Report of the 21st Meeting of the Accelerator Technical Advisory Committee for the Japan Proton Accelerator Research Complex (J-PARC)

February 7 – 10, 2022
Remote Zoom Meeting

The Accelerator Technical Advisory Committee (A-TAC) for the J-PARC Project held its twenty-first meeting from February 7 to 10, 2022 via remote Zoom contention due to COVID-19 precautions. The A-TAC members participating were: Alexander Aleksandrov (ORNL), Wolfram Fischer (BNL), Simone Gilardoni (CERN), Toshiyuki Shirai (QST), John Thomason (STFC), Sheng Wang (IHEP), Robert Zwaska (FNAL) and Jie Wei (MSU, chair) (Appendix 1). Mats Lindroos (ESS) was unable to attend.

The A-TAC thanks the J-PARC management and staff for their thoughtful arrangement of this remote Zoom meeting under the COVID-19 circumstances, and all the presenters for their excellent and comprehensive talks. Presentations were mostly given around midnight local time to accommodate the committee members distributed globally. In addition, the accelerator team responded appropriately arranging specific talks to the requests made at the last A-TAC Review and to the questions and homework requests from the committee at this review.

Executive Summary

Since the last A-TAC review held in February 2021, the J-PARC accelerator complex has continued to maintain high beam power at an impressively high machine availability for a scientific user facility for both discovery and applications. The beam power for MLF operation is steadily above 700 kW with availability above 95%. The beam power for MR-FX to the neutrino experimental facility and MR-SX to the hadron experimental facility have been maintained at 510 kW and 64 kW, respectively, with availability above 90%.

Due to cooling capacity issue of the RCS, the beam power delivered to MLF was reduced from 740 kW to 630 kW in June 2021. A malfunction with the electrical transformer powering MR magnets caused damage in MR extraction system. J-PARC was able to adjust the operation schedule to minimize impacts to users.

Since April 1, 2021, Prof. Takashi Kobayashi has been appointed as the Director of J-PARC Center. Dr. Michikazu Kinsho continues heading the J-PARC Accelerator Division.

As part of the medium-/long-term plan from 2022 to 2028, the Accelerator Division identified its top-priority goal to be high availability operation at 1 MW beam power level to be realized by steadily increasing beam power annually by 100 kW. Measures to enhance spares and in extending lifetime of equipment are planned, along with efforts to develop energy saving devices, like raising the efficiency of the wide-band RF system in the RCS. Research and Development (R&D) themes were developed including topics directly benefiting J-PARC's future plan and topics benefiting the general accelerator community.

The J-PARC team is commended for continuing to maintain high user availability and work efficiency during the period of the persistent COVID-19 pandemic. J-PARC continued to show flexibility where possible to re-schedule user time when interruptions occurred. User hours this year continued to be limited due to funding constraints.

The MR upgrade work followed last year's plan and made significant progress with beam tests in the new configuration for a 1.36 s cycle time scheduled for June 2022.

The J-PARC accelerator team has addressed most of the twelve A-TAC 2021 recommendations. Presentations were given at this review on the six topics requested by A-TAC at the 2021 Review. Responses to a long list of written questions and six homework assignments at the 2022 Review were timely and comprehensive. The committee commends the J-PARC team on their dedication and vigor addressing pressing issues.

In the following, we summarize the main recommendations of the A-TAC 2022. Each of the ten recommendations (**R1** – **R10**) will be elaborated multiple times across the main body of this report following committee findings and comments. The order of the main body of this report follows the eleven talks (Appendix 2) and six homework assignments presented at this review.

Accelerator R&D and improvement projects (AIP) are important for maintaining high machine availability and reliability, and will be critical to establishing the path forwards for J-PARC. Such program may include topics like integrated machine protection and major utility infrastructure renovation. The committee have heard some information, spread across a number of talks, about R&D topics that J-PARC are interested in pursuing, but would like to understand the overall direction of R&D as well as prioritized AIP, and how decisions are being made and priorities set.

R1: Develop a prioritized list of the accelerator R&D and AIP which J-PARC would like to pursue, along with a clear explanation of the decision making and prioritization process, and present this at A-TAC 2023.

J-PARC previously identified staffing as an issue and has made efforts to address it, including the hiring of seven staff members this year – several term positions. Staffing levels are already lean for the responsibilities of operation. The workforce is highly bunched in age and retirements are expected to occur at a rate of between up to 10% per year for the next 15 years. Furthermore, there is no margin of labor available for new projects. This is a liability for future operations and may need more creative approaches in light of the limitations of permanent staff at J-PARC. Options to consider are guest workers from other institutes, joint positions with universities, and other contract positions with areas of expertise to maintain sustained effort.

R2: Update the J-PARC staffing plan to consider alternatives to permanent employment at J-PARC and other solutions to the anticipated shortage.

A new MEBT design was motivated by desire to add one more RF buncher to increase tuning flexibility. No supporting evidence for an additional buncher need was found in the beam study, at least for 50mA operation. Significant discrepancies between the model prediction and the measurements were discovered.

R3: Keep the new MEBT design on hold. Continue beam study to resolve the observed discrepancy between the measurements and the model.

It is clear that kicker impedance is a major source of instability in the RCS, and that this will be a limit to potential increased beam intensity for the MLF and high-beam intensity and low emittance for the MR. Therefore, it is very important to suppress this instability in the RCS. Machine studies have shown that installing a diode unit in the kicker magnet can effectively suppress the instability.

R4: Consider adding new diode units to all eight kickers in the RCS as quickly as possible. This will mitigate the major source of instability and extend the parameter windows for commissioning in anticipation of future high-power operation.

In recent years, beam commissioning for the RCS has progressed smoothly, with beam powers of 1 MW, equivalent 1.2 MW and equivalent 1.5 MW demonstrated successfully. From the point of view of beam dynamics, there appears to be no limit to reaching 1.5 MW. However, it will take a concerted effort on other aspects, such as the cooling water system, RF systems, kicker impedance, etc. to achieve future high-power operation.

R5: Study and present the analysis of what further upgrades to the RCS cooling system will be required for future high-power operation at 1.5 MW, and present an integrated plan of how this will fit in with upgrades to the RF systems and kicker impedance.

From the well-conducted studies in MR, it is clear that the formation of the electron cloud generating the transverse instability during the SX is triggered by a modulation of the longitudinal density of the beam. While on the one hand the program undertaken to reduce the longitudinal impedance to a minimum is well established, it would be advisable to try to tackle the transverse instability as well, in particular both through an identification and reduction of the possible hardware sources of the electron cloud, such as the vacuum chamber but not only, as with an active system to damp the instability.

R6: Prepare a plan to mitigate or cure the transverse instability, with particular attention to the source of electron-clouds, and which should include the appropriate machine time devoted to the experimental study of the instability, and execute it if possible.

