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VERSAILLES

Book of Abstracts

Contents

Common Operation Metrics for Storage Ring Light Sources: an Update 1

Creation, Tracking, and Reporting of Reliability Statistics at the APS 1

CERN's approach to availibility tracking and metrics 1

Dependability Studies Towards Optimized Accelerator Performance 2

Designing for Reliability of the TRIUMF Pneumatic Radioisotope Transfer System 2

High Availability at ESS: Lessons Learned During the Design Phase 3

The Nuts and Bolts Affecting Accelerator Reliability 3

Current status of J-PARC accelerator infrastructure 3

LHC Cryogenic Infrastructure Reliability, Towards High Availability 4

The Cryogenics of the ISAC-II Superconducting LINAC at TRIUMF 4

Improvements to Trim Coil Power Supplies at TRIUMF 5

SOLEIL Experience with RF Solid State Power Amplifiers (SSPA's) 5

Magnet Power Supplies for SuperKEKB Main Ring 5

Continuous Delivery Workflow for Machine Protection Control Software: Feedback, Lessons Learned and Next Steps 6

LIPAc Control Systems and Reliability Improvement 6

The Use of PANIC Alarm System at ALBA 7

TRIUMF Failure Investigation Tool 7

Vibration Analysis of Dipole Magnets Using Piezoelectric Accelerometers in the ISIS Synchrotron 7

Failure Analysis at BEPCII 8

Maintenance and Upgrades at Brookhaven National Laboratory's Collider Accelerator Department 8

Improving the Reliability of the Accelerator Facility at iThemba LABS 9

Planning and Tracing a 2-year Long Shutdown Period 9

Reliability of Space Instrumentation 10

Round-table Discussion 10

Dependability and Driving Delegation 10

Operation Scripts 11

Magnet Power Supplies Reliability Improvements at SOLEIL 11

Availability tracking at PETRA III 12

Refurbishment of the the DEE on a Cavity for a Compact Cyclotron 12

Operation Reliability of SSRF in the Last Operation Season and upgrade plan at SSRF . . 12

Utilization of Trend Data for Reliable Delivery of a Treatment Beam 13

13 Years of Development - Machine Reliability at the Canadian Light Source 13

Increasing Operational Efficiency by Re-Evaluating and Improving Obsolete Operational Processes 14

Beam Drift at a Secondary Electron Emission Monitor Used for Dose Control in Carbon-Ion Radiotherapy 14

Scroll Pumps "on Demand" Usage for Reduction of Operating Costs. 14

Maintenance Method for Stable Operation of a Superconducting Rotating-Gantry 15

SOLEIL Maintenance Management 15

Evolution of an Alarm System: Merging Old Accelerators with New Installations 16

Operational Experience with the SOLEIL Storage Ring RF-System 16

Main Control Room: Upgrade Measures in Preparation for FAIR Phase 0 16

Reliability of the Taiwan Photon Source 17

MCO Strategy to Maintain High Level of Reliability for Control Systems Electronics . . . 17

Reliability of J-PARC 18

Improvement Towards Reliable Beam Operation in Indus-2 Storage Ring 18

LINAC Accelerators - Design for Reliability 19

Root Cause Analysis Experience, Highs and Lows. 19

Operation Status and Upgrade Projects for HEFEI Light Source 19

Dependability Study of the Large Hadron Collider Beam Loss Monitor Optical Link and Comparison to the Next Generation Link under Development 20

Reliability of the GSI / FAIR Facility After a Long Shutdown Phase. 20

Radiation Damages and Characterization in the SOLEIL Storage Ring Tunnel 21

Reliability of Water Cooling Systems on Radio-Frequency Modulators of the Industrial LINAC Accelerators 21

SOLARIS Facility Operational Status 22

SOLEIL Operation and Adaptation to the New Common Metrics 22

First Line Diagnosis at ISIS 23

Project to install a Tandem Accelerator at USTHB (Algeria) 23

Long Term Investigation of Beam Parameters Based on Beam Diagnostics Data Exports . 23

Reliability of Target Ion Source System on SPIRAL1 - GANIL 24

Calculation of the Machine Availability for the Complex Parallel Operation 24

Improvement of Operational Processes at the Institute Level 25

Assessment of Classical and Modern Dependability Methods to Analyse Electrical Faults in the LHC Superconducting Magnets and Circuits 25

A Scalable and Open System for Complex System Behaviour Assessment 26

Ion Beam Application to Material Analysis in Ghana: Problems and Prospects 26

Quantitative Reliability Demonstration from Production to Operation on the Example of the new Radiation Tolerant Power Converter Controller for the LHC 26

Helium Burst Incident at the PROSCAN Medical Cyclotron Facility 27

Cryogenic System Operation and the Progress of SSRF II 27

Maintenance of the Accelerator Control System at the Marburg Ion-Beam Therapy Center (MIT) 28

Shared Contract of Service with an Industrial-Supplier of a Particle Therapy Facility . . . 28

Reliability of a Compact Carbon Ion Medical Accelerator 29

Availability Considerations for an Accelerator System Based on the LHC Power Converter Controls 29

Jefferson Lab Reliability Task Force 30

Age Related Failure of K1200 Cyclotron Electrode at National Superconducting Cyclotron Laboratory 30

A Long Term Reliability Challenge at the RHIC 31

Experience with the KEKB/SuperKEKB Magnet Cooling Water System 31

Gradient Maintenance at Jefferson Lab 31

Effort for the Reliable Operation in J-PARC Rapid Cycling Synchrotron 32

Analysis of High-Intensity Proton Accelerator Availability over the Last 15 Years of Operation at PSI . . . 32

Machine Protection Analysis for Increased Availability at ESS . . . 33

Radiological study of the nuclear facility S3 of SPIRAL2 . . . 33

Director's Welcome . . . 33

IOC chairman's Welcome . . . 34

LOC chairman's Welcome . . . 34

Closing Remarks . . . 34

Next WAO and ARW Announcements . . . 34

Workshop Highlights . . . 34

Picture Award . . . 34

Parallel Session Summary . . . 35

02- Availability Tracking and Metrics / 85

Common Operation Metrics for Storage Ring Light Sources: an Update

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There are a lot of storage ring light sources operational, and users, funding agencies and others compare these light sources. If different light sources are compared, one important parameter is the beam availability. A meaningfull comparison of availabilities is only possible if the numbers are calculated the same way.

At ARW 2013 in Melbourne a group of operations managers began to develop ideas for a common operation metrics for storage ring light sources. The feedback from 7 different labs went into a common definition of the main operational parameters of light sources. 2016 a paper was published in PhysRev, introducing this common operation metrics.

This talk will give an update on this initiative.

02- Availability Tracking and Metrics / 72

Creation, Tracking, and Reporting of Reliability Statistics at the APS

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The Advanced Photon Source is a third generation light source that consistently provides beam reliability above 98% with MTBF in excess of 90 hours. This presentation will show how we use automated tools to acquire and interpret reliability data and how that data is used to prepare reports on machine reliability.

02- Availability Tracking and Metrics / 93

CERN's approach to availibility tracking and metrics

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The consideration of availability tracking and availability metrics at CERN differs significantly between different parts of the organisation. Equipment experts are predominantly concerned by equipment failure rate and repair time. Operators are concerned by the amount of time which is lost due to faults. Physicists are concerned by the amount of physics which is lost due to faults.
Over the course of the last 10 years CERN has developed several different approaches and metrics to deal with these different viewpoints. This paper will attempt to highlight some of these different approaches, and to explain the basic metrics that are used in colliders, such as the LHC, which differ to the concepts used in light sources.

03- Reliability Before Design / 79

Dependability Studies Towards Optimized Accelerator Performance

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Dependability studies are of fundamental importance for the performance of particle accelerators. The possibility of influencing such performance is nevertheless significantly higher (and more cost-effective) if studies are carried out in the early stages of a project, at the beginning and throughout the design phase. Developing dependability models to predict the evolution of key performance indicators as a function of system parameters (failure rates, repair times) can give hints towards an optimised approach for accelerator design. This contribution discusses a general approach to dependability studies for particle accelerators with examples from the CERN experience.

