THE INTERNATIONAL ADVISORY COMMITTEE

ON THE J-PARC PROJECT

REPORT

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EXECUTIVE SUMMARY

The International Advisory Committee (IAC) for the J-PARC joint project of the Japanese Atomic Energy Agency (JAEA) and the High Energy Accelerator Research Organisation (KEK) met between 15 and 16 March 2010 at J-PARC Centre, Tokai and toured the construction site of J-PARC.

The IAC had reports from the Accelerator Technical Advisory Committee (A-TAC), the Muon Science Experimental Facilities Advisory Committee (MUSAC), the Neutron Instrument Advisory Committee (N-IAC) and the Program Advisory Committee for Particle and Nuclear Physics (KEK/J-PARC) which met in the preceding two months. The agenda of the IAC meeting is attached as Appendix I and the membership at Appendix II.

The year 2009-2010 was a year of great achievement for the whole project. The IAC has seen results from all sectors using initially 20kW and finally 100kW Linac power. Some of these have indicated truly world-leading status at present or in the near future for the facility. The IAC strongly commends the commitment of the Director and all of the staff at J-PARC Center for an amazing effort in recognizing 'teething' troubles in some areas and rapidly solving the problems so as to explore as soon as possible the potential of this, already remarkable facility. The reports from the various sections in this document will give the detail of these achievements.

The morale of the J-PARC Center staff has been greatly sustained by the strong commitment from both the JAEA and the KEK. The maintenance of sufficient budget flexibility to allow problems in this first phase of the operation to be addressed expeditiously has been very valuable. If close cooperation and shared credit in the achievements with J-PARC 'parents' can be enhanced as the energy recovery project proceeds, and if the necessary new staff are recruited as instruments in the MLF facility achieve full productivity J-PARC will become a world leading facility in materials and life sciences as well as nuclear and particle physics.

The IAC has the perception that the B-factory upgrade is now the top priority for KEK and that outsourcing funds and personnel from J-PARC might be an option to meet this priority. The IAC is clear that a strong commitment must be maintained by both partners to reach the design goals for operation and experiments in a timely manner.

The position of the Director of J-PARC Center and his relationship to the parent organizations as well as to the broader science organization of Japan is of the highest importance. At this important stage, the intersection between the directors of J-PARC and the directorates of JAEA and KEK must be very good.

The IAC foresees complete success of the experiment by the Japanese Government in melding together in J-PARC Center, the complementary scientific and engineering cultures of KEK and JAEA. J-PARC Center is now reaching the strength where our primary recommendation in 2009 of setting priorities with the partners, while still a necessity, is now surpassed. We recommend that suitable steps be taken for the partners and J-PARC Center together to identify future goals and ways in which the complementary cultures of KEK and JAEA can further contribute to outcomes of the highest quality.

Developing a Strategy with KEK and JAEA

With the successful extraction of four different kinds of beam last year the construction stage of J-PARC is basically over. It is time to develop a strategy to exploit the full capacity of this precious facility for scientific activities. In this strategy, the efficiency and co-operation with which the J-PARC Center can operate with its own, and personnel attached from both KEK and JAEA, is crucially important. It becomes the responsibility of the partners working with the J-PARC Center Director to cope with this in a smooth way. The "mirror" structure, which has been so successful in the construction stage should be kept in the J-PARC Center during the next few years.

For this strategy to work it is necessary to have the key administrative members of J-PARC Center involved in the administration of KEK as well as JAEA. The establishment of this organizational structure is crucial to successful scientific activities in years to come for both JAEA but also KEK - as promised to the government and scientific communities. The National as well as international mission J-PARC depends on this.

IAC Recommendations

STRATEGY

The IAC commends the success of the established J-PARC management structure. The principal recommendation of the IAC is that for J-PARC. JAEA and KEK should have a mirror image management structure to co-operate seamlessly at financial, management and scientific levels - especially for the most expeditious achievement of the Linac energy recovery program in parallel with growth of the whole user program.

BUDGET

The IAC has requested the J-PARC study all means for meeting the present plan and speeding the increase of intensity in the Main Ring if possible. This should be done without sacrificing a proper understanding and long term operation of the accelerator system. There will be budgetary consequences of this and the parallel fast growth of the user program in the 2010-2013 period.

