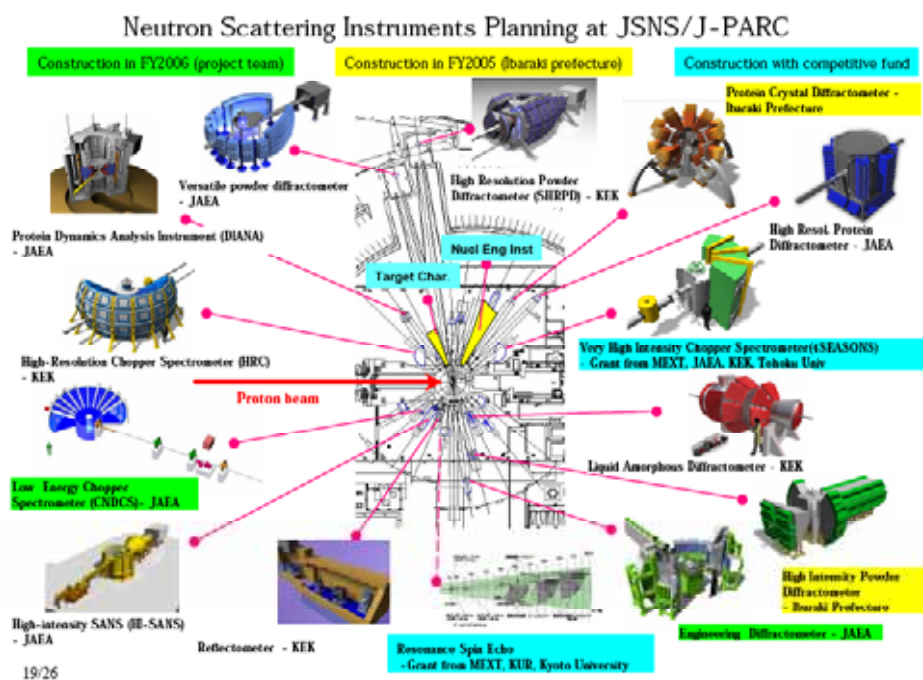


# THE INTERNATIONAL ADVISORY COMMITTEE

## ON THE J-PARC PROJECT

REPORT 30 MARCH 2006



Meeting 27 -28 February 2006

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 26 and 28 February 2006 at JAEA, Tokai and toured the construction site of J-PARC.

The IAC had reports from the Accelerator Technical Advisory Committee (A-TAC), which met the previous week at Tokai and the Neutron Technical Advisory Committee (N-TAC), which met at Tokai 14-16 November 2005. The present report is also informed by reports from the Muon Science Experimental Facilities Advisory Committee (MUSAC) meeting at KEK 25-26 February 2006. The agenda of the IAC meeting is attached as Appendix I and the membership at Appendix II.

The IAC notes the integration of JAERI and JNC into the Japan Atomic Energy Agency (JAEA), wishes the new organization well and looks forward to fruitful collaboration with JAEA at Tokai, to bring the J-PARC project to a foremost position in world science and technology. We note also the changes in the Directorate of KEK and particularly acknowledge the very positive interactions of the project with that excellent organization and its Director Professor Totsuka. The continuing programs in accelerator science at KEK will be of enduring importance to J-PARC and we look forward to continuing close cooperation as J-PARC develops.

Our warmest congratulations to both JAEA and KEK on the timely establishment of the J-PARC Center. The autonomy given to this "child" of the two organizations will be a measure of their confidence in it and its success. We make recommendations in this report for J-PARC Center development as commissioning starts and transition into the operation phase.

The IAC thanks the J-PARC Director, Professor Nagamiya, and the project team for the detailed information and discussion at the IAC meeting. The distribution of papers before the meeting was of great help. The Director and his colleagues are thanked for this. Because of our growing familiarity with the project, the early flow of information by electronic means can benefit the IAC meeting process. As a next step we suggest that the style of the IAC meeting itself might change. Approximately equal time for presentations of key points in the already studied reports, and discussion with presenters is suggested. The IAC notes with approval the extent to which its recommendations for IAC 2005 have been taken up by the project team and the individual project leaders – as reflected in their presentations.

The progress made in 2005 with the construction of the buildings, the accelerators and the associated target systems is impressive. The IAC congratulates the project team and the Directors of KEK and JAEA on the work done. The IAC detects a great boost to morale in the project from the successful approaches to government by JAEA, KEK and MEXT to find sufficient funds for the 2005-2006 budget. The next two

years will be critical in maintaining this momentum into the early operation part of Phase I to commission the accelerators and other components. It is inevitable that there will be technical and organizational challenges and the strength of the J-PARC Center management and the flexibility of its funding will be a key importance. This matter is addressed in the report.

The J-PARC Center will blend the cultures of two distinguished Japanese research institutions with that of national and international colleagues. This has occurred in other parts of the world - for example the Institut Laue Langevin Grenoble. With appropriate organizational arrangements and support to the J-PARC Center from the JAEA and KEK partners as well as the influx of talented users, this may lead, as elsewhere, to outcomes of the highest quality. Now is the time for J-PARC Center to define itself as a user oriented center, but one where scientists and technologists of the highest quality are recruited to do, also, their own work. This suggested vision for J-PARC Center is developed in the report from discussions at the current meeting based on the outlines given in our 2005 report.

