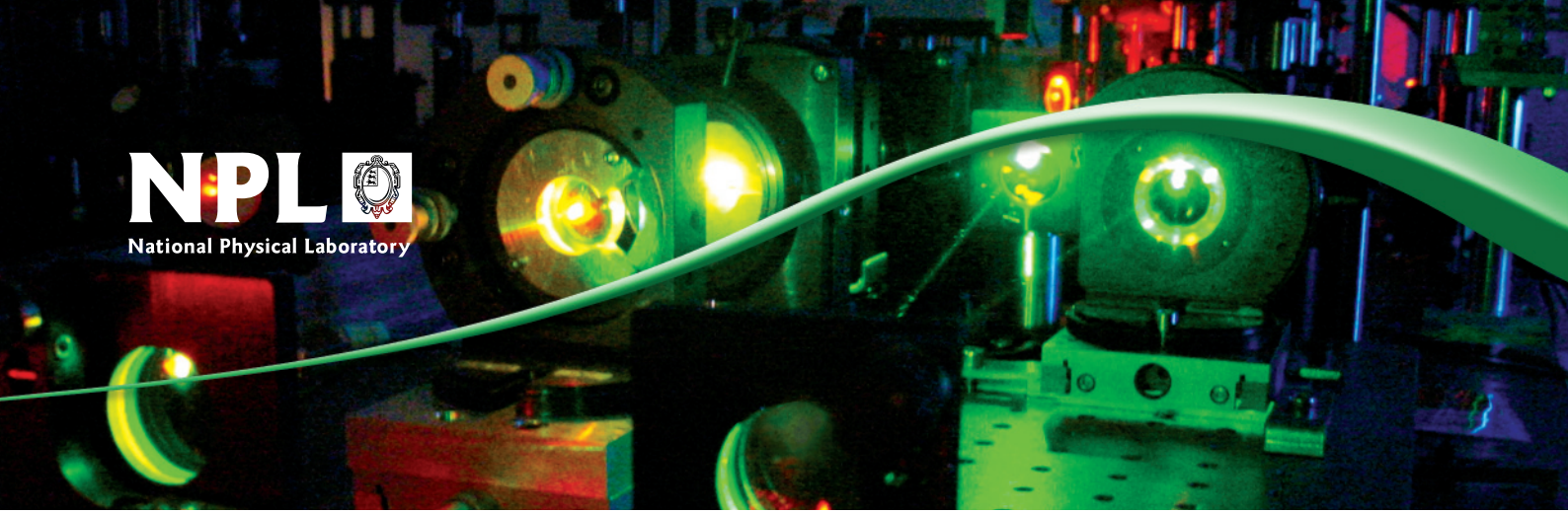


NPL
National Physical Laboratory

Ultrafast Measurements

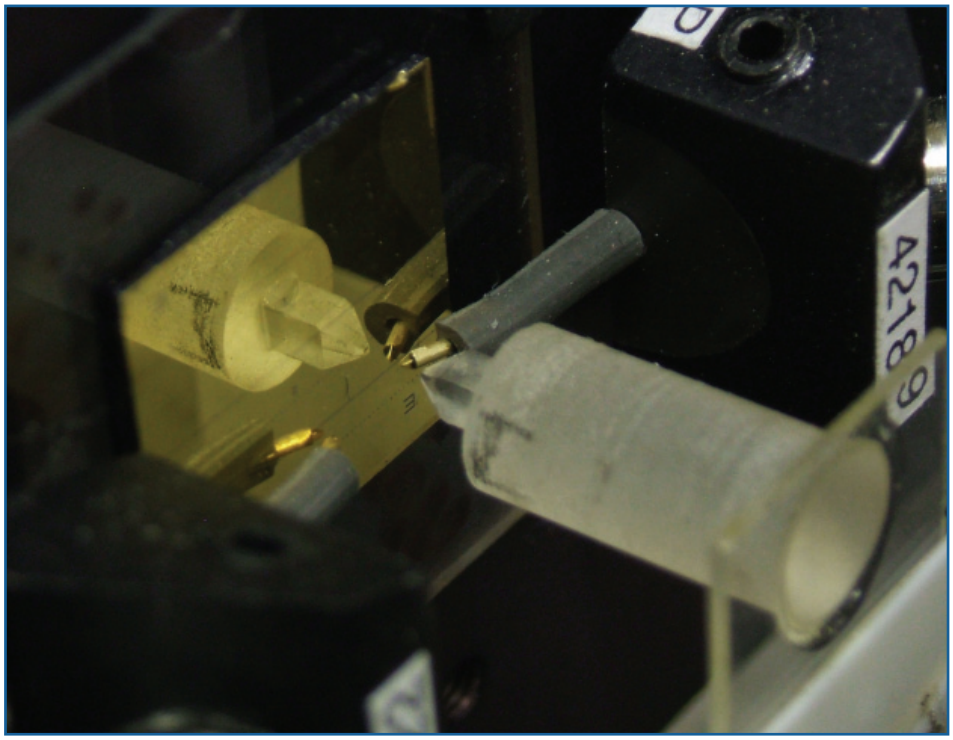
The Ultrafast Measurements section at the National Physical Laboratory (NPL) have over twenty years of experience in providing industry with standards for fast electrical and optical measurements. Ultrafast laser systems are used to provide traceable calibration for high bandwidth instrumentation and devices used in fields ranging from optoelectronics to high-speed and wireless communications.

The increasing pace of development in high-speed electronic instrumentation has seen sampling oscilloscopes pushing 100 GHz bandwidth, and real time oscilloscopes now reach 20 GHz bandwidth –which only a few years ago was the preserve of the sampling systems. Pulse generators can produce edges with risetimes below 5 ps, and there is also an increasing diversity of devices. Power meters can now measure rise time, spectrum analysers can record temporal waveforms and oscilloscope mainframes can contain high-speed photodetectors. Coupled with the ever growing range of applications, especially in communications, and it becomes clear that an in-depth understanding is crucial to getting the best measurements from your instrument.

