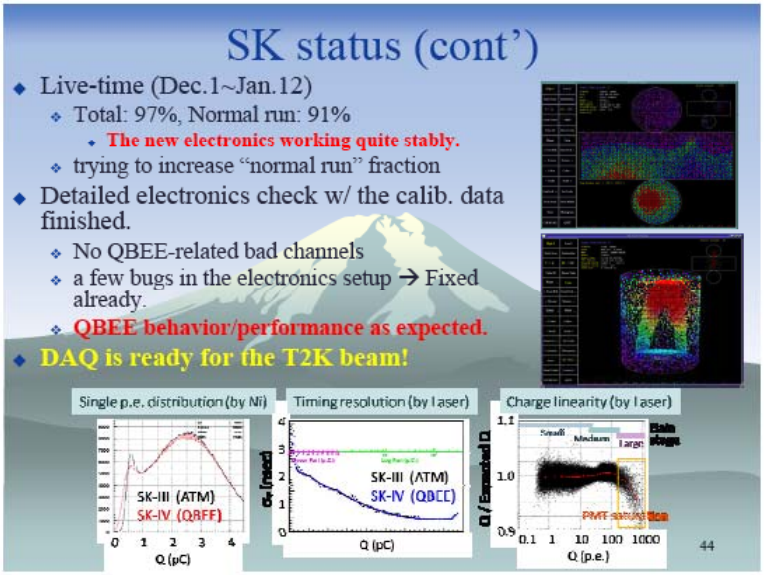
THE INTERNATIONAL ADVISORY COMMITTEE

ON THE J-PARC PROJECT

REPORT

2 April 2009



Meeting 9 -10 March 2009

Tokai, Japan

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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 9 and 10 March 2009 at JAEA, 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) and the Neutron Technical Advisory Committee (N-TAC), which met the previous week at Tokai. The agenda of the IAC meeting is attached as Appendix I and the membership at Appendix II.

The IAC has heard in its meeting a truly impressive delivery of outcomes from the construction phase. The standard of achievement on entering the operational phase meets international best standards for all aspects of this complex project. The three main streams are the conclusion of the infrastructure and building program on budget and on time, the proof that the accelerators from lowest to highest energy are capable of 300kW operation and the quality of major facility and instrument installation are at or will reach world's best levels.

All of the major milestones for the project, as scheduled in 2007 have been reached since the last IAC, except for completion of the neutrino experimental hall which is expected in April 2009. The report on the neutrino project was quite outstanding.

The milestones reached are: February 2008 - a proton beam power of 5 kW/pulse (130 kW equiv) was circulated in the RCS and in May 2008, injection, RF capture and extraction of 3 GeV beams to the Main Ring. The first production of neutrons on the mercury target of the MLF was on 30 May 2008 and all indications are that this major development is a success. A beam power of 12 kW/pulse (300 kW equiv.) was extracted on 26 September at 3 GeV leading to the production of muons and further impressive results from the neutron instruments. Neutron and muon beams (at powers comparable to those at the KENS facility) were made available for General Users on 23 December.

At the main ring, acceleration of beams to 30 GeV occurred on 12 December and first extraction of the 30 GeV beams to the Hadron Experimental Hall was on 27 January 2009. The Materials and Life Sciences Facility was formally opened to users on 16 December 2008 and a celebration of the end of the Phase 1 project will be held in July 2009.

This catalogue of success, achieved in a timely manner, is a great tribute to the J-PARC Center, the energy and quality of the Director and staff of J-PARC, the parent organizations and Japanese industry - who have made it possible. It illustrates the potential for Japan of the asset created by the two investing partners JAEA and KEK. J-PARC is on the threshold of great and lasting international impact. The continuity of JAEA’s and KEK’s full support is essential to this.

The "ramp up" of beam power in the operation phase has revealed some defects in component systems, notably the RFQ, the RF cavity chokes and the "ripples" on the main ring power supply. Such things are expected for innovative accelerator systems such as J-PARC and are part of the initial operational commissioning. All can be rectified - some requiring research during low power operation. Recommendations for this are made in the text of this report. Their focus is to allow continuing instrument based experimentation while restoring the "ramp-up" process to deliver projected power to the Neutrino, Hadron and MLF sectors as soon as possible.

The IAC has suggested that the J-PARC Director define budget and project targets for JFY2009-2010 to deal with the evolving accelerator conditioning whilst embracing a continued 400MeV injection upgrade, the continuity of user access to the MLF facility and the early production of neutrino beams - even at the expense of delaying the user program. Spares for the operation phase are very low in all departments. The conditioning process for the accelerators - while user access and instrument testing continue - makes this matter urgent. The IAC, is confident that the J-PARC staff is fully capable in terms of expertise and dedication to overcome the current issues.

In addressing the "conditioning" matter by component replacement, work must be continued and international collaborations maintained on the accelerator and neutron target systems. The operation phase must

therefore contain an R&D component as well as general operations and user facilitation components. The budgetary emphasis at this stage must be on sustainability in the next 4-5 years as recommended in the 2007 IAC report.

The IAC welcomes the continued development of planning and organizational strength within the J-PARC Center - as an advantage for all users. There has been a positive response to our past recommendations but defined task forces need to be set for the present recovery programs. Common needs for the quickest progress to high power for all sectors require this coordination. The points made in 2008 are still valid. Establishment of an overarching schedule for beam commissioning, a plan for accelerator running in JFY2009 and the Users Steering Committee are positive steps to a planned "proton economy" for the Facility.

