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# What's New in the World of Superconductivity (October, 2011)

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## Critical Materials Initiative

The "Trilateral EU-Japan-US Conference On Critical Materials for a Clean Energy Future" was held in Washington D.C., U.S.A. on 4-5 October 2011. The conference was jointly organized by The European Commission's Directorate General for Research and Innovation, Japanese Ministry of Economy, Trade and Industry, and The U.S. Department of Energy (DOE).

Keynote speakers from EU-Japan-US trilateral regions, focused on possible supply disruptions of critical materials, which are currently supplied by one country (China) to fulfil world demands. In particular, the importance of 3R (Replace, Reduce, Recycle) pertaining to those rare metal and rare earth elements was stressed.

Reference: To be published in http://www.istec.or.jp/web21/pdf/12_Winter/E4.pdf

## Electronics

### HYPRES, Inc. (October 4, 2011)

HYPRES, Inc. and Stony Brook University have successfully demonstrated the world's fastest arithmetic-logic unit (ALU), a 20 GHz, 8-bit circuit on a digital superconductor chip produced in the Hypres foundry. The milestone represents an important step in the development of next-generation, energy-efficient, high-performance digital circuits for a variety of ultrahigh-speed computing applications. Digital superconductor single flux quantum electronics are capable of providing tens-of-gigahertz processor speeds without the high levels of power dissipation associated with CMOS. In the development of the ALU chip, researchers at Stony Brook have developed a new asynchronous wave-pipelined processor micro-architecture and a complete cell-level ALU design that is scalable to 32- and 64-bit processing. The researchers at HYPRES developed the physical chip design and fabricated and experimentally verified the ALU's high-speed operation. Senior vice president and general manager at HYPRES Oleg Mukhanov, Ph.D., commented, "This exciting collaboration between the HYPRES and Stony Brook teams has opened the door to a new level of digital superconductor processor performance. We are steadily driving this technology into the realm of practical applications."

Source: "HYPRES and Stony Brook University Collaborate to Achieve A 20 GHz 8 Bit Digital Circuit for Future Microprocessors"
Hypres Inc. press release (October 4, 2011)

http://www.hypres.com/newsroom/press-releases/hypres-and-stony-brook-university-collaborate-to-achieve-a-20-ghz-8-bit-digital-circuit-for-future-microprocessors/

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## Power equipment

### American Superconductor Corporation (October 13, 2011)

Nexans, Siemens, and American Superconductor Corporation have announced the successful qualification of a transmission voltage resistive fault current limiter (FCL) utilizing HTS wire. The achievement marks the first time that a resistive superconductor FCL has been developed and tested at power levels suitable for application in a transmission grid (138 kV insulation class and a nominal current of 900 A). The resistive FCL consists of low inductance superconducting coils that work in parallel with a shunt reactor. This type of system has a low impedance, making it “transparent” to the grid until a fault occurs, at which time the superconductor coils transition from a conductive to a resistive state to suppress the fault current. The present system was capable of reducing fault current levels by more than 50 %, thereby limiting damage and stress to other grid components. The development and testing of the superconducting FCL was performed as part of a cost-shared project by Nexans, Siemens, and American Superconductor Corporation and the U.S. Department of Energy. Siemens developed the low inductance coil technology that makes the FCL transparent to the grid until the FCL switches to a resistive state, Nexans designed and built the high-voltage terminations and their connection to the FCL module in the cryostat, and American Superconductor Corporation provided the proprietary Amperium™ HTS wire used in the system.

