The Quartet: A Brief Introduction

The Quartet is a high sensitivity interferometer for ultrasonic, non-destructive testing. Designed around our patented Multi-Channel Random Quadrature (MCRQ) Technology, it is an exceptionally rugged laser ultrasound receiver. MCRQ technology is designed to overcome the speckle limitation that occurs when a coherent laser beam is reflected off an optically rough surface, allowing the Quartet to effectively perform measurements—including rapid scans—on porous, rusted or even mirror-like surfaces without the need for surface preparation. To increase the adaptability and practicality of the instrument, the Quartet has a compact, fiberized optical head that can be easily moved and mounted, making it ideal for both experimental setups and integration into larger systems, such as on a robotic arm or into a complex manufacturing process.

Optical Design and Signal Processing

Sound & Bright's proprietary **MCRQ Technology** combines a classic interferometric design (as found in Michelson or Mach-Zehnder interferometers) with an innovative multi-speckle processing technique that allows us to take advantage of the random distribution of speckles for quadrature detection. In the Quartet, the speckle limitation common to most laser-based interferometer designs is overcome using two detector arrays and parallel processing (each detector element constituting the two arrays captures a single speckle). It is this large number of detector elements that deliver high sensitivity on **all surface types** while remaining remarkably efficient in optically challenging contexts. The Quartet does not require critical alignment, requires low to no maintenance, and rejection of unwanted environmental perturbations is achieved electronically making for a **highly robust** instrument. The ability to work with speckled light also allows us to fit the Quartet with a multi-mode fibre for remote detection, as shown Fig.1. The **multi-mode fibre** allows us to direct most of the Laser light onto the sample, as the reference beam is generated from the reflection losses occurrent at the fibre input/output interface. Combined with an optical isolator within the receiver, this fiberized design makes use of 100% of the collected light for interference, independently of its polarization, making for a highly effective interferometric scheme. The system can also be fitted with one of two sets of detectors arrays, built with SI or GAAS photodiodes, meaning that the Quartet **can be fitted with a variety of laser wavelengths** ranging from the visible to infra-red.

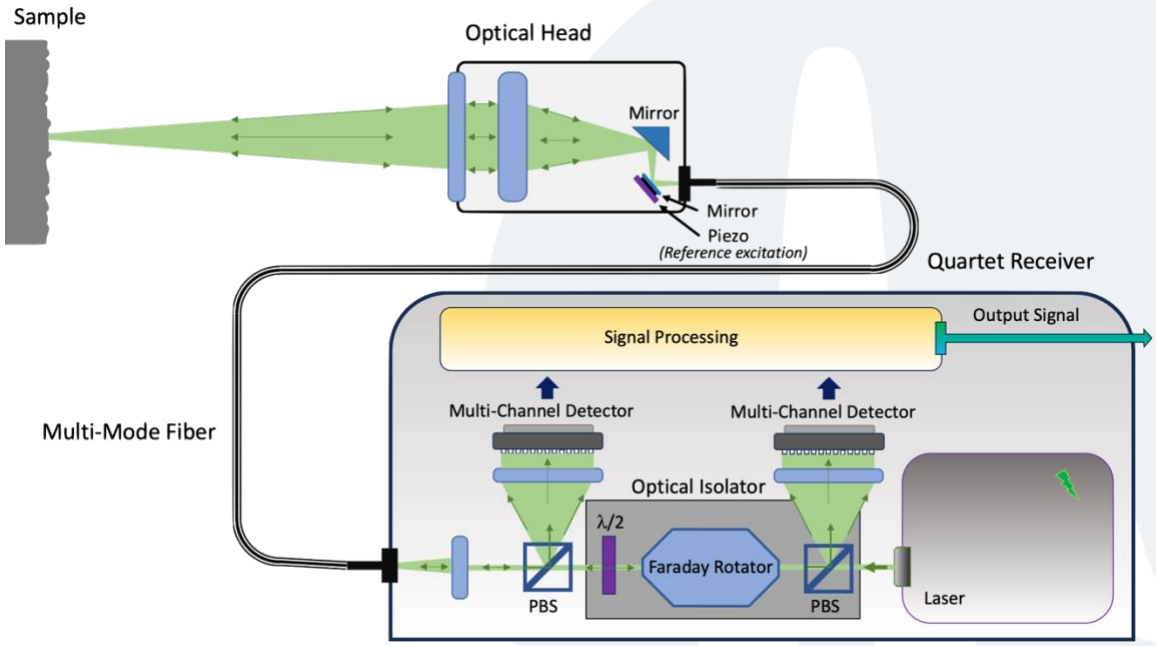

Figure 1: Quartet Optical Design

Sound & Bright
622 Magnolia Ave
Inglewood, California 90301
info@soundnbright.com
+1 (424) 227 4176

