Report from the Muon Science Advisory Committee (KEK-IMSS) and Muon Advisory Committee (J-PARC Center)

May, 2012

Report from the Muon Science Advisory Committee (and the 10th J-PARC Muon Advisory Committee) Held on February 17 - 18th 2012 at J-PARC, Tokai

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Table of Content

Executive Summary

The Muon Science Advisory Committee (MuSAC) met at J-PARC, Tokai on February 17th and 18th, 2012.

The committee congratulates all the people involved at J-PARC, MSL and MUSE for the reconstruction and repair work performed in 2011 after the giant earthquake and tsunami that struck Japan on March 2011. Not only most of the damage has been repaired but accelerator and user operation have resumed within less than one year. Considering the extent of the damage suffered by J-PARC this is truly an outstanding achievement and the committee expresses his greatest respect and recognition for this accomplishment.

The committee was charged to review and give recommendations on the following questions:

1) **User Operation of the MUSE facility**
   - 1.1) Are D1/D2 instruments sufficiently equipped and users friendly?
   - 1.2) Are the obtained scientific results from the Inter-University Research program satisfactory?
   - 1.3) Recommend the upgrade of the other beam lines/instruments
2) **Construction of the Ultra Slow Beam line**
   - 2.1) Is the roadmap of the construction reasonable?
   - 2.2) Are the scientific goals clearly defined?
3) **Future plans**
   - 3.1) How do the committee judge the future plan of S-line and H-line?
4) **Expansion of the community**
   - 4.1) How to make domestic/international collaboration on the construction and operation of the beam lines?
   - 4.2) How to expand the users community?

Before entering into specific recommendation and in order to put them in a more general context, the committee thought useful to summarize the vision and global plan for the MUSE facility. The overall goal of MUSE is to 1) Develop and build state of art muon beams and instruments to exploit these beams and advance science. 2) Support a large user community and 3) Engage in front line research in material science and muon physics.

The global long term plan for the MUSE facility, which has been worked out and consolidated over the past years over the last years: includes the development of four multi users channels: 1) The D line: a versatile decay channel of variable energy muon servicing two experimental stations. 2) The U line: a state of art high flux ultra slow muon channel servicing two of more experimental stations 3) The S line: a surface muon complex with multiple beamlines and instruments and 4) The H line: a specialized beam line for fundamental muon science and high energy beams.

To deliver this master plan a strategic short term prioritization is needed taking into account the beam delivery and shut down program in the next years, man power and resources available.

MuSAC was impressed by the progress at the D-line. A kicker has been installed, which will allow operating two stations with a single well defined pulse. This is an important step towards establishing D line as a full fledge user facility. The committee considers the optimization of the experimental instruments at D1 and D2 to be of high priority as these instruments will generate all the competitive applied muon science for the next few years. As mentioned in the last MuSAC report, the D1 experimental area is greatly hampered by the lack of appropriate detectors and severe limitations on sample environment imposed by the existing equipment. Specifically priority should be given for the D1 spectrometer upgrade to be completed in time in order to capitalize on the large amount of user beam time scheduled for FY 2012. Pending final and imminent tests of the prototypes, the focus should shift to the design of a new fully operational spectrometer optimized for D2 (and later for the phase 0 of the S line) (so called JAEA spectrometer). Even greater progress is expected when the sample environment suite is broadened. The addition of the dilution refrigerator should greatly increase the number of applications from the physics community.

A questioning of the users by Prof. Torikai (in her function as user representative) brought several suggestions regarding user friendly operation. The committee took notice of several useful comments and thinks that the detailed suggestions and requests will be best discussed in detail in the course of a user meeting.

In view of the extremely difficult circumstances imposed by the earthquake and the concomitant heavy demand on KEK-MSL staff member time in developing and building the MUSE facility, the scientific results from the Inter-University Research program are impressive. Significant and topical problems in magnetism, superconductivity and other aspects of materials science are well represented and optimum use has been made of external facilities such as RIKEN-RAL, PSI and TRIUMF.

To optimize the user operation the committee recommends a staged upgrade of beam lines and instruments. Putting the major effort to complete beam lines in advanced stages and provide instruments with suitable sample environment appears to be the most effective use of resources for the coming fiscal year.