The Committee welcomes the re-appointment of Professor Shoji Nagamiya as J-PARC Director and congratulates him and his staff on the exceptional progress made in all parts of the project. The papers distributed before the meeting expedited the IAC's work by allowing IAC members to form and discuss views on key policy issues before the meeting. The IAC thanks again the J-PARC Director, Professor Nagamiya, and the project team for the preparation and the openness of discussion at the IAC.

IAC Recommendations

STRATEGY

Recommendation: ***The IAC recommends that J-PARC, JAEA and KEK management be fully engaged in a joint effort to develop the facility commissioning and exploitation strategy to maximize the scientific return from the investments made in the J-PARC project.***
The strategy should establish short-term and long-term priorities for the many remaining technical tasks as well as the resources needed for a timeline that keeps the highest priority experiments internationally competitive.

BUDGET

Recommendation: ***That as J-PARC enters full commissioning and the initial experimental phase, KEK and JAEA give the strongest support to the Japanese Government for a strong J-PARC operational budget in JFY2009-2010 noting that in 2007 the IAC recommended an***

> ***"operational budget - so that systematic improvement of the accelerator system and instruments can be done within the envelope of about 190 Oku Yen per annum (estimated last year) at full operation after 2008."***

Recommendation: ***That a spares capacity be established 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 continuing development and spares component of the operations budget.***

WHOLE ACCELERATOR SYSTEM -MANAGEMENT

Recommendation: ***Management needs now to give strong attention to planning facility improvements in both near and intermediate terms. In the near term "task forces" reporting to the Director are needed for the identified remedial tasks.***

Recommendation*: Management needs a more coherent approach to planning for facility improvements in both near and intermediate*

terms. Establishment of a roadmap for the next ~5 years would facilitate this activity. Such a roadmap should be developed in consultation with all stakeholders and should then provide the framework for a more detailed commissioning and operations plan.

Recommendation (repeat): ***The integrated commissioning/operations plan should be extended through the first few years of operations and should be discussed with, and made available to, the user community. The published plan should include estimates of performance, anticipated reliabilities, and the time allocation between users and accelerator physics. The integrated plan should also identify resources required to support the plan.***

Recommendation: ***The commissioning team should move toward commissioning with high intensity (100 kW equivalent) single beam transfers from the RCS to the MR as soon as possible.***

LINAC ENERGY UPGRADE

Recommendation: ***Give investigation of the RFQ problem the highest priority.***

Recommendation: ***Consider improving isolation of the RFQ from the ion source vacuum by increasing the length of LEBT vacuum manifold. Additional beam scraping could also be effective, if designed to assure that ions outside the acceptance of RFQ are not injected into RFQ.***

Recommendation: ***A careful examination identifying the likely causes of the RFQ breakdown should be undertaken before a spare RFQ is built.***

Recommendation: ***The committee recommends that the linac energy upgrade be implemented in a single step***.

Recommendation: ***The LINAC energy upgrade should be implemented only after the RCS injection has been upgraded to 400 MeV and the front-end is capable of producing a pulse intensity that supports an increase in RCS output power relative to that achievable with 181 MeV injection energy.***

SCIENTIFIC PROGRAMS

Recommendation: ***J-PARC and KEK needs to develop a clear long-term strategy to maximize the scientific impact of T2K in the face of strong international competition and of a rare kaon decay program. The strategy should include identification of appropriate resources to realize timely delivery of several hundred kilowatt beam power.***

Recommendation: ***The parent organizations of KEK and JAEA need to capitalize on the investments made so far in the MUSE facility, on the superb technical skill available in the current team and on the various funding opportunities available to the users by investing in a strong scientific leadership who could bring these realizations into fruition. The IAC reaffirms that the development of the Ultra slow muon beamline is of the highest priority.***

USER MANAGEMENT

Recommendation: ***That the continuing, integrated operations plan should be discussed with, and made available to, the user community. The published plan should include estimates of performance, anticipated reliabilities, and the time allocation between users and accelerator physics.***

Recommendation: ***The IAC notes with satisfaction the formation of the J-PARC User Advisory Committee reporting to the J-PARC Director, and its broad composition. It is recommended that a report from the Committee be available to the IAC at its annual meetings.***

NUCLEAR TRANSMUTATION

Recommendation: ***The IAC reiterates its recommendation that J-PARC should develop a long-term strategy in transmutation experiments and ADS research, with a significant increase in experimental efforts as well as in the TEF facility design studies.***

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 IAC meeting reported here was a historic one for J-PARC. The vision of the Japanese Government in 2001 to create a world center of excellence through JAEA and KEK has been realized in the construction phase. Moreover, the combined staff from the two parent agencies, with Japanese industry, has shown high skill and innovation in design and construction of the accelerator systems, beam lines, experimental facilities and instruments. This group of people is a new asset for Japan and the parent organizations. Most money has been spent on the accelerator systems - with a long-term view to provide the strongest proton beams in the world for neutrino and nuclear physics, materials and life sciences research as well as radioactive waste transmutation.

A wider world vision, first enunciated in about 1995 by the OECD Megascience Forum is also being realized - the establishment of three "state of the art" neutron sources around the globe - in response to the great growth in the need for intense neutron beams for materials and life sciences. The European and American Neutron Scattering Association have functioned for more that a decade. Now the newly formed Asia-Oceania Neutron Scattering Association is located in J-PARC.

