Practical example: high precision positioning system

Topics

- Competences and system boundaries
- Practical example: overview
- Main components
- Technical specifications
- Factors influencing precision: user side
- Factors influencing precision: manufacturer side
- Effectively realized results in accuracy

Competences and system boundaries

Practical example, based on experience

Products

- Standard and customer specific
- Complete product lifecycle: Development, manufacturing, calibration SCS (ISO/IEC 17025), maintenance, recalibration, retrofit, disposal

Measuring and calibration service

- Calibration and optimization of high-precision measuring equipment and machine tools

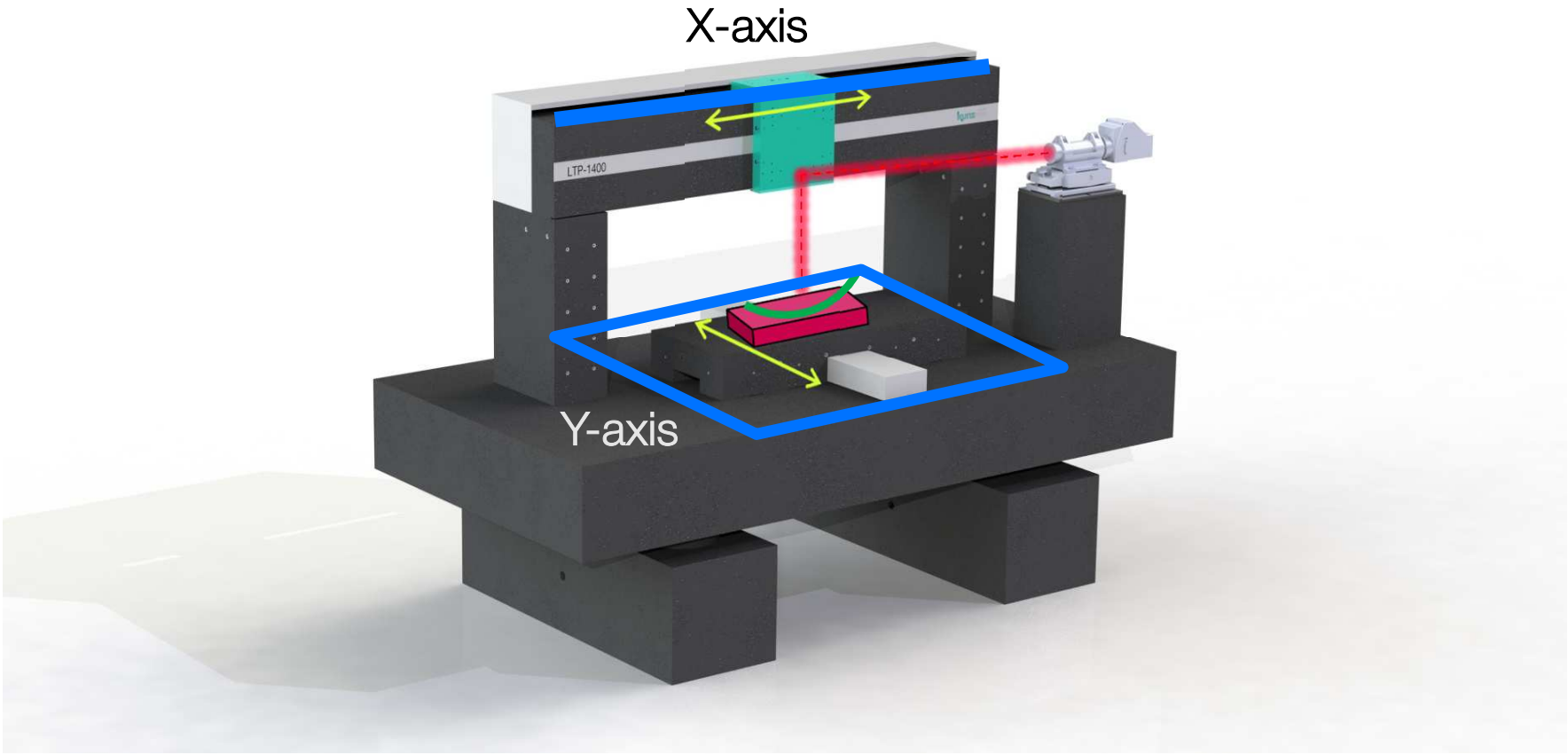
System boundaries

- Control, programming → external partner / specialists

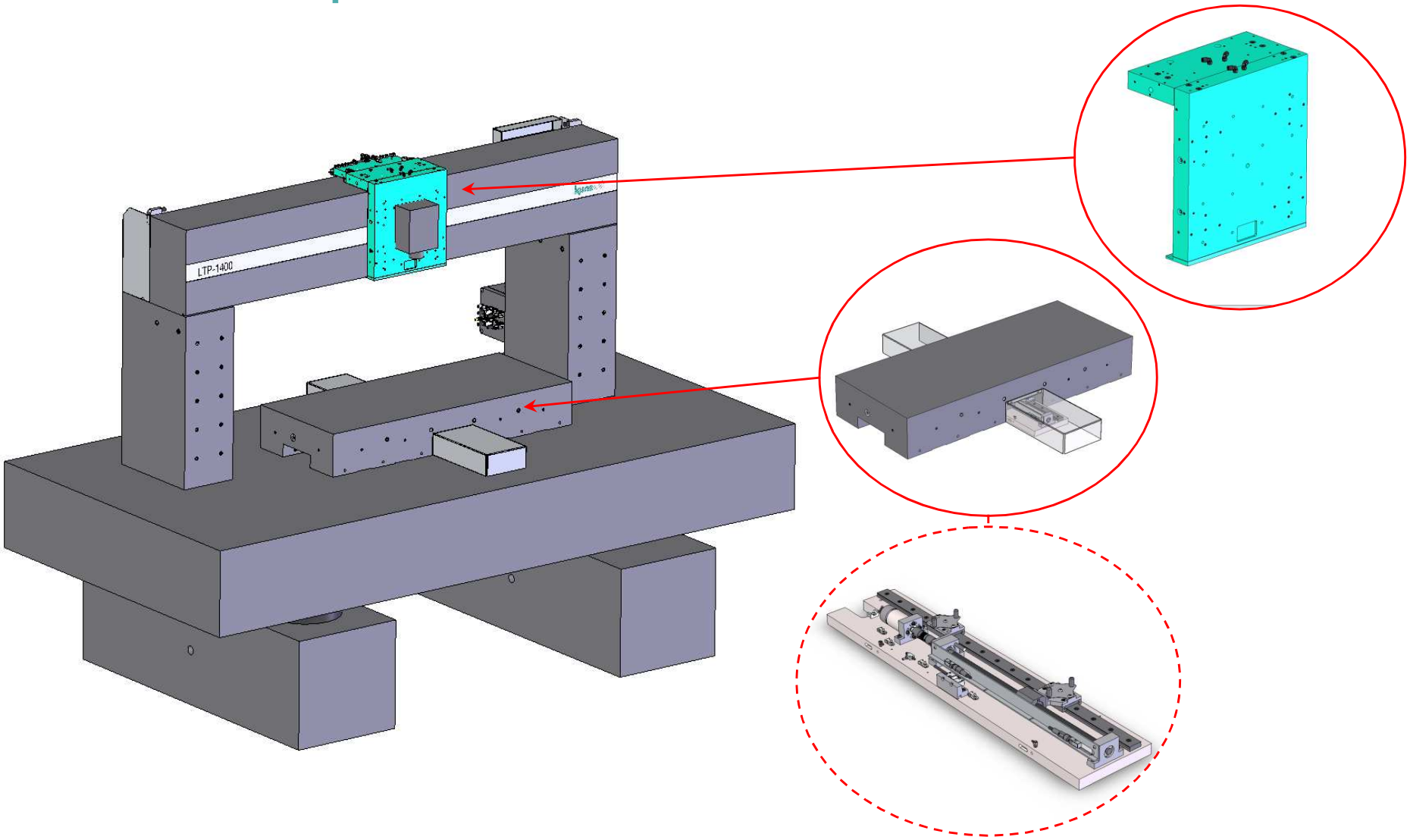
Practical example: overview

Measuring system:	LTP 1400 (Long Trace Profiler)
Customer:	Paul Scherrer Institut
Construction year:	2017
Reference:	https://www.psi.ch/industry/kunz-precision-ag
Usage:	Characterization of exact mirrors, used in the electron acceleration research facility

