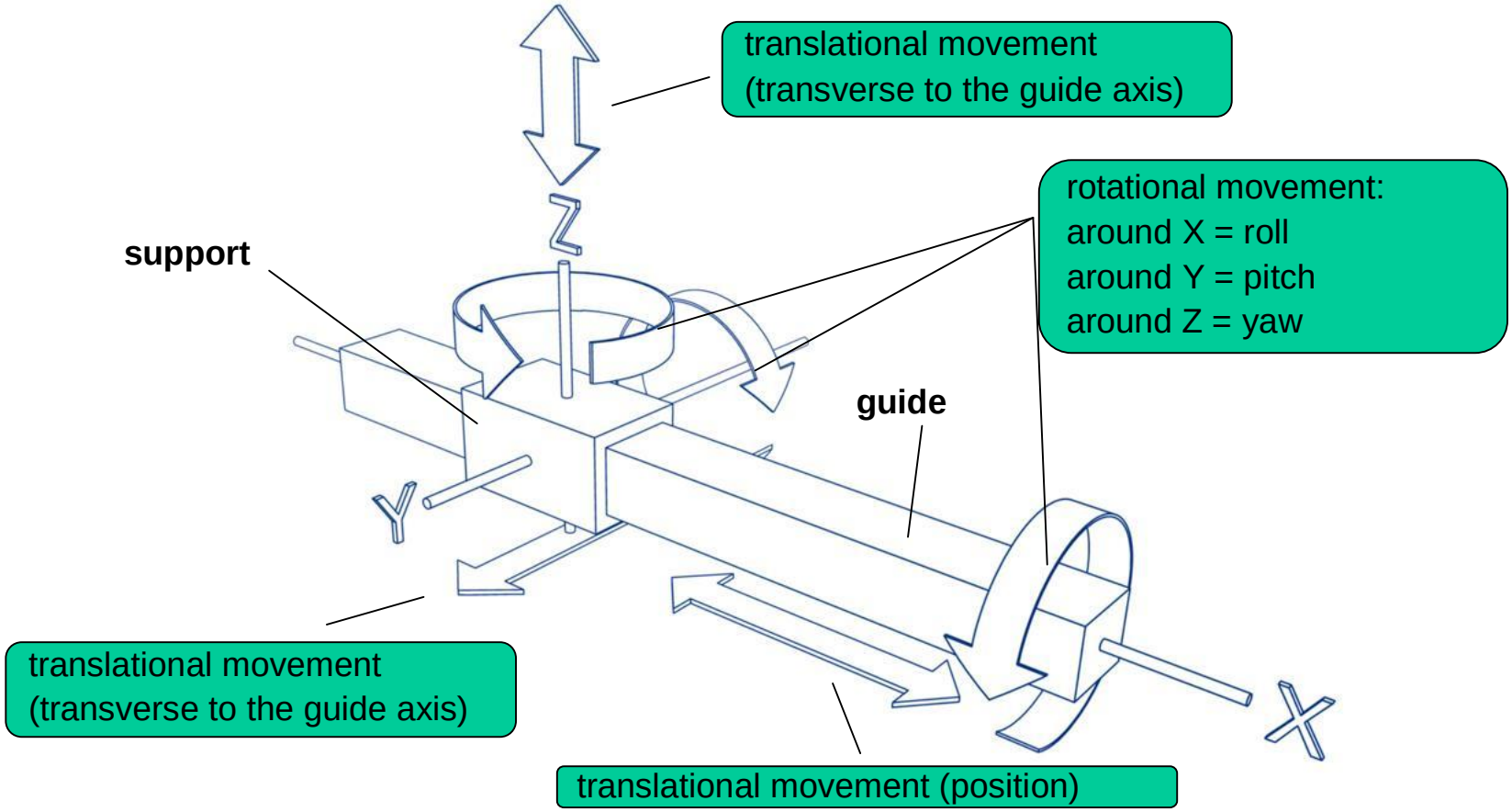
AfM Technology GmbH

Accuracy for Machines

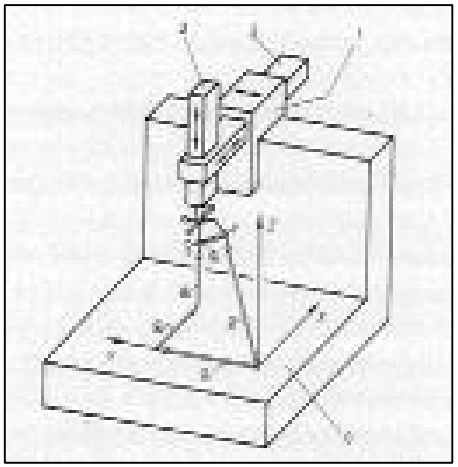
Geometric deviations of one axis

Each linear guide have 6 degrees of freedom, 3 translational und 3 rotational

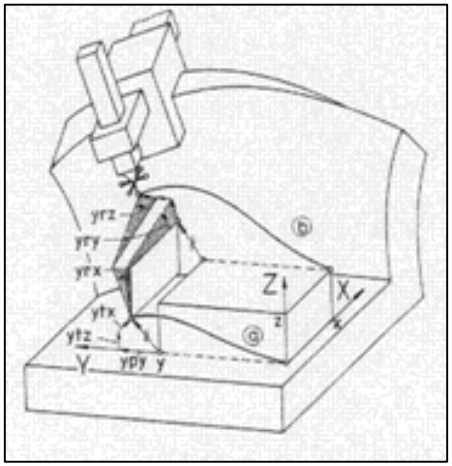


Geometric errors in 3- axes CMM

Ideal



Real



For each linear axis X, Y and Z in total 6 geometric errors can appear (T: Translatory R: Rotatory) :

- **Positioning** XTX YTY ZTZ
- **Straightness** XTY XTZ YTX YTZ ZTX ZTY
- **Yaw** XRZ YRZ ZRX
- **Pitch** XRY YRX ZRY
- **Roll** XRX YRY ZRZ

For 3 linear axes this means 18 error sources in total.

