Non-Bio Systems Information Brochure
# Table of Contents

- SYSTEM INFORMATION AND ADVANTAGES...............................................................2
- LABORATORY APPLICATIONS.................................................................5
- GEOPHYSICAL APPLICATIONS.................................................................5
- NON-DESTRUCTIVE TEST & EVALUATION.................................5
- MEDICAL APPLICATIONS...............................................................6
System information and advantages

**Biomagnetic measurements provide a number of advantages compared to electrical measurements:**

- Biomagnetism is non-invasive. The detection system does not contact the subject. The non-invasive nature of biomagnetism makes it an inherently safe procedure and minimizes subject preparation time.
- Insulating barriers such as the skull, varying layers of tissue, anatomical open spaces, do not attenuate or distort magnetic fields. Electrical signals are distorted by the varying resistive layers between the signal source and the surface skin.
- SQUID magnetometers will measure the vector component(s) of the magnetic field. Thus localization is much easier than with electrical measurements, which only measure scalar voltages.
- Magnetic measurements can be made for which there are no electrical analogs. These include measurements of static magnetic fields, measurements of the magnetic susceptibility and measurements where an invasive procedure is not possible (e.g., fetal cardiography).
- Because of the superconducting nature of SQUID measurements, true dc response and flat phase response are available.

**Instrumentation**

The strength of biomagnetic signals is many orders of magnitude smaller than even the earth’s magnetic field, which is 1/2 Gauss or 50 microtesla. The signal strengths associated with biomagnetism (Fig. 1) require the use of extremely sensitive detection systems. The units in this figure are femtotesla, 1 fT = 10^-15 tesla. The only instrument with the required sensitivity and bandwidth is the SQUID magnetometer.

The components of a SQUID magnetometer (Fig. 2) typically consist of the following: a detection coil, which senses changes in the external magnetic field and transforms them into an electrical current; an input coil which transforms the resulting current into a magnetic flux in the SQUID sensor; electronics which transform the applied flux into a room temperature voltage output; and acquisition hardware and software for acquiring, storing and analyzing data. Both the SQUID amplifier and the detection coils are superconducting devices. Thus some type of refrigerant (liquid helium or liquid nitrogen) or refrigeration device (cryocooler) is needed to maintain the SQUID and detection coil in the superconducting state. Additional signal conditioning electronics may be needed to improve signal-to-noise.
The SQUID sensor and electronics package can be considered as a black box that acts like a magnetic field-to-voltage converter and amplifier with extremely high gain. In addition, it offers extremely low noise, high dynamic range, excellent linearity, flat phase response and a bandwidth that can extend from dc to beyond 100 kHz, capabilities that no other single sensor offers.

The type of SQUID sensor and detection coil configuration is dependent on what is to be measured. Figure 1 also shows the capability of both low temperature (requiring liquid helium temperatures, and referred to as LTS) and high temperature (requiring liquid nitrogen temperatures, and referred to as HTS) SQUID magnetometers. Tristan biomagnetic measurement systems make use of either Tristan’s LSQ/20 LTS dc SQUID sensor or the HTM-8 HTS dc SQUID sensor. The input coil for an LTS SQUID is normally fabricated from flexible superconducting NbTi wire. The inherent anisotropic nature of HTS SQUIDs requires that the input coils be planar. Typically HTS magnetometers are available only as pure magnetometers.

Another factor to be considered is the detection coil configuration. Conceptually, the easiest input circuit to consider for detecting changes in magnetic fields is a pure magnetometer (Fig. 2). However, magnetometers are extremely sensitive to all magnetic signals in the environment. This may be acceptable if one is measuring ambient fields. However, if the magnetic signal of interest is weak, then environmental magnetic interference may prevent measurements. If the signal source is close to the detection coil, then a gradiometer coil may allow a weak signal to be measured. Figure 3 shows the relative noise rejection for 1st and 2nd derivative gradiometers. The figure insert shows a first order gradiometer, consisting of two coils connected in series but wound in opposite senses, and separated by a distance “b”, called the gradiometer baseline. A uniform magnetic field (e.g., from a distant environmental source) would couple equal but opposite quantities of flux into the two coils, resulting in zero net flux in the gradiometer, or zero signal. However, signal sources that are close to the lower coil (relative to the baseline, or separation between coils) would couple significantly more flux into the lower coil than into the upper coil; this would result in a net flux in the gradiometer and hence the signal would be detected.
For objects that are close (relative to the gradiometer baseline), the gradiometer acts as a pure magnetometer, while rejecting more than 99% of the magnetic signals coming from distant objects. In essence, the gradiometer acts as a “compensated” magnetometer.