Recommendation*: The IAC recommends that both KEK and JAEA work closely with J-PARC to ensure success of proposals to the Japanese Government for an increased operational budget in 2011 and 2012.*

ACCELERATOR SYSTEMS

Recommendations*: The IAC recommends that J-PARC set up a task force with the goal of mapping a strategy to get beam losses under control as soon as possible and to make sure that the Linac upgrade project does not eclipse the beam losses mitigation priority.*

In particular the IAC and A-TAC recommend that accelerator studies be pursued that aim at characterizing and understanding losses observed in the RCS and MR at the highest beam intensities possible. Strategies should also be developed that could substantially increase the MR fast extracted beam power as soon as possible and even before the completion of the 400 MeV Linac upgrade to satisfy the urgent need to maximize the beam power delivered by the Main Ring to the neutrino target.

SCIENTIFIC PROGRAMS

Particle And Nuclear/Hadron Physics

Recommendation*: The IAC urges that a clear strategy for maximizing the impact of T2K be a critical component of an overall J-PARC strategic plan in the face of strong international competition. The strategy should include identification of appropriate resources to realize timely delivery of the 5-year beam plan.*

Recommendation*: The IAC recognizes the need for short term physics returns, and recommends that J-PARC should concentrate its efforts on improving the power and, especially, the duty factor of the slow extraction beams from the Main Ring.*

Materials And Life Sciences

Neutrons

Recommendation*: The IAC recommends that JPARC adopts a coordinated and coherent approach to the operations and future development of the MLF, embraced by all partners.*

This will require

- ***an organizational structure that enables both the scientific and technical development to be owned equally by all partners.***

- ***a process which ensures that the evolution of the detector suite delivers world leading instruments fitting into a coherent strategy agreed upon by all stakeholders***

Muons

Recommendation*: The highest priority is to secure funding for ultra slow muon beam line for μSR and to involve the condensed matter community in this unique opportunity (workshop, scientific case). To secure the operation of a strong user program on the existing D1 and D2 beam lines and to realize the construction of the new ultra slow muon beam line on a short time scale, the IAC recommends to strengthen the research and technical staffs of the Muon Science Section of the J-PARC Center.*

NUCLEAR TRANSMUTATION

Recommendation: ***The IAC recommends that J-PARC should propose in collaboration with JAEA a coherent strategy on nuclear wastes associating ADS, P/T and FBR in collaboration with University research.***

Recommendation*: J-PARC should increase the efforts in the preparation of ADS experiments and develop a roadmap to the completion of the TEF II facility.*

Recommendation***: The IAC recommends that experimental results should be presented to the IAC meeting next year.***

Recommendation***: J-PARC should continue to contribute to education and training in Japan to build a new generation of scientists and engineers.***

GENERAL STATUS OF THE PROJECT

The beginning of the operation phase of J-PARC has been spectacular. Highlights have been an almost complete solution to the problems identified early in 2009 which limited the power of the proton accelerator to 20kW with "frequent conditioning", the demonstration at this power that calculations of instrument performance were fulfilled in experiments both in the MLF and the neutrino areas.

In the former, world leading performance has been achieved in high resolution powder diffraction and new, highly innovative, techniques in time of flight spectroscopy have been demonstrated and published. For muons, a similar world class performance has been demonstrated and published. The observation of the first neutrino events, first in the near neutrino detector, and then across Japan in the far detector at SuperKamiokande (on 24 February 2010) were milestone events.

The IAC also notes that good care is being taken by the direction to manage generational change in the staff while retaining the expertise of some who have made unique contributions, and can still do so, to accelerator, neutron target, beam line and instrument development. All of this is a good indication for the future. The intersections between staff of KEK, J-PARC and JAEA will continue to be vital to maintaining the momentum of the project. The rare qualities in each organization, and their budget provisions, must cohere to this end. The IAC already commends the harmonious inclusion of former and actual KEK and JAEA employees as well as new recruits into the J-PARC operational structures.

For future appointments, this intentional blending of cultures should be an administrative priority for KEK and JAEA as well as J-PARC.

