Report of the 19th Meeting of the Accelerator Technical Advisory Committee for the Japan Proton Accelerator Research Complex (J-PARC)

February 24 – 26, 2020
J-PARC Research Building
Tokai, Japan

The Accelerator Technical Advisory Committee (ATAC) for the J-PARC Project held its nineteenth meeting from February 24 to 26, 2020, at the J-PARC Research Building in Tokai, Japan. The ATAC members physically participating were: Alexander Aleksandrov (ORNL), Wolfram Fischer (BNL), Simone Gilardoni (CERN), Mats Lindroos (ESS), Toshiyuki Shirai (QST), and Jie Wei (MSU, chair). The ATAC members remotely participating due to travel restrictions mostly relating to COVID-19 occurrence were: John Thomason (STFC), Sheng Wang (IHEP), and Robert Zwaska (FNAL) (Appendix 1).

The ATAC thanks the J-PARC management and staff for their hospitality during this meeting, video conferencing arrangements, and all the presenters for their excellent and comprehensive talks. In addition, the accelerator team responded promptly to the homework requests from the committee.

Executive Summary

Since the last ATAC review held in February 2019, the J-PARC accelerator complex has been maintaining 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 500 kW with an availability of 95% and further power increases depend on the neutron target performance. The beam power for MR NU and HD has been maintained at levels of 510 kW with 90% availability and 51 kW with 80% availability, respectively. J-PARC also demonstrated flexibility in its user schedule so as to maximize time allotted to users when unexpected conditions affected beam delivery: MLF target installation schedule and a magnet failure into the Main Ring.

The J-PARC accelerator team has been conducting beam experiments in the Linac, RCS, and MR to ensure the success of planned upgrades including the approved Hyper-Kamiokande project. 1 MW was demonstrated for more than ten hours in the MLF. J-PARC continues to appear ready to capitalize on the planned upgrades over the next several years to its facilities; ultimate performance will continue to be challenged by available budget (which has been inadequate for optimal operation) and personnel (who are limited in number and may retire in large numbers within the next decade).

The J-PARC accelerator team has been proactively addressing the 2019 ATAC recommendations and requests. Progress reports were given at this review on the four topics requested at the 2019 ATAC. The presentation and homework response on the personnel protection system is comprehensive. Work on the other three topics is progressing. 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 2020 ATAC. Each of the twelve recommendations (**R1** – **R12**) 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 sixteen talks (Appendix 2) and four homework assignments presented at this review.

J-PARC accelerator complex has successfully operated for over 10 years. Along with the aging hardware and infrastructure, J-PARC must face potential issues of an aging workforce and departure of mission critical subject-matter experts. Some areas of expertise take at least 5 years to grow into maturity for future mission scope delivery. Examples include cryogenics, high power RF, superconducting RF, pulsed power, and high power targetry. We encourage J-PARC to further develop a strategy to attract and retain mission critical expertise. A succession plan should be established to motivate new recruitments and assure that mission critical positions are preserved and that key skills are sustained.

R1: Develop a list of expertise subjects pertaining to J-PARC's strategic future missions; develop plans to attract, retain and grow mission-critical subject-matter experts.

The staffing levels in the Accelerator Division for the responsibilities of operations are lean in general compared to similar facilities worldwide. The age profile is an obvious issue as retirements are expected to occur rapidly for an extended period leading to a sudden and quick loss of key competences. The low number of post docs and technicians is also a concern. Furthermore, there is little free energy and no margin of labor available for new initiatives and projects. This staffing issue is potentially critical for J-PARC's sustainable operations and future growth.

R2: Recruit new accelerator staff to address issues of staff aging, imbalance, and work demands.

Operating hours continues to be a challenge for J-PARC, while availability within those hours continues to improve. Assigned hours have been limited by multiple factors: funding, user availability, and technical issues. 2020 is potentially worse due to these factors, and 2021 will see no MR operation at all due to the upgrades. J-PARC and its sponsors need to work toward a plan of sustained operations so that the large capital expenditures are properly exploited. J-PARC should choose a number of user hours and attempt to achieve it for the MLF, and half that each for the neutrino and hadron users. "9 cycles" (4752 hours) is the optimal mode of operation for the MLF, and could be a good baseline. Only 7.2 cycles are planned for 2020, and the trend is downward.

R3: Seek to maximize operating periods at both the MLF and MR in balance with the upgrade strategy. Maximize allocated user hours within those periods by measures including coordinating the down time requests for different areas of the facility and economizing the time spent on commissioning and studies (perhaps by increased automation of the accelerator mode switching).

As J-PARC is coming of age an optimized spares inventory will allow for a cost-effective maximization of the facility use. Recent failures have illustrated the need for this. This process has started but is not yet completed.

R4: Complete the inventory lists; evaluate the downtime risk from failures in the technical infrastructure, and estimate the funding need to fully implement a spares policy.

The number of conditioned spare klystrons must be increased. As a general rule, it is standard practice to keep at least 50% of the number of operational klystrons as spares. This number of spares is usually increased to 100% as the operational klystrons approach their nominal lifetime.

R5: Increase the number of conditioned spare klystrons to at least matching those approaching the expected lifetime.

The capacitor banks in the high voltage system for the klystrons will have to replaced. Before launching such a procurement, investigate what the cost would be to replace the aging HV system with a modern switched technology system e.g. the ESS modulator design is available for research partners and can be used after required modifications as “build-to-print” to local industry.

R6: Consider modern switched technology in the linac converter modulator system upgrade.

Some simulation studies are presented for the MR upgrade and for the RCS. Space-charge in the RCS, collimation loss patterns in the MR for the upgrade, transverse beam instabilities and their damping, are all being subjects of simulations. While beam observation and beam tuning periods are clearly improving the machine operation, and necessary to bring the machines to higher intensities, these studies should be supported by even more detailed simulations, also to guide beam study periods with respect to beam observables (losses, transverse and longitudinal profiles). This could help also to optimize the time required for beam tuning, which has been presented as so precious and reduced to a bare minimum in the case of the MR.

R7: Increase computer simulation and modeling efforts to enhance efficiency in beam tuning and machine operations.

An MPS failure to protect the machine from misdirected beam on 2018/1/20 opens a question of how the working condition of the MPS is ensured and tested. We did not receive a clear answer as to whether a formal process exists to document, approve and test changes and/or return from maintenance periods. Continue the effort to proactively and comprehensively review the machine protection system to locate hardware systems that are not adequately protected. Implement an MPS review process for all new hardware that is consistent throughout the J-PARC organization.