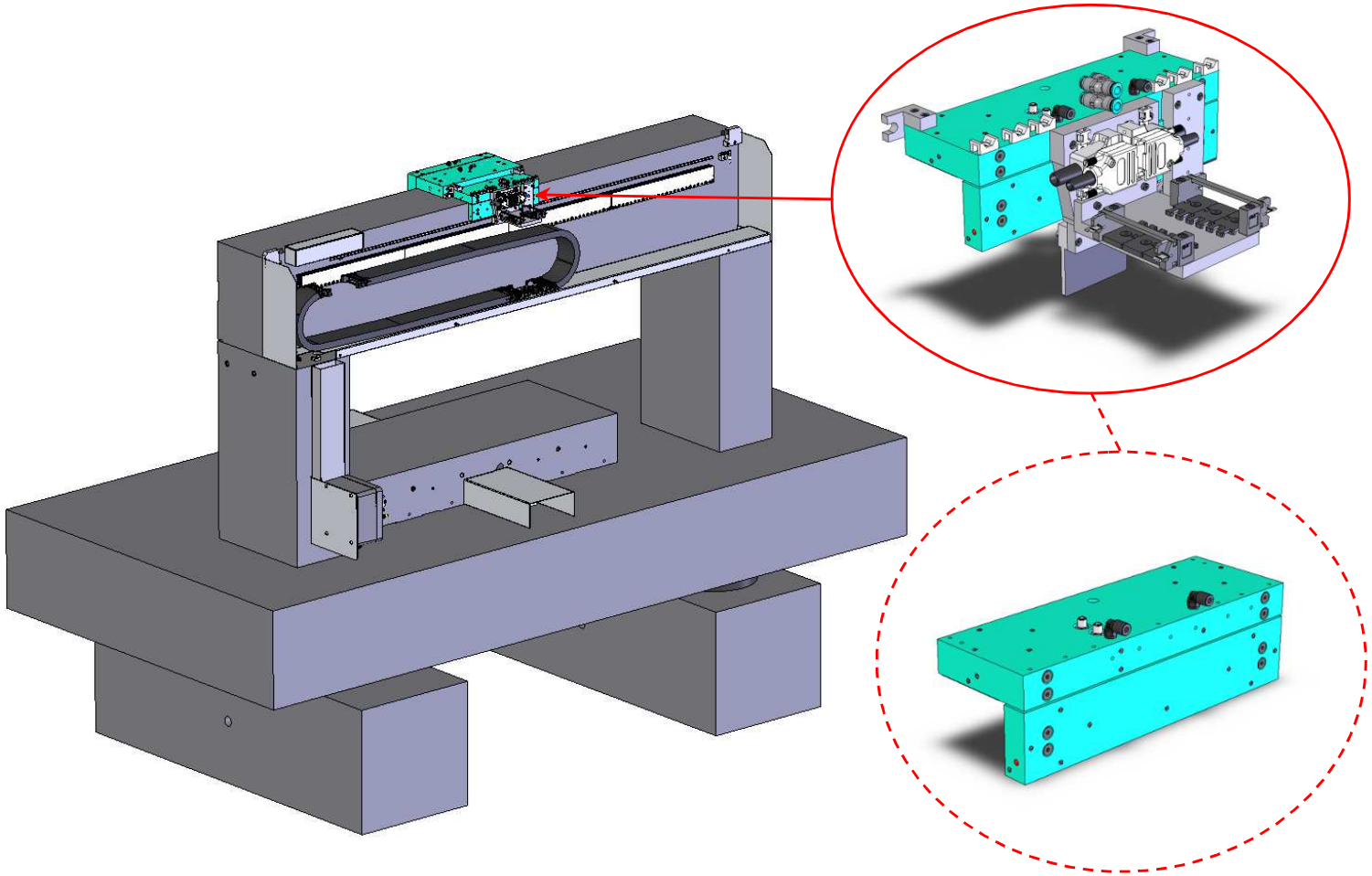
Practical example: system overview



Main components – front side



Main components – rear side



Technical specifications

Dimensions (L x W x H):	2400 x 1200 x 1650 mm
Weight:	4’500 kg
Flatness movement surface Y-axis:	1.5 µm
Straightness movement X-axis:	< 2.0 µm / 1400 mm
Angle deviations (pitch, yaw, roll):	5 µrad (1.03“)
Air bearing stability x-axis:	< 5 nm

Factors influencing precision: user side

- Temperature → stability, all sectors (20°C)
- Humidity → stability (50%)
- Type of air conditioning → air currents
- Lighting → radiation
- Heat sources → radiations (computers, etc.)
- Cleanness → dust / impurities
- User → temperature radiation
- Building → vibrations
- Compressed air source → clean, dry

This list is not exhaustive.

Factors influencing precision: manufacturer side

- Selection material of basic body and dimensioning

  Fine grained hard stone

  → Cross section adequate dimensioned (stability)

