THE INTERNATIONAL ADVISORY COMMITTEE ON THE J-PARC PROJECT

REPORT

Meeting held Feb 27-28 2012

Tokai, Japan

Restarting the J-PARC accelerators after the giant earthquake of March 11th

April 3rd, 2012

Contents

EXECUTIVE SUMMARY

The International Advisory Committee (IAC) for the J-PARC project met on February 27th and 28th 2012 at the J-PARC centre, Tokai and toured the main J-PARC experimental facilities. The IAC thanks the Director of KEK- Dr. A. Suzuki and the Executive Director of JAEA- Dr. H. Yokomizo, for addressing the IAC and presenting the view of the partners on the project. The IAC thanks the J-PARC director Dr. S. Nagamiya for providing a comprehensive view of the laboratory through detailed presentations from his staff. Hence the IAC received a very global view of the project on which to formulate its recommendations. The IAC also thanks the governor of the IBARAKI prefecture and the mayor of Tokaimura for celebrating with us the grand reopening of the J-PARC accelerators to the user community. The support and interest of the senior officials in Japan for J-PARC is a great testimony to the scientific, economic and social relevance of the laboratory to Japan. This is the result of the great leadership and of the superb staff who worked so hard to recover from the March 11 disaster and to pursue the vision of the founders of J-PARC.

The laboratory has mostly recovered from the major damages inferred by the great earthquake of March 11th 2011. Considering the severity of the tremors and the difficult environment in which to operate the repairs, it is quite remarkable that the team of J-PARC was able to re-establish beam properties close to those that were available just before the earthquake in less than 9 months. The IAC is praising the determination, hard work and intelligent decisions of the J-PARC leadership and staff to unsure that the user program would restart as soon as possible to restore the intellectual life of the laboratory.

The IAC congratulates the director of J-PARC and his staff for a truly exceptional achievement. The role of the J-PARC centre Director is key in the development of J-PARC and its positioning on the world scene. IAC recommends that both host institutions strive to maintain the international calibre of the position.

The Japanese government has recognized the value of the laboratory in providing recovery funds and operational funding which should allow for 8 months of user operation for the 3GeV based program and 6 months for the 30 GeV one. In view of the accelerator performance and of the very high demand for beamtime from users, the IAC supports identifying supplementary resources to run both programs for 8 months in FY2012 so that the world class programs (like the neutrino and nuclear programs) can resume effectively. Together with the MLF programs they bring truly unique opportunities which will draw a large national and international user community to J-PARC.

Recommendation:

All of the participants, J-PARC, KEK, and JAEA must continue and redouble their efforts to secure the appropriate levels of funding to run an extensive (8 Months) user program in the coming year for all aspects of the J-PARC program.

SUMMARY OF THE RECOMMENDATIONS BY SECTIONS IN THE REPORT

Management:

IAC recommends to use this as an opportunity to assess the management of J-PARC, build on its past success but also address some of the perceived deficiencies linked to the complex funding environment between partners.

Budget:

The IAC urges all partners to secure enough funding for an 8 cycle operation of the full complex in FY2012.

Accelerators:

- ***Recommendation #1***
  Establish a plan for the summer 2013 shutdown that integrates all activities across the complex and connects them through a common set of schedule milestones.

- ***Recommendation #2***
  The present source intensity limitations are not yet on the critical path for delivering the revised user beam intensity plan until the summer of 2014. Therefore, committee recommends keeping alive the existing ion source, and putting more effort in a comprehensive analysis of the performance and failure mode of the new source , i.e., filament lifetime, gas load on the RFQ,… on the test beam facility before committing to the installation on the Linac.

Particle and Nuclear Physics:

- ***Recommendation #1***
  Operate the Main Ring for 8 cycles in JFY2012 to ensure international leadership in long baseline neutrino (T2K) and rare kaon decay programs such as KOTO and hadron hall experiments.

- ***Recommendation #2***
  Develop a clear path towards beam improvements, including a plan to reach 750 kW MR fast extracted beam power and a plan to reach 100 kW MR slow extracted beam power with good efficiency and duty factor.

- ***Recommendation #3***
  Develop a strategy (priorities beyond neutrinos and rare kaon decay) and a prioritized plan for beam power sharing. This would give those 'best' experiments timely and sufficient beamtime to make a strong impact in this competitive scientific field.

- ***Recommendation #4***
  We recommend that an appropriate Scientific Body sets up priorities and follows closely the progress of the approved projects. Prioritization and clear commitments on the beam will greatly increase the appeal for international participation.

- ***Recommendation #5***
  For the "fundamental" Muon and Neutron Programs, the IAC recommends to develop an overall science strategy with priorities and timelines jointly with IPNS, IMSS, MLF and J-PARC.

MLF

- ***Recommendation #1***
  - Proceed with the plans to deploy the next generation target incorporating cavitation mitigation as soon as possible.
  - Incorporate plans for target development and spares acquisition into the overall plan for beam power scheduling for the MLF.
  - Bring the instruments to full capabilities and enhance the support experimental facilities for users.
- **Recommendation #2**
  - Establish a scheme to assess and decide on truly challenging scientific targets strategically based on collaborations with every sector of research community
  - Determine performance indicators which will be used to judge the scientific impact of the MLF.

MUSE facility:

- ***IAC repeats the recommendation that the design, construction the remaining front end elements of the S and H channels be funded soon so they can be installed in the proton tunnel in the upcoming summer 2012 shutdown before significant radiation levels are generated in the muon production target area.***

Transmutation:

- **Recommendation #1**
  The IAC welcomes the new proposal of the transmutation group. The IAC recommends involving future users in the definition of the experimental program and in the design of the facility. The IAC recommends that J-PARC and JAEA should fully support the proposal to MEXT for building TEF-T.

