THE INTERNATIONAL ADVISORY COMMITTEE

ON THE J-PARC PROJECT

REPORT 2 April 2008

The first great achievement of the J-PARC - the next Challenge the operation phase

Meeting 3 -4 March 2008

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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 3 and 4 March 2008 at JAEA, Tokai and toured the construction site of J-PARC.

The IAC had reports from the Accelerator Technical Advisory Committee (A-TAC) and the Neutron Technical Advisory Committee (N-TAC), which met the previous week at Tokai. The present report is also informed by reports from the Muon Science Experimental Facilities Advisory Committee (MUSAC) meeting at Tokai on 15-16 January 2008. The agenda of the IAC meeting is attached as Appendix I and the membership at Appendix II.

The J-PARC Project is beginning operation in 2008 as Phase 1 of the project comes to a successful conclusion. The IAC wishes to use nothing but superlatives to describe what it has read, listened to and seen on this visit. The buildings and the first two components of the accelerator complex as well as instruments have been or are being delivered on schedule and on budget.

We attribute this great success - organizationally to the formation of the J-PARC center and its support by the partner organizations JAEA and KEK. At the human level, these achievements have come from a heroic performance of the whole J-PARC team from the Director (Professor Nagamiya) to the staff involved in all operations. High standards of commitment by the personnel have been demonstrated. The developments - in the experience on the IAC - have been little short of miraculous given the financial and other constraints and the time schedule.

The budget constraints during Phase 1 - though greatly relieved by the strong efforts of the partners and the Japanese Government mean that spares for the operation phase are very low in all departments. There are high risks in some areas. For example, only three spare klystrons exist, there is no spare neutron target and the replacement capability for components in the accelerators which show variability in manufacture and a tendency to fail is minimal.

The budgetary constraints also indicate that in the next phase as operations build up, money will be needed to spend on solvable problems identified as power increases in the accelerator and target systems. Examples are - the accelerator cavities are running at nearly 100% of their rating and solutions must be developed as long use and higher power becomes common. In addition, work must be continued and international collaborations maintained on the all-important cavitation problems of the neutron target systems. The operation phase must therefore contain an R&D component as well as general operations and user facilitation components.

With a suitable operation budget in the above terms the IAC sees no obstacle to a successful start-up of the first user operations with neutrons (2008) and nuclear physics and neutrinos (2009). The budgetary emphasis at this stage must be on sustainability in the next 4-5 years as recommended in the 2007 IAC report.

The committee is aware that the J-PARC directors and partners are pursuing this goal with the Japanese government. The committee strongly supports these processes to obtain a strong operational budget at least at the minimum level proposed in the IAC's 2007 report and has recommended accordingly. We recall here the 2007 key point :

"At our request the Director has prepared an analysis of cost cutting measures in the operational budget - so that systematic improvement of the accelerator system and instruments can be done within the envelope of about 190 OYen per annum (estimated last year) at full operation after 2008."

Listening to the record of achievement, the IAC is completely convinced of its previous recommendations for a clear timetable and funding to achieve the energy upgrade. Our appraisal of the experimental needs in all sectors indicates the benefit of holding to the vision of world's best performance for the accelerators and their dependent instruments.

The IAC welcomes the acceptance by J-PARC of its recommendations on organization within the Center. There has been a positive response to all recommendations but more needs to be done to ensure smooth installation of remaining Phase 1 components and maximum efficiency for engaging the user communities. Key areas of administrative process - some of them mentioned in 2007 - remain. These include -

- Smooth translation of key personnel from construction into operation so that the experimental "know-how" of those who have built instruments, the target station, the accelerator complex, and the technical support is retained both in the form of documents and enduring personal knowledge.
- The processes of coordination need to be further strengthened so that very clear lines of responsibility are available to new users and experimental groups.
- The culture of a very friendly user office as well as personally responsible scientists and technicians at the instruments needs to be progressively established. As experiments and instruments come online this organizational structure must be very visible to the external world and easily approachable.

The IAC advises that the first few years of the operation phase will be very important in establishing J-PARC's scientific credentials. The clear budgetary signal on operational funding from JAEA, the KEK and the Japanese government is vital. For the high volume user experiments such as Materials and Life Sciences the best scientists nationally and internationally should be recruited to mentor new users in the initial operation and by their own excellence recruit them a vision of J-PARC as the world's best institute for their work.

The status of J-PARC's own staff scientists was discussed in 2007. The IAC holds to these recommendations on internal contestability and a single PAC process for all users. We go further in 2008 to suggest that excellent "in house" scientists should have the right to apply for external grants and join external collaborative grant processes for their work within an eventual goal - of their having an appreciable portion (e.g. 20%) of their time available for personal science.

The IAC thanks the J-PARC Director, Professor Nagamiya, and the project team for the preparation and the openness of discussion at the IAC. 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 notes with approval the extent to which its recommendations of IAC 2007 have been taken up by the project team, the individual project leaders and the partner organisations.

IAC Recommendations

Recommendation 1: The IAC recommends that KEK, JAEA and the Japanese Government come together to decide on a J-PARC operational budget profile for 2009-2012. The analyses of the 2007 IAC report should be the basis of this. Such a multi-year commitment is needed for planning purposes and to launch a user program which will allow Japanese and foreign groups to make scientific commitments to J-PARC.

The committee strongly supports the efforts of the J-PARC Director and partners with the Japanese government to resolve this matter. The method used for SPring-8 designating J-PARC as a "National Facility" under the new law, for example, already appears attractive for the JAEA funding component. We recommend that innovative consideration be given also to the KEK part to ensure balance.

Recommendation 2 The IAC is convinced that the full potential of the J-PARC complex cannot be realized with a 181 MeV linac. We therefore urge the identification of funding profile for restoration of the linac energy to 400 MeV as a high priority item.