The IAC was pleased to see the steps taken by J-PARC to use the new J-PARC building and our meeting was held there. The description of plans for student and visitor accommodation in proximity to the J-PARC building was encouraging as was the interest of the Tokai Mura village in the project. A highlight was the reception given to the IAC and J-PARC members by Tatsuya Murakami, Mayor of Tokai Muraon the evening of 15 March 2010. It is apparent to the IAC that as the J-PARC operation phase grows, there will be much greater needs for local accommodation by national and international visitors as well as social and meal facilities nearer the J-PARC facilities and easy access between them and the J-PARC center building.

ACCELERATOR SYSTEM STATUS

The J-PARC accelerator complex has been developed to be the highest intensity machine in its category.

A compromise was made during phase 1 by limiting the injector LINAC to 180 MeV. Now funding has been secured to increase the energy of the linac to 400MeV as originally intended. This is one of the requirements for achieving the predicted 1MW power level in the RCS or 0.75MW in the MR. This upgrade part is well in hand and the installation is planned for the summer shutdown 2012.

Even with lower RCS injection energy, both the RCS and Main Ring have been operated with significant beam power, but the beam intensities are still quite low and space charge effects are difficult to identify. Consequently beam loss mechanisms in the RCS and MR are not well understood at the moment. However, it is critical to understand the loss mechanisms at every stage of acceleration, as these present the largest degree of uncertainty in planning for mitigation strategies and upgrades.

Recommendation: ***Set up a task force with the goal of mapping a strategy to get beam losses under control as soon as possible and to make sure that the Linac upgrade project doesn't eclipse the beam losses mitigation priority. In particular the IAC and A-TAC recommend that accelerator studies be pursued that aim at characterizing and understanding losses observed in the RCS and MR at the highest beam intensities possible.***

There is an urgent need to maximize the beam power delivered by the Main Ring to the neutrino target. Strategies should be developed that could substantially increase the MR fast extracted beam power as soon as possible and even before the completion of the 400 MeV Linac upgrade.

As part of its deliberations, the IAC enquired of the Accelerator team about the possibility of significantly increasing the intensity in the main ring by expediting the Linac energy recovery program without sacrificing the development of knowledge of the operation of the accelerators and the monitoring and reduction of beam loss in all accelerator components. The combination of these two objectives and particularly funding and manpower limitations make this not possible. In the process of these deliberations, the IAC became aware of the funding shortfall against an optimum profile for the energy recovery process.

Recommendation*: The IAC recommends that a very high priority be given to the proposed funding requirements for bringing the accelerators and target systems to their designed performance.*

A detailed appraisal of the Accelerator program was made by the accelerator technical Advisory Committee. Its report- presented to the IAC is attached. The report has recommendations for the next phase of the accelerator development and the IAC endorses these.

PARTICLE AND NUCLEAR PHYSICS

The J-PARC program of particle and nuclear physics is supported primarily by the operation of the 30 GeV Main Ring (MR). The hadron program uses slow extraction to a number of beam lines in the hadron hall. The neutrino beam uses fast extraction and sends an off-axis neutrino beam in the direction of the underground water Cerenkov detector Super-Kamiokande at Kamioka nearly 300 kilometers from Tokai. For the former experiments the quality and duty factor of the beams are important. For both hadron and neutrino experiments, beam power is important.

HADRON EXPERIMENTS

Currently there are two charged particle beams K1.8 and K1.8BR, which will support a number of experiments using charged pion and kaon beams to search for and examine nuclear structure and nuclear matter to study QCD under some specific and extreme conditions. Some are hypernuclear experiments which provide information on the forces inside the nucleus. Another searches for an exotic bound state called a pentaquark. J-PARC is to be congratulated for the considerable progress has been made in commissioning the two programs associated with these beam lines and establishing good pion-kaon separation.

Also being developed is a rare kaon decay installation, which will search for the decay of the K^0_L into a pizero and neutrino-anti neutrino pair. The current state of the art suggests that this mode offers a window on new physics. Development of the beam line, which is being operated in test mode, and the experiment, will take place over the next couple of years. Progress has been made on each.

