Report of the Neutron Advisory Committee 2012 for the J-PARC MLF Facility

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The Neutron Advisory Committee congratulates J-PARC in general and the MLF Facility in particular for the impressive recovery from the devastating effect of the March 2011 earthquake. It was impressive to see that many of the neutron and muon instruments have restarted the user programme. This achievement is a testimony to the strong leadership of J-PARC and the MLF and the dedication and hard work of the whole team.

Target

Despite of the impact of the earthquake, impressive progress has been made in target development and other activities around target and moderators.

One of the most critical incidents was the displacement of the target trolley: the compressed air pipe was cut which resulted in a stretched bellow between the large flange and the target shroud. The worst scenario would have been spilling mercury into the target service bay, which fortunately did not happen.

Following the earthquake, target #1 was removed and investigated. Samples from the beam entrance window were drilled with a newly developed cutting/drilling device. Considerable damage by **cavitation erosion** was observed with a mean pitting depth of 25-50 µm, some pitting clusters reaching up to 250 µm in depth. A CCD camera inserted into the target nose did not observe obvious or severe Hg-flow erosion, but the quality of the pictures was not sufficient to make such damage clearly visible. Although the degree of cavitation erosion was close to previous estimates, the result, in view of the relatively low irradiation load of 500 MWh, underlines that mitigation measures are of paramount importance.

The NAC was pleased to be informed about great efforts made in this direction. Gas bubbling is expected to be the most promising mitigation measure. At J-PARC, intensive R&D efforts were undertaken developing improved bubblers, swirl bubblers with/without venturi, conducting the WNR experiment at LANL (in collaboration with SNS) using a Hg-loop with bubbler inserted, and testing bubblers with Laser Doppler Vibrometer (LDV) to monitor vibrations. The (still preliminary) results are: a) bubbling is a promising method to mitigate pitting damage and b) LDV has great potential for *in-situ* diagnostics. The latter is of particular importance since without diagnostic the bubbling effect can only be tested while 'flying blind'.

These and other considerations were the input for a new improved design of target #3:

- A **slim target vessel** with **dismountable nose**: this compact design, besides being less expensive, will require less storage space when decommissioned, a general and very important issue at J-PARC;
- **A gas bubbler** installed at the side of the mercury in-flow to the window. Bubbling is planned to start after the summer shutdown (after repair of the He-pump);
- **A** newly developed, micro machined **mirror** attached to the target nose
- …combined with ***in-situ*** **LDV monitoring** during operation for on-line control of the bubbler efficiency.

Other developments are under way: double-walled beam window (as at SNS), beam profile flattening for reduced peak power at the beam entrance, improvements to reduce flange deformation by the temperature difference between coolant in- and outlet.

The new decoupler material has been successfully developed and the issues with the He circulating system have been improved and steadily resolved.

In a high power beam system like MLF it is essential to have reliable measurements of the ortho-para ratio in order to maintain the neutronic performance. Further improvements of the measuring system should be continued and collaboration with the SNS on this issue is strongly encouraged.

NAC recommendations:

- *Continue and intensify the efforts in target development towards more robustness and efficient mitigation measures against cavitation erosion;*
- *Devote additional effort to proton beam distribution flattening to reduce peak doses on the target and extend its lifetime;*
- *Develop urgently a storage, dismantling and disposal concept for used targets appropriate for the long term;*
- *Consider measures to prevent uncontrolled trolley movement, elaborate a failsafe concept which does not depend on active media (like pressurized air);*
- *Intensify development of the ortho-para ratio measurement; collaboration with the SNS is strongly encouraged.*

Instruments and Operations

At this point, the instruments have largely been repaired with 17 currently being commissioned or re-commissioned while two additional instruments are in the late stages of construction. The commissioning of these instruments is expected to begin in the next months. The recovery of the annex buildings is particularly noteworthy as one of the buildings was raised 15 cm while in another the guide supports were readjusted so that the guides could simply be realigned. This flexible approach to the recovery, evident throughout the MLF, is particularly noteworthy and, in the opinion of the NAC, a key to the rapid return to producing neutrons with user operations imminent.

The performance of the instruments is excellent making the MLF a world-leading facility for neutron scattering research. The high resolution of Super HRPD and the high intensity of the NOVA instrument make them world leading, while the sample-exchange robot available on iMATERIA is turning this into a highly productive instrument. Thus it is not surprising that high-profile publications reporting neutron results from J-PARC have begun to appear. Based on the results reported to date and the increasing number of instruments, the NAC expects that the quantity of publications will increase quickly as operation returns to normal. There are however two important issues that must be addresses if the MLF is to reach its full potential. The first is that many of the instruments are operating without a full complement of detectors. Because of the world-wide shortage of ^{3}He, this is a rather difficult situation that will require a multi-pronged approach, including the procurement of currently available detectors and the development of new technologies.

The second and most pressing issue that the MLF must overcome if it is to achieve its full potential is providing adequate support for all of the operating instruments. Not only have the number of scientific staff been inadequate, they have typically been involved in multiple activities ranging from data acquisition, sample environment, detectors, safety committees, as well as operating specific instruments. This problem however, is not uniform across the MLF. For example, the two instruments built and operated by the Ibaraki Prefecture are well-staffed. Thus it is not surprising that one of these, iMATERIA, is the instrument in most demand. In this context, the new legislation for the “Promotion of Public Utilization of Specific Advanced Large Research Facilities” is welcome news. The MLF has responded by creating the “Comprehensive Research Organization for Science and Society” or CROSS which has secured 7.2 Oku ¥ for operating six “public” instruments, five of

which are operating or nearing completion (construction funding for the imaging station is expected in FY 2012). This provides adequate scientific and technical staffing of 5.2 staff per instrument, close to the international standard of at least 6 staff per instrument.
Unfortunately the level of staffing for the CROSS instruments and the Ibaraki Prefecture instruments is not available throughout the MLF. The situation is particularly acute for the instruments built and operated by the KEK which apparently has only 14 staff for 8 instruments (six in operation, one in construction, and one proposed). While KEK has done an admirable job in forming alliances with universities to help alleviate this issue, this low level of staffing will cause major difficulties as operations ramp up at the MLF.

As the staffing situation for the CROSS instruments appears adequate, this could possibly involve expanding the partnership with CROSS. The difficulties in providing adequate staff for robust user operations also makes it essential that the management of MLF carefully considers what mix of being a "scientific user facility" as opposed to a "development laboratory", they wish to achieve. Within the available funding, it is likely impossible to be truly excellent at both. The bottom line is that *all aspects of the user experience should be similar regardless of the "ownership" of the instrument they are using.* The NAC notes that excellent progress towards this goal has been achieved for the administrative aspects of using the MLF, including the proposal system. We believe that the ultimate scientific productivity of the MLF will depend on achieving similar progress for a consistent user experience on all the instruments.

The experimental halls at the MLF are nearly fully instrumented. Twenty one instruments are complete or under construction while two more instruments have been approved for construction with funding expected in FY 2012. Thus only two beams are left for new projects, with the space severely constrained at BL07. The NAC congratulates J-PARC on the rapid progress in fully developing the instrumentation in the MLF and applauds the continued involvement of the scientific community in the selection process. *The NAC also strongly supports the plan to review the scientific productivity and impact of each instrument every five years to assess the need for upgrades or replacement.*

Going from an unpolarised beam to full polarisation analysis reduces the overall intensity typically by a factor of 10. We recommend therefore that POLANO is designed to take a much larger scattered solid angle, even if the full detector complement is currently not affordable. Unless the MLF is able to produce supermirrors in-house, we believe that this technology will be prohibitively expensive. With polarised 3He, MEOP will most probably be the best option. Currently ILL, ISIS and ANSTO are all working on implenting wide-angle polarisation analysis in this manner and MLF will benefit from their experience.

We have the impression that there is some tension between allocating money for the construction of instruments and budgets for operating instruments. We believe that priority should be given to provide good support for the operation of the instruments rather than having a very large number of instruments inadequately supported.

Finally, proposal pressure remains quite reasonable with nearly 300 proposals received for FY 2011 with an impressive ⅓ coming from industry. Without the severe interruption to operations in the aftermath of the earthquake, this would have translated into more than 500 users in FY 2011. This is fully satisfactory at this stage of the life of the MLF.

NAC recommendations:

- *Develop a prioritised plan to acquire and/or develop and install the full detector complement on the entire suite of neutron scattering instruments;*
- *Design POLANO with a much larger scattered solid angle;*

- *The leadership of the MLF should work with the KEK (and any other partners) to ensure adequate staffing for the operation of all instruments at the MLF*.

Devices (detectors, choppers etc)

We note the progress made in the last year on polarised ^{3}He, magnetic lenses, supermirrors, choppers and detectors. In particular, we were very impressed with the magnetic lenses (especially the achromatic double lens), the very-low off-specular reflecting focussing supermirrors, and the variety of detector developments.

We note and applaud the decision to concentrate on SEOP ^{3}He polarisation, rather than MEOP, and the reduction in size of the polarising equipment. We also note that the team has identified the instruments which are likely to need polarised beams and/or polarisation analysis. However, we note that no improvement in gas polarisation levels has taken place since the last meeting, despite some interaction with leading international groups in the last year. We look forward to seeing implementation on a user instrument at the next meeting in 2013.

Regarding detectors, we applaud the engagement with international efforts in response to the ^{3}He crisis. It may be beneficial also to commence a dialogue with the detector groups in other Asian countries, specifically China and Korea. There are indigenous detector development labs at KAERI, the Chinese Institute of High-Energy Physics and Tsing-Hua University, and it might be a good long-term investment to engage in stronger dialogue with these Asian laboratories.

NAC recommendations:

- *Consider collaboration on detector development with expert laboratories in other countries, in Asia and beyond.*

Safety

Generally speaking, safety management including training, safety reviews, chemical safety, mechanical & electrical safety are going well. The number of user samples will increase significantly as operation is ramping up and if instrument scientists will have to deal with sample safety checks this will put an additional burden on them. More staff, and probably dedicated staff will be necessary to handle the increased number of samples and carry out an overall risk assessment of the experiments.

The emergency response during the 2011 earthquake has been good and lessons have been learnt leading to new safety measures being implemented.

Radiological control problems in the experimental halls continues to be an issue. J-PARC/MLF excludes many power and liquid samples because the MLF experimental halls are uncontaminated areas. For example, users are not able to do reflectivity measurements on liquid free surface. This puts the MLF programme at a great disadvantage. At every meeting so far the NAC (or previously NIAC) has recommended solving this problem as soon as possible and this NAC is again urging the MLF management to address this issue speedily.

NAC recommendations:

- *Write down the lessons learnt from the 2011 earthquake for future reference and expand this into a more general 'activity continuation plan' which would also address measures to be taken in the event of other disasters;*
- *Address with urgency the issue of measurements of powder and liquid samples in the experimental halls.*

User infrastructure, sample environment and user management software

We note that there is progress with providing additional infrastructure space, e.g. construction of the mezzanine floor in the experimental hall and instrument cabins. Overall space for ancillary equipment in the experimental hall is rather limited and we are concerned that this will create issues when the full user programme is in operation, The formation of a sample-environment group is very much appreciated; however, we would like to see a dedicated sample-environment laboratory which would form the basis for sample environment suport across the whole instrument suite. Space for storage and preparation of sample-environment kit is an issue across all instruments

We note that the planned User Building has not yet been approved. We consider this building as essential for a successful operation of the MLF and would like to see it built as soon as possible. It will not only provide space for laboratories in support of the scientific programme, but will also provide important interaction opportunities for MLF users with potential for new collaborations across disciplines. A key laboratory for the future User Building is a deuteration laboratory; this is essential for an effective exploitation of the MLF in particular in biology and soft matter research. It is important to note that all support laboratories have to be properly supported by technical staff with the appropriate exertise.

Transportation from the nearest train station (Tokai station) to J-PARC/MLF and within J-PARC/MLF is very bad, and the experimental hall is far from the User Office and the dormitory. It takes about 30 minutes on foot from the User Office to the experimental hall. This is very inconvenient for users. The dormitory located near the User Office is in use and provides reasonably comfortable accommodation for users. However, the distance from the MLF is an issue.

We welcome the effort now starting to address remote access to the MLF instruments. This should be progressed with high priority. We also note the initiative to update and improve the external webpage with information etc. for users. We want to point out that such systems have been developed by many faciilties world-wide and it is not necessary to invent everything from scratch. We encourage the MLF team to see if they can make use of already existing system and focussing their effort on customising them; we recognise that there is only limited effort available and collaborating on shared and joint development would be an effective way forward.

NAC recommendations:

- *Consider formation of a dedicated sample-environment laboratory which provides technical support across the whole suite of instruments – adequately staffed to accommodate the expanding programme;*
- *Consult more with users on sample-environment requirements and learn from international facilities – participate in regular meetings of sample environment teams world-wide (next workshop will be held in Sydney on 17 – 20 September 2012）;*
- *Construct as soon as possible the User Building, which should include a deuteration laboratory with a specialist in chemical synthesis.*
- *Consider building a new canteen close to the MLF to support users and MLF staff who work long hours;*
- *Progress the devlopment of remote access with high priority;*
- *Consider using existing 'user management software' from other user facilities.*

Muon target and beamlines.

The committee was very pleased to be informed about plans and status for the muon target and the four muon beam-lines. Neutrons and muons are complementary tools, and experience from other facilities (ISIS and PSI) clearly demonstrates synergistic advantages of having both tools at one facility, closely collaborating and sharing both science problems, support staff and infrastructure. Japan has from the previous muon facilities in Tsukuba a well organised, experienced and internationally recognised muon community, which is eager and able to establish MLF as a world leading centre for μSR. The NAC welcomes and supports the addition of the second world leading capability at MLF that will be provided by the muon instrumentation.

The four beam-lines (U, D, S and H) will feed experimental stations with microbeams (μm spot size), low energy muons for nm depth resolution, surface muons for bulk measurements, and very penetrating (high energy) decay muons and reaching out to both the condensed matter and particle physics communities. The target and instrumentation is based on the latest muon technology and will deliver unprecedented intensities,

The neutron and muon activities will share the same experimental hall and target station; it is therefore essential that the two activities are well coordinated – especially during shut down and maintenance periods for the facilities.

NAC recommendations:

- *Coordinate neutron and muon shutdown activities.*

User programme and outreach

The 1st AOCNS was very successful with the support of J-PARC, KEK, JAEA and JSNS. This kind of supportive work for the international community should continue with international organizations, such as AONSA. This will help to expand the scientific activity to other countries within Asia and beyond and establish MLF @ J-PARC as an international centre.
The user programme runs very well; the single entry point for proposals to instruments operated by different agencies is a step in the right direction for a unified operation of MLF. It may be a better way to give the external proposal process to CROSS. This may make it a simpler approach. It would be nice to see more long term outreach programmes for the future. The general public relationship can be done by the each individual organization for itself. However, CROSS can generate more cohesive programmes for high school and undergraduate students for summer research projects and other activities. Organisations like NIST and BNL in the USA are very experienced in running such programmes and J-PARC could learn from them. Furthermore, try to develop an international outreach programme with the AONSA.

NAC recommendations:

- *Consider a long term outreach programme for students, across Asia, maybe co-ordinated through CROSS and in collaboration with AONSA.*

General

We note that the lack of adequate storage space for radioactive components has been highlighted in several presentations. The need to store components either as spares or until activity levels have decreased so that items can be sent for disposal will increase with continuing operation. This is a problem which needs to be addressed across the whole of J-PARC and we wish to escalate this issue to the highest level of the J-PARC management.

Many presentations highlighted inadequate numbers of staff to cope with the programme of work. We want to encourage the MLF management to review staffing levels and staff distributions now that MLF has made the transition from a construction projects to an operating science facility.

NAC recommendations:

- *Address the issue of insufficient storage space for radioactive components across the whole of J-PARC;*
- *Review staffing levels and distribution to ensure that allocations are appropriate for an operating facility.*

We would like to make suggestions for the next meeting of the NAC:

- We would like to have more time for discussion and questioning; the time allocated for each session should be divided equally between presentations and time for questioning;
- We would like before the next NAC meeting a written response how the recommendations from this NAC meeting have been addressed;
- We would like the MLF management to decide on a number of performance indicators which would be presented on a regular basis and which would demonstrate the scientific impact of the MLF;
- Specifically we would like to hear at the next NAC meeting presentations on software developments for data analysis, visualisation and modelling;
- We would also like to hear about control systems for instruments.

The NAC committee would like to thank all presenters for their effort in preparing the material and everybody for the welcome and hospitality during our visit.