Development of a mobile magneto-cardiograph for heart disease screening
-- with 51-channel high-Tc superconducting sensor and dome-shaped magnetically-shielded room --

Tokyo, June 1, 2004 ---Hitachi, Ltd. (NYSE:HIT / TSE:6501), as part of the METI (Ministry of Economy, Trade and Industry) and NEDO (New Energy & Industrial Technology Development Organization) Support Program for Technology Development for practical use, has developed the world's first compact and mobile high-Tc superconducting magneto-cardiograph capable of quick examination for heart disease. This was achieved by the development of a highly sensitive 51-channel high-Tc superconducting sensor and a dome-shaped magnetically shielded room. This technology may be applied to future heart disease screening equipment for group medical examinations and health check-ups, as highly precise mapping can be conducted within a minutes whilst clothed.

Heart disease is the number two cause of death in Japan today. The electro-cardiograph is widely used as a simple method to screen for heart disease, however, it is not capable of providing detailed data with high sensitivity. To overcome this problem, echocardiography or methods using radio isotopes are employed.

As a new technology for heart disease screening, Hitachi developed a magneto-cardiograph system capable of detecting the very weak magnetic field[*1)] formed on the surface of the body as a result of cardiac activity, using a special magnetic sensor called SQUID[*2)] (superconducting material with an electrical resistance of zero). As the system is able to conduct detailed examinations of the heart quickly and while clothed, it is expected to contribute to the early detection of ischemic diseases such as angina pectoris or acute myocardial infarction. There are two types of superconductors employed in the magneto-cardiograph SQUID sensor: one is a high-Tc superconductor that reaches a superconducting state at the temperature of liquid nitrogen (77 kelvin, -196℃ or -321℉), and the other is a low-Tc superconducting material, which reaches a superconducting state at the temperature of liquid helium (4.2 kelvin). The advantages of the high-Tc material, is that it uses liquid nitrogen which is relatively simple to handle, and thus the cooling system is simplified, leading to a relatively compact system. The disadvantage, however, was that it was considered difficult to achieve a stable high-Tc superconducting sensor capable of high quality and high sensitivity measurement.

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Hitachi successfully developed mass production technology for high-Tc superconducting sensors[*3)] and a dome-shaped shielded room to achieve a heart mapping examination using a mobile magneto-cardiograph with a high-Tc superconductor.

The system developed has the following features:

(1) Use of multi-channel high-Tc superconducting sensor for heart mapping:
The composition of the high-Tc superconducting material was optimized, and a processing technique to produce high-quality high-Tc superconducting thin films, previously considered difficult, was developed. Using this technology, a 51-channel high-Tc magneto-cardiograph system capable of, for the first time in the world, monitoring the entire heart at the same time, was developed.

(2) Open measurement environment achieved through a dome-shaped magnetically shielded room
To reduce interference from the Earth's magnetic field and external magnetic noise, a compact dome-shaped magnetically shielded room was designed. The subject's heart can be examined while lying down fully clothed.

It was confirmed that high quality high sensitivity data of the entire heart could be obtained within a few minutes from a fully clothed subject. The next step will be to increase the sensitivity of the high-Tc sensor, and develop the system for future heart disease screening equipment to be used in group medical examinations and health check-ups.

This system was developed in under the guidance of Prof. Iwao YAMAGUCHI of the University of Tsukuba and Prof. Yoichi KIMURA of Ehime University.

These results were presented at the Japan Biomagnetism and Bioelectromagnetics Conference, 4^{th}-5^{th} June 2004, held in Tokushima, Japan.

■ Notes:

*1) Strength of the heart's magnetic field:
A magnetic field of 100fT (femto-tesla: 10^{-15} tesla) to several tens of pT (pico-tesla: 10^{-12} tesla) is emitted from the heart. The earth's magnetic field is approximately 50μT (10^{-6} tesla), thus the heart's magnetic field is approx. $^{1}/_{1,000,000}$ that of the earth's field.

*2) SQUID: Superconducting Quantum Interference Device
A magnetic device formed from one or two Josephson junctions arranged in a superconducting ring. The maximum (superconducting) current which can be applied to the loop changes with the magnetic flux

confined in the ring. This change becomes a periodic change in each quantum flux (Φ_0=2.07×10^{-15}Wb). This highly sensitive response to minute changes in the magnetic field is employed to create an extremely sensitive magnetic sensor.

*3) High-temperature Superconducting Sensor:
Oxide superconducting material containing elements such as yttrium, bismuth, copper and oxygen. By developing optimal processing technology for composition and manufacturing, a magnetic field sensitivity of 50～100fT/√Hz was achieved.

About Hitachi, Ltd.

Hitachi, Ltd., (NYSE:HIT/TSE:6501) headquartered in Tokyo, Japan, is a leading global electronics company, with approximately 326,000 employees worldwide. Fiscal 2003 (ended March 31, 2004) consolidated sales totaled 8,632.4 billion yen ($81.4 billion). The company offers a wide range of systems, products and services in market sectors, including information systems, electronic devices, power and industrial systems, consumer products, materials and financial services. For more information on Hitachi, please visit the company's Web site at http://www.hitachi.com.

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