Report of the 23rd Meeting of the Accelerator Technical Advisory Committee for the Japan Proton Accelerator Research Complex (J-PARC)

February 5 – 7, 2024

The Accelerator Technical Advisory Committee (A-TAC) for the J-PARC Facility held its twenty-third meeting from February 5 to 7, 2024, at the J-PARC Research Building in Tokai, Japan. The A-TAC members participating were: Alexander Aleksandrov (ORNL), Wolfram Fischer (BNL), Simone Gilardoni (CERN), Toshiyuki Shirai (QST), John Thomason (STFC), Sheng Wang (IHEP), Alexander Valishev (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 meeting, and all the presenters for their excellent and comprehensive talks. 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

The J-PARC accelerator team reached a major milestone achieving beam power exceeding 750 kW in the MR-FX to the neutrino experimental facility after successfully commissioning the new MR power supply system shortening the acceleration cycle, 15 years after the completion of the J-PARC construction project. The beam power for MLF operation is steadily in the range between 660 kW and 840 kW. Beam was also delivered to the hadron facility for the COMET experimental beamline for the first time.

During the past year, the J-PARC accelerator complex operated without reportable incidents on personnel safety or beam-induced machine protection. However, two incidents of equipment fire caused significant downtime to the user programs. A-TAC suggests that incident response processes corresponding to different levels of impacts (personnel and environmental protection, beam-induced machine protection, and equipment protection) be clearly defined to expedite the recovery and minimize the impact to user programs.

User satisfaction is vital to a user facility like J-PARC. Every effort should be made to protect machine availability and long term sustainability.

Attracting and retaining talented accelerator researchers/experts and strengthening the workforce are essential to J-PARC's future undertaking. Concrete accelerator initiatives and R&D projects will be important in this regard.

The J-PARC accelerator team has addressed most, though not all, of the 13 A-TAC 2023 recommendations. Presentations were given at this review covering the 6 topics requested by A-TAC at the 2023 Review. Responses to the 3 homework assignments at the 2024 Review were timely. 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 2024. Each of the recommendations (R01 – R06) will be elaborated across the main body of this report following committee findings and comments. The order of the main body of this report follows the thirteen talks (Appendix 2) and three homework assignments presented at this review.

As a result of the two fires, MLF operations were suspended for a significant period, even though there was no damage to any equipment in the RCS. Accelerator incidents fall into various categories in accordance with their impact to (a) personnel and environmental protection, (b) beam-induced machine protection, and (c) equipment protection. Corresponding response protocols should have been established for each category allowing expedited recovery and minimizing overall impact to accelerator availability and user programs without compromising safety.

R1: Establish appropriate response protocols in accordance with the category and severity of incidents to ensure that impact on user operation is minimized.

The J-PARC complex consists of both accelerator equipment and infrastructure established about 20 years ago, and legacy experimental systems and equipment, e.g. those contributed by KEK. Aging and deterioration inevitably start to compromise facility availability. Given limited resources, systematic failure mode and effects analysis (FMEA) based on downtime statistics and system performance projection should be conducted to establish a prioritized list of aging legacy systems that may cause major downtime to operations.

R2: Prepare a prioritized list of aging systems that may cause major downtime to operations. Identify a list of mission-critical items whose replacement or preventive maintenance cannot be funded internally by J-PARC and would require additional external funding.

It is becoming increasingly clear that the current J-PARC accelerator budget is not sufficient to address all of the emerging issues of aging equipment, highly radioactive equipment maintenance and fluctuating electricity costs, all against a background of post-pandemic inflation.

R3: Work with J-PARC leadership to convince the funding agency on the needs to enhance accelerator operations funding to maximize user time and reduce the risk of growing obsolescence issues resulting in significant unplanned downtime.

Upon development of the roadmap and long-term missions after the symposium ‘Future of J-PARC, Future by J-PARC’ planned in October 2024, A-TAC suggests that a task force is formed to identify accelerator development blueprints and initiatives. Concrete plans and initiatives can be essential in attracting and retaining talented researchers/experts and strengthening the workforce required to realize J-PARC’s future.

R4: Work with J-PARC leadership to identify accelerator development initiatives to be aligned with J-PARC’s long-term missions, create a task force to explore these initiatives further, and present at A-TAC 2025. In the longer-term use accelerator development initiatives as a way to attract talented researchers to the facility.

Operations hours consist of hours for user experiments, machine tuning/restore, and beam studies. An appropriate allocation of machine tuning and beam study hours assures the accelerator complex performs at desired level meeting expectations of the users and the funding agency. Such allocation is in particular important for a machine like MR with newly commissioned power supply systems.

R5: Ensure adequate machine tuning and beam study hours in particular with accelerators with newly commissioned or renovated systems.

Of concern is the noise of some of the new/reused MR power converters, which affects the beam and could reduce the overall machine performances. In particular it is understood that the 150 Hz ripple could come from a too large mismatch between the power converter rating and the impedance load of the QFR circuit. This, together with other possible sources of ripple that could affect the beam, should be investigated and when possible reduced to a minimum.

R6: Investigate an alternative solution to improve the matching between the QFR reused power supply and the load, with the goal of reducing the effect of the circuit noise now potentially impacting beam performances.

Items for the Next Meeting (A-TAC 2025)

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

1. Present accelerator development initiatives aligned with J-PARC's long-term missions, as well as follow-up activities.

2. Present a prioritized list of aging legacy systems that may cause major downtime to operations. Identify a list of mission-critical items whose replacement or preventive maintenance cannot be funded internally by J-PARC and would require additional external funding.

02 J-PARC Accelerator Overview (JT, ST)

Findings

J-PARC, in JFY2023, delivered high-quality beam to the MLF and re-commenced MR beam operations following the installation and commissioning of major power supply upgrades during JFY2022 to enable a 1.36 s cycle. The RCS operated well, achieving > 800 kW beam power with high availability, the only significant downtime being caused by factors external to the RCS itself. The MR has experienced some power supply problems but is now running stably and has demonstrated successful continuous operation with 760 kW beam power. Overall facility availability has been affected by two power supply fires. Concerns raised at the last A-TAC that high electricity prices would reduce operating hours in JFY2023 by more than half were not realized and operations continued throughout the year.

Statistics for JFY2023

MLF user operation:

● Overall availability was ~ 82% (119.5/145.5 days) due to two power supply fires and a delay in neutron production target maintenance. However, during operation availability was ~ 95%.

