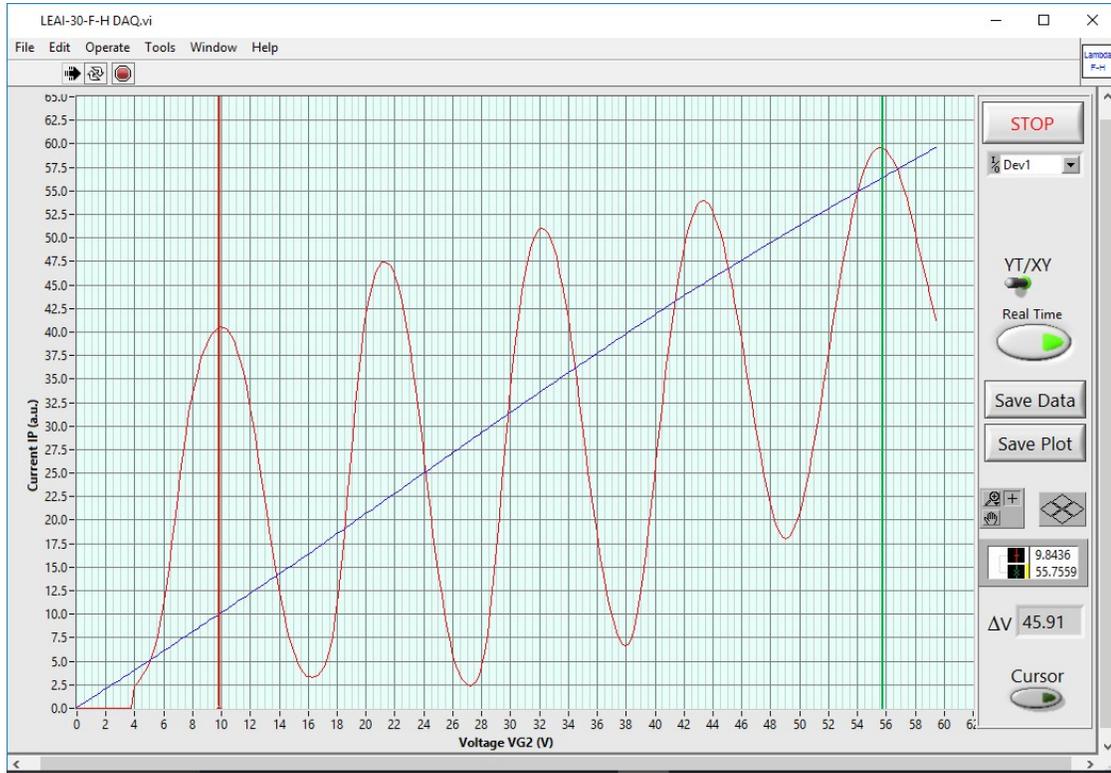
Figure 5 Experimental waveform acquired by software to PC

12) To determine the location of each local minimum (valley) or maximum (peak) of the above waveform with high accuracy, the data segment around each local minimum or maximum should be curve-fitted to a quadratic polynomial function using Excel, as shown below

$$I_A = aV_{G2K}^2 + bV_{G2K} + c$$

Thus, the location of each local minimum or maximum can be determined as

$$\left(V_{G2K}\right)_{min/max} = -\frac{b}{2a}$$

Using the derived minimum/maximum locations, the 1st excitation potential of argon atoms can be calculated.

Using the acquired 1st excitation potential, calculate Planck's constant h based on the formula: $h = eV_1\lambda/c$ (where e=1.602×10^{-19} C, λ=106.7 nm, and c=3×10^8 m/s) and compare it with the accepted value (h$_0$ = 6.626 × 10^{-34} J•s).