- **Recommendation #2**
  After the Fukushima accident, the public needs to significantly increase its confidence in the management of nuclear power and nuclear wastes. New initiatives must be proposed. Time is important. The public is not ready to wait. Thus the IAC recommends that J-PARC and JAEA should take advantage of this window of opportunity for R&D and accelerate R&D on the management of nuclear wastes, in collaboration with University researchers.

- **Recommendation #3**
  The IAC is pleased of the progress of the collaboration with the MYRRHA international ADS project. The IAC welcomes the proposed plan to develop J-PARC and MYRRHA as complementary facilities to maximize synergies on ADS research.

- **Recommendation #4**
  J-PARC should continue to contribute to education and training in Japan to build the new generation of scientists and engineers that will have to extend considerably the frontiers of the knowledge on nuclear safety and risk management.

Cryogenics:

The IAC Committee recommends to explore the potential usage of
(1) Any beamline within J-PARC that could deliver high fluxes of neutrons
(2) the IFMIF Test Accelerator (which is under construction in Aomori Japan under ITER project). Even if there is no planned user program at this test accelerator, it will be worth to evaluate the IFMIF capability for generic radiation testing.

GENERAL STATUS OF THE PROJECT

The International Advisory Committee (IAC) for the J-PARC project met on February 27th and 28th 2012 at the J-PARC centre, Tokai and toured the main J-PARC experimental facilities. The IAC thanks the director of KEK- Dr. A. Suzuki and the Executive Director of JAEA- Dr. H. Yokomizo, for addressing the IAC and presenting the view of the partners in the project. The IAC acknowledges the participation of the Governor of the Ibaraki prefecture and of the Mayor of Tokaimura to the celebration on Monday, demonstrating the commitment of the local administration to making J-PARC an attractive international destination.

Presentations on the status of the laboratory by the Director- Dr. S. Nagamiya and on the status of the technical facilities were supplemented by science presentations highlighting the recent scientific achievements. The IAC heard also reports from the Accelerator Technical Advisory Committee (A-TAC) and from the Muon Science Advisory Committee (MUSAC). Hence the IAC had a very global view of the project on which to formulate its recommendations.

MANAGEMENT: J-PARC, KEK, AND JAEA, CROSS

The IAC notes with great appreciation the support given to J-PARC in 2011 by the two J-PARC "parents" JAEA and KEK. The remarkable achievement of J-PARC's recovery by December 2011 is due in part to their substantial current and foreshadowed future support despite their own budgetary profile and the need to fund new programs post 2011. This along with the new budgetary provisions by the Japanese Government is strong encouragement to the staff of J-PARC and international partners to go beyond the present excellent performance to new heights. The Governments direct grants to the partners and to J-PARC – for the increased cost of electricity, though JAEA for the 400MeV LINAC and for improvement of user access are greatly appreciated. The IAC notes the numerous calls upon KEK resources for renewal and new projects on the Tsukuba campus. More financial support and continued injection of the KEK scientific culture will be necessary as the user program at J-PARC continues to grow, particularly in the MLF and Hadron areas. The high priority of the particle physics area is an ornament showing KEK's participation.

The IAC welcomes the participation of CROSS as a third partner in the development of J-PARC as a user-oriented facility. The IAC has repeatedly emphasised the importance of joint projects between the scientists at J-PARC and external users as one means of maintaining the scientific quality of J-PARC scientists. The recognition of the Japanese Government through CROSS (as a Registered Institution) and the security to operation of J-PARC given through this is welcomed. The IAC notes the advantages that will come from a transparent review process for entry of users into the J-PARC MLF instrument program and commends the use of peer review for all proposals using the facility. The IAC recommends the closest cooperation between all partners to achieve a scientific program whose culture and performance is comparable or better than the best international benchmarks set by the Institut Laue Langevin Grenoble, ISIS UK, NIST and the SNS in the United States as well as reactor based institutions in our region and in Europe.

MANAGEMENT

The IAC is fully aware that the leadership of J-PARC has played a critical role in the success of the laboratory during the construction phase and in establishing the initial scientific program. The IAC would like to express its admiration for the achievements of Shoji Nagamiya over the past 12 years. The IAC was pleased to have been associated with this success story.

A process is in place to identify the next director. The vision of J-PARC as an international world class laboratory serving a wide range of science remains the corner stone of the laboratory`s mission. This can only be accomplished by identifying a leader for J-PARC who will bring scientific leadership and international profile, determination, people skills and team work abilities, good connexion to funding agencies and governments. Dr. Nagamiya encompassed all these qualities and has demonstrated the need for such talents.

The future of the laboratory will be determined in part by the next five year plan to be submitted to the current government review; hence the timing of the change in leadership comes at a crucial moment. Ideally both the past and new directors should be fully engaged in the review process. In the aftermath of the earthquake, time has been a very expensive commodity and delays in the search for the new director have been encountered. However such a critical appointment cannot be made in haste and the IAC recommends that the process be allowed to follow its normal course even if it possibly creates a delay in the appointment of the new director.

IAC recommends to use this as an opportunity to assess the management of J-PARC, build on its past success but also address some of the perceived deficiencies linked to the complex funding environment between partners.

BUDGET

For FY2012, JAEA will provide funds to run 8 cycles of user beamtime while KEK could only provide for 6 cycles. This is the same situation that was planned for FY2011 before the earthquake struck. In the case of JAEA most of the funds come directly from the government (78.21 Oku Yen) plus 5.29Oku Yen from the JAEA base funds. KEK is providing 66.17 Oku Yen for operation and CROSS will add 7.02 Oku Yen for operating the neutron source. There is a large uncertainty on the increase on power cost by TEPCO (up to 30%) for which a supplementary budget of only 3.6 Oku Yen have been allocated through JAEA. This is a serious problem which may limit the amount of beamtime to all users. As reported in the particle physics section it is also most important that the neutrino program be able accumulate enough statistics before the 2013 long shutdown to clearly establish the discovery of θ_{13} in the ν_e appearance mode. Hence the IAC urges the partners to optimise the science output of J-PARC during FY 2012 by delivering 8 cycles of user beamtime. The IAC was made aware of the new Large Project Framework from the government which may provide an avenue for better operational support of large user facilities like J-PARC.