○ January to March 2023: user operation proceeded as scheduled, providing 740/815 kW beam (dependent on the MR cycle 1.36/4.8 s) to the MLF with 95% availability.

○ April to June 2023: operation began at 840 kW but was suspended from 25 April to 14 May because of a QDN power supply fire in the MR. After resuming operations, beam power was reduced to 800 kW on 2 June and then to 750 kW on 8 June due to cooling capacity limitations in the RCS. Operation was curtailed on 22 June because of a fire in the Hadron Power Supply Building.

○ November to December 2023: The start of operation was delayed from 21 November to 3 December due to a delay in target summer maintenance. Thereafter 660 kW beam (restricted due to target availability) was consistently delivered to the MLF until the scheduled end of user operation on 25 December.

○ 7.2 cycles (159 days) of MLF operation are scheduled for JFY2024 but still somewhat dependent on electricity prices.

MR beam operation:

● Beam was delivered to the Hadron Facility for the COMET experimental beamline. Despite low overall availability of ~ 42% (37/88 days), the scheduled program was completed and successful continuous operation at 760 kW was demonstrated.

○ January to March 2023: following repair of the septum magnet (SM31) beam tuning at 8 GeV started on 23 January. Beam was delivered for the COMET beamline (10 – 14 February and 1 – 14 March) before continuous operation testing and adjustment of new power supplies for fast extraction at 30 GeV.

○ April to June 2023: beam commissioning and successful acceleration of particles equivalent to 750 kW up to 30 GeV but interrupted by two power supply fires.

○ November to December 2023: starting on 20 November beam power was ramped up to reach 710 kW by 14 December. On 25 December, beam was run at 760 kW for ~ 50 minutes, demonstrating continuous operation at this power level, but showing that further beam loss suppression will be required to achieve this performance in user operation.

○ 6.5 cycles are tentatively scheduled for JFY2024, but this has yet to be completely finalized.

JFY2023 operation was substantially interrupted by two fires, the first on a QDN power supply in the MR and the second on the polarity-changer of a power supply in the Hadron Power Supply Building. Both fires were extinguished by KEK staff and shortly thereafter attended by the Fire Department. Neither incident required legal reporting under the ‘Act on Prevention of Radiation Hazards due to Radioactive Isotopes, etc.’ as there was no leakage of radioactive materials, no impact on the environment and no radiation contamination or exposure.

● 25 April 2023: during beam tuning of the MR the QDN power supply in Building 2 indicated an abnormal ‘transformer temperature high’ status. On inspection a flame was observed on the transformer in the initial charging circuit, and this was put out using a powder fire extinguisher. Damage was restricted to the transformer and subsequent detailed investigation determined the cause of failure to have been a deterioration in insulation because the effects of high-frequency noise had not been fully taken into account when the transformer was designed. The initial charging circuit has now been redesigned replacing the transformer with a bypass circuit which has no risk of being damaged by high-frequency noise. This measure has also been adopted on the one other power supply (QFN) of the same type, and a J-PARC wide survey has concluded there are no other power supplies that are vulnerable to this failure mode.

● 22 June 2023: a fire alarm was raised in the Hadron Power Supply Building. On investigation KEK staff observed a fire on the polarity-changer of a power supply, and this was put out using two powder fire extinguishers. There was no spread of fire to adjacent equipment or facilities. The cause of the fire has been determined as age-related deterioration, and it has been demonstrated on a similar supply that a disc-shaped insulator may eventually be damaged by repeated energizing and de-energizing. The polarity-changers of the supply involved in the incident and all similar ones have either been removed or replaced with different ones with electromagnetic contactors. Periodic inspections will be made to ensure the new polarity-changers remain problem-free and will also cover other aging equipment.

A full response to the request to present accelerator development initiatives aligned with J-PARC's long-term missions at this A-TAC meeting has been deferred as the accelerator team are still in the process of discussing the future plan for J-PARC, especially after 2030. As part of this process, a J-PARC symposium is planned for autumn 2024 under the title 'Futures of J-PARC, Futures by J-PARC'. After the symposium, the long-term mission of J-PARC will be reconfirmed, and accelerator development will be discussed accordingly and presented at the next A-TAC.

Comments

J-PARC continues to make progress by delivering high-intensity and quality of beam to the MLF. The RCS availability remains very impressive, but difficulties in regulating temperature during warm and/or moist weather persist and represent a limit to J-PARC's ambition to operate the MLF in the MW regime. Despite low overall availability as a result of the two fire incidents, the MR has demonstrated the rapid increases in beam power promised by the recent upgrades.

The two fires which occurred during JFY2023 were dealt with very professionally. In the first instance, interlocks, alarm systems and the prompt fire response from KEK staff and the Fire Department ensured that the fires were caught early, put out efficiently and therefore that damage to adjacent equipment was avoided. The root causes of each fire have been clearly identified, and the mitigations that have been put in place are appropriate. Neither of the specific problems that resulted in these fires seems likely to recur, but other ~ 40-year-old equipment (largely reused Power supply components from KEK) and aging of J-PARC equipment in general needs to be addressed.

As a result of the two fires, MLF operations were suspended for a significant period, even though there was no damage to any equipment in the RCS. Accelerator incidents fall into various categories in accordance with their impact to (a) personnel and environmental protection, (b) beam-induced machine protection, and (c) equipment protection. Corresponding response protocols should have been established for each category allowing expedited recovery and minimizing overall impact to accelerator availability and user programs without compromising safety.

Recommendations **R2**, **R3** and **R4** from the last A-TAC, all connected to concerns raised that high electricity prices would severely reduce operating hours in JFY2023, were not explicitly addressed but this is understandable given that in reality the impact proved much less than expected. Electricity prices peaked in 2023, but the effect this would have had was offset by not having to pay for the days lost during the two fire incidents – in fact overall less was spent on electricity than budgeted for and this saving can possibly be carried forward to cover costs in JFY2024. Electricity prices have now returned to levels of 1 year ago.

The challenge of high electricity prices remains as a pressure on J-PARC operation and J-PARC should maintain a strategy for reduced electrical usage, procurement of electricity in alternative ways and optimization of technical activities if there is no beam operation due to electricity costs and funding limitations.

Upon development of the roadmap and long-term missions after the symposium ‘Future of J-PARC, Future by J-PARC’ planned in October 2024, A-TAC suggests that a task force is formed to identify accelerator development plans (blueprints) and initiatives. Concrete plans and initiatives can be essential in attracting and retaining talented researchers/experts and strengthening the workforce required to realize J-PARC’s future.

