ACCELERATOR RELIABILITY WORKSHOP

ARW 2022

PROGRAM

October 16 – 21, 2022
Newport News, VA, USA

Jefferson Lab
Local Sponsor ARW

https://indico.jlab.org/event/495/


Jefferson Lab
Is proud to support the
8th Accelerator Reliability Workshop
as the local sponsor.
Welcome attendees!

ACCELERATOR RELIABILITY WORKSHOP

ARW 2022

Welcome

This is the eighth workshop in the Accelerator Reliability series. Previous workshops were held in Grenoble, France, Vancouver, Canada, Cape Town, South Africa, and Melbourne, Australia.

ARW 2022 will follow the established format of previous ARW workshops that foster formal and informal interactions between accelerator scientists, engineers, and students. Emphasis is placed on the exchange of information and ideas across the broad spectrum of accelerator science and technology topics.

Ken Baggett, Local IOC Chair
https://indico.jlab.org/event/495/

Organizing Committees

LOCAL ORGANIZING COMMITTEE:

- Chair: Ken Baggett, Jefferson Lab
- Anita Seay, Jefferson Lab, Conference Manager
- Erica Jones, Jefferson Lab, Workshop Manager
- Jen Losik, Jefferson Lab, Workshop Coordinator
- Randy Michaud, Jefferson Lab
- Brian Freeman, Jefferson Lab

INTERNATIONAL ADVISORY COMITTEE:

- Chair: Rossano Giachino, CERN, Switzerland
- Ken Baggett, Jefferson Lab, USA
- Kathleen Genge, TRIUMF, Canada
- Samuel Meyroneinc, Institut Curie, France
- Laurent Nadolski, Soleil, France
- Duane Newhart, FNAL, USA
- Annika Nordt, ESS, Sweden
- Douglas Preddy, TRIUMF, Canada
- Qing Qin, ESRF, France
- Muneer Sakildien, iThemba LABS, South Africa
- Paul Sampson, Brookhaven National Lab, USA
- Hikaru Souda, Yamagata U, Japan
- Benjamin Todd, CERN, Switzerland

Jefferson Lab

ARW 2022 local host is Jefferson Lab. The workshop is being held in Newport News, Virginia at the Marriott City Center.

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General Information

Venue

Marriott at City Center
740 Town Center Drive
Newport News, Virginia, USA, 23606
Front Desk: +1 757.873.9299
Toll Free: +1 866.329.1758
Fax: +1 757.310.5040

Local Host

Jefferson Lab
12000 Jefferson Avenue
Newport News, VA 23606
Main Phone: 757.269.7100

Emergency Contacts:

- Ken Baggett (on-site)
  - baggett@jlab.org
  - 757.871.2501
- Anita Seay
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  - 804.339.2006

Administration:

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- Jen Losik:
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  - 980.200.3670

Disclaimer

The ARW 2022 committees reserve the right to make changes to the workshop program at any time without notice.

Registration

Registration opens on Sunday from 2 p.m. to 6 p.m. in the Coat Room across from the Grand Ballroom on the first floor of the conference center and Monday morning from 8 a.m. to 10 a.m.

Meeting Space:

General sessions are located on the 1st floor of the Marriott Newport News Conference Center in the **Pearl Ballroom.** Breakout session locations will be provided during the workshop.

Speakers

All speakers should submit their presentations electronically to their session chair and Jen Losik at Losik@jlab.org via email by Friday, October 14. This will allow sufficient time for presentations to be loaded onto the workshop USB drive, organized and tested prior to the start of your session.

Name Badges / Lanyards

For security purposes, and to encourage networking, attendees are asked to wear their name badges at all times during the workshop. ***Badges will be required for the tour of Jefferson Lab.***

Touring JLab—Dress Code

Your safety is important. Please follow these dress guidelines during the tour:

- Wear long pants or slacks. Shorts, Capri pants, skirts, and dresses are **not permitted**.
- Wear short or long-sleeved shirts. Sleeveless shirts or tank tops are **not permitted**.
- Wear flat or low-heeled, closed-toe shoes . Sandals, open-toe or high heel shoes are **not permitted**. It is advisable to wear comfortable walking shoes as tours at JLab do involve quite a bit of walking and going up and down stairs.

General Information—Meal and Event Planning

Welcome Reception—Sunday, October 16, 5:00 p.m. to 6:30 p.m.

Sunday's Welcome Reception will be in the Rotunda area of the Marriott Newport News from 5:00 p.m. to 6:30 p.m. Take time to renew acquaintances and make new friends while enjoying beverages and hors d'oeuvres.

Morning and Afternoon Breaks—Monday, Tuesday, Thursday & Friday

During workshop sessions at the Marriott, coffee, tea, water and soda will be available throughout the day. Beverage stations are located immediately outside the meeting rooms. In the mid-morning and mid-afternoon a variety snacks will be made available to attendees.

Lunch—Monday & Tuesday

Monday and Tuesday join us for a buffet lunch at the Marriott.

Scientist Walks Into a Bar—Tuesday, October 18, 6:00 p.m. to 7:30 p.m.

Tuesday, October 18, Scientist Walks Into a Bar event will take place at Tradition Brewery (under 10-minute walk). Network with fellow scientists in the area, Jefferson Lab leadership team members, as well as the community to discuss the advances in science, specifically in AI. A walking map and invitation are in the conference bag. Attendees are responsible for their brewery beer and snacks which are available for purchase.

Full American Breakfast—Wednesday, October 19, 7:00 a.m. to 8:30 a.m.

Join us for a full American breakfast including eggs, bacon, potatoes, coffee, juice, and more in the Rotunda area of the Marriott Newport News.

Colonial Williamsburg Excursion and Banquet—Wednesday, October 19*

- Lunch—On-the-Go "Bus Picnic Lunch"
- Reception and banquet dinner at James River Country Club
- *Additional $150 USD fee paid at registration

Meal Planning:

The Welcome Reception, lunch on Monday and Tuesday, Wednesday morning breakfast, and workshop morning and afternoon break refreshments are provided as part of your workshop registration fee. All other meals are the responsibility of workshop attendees. Please consider these dining options:

- The Marriott offers a daily breakfast buffet at a fixed rate of $19 USD plus tax and tip.
- Thursday lunch and dinners:
    - Restaurants within walking distance of the Marriott including Cove Tavern, Cure Coffee House, Hayashi Sushi & Grill, Juicing Life Bar, Salsa's Mexican Grill and Tucanos Brazilian Grill.
    - Open Table provides a listing of over 70 restaurants in the vicinity of the Marriott. Link: https://www.opentable.com/landmark/restaurants-near-newport-news-marriott-at-city-center.

Excursion & Networking Banquet—Wednesday, October 19

Wednesday will be a full day for workshop attendee and excursion participants. Our day begins at the Marriott with a full American breakfast from 7:00 a.m. to 8:30 a.m. Sessions begin at 8:30 a.m. sharp when we will hear from two accelerator experts, ***Clayton Smith*** and ***Resit Unal.***

At 10:00 a.m., attendees wishing to tour JLab and who have completed JLab's Visitor Registration, will load the buses for the short 10 minute ride to the lab. Attendees who opted out of the tour and excursion will rejoin the workshop Thursday morning. Enjoy your free time!

Tour attendees will be divided into three groups for round-robin tours which will take approximately two hours. At the end of the tour those individuals who are not continuing on the excursion will be bused back to the Marriott and are free until the workshop resumes on Thursday morning. Attendees continuing on to Colonial Williamsburg will load the buses. To maximize our time in Colonial Williamsburg, we will be having an on-the-go picnic lunch on the buses.

Excursion goers will be dropped off near the Duke of Gloucester (D.O.G.) Street to begin their self-guided and self-paced exploration. From D.O.G Street, which is approximately a mile long, guests can access many of the exhibits and buildings. We strongly encourage excursioners to visit the Colonial Williamsburg website and plan their afternoon activities. Colonial Williamsburg offers a downloadable map app called "The Explorer." Visit Apple's App Store or Google Play to download.

By 5:00 p.m. excursioners ***MUST*** return to the bus for departure. ***Buses leave promptly at 5:00 p.m.*** From Colonial Williamsburg we will be traveling directly to the James River Country Club for the evening reception and dinner. At the conclusion of the dinner the buses will return attendees to the Marriott.