Future facilities in preparation are another low energy beam, K1.1BR and an extracted high momentum, primary, proton beam. The K1.1BR beam line is expected to begin its beam commissioning in FY2010 and will be used initially for test beam work. Funding for the high p beam line has been requested in the FY2010 budget. This would complete the complement of beamlines intended for the first phase of hadron experimentation. In this context and expecting that there will be little conflict with the program to improve the existing slow extraction performance, the IAC supports this initiative.

Eventually to fully exploit the capabilities of the machine it is expected that the large hadron hall be extended. At present the funding for the extension is not in the planning although we heard an intriguing thought that the RIKEN organization might take on this task. The IAC encourages the J-PARC management to explore further this possibility.

In the very recent commissioning work, there have been difficulties, some partially understood and mitigated, which have resulted in a low duty factor for the slow extraction beam. Improvement to a level of order 80% at high beam power, which would be needed to support the full program, will require considerable attention, time and resources but is mandatory for the program. It should also be noted that there is more than one path to achieve acceptable yields in the two operating beam lines. It is necessary to optimize the yield, not necessarily the beam power. This might be achieved using a higher Z production target. An optimum approach should be developed.

Planning for operation for the next year reflects the tensions in play. Given the priority of the neutrino beam, it is likely that 60 days or less of hadron beam operation will be available in the next fifteen months. In this context, the PAC has offered a set of priorities. This committee endorses those priorities, which could support the completion of about two of the experiments in the K1.8 and K1.8BR complex and could provide short exposures for the neutral kaon beam line. However, this committee would not like to see the laboratory sacrifice its longer-term needs for the beam duty factor and power to improve to an extended run of experiments for which the beam conditions fall short.

While recognizing the importance of moving continuously to flesh out the facilities supported by the MR, the IAC believes that investment in the new high momentum proton beam should be balanced against the resources needed to improve the beam quality.

If new, creative methods arise to provide funding for extensions to the facilities, for example, extending the hall, the committee encourages the laboratory to explore them.

NEUTRINO EXPERIMENTS

The T2K experiment, directing a muon neutrino beam from the Main Ring toward the Super-Kamiokande detector, is the centerpiece of the particle and nuclear physics program at J-PARC. There has been impressive progress in the past few years: Beamline completion in 2008; the first beam to neutrino beamline and beam commissioning in April-May 2009; the installation of the second and third horns and the completion and commissioning of the on-axis near detector (INGRID) in June-October 2009; the completion of the off-axis near detector and the first neutrino event in both near detectors in November-

December 2009; the start of physics data taking in January 2010; and the first J-PARC neutrino event in the Super-Kamiokande detector on February 2010. The IAC whole-heartedly congratulates the J-PARC / KEK team and the T2K collaboration for this incredible progress and success. The T2K collaboration with about 500 members from 62 institutions in 12 countries is a strong international collaboration. The collaboration has started analysis activities and plans to produce the first oscillation result by Summer 2010. Besides relatively minor work envisaged during the 2010 Summer shutdown and new horn power supplies needed for higher current running, the experiment is fully ready for physics data taking with higher power beams.

The T2K has strong international competitors in other reactor- and accelerator-based neutrino oscillation experiments with a similar goal of improving sensitivity to the unknown mixing angle $\sin^2(2\theta_{13})$ to a level of 0.01 or beyond. In order for T2K to remain competitive or to observe electron neutrino appearance implying, a finite $\sin^2(2\theta_{13})$ first, J-PARC will have to improve beam power rapidly. The IAC was presented with a viable 5-year Main-Ring beam plan. Assuming this is delivered, the T2K will be competitive because the reactor experiments have been delayed. The NOvA experiment must be taken into account since it is back on track in the U.S. and is likely to start earlier than anticipated.

Recommendation*: The IAC urges that a clear strategy for maximizing the impact of T2K be a critical component of an overall J-PARC strategic plan in the face of strong international competition. The strategy should include identification of appropriate resources to realize timely delivery of the 5-year beam power plan.*

MATERIALS AND LIFE SCIENCES

NEUTRON SCATTERING

The staff of J-PARC and the Materials and Life Sciences Facility (MLF) is to be congratulated for the impressive progress seen over the last year. Among the many achievements to be highlighted are

- Stable operation at 120 kW with very high reliability
- nine instruments are now operating in a user program, three are undergoing commissioning, three more instruments are under construction, and funding has been secured for an additional three instruments – this is an impressive feat by any standards and could not have been achieved without the tireless efforts of a relatively small staff.
- An innovative early publication with the first scientific results demonstrating repetition rate multiplication
- Demonstration of energy-dispersive imaging
- Outstanding new developments in scintillator detectors

MLF staff are also dealing with, and learning from, the normal teething problems encountered during the commissioning of a new facility. Nevertheless the facility is already delivering top quality scientific results.