R8: Determine the root causes, engineering and administrative, of the three machine protection system malfunction events that occurred during recent years and develop mitigation measures that will prevent future occurrences.

The introduction of multi-harmonic vector RF voltage control feedback in the LLRF for both the RCS and MR has been remarkably successful. This sets a clear direction of travel for the future of the ring LLRF systems at J-PARC. In the MR, residual longitudinal oscillations are observed with a pattern which does not correspond to coupled bunch instabilities. Further studies should be pursued to understand the source of the oscillations and their possible intensity dependence.

R9: Resolve the remaining problems with distortion in the RCS amplifier chain; complete the development on the longitudinal damper of the MR for operations.

The two water leaks on two different magnets in such a short space of time is worrying. After 10 years of operation, it could indicate a first sign of a more general problem on the brazed connections for other magnets.

R10: Organize a verification campaign of the water-cooling circuits and electrical connections of the MR and 3-50 BT line magnets.

The existing MEBT1 design supports stable facility operation at 500 kW and performed well during 1 MW demonstration. The quality of the beam formed in the injector is of major importance for low-loss linac operation. The proposed MEBT1 is an opportunity to improve the beam quality and simplify the machine tuning. Special attention is needed to make sure the new design makes as many improvements as feasible and does not unintentionally degrade performance in any area.

R11. Present results of the beam dynamics simulation and the experimental study providing compelling evidence the proposed MEBT1 design changes will improve the linac performance. Present a detailed plan on how the shorter RFQ will be incorporated into the existing machine.

The back-up shielding in the RCS injection area should be constructed as soon as possible. The upgrade is a big step, and before going ahead with the upgrade the benefit remains to be investigated further and should be backed up by simulation for the different conditions – without shielding, with backup shielding and for the upgrade scheme – and compared with the measurement results for the first two cases. Even with the upgrade of the injection area some dose rates will still be far beyond the normal manual maintenance threshold of 1 mSv/hr. Besides strengthening the shielding another option is using a mechanical arm or robot to reduce the requirement for direct manual maintenance.

R12: Consider development of mechanical arm and robot technology for disassembly and installation of high dose rate components in the injection area.

Items for the Next Meeting

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

1. Consider to revise the A-TAC presentation structure to reduce the number of general talks (e.g. general beam study results talk containing non-consequential material) and increase the number of talks reporting issues, root cause analysis and mitigations, and topics for which the J-PARC team looks for comments, advice, and endorsements;

2. Present beam diagnostics and instrumentation across the accelerator complex from the ion source to the experimental targets;

3. Present the status, focuses, and challenges of mechanical and electrical utility systems of the accelerator complex;

4. Present the completed accelerator component inventory list as the basis for the spares inventory with identified single points of failure;

5. Present the administrative measures ensuring the functioning of the implemented machine protection systems and its configuration control.

02 J-PARC Accelerator Overview (RZ, AA, ML)

Findings

JFY2019 has been a year of consistent operations for J-PARC, with an eye to the coming upgrades for power to all stations (MLF, MR FX, and MR SX). J-PARC demonstrated flexibility in its user schedule so as to maximize time allotted to users when unexpected conditions affected beam delivery: MLF target installation schedule, and a magnet failure into the Main Ring. User hours have continued to be limited due to scheduling, beam studies, and downtime. Availability was good during scheduled hours for the MLF and showed improvement for the MR; J-PARC still formally lists its availability goal as > 90%, but has pushed for better to 95%. Further experiments have been performed in the Linac, RCS, and MR to ensure the success of planned upgrades. 1 MW was demonstrated for more than ten hours in the MLF. J-PARC continues to appear ready to capitalize on the planned upgrades over the next several years to its facilities; ultimate performance will continue to be challenged by available budget (which has been inadequate for optimal operation) and personnel (who are limited in number and may retire in large numbers within the next decade). As the MLF target becomes capable of accepting 1 MW, J-PARC plans to develop stability of operations before pushing to further upgrades beyond 1 MW.

RCS for MLF:

- The RCS provided >500 kW to the MLF in the previous year, limited by the MLF target capability, while also further demonstrating that the RCS is capable of 1 MW and ready for operation when the MLF target is capable. J-PARC is preparing plans for increasing beam power to 1 MW over the next 4 years, entirely limited by the capability of the MLF target
    - 2641 hours of beam delivery were achieved out of 2775 scheduled for the MLF in JFY2019 to Feb 19. The downtime remained low, achieving an availability of 95.1%, well exceeding the goal of 90%.
    - 1 MW beam is available but awaits a higher-power target.
    - For the near term, operation will be limited to 500-600 kW until targets capable of higher power are installed (anticipated to be within four years).
- 1 MW equivalent beam operation was further affirmed during the past year.
    - Beam experiments demonstrated sustained 1 MW operation for 10.5 hours – a robust demonstration of the accelerator’s capability.
    - The experiments demonstrated the changes needed for 1 MW operation, and resulted in a mode with ~ 0.2% loss, dominated by foil losses.
- Long-range plans for 1+ MW have been generated, and studies performed up to 1.5 MW equivalent injection intensity, though aborting at 0.8 GeV to avoid beam loading instabilities. These studies have been very successful.

MR with fast extraction for neutrinos:

- Beam delivery was consistently greater than 500 kW in JFY2019. Further beam power improvements will be possible with replacement of the MR magnet power supplies (after

JFY2021) to allow a shorter cycle time and then other enhancements to the machine allowing higher beam intensity. Operating hours were limited due to scheduling, funding, and the failure of a magnet in the transfer line to the MR.

  - Beam power to T2K increased from 500 kW to 520 kW.
  - 1295 hours of beam were delivered out of 1434 assigned hours in JFY2019 to Feb 19, for an availability of 90.3%, exceeding the 90% goal.
  - Run-time in JFY2020 will be very limited due to user availability and funding. There will be little or no running in FY2021 for the MR upgrade.

- J-PARC will reduce the MR cycle time to < 1.3 sec 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.
  - Power supplies are all under construction, several have been tested under full load and in operation.
  - J-PARC now plans to complete procurement of the power supplies in the next year and install them in a full-year MR shutdown in JFY2021.
  - The power supply upgrade and 1.3 s cycle will be available in JFY2022.
- A further program of modest improvements to the MR will result in increased beam intensity. When combined with the power supply upgrade (and further exploitation to 1.16 s cycle time), 1.3 MW should be available from the MR for fast extraction. These plans are now well understood. The mid-term plan has been consistent with a gradual rise to 1.3 MW in JFY2028 to be available for Hyper-K.