The construction budget is sufficient to complete the energy upgrade in the summer of 2013. There also a supplementary budget of 73 Oku Yen from KEK for earthquake related repairs.

Recommendation

The IAC urges all partners to secure enough funding for an 8 cycle operation of the full complex in FY2012.

As part of review of J-PARC conducted by the government, a five year projection for new investments is requested. This is the main opportunity for equipment funding to bring the complex to a fully operational level consistent with the initial design goals of 1MW operation of the MLF and 750KW operation of the MR and completing the missing muon beamlines in the MLF and in the Hadron hall. KEK's request is focused on the MR improvement for both fast and slow extraction operation, the extension of the hadron beamlines and new muon lines in the MUSE facility. For JAEA, the initiation of the accelerator driven source (ADS) is the key missing component. A symposium was taking place just after the IAC meeting to formulate a realistic plan taking into account of the re-evaluation of the nuclear power strategy in Japan.

The IAC views this five year planning exercise as a critical component in the development of J-PARC and urges all partners to present a coherent and well orchestrated strategic plan which would fulfill the mission of J-PARC to operate as a world class international laboratory.

STATUS OF THE ACCELERATOR SYSTEMS:

After a demanding recovery effort, the operating performance of the accelerator complex is close to pre-earthquake levels: RCS capability at 300 kW, the MR fast extraction at 125 kW and MR slow extraction at 3.3 k have been demonstrated. This is a remarkable achievement as reported in the ATAC report.

The installation of the 400 MeV Linac has been delayed by about one year to the summer of 2013 and will occur now at the same time as the installation of the new ion source and RFQ. ATAC has examined the consequences of this dual upgrade and is concerned with the workload associated with the installation and commissioning of the two brand new systems especially when some of the testing facilities needed for acceptance tests are not fully operational due to the earthquake.

The IAC concurs with the ATAC recommendation to establish a resource loaded schedule for the summer 2013 shutdown as soon as possible.

Recommendation

Establish a plan for the summer 2013 shutdown that integrates all activities across the complex and connects them through a common set of schedule milestones.

Moreover it is essential to develop and establish convincingly the technology for a stable and reliable ion source to operate over long periods. Preferably the prototype which has just been successfully operated off line should be mounted on the RF-Q test stand and run for a certain amount of time to establish realistic reliability and life time. If the prototype passes this test, then a full scale source can pursued. The long time delay to acquire the operating license to accelerate beam in the RFQ test stand makes this incompatible with the 2013 shutdown installation. The IAC is concerned that when a new scheme is

implemented in a real experimental setup, unexpected side effects or hidden difficulties are encountered which are difficult to tackle in an operational context.

- ***The present source intensity limitations are not yet on the critical path for delivering the revised user beam intensity plan until the summer of 2014. Therefore, committee recommends keeping alive the existing ion source, and putting more effort in a comprehensive analysis of the performance and failure mode of the new source , i.e., filament lifetime, gas load on the RFQ,… on the test beam facility before committing to the installation on the Linac.***

The revised plan for 1 MW beam power from RCS by JFY15, after energy and intensity upgrade, is realistic. Reaching 750 kW for MR fast extraction will require additional upgrades of RCS and/or MR. Improvements at RCS (more 2nd harmonic rf, variable tune along ramp, etc.) could improve the 3 GeV high intensity beam quality enough to move significantly towards the design 750 kW from MR.

Reducing the MR cycle time from 2.56 to 1.28 seconds with a new MR power supply and high gradient rf cavities ensures that the design beam power of 750 kW can be reached and also has the potential for a MR performance much beyond 750 kW.

Some progress has been made with slow extraction from MR. But no clear plan exists to reach 100 kW slow extracted beam power with good efficiency and duty factor.

SCIENTIFIC PROGRAMS

PARTICLE AND NUCLEAR/HADRON PHYSICS

The IAC congratulates J-PARC and T2K team for their first physics results using nu-e-appearance and nu-mu disappearance events taken before the earthquake. The nu-e appearance events result in a measurement of $\sin^2 2\theta_{13}$ at the 2.5σ level, creating a lot of excitement in the community.

Accelerators started their operations after successful recovery from the major damages inferred by the great earthquake of March 11th 2011. Their current capabilities are 125 kW for the Neutrino program and 3.3 kW for experiments in the hadron hall.

Particle and nuclear physics programs are primarily supported by the MR fast extracted beam for the neutrino program, and the MR slow extracted beam lines for experiments in the hadron hall. Two additional beams support particle and nuclear physics programs. They are the MLF H-line that supports muon g-2 and muon EDM measurements and the LINAC beam that supports neutron EDM measurements.

NEUTRINO EXPERIMENTS

The T2K collaboration with about 500 members from 62 institutions in 12 countries is a strong international collaboration. The T2K experiment, directing a muon neutrino beam from the Main Ring toward the Super-Kamiokande detector, is the centerpiece of the particle and nuclear physics program at J-PARC. The IAC congratulates the J-PARC/KEK team and the T2K collaboration for this continuous progress and success.

First physics results in both nu-e appearance and nu-mu disappearance modes using pre-earthquake data were published in 2011. Using the nu-e appearance mode, the T2K collaboration measured $\sin^2 2\theta_{13}$ at the 2.5σ level and this was very well recognized by the international community in particle physics.
In December 2011, all beam lines and detectors except the horns were successfully tested, and their performances confirmed by muon and neutrino yields. The horn problem was due to the failure of the new power supply system, which is being investigated. This problem is resolved by switching back to the old power system. The physics run with about 120 kW is expected to begin in March. A timely delivery of neutrino beam at the highest intensity (the total number of protons-on-target which is proportional to beam power and beam time) continues to be critical in the face of strong international competition: Daya Bay, Double CHOOZ, RENO, MINOS, and NOvA.

