Report from the
9th Meeting of the Accelerator Technical Advisory Committee for the Japan Proton Accelerator Research Complex (J-PARC)

March 11 - 13, 2010
J-PARC Center
Tokai, Japan

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Overview

The Accelerator Technical Advisory Committee (ATAC) for the J-PARC Project held its ninth meeting over the period March 11-13, 2010 at the J-PARC Center in Tokai, Japan. This report of ATAC was presented to the Meeting of the International Advisory Committee (IAC) on March 14, 2010.

ATAC members in attendance at this meeting included: J. Galambos (SNS), D. Findlay (RAL) R. Garoby (CERN), S. Holmes (Fermilab), A. Noda (Kyoto), P. Ostroumov (ANL), T. Roser (BNL, chair), J. Wei (Tsinghua Univ.)

U. Ratzinger (U. Frankfurt) was unable to attend.

The ATAC wish to express its appreciation to JAEA and KEK management and support staff for their hospitality during this meeting, and to the J-PARC staff for their excellent and comprehensive presentations. The Committee also greatly appreciates that the J-PARC team has carefully addressed all recommendations from the last review.

- J-PARC completed the construction of phase 1 in 2008 and, since then, steadily increased its performance and delivered beams for a growing user community:
    - The construction schedule and performance ramp-up followed plan from 2005 quite accurately. This is a great success.
    - Many firsts during the last year: first Kaon and neutrino production, first 300 kW beam power from RCS for 1 hour, first neutrino event at SuperKamiokande
    - After resolving RFQ break-down issue continuous operation with 120 kW beam power to MLF; 9 neutron beam lines in operation and, 3 in beam commissioning, 3 under construction, and 3 more are funded from a total of 23 possible beam lines.
    - About 10 hadron experiments have been approved serving about 200 users

- Beam power achieved:
  - RCS: 120 kW; 300 kW for 1 hour test
  - MR: ~ 30 kW for fast extraction; ~ 2 kW for slow extraction
- Beam power plan for the future:
  - By 2012: 300 kW for RCS, 400 kW for MR FX, 20 kW for MR SX
  - Linac Energy Recovery construction completed and installed by the end of 2012 (65 Oku Yen in hand, need additional 30 Oku Yen)
  - Request 90 Oku Yen equipment funding for Linac, RCS and MR to reach design performance (1 MW @ RCS, 750 kW @ MR) by 2014 (2 year delay for RCS)
- Plan to increase operation to more than 200 days and pursue more beam lines for
  - Muon facility (1/4 funded)
  - MLF neutron facility (18/23 funded)
  - Hadron facility (several Kaon beam lines and primary beam line)
  - Available funding is 71% of 200 day operations

<u>Comments and recommendations:</u>

- J-PARC is now serving four user groups: muon, neutron, neutrino, and hadron beams. At the same time extensive machine commissioning is required and there is an ambitious upgrade program.
- Continuing commissioning and operation of J-PARC Phase 1 as well as completing the upgrade plans over the next few years will be very challenging.

> **Rec. #1: A detailed schedule should be developed to coordinate the commissioning and upgrade efforts with the user requirements and expectations for machine operations. The schedule for some of the performance improvement and upgrade plans may need to be extended to accommodate the steady production periods requested by the users.**

<u>Operations and Power Projections</u>

The entire J-PARC complex is now in an operational state. Beam is being provided routinely to the Materials and Life Sciences Facility from the RCS at a level of 120 kW, and from the MR to the neutrino target at 30 kW, and to the hadron experimental area at 2 kW. Planning has been initiated for a program to achieve the full Phase I goals for the J-PARC facility.

