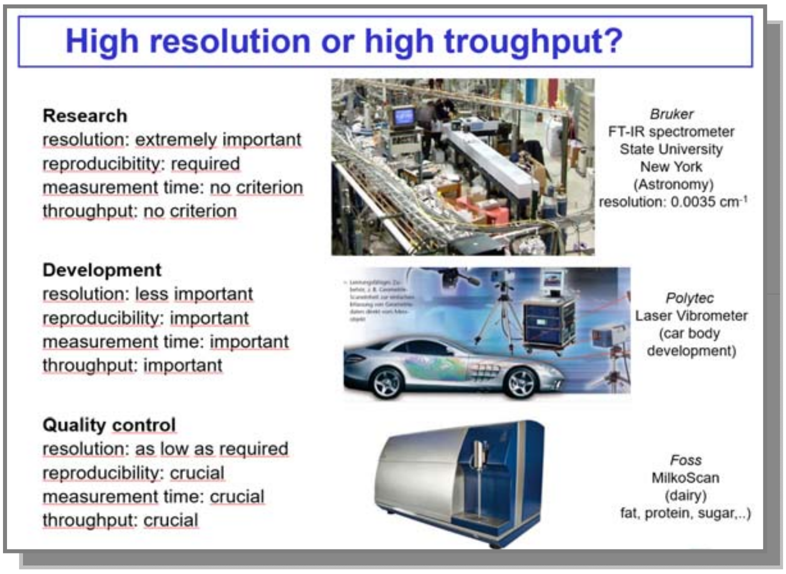
Laboratory Techniques and Metrology

Module

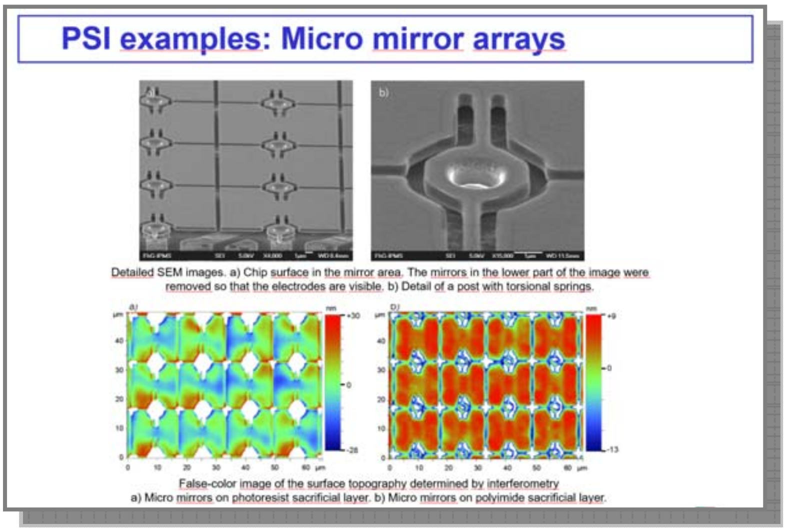
Experimental investigations are key to testing of theoretical models and for gaining new insight into physical processes not yet described by sufficient models at all. In addition, they allow for optimization loops in development processes of materials, devices and highly complex systems and enable fast and secure control and monitoring of industrial fabrication processes from food to cars.



Hence, requirements for experimental investigations range from extremely high accuracy and resolution in basic research (where measurement time is of low importance) up to extremely fast but yet highly reproducible measurements in production environments e.g. for quality or process control.

In all cases, experimental investigations require a **solid understanding of the underlying measurement principles**, their application scope and theirs potential as well as their **physical and technical limits**. Further, before any conclusions from experimental obtained data are drawn, **systematic and random errors** of measurement set-ups need analyzing, possibly minimizing and consideration.

The lecture provides detailed insight into the physics of modern metrology, details the measurement concepts and their technical instrumentation. The spectrum ranges from optical instruments and metrology (e.g. microscopy, spectroscopy, ellipsometry) to electron microscopy up to non-optical surface characterization (e.g. nanoindendation). Additionally, noise sources and techniques to minimize noise in measurements by means of modulation/demodulation techniques are presented. The lecture closes with a discussion of measurement errors and error propagation.



As a major part of the lecture focuses on optical measurement techniques, optical principles in ray tracing and wave optics are repeated in the beginning and complemented by Fourier-optical concepts like e.g. the modulation transfer function (MTF).