EUCAS Short Courses

Report of Contributions

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Contribution ID: **1** Type: **not specified**

High Temperature Superconductors: the path from the materials to the technical conductors

Abstract
This course addresses the current state and prospects of high temperature superconductor (HTS) technology. The scope is to illustrate the close synergetic relationship between the development of a deeper understanding of the material properties and the progresses in the conductor technology, with a focus on high field magnet applications. The course is organized in four parts:
1) An introduction to high temperature superconductivity;
2) The basics of HTS conductor fabrication (REBCO coated conductors, BSCCO-2223 tapes and BSCCO-2212 wires), including latest developments to improve performance;
3) An overview of the electromagnetic, electromechanical and thermophysical properties of the conductors;
4) Critical issues and innovative design concepts for the HTS-based magnet with an overview of noteworthy ongoing magnet projects.

Speaker Bio.

Carmine Senatore.

Prof. Carmine Senatore was appointed head of the Group of Applied Superconductivity at the University of Geneva, Switzerland, in 2010. He received his MSc degree cum laude in Physics in 2000 and his doctoral degree in 2004 at the University of Salerno, Italy. His formation as solid state physicist was focused on the vortex dynamics in high-Tc
superconductors. Presently, his primary activity is on superconducting materials for largescale applications. The research of Prof. Senatore is driven by the challenge to understand and control the basic properties required for the practical implementation of superconductors. This includes all material aspects that play a role in tuning the superconductor properties aswell as innovative approaches to the processing of superconducting wires and tapes. His activities focus on the development of both low- and high-Tc superconductors for applications in various fields, from the high field magnets for NMR/MRI systems and particle accelerators to the emerging applications in the electric power infrastructure. Recently, his group has developed and tested in collaboration with Bruker BioSpin a superconducting coil able to generate a magnetic field of 25 Tesla. Senatore also takes part in the CERN study forthe next generation accelerator magnets in view of a 100 TeV energy-frontier hadron collider.

Matteo Alessandrini

Matteo Alessandrini is a Group Leader in the R&D department of NMR magnets of Bruker BioSpin AG in Switzerland. He has 10+ yrs of experience in the field of MRI/NMR magnets and superconducting wire technologies. He holds a Master in Mechanical Engineering from University of Bologna and a Master in Space Studies from ISU, Strasbourg. He received his PhD in 2007 in the group of Dr.Salama at UH-TcSUH under the interdisciplinary program of Materials Engineering working in collaboration with NASA-JSC and AdAstraRocket co. on a thesis about MgB2 wires for weight-critical applications. He was an intern at LASA-Milan and at LBNL. Before joining Bruker, Dr.Alessandrini worked on MRI magnet technologies at GE-GRC in Niskayuna, NY.

Kenneth Günter

Kenneth Günter is a R&D scientist at Bruker BioSpin developing superconducting magnet systems. He received his Ph.D. degree in experimental Physics from the Swiss Federal Institute of Technology (ETH) in Zurich for his work in the domain of quantum optics and cold atomic gases. From 2008 to 2011 he worked as a Marie Curie researcher at Ecole Normale Supérieure in Paris, before returning to Switzerland and joining Bruker BioSpin. Kenneth leads various R&D projects

and focuses in particular on technology development and magnet design of devices using high-Tc superconductors, mainly for magnetic resonance applications.

Presenters: SENATORE, Carmine (University of Geneva); GÜNTER , Kenneth (Bruker BioSpin); ALESSANDRINI , Matteo (Bruker BioSpin)

Contribution ID: **2** Type: **not specified**

Design of Superconducting magnets for particle accelerators and detectors

Abstract
This course covers the design of superconducting magnets for particle accelerators and detectors. The lectures are intended for physicists and engineers working in the areas of magnet technology and applied superconductivity, and interested in basic principles, physical parameters, analytical and numerical tools used for superconducting magnet design. For each of the applications considered, the courses will start by presenting the properties and characteristics of superconducting strands and cables. The main concepts related to magnetic design and coil lay-outs will be then outlined. In addition, the lectures will deal with the mechanics and fabrication techniques of a superconducting magnet, focusing in particular on coils and the structural components aimed at containing the electro-magnetic forces and managing the stresses. Finally, a description of the different systems devoted to cool and protect a magnet after a quench will be provided.

Speaker Bio.

Paolo Ferracin

Paolo Ferracin is currently a staff scientist in the Magnets, Superconductors and Cryostats (MSC) Group at the European Organization for Nuclear Research (CERN) in Geneva. After graduating in Nuclear Engineering at the Politecnico of Torino, Italy in 1998, he joined the CERN Main Magnet and Superconductors Group as a PhD Student to work on the mechanics and magnetics of the main superconducting dipole magnets for the Large Hadron Collider (LHC). In May 2002, he started working in the Superconducting Magnet Program of Lawrence Berkeley National Laboratory (LBNL), first as a Physicist Postdoctoral Fellow and then as a Staff Scientist, on the development of Nb3Sn dipoles and quadrupoles for the next generation particle accelerators. In 2011, he re-joined the MSC group at CERN. For the past 19 years, he has conducted research in the area of applied superconductivity and superconducting magnet technology for particle accelerators.

