Accelerator Reliability Workshop 2019(2019 加速器可靠性国际研讨会)

Sunday, November 10, 2019 - Friday, November 15, 2019

Guangzhou SYSU Kaifeng Hotel

Book of Abstracts

Contents

Accelerator Systems / **42**

Operation of SSRF and Reliability based on the Feedback System

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SSRF is a 3rd generation 3.5 GeV light source. It became fully operational for users in 2009 and is presently celebrating its 10 years operation in 2019. From the former seven beamline, SSRF has fifteen beamlines and nineteen experiment stations in 2019. Ten Insert Devices (IDs) had been installed in the Shanghai Synchrotron Radiation Facility (SSRF) storage ring. The ID gaps were repeatedly adjusted for the scientific experiments during the user time. The residual quadrupole errors beyond the ID feedforward disturbed the beam optics, which include the betatron tune deviates that will spoil machine performance and brightness stability. To resolve the deterioration, a feedback system including SOFB, FOFB, ID Feedforward and Tune Feedback system has been developed and implemented in SSRF. The report will give a brief introduction of the operation of SSRF and the Feedback System using in the SSRF.

Accelerator Systems / **7**

RF System Development and Reliable Operational Experiences of TRIUMF ISAC Linac Accelerator

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The TRIUMF ISAC accelerator complex is in consists of ISAC-I room temperature structure and ISAC-II superconducting structure. ISAC-I linac has eighteen RF systems in operation for about twenty years, and ISAC-II linac has forty superconducting QWR. The SRF cavities has been in operation for some about ten years. Major developments in the RF systems for the system reliability will be reported in this talk. And the operational experiences for the RF systems will be presented as well.

Accelerator Systems / **18**

The improvement in reliability of RF system of Linear IFMIF Prototype Accelerator (LIPAc)

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The Linear IFMIF Prototype Accelerator (LIPAc) to accelerate a 9 MeV deuteron beam at 125 mA in CW is under commissioning in Rokkasho, Japan, in order to validate the low energy section of the 40 MeV IFMIF accelerator under the Broader Approach Agreement in the field of fusion energy research between Japan and EURATOM. The LIPAc RF system for RFQ consists of eight RF chains, whose maximum output power are 200 kW each in CW at 175 MHz. The RFQ is designed to accelerate a deuteron beam of 125-130 mA from 0.1 MeV to 5 MeV in CW, which demands a total RF injected power of about 1.2 MW in CW. During the RF conditioning of the RFQ up to the deuteron acceleration level starting from July 2017, we faced difficulties for increasing RF power due to the unexpected high reflected power from the RFQ to the eight RF chains and the requirement of the short pulse and high repetition rate operation for the RF conditioning. During the two experimental campaigns a drastic maintenance was carried out, and resulted in overcoming the difficulties and succeeding to perform the deuteron beam commissioning in the low duty cycle. The experience and the lesson learnt will be presented so as to provide some hints to build a similar high power accelerator facility.

Fault Investigation / **20**

Fault investigation tools at the ALBA syncrotron light source

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ALBA is a third generation synchrotron light source near Barcelona (Spain). In operation for users since 2012, we aim at continuously improve the beam availability by increasing the mean time between failures (MTBF) and decreasing the mean time to recover (MTTR). In order to reduce the MTTR a good set of tools to quickly diagnose what has caused the incidence is a must. From the timing or PLC logs to the BPMs buffers; here we report our sources of information to investigate the failures. But, it ' s not only a matter of having the information, but being able to quickly access to it. Thus, the Operator oriented tools to extract the data in the Control Room will also be presented. Finally different examples of failures will be given to illustrate our means and a list of "what we would like to have" will be discussed.

Fault Investigation / **77**

Fault detection methods for the LHC BLM system at CERN

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The LHC Beam Loss Monitoring (BLM) system is one of the most complex instrumentation systems deployed in the LHC. In addition to protecting the collider, the system also needs to provide a means of diagnosing machine faults and deliver a feedback of losses to the control room as well as to several systems for their setup and analysis. It has to transmit and process signals from almost 4 ' 000 monitors, and has nearly 4.5 million configurable parameters. In a system of such complexity, system fault detection, quick resolution of issues, and fault tracking become critical issues. The integrity of the signal chain of the LHC BLM system and its ability to correctly detect unwanted scenarios and thus provide the required protection level must be ensured. To cover the maximum error detection area, an advanced verification environment has been developed that operates in parallel to evaluate the performance and response of the system. This paper will report on the numerous checks that are

been performed and on how the results are used to identify the cause or schedule the maintenance of the system.

Fault Investigation / **78**

Stability and Reliability Study on the China ADS Front end superconducting demo linac (CAFe)

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The he Chines ADS Front-end superconducting demo linac (CAFe) constructed 2017. It is used to demonstrate the SRF technology in low energy session and investigate the feasibility and the reliability for the Chinese initiative Accelerator Driven System (CiADS). It is designed to accelerator 10-mA continuous-wave (CW) proton beam to the energy of 25 MeV. It operated the first 25 MeV beam on June 5th, 2017 and primary stability with pulsed beam was investigated by 72 hours operation. Recently, it achieved the max beam power of 45 kW (2.55 mA and 17.5 MeV). The high-power reliability was demonstrated with the beam of the 2-mA, 16-MeV CW beam by the operation of more than 110 hours. During the operation, the availability was 89%, the MTBF was 99 min, and the MTTR was 12 min. CAFe has supplied user's experiments in 2018 and 2019. The reliability during user's operation was analysed too. All the sources of trips are traced, and two main reasons caused the frequent trips are identified. We found the field emission in the superconducting HWR cavity will lead to discharging in the pickup and the further the open loop of RF control. It is a special phenomenon in the compact coaxial superconducting resonators. The experiments show the relations between the field strength and the trips. The frequency and phase shift due to beam loading is another main reason of trips. It will exit the pondermotive oscillation. The stability testing results and sources analysis will be introduced.

Machine Learning Tutorial / **27**

Machine Learning for Accelerator Reliability and Availability

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Machine Learning has had successes in several applications, from computer vision to anomaly detection, using both supervised and unsupervised learning techniques. These techniques can also be applied to reliability engineering, and have already been used in fields such as aerospace and manufacturing for predictive maintenance, fault detection and diagnosis. This talk will first provide a review of supervised and unsupervised learning techniques, such as regression analysis, classification and anomaly detection which will be followed by a Python tutorial which will apply these techniques to data from various scenarios.

Maintenance / **76**

The challenges to maintain good accelerator reliability in an ageing facility when the institute embarks on new projects to stay

relevant in the research community

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iThemba LABS operates four cyclotrons and three electrostatic accelerators. The age of these accelerators varies from 2 to 34 years. Aging accelerators bring its own unique reliability issues depending on the type and use of the accelerators. When an institute also embarks on a number of new projects to stay relevant in the national and international research communities, with no increase in manpower, accelerator reliability becomes a difficult challenge. This talk will discuss the different methods which were put in place to ensure that iThemba LABS will maintain the high reliability standards that was set in the past.

Maintenance / 56

Shutdowns at TRIUMF: A systematic approach

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Maintenance and upgrade activities at TRIUMF 520 MeV Cyclotron and Ion Separation and Accelerator (ISAC) facilities are scheduled for either a regularly occurring short maintenance period or a longer semi-annual site-wide shutdown period. The long shutdown periods are organized by the Systematic Approach to Shutdown (SAS) Committee. This committee is responsible for scheduling, coordinating, and tracking all shutdown activities that would otherwise impact beam delivery. With the addition of the E-LINAC and the Advanced Rare Isotope Laboratory (ARIEL) to the TRIUMF accelerator complex, the semi-annual site-wide shutdown periods will come to an end. Can the present SAS model be adapted to a year-round rotating shutdown schedule? In this presentation, an overview of the TRIUMF maintenance program will be described. The duties of the SAS Committee and SAS process will be discussed.

Maintenance / 50

Maintenance strategies for reach and maintaining top performance of accelerator facilities

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In this talk we will address maintenance strategy to reach and maintain over time very high beam availability of an accelerator and short time to recover after a beam interruption. Using the example from several facilities we will explain how lessons learned may be very useful for establishing and improving the strategy for predictive maintenance, corrective maintenance for a running facility.