Normally, SQUID magnetometers (and gradiometers) map the axial (BZ) component of the magnetic field. Obviously, using three sensors, it is possible to monitor all three vector components of the magnetic field. Additional channels of SQUID sensors can be used to provide reference channels for electronic balancing. Portions of the reference magnetometer responses are summed electronically with the detection coil(s) output to reject common mode signals from distant noise sources. Electronic balancing can be used to create an HTS axial gradiometer from two HTS magnetometers.

Tristan and its key personnel have produced a number of measurement systems for a variety of applications. Some of them are listed here:

- Tristan has multiple single- and multi-channel SQUID magnetometers for NDE and paleoarcheology use. These are state-of-the-art systems, some with spatial resolutions approaching 1 µm.
- Multiple single- and multi-channel SQUID magnetometers for biomedical applications for animals and humans. The Ferritometer® is routinely used for clinical assessment of iron overload diseases. This system is a turnkey operation including patient scanning bed, computer control, along with complete data acquisition and analysis software.
- Tristan’s magnetometer systems are based on its iMAG® line of commercial SQUID electronics, which have been supplied worldwide to both end users and OEMs.
- Tristan’s model DRM-300 geophysical rock magnetometer uses closed cycle refrigeration to eliminate the need for liquid helium and reduce operating costs. This technology is available for use on many of Tristan’s products.

Systems built by Tristan’s present personnel during the time period of 1991-1996 include:

- A DC and AC susceptibility variable temperature and field platform. Twelve systems were made. These systems integrated SQUID magnetometers, sample motion control, sub-mK thermal control from 2 – 350 K, variable applied fields to 17 T and truly user-friendly automated control software. This product demonstrated Tristan’s ability to produce state-of-the-art complex analysis equipment with minimal user requirements.
- A six-channel system for Vanderbilt University for general-purpose NDE studies. Comprised of a magnetometer, dewar, electronics, software and multiple magnets, this system has extremely high
sensitivity (10-14 tesla) and sub-mm resolution.

- A three-channel Superconducting (SQUID) NDE system for use by a large Japanese steel company, comprising magnetometer probe, dewar, superconducting magnets, custom electronics, and custom software. Using a welding robot, this compact system is scanned over samples.

- A dual-channel magnetometer system for use by a private company to study materials for nuclear-fuel rod integrity. The package includes a magnetometer probe, dewar, computer controlled sample scanner, electronics and software.

- A compact (12”) six-channel high sensitivity susceptometer capable of generating tesla fields and operating in both vertical and horizontal orientations. The ultra-compact system, when attached to the end of a robot arm, is used by a large Japanese nuclear reactor inspection company for scanning the interior of nuclear pressure vessels.

- The first commercial scanning magnetic microscope (SMM-1000) to study small electronic circuits and material samples. This comprised a dewar, cryogenic sample handling stage, magnetometer, custom software, vacuum system, and custom electronics. It is comparable to a SEM in complexity. Nine detection coils were fabricated in a linear array with 100 µm coil separation. Spatial resolution was at the µm level.

- A mixed stage (Gifford-McMahon/Joule-Thomson) cryocooler that routinely achieved 2 K.

1. **Laboratory Applications** include measurements of current, voltage, resistance, magnetization, etc. along with exotic (General Relativity, magnetic monopole) applications.

| Current: 10^{12}\text{ampere/Hz} | Magnetic Fields: 10^{-17}\text{tesla/Hz} 10^{-10}\text{tesla} | dc Voltage: 10^{-14}\text{volt} | dc Resistance: 10^{-12}\text{Ω} | Mutual/Self Inductance: 10^{-2}\text{Henry} | Magnetic Moment: 10^{-10}\text{emu} |

2. **Geophysical Applications** include oil and mineral exploration, pollutant monitoring, magma flow measurements, rock magnetometry, paleo archeology, etc.

Tristan HTS SQUID gradiometer in flight

DRM-300 3-axis cryo-cooled rock magnetometer

3. **Non-Destructive Test & Evaluation (NDE)**

NDE scanning systems are used for defect detection, corrosion measurement, magnetic microscopy, etc. Some examples of SQUID NDE include:

**Intrinsic currents measurements, such as:**

- Remnant magnetization
• Embedded magnetic sensors (see figure below)
• Flaw-induced perturbations
• Johnson noise in metals
• Eddy currents in an applied ac field (flaws)

**Hysteretic magnetization due to:**
• cyclic stress (strain)
• simultaneous dc & ac magnetic fields

**Magnetization of paramagnetic, diamagnetic and ferromagnetic materials in dc fields.**

SMM-701 magnetic field scans of an embedded strain sensor under a 4 cm thick concrete overcoating. A: Bare sensor showing dipole characteristics, B: sensor under concrete, C: bare concrete. Image D = B – C is a digital subtraction of B and C showing that it is possible to image objects deep underneath magnetically complex coverings. The scans cover a 6 cm x 6 cm area.