The committee reinforces his recommendation of the ultra slow muon beam line as top priority. MuSAC is very pleased to hear that KEK has released the funds needed for the construction and installation of the ultra slow muon beam line. The project has made considerable overall progress in 2011, in spite of the already mentioned difficulties. In addition the committee was pleased to hear that a grant-in-aid for scientific research in innovative areas was approved.

The road map appears very well defined. Installation of the curved solenoid and of the axial focusing solenoids with positron separator stages is scheduled during the shut down. Important

elements of the ultra slow muon setup (moderator section, lasers) are in advanced stage of development and may be installed before end of 2012.

We are pleased to see that enough time is allocated for commissioning and detailed studies of the beam properties in order to check the simulations. Although, this will represent a considerable challenge for the small team, a detailed understanding of the transport properties of U line is the basis for the successful application of the ultra slow muon beam line as unique tool for novel experiments in nano science, life science material science and particle physics. Particularly the micro beam will deliver unique real sample information of samples in the mg range and the lowest eV energy will allow investigating the uppermost surface layers. The quality of the scientific program was instrumental in securing strong support from large community of users including international participants, which lead to the success of the grant.

In her presentation Prof. Torikai summarized a number of ambitious scientific goals, which should be the focus of the scientific program in the forthcoming years.

MuSAC was pleased to see that, in spite of the general delay caused by the earth quake damage, installation of the S-line quadrupoles and of the front end of the H-line should be ready in 2012. It is essential that the front ends of both the S and the H lines are installed before the radiation levels around the target station becomes too high for manual work. On the longer term the S-line will be essential to broaden the μSR community by providing unique options (e.g. beam slicing) and spectrometers. An interesting scheme to optimize the use of four beamlines simultaneously has been presented to the committee. However, for the current year in accordance with our general recommendation, we think that only the so called phase zero of this beam line, which involves one beamline to possibly accommodate the new JAEA spectrometer with a beam slicer to optimize the pulse characteristics of the delivered beam, should be considered. MuSAC is aware that all the ambitions of the muon program will be difficult to realize at the current level of staffing. The committee fully recognizes that it may be placing an excessive demand on the existing manpower and setting a potentially unrealistic time scale for the development of the S-beam line.

We recommend that attempts should be made to secure sufficient manpower to complete the scientific and technical projects. This could be achieved in the short term through the appointment of temporary contract staff by a careful balance between operational and staffing cost.

The committee feels that further advertising J-PARC MUSE at international conferences (as it has been done at the μSR2011 conference in Mexico) but also involving the broader condensed matter physics and materials science communities via workshops and seminars (possibly in collaboration with the local neutron and synchrotron facilities) are necessary steps for expanding the user community and establishing collaborations. In this respect, defining a person within MUSE for outreach programs (which include the summer challenge KEK program or other training courses for young scientists in μSR techniques) will allow to coordinate these efforts.

I. Overview Session

Prof. Kadono gave the welcome address and introduction to the session and outlined the charge to the committee on behalf of Prof. O. Shimomura, who presented his apologies for not being able to attend the meeting. Dr. Y. Ikeda overviewed the J-PARC activities, followed by status reports on the Material and Life Science experimental Facility by Dr. M. Arai and on the Muon Science Facility (MUSE) by Prof. Y. Miyake.

In his presentation Dr. Ikeda showed some pictures taken immediately after the great East Japan earthquake of March 2011. Although the main buildings were mostly unaffected, do to their underpinned structure, the extent of the damage to the J-PARC area was significant. It affected roads, transport paths, infrastructure and annex buildings (with in some cases the floor sagging as much as 4 cm) and caused an operational stop of the accelerator complex of about 8 months. MuSAC was extremely impressed by the vigorous recovery work, which started immediately according to a well defined schedule and which was financed by a specially allocated recovery budget. Already in December beam tests could be performed.

The success and efficiency of the recovery work is also reflected by the revised operational plan, which foresees a steadily increase of the beam power to reach 300kW in summer 2012 and aim to provide in FY2012 eight or nine cycles of operation for a total of about 200 days.