Primary Achievements

- 120 kW of beam to the MLF on a routine basis
  - 12 neutron and 1 muon beamline in operation
  - 300 kW of beam from the RCS demonstrated for one hour
- 30 kW of beam at 30 GeV to the neutrino target on a routine basis
  - First observed neutrino events in near and far T2K detectors
  - Single pulses accelerated and extracted from MR at intensities corresponding to 100 kW
- 2 kW beam at 30 GeV slow extracted beam to the Hadron Area (6-bunch operation)
  - Three beamlines commissioned
  - 98.5% efficiency, 11% duty factor
- Many technical issues either resolved or significantly mitigated in last year
  - RFQ
  - Ring RF systems
  - MR power supply system
  - MR slow extraction system
- Accelerator availability of 92% over last three month
- Planning initiated on multi-year program to achieve, and then exceed, original J-PARC goals

Comments and Recommendations

- User priority over next five years is identified as stable operations
- Goals for JFY2010
  - RCS: 200 kW operations (routine)

    - MR Fast Extraction: 100 kW (routine)
    - MR Slow Extraction: 5 kW (routine)
    - 200 days of machine operations including accelerator studies
- Residual activation is being monitored in all machines and beamlines
    - Measurements are being done periodically, and all presented measurements are on contact

    R2: Establish an activation-monitoring plan that provides the information required to connect with beam loss simulations, provide projections into the future, and assure that equipment can be maintained without unacceptable dose to workers.

- Spares queues are being built up per prior ATAC recommendations
    - Spare RFQ
    - Spare klystrons
    - Spare ring rf cavities
    - Still no overall strategy on spares

    R3: Establish a spares strategy based on a risk analysis incorporating mean time between failure (MTBF), performance impacts of failures, fabrication/procurement lead times, costs, etc. Such a strategy should be used as a basis for establishing the spares component of the operations budget.

- Beam loss mechanisms in the RCS and MR are not well understood at the moment. It is critical to understand these mechanisms, as these will form the basis for the upgrade plans.

    Rec. #4: Pursue studies aimed at characterizing and understanding losses observed in the RCS and MR at the highest beam intensities possible.

- Projected performance goals for RCS and MR are now available through JFY2014

  - Achieves original J-PARC Phase 1 goals: RCS=1.0 MW, MR=0.72 MW
  - MR performance goal is dependent upon RCS achieving its performance goal
  - Slow extracted beam power exceeds 30 kW
  - Assumes linac upgrade to 400 MeV completed in JFY2012
  - Continues operations of MR at 30 GeV through the period
  - Upgrade to 50 GeV is not strongly motivated at this point, and appears to be difficult due to magnet saturation
- Primary elements of the upgrade plan
  - Ion source to 60 mA
  - RFQ to 50 mA
  - Linac to 400 MeV/50 mA
  - Upgrade of the RCS injection to 400 MeV
  - Improvements to MR power supply system to support shorter cycle time
  - Second harmonic cavities in MR
  - Aperture improvements in the MR injection and fast extraction area
  - Collimator upgrades in 3-50 BT and MR to multiple kWs
- The ATAC finds the overall approach to achieving Phase I goals as generally plausible, and offer the following comments and recommendations to establish this plan on a firmer footing:
- The Linac Energy Upgrade is well underway, but 30 Oku-yen of funding still to be secured
- The MR slow extraction goal is less than user expectations.

Rec. #5: Continue simulations of slow extraction in the MR including all known beam intensity dependent effects.

Rec. #6: Prepare a strategy for managing losses in excess of a few kW in the extraction region.