The ESS will always be a vulnerable point of failure for the MR. The MR stores a very large amount of beam energy and additional near misses and impacts of beam upon the ESS can be anticipated. These devices need to be considered consumable and/or recoverable; a ready inventory of spares is necessary for reliable operations.

R7: Develop a program to simultaneously produce multiple spare electrostatic septum devices, and investigate methods to repair devices removed from service.

The faulty microswitch on the transformer pressure relief valve in the MR still presents an increased machine protection risk. The microswitch may not operate properly in the case of a real pressure excursion within the transformer (such as in the case of an internal arc). The expectation is that the MPS would still trip off after a delay when the temperature rise of the oil is detected – this feature should be verified. There is an additional fast pressure rise detector which could be the best way to trip on a transformer failure.

R8: Extend the MPS to have redundant safety elements to detect transformer failure, understanding that some portion of the microswitches may fail over time.

The most straightforward machine protection innovation would be to enable the primary abort line to operate throughout the slow extraction cycle. This is presently not performed due to concern about prefires of the thyratron-based switches for the kicker magnets. Prefires could conceivably cause the beam to damage the ESS or other components of the accelerator. This situation should be analyzed to quantitatively understand the risk, and whether it is worth not having the "ms abort" used during fast extraction. Additionally, the kicker system could be augmented with more reliable switches, such as solid state, which could reduce the risk of prefires.

R9: Investigate upgrade of the abort kicker system to allow fast, ms abort of the beam during the entire slow extraction cycle.

The new MR power supplies are still being installed and R12 from the last review could not be completed yet. It is anticipated that the new power supplies will be ready for full system tests in May of 2022.

R10: Perform heat runs and current ripple measurements over the full operating cycle with all new quadrupole and sextupole PS as soon as this is possible (outstanding recommendation R12 from A-TAC 2021 review).

Items for the Next Meeting (A-TAC 2023)

The committee would like to hear from the J-PARC accelerator team in particular to:

1. Present prioritized lists of the accelerator R&D and accelerator improvement projects (AIP) which J-PARC would like to pursue, along with a clear explanation of the decision making and prioritization process.

2. Report the current understanding of the beam dynamics and major sources of the beam loss in the linac from the RFQ exit to the RCS injection. Specifically, model vs measurements for the RMS beam parameters and the loss pattern; correlation between the residual activation and the BLM readings; and how the model is used for linac tuning and loss reduction.

3. Present plans for the use of Artificial Intelligence and Machine Learning techniques in failure prediction, pre-operational adjustments and constant monitoring of beam status during operation of the J-PARC accelerators.

4. Report on the MR PS commissioning, in particular current ripple measurements over the operating cycle

5. Present MR beam dynamics studies and commissioning plans beyond 700 kW beam power.

6. Provide (in English) a summary of the multi-year maintenance and upgrade plan pertaining to utilities and infrastructure.

02 J-PARC Accelerator Overview (RZ, JT)

Findings

JFY2021 was a year of considerable progress for J-PARC. This was the second year of the COVID-19 pandemic and J-PARC seems to be operating with only nominal impacts. The MLF operated regularly, achieving record 740 kW beam power with high availability. The MR operated for a substantial portion of the year, even while upgrading its magnet power supplies to enable future beam power in excess of 1 MW. J-PARC continued to show flexibility where possible to re-schedule user time when interruptions occur. J-PARC has plans to increase user time in future years with adequate funding and when the MR PS upgrade project is complete.

[statistics JFY2021 through July 2021 – beam was restarting in January]

RCS for MLF:

- The RCS provided 630-740 kW to the MLF in the previous year, limited by the MLF target capability and RCS cooling capacity during the summer (later found to be a heat exchanger issue which has been addressed). J-PARC intends to increase beam power by ~ 100 kW each year, as allowed by the target and maintaining high availability. Future running of 1.5 - 2 MW is anticipated to support a second target station.
    - 1974 hours of beam delivery were achieved out of 2030 scheduled for the MLF. The downtime remained low, achieving an availability of 97.2%, well exceeding the goal of 90%. The scheduled number of hours was low due to a long maintenance outage, and rescheduling to allow additional target work.
    - A total of 151.9 days of operation is anticipated in JFY2021, compared to the initial plan of 159 days. 159 days (7.2 cycles) is also anticipated for JFY2022 – that amount has been typical in recent full years of operations. With additional funding, J-PARC could optimally run at 9 cycles per year

MR with fast extraction for neutrinos:

- Scheduled beam delivery was minimal due to the long summer maintenance outage and the intense MR power supply upgrade underway. Beam was delivered at up to 510 kW during this period.
    - 347 hours of beam were delivered out of 371 scheduled for neutrino operation. Availability during this period was among the best achieved in the MR at 93.6%.
    - Beam was made available earlier than scheduled due to a failure of the ESS used for slow extraction. The pivot to fast extraction was possible due to development of flexibility at J-PARC in the accelerator facilities and experiments.
    - 99 days of MR user operation is planned for JFY2022 after the long summer outage for the MR PS upgrade commissioning. The time will be split between neutrino and hadron operation.

- J-PARC will reduce the MR cycle time to < 1.3 s to achieve >750 kW in the MR. Reducing the cycle time is the most straightforward path to higher power. Combined with other improvements to loss control and RF power, J-PARC should be able to produce high-power beam for the Hyper-K experiment, and be capable of 1.3 MW by 2028, and perhaps sooner.
    - Power supplies are all installed and the connections to the magnets are being made. Several have already proved capability through beam operation.
    - The power supply upgrade and 1.3 s cycle will be available in early JFY2022, making a substantial increase in beam power possible in the near future.
- A further program of modest improvements to the MR will result in increased beam intensity. When combined with the power supply upgrade (and further extension to 1.16 s cycle time), 1.3 MW should be available from the MR for fast extraction. These plans are now well understood and well underway. The mid-term plan has been consistent with a gradual rise to 1.3 MW in JFY2028 to be available for Hyper-K. The technical improvements will be in place by 2025 allowing time for commissioning.

MR with slow extraction to the Hadron Facility:

- Beam of up to 64 kW was delivered to the Hadron Facility in JFY2021. Further improvements are planned to > 80 kW in the next few years.
    - 952 hours of beam were delivered out of 1016 scheduled, for an availability of 93.7%, among the best achieved at the MR.
    - Extraction efficiency was 99.5% and Spill Duty Factor was 50-55%, both excellent metrics.
    - Beam was substantially rescheduled due to failure of the ESS. Flexibility in the schedule allowed most of the time be exchanged with fast extraction so that the loss was minimal.
    - 99 days of MR user operation is planned for JFY2022 after the long summer outage for the MR PS upgrade commissioning. The time will be split between neutrino and hadron operation.

MR with slow extraction at 8 GeV to COMET

- One week of 8 GeV beam studies were performed in anticipation of the COMET experiment entering operations within the next few years.
    - 1.8 kW of beam was extracted with 99.1% efficiency, and 55% Spill Duty Factor – both substantially improved from previous studies.

