Single Quantum Eos

SNSPD Closed-Cycle System

SINGLE QUANTUM
Excellence in photon detection

High detection efficiency. Unrivalled time resoluton.

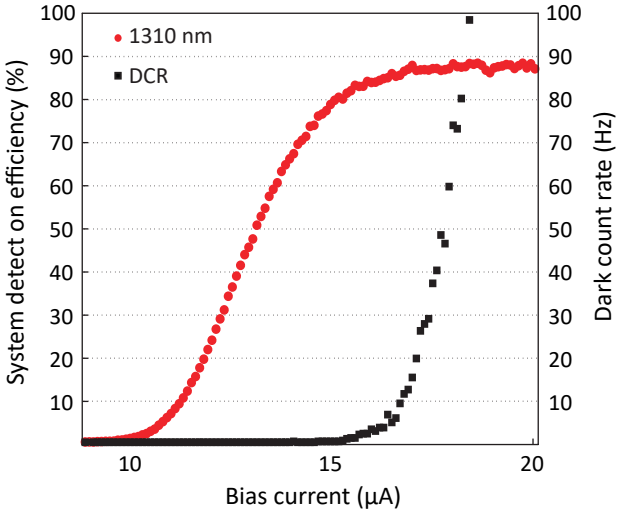
Single Quantum develops the fastest and most sensitive light sensors on the market, based on the breakthrough technology of superconducting nanowire single photon detector (SNSPD). With 80 systems installed worldwide, Single Quantum Eos is recognized for its reliability, high performance, and long lifetime.

Features

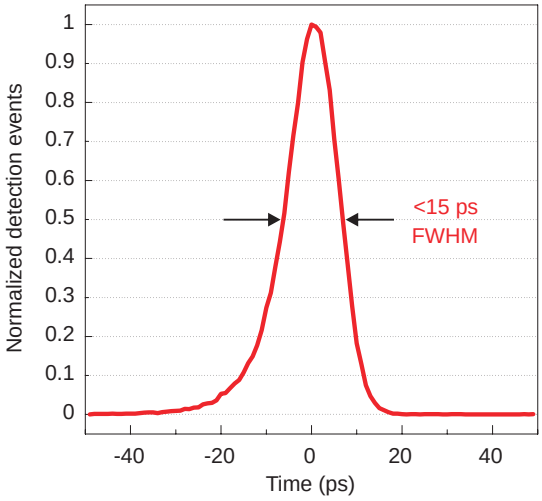
- High detection efficiency
- Low timing jitter (high time resolution)
- Short dead time
- High photon detection rate
- Low dark count rate
- Broad bandwidth
- No afterpulsing
- No helium consumption
- Continuous operation >10,000 hours
- A turn-key system

A complete solution comprising closed-cycle cryostat, helium compressor, electronic driver, and software.

High detection efficiency



Low timing jitter



Specifications

Optimization wavelength	800 nm	900 nm	1064 nm	1310 nm	1550 nm
System detection efficiency	≥ 90%	≥ 90%	≥ 85%	≥ 85%	≥ 85%
Dark count rate	≤ 10 Hz	≤ 10 Hz	≤ 20 Hz	≤ 100 Hz	≤ 300 Hz
Standard timing jitter	≤ 40 ps	≤ 40 ps	≤ 50 ps	≤ 50 ps	≤ 50 ps
Optional low timing jitter	≤ 15 ps	≤ 15 ps	≤ 20 ps	≤ 20 ps	≤ 25 ps
Dead time[1]	≤ 10 ns	≤ 15 ns	≤ 20 ns	≤ 25 ns	≤ 30 ns
Maximum count rate[2]	≥ 80 MHz	≥ 60 MHz	≥ 30 MHz	≥ 30 MHz	≥ 50 MHz
Output pulse height	≥ 200 mV	≥ 200 mV	≥ 200 mV	≥ 200 mV	≥ 200 mV
Number of channels	1-24				

[1] Minimum time separation where the second photon can be detected with half of the peak efficiency.

[2] Maximum continuous detection rate where the system detection efficiency reduces by less than 3 dB.

Please contact us for dipstick system and customized solutions.

email: info@qdusa.com

Distributed in North America by Quantum Design

www.qdusa.com

quTAG HR - High Resolution Time Tagger

High resolution variant of the quTAG family.