- Planning for operation of the RCS with 400 MeV injection has been focused almost entirely on the upgrade to the injection area. There is a need to analyze all aspects of the RCS in terms of the increased beam intensity
- Planning for the MR 720 kW upgrade is based on a preliminary concept and supporting simulations have been initiated. Plans are being made to upgrade the collimators for a 10% beam loss at injection (~ 7kW). This is based on space charge simulation and also is reasonable, based on scaling from similar machines.
- Preliminary concepts for 1.7 MW from MR are based on reduction of cycle time to 1.0 sec. In addition to power supply and RF upgrades this would likely also require a further upgrade of the collimators.
- The plan for the MR relies on success in achieving 1 MW in the RCS. However, if this achievement were to be delayed there may be other options for providing 720 kW from the MR including: further reduction of the MR cycle time, increasing the MR operating energy, and stacking of more than four RCS cycles in the MR. The committee suggests continuing consideration of such options.
- The upcoming five year period will involve accelerator operations, accelerator studies aimed at providing short term improvements and to support longer term improvement strategies, installation and commissioning of the linac energy upgrade, and a number of further installations required to support the final goals. Careful planning will be required in order to deliver the maximum integrated beam power to the users over this period.
- A complete operations plan is desirable including the following elements:
    - Estimates of peak performance in the RCS and MR by year
    - Estimates of the integrated beam power delivered from the RCS and MR by year
    - Estimates of the integrated hours of beam on target for users and accelerator studies by year.
    - Estimates of commissioning time required following the linac upgrade.
    - Estimates of the expected availability by year.
    - Estimates of required resources to support the plan by year.

Rec. #7: The existing operations plan should be further developed to include the above-mentioned elements. This plan should include input from the user community.

- A complete upgrade plan is needed, incorporating the following elements:
  - Parameter tables for each ring, including all relevant beam and machine operational parameters. These parameter tables should be modified as operational or development activities indicate the need for changes.
  - Complete beam simulations should be pursued to guide the evolution of the above parameter table.
  - Complete consideration of potential beam instabilities.

Rec. #8: The operations plan should be augmented by a technical upgrade plan that describes the configuration of the complex, and associated performance goals through the upgrade period.

Linac Status

Primary achievements

- Successful RFQ recovery program.
- Successful support of RCS and MR beam operations
- Compared to one year ago, the linac team has made tremendous progress, and the linac is able to supply adequate beam to support operations and beam studies of downstream accelerator systems.

Comments and recommendations

- Attention has been given to the issues highlighted by the ATAC-09 review.
- The RFQ conditioning issue has been attacked on many fronts, and the results show dramatic improvement in the ability for the RFQ to run for extended periods. Many modifications have been applied (additional pumping, restricted aperture,

elimination of oil contamination sources, etc.), and there is a better understanding of the problem provided by monitoring of vacuum and RGA measurements.

> **Rec. #9: Consider trying to operate the RFQ longer than the one-week period successfully demonstrated to date. This could possibly be done during beam study time. If successful, this will allow more freedom in scheduling production hours for the user facilities.**

- A number of operational hardware issues have arisen and are being dealt with appropriately (e.g. vacuum seals, water flow balancing). This is a natural part of a machine operation power ramp-up.
- The klystron lifetime of 25,000 hours is being approached (~ half) and some evidence of RF performance change was presented. The quoted klystron lifetime seems short as compared to the experience at other installations, but an active monitoring of the RF performance system is being done and should be continued.
- A new spare RFQ with similar beam performance specifications as the present RFQ is being prepared. This is an important effort to ensure reliable beam production and to enable higher intensity beams for RCS studies. However, the suggested completion date of Nov. 2010 is optimistic.

> **Rec. #10: Develop a more detailed resource loaded schedule for the new RFQ, including testing. One particular concern is the proposed horizontal brazing scheme. Care should be taken to maintaining high vane tip positioning accuracy for horizontal brazing.**

- The ion source capability is adequate for present day operation and has been demonstrated to support 300 kW operation (15 mA at 0.5 ms). Nonetheless, there is a need to demonstrate higher capability for the ultimate 1 MW scenario (up to 60 mA). More aggressive efforts with test stand ion source studies should be pursued. Also, the rather long source changeover time of 3 days was identified as a limitation. This will impact the hours one can supply beam to users eventually and should be addressed.

Rec. #11: Have the ion source test stand operation be monitored by the central control room to facilitate 24/7 operation for extended tests, as is done at other facilities.

Rec. #12: Investigate means to reduce the source changeover time (examine techniques at other facility).