Hermann Ten Kate

Herman ten Kate received his Bachelor degree from the University of Twente in 1976, his M.Sc. degree in Applied Physics and Superconductivity in 1980 (for research on superconducting switches and transformers) and his Ph.D. degree for thesis research on 'Superconducting Rectifiers"in 1985. In 1985 he became an assistant professor at the University of Twente and was the leader of the High Current Superconductivity Group from 1991 though 1996. In 1997, Prof. Ten Kate was appointed to a special chair as Extraordinary Professor for Industrial Applications of Superconductivity. In 1996 he accepted an appointment at CERN where he worked on a number of projects developing high performance, high field superconducting magnets for particle accelerator applications as a staff member of the Physics Department and became the ATLAS Magnet Systems Project Leader. The ATLAS Magnet system is the largest superconducting magnet system built for particle accelerator applications and played a critical role on the recent discovery of the Higgs boson. In addition to ATLAS he and his team is involved in problems solving for various detector magnets at CERN, as well as design of new detector magnets for ILC, IAXO and PANDA and is leading the design of the new detector magnets for the Future Circular Collider.

Presenters: TEN KATE, Herman (CERN); FERRACIN, Paolo (CERN)

Contribution ID: **3** Type: **not specified**

Superconducting electronics - from Josephson effects to quantum computing

Abstract
The Josephson effects are the basis for many applications in the field of superconducting electronics. First there will be a discussion of these effects from theoretical aspects up to applications. After introduction of single Josephson junctions different circuits will be introduced like superconducting quantum interference devices (SQUIDs) and many junction arrays. Well-established applications like the voltage standard and SQUIDs as very sensitive sensors will be discussed. The superconductor digital electronics reaches from classical logic circuits up to advanced devices. As one realization of quantum computing devices circuits with Josephson junctions show promising performance and will be discussed in detail

Speaker Bio.

Paul Seidel.

Paul Seidel is professor of Applied Physics and head of the Low Temperature Physics Department at Institute of Solid State Physics of the Friedrich Schiller University Jena, Germany. He works in the field of superconductivity since 1975. His research interests are Josephson effects and tunnelling in superconducting devices, thin film SQUIDs and their applications, surface and transport properties in epitaxial layer systems, cryogenics, and material science at low temperatures. Prof. Seidel got an Alexander von Humboldt fellowship and acts as a guest professor at the University Bonn, Germany as well as at the University Osaka, Japan. He has authored more than 300 papers in peer-reviewed journals. Prof. Seidel is member of the German Physical Society, the Materials Research Society and the European Society of Applied Superconductivity (ESAS) since their foundation. Since 2015 he is the secretary of the ESAS president. He worked in advisory boards of international conferences and workshops, like ASC, ISEC and EUCAS. He was the editor of the book "Applied Superconductivity –Handbook on devices and applications".

Pascal Febvre.

Pascal Febvre has been working on superconducting electronics since 1991 when he started to develop submillimeter superconducting heterodyne receivers for radioastronomy applications at the Observatory of Paris, France and at NASA-JPL in Pasadena, California. Since 1997, Pascal Febvre is in the IMEP-LAHC laboratory (CNRS UMR5130) of University Savoie Mont Blanc in France. He built a research activity aimed at developing fast digital superconducting electronics based on the Rapid Single-Flux-Quantum (RSFQ) technique. He has been involved in several national and european projects related to superconducting electronics in the microwave and THz frequency range. He is currently involved in the development of digital Superconducting Quantum Interference Devices (SQUID) magnetic sensors for geophysics applications with the Low-Noise Underground Laboratory (LSBB –CNRS UMS3538) of Rustrel in France, and collaborates with several groups in Germany, Italy, South Africa, Turkey and Ukraine.

Presenters: FEBVRE , Pascal (Université Savoie Mont Blanc); SEIDEL, Paul (Freidrich-Schiller-Universität Jena)

Contribution ID: **4** Type: **not specified**

Superconducting RF Cavities

This 6-hour lecture will start with the basic principles of RF superconductivity. It follows an introduction to cavities - starting from Maxwell's equation, eigenmodes and characteristics of standard (TM-mode elliptical) accelerating cavities will be introduced. After an excursion to non-elliptical cavities, the lecture will introduce the technologies used to fabricate, treat and assemble superconducting RF cavities and the methods to test them, including specialized diagnostics. Performance limitations and their mitigation will be mentioned. An important chapter will be on power couplers, higher-order modes and their coupling and damping. Finally recent progress in cavity performance and future trends of developments in the field will be presented.

