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PREFACE BY ACAD. NICOLAE-VICTOR ZAMFIR

It is my great pleasure to welcome you in Magurele at Extreme Light Infrastructure – Nuclear Physics (ELI-NP), the first large scale European research facility in Romania. We are honored to host the fourth edition of the workshop "Energy for Sustainable Science at Research Infrastructures".
Physics research in Magurele started more than 65 year ago and has continuously developed new research directions, reaching a new dimension by constructing ELI-NP - the most advanced research facility in the world focusing on the study of photonuclear physics and its applications, part of the Pan-European Project ELI.

Fully aware that energy efficiency is the key to ensuring a safe and sustainable energy system, we have been preoccupied with this issue since the design phase of the ELI-NP research infrastructure. Due to the very precise and steady environmental conditions needed by the equipment, a strong HVAC system has been installed, powered by an impressive network of geothermal heat pumps, the infrastructure featuring the largest geothermal plant in this part of the world. Through the 1080 geothermal drillings at a depth of 120 m, able to provide a 4 MW peak power, we became one of the greenest research infrastructures, able to address energy security to environmental and economic challenges.

Having in mind that RIs are very appropriate tools for addressing scientific issues to confront global climate and energy challenges, we are highly committed to the importance of the workshop "Energy for Sustainable Science at Research Infrastructures" which, during the previous editions, created the appropriate framework to connect transversally the different major infrastructures and to reinforce the links to universities, specialized and applied research institutes.

We hope that its fourth edition, jointly organized by the European Organization for Nuclear Research- CERN, European Association of National Research Facilities- ERF and European Spallation Source- ESS in cooperation with ARIES (Accelerator Research and Inovation for European Science and Society) and hosted by ELI-NP is the perfect framework of high expertise for bringing techonolgical solutions to the increasing environmental concerns.
I take the opportunity to thank the organizers and wish all the participants a very successful workshop!

Acad. Nicolae-Victor Zamfir
Director General "Horia Hulubei" National Institute for Physics and Nuclear Engineering, Magurele, Romania

PREFACE BY FRÉDÉRICK BORDRY

As we embark on the fourth Energy for Sustainable Science Workshop, I'd like to look back on what we've achieved so far. At the first workshop in Lund, our ambition was to raise awareness of the issues at stake – in Research infrastructures and laboratories at the European level, and also globally. That's an objective that has been emphatically achieved, as witnessed by our colleagues from China, Japan, the Middle East and the USA who are joining us for this 4th Workshop Energy for Sustainable Science at Research Infrastructures, along with representatives of the European Commission's Directorate General for Research and Innovation.

Drilling down more deeply into the four themes that are common to each workshop – sharing experience, improving efficiency, recovering waste energy, and advanced technologies – we are at the beginning, but we have already achieved a lot. At CERN, we have appointed an energy coordinator and established an Energy Management Panel (EMP). As a result, we now forecast our energy consumption for the year ahead, allowing our electricity supplier to plan forward, and earning us a discount on our energy bill. We have refurbished an experimental area in a way that reduces energy consumption by 90%. We have developed an energy economy cycle for the SPS accelerator that kicks-in when beam is not available from the upstream accelerators, and the major experiments are implementing low energy modes of operation for periods of operational stops.

All this contributes to making CERN more efficient, but we want to go further, by applying our technologies to global energy challenges. To this end, we have been working with local communities on ways to use our waste heat, and are in the process of installing systems that will use waste heat from the LHC to contribute to the heating of a new neighbourhood. When we were building the LHC, the eyes of the energy supply industry were on us. Never before had here been such a large superconducting installation, or one that required such metronomic reliability. Now that we have risen to that challenge, eyes are still on us, because we're now working with one of the most promising conventional superconductors, Magnesium Diboride. It's early days yet, but this material could might offer a route to superconducting, loss-free, electricity distribution.

These examples cover just CERN, but each of the partners in these workshops has a similar story to tell. Together, we are making research infrastructures part of the solution.

Frédérick Bordry

CERN – Director for Accelerators and Technology

OBJECTIVES AND GOALS

Research Infrastructures (RIs) are a crucial pillar of modern knowledge societies. They allow cutting-edge research in various scientific disciplines and are home to some of the greatest scientific and technological discoveries and innovations. Apart from substantial scientific and technological impacts, RIs have direct environmental footprints as well: operating accelerator-based research facilities, high power lasers or high performance computers is energy intensive and requires significant amount of electrical energy. Certainly, much more efforts to find sustainable solutions have to be made in order to reduce the adverse effects on climate and environment.

This is the major theme of the biennial workshop series "Energy for Sustainable Science at Research Infrastructures". The series was initiated in 2011 by major research laboratories and organizations such as the European Organization for Nuclear Research (CERN), the European Spallation Source (ESS) and other national laboratories that joined forces in the Association of European-level Research Facilities (ERF-AISBL). An important cooperation partner is ARIES, an Integrating Activity project under H2020 which aims to further develop European particle accelerator infrastructures.

After three successful events in Lund (2011), at CERN (2013) and at DESY (2015) the workshop "Energy for Sustainable Science at Research Infrastructures" represents now an important platform to bring together international sustainability experts, stakeholders and representatives from research facilities and future research infrastructure projects from Europe and all over the world in order to identify the challenges, best practices and policies to develop and implement sustainable solutions at research infrastructures. This includes the increase of energy efficiencies, energy system optimizations, storage and savings, implementation and management issues as well as the review of challenges represented by potential future technological solutions and the discussions of tools and instruments for effective collaboration.

It is one of the main objectives of the workshop to raise the necessary awareness and to foster a continuous and close cooperation on energy related issues among all research infrastructure stakeholders from science, funding agencies and politics. The workshop shall mobilize the relevant actors to discuss the key challenges and to identify appropriate opportunities towards a sustainable pathway for the research infrastructure landscape. Advancing the implementation of sustainability at RIs on European and international level has to be achieved in a concerted effort with coordinated initiatives, common projects and joint programs. It is hoped that the workshop will contribute to this important task.

ORGANIZING INSTITUTIONS

CERN

CERN (www.cern.ch), the European Organization for Nuclear Research (Organization européenne pour la recherche nucléaire), is a European research organization that operates the largest particle physics laboratory in the world. Established in 1954, the organization is based in Geneva on the Franco–Swiss border, and has 22 member states. CERN's main function is to build and operate large scale particle accelerators and other complex research instrumentation needed for high-energy physics research probing the fundamental structure of matter and of the universe. Numerous experiments have been constructed at CERN as a result of international collaborations. CERN is the place where the Higgs boson was discovered, as well as the birthplace of the World Wide Web. The main site at Meyrin has a large computer facility containing powerful data processing facilities, primarily for experimental-data analysis; because of the need to make these facilities available to researchers elsewhere, it has historically been a major wide area networking hub.

ERF-AISBL

ERF-AISBL (www.erf-aisbl.eu), the Association of European-level Research Infrastructure Facilities has the not-for-profit purpose to promote the cooperation and the projects between European level research infrastructures which are open, at international level, to external researchers. These Infrastructures include national infrastructures as well as European networks and consortia of research infrastructures. Since 2013 ERF has been recognized as an AISBL (Association Internationale Sans But Lucratif) according to the Belgian law, taking the place of the former ERF de facto association. In order to promote the cooperation and the projects between European-level research infrastructures the Association

- acts as a single voice, representing the Members with decision-makers, in particular at EU and international level;
- encourages the coordination, the development, the setting-up and the operation of high quality
- infrastructures, open at world level, contributing to the strength of the European Research Area, also
- through high level workshops and meetings;
- helps in the creation of mechanisms and best practices for an appropriate allocation of funding
- and resources by the European States and the EU, to ensure the best response to international
- users requirements and to societal challenges;
- facilitates the availability of resources (human, financial, instrumental) for high quality research
- infrastructures by encouraging the cooperation of the members, also through the initiation of specific
- joint initiatives, training courses or consortia;
- facilitates and support the collection and the access to data relevant for users, policy makers and other stakeholders;
- develops and implements specific projects of

common interest, supported by the EU and/or international funding;
- supports the development of strategic planning and forward looking at national and international level.