Recommendation 3: The IAC recommends that sufficient funds be set aside within the J-PARC operating budget to secure an appropriate level of spares and to support necessary improvements to the J-PARC complex with a goal to providing 0.6 MW from the RCS and 0.4 MW from the Main Ring (MR).

Recommendation 4: The IAC urges both KEK and JAEA management to transfer operational responsibilities and associated financial and personnel resources to the J-PARC Center management as soon as possible. The Center should establish strong and clear lines of responsibility for coordination of all J-PARC experimental programs to meet the expectations of the users in a way that achieves world's best practice.

Recommendation 5: 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.

Recommendation 6 The Director of J-PARC should put in place a proposal evaluation structure for J-PARC operations involving a Central Advisory Committee reporting to the Director which brings together the recommendations of the program advisory committees (PACs) for all elements of J-PARC use. We recommend that this be done with the help of the KEK and JAEA as well as the advice of the newly formed user committee.

Subsidiary Recommendations

The IAC cannot stress strongly enough the importance of:

- **developing a plan for deployment of the linac energy upgrade to achieve the ultimate performance capability of the J-PARC complex, namely 1 MW of beam power from the RCS and 0.75 MW from the MR**

The IAC agrees with the ATAC recommendation that, <u>if</u> the full funding profile is delayed, it would be timely to reconsider the type of accelerating structure for the LINAC energy recovery plan , including superconducting or side coupled,

IAC congratulates J-PARC in attracting funds for the 10 initial neutron scattering instruments which will ensure a solid platform for early operations. The IAC recommends the choice of the next wave of instruments be very innovative and forward looking.

IAC notes the value of ATAC, NTAC and MUSAC as advisory committees and recommends a similar committee to oversee the construction and exploitation of facilities for neutron scattering within the MLF.

USER OPERATION

1) **It is recommended, that all users go through the same office of J-PARC CENTER to get experiments approved. This office should establish common rules of procedure.**
2) **It is essential to have a directors advisory committee to make recommendations on the overall program balance and the proton economy, taking into account the recommendations of the various PACs.**
3) **Proposal selection mechanisms should be developed adapted to the scale of the scientific work. For large experiments this may involve presentation (and defense) by proponents at open meetings.**
4) **The after approval process should be defined; this includes communication of results from the PAC, feedback, scheduling process, management of the day to day schedule, flexibility of scheduling, safety reviews, etc.**

GENERAL STATUS OF THE PROJECT

From the presentations and the tour of the accelerators the Committee has formed a clear impression that J-PARC will become a world center of excellence in the broad area of science set out in the original goals by the partners JAEA and KEK.

The presentations to the International Advisory committee were thorough and gave a comprehensive understanding of the amount and quality of work done by the staff of J-PARC between March 2007 and March 2008. The amount of work was truly impressive both in its extent and in the very detailed problems which have been tackled and overcome. The performance targets already reached indicate high quality construction in many aspects and bode well for the future.

The buildings and underground spaces for the 3 GeV RCS and the 50 GeV main ring are completed on budget and on time and are impressive. The construction of accelerators is near completion and beam was injected successfully into the 3 GeV synchrotron. The RCS accelerated the beam to a design value of 3 GeV on October 31 2007. The accelerator delivered 50-kW beam power for 4 minutes (limited only by the beam dump capacity). This high power availability is a significant milestone. Subsequently, the RCS ejected one shot of the beam, equivalent to 130 kW, if operated at 25 Hz. The 50 GEV ring will be ready to accept beam in December 2008 and the instruments for the Materials and Life sciences beam hall are progressing well.

That all of this has been done on budget and on the scheduled time established in 2006 is very impressive. Perhaps one of the most important single achievements has been the design and construction of the mercury target system. The collaboration with the Oak Ridge National Laboratory (USA) has been fruitful for both sides. The Japanese contribution in solving the cavitation problem at the target window - produced by the mercury flow at high power dissipation by the proton beam is a major step towards one megawatt operation. Another shared technology - the introduction of bubbles into the mercury target looks as if it will also prolong target life very considerably in high power operation. Finally the Japanese invented mercury pump (now taken up by the SNS at Oak Ridge) has also been a significant

feature of this collaboration - which should continue as both neutron sources approach the one megawatt level.

The report of the N-TAC (below) has much praise for the target work and wise counsel about important details related to the best way to ensure smooth and continuous operation from these very novel technologies.

J-PARC CENTER ORGANISATION

The J-PARC Center is now an operational success. The IAC attributes the great improvement in staff morale over the last two years not only to their dedication to the task of finishing the construction phase but also to the growing sense of a common achievement shared in the last year. The IAC is grateful to the KEK and JAEA for their support of this unifying concept. We have confidence that it will grow in value with the beginning of outside users operation .

We note that recommendations for a transparent organizational structure with authority in the J-PARC Center has been recognized by the partners in the new organizational charts shown to the IAC. Of essential value to the project in the future, is the management of the user process by a Central Advisory Committee (CAC) to the Director of J-PARC and a coordinated project management office reporting to the Director. The lines of authority between the Director through the CAC to the individual program advisory committees (PACs) need to be clearly spelt out and a sensitive management process developed with the scientific structures of KEK and JAEA, developed within this framework. For example, the complementarity between the excellent neutron instruments in the JRR(Japan Research Reactor)-3 reactor and the new time of flight instruments in the Materials and Life Science area is a great advantage to Japanese science and industry and, possibly, international science at the Tokai campus of both KEK and JAEA. The establishment of mutually beneficial relations between the programs in these areas will be a long term test of the good relationships that are developing.

Recommendation The Director of J-PARC should put in place a proposal evaluation structure for J-PARC operations involving a Central Advisory Committee reporting to the Director which brings together the recommendations of the program advisory committees (PACs) for all elements of J-PARC use. We recommend that this be

done with the help of the KEK and JAEA as well as the advice of the newly formed user committee.

