KEK/J-PARC-PAC 2010-20
January 16, 2011

J-PARC Program Advisory Committee

for the

Nuclear and Particle Physics Experiments at the J-PARC 50 GeV Proton Synchrotron

Minutes of the 11th meeting held on
Friday, Saturday and Sunday, 14-16 January 2011

OPEN SESSION (14,15-January-2011):

1. Welcome, Mandate of this meeting: K. Nishikawa (KEK)
2. Status of Hadron Beam lines: K.H. Tanaka (KEK)
3. E19 Status Report （High-resolution Search for Θ^+ Pentaquark in $\pi^- p \rightarrow K^- X$ Reactions): M. Naruki (KEK)
4. E11(T2K) Report : D. Wark (ICL/RAL)
5. E14(KOTO) Status Report : T. Yamanaka (Osaka)
6. J-PARC Status: S. Nagamiya (J-PARC)
7. J-PARC Accelerator Status and Commissioning Plan: T. Koseki (KEK)
8. P41 Presentation （Proposal of an Experimental Search for mu-e Conversion in Nuclear Field at Sensitivity of 10^{-14} with Pulsed Proton Beam from RCS）: A. Aoki (Osaka)
9. Updates on MLF muon beam lines: Y. Miyake(KEK)
10. E18 Presentation (Coincidence Measurement of the Weak Decay of $^{12}_{\Lambda}C$ and the three-body weak interaction process): H. Bhang (SNU)
11. E17 Status Report (Precision spectroscopy of Kaonic ^{3}He 3d→2p X-rays): R.S. Hayano (Tokyo)

12. E15 Presentation (A Search for deeply-bound kaonic nuclear states by in-flight ^{3}He(K^{-}, n) reaction) (update): M. Iwasaki (RIKEN)

13. Plan on SKS experiments (K1.8 beam line): T.Takahashi (KEK)

14. P36 Presentation (Measurement of $\Gamma(K\rightarrow e\nu)/\Gamma(K\rightarrow\mu\nu)$ and Search for heavy sterile neutrinos using the TREK detector system): S. Shimizu (Osaka)

15. P40 Presentation (Measurement of the cross sections of Σp scatterings):
K. Miwa (Tohoku)

16. Report from Muon Task Force: S. Mihara (KEK)

17. E21(COMET) status: Y. Kuno (Osaka)

18. P34 Status Report (A New Measurement of the Muon Anomalous Magnetic Moment *g*-2 and Electric Dipole Moment at J-PARC):
N. Saito (KEK)

CLOSED SESSION(14,15,16-January-2011):

Present: A. Gal, M. Gross-Perdekamp, M. Ieiri(Secretary), T. Kishimoto, K. Kleinknecht, T. Kobayashi (Secretary), T. Komatsubara (Secretary), S. Kumano, T. Mori, T. Nagae, Y. Nagai, S.Nagamiya (J-PARC Center Director)*, S. N. Nakamura, K.Nishikawa (IPNS Director), N.Saito (Secretary), M. Shaevitz, S. Shimoura*, R.Tschirhart, K.Tokushuku (Chairperson), H.Yamamoto

*) Part of the time

1. PROCEDURE

The minutes of the tenth J-PARC-PAC meeting (KEK/J-PARC-PAC 2010-10) were approved.

2. REPORT FROM THE IPNS DIRECTOR

K. Nishikawa reported the budget situation at KEK. The budget for JFY2011 was proposed by the government and will be discussed in the Diet. The total KEK budget is 294 Oku-yen (29.4 billion yen) and the J-PARC part is 66 Oku-yen, which is 2 Oku-yen less than the JFY2010 budget. In addition, 5.4 Oku-yen is assigned for construction of

muon beam lines. Under these budget constraints, J-PARC will make every effort to have 9 month beam time in JFY2011 with more than 24 days of operation per month.

The main ring (MR) operation in the October-December period of 2010 was successful. In October and November, the E19 experiment had their first physics run. The spill structure for the slow extraction was improved and the spill duty factor was about 16%. In the December run, the MR was stably operated for fast extraction with 114kW beam power. Total accumulated proton on the neutrino target reached 7.3×10^{19}. The machine efficiency was improved to 73% as compared to 45% in spring 2010.

In response to the previous PAC recommendation with respect to developing a long term run plan, two task forces have been set up. The first is a task force for higher power operation and is a joint group of the IPNS and the Accelerator laboratory of KEK. This group discusses the milestones for increasing the number of protons per bunch and the repetition rate. Several sub-working groups have been formed on the critical issues including beam dynamics, new power supplies for the MR magnets, the RF cavities and consolidation of the current components. Another task force is to focus improvements in the slow extraction. In the short term, this task force will examine the data obtained in 2010 and make a plan to increase the beam power and improve the duty factor. For the design of the new power supplies for the MR magnets, requirements on both the ripple and high repetition operation need to be met.

There are several boundary conditions in the scheduling of the beam time for the first half of the 2011 runs. The slow-extracted beam time has been assigned to the April run since the replacement of a broken damping resistor will not be ready before and since the longer cool down period is favorable for the work during the summer shutdown. The power for the fast extraction is limited to 115kW at the moment by radiation losses at injection, which is caused by the field instability of the kicker magnets. Improvements will be needed for higher power operation.

For this PAC meeting, two new proposals (P40 and P41) and the update of P34 were received. In addition, the E18 experiment is requesting stage-2 approval.

Experiment updates and a new staging strategy for E15 and E17 were proposed. A running plan of the experiments in the K1.8 beam line was also proposed. The PAC was requested to recommend a realistic plan for carrying out the experiments in the K1.8 and K1.8BR lines, which cannot operate simultaneously.

In addition to these assessments, the PAC was also asked to evaluate the progress in the approved experiments (T2K, KOTO) and the progress on the COMET experiment and the (g-2) experiment initiative. The status report of the neutron EDM experiment (P33) will be presented in the next PAC meeting after R&D work is finished.

The PAC took note of these requests and made them part of the discussions and deliberations.