Additionally the 3 squareness errors of the linear axes must be taken into account:

- **x ^ y** XWY
- **x ^ z** XWZ
- **y ^ z** YWZ

In total 21 geometric errors have to be handeld for a 3-axes machine tool.

Animation of geometric errors

Translatorical deviation

- **Positioning error**
  - XTX
  - YTY
  - ZTZ
- **Straightness error**
  - XTY
  - XTZ
  - YTX
  - YTZ
  - ZTX
  - ZTY

Rotational deviation

- **Yaw**
  - XRZ
  - YRZ
  - ZRX
- **Pitch**
  - XRY
  - YRX
  - ZRY
- **Roll**
  - XRX
  - YRY
  - ZRZ
- **squareness errors**
  - XWY
  - XWZ
  - YWZ

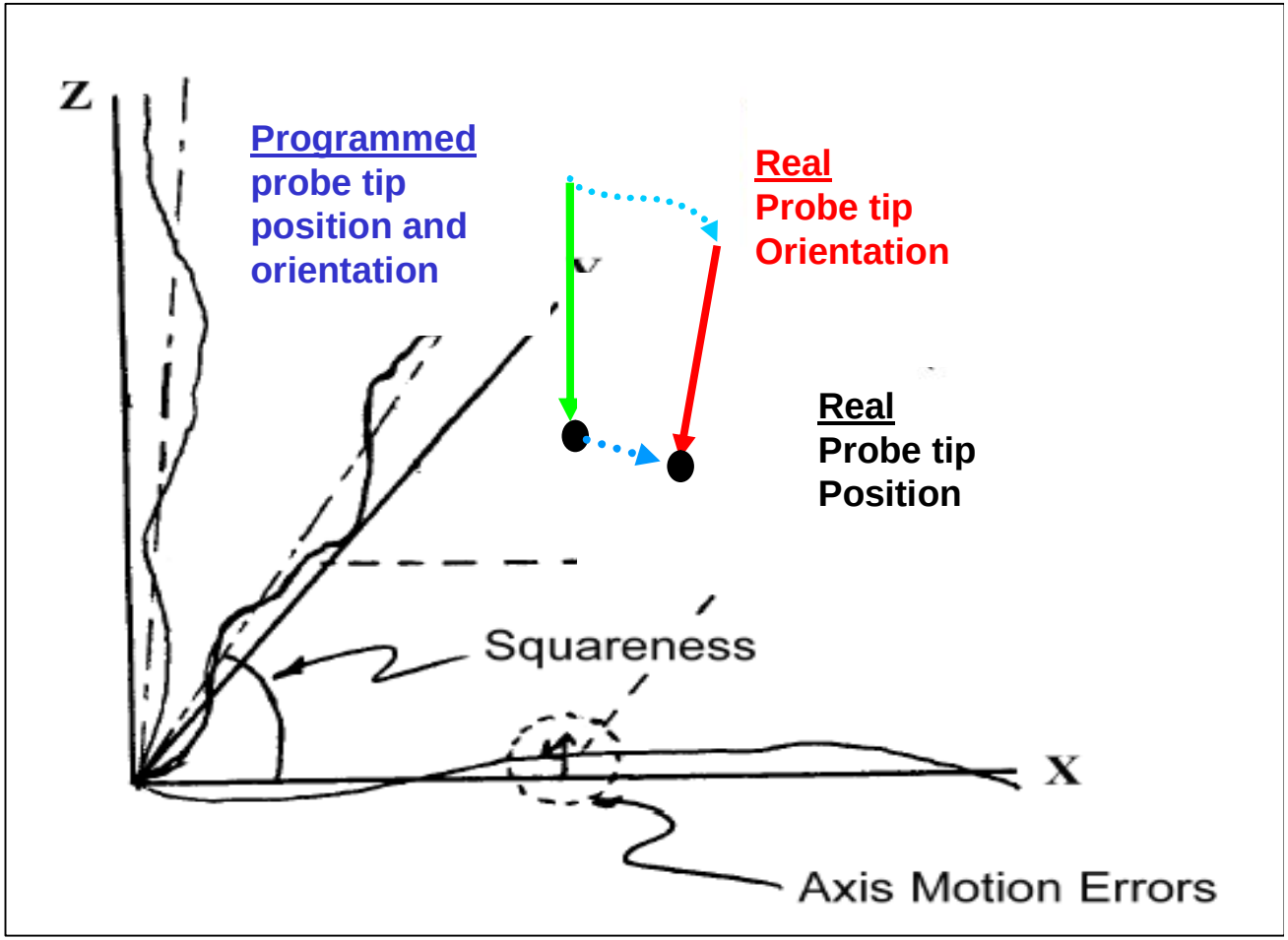
Resulting errors at the probe tip of a 3-axes CMM