ESS

ESS (www. europeanspallationsource.se), the European Spallation Source ESS is one of the largest science infrastructure projects being built in Europe today. ESS has the objective to be the world's leading research facility using neutrons, providing the tools for analysis that will enable the next important discoveries in nanotechnology, life science, pharmaceuticals, materials engineering, and experimental physics. It will also be the first large scale research facility that will be environmentally sustainable. Organized as a European Research Infrastructure Consortium, or ERIC, this next-generation research facility is being built through the collective global effort of hundreds of scientists and engineers from institutes and laboratories in the Member Countries throughout Europe. Located in Lund (Sweden), next to the world-leading synchrotron light source MAX IV, it will be an economic driver for all of Europe, serving up to three thousand guest researchers from universities, institutes and industry each year. ESS construction formally began with the Groundbreaking Ceremony on September 2, 2014. The first neutrons will be delivered by the end of the decade, with the user program to follow in 2023.

ERF-AISBL

ARIES (https://aries.web.cern.ch/), the Accelerator Research and Innovation for European Science and Society, is an Integrating Activity project dedicated to the research, development and innovation of European particle accelerators and their related infrastructure and technology. The project will run for a duration of four years from May 2017 to April 2021 and is co-funded by the European Commission under its Horizon 2020 programme.
Future accelerators will need higher energy and luminosity to allow scientists to continue exploring the fundamental building blocks of the universe. To reach this goal new technologies and materials must first be developed so accelerator infrastructures can cope with the requirements of future research. Accelerators and their related technologies are used in a variety of different scientific disciplines and have broad applications in fields such as industry, healthcare, energy, environment, security and cultural heritage.
Comprising 41 partners from academic and industry from 18 different European countries, including CERN, ARIES will combine an innovative programme of R&D with wider involvement and engagement from the scientific community to help ensure the future of accelerators is secured.

ELI-NP

ELI-NP (http://www.eli-np.ro/index.php), the Extreme Light Infrastructure - Nuclear Physics, part of the ELI Pan-European project, is going to be the most advanced research infrastructure in the world focusing on photonuclear physics studies and applications, covering frontier fundamental physics, new nuclear physics and astrophysics, as well as applications in nuclear materials management, materials science and life sciences. The implementation of the ELI-NP project, valued at 311 Meuros and financed by Structural Funds and Romanian national budget, started in 2013 and will be finalized in 2019. Selected by the most important science committees in Nuclear Physics in Europe - NuPECC - in the Nuclear Physics Long Range Plan in Europe as a major facility, the ELI-NP infrastructure comprises two main components:
- A very High Power Laser System (HPLS), with two 10 PW (=1016 W) laser arms;
- A very intense Gamma Beam System (GBS) with Eγ up to 19.5 MeV, which is obtained by

Compton back scattering of a laser light off a very brilliant, intense, classical electron beam produced by a warm LINAC.

A cutting edge infrastructure to serve the world wide scientific community, ELI-NP is aiming to be a catalyst for innovation in industry and the private sector, able to enhance transfer technology and to train scientists and engineers in numerous disciplines associated with Extreme Light.

International Advisory Committee:

Frédérick Bordry (CERN)
Roland Garoby (ESS)
Ornela de Giacomo (CERIC-ERIC)
Frank Lehner (DESY)
Carlo Rizzuto (ERF)
Mike Seidel (PSI)

Organizing Committee:

Dan Gabriel Ghita (Chairman)
Catalina Oprea (Secretariat)
Gabriela Apetrei
Alexandra Carlig
Irina Ghinet
Andreea Moldoveanu
Georgeta Pana
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PROGRAMME

IV. CERN/ERF/ESS Workshop on Energy for Sustainable Science at Research Infrastructures

Organized by CERN/ERF/ESS in cooperation with ARIES – hosted by ELI-NP

Dates:
Thu/Fri – 23/24 November 2017

Location:
ELI-NP, Magurele, Romania
Website: *http://www.eli-np.ro/4ess/*

Format of the workshop:
- Two-day workshop with plenary and parallel sessions
- Plenary Talks are (25+5)', Parallel Talks are (20+5)'

THURSDAY, 23 NOVEMBER 2017

08:30 **Registration**

09:00 **Welcome Session**
- Welcome by Host – Acad. Victor Nicolae Zamfir, Director-General National Institute for Physics and Nuclear Engineering "Horia Hulubei", IFIN-HH
- Overview ELI-NP – Acad. Victor Nicolae Zamfir
- Introduction, Goals and Summary of the last workshops – Frank Lehner, DESY

09:45 **Plenary I: Political Landscape (2 Key Notes)**
Chair: Victor Zamfir, ELI-NP
- Ciprian Preda, Secretary of State at the Ministry of Research and Innovation, Romanian Government
- Jean-David Malo, DG Research & Innovation

10:30 **Coffee Break**

11:00 **Plenary II: (3 Talks)**

Chair: Frédérick Bordry, CERN

- ESS Status and plans – John Womersley, DG ESS
- Energy Efficiency of Accelerators in the European Programs Eucard2 and ARIES – Mike Seidel, PSI
- CERN energy recovery analysis and selected projects – Serge Claudet, CERN

12:30 **Lunch**

14:00 **Plenary III: (4 Talks) – International Laboratories**

Chair: Carlo Rizzuto, ELI-AISBL

- High Q s.c. Cavities for CW LINACS – Vyacheslav Yakovlev, FNAL
- Energy Issues at RIs – a Chinese perspective – Yongbin Leng, SINAP
- ESRF and ESRF phase II – Harald Reichert, ESRF
- Energy Management at KEK - Takayuki Saeki, KEK

16:00 **Coffee Break**

16:30 **Parallel Sessions: Two Parallel Sessions w/ 6 talks each**

Parallel Session Ia: Energy Management at Laboratories

Chair: Ornela de Giacomo

- CERN electricity consumption forecast and validation – Bruno Mouche, CERN
- Energy Management at DESY/XFEL – Jens-Peter Jensen, DESY
- Energy Efficiency and Recovery at Large Scale Cryogenic Plants: A Survey – John G. Weisend, ESS
- Introduction of economy cycles in the CERN SPS accelerator to reduce the energy consumption – Quentin King, CERN
- Campus Development guided by KIT Masterplan – Rupert Lohr, KIT
- Distributed Control System application to tertiary infrastructures energy management and optimization – Christophe Martel, CERN

Parallel Session Ib: Energy Efficiency

Chair: Mike Seidel, PSI

- Generalisation of energy storage in power converters to save energy, to reduce electrical and cooling infrastructure – Thomas Höhn, CERN
- Use of Energy Storage to take advantage from low energy prices, Hans-Jörg Eckoldt, DESY
- Tunable permanent accelerator magnets – Ben Shepherd, STFC Daresbury
- Development of efficient klystrons – Claude Marchand, CEA
- Measured performance of Multi Beam IOTs and klystrons – Morten Jensen, ESS
- ForHLR II – energy – and resource efficient computing at KIT – Rudolf Lohner, KIT

19:30 **Transfer to Restaurant**

20:00 **Dinner**

FRIDAY, 24 NOVEMBER 2017

08:30 **Plenary IV: Advanced Energy Technologies**

Chair: Roland Garoby, ESS

- ALFRED Demonstrator towards an Improved Sustainability of Nuclear Energy – Ilie Turcu & Marin Constantin
- Long term plans for MYRRHA in view of a future ADS facility – Hamid Aït Abderrahim, *SCK-CEN, Belgium*
- Research and Prospect for Sustainable Nuclear Energy Utilization in Japan – Kazufumi Tsujimoto

10:00 **Coffee Break**

10:30 **Plenary Session IV: Energy Management and Efficiency**

Chair: Frank Lehner, DESY

- Energy efficiency of particle accelerators and colliders – Philippe Lebrun, CERN
- Computing – Volker Lindenstruth, U Frankfurt
- RE100 – Alberto Carrillo Pineda
- SESAME – Yasser Khalil, SESAME

