KEK/J-PARC-PAC 2010-10
July 18, 2010

J-PARC Program Advisory Committee

for the

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

Minutes of the 10th meeting held on
Friday, Saturday and Sunday, 16-18 July 2010

A VISIT TO THE J-PARC FACILITIES (16-July-2010)

OPEN SESSION (16,17-July-2010):

1. Welcome, Mandate of this meeting: K. Nishikawa (KEK)
2. J-PARC Accelerator Status and Commissioning Plan: T. Koseki (KEK)
3. Report from Muon Task Force/ E21(COMET) status: S. Mihara (KEK)
4. E11(T2K) Report : T. Kobayashi (KEK)
5. Beam line commissioning of K1.1BR: J. Imazato (KEK)
6. T32 (Liquid Argon detector) Status Report: A. Rubbia (ETH Zurich)
7. E19 Status Report （High-resolution Search for Θ^+ Pentaquark in $\pi^- p \rightarrow K^- X$ Reactions): M. Naruki (KEK)
8. E17 Status Report (Precision spectroscopy of Kaonic ^{3}He 3d→2p X-rays): T. Suzuki (Tokyo)
9. J-PARC Status: S. Nagamiya (J-PARC)
10. E27 Presentation (Search for a nuclear Kbar bound state $K^- pp$ in the $d(\pi^+,K^+)$ reaction): T. Nagae (Kyoto)

11. 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)

12. P33 Status Report (Measurement of Neutron Electric Dipole Moment): H.M. Shimizu (KEK)

13. P26 Presentation (Search for ω-meson nuclear bound states in the $\pi^{-}+{}^{A}Z \rightarrow n+{}^{(A-1)}{}_{\omega}(Z-1)$ reaction, and for ω mass modification in the in-medium $\omega \rightarrow \pi^{0}\gamma$ decay): K. Ozawa (Tokyo)

14. P02 Presentation (Study of Exotic Multiquark States with Λ-Hyperons and K_S^0 Meson systems at J-PARC): P. Aslanyan (JINR)

15. E14(KOTO) Status Report : T. Yamanaka (Osaka)

16. P29 Presentation (Search for ϕ-meson nuclear bound states in the $\bar{p} + {}^{A}Z \rightarrow \phi + {}^{(A-1)}{}_{\phi}(Z-1)$ reaction): H. Ohnishi (RIKEN)

17. 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(16,17,18-July-2010):

Present: A. Gal, 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 ninth J-PARC-PAC meeting (KEK/J-PARC-PAC 2009-18) were approved.

On behalf of the committee, the PAC chairperson expressed their thanks to the J-PARC staffs and experimental groups for their arrangement of the facility tour held in the morning on July 16th.

2. REPORT FROM THE IPNS DIRECTOR

K. Nishikawa reported the budget situation at KEK. In addition to what was shown at the previous PAC meeting, 0.6 billion yen has been allocated for the KEKB facility improvement. In June 2010, a new supplemental budget was given for the KEKB upgrade amounting to 10 billion yen in the 3 years starting from this fiscal year. This is a big step forward to the KEKB upgrade, whose total cost is estimated to be 35 billion yen.

The budget request for JFY2011 is being prepared and includes new requests related to J-PARC for the ultra slow muon beam line at the MLF, improvement of the MR, and the high momentum beam line in the hadron facility.

Since March, routine operation of the neutrino beam has started. The accumulated number of protons since January to May on the neutrino target was 2.34×10^{19}. Stable running with 50kW of MR power was achieved. For higher power operation, a heating problem of the kicker magnet was observed. The details of this problem are presented below in the accelerator report section.

In the hadron hall, the installation work for the K1.1BR line was started in March. With the D1 magnet of the K1.1BR line, the installation of the major components in the target station (T1) has now been completed.

Following the recommendation of the previous PAC meeting, the machine schedule in the fall was proposed by JPNC. Machine operation will start for slow extraction on October 12th. In the first 2 weeks until October 27th, the operation time will be shared by the accelerator study and experiments, probably 12 hours for each per day. After a short break, the experiments requiring slow extraction will be able to run for the period from November 4th to 15th. On November 16th, the beam will be switched to fast extracted neutrino beam at least until the end of December.

The following constraints are foreseen in the planning of the beam schedule for January through June 2011:

- In January, a government inspection will be made for the fast extraction, which means that the beam should be sent to the neutrino beam line in January.
- The maximum power that can be sent to the slow extracted beam is limited, under the present authorization from the government, to 5kW, at least until the end of March, and practically until the 2011 summer shutdown.
- Work on shielding materials near the slow extraction target area is foreseen for the summer shutdown of 2011. In order to keep radiation level low during this work, it

is preferable to stop the slow extracted beam operation before June or even better before May.

- If there is a power outage longer than a few days, the SKS magnet in the hadron hall needs to be warmed up and it then takes about one month to go back to normal operation. There will be a scheduled power outage in the first quarter of 2011 but the date is not yet fixed.

