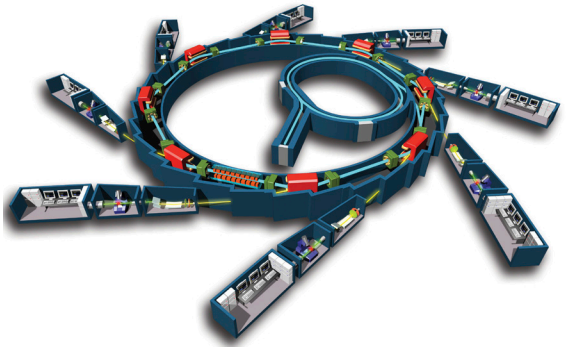
THE R&S®RTO/RTP IN ACCELERATOR PHYSICS

In accelerator physics, pulsed signals frequently need to be measured. The digital trigger and low noise frontend of the R&S®RTO/RTP oscilloscope make it possible to perform the high precision measurements needed to characterize the experimental setup. Several measurement functions specially developed for accelerator physics labs support detailed signal analysis.



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Your task

Experiments in accelerator physics, e.g. in synchrotron labs, often demand very accurate measurements of pulse parameters or of the jitter between two signals. This data needs to be measured during start-up and characterization of the experimental setup as well as during operation for continuous monitoring. For monitoring, the data needs to be stored and downloaded at a high update rate in order to catch every pulse of a free electron laser operating at e.g. 100 Hz.

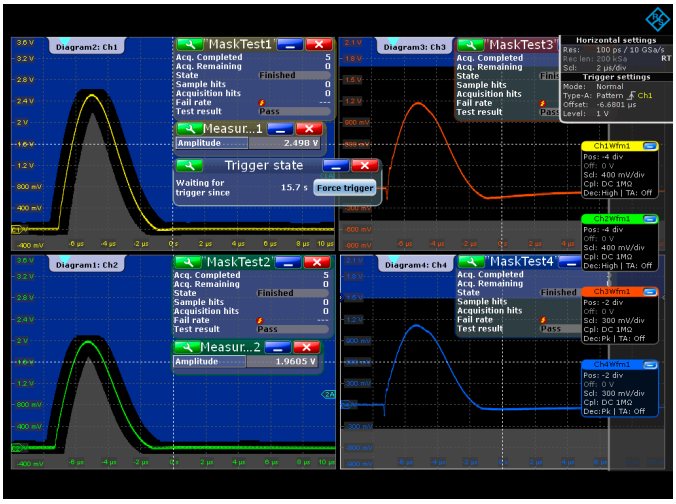
Rohde&Schwarz solution

Researchers will appreciate the outstanding accuracy of the R&S®RTO/RTP. The low noise frontend and the 10 Gsample/s single-core monolytic A/D converter offer an effective resolution of > 7 ENOBs for precise measurement data. The 100 ps sampling resolution allows the detection of high-frequency signal components. The digital trigger architecture is the key to the low trigger jitter of 1 ps (RMS). The R&S®RTO-B4 oven controlled oscillator (OCXO) option improves the timebase accuracy to 0.2 ppm, which is important in order to minimize long-term drifts. The R&S®RTO/RTP performs measurements fast: 600 000 mask tests/s detect signal deviations faster than ever before. Overall the R&S®RTO/RTP is perfect for precise measurements in many accelerator physics lab applications, such as in synchrotrons or free electron lasers.

Application

Beam quality safety interlock system

With the introduction of continuous top-up operation of synchrotron light sources, the injection process has to be fully automated. This requires major changes in the control system and drives the need for a new safety interlock system to prevent damage e.g. to the synchrotron. The R&S®RTO/RTP is the ideal tool for such safety interlock systems. Its fast mask test monitors the pulse that drives the injection kicker in a synchrotron. The R&S®RTO/RTP prevents damage to the synchrotron by stopping the injection process if the kicker pulses are not correct and the mask is violated. In addition, full remote operability is a big plus because experts can remotely support troubleshooting while having full access to the R&S®RTO/RTP.



Mask test to monitor injection kicker pulse (© Helmholtz Center Berlin)

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Make ideas real

Monitoring of RF pulses in the acceleration path of free electron lasers

In free electron lasers (FEL), the pulse shape of the RF pulses is continuously monitored to prevent damage to the accelerator. This requires that every single pulse be captured and that the data be continuously recorded. The latest-generation FEL increases the pulse rate to 100 Hz. The R&S®RTO/RTP allows waveform acquisition and download to a PC at rates of up to 100 Hz to catch "every pulse".