J-PARC plans to operate the MLF for 7.2 cycles = 159 days in JFY2022, though optimal operation is considered 9 cycles per year. Future planning is for 9 cycles per year. The MR will operate for 99 days (4.5 cycles), and anticipates requesting up to 9 cycles in future years.

J-PARC is at risk of losing key expertise in the next 10-15 years as it may have a large portion of its staff retire. J-PARC recently hired seven new staff members, but is under significant limitations on its total staffing.

J-PARC has started approaching new areas of accelerator R&D relevant to its future mission. This may be a very effective activity for the J-PARC staff, and the A-TAC looks forward to hearing the results in future years.

Comments

J-PARC's progress over this last year has been outstanding. They have provided beam with high availability, while making progress towards higher powers. The RCS stands ready to provide 1 MW when the target facilities are available. High-availability and low-loss operation both look achievable, but will need to be proven by operations. J-PARC investigated their limiting cooling issues in the RCS and may have found the problem and solved it. The MR continued its record of operation and made excellent progress towards its power supply upgrade. Rapid increases in beam power to the neutrino beamline can be expected when commissioned, and powers exceeding 1 MW can be expected within a few years, with additional upgrades underway.

Operating hours were satisfactory for J-PARC, considering all the upgrade work underway. Also, availability within those hours continues to improve, being excellent (> 95% for the MLF, and >90% for the MR). Further increases will be possible when upgrades are complete, and if funding improves. Efforts may also be taken to reduce the impact of commissioning and studies, perhaps through more automation of the equipment switching between different modes.

J-PARC has developed a strategy with a period of "Stable Operations at 1MW" for the Linac and RCS, after reaching 1 MW operation. This program should be pursued, as 1 MW is delivered to the target within the next few years. The user community will of course benefit from high availability. The committee notes that many of these improvements may be useful for 1.5 - 2.0 MW operation with an additional target station. It would be useful for J-PARC to decide the operating scenario for 1+ MW (choose power, linac current, pulse length, etc.) so that these mid-term upgrades can be designed to be compatible with that mode, and also to inform future target station designs. The change in cycle sharing may result in an increased pulse intensity to the MLF (even at the same power) which may require target design changes. The target development process takes years, so sufficient notice is required.

J-PARC previously identified staffing as an issue and has made efforts to address it, including the hiring of seven staff members this year – including several term positions. Staffing levels are already lean for the responsibilities of operation. The workforce is highly bunched in age and retirements are expected to occur at a rate of between up to 10% per year for the next 15 years. Furthermore, there is no margin of labor available for new projects. This is a liability for future operations and may need more creative approaches in light of the limitations of permanent staff at J-PARC. Options to consider are guest workers from other institutes, joint positions with universities, and other contract positions with areas of expertise to maintain sustained effort.

Recommendation

R2: Update the J-PARC staffing plan to consider alternatives to permanent employment at J-PARC and other solutions to the anticipated shortage.

03 MEBT1 (AA, ST)

Findings

An intention to design a new MEBT was motivated by a general assumption that three independently tunable buncher cavities are required to optimize performance of the RF chopper and match the longitudinal Twiss parameters at the DTL entrance.

As a response to R4 from the A-TAC 2021 review, an extensive study of the above assumptions was conducted. It was found that the first buncher provides optimal chopper performance in a wide range of parameters, and the second buncher provides sufficient tunability to ensure low loss longitudinal matching. No need of an additional buncher was supported by the study at least for 50mA operation, therefore plan for the MEBT redesign was suspended.

Some discrepancies between the model prediction and the measurements were discovered: the longitudinal bunch profile in the MEBT did not depend on the first buncher amplitude, and the transverse RMS beam emittance in the linac was significantly large than predicted. Causes of the discrepancies are not understood at this moment.

Beam diagnostics improvements in the MEBT include new carbon nanotube wires for the wire scanners and a new Beam Shape Monitor.

Comments

The committee thanks the team for their clear and detailed presentation on the beam study results. This is an exemplary response to the recommendation.

The bunch profile independence on the longitudinal focusing strength, i.e. the buncher RF amplitude, is puzzling. It could be a result of strong space charge effect at the focal point or insufficient resolution of the BSM. The space charge effect can be ruled out by making measurements with reduced beam current.

The RMS transverse emittance is calculated using the beam profile measurements and a model fit. The reported measurement error bars, in the range of few percent or lower, are surprisingly small for this type of measurement. It is not clear how many separate measurements were taken to have reasonable statistics for the error estimate. Also, this type of emittance calculation can have a significant uncertainty, if the wire scanners positions are not optimal.

It is prudent to compare the IMPACT simulation code results with other well established tracking codes, e.g. PARMILA

Recommendations

R3: Keep the new MEBT design on hold. Continue beam study to resolve the observed discrepancy between the measurements and the model.

04 RCS beam commissioning (SW, RZ)

Findings

The RCS commissioning team continuously made effort to Beam loss mitigation for high intensity operation. In the past year, it took 10 days for beam commissioning, and the good progress has been made. Three ways were tried to reduce beam loss under high beam intensity:(1) instead of RF frequency offset, linac beam momentum offset was used to optimize the injection; (2) reducing the width of stripping foil by minimizing the beta-y of vertical injection beam at the injection point; (3) optimizing the vertical tune. The beam commissioning shows that, these three ways effectively mitigate the beam loss for high intensity operation. The optimization of linac beam momentum offset well controlled the tune change and closed orbit distortion in the peak dispersion area; small foil effectively decreased the traversal number of the foil, as well as decreased the beam loss due to foil scattering; the optimization of transverse tune separated the beam from strong resonance. With these optimizations, the beam loss for 1 MW was controlled to below 0.1%.

The optimization of emittance has been made for the MR mode in the beam commissioning. By optimizing the transverse tune and chromaticity correction, the beam emittance was reduced by about 12% with low beam halo.

To confirm the feasibility of using small size stripping foil for 1.5MW, the beam commissioning was done. With 60mA peak current 600us pulse width linac beam, 1.45MW equivalent beam was accumulated and accelerated to 0.8GeV with well controlled beam loss, and confirmed that the small foil can be used for 1.5 MW operation.

One diode unit has been installed into kicker-8, and beam test showed the impedance was effectively mitigated. Installation of diode unit to all kicker is essential for a sufficient impedance reduction to mitigate the beam instability, as mentioned in R4.

Comments

In the beam commissioning for increasing the beam power, for both MLF and MR mode, the tune needs to be optimized. It appears for higher beam intensity, the vertical tune needs to be increased. In general, the optimized tune for high intensity, should be also a good tune for low intensity as well. It is suggested to do a tune scan in high beam intensity to investigate what is the upper limit of the vertical tune.