There are special and generic comments on the user program in the Materials and Life Science sections below. Here, we wish to reinforce our comments from the 2007 report on both the provision of appropriate staff and the way in which they and the user office should interact at long distance and on the site with new users. The provision of information, the mentoring and induction of users by the scientific and technical staff and eventually, the collaboration of J-PARC staff and users are matters for deliberate policy in J-PARC are careful nurture by the management.
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ACCELERATOR STATUS

The Accelerator Technical Advisory Committee (ATAC) for the J-PARC Project held its seventh meeting over the period February 28-March 1, 2008. The ATAC delivered its report during the IAC meeting.

Significant progress has been made over the last year on all fronts, highlighted by the achievement of full acceleration and extraction of the 3 GeV beam in the RCS. The IAC joins the ATAC in offering its congratulations on these achievements to the entire J-PARC team!

The J-PARC project is now nearly complete with construction of the neutrino beamline the sole significant construction/installation activity remaining. Beam commissioning is well advanced in both the linac and RCS. Hardware commissioning is underway in the Main Ring, with beam commissioning scheduled to start in May. The schedule remains unchanged from that presented to the IAC two years ago—an outstanding achievement. Startup of accelerator operations in support of the research program is expected in the 3rd quarter of JFY2008.

As the construction project nears completion there remain several areas that will require continued attention to assure a smooth transition to operations and full realization of the potential of the J-PARC complex:

- Planning for the upgrade of the linac energy to 400 MeV
- Main Ring performance

- Establishing rf accelerating systems in the RCS and MR sufficient to support long-term goals.
- Maximizing performance of the J-PARC complex over the first several years of operations.

These items are discussed in detail in the ATAC report, and are summarized herein.

Linac

The linac has been in operations at its design energy of 181 MeV for more than a year. It is operating well and reliably, supporting commissioning activities both within the linac itself and within the RCS. The level of performance in the linac is sufficient to support the initial operational goals of the J-PARC complex.

Linac Energy Upgrade Plan

The linac energy upgrade will restore the 400 MeV linac capability that was included in the original scope of Phase 1 of the J-PARC project. With 181 MeV linac output energy, the RCS is limited to 0.6 MW beam power, and the Main Ring is limited to less than 0.45 MW beam power. These performance levels fall well short of the envisioned performance capability of J-PARC.

Recommendation: The IAC is convinced that the full potential of the J-PARC complex cannot be realized with a 181 MeV linac. We therefore urge the identification of funding for restoration of the linac energy to 400 MeV as a high priority item.

The total cost of the energy upgrade is approximately 90 Oku-yen. The upgrade includes the construction of 21 acceleration modules, two buncher modules, and two debuncher modules. The modules all utilize (room temperature) annular coupled structures (ACS). To date two annular coupled structure (ACS) buncher modules have been fabricated and tested at high power, and one low beta accelerating module has been fabricated and characterized at low power.

A “feature” of the ACS is that it is impossible to tune the accelerating cavities after brazing. Manufacturing errors then manifest themselves as

"field tilt" in the cavities. While the low beta module shows such a tilt, it is probably usable as is. Nevertheless, as recommended by the ATAC, this issue points to the importance of i) establishing ACS assembly specifications required to accommodate the acceptable range of field tilts, and ii) considering an arrangement that would allow tuning of the coupling cells.

The IAC agrees with the ATAC recommendation to reconsider the type of accelerating structure, including superconducting or side coupled, for the energy upgrade <u>if</u> funding is delayed by a year or two.

3 GeV Rapid Cycling Synchrotron Status

Great success has been achieved in the RCS beam commissioning. Beam commissioning was initiated in early October and 3 GeV accelerated beam was established by the end of the month, ahead of schedule. The RCS is working well at low intensities and many aspects of the beam and lattice properties are well characterized. A particularly important accomplishment was the successful single-bunch operation of the RCS for several minutes at a beam power of 50 kW. The RCS is prepared to support beam commissioning in the MR, scheduled for May. The IAC congratulates the entire RCS team on these fine accomplishments!

The expectation is that the current configuration will support 300 kW operations in 2009.

Beam loss of 6% is observed at roughly 10% of nominal intensity in the RCS for conditions in which the beam is not painted. It is important to understand the source of this loss. Possibilities might include space-charge (since the beam is not painted), optics mismatches, leakage from the rf bucket, and/or extensive foil interactions. Continuing the commissioning studies with injection painting to explore higher intensity operations is a high priority for the upcoming study periods.

The ATAC continues to be concerned about how losses are distributed on the collimators, and in particular the possibility of uneven deposition on the collimators that would exceed the rated capability of any single collimator jaw.

The IAC agrees with the recommendation of ATAC that an improvement plan should be prepared for the RCS collimator system

that provides sufficient margin to cope with realistic operations scenarios.

The extraction kicker impedance remains at a level that could readily lead to instabilities at the design beam power levels. The IAC agrees that it is very important to prepare a plan to address beam instabilities caused by the large kicker impedance.

Main Ring Synchrotron Status & Commissioning Plan

The Main Ring (MR) installation is complete with the exception of some injection/extraction devices and the collimators. Power testing has been underway since December 2007. Beam commissioning at the injection energy of 3 GeV is scheduled for May-June, 2008. Following a summer shutdown beam acceleration and extraction commissioning is scheduled to start in December, 2008.

The decision has been taken to initiate operations at 30 GeV, with 6 bunches, and a 3.0 second cycle time, to yield 100 kW of beam power at 1.2E13 protons/bunch, which is the established operational goal for JFY2009. No specific plan was presented for moving beyond this performance level in subsequent years. The IAC believes it is very important to prepare to move well beyond 100 kW in the years prior to the linac upgrade completion, in order to realize the full potential of the Phase I configuration.