Schedule

7:00—8:30	All workshop attendees	Full American Breakfast in the Rotunda of the Marriott
8:30—10:00	All workshop attendees	Honored guest speakers
10:00—12:30	Workshop attendees who signed-up for and completed JLab Visitor Registration Buses leave promptly at 10 a.m.	Load buses to JLab Tour
12:30—5:00	Attendees who signed-up for and paid For excursion and banquet	Load buses, picnic lunch, travel to & explore Colonial Williamsburg
5:00—6:00	Excursion & banquet attendees ***Buses leave promptly at 5:00 p.m.***	Load buses, travel to JRCC
6:00—9:30	Excursion & banquet attendees	Arrive JRCC, reception, banquet
9:30—10:00	Excursion & banquet attendees	Load buses, return to Marriott

Excursion & Networking Banquet—Frequently Asked Questions

I did not sign-up for the excursion/banquet. After the guest speakers are finished, am I free for the day?

- Yes, if you opted out of the excursion and banquet, the workshop ends for you when the guest speakers conclude their discussion. We will see you bright and early Thursday morning. Enjoy your free time.

I did not sign-up for the excursion when I registered, but would like to do so now. Is that possible?

- Yes, you can sign-up and pay for the excursion/banquet during the on-site Marriott registration process. The cost for the excursion/banquet is $150 USD. However, you may be limited in your banquet meal selection. The deadlines for selecting the banquet dinner item was October 12. The JRCC will make every effort to accommodate selections, but cannot guarantee selections after the October 12 deadline.

I signed-up for the JLab tour, but not the excursion. How will I get back to the Marriott?

- At the end of the JLab tour, a bus will bring the attendees who participated in the tour, but are not participating in the excursion/banquet, back to the hotel.

I signed up for the excursion/banquet, but have decided to skip the JLab tour and excursion. Can I attend just the banquet? How do I get there?

- Attendees who do not follow the bus schedule are responsible for their own transportation to events they choose to attend. For example:
  - If you go on the JLab tour and decline to go to Colonial Williamsburg, but want to go to the banquet, you will be bused back to the Marriott after the tour. You are then responsible for making your way to the James River Country Club to meet the group at 6:00 p.m. You can ride the bus back to the Marriott from the James River Country Club.

I am planning to attend the tour, excursion and banquet. Are there facilities for me to change clothes and freshen up at the country club?

- Yes, the JRCC has men's and women's changing rooms. You are welcome to bring a change of clothing or other personal items with you. They will be secure on the bus while you explore Colonial Williamsburg.

What if I miss the bus or am late getting back to the bus?

- Please be respectful of the other participants and make every attempt to be prompt. ***Buses leave Colonial Williamsburg at 5:00 p.m. sharp.*** If you have an emergency please, contact one of the local hosts for guidance.

About Colonial Williamsburg

Helpful Planning Links:

- Online Map Link: https://www.colonialwilliamsburg.org/map/?from=home
- Colonial Williamsburg Link: https://www.colonialwilliamsburg.org/

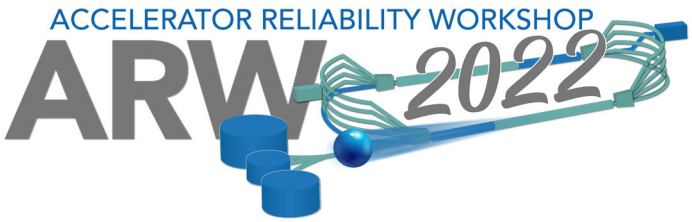
When Visiting:

- Flags in front of buildings designate open sites. Stop in and visit.
- The Governor's Palace and Capital are two of the most visited sites in Colonial Williamsburg.
- Book in advance and you can experience a horse drawn carriage ride! Link: https://www.colonialwilliamsburg.org/explore/carriage-wagon-rides/
- Merchant's Square, which is adjacent to D.O.G. Street, is a shopper's paradise.
- William & Mary is less than a half mile from D.O.G. Street.

Interesting Colonial Williamsburg Facts:

- Williamsburg was a "planned city." Duke of Gloucester Street was intentionally cleared to be the central street through the town, and then buildings and streets were built according to a blueprint.
- William & Mary, the nation's second oldest college, is located in Williamsburg.
- The first hospital for mentally ill patients in North America, The Public Hospital for Persons of Insane and Disordered Minds, was located in Williamsburg. It admitted its first patient in 1773.
- 88 of Williamsburg's original structures were preserved in the development of Colonial Williamsburg.
- Colonial Williamsburg utilizes the services of more than 800 volunteers to run its operations.
- The Peyton Randolph house, built in 1715, is said to be one of the most haunted homes in America, and one of several supposedly haunted spots in Williamsburg, making the town a popular spot for history buffs and ghost hunters alike.
- Williamsburg was the original capital of Virginia.
- Colonial Williamsburg spans 301 acres.
- Colonial Williamsburg is home to many firsts in Virginia. At one point, Williamsburg was the cultural, social, and political epicenter of the state. Virginia's first printing press, first newspaper, first theatre, and first paper mill all appeared in Williamsburg over the duration of the 1700s.
- It was the filming location for many movies and TV shows. Apart from Lassie, over a hundred movies and TV shows have been filmed in Colonial Williamsburg. Do Cold Mountain or John Adams ring a bell?
- Colonial Williamsburg has four hotels and rents colonial era houses to guests. It also offers award winning golf courses and amenities.

NOTES:



TECHNICAL PROGRAM AGENDA/TIMELINE

Jefferson Lab

Technical Program At-A-Glance

TIME	MONDAY (10.17)	TUESDAY (10.18)	WEDNESDAY (10.19)	THURSDAY (10.20)	FRIDAY (10.21)
7:00			Full American Breakfast Buffet (Rotunda at the Marriott)		
8:00	Registration				
8:30	LOC/IOC Welcome, Introduction & Terms (K. Baggett) ARW Introduction (A. Apollonio) Fault Tracking Panel (R. Giachino)	Machine Learning & Reliability (R. Giachino)	Invited Speakers (K. Baggett)	Reliability of Medical Facilities (K. Genge)	Reliable Protection Systems (M. Carroll)
10:00	BREAK		JLAB Visit	BREAK	
10:30	Accelerator Support Systems (K. Genge)	Reliability in Harsh Environments (D. Newhart)		Predicting Failure (A. Nordt)	Reliability Consideration During Commission or Machine Upgrade (K. Baggett)
12:00	LUNCH		Colonial Williamsburg Excursion	LUNCH	
13:30	Plenary Discussion (A. Nordt & D. Newhart)	Poster Session (D. Preddy & P. Sampson)		Breakout Session	Workshop Highlights, Closing Remarks, Future Workshops & Adjourn (R. Giachino)
15:00	BREAK			BREAK	
15:30	Maintenance & Obsolescence (L. Nadolski)	Breakout Session		New & Innovative Accelerator Tecnology (M. Di Castro)	
17:00	SESSIONS END		Workshop Banquet Dinner (18:00 - 21:00)	SESSIONS END	
17:30				ICO Meeting	
18:00	IOC Meeting				

Monday, October 17, 2022

8:00	**Registration**
8:30 - 10:00	**Workshop Welcome, Introductions & Fault Tracking Panel** Chair: BAGGETT, Ken (Jefferson Lab)
8:30	**LOC/IOC Welcome** Speaker: BAGGETT, Ken (Jefferson Lab)
8:50	**ARW Introduction** Speaker: APOLLONIO, Andrea
9:15	**Fault Tracking Panel** **Speakers**: APOLLONIO, Andrea (CERN), BAGGETT, Ken (Jefferson Lab), BLACKLER, Ian (Brookhaven National Laboratory), FERNANDEZ, Ferran (ALBA synchrotron), GENGE, Kathleen (TRIUMF), GIACHINO, Rossano (CERN), PETERS, Charles (SNS)
10:00	**MORNING BREAK**
10:30 - 12:00	**Accelerator Support Systems** Chair: K. Genge
10:30	**Maintenance and Recommissioning of the LHC Cryogenic System for the Physics Run3** Speaker: FERRAND, Frédéric (CERN TE-CRG)
11:00	**Cryogenic Supply Chain Disruptions Effect on Accelerator Operations** Speaker: KISHI, David (TRIUMF)
11:30	**Operation History and Current Status of Electrical Power Conversion Equipment at the SNS** Speaker: TAN, Yugang (Oak Ridge National Laboratory)
12:00	**LUNCH BREAK**
13:30 - 15:00	**Plenary Discussion** Speakers: NEWHART, Duane (Fermi National Accelerator Laboratory), Dr NORDT, Annika (European Spallation Source ERIC)
15:00	**AFTERNOON BREAK**
15:30 - 17:00	**Maintenance & Obsolescence** Chair: L. Nadolski
15:30	**Recent Experience on LIPAc Reliability** Speakers: Dr CISMONDI, Fabio (Fusion for Energy), Mr SCANTAMBURLO, Francesco (F4E)
16:00	**Maintenance and Reliability Overview at the Canadian Light Source** Speaker: LE PIMPEC, Frederic (Canadian Lightsource)
16:30	**STAR Accelerator High Voltage Generator Driver Replacement** Speaker: Mr PANERAS, Nikolas (ANSTO)
17:00	**SESSIONS END**
18:00	IOC Meeting