Target and moderators systems are performing well and will not be stressed at current power levels. An impressive number of instruments now exists on the experimental floor, but with limited (although adequate for initial scientific commissioning) detector complements. Completing instrument detector coverage will be essential to realize the full potential of J-PARC, but is not a critical issue at this stage. Commissioning this diverse instrument suite, developing coherent across-the-board operational procedures and attracting, sustaining and inspiring a growing user community are the prime challenges at this stage in this sector of J-PARC's development.

The MLF is now facing the common concern that all major user facilities of this nature face, namely a transition from a construction project to a reliable, operating facility which can support a vibrant user program, delivering both science and innovation. This transition is difficult at the best of times but somewhat exacerbated in the case of the MLF by the diversity of stakeholders and funding sources - JAEA, KEK, Ibaraki Prefecture. It is critical at this stage to consolidate and stabilize the operation of the facility to support the demands of the rapidly growing user community. In this context, stabilization means the following:

- Increasing the staff for instrument support, including both staff dedicated to specific instruments as well as those needed for core support groups such as data acquisition, sample environment, and detectors. We note that international best practice for operating a neutron user facility is at least six staff per instrument. A coherent staffing plan should be developed across organizational boundaries allowing the MLF to take advantage of the skill sets available in all participating institutions to fully support the user program.
- In order to maximize the efficiency and the cost effectiveness of the user support organization it is crucial that the MLF adopt a high level of standardization across instrument operations of all stakeholders such that support functions for the instruments (detectors, sample environment, instrument control, data analysis software) can be maintained through

centralized groups. All institutions operating instruments at the MLF should contribute to, and be partners in, a unified instrument operations support organization. The essential point is that user support must be essentially equal for all instruments, regardless of the source of funding and all of the institutions building and operating instruments at the MLF should work to achieve this goal.

- It is essential to make available a suite of facilities that includes sample handling capabilities, science support laboratories incorporating standard laboratory equipment and analysis techniques, restaurants, accommodation, and reasonable office and meeting space.
- The operational focus should be to increase the number of instrument days, and the reliability of the source at a reasonable power level – 300kW is sufficient and at this power level the MLF will produce the most intense peak pulse intensities in the world. Pushing the source power to 1 MW, with increasing likelihood of lower reliability, is less important at this stage.
- It is neither critical, nor advisable, at this stage for the MLF to actively seek funding for new instrumentation. There are only a few beam lines left unallocated. It is important to define a process which ensures that only world leading instruments, those that fit into a coherent long term strategy, are approved for future construction. Any long term planning for future instrumentation should take into consideration the operation of the JRR-3M, and include input from all stakeholders, especially the user community.

In parallel to stabilizing and expanding the user operations, MLF management must turn to developing and enabling a world class internal science program.

The creation of a strong in-house research program will be critical to the long term success of JPARC/MLF, and will act as an intelligent customer base to promote and develop sophisticated user support and science-led instrument development.

In this case the multiple ownership of J-PARC/MLF provides a unique opportunity to attract the best scientific staff to the facility. It is essential that a common, coherent recruitment policy be established that leverages to a maximum the distinct capabilities, and collaborating networks, of the stakeholder institutions. A broad portfolio of recruiting mechanisms should be considered including joint university appointments, fellowships, postdoctoral and student programs and sabbaticals. Strong links to the academic community that forms the base of the user program is essential. The recruiting activities should be closely coupled to outreach programs such as workshops, schools, and training activities. The IAC strongly recommends that a comprehensive communications and outreach plan be developed that incorporates all the above activities.