It can also be applied for guiding the choice of equipment, their technology and spares for a new green field facility or a major upgrade of an existing facility. Each strategy will need to be carefully choosing depending on factors such as the impact of a failure, the budget available, the on-site expertise, etc.

Methods / **8**

Importance and impact of dependability studies for particle accelerators

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This talk will highlight the main challenges in terms of reliability, availability and protection for different types of particle accelerators. The talk will stress the importance of performing reliability studies as early as possible in the lifecycle of an accelerator, starting from the conceptual phase to its exploitation and upgrades. A summary of the main lessons learnt at CERN on the use of reliability analysis methods and tools will be given, with a particular interest towards new generation machines.

Methods / **33**

Evaluation of Machine Protection Systems and Machine Protection Functions contribution to availability

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When contributions to downtime (unavailability) are evaluated the main system (functions needed to perform the system requirements) and the machine protection system (functions that prevent and mitigate the consequence of a failure) are grouped together. This makes it difficult or impossible to separate how much downtime is caused by the main system and how much is caused by the machine protection system.
The main system contributes to availability by being functional and cause downtime by not being functional. Machine protection systems contribute to availability in a different way. Part of the purpose of machine protection systems is to create short downtimes to prevent long downtimes. I.e. if a piece of equipment is overheating operations are stopped in order to fault track and prevent further overheating. This causes a short downtime instead of a long downtime due to the equipment becoming damaged by overheating. The stopping of operations is the expected and desired outcome in the above scenario, but it would be recorded as a contribution to downtime instead of a reduction of downtime.
In order to evaluate how machine protection systems and functions contribute to availability they have to be separated from the main system and be treated differently.

New Trends, Big Data, Machine Learning / **28**

Status of Application of Machine Learning Techniques at CRYRING ESR

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The ion storage ring is a FAIR phase 0 machine and used as test bed for FAIR concepts and prototypes in addition to being a facility for physics experiments. CRYRING ESR is equipped with an offline ion source and linear accelerator providing ion beams with energies up to 300 keV per u. This so called injector can be operated independently of FAIR or GSI and is used for machine testing and local physics experiments. In this setting, we are investigating in how far machine learning can be employed for the supervision and the operation of the local plasma ion source and the injector or linear accelerator section. One goal of the project was to implement automated machine optimization in the framework of the FAIR control system. In a more recent project we investigate if the analysis of detector raw data provides signals making it possible to predict if the ion source will run within or without of the desired operation regime. A machine learning algorithm shall generate signals allowing preventive human action on the ion source if required. We will report on the status of the project of making machine learning techniques available for CRYRING ESR.

New Trends, Big Data, Machine Learning / 60

Using laser scanners and trackers to optimize accelerator installations

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By combining data from laser trackers and laser scanners we can develop 3D models of an accelerator system as it is built. This allows more precise shielding installations, higher tolerancing of equipment placement and a more productive design environment. Scans of areas are taken during beam off periods and combined with other alignment parameters. The designers can use this information to accurately place equipment and shielding even when they can not access the areas. This gives the design teams the ability to look at new areas and place equipment in these areas without leaving their desks. The resulting designs allow for tighter placement of shielding and equipment, while being assured that they will fit into the areas. In this talk I will outline how we are using the trackers, scanners and software to achieve the outcome we want.

New Trends, Big Data, Machine Learning / 25

Web Application for Operations

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Web applications are very popular tools now in the operations and they will become more and more useful along with web technology development. Because web applications have the advanced benefits like cross operating system, easy to use, and update without download the software. By using these very useful tools we can speedup operation, do monitoring the system easily, organizing people and equipment efficiently, reducing human errors, and finally improve reliability of the accelerator operations.

Optimising Availability / **22**

Beam commissioning and operation reliability of the CSNS accelerator

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The China Spallation Neutron Source (CSNS) accelerator consists of an 80MeV H- linac, a 1.6GeV Rapid Cycling Synchrotron and two beam transport lines. The designed proton beam power is 100kW in Phase-I. CSNS project has been passed national acceptance in August 2018. From September 2018 to June 2019, CSNS successfully completed its first annual open run of user experiments and the beam power has been increased from 10kW to 50 kW step by step. In this presentation, the accelerator beam commissioning and operation reliability will be covered.

Optimising Availability / **19**

The LHC Long Shutdowns - impact on availability, reliability and routine machine operation

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The CERN accelerator complex is presently undertaking a long period of shutdown, meant to consolidate and upgrade its availability and performance. The Large Hadron Collider (LHC) operation relies on 1232 superconducting dipoles and 400 superconducting quadrupoles powered at 12 kA, operating in superfluid He at 1.9 K. A sophisticated magnet protection system allows safe energy extraction in case of a resistive transition (quench). Presence of metallic debris in the cryostats represented a problem in the past, originating a few short circuits in the diode connection. A consolidation process was deemed necessary. Besides, while the injector complex will be highly upgraded, several interventions are mandatory to cope with the improved situation. This Long Shutdown (LS2) is part of regular interruptions of operation carried out at CERN every three to five years. Furthermore, regular short interruptions also happen every year when the most urgent interventions are carried out. Due to the complexity of the infrastructure, these periods are vital to guarantee reliability and high performance standards of operation.

Optimising Availability / **12**

Reliability and Availability improvement of the Linear IFMIF Prototype Accelerator

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The International Fusion Materials Irradiation Facility (IFMIF) aims to provide an accelerator-based D-Li source to produce high-energy neutrons at sufficient intensity for DEMO materials characterization. As part of the Broader Approach (BA) agreement between Japan and EURATOM, the IFMIF/EVEDA project has the mission to work on the engineering design of IFMIF and to validate the main technological challenges, which among a wide diversity of hardware includes a 125mA continuous wave (CW) deuteron accelerator up to 9 MeV mainly designed and manufactured in Europe.

The Linear IFMIF Prototype Accelerator (LIPAc) under installation and commissioning at Rokkasho Fusion Institute (Japan) entered in its second commissioning phase with the objectives to validate the design of the RFQ, MEBT with its bunching cavities, Diagnostics and the RF System.

Since the beam commissioning of the LIPAc started in June 2018, the machine has gained in reliability and availability. The aim of this presentation is to show the different necessary steps of the continuous improvement such as the evolution of the organization and the implementation of the operational and maintenance procedures, which enable us to reach successfully our project milestone.

Summary:

The aim of this presentation is to show the different necessary steps of the continuous improvement such as the evolution of the organization and the implementation of the operational and maintenance procedures, which enable us to reach successfully our project milestone.

Performance Tracking & Panel Discussion / **30**

Performance tracking at BNL C-AD

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This presentation briefly describes performance metrics and tracking methods for the Collider-Accelerator Department (C-AD) at Brookhaven National Laboratory (BNL),including the Relativistic Heavy Ion Collider (RHIC) and its historical performance statistics.

Performance Tracking & Panel Discussion / **61**

Progress of BEPCII Top-up Improvement

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For getting the higher experimental efficiency of BEPCII, top-up injection which can keep the higher luminosity as long as possible was studied. With the upgrades of some systems and the optimization of injection, top-up operation is feasible for colliding mode now. Preliminary top-up experiments show that the top-up operation can increase the integral luminosity about 20% than the conventional decay operation. Further upgrades and optimization for much higher integral luminosity are underway.

Performance Tracking & Panel Discussion / 80

Performance tracking at Institut Curie

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Performance Tracking & Panel Discussion / 81

Introduction to panel discussion

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Performance Tracking & Panel Discussion / 48

SOLEIL tracking Performance

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Synchrotron SOLEIL is the 3rd generation French synchrotron light source. It has been in operation since 2007 providing photon beams to 29 beamlines with a maximum intensity of 500 mA, 5000 hours a year.

We will present shortly our facility in terms of organization, key performance indicators. Management of the day-to-day operation will be discussed. The fault process management will be somehow detailed in terms of diagnostics, logistics, spares, repair strategy (planning, organization, follow-up, etc.) and restart after a shutdown. Metrics are constructed and available to every support group and should be a guideline for middle and upper management to maintain utmost performance from the electron source to the photon on the samples of the beamlines.