Take the advantage of angle scan in the painting scheme, both correlated and anti-correlated painting can be performed, and for MLF and MR mode, the painting emittance can be chosen from 200 to 50 pi.mm.mrad. This means the space charge effect is not a limit for present beam power, and there is large parameter space to optimize the injection. It is suggested to plan more machine study to further optimize the beam parameters with higher beam intensity.

Recommendations

R4: Consider adding new diode units to all eight kickers in the RCS as quickly as possible. This will mitigate the major source of instability and extend the parameter windows for commissioning in anticipation of future high-power operation.

R5: Study and present the analysis of what further upgrades to the RCS cooling system will be required for future high-power operation at 1.5 MW, and present an integrated plan of how this will fit in with upgrades to the RF systems and kicker impedance.

05 Slow extraction beam dynamics (SG, WF)

Findings

Studies on the transverse instability that appears 60 ms after the start of de-bunching prior to the SX continued, with an excellent follow-up of the **R10** of the A-TAC 2021.

The sequence of events leading to the development of the transverse instability is well understood: the longitudinal impedance of the machine creates a longitudinal micro-structure during the de-bunching process, when the bunches start to overlap. This microstructure causes the formation of electron clouds in a diffuse way along the entire ring, electron clouds which then cause a transverse instability, and therefore losses that limited the maximum beam power achievable.

Electron cloud measurements and simulations, and the wall current monitor measurements, indicate the longitudinal microstructure at 30-50 MHz as the triggering event for the formation of the electron cloud.

The effort has been concentrated on reducing, where possible, the longitudinal impedance of the new elements, to minimize the longitudinal modulation considered the root cause of observed phenomena. In addition, the contribution to the longitudinal impedance of the main elements of the machine, such as the RF cavities, the septa, the kickers, was determined through measurements or simulations, and, together with the Resistive Wall contribution, an impedance model of the machine is now available for the existing machine. It was used also to evaluate the future contributions of new elements.

The model is so precise that the simulations of the longitudinal beam density are able to reproduce the structure observed in the measurements.

Comments

The next steps proposed for the longitudinal dynamics studies are adequate and well structured, even if they should probably also be accompanied by simulations of the transverse dynamics of the instability.

The details of the dp / p distribution could also depend on how the RF voltage is reduced during de-bunching, if adiabatically reduced for example, and perhaps even deserves a brief systematic study.

It would be interesting for the next A-TAC to learn about the performance of the diluters and the plans for the use of the crystals, mentioned as a follow-up to the **R11** of the A-TAC 2021. If clearly neither system would help protect the septa in the event of an accident similar to the last two that led to the replacement of the electrostatic septum, they will certainly help reduce losses to the critical elements of the extraction, thus also reducing the dose to personnel in case of intervention in the region such as during the wiring campaign. As already demonstrated by the successful reduction of losses mentioned for diluters.

Recommendations

R6: Prepare a plan to mitigate or cure the transverse instability, with particular attention to the source of electron-clouds, and which should include the appropriate machine time devoted to the experimental study of the instability, and execute it if possible.

06 Controls (JT, RZ, ST, AA)

Findings

The J-PARC accelerator controls system has been working smoothly since 2005 with no serious problems encountered so far. There are two separate control systems (one for the Linac and RCS which is run by JAEA staff, and one for the MR which is run by KEK staff), which are closely coordinated and built on a common infrastructure.

Development of a next-generation timing system began in 2016, with newly developed modules gradually replacing obsolete equipment, and multiplexed optical fan-out replacing three cables per transmitter station. Work should be complete by FY2023.

There is a plan in place for continuous renewal of the accelerator controls network on a 7-8 year cycle. The Controls Team is also addressing updates of storage systems, archiving systems and configuration databases.

EPICS IOC software and control screens are usually implemented by equipment groups, but supported by the Controls Team.

Comments

The committee thanks the Controls Team for their comprehensive presentation on the status and plans for site-wide global systems for controls, global timing, configuration databases and archivers, as requested in the A-TAC 2021 report.

The committee agrees that there are no serious issues with the J-PARC accelerator controls system. The Controls Team have addressed updates of the timing system and network in a timely manner, and obsolescence issues for individual systems are well understood.

The committee understands the logic behind choosing not to replace the whole of the timing system at once in order to maintain compatibility with the original system. Although the committee has some concern that large parts of the design will therefore remain at an outdated specification from 2005, the Controls Team are satisfied that the 2005 design is good enough for the foreseeable future, and have also included a number of enhancements as part of the recent system development work.

Long-term maintenance of the network infrastructure is via an onsite service contract with ~1 working day response time, but appropriate mitigation is in place because of built-in system redundancy.

Although the overall number of FTE working in the Controls group is appropriate, it seems unusual that such a high proportion (six FTE for Linac and RCS, five FTE for MR) is outsourced.

As part of the overall development of a recruitment and succession plan for J-PARC staff (**see R2**), address the issue of eventual retirement of the two over 60s (and five over 50s) in the core Controls Team, and consider changing the balance between the core team and outsourced effort.

Recommendations

None.

07 MR upgrade (WF, SG)

Findings

The MR has reached 510 kW for FX, and 65 kW for SX operation at 30 GeV and 1.8 kW at 8 GeV (for COMET).

Issues with aging equipment and obsolescence have emerged including an accidentally opened circuit breaker (leading to a damaged extraction septum), damaged IGBT modules due to high ambient temperatures, and PLCs that need to be replaced since they cannot be serviced any more.

The MR is in a long shut-down to upgrade the main magnet power supply that will allow for a 1.36 cycle. After this shut-down there will be 8 of eventually 11 fundamental cavities available, and 2 of the 2 2^{nd} harmonic cavities. The SM32 septum will be completed by August 2022, and the total number of collimators will reach 7 by the end of the summer. Beam operation is scheduled for FX and SX tuning as well as beam scrubbing.

A plan has been developed for the upgrade of the RF anode power supplies, raising the peak anode current from presently 110 A to 140 A. This is necessary to for the beam loading compensation with the increased intensity. Presently the intensity is limited to 2.6×10^{14} ppp.

Injection and extraction kickers and septa are being upgraded, and the number of collimators will be increased from 4 to 7, which allows to increase the beam power loss from 2.0 kW to 3.5 kW.

PS, RF systems, injection and FX elements and the additional collimators are expected to be ready by April 2022. Power supply tests are scheduled for April and May, and beam test in June 2022. MR operation is planned to resume in November 2022, then with the reduced cycle time of 1.36 s in FX mode. A FX and SX tuning plans have been developed, including time for beam conditioning.

Comments:

The MR upgrade plan from last year is unchanged. The plan has been executed without significant changes, and all hardware is expected to be in place for power supply and beam tests by the end of JFY2021.

An effort is under way to address the observed issues with aging equipment and obsolescence, and a maintenance and upgrade plan has been developed. Greater attention will need to paid to aging infrastructure and equipment. Good maintenance and upgrade plans use both observed failures (backward looking data) and schedules for anticipated obsolescence.