Dr. Arai gave a more detailed view of the specific damage suffered by the Materials and Life Science Facility after the disastrous earthquake. Fortunately, an 8 m height bank protected J-PARC from the Tsunami. Remarkably, neutrons could be produced already on December 22. The comparison between neutron intensity versus energy before and after the Earthquake confirms that all components from moderator to the beam line are working properly. The user program will resume in February- March. At the end of the talk Dr. Arai outlined a new cooperation scheme, which will allow the MLF neutron program to be partially supported by a new institution (CROSS) created and funded under legislation with the goal to promote the use of facilities.

Prof. Miyake specifically overviewed the damage and repair work of J-PARC MUSE after March 2011. Overall, the damage was judged not too serious. The repair work was very effective and successful so that the muon user operation has already resumed. MuSAC congratulates all the teams involved for this great achievement.

The rotating target system that will be necessary when the power is increased to 1 MW and will replace the present fixed edge-cooling graphite target, which performed well at 200 kW, has been fabricated. It will be commissioned in the summer of 2012 and installed one year later. Prof. Miyake summarized the development work at the various muon beam lines, which in spite of the halt imposed by the disaster of March 2011 showed important advancements. The kicker device that

will enable the simultaneous operation of the D1 and D2 legs of the D-line has been installed and first tests performed.

Essential progress was reported concerning the ultra slow muon beam line (U-line), a dedicated beam line designed to produce ultra slow muons in the eV to keV range with high intensity and luminosity. The part of the beam line delivering the surface muons is scheduled to be fabricated and installed by September, so that commissioning toward end of the year should be possible.

In parallel, progress is registered concerning the ultra slow muon set up (e.g. moderator chamber) and laser, where installation work for infrastructure (laser cabin, pathways,..) is under way.

The committee was very pleased to hear that an important grant-in-aid to explore frontier of materials, life and elementary particle science by the ultra slow muon microscope was awarded to a collaboration of universities led by Prof. E. Torikai.

For the S-line, where the front end quadrupole and bending magnet have been previously installed, the next set of quadrupoles is planned to be installed in summer 2012. Various projects have been submitted to IMSS concerning the H-line where progress in design has been reported. Installation of the front end is scheduled before the radiation level around the target station becomes too high for manual work.

Prof. Kadono overviewed the Inter-University Research program. The committee considered the results in light of the Great East-Japan Earthquake that occurred on March 11, 2011, just three weeks following the February 18-19, 2011 MuSAC meeting. This tragic event greatly hindered the productivity of all Inter-University Research Program members this past year. With this in mind, it was a great surprise to see a strong representation of this program two months later at the 12th International Conference for Muon Spin Rotation, Relaxation and Resonance in Cancun, Mexico, May 16 to 20, 2011. Scientific results from the Inter-University Research Program were prominently featured throughout the conference. Needless to say, MuSAC was impressed to see that a number of significant μSR studies have recently been completed by members of this program. Overseas projects included investigations of thin films of the magnetic-rare-earth-free T'-phase material $La_{2-x}Y_xCuO_4$, and the rare occurrence of superconductivity in a compound, (Cu, Zn)Ir_2S_4, with a spinel structure. These works are aimed at addressing open questions concerning the microscopic mechanism of superconductivity and the role of spin fluctuations, and the experimental information obtained on these interesting systems sheds further light on both these issues. Some recent results from μSR experiments at J-PARC MUSE and RIKEN-RAL were also presented to MuSAC. This includes an opportune search for a recently predicted time-reversal-symmetry breaking pairing state in an iron-based superconductor, and Li diffusion in a solid electrolyte with applications to the fabrication of an all solid-state Li-ion battery. These are highly relevant experimental studies that directly address important questions posed by the broader research community. MuSAC therefore supports further research of this kind, and continued use of the various unique resources at the different μSR facilities.

II. MUSE Facility

Muon Production Target:

The status about the current fixed muon target and the development of a rotating muon target were reported in a presentation by Mr. S. Makimura and Mr. Y. Kobayashi.

MuSAC was pleased to learn that the damage suffered by the current target during the big earthquake was negligibly small with a displacement of less than 0.2 mm compared to a mock-up and a spare target. The remote control system necessary for target transport and replacement performed also very well before and after the earthquake.