- A primary machine activation mechanism was identified as H+ production in the LEBT, which was fully accelerated and lost at the first bend. A clever chicane scheme with appropriate scraping has remedied the problem and clearly identified the issue.
- Beam losses measurements in the ACS upgrade area of the Linac have been performed for two different vacuum pressures. These experiments clearly demonstrate beam loss increase in the ACS area when the pumps are off in the SDTL linac.

Rec. #13: Additional studies are required to understand whether this effect is a dominant source of the losses in the ACS area. Measure the beam loss as the vacuum pressure is progressively increased.

- Extensive beam studies were presented. There is an un-identified RMS emittance growth in the DTL, but no apparent halo is generated. In the SDTL no further RMS emittance growth is observed but beam halo is generated. A matching scheme has been developed that uses empirical MEBT RF adjustment to minimize halo at the end of the SDTL. Model comparisons suggest this is due to a longitudinal miss-match and coupling to the transverse plane. Interestingly, beam loss at the end of the SDTL is insensitive to the reduction of the observable beam halo.

- Beam loss is sufficiently low for present day operation, but the loss at the future ACS upgrade region is a concern for higher power operation. This loss appears to be insensitive to normal tuning adjustments.

Rec. #14: Continue both theoretical and experimental studies towards the reduction of beam losses in the ACS area: study longitudinal beam parameters with available equipment (e.g. consider acceptance scans)

and consider implementing additional longitudinal measurement techniques.

Rec. #15: Consider implementing an RF subtraction scheme with the BLMs in the linac.

3 GeV Rapid Cycling Synchrotron

Primary achievements

- Running the RCS routinely at 120 kW.
- Demonstrating operation at 300 kW.
- Carrying out an extended programme of machine physics measurements.
- Establishing the extent to which the synchrotron and its systems are becoming activated due to beam losses.
- RF systems are adequately supporting operations.
- The RCS team are to be thoroughly congratulated on making the operationally important transition to a régime of routine running.

Comments and recommendations

- The RCS team have addressed the issues highlighted by the ATAC-09 review.
- Although several significant issues have been highlighted by the RCS team, most of RCS systems must have run well, *e.g.* the power supplies for the main magnets and the high-power RF drivers, and this success certainly deserves recognition.
- Operation for 1 hour at 300 kW was achieved, which is good for demonstration of the beam stability at this intensity. However 1 hour is a rather short time to run at such powers.

Rec. #16: The RCS should be carefully run at 300 kW for periods longer than 1 hour to help reveal any latent problems and weaknesses.

It could also be worthwhile to increase incrementally the beam power above the nominal level on some run cycles by ~ 10%, if possible, and to note any resultant changing trends in activation.

- While the RCS team have successfully carried out effective and extended programmes of machine physics measurements, both for themselves and for comparison with beam dynamics simulations, much remains to be done.

  Rec. #17: Sufficient time should always be made available for comprehensive programmes of machine physics measurements.

  Work remains to be done to optimise settings of trim quadrupoles and other correctors to compensate for inevitable imperfections in the lattice, and also to enhance performance by suitably varying the tunes throughout the acceleration cycle. Such work inevitably depends on the availability of extended periods of running at the higher power settings.

- Much effort has been devoted to measurement of dose rates from radioactivity induced in machine structures by beam losses. No doubt, in view of the relatively short time the machine has been running, there are day-to-day and cycle-to-cycle variations in the measured dose rates, but gradually over time the systematics of the dose rates should become apparent. It should be remembered that it is radiation doses to personnel, not radiation dose rates *per se*, that are important, and that often appropriate engineering design can be used to partially offset effects of radiation dose rates.

  Rec. #18: Systematics for dose rates at 30 cm from contact should be established as well as for dose rates on contact.

  Eventually it may become worthwhile to install a set of long beam loss monitors all around the ring some ~1–2 metres from the beam line to provide a consistent measure of radiation dose rates in practical working environments.

