

## Aims of the Project

### Execution of the course

The participants of the MUVot course acquire established knowledge considering the determination of uncertainty in measurement as well as the theoretical background concerning relevant physical effects and underlying mathematics. Web-based course material is provided for a self-controlled learning. In two presence workshops, the participants will apply the newly achieved knowledge on practical tasks and discuss open questions with competent tutors.

### Participants

The course is designed for employee in industrial metrology or related fields, who want to know more about uncertainty in measurement and the accurate calculation of the uncertainty budget. There are no requirements regarding basic knowledge, but access to internet should be available. Cause of the flexibility in time, MUVot is a job-accompanying course.

### Registration

Starting dates of oncoming courses are listed on the homepage and courses can be individually arranged for a bigger group. The number of participants is limited to 15.

### Certification

Every participant gets a certificate specifying the acquired knowledge, if passing the exam at the end of the course.

### Overall amount of the course

Workshops:	7 days
Self-controlled learning:	ca. 45 h
Total duration:	3 months

## Contact

Lehrstuhl Qualitätsmanagement und Fertigungsmesstechnik

Contact person

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## Partners

University of Bielsko-Biala  
Laboratory of Metrology  
Academic Center of Informatic

University Erlangen-Nuremberg  
Chair Quality Management and  
Manufacturing Metrology

University of Huddersfield  
Centre for Precision Technologies (CPT)

University of Padova  
Department of Industrial Engineering

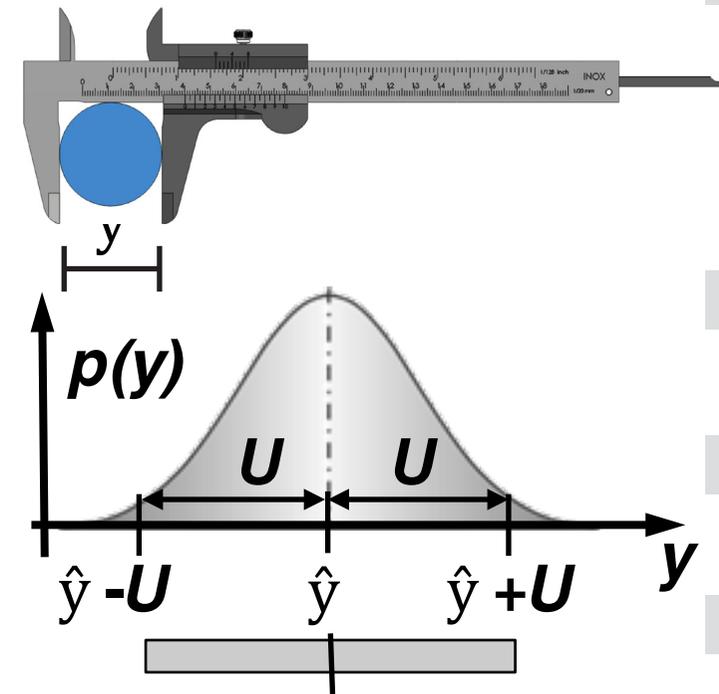
Technical University of  
Cluj-Napoca

Interstaatliche Hochschule  
für Technik Buchs NTB

International Foundation for  
World Class Manufacturing



Blended Learning course on Measurement Uncertainty for advanced vocational training



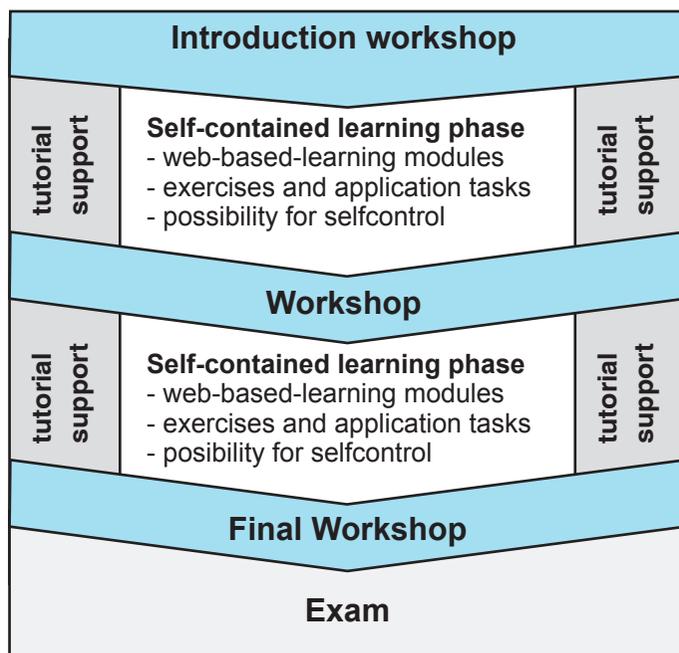
- web-based
- free pilot course
- international training programm



## Project Coordinator

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## Structure and concept of the course



The course starts with an introduction workshop, where the concept gets explained and organisational questions can be settled.

It will be followed by a learning phase, where the course participants acquire the knowledge on their own. Therefore, the single courseparts will be regularly available online. Of course, it is always possible to get in contact with an advisor or the other participants.

There will be a final workshop in the end, where remaining questions can be asked.

The course ends with an exam. Every participant will get a certificate after passing.

## Content of the course

### 1. Basic Statistic

Basics of descriptive statistics and stochastics; Analysis of correlation and regression; Statistical estimation and testing

### 2. General Methodology of Uncertainty Evaluation

Uncertainty budgeting according to GUM; Overview of approaches to uncertainty calculation; Documentation and interpretation of measurement uncertainty

### 3. Uncertainty of Conventional Measurements

Introduction to conventional measurements and main error sources; Uncertainty budgets for typical examples of conventional measurements (gauge blocks, calliper, micrometer, dial gauges)

### 4. Uncertainty of Coordinate Measurements

Introduction to Coordinate Metrology; Evaluation of uncertainty using calibrated workpieces; Evaluation of uncertainty using computer simulation

### 5. Uncertainty in Surface Roughness Measurement

Introduction to Surface Metrology; Evaluation of uncertainty using ANOVA method; Evaluation of uncertainty using computer simulation

### 6. Uncertainty in Calibration

Requirements of a Calibration Laboratory; Calibration monitoring

### 7. Measurement System Analysis

Aim and Framework of Measurement Systems Analysis; Characterising properties of measurement systems

### 8. Economics in manufacturing metrology

Quantification of inspection process costs and value-adding; Economic evaluation of investments in metrology

### 9. Uncertainty in Case of Multivariate Measurands

Introduction to advanced modelling of measurements; Uncertainty analysis with correlation calculation

## About the project

The project SAM-EMU has delivered the first web-based eLearning course specifically designed to teach the subject of measurement uncertainty to students in universities, creating the basis for the development and delivery of a vocational training course. The user-needs analysis indicated that there is strong and growing demand for adequate and flexible training in this area for industrial employees as well.

The results of the user-needs analysis meant that it became a key aim of the new MUVOT project to adjust the existing material to fit this model. This was achieved through adapting the existing material to a less purely 'theoretical' level of knowledge whilst developing additional elements of training to enable employees to participate in this new, self-guided learning activity.

During the project, the available content of SAM-EMU was adapted to the specific requirements of the target group by the project consortium, featuring partners from six countries, each of which are active in vocational training for manufacturing metrology and who translated the existing material into national languages.

The existing material was augmented by exercises specifically prepared for face-to-face workshops. Additionally, some new content was developed and provided which is of specific relevance for the industrial application of knowledge about measurement uncertainty and was requested from interested participants.