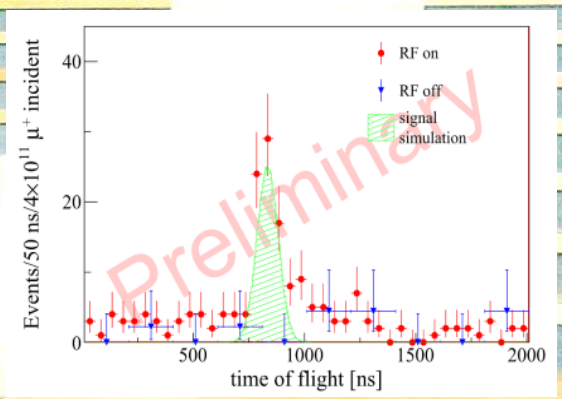
THE INTERNATIONAL ADVISORY COMMITTEE ON THE J-PARC PROJECT

REPORT

Meeting held March 5th - March 6th2018

In the J-PARC research building, Tokai, Japan

First acceleration of a muon beam at J-PARC



May 20th 2018

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EXECUTIVE SUMMARY:

The International Advisory Committee of J-PARC (IAC) met March 5th and 6th at J-PARC. The committee heard presentations from the director, the Safety and Accelerator groups, the scientific groups and their respective advisory committee chairs, from representative of MEXT and management of JAEA.

The committee was very pleased to see that the shift in priority to favor a safe, reliable delivery of beam at the expense of pushing the frontier of beam power led to an improved production of interesting science in all areas. In particular, numerous publications were reported in prestigious journals, involvement of industry is very high by international standards and Press releases are used to communicate the exciting results to the general public. This is all going in the direction favored by the IAC last year.

The accelerators are showing excellence performances and it is the targets and beam extraction elements (kicker magnets, electrostatic septum…) that are limiting the beam power. Progress is being made in developing more reliable targets with help from international expertise but the IAC is still advocating a conservative approach in commissioning high power systems, both from the point of view of reliability and dose management. The safety culture of J-PARC has changed and is more and more in line with international standards. The implementation of a stop work order policy is in progress and the IAC was shown evidence that the number of safety incidents are decreasing while the reporting of potential problems is increasing indicating that staff is being more aware of safety issues and willing to act on them at all levels. The IAC recommends to formalize the reporting along a severity scale so that trivial issues can be dealt with at the local manager level while more serious breaches are transferred to J-PARC management for action and further evaluation.

The IAC notes that good progress was also made in bringing key new experiments on the floor (g-2/EDM, COMET for ex) while improvements on the MR slow extraction allowed a hyper-nuclear program to produce new results and lead a world-wide activity in that field. The neutrino program received close to 500 kW of reliable beam on target and was able to show first evidence for lepton CP violation.

However, the MR program is awaiting anxiously the replacement of the MR magnet power supplies(PS) which would allow to reduce the beam cycle time and hence improve beam intensity and quality. Funding for the PS is not in place and this compromises the long-term competitiveness of the high energy program. This is an urgent matter to be addressed so as to keep the international appeal of the facility and not compromise the scientific reach of the HyperKamiokande(HK) program which was rated as one of two highest priority items in the MEXT roadmap for large scale frontier projects in high energy physics.

SUMMARY OF THE RECOMMENDATIONS BY SECTIONS IN THE REPORT

Management

Safety

Recommendation:

"Stop Work": Prepare written guidelines about when the situation can easily be corrected and work resumption can be authorized by the work site manager (e.g. missing PPE) or when an investigation is required (e.g. unsafe behavior or near miss) and work needs to be reauthorized by management.

Accelerators

Recommendation:

- **Explore opportunities to reduce the time spent on machine start-up and beam tuning**

- **Implement the MR fast extracted beam power upgrade as soon as possible**

Particle and Nuclear Physics

- **Neutrino**

Recommendation:
The MR power supplies upgrade requires an urgent firm commitment and time table as part of a global strategy to increase the number of proton on the neutrino target to firmly establish CP violation in the lepton sector.

- **Kaon Physics**

Recommendation:
The IAC looks forward to a prompt publication of the analyses of E36 and KOTO's 2015 data

- **Muon**

Recommendation:
After reaching key milestones this past year, both the g-2/EDM and COMET efforts must be given strong support to compete on a time scale set by the parallel efforts at FNAL.

- **Hadron facility**

Recommendation:

The IAC recommends to proceed with the construction of the new spare target assembly for the slow extracted beam program as soon as possible.

Material and Life Science Facilities:

Recommendations:

MLF should prioritize availability for science rather than power level. A disciplined approach to power ramp-up will result in earlier sustained operation at 1 MW.

MLF should endeavor to determine the bottlenecks from proposal to publication that limit scientific output.

MLF should further address uneven staffing across the instrument suite by, for example, pursuing the idea of "public beam time".