Tuesday, October 18, 2022

8:30 - 10:00	**Machine Learning & Reliability** Chair: GIACHINO, Rossano (CERN)
8:30	**Toward More Efficient Accelerator Tuning with Deep Learning** Speaker: TENNANT, Christopher (Jefferson Lab)
8:55	**Pulse-by-Pulse Classification System at CRYRING@ESR** Speaker: Dr GEITHNER, Wolfgang (GSI Helmholtzzentrum fuer Schwerionen-forschung)
9:15	**Sustainable Implementation of Machine Learning for Particle Accelerators** Speaker: MICELI, Tia (Fermilab)
9:35	**Uncertainty Aware Anomaly Detection to Predict Errant Beam Pulses and GradCAM Analysis** Speaker: RAJPUT, Kishansingh (JLab)
10:00	**MORNING BREAK**
10:30 - 12:00	**Reliability in Harsh Environments**
10:30	**Industry 4.0 Boosting Reliability in Particle Accelerators** Speaker: Dr DI CASTRO, Mario (CERN)
11:00	**Power Interruption at BNL** Speaker: TERHEIDE, Rachel (Brookhaven National Lab)
11:30	**High Power Operation of J-PARC 3 GeV Rapid Cycling Synchrotron Under High Temperature and Humidity** Speaker: YAMAMOTO, Kazami (J-PARC Center, Japan Atomic Energy Agency)
12:00	**LUNCH BREAK**
13:30 - 15:00	**Poster Sessions** Chairs: PREDDY, Doug (TRIUMF), SAMPSON, Paul (Brookhaven National Lab)
15:00	**AFTERNOON BREAK**
15:30 - 17:00	**Breakout Session**
17:00	**SESSIONS END**
18:00 - 19:30	**Scientist Walks Into a Bar** Tradition Brewery Hosted By: JLab / The Accelerator Reliability Workshop 2022—Admission is Free

Wednesday, October 19, 2022

7:00 - 8:30	**All American Breakfast Buffet**
8:30 - 10:00	**Invited Speakers** Clayton Smith and Resit Unal Chair: BAGGETT, Ken (JLab)
10:00 - 12:30	**JLab Tour**
12:30 - 13:00	**Excursion - Travel to Colonial Williamsburg & Bus Picnic Lunch**
13:00 - 17:00	**Colonial Williamsburg Excursion**
17:00 - 18:00	**Reconvene at buses and transport to James River Country Club** ***Buses leave promptly at 5:00 p.m..***
18:00 - 21:30	**Networking Reception & Banquet**
21:30 - 22:00	**Transportation back to Marriott**

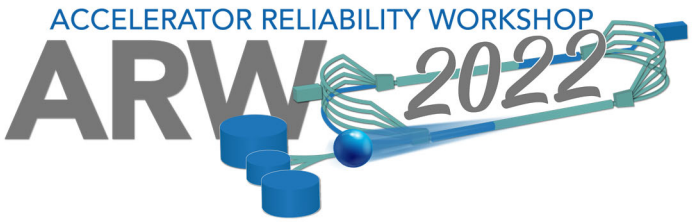
Thursday, October 20, 2022

8:30 - 10:00	**Reliability of Medical Facilities** Chair: GENGE, Kathleen (TRIUMF)
8:30	**The MedAustron Ion Therapy Centre: Experiences from 6 Years of Clinical Operation** Speaker: Dr NOWAK, Sebastian (MedAustron)
8:55	**Maintenance Program of HIMAC** Speaker: KADOWAKI, Tetsuhito (Accelerator Engineering Corp.)
9:20	**Reliability of the Medical Cyclotron at BC Cancer in Vancouver** Speaker: SINGH, Baljit (BC Cancer)
9:40	**Development, Testing, and Installation of the LANSCE Isotope Production Facility Target Transfer Push Pull Chain** Speaker: KOPPI, Anthony (Los Alamos National Laboratory)
10:00	**MORNING BREAK**
10:30 - 12:00	**Predicting Failure** Chair: Dr NORDT, Annika (European Spallation Source ERIC)
10:30	**Utilizing Machine Learning to Improve Superconducting RF Cavity Linac Reliability*** Speaker: PETERS, Charles
11:00	**Prediction, Prevention and Handling of Failure at MAX IV** Speaker: NIEUWENHUIS, Rutger Arend (MAX IV Laboratory)
11:30	**RAMI Analysis of IFMIF-DONES Lithium Systems Events Important for Beam Interlocks of the 5** Speaker: Mr RUEDA PÉREZ, Juan José (University of Granada) MW Superconducting LINAC
12:00	**LUNCH BREAK**
13:30 - 15:00	**Breakout Sessions** Chairs: BAGGETT, Ken (Jefferson Lab), GIACHINO, rossano (CERN)

15:00	**AFTERNOON BREAK**
15:30 - 17:00	**New & Innovative Accelerator Technology** Chair: DI CASTRO, Mario (CERN)
15:30	**A Digital Twin Application for Particle Accelerators** Speaker: SMAKULSKA, Dorota (CERN)
15:50	**Hardware Integrity Assessment of the Fast Beam Interlock System (FBIS) at ESS** Speakers: GUSTAFSSON , Johannes (ESS), WENG, Joanna (ZHAW)
16:10	**Alarm Management at the Australian Synchrotron** Speaker: DE BOOY, Jonathan (ANSTO)
16:35	**Multi-Module Based VAE to Predict HVCM Faults in the SNS Accelerator** Speaker: ALANAZI, Yasir (Old Dominion University)
17:00	**SESSIONS END**
17:30	IOC Committee Meeting & Dinner

Friday, October 21, 2022

8:30 - 10:00	**Reliable Protection Systems** Chair: CARROLL, Martin (European Spallation Source ERIC)
8:30	**Lessons Learning: Vacuum Protection for TRIUMF's Superconducting Linear Accelerator (SCLinac)** Speaker: ANGUS, Tiffany (TRIUMF)
9:00	**Equipment Protection System Checks at ALBA** Speaker: FERNANDEZ, Ferran (ALBA synchrotron)
9:30	**Beam Abort System for the SLS 2.0** Speaker: ARMBORST, Felix (Paul Scherrer Institute (PSI))
10:00	**MORNING BREAK**
10:30 - 12:00	**Reliability Consideration During Commission or Machine Upgrade** Chair: BAGGETT, Ken (Jefferson Lab)
10:30	**An Overview of Power Supply System of the EBS** Speaker: GOUDARD, Olivier (ESRF)
11:00	**Considerations on the Reliability of FAIR** Speaker: Dr REIMANN, Stephan (GSI/FAIR)
11:30	**Reliability of Proton Superconducting Linacs: SNS Case Study and Perspective on Future Machines** Speaker: GENG, Rongli (Oak Ridge National Laboratory)
12:00 - 13:00	**LOC/IOC Closing Remarks, Workshop Highlights & Next Workshop**
13:00	**WORKSHOP ADJOURNS**



ATTENDEES

Jefferson Lab

ARW 2022 Registered Attendees

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7	**Ayas Iglesias, Esther**	eayas@cells.es	Spain	ALBA Synchrotron
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16	**Carroll, Martin**	martin.carroll@ess.eu	Sweden	European Spallation Source
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ARW 2022 Registered Attendees

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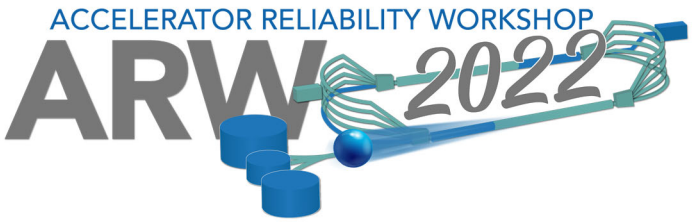

ABSTRACTS

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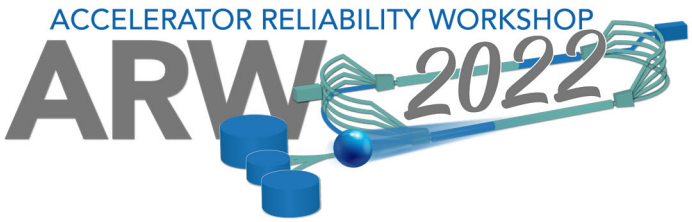


ACCELERATOR SUPPORT SYSTEMS

Chairperson: Kathleen Genge

Monday, 17 October 2022
10:30 a.m.—12:00 p.m.

