REPORT

OF THE

INTERNATIONAL ADVISORY COMMITTEE

ON THE J-PARC PROJECT

Meeting held February 27 – 28, 2017

at the J-PARC Research Building, Tokai, Japan

April 3, 2017

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Executive Summary

The International Advisory Committee (IAC) of J-PARC met at the laboratory on February 27 and 28, 2017 to evaluate the performance of J-PARC over the past year and to provide recommendations on proposed future directions for the J-PARC programs. The IAC commends the laboratory on the improvements that have been made to accelerator system, which led to very good reliability for beams into the MLF. Some issues still remain for providing beam with high efficiency for the neutrino experiment. Major advances were made in all experimental areas during the past year. In the Materials and Life Science (MLF) area, the IAC notes that J-PARC has done an excellent job in attracting industrial users to the facility. The high efficiency for beam on the neutron target has led to many experiments being completed there. Advances have also been made in developing an ultra-slow muon beam. In the Nuclear and Particle Physics program, the T2K collaboration has submitted a paper for publication that gives the first hints of CP violation occurring in the neutrino sector. Advances have been made in experiments using muons and kaons to test the Standard Model of particle and nuclear physics at high precision. The ADS effort developed a Technical Design Report that was reviewed by an external committee late in 2016. A few modifications were suggested that are now being implemented. Proceeding to the construction phase requires a decision be made by the Japanese government on how the project fits within the newly revised energy policy of Japan. Strong support from the organizations that fund J-PARC—MEXT through KEK and JAEA—was shown at the IAC meeting. But the funding level supporting operations for the Nuclear and Particle Physics program is severely limiting the number of hours that the facility can provide a neutrino beam and deliver beam to the Hadron Experimental Facility. The delay in obtaining funds to replace the power supplies on the Main Ring accelerator will further limit the number of protons on target that can be delivered to the T2K collaboration. These issues threaten the world-leadership position that Japan has enjoyed in neutrino physics. Finally, the IAC applauds the efforts J-PARC has made in elevating the message that safe operations are a high priority at the laboratory and encourages the laboratory to sustain these efforts into the future.

Major Recommendations

General

The IAC strongly encourages J-PARC to adopt the open campus concept. This will provide much better access for users at the facilities, thus making J-PARC more attractive to both researchers and local communities.

Accelerators

Pursue a higher reliability for the accelerator complex with a goal of at least 90% availability for the MR operation.

Procure, construct, install and commission the new MR power supplies and start operation at the faster repetition rate as soon as possible.

Safety

Maintain the momentum gained this past year in advancing safe operations at J-PARC and determine if a local 'Stop Work' order can be implemented to stop an action that could lead to imminent danger if continued.

Materials and Life Sciences Facilities

Neutrons: The IAC recommends a more cautious approach to power ramp up in the MLF. Reliability should continue to be given preference over increasing power, until the upgraded target #10 becomes available after summer 2018. We understand that Target #2 might be at risk from cavitation damage if operated beyond summer 2017 so Target #8 and its backup, the identical Target #9 (which only becomes available in early 2018), must be operated with some caution so as not to put the MLF program at reputational risk. Failure is not an option.

Neutrons: Develop a coherent strategic science plan which sets out the scientific agenda of MLF and defines a set of prioritized instrument and technique developments.

Muons: Seek out specialized expertise to help solve the limitations of the laser amplifier rod to improve the intensity of the ultra-slow muon source, possibly through hiring an external expert for a sabbatical period.

Nuclear and Particle Physics

General: Seek increased operating funding for main ring operations.

General: Explore the possibility of increasing the flexibility of MR operation to make more efficient use of the facility and serve more users.

Neutrinos: Procure, construct, install and commission the new MR power supplies and start operation at the faster repetition rate as soon as possible.

Nuclear Physics: Continue the experimental studies of the various aspects of strangeness in nuclei, and develop a plan for an exciting hadron physics program exploiting the envisioned upgrade of the Hadron Experimental Facility intensities.

Kaons: Proceed with the calorimeter upgrade and demonstrate improved performance. A further step will be made with the SX upgrade as a result of the new power supplies in the main ring.

Muons: Both the COMET and g-2 experiments are high priority for J-PARC. COMET, in particular, has the possibility of being ahead of the competition and should endeavor to move forward as quickly as possible.

Accelerator Driven Transmutation

Make a concerted effort to get approval from the government for the construction of TEF within J-PARC, by concentrating on the TEF-T that is of value in the international scene of Accelerator Driven Systems and material testing. Conduct careful safety studies of TEF-P.