Performance Tracking & Panel Discussion / 41

Availability Accounting at GSI/FAIR: Present Status and Future Perspectives

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Due to the quite complex parallel operation, availability accounting at GSI has been always a tricky task. Since last year, a clear separate bookkeeping for the availability of each of our accelerators was introduced. Correspondent results for the FAIR Phase 0 physics run in 2019 will be presented. In order to increase the quality of the failure data, an Availability Working Group is about to be established during this year’ s engineering-run. First version of the Archiving System is presently tested. It enables us to track some beam parameters and to complement ‚Beam on Target ‘time with delivered beam quality. Our next step would be an automatized (or automated) failure event generation in electronic logbook.

Performance Tracking & Panel Discussion / **72**

Availablity improvement at PETRA III

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PETRA III, a third generation synchrotron light source at DESY, had for many years reached availabilities in the order of 95 %, while other light sources reached 98 to 99 %. In recent years, a lot of effort has been put into increasing PETRA's availability, and this year the availability might surpass 98 %. This paper will describe the efforts to increase the availability, and discuss the remaining sources of downtime.

Performance Tracking & Panel Discussion / **37**

Australian Synchrotron Reliability Update

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The Australian Synchrotron is a 3rd Generation Light Source located in Melbourne, Australia. It has been in User Operation since April 2007.
It consists of a 318m circumference 3GeV Electron Storage ring with a full energy injector and currently has 9 beamlines servicing more than 2000 users per year. Over the coming years this will increase to at least 14 beamlines with the BRIGHT upgrade program.

While we achieve high beam availability (99.42% in 2018) we are beginning to see End of Life issues with some components.
Significant issues effecting machine down time in 2018/19 have been:

1. Efficiency upgrade to the synchrotron plant facility
2. End of life power supplies and some parts of the RF system

Poster Session - Board: 30 / **58**

Implementing quality Management at the FLASH Accelerator

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Quality Management becomes more and more relevant in terms of availability and reliability of an state-of-the-art Accelerator. We present the implementation of methods and tools which will be used in the future to overcome unneeded downtime.

Poster Session - Board: 32 / **62**

Progress of Longitudinal Tomography in RCS of CSNS

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Two kinds of Longitudinal Tomography algorithms have been developed in RCS of CSNS. Advantages and disadvantages of the two method will be discussed in this work

Poster Session - Board: 33 / **63**

Beam Position Measurement and Control at the CSNS Target

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The target is a key part of the CSNS facility, which bears the average beam power of 100KW to 500KW. Beam position on the target must be strictly controlled to avoid damage to the target. The target imaging system can give the position and size on the target, but it is difficult to observe the signal in single shot mode and it become insensitive over time. In this paper, we propose to estimate

the beam position on target by BPMs and multi-wire scanners on RTBT, which plays an important role during beam commissioning.

Poster Session - Board: 34 / **64**

Correction of sextupole

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At present, the Loco correction of quadrupole has been a application in the operation of the BEPCII accelerator division. When exists the energy deviation in the collider, the beam correction is used to improve the luminosity. However, there is a lack of sextupole correction. Sextupole corrections has been used in KEKB and RHCIL. Correcting the sextupole can increase beam life, dynamic aperture and so on. This poster mainly focuses on the lattice structure of BEPCII, and carries out some theoretical calculation and simulation verification for the beta function measurement and sextupole correction.

Poster Session - Board: 35 / **65**

Maintenance of the flow meter to prevent un-noticed false reading.

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Cooling of magnet coil by LCW (Low Conductivity Water) is among basic things of most particle accelerator facilities. Magnet protection by water flow rate will fail, if flow meters fraud, like reading stuck to “good” value despite reduced or even stopped flow. We have suffered from false reading from time to time, because we just checked face value during our routine bi-weekly maintenance rounds. Recently, we add new check items; for example, stick, abnormal noise, vibration to the bi-weekly check menu. Further, we add an active, somewhat interventional, check method by closing / opening relevant value and monitoring change of reading, in about semi-annual frequency. We evaluate the condition of the flow meter according these items. As a result, it becomes easy for us to understand the condition of the flow meter. We will keep on monitoring these items in future.

Poster Session - Board: 36 / **66**

Measurement and correction of coupling with skew quads in BEPCII/BER

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We used only vertical correctors to correct the coupling in the positron ring (BPR) and the electron ring (BER) of BEPCII. However, in recent years, the experience in operation indicated remarkable differences in the corrections of coupling between BEPCII/BER and BEPCII/BPR. In this case, vertical correctors and skew quads were used to make correction of coupling in BEPCII/BER and control the vertical dispersion. Some simulations with SAD program have been performed, and the feasibility was demonstrated with the luminosity optimization in BEPCII.

Poster Session - Board: 37 / **67**

Working point optimization towards high intensity beam commissioning at CSNS-RCS

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China Spallation Neutron Source (CSNS) is the pulse facility that aims to provide hundreds kilowatt beam power for users. The Rapid Cycling Synchrotron (RCS) is a important part that under 25Hz to accelerate and accumulate beam energy to 1.6 GeV from 80 MeV. As a high intensity facility, the resonance dominated by space charge is very serious for the RCS. Towards to high intensity beam commissioning, the orbit matrix methods were used to calibrate lattice functions. After the working point is corrected to design mode, the working point is carefully optimized to reach high effective beam transmission and low beam loss.

Poster Session - Board: 38 / **68**

Multi-function use of BPM on CSNS linear accelerator

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The CSNS linear accelerator is equipped with a number of strip-line BPMs, and we will describe the different uses of this type of BPM in machine tuning and operation. The most basic usage is to measure the orbit of the beam. Later, BPM is used to measure the phase and calculate the energy of the beam by the time-of-flight method. Through the improvement of the electronic system, BPM can be used to scan the high RF cavity on the CSNS linear accelerator to find a proper acceleration phase and field amplitude. In the future, maybe we will use this type of BPM to measure beam emittance and twiss parameters on linear accelerators.

Poster Session - Board: 39 / **69**

Reliability analysis of superconducting section for CAFe

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There is an introduction to superconducting section for CAFe(Chinese ADS Front-end Demo Linac).And on this basis a simple reliability analysis is applied.

Poster Session - Board: 12 / **24**

The Improvement of CSNS Linac RF System Operation Stability

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The CSNS proton linear accelerator (Linac) delivers 81MeV proton beam to RCS ring. The Linac is comprised of H- ion source, RFQ, two Buncher cavities (MEBT), four DTL accelerators and one Debuncher cavity (LRBT).Three 25kW solid state amplifiers supply RF power to two Buncher cavities and one Debuncher cavity, repectively. The RFQ and four DTL accelerators are powered by five sets of klystron power sources. The fault rate of CSNS Linac RF system is correspondingly higher than other accelerator systems. The faults are mainly from five klystron power sources, including the klystron discharge, crowbar malfunction, etc. Some downtime is also from LLRF control system. This report will present the types of the faults and the improvement methods.

Poster Session - Board: 13 / **26**

Single points of failure at the Canadian Light Source

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The Canadian Light Source (CLS) Synchrotron had first light in 2004. Our linac was built in the 1960's and was a part of the Saskatchewan Accelerator Laboratory (SAL), whereas the rest of accelerator was built under the CLS project, approved in 1999. Over the last 15 years we have made upgrades

to various accelerator systems to operate reliably. Herein we will review the upgrades done to the linac, booster ring RF, and storage ring RF in addition to the upgrades we are planning in the near future. The electron source failure we had in 2018 and our experience in recovering from this failure will also be discussed.

Poster Session - Board: 11 / **21**

Reliability of the Coupled Cyclotron Facility at NSCL

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The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University is a United States national user facility for rare isotope research and education in nuclear science, astro-nuclear physics, and accelerator science. The Coupled Cyclotron Facility at NSCL, consisting of two coupled cyclotrons, accelerates stable ion beams to energies of up to 170 MeV/u. Rare isotope beams are produced by projectile fragmentation and separated in-flight in the A1900 fragment separator. NSCL uses a standards-based integrated management system including continuous improvement to achieve high accelerator reliability and user satisfaction. As the over 30 years old cyclotrons are slated to be replaced by a new superconducting linear accelerator at the end of next year, operations and maintenance strategies need to optimize scientific output.

