EAJADE Workshop on Sustainability in Future Accelerators (WSFA2023)

Sep 25, 2023, 8:00 AM → Sep 27, 2023, 6:00 PM Asia/Tokyo

Iwate Prefecture Citizen's Cultural Exchange Center Aiina, Morioka, Japan

Description Workshop webpage: https://wsfa2023.huhep.org

******* Zoom link (for remote participants) https://us02web.zoom.us/j/85367199808?pwd=VnNFdWI4Q2JiK1VIcjF0YnZmeko5Zz09

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The environmental credential of future colliders are increasingly in the spotlight, because of their size and complexity, and will be under scrutiny for their impact on the climate. Therefore, sustainability is becoming a prioritized goal in the design, construction and post-experimental phases of future large-scale accelerator facilities. Approaches to improved sustainability range from overall system design, optimization of subsystems and key components, to operational concepts. A direct quantification of the ecological footprint, be it greenhouse gas emissions during construction and operation, or consumption of problematic materials, is currently performed only sporadically, mostly through translation of electricity consumption into equivalent CO2 emissions, with Lifecycle Assessments (LCA) emerging as a more comprehensive approach. Such assessments provide the accelerator community with new guiding principles for sustainable large-scale future projects. Two large-scale electron-positron linear colliders are currently being studied as potential future Higgs-factories, ILC in Japan and CLIC at CERN. These are the central elements of the recently approved EAJADE ("Europe-America-Japan Accelerator Development and Exchange") Marie Sklodowska-Curie staff exchange action under Horizon-Europe that will run for four years, starting in 2023. The focus of this workshop is to elucidate the current status and future challenges for sustainability of large-scale accelerator infrastructures, with particular focus on the globally anticipated linear collider project.

NATURE2023-EDIT..

Monday, September 25

Facility Tour (Visit to geothermal power plant in Hachimantai-city)

Schedule (estimated time) 8:30 Depart from Morioka station west exit bus terminal. 10:00 Arrive at the power plant 11:00 Leave for Morioka 12:30 Arrive at Aiina

Opening & Introduction

1 Opening

3

4

Speaker: Shinya Narita (Iwate University, Japan) 2509_Narita_Welco...

2 Address by the President of Iwate University

EU Horizon-Europe: EAJADE WP4 "Sustainable Technologies for Scientific Facilities"

EAJADE Project, a Marie Sklodowska-Curie Staff Exchange Program funded by the EU under Horizon-Europe, addresses the need of exchange of ideas on R&D and implementation of future accelerators for particle physics, in particular for a future Higgs factory. A direct societal impact is expected through EAJADE WP4 "Sustainable Technologies for Scientific Facilities", where methods to reduce the power consumption and to increase the energy efficiency of accelerator components and systems, Lifecycle Assessments (LCA) studies for the accelerator construction and operation, as well as smart integration of future accelerator infrastructure with the surrounding site and society (e.g. Green ILC concept) will be discussed. This contribution will highlight the key elements of the EAJADE WP4 program.

Speaker: Maxim Titov (CEA Saclay, Irfu)

2509_Titov_Introdu... 2509_Titov_Introdu...

EU Horizone-Europe: Innovate for Sustainable Accelerating Systems (iSAS)

With the ambition to maintain competitiveness of European accelerator-based research infrastructures and to enable Europe's Green Deal, it has been proposed to Innovate for Sustainable Accelerating Systems (iSAS) [1]. iSAS aims to broaden, expedite and amplify the development and impact of novel energy-saving technologies to accelerate particles with enhanced collaborations. Presently, the iSAS consortium includes 17 partners from research institutions, universities and industry. For many frontier accelerators, superconducting RF (SRF) systems are the enabling technology. Facilitated by the extensive developments in preparing the European accelerator R&D roadmap, the synergies between the ERL and RF panels were exploited to innovate technologies which are common to SRF accelerating systems and have the largest leverage for energy savings in all phases of machine operation. Directly connected to the SRF accelerating system itself, three key technology areas requiring high power, can provide significant energy-savings: RF power, cryogenics and beam energy recovery. The objective of iSAS is to develop, prototype and validate new impactful energy-saving technologies so that SRF accelerators can provide the same, or improved, performance while using significantly less energy. Leveraging, and complementary to, current technological advances, the most promising and impactful technologies will be developed to increase their Technology Readiness Level and ease their integration into the largest existing European research infrastructures and/or in the design of future accelerator-driven research infrastructures by industry. iSAS considers three integration activities to introduce energy-saving technologies into research facilities: integration into the design of a new sustainable LINAC cryomodule, into existing cryomodules and into industrial solutions. While SRF systems with energy-recovery capability are an enabling technology for high-intensity beams with modern accelerators, the iSAS proposal emerges as a pathfinder for Europe to deliver the related energy-saving technologies more widely, including compact accelerators for a variety of applications. Importantly, the objective of iSAS is not only to raise the technology readiness to achieve impactful energy savings, but also to train experts and newcomers in the field. [1] The iSAS proposal, https://indico.ijclab.in2p3.fr/event/9521/

Speaker: Jorgen D'HONDT (Vrije Universiteit, Brussel, Belgium)

2509_D'Hondt_iSAS...