Continue the support R&D needed to secure the TEF construction (for prioritization consider as first priority the realization of TEF-T and refer to the T-TAC report of the December, 2016, Meeting).

Start R&D activities on accelerator reliability improvements to meet the very demanding requirement of ADS application and that will be beneficial to all J-PARC applications.

Introduction

The J-PARC IAC met at the laboratory on February 27-28, 2017. Four members of the IAC were unable to attend the meeting (J.-M. Poutissou, H. Fukuyama, P. Langan, and P. McBride). Following an overview by Director Saito, the committee heard presentations on the safety program, accelerator operations and from the different science programs underway at J-PARC. Representatives of JAEA, KEK, and MEXT were able to join the meeting during the afternoon of February 27 and provided the committee with their views on the J-PARC programs. The committee met with laboratory staff and officials, including the mayor of Tokaimura, at a reception on the evening of February 27. It was great to hear the comments made by the mayor that indicate a trusting relationship between the laboratory and the surrounding community. This is often difficult to develop and is easy to lose.

J-PARC has a very broad science agenda ranging from fundamental studies that search for deviations from the Standard Model of particle and nuclear physics to studies for material and life sciences that include many applications for industry. During 2016, advances were made on all of these fronts, as will be noted below in the detailed reports on the science programs. Accelerator operations are at the center of this as all the science programs require proton beams on target to advance. Efforts made in the past several years to improve the reliability of the accelerator systems are now being realized. During 2016, over 2600 hours of beam were supplied to the Materials and Life Science Facility (MLF). The decision was made to operate at 150 kW of beam power in the MLF in order to ensure that the neutron target now in place would not be damaged. The IAC applauds this decision noting that the MLF operated at high efficiency, having over 90% of the available time with beam on target. This high efficiency is very important for a facility with a large number of users. Over 2000 hours of beam were scheduled for the neutrino program but issues primarily in the accelerator lead to just over 1500 hours of usable beam at a maximum beam power of 470 kW. The program of science in the Hadron Hall had over 616 hours scheduled and utilized 515 of them. The beam power available there was typically 42 kW. In all areas, the amount of beam time on target was limited by budget constraints.

Nearly all of the programs at J-PARC require secondary beams. Thus beam power is an important consideration. The MLF beam power is limited today by the neutron target and not the accelerator. Much work has been done to design and construct a new target that should allow significantly higher beam powers to be delivered. The decisions for when to install the new target and how quickly to ramp up the beam power to it need to be carefully considered. There is no doubt that the new target is being engineered to withstand high power but failure modes usually occur because of some lack of understanding of how materials work under high radiation environments. Thus the IAC recommends that a backup target be available before significant increases in beam power are applied to a new target. For the MLF users, stable beam at lower power is likely preferable to long periods of no beam due to target failure. The beam power to the neutrino and Hadron Hall experiments can be improved by shortening the Main Ring (MR) accelerator cycle time with the new MR power supplies. New power supplies, which have been designed and are ready to be built, will cut the cycle time in half. This will allow the beam power at the neutrino target to be increased to over 700 kW immediately and to close to 1 MW within a couple of years of operation. The new supplies will also provide significant improvements in both beam power and beam quality for experiments in the Hadron

Experimental Facility. The IAC strongly urges engaging with partners and funding agencies to work together to provide the resources for this critical upgrade.

A Technical Design Report has been developed for a 2018 start to the construction of the Accelerator Driven System Test Facility for Nuclear Transmutation. The report was recently reviewed and found to be very close to final—a few modifications were suggested that are now being implemented. With this report in hand, J-PARC is ready to advance toward the construction of the test facility. Recent decisions within the Japanese government have led to possible delays in proceeding with this program. It is important for the laboratory to seek clarification soon as to the program's status in order to not lose critical personnel if the program is to continue.

Over the past year, J-PARC management has continued its efforts to implement a safety program that reaches out to all laboratory employees. A major attribute of the program is that all employees should be watching out for the safety of themselves and their colleagues as they carry out their work. This effort has been named 'Mindful of Others' as it has been rolled out to the staff. It appears to the IAC that this effort has been quite successful in raising the awareness of the importance to maintain a safe operating environment at the lab. We applaud this innovative approach and urge that the momentum gained this past year be used to propel the lab forward in the future as it strives for an excellent safety record.