3. REPORT ON THE BEAM LINE STATUS

K.H. Tanaka reported on the status of the beam lines in the hadron hall. The K1.8/K1.8BR and K0 lines are operational. The K1.1BR beam line was constructed in the summer and was commissioned and tuned in October. For the 800MeV/c beam, a π/K ratio of 1.14 was achieved with the voltage of the electrostatic separator at ±300kV.
Target options for the secondary beam include a 60mm long platinum target or a 54mm thick nickel target. These targets will survive up to 5kW beam power. A new thicker platinum target has been designed and will be ready soon. It is indirectly water cooled. It can stop 50% of the primary beam and be operated up to around 30kW. The intensity of the secondary beam is expected to increase at least by a factor 2 compared to the current Ni target. For the higher power period, a water-cooled Ni target will be used as in the original design.
Discussions and meetings between the slow-extraction users and the accelerator group have started in the task force for the slow extraction (mentioned in Section2) and should help in developing a coherent plan for the slow-spill physics program.
The PAC congratulates the beam line group for their success in the construction of the beam lines and their work to improve performance.

4. REPORT ON THE J-PARC ACCELERATORS

T. Koseki reported on the status of the accelerators.
Beam power of the rapid cycling synchrotron (RCS) in June 2010 was up to 120kW. In the summer shutdown, the charge exchange foil at the injection point was replaced by a smaller one, which resulted in the particle loss downstream being reduced by 50%. In the autumn runs, pattern operation of the sextupoles and compensation of the beam loading with a feed forward mechanism were activated. With these improvements and further optimization of the various machine parameters, 200kW stable beam operation started December 2010. Beam tuning aimed at higher power operation up to 400kW was also performed. An increase of the beam loss in the arc sections was observed and the mechanism of these losses needs to be understood with further studies.
For the MR improvement, a new kicker system for fast extraction was installed in the summer shutdown. The rise time of the magnet field is now less than 1.1μs. By installing damping resistors in the kicker magnet and a water cooling system, the beam

angle drift due to heat generated from the wake field was reduced and the system is now expected to be able to handle up to 750kW beam.

An additional shield was installed in the 3-50BT collimator area, which increased the beam loss capacity from 0.45kW to 2kW.

Various improvements of the power supplies were also made. The energy recovery condensers were adjusted to handle higher beam repetition rates. The cycle time of the fast extraction was shortened from 3.52 to 3.20 seconds and the flat top time for the slow extraction was elongated from 2.63 to 2.93 seconds. Trap filters for 300/600Hz noise have also been installed.

With these improvements, stable operation of the fast extraction with 115kW beam power was successfully achieved in December 2010. The extracted beam is 7.7×10^{13} protons per cycle, which is a world record intensity for a synchrotron. The total beam loss was about 150W and is mostly located at the collimators during injection. The particle loss during acceleration was found to be less than 0.1%.

For the higher beam power above 120kW, the beam loss during injection needs to be reduced. The main beam loss now comes from effects of the injection kicker. Due to the electrical reflections in the kicker's pulse circuits, the circulating bunch gets an extra kick when new bunches are injected. To solve this, better impedance matching is under study and installation of waveform correction circuits is also being considered. These problems need to be solved with high priority in order to achieve 150kW operation and provide the T2K experiment with the $150\text{kW}\times10^{7}$sec luminosity goal before summer 2011.

The problem of the sudden decrease of the impedance of the RF cavity, reported in the previous PAC meeting, has been investigated. The RF cavity was opened and its metal-alloy (MA) cores examined. At the cut surface of the cores, copper corrosion was observed, which deteriorated the electric insulation. Since the cooling water is common for the magnets and the cavities, copper ions produced in the magnet circuit can be transported to the cavities. To solve this problem, these two water-cooling systems will be separated in the summer 2011. In addition, the sealing of the cut surfaces of the MA cores is being considered.

There were also many improvements on the slow extraction. Beam loss near the extraction kickers has been much improved by the adoption of dynamic bump. The extraction efficiency has reached 99.5%, which is the design value. The spill structure was also much improved by using a short circuit for the trim coils on the quadruple magnets. Trim coils will also be added to the dipole magnets in summer 2011 for the further improvement. Another improvement is associated with the beam extraction with

the transverse RF field using horizontal exciter. The spill duty factor was improved to 29.9%. With these improvements, stable 3kW operation was performed and trials for 9.9kW operation were made in the autumn run.

Based on these successful improvements, future plans and milestones have been set. For the fast extraction, the short term goal is to provide 150kW×10^7 sec to the T2K experiment by the summer 2011 and the medium term goal is to provide 1MW×10^7 sec by the summer 2014. In the longer term, MW-scale operation will need to be established in order to keep T2K at the forefront in neutrino-oscillation sensitivity. Three essential improvements need to be made in order to meet these goals: 1) increase of the beam loss capacity of the collimator, 2) increase of the number of particles per bunch and 3) increase of the repetition rate.

In summer 2011, the shield for the ring collimator will be enhanced. Adoption of second harmonic cavities will be used to reduce the space charge effects. The installation of the 400MeV linac will improve the beam emittance. Improvements of the RF cavities and replacement of the power supplies of the MR magnets is essential in order to increase the repetition rate. The expected power is 250kW in 2011 increasing to 350-400kW in 2014. The midterm requirement for T2K can nearly be achieved in this optimistic scenario assuming a long shut down in 2012 for the installation of 400MeV linac and a 2 to 1 ratio for the fast and slow extraction beam time.

For the slow extraction, since the extraction efficiency is already optimal, reducing the radiation activation is a key issue. Replacement of the existing beam pipe to titanium beam pipe in high-radiation areas and adding additional collimators at the downstream end of the electrostatic septum are planned for the future. The improvement of the spill structure is foreseen to be accomplished by the increase of the power on the transverse RF system and continuous improvements on the RQ's, trim coils and active ripple cancellers. It is hard to estimate how much the spill structure will be improved, but in an optimistic scenario, a 50% duty factor seems possible. In order to improve the spill structure ultimately, the replacement of the power supplies for the magnets will be necessary.

