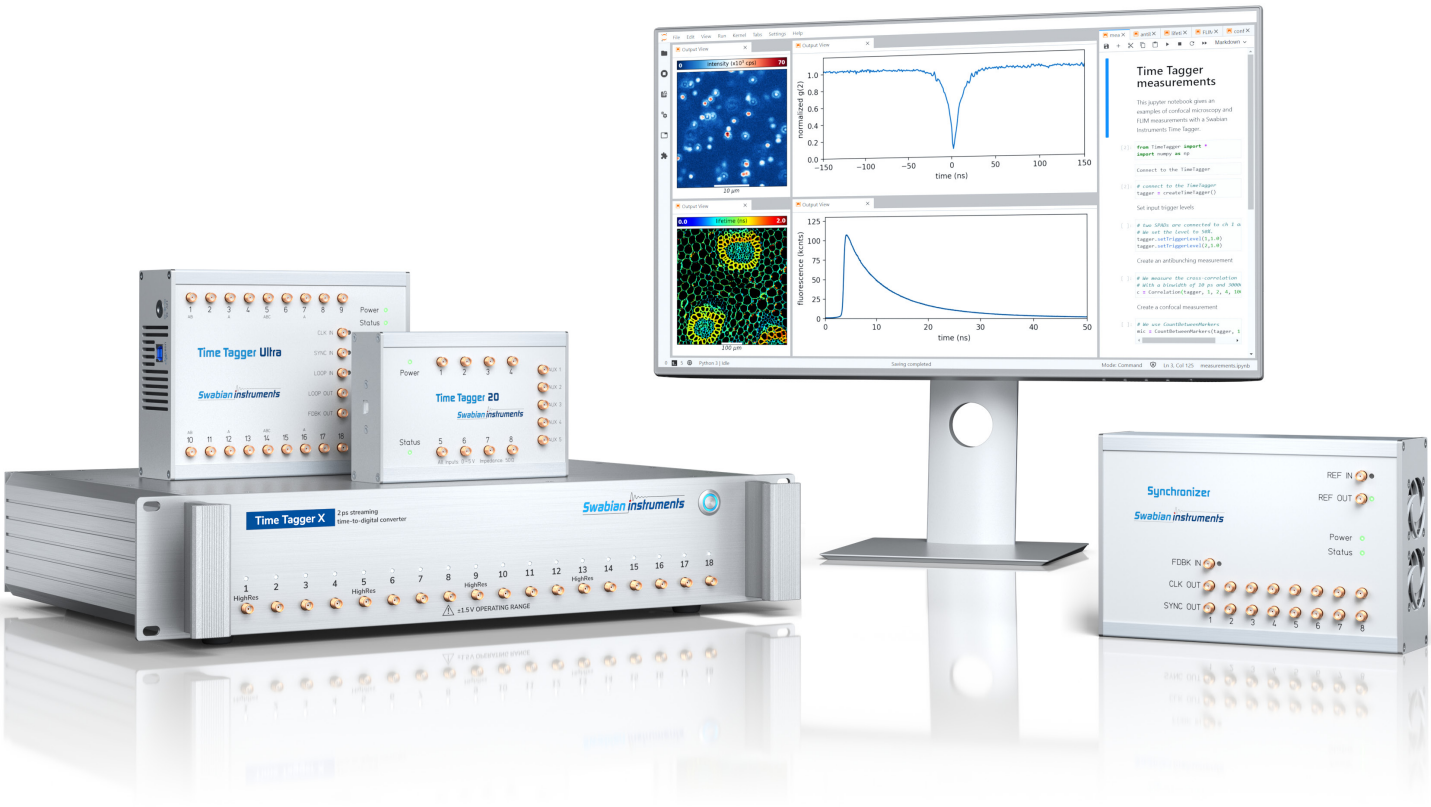
Swabian instruments

## Time Tagger Series

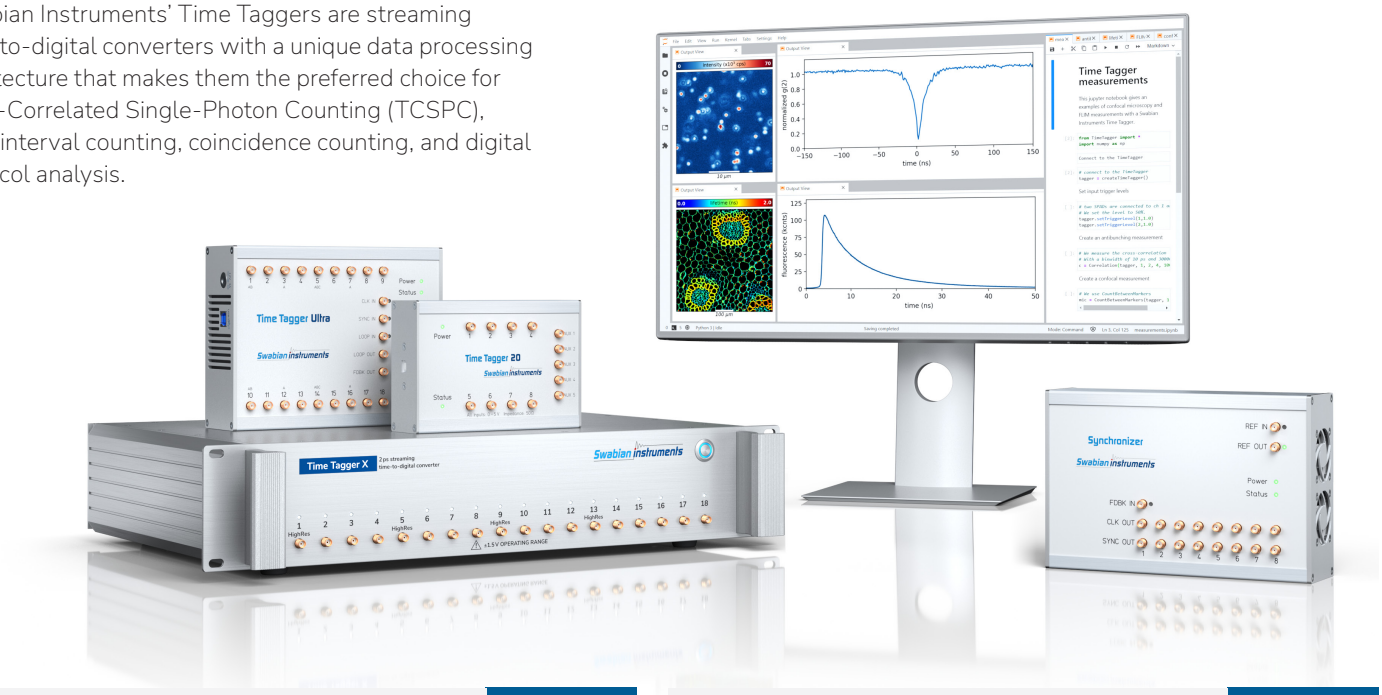
# Streaming time-to-digital converters



TIME TAGGER SERIES

# Streaming time-to-digital converters

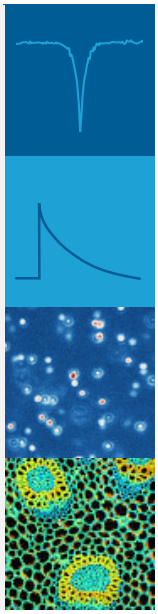
Swabian Instruments' Time Taggers are streaming time-to-digital converters with a unique data processing architecture that makes them the preferred choice for Time-Correlated Single-Photon Counting (TCSPC), time-interval counting, coincidence counting, and digital protocol analysis.




## The new Standard in Time-Correlated Single Photon Counting.

The Time Tagger Series provides endless capabilities for single-photon counting and you unleash them with no efforts. Whether you use the Time Taggers' powerful Software or derive from extensive code examples in Python, Matlab, LabVIEW, or C#/C++ - you get your experiments up and running within minutes.

