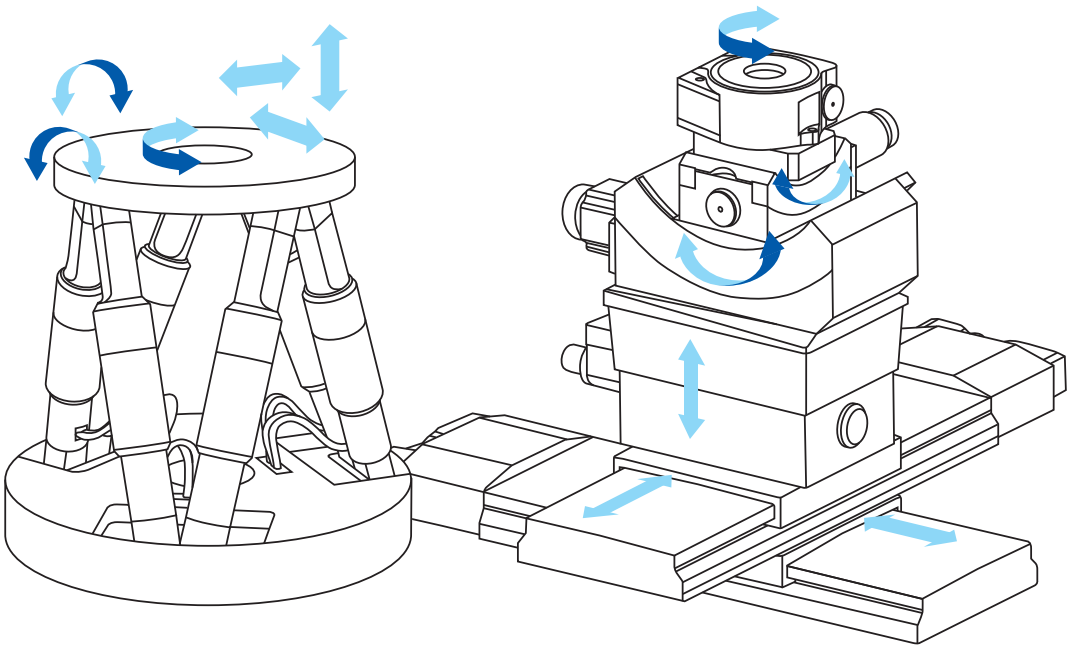
Parallel-Kinematic Precision Positioning Systems

Six Axes of Motion with Hexapods and SpaceFAB



Compact Positioning System with Six Degrees of Freedom

Hexapod platforms are used for moving and precision positioning, aligning and displacing loads in all six degrees of freedom, i.e. three linear and three rotational axes.

Hexapods have a parallel-kinematic structure, i.e. the six drives act together on a single moving platform. The length of the single drives can be changed so that the system moves in all six degrees of freedom in space. This special Hexapod design optimizes the overall system stiffness and allows for a large central aperture.

Precise Positioning Even of Heavy Loads

Depending on their design, Hexapods can position loads from several kg up to several tons in any spatial orientation, in other words independently of the mounting orientation and with submicrometer precision.

Advantages over Serial-Kinematic Design

Hexapods can be designed considerably more compact than serially stacked multi-axis positioning systems. Since only a single platform, most often provided with a large aperture, is actuated, the moving mass of the Hexapod is significantly smaller. This results in improved dynamics with considerably faster response. Furthermore, cabling is no issue, so that no additional forces and torques reduce the accuracy.

In case of stacked systems, the lower axes not only move the mass of the payload but also the mass all other following drives. This reduces the dynamic properties and the total system stiffness. Moreover, the runouts of the individual axes add up to a lower accuracy and repeatability.

Cardanic joints of the H-840 Hexapod model

Ball-and-socket joints

Matching Components for High Precision

The basis is a zero-backlash structure and carefully selected and matching components. This includes first of all the right material selection, when e.g. thermal effects are to be expected at the place of operation. The motor, if necessary with gearhead, an integrated guiding, the leadscrew/nut unit, as well as the joints for the required load range up to high-resolution position detection in every strut – all these elements determine the achievable precision.

Motors and Drives

PI Hexapods are based on electromechanical drives and are much more accurate than the hydraulic Hexapods known from flight or driving simulators. Precision leadscrew drives or piezo linear motors are used. Most systems are self-locking. Direct-drive Hexapods ensure higher velocities; for industrial use, brushless motors (BLDC) are particularly suitable.

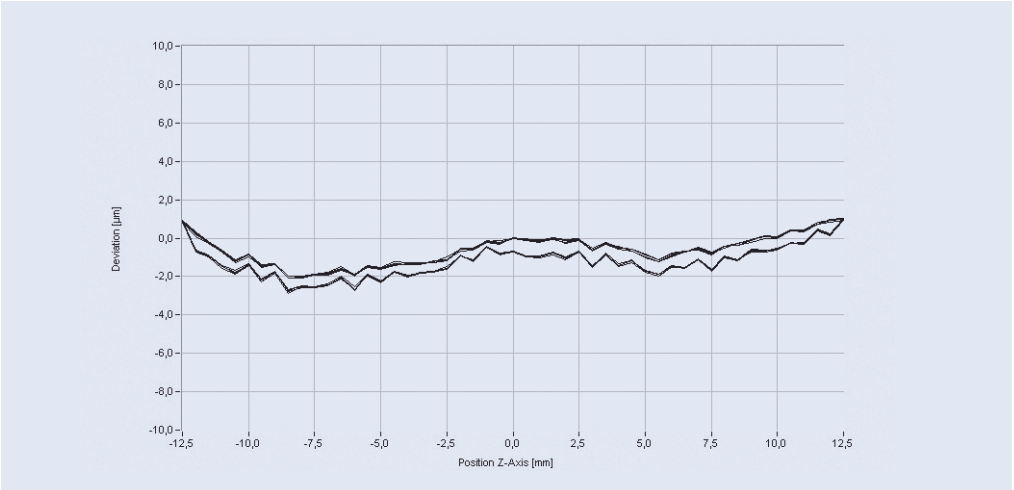
The application determines the drive technologies: Hexapods with piezoelectric PiezoWalk® stepping drives are suitable for ultrahigh vacuum applications and can also be operated in very strong magnetic fields.

Joints

Hexapods for precision positioning often have Cardanic joints with two orthogonally arranged axes. This is the optimum combination of two degrees of freedom and the stiffness of the structure.

Ball-and-socket joints offer more degrees of freedom in a relatively simple design. However, the overall stiffness and precision in case of external loads and torque can suffer. A compensating preload is recommended but requires drives with high output forces such as the NEXLINE® piezomotor drives.

If the highest precision and few linear bending displacements and angles are required, flexure joints are recommended. They exhibit neither friction nor backlash and do not require lubricants.



The positioning accuracy of a precision H-824 Hexapod in Z direction over the complete travel range of 25 mm is a few micrometers, and the repeatability is considerably below ±0.1 µm

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