MR with slow extraction to the Hadron Facility:

- Beam of up to 51 kW was delivered to the Hadron Facility in JFY2019. Further improvements are planned to 70 kW in 2020 and >80 kW in future years.
  - 355 hours of beam were delivered out of 445 scheduled, for an availability of 79.8%, short of the J-PARC goal of 90% availability. This was impacted by the failure of the B15D dipole magnet.
  - The new target installed is to be capable of 80 kW, once it is completely licensed. Beam studies at this power need to be performed.
  - The slow extraction program will also not see any beam during the upgrade of JFY2021.

J-PARC plans to operate the MLF for 7.2 cycles = 159 days in 2020, though optimal operation is considered 9 cycles per year. The MR may operate for as few as 77 days (though more days are available on the calendar), due to the availability of the experiments and funding issues. In 2021 the MLF will continue to run while the MR is shut down for the upgrade of its power supplies.

The J-PARC accelerator division has essentially demonstrated 1 MW capability for the MLF, but is waiting for a capable target. Once 1 MW is achieved routinely with a MLF target, J-PARC foresees a period of developing stability in that mode of operation while preparing for further upgrades. A series of individual activities have been identified for the Linac and RCS over the next 5 years. Further beam intensity improvements have been explored through preliminary Linac and RCS studies.

J-PARC has analyzed its personnel succession situation and determined that it is at risk of losing key expertise in the next 10-15 years as it potentially has more than half of its staff retire. A number of issues contribute to this including the stability in staff since the start of the lab, and the lack of new hiring.

Comments

The 1 MW and >1 MW studies in the RCS show outstanding results. 1 MW is ready for the MLF from the accelerators. The >1 (1.5) MW studies are also very encouraging, demonstrating that a 1.5 MW upgrade should be achievable with additional RF power. It is somewhat unfortunate that the studies must be aborted at 0.8 GeV – it would be desirable to explore the higher energy portion of the accelerator cycle. The results are promising enough that J-PARC should start to consider even higher power.

Operating hours continue to be a challenge for J-PARC, while availability within those hours continues to improve, being excellent (> 95%) for the MLF where it is most significant. The number of assigned hours starts from a low level due to a number of issues: funding, user availability, and technical issues. J-PARC showed good flexibility responding to the limitations of the B15D magnet failure, MLF target installation, and now the Super-K and Hadron Hall availability. Unfortunately, next year is potentially worse due to all these same factors, and 2021 will see no MR operation at all due to the upgrades. J-PARC and its sponsors need to work toward a plan of sustained operations so that the large capital expenditures are properly exploited. Future users have high expectations for J-PARC and need to have a plan that achieves greater operating time in addition to operating power. A reasonable benchmark is 5000 scheduled hours of operations per year – J-PARC should choose some similar number and attempt to achieve it for the MLF, and half that each for the neutrino and hadron users. Efforts should 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 identified "9 cycles" as its optimal mode of operation for the MLF. Meaning 9 cycles of 22 days of operation, leading to 198 days, or 4752 hours of operation – very close to 5000 hours. Achievement of this cycle would be a continuing achievement for J-PARC. Unfortunately, J-PARC only anticipates funding for 7.2 cycles in 2020, and the trend is downward. Achieving a similar amount of user time for the Main Ring is also desirable. It would be useful for the committee for the next year projections of cycles to be decomposed into projected hours of user operation, startup and tuning so as to be able to compare to achieved (prior year) numbers.

J-PARC has proposed a period of "stability improvement" for the Linac and RCS, after reaching 1 MW operation. There is a program of improvements for each portion of the machine to be able to achieve this stability. This program of stability is desirable and achievable, as all of the improvements are to be achieved over the next five years, while a 1 MW target may be as long as four years away. The committee notes that many of these improvements may be useful for ~1.5 MW operation. Therefore, it would be useful for J-PARC to settle upon an operating scenario for 1+ MW (choose power, linac current, pulse length, etc. – perhaps also a second target station) so that these mid-term upgrades can be designed to be compatible with that mode.

J-PARC has identified staffing as an issue. 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 5-10% per year for the next 15 years. Furthermore, there is no margin of labor available for new projects. J-PARC has expressed reluctance (or been forced to be reluctant) to increase staffing for future projects. This staffing issue is potentially critical for J-PARC, and J-PARC must develop a staffing plan. This staffing plan should attempt to:

- Transfer knowledge between generations of workers.
- Develop the depth of the team by moving persons between areas of responsibility over time, so that there are multiple experts on various systems.
- Develop the capabilities of individuals by issuing them new responsibilities, and other forms of professional development or education.
- Anticipate the future needs of J-PARC, particularly for future projects.

Succession planning is vital as any employee could be lost at any time to another position, illness, or other personal issues. One of the functions of management is to predict the future for the organization and make decisions based on that expected future: hiring is one of the most important activities to perform. There are many methods to develop a staffing plan, and the J-PARC management should choose a method with which they are comfortable. These approaches can vary from a more mechanistic accounting of skill areas, to a developmental model of individuals.

Recommendations

R1: Develop a list of expertise subjects pertaining to J-PARC's strategic future missions; develop plans to attract, retain and grow mission-critical subject-matter experts.

R2: Recruit new accelerator staff to address issues of staff aging, imbalance, and work demands.

R3: Seek to maximize operating periods at both the MLF and MR in balance with the upgrade strategy. Maximize allocated user hours within those periods by measures including coordinating the down time requests for different areas of the facility and economizing the time spent on commissioning and studies (perhaps by increased automation of the accelerator mode switching).

03 Status of Linac (ML, TS)

Findings

During 2019 the linac has operated at 50 mA and 400 MeV with 0.5 ms long pulses at 25 Hz with an impressive availability well above 95%.

The number of trips is dominated by RFQ trips. Failure of the ion source and a klystron power supply also contributed to down time. The ion source operates with 60 mA for user operation. It suffered a failure of the internal antenna during operation (vacuum leak). It was repaired and an improved design is under way for the failed part (will be installed in the next shutdown) to avoid similar issues in the future.

To reduce the down time linked to regular RFQ trips modifications have been done to the LLRF system so that the LLRF system can re-start with the next macro-pulse (1 second to 40 ms). A re-start of MPS by the operator adds 30 seconds to the re-start time, but a quick start without MPS is planned for next year. The DTL/SDTL trip frequency is low (<0.3 trips per day). The earth-quake in 2011 resulted in multipactor issues in the DTL/SDTL section. Cleaning with acetone solved that for all cavities except one. This cavity has been re-cleaned several times but the multipacting re-appears after some time. A tested method using diluted sulfuric acid for the cleaning will be applied in the next shut-down. The ACS section is operating without any major issues.