- It is clear that there are substantial uncertainties at injection into the RCS, and that much work remains to be done over optimising injection schemes, particularly with regard to stripping foil configurations, to help make progress towards higher beam powers.

> **Rec. #19: The proposed programme of measurements for different painting regimes and for different geometries and thicknesses of stripping foils is encouraged. A range of foil sizes, rather than just two sizes, should be considered for installation and testing at the next foil-change opportunity. Also considered should be a diagnostic system to provide direct information of the linac beam spot on the foil (*e.g.* a thermal imaging camera for high power operation, or a phosphor screen "foil" for low intensity usage).**

> **Rec. #20: Further measurements should be made to provide a more detailed picture of beam loss mechanisms at injection (*e.g.* by making measurements using a fast local beam loss monitor to distinguish between losses arising directly from the injected H^- beam and the circulating H^+ beam).**

- It is especially important to understand thoroughly the beam dynamics at injection if the full benefits of injection at 400 MeV from an upgraded linac are to be gained.
- The acceptances of the beam lines to the neutron producing target and to the Main Ring (MR) are different. Could a scheme be devised to "vary" collimation on a pulse-by-pulse basis, perhaps by incorporating beam bumps?
- Problems have been encountered with the RCS extraction kickers; electrical breakdown has occurred in the plugs connecting the coaxial cables from the kicker drivers to the kicker vacuum vessels. The committee supports measures that are being taken to resolve the breakdown problems.

Main Ring Synchrotron

Primary Achievements

- Successful beam delivery to neutrino (NU) beam line (up to 32 kW) and hadron (HD) beam line (2-3kW) has been accomplished. Operation with the beam power up to 100 kW for NU was also demonstrated.
- First neutrino event has already been detected on site on November 22nd, 2009, and at SuperKamiokande on February 24th, 2010.
- Beam is delivered to Hadron Experimental Hall

Congratulation to all members of the MR team and related groups

Comments and recommendations

- Total injection beam loss amounts to 105 W for 100 kW MR operation.

  Rec. #21: The beam halo development just after transfer from RCS to MR should be carefully studied up to highest beam intensity achievable.

- Beam loss at the slow extraction equipment area is observed together with a vacuum pressure rise when operating with higher beam intensity. The vacuum pressure rise is reduced after some hours of beam operation.

  Rec. #22: The beam loss during acceleration might be due to electron cloud. This should be investigated with appropriate diagnostics.

- Slow beam extraction has been achieved with beam power up to 3 kW and with duty factor up to 11 % using spill feedback and shorted trim coils of the ring quadrupoles. The duty factor is further increased to 15 % by application of RF noise, which increases the horizontal transverse motion. The extraction efficiency is estimated to be 98.5 %.

  Rec. #23: To raise the available beam power with slow extraction and improve the duty factor to larger than 50 %, other possible schemes such as RF knockout to increase horizontal beam emittance or the slow extraction scheme used at the BNL/AGS should be investigated.

- A new main magnet power supply is being designed to increase the repetition rate of the MR. This offers the opportunity to incorporate further measures to reduce ripple at flat top.

Rec. #24: Consider a dedicated low voltage supply for improved current regulation at flat top and flat base.

Rec. #25: The beam loss during slow beam extraction should be carefully investigated and compared to reliable simulation codes that include high intensity effects.

- Realization of 0.72 MW beam power for fast extraction with 30 GeV is to be realized by the supply of 1MW beam from RCS with the 400 MeV linac beam energy upgrade by the end of 2014.

Rec. #26: For the purpose of beam loss reduction, the beam characteristics near the end of 3-50 BT line should be evaluated with measurements of beam profile and momentum spread.