Recommendations

R1: Establish appropriate response protocols in accordance with the category and severity of incidents to ensure that impact on user operation is minimized.

R4: Work with J-PARC leadership to identify accelerator development initiatives to be aligned with J-PARC’s long-term missions, create a task force to explore these initiatives further, and present at A-TAC 2025. In the longer-term use accelerator development initiatives as a way to attract talented researchers to the facility.

03 Status of MR (WF, AV)

Findings

The beam power in FX operation reached 760 kW with 1.36 s cycle time and 2.16e14 protons at the end of acceleration. 2.77e13 protons were injected in 8 bunches. The loss power of 1.2 kW is below the present collimator limit of 3 kW. One collimator is still to be installed to reach the design 3.5 kW limit.

In SX operation for COMET with an extracted beam of 8 GeV energy, the MR ran with a 2× 4.8 s cycle and reached 240 W beam power. In SX operation at 30 GeV beam energy, the MR ran with a 5.2 s cycle time and reached 50 kW (64 kW last year) and after only 10 days due to MR failures.

The main PS upgrade resulted in the ability to run 1.36 s cycles. Several issues were encountered and overcome, including a faulty contactor, damaged fuses, noise in the interlock system, a charge transformer failure, and IGBT failures.

The upgrade of the fast extraction system continues with SM30 and SM31 coils still to be replaced in the summer of 2025.

Further upgrades include the installation of the remaining two RF cavities to increase the voltage and RF anode power supplies to increase the beam power. These upgrades are planned to be complete in 2026. One collimator is yet to be installed to bring the acceptable loss power from presently 3.0 kW to 3.5 kW, and improve the loss localization. This collimator is to be installed in 2024.

To reduce losses at extraction the aperture of the present QDT magnets will be increased from 150 mm diameter to 220 mm diameter. While magnet cores were already completed in 2016, coils for only one magnet were completed and a magnet was assembled.

All QM and SM have trim coils and some of these corrector magnets are used for optics and resonance correction in order to reduce beam losses, primarily in the early part of the acceleration ramp. Simulations show that beam losses can be reduced by going from no to 4 sets, 12 sets and eventually 24 sets of correctors.

The present beam dump allows for 7.5 kW power or only 19 shots/hour with 3.2e14 ppp. The upgraded beam dump, being developed with RAL, will be designed for 30 kW, allowing then for 81 shots/hour. It is planned to complete the design in 2024, construction in 2025, and installation in 2026.

Comments

With 760 kW in FX operation the J-PARC MR has reached a new power record, 50% higher than reported at the last A-TAC, and has now exceeded the initial MR power specification. The MR is now also close again to the decadal (2018-2028) power ramp up plan from 500 kW to 1.3 MW, and positioned for further power increases. We congratulate the J-PARC team for this achievement.

Failures and the availability are of increasing concern, the past run being most significantly impacted by two small fires. While the two fires did have unrelated causes, both are a serious concern. Failures are driven by a number of causal factors, ranging from new equipment with engineering deficiencies to old equipment that has reached the end of its useful life and has not been replaced. Sea water from the nearby ocean has deteriorated outdoor technical infrastructure elements. Critical spares are missing in several areas. Although some of these issues are addressed, there is presently no comprehensive plan with funding in place to systematically address the aging technical infrastructure. This makes it likely that failures will occur at the present or even a higher rate in the future.

With increasing power levels loss reduction measures must keep pace in order for efficient maintenance and upgrade. In some areas (e.g. FX extraction, near some RF) relatively high activation levels were found, and could be mitigated with, e.g. orbit changes. Loss reduction through the use of the full corrector set is guided by beam dynamics simulations and should be continued.

The long lead items for many spare components represent a significant challenge for maintaining operation with high reliability. If the lead times for even rather common items such as fuses do not become short again, a sufficiently large inventory for all components that are critical for operation and have long lead times need to be maintained. This will require a large investment.

For every year with about 100 kW beam power increase the hardware items that must be installed, and beam dynamics issues that must be addressed were tabulated.

Recommendations

None.

04 (MR) Power supply status of main magnet (AV, WF)

Findings

The J-PARC team continued work on improvements of the MR power supply systems addressing the recommendations R06-R09 of A-TAC 2023 and earlier reviews. Sharing loads or switching to degraded modes of operation was determined to be impossible. The replacement of 12 old power converters is presently not feasible due to the high cost, hence the strategy for maintaining long-term operation relies on annual maintenance inspections, using spare components made available by the earlier upgrades, and maintaining stock of off-the-shelf components. In case funding becomes available, the replacement of QFR power supply will be prioritized due to the mismatch between the impedance of the load and the power supply. As an interim solution, an additional magnet (QDS spare) was connected in series with the QFR magnet family.

In JFY2023 operations, the power supply systems experienced two major failures: the transformer fire on QDN circuit on April 25, and the IGBT module failure on BM3 on December 16. The QDN pre-charge transformer fire causal analysis determined that the design did not appropriately consider potential discharge between the secondary shield and coil, resulting in the deterioration of insulation. Subsequently, the design was changed to a transformer-less method on all converters of this type.

The IGBT module failure was repaired over 4 days using the available spare parts. In this event, the protection system worked as designed, preventing wider damage.

Additionally, frequent failures of BM1 and BM2 power supplies were observed in February 2023 attributed to the interlock system triggering because of the high gain of the AC/DC converter. The gain was matched to the VDC thus eliminating this failure mode.

The team continued procuring long lead-time components and built stock of all except for the 40 A fuses.

The lower than design capacitance of 11 banks is being addressed by the addition of small capacitors (192 per bank) with 6 banks modified in JFY2023 and further 5 modifications planned for JFY2024. Stable operation of the modified supplies was demonstrated in November and December.

To improve the current ripple, the team focused on the noise contamination before the digitization of the current signal upstream of the ADC input. A modification of the ground route near the DCCT in power supplies for BM1, BM2, BM4 and QFN resulted in the improvement of current ripple of three of the supplies (BM1, BM2, and QFN) in the frequency range below 500 Hz.

Comments

The team is commended for the progress with the power supply tuning and improvements, which had resulted in the mitigation of beam losses.

