# Low-Cost Computer-Controlled Power Supplies for Optimization and Control of Electron Spectrometers

**Ahmad Sakaamini*[2], Matthew Harvey*, Andrew James Murray*[1]**

* Photon Science Institute, School of Physics & Astronomy, University of Manchester, Manchester M13 9PL, UK.

**Synopsis** New Arduino-based power supply designs are presented that have direct applicability to electron spectrometers such as the (e,2e) spectrometer that is used in Manchester. Voltages from these supplies can be manually selected using digital potentiometers, or can be remotely controlled using LabVIEW. These new control routines allow the apparatus to explore both ground state and laser-excited targets.

New computer controlled power supplies have been designed using an Arduino microcomputer as the interface between the power supplies and personal computer system, as shown in figure 1. The supply voltages to the experiment can either be adjusted manually using a set of digital potentiometers, or can be directly controlled by a personal computer using LabVIEW. All power supplies are optically isolated from ground, so that they can be used for either electron detection or ion detection by changing their relative common point.

The Arduino also monitors analogue signals from the apparatus to determine different experimental parameters. These range from the vacuum pressure through to the angles of the electron analyzers and electron gun. All signals to and from the Arduino to the control computer are via a USB interface.

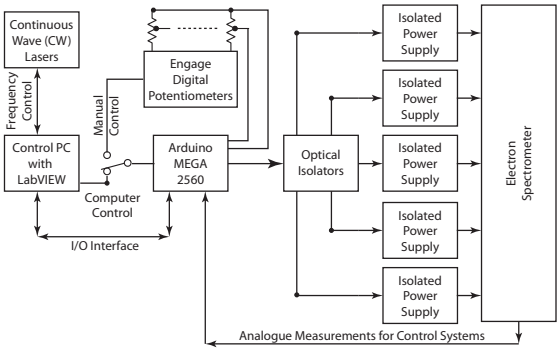


**Figure 1.** Block diagram of the new interface and power supplies that are currently being installed on the (e2e) spectrometer in Manchester.

The control computer can hence be used to optimize the spectrometer for different experiments, using the same type of Simplex routine that has been adopted in the (e,2e) spectrometer in Manchester since 1992 [1]. In this way the control systems operate and optimize the spectrometer 24 hours/day for long periods of time without user intervention. The new supplies are currently replacing the older supplies that have been operating successfully on this experiment for many years [2].

A further cost advantage of the new design is that the coincidence signal from the experiment is monitored by a software-built Multichannel analyzer (MCA) that operates under LabVIEW. The electron detectors are amplified using home-built preamplifiers [3], further saving on the cost of the instrument, and making any component failures easy to fix.

By modernizing the computer interface to the spectrometer, new experiments become possible, including ionization measurements from laser-excited atoms. These new experiments require the laser systems to be frequency controlled to ~1 part in $10^{10}$ for long periods of time, and this becomes possible by interfacing the laser control systems through the common LabVIEW hierarchy. Control of the lasers will be achieved by using the same optimization routines as adopted for the electron spectrometer, as shown in figure 1.

Full details of the new supplies and the interface will be presented at the conference, as well as experimental results that have been taken with the spectrometer using these new supplies.

## References

[1] A. J. Murray *et al Rev. Sci. Inst.* **63** 3346 (1992)
[2] A. Sakaamini *et al J Phys. B* **49** 195202 (2016)
[3] A. J. Murray *Meas. Sci. Tech.* **23** 107001 (2012).

[1] E-mail: Andrew.Murray@manchester.ac.uk

[2] E-mail: Ahmad.Sakaamini@postgrad.manchester.ac.uk