Experiments in the Hadron Hall

The first slow extraction of beam to the Hadron Hall beam dump in 2012 occurred on January 28. At this time the hadronhall is ready for high intensity beam.

The current layout of the Hadron Hall supports three beamlines from the same target. These are the K1.8 beamline and its branch line K1.8Br, on the north of the center line. On the south there are two beamlines the short K1.1BR line, and the neutral kaon line which serves the KOTO experiment. The K1.8 facilities are executing a dual program of hypernuclear and hadron spectroscopy experiments. Prominent among the latter is the search for pentaquarks, in particular the Θ^+. Thus far the results are inconclusive. It is expected that the hypernuclear program will run in June the expectation of achieving a beam power of 10 kW. Up until now power in the region of 3-5 kW has been achieved. The KOTO experiment is ready to take beam and to embark on their search for the kaon decay mode $K^0_L \rightarrow \pi^0 \nu\nu$. The initial goal will be to reach a sensitivity corresponding to the Grossman-Nir bound at a branching ratio of a few times 10^{-10} before the summer 2013 shutdown. This would correspond to 4 weeks running with a proton beam power of 30 kW and a good duty cycle.

It is clearly important that even for this early phase of the program, success is predicated on the steady increase of beam power and improvement of duty factor. The issue is discussed in detail in the accelerator report.

This initial phase of operations is dominated by the SKS experiment for the hypernuclear and pentaquark searches. In the K1.8 line, there is a proposal to replace the SKS spectrometer by 2015 with a recently funded S-2S spectrometer with two quadrupoles and one dipole magnet. The new spectrometer would have better momentum resolution and reasonable solid angle coverage (60msr) and be optimized for S=-2 (K-, K+) spectroscopy. Starting in summer 2013, it is the intent to reconfigure the north side of the hall. The first move would be to develop the K1.1 lines such as to accommodate a move of the SKS spectrometer from the K1.8 line to that line. The high momentum beam, which has so far not received funding, would also be introduced with a three year construction project; from that point the K1.1BR line would be unavailable. The high momentum line with a primary beam of 30GeV up to 10^{10} protons or un-separated secondary beams with momentum between 2 and 15 GeV/c. would enable a suite of experiments exploring confinement by examining vector meson masses in different nuclei, using a new electron spectrometer. It is hoped that the Riken Nishina Accelerator Center would

participate in this project, perhaps as a precursor to full participation in the Hadron Hall extension (see below). Potentially the high momentum line, which is considered to be a very high priority by the hadron physics community, could also support the COMET, muon conversion, experiment with a branch off that line. However, it is important to note that the high momentum line would prevent operation of the K1.1 line.

There is a large number of experiments proposed or planned for the Hadron Hall. Given the limited resources, it is important that the program be planned with a clear vision as to what is important. It is also obligatory to give strong emphasis to allowing accelerator, extraction and beam improvements to achieve the necessary performance parameters. It is important that the vision for the program be owned also by the users, for example by the Hadron Users' Association. We understand that this recommendation from last year led to a number of exchanges at the detailed operations level, but it will be important that the vision of the bigger picture also be shared.

IAC Recommendations

- ***Operate the Main Ring for 8 cycles in JFY2012 to ensure international leadership in long baseline neutrino (T2K) and rare kaon decay programs such as KOTO and other hadron hall experiments.***
- ***Develop a clear path towards beam improvements, including a plan to reach 750 kW MR fast extracted beam power and a plan to reach 100 kW MR slow extracted beam power with good efficiency and duty factor.***
- ***Develop a strategy (priorities beyond neutrinos and rare kaon decay) and a prioritized plan for beam power sharing. This would give those 'best' experiments timely and sufficient beamtime to make a strong impact in this competitive scientific field.***

FUNDAMENTAL PHYSICS WITH MUONS AND NEUTRONS

Four projects *in different status of maturity are being considered for new beamlines in the MUSE facility (g-2,DeeMe), a modified hadron hall(Comet) and a special extraction from the Linac (n edm).*

- ***The Lepton Flavor Violation m -> e conversion (COMET) with a single event sensitivity (SES) of ~ 2.6x*** 10^{-17} *has received stage-1 approval from the J-PARC-IPNS PAC and is very busy with R&D on the detector and on the beam line design. (For ex, measurements of the extinction ratio for both fast and slow extraction are still not sufficient to reach the desired sensitivity). The collaboration is now considering a staged approach, which needs to be specified in more details.*
- ***Muon g-2/EDM experiment is based upon a new approach to g-2/EDM using ultracold muons, with .1 ppm sensitivity in*** a_m ***and dm ~*** 10^{-22} ***e cm.*** *Stage 1 approval has been recommended by both the IPNS and IMSS PAC as it will use the H-line of the MUSE facility in the MLF (based upon the 3 GeV RC proton beam). A large collaboration has been formed (92 members) and is working to a TDR and to address the R&D aspects connected to the beam, the high precision magnet, the production of ultracold muons (in collaboration with TRIUMF and RIKEN). It is a world class project, which will need to be assessed carefully.*
- ***cLFV DeeMe is a new approach to m -> e conversion with SES ~*** 10^{-14}. *The experiment would use the same H-Line as the g-2/EDM. Approval is still deferred. Although the approach is interesting,*

the limited sensitivity puts seriously in question the need to do it. *Moreover, it will compete on the same line of g-2/EDM and muonium HFS experiments.*

- ***nEDM is an effort to measure the neutron EDM using ultracold neutrons produced by the LINAC beam to reach a sensitivity of 10^{-27} e cm****. Approval is deferred as there is a need to understand more about the feasibility of the source. This is a very active field worldwide and a clear advantage for this method has not been demonstrated yet.*

It is difficult to imagine that all these proposals could be carried out in a short time scale because of anticipated resource limitations. It is also clear that these initiatives, originating from the particle and nuclear physics communities, but sited in the muon facilities cross or bridge current committee boundaries.