Considering these facts, the best time for a slow extracted beam period would be March but the decision, after reviewing the situation, can be made at the next PAC meeting scheduled in January 2011.

The PAC will consider all of these constraints for the future discussions on the beam time assignment.

3. REPORT ON THE J-PARC ACCELERATORS

T. Koseki reported on the status of the accelerators.

The RFQ in the LINAC has been working well after the improvements installed during the 2009 summer shutdown, mainly on the vacuum system. A new spare RFQ is ready but will not be installed before summer 2012 unless there is an emergency.

The rapid cycling synchrotron (RCS) has been running stably at 120kW of beam power. In December 2009, one hour of 300kW operation was demonstrated. An increase in beam losses was observed which was related to the beam stripping foil. During the summer shutdown of 2010, the foil will be replaced with a smaller one in order to improve the situation. At the same time, AC power supplies will be installed for the sextupole magnets, which enable chromatic corrections during acceleration.

In MLF, twelve neutron beam lines have been commissioned and are being used for experiments. The muon beam line recorded the world's strongest pulsed muon source even at the 120kW runs.

Stable Main Ring (MR) operation at ~50kW has also been demonstrated since April for fast extraction (FX) to the neutrino experiment. The repetition cycle time was 3.52 seconds.

In June the first trial of continuous FX operation at 100kW was performed. The beam loss was well localized at the collimator section and was typically 100~200W, well below the current collimator limit of 450 W. During the summer, additional shielding will be installed for the 3-50 BT collimators increasing the power loss capability to 2kW.

After 1~2 hours of continuous 65kW running, it was observed that the orbit of the extracted beam drifted horizontally about 1 mm at the graphite target for the neutrino beam. This was due to a change in permeability of the ferrite cores of the FX kicker magnet caused by heating from beam induced wake fields. The cores were in vacuum and no cooling circuit had been installed. Fortunately the kicker will be replaced this summer with a new one having a faster risetime. The temperature increase of the new magnet will be much reduced by introducing a damping resistor in the mid-point of the magnet coil and a water-cooled copper block near the core. The new magnet is estimated to survive up to 750kW operation.

The rise time of the new kicker has been measured to be 1 microsecond so that 8 bunch operation (instead of 6) can be used for the fall 2010 runs. With these improvements on the kicker and collimators, continuous run with more than 100kW are expected.

For slow extraction (SX), the improvement of the spill structure was studied in January and February. The duty cycle for a SX spill is defined as:

$$D \equiv \frac{\left(\int_0^T I dt \right)^2}{\int_0^T dt \int_0^T I^2 dt},$$

where D would be 1.0 if the current (*I*) is constant during the extraction time (from 0 to T).

Due to ripple in the power supplies of the MR magnets, the duty cycle was only 1% at the beginning of J-PARC operations. By installing a spill feedback system for the EQ and RQ magnets, which were reported in the previous PAC meeting, the duty factor was improved to ~6%. A further improvement was achieved in February up to an 11% duty factor, by shortening trim coils installed in all quadrupoles during the flat top. More improvement is expected from adding a transverse RF field at the extraction time and installing an active ripple cancellation system this summer. The target duty factor for the fall run is >15%.

The maximum beam power achieved so far for the SX was 2.6kW. The main obstacle to high power operation is control of the beam losses. The achieved maximum extraction efficiency so far was 98.5% where the loss was localized in the SX section during the flat top (i.e. extraction) period. The residual radiation level was surveyed after the February SX run which was 5 days of a few kW running followed by 3 days of a few tens of kW FX running. The level was measured 7 days after the SX run and one in the SX section was about 0.1 mSv/h. The present guideline on the maximum radiation level is 1mSv/h. This indicates that it is possible to run with 5kW operation in the fall run. A dynamic bump scheme will be tested in the fall run with hopes to improve the extraction efficiency further.

There is a concern related to the degradation of the RF cores in the RCS/MR cavities. The cores are made of Magnetic Alloy (MA). As reported in the past meetings, reduction of the impedance was observed in several cavities. In some of the RCS cores, cracks were observed which are probably caused by deformation due to thermal stress. The manufacturing process has been improved and new cores have been made without impregnation of epoxy resin. For the MR cores which have slits to control the impedance, oxidization of the cut surfaces of the slits might be the cause of the reduction. It was found that their impedance was recovered after atmospheric exposure. Polishing of the cut surface will also be routinely planned during shutdown periods. There was an indication that copper contamination in the cooling water might also degrade the impedance and further investigations are ongoing.

In summary, after the various improvements this summer, FX operation at more than 100kW is expected to be achieved. For the SX, 5kW operation with a duty factor better than 15% is the goal during this period.

For further upgrades of beam power there are two key issues: the installation of the 400 MeV linac and the reduction of the cycle time. The 400 MeV linac will be installed in the summer of 2012. A detailed schedule is under discussion but it is likely to take about 5 months for the installation with commissioning time to follow. Therefore, the beam time for experiments in 2012 may be very limited.