The Importance of Sustainability in the Spanish Science Industry Future

Spanish Science Industry represent a growing sector with references in the main labs worldwide. The effort carried out in Spain for the development of this highly technological sector has been based on the research of key accelerator technologies (cryogenics, radiofrequency, superconductivity...). However, the future of the sector need to put the focus on reduce the environmental impact of every manufactured element and this will be on the priorities in the Spanish Science Industry companies in the next years.

Speaker: Erik Fernandez (INEUSTAR, Spain)

2509_Fernandez_IN...

3:50 PM

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8

5

Coffee Break

6 The EU-Japan Regional & Cluster Cooperation Helpdesk: A bridge for promoting and accelerating industrial regional cooperation

EU and Japan share key priorities for the future, especially in green transition and decarbonization. In Japan and Europe, local stakeholders - clusters, cities, regions, prefectures - are at the forefront of decarbonization, and future accelerators are involved in these initiatives for the green transition. The EU-Japan Centre for Industrial Cooperation has put in place several years ago a dedicated Helpdesk to promote EU Japan cooperation at the local level of industrial clusters, regions and prefectures. https://www.ejrc-helpdesk.eu/

The EU-Japan Centre for Industrial Cooperation was established in 1987 as a joint venture of the European Commission (DG GROW) and the Japanese Government (METI) for promoting all forms of industrial, trade and investment cooperation between the EU and Japan. The centre is managing several other dedicated helpdesks as for instance the "EU-Japan Technology Transfer Helpdesk" as well as training programs (Vulcanus). The EU-Japan Centre for Industrial Cooperation Tokyo is the National Contact Point for Horizon Europe.

Speaker: Virginie Fermaud (EU-Japan Regional & Cluster Cooperation Helpdesk)

2509_FERMAUD_EU...

Sustainability Session I: Technology

High Efficiency Klystrons Projects at CERN

All the future large scale accelerators projects for particle physics, like ILC, CLIC, FCC. CEPC and Muon Collider will consume enormous amount of RF power - at a level of 100MW of average power from grid. The base line option for all these projects is to use High Power (1MW-20MW) Low frequency (0.3GHz-1.3GHz) klystron amplifiers as RF power sources. Thus, the efficiency of these devices is one of the most critical elements of the overall accelerator power consumption. We will present the recent progress of the high efficiency (~85%) klystrons development at CERN.

Speaker: Igor Syratchev (CERN)

2509_Syratchev_CE...

Sustainable Accelerators in the UK

This talk gives an outline of the state of research and development into sustainable accelerator technologies in the UK, from the perspective of the STFC's Sustainable Accelerator Task Force. Topics include permanent magnets, including STFC's tuneable ZEPTO magnets; thin-film superconducting RF cavities; more efficient RF drive technology, including high-efficiency klystrons and fast reactive tuners. We will also highlight our recent work looking at the overall carbon footprint of a small accelerator facility, and show the top-level findings from this report.

Speaker: Ben Shepherd (STFC Daresbury Laboratory)

2023-09-25 Shepher...

TUESDAY, SEPTEMBER 26

Sustainability Session II: Green ILC & Japanese Industry

9 Scenarios toward 2050 Carbon Neutrality in Japan and ILC

Japan's scenario for achieving carbon neutrality is to reduce CO2 emissions and offset them by simultaneously increasing CO2 absorption. I will first explain the overall scenario, followed by the companies' presentations. The Tohoku region where the ILC will be located is blessed with forest resources and long coastal areas. Therefore, green carbon (CO2 absorption by forests) and blue carbon (CO2 absorption by seaweed) can be expected. We believe that the ILC, in cooperation with the community, should follow this scenario in its policies.

Speaker: Masakazu Yoshioka (Iwate Univ./Iwate Prefectural Univ.)

Yoshioka_WFSA202...

Efforts of Taiheiyo Cement towards Carbon Neutrality 10

In the cement industry, efforts to achieve carbon neutrality are becoming exceedingly significant. This presentation will delineate our initiatives aimed at reducing CO2 emissions and utilizing waste materials throughout cement manufacturing. Moreover, it will provide insight into our projections for the forthcoming decade.