We recommend that an appropriate Scientific Body sets up priorities and follows closely the progress of the approved projects. Prioritization and clear commitments on the beam will greatly increase the appeal for international participation.

For these Muon and Neutron Programs the IAC recommends developing an overall science strategy with priorities and timelines jointly with IPNS, IMSS, MLF and J-PARC.

MATERIAL AND LIFE SCIENCES

MLF Accomplishments and Status

The committee admires the efforts of all the members of MLF staff to bring the facility back online and fully operational.

Target:

The long shut down was used to replace the target with a new design, including He bubblers, which should enable the MLF facility to go to higher beam power. This was a significant achievement. However at present the bubblers do not function so the beam power is limited to 100kW although the accelerator can deliver 300kW. While excellent science can, and is being done at 100kW, the team should continue efforts to repair the He pump and start the bubbler as soon as possible.

The new target design requires less storage space after use, which is another critical feature of the design, but at the present planned ramp up to power the present target storage space will be full by 2018. It is urgent that the JPARC facility determine a long term strategy to dispose of used targets, and initiate design of the required infrastructure.

Instruments:

JPARC has developed rapidly a suite of world class instruments with 20 instruments complete or under construction, 12 of which are in the user program, and 2 more approved for construction – there are only two slots left and space around the instruments is at a premium! The progress on instrument development and commissioning has been incredible, which is a witness of the excellent team assembled between JAEA, KEK and partners. However a number of instruments are not complete in that they do not have the full complement of detectors, or the necessary suite of sample environment equipment and analysis software. It should be noted that this is quite a normal situation for a facility at

this stage of development, though perhaps somewhat exacerbated in the case of MLF due to the differing agenda's on the various stakeholders. The scientific productivity of the facility (note on-going review) can be optimized by ensuring that the operating instruments are doing so at full capability including detector coverage, sample environment and software. This requires both technical equipment and support staff.

We strongly recommend that the MLF management develop a long term plan to complete the instruments (detectors, sample environment, software etc.) that aims at optimizing the scientific productivity and balances the development of new techniques and new instrumentation.

The committee is very pleased to note that the MLF has achieved a level of 6-7 support staff for public and Ibaraki-prefecture beam lines. This number of support staff is consistent with international standards for major user facilities of this nature and is much more than the present Japanese standard. However, there is still a wide variation in the number of support staff per instrument; in particular the public beam lines, with support from the new CROSS organization, appear to be well supported, while the KEK instruments seem to be severely understaffed. Furthermore the balance between technical support and research staff should be assessed to ensure that 'all aspects of the user experience should be similar regardless of the "ownership" of the instrument they are using' [NTAC report]. The committee believes that it is timely to set and define standards across all MLF instruments, independent of 'ownership', for support, software and sample environments (including those at extreme conditions).

We fully support the NTAC view that that priority should be given to provide good support for the operation of the instruments rather than having a large number of instruments inadequately supported.

Additional User support:
The committee also noted that MLF management is planning for the integration of support facilities, including establishment of data analysis facilities and sample synthesis environments together with the installation of experimental facilities for extreme conditions (high magnetic field, high pressure etc.). The committee entirely endorses these actions, keeping in mind the fact that for sample preparation, collaborations with the entire user community are crucial.

Furthermore users will, and should, expect a comprehensive support infrastructure which includes:

- Sample environments and handling capabilities for a complete range of sample types (powder, liquid, irradiated etc.).
- Laboratory facilities and space for sample preparation, and specifically deuteration capabilities
- Enhanced logistics and infrastructure for MLF visitors (both short and long term), including office and interaction space, transport and FOOD.
- Remote access to instruments

In this light we see the construction of the User building, which would provide essential laboratory and interaction space for the developing program, as essential.

Scientific Direction:

The implementation of the new CROSS organization is a witness of the support at very top level for the neutron program. It provides an excellent opportunity to support the operation of a number of beam lines (5 at present), and the neutron delivery system, for public access. As such it provides a mechanism for engaging a broader scientific community with the JPARC neutron facilities and will certainly play a key role in developing the science programs at the MLF. A successful expansion of the CROSS program to other instruments in the available suite would be a good mechanism to provide the additional operational support needed.

The technical components of the neutron facility are well on the way to reaching stable operations so attention is turning towards building a vibrant science program in partnership with users. Excellent publications are emanating from the facility at a rate commensurate with the number of instruments and operating schedule.

However, the neutron beams provided by the MLF are rare and extremely valuable resources whose use should be closely managed by the facility to optimize the scientific productivity and stature of the facility. Although the user program will produce excellent research programs, due to the world leading nature of the facility, this alone is not sufficient. MLF management can act strategically to enable and direct science programs that go above and beyond the simple proposal system and provide a path to really distinguishing science.

Hence, the committee strongly urges MLF to establish scheme(s) to assess and decide on truly challenging scientific targets strategically based on collaborations with every sector of research community. This is crucial for the future of MLF as a scientific organization.

In doing this we also recommend that MLF management set a number of performance indicators to judge the scientific impact of the MLF, such as:

- High impact publications, citations
- Involvement of industry
- Expansion of the user base into new fields

The strategy for developing the science programs at MLF should also include close partnerships with other Advanced Large Research Facilities in Japan such as K-Computer; Spring-8, and SACLA.

Recommendation #1

- ***Proceed with the plans to deploy the next generation target incorporating cavitation mitigation as soon as possible.***
- ***Incorporate plans for target development and spares acquisition into the overall plan for beam power scheduling for the MLF.***
- ***Bring the instruments to full capabilities and enhance the support experimental facilities for users.***

Recommendation #2

- ***Establish a scheme to assess and decide on truly challenging scientific targets strategically based on collaborations with every sector of research community***
- ***Determine performance indicators which will be used to judge the scientific impact of the MLF***

Muon Science and the MUSE facility

Dr. Shimomura reported the conclusions of the recent MUSAC committee meeting which was held February 17th and 18th at J-PARC under the chair of Dr. E. Morenzoni.