The ATAC recommended establishing a multi-year strategy for achievement of 400 kW performance in the MR with the 181 MeV linac, based on the April 2009 configuration as a starting point. Such a strategy could include any or all of the following: 8 bunch operations, reduced cycle time, second harmonic operations of the MR rf system, increasing the loss budget at 3 GeV, h=18 operations of the MR, h=1 operations of the RCS, and/or means for providing longer bunches from the RCS.

The IAC agrees with the recommendation of ATAC that a multi-year strategy be developed for achieving 400 kW MR performance with the 181 MeV linac.

Several technical issues were highlighted by the ATAC that will need to be addressed in order to reach ~400 kW. These include

- Poor risetime of the fast extraction kicker that limits operation to 6 bunches (rather than 8 in design)
- The need for a 6th RF station to reduce the cycle time from the present 3.0 seconds to the necessary 2.0 seconds.
- Beamloss simulations predict 330 Watt, compared to the loss limit of 400 W, for 200 kW operation
- Machine impedance and beam instability issues threaten to limit operation to a few hundred kW. These investigations need to be extended, utilizing the full capability of existing simulation codes to estimate instability thresholds.

The IAC concurs with the ATAC recommendation to i) continue instability analysis, utilizing existing multi-particle simulation tools to estimate instability thresholds under realistic conditions, ii) develop a transverse damper, iii) investigate whether chromaticity is effective for beam stabilization, and is consistent with the required dynamic apertures requirements.

RCS & Main Ring RF System

Currently 10 RF stations are installed in the RCS and 4 stations in the MR. The RCS stations are performing well and have accumulated roughly 500 hours of operations. The RCS stations utilize un-cut cores, with external inductors. The MR stations utilize cut cores, according to the plan developed a year ago.

It has been found that more voltage than anticipated is required to accelerate the RCS beam without loss. As a result cavities are being operated at higher gradients than the ATAC had suggested. (ATAC suggested running with limited field (85% of design) in RCS. Current operation is close to 100%.) It is extremely important to understand why the voltage seen by beam is lower.

11-12 stations are required in the RCS to support 0.6 MW beam power. The ATAC recommends to prepare for installation of 12 rf stations in the RCS in order to realize the pull performance potential of the RCS.

6-7 stations are required in MR to support Phase 1 potential of a 2.0 second cycle at 30 GeV. The ATAC recommended preparation for installation of at least six rf stations to realize the full potential of in the MR in Phase 1.

While the installed RCS RF stations have operated ~500 hours (with uncut cores), the ATAC remains concerned about the long term performance of the RCS and MR RF systems. The ATAC is concerned that there is no monitoring for any incipient degradations, and therefore encourages the development of a monitoring strategy.
The ATAC has supported investigation of oil filled cavities as a long term solution, particularly for the MR. Design work has been initiated in this alternative, but the ATAC recommends strengthening the effort invested in the study of oil cooling with the goal of a full scale demonstration on an MR cavity within 2-3 years.

The ATAC reiterates strongly the need for having an RCS and MR type rf systems available outside of the rings to pursue testing and development.

Realizing the Full Potential of the J-PARC Complex

At this stage of the Project, it is natural that the efforts of the staff are focused on the very near-term challenges and stresses of meeting project installation and commissioning milestones and project performance goals. Further, with the uncertainty in the operating budget in the out-years, it is more difficult to develop detailed operating plans. While this emphasis on the near-term is understandable, **the IAC would like to emphasize the central importance at this time in the Project to re-focus attention on achieving the ultimate goals of the J-PARC complex**, namely a world-class, robust materials and life science program enabled by 1 MW of beam power delivered by the RCS, and a world-leading particle physics program enabled by 0.75 MW of beam power delivered from the Main Ring.

To that end the IAC cannot stress strongly enough the importance of:

- **Securing a realistic operating budget with sufficient support for spares and the inevitable capital improvements that will be required as a result of lessons-learned during beam commissioning**
- **Developing an operations plan to achieve the Phase 1 performance goals for the accelerator complex, namely 600 kW from the RCS and 400 kW from the MR**

- **Securing funds to begin immediately the linac energy recovery project to increase the linac output energy to 400 MeV**
- **Developing a plan for deployment of the linac energy upgrade to achieve the ultimate performance capability of the J-PARC complex, namely 1 MW of beam power from the RCS and 0.75 MW from the MR**

The IAC shares the concerns expressed by ATAC and NTAC regarding the availability of spare components as J-PARC prepares to enter the operations phase. The committee was told that ~10 Oku-Yen is required to acquire the complement of initial spares. Procurements for high cost "consumables", such as klystrons and target modules, need to be put in place very quickly in order to avoid the possibility of an extended interruption.

As beam commissioning progresses, the team identifies limitations in the existing hardware that must be corrected early in operations. The identification of weak components early in commissioning, and their subsequent correction or replacement is an inevitable process that has been repeated at all large accelerator facilities. Already there is a substantial list of hardware components and systems that will have to be redesigned, refurbished, enhanced or even replaced. This list includes additional RF stations in the MR and RCS, a transverse damper system for the MR, new extraction kickers for the MR, potential improvements in the collimation systems and so on. This history speaks to the need to secure an adequate capital improvement funding in the early operations budgets at a level of 5-10 Oku-Yen.

Recommendation: The IAC recommends that sufficient funds be set aside within the J-PARC operating budget to secure an appropriate level of spares and to support modest improvements to the J-PARC complex with a goal to providing 0.6 MW from the RCS and 0.4 MW from the MR prior to the completion of the linac energy upgrade.

Some progress has been made in defining the accelerator performance specifications through JFY2009. This effort needs to be continued to chart the path to the full capability of Phase 1.

Recommendation: The IAC recommends developing and broadly communicating a formal Operations Plan for achieving the Phase 1

goals (0.6 MW from RCS, 0.45 MW from MR), under the assumption of adequate funding. 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.