We have given much thought to the transition to the operational phase of J-PARC Center. We are glad that an international committee was established to review the budgetary needs in this respect and have considered its report. The report gives about the expected level needed to run an international center of excellence but the details will become clearer as the center develops. The early operations consist of trials on the accelerator, target and instrument components. As these come in from external sources, technical questions will arise. Construction merges into early operation and diagnostics. The question of how to provide an operating budget commensurate with the quality of the infrastructure being created is of importance at this time. The IAC urges JAEA, KEK and MEXT to use all means to ensure successful completion of the Phase I project and a smooth change over to operation. Success in this endeavour will require a clear understanding between the J-PARC Center Director, JAEA and KEK regarding the responsibilities and delegations of the Director. He must be able to draw effectively on their joint resources to support the J-PARC mission.

In this report the principal recommendations have been numbered and brought to the Executive Summary. There are a number of important process recommendations – left un-numbered in the text.

## SUMMARY OF RECOMMENDATIONS

*The IAC notes with respect the great efforts of the JAEA and KEK partners and project team to bring new funds to meet the "alarming budget shortfalls" mentioned in our 2005 IAC report. This has produced remarkable momentum to the J-PARC project in 2005. We spoke, in 2005, of the importance of the "next two critical years" and we reiterate this point.*

- 1. We recommend that the momentum and high morale created by all the actions of 2005 be sustained by a strong budget allocation for 2007-2008 to bring the project to operation in 2008-2009. We have identified technical, financial, and organizational challenges in this last part of the PHASE I construction as well as the commissioning of facilities for operation. We give completion of Phase I construction and the transition to operations as the highest priority.*
- 2. In its orientation to achieve the successful completion of Phase I as its highest priority the J-PARC organization needs to establish the clearest lines of responsibility and authority for the project completion, the commissioning activity, and the initiation of operations. This will also require a clear understanding between the J-PARC Center Director and the sponsoring institutions as to how the J-PARC Director can most effectively draw on the resources of JAEA and KEK to support this mission.*
- 3. The IAC recommends that the J-PARC Center organization be extended and carefully defined in the area of project-wide technical coordination. The Technical Coordinator should have sufficient knowledge of status and risk factors across the whole effort, so as to be able to advise the Center Directorate on choices and trade-offs necessary to complete and commission J-PARC in the most timely and effective way.*
- 4. We recommend that JAEA and KEK enhance the delegated authority of the J-PARC Center so that it will blend the creative cultures of JAEA and KEK in the project for construction, maintenance, research and to develop a strong user orientation. The blending of the cultures will be perfected by the commissioning and early operational stages if the authority is there.*
- 5. We recommend speedy agreement between all parties on an operations and commissioning budget as an essential component of 2007-2008 budget and as the first step towards a smooth transition to the operations budget of Phase I in 2009. As a basis for this, we have analysed and accept the recommendations of the independent international committee on the J-PARC operations budget.*
- 6. We recommend that the vision of the J-PARC Centre be that of a center of excellence in quantum beam science for a broad user community and an "in*

*house" scientific community of such quality as to achieve international respect for their science.*

- 7. Full realization of the capabilities of the J-PARC facility cannot be achieved with the current 181 MeV linac energy. We recommend that the 400 MeV linac capability be restored as the immediate priority following successful completion of the Phase I construction project and the transition to initial operations.*

## STATE OF THE J-PARC PROJECT

From the printed material distributed beforehand and the presentations during the IAC's review the Committee has gained a strong impression of the commitment of staff in J-PARC and of the great progress made in 2005 for construction. Detailed comments on various parts of project are given in subsequent sections on the accelerator program, the condensed matter and life sciences program, nuclear and particle physics as well as transmutation/ADS.

During 2006-2007 and strongly in 2007-2008 commissioning of accelerators, targets and some instruments will occur. As some of these components of the project are "state of the art" using new technologies, introduced to achieve the highest performance, there is an experimental aspect to the commissioning process.

Commissioning is a critical phase for any project and especially so for one as large and complex as J-PARC. The transition from construction to commissioning (as well as the transition to operations) must be very well coordinated across the whole facility. Among other challenges, the transition will be constrained – maybe even over constrained – by the availability of resources of all types: manpower (especially technical experts), funds and time. Also, during this period the “flavor” of funding will be changing from Construction to Operations. Here also, the management leaders, fully informed about available resources, may need to make technical trade-offs and priority decisions.

In the event of irremediable budget short falls and the necessary prioritization that should follow, the Director and the J-PARC management should determine what would be cut from the 2007-2008 program. There will be elements of the commissioning process and a logical sequence to achieve pre-operational success in vital components of the accelerator system and targets. These and the "improvements" suggested by the experimental part of the commissioning process will have to be prioritized. Agreement with all involved parties as soon as possible on a smooth transition in to an operating budget for 2008-2009 will itself be a priority into 2007-2008.