Recommendation*: The IAC recommends that JPARC adopts a coordinated and coherent approach to the operations and future development of the MLF, embraced by all partners.*

This will require

- ***an organizational structure that enables both the scientific and technical development to be owned equally by all partners.***

- ***a process which ensures that the evolution of the instrument suite delivers world leading instruments fitting into a coherent strategy agreed upon by all stakeholders***

MLF MUON FACILITY

The IAC heard a presentation by Dr. Miyake on the status of the MUSE facility and plans for the future development of a user program. The observations and recommendations from the Muon science advisory committee (MUSAC) which had met just two days prior were given by Dr. Poutissou (replacing Dr. E. Morenzoni, chair of MUSAC who could not attend).

The IAC was pleased to hear about the success of the initial beam delivery campaign which led to the first publication of J-PARC in Physical Review Letters. It showed, that even under trying circumstances, the facility is able to deliver top results and is already providing the world's best pulsed muon intensities. The first muon beamline and its spectrometer are being optimized in a collaboration between JAEA and KEK to service a more versatile and competitive program.

By far the highest priority should be to secure funding for developing the Ultra Slow Muon beamline which promises to be the unique facility that will attract users worldwide. Through a strong synergy with the R/D program initiated by the G-2 collaboration, KEK and RIKEN are developing a state of the art laser ionization system which will be ideally suited for the J-PARC pulse muon beam and would provide an enhancement of two orders of magnitude in the yield of ultra slow muons (USM) produced per incident surface muon delivered to the muonium target compared to what has been demonstrated at ISIS by the RIKEN-

RAL collaboration. The J-PARC USM source would be truly unique and tailored to pulsed excitation of many classes of nano-materials.

For the longer term plans, adding a couple of surface muon experimental stations on the S line would allow the MUSE facility to service a large community of users, both nationally and internationally. The remaining port (H-Line) could be reserved for a more specialized, very high acceptance line that could service the G-2 experiment , very high luminosity micro beams , negative muon based programs etc. It is urgent to come to a consensus on the kind of front end that needs to be installed before the activation in the target region makes the task too dose intensive.

The MUSE team has been extremely successful .However maintaining and operating the present infrastructure, completing the three other beamlines while running a user program will be a challenge for the current level of personnel.

Recommendation***: The highest priority is to secure funding for ultra slow muon beam line for μSR and to involve the condensed matter community in this unique opportunity (workshop, scientific case). To secure the operation of a strong user program on the existing D1 and D2 beam lines and to realize the construction of the new ultra slow muon beam line on a short time scale, we recommend to strengthen the research and technical staffs of the Muon Science Section of the J-PARC Center.***

USER INTERFACE, SAFETY and COMPUTING

User Interface

The creation of the J-PARC User Office is now a reality. For the first time the IAC met on 'J-PARC Premises' - a notable step.

The User Office defines the culture of many aspects of life for the J-PARC user community and has the potential to develop harmony with the wider user community at Tokai, including, for example, users of JRR3-M. The IAC is pleased to see that progress continues to be made in developing a pro-active user interface at J-PARC. The IAC noted many favorable developments: the feedback to the J-PARC center from the Users Steering Committee was seen as an essential engagement for shaping the future directions of the facility; IUC welcomed the opportunity to interact with local political figures (the Mayor of Tokai attended the Monday evening reception) and impress on them the importance of J-PARC internationally; outreach to the local community through TV exposure, open days etc is strong and outreach to industry (including the efforts of Ibaraki Province) is pioneering and has already achieved an engagement unsurpassed elsewhere.

Much remains to be done both locally - accommodation for users; a user building including rest areas, discussion space, and laboratories; easier access to the J-PARC site; and globally - strengthening membership of JSNS; developing outreach in the Asia-Oceania region and increasing visibility of J-PARC internationally through the internet and focused intentions. But an impressive start has been made towards the realization of a "TOKAI campus" which will provide an active intellectual forum for researchers, post-doctoral fellows and students across the J-PARC enterprise and for the community at large.

Safety

The IAC again emphasizes the importance of safety and risk evaluation. It reiterates its comments from the 2009 IAC report: "As the community of users grows at J-PARC, the opportunity must be taken to create the strongest safety culture with respect to operations and radioprotection. A highly safe-conscious user group is a foundation for success and an asset to the institution. The induction processes, the refresher courses and the public awareness of the care for safety in the whole organization are important. The IAC is aware that attention is being paid to these matters and commends this. As J-PARC moves to operations in an international context, an explicit rather than implicit approach to safety needs to be established.