- antibunching
- coincidence counting
- laser scanning microscopy
- multidimensional histograms
- supports SPADs, PMTs, SNSPDs, SiPMs



## Frequency Stability Analysis made easy.

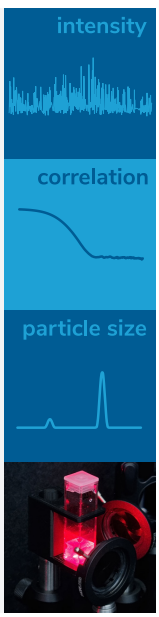
Are you looking for a versatile frequency counter or continuous time interval analyzer (CTIA)? Do you perform Allan Deviation, Modified Allan Deviation, or Hadamard Deviation measurements? Or do you test synchronization of 1 PPS signals? The Time Tagger Series lets you do this easier than ever.

- Allan Deviation 8E-13 at 1 s
- realtime ADEV, MDEV, HDEV, phase and frequency error measurements
- up to 18 inputs simultaneously
- easy 1 PPS testing and logging
- log and post process your raw data


## Take Dynamic Light Scattering to the next level.

Unsurpassed timing resolution paired with unlimited logarithmic histograms on a multitude of detectors. That's the Time Tagger's capabilities for dynamic light scattering.

- measure simultaneously at up to 18 different scattering angles
- remove intensity spikes on-the-fly and in post processing with advanced data filtering tools
- calculate particle size distributions with Cumulants and CONTIN analysis
- resolve down to picoseconds




## Endless processing capabilities.

Learn more on

**swabianinstruments.com/static/documentation/TimeTagger/**

## Time Tagger 20


**Compact.**
**USB powered.**

34 ps
RMS jitter

8.5 M tags/s
data transfer rate over USB 2

8
input channels

## Time Tagger Ultra


**Flexible.**
**Powerful.**

| Performance | Value |
|---|---|
| 8 ps RMS jitter | 42 ps RMS jitter |

70 M tags/s
data transfer rate over USB 3

min 4 and up to 18
input channels

Over-the-air upgradable

+ more input channels

+ Value to Performance

+ lower jitter - HighRes

## Time Tagger X


**X-treme resolution.**
**X-treme interfaces.**

2 ps
RMS jitter

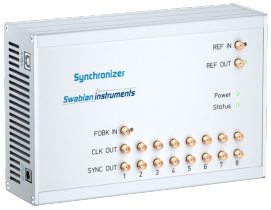
70 and 300 M tags/s
over USB 3 and FPGA link

min 4 and up to 18
input channels

Over-the-air upgradable

+ more input channels

## Synchronizer




**Large scale systems.**
**Combined into one.**

0.8 ppb
clock stability over 24 h

combine up to 8
Time Tagger Ultra and X

up to 144
input channels total

### Implement your ideas within minutes

What makes our Time Taggers unique is their powerful software engine that offers effortless data processing capabilities. You will implement your measurement ideas within minutes - promised.

### High timing resolution

The low instrument jitter down to 2.0 ps RMS (4.7 ps FWHM) combined with exceptionally short dead time down to 1.5 ns makes sure that you achieve the highest timing resolution for your application.

### Versatile onboard event filter

A unique onboard event filter enables you to increase the effective time tag rate way beyond the streaming bandwidth by filtering out unneeded time tags right on the hardware.

### Unlimited network capabilities

You can use the Time Tagger's software engine to cast your Time Tag Streams into a network. On client computers you can fire up virtual Time Taggers and work with them as if they were physically attached to your computer, providing the full measurement and data processing capabilities of a hardware Time Tagger.

### Maximum flexibility

Run measurements independently using any combination of your input channels. You can take data simultaneously from independent physical setups and run multiple measurements on the same channels at the same time.

### High data transfer rate

The high data transfer rate of 70 M tags / s to your computer over USB 3.0 enables you to process huge amounts of events on the fly.

### Native software libraries

Run your measurements in your preferred programming language with our included native software libraries, covering Python, MATLAB, LabVIEW, C#, C++, and even Mathematica.