The PAC was very impressed with the improvements both in fast and slow extraction and congratulates the J-PARC accelerator crews and managements for the achievements. The PAC, however, is still concerned that the long term plan is not yet clear. This is especially true for slow extraction where the path to significantly increasing beam power has not yet been shown. It is essential for several experiments with high physics merit to have more than 100kW of SX beam power.

4. REPORT FROM THE J-PARC PROJECT DIRECTOR

The J-PARC Center Director S. Nagamiya presented the status of J-PARC.

The science output from the J-PARC facilities is flowering. On February 24th in 2010 the first neutrino events from J-PARC were observed in the Super-Kamiokande detector which is located 295 km from the J-PARC. By the middle of May, 22 events were recorded. Most of beam lines of the hadron hall are ready for the nuclear and particle physics experiments. A high intensity muon beam is operational in the MLF. In one of the neutron beam lines (4SEASON), the Multi-Ei method has been applied. By having a higher chopping frequency than the RCS frequency, scattering data of several different energies can be simultaneously collected. For example, measurements of the residual stress in super conducting cable have been measured with one of the neutron beams. This material (Nb_3Sn) will potentially be used for the ITER project. Also, the Ajinomoto Co., Inc. measured the structure of a glutamic acid. Study on the hydrogen storage in rare metals is started.

The first phase of the J-PARC construction project and budget was complete in 2008. Since then supplemental budgets have been obtained for neutron beam lines, the 400MeV linac and the 3-GeV linac for neutron beam lines.

For the next year operations budget, KEK and J-PARC will request 8-cycle operation funding for FY2011. In addition to the KEK requests which were described by the IPNS director, JAEA will request funding for additional neutron beam lines. From the same supplement budget as KEKB, JAEA has received 4.8 billion yen (1.2 billion yen for this year) primarily for the Linac and RCS upgrade toward 1MW operation. There is also a possibility to collaborate with RIKEN on the extension of the hadron facility.

The J-PARC Users Office is in operation and handling users, now are at the level of 100 persons a day. A new lodging facility is under construction and 50 rooms will be available by December 2010. A dining space inside the J-PARC will also be available from September 2010.

Another open house is planned for August 28, 2010 building on last year's very successful event where 4500 people visited.

5. PROPOSAL EVALUATIONS

1. **E27:** (Search for a nuclear Kbar bound state K^-pp in the $d(\pi^+,K^+)$ reaction)

   The experiment aims to produce the widely discussed K^-pp bound state by the $d(\pi^+,K^+)$ reaction. The scientific merit of this proposal had been acknowledged during the PAC08 deliberations which resulted in a stage-1 approval.

   The experiment proposes to suppress the background originating from quasi-free hyperon production by tagging the two protons (p>250MeV/c), one resulting from the decay of the K^-pp bound state into Λp and the other one from the subsequent weak decay $\Lambda \rightarrow p + \pi^-$.

Additional careful consideration is necessary for the analysis since the shape of the Λp invariant-mass spectrum may be modified by rescattering of hyperons produced quasi-freely, and by a density dependent variation of the $K^-pp \rightarrow \Lambda p$ branching rate over the spectrum.

Except for the range counters used for proton tagging, the basic setup is the same as E19 which is scheduled to run this coming year. The design of the range counters was finalized and funding for their construction is already secured.

Although the yield estimate might prove to be lower than cited in the proposal by roughly a factor 2-3, due to a lower trapping rate of Λ(1405) in the formation of the K^-pp bound state and to a lower branching rate of the non-mesonic decay $K^-pp \rightarrow \Lambda p$, the experiment is expected, within the requested running time, to shed light on the existence, binding energy and width of the K^-pp system. The PAC recognizes that the proponents are ready to carry out the experiment and recommends stage-2 approval for E27.

2. <u>**P02:** (Study of Exotic Multiquark States with Λ-Hyperons and K_S^0 Meson systems at J-PARC)</u>

The proposal aims to study exotic multiquark states by using a propane bubble chamber. The proponents also expressed an intention to have scientific collaboration with some other experiments at J-PARC.

On the other hand, none of the previous peak structures claimed by the proponents using an old bubble chamber are convincing at this time.

The PAC recognizes that the proposed improvement in the statistical significance by a factor of 3-4 will not give compelling results on the existence of these exotic states, and has a limited scientific merit.

The proposed digital bubble chamber technique does not have a relevant advantage over other tracking technologies in the J-PARC high-intensity environment. Therefore, the PAC recommends this proposal be rejected from further considerations.

3. <u>**P26:** (Search for ω-meson nuclear bound states in the $\pi^- + {}^AZ$ -> $n + {}^{(A-1)}_{\omega}(Z-1)$ reaction, and for ω mass modification in the in-medium ω -> $\pi^0\gamma$ decay)</u>

The PAC heard the updated P26 proposal. The experimental principle of the revised proposal can be summarized as the following physics issues which were stimulated by the comments raised at the 9th PAC meeting:

- Nuclear transparency ratio relating to ωN interaction in the nuclear medium via ω production cross sections as a function of the target mass
- Mass modification in the nuclear medium via invariant mass measurement
- Search of nuclear bound state of the ω meson via the missing mass spectra by detecting a neutron (both for singles and coincidence with the invariant mass)

The major revisions of the experiment are the trigger scheme to allow single measurements with high statistics and the configuration of the γ-ray detector to minimize bias in the invariant mass.