The committee was charged to answer the following questions:

Are the D1/D2 instruments sufficiently equipped and users friendly?

The committee considers optimization of the experimental stations at D1 and D2 to be high priority since they will generate all the competitive muon science for the next few years until the Ultra Slow Muons become available. The D1 spectrometer upgrade must be completed and the sample environment suite should be broaden (dilution refrigerator, high field and high temperature ranges…). The new spectrometer being developed JAEA should be initially used in D2.

Are the scientific results obtained from the Inter-University Research program satisfactory?

The committee felt that taking into account the difficulties encountered last year, the science achieved was impressive and covered significant problems in magnetism, superconductivity and other aspects of material science.

Is the roadmap for the Ultra Slow Muon beamline reasonable? Is the scientific goal clearly defined?

The committee reaffirms its recommendation that the Ultra Slow Muon(USM) beam be the top priority. With the good support from KEK and a grant in aid for scientific research, the road map for construction appears well defined and achievable. Sufficient time must be allocated for detailed commissioning of the new U beamline as a good understanding of the beam transport properties of the solenoidal line is key to optimizing the USM yield. Some of the USM experimental equipment could be in place by Dec 2012. The initial focus of the program will be on thin film and surface studies in the U1A area with development of micro beams in the U1B. Amongst the many applications of USM, those two area form a good subset to initiate the scientific program.

How do you judge the future plan for the S-line and H-line?

S-line will be essential to broaden the mSR community by providing unique options including applied science. Although the long term plans are sound, a staged approach for installation should be considered in view of all the other commitments of a small team. Initially a unique surface muon beam station, S0, with a state of the art spectrometer would be sufficient to generate superb science.

H-line is specialized beam line for fundamental muon science and high energy beams. There is an important involvement of academia to seek funding for instruments. A commitment to operate the externally funded facilities is needed. G-2/DEEME/Hyperfine Structure of Muonium and Muon Magnetic moment combined effort to develop H-line have already attracted international partners. A firm commitment from the host institution is needed to bring these proposals to the floor.

Now that a common ground has been found to specify the front end elements of the H beamline, the overall priority is to install them before human access to the proton beam tunnel becomes impossible. The realignment of the H line base plates after the earthquake is one such operation that will require manual intervention.

The IAC concurs that exciting scientific prospects exist for both MLF science and Particle & Nuclear Physics with the H line.

Recommendation

IAC repeats the recommendation that the design, construction the remaining front end elements of the S and H channels be funded soon so they can be installed in the proton tunnel in the upcoming summer 2012 shutdown before significant radiation levels are generated in the muon production target area.

NUCLEAR TRANSMUTATION

The project of nuclear transmutation at J-PARC was presented by Dr. H. Oigawa. In response to last year's IAC recommendations, the J-PARC group has developed a new proposal for a Transmutation Facility (TEF). The project consists in building two independent experimental physics facilities:

- (TEF-T) is an irradiation test facility with a max. 200kW proton beam that will be an ADS Target Test Facility. TEF-T will be designed as a multi-purpose experimental facility to satisfy potential needs for experiments using a lower-energy proton beam. Various experiments using protons and neutrons will be possible, using a solid target (maximum power of 133kW) prior to TEF-P. The facility will be designed to use a Lead Bismuth Eutectic target (max. power of 200kW) in the future.
- TEF-P is a nuclear reactor facility for critical/subcritical experiments with a lower intensity proton beam.
- This project will be proposed to MEXT for financing, at a cost estimate of 217.6 Oku-Yen for the construction. TEF-T construction is proposed as a first step starting in 2013, to be followed later by TEF-P. It is expected that the licensing process of TEF-P will take a few years.

The IAC is pleased by the perspectives opened by this revised proposal. This approach seems to be more realistic in the present situation. The IAC would have been interested in more details on the physics program and on the expected impact of this project. To bring this project to completion, a strong team with sufficient human, technical and financial resources is needed to design a detailed project. The IAC reiterates its concerns by the relatively small size of the group (10 members). The IAC believes that a major increase in the support of the group is needed.

Recommendation #1

The IAC welcomes the new proposal of the transmutation group. The IAC recommends involving future users in the definition of the experimental program and in the design of the facility. The IAC recommends that J-PARC and JAEA should fully support the proposal to MEXT for building TEF-T.

The IAC understands that the situation of nuclear energy today in Japan is complex. The Fukushima accident has led Japan to reconsider its nuclear policy. Essentially all nuclear reactors but two have been stopped. The danger of accumulating radioactive spent fuel in cooling pools at reactor sites has been realized. Operations at the reprocessing plant at Rokkasho have recently been stopped due to a problem in the design of the vitrification process. Public opinion is more concerned than ever by the challenge of managing nuclear wastes. The need for a clear strategy on the management of nuclear wastes in Japan is critical.

The ADS project at J-PARC is a great opportunity for JAEA to demonstrate the importance of R&D and restore confidence in the safe use of nuclear power. The recent ADS symposium held in Tokyo showed that there is a significant interest from the Japanese community in an ADS project in Japan. But, the community needs a powerful national project and expects a strong leadership of J-PARC to coordinate the efforts of the users.

Recommendation #2

After the Fukushima accident, the public needs to significantly increase its confidence in the management of nuclear power and nuclear wastes. New initiatives must be proposed. Time is important. The public is not ready to wait. Thus the IAC recommends that J-PARC and JAEA should take advantage of this window of opportunity for R&D and accelerate R&D on the management of nuclear wastes, in collaboration with University researchers.

