A Simple, Automated, Cost-Effective Solution To Beam Stabilization And Optical Alignment Recovery

Background
Laser based optical systems often have critical alignment requirements that must be attained and maintained to achieve system performance. Changes in pointing angle or position drift can affect the efficiency and performance of active optical elements and directly introduce errors that are propagated throughout the optical path. Eliminating these errors often require careful manual adjustment, which can be tedious, require expertise and direct interaction with the optics that may be remote or difficult to access. To address pointing angle and position drift instability in laser systems, Newport is introducing a compact, robust, modular beam stabilization setup with intuitive software developed for plug and play operation.

As a single point provider of motion control hardware, opto-mechanics, photonics instrumentation and optics, Newport is uniquely positioned to provide an integrated, cost-effective beam alignment and stabilization tool. Beam stabilization is ideal for CW and pulsed laser systems with beam position drift and is an excellent tool for maintaining beam position to previously-aligned optics.

Basic Setup
The beam stabilization kit uses a closed-loop optical path with a motorized mirror mount and integrated beam splitter. The beam splitter divides the beam into a transmitted portion and a pick-off path passed to the sensor. The software sets up a real-time control loop commanding the mirror to compensate for angular pointing errors and return the beam to the fixed reference at sensor center. This naturally, keeps the transmitted beam in the optical path and automatically compensates for angular instability from the laser source or other environmental factors that would cause angular errors.

A real-time display actively follows the beam position with point tracing for monitoring alignment stability. Not only is the beam position provided, but also relative laser power measurements are displayed. Beam stabilization can be activated or disabled at any time.

Adding a second correction loop or module, both pointing angle and beam position drift can be corrected. In this configuration, two loops can be configured sequentially with the optical path entering the next corrective loop. In both configurations, the optical path is not pre-determined and can be customized for easy modular integration with your setup. The software does not require a preferred configuration and the motorized mirror will always be programmed to correct to the sensor’s center position.

Newport Motion offers a wide selection of motorized positioning solutions and the integration of motorized optical mounts in the beam stabilization setup was carefully considered for dynamic performance, in-position stability, compact, modular construction and cost.

The Technologies behind the Kit
To understand the performance considerations of beam stabilization, it is important to look at the technologies behind active positioning and
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The elements in the stabilization are configured with three key components in the dynamic correction loop:

1. Motorized Mirror Mount
2. Position Sensing Detector
3. Beam Stabilization Software

To understand how these elements affect performance, it is best to understand the advantages that each bring to beam correction and alignment recovery.

Agilis Piezo Motor Mirror Mount
The Agilis AG-M100L is an extremely compact mirror mount with integrated piezo motors driving angular adjustments. The adjustment sensitivity is set by the excellent incremental motion capability of each piezo actuated axis (50 nm) which results in 1 urad angular adjustments. The maximum speed of the motor is 0.5 deg/s and angular range is ±2°. The design and holding force of the motor provide excellent in-position stability.

CONEX-TRACC Actuator w/ Compatible Opto-Mechanical Mount
The CONEX-TRACC Actuators are integrated with your chosen Newport opto-mechanical mount providing outstanding in-position stability. The TRA is compatible with a variety of mirror mounts. With a 50 N Axial load capacity, 0.4 mm/s speed and Minimum Incremental Motion capability of 200 nm on each axis, the CONEX-TRA is a cost-effective solution for beam stabilization ideal for numerous operating environments.

CONEX-PSD9 Beam Position Detector
The beam position is monitored by the CONEX-PSD9. Accurate measurements of beam XY position are made with high linearity over the tetra-lateral effect diode sensor. With a 9mm x 9mm sensor size, the CONEX-PSD9 also provides a large target for beam positioning feedback. Suitable for lasers with 320-1100nm (and 1300 nm in the Germanium Sensor) the CONEX-TRA with integrated controller is an excellent tool for beam diagnostics (including relative power measurements). The sensor has a minimum detectable position resolution of 2.5 µm, which can be optimized by configuring the optical path for the highest angular resolution.

Modular Optics
A standard 1” optical beam sampler can be used for beam splitting. Newport provides 1” broadband beam samplers that provide between 1 and 10% Fresnel reflectance with 45° beam incidence angle. An AR coated back surface minimizes ghosting on the sensor face (and has an operating wavelength range from 440-700nm). The setup is not constrained to this type of beam splitter, and the software will operate properly as long as sufficient laser power is detected by the sensor.

Windows Executable Beam Stabilization Software
The beam stabilization software provides an immediate platform for instrument recognition and quick integration. Within minutes the laser is aligned to center reference and held in position by the motorized mirror mount. The software provides an intuitive graphical user-interface that allows the user to define the dimensions of the target area; laser power threshold and motorized mirror mount default position (software default uses motor positions that offer most travel forward/back).

The beam is mapped to a graphical Cartesian plane and calibrated automatically by the software. The user can monitor the correction in real-time during active stabilization or observe the drift at any-time. A real-time feedback of numeric position is provided as well. The stabilization software has been developed to correct, irrespective of preferred optical path and the user can integrate according to the best configuration of the path.

Summary
The compact, modular and cost-effective approach to beam stabilization is intuitive and easy to use, robust, configurable, easily integrated in your preferred optical path and can operate with a variety of laser sources. Driven by Newport Motion technology, the beam stabilization kit is an ideal tool for alignment recovery for beams with slow drift and alignment recovery when changing laser sources.

For more information please contact Newport Corporation Application Engineers at 800.222.6440.