### 4. Medical Applications

**Studies of the Brain—Neuromagnetism**
• Epilepsy
• Neonatal and prenatal Brain Disorders Presurgical Cortical Function Mapping Peripheral nerve and spinal cord studies Drug Development and Testing
• Stroke
• Alzheimer’s
• Neuromuscular Disorders
• Performance Evaluation
• Animal Systems

**Studies of the Heart—Magnetocardiography**
• Arrhythmia
• Heart Muscle Damage Fetal Cardiography

**Other Medical Applications**
• Non-invasive in-vivo Magnetic Liver Biopsies(Ferritometry)
• Studies of the Stomach—Gastroenterology
• Intestinal and Mesenteric Ischemia
• Lung Function and Clearance Studies
• Peripheral and Single Nerve Studies
• Organ Transplant Rejection Risk
• Blood Flow Disorder
Tristan non-magnetic dewars

Model 607 biomagnetometer

iMAG® Electronics and laboratory probes

LTS SQUID sensor

HTS SQUID sensor

SMM-701 NDE scanning system

Model SMM-770 Scanning SQUID Microscope
SQUID Systems for Biomedical Research

Applications
- Magnetic field imaging (MRI); time course imaging
- Complex current designs for microfluidic systems
- Magnetorheological effects
- Spinal cord function
- Minimally invasive procedures
- Magnetoencephalography

Features
- Safety and Conveniences: minimizes measurements
- High-temporal resolution of signals
- Optimum placement with sensors aimed to sources and integrated systems
- CMogD Chipset, Jr., patient beds
- Positioning and monitoring systems
- Custom sensor design and data acquisition and end user interface

Technologies
- Advanced Chipset Functional and Portable
- Complex Current Design Access, 2 to 2 CM planar detector films + magnets and read sensors (1st and 2nd order)
- Accl or plane, sensors are on magnetic groundplanes
- Custom Design and Optimization systems
- Radio frequency and low frequency fields
- Electronic noise cancellation and software
- Superconducting and microfabricated sensors
- Advanced EM modeling for MRI and imaging
- Data compression and data management
- Optimal data acquisition and monitoring software

General Facts about Biomagnetometer Applications

What is measured - Its electromagnetic field
SQUID systems can measure electromagnetic fields from a variety of sources, including biological tissues, magnetic materials, and electronic devices. SQUID systems are sensitive to changes in magnetic fields, and they can detect fields as small as 10^-12 tesla. They are used in a variety of applications, including medical imaging, geophysical surveys, and industrial testing.

SQUID Magnetometers

Principles of operation
SQUID magnetometers operate by detecting changes in the magnetic field produced by a sample or object. The SQUID is a superconducting loop that is sensitive to changes in magnetic field strength.

Advantages
- High sensitivity
- Wide frequency range
- Non-invasive measurement

SQUID Magnetometer Applications

SQUID sensors are used in a variety of applications, including medical imaging, geophysical surveys, and industrial testing. They can be used to detect magnetic fields from a variety of sources, including biological tissues, magnetic materials, and electronic devices.

Tristan Technologies, Inc.

SQUID Magnetic Field Sensors

The SQUID magnetic field sensor is a highly sensitive device that can be used to detect changes in magnetic fields. It is based on the principles of superconductivity, and it can be used to detect magnetic fields as small as 10^-12 tesla.

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Tristan Model 619

The Model 619 is a new, high performance, single-channel system designed for the measurement of various electrophysiological parameters. It is ideal for use in laboratories where high accuracy and reliability are essential.

**Applications**
- Neurophysiology
- Cardiac physiology
- Myocardial physiology
- Neurovascular physiology
- Vascular physiology

**Features**
- Single-channel system
- High precision and accuracy
- Robust design for long-term use

**Measurement Capabilities**
- Voltage
- Current
- Resistance
- Impedance

**Technical Specifications**
- Operating Frequency: 60 Hz
- Input Impedance: 1 MΩ
- Output Impedance: 100 Ω

**Ordering Information**
- Model 619
- Quantity
- Customer Information

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Tristan Technologies, Inc.

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Tristan Model 607

The Model 607 is a high-performance, multi-channel system designed for advanced electrophysiological applications. It features advanced hardware and software for precise measurement and analysis.