As the scale of J-PARC operation grows a new scientific and political asset is forming through the extensive group of users. The outcome for science from systematic merging of national and international science, for example, in the thousands who will come for brief experiments in the materials and life sciences, must be strongly supported by sociable meeting and resting places, seminars and amenities at the site. The marginal cost of this is negligible in terms of the Center operating budget but this outcome is well recognized in major user facilities world-wide.

The strong support of KEK and JAEA for the growing J-PARC program through budget and advocacy is essential - even as they form the new visions for their programs that were presented to the IAC at this meeting. The importance of a strong operations budget now cannot be overestimated. The "partners'" provision of continuing scientific and management expertise, of access to their facilities and staff will be very important as J-PARC grows.

Recommendation: ***That as J-PARC enters full commissioning and the initial experimental phase, KEK and JAEA give their strongest support***

in submissions to the Japanese Government for a strong J-PARC operational budget - noting that in 2007 the IAC recommended an

> ***"operational budget - so that systematic improvement of the accelerator system and instruments can be done within the envelope of about 190 Oku Yen per annum (estimated last year) at full operation after 2008."***

In summary, the IAC congratulates the entire J-PARC team for their heroic efforts, and JAEA and KEK for their wise investments, in bringing the J-PARC construction project toward a timely and successful completion. Many challenges have been overcome but the transition to full operation brings more challenges for a facility aiming for strong international scientific impact.

The IAC has consistently advocated a model for J-PARC where the partners remain fully engaged at the operational and scientific level as the Center grows. The IAC believes that it is critical in this all-important commissioning phase, and consistent with international best practices, that both partner institutions retain fully engaged ownership stakes in bringing J-PARC performance and instrumentation to fulfill its promise. The opposite model as the operational phase is entered, where the ownership is diminished and the Center role reduced to that of a beam provider is threatening to the future excellence of the center and its scientific impact.

The IAC attaches great importance to maintaining top level participation of the J-PARC Director in the management decisions of KEK and JAEA affecting J-PARC after April 1, 2009. The IAC strongly advocates inclusion of J-PARC directors in the parent advice structures and a continuing help in the recruitment of the next generation of leaders in the J-PARC Center.

Recommendation: ***The IAC recommends that J-PARC, JAEA and KEK management be fully engaged in a joint effort to develop the facility commissioning and exploitation strategy to maximize the scientific return from the investments made in the J-PARC project. The strategy should establish short-term and long-term priorities for the many remaining technical tasks as well as the resources needed for a timeline that keeps the highest priority experiments internationally competitive.***

ACCELERATOR SYSTEM STATUS

The IAC is indebted to the A-TAC and its Chairman Dr Stephen Holmes for providing it with the draft A-TAC report prior to the meeting. This detailed examination of the present status of the accelerator systems. Some of the key draft recommendations available to the IAC have been brought forward into the main recommendations of the Executive Summary. Much time was spent at the IAC formally discussing the technical analysis of accelerator performance and the plans of J-PARC and suggestions of the A-TAC for the next steps in reaching high power in a careful but expeditious way.

The IAC would like to acknowledge the very impressive progress evident in the completion of construction and initial beam commissioning of the accelerator complex since the last meeting. The list of accomplishments is spectacular, including: first neutrons and muons produced in the MLF, the high power demonstration of RCS operation, 30 GeV acceleration and extraction from the MR, and delivery of beam to the Hadron hall. Just one of these accomplishments in a single year would be significant. The fact that so many successes have been achieved in the past year is evidence of the tremendous hard work and dedication of the J-PARC staff, and is highly commended by the IAC.

Basic Functionality of the Accelerator Complex

It must be emphasized that at this point the basic functionality of the accelerator complex is proven. This is a very significant fact that was by no means guaranteed, and therefore is worthy of emphasis. The J-PARC is one of the most technically sophisticated and complicated scientific facilities in existence. The demonstrated functionality of the accelerator infrastructure is a major, significant accomplishment in which the J-PARC staff should take great pride.

As in all accelerator projects of this complexity, initial operation has revealed some weaknesses in “day-one” systems and components. It should be kept in mind that this is a natural stage of any such project which aims to extend the present state-of-the-art in technology. Therefore, these difficulties should not be viewed as setbacks, but should be considered as among the inevitable “growing pains” of such a facility.

To analyse the way ahead with accelerator developments and their consequences, the IAC formulates a response in terms of five questions and answers:

1. Are the main performance limitations and risks to the near-term program identified and adequately understood and prioritized?

The three primary performance limitations were identified as i) breakdown in the RFQ, ii) damage to some of the magnetic alloy cores in the RF systems, iii) excessive current ripple in the main ring dipole power supply.