Jefferson Lab

Maintenance and Recommissioning of the LHC Cryogenic System for the Physics Run3 #22

Speaker: FERRAND, Frédéric (CERN TE-CRG)
Authors: Frédéric Ferrand, Krzysztof Brodzinski , Laurent Delprat
Co-authors: Luigi Serio, Serge Claudet, Dimitri Delikaris

CERN operates and maintains several large cryogenic systems with complex architecture necessary for the operation of the Large Hadron Collider (LHC). Continuous operation of the accelerator during Run2, and the implementation of availability calculation tools as well as the use of a fault tracking system on cryogenics equipment, has allowed the CERN cryogenics team to gain valuable experience and data to drive maintenance and consolidations. Major maintenance tasks and a comprehensive consolidation program have been planned during the Long Shutdown 2 based on a data driven approach. In this talk we will review the methodology, approach and main issues addressed to improve reliability of the cryogenic infrastructure aiming at maintaining the cryogenic system availability for the accelerator complex above 98% for the coming years. We will report on the initial operation results achieved and we will also give some perspective on the new time line for cryogenics operation during the extensive Run3 including impact of energy preservation scenarios.

Cryogenic Supply Chain Disruptions Effect on Accelerator Operations #77

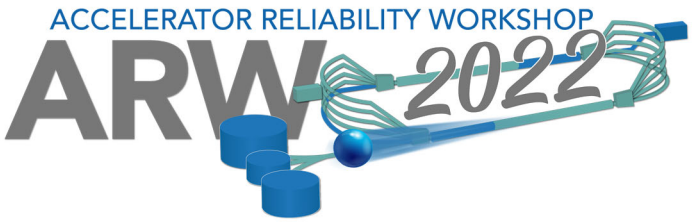
Speaker: KISHI, David (TRIUMF)
Author: David Kishi

TRIUMF is heavily reliant on supplies of liquid helium and liquid nitrogen to maintain operations. The Cyclotron uses bulk LN2 and a Linde 1630 helium refrigerator to support the vacuum system. There are two superconducting LINAC's at TRIUMF as well. Both use LN2 to cool the necessary 80K thermal shields. There are three Helium Refrigeration cold boxes to supply LHe for the cryomodules. The on-going helium shortage, Covid-19 pandemic and natural disasters have created restrictions and interruptions to cryogenic fluid supply that has impacted operations. This presentation will discuss the impact, our response and possible future plans to attempt to mitigate the impact of these issues on lab operations.

Operation History and Current Status of Electrical Power Conversion Equipment at the SNS #21

Speaker: TAN, Yugang (Oak Ridge National Laboratory)
Author: Yugang Tan

The Spallation Neutron Source (SNS) started operations in 2007 after extensive equipment commissioning. Electrical Power Conversion (EPC) equipment was originally specified or designed by different national laboratories and manufactured by various vendors. The equipment includes Low Energy Beam Transport (LEBT) chopper pulsers, High Voltage Converter Modulators (HVCMs), DC magnet power supplies, and injection and extraction kicker power supplies. Miscellaneous issues caused lengthy down time in the beginning, but the issues have been resolved through many prioritized upgrades and improvements. EPC equipment availability reached 98% in 2011 and has remained high. This presentation will discuss the past operation history and the current equipment status. Ongoing and future upgrades will also be discussed.



PLENARY DISCUSSION

Chairpersons: Annika Nordt and Duane Newhart

Monday, 17 October 2022
13:30 p.m.—15:00 p.m.

Jefferson Lab

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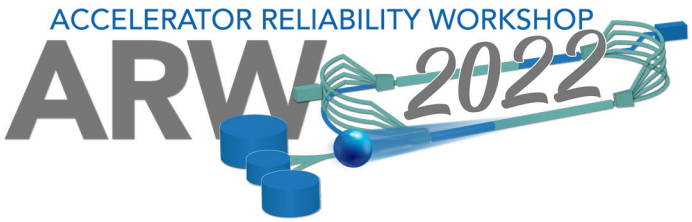


MAINTENANCE & OBSOLESCENE

Chairperson: Laurent Nadolski

Monday, 17 October 2022
15:30 p.m.—17:00 p.m.

Jefferson Lab

Recent Experience on LIPAc Reliability #76

Speakers: Dr CISMONDI, Fabio (Fusion for Energy), Mr SCANTAMBURLO, Francesco (F4E)
Authors: Fabio Cismondi, Francesco Scantamburlo

Construction, commissioning and validation of the Linear IFMIF Prototype Accelerator (LIPAc) are carried out in the framework of the IFMIF/EVEDA project. The LIPAc in its current configuration operates with D+ and consists of a 100 keV injector, a 5 MeV RFQ accelerator, a medium and high energy beam transport lines and a beam dump. In its final configuration it will include a Half-Wave Resonator-SRF (HWR-SRF) linac and will target to commission a D+ beam in Continuous Wave (CW) of 125 mA CW at 9 MeV. A temporary transport line is currently replacing the SRF linac.

In 2019 the beam commissioning campaigns achieved to accelerate a 125 mA D+ beam through the RFQ at low duty cycle of ~0.1 %. Beam operation were carried out until December 2021. In 2021 and 2022 extensive experimental campaigns have been carried out on the injector and RFQ targeting CW operation. The injector campaign aims at identifying the best configuration for operating at CW and nominal beam current. The RFQ operation aims at reaching RFQ conditioning at CW at nominal voltage of 132kV.

This paper will focus on the reliability of injector and RFPS-RFQ during the respective conditioning campaigns and recent efforts made to improve future LIPAc reliability.

Maintenance and Reliability Overview at the Canadian Light Source #24

Speaker: LE PIMPEC, Frederic (Canadian Lightsource)
Author: Frederic Le Pimpec

The Canadian Light Source (CLS), a 3rd generation light source operates since 2004 and is comprised of a 250 MeV Linac dating from 1964, a booster and a Storage ring built in 2003 and having seen completion of its last beamline(BL), #22, in 2019. For many years focus on BLs has put the maintenance of the machine in a dire position. With the completion of the last BL the Machine division can reclaim long overdue heavy maintenance to ensure both quality and reliable beam to CLS' users. I will present the status of the machine and needs for improvement as well as the CLS maintenance strategy to ensure that no system is orphan of a responsible group.

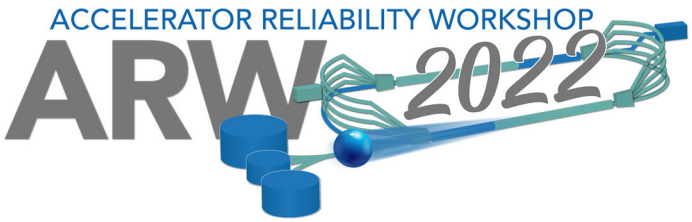
STAR Accelerator High Voltage Generator Driver Replacement #44

Speaker: PANERAS, Nikolas (ANSTO)
Author: Nikolas Paneras
Co-author: Yasser Mafi Nejad

The STAR Accelerator is a 2 MV Tandetron manufactured by High Voltage Engineering Europa. STAR is located in the Centre for Accelerator Science, Australian Nuclear Science and Technology Organisation, Australia. Commissioned in 2004, it has been reliably used for Ion Beam Analysis and Atomic Mass Spectrometry ever since.

In 2022, aging and obsolete electronics are posing a reliability threat to the STAR Accelerator. The high voltage generator driver is such an example. The analogue frequency synthesiser and phase locked loop driver board is populated with obsolete and no-longer available components. The driver had been incrementally repaired, however now the store of replacement parts has been depleted and a new solution is required.

This presentation will focus on the journey of re-designing the high voltage generator driver, including problem solving, technical hurdles and assumptions that had repercussions for the project.



MACHINE LEARNING & RELIABILITY

Chairperson: Rossano Giachino

Tuesday, 18 October 2022
8:30 a.m.—10:00 a.m.

Jefferson Lab

Toward More Efficient Accelerator Tuning with Deep Learning #18

Speaker: TENNANT, Christopher (Jefferson Lab)
Author: Christopher Tennant
Co-authors: Daniel Moser, Theo Larrieu, Jundong Li, Song Wang, Zhiming Xu

Enormous efforts are expended creating high-fidelity simulations of accelerator beamlines. While these simulations provide an initial starting point for operators, there exists a gap between the ideal simulated entity and the real-world implementation. Bridging that gap requires a brute force and time consuming task known as beam tuning. This project develops a data-driven approach to beam tuning in the CEBAF injector, which leverages deep learning over structured data (graphs). Specifically, we use graphs to represent the injector beamline at any arbitrary date and time and invoke a graph neural network to extract a low-dimensional representation that can be visualized in two-dimensions. By analyzing historical operational data from the CEBAF archiver, good and bad regions of parameter space can be mapped out. Initial results demonstrate the validity of the concept. We then suggest how this framework can serve as a real-time tool to aid beam tuning – which represents the dominant source of machine downtime – as well as address issues of reproducibility and stability in the machine.