Poster Session - Board: 23 / **46**

Electrical design, installation and commissioning

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Modular design to enhance flexibility to cope with changes both in regards of permanent devices but also change of strategies for installations. I will show how we have implemented this concept into out design for machine protection at ESS and perhaps there are other people with similar experience who can add value to our upcoming design phases. At the moment we are building and installing the first systems for the first sections (Ion Source, LEBT, RFQ and DTL) of the accelerator.

Small installation and testing scopes to be flexible for changes of sequence or delays of equipment dependent on other stakeholders.

Asset management tool to keep track on maintenance intervals, spare parts in stock and versions of firmware for PLC equipment etc.

Functional breakdown in regards of naming, tagging and labeling of both functions/equipment but also assets. In some accelerator facilities there seems to be a different attitude towards a standardized naming/tagging than what people from industries and nuclear power plants are used to. I will try to highlight benefits of good naming/tagging/labeling in regards of future and perhaps also centralized commissioning and maintenance.

Poster Session - Board: 24 / **47**

Accelerator Performance in FAIR Phase 0

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The Facility for Anti-Proton and Ion Research (FAIR) is presently under construction on the campus of the GSI Helmholtzzentrum fur Schwerionenforschung GmbH at Darmstadt, Germany. It extends and partly supersedes the existing GSI accelerator complex. In 2018, the intermediate experimental program FAIR phase 0 has been started, which offers beam time for experiments until the start of FAIR operation. FAIR Phase 0 exploits the GSI accelerators, which have been upgraded for the use as FAIR injectors. Additionally, it allows an early use of detectors, which have been developed for FAIR. However, the performance suffers from impacts of the construction work for FAIR as well as refurbishing work on buildings, building technology and legacy electronics.
The poster will give some insight, how these impacts show in the usual beam time statistics.

Poster Session - Board: 21 / **44**

Gradient Maintenance at Jefferson Lab

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The 12GeV upgrade at Jefferson Lab doubled the energy reach of the lab’s recirculating accelerator. This upgrade was made possible by advances in cryomodule and cavity design improvements that led to higher gradient gain per cryomodule. The upgrade included 10 these new “C100” modules designed to provide 100MeV of acceleration capability plus an additional margin of 10%.
Now that we are operating, cryomodule performance is being limited by field emission, resulting from suspected particulates in the cavity vacuum space. Currently, the cryomodules operate at an average of ˜80% of their nominal value when set to reasonable trip levels. Optimizing gradients to minimize field emissions provides additional challenges. Gradient reach continues to degrade at a statistical rate of 34MeV/pass per year adding additional strain to the energy reach.
A performance plan that involves new and refurbished cryomodules is now underway to mitigate the system issues and restore the accelerator’s energy reach capability. Energy reach optimization efforts and the performance improvement plan will be discussed.

Poster Session - Board: 22 / **45**

Top-off operation realization for Hefei Light Source II

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Hefei Light Source (HLS) successfully completed its major upgrade project in 2014. The lattice structure is changed from TBA to DBA while the circumference remains 66 m due to the limitation of the facility building. The beam energy is kept 800 MeV and the current is raised to 360 mA. The upgrade greatly improved the performance of the light source including its stability and reliability.

However the change of the operation mode was not taken into consideration in the upgrade project. In order to meet the incremental requirements of the users, we carried out a project to realize top-off operation in 2016. This project was successfully finished in July, 2018. In this poster, we present our efforts in the realization of the top-off operation for Hefei Light Source, including the improvement of the injector performance, optimization of the beam injection system and the personnel protection system, etc.

Poster Session - Board: 14 / **29**

ESS Machine Protection System Lattice Simulator for Use Cases

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The ESS machine being still under construction, Machine Protection at ESS needs to foresee a maximum of scenarios of what could happen in the machine and how the protection systems should react. These scenarios are discussed through Use Cases, which are difficult to manage because of the complexity of the dependencies between the systems involved. To cover this complexity, a part of the Use Case needs to be automatized by software programming. This document describes the Simulator, program taking as inputs the events happening on the machine, calculating and displaying the consequences on all systems modeled, and generating Use Cases reports to be interpreted and validated by the Machine Protection team.

Poster Session - Board: 20 / **40**

First experiences during ESS commissioning

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The first section of the ESS Linac, the proton Ion Source and the LEBT, were commissioned between September 2018 and July 2019. That was the first time that beam has been produced at the ESS, and it is the first step to the planned start of the user program in 2023.
In this presentation we show the first results of the commissioning, as well as showing the main problems found during operation of the Ion Source and LEBT; how this problems were solved; and which lessons were drawn to improve the plans for commissioning and operations.

Poster Session - Board: 2 / **1**

CERN LHC Cryogenics: availability calculation tool improvement and new helium balance monitoring tool development

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The Large Hadron Collider (LHC) cryogenic system architecture is made up of eight independent cryogenic plants at 4.5 K linked with eight units at 1.8 K and the associated cryo-distribution system, supplying each of the eight ring sectors with superfluid helium for a total helium inventory of more than 130 tons. It is using a wide variety of equipment with over 3 ' 500 operating conditions to manage in order to allow beams to circulate and be maintained for physics production. These conditions mathematically define the availability of the system. Meeting the requirements for the production of beam for physics imposes to maximize this availability. A constant attention is required on optimal functioning of cryogenics as well as its operational margins. This implies reliable and efficient tools to ensure a close and on-line follow-up. This presentation will briefly recall the LHC cryogenic system architecture before focusing on the definition and calculation of LHC cryogenics availability, taking into account operational margins. We will highlight the optimization and automating of the availability calculation tool performed during the RUN 2 period from 2015 to 2018 inclusive, allowing more precise statistics production in less time. Complementary aspects regarding the possibility to push data from the tool to the CERN Accelerator Fault Tracking (AFT) are presented. The ongoing development of an automatic tool to monitor the helium inventory based on the methodology developed for the automatic calculation of availability statistics will be introduced. Ongoing work to use these tools in collecting early warning signals data during operation, thus allowing to even more improve the overall availability of the LHC cryogenic system, will be discussed. Finally, the overall availability results and helium management of the LHC cryogenic system during the RUN 2 operational period will be presented.

Poster Session - Board: 1 / **0**

The new vibration condition monitoring system at the ISIS Synchrotron

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This poster will go through the concept, design, implementation and delivery of the new vibration condition monitoring system at the ISIS Synchrotron in Oxford England. It will show the initial reasons for doing the project and the problems and limitations of installing the system within a 35 year old Synchrotron building. We then explain the software infrastructure and new analytical tools available to diagnose and condition monitor the Synchrotron magnets. Example of anomalous data are shown and how potential analytical tools, developed in academia and industry will help us to monitor health and trends as well as predict fault modes before they become catastrophic causing the beam to trip.

Summary:

The new vibration condition monitoring system at the ISIS Synchrotron in Oxford England was designed and commissioned by the ISIS performance Improvement department in March 2019. It replaced a manual condition monitoring system that exposed personnel to unnecessary safety risks and only gave instantaneous data, often inexact and variable, at the time of measurement. The new system has automated the process providing rigorous 24/7 vibration data on all Synchrotron lattice magnet systems and presents data for potential real time fault detection on the ISIS control system as well as storing data for post analysis, looking for trends and developing fault modes. The data has exposed a whole new dimension for understanding the Synchrotron magnets. We are now learning to interpret this new information within a landscape of improved data processing and machine analytics technology from both

within the accelerator community and from other industries.

Poster Session - Board: 3 / **3**

Automatic Fault Notification and Analysis for RHIC Operations

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Monitoring a display of alarms can suffice to quickly notify Operators of a fault condition. However, alarm management can be difficult. Diagnosing the root cause in complicated subsystems can be a lengthy task. Operations at the Collider-Accelerator Department (C-AD) of Brookhaven National Laboratory (BNL) makes use of some automated analysis tools to collect and process data when certain faults are triggered, with results posted to electronic logbooks. Alarm management, Permit and Machine Protection Systems (MPS), and analysis tools will be presented here as used for the Relativistic Heavy Ion Collider (RHIC) and its various beam sources.