Breakdown in the RFQ

The difficulties related to arcing in the RFQ are the most serious performance limitation, with the highest risk to the near-term program. The most likely cause (as identified by A-TAC) seems to be related to higher than desired residual gas pressure in the RFQ due to inadequate pumping of hydrogen gas (H2) introduced in the negative hydrogen ion source. The details of the role of H2 and quantification of its influence are not yet well understood. Plans are underway to prepare a spare RFQ. The ATAC committee recommends building a spare RFQ, but only after the underlying cause of the breakdown is understood, in order to ensure that the new RFQ doesn't suffer the same fate as the original one. The following recommendations from the A-TAC report are specifically endorsed:

Recommendation: ***Give investigation of the RFQ problem the highest priority.***

Recommendation: ***Consider improving isolation of the RFQ from the ion source vacuum by increasing the length of LEBT vacuum manifold. Additional beam scraping could also be effective, if designed to assure that ions outside the acceptance of RFQ are not injected into RFQ.***

Recommendation: ***A careful examination identifying the likely causes of the RFQ breakdown should be undertaken before a spare RFQ is built.***

The IAC notes, with pleasure, that funding for the upgrade in the linac injection energy to the RCS has been agreed and that plans are now advanced for the implementation of this in 2010-2011. The necessary developments associated with the RFQ and this upgrade are linked. The relationship was considered by the A-TAC and, subject to the studies mentioned above, the IAC has brought forward into this document the advantageous recommendations for this linkage to be considered by J-PARC management within the financial and personnel resources framework.

The timing of the LINAC upgrade is brought to the J_PARC management's notice. The advice is to delay that until the front end is producing sufficient current x pulse length to support an increase in power out of the RCS. Our reasoning was that simply raising the injection energy without raising the charge delivered to the RCS could actually make things worse. For example, total activation in the injection area could go up as the energy goes up. Whether the criteria for implementation should be pegged to 50 mA or 40 mA is a gray area.

Recommendation: ***The LINAC energy upgrade should be implemented only after the RCS injection has been upgraded to 400 MeV and the front-end is capable of producing a pulse intensity that supports an increase in RCS output power relative to that achievable with 181 MeV injection energy.***

The IAC endorsed the recommendation of the A-TAC that the staging of the installation of the ACS Linac in phases is not the most effective utilization of times and resources.

Recommendation: ***The committee recommends that the linac energy upgrade be implemented in a single step***.

Damage to some of the Magnetic Alloy Cores in the RF Systems

Recent observed damage to the magnetic alloy cores used in the ring RF systems is another performance limitation revealed in initial operations. Use of this core material is one of the new developments implemented in the J-PARC complex. Much work has been performed over the last several years in order to improve the performance of the cores and cavities. The committee notes that the team has already demonstrated an improvement in core lifetime of more than an order of magnitude in the last 4 years.

Recommendation: ***Manage this issue – while improvements are developed -- through preparation of a sufficient inventory of spare cores and cavities, as well as the preparation of a 12th RCS RF cavity. In addition, further improvement in the core performance is required. The committee urges a dedicated program making use of the test-stand capability for further improving performance.***

Operational budget limitations continue to limit the ability to acquire much needed spares. A detailed spares strategy is required in order to both set priorities for acquisition of spares, and to use in formulating a sustainable operations budget.

Recommendation: ***That a spares capacity be established 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 continuing development and spares component of the operations budget.***

Current Ripple in the Main Ring Dipole Power Supply

In operation of the main ring excessive current ripple on the dipole power supply was noted during initial startup. This was at the level of 3×10^{-3} at 3 GeV and at 1×10^{-2} during acceleration. The ripple is in a common mode component with the neutral potential point floating with a variation of ±400 V during acceleration. Modifications have been implemented in the power supply and have reduced ripple to 1×10^{-3} at 3 GeV and acceleration, 2×10^{-4} at flattop (slow spill). There is a new filter under design to achieve full performance (few $\times10^{-6}$ at flattop). The IAC concurs with the A-TAC committee view that the current level of power supply ripple is not an impediment to operations with fast extraction. Although the present 90% slow extraction is acceptable as starting point the limiting of cycle time to six seconds is a problem which could be remedied by a dedicated low voltage supply.

2. Are mitigation plans in place and appropriate for addressing performance limitations observed in initial operations?

The underlying cause of the RFQ breakdown remains to be explained in detail and remains to be proven experimentally. Whilst operations at 20KW have been of considerable benefit for testing the accelerator system, understanding instrument performance and even allowing some users to perform novel scientific experiments, the highest priority must be given to understanding RFQ performance now that possible causes have appeared from J-PARC analysis and the discussions of A-TAC. The plans for addressing other limitations are appropriate.

3. Is the impact on operations understood and has it been clearly communicated with the user community?

It is essential to establish and communicate a realistic beam power trajectory which takes into account the envisaged hardware modifications. The IAC has previously recommended that a formal Operations Plan be established and used as a mechanism for capturing hardware upgrade plans, notional operating schedules and anticipated budget needs. It is also a necessary process for communicating projected performance to the user community. The IAC considers the formulation and communication of such a plan as an urgent matter.

Recommendation: ***Management needs now to give strong attention to planning facility improvements in both near and intermediate terms. In the near term "task forces" reporting to the Director are needed for the identified remedial tasks.***

4. Is an organizational structure in place that can effectively coordinate the transition to operations while simultaneously resolving performance issues?

The overarching goal at this time is rightly focused on obtaining first scientific results from the facility. As a result there is intense focus on the very near-term difficulties that are being faced, including the RFQ mitigation, further development of magnetic alloy core issues, resolution of the ring dipole power supply performance issues and increasing ion source performance.

In addition, the linac energy recovery project is now funded, and demands a substantial effort to complete within the timeline established by the funding agency.

The committee is concerned that the present organizational responsibilities and structure leaves open the possibility of a conflict between day-to-day operational needs (and distractions) and those needs which have a longer timeline. As a good example, we note that the linac energy recovery team is composed of members who are busy operating and improving the accelerator performance right now. Likewise, the ion source development requires a dedicated effort free from distractions of day-to-day operations.