*We recommend that the momentum and high morale created by all the actions of 2005 be sustained by a strong budget allocation for 2007-2008 to bring the project to operation in 2008-2009. We have identified technical, financial, and organizational challenges in this last part of the PHASE I construction and commissioning the facilities for operation. We give completion of Phase I construction and the transition to operations as the highest priority.*

### Organizational Structure

#### (a) J-PARC Center

The J-PARC organization has taken an important step forward through creation of J-PARC Center. This approach recognizes the desirability of establishing a single organization with responsibility to complete construction the J-PARC facility, and to

oversee commissioning and subsequent operations. The proper functioning of this organization requires the strong backing of the sponsoring institutions, JAEA and KEK, where most of the resources lie. However, as noted in last year's report, the IAC feels that to be effective, the J-PARC Center Director should be the decision-maker and responsible officer for all aspects of the Center operation and for the approval and execution of the J-PARC program. As such, the new organization structure needs to evolve to reflect the fact that the highest priority over the next three years is the successful completion of the Phase 1 project. This includes the commissioning activities that will assure all the accelerators and experimental facilities are working efficiently together.

***Recommendation: In its orientation to achieve the successful completion of Phase I as its highest priority the J-PARC organization needs to establish the clearest lines of responsibility and authority for the project completion, the commissioning activity, and the initiation of operations. This will also require a clear understanding between the J-PARC Center director and the sponsoring institutions as to how the J-PARC Director can most effectively draw on the resources of JAEA and KEK to support this mission.***

On a related subject, the IAC heard a report on the view from KEK, from its Director, Prof. Totsuka. KEK has proven its outstanding ability to construct and operate world class, large scale accelerator facilities as for example, KEKB. In order to commission J-PARC successfully as soon as possible and prepare for future intensity improvements, this expertise will continue to be necessary. In consequence, the IAC observes that it is necessary to maintain a thriving program at KEK to retain this manpower.

**(b) Technical Coordination**

The construction project is entering a vital transition, namely from completion of the Phase I construction to the beginning of commissioning the facility. It is important that the construction, which the IAC recognizes has been very well executed, be finished on schedule. A number technical problems, fiscal constraints and schedule slippage in sub-projects of the construction have arisen. While none of these look to be overwhelming for the project, the IAC is concerned that, in their aggregate, they could pose significant risk to timely completion of the project if not managed properly. Continuing provision of strong financial and human resources support as well as tough priority decisions may need to be made by project leadership. To do so, management must possess full knowledge of available resources and of the "critical path" to completion.

The IAC felt that the Organization of the J-PARC Center as presented by its Director, S. Nagamiya, contained the management elements necessary for success during the commissioning. Although designed for Operations, the Organization Chart recognizes the need for Coordination. The "Coordination" box should be labeled "Project Technical Coordination" and later "Commissioning Technical Coordination." However, the coordination function really belongs with the Center Directorate, and should not be seen



as co-equal with the “subprojects” which lie below the Director on the chart. One solution may be that a Technical Coordinator should sit between the Director and the subprojects as a part of line management or in a separate box, which reports to the Director, perhaps as chair of a Technical Coordination Committee. The important thing is that the Center recognizes the need for high-level technical coordination and that the Director takes ultimate responsibility for the decision-making process, which will make both Project completion and Commissioning successful.

In order for technical coordination to work, the coordinator needs sufficient information from the subprojects. It is not enough to know that “subproject X needs an unspecified number of additional engineers in order to finish on schedule.” The coordinator must be empowered by the Director to get the information necessary to determine the resources needed over time.

When J-PARC is operational, the same type of coordination will be needed in order to make a sensible plan that encompasses not only operations but also linac energy restoration and Phase II construction.

***Recommendation: The IAC strongly recommends that the J-PARC Center organization be extended and carefully defined in the area of project-wide technical coordination. The Technical Coordinator should have sufficient knowledge of status and risk factors across the whole effort, so as to be able to advise the Center Directorate on choices and trade-offs necessary to complete and commission J-PARC in the most timely and effective way.***

**(c) Delegated Authority of the Director**

As the project enters commissioning and operation there will be a need for enhanced flexibility in decision making on the priorities established internally as well as externally. The IAC considers that it is essential for this decision making to be speedy and coherent with the evolution towards the operation of Phase 1. The opportunity exists for the partners and the Director to grow J-PARC structures, vision and operational culture in a way that will blend the qualities of staff coming from JAEA and KEK with those of the user community and new staff. This can be done in a consultative way with the user community and Program Advisory Committees now forming. It is now timely to anticipate the expected flow of national and international users and the style of operation needed to ensure a growing facilitation of the attractiveness and prowess of J-PARC Center.

***Recommendation: We recommend that JAEA and KEK enhance the delegated authority of the J-PARC Center so that it will blend the creative cultures of JAEA and KEK in the project for construction, maintenance, research and to develop a strong user orientation. The blending of the cultures will be perfected by the commissioning and early operational stages if the authority is there.***

## **OPERATIONS BUDGET**

During the last year a detailed proposal for the operations budget of J-PARC center was assembled. This proposal was reviewed by an external review committee, consisting of experts in this field from the US, Europe and Japan. The strength and weaknesses of the proposal were clearly identified by the committee and J-PARC management has already addressed and implemented many of the suggestions. The IAC agrees with the analysis of the international committee on the operation budget that the proposed budget of 190 O Yen is appropriate for the initial operation of the J-PARC Center.

In response to the request to reduce this budget by 15-20%, we suggest that a detailed list be assembled of experimental capabilities and/or accelerator performance improvements that would be lost or delayed (and to what extent) as the budget is incrementally reduced by 5% steps. This list should help all affected partners, JAEA, KEK, MEXT and J-PARC center to balance cost and benefit.