Pulse-by-Pulse Classification System at CRYRING@ESR #33

Speaker: Dr GEITHNER, Wolfgang (GSI Helmholtzzentrum fuer Schwerionenforschung)
Author: Wolfgang Geithner
Co-authors: Zoran Andelkovic, Svetlana Fedotova, Oksana Geithner, Frank Herfurth, Claude Krantz, Simon Kundrat, Vitaliy Rapp, Gleb Vorobyev

With the many advances in machine learning in recent years, adopting this technology for accelerator operation offers promising perspectives. At CRYRING@ESR we implemented an operator-grade machine automation application with beam optimization support based on a Genetic Algorithm. This tool was used for optimizing the beam intensity via several machine sub-systems such as injection, ion source, local injector beam line.

One challenge for automatically optimizing the machine is the reliability of the injected beam in terms of pulse-by-pulse intensity variation. To mitigate this beam-variation issue, our recent work aims at developing software discrimination signals to identify „bad“ beam pulses based on time-series data. For this, our team established a rather lightweight framework of tools for on-line data monitoring and mid-term data storage in parallel to the official FAIR Archiving system based on the InfluxDB and Grafana software packages. Besides reporting on the technology stack for this framework we will provide a status update of the development of our „bad pulse“ detection which as a by-product allows user-friendly availability calculation and online monitoring.

Sustainable Implementation of Machine Learning for Particle Accelerators #73

Speaker: MICELI, Tia (Fermilab)
Author: Tia Miceli

The deployment of Machine Learning (ML) applications in a production environment requires verification, validation, assurance, and trust. ML models are notoriously difficult to maintain in these environments where data and systems may evolve over time and long-term maintenance is required. The models require active management for (1) reproduction or replication of model weights, (2) monitoring data drift, (3) tracking model performance, and (4) updating models. A Machine Learning Operations (MLOps) framework that will ensure a sustainable develop-deploy-monitor paradigm for accelerator control systems will be presented along with an overview of R&D to enable ML capabilities for accelerator operations. The R&D is being initiated by the Accelerator Controls Operations Research Network (ACORN) DOE O413.3b project to modernize Fermilab's accelerator control system in preparation for operations with megawatt particle beams.

Uncertainty Aware Anomaly Detection to Predict Errant Beam Pulses and GradCAM Analysis #72

Speaker: RAJPUT, Kishansingh (Thomas Jefferson National Accelerator Facility)
Authors: Kishansingh Rajput, Malachi Schram, Torri Jeske, Willem Blokland, Pradeep Ramuhalli, Charles Peters, Yigit Yucesan, Alexander Zhukov

In order to improve the day-to-day particle accelerators operations and maximize the delivery of the science, new analytical techniques are being explored for anomaly detection, classification, and prognostications. We describe the application of an uncertainty aware machine learning (ML) method using Siamese neural network model to predict upcoming errant beam pulses as Spallation Neutron Source (SNS) accelerator. Predicting errant beam pulses reduces downtime and can prevent potential damage to the accelerator. The uncertainty aware machine learning model was developed to be able to detect upcoming errant beam pulses not seen before. Additionally, we developed a gradient class activation mapping for our model to identify relevant regions within a pulse that makes it anomalous and we use these regions for clustering fault types. We describe the accelerator operation, related ML research, the prediction performance required to abort beam while maintaining operations, the monitoring device and its data, the uncertainty aware Siamese method with its results, and fault type clustering results.

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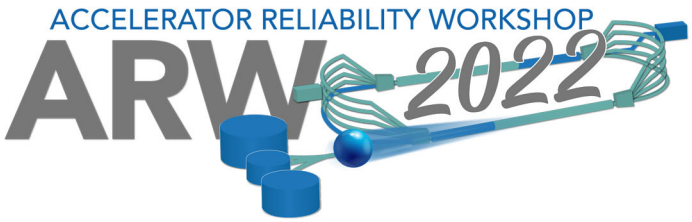


RELIABILITY IN HARSH ENVIRONMENTS

Chairperson: Duane Newhart

Tuesday, 18 October 2022
10:30 a.m.—12:00 p.m.

Jefferson Lab

Industry 4.0 Boosting Reliability in Particle Accelerators #23

Speaker: Dr DI CASTRO, Mario (CERN)
Author: Mario DI CASTRO

The fourth industrial revolution, the current trend of automation and data interconnection in industrial technologies, is becoming an essential tool to boost maintenance and availability for space applications, warehouse logistics, particle accelerators and for harsh environments in general. The main pillars of Industry 4.0 are Internet of Things (IoT), Wireless Sensors, Cloud Computing, Artificial Intelligence (AI), Machine Learning and Robotics, and we are finding more and more way to interconnect existing processes using technology as a connector between machines, operations, equipment and people. Facility maintenance is becoming more streamlined with earlier notifications, simplifying the control and monitor of the operations. Core to success and future growth in this field is the use of robots to perform complex tasks, particularly repetitive, unplanned or dangerous, which humans either prefer to avoid or are unable to carry out due to hazards, size constraints, or the extreme environments in which they take place. In this presentation, the status of the Industry's 4.0 IoT and robotic activities performed at CERN by the BE-CEM group, is presented.

Several robotics and AI solutions have been applied in the past years at CERN, as well as custom made robotic devices. New ideas and solution could arrive in the near future to increase the safety of CERN personnel. The current and future research and development in robotics done at CERN are described, as well as the results from the commissioning of various novel robotic controls, and how this knowledge is being culminated in a set of best practises to improve machines availability.

Power Interruption at BNL #25

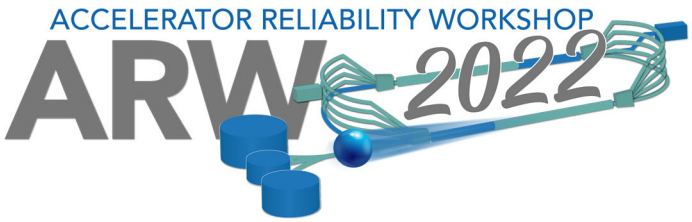
Speaker: TERHEIDE, Rachel (Brookhaven National Lab)
Author: Rachel Terheide

Experiences gained in the FY22 RHIC Run at BNL have been informative to dealing with common weather challenges. In particular, power interruption and its negative effects will be discussed here, as well as ways to avoid it. Typically when weather conditions seem likely to cause power interruptions weather standdowns are initiated. These conditions are detected with an accuweather account setup to notify operators of nearby lightning. The standdowns target vulnerable equipment that could be damaged permanently by being tripped off from a power interruption. There were several instances of unexpected power outages that exposed weaknesses in the system and demonstrated the usefulness of the weather standdowns which will be discussed here.

High Power Operation of J-PARC 3 GeV Rapid Cycling Synchrotron Under High Temperature and Humidity #19

Speaker: YAMAMOTO, Kazami (J-PARC Center, Japan Atomic Energy Agency)
Author: Kazami Yamamoto

The J-PARC 3GeV Rapid Cycling Synchrotron (RCS) is aiming to provide the proton beam of very high power for neutron experiments and the main ring synchrotron. We have continued the beam commissioning and the output power from RCS have been increasing. In recent years, we have been trying continuous supply of 1-MW high-intensity beam, which is the design value, to a neutron target. We tried to operate continuously for over 40 hours in June 2020. However, some trouble occurred and the operation was frequently suspended. In June 2021, we tried again 1-MW operation but it was suspended due to deterioration of the cooling water performance. Last summer shutdown period, we recovered performance of the cooling water system and retried in this June. In the final case, the outside temperature became extremely high. We could not keep 1-MW power, whereas 600 kW beam was delivered in stable.



POSTER SESSION

Chairpersons: Doug Preddy and Paul Sampson

Tuesday, 18 October 2022
13:30 p.m.—15:00 p.m.

Jefferson Lab

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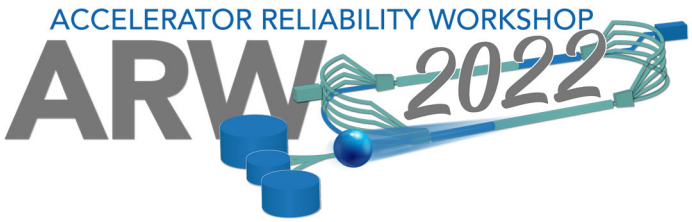

BREAKOUT

Tuesday, 18 October 2022
15:30 p.m.—17:00 p.m.