In the opening remarks by the Director, a proposed 'open campus' vision was given that would change the entrance of the laboratory to a location that would not require the heightened level of security that is now in place. The new entrance would allow the sensitive areas under JAEA to be completely separated from J-PARC. With the large number of users that are now working at the lab and the expectation that many more users will be coming in the future as the facilities further mature, this change to an open campus is highly desirable.

Recommendation: The IAC strongly encourages J-PARC to adopt the open campus concept. This will provide much better access for users at the facilities, thus making J-PARC more attractive to both researchers and local communities.

Below we summarize the reports on the different areas that make up the accelerator operations and the science programs at J-PARC.

Safety

The report to the IAC on safety at the laboratory reviewed the efforts that were made during the past year to implement the recommendations made by the IAC in its 2016 report. Much work has been done with positive results. The lab has been engaging the staff in an effort to make safety a high priority. The approach has been to engage staff to be aware of their own safety and those of workers in their area through an approach that was called 'Mindful of Others.' From what the IAC heard, this appears to be successful. The experience with safety programs at other labs shows that it is important to maintain continuing engagement with the staff for long term changes in the safety culture.

During the past year, a drill simulating an accident was carried out that demonstrated a number of issues. The lab is to be congratulated on carrying out this drill. From the lessons learned, it is important to implement changes in how the lab responds to an emergency and test that the changes have been effective by carrying out another drill in the near future.

Most of the members of the IAC work at laboratories outside of Japan. It is typical for employees to have the ability to issue a 'stop work' order when imminent danger is seen in allowing work to progress. If this is done, a formal process is put into motion to evaluate the work underway and make changes where appropriate. Last year the IAC recommended that J-PARC develop a similar procedure. In the presentation on safety at the lab, it was noted that the ability to 'stop work' is not something that is recognized in Japan. The IAC recommends that the laboratory institute a policy for J-PARC that replicates a 'stop work' action in order to provide a way to mitigate a major accident from occurring when it could be avoided.

Recommendation: Maintain the momentum gained this past year in advancing safe operations at J-PARC and determine if a local 'Stop Work' order can be implemented to stop an action that could lead to imminent danger if continued.

Accelerators

The J-PARC facility has operated very well during the last year with a strong emphasis on the users program. The changes made in the accelerator systems to improve stability led to steady operation of MLF with an availability of 93%. This resulted in a very significant number of science results being produced.

The MR has achieved the new record beam power of 470 kW for fast extracted beam and 42 kW for slow extracted beam. Several equipment failures are still impacting reliable operation of the MR, the beam transport to the targets and the targets themselves. The reliability improvement efforts of the J-PARC facility should be strengthened to achieve the high level of availability that is expected from all parts of this world-class user facility.

The quality of the RCS space charge simulations and the degree to which they agree with measurements is very impressive. Reducing beam loss to 0.2% for a 1 MW equivalent beam power is a very significant achievement. It should lead to very good operation into the MLF when a new target is in place that can survive with a sustained high power beam.

To reach the phase 1 design goal of 750 kW from the MR and to keep the T2K neutrino experiment internationally competitive it is critical that the new MR power supplies are constructed and installed in a timely way.

Recommendations:

Pursue a higher reliability for the accelerator complex with a goal of at least 90% availability for the MR operation.

Procure, construct, install and commission the new MR power supplies and start operation at the faster repetition rate as soon as possible.

Materials and Life Sciences -Neutrons

Significant progress has been made on many fronts since the last IAC review. Users have welcomed the >90% reliability that has been achieved at 200kW. Indeed, the 25 Hz MLF neutron target with its highly optimized cold moderators is an impressive source on the world scale. MW capability has been demonstrated by the RCS accelerator, but a cautious approach to the future ramping up of beam power is recommended.

J-PARC is on a path to becoming a major center for neutron scattering research but recent structural problems with the mercury target, seen while operating at power levels of ~500 kW, will delay achieving that goal. The approach of operating at reduced power levels of ~200 kW in order to preserve reliability until a solution is fully developed is very sensible. Operating at high reliability and reduced power levels will allow for continued growth in the science program. The next generation target designs may solve the problem but are as yet untested and it is not clear to what extent cavitation will be a problem at higher power levels

Recommendation

The IAC recommends a more cautious approach to power ramp up in the MLF. Reliability should continue to be given preference over increasing power, until the upgraded target #10 becomes available after summer 2018. We understand that Target #2 might be at risk from cavitation damage if operated beyond summer 2017 so Target #8 and its backup, the identical Target #9 (which only becomes available in early 2018), must be operated with some caution so as not to put the MLF program at reputational risk. Failure is not an option.

