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GEC

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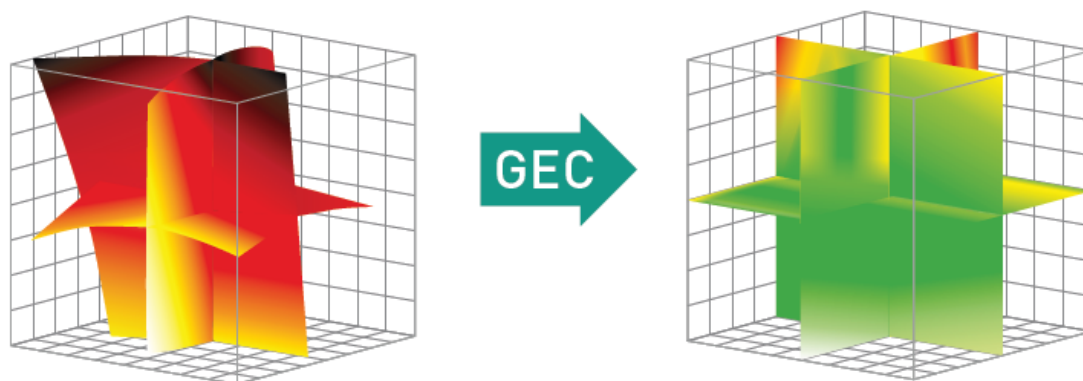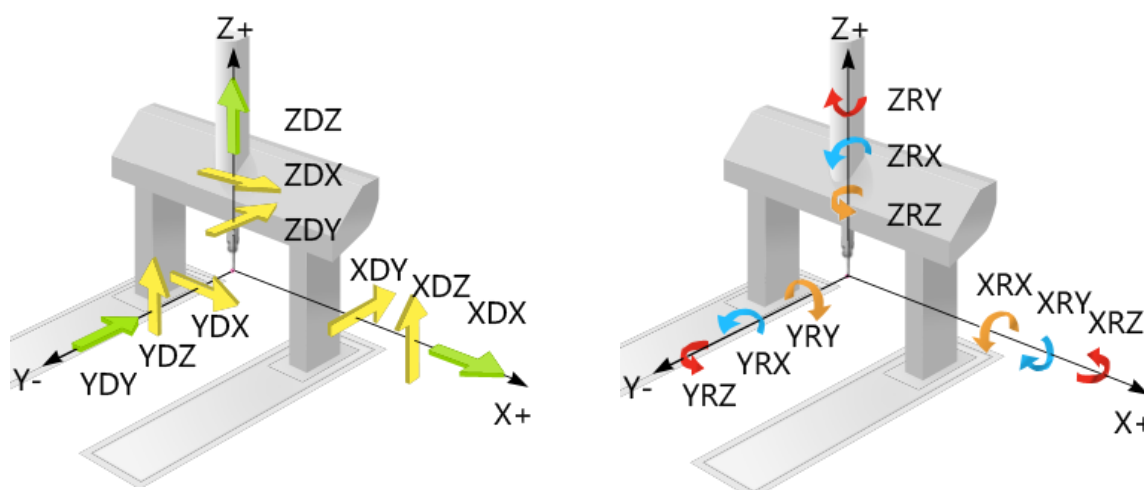## Geometric Error Compensation

Geometric Error Compensation

Geometric Error Compensation (short: GEC) is one of the key technologies in operating Coordinate Measurement Machines (CMMs) today. To ensure a high accuracy of the measurements, GEC not only involves the compensation of inherent geometric errors but also thermally induced errors of CMMs.

Geometric Error Model

A commonly used model for 3 axis CMMs is the 21-parameter error model which involves 9 translational, 9 rotational as well as 3 squareness errors:

9 translational and 9 rotational errors

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Supported CMM types

The GEC algorithm also takes into account the layout of the CMM (moving bridge, moving horizontal arm …) as the kinematic chain of the axes have an influence on how the various errors add up. Currently Pantec's GEC supports the following machine layouts:

- Moving bridge, with axes sequences : Y-X-Z, X-Y-Z, or X-Z-Y
- Moving horizontal arm, with axes sequences : Y-X-Z, X-Y-Z, or X-Z-Y

GEC Options for EAGLE™/CONDOR™ controllers

Full variant (21 compensation parameters + 3 linear thermal expansion coefficients)
For those customers who require a high accuracy, the full 21-parameter error model (including roll, pitch and yaw errors) is available through our driver-based solution. However, this option poses some constraints to the measurement software the customer intends to use: the connection to the controller has to use the Ethernet channel and a recent version of the Pantec Driver has to be interfaced by the measurement software.

Basic variant (linearity, squareness error and linear thermal expansion)
Dynamic temperature monitoring and compensation as well as linearity and squareness correction can be performed **inside** the Pantec controller. The current axis temperature is automatically updated from our T-Bus Sensors. The basic variant is a good option if the measurement software does not support the full variant.

Temperature compensation – direct interface to Pantec T-Bus sensors

To compensate for the effects of thermal expansion a first order correction model is applied. For each scale attached to the CMM a dedicated linear thermal expansion coefficient is defined. If a Pantec T-Bus is connected to the controller, the current temperature data is provided automatically by the available sensors. Each temperature sensor is associated to the corresponding axis. Alternative temperature sensor types may be incorporated via our software interface.

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GEC Setup and Configuration with Pantec Support-Tool SW

For convenience and ease of use, the entire compensation procedure for both the full and basic GEC variant is done through the Pantec Support Tool tuning and analysis software. The GEC Wizard also automizes geometric error capture interfacing both laser interferometer and CMM.

Pantec Support-Tool offers:
- Setup of the GEC configuration
- Schematic mirror setups for each measurement
- Assistance in laser alignment
- Automatic or manual capturing of Laser and machine position
- Review and management of correction parameters in the GEC editor
- Automatic slope correction for straightness data
- Every single error parameter can be enabled/disabled separately
- The compensation project can be stored in a file and recovered

Support-Tool Interfaces to measurement hardware

Currently, the Renishaw laser interferometers XL-80 and ML10 (via USB interface) including their corresponding environmental measurement stations are supported.

The angular error due to roll is commonly not measured by a laser, but by other tools and devices. The user can move the machine in steps along the predefined grid, perform the measurement externally and then enter the deviations into the given fields corresponding to the current coordinates. It is also possible to load external data, as well as scaling and storing the already entered data for later use.

The squareness error is commonly measured with gauges. The values for nominal and measured distance are entered into the corresponding fields on the squareness page of GEC Wizard. The corresponding compensation parameter is computed immediately.

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