facilities will enable over 3000 scientists from 50 countries to conduct experiments on the structure of matter, including antimatter and stellar matter.

Nine countries have agreed to fund the $1.2 billion project, with Germany providing about three-quarters of that total. The SIS-100 accelerator will be the centerpiece of the facility, providing pre-accelerated particles for other experiments.

"The testing of the cable and the first magnet built with it should be completed within one year," said Fischer. "The SIS-100 dipole series production should be finished in 2016.

"The first FAIR modules, including the SIS-100, are scheduled to be in operation in 2017. Other parts of the system will follow later." ❍

ACT Signs Exclusive Option Agreement with CU

Advanced Conductor Technologies LLC (ACT) , a company that markets thin, flexible, and lightweight HTS rare earth barium cuprate (REBCO) superconducting cables, has completed an exclusive option agreement with the University of Colorado (CU) for the HTS cabling technology that will enable ACT to develop conductor-on-round-core (CORC) cables. The agreement does not cover any technologies unrelated to CORC.

"CU has been very open about their intentions regarding the option agreement," said Danko van der Laan, President and Founder of ACT. "CU generally provides spin-off companies with the possibility of securing an exclusive option or license for the technology that formed the basis of the spin-off."

CORC Helps REBCO Retain I_c

"We noticed that the coated conductors retained at least 90% of their performance after cabling when we first developed the compact HTS cable. The I_c of REBCO coated conductors is reduced reversibly by strain and it was thus expected that the heavily-strained conductors in the cable would have lost a fair amount of their I_c.

"We found that the I_c of GdBCO was much less sensitive to strain, compared to that of YBCO. The compact cables were wound from GdBCO coated conductors and the high cable performance was attributed to the reduced strain sensitivity of GdBCO.

Superconductor Week

Superconductor Week (ISSN 0894-7635) is published 24 times a year by **Peregrine Communications**

Publisher: Klaus Neumann

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"At the time we didn't know that the reversible strain effect in many REBCO coated conductors is actually anisotropic in nature with respect to the in-plane strain orientation. The effect of strain on the I_c of many REBCO coated conductors is highest when strain is applied along the conductor axis, while it almost completely disappears when strain is applied at an angle of 45° with respect to the conductor axis.

"The retention of the I_c in what are now called CORC cables is mainly caused by the anisotropic nature of the strain effect. The winding angle of the coated conductors in CORC cables causes the strain to be oriented close to the favorable angle at which the strain effect disappears."

GdBCO Strand has Higher Strain Tolerance than YBCO

The REBCO cable that is proprietary to ACT was developed by van der Laan when he was a researcher with CU and the National Institute of Standards and Technology (NIST) (see *Superconductor Week*, Vol 25, No 11). The cables are thinner and more flexible than most contemporary HTS cables while carrying the same or more current.

The GdBCO tapes used in the cables have a high tolerance for strain compared to other HTS tapes, allowing for the use of an unusually slender copper former. The reversible change in I_c with strain that occurs even at low strains is lower for GdBCO than it is for YBCO.

The cable's flexibility offers cost benefits, such as requiring less space to install, thus allowing for a higher current capacity to be installed in an existing conduit. The flexibility and weight also allow for longer cable lengths on the same cable spool. One major obstacle to the broader deployment of the REBCO cable technology is the price of the deposition process.

Van der Laan said that CORC cables could be used in high-field applications: "Some of the most promising applications of CORC cables are high-field magnets. The in-field performance of REBCO coated conductors is already very high and wire manufacturers are constantly raising the high-field pinning properties of the conductor.

"In addition to high-field applications, ACT has developed some concepts for AC applications of the CORC cable. However, funded programs at ACT are currently aimed at DC power or very low frequency applications."

ACT Involved in DOE, Navy, Air Force SBIR/STTR Awards

Van der Laan said that ACT had received three SBIR/STTR awards over the last year: "ACT has made some major steps in raising the funds for the development of CORC cables. The first award ACT received was a Phase I STTR from the DOE to develop CORC cables for fusion applications. The award is for $150,000 and is subcontracted with the Massachusetts Institute of Technology (MIT)."

