Space Optics Testing and Metrology with Newport Hexapod

A well known research institute in East Asia develops large-scale aspheric optical mirrors and lenses for space applications. The mirrors, manufactured with a high surface quality of $\lambda/30$ rms and a diameter up to 2 m, are used in high resolution satellites or large telescopes. In the testing process of the space optics, a Newport HXP series Hexapod 6-axis parallel kinematic motion positioner plays an important role for metrology and quality control.

Due to a high cost of launching payloads into space, researchers have discovered ways to reduce size and minimize weight of optical systems used in the satellite. To produce a smaller overall packaging that is lighter and more cost-effective, a single large high precision aspheric lens or mirror has replaced multi-lens array that is more complex in design. As image quality is a key element of the optical system, surface quality of this monolithic aspheric lens or mirror is fully characterized after fabrication in order to avoid possible deterioration of overall imaging in satellite CCD camera.

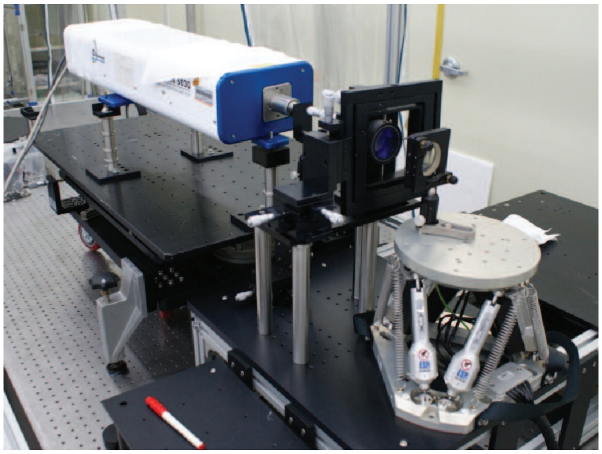

Figure 1: An example of setup to characterize an aspheric lens using HXP100-MECA

In the test setup, a small reflective mirror or a lens, which represents a CCD camera inside the satellite, is mounted on a motorized platform for measurements of Modulation Transfer Function (MTF) and Wavefront Distortion Error (WDE) of the device under test (DUT), which is the large aspheric lens or mirror placed in the beam path. When a collimated beam passes through or gets reflected from the DUT, the change in shape of a wavefront is observed and compared to the incident wavefront, providing an indication of the optical surface quality. As the DUT comes in various sizes and requires testing under varying incident beam angles, the controlling optics need five distinct freedoms of motion: two for positioning to the center of incident beam, two for tip-tilt adjustment and one for focusing along the optical axis.

As it became evident that alignment is the most labor-intensive and time-consuming part of testing process, researchers approached Newport for a Hexapod solution as an alternative to their existing setup using motorized linear and rotary stages in a combined stack. With the stacked stages, it took several days to reconfigure the setup for a new DUT, mainly because it was difficult to relocate the pivot point of the optics following any change in height of optical axis or focal distance of the mirror or the lens. Moreover, due to an error contributed from each axis movement in the stack, it was not easy to estimate the travel lengths required in all axes to reach a desired position in 3-D coordinate within a tight tolerance.

Thanks to dual coordinate systems provided by the Hexapod control algorithm and its ability to define virtual pivot points, overall production cycle times are greatly reduced, minimizing the cost of operation.

"It took almost one week for an optical system qualification and characterization process before arrival of the Newport hexapod. Now, it takes no more than two days for us to complete the test cycle", a researcher says.

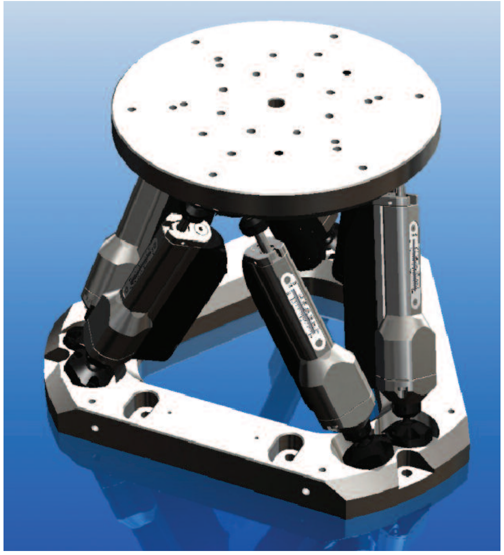

Figure 2: Newport HXP100-MECA assembly

The Newport HXP100 series Hexapod, driven with six high performance DC servo motor LTA actuators, provides six degrees of freedom that are X, Y, Z, pitch, roll and yaw. A virtual pivot point allows the user to freely choose the rotation center and it helps minimize the time to reconfigure the setup, following any shift in the position of optical components or beam orientation. The HXP100 provides an option to relocate the entire coordinate system so that a single user-defined coordinate system can be used to control all the active components including laser beam, DUT and reference optics. A dedicated Hexapod controller HXP100-ELEC provides a high speed Ethernet TCP/IP communication interface, advanced motion profiler with synchronized control and various software program libraries including LabVIEW to help ensure a smooth programming for integrated software control in user environments.

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Travel range (X)	±29 mm
Travel range (Y)	±26 mm
Travel range (Z)	28 mm
Travel range (Θx)	±12°
Travel range (Θy)	±10°
Travel range (Θz)	±20°
Min. incremental motion (X, Y, Z)	0.5 µm
Min. incremental motion (Θx, Θy, Θz)	5 µrad
Repeatability (X, Y, Z)	0.5 µm
Repeatability (Θx, Θy, Θz)	17 µrad
Max. speed (X, Y, Z)	1 mm/s
Centered load capacity	200 N
Rigidity (Z)	40 N/µm

Newport provides a number of different Hexapod configurations to help meet the diverse applications needs such as optics and satellite assembly and testing, alignment, biotechnology, X-Ray diffraction study and micromachining. The HXP1000 series is available for larger travels and higher load capacity up to 5000 N and the HXP50 series provides a low profile, smaller travels and higher speeds at a reduced cost. A vacuum compatible version is also available upon request.

For additional information, please contact Newport applications and sales engineers at tech@newport.com.