The rate of construction of new neutron scattering instruments at MLF over the past few years has been impressive. MLF now has a portfolio of world-class instruments with 21 out of 23 beam ports being instrumented. Even with 150 kW of beam power, the 25 Hz rate with highly optimized moderators and over 90% reliability makes it a potent source. Furthermore, the significant engagement by industrial users is unprecedented and 'headline' papers are now appearing in prestige journals. J-PARC can be proud of these achievements. However, the scientific productivity from these instruments, as measured by the number of publications, has been limited likely due in part to past issues with source reliability. Nonetheless, it may be helpful to conduct a careful analysis of each instrument in order to identify any bottlenecks in the publication pipeline. This should include all aspects of the scientific performance including data collection, reduction, and analysis software, sample environment, instrument hardware, ancillary laboratories, staffing levels, etc., and be compared to user expectations and requirements. Any gaps between present performance and expected performance should be identified and a prioritized plan should be developed to address these gaps in a systematic way. In addition, this analysis should include a bench marking exercise in which the scientific productivity (# of papers) of each instrument is compared to similar instruments at other sources. This would help in identifying where the greatest improvements in scientific productivity might be realized, assisting MLF management in setting priorities.

Beyond any limitations in instrument performance, it is important to provide an environment for beam line staff that promotes a strong science and innovation culture. Aligning staff in cross cutting scientific groups and developing a uniform approach to all users may help. Setting staff very clear expectations for scientific productivity and then rewarding those who achieve those expectations may also help. As MLF continues the difficult transition from a construction project to a mature facility, it may also be important to ensure that early career staff have strong scientific mentorship and that they are encouraged to fully engage in mainstream scientific communities through participating in conferences and in professional societies.

Recommendation
Develop a coherent strategic science plan which sets out the scientific agenda of MLF and defines a set of prioritized instrument and technique developments.

Materials and Life Sciences – Muons

Encouraging progress has been made on all four beamlines and their associated instruments. A significant landmark was provided by the generation of the first ultra-slow muons in February, 2016. A steady increase in the rate has been obtained by tuning and optimizing the beamline, however the absolute counting rate is still 1 to 2 orders of magnitude below that needed for a viable user facility offering USM μSR. The current limiting factor is the quality of Nd:YGAG material forming the laser amplifier rod. Alternatives to this material have been explored; however this has not yet led to a viable fallback solution.

Recommendation
Seek out specialized expertise to help solve the limitations of the laser amplifier rod to improve the intensity of the ultra-slow muon source, possibly through hiring an external expert for a sabbatical period.

Progress has also now been made on the H-line with front end devices, beam line elements and the iron shielding in place, including that for the H1 area to house the DeeMe/MuSEUM experiments. We particularly applaud the creation of a new position for a physicist dedicated to the H-line. This will be important to efficiently complete the H-line and to efficiently organize the logistics and infrastructure. Still a point of concern for H-line is the available electrical power in the area. The laboratory management is encouraged to arrange for a schedule to upgrade the power in the area that enables the beam line to be operated. This will enable a timely start of the physics program for the envisaged fundamental physics experiments.

The first part of the new S-line surface muon channel (S1) has now been commissioned. This is officially open from April 2017 and will reduce the previous heavy load on the D-line. The D-line will then become a special line dedicated to high-momentum muons and negative muon experiments. After the replacement of the superconducting solenoid of the D-line with a warm bore window-free design, the momentum range of the negative muons has been expanded to cover 65 keV to 54 MeV. This will open up new applications based on muonic-X-ray elemental analysis as a function of depth and tomographic imaging has also been demonstrated using pixelated detectors.

A clearly demonstrated fully functioning USM beamline will be the strongest internationally unique feature of MUSE and should remain the highest priority. Completion of the H-line in timely manner to start to deliver the fundamental physics program in the H1 area should be the next priority. Beyond the completion of H1, a roadmap should be drawn up for further developments. S1 now provides the first dedicated surface muon μSR instrument at MUSE, which should have the most widespread initial appeal to the μSR community. This presents a good opportunity to support and expand the user base and boost the scientific output of the facility.