Earlier this year, ACT was awarded Phase I SBIR funding from the U.S. Navy to develop reliable HTS cable systems for shipboard cables. The Center for Advanced Power Systems at Florida State University (CAPS-FSU) is also a partner in the award. The award is funded in two stages, with a base of $80,000 for 6 months and an option for an additional $70,000.

The HTS systems developed under the award are intended for shipboard power transmission and degaussing purposes. The award lists ACT's CORC cable as the only one flexible enough to be pulled through a pre-installed cryostat, a requirement of the shipboard cable system. The program began in June.

"The Navy program will be a good test bed for CORC cables," said van der Laan. "The cables could potentially be applied in other maritime applications."

Also earlier this year, ACT, along with The Center for Superconducting and Magnetic

Materials at Ohio State University was awarded a $100,000 STTR Phase I by the Air Force Research Lab to develop a High-T_c superconducting magnetic energy storage (SMES) system for airborne applications. The STTR specifies the development of a low-inductance SMES system from HTS CORC cables that can be discharged at high powers within the limitation of 270 V.

"The 270 V limit is set to prevent electrical discharge at high altitude," added van der Laan. "This limits the voltage that may develop over the SMES during charge and discharge, even at high powers of several megawatts. This requirement can only be met by a SMES that has a low inductance. A high winding current of several kilo-amps will ensure a high stored energy, even at a low inductance.

"The Phase I award seeks to optimize the SMES configuration to minimize weight and volume for different stored energies between 150 kJ and 100 MJ, and to determine the requirements for the superconducting cable from which a 200 kJ to 1 MJ SMES would be wound. The feasibility of the CORC cable for SMES systems would be determined by measuring its mechanical strength, its performance in high-magnetic fields, and the AC losses in changing magnetic fields.

"To date, we have performed a lot of measurements and are working on the final SMES design. Our approach to developing a SMES from CORC cables seems to be quite feasible." ❍

U Lincoln Awarded £1.6 Million to Develop PBRT Sensors

A research team at the University of Lincoln in the UK has been awarded a £1.6 million ($2.5 million) Translation Award by the Wellcome Trust to employ 3D imaging sensors developed at the university with superconducting proton radiation beam therapy (PBRT) systems. The 3-year research project is called Pravda and will deploy the U Lincoln detectors alongside other detectors developed at the University of Liverpool and used at the Large Hadron Collider (LHC). Other institutions involved in Pravda are the University of Birmingham, the University of Surrey, the University Hospitals Birmingham NHS Foundation Trust, the University Hospitals Coventry and Warwickshire NHS Trust, and the iThemba Labs in Cape Town, South Africa.

Pravda will seek to provide not only accurate measurements of the therapy dose but also 3D images of where the radiation is absorbed at a tumor site. Treatments should become more effective and shorter using the new sensor, and may open up the ability to treat some common cancers that so far have resisted treatment with conventional therapy.

"Strip detectors are very fast and extremely radiation hard, having no active components near the beam," said Nigel Allinson, Professor at U Lincoln who has helped to develop the new PBRT sensors. "Essentially, they will work as particle trackers, as in high energy physics (HEP). There will be crossed strips to allow accurate x-y locations, and we will need to produce new strip designs (pitch of strips, etc.) and new readout ASCI as the dynamic range of signals is much greater than in a typical HEP experiment.

"To date, there has been no attempt to produce 3D proton computed tomography (CT) images where we record the deposited dose in the treatment region. Over the course of this project we will produce a prototype system that will be tested at the iThemba proton therapy center on phantoms and animal carcasses. It is a much longer road to get approval to test the sensor on patients.

"At the conclusion of this program, the system will be commercialized, possibly through a licensing deal with a major medical instrumentation manufacturer or through a start up company. We would expect PBRT treatments to be shorter with a reduced number of sessions and able to treat tumors in challenging locations