The PAC was very impressed with the improvements both in fast and slow extracted beam. Long term operation above 100kW for the neutrino experiment and the achievement of 99.5% slow extraction efficiency are great steps toward the higher power operation. The PAC congratulates the J-PARC accelerator crew and management for these achievements. The PAC took note of the midterm (before JFY2014) estimates/goals presented for the fast and slow extraction beam power and

slow spill duty factor. These estimates will help in planning the schedule for the experiments. In this area, the PAC has the following comments:

- The PAC fully supports the milestones for achieving high power operation in 2014. The PAC encourages the J-PARC accelerator group and IPNS to support and monitor these milestones. On the other hand, the plan shows that the fast extraction beam power in 2014 is slightly below the 500kW level required for the midterm goal. For the long term, it appears necessary to replace the power supplies of the MR magnets in order to ultimately solve the spill structure problem and to go to higher power by increasing the repetition rate. The PAC also encourages the Lab to initiate R&D work for the new power supplies and to start on a financial plan for this important replacement. This will need to be accomplished while keeping the planned improvements on the current system.

- The PAC understands that the present obstacle for higher-power, fast-extraction operation is in the injection kicker in the MR. In order to provide 150kW×10^7 sec integrated power to the T2K experiment by summer 2011, this problem needs to be solved. The PAC endorses the importance of near term tests with higher intensity to identify other possible obstacles for the future higher-power operation.

- The PAC requests information on the quantitative improvement of MR power expected from installing the 400MeV linac.

- The long shut down planned in 2012 for the installation of the 400MeV linac will have a large impact on the physics output from the experiments in the MR. Every effort to minimize the no-beam period is encouraged.

5. REPORT FROM THE J-PARC PROJECT DIRECTOR

The J-PARC Center Director S. Nagamiya presented the status of J-PARC. The year 2010 was a successful year. The MR was operated steadily above 100kW for fast extraction and the RCS was steadily 200 kW. The availability of the 3 GeV RCS beam was above 90% since December 2009. A 99.5% operation was successfully achieved for a slow extraction at MR.

Neutron, muon, hadron and neutrino beam lines in the RCS and MR were operational and many experiments are now in progress. The first neutrinos from J-PARC were observed in the SK-II detector on February 24, 2010.

The construction of the 400MeV linac is in progress. It will be ready for installation in summer 2012.
The JFY2011 operational budget for KEK is 66.2 Oku-yen and that for JAEA is 76.7 Oku-yen. An additional 7.2 Oku-yen is funded for a new organization, which will be available for neutron facility operations. The total construction budget is 46.4 Oku-yen, part of which is from the supplemental budget of JFY2010. The construction funding for JAEA is for the new neutron lines, the 400MeV linac, and new elements in the linac and RCS, 3 GeV new elements. The ultra slow muon beam line is funded for KEK.
The Ibaraki Quantum Beam Research Center has been set up just outside the J-PARC site. The user's office, meeting rooms and offices for users are located in this center. On average, more than 100 users stay in the J-PARC area and a new dormitory with 49 rooms will be operational starting in mid-January. There is a plan to create a new entrance gate and a connecting road near the MR area. By separating the J-PARC user area from the atomic energy research area of JAEA, easier access and more relaxed regulations can be implemented for J-PARC user.
The mayor of the Tokai-village visited RAL and CERN. Meetings with the local governments (Gex in France and Geneva in Switzerland) were also held. Tokai-village is now planning to set up a Center-of-Excellence in atomic energy as a way to strengthen support for international users.

The PAC congratulates the J-PARC center for the successful operation of all the facilities.

6. EVALUATIONS OF THE PROPOSALS AND STATUS OF THE ONGOING EXPERIMENTS

1. **E19:** (High-resolution Search for Θ^+ Pentaquark in $\pi^- p \rightarrow K^- X$ Reactions)

   The first phase of the experiment was performed with the beam momentum of 1.92GeV/c in October and November. In total, 157 hour beam time was dedicated to the physics run with a liquid hydrogen target. The spill duty factor measured by the experiment during the physics run was 12-16%, which limited the pion intensity to 1.1 M pions per spill. Because of the bad spill structure, 15% of the triggered events had multi-tracks in the upstream beam line chambers. These events are removed for the present analysis.

The liquid hydrogen target was operational without major problems. The spectrometer performance was measured with the $\pi p \rightarrow K\Sigma$ reaction and it was found that the missing mass resolution reached 1.5 MeV at FWHM in the Θ^+ mass region, which is better than the assumptions in the proposal (2.5MeV). The accumulated events correspond to the sensitivity of 0.3μb/str. In the preliminary analysis, no apparent resonance structure is observed.

The E19 experiment requested further beam time in April with a higher beam momentum (2GeV/c). In the autumn run, 14 days of beam time is requested to achieve the planned sensitivity of 75nb/str.

The PAC was impressed by the rapid analysis of this experimental data, which is the first physics results from the hadron hall, and congratulates the E19 group for their successful data taking.

2. **P36:** (Measurement of $\Gamma(K \rightarrow e\nu)/ \Gamma(K \rightarrow \mu\nu)$ and Search for heavy sterile neutrinos using the TREK detector system)

The P36 collaboration is proposing to pursue two important measurements with an evolution of the KEK E246 apparatus in the K1.1-BR beam line.

1) Measurement of $R=\Gamma(K^+ \rightarrow e^+\nu(\gamma))/\Gamma(K^+ \rightarrow \mu^+\nu(\gamma))$ with a precision of $\delta R/R < 0.2\%$.

2) Search for sterile heavy neutrinos (N) through a high sensitivity measurement of $K^+ \rightarrow \mu^+ N$.

The R measurement and heavy neutrino search are sensitive to new physics beyond the Standard Model and have long been pursued by previous experiments.

The addendum to the proposal P36 presented to the PAC addresses the questions described in the minutes of the 10th PAC meeting. The evaluation of the systematic uncertainties for the measurement of R is now sufficiently detailed to serve as a basis for a recommendation by the PAC. The sensitivity of P36 can plausibly reach beyond the present results from NA62 and KLOE. The PAC also acknowledges the excellent progress made by the proponents with the tuning of the K1.1BR beam line, understanding of the beam characteristics, and initial studies of a prototype aerogel Cherenkov counter.