Speaker Bio

Erk Jensen

Erk Jensen received his PhD in Electrical Engineering from TUHH (Technical University Hamburg-Harburg, Germany) in 1991 with a work on Gyrotrons. He then worked at CERN on normal-conducting and superconducting RF accelerating structures for synchrotrons and linacs as well as high power, high efficiency RF sources. Dr. Jensen leads the CERN RF group since 2011.

Presenter: JENSEN, Erk (CERN)

Contribution ID: **5** Type: **not specified**

Superconducting Power Devices

Abstract
Many power device applications are under development using superconducting materials. Novel designs have been proposed to take advantage of the unique properties of superconducting materials and to achieve higher performance standards compared to conventional power devices. The short course on Superconducting Power Devices will cover Superconducting Fault Current Limiters, Superconducting Transformers, Superconducting Rotating Machinery, Superconducting Cables and Superconducting Magnetic Energy Storage. The course will cover the basics of each application and describe the latest developments and ongoing projects in each application category. The course will also summarize on future directions and research needs for advancing Superconducting Power Devices technology.

Speaker Bio.

Mathias Noe

Mathias Noe has received his M.S. in Power Engineering in 1991 and his Ph.D. in 1998, both from the University of Hanover in Germany. After a Postdoc position at the Ecole Polytechnic Federale de Lausanne in Switzerland, he joined Forschungszentrum Karlsruhe in 1998 and became later group leader for high temperature superconducting power devices at the Institute for Technical Physics. Since 2006 he is director of the Institute for Technical Physics at the Forschungszentrum Karlsruhe and full professor for technical applications of high temperature superconductivity at the faculty of electrical engineering and information technology of the University Karlsruhe. In 2009 Forschungszentrum Karlsruhe and Karlsruhe University merged to the Karlsruhe Institute of Technology (KIT). The Institute for Technical Physics is a national and international centre of competence for applied superconductivity and cryogenics. Prof. Noe is active in the field of new energy technology and applied superconductivity since 1991 and is the author of more than 100 reviewed articles in this field. He is spokesperson of the Helmholtz Program Energy Storage and cross-linked Infrastructure and Coordinator of the EERA Joint Program Energy Storage. In addition, he is member of several boards, panels and committees in his research field among them he served from 2011-2015 as a president of the European Society of Applied Superconductivity.

Mark Ainslie

Mark Ainslie received the B.E. (Electrical & Electronic) & B.A. (Japanese) degree in from the University of Adelaide, Australia, in 2004, the M.Eng. degree from the University of Tokyo, Japan, in 2008, and the Ph.D. degree from the University of Cambridge, UK, in 2012. In 2011, he was awarded the European Society for Applied Superconductivity (ESAS) Young Researcher's Award in Large Scale Applications for his PhD work on transport AC loss in high-temperature superconducting (HTS) coils. From 2012-2017, he was a Royal Academy of Engineering Research Fellow in the Bulk Superconductivity Group at the University of Cambridge, where he investigated the engineering interactions of conventional, magnetic and superconducting materials for electrical applications. This work focussed on the use of HTS materials in bulk and wire form to increase the electrical and magnetic loadings of an axial gap, trapped flux-type superconducting electric machine. In July 2017, he became an EPSRC Early Career Fellow, also in the Bulk Superconductivity Group, as the principal investigator of a five-year, £1.1 million project investigating the use of bulk HTS materials in portable, high field magnet systems. His research interests cover a broad range of topics in applied superconductivity in electrical engineering, including superconducting electric machine design, bulk superconductor magnetisation, numerical modelling, and interactions between conventional and superconducting materials.

Antonio Morandi

Antonio Morandi holds a PhD in Electrical Engineering. Since 2006 he is with the Department

of Electrical, Electronic and Information Engineering where is appointed professor of Elements of Electrical Engineering, Electric Energy Storage and Applied Superconductivity. He is also supervisor of PhD programs on Applied Superconductivity. His research interests are on power applications of High Temperature Superconductors and advanced energy systems. He has coordinated several research projects in this field funded by Public Agencies and by private companies and has contributed to the prototyping of superconducting power apparatus (FCL and SMES) and to the development of modelling and design tools. Antonio Morandi is author of about 50 technical papers published in international journals and conferences. He is inventor of two patents. He is reviewer of research projects in the energy sector for the European Commission, the Italian Ministry of Education, Universities and Research and foreign research institutes. He has given several invited talks at international conferences and research associations and has moderated several technical discussions. He is member of the Italian mirror Committee IEC TC90 –Superconductivity and is member of the International Steering Committee on HTS Modeling. He has been member of program committees in international conferences. He has been the chairman of the 5th International Workshop on Numerical Modelling of High Temperature Superconductors, Bologna-Italy, 2016. Antonio Morandi is member of the ESAS board. He is a senior member of IEEE and serves as technical editor for IEEE Transaction on Applied Superconductivity.

Presenters: MORANDI , Antonio (University of Bologna); AINSLIE, Mark (University of Cambridge); NOE, Mathias (Karlsruhe Institute of Technology)