Recommendation: ***Report explicitly on safety and risk evaluation procedures at future IACs."***

Computing and Networking

The progress in computing and networking for the J-PARC facility as seen by the IAC was developing well. The attention being paid to future needs and the openness of communication is highly desirable as is the provision - with strong input from instrument scientists of "user friendly" software for immediate processing of data at the instrument as results are taken. This is important for the MLF Facility where it may be necessary to assess whether the biological and other fragile samples have not deteriorated before or during the experiment. The provision of "user friendly" software as "freeware" to the user community and the standardization of its use among the users will promote scientific communication and publication.

Cryogenics

Sample environment cryogenics for the MLF are a separate issue from the major cryogenic systems required for the accelerator. Delivery of this service is user driven and should be part of a developing Sample Environment(SE) capability in MLF and not tied – on a day to day basis – to a central cryogenics service. As the facility ramps up in both operational days, power and variety of instrumentation, an service essential to deliver science will be the development of both sophisticated sample environment infrastructure and a competent coherent team to deliver, operate and develops the SE kit. ISIS currently supports some 200 pieces of SE kit with a team of some 25 staff.

NUCLEAR TRANSMUTATION

The recent report of the AEC committee composed of high-level representatives of academic, public organizations and industry, chaired by Professor Yamana strongly supports partitioning and transmutation (P&T) technology. The IAC fully agrees with the recommendations of the AEC Committee that R&D should not aim only at the improvement of the P&T performance, but at the achievement of the whole performance including safety, economy, environmental-friendliness, saving resource, and non-proliferation.

The IAC was pleased to hear the presentation of the Transmutation group. The recommendations of the IAC have been carefully addressed. The group has also well taken into account the conclusions of the AEC report. The IAC endorses the planned activities that will be included in the new 5-year plan (FY 2010-2014) of JAEA.

Nuclear Power is an essential component of the Japanese energy portfolio. Research on nuclear wastes is essential. The IAC appreciates the efforts of the J-PARC team to build a strong R&D community bridging academic and industry technology research, in particular the collaboration with Kyoto University on the FFAG- KUCA experiments. The IAC reiterates that fruitful collaborations between J-PARC and academic R&D in Japan are essential for the development of future nuclear reactors. Confidence of the public needs coherent information from universities, public organisations and industry research. This is one of the essential keys for continuing to use nuclear power in Japan in the long term. The difficulties observed in recovering from the sodium leak that occurred in the Monju fast breeder reactor, 14 years ago, are emblematic of the public need for reliable information. The IAC was pleased to learn that the procedures for resuming the test operations of the Monju reactor have entered their final phase and that JAEA is hoping to resume the test operation by the end of March this year.

Recommendation: ***The IAC recommends that J-PARC should propose in collaboration with JAEA a coherent strategy on nuclear wastes associating ADS, P/T and FBR in collaboration with University research.***

The group has an active participation in EU major collaborative experimental programs: R&D on transmutation of Minor Actinides (MA) with the fast breeder PHENIX (sodium cooled (similar to Monju) in France, PSI in Switzerland and preparation of the MYRRHA project under development at Mol in Belgium in association with the EUROTRANS collaboration. MYRRHA is the most ambitious ADS project in Europe. It is the basis for a future European XT-ADS (eXperimental demonstration of Transmutation in an ADS and for various R&D applications. It consists in a proton accelerator delivering a 600 MeV - 2.5 mA (or 350 MeV - 5 mA proton beam) to a liquid Pb-Bi spallation target that in turn couples to a Pb-Bi cooled, subcritical fast nuclear core. On March 4th 2010, the Belgian government has decided to finance about 40% of the MYRRHA project (1000 M€). This project is expected to be completed in 13 to 15 years. A member of the J-PARC group is now staying at Mol to join the Central Design Team (CDT) of the European 7^{th} Framework Program (FP7). The IAC is pleased by the important role of the J-PARC group in international R&D on transmutation.