03- Reliability Before Design / 36

Designing for Reliability of the TRIUMF Pneumatic Radioisotope Transfer System

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To illustrate TRIUMF design practices I will detail a project that I have undertaken to upgrade an underground pneumatic transfer system connecting a TRIUMF radioisotope lab to the UBC hospital 2.7 km away. In order to enhance our research program this system required an electrical, mechanical, and controls upgrade to provide isotopes to a second facility in addition to the hospital. It is important that the rabbit line works reliably as patients requiring PET scans can be very sick and highly immobile, making rescheduling difficult. Reliable radioisotope delivery is also necessary for time-sensitive research and to ensure that radiation safety is maintained. I will speak about the Product Development Process steps that I have used to design for reliability, emphasizing FMEA risk analysis with a focus on reliability and safety during the design review process. Additionally, I

have heavily incorporated safe-guards against operator error into the control system. This human aspect must be addressed early in the process to minimize risk and must be uniquely addressed in a dynamic, operator-controlled system to ensure reliability.

03- Reliability Before Design / 53

High Availability at ESS: Lessons Learned During the Design Phase

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The European Spallation Source ERIC is currently under construction in Lund, Sweden. One of the main requirements for this facility is to have high operational availability in order to compete with the highly reliable performance of the nuclear reactors that it is intended to replace. During the last years, the design of the different subsystems has been crystallising and going through design reviews, prototyping, tests, etc. These subsystems are now in different states depending on their installation schedule, but the design, construction and installation steps are rapidly advancing. During this process, the dependability aspects (Reliability, availability, maintainability, inspectability…) have been analysed and discussed and, in some cases, the outcome of those studies led to changes in the systems. The process, the main outcome of the analyses and finally the lessons learned during this process will be presented in this contribution.

05- Infrastructure / 41

The Nuts and Bolts Affecting Accelerator Reliability

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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. A recent lab-wide initiative to improve the electrical connections from power supplies to room-temperature and superconducting magnets called for the replacement of stainless steel bolts with bolts made from materials with better electric conductivity. The presentation will provide insight how using a single inadequate 5-dollar part in the electrical infrastructure system can cause a catastrophic $500,000 damage, forcing the facility into a 2-month shutdown. Lessons learned and preventive programs from the incident will be presented.

05- Infrastructure / 54

Current status of J-PARC accelerator infrastructure

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The J-PARC facility has been running an accelerator since 2007 and it has been about 10 years since. Since the facility is close to the coastline and is built on soft ground, it was hit hard by the 2011 Great East Japan Earthquake. Maintenance of various infrastructures is required due to aftereffects and aging. In this report, we will report on the current situation of infrastructure (buildings, electric power, cooling water, air conditioning etc.) of J-PARC accelerator. We will also introduce future efforts to reduce the failure rate of equipment.

05- Infrastructure / **39**

LHC Cryogenic Infrastructure Reliability, Towards High Availability

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The operation of the LHC accelerator requires a large cryogenic infrastructure composed of eight cryoplants at 4.5 K, eight units at 1.8 K and the associated cryo-distribution, supplying each ring sector and using a variety of equipment with over 3'500 operating conditions to manage. In order to maximize the availability of the machine and meet the requirements for physics, constant attention is required on cryogenics and its operational margins, which are highly dependent on several phenomena among them the electron-cloud heat loads originated from the beams, requiring careful management.
In this workshop, we will describe the LHC cryogenic system architecture and the reliability management using basic functional analysis and identification of critical failure modes. We will explain anticipated operation scenarios that can be set to mitigate, when possible, occurrence of failures. We will highlight the observed main failures in the past years and actions taken to either prevent or mitigate risk of occurrence. Finally, we will discuss ongoing work to collect detailed failure data during operation, in order to improve continuously the overall availability of the cryogenic system.

06- Accelerator Systems / **42**

The Cryogenics of the ISAC-II Superconducting LINAC at TRIUMF

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The ISAC-II LINAC at TRIUMF employs superconducting RF cavities to accelerate heavy ions to high energies efficiently. Keeping this accelerator functioning consistently means that its supporting cryogenics system must be kept working dependably and the aftereffects of detrimental events, like site power disruptions and cavity quenching, must be reduced to a minimum. Improvements and upgrades are implemented to enhance its reliability as new things are learned. This presentation will cover how this is accomplished at the ISAC Facility at TRIUMF.

06- Accelerator Systems / 45

Improvements to Trim Coil Power Supplies at TRIUMF

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The TRIUMF 520 MeV cyclotron requires a precise magnetic field in order to operate. 55 pairs of trim coils allow small corrections to be made. In 2013, the ageing 110 trim coil power supplies were replaced with new switch mode power supplies. This greatly improving reliability and performance.

Trim coil tuning is accomplished by making small changes to individual coils in an effort to improve cyclotron performance. Some of coils run near their power supply limits, making further changes difficult. An application is currently under development that will optimize the power supply settings while maintaining the initial magnetic field. The goal is to reduce the output of the power supplies and increase the available range for tuning.

The initial tests of the program show encouraging results. Possible errors exist in the underlying magnetic field data that may need to be resolved. Further improvements are still in development.

06- Accelerator Systems / 64

SOLEIL Experience with RF Solid State Power Amplifiers (SSPA's)

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SOLEIL has pioneered the use of RF solid state power amplifiers (SSPA's), 1 x 35 kW in its Booster and 4 x 180 kW in its Storage Ring at 352 MHz. After 11 years of operation, these SSPA's, which were developed in house, have demonstrated that they could advantageously replace the vacuum tubes in such CW application thanks in particular to their inherent modularity/redundancy, the absence of HV and their very low phase noise. Further R&D, carried out at SOLEIL, allowed improving the original design in compactness, reliability and efficiency along with the extension to other frequencies. Following the success of the SOLEIL SSPA's, several accelerator facilities expressed their intention of adopting this technology, which led SOLEIL to share its experience in this domain through scientific collaborations and technology transfers (ESRF, LNLS, SESAME, ThomX, LUCRECE, …). Since 2014, the French company SigmaPhi Electronics is the unique SOLEIL licensee. SSPA technology has now reached maturity; in addition to SOLEIL, SSPA's have run for more than 5 years in ESRF at 352 MHz, LNLS at 476 MHz, ELBE at 1.3 GHz, and the operational experience feedbacks are excellent. It is being adopted by many other accelerator facilities and taken up by the industry for applications ranging from the FM to L band with power from a few 10 to few 100 kW.

06- Accelerator Systems / 66

Magnet Power Supplies for SuperKEKB Main Ring

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The first beam commissioning of the SuperKEKB has finished in June 28, 2016. Almost all the magnet power supplies in SuperKEKB were reused ones of KEKB main ring. Some of the power supplies were improved to satisfy the requirements of optical design, and some of them were replaced by new power supplies. Several tests were performed for all of the power supplies to check the soundness. The total number of the power supplies is about 2500. Several failures of the power supplies were happened and they stop the beam operation during the first beam commissioning.

07- Accelerator Control / 73

Continuous Delivery Workflow for Machine Protection Control Software: Feedback, Lessons Learned and Next Steps

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The Machine Protection Software Team has been using a Continuous Delivery workflow for numerous years, covering shutdown and physics activities of the LHC. This continuous delivery workflow relies on numerous practices that are necessary to ensure the automated validation of the software products: unit tests, automated user acceptance tests, static code analysis, quality tracking, etc. This workflow brings ease and confidence for the deployment of the software products. Some challenges are however left unaddressed for the time being, like how to integrate a continuously delivered set of dependencies into a product that doesn't implement continuous delivery. We propose to present the implementation of the continuous delivery workflow, its outcomes for the development team and for the product users, and the current limitations and the questions that are left unresolved.

07- Accelerator Control / 84

LIPAc Control Systems and Reliability Improvement

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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 qualify 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), currently under commissioning at Rokkasho (Japan), will accelerate a 125mA CW and 9MeV deuteron beam with a total beam power of 1.125MW.

The LIPAc Control Systems are supplied by three European labs (CEA, CIEMAT and INFN), coordinated by F4E as European Implementing Agency, together with QST as Japanese Implementing Agency for the central control systems (including MPS & PPS).
Although IFMIF engineering design demands high availability figures, being LIPAc a prototype accelerator reliability figures were not formally assessed during the design stages. Currently, LIPAc's potential upgrade towards the required neutron source for fusion is under serious consideration by EU and Japan. This involves reliability analysis on operational data of subsystems already commissioned to identify potential improvements for future operation.

07- Accelerator Control / 27

The Use of PANIC Alarm System at ALBA

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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 and decreasing the time to recover the beam. . Here we present our experience with PANIC; an alarm handler that puts on alert the accelerator control room crew when a subsystem or a beam parameter drifts away from its nominal values. PANIC is completely integrated in the Tango control system and can be easily configured by the final user. The notifications are sent out by SMS, email or loudspeaker in the Control Room. Other actions like moving motors or launching scripts have also been configured as a response when an alarm is activated. In this contribution we will show you some of the examples developed at ALBA and how they helped to improve the machine availability.