As previously stated, the PAC recognizes the importance of the physics goals and now considers the experimental methods as valid.

The PAC therefore recommends granting P26 stage-1 approval.

For stage-2 approval, the group will need to decide on the choice of the γ-ray detector and prepare a detailed experimental design that can realize the proposed measurement.

4. **P29:** (Search for ϕ-meson nuclear bound states in the $\bar{p} + {}^{A}Z \rightarrow \phi + {}^{(A-1)}_{\phi}(Z-1)$ reaction)

The proposed experiment will look for a bound state of ϕ meson in nuclei by using the anti-proton beam with the ($\bar{p}$, ϕ) reaction at around 1 GeV/c. The PAC recognized that the proposed experiment addresses an important issue related to the ϕ-N interaction. At this PAC meeting, there were presented good responses to the questions raised by the previous PAC.

The background simulation has been carefully performed, and it proved that the Λ tagging effectively suppresses the backgrounds. The newly proposed idea to start the experiment from a survey of the ($\bar{p}$, ϕ) reaction using a deuterium target is reasonable. With this progress, the PAC recommends this proposal to have a stage-1 approval.

The proponents propose to carry out the experiment in the K1.1 beamline. The PAC notes that the beam line still needs to be completed and that the experiment will require high beam power operation of more than 100 kW.

5. **P36: (**<u>Measurement of Γ(K→eν)/ Γ(K→μν) and Search for heavy sterile neutrinos using the TREK detector system)</u>

The P36 proponents are proposing the pursuit of two important measurements with an evolution of the KEK E246 apparatus in the K1.1-BR beam line as an intermediate research program prior to the TREK (E06) research program. This pursuit is in part motivated by an estimated P36 proton beam power requirement of 30 kW for 30-60 days, which is considerably lower than the required high power beam of ~300 kW for TREK.

The P36 proposed measurements are:

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

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

The R measurement and heavy neutrino search are sensitive to new physics beyond the Standard Model and have long been pursued in previous experiments. A new initiative in this mature field must demonstrate systematic uncertainty control and sensitivity beyond the state of the art. The measurement of R and the search for heavy sterile neutrinos are discussed below in turn.

The KLOE (Frascati) and NA62 (CERN) experiments have recently reported new precision measurements of R. The NA62 experiment leads the precision with $\delta R/R$ of 0.5%. The current NA62 measurement precision is dominated by statistics but there is a sizeable systematic component which has been carefully evaluated by the NA62 collaboration. The NA62 experiment projects a sensitivity in the near future of 0.3% where this technique will become systematics limited, which motivates consideration of other techniques to measure R. The PAC supports the eventual goal of another precision measurement of R at J-PARC and appreciates the P36 initial study of a new measurement concept. The P36 proponents have not yet demonstrated, however, that the measurement at J-PARC can be controlled to the 0.1% level, and the following concerns should be addressed for consideration of a stage-1 approval:

1) The proponents presented a table summarizing systematic studies at the 0.1% level but offered few details. Systematic control at this level is the core requirement for the experiment and each study needs to be presented in detail. Particular areas of concern include (but are not limited to):

   a) The degree of Ke2/Kμ2 cancellation in detector acceptance corrections, and how the data can be used to demonstrate that the residual acceptance correction is understood to the required level.

   b) Understanding of Ke2(γ) radiative effects and the migration of events between the radiative classes due to detector effects.

   c) The sensitivity of the measurement to rate effects (e.g. accidental vetoes, accidentals migrating events in radiative classes, accidentals corrupting reconstruction of tracks, etc.) that will be exacerbated by low instantaneous beam duty factor.

   d) How the data can be used to explicitly determine Particle-ID efficiencies.

2) The experiment requires very high performance particle ID that is proposed through Cerenkov and Time-Of-Flight tags. These system concepts must be further studied and prototypes built and tested to demonstrate that the required performance can be achieved.

3) In contrast to the NA62 in-flight experiment, the stopped K^+ technique proposed in P36 has the advantage that the incident K^+ momentum is well known. The stopped technique however has the disadvantage of the stopping material corrupting momentum measurements, corrupting photons in the radiative classes, or generating background through processes such as K^+ to K^0 charge exchange that has been observed in the BNL E787/E949 experiment. The proponents have yet to demonstrate that these target related corruptions are controlled to the 0.1% level.