Recommendations:

None.

08 MPS (AA, SW)

In response to R2 from A-TAC 2021, an extensive presentation from the MPS team provided many details of the MPS design and operation.

It was explained how the beam destination is established, what limits the beam power, and how beam is shut off in an emergency.

The beam shutoff is straightforward for the LI and RCS, where beam is stopped at the source within tens of microsecond after a fault is detected.

It is possible to inhibit the MR pulse while continuing the MLF operation by shifting the Ion Source pulse in time.

The beam abort for the MR is much more complex and not as fast. Not all possible fault scenarios and the corresponding MPS responses were covered in the presentation.

The MPS hardware is aging and approaching obsolescence stage. A hardware replacement project is ongoing. General MPS logic and layout are kept the same. New functional modules are being developed and tested in parallel operation with the old system. The replacement process is gradual. No complete beginning to end schedule was presented.

The MPS configuration integrity is supported by signed approval forms for the hardwired masks changes, and by automatic reset of temporary software masks changes.

The design changes are discussed at the Division meetings and approved by the Division Director. The only paper track is minutes of the Division meetings. Some safety issues are discussed at the Division Safety Meetings with expanded attendance of technical staff.

A beam loss event resulting in damage of the ESS#1 and significant impact on the user operation happened in February 2021. The MPS detected the fault and reacted as designed but did not prevent the equipment damage. The root cause was traced to a faulty microswitch in the high-power AC transformer self-protection system. The faulty switch caused the transformer to shut off in the middle of the slow extraction cycle, what resulted in uncontrolled beam loss at the fragile septum blades.

More detailed findings are discussed and recommendations given in the **Homework 1 and 6** below.

Comments

The committee thanks the team for a detailed presentation. It contains a lot of important information and clarifies many questions we had during several past reviews.

We did not receive an explicit answer to R3 from A-TAC 2021. The MPS upgrade is proceeding by replacing old hardware while keeping the design and configuration of the MPS mostly intact.

The beam loss event of February 2021 clearly demonstrates an existing deficiency in the Machine Protection System, because accelerator equipment was damaged by the beam. However, the scope of this problem is larger than just the MPS team in the Controls Group responsibility. Mitigating measures will require significant contribution from the MR accelerator physics team and other groups, therefore more comments are provided in the MR section.

Recommendations

See below in Homework 1.

09 Linac status (JT, SW, ST)

Findings

The Linac has continued to operate reliably during the period February 2021 to January 2022, with downtime largely limited to a few discrete failures of peripheral devices. The auto-restart system for the RFQ has decreased the number of RFQ trips by ~95%, saving about 10 minutes of downtime per day.

There have been significant advances in the performance of some key components, including achieving a record ion source lifetime of ~5 months running at 60 mA output current, solution of the multipactor problem in the SDTL05 cavity by using a new cleaning method with dilute hydrochloric acid, and implementation of a LLRF feedback system upgrade.

The holding of conditioned klystron spares is now 40% for 324 MHz klystrons and 48% for 972 MHz klystrons. One 324 MHz klystron was replaced due to a deterioration of vacuum pressure in the tube – this was after ~80,000 hours operation, which is the expected lifetime for one of these devices. Conditioning of all unconditioned klystrons should be complete by the end of March 2022 and next year the J-PARC team will focus on procuring another 324 MHz klystron.

Beam loss studies at 50 mA have continued. The main sources of beam loss and residual radiation come from gas stripping in the SDTL and intra-beam stripping in the SDTL and ACS. In May 2021 the Linac Team obtained intra-beam stripping mitigation lattices with T = 0.5 and T = 0.3, which reduced the beam loss by 27% and 34% respectively compared with the present T = 0.7 lattice (although the T = 0.3 data was not reproduced during further tests in December 2021).

In December 2021, beam loss studies at 60 mA using iterative transverse and longitudinal matching demonstrated improved results for an intra-beam stripping mitigation lattice with T = 0.7. This has now become the nominal setting and has been successfully applied for 60 mA / 600 μs injection into the RCS for 1.44 MW equivalent beam studies.

Comments

The committee congratulates the Linac Team on an impressive year of achievements.

Spares levels for klystrons are now approaching the 50% goal, with good plans in place to maintain conditioned spares. This is an excellent response to **R5** in the A-TAC 2021 report.

The continued beam loss studies at 50 mA and 60 mA, as requested by **R6** in the A-TAC 2021 report are very encouraging. The consistency of measured beam loss patterns and simulations seems to support the source of loss being intra-beam stripping, but further studies should be done to confirm this.

The committee supports the Linac Team's plan to continue loss mitigation lattice studies and emittance optimization by investigating and improving the performance of the ion source and LEBT, and the beam instrumentation and optics in MEBT1.

The committee encourages using the RFQ Test Stand to investigate the effect of the ion source and LEBT parameters on the RFQ output beam.

It appears to take a relatively long preparation time for starting linac operation after shutdown. It is suggested to optimize the phase scanning method and process to save commissioning time. Hopefully the preparation time should be decreased to less than 2 days.

Recommendations

None.

10 RCS status (JT, RZ, SW)

Findings

The RCS has remained in stable user operation, delivering 630 – 740 kW beam to the MLF during the period 1 April to 20 July. Availability for the RCS only has again been very good, at 99.6%, but due to reduced cooling capacity in the RCS, the beam power had to be reduced from 740 kW to 630 kW from 24 June until the last day of operation.

A new design of RF cavity, with four acceleration gaps, has been developed and installed to replace one of the twelve original cavities in the RCS. Measurements of the new cavity performance show a significant reduction in the anode current demand. The team plan to install two new cavities per year, and it is anticipated that when all the cavities have been upgraded there will be sufficient RF capacity to handle beam powers of up to 2 MW. This will also reduce the load on the cooling water system to about 84% required for the original cavities.

In order to reduce kicker impedance one new diode unit has already been fabricated and another will be made next year. This will allow connection of the new diode units to two of the eight kickers, ideally reducing the overall impedance to 75%.

The performance of the RCS cooling water system deteriorated from a thermal exchange efficiency of just below 0.9 in 2016 to about 0.7 in 2021. This was the reason for the need to reduce beam power at the end of the operation period this year and for limiting the high-power trial at 1 MW referred to in the A-TAC 2021 report. The root cause of this problem has been identified as a significant build-up of contamination on the layered plates of the heat exchanger. After disassembly and chemical cleaning of the heat exchanger plates, preliminary measurements indicate that the thermal exchange efficiency has been restored to just above 0.9.

Another high-power trial, with 1 or 2 days' continuous running at 1 MW is planned for Summer 2022. This will demonstrate that the cooling water system is now effective.

With a second target station (TS2) now under consideration as part of the future plan for J-PARC, RCS beam power of 1.5 MW (1 MW to TS-1 and 0.5 MW to TS-2) will be required. An additional 130 kW of beam from the RCS is required to support simultaneous operation of the MR at 1.3 MW.