The 2007-2008 budget covers a period of time where testing of components and subsystems with beam may reveal weaknesses that will have to be eliminated before going into high reliability operation. Therefore it is very important to generate a pre-operations budget for '06, '07 and '08 that will allow J-PARC management to deal with these issues. Spares, general material and supplies, consumables, utility costs and additional man power where necessary, will have to be funded to be able to finish and successfully commission the accelerator complex in time. While initial attempts have been made to secure this budget, the numbers presented to the committee seem not sufficient, certainly for 2007, and we suggest to plan a smooth transition from the present level of operations funding of 10.0 Oku Yen[nh1] to 190 Oku Yen in 2009 as the construction budget winds down.

***We recommend speedy agreement between all parties on an operations and commissioning budget as an essential component of 2007-2008 budget and as the first step towards a smooth transition to the operations budget of Phase I in 2009. As a basis for this, we have analysed and accept the recommendations of the independent international committee on the J-PARC operations budget.***

Finalizing this discussion as soon as possible  of utmost importance from our point of view since it provides planning security for the J-PARC center.

It is very encouraging that the strong support for J-PARC center has manifested itself in the '06 budget. With approximately 280 Oku Yen J-PARC should be able to quickly finish up the contracts and installation of components. In 2007-2008 the budget still needs to be very significant and we urge the partners to give J-PARC a continuing support to guarantee timely success of the project.

## **J-PARC - A User Oriented Research Center**

As J-PARC approaches its operational phase it is not too early to begin the definition of the "vision" for the center. In addition to the major experiments in neutrinos, nuclear physics and transmutation, the materials and life sciences component will attract initially hundreds and eventually thousands of users each year. This is the situation in other major neutron and muon institutes and provision of accommodation and services for these users will be a vital part of J-PARC's success in "small science". The creation of a culture of "service" to these users by the scientific, engineering and technical staff, whilst at the same time encouraging members of the J-PARC staff to perform their own research at the highest level internationally, is an important challenge for the J-PARC management and the partners. We have spoken of a blending of cultures before. This will be one area of importance in that process.

*We recommend that the vision of the J-PARC Centre be that of a center of excellence in quantum beam science for a broad user community and an "in house" scientific community of such quality as to achieve international respect for their science.*

### **Beam Resource Management**

In last year's report we suggested to summarize in a separate document written by J-PARC management how beam power, availability and beam time would develop in the first few years after finishing the construction of Phase I. This document will clarify to the user community what can be reasonably expected in the first years of operation and help J-PARC leadership to manage these expectations.

*Recommendation: The IAC reiterates the suggestion that a Beam Resource Management Plan be created and hopes to see this document at its next meeting.*

### **Program Advisory Committees**

To advise the Director and give substance to the user orientation of J-PARC, the IAC is clear that Program Advisory Committees (PACs) must be established as soon as possible. These should suggest how experimental proposals for individual areas of research are to be reviewed and are needed for neutrons, muons, nuclear and particle physics. In connection with this process and ultimately to manage the user interaction with J-PARC, the IAC's experience suggests an immediate start of discussions for establishing the J-PARC Users Office.

*Recommendation: The IAC recommends that the plans for linking J-PARC to the user community be established, in the form of PACs and the J-PARC Users Office.*

## **User Infrastructure**

Once fully in operation, J-PARC will be a thriving center for a large variety of sciences. Thousands of users, national and international, will be using the facilities and it is very important to start planning for their support early on. Offices, computer support, materials and supplies, sample preparation laboratories, workshops and finally user housing are some of the most important issues that will need to be addressed.

The committee was very interested in the data storage and retrieval systems proposed. The IAC heard about this in the neutron area but it applies to all areas. Much ingenuity is being shown, to allow direct interaction during experimentation with the extensive and rapidly acquired data sets. This is essential since, in the neutron and muon areas, the J-PARC facility will allow real time measurements on evolving systems rather than simply sets of preconceived measurements.

Much more work and resources will be needed in this area and early attention to the way in which data can be accessed remotely is essential. Some of the data flows will be like those at synchrotrons and there, standard practice is to allow external control and inspection of data from remote sites. The protocols for this access should be established as soon as possible. For this access, J-PARC will have to think such data inspection from international sources as well as national. The current restrictions, for example for email, at the JAEA site will need to be reviewed and appropriate protection as well as access installed.

Substantial costs are associated with installation of this infrastructure and they have to be covered out of the operations budget.

***Recommendation: The IAC recommends that a comprehensive User Infrastructure Plan be developed to address these issues one by one as more users enter the site and would like to hear about this plan during our next meeting.***

## **User Access Charges**

The IAC had the benefit of and analysis of policy on access charges and payment of travel and accommodation costs for users at major facilities in Europe and USA. There is common agreement that these charges were appropriate for industrial use - especially when publication of results was to be withheld. For national users (Universities and Institutes where open publications was the rule) there was wide agreement that the charges should be zero and, for some major national and international facilities the travel and accommodation charges of users from member countries are paid (at least in part).