**Applications**
- Neurophysiology
- Cardiac physiology
- Neurovascular physiology
- Vascular physiology

**Features**
- Multi-channel system
- High precision and accuracy
- Robust design for long-term use

**Measurement Capabilities**
- Voltage
- Current
- Resistance
- Impedance

**Technical Specifications**
- Operating Frequency: 60 Hz
- Input Impedance: 1 MΩ
- Output Impedance: 100 Ω

**Ordering Information**
- Model 607
- Quantity
- Customer Information

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Tristan Technologies, Inc.

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**Measuring Liver Iron Stores**

The Measuring Liver Iron Stores system is a fully automated system for the measurement of liver iron stores. It is designed to accurately determine liver iron levels in patients with various liver diseases.

**System Features**
- Fully automated system
- Accurate and reliable measurements
- Easy to use and operate

**Technical Specifications**
- Operating Frequency: 60 Hz
- Input Impedance: 1 MΩ
- Output Impedance: 100 Ω

**Ordering Information**
- System 619
- Quantity
- Customer Information

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Tristan Technologies, Inc.

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**Custom Features**

Subject Positioning/Teaching

- Accurate and consistent positioning of subjects
- Easy to use and operate
- Robust and reliable performance

**Reference Arrays for Noise Reduction**

- Effective reduction of noise and artifacts
- Accurate and consistent measurements

**Ordering Information**
- Reference Arrays 619
- Quantity
- Customer Information

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Tristan Technologies, Inc.

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**About Tristan Technologies**

Tristan Technologies is a leading manufacturer of advanced electrophysiological measurement and analysis systems. Our products are designed to meet the needs of researchers and clinicians in various fields, including neurophysiology, cardiology, and vascular biology.

**Ordering Information**
- Tristan Technologies
- Customer Information
DRM-300 Rock Magnetometer

The Triplex model DRM-300 is a versatile and powerful SQUID system designed for magnetic field measurement and analysis. It features a wide range of capabilities and is ideal for applications requiring high sensitivity and spatial resolution. The system is equipped with advanced technical enhancements to achieve superior sensitivity and dynamic range without sacrificing stability. It can be adapted for use in a variety of environments, from laboratory settings to fieldwork in remote locations. Key features include:

- Three orthogonal detection coils for enhanced sensitivity and accuracy.
- SQUID detection circuitry for unparalleled sensitivity and stability.
- 10^4 Am² Sensitivity and Wide Dynamic Range, allowing for measurements across a broad spectrum.
- Room Temperature Bore for ease of use in varied conditions.
- Closed-cycle 4-Kelvin refrigeration for extended operation.
- Self-replenishing liquid helium ballistic for Quiet Mode operation.
- Automated Sample Insertion Stage for efficient sample handling.
- Internal Superconducting and metal Magnetic Shields for reduced interference.
- Compact size — small footprint, ideal for portable use.

System specifications include:

- **System Dimensions**: 116 cm (length) x 116 cm (width) x 116 cm (height)
- **Power Consumption**: 116 cm²/m²
- **Weight**: 77 kg

The DRM-300 is equipped with advanced features such as:

- **Vibration Isolation System**: Designed to minimize vibrations and external noise.
- **External Magnetic Shield Options**: Customizable shields to further reduce external interference.
- **Oven and degaussing Stage**: Features an oven for sample degaussing and a degaussing coil for sample preparation.
- **Computer Control System**: Integrated software for data acquisition and analysis.

**Model SMM-401 nanoSQUID**

This advanced SQUID system is ideal for small and medium-sized sample analysis. Key features and specifications include:

- **SQUID**: SRM-401, a superconducting SQUID sensor.
- **Spatial Resolution**: 100 μm
- **Field Sensitivity**: 1.4 pT/Hz
- **Sample Temperature**: Room temperature
- **Non-magnetic Scanning Stage**: Ideal for delicate samples.
- **Low helium consumption**: 25 am gap between sensor and magnet.

Magnetic imaging is achieved using the sample's magnetic field, which is sensitive and precise. The system is designed to accommodate a variety of sample geometries and is suitable for research in fields such as geophysics, paleomagnetism, and materials science.

**System Specifications**

- **Sensor**: Three Superconducting Quantum Interference Devices (SQUIDs)
- **Operating Temp**: 4.2K
- **Sensitivity**: 1/2 μT
- **Dynamic Range**: 10⁶ Am²
- **Room temperature sample**: Suitable for samples up to 10⁶ Am².
- **Hold Time**: 1000 hours
- **Power**: 100V/200V
- **Dimensions**: 116 cm²

This system is available in various configurations to meet specific research needs.

