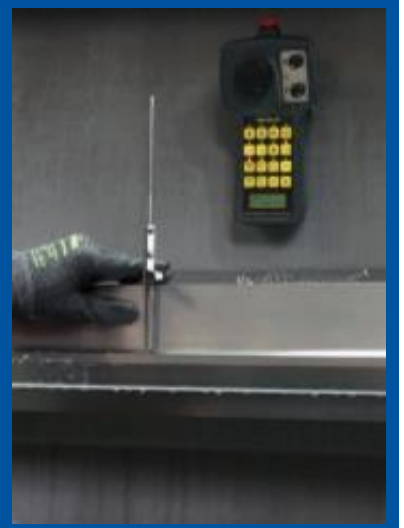
Motivation for geometric inspection done with machine tools



Manual geometric inspection:

- ✘ Major time factor in overall manufacturing duration
- ✘ Disruption of manufacturing cycle for measurements
- ✘ Climbing gear for accessing workpiece with dirt, burrs & chips yields risk for workers
- ✘ Multiple measurement devices with up to 3 workers required

Geometric inspection done with machine tools:

- ✓ Savings in time and ressources
- ✓ Direct feedback loop for manufacturing
- ✓ No transport necessary
- ✓ No waiting for acclimatization period
- ✓ Clamping situation unchanged
- ✓ Reduction in manual operator effort
- ✓ Part size not limited by CMM

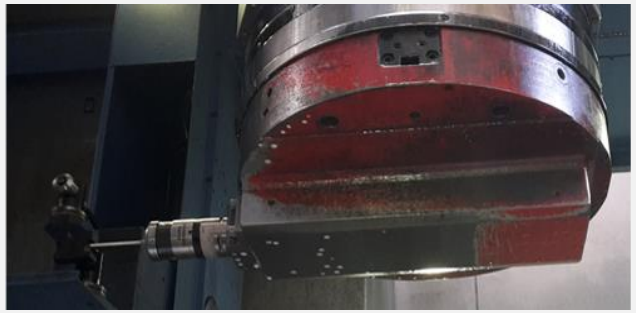
Motivation for ISO TS 230-13 „Guidelines for the determination of the measuring performance of machine tools used as coordinate measuring machines”