The PAC supports the strategy of advancing P36 before TREK (E06) and **is pleased to recommend stage-1 approval for the P36 program based on the scientific**

merit. The PAC however does not at this time endorse the schedule outlined by the proponents. Execution of the R&D program must advance before the proposed P36 schedule can be reviewed. In preparation for this future review the PAC requests that a detailed plan of collaboration responsibilities for the construction of the necessary detector components be developed.

3. **P40:** (Measurement of the cross sections of Σp scatterings)

The proposed experiment aims to greatly improve the statistics of the Σp scattering data with about 10,000 scattering events for each channel, Σ^-p and Σ^+p elastic scattering and $\Sigma^-p \rightarrow \Lambda n$ conversion. It is very important to get baryon-baryon scattering data in order to construct an interaction model in the modern picture of "nuclear force" based on QCD. Considering the recent theoretical success to extract the nuclear potential from lattice QCD simulations, it is timely to obtain such basic scattering data as a solid base for theoretical studies.

However, the proposed detector system does not have acceptance for forward scattering angles, and so it will be difficult to obtain total cross sections. Under such limitations, it is not clear to the PAC how useful the data will be in constraining the interaction models. The proponents are requested to identify the scientific goals of the measurements more concretely. Before stage-1 approval can be granted, the collaboration needs to quantify the ability of the experimental observables to discriminate between different interaction models. Discussions with theoretical experts working on the baryon-baryon interaction based on their most up-to-date models might be helpful. The detector configuration should be optimized to maximize the physics outputs and significance of the new data.

A new tracking detector system with fiber trackers with a MPPC readout system is proposed both for beam and final state event tracking. It is an important effort to develop such detector and readout systems for high-rate environments. The PAC requests a realistic design of the detector system and detailed information with regards to the full specifications of each detector component used in the detector simulations. The PAC is particularly concerned with regards to the energy resolution of the calorimeter surrounding the vertex tracker.

4. **P41:** (An Experimental Search for μ^--e^- Conversion in Nuclear Field at Sensitivity of 10^{-14} with Pulsed Proton Beam from the RCS (The DeeMe Experiment))

The P41 proposal aims to improve the experimental sensitivity of detecting muon-to-electron conversion by one to two orders of magnitude beyond the current measured limit in ~5 years at modest cost. Measurements at this sensitivity level ($\sim 10^{-14}$) would be sensitive to well-studied new physics models such as SUSY. The proponents presented a novel experimental concept based on muonic atoms formed by 3 GeV RCS proton beam traversing a thin (~10% λ_I) silicon-carbide production target in the MUSE facility. The production target is imaged by a narrow-band (~5MeV/c) momentum spectrometer tuned to the μ^--e^- conversion region (100-105 MeV/c) of muonic atoms formed in the target. A beam kicker system fires immediately after the RCS pulse to sweep prompt activity away from the spectrometer. In order to control background sources below the 10^{-14} level the experiment requires an extreme RCS extinction of better than 10^{-17}. They expect the physics run for 2×10^7sec.

The PAC recognizes the scientific merit of timely realization of such measurements but considers the description of the experiment to be largely at the conceptual level. There are several important issues to study before any serious consideration:

(1) Extinction of late protons in the fast extracted beam at 10^{-17} level needs to be shown to be plausible. A clear plan should be made for further measurements and simulation studies to achieve this goal.

(2) Rather limited acceptance and a broadened spectrum of signal electrons by scattering and energy loss in the target make an evaluation of the signal sensitivity difficult. Also it is not clear how the number of the produced muonic atoms within the acceptance can be monitored during the long data taking period. A stronger case should be made that the sensitivity and the backgrounds can be understood.

(3) Replacing the current graphite target with SiC increases the muon capture rate by a factor of 6 and is important for making this measurement competitive. Although SiC is known to have good thermal and radiation resistance, further studies on neutron background and design optimization are needed in consideration of the impacts on other experiments.

(4) As there may be no opportunity for a long dedicated run in the existing heavily subscribed D beam line, the new H beam line which has 10 times larger acceptance would accommodate the experiment better. The construction of the H beam line will strengthen opportunities for the muon physics program at J-PARC and the PAC, therefore, encourages the lab to move towards constructing this beam line.

(5) The background rates and sources of backgrounds should be estimated. In situ

measurements of background rates will be needed in the longer term to quantify the size and effects of these backgrounds on the sensitivity.

The PAC encourages the proponents to continue the R&D studies and the extinction study in particular. It is hoped that these studies should be carried out in a way to maximize synergy with the COMET collaboration.

5. **P34:** (A New Measurement of the Muon Anomalous Magnetic Moment *g*-2 and Electric Dipole Moment at J-PARC)

The PAC heard a progress report from the g-2 collaboration at J-PARC. The collaboration aims to measure the anomalous magnetic moment, a_μ, of the muon with a precision of 0.1 ppm and the electric dipole moment of the muon possibly reaching $d_\mu=1.0\times10^{-22}$ e·cm. The proposed measurement will improve the precision of the previous experiment at BNL, E821, by a factor 5 for a_μ from 0.54 ppm to 0.1 ppm and by more than a factor 100 for d_μ from the E821 limit of $d_\mu<1.9\times10^{-19}$ e·cm.

The collaboration reported significant progress in the development of the new experimental method proposed:

(1) In a beam test at TRIUMF it was demonstrated that high muonium yields can be obtained from a room temperature silica-aerogel target. The distribution of the produced muonium above the target surface was measured as a function of time. Compared to the hot W-targets used at RAL, a room-temperature target leads to colder transverse-muon-beam phase space and higher concentrations of muonium for laser ionization in the vacuum next to the target.

(2) A high power laser system, with 10 times increased power, is being developed for a beam test at RAL. This beam test will be critical in determining if the cold muonium source intensities reached at RAL can be increased to the levels needed for the g-2 experiment. The beam test at RAL is scheduled for March 2011.

(3) An initial design of the linear accelerators used for the re-acceleration of the cold muons has been used to carry out initial beam tracking simulations and has resulted in a first estimate of the longitudinal beam momentum distribution.