Having accomplished the Phase 1 level of performance, the full potential of J-PARC is not realized without the 400 MeV Linac energy upgrade. Only with the energy upgrade will the MR performance of 0.75 MW remain competitive on a world scale, as already emphasized several times in this report.

HADRON EXPERIMENTS

Excellent progress has been made during the past year on civil construction in the Hadron Hall. Development of instrumentation for two beam lines, K1.8BR and K1.8, is well under way, with plans to deliver charged kaon beams to these lines in December 2008 and October 2009, respectively. The IAC was shown tentative plans to complete an additional neutral kaon line (K0) in the 2009-2010 period. There is an engaged user community that has made many proposals for experiments in Hadron Hall and is busy building much of the needed detection equipment. The Nuclear and Particle Physics Program Advisory Committee has already approved 5200 hours of beam time at an assumed primary beam power level of 300 kW, and an additional 15000 hours of beam time proposals already have Stage 1 approval. The user community expressed a strong desire for improved primary beam power, for additional beam lines and for more resource support from J-PARC in mounting experiments. In engaging the user community in a dialogue regarding these requests, it is essential that J-PARC management begins soon to establish priorities and a target schedule among the experiments.

The early experiments that were described to the IAC in the most detail form a varied program with lines K1.8BR and K1.8, studying hadronic interactions and nuclear spectroscopy in the strangeness sector. The K1.8BR line would house two experiments (E15 and E17) searching for

effects of a hypothesized deep nuclear potential binding K^- to nuclei. E15 would search for a bound K^-pp system via the reaction $^3He(K^-,n\Lambda p)$, detecting all final state particles. E17 would use X-ray spectroscopy following atomic capture of K^- by ^3He to determine the strong interaction from the width and shift of the atomic 2p state. Target and detection equipment for these two experiments appear well matched to the beam delivery schedule. Both experiments have international competition and would benefit greatly from an early demonstration of beam power well above the 100 kW level available in the slow extraction mode from the Main Ring. Beam line K1.8 would be home to a program of hypernuclear spectroscopy, featuring doubly strange nuclei prominently, utilizing the SKS magnetic spectrometer and a Germanium Hyperball-J to detect hypernuclear gamma rays in coincidence with the charged reaction product. The Japanese teams proposing these hypernuclear experiments are the world leaders and they have little worldwide competition.

The above experiments are likely good commissioning experiments for the Hadron Hall. Higher impact, but longer-term, experiments in nuclear and particle physics were mentioned only in passing during the presentations. These include a search for CP violation beyond the Standard Model via the rare decay branch $K_L^0 \blacklozenge \pi^0 \nu\nu^-$
a search for charged lepton flavor violation via μ-to-e conversion in the field of a nucleus (PRISM project), and a refined measurement of the muon's anomalous magnetic moment (g-2), which already shows a tantalizing discrepancy from the best Standard Model calculations. Serious international competition for each of these experiments is currently under discussion at Fermilab and (in the g-2 case) at the AGS at Brookhaven. These experiments would all benefit greatly from the increased beam power provided by the linac upgrade to 400 MeV, and could help to establish a world leadership position for J-PARC in nuclear and particle physics, *if* they can be performed on competitive time scales. The likely cost for detection equipment for each of these experiments is in the many tens of Oku Yen range.

Given the above options, it is clearly important for J-PARC management to decide soon, in collaboration with the user community, on priorities among the linac upgrade, new hadron hall beamlines, and additional support for high-profile experiments. The IAC urges the management to decide soon on the one or two experiments in nuclear and particle physics on which

it hopes to stake its claim to world prominence in these fields, and to allocate resources and support collaboration-building accordingly. In parallel with this decision, it is also important to engage the community in a realistic discussion of the likely evolution in beam power and a suitable schedule for experiments during the next few years.

Recommendations (these could clearly be subsumed in more general recommendations)**:**

The IAC recommends that J-PARC management develop a plan for resource allocation priorities to optimize the scientific impact of the facility in both the short and long terms. Such a plan should designate a few specific high-impact experiments or programs with which the facility can establish its reputation, in competition with analogous facilities world-wide, in light of realistic assessments of operations funding and upgrade timelines.

The IAC recommends that J-PARC management improve the dialogue with users concerning a scheduling and facility development plan, assembled in the light of best guesses concerning operations funding, beam power evolution, equipment readiness, worldwide competition and scientific priorities.

NEUTRINO EXPERIMENTS

The T2K experimental program is based on the neutrino beam under construction as part of the J-PARC facility and the SuperKamiokande detector approximately 295 km distant. The experiment will explore important parameters within the neutrino sector, in particular the mixing parameter $\sin^2 2\theta_{13}$ with a sensitivity beyond that achievable in the upcoming round of reactor-based experiments currently in preparation (Daya Bay). The understanding of this parameter provides a “gateway” to the more fundamental understanding of the neutrino mass hierarchy and possible CP-violation in the neutrino sector. These questions have potential implications for our understanding of the asymmetry between matter and anti-matter in the universe.

T2K is organized as an international collaboration involving 61 institutions from 12 countries, with a total of 400 individual collaborators currently involved. The organization and management of a collaboration involving

such a large number of institutions spread over several continents, and supported by a multitude of funding sources, represents a challenge. Over the last year a T2K International Organization has been formed that meets these challenges. The organization includes bodies for coordinating effort and financial support from the participating institutions, for mapping the scientific strategy, for operating the detectors, and for analyzing and publishing results. The IAC views this organization as capable of effectively coordinating the T2K effort. The T2K experiment is integrated in the J-PARC centre as part of the Particle/Nuclear physics division. Most of the required funding is in place and agreements have been reached on the cost to completion for common items. Discussions are under way with the funding agencies to establish common operating funding for shared items

Construction of the neutrino beamline at the J-PARC facility is well-advanced and is on track for startup in April 2009 as previously scheduled. This is consistent with the J-PARC Main Ring schedule which shows a April 1, 2009 startup of neutrino operations for a three month low intensity run, followed by a two month shutdown, followed by an extended run at 100 kW of beam power.