Nuclear and Particle Physics – General Comments

The nuclear and particle physics program includes the neutrino program with the fast extracted beam from the main ring, the kaon decay, hadron physics and hypernuclear physics programs in the hadron hall with slow extracted beam from the main ring, and muon physics, both in the hadron hall with the COMET experiment and in the muon beams of the MLF facility. There has been significant progress in increasing the beam intensities in each area and beam powers that are approximately half of the near-term goals have now been achieved for the neutrino program (470 kW) and in the slow extracted beam (42 kW). The improvement of the average duty factor for the slow extracted beam from ~40% to 55% was a notable achievement. Plans are in place to increase the beam power in each mode to and perhaps above the near-term goals. Potential concerns are the lower beam availability this year of the fast extracted beam (69%) and the lack of backup production targets for the slow extracted beam. The R&D for the 100 kW slow spill production target based on a quite different design is also very important. The consolidation of the vacuum system for the hadron primary beam line has just been completed.

Major progress has been made on the construction of the beam line for the COMET experiment and commissioning will begin this year. The planned hadron hall extension would increase the multiplicity of simultaneous running slow-extraction experiments and provide more optimized beam in different energy ranges. The complexity of achieving sufficient beam time for the fast and slow extracted beam programs will increase as a third mode, dedicated 8 GeV proton running for the COMET beam, comes into operation.

The IAC has two general recommendations for the Nuclear and Particle Physics program.
Recommendations:
Seek increased operating funding for main ring operations.

Explore the possibility of increasing the flexibility of MR operation to make more efficient use of the facility and serve more users.

Neutrinos

The J-PARC long base line neutrino program using the Super-K detector at Kamioka is one of the leaders in the world-wide effort to discover if the CP symmetry is violated in neutrino mixing. This observation would provide important insight on the potential role of the neutrino sector in the preponderance of matter over antimatter in the universe. The recent T2K collaboration result that the CP conservation hypothesis is disfavored at the 90% confidence level is especially notable. The importance of the result is emphasized by the intense competition from the NOVA experiment at FNAL, which is the highest priority effort at that U.S. laboratory. NOVA is releasing preliminary results with comparable discriminating power. The science goals are of sufficient importance that these intense competing efforts are well warranted. Indeed combining the data from the two experiments can increase the discrimination power over that of a single experiment. Secondly the two different experiments have different systematic errors for the identification of electron neutrino events, where potential backgrounds may be lurking. Experience shows that either program could be unfortunate enough to suffer a major setback that could delay future results and leave the path open for the other.

It is remarkable that the event rates of the two experiments are quite comparable. FNAL runs for ~9 months a year with a 120 GeV ~700 kW proton beam. If J-PARC runs 4-5 months a year with 30 GeV ~470 kW beam, the event rate per proton on target and event rate per year are quite similar. For J-PARC, it should be a high priority to maintain the operating schedule and efficiency that preserves this parity. The committee heard that the limitations of the operating budget for physics at the main ring make this a real challenge for the near future. This must be a sustained program. It is essential that the program be optimized recognizing that time scale.

The replacement of the main ring power supplies to enable the delivery of 750 kW of beam power, now expected to occur in 2019, is the centerpiece of the improvements planned for J-PARC. Credible options to further increase the beam power to 1.3 MW have been identified. In the long term, all of these contribute to world-leading scientific power of the proposed Hyper-K detector that is the primary vision for the future of the Japan's neutrino physics program.

Decisions on other trade-offs between near-term running, improved reliability, and future improvements are delicate ones and the path to optimization would appear quite soft. Either extreme is likely to be a mistake, over commitment to production data taking could jeopardize other important J-PARC physics communities and the long-term maintainability of the neutrino beam. On the other hand, a temporary halt in production data taking could undercut the morale of the collaboration, where important attempts to improve the reconstruction efficiency and event characterization are underway, and damage the international perspective of the laboratories commitment to this science. We strongly support the Laboratory's efforts to obtain additional operating funds for the exciting main ring experimental program.

Recommendation: Procure, construct, install and commission the new MR power supplies and start operation at the faster repetition rate as soon as possible.

Nuclear Physics

The nuclear physics activities concentrate on experimental studies of strangeness in nuclei, motivated by quests to unify the forces among the members of the baryon octet and to constrain the KN, ΛN and ΛΛ interactions in the nuclear medium. It is now beginning to focus on multiply strange systems. As highlights in a pilot experiment performed in recent years, the J-PARC group found some excess in the $^{12}_{\Xi}$Be missing mass spectrum, which is tentatively related to a potential bound state. A new effort has begun to observe hypernuclear states in emulsion experiments exploiting a novel scanning method. An upcoming run later this year is expected to deliver a multitude more double hypernuclear states for nuclei lighter than oxygen, which will likely improve the knowledge of the Λ-Λ interaction. Future experiments will search for the H dibaryon, which recent lattice QCD calculations predict as a resonant state near the Λ-Λ threshold, and for a potential bound state in the $K^{-}pp$ system, indicated in a recent JPARC experiment. Another planned experiment will search for medium modifications for vector mesons in the nuclear medium.