The average operating time of klystrons is very high with 8 of the 324 MHz klystrons approaching 70,000 hours and 19 (out of 25) 972 MHz klystrons approaching 35,000 hours. New klystrons are being purchased but only three of each type are conditioned. An additional four 324 MHz unconditioned klystrons and seven 972 MHz unconditioned klystrons are presently stored at J-PARC. A small oil leak from a capacitor bank for the high voltage power supply was found last year. The high voltage systems have been in operation for 15 years and an important budget is required for the replacement of the capacitor banks.

The linac operations talk was followed by the linac study talk. The two talks were not strongly linked.

Comments

- The performance and availability of the linac continues to be very impressive.
- At the present number of operational hours per klystron, the low number of spares is a big concern. As a general rule, it is standard practice to keep at least 50% of the number of operational klystrons as spares. This number of spares is usually increased to 100% as the operational klystrons approach their nominal lifetime.
- The small oil leak in the high voltage system is another big concern as the system is old and the replacement cost is high. There might be an opportunity here to not only replace the system but to upgrade to a more modern switched technology modulator system e.g. the ESS modulator design is available for research partners and can be used after required modifications as “build-to-print” to local industry. It will definitely create space and add flexibility.

- A strong collaboration between the operations team and the study team is likely to be beneficial for both teams.

Recommendations

R5: Increase the number of conditioned spare klystrons to at least matching those approaching the expected lifetime.

R6: Consider modern switched technology in the linac converter modulator system upgrade.

04 Beam Study Results of Linac (TS, ML)

Findings

Many beam studies have been conducted and the results are very impressive. The improvements toward future high intensity operation are promising.

The increase of the residual radiation at DTL1 was observed at 50 mA. The local envelope correction and the scintillation monitor measurements work very well, and the radiation source has been removed.

The residual radiation in the ACS linac was reduced by the aperture rearrangement last year. This year, the suppression of Intra-beam Stripping in the ACS was successfully performed with the lower transverse-longitudinal ratio lattice, T=0.7 at 50 mA and the residual radiation has been further decreased by 40%.

The beam study at 60 mA and 600 microseconds has also been carried out in this year toward 1.44 MW operation. Based on the measurements of the beam parameters, the mismatching to the RCS has been improved and the output emittance of Linac decreased, while curious behavior of the wire scanner is observed. Continuous efforts are desired.

Comments

- Because J-PARC is increasing beam power, it is increasingly important to understand the beam parameters more precisely for the reduction of the beam loss. It is required to promote information sharing among the beam study, the machine modeling including errors and the machine operation to understand the beam parameters in the limited time available.
- The design of MEBT1 should be carried out based on the beam study results of the Linac and simulation with machine modeling.

Recommendations

R7: Increase computer simulation and modeling efforts to enhance efficiency in beam tuning and machine operations.

05 Status of RCS (JT, AA, RZ)

Findings

The RCS has continued in stable user operation, delivering 500 – 530 kW beam to the MLF, ~500 – 510 kW for MR-FX to the neutrino (NU) experimental facility and ~50 kW for MR-SX to the hadron (HD) experimental facility. Availability for the RCS only has been very good, at ~99.0%. Operational beam power is currently limited by the neutron target.
Worker dose rates for JFY2019 summer maintenance work have been well managed, but it is noted that the higher doses are always near the injection area and that some improvement may be possible here. This is the intention of the proposed RCS injection area upgrade.

Hybrid Boron Carbon (HBC) stripping foils fabricated at the Tokai site (J-HBC) have been used in the RCS since October 2018. Each of the five J-HBC foils used in the RCS has survived for at least two months of operation at 500 kW. Since November 2019 a commercial graphite thin film (GTF) foil supplied by Kaneka has been successfully used in the RCS.

A successful high-power trial at 1 MW for 10 hours of continuous operation was held immediately before the summer shutdown. All components remained stable, beam losses were well controlled and increases in residual activation were as expected. Concerns raised in the previous 1 MW trial about deterioration of vacuum pressure in the RCS and foil durability have now been alleviated.

Further trials beyond 1 MW were carried out by increasing injection pulse lengths and I_{peak} at low repetition rate to produce up to 1.5 MW-equivalent bunches. The results indicated that the RCS has enough capability to accelerate 1.5 MW beam, provided the RF system is reinforced.

The possibility of implementing beam sharing between the pulsed parts of the J-PARC complex has been investigated in line with R9 from the 2019 ATAC Report. The operational mode to deliver beam simultaneously to the MLF and for MR beam study has already been established. However, it has been concluded that additional modes (e.g. MR (NU or HD) + 3NBT or MLF + MR + 3NBT) are not reasonable.

Comments

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

The J-PARC team has had great success producing J-HBC foils and continued use and development of the J-HBC foil remains their priority. However, the committee thanks them for following up on the advice to explore the possibilities of foils being produced commercially. The Kaneka-GTF foil looks like a promising option.

Trials at 1 MW and beyond are very encouraging and show continuous improvement year on year (1 shot in 2015, 1 hour in 2018 and 10 hours in 2019).

The measurements of residual dose rates after the 1 MW trial are difficult to compare with the typical values after 500 kW user operation because the cool down times before survey were very different in each case. Also, one of the typical measurements was actually taken inside the collimator shield, again making comparison difficult. Could this inconsistency be addressed in future?

Recommendations

None.

06 Beam Study Results of RCS (SW, SG)

Findings

Beam commissioning has been successfully performed. By the detailed and comprehensive beam study, with the injection beam current of 50 mA, a 1 MW beam operation at 25 Hz over 10 hours has been demonstrated. The beam power in the MR reached 500kW. By realizing pulse-by-pulse switching, the 1 MW mode can meet the different beam requirements for MLF and MR, and meanwhile, the beam loss was well controlled in the 1 MW beam operation.

The beam loss introduced by the new LLRF system was perfectly solved. By optimizing the tune and longitudinal parameters, the emittance growth and beam loss were well controlled.

Much higher beam intensity beyond 1 MW was tested, and 1.5 MW equivalent particle number was accumulated and accelerated to 0.8 GeV. It shows that, with sufficient RF voltage, the RCS can deliver >1.5 MW beam. This is encouraging, and far above the design beam power of 1 MW.