  → Sufficient storage components in the measuring laboratory (dehydration after manufacturing process)

  → Fine lapping components step by step over long time period

  → Consideration vertical straightness and angle deviation

  Influences by weight measuring slide

  Influences by weight assembled equipment

  → compensation deviation by fine lapping

This list is not exhaustive.

Factors influencing precision: manufacturer side

- Selection of measuring slide

  Vacuum-air bearing measuring slide, customized

  → Optimal dimensioning according to requirements

  → Wear-free vacuum-air bearing

  → Highest stability, rigidity and repeatability

  → Resistance-free linear movement, no stick-slip effect

  → Minimal bearing noise

  → Large bearing support area: stable against angle deviation

This list is not exhaustive.

Factors influencing precision: manufacturer side

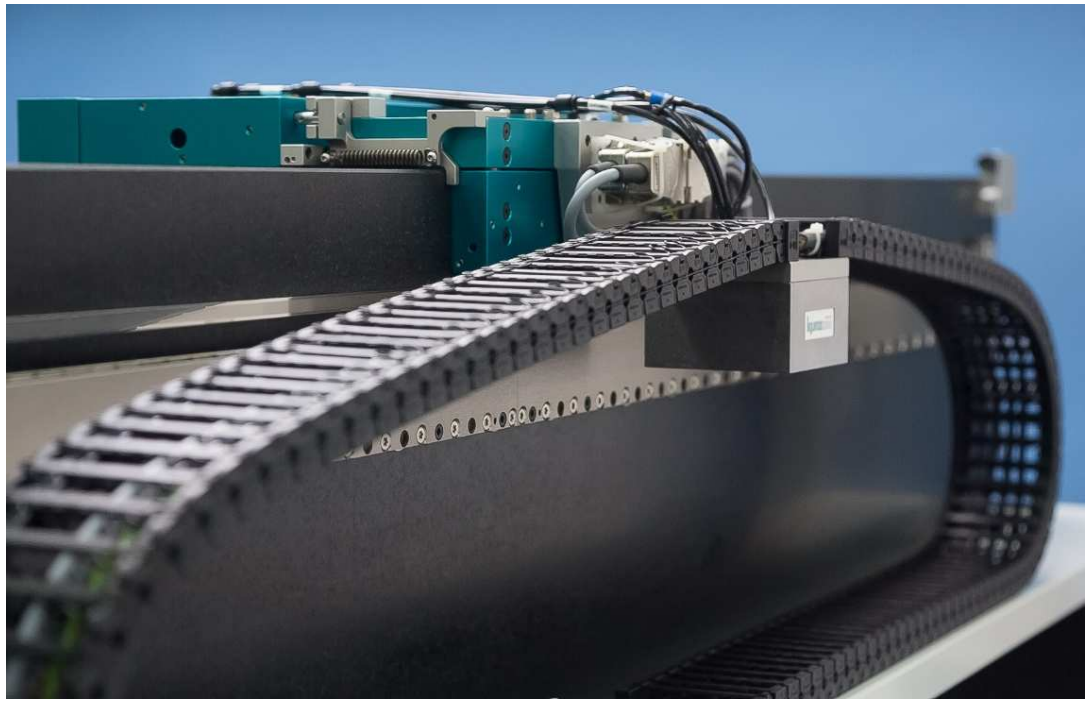
- Selection of transmission motorization to measuring slide