The short term goal of the T2K collaboration is to integrate 100 kW $\times$ 10^7 seconds of beam on target by the summer of 2010. This goal is consistent with the performance projected by the J-PARC accelerator team, assuming approximately equal sharing of the Main Ring beam between the neutrino and hadron programs. Such an exposure would allow the publication of competitive physics results later in 2010. The natural next step would be an exposure of approximately 300 kW $\times$ 3×10^7 seconds. It would be desirable to achieve this exposure over a period extending over 2011-2013. To meet the ultimate goals of the experiment the T2K collaboration is requesting 750 kW $\times$ 5×10^7 seconds of beam on target. This exposure gives a sensitivity that exceeds that of the Daya Bay experiment over half the range of possible values for the CP violating phase, δ. (90% sensitivity for $\sin^2 2\theta_{13} < 0.008$ at $\delta=0$). The IAC notes that this goal is highly unlikely to be met in a timely manner without an upgrade of the linac energy to 400 MeV.

The IAC has had some concerns in the past with respect to mismatch of expectations between the experimenters and the accelerator group. Presentations of the two groups at this meeting were well aligned, indicating

good communications. This is important to prevent problems of mismatched expectations.

COMPUTER NETWORKS AND REMOTE ACCESS

Good progress was reported on the Information System to be provided at J-PARC. The current activities are aimed at implementing basic user services through a new JLAN network. It is anticipated that up to 960 users can be connected by March 2008. A major upgrade is scheduled for this upcoming year (Phase -2).However so far during commissioning of the JLAN system, access is limited to internal staff . This will quickly need to be extended to outside users as the science program is about to begin. The focus of the effort has been in setting up a user database to provide the basic administrative services (room reservation, travel, registration, computing access, radiation training etc) The IAC reiterates that another layer is critical for outside users in particular.

It will be an expectation that ***all visitors*** to the J-PARC campus are able to achieve seamless wireless access to facilitate interaction with their home institution via open access to the internet from within the J-PARC Center, Guest House and Support Laboratories. As installation of the very large international T2K experiment will start in earnest this coming year, the T2K collaboration will be the testing ground for many of the IS services at J-PARC., but this will also be the case for all external users getting ready for the fall 08 beamtime.

The IAC recommends that the JLAN phase 2 program be implemented at the earliest possible time in anticipation of the start of the scientific program in JFY08.

Some J-PARC users will require restricted and controlled access to J-PARC systems, in order to monitor experiments and access data. Some ***specific collaborators*** will require privileged access to J-PARC system in order to remotely control experimental systems and diagnostics.

They have also already identified the need for experts resident in partner institutes worldwide to have such access to systems associated with their experiments or with the beam delivery systems.. Such privileged access – with administrator authority over appropriate subsystems – is standard for international laboratories – but needs to be limited and demonstrated to be secure with respect to JAEA systems.

MATERIALS AND LIFE SCIENCES

Target System

The N-TAC Committee report was delivered verbally to the IAC on 3 March by Dr G Bauer. The committee's admiration for the work done in 2007 was clearly expressed in the summary of its recommendations and in the detailed advice on the target system as the J-PARC system enters the operational phase. Their summary spoke of truly impressive progress. Target vessel structure, seal performance, remote handling, alignment, target vessel maintenance and trolley maintenance, functional performance and installation alignment readiness checklists are all completed.

In the view of N-TAC, completing all of this was a major accomplishment and the team should be congratulated.

For the target there was recommended continuing work program to re-design the proton beam window to incorporate more beam diagnostics and that this should be pursued with priority and the window should be exchanged as soon as the new one becomes available. The present one can then be kept as a backup-spare.

Detailed advice from the committee:

- Target Trolley remote handling checklist tasks remaining are grease application to the trolley rail and replacement of the slide unit.
  Greasing with remote handling tooling can be difficult and this testing should be done early to determine if tooling modifications are needed.
- A great deal of detailed commissioning work remains to be done in the Hot Cell areas. Time is limited and there may well be competition for resources (e.g the Power Manipulator) so detailed management will be required
- As concerns the excellent progress with **Remote Handling Devices**
  - Equipment to replace the major components is in good shape,
  - Some difficulties have been found often with viewing – consideration should be given to installing a movable camera (e.g. held by a master slave manipulator or on a tripod),

- Maintenance of some of the services in the hot cell (e.g cameras, cabling) appears to be very difficult by remote means – the requirements should be checked,
- During testing consider keeping a list of 'vulnerable' activities – i.e. those where recovery from equipment failure would be particularly difficult,
- For the **moderator** change some work is needed to improve the collection of residual water from the circuits, after drain down, to limit spillage
- Remote handling of **Muon** target and components in the Hot Cell remains to be demonstrated and that,
- the management should undertake commissioning of the muon target replacement in hot cell as an 'indispensable' item for Day-1

Cavitation Erosion

Here again more excellent progress was reported on understanding of the cavitation erosion (CE) -mechanism. An important conclusion was that a distribution of bubble sizes may be most effective in damage mitigation. The situation is that the probable target life time is still difficult to predict due to unclear effects of geometry and flow conditions but that the measures foreseen to evaluate damage potential on real target are comprehensive and look promising.

N-TAC evaluated plans for future investigations (effect of pulse duration and bubble transport in target) and concluded that

- they are well thought through and should be fully supported and that,
- the new pressure wave generator (AUTOLITH® spark device) is a perfect complement to MIMTM

The committee recommended that collaboration with SNS (Oak Ridge) team remains very important (use of TTF and WNR) and should be extended to include PIE activities on the first SNS target.