Comments

The committee congratulates the RCS team on another year of stable user operations, with excellent availability.

It is likely that although the plan is to install two new RF cavities per year, budget constraints will mean only one new cavity will be fabricated next year.

It is clear that kicker impedance is a major source of instability in the RCS, and that this will be a limit to potential increased beam intensity for the MLF and high-beam intensity and low emittance for the MR. Therefore, it is very important to suppress this instability in the RCS. Machine studies have shown that installing a diode unit in the kicker magnet can effectively suppress the instability.

It is very good news that the problem with the heat exchanger has been identified and rectified. However, more work still needs to be done to set up an effective maintenance regime to ensure that this fault does not recur on any of the cooling water systems. It is reassuring that the manufacturer of the heat exchangers has been involved in specifying the chemical cleaning process, and that the process of disassembly, chemical cleaning and reassembly should not cause any long-term problems.

Although cleaning the heat exchanger seems to have solved the short-term issue, and therefore partially addresses **R9** from the A-TAC 2021 report, it is not clear that the present RCS cooling system will meet the requirement for >1 MW operation in anticipation of future 1.5 MW operation to two target stations.

In recent years, beam commissioning for the RCS has progressed smoothly, with beam powers of 1 MW, equivalent 1.2 MW and equivalent 1.5 MW demonstrated successfully. From the point of view of beam dynamics, there appears to be no limit to reaching 1.5 MW. However, it will take a concerted effort on other aspects, such as the cooling water system, RF systems, kicker impedance, etc. to achieve future high-power operation.

Not much detail was presented regarding the forthcoming high-power trial at 1 MW, as requested in **R7** from the A-TAC 2021 report. The committee would have liked to have heard more about specific hardware and utilities upgrades, and a clear statement of the success criteria.

Recommendations

R4: Consider adding new diode units to all eight kickers in the RCS as quickly as possible. This will mitigate the major source of instability and extend the parameter windows for commissioning in anticipation of future high-power operation.

R5: Study and present the analysis of what further upgrades to the RCS cooling system will be required for future high-power operation at 1.5 MW, and present an integrated plan of how this will fit in with upgrades to the RF systems and kicker impedance.

11 MR PS status (WF, SG)

Findings

The manufacturing of new power supplies for the MR, preparation of the electrical infrastructure, re-arrangement of the re-used power supplies and wiring largely followed the plan presented a year ago.

One change was the combination of the SDA and SDB circuits with 24 magnets each into a single SD circuit with a new power supply. In operation to date the currents in the SDA and SDB circuits were always the same.

In addition, the completion of the manufacturing of the QDNPS, QFNPS, QDRPS and SD power supplies was delayed by 2 months from November 2021 to January 2022. This delay will not affect the overall completion date of the MR power supply upgrade.

Power supply tests are planned for April and May of 2022, and first beam tests for June 2022.

Comments

We congratulate the team on holding to the overall schedule despite the 2-months delay in the completion of the new power supplies.

A successful thorough test of new power supplies will give confidence in future performance. And a characterization of the current ripple frequency spectrum and amplitude throughout the operating cycle is essential in understanding emittance growth and beam loss during acceleration and storage at flat bottom and flat top.

After some operating experience has been gained with the new configuration an analysis of the maintenance needs of the re-used power supplies should be done for the long-term viability of the new configuration.

Recommendations

R10: Perform heat runs and current ripple measurements over the full operating cycle with all new quadrupole and sextupole PS as soon as this is possible (outstanding recommendation R12 from A-TAC 2021 review).

Homework 1: MR incident of Feb 28, 2021. (RZ)

The committee's understanding is that the faulty pressure relief valve caused the break trip, which triggered the MPS (worked mostly as designed), and caused a significant amount of beam to be deposited on the ribbons of the ESS, causing them to break and short. Please clarify the above, and correct any misunderstandings. The committee has several questions about the sequence: (a) Has a root cause analysis of this incident been performed? Has the relief valve been verified as the cause of the breaker trip? Could there be another cause? (b) May this relief valve issue exist on other significant devices? And will there be a program of preventative maintenance? (c) Can you explicitly state how the MPS was designed to respond in this situation? Did the MPS respond as designed? Was this damage foreseen as part of the MPS? What was unanticipated (ESS damage and radiation deposition)? (d) What are the issues that prevent use of the external dump for aborts? Would an internal dump share these issues? Is an extraction gap an issue? Would a barrier bucket be useful? (e) Could the collimation system be used as an emergency beam absorber? That is, would the data from a small number of rare beam aborts be acceptable? (f) Could the ESS be made more robust? perhaps by the addition of upstream sacrificial blades? Or a system to withdraw damages foils? (g) The committee also notes that there is a very high likelihood of future beam impacts upon the ESS foils, even outside of this particular failure mode (breaker trip).

Findings

On Feb 28, 2021, beam was interrupted in the Main Ring (MR) in a semi-controlled manner that resulted in significant damage to the electrostatic septum (ESS). The ESS is used for delivering beam to the Hadron Facility. The hadron production target and other components were not damaged in this incident.

The initiating event of the incident was found to be a faulty microswitch on a pressure relief valve of an electrical transformer. The microswitch incorrectly indicated an overpressure excursion of the transformer. The faulty indication caused the Machine Protection System (MPS) to ramp down the attached power supply which controlled a string of quadrupole magnets. That then caused the vacuum circuit breaker (VCB) to open, and the MPS to attempt internally aborting the beam, avoiding sudden extraction to the target. The target was indeed spared, and the beam was largely spread through the MR. However, a series of extraction bump magnets ramped down more slowly, and brought the beam core into contact with the ribbons of the ESS, breaking more than 60 of them and electrically shorting the device.

Slow extraction beam was halted until a spare ESS could be installed, months later. Instead, the MR restarted quickly in fast extraction mode, made possible by flexibility of the users and machine conditions. The beam time lost was nominal.

Several investigations and studies have been performed to understand the failure mode, and implement mitigations. The pressure relief valve was found to have been rusted, and the microswitch to have incorrect resistances, likely from weathering. The transformer itself and its oil have been found to be in good conditional. A program of inspection and maintenance will be maintained for these devices around J-PARC, including replacement of mechanical components every 10 years, and transformer refurbishment every 15 years.

The machine protection system has been updated to allow safer dissipation of the beam within the accelerator. Specifically, the MPS abort will trigger 20 ms earlier due to triggering off of detection of the pressure excursion signal, rather than the power supplies turning off. The bump magnet rampdown was substantially shortened to prevent the beam core from drifting into the ESS ribbons. Careful control of the tunes and crossing the integer resonance allows the beam to be dispersed in a more ideal manner within the MR. The possibility of using the collimators as beam absorbers has been identified, but is challenging due to beam dynamics issues. The possibility of an internal beam dump and kicker system has been considered.