Recommendation*: J-PARC should increase the efforts in the preparation of ADS experiments and develop a roadmap to the completion of the TEF II facility.*

Dr.Oigawa's presentation briefly described the many areas in which the group is involved, in particular nuclear data on minor actinides (MA) and long-lived fission products (LLFP), irradiation of MA, and the experimental preparation of the TEF facility including spallation target design, beam trip effects, material corrosion, thermal hydraulics of the spallation target.

Recommendation*: The IAC recommends that experimental results should be presented to the IAC meeting next year.*

The IAC reiterates that the considerable knowledge of Japan in accelerator development, design and safety studies in ADS, fuel studies, materials science, and nuclear data is fundamental to expand the frontier of knowledge in safe and reliable nuclear waste management.

Education and training in JAEA’s facilities in Tokai, advanced reactors and J-PARC offers unique opportunities to strengthen a unique combination of research and engineering.

Recommendation*: The IAC recommends that J-PARC should continue to contribute to education and training in Japan to build a new generation of scientists and engineers.*

APPENDIX I

Agenda for the 9th International Advisory Committee Meeting
J-PARC

Agenda for the International Advisory Committee Meeting of J-PARC
(Preliminary)

Date: March 15 (Mon) and March 16 (Tue), 2010
Place: J-PARC Center – Tokai

March 15 (Mon)

8:50 - 9:10	Executive Session (Closed) Committee + S. Nagamiya, H. Kobayashi, Y. Ikeda	
9:10 - 9:30	Overview of KEK (+ J-PARC)	A. Suzuki
9:30 - 9:50	Overview of the JAEA (+ J-PRC)	H. Yokomizo
9:50 – 10:10	-- Coffee Break –	
10:10 – 11:10	Status of J-PARC	S. Nagamiya
11:10 – 12:20	Accelerators	
11:10 – 11:50	J-PARC Accelerator Progress Report	A. Ando
11:50 – 12:20	A-TAC Report	T. Roser
12:20 – 12:40	Closed Session	
12:40 – 13:30	-- Lunch –	
13:30 – 15:30	Material and Life Science Experimental Facility	
(13:30-13:55)	- Status of MLF and Topical Progress Report of Neutrons	Y. Ikeda
(13:55-14:20)	- Experimental Results from Neutrons	M. Arai
(14:20-14:35)	- N-TAC Repor	Y. Ikeda for D. Newmann
(14:35-15:00)	- Current Status and One year progress of MUSE	Y. Miyake
(15:00-15:15)	- Competition/Coexistence of Magnetism in Iron Pnictides Probed by Muon Spin Rotation	R. Kadono
(15:15-15:30)	- MuSAC report	J.-M. Poutissou for E. Morenzoni
15:30 – 15:50	-- Coffee Break –	
15:50 – 17:40	Nuclear and Particle Physics Experimental Facility	
(15:50-16:20)	- T2K experiment	T. Kobayashi
(16:20-16:55)	- Nuclear physics experiments (mainly for K1.8/K1.8BR)	T. Takahashi
(16:55-17:20)	- Particle physics experiments (mainly for KL)	T. Komatsubara
(17:20-17:40)	- Plan of particle and nuclear physics experiments (PAC/JPNC, Hadron hall plan, R&D for future exps.,...)	K. Nishikawa
17:40 – 18:20	Closed Session	

18:30 -	Reception	
March 16 (Tue)		
8:50 - 9:10	Executive Session (Closed)	
9:10 – 9:40	Nuclear Transmutation	H. Oigawa
9:40 – 10:00	Network and Computing at J-PARC	A. Manabe
10:00 – 10:25	-- Coffee Break –	
10:20 – 11:40	Closed Session & Working	
11:40 – 12:00	Summary Session	
12:00 – 13:00	-- Lunch –	
13:00 – 15:00	-- Site Tour --	
Adjourn		

APPENDIX II IAC COMMITTEE MEMBERS

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APPENDIX III

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

Comments and recommendations:

- 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.

Operations and Power Projections

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.

<u>Linac Status</u>

<u>Primary achievements</u>

- 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.

<u>Comments and recommendations</u>

- 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.

Comments and recommendations

- 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,

- o BPMs are being modified for the TOF measurements,
- o BLM detectors are being developed,
- o 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.

Comments and Recommendations

- 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.

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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

time		period (min)	Category	Title	Speaker
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

time		period (min)	Category	Title	Speaker
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.)					