***Recommendation: The IAC recommends that access charging and user support are important issues for the success of major international facilities. The great***

*benefit of drawing in a wide community of users (and their ideas) from the start of J-PARC compared to the cost of facilitating access needs to be considered.*

## DETAILED REVIEW OF THE PROGRAM

### ACCELERATOR PROGRAM

#### Accelerator Status and Recommendations

The J-PARC project is now well advanced, both in terms of civil construction and fabrication of accelerator components. The installation phase has begun and will be followed by beam commissioning, starting in the linac, at the end of 2006. The IAC received the report from the Accelerator Technical Advisory Committee (ATAC) describing excellent progress on the accelerator construction over the last year, accompanied by a number of technical issues that have become evident as accelerator components are assembled and tested. The IAC has accepted and endorses this report. Issues identified by the ATAC for special attention by management include:

- Performance of rf accelerating cavities for the RCS and 50 GeV MR
- RCS and Main Ring performance with the 181 MeV linac
- The budget and schedule to completion
- Installation and commissioning planning, including the transition to operations

#### RF Accelerating Cavities for the Rapid Cycling Synchrotron (RCS) and Main Ring (MR)

The development of accelerating cavities for the RCs and MR has experienced difficulties related to the performance of the Finemet cores. Several cores have failed after relatively short periods of testing at high power. These failures are understood as being related to the fabrication process of the cores. The ATAC identified these issues as a serious problem that could jeopardize the successful completion of the project. The ATAC report offers a recommendation, based on the priority of maintaining the installation and commissioning schedule. *The IAC endorses the ATAC recommendation.*

#### RCS and MR Performance Goals

The J-PARC project was established with Phase 1 performance goals of 1 MW beam power at 3 GeV in the RCS and 0.75 MW at 40 GeV from the MR. The decision was taken in late 2003 to reduce the linac energy from 400 MeV to 181 MeV in Phase 1. This decision was taken in order to provide funds for the priority decision to incorporate the neutrino beam line into Phase 1 of the project. It has been anticipated that the linac energy will be restored to 400 MeV over the period 2008-2010. The cost of the restoration is estimated at 85 O¥. This funding is not yet secured.

The reduction in linac energy has major implications for the performance of both the RCS and the MR. Mitigation of these effects and evaluation of likely performance in the presence of reduced linac energy was a major topic of discussion in the 2004 and 2005

ATAC meetings. Established performance goals during the 181 MeV era are now 0.6 MW in the RCS and 0.45 MW in the MR. The RCS goal involves extrapolations based on simulations in the presence of strong space-charge forces at injection and allowance for higher beam losses than originally planned for. While simulations have been significantly advanced over the last several years, they are still not adequately comprehensive to provide confidence in the RCS goal. It has been the judgment of the ATAC that while these goals should be retained, the higher confidence level goals are 0.33 MW and 0.45 MW in the RCS and MR respectively. The ATAC reiterated this assessment at its February 2006 meeting. A number of technical issues relating to these performance extrapolations are contained within the ATAC reports and will not be repeated here. However, among the options available for restoration of full performance in the RCS and the MR the ATAC feels that restoration of the full 400 MeV linac energy is the most straightforward approach and encompasses the least performance risk.

***Recommendation: Full realization of the capabilities of the J-PARC facility cannot be achieved with the current 181 MeV linac energy. We recommend that the 400 MeV linac capability be restored as the immediate priority following successful completion of the Phase I construction project and the transition to initial operations.***

### **Accelerator Installation and Commissioning Planning**

The ATAC was presented with a preliminary integrated plan for the installation, commissioning, and transition to operations of the J-PARC accelerator complex. Installation is well advanced in the linac and MR, and will start in the RCS in a few weeks. The ATAC found that planning for installation, commissioning, and the initial operations phase is advanced relative to a year ago. A first pass at the evolution of beam power in both the RCS and MR during the initial operational period has been developed. The ATAC regards the present level of planning as a reasonable start. However, they advocate further steps including integration of plans across machine boundaries, identification of resource requirements, and identification of applications program needs during the commissioning period. The ATAC believes that this task can only be accomplished by establishing a single commissioning team, lead by a full time dedicated leader with the responsibility and authority for commissioning the accelerator complex.

***Recommendation: Establish a commissioning team to coordinate planning and execution of commissioning activities across the entire complex.***

This recommendation of A-TAC is picked up in our main **Recommendations 2 and 3** above.

### **Schedule to Complete**

The overall accelerator construction and commissioning schedule has slipped by roughly 6 months in the last year. This is due primarily to the JFY2005 funding shortfall, but

technical issues are also contributing. It is clear there is little-to-no margin on completing Phase 1 in JFY2007.

The J-PARC staffing level, and in some instances financial resources, appears marginal for meeting project goals across all machines. The symptoms are that technical development is occurring at the last moment in several systems (rf, pulsed devices, and collimators) and at the same time installation and preparation for commissioning is occupying a greater share of people's time. The level of activity is expected to increase as installation is completed and beam commissioning is initiated shortly. The ATAC believes the project requires additional people with experience in installation, commissioning, and operations assigned during the upcoming year. The assessment received from the machine group leaders totals roughly 20 people. Migration of KEK staff out of the PS program, along with some reassignment of staff from KEK-B, has started. This is a welcomed sign.