The committee heard that the transfer of operational responsibilities from KEK to the J-PARC center is not clear. The IAC would like to re-emphasize the importance of establishing full responsibility for the operation and experimental program within the J-PARC Center.

An organization exists on paper and there is an assigned commissioning coordinator. However, it is unclear what authorities the coordinator has. The organization would benefit greatly from a documented plan that integrates commissioning, repairs to under-performing components, and operations activities over the next several years. Such a plan should be accompanied by a roadmap that establishes the evolution of the complex over the next five or so years, and provides the framework for a more detailed operational plan. It is important that the roadmap be developed by the J-PARC management with all stakeholders, including the users, the sponsoring laboratories (KEK and JAEA). The sponsoring institutions need to assume joint responsibility for the successful execution of the plan, including committing the required resources.

Recommendation: ***Management needs a more coherent approach to planning for facility improvements in both near and intermediate terms. Establishment of a roadmap for the next ~5 years would facilitate this activity. Such a roadmap should be developed in consultation with all stakeholders and should then provide the framework for a more detailed commissioning and operations plan.***

Recommendation: ***The integrated commissioning/operations plan should be extended through the first few years of operations and should be discussed with, and made available to, the user community. The published plan should include estimates of performance, anticipated reliabilities, and the time allocation between users and accelerator physics. The integrated plan should also identify resources required to support the plan.***

5. Are adequate plans in place to take the present post-commissioning performance to the ultimate operating capability?

J-PARC has plans for call into service an "Accelerator Review Committee" populated with local experts, enhanced by a few outside experts, to guide the planning and prioritization for the next several year. The agreed implementation of Linac energy recovery is welcomed and must be included. The formulation of an Operations plan or "roadmap" for the next ~5 years has not yet been developed and, as the next step requires management priority to ensure its completion. We therefore think it is timely for full implementation of our recommendation from the 2008 IAC report:

Recommendation: ***The IAC recommends developing and broadly communicating a formal Operations Plan and notional funding profiles required to achieve the Phase 1 goals (0.6 MW from RCS, 0.4 MW from MR). Such a plan should capture the necessary hardware improvements and their anticipated deployment schedules, the necessary spares for high-reliability operation, the anticipated beam-power trajectory, estimates of performance, and the anticipated operating hours available to each end user program, and time allocation for accelerator physics studies.***

The IAC recommends that the various J-PARC technical advisory committees assess these plans prior to the next IAC meeting.

PARTICLE AND NUCLEAR PHYSICS

HADRON EXPERIMENTS

The IAC congratulates the Hadron Hall and T2K teams for their impressive installation progress during the past year, keeping both programs on track for a timely launch of data-taking.

In particular, the Hadron Hall was made ready to accept first slow-extraction beam on January 27, 2009 and the T1 secondary beam production target was installed, permitting a start on commissioning of the first secondary beam line (K1.8BR), on February 10, 2009. Both of these events are major milestones for the facility. Two other beam lines (K1.8 and KL) should be ready for commissioning by Fall 2009, with K1.1BR and a Test Line scheduled for completion around the start of JFY2010. A partial installation of the detection equipment for the K1.8BR line will allow data-taking to begin soon on experiment E17, studying kaonic atom X-rays from the K^--^{3}He atom. The SKS spectrometer for the K1.8 line has been moved from KEK and should be ready for installation, with its complete detector package, by Fall 2009. This setup will facilitate a program of high-resolution hypernuclear spectroscopy, with the first experiments scheduled to investigate (π,K) reactions on light nuclear targets. A very sensible short-term plan was presented for commissioning the K1.8BR and K1.8 beam lines, and for launching early experiments that can produce significant physics results at the beam power performance levels anticipated for the next year.

In the longer term, the experiment planned for the Hadron Hall that is likely to have the greatest international visibility is the E14 search for the direct CP-violating decay $K_L^0 \to \pi^0 \nu \bar{\nu}$. The KL beamline needed for this experiment should be ready for beam survey in Fall 2009, but a clear timeline for mounting the experiment was not presented. The cesium iodide crystals needed for the detector are to be moved from Fermilab. The first phase of the experiment aims to reach sensitivity levels that will allow a first observation of the decay if its branching ratio occurs at the Standard Model prediction, and therefore provides significant discovery potential for physics beyond the Standard Model. Reaching this sensitivity requires three years of exposure at a beam power of 300 kW. The IAC believes that establishing a clear timeline for completing this first phase of E14 should be an important part of a developing strategy to optimize the J-PARC scientific impact.

NEUTRINO EXPERIMENTS

The centerpiece of the particle and nuclear physics program at J-PARC is the T2K experiment that will direct a muon neutrino beam toward the Super-Kamiokande detector. The past year also saw impressive progress toward the launch of this experiment. Fast extraction of beam from the Main Ring was successfully demonstrated in December 2008, and first beam commissioning with the production target and first neutrino horn is anticipated for Spring 2009. The second and third horns are scheduled now for installation during the Summer 2009 shutdown. Near detector construction is proceeding at a high level of activity toward completion in time for full beam and detector commissioning near the end of 2009. Data acquisition system and readout electronics upgrades of the Super-Kamiokande detector have been completed, so that SuperK is now ready for beam from J-PARC.