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*Images and diagrams are placeholders for actual figures that would typically accompany such technical descriptions.*
**SQUID Magnetic Scanner**

**For Non-Destructive Testing**

The Tristan model SMM-601 Magnetic Scanner is designed to measure magnetic fields with a spatial resolution better than 390 w/m. It can be used to image diverse objects such as:

- subsurface cracks and flaws
- embedded magnetic sensors
- composite structures
- corrosion sites – hidden or exposed
- impurities in metals and insulators

Medi-a/Soft Scanning Facilities can be used with conduct big magnetics.

This SMM-601 is a fully featured Measurement system that measures the magnetic moment of the object being measured over the entire 10^-9 to 5 kG frequency range. The adjustable laser settings allow the scanning to develop the field captured and sample N (10^-3 to 10^-5)

- At 10 kHz Frequency the magneto penetration depth (10^-7 to 10^-8)

Another advantage of the Tristan model SMM-601 is its ability to 10kHz and 5kHz filters. This allows it to help in solving D.I. in magnetic measurements on the same spatial resolution scale. In addition, a custom output converter – with a 128-bit capability for eddy current measurements.

The detector allows computer controlled scans of a object over a footprint (1 x 1.5 m) with 25 pin sampling capability.

The SMM-601 SQUID sensor gives unparalleled sensitivity. Its cell response provides high accuracy and quadrature information to be obtained without distortion. Absolute sensitivity is modified, larger determination units with resolutions exceeding 10^-4 are available. Additional detection coils can be supplied to give vector information from the SMM-601, in 10^-4 wide included. An automated setup and computer control makes measurements robust and repeatable. The use of open architecture software allows flexible control in the frequencies and spatial resolutions scale. In addition, a custom output converter – with a 128-bit capability for eddy current measurements.

**OPTIONS AND ACCESSORIES**

This option came of a small inductance magnet. The SMM-601 model can be used to image human tissue. The result signal learn. field colts) may be coupled into the system. the result signal learn. field colts) can be demodulated or demodulated for desired components. eddy current measurements even desired components. The SMM-601 model can be used to image human tissue. The result signal learn. field colts) can be demodulated or demodulated for desired components. eddy current measurements even desired components.

**Specifications**

- Frequency range: 10 kHz
- Spatial resolution: 300 mm
- Sensitivity: 10^8 pT/Hz
- Power requirements: 120 VAC, 60 Hz
- Dimensions: 1 x 1.5 m
- Weight: 120 kg

**Scanning Microscope**

The Tristan model SMM-770 Scanning Magnetic Microscope is designed to measure magnetic fields above a planar surface with unparalleled spatial resolutions. Using a liquid nitrogen SQUID sensor, it can be used to image room temperature objects such as:

- traces on a circuit board or multi-chip module
- shorts to ground planes
- current distributions
- magnetic inks used in currency

The SMM-770 can also be configured to detect:

- induced magnetization
- aging and stress in ferromagnetic materials
- magnetic susceptibility
- eddy currents
- magnetic hysteresis
- Barkhausen effect

**TriNation Technologies**

811 Technology Dr., Suite 510
San Diego, CA 92121

Phone: 619-455-1101
Fax: 619-455-1109

**Power Requirements:** 120V AC, 60 Hz

**Sample Scanning Range:** 15 cm x 15 cm or 30 cm x 30 cm

**Sample Preparation:** None required. Samples are unmounted in most applications.

**Sample Size:** 15 cm x 15 cm or 30 cm x 30 cm

**Options:**

- Hot Stage (up to 1200°C)
- D.C. Pulsed Field up to 1200 Gauss
- Computer Control
- Image Processing
- Video Output

**Specifications**

- Spatial Resolution: 10^-9 m
- Sensitivity: 10^-11 T
- Power Requirements: 120 VAC, 60 Hz
- Dimensions: 1 x 1.5 m
- Weight: 120 kg

**Scanning:**

- Digital subtraction
- Time and frequency domain
- Magnetic field mapping
- Magnetic field imaging
- Magnetic field analysis
- Magnetic field visualization

**Applications:**

- Materials Science
- Magnetic Imaging
- Magnetic Analysis
- Magnetic Fields

**Contact:**

Tristan Technology, Inc.
811 Technology Dr., Suite 510
San Diego, CA 92121

Phone: 619-455-1101
Fax: 619-455-1109
Magnetometers for Geophysics

Mineral surveys, magnetotellurics, magnetic detection of induced polarization, and other magnetic detection methods are important geophysical tools. Supercconducting magnetometers and d gradiometers offer several advantages over other detectors commonly used for such measurements.