***Recommendation: The IAC recommends that the J-PARC Directorate do everything possible, including increasing staff support, to hold the schedule, but don't assume undue risk in the process.***

## **MATERIALS AND LIFE SCIENCES**

This area of the future program of J-PARC is the most likely to produce the largest number of users of the facility per annum from national and international scientific communities as well as industry. The success in this area is vital to the future of a broad range of materials and life science and will depend not only on the "leading edge" nature of the facilities and instruments at J-PARC but on the close engagement and flow of ideas between the center and the user community in commissioning and during operations. The scientific renown will ultimately depend on the "freshness" of the ideas brought into the center and sustained by it.

### **Neutron Scattering**

The IAC had a very good impression of progress in the materials and life sciences area of the project. The target system for production of neutrons is at the leading edge of technology in this area and the construction of its target station and associate facilities has been reviewed in November 2005 by the Neutron Technical Advisory Committee (N-TAC) who had many very important recommendations as the developments proceed. A similar report on the muon project was also received by the IAC from its meeting in February 2006. For both neutrons and muons there are very important challenges - some of technical origin and some produced from budgetary constraints.

The IAC was impressed by the response of the communities to these challenges - many of the questions of N-TAC having been responded to and others under active investigation. In the neutron area what most impressed the IAC was the novelty of the



instrument portfolio proposed around the neutron target. (Front cover of this report) The work of the project scientists and the Instrument Advisory Committee has produced instrument designs and proposals that are innovative and in many areas go beyond those available elsewhere in the world at this time. This is a very good sign for future developments. Important also has been the support from the Ibaraki prefecture and JAEA to allow four of these new designs to be built in the first round of instruments. The IAC regrets that initially at least some of the remaining beamlines will have to rely on recycling components from KENS. State of the art instrumentation is required if J-PARC is to realize its full potential. It is encouraged that new KEK instruments be built at an early stage.

Impressive also, were the technical developments by the project team, based on the nation-wide collaboration of the NOP project. These have allowed new instrumental concepts to be proposed - "super mirrors" whose reflectivity is appreciable at four times the angle of conventional nickel mirrors, detectors with very high neutron counting rates and instrument geometries of clever conception will make the best use of the high brightness of the neutron target when at full power.

### **Muon Science**

The Muon Science Advisory C committee (MUSAC) met at KEK on February 25<sup>th</sup> and 26<sup>th</sup> to review the progress in the construction of the J-PARC Muon facility and to comment on the 24 letters of Intent received earlier from potential users. On the technical side major advances were noted. The extensive shielding is in place and a very comprehensive alignment procedure is being implemented to insure proper installation of the components of the primary proton transport system and of the secondary muon channels as well as anticipating future access and removal of components for servicing. The recommendations of the Dec 04 technical panel, which were mainly concerned with the long term maintenance issues, have been implemented.

The primary beamline elements are all on order so are the muon production target vessel and its target. However infrastructure components related to the proton beamline have not been taken into account in the funding and must be covered within already scarce resources. The main concern is the availability of funds for transferring the KEK superconducting decay muon channel and refurbishing it for installation on day one on the southwest port.

Another concern was raised when it was revealed that the requested 100 nsec proton pulse width would *possibly* seriously compromise the full beam power available for neutron users. Any degradation of the proton beam pulse width beyond 100nsec would have serious consequences for all muon users in terms of time resolution and make the muon source less and less attractive compared to the ISIS-RAL source for example. Since this was raised as a flag by the accelerator team it is important to study the space charge effect causing this degradation and mitigate it during the commissioning period.

The committee reviewed some of the Letters of intent received and identified the core projects that would contribute to enhancing the bare initial channel. A number of initial programs could use the decay channel from KEK on day one while a number of very innovative ideas were presented to develop unique capabilities at J-PARC in terms of ultra slow muon beams or pencil beams which would open very important scientific fields in surface or interface physics, molecular and biophysics etc. The committee considers that these initiatives should be encouraged so that the J-PARC muon facilities be positioned to offer the Japanese and the world communities with unique instruments. The committee also noted the pledges for involvement of new University based group in particular in the chemistry community and of important industrial users (The Toyota group).

Enormous progress has been made on the facility development and a dedicated commitment of the KEK construction team is evident. One is entering a delicate phase when, with the shutdown of the  $\mu$ SR program at KEK, a significant gap in physics capability exists. University users will have to rely on sources abroad to keep an active physics program for their students. On the other hand installation tasks are very demanding as well and could use more manpower. It is important to identify the real timing for restoration of a muon physics program in Japan to allow concrete planning. This is especially important for university groups and industrial groups relying on muon sources. At the moment the shortage of funds for installation and the uncertainty on the realization of the first muon beam at  $t=0$  doesn't allow for clear statements to be made. This is most unfortunate and should be addressed so that a firm commitment can be given to users.

## **NUCLEAR AND PARTICLE PHYSICS**

The IAC was presented with excellent information on the status and progress of the nuclear and particle physics experimental program, including neutrino and hadron components and plans for the formation of a Program Advisory Committee (PAC) for this science. These are discussed in turn below.

