Publications of the Publishing House of Warsaw University of Technology (OWPW — Oficyna Wydawnicza Politechniki Warszawskiej) and its publication catalogues are available in most technical-scientific bookshops in Poland, as well as in reading rooms and libraries of universities.

The full offer of our publications is presented on the Internet at

http://www.wydawnictwopw.pl

The Publishing House of Warsaw University of Technology offers also mail-order sale (national and international deliveries)

phones: 0-22 825-75-18
0-22 234-75-03
fax 0-22 234-70-60
e-mail: oficyna@wpw.pw.edu.pl

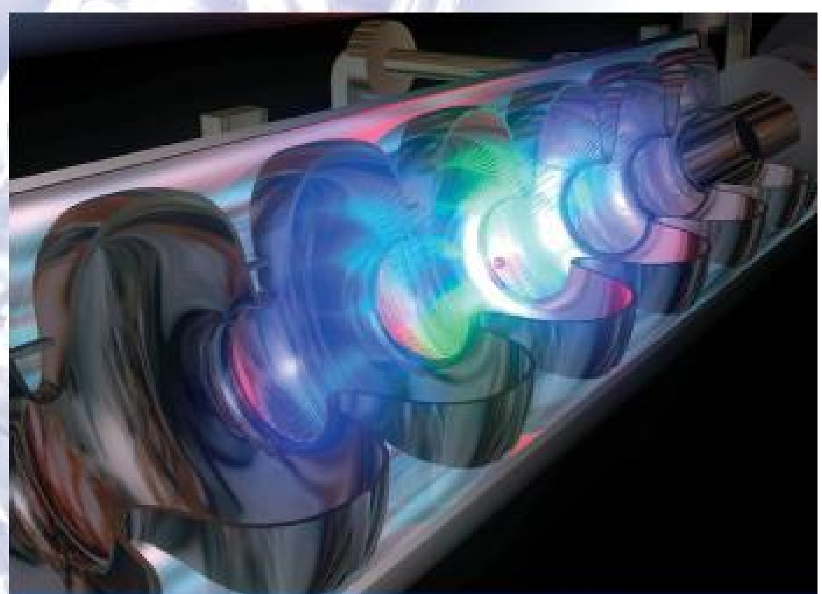
ISBN 978-83-7207-666-3

9 788372 076663

Multi-cell Superconducting Structures for High Energy e+ e- Colliders and Free Electron Laser Linacs

Jacek Sekutowicz

Multi-cell Superconducting Structures for High Energy e^+ e^- Colliders and Free Electron Laser Linacs



Editorial Series on ACCELERATOR TECHNOLOGY

Institute of Electronic Systems
Warsaw University of Technology

EuCARD

The work is vol I in a new editorial series on Accelerator Technology. The series is associated, among others, with the following, realized or planned, programs and collaborations: ESGARD-European Steering Group for Accelerator Research and Development, CARE-Coordinated Accelerator Research in Europe, EuCARD-European Coordination for Accelerator Research and Development, TESLA Technology, ILC-International Linear Collider, FLASH and XFEL, POLFEL.

Series Editor

Ryszard Romaniuk, Warsaw University of Technology

Reviewers:

Eugeniusz Pławski, A. Sołtan Institute for Nuclear Studies
Janusz Chwastowski, H. Niewodniczański Institute of Nuclear Physics

Cover design

Danuta Czudek-Puchalska

The photo on the cover was taken from the DESY web resources [www.desy.de] and presents an artist impression of particle acceleration in a superconductive cavity.

ISBN 978-83-7207-666-3

Internet bookshop of the Warsaw University of Technology Publishing House (OWPW):
thttp://www.wydawnictwopw.pl; e-mail: oficyna@wpw.pw.edu.pl
phones: 48-22 825-75-18, 48-22 234-75-03; fax 48-22 234-70-60

Printed and bound by: WUT Publishing House:
ul. Polna 50, 00-644 Warszawa, Poland. 1st edition. Order no 575/2007

Editorial

The new Editorial Series of short research and didactic monographs on "Accelerator Technology" or, in Polish, "Technika Akceleratorowa" is devoted to all aspects of the research, design, construction, testing, commissioning, and exploitation of very complex components and apparatus for particle accelerators, detectors, energy and particle sources, astro-particles and high energy physics experiments. A short, symbolic title of the editorial series "Accelerator Technology" embraces, perhaps somehow awkwardly, a large, flourishing branch of scientific activity. The monographs to be published in the series will be around 100 pages (occasionally as high as 150) but very concisely and in depth covering specific, relevant, narrowly defined topics. The books will be published in English, usually by international experts, but some of them also in Polish. They are mainly intended for students as well as young and new-to-the-field engineers and physicists, as a fast start up for further and more advanced studies.

The accelerator facilities, their components, construction, and exploitation are unique in nearly all aspects: in time, since design through implementation usually requires more than a decade; in resources since, hundreds of people are involved in each realization; in costs which can be as high as billions of Euro; in technology, because often only cutting-edge technical solutions are used, etc. The accelerator community integrates uniquely expertise in physics, chemistry, and engineering sciences such as materials research, electronics, photonics, mechatronics, nano-technologies, and metrology.

What really counts for us, physicists and engineers working as teachers at the Universities of Technology, National/International Research Laboratories, and high-tech industry or yet learning as M.Sc. or Ph.D. students, is a constant flow of applicable research results, new solutions and ideas, emerging applications and even great discoveries. Some of us participate actively in these magnificent endeavors of global extent. We notice how fast many new ideas have been implemented in the industry. The examples are: medical accelerators protecting our health, new communications media increasing the dimensions of the social space of the Internet, new telemetric systems protecting and increasing the knowledge of our environment, new more efficient energy sources protecting limited natural resources and relevant defense systems increasing our safety against terrorism.