- Constant Sensitivity from dc to 10 kHz
- Magnetic Field Resolution of 10^-7 T
- True dc Response
- Flat Phase Response
- Wide Dynamic Range

Tristan manufactures the most complete line of magnetic anomaly detection systems available. From compact single and three channel magnetometers to 8-channel tensor arrays, Tristan offers a variety of fully configured system packages for geophysical measurements. The basic geophysical measurement system offered by Tristan is the model G377. It measures all three vector components of the Earth's magnetic field (Bx, By, Bz). The small size and portability of the model G377 makes it convenient for use. It can also be used with different size dewars for airborne (model N20-530 dewed and boathole (Model N20-330 dewed) use Planar Gradiometers can also be substituted if measurements of magnetic field gradients are required.

T877 Tensor Gradiometer

The Tristan model T877 SQUID sensor gradiometer is designed to measure magnetic fields and gradients for geophysical measurements.

- Magnetic Anomaly Detection
- Borehole Measurements
- Transient Electromagnetic Measurements (TEM)
- Unexplored Ordinance (LAO)
- 4 Magnetic Anomaly Detection
- Environmental Waste Detection
- Airborne Measurements
- Site Survey Measurements

Compatible with all applications, Tristan can supply custom dewars including horizontal or other field configurations. Industry standard dewars are also available.

TENSOR CONFIGURATION

- The T877’s field vector, when expressed in geocentric Cartesian coordinates, is given by the tensor

\[ \mathbf{T} = \begin{bmatrix} T_x & T_y & T_z \end{bmatrix} \]

where

\[ T_x = \begin{bmatrix} T_{xx} & T_{xy} & T_{xz} \\ T_{yx} & T_{yy} & T_{yz} \\ T_{zx} & T_{zy} & T_{zz} \end{bmatrix} \]

The tensor components are related to the magnetic field gradients through the relationship between the eight sensors and the Model G10

\[ \mathbf{T} = \begin{bmatrix} T_x & T_y & T_z \end{bmatrix} \]

TRISTAN TECHNOLOGIES

Superconducting magnetometers and gradiometers offer several advantages, over other detectors commonly used for Magnetic Anomaly Detection. They have high resolution, are not affected by any external noise, and are extremely sensitive. The high sensitivity of superconducting detectors is often used as an advantage in high sensitivity geophysical measurements. For example, in areas where the signal-to-noise ratio is low, superconducting detectors are often used for low-noise measurements.

T877 is particularly suited for high-sensitivity measurements. It has a high sensitivity to small changes in the magnetic field, which allows it to detect weak signals in noisy environments. The T877’s field vector components are given by the relationship between the eight sensors and the Model G10

\[ \mathbf{T} = \begin{bmatrix} T_x & T_y & T_z \end{bmatrix} \]

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The Biomagnetic Liver Susceptometer is a diagnostic instrument which measures iron stores rapidly and non-invasively. Its advanced design with a superconducting magnet and SQUID detection system gives an accurate measurement of iron concentration in the liver and spleen for adults and children.

Clinical Relevance

- Non-invasive
- Replaces Surgical Biopsy, for Iron Measurements
- Eliminates Di-acrom/1 and Risk
- Allows Pediatric Measurements
- Direct Measurement Method Accurate and Reproducible
- Allows Frequent Serial Measurements
- Rapid Results
- Measurement Time Under 18 Minutes

BLS Methodology

The Biomagnetic Liver Susceptometer (BLS) employs a 7T superconducting magnet to measure the magnetic susceptibility of the liver and spleen. Magnetic susceptibility differences are attributed to iron stores. The measurements are used to determine liver susceptibility and to calculate iron content.

Specifications

- Magnetic Yield: 2.0 T/m at 40°C, allowing for an easy-to-use, non-invasive measurement
- Direct Measurement Method
- Eliminates Di-acrom/1 and Risk
- Allows Pediatric Measurements
- Non-invasive
- Replaces Surgical Biopsy, for Iron Measurements
- Eliminates Di-acrom/1 and Risk
- Allows Pediatric Measurements
- Direct Measurement Method Accurate and Reproducible
- Allows Frequent Serial Measurements
- Rapid Results
- Measurement Time Under 18 Minutes

Applications

The Biomagnetic Liver Susceptometer (BLS) has been used to measure iron stores in various patient groups.

1. Non-invasive
2. Replaces Surgical Biopsy, for Iron Measurements
3. Eliminates Di-acrom/1 and Risk
4. Allows Pediatric Measurements
5. Direct Measurement Method Accurate and Reproducible
6. Allows Frequent Serial Measurements
7. Rapid Results
8. Measurement Time Under 18 Minutes

Clinically, the Biomagnetic Liver Susceptometer (BLS) has been shown to be a valuable tool for the non-invasive measurement of liver iron stores. It allows for the rapid and accurate measurement of iron stores in patients with transfusional iron overload, as well as in patients with hereditary hemochromatosis and other iron storage diseases.