12:30 **Final Plenary**

Chair: Frédérick Bordry, CERN

- Reports from Parallel Sessions
- Closing Talk – Carlo Rizzuto, ELI-AISBL

13:15 **Working Lunch**

afterwards **Tour of ELI-NP Facilities**

ABSTRACTS
THURSDAY, 23 NOVEMBER 2017

Plenary I

Political Landscape (2 Key Notes)

Ciprian Preda, Secretary of State at the Ministry of Research and Innovation, Romanian Government

Ciprian Preda is a researcher and academic professor in mathematics. He started his academic career at West University of Timisoara in 1998. After he got his Ph.D. in Mathematics, he started to work as a researcher for NASA-UCLA Flight Systems Research Center in U.S., California. In a short while he became also an academic professor at the well-known University of California at Los Angeles, UCLA. Very appreciated by his students, he was nominated three times in Top Ten UCLA Professors and he received in 2006 the Robert Sorgensfrey Teaching award. In 2011 he moved on the East Coast as an associate professor at Cornell University, Ithaca, New York. He returned recently to Romania at his home-town West University of Timisoara. His research work has resulted in the publication of over 60 articles in very prestigious ISI Thomson indexed journals and the participation in several research grants. He is one of the leading experts in the admissibility and exponential dichotomy of (non)autonomous differential systems. From March 2017 he has been an Advisor for the Prime Minister of Romania, and from June 2017 he is a State Secretary (Deputy Minister) at the Ministry of Research and Innovation.

Political Landscape (2 Key Notes)

Jean-David Malo, DG Research & Innovation

Jean-David Malo studied in the Institut National Supérieur des Sciences Economiques et Commerciales (Paris) and the University of California (Berkeley). He started his career as Head of internal control management in the Comité Professionnel de la Distribution de Carburants in France before joining ARMINES, a body managing contractual research and innovation for French engineering schools (Ecoles des MInes, Ecole Polytechnique, ENSTA, …), where he created, developed and managed the European Affairs Directorate. He joined the European Commission in January 2001. In the Directorate General for Research, he participated actively to a number of developments on the design of funding instruments, rules for participation, funding schemes, etc, both for FP6 and FP7. From 2003 to 2006, he was the assistant of Director Robert-Jan SMITS. After heading the unit in charge of the regional aspects of FP7, ie. the "Regions of Knowledge" and "Research Potential" programmes, from 2006 to 2010, he was managing from 2011 to 2013 a newly created unit in DG Research and Innovation, the main objective of which was to contribute to increase private finance and close market gaps in investing in research and innovation by expanding the scope and scale of existing EU innovative financial instruments (like the Risk-

Sharing Finance Facility) and by developing new ones in the fields of debt (including guarantees) and equity financing, notably in the context of Horizon 2020 ("InnovFin"). The EU state aid framework, tax incentive schemes and philanthropic funding were also areas covered by the work of the unit. From 2014, this unit was also covering the SMEs dimension of Horizon 2020, including in particular EUROSTARS II and the design and coordination of the SME Instrument and the Fast Track to Innovation pilot. On February 2017 he has been appointed as Director of the Directorate in charge of "Open Innovation and Open Science". The European Innovation Council, the Pan-European Venture Capital Fund(s)-of-Funds Programme, the RDI dimension under the European Fund for Strategic investments, the European Open Science Cloud, the long-term sustainable investments for Research Infrastructures, the monitoring of the ERA Roadmaps, etc… are among the various files he is in charge of or contributing to.

Plenary II: (3 Talks)

ESS Status and plans

John Womersley, DG ESS

Professor John Womersley is Director General for the European Spallation Source ERIC (ESS), a new European intergovernmental laboratory under construction in Lund, Sweden. ESS will probe the atomic structure of materials and molecules using beams of neutrons, with a wide range of applications from engineering to energy to the life sciences, and will start operation in 2022.

Prof. Womersley previously held the position of Chief Executive of the Science and Technology Facilities Council (STFC), the United Kingdom's funding agency for, for large scale science facilities and national laboratories, particle physics, nuclear physics and astronomy.

He led the UK's membership of the European XFEL, ESS, and the SKA telescope project, and established the Hartree Centre as a £300m joint project with IBM.

A graduate of Cambridge and Oxford (D. Phil. Experimental Physics), he has played a leading role in particle physics both in Europe and the United States. John worked at Fermilab before becoming a scientific advisor to the Department of Energy in the US. He returned to the UK in 2005 to become Director of the Particle Physics Department at the STFC Rutherford Appleton Laboratory at a time when it was building and delivering vital components to CERN's Large Hadron Collider. In time John took on a broader role as Director of the Science Programmes Office and was then appointed Chief Executive in 2011.

He has served on the councils of CERN and ESO, the Fermilab (FRA) Board and the board of AURA. John has chaired the European Strategy Forum on Research Infrastructures (ESFRI) and the European Commission's Expert Group on Cost Control and Management in Large Research Infrastructures. John has also served on numerous review panels and boards as an expert including the Helmholtz Association and the Human Brain Project.

Abstract:

The presentation will describe the status of the ESS facility, which is currently under construction in Lund, Sweden. The ESS approach to sustainability and energy management will be explained, both for the construction phase, and for energy supply and waste heat recovery during facility operation.

Energy Efficiency of Accelerators in the European Programs Eucard2 and ARIES

Mike Seidel, PSI

Dr. Mike Seidel works in the field of accelerator physics and technology since 1989. He received his PhD from the University of Hamburg on a topic related to the electron proton collider HERA at DESY. Since 2006 he has responsibility for a high power proton accelerator at the Paul Scherrer Institut in Switzerland, which is used for the production of intense muon and neutron beams. Dr. Seidel is presently chairing the Accelerator Group in the European Physical Society, he leads a work package on accelerator efficiency in the European program ARIES, and he is a member of the CERN machine advisory committee.

Abstract:

Scarcity of resources, along with rising energy costs and climate change are ever growing concerns for the next generation of large accelerator based research facilities. Indeed, the much increased performance of proposed new facilities comes together with anticipated increased power consumption. Two work packages in the European programs EUCARD-2 (2013-17) and ARIES (from 2017) address this growing consciousness that accelerators have to be sustainable over the long term and socially acceptable by reducing their environmental impact and their energy consumption. The presentation introduces and motivates efficiency considerations for particle accelerators. Specific topics with relevance for efficiency are treated in the mentioned programs and will be discussed. These include heat recovery, magnets, s.c. resonators, RF generation, energy storage and neutron production.

CERN energy recovery analysis and selected projects

Serge Claudet, CERN

Serge CLAUDET (F), at CERN since 1991 with helium refrigeration activities for projects, operation and maintenance. Presently in charge of HiLumi-LHC Cryogenics workpackage.
Since 2014: appointed (part-time) Energy Coordinator for the Accelerator and Technology sector at CERN.

Abstract:

With energy consumption around 1.2 TWh per year and following the change of electricity supply contract type in 2016, CERN has revived an Energy Management Panel. Besides promoting efficient energy management associated with the physics program, this panel has identified a series of potential energy efficiency programs and decision criteria towards possible implementation.
Energy recovery is one of them and specific projects under study will be presented.

Plenary III: (4 Talks) – International Laboratories

High Q_0 Superconducting Cavities for CW Linacs

Vyacheslav Yakovlev, Fermi National Accelerator Laboratory, Batavia, IL, 60510, USA

Dr. Vyacheslav Yakovlev earned his PhD in accelerator and beam physics in 1988 at Budker Institute of Nuclear Physics in Novosibirsk, Russia. He is currently a Senior Scientist and the Head of SRF Development Department in the Technical Division at Fermilab, USA, responsible for a full cycle

of works related to R&D, design and manufacturing of SRF cavities, RF components and cryomodules for superconducting particle accelerators.