In the midterm future, after an extension of the Hadron Experimental Facility, spectroscopy of medium and heavy Λ hypernuclei as well as production and studies of neutron-rich hypernuclei are envisioned. These investigations aim at constraining the Λ-N interaction in the medium with relevance for neutron star models.

The nuclear physics program is scientifically very sound and of significant relevance to nuclear astrophysics. It also produces a quite impressive number of PhD and master theses and hence successfully serves to educate the next-generation scientists.

Recommendation: Continue the experimental studies of the various aspects of strangeness in nuclei, while, and develop a plan for an exciting hadron physics program exploiting the envisioned upgrade of the Hadron Experimental Facility intensities.

Kaon Physics

The Kaon program addresses physics beyond the standard model by testing lepton flavor universality (E36) and looking for CP violating ultra-rare decays of K_L (KOTO).

Experiment E36 has completed data taking in 2015 using the beam from the main ring and is now analyzing the electron/muon ratio of K^+ decays. The helicity suppression in electron decays a priori yields a high sensitivity for new physics. E36 hope to improve the current world average on this by a factor 2 in accuracy. They see clear signals of the K^+ decays for both muons and electrons. The analysis is ongoing, with continued improvements being made for particle identification and tracking, and an update on the attainable accuracy will be presented in 2017. Meanwhile the experiment has been dismantled.

The KOTO Experiment is installed in the Hadron hall (as E14) and tries to observe the rare decay of $K_L \rightarrow \pi^0 \nu \nu^{bar}$ using the slow-extracted beam of the main ring. The signal, 2-gamma decay of the pion, and nothing else, requires low backgrounds and the goal for the branching ration limit to be measured requires the maximum number of K_L. The collaboration has installed a new barrel detector and used the K_L decays to 4 or 6 gammas (from 2 or 3 π^0, respectively) to understand backgrounds. Halo neutrons and the three π decay of the K_L with escaping charged π's constitute the main backgrounds. The position along the decay volume is used to define a yet blinded signal region. A priori, 1 event corresponds to 10^{-9} sensitivity ignoring background. They are examining a CsI calorimeter with MPPC or PMT readout upstream and downstream respectively as a veto which should increase sensitivity by an order of magnitude in 2018. A DAQ upgrade is planned for 2017. They require the power supply upgrade of the main ring to reduce the ripple so that the spill duty factor can be doubled (45% to 100%) and the main ring slow extraction cycle time can reduced from every 5.5s to every 4s. At CERN, NA62 is trying to improve the accuracy on the equivalent charged K decay to 10%. The experiments are complementary as deviations from the SM would require different explanations as to the type of new physics. The IAC notes good progress on this effort and supports work to proceed with the calorimeter upgrade and demonstrate improved performance. A further step will be made with the slow extraction upgrade as a result of the new power supplies in the main ring.

Recommendation
Proceed with the calorimeter upgrade and demonstrate improved performance. A further step will be made with the SX upgrade as a result of the new power supplies in the main ring.

Muon Physics

J-PARC has an ambitious and exciting program of fundamental physics with muons planned for the near future. Two large projects, a new measurement of the muon g-2 factor and a μ-e conversion experiment, COMET, are competing with experiments at Fermilab with similar goals. COMET is being staged in the Hadron Hall and will use an 8 GeV μ^- beam. The g-2 measurement will be done in the MLF area using an accelerated beam of ultra-cold muons to produce a 300 MeV/c muon beam with very small emittance. Two smaller experiments, DeeMe and MuSEUM are also being planned for muon beams in the MLF hall.

The COMET experiment is being carried out in two phases. It now has stage-2 approval for the first phase and beam line and detector construction are underway. In the first phase, a shorter beam line will be used following the production target where a primary beam of 3.4 kW using slow extraction will produce the secondary muons. The goal of the first phase is a measurement sensitivity of $\sim 10^{-15}$ for the conversion. Commissioning of the beam line and detector components will begin in 2019 at the earliest. In 2017, tests of 8 GeV acceleration and bunched slow extraction, as well as a measurement of the proton beam extinction, will be performed. The second phase of COMET requires a substantially longer beam line to reduce backgrounds. The plans for the next phase call for 56 kW of primary proton beam power, again using slow extraction, in order to reach an overall sensitivity of $\sim 10^{-17}$. The IAC strongly supports the work heading toward the first measurements with COMET. The effort appears to be on track to be the first new generation μ-e conversion experiment to run.