Comments

By optimizing the parameters of the secondary harmonic RF, the bunching factor was recovered to the previous value with the old LLRF, and the beam loss was also recovered. Is there room for further optimizing the longitudinal parameters and achieving much larger bunching factor? It is suggested to do the further beam study.

From the results of the beam commissioning for equivalent 1.5 MW beam, is there still potential for higher beam power? It is worthwhile to try much higher intensity, and find the space charge limit for J-PARC RCS?

Recommendations

None.

07 Status of MR (SG, WF, RZ)

Findings

The MR operated regularly at ~510 kW beam power for the neutrino users (FX extraction) and ~51 kW for the SX.

The MR operation suffered from two failures, in both cases due to interlayer short-circuits of the 3-50BT line magnet, a dipole and a quadrupole, both caused by a water leak at a brazed joint of one of the coil connections. Fortunately, FX users were able to fully recover their physics beam time, while SX users lost 2 weeks. In both cases no spare coils for the magnets were available. In contrast to the case of the dipole, operation could resume with one quadrupole less – the optics of the line have been changed to compensate for the lack of this element.

The dipole was replaced once the coil had been produced. The quadrupole will be replaced during a maintenance period in 2020, while two similar dipoles could eventually be preventively replaced. The brazing quality of the coil connections is in doubt after 10 years of operation.

The slow extraction regularly delivered beam power over 50 kW, with an efficiency of 99.5%. The beam was prepared up to a power of 63 kW, while the hadron hall target and the transfer lines were improved to receive up to 95 kW. The license to operate at higher power is not yet available from the authorities, and it will take some time to optimize the extraction and extraction lines at the beginning of the higher power operation period.

The mid-term plan of MR upgrade includes a long shutdown in 2021 for the commissioning of the new main magnet supplies, the installation of the new injection and extraction elements and the RF cavities.

An incremental increase in intensity is expected from 2022, after the long shutdown, first to reach the design 750 kW, and then up to 1.3 MW for the Hyper-K operation. During the shutdown there will be no user operation, i.e. between May 2021 to April 2022, and the FX will start again in May 2022 with 1.32 s cycles for the T2K operation.

The maximum power for the SX, once the new license will be obtained, will depend on how much losses can be reduced during extraction. For the time being, even a demonstration run with power above 50 kW is not possible due to the license, even if the target could receive larger beam intensities. It is noted that the maximum design power for the SX is 100 kW. While the Hadron experimental facility has been upgraded to a maximum power of 95 kW, regular ~100 kW operation also requires an improvement of the SX collimator and of the local shielding.

Comments

The regular operation of the SX with high availably and low beam losses is remarkable, as is the stable operation of the FX beyond 0.5 MW.

Recommendations

The two water leaks on two different magnets in such a short space of time is worrying. After 10 years of operation, it could indicate a first sign of a more general problem on the brazed connections for other magnets.

R10: Organize a verification campaign of the water-cooling circuits and electrical connections of the MR and 3-50 BT line magnets.

08 Beam Study Results of MR (SG, WF)

Findings

The MR successfully operated at 510 kW for the FX - with a record at 515 kW - and at 51 kW for the SX. SX operation at 63 kW has been demonstrated.

The collimation systems of the 3-50 BT transfer line and the MR have each been designed to cope with 2 kW of beam losses. For operation at 450 kW, losses in the 3-50 BT lines are limited to 100 W, whereas in the MR at 800 W.

In the MR, losses are localized in the collimation area and mainly limited to the injection energy.

Beam brightness increased thanks to an improved beam from the Linac and the optimization of the RCS, contributing to better transmission of the 510 kW beam. A better transverse emittance allowed also a reduction of chromatic correction.

The renovated LLRF feedback systems contributed to further loss suppression during acceleration, by effectively damping coupled bunch instabilities appearing for h=8 and h=10. In particular, the feedback system proved to be extremely effective, more than the feed forward one.

Tune tracking during the acceleration reduced losses in the collimation system even further.

More beam study time would be needed to better conclude on the losses appearing during the start of the acceleration.

Comments

A series of successful empirical studies and optimization led to good machine loss levels, even if further improvements are needed to reduce to less than 300 uSv/h at one foot for some of the non-collimation sectors.

Loss reduction at injection is achieved thanks to the introduction of an offset of some mm for the injected beam. Further studies are needed to improve the understating of the need of this offset.

Recommendations

Support beam studies by simulations. While beam observation and beam tuning periods are clearly improving the machine operation, these studies should be supported by simulations, also to guide beam study periods. This could help also to optimize the time required for beam tuning.

R7: Increase computer simulation and modeling efforts to enhance efficiency in beam tuning and machine operations.

09 Ring RF (JT, SG)

Findings

A full replacement of the LLRF for 12 cavities in the RCS was done in the JFY2019 summer maintenance period. The original feed forward system was upgraded to implement multi-harmonic vector RF voltage control feedback. In tests using 1 MW-equivalent beam more stable beam was achieved with the new system – wake voltages associated with higher harmonics are significantly suppressed and intensity effects (such as momentum deviation and timing variation of beam bunches) are well controlled.

There are some outstanding issues due to distortion in the amplifier chain. Consolidation of the chain is under careful consideration. Based on the beam loading compensation performance demonstrated at 1 MW it is anticipated that at higher beam intensities (1.5 – 2 MW) multi-harmonic vector RF voltage control feedback will work well with the proposed new cavities, which have a greater number of gaps than the existing cavities.

In the MR longitudinal bunch instability above 450 kW is a limiting factor for available beam power. It has been demonstrated that this instability is significantly reduced by multi-harmonic vector RF voltage control feedback at h=8 and h=10, which has been prototyped on the six main cavities, but not the two second harmonic cavities.

The longitudinal damper is still in the development phase and needs more work to become more effective, in particular for high intensity beams. The RF feedback system proved to be extremely efficient – better than the feed forward. Dipole coupled-bunch instabilities seem to be completely damped by the systems, whereas there are no traces of quadrupole longitudinal oscillations.

A complete new LLRF system for the MR will be constructed in JFY2020. This will implement multi-harmonic vector RF voltage control feedback on all cavities, including second harmonic.

The main limiting factor to increase the beam power further is given by the high-level RF, in particular from the driver amplifiers, whereas the LLRF seems to be sufficiently effective to assure beam stability during acceleration.