Geometric errors

- positioning error
- straightness
- roll
- yaw
- pitch
- squareness

Resulting error at probe tip

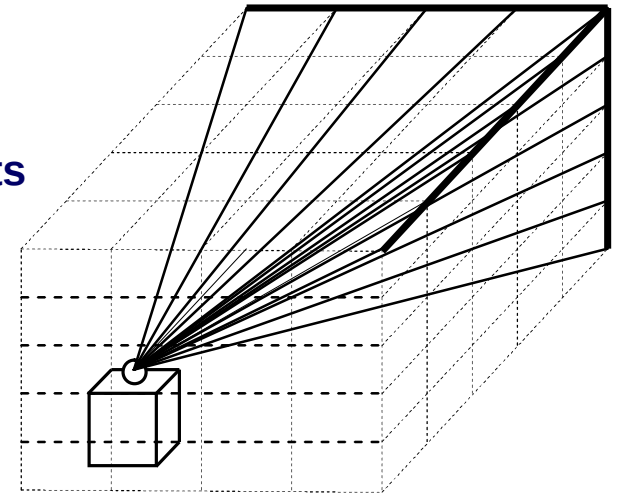
- positioning error
- orientation error

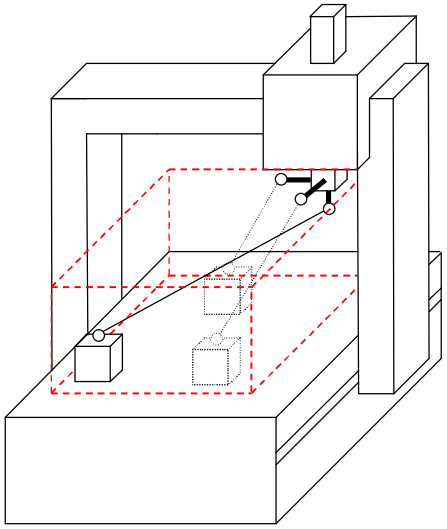


The geometrical errors of the linear axes of a 3-axes CMM cause spatial errors of the probe tip concerning position and orientation.