Key Features

- High-sensitivity.
- Straight-forward operation.
- Factory aligned turnkey receiver—no internal adjustments required.
- Exceptionally robust, highly-efficient design—remains effective in harsh environment.
- Proven in both laboratory and industrial settings.
- Fiberized Optical head with no limitation of fiber link length.
- Available with both Linear and rectified demodulations schemes:
  - *Linear demodulation:* Output is proportional to ultrasonic displacement – *High-frequency, fast scanning capability*
  - *Rectify demodulation:* Output corresponds to the absolute value of the ultrasonic displacement - *Very robust demodulation best suited for ultrasonic measurement in highly disturbed environment, Very fast scanning capability >1m/s*
- Modular electronic design—customizable detection for specific measurement requirements.
- Highly Effective between 1-100MHz.
- Can be fitted with various wavelengths: Standard (λ=532nm) or Infrared (λ=1064nm). Any wavelength between 400nm and 1700nm could be used so long as the laser has good coherence properties suitable for interferometry.

Figure 2: Quartet LU Receiver with Standard and Mini Optical Head

Sound & Bright
622 Magnolia Ave
Inglewood, California 90301

info@soundnbright.com
+1 (424) 227 4176

Technical Specs.

Output Power

- Integrated Laser.
- Standard version includes a 500mW, 1W or 1.5W laser at λ=532nm.

Dynamic range:

- Largest displacement corresponds to λ/8: (Max=66nm for λ=532nm)
- Minimum displacement is established by the NESD (Noise Equivalent Surface Displacement) and is factor of the target reflectivity and stand-off distance.

Detection Bandwidth Upper limit

Linear detection bandwidth upper limit is 100MHz when using internal laser 1.5 W @532nm

Detection Bandwidth Lower limit

Linear detection bandwidth lower limit is set electronically and can be tailored to requirement.

Note: for demodulation and calibration purposes, the Quartet uses an internal calibration signal at a frequency outside of the measurement bandwidth. A Narrow band filter is then utilized to reject the calibration frequency from the Output Signal

Output:

Two analogue outputs: ***Signal*** and ***Calibration***.

Signal**:** Analogue signal proportional to the surface displacement at ultrasonic frequencies. **(1)** When Calibration mode of operation is set to ***Auto***: The *Output Signal* is automatically normalized to 100mV for 1nm displacement. **(2)** When Calibration mode of operation is set to ***Free:*** The *Output Signal* can be normalized to nanometer displacement by using the amplitude of the *Output Calibration*

Calibration**:** This output delivers a DC level, corresponding to X10 the amplitude factor for a 1nm displacement amplitude: A 1Vdc amplitude corresponds to 100mV for 1nm conversion.

The amplitude of this calibration signal will fluctuate according to the amount of collected light (Interferometer sensitivity). Highest calibration value is achieved when placing the target at the focus.

Calibration Display: In addition to the *OUTPUT Calibration, the Calibration Value* (mV/nm) is always displayed.

Measurement setup:

Delivered with all the components needed for measurement. The Optical Head is connected to the QUARTET demodulator via a 5-meter-long optical fibre link. Three lenses of varying focal length are included. Focusing is manually adjustable. Examples of focusing range:

Stand-off distance [DOF]* **(2-inch aperture diameter)**	F=100	82[1.2] – 110[2.5]	mm
	F=200	178[3.2] – 306[11]	
*DOF= Depth Of Focus	F=500	440[13.5] – >2000	

Figure 3: Stand-off distances *(with manual focusing adjustment) for 3 lenses of focal: f=100mm, f=200mm and f=500mm.*

Radiation:

The Quartet uses a Class IV laser. The receiver is equipped with an interlock switch that must be closed in order lase. The interlock can also be connected to a door switch that will disable the laser if open. There are two optical shutters to open or close the output beam when in use. One shutter is located on the main unit of the receiver, the second in the optical head. Appropriate laser safety procedure should be followed when using a Class IV laser:

- The Experiment should be enclosed, such as to contain the Laser Beam.
- Protective eyewear (suitable for the laser wavelength) should be worn when operating with an open laser beam .

Note: *The Laser output is reduced to less than 2mW when the beam lock is set to "Align Position"*

Warranty & Maintenance

The Quartet comes with a 12-month warranty which begins after installation and training is complete and the equipment is formally accepted on site through signature of an appropriate document. The Quartet is a self-contained unit that does not required maintenance during normal operation. For the internal Laser we use a Cobolt SAMBA, highly reliable and does not require maintenance.

Sound & Bright
622 Magnolia Ave
Inglewood, California 90301

info@soundnbright.com
+1 (424) 227 4176