Comments

The introduction of multi-harmonic vector RF voltage control feedback in the LLRF for both the RCS and MR has been remarkably successful. The committee congratulates the J-PARC team on the progress they have made. This sets a clear direction of travel for the future of the ring LLRF systems at J-PARC.

In the MR, residual longitudinal oscillations are observed with a pattern which does not correspond to coupled bunch instabilities. The source could not be identified, at it seems that in the ring there are no sources of impedance that could cause these oscillations, and the phase loop seems to act correctly. Further studies should be pursued to understand the source of the oscillations and their possible intensity dependence.

Recommendations

R9: Resolve the remaining problems with distortion in the RCS amplifier chain; complete the development on the longitudinal damper of the MR for operations.

10 Machine Protection System (AA, WF, JT)

Findings

The presentation on the JPARC MPS showed the recent effort to accommodate and educate personnel on some general good practices of safety engineering, e.g. the STAMP/STPE process.

In addition, slides were provided describing the functions and layout of the MPS. A misunderstanding caused by ambiguity of the term "Run Permit" was revealed. Apparently, the J-PARC MPS system does provide functionality controlling the beam destination using hardware means. This should satisfy the Recommendation R3 in the previous report.

Several instances of MPS protection failure resulting in damage to the accelerator equipment were described in detail.

An event on 2016/02/25 was caused by a misfire of a magnet during an MPS initiated beam abort. The damage to the equipment was a result of a single misplaced beam pulse. Corrective action was implemented which reduced waiting time for an abort kick, thus reducing the probability of a magnet misfire during the waiting time.

An event of 2018/1/20 involved a failure of the primary MPS function to power up a magnet directing the beam to the MR. In addition, a secondary MPS protection mechanism to detect the misdirected beam failed as well. Damage to a vacuum window was a result of the incident. A trigger module hardware failure and a misconfiguration of the FCT timing gate are believed to be the causes of the failures.

Comments

An MPS failure to protect the machine from misdirected beam on 2018/1/20 opens a question of how the working condition of the MPS is ensured and tested. We did not receive a clear answer whether a formal process exists to document, approve and test changes and/or return from maintenance.

Recommendations

R8: Determine the root causes, engineering and administrative, of the three machine protection system malfunction events that occurred during recent years and develop mitigation measures that will prevent future occurrences.

11 Personnel Protection System (ML, TS)

Findings

A comprehensive presentation of the J-PARC PPS system which included explanations for the zoning, access policy and beam stop philosophy was given. It was clear from the presentation that J-PARC assures that the PPS system operates according to and in line with the regulatory bodies' rules and standards.

Comments

The committee felt assured that the PPS system is fully adequate and fulfils regulatory requirements.

Recommendations

None.

12 Answer to Recommendations on Spares (WF, JT)

Findings

In response to a recommendation from the last A-TAC, a list of major components, parts, failures since 2015 and estimated recovery time was presented. Components that presently have no spares were listed. The inventory lists are about 80% complete.

Since the last A-TAC two significant events happened in the 3-50BT transfer line. In one event a dipole magnet failed, requiring the manufacture of a new coil. In another event a DC quadrupole failed, which could be mitigated by changing the optics in the transfer line. The 3-50BT line is also vulnerable because it contains a pulsed bending magnet that has no spare and an old power supply.

Components with short and long MTBF have been identified, and in particular items that presently have no spares. These include in the Linac cavities except the RFQ and some magnets; in the RCS coils of DC magnets for the injection and extraction systems; in the MR quadrupole magnets in the 3-50 transfer line; and in the MR the magnetic septum for slow beam extraction.

The responsibility for cooling, electrical power and air conditioning is with the respective facility engineering groups. Some of these systems have redundancies. Some of the electrical power systems have shown signs of deterioration, for example due to exposure to saltwater.

Comments

A good spares policy balances the cost of mitigating substantial downtime with the cost of holding the spares inventory. The spares policy should support making full use of the large investment made in the J-PARC research facility.

The failure of the B15D magnet in the RCS to MR transfer line in March of 2019 illustrates the need to have a comprehensive spares inventory. The B15D magnet was a single point of failure, with no available spare magnet. A new coil had to be manufactured, for which material had to be acquired. The repair required rescheduling of the MR physics program, and the new magnet was installed in October 2019.

Although the responsibility for the technical infrastructure (cooling, electrical and air conditioning) is with the respective facility engineering groups, understanding the impact of failures in these systems and the available mitigation measures is necessary for an overall risk assessment.

The MTBF for systems can be estimated from the known MTBF of the components in some cases. This can be a valuable tool for systems like modulators or solid-state amplifiers.

The spares policy and a maintenance policy complement each other in maintaining the facility.

Recommendations

R4: Complete the inventory lists; evaluate the downtime risk from failures in the technical infrastructure, and estimate the funding need to fully implement a spare policy.

13 Upgrade of MR (SG, RZ, SW)

Findings

The upgrade of the MR towards 1.3 MW operation involves the reduction in FX cycle length by a factor of 2 and an increase in intensity of 30%. This requires the construction of new power converters for main dipoles and quadrupoles and the introduction of new RF cavities.

The new power converters are in construction and their noise is significantly improved (factor of 10) compared to the operational ones. Beam simulations showed a better beam survival at injection energy and at the beginning of the acceleration when power converter noise is reduced.

The RF cavities of the fundamental system will be increased in number over the years from 7 to 9 to 11. The number of second harmonic cavities will remain at 2, although they will be replaced with new ones. The RF anode current will have to be increased from 110 A to 140 A by adding new units to the existing anode power supply to make the increase in beam power available.

The injection and extraction elements (septa and kicker) will be changed to increase their repetition rate. In particular, the magnetic field of the new extraction magnetic septum is being optimized to minimize the leakage field. Also, the cooling of the matching box of the injection kickers is being improved.

The collimation system of the 3-50 BT line is already adapted for 1.3 MW operation, while that of the MR must be upgraded to go from a maximum loss of 2 kW to 3.5 kW.

The upgrade of the collimation system foresees the use of a scatterer as primary collimator and a secondary collimator to absorb the scattered particles (Scatterer-Catcher scheme). Tests at 450 kW beam power equivalent indicate an improved localization of the beam losses.

Losses generated by the collimation system have been simulated using a Geant4, to introduce proton interactions with the collimators, coupled with a tracking program. The loss pattern along the ring introduced by the collimators is quite well reproduced and only some sections of the machine require additional studies.