Key Features

- 1 ps digital resolution
- Timing jitter down to 2.3 ps RMS / 5.4 ps FWHM
- Sustained event rate 100 M tags/sec
- Up to 16 high resolution stop channels
- USB 3.0 interface
- Cost-sensitive, modular versions available

Applications

- Time-correlated Single Photon Counting (TCSPC)
- Quantum Optics / Information / Communication
- Quantum Key Distribution / Quantum Cryptography
- Fluorescence Lifetime Imaging (FLIM)
- Fluorescence Correlation Spectroscopy (FCS)
- Foerster Resonance Energy Transfer (FLIM-FRET)
- Single Photon Emitter Characterization
- Light Detection and Ranging (LIDAR)

quTAG HR Specifications

Time to Digital Converters	
Digital resolution	1 ps
Timing jitter*1 RMS	down to 2.3 ps*2
Max. event rate per channel	25 Mcps 200 MHz periodic*3
Sustained throughput rate	100 M tags/sec
Delay range	-100 ... +100 ns
Delay resolution	1 ps
Min. pulse to pulse separation	40 ns
Differential non-linearity	<1 %

Input Channels	
Number of channels	8, 16 & 1 start
Connectors	SMA
Signal levels	-5 ... +3.5 V
Threshold level resolution	2.5 mV
Edge	rising, falling
Min. input pulse width	300 ps
Impedance	50 Ohms
Divider on start input*4	1, 2, 4, 8

Output Channels	
Number of channels	2
Signal levels	LVTTL
Delay resolution	10 ps

Synchronisation	
Number of synchronisable quTAGs	10
Number of synchronised channels	160

Marker Inputs	
Number of channels	4
Digital resolution	5 ns
Impedance	470 Ohms

Clock Input	
Frequency	10 MHz*5
Signal level	-5 ... +5 V
Impedance	50 Ohms
Connector	SMA

Clock Output	
Frequency	10 MHz*5
Signal level	LVTTL
Impedance	50 Ohms
Connector	SMA

Operation	
Interface	USB 3.0
Supplied software	GUI, Python, LabView, DLL, command line
Dimensions: 8 / 16 channels	440 x 330 x 75 / 97 mm

*1: see measurement method, *2: enhanced jitter values by redistribution of resources & channels, *3: divider enabled, *4: optional for stop channels, *5: various frequencies

quTAG HR variants

The time taggers of the quTAG family are available with a wide range of timing resolution and channel numbers. Enhanced timing jitter values can be achieved by interconnecting input channels via software.

The following table shows all quTAG HR versions with varying number of input channels and timing RMS jitter in picoseconds. Achieved timing jitter by interconnecting input channels are listed horizontally.

Versions	16 Ch	8 Ch	4 Ch	2 Ch
HR-04/08		*4.5*	3.2	2.3
HR-06/08		*6.4*	4.5	3.2
HR-06/16	*6.4*	4.5	3.2	2.3
HR-15/08		*15.0*	10.6	7.5
HR-15/16	*15.0*	10.6	7.5	5.3

Available quTAG HR extensions

Lifetime software extension

The software add-on enables analyzing lifetime measurements on the fly. The software calculates histograms and fits exponential decreases.

Cross-correlation software extension

The software extension calculates the correlation function needed in Hanbury Brown-Twiss experiments or fluorescence correlation spectroscopy.

Clock input*

The quTAG can be synchronized to an external clock to allow more precise long-term accuracy.

Synchronization of devices*

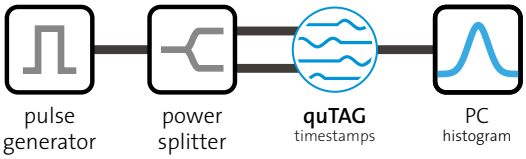
This extension allows to synchronize up to 10 devices. Up to 160 equal stop channels of HR version are offered – all sharing the same clock.

Start-channel as input*

The start channel can be converted to another stop channel, allowing one more equal input channel.

How we measure the jitter

In order to measure the jitter, we generate an electrical pulse with steep edges. This pulse gets split into two by a power splitter and sent into two different inputs of the quTAG (i.e. start and stop-X or stop-X and stop-Y).



Then we use the quTAG software to generate a start-stop-histogram. We fit a Gaussian function to this histogram and determine RMS and FWHM. The single channel jitter corresponds to $\sigma/\sqrt{2}$ from this two channel measurement, assuming equal Gaussian contributions from both signals. The FWHM can be obtained by the standard deviation with the relation $\mathrm{FWHM} = 2\sqrt{2\ln 2}\,\sigma \approx 2.35\sigma$.