Abstract:
CW superconducting linacs, electron and proton, are the base of future big facilities for different applications – Free Electron Lasers, proton drivers for scientific experiments, Accelerator-Driven Subcritical Reactors, etc. Recently, several such projects are at different stage of development: LCLS II (SLAC, USA), PIP II (Fermilab, USA), CIADS (IMP, China) and ADSS (BARC, India). XFEL (DESY, Germany) upgrade for high duty factor or CW is also under consideration. For superconducting accelerators RF loss in the cavity is an issue at high duty factor or in CW operation regime, because it causes significant impact to the overall grid power consumption and, therefore, determines a linac efficiency. To improve the efficiency, the cavity surface resistance should be decreased, or, in other words, unloaded quality factor Q_0 should be increased. In the talk, the impact of Q_0 to the SRF linac overall efficiency is considered, as well as state-of-the art technique and technology of the SRF cavity surface processing for Q_0 increase. The concomitant issues and problems, related to achievement and preservation of high Q_0 are discussed also.

Energy Issues at RIs – a Chinese perspective

Yongbin Leng, SINAP

Yongbin Leng got his Ph.D. degree from Heifei Light Source, University of Science and Technology of China in 1999. As a postdoctoral fellow working for SSRF preliminary research project from 1999 to 2001. As a postdoctoral fellow and application engineer working for SNS project in BNL from 2001 to 2004. As the beam instrumentation group leader working for SSRF project from 2004 to 2009. As the beam instrumentation and control division head and the deputy chief-engineer working for SSRF-II and SXFEL project. His interests mainly focused on beam control and diagnostics technologies.

Abstract:
During the past ten years, several light source facilities including Shanghai Synchrotron Radiation Facility (SSRF), Shanghai Soft Xray FEL facility (SXFEL), Dalian Coherent Light Source (DCLS), Beijing Electron Positron Collider (BEPC-II) and Heifei Light Source (HLS), have been built or upgraded. The operation status and related energy issues of these facilities will be introduced. One more synchrotron light source (High Energy Photon Source, HEPS) and one more FEL facility (Shanghai Coherent Light Facility, SCLF) had been proposed and recently proved by the central government. Both of them need to be completed in the next 7 years. Energy management and efficiency are more critical for HEPS and SCLF due to higher energy and CW operation mode. Preliminary consideration of energy issues for HEPS and SCLF will be discussed in this talk.

ESRF and ESRF phase II

Harald Reichert, ESRF

Harald Reichert, is Director of Research in Physical Sciences at the European Synchrotron Research Facility (ESRF) since 1 January 2009. He holds a doctorate in Physics from the University of Munich obtained in 1995and has been performing research in condensed matter with synchrotron radiation since then. After graduation he went first to the University of Houston (USA) on a Feodor-Lynen Fellowship before moving briefly to the University of Wuppertal (Germany) and finally to a position at the Max Planck Institute for Metal Research in Stuttgart (Germany) where he spent 11 years in developing methods for the study of deeply buried interfaces. In the past 15 years he became

one of the leading experts for the exploitation of high energy X-rays for materials science including the development of dedicated instrumentation. For this work he received the Walter-Schottky-Award for Solid State Physics from the German Physical Society in 2002.

He joined the ESRF in 2009 as Director of Research. During his mandate at the ESRF he is responsible for the renewal of the beamline portfolio of the ESRF and the development of a long-term scientific strategy for the facility in the context of an upgrade of the source to a near diffraction limited light source. He is a member of numerous advisory bodies for X-ray science around the world.

Abstract:

The control of energy consumption is a corner stone in the efforts to keep the operation of the ESRF sustainable. Despite a substantial increase in conventional facilities and the ongoing construction of a new and much higher performing high energy electron storage ring, we are reducing the energy consumption of the facility significantly. This will be achieved by a series of measures within the standard facility management as well as the development of new technologies for the accelerator complex. Employing new concepts in magnet design, the reduction of electrical energy consumption in the new storage ring is the single most important measure which will be discussed more detailed in the presentation. These concepts can be employed for the design of new high energy photon sources and may become the standard for the next generation of synchrotron radiation facilities driven by an electron storage ring.

Energy Management at KEK

Takayuki Saeki, KEK

Takayuki SAEKI obtained the Doctor Philosophy degree from the Department of Physics, Faculty of Science in the University of Tokyo in 1996. He served as a Research Associate in International Center for Particle Physics (ICEPP) in the University of Tokyo to study on the pair production of W-boson in OPAL experiment at CERN. In 2004, he moved to the accelerator division in KEK to study on the Superconducting RF (SRF) accelerator for ILC. He was promoted to Senior Assistant Professor in 2008 and to Associate Professor in 2015.

Abstract:

The design of International Linear Collider (ILC) is based on the Superconducting RF (SRF) technology, which is more efficient than the normal conducting technology in terms of the energy consumption. However, still the total energy consumption of ILC (500 GeV) is 164 MW, which is much larger than those of existing accelerators in the world. In such a situation, the reduction of energy consumption in ILC, thus the efficient and sustainable design of ILC, is the crucial issue to realize it in the near future in a Japanese site. In order to challenge the issue, we organized a working group, so called "Green-ILC WG" in the Advanced Accelerator Association (AAA) in Japan, which involves 112 companies from industry and 42 organizations from academia. The Green-ILC WG is also collabotrating with the international team of ILC. The activities are covering the studies on the efficient design of componets, accelerator sub-systems, ILC-system, and even ILC-city. This presentation will report the current status of these studies.

Parallel Session Ia: Energy Management at Laboratories

CERN electricity consumption forecast and validation

Bruno Mouche, CERN

After 15 years of experience as a professor of electrical engineering in University Institutes of Technology in France, Bruno Mouche has been working at CERN for 3 years as an operation engineer in the electrical engineering group, and is responsible for the management of CERN's electrical energy and the related supply contracts. He has contributed to the creation of CERN's energy management panel, which brings together CERN's main energy consumers, and he co-chairs the panel. Bruno Mouche has also led the design office of CERN's electrical engineering group for 2 years.

Abstract:

An accurate understanding of consumers' electricity consumption profile is a fundamental step towards better energy efficiency management.

The purpose of this talk is to describe the tools put in place at CERN to follow up the electrical consumption of the laboratory and its breakdown among the different accelerators, experimental areas and facilities.

The measuring tool used to set up a consumption model for forecasting purposes, using the physics schedules as an input, will be explained.

Finally, the use of real measurements in view of improving consumers' awareness as well as the use of consumption forecast for internal budgeting and contractual communication with electricity supplier(s) will be discussed.

Energy Management at DESY/XFEL

Jens-Peter Jensen, DESY

Jens-Peter Jensen (63) studied electrical engineering at the University of Hannover. After his Diploma in Power Electronic he made his PhD-Thesis at the Institute for Auxiliary Ship Machines. In 1987 he joined DESY during the construction phase of HERA. He worked on the installation and commissioning of the power converters and the quench protection system of the super conducting magnets. In 1993 he became group leader of MKK which is responsible for the mains, high power supply, power converter and cooling, heating and ventilation systems as well. He worked on the design of the technical systems for TESLA and later for XFEL, PETRA III and FLASH II. For the European XFEL he was work package leader for the technical systems. Since the liberation of the electricity market in Germany he worked on the specification for the electricity procurement. His particular interest is the combination of the energy systems and the reuse of the waste heat from the cryogenic and the cooling systems.

Abstract:

Energy Management at DESY/XFEL Large research facilities like CERN, DESY, ESRF etc. have a severe electrical power consumption. The main consumers are the RF-systems, magnets, cryogenic, heating and air conditioning as well. In the past the technical systems were designed to the requirements of the users. The metering was manly for the electricity bill and to invoice the collaborators or the guest laboratories. But now a days the load profile of the electrical consumption determines the price for the electricity. One has to prevent power peaks. It is evident to manage the operating times of the accelerators, infrastruc-

ture and test stands in order to flatten the power profile. Therefore DESY is building up an energy management system for the DESY site and for the XFEL as well.