There is strong international competition for T2K 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, J-PARC will have to upgrade delivered beam power rapidly. The IAC was presented with a viable, though aggressive, short-term T2K strategy in which a 2010 run of duration 1×10^7 seconds at beam power of 100 kW could produce a first physics result by the end of 2010 that is comparable to the anticipated goal on that timeline for the Double Chooz reactor experiment. However, the longer-term strategy is not entirely clear. The ultimate T2K goal sensitivity below 0.01 requires 750 kW beam exposure for 5 years, and could thus deliver a result substantially later than the similar sensitivity measurement anticipated for the Daya Bay reactor experiment by 2013. The NOνA experiment utilizing a beam from Fermilab is now back on track in the U.S., and its timeline must also be taken into account. The IAC urges that a clear strategy for maximizing the impact of T2K be a critical component of an overall J-PARC strategic plan.

Recommendation: ***J-PARC and KEK need to develop a clear long-term strategy to maximize the scientific impact of T2K in the face of strong international competition and of a rare kaon decay program. The strategy should include identification of appropriate resources to realize timely delivery of several hundred kilowatt beam power.***

MATERIALS AND LIFE SCIENCES

NEUTRON SCATTERING

The International Advisory Committee congratulates J-PARC on the successful completion of the construction phase of the Materials and Life Science Facility and welcomes its transition to face the next set of challenges - commissioning and then full exploitation.

Neutrons were first produced and recorded in the MLF on the 30th of May 2008. In June 2008, one of the first instruments, the Super High Resolution Powder Diffractometer (SHRPD) recorded the world's highest resolution neutron diffraction pattern.

All early results have confirmed the efficacy of the advanced design concepts of the neutron production target, coupled and high resolution moderator systems and innovative neutron scattering instrumentation. This, together with the demonstration of the potential to deliver 300 kW beam for a short period, bodes extremely well for the realisation in Japan of a world leading facility for the Materials and Life Sciences.

The transition from early commissioning to full user operation with beam allocation via an external PAC may, however, be premature. Intermittent beam at 30 kW is fully adequate for the early phases of instrument commissioning, allowing the calibration of detectors, debugging and testing of software and the start of the long process of finding and reducing sources of background and optimising instrument performance. There is clearly pressure to move from the successes of this early commissioning phase into an operational phase with undue haste: this must be resisted and the expectations both of the user community and the facility sponsors managed. Exposing a new and expectant community to unreliable and under-resourced operations is not to be advised.

The building blocks for success are all potentially in place, but delivery of a robust user operation for demanding and unforgiving users – especially those unfamiliar with central facilities (eg industry) will take time. The IAC accepts the arguments made by N-TAC on instrument staffing. Current staffing levels, typically 3.5 FTEs per instrument, are perhaps adequate for commissioning at 20 kW, but fall woefully short of the internationally recognised standard of the 6-8 FTEs of technical and

scientific support required to realise a world ranking user programme at 100 kW+ operations.

Recommendation: ***In parallel with delivery of increasing beam power from the accelerator, a strategy to build up scientific and technical support for the MLF program to international levels should be established.***

The IAC agrees with the N-TAC analysis that needs for support laboratories near the instruments must be arranged and prioritized.

"As the type of equipment one requires depends critically on the types of users one seeks to serve, this will require that the MLF at least estimate the balance of scientific usage on each instrument. Desired service levels and space requirements can be developed by benchmarking against other leading neutron facilities.

Some soft matter users may run 20 or more samples per hour on a SANS instrument, and at a lesser but still significant rate on the reflectometers. As these samples are usually prepared at the facility, well-equipped user support laboratories very near the neutron instruments are essential for users in the areas of soft matter and biology. This space should be separate and in addition to the existing facilities for powders and other hard matter. Unfortunately, the current laboratory space in the MLF is wholly inadequate and the Ibaraki Quantum Beam Research Center is too far from the experimental halls to serve this function.

NTAC recommends that the MLF develop a prioritized plan for support laboratories at the MLF and/or accessible to users of the MLF by the next NTAC meeting. In addition, a plan should be developed for the equipping and staffing of these support laboratories."

The IAC was delighted to see that our earlier recommendation to deliver 10 neutron scattering instruments has been achieved and indeed exceeded. Welcome investment from Ibaraki prefecture and the transfer of the highest quality instruments from KENS means that a total of 15 of the 23 beamlines will be instrumented at some level in the early days. Partial detector coverage is adequate for initial operation, and plans are in place to raise the capability of all of these 15 instruments to world standard in the not too distant future. The IAC recommends that J-PARC focuses its resources in bringing the initial instrument suite to full

world standard before embarking on the development of the unassigned beamlines. These slots are precious, and a strategic rather than pragmatic allocation would be wise in the future.

Recommendation: ***The IAC recommends that the unassigned neutron beamlines are not allocated at this stage so that future choices, informed by experience gained with this initial instrument suite, can be made.***

MLF MUON FACILITY

The successful completion and initial operation of the muon production facility represents a defining event in the life of the MLF at J-PARC. Through sheer hard work and dedication, a muon beam was produced on time and the first five experiments received beamtime. Even in somewhat trying conditions, interesting and publishable results were obtained in the first user cycle. This is a tremendous achievement and the IAC congratulates the entire team for this success.