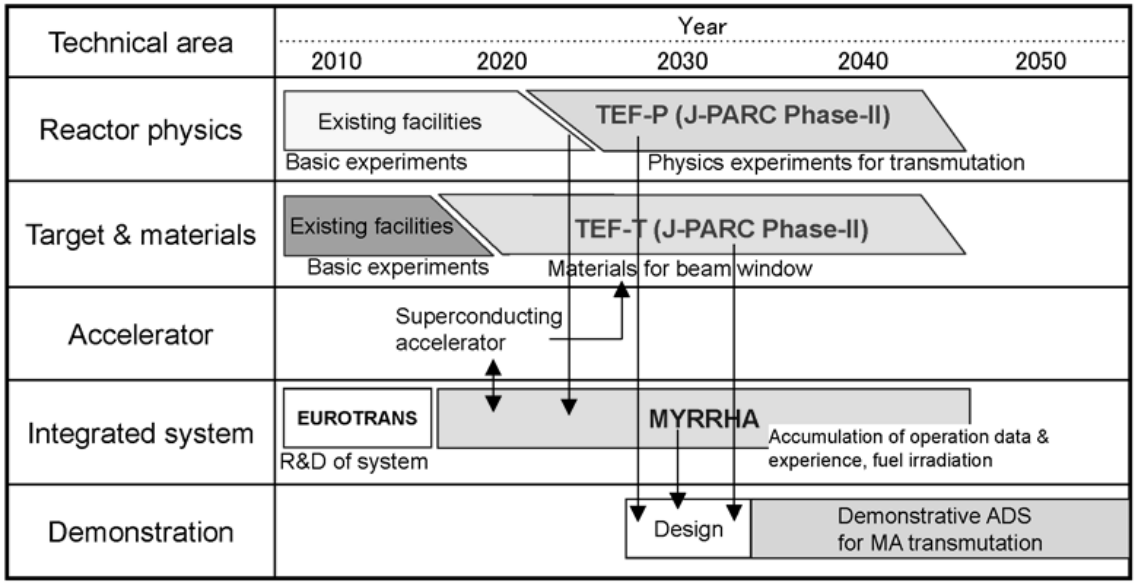
Considerable efforts have been done around the world to take into account the lessons from Fukushima. One year after the catastrophe, the world, apart from Germany, has decided to continue to use nuclear energy. The situation can be summarized by the statement of the Director General of IAEA, Yukiya Amano, on the 19th of September 2011, in his opening talk of the 55th session of the General Assembly of the AIEA.

> "Following the Fukushima Daiichi accident, there was speculation that the expansion in interest in nuclear power seen in recent years could come to an end. However, it is clear that there will, in fact, be continuous and significant growth in the use of nuclear power in the next two decades, although at a slower rate than in our previous projections**.** We expect the number of operating nuclear reactors in the world to increase by about 90 to 350 by 2030, in our low to high projections, from the current total of 432 reactors."

In this context, the interest for ADS is increasing around the world. ADS is recognized by several countries as a potential option of a transmutation system in terms of the partitioning and transmutation strategies for radioactive waste in the advanced nuclear fuel cycle.

The IAC was pleased to hear the commitment of KEK on accelerator research for both ADS and high energy colliders. Similar interest for using superconducting radiofrequency proton accelerators has emerged in many countries. This was clearly shown at the conference organized by the Nuclear Energy Agency on "Technology and Components of Accelerator Driven Systems", 15-17 March 2010, in Karlsruhe, Germany. This was also confirmed by a conference in Mumbai, 12-14 December 2012, which reviewed ADS systems and Thorium utilization.

The IAC welcomes the proposal of extending Japan's collaboration with the MYRRHA project at the SCK-CEN Institute in Belgium. MYRRHA is a major European initiative on ADS involving a large consortium of research organizations and industries. SCK-CEN has successfully coupled an accelerator producing fast neutrons to a lead experimental reactor which is an important first step of the final project. Belgium is welcoming international participation in the MYRRHA consortium, with eligibility based on a balanced in-cash/in-kind contribution.



Recommendation #3

The IAC is pleased of the progress of the collaboration with the MYRRHA international ADS project. The IAC welcomes the proposed plan to develop J-PARC and MYRRHA as complementary facilities to maximize synergies on ADS research.

Nuclear safety and risk management are the focus of attention in the whole world. Previous recommendations of the IAC stressed that R&D at J-PARC was one of the best training ground for education and training in these fields. The analysis of the Fukushima accident has shown that the catastrophe could have been avoided to a large extent if the crisis had been handled by people who had, at all levels, a better understanding of what was going on.

Recommendation #4

J-PARC should continue to contribute to education and training in Japan to build the new generation of scientists and engineers that will have to extend considerably the frontiers of the knowledge on nuclear safety and risk management.

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

Network and Computing

Dr. Manabe gave an update on the planned improvements for data transfer and inter institution communications.

The Japan Science Network (SINET) and JLAN have been upgraded themselves but the connection between them is still based on one Gigabit Ethernet Link until the summer 2012. The J-PARC internal links will also be upgraded to 10Gbps. However users requirement for easy access to data and/or data base information from the remote user site is not supported by the J-PARC Information system group and is relying on the effort of each facility.

A new computing system will start operating at KEK in April. J-PARC users should see about a tripling of the resources available.

Half of energy consumption of 1MW for computing system is for cooling. A more efficient cooling system to save energy and costs should be evaluated.

Cryogenics

This is a strong group providing essential support to many J-PARC programs. This expert team is nicely performing a wide variety of support tasks including technical support on cryogenic supply, construction, and operational support of superconducting devices while carrying also R&D for new projects.

The IAC recognizes the importance of R&D component to keep the team at the forefront of cryogenics research. The work on radiation hard superconducting magnets is well focused and highly relevant for many future projects.

However, the radiation testing sites are limited worldwide. At the moment, KURRI (Kyoto University Research Reactor) is available for testing, with limited user time and a risk of shut-down in future due to lack of funding.