08- Failure Investigation / 30

TRIUMF Failure Investigation Tool

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TRIUMF uses the TapRooT® System for failure investigation. TapRooT is a systematic process for finding the root causes of problems: major accidents, everyday incidents, minor near-misses, quality issues, human errors, etc
In my talk I'll introduce the TapRooT system and illustrate its use for the investigation of failures.

08- Failure Investigation / 33

Vibration Analysis of Dipole Magnets Using Piezoelectric Accelerometers in the ISIS Synchrotron

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Dipole magnets at ISIS are utilised in the Synchrotron particle accelerator to steer the 800MeV proton beam and maintain a circular trajectory within the 163m ring. Such is the importance of these magnets that failure of a single Dipole terminates the beam current, resulting in costly machine downtime. ISIS currently employs a simplistic form of condition monitoring to assess magnet health using a vibration meter to inspect pre-set locations across selected magnets before each cycle. This paper discusses a new condition monitoring scheme that utilises piezoelectric transducers and data acquisition technology, to perform real-time vibration monitoring and analysis, improving beam availability. In our feasibility study, two dipole magnets were instrumented and data acquired across two cycles. Proven analytical methods were applied and results showed initial characterisation to understand vibration modes. The challenges of operating the sensors in a high-radiation environment with large B fields, safety benefits of monitoring remotely, detail of the methodology, implementation, data acquisition, results and the aspirations to roll out this idea across the whole of ISIS are covered.

08- Failure Investigation / 37

Failure Analysis at BEPCII

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The Beijing Electron Positron Collider II (BEPCII) is a double-ring e+e- collider running in the tau-charm energy region (Ecm = 2.0-4.6 GeV), with a design luminosity of 1 × 1033 cm-2s-1 at the beam energy of 1.89 GeV, which had been achieved on April 5th 2016. The failure analysis system of the BEPCII has two subsystems to get the designated signals when the beam loss: the multiple channel recorder of the RF system and the beam loss diagnostic system based on the bunch by bunch beam position measurement. The causes behind the failure can be identified through the beam dynamics analysis. The failure analysis system can improve the reliability of the BEPCII. Two cases will be represented in this talk.

09- Maintenance for High Reliability / 92

Maintenance and Upgrades at Brookhaven National Laboratory's Collider Accelerator Department

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The Collider Accelerator Department (CAD) at Brookhaven National Laboratory, which includes the Relativistic Heavy Ion Collider (RHIC), has been in operation for 57 years. For the past 17 years, production at RHIC has been the major focus, but new goals loom on the horizon. In this paper and presentation, I will discuss, compare and contrast early methods to those used in the modern era here at CAD. I will focus on the challenges of maintaining both old and new systems with an eye on

the future. In addition, methods for coping with the many faceted challenges of installing new and upgrading old equipment for a major construction period while maintaining the ability to deliver product for the current users will be discussed. Other topics including scheduling, coordinating, planning, documenting and reviewing all phases of work will be touched upon.

09- Maintenance for High Reliability / 29

Improving the Reliability of the Accelerator Facility at iThemba LABS

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iThemba LABS will be celebrating 30 years of operation with the K200 separated sector cyclotron (SSC) in 2017. This accelerator has produced charged particle beams for radioisotope production, nuclear physics research and medical radiation therapy very reliably over the years. iThemba LABS also operates two electrostatic accelerators. As a result of aging equipment, the number of interruptions to the scheduled beam delivery has gradually increased. This situation has been compounded by external influences such as power failures and interruptions to the water supply. To curtail the amount of downtime the facility has had to embark on a dual approach to limit interruptions to the scheduled beam delivery. The first approach entails replacing obsolete and inefficient infrastructure. Examples of such aging infrastructure are the chiller plant and Van de Graaff accelerator. The other approach is to upgrade outdated infrastructure. An example of is the control electronics upgrade, as well as moving the control system onto an EPICS platform. Details of these interventions will be presented as well as their positive impact on the reliability of the facility.

09- Maintenance for High Reliability / 48

Planning and Tracing a 2-year Long Shutdown Period

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The GSI Helmholtzzentrum für Schwerionenforschung GmbH at Darmstadt, Germany, operates three accelerators, the main linac UNILAC (UNIversal Linear ACcelerator), the heavy ion synchrotron SIS18 and the experimental storage ring ESR. The 'Facility for Anti-Proton and Ion Research' (FAIR) which is presently under construction, extends and supersedes the existing GSI. Major service and upgrade measures of the GSI accelerator facilities were started in 2016 and will be continued until mid-2018. They are in conflict with large civil construction projects in preparation of FAIR and with refurbishment projects for the technical infrastructure of existing buildings. Furthermore, during the shutdown, several new projects were started, while others had to be canceled. The planning tools and communication structures have been adapted with the experience of the 2013 shutdown, to monitor actual progress, and adjust the schedule when necessary. In this presentation, we will show how this enabled us to react to unexpected incidents and to deal with the additional challenges of long-term projects.

10- Invited Speaker / 98

Reliability of Space Instrumentation

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Space-borne instrumentation has entered a maturity age with standards, methods and workmanships that grant instrument lifetimes exceeding ten years without maintenance. This has been achieved through the adoption of a common technical reference imposed by space agencies to all segments of a space mission.

I will shortly expose this reference with associated methods and how our lab (Astrophysics Dept of CEA-IRFU) has implemented it on the instruments of the Euclid ESA mission to be launched in 2020.

I will in particular discuss the following aspects, covering all steps from the initial definition of the architecture of the instrument, to the detailed design and manufacturing of its subsystems:
- The reliability apportionment from top level to subsystems, with trade-off of architectures, and detailed reliability analysis of subsystems
- The Failure Mode Effect Analysis, with early identification of failure tolerance requirements, and detailed FMEA analysis at subsystem level
- The part-stress and worst-case methods, aimed at limiting the wear-out of components and predicting the ageing drifts of critical functions
- The control of procurement (components, manufacturing processes).

10- Invited Speaker / 104

Round-table Discussion

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Round-table discussion about Reliability, maintenance, quality in Accelerator, Self-driving car, space-borne instrumentation.

10- Invited Speaker / 110

Dependability and Driving Delegation

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Automotive has since long faced the need for a strong reliability, leading to cars that seldom fail and have enlarged maintenance intervals. The subject was complexified when electronics entered in

the automotive controls, requiring to elaborate specific methods, processes and tools to handle the dependability in all its aspects:

- Reliability, through management of the reliability of the electronic components with specific requirements
- Availability, through "back-up" modes allowing to be tolerant to some failures
- Safety, through dedicated analysis of the specifications and the related implementation (ISO 26262).

With this respect, I will briefly present the status of automotive domain, and then more specifically discuss the impact of driving delegation.

Driving delegation addresses the more general scope of "Autonomous vehicle". I will elaborate on some other fields that are investigating the autonomous move, and I will focus on the main topics that need to be considered, and how to reach the maturity and confidence for deployment:
- Technical aspects of the vehicle and the infrastructure
- Legal and responsibility aspects
- Human factors
- Transition period

11- Poster Session / 31

Operation Scripts

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The ALBA Synchrotron is a 3Gev, third generation synchrotron light source located near Barcelona (Spain). The accelerators are typically operated 6000 h a year, with closed to 80% of the time dedicated to provide beam for users. In addition to ensure a successful routine operation, the operators develop Python scripts and GUIs to simplify the Control Room procedures. These scripts are mainly focus on automatizing routine actions like checking machine parameters after a shut-down, opening/closing IDs, sequential actions to switch off the accelerators when going into a shut-down, among others. This poster will present a summary of these scripts

11- Poster Session / 63

Magnet Power Supplies Reliability Improvements at SOLEIL

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Maintenance and upgrades of the magnet power supplies are a critical consideration for our facility since the injector complex is already 10 years old and main of the storage ring equipment are approaching the same age.
This presentation first focuses on the main maintenance operations carried out on these systems, which represent more than 600 power converters. Two important reliability improvements implemented on the Booster 3Hz power supplies and on the Storage Ring quadrupole power supplies are then detailed.
Finally, the in-house construction of new spare power supplies, in order to improve the equipment

availability, is presented. The strategy adopted regarding the spare parts for the whole of our equipment is also examined.

11- Poster Session / 69

Availability tracking at PETRA III

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The basis for machine reliability investigation is a reliable operation statistic. At Petra III we recently implemented a new control system feature to generate the statistics automatically according to predefined rules. Here we describe the key components and tools: a beam operation calendar for definition of the planed machine status, the central logic to generate the actual machine state and the OperationHistoryViewer as the flexible tool to view and, if necessary, correct the results.