Poster Session - Board: 42 / **73**

Measurement and matching of beam parameters extracted from CSNS/RCS

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In order to study the emittance evolution of the circulating beam in the fast cycling synchrotron (RCS) of the Chinese spallation neutron source (CSNS), the parameters of beam currents extracted at different times were measured. The measurement is based primarily on the wire scanners mounted in a high-energy transmission line (RTBT) for beam profile measurement, and the solution process uses two different methods. The measured emittance and TWISS parameters of the beam at different times provide a basis for the physical tuning of the RCS. The whole beam envelope in the RTBT is optimized based on the matching of the measurement results. The measured results are in agreement with the theoretical calculations.

Poster Session - Board: 4 / **9**

Reliability maintenance of microwave sources for BEPCII Linac

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The injector linear accelerator (Linac) for the upgrading project of Beijing Electron Positron Collider (BEPCII) was completed in 2007, and has been operated smoothly for almost 12 years. Some reliability maintenance in the system of microwave sources has been carried out over the last few years to ensure the beam quality. The maintenance jobs include: 1) monitoring the Six Reference Signal Converter (SRSC) and 60 W continue wave (CW) solid state amplifier (SSA) weekly; 2) upgrading the thermostat for SRSC; 3) diagnosing the fault of phase shift keying (PSK) and repairing; 4) detecting the oscillation of 1 kW pulse SSA. Because of the timely reliability maintenance, total tripping time of microwave sources per year has been less than 2.5 hours in the successive 3 years since 2016.

Poster Session - Board: 25 / **49**

Reporting Incidents using JIRA Software at Synchrotron SOLEIL

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Synchrotron SOLEIL is the 3rd generation French synchrotron light source. It has been in operation since 2007 providing photon beams to 29 beamlines with a maximum intensity of 500 mA 5000 hours a year.

Since the beginning of 2018, the operation group has been migrating to JIRA Altassian Software as a unique tool for reporting failures. The tool was already used by the computing division for managing user requests, software evolutions, problems, etc. On the operation level, JIRA is already recording all the demands of interventions and access to the tunnels. It provides a better interaction between the reporter and the support groups that are involved in the process of resolution. Anyone can report a failure related to the accelerators by creating a ticket. Here we will describe the workflow to manage an incident during its full lifetime and give first operational feedback.

Dashboards are available for all support groups reporting incident by severity level, which is a major asset compared to the previous logbook we used in terms of quality, interaction with people and reviews. It also improves integration between support, developers and operations.

Since mid 2019 a JIRA referent for each support group was appointed; their role is to follow their group incidents and keep the incident database up-to-date. We have set up JIRA training courses to teach best practices for tracking incidents.
Our goal is at the beginning of 2020 all the support groups are self-ruling.

Poster Session - Board: 44 / **75**

Machine parameters management of CSNS accelerator

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Traditional machine parameters management just concerns about magnetic fields and is not conducive to management for a long time by text file . This paper will introduce the state of CSNS accelerator machine management. Based on the MySQL database, all the accelerator parameters are stored in the database and later used for machine recovery. In addition to the single point data, we also consider the array variables involved in the CSNS ring accelerator, which realizes the complete storage and provide the reliable operation of the machine.

Poster Session - Board: 43 / **74**

Energy Dispersion Measurement and Optimization of CSNS Linear Accelerator

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The beam energy dispersion in the injector of CSNS RCS is critical to the optimization of the RCS beam parameters. This paper introduces two different methods based on the wall current monitor (WCM) and wire scanner installed in the CSNS linear accelerator to measure the beam energy dispersion. The measurement errors are analyzed. The debuncher is used to adjust the energy dispersion of the beam and the center energy offset. The measurement results are in good agreement with the theoretical simulation values.

Poster Session - Board: 41 / **71**

Inspections for a superconducting rotating-gantry

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A superconducting rotating-gantry for carbon ion radiotherapy had first patient in May 2017, the number of therapeutic irradiations in a day is almost 20shot recently. This gantry using superconducting magnets can transport heavy ions having 430 MeV/u to the isocenter. The length and maximum radius are 14 m and 6.5 m, and the total weight of the rotating structure is approximately order of 300 tons. Meanwhile, unexpected problems have arisen as a result of iteration rotations, which was no need to consider in fixed irradiation port operation. Although we have only a few times for maintenance owing to usage for irradiation, we have to make inspections and take measures deal with these problems repeatedly. Then we treat efficiency and precision improvement of inspection as issue. We report failures occurred in the gantry and inspections for recurrence prevention.

Poster Session - Board: 40 / **70**

Reliability test of small power supplies in SuperKEKB Main Ring

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SuperKEKB is an asymmetric-energy electron-positron collider for Belle II experiment to search new phenomena in B-meson decays.
The MR magnet system consists of about 2,600 magnets, power supplies, and their interlock system. More than 400 magnets and power supplies were newly fabricated.
The number of power supplies for the Main Ring (MR) magnets is 2393 as of June 2019.
The most part of the power supplies are small class power supply which output power is less than 1 kW.
Stability and setting accuracy of the power supplies are among the most critical factors for successful luminosity tuning.
We construct a test-stand of the small-class power supplies to confirm its soundness.
The MR magnet system ran stably without any serious problems during the Phase I and II commissioning runs, which contributed greatly to the smooth start-up of the MR.

Poster Session - Board: 31 / **59**

Failure analysis and fault tracking at the synchrotron light source PETRA III

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A high machine availability is an important performance indicator for modern synchrotron light sources. To reach this goal of stabilizing operations by minimizing the occurrence and duration of downtime events, reliable tools and methods for root-cause analysis and fault tracking play an important role. Here we describe how we do this business at PETRA III.

Poster Session - Board: 6 / **11**

Software development to support LIPAc beam operation and RFQ conditioning

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The Linear IFMIF prototype accelerator, LIPAc, aims at producing a powerful (9MeV, 1.1MW) deuteron beam at 125mA in CW, to validate the concept of the future IFMIF accelerator (40MeV, 125mA CW). The beam is accelerated through two main accelerating stages (RF Quadrupole (RFQ) and SRF Linac), plus two bunching cavities as part of the Medium Energy Beam Transport (MEBT). In order the beam to be accelerated continuous wave RF power at 175 MHz for the 18 RF power sources feeding the eight RFQ couplers (200kW), the two buncher cavities (16kW) and the eight superconducting half wave resonators of the SRF Linac (105kW) are needed in the final stage.

Presently LIPAc consists of the Injector, RFQ, MEBT, Diagnostics-plate and Low Power Beam Dump components as the second phase of the project. This phase aims to demonstrate the acceleration of a deuteron beam through RFQ up to 5 MeV in pulsed mode at a low duty cycle of 0.1%. For the successful commissioning including the beam operation, RFQ conditioning and other activities, the greatest care was necessary for integrating the local control systems (LCS) from Europe coordinated by Fusion for Energy to the central control system (CCS) that is designed and managed by QST.

For example, to optimise the RFQ conditioning process the control of the RF power system for the RFQ consisting of four LLRF units with two RF chains each was enhanced with a python based automatic rearming tool to resume the RF power automatically in case of safety interlocks. The rearming tool is communicating with EPICS channel access using pyEPICS module in Python language, running on the CCS and is interfacing the RF power system LCS through EPICS. Additionally, the effective ways to share the large amount of data collected during the commissioning with the participating laboratories in Europe are currently under preparation.

Poster Session - Board: 5 / **10**

Maintenance and enhancement of the electrical and cooling systems for the operation of Linear IFMIF Prototype Accelerator (LIPAc)

Author: Keitaro Kondo[1]

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The construction of the Linear IFMIF Prototype Accelerator (LIPAc) has been conducted at Rokkasho, Japan for the development of the International Fusion Materials Irradiation Facility (IFMIF) aiming at material characterization for fusion power plants. The aim of this prototype accelerator is to demonstrate the validity of the low energy section of an IFMIF deuteron accelerator up to 9 MeV with a beam current of 125 mA in continuous wave (CW). The high power conditioning and the beam commissioning have been conducted since July 2017 on the world longest and highest power Radio Frequency Quadrupole (RFQ) linear accelerator. This RFQ requires 1.6 MW of RF power, and we have faced several problems on the cooling and electrical system specific to such a very high power accelerator. In this presentation, we will describe lessons we have learned over the past two years of operation in particular for maintenances and how an improvement is implemented to achieve stable operation.