Measurement technique: LaserTRACER

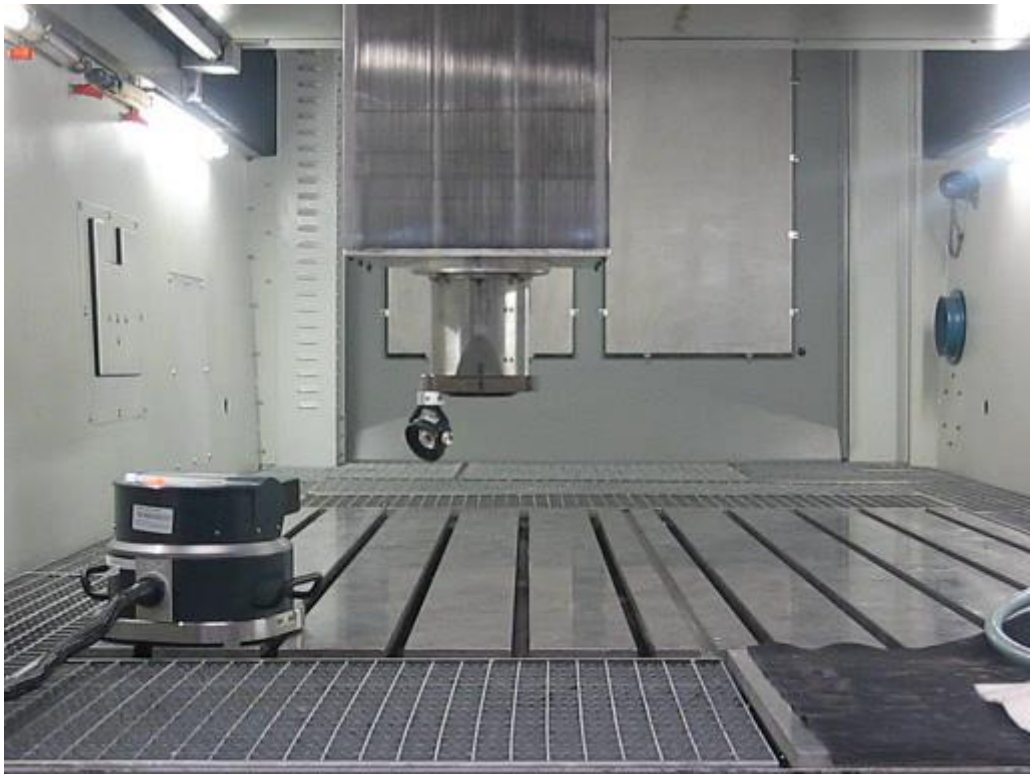
- **Developed especially for the calibration of coordinate measuring machines and machine tools**
- **Complete error analysis solely by length measurements**
- **Automatic tracking interferometer**
- **Resolution: 1 nm**
- **Length measuring error: 0,2 µm + 0,2 µm/m**
- **Measuring range: 10 m**
  (extandable by mathematical superposition)