  By transmission slide with vacuum-air bearing

  → decoupling from influences by:

  - forces of motorization
  - cables
  - cable chain

  → consistent, symmetric influence to guideway by air flow of vacuum-air bearings



This list is not exhaustive.

Factors influencing precision: manufacturer side

- Special competences manufacturer / advantages:

  Symbiosis knowledge product manufacturing ↔ calibration service:

  → perfect interaction between areas

  → permanent cooperative consultation

  Manufacturing process in-house:

  → fast and flexible (also for optimization)

  Calibration service SCS (ISO/IEC 17025) in-house:

  → best knowledge about precision systems

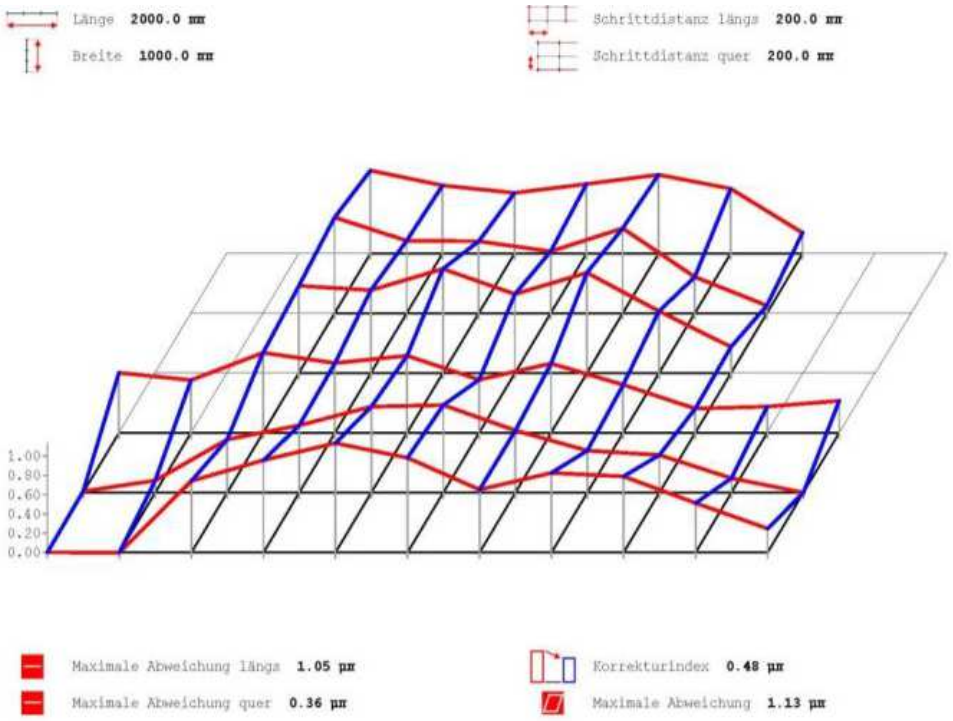
  → modern / state-of-the-art measuring equipment

  → certainty in measuring

This list is not exhaustive.