(4) Beam injection studies have been carried out based on the first design of the storage magnet and its injection fringe field.

(5) A storage magnet design was developed and was used to study field uniformity and stability, to evaluate the choice of superconductor, and to study seismic stability and quench stability.

(6) A conceptual study of the precision field shimming has been started.

(7) The development of a NMR-based precision field-measurement system has been started and first tests have been carried out in a 3T magnet at the National Institute for Radiological Science.

(8) A conceptual design for a kicker system was developed and the resulting eddy currents and their fields were studied.

(9) A first design of the decay positron detection system including its timing system was developed. Fringe electric fields from the silicon detector in the muon storage area were estimated.

(10) A detailed schedule has been developed.

(11) The g-2 collaboration informed the PAC of their intent to collaborate with the proposed muonium hyperfine-structure experiment at MUSE by taking advantage of synergy in the magnet and hardware development.

The PAC has following comments:

(1) The PAC commends the collaboration on the excellent progress achieved in the development of all aspects of this novel experimental technique.

(2) The PAC continues to recognize the very strong scientific merit of the proposed measurement. LHC has started operation and experiments there may directly identify the physics responsible for any difference between the measured anomalous magnetic moment and its Standard Model expectation. A g-2 measurement with the highest precision could be important in guiding and testing the theoretical interpretation of LHC data. In some cases a new high precision g-2 result could lead to precise constraints on important parameters associated with LHC physics.

(3) In addition the PAC notes that no CP violation has been seen in lepton transitions. Improving the E821 limit of $d\mu<1.9\times10^{-19}$ e·cm by two orders of

magnitude or more in a purely leptonic process may contribute to the understanding of baryo (lepto)-genesis.

(4) The g-2 experiment proposed at FNAL has received stage-I approval on January 14th in 2011. The proposed precision for g-2 of the new FNAL experiment is similar to the precision proposed for the J-PARC experiment. Given the importance of the measurement the PAC recognizes the value of measuring g-2 with independent experimental approaches and independent groups.

(5) The PAC would like to hear the progress on the muonium hyperfine structure experiment at the next PAC meeting. A focus of the discussion should be on the common efforts in hardware development and the expected synergy in these developments.

(6) The PAC intends to continue reviewing the J-PARC g-2 proposal for stage-1 approval. Besides hearing the general progress of the experiment, the PAC has currently identified key areas in which quantitative results from the R&D efforts will be needed as input to the stage-1 approval decision:

   a. Based on the beam test with 10 times higher laser power scheduled for March at RAL, quantify the intensity expected from the proposed cold muon source.
   b. Based on the design of the re-acceleration systems and the magnet design with its injection scheme, quantify the transverse and longitudinal phase space of the stored muon beam. The estimate should include a study of possible mixing of longitudinal and transverse momentum dispersion from the injection angle.
   c. Quantify electric and magnetic stray fields and their early-to-late stability from the detection systems in the muon storage area. The estimates should include the design of any electromagnetic shielding surrounding the detection systems. For example, the collaboration may consider measuring the magnetic stray fields from a detector prototype and its power lines in the 3T magnet at the National Institute for Radiological Science.

d. Evaluate the present "technical driven" schedule in view of the available resource and specify the resources needed to meet this technically driven schedule. The PAC anticipates that it will be of particular importance to evaluate the manpower needed to advance R&D on the several new experimental technologies.

6. **E18:** Coincidence Measurement of the Weak Decay of ${}^{12}_{\Lambda}C$ and the three-body weak interaction process

The PAC heard an updated report requesting stage-2 approval.

The aim of the experiment is a study of the non-mesonic weak decay (NMWD) in ${}^{12}_{\Lambda}C$, in particular to extract the two-nucleon induced non-mesonic weak decay (TN-NMWD) ΛNN-NNN by measuring the coincidence of three nucleons. The detector and run plan now look fine and, thus, the PAC recommends stage-2 approval. However, the PAC expresses some concern on the physics results. Even though a triple coincidence is detected, there is no clear way to separate TN-NMWD from a NMWD (ΛN-NN) with final state interactions (FSI). One will have to rely on the inter-nuclear cascade (INC) calculations or equivalent procedures, which may limit the precision that can be reached to that of the previous KEK-PS experiment. Meanwhile FINUDA showed a new result based on mass number dependence where TN-NMWD was derived in a way related directly to the experimental spectra. The PAC encourages the proponents to clarify the precision expected in extracting TN-NMWD signal including the INC calculation. The PAC also encourages efforts to tolerate higher beam intensity to reduce the precious beam time.

The PAC recommends that E18 be granted stage-2 approval.

7. **E11:** Tokai-to-Kamioka Long Baseline Neutrino Oscillation Experiment (The T2K experiment)

Over the past six months, the T2K experiment has moved into a full data-taking mode with the completion of the near detector and the increase of beam power to 115 kW. This is a great achievement for the Lab and collaboration and indicates that the experiment is now ready for significant physics running.

The Super-K detector has been running very well, taking data continuously with and without beam, and is operationally very stable. The completed near detector including the full ECAL system has taken data during the Nov.-Dec. 2010 running period and shows that the experimental resolutions and particle identification performance are as expected. Electrical upgrades also now allow running of the near detector with a 0.2 T magnetic field. The INGRID beam monitoring system has been enhanced with two off-diagonal and one proton modules. The measured muon neutrino rate in the near detector is close to expectation with a data to prediction ratio of 1.06 ± 0.06 and indicates a good understanding of the details of the neutrino beam. Initial publications on the detector and experiment performance from the spring 2010 run are expected in the next few months.

The main challenges now are associated with providing high-intensity beam to the experiment so that T2K can remain competitive with the other upcoming reactor- and accelerator-based neutrino oscillation experiments. The PAC was impressed with the work and plans being developed by the JPNC and high-power task force, and encourages continued efforts to improve the fast spill beam. The near-term goal, to reach 150 kW × 10^7 sec during the running period through June 2011, will keep T2K at the forefront in appearance sensitivity ($\sin^2 2\theta_{13} \approx 0.05$ @ 90% CL) with respect to Double Chooz, MINOS, and Opera/Icarus. This will require 6 months of 23 day per month running with 85% efficiency and with 150 kW fast spill operation. For the medium term, T2K will need to obtain on order 1000 kW × 10^7 sec by 2014 to stay competitive with the NOVA and Daya Bay experiments with the goal of reaching $\sin^2 2\theta_{13}$ near 0.01 @ 90% CL. In the longer term, T2K running with 500 kW has a similar oscillation event collection rate to the NOVA experiment so data taking at this level or higher will keep the J-PARC experiment at the forefront in the field.