The expected losses for 1.3 MW operation, extrapolating from 515 kW operation, are of the order of 1.7 kW, and therefore they have to be reduced. Simulations and measurements show that the dynamic aperture was improved by compensating for one of the systematic third order resonances. The search for a new working point away from structural resonances in general also continues.

The system with two intra-bunch feedback dampers has proven effective for transverse instability, both in simulations and with first tests with a second less performant hardware newly installed in D1. A detailed campaign of intra-bunch instability simulations has begun, currently in simplified conditions with only 1 bunch, no space charge and a simplified impedance model. Improvements are planned for simulating 1.3 MW operation.

Comments

Simulation at injection and beginning of the ramp shows an expected reduction of the losses with reduced noise of the main power supply. Precise tune measurements at injection and during the ramp could indicate the effect of the noise on the beam and validate these results.

Impedance models of injection and extraction elements are in development. Particular care should be given to avoid any impedance increase in the MR that could prove detrimental for high intensity operation.

The simulation model of the collimation system should also include a realistic closed orbit, magnets and aperture mechanical alignments. Simulations could also be used to determine the best set up of the existing system.

Funds for instrumentation and the intra-bunch feedback system improvements are not secured.

In the beam commissioning, the RCS accumulated 1.5 MW equivalent particle number and accelerated to 0.8 GeV. This shows that the RCS is capable of providing 1.5+ MW beam power. With this particle number, the MR can reach 1.9 MW beam power with a cycle period of 1.16s. Will this be considered in the upgrade of MR?

Recommendations

None.

14 Status of MR Power Supply (WF, RZ)

Findings

The existing main dipole and main quadrupole power supplies will be replaced with new power supplies that include capacitive energy storage and allow reduction of the FX cycle time from the present 2.48 sec to 1.3 sec in JFY2022, and 1.16 sec in JFY2025 after the installation of additional RF power. With these upgrades the MR beam power can be increased to more than 1 MW.

A test of 2 out of 6 new power supplies for the main dipoles has been completed. In the test both the FX (1.3 sec cycle time) and SX (4.2 sec cycle time with 2.61 sec flattop) were run, and the power supplies ran over 50 h. Only small differences between the two power supplies were measured. In addition, the current ripple was measured over the operating cycles, and was shown to be 10× smaller than the existing power supplies. This had also been shown for the new main quadrupole power supplies.

An online measurement of the capacitance of the capacitor bank has been developed that can detect a change of 1%.

4 of the 6 new main dipole power supplies were manufactured, and the production of the smaller power supplies will start when funding becomes available. The installation of the power substation for BM and large QM is scheduled for the end of JFY2021.

Comments

The MR power supply work followed the plan outlined in the past, and the new MR power supplies made significant progress since the last A-TAC.

With both the FX and SX cycles tested and run over 50 h, and a demonstrated 10-fold reduction of the current ripple throughout the operating cycles compared to the existing main power supplies, the performance parameters have been established.

It is now necessary that the manufacturing of the remaining power supplies remains on schedule, and that these too perform at the same level. This requires quality assurance over the production period.

Recommendations

None.

15 Linac (MEBT1) Upgrade (AA, ML, TS)

Findings

A design change of MEBT1 is proposed to improve the beam dynamics and provide additional beam diagnostics. The new design includes an additional buncher cavity and a Beam Shape Monitor. The MEBT length will increase by 0.5 m with a shorter RFQ to make the total beam line length the same.

A result of the RMS beam emittance measurement at the linac exit vs. buncher 1 amplitude was presented.

A 4-step, 4-year long development plan was presented.

Comments

No experimental evidence was presented that the current MEBT1 design is insufficient for properly matching the beam to the DTL in all 3 planes. The transverse RMS beam emittance at the linac exit is considered as the main parameter for the optimization but the beam loss in the linac due to improper matching is by far more important. A relation between beam halo and RMS emittance is in general not obvious.

A new Beam Shape Monitor is proposed to measure the longitudinal beam profile. There is already an RF deflector to achieve this purpose. An explanation that the RF deflector requires 6 hours to make a measurement is not satisfying – a BSM operates on the same principle and will require the same time.

The exact reasons for adding a buncher were not presented. One reason for using 3 bunchers is that the first buncher is used for minimizing the longitudinal beam size in the chopper. Considering the small distance between buncher and chopper, it should be not efficient to control the bunch length in the chopper by using the first buncher. It is suggested to do the simulation to check this point, and also beam study to find the reason for imperfect chopping.

It appeared in passing in the presentation that the new RFQ is shorter than the previous designs and will require a new longer MEBT regardless of the beam dynamics considerations.

Recommendations

R11. Present results of the beam dynamics simulation and the experimental study providing compelling evidence the proposed MEBT1 design changes will improve the linac performance. Present a detailed plan on how the shorter RFQ will be incorporated into the existing machine.

16 RCS Upgrade (SW, JT)

Findings

The hottest part of the RCS is the injection area, and the beam loss due to the foil scattering is the intrinsic. Many efforts have been made to control the workers' radiation dosage.

The upgrade of the injection area has been planned and investigated. By re-design of the two chicane bump magnets some space will be saved for installation of additional shielding.

A back-up shielding scheme has also been proposed and investigated, which can be performed at small cost, and without any risk.

Comments

The back-up shielding should be constructed as soon as possible. The effectiveness of back-up shielding is an important prerequisite to decide the performance of the injection upgrade.

The upgrade is a big step, and the only advantage is to save the space for shielding. Before going ahead with the upgrade the benefit remains to be investigated further and the possible beam dynamic risk should be avoided.

The source of the beam loss is clear, and with the proposed structure the simulation results will be one of the factors to decide whether to go ahead with the upgrade. The simulation for the different conditions – without shielding, with backup shielding and for the upgrade scheme – should be done and compared with the measurement results for the first two cases.

Even with the upgrade of the injection area and the improvement of some of the hot spots, the dose rates will still be far beyond the normal manual maintenance threshold of 1 mSv/hr. Besides strengthening the shielding another option is using a mechanical arm or robot to reduce the requirement for direct manual maintenance. Most of the manual maintenance works, such as component disassembly and installation, can be displaced by mechanical arms or robots.

Recommendations

R16: Consider development of mechanical arm and robot technology for disassembly and installation of high dose rate components in the injection area.

Homework 1: Staffing of J-PARC Accelerator Division (ML)

Findings

The J-PARC accelerator division consists of some 120 engineers and technicians. This number does not include utilities, operation and staff contracted for maintenance periods. The JAEA and J-PARC staff are grouped separately. The age profile which is biased to the 50-60 age bracket is an overall concern and is much worse on the JAEA side. There are a number of students working at J-PARC, typically 1-2 per group. The Engineer-Scientist/technician ratio is heavily biased towards a larger number of engineers and scientists. A very moderate rate of re-hiring has started on the JAEA side. The KEK side have in general had a better re-hiring rate.