As predicted previously, the user community has realized the unique opportunity presented by the development of the world most intense pulse ultra slow muon beams at J-PARC. Large collaborations are now forming to exploit this unique opportunity and seek funding to mount a world class experimental program. A visionary scientific leadership has to be put in place to nurture the large international interest in Ultra slow muon beams at J-PARC and orchestrate the activities of the muon facility complex. Interest in such beams are coming from different communities like material sciences, particle physics and industrial applications. Although this represents a departure from the initial vision, it should be taken as a positive endorsement of what is being build . This represents a challenge to adapt the MUSE complex to this new reality. The IAC reaffirms its strong support for building the planned Ultra Slow Muon line as soon as possible to initiate the science program at the earliest opportunity.

Strong leadership will be needed to select the optimal roadmap for the MUSE program at J-PARC . By exploiting the specialized expertise which are getting engaged from key players in academia , research institutes and industry, J-PARC will be in a position to develop the world most powerful source of ultra slow muons. This will benefit the

main customers which are still going to be the large community of material scientists who will want access to micro probes to study surfaces, thin films and nanostructure. The new organization of the J-PARC MUSE group should reflect this new reality and include review mechanisms for selecting projects on scientific merit within a defined vision, for blessing facility developments prior to developing external funding applications and for approving muon beamtime.

Recommendation: ***The parent organizations of KEK and JAEA need to capitalize on the investments made so far in the MUSE facility, on the superb technical skill available in the current team and on the various funding opportunities available to the users by investing in a strong scientific leadership who could bring these realizations into fruition. The IAC reaffirms that the development of the Ultra slow muon beamline is of the highest priority.***

USER INTERFACE, SAFETY and COMPUTING

User Interface

The creation of a User Office has been an important step. It will define 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 substantial progress in developing a pro-active user interface at J-PARC, addressing issues such as:

- Communicating opportunities afforded by J-PARC to a wide-ranging scientific field
- Developing the appropriate peer review processes to ensure a high quality and balanced programme
- Scheduling and organising support before during and after experiments
- Creating the appropriate safety culture for J-PARC Users
- Delivering feedback from to users to the facility, enhancing future capabilities
- Publicising success and broadening the appeal of J-PARC in new communities

The IAC agrees with the N-TAC discussion on the importance of sociable rest facilities convenient to the instruments in the MLF facility.

"J-PARC will be a focus for some of the world's best scientists. Informal meetings and discussions are an important contributor to the scientific atmosphere in any research organization. These meetings often lead to new collaborations and result in significant advances in our understanding of materials and the development of new technologies for neutron science. These interactions are so important and exciting that certain areas at existing facilities are legendary as a highlight of the user's scientific experience. The committee did not see any location where these important interactions would naturally occur at the MLF. It seems to us that the Ibaraki Quantum Beam Research Center is too far from the MLF for informal scientific discussions to occur naturally. Moreover the Ibaraki Quantum Beam Research Center is on the other side of a very busy road which is difficult to cross safely. On a related note, J-PARC is located in the country-side. Thus the development of appropriate accommodations and restaurants are very important to attract users to the MLF."

The IAC supports the idea of developing a "TOKAI campus" which would provide an active intellectual forum for researchers, post-doctoral fellows and students across the J-PARC enterprise and even for the community at large.

Safety

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.***

Informatics and Computing

The IAC notes the progress made by the information section since its establishment in April 2008. The thought given to providing ease of external user access, to instrumental operation and gathered data both at

the center and remotely, is an important step forward and the cooperation of the J-PARC partners in achieving this and future developments shown to the Committee is commended.

User-friendly data information and data base systems will be an important feature of J-PARC success. The high volumes of data from the MLF facility will increase as greater detector areas are used and the power of the accelerator grows. Similarly, the hadron and neutrino programs will place large demands on data processing and data storing capabilities at J-PARC. In concert with the users, the computing group should anticipate how these critical resources will be allocated and managed. Transformation of the data sets during experiments at J-PARC and remotely by the national and international user communities will be essential to the productivity of the facility. The cooperation of instrument scientists and the information section of J-PARC will be essential in achieving this.

USER ADVISORY COMMITTEE

The IAC thanks Professor T. Yamanaka and the User Advisory Committee for their detailed work and helpful advice to J-PARC. Every Director needs the advice on a regular basis from the user community and the channel provided in the J-PARC User Advisory Committee is a good one. The scope of this user advice was wide ranging and was an important insight for the IAC into the long-term thinking of the broad scientific group represented in the Committee. The IAC would appreciate an annual report from the User Community focusing on the larger issues for J-PARC that they see as the operational phase develops in the various sectors.

Recommendation: ***The IAC notes with satisfaction the formation of the J-PARC User Advisory Committee reporting to the J-PARC Director, and its broad composition. It is recommended that a report from the Committee be available to the IAC at its annual meetings.***

NUCLEAR TRANSMUTATION

The IAC was pleased to learn that the AEC committee chaired by Professor Yamana AEC will include a review of partitioning and transmutation (P&T) technology. The publication of this report at the end of March will address some of the important concerns about the contribution of P&T to nuclear waste management using the future generation of nuclear reactors. The intermediate report indicates that current research in Japan will be carefully evaluated and that the directions of R&D concerning different concepts, future infrastructures requirements and international cooperation will be ranked by priorities. The final report from this committee composed of high-level representatives of academic, public organizations and industry, will be essential to support J-PARC transmutation R&D.

The IAC appreciates the efforts of the J-PARC team to build a strong R&D community bridging academic and industry technology research. The IAC recommends that the J-PARC team contributes to the experimental work at Kyoto University for the FFAG-KUCA coupling experiment that is about to start. It will have a significant impact on the development of fruitful collaborations between J-PARC and academic R&D in Japan. 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 reactor ten years ago are emblematic of the public need for reliable information.