Energy Efficiency and Recovery at Large Scale Cryogenic Plants: A Survey

John G. Weisend, ESS

John Weisend is currently Deputy Head of Accelerator Projects and Group Leader for Specialized Technical Services at the European Spallation Source in Lund, Sweden. He is also an Adjunct Professor of Engineering at Lund University. He received his Ph.D. in Nuclear Engineering & Engineering Physics from the University of Wisconsin – Madison, where he investigated engineering applications of He II. He has worked at the SSC Laboratory, the Centre D'Etudes Nucleaires Grenoble, the Deutsches Elecktronen-Synchrotron Laboratory (DESY), the Stanford Linear Accelerator Laboratory (SLAC), the National Science Foundation and Michigan State University

Dr. Weisend's research interests include He II and large scale accelerator cryogenics. He is the Chairman of the Board of Directors of the Cryogenic Society of America (CSA) He has led the CSA Short Course Program since 2001. He is Chief Technical Editor of Advances in Cryogenic Engineering. In addition to co-authoring more than 70 technical papers, Dr. Weisend is the co-author (with N. Filina) of Cryogenic Two-Phase Flow and the editor of the Handbook of Cryogenic Engineering and of Cryostat Design.

Abstract:

Significant amounts of energy are required to produce cooling and liquefaction at cryogenic temperatures. Cryogenic plants are frequently one of the largest energy users at large science facilities such as particle accelerators or fusion experiments. Modern facilities minimize these energy needs by using thermodynamic cycles that maintain their efficiency over a wide range of operating conditions, designing cryogenic plants that permit easy turn down to respond to lower than nominal loads and, increasingly, recovering the waste heat from the plant for other uses.

This work describes the energy efficiency and recovery approaches used at a number of large science facilities including: ESS, ITER, LCLS-II and FAIR. It also briefly examines approaches used at air separation and liquefied natural gas plants. The value of these approaches and possible future directions are also discussed.

Introduction of economy cycles in the CERN SPS accelerator to reduce the energy consumption

Quentin King, CERN

Quentin King first worked at CERN between 1987 and 1989 while finishing his diploma in applied physics. Then in the 1990s, he spent six years working in the controls group at the JET fusion project in the UK before returning to CERN in 1998 to work on power converter control software. Since 2002 he has lead the converter controls software section.

Abstract:

When the Super Proton Synchrotron (SPS) accelerator was commissioned in 1976, it became the largest consumer of electricity at CERN. Now in the era of the Large Hadron Collider (LHC), the SPS uses about 30% of the roughly 1.2 TWh of electricity consumed by CERN during a typical operational year. About 45% of the consumption by the SPS is for magnets that ramp up and down with each accelerator cycle. In the early 1990s,

it was recognized that a significant reduction in energy consumption was possible if the ramping could be stopped or modified during periods when beams were not being accelerated. This presentation will review the evolution of these "economy" modes in the SPS, and the strategies used to handle magnetic remanence and eddy currents. Taken together, the different economy modes have allowed savings of up to 15% of the annual electricity consumption of the SPS.

Campus Development guided by KIT Masterplan

Rupert Lohr, KIT

After finishing his studies at the University of Karlsruhe Rupert Lohr has been working in various positions in the industry. He became professional in industrial maintenance, quality management and process optimization. His long experience also includes energy management in different settings.

Today Rupert Lohr is responsible subject lead for Environmental- and Energy Management within the FutureCampus at KIT, which is striving for a sustainable Campus. As a co-editor of the Masterplan 2030 he is also the lead for the Energy Concept and the EnergyTransition@KIT.

Abstract:

To shift towards a sustainable campus in 2016 the Masterplan 2030 has been launched - targeting less claiming of resources and for climate protection. Focusing on an integrated and sustainable campus development the Masterplan 2030 outlines basic directives in three core areas: properties with buildings, energy with climate protection and mobility.

In many ways energy demand is dominated by the building portfolio and its divers uses in teaching and research. Based on comprehensive analysis the first aim is to reduce energy demand and secondly to achieve CO_2 reduced supply. Dedicated activity schemes and subjects have been outlaid in the Energy Concept. As a main topic on demand side the Lab Strategy assesses existing lab-structures and also outlines principles for new flexible and sustainable lab-structures.

Both Masterplan 2030 as well as the Energy Concept feature basic elements of a Management Systems according the P-D-C-A circle, thus providing long term perspective in continuous improvement and adoption. Cooperation with stakeholders and user participation is a fundamental prerequisite.

The presentation illustrates the foundations of the KIT-Masterplan 2030 and outlines the structure of the integrated Energy Concept, covering demand side and supply. Hence in both areas activity fields will be indicated with their potential and integrative time horizons, forming the EnergyTransition@Kit.

Distributed Control System application to tertiary infrastructures energy management and optimization

Christophe Martel, CERN

Engineering degree in general Physics and Technology from Nancy Polytech in 1991. Consulting engineering experiences in several technical services design offices in Paris. Joined CERN in 1997 for the conception and the works follow up of the ventilation installations for the LHC machine and its experimental areas. Head of the CERN Hvac and Electricity Section, in Site Management and Buildings department, since 2010.

Abstract:

The operation of the CERN tertiary infrastructures is carried out via a series of control systems distributed over the two main CERN sites (Meyrin

and Prevessin). The scope comprises about 300 buildings, *2 heating plants (50 MW overall capacity) with 27 km distributed heating network, 200 Air Handling Units, 50 chillers, 3000 electric distribution boards and 150 000 lights.*
In the last five years, CERN has launched major tertiary infrastructure consolidations. CERN is carrying out a migration and an extension of the old control systems dating from the 70's, 80's and 90's to a new simplified, yet innovative, distributed control system aimed at minimizing the programming and implementation effort, standardizing equipment and methods and reducing lifecycle costs. This new methodology allows for a rapid development and simplified integration of the new controlled building/infrastructure processes.
Energy management and optimization is one of the main benefits of the new technology. Examples are presented such as lighting management with reduction on energy consumption and real-time monitoring of building energy consumption with multiple productions.

Parallel Session Ib: Energy Efficiency

Generalisation of energy storage in power converters to save energy, to reduce electrical and cooling infrastructure

Thomas Höhn, CERN

Thomas Höhn is a PhD-Student at the Technology Department of CERN. Höhn's mandate is to design a powering concept for the Future Circular Collider (FCC), with a focus on power quality and optimal energy usage. Höhn's background lies in classical power grid solutions. During his work at the Institute of Power Systems at Graz University of Technology, he worked closely with industrial partners including distribution grid operators. His activities in Graz included measurements in the field, numerical simulations, chairing meetings and lecturing.

Abstract:
The power demand of particle accelerators varies during the operation cycle. In a classical design, the peak demand is taken from the grid and this lead to a large electrical infrastructure. This peak demand can be largely reduced by integrating energy storage system in the magnet power converters. This was implemented first on the high power system of the PS machine at CERN and this concept is now generalized with the new SIRIUS converter family developed for the EAST area consolidation. In the framework of the FCC study (Future Circular Collider), an advanced concept will be proposed to minimize the power demand on the grid.

Use of Energy Storage to take advantage from low energy prices

Hans-Jörg Eckoldt, DESY

1990 Master degree at Technical University Braunschweig
1990 start as electrical engineer at DESY
1992 group leader of the magnet power supply group
2000 deputy group leader MKK, general electrical energy supply, water cooling, air conditioning, process control and alarm handling, power electronic development, magnet power supplies, klystron supply
2010 group leader of magnet power supply and XFEL modulators

Abstract:
The price of energy is not constant over a day. Here the demand of energy consumption during the day is the driving factor. Within the week the morning and evening hours, electrical energy has a higher price the rest of the day. The generation of energy and the meteorological dependency adds to this. A windy and sunny day leads to a high production of energy, this in combination

with a low consumption lead to even negative prices. This means that consumers may get payed for taking the energy. This phenomenon is even published in media.
It was investigated whether it is possible to take profit from this effect by the use of energy storages. The data of the energy prices of the last three years was base for this study.

Tunable permanent accelerator magnets

Ben Shepherd, STFC Daresbury

Ben Shepherd is a physicist specialising in magnet design, based at the Accelerator Science and Technology Centre at STFC's Daresbury Laboratory in the UK. He has worked on innovative magnet designs for the ALICE and EMMA prototype accelerators. In recent years, he has developed tunable permanent magnet quadrupoles in collaboration with CERN's magnet group.