Jefferson Lab

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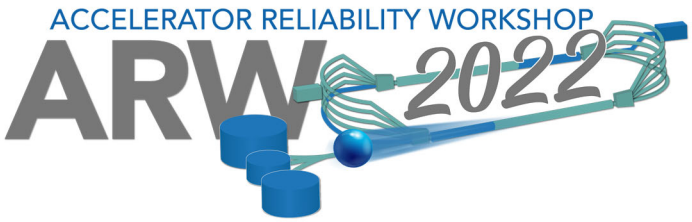

INVITED SPEAKERS

Chairperson: Ken Baggett

Wednesday, 19 October 2022
8:30 a.m.—10:00 a.m.

Jefferson Lab

Resit Unal, Professor
Engineering Management & Systems Engineering
Old Dominion University

Engineering Expertise

Robust Design Using Design of Experiments/Reliability and Maintainability/Decision Making Using Expert Judgment/Cost Estimating

Research Interests

Dr.Unal's research interests include Multidisciplinary Design Optimization, Robust Design, Quality Engineering, Response Surface Methods, and Parametric Cost Estimating. He has published in the Engineering Management Journal, IEEE Transactions in Engineering Management, Quality Engineering, Journal of Cost Analysis and Management, Reliability Engineering & System Safety, Journal of Parametrics and in the Journal of Spacecraft and Rockets.

Education:

Ph.D. in Engineering Management, Missouri University of Science and Technology, (1986)

M.S. in Engineering Management, Missouri University of Science and Technology, (1983)

B.S. in Electrical Engineering, Middle East Technical University, (1975)

Clayton A. Smith, Ph.D.
Johns Hopkins University Applied Physics Laboratory
Space Systems Engineering Group
Section Supervisor – Reliability and Probabilistic Risk

Clayton Smith is a member of the Principle Professional Staff at JHU/APL with over 35 years of experience analyzing systems from risk, reliability, and safety perspectives. These systems included: NASA and DoD missions, payloads, ground communication systems, air traffic control systems, and missile systems. Dr. Smith is the reliability engineering lead for APL's Space Exploration Sector and is currently working various projects such as the Dragonfly mission to Titan. He created and managed NASA's International Space Station Program Probabilistic Risk Assessment specifically geared toward quantifying the safety risk during operations. He received his B.S. in Aerospace Engineering, M.S. in Engineering Management, and Ph.D. in Reliability Engineering all from the University of Maryland.

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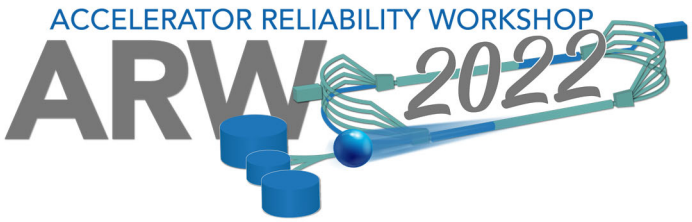

RELIABILITY OF MEDICAL FACILITIES

Chairperson: Kathleen Genge

Thursday, 20 October 2022
8:30 a.m.—10:00 a.m.

Jefferson Lab

The MedAustron Ion Therapy Centre: Experiences From 6 Years of Clinical Operation #49

Speaker: Dr NOWAK, Sebastian (MedAustron)
Author: Sebastian Nowak
Co-author: Christoph Heuer

The MedAustron Ion Therapy Centre has seen the first patient treatment in December 2016. Starting as a single-room, proton-only machine employing only one horizontal beam line, the therapy accelerator has gradually evolved to a three-room p+ and C6+ facility encompassing two horizontal beam lines, one vertical beam line, and a Gantry, allowing us to routinely treat more than 40 patients per day.

This contribution focuses on the challenges related to providing particle beams with high quality and reliability within a clinical setting experiencing a constantly increasing number of patients. Apart from the overall accelerator performance, a key parameter is the accelerator uptime which is basically defined by the mean time between failures (MTBF) and mean time to repair (MTTR) of the accelerator hardware and software components. Based on selected examples, we report on our strategies and methods developed during the last six years for maximizing the MTBF and minimizing the MTTR.

Maintenance Program of HIMAC #82

Speaker: KADOWAKI, Tetsuhito (Accelerator Engineering Corp.)
Author: Tetsuhito Kadowaki

The Heavy Ion Medical Accelerator in Chiba (HIMAC), a heavy ion radiotherapy device of the National Institutes for Quantum Science and Technology (QST), is the first dedicated machine for heavy ion cancer therapy in the world. Beam stop due to device failure add a burden and excess amount of radiation to the patient because of retry of the patient positioning. However a preventive maintenance is indispensable so as not to bring such situation, it is not so easy because of deterioration of HIMAC, budget constraint and so on.

Accelerator Engineering Corporation (AEC) is a company that supports the operation and maintenance of heavy ion medical accelerators in Japan including HIMAC, and we carry out various maintenance work to produce the stability and reproducibility of the beam. QST and AEC organized "Maintenance Program (MP)" team in 2011, and review the utilization of fault history data. MP team analyzed those statistics in detail, and set priority to the problems which should be solved in order to improve the reliability and availability of HIMAC.

Present status, availability and MP procedures will be presented.

Reliability of the Medical Cyclotron at BC Cancer in Vancouver #78

Speaker: SINGH, Baljit (BC Cancer)
Author: Baljit Singh

The cyclotron at BC Cancer in Vancouver (model TR19 by Advanced Cyclotron Systems Inc.) supplies F-18 to manufacture [F-18]FDG for 3 provincial PET centers: Vancouver, Victoria, and Kelowna (total of four scanners with around 16,000 patients scanned per year). During planned maintenance and any downtime, a backup supply of F-18 is obtained from nearby TRIUMF's TR-13 cyclotron. The activity supplied by TRIUMF is enough to sustain 80% of BC Cancer – Vancouver's demand; no FDG is shipped to Victoria or Kelowna; therefore, the reliability of the BC Cancer cyclotron is of the utmost importance.

Striving for maximum reliability (zero downtime, minimum component failures) puts full focus on preventative maintenance of major components of the machine during maintenance days (done every 2 or 3 weeks) and during the annual shutdown periods (1 week every year).

Also, in order to mitigate supply-chain issues encountered in the recent period and reduce the downtime after component failures (e.g. power supplies, controllers, pumps, and gauges), on-site spare part inventory will be increased. Deciding on what components and systems need upgrading, while taking into account the department's budget, is an ongoing challenge.

Development, Testing, and Installation of the LANSCE Isotope Production Facility Target Transfer Push Pull Chain #80

Speaker: KOPPI, Anthony (Los Alamos National Laboratory)
Author: Anthony Koppi

The Isotope Production Facility (IPF) at the Los Alamos Neutron Science Centre (LANSCE) linear proton accelerator extracts and utilizes 100 MeV protons for the bulk production of isotopes for the DOE Isotope Program.

To facilitate the safe irradiation of isotope production targets at this facility, the target bombardment station is embedded in concrete and connected directly to a hot cell above through a 40 foot tall transfer tube filled with cooling water. A motorized chain drive system is used to move production targets between the hot cell and the target bombardment station.

We recently replaced the existing target transfer system, consisting of an old motorcycle chain, with a new push pull chain to facilitate better maintenance and reliability and to mitigate risks associated with the inability to repair the chain transfer system in the event of failure. We will present some of the installation and commissioning challenges faced during this process as well as lessons learned for future design improvements.

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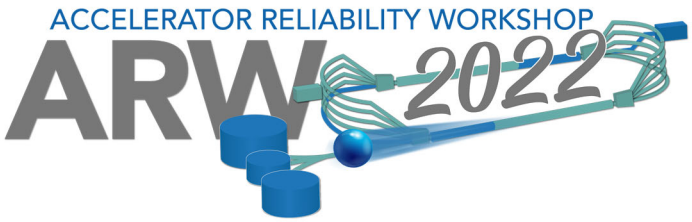


Predicting Failure

Chairperson: Annika Nordt

Thursday, 20 October 2022
10:30 a.m.—12:00 p.m.