Recommendation

The IAC Committee recommends exploring the potential usage of
(1) Any beamline within J-PARC that could deliver high fluxes of neutrons
(2) the IFMIF Test Accelerator (which is under construction in Aomori Japan under ITER project). Even

if there is no planned user program at this test accelerator, it will be worth to evaluate the IFMIF capability for generic radiation testing.

INTERNATIONALIZATION OF J-PARC

A new position was created last May to lead the international relations at J-PARC. Dr. Y. Watanabe took office in July and has been establishing a plan for actions. This plan includes creating an organisation network to promote effective internationalisation efforts by linking KEK, JAEA, CROSS, the Tokaimura City Hall, and the Ibaraki prefecture, promoting the bi-lingualisation of the J-PARC operations and providing an international perspective on J-PARC committees as needed. The challenge is reflected in the fact that only 2.7% of J-PARC staff is non-Japanese while catering to a user community which has a much larger participation from abroad (35% for hadron users, 80% for neutrino users, 10% for MLF users).

The survey of the current user community reveals a wide spectrum of length of stays, of countries of origin, and of scientific and cultural needs. A strategic plan is being formulated and the IAC would make the following recommendations:

- Acknowledging that some of the already well established collaborations have found a way to handle long stays at J-PARC with the present support of the user office, the focus should be first directed on helping the large number of short term visitors who needs very effective and timely support to make their short stay efficient.
- It would be desirable to establish both a scientific academic environment (seminar/colloquium series poster sessions) and a social activity group for students and post docs targeting the longer stay visitors
- Negotiations for family support (for long term visitors) should be initiated knowing that this is long lead item that requires a good understanding of the demands and its fluctuations with time.
- The plan should identify short term goals and associated metrics to monitor the program's success on yearly basis

The IAC very supportive of these efforts and considers that a large potential exists for making J-PARC a truly international facility.

CONCLUSIONS

The IAC would like to congratulate the J-PARC team for showing determination, competency and drive in recovering from the March 2011 earthquake. The team spirit that was very much in evidence for the last 12 months is a good omen for the future of J-PARC. This has been built over the past ten years by the strong leadership of J-PARC management and by the strong support of the founding partners (KEK and JAEA) and that of the Japanese government. The IAC is confident that the scientific program will be fully restored shortly and that the pre-March 11 development plans will only be delayed by a short period of less than a year. Yet much effort remains to fulfill the initial goals of a 1MW neutron source and of a 750KW hadron and neutrino source. The strength of a laboratory resides also in its ability to transfer knowledge and leadership from its pioneers to a new generation of leaders. J-PARC is well positioned to do so successfully.

The IAC wishes J-PARC good luck in resuming its science program and moving forward as a leading research institution.

Appendix I

Agenda for the International Advisory Committee Meeting of J-PARC in 2012

Date: February 27 (Mon) and February 28 (Tue), 2012
Place: Conference room at the Ibaraki Quantum Beam Research Center (IQBRC)

February 27 (Mon)

Report from the Director	S. Nagamiya
Accelerators	
Progress and Prospects	K. Hasegawa
A-TAC Views	T. Roser
Materials and Life Science	
Overview of MLF	M. Arai
Neutron Results	H. Seto
MSAC	O. Shimomura
Muon Results	R. Kadono
Particle and Nuclear Physics	
Overview of Particle and Nudear Physics	T. Kobayashi
Nuclear Physics	K. Tanaka
Hadron Hall Extension	H. Enyo
Fundamental Physics with Muon and Neutron	N. Saito
Institutional Views	
KEK and J-PARC	A. Suzuki

JAEA and J-PARC	H. Yokomizo
CROSS and J-PARC	Y. Fujii

February 28 (Tue)

Cryogenics System at J-PARC	T. Ogitsu
Network and Computing at J-PARC	A. Manabe
Accelerator Driven Transmutation Research	H. Oigawa
Internationalization of J-PARC	Y. Watanabe

Appendix II:

IAC 2012 Committee membership

Jean-Michel A Poutissou	TRIUMF	Associate Director Emeritus. Head of Nuclear Medicine	jmp@triumf.ca
John William White	Australian National University	Professor	jww@rsc.anu.edu.au
Andrew Dawson Taylor	ISIS, Rutherford Appleton Laboratory, STFC	Director Facility Development and Operations; Head of ISIS	andrew.taylor@stfc.ac.uk
Bernard Frois	CEA	Director	bernard.frois@cea.fr
Hidetoshi Fukuyama	Tokyo University of Science	Vice President and Professor	fukuyama@rs.kagu.tus.ac.jp
Ian Anderson	NScD/ORNL	Associate Laboratory Director for NScD	andersonian@ornl.gov
Sergio Bertolucci	CERN	Director for Research and Computing	sergio.bertolucci@cern.ch
Young-Kee Kim	FNAL	Deputy Director/Professor of Physics	ykkim@fnal.gov
Hugh Montgomery	Thomas Jefferson National Accelerator Laboratory	Laboratory Director	mont@jlab.org
Thomas Roser	Brookhaven National Laboratory	Accelerator Division Head, Collider-Accelerator Dept.	roser@bnl.gov
Hoerst Stoecker	GSI Helmholtzzentrum fuer Schwerionenforschung	Scientific Director and CEO	H.Stoecker@gsi.de
Eiko Torikai	University of Yamanashi	Professor	et@yamanashi.ac.jp
Tsumoru Shintake	OIST, Okinawa	Principal Researcher	shintake@oist.jp

Shoji Nagamiya	J-PARC Center	Director	shoji.nagamiya@j-parc.jp
Yujiro Ikeda	J-PARC Center	Deputy Director	ikeda.yujiro@jaea.go.jp
Koichiro Nishikawa	J-PARC Center	Deputy Director	koichiro.nishikawa@kek.jp