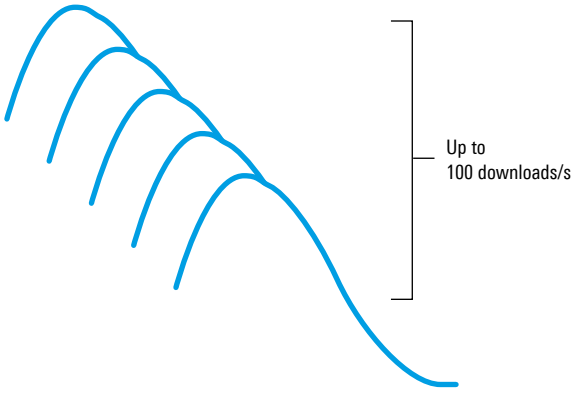
Jitter between laser pulse and synchrotron

In many experiments, different pulsed sources need to be synchronized. One example is the alignment of a laser pulse with a synchrotron source based on the delay measurement. It is crucial for measurement accuracy that any jitter between the two be minimized. The precise digital trigger of the R&S®RTO/RTP in combination with the OCXO option is the only way to reach sub-picosecond accuracy for the time correlation between the two pulses. The user can analyze the delay measurement results in measurement statistics, the histogram distribution and the long-term trend.

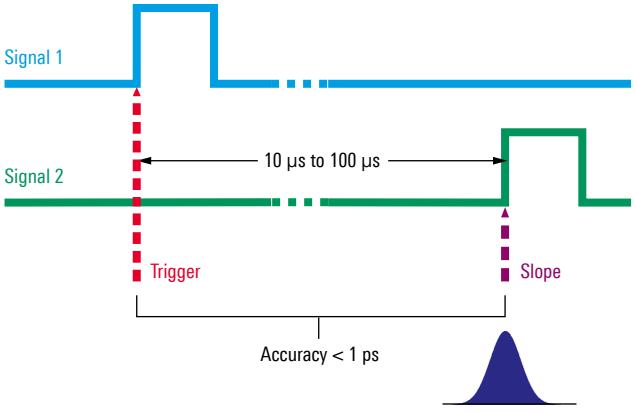
Trigger distribution accuracy measurements

The trigger signal of a synchrotron or FEL is crucial to all time-resolving experiments. The trigger signal, which is typically available in the control room, needs to be distributed throughout the entire research institute. To reach sub-picosecond accuracy, thermal and other signal fluctuations need to be corrected. How to characterize such a trigger distribution system? The digital trigger architecture of the R&S®RTO/RTP plus the R&S®RTO-B4 OCXO option allow an outstanding accuracy of less than 1 ps on pulses several microseconds apart.

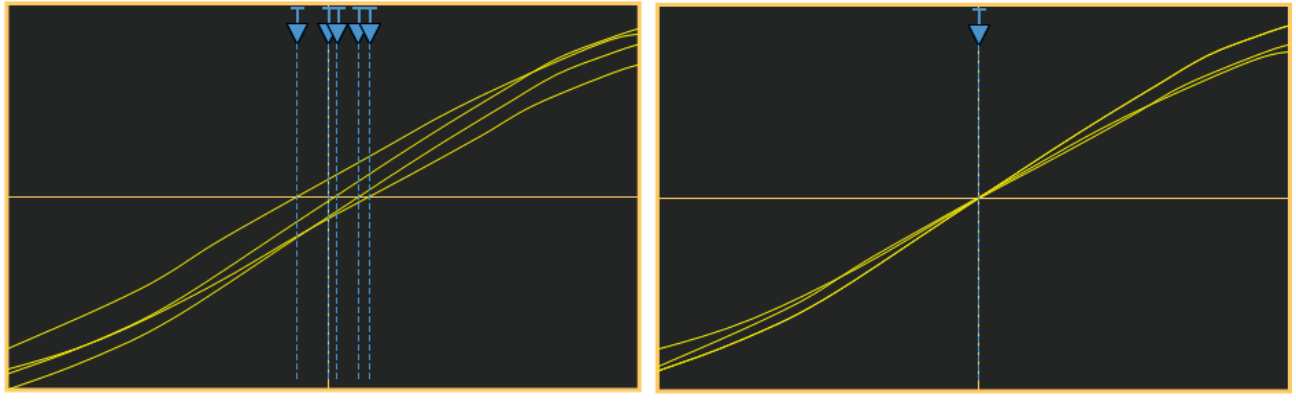
Waveforms can be acquired and downloaded at rates up to 100 Hz



The jitter between two signals can be measured with sub-picosecond accuracy



Comparison of trigger jitter with analog trigger (left) and digital trigger (right)



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