Biomagnetic Technologies Incorporated (BTi)

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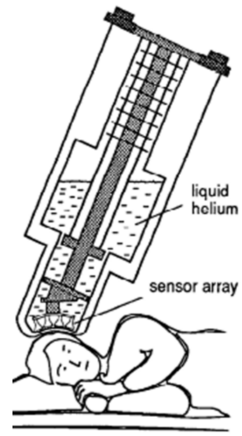
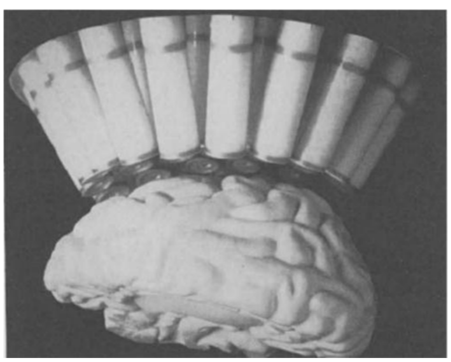
San Diego-based company that pioneered the field of magnetic source imaging, a technology used primarily to map brain function. Founded in 1970 as S.H.E. Corporation, BTi originally developed equipment for physics labs and later transitioned into creating medical instrumentation.

During the 1980s, BTi underwent a significant shift in its focus, moving from general physics lab equipment to specializing in medical applications of biomagnetism. BTi leveraged its expertise in superconducting quantum interference device (SQUID*) magnetometers, devices designed to measure minute magnetic fields, to create specialized devices called biomagnetometers. Biomagnetometers measure extremely weak magnetic fields generated by electrical activity within the brain and other parts of the body.



BTi was at the forefront of developing biomagnetometers - no other company in the world at that time had developed the technology so thoroughly. Recognizing the potential of biomagnetism in medicine, BTi strategically refocused its efforts.

By 1982, BTi's refined devices, in collaboration with UCLA researchers, demonstrated the ability to pinpoint the brain tissue responsible for epileptic seizures. This breakthrough highlighted the potential of the technology in guiding surgical interventions, aiming to remove only the affected tissue while preserving as much healthy brain tissue as possible.



This change was spearheaded by the recruitment of a new board of directors in 1984, which tasked the company with developing medical applications for its existing magnetometer technology. This technology, also known as magnetoencephalography (MEG), aimed to provide a non-invasive way for physicians to monitor bodily functions and aid neuroscientists in understanding the brain.

BTi envisioned its technology being used to diagnose and treat a wide range of neurological and cardiac conditions, including epilepsy, stroke, Alzheimer's disease, and sleep disorders. They specifically highlighted the potential benefits of the technology in localizing dysfunctional brain tissue, such as identifying the origin of epileptic seizures, potentially reducing the need for more invasive procedures like EEG.

BTi targeted a niche market of advanced medical research centers across the United States, Western Europe, and Japan. Their products, including 37-channel Neuromagnetometers (above and at right), were specialized and expensive, with prices reaching upwards of $2 million each. The 1980s were a period of intense research and development for BTi, as it worked to refine its technology and explore new applications. The company invested heavily in its scientific and engineering teams, employing over 180 individuals in these roles by the late 1980s.

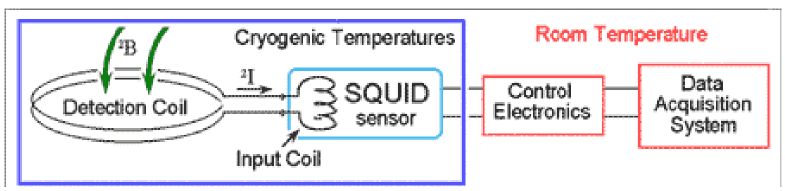
* Superconducting Quantum Interference Device (SQUID) sensors were at the core of early biomagnetometers and were essential for detecting the incredibly weak magnetic fields generated by the brain.

Here's how they work:

- *Superconducting Loop and Josephson Junctions: A SQUID essentially consists of a superconducting ring interrupted by one or two "weak links" known as Josephson junctions. These junctions are very thin insulating layers or constrictions that can be crossed by a supercurrent (current that flows without resistance) below a certain critical value.*

- *Quantum Interference: When a magnetic field passes through the superconducting loop, it induces a supercurrent within the loop. The critical current at the Josephson junctions becomes sensitive to the magnetic flux passing through the loop. This sensitivity arises from the principle of quantum interference, according to HyperPhysics.*

- *Detecting Changes in Magnetic Flux: As the magnetic field changes, the phase difference of the electron wavefunctions across the Josephson junctions changes, which in turn influences the supercurrent flowing through the device.*



- *Voltage Output: If a constant bias current is applied to the SQUID, the measured voltage across the junctions will oscillate in response to changes in the magnetic flux penetrating the loop. By carefully measuring these oscillations and the corresponding voltage, the extremely small changes in the magnetic field can be quantified.*

- *High Sensitivity: SQUID sensors are known for their extremely high sensitivity, capable of detecting magnetic fields as low as 5x10^-18 Tesla. This sensitivity is crucial because brain signals produce magnetic fields that are billions of times weaker than the Earth's magnetic field.*

- *Cryogenic Cooling: To maintain their superconducting properties, SQUID sensors must be cooled to extremely low temperatures, typically within a few degrees of absolute zero, using liquid helium. This is usually accomplished by housing the SQUIDs in a specialized container called a cryostat or Dewar vessel.*

- *Flux Locked Loop (FLL): To further enhance the SQUID's performance and linearize its output, a specialized electronic circuit called a flux locked loop (FLL) is used. The FLL employs a feedback mechanism that effectively balances and nullifies variations in the detected magnetic flux, leading to a more stable and linear output signal.*

In essence, BTi's neuromagnetometers harnessed the unique quantum properties of SQUID sensors and operated in an extremely low-temperature, magnetically shielded environment to detect and measure the minute magnetic fields associated with brain activity (billions of times less than the earth's magnetic field), paving the way for non-invasive brain imaging applications.