The ESS has been made more robust to failure with an improved ribbon retraction system, such that failed ribbons are less likely to short the device.

Comments

The improvements implemented will all result in more reliable operations. The continued maintenance of the electrical infrastructure, the tuned MPS, and reinforced ESS will all result in a more robust system. In fact, the existing system prevented damage to the target.

The ESS will always be a vulnerable point of failure for the MR. The MR stores a very large amount of beam energy and additional near misses and impacts of beam upon the ESS can be anticipated. These devices need to be considered consumable and/or recoverable; a ready inventory of spares is necessary for reliable operations.

Recommendation

R7: Develop a program to simultaneously produce multiple spare electrostatic septum devices, and investigate methods to repair devices removed from service.

Additional measures should continue to be explored. Specifically, the possibility of sacrificial blades upstream of the ribbon to diffuse the beam should be analyzed against their cost of additional extraction losses.

The maintenance program of the electrical infrastructure is important for safety as well as reliable operation, so it should continue to be emphasized even if full funding for maintenance is not available. The pressure relief valves should be understood to work properly in all manners. Painting and rust inhibition of the devices should be explored with care: some pressure relief devices are specifically to not be painted, as the paint could interfere with operation of the pressure relief mechanism.

The faulty microswitch on the transformer pressure relief valve in the MR still presents an increased machine protection risk. The microswitch may not operate properly in the case of a real pressure excursion within the transformer (such as in the case of an internal arc). The expectation is that the MPS would still trip off after a delay when the temperature rise of the oil is detected – this feature should be verified. There is an additional fast pressure rise detector which could be the best way to trip on a transformer failure.

Recommendation

R8: Extend the MPS to have redundant safety elements to detect transformer failure, understanding that some portion of the microswitches may fail over time.

The MPS should continue to be optimized to gracefully abort the MR beam. Use of the collimation system is encouraged as the secondary absorbers are likely to be able to take a finite number of intense impacts – a topic for analysis. A new internal beam abort would be challenging, expensive, and possibly subject to the same prefire issues that are concerning for conventional extraction.

The most straightforward machine protection innovation would be to enable the primary abort line to operate throughout the slow extraction cycle. This is presently not performed due to concern about prefires of the thyratron-based switches for the kicker magnets. Prefires could conceivably cause the beam to damage the ESS or other components of the accelerator. This situation should be analyzed to quantitatively understand the risk, and whether it is worth not having the "ms abort" used during fast extraction. Additionally, the kicker system could be augmented with more reliable switches, such as solid state, which could reduce the risk of prefires.

Recommendation

R9: Investigate upgrade of the abort kicker system to allow fast, ms abort of the beam during the entire slow extraction cycle.

Homework 2: Slow extraction beam tests at 8 GeV for COMET (SG)

Slow extraction beam tests at 8 GeV were done in preparation for the COMET experiment. The committee's understanding is that the tests are in preparation for future physics runs. The committee asks if a very short report could be given on the subject in particular to reply to the following questions concerning the tests: (a) What was the extinction efficiency reached? (b) Is the nominal intensity already realised? (c) Are the results conclusive for the future physics runs and what are the plans for 2022?

Findings

The MR will have to provide a slow extracted beam at 8 GeV on a regular basis for the COMET experiment. Beam tests for the preparation of this mode of operation started in 2018 and continued during 2021 for 5 days with a 1.8 kW beam. The extraction efficiency increased from 97.8% to 99.1%, the spill duty factor from 16% to 55%.

The extinction factor of 10^-10 needed for the physics programme has already been reached, with some difficulties only in the measurement due to the background created by the interaction of the beam with a collimator.

The beam for the COMET phase I (2.48 s acceleration cycle, 5.2 s repetition rate, 7.4 10^12 ppp - 4 bunches) has been produced regularly.

The COMET phase-alpha is planned for the end of JFY2022, with 4 10^11 ppb x4 bunches with a 9.2 s cycle and without the pion capture solenoid.

Comments

The committee congratulates the J-PARC teams for the beam performance achieved and supports the allocation of the machine time foreseen for JFY2022 to continue the beam tuning, to test the stability of the 8 GeV operation and to prepare the COMET phase-alpha.

Recommendations

None.

Homework 3: e-cloud studies in the MR. (SG)

The committee's understanding is that the slow extraction is for the moment limited by the transverse instability induced by electron clouds. While work is well advancing in understanding and, when possible, reducing the source of the microwave instability that triggers the electron cloud formation, more information would be needed to understand the next steps, e.g.: (a) Is possible to improve the e-cloud detection with a specific e-cloud monitor? (b) Is the SEY of the vacuum chamber alone sufficient to explain the observed vacuum rise and the subsequent instability? (c) What is the rise time of the transverse instability and the characteristic frequencies? Is this being simulated? (d) Is a wide-band pick-up available to observe the microstructure of the instability? (e) Would it be possible to cure or reduce the instability by a transverse damper? (f) Is there any vacuum chamber conditioning during the year? Could one have scrubbing runs to condition the vacuum chamber? (g) What is the future plan to reduce the instability beyond controlling/reducing when possible, the longitudinal impedance?

Findings

The committee would like to thank the J-PARC team for the comprehensive answers provided in such a short time.

The MR has two electron cloud detectors with a bandwidth of 900 Hz-90 MHz. Both are located in field free regions, and the installation of new ones in the main bends or quadrupoles requires a dedicated study.

The studies presented indicate that the electron cloud appears throughout the ring, as indicated by a widespread increase in vacuum pressure, but other, as yet unidentified electron sources appear to contribute up to 50% to the observed electron cloud.

The vacuum chamber is conditioned with a scrubbing run and this is necessary to increase the intensity of the beam.

The experimental study of the instability is difficult, both because it does not appear at every cycle during normal operation, and because there is little machine time dedicated to the study itself. No instability simulations are available yet.

The instability is observed with a wide-band pickup with a bandwidth higher than 1 GHz, but it cannot be countered by the current transverse damper: the system samples only at each RF bucket and therefore not adequate for a quasi-coasting beam.

While no precise plan has been drawn up on how to mitigate the instability, two actions appear to be the most promising:

(a) modify the signal processing of the transverse damper to accommodate nearly coasting beam;
(b) coat the inner surface of the vacuum chambers.

Comments

The proposed changes to the transverse damper processing system seem reasonable and could be a first step to counteract the instability.

The vacuum chamber does not produce enough electrons to justify the observed increase in vacuum pressure around the ring. In this sense, it would be appropriate to try to identify other possible sources of electron-cloud, before further investigating the graphite coating of the vacuum chambers.

Recommendations

R6: Prepare a plan to mitigate or cure the transverse instability, with particular attention to the source of electron-clouds, and which should include the appropriate machine time devoted to the experimental study of the instability, and execute it if possible.