Speaker: Yoshifumi Ohgi (TAIHEIYO CEMENT CORPORATION)

Related materials

11 The Future of Construction: Carbon-Negative Concrete for a Greener Tomorrow

Concrete, a construction material comprised of cement, water, sand, and aggregates, plays an indispensable role in the advancement of society. However, cement, the primary component of concrete, is the culprit behind CO2 emissions and an environmental challenge for the construction industry. To mitigate the environmental impact of concrete, it is essential to take a step back and meticulously reassess the composition of concrete. The construction industry is predominantly concentrating on three innovative strategies to assuage the carbon emissions associated with concrete. Firstly, substituting cement with industrial by-products, such as blast furnace slag powder and fly ash. Secondly, applying special admixtures that absorb CO2 in concrete products while performing carbonation curing to mineralise the CO2 in concrete. Lastly, employing waste materials containing mineralized CO2 as aggregates. Kajima is working on reducing environmental burden of construction and cultivating a sustainable society for the ensuing century.

NUM ENONDE NU.	
Large-Scale Wooden Co	nstruction
Our company has been cor discuss the significance of sequestration, using the ex	nmitted to large-scale wood-frame construction and has accumulated much experience in this field. In this presentation, we will utilizing timber as a solution for mitigating global warming and elucidate the correlation between timber construction and CO2 ample of the ILC assembly hall.
Speaker: Yuka Shibuya (She	alter Inc.)
ILC International W	
M	Coffee Break
_	
Sustainable Forestry in t	the Tohoku region
Shibata Sangyo Co., Ltd. is downstream, including logg industry will contribute to t	involved in the forest industry in northern Iwate Prefecture. The company is involved in the entire forestry industry from upstrea ging, silviculture, forest growing, sawmilling, and construction. The company believes that the realization of a sustainable forest he sustainability of the ILC.
Speakers: Kimiya Shibata (Shibata Industry Co., Ltd.) , Masakazu Yoshioka (Iwate Univ./Iwate Prefectural Univ.)
ShibataKimiya.pdf	
Quantitative Evaluation	of Forest CO2 Absorption in Ichinoseki City
The amount of CO2 absorp status of forests in Ichinos	ntion by forests is considered to be strongly dependent on tree species, age, and management conditions. We will report the curr eki City, as well as the method and results of the quantitative evaluation of CO2 absorption.
	chinoseki City)
Hiroshi_KIKUCHI.pp	
Creation of a sustainable	e society model utilizing IoT technology and local resources
In general greenhouse agric introduce greenhouse agric	culture, fossil fuels are used to maintain the temperature inside the greenhouses, which emits carbon dioxide. This report will culture using sustainable energy sources that are being undertaken in Iwate Prefecture, and discuss its impact on carbon neutra
	OVIMAS)
20230926_MOVIMA	
Commercialization of Lo	ow-Grade Waste Heat Recovery
The temperature of the hea actively pursuing the comn	at emitted from accelerators is too low for efficient heat recovery applications, posing challenges in energy recovery. Our compa Inercialization of low-grade waste heat recovery and heat utilization with porous sintered materials.
Yuichi Kouno pdf	
Discussions	
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The ISIS-II Neutron And Muon Source Life Cycle Assessment: An Introduction

The ISIS-II Neutron and Muon Source is the next generation of, and successor to, the ISIS Neutron and Muon Source based at the Rutherford Appleton Laboratory in the United Kingdom. Proposed to begin construction sometime after 2030, ISIS-II will have the rare yet exciting opportunity to embed environmental sustainability into the early stages of the design process. One instance of this is to use Life Cycle Assessments to investigate the environmental impacts of different ISIS-II design options at various phases of the project. This talk will introduce the first efforts of performing a Life Cycle Assessment at ISIS-II and discuss the next strategic steps.

Speaker: Hannah Wakeling (Oxford, UK)

2609_Wakeling_ISIS...

