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A Simple Internal Active Field Compensator For Post Column Spectrometers

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Many factors affect the resolution seen in an energy loss spectrum. In real world settings stray magnetic fields can often be a significant factor. Conventional field compensation systems rely on 3 or 6 coils covering the whole room, or just mix in a pre set amount of mains frequency [1]. We built a system that uses a coil in the prism and a small sensor to detect and correct fields of mains and its major harmonics frequencies.

In most energy loss spectrometer installations the "usable" resolution is determined by a combination of the energy spread of the beam and environmental conditions. The energy spread of the beam can be improved by reducing the beam current, going to a different source or using a monochromator. The most common environmental problem that affects spectrometers is stray AC fields. These are always best dealt with by removing the source of the field or moving the microscope however this can be impractical.
The authors have noted an empirical formula for resolution loss vs field.

$$1\text{mG} \sim 1\text{eV}$$

Typical rooms have 0.1 to 1mG fields. This requires field compensation. Gatan post column systems, SEELS, PEELS, GIF and ENFINA used a system of mixing in a user set amount and phase of line frequency. This works well in many situations where most of the field is at line frequency AND constant over the coarse of the day or experiment. Typically these fields are generated on the TEM and accessories, from monitors, computers, diffusion pumps etc. as long as the field is not too strong (<1mG) this works well. If the frequency is a long way from mains it normally has an obvious and easy to track cause i.e. trams, underground trains. This system is not aimed at fixing these types of problems, moving the laboratory is the best solution. More common problems are frequencies close to mains and harmonics of mains (100 and 150 in Europe and part of Japan and 120 and 180 Hz in US and other parts of Japan). The system described here will correct these problems.

A standard Gatan prism current source was modified to accept a signal from a field sensor rather than the line power for the source for the ac corrector. This sensor gave a flat response from 25Hz to 1KHz. This covers the most problematic regions. The signal was suitably amplified and then fed into the normal ac field compensator coil in the prism.
To test the system a room was setup with a coil at each end to mimic forms of poor environmental conditions. First a pure 60Hz field 5mG field was generated and later a rectified 60Hz field of about 3mG was created. The rectified signal had a large range of frequencies some well outside the range of the system but the strongest field at 120Hz.
The initial tests were done on a FEI Tecnai 20 with a heavily under saturated filament. Figure 1 and 2 show the active system worked in both cases. The system was also tested on a JEOL 2010 in a room with a real field problem, see figure 3. The field problem was better corrected with the active system than the current passive system. A resolution of 0.75eV was achieved with the old system and 0.55eV with the active system.

References
[1] O.L. Krivanek, C.C. Ahn and R.B. Keeney, *Ultramicroscopy* 22 (1987) 103-116

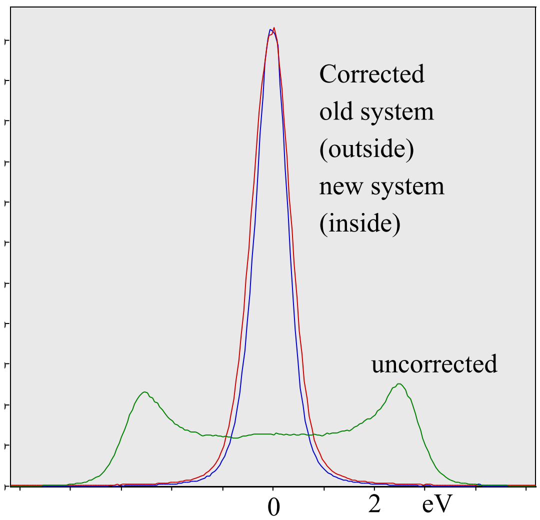

Fig. 1. Effect of 5mG 60Hz field

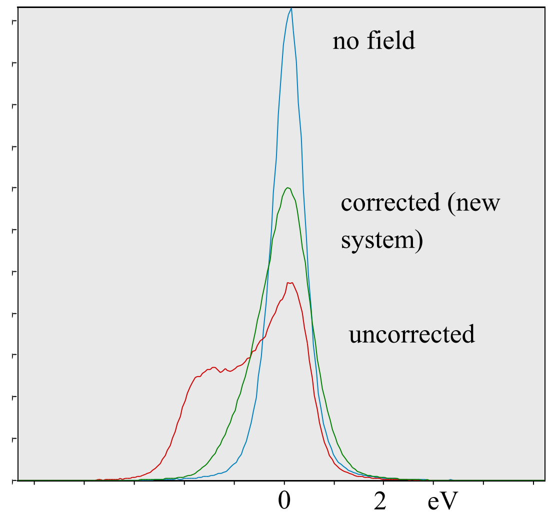

Fig. 2. Effect of 3mG 60Hz rectified field

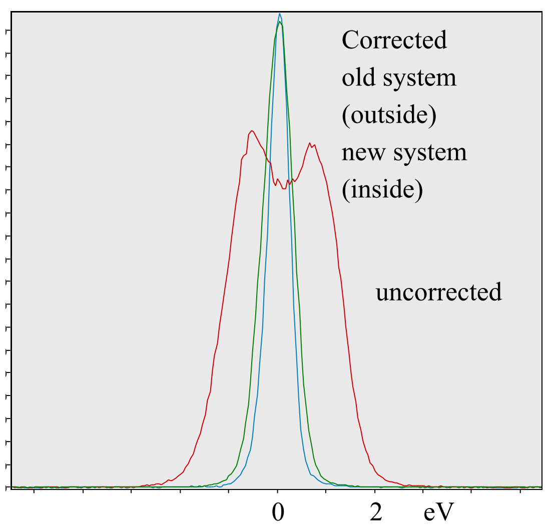

Fig. 3. Comparison of current and new system on real field problem

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