Servo vs. Stepper motors: Minimum Incremental Motion and Holding Stability in Beamline Positioning

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Many applications, such as X-ray microscopy and Computed Tomography (CT), require positioning of samples, detectors, and optics in order to perform measurements. Microscopy applications often require imaging of the structure of matter at the sub-micrometer and even nanometer level. Good holding stability, both short-term and long-term, is required because movement of the sample, optics, or detector over the time of measurement will cause poor images. Also, the ability to make small mechanical movements on the order of nanometers is often critical for alignment and adjustment of samples or optics.

Stepper and servomotors are two common means of controlling position in mechanical systems used in beamline applications. In this study, the performance of each motor and feedback type is evaluated for minimum incremental motion, short-term stability, and long-term stability.

Our testing results show that servomotors outperform stepper motors in terms of long-term holding stability and minimum incremental motion, and rival the performance of screw-driven stepper-motor stages for shorter-term holding stability (in-position jitter).

The positioning system will play an ever-increasing role in achieving high-quality images. The capability for extremely fine positioning and stability makes both linear and rotary servomotors an excellent choice for applications in which achieving sub-micrometer or even nanometer precision in sample and optics positioning is critical.