Nanometric positioning using a Stewart platform for the CEA–CNRS FAME-PIX ptychography beamline at the ESRF

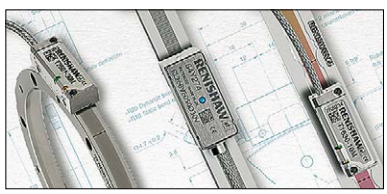
As part of the development of the FAME-PIX ptychography beamline (CRG CEA–CNRS) at the ESRF synchrotron (Grenoble, France), a Stewart-type hexapod is used to ensure the precise positioning of the focusing mirrors and the sample holder. This beamline implements an innovative approach to ptychography, a lensless microscopy technique based on the analysis of far-field diffraction patterns (Fourier transforms), obtained through controlled nanometric-scale movement of the sample.

The uniqueness of FAME-PIX lies in its use of a secondary optical system composed of Kirkpatrick–Baez mirrors mounted on a large optical table measuring 2000 × 1500 mm (see image, top right). This table supports the entire secondary optical system, as well as the sample, with a total mass of approximately 800 kg.

The positioning of the table is secured by a JORAN hexapod, developed by Symétrie. This system enables precise positioning in six degrees of freedom, ensuring the alignment of the secondary optics with the synchrotron beam.

The hexapod's actuators must achieve extremely high motion resolution (minimum incremental motion) to allow the optimal alignment of the mirrors. Once the correct position is reached, stability is crucial: it must remain below 0.1 µm in translation and 1 µrad in rotation.

To meet these requirements, the actuators are equipped with RESOLUTE encoders and RELA measurement scales made of ZeroMet and provided by Renishaw, offering a resolution of 5 nm. These compact and robust scales integrate seamlessly into high-precision actuators while ensuring excellent reliability. Stability is enhanced by control algorithms specifically developed for the system,



incorporating a thermomechanical model of the actuators to compensate for environmental effects in real time.

Indeed, the Renishaw RESOLUTE optical absolute encoder measures absolute position with fine resolutions down to 1 nm and high speeds up to 100 m/s. Advanced optics and innovative position determination algorithms deliver exceptional metrology performance. The low sub-divisional error and ultra-low noise (jitter) also make it suitable for demanding motion-control challenges.

The whole product range includes linear, partial arc and rotation encoders (see image above). Application-specific variants include the RESOLUTE ultra-high-vacuum (10^{-10} torr) and the RESOLUTE extended temperature range (from −40 °C up to +85 °C).

Optional advanced diagnostic tools and the ADT View software can provide comprehensive real-time encoder data, allowing optimisation and in-field fault finding. The BiSS-C interface is also directly integrated into the controllers, enabling absolute position measurement and perfect repeatability at startup, without the need for recalibration.

By combining world-class expertise in their relevant domains, Symétrie and Renishaw have made the challenging realisation of an advanced scientific hexapod possible.

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