Comments

- The total number of staff in the Accelerator division is low compared to similar facilities, especially if one considers that J-PARC operates the Main Ring in addition to the linac and the RCS.
- The age profile is a major concern as this could result in the sudden and quick loss of key competences. This is especially true for the JAEA side of the division.
- The low number of technicians is a concern. The continuous replacement of technicians as contracted staff means that time is lost for the re-training of new technicians and the possible loss of key skills for accelerator specific maintenance work. However, there is a general trend at accelerator facilities to have more engineers than technicians as modern accelerator systems with high complexity and a high level of digitalization require higher training for the staff that maintain them. Some US labs have introduced the term “field-engineer” to cover this kind of position.

Recommendations

R1: Develop a list of expertise subjects pertaining to J-PARC’s strategical future missions; develop plans to attract, retain and grow mission-critical subject-matter experts.

R2: Recruit new accelerator staff to address issues of staff aging, imbalance, and work demands.

Homework 2: Machine Protection System Malfunction Details (AA, WF)

Findings

Detailed explanations were given on what part of MPS did not function for the cases described in slides 26 and 28 of talk 10.

An event on 2016/02/25 was caused by a misfire of a magnet during an MPS initiated beam abort. The damage to the equipment was the result of a single misplaced beam pulse. Corrective action was implemented, which reduced waiting time for an abort kick thus reducing the probability of a magnet misfire during the waiting time.

An event of 2018/1/20 involved a failure of the primary MPS function to power up a magnet directing the beam to the MR. In addition, a secondary MPS protection mechanism to detect the misdirected beam failed as well. Damage to a vacuum window was a result of the incident. A trigger module hardware failure and a misconfiguration of the FCT timing gate are believed to be the causes of the failures.

Comments

An MPS failure to protect the machine from misdirected beam on 2018/1/20 is quite troubling. How can one be sure a similar event doesn't happen again at the same or other place? We did not receive a clear answer whether a formal process exists to document, approve and test changes and/or return from maintenance.

Recommendations:

R8: Determine the root causes, engineering and administrative, of the three machine protection system malfunction events that occurred during recent years and develop mitigation measures that will prevent future occurrences.

Homework 3: Radiation Control of Dispersive Material (TS, SG)

Findings

A comprehensive description of radiation control of dispersive material (e.g. ground water activation, air activation, sky shine, tritium production) at J-PARC was given.

J-PARC always monitors radioactive dispersive material and has a more strict radiation control regulation than that required by law. Some radiation monitors are linked to the interlock system to stop the beam. The regulations are revised by the decision of J-PARC and negotiation with local government.

Comments

The committee has confirmed an adequate method for the radiation control of dispersive material and a strict process for change and approval.

Recommendations

None.

Homework 4: Budget Profile of J-PARC (JW)

Findings

The operations budget profile of J-PARC was presented to the A-TAC committee with a breakdown between KEK and JAEA. With the total budget flat over the past three years, the total KEK budget has declined. The maintenance budget for KEK was significantly reduced in JFY2019 to fund the Main Ring upgrade, which costs about 20% of the annual operations budget.

Comments

The significant reduction of maintenance budget of annual operations will inevitably compromise the reliability, availability, progress in reaching the full design capacity, and user time of accelerator systems covered by KEK's operations scope. The committee has seen evidence of consequences as reflected in this report.

Recommendations

None.

Appendix 2 – Agenda

Agenda for A-TAC2020 (Q&A included for each report) 2020/2/13

February 24, Monday Venue: a conference room on the 2nd floor of the J-PARC Research Building

Time		Period	Category	Title	Speaker	File Name
8:00		*Departing the hotel, "Terrace Inn Katsuta", for J-PARC*				
8:40	9:00	0:20	Time for LAN Connection	*(+20minutes for registration at the JAEA gate)*		
9:00	9:15	0:15	**Executive Session**	*Closed*		
9:15	9:55	0:40	**Project Status**		N. Saito	
9:55	10:25	0:30	**Accelerator Overview**	J-PARC accelerator overview	K. Hasegawa	
10:25	10:55	0:30	**Coffee break, Group photo**			
10:55	11:25	0:30	**Status & Commissioning**	Status of Linac	H. Oguri	
11:25	11:55	0:30		Beam Study results of Linac	Y. Liu	
<< lunch >>		1:05	*Lunch will be served.*			
13:00	13:30	0:30	**Status & Commissioning**	Status of RCS	K. Yamamoto	
13:30	14:00	0:30		Beam Study results of RCS	H. Hotchi	
14:00	14:30	0:30		Status of MR	F. Naito	
14:30	15:00	0:30		Beam Study results of MR	Y. Sato	
<< coffee break		0:20				
15:20	15:50	0:30		Ring RF	F. Tamura	
15:50	16:20	0:30	**Safety System**	Machine Protection System	N. Yamamoto	
16:20	16:50	0:30		Personnel Protection System	K. Niki	
16:50	17:20	0:30	**Spares**	Answer to recommendation on spares	M. Yoshii	
17:20	17:50	0:30	**Executive Session**	*Closed*		
<<Reception>> 18:00 - 19:30 at the KEK 1-gou kan						

February 25, Tuesday

8:00		*Departing the hotel, "Terrace Inn Katsuta"*				
8:40	9:10	0:30	**Executive Session**	*Closed*		
9:10	9:50	0:40	**MR upgrade**	Upgrade of MR	S. Igarashi	
<< coffee break		0:20				
10:10	10:40	0:30		Status of MR power supply	T.Shimogawa	
10:40	11:10	0:30	**Li/RCS upgrade**	Linac (MEBT1) Upgrade	K. Okabe	
11:10	11:40	0:30		RCS Upgrade	J. Kamiya	
<< lunch >>		1:20	*Lunch will be served.*			
13:00	17:10	4:10	**Executive Session**	*Closed*		
<< dinner >> 19:00 - 20:30 at the restaurant in Katsuta						

February 26, Wednesday

8:00		*Departing the hotel, "Terrace Inn Katsuta"*				
8:40	10:30	1:50	**Executive Session**	*Closed*		
10:30	11:30	1:00	**Recommendations to J-PARC**		J. Wei	

adjourn

Tour(optional)