Poster Session - Board: 19 / **39**

Framework for flexible Programmable Logic Controller (PLC) design in protection systems

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When designing PLC based safety or protection critical systems to be used in a dynamic design environment, flexibility of design is crucial for the operation and integrity of the system. A dynamic design environment is one where change can be constant, such as when the implementation stage of the project life cycle overlaps largely with the design stage due to complexity or time limitations, or where a facility can have a very fast ramp up in size requiring fast incremental updates in the system. A system design which is not flexible and well considered from its conception in this environment can easily lead to loss of the system integrity through repetitive complex changes requiring detailed and lengthy change management and testing exercises to re-validate. This scenario will result in project delays, a sub-standard system and decreased motivation in the development team. To achieve maximum flexibility and minimise verification and validation activities, the PLC design should be based on the use of a high degree of modularity and incorporate the use of centralised reusable component libraries where possible.

Poster Session - Board: 8 / **15**

LIPAc Control System from Reliability Point of View: Design Concept and Integration

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The development of IFMIF (International Fusion Material Irradiation Facility) to generate a 14 MeV source of neutrons with the spectrum of D-T fusion reactions is indispensable to characterize suitable materials for the first wall of the nuclear vessel in future fusion power plants. As part of IFMIF validation activities, LIPAc (Linear IFMIF Prototype Accelerator) is being constructed at Rokkasho (Japan) to demonstrate the validity of deuteron acceleration up to 9 MeV step by step with a beam current of 125 mA in CW (Continuous Wave). Since July 2017, high power conditioning and the beam commissioning with the world longest and the highest-power RFQ (Radio Frequency Quadrupole) Linac, which accelerates the deuteron beam up to 5 MeV, have been carried out.
The LIPAc Local Control Systems are supplied by CEA, CIEMAT, INFN and F4E as the European Implementing Agency coordinating the European procurement, together with QST as Japanese Implementing Agency for the central control systems (including MPS & PPS). Since the LIPAc is a prototype for the IFMIF, the control systems have been designed for providing as much freedom

as possible in operation for an efficient development of this challenging accelerator. At the same time, it should prevent detrimental damage on the accelerator even for most flexible operations. The central control system has been so designed to balance this contradiction by providing minimum but most reliable functions to secure the accelerator operation.
In the presentation, the design concept and concrete measures in the control system that allow such a flexible but secured accelerator operation will be discussed. In addition, realities that we faced and overcame in integrating the local control systems into the central control system will be presented hoping that those could be used as lessons learned in carrying out the commissioning in these innovating international and intercultural projects. Maintenance issues toward long pulse RFQ commissioning will be also discussed.

Summary:

The development of IFMIF (International Fusion Material Irradiation Facility) to generate a 14 MeV source of neutrons to characterize suitable materials for the first wall of the nuclear vessel in future fusion power plants. As part of IFMIF validation activities, LIPAc (Linear IFMIF Prototype Accelerator) is being constructed at Rokkasho (Japan) to demonstrate the validity of deuteron acceleration up to 9 MeV step by step with a beam current of 125 mA in CW (Continuous Wave). Since this project is based on international collaboration and the control systems of subsystems have been designed and implimented by institutions of various countries, we have a variety of problems before the integration. In this presentation, the design concept and realities will be discussed. Future plan for maintenance will be also discussed.

Poster Session - Board: 7 / **14**

Operation statistics of Gunma University Heavy Ion Medical Center

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Gunma University Heavy Ion Medical Center has operated a heavy ion treatment system consists of an ion source, linear accelerators, a synchrotron and irradiation systems for 9 years. Machine availability is around 99% for treatment operation after 2015, and around 98% for overall operation including experiments. Until August 2019, fatal trouble which stops the treatment for a more than 2 days did not occur.
After 2016, most troubles are related to aging deterioration and need more preventive maintenance. In order to realize sustainable operation, improvement for not only the hardware, but also the framework of operation and maintenance will be required. Replacement of computers of the control system of the accelerator, the irradiation system, and the infrastructure is being carried out. In this poster, the machine availability varying with years and maintenance strategy including replacement is discussed.

Summary:

Gunma University Heavy Ion Medical Center has operated a heavy ion treatment system for 9 years. Machine availability is around 99% for treatment operation after 2015, and around 98% for overall operation including experiments. Until August 2019, fatal trouble which stops the treatment for a more than 2 days did not occur. In this poster, the machine availability varying with years and maintenance strategy including replacement is discussed.

Poster Session - Board: 9 / **16**

Development of web tools for fault tracking of the Linear IFMIF Prototype Accelerator (LIPAc)

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In order to improve the workflow of the people working on the construction of the Linear IFMIF Prototype Accelerator (LIPAc), several web-based tools have been implemented. One of the most important ones is a custom fault tracking system, developed in-house. Previously, when a problem was found, workers had to fill an "event report" (a Word document) and upload it to the the document management system for discussion, analysis and eventual approval. Any change to the document meant downloading, modifying and reuploading it. Furthermore, there was no search capability, so a separate document with a summary of every report had to be kept. The whole procedure was very time consuming, and user satisfaction was very low. As a result, many problems would not be reported. The new tool offers an easy to use web-based interface, with an integrated workflow, search capabilities, and automatic email notifications. User satisfaction is higher, and as a result more problems are being reported, which means that they can be solved faster.

Poster Session - Board: 29 / **57**

The operation status of CSNS front end

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The front end means the front part of linac that includes IS, LEBT, RFQ and MEBT. As the start point of CSNS, the condition of front end is one of key factors which influence the stable operation of CSNS. Based on the beam requirement of CSNS phase I, the front end should provide a stable H- beam with energy of 3.0MeV, a maximum pulsed peak current up to 15mA, a beam duty factor 1.0% at a repetition of 25Hz and beam pulse width of 400us before chopping. The installation of CSNS front end was completed in 2015. Although the front end satisfies the beam requirement of CSNS phase I, the stability of the front end is not satisfactory during beam commissioning. The instability mainly comes from the ion source and RFQ sparking. After last 3 years commissioning and improvements, now the stability of CSNS front end was improved a lot. The beam availability of beam from the front end reaches 99.5% in the last year.

Poster Session - Board: 26 / **51**

Action plan to reduced water leaks on brazing joints at SOLEIL

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Synchrotron SOLEIL is the 3rd generation French synchrotron light source. It has been in operation since 2007 providing photon beams to 29 beamlines with a maximum intensity of 500 mA, 5000 hours a year.

Since a few years, we are facing at an increasing number of leaks on brazing joints of our LCW cooling circuits. This type of incident impacts deeply the beam availability and may be the sign of an aging facility requiring corrective maintenance. We decided to set up a task force to handle this issue and to define of the strategy to follow. The first step was to make a survey of similar issues in sister facilities. Among the key players are listed a large water flow, the water chemistry, the level of dissolved oxygen coupled with the value of the pH of the deionized water used to cool down the equipment, radiation-induced oxidation chemical reactions, mix of different types of materials (Al, SS, Cu, etc.), mechanical stress or shocks and finally the experience and qualification of the welders and the brazing material. Galvanic corrosion has also been observed producing copper oxide mud and blocking the water flowmeters. Several actions have been undertaken: in the short term, reinforcing visual control of sensitive equipment during all shutdown periods, treating the identified high risk brazing joints, searching for abnormal vibration levels, analysis if any blocking materials and a campaign to clean the flowmeter filters. In the long term diagnostics are progressively installed: pH meters and dissolved oxygen sensors. Expert from the service of corrosion of CEA were also consulted.

If no major incident has been reported recently, very useful knowledge was gathered during these late years for improving the running of the present facility and also to prepare the major upgrade of our accelerator and technical facility.