Abstract:
Particle accelerators are often large-scale projects which consume a great deal of energy. One of the largest contributors to this energy consumption is the magnet system, which steers and focuses a charged particle beam inside an accelerator. Traditionally these magnets have consisted of iron-dominated electromagnets, using a high current running through water-cooled coils. Permanent magnets (PMs) have been limited to small, fixed-field devices. However, recent advances in permanent magnet technology, as well as motion systems and feedback, mean that adjustable PM-based magnets can now compete with traditional electromagnets. Tunable PM devices have many advantages, including low energy use, reduced vibration, and lighter infrastructure. This talk highlights the adoption of PMs in several accelerators around the world. It will also focus on the ZEPTO project, a collaboration between STFC and CERN to develop PM-based quadrupoles funded by the CLIC design study.

Development of efficient klystrons

Claude Marchand, CEA

1983-1987: PhD in Nuclear Physics (Structure functions of 3He by electron scattering)
1987-2013: Study of nuclear and nucleon structure by inelastic scattering of electrons and muons at NIKHEF-K, JLAB, CERN, in particular polarized distribution functions of quarks and gluons in proton and deuteron at COMPASS experiment at CERN, with supervision of 5 PhD students.
2014-2017: Head of RF lab in accelerator science at CEA/Irfu, involved in several major accelerator projects under construction (XFEL, IFMIF, ESS, SARAF…)
Supervisor of a PhD thesis on "Study and construction of a high efficiency klystron based on the adiabatic bunching principle" (A. Mollard).

Abstract:
With the advent of new electron-electron collider projects like CLIC, ILC, and FCC-ee, all implying use of hundreds of MW RF power, as well as increased ecologically aware projects like ESS, sparing on the energy consumption by improving efficiency of RF power sources has become a renewed source of interest in the recent years. I will first give an overview of several new methods proposed to improve efficiency of klystrons, putting emphasis on simulation efforts, and then review the tubes actually under construction and testing to validate the new concepts.

Measured performance of Multi Beam IOTs and klystrons

Morten Jensen, ESS

Following his PhD in physics, Morten Jensen joined e2v, a tube manufacturer in the UK. At e2v he initially worked on gridded tubes and super power klystrons and finally set up the in-house modelling group.

In 2003, after six years at e2v, Morten moved to the RF group at Diamond Light Source, where he later became Group Leader responsible for all storage rings RF systems and associated power supplies, the superconducting cavities and the cryogenic systems. During his 10 years at Diamond, he saw the start of construction, installation and commissioning of the accelerators. Diamond was the first IOT based RF system for accelerators and has been a user facility since 2007.

Morten joined the RF Group at the European Spallation Source in Lund, Sweden in 2013, with a focus on the high power RF generation. He is currently RF Section Leader with responsibility for the RF amplifiers systems for the ESS accelerators.

Abstract:

The European Spallation Source, currently under construction in Lund, Sweden, will contain 155 RF sources with an RF pulse width up to 3.5 ms. The repetition frequency is 14 Hz which results in 5% duty. 120 of the RF sources will operate at 704 MHz and will be based on 1.5 MW pulsed power klystrons and 1.2 MW MB-IOTs. The final mix of sources remains to be decided. ESS ordered three klystron prototypes designed for the ESS parameters from different suppliers and two multi-beam IOT technology demonstrators under two different contracts. We present the specifications for the amplifiers and the results of the klystron prototypes and report the results of the first 1.2 MW multi-beam IOT prototypes.

ForHLR II – energy – and resource efficient computing at KIT

Rudolf Lohner, KIT

Rudolf Lohner is a Professor of Mathematics at the Steinbuch Centre for Computing (SCC) and the Department of Mathematics of the Karlsruhe Institute of Technology (KIT) in Germany. In 2001 he joined the Scientific Supercomputing Centre of Karlsruhe University, the predecessors and founding members of SCC and KIT. At SCC he held several leading positions in High Performance Computing. Currently he is focused on energy efficient computing, a key problem in HPC. His research interests include applied mathematics, self-verifying numerical algorithms, scientific supercomputing, and energy efficient computing.

Abstract:

The HPC-System ForHLR II (Forschungs-HochLeistungsRechner Phase II) at KIT is a Petaflop HPC – System for researchers in Germany which was planned and built to be highly energy– and resource efficient. The major part of the system uses warm water cooling with 40°C inlet and 45°C outlet temperatures which allows efficient free cooling by dry coolers all over the year, even in hot and humid summers which are quite common in Karlsruhe. In addition, waste heat is reused for heating office buildings in the cold seasons. For those parts of the system which still need classical air cooling (e.g. storage), cold water is generated in a gas-powered combined heating and power station by use of an absorption chiller which is much more efficient than electrical compression chillers.

ABSTRACTS
THURSDAY, 24 NOVEMBER 2017

Plenary IV: Advanced Energy Technologies

ALFRED Demonstrator towards an Improved Sustainability of Nuclear Energy

Ilie Turcu & Marin Constantin

Mr. Turcu has 45 years experience in nuclear field as an employer of the Institute for Nuclear Research, since 1972. As junior engineer he worked for the development of models and computer codes for thermal hydraulic and dynamic behaviour of nuclear reactors (FBR, BWR, PHWR, VVER and TRIGA RR).

He was the team leader of thermal hydraulic, training simulators and Probabilistic Safety Assessment (PSA) for CANDU technology activities in ICN and contributed to the performance of over 200 ICN technical reports or papers published or presented at technical meetings and conferences. He was involved and coordinated several technical cooperation projects and research contracts with IAEA, research agreements with AECL, Canada, and EU research projects under FP5, FP6, and FP7.

Mr. Turcu has managed the ICN Nuclear Safety Research programme and has contributed to the development of Romanian National Nuclear Programme (PNN).

During the last decade he is involved in the development of research program related to Generation IV reactors, together with partners at European level, with the final objective to construct the ALFRED demonstrator for Lead Fast reactor technologies.

From 2006 to 2017 Mr. Turcu was the Scientific Director of the Institute for Nuclear Research. In this position he coordinated the scientific activities and projects as well as the international research cooperation. Now he is the coordinator of the ALFRED project having as the objectives to contribute to the international efforts for the development of the Lead Fast Reactors technology and the construction of the demonstrator (ALFRED) on the RATEN ICN site.

Marin Constantin, PhD in Nuclear Physics, senior researcher, more than 30y experience in nuclear field (reactor physics, safety analysis, computer codes development, innovative systems, decision making process), member of management group of FALCON, editor-in-chief of "Journal of Nuclear Research and Development", representative of Romania in SET Plan, member of expert group of NEA/OECD Advanced reactors and future energy market".

Abstract:

Romania is deeply involved in Lead Fast Reactor (LFR) international cooperation through Euratom and multi-lateral agreements. At national level important efforts were oriented toward the closed fuel cycle with a focus on LFR technology. ALFRED (Advanced Lead Fast Reactor European

Demonstrator) is a crucial step to LFR commercial deployment. It aims to build a 125 MWe system, connected to the grid, planned to start the operation in 2028. In 2011 Romanian Government approved the option to host ALFRED demonstrator based on availability of structural funds, national nuclear expertise, and EU policy to reduce disparities in the infrastructure development.
In 2013 FALCON (Fostering ALFRED Construction) was set-up to achieve the preparatory activities. The Roadmap is structured in Viability, Preparatory, Construction, and Operation phases. An detailed Implementation Plan was developed together the Action Plan, Scientific Case, preliminary Cost-Benefit Analysis, identification of needs for licensing, siting and competence buildding.
The paper presents the strategic approach and the curent status. The pan-European dimension, the national, regional and local benefits are discussed together with the involvement of local, national, and European stakeholders. On the other hand the supporting infrastructure is presented with the availability of the open access option. The energy impact is also discussed.

Long term plans for MYRRHA in view of a future ADS facility

Hamid Aït Abderrahim, SCK-CEN, Belgium

Prof. Dr. Hamid Aït Abderrahim is the Deputy Director General of SCK•CEN, the Belgian nuclear research centre. He is also professor of reactor physics and nuclear engineering at the "Université Catholique de Louvain" (UCL) at the mechanical engineering department of the "Ecole Polytechnique de Louvain (EPL)".