The introduction of protective design measures such as fuses led to the containment of damage in the case of IGBT failures. However, the root cause of the IGBT circuit damage has not been determined and the investigation continues. In the interim, the team continues procuring spare parts to maintain adequate stock and effectuate repairs as needs arise. The latest repair of the IGBT module took 4 days, faster than the previous occurrence yet it is advisable to consider the approach to a more rapid process.

Recommendations

None.

05 (MR) Fast extraction magnet and power supply (WF, SG)

Findings

New septum magnets were installed for 1 Hz operation in 2021, and the MR now achieved stable FX operation for neutrino users with up to 710 kW.

The measured residual component activation reached its maximum near the QDT155 magnet in the fast extraction area, and was reduced by shifting the orbit by 3.4 mm to the inside.

Weak soldering connections at extraction magnet SM31 led to sparking and melting in 2022, and soldering connections were reinforced with additional copper plates. SM32 had been reinstalled with the Sigma-Phi coil on the abort side, and a new Techno coil on the neutrino side. The MR operated with this configuration from January 2023.

In March 2023 a bypass was installed on the SM31 neutrino side, required to extract the beam and the magnet was operated with 4.0 kA for 101 h, and 3.5 kA for 102 h. Magnetic measurement confirmed calculations of the field with the bypass that reduced the number of turns from 30 to 28. In the summer of 2023, the abort side coil of SM32 was also replaced with a coil from Tecno, and the large flange with three openings welded into place. Further tests after installing the vacuum connections were done with 4.0 kA over 44 h, and 3.5 kA over 132 h.

The new coil replacement is now planned for completion in 2025, one year delayed due to the manufacturer. The ceramic ducts are reused but it is difficult to assess if they can be reassembled after disassembly. These ducts will be redesigned to have longer bellows.

A recovery plan was developed for various scenarios of magnet and/or power supply failures in case a bypass recovery is not possible. Several details still need to be worked out with completion planned in 2026.

In preparation of possible failures additional ducts were made for SM31. In the backup plan, SM30/31 can be replaced by the old SM31, and both sides of the old SM33 can be reused. A detailed design should be completed by 2026.

Comments

Stable operation at 710 kW beam power validated the general approach to the upgrade of the SM magnets for 1 Hz operation and higher beam power after a number of individual issues were addressed including weak solder connections.

Preparation for possible failures have been made. In the case of component failures, the backup plan relies on re-using previous magnet configurations.

As power levels increase, closely monitor all extraction elements for emerging weaknesses or possible precursors for failures.

Recommendations

None.

06 (MR) RF system status and upgrade plans (AV, SW)

Findings

The MR power upgrade to 1.3 MW demands modifications to the RF system: the faster acceleration cycle requires more accelerating voltage (increase to 550 kV from 450 kV), while the increase of the beam current necessitates the higher RF anode power supply current (upgrading from 85 A to 110 A). The presently installed system uses 9 fundamental mode cavities and 2 2^{nd} harmonic cavities. Two further main RF cavities will be installed in the future. The original plan of 2023 upgrades called for 9 4-gap cavities and 510 kV, however due to the issues with installing additional anode power supplies on stations #1, 2, and 9 caused by the interference with overhead cable trays it was decided to use 3 3-gap cavities and 6 4-gap cavities for the voltage of 460 kV. During the summer shutdown, additional racks were installed on anode power supplies 3 through 8, 3 inverters removed from 1, 2, and 9 and installed onto 3-8, and anode power supplies 3-8 were recommissioned. Cavities 5-7 were reassembled and three new cavities were built.

Addressing recommendation **R11** of A-TAC 2023, during 2023 operations the team focused on tuning the LLRF digital feedback that successfully suppressed coupled bunch instability. However, the limited study time did not allow addressing the quadrupole mode instability.

The path to full power was presented, and it is concluded that the RF system will be able to accelerate > 1 MW with 10 cavities at 1.36 s, and 1.3 MW is achievable with the shorter cycle. An additional, 11^{th} cavity is preferred for reliability. This capability to accelerate 3.3e14 protons per pulse will be in place by October 2025.

While the RF system is stable in operation at the present time with minor downtime caused by the anode power supply trips, the aging infrastructure is a significant cause of concern for the RF team.

Comments

The achievement of 760 kW beam power is an impressive accomplishment. Operation of the LLRF digital feedback system at that power was successful with coupled bunch instability suppressed. The plan for implementing RF system upgrade takes into consideration the production line capabilities and overall project schedule and appears to be feasible.

The RF team is concerned by the residual activation of components in the area where extensive upgrade work is expected in the coming years. In view of the ever increasing beam power, collaboration with the beam commissioning team and effort to mitigate the beam losses are essential.

Similarly, we encourage the collaboration between the RF group and the conventional facilities support organization to ensure proper planning, resource allocation and implementation of critical RF infrastructure updates to ensure long-term reliability of the system.

The staffing of the RF group has been declining, we again stress the recommendation **R12** of A-TAC 2023 urging the team to maintain expertise at the level sufficient to complete the RF system upgrade on schedule.

Recommendations

None.

07 (MR) Beam commissioning (SG, ST)

Findings

The MR plans, hence the studies, for reaching higher beam power operation envisage a reduction in the magnetic cycle from 2.48 s to 1.36 s for the FX from 2023, a reduction in the magnetic cycle from 5.2 s to 4.24 s for the SX, and an increase of the total available RF voltage. For the FX, the ultimate goal is to reach 1.3 MW by 2028, and for the SX, 100 kW. The MR operated at a maximum of 766 kW for FX test beams, providing the Neutrino Programme with 710 kW, and the SX with a maximum of 65 kW. For the FX operation, in order to reach 1.3 MW, it is planned to shorten the magnetic cycle to 1.16 s while maintaining the same beam intensity. Beam was provided to the NU line at 764 kW for a brief period.

The studies during 2023 focused on optics corrections/optimization of the collimation system and dynamic optimization of the transverse working point.

The new power converter cablings for the main quadrupoles increased the number of families, but also broke the 3-fold symmetry naturally present in the lattice. Studies were done to reduce the new betatronic resonances by optics corrections, and to re-establish the lost symmetry and to limit the excited betatronic resonances either from space charge or from magnetic errors. By recovering the 3-fold symmetry of the machine, losses improved, with a transmission from <96% to 99% for mid-intensity beams.

The new power converters generated more ripple than before, breaking also in this case the lattice symmetry. Some frequencies could be corrected by re-routing the grounding in the converters. The closed orbit at the location of the dispersion peak improved. Simulations predict the formation of a transverse halo due to the ripple from the Main Bends power converters exciting some betatronic resonances. To mitigate the ripple effects, the tune is dynamically changed during the magnetic cycle and the resonance mux=21.33 is compensated by trim sextupoles.