These goals will require significant improvements in the fast spill rate and cycle time along with the allocation of 6 to 7 months of fast spill running per year. The PAC encourages the Lab to give these goals high priority for the next several years to give T2K the physics potential to make important discoveries.

8. **E14:** Proposal for $K_L \rightarrow \pi^0 \nu\bar{\nu}$ Experiment at J-PARC (The KOTO Experiment)

The CP violating decay $K_L \rightarrow \pi^0 \nu\bar{\nu}$ can measure the CKM parameter η with small theoretical uncertainty and is sensitive to new physics which could appear below the

so-called Grossman-Nir branching fraction limit of 1.4×10^{-9}. The aim of the KOTO experiment is to search for this decay mode with a single-event sensitivity corresponding to the standard model expectation which is about two orders below the Grossman-Nir limit.

The PAC is pleased to see substantial progress since the 10th PAC meeting and the autumn 2010 run. Most of the effort has focused on the CsI calorimeter: about 1800 blocks have been stacked and 1200 channels have been readout out of the total 2700 channels. The instrumented calorimeter channels have been individually calibrated with cosmic rays prior to the autumn run. Beam data was collected during the 2010 autumn run with a platinum target which generated samples of $K_L \rightarrow \pi e \nu$ (Ke3), $K_L \rightarrow \pi^0\pi^0\pi^0$, and π^0 decays from a secondary target that was located in the neutral beam line. Although much detailed analysis work remains to be done, the kaon yield has already been found to be consistent with the result of the previous beam survey which measured the K_L yield to be 2.3 times what was assumed in the proposal (with a nickel target), and the yield with a platinum target is twice that with a nickel target. In addition the photon and neutron content of the neutral beam was measured. The neutron content of the beam is consistent with expectations; the preliminary photon content of the beam is higher than expected and will be studied further.

The proponents plan to complete the stacking of the CsI calorimeter and finish installation of the DAQ and trigger by April 2011 when they request a run to study the full calorimeter in detail with high statistics samples of momentum analyzed Ke3 decays and $K_L \rightarrow \pi^0\pi^0\pi^0$ decays. Following this commissioning, the CsI calorimeter will be moved downstream to its nominal experiment position and the main barrel and all other counters will be installed. The proponents then request two engineering runs of 10 kW×2 weeks each from December 2011 to January 2012, a brief commissioning run at 10~20 kW in spring 2012, followed immediately by a physics production run of 10-30 kW×(~4 weeks) in order to reach the Grossman-Nir sensitivity limit before the onset of the linac upgrade shutdown. The PAC supports the proposed goals of the beam time requests. Even though the projected beam power given by the accelerator division is ~10 kW for the physics run, there should be enough safety margin to achieve the data collection goal since the K_L yield with a Pt target is found to be 4.6 times that assumed in the proposal.

The PAC is however concerned that the timeline for the detector assembly in 2011 is extremely tight. We note that the original plan described at the 10th PAC meeting was to have the entire array stacked (2700 crystals) and 1600 channels instrumented

(instead of the achieved 1800 stacked and 1200 instrumented) before the 2010 autumn run.

Completing the installation and instrumentation of the whole CsI system before the 2011 April run, which is the last chance to use Ke3 decays to calibrate the crystals, is a challenging and important goal. The PAC feels that calibration of the calorimeter with electrons will be critical for the eventual success of the experiment. In addition, assembling the rest of the detector in the following seven months is at least as challenging. The PAC, therefore, encourages the proponents to take all possible measures to remain on this aggressive schedule and encourages the laboratory to work closely with the proponents to realize this schedule.

9. **Muon Task Force Report and E21:** An Experimental Search for Lepton Flavour Violating mu-e Conversion (The COMET experiment)

The COMET experiment aims to improve the experimental sensitivity to detecting muon-to-electron conversion by four orders of magnitude beyond the current measured limit. Measurements at this sensitivity level would probe the region of branching fractions expected by many well-studied new physics models such as SUSY-GUT. As such, COMET could become one of the flagship experiments at J-PARC later in the decade.

The PAC was pleased to receive a report from the Muon Task Force (MTF) and the COMET collaboration on the following critical milestones: beam extinction studies, demonstrating the principle of a solenoid-based high intensity muon source, and radiation hardness tests of capture-solenoid conductor material. These will be discussed in turn.

The extraordinary beam extinction (fraction of residual protons between bunches incident on the muon production target) required by the experiment (1×10^{-9}) is one of the most important performance parameters and is critical to the eventual success of the experiment. The MTF presented extinction measurements of fast-extracted and slow-extracted beam from the Main Ring which are consistent and about $5x10^{-7}$ for 3 kW of extracted beam. Intriguing "Double Kick" studies were presented which have the potential to dramatically improve the extinction by another factor of 10^{-6}. While further tests closer to the nominal experiment beam power (~50kW) will be necessary, these studies together with the expected multiplicative extinction of external systems provide ample insurance that the required beam extinction can be

achieved. The PAC congratulates the MTF and the laboratory on this remarkable achievement, and support the T25 request for beam time in the April 2011 run for continued studies.

The reach of the COMET, PRISM, and Mu2e designs beyond the demonstrated SINDRUM-II experiment is based on the concept of a high power production target inside of a muon capture solenoid which will increase the muon-flux/proton-power by a factor of 1000 over SINDRUM-II. While this concept has been studied and simulated in detail for more than twenty years, the COMET collaboration has now begun to study the particle yield per proton of this technique with low power studies at the MuSIC facility in Osaka. This is an important development for COMET and the field broadly, and we encourage the MuSIC team to continue this work. We look forward to further composition studies of the particle yield.