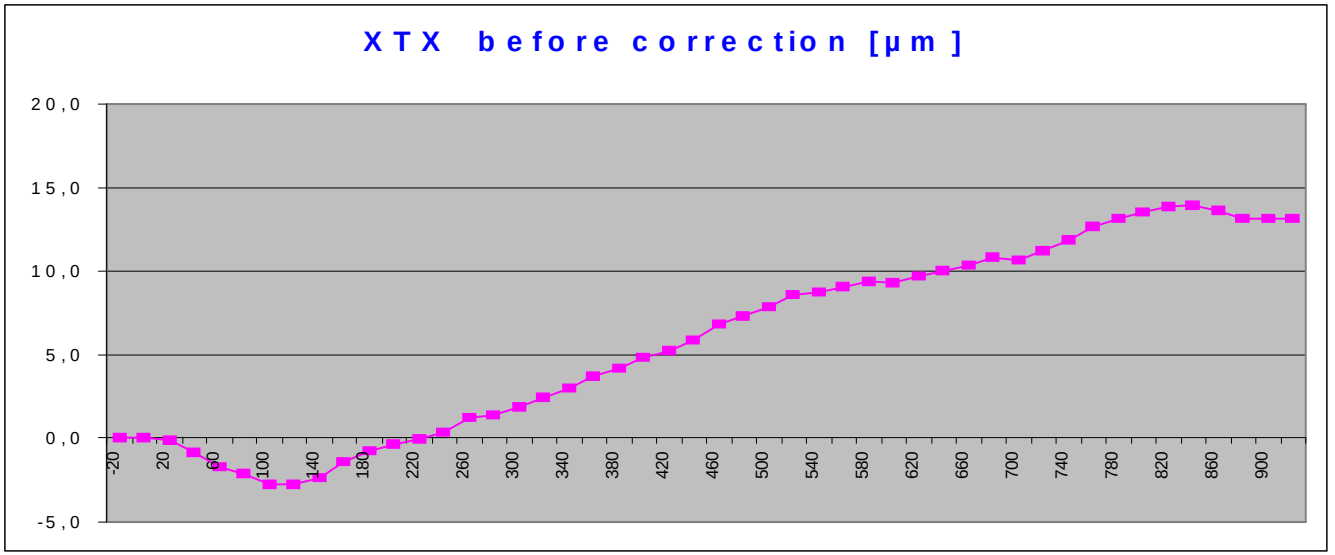
Measuring data acquisition

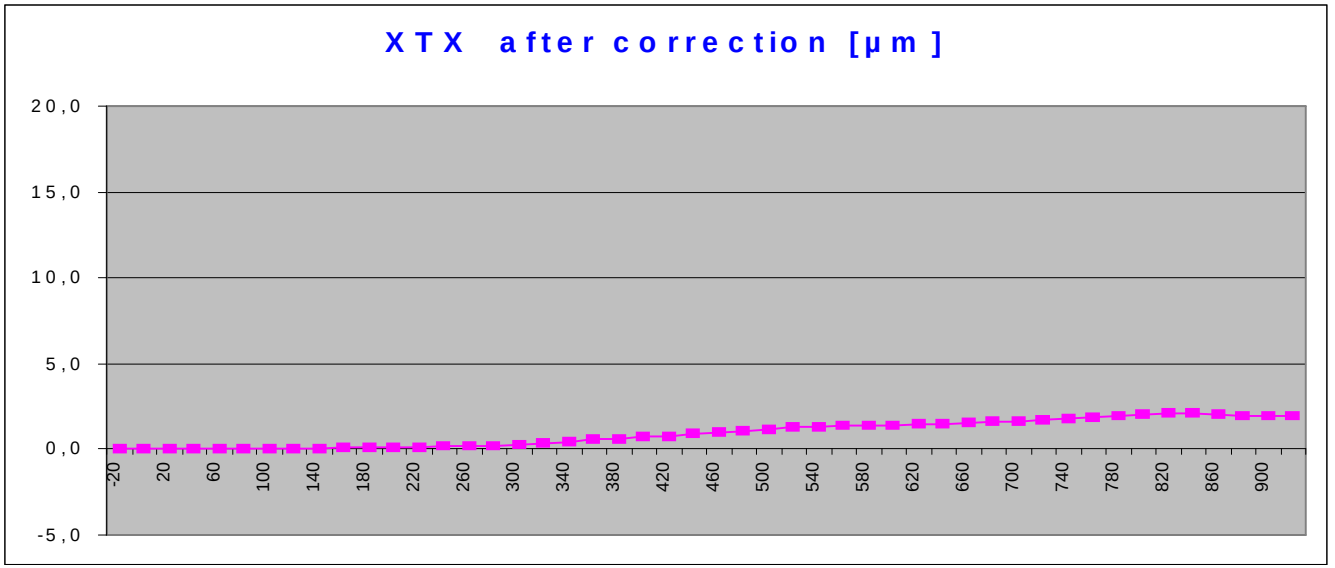
- Mounting of the Cat Eye at the Z axis
- Set-up of the LaserTRACER at 6 positions in space. An exact alignment of the LaserTRACER is not necessary.
- Connecting CMM control with Laser tracer, running the CMM online controlled
- Automatic measurement of the LaserTRACER during machine standstill
- Measuring time about 1 h per position