Control System and Buildings

The N-TAC reports that the MLF General Control System is in good shape and it appears that the remaining work can be completed in time. Also the settlement (under loading from the instruments and shielding at this stage) of the MLF building is close to the predicted values. The distortion (uneven settlement) of the experimental hall floor is within acceptable limits but re-alignment of the proton beam in the MLF building may be required as the loading on the building changes.

Control and Diagnostic Instruments

- The instrumental diagnosis for radiation safety seems to be very well prepared.
- There should be shielding in place around the mercury filter and the molecular sieve column in the off gas process system before medium power levels (ca. 100 kW) are reached.
- Silicagel absorbs not only HTO but also H_2O, which should be considered in the capacity and in the operating period of the systems ability to hold back tritium.
- The hot cell ventilation system should be monitored for mercury to estimate the loading of the filters (e.g. by air sampling).

Spares

N-TAC commented specifically on the need for a spares policy for the target system and instruments. In particular it was suggested that:

- As far as the operating budget allows, most critical parts should be kept in stock to remain independent from vendor availability and delivery time.
- The spare part problem concerns especially electronic equipment, where products life cycle becomes shorter from year to year.
  As far as the operating budget allows, most critical parts should be kept in stock to remain independent from vendor and delivery time.

Start-up Procedures and Documentation

- The readiness checklists should define criteria and numbers and also the set-points (H,HH & L,LL) for alarms and system actions. These can be temporary default values, to be adapted to the needs of the process, when the final operating conditions of the systems are known.
- There should be one single open issue list to keep track of the progress made in the check lists of the many individual systems. The open issues are closed and documented in only one single version when decisions have been made about the handling the issues by system engineers and project management.
- Consider keeping a master list of just the remaining status B and C items.
- Consider having a review to ensure all 'indispensable' items have been identified and whether some could be re-classified as 'preferable'. This review should include preparation of any required operational procedures and operating parameters/limits in all acceptance criteria.

Overall Comments On Systems

The N-TAC advised that all systems appear to be extremely well engineered, the fabrication and installation looks very professional and the level of cleanliness is exceptional, there has been adequate attention given to remote handling operations and maintenance.

Assuming success for the hydrogen system testing, the systems can be expected to be ready for beam in May. The next level of preparation will involve documenting procedures and establishing operating limits and alarm levels for the process variables.

The N-TAC overall conclusion is that the performance of the JSNS team has so far been outstanding but expressed its concern about the extremely tight budget. In particular:

The target team is clearly understaffed. The committee notes that a certain work overload is normal towards the end of a project, but care must be taken for it not to lead to unnecessary mistakes.

The team has so far managed to cope with severe budget restraints remarkably well, but one serious consequence clearly, is the lack of spare parts. They feel that this might become a serious problem.
Also, important R&D to solve existing difficulties must be properly funded in order to secure successful full power operation and high availability of the facility. Nevertheless, we do not see any obvious reason why JSNS should not meet its readiness criteria in the near future.

NEUTRON SCATTERING

The International Advisory Committee notes with pleasure the progress described at its meeting and seen on the floor of the MLF building - in the construction of the instruments for neutron scattering. The projected use of very large detection areas, some new detector developments of great interest and the high flux to be delivered from the target offer great promise for the work to be done with the first group of instruments installed.

The parallel development of detectors and ancillary equipment, despite the high load on staff to produce the instruments ready for beam in 2008-2009, is commended. These ancillary devices such as high pressure, variable temperature and the associated laboratory facilities needed for the user program are essential aspects of user-oriented neutron scattering programs. The continued developments of ancillary devices as well as data processing and new instruments should be a very high priority as the operational phase is entered and continues.

Oversight of Experimental Systems in the MLF sector.

The IAC discussed the best method to give oversight to the future development of neutron instruments and the program of development of them as well as their user orientation. The technical aspects of the source are well covered by the ATAC/NTAC committees, and although a forum (MUSAC) exists for muons, there was no high level advisory committee to take an overview of the development of the neutron instrument suite and of the overall user “experience” for the MLF (everything from standardised sample environment to pre-, during and post- experimental support as well as the user office culture for example.

Recommendation

IAC notes the value of ATAC and NTAC and MUSAC as advisory committees and recommends a similar committee to oversee the construction and exploitation of facilities for neutron scattering within the MLF.

Future Development of the Neutron Instrument Suite

The IAC is strongly encouraged by the success of J-PARC in attracting funds to develop ten initial, high quality neutron scattering instruments for the MLF programme. The scope and variety of this suite makes the initial performance of the MLF highly credible on the international scale. A period of consolidation is now necessary to ensure that these instruments are resourced to deliver their maximum performance, and for the Japanese and international scattering communities to appreciate their potential.

Drawing on experience gained at the new level of source performance afforded by J-PARC, there is an opportunity to be adventurous in the selection of the next set of instruments to be very innovative, building on, rather than simply reproducing developments at the previous generation of reactor or spallation sources.

MLF MUON FACILITY

The Phase I muon facilities are nearing completion and the very hard work of the team to meet the milestone of May 08 for first beam commissioning has paid off. The meticulous execution of the project is truly impressive. The proton beam line has been evacuated and the vacuum achieved is well within specification. Cabling and plumbing is continuing to meet the September deadline for beam-on commissioning. No road blocks are envisaged at this stage.

On day one, only one muon channel will be available. The reconditioned KEK superconducting solenoid has been installed and should be ready in time for commissioning in September 08 to insure muon production to users during the planned two month cycle of beam delivery later in the fall. It is crucial to deliver an early physics output from this first muon channel so as to provide the incentive for the muon user community to seek alternative supplementary funding for core user projects and hence complete the MUSE

facility as early as possible. Attracting foreign users and industrial investments is directly linked to having an early minimal initial program available at start up. The committee congratulates the MUSE team for delivering on its promises to have an operational facility by September 08.

