ASSCA 2023 Lecture Synopses

Day 1 : January 29, 2024, Monday

●Tripti Sekhar DATTA: Introduction to Cryogenics and Superconductivity for Accelerator

This lecture will give an overview on the Role of Superconductivity and Cryogenics particle accelerator. Marriage between Nuclear Science and Cryogenics through liquid Hydrogen Bubble Chamber to Liquid Argon Neutrino detector will be discussed. Superconducting Magnet and Superconducting Cavity are the two Primary components of modern powerful accelerators. This talk will give an advantage and disadvantage of superconducting elements over normal conducting elements along with the history of Superconducting accelerators starting from Tevatron Accelerator to LHC, CERN and with future ILC programmes. The advantage on size and power consumption will be discussed. Present talk will be also highlighting the present scenario on various Superconducting accelerator programme in Asia.

●Toru OGITSU: Introduction of Superconducting Magnets for Accelerators

Introductory lecture for superconducting magnets for accelerators. Basics of superconducting magnet technologies will be briefly introduced. History and various applications of superconducting magnet on accelerators will be lectured.

●Eiji KAKO: Introduction to Superconducting RF Cavity System

Fundamentals of superconductivity, basics of electromagnetic properties in Superconducting Radio-Frequency (SRF) cavity, generic technologies in fabrication and surface treatment of SRF cavity, explanation of SRF cavity system with couplers and tuners, history of high gradient performances and introduction of worldwide accelerator projects using SRF cavities will be covered in this lecture.

Day 2 : January 30, 2024, Tuesday

●Michinaka SUGANO: Superconducting Wires and Cables for Accelerator Magnets

In this lecture, practical superconducting wires including LTS and HTS will be introduced. Then superconducting cables for accelerator magnets will be explained with some examples. Electromagnetic and mechanical properties that are important for an application to accelerator magnets will also be discussed.

●Yasushi ARIMOTO: SC Magnet (2)

This lecture delves into magnetic field design and considerations regarding electromagnetic forces. The discussion extends to magnets' role as beam optical elements. Additionally, methods for evaluating magnetic field quality in accelerator magnets are introduced.

●Kento SUZUKI: Quench Protection and Diagnostics of Superconducting Accelerator Magnets

In this lecture you will learn essence of the quench protection and its application to the testing accelerator magnets. Some diagnostic techniques will also be introduced such as quench localization and strain measurements, which are important for successful training of your magnets.

Day 3 : January 31, 2024, Wednesday

●Yasuhiro MAKIDA: Superconducting Detector Magnets

Superconducting magnets have been adopted for the detectors used to analyze collisions. A magnetic field is essential for identifying the particles emerging from collisions: curves their trajectory allowing physicists to calculate their momentum and to establish whether they have a positive or negative charge. The larger the volume on which magnetic field acts is their feature. In this lecture such superconducting magnets, especially thin solenoids, will be introduced.

●Masami IIO/Makoto YOSHIDA: Development of Radiation-resistant Superconducting Magnet

In recent years, superconducting magnets have been required to operate in high radiation environments with beam intensity increasing of accelerators. KEK has been developing radiation-resistant superconducting magnets to meet the requirements. This lecture will introduce irradiation research on magnet materials, the status of actual magnet development and production, research and development for future applications.

●Hiroaki UMEZAWA: Production of High Purity Niobium for SRF Cavities

The superconducting cavities are made of high-purity niobium sheets. Its purity is evaluated by RRR (Residual Resistivity Ratio), and a high RRR guarantees high purity and high thermal conductivity. This program explains the manufacturing process and quality control of niobium for superconducting cavities. I hope that young researchers who will build superconducting cavities will learn about niobium as a cavity material.

Day 4 : February 1, 2024, Thursday

●Takeshi DOHMAE: Fabrication and Evaluation of 1.3 GHz 9-cell Cavities for ILC

Manufacturing high performance SRF cavity cannot be done in a day. There are a lot of know-how in manufacture of cavity. In this lecture, basics of SRF cavity manufacturing will be presented. And, the latest information about cavity manufacturing will be also explained.

●Jun TAMURA: Development of Spoke Cavities at JAEA and Worldwide ADS Projects

In this lecture, superconducting cavities used for accelerating low velocity particles will be explained first. These cavities can be called non-elliptical TEM-mode cavities. As one of these cavities, the spoke cavity we are currently developing at JAEA will be presented. One of the applications of proton beam acceleration using spoke cavities would be ADS. Worldwide ADS projects will be also introduced.