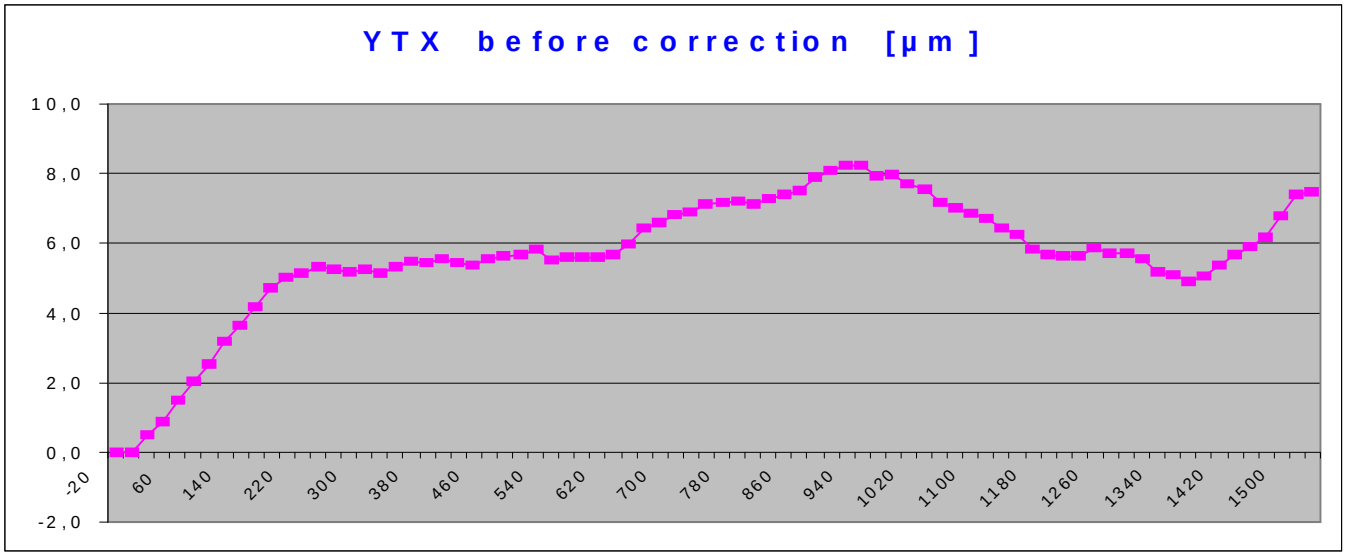
- In preparation for the measurement for each type of machine will developed a measurement strategy.
- The measurement strategy have to be adapt on-site.