Virtual channels & filters*

The device allows to enable virtual channels or user-defined filters. The filtering is based on hardware and happens inside the device to save USB bandwidth.

Marker inputs - *optional*

The device features marker inputs, inserting timestamps in the timeline. Marker inputs are needed e.g. to read a pixel or line clock in a FLIM setup.

Divider for stop channels - *optional*

This option allows you to enable the divider on all stop channels. This allows higher frequency periodic signals to be recorded.

Output channels - *optional*

The two programmable outputs enable conditional measurements, state preparation, gating of detectors, control of shutters and more to synchronize events.

* not included in both quTAG HR-15ps variants

OptiCool®
By Quantum Design

Product Description

Quantum Design's OptiCool is a new, magneto-optical cryostat that builds on our 30+ years of experience developing and manufacturing automated temperature and magnetic field control platforms. The innovative cryostat and magnet design puts the sample in the heart of your optical environment. This highly integrated design means, even with a magnet, your sample isn't buried inside a large cryostat, far away from the optics. Seven side optical ports and one top optical port allow for optical access to your sample from a wide array of directions.

Every aspect of the OptiCool has been developed to provide the largest range of sample access, while also ensuring that the system is easy to use. Utilizing and adapting DynaCool's successful approach to cryocooler equipment design, the system requires only a small volume of helium gas for its fully automated startup and operation.

Magnetic Design & Control

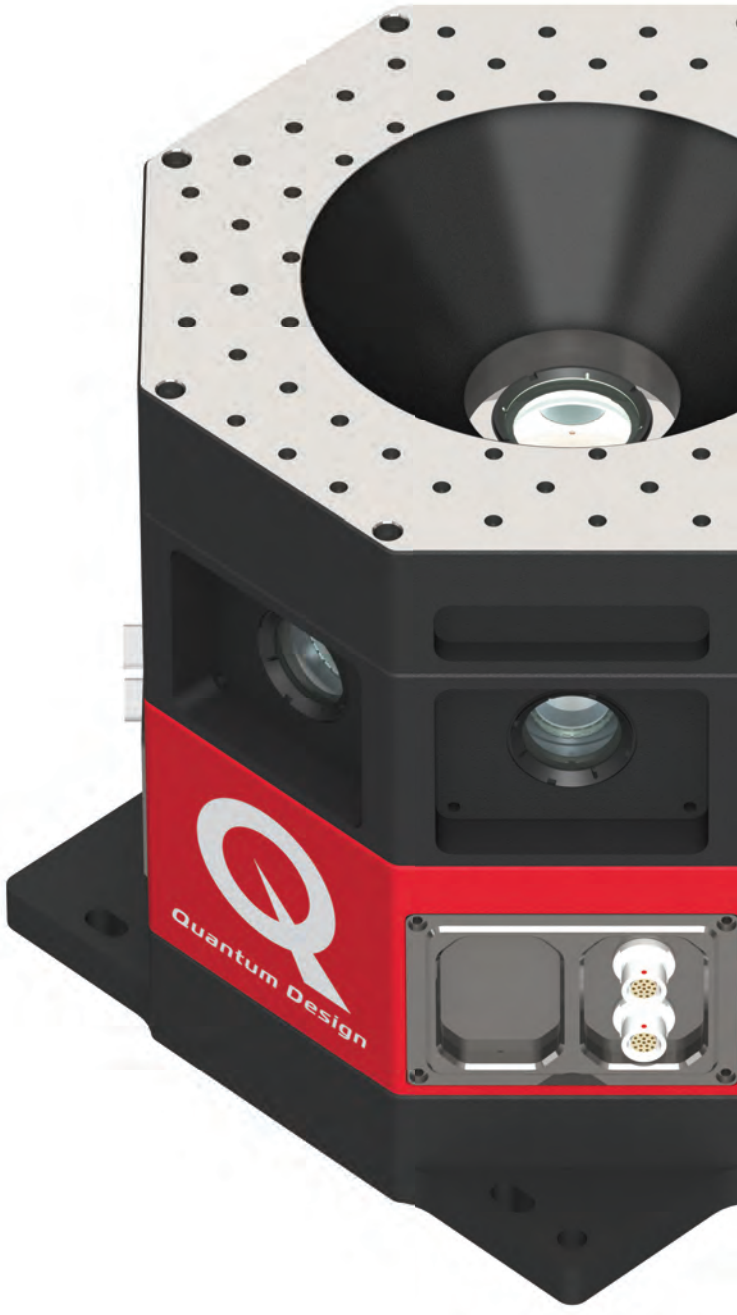
The OptiCool comes with a new superconducting, split-coil, conical magnet that has been custom designed by Quantum Design for this platform. This large bore magnet offers fields perpendicular to the optical table up to ±7 tesla. The system includes a hybrid digital/analog magnet controller designed for precise, quiet control of the magnetic field. The bipolar design also allows smooth continuous ramping through zero field.