The examples of large experiments, which we intend to portray in this editorial series, are:

- Free Electron Lasers,
- Large Hadron Colliders,
- Compact Muon Solenoid,
- ATLAS detector,
- International Linear Collider (ILC),
- Compact Linear Collider,
- GSI Accelerator Facility,
- ITER,
- Atacama Large Millimeter Array,
- Very Large Telescope,
- Spallation Neutron Source,
- Wilkinson Microwave Anisotropy Probe of Cosmic Microwave Background Radiation,
- Low Frequency Array,
- CODALEMA,
- Pierre Auger Observatory

All of these research complexes are eruptive birthplaces of new, more effective technologies, from which we all shall profit.

Usually, the above mentioned experiments are associated with large research institutions. For example – CERN in Geneva, DESY in Hamburg, INFN in Rome, Milano and Padova, PSI in Willingen, CNRS/CEA/IN2P3 in France, Thomas Jefferson National Accelerator Facility (TJNAF) in Newport News, ORNL in Oak Ridge, FNAL in Chicago, Brookhaven National Laboratory (BNL) in Upton, KEK in Tsukuba, Rutherford Appleton Laboratory (RAL) in Oxfordshire, etc. In addition, several universities, especially in the USA, operate large accelerator complexes like Cornell (LEPP, CESR), Stanford (SLAC), etc. In this country, there are several laboratories active in the relevant subjects. Wrocław University of Technology is focused on the cryogenic technology. Warsaw University of Technology (WUT) has expertise in nuclear power plants, accelerator and detector electronics and photonics systems. Łódź University of Technology contributes worldwide to R&D programs on accelerator electronics. Institute of Experimental Physics at Warsaw University, Sołtan Institute for Nuclear Studies in Świerk, Niewodniczański Institute of Nuclear Physics in Kraków, Institute of Physics of Polish Academy of Science, Institute of Plasma Physics and

Laser Microfusion participate in experiments and accelerator and detector programs for high energy physics. There are several planned projects in relevant areas like: coherent light source POLFEL in Swierk [www.polfel.pl] and National Center of Synchrotron Radiation in Kraków – NCPS [synchrotron.pl].

Authors of the monographs in this editorial series are recruited from these recognized Institutes and Universities.

Particular research and technical subjects behind the experiments, which will be covered in this editorial series, embrace for example:

- In optics and photonics – high quality optical systems, large optical systems, adaptive optics, laser beam monitoring and control, high power optical systems, ultra-high speed multi-gigabit optical data transmission, optical fiber reference clock distribution systems, large optical telemetric networks, electron beam position and quality monitoring, novel laser based accelerator schemes, petawatt lasers, laser generated high energy ionizing radiation.
- In microwaves – ultimately high power microwave sources, stable superconducting resonant cavities for SRF accelerators, high gradient SC cavities, higher order modes (HOM) in accelerating cavities, continuous wave (cw) and or near-cw operating accelerators.
- In plasma technology – novel plasma accelerating schemes, application of plasma technologies, micro-fusion.
- In electronics – more efficient topological solutions for electronic systems for less power consumption, more processing power, less occupied space, intelligent reconfigurability options, optimal superconducting cavity controllers, accelerator simulators, complex system mapping in large dynamic and fast databases.
- In mechatronics – applications of MOEMS, micro and nano-systems.
- In material research – novel materials for the critical system components, superconducting materials, low-loss and nonlinear microwave and optical materials, thin film technologies, sputtering and plasma deposition methods.
- In nuclear sciences – high temperature nuclear reactors, safety problems in nuclear energy production, future energy sources.
- In medicine, biology and industry – applications of accelerator, synchrotron radiation, laser and nuclear technologies.

This volume, which is the first in the editorial series on "Accelerator Technology", is closely combined with the most advanced particle accelerators – based on Superconducting Radio Frequency (SRF) technology. In general, SRF research includes following areas: high gradient cavities, cavity prototyping, thin film technologies, large grain and mono-crystalline niobium and niobium alloys, quenching effects in superconducting cavities, SRF injectors, photo-cathodes, beam dynamics, quality of electron beams, cryogenics, high power RF sources, low level RF controls, tuners, RF power coupling to cavities, RF test infrastructures, etc.

The Author of this volume on "Multi-cell superconducting structures for high energy e^+e^- collider and free electron laser linacs", Dr Jacek Sekutowicz, is since 23 years staff scientist at Deutsches Elektronen-Synchrotron (DESY) in Hamburg working in the field of the SRF technology and a recognized expert in this area. He visits frequently TJNAF and BNL to contribute to the R&D programs on accelerators. He participates in the ILC and XFEL international projects and takes actively a leading part in the current projects like R&D for SRF-photoinjectors and design of new structures for the ILC main accelerator. He proposed and proved experimentally the first Nb prototype of superconducting superstructure, HOM suppression system for HERA and TESLA colliders and contributed to designs of several other superconducting accelerators for leptons and hadrons. Recently, he is involved in the European studies (EuroFEL) on high power pulse to cw operating RF-sources for the linear accelerators driving coherent light sources. Dr. Sekutowicz is a frequent visitor at KEK in Japan and Tsinghua and Beijing Universities in China. His research ties in Poland are INS in Świerk and WUT. He is author and co-author of more than 110 essential papers on SRF components and accelerating systems.

Series Editor
R. Romaniuk