Oscillation camera control for crystallography

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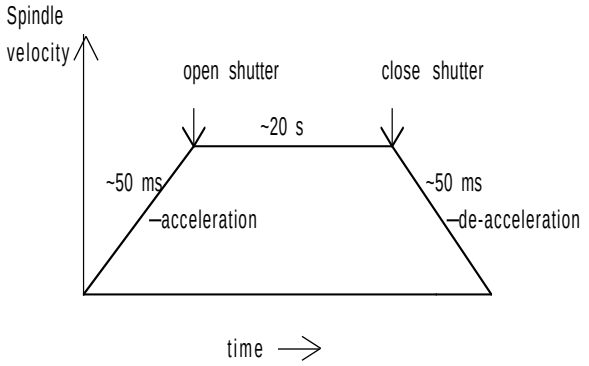


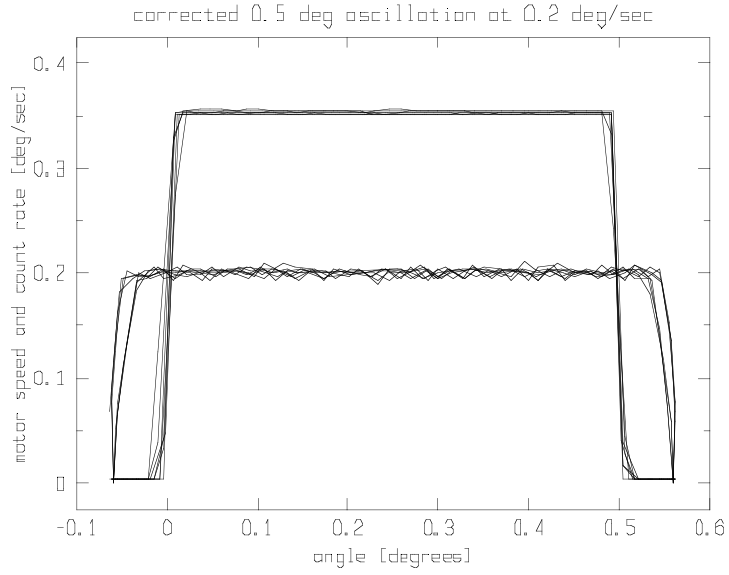
The mechanical requirements of oscillation photography are quite simple: the crystal must move over a well defined angular range at a constant speed. The practical problem is that a stepping motor needs a significant amount of time to speed up and to slow down, and one must compensate for the distance traveled during this time in setting up the oscillation range and in controlling the opening and closing of the shutter.

In a recent F1 upgrade, the program immed has been replaced by oscam, a macro package that performs oscillation scans within the lab-standard diffractometer program spec. Oscam, and camera control program osc, mimic the internal functions of immed while providing a more user-friendly interface. osc is menu-driven, and editing oscillation parameters has been simplified. Rather than specify motor speed, acceleration time, and shutter opening point, then creating loops to do multiple passes, the user now simply provides the range, total exposure time, and sample advance. osc calculates the optimal motor speed and number of passes.

The most important improvements are internal, however. oscam allows us to quantify the performance of the entire system, which could not be done under immed. We discovered flaws in the basic camera behavior, among them that the E500 motor controller did not guarantee the same rate for accelerating and decelerating motors. Since the shutter had been controlled by motor speed, the nonuniform rate resulted in angular passes which did not perfectly overlap.

We found, however, that software corrections, such as delay and offset loops, could not guarantee precision in all experimental situations. Hardware modifications were needed. The shutter is now controlled by an accurate optical angle encoder mounted on the spindle motor and an electronic timing generator, ensuring pinpoint accuracy of the oscillation range. The **figure below** shows both the accuracy and precision acheived. At the start of an oscillation, the spindle is backed off a distance and the motor starts moving. When the spindle passes the starting angle, at full speed, the shutter is opened. After the specimen has completed the full oscillation range, the shutter is closed, and the motor begins to decelerate. At all times the exact position of the spindle encoder is known, and the spindle is always travelling at a constant speed while the shutter is opened.

Other features of osc include precise reporting of the measured range and time of the exposure, graphical depictions of speed and count rate, and automated record keeping to file and printer. The current oscillation camera control system is intended to evolve along with the needs of the crystallographic community, so users should feel free to make suggestions for improvements. Direct your comments to Jim LaIuppa or Tom Irving (607-255-7163).



The bottom curves show the instantaneous velocity of the camera spindle for 3 complete oscillation cycles (six passes). The velocity fluctuations are due to timing errors in reading the E500 motor controller. The top curves show the opened/closed state of the shutter: the specimen is only exposed to x-rays when the spindle velocity is constant.