Poster Session - Board: 18 / **36**

Warning System in Operation of the PLS-ll

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We aim to recover the machine faults as quickly as possible to provide a stable beam of good quality. But preventing the machine faults is more important. To do that, we had to make ‘warning signal’ about getting out of the stable range. And when the operator’s direct action is needed immediately, the appropriate range and logic are made to generate a warning signal for each device by using software like that CSS, Labview, etc. It is very important that the warning signal is generated at the right time by specifying the appropriate range. Because at the moment before the machine fault, it is difficult to expect a preventive effect. And operators can be dull about the operation status if alarms occur from time to time with a very small range setting. Also, because all devices of PLS-ll works differently, it is necessary to have an understanding of all devices in order to make ‘Warning System’.

We have made ‘PSI(Personal Secure Interlock), MIS(Machine Interlock System), PLS-ll SR Operation Alarm System, PLS-ll Orbit Interlock System, PLS-ll MPS Control System, PLS-ll Linac Automation

System’. And these programs are always used to prevent the machine faults. In the event of the machine fault, interlock systems of software and hardware prevent human damage, minimize machine damage, and show the cause of the fault in a detailed graphic to do quick recovery action of operator. We will introduce in detail our ‘Warning System’ to prevent and recovery the machine fault of PLS-ll.

Poster Session - Board: 17 / **35**

The operational reliability of CSNS 400Hz AC Series Resonant Pulse High Voltage Power Supply

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400Hz AC Series Resonant Pulse High Voltage Power Supply is an important part of Klystron Power Source of China Spallation Neutron Source Linear Accelerator. It can provide maximum - 120 kV DC high voltage. Each set of the high voltage power supply drives two klystrons. There are five sets of klystron power sources in CSNS linear accelerator, so there are three sets of high voltage power supply running online. The advantages of this type of high voltage power supply are simple topology and high availability. This paper will introduce the principle and the operational reliability of 400Hz AC Series Resonant Pulse High Voltage Power Supply since CSNS was put into operation from October, 2018.

Poster Session - Board: 27 / **52**

Production of carbon ion at electron cyclotron resonance ion source for high energy carbon ion radiotherapy

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Carbon-ion radiotherapy (C-ion RT) using Heavy Ion Medical Accelerator in Chiba (HIMAC) has been carried out in National Institute of Radiological Sciences (NIRS-QST) since 1994. Over 12000 cancer patients have been treated with carbon beams having energies of between 56-430 MeV/u. A 10 GHz electron cyclotron resonance ion source, named NIRS-ECR, is used for production of carbon ion at HIMAC. There is a carbon stacking in the plasma chamber and insulator for beam extraction. Therefore, we needed cleaning of NIRS-ECR two times per year until September 2018. In order to increase an operation time for C-ion RT, we change operation parameters for production carbon ion. Usually, CH4 gas is used for production of carbon ion. We decreased the gas flow with enough beam current for medical use. As a result, we could operate during one year with small stacking of carbon to the insulator compared previous parameters. However, we found new problem about starting of the NIRS-ECR. Plasma is not turn on during about 10 minutes in starting. We increase the gas flow a little since September 2019. Improvement of carbon ion production with long life time at NIRS-ECR for C-ion RT will be described.

Poster Session - Board: 28 / **55**

ALBA synchrotron tunnel HVAC system review

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The storage ring is feed from a full-energy 249.6 m booster ring preceded by a 100 MeV LINAC that acelerates electrons from a 100KeV electron gun.

The electron gun, the LINAC, the booster ring and the storage ring are enclosed in a high density BaSO4-filled concrete bunker (tunnel-like) provided with a high capacity dedicated HVAC system aimed to keep temperature stable within a very narrow range (whatever the thermal load generated by the accelerators). In order to reach this very demanding thermal regulation, the design and distribution of the air nozzles inside the tunnel is a key factor.

After ten years of operation, it's time to review how this air distribution inside the tunnel is performing. By checking the air flow inside the tunnel (and indirectly, the map of temperatures) it will be possible to make this process more reliable during operation.

In order to perform this test, a visual tool has been used. Some smoke (from a standard smoke machine) has been pumped into the air ducts, allowing us to visually check the air flow and its turbulence.

Poster Session - Board: 16 / **32**

Reliability and Trust –The case of a Protontherapy facility including a Particle accelerator

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Optimizing the reliability of a Particle Accelerator consists in organizing tasks for scheduled and unscheduled events, in order to reach the beams and the global performances expected.
The word of trust is usually more used than rely on to qualify the relation with a person or a team. Based on analogies with Radiation Oncology and Medical Physics, we will develop the fact that trust can also be defined with a rational approach for the systems or for the people. And we will give some concrete examples in relation with our 10 years experience with a modern particle therapy facility.

Poster Session - Board: 10 / **17**

AVAILABILITY ANALYSIS OF CEPC LINAC

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Circular Electron-Positron Collider (CEPC) is a 100 km ring e+ e- collider for a Higgs factory. The injector is composed of Linac and Booster. Luminosity is the core and key parameter of the collider. High integral luminosi-ty is the pursuit of CEPC design, so the top-up injection scheme, long running time and high availability is neces-sary. As the first part of injector, high availability of the Linac is very important and should be considered care-fully in the design. A reliability and availability analysis program RAAS is under developing based on Monte Carlo method and will be introduced. The preliminary availability analysis of the CEPC Linac will be presented and discussed using RAAS.

Poster Session - Board: 15 / **31**

High Power beam commissioning of CAFe

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The Chinese ADS project now is under key technology R&D, after 25 MeV proton superconducting linac had been assembled and commissioned in Lanzhou by collaboration between IMP and IHEP. This accelerator is updated to a 1/2 charge to mass ratio super-conducting Linac which is called CAFe(Chinese ADS facility experiments in Lanzhou). This facility can provide 25MeV proton beam and 38MeV α beam for ADS key technology research and nuclear physics experiments. This poster will present 2 mA@17MeV CW proton beam commissioning results and lessons learned from CAFe, also the reliability statistics with some α beam commissioning for nuclear physics experiments this year.

Reliability Before Design / **53**

Designing ESS Machine Protection Systems highly integrated into operations and commissioning

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The machine protection (MP) systems are of the utmost importance to reach high availability and reliability in a particle accelerator driven facility such as ESS. Designing robust and reliable MP systems is essential to achieve low-risk operation, yet a smooth and highly available operation has to be facilitated. The ESS MP systems evolved throughout their iterative design processes in the effort of reaching robustness, reliability as well as flexibility. Even if the design process usually focusses on reaching high reliability (in the protective sense) as well as fast response time and other MP specific aspects, the overall perspective where smooth operation is allowed is sometimes not properly taken care of. However, to reach high availability and to interfere as little as possible into operations, these systems have to be thought in conjunction with the rest of the machine considering how it is meant to operate as a whole. This contribution will show how some of the ESS MP systems changed during

their design phase in order to have an easier and more available operation yet maintaining a high degree of protection.

Reliability Before Design / **23**

Robotic Solutions for Inspection and Maintenance in Accelerator Harsh Environments

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Nowadays, intelligent robotic systems are becoming essential for industry and harsh environments, such as the CERN accelerator complex. Aiming to increase safety and machine availability, robots can help perform repetitive and dangerous tasks which humans either prefer to avoid or are unable to do because of hazards, size constraints or the extreme environments in which they take place, such as outer space or radioactive experimental areas. In this presentation, the state of the art in industrial and experimental robotics is presented, as well as the current status of the robotic activities and the application of artificial intelligence performed at CERN by the EN-SMM group. Several robotics solutions have been applied in the past years at CERN, as well as custom made robotic devices. New ideas and solutions could emerge in a near future to increase safety of CERN personnel, decreasing radiation dose intake and increasing machines uptime. Current and future research and development in robotics are described, as well as the results from the commissioning of various novel robotic controls.