RF Systems for the Synchrotrons

Primary Achievements

- The performance of the FineMet loaded cavities in both synchrotrons is still a subject of concern. Large efforts are being invested to understand and cure the observed problems in the short term.
- For the long term, alternative solutions are studied, and preliminary ideas for increasing the gradient are investigated.
- As a matter of fact, the present difficulties do not impact on the operation of the J-PARC complex. The reliability of the synchrotrons RF systems is continuously improving and contributes clearly to the regular progress in performance of the whole J-PARC complex.

<u>Comments and recommendations</u>

- Status of investigation on the degradation of RCS uncut FineMet cores:
    - Impedance reduction in the RCS cavities has been intensively studied: out of the 90 cores analyzed, 25 showed buckling with 2 having degraded impedance.
    - Buckling is clearly correlated with a specific preparation process, based on impregnation with low viscosity epoxy resin.
    - A “flawless” preparation process is identified (“type C”). New cores are being built to replace the ones prepared with other techniques.

- Recently observed degradation of MR cut cores:
    - Impedance reduction has been observed in all cavities since the summer of 2009.
    - This effect is understood as related to a degradation of the surface of the cuts. Initial characteristics can be recovered by exposure to air and/or polishing.
    - In the short term, cavities will be systematically opened and core cuts polished during ordinary shutdowns.
    - For the longer term, silica coating is being studied.

    Rec. #27 (for RCS and MR): The ATAC fully agrees with the procedure and with the high priority given to this work by the J-PARC management. Moreover, the Committee underlines that systematic monitoring of the characteristics of the cavities remains essential to detect as early as possible any future source of trouble.

- Independent analysis of FineMet loaded cavities and search for alternative solutions:
    - Computations and mechanical tests can largely explain buckling.
    - The use of “raw FineMet” immersed in a chemically inert cooling fluid is advocated.
    - A test set-up is being assembled to demonstrate performance of such a solution on a single core assembly.

Rec. #28: The committee confirms its support of the investigation of this alternative scheme. If the test is successful it should be considered whether a complete cavity that uses the alternate cooling fluid is built and installed in the ring.

- Possibility to increase the accelerating gradient:
  - More voltage will be necessary to reduce significantly the MR cycling time and reach beam power beyond 0.72 MW. A new FineMet preparation scheme is proposed that could increase the impedance of the cores.
  - Preliminary development proceeds without interfering with the more urgent work programs.

Rec. #29: This proposal has a high potential interest, either to increase the voltage for a given RF power, or to reduce dissipation for a given voltage. The ATAC encourages this development.

Linac Energy Upgrade

Primary Achievements

- Procurement and fabrication of major components of the 400 MeV Energy Upgrade are being performed according to the original schedule:
  - Contract has been placed for fabrication of all accelerating modules except the debuncher modules.
  - Procurement of 972 MHz klystrons is on schedule and 16 klystrons will be delivered by the end of 2010.
- The R&D module consisting of accelerating and coupling segments with tuners has been built and successfully tested at design power level.
- All recommendations of the ATAC-2009 sub-committee on Linac Energy Upgrade are being implemented:
  - 3 BSMs will be ordered,

- BPMs are being modified for the TOF measurements,
- BLM detectors are being developed,
- Extensive beam dynamics simulations are in progress.

- Development of the beam diagnostics system for the 400 MeV energy upgrade is well advanced and all components of this system will be delivered by the end of 2011.
- A high-power test area of the ACS modules is being prepared and a few accelerator modules will be ready for the tests by the fall of 2010.

<u>Comments and Recommendations</u>

- Off-line high-power tests of the ACS module have been successfully performed. These tests validated fabrication technology based on simplified machining of the accelerating cells developed for the mass production of the ACS accelerating cells. In addition, operation of the tuners at high-power level has been successfully demonstrated.