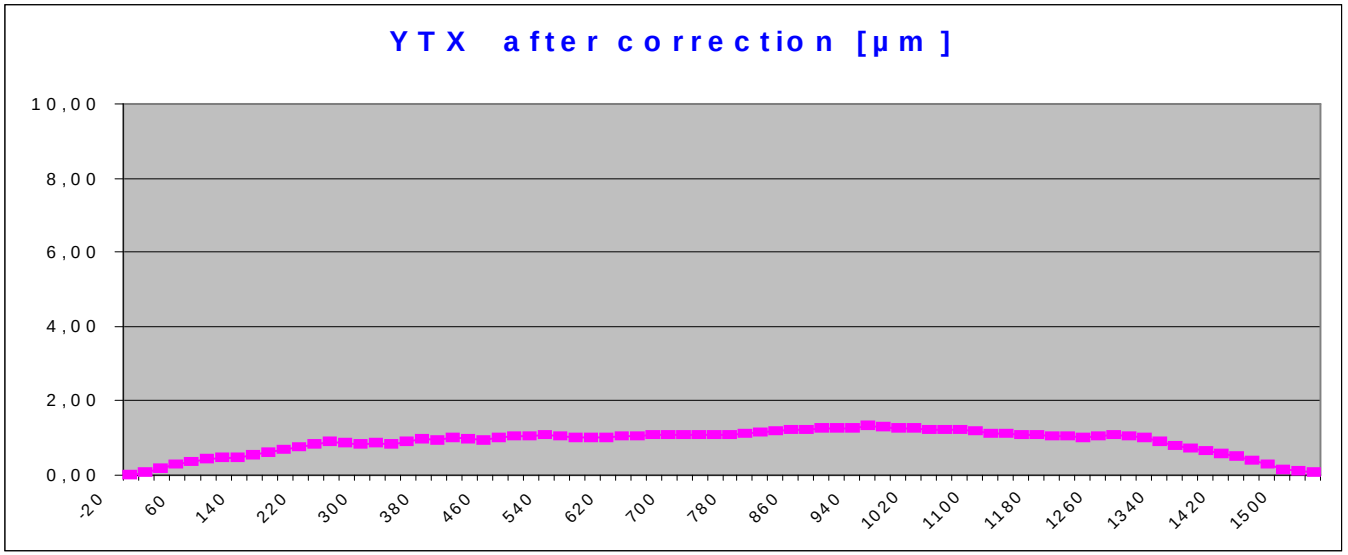
Example: Position errors XTX



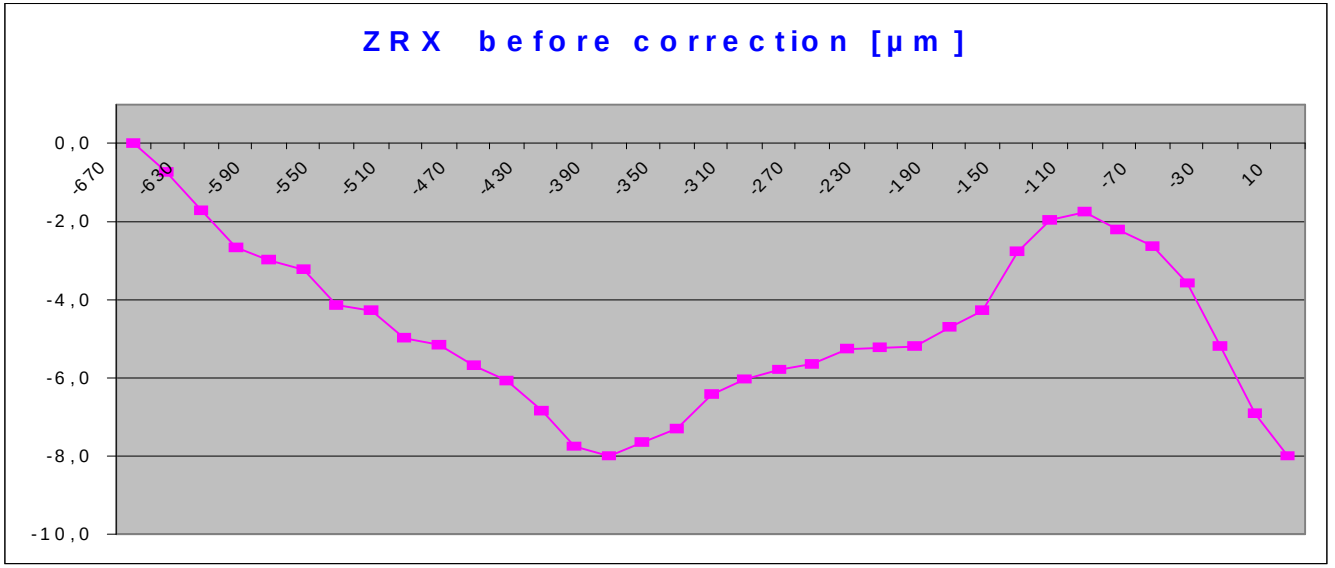


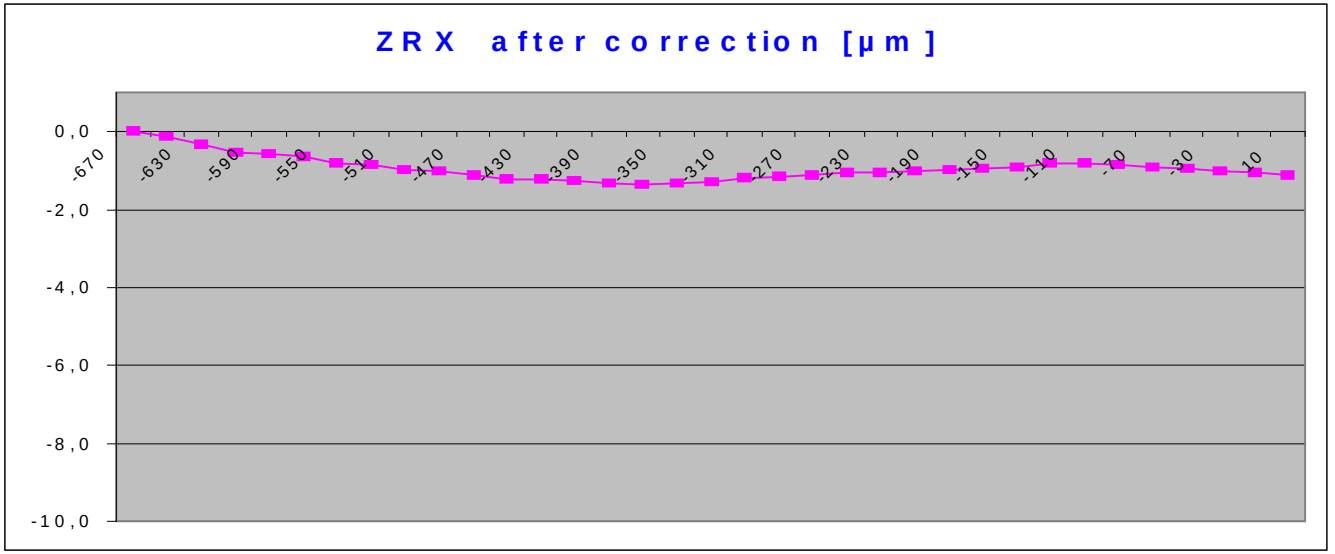
Example: Straightness errors YTX





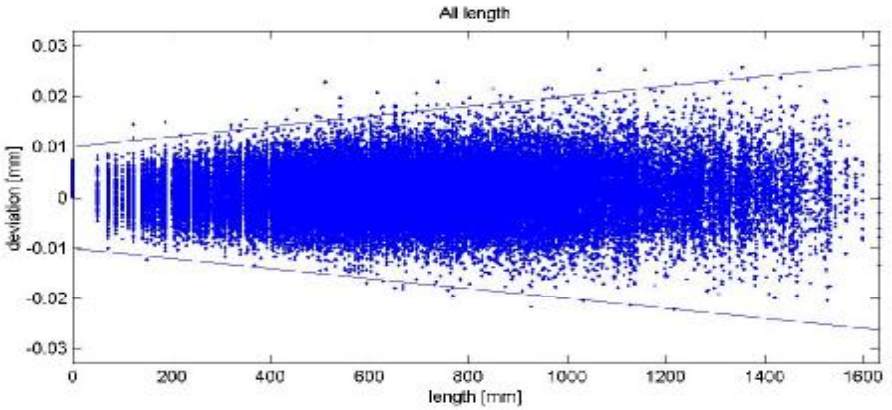
Example: Rotation errors ZRX



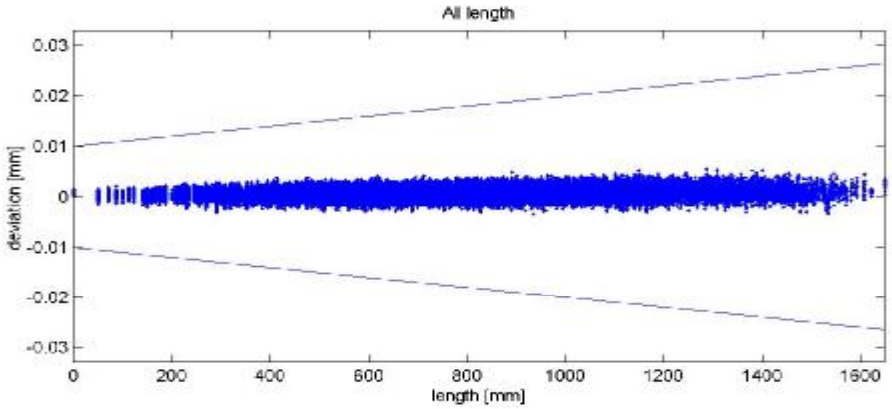


Comparement with 100000 simulated lengths

Before Correction



After Correction



Example KMG Nr.:123456

$E_3(sim) = 10\ \mu m + L \times 10\ \mu m/m \leq 30\ \mu m$

Sample size : 100000 length
Total coverage : 100%
Coverage ($l_{act} = 0$) : 100%

Measurement Results

- AfM generates a detailed report with figures and graphs from all 21 erros

- Additional contains the report the uncertainty of measurement results

- AfM creates the error map file out of the measurement results in different formats, depend on the control

- Transfer of correcture data into the control panel and activation of correction

- On costumer demand, verification according ISO 10360 including report

Services and products

Service

- Performance test of CMMs according to ISO 10360 or VDI 2617,
- Determination of machine errors, complete error correction of CMM and performance test of the corrected CMM according to ISO 10360 or VDI 2617

Engineering

- Know how transfer for the implementation of the complete error correction in control panel of CMM.

Products

- LaserTRACER

The way to volumetric CMM-correction

AfM
Accuracy for Machines

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ü AfM have the full error compensation knowledge, the mathematics, the source code, the measurement service, the inspection technology.

Ø AfM offers the full error compensation as a engineering package for online, inline or offline solution to cmm manufacturer

EVEREST
Industry Technology GmbH

ü Everest represant AfM in China and have the inspierience with chinese and europeen market culture

üEverest will sales AfM products, engineering and service in chinese market

Ø Everest will perform the project management for these international joint venture business

chinese CMM manufacturer

ØThe chinese CMM manufacturer implemented the fullerror compensation in the own CMM

<u>Advantages</u>

ØMore accurate CMM give a bigger range of application

ØIncrease of market share

ØIncrease of the target price