In order for this now demonstrated technique to serve the COMET experiment the superconducting capture solenoid must withstand the radiation fluence of a 50kW proton beam striking the internal production target. There are published reports that the resistivity of superconductor matrix material (high purity aluminum) could be substantially degraded by the expected radiation dose. These reports further suggest that the matrix resistivity can be recovered with thermal cycling of the superconductor. The COMET collaboration reported on measurements of the aluminum-matrix resistivity growth in the presence of a large neutron fluence at the KUR research reactor, and demonstrated that low resistivity can be recovered by thermally cycling the conductor to room temperature. The resistivity growth studies suggest that at nominal neutron fluence, the capture solenoid will need to be temperature cycled at least once during production running, but probably not many times during the run. To provide a safety margin the design of the capture solenoid should include provisions for temperature-cycling the capture solenoid several times during the production run.

The PAC looks forward to receiving a Technical Design Report of COMET at the July 2011 meeting. This report should identify and address the critical technical milestones, experiment location issues, and provide a cost estimate. The July 2011 meeting will mark the beginning of the TDR review process, which will include FIFC review following the July 2011 meeting.

10. **E15:** A Search for deeply-bound kaonic nuclear states by in-flight ^{3}He(K^-, n) reaction

The E15 experiment aims to perform both invariant-mass and missing-mass spectroscopy of the K^-pp system. The existence of a K^-pp bound state has been widely discussed and its experimental confirmation will contribute significantly to the understanding of the $\overline{K}N$ interaction.

The E15 collaboration proposes a staging strategy to perform the experiment using the currently available beam since the originally requested beam of 1500 kW×week is unrealistic under the present beam conditions.

Motivated by a recent theoretical calculation of the K^-pp production spectra that suggests cross sections significantly higher than assumed in the original E15 proposal, the collaboration now proposes to carry out the first stage of the experiment using a beam of 30 kW×week.

It is not clear what fraction of the calculated cross section applies to the bound state since that depends on how bound and how broad it is. Nevertheless, the first stage experiment may have a chance to clarify whether the recently reported DISTO resonance is interpretable in terms of a K^-pp bound state. The collaboration also presented the Dalitz plot studies for the background from two nucleon reactions and final state interactions in comparison with an experimentally expected signal.

Even though the beam allocation will not be decided until there are further updates of the accelerator status, the PAC encourages the efforts to start the experiment earlier using this staging strategy.

11. **E17:** (Precision spectroscopy of Kaonic ^{3}He 3d→2p X-rays)

The PAC heard a status report of the E17 group on the operation of 8 silicon drift detectors (SDD) under beam condition and on the beam rate dependence of the yield and S/N ratio of calibration peaks. The energy resolution was confirmed to be 150 eV at 6.2 keV as expected for the iron K X-ray peak and the calibration peaks were shown to be controlled with good signal-to-noise value of about 3. They also reported that the liquid ^{3}He target system would be ready by the end of March 2011.

In addition, the E17 group reported new results for the 3d→2p X-ray energies from kaonic ^{3}He and ^{4}He by the SIDDHARTHA experiment. Although both reported energies are consistent with no shifts within the statistical and systematic

uncertainties (2-3 eV and 4 eV, respectively), a possible non-zero isotopic shift as large as 7 eV between the ^{4}He and ^{3}He was presented assuming a cancellation of the relative systematic uncertainties. The E17 group intends to study this isotopic shift by performing precise measurements at the 1.5 eV precision level using a 20kW×week run (8kW×week for ^{4}He) with a Pt target and better tuning of the beam.

The PAC recognizes the importance of high-precision measurements and endorses the 3-days beam tuning in April along their new running plan. Since the impact of E17 rests with the precision of the measurements, the PAC asks the E17 group to show quantitative evaluations of the systematic uncertainties of the isotopic shift at the next meeting.

12. **SKS experiments:**

The SKS collaboration reported the achieved performance of the K1.8 beam line during the 2010 autumn run and the beam assignment request for the SKS experiments.

Stable operation with 3kW of beam power was realized although the 16% duty factor limited the beam intensity for experimental use.

The electrostatic separator (ES) voltage was not optimized for kaon running, but the K^-/π^- ratio was experimentally measured with 1kW beam. Extrapolation of the ES voltage to the designed value predicts kaon purity of more than 1 kaon to other particles.

For 2011-spring slow extraction runs, the beam intensity is under the administrative control to be less than 5kW.

Assuming 1M particles/spill pion beam with a 20% duty factor, the beam allocation for the 22 days of the slow extraction would include E27, E19, resolution studies by ^{12}C(π,K) $^{12}_{\Lambda}$C reaction and K^- beam tuning.

E27 (A search for K^-pp bound state in the d(π^+,K^+)X reaction) is ready for beam, and proposed to measure d(π^+,K^+)X in the missing mass from 2.2 to 2.4 GeV/c^2 for 7 days to check feasibility of the 1 and 2 proton tagging technique. A few days of detector / trigger commission are necessary.

E19 (The pentaquark search) proposed to continue data taking as in the last autumn run but with higher momentum of 2.0 GeV/c. A few days of downtime will be

necessary to change targets and this time slot can be assigned to K1.8BR beam running. The PAC endorses the K1.8 beam plan for the 2011-spring slow extraction.

For the 2011 autumn/winter runs, the K1.8 beam allocation should be decided in conjunction with the plans for the K1.8BR and KOTO beams. For this period, E10, E13, E19 and E05 calibration runs are proposed assuming that 10kW of beam is available but the optimum SKS configuration differs for these experiments. It should be noted that a SKS configuration change will take about 2 months and, thus, the beam allocation should be done well before the beam time.

E10 (Study of neutron rich hypernuclei by double charge-exchange reactions) offers to run (π^-, K^+) experiment on a ^{6}Li or ^{9}Be targets to measure $^6_\Lambda$H or $^9_\Lambda$He, respectively. Establishing a particle-stable $^6_\Lambda$H could have great impact, but its existence is not unanimously agreed on by theorists. In contrast, the existence of a particle-stable $^9_\Lambda$He is rooted in more solid theoretical predictions. The PAC recommends that the collaboration choose carefully on which target to run the experiment in order to maximize the physics output with the limited beam foreseen to be available.