For a stable long term operation of the target under the high proton irradiation at 1MW, the development of a rotating muon target is mandatory and in progress. Durability tests under realistic heating and rotating conditions with a mock-up target have been performed. The expected lifetime, essentially determined by the bearings, is 10 years. After detailed commissioning studies it is planed to install the final version of the rotating target in summer 2013. The importance to work out a scenario for disposal of the radioactive parts and to define a disposal area was stressed at the end of the talk. MuSAC was impressed by the high level of engineering of the small team involved in this important project.

The Super Omega Project:

The Super Omega project is a key component in J-PARC's MUSE to deliver the world's most intense muon beam, capturing and transporting, simultaneously, both μ^+ and μ^-. The primary goal of Super Omega is to deliver intense ultra slow muons in the energy range 0.3eV to 30keV. At MuSAC Dr. Y. Ikedo (KEK) gave an update on the status of the Super-Omega Muon beam line.

Super-Omega consists of three solenoidal components: a normal conducting capture solenoid, and superconducting curved transport and axial focusing solenoids, giving a total length of 18 m. Whilst the normal conducting capture solenoids were installed three years ago, the curved superconducting transport solenoid has been now constructed by Toshiba and has been successfully tested in January 2012, carrying an applied current of 83 A. The superconducting axial focusing solenoid is currently under construction. Beam transport simulations in the latter component indicate that almost all positrons can be eliminated from the beam by the third separator. Finally simulation of the final focusing predicts that at 2×10^8 μ^+/s will be incident at the sample position 1 MW intensity.

It is planned that Super Omega will be fully installed in summer 2012, and that commissioning and first beam extraction will follow shortly after in October 2012.

MuSAC commended the Super Omega team on their progress and achievements. Installation and detailed commissioning of Super Omega are key steps towards the production of world leading ultraslow muon beams.

The Ultra Slow Muon Beam line:

Mr. J. Nakamura and Dr. T. Nagatomo reported progress on the construction of other key components of the Ultra Slow Muon beam line. Specifically, a detailed status report of the laser beam development and related facilities was given, a central component for the realization of the Ultra Slow Muon Microprobe technique. This new unique experimental tool requires a small beam radius (~ mm^2), a small energy spread (~ 2 eV) and a short duration time (~ 8 ns). The beam quality is crucially determined by the initial stage of acceleration of the muons obtained by laser ionization of Muonium. MuSAC was pleased to see that the design of the beam line including SOA lens has been very carefully examined by using various simulations codes such as OPERA, musrSim, etc. MuSAC is also aware that the specification and performance of a pulsed HV Power Supply will be crucial and still needs to be investigated.

D1/D2 Beam Line Upgrade:

In the last fiscal year a beam kicker and septum magnet were installed in the D-line to separate the double-pulse structure of the muon beam, and deliver single-pulsed muon beams to each of the D1 and D2 legs. In its previous report, MuSAC acknowledged the importance of this upgrade for optimizing the efficiency of the D-line. Recently the kicker system has been successfully demonstrated to separate the double-pulsed muon beam, without reducing the beam transmission rate efficiency. The muon-decay signal measured in the D1 experimental area for the single-pulsed beam, however, has a high noise level compared to the double-pulsed beam signal recorded with the kicker off. While some effort must be devoted to reducing the kicker noise before it can be used for experiments, there is a high probability that the source of the problem has already been identified and that it will be fixed in the current cycle.

The current optimization and utilization of the D-line was discussed by the committee at some length. It was somewhat disappointing to hear that it was necessary to remove the beam slicer that has been in operation on the D1 leg since 2009, because of space restrictions. The beam slicer improves the timing resolution, permitting transverse-field μSR experiments at higher magnetic field and the capability to resolve the contribution of faster relaxation phenomena to the mSR signal. The beam slicer will instead be employed on the S-line.

At present, only the D1 leg is being used for experiments. As mentioned in the last MuSAC report, the D1 experimental area is greatly hampered by the lack of appropriate detectors and severe limitations on sample environment imposed by the existing equipment. The committee understands that outfitting the D1 beam line with a suitable modern spectrometer first requires successful development of a detector that integrates semiconductor-based multi pixel photon counters (MPPC). While the D-line at J-PARC MUSE accommodates the world's most intense pulsed muon beam, the existing DΩ1 spectrometer in the D1 experimental area cannot handle such high intensity. Incorporating MPPC technology into a new μSR spectrometer is necessary to overcome

this limitation, and this challenge must be met before the experimental capabilities of the D-line can be significantly improved. MuSAC was pleased to hear that much progress has been made on this front, and that critical testing of a 32 channel MPPC prototype detector will be taking place in the months ahead.

