THE INTERNATIONAL ADVISORY COMMITTEE ON THE J-PARC PROJECT REPORT

Meeting held virtually March 3rd - March 4th, 2022

March 4th, 2022

Contents

EXECUTIVE SUMMARY:

The International Advisory Committee (IAC) on J-PARC met virtually on March 3rd and 4th 2022 to review the progress and prospects since the last meeting in March 2021.

All the presentations were made available ahead of time; questions from IAC members were solicited and addressed in video meeting or via Google docs. Overall, the committee was able to fulfill its mandate as set by the director (see Appendix III). The IAC thanks J-PARC staff for the considerable efforts put into the preparation of the material and the efficient running of the meetings.

J-PARC is a world class scientific research facility with a very broad scientific remit. The science programme in 2021 has been underpinned by the excellent performance of the accelerator, delivering high power beam with well over 90% availability. The accelerator has continued to operate, and the science program to run, despite the challenges of the Covid pandemic. Both safety and health metrics are excellent. There is an active program of science communication which reaches a large audience, and could extend further when in-person visits to J-PARC are again possible. Industry use of MLF is high and publication rates are steadily improving.

Several challenges lie ahead to maintaining or improving this record, the greatest and most urgent of these being the increasing cost of electricity within a constrained budget. This could have a particularly hard impact on the hadron/neutrino programs because the planned number of operating cycles for the MR was already too low to compensate for the large backlog of important experiments.

The level and age profile of J-PARC staff is also a matter of concern. Excellent performance is achieved through the dedication and hard work of staff, but the workload is not sustainable. With a significant number of staff due to retire within the next 5-10 years there is a risk that critical skills will be lost if recruitment is not early enough and sufficient to allow for knowledge transfer.

SUMMARY OF THE RECOMMENDATIONS BY SECTIONS IN THE REPORT

General status of the project

- The present steady systematic approach to increasing beam power while prioritising availability should be continued, particularly if there is a risk that the number of cycles may be reduced.
- J-PARC needs both a short term and a long term strategy regarding increasing electricity costs. Even if the cost stabilises, there will be increasing pressure to use less energy. This strategy should be a key topic for the next IAC meeting.
    - Short term: J-PARC should, if at all possible, urgently seek additional funding to mitigate the problem for the current financial year. Postponing maintenance, without certainty of increased future funding, is a high risk because it just accumulates future problems.
    - Long term: Scientific output needs to be maximised whenever the facility is operating, which might be done through capital investment, e.g. running more experiments simultaneously through the hadron hall extension, but this will also require increased staffing.
- Despite the challenges in being able to fulfil it, J-PARC nevertheless needs to develop a long term staffing plan for the staff and skills required to operate the facilities and produce world class science. This plan would take the current staffing distribution and propagate it forward in time with different hiring rates in order to understand the likely impact in 5-10 years. Without such a plan it is impossible to tell if the current approach and level of recruitment are adequate.
- J-PARC should work in collaboration with universities to seek an improvement in NRA approval times. However, until the situation is seen to improve J-PARC unfortunately needs to forward plan on the basis of long approval times.
- Efforts to maintain a strong safety culture should continue. This could be supported/reinforced by commissioning an external audit of safety and safety culture.
- J-PARC needs to develop a long term plan for dealing with all radioactive waste, not just highly active (e.g. targets, moderator/reflector) but including lower activity but high volume waste (e.g. accelerator components).
- The development of methods for remote working during the pandemic has been very valuable. However, J-PARC should recognise that the physical presence of users is extremely important for high quality science, training of students and postdocs, and reducing workload on staff. IAC recommends that a policy is developed to clarify for users what their obligations (to be physically present at J-PARC) are.
- The access road is extremely important for the future of the site as a user facility. The IAC strongly support it.
- If JAEA and J-PARC are to participate effectively in the move of ADS technology from lab scale R&D towards “engineering” and “performance” demonstration, within an international collaboration, more resources will be required than are presently foreseen.

Safety

- Efforts to maintain a strong safety culture should continue. This could be supported/reinforced by commissioning an external audit of safety and safety culture. This audit should involve interviews with personnel at all levels in order to assess progress with continued improvements in safety culture. To be most beneficial, such an audit should be conducted every year in order to inform management of any trends.
- An integrated system of recording safety training needs to be implemented.

Public affairs and communication

- The activities have been very good in communicating the importance of basic science to society. IAC recommends that this should continue.
- J-PARC should be careful about the gender balance of the researchers who appear in lectures and on Youtube. The current J-PARC gender balance is not adequate, but the balance of presenters should aim to reflect the future realization of diversity & inclusion.
- In order to increase J-PARC presence internationally, an English communication strategy should be developed. This might include expanding the content of the English website or more Youtube content in English.
- Face to face communication is important not only with the government but also with the local communities such as prefectures and villages. When it is possible, short tours might be organised for local communities. This would also be a good opportunity to involve a wider range of staff in communication activities, for example technical and engineering staff as well as scientists.

Radioactive waste management

- The size reduction development for the MLF target should continue, but only in a way that does not disrupt the planned operating schedule.
- Inclusion of some storage capacity in the Hadron Hall extension should be explored as a possible cost effective solution.
- At some point MLF will change from planning to run a neutron target for 1 year to planning to run it for 2 years. Obviously this will increase the risk of target failure during that period. Increasing the power on the target also increases the risk of failure, so IAC would advise MLF not to make both changes in the same year.
- The plan for the RAM building needs to include the possibility of a second target station even if the timing is not known.
- A holistic overview of the long term overall strategy for waste generation, handling and storage should be presented at a future IAC meeting. This should include coordinated plans for end-of-life targets, accelerator components, and MLF reflector and moderator system components from across the accelerator complex.

Accelerator systems

- Extend the Machine Protection System (MPS) to have redundant safety elements to detect transformer failure, understanding that some portion of the microswitches may fail over time.
- Investigate upgrade of the MPS abort kicker system to allow fast (ms) abort of the beam during the entire slow extraction cycle.
- Develop a prioritized list of the accelerator R&D and improvement projects (AIP) which Accelerator Division would like to pursue, along with a clear explanation of the decision making and prioritization process.

Particle and Nuclear Physics

- The IAC recommends construction of the hadron hall extension as soon as possible. This will enrich the scientific program considerably by addressing timely questions in nuclear and particle physics.
- J-PARC should dedicate additional efforts to increase and optimize use of beam time for the current and planned experiments.

Materials and Life Sciences - Neutrons

- The IAC continues to strongly believe that all users should have a similar scientific experience at the MLF regardless of the instrument "owner". We applaud the efforts to harmonize instrument operations across the MLF, but believe more should be done in this regard.
- While publications are still increasing, the IAC believes there is still some room for improvement. As the publications are not too far below what is expected, we suggest a more granular analysis which considers the publication rate on particular classes of instruments, such as inelastic scattering powder diffraction, SANS etc. Discrepancies in the publications/experiment can be used to target efforts to improve the workflow for these instruments.
- J-PARC is rich in top-class instruments, with potential of high-impact. The visibility of J-PARC will be greatly enhanced if their potential is fully realized. A major reason for not achieving the full potential is the small size of the user base, which is composed mainly of domestic users. To expand the user base it is important to add strong users, including from overseas, with the aim of increasing the number of high-quality scientific projects undertaken at the MLF. Locating such potential users requires planned targeted collaboration effort. The IAC believes that staff should be encouraged to engage in outreach and collaborations with top scientists, both domestic and foreign, and should be allowed to allocate enough time for such effort.
- The IAC applauds the creation of J-JOIN. The united proposal platform for JRR-3 and MLF is an excellent start to what we believe should become a deep collaboration between these facilities. The IAC believes MLF should look for other opportunities for

collaboration and consolidation in areas such as sample environment, technique development, sample preparation and characterization, data reduction and analysis, etc.

- The proportion of beamtime allocated to industry (25%) is very strong. Rather than growing this proportion further, we encourage management to stabilize industrial use at this level and to set goals for the type of industrial use they wish to prioritize together with success metrics.
- The MLF should continue to prioritize stable operations and increasing neutron production hours to support growth in number of experiments and scientific productivity and continue the careful, systematic, stepwise power ramp-up. The IAC also notes that, at some point, the decision will need to be made to operate the target for 2 years rather than 1. This will entail additional risk of target failure. Thus we suggest that the MLF carefully consider the timing of this decision with respect to power ramp-up.

Materials and Life Sciences - MUSE

- The IAC reiterates its recommendation to make available additional staff with part of their duties assigned to the 'instrument scientist' role. Developing a strong and stable muon users' community relies on such support from the facility:
    - The IAC recommends strengthening the group of MUSE people being responsible for the M1/M2 proton beam line/muon production target. On a medium-term, IAC recommends that J-PARC manage the safe delivery of proton beam by a J-PARC group.
    - The IAC recommends that MUSE management continue establishing new links of MUSE with other organizations to widely support the muon activities and community by increasing the number of staff to keep and enhance the current and future activities.
    - The IAC recommends evaluating a closer involvement of KEK-IPNS in the user operation of the particle/nuclear physics program at MUSE.
- The IAC recommends completion of the H-line and the continuation of the TμM feasibility study with high priority.
- The IAC recommends evaluating the possibility of implementing a cryogenic muon moderator target for a short-term increase of the USM rate for the μSR program in the U1A area. The laser development for USM generation should be re-evaluated by a team of external experts, and a report about the strategy of laser development should be submitted by the end of 2022.
- The IAC recommends MUSE management to work out a proper balance between IURP general-use and S-type proposals. Due to oversubscription of the muon facility, it is difficult for new user groups to get access to the instruments.
- The IAC recommends MUSE management to draw-up a long-term vision on the further development of the facility with clear assignments of staff and responsibilities, and to define the resources needed to realize the long-term vision. MUSE management should

develop career plans for the next generation of scientists, to enable a sustainable long-term operation of the facility.

ADS

- As the level of demonstration that is needed today is to reach a TRL 7, IAC considers that it is difficult to plan for this within the limited budget presently assigned. J-PARC and JAEA should promote domestic skills retention/development for later ADS activities through international collaboration and use of existing equipment in Japan, and research utilizing the proton beam irradiation capabilities of J-PARC.
- J-PARC and JAEA should continue to strive for the realization of TEF-T.
- Work on TEF-P should be reduced as soon as possible. Priorities are needed because of limited funding, but also the volume of fissile material required for TEF-P may not be compatible with running J-PARC as an open user facility

MEXT view of J-PARC

- IAC thanks MEXT for the overview of the large accelerator facilities in Japan and their scientific context.
- IAC would be interested to know how MEXT views the provision of computing and data resources in relation to the requirements of the large facilities such as J-PARC.
- IAC would welcome comments from MEXT on the value of the international contributions by J-PARC, and encouragement for further international visibility.

JAEA view of J-PARC

- IAC appreciates the strong support to J-PARC as one of the major facilities for JAEA in research and development.
- IAC appreciates the moves so far to integrate the capabilities of J-PARC MLF and JRR-3 and strongly encourages JAEA to continue in this direction.

KEK view of J-PARC

- IAC appreciates the strong engagement of KEK and its research institutes in J-PARC.
- IAC notes that the age distribution of KEK staff at J-PARC is particularly worrying.

GENERAL STATUS OF THE PROJECT

Findings:

- The J-PARC accelerators have maintained excellent performance and availability since the IAC meeting in 2021. Beam power over 700kW and availability well over 90% is truly world class. This performance enables a wide range of world class science.
- Facility operation and the science program have continued at a high level despite the pandemic.
- Safety performance has been good, with low incident numbers and very low numbers of Covid cases (even in the latest wave).
- The recent rapid increase in the cost of electricity, with a fixed budget, means that the planned number of operational cycles in the next FY may not be achievable. This obviously has direct consequences for the science programmes. The MR programmes in particular already have a growing backlog of experiments due to the small number of cycles in recent years.
- Overall staff numbers are low to support a scientific infrastructure of the scale and sophistication of J-PARC, even including outsourced company employees. Excellent performance is only achieved through a heavy workload on staff, which is not sustainable, particularly if there is a move towards more remote operation and less user presence.
- The staff age distribution, particularly for KEK staff, is heavily weighted towards those approaching retirement within 10 years.
- The increasing time required for NRA approval of facility modifications is an increasing risk to operations.
- The scale of the J-PARC ADS program has been steadily shrinking at the same time as the potential importance of this program for the energy requirements of Japan has been increasing.

Recommendations:

- The present steady systematic approach to increasing beam power while prioritising availability should be continued, particularly if there is a risk that the number of cycles may be reduced.
- J-PARC needs both a short term and a long term strategy regarding increasing electricity costs. Even if the cost stabilises, there will be increasing pressure to use less energy. This strategy should be a key topic for the next IAC meeting.
    - Short term: J-PARC should, if at all possible, urgently seek additional funding to mitigate the problem for the current financial year. Postponing maintenance, without certainty of increased future funding, is a high risk because it just accumulates future problems.

    - Long term: Scientific output needs to be maximised whenever the facility is operating, which might be done through capital investment, e.g. running more experiments simultaneously through the hadron hall extension, but this will also require increased staffing.
- Despite the challenges in being able to fulfil it, J-PARC nevertheless needs to develop a long term staffing plan for the staff and skills required to operate the facilities and produce world class science. This plan would take the current staffing distribution and propagate it forward in time with different hiring rates in order to understand the likely impact in 5-10 years. Without such a plan it is impossible to tell if the current approach and level of recruitment are adequate.
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- If JAEA and J-PARC are to participate effectively in the move of ADS technology from lab scale R&D towards “engineering” and “performance” demonstration, within an international collaboration, more resources will be required than are presently foreseen.

SAFETY

Findings:

- Safety performance has been good, with low numbers of incidents and a good ratio to the number of near miss reports.
- Emphasis is being put on safety training and practical exercises, including risk assessment ('KY' training).
- The incidence of Covid cases was extremely low, even in the latest wave.

Recommendations:

- Efforts to maintain a strong safety culture should continue. This could be supported/reinforced by commissioning an external audit of safety and safety culture. This audit should involve interviews with personnel at all levels in order to assess progress with continued improvements in safety culture. To be most beneficial, such an audit should be conducted every year in order to inform management of any trends.
- An integrated system of recording safety training needs to be implemented.

PUBLIC AFFAIRS AND COMMUNICATION

Findings:

- J-PARC is extremely active in public affairs and communications. These activities have contributed effectively to improving the social role of J-PARC.
- The 'medicine bottle' and 'comet' studies attracted strong media interest.
- The on-line open house events have been particularly successful, with thousands of viewers.

Recommendations:

- The activities have been very good in communicating the importance of basic science to society. IAC recommends that this should continue.
- J-PARC should be careful about the gender balance of the researchers who appear in lectures and on Youtube. The current J-PARC gender balance is not adequate, but the balance of presenters should aim to reflect the future realization of diversity & inclusion.
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RADIOACTIVE WASTE MANAGEMENT

Findings:

- Because Japan has no long term repository for high level waste, some waste including used targets needs to be stored on the J-PARC site. Without mitigating actions, the storage areas that are currently available will become full in the early 2030's. Potential mitigations are including storage areas in the hadron hall extension, size reduction of used targets and longer target lifetimes.
- The waste disposal plan as presented focusses on hadron, neutrino and MLF neutron targets.
- The plan for the RAM building does not yet include the possibility of a second MLF target station.
- It is not clear what the plans are for replacing the MLF moderator and reflector system when it reaches end-of-life in a few years, and how that will be managed to reduce the potential for radiation exposure and waste generation, and how the irradiated components will be transported and stored.

Recommendations:

- The size reduction development for the MLF target should continue, but only in a way that does not disrupt the planned operating schedule.
- Inclusion of some storage capacity in the Hadron Hall extension should be explored as a possible cost effective solution.
- At some point MLF will change from planning to run a neutron target for 1 year to planning to run it for 2 years. Obviously this will increase the risk of target failure during that period. Increasing the power on the target also increases the risk of failure, so IAC would advise MLF not to make both changes in the same year.
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- A holistic overview of the long term overall strategy for waste generation, handling and storage should be presented at a future IAC meeting. This should include coordinated plans for end-of-life targets, accelerator components, and MLF reflector and moderator system components from across the accelerator complex.

ACCELERATOR SYSTEMS

Findings:

- The J-PARC accelerators have maintained excellent performance and availability since the IAC meeting in 2021. The RCS has operated regularly, achieving record 740 kW beam power with high availability. The MR operated for a substantial portion of the year, even while upgrading its magnet power supplies to enable future beam power in excess of 1 MW. J-PARC has continued to show flexibility where possible to re-schedule user time when interruptions occur.
    - The RCS has remained in stable user operation, delivering 630 – 740 kW beam to the MLF during the period 1 April to 20 July. Availability to the MLF has again been very good, at 97.2%, but due to reduced cooling capacity in the RCS the beam power had to be reduced from 740 kW to 630 kW.
    - The beam power for MR fast extraction to the neutrino experimental facility and MR slow extraction to the hadron experimental facility have been maintained at 510 kW and 64 kW, respectively, with availability > 93%.
    - The MR power supply upgrade work will reduce the MR cycle time to < 1.3 s to achieve > 750 kW. A further program of modest improvements to the MR will result in increased beam intensity. When combined with the power supply upgrade (and further extension to 1.16 s cycle time), 1.3 MW should be available from the MR for fast extraction.
- The J-PARC accelerator team has addressed most of the six recommendations from the IAC meeting in 2021. Concerns still remain around staffing levels and, even with seven new staff expected to be hired next fiscal year, more still needs to be done to address issues of an aging workforce and knowledge retention.
- Some operational issues, such as reduction of cooling capacity in the RCS and the damage to the electrostatic septum in the MR due to the Machine Protection System (MPS) response to a faulty microswitch on a transformer, have been dealt with effectively, but highlight the need to enforce strict maintenance regimes and continue improvement of the MPS.
- Accelerator energy consumption is an important issue because of long-term carbon neutrality and recent increases in electricity costs. In this context the new design of RCS RF cavity, which shows a significant reduction in power consumption, is very welcome. The J-PARC accelerator team is encouraged to pursue similar initiatives wherever possible.
- As part of the medium-/long-term plan from 2022 to 2028, the Accelerator Division has identified its top-priority goal to be high availability operation at 1 MW beam power level, to be realized by steadily increasing beam power annually by 100 kW.
- Accelerator R&D and improvement projects (AIP) are being developed, including topics directly benefiting J-PARC's future plan and topics benefiting the general accelerator community.

Recommendations:

- Extend the Machine Protection System (MPS) to have redundant safety elements to detect transformer failure, understanding that some portion of the microswitches may fail over time.
- Investigate upgrade of the MPS abort kicker system to allow fast (ms) abort of the beam during the entire slow extraction cycle.
- Develop a prioritized list of the accelerator R&D and improvement projects (AIP) which Accelerator Division would like to pursue, along with a clear explanation of the decision making and prioritization process.

PARTICLE AND NUCLEAR PHYSICS:

J-PARC has a wide-ranging program in particle and nuclear physics, recognized worldwide for its excellent research. This includes investigations of neutrino oscillations and the search for sterile neutrinos, precise measurements of muon g-2, the search for the muon-to-electron conversion, meson properties in nuclear matter, strangeness nuclear studies, and hadron physics. A comprehensive strategy for the future is in place and is designed to reinforce J-PARC's key role in this field by contributing with unique experiments through exploiting the high intensity beams. It is critical that results from many J-PARC experiments are timely obtained as they will influence the future of the field.

Findings:

- J-PARC has done a remarkable job in the upgrades, delivering beam, and reacting promptly to problems when they occurred. The scientific programs at J-PARC, in both nuclear and particle physics, are world-class.
- A major concern is the shortage of beam time, a persistent issue over the years, which has created a large backlog and even cancellations of approved experiments. It is encouraging to see funding in FY2022 for 4.5 cycles, although the electricity cost may impact this plan. It is important to maintain a high level of operation on the MR.
- The neutrino program remains a highlight of the J-PARC physics program. The committee again notes that the experiments will need reliable high-power beam operations with maximum user time and availability to remain world leading. The strong publication record of the T2K experiment is commendable.
- The Hyper-Kamiokande project has been approved and construction began in 2020. The 190kt-FV detector is expected to begin operation in 2027 and relies on the upgrade of J-PARC to 1.3 MW. This is one of the most critical J-PARC activities in the coming decade.
- The J-PARC muon g-2 experiment at the MUSE facility is making steady progress in design and R&D. With the new Fermilab result, that is consistent with the previous BNL result using a similar setup, an independent measurement as planned at J-PARC is critical.
- Phase-I of the COMET experiment, which will search for coherent neutrino-less conversion of a muon to an electron, is progressing well and on track for physics runs starting in FY2023. A beam engineering run on the completed proton transport line is scheduled for FY2022 and substantial progress is being made on the solenoid magnet system and the detector.
- The KOTO neutral kaon rare decay experiment has been accumulating physics data in 2020 and 2021 with improved charged veto.
- The hadron hall extension will not only provide more space for the planned instrumentation, like the high-resolution spectrometer, but at the same time enable a more efficient operation of the experimental program in terms of efficiency of data taking, as well as mounting and dismounting of instrumentation. The recent workshops on the hadron hall extension were successful and demonstrate strong support from the community for the hadron hall extension and its science program.

- The measurements of meson mass modifications in nuclei, recently made at the high momentum beam line, will provide relevant information on finite density effects in nuclear matter.
- Within the interesting ongoing program on nuclear physics with strangeness, the precise measurements of differential cross sections for the interaction of sigma baryons with protons have published results testing the theory of QCD at low energy.
- Particle and Nuclear Physics PAC activities are commendable and provide critical feedback in shaping world class programs.

Recommendations:

- The IAC recommends construction of the hadron hall extension as soon as possible. This will enrich the scientific program considerably by addressing timely questions in nuclear and particle physics.
- J-PARC should dedicate additional efforts to increase and optimize use of beam time for the current and planned experiments.

MATERIALS AND LIFE SCIENCE - NEUTRONS

Findings:

- The MLF ran exceptionally well over the past year, delivering neutrons with high reliability to its world-class instrument suite.
- Publications have been steadily increasing, though there is still room for improvement.
- J-JOIN has been initiated to attempt to enhance synergies between the MLF and JRR-3.

Recommendations:

- The IAC continues to strongly believe that all users should have a similar scientific experience at the MLF regardless of the instrument "owner". We applaud the efforts to harmonize instrument operations across the MLF, but believe more should be done in this regard.
- While publications are still increasing, the IAC believes there is still some room for improvement. As the publications are not too far below what is expected, we suggest a more granular analysis which considers the publication rate on particular classes of instruments, such as inelastic scattering powder diffraction, SANS etc. Discrepancies in the publications/experiment can be used to target efforts to improve the workflow for these instruments.
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- The IAC applauds the creation of J-JOIN. The united proposal platform for JRR-3 and MLF is an excellent start to what we believe should become a deep collaboration between these facilities. The IAC believes MLF should look for other opportunities for collaboration and consolidation in areas such as sample environment, technique development, sample preparation and characterization, data reduction and analysis, etc.
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- The MLF should continue to prioritize stable operations and increasing neutron production hours to support growth in number of experiments and scientific productivity and continue the careful, systematic, stepwise power ramp-up. The IAC

also notes that, at some point, the decision will need to be made to operate the target for 2 years rather than 1. This will entail additional risk of target failure. Thus we suggest that the MLF carefully consider the timing of this decision with respect to power ramp-up.

MATERIALS AND LIFE SCIENCE – MUSE

Findings:

- The IAC is pleased to see the continuing outstanding work of the MUSE team in all fields of its responsibilities, and the increase of permanent staff by one person. The MUSE team overcame the challenges of the Covid-19 pandemic by their efforts to run a normal beam cycle, while putting additional load on MUSE staff.
- The IAC acknowledges the well-balanced program between fundamental particle and condensed matter physics, materials science, and developing new research directions. For example, the Transmission Muon Microscope (TμM) would be a unique extension to the MUSE facility. The IAC attributes the continuing interest from broad scientific communities in muon science at J-PARC to this wide-ranging scope of muon research at MUSE. Several excellent publications in 2021 in various fields are a manifestation of the very rich opportunities of muon applications. The scientific results from the Inter-University Research Program (IURP) reflect a high standard of productivity.
- The negative muon program is making substantial progress with an excellent scientific output of 16 publications in 2021. The research program is broad, including industrial applications and joint projects of humanities and sciences. The IAC applauds the initial analysis of a sample from the asteroid Ryugu, brought to Earth by the Hayabusa 2 space mission.
- The IAC highly appreciates the efforts in providing the resources to build the spare muon target. In the ongoing transition from the construction phase to operational mode, the IAC acknowledges the continuous progress in instrumentation for user operation in the D1/D2 and S1 areas, and IAC congratulates for the installation of the S2- and H-lines to start the long-awaited particle physics programs (DeeMe, MuSEUM) to deliver world-leading results soon. Commissioning of the U-line for the generation of ultra-slow muons (USM) is continuing, preparing to begin the μSR user program in U1A experimental area with USM.
- The muonium laser ionization program for the generation of USM is making slow progress. A new pumping scheme of the Nd:YSAG amplifier is in preparation to significantly enhance the laser pulse energy and the USM generation rate, which is of pivotal importance for MUSE. The IAC evaluates the formation of a larger collaboration of domestic laser experts as an important step towards efficient generation of USM.
- Insufficient manpower for user operation and the development/operation of the laser for USM generation is one of the most important concerns about the operation and further development of the facility. This poses a risk for the full exploitation of the very rich scientific opportunities of muon applications in fundamental and applied/materials science. The impressive scientific output in 2021 – in terms of impact, quality, and number – could only be achieved with a large overload on staff, which is not sustainable for the operation as a user facility. In view of the limited manpower and of a uniform, site-wide safety concept for the operation of the accelerator facility, the IAC notices that it is

internationally unusual that muon scientists of MUSE would be given the task of being responsible for the safe operation of the M1/M2 proton beam section and the muon production target.

Recommendations:

- The IAC reiterates its recommendation to make available additional staff with part of their duties assigned to the 'instrument scientist' role. Developing a strong and stable muon users' community relies on such support from the facility:
    - The IAC recommends strengthening the group of MUSE people being responsible for the M1/M2 proton beam line/muon production target. On a medium-term, IAC recommends that J-PARC manage the safe delivery of proton beam by a J-PARC group.
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- The IAC recommends completion of the H-line and the continuation of the TμM feasibility study with high priority.
- The IAC recommends evaluating the possibility of implementing a cryogenic muon moderator target for a short-term increase of the USM rate for the μSR program in the U1A area. The laser development for USM generation should be re-evaluated by a team of external experts, and a report about the strategy of laser development should be submitted by the end of 2022.
- The IAC recommends MUSE management to work out a proper balance between IURP general-use and S-type proposals. Due to oversubscription of the muon facility, it is difficult for new user groups to get access to the instruments.
- The IAC recommends MUSE management to draw-up a long-term vision on the further development of the facility with clear assignments of staff and responsibilities, and to define the resources needed to realize the long-term vision. MUSE management should develop career plans for the next generation of scientists, to enable a sustainable long-term operation of the facility.

ADS

Background:

The security of supply of electricity at predictable and affordable price for the society is an absolute need. This is also important for large research facilities such as JPARC for making use of their maximum capabilities.

J-PARC has had a research program on ADS, and important facilities related to this program that are under development, for many years. This program is of prime importance if nuclear energy is to continue to be part of the energy-mix for guaranteeing the energy supply and affordability. ADS technology has important figures of merit when it comes to reducing the ecological footprint of the geological disposal of high level waste, and drastically reducing its radiotoxicity from hundreds-thousands of years to hundreds of years. This technology has to move from lab scale R&D towards “engineering” and “performance” demonstration in an international collaboration; the JAEA program and J-PARC facilities are contributing to this and can continue doing so thanks to the multi-annual program 2022-2028, but the objective of the targeted demonstration will require larger scale funding than presently foreseen.

Findings:

- The present program conducted at J-PARC and JAEA has been limited to the design and research activities of the ADS facility, but no actual research facility has been constructed yet.
- In the contents of the research program there are various topics related to the specific needs of the design of the TEF-T facility, or for the more general needs of ADS
- As pointed out in the T-TAC report, some of the proposed tasks should be left out because the work is already conducted elsewhere or will not be achievable within the present budgetary envelope. The priorities indicated in the T-TAC report can serve as a guidance for this prioritization exercise.

Recommendations:

- As the level of demonstration that is needed today is to reach a TRL 7, IAC considers that it is difficult to plan for this within the limited budget presently assigned. J-PARC and JAEA should promote domestic skills retention/development for later ADS activities through international collaboration and use of existing equipment in Japan, and research utilizing the proton beam irradiation capabilities of J-PARC.
- J-PARC and JAEA should continue to strive for the realization of TEF-T.
- Work on TEF-P should be reduced as soon as possible. Priorities are needed because of limited funding, but also the volume of fissile material required for TEF-P may not be compatible with running J-PARC as an open user facility

Appendix I

Agenda for the International Advisory Committee Meeting of J-PARC in 2022

March 3, Thursday

Connecting to Zoom (20:45-21:00)

Introduction (Member introductions / Appointment of chair) (21:00-21:10)

Charge to the Committee / Report from the Director (21:10-21:25)

time	title	presenter
21:10	Charge to the Committee /Report from the Director	Takashi KOBAYASHI

Views from Funding Agency and Host Institutes (21:25-21:55)

time	title	presenter
21:25	View from MEXT	Hiroshi FURUTA
21:35	KEK and J-PARC	Junii HABA
21:45	JAEA and J-PARC	Hiroyuki OIGAWA

Safety (21:55-22:05)

time	title	presenter
21:55	Safety at J-PARC	Yoshimi KASUGAI

Public affairs and communications (22:05-22:15)

time	title	presenter
22:05	Public affairs and communications at J-PARC	Fujio NAITO

Accelerator (22:15-22:35)

time	title	presenter
22:15	Progress and Prospects	Michikazu KINSHO
22:25	A-TAC View of Accelerator Activities	Jie WEI

Material and Life Science I (22:35-22:55)

time	title	presenter
22:35	Overview of Neutron Facility	Toshiya OTOMO
22:45	NAC Review	Jamie SCHULTZ

Break (22:55-23:05)

Material and Life Science II (23:05-23:25)

time	title	presenter
23:05	Status of MUSE	Koichiro SHIMOMURA
23:15	MAC Review	Thomas PROKSCHA

Particle and Nuclear Physics (23:25-23:45)

time	title	presenter
23:25	Overview of Particle and Nuclear Physics	Naohito SAITO
23:35	PAC Report	Rikutaro YOSHIDA

Accelerator Driven Transmutation Research (23:45-23:55)

time	title	presenter
23:45	ADS Project	Fujio MAEKAWA

Radioactive Waste Management (23:55-0:05)

time	title	presenter
23:55	Radioactive Waste Management	Shuichi WAKIMOTO

Executive Session (closed) (0:05-0:30)

time	title	presenter
0:05	Review and Discussion	IAC Members

March 4, Friday

Connecting to Zoom (20:45-21:00)

Executive Session (closed) (21:00-23:30)

time	title	presenter
21:00	Review and Discussion, Drafting Recommendations	IAC Members

Close out (23:30-0:00)

time	title	presenter
23:30	Recommendations	IAC Chair

Appendix II

IAC Committee members for 2022

Name	Affiliation	Field
Robert McGREEVY (Chair)	Science & Technology Facilities Council (STFC) *Former position	Neutron
Takeshi EGAMI	University of Tennessee	Neutron
Paul LANGAN	Institut Laue-Langevin (ILL)	Neutron
Dan Alan NEUMANN	National Institute of Standards and Technology	Neutron
Thomas PROKSCHA	Paul Scherrer Institute	Muon
Yoko SUGAWARA	Toyota Physical and Chemical Research Institute	Muon
John THOMASON	Science & Technology Facilities Council (STFC)	Accelerator
Jie WEI	Michigan State University	Accelerator
Dmitri DENISOV	Brookhaven National Laboratory	Particle Physics
Joachim MNICH	European Organization for Nuclear Research (CERN)	Particle Physics
Angela BRACCO	Istituto Nazionale di Fisica Nucleare (INFN)	Nuclear Physics
Reiner KRUECKEN	TRIUMF, Canada's Particle Acclerator Centre	Nuclear Physics
Hamid Aït ABDERRAHIM	Belgian Nuclear Research Centre (SCK•CEN)	ADS
Akira HASEGAWA	Tohoku University	ADS
Shinichi KAMEI	Mitsubishi Research Institute	Social tolerance/implementation
Hiromi YOKOYAMA	University of Tokyo	Social study of science

Appendix III

Charges to IAC2022 from J-PARC by T. Kobayashi, 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
- Future vision of the facility – J-PARC Decadal Plan
  - Actions on pandemic of COVID-19
- Review safety activities at J-PARC
  - Safety culture is well penetrated through staff and users?
- Any suggestions to improve the total performance are welcome. Our concerns include but are not limited to
  - Open access for users
  - More uniform operation combining KEK, JAEA, and CROSS efforts is critical to further success of MLF