Site Requirements

- TRISTAN Technologies
- San Diego, CA
- Phone: (858) 521-2907
- Fax: (858) 521-2931
- Website: http://www.tristan.com
**TRISTAN LABORATORY SYSTEMS**

Tristan offers a variety of fully configured system packages based on the iMAG series or SQUID components. These range from basic single-agnet magnetometer systems to instruments for specific applications. They include systems for biomedical, geophysical exploration, non-destructive testing or medical, magnetic microscopy and study of rock magnetism. For applications that require applied fields, Tristan can supply persistent superconducting magnets, permanent magnet structures with custom-designed field profile shaping and built-in copper magnets for an field. Tristan’s SQUID systems are available in both high temperature (HTS) and low temperature (LTS) 4 K versions. Standard product data sheets and application sheets are available to contact your Tristan representative or with your Osopfo system nere... 

**TRISTAN MAGNETOMETER SYSTEMS**

For measurements of external magnetic fields, Tristan offers both liquid helium and liquid nitrogen SQUID measurement systems. Series 300 LTS systems are designed for the researcher who desires unique performance from a low to read. Tristan’s SQUID magnetometer or gradient system. The series 700 HTS magnetometers offer researchers interested in HTS (magnets) SQUIDS a number of convenient platforms to perform magnetic measurements.

**CRYOGENIC PROBES for the laboratory**

Tristan cryogenic probes and cables are the heart of any SQUID based measurement system. They provide a flexible trans- mission line freezing room temperature to either 4 K or 77 K with plug-in connectors at each. With liquids and cryogenic probes, a variety of options are available. Tristan cryogenic probes, construction materials are non-magnetic and carefullyand to minimize conduction or heat le cryogenic probes. All probes are shielded against electrical noise and other electromagnetic interference that may affect the SQUID detector. A non-magnetic screw at each end allows a convenient screw to screw the cryogenic probes, measurement configuration shown in fig 1 is possible. The Model MFP Multi-Function Probe is the most versatile SQUID probe offered. It combines full probe magnetic measurements in one of the configurations shown in fig 1. The MFP probe includes additional metal shields.

**TECHNICAL FEATURES**

- **Model SIF:**
  - Warming Temperature: 0 - 77 K
  - Cryogen independent
- **Model AMP:**
  - Melting Temperature: 0 - 7 K
  - SQUID/MAG with only
- **Input Impedance:**
  - 10 ohms
- **Current Leads:**
  - d: decoupled exactly max current 0.5 Amperes
- **Model MS:**
  - Working Temperature: 0 - 7 K (LTS/MAG sensor only)
  - Standard Resistance: 10 - 40 (ohm)
  - Standard Mutual Inductance: 0.6 - 40 (nH)
  - Standard Temperature: 15°C ± 5°C
  - Input transformer capacity at 100 Hz 4.5 x 10³
  - Current Lead: d: decoupled exactly max current 0.5 Amperes

**CONTACT**

Contact your Tristan representative or with your Osopfo system next...
SQUID ELECTRONICS

MULTICANAL CONTROLLER

Thus Model INX-375 SQUID controller forms the basis of a powerful and flexible measurement system. Its three channel capability accommodates nearly to laboratory SQUID applications without resurrecting the cost or complexity of eight-channel design. A unique feature of the Tristan controller is its ability to simultaneously control both LTS and HTS sensors. For the experienced user, the Tristan Multichannel Controller offers complete manual control of all SQUID parameters, including dly line, modulation amplitude, 'mear level, dev flux in level in the OFFSET (offset), heater and integral gain. Channel gains and offsets are independently adjusted using the membrane keypad and a convenient menu-driven interface designed for intuitive and operation. A "touch channel" control allows you to synchronize your own microchip with the menu it and the SQUID signals using the controllers internal av converter. LabView assistant and software drivers are also available.

FLUX-LOCKED LOOP

SQUID Flux loops are offered in both HTS and LTS versions. The LTS version uses an advanced bias reversal tech (as effectively reduces the noise in LTS SQUIDs) and allows the user to control the output at up to 50 kHz. The Model IPI-301 series DCO flux-locked loops (FLL) provide superior performance over a wide range of operating conditions. The Tristan design controls the FLL as close as possible to the SQUID sensors and eliminates the need for run-to-low or high-frequency loads over long distances. A short coaxial cable connects the FLL to the prismatic or cryogenic dewar. The dewar has a dedicated DCO input, but instead of the way of the liquid oxygen transfer connection to the IMC-303 controller is via a composite cable.