Source: “Industry Leaders Successfully Demonstrate Transmission Voltage Superconductor Fault Current Limiter”
American Superconductor Corporation press release (October 13, 2011)

## X-ray source

### Cornell University (October 25, 2011)

Researchers at Cornell University have passed two major milestones toward the construction of a novel, extremely powerful X-ray source known as the Energy Recovery Linac (ERL): the development of a record-breaking electron gun emittance, and a successfully tested prototype for a superconducting linac cavity. This electron accelerator would be capable of producing coherent X-ray beans that are 1,000 times brighter than any presently in existence. Ultimately, this technology would be used to upgrade the Cornell High Energy Synchrotron Source (CHESS). The project is being partially funded by the National Science Foundation, which has provided US $50 million for 2006 – 2014 to build prototype instrumentation and test ERL concepts.

Regarding the latter achievement, the researchers have built and tested a prototype seven-cell superconducting radio frequency (SRF) cavity, which will be used to accelerate electrons from the injector to very high energies so as to produce the X-rays. The cavity is operated at slightly above a temperature of absolute zero. Testing has confirmed that the cavity meets the required performance specifications necessary to continuously power a high-intensity ERL. The next step will be to demonstrate the efficacy of the cavity in tests scheduled to occur in 2012.

Source: “Cornell reaches two milestones toward a new coherent X-ray source”
Cornell University press release (October 25, 2011)

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http://news.chess.cornell.edu/articles/2011/CoherentOct2011.html

## SQUID application

### BioMed Central (October 27, 2011)

New research published in BioMed Central's open access journal *Breast Cancer Research* has described a sensitive new method for detecting breast cancer using tumor-targeted magnetic nanoprobes and superconducting quantum interference device (SQUID) sensors. A team from the University of New Mexico School of Medicine and the Cancer Research and Treatment Center, Senior Scientific, LLC, and the Center for Integrated Nanotechnologies facility at Sandia National Laboratories has created nanoprobes by attaching iron-oxide magnetic particles to antibodies for HER-2, a protein that is overexpressed in about 30 % of all breast cancers. These nanoprobes were capable of distinguishing between cells with HER-2 and those without, enabling HER-2 cancer cells in biopsies from mice to be identified. As a final test, the team also used a synthetic breast to determine the potential sensitivity of their system. Dr. Helen Hathaway commented, "We were able to accurately pinpoint one million cells at a depth of 4.5 cm. This is about 1000x fewer cells than the size at which a tumor can be felt in the breast and 100x more sensitive than mammographic x-ray imaging. While we do not expect the same level of nanoparticle uptake in the clinic, our system has an advantage in that dense breast tissue, which can mask traditional mammography results, is transparent to the low-frequency magnetic fields detected by the SQUID sensors." Further refinements of the system may allow not only the imaging of tumors, but also their classification according to protein expression, enabling the prediction of disease progression and the refinement of treatment strategies to improve patient survival.

Source: "High tech detection of breast cancer using nanoprobes and SQUID"
BioMed Central press release (October 27, 2011)

## Quantum computing

### D-Wave Systems (October 28, 2011)

The University of Southern California (USC), Lockheed Martin, Inc., and D-Wave Systems, Inc. have unveiled the first commercial and operational quantum computer academic center at the USC Viterbi School of Engineering's Information Sciences Institute. The center has used superconducting technology to construct a high-fidelity computing center to house D-Wave's quantum computing chip, which was recently purchased by Lockheed Martin and provided to USC for its applicability to information technology. USC and Lockheed Martin will work together to explore the potential of the 128-qubit computing chip. Dean Yannis C. Yortsos, Dean of the USC Viterbi School of Engineering, commented, "The USC Lockheed Martin Quantum Computing Center will open new windows into the fascinating world of quantum computing. It will help advance our understanding of the potential of this new technology and provide a new paradigm in the quest for faster and more secure computing."