The new septa have a better leakage field than their predecessors, and no longer excite beta beating in the vertical plane.

A series of studies were carried out to further reduce losses during stable NU operation at a power of 710 kW, considering the test done in April 2023 for the FX with 766 kW with estimated losses of 840 W.

In particular, the following mitigation were implemented: a) reduction of the beam halo in the RCS; b) optimization of the longitudinal plane; c) use of sextupole trim; d) optimization of the FX orbit and introduction of local bumps; e) optimization of the collimation system.

The collimation system is used for halo cleaning in two stages and in single passage. The upgrade of the system to be able to absorb up to 3 kW is almost complete and to cut the complete phase space in a single passage. The system is optimized to maintain, where possible, residual dose of the equipment still compatible with hands-on maintenance and to reduce to a minimum losses leaked from the straight section.

Some orbit local bumps were introduced in key locations, such as around RF#4 to also reduce losses and to limit the residual dose to be compatible with hands-on maintenance

Thanks to all these mitigation measurements, losses at 760 kW are limited to a maximum of 1.2 kW, whereas any further reduction requires more time for machine studies, in particular to reestablish losses below 0.8 kW realized in April 2023.

For the future, it is proposed to use a different optics, because for the current one, even at the level of simulations, the minimum expected losses are 1%. New trim coils are needed to compensate for the resonances present for the off-momentum particles that are not affected by the already installed trim-coils.

Comments:

Studies for increasing the beam power are limited by the available machine time, but are well supported by studies on theoretical models that are validated when possible by measurements. The team was able to demonstrate that the machine can operate at more than 750 kW with acceptable losses, and when possible localized well within the collimation zone. Having exceeded 750 kW beam operation is an important milestone that A-TAC wishes to congratulate. It is the result of a team effort from the Linac, the RCS and the MR different colleagues.

The ripple on new main magnet power supplies and the circuit separations added a new challenge for increasing intensity while keeping low losses, a challenge that the team has been able to address by proposing solutions that have already been successfully implemented or will be studied in the near future. The studies should continue, including for the proposed new optics and resonance compensations.

A-TAC understands the importance of the new trim-coils for the sextupoles, and supports the installation of the maximum number of coils (24) to effectively control and reduce beam losses.

Recommendations:

None.

08 (MR) Slow extraction status and plan (SG, AV)

Findings

The slow extraction (SX) will increase the power delivered to the Hadron Hall target, considering the needs of the planned hall extension and with the arrival of new experiments. A new target is being designed, and it should be compatible with a maximum beam power exceeding 150 kW.

Before the first phase of the MR upgrade, the SX extraction operated at 64 kW, a cycle length of 5.2 s, the spill duration was 2.61 s with an extraction efficiency of 99.5%. The spill duty factor reached 60%. After the MR upgrade, due to the lack of available tuning time and the higher and still uncorrected noise of the new power converters, the power was limited to 50 kW, with an extraction efficiency of 99.5%, a duty factor of 50% and a cycle length of 5.2 s.

For the main new user, i.e. COMET Phase I, extraction tests during 2021 have already shown that the quality of the beam, in particular for the beam extinction, complies with the demands of the experiment.

For the future it is planned to operate first at 80 kW, by reducing the magnetic cycle from 5.2 s to 4.24 s with a flat top of 2.61 s and at the same beam intensity. Considering the higher beam power, losses must be kept under control and reduced, particularly at the SX ESS electrostatic septum. The dose levels at the septum allow for hands-on maintenance for now, but loss optimization is required after the power upgrade. There are two proposed strategies to intercept particles that could hit the SX ESS septum during the extraction, one involves the use of two particle diffusers, another the installation of a bent crystal.

The two diffusers were already installed, but it was not possible to test them in all planned configurations due to lack of beam time. By using only one of the two diffusers, the simulated loss reduction down to 40% with a 10 kW beam was observed. Measurements with higher intensity and with both diffusers are planned, aiming for a reduction down to 35% with respect to today's losses. The next step involves the installation of a bent crystal, which, according to simulations, should reduce losses to 25%.

Further studies are being done to mitigate the longitudinal instability appearing during debunching. It is believed that a longitudinal microwave instability causes electron clouds, with a consequent increase in transverse beam size and beam losses. The Keil-Schnell stability criterion was used to choose the accelerator parameters for the instability mitigation studies. First, it was decided to act mainly on the longitudinal plane: a phase error was introduced at injection as an ad-hoc change in voltage at the flat top to modify the longitudinal plane beam distribution. Already in this operational condition, the beam was observed stable up to 70.8 kW. In the future, the momentum compaction factor could also be modified by changing the optics, bringing the machine to more favorable stability conditions. The study of a dedicated very high-frequency cavity (VHF) has also been proposed to introduce phase modulation and increase the longitudinal emittance in a controlled manner.

Considering the best operational conditions, the spill duty factor measured is about 60% for 64 kW beam operation, which would be only 4% without a dedicated SX feedback that relies on two systems: fast quadrupoles, whose fields are driven by the shape of the measured spill, and a transverse kicker that injects a programmed RF noise. In order to improve the duty factor even further, it is already planned to use the signal of the main magnet power converters to drive the correction of the fast magnets and the signal of the transverse kicker. There are also plans to develop an optimisation algorithm based on Machine Learning.

For the COMET operation, especially for the 56 kW phase II, it will be also necessary to introduce a larger aperture quadrupole, already developed for the FX, as well as a larger aperture septum SMS1.

Comments

The slow extraction losses are handled carefully and methodically, with a well-targeted and rigorously conducted series of studies.

Beam loss mitigation strategies for the ESS are very promising, bring already significant reduction to the loss, and thus activation. For long-term operation, loss reduction stability and maintainability should be validated once the best method, diluters or bent crystal, will be chosen.

In the mitigations of the microwave instability, the use of the second harmonic as mentioned could bring benefits for the longitudinal emittance shaping, such it could be bringing the beam to the unstable fixed point prior debunching as studied in the past.

Of concern is the very large noise observed in the time domain on the measured spill, and in the frequency domain the peaks at approximately 20 Hz and 150 Hz. These frequencies are a source of disturbance also for the experiment. It is understood that, while the 20 Hz could have been eventually already improved by the modification to the power converter grounding, the 150 Hz ripple could come from a too large mismatch between the power converter rating and the impedance load of the QFR circuit.