Effectively realized results in accuracy

	specification	effective
Flatness movement surface Y-axis:	1.5 µm	1,13 µm

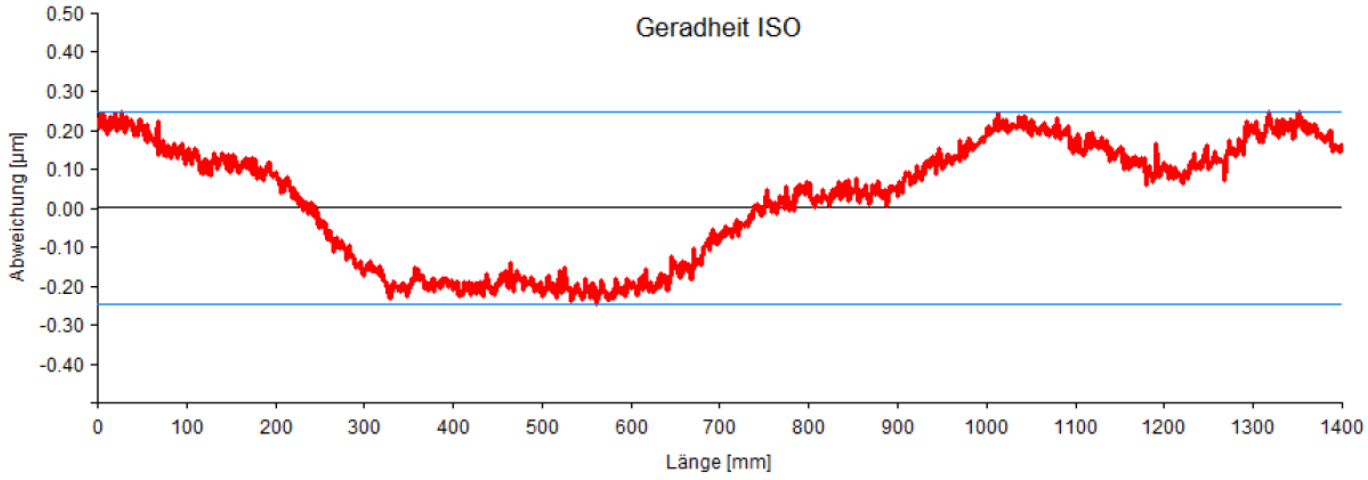


Effectively realized results in accuracy

	specification	effective
Vertical straightness movement axis X:	2.0 µm	0,49 µm

X-Achse, vertikal

Messlänge: 1400 mm **Geradheit: 0.49 µm**
Messung von 1400 nach 0 (Maschinenkoordinatensystem)



Messlänge: 1400 mm
Kanal 1

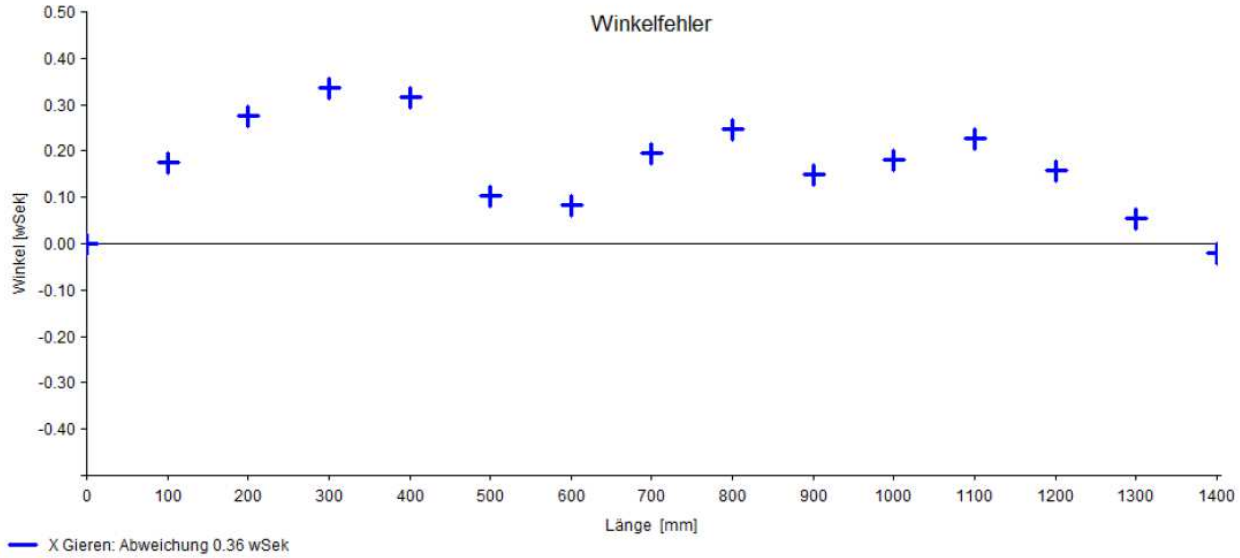
Geradheit ISO
Original-Messwerte
0.49 µm