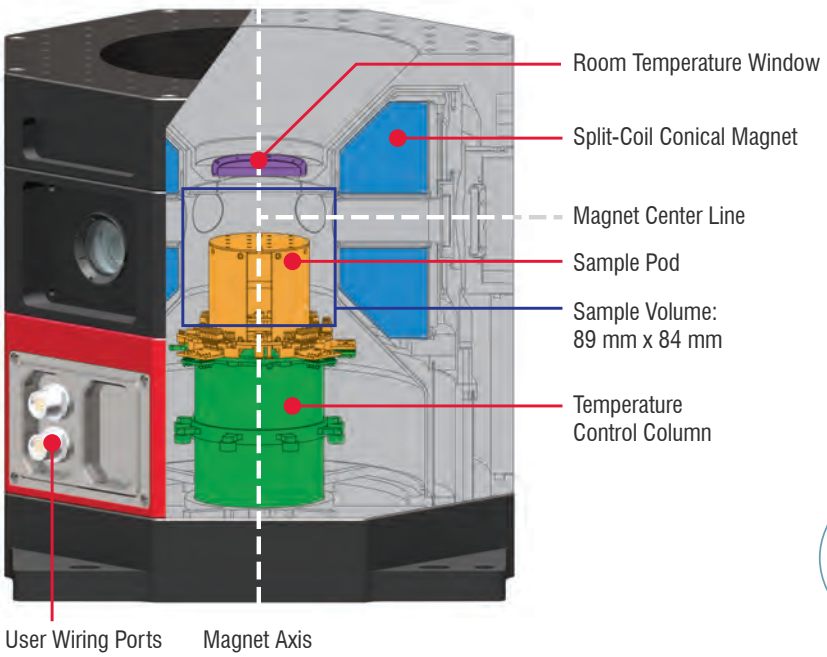
Temperature Control

Quantum Design customers have come to expect easy-to-use automated temperature control. OptiCool delivers on this promise with a unique, single-cooler design that provides cooling for both the magnet and the circulating helium. This system provides seamless transitions throughout its temperature range of 350 K to 1.7 K, and stable operation at its base temperature of 1.7 K.

Fully Automated Operation

Included with the OptiCool is custom control software that automates the operation of the cryostat. The cryostat can be cooled down and warmed up with a click of the mouse, requiring no user intervention. Changing the sample temperature or applied magnetic field is also fully automated. The software also allows you to graph and analyze your data in real time to quickly see trends and features. A LabVIEW interface is included to allow you to control the instrument within your existing LabVIEW measurement software.





Cutaway of OptiCool Cryostat showing sample pod, sample space and magnetic axis and center.

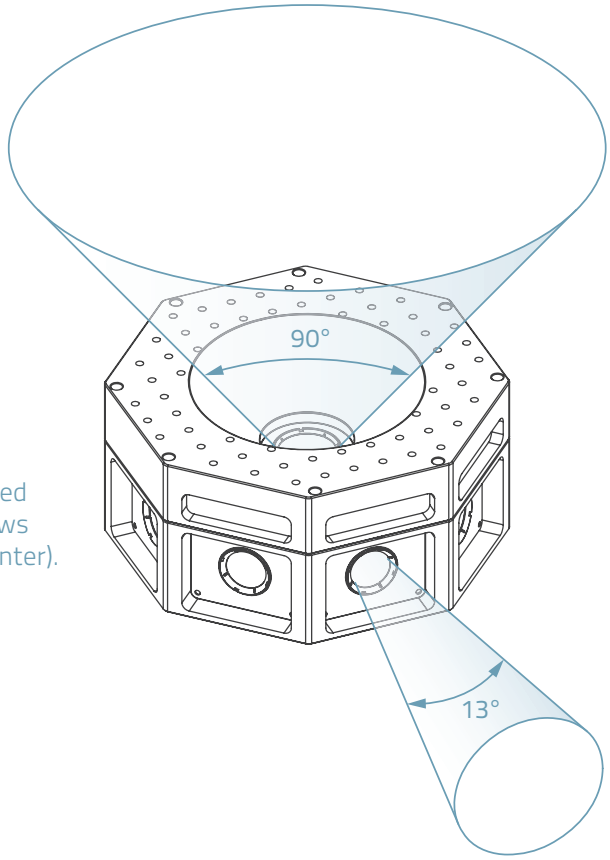
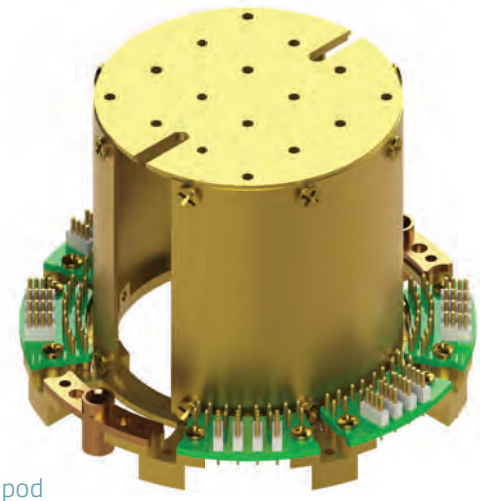