Recommendations

R6: Investigate an alternative solution to improve the matching between the QFR reused power supply and the load, with the goal of reducing the effect of the circuit noise now potentially impacting beam performances.

09 (MR) Maintenance plan of utilities (ST, JT)

Findings

After nearly 20 year's operation of J-PARC, it has many aging issues of utilities. There are 6 power supply buildings (D1-D6) in J-PARC-MR. Three of them (D1-D3) have serious aging problems. Three machine buildings (M1, M2, and M3) also have aging problems.

Although some of the air-conditioning units in the power supply buildings D1, D2, and D3 were broken, the budget became available and the J-PARC MR team can replace 7 air conditioning units in the power supply buildings D1 and D3.

But many aging issues still remain as shown below. The J-PARC MR team is requesting the budget to replace them but this is not guaranteed now.

- One of urgent issues is the pure water system, which covers the whole MR area including NU and HD. It has repeatedly failed and been repaired in 2023, and further repairs are not practical.
- Some hot machine room dampers also have repeatedly failed and been repaired in the machine buildings (M1, M2, and M3).
- The motors and fans in the cooling towers in the machine buildings (M1, M2, and M3) are considerably damaged.
- Chiller units and water pumps in the machine buildings also have aging problems.

Comments

The J-PARC MR team is working on many aging issues of utilities with the limited resources for the stable operation and the upgrade project of MR.

The J-PARC MR team should make a spares inventory list for all utilities, not only the cooling water pumps. The appropriate number of spares should be determined based on the statistics, such as MTBF, lead time and the number of equipment. Then, the priority should then be determined based on the systematic failure mode and effects on user beam time. J-PARC should consider an appropriate ongoing yearly budget for utilities to deal with routine maintenance and aging issues.

In the presentation of A-TAC 2024, there was no mention of the lack of cooling water toward MR 1.3 MW operation, which was discussed in A-TAC 2023. The priority of utilities should be also discussed from both sides, aging and upgrade.

Recommendations (part of the following recommendation)

R2: Prepare a prioritized list of aging systems that may cause major downtime to operations. Identify a list of mission-critical items whose replacement or preventive maintenance cannot be funded internally by J-PARC and would require additional external funding.

10 Status of linac (AA, SW)

Findings

The linac performed very well since the last review with the number of trips and downtime similar to the previous year.

The ion source delivers a 60mA beam with high reliability. The time between the source changes increased by about 400 hours to 4,412 hours. The antenna failures are rare (the last one happened in 2019) and sufficient spares are available (> 10).

The RFQ trips frequency remained on the same level and implementation of the autoreset feature reduced the effect of the trips on the total downtime. The RFQ transmission remained unchanged.

The DTL cavities trip rate remained the same as the previous year, with the exception of the DTL3 suffering from the RF window discharge. The DTL3 normal operation recovered after the RF window replacement.

The SDTL operation remained stable after cleaning the S04A and S04B cavities during the summer 2022 shutdown. No recurrence of a multipactor was observed in any of the cavities.

The ACS ran stably with the trip rate steadily decreasing.

Many klystrons reached a very large number of operating hours: up to 90,000 hours for the 324 MHz klystrons and 60,000 hours for the 972 MHz klystrons. Several klystrons developed problems and had to be replaced. The current inventory of spare klystrons is 40% for both types. The inventory is planned to be increased to 50% in the future.

There is a sufficient number of spare RF windows.

The tunnel floor deformation is continuing though at a lower rate. The alignment is checked regularly and corrected as needed. There was no obvious detrimental effect on the beam quality.

Comments

The Front End and linac demonstrated stable operation with generally improved performance. The team should be commended for this significant result. The ion source performance is especially impressive.

Recommendations

None.

11 Beam study results of the linac (AA, JT)

Findings

The main linac beam study activities included:

Measurement and mitigation of the MEBT chopper leakage. The leakage is small and doesn't present an immediate problem but can cause beam loss increase in the RCS with higher peak current. The leakage was measured by applying full chopping and measuring beam loss on the scraper in the MEBT2. The MEBT1 buncher voltage and the MEBT1 scraper position were found to be effective for reducing the leakage. The leakage was found to change when the ion source was changed.

Investigation of the ACS beam optics on the IBSt losses. The BLM signal was used as an observable. Two optics configurations were investigated, both with reduced transverse and longitudinal focusing strength relative to the design values. The two cases didn't show significant global reduction of the beam loss.

Investigation of the output linac energy jitter compensation using a Machine Learning algorithm. Only computer simulation results were presented with no experimental data.

A general effort to improve beam quality in the Front End. No definitive result was presented.

Comments

The chopper leakage investigation lacks quantitative evaluation of the leakage current and/or quantitative evaluation of its contribution to the total RCS losses.

The proposed approach of measuring fully chopped beam leakage can significantly underestimate the chopper related beam losses, because it doesn't account for partially chopped beam during the RF deflector rise and fall transients.

The whole suite of diagnostics (BSMs, wire scanners, etc.) should be used to obtain qualitative data on the chopper performance.

Only BLM measurements were used for the IBSt study. The beam loss data interpretation is notoriously difficult, because the BLM signal is a convolution of many potential loss mechanisms. All available diagnostics should be used to untangle those loss sources, such as wire scanners, BSMs, etc.

Reducing the focusing strength to mitigate the IBSt is a common sense approach that has proved to be effective at other facilities. The presented study self-imposed a limit to this approach out of a fear of pushing the beam to the 'danger' areas of the Hofmann diagram. To compensate for the transverse focusing reduction, the cavity RF amplitude was reduced with a detrimental effect on the beam transmission and quality, as expected. The Hofmann diagram is a theoretical construct providing some guidance for a linac design, but it shouldn't be used as a hard rule for real linac beam dynamics study.

The linac output energy jitter compensation study lacks quantitative data. The actual jitter distribution and its spectrum should be measured and analyzed. If the distribution has a significant component with frequency higher than a few Hz, the proposed ML algorithm with a few seconds/correction is too slow.

As stated in the presentation, the high beam intensity results in an increase in the bunch length at the MEBT, causing the effective RF field of the MEBT chopper to not cover the entire bunch. This leads to some particles at the edge of the bunch not being cut off, resulting in their loss in the downstream linac and RCS. This issue requires further simulation and beam study. Currently, the compression of the bunch length is being achieved using Buncher 1 to reduce this effect, but it has an impact on the longitudinal matching of the beam entering the DTL. For the 3 m-long MEBT, the use of two bunchers for longitudinal matching is already quite tight. It is recommended to consider redesigning the MEBT and using three bunchers, which can effectively solve the issues of beam bunch length compression and longitudinal beam matching.