In parallel with and following precision measurement of R, the proponents have proposed a search for heavy sterile neutrinos through the $K^+ \rightarrow \mu^+N$ process, where the signal would be an anomalous peak in the 2-body missing mass spectrum determined from the reconstructed muon momentum. The P36 proponents have investigated a novel technique of using the measured muon polarization to assist in controlling backgrounds in the 2-body missing mass distribution, principally from Kμ3 decays. Such a technique, if demonstrated viable, would be a very good use of the KEK E246 apparatus and contribute substantially to the preparation of the eventual TREK experiment.

The rejection power of the polarization technique depends, however, on the muon polarization in $K^+ \rightarrow \mu^+ X$, which is model dependent. The P36 proponents analyzed one model scenario where the heavy sterile neutrino is fully right-helicity from its V+A coupling and where the muon polarization is 100%. The degree of polarization will be degraded with increasing mass of N, and the (V+A) coupling is just one of many models. The heavy neutrino could for example arise through mixing with an initial standard model neutrino with (V－A) interactions. The P36 proponents should perform a more detailed analysis of the interpretation of signal and of the polarization rejection power with explicit consideration of the N-mass dilution and consideration of models other than direct (V+A) coupling.

The PAC is pleased that the TREK/P36 collaboration is considering a research program interim to the J-PARC high-power era, and is impressed with the physics goals of P36. The PAC will defer further consideration of P36 for stage-1 approval until the a more complete analysis of systematics in measuring R, and a more complete analysis of the polarization technique is presented.

6. **T32:** (Liquid Argon Detector Beam Test Experiment)

The T32 test experiment should demonstrate the properties of a liquid argon detector for the detection of long tracks up to 40 cm as well as for the particle identification.

The presentation showed good progress with the cryo-system for the 250 liter vessel prototype in the KEK laboratory. However, the oxygen purity is not yet at the level of 1 ppb needed for long electron lifetimes. A new type of readout is being constructed and will be installed in this prototype detector. It is important that the detector system be shown to be operational with cosmic-ray tracks before it is moved to J-PARC and this requirement should be monitored and overseen by the JPNC. In order to fit in with the schedule, the whole system must be installed at J-PARC well before the start of beam operation in mid-October. Thus, the timetable presented seems challenging but should be kept.

7. **P33:** (Measurement of Neutron Electric Dipole Moment)

A finite electric dipole moment (EDM) measured with respect to spin in general indicates violation of T since spin changes sign under T while the EDM does not. Through CPT invariance, T violation implies CP violation which may be a requirement to explain the matter-antimatter asymmetry of the present universe. The CKM mechanism of CP violation cannot account for the observed matter-antimatter asymmetry thus requiring some physics beyond the standard model. The current upper bound on neutron EDM, $d_n < 2.9\times10^{-26}$ e cm, already constrains some extensions of the standard model.

P33 proposes to probe neutron EDM with a sensitivity below 10^{-27} e cm using Ramsey's method of a separated oscillatory field acting on neutrons from an ultra-cold neutron (UCN) source constructed using the 400 MeV pulsed proton beam soon to be available at J-PARC. The experiment plans to achieve the sensitivity by realizing high neutron density in a relatively small storage cell with the intense UCN source and rebuncher and by improving magnetometry using Hg co-magnetometer and Rb NMOR.

R&D plans with the J-PARC/MLF neutron beam lines for material wall surface reflectivity, for demonstration of rebuncher optics, and for magnetometry have been reported. Most of them are already funded, and the results will be reported at the next PAC. The project, however, is still at an early stage and the effort on the R&D needs to be accelerated.

The proposed experiment would be one of the major efforts in this very active and competitive field.

This could be one of important physics measurements to be produced at J-PARC demonstrating its versatility. The competition, however, is stiff. For example, PSI is planning to reach 5×10^{-27} e cm in 2012 and 6×10^{-28} e cm in 2015, and SNS at Oak Ridge during an R&D phase is aiming at 10^{-28} e cm. The PAC strongly urges that the proponents work with laboratory management to develop a competitive, yet realistic, schedule with key R&D milestones laid out prior to any consideration of scientific approval.

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

The PAC heard a report from the J-PARC *g*-2/EDM collaboration.

There has been important progress on many fronts for the R&D activities: a study on a muonium production target at TRIUMF; laser system development at RIKEN which will be tested at RAL in March, 2011; R&D for precision field measurement using 3T MRI magnet; development of a realistic model of the solenoid; and a conceptual Silicon tracker design using Belle II DSSD sensors with SiLC frontend electronics; etc.

The J-PARC *g*-2/EDM experiment has the potential to achieve better sensitivity in measuring the muon EDM than the proposed FNAL experiment thanks to its ability to track all the electrons while the precision for the *g*-2 measurement is nearly identical with FNAL. In addition to the physics importance of determining the muon EDM, a precise EDM measurement would also help understand the *g*-2 anomaly by disentangling possible correlations between *g*-2 and EDM.

The committee strongly encourages the collaboration to continue their R&D efforts. A detailed schedule with a set of milestones should be prepared by the next PAC meeting for efficient and coordinated R&D and for future review by the PAC.