Amongst the Phase 2 projects, the committee reaffirms its support for developing a unique ultra slow muon source based upon the technique of laser ionization of thermal muonium atoms. The committee supports the recommendation of MUSAC to form a task force to identify a pathway to realizing ultra slow muon beams as soon as possible as it is seen as the most innovative and unique opportunity for Muon users in Japan.

USER INTERFACE

In a multi-disciplinary facility such as envisaged for JPARC, the user interface has many dimensions. These include:

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

All of these need to be developed and refined in the coming months. Creation of a User Office is a critical next step for J-PARC. 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.

NUCLEAR TRANSMUTATION

The IAC was pleased to hear that the recommendations made in its 2007 report have led to successful developments and that important work has been undertaken within OECD/NEA, IAEA, Asian countries (China, India and Korea) and Europe. Strong links have been established in particular with the most active European partners in the EUROTRANS framework (33 research organisations and 16 universities). Important synergies were found in the recent workshop dedicated to transmutation research in Europe and Japan (FZK, 27-28 February 2008).

The IAC recommends that a long term common strategy in transmutation experiments and ADS research be developed. Japan collaboration is most welcomed in European programs and JPARC future transmutation program appears as one of the best complement to the European 6^{th} and 7^{th} Framework Programs. 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.

The IAC strongly encourages JAEA to develop detailed concrete experimental proposals using JPARC future TEF facility with EUROTRANS partners for the study of advanced nuclear fuels and transmutation technology in both fast breeders and accelerator driven systems. JPARC will be able in phase 2 to host a new generation of experimental work and become the world leading facility in an innovative area of nuclear waste management.

The experimental transmutation program needs the full power of JPARC foreseen in the construction of phase 2. The IAC believes that this program as others would considerably profit from the integration of superconducting cavities in the phase 2 of the accelerator in particular for the development of highly stable beams, one of the focus of accelerator research today.

In 2007, the Intergovernmental Panel on the Climate Change has included acknowledged nuclear power among the commercially available climate change mitigating technologies. This is the first time that this United Nations panel acknowledges the importance of nuclear power in the fight against global climate change. It is now expected that nuclear power will expand, but safety, proliferation and waste remain major preoccupation of most countries. Some of the most important concerns will only be answered

by experimental studies of partition and transmutation. It is expected that future fast breeders will burn a significant fraction of nuclear wastes (minor actinides). But, this will require a complete understanding of transmutation processes in the new generation of innovative (radioactive) fuels.

European and international programs have recently confirmed their support to ADS research in order to fully understand the burning of nuclear wastes using a complementary approach to reactor research. A new French law imposes research both on transmutation in reactors and on ADS in the European 7^{th} FP. The question is whether it will be possible to burn very large quantities of actinides in non dedicated systems. Complex innovative fuels do not yet exist and transmutation processes will need to be validated by experimental demonstrations. Massive burning of nuclear wastes may require specific dedicated systems based on ADS.

Academic commitment in Japan is of great importance to give confidence to public opinion in the future of nuclear power. Confidence of the public opinion is the key to the expansion of fast breeders in Generation IV. This is a general observation in all the countries interested in the expansion of nuclear power. All are aware of the need to establish strong links between academic research and industry to remove the obstacles observed in the past. Moreover, there is a considerable need to build a new generation of scientists and engineers over the next 20 years. Education and training in JAEA's facilities in Tokai, advanced reactors and JPARC offers unique opportunities to strengthen a unique combination of research and engineering.

The IAC endorses the strong commitment of JAEA in the preparation of the AEC "5-year plan". The IAC recommends that major efforts are undertaken to build a strong research and development community bridging academic and industry technology research.

APPENDIX I

Agenda for the 7th International Advisory Committee Meeting
J-PARC

Date: March 3 (Mon) and March 4 (Tue), 2008
Place: J-PARC Center – Tokai

March 3 (Mon)

8:50 - 9:10	Executive Session (Closed) Committee + Nagamiya, Oyama, Yamazaki	
9:10 – 10:10	Status of J-PARC	S. Nagamiya/Y. Oyama
10:10 – 10:30	-- Coffee Break –	
10:30 – 12:00	Accelerators	
	- Progress report	Y. Yamazaki / A. Ando
	- A-TAC report	S. Holmes
12:00 – 13:20	-- Lunch –	
13:20 – 14:50	Nuclear and Particle Physics Experimental Facility	
(13:20-13:45)	- Hadron Experiment	H. Tamura
(13:45-14:05)	- Hadron Facility	K. Tanaka
(14:05-14:50)	- Neutrino Experiment	K. Nishikawa
14:50 – 15:20	-- Coffee Break –	
15:20 – 17:00	Material and Life Science Experimental Facility	
(15:20-16:05)	- Progress report of Neutron	Y. Ikeda
(16:05 -16:20)	- N-TAC Report	G. Bauer
(16:20 -16:45)	- Progress report of Muon	Y. Miyake
(16:45-17:00)	- MUSAC report	J.-M. Poutissou
17:00 – 18:00	Closed Session	
18:30 -	Reception (Akogi-ga-ura Club)	

March 4 (Tue)

8:50 - 9:10	Executive Session (Closed)	
9:10 - 9:30	KEK and J-PARC	A. Suzuki
9:30 - 9:50	JAEA and J-PARC	H. Yokomizo
9:50 – 10:15	-- Coffee Break –	
10:15 – 10:45	Nuclear Transmutation	H. Oigawa
10:45 – 11:00	Information System	A. Manabe
11:00 – 11:15	Users Office	M. Ieiri
11:15 – 12:15	Closed Session & Working	
12:15 – 13:15	-- Lunch –	

13:15 – 14:30	-- Site Tour --
14:30 – 15:30	Working Hour
15:30 – 16:00	Summary Session
	Adjourn

APPENDIX II
Committee Members

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