### **Neutrinos**

The neutrino experiment at JPARC, T2K consists of 189 physicists from eleven countries. In 2005, extensive progress in the construction of the neutrino beam line, the design of near neutrino detectors and full restoration of Super-Kamiokande has been made. Large foreign contributions are expected in most parts of the project. For the neutrino beam line, the pion decay volume was partially completed and the tunnel construction of the primary beam line has started. Productions and tests of major devices have begun. A highlight in 2005 is the start of the mass-production of superconducting combined-function magnets, the major components of the beam line. The first magnet was successfully produced and was excited up to 105% of the nominal current for 50GeV operation. The start time of the construction of the target station was moved by one year forward to 2006, so that the beam line can be completed by March 2009. A conceptual design of the near neutrino

detectors has finished, and the shared responsibilities of the detector construction to each country are defined. The budget requests in most collaborative countries have been submitted. A near neutrino detector uses a large dipole magnet which was the magnet used by the UA1 experiment at CERN. The rebuilding of Super-Kamiokande is also ongoing and Super-Kamiokande-III will start operation in June, 2006.

T2K: Dr. T. Nakaya presented the T2K collaboration and program in a very concise and useful form, indicating both the competition and complementarity of T2K with other current- and next-generation neutrino measurements worldwide. Dr. Nakaya took proper notice of the need to compare T2K with the global activity in this important area, where Japan has had enormous international impact.

T2K's Phase-I physics goals are to observe  $\nu_\mu \rightarrow \nu_e$  in a narrow band beam and with this data to determine  $\theta_{13}$ . This poorly measured mixing angle is a key measurement in the understanding of flavor mixing in the lepton sector and knowing its magnitude, ultimately with sensitivity down to  $\theta_{13} \sim 0.01$ , will enable the neutrino community to set the direction of a future international program to look for CP violation in the lepton sector. T2K's expected sensitivity is expected to be in the range  $0.3 \times 10^{-2} \leq \theta_{13} \leq 3 \times 10^{-2}$ , depending on  $\delta$ , the magnitude of the CP-violating phase. Competitive with, and to some degree complementary to, T2K are the NOvA  $\nu_e$  appearance experiment at Fermilab and one or more reactor-based  $\theta_{13}$  experiments looking at  $\bar{\nu}_e$  disappearance.

T2K will also add significantly to the world's knowledge of  $\Delta m_{23}^2$  and  $\sin^2 2\theta_{23}$  via  $\nu_\mu \rightarrow \nu_x$  disappearance. The goals for precision in these mixing parameters are  $\delta(\Delta m_{23}^2) \sim 10^{-4}$  and  $\delta(\sin^2 2\theta_{23}) \sim 0.01$ . The plan is to begin the experiment in early 2009, which requires the neutrino line and the near detector be completed, commissioned and tested by 2008.

Although most parts of the T2K project are going well, T2K has the following problems. The most critical one is the low beam power of J-PARC expected at the initial stage since T2K faces severe international competition from the neutrino experiment at Fermilab, NOvA, and a couple of reactor neutrino experiments planned in the world. The high beam-power of J-PARC by using any optional scenarios and techniques such as more protons from RCS to MR, doubling the harmonics (bunches) of MR and a longer running time even with lower proton energy are necessary as well as the prompt start of the experiment in April 2009.

Dr. T. Kobayashi presented a detailed report on the construction status of the J-PARC neutrino beam line. He reported significant progress and, in particular that the potential crisis described to the IAC last year (on the target station construction schedule) had been averted. However, he also reported that further negotiation would be needed on the commissioning schedule of the accelerators and the hadron facility vs. the construction schedule of the neutrino line. This is felt by the IAC to be an example of the need for technical coordination across the whole project (see *Recommendations 2 and 3* above).

Significant progress was reported by Dr. Kobayashi to the IAC on the design, production and testing of components and the decay volume, and this information was also warmly

received. The entire staff of the neutrino beam line effort is to be congratulated on its excellent progress and performance. This staff presently comprises about 40 FTEs and was said to be short-handed in the areas of engineering (presently 13 FTEs) and in Data Acquisition, Controls and Electronics, where there is apparently no one assigned at present. It was somewhat disturbing to learn that this shortfall could not be quantified, and it was said that the project could hire the needed extra staff. This would seem to imply an unknown cost/schedule risk to this very high priority component of J-PARC. This also relates to the IAC's desire to see the implementation of project-wide technical coordination.

### **Hadron Program:**

Drs. J. Imazato and K.-H. Tanaka made presentations to the IAC, summarizing the status and progress on the beam lines + spectrometers and on the facility construction, respectively. The presentations were thorough and informative, conveying significant progress since last year. Several issues are worthy of note.

- The Hadron Experimental Facility scientific program is diverse and compelling. The specifics need to be confirmed by the approval process, but the IAC supports the program, which emphasizes fundamental research in kaon physics, hadron physics and strangeness nuclear physics.
- The Hadron Program is a small user of beam power and so can be productive right from the start of operations. Its early incarnation is based on detectors that have seen service at other facilities, including the KEK PS and possibly the BNL AGS; this is another point favoring the early phase of the program at the start of operations.
- Realization of the program requires endorsement of detailed proposals by the PAC and is constrained by the availability of funds.
- The beam line design for the A-line servicing the hadron program is based largely on "recycled" magnets and power supplies, with the coils of some – especially at the front end of the line – being replaced with new, radiation-hard MIC coils. This work is proceeding very well, as is R&D and design on beam monitors, beam separators and the beam dump.