μSR Spectrometer Upgrade:

Dr. K.M Kojima gave an interesting and informative presentation on the μSR Spectrometer upgrade. It was noted that J-PARC/MUSE already delivers the world's most intense muon beam (equivalent to 2-3 times that of RIKEN/RAL) but that data acquisition rates remain limited by the solid angle of the DΩ1 spectrometer's detector. Moreover the existing individual detectors elements of DΩ1 are too large leading to dead time problems. The goal is therefore to provide smaller detector elements over a larger solid angle, approaching 25% coverage. This will be achieved by adding up to 1024 Avalanched Photo Diode-based detectors.

This new detector technology has been prototyped and tested at RAL in 2011 and has been found to be stable and operate successfully under high magnetic fields. The detector elements are relatively inexpensive, (~$30 per unit) and a thousand units with control systems will cost approximately ¼ that of PMT-NIM-VME systems.

MuSAC welcomed the development of these new detector systems and recognized that these low cost high performance units will represent a major saving and technological advantage for the development and construction of further advanced μSR spectrometers at MUSE.

S Beam line:

The committee was pleased to hear that the front end components of the S line are ready to be installed into the M2-tunnel during the shutdown between June and September 2012. Dr. P. Strasser presented a detailed development plan of this line, which in its final shape will consist of four experimental areas (S1, S2, S3 and S4) operated by switchyard magnets and two spin rotators in the S2 and S4 areas. Detailed beam optics and optimization calculations have been performed for the S1 line but similar work remains to be done for the other three beam lines.

An interesting delivery mode concept to optimize the beam time usage in all four experimental areas was presented showing that the location of instruments in specific area can lead to optimum use of the single or double-pulsed beams. For instance in the S3 and S4 areas Dr. Strasser suggested the installation of a beam slicer or of a spectrometer able to utilize both pulses, such as an instrument with a π/2-RF pulse option or an instrument for integral measurements. MuSAC was impressed by results showing the high time-resolution, which have been achieved with a π/2 -RF pulse at KEK-BOOM. Spin precession at 200 MHz was successfully observed with muons stopped in MgB_2. This is well in excess of the time resolution limit of the pulsed beam (about 10 MHz) and opens the way to vortex state studies of superconductors.

Strategies for the S-line construction were shown with one beam line in Phase 0, Phase 1 with two beam lines (S1 and S2), and Phase 2 with all the four beam lines. Phase 0 will be realized in short term. On the longer term, Phase 2 will be the most attractive. It will broadens the μSR community by providing a wide option of instruments with unique extreme conditions. However, in the current year in accordance with the general guide lines already expressed, MuSAC recommends concentrating on Phase 0. It involves one beam line to possibly accommodate the new JAEA spectrometer with a beam slicer or a π/2-RF pulse device to optimize the characteristics of the beam. MuSAC recommends the longer term plan for the S-line to be realized when the KEK executives will come up with practical means to increase the staff to a sufficient level to build and operate the four beam lines and the corresponding instruments and sample environment.

H Beam line:

Dr. N. Kawamura presented a status report on the development of the H beam line. The initial potential users have now converged to a design of the front end part of the channel that could provide a versatile high flux of positive and negative muons with variable momenta from 30 MeV/c to 120 MeV/c. Thanks to initial support from KEK and J-PARC, some of the front end components are now under fabrication. The front end devices include: HS1 -a radiation hard large acceptance capture solenoid-, a beam blocker system, HB1- a radiation hard bending magnet- and HGV1- an all metal gate valve-, plus several pillow seals for the vacuum connections.

Due to the movement of the floor of the MLF building after the large earthquake of March 11, some of the precision alignment plates that were installed initially cannot be relied upon as such and must be resurveyed, a task which will involve some dose exposure to personnel. MuSAC is on record in recommending doing this installation work as soon as possible and this advice remains valid.