Recommendations

None.

12 Status of RCS (JT, SW)

Findings

The RCS has remained in stable user operation, delivering 600 – 800 kW beam to the MLF during the periods January to March, April to June and November to December. Availability for the RCS only has again been excellent, at 98.3%. The majority of the 25:31 hours of downtime for the RCS was due to a small water leak resulting in damage to a capacitor in one of the RF systems.

As noted at the last A-TAC, an over-current occurred in the transformer-rectifier assembly for RF system 10 during JFY2022. The RCS was reconfigured to accelerate an 800 kW beam with only 11 (of 12) RF cavities. It has since been determined that with 11 cavities the maximum power is limited to 950 kW. The original plan was for a spare transformer-rectifier assembly to be installed in March 2023, but on inspection it was found that both a diode and a transformer were broken, so that there was no longer a viable spare. A new transformer-rectifier has been fabricated and is expected to be in use from April 2024. This should allow a return to 1 MW RCS operation (dependent on target status). 1 MW RCS operation is sufficient to enable 1.3 MW MR operation.

At present there is insufficient cooling capacity to run the RCS above 800 kW beam power if the wet-bulb temperature is > 24°C. As a result, beam power was reduced to 750 kW in June 2023.

As part of the program of replacement of all 12 RCS RF cavities by JFY2028, 3 new RF cavities have now been installed. At 740 kW beam power, the power consumption per cavity has been shown to drop by nearly 300 kW compared with the original design. It is hoped that this will reduce the load on the cooling system and alleviate the need to reduce beam powers below 800 kW in the summer. Further cavities will be replaced, prioritizing those with high heat loads.

A pure carbon stripping foil has been developed to replace the Hybrid Boron-doped Carbon (HBC) and Graphite Tin Films which have been used previously at J-PARC. In operation the new foils show less deformation and none of the unexpected increases in beam dump temperature associated with the old foils. J-PARC has started a pure carbon foil development collaboration with LANL and Sumitomo Heavy Industries.

Simulations have indicated that to control the primary source of beam instability and achieve 1.5 MW beam power, diode units will need to be installed in a minimum of 4 (of 8) kicker PSUs in the RCS. The first 2 units have already been installed and another 2 are under construction and should be installed during JFY2024.

In response to **R13** from A-TAC 2023, the J-PARC team considered the effect of insufficient cooling capacity for high-power operation. As a result, the decision has been made to suspend user operations in Summer JFY2024 on 26 June to avoid predicted high ambient temperatures, but to continue beyond this date with lower repetition rates for trials at > 1 MW equivalent particles.

Comments

A-TAC congratulates the RCS team on another year of stable user operations, with excellent availability.

It is good news that the 3 new RF cavities have demonstrated a considerable decrease in power consumption compared with the original design. A-TAC looks forward to seeing more resilience to the effects of ambient temperatures as a result and encourages the installation of the remaining 9 cavities in support of the J-PARC ambition of > 1 MW operation.

The development of pure carbon stripping foils is very promising and may be of considerable interest at other spallation sources such as ISIS, SNS and CSNS.

Recommendations

None.

13 Beam study results of RCS (SW, AA)

Findings

Machine studies were conducted during runs 90# and 91#, resulting in significant progress. Through continuous efforts, beam loss has been further reduced for power to MLF of up to 1 MW and to MR of up to 760 kW with a cycle time of 1.36s. All the findings from the machine studies have been successfully implemented into operation.

For MLF mode, efforts were made to decrease the perturbation of the shift bump magnet by conducting a machine study with decreased shift bump magnetic field. A 20% decrease in the shift bump field led to reduced beta-beating and beam loss. Additionally, resonance corrections and optimization of transverse and longitudinal paintings were carried out in the machine studies, resulting in a significant reduction in beam loss during the 1 MW beam commissioning.

In MR mode, optimization of the transverse painting emittance further mitigated beam loss by more than 30%, while maintaining the same rms emittances as the original painting emittance. This optimization also reduced the foil traversal number. Furthermore, reducing the macro pulse length from 0.5 to 0.4 ms mitigated beam loss in the dispersion area and reduced the emittance.

Two RF cavities were replaced by single-ended (SE) type, and the second diode unit to the kicker magnet (KM#5) was installed, providing potential for further increasing beam power.

Comments

A-TAC congratulates the RCS commissioning team on their achievement in further reducing beam losses in both MLF and MR modes, as well as effectively controlling the emittance growth in MR mode.

The report presents the optimization results of the injection process, which further reduces the beam loss during injection. The optimized results include the injection pulse length, injection beam dispersion, longitudinal smearing, and the optimization of the RF frequency curve during injection. Many parameters in the injection process are coupled together, and by simultaneously optimizing multiple parameters, it is possible to find a better parameter window and reduce the requirements for some equipment, such as the debuncher.

The fringe field of the shift bump can cause beta-beating and disrupt the three-fold symmetry of the RCS. The disruption of the symmetrical structure can lead to significant emittance growth. By reducing the strength of the shift bump, the impact can be mitigated, but even with a maximum reduction of 20% in shift bump strength, it still results in considerable emittance growth. By using trim Q, it is possible to compensate for the disruptive effect of the shift bump on the symmetrical structure, potentially further reducing emittance growth and beam loss. Simulation studies should be able to provide insight into the compensatory effect of trim Q.

After years of commissioning and optimization, the beam loss has been minimized, and many parameters are at a critical point. For example, small changes in parameters such as injection beam parameters and tune can lead to relatively large variations in beam loss. When optimizing the operational mode, it is important to consider as wide a parameter window as possible to ensure that the parameters of the operational mode have better robustness and repeatability.

Recommendations

None.

Homework 1: Present a prioritized (top 10 systems) list of aging legacy systems that may cause major downtime to operations. Include a list of mission-critical items whose replacement or preventive maintenance cannot be funded internally by J-PARC and would require additional external funding. (SG)

Findings

A prioritized (top 10 systems) list of aging legacy systems that may cause major downtime to operations for the MR have been presented. These are also mission-critical items whose replacement or preventive maintenance cannot be funded internally by J-PARC and would require additional external funding. Some of them have long procurement time, others could cause a very long beam stop or degraded operation. In the case of the FX and injection septum the funding for maintenance is missing.