His fields of specialisation are Reactor Physics, Reactor Dosimetry, Nuclear Fuel Cycle, Partitioning and transmutation of high level nuclear waste and Nuclear Reactor Technology.

Since 1998 he is the director of the MYRRHA project: an accelerator driven system coupling a sub-critical Pb-Bi cooled reactor and a high power proton accelerator through a spallation target.

He is partner and/or coordinator of various projects of the European Commission framework programme related to advanced nuclear systems or to partitioning and transmutation of high level nuclear waste management. He chaired the Strategic Research Agenda (SRA) working group of the European Sustainable Nuclear Energy Technology Platform (SNETP, http://www.snetp.eu) from September 2007 to December 2011. Since 2015 he is the chairman of the Governing Board of SNETP.

He is the representative of Belgium in the Governing Board of the project JHR (Jules Horowitz Reactor, a MTR under construction in Cadarache, France).

Furthermore he is member of various Scientific Committees among them:

- Federal Council of Science Policy of Belgium
- The International Scientific Committee of P2IO LabEx (Laboratoire d'Excellence de Physiques des 2 Infinis (grand et petit) et des Origines in France;
- The International Advisory Committee of J-PARC : Japan Proton Accelerator Research Complex in Japon
- The Advisory Committee to the French R&D association GEDEPEON related to HLW mgt via P&T
- The GPR (Groupe permanent d'experts pour les réacteurs nucléaires) de l'ANS (Autorité de sureté nucléaire) in France

He is author of more than 100 scientific publications in peer review journals and international conferences. He directed many PhD and masters theses in the various fields of nuclear technology.

Last but not least in April 2014, he has been honoured by the King of Belgium by nominating him as "Grand Officer in the Crown Order" for his contributions in progressing science and knowledge in the field of nuclear engineering of innovative systems for High Level Waste management.

On February 15, 2016 he received the title of Doctor Honoris Causa to the Kaunas University of Technology for his personal achievements and long term collaboration with Kaunas University, especially with the Baršauskas Ultrasound Research Institute.

He is involved in various social and NGO activities related to Business development with the South such as Aïn El Kheir Club (www.ainelkheir.com) or associations in Belgium related to the Algerian community such as AIB, LABA, TIMLILITH, etc…

Abstract:

Presently, the European Union produces 30% of its electricity by Gen.II nuclear reactors and Gen. III in the near future. This leads to the production of 2500 t/y of used fuel, containing 25 t of Plutonium, and High Level Wastes (HLW) such as 3.5 t of minor actinides (MA), namely Neptunium (Np), Americium (Am) and Curium (Cm) and 3 t of long-lived fission products (LLFPs). The used fuel reprocessing followed by the geological disposal or the direct geological disposal are today the envisaged solutions depending on national fuel cycle options and waste management policies. The Partitioning and Transmutation (P&T) has been pointed out in numerous studies as the strategy that can relax constraints on the geological disposal, and reduce the monitoring period for waste storages to technological and manageable time scales. Transmutation based on critical or sub-critical fast spectrum transmuters should be evaluated, in order to assess the technical and economic feasibility of this waste management option.

After nearly twenty years of basic research funded by national programmes and EURATOM framework programmes, the research community needs to reach a position of being able to quantify indicators for decision-makers, such as the proportion of waste to be channelled to this mode of management, but also issues related to safety, radiation protection, transport, secondary wastes, costs, and scheduling.

From 2005, the research community on P&T within the EU started structuring its research towards a more integrated approach. This resulted during the FP6 into two large integrated projects namely EUROPART dealing with partitioning and EUROTRANS dealing with ADS design for transmutation, development of advanced fuel for transmutation, R&D activities related to the heavy liquid metal technology, innovative structural materials and nuclear data measurement. This approach resulted in a European strategy given in introduction based on the so-called "four building blocks" at engineering level for P&T.

The MYRRHA project contributes heavily to the third building block of this European strategy and in this paper we will focus on the ADS programme in the EU through the MYRRHA project.

In this seminar we will present the EU strategy for P&T towards industrial deployment and the status of the MYRRHA project as by end 2017 concerning the technical design, the pre-licensing and the implementation staged strategy as well as it role in paving the road towards an industrial ADS deployment.

Research and Prospect for Sustainable Nuclear Energy Utilization in Japan

Kazufumi Tsujimoto

1996: Doctor of engineering in nuclear engineering at the University of Tohoku
1996: Japan Atomic Energy Research Institute (former organization of JAEA)
2006: Secretariat of Japan Atomic Energy Commission in Cabinet Office
2009: Transmutation section, J-PARC center, Japan Atomic Energy Agency (JAEA)
2010: Group Leader of Nuclear Transmutation Group, JAEA
2016: Division Head of Partitioning and Transmutation Technology Division, JAEA

Research Field
Reactor physics of transmutation system
Validation of cross section of Minor Actinide (MA)
Neutronics design of Accelerator-Driven System (ADS)

Abstract:

The Government of Japan periodically formulates the Basic Energy Plan in accordance with an article in the Basic Act on Energy Policy that entered into force in 2002. The latest version, called the Strategic Energy Plan, was issued in April, 2014. The largest change from the previous versions must be the accident of the Fukushima Daiichi Nuclear Power Plant. In spite of the accident, the Plan defines the nuclear power as an important base-load power source as a low carbon and quasi-domestic energy source, contributing to stability of energy supply-demand structure, on major premise of ensuring of its safety. The Plan puts emphasis on the importance of activities to resolve the challenge of how to manage and dispose of spent fuel, as well as the Fukushima restoration, safety operation of nuclear plants, and public acceptance.
As for the P&T technology, the Government will promote technology development on volume reduction and mitigation of degree of harmfulness of radioactive waste. Specifically, development of technologies for decreasing the radiation dose remaining in radioactive waste over a long period of time and enhancing the safety of processing and disposal of radioactive waste, including nuclear transmutation technology using fast reactors and accelerators, will be promoted by utilizing global networks for cooperation.
To continue the utilization of the nuclear fission energy, the management of the high-level radioactive waste (HLW) is one of the most important issues to be solved. Partitioning and Transmutation (P&T) technology of HLW is expected to be effective to mitigate the burden of the HLW disposal by reducing the radiological toxicity and heat generation. Based on this new Strategic Energy Plan, research and development (R&D) on P&T are being accelerated in Japan. The Japan Atomic Energy Agency (JAEA) has been continuously implementing R&D on P&T technology. The R&D on P&T in JAEA are basing on two kinds of concepts: one is the homogeneous recycling of minor actinide (MA) in fast reactors and the other is the dedicated MA transmutation, so-called "double-strata" strategy, using an accelerator-driven system (ADS). In this work, recent R&D activities based on these policies are briefly shown.

Plenary IV: Energy Management and Efficiency

Energy efficiency of particle accelerators and colliders

Philippe Lebrun, CERN

A graduate of Ecole des Mines (Paris) and the California Institute of Technology (Pasadena), Philippe Lebrun has worked on the design, construction and management of high-energy particle accelerator projects at CERN since the 1970s. With a background in superconducting magnets and cryogenics, he led the "Accelerator Technology" department of CERN during the construction of the Large Hadron Collider (LHC), CERN's flagship facility. Recently retired from CERN, he is now director of the Joint Universities Accelerator School (JUAS).

Abstract:

Particle accelerators and colliders at the energy and intensity frontiers feature beam power in the multi MW range with overall grid-to-beam efficiency below 10 %, resulting in costly electricity bills and heat rejection. It is therefore essential to diagnose the sources of inefficiencies and understand the potential for improvement in the different systems at stake. We first discuss relations between beam parameters and performance for physics in the different types of machines. We then define efficiency estimators based on different sources of losses, from the "intrinsic" ones resulting from beam physics to those depending on accelerator technology and technical infrastructure, and apply them to some large particle colliders, in operation or projected. Analyzing these processes and their possible mitigation enables to propose strategies for better efficiency.