Jefferson Lab

Utilizing Machine Learning to Improve Superconducting RF Cavity Linac Reliability* #29

Speaker: PETERS, Charles
Author: Charles Peters
Co-authors: Willem Blokland, Frank Liu, Cary Long, Pradeep Ramuhalli, Yigit Yucesan, David Brown, Alexander Zhukov, Malachi Schram, Kishansingh Rajput, Torri Jeske

The Spallation Neutron Source (SNS) Superconducting Radio Frequency (SRF) Linac has been in production operation since 2006. Since that time much has been understood about causes for SRF downtime with a high-power proton beam. One of the important causes for downtime is related to repeated beam loss events which lead to the need to reduce cavity gradients to maximize reliability. Significant time has been spent to try to first reduce the frequency of beam loss events, and second to reduce the beam lost during each event. The need to reduce gradients has slowed significantly, but the need does remain. With the Proton Power Upgrade (PPU) ongoing which will double the beam power capability of the linac the need to further prevent beam loss events remains a high priority. The source and frequency of beam loss events are difficult to predict and prevent and the protection system turn off time is hardware limited. This all led to the idea to try to utilize machine learning to monitor beam pulses to try to predict an upcoming beam loss event and when predicted hold the beam off during the event to prevent beam loss occurring. The focus is not to prevent the cause of the beam loss but just prevent the beam from occurring in the SRF cavities. The timeline to reach the point of need for machine learning as well as the current implementation and future utilization will be discussed.

*ORNL is managed by UT-Battelle, LLC, under contract DE-AC05- 00OR22725 for the U.S. Department of Energy.

Prediction, Prevention and Handling of Failure at MAX IV #34

Speaker: NIEUWENHUIS, Rutger Arend (MAX IV Laboratory)
Author: Rutger Arend Nieuwenhuis

MAX IV is a synchrotron radiation facility based on a 3 GeV linear accelerator, which powers a soft and hard x-ray storage ring, as well as a short pulse facility. At MAX IV, the prediction, prevention and handling of failure is a critical part of ensuring a reliable beam for user access. A robust set of tools has been developed for use in failure-related procedures, which will be presented along with several examples.

Before handover to beamlines, parameters are compared to past and nominal values and alterations are made if necessary. Furthermore, after longer maintenance, a system of checklists delegated to subsystem owners is used to verify the equipment. During user access, operations personnel monitor accelerator systems with several applications, and are notified by an alarm system when parameters go beyond specified limits. When failure does occur, the personnel use various applications to diagnose the failure and collect data. Repetitive start-up tasks are automated to allow for a quick recovery.

After a failure, details are logged in a home-built data-driven logging system. This allows for evaluation of the performance of the facility, presenting statistics such as the uptime%, mean time to failure and mean time to repair. Moreover, the logged details are discussed with relevant subsystem owners to identify causes and formulate potential plans to improve facility performance. After a plan is made, progress is tracked and archived on completion. Several past examples of the continues improvements and their effects on performance will be presented.

RAMI analysis of IFMIF-DONES Lithium Systems Events Important for Beam Interlocks of the 5 MW Superconducting LINAC #63

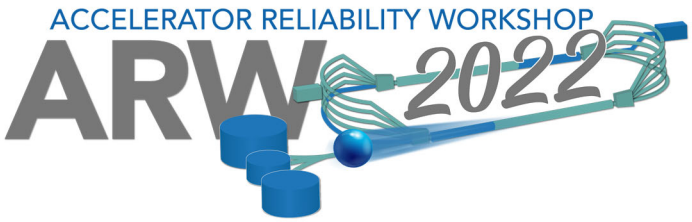
Speaker: Mr RUEDA PÉREZ, Juan José (University of Granada)
Authors: Danilo Dongiovanni, Tonio Pinna, Juan José Rueda Pérez
Co-authors: Ángel Ibarra, Ivan Podadera, Claudio Torregrosa

The IFMIF-DONES facility is aimed at providing a database of materials exposed to similar irradiation conditions as in DEMO. For this purpose, a neutron source facility will be built, consisting of a superconducting linear Accelerator Systems (AS) generating a deuteron beam impacting onto a target made of a liquid lithium jet provided by the Lithium Systems (LS).

An important aspect of the project design activities is to assess the system reliability at all phases of the facility life cycle to support a reliability growth during the ongoing design phase and to monitor the compliance with the stated availability targets.

In DONES facility, AS and LS are functionally and physically entangled. In fact, AS operation has an interlock dependency on the LS which can be “ready or not ready for beam” since the liquid lithium jet must be ready to receive the 5 MW power of the accelerator. In this context, the present study focuses on the failures arising in LS that can lead to a beam interlock to the AS.

Following RAMI methodology, first a Failure Mode and Effect Analysis (FMEA) is done in order to point out all the relevant unavailability conditions in the LS subsystems (lithium loop, secondary and tertiary cooling loops and target system) that could lead into a shutdown event on the AS. Then, Reliability Block Diagrams (RBDs) are derived from FMEA by implementing a reliability-wise representation of system component behavior and simulating the system performance under due operating conditions.



BREAKOUT

Tuesday, 18 October 2022
15:30 p.m.—17:00 p.m.

Jefferson Lab

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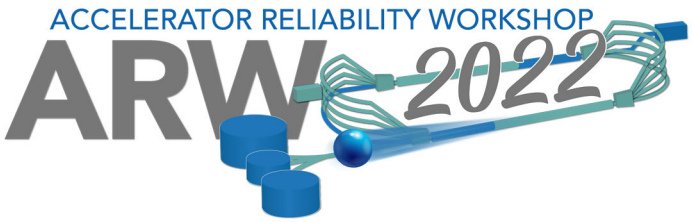

New & Innovative Accelerator Technology

Thursday, 20 October 2022
15:30 p.m.—17:00 p.m.

Jefferson Lab

A Digital Twin Application for Particle Accelerators #20

Speaker: SMAKULSKA, Dorota (CERN)
Author: Dorota Smakulska
Co-authors: Said Atieh, Marco Garlasche

A Digital Twin is a dynamic, bespoke model of a physical system, providing real-time information on the asset instant state and allowing for data extrapolation and predictive modelling.

The application of Digital Twins can open a new chapter in the engineering of particle accelerators and their systems. With Digital Twin, data acquisition and asset modelling can be augmented in space and in time: plentiful additional insight may be provided with respect to 'standard' data acquisition of physical parameters, thus allowing for enhanced perspectives in design and engineering; asset prediction is bespoke and real-time, to the great enhancement of predictive and corrective maintenance activities.

This contribution will detail what makes a Digital Twin so unique and different from the historical methods applied in engineering design, data acquisition, monitoring and failure prediction. Applications for accelerator systems will be presented, together with the status of ongoing activities within the Mechanical and Materials Engineering Group at CERN.

Hardware Integrity Assessment of the Fast Beam Interlock System (FBIS) at ESS #58

Speakers: GUSTAFSSON , Johannes (ESS), WENG, Joanna (ZHAW)
Author: Joanna Weng
Co-authors: Silvan Fluri, Johannes Gustafsson , Patrick Probst, Martin Rejzek , Christian Sommer

The fast beam interlock system (FBIS) for the ESS accelerator was developed and built in-house by the safety critical systems (SKS) group at the Zurich University of Applied Sciences (ZHAW), in close collaboration with the ESS machine protection (MPS) group. The FBIS plays an essential role in ESS machine protection and is the logic solver element of most protection functions. In order to ensure high reliability of the FBIS, a reliability analysis is performed following the IEC 61508 functional safety standard for the assessment of hardware integrity.

The presentation shows the various steps needed to verify the hardware integrity.
This includes the calculation of the Probability of dangerous Failure per Hour (PFH) and the evaluation of the architectural constraints by calculating the Safe Failure Fraction (SFF) and the Hardware Fault Tolerance (HFT) of the system. These calculations are based on failure rate predictions using the Siemens SN 29500 standard and a detailed Failure Modes, Effects and Diagnostic Analysis (FMEDA).

The current results of the FBIS reliability analysis are presented and compared with the corresponding hardware integrity requirements. In addition, an example reliability analysis of a complete ESS machine protection function containing a senor system and actuators is shown.

Alarm Management at the Australian Synchrotron #27

Speaker: DE BOOY, Jonathan (ANSTO)
Authors: Jonathan de Booy, Andrew Starritt, Joel Trewhella, Cameron Rodda

An alarm management system is an essential tool for control room operators to facilitate a fast and effective response to abnormal operating conditions. A major challenge for operators is alarm fatigue resulting from too many concurrent alarms, frequent alarm state changes (nuisance alarms), or recurrence of known bad alarm states that are already handled. We have sought to create a control-system-agnostic alarm management system that is fast, scalable, distributed, fault tolerant, and allows for on-the-fly event processing providing additional custom functionality beyond simply logging and acknowledging alarm state changes. Expected benefits include assisting operator decision making, reducing nuisance alarms, seamless integration with different and future control systems, and the ability to tailor the system to different end users and GUIs.