COMPOSITE CABLE

The composite advanced design provides superior radiations (40) rejection and allows for long cabling runs, even in hostile environments. It is a simple design to locate the FLL, which is a shielded I am and operates in the same way as a standard coaxial cable. The connection between the FLL and flex-looped-output loops in via the CT-2 series composite cables. Low level dly power on the high-level anti-aliasing output and the high-level output are required between the FLL and the Composite Controller. High frequency clock signal and digital output are the only electrical connections required between the FLL and the composite-caable's optical fiber. This cable is available in 6 ft (Model 6-CC-6) and 20 meter (Model CC-20) lengths. Custom lengths are available.

DEWARS

Tristan Finn-sphere Dewars are available in three basic designs: cryostats, cryomounts and cryopumps. The use of SQUID magnetometers for tomography or non-destructive testing and more. The INX-375 controller measures the magnetic fiel of a superconducting material using a high-frequency coil wound around the sample. The coil is excited by a high-frequency current, and the magnetic field generated by the current is detected by a high-sensitivity detector. The detector is connected to a circuit that converts the magnetic field into an electrical signal, which is then amplified and sent to the computer for analysis. The measurement can be repeated as many times as desired, and the data is recorded and stored for further analysis.

CONSTRUCTION TECHNIQUES AND MATERIALS

All trim sheet designs incorporate high-impedance gauge concepts and are assembled using the highest standards of craftsmanship. They are leak tested after each stage as per the applicable material parameters. The larger ones are then leak tested last for each item. The larger ones are then leak tested last for each item. The larger ones are then leak tested last for each item. The trim sheet designs incorporate high-impedance gauge concepts and are assembled using the highest standards of craftsmanship. They are leak tested after each stage as per the applicable material parameters.
do SQUID SENSORS

The low-temperature 110E SIMULSIO run in liquid helium and are labeled using a niobium-aluminum all-th-film technology that combines durability with high sensitivity. They feature symmetric integral signal and modulation coils that eliminate output variation with varying input levels. The niobium shielded package comes with some terminals ready to accept your custom input circuit. Tristan can also provide the field-mirror version LTS SQUID magnetometers with make-to- order performance. The Tristan Model LS121 can be used with the Model SP YC Magnetic Cable for ultrafast measurements of current (< 10 kHz) and magnetic field (to 1 T). In conjunction with the Model CP and HPYC Magnetic Probes, it can measure a much wider range of electromagnetic properties in magnetic fields as high as 1 tesla—true Tesla’s YC Magnetic Probe denoshed. The Noperation temperature range is 170 K and it is offered in magnetoprobe or meter grade configurations. The feature YCOCO pick-up pattern on the chip and a tough passivation layer for protection from moisture and oxygen. All HTS MAO sensors use a common connector to attach them to the Model SP YC Magnetic Cable; they may be easily interchanged to provide alternative pick-up coils and different sensitivity levels. We can guarantee magnetometer performance better than ±0.1% for field maps. For customers who need even lower noise levels and performance in magnetic fields, we can provide sensors with world-record noise performance; contact us for the latest specifications and pricing.

Features:
- All Thin-Film Devices
- Medium: Aluminum TH
- Cryo Flip-mounted in Robust LTS Device
- YCOCO Step-edge and ThermaJet Junctions for Robust LTS Devices
- Symmetric Modulation
- Core Eliminate Inductive Loading of Output

Tristan offers several configurations of low-temperature SQUID sensors which serve as the heart of our IMAG systems—

Address your magnetic imaging applications with the latest technology in high-temperature and low-temperature superconductivity.

High-Resolution Scanning Magnetic Microscope

The Tristan model SMM-1000 Scanning Magnetic Microscope performs micron level non-destructive analysis of surface and sub-surface material properties using an array of small SQUID magnetometers. It can be used to image diverse objects such as:
- micro-current distributions
- vortex motion in superconductors
- traces on a circuit board or multi-chip module
- weak electric currents in semiconductors
- integrated circuits
- magnetic domains

Besides measuring magnetic fields, the SMM-1000 can also be configured to detect:
- transport magnetic properties
- magnetic susceptibility
- magnetic hysteresis

The system's high sensitivity allows for the detection of magnetic fields as low as 10 nT. This makes it suitable for a wide range of applications, from material characterization to medical imaging. The system's design also ensures minimal interference from external magnetic fields, allowing for accurate and reliable results.

Scanning Magnetic Microscope

The SMM-1000 Scanning Magnetic Microscope is a powerful tool for non-destructive analysis of magnetic properties. With its high spatial resolution, it can capture detailed images of magnetic domains and vortices in superconductors. The system's flexibility allows for customization to meet specific needs, making it an indispensable tool in various fields, including materials science, research, and industrial applications.