21

3:30 PM

22

Coffee Break

The HElmholtz Linear ACcelerator HELIAC – an advanced energy efficient and compact superconducting particle accelerator for heavy ions

Nowadays, many fundamental scientific findings are obtained with the help of large-scale equipment. Particle accelerators for high-energy and high-intensity heavy-ion beams play a special role as key infrastructures for fundamental science, e.g. for the ambitious superheavy element program and for applicationoriented research, including projects in material and life sciences. Innovative research with particle accelerators in fundamental physics requires ever higher particle energies and beam intensities. In the HELIAC project, we tackle the problem that increased particle energies and beam intensities are accompanied by a considerable increase in the demand for primary energy. Several developments towards efficient particle accelerators for a broad range of applications in fundamental, materials and life sciences have already been made. It is intended to investigate a novel and unique approach that combines a significant boost in energy efficiency, compactness and applicability for different user communities. The HELIAC-project targets the operation of sophisticated superconducting key elements in particular the so-called Crossbar H-mode (CH) radio frequency cavities, at 4 Kelvin and later on at 2 Kelvin, which promises an efficiency gain factor of up to 3. Compared to the currently operated GSI-UNILAC heavy ion accelerators, the cumulative efficiency gain would be in the order of a factor of 20 to 30. In the presentation, the novel heavy ion accelerator HELIAC will be introduced and, in particular, the significant energy saving potential compared to existing accelerator will be shown.

Speaker: Winfried Barth (GSI Darmstadt, HI Mainz / JGU Mainz)

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23 **CERN Accelerates Sustainability**

In parallel with the technical activities to prepare Future Collider studies to the scrutiny of the next European Strategy for Particle Physics Upgrage, due to take place as from 2026, CERN is increasing the resources to cope with the UN agenda 2030 on the Sustainable Development Goals from several point of views. I will give in this talk an overview of the different Panels active on SDG related activities at CERN and on the efforts to harmonise the approach to sustainability and share the information among the main Collider Studies being pursued at CERN. I will provide some details to the recent ISO 50001 certification obtained by CERN for its Energy management framework, and on some of the technologies being developed to reduce the impact on the environment of future projects.

Speaker: Roberto LOSITO (CERN)

CERN Accelerates S...

24 **Optimisation of the FCC Power Consumption and Next Steps for Sustainability Studies**

The FCC-ee will be the largest accelerator ever built and it requires to be connected to the European grid for electricity supply. The power demand is a key parameter to define the grid connection. The identification of the main loads was performed as well as the forecast energy consumption depending on the machine's configurations. The grid connection strategy will be detailed as well as the potential supply of renewable energy. Last, a plan for sustainability studies will be discussed.

Speaker: Jean-Paul Burnet (CERN)

2609_Burnet_FCC_E...

25 **Objective Assessment of Sustainability Aspects of New Large Infrastructures**

The last update to the European Strategy for Particle Physics highlighted the need to factor sustainability aspects into the decision process of large future projects in particle physics. Recently the European Laboratory Directors Group (LDG) of European Laboratories with a strong interest in particle physics decided to setup a working group that will define guidelines on how this assessment should be made so that all projects can evaluate the environmental impact following the same standards. This talk will present this proposal.

Speakers: Beate Heinemann (DESY and University of Freiburg (Germany)), Jim Clarke (STFC Daresbury Laboratory), Mike Seidel

2609_Heinemann-E...

Banquet

WEDNESDAY, SEPTEMBER 27

Sustainability Session IV: Outlook

26 A Sustainability Roadmap for C3

The particle physics community has agreed that an electron-positron collider is the next step for continued progress in this field, giving a unique opportunity for a detailed study of the Higgs boson. Several proposals are current under evaluation of the international community. Any large particle accelerator will be an energy consumer and so, today, we must be concerned about its impact on the environment. This paper evaluates the carbon impact of the construction and operations of one of these Higgs factory proposals, the Cool Copper Collider (C3). It introduces several strategies to lower the carbon impact of the accelerator. It proposes a metric to compare the carbon costs of Higgs factories, balancing physics reach, energy needs, and carbon footprint for both construction and operations, and compares the various Higgs factory proposals within this framework. For C3, the compact 8 km footprint and the possibility for cut-and-cover construction greatly reduce the dominant contribution from embodied carbon (see https://arxiv.org/abs/2307.04084)

Speaker: Brendon Bullard (SLAC, USA)

C3-SUSTAINABILIT ... 2709_Bullard_Susta...

27 A Sustainability Outlook for CLIC / ILC

The CLIC project has pursued power reductions, energy efficiency and more general sustainability studies for almost a decade. These were initially motivated by the 3 TeV power projections but have since then allowed us to reduce the 380 GeV power by almost a factor two. The studies cover from design optimisation to technical developments of klystrons, RF systems and permanent magnets. Operation modes relying on renewable energy have been studies, and recently a life cycle assessment of the carbon footprint of the civil engineering was made. This talk will cover these studies, current status, and the planned future studies in 2024-25 to reach a full life cycle assessment of an optimised accelerator in two years time.

Speaker: Steinar Stapnes (CERN)

linear-colliders.pptx

28 **Concluding Remarks: A Way Forward**

Goodbye Coffee Break

Sightseeing tour in Morioka

10:30 AM