Recommendation: ***The IAC reiterates its recommendation that J-PARC should develop a long term strategy in transmutation experiments and ADS research, with a significant increase in experimental efforts as well as in the TEF facility design studies.***

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.

It is worth noting the considerable evolution of nuclear power perception around the world. In particular Italy, Sweden and other countries across Europe are embracing nuclear energy after years of

opposition. A startling change on the issue has also come from leading environmentalists. These changes have encouraged the creation of a European Sustainable Nuclear Energy Technology Platform. The first general assembly has taken place in October 2008. P&T research is recognized as a lead to systems that would effectively reduce the volume and long-term toxicity of radioactive waste emanating either from the reprocessing of spent nuclear fuel or the spent fuel itself. Research will also explore the potential for new reactor concepts and/or fuel cycles to produce less waste during operation of nuclear power plants. Work in this area will lay the groundwork for future sustainable nuclear fuel cycle strategies involving transmutation in a dedicated waste-burning Accelerator Driven System (i.e. sub-critical reactor).

The IAC acknowledges that the J-PARC team has developed important collaborations with the EU R&D programs EUROTRANS and MEGAPIE. J-PARC has also participated in several meetings held by OECD/NEA, IAEA, and Asian countries. These meetings have been the opportunity to establish fruitful contacts to encourage the participation of foreign countries to J-PARC experimental program on P&T.

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

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: ***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 8th International Advisory Committee Meeting
J-PARC

Date: March 9(Mon) and March 10 (Tue), 2009
Place: J-PARC Center – Tokai

March 9 (Mon)

8:50 - 9:10	Executive Session (Closed) Committee + Nagamiya, Oyama, Yamazaki	
9:10 - 9:30	KEK and J-PARC	Y. Kamiya
9:30 - 9:50	Overview of the Japan Atomic Energy Agency	H. Yokomizo
9:50 – 10:10	-- Coffee Break –	
10:10 – 11:10	Status of J-PARC	S. Nagamiya/Y. Oyama
11:10 – 12:40	Accelerators	
	- J-PARC Accelerator Progress Report	A. Ando
	- A-TAC Report	S. Holmes
12:40 – 14:00	-- Lunch –	
14:00 – 15:30	Nuclear and Particle Physics Experimental Facility	
(14:00-14:20)	- Hadron Facility of J-PARC	K. H. Tanaka
(14:20-14:45)	- Experiments at Hadron Hall in JFY2009	T. Takahash i
(14:45-15:30)	- Status of Neutrino Experiment T2K	T. Kobayashi
15:30 – 15:50	-- Coffee Break –	
15:50 – 17:30	Material and Life Science Experimental Facility	
(15:50-16:35)	Status of MLF and Topical Progress Report of Neutron	Y. Ikeda
(16:35 -16:50)	- N-TAC Report	D. Neumann
(16:50 -17:15)	-One Year Progress of J-PARC Muon Facility MUSE	Y. Miyake
(17:15-17:30)	- MUSAC Report	J.-M. Poutissou
17:30 – 18:00	Closed Session	
18:30 -	Reception (Akogi-ga-ura Club)	

March 10 (Tue)

8:50 - 9:10	Executive Session (Closed)	
9:10 – 9:40	Nuclear Transmutation	H. Oigawa
9:40 – 9:55	Network and Computing in J-PARC	A. Manabe
9:55 – 10:10	J-PARC USERS OFFICE in FY 2008	M. Ieiri

10:10 – 10:30 -- Coffee Break –

10:30 – 11:10 Report from J-PARC Users Committee
-- Prospects of Science at J-PARC --
（presented by phone from Aichi pref.） T. Yamanaka
11:10 – 12:15 Closed Session & Working

12:15 – 13:10 -- Lunch –

13:10 – 15:00 -- Site Tour --
15:00 – 15:30 Working Hour
15:30 – 16:00 Summary Session
Adjourn

APPENDIX II

COMMITTEE MEMBERS

CHEN, Jia'er	Professor, Peking University. chenje@pku.edu.cn
FROIS, Bernard	Director at CEA of the "New Energy Technologies" programs of the French National Research Agency.CEA-Saclay bernard.frois@cea.fr
FUKUYAMA, Hidetoshi	Professor, Tokyo University of Science, fukuyama@rs.kagu.tus.ac.jp
HENDERSON, Stuart	Director, Research Accelerator Division, SNS, Oak Ridge, shenderson@ornl.gov.
HOLMES, Steve	Associate Director, Fermilab, USA. holmes@fnal.gov
PETITJEAN, Claude	Science coordinator, Laboratory of Particle Physics, Paul Scherrer Institute, Switzerland. Claude.petitjean@psi.ch
POUTISSOU, Jean-Michel	Associate Director, TRIUMF, Canada. jmp@triumf.ca
TANAKA, Satoru,	Professor, University of Tokyo, s-tanaka@q.t.u-tokyo.ac.jp
TAYLOR, Andrew	Director, RAL and ISIS, UK. adt@isise.rl.ac.uk
VIGDOR, Steve	Deputy Director, Brookhaven National Laboratory vigdor@bnl.gov
WHITE, John W. (Chairman)	Professor, Australian National University Canberra, Australia, jww@rsc.anu.edu.au