●Naruhiko SAKAMOTO: Navigating the Challenges of Designing, Constructing, and Operating Superconducting Linear Accelerator for Heavy Ions for RIKEN RI-beam Factory

The RIKEN heavy-ion linear accelerator was upgraded by introducing a new super-conducting linac-booster to advance the super-heavy elements synthesis program be-yond nihonium at the RIKEN Radio- active Isotope Beam Factory (RIBF). The total acceleration voltage was upgraded from 25 MV with 12 room temperature drift-tube-linacs (DTLs) to 39 MV by introducing a superconducting linac booster, SRILAC. The upgrade of the beam intensity is realized by a newly constructed superconducting electron-cyclotron resonance ion source (SC-ECRIS). The construction of SRILAC and the SC-ECRIS started in 2017. After the hardware installation and commissioning, the first beam acceleration test was successfully conducted in January 2020, and then user beam service was started. This lecture will share our experiences with design, constructing, commissioning, and operation of SRILAC, superconducting linear accelerator for heavy ion. It will include the issues we encountered through four-year operation.

Day 5. : February 2, 2024, Friday

●Alexander NAVITSUKI: SRF Activities on Cavities and Cryomodules in RI

The lecture "SRF Activities on Cavities and Cryomodules in RI" will cover the whole lifecycle of the SRF cavities and modules fabrication and testing. There will be details

presented about the niobium sheet inspection, mechanical cavities fabrication incl. some details about the shaping of cells, trimming, surface polishing, EB welding, clean room assembly technologies, surface treatment, heat treatment, cryomodule assembly and testing, and shipment.

●Tripti Sekhar DATTA: Cryogenics (Theory)

This talk will be covering:

1. Basis Thermodynamic Process (Isothermal Compression, AdiabaticExpansion, Isenthalpic Cooling) for Cooling
2. Few Cryogenics Liquefaction Cycle
3. Comparison with Carnot cycle and efficiency
4. Performance of Cryogenic Cycle with respect to Yield, Inverse COP and Figure of Merit (FOM)
5. Practical liquefier

●Rui GE: Cryogenic Engineering - Large Cryogenic System and the Cryomodules

The basics of 4K and 2K cryogenic system in reference to the particle accelerator. Through the introduction of the typical large cryogenic system to introduce the cryogenic engineering for the superconducting accelerator and the special requirements from the superconducting cavities and the superconducting magnets, which include the obtaining of the cryogenics, the cryogenic fluid distribution and transfer, cryostats and cryomodules, the cryogenic system integration and operation.

Day 6 : February 3, 2024, Saturday

●Hirotaka NAKAI: Superfluid Helium Cryogenics and Superfluid Helium Cryogenic Systems

As the operation temperature of the superconducting devices for the accelerators is getting lower down to 2 K or below, the superfluid helium cryogenic system is indispensable for stable and long-term operation of the devices. Superfluid helium cryogenics and superfluid helium cryogenic systems for the superconducting accelerators will be introduced briefly to cope with this lower temperature requirement.

●Xilong WANG: Large Scale Cryogenics System in XFEL, ESS, DALS and S3FEL

Upon my work experiences, the applications of large-scale cryogenics system in the big science facilities, especially based on the SRF accelerators, will be introduced firstly. The cryogenic system could be generally deemed as a big project. From the project

management point of view, there are some common methods and work routines to run a project. A case study of one accelerator cryoplant will be presented considering the project lifecycle: Pre-study, Planning, Execution, Closure. Pre-study could include the lab-visiting, users understanding, system performance, staging & operation modes, industry studies etc. Planning will encompass schedule, staffing, budget, technical specification and call for tender. Execution covers project meeting & Reviews, intermediate inspection, delivery, installation, and commissioning. The documentation and lessons learnt will be described in the closure phase. By the case study, the project methodology, the key design considerations, technical issues, challenges, experiences and lessons learnt for the large-scale cryogenics system will be given in this lecture.

●Taekyung KI: Cryogenic Systems for RAON Accelerator

RAON heavy ion accelerator has two SuperConducting Linacs (SCL3 and SCL2) with superconducting cavities. After SCL2, superconducting magnets are used to separates/dumps/focuses rare isotopes. Large-scale cryogenic systems are essential to create and maintain cryogenic conditions and consists of two cryogenic plants (including a helium recovery purification and storage system), a helium distribution system, a cryogenic control system, and a test facility of cavities and cryomodules. From 2018, all cryogenic devices were designed for operation at liquid helium temperatures (4.5 K and 2.05 K) and fabrication/installation/inspection & pre-commissioning had been carried out by 2021. SCL3 was cooled to 4.5 K and 2.05 K successfully in 2022. The cryogenic commissioning, operation, and maintenance for SCL3 were performed by 2023. This talk will cover the overall content from the introduction of RAON cryogenic systems to recent activities (cryogenic commissioning, operation, and maintenance) in order to give the practice in cryogenic engineering.