At NPL the Ultrafast Measurements section work at the forefront of technology to provide traceable measurement solutions not only for oscilloscopes and pulse generators but for a wide range of related instruments including RF calibrators, bit error rate testers (BERT) and signal generators. In addition, the use of a femtosecond laser system to achieve traceability has led to broader fields of work including ultrafast optical pulses at telecommunications wavelengths, optical pulse shaping and terahertz (THz).

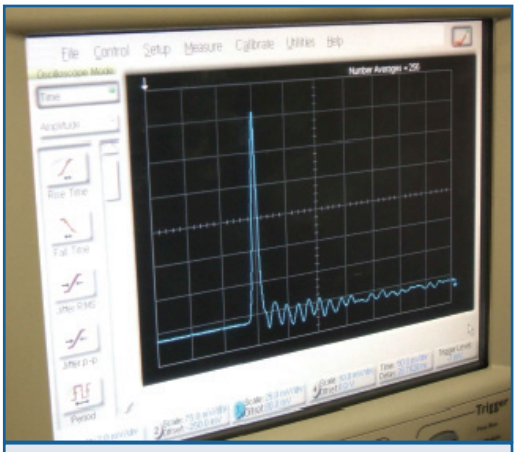
Electro-Optic Sampling System

At NPL we use a femtosecond electro-optic sampling (EOS) technique to characterise electrical pulses in transmission line. An electro-optic probe is positioned close to the line and laser pulses with durations of less than 200 fs passed through the probe. Changes in the optical polarisation state caused by the interaction of the electrical pulses with the probe are measured with a sensitive detection system. An optical delay line on the probing beam enables the measurement of a sampled profile of the electrical pulse in time. The EOS system at NPL is equivalent to a sampling oscilloscope of over 600 GHz bandwidth.



dti
National Measurement System

National Physical Laboratory | Hampton Road | Teddington | Middlesex | United Kingdom | TW11 0LW
Switchboard 020 8977 3222 | **NPL Helpline** 020 8943 6880 | **Fax** 020 8943 6458 | **www.npl.co.uk**