Effectively realized results in accuracy

	specification	effective
Angle deviation yaw:	5.0 µrad	1.75 µm

X-Achse, Gieren

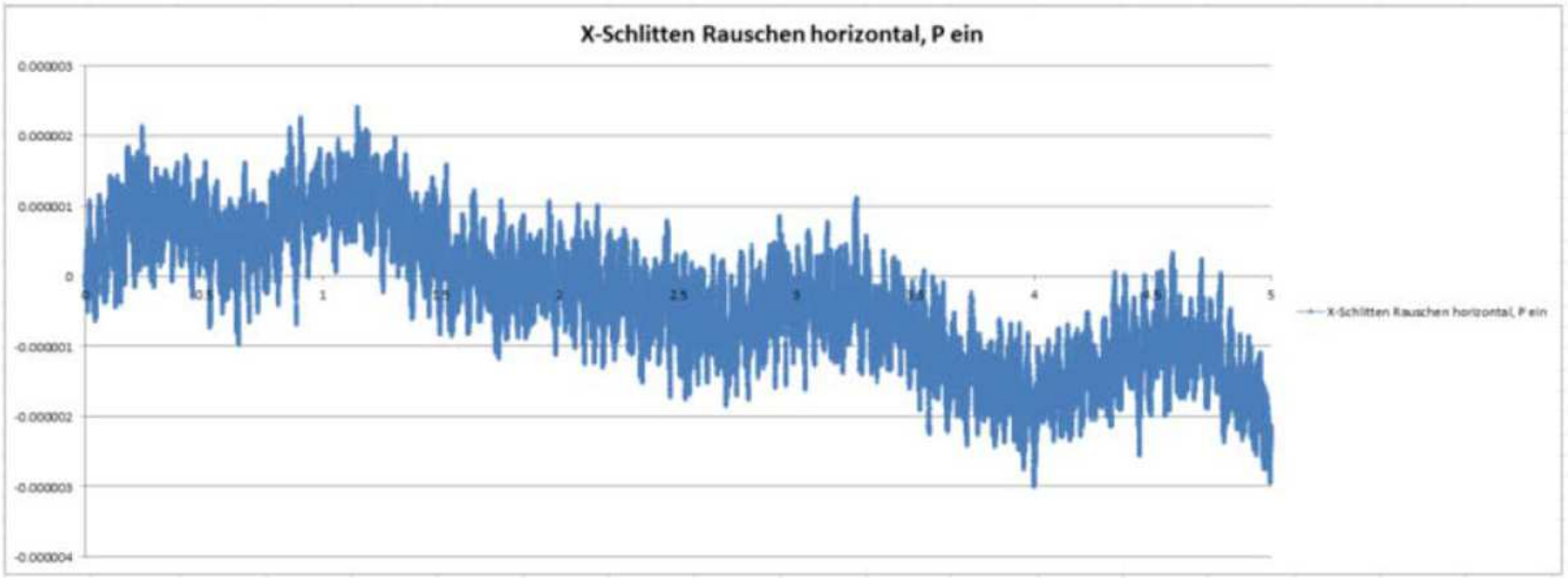
Messlänge: 1400 mm **Kippfehler: 0.36 wSek (≙ 1.75 µrad)**
Messung von 1400 nach 0 (Maschinenkoordinatensystem), + = Führung vorne ballig



Effectively realized results in accuracy

	specification	effective
Air bearing stability X-axis:	< 5.0 nm	3.07 nm

Druckluft Messschlitten vorne EIN
Messung: 5 s mit 50 kHz



Thank you for your attention