The PAC feels some concern about the plan for the proposed high intensity ultra cold muon source at the MLF muon facility. The upstream part of the beam line must be prepared before activation levels become very high. Recognizing the strong scientific merit of the proposed experiment, the committee considers that it might be appropriate to set up a forum between IMSS and IPNS to discuss issues concerning the implementation of these types of experiments at the MLF muon facility.

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

The T2K collaboration and J-PARC accelerator group have made excellent progress since the last PAC meeting. The far Super-K detector is fully operational and the collected neutrino beam data is being analyzed. The ND280 detector is almost complete and has been collecting neutrino data over the past several months. The fast extracted neutrino beam has been operating at ~50 kW since April providing an integrated T2K data sample of 15.5×10^7 kW sec. For this period, the beam as measured by the muon and INGRID monitors was very stable in position and the rate was consistent with expectations. During this data run, the Super-K detector observed 33 events, all within about 100 nsec of the J-PARC beam time and the

ND280 detector is also starting to show analysis plots. It is clear that the T2K experiment is now ready for an extended data run. The PAC congratulates the laboratory and the T2K collaboration for these impressive accomplishments.

During this summer, several improvements will be accomplished. A new fast extraction kicker is being installed and should improve the reliability for running. A new power supply for the horns is to arrive which will allow the horn focusing system to run at full current increasing the beam rate by 10-20%. A spare first horn has been delivered and a spare third horn will arrive in the next several months. The hot-horn handling system hardware will be available soon and the system is to be exercised at the end of the summer. The ND280 detector will be completed and fully ready for the next data run. The accelerator is also making improvements and expects to run with eight bunches at higher power during the next year.

It is now imperative that the T2K experiment collect a data sample of 100×10^7 kW sec over the next year running period. This will provide a first significant measurement of the θ_{13} mixing angle at the level $\sin^2 2\theta_{13} < 0.05$ allowing T2K to remain competitive with the Double Chooz reactor experiment that is to start running this fall. Reaching this integrated exposure is marginal with the current run plan and estimated beam power. It is, therefore, important that the accelerator group work towards raising the beam power and maximizing the fast extraction physics running periods.

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

Measurement of the CP violating decay $K_L \rightarrow \pi^0 \nu\bar{\nu}$ branching fraction can measure the CKM parameter η with small theoretical uncertainty and is sensitive to new physics which could appear below the Grossman-Nir 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 of magnitude below the Grossman-Nir limit.

At this review, the KOTO group reported the results of the beam surveys conducted from the end of 2009 to February 2010. The K_L yield measured by $\pi^+\pi^-\pi^0$ decays, a preliminary result of which had been reported at the previous PAC meeting, was found to be 2.3 times more than that used in the proposal. The core and halo neutron fluxes, however, were not shown since the response of the relevant counters has not been determined yet. The collaboration is thus proposing to test the response of these counters (Cerberus and NCC) to protons and pions using the K1.1BR test-beam line during the slow extraction run in 2010. The test will take two days including installation, and PAC supports this effort.

Good progress since the last PAC meeting was reported for the preparation of the KOTO detector. In particular, the 144 channel CsI module has been successfully tested using the electron beam at Tohoku University. Testing, gain-matching, and stacking of the actual CsI calorimeter is progressing well and scheduled to be completed by September 2010, followed by running in October and November to commission the fully stacked but partially instrumented CsI calorimeter. The collaboration is requesting one month of slow extraction running in March 2011 to fully commission the CsI calorimeter which will also support a more precise characterization of the neutral beam line. The PAC supports the goals and timing of the fall 2010 and spring 2011 running requests. All other detector components are planned to be installed starting April 2011 in preparation for the first physics run.

The collaboration has requested a beam time of 30kW×30days to reach the Grossman-Nir limit before the 2012 summer shutdown. The PAC supports this goal, and strongly urges the management to make efforts to improve the beam power as well as the duty factor in order to meet this request.

11. **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 4 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 flag-ship experiments at J-PARC later in the decade.

The committee was pleased to hear a summary of activities from the Muon Task Force (MTF) and the COMET collaboration and is particularly interested in preparations for tests of "beam extinction" at J-PARC and the radiation hardness of superconducting solenoids (to be performed at the Kyoto University Research reactor, KUR); both of these tests are to occur in the fall of 2010.

The extraordinary beam extinction (the fraction of residual protons between bunches incident on the detector) 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. At the 9th PAC meeting the MTF presented results of fast extracted bunch studies in the J-PARC MR that suggest that a beam extinction of $1x10^{-5}$ could be achieved internally with the accelerator complex. This level of internal extinction together with an external extinction system could plausibly provide the 1×10^{-9} aggregate extinction required. The COMET experiment is however driven with slow extracted (SX) beam, where the extinction between beam pulses could be corrupted by the SX process. The SX bunched extinction studies proposed for the October SX run will be critical in understanding the eventual beam extinction that can be achieved.