Rec. #30: Additional measurements are recommended during high-power tests of each ACS module prior to beam commissioning:

i. **Take measurements of the frequencies of nearest two modes at high-power level with the goal to confirm correct tuning of the dispersion curve. For some modules it may require fine-tuning to avoid accelerating field distortions at high-power level.**
ii. **High-power conditioning should be continued until the design value of the residual gas pressure at full RF power level will be achieved. It is reasonable to estimate the residual gas pressure in the accelerating cell aperture from its relationship to the vacuum gauge reading. This will help to control H-minus stripping by the interaction with the residual gas.**

- There is progress in end-to-end beam dynamics simulations including the 400 MeV upgrade section and beam transport to the RCS. Following the recommendation of the ATAC-2009, the effect of various machine errors on 50-

mA beam parameters has just begun to be investigated. Simulations with very low statistics have already revealed significant increase of the emittance containing 99% particles in the transverse phase space even though the input emittance was lower than the measured beam emittance. The study of beam losses in the high-energy section is the part of the beam dynamics simulations. Current operation of the linac reveals appreciable beam halo formation after the DTL-SDTL. There is a unique opportunity at the J-PARC linac to implement beam collimators at the MEBT-2 due to the fact that sufficient space is available.

Rec. #31: Continue high-statistics simulations with all machine errors with the goal to deliver high-current beam parameters to the RCS stripping foil according to the design specifications. Following the positive SNS experience, consider implementation of a beam collimation system between the SDTL and ACS. Include the effect of collimators into the computer simulations.

- Tentative plan for procurement and installation of the Energy Upgrade equipment has been developed, which shows that the final installation and beam commissioning will take place within 6 months during the second half of 2012. This schedule is ambitious and could be implemented if appropriate funding is provided.

Impedance and Instabilities

Primary Achievements

- Vacuum pressure rise was observed in the MR.
- Transverse damping system was developed for the MR.

Comments and recommendations:

- Like many other high-intensity accelerators, the performance of J-PARC accelerators is eventually limited by beam loss and instabilities. It is important to find out as early as possible bottlenecks of the machine so that mitigations can be planned and implemented. Implementations of remedies like nonlinear correctors and ramping power supplies, ramping trim quadrupoles, coating of component surfaces of high secondary-electron yield take time. In many aspects, the J-PARC RCS resembles the RAL/ISIS ring, and the MR resembles the BNL/AGS. It is important to carefully study the experience at these machines.

> **Rec. #32: Test the beam at highest possible single-pulse intensity to determine performance limitation at RCS and MR; refer to the operational experience of accelerators like RAL/ISIS, BNL/AGS, CERN/PS, and ORNL/SNS pertaining to beam loss, instabilities and their remedies.**

- Beam diagnostics with sufficient speed and dynamic range is needed in understanding the mechanisms of beam loss and the nature of possible instabilities. Detailed analysis and planned machine studies are crucial in the understanding of machine features.

> **Rec. #33: Enhance beam diagnostics and analysis capabilities, including e.g. fast beam loss measurements, high-frequency beam position measurements in RCS and MR, fast transverse beam profile measurements, and longitudinal wall-current-monitor measurements.**

- Most of the time, computer simulations only provide qualitative indications of the actual machine conditions. It is risky to quantitatively base the design of e.g. collimation systems and device coating decisions on the simulation results. Even for qualitative comparison purposes, the model, the approach, and the coding of computer simulations need to be benchmarked with machine study results under simple and known machine conditions. It is also helpful to benchmark with other similar machines. For example, thresholds and growth of several types of instabilities were predicted and simulated for the SNS accumulator. Such results could be closely compared and referenced for RCS. Slow-extraction experience at BNL/AGS could also be closely referenced.

Rec. #34: Benchmark simulation models and codes using machine study results of J-PARC accelerators; benchmark with results of other accelerators like RAL/ISIS, BNL/AGS, CERN/PS, and ORNL/SNS.

- At early stages of machine commissioning and operation, extensive machine studies are needed to assess the equipment reliability and accuracy, machine aperture, single-particle versus collective effects, instability threshold and growth rate, and beam loss mechanisms. Even at intensities much lower than the full design value, instabilities can be enhanced by adjusting the machine lattice conditions like the tunes and the chromaticity, and the beam conditions like bunch intensity, length, size, and momentum spread.