Reliability Before Design / **38**

RAMI analyses for the IFMIF-DONES facility

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The Demo Oriented Neutron Energy Source (DONES) plant design has been evolved from the 2013 IFMIF-EVEDA design. The current design activities are set in the frame of the EUROFUSION work programmes. Reliability, Availability, Maintainability and Inspectability (RAMI) analyses are part of these activities.
A target of 70% of operational availability was established for IFMIF-DONES facility design, which means, the facility is expected to be available for irradiation (i.e. beam on at full power) for 255.5 days per year. Such average operational availability requirement combined with the foreseen scheduled annual maintenance scheme (20 + 3 days) implies inherent availability requirement of 74.7% (i.e. ~75 %) for the DONES facility. Allocating such target for the whole plant to the single systems, the following system targets for inherent availability were defined: Accelerator Facility 87 %; Lithium Target Facility 94 %; Test Facility 96 %; Conventional Facilities 98 %; Central Control System 98 %. The compliance of the plant with these targets is analysed together with the design development.
Several sources of uncertainties still impact RAMI analyses for the facility. Some of them are related to the fact several systems are one of the kind and design is not yet sufficiently detailed.
Evaluations of reliability and availability parameters performed in the past for the different systems of IFMIF showed that the targets fixed for the availability requirements were not met. Nevertheless, a lot of design improvements that could contribute in matching with the fixed requirements were identified. With the development of DONES design such requests of improvements are pursued.

Particular attention is focused on the removal of several uncertainties still impacting RAMI analyses. Some of these are related to the fact several systems are one of the kind and design is not yet sufficiently detailed. For example, for the Lithium and Test systems, uncertainties are related to the lifetime of components, maintenance strategy, Li loop process boundary, fault tolerant approach, purification phases, system layout, auxiliaries and degraded operating mode assumptions. Experimental facilities are built or are under consideration to better define the different fields of application. On the same time the design is in progress in defining issue not yet treated.
Failure Mode and Effect Analysis (FMEA) and Reliability Block Diagram (RBD) analysis are the tools selected for the RAMI assessment. Some of the main outcomes of the RAMI studies will be presented at the Workshop.
Moreover, a mention will also be made in the use of RAMI results, in defining components relevant to safety through a probabilistic approach.

Summary:

Overview on RAMI studies for DONES-IFMIF facility. Particularly, availability targets for the different systems, sources of uncertainties on RAMI results, methodology applied for the studies and the use of probabilistic approach in defining safety relevant components are presented.

Safety Culture, Human Factors and Managerial Decisions / **4**

Reliability of Japan Proton Accelerator Research Complex

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The Japan Proton Accelerator Research Complex (J-PARC) is a multipurpose facility for scientific experiments. The J-PARC facilities were constructed at the Tokai site of the Japan Atomic Energy Agency. The accelerator complex consists of a 400-MeV Linac, a 3-GeV Rapid-Cycling Synchrotron (RCS) and a 30-GeV Main Ring synchrotron (MR). The RCS delivers a proton beam to the neutron target and MR, and the MR delivers the beams to the neutrino target and the Hadron Experimental Facility. The first operation of the neutron experiments began in December 2008. In January 2009, we achieved the slow beam extraction to the Hadron Experimental Facility at the MR. The regular neutrino experiments to obtain physical data began in January 2010. Following this, the user operation has been continued with some accidental suspensions. These suspensions include the recovery work due to the Great East Japan Earthquake in March 2011 and the radiation leak incident at the Hadron Experimental Facility.

Summary:

we summarize the major causes of suspension, and the statistics of the reliability of J-PARC accelerator system is analyzed. Owing to our efforts to achieve higher reliability, the Mean Time Between Failure (MTBF) has been improved.

Safety Culture, Human Factors and Managerial Decisions / **13**

Construction of Compact Heavy Ion Medical Accelerator with a Superconducting Rotating Gantry

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A compact heavy ion medical accelerator with a superconducting rotating gantry is under construction in Yamagata University. The carbon ion medical accelerator consists of a permanent-magnet type electron cyclotron resonance (ECR) ion source, a series of linear accelerator of radiofrequency quadrupole (RFQ) and interdigital H-mode drift tube linac (IH-DTL) with an energy of 4 MeV/u, and a synchrotron of 430 MeV/u.
The facility has three new features: a compact building, energy-saving operation, and superconducting rotating gantry. The first is the compact building. The footprint of the building is 45x45 m, which is the smallest heavy ion treatment facility in the world. This compactness was realized by the vertical layout of the accelerator, irradiation rooms, and infrastructure equipments. The second is energy-saving operation with no idling and natural air conditioning. The third is the superconducting gantry, which is more compact than the first model built in NIRS. These features contribute to an advanced carbon ion therapy with a lower cost and a small facility. In this presentation, progress of the project and reliability of the system and infrastructure are discussed.

Summary:

A Compact Heavy Ion Medical Accelerator is under construction in Yamagata University. The main features are compact building, energy-saving operation, and a superconducting rotating gantry. Progress of the project and reliability of the system and infrastructure are discussed.

Safety Culture, Human Factors and Managerial Decisions / 34

Several Significant Fault Recoveries and the Operation Status of the PLS-II

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PLS-II has been upgraded from PLS (Pohang Light Source) from 2011. There are two important changes. At first electron beam energy changed from 2.5 GeV to 3.0 GeV. The other is operation mode from decay to top-up. For them, RF systems in the storage ring were changed from 5 normal conducting cavities to 3 super conducting cavities. And the super conducting system is the largest fault source in operation by several big issues related in cryogenic systems. On the 15th of November, an earthquake occurred 9 km away from the facility with a magnitude 5.4. It also took 21 days to recover all of the systems related in the electric power problem. And another big problem was the overheating of the magnets. Including these problems, this report will describe the operation status of the PLS-II with various operational parameters

Software Tools for Reliability / 5

Auxiliary Tools for the Taiwan Photon Source Operation

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The auxiliary tool of the Taiwan Photon Source (TPS) is developed to help operators improve the failure analysis ability to shorten the machine downtime. Presently, We have an operating alarm system to assist the accelerator operation, and a home-developed record-analysis tool for beam trip analysis. The part of alarm system, Alarm systems is developed by the use of the Control System Studio (CSS) platform and the Experimental Physics and Industrial Control System (EPICS) channel that gathers machine information and sets high/low warning and fault limits for various signals which can help operators to quickly identify abnormal subsystems. The part of record-analysis tool, Due to the orbit interlock system is one of the most important machine protection systems. It is the fastest and the most preferred system to detect abnormalities to prevent possible damages caused by magnet power supply failures or subsystems failures. In order to monitor electron orbit changes during a beam trip, we developed the "orbit monitoring and recording tool", the "Turn-By-Turn BPM analysis tool "and the "magnet power supply recording and analysis tool" to assist us in the beam trip analysis.

Software Tools for Reliability / **6**

Configuration control tools and their impact on returning to standard running

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Periods of extended maintenance or failure often lead to systems being returned to Operations not behaving as they had. The changes can be subtle, but the consequences can be large.

The Collider-Accelerator Department at Brookhaven National Laboratory has developed various tools to help identify unexpected changes in settings and in device behaviour.

This poster outlines the different tools, their utility, and how they fit into everyday operations for RHIC and all the other programmes being run by the Collider-Accelerator Department.

Software Tools for Reliability / **54**

Why change our fault logging system?

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Operations group have developed and used a Microsoft Access based fault database since we started commissioning Diamond in 2006. Inconsistent update of responses and corrections sent be email or posted in the main log often results in information about the faults being lost, meaning a new more integrated approach was desired. In addition concerns with the lack of change history and granular control within this database resulted in limiting who had permission to use it. Partially as it was already in use in other groups within Diamond, we selected JIRA as a replacement platform. Some of its main advantages are, its web based and therefore cross platform nature, user logging and tracking, and its ability to link faults to each other even across JIRA projects from other groups. Our rollout strategy allows migration in incremental steps, currently synchronising to the access database using a python API.

Welcome & introduction to accelerator reliability workshop. / 79

The status and upgrade plan of CSNS

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China Spallation Neutron Source (CSNS)) is a high intensity proton accelerator based facility for delivering spallation neutrons to users. It consists of an 80-MeV H- DTL linac, and a 1.6-GeV Rapid Cycling Synchrotron and a neutron production target. The accelerators will provide 100kW proton beam for neutron target. The construction began in 2011, and completed in 2018. From Aug. 2018, the facility was open to users. Now the facility is operation with beam power of 80kW. The introduction to the construction, beam commissioning and operation will be given, including the gradually increased beam power and availability. The plan for upgrading to 500kW will be also introduced in the presentation.