The radiation damage studies at KUR are important for the design of the production solenoid which must capture muons from the decay of pions produced from a high power target. The superconductor that composes the production solenoid must function near this high radiation field. There are published reports that the resistivity of superconductor matrix material (with 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 MTF is working with both the COMET and Fermilab Mu2e collaborations in the tests this fall to study the degree of damage and recovery through thermal cycling.

The PAC strongly supports these measurements and encourages the laboratory to support and facilitate these studies in the fall of 2010.

At the 11th PAC meeting in January 2011 the committee would like to see a review of the completion dates for critical milestones that have been identified by the COMET collaboration and the MTF. This review will be important to plan the schedule for submitting a Technical Design Report to the laboratory for consideration.

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

The E17 group reported its detector status and results of the beam survey performed in February 2010.

The beam line detectors and all 4 silicon drift detectors (SDDs) are ready. The energy resolution measured with Mn and Ti K-lines are 140 eV for the expected 6.2keV kaonic X-ray. Temperature dependence and incident-angle dependence were measured at a test bed to find an optimal condition. Pile-up effect was also investigated.

The heat-load of the SSDs on the ^{3}He target system has been improved and now is at an acceptable level. The final target system which uses beryllium foil will be available by the end of 2010 and ready for next year running.

An extensive beam tuning was performed in February. The maximum K^- yield at 700 MeV/c was found to be 1.8k particles/spill at 1 kW of MR power. Based on this, the required beam time was recalculated and found to be 10kW×week in order to achieve the precision of ΔE_{stat}=2eV with the nickel production target. The estimate is 3 times lower than what was shown in the previous meeting.

The group requested a beam time allocation during the Oct-Nov run for further beam commissioning and detector tuning.

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

The goal of the experiment is to search for Θ^+ pentaquark in $\pi^- p$ interactions using the SKS spectrometer. The required missing mass resolution measured from the incident pion and outgoing kaon is 2.5 MeV (FWHM). The first step is to confirm the pentaquark with a 10 sigma sensitivity at the optimum beam momentum (1.92GeV/c). The beam momentum dependence of the production cross section will be measured in later runs.

The SKS spectrometer with the E19 hydrogen target was operational in the spring run. The $\pi^- p \rightarrow K^+\Sigma^-$ reaction was successfully observed from the missing mass distribution. The resolution was ΔM=1.66 MeV (FWHM), which can be translated to ΔM = 1.8 MeV at the Θ^+ mass region.

In order to achieve the first step, the E19 group requested 6 days for data taking and 5 days for calibration, assuming the beam power and quality as it was in February, i.e. 750k pions per spill with 10% beam duty factor.

6. COMMISSIONING OF THE K1.1BR BEAM LINE

The PAC heard about the commissioning plan for the K1.1BR beam line. The vacuum vessel of the T1 target station (Pentagon) was open since spring and the installation of an inorganic and indirect water-cooled radiation hard magnet (D1) was almost completed. The magnet is the last missing component which should be in the vessel. Most of the downstream beam components are from KEK-PS beam lines. The electro-static separator from the KEK K5 beam line has insulating oil that is not radiation hard and, therefore, the present electro-static separator needs to be replaced with a radiation-hard one before high power operation.

The current beam line is longer and has a smaller bending angle than originally designed. Nevertheless, 1.0GeV/c K^+ yield is expected to be several $\times 10^5$ particles per spill at 5 kW MR operation when the platinum target is used.

The beam tuning will be performed during the October-November run by the TREK group with a close collaboration with the hadron beam group. MWPCs and scintillator hodoscopes are ready to use. For the particle identification a Fitch Cherenkov counter has been developed whose π/K mis-identification probability is below 10^{-4}, as well as a gas Cherenkov counter and TOF counters.

The beam line will be first tuned for 750-800 MeV/c beam and the K^+ intensity and K/π ratio will be measured for various settings. If time allows, tests with lower momentum will be tried. The beam tuning will start from October 12th.

The PAC took note of these plans and understood that the detailed schedule will be discussed and developed in the JPNC.

7. EVALUATION OF TEST EXPERIMENTS

The PAC chairperson K. Tokushuku reported on the handling of detector test proposals. Three new proposals were received since the last PAC meeting (P37, P38 and P39). A committee to evaluate test experiments has been formed and its first meeting was held on July 12th. The members are Katsuo Tokushuku (the PAC chairperson), Junji Haba (the FIFC chairperson), Takashi Kobayashi (the leader of the particle and nuclear physics division of J-PARC), and Masaharu Ieiri who is a member of the JPNC and a consultant for the capabilities and schedules of the hadron hall beam lines.

P37 is on the test of the time-of-propagation (TOP) counters which will be used in the Belle-II experiment. The beam test is needed to determine the final parameters of the detector, such as the thickness of the quartz radiator. After discussions with the proponents on the beam availability, the minimum request of the proponents is 2-day of 1 GeV pion beams.