The IAC learned that, in addition to funds and approvals for the experimental program, the hadron community would greatly benefit from early implementation of a test beam facility. This beam, using a 0.5% "T0 target" servicing a separate experimental hall, is not funded at present. It is certainly the case that the world-wide effort in nuclear and particle physics is lacking sufficient test beams of high quality, intensity and energy. The IAC was told that, absent the needed funding, the leaders of the hadron program were considering a "poor man's" test beam looking at the T1 target, with significantly worse performance. The IAC questions the priority of such a low-quality beam, relative to the installation of the experiments themselves, which are also funding-constrained at present.

## NUCLEAR TRANSMUTATION

The nuclear transmutation programme was presented by H. Oigawa. In its previous report the IAC has reaffirmed the importance and the priority of ADS technology development at J-PARC for the development of nuclear energy and the management of nuclear waste. The objective is to study in depth transmutation to reduce the radiotoxicity, volume and heat of high level nuclear waste that has to be put in a final repository.

The committee has appreciated the comprehensive review on international ADS transmutation projects. The importance of ADS research is assessed by the high priority given by the European Framework Programme to the EUROTRANS integrated project proposed by a large collaboration of 17 countries together with 10 industry partners, 18 national research centres and 14 universities. From this presentation, the committee believes that J-PARC is the most advanced facility for ADS research, but needs increased support. The proposed experimental programme will provide important information on the potential of ADS for nuclear waste management and advanced materials. This information will be complementary to the research on the transmutation of actinides to be carried out at Monju in a fast sodium reactor. Japan would be thus the world leader in the research on the transmutation of nuclear waste using the full potential and the synergies of the new JAEA organisation.

The development of a new generation of nuclear reactors and the management of high level radioactive waste are now the focus of major R&D efforts in Japan within the Generation IV international collaboration. Advanced isotope separation combined to transmutation in these new reactors will play a central role and provide significant advances in nuclear waste management. But this will require intense research efforts worldwide, it is expected that R&D will take about 20 years. Thus, it is essential for the nuclear industry to develop, in addition to the expertise in the design of new Generation IV reactors, an adequate basis in experiment, theory and testing to support the advanced design concepts that will be used.

The committee essentially agrees with the conclusions presented by H. Oigawa. The J-PARC transmutation programme should be integrated in an international roadmap. The user community should be developed in Japan and in other countries in particular in Asia.

As partitioning and transmutation technology is being recognized as an ultimate goal of the nuclear fuel cycle and the waste management in the world, IAC endorses the uniqueness of the Transmutation Experimental Facility (TEF) and its possibility to become a Center of Excellence for the transmutation technology by both ADS and FBR. IAC recommends JAEA management to discuss the integrated plan for the research and development of the transmutation technology by both ADS and FBR by taking account the potential capability of TEF/J-PARC in such an integrated plan.

## APPENDIX I

### Agenda for the 5th International Advisory Committee Meeting J-PARC

#### February 27 (Mon)

8:50 – 9:10	Executive Session (Committee + Nagamiya + Oyama)	
	Change of comm. members, Points of advice, Agenda, etc.	
9:10 – 9:30	JAEA and J-PARC	Y. Tonozuka
9:30 – 9:50	KEK and J-PARC	Y. Totsuka
9:50 – 10:10	Coffee Break	
10.10	Status of J-PARC	S. Nagamiya / Y. Oyama
	Progress of Construction, Budget, Schedule, Organization, Operational Budget, Activities by Committees, Actions for the last year's recommendation items, etc.	
11:10 – 12:10	Accelerator Progress, Status A-TAC report	H. Kamiya / Y. Yamazaki S. Holmes
12:45 – 13:45	Lunch	
13.45 - 14.00	Closed session - common points for our recommendations	
14:00 – 14:20	Report from the Review Committee for Operational Budget	Y. Cho
14:36 – 15:36	Materials and Life Experimental Facilities One Year Progress (50) Progress plus N-TAC Report Neutron Committee (10)	Y. Ikeda M. Arai K. Yamada
15:5 – 16:05	Coffee Break	
16.05- 16.20	One Year Progress for Muons (20)	Y. Miyake
16.25 -16.30	Muon Committee (10)	J. –M. Poutissou
16.40- 17-00	Neutrino Experimental Area (40)	T. Nakaya (Kyoto)
17.01- 17.15	Neutrino beamline construction.	T. Kobayashi
17:15 – 17:45	Promotion Policy for R&D and Utilization of Quantum Beams	N. Saito (MEXT)
17:30 – 18:30	Executive Session	
18:30 –	Dinner Party	

February 28 (Tue)

08.15 - 08.45 Closed session

08.45 - 9.30 Nuclear and Particle Physics Experimental Facilities

09.30 - 09.43 Hadron Experimental Area (40) J. Imazato  
Construction report K.H.Tanaka

09.44-- 10.00 Formation of PAC (10) T. Nagae

10.00 - 10.15- Nuclear Transmutation H. Oigawa

10:30 - 10:45 Coffee Break

11.00 - 12:30 Tour of the Site

12:30 - 13:30 Lunch (could be a working lunch)

13:30 - 14:00 Network and Computing S. Kawabata

14:00 - 14:30 Open Discussion, Report writing (Up to chairperson)

14:45 - 15.15 Summary Session

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