### Low latency FPGA output

The Time Tagger X introduces a low latency FPGA interface with 300 M tags / s bandwidth to transfer your time tags into your own FPGA, enabling endless processing capabilities. Get started immediately with your own FPGA project with our free FPGA reference designs.

# Specifications

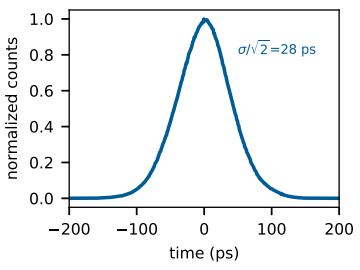
| **Timing precision** | Time Tagger 20 | Time Tagger Ultra | | Time Tagger X |
|---|---|---|---|---|
| RMS jitter (typical) | 34 ps | 8 ps (Performance) | 42 ps (Value) | 2.0 ps |
| RMS jitter (typical, HighRes) | - | 3 / 4 / 6 ps (2 / 4 / 8 HighRes channels) | | - |
| FWHM jitter (typical) | 80 ps | 19 ps (Performance) | 100 ps (Value) | 4.7 ps |
| FWHM jitter (typical, HighRes) | - | 7 / 10 / 14 ps (2 / 4 / 8 HighRes channels) | | - |
| digital resolution | 1 ps | 1 ps | | 1 ps |
| **Processing capabilities** | | | | |
| input channels | 8 | 4 to 18 | | 4 to 18 |
| dead time | 6 ns | 2.1 ns | | 1.5 ns |
| data transfer rate (to PC) | 8.5 M tags/s | 70 M tags/s | | 70 M tags/s |
| data transfer rate (FPGA link) | - | - | | 300 M tags/s |
| burst memory | 8 M tags | 512 M tags | | 512 M tags |
| maximum input frequency | 167 MHz | 475 MHz | | 700 MHz |
| **Input signals** | | | | |
| input impedance | 50 Ω | 50 Ω | | 50 Ω / 1 MΩ |
| input signal range | 0 to 3 V | -3 to 3 V | | -1.5 to 1.5 V |
| maximum input (no damage) | -0.3 to 5 V | -5 to 5 V | | -3 to 3 V |
| trigger level range | 0 to 2.5 V | -2.5 to 2.5 V | | -0.75 to 0.75 V |
| minimum pulse width | 1 ns | 500 ps | | 350 ps |
| minimum pulse height | 100 mV | 100 mV | | 100 mV |
| **External clock input** | | | | |
| frequency | - | 10 MHz or 500 MHz | | 10 MHz or 500 MHz |
| coupling | - | AC, 50 Ω | | AC, 50 Ω |
| amplitude | - | 1 to 3 Vpp | | 0.5 to 4 Vpp |
| **General parameters** | | | | |
| data interface | USB 2.0 | USB 3.0 | | USB 3.0, SFP+ |
| size (L x W x H) in mm | 145 x 100 x 50 | 190 x 140 x 60 | | 380 x 480 x 90 (2U) |

# Typical performance

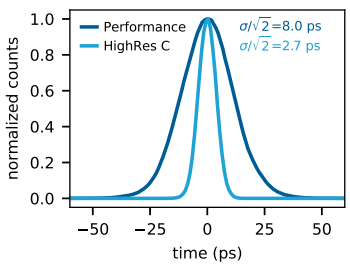
## Instrument response

1 MHz square wave, 1 Vpp, 1 ns rise, applied to two input channels, trigger 50%. The standard deviation σ of the distribution measures the jitter of two input channels. The RMS jitter of each individual channel is σ/√2. The FWHM jitter of each channel is 2.35 σ/√2.

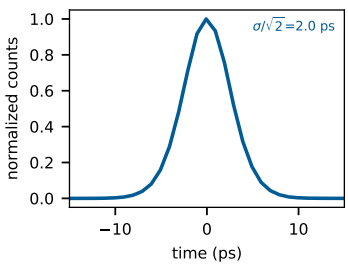
Time Tagger 20




Time Tagger Ultra




Time Tagger X




## RMS Jitter

The plots show the RMS jitter obtained from instrument response measurements with all pairs of the first 8 input channels.