Exemplary demand in industry

Manufacturing of large gas turbine parts

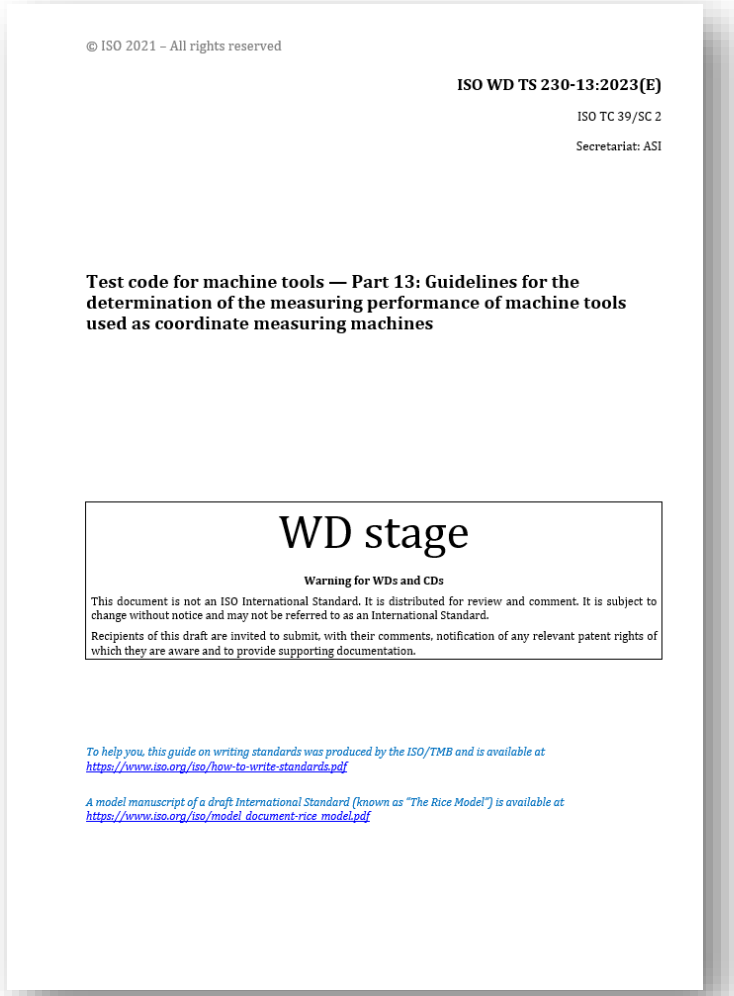
Need for On-Machine Measurements

Ready-to-use products like touch probes and measurement software available



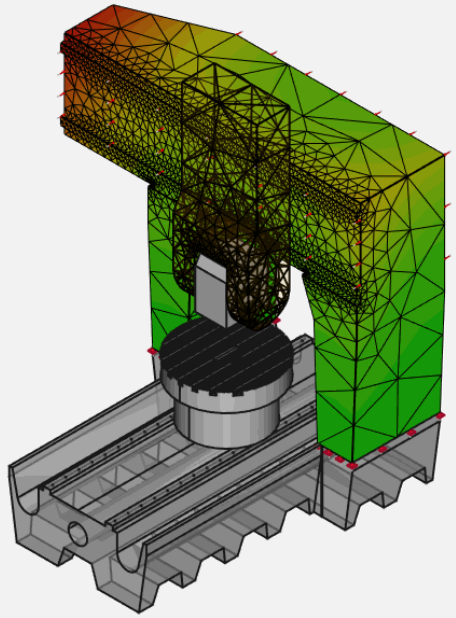
Need for standarized acceptance tests

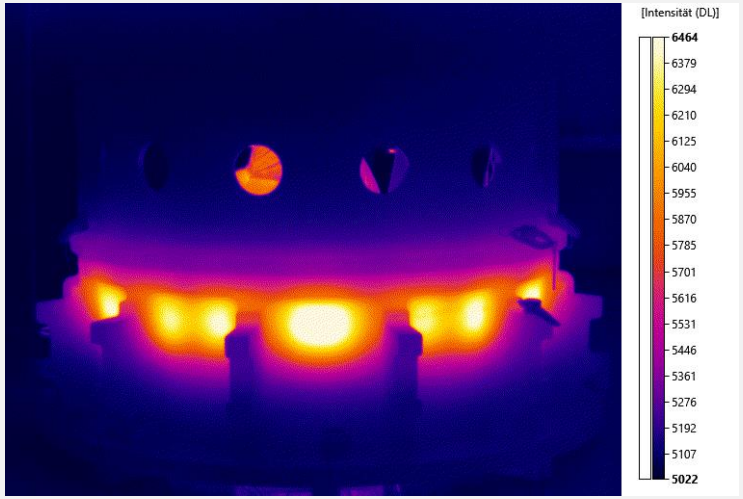
Test setup with calibrated reference lengths



Motivation for ISO TS 230-13 „Guidelines for the determination of the measuring performance of machine tools used as coordinate measuring machines”

The biggest challanges are thermal issues!





ISO

Survey on ISO TS 230-13

https://forms.office.com
/e/0H8H2cMTNc

Handling of temperature effects in ISO TS 230-13 I/II

General statements:

- Handling of temperature and thermoelastic effects is the biggest challenge of this standard
- Compared to CMM applications, higher temperature variations can be expected in environment, machine and workpiece
- Thermoelastic behaviour of machine tools is an ongoing major research topic. This standard cannot summarize all approaches and thermal models that have been presented

General approach of this standard

- Measurement performance evaluation is done experimentally based on gauges, lasers or calibrated workpieces
- General rule is to extend the sampling procedure as much as possible over the expected operating conditions
- Extensions of this experimental approach are proposed only to consider additional effects that could not be covered during the experimental procedure

Challenges

- Find an acceptable compromise between scientific rigour and a practical solutions that can benefit industry without jeopardizing quality of the measurements performed
- Keep the document sufficiently compact to allow the industrial use
- Avoid technically not acceptable “shortcuts”
- Overestimation of measurement uncertainties preferred to underestimation of measurement uncertainties (safety margins)

Handling of temperature effects in ISO 230-13 II/II

Special Challenges and current handling in the document:

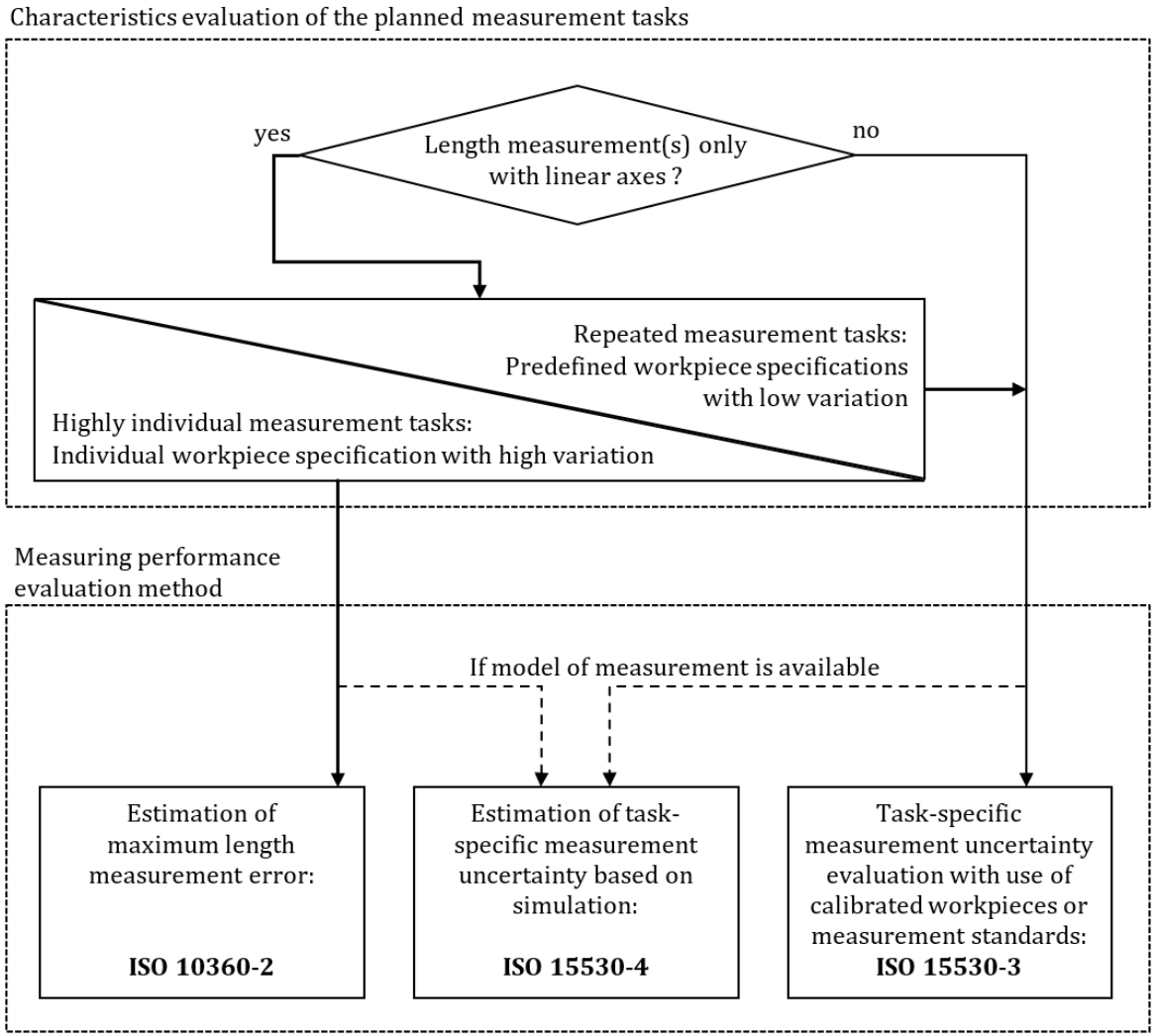
1. Measurement shortly after machining where process energy heated up the workpiece. This effect cannot be experimentally determined since a calibrated workpiece, a step gauge or a laser cannot be machined.
   - Requirement of thermal equilibrium to fulfil the assumptions of the experimental approach
   - Estimation of required waiting time after machining
   - Currently not: Estimation of additional uncertainty contribution based on simple thermal modelling

2. Non-linear thermoelastic deformation of machine tool and workpiece (bending). These effects are too complex to be modeled in the document and taken into account accordingly in the measurement performance determination.
   - Part of the experimental assessment for the experimental operation conditions
   - Extension over the experimentally assessed conditions only based on linear model

3. Experimental coverage of all possible environmental temperature scenarios
   - See 2

4. Material difference between workpiece and standard used for performance verification (gauge, laser)
   - “virtual material” in case of laser
   - Currently not: Virtual material for physical standards, e.g. step gauge (e.g. steel → aluminium)
   - Use of calibrated workpieces: Inherently solved

Abstract of ISO TS 230-13: Selection of measuring performance evaluation method based on the characteristics of the measurement tasks



Thank you for your attention!

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PhD presentation “Measurement of Non-stationary Measurands – A general Modeling Approach”

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