E13 (Gamma-ray spectroscopy of light hypernuclei) aims to study level spacings in the light hypernuclei by using gamma-ray spectroscopy in correlation with a produced meson. The $^4_\Lambda$He hypernucleus is one of the two key hypernuclei available to understand the charge symmetry breaking of the YN interaction. The E13 experiment can measure precisely the $^4_\Lambda$He level spacing to replace old data. Another hypernucleus $^{19}_\Lambda$F is proposed for the next run in order to provide a first precise measurement of the ΛN spin-spin interaction in *sd*-shell hypernuclei, following its determination in previous KEK and BNL experiments on lighter p-shell hypernuclei. These energy level measurements can be performed with 10kW beam for 2 weeks. The collaboration also proposed to measure, using an additional beam time of 10kW×2 weeks, the B(M1) (essentially the magnetic dipole transition rate) of $^{19}_\Lambda$F in order to study the in-medium *g*-factor of the Λ hyperon. Since the B(M1) measurement is not a part of the original E13 proposal, the collaboration is asked to provide a scientific justification for this measurement in sufficient time before the next PAC.

E05 (Spectroscopic study of Ξ$^-$ hypernucleus, $^{12}_\Xi$Be via the ^{12}C(K^-,K^+) reaction) proposes to check the resolution with the p(K^-,K^+)Ξ$^-$ reaction using a CH_2 target and several days of beam.

E19 (pentaquark search) needs more beam to reach the proposed 75nb/str sensitivity with three different momenta.

The actual beam time assignments for the 2011 autumn/winter slow-extraction period will be discussed at the next PAC meeting when an updated beam status will be available .

7. EVALUATION OF TEST EXPERIMENTS

K. Nishikawa reported on the status of the test beam experiments. No new proposals have been received since the previous PAC meeting. The T37 (Test of TOP counter for B-factory upgrade) program was withdrawn by the proponents. The T32 (Liquid argon TPC) and T38 (Proposal for Measuring Hadron Response at K1.1BR for KOTO Experiment) test experiments successfully took data. The T32 group plans to show the results at the next PAC meeting. The results of the T38 experiment are shown in the KOTO status report.

A proposal for the T39 (A study of water Cherenkov detectors for counting the number of neutrinos at the near detector hall of J-PARC neutrino beam-line) test experiment is in preparation with the close contact with the T2K group.

8. RECOMMENDATIONS FOR BEAM TIME ASSIGNMENT AND PLANNING FOR THE FUTURE

The PAC reiterates that the two issues with the highest priority are: 1) a timely delivery of neutrino beam at the highest intensity to the T2K experiment and 2) the commissioning of the slow extraction to improve the spill structure and beam rate.

The PAC endorses the plan for the slow-extraction beam time in April 2011. In the K1.8 line, a pilot run for E27 and the second run of the E19 with a 2GeV/c pion beam are scheduled. In addition, beam tuning for the E17 in the K1.8BR line and the beam extinction test led by the MTF group should be arranged. In the K0 beam line, the PAC strongly supports the calibration the CsI calorimeter by the KOTO experiment.

The overall plan for the period of October 2011 – June 2012, where 9 months of beam time has been allocated, will be discussed in the next PAC meeting. Considering the installation time for the KOTO detector, no slow extraction run is foreseen before December 2011. The experiments, which have requested to run in this period in the

K1.8 and K1.8BR lines are E17 and E19. There are also requests for pilot runs for E10, E13 and E15. The requests for beam time and the SKS spectrometer configuration during this period are in conflict. The PAC would therefore like to hear a proposed plan from the JPNC at the next meeting in addition to the presentations from the experimental groups.

9. DATE FOR THE NEXT J-PARC PAC MEETING

The date for the 12th meeting is 8-10 July 2011. The tentative date of the 13th meeting is 13-15 January 2012.
The tentative agenda is;

- Status report on J-PARC
- Discussion on the priority of K1.8/K1.8BR experiments
- Status Reports from the KOTO and T2K experiments
- Report from the MTF and COMET collaboration
- Report from the *g*-2 collaboration
- Report from the nEDM collaboration

10. FOR THIS MEETING, THE J-PARC PAC RECEIVED THE FOLLOWING DOCUMENTS:

- Minutes of the J-PARC PAC meeting held on 14-16, July 2010 (KEK/J-PARC-PAC 2010-10)
- Letter of Intent for J-PARC: Search for K^-pp Bound State by Stopped K^- Absorption Reaction on ^3He (KEK/J-PARC-PAC 2010-11)
- Experimental Proposal for J-PARC (P40): Measurement of the cross sections of Σp scatterings (KEK/J-PARC-PAC 2010-12)
- Experimental Proposal for J-PARC (P41): An Experimental Search for mu-e Conversion in Nuclear Field at Sensitivity of 10^{-14} with Pulsed Proton Beam from RCS (KEK/J-PARC-PAC 2010-13)
- A staging strategy of E15 experiment with 30 kWweek operation (KEK/J-PARC-PAC 2010-14)

- Realistic Plans to Carry Out the Approved Experiments at K1.8 Beam Line in the Coming Few Years (KEK/J-PARC-PAC 2010-15)

- Addendum to the Proposal for J-PARC (P36): Measurement of $\Gamma(K^+ \rightarrow e^+\nu)/\Gamma\ (K^+ \rightarrow \mu^+\nu)$ and Search for heavy sterile neutrinos using the TREK detector system (KEK/J-PARC-PAC 2010-16)

- Report on Technical Issues for J-PARC E18 Experiment (Revised Version for the two-step plan): Coincidence Measurement of the Weak Decay of ${}^{12}_{\Lambda}C$ and The Three-Body Weak Interaction Process. (KEK/J-PARC-PAC 2010-17)

- An Update Report on COMET (KEK/J-PARC-PAC 2010-18)

- Response to the PAC Comments and Updates on a New Measurement of the Muon Anomalous Magnetic Moment g−2 and Electric Dipole Moment at J-PARC (KEK/J-PARC-PAC 2010-19)