The g-2 experiment at J-PARC uses a very different approach than the most recent experiment that was carried out at Brookhaven National Lab. The storage ring that was used at BNL has been moved to Fermilab where a muon production beam line is being built to supply muons to the ring for a new, higher statistics, measurement. The g-2 experiment being developed at J-PARC will have very different systematic effects than the BNL and Fermilab measurements.

As noted above, the J-PARC approach to g-2 requires accelerating an ultra-cold muon beam produced from laser-ablated aerogel. The initial goal of producing such a beam has been achieved and further improvements are underway on the D-line in the MLF. Work on the beam production has been on-going over the past year with good success. A further test has been approved at the D2 area for March, 2017. The g-2 collaboration put together a TDR plan for staging the experiment that was reviewed in November, 2016, by the PAC. The outcome of the PAC review was to develop a fast track plan to carry out the first phase of the experiment in a timely and cost-effective manner. Following the resolution of some remaining issues, the PAC noted that the experiment should be ready for Stage-2 approval. The collaboration is now working on these remaining issues. The IAC is very supportive of this effort. It will be extremely important to carry out a sensitive measurement with this very different approach.

The DeeMe experiment will search for μ-e conversion in the production target at MUSE H-line. The group working on DeeMe has completed and tested the tracking detectors that precede the spectrometer magnet, which also has been completed. The experiment is now waiting on the construction of the H-line at MUSE. The anticipated sensitivity at DeeMe is $\sim 10^{-13}$ with a graphite target and $\sim 5 \times 10^{-15}$ with a SiC target. MuSEUM is an experiment to measure the hyper-fine splitting in muonium. It has now completed two runs and has successfully measured a hyper-fine resonance curve. Work is continuing on MuSEUM to improve its sensitivity.

Recommendation
Both the COMET and g-2 experiments are high priority for J-PARC. COMET, in particular, has the possibility of being ahead of the competition and should endeavor to move forward as quickly as possible on the phase-1 version.

Accelerator Driven Transmutation Research

In the report to the IAC on Accelerator Driven Systems, the head of the Nuclear Transmutation Division of J-PARC, reviewed the strategy proposed by JAEA to reach the deployment of industrial based ADS for the purpose of handling high level nuclear waste via transmutation. He described the progress accomplished on the Transmutation Experimental Facility (TEF) design and the associated R&D support program. He also presented the assessment work and recommendations of the T-TAC (Transmutation – Technical Advisory Committee) that held its annual meeting on December 12-14, 2016, as well as the actions taken corresponding to the IAC'2016 recommendations.

The IAC acknowledges the prompt actions J-PARC has taken in response to the 2016 recommendations and commends management for having requested the production of the Technical Design Report for TEF-T and consolidated the collaborations with the international groups in the field of ADS development.

The IAC acknowledges the enhanced importance of ADS activity within J-PARC through the creation of two sections under the Nuclear Transmutation Division, one in charge of the support R&D program and the other dedicated to the design of the TEF facility and the preparation of its use later.

The IAC acknowledges the very detailed recommendations of T-TAC for the TEF related to the improvement of the TDR of the TEF and the support program on Heavy Liquid Metal technology, dedicated instrumentation (Oxygen-meters and HLM US-flowmeters) and the recommendation for safety assessment on TEF-P. Building on this evaluation report and the general view and prospect of the evolution of J-PARC in terms of accessibility as an open-user facility sketched by the director of J-PARC Dr Saito and on the importance of the ADS activities at J-PARC for JAEA as stressed by the Executive Director of JAEA Dr Yukitoshi Miura, the IAC proposes the following recommendations.

Recommendations:
Make a concerted effort to get approval from the government for the construction of TEF within J-PARC, by concentrating on the TEF-T that is of value in the international scene of Accelerator Driven Systems and material testing. Conduct careful safety studies of TEF-P.

Continue the support R&D needed to secure the TEF construction (for prioritization consider as first priority the realization of TEF-T and refer to the T-TAC report of the December, 2016, Meeting).

Start R&D activities on accelerator reliability improvements to meet the very demanding requirement of ADS application and that will be beneficial to all J-PARC applications.