Illustration of OptiCool Cryostat demonstrating optical access angles available through 8 optical ports. Top window (NA > 0.7; 90° for sample located 13 mm above magnetic center) and 7 side windows (NA > 0.11; 13° for sample located at magnetic center).

Optical Access & Sample Space

OptiCool leverages state-of-the-art magnet and cryostat design to offer an excellent combination of optical access and magnetic field range. This unique magnet allows the sample space to be accessed by eight optical ports – one top and seven side ports – all within a magnetic field range of ±7 tesla. With a numerical aperture of >0.7 for the top port and >0.11 for side ports, OptiCool provides a wide variety of optical angles and magnetic field variations. In addition, the 89 mm (diameter) by 84 mm (height) sample volume offers lots of space for your experimental hardware inside the cryostat vacuum.

A History of Innovation
8 Optical Access Ports
1.7 K to 350 K; ±7 tesla
Cryogen Free
Automated Operation



OptiCool sample pod showing sample surface and prewired sample boards available.

Sample Pod & Wiring Possibilites

OptiCool's Sample Pod provides a place to build and customize your experiment on the bench. When you are ready to make a measurement, the Sample Pod easily plugs into the pre-wired temperature control column. When your measurement is finished, the pod is easily swapped with another pod, already wired up with your next experiment. OptiCool comes pre-wired with 16 wires, routed and thermally anchored from the outer User Wiring Ports to the sample volume. Additional wires can be installed for up to 80 wires total.

With this ease of access, large sample volume, and wide range of possible wiring configurations, a researcher will only be limited by their imagination.

Only be limited by your imagination...

OptiCool® Specifications*

Temperature Control	
Temperature Range:	1.7 K to 350 K
Temperature Stability:	±0.2% for T < 20 K; ±0.02% for T > 20 K
System Cooldown Time:	17 hours (typical)
Magnetic Field Control	
Maximum Field:	±70,000 Oe (±7 T)
Field Uniformity:	±0.3% over a 3 cm diameter spherical volume
Optical Access	
Access Port Details:	1 top window (user-replaceable), 50 mm diameter, 41.5 mm clear bore
(8 total access ports standard)	7 side windows (user-replaceable), 40 mm diameter, 24.5 mm clear bore
Numerical Aperture:	Top Window: NA > 0.7 for sample located 13 mm above field center.
	Side Windows: NA > 0.11 for sample located on magnet axis.
Acceptance Angle, Top Window:	70 degrees full angle: Sample located at magnet center
	90 degrees full angle: Sample located 13 mm above magnet center
Acceptance Angle, Side Window:	13 degrees full angle: Sample located at magnet axis
Vibrational Stability	
Horizontal:	< 10 nm peak-to-peak
Vertical:	< 4 nm peak-to-peak
Sample Space	
Maximum Sample Volume:	89 mm diameter by 84 mm tall
Sample Environment:	Sample in cryostat vacuum space
Dimensions	
Optical Table:	Cryostat Footprint: 1 m x 0.5 m (minimum)
	Cryostat Height: 1 m (minimum)
Floor Space:	Tower Footprint: 0.75 m x 0.75 m
	Tower Height: 2 m (minimum)
	Cabinet** Footprint: 1 m x 1 m
	Cabinet** Height: 0.68 m (minimum)

OptiCool Platform

Quantum Design

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*Specifications subject to change without notice. 1318-003 Rev. C0
**Cabinet not shown