P38 is a request to measure the hadron response of the calorimeter to be used by the KOTO experiment for the survey of the KL beam line, as reported in the KOTO status report.
During the fall 2010 run, the K1.1BR beam line is scheduled for initial beam tuning by the TREK group and for the running of the test experiment T32 of the liquid argon detector. On the other hand, the test experiment committee has judged that it is possible, although very tight in beam time and space, that both experiments, P37 and P38, be done in the October-November runs on the K1.1BR beam line and recommends that both be approved. The allocation of the beam time and the priority among the test experiments should be done by the JPNC.
P39 is a test of a water Cherenkov counter whose water tank is 1.6m long and 1.4m in diameter. The main interest is to investigate if the detector can work in the high-rate neutrino near-detector area. The proponents request to locate the detector on the B2 floor at a 2 degree off-axis position. Since the test does not require any beam time in the hadron hall, the test experiment committee thinks the decision for going ahead with this test experiment should be determined by the T2K experiment and Laboratory management. A similar decision was made by the PAC for the P35 proposal in the previous meeting.
The PAC discussed in these test experiments in closed session and endorses the test experiment committee's decisions.
The PAC also supports the beam extinction measurements (T32) with the bunched slow extraction, proposed by the MTF, to be done in the October-November run period.
The PAC was informed by the IPNS director on the decision for P35. (P35 is a test experiment which uses a tracking detector composed of interleaved layers of iron and scintillator bars in the ND280 hall in order to gather information for the on-axis neutrino flux and energy distribution.) In the previous meeting, the PAC judged the decision should be made by the T2K experiment and Laboratory management. It turned out that the detector will not be ready until the summer shutdown of 2011. After discussion with the proponents and T2K, it has been agreed that the detector can be installed during the summer shutdown in 2011 and the test can be performed, on the condition that the T2K group should be consulted before the results are shown in public. If the installation cannot be completed in the summer shutdown in 2011, the installation permission may be cancelled.

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.

Also, as stated previously, the PAC guidelines for beam running during the next year should consider the following:

- The overall priority should go to the T2K experiment to gather a data sample of 100×10^7 kW sec over the next year.
- During this period, slow extracted beam should be scheduled including a run in the month of October 2010 and another one-month run before June 2011. The detailed running scenario for spring 2011 should be decided after seeing the progress of the T2K experiment plus fast extraction and the status of the slow extracted beam and experiments.
- Efforts should be made to increase the physics beam time by optimizing machine study and maintenance periods during the run.

As for the experiments on the K1.8/K1.8BR lines, the PAC considers that the E19 experiment has priority in the October-November beam period. Since it is expected that the experiment will be able to finish its first phase in this running period, the priority should be reassessed at the next PAC meeting for the run in 2011 and beyond. The PAC would like that each of the experimental groups in the K1.8 and K1.8BR beam lines discuss the running plan beforehand and develop a proposal to be shown at the next PAC meeting.

In the longer term, the PAC considers that it is essential to set realistic milestones for the expected MW-levels for fast extraction and hundreds of kW levels for slow extraction. The PAC recommends that this work be done by the collaboration of the accelerator and experimental groups to optimize the physics priority in each period. The PAC would like to hear the progress on this exercise at the next meeting.

9. DATE FOR THE NEXT J-PARC PAC MEETING

The date for the 11th meeting is 14-16 January 2011. The tentative date of the 12th meeting is 8-10 July 2011.

The tentative agenda is;

- Status report on J-PARC
- Milestones and expectations for future high-power running
- Discussion on the priority of K1.8/K1.8BR experiments
- Status Report from the E19 experiment
- Status Reports from the KOTO and T2K experiments
- Report from the MTF and COMET collaboration on their milestones.
- 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 15-17, January 2010 (KEK/J-PARC-PAC 2009-18)

- Experimental Proposal for J-PARC (P02): The Study of Exotic Multiquark States with Λ-Hyperons and K^0_S-Mesons Systems at J-PARC (KEK/J-PARC-PAC 2010-1)

- Addendum to the proposal P29: Study of in medium mass modification for the ϕ meson using ϕ meson bound state in nucleus (KEK/J-PARC-PAC 2010-2)

- Status Report for Measurement of Neutron Electric Dipole Moment (J-PARC P33) (KEK/J-PARC-PAC 2010-3)

- Experimental 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 2010-4)

- Experimental Proposal for J-PARC (P37): Test of TOP counter for B-factory upgrade (KEK/J-PARC-PAC 2010-5)

- Experimental Proposal for J-PARC (P38): Proposal for Measuring Hadron Response at K1.1BR for KOTO Experiment (KEK/J-PARC-PAC 2010-6)

- The additional report for the proposal: P35 (KEK/J-PARC-PAC 2010-7)

- Updated Revised Proposal for J-PARC (P26): Direct measurements of ω mass modification in $A(\pi^-,n)\,\omega$ reaction and $\omega \to \pi^0\gamma$ decays (KEK/J-PARC-PAC 2010-8)

- Experimental Proposal for J-PARC (P37): A study of water Cherenkov detector for counting the number of neutrino at Near detector hall of J-PARC neutrino beam-line (KEK/J-PARC-PAC 2010-9)