APPENDIX I

Agenda for the International Advisory Committee Meeting of J-PARC in 2017

Date: February 27 (Mon) and February 28 (Tue), 2017
Place: J-PARC Research Building

Draft v3.1

February 27 (Mon)

Executive Session				
8:45 – 9:00	(10 + 5)	Charge to the Committee	Naohito SAITO
Opening				
9:00 – 9:40	(30 + 10)	Report from the Director	Naohito SAITO
9:40 – 10:10	(20 + 10)	Safety at J-PARC	Tetsuro ISHII
10:10 – 10:20	(10)	Coffee	
Accelerator				
10:20 – 10:45	(20 + 5)	Progress and Prospects	Kazuo HASEGAWA
10:45 – 11:05	(15 + 5)	A-TAC View of Accelerator Activities	Thomas ROSER
Material and Life Science I				
11:05 – 11:45	(30 + 10)	Overview of Neutron Facility	Toshiji KANAYA
11:45 – 12:25	(30 + 10)	Neutron Instruments, Operations & Science at MLF	Kenji NAKAJIMA
12:25 – 13:25	(60)	Lunch	
Material and Life Science II				
13:25 – 14:05	(30 + 10)	MUSE Status and MAC Review	Yasuhiro MIYAKE
Particle and Nuclear Physics I				
14:05 – 14:35	(25 + 5)	Overview of Particle and Nuclear Physics	Takashi KOBAYASHI
14:35 – 14:50	(15)	Coffee	
Particle and Nuclear Physics II				
14:50 – 15:15	(20 + 5)	Nuclear physics program	Hirokazu TAMURA
15:15 – 15:40	(20 + 5)	Neutrino physics	Takeshi NAKADAIRA
15:40 – 16:00	(15 + 5)	Kaon physics	Taku YAMANAKA
16:00 – 16:20	(15 + 5)	Muon program	Tsutomu MIBE
Executive Session (closed)				
16:20 – 17:45	(85)	Review and Discussion	IAC Members
17:45 – 17:50	(5)	Group Photo	
Views from Funding Agency and Host Institutes				
17:50 – 18:10	(15 + 5)	J-PARC: A View from MEXT	Mitsuyuki UEDA
18:10 – 18:30	(15 + 5)	KEK and J-PARC	Masanori YAMAUCHI
18:30 – 18:50	(15 + 5)	JAEA and J-PARC	Yukitoshi MIURA
Banquet				
19:00 – 21:00	(120)	Banquet	

February 28 (Tue)

Accelerator Driven Transmutation Research			
9:00 – 9:40	(30 + 10)	ADS Project	Fujio MAEKAWA
Executive Session (closed)			
9:40 – 11:30	(110)	Review and Discussion, Drafting	IAC Members
Close out			
11:30 – 12:00	(30)	Recommendations	Robert Tribble
12:00 – 13:30		Lunch	

APPENDIX II

Jean-Michel Poutissou	TRIUMF
Francis Pratt	STFC(ISIS Neutron and Muon Source)
Jun Sugiyama	Toyota Central R&D Labs. Inc
Thomas Roser	Brookhaven National Laboratory
Shinian Fu	Institute of High Energy Physics
Eckhard Elsen	European Organization for Nuclear Research(CERN)
Patricia McBride	Fermi National Accelerator Laboratory
Robert Tribble	Brookhaven National Laboratory
Donald F. Geesaman	Argonne National Laboratory
Karlheinz Langanke	GSI Helmholtzzentrum für Schwerionenforschung GmbH
Hirotada Ohashi	Department of Systems Innovation, School of Engineering, University of Tokyo
Hamid Aït Abderrahim	SCK•CEN
Paul Langan	Oak Ridge National Laboratory
Hidetoshi Fukuyama	Research Institute for Science & Technology, Tokyo University of Science
Dan Alan Neumann	National Institute of Standards and Technology
Andrew Dawson Taylor	National Laboratories, Science and Technology Facilities Council

APENDIX III

Charge to IAC 2017

- Evaluate overall performance of J-PARC Center
  - Promotion of science with safety
    - Each facility should have a good balance of user program and facility improvements
- Review safety activities at J-PARC
  - Safety culture is well penetrated thru staff and users?
- Any suggestions to improve the total performance are welcome. Our concerns include but not limited to
  - Budget situation
  - Open access for users
  - More uniform operation combining KEK, JAEA, and CROSS efforts is critical to further success of MLF
  - Governmental panel review is approaching