11- Poster Session / 58

Refurbishment of the the DEE on a Cavity for a Compact Cyclotron

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This project relates to the restoration of the copper electrode of a resonator at GANIL. It makes following important problems of corrosion of the copper pipes.

- Refurbishment of the DEE of a cavity in cooper for a compact cyclotron
- Thermal computation
- Implementation
- Manufacturing
- Three axe control
- RF qualifications
- Commissionning

11- Poster Session / 49

Operation Reliability of SSRF in the Last Operation Season and upgrade plan at SSRF

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The Shanghai Synchrotron Radiation Facility (SSRF) has opened to user for eight years, and the performance has been improved continuously to satisfy the users' needs. The operation performance and the reliability of SSRF have been kept in high level to provide users sufficient and stable synchrotron radiation laser. The report will focus on the operation performance of SSRF in last operation season, and the analysis of reliability is also shown in the report. In addition, the upgrade program of SSRF accelerator will be brief introduced in the report, including superbend, double-waist lattice, and electric power stabilization, the phase II beamline project with more than 20 new beamlines will be constructed with next 5 years.

11- Poster Session / 60

Utilization of Trend Data for Reliable Delivery of a Treatment Beam

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Most important ingredients of reliability in particle-therapy accelerators like HIMAC are reproducibility of a treatment beam as well as prevention of unexpected down time.
In order to realize reliable operations of medical accelerators, we take trend data of many parameters. For example, water flow of magnets has been readjusted during biweekly maintenance according to recent trend data, so that we could prevent interlock by flow-meters.
Analyzing trend data in the long term may be more important and rewarding. It was known that a treatment beam has faint fluctuations in a beam position, as measured by beam monitors. Due to this fluctuation, correction of a position had to be frequently made by steering magnets. By taking long-term trends and analyzing them, we found that this fluctuation would have seasonal characteristic. Thus, we optimized parameters of the steering magnets to minimize the effect of the fluctuation, and hence eliminated frequently retuning.
This and other cases will be discussed in the present report, together with future prospects.

11- Poster Session / 88

13 Years of Development - Machine Reliability at the Canadian Light Source

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The Canadian Light Source had first light in 2004 and has been shining since then. Achieving high operational reliability and availability is done through periodic monitoring of benchmark statistics and having a responsive organizational structure that can push these statistics in the right direction. Reliability is further enhanced through mitigating the risk of infrastructure failures and prior-

ity management. Here we report our historical operation statistics and provide some catastrophic highlights that have motivated risk mitigation.

11- Poster Session / 83

Increasing Operational Efficiency by Re-Evaluating and Improving Obsolete Operational Processes

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Often in well-established facilities, operational processes have not been reevaluated since their infancy. Some of these processes must be re-evaluated to increase performance, efficiency, and maintain reliability. Los Alamos Neutron Science Center (LANSCE) supports a fast neutron target that must be replaced every two years and aligned to the beam path. The previous alignment process required significant amount of effort and resulted with sometimes less than desirable results. To improve target performance and operational efficiency, the alignment process was re-evaluated and an alternative process was developed. The developed alignment device has significantly reduced the amount of effort, greatly improving operational efficiency and target position repeatability.

11- Poster Session / 81

Beam Drift at a Secondary Electron Emission Monitor Used for Dose Control in Carbon-Ion Radiotherapy

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In our therapy center, accelerators (linacs and the synchrotron with the maximum energy of 400MeV/u) have been dedicated for carbon radiotherapy. The number of treated patients has exceeded 2,000 in this May.
The beam extracted from the synchrotron is transported to each treatment room and at upstream of the irradiation devices, a couple of dose monitor are located to control the dose deposition on a target. The dose monitors are secondary electron emission type in consideration of the high beam intensity. After about 4 years' operation, their sensitivity have gradually changed as the beam go through, which came out certain position dependence at the monitor.
On the other hand, extracted beam position on the monitor is slightly shifting during daytime operation with its length of around 1mm. The cause of the drift seems to arise from the closed orbit variation of the synchrotron.
Both behaviors combine and adversely affect the dose deposition. It's undesirable for the patient treatment.
In this study, we present these changes (sensitivity of the monitor, daily drift of the beam position) and their impact on the dose deposition.

11- Poster Session / 74

Scroll Pumps "on Demand" Usage for Reduction of Operating Costs.

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TRIUMF is Canada's national laboratory for particle and nuclear physics and accelerator-based science. The facility produces and delivers a variety of beams to targets and experiment stations through beam lines. The total length of beam lines operating at TRIUMF is about 700 meters. The vacuum in these beam lines is supported by turbo pumps backed by scroll pumps. There are more than 65 scroll pumps operating continuously and TRIUMF spends more than 50 days of maintenance related activities per year. A new mode of operation, permitting the usage of the scroll pumps only when they are needed was proposed, tested and it is in process of implementation. The savings in reduced maintenance activities and electrical power consumption are expected to exceed 50%. Details of the new operating mode will be presented.

11- Poster Session / 68

Maintenance Method for Stable Operation of a Superconducting Rotating-Gantry

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At National Institute of Radiological Sciences (NIRS), carbon-ion radiotherapy has been carried out since June 1994. Recently, the world's first superconducting rotating-gantry was developed, and further installed in the new treatment facility at NIRS. This gantry equips ten superconducting magnets, and can transport carbon ions to an isocenter over irradiation angles of between ±180 degrees. For cooling of the superconducting coil in the magnet, cryocoolers are employed; each magnet has three or four cold heads of cryocoolers, and totally 34 cryocoolers were employed for the ten magnets. The cryocoolers have to be continuously operated, however periodical maintenance of cold heads and compressors is required for every 10,000 and 30,000 hours, respectively. In the spring of 2017, we carried out the first maintenance of all the cold heads, while conducting the beam commissioning of the gantry before treatment operation starts. Having replaced and maintained all the cold heads, the superconducting gantry is now in clinical use since May 2017. In this presentation, we will introduce the maintenance method for stable operation of the cryogenic system for the superconducting gantry.

11- Poster Session / 59

SOLEIL Maintenance Management

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SOLEIL is the national French synchrotron, in operation since 2007: 27 beamlines provide photons to the users more than 5000 hours. For this instrument that operates a 24/7 beam and whose availability rate is of over 98%, the issue of maintenance is essential. First, it is necessary to ensure optimal operating condition because the equipment is becoming older and older. Then, preventive maintenance helps to optimize operating costs and to free up time for resources. Very implicated in this issue, SOLEIL has set up in 2011 an international Workshop, « Asset and Maintenance Management ». Then SOLEIL decided to undertake concrete actions, after having pointed out a main deficiency: the lack of a general maintenance policy. One of these actions consists in implementing a "criticality matrix", not only to identify the most critical equipment, but also to track them and to anticipate further deterioration. The objective is now to share these methods in the whole Synchrotron. So it appears that the implementation of a "maintenance management" goes through the specification of processes, organization and methods. All these parameters contribute to the excellence of the facility reputation.

11- Poster Session / 86

Evolution of an Alarm System: Merging Old Accelerators with New Installations

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The Collider-Accelerator Department's Main Control Room Operators at Brookhaven National Laboratory have long used an alarm display as a first-line diagnostic for failures in our accelerator chain, as well as a tool to prevent or minimize downtime. Our method of monitoring and tracking alarms has evolved as the accelerator complex has grown, and with new systems being commissioned the burden of sorting through relevant alarms has increased dramatically. This presentation will discuss: our strategy for alarm management, our current issues with integrating new installations, nuisance alarms, and dealing with high volumes of alarm data.

11- Poster Session / 76

Operational Experience with the SOLEIL Storage Ring RF-System

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Using HOM free superconducting cavities and high power solid state amplifiers, both developed in house, the SOLEIL storage ring 352 MHz RF system was quite innovative. After more than ten years of operation, it has proved itself; the assessment of the operational experience and of the upgrades which were brought in are reported here.

11- Poster Session / 40

Main Control Room: Upgrade Measures in Preparation for FAIR Phase 0

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The existing GSI Main Control Room (MCR) is used for the accelerator complex operation since 20 years. In this time no major updates to its equipment and layout have been done. As its design, size and functionality cannot meet the requirements for running the upcoming FAIR accelerator facility, the planning for a modern fully digital control room is presently ongoing. The construction of a new building is planned for around 2020. However, the research program for FAIR Phase 0 is to be carried out at GSI next year. The main challenge of Phase 0 is operation of all machines, except UNILAC, with a new control system. The old console design is not suitable for that. In order to be prepared for the digitization and the move to the FAIR-MCR, it was decided to modify the existing control room and make it ready to test the console prototypes for the future FAIR-MCR in operation already next year. The upgrade project, the progress and the challenges of dismantling the analogue technology without limiting the functionality for the operation are presented here.