Computing

Volker Lindenstruth, U Frankfurt

Volker Lindenstruth is Chairman of the board at Frankfurt Institute for Advanced Studies since 2012. He conducts the Department of High Performance Computer Architecture which is concerned with the architecture, the application and the continued development of high performance computers useful to the natural and life sciences. In 1997 he founded ICore Tehnologies in United States and in 2000 he was appointed Chair for ALICE HLT project, at CERN LHC. He managed to gather more than 40 million € in project funds since 2010 and he was awarded in the ranking list of most efficient HPC systems as the first in the world.

Abstract:

The energy consumption of IT infrastructure is one of the major cost factors, driven by the power consumption of the computers themselves and the often highly inefficient data center cooling. The presentation will give examples of energy efficient solutions on both fronts. At the side of computing efficiency algorithm efficiency is of most importance. For example all processors today implement a rich set of vectorization features, which are hardly used as auto vectorization can only function if the algorithm is implemented accordingly. We have developed a vectorization package, which allows highly portable vectorized code. Further examples driving inefficient software are the poor allocation of data structures, which lead to poor cache efficiencies, the use of unnecessary high precision (double precision versus single precision), the algorithm dependent generation of high degrees of data dependencies in the code

which prevent instruction level parallelism or better parallelism. A high degree of parallelism is offered by GPGPUs, which provide in particular in single precision a typical factor 20 of energy- and cost efficiency when compared to CPUs. Example algorithms out of the high energy physics field will be presented, which work well on GPGPUs. The last important point is the data center cooling itself, which often requires 50% of the computer power. A novel architecture was developed at Frankfurt, which allows to reduce that cooling overhead to below 7% (2,4% demonstrated). This architecture will be presented as well.

RE100

Alberto Carrillo Pineda

Alberto acts as Director of Science Based Targets and Renewable Energy Procurement for CDP, the global environmental reporting system for companies, cities, states and regions. In this role, Alberto leads CDP's efforts to help scale-up and mainstream the adoption of science-based target setting and the procurement of renewable energy in the corporate sector.

Before joining CDP, Alberto led WWF's Climate & Business efforts globally; first, as Head of Climate Business Engagement for WWF's Global Climate and Energy Initiative, and then as Leader of Science Based Targets for WWF's Climate and Energy Practice. Before joining WWF, Alberto occupied different management and consulting positions in leading global carbon asset management firms including the South Pole Group. and Ecosecurities Ltd.

Alberto holds an M.Sc. In Environmental Change and Management from Oxford University and a B.Sc. in Chemical Engineering from the National Autonomous University of Mexico (UNAM).

Abstract:

The adoption of the Paris Agreement in 2015, set a clear direction of travel with the goal of limiting global warming to well below 2ºC or 1.5ºC compared to pre-industrial temperatures. A number of climate scenarios show that, in order to meet this goal, we need to phase out CO2 emissions from our energy system in the next 3 to 4 decades.
The Paris Agreement has triggered an unprecedented level of action from governments as well as from non-state actors willing to embrace the common challenge of transforming our energy system with the goal of limiting warming to well below 2ºC.
Examples of these actions include the more than 640 corporates, representing over 15.5 trillion USD in market capitalisation - almost 1/3 of the total market capitalisation of all publicly traded companies - and who have made a number of bold commitments through the We Mean Business commit to action campaign. Within these commitments, 115 companies have committed to go 100% renewable power, more than 300 companies have committed to reduce GHG emissions in line with what science indicates is necessary to meet the goals under the Paris Agreement, and a number of companies have started to commit to scale-up the use of electric vehicles.
The presentation will present an overview of the transition of our energy system in the context of the Paris Agreement,and will highlight lessons learned from the energy-transition in the corporate sector and its potential implications for research infrastructure.

USEFUL INFORMATION

Dates
Thu/Fri – 23/24 November 2017

Format of the workshop:
- Two-day workshop with plenary (25+5 minutes) and parallel sessions (20+5 minutes).

Accomodation:
Sheraton Hotel, Calea Dorobanți 5-7, Phone + 4021-201 5000
Ibis Hotel, Str. Izvor 82-84, Phone + 4021- 401 1000

Venue:
ELI-NP/IFIN-HH, Magurele, Romania
Workshop rooms for plenary and parallel sessions: The National Physics Library, IFIN-HH Conference Hall.

Workshop rooms for plenary and parallel sessions:
The National Physics Library, IFIN-HH Conference Hall

Official Language:
The official language of the Workshop is English. No simultaneous translation will be provided.

Transportation:
We offer an ELI-NP shuttle from the Sheraton/Ibis Hotels to ELI-NP site on Thursday 23 and Friday 24, at 8:00 o'clock and return as follows:
- Thursday/23 at 19:30 o'clock at Sheraton Hotel for the festive dinner;
- Friday/24 at 15:00 o'clock - transfer to hotel or airport, at the participants' choice.

Airport transfers:
Recomended: On-demand taxi services are available at Bucharest Henri Coandă International Airport. You may order a taxi by getting a reservation ticket with a taxi number (written on the side of the taxi, behind the rear door) from one of the touch screen units available in the public area of the Arrivals Terminal, on the left side after the passangers' exit. The passengers get on

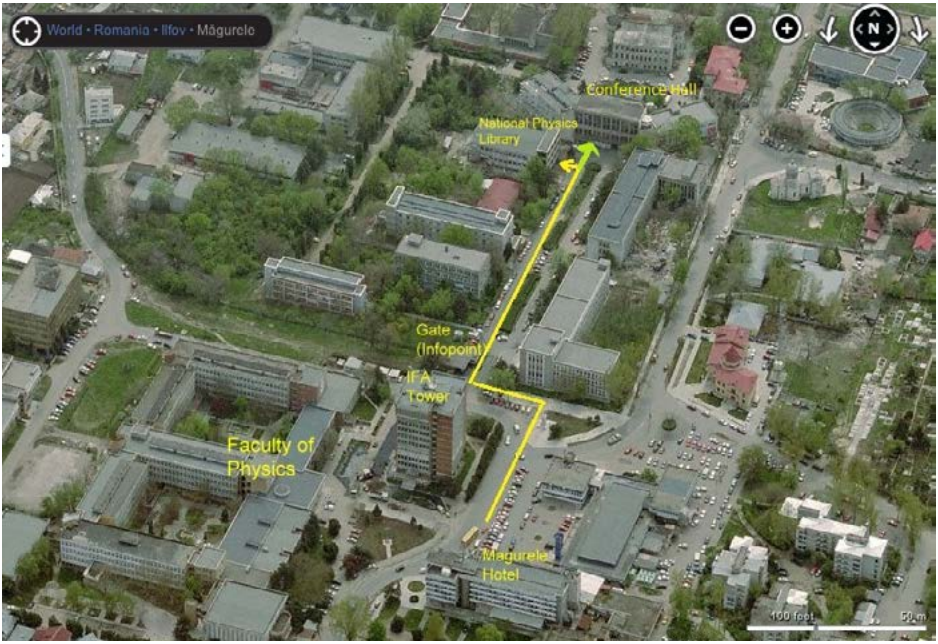
the booked taxis right outside the terminal, on the same floor, by showing the ticket issued by the automatic touch screen to the taxi driver with the allocated number. Charges vary between 1,39 RON/km and 3,50 RON/km (aprox. 0,3 - 0,8 EUR/km) and there are about 16 km between the airport and the hotel, so the total cost of a taxi ride will amount to about 25 RON to a maximum of 60 RON for the most expensive taxi companies.

As a cheap alternative: you may choose the 783 Express bus line connecting Bucharest Henri Coandă International Airport and the city center. This line runs day and night. At night, the bus leaves every 40 minutes. Airport stops: in front of the Arrivals Terminal and Departures Terminal.

The price for one trip is 3,5 RON and the magnetic card valid for two travels costs 7 RON.

More information: **http://www.bucharestairports.ro/en/transport.**

Several ATMs are available just in front of the Passangers Exit on the Arrivals Terminal, and the EUR/RON exchange rate might range: 1 EUR = 4,5 - 4,8 RON, depending on the bank used.



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