All the front end components need to be installed as soon as possible but certainly before the end of the summer 2012 shutdown as the radiation levels that will be experienced in the summer 2013 long shutdown will not allow any hands on activities anymore after running 10-12 cycles of high intensity user beam as is currently planned for FY2012 and FY2013. Optimization of the rest of the beam line beyond the tunnel shielding and setting of the accessory facilities for each experiment do not depend strongly on the front end part. The scientific decisions regarding the initial suite of experiments to be performed have not been taken at the PAC level yet. Hence the focus of this year's activity should be the completion and installation of the front end elements followed by an initial commissioning of the H beam line to confirm the proper operation of the line and its effect on the proton beam transport.

III. Research Projects Review

ASRC(JAEA)-KEK Project:

Dr. W. Higemoto reviewed his leading JAEA-ASRC μSR project entitled "Microscopic study of novel properties of *f*-electron systems by means of μSR", which started in 2009 with the focus on the study of (i) competing ground states in the vicinity of quantum critical points (ii) higher-order multipole ordering in *f*-electron compounds, and (iii) the symmetry of superconducting order parameters. The recent research activities of the project have been directed toward the study on how to identify the higher-order multipole ordering in *f*-electron compounds. The research group performed muon-spin-relaxation measurements on the cubic compounds SmX3 (X = In, Sn, and Pb) and SmT_2Al_{20} (T = Ti, V, Cr), and found that static spontaneous internal fields develop in their unknown low-temperature phases. This provides the first clear evidence that the primary ordering elements for these systems are not pure quadrupoles but magnetic dipoles or octupoles. As an alternative case, they have also shown the absence of internal fields in an ordered state of $PrIr_2Zn_{20}$ below 0.1 K, supporting a quadrupole ordering scenario. The results have effectively demonstrated the usefulness of μSR experimental techniques for characterizing the higher-order multipole ordering. It should be noted that the compounds chosen for investigations contain Sm and Ir, which are good neutron absorbers. Together with other interesting results on $CeOs_4Sb$, DyB_6, YbPtSb etc., a number of research papers have been published in connection with this project. MuSAC acknowledges that the project has been going on very successfully.

IV. Research Projects (S-Type Proposals)

Muonium hyperfine parameter:

Muonium as a pure leptonic system is well suited for QED tests, determination of fundamental muon properties such as mass (m_μ/m_e) and magnetic moment (μ_μ/μ_p) and search for violation of CPT and Lorentz invariance. Moreover, there is a relationship between different precision experiments, for instance μ_μ/μ_p enters into the determination of the muon magnetic anomaly.
This project aims at a very precise spectroscopy for the hyperfine structure of Muonium in the ground state. Muons will be stopped in a Kr gas target where Muonium forms and where transition between different eigenstates will be induced by microwave radiation. The precision of the previous similar experiment by Liu *et al*. was limited by statistics. It is expected that one order of magnitude improvement can be obtained by using the high intensity muon beam from the H line of J-PARC-MUSE and by optimizing the experimental setup and components to reduce systematic errors.

The design of the apparatus (magnet, cavity), detector system and the beam line (H line) are under way. A GEANT simulation should be able to better quantify the reduction of systematic error,

which can be achieved in the present experiment. Pending this simulation 2nd stage submission of the proposal has been deferred. MuSAC recognizes that this project should be realized at J-PARC. The committee support further efforts to get the funding necessary to realize the experiment and strongly encourages working out synergies with the other potential users of the H-line.

μN-eN rare process:

The committee heard a progress report by Prof. Aoki on the DeeMe proposal aiming to improve the search of the lepton flavor violating μ+Z -> e+Z decay.

The group has worked with other potential users of the H line to come up with a compatible configuration which would be versatile and could also accommodate a wide class of experiments including ultra slow muons for g–2 and surface muon for an Hyperfine muonium experiment. The IMSS PAC has given stage 1 approval. This latest approval has triggered the funding of the front end elements of the H beam line which is a critical path item and a final decision on the configuration of the H line front end was made which allows for the installation of the front end components during the upcoming shutdown (2012). These elements are under construction while the kicker magnets and spectrometer magnet are still under conceptual design.

Further tests of the proton beam extinction between bursts were delayed due to the earthquake and should resume soon. The IPNS PAC has not given its stage 1 approval yet pending results from these tests and R/D results on the detection scheme. Cost estimates for the experimental apparatus are being firmed up and have led to a grant in aid of research submission.