Comments

For most of the elements, the beam stop announced for the MR could go up to 2 years, in particular for the magnet harmonic filters and transformers.

A-TAC supports the importance of securing the proper maintenance and spare acquisition for these mission-critical items.

Recommendations

R2: Prepare a prioritized list of aging systems that may cause major downtime to operations. Identify a list of mission-critical items whose replacement or preventive maintenance cannot be funded internally by J-PARC and would require additional external funding.

Homework 2: Itemize major annual objective measures in both hardware establishments and performance improvements during the ramp up of MR beam power towards 1.3 MW (given required availability > 85%) (WF)

Findings

For each year, the targeted beam power, intensity, RF voltage etc. was listed, and the beam dynamics improvements such optics correction and resonance compensation.

Comments

The table is a concise overview of annual deliveries, and a useful tool to communicate multi-year milestones of all major subsystems.

Recommendations

None.

Homework 3: Tie timeline for installation of new RCS cavities to expected increases in beam power level. Itemize other major objective measures in both hardware establishments and performance improvements during the ramp up of RCS beam power towards > 1 MW. Outline programme of > 1 MW testing. (JT)

Findings

J-PARC expects to return to 1 MW RCS user operations in April 2024 as soon as the new transformer-rectifier for RF system 10 has been installed. The plan is then to continue user operation at 1 MW until the installation of all 12 new RF cavities is completed in 2028. Thereafter the intention is to increase RCS beam power immediately to 1.2 MW and then to reach 1.5 MW as quickly as possible.

In addition to the replacement of the RF cavities there are other specific considerations to enable > 1 MW operation.

- In the ring RF system, reinforcement of the amplifier chain is required.
- The duration of the field patterns of the injection magnets must also be extended.
- Beam monitors may need to be replaced in order to provide sufficient dynamic range.
- Pure carbon foils may be preferable to HBC foils for higher power operation.

A goal of has been set to address all these items by JFY2028, ready for the ramp up to 1.5 MW user operations.

Lower repetition rate trials at > 1 MW equivalent particles are planned after user operations are suspended in Summer JFY2024 on 26 June.

Comments

The imminent return to 1 MW RCS user operations is very welcome. Equipment upgrade plans in preparation for the ramp up to 1.5 MW starting in 2028 seem well developed.

At present there is no detailed plan for further lower repetition rate trials at > 1 MW equivalent particles after JFY2024. A-TAC encourages J-PARC to create such a detailed plan in support of the move towards 1.5 MW user operations.

Recommendations

None.

Appendix 1 – 2024 A-TAC Committee

Below is the list of those attending the 2024 A-TAC:

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Appendix 2 – Agenda

Agenda for A-TAC2024 (Q&A included for each report) 2023/11/29

February 5, Monday Venue: a conference room on the 2nd floor of theJ-PARC Research Building and Remort

Time(JPN.ST)		Period	Category	Title	Speaker	
8:00		*Departing the hotel, "Terrace Inn Katsuta"*				
8:40	9:00	0:20	Time for LAN Connection			
9:00	9:15	0:15	**Executive Session**	*Closed*		
9:15	9:55	0:40	**Project Status**		T. Kobayashi	
9:55	10:25	0:30	**Accelerator Overview**	J-PARC accelerator overview	M. Kinsho	including item#1
10:25	10:45	0:20	**Group Photo and coffee break**			
10:45	11:25	0:40	**MR**	Status of MR	S. Igarashi	including item#2, 6
11:25	11:55	0:30		Power supply status of main magnet	Y. Morita	
11:55	13:00	1:05	***Lunch***			
13:00	13:30	0:30	**MR**	Fast extraction magnets and power supply	K. Ishii	including item#4
13:30	14:00	0:30		RF system status and upgrade plan	K. Seiya	
14:00	14:20	0:20	**coffee break**			
14:20	15:00	0:40	**MR**	Beam commissioning	Y. Sato	
15:00	15:30	0:30		Slow extraction status and plan	R. Muto	including item#3
15:30	16:00	0:30		Maintenance plan of utilities	M. Shirakata	including item#5
16:00	17:00	1:00	**Executive Session**	*Closed*		
<<Reception>> 18:00 - 19:30 at the KEK 1-gou kan						

February 6, Tuesday Venue: a conference room on the 2nd floor of theJ-PARC Research Building and Remort

Time(JPN.ST)		Period	Category	Title	Speaker	
8:00		*Departing the hotel, "Terrace Inn Katsuta"*				
9:00	9:10	0:10	Time for LAN Connection			
9:10	9:25	0:15	**Executive Session**	*Closed*		
9:25	9:55	0:30	**LINAC**	Status of LINAC	T. Morishita	
9:55	10:35	0:40		Beam study results of the LINAC	Y. Liu	
10:35	10:55	0:20	**coffee break**			
10:55	11:25	0:30	**RCS**	Status of RCS	K. Yamamoto	
11:25	12:05	0:40		Beam study results of RCS	P. Saha	
12:05	13:05	1:00	***Lunch***			
13:05	16:30	3:25	**Executive Session**	*Closed*		
<< dinner >> 19:00 - 20:30 at the restaurant in Katsuta						

February 7, Wednesda Venue: a conference room on the 2nd floor of theJ-PARC Research Building and Remort

9:00		*Departing the hotel, "Terrace Inn Katsuta"*				
9:40	11:00	1:20	**Executive Session**	*Closed*		
11:00	12:00	1:00	**Recommendations to J-PARC**		J. Wei	
12:00	13:00	1:00	***Lunch***			
adjourn						

Required items from last ATAC	1. Present accelerator development initiatives aligned with J-PARC's long term missions.	M. Kinsho	in Overview
	2. Present progress on the delayed MR hardware and beam commissioning activities and compare with the adjusted plan made at A-TAC 2023.	S. Igarashi	in MR
	3. Present concepts for the future slow-extraction system to accompany the major future investment of the Hadron Hall Extension.	R. Muto	in MR
	4. Present the plan for an optimal fast-extraction septum-magnet array, incorporating all lessons	K. Ishii	in MR
	5. Elaborate a long-term strategy for the maintenance or replacement of the power converters that were reused in the MR upgrade.	M.Shirakata	in MR
	6. Present the upgrade plans for the MR beam dump, including the design and construction timeline and budget needs.	S. Igarashi	in MR