MUSE Facility:

Recommendations:

Since the generation of ultraslow muons is the key issue not only for the USM project on U-line but also for several experiments on H-line, multiple backup plans should be considered for the case that the Nd:YSAG material is unsuccessful.

The exciting science program planned for the H-line can only be enabled with functioning H-line which we recommend to be completed with high priority.

TEF (transmutation Facilities):

- **Recommendations :**
  - **complete the English version of the TDR of TEF-T**
  - **To update the ADS roadmap of JAEA regarding the construction of the TEF-T facility**
  - **To enlarge the R&D on accelerator reliability which is of paramount importance for the ADS application**

INTRODUCTION:

The International Advisory Committee (IAC) for J-PARC met on March 5th and 6th at the J-PARC research building to review the progress and scientific achievements of J-PARC over the past year. The agenda for the meeting is given in appendix I, the committee's composition in appendix II and the charge to the committee n appendix III. A site visit took place in the afternoon of Tuesday March 6th when the committee toured the MLF experimental areas, the hadron facility hall including the new extension for the COMET experiment and the near detector of the T2K neutrino experiment. The committee heard the view of the MEXT funding agency responsible for most of the support for J-PARC during a presentation by Dr. Todoroki. Dr. Miura-san reported on the situation at JAEA and how J-PARC fits in its mandate. KEK director Professor Yamauchi-san was unable to attend due to a last -minute dental emergency.

The committee heard from the advisory committees monitoring specific areas of the complex: the Accelerator Technical Advisory Committee represented by its chairman Dr. T. Roser, the Transmutation Advisory Committee by the Dr. Maekawa-san, the Neutron and Muon Advisory Committees by their respective chairs Dr. Shibayama-san and Dr. F. Pratt.

Safety has been elevated as the overriding priority for all J-PARC activities and the IAC was briefed on the progress made to institute a global safety culture for all permanent staff, contractual workers and users by Dr. T. Ishii.

GENERAL STATUS OF THE PROJECT:

Dr. N.Saito reviewed the major accomplishments of the past year. He placed his remarks in the context of the J-PARC action plan being implemented and showed how he responded to the recommendations made by the J-PARC IAC last year. The key objective was to provide a safe and stable operation on the way towards high-power operation, with two priority milestones in terms of beam availability to users and science output.

By focusing the site priority on beam availability and delivering more than 90% of the scheduled beam to experiments, many users enjoyed reliable data taking performance at a level which guarantees significant progress towards their scientific objectives. This was shown by the number of press releases (11) which publicized new important results and by the number of high level publications.

To increase the scientific output of J-PARC, a concerted effort has been mounted to connect with Universities, Industries and Institutes worldwide. Four Japanese Universities are creating branches at J-PARC focusing on support for students and young researchers, four Memoranda of understanding have been signed with foreign institutes and strong partnership with industries have already led to the funding of special fellowships to support collaborative work (e. g. Sumimoto Fellowship.). A notable effort is the creation of a Science focus group for MLF users aiming at facilitating the extraction of results from

data collected at the MLF by providing and supporting universal data analysis frameworks. The IAC is strongly encouraging this effort. It needs strong leadership to succeed.

The IAC applauds the initiative to join the RaDIATE organization which allows all major laboratories facing radiation damages issues (e.g. target failures) to share their experience and expertise. This is bound to provide solutions to the current limitations in power delivery to the various targets on J-PARC's facilities. In parallel a major project to upgrade the capacity of the main ring (MR) power supplies to allow a faster cycling rate is progressing but is limited by available funding and may not be available to users before JPY 2022. This is part of the intensity upgrade required by most experiments using either slow or fast extraction from the MR. The IAC is fully in support of the project and recommends that a comprehensive technical document be prepared describing the global efforts needed to increase the beam power and beam quality to MR users thereby achieving the design goals for J-PARC and to meet the requirements of the user community as expressed in the recent Japan Science Council master plan document.

At this time, MEXT has started the laboratory review process (which happens every five years). Together with the development of the Japan Science Council master plan and MEXT 's roadmap, this would provide for a long-term vision for the laboratory. The IAC believes that the laboratory will be able to demonstrate that it is on the path to and already delivers world class science and given adequate resources could be a world class international attractor for a wider range of scientific researchers.

SAFETY:

Management has made continued good progress in implementing all the elements of a safe workplace at J-PARC, which includes: an established process for safety reviews, a fully developed and broadly implemented work planning process, a safety culture that allows the staff to speak up about unsafe behavior of others, called "Mindful of Others", and a process to "Stop Work" in a potentially unsafe situation.

The "Stop Work" policy is implemented locally at J-PARC through the work site manager, who then can also authorize the resumption of work. The Committee congratulates J-PARC management to have found a way to implement the "Stop Work" process even though such a policy is not recognized in Japan.

