Q420: Calibration-Free Precision Time Tagger for Quantum Experiments

In advanced quantum and photonics experiments, timing stability, precision, and seamless system integration are key. The Q420 delivers all three — with low jitter, effective single shot precision (SSP) <=11.2ps rms, and calibration-free operation in a scalable PXIe platform. Below is a focused comparison showing where these strengths make Q420 the most reliable choice for demanding applications.

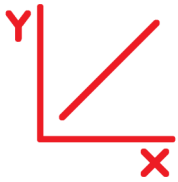
Key advantages

1. Time resolution / precision

The Q420 offers a ≤11.2ps single shot precision with a 31.25ps bin size. Unlike some other time-taggers this has a very low dependence on process or temperature. The clock is derived from the PXIe clock or an external timing module such as Rubidium or GPS.
This makes Q420 an excellent choice when long-term stability and repeatability are required.

2. High Tag rates and low dead-times

By using PCIe, the Q420 can measure tags at far greater rates than would be feasible with USB or Ethernet without interruption. The Q420 has a typical maximum measurement rate of 500 Megatags/s, which opens the door to high count photon counting experiments, such as those using superconducting nanowire single-photon detectors (SNSPDs) and multi-pixel photon counters (MPPCs)/Silicon Photo Multipliers (SiPM).
The Q420 also has a measurement dead-time of ≤2ns, almost eliminating the effects of dead-times on measurements.



3. Linearity

A critical differentiator is Q420's excellent linearity (maximum differential non-linearity of 0.13), ensuring excellent measurement repeatability. The unique method employed avoids missed bins and achieves better performance for QKD. It also boasts sub-picosecond channel variance (<0.4 ps).

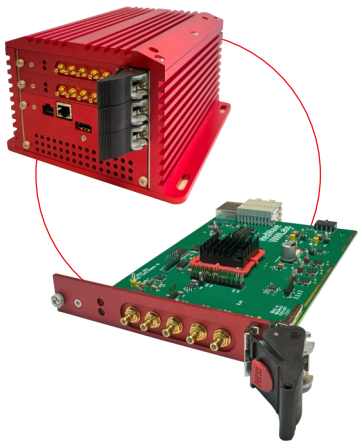
4. Calibration and stability

While many time taggers require periodic calibration to maintain their specifications, Q420 is designed to run without internal calibration. This ensures:
- Fewer interruptions in long experiments,
- Less drift over time,
- Higher reliability in field-deployed or 24/7 environments.
- No need for extra calibration input processes.

5. Q420 Channel Capabilities and Advantages

Q420 provides 4 timing channels + 1 dedicated sync/offset input and allows modular scalability. It can also use the PXI triggers for timing synchronisation.
- Q420 offers outstanding linearity, tag rates and enables truly continuous measurements
- As a PXIe module, multiple Q420 units can be installed in the same chassis, allowing nearly an unlimited number of channels to be synchronised in one system.
- All modules share the backplane clock and trigger fabric, ensuring deterministic synchronisation across systems (software calibrates out back plane delays)

Pricing Advantage of Q420



- Market prices: Comparable systems are typically in the **$10,000–$20,000** + range.
- Q420 performance: Offers PXIe integration, <=11.2ps rms precision, and calibration-free continuous operation.
- Your benefit: Delivered at a lower price point than any of these known figures, making Q420 the most cost-effective high-performance choice.

If you need stable performance without constant recalibration (especially in system racks): → RedWave Q420 is outstanding: a continuous tag rate of 500Megatag/s, its effective precision <=11.2ps rms with excellent converter linearity (differential non-linearity of <=0.13) means you get high tag rates, precision and linearity.

Applications where Q420 excels

Application	Typical Needs	Q420 Strengths	Why Q420 is the Best Fit
Quantum Key Distribution (QKD)	Use of recovered clock signal long-term reliability	PXIe ref-clock lock, 11.2ps SSP, low drift, calibration-free operation	Ensures secure, stable key exchange with minimal downtime and external chassis sync ready for a telco environment.
High count rate photon counting experiments	Low time-tagger measurement dead-times, high sustained measurement rates	Sustained tag rate of **500 Megatags/s**. Measurement dead-time of **≤ 2ns**.	The high tag measurement rate enables high count rate experiments using Single-photon avalanche diode (SPADs), multi-pixel photon counters (MPPCs) or Superconducting Nanowire Single-Photon Detectors (SNSPDs).
Coincidence counting	Multiple channels, low dead-times, moderate precision	The low dead-time (**≤2ns**) ensures that dead-time effects caused by the timing are negligible. The precision and high linearity ensure coincidence events are measured accurately and no events are missed.	The low dead-time and coincidence filtering provided in the API is suitable for custom coincidence counting setups.
Quantum Computing / Control Racks	Tight synchronization across many instruments, scalable integration	PXIe form factor, PCIe data path, shared clock and PXI triggers for gating	Provides deterministic timing alignment across AWGs, digitizers, and controllers in one chassis
Spectroscopy / Time-Resolved Quantum Optics	Stable long runs, no drift, precise timing when locked to external clock	No internal calibration, **11.2ps rms precision**	Ideal for long-duration measurements without recalibration interruptions
Microscopy (TCSPC, FLIM)	Typically 1–2 channels, integration into imaging systems	4 timing + 1 sync channels, precision **≤11.2ps rms**.	While not designed as a microscopy card, Q420 provides higher stability for research setups that demand PXI sync. The linearity of the Q420 enables a well-defined instrument response function.

Table 1: Q420 Application Matrix