Quotation DS1009

Prepared for:

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Dear Ray,

Following our recent email exchange, I am pleased to offer the following fixed price quotation for a Terahertz detector system. This easy-to-use detector system does not require liquid cryogens for operation and instead utilises a closed cycle cryocooler which is offered with either air or water cooling.

Product Code	Description	Price
QNbB/PTCW	*NbTES Bolometer mounted in a* **water** *cooled cryocooler*	*£70,254.00*
QNbB/PTCA	*NbTES Bolometer mounted in an* **air** *cooled cryocooler*	*£72,844.00*

Quote validity: 90 days from date of offer
Delivery*: 6 -9 months from receipt of order
Delivery Terms: Ex. Works (Cardiff, Incoterms 2020)
Warranty Period: 2 years from day of shipping
Payment Terms: 30 days

Details of the technical specification and discussion follows in the next pages.

We trust this quotation is acceptable and look forward to receiving your order. Should you require any further information, please do not hesitate to contact me.

Yours truly,

James Cox
(Sales & Technical Support)

* Please note that our delivery timescales have been affected by the COVID-19 pandemic, and while 6 months is our “regular” delivery expectation, we may take up to 9 months to complete delivery to you.

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Technical Discussion – Cryocooled Niobium Transition Edge Sensor Bolometer

The Niobium superconducting bolometer (Nb TES) is our most recent development improving significantly on crucial aspects of the performance of traditional broadband semiconductor based bolometers.

This new detector technology offers excellent sensitivity with a low operating impedance to reduce susceptibility to microphonic noise and electromagnetic interference. Noise reduction is assisted by novel noise cancellation techniques in the detector bias and amplification circuitry so that the detector gives identical performance in both liquid helium reservoir and electrical (pulse tube) cooling platforms.

The 1/f noise component in this superconducting thermistor is greatly reduced, whilst speed of detection is increased, so that the range of modulation frequencies at which the detector operates near optimum sensitivity is significantly increased.

The thin film Niobium thermistor is photolithographically deposited onto a SiN substrate along with a thin metal absorbing film and electrical contacts. The thermistor is in good thermal contact with the metal absorber which changes temperature as it absorbs THz power. The SiN substrate provides excellent thermal isolation of the active parts of the detector.

The operation of a superconducting thermistor on its transition edge permits the use of electro-thermal feedback to stabilize the device. A direct consequence of this scheme is a major improvement by orders of magnitude compared to the linear dynamic range available from semiconductor based cooled detectors.

The bolometer has essentially constant spectral responsivity from 90GHz through the THz region and into the near infra-red. In practice (unless available funds can allow the use of large diameter CVD diamond as a vacuum window) its spectral range is limited by the transmission properties of vacuum window materials. Our unique multi-layer mesh filters are included in these systems to ensure that any unwanted frequencies are rejected to a high level and that sensitivity is optimized for the particular circumstances of the experiment to hand.

The technical specification of the Nb TES is as follows:

Technical Summary – NbTES Bolometer

Parameter	**Specification**
System Optical NEP	1.0 – 3.9 pW/√Hz (measured at 27h GHz, 80 Hz modulation)
Rise time (-3dB)	500 µsec (1 – 2 kHz)
Optical coupling	Choice of f/3.5 or f/4 Winston cone
Linear dynamic range	> 70 dB

QMC Instruments Ltd. is the first to offer commercial THz broadband bolometer systems configured in a cooled environment which requires no liquid cryogens. Continuous operation is possible wherever there is a standard (single phase) mains power supply.

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The cooling platform for the detector comprises a pulse-tube refrigerator with a compressor which may be cooled by air or by water. The technical specification for the system is as follows:

Technical Specification – Pulse tube cooler

Parameter	Specification
Cooling capacity	0.22 W @ 4.2 K and 6 W @ 65K
Compressor Package	CP103
Water Cooled Weight	76kg
Water Cooled Dimensions	46 X 46 X 56cm
Air Cooled Weight	80kg
Air Cooled Dimensions	48 X 56 X 56cm
Power Consumption 60Hz (Input Power)	208/230 VAC 1PH / 3.0kW
Power Consumption 50Hz (Input Power)	200/220 VAC 1PH / 3.0kW
Cooling Water Requirements	1.2 GPM (4.5 LPM) @ 27°C
Flexible Lines	10ft_3m
Helium Pressure	220 ± 5 PSIG (15.2 ± .34 bar) @60Hz 250 ± 5 PSIG (17.2 ± .34 bar) @50Hz
Ambient Temperature Range:	7 TO 38°c