Source: "USC to Establish First Operational Quantum Computing System at an Academic Institution"

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D-Wave Systems press release (October 28, 2011)

## HTS magnet

### Oxford Instruments (October 28, 2011)

The fusion research company Tokamak Solutions, together with partners at Oxford Instruments, the Czech Technical University, and the Institute of Plasma Physics, Prague, has used high-temperature superconducting magnets in the construction of a tokamak for the first time. High-temperature superconductor coils cooled in a cryostat were used to replace two copper magnetic field coils in the Golem tokamak (Prague). Plasma pulses were then created in the normal manner, and the tokamak operated exactly as expected. A series of additional experiments is now being planned. Dr. Mikhail Gryaznevich, Chief Scientist of Tokamak Solutions, commented, “This was an important step for fusion research. We have learned a lot about the practical use of high temperature superconductors on tokamaks and these new materials are now certain to play a key role in the future of controlled fusion.”

Source: “High temp superconducting magnets on a tokamak”
Oxford Instruments press release (October 28, 2011)

## Proton therapy

### Mevion Medical Systems (October 31, 2011)

Mevion Medical Systems has delivered the world’s first superconducting synchrocyclotron to the S. Lee Kling Center for Proton Therapy at the Siteman Cancer Center at Barnes Jewish Hospital and Washington University School of Medicine, St. Louis, MO. The shipment marks the last phase of the manufacturing of the first MEVION S250 proton accelerator module, powered by a TriNiobium Core™. The new device preserves the treatment benefits of conventional proton therapy while reducing the obstacles of size, cost, and complexity that have limited the widespread adoption of proton therapy for the treatment of cancer. The installation is scheduled for completion early in 2012. Two additional facilities are also in the midst of installing similar systems, with these installations also scheduled for completion in 2012. (Note: Mevion Medical Systems was formerly known as Still River Systems, Inc. The MEVION S250 Proton Therapy System has not yet been cleared for clinical use by the United States Food and Drug Administration.)

Source: “Mevion Medical Systems Delivers the World’s First Superconducting Synchrocyclotron for Proton Therapy to Barnes Jewish Hospital”
Mevion Medical Systems press release (October 31, 2011)

## Contract

### Bruker Energy & Supercon Technologies, Inc. (November 1, 2011)

Bruker Energy & Supercon Technologies Inc. (BEST) has received two large, multi-year contracts for metallic, low-temperature superconductors from existing customers who are leading manufacturers of

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magnetic resonance imaging (MRI) systems. The minimum total order value for the two contracts, lasting until September 2014, is approximately US $71 million; the actual purchases may total as much as 25 % higher than the minimum commitment levels. Burkhard Prause, President and CEO of BEST, commented, “These two new multi-year contracts give us significant additional visibility into future demand, as we continue to move forward with our planned LTS capacity expansion in support of our major customers with long-term commitments. We are very pleased that our discerning major customers in the MRI field have placed multi-year contracts for BEST’s high-quality, high-performance superconductors.”

Source: “Bruker Energy & Supercon Technologies (BEST) Announces Two Large, Multi-Year Superconductor Contracts from Leading MRI Manufacturers”
Bruker Energy & Supercon Technologies press release (November 1, 2011)

## Settlement

### Superconductor Technologies Inc. (November 2, 2011)

Superconductor Technologies Inc. (STI) has reported its financial results for its third fiscal quarter ending October 1, 2011. The total net revenues for the third quarter were US$479,000, compared with $2.0 million for the same period in the previous fiscal year. The net loss for the third quarter was $3.3 million, compared with a net loss of $3.4 million for the same period in the previous fiscal year. Jeff Quiram, STI's president and chief executive officer, commented, "While challenges in our commercial wireless business persist due to our customers' emphasis on their 4G data network expansions, STI continues to execute on our 2G HTS wire strategic initiative. Shortly after the first of the year, we expect to install new advanced development equipment to dramatically increase the lengths of our wire templates by mid-year 2012. This is a critical step in our plan to begin producing the longer lengths of HTS wire required by prospective customers next year." As of October 1, 2011, STI had $9.7 million in cash and cash equivalents and a backlog of $4,000.

Source: “Superconductor Technologies Reports Third Quarter 2011 Results”
Superconductor Technologies Inc. press release (November 2, 2011)

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