11- Poster Session / 90

Reliability of the Taiwan Photon Source

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Taiwan Photon Source (TPS) is a newly deployed 3 GeV synchrotron light source. Reliability design have been considered at design phase. Adopt right technology, adequate redundancy, enough safety margin are used to ensure acceptable reliability. However, some subsystems inherent operate in reliable way but some not due to various reasons. The light source was operate for dry run, beam-line commissioning, and pilot experiments during March-June, 2016. User service started from September 2016. Reliability is not good during early operation. Improvement of subsystems and reduce troubleshooting efforts to minimize downtime were achieved after analysis causes of various unreliability events and to do adequate actions. Various diagnostics tools were employed to record related signals at the event happened. These diagnostic tools can capture various signals for post-mortem analysis. Lessons learned from these events teach us how to manage reliability of the accelerator system. After the efforts for last two years, reliability of the accelerator system improved drastically since operation of the TPS. Some unreliable scenarios, efforts to improve and plans for future will be summarized.

11- Poster Session / 89

MCO Strategy to Maintain High Level of Reliability for Control Systems Electronics

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SOLEIL control system is running for 10 years on accelerators and beamlines. It has been designed with an object-oriented architecture both for software and hardware. Electronics devices have been standardized by functionalities allowing to build the control system with a "LEGO" approach. These electronics connected to the Tango framework are mainly based on industrial off-the-shelf devices: Siemens PLC, cPCI industrial computer and motion controller Galil or DeltaTau. Over the last 10 years of operation, these systems have proven their reliabilities. The MCO strategy based on a continuous upgrade of the systems allows us to maintain with agility and flexibility the control system. This approach permits us to operate safely while improving performances of the electronics. This poster will describe the strategy of the controls group working on preventive maintenance they are in charge, for about 7000 devices in operation, the method to continuously upgrade these systems based on the same technology. A focus will be done on the challenge we are facing to renew the technology which becomes out of date while maintaining the same level of reliability for operation.

11- Poster Session / 75

Reliability of J-PARC

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The Japan Proton Accelerator Research Complex (J-PARC) is a multipurpose facility for the physical experiments. The J-PARC facilities were constructed in the Tokai site of the Japan Atomic Energy Agency (JAEA). The accelerator complex consists of a linac, a 3 GeV Rapid-Cycling Synchrotron (RCS), and a 50 GeV Main Ring synchrotron (MR). RCS delivers the beams to the neutron target and MR, and MR delivers the beams to the neutrino target and the hadron experimental hall. At the beginning, the beam commissioning of the linac started in November 2006. Construction of another accelerators and experimental facilities were continued afterwards, the user operation of the neutron experiments was started in December 2008. In January 2009, we achieved slow extraction for the hadron beam line. The regular neutrino experiment was started in January 2010 to take the physics data. After that, we continued user operation but had some accidental suspensions. We summarize the reliability of J-PARC, the accidents and major causes of suspensions.

11- Poster Session / 65

Improvement Towards Reliable Beam Operation in Indus-2 Storage Ring

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Overall machine reliability and availability are important objective of any accelerator and that depends on individual components reliability and skill of operators. However, the only presence of beam in a storage ring is not adequate enough to validate a reliable operation, but providing beam with desired quality is utmost important for the synchrotron radiation source serving a large and diverse user community. Various steps are taken to improve the beam availability and reliability of Indus-2, and these are discussed. Improved beam diagnostics, software applications and training imparted to operators plays the major role in achieving high beam availability in Indus-2. The beam availability and the machine downtime analysis along with subsystem failure is also presented.

11- Poster Session / 57

LINAC Accelerators - Design for Reliability

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Empresarios Agrupados (EA) has been contributing to different EU funded projects regarding the reliability of high-power particle accelerators. Previous projects are the Eurotrans/Max project and studies currently continue with the activities for the Myrte project. For the Myrte project the reliability of the Myrrha Linac is taken into account from the early design stage, using relevant data from existing machines (SNS LINAC) and machines presently being commissioned (CERN LINAC4).
This paper will briefly present the SNS Risk Spectrum model developed as a tool for reliability modelling of the Myrrha Linac concept design and the main results & conclusions of reliability analysis performed using the two models (during FP7 MAX project). As a second topic it will present the reliability modelling and the reliability run of LINAC4 (CERN), with the objective to extend conclusions & formulate recommendations to Myrrha Linac case: compiling Reliability Database (failure data), modelling tools/models and optimization proposals (preliminary).

11- Poster Session / 47

Root Cause Analysis Experience, Highs and Lows.

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Overall since starting to use RCFA on all trips we have seen our annual MTBF increase from around 24 hrs to above 100 hrs.
However we have mixed experience with reactions to requiring a root cause failure analysis is performed on all major systems failures on Diamond. Ideally we get clear identification of the causes and a practical set of actions to address them, but this is not always the result. The less successful results we can get are either :- An over simple evaluation of problem, or a failure to focus on key issues resulting in a very long list of speculative actions, or an assumption that the problem has already been looked at as far as possible.
Which leads to the question how can we improve the way we run the process to continue to get a useful analysis more often?

11- Poster Session / 43

Operation Status and Upgrade Projects for HEFEI Light Source

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Hefei Light Source (HLS) has successfully finished a major upgrade project and has been officially opened to users since January 2016. The planned operation time of the year 2016 for Hefei Light Source is 7008 hours and the planned user time is 4752 hours. The actual operation time and user time is 7009 hours and 5019 hours, respectively. The machine down time is much less than the planned one, which leads to a high availability of 99.03%. The mean time between failures (MTBF) then comes to 91.26 hours. Before the upgrade project, the operation for HLS adopts current decay mode. The injected beam from the 200 MeV linac needs to be energized to 800 MeV through ring energy ramping. After the upgrade project, we now have the ability to operate Hefei Light Source in the top-off mode since the injector energy is raised to the ring energy. The main challenge for the top-off operation is to control the radiation dose for personal and equipment safety. This requirement can be met by increasing the injection efficiency and enhancing the radiation shield. This project can further increase the performance of Hefei Light Source as long as the reliability and stability of its operation.

11- Poster Session / **44**

Dependability Study of the Large Hadron Collider Beam Loss Monitor Optical Link and Comparison to the Next Generation Link under Development

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The primary function of the Large Hadron Collider beam loss monitoring system is to protect the accelerator components from damage due to unacceptable beam losses. It acquires data from 4000 ionisation detectors distributed along the accelerator tunnel using radiation tolerant front-end electronics linked to surface electronics that perform continuous real-time processing. To connect these two parts approximately 1400 optical links transmit more than 3×10^7 packets per second. Combining an extensive dependability study and many years of operational experience, this large and distributed system serves as the basis for developing a new link for future upgrades. This next generation link will employ the best performing parts of the existing system, but also introduce new, redesigned parts such as the surface transceiver module. The design differences with related advantages and disadvantages are compared, and two failure rate predicting models are presented including a sensitivity analysis for the observed failure mechanisms based on operational data.

11- Poster Session / **35**

Reliability of the GSI / FAIR Facility After a Long Shutdown Phase.

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The 'Facility for Anti-Proton and Ion Research' (FAIR) which is presently under construction, extends and supersedes the existing GSI. In July 2016 began longest shutdown GSI has ever seen. The main work package is the civil construction project GAF (GSI Anbindung an FAIR, Link of GSI to FAIR) which comprises additional shielding of SIS18,fire protection measures, as well as the connection of the new beam line between FAIR and the existing GSI facility. During construction work of the GAF project the SIS accelerator components are inaccessible. Therefore, maintenance and repair work on the kicker and on RF cavities was scheduled at the beginning of the shutdown and finished before the start of GAF. The modernization of the post stripper RF system which need regular test periods are in conflict with the refurbishment of the HVAC system (Heating, Ventilation and Air Conditioning). Another import project is the retrofitting of the FAIR control system to SIS18, ESR and HEST. Careful coordination of those projects is mandatory to finish in time for the beam time 2018. The planning and monitoring of the most important shutdown projects and the reliability of the system will be presented.