Electro-optic techniques are used at NPL to calibrate oscilloscopes and pulse generators

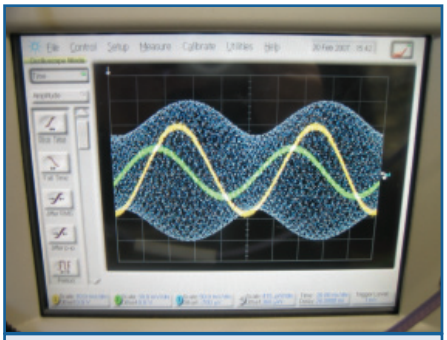
Calibration and Measurement Services

Traceable calibration services

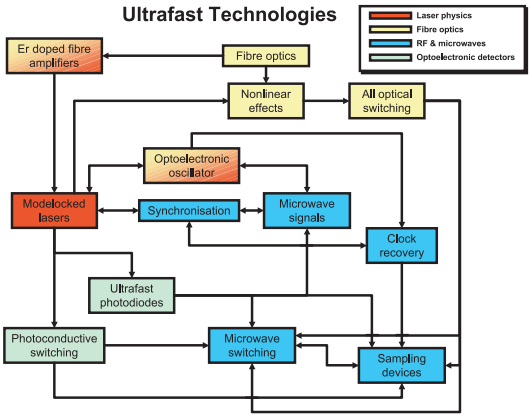
- Risetime and frequency calibration of > 4 GHz real-time oscilloscopes
- Phase and magnitude measurement of > 75 GHz optical receivers
- Measurement of impulse response for fast photodiodes and optical receivers
- Deconvolution and jitter analysis
- Frequency domain measurements up to 67 GHz
- Risetime of electrical power meters

Femtosecond Electrical Pulses

To generate fast electrical pulses for characterising the latest sampling oscilloscopes NPL uses a photoconductive pulse generator. Fabricated on low-temperature grown gallium arsenide and built into a microwave transmission line, illumination of the switch with < 200 fs laser pulses enables electrical pulses as short as 600 fs (500 GHz bandwidth) to be generated.



Characterisation of a modulated RF waveform using timebase correction on a sampling oscilloscope



Current research areas

- Bit Error Rate (BER) and Error Vector Magnitude (EVM) systems
- Wideband Code Division Multiple Access (WCDMA)
- Timebase nonlinearity and jitter corrections
- Femtosecond pulse shaping and measurement
- Quantum coherent control
- Terahertz
- Optical Parametric Oscillators (OPO)

Terahertz technology

Terahertz is a previously unexplored part of the electromagnetic spectrum that has recently found applications in security, healthcare and non-destructive testing as a result of improved instrumentation. NPL is supporting emerging instrumentation and applications through the development of measurement standards for THz power, wavelength, absorption and penetration depth into materials. In additional, the exploration and development of new applications in the security and bio-medical environment are in progress.

	Range	UKAS Accreditation*
Sampling Oscilloscope risetime	5 ps – 50 ps	1.3 ps
	50 ps – 1 ns	0.5% + 3 ps
Real-time oscilloscope risetime	300 ps – 10 ns	0.2% + 20 ps
Pulse generator risetime	11 ps – 60 ps	0.9 ps
	60 ps – 10 ns	0.5% + 1.4 ps
Pulse amplitude	50 mV – 800 mV	0.3%
	800 mV – 1 V	0.5%
Pulse settling	-	0.05%
Pulse pre/over/undershoot	-	0.1%

** UKAS accredited uncertainties quoted for a probability of not less than 95%. These are the best normally achievable – actual values are dependent on the particular instrument and the shape of the instrument response waveform.*

For more information contact Matthew.Harper@npl.co.uk or visit http://www.npl.co.uk/electromagnetic/ufe-opto/ufe.html

NPL is a UKAS-accredited calibration laboratory no 0478

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