Technical Specification – Detector System Optics

Parameter	Specification
System cool-down time (from 300K to operation)	< 6 hours
Vacuum window	HDPE
Optical coupling options	Choice of f/3.5 or f/4 Winston cone
Optical filtering options	Cut-off options at 0.3, 1, 2, 3, 6, 10, 15 and 18 THz

Technical Specification – Detector System Readout

Our TES detector systems are supplied with a low-noise amplifier and read-out unit which mounts directly to the side of the cooling platform. Unlike conventional TES readout systems, our amplifier design does not use cold SQUID amplifiers and is therefore highly immune to external magnetic fields. Furthermore, our unique biasing system ensures unsurpassed detector linearity over a very wide dynamic range. The detector operating conditions are set to optimum values during our factory calibration routine prior to shipment. The end user need only apply power to the unit – no further tuning is required and the ideal operating conditions will not vary with time or illumination conditions.

Two voltage output signals are provided on BNC connectors, each signal directly proportional to absorbed optical power:

i) DC Output: This unconditioned output provides a DC voltage signal. This output will feed an output load $R_L \geq 1KOhm$;

ii) AC Output: This is low-pass filtered at 5 kHz with a two-pole electronic filter and provides user selectable additional gain compared to the DC Output. This output will feed an output load $R_L \geq 1KOhm$;

Note: All gains and band-passes can be tuned to match the data acquisition system.

Our TES amplifier electronics can be powered by a single power supply in the range 5V - 9V DC @ 1Amp. As standard we supply a mains USB power adaptor. The user can also run the amplifier with a USB battery (not supplied) if desired.

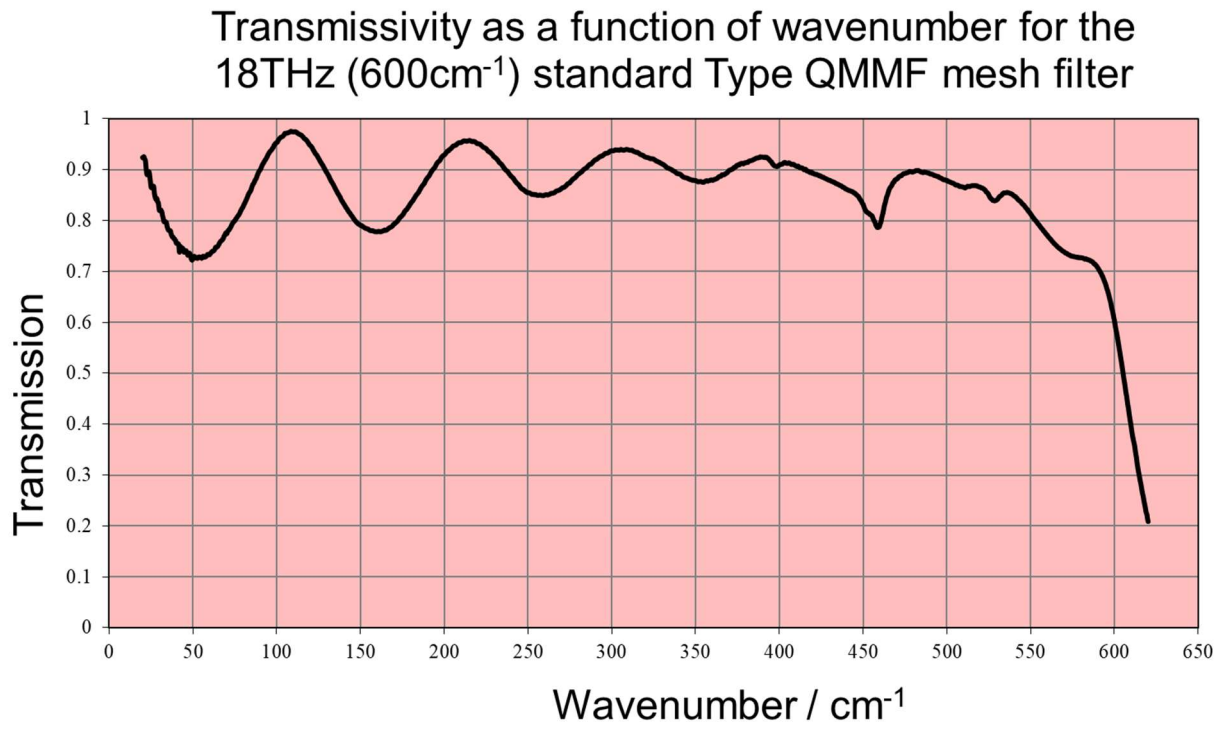

Figure 1 - Transmissivity as a function of wavenumber for the 18 THz LPE filter

We trust these specifications are acceptable and look forward to receiving your order. Should you require any further information, please do not hesitate to contact me.

James Cox
(Sales & Technical Support)