Homework 4: R&D pertaining to J-PARC's path forward (JT)

The committee have heard some information, spread across a number of talks, about R&D topics that J-PARC are interested in pursuing (e.g. superconducting magnets, superconducting RF systems, laser stripping, ML algorithms for machine set-up, graphite coatings to reduce SEY, etc.). Some of these appear directly related to the J-PARC path forward and others are not directly related to J-PARC, but are interesting topics that could be pursued using non-J-PARC funding. Please can the J-PARC team present a full list of these potential R&D topics and expand upon: (a) Which are directly relevant to the J-PARC path forward and which are not. (b) The relative priority for pursuing each topic. (c) How much staff effort and additional resource is expected to be diverted towards each of these topics. (d) The benefits that are expected to be realised. (e) Whether any new topics are expected to be added to the list in response to recent equipment failures (e.g. MR-incident related machine protection).

Findings

The J-PARC team have just started to consider R&D themes and are currently in the process of gathering information on the wide range of research topics in which their researchers are interested.

Some research themes, such as the development of the RCS kicker power supply using semiconductor switches instead of thyratrons, are directly related to performance improvement of the J-PARC accelerators. Others, such as the development of superconducting FR cavities, will not directly contribute to the J-PARC accelerators, but are interesting for other accelerator projects such as accelerator-driven nuclear transmutation.

The J-PARC team will continue to review and add to their list of potential research themes, taking into account results from the high-power beam trial planned in Summer 2022, and will decide on prioritization, allocation of effort, a rough schedule and, if possible, a budget plan by the end of FY2022. The criteria listed (a) to (e) above will be used as part of the process for determining priorities.

Comments

This is a reasonable and sensible course of action and the committee looks forward to hearing the results at A-TAC 2023.

Consideration should also be given to how this R&D will be organized, for instance whether it will be embedded within the groups already established in the Accelerator Division, or whether individuals are identified to lead and champion particular research themes.

Recommendations

R1: Develop a prioritized list of the accelerator R&D and accelerator improvement projects (AIP) which J-PARC would like to pursue, along with a clear explanation of the decision making and prioritization process, and present this at A-TAC 2023.

Homework 5: Identification of obsolete systems. (WF)

Systems are presently replaced based on observed failures, and to a limited extend based on the anticipated obsolescence. (a) With the performance upgrades being implemented for the next decade, have replacements and upgrades identified that also need to be done over the next decade in order maintain the upgraded performance? (b) How does the needed funding compare to the anticipated funding?

Findings

Issues of maintenance and obsolescence are emerging throughout the J-PARC accelerator complex, and have been presented in the talks on the Linac, RCS and MR.

A general plan for infrastructure was developed but not presented to the committee.

The presently anticipated funding is below the level needed for optimum maintenance and upgrades.

Comments

An effort is under way to address the observed issues with aging equipment and obsolescence, and a maintenance and upgrade plan has been developed. Greater attention will need to paid to aging infrastructure and equipment. Good maintenance and upgrade plans use both observed failures (backward looking data) and schedules for anticipated obsolescence.

Recommendations

None.

Homework 6: MR transformer maintenance. (RZ)

Concerning Maintenance of the Pressure Relief Valves for the MR transformer. The committee would like to understand the function and safety implications of these devices, can you summarize those issues please? Please try to address the following issues in your summary: (a) Are pressure excursions expected in normal operation? Are they expected in emergency operations, such as an internal arc in the transformer? (b) What are the implications of a faulty pressure relief valve? What happens if the pressure cannot escape? Is there a safety risk to having faulty pressure relief devices? (c) How did the pressure excursions within the transformer trip the VCB? Is there pressure feedback? A device protection / interlock system? (d) Can the timing of the trip of the VCB be optimized to allow a more controlled abort of the MR? (e) Is the source of the pressure excursions understood? (f) Is there a recommended maintenance schedule with this device or transformer? What periodic and specific maintenance has been performed? Is the maintenance specified and performed by J-PARC personnel or contractors? (g) Is paint recommended for these devices? Is it known to have been removed? or never applied?

See above in Homework 1.

Appendix 2 – Agenda

Agenda for A-TAC2021 (Q&A included for each report) **12/8/2021**

1st Day: 7th Feb. Venue: Remort

Time(JPN.ST)		Period	Category	Title	Speaker
21:40	22:00	0:20	Time for LAN Connection		
22:00	22:15	0:15	**Executive Session**	*Closed*	
22:15	22:50	0:35	**Project Status**		T. Kobayashi
22:50	23:05	0:15	**Accelerator Overview**	J-PARC accelerator overview	M. Kinsho
23:05	23:15	0:10	**Coffee break**		
23:15	23:30	0:15	**Required items from last ATAC**	1. MEBT1	K.Okabe
23:30	23:45	0:15		2. RCS Beam Commissioning	P. Saha
23:45	0:00	0:15		3. Beam dynamics studies for slow extraction	M. Tomizawa
0:00	1:00	1:00	**Executive Session**	*Closed*	

2nd Day: 8th Feb. Venue: Remort

Time(JPN.ST)		Period	Category	Title	Speaker
21:40	22:00	0:20	Time for LAN Connection		
22:00	22:15	0:15	**Executive Session**	*Closed*	
22:15	23:00	0:45		reply for home work of 1st day	
23:00	23:10	0:10	**Coffee break**		
23:10	23:25	0:15	**Required items from last ATAC**	4. Status and plans for controls	S. Yamada
23:25	23:40	0:15		6. Present the overall planning -> MR upgrade	S. Igarashi
23:40	23:55	0:15		7. MPS: reply for recommendations	N.Hayashi
23:55	1:00	1:05	**Executive Session**	*Closed*	

***5. Problem of aging… will be reported in each status presentat**

3rd Day: 9th. Feb.

Time(JPN.ST)		Period	Category	Title	Speaker
21:40	22:00	0:20	Time for LAN Connection		
22:00	22:15	0:15	**Executive Session**	*Closed*	
22:15	23:00	0:45		reply for home work of 2nd day	
23:00	23:10	0:10	**Coffee break**		
23:10	23:25	0:15	**Status**	Linac status	H. Oguri
23:25	23:40	0:15		RCS status	K. Yamamoto
23:40	23:55	0:15		Status of MR power supply	Y. Morita
23:55	1:00	1:05	**Executive Session**	*Closed*	

Final Day: 10th Feb.

Time(JPN.ST)		Period	Category	Title	Speaker
21:40	22:00	0:20	Time for LAN Connection		
22:00	0:00	2:00	**Executive Session**	*Closed*	
0:00	1:00	1:00	**Recommendations to J-PARC**		J. Wei

adjourn

The presentation materials should be uploaded by Jan.28th p.m.5:00
The presentation materials should be prepared with audio.
There will be no specific presentation time for the presentation materials to be prepared in advance.
Presentation:5min. Discussion: 10 min. at ATAC