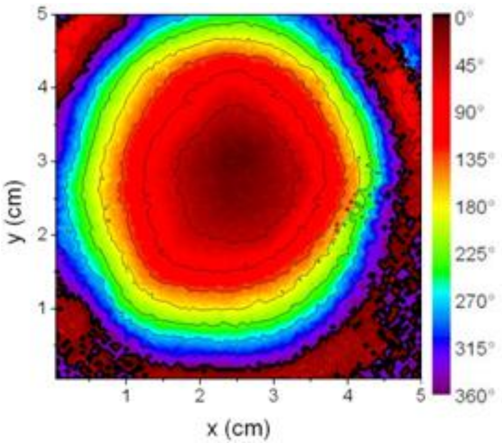
Spatially resolved far-field measurements using femtosecond lasers

A measurement technique has been developed which allows for spatially resolved characterization of free-space GHz and THz emitters with regard to their key parameters "frequency", "amplitude", and "phase". The measurement principle is based on a THz frequency comb generated by an unstabilized femtosecond laser. Via heterodyne detection, the mixing product between the cw GHz or THz radiation and the frequency comb is measured and analyzed using digital signal processing. Comparing the mixing product to a reference source, relative phase and amplitude measurements are possible. Additionally, the technique, which covers a very broad frequency range from several GHz to several THz, allows for high-precision frequency measurements. The figure below shows the spatially resolved phase pattern of a 100 GHz emitter.



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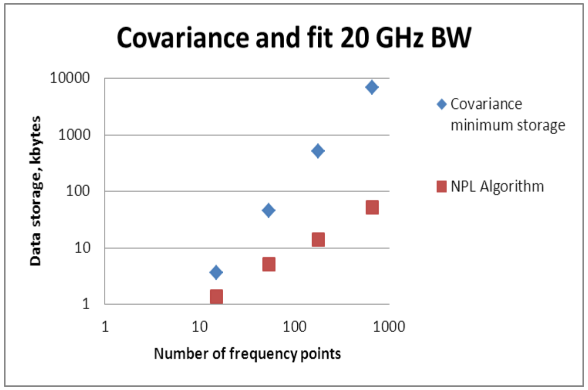
Uncertainty propagation for very long record lengths

The ability to apply waveform uncertainties from the calibration process to time-domain or frequency-domain measurements improves the confidence of measurement-based decisions. To be useful, an important prerequisite is low additional processing and storage overheads. Within a typical covariance approach the storage grows as the square of the trace length. In this workpackage the covariance behaviour of real-time oscilloscopes, sampling oscilloscopes and S-parameter measurements has been analysed. Based upon this information, an algorithm that uses a simplified model of the noise processes (jitter, amplitude noise and correlated noise) has been developed. Due to significantly reduced data storage requirements, see figure below, this algorithm can be applied to a waveform of any length. In particular this might prove very useful for data analysis using vector signal analysers and real-time oscilloscopes.



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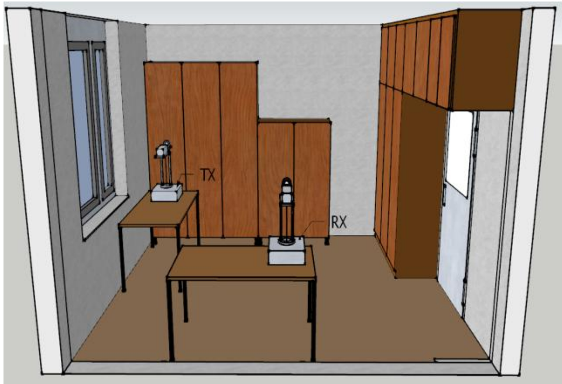
Channel measurements in typical indoor environment

To provide channel measurements for realistic modeling and design of existing state-of-the-art and future communication systems up to 325 GHz, a measurement system was developed and built in cooperation with the "Institute for Communications Technology" at the Technical University Braunschweig.
A transmitter (TX) and receiver (RX) unit are both mounted on motors which are rotatable horizontally in a range of 360 . In office communications scenario, both TX and RX are placed in a room on two tables separated few meters from each other (see drawing below).
For realistic conditions, typical office contents (such as tables, wardrobes, a glass window and a door) are considered here. Channel propagation in several relevant constructions will be taken into account.
Measurements investigating other scenarios such as kiosk, industry, and living room environments will be also performed.



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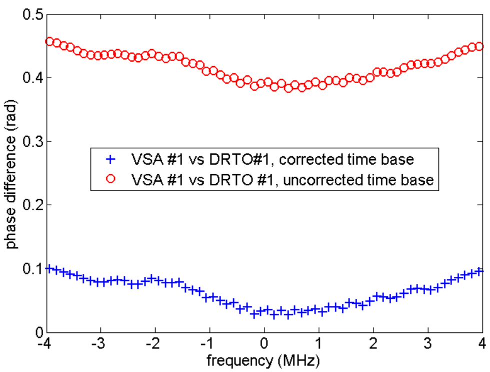
Establishing traceability for modern vector signal analysers

To characterize the full vector response of modern vector signal analysers, a method using real-time digital oscilloscopes has been proposed. Measurements of the phase response of several samplers available among the project partners have been performed. The phase response has been determined by excitation of the samplers with a multisine signal with proper amplitude and phase relations between adjacent tones and subsequent measurement of the same signal using a digital real-time oscilloscope. A vector response of the sampler can be determined by deconvolution of the input signal. An example of phase characteristics measurement of a VSA is shown below with and without time-base correction. Another achievement within this workpackage is a traceable measurement of source and receiver EVM using a real-time oscilloscope. The source and receiver EVM uncertainty contributions have been identified.



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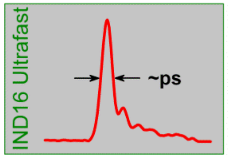

EURAMET European Association of National Metrology Institutes

Metrology for Ultrafast Electronics and High-Speed Communications

"Ultrafast Electronics"
July 2011 – June 2014

Newsletter 1, June 2012

Overview

The steady increase of the bandwidth of new communication systems and remote sensing applications continuously improves the quality of life of many people worldwide. In fact, ultrafast electronics and high-speed communications are among the technologies with the strongest growth with capital investment of $40.3 billion in 2009 to deploy 4G networks worldwide. Yet this development also faces unsolved challenges in metrology regarding the exact measurement of amplitude and phase of continuous wave and pulsed high-frequency signals, the uncertainty propagation between the time and frequency domain, channel and antenna characterisation, as well as exact measurements of digital signals. These deficiencies currently hinder new and progressive developments of high-frequency devices in Europe. This main goal of this research project is to provide the basic metrological infrastructure concerning ultrafast electronics and high-speed communications in Europe.

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