11- Poster Session / 102

Radiation Damages and Characterization in the SOLEIL Storage Ring Tunnel

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After six years of operation, equipment located close to some vacuum chambers of the SOLEIL storage ring started to show unexpected damages due to radiation. It has been pointed out that, around the so called "quadrupole" vacuum chambers that intercept upstream dipole synchrotron radiation, X-rays are emitted. Their energy is too high to be significantly attenuated by the 3mm aluminum of which the vacuum chamber is made. Diagnostics and means used to understand and characterize this radiation are presented in this poster.

11- Poster Session / 101

Reliability of Water Cooling Systems on Radio-Frequency Modulators of the Industrial LINAC Accelerators

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The high frequency power provided by high-voltage modulator designed with vacuum tubes, serves to accelerate the electron beam in the section formed by copper cavities. Some of the remaining power is dissipated in the cavities and metallic components of the modulator such as PFN, tubes, power supplies.

These components are cooled by a circulation of water. The importance of regulating the temperature of the cooling water is to maintain the same temperature in the cavities and in highpowercomponents. Thisisanimportantfactorinmaintainingfrequencytuning.
The design and sizing of the cooling system must take into account the influence of ambient temperature, the nature of the water used, the power generated by the accelerator and other important factors.
Based on a history of our Linac accelerator, this work will focus on the cooling problems that may affect reliability of radiofrequency modulator installed hot-cavity accelerator.

11- Poster Session / 96

SOLARIS Facility Operational Status

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SOLARIS is a National Synchrotron Research Center built at the Jagiellonian University Campus in Krakow, Poland. It is a green field project that was funded from the EU Structural Funds with the total budget of 50 M€ covering the cost of the building, people, 600 MeV linac with the transfer line, 1.5 GeV storage ring with the circumference of 96 m and two beamlines. The machine was constructed in 2015 thanks to the unique cooperation with MAXIV Laboratory in Lund, Sweden. The project was officially terminated in December 2015. Since March 2016 Solaris became CERIC part and achieved the operational funds from Polish government for 5 years. Recently the funds for next two beamlines were allocated.
Currently the commissioning of two experimental beamlines is performed. The plan is to start the user operation in mid of 2018. By this time the focus is on increasing the performance of the storage ring and existing beamlines, as well as purchasing the strategic spare parts, to build up the expertise team and implement the tools and procedures allowing for the reliable operation in the future.

11- Poster Session / 100

SOLEIL Operation and Adaptation to the New Common Metrics

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Synchrotron SOLEIL is the 3rd generation French synchrotron light source. In operation since 2007, it provides photon beams to the 29 beamlines in operation whose intensity can reach 500 mA according to the filling (5 different modes are available).
After early age failures, the efforts to improve the reliability of the equipment and the availability of the beam contributed to bring us close to the target objectives, namely 99% availability and 100 hours of MTBF. We are going to present the evolution of these results and the major breakdowns that have marked these ten years of operation. Also we did the exercise of adapting our statistics to common metrics shared with other synchrotrons. All these results are accessible from a internal WEB page, thanks to a development carried out by an operator of the group.

11- Poster Session / 99

First Line Diagnosis at ISIS

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FLD, "First Line Diagnosis", is the ISIS fault diagnosis tool and technical knowledge base, which has undergone a recent system-wide upgrade. FLD 2.2, like previous versions, contains a wide range of online operational resources, from fault analysis flowcharts and repair procedures to risk assessments and video tutorials. This valuable information is curated by equipment specialists spanning all sections of the ISIS facility, and has been shown to reduce accelerator downtime. Whilst expanding content remains a key focus, the user experience and subsequent feedback is critical to improving take-up. The enhanced version, FLD 2.2, utilises modern web technologies including HTML5 with AJAX and JSON to deliver new features including user pathway tracking, global UI elements and a purpose-built, fully searchable content library. The result is a more scalable and usable system, with facilitated user interactions and faster navigation.

11- Poster Session / 97

Project to install a Tandem Accelerator at USTHB (Algeria)

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The Nuclear Sciences and Radiation-Matter Interaction Laboratory (SNIRM) at the Faculty of Physics of the University of Sciences and Technology Houari Boumediene (USTHB) is engaged in the acquisition of a tandem ion accelerator in the range of a few MeV. This facility will be located on the USTHB site. The characteristics of the accelerator have been defined and relate mainly to the installation of a tandem accelerator with two sources of ions, the first for light ions (H, D and He) and the second is a sputtering one for intermediate and heavy ions. It is also planned to acquire two beam lines equipped (goniometer analysis chamber and a chamber for irradiation and ion implantation)
The main projected activities are: Nuclear sciences, Ion beam characterization, Ionic implantation and Nano structuration, Materials under irradiation (stopping power, radiation damage, sputtering …)

11- Poster Session / 26

Long Term Investigation of Beam Parameters Based on Beam Diagnostics Data Exports

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A high degree of beam stability is essential for the smooth operation of an active scanning system as applied by the Heidelberg Ion Beam Therapy Centre (HIT). Amongst other parameters such as particle intensity and beam width, the feedback controlled beam position at the isocentre is particularly crucial as it has to meet a very tight tolerance band of ±1.0 mm. Due to this fact we pay special attention to beam position fluctuations along the beamline by running daily procedures. The results are stored in CSV-files and visualised by python scripts using the matplotlib plotting library. Our investigation comprises the beam positions as a function of time in the accelerator sections MEBT (middle energy beam transport), synchrotron and HEBT (high energy beam transport). These sections are successively equipped with profile grids, position pick-ups or multi wire proportional chambers (MWPC). The aim is to find correlations between the beam position and external factors like e.g. temperature conditions of the surroundings or the cooling water. We also look for seasonal dependencies and interactions with the power load of the facility.

11- Poster Session / 77

Reliability of Target Ion Source System on SPIRAL1 - GANIL

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The SPIRAL1 facility at GANIL produces radioactive ions beams (RIB) since 2001. Target Ion Source Systems (TISS) employed are exposed to severe dose rates, requiring both simple and radiation hard technologies. Moreover, the production is performed in a Nuclear Installation Plant, where all the processes must cope with constraining safety rules. Once the TISS is irradiated by primary beams of heavy ions, the dose rate, the activation level and the potential contamination in the surrounding of the TISS make the access and the maintenance prohibited. All parts of the production system must thus be highly reliable. An important process for the preparation, operation and recycling of the TISS has been developed to minimize the failure probability and optimize the availability of the beam for the users.
Up to now, 45 target ion source systems have produced 70 RIBs delivered to physic experiments. Only 3 TISS have failed.
The organization and methods to achieve these results will be discussed.

11- Poster Session / 46

Calculation of the Machine Availability for the Complex Parallel Operation

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A new concept for the calculation of the individual machine availability is introduced and will be applied for the next beamtime at GSI in 2018.
The calculation of the machine availability has never been done at GSI so far. The whole accounting was experiments-oriented. Hence, for the general statistics per beam-time, times were scaled with

the number of concerned parallel experiments.
The machine availability calculation will have the following philosophy:
- The machine works in 2 regimes: serving the local experiments or serving further machines (working as part of the production chain);
- The availability calculation will be done separately for those regimes: Alocal, Achain
- Example: the availability of the PANDA production chain then would be:
Achain_pLinac*Achain_SIS18* Achain_HEBT *Achain_SIS100*Achain_pbar *Achain_CR

11- Poster Session / 70

Improvement of Operational Processes at the Institute Level

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Our own experience as well as that of other organizations is that it is possible to efficiently model the operational activities of groups with very different activities (from technical groups to scientific teams) with notions sumarized in six different types of process which are incidents, problems, service requests, requests for changes, changes, interventions. The aim of this modeling is to give a common framework to projects and operation. It also allows a coherent measurement of the final service delivered to the end users despite the great variety of technical services whose operational performances are crucial to perform a high quality measurement on a beamline.

In this presentation, we will define the semantics of each of these processes, describe them and show how they work and interact together.
We'll give our feedback on the current implementation of this "service oriented" methodology at SOLEIL , and how it helps us to ensure a controlled operational functioning that secures the work of the support groups and the efficient delivery of services to their users in a continuous improvements dynamic.

11- Poster Session / 109

Assessment of Classical and Modern Dependability Methods to Analyse Electrical Faults in the LHC Superconducting Magnets and Circuits

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The Large Hadron Collider (LHC) at CERN relies on more than 9000 superconducting magnets working since September 2008 in order to produce physics at high energy. The experience accumulated has shown up the frequency of electrical faults in the superconducting magnets, as well as their protection and instrumentation circuits. An internal collaboration group within CERN has carried out a first statistical analysis to provide a global approach in the first years of operation. The next step is to perform an extended dependability study on the mentioned electrical faults to provide better figures for operation. Complex systems have used modern techniques such as Systems Theoretic Accident Models and Processes (STAMP) to complement classical techniques such as Fault Tree Analysis (FTA) or Failure Mode and Effect Analysis (FMEA), among others, in order to provide a larger and deeper failures overview, both qualitative and quantitative. This poster evaluates classical and modern dependability methods to assure optimised results in the future analysis.

11- Poster Session / 113

A Scalable and Open System for Complex System Behaviour Assessment

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Particle accelerators exhibit complex behaviour emerging from the interaction of diverse machine systems, services, beam and environmental conditions. Since 2015 we have explored the fitness of probabilistic reliability engineering to particle accelerators. The investigation relies on the LHC as a use-case. Results indicate that the approach, already well established in manufacturing, automotive, pharmaceutical, process and other industries fits well the needs of particle accelerator facilities. Consequently, an R&D project has been launched to develop an open method to model and simulate the behaviour large systems efficiently. It does not rely on graphical user interfaces, permits specifying large sets of equipment characteristics in time and space saving manner, adequately addresses building models in a collaborative fashion, is data store agnostic and is incrementally extensible to different modelling techniques and simulation engines. Considering the processing requirements, the implementation by Ramentor will also permit deployment in a distributed computing cluster, leading to simulation speedup by a factor 10 to 100. The approach and tool will help building reliability, availability and energy efficiency into the designs of a future circular collider. Ramentor will offer the suite to industrial clients for the assessment and improvement of energy efficiency and availability in very diverse domains such as data centres, cargo handling and natural gas distribution.

11- Poster Session / 112

Ion Beam Application to Material Analysis in Ghana: Problems and Prospects

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In 2016, Ghana's with assistance of International Atomic Energy Agency (IAEA) installed a 1.7MV 5SDH-2 Pelletron accelerator donated by Government of Netherlands through a technical co-operation agreement. A new beam line is installed on the 15degree port at the high energy end of the accelerator and connected to an RC-43 multipurpose chamber with IBA capability. This study provides a summary of various research works carried out at the Centre to demonstrate the versatility of the installed system vis–a-vis the challenges of operating such a sensitive analytical facility in a developing country like Ghana. The limitations of the installed system are identified and strategies to overcome these difficulties in order to expand the utilization of the accelerator are presented and distributed.

11- Poster Session / 56

Quantitative Reliability Demonstration from Production to Operation on the Example of the new Radiation Tolerant Power Converter Controller for the LHC

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Highly reliable systems rely on methodical procedure during the design phase, production and deployment. This paper presents a methodology that covers production quality, reception tests and field analysis on the example of the mass produced accelerator control system for the LHC (FGClite). The production quality analysis of each board consists of functional tests based on the PXI test platform. Accelerated life tests at elevated temperature ("burn-in") are then used to accumulate mission time in order to prove a certain reliability level before deployment. Both production quality analysis and burn-in lower the number of post-deployment infant mortality failures significantly. In order to assess the FGClite reliability after deployment, the instantaneous failure rate is monitored quantitatively. This allows to detect possible early wear-out failures and forecast the number of failures for the next period of time. It is then discussed whether a constant failure rate is observed after deployment and appropriate to model electronic systems, since the applied Weibull Analysis is sensitive to certain assumptions.

11- Poster Session / 115

Helium Burst Incident at the PROSCAN Medical Cyclotron Facility

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PROSCAN is a proton irradiation facility for tumor treatment at the Paul Scherrer Institute in Switzerland; it is in operation since 2007. At the heart of the facility is COMET, a compact, super-conducting 250 MeV cyclotron. The facility serves three Gantries for generic tumor treatment, OPTIS 2 for eye cancer treatment and the proton irradiation facility (PIF) for radiation resistance tests of electronics. PROSCAN is operated 52 week per year, four to five days per week for cancer treatment. The facility is operated most weekends as well for PIF. About eight long weekends a year are scheduled for maintenance.
On the maintenance weekend in October 2016 a severe incident happened that caused an interruption of several days. The cryostat warmed up suddenly and the evaporating liquid Helium bursts out of the He tank. The poster will describe the sequence of events and presents the measures taken to prevent a similar event from happening again.

11- Poster Session / 114

Cryogenic System Operation and the Progress of SSRF II

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The Shanghai Synchrotron Radiation Facility (SSRF) is an intermediate energy light source built at Zhang-Jiang Hi-Tech Park in Shanghai, China. The SSRF consists of a 432 m and 3.5 GeV storage ring with a 2.9 nm-rad emittance. The RF power and voltage required for storing the electron beam are provided by means of three SC cryomodules, each containing one 499.654MHz superconducting cavity. The Nb cavities, are bath-cooled with saturated liquid helium at 4.5 K. A cryogenic plant with cooling capacity of 650 W at 4.5 K has been in operation since August of 2008 to provide cooling for the 3 SC-cavities.

In order to further improve the performance of SSRF, the following SC devices will be applied as the SSRF Phase II project:
1) One third harmonic SRF cavity with 1.5 GHz to be positioned at the SSRF storage ring, will run at 2 K (31 mbar) by bath cooling.
2) One SC wiggler is to be used for one of the new-built beam lines, ultra-hard multi-functional beam line. The SC wiggler will be cooled by cryocoolers at 4.2 K.

For the purpose of supporting operation of the above SC devices, a new cryogenic system (SSRF-II cryoplant) with equivalent cooling capacity of at least 650 W at 4.5 K (including at least 60 W at 2 K) will be designed, fabricated, test and operated for the SSRF-II.
Additionally, the new cryoplant will be used as the back-up of current 650 W refrigeration system at 4.5 K to support normal operation of the online three 500MHz SRF cavities in case of any failure occurred to the current 4.5 K cryoplant.
This paper will present the whole plan of SSRF-II cryoplant.

12- Medical / 82

Maintenance of the Accelerator Control System at the Marburg Ion-Beam Therapy Center (MIT)

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The Marburg Ion-Beam Therapy Center is Germany's second facility providing a highly precise cancer treatment with hydrogen and carbon ions using the raster scanning method. The accelerator control system is part of a medical product resulting in strict constraints which must be considered in each maintenance step of the accelerator control system. Furthermore, the medical application necessitates an almost continuous availability throughout the year with a high reliability. Hence, upgrades and updates of the accelerator control system must end up in a proper state fulfilling the required clinnical quality standards.

12- Medical / 95

Shared Contract of Service with an Industrial-Supplier of a Particle Therapy Facility

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From now seven years, Institut Curie-CPO has a shared contract of maintenance with the supplier of his Particle Therapy facility. The two main reasons of this decision were: 1. the connection of this new device to the two historic beamlines 2. the existing local team already involved in Particle Therapy Equipment, including the particle accelerator. We will mainly describe:
- the principles discussed and signed in the first contract: training, way of operations, preventive and corrective maintenance, …
- the realities on the deployment of this contract, from the early years (ex: learning curves) to the middle-term adjustments (technical and organizational)
- the lessons learned from this middle-term history (ex: what kind of Key Performance Indicators)
- the present situation and the challenges expected for the next years.

12- Medical / 50

Reliability of a Compact Carbon Ion Medical Accelerator

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Gunma University Heavy Ion Medical Center has provided a carbon ion radiotherapy by a compact carbon ion accelerator since 2010. Carbon ions are generated in a permanent-magnet ECR ion source and accelerated in RFQ linac and APF-IH linac. The carbon ions are accelerated up to 400 MeV/u in a synchrotron and extracted to treatment rooms with a beam intensity of 1.3×10^9 particles per second.
High availability and enough safety are required in the treatment operation. In order to satisfy such requirement, daily / weekly quality assurance (QA) and inspection and yearly maintenance was carried out. The medical physicists and the operators recorded and analyzed machine troubles and operation failures in order to prevent recurrence of the trouble and realize more stable operation. The availability concerning treatment operation was 92.5% in the first year and 98.4±0.6% after the second year. In order to improve the availability further, preventive maintenances, such as prompt replace of the parts, are necessary but it is still difficult to decide the timing of replacing. We started to use failure mode and effect analysis (FMEA) technique to recognize the severity of a certain trouble.

13- Insuring Long Term Reliability / 78

Availability Considerations for an Accelerator System Based on the LHC Power Converter Controls

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In 2010, FGC2 failure rate predictions based on LHC failure data have shown a need for a new radiation-tolerant power converter controller. For the new system, the electrical reliability and radiation-induced failure rate requirements were defined to achieve a target reliability for the HL-LHC era.

This talk will present main steps of the FGClite design: form specification, prototyping and radiation qualification, through mass production, test and reliability demonstration to commissioning and operations of both hardware and software.

A first feedback from operations and future performance will be presented as well as lessons learned for future projects.

13- Insuring Long Term Reliability / 80

Jefferson Lab Reliability Task Force

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Jefferson Lab's Continuous Electron Beam Accelerator Facility (CEBAF) has moved into production running after completing the 12 GeV upgrade. In many instances, new equipment has been integrated into the original CEBAF infrastructure and systems. Some challenges and opportunities have presented themselves during and following commissioning of the "new" machine that have prompted Jefferson Lab management to take action regarding systems reliability. A series of systems failures and input from an Accelerator Advisory Committee report prompted Jefferson Lab's Director to launch a Reliability Task Force. The primary focus of the task force was to explore technical systems and in addition to look at contributing systems, processes, and tools. The Task Force charge also included emphasis on data-driven decision making; "Prioritization of maintenance, replacements, upgrades and new projects should be data driven with emphasis on getting maximum return (system reliability) on investment (resources)." I will summarize and discuss the efforts of the Reliability Task Force as well as methods, findings, and recommendations for improvements.

13- Insuring Long Term Reliability / 38

Age Related Failure of K1200 Cyclotron Electrode at National Superconducting Cyclotron Laboratory

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The K1200 cyclotron is part of the Coupled Cyclotron Facility (CCF) at National Superconducting Cyclotron Laboratory (NSCL). It was built starting in 1987 and produced its first standalone beam in 1989. The expected life of the K1200 was estimated to be 20 years. In 2017, 28 years first beam, the K1200 continues to produce extremely useful science. As the cyclotrons age, maintaining their reliability has become more difficult and time consuming. After emerging from a three month planned maintenance shutdown at the beginning of 2017, there was an unprecedented failure of the upper half of one of accelerating electrodes. The troubleshooting process covered eight weeks, with an additional two weeks for repair and restart. The failure was a direct result of age related stresses of the copper skin of the C Upper electrode. There are a total of three electrodes in the K1200, each

made up an upper and lower half. The other five halves of the electrodes are showing stresses similar to the electrode half that failed. Ensuring the K1200's reliability for the remainder of its newly projected life span is a top priority within the accelerator maintenance group at NSCL.

13- Insuring Long Term Reliability / 87

A Long Term Reliability Challenge at the RHIC

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Long term reliability is critical for any successful particle accelerator operation. The Relativistic Heavy Ion Collider (RHIC) is now faced with a reliability challenge owing to age, continual performance improvements, and even best practice design considerations. This presentation will focus on our experience with the RHIC quench protection diodes; a passive part of the machine protection system. The history and the affect that failed diodes have had on RHIC operations during the recently completed Runs 16 and 17 will be reviewed.

15- Strategy for Continuous Reliable Operations / 34

Experience with the KEKB/SuperKEKB Magnet Cooling Water System

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KEKB and its successor, SuperKEKB, are double-ring, e+e- colliders made for producing B mesons. The construction of KEKB started in 1994, utilizing the existing 3 km circumference tunnel of TRISTAN, a single-ring e+e- collider. KEKB commissioning started in 1998, and lasted until June 2010. KEKB's max peak luminosity, 2.11×10^34/cm^2/s, remains as the current world record. The magnet system consists of more than 1600 (KEKB) or 1700 (SuperKEKB) water-cooled magnets. Though the number of magnets was doubled from TRISTAN to KEKB, the cooling water system was unchanged, resulting in a need for delicate flow balance among individual magnets, which resulted in a system vulnerable to water flow fluctuations. The balance was checked every year during the shutdown, and the occurrence of magnet water trips was kept low. However, the trip rate incidents started to increase from 2003, when the system was contaminated by oil used for maintenance work on the pumps. Our experiences with magnet trips, caused by contamination, by clogging of the strainer mesh attached to the water channel, and by other causes, will be presented along with countermeasures for a more reliable system for SuperKEKB.

15- Strategy for Continuous Reliable Operations / 62

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. To meet the upgrade requirements, ten new C100 style cryomodules were added to the linacs to supply the additional energy reach. Each C100 was designed to provide 100MeV of acceleration capability plus a 10% margin; twice that of 6GeV era cryomodules . Acceptance testing of the first C100 showed that the new cryomodule met the design specification. However, this performance has not been reproduced during production operations with installed cryomodules currently operating at ~80% of their nominal value. Further, the linacs continue to degrade at a rate of 34MeV/pass/year. As a result a "Gradient Team" was formed to understand and mitigate the system performance issues. The team identified several issues including field emissions, microphonics, vacuum cleanliness, trip restoration, and other issues negatively affecting the C100 performance. Three themes were identified to focus improvements on including optimizing gradient, reducing trips, and minimizing recovery time. The categorization, prioritization, and solutions of the identified issues will be discussed.

15- Strategy for Continuous Reliable Operations / 28

Effort for the Reliable Operation in J-PARC Rapid Cycling Synchrotron

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The beam commissioning of the J-PARC 3 GeV Rapid Cycling Synchrotron (RCS) has been started since 2007, and the proton beams were delivered to a neutron target and a main ring synchrotron on Dec. 2008. At the beginning of RCS operation, an availability of RCS was depressed by a discharge of a thyratron which used in a power supply system of the extraction kicker magnet. We investigated the operational statistics of the thyratron in order to improve availability, and found a better treatment which fits a characteristic of an individual thyratron. As a result, the discharge rate was improved dramatically. After the improvement, a radiation leak accident was occurred in the Hadron Experimental hall. From this accident, we considered that it was necessary to monitor not only the status of the RCS components but the beam condition in order to improve the availability of the J-PARC facility. Therefore we developed new interlock system to prevent an extraction of unexpected beam which might affect the component of the downstream facilities. Due to these improvements, the availability of RCS is more than 90 % every year.

16- High Intensity Beam Reliability / 71

Analysis of High-Intensity Proton Accelerator Availability over the Last 15 Years of Operation at PSI

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Paul Scherrer Institut (PSI) is home to cyclotron-based high intensity proton accelerator facility HIPA, which presently delivers a maximum of 1.4 MW beam power. Detailed analysis on unexpected outages due to various failures is presented and how the failure rate of each subsystem evolved over

the years. Main severe events (interlocks malfunction, vacuum, discharge problems, failures of cavities, magnets, power supplies and targets) impacting the availability for each year are revealed, compared and discussed. These findings serve to a better understanding and further possible optimizations of operation and maintenance in order to keep high reliability and availability above 90% for the users of the HIPA facility.

16- High Intensity Beam Reliability / 55

Machine Protection Analysis for Increased Availability at ESS

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The machine protection strategy at ESS is an important component in reaching the high availability goals of the facility. Machine protection at ESS follows a holistic functional protection lifecycle to define, analyze, implement, monitor, and adjust the different protection-related systems at the appropriate stage. One key pillar in this lifecycle is the fit-for-purpose protection analysis during the ESS design phase. This contribution describes this analysis process, defines its role in the functional protection lifecycle, and ties it to the ESS reliability and availability goals.

16- High Intensity Beam Reliability / 67

Radiological study of the nuclear facility S3 of SPIRAL2

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The modeling of a nuclear facility is a necessary tool to define the radiological environment and to draw the rays map. This quantification is an important phase in the conception of a facility. It allows to know how the facility respects the safety constraints as well as the general operating for what it is authorized. This work presents S3 as an example of the modeled nuclear facility. S3 (Super Separator Spectrometer) is a device of SPIRAL2 dedicated to the experiments with high intensity stable beams to study heavy and super heavy nuclei, especially the neutron deficient ones. Light nuclei, namely those produced by transfer reaction, will also be available in S3. In this work we present the modeling of the current S3 facility, the simulation results of particles transport and the rays map (neutrons and other light particles) in S3 building. Some consequences of these calculations as the damage for electronic components or for cryogenic liquids will also be presented.
These studies used a Monte Carlo calculation method, namely with the Japanese code PHITS2.82.
Keywords : Modeling, Monte Carlo simulation, Particles transport, Neutron doses

ARW Welcome / 3

Director's Welcome

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Director's words

ARW Welcome / 5

IOC chairman's Welcome

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ARW Welcome / 4

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Workshop Highlights / 107

Closing Remarks

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Workshop Highlights / 108

Next WAO and ARW Announcements

Workshop Highlights / 106

Workshop Highlights

Workshop Highlights / 105

Picture Award

Workshop Highlights / 111

Parallel Session Summary