The number of incidents at J-PARC has been declining over the last few years. At the same time there is a positive indication of improved safety awareness by the staff as the reported number of "near misses" is has been increasing.

Extensive safety training is being implemented throughout the J-PARC facility. The Committee supports the plan to train shift leaders in the proper response in emergency situations.

Recommendations:
"Stop Work": Prepare written guidelines about when the situation can easily be corrected and work resumption can be authorized by the work site manager (e.g. missing PPE) or when an investigation is required (e.g. unsafe behavior or near miss) and work needs to be reauthorized by management.

STATUS OF THE ACCELERATOR SYSTEMS:

The IAC congratulates the accelerator group on the significant improvements that were made in accelerator operations and beam delivery during 2017. All parts of the science program benefitted. Notably:

- Beam availability to the MLF was better than 90% during 2017. This was accomplished while delivering an average power of 400 kW.
- The MR has also operated well with beam availability near 90%. For much of the period, power for FX was 475 kW and it was up to 50 kW for SX.
- Problems with the ESS have been corrected for the SX beam and successful beam extraction at both 8 and 30 GeV has been accomplished.

It is rather remarkable that the linac was able to operate for three months without an ion source change. This should lead to even more beam availability. As part of a continual effort to improve efficiency for beam delivery, the accelerator division has worked to lower the time lost due to beam trips. But the procedure to recover from all trips seems to require human intervention. There are likely classes of trips that could have automatic recovery systems that would not lead to potential machine damage. It would useful to investigate this and implement automatic recovery where possible.

- There are many demands on the beams from the accelerators at J-PARC. But science output is now a primary concern for all of the J-PARC programs, so further improving beam availability is a priority. The IAC supports the ATAC recommendation to explore opportunities to reduce the time spent on machine start-up and beam tuning

Optimizing running time for experiments requires having the accelerators deliver beam to targets and having the targets support the available beam. Moving forward, the accelerator group needs to work closely with target groups to optimize the machine performance and availability. Coordination is needed to determine when to change targets and when to push the beam intensity on existing targets. For example, plans are now in place to install a new target that should allow for higher beam power for the MLF. This will be a welcomed development but should be done carefully so that a target failure does not result in significant down time. Increasing the beam power on a new target design should be done only if there is a good backup target available in case there is a failure.

For the MR, increasing the beam power to the neutrino program and to the Hadron Hall is very important but it needs to be done while maintaining beam availability. Plans were discussed for improving the MR beam power, eventually up to 1.3 MW for the neutrino program. This effort will need to be done in steps and ultimately will require improvements to power supplies and to the MR performance. It is crucial that this improvement program get underway, hence the IAC supports the ATAC recommendation:

As part of the effort to move to higher MR beam power, the IAC recommends that a Design Report be developed soon that looks at all potential ways for improving MR beam power and machine performance. The Design Report should at least consider the improvements from faster cycle time with upgraded power supplies, running with more protons per bunch, and the reduction of beam loss during the early stage of MR acceleration.

Recommendations:

- **Explore opportunities to reduce the time spent on machine start-up and beam tuning**

- **Implement the MR fast extracted beam power upgrade as soon as possible**

SCIENTIFIC PROGRAMS:

PARTICLE AND NUCLEAR PHYSICS:

Neutrino Physics

The determination of neutrino oscillation is one of the outstanding science achievements of the last decades. The contribution of J-PARC to this scientific milestone via the T2K experiment was widely recognized and strengthens its worldwide reputation.

As the next step, the T2K collaboration aims to firmly establish CP violation, in the lepton sector, which would certainly be another outstanding achievement. Currently this effect is observed at the 95% confidence level, but the T2K collaboration feels that it has to be improved to the 3 sigma level and beyond. To achieve the 3 sigma goal, 20 times 10^21 protons on target are required. As currently less than 10^21 POT are reached annually, an upgrade program is proposed that increases the annual POT to about 2-3 10^21. The committee would like to see an updated time schedule showing how this upgrade program and the data taking with it fits into the general J-PARC planning.

The committee, however, notes that the proposed upgrade plans will have to be reconsidered once the Japanese government makes a determination of the funding profile for the Hyper-Kamiokande project. A positive decision for Hyper-K would be a complete game changer, which would open up exciting new perspectives for J-PARC.

In addition to the highly visible CP violation efforts, J-PARC is also running a wider neutrino physics program. In particular, the E61 experiment aims at measuring neutrino cross sections on various targets. These data are crucial to reduce uncertainties in the CP violation search. Furthermore, a dedicated experiment to search for sterile neutrinos is being performed at the MLF in a parasitic mode (JSNS2 experiment).

The IAC congratulates J-PARC and the T2K collaboration for their worldwide recognized achievements. The committee strongly endorses the proposed measures to firmly establish CP violation in the lepton sector.

Recommendation:
The MR power supplies upgrade requires an urgent firm commitment and time table as part of a global strategy to increase the number of proton on the neutrino target to firmly establish CP violation parameters in the lepton sector.

Kaon Physics

The KOTO experiment is making increment progress towards reaching the Nir-Grossman limit for the branching ratio $K_L^0 \rightarrow \pi\nu\bar{\nu}$. Significant data accumulated in 2015 are being analyzed with a blind analysis technique and should reveal the extent of background level encountered. It is very important to complete this analysis as it may dictate the path towards better sensitivity. Meanwhile improvements in background reduction are being made in the trigger and online processing of the data and validated by looking at the side-band content. Assuming that no new background sources are revealed by the analysis of the 2015 data, the experiment requires stable and long beam delivery at the 100 kW level with controlled beam targeting. The planned upgrade of the MR power supplies will also be crucial towards that.

E36, a measurement of the lepton universality in the two body decay of K+, has completed its data taking and should provide a measurement of the ratio of branching fractions $K^+ \rightarrow e\nu$ / $K^+ \rightarrow \mu\nu$ at a precision less than 1%. This result would be timely as there is renewed theoretical interest in this type of constraints on extensions of the standard model.

Recommendation:
The IAC looks forward to a prompt publication of the analyses of E36 and KOTO's 2015 data

Muon Physics:

Three major efforts are in progress: a new innovative approach for measuring the g-2 and the dipole moment of the muon with very high precision, a study of the muon to electron conversion at a sensitivity level of 10^{-14} (in phase 1) with the COMET set up and a muonium spectroscopy study.
In the MUSE facility, the H line is being built to produce muonium from a muon beam stopped in an aerogel target, followed by ionization and reacceleration of the resulting low transverse momentum muons. After demonstrating that a laser ablated aerogel target can enhance the muonium production to satisfactory levels, the g-2/EDM team reached a second milestone with the recent demonstration of RF acceleration of a muon beam in the D2 line of MUSE (a world first).
Also cross calibration of the NMR probes from the KEK and FNAL teams demonstrated an agreement within 8 significant digits.
A re-evaluation of the systematic uncertainties was made, confirming previous estimates and a new international theory initiative has started to provide the necessary theoretical hadronic corrections ahead of the results of both the KEK and the FNAL experiments.
A revised g-2/EDM Technical Design Report(TDR) was produced to respond to the recommendations of the Program Advisory Committee and the team is now requesting stage 2 approval.
For the COMET effort, a new 8 GeV beam will be delivered from the MR to a new dedicated target facility. Since the measurement takes place in between beam buckets where some background is expected from leaking protons, a test measurement was made in the K1.8 beamline which demonstrated that a better than 10^{-10} extinction can be obtained, which leads to a sensitivity of the order of 10^{-14} in the first stage of the experiment. The collaboration has now 182 researchers from 32 Institutes and is concentrating in delivering the beam transport system and the initial detectors in the completed new building.

Recommendation:
After reaching key milestones this past year, both the g-2/EDM and COMET efforts must be given strong support to compete on a time scale set by the parallel efforts at FNAL.

Nuclear Physics
Over the past three years the accumulated beam for slow extracted beam experiments (nuclear physics and kaon experiments) has increased by an order of magnitude compared to the results from FY09 to FY14. The power of the slow extracted beam has reached 50% of the design power and the instantaneous duty factor was increased to about 50%. This has allowed the

research to go beyond initial exploratory studies to the more definitive work for which the facility was designed.

The observation of the multi-messenger signals from colliding neutron stars highlights the importance of this research in understanding the properties of high density nuclear matter with strangeness. A number of approaches predict that strange baryons and mesons should play a defining role in the equation of state of neutron stars, but the uncertainties in the elementary hyperon-nucleon and meson- nucleon interactions have made the predictive power of current theories limited. The observation of a clear peak in the K^-pp system at a binding energy of about 40 MeV seems to validate a number of the theoretical predictions. The first information on the structure of the s-d shell hypernucleus, F_{Λ}^{19}, demonstrates that the spin dependence of the ΛN interaction is under control. New substantial data sets for Σp scattering and strangeness -2 systems are now being analyzed. The expected improvement in the resolution with the S-2S spectrometer will be very valuable.

It is important for the future that the user community accelerate the stream of impactful publications from the nuclear physics program. We encourage the laboratory to continue to closely monitor the progress on all the experiments.

The IAC was pleased to see the PAC has re-examined the science goals and progress of the early round of nuclear physics experiments in light of actual performance and updated schedules. This should give the users more realistic expectations for future experiments. Several have been given stage 2 approval for additional measurements.

Hadron Facility:

The IAC continues to be concerned that the existing slow extraction production target remains a substantial risk to the nuclear physics, kaon and COMET programs. Another secondary risk is the lack of a spare extraction septum. The beam delivery group has shown that operation with a single septum is possible, but with increased beam losses. As elsewhere, the IAC notes that if beam losses are not reduced, higher power operation will be compromised.

It is essential to have a spare production target available as soon as possible. The existing target system has two identical production targets in the chamber so that, when the target monitors indicate some cooling deterioration, the target can be exchanged. We appreciate the work that has gone into the target upgrade project and urge the lab to give it extremely high priority. A decision needs to be made to either produce a backup to the existing target or proceed with the construction of the new target. If the new target can be produced on a timescale that would allow it to be the backup, that would be the preferred option. If this cannot be done but a copy of the present target can be procured soon, then that option should be considered. It is very risky to plan to run the SX beam with no backup.

Recommendation: The IAC recommends to proceed with the construction of the new back up target assembly for the slow extracted beam program as soon as possible.

MATERIAL AND LIFE SCIENCES FACILITY (MLF):

MLF - Neutrons

The Materials and Life Facility (MLF) is a world leading research institute for neutron science. The combination of the proton power on the target, the 25 Hz frame rate, the exceptional design of the moderators, and 20 excellent instruments provide the scientific community in Japan and around the world an outstanding resource for neutron-based research. Availability is essential for maximizing the scientific return on the considerable investment Japan has made in neutrons at J-PARC. Last year the MLF achieved a remarkable 93% availability allowing users to plan their beam time effectively. The community has taken note with more than 900 scientists making use of the MLF in FY2017. The IAC is particularly impressed by the 30% of experiments that involve industrial scientists. Much of the science coming from the MLF is at the world standard and promises important societal benefits. Of particular note, Toyota will use a new Li solid electrolyte ($Li_{9.54}Si_{1.74}P_{1.44}S_{11.7}Cl_{0.3}$) to provide all solid-state Li-ion batteries in their 2022 electric vehicles thereby reducing the risk of fire. The development of this material was greatly facilitated by neutron diffraction results from the MLF (Nature Materials (2011) & Nature Energy (2016)).

In spite of the MLF's considerable achievements, the number of publications remains low by international standard. When considering this, it's important to note that the large industrial engagement (30%) will significantly reduce the number of open publications. However, there is still a shortfall. MLF recognizes this and is taking steps to increase the number of experiments that turn into publications by revising the reviewing process of user program, enabling more detailed assessment of proposals, together with unifying BL operation, by the newly established neutron science groups within in MLF and increasing interaction with science community in general through the establishment of science promotion board. However, the reason for the shortfall is still not quite fully understood.
We also note that "solutions" that don't directly address real bottlenecks will likely distract staff from actions that might improve the situation. Thus a targeted, evidence-based approach is definitely needed. However, it is also essential that staff continue their role in enabling exceptional science.

The IAC recommends that the MLF should endeavor to determine the bottlenecks from proposal to publication that limit scientific output.

Although the long term plan for the MLF must include a 2nd target station, the immediate priority should therefore be on realizing the potential of the considerable investment already made in the MLF.

Issues with the mercury target including unanticipated failures have limited the productivity of the MLF. Thus the IAC was pleased to hear that the most recent target (#8) has performed admirably allowing sustained operation first at 0.3 MW and now at 0.4 MW. In April, it is planned to go to 0.5 MW. This is excellent progress toward the goal of 1 MW operation. We were also pleased that target 9, which has the same design as 8, is available in case of unexpected problems. However we caution that there is still a long way to go before 1MW operation becomes routine. Thus it is essential that the MLF learn as much as it can from post irradiation examination (PIE) on each target. This requires careful consideration of how to proceed. To the extent possible, every target should be operated in such a manner as to maximize the usefulness of the information that can be gained from PIE. In this regard, we note that a limited 1 MW test on target 8 for the last week before the summer shutdown will unnecessarily complicate the analysis of the PIE. We also note that target 10 has a different design so the MLF should carefully consider what really can be learned from this short test when the aim must be sustained, reliable operation.

Recommendation:

The IAC recommends that the MLF should prioritize availability for science rather than power level. A disciplined approach to power ramp-up will result in earlier sustained operation at 1 MW.

In addition, we note that target 10 is not scheduled to arrive until August or September and must be installed by the end of September. As target 10 has new design, this entails some risk which is mitigated by having target 9 on hand as a backup with a new proven design. So only if 10 is late, might target 9 be used.

The management environment of the MLF is quite complex with instruments operated by four different organizations. This leads to inconsistencies in the support that users receive based solely on the resources of the organization that operates the particular instrument they are using inevitably leading to frustration. The MLF has recognized this issue and has taken steps such as providing an integrated proposal system and user portal to address it. They have also worked to better engage the community through a variety of steps such as user surveys and the Science Council. This is a good start, but the heart of the issue remains. The IAC supports the establishment of the public user beam tine on all MLF lines.

Recommendations:
the IAC recommends that the MLF should further address uneven staffing across the instrument suite by, for example, pursuing the idea of "public beam time".

Materials and Life Sciences – Muons

U-line

Impressive progress has been made on all four beamlines, i.e. D, U, S, H-lines and their associated instruments. A very significant achievement is the first observation of the muon spin rotation spectrum with ultra-slow muons, which will open a new era for surface and hidden interface analyses, in February 2018. However, the absolute counting rate is still 2 orders of magnitude below that needed for a viable user facility offering USM μ^+SR mainly due to the lack of a high quality laser crystal/ceramic rod for final amplification of the beam.

Recommendation

IAC looks forward to hearing about results from the new way of producing Nd:YGAG and the developments around Nd:YSAG material. Since the generation of ultraslow muons is the key issue not only for the USM project on U-line but also for several experiments on H-line, multiple backup plans should be considered for the case that the Nd:YSAG material is unsuccessful.

D-line

Creative advances in beam diagnostics enabled a substantial improvement in beam transport of negative muons at D line. This enabled implementation of a new collimator system and measurement chamber and resulted in demonstration experiments with these new capabilities. This progress, complementary to standard μSR, is excellent, and it should soon move beyond demonstration experiments and begin to have impact in other fields. We look forward to high profile uses of muonic X-ray elemental analysis, positive and negative muons induced single event upsets diagnosis and negative muon spin rotation and relaxation (μ^-SR) technique in the coming year.

S-line

The first port among the four of the S-line surface muon channel (S1) has now been opened for users' program. μSR sample conditions, auto-run program, and on-line monitoring system by users have been upgraded steadily at the D1 and S1 ports.
Such progress has made MUSE an excellent world-class facility in terms of user interface to the experiments.

H-line

The H-line will be the spinal cord of a broad new research program at J-PARC. Its speedy completion is strongly required and IAC recommends to J-PARC/ KEK management that all possible means should be taken to realize the H-line and its promising scientific program with high priority. We are pleased to learn that the necessary steps were already taken to provide an

additional 4 MW electric power to the experimental hall. We expect that this started development will be completed within the next couple of years.

Recommendation

The timely completion of the H-line will be important for the scientific success and impact of experiments like the muonium hyperfine structure, muon g-2/EDM, DeeMe and the muon microscope. All these projects are timely now and have tremendous scientific discovery potential. The exciting science program planned for the H-line can only be enabled with functioning H-line which we recommend to be completed with high priority.

Muon production target

The current rotating muon target has operated for 40 months without trouble, making 10M revolutions out of its full design life of 50M. Work continues on improving the target diagnostics and developing next generation muon targets using materials such as SiC coated graphite and SiC composites.

Target Station 2

Working groups of J-PARC MLF division and of the Japanese Society for Neutron Science and the Society of Muon and Meson Science of Japan were organized to discuss the plans for a future target station 2 in MLF in order to apply Japan Science Council's Master Plan 2020 (the deadline is February 2019). This plan includes an upgrade of the proton beam power to 1.5 MW, a splitting of the proton beam in front of the existing MLF hall by a fast magnetic kicker, and the building of a new experimental hall with a combined muon/neutron spallation target.
The extraction of the muons from the entrance window of the spallation target will be achieved by a large acceptance solenoid, and a surface muon beam (or decay muon beam) intensity increase by a factor of 50-100 compared to the existing muon beams at target station 1 are expected.

Recommendation

This is a project for the time horizon beyond 2030 and IAC welcomes and encourages these initial ideas for future large scale muon projects at J-PARC, although more detailed discussion is necessary for preparing a suitably persuasive conceptual design report (CDR).

NUCLEAR TRANSMUTATION:

After having heard the reporting of Dr Fujio MAEKAWA , the head of the Nuclear Transmutation Division of J-PARC on the outcome of the ADS T-TAC meeting held on February 19-20, 2018 and the progress accomplished on the TEF design program and the associated R&D support program reported by Dr Toshinobu SASA, the IAC acknowledges the J-PARC responses to the 2017 recommendations but recognizes the difficulty for the ADS team to progress seriously on the realization of TEF facilities until a clear vision is formulated in the JAEA roadmap.
The IAC acknowledges the enhanced international collaborations on ADS activity within J-PARC ADS group and the extension of the scope of activities towards the accelerator reliability activities.
The IAC acknowledges the progress accomplished by the ADS team on:

- The safety report of the TEF-P
- The completion of the TEF-T TDR (but unfortunately the English version was not ready to be submitted to the T-TAC)

It is now important to establish and evaluate carefully the experimental program of TEF-P loaded with MA based Fuel in terms need for V&V in an international context where the number of fast spectrum reactor facilities is being drastically reduced。

LBE target technology has been selected as a major subject of TEF-T and intensively studied, other alternative technologies, such as granule target and windowless scheme, may be worthy to study for providing other option which will be utilized in CiADS.

A number of critical design requirements for ADS activities have a significant overlap with other J-PARC programs and such synergies should be exploited for example in the accelerator R&D for reliability issues or in the targetry systems.。

Recommendations:

- **Complete the English version of the TDR of TEF-T**
- **update the ADS roadmap of JAEA project in regard to the construction of a TEF T facility material testing**
- **enlarge the R&D on accelerator reliability and join the J-PARC accelerator team in areas where synergies for both teams can be found (SC cavity development, especially for the low-beta section, Room temperature CW RFQ linacs)**
- **establish and evaluate carefully the experimental program of TEF-P loaded with MA based fuel in terms of international need.**

- **Examine technologies other than LBE targets such as granule target and windowless scheme.**

INSTITUTIONAL SUPPORT BY JAEA:

Dr. Miura-san reviewed the challenges faced by JAEA which is planning to reduce drastically its operating facilities (44 out of 89). JAEA is also facing several contamination incidents and is reviewing its safety culture. JAEA views J-PARC as an important component of its mandate and is strongly supporting its operation. JAEA is also in favor a strong Science group to improve the reach of MLF to a large community of both academic and industrial users and pledges to support the efforts of management to increase user beamtime on all MLF beamlines.

MEXT view of J-PARC:

Dr. Todoroki-san gave an overview of the long-range planning process at MEXT for supporting large scale scientific projects. It starts with the master plan by the Science Council of Japan which considers community driven projects. MEXT then establishes a roadmap for a selected number of projects based upon scientific evaluation, urgency and needs. The top priority project are then evaluated and submitted to the Ministry of Finance for budget allocation. In the new road map, two large scale frontier projects in high energy physics were selected: High luminosity LHC upgrade and HyperKamiokande (HK). The HK proposal is directly linked to the J-PARC neutrino beam upgrade and requires operation of a 1.3 MW proton beam for at least 10 years once the far detectors are operational. However due to budgetary constrains, it was not possible to convince MOF to start the funding in this fiscal year.
In parallel, MEXT has initiated the five year review of the laboratory which provides MEXT with a good evaluation of the performance of the laboratory and gives MEXT ammunition to defend the importance of the research done by J-PARC to the public of Japan. MEXT was particularly sensitive to the publicity generated by the results of the neutrino program (evidence for asymmetry in neutrino-antineutrino oscillation) and by the press releases related to MLF experiments.
Dr, Todoroki pledged to continue to work hard to promote the importance of J-PARC at the government level as well as in the general public.

Conclusions:

The IAC had a good overview of all aspects of the J-PARC operation thanks to well prepared presentations. Excellent progress was made last year especially in responding to the recommendation made at the last review to focus on the delivery of science at the expense of pushing the frontiers of the beam intensity. A conservative approach was followed to minimize target failure risks and optimize beam delivery to users. This paid off for MLF users and MR

users who produce novel results. This was also in line with recommendations made in the past on risk management. Together with a significant improvement in establishing a safety culture at all levels, the IAC finds that J-PARC is operating more and more along international norms.

Challenges remain in particular with the development of reliable high power targets and with operation funding levels for the MR. Steps are being taken to strengthen the target groups and to integrate the effort site wide. The upgrade of the MR power supplies has started (2 of the 3 buildings needed are available) but is awaiting further funding to order the supplies and install them. The time scale for this to happen is already shifted to JFY2022 and further delay will affect the competitivity of the science program, notably the neutrino effort to nail down the parameters of CP violation in the neutrino sector and the Kaon program in the hadron hall.

Nevertheless, the IAC considers that the future of J-PARC is quite attractive and that a good case can be made to obtain the resources needed to operate the facility reliably and at high power level. However one should focus on the near future and urgent requirements (MR power supplies and high power targets) before considering the longer term aspirations like second neutron target and Hadron hall extensions. A J-PARC roadmap should present a strongly motivated near term growth path which could be more palatable to the funding agencies together with an outline of a plausible longer term vision.

J-PARC has matured a lot and is already delivering exciting results. The J-PARC team is to be congratulated for achieving world class status in many aspects of the scientific program. The IAC is pleased to extend its best wishes for the future.

Appendix I
Agenda for the International Advisory Committee Meeting of J-PARC in 2018

Agenda for the International Advisory Committee Meeting of J-PARC in 2018

Date: March 5 (Mon) and March 6 (Tue), 2018
Place: J-PARC Research Building

March 5 (Mon)

Executive Session			
8:30 – 8:45	(10 + 5)	Charge to the Committee	Naohito SAITO
Opening			
8:45 – 9:25	(30 + 10)	Report from the Director	Naohito SAITO
9:25 – 9:55	(20 + 10)	Safety at J-PARC	Tetsuro ISHII
9:55 – 10:05	(10)	Coffee	
Accelerator			
10:05 – 10:30	(20 + 5)	Progress and Prospects	Kazuo HASEGAWA
10:30 – 10:50	(15 + 5)	A-TAC View of Accelerator Activities	Thomas ROSER
Material and Life Science I			
10:50 – 11:30	(30 + 10)	Overview of Neutron Facility	Toshiji KANAYA
11:30 – 12:10	(30 + 10)	NAC Review	Mitsuhiro SHIBAYAMA
12:10 – 13:00	(50)	Lunch	
Material and Life Science II			
13:00 – 13:20	(15 + 5)	MUSE Status	Yasuhiro MIYAKE
13:20 – 13:40	(15 + 5)	MAC Review	Francis PRATT
Particle and Nuclear Physics I			
13:40 – 13:55	(10 + 5)	Overview of Particle and Nuclear Physics	Katsuo TOKUSHUKU
13:55 – 14:20	(20 + 5)	Neutrino including the beam	Morgan WASCKO
14:20 – 14:30	(10)	Coffee	
Particle and Nuclear Physics II			
14:30 – 14:50	(15 + 5)	Hadron facility	Hitoshi TAKAHASHI
14:50 – 15:10	(15 + 5)	Kaon physics	Tadashi NOMURA
15:10 – 15:30	(15 + 5)	Nuclear physics	Tomofumi NAGAE
15:30 – 15:50	(15 + 5)	Muon physics	Satoshi MIHARA
Executive Session (closed)			
15:50 – 17:15	(85)	Review and Discussion	IAC Members
17:15 – 17:25	(10)	Group Photo	
Views from Funding Agency and Host Institutes			
17:25 – 17:45	(15 + 5)	J-PARC: A View from MEXT	Wataru TODOROKI
17:45 – 18:05	(15 + 5)	KEK and J-PARC	Masanori YAMAUCHI
18:05 – 18:25	(15 + 5)	JAEA and J-PARC	Yukitoshi MIURA
Banquet			
19:00 – 21:00	(120)	Banquet	

March 6 (Tue)

Accelerator Driven Transmutation Research			
8:30 – 9:10	(30 + 10)	ADS Project T-TAC Review	Toshinobu SASA Fujio MAEKAWA
Executive Session (closed)			
9:10 – 11:00	(110)	Review and Discussion, Drafting	IAC Members
Close out			
11:00 – 11:30	(30)	Recommendations	Jean-Michel Poutissou
11:30 – 13:30		Lunch	

Appendix II

IAC Committee members for 2018

	Name	Affiliation	Position	Area
1	Jean-Michel Poutissou (chair)	TRIUMF	Associate Director & Nuclear Medicine Division Head emeritus	General
2	Francis Pratt	Rutherford Appleton Laboratory, STFC(ISIS Neutron and Muon Source)	Professor	Muon
3	Jun Sugiyama	Toyota Central R&D Labs. Inc	Fellow	Muon
4	Thomas Roser	Brookhaven National Laboratory	Deputy Associate Laboratory Director for Accelerators	ACC
5	Shinian Fu	Institute of High Energy Physics	Director, Accelerator Technology Division, Dongguan Branch	ACC
6	Eckhard Elsen	the European Organization for Nuclear Research(CERN)	Director for Research and Computing	Particle
7	Patricia McBride	Fermi National Accelerator Laboratory	Head, Particle Physics Division	Particle
8	Robert Tribble	Brookhaven National Laboratory	Deputy Director for Science and Technology	Particle/ Nucl
9	Donald F. Geesaman	Argonne National Laboratory	Distinguished Argonne Fellow and Associate Director, Physics Division	Nucl
10	Karlheinz Langanke	GSI Helmholtzzentrum für Schwerionenforschung	Professor	Nucl
11	Hamid Aït Abderrahim	SCK•CEN	Deputy Director-General International Relations and Director MYRRHA project	ADS
12	Hirotada Ohashi	Department of Systems Innovation, School of Engineering, University of Tokyo	Professor	ADS
13	Paul Langan	Oak Ridge National Laboratory	Associate Laboratory Director, Neutron Sciences Directorate	Neutron
14	Hidetoshi Fukuyama	Department of Applied Physics, Faculty of Science, Tokyo University of Science	Professor	Neutron
15	Dan Alan Neumann	National Institute of Standards and Technology	Group leader of Neutron Condensed Matter Science Group, NIST Center for Neutron Research	Neutron
16	Andrew Dawson Taylor	National Laboratories, Science and Technology Facilities Council	Executive Director	Neutron

Appendix III

Charges to IAC2018 from J-PARC by N. Saito, director

- 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 ongoing