Rec. #35: Perform extensive, dedicated beam studies on beam loss and instability by varying machine conditions like transverse tunes and chromaticity, and beam parameters; benchmark with computer simulation and theoretical estimations on instability threshold, growths, and beam loss.

- Vacuum pressure rise in a ring could be the effect of an electron cloud. The effect is likely to be enhanced as the beam intensity is raised in future. In RHIC, vacuum pressure rise and signals in the electron detectors are the clear signatures of electron cloud, even though electron-cloud may not cause instabilities in the beam.

Rec. #36: Look for possible signatures of electron-cloud effects in both MR and RCS; prepare corresponding diagnostics and potential remedies.

- Maneuver of the transverse tunes along the ramping cycle and resonance correction with nonlinear correctors is crucial in avoiding resonances and instabilities at high intensity machines.

Rec. #37: Study the potential benefits of tune maneuver and nonlinear corrections during the ramping cycle in RCS and MR; consider possible implementations.

Appendix: Meeting Agenda

ATAC2010 Agenda (10-min QA included for each report)

March 11, Thursday				At Ibaraki Quantum Beam Research Center 1F conference room	
time		**period (min)**	**Category**	**Title**	**Speaker**
830		*Andou-san will guide and walk with you to conference room only first day. It takes 10 minutes.*			
850	920	30	Time for LAN connection		
920	1000	40	**Project status**		S. Nagamiya
1000	1050	50	**Accelerator Overview**		A. Ando
<< coffee break >>		20			
1110	1140	30	**Executive session**	*closed session*	
<< lunch >>		80	*We serve lunch boxes for committee members in another confernce room on the same floor.*		
1300	1350	50	**Linac**	Linac Status and RFQ Issues	K. Hasegawa
1350	1420	30		Beam Study Results of Linac	M. Ikegami
1420	1450	30	**RCS**	RCS Status	M. Kinsho
1450	1540	50		Beam Study Results of RCS	H. Hotchi
<< coffee break >>		20			
1600	1700	60	**Ring RF**	Ring RF Status	M. Yoshii
				Alternative Solutions for the Ring RF Cavity Structures	T. Kageyama
1700	1740	40	**Control**	Status of the Control System	N. Yamamoto
1740	1820	40	**Executive session**	*closed session*	
<<RECEPTION>> 1900 - 2030 (Please walk from meeting place to 'Akogigaura' restaurant.)					
March 12, Friday					
820		*Please walk to the conference room.*			
840	910	30	**Executive session**	*closed session*	
910	950	40	**MR**	MR Status	H. Kobayashi
950	1030	40		Beam Study Results of MR	T. Koseki
<< coffee break >>		20			
1050	1120	30		Slow Extraction	M. Tomizawa
1120	1220	60		Magnet - Power Supply	S. Nakamura
				FX kicker status	K. Koseki
<< lunch >>		80	*We serve lunch boxes for committee members in another confernce room on the same floor.*		
1340	1420	40		Fast Extraction	K. Ishii
1420	1500	40	**Impedance and instability**	Impedance and instability	Y. Chin
1500	1630	90	**Towards 1-MW RCS and 0.75-MW**	Linac Energy Upgrade	H. Ao
			MR (fast) with Linac Energy	RCS Plan for 1 MW	N. Hayashi
			Upgrade	MR Plan for 0.75-MW Fast Extraction	S. Igarashi
1630	1800	90	**Executive session**	*closed session*	
<< dinner >> 1840 - 2030 (Please walk from meeting place to 'Akogigaura' restaurant.)					
March 13, Saturday					
840		*Please walk to the conference room.*			
900	1100	120	**Executive session**	*closed*	
1100	1200	60	**Report to project team**		T. Roser
<< lunch >> 1240 - 1340 (Please walk from meeting place to 'Akogigaura' restaurant.)					