Multi-Module based VAE to Predict HVCM Faults in the SNS Accelerator #15

Speaker: ALANAZI, Yasir (Old Dominion University)
Authors: Yasir Alanazi, Malachi Schram, Kishansingh Rajput, Chris Pappas, Majdi Radaideh, Dan Lu

The anomalies in the High Voltage Converter Modulator (HVCM) remain a major down time for the Spallation Neutron Source (SNS) facility. To improve the reliability of the HVCMs, several studies using machine learning techniques were to predict faults ahead of time in the SNS accelerator using a single modulator. In this study, we present a multi-module framework based on Conditional Variational Autoencoder (CVAE) to detect anomalies in the power signals coming from multiple HVCMs that vary in design specifications and operating conditions. By conditioning the VAE according to the given modulator system, the model can capture different representations of the normal waveforms for multiple systems. Our experiments with the SNS experimental data show that the trained model generalizes well to detecting several fault types for several systems, which can be valuable to improve the HVCM reliability and SNS as a result.

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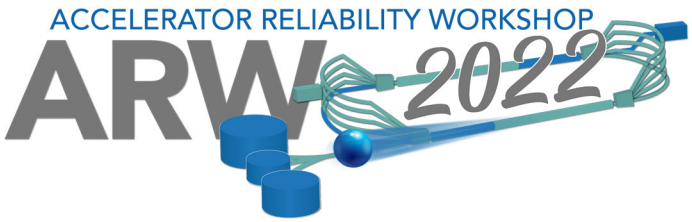


Reliable Protection Systems

Friday, 21 October 2022
8:30 a.m.—10:30 a.m.

Jefferson Lab

Lessons Learning: Vacuum Protection for TRIUMF's Superconducting Linear Accelerator (SCLinac) #37

Speaker: ANGUS, TIFFANY (TRIUMF)
Author: TIFFANY ANGUS

The SCLinac at TRIUMF's Isotope Separator and Accelerator (ISAC) Facility can provide energies above the Coulomb barrier to create nuclear reactions at our third/final set of experimental facilities. High vacuum is required to support the operation of RF & Cryogenics. This past June, two forms of vacuum protection failed in tandem to adverse results. Two years minimum are needed to regain the accelerating capacity, & there are implications for these experiments in the meantime. This talk will explore what information indicative of such potential vacuum failures we had in advance, what was immediately implemented as temporary additional protection, & opportunities being explored to increase reliability for the future as we upgrade existing & design new accelerators & beamlines.

Equipment Protection System Checks at ALBA #41

Speaker: FERNANDEZ, Ferran (ALBA synchrotron)
Author: Ferran Fernandez

ALBA is the Spanish 3rd generation synchrotron light source. In operation since 2012, we are continuously aiming to maximize the beam availability for users. Like the rest of particle accelerators, an Equipment Protection System (EPS) takes care of avoiding situations that could damage the accelerators.

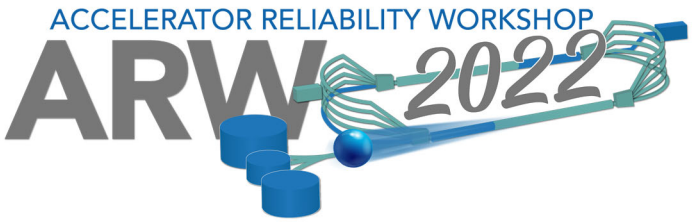
Based on sensors (that gather information), PLCs (that processes it) and switches (that act on hardware), many different hazards are taken into account in the EPS: magnet thermal switches interlocks power supplies, vacuum gauges and pump pressures close valves, surface thermocouples inhibits RF,... However, these situations rarely occur.

Here we discuss which checks we perform on the EPS to ensure it is working properly, not only focusing on what/how often do we check, but also how we do it; one can easily simulate a thermocouple error signal in a PLC, but it's not that easy to heat it up physically.

Beam Abort System for the SLS 2.0 #36

Speaker: ARMBORST, Felix (Paul Scherrer Institut (PSI))
Author: Felix Armborst

The beam abort system for the current Swiss Light Source (SLS) is based on inverting the RF phase to decelerate the stored beam. The loss process was assumed to evenly spread out the stored beam around the ring. However, it is actually localised at longitudinal positions where the dispersive orbit meets the machine aperture. For the SLS, these losses mainly occur at the septum and triple-bend-achromat arc sections. For the SLS 2.0 with its seven-bend-achromat lattice and thus much lower dispersion in the arcs, tracking simulations show that these losses are localised at a superconducting super bend and an in-vacuum insertion device. Due to this unfortunate dispersive loss distribution, the small beam size, the fragile vacuum chamber and the stored beam energy of 1 kJ, a more controlled beam abort is desired. In case of an RF failure, the beam abort system must dump the beam safely before the critical dispersive orbit is reached. A fast beam dump controller with dedicated inputs for fast systems such as the low-level RF and fast feedback systems is foreseen for triggering the required emergency beam dump procedure. The majority of the well over 6000 machine interlock signals will pass through the slow, programmable-logic-controller-based machine interlock system. Here the sheer amount of signals will pose a challenge.



Reliability Consideration During Commission or Machine Upgrade

Friday, 21 October 2022
10:30 a.m.—12:00 p.m.

Jefferson Lab

Considerations on the Reliability of FAIR #46

Speaker: Dr REIMANN, Stephan (GSI/FAIR)
Author: Stephan Reimann
Co-author: Petra Schuett

With the Facility for Antiproton and Ion Research (FAIR), an extension of the existing accelerator facility is being built at the GSI Helmholtz Centre in Darmstadt/Germany, which will increase the area of the research center by a factor of four. Within the framework of the project, a superconducting 100 Tm synchrotron, a superconducting fragment separator and 2 storage rings, as well as several kilometers of beamline and target stations are built. With the increased complexity and the number of devices, the possible sources of failure also multiplied. It was therefore necessary to keep reliability in mind from the very beginning and to develop a corresponding concept for the operation and maintenance of the facility. In this talk, the concepts are presented and a short status update on the state of the project will be given.

Reliability of Proton Superconducting Linacs: SNS Case Study and Perspective on Future Machines* #75

Speaker: GENG, Rongli (Oak Ridge National Laboratory)
Authors: Rongli Geng, Sang-ho Kim, Amith Narayan, Charles Peters

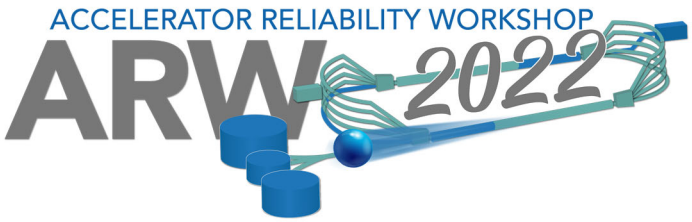
Future proton superconducting RF (SRF) linacs used as accelerator driven systems (ADS) must achieve high reliability and availability to meet the challenging parameters for applications in medical treatment, nuclear waste reduction, and nuclear power generation. What SRF innovations and advanced concepts are needed? To answer this question, a case study of the past, current, and possible future downtime sources is carried out for the Spallation Neutron Source (SNS) SRF linac systems. SNS is an accelerator-driven neutron source facility routinely operated at a 1.4 MW beam power with a 99% availability in its SRF systems and is currently undergoing an upgrade to a new level capable of a 2.8 MW beam power. The preliminary outcome of this study is to be presented. We will discuss its implications to the needed development of the next generation SRF systems and related systems towards 10-20 MW proton SRF linacs required for future ADS facilities.

*Work supported by ORNL LDRD

An Overview of Power Supply System of the EBS #42

Speaker: GOUDARD, Olivier (ESRF)
Authors: Olivier Goudard, Laurent Jolly

An overview of the power supply system installed during the EBS upgrade will be presented. The focus will be on the operation of the storage ring main magnet power supplies. A comparison between the old and the new power supply structure will be given. The current topology of the system and the main issues since the beginning of the EBS operation will be presented in detail. The description of a power supply hot swap system to enhance the global system availability and reliability will also be provided. Finally, the perspectives for the future will be discussed.



LOC/IOC Closing Remarks, Workshop Highlights & Next Workshop

Friday, 21 October 2022
12:00 p.m.—1:00 p.m.

Jefferson Lab

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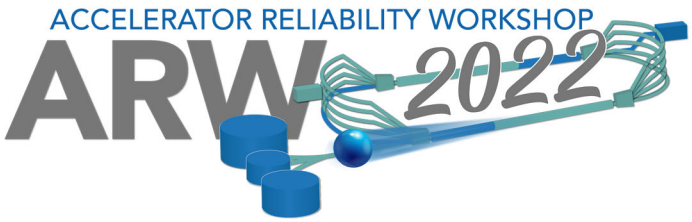

Thank you for

joining us at ARW 2022.

Safe travels!

Jefferson Lab