A SiC production target is preferred for DeeMe and is being considered for one of the rotating wheels on the new production target assembly.

The schedule as presented is overly optimistic and it is not clear how this program will interfere with the COMET effort in view of the large overlap of personnel between the two proposals.

MuSAC recommends that KEK work with the potential users of the H-line to insure installation of the elements positioned in the Proton tunnel in the 2012 shutdown. Potential users should be asked to contribute installation effort to make sure it is done on time.

Muon anomalous g-factor:

MuSAC heard an update from Prof. N. Saito on the R and D being done towards a new muon g–2/EDM measurement proposed for the H beam line. The experiment has just received stage 1 approval from both the J-PARC IPNS PAC and from the IMSS PAC (as a S-type proposal).

The goal of the experiment is to determine the muon anomalous magnetic moment to a statistical precision of .1ppm. The novel approach proposed by a KEK/RIKEN has attracted a large international collaboration of about 92 researchers and should be able to confirm or disprove

the current discrepancy between the BNL experiment and the standard model prediction in a systematically independent way. A new determination of the electric dipole moment of the muon can be made at the level of 10^{-21} e cm or better with the same apparatus.

Many challenges have to be met. The experiment requires 10^6 ultra slow muon (USM) per second with a reduced transverse momentum to less than 10^{-5} $\Delta p/p$, a muon accelerator to 300 MeV/c and injection in a high precision solenoid magnet ($\Delta B/B < .3$ppm). All aspects are under development and made some considerable progress despite the slowdown due to the earthquake of March 11. A dedicated experiment at TRIUMF is studying the room temperature production of muonium in various target, focusing on aerogel for the time being. New data taken in 2011 showed that release from existing aerogels but at a rate which is below expectation by one order of magnitude compared to that of silica powder. Optimization of the release is ongoing to improve that rate. The laser test scheduled last March at the RIKEN-RAL facility was delayed but is now scheduled for March 2012 while work is continuing on a improved laser which could give two orders of magnitude improvement of the muonium ionization.

The design of the muon accelerator has now been changed to minimize cost and a new IH linac is considered. Specifications for the NMR magnet are being transformed into possible configuration designs and evaluated. A prototype of such an NMR magnet could be used by the Muonium hyperfine proposal.

MuSAC congratulates the g–2 team for its strong R and D effort and for engaging a strong international group of collaborators.

Over the longer term, a significant amount of resources will be required to mount the g-2 experiment - including an extension to the MLF building. The time scale envisaged for start of data taking is FY2016. A possible difficulty resides in the ownership of the H1 beam line (by IMSS) and the associated operational funding commitment for the beam line and muon production target. A mechanism (formal MOU) must be put in place to accommodate long term users from other divisions – like IPNS- or other institutes.

Muon-microscope:

Prof. E. Torikai presented an interesting and comprehensive overview of the muon-microscope at the ultra slow muon beam line. It is proposed that micro beam focusing will be achieved by the reacceleration of the ultra slow muons, leading to a reduction of beam size without any significant reduction of intensity.

Very positively received was the news that a grant-in-aid for scientific research in innovative area (KAKENHI (Shin-Gakujutu-sosei)) organized by Prof. E. Torikai has been allocated. The idea of producing ultra-slow muons has been pursued and developed in Japan over the past 20 years and the establishment of this technique at J-PARC is expected by the Japanese and worldwide muon community.

In the first part of the presentation the road map was summarized, which, though presenting challenging milestones, appears to the committee well defined. MuSAC was pleased to hear that important elements of the ultra-slow muon set up may be installed before the end of 2012.

In the second part of the talk the scientific program was overviewed.

Prof. Torikai proposed a number of ambitious scientific experiments to be realized in the forthcoming year. Examples include study of spin transport and ion diffusion across interfaces, investigation of interface states in heterostructures and extend to applications in catalytic chemistry and in life sciences such as studies of electron transport and transfer in DNA. Finally, it was mentioned how the ultra slow muon beam can be exploited in the novel g–2 experiment, previously discussed.

MuSAC is extremely supportive of the overall program, and rates it at a very high priority. Depending on the progress in the commissioning of Super Omega, which will start in FY2012